



EXPERIENCE IN A BOOK

Help For The Jaguar XJ-S Owner

by

Kirby Palm

Updated: September 15, 2002



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by Kirby Palm

Compiled by an XJ-S owner, *Experience in a Book* is a unique type of automotive resource providing the sort of how-to information not found in either owner's handbooks or repair manuals. The information provided includes maintenance tips, common problems, suggested modifications, and some sources for parts. The book is not intended to replace a repair manual, but rather to complement it.

This is not a small pamphlet; the book is 690 pages when printed with a 10-point proportionally-spaced font, and includes quite a few illustrations and schematics. It grows as more information becomes available.

Experience in a Book may be downloaded, free of charge, from the World Wide Web at:

<http://www.jag-lovers.org/xj-s/book/>

Yes, you read right: This whole thing is *free*. If you have a computer, internet access, and a printer, all it costs you is the effort to log on and download plus the paper and ink to print. There are no catches; this is a hobby, not a profit-making enterprise.

This book -- along with a great deal of other Jaguar-related stuff -- is also available on the *Nine Lives* CD-ROM. There are links to online ordering from the URL provided above, or you can order it directly from:

Coltrane Productions
PO Box 932
Morgantown, WV 26507

The cost is \$2 plus shipping, and shipping is \$0.97 in the US, \$1.20 to Canada, \$1.66 to Mexico, or \$3.40 to the rest of the world.

Experience in a Book is a work in progress and is revised when new information becomes available. If you have learned something about your XJ-S that the rest of us should know, please visit:

<http://www.jag-lovers.org>

and log on to the xj-s@jag-lovers.org or v12-engine@jag-lovers.org e-mail discussion lists and post your discoveries there. Most of the contents of this book came from these discussions.

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The door locks are electric, so they are discussed under Electrical. However, the handles themselves are discussed under Body.

Cover design: Glen MacDonald

I live in the US. This book has been distributed worldwide, and upon rereading and editing I constantly notice comments I have made that have a distinctly US bias, like how such-and-such part can be found at the local Wal-Mart. I have made the decision that I will leave the book this way, rather than trying to qualify each of these instances for all the people in various parts of the globe. Those in other countries will know better than I how the advice given will apply in their area.

The XJ-S is sold in countries where they drive on the wrong side of the road, so there are left hand drive (LHD) and right hand drive (RHD) models. To minimize confusion, in this book the location of an item will nearly always be described as being on the left side or right side of the car -- meaning left or right as viewed sitting in the car facing forward. The terms "driver's side" or "passenger's side" will *only* be used to describe the location of items that *switch* sides between LHD and RHD models, such as steering column, pedals, glovebox, fuseboxes, etc.

Please note that I have made the decision *not* to cover the six-cylinder AJ6/AJ16 engines in this book in any detail (there are a few minor exceptions). Since it is the same engine that is in the XJ40/X300, it shouldn't be too much trouble to find information on this engine elsewhere. The parts of this book covering non-engine items should still be of some value to owners of AJ6/AJ16-powered XJ-S's.

I also make no effort to cover features unique to the XJ12. Owners of such cars would probably be well advised to acquire both this book and Jim Isbell's book on the XJ6 (see <http://www.jag-lovers.org>) and use the parts of each that apply. There will still be some shortcomings -- neither will properly cover the carburetor setup on the early XJ12, for example -- but the owner is still likely to benefit greatly from both books.

One final note: I only charge a small fee for printed or diskette copies of this booklet to cover costs of copying and postage; those who download it from the Internet get it for free, as do people who obtain copies from others or from their clubs. However, all this doesn't mean that I am adverse to donations! If you feel the book has been of some help, you are more than welcome to send whatever you feel is appropriate. If you send a donation, please clarify that it is a donation and not an order for a printed copy or a diskette or something.

DISCLAIMER

My own car is a 1983 XJ-S H.E.. Understandably, this book is likely to be more complete and accurate for similar vintage cars than for the early (B-W tranny, non-H.E.) cars or the newer (ABS, revised bodywork, 6.0 liter) cars. It also cannot be expected to accurately cover the differences of cars sold in countries other than the US.

While most of the information (both from my own experience and that sent in from others) has been verified on my car, obviously I cannot be responsible for the applicability to other XJ-S's. I am not associated with Jaguar, and have no means for verifying configurations of other cars. Therefore, the XJ-S owner should take advice accordingly and determine for himself if it applies to his car and will serve his purposes.

It should also be understood that an owner performing even minor work on his own car can affect his warranty. If there is any doubt whether or not the item in question is covered under warranty, the owner is advised to take it to his dealer prior to doing any work himself. If the owner is told by the dealer that the item is not covered, then the owner can make his own informed decision how to proceed.

Finally, an owner making changes to his car is responsible for making sure he is not violating emissions laws or safety or other regulations applicable where he lives and drives. There have been a few comments made in this book about regulations in various areas, but they are to be taken as general info, not legal advice.

IS THIS A REFERENCE BOOK?

Many XJ-S owners may consider this book reference material, and don't bother to look at it until they need to work on something or spend some money on the car. Unfortunately, sometimes the money spent could have been saved if they had read about how to avoid problems in the first place! And, yes, sometimes the money saved can amount to thousands of dollars; both the Lucas and later Marelli ignition systems have faults that can cost you an engine or even the entire car in *very* short order.

Hey, it's up to you; it's your car, your time, and your money. However, I highly recommend you *read* this book! Jaguars are not drive-it-and-forget-it cars; they demand a certain amount of awareness on the part of the owner, and reading this book cover-to-cover will go a long way toward making the owner aware of his car -- and possibly save him loads of \$\$\$ in the future, as well as making Jaguar ownership a more pleasant experience.

If you cannot be convinced, at a minimum *please* read about the following topics:

- Ordering manuals and catalogs starting on page 16.
- Hot shutdowns on page 33.
- Centrifugal advance mechanism seizure (pre-Marelli ignition) beginning on page 131.
- Reread the discussion of centrifugal advance mechanism seizure beginning on page 131.
- If you still haven't overhauled the distributor by this point, reread the discussion of centrifugal advance mechanism seizure again. In fact, keep rereading it until that distributor has been overhauled. Am I getting through yet?
- Relocation of ignition amp (pre-1983 models), page 142.
- Catalytic convertor meltdowns on page 154 (Marelli ignition cars; if you have a car with Marelli ignition, *do not fail to read this section!*).
- Shortcomings of the cooling system, including "How hot is too hot?", starting on page 168.
- Correcting a banjo bolt design defect in the air purge system on page 180.
- Advice on using cooling system sealers on page 181.
- Installing radiator hose filters, page 183.
- Fan cracking on page 204.
- Engine fires on page 220.
- Fuel sump pickup problems on page 234.
- Soft shifts on page 308.
- Replacing the steering rack bushings on page 348.
- ABS brake testing (on cars so equipped) on page 424.
- Radius arm mount rust problems on page 427.
- Brake fluid level switch problems on page 550.
- Saving the stereo from water damage on page 614.

THE JAGUAR XJ-S

WHAT'S IN A NAME?: First and foremost, it's high time to quit abusing the name "Jaguar". It does not rhyme with "quagmire"! According to Jim Isbell: "At a recent Jag Club meeting they showed a video of the history of Jaguar from the Swallow to the present. I was most interested to see how the owners and perpetrators of the Jaguar company pronounced it. There were several old voice interviews and I listened very carefully every time one of them spoke. The pronunciation I got from those interviews was: Jag-u-wer. I think the people who invented it must know how to pronounce it."

The name of the car that this book addresses is the "XJ-S" -- or, at least that *was* the name. Up until 1982 the dash actually had its own part number, since the four characters on the back end of the car were four separate pieces; through the rest of the 80's, the four characters on the back of the car were a single badge, but the hyphen was still apparent. Since the badge on the car itself has to be considered the ultimate authority, up until 1991 anyone referring to the car as an "XJS" was in error. This was a very common error, since XJ6 and XJ12 do not have dashes in the names and it was commonly assumed that this was normal Jaguar naming convention. Unfortunately for anyone trying to keep such things straight, even the folks at Jaguar were guilty of this error, as evidenced in several of their brochures and manuals.

According to Paul Skilleter's book "Jaguar XJS: A Collector's Guide", when the bodywork was revised for the 1991 model year the name of the car was officially changed to "XJS" to emphasize the change.

I will also mention what a "Daimler" is. Daimler was a distinct British automobile company that was bought out by Jaguar in 1960. However, Mr. Daimler also had a relationship with Mr. Benz at one time, leading to the German company Daimler-Benz, renamed DaimlerChrysler after merging with the US automaker in 1998. The Mercedes manufacturer registered the name Daimler in the US, so Jaguar cannot use the name in the US even though the former company by that name belongs to them. Daimler-Benz always called its cars Mercedes (after somebody's girlfriend many decades ago), so there are no cars known as Daimlers sold in the US.

While the British Daimlers were originally a distinct line of automobiles, eventually they became variations on Jaguars. Regarding the cars covered by this book, the Jaguar XJ12 was also sold as the Daimler Double Six in some countries, with detail differences including a distinctive fluted grille.

S TYPE: From "Great Marques - Jaguar" by Chris Harvey:

The S type saloon

There was a considerable demand for a more luxurious version of the compact saloon, and Lyons decided to combine the major improvements of the Mark X with the established features of the Mark 2, once the Daimler had been launched. The result was the Jaguar S type saloon introduced in 3.4-litre and 3.8 litre forms in September 1963. These cars were similar to the Mark 2 in most dimensions and running gear, except that they had the new independent rear suspension.

The S type (no hyphen) and most other lines of Jaguar saloon were discontinued when the XJ6 was introduced in 1968.

In a shameless attempt to capitalize on William Lyons' glory of years past, Ford/Jaguar introduced a new S-type (with hyphen) in 1998. David Berman says, "The S-TYPE is related to the Lincoln LS6/8. This is known as the DEW98 platform."

So why is all this discussion in a book on the XJ-S? Because some people insist on referring to the XJ-S as an "S-type". Makes sense; the rolling phallic symbol known as the E-type in Europe and elsewhere was marketed as the XKE or XK-E in the US, so it naturally follows that Jaguar's marketing department must be similarly misguided regarding the XJ-S. Connoisseurs of the E-type sometimes get huffy if you are so base as to refer to their cars as XKE's, so people may actually think they are using the more proper term for the XJ-S when they call it an S-type.

So, how common is this error? Believe it or not, it spread to the marketing department at Jaguar again! The 1981 XJ-S sales brochure said:

Jaguars have always been distinguished by a special grace of form and a rare poise in motion. Yet even among the legendary Jaguars of the past, this new S-type stands out. The XJ-S does what Jaguars have always done -- only better. It is quick and responsive, stable at speed, silent in motion and notably luxurious.

Despite the disinformation tactics of those goobers, it's really not proper to refer to an XJ-S as an S-type; the mid-60's car was an upscale compact saloon, and even the 1998 knockoff appears to follow along that same theme. The XJ-S is clearly in an entirely different class.

VIN NUMBER DECODING: There are two different VIN numbering schemes for the Jaguar XJ-S. All cars have a VIN number stamped into the sheet metal dead center in front of the hood seal, and this VIN corresponds to the scheme described below, based on input from Richard Mansell, William Noorloos, and Paul Skilleter's book.

Position 1-3 denotes manufacturer
SAJ = Jaguar

Position 4 denotes marque
J=Jaguar
D=Daimler

5th is model
N=XJ-S
S=XJR-S
T=Special edition

6th is class
A=baseline
J=Japan
K=Japan with airbag
L=Canada
M=Canada with airbag
V=USA spec with manual belts
W=USA spec with driver airbag
Y=USA spec with passive belts.

7th is body type
C=Cabriolet
D=Convertible
E=Coupe
F=2+2 Convertible

8th is engine type

B=3.6 4VB
C=3.6 4VC or 3.6 4Y
D=3.6 4VD or 4.0 4Y
E=3.6 4VE
K=5.3 F
S=6.0
V=5.3 A
W=5.3 B
X=5.3 C
Y=5.3 D
Z=5.3 E

9th is Transmission and steering

3=Auto RHD
4=Auto LHD
7=manual RHD
8=manual LHD

10th is model or year change

A=XJ-S original spec
B=HE coupe
C=AJ6 coupe and convertible
D=V12 convertible
E=facelift (1992-)

except for USA, Canada and Korea where from 1981 the 10th letter indicates year of build starting with B=1981

11th is emission control equipment

(up to 1987: manufacturing plant, C=Browns Lane)

12th-17th are the vehicle's unique number.

Andrew Stott says, "My car is UK spec, pre-HE, made in 1979, D-Jetronic. The VIN is JNAEW1AC101185. One confusing thing is that the character in the VIN that denotes the transmission and steering is a 'l' and according to the books it should be a '7' as it is a manual RHD car. In Skilleter's XJ-S Collectors Guide, he gives details of the last production XJ-S manual. It was made in 1979 and had a VIN of JNAEW1AC1018xx; this would suggest that the 'l' in the transmission character position is valid for a RHD manual car."

Now, if you have a US-spec car, there is a tag within the left edge of the windshield that carries a totally different VIN number. This VIN corresponds to the following scheme, from the "MOTOR import car crash estimating guide" for the US:

1st-3rd Position - Manufacturers Code
SAJ=Jaguar, United Kingdom

4th Position - Model Line

A=XJ6
A=Vanden Plas
C=Sovereign
F=XJ6
H=XJ6, Sovereign
K=Vanden Plas
M=Majestic
M=XJ12
N=XJ-S/XJSC
P=XJR/Sport
S=JagSport
T=Rouge/Classic

5th Position - Class/Restraint

A=Passive Seat Belt (87-89)
T=Driver Air Bag w/Passive belt
V=Active Seat Belt
W=Driver Air Bag (90-95)
X=Driver & Pass Airbag
Y=N. American Spec (83-87)
Y=Passive Seat Belt (89-93)

6th Position - Body Style

1=4 door sedan
2=2+2 Convertible
3=2 door Cabriolet
4=Convertible
5=2 door coupe

7th Position - Engine Code

0=5.3l 12 cyl, Calif.
1=4.0l 6 cyl, Supercharged
2=4.2l 6 cyl, Calif.
3=4.2l 6 cyl
3=6.0l
5=3.6l 6 cyl low compression
6=3.6l 6 cyl high compression
7=4.0l 6 cyl
8=5.3l 12 cyl
9=4.0l 6 cyl

8th Position - Transmission & Steering

4=Automatic (LHS)
8=Manual (LHS)

9th Position - Check Digit

10th Position - MODEL YEAR

D=1983

E=1984

F=1985

G=1986

H=1987

J=1988

K=1989

L=1990

M=1991

N=1992

P=1993

R=1994

S=1995

11th Position - Assembly Plant

C=Browns Lane, England

12th-17th Position - Production Sequence Number

Alex Dorne had a US-spec car shipped to Sweden, and reports that the process included removing the VIN tag at the left side of the windshield -- possibly to avoid confusion between this VIN and the one under the hood. He was allowed to keep the windshield tag. Also, the VIN under the hood also appears on the aluminum panel inside the trunk, just to the right of the latch. He postulates that this may have been stamped as part of the Swedish import procedures as well.

ACTIVE SEAT BELTS? They don't *look* very active. Peter Cohen clarifies: "It means that if you are not "active" and "actively" fasten your seat belt, it ain't gonna be fastened. As opposed to "Passive" seat belts that are motor mouse driven."

WHAT'S IN A YEAR?: Now that you have deciphered your VIN and know for sure what year your XJ-S is, do you really know what year your XJ-S is? If you live in the US, perhaps you've noticed that each model year seems to appear several months before the year itself, which certainly makes it doubtful that the car was actually *built* in the year it's purported to be. Apparently, the "model year" is a term that varies from country to country, and -- of course -- the US has the least rational definition. Peter Cohen says, "For those interested in trivia, here's how it works: In the US a given model year can only be manufactured to be offered for sale on a single January 1st. That's the only rule. This can result in the following (more or less true) example: A certain 1996 model of vehicle began manufacture in December 1994, was put on sale 2 January 1995 and continued to be sold as a 1996 model until September 1996 (although legally they could have been sold until 31 December 1996). This is not to say that one that remained unsold on 1 January 1997 would have become a 1997. It is the date that it is intended to be sold as a "current" model that the regulation applies to. So, that's what happens when marketing types run amok.

"I find it particularly galling when you go to buy a used car. You will be asked the same price for a 4 year old car as for a 5 year old car. You don't know what you are buying unless and until you remember to check the manufacture date, and even then it probably won't help your bargaining position.

"On US spec vehicles, the certification label should say something like "This vehicle meets all US specifications...in effect for model year 19xx." IMHO, that is what year a US spec car is, regardless of the manufacture date or what's on the title.

"When you get outside of the US, "year" becomes too simplified of a question. I don't think that non- North American spec cars come labelled with month/year of manufacture. In England, cars are referred to by their registration letter, which changes on 1 August each year. So a leftover model becomes next years' car by virtue of having the newer registration letter."

John Littler adds, “In Oz, date of manufacture is required on the ADR compliance plate. We have a nice simple system where a car made in ’88 is an ’88 model.”

Unfortunately, this MY hogwash can’t help but cause some inconsistencies in this book. For example, one person’s quote might describe a fix on his ’88 when somewhere else it’s made clear that the problem shouldn’t even exist past 1987. There is simply no way to correct such things in everyone’s direct quotes, although wherever possible attempts are made to clarify which configuration a quote is intended to reflect. In general, if this book states that something applied to a particular range of model years, please allow about one year of leeway before deciding whether or not it applies to your car.

XJ12 STYLES: For the benefit of those XJ12 owners who read this book, I am including some info on the various different cars that have all been called an XJ12. The following is courtesy of B.J. Kroppe: “XJ12s were made in Series III body style until 1992 (yes, alongside XJ40 6-cylinder models). XJ12s in XJ40 body style were made for one year. Whether it was only one-half of a year or a full year, it was 1994. XJ12s in X300 body style were made from 1995 - 1997, when the V12 engine was retired from production.

Series I XJ12 5.3l	1972 - 1974
Series II XJ12 5.3l	1974 - 1979
Series III XJ12 5.3l	1979 - 1992
XJ40 XJ12 6.0l	1993.25 - 1995
X300 XJ12 6.0l	1995 - 1997
XJ-S 6.0l	1993.5 - 1997

“Note there were no XJ40 5.3l cars produced.”

Steve Lipscombe explains why the Series III XJ12 continued long after the XJ40 was introduced: “The first XJ40 was certainly designed with a narrow engine bay to prevent the British Leyland management forcing the Rover V8 unit on them. Later, when privately owned, they redesigned the bay to take the V12. This was before the Ford takeover and the X300.”

CABRIOLET: David L. French, a US owner, describes the Cabriolet: “It has the body profile of the convertible that was made later but has a 3-piece removable hardtop. T-tops up front and a fully removable hardtop on the rear. Totally factory made.”

Since the Cabriolet lacks the buttresses of the coupe, it stands to reason that the body isn’t as stiff in that area. Jaguar apparently addressed that problem by adding “ladders” underneath the rear suspension. Julian Mullaney reports: “The ladder brace was fitted to Cabrios from the factory. Quite crude looking. You can easily spot it on a cabrio just looking from the side. I think it connects the chassis with steel bars fore and aft of the diff. It passes under the diff. The ladder frame does not connect to the subframe, it is definitely a chassis stiffener.”

The Cabriolet was apparently offered in 1986-87-88 model years. David King says, “There were at least 1900 Cabriolets shipped to the US and all were V12s even though it looks as if in the rest of the world the AJ6 was the more common engine for the Cabrio. There were a total of 5014 Cabriolets built during their production run: 5013 Jaguars and a one-off Daimler.”

HESS & EISENHARDT CONVERTIBLE: The XJ-S was designed in an era that never expected to see a convertible again; they were expected to be outlawed for safety reasons. For many years, the only way to get an XJ-S convertible was to hire one of many aftermarket customizing outfits to cut the roof off your coupe. By the mid-80’s the expected ban on convertibles had failed to materialize and convertibles were making a comeback, so Jaguar responded by contracting with Hess & Eisenhardt in Cincinnati, Ohio to make convertibles from coupes to be sold as new cars at the Jaguar dealerships. After two years, the response had been so good that Jaguar began making its own convertibles at the factory, and continued until the end of XJ-S production.

Mike Cogswell elaborates: "The H&E's were built in '87 and '88 (my '88 is one of the last, possibly *the* last). The H&E is easily spotted by:

1. The small oval Hess & Eisenhardt badge on each side behind the front wheel well.
2. The top folds down flat, the later factory convertible tops are pretty high when folded.
3. The H&E has four window rocker switches. Early ones are separate, later ones in a single gang of four.
4. The factory convertible has a small, ugly <grin> hump in the sheet metal on the side right behind the doors. This covers the tops of the rear quarter windows, which don't fully retract.

"There are many other differences, but those are some of the most obvious."

David Johnson adds, "The top also looks better than the regular convertible because it is fabric, not a plastic." This may be true for only *some* of the H&E tops, though. Another owner says, "I figure they had the tops made in California by Robbins."

Supposedly the building the H&E's were made in burned down, but H&E is still in business making limousines and other things.

Of course, the nickname H&E is only too likely to cause confusion with the H.E. used to describe the V12 engine with the Michael May-designed heads.

If you own an H&E or would like to know more about them, Johnson is the guy to talk to. He operates an e-mail discussion list dedicated to the H&E and serves as a clearinghouse for available information. His phone number is +1 303-708-1850, you can send him e-mail at david@davemjohnson.com, or you can visit his web site at

<http://www.davemjohnson.com/jaguar1/jaguar.htm>.

LISTER: Lister is the name of an outfit that became famous for building racing "specials" powered by Jaguar XK engines in the late 50's. Brian Lister withdrew from the racing scene in 1959 when one of his drivers was killed in a Formula 2 race, but the Lister name reappeared in the mid 80's in a modified form of the XJ-S. Peter Cohen describes a 1988 Lister XJ-S he looked at: "The car had a V12 with a 5 speed manual gearbox, as well as all trim in body color (no chrome, no stainless, no black rubber or vinyl), as well as suspension modifications. The car also has some "ground effects" type body cladding."

Brian Schreurs refers to a Road & Track article on the Lister: "It states that US versions got no engine upgrades, but outside-US versions were tweaked considerably. It received a 5-speed from Getrag, the same used in BMW's 7-series at that time, and also significant improvements to handling at no cost in ride."

Of course, when Jaguar started offering its own JaguarSport models, the market for such aftermarket modifications dropped. For the 90's, Lister was building a fire-breathing monster called the Storm powered by a highly souped up 7+ litre Jaguar V12, and was competing in the major endurance races against Vipers and the like.

TWR: Stands for Tom Walkinshaw Racing, an organization with considerable success racing Jaguars in Europe. Walkinshaw's team won the James Hardie 1000 in Australia (better known as the Bathurst 1000) in 1985 in an XJ-S, after an ignominious effort in 1984 in which the engine stalled on the starting grid and the car was creamed by a Camaro coming from behind.

TWR modified customers' XJ-S's for street use until the formation of JaguarSport -- see below.

1988 LE MANS: Jaguar won the 24 hours of Le Mans! Brian Schreurs says, "The original XJR-S of 1988 was considered the 'Le Mans Celebration' model. The first 100 were grey in color, had special badging, and a build number plate. Otherwise they were built to the same specs as any other XJR-S."

John Goodman elaborates: "Early '88, all tungsten grey, 15" speedline "bottletop" alloys and body spoiler kit, slight suspension upgrade. A limited edition to commemorate Le Mans races."

JAGUARSPORT: John Goodman: "It was set up in the late eighties, a joint venture between Jaguar and TWR Group, sadly disbanded in '93-'94, all the tech people now work for Aston Martin. Remember, in the late eighties Jaguar was on a high, winning race cars and everyone hyped up over the XJ220 (till they found out it had a poxy V6!). Obviously Jaguar wanted to promote their racing pedigree... Enter Tom Walkinshaw who had been modifying Jaguars to special order.

"Standard XJ-S's and XJ40's were taken from the Coventry production line and modified at the new JaguarSport plant in Bloxham (near Banbury in the Cotswold hills England). This is the same plant that assembled the XJ220 and race cars. This plant now makes the Aston Martin DB7.

"The very low volume production run of JaguarSport 6.0L engines were expensive to produce. Jaguar upped the cc of the last of the standard Jaguar XJ-S's and XJ12's with a different uprated 6.0L engine and 4 speed autos, this is reportedly *not* the same 6.0L as the JaguarSport unit; I do not know the difference, output is similar at 335 bhp, but retains Marelli ign.

"The JaguarSport XJ40's '88-'92 (both 3.6 and 4.0L models were made, no US versions) were more heavily modified, special cams and cyl heads."

Richard Mansell adds: "The first JaguarSport cars were modified at Kidlington, the home of the TWR Jaguar racing team. JaguarSport moved to Bloxham a year or two later. Cars to be modified were delivered there minus bumpers but trimmed to JaguarSport spec.

"Owners with standard cars could have them modified to JaguarSport spec under the FAB scheme (Fitted At Bloxham)."

Nathaniel Musselman says, "I tried to call JagSport in UK, but the number is answered as Aston Martin."

XJR-S: Richard Mansell: "Some of the many mods included on the original XJR-S's were: 11% stiffer front springs, 20% less compliant rear radius arm bushes, specially valved Bilstein shocks. They were shod with 15" x 7.5" Speedline wheels. Later on the wheels were widened by 0.5" and different tyres specified. Various suspension mods were made along the way too. The original paint colours available were - Signal Red, Regency Red, Black, Solent Blue, Silver Frost and Brooklands Green. The only other colour mentioned for the early cars is Tungsten Grey which was used on the first 100 XJR-S's sold as Le Mans specials.

"In theory a real XJR-S will have the letter S as the 6th character of the VIN."

John Goodman: "The Le Mans model changed or rebadged to the XJR-S in '88 until October '89 when the XJR-S was more heavily modified with uprated engine (6.0L), autobox, all new uprated suspension, and similar "bottletop" wheels but 8" wide and 16" diameter. Except for the spare which is still 15" with a temporary speed limited tyre!! Could be because the 245/55 tyres don't fit the wheel well in the trunk; more likely it is because the wheels have different offsets and different size tyres (225/50 front), so you would need *two* spares! Or risk mismatched wheels; at least with this it has a bright orange label on it clearly showing the speed restriction and a warning to change as soon as possible.

"Surprisingly there is no rear anti-roll bar fitted, do not know about the '92's. I do know that TWR spent a lot of time perfecting the setup for its intended market, i.e. it must retain its Jaguar qualities and handle better, it was never meant to be a track car. The Lister modified cars were more for the race track feel. Similarly the Sportspack equipped 3.6 manual was designed for another market, it had to *feel* like it was sporty even if the ride was uncharacteristic for a Jag.

"The XJR-S continued in the new body shape with even more revisions until the introduction of the last of the "standard" XJS's with the 6.0L/4 speed auto. A dark blue was introduced for the '92 cars and a nice metallic silver/pink, but you could probably have any Jaguar colour off the production line.

"The genuine JaguarSport XJR-S 6.0 may be identified by the red "JaguarSport V12" badge on the inlet manifolds at a quick glance. Officially these came out in Sept '89. I think all 6.0L engine numbers must start with 8W01***** (mine does anyway)

"The '88 XJR-S and Sept '88 limited edition Celebration model XJR-S were all standard 5.3. However, TWR converted a few cars to special order before it changed over to JaguarSport. Some were just cosmetic with standard engines and some had various engine mods up to 7.2L but the most common was 6.1L and apparently more V12 saloons were converted than XJ-S's.

"As TWR rebuilt customers' own cars/engines (not necessarily new ones either) then I would guess that the engine no. relates to the original 5.3 that the car started with. But, I believe there should be a bronze identification plate somewhere on the engine indicating a genuine TWR engine.

"Should you be lucky enough to actually have an early pre production XJR-S 6.0 it could be some sort of hybrid, may not have all the mods.

"First look in the boot, the ECU is very obviously different, for a start it's mounted on the left of the fuel tank. There are two injector power resistors on the L/H inner front wing instead of the usual one of the standard V12 and the air boxes are also totally different from the standard car, everything else looks the same.

"On the road they are magic! Not harsh, but very good handling. The GM 400 auto box has modified shift speeds and are quicker in changing, and less reluctant to kick-down into 1st. The steering racks have reduced assistance and appear to turn faster. The suspension/spring set up is unique to the 6.0L, not the same as the sport spec. option.

"The '92 cars had more power than the pre-facelifted version, went from 318 to 338 BHP with cat exhausts. The BHP increase is quite small but the engine has a lot more torque.

"US spec: Only 50 coupes and 50 convertibles imported '93 -'94, all were red or black.... So are very rare. Easily identified by special steering wheel and JaguarSport logo on the seat headrests. Special 6.0L engine (338 bhp) with Zytek ignition/injection and sequential injection, special reprogrammed GM400 shift speeds, special springs/ bilsteins (not the same as the sport spec option on the standard cars), 8" wide special alloys with different offsets for front and rear and an odd mix of rubber, 245/55 rear 225/50, front revalved power steering rack 30% stiffer, twin in tank fuel pumps. Also, revised more efficient electric cooling fan, revised ducted cold air intakes for the manifolds and a few other bits! It's not just plastic body mouldings and badges as you thought!!!

"You can order the XJR-S product support manual publication no S-80, unfortunately only available in the USA. Around \$25, but it looks like a dealer service manual.

"The only downside to these cars are the special ECU and distributor. Very expensive and the average Jag dealer knows little about them! They can be repaired however if sent to the Zytek factory here in the UK. All the other engine sensors are std. XJS. JaguarSport parts are easily available, I have had no difficulty."

"Any Jag dealer should be able to give you a print out of all the JaguarSport parts (a few hundred). Apart from the engines, revised GM400 shift settings, injection/ignition, suspension, bodykit and minor interior changes the rest of the parts are the same.

"JaguarSport has been disbanded, I have horrendous trouble trying to get technical information for my F.I. problem (minor problem). However, I have had no trouble in the availability of "JaguarSport" parts.

"US dealers did have, may still have, a technical help hotline to Jaguar UK for all XJR-S queries."

Goodman adds that "There are full parts lists for all JaguarSport bits on the XJR-S web pages."

<http://www.jag-lovers.org/xj-s/xjrs/index.htm>

SPORTSPACK: John Goodman: "The SportsPack has nothing to do with JaguarSport. In fact I believe it is standard on most of the 3.6L coupe XJ-S's (not sure on US cars) and an option on the V12 and 3.6 convertible. Jaguar assumed the 3.6 5 speed would appeal to the sporty driver! Basically it is harsher springs and dampers, rack bushes and a sporty

steering wheel; I think the cross spoke alloys with 235/60 tyres were part of the package at first but were later offered separately. Ride is quite knobbly; it does not include the re-valved steering rack of the XJR-S 6.0L, which has yet again different springs/ bilsteins (which also appears lower) and has a far smoother ride than a V12 with the SportsPack option.”

Richard Mansell: “It was introduced by Jaguar as standard on the 3.6 in Sep 1987 and comprised of 43% uprated front springs, 3% uprated rear springs, uprated Boge shocks all round, increased diameter front anti-roll bar, rear anti-roll bar re-introduced, reduced assistance power steering, stiffer rack bushes and Pirelli P600 235/60 VR tyres on the lattice wheels.

“The SportsPack, a variation of the one on the 3.6, was introduced on the V12 in Dec 1989. Judging by the parts manual the front suspension is different, I guess because of the extra weight of the V12. The rear springs and shocks are the same as the 3.6. The rear radius arm and anti roll bar is from the 3.6.

“The sports suspension became available in the US in Feb 1993.

“The later 5 volume workshop manual has a table of shift points for the standard gearbox and one for the SportsPack gearbox.”

“The twin coachlines along the side of the car were two tone as part of the SportsPack although from VIN 144700 (3.6) and VIN 148782 (V12) this became standard.

“The sports seats were originally only available as part of the SportsPack.”

1990 LE MANS: Jaguar won again! Mansell: “The second Le Mans Special Edition was introduced at the Birmingham (UK) Motor show in September 1990 to celebrate the TWR XJR-12 win. Based on a standard car, the 280 models built had quad headlights, 16" lattice wheels, sports suspension, full Autolux leather interior, high-contrast walnut veneer, a four spoke leather steering wheel and Wilton carpets. The stainless steel sill plates had a 'Le Mans V12' motif along with the limited edition serial number.

North America did not receive the Le Mans but had their own Classic Collection instead. Along with unique paint colours, magnolia leather with contrasting piping, leather gearshift knob, charcoal toned leather steering wheel they also had gold boot and bonnet badges.”

Goodman: “Just a standard XJ-S with SportsPack and spoilers.”

Brian Schreurs says, “There were 280 built for the world. No breakdown on Federal vs. ROW.”

1990 ROUGE EDITION: Brian Schreurs says, “It is a special trim package; no structural changes.”

CALIFORNIA, 1991: Peter Cohen says, “Here in California, there were no 1991 XJ-S’s. The dealers sold 1990 models all through 1991, until the 1992 model came out. I thought that was just the way it was until 1994 when I came across an actual 1991 Federal model. Now I realize that there are 1991 XJ-S’s all over, just not in California.”

INSIGNIA EDITION: Brian Schreurs says, “Insignia was a limited edition special order. The differences were:

- The wood veneer in any colour.
- The leather colour any which you wanted.
- Piping on the seats.
- Insignia Alloy wheels.
- Boot fabric was different, thick flannel.”

John Goodman adds, “Not sure about the numbers produced but certainly not more than 100-200, documented information is very scarce. Mechanically a standard XJS, but with the option at the time to choose a wide range of wild

pearlescent non-standard body colours and customised interior colours/fabrics, including I believe the option of different wood veneers or grey stained (like the XJ sports sedans). UK market had the quad headlights as well.

"Basically, whatever the customer wanted Jaguar would try to do it! Some colours were quite tame, some wild! All the mechanical bits are standard so no maintenance worries. May have the option of the sports suspension kit as well; depends, I think, on country."

Richard Mansell: "The Insignia options were available by special order from October 1992 and it basically allowed you to personalise your car with a range of different finishes. The Jaguar sales catalogue from around that period says:

"Like all Jaguars, the latest XJ-S models provide a comprehensive wealth of equipment and appointments as part of their standard specification; there is no question of providing just a basic car and then charging extra for virtually every desirable refinement. As a result, the list of items shown here as being optional at extra cost is quite small. Nevertheless, there is one important development which must be mentioned. This is 'Insignia', a service carried out by the craftsman of Jaguar Special Vehicle Operations. Under this service they offer:

Stunning, exclusive paint colours

Soft, semi-aniline all-leather interiors, uniquely styled and trimmed in a range of special colours

A choice of natural or tinted wood veneers to compliment and enhance the chosen paint and trim colours"

Mansell mentions that Jaguar Special Vehicle Operations "built the Daimler DS420 Limousine and other specials."

WEIRD CONVERSIONS: Lots of Jaguars end up converted or modified, especially in the early years when convertibles weren't available from the factory. If you have something you can't identify, Peter Cohen suggests: "The answer should lie on your doorpost. US federal law requires that a company that modifies a vehicle (such as a motorhome or convertible conversion) affix a label to the vehicle that says something to the effect of:

"Modified by: _____ Date: _____

This vehicle conforms to all applicable motor vehicle safety standards in effect on date of manufacture shown above"

or something like that.

"This should tell you who did the conversion, and, if you are lucky, it will tell you where they are located."

PRODUCTION NUMBERS: John Ratcliff provided these numbers from "a 60-page supplement to the June 95 edition of Classic and Sports Car, called '60 Years of Jaguar - A Celebration'."

XJ12	1972-73	3228
XJ12 SII	1973-79	16,010
XJ Coupe (5.3)	1975-77	1855
XJ-S	1975-81	14,890
XJ12 SIII	1979-92	15,918
XJ-S H.E.	1981-91	46,895
XJ-S Cabriolet	1983-88	1143 (3.6) 3864 (5.3)
XJ-S 3.6 coupe	1983-91	9979
XJ-S V12 convertible	1987-91	12,771
XJR-S	1988-93	n/a
XJS (4.0, 5.3, 6.0)	1991-	n/a
V12 saloon (XJ40)	1993-94	n/a
XJ6/XJ12 (facelift)	1994-	n/a

HORSEPOWER: Brian Schreurs: "According to my library, these are the various horsepower/torque ratings:

British-spec pre-HE 5.3L V12: 285@5500/294@3500
Federal-spec pre-HE 5.3L V12: 244@5250/269@4500

British-spec 5.3L V12 HE: 299@5500/318@3000
Federal-spec 5.3L V12 HE: 262@5000/290@3000

British-spec 3.6L 6-cyl: 225@5300/240@4000

British-spec AJ6 4.0L 6-cl: 223@4750/277@3650 (to summer 1994)
Federal-spec AJ6 4.0L 6-cyl: 219@4750/273@3650 (to summer 1994)

British-spec AJ16 4.0L 6-cyl: 241@4700/282@4000 (to present)
Federal-spec AJ16 4.0L 6-cyl: 237@4700/282@4000 (to present)

(no difference in market noted) 6.0L V12: 308@5350/355@2850

SHOPPING FOR A USED XJ-S

If you are considering the purchase of a used XJ-S, there is one very important thing to do: Insist upon having a compression check performed -- by an independent mechanic, if possible. On a V12, one or two bad cylinders can easily go unnoticed on a test drive if you aren't familiar with how the Jaguar should drive.

If any cylinders read lower than the rest by more than 10% or so, be aware that an engine overhaul will cost thousands. You will probably decide to pass on the car unless it is really cheap and you plan on engine work anyway.

Note that it is unusually difficult to pull the spark plugs on this car, so a compression check will involve a couple hours labor on the part of your mechanic. Money well spent.

One other noteworthy comment regards mileage. If properly maintained, the Jaguar can easily pass 200,000 miles before any major renovation is needed. So, the prospective Jaguar buyer would be well advised to pay a little less attention to what the odometer says and a little more attention to the completeness of the maintenance records.

As far as everything else on the car is concerned, it's pretty much the same as buying any other car. Bodywork and repainting are always expensive, and are more so on a Jaguar. Rust is always a call for concern. Apparent bodge or slipshod repairs are signs of trouble.

If you're really a careful shopper, read this entire book first. It will give you a really good idea what pitfalls to look for in a used car.

Don Marlin notes that you can check out the Kelley Blue Book WWW page at:

<http://www.kbb.com/>

Or, of course, you could actually buy a Kelley Blue Book. There is another similar product by the National Automobile Dealers Association (NADA). Both come in both a consumer and a dealer version.

Mike Wilson adds another source of value estimation:

CPI Value Guide
P.O. Box 3190
Laurel, MD. 20709
1-800-972-5312

RELIABILITY CONCERNS: Is the Jaguar XJ-S a reliable automobile? I think that, based on a review of any of the available statistics, the short answer would have to be no. However, the real reasons for the poor reliability record are probably not those commonly offered. It's not really the fact that the engine has 12 cylinders, although this does affect the cost of repairs.

There are really two basic reasons for the poor reliability record. The first is that there were a few minor glitches in the design of particular components, which is not all that unusual in automobile design, but while most automakers try to correct such problems in a timely manner Jaguar apparently allowed many of these problems go unaddressed for *decades*. This is arguably because Jaguar was suffering management problems as well as financial problems for a considerable portion of the production life of this car.

The second reason is a long and shameful history of consistently incompetent service from Jaguar dealers, specialists, and everyone else offering to work on these cars. Obviously, when a common problem becomes apparent in the design of a car, competent service providers would determine the corrective action necessary and offer such repairs to owners. But, as noted in many places in this book, service providers have not helped and have even exacerbated many problems, and apparently continue to do so to this day!

Fortunately, the problems of the design of the XJ-S are all minor and easily corrected, which can render the car very reliable indeed. When looking for a used car, make sure to select one that hasn't already been seriously damaged by

poor maintenance (notably overheating), and then promptly read the page titled "IS THIS A REFERENCE BOOK?" at the front and check through all the items listed. Be sure to actually take the corrective actions recommended; don't just read about them!

Some prospective owners are reportedly even scared off by the size of this book! As the author I'm clearly biased, but I'd suggest that anyone who spent more than ten years compiling information on a Chevrolet Camaro or Ford Mustang or any other model that's been offered for more than 20 years would end up with a book at least as hefty as this one!

DURABILITY: Durability is really a different concept than reliability. Reliability is all about a car's tendency to quit and leave you stranded or cost you money, while durability is about how long you can drive the car before it's worn slap out and needs to be completely renovated or replaced. The two concepts are often confused, and in fact are somewhat related; as individual components wear out and break down, they render the car unreliable. But when talking about true durability, the Jaguar XJ-S is a standout among automobiles. One being worn to the point of requiring renovation is almost unheard of. If the car has the problems noted in this book addressed and the owner replaces items such as rubber seals, belts and hoses, and normal wear items on a timely basis, the Jaguar XJ-S could easily be considered a car to last a lifetime. There may be a few other cars with comparable durability, but one that's this much fun to drive is truly rare!

The one notable exception to the car's durability is probably the original paint. The paint used up until at least the mid-80's was lousy, usually fading, crazing, and otherwise looking really terrible. If such a car hasn't been repainted already, purchasers should probably budget about \$3000 for a complete strip and repaint as part of bringing such a car up to acceptable condition. The 90's cars supposedly used better paint.

GENERAL

GETTING SERVICE: Keeping your Jaguar in good working order is like anything else: If you want it done right, do it yourself. Doing as much of your own maintenance as possible is *highly* recommended, based on experiences shared on the online discussion lists (many of which are related in this book). You might be thinking, “Yeah, but wouldn’t I be better off hiring somebody with a lot of experience working on these cars?” The answer: You’re holding all the experience you’re ever likely to need. That’s why the book was so named.

Nevertheless, there will be owners who don’t want to get dirty, or don’t have the time, or don’t have the tools, or don’t have a garage, or for whatever other reason would simply prefer to pay someone else to work on their car than do it themselves. There’s nothing wrong with such a strategy; it simply must be made clear that such a decision should *not* be made with the expectation that the car will get *better* service. More convenient, maybe; quicker, quite possibly. But a long history of experiences with Jaguar dealers, specialists, mechanics, and the like indicate that the XJ-S owner should expect *more* problems if he takes his car somewhere for service than if he maintains it himself using this book as a guide.

That said, some guidelines on finding a good mechanic: First, note that the XJ-S has been out of production for some time now, and Jaguar dealerships are not likely to be all that enthused about working on it. Some dealers might be lucky to even have a mechanic on staff that was there when these cars were built, and all the newer mechanics will have been trained on the current models rather than the older models. When you pull into a dealer for service, don’t be surprised if the only enthusiasm displayed towards you and your car comes from a salesman anxious to talk you into trading in that old pile of junk on a brand new whatever.

With a car such as the Jaguar XJ-S, you will invariably be far better off finding an “enthusiast” -- a guy who loves these cars and loves to work on them. Even if he works in a dilapidated shack, you’re likely to be much happier with his work than you would taking the car to a shiny dealership that doesn’t care about your car.

Of course, enthusiasts can be hard to find. One excellent idea would be to ask other Jaguar owners who they take their cars to. If there is a Jaguar club in the area, ask them. Finally, if there simply are no enthusiasts in your area, consider finding out where the nearest one is anyway; even if you don’t take your car that far away for oil changes and the like, there may come a day when you need someone to call who can really help.

Striking out totally in the enthusiast search, your next best option would be to simply find a good independent mechanic. If he’s willing to tackle a Jaguar, he will probably be capable of fixing most of the problems likely to crop up; it’s not *that* different from other cars. If you do a little reading in this book before you go, quite likely the two of you can get started in the right direction towards getting your problems sorted.

I’d like to suggest that you simply make a copy of this book and give it to your mechanic to help him work on your car, but experience shows that this doesn’t work very well. Many mechanics seem to consider it an insult that you would suggest that he needs help from a book. Others apparently can’t read. And almost none of them are inclined to put that kind of time into learning about Jaguars, especially since they have never seen a book like this one and are unaware anything of the sort exists. So, perhaps you might offer a copy, or perhaps just discuss your car with him and if he asks how come you know so much you can tell him about it. If you happen to find a mechanic who expresses an interest in the book, I’d suggest you have a keeper; if he actually reads a significant portion of it, he *will* be the best mechanic you’re likely to find.

Meanwhile, if *you* will read this book, you will find yourself far better able to judge whether or not a mechanic is up to snuff on the Jaguar XJ-S. You will become an informed consumer.

PARTS REPLACEMENT STRATEGIES: For those obsessed with keeping their cars in original condition, obviously only original parts will do. The suggestions throughout this book are for those who simply want their cars to run and to minimize cost and grief in the process.

Experienced British car enthusiasts will agree that most of their reliability problems come from two sources: Non-metallic parts and Lucas electrics. This is especially true for Jaguars, where the rest of the car is generally excellent.

Rumors abound as to why the rubber and plastic parts on British cars tend to crap out so soon. One rumor says there is a law in Britain requiring the use of natural rubber rather than the far superior synthetic elastomers. Whatever the cause, the Jaguar owner is well advised to replace the original Jaguar seals, hoses, belts, etc., with non-British substitutes whenever feasible.

It has been suggested that the various vinyl and rubber protectants on the market, such as STP Son Of A Gun, can be used to help many rubber components last longer. Sandy Gibbs: "When I owned a TR8 I had many of the same problems regarding engine heat and rubber components. I found Armor All and Son of a Gun were useless unless applied every three or four days (if you drive the car much). What did work was brake fluid, of all things. You have to soak the part in question pretty well then rub the fluid in. Let the part dry before running the car. This procedure may have to be repeated two or three days in a row but then the rubber is revitalized, after that one need only repeat the procedure every two or three months. The key here is keeping the brake fluid off anything but the rubber part. This process works on nearly any rubber part except, for some reason, tires."

Lucas has been called the "Father of Darkness". Contrary to popular opinion, Lucas did not invent darkness -- they merely perfected it to a fine art! The owner is well advised to replace Lucas electrical components with alternative products when feasible. It should be noted that many of the electrical parts on a Jag are not really Lucas; the "Jaguar" stereo is probably made in Japan, and many of the EFI components are Bosch relabelled as Lucas.

Other than electrical and non-metallic parts, Jaguar components are typically excellent, and most are reasonably priced. Whether it is better to replace a broken item with the Jaguar original or a substitute must be decided on an individual basis. A good general rule is: If the original failed of its own accord, it might be better to try another source. But if the failure was secondary (due to something else failing first), the Jaguar parts may very well be the best there are; substitutions are in order only where the prices of the originals are unreasonable.

Regarding rebuilt parts, Randy Wilson says, "There are many companies out there that rebuild to a price, replacing only the "common" failure part. Their attitude is it's cheaper to only replace the one part and let the consumer figure out which units need more work than it is to full rebuild and test every unit. This is true with electrical, a/c, steering gear, and other things. The real sad part is these unscrupulous clowns often drive the reputable rebuilders out of the market by the price difference. Rebuilds are a pain. The cheap ones are no bargain. And just buying an expensive one is no guarantee. It may be a thorough rebuild, or it may be a cheap one that your vendor is making a killing on."

REPAIR MANUALS: For a listing of sources for manuals, see "PUBLICATIONS AND PERIODICALS" starting on page 672.

As mentioned on the flyer page, this book is *not* intended to substitute for a proper repair manual; you will need to buy one if you intend to do any work on the car. In general, there appear to be three to choose from: an *XJ-S Repair Operation Manual* from Jaguar intended for owners, a set of *XJ-S Service Manuals* from Jaguar intended for dealers and authorized mechanics, and a Haynes manual. The Jaguar publications come in several varieties for different model years, while the Haynes has been published in only one version.

The *XJ-S Repair Operation Manual* (commonly referred to as "the ROM"), is expensive (around \$100) and mediocre; not only is it somewhat difficult to follow, it is also fraught with errors. Nevertheless, it's still probably the best choice here.

From the introduction of the XJ-S until 1982, Jaguar offered a basic ROM, part no. AKM 3455, ©1975. This edition does not cover the GM400 automatic transmission.

With the introduction of the H.E. in 1982, Jaguar issued an addendum titled *Jaguar XJ-S H.E. - Supplement to the Repair Operation Manual*, part no. AKM 3455/S1, ©1982, commonly known as "the H.E. Supplement". They also issued an updated edition of the ROM, AKM 3455 Ed 3 "incorporating H.E. Supplement", ©1982. Understandably, the H.E. Supplement included in Ed 3 is identical to the Supplement available as a separately bound volume. Ed 3 does cover the GM400 automatic transmission, though.

In 1984 part no. AKM 3455 Ed 4 was issued; this apparently represents the last correction and update to the ROM itself, even though rather than incorporate the H.E. data into the main part of the manual it continued to feature an H.E. supplement. From 1984 on, the ROM was updated solely by the addition of supplements; "Ed 4" comes with Supplement A only, "Ed 4/2" (©1989) comes with Supplements A & B, and "Ed 4/3" (©1995) comes with Supplements A, B, and C:

A	1979 - 1984	H.E.
B	1984 - 1988 1/2	Lucas 'P', cabriolet from VIN 112586, 30 pages
C	1988 1/2 - on	6.0 litre, 4-speed A/T, ABS, new body, convertible, 168 pages

Physically, the ©1975 ROM and ©1982 Supplement came as separate softcover books with off-white covers, while in the Ed 3 and Ed 4 versions Jaguar incorporated the manual and supplements into a single binding. John M. Smith has the Ed 4 printing, and somehow got a hardbound copy: "Pre-H.E. sections in white pages. H.E. supplement at rear in green pages." Steve Draper reports on his Ed 4/2: "It is a single softbound volume." Chris Carley got the Ed 4/3, "One book soft bound in Jag green. Each supplement has black edge at the beginning page with heading so you can flick through & see it."

Supplement A in the Ed 4 books is apparently quite similar to the ©1982 separately-bound H.E. Supplement, even though the ©1982 Supplement is 63 pages while Supplement A is 74 pages. The pages must be counted by hand since neither of these supplements have sequentially numbered pages. This book contains many references to the ©1982 Supplement, since the author owns a copy; readers should generally presume that the references apply equally well to Supplement A.

Unfortunately, when you actually try to buy a repair manual, you not only may have trouble telling which version you're getting -- you may have trouble telling if it's a ROM! For some reason, many booksellers have an aversion to actually listing the title as clearly printed on the front of the book. Rather than offering an *XJ-S Repair Operation Manual*, they will call it an "Official Shop Manual", "Official Jaguar Repair Manual", or whatever other name they can dream up to confuse the customer. In general, if the price is in the \$80-\$120 range, you can assume it's the *XJ-S Repair Operation Manual*, but it never hurts to ask to make sure before shelling out the cash.

Also note: With some bookstores, if you tell them what year car you have, you may get only what they think you need; this author has an '83, and ended up with the ©1975 edition ROM and the ©1982 Supplement. While this may be considered acceptable, a later ROM is always better since they still contain the earlier info; the Ed 4 is clearly an improvement over the ©1975 ROM even if you own a mid-70's XJ-S simply due to the corrections incorporated. And there is always the possibility that you may decide to upgrade some part of your car with the parts from a later car. Just about the only reason to accept an earlier ROM is if you find a clearance price.

Note that if you have the GM400 transmission, you will want to insist upon the Ed 3 or Ed 4 edition; the ©1975 ROM covers only the Borg-Warner, and the ©1982 Supplement doesn't help. The Ed 4 edition covers the GM400 quite thoroughly, as described by Patrick MacNamara: "My ROM AKM 3455 Ed 4 has an extensive chapter on removal, fault finding and overhaul for the GM 400. It also contains everything on the BW except removal. Interestingly, the table of contents lists both transmissions and all related chapters as the same for both (ie 44.00.00 is data and description for the GM, while 44.00.00 is hydraulic flow charts for the BW). You just have to make sure you are looking at the correct chapter 44 in the text as there are two."

If you happen to get stuck with the ©1975 ROM and wish to work on your GM400 automatic transmission, your best bet would be to get a separate repair manual for the tranny. Andrew Kalman suggests *How To Work With And Modify The Turbo Hydra-matic 400 Transmission* by Ron Sessions, Motorbooks International, 1987, 224 pages, 300 illustrations. Kalman says: "It seems quite complete, with a historical overview, basic maintenance, operation, overhaul, modifications and speed tuning." Of course, you will still lack instructions on how to remove and reinstall the GM400 in an XJ-S, but you can pretty much make that up as you go along (with help from the transmission mount info starting on page 314 in this book) -- or you could just buy a Haynes manual, described below. The Sessions book plus the Haynes manual will still be cheaper than buying another ROM to get the GM400 info.

Your second repair manual option is to purchase the *XJ-S Service Manuals*, which come as sets of several volumes each. If you thought the *Repair Operation Manual* was expensive, the series of *XJ-S Service Manuals* ought to be good for a major coronary: Several hundred bucks a set. On top of that, you may end up having to buy more sets than you

anticipated; while the later edition ROM's contain all the info on earlier cars, the multi-volume Service Manuals do not. Richard Mansell: "Now that I have the manuals in my hot little hands it appears to be more complicated than I thought. The pre-H.E. to 87-88 manuals (JJM 10 04 06) appear to be based around the pre-H.E. with extra sections to cover the differences between these and the H.E. (pretty logical so far). The new manuals, up to 91, (JJM 10 04 06-20) come in 5 volumes rather than the earlier 4 but only appear to cover the additions since the earlier manuals for the 5.3 plus a random selection of the original information. Oh, and it covers the 4.0 engine too. In other words, if you have an '89 to '91 5.3 and you want to know about the new ignition, etc., you will need both sets as the later volume set refers to many sections that only exist in the earlier set; e.g. under the heading "Cylinder heads overhaul" it says:

Remove left and right hand cylinder heads, see 12.29.01.

Where is 12.29.01? Only in the earlier set! Since the five-volume set costs more than the earlier one, I assumed it would be a complete guide to the later cars. Wrong!

"The only thing of great value in the five-volume set that is not in the four is the Marelli ignition.

"Each set comprise of hardback green ring bound folders with a white growler and the words Service Manual on the front. The copyright of the first manual is 1988. JJM 10 04 06-20 has the copyright date of 1991.

"I understand that there are add-ons, JJM 10 04 06-201 and 202 that cover models '92 to '96. 6.0L engine plus other changes." The H. D. Rogers web site (page 662) confirms this, and reiterates that these later manuals are not stand-alone either -- if you have a '92-on car you will need *all* of these sets to cover it.

Robert Woodling says, "I have purchased both the factory four-volume set and the *Repair Operation Manual*. The four-volume set in some instances provides better detail while the ROM provides a better step-by-step approach."

Before buying the multi-volume Service Manuals, you might want to consider the CD-ROM mentioned below. In fact, you might have to; Keith Lumsdaine says, "As of December 2000, the official Jaguar Workshop Manual part number JJM 100406 20 for the 1991-on cars is no longer available, as Jaguar have now [Feb 2001] issued it with the Supplements JJM100406 201 & JJM 100406 202 in CD-ROM form."

The only XJ-S repair manual made by anyone other than Jaguar is a Haynes manual, *Jaguar XJ12 & XJS*. This was manual #478 in Haynes' old numbering scheme, and is #49015 in their new numbering scheme -- but it's the same book either way. It's a *lot* cheaper than the Jaguar publications (under \$20), cheap enough you might as well pick one up even if you plan on buying the Jaguar books anyway. It's based on portions of the factory manuals with some photos of a teardown of a Daimler Double Six added. This repair manual is referred to simply as "the Haynes manual" throughout this book.

Classic Motorbooks catalogs list a Haynes manual titled *Jaguar 12-Cylinder 1972-85*, but this is actually the same book -- Classic Motorbooks simply cannot bring themselves to list the correct title.

The Haynes manual benefits from some recall and technical bulletin info that does *not* appear in the Jaguar manuals. It includes some basic procedures for the GM400 automatic, including a removal/reinstallation procedure, but no overhaul info. It only covers up to 1985, so owners of later cars will not get any info on the ABS brakes, Marelli ignition, etc., and would therefore be better advised to get the *Repair Operation Manual* with suitable supplements.

Gross errors in the ROM as well as the Haynes are addressed in this book, since the author owns both books; it is suggested that owners mark all corrections in their manuals as they read about them.

REPAIR MANUALS -- 6-CYLINDER XJ-S'S: The *Jaguar XJ-S Repair Operation Manual*, AKM 3455, does not cover the 6-cylinder engines at all, nor their respective transmissions. Gerda Kennedy of Bookspeed (page 673) says, "There is a separate manual for the XJS 6-cylinder 3.6 and 4.0" and that Bookspeed can provide it. The part number is AKM 9063. Unfortunately, Walter Petermann counters: "I picked up the AKM 9063. It only covers the 3.6. Copyright date is 83." That explains that; 1983 is when the AJ6 engine was *introduced*, so obviously the book won't contain the 4.0 AJ16 engine or even the EFI system that was introduced in 1988 with the XJ40.

Petermann goes on to describe the publication: "There's 9 'booklets', about 30-45 pages each. The complete manual is AKM 9063, but each book has its own number e.g. AKM 9063/1..2 etc.

Book 1: intro, general specs, engine tuning data, jacking, lubricants, maintenance, service tools.
Book 2: Engine
Book 3: emission control, fuel system, cooling system, manifold & exhaust
Book 4: Clutch, manual gearbox
Book 5: Propellor (?), final drive
Book 6: Steering, front suspension, rear suspension, brakes, wheels & tires
Book 7: Body
Book 8: Air conditioning
Book 9: windscreen wipers & washers, electrical, instruments

"The AKM 9063 is now discontinued."

Note that AKM 9063 *does* cover the 8CU electronic fuel injection system used on the early AJ6, which never appeared in any other Jaguar and therefore may be a bit difficult to get info on elsewhere.

Even if you have a later 6-cylinder car, buying AKM 9063 might still make more sense than buying a V12 ROM. Perhaps you might choose to buy AKM 9063 along with another book -- such as an XJ40 (1988-94 XJ6) manual -- that covers the later engine configurations (the XJ40 and the '88-on 6-cyl XJ-S have the same engine and transmission). XK's Unlimited (page 647) offers a book called the *Jaguar XJ6 Workshop Manual -- Owners Edition*: "Covers 1988 to 1994, 180 pages. This is an "Owners Edition" manual, meaning it is a boiled-down version of the full factory manuals and covers the maintenance and repair projects most likely to be tackled by an owner." The good news is that it's only about forty bucks. A Haynes manual might also be a consideration; see below.

There apparently is a later Jaguar publication that covers the 6-cylinder XJ-S. XK's Unlimited offers a book titled *XJ-S 3.6/XJ-SC 3.6/XJ-S 4.0 Service Manual*, number 11-0252D (which may be an XK's number rather than a Jaguar number). It's priced at a little over \$100, indicating it may be the equivalent of a ROM.

If you're interested in the multi-volume *XJ-S Service Manuals* described above, Richard Mansell indicates that they *do* cover the 6-cylinder engines.

If you have a 6-cylinder XJ-S, the Haynes manual #478/49015 will be no help with the engine or transmission at all. However, you could opt to buy the Haynes #478/49015 to cover the rest of the car *and* Haynes manual #49011, *Jaguar XJ6 1988 thru 1994: Automotive Repair Manual*, ©1997 (thanks to Loudon Seth for this info) for information on the engine and transmission, as well as the later IRS with outboard brakes. Or, you could supplement the Haynes #478/49015 with the *Jaguar XJ6 Workshop Manual -- Owners Edition* described above. Either combination of two books should cover most of what you need to know, with the notable exception of the 8CU EFI system used on the 1983-87 3.6 cars.

REPAIR OPERATION MANUALS -- XJ12, DAIMLER DOUBLE SIX: This book is on the XJ-S, but I'll be a nice guy and list what little I know about *Repair Operation Manuals* for saloons as well. John Littler reports that for Series I/II cars, Jaguar issued one manual for the XJ12 and another for the XJ6, but starting with the Series III they issued a single manual to cover both.

Regarding the S I/II manual, Littler says, "*Jaguar XJ12, Daimler Double Six, Repair Operations Manual*. Publication Part No. E190/4. Copyright 1979. Covers Series 1 and 2 (of which the only significant difference are carbs vs. EFI and the swap to GM400 halfway through the S2 model run - not the start contrary to common belief.)"

"*Series 3 Service Manual* - 3 items listed on first page:

Service Manual complete, AKM 9006 Edition 2
Service Manual Book 14, AKM 9006/15 Ed. 2
Service Manual Binder, AKM 9006/B Ed.2

"Copyright 1985. Covers both XJ6 and XJ12 series 3; the XJ12 has both H.E. and Pre-H.E. sections although they aren't particularly differentiated. The S3 manual I have doesn't seem to cover the late XJ12 S3's (1987-92). It covers P and D Jetronic but there's no mention made about the later ECUs."

ADDING YOUR OWN BINDER: If you get a softbound ROM -- or any other manual from Jaguar or the UK in general -- and decide to tear it apart, holepunch it, and put it in a 3-ring binder, you will find that it is a metric sized book and won't fit in a US-standard 8½" x 11" binder. If you're in Europe that's no problem, but here in the US you may find it a bit of a challenge. Better office supply stores sell metric "A" size binders, but you'll also need to get the proper 4-hole punch.

Another option is to drop into a Wal-Mart and buy a photo album intended for the Kodak Advanced Photo System; these albums are quite a bit larger than standard notebooks yet retain the standard 3-hole pattern. Having a 3-hole punch with an adjustable paper stop is a plus, so you can adjust the stop to center the holes on the longer pages. Just throw the photo sleeves out, although the section dividers are nice, you'll wanna keep them to separate the manual from the supplements and the like. These photo albums have the added benefit that they are really nice quality; this author even found one with a dark green, gold, and black cover that looks like it could have come from Jaguar.

PRIMERS: If you are new to automotive tinkering, you should buy one of the many books on the market explaining general procedures for car repair. While this book is written to be as clear as possible, it is not intended as a primer and no efforts are made to explain standard auto repair procedures. For example, this book may describe in great detail how a particular electrical component has a history of shorting out at a particular spot, but it will not provide any instructions on how to use a VOM to track down a short. Quite the contrary, the reader is expected to know how to do things like track down a short, so problems that are easily isolated and corrected may not even be mentioned.

PARTS BOOKS: Jaguar also makes parts books. Many owners suggest these books are *more* helpful to the mechanic than the repair manual; they contain exploded views of just about everything which are often easier to understand than the step-by-step text in the ROM or Service Manual. And it helps to know the part number of what you need when placing a parts order by phone, since the names of Jaguar parts are often confusing and mercurial.

Stephen Wood describes the parts book for the early XJ-S: "*Jaguar Parts Manual*, RTC-9109-B, for the XJ-S, 1976 to 1982, pre-H.E. cars."

This author owns the one for the next generation: "*Jaguar Parts Catalogue, XJ-S H.E. and XJ-S V12*", RTC9888CE, August 1987. Note that the title might be misleading; this parts book does *not* cover the pre-H.E. cars. The title probably reflects the fact that the H.E. badge on the car was replaced with a V12 badge starting with VIN 125020 even though otherwise it's still the same car with the same engine. This book covers models from the introduction of the H.E. engine through the mid-1980's -- which should be kept in mind when using it, remembering that "up to" really means "from the introduction of the H.E. up to" and "from" really means "from this point until 1987."

Richard Mansell reports on the next edition after that: "...the Jan '87 to late-'89 parts book (RTC9900CA). IMHO¹ this is laid out a lot better than the earlier parts manuals as it has a description for each item on the same page as the pretty picture. If you have an '87 to '89 3.6 or 5.3 XJ-S this guide is well worth getting, especially to aid reassembly." He has a point about the layout since RTC9888CE has no descriptions at all on the page with the illustration but rather has the descriptions listed in the back under the part number.

JAGUAR BOOKS ON CD: The Jaguar Daimler Heritage Trust (page 640) offers several of the repair manuals and parts catalogues described above on CD-ROM. Compared to the paper publications, these CD's are dirt cheap: £12.77 + 17.5% VAT (£15 even) each plus £2.50 shipping, which adds up to about \$25 each or so. If you're outside Europe you're not supposed to have to pay VAT but they charge it anyway and so far nobody has called them on it. Tony Bailey says, "e-mail Julia Simpson at the JDHT on <jsimps16@jaguar.com> with credit card number and other details. If you are worried about the security of using plaintext e-mail, Julia's telephone number is +44 (0)24 76 202141, and her fax number is +44 (0)24 76 405581." Of course, you could always write a letter.

¹ IMHO is an Internet abbreviation for "in my humble opinion".

There are two CD-ROM's of interest to the Jaguar XJ-S owner. The first is titled *XJ-S to 1987 - Original edition Service & Parts catalogues*, part number JHM 1114. This disc contains:

JJM 10 04 06	Service Manual (4-volume)	1988
AKM 3455	Repair Operation Manual (Ed 3 with H.E. Supplement)	1982
RTC 9109B	XJ-S Parts Catalogue	January 1977
RTC 9889CA	XJ-S 3.6 Parts Catalogue	November 1985
RTC 9888CE	XJ-S H.E. Parts Catalogue	August 1987

Plus some photos, a JDHT brochure, etc. The Ed 3 ROM included doesn't cover 83-on cars, but hopefully the Service Manual will cover most anything in the pre-88 cars that isn't in the Ed 3 ROM.

The other CD-ROM is *XJS post 1987 - Workshop Service Manual*, part number JHM 1127. This disc contains:

JJM 10 04 06/20	Service Manual (5-volume)	March 1991
Amendment No. 1		August 1993
Appendix 1		August 1993
Appendix 2		January 1995

Amendment No. 1 was originally issued as four packages of pages; you're supposed to whip out your Volumes 1 through 4, pull out old pages and replace them with new pages. Of course, you can't do that when all the pages are on a CD-ROM. Good luck keeping this straight when looking things up. Printing out the tables of contents might help.

Apparently if you want a parts book for a 90's car, you're SOL.

There is a third CD-ROM that might interest some readers: JHM 1122 covers the SIII XJ12.

Now the bad news: these CD-ROM's are formatted using a software package called ScanFile, which is unsearchable. Really, it's only presenting scans of the paper; it doesn't recognize the data on it and therefore cannot sort or search it. The only way to find anything is basically the same way you'd find it in the paper version: you have to display the table of contents pages, find a listing that looks like it might contain the info you're looking for, display that page, read it, get frustrated, return to the table of contents, try to figure out where the Brits hide information, etc., etc.

Note that JHM 1127 has a later release of ScanFile than JHM 1114. If you buy both, install the later release and use it to view both discs.

Nope, these CD's reportedly won't run on a Mac. The savings over buying the printed versions would probably pay for a real computer, though.

It doesn't help that whoever put these packages together didn't do the best job. Some collections start with the table of contents, completely omitting the title page and the copyright date. Sometimes they make up names; the four packages in Amendment No. 1 are called "Supplements" for some reason.

Besides ordering directly from JDHT, Craig Sawyers says you can get them "...from a small number of appointed UK dealers and specialists - JDHT have only appointed 10 of these. The best one to go for IMHO is Martin Robey Ltd on (+44) 2476 386903. They export too, so no problem there (One of their quoted phone numbers is (+44) 7000 ROBEY SALES so it could be worth trying that from the US). Don't bother looking at their website at <http://www.martinrobey.co.uk> - it is pretty useless and also doesn't mention JDHT parts."

JHDT says, "Please note that these CDs are generated by Jaguar Classic Parts at Unipart House and that we simply retail them. In principle therefore, the same CDs should be available at the same price from all the Jaguar Classic Parts outlets, whether Jaguar dealers or independent approved specialists."

Apparently the US dealers think you need to pay more -- *much* more -- than \$25 for this info. Don Lundquist says, "I tried to order from local Jag dealer (JHM1127)... Price quoted was \$123.37." JDHT responds: "Originally these CDs were being retailed in the USA by Jaguar dealers at far too high prices. However, it has now been agreed that they will be available through all Jaguar dealers in the USA at the cost of \$25.00. We have accordingly been asked by Jaguar Classic Parts to cease accepting orders from the USA, since we want to give the US dealers a fair chance. Any US customer who either has difficulty ordering a CD from a local dealer or is still being quoted the old price should contact

Jaguar Classic Parts on +44 (0)1865 383358, or e-mail Brian_North@unipart.co.uk.” There are already reports that the US dealers insist on adding fees to that \$25.

Even if you’d prefer the paper versions, it will undoubtedly prove cheaper to buy these CD-ROM’s and print the books in entirety on your trusty inkjet. They print just fine -- although they want to print to metric-size paper and will try to make one page into two when printing on 8½ x 11. The part on the second page is usually just a blank half inch.

OWNER’S HANDBOOK: Owners who don’t have an owner’s handbook might want to get one. However, note that insisting on the proper one for your model year XJ-S might not work; apparently Jaguar published a single edition of the handbook intended to suffice for multiple model years without change. For example, the owner’s handbook for the 1983 model year is titled “XJ-S H.E. HANDBOOK” and is publication part no. AKM 9045, 2nd Edition -- no model year evident. The copyright date is 1981. Ask for the one with the most recent copyright date *before* your model year.

If you have trouble finding a handbook from a bookseller, ask at junkyards and similar places that might be parting out a car of the same year as yours.

SCHEMATICS: See page 510 for info on available electrical schematics -- invaluable on this car.

MAIL ORDER CATALOGS: To those just getting started with the XJ-S, take this bit of advice: Order at least two mail-order catalogs immediately. Turn to page 641, look through the list of new parts suppliers, and start calling until you have a couple of catalogs coming in the mail. You will want to have such catalogs on hand even if you never order any parts just so you can tell when some unscrupulous repair shop is trying to rape you on parts costs.

OTHER BOOKS: Richard Mansell suggests: “For XJ-S fans there is a book by Paul Skilleter called *Jaguar XJS: A Collectors Guide* (ISBN 0-947981-99-3). It is full of pretty pictures (nearly 200) of XJ-S’s and variants. There is a fair bit of history detailing specification changes, etc., covering a total of 144 pages.

“Appendix A lists the technical specifications model by model.

“Appendix B lists the location of the chassis/VIN numbers and explains what each bit of the VIN means.

“Appendix C lists launch dates and prices.

“Appendix D is a fairly detailed list of production changes by date chassis and/or engine number.

“Appendix E lists annual production numbers.

“Appendix F lists performance figures.

“If you are into XJ-S’s it is well worth a look.” Skilleter’s book is published by Motor Racing Publications Ltd., Unit 6, The Pilton Estate, 46 Pitlake, Croydon CR0 3YR, UK, ©1996.

Victor Naumann recommends Publication #S-58, *XJ-S Engine Performance*. “It has photos and diagrams of ignition and fuel systems, all the controls and switches and a good section on maintenance procedures, setting throttle plates and linkage and checking the potentiometer etc.”

Jaguar XJS Gold Portfolio 1975-1988, compiled by R. M. Clarke, is a collection of road tests, specifications, comparisons, and reports on racing and other modifications. It is published by Brooklands Book Distribution Ltd., “Holmerise”, Seven Hills Road, Cobham, Surrey, UK.

John T. Horner suggests “There is a brochure type booklet written by Jaguar when the V12 was introduced and which is sometimes still available: *Genesis of the Jaguar V12*. It has a good official summary of the history and specifications as well as beautiful color overlay drawings of an engine cutaway. I think Bookspeed in the UK may still offer it.” This author has acquired a copy of this book; it isn’t much from a maintenance standpoint, but it cannot be beat for instilling

an appreciation of one of the finest automotive engines ever designed, providing a concise history and background of the engine's development. From an XJ-S owner's standpoint, the worst thing about the book is that it truly applies to the original Jaguar V12 introduced in the Series III E-type; many of the details changed by the time most XJ-S's were built. The engine shown in the book has carburetors, a canister-type oil filter mounted under the front end of the sump, an oil-to-coolant oil cooler, an oil pan that is no wider than the bottom of the block, an alternator mounted backwards so it sticks out the front of the engine, etc.

Bookspeed's address is on page 673. *Genesis of the Jaguar V12* is also available from Classic Motorbooks, page 673.

Lawrence Buja recommends *Jaguar Driver Technical Tips* by Bob Bate, ©1990, R.G. Bate Publishing, 501 Cleveland St., Birkenhead, Merseyside, England. "Technical Tips is a huge collection of tech articles published in the Jaguar Driver Club magazine by a professional Jaguar mechanic. It is about 500 pages long and covers an immense range of topics all related to the real-world operation, diagnosis and repair of Jaguar automobiles." Makoto Honjo adds, "Bob does advertise on the JDC, whose flier I sought for a lead. Well, turns out that *Jaguar Driver Technical Tips* is his private and is available through him at GBP40 (hey, you've got to pay for quality). You can call him at phone +44-151-653-6765 for a copy."

TECHNICAL PAPERS: In the US the Society of Automotive Engineers (SAE) maintains a collection of technical papers. Paper #720163, by Walter T. F. Hassan of Jaguar Cars Ltd., Div., British Leyland Motor Corp., is a quite detailed engineering study of the development of the Jaguar V12. Of course, the paper predates such later developments as the H.E. Bob Weisickle points out that SAE papers can be ordered from:

<http://www.sae.org/>

but note that they only offer recent papers online; older papers don't even show up in a search! You'll have to call SAE at +1 (724) 776-4970 Monday through Friday, 8:00 a.m. to 5:00 p.m. Eastern time to get older publications.

In the UK there is a similar paper titled "Jaguar V12 Engine - Its Design and Background", also by Hassan, from the Technical, Administrative and Supervisory Section of the Amalgamated Union of Engineering Workers (AUEW-TASS), Onslow Hall, Little Green, Richmond, Surrey.

Roger Bywater says "there is also a similar Institute of Mechanical Engineers paper by Harry Mundy from about the same time (1972)."

SERVICE RECORDS: Chad Bolles: "...just go to any dealer's service dept., give them the serial no. of your car; they can pull it up on the computer and give you the available history."

FUEL ECONOMY: Keeping an eye on fuel consumption is an excellent way to monitor your car's condition. Since EPA ratings are generally unreliable in the real world, it is helpful to know what kind of fuel consumption the XJ-S *should* have:

	<u>miles/US gal</u>	<u>miles/Imp. gal.</u>	<u>litres/100km</u>
XJ-S H.E.:			
everyday:	16-18	19-22	13-15
highway:	18-20	21-24	12-13
Pre-H.E.:			
everyday:	9-12	11-14	20-26
6.0:			
everyday:	12	14	20
highway:	16-18	19-22	13-15

For those who like to do their own converting, there are 0.83267 Imperial gallons in a US gallon, 3.7854 litres in a US gallon, and 1.609344 kilometers in a mile.

The values for the pre-H.E. are based on fewer reports, but those reports were fairly consistent; apparently the H.E. really was a *huge* improvement in fuel efficiency over the previous design! Note that reportedly the difference only occurs under light (street) use; with harder running or racing the economy difference diminishes.

The values for the 6.0 are likewise based on fewer reports but the reports were consistent; since the cars are of more recent vintage and have electronic controls less subject to variation or misadjustment, you'd expect them to be consistent. It's perhaps surprising that these cars don't get better economy than they do, especially considering the improved transmission and the longer stroke engine. Perhaps the 6.0 drivers have their foot in it more than the 5.3 drivers!

Of course, the standard disclaimer: "Your mileage may vary." But you know if you are driving harder or under worse conditions than the average driver, and if you think your fuel mileage is worse than it should be you should immediately investigate the causes. Many of the common causes also result in major engine damage if left uncorrected.

Jim Isbell was doubtful, but now is a believer: "The O₂ sensors were changed. The results were fantastic. The around town mileage has increased from 12 MPG (US gallon) to 17 MPG on the first tank after the change."

Unfortunately, there is one other reported reason for bad city mileage. "B emission" (UK and Europe spec) H.E.'s have a timer that disables the vacuum advance for 15 minutes after startup if the coolant was below 45°C when started. If you drive 15 minutes to work, park there 8 hours, and drive 15 minutes home, you are *always* operating on retarded timing and will get something around 12 mpg. See page 130.

Note also that some areas require the use of "oxygenated fuels", sometimes just during particular seasons. Oxygenated fuels result in *far* worse fuel consumption in *any* car.

THREADS: The British invented the inch/foot system of measurement, so most of the fasteners on the pre-1984 XJ-S are English fine thread (UNF or National Fine), available in any hardware store in the US. Jaguar and other British cars extensively use fine threads, as opposed to the coarse threads (SAE or National Coarse) normally used on American cars. Coarse threads are sometimes used in aluminum parts, because aluminum is too soft for effective use of fine threads.

In 1984, many of the fasteners within the engine itself changed to metric sizes. Notably, just about every 5/16" stud appears to have changed to M8, according to David Johnson. Many of the 1/4" threads changed to M6.

Thanks to a continuing effort towards metric standards, there are metric fasteners in other parts of the car as well -- even in the pre-1984. Many of the subcomponents, such as the alternator, air conditioner compressor, and stereo are made with metric threads. Later cars seem to have more and more metric threads. Mike Morrin says, "The nuts holding the wiper blades are the only metric fasteners I have found on my 1975 car."

WHITWORTH/BSF: There are, unfortunately, a couple of places where obsolete British standards such as BSF or Whitworth are found on the XJ-S. See the discussions on the crank damper retaining bolt on page 85, the surge tank vent connection on page 238, the main power terminals on the firewall on page 517, and the battery terminals and hold-down nuts on page 541. Also note that page 12 of the Haynes manual lists wrench sizes for such oddities. Most of the BSF/Whitworth wrench sizes don't correspond to anything in SAE or metric sizes; supposedly, Mr. Whitworth decided to size his bolt heads so that the length of a flat on one side of the hex was some nice even number.

Keep in mind that BSF and Whitworth wrench sizes are the diameter of the bolt, not the dimension across the flats on the head. And, for some reason, the wrench that fits a BSF bolt seems to fit the next smaller size bolt in Whitworth.

To learn more about British non-standard standards, David Littlefield suggests visiting these WWW sites:

<http://www.team.net/sol/tech/whitworth-hist.html>

<http://home.sol.no/~karne/threads/threads.htm>

Craig Sawyers: "At least here in the UK you can get spanners and sockets from the local tool store that are correct." Actually, you can obtain Whitworth tools in the US and presumably other countries; it just takes more looking. Jeb Boyd says Snap-On has Whitworth tools. David Littlefield suggests British Tools and Fasteners; see page 660. A search of the WWW should turn up an assortment of mail-order sources.

Note: with the exception of the crank bolt (for which wrench options are discussed on page 85), all of the Whitworth/BSF wrench sizes used in the XJ-S seem to be the same size: 1/4" Whitworth/5/16" BSF. Hence, it might be good advice for the XJ-S owner/mechanic to obtain *one* wrench. The entire Whitworth set is not needed.

TORQUE UNITS: Torque, or twisting force, is specified as an amount of force applied at a radius. In the English system of measurement force is typically given in pounds or ounces, and radius (distance) in either feet or inches. The first point of confusion arises because units of mass are also called pounds. As a result, it is increasingly preferred to speak of pounds force or pounds mass instead of simply pounds. The abbreviation for pounds force is "lbf." The f does *not* stand for feet, and lbf. does *not* stand for foot-pounds. Readers are encouraged to beat this into their hard skulls until it sinks in; reading "lbf." and thinking "foot-pounds" is a good recipe for disaster with this car and this ROM.

The torque value is the amount of force applied *times* the radius. Twenty pounds applied at a radius of 18 inches is 360 inch-pounds or thirty foot-pounds. Hence, the terms for force and the terms for distance are written sequentially (doesn't matter which order, really). Sometimes a hyphen is used, which in this author's opinion makes things clearer, but as expected that means that Jaguar chooses not to use a hyphen. In the XJ-S ROM, foot-pounds are written as "lbf. ft" and inch-pounds are written as "lbf. in" That last one, if you're not paying attention, looks like foot-pounds followed by the word "in" -- especially if it's word-wrapped and the "in" is at the beginning of the next line. If you make a mistake here, you will overtighten something by a factor of 12.

Lacking a hyphen may be confusing, but at least it's technically correct. Putting a slash between the terms, such as lbf./ft or lbf./in indicates pounds force *divided by* feet or inches, and this is most definitely incorrect when used to indicate units of torque; lbf./ft or lbf./in are units of spring rate, not torque. Unfortunately, Jaguar is reportedly guilty of this error -- not just once or twice, but throughout entire manuals. The XJ-S ROM uses correct terms, but Peter Cohen reports "I don't have the ROM. I have the 4 volume service manual. They use the term "lbf/in"." Loudon Seth says, "The SIII ROM uses (incorrectly) the form lbf/in or lbf/ft throughout."

STUDS: Jaguar studs sometimes have fine threads on both ends, and are therefore difficult to find locally. Most studs in the US have coarse threads on one end and fine on the other. You can, of course, order studs from a Jag mail order outfit -- sometimes they're even reasonably priced. If you want to get on with the job and not wait on the mail, however, you can find a very long stud or bolt at your local auto parts store on which the fine threaded end by itself is longer than the entire Jaguar stud (many Jaguar studs are rather short). Simply cut the end off and dress up the threads. Thread the sawn end into the part, leaving the factory-made threads for assembly.

SPIRAL GROOVE WASHERS: The V12 engine is covered with an unusual type of 5/16" washer, C30075/2, that has a spiral serration pattern on it and is slightly dished. This washer serves the purposes of both a flat washer and a lock washer. While the serrations may help prevent nuts and bolts from unscrewing, the real locking feature is the dishing; it makes the washer springy, keeping tension on the fastener.

David Johnson found an acceptable substitute for the spiral groove washers: "I found at Pep Boys an 8MM spring washer. It's part number is 153-0800. They are in the racks of boxed hardware." Note these washers don't look much like the spiral groove washers; they have no serrations and are sprung the other way -- they're not dished, they're wavy. They are dirt cheap, though. If you find an auto parts store with a Dorman hardware case, Dorman sells essentially the same type wavy 8mm washer as part number 436-008. They are also available at Lowe's as Pik-A-Nut part number 792694. Nobody seems to sell wavy spring washers in SAE sizes, but 8mm will fit perfectly on 5/16" bolts.

The V12 also uses a few 1/4" spiral groove washers. A 6mm wavy spring washer (153-0600 at Pep Boys, 436-006 in a Dorman case) will fit a 1/4" bolt perfectly and serve well.

Note that it is *always* recommended to use some sort of flat washer whenever a bolt head or nut tightens down onto aluminum. If you find any places on your engine where a fastener is tightened onto aluminum without a flat washer, it is recommended that you provide a flat washer.

Conversely, lock washers are only required in certain places. For example, the head studs require no locking feature because the tension on the stud is carefully applied with a torque wrench and the designers have ensured that the assembly will never allow the stud to become untensioned in operation. As a general rule, lock washers are required on short bolts or studs but not required on longer ones because the longer fasteners provide enough stretch to absorb vibrations and thermal transients without ever going completely slack.

PHILLIPS? THINK AGAIN!: Greg Meboe says, "All Phillips-looking screws on English cars are Pozidriv screws. (The Japanese radios do use real Phillips screws.) The two standards are different, and once I bought a set of Pozidriv screwdrivers I found life *much* easier. The practical difference is quite noticeable. The impressed angle, impression depth and drive spline widths are different between a Pozidriv and Phillips head design. Using the correct Pozidriv screwdrivers, I've even had consistent luck removing Pozidriv screws which appeared nearly rounded due to years of Phillips-buggering by misinformed mechanics.

"A Pozidriv screwdriver will not fit in or drive a Phillips screw. The drive lugs are generally too wide.

"Snap-On, Mac and others sell Pozidriv screwdrivers, but most Americans don't know they exist (I didn't for many years). I've found Pozidriv #2 bits for the cordless screwdriver at Home Depot for a few bucks. Most Pozidriv screws on our cars are #2, while door striker mounts and seat mounts are #3." The big flush-head screws at the back end of the diagonal struts in the engine compartment are Pozidriv #4.

Peter Cohen adds, "From the look of several Pozidriv screws on my car (removed only by Jaguar dealer personnel, while under warranty), the dealer tool is a chisel."

You can learn all about Pozidriv at <http://www.phillips-screw.com/>.

Sometimes Phillips screwdriver bits are marked "No.2" or "P2" while Pozidrive bits are marked "PZ.2" (using size 2 as the example). Other companies mark their Phillips as "#2" and their Pozidriv as "P2". The marking on the packaging can be similarly confusing; the popular idea is to indicate tip types with a little symbol within a circle, but some companies show the Phillips with a + within a circle and the Pozidriv as an 8-point symbol within a circle while others show the Phillips as the + within a circle and the Pozidriv as an × within a circle -- basically the same as the Phillips symbol only rotated 45°. Forget about the markings and simply look for the telltale ridges down the center of each flute, which may be difficult to make out through the bubble packaging.

Apparently, Phillips Screw has the name "Pozidriv" trademarked, so some other toolmakers make tools to fit Pozidriv screws while carefully avoiding the illegal use of the name. Easypower Corporation of Chicago makes screwdriver bits described as "Positive Drive Phillips", and in fine print says "will fit Pozidriv screws". Easypower also makes

screwdriver bits called "Octo Driv", apparently their own trademark, but indiscernable from Pozidriv. All of Easypower's bits that fit Pozidriv screws are marked "EZP.1", "EZP.2", or "EZP.3".

Note that Posidriv is *not* the same thing as "anti-slip". Phillips screwdrivers described as anti-slip are regular Phillips screwdrivers with tiny ridges on the tip to supposedly keep the bit from slipping.

Meboe is quite right about *all* of the Phillips-looking screws being Pozidriv; the little screws on the taillight lenses, the big screws holding the mirrors on, the small screws holding the ignition pickup in the distributor, *everything* is Pozidriv. However, if your car has had any work done that may have involved replacing screws, chances are (in the US, anyway) that the replacement screws are Phillips. So, you may need both types of screwdriver to work on the car. You could closely inspect each screw before choosing a screwdriver, but that's a pain and strains the eyes. Instead, proceed as follows: Assume *all* screws are Pozidriv until you find a screw that the Pozidriv screwdriver won't even fit into, then pick up the Phillips.

LOCKING WIRE AND TOOLS: Several places on the XJ-S call for locking wire, safety wire, siezing wire, whatever you call it -- notably on the braking system and IRS. You can buy suitable plain steel wire anywhere, even at Wal-Mart. Of course, you want it to look nice, so you want stainless steel wire. Many places sell one size of SS wire, 19 gauge, which is actually about right for most purposes. Note that you need a soft alloy for this job; many types of SS wire, such as fishing leader wire, are too hard for lockwiring.

If you want to get fancier, specialty stores sell stainless steel, inconel, or monel wire in various gauges along with "lockwire pliers". Lockwire pliers are a specialized tool with a latch that holds the jaws clamped down on the wire and a spiral slider that spins the pliers with a simple pull. Lockwire pliers are popular with aircraft mechanics who may be applying lockwire from sunup to sundown, but for XJ-S purposes they are not really justified; you can do the few lockwiring jobs found on this car in a couple of minutes with regular pliers.

The theory of lockwire is simple enough, but aircraft mechanics and FAA inspectors will tell you that its use requires a specific technique and careful application to ensure the intention is achieved: Safety. Applying lockwire requires a bolt head with a hole drilled crossways through it; sometimes two holes are provided just to allow the choice of whichever one lines up the best. Often it's the fact that the bolt heads *have* such holes that tells you that lockwire might be a good idea in this location. Insert the wire through the head of the bolt, wrap one end around one side of the bolt head and *underneath* the other end, and twist them together in the direction that is likely to *keep* the wire around the side of the bolt head instead of flipping off the top. On a right-hand-threaded bolt, the end wrapped around the head should wrap to the right, and the two leads should be twisted to the right. Twist enough wire to reach a second bolt head and insert one of the wires through that one, wrap the other wire around the head (this wrap will actually be to the left, since you are going the other direction), and twist the ends together on the other side (a left twist this time). The twisted section between the bolt heads doesn't need to be in tension, but there shouldn't be much slack in it. The twisted section should come to a hole on the right side of each head (looking at each from the other), so the two bolt heads and the twisted strand form a Z pattern. If done correctly, the wire between the bolt heads as well as the wraps around the bolt heads themselves are arranged so that neither bolt can turn in the loosening direction without stretching the wire. Finally, clip off the excess wire and bend the tip of the last twisted section back on itself to keep from snagging yourself on it when working in the area.

If you happen to be lockwiring a single bolt, you will need to tie the other end of the lockwire down to something nearby to effectively prevent the bolt from loosening. If you happen to be lockwiring three bolts, you can tie all three together by simply continuing on past the second to the third. If you happen to be lockwiring bolts that are pretty far apart, you may choose to tie each to something nearby rather than to each other, or to wrap the wire onto something in between rather than leaving a long span unsupported; vibrations may cause a long section of wire to wiggle, eventually breaking off.

If any of this is unclear, you can probably drop in on any aircraft maintenance shop and pick up a few pointers. It is rather important that you get it right, obviously.

If you decide you'd like more safety than was originally provided for, you can drill lockwire holes in bolt heads that don't come with them. This is popular in racing, and some racing venues actually have specific requirements for things that must either be lockwired or provided with tabwashers or self-locking nuts.

ANTI-SEIZE COMPOUND: Since the XJ-S has many bolts and studs threaded into aluminum, be sure to keep a supply of anti-seize compound on hand. The stuff is a goop with tiny particles of soft metal in it -- usually copper, nickel, or silver. As threaded items are screwed together, these soft metal particles get crushed between the threads; later, after time, heat, and electrolysis have caused all the metals involved to fuse together, this layer of soft metal can easily be sheared by unscrewing without damaging the parent parts. Use it anytime steel is threaded into aluminum, to prevent galvanic corrosion from seizing it up. It also works great on exhaust manifold studs. The fact is, many experienced mechanics (including the author of this book) swear by the stuff, buy it in one-pound cans at better hardware stores (auto parts shops usually carry it only in small tubes) and use it on *everything* with threads.

An old toothbrush works great to apply anti-seize compound to threads. You only need to apply enough to give the parts the color of the anti-seize compound; no need to pile it on, it'll just come off as the parts are screwed together anyway.

Anti-seize compound seems to work well on post-and-nut electrical connections, too. This is probably because the metal particles help make a more secure connection. Be careful not to cause shorts with it, though.

Note that anti-seize compound is not a lubricant, and should never be used on moving parts.

SO YOU FORGOT TO USE ANTI-SEIZE COMPOUND LAST TIME: Steve Hammatt describes a product to get stuck bolts loose: "The division is called National Chemsearch and the product is called "YIELD" and is quite unbelievable in loosening rusted nuts, bolts, etc. Their number is 1-800-527-9919. Their salesmen are everywhere including (believe) even in Russia!"

"The key is to use a true penetrating product that has a lubricant, plus *time*. Leave it on for at least an hour, then return and proceed."

Other folks swear by Liquid Wrench, and even WD-40 has its admirers. Whatever is used, allowing adequate time to soak in is always required.

Heating a bolt with a torch is also suggested as a method for loosening, but obviously it's a good idea to wipe the penetrating oil away first. It also is a good idea to replace the bolt/nut, since the heating may destroy the temper.

SILICONE SEALANTS: Apparently, some silicone sealants can corrode metal parts. Jan Wikström says: "To quote the famous Castrol ad, silicones ain't silicones. Some leave a residue of acetic acid as they cure, which is a very weak acid but could conceivable harm bare metal. The trick is to buy "neutral-cure" silicon."

Ed Mellinger says: "Silicone sealant isn't permitted in most aircraft applications for this reason (among others). Two neutral-cure silicones I know of are Dow Corning 3140 and 3145; one's an adhesive and one's a thinner "coating", but I'm not sure either is designed to be an engine gasket so buyer beware. Warning... they are priced like aircraft parts too!"

"In the "among others" category is the tendency of silicone to squeeze out in a bead and then peel off in strings... possibly into your engine oil on its way to a bearing! This definite no-no is the most cited reason I've heard against use of silicone in, er, sensitive areas."

SEALS: If you're shopping for parts and find you have a choice of seals, Richard Griffiths suggests "use a seal with an outward facing second lip to prevent dirt getting under the sealing lip."

If you put a new shaft seal in and there is a bad shaft surface for it to ride on, the new seal won't last long -- but replacing the shaft, or removing it for machining, is likely to greatly increase the cost and effort involved. Griffiths and others

point out that there is an easier fix: Thin sleeves that can be slid over the original shaft and held in place with adhesives. Mike Morrin mentions "the "CR SPEEDI-SLEEVE" which is just this device. Their US number is 1-800-882-0008. Their range suits shafts from 0.472" to 8.00"." Brian Schultetus: "These sleeves are almost as old as dirt and available at any good bearing supply. Since these are basically universal listed by shaft size and width, no application will be listed as a rule. There are two types of these made; stainless steel are best, the other versions I've seen were chrome plated and had a tendency to disturb or break the chrome loose when installed. The plated ones I've seen came from Silver Seal."

DRIVE-ON RAMPS: The need to get under a car is inevitable, and for those of us who don't have access to a garage with a lift, drive-on ramps appear to be a good solution -- cheap, easy to use, and sturdy enough to hold a 4000-lb Jaguar without dropping it on its owner. However, most ramps appear to have been designed for cars from another era, and the spoiler pushes them away long before the front tires get near them. Patrick Krejcik provides a solution: "I got the \$17.95 specials, and all I had to do was to put a 2x6, about 18-24 inches long on each ramp to lengthen the slope. I used a nail in the end of the 2x6, bent it and stuck it in a hole about half way down the original slope, and made the slope longer and more shallow."

If you wanna get fancier, Mike Wilson says that Griot's Garage (page 661) offers a "ramp extension kit".

CHECKING FOR CRACKS: Jan Wikström provided this "backyard Magnaflux test" for checking for cracks in steel parts: First, the area needs to be clean and smooth, so polishing may be required first. Allow a large, powerful horseshoe magnet to latch on to the part across the area to be checked. Now dribble kerosene with iron powder (collected from grinder) over the area; any crack will show up clearly.

ENGINE

H.E. VS. NON-H.E.: The H.E. (High Efficiency) engine, with 11.5:1 compression (12.5:1 outside the US) and a swirl combustion head designed by Porsche expert Michael May, was introduced in July 1981 and indicated by the letters “H.E.” on the back of the car in place of the former “V12” emblem. In 1986, the H.E. emblem was unceremoniously dropped and a V12 emblem was used once again, but the H.E. combustion chamber design continued to be used in all Jaguar V12 engines until it ceased production.

If you have an engine laying around and need to know which it is, the trick is to look at the spark plugs. The plugs on the pre-H.E. tilt forward or rearward and are relatively easy to replace. The plugs on the H.E. tilt toward the centerline of the engine just enough to make them a real pain to get a socket on.

ENGINE NUMBERS: The engine number is stamped on the top rear center of the block just forward of the joint with the GM400 transmission bellhousing, but it is typically hard to find because it is covered with grime. Paul Hackbart sends this tip: “Take your oil dipstick out and get on the passenger side of car. You can stick it through near the oil pressure sender and scratch away until you see it. Just make certain you clean it off afterwards.”

The XK’s Unlimited catalog includes a guide of engine numbers for the XK 6-cylinder and the V12. It provides the following info on the V12:

7S1001>	E-type Series III	3/1971-2/1975
7P1001>	XJ12 Series I	1972-73
7P4000>	XJ12 Series II	1973 (Carbs)
7P25001>	XJ12 Series II	1974-79 (EFI)
7P?>	XJ12 Series III	1979-8?
8S1001>	XJ-S	up to 1980
8S18001>	XJ-S H.E.	1981-87

For more detail on XJ-S engines, Richard Mansell sends this helpful data from “The XJ-S Collectors Guide”:

8S4551	Feb 76	Canister type oil filter introduced
8S5203	Oct 76	Revised EFI
8S6454		Modified fuel pump
8S7017	Apr 77	GM400 introduced
8S8632	Nov 77	Stronger manual trans selector shafts
8S10195	May 78	Modified air filter box to stop blowing off!!
8S11262	Oct 78	Ignition amplifier re-located
8S13094	Oct 78	Twin V groove water pump pulley introduced
8S16401	Nov 80	Digital P injection introduced*
8S17194	Nov 80	Sump plug relocated
8S18001	Jul 81	HE Introduced

Most changes after this are listed by VIN number but the following are listed too:

8S24175	Metric threaded cylinder heads
8S26992	Piston spec modified
8S27297	Inlet manifold modified to remove holes for cold start injectors
8S31737	Modified drive plate
8S41339	Spark plugs changed from B6EFS to BR7EFS
8S41344	Sump oil baffle plate changed
8S44227	Water pump bearing size increased
8S44317	Full flow oil cooling replaces relief flow
8S45527	GM400 revalved, modified sump pan

* Apparently the November 1980 introduction of Digital P is incorrect, as Ron Kelnhofer owns a Digital P car built in June 1980. His engine number is 8S17116SB, which does not conflict with the data in the listing, so perhaps only the date is incorrect.

5.3 vs. 6.0 LITER: The Jaguar V12, from its introduction in the E-type MkIII up to 1993, has been a 5.3 liter engine (326 c.i.), with a bore of 90 mm and a stroke of 70 mm.

Engines are often described by the relationship of bore to stroke. When the bore equals the stroke, the engine is described as "square". Early gasoline engines tended to have long strokes and small bores, described as "under-square". Racing engines have evolved to having the bore larger than the stroke, or "over-square". The Jaguar V12 was designed to reestablish Jaguar's eminence as a world-beater in the racing community (and prior to the fuel crisis of the early 70's), hence the considerably over-square design. It was quite successful in this regard, still winning LeMans races in the late 80's.

The popularity of over-square engines in racing is actually somewhat artificial. Most racing programs divide competition into classes based on engine displacement. An over-square design provides the most power for a given displacement, since it permits higher RPM and provides room for large valves. However, these priorities do not translate well to street use. Over-square engines tend to be heavy for their displacement; a larger displacement engine of comparable size and weight can be constructed with a nearly square configuration. The over-square layout also results in larger surface areas in the combustion chamber, which absorb combustion heat and reduce fuel efficiency. And while the design provides excellent power at high RPM, it tends to lack torque at lower RPM; since people like their engines to be turning slowly when cruising on the freeway, an over-square engine can seem anemic under these operating conditions.

Ford suspended production of the V12 for 1993, and reintroduced it in 1994 as a 6.0 liter (366 c.i.). More than merely an engine enlargement, the change made the V12 much less over-square, since the change was entirely an increase in stroke; the new engine has a 90 mm bore and a 78.5 mm stroke. This would tend to make the engine much more suitable for street use. It remains more over-square than most engines, and hence can provide excellent performance at high RPM, but is more tolerant of stop-and-go driving conditions and tall final drive ratios. The Michael May-designed H.E. combustion chambers remain in use in the larger engine, while the compression ratio has been reduced to 11.0:1.

Tom Walkinshaw Racing (TWR) was offering 6.0 litre engines much earlier. According to Richard Mansell, "TWR started making 'sporty' XJ-S's in 1984. One of the options then was a 6.0 litre engine." John Goodman reports that TWR also made 6.2 and 6.4 litre versions, and maybe even a 6.7.

Later on the JaguarSport XJR-S also had a 6.0. Mansell: "When JaguarSport officially started producing the XJR-S in 1988 only a 5.3 litre engine was available. It was not until mid-89 that the 6.0 litre was introduced as standard. This was then discontinued in 1993 as by then the standard XJ-S now had a 6.0 litre engine."

Note, however, that the 1993-on updated engine has a lot of other features these earlier engines lacked, such as a revised bolt pattern for connecting the GM400 transmission.

WHAT'S IN A REDLINE?: Some people, probably accustomed to American pushrod V8's, feel that the 6500 RPM redline marked on the tach is really aggressive and far too high for an engine this big for everyday use. Nothing could be farther from the truth; this is *not* an American pushrod V8, it's an OHC V12 with an unusually short stroke. Roger Bywater, who worked in the engine development department at Jaguar when this engine was designed, provides a more realistic understanding of just what that 6500 RPM redline is all about: "6500 r.p.m. is certainly safe and 7000 would not be a cause for concern. In fact I know of basically standard 5.3 V12s cobbled together with second hand bits being taken to near 8000 in race cars without suffering any problems at all. On the other hand an elderly engine does deserve a certain amount of respect. I expect the one thing that would result is that the timing chain and tensioner would start to show signs of distress a bit sooner if subjected to continual high r.p.m. In reality, there is not much point in revving a standard V12 beyond 6000 because it will be running out of breath anyway and therefore won't be making much power.

"The real problem taking these engines to 6000 and above is that the GM 400 torque converter distorts under centrifugal loads so that the blading can make contact creating fine metallic particles which then cause accelerated wear of the transmission. A way around this is to use a furnace braized converter which is more rigid and able to tolerate the higher r.p.m. without distorting so much."

END OF AN ERA: The final Jaguar V12 engine was built April 17, 1997.

HOT SHUTDOWNS: It is never a good idea to shut down an engine immediately after running it hard; it is always better to run it at reduced power for a few minutes first to let it "cool down". This has nothing to do with the temperature reading of the coolant; the problem lies with parts within the engine that get much hotter at full load than at low load, and can be subjected to high thermal stresses if the transition from high load to off is too sudden.

This problem is especially serious in the case of the Jaguar XJ-S. Several problems the car seems to have, including vapor locks, distributor seizures, and ignition amplifier failures, may be exacerbated by hot shutdowns. The underhood temperatures may skyrocket after a hot shutdown, and Jaguar is known to have had underhood temperature problems during development of this car.

Whenever you are driving the car hard, always drive the car leisurely for a few minutes before shutting it off. If you are forced to shut the engine off after running hard -- having a mechanical problem, for example -- at least open the bonnet to allow the heat to rise out of the engine compartment, providing some convective cooling.

See page 217 for tips on improving post-shutdown cooling.

KNOCKING/PINGING/PINKING/DETINATION/WHATEVER: Regardless of what you call that sound, it ain't good for an engine. A brief description of what's going on: When an engine is running properly, the fuel/air mixture within the cylinder is ignited by the spark plug and the flame front grows continuously and spreads throughout the combustion chamber until the entire charge has been burned. However, while this is going on, the piston is moving upwards towards the head, compressing the charge and thereby heating it. In the most severe cases of knocking, the compression causes the charge to self-ignite before the spark plug even fires. The result is that the entire charge ignites at once, rather than the gradual ignition of the flame front moving through the charge. This "explosion" has been likened to hitting the piston with a hammer. It can damage the piston, connecting rods, and the bearings in both ends of the con rods.

What usually happens is less severe, however. The spark plug fires well before the piston reaches the top of its stroke, so the flame front has begun its travel while the compression is still in progress. Since the burning charge is expanding, it is compressing the unburned charge into the far corners of the combustion chamber. The combined effects of the piston rising and the flame-induced pressure causes the remaining portions of the charge to self-ignite. The actual amount of charge exploded in this fashion can vary anywhere from a tiny portion to the entire charge, so knocking can be either severe or barely detectable.

There are many factors that contribute to knocking. The most notorious is compression ratio; the higher the compression ratio, the more likely it is for the charge to be detonated. Another key issue is the octane of the fuel, which is a measure of how hot it must be before it self-ignites; the higher the octane, the hotter the mixture must get before it will burn. And ignition timing is a factor, since lighting the mixture earlier will cause more of the charge to be burned before the piston gets to TDC and therefore increase the peak pressure.

Other factors include the intake air temperature, the fuel temperature, and cylinder wall and head temperatures. EGR, which puts some inert gases into the mixture, makes it harder to ignite and therefore reduces the tendency to knock. Also, there are some minor details that can complicate the issue; sharp edges in the combustion chamber can act as "glow plugs" and ignite the charge prematurely. Carbon deposits can increase the compression ratio, as well as provide glowing embers to preignite the charge.

Knocking can be difficult to detect on the Jaguar V12. All those little cylinders mean that each knock is small, and all that sound deadening built into the car keeps the driver from hearing much of anything in the engine compartment. Basically, if you can hear it at all, you might need to be concerned. On the other hand, Mike Wilson reports: "I asked the local Jaguar rep and he had the audacity to say that "All Marelli cars ping". He said it was even in the owners manual! So, I came home and read mine and sure enough, there it was in black and white! It said that a small amount of pinging was normal and if it happens on flat roads under no load, to see your dealer for further assistance."

If something needs to be done about pinging, the usual reactions include changing to better octane fuel or retarding the timing. On the later XJ-S with Marelli ignition, you can't adjust the timing by just rotating the distributor, so a jumper was provided that can be pulled to put the system onto a more retarded map when needed. Even if we try to buy good fuel, occasionally we always seem to get a tankful of real crap, and this jumper is a handy fix to get us to the next fillup.

Joe Ziehl shares some experience: "My mechanic told me to first try a higher octane fuel because while retarding the timing may help, the preignition might be caused by something other than sparkplugs, such as carbon in cylinders or on pistons. He also recommended that I treat the gasoline and run the car hard for a few days. This made a significant improvement in the pinging."

Jeff Elmore reports: "I had been getting some slight pinging under medium acceleration after the car had warmed up. I had tried many things, including checking the timing, high octane gas, etc. Then I tried the temperature at the thermostats. It was 213°F on one side and 203°F on the other. I just changed the thermostats and topped off the coolant (almost half a gallon low), and the pinging is gone. The car now runs better as a result, with my guess being that a lower CWT sensor means more fuel and power."

The experience on the internet discussion lists, however, indicate there is one sure-fire cure for knocking: the Italian Tune-Up. Get the car fully warmed up, then while cruising along at about 60 mph, move the shifter into 2 and punch it. Hold the pedal to the metal until somewhere close to redline, then let off and coast back to 60 -- and repeat. The first time or two, the car will object and show its displeasure by stumbling and blowing great clouds of black smoke out the rear. After a few such accelerations, the car will react *much* better to being punched, even feeling as though it is anxious to do it again, and there will be no trace of smoke. Owners consistently report there is no longer any trace of engine knock either, and the car runs better all around.

Obviously, an Italian Tune-Up wouldn't be a good idea if the engine has serious mechanical faults such as fuel supply problems, overheating problems, etc. It also wouldn't be good to run it through a speed trap.

OCTANE: ...ain't octane. If only things were simple. John Littler picked the following explanation up from an internet discussion; I presume that ULP stands for UnLeaded Petrol and PULP stands for Premium: "The US does things differently to the rest of the world (I bet you've heard that before!). In Australia the octane reported at the pump is the RON (research octane number). There is also another octane that you never hear about called MON (motor octane number). The MON is determined in a similar way, but under more severe conditions (so it yields a lower number). In the US they report AKI (anti knock index) which is an average of MON and RON.

"The ratings for ULP and PULP are typically:

	<u>MON</u>	<u>RON</u>	<u>AKI</u>
ULP	82.5	91	87 approx
PULP	86	95.5	91 approx

You can see that the US 91 is actually our PULP. This is the US mid-grade (also the main grade in Europe). They also have a premium grade which has an AKI of 93 or a RON of about 98."

Littler adds his own editing to this snippet: "I wish it were true that the US had a mid-grade rated at 91 AKI/95 RON. Then it would be suitable for my Jag which requires 95 RON. Unfortunately the US mid-grade is only 89 AKI/94 RON, so I have to pay for the 93 AKI/98 RON Super-Unleaded. If the Jag had a knock sensor I would risk trying the 94 octane stuff, but it doesn't, and the dealer has warned me to always use 98."

"BTW, prior to 1973 the US reported octane as RON like the rest of the world."

UNLEADED FUEL: XJ-S owners in the US have been using unleaded fuel for decades, but many owners in other countries are only recently facing the prospect of leaded fuel being no longer available. Since some of their owner's handbooks specify the use of "Four Star" leaded fuel only, they are understandably concerned.

Addressing this concern, Roger Bywater of AJ6 Engineering (and formerly with Jaguar Engine Development) wrote an excellent article for *Jaguar World* magazine (see page 674), Vol 10 No 3, January/February 1998, page 42. Some of the high points are summarized here.

There are two reasons for concern regarding the use of unleaded fuel: Octane and valve seat lubrication. Valve seat lubrication is simply not an issue in the Jaguar XJ-S; every engine the car has ever been built with has an aluminum head with hardened valve seat inserts, and the part numbers for these parts are the same for US-spec models always intended to run on unleaded fuel. If you have shoehorned in a Chevy engine old enough to have a cast iron head with no inserts and designed to require leaded fuel, well, shame on you.

Octane is another story. The US-spec engines have lower compression ratios to run on lower octane fuel. To be able to run the high compression engines on lower octane fuel, either the compression ratio will need to be lowered or the timing will need to be retarded. If the engine is being rebuilt anyway, lowering the compression ratio (different pistons, thicker head gaskets, machining the combustion chamber, whatever) may be workable, but most people will prefer to simply retard the timing. Bywater suggests that there's very little difference between a high compression engine with retarded timing and a low compression engine with advanced timing anyway.

With the Lucas ignition systems, retarding the timing is simply a matter of turning the distributor to a new setting. Bywater says that for the 95 octane unleaded that will be available in the UK and Europe, about three degrees should do it, although as many as five may be necessary for older cars with a lot of carbon buildup. On Marelli ignition cars, retarding the timing only requires pulling a jumper to switch the ignition ECU to a more retarded timing map.

UNLEADED FUEL -- AJ6 ENGINE: If you own an early ('83-87) AJ6-engined car with the Lucas 8CU EFI, you can retard your timing by simply turning the distributor. However, if you have a later ('87-on) 3.6 with the 9CU engine control system, the ignition timing is controlled electronically and not so easy to change. According to Bywater's article, there are two options: You can remount the crankshaft position sensor using the mount from the later 4.0 AJ6 engine, or you can remove the crank pulley and reposition the toothed rotor by drilling new mounting holes.

John Littler says, "Well, for around \$50US you can get a little gizmo from a number of vendors which then gives you a dial to advance or retard the stock timing by up to about 5 degrees either way (does it on the fly so it just takes 1 degree off whatever the ECU says etc). Definitely available from Summit (MSD and Crane), also available in Oz from two other suppliers as well. Lastly, seeing as I believe the AJ6 use Delco ECU's (is that right?), then a copy of the Kalmaker software will let you change anything you want on the EPROM."

THE DANGERS OF RUNNING LEAN: Most people tend to think of their car's fuel system as an on/off proposition: either you've got fuel, or you don't -- and if you don't, it won't run, so you've gotta fix it. There is, however, a third possibility that bites the Jaguar V12 owner only too often, and that is running lean.

Running lean is no big deal if you're driving gently; in fact, there are modern automobiles designed for "lean burn" operation, which means that at light throttle they can operate quite a ways leaner than stoichiometric in order to optimize fuel economy. But running hard -- in any gasoline engine, Jaguar, lean burn, whatever -- with an air/fuel ratio leaner than stoichiometric is just asking for engine damage. A Jaguar V12 that has been running lean for a year but has never seen full throttle is probably as good as new, but hold that pedal to the metal for 30 seconds and a couple of new pistons will probably be needed.

Why am I making a big deal out of this? After all, the XJ-S has EFI, which should provide reliable fuelling at all throttle conditions. The later models even have oxygen sensors that will correct for either lean or rich conditions on the fly. Why worry? Well, there's plenty to worry about. If the fuel pump or other parts of the fuel system aren't up to par, the

EFI system may provide correct fuelling under normal driving conditions, but when floored the fuel supply can't keep up -- and the engine runs lean just when it is most dangerous! And, horror of horrors, there are absolutely no warnings that you're in trouble; everything on the dash looks just great, the engine sounds just dandy, and the car has plenty of pep -- right up until it starts missing on a couple of cylinders because the pistons are toast.

If you ever intend to explore the lower half of the pedal travel on the Jaguar V12 (and who doesn't? Why else would you own the car?), it is recommended that you install air/fuel ratio indicators, which are commonly available; they are very popular with performance enthusiasts for exactly the same reason: they provide a warning before it's too late. These indicators operate off the signal of a regular oxygen sensor. If your car doesn't have oxygen sensors, you can purchase generic sensors (the heated type are recommended), and it's a simple matter to have bosses welded into the exhaust downpipes to install them. If your car already has oxygen sensors, there's no need to install more; the indicators will read the signal from the existing sensors without interfering with EFI operation.

Both Jeg's (page 667) and Summit (page 670) offer LED air/fuel indicators, and they're even reasonably priced. You'll probably want two indicators, since you have two oxygen sensors -- or perhaps you can rig a switch to read one sensor and then the other with a single indicator. The indicators usually feature three colors of LED. If the engine is running near stoichiometric mixture, LED's near the center of the display are lit, and they are usually green. The rich and lean sides of stoichiometric are usually red and yellow LED's, but some indicators have red as rich and some have red as lean; make sure you understand that it is lean that means trouble, whichever color the LED's are.

When the engine is running in closed-loop mode (warmed up, light throttle), the indicators should be reading green. When floored, the ECU goes into open-loop mode, which means it should run richer than stoichiometric. A rich indication when floored is OK. If the gauge ever starts to read on the lean side of stoichiometric while you have your foot in it, lift your foot *now* and investigate problems in the fuel system before you romp on it again.

Air/fuel indicators can help you spot a *lot* of ills, including totally unheard-of problems not covered in this book. You'll be able to monitor how your fuel system is working at all times and notice when something goes wrong.

The May 1996 issue of Skinned Knuckles has an article, "Oxygen Sensors & Air/Fuel Ratio" by Hugh Poling, in which the author points out the limitations of air/fuel indicators that use a conventional oxygen sensor for input. Some A/F indicators have three LED's, indicating lean, stoichiometric or rich. Others have more than three, apparently indicating different degrees of lean or rich; according to Poling, these indicators are wired so that particular voltages from the oxygen sensor light up particular LED's. The indicators Poling objects to are the ones that are actually marked with different Lambda values; "From the SAE Transaction pertaining to oxygen sensors, this relationship of voltage to LED markings is bogus...Since the standard oxygen sensor covers a very narrow range of only a few percent around stoichiometric, this labeling is fraudulent." In other words, an LED indicator connected to a conventional oxygen sensor is quite reliable at indicating whether you are running lean or rich, but do not rely on it to tell you *how* lean or rich.

Note that there are instruments on the market that *can* provide accurate indications of mixture within the lean or rich ranges, but you'll know if you buy one -- they are very expensive, and they do not use a conventional oxygen sensor for a signal.

OIL CHANGING: If you buy an oil drain pan from the local auto parts store, slide it under the Jag, and open the plug in the sump, you may be in for a messy surprise. The Jag V12 will drain around 11 US quarts of oil, and this is more than the capacity of many conventional oil drain pans. Either be sure to get a really big pan, or figure out how to drain the sump into two pans.

Here's an idea: Get one of those plastic oil drain tubs that features a spigot to pour the oil into bottles without a funnel. When the tub is sitting on the floor, the spigot acts as a spillover; if too much oil is drained into the tub, it'll come out the spigot rather than spilling over an edge. With the tub sitting under the engine, set *another* container under the spigot. Your total drain capacity hence becomes the total of both tubs.

A disposable aluminum turkey broiling pan works great for that second pan. If it doesn't fit neatly under the spigot as is, it's not difficult to mangle the edge a bit to allow it to sit right.

OIL FILTER REPLACEMENT: The oil filter on the Jaguar XJ-S mounts nearly vertically, the way they all should; the dirt stays in the filter as it's being removed. Considering the position, you can do your engine a favor by filling the new filter with oil prior to installing it. When you start up, you will get pressure that much sooner. You will find it helpful to use a small screwdriver or some such to poke through the smaller holes in the base of the filter and push open the flap a little to provide a vent while trying to pour oil in the center hole.

It has been noticed that some filters for the XJ-S are different from others. Some are very large, extending almost level with the bottom of the pan. Others are of conventional size. Some have a series of flats around the bottom edge to fit the socket-type filter wrench that goes on the end, and some don't. Since you can't get to this filter from the side, it is recommended you get a filter wrench that can be used from the end, and make sure the filters you purchase can be removed with your wrench. The socket-type filter wrench works well and is cheap, but requires the series of flats on the filter. There are also coil type and strap type filter wrenches that will work on most any filter; note that the coil type cannot be used to tighten the filter.

Peter Cohen says, "I have found that if I hand tighten them as much as I can with one hand with the little bit of leverage available down there, I am able to hand remove them as well." Peyton Gill adds, "I got a box of disposable latex rubber gloves (used in the medical industry). They provide additional grip and make hand removal and installation much easier plus keep your hand clean when the oil runs down the filter. These things are cheap and can be bought at drugstores. It really makes a big difference applying torque."

OIL FILTER REPLACEMENT -- EARLY CANISTER TYPE: Until sometime in 1976, the XJ-S came with a canister filter assembly. Not only does this make it more difficult to change, but more care must be taken to make sure everything is working properly. Mike Morrin says, "The cartridge filter has a bypass valve which sits inside the bottom of the cartridge, and seems to be there to bypass the filter when it gets clogged. When I had the old cartridge out and was cleaning the parts (such as the bypass valve) which get re-used, I noticed that the bypass valve was actually about half way open!! This is presumably not good for filtration efficiency. On dismantling the bypass valve, it became apparent that the alloy valve body had been strained, probably by someone tightening up the filter assembly with something not seated correctly. I was able to straighten and reassemble the valve, and it looks like it should work as good as new."

OIL ADDITIVES: Don't use any. The quintessential article on the subject is "Snake Oil! Is That Additive Really A Negative?" by Fred Rau, ROAD RIDER, August 1992, Pg 15. Transcripts of this article appear in literally dozens of places on the WWW, any search should find one. A couple such places include:

<http://www.vtr.org/maintain/oil-additives.html>

<http://members.aol.com/brnorth3/amsoil/snake.html>

For those who feel compelled to spend more money on oil than merely following the manufacturer's recommended change intervals, the following options are suggested:

1. Install a bypass filter system -- see page 110.
2. Change oil more often. In fact, changing oil ridiculously often using el cheapo oil is a very workable plan, but some consider it environmentally unwise. It's also a lot of work.
3. Use synthetic oil. Tests have indicated that synthetic oil coming out after the recommended change interval is often *better* than new regular oil.
4. Change the *filter* more often. They're cheap, and indications are they get plugged and begin bypassing long before the scheduled oil change interval.

On my car, I change the oil according to Jaguar's recommended interval (6000 miles), use synthetic oil (Mobil 1, 15W-50), and change the filter every 3000 miles.

Leaks

LEAKY GASKETS: One of the improvements Ford made to the Jaguar product line after they purchased the company was that they “Fordified” the gaskets and seals for the V12. While all of the old style gaskets look like plain paper of various thicknesses, the new gaskets are often “Gortex” (teflon) sandwiched around metal foil. This upgrade is explained in Technical Service Bulletin #12-35 dated 8/92, which states that engines were fitted with these gaskets from the factory starting with engine #8S86317SA. All of the upgraded gaskets fit the older engines, so whenever engine work is being done it would be wise to use the newer gaskets.

Redesigned gaskets, along with the new part numbers:

	<u>Old P/N</u>	<u>New P/N</u>
Oil Filter Housing	EAC6337	EBC 9624
Oil Pan Gasket	EAC7251, GEG560	EBC 9623
Cam Cover Gasket, Right	C29428, TJM536	EBC 9628
Cam Cover Gasket, Left	C29429, TJM537	EBC 9627
Thermostat Housing, Right	EAC7048, GTG130	EBC 8330
Thermostat Housing, Left	EAC7047, GTG129	EBC 8331
Valley Cover	C29485	EBC 9631
Sandwich Plate Gasket	EAC7252	EBC 9637
Coolant Manifold Gaskets	C30344	EBC 9634
Exhaust Manifold Gaskets	C33921, GEG688	EBC 10199
Throttle Body Gaskets	C33280	EBC 9635

There are more, I just don't have all the part numbers.

The original valley cover gasket was a piece of thin paper, and the new one is a piece of thin Gortex -- black on one side, red on the other. This one isn't sandwiched around metal foil; it's really flexible, it even comes all crumpled up in a bag. Offhand it wouldn't appear to make any difference which way is up, but the TSB specifies that it should be installed with the black side towards the block. If you install the valley cover while the heads are off, trim the edges of this gasket wherever they protrude out from under the cover to make sure they don't interfere with head gasket seating.

The TSB clarifies that all of the Gortex and Gortex sandwich gaskets should be assembled dry; no dressing should be used. It also specifies replacement bolts; “Revised bolts have flanged heads to prevent loosening. Do *not* use a washer on revised (flanged) bolts.” The TSB only mentions replacement bolts for the oil sump, sandwich plate, and cam covers. See the cam cover sealing discussion starting on page 57 for more ideas on this bolt replacement. Also see the discussion on sandwich plate bolt sealing on page 45.

The TSB also says that the water pump elbow gasket should be installed with the black side towards the block. Clearly, there's a new gasket there, too, even though it's not listed above.

This author ordered a set of thermostat housing gaskets by the above part numbers, and received normal paper gaskets. They are black paper and kinda thin, while the older style is thicker red paper. The only other difference I can see is that the outside edge of the newer 3-bolt cover gasket lacks the bulge at one corner, so it can fit on in any of three orientations. I have been told that Gortex sandwich gaskets do exist for the thermostat covers, but part numbers are unknown.

The original coolant manifold gaskets were apparently very thin paper and later versions were really thick pink cardboard; the EBC 9634 gaskets are Gortex/metal sandwiches, and are pretty thin. There are 12 used on the engine, although because some are used under the coolant headers and others are used under blank-off plates they may be listed in catalogs as 8 needed in one place and 4 in another. Note that the steel blank-off plates tend to distort with stress and time, especially if they've been holding down the thick paper gaskets; prior to reinstalling, it'd be a good idea to run a flat file across the bottom to make the surface flat again.

A single design gasket is used on both sides of the throttle body, between the air filter housing and the throttle body and between the throttle body and the intake manifold, so you need a total of four. The EBC 9635 gasket is a Gortex/metal

sandwich and has 7 bolt holes in it; four in a rectangular pattern, two more at 10 and 4 o'clock for the hidden bolts that hold the throttle body to the intake manifold, and a single loop that can either point straight up or straight down depending on which way you flip it. The TSB says they should be installed with the tab pointing downwards. The tab serves no purpose on the '83, and can either be cut off or left in place to hang out the edge of the assembled joint.

Mike Morrin says, "The top gasket set is Jaguar P/N JLM12229, and has all of the new style gaskets."

The new gaskets should be widely available. Be sure to check the part number or description of the gasket as some parts people may try to give you the old style to get rid of old stock.

INTAKE MANIFOLD GASKETS: During the Ford gasket upgrade, the 12 individual intake manifold gaskets C43354 or AJM687 were replaced with two gaskets; each serves all six ports on one bank. The part number is NNA-3020BA. The original gaskets were either a very hard thick cardboard or an embossed metal piece, and the new gaskets are a really thick, soft cardboard.

If you happen to have a pre-H.E., these new intake manifold gaskets pose a problem. Peter Smith reports that the sections of gasket between the intake ports interfere with installation of the vertical spark plugs used on the pre-H.E.. He also reports that the 12-piece gaskets are NLA. If you have a pre-H.E., here's a plan: set some 5/16" bolts on the floor standing on their heads and set one of the new gaskets down over them. Set the intake manifold over it, using the bolts to align the gasket with the manifold. Use a marker to mark the outline of the manifold onto the gasket. Then take a pair of stout scissors or sheet metal shears and cut that single gasket into six individual gaskets, throwing away the sections between intake ports. Let's face it, any portion of the gasket that isn't pinched between the manifold and the head is useless, it won't hurt anything to cut it away.

The spark plugs on the H.E. are canted inward and are a PITA to install, but the 2-piece gaskets don't make it any more difficult. Nonetheless, it still might be a nice idea to cut the gaskets into six pieces and discard the useless sections between ports; it results in a cleaner appearance in the vee, an area that's too cluttered already.

EXHAUST MANIFOLD GASKETS: The original exhaust manifold gaskets are sort of a metal/asbestos/metal sandwich with dimpled surfaces, and the newer ones are the same stuff except that they have added a collar around the center opening. This is a significant improvement; the earlier gaskets tend to erode from the exhaust passage outward.

DRY PAPER GASKETS: For the few places where paper gaskets are still used on the XJ-S, Walt Osborn of Vintage Jaguar (page 646) sends this tip: "When paper gaskets are stored for a certain period of time, they shrink and become hard and brittle. If you are in a hurry, just dip in warm water and pat it dry with a paper towel or shop rag. Keep doing it until it fits. If you have a little time put it in a plastic bag with a slightly damp rag. The gasket will usually reconstitute overnight. Once it is okay, remove the rag and seal the bag until ready for use."

PARTS BOOK CONFUSION: At the rear end of each intake manifold is an opening covered by a throttle linkage support plate and a triangular cover with hose connections for the crossover pipe, all held to the manifold with three bolts. It is plainly obvious that this assembly requires two gaskets, one between the manifold and the throttle linkage support plate and one between the throttle linkage support plate and the triangular cover. The August 1987 Jaguar Parts Catalogue shows this assembly on page 1C-15L and 1C-15R, but it shows only one gasket, EAC2650. It indicates two required, but all the other quantities shown on the page are per-car numbers, so one could conclude that it means one per manifold. Worse, many other sources, such as the catalogs from the mail order outfits, base their listings on this parts catalog and repeat this error. Ignore all this misinformation and order two EAC2650 gaskets per side, four total.

GASKET DRESSING: Hylomar is commonly called out in Jag manuals as the stuff to smear on gaskets prior to assembly. Note that, if the gasket in question is one of the newer Goretex or Goretex sandwich gaskets, ignore this; Goretex gaskets should be installed dry. Most ROM's were written before the advent of Goretex gaskets.

If it's a paper gasket, Hylomar works pretty well. However, Greg Fronczak of Jag Services suggests the use of a Toyota sealant in its place. It's available at any Toyota dealer as part number 023500102. This is a black substance.

When installing the intake manifold gaskets, Chad Bolles suggests "Though you do not really have to seal the intake gaskets, I do anyway. I use a non-hardening sealer that I get from a GM dealer, part no. 1050026. I have spent almost 30 years racing automobiles and have found that this sealer really does not get hard. On my race engine I have even used the intake gaskets over again, cause they just peeled right off with no tearing."

Roger Homer says, "I use some stuff from Caterpillar (The engine variety, not the garden variety!). I'm not sure of its official name/number but out here I just go into the local Caterpillar dealer and ask for a tin of Cat Red. This stuff isn't cheap, but it works well, it will seal the gasket joints but not weld itself like glue to either surface; if the gasket needs replacing later Cat Red virtually peels off both surfaces."

SEALANTS: Note that "gasket dressing" and "sealant" are two different things; a gasket dressing is used to help a gasket seal properly, while a sealant is used where there is no gasket. Nobody is strict about the use of these terms, but the wise mechanic will note how a product is intended to be used and avoid trying to use products for applications they are not suited for.

Loctite makes just about anything you'd ever need, and several of its products are referred to in this book. Steve Cranswick says, "The best sealant I have come across is the one used by Ford (and probably many other manufacturers) in place of gaskets. It is called Loctite 5900 Flange Sealant. It is 'Used for engine/transmission gasketing on pressed sheet steel, plastic and non-rigid parts, machined/non-machined parts with a large gap' and is/has excellent oil resistance, low odour, oxygen sensor safe *Very important that what you use says this*, and suitable for catalyst-equipped cars. The 5900 can seal from 0.000 inch gap to 0.5 inch gap. The fact that it is specified as a sealant capable of sealing large gaps does not detract from the fact that it is more capable of sealing tightly clamped surfaces. It's quite practical to squirt down a 2 inch long hole, as long as it's all clean down there."

"You can buy it at Ford dealers I guess, and it comes in a 300 ml pistol-grip applicator sort of tube. It's important to seal the end very well after use, otherwise the whole lot goes hard!"

Loctite's not the only source for sealants, though; James Teston points out that Herno makes similar products, and there's a Loctite/Herno cross-reference list on the www at

<http://www.herno.thomasregister.com/olc/herno/cross.htm>

SEALANTS VS. OXYGEN SENSORS: You should look for an indication that a sealant is "oxygen sensor safe" before using it *anywhere* on an engine fitted with oxygen sensors. Apparently some sealants will emit something that gets in the oil and eventually into the exhaust and ruins the oxygen sensors. Joe Bialy provides a www site that explains all about oxygen sensors, including contamination problems:

<http://www.autotrack.net/ms/archives/1999/0999/999hego.asp>

LEAKY SEALING WASHERS: For drain plugs, banjo bolts, wherever a sealing washer is used, XK's Unlimited (page 647) offers something called a Stat-O-Seal washer. It's an alloy washer with a rubber ring around the ID. They come in 1/8" increments.

Really, copper sealing washers work just fine -- once. The work-hardening properties of copper are rather extreme; when fully annealed pure copper is *very* soft indeed, but just bend or deform it a little bit and it gets very hard very suddenly. Copper sealing washers are intended to exploit this very feature; as the components are tightened down on

them, they initially crush to form a good seal and then promptly get hard. If you try to reuse one, you almost might as well use a steel washer for sealing.

Craig Sawyers points out you can reuse copper washers if you anneal them. "Heat it up to cherry red in a flame (just a plumbing gas burner will do, or even the stove) and let it cool slowly. It will then be as soft as putty, and will tighten nicely without too much torque to give a good seal." Hanging the washers with little pieces of wire makes it easy to use a propane torch on them.

Is it important to let it cool slowly? Nope! Martin Lappin says, "Unlike steel, the copper will also stay soft if you quench it in cold water. The advantage of this is it removes the oxide scale from the surface." It turns out you simply cannot quench copper fast enough to cause it to harden, at least not without special equipment; dunking it in water isn't fast enough. Michael Eck says, "The advantage is that the thermal shock causes the oxide to fall off." If you don't dunk it, you'll have to sand the washer lightly after it cools to get the oxide off.

So why am I wasting space in this book to tell you how to save a few cents by reusing copper washers? Because you need to start annealing *new* washers. Sawyers: "They are supplied as stamped from sheet copper. In other words they are in half-hard anneal. I *always* heat treat new washers to put them in a state of soft anneal. Try it and you'll see what I mean."

By annealing each time, you can apparently reuse copper seals as many times as you like. People who use copper head gaskets in competition find this a very appealing prospect. For a ten cent washer, though, you'll probably want to replace them nearly every time anyway just because they eventually get pretty mangled.

If you find any aluminum sealing washers, throw them away. They cannot be reused. In fact, they're not all that great the *first* time; replace them with copper washers instead.

Fiber washers work fine once or twice as long as you don't overtighten them, but eventually they tend to split open -- and not necessarily while you're tightening them; they may crack open later when you're 100 miles from home. Hence, it is suggested that you replace fiber washers every time you disassemble them. For the most part, copper washers are more reliable and therefore a better idea for places that are difficult to get at and you don't intend to visit again anytime soon.

LEAKY OIL DRAIN PLUG: The general comments above regarding sealing washers apply. Fiber washers seem to work fine on the oil drain plug as long as you don't use those quick-oil-change shops where the gorillas will tighten the drain plug with a power tool and break the fiber washer. You can also purchase drain plug washers that are solid plastic, usually with concentric ridges on both sides; these work well, but again it's a good idea not to overtighten. Some of these plastic washers come with a tang hanging out the side; intention unknown.

Michael Neal indicates that a Stat-O-Seal washer (or something very similar) is OEM equipment on the XJ40: "The drain plug washer for the S3 XJ6 and XJ-S can be replaced with the transmission cooler line banjo bolt seal from an XJ40, EBC4896. This is a neoprene-lined washer that is reusable, life is about a year or two."

LEAKY O-RINGS: The O-rings available at your local parts store are probably as good as the Jaguar originals -- which is to say not worth a damn. Whenever an O-ring is encountered during disassembly of the V12, it invariably is hard and brittle and has long since ceased sealing properly. Viton O-rings are the recommended upgrade, although you won't find them in your local auto parts store; you will need to visit a good industrial supply place to find them. They can be ordered in various colors, but basic Viton O-rings are black so they cannot be distinguished from regular O-rings on sight. The price is a giveaway, though; they cost several times as much. Andy Hutchinson reports: "Looked at my book today. It would seem the choice of "elastomers" (posh for rubber) is Nitrile, Flurocarbon or Flurosilicon. Viton is Flurocarbon. Excellent hot and chem resistant. Not so good cold. Flurosilicon is good at both ends but not very tough (fixed surfaces only). Nitrile is a good all rounder and I suspect the standard material. Rubber, silicone, neoprene, etc. are dogs." As long as you're not building Space Shuttle solid rocket boosters, that lack of cold performance of Viton may be acceptable; on the Jag V12, it'd be preferable to leak only in freezing weather than to leak all the time!

Viton O-rings can be ordered from McMaster-Carr (page 662).

LEAKY BANJO FITTINGS: Banjo fittings require two sealing washers. The copper washers used to seal the banjo fittings at the back end of the tappet blocks are really thin, only about .010" thick. This is too thin for reliable sealing, so chances are pretty good that these banjo fittings will leak right after assembly.

If your local auto parts store has a rack of red cards titled "Help!", it probably has a package of sealing washers that are the correct diameter for these fittings but a *lot* thicker: Part number 66272, labelled "Brake Hose Bolt Washer". It says they are ID 25/64" and OD 5/8". These washers are about 1/16" thick and will seal just fine -- but will aggravate another problem.

Craig Sawyers pointed out that the alignment of the cross hole in the banjo bolt doesn't line up with the channel inside the collar as well as might be hoped -- see **Figure 1**. The collar is about 13/32" thick, with the channel right in the middle, but the cross hole in the bolt is located only about 5/32" from the underside of the head -- and the thickness of the sealing washer between the bolt head and the collar makes this misalignment even worse. The drawing at left includes a 1/16" thick copper washer, and the two passages barely overlap. Jaguar's fix: those really thin sealing washers described above.

A better fix is pretty easy, though: using a Dremel or some such, lengthen the opening on the cross hole in the bolt in the direction of the threaded end (basically, enlarge the chamfering in that direction). This will help the oil flow to the camshafts even if the original thickness washers are used.

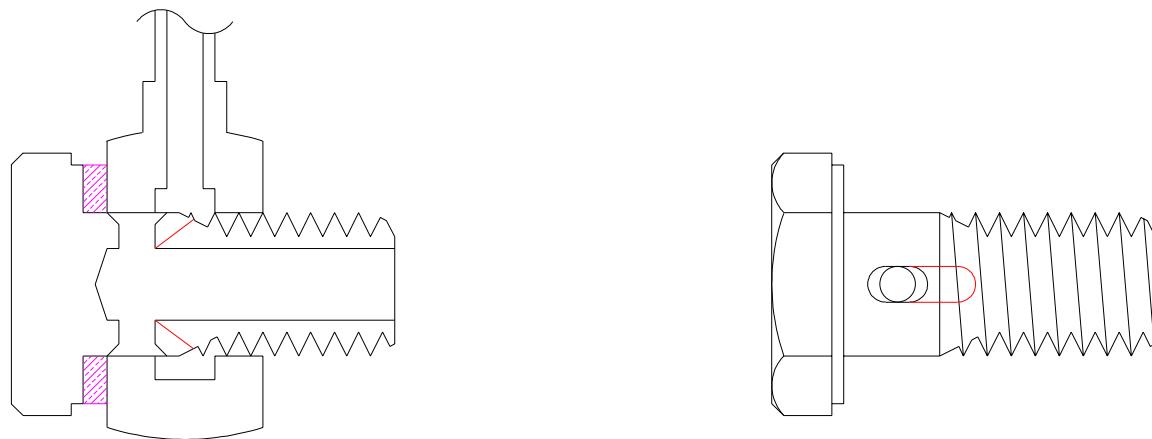


Figure 1 - Banjo Bolt Modification for Better Oil Flow

Now that you're practiced at this modification, do the same thing to the banjo bolt at the top right of the radiator -- see page 180.

If you'd prefer, Ron Kelnhofer (page 669) offers a custom banjo bolt to replace the OEM item. He includes a pair of copper sealing washers with each bolt that are 0.031" thick -- thicker than the OEM washers and thick enough to seal properly, but only half as thick as the Help! items described above. Kelnhofer located the cross hole in his banjo bolt correctly for his 0.031" sealing washers; if either the thin OEM washers or the thicker Help! washers were used with it the cross hole would still line up *better* than the OEM banjo bolt with the OEM thin washers, but nevertheless Kelnhofer suggests you use the washers he designed it for to ensure optimum flow.

He also made his banjo bolt a little longer. "1.015" long overall. The bolt was lengthened only an amount equal to the change in the washer thicknesses." It is therefore *not* a solution for the stripped banjo bolt hole problem described below. "The reason behind this is that with the limited amount of space between the head and the firewall, I wanted to keep it as short as possible but still permanently address the real issue, leaking. I could have made them longer but

actually can't see a real benefit as far as sealing is concerned by doing so. As far as stripping the head threads, my feeling is that it isn't really a problem if one uses common sense in tightening the bolt."

Kelnhofer's banjo bolt is made of stainless steel. You can look at a pic of this bolt at

<http://neptune.spacebears.com/cars/engr/banjoeng.html>

When tightening banjo bolts, be sure to hold the collar still. Failure to do so will allow the turning of the bolt to twist the collar and bend the tubes.

STRIPPED BANJO BOLT HOLES: The banjo bolts thread into the back ends of the tappet blocks only about 0.35", even though the holes are tapped more than an inch deep. That's not much thread engagement for screwing 3/8" bolts into soft aluminum, and combined with the fact that the banjo fittings often leak at assembly due to the thin copper washers, it's only too common that a mechanic tightens them too many grunts trying to stem a leak and winds up stripping out the threads in the tappet block. This will require many pints to get over since it would normally require removing the tappet block to helicoil, and removing the tappet block requires removing the camshaft, and removing the camshaft requires fiddling with the timing chain tensioner -- see page 62.

Modifying the banjo bolt and using thicker copper washers, as described above, will solve the sealing problems and make it unnecessary to go cranking on that banjo bolt so hard -- but it also means that there are even less threads engaged, so being judicious about tightening is highly recommended.

Nick Johanssen and Craig Sawyers report that the Jaguar Enthusiasts' Club (page 681) offers longer banjo bolts. "A get-you-out-of-trouble idea for a temporary way of avoiding the removal of the cylinder head if the original bolt's thread strips. This bolt has extra threads to take up with the deeper threads always present, but not always made use of." He means avoiding removing the tappet block rather than the cylinder head of course, but it's still a task to avoid.

Of course, it might not be a bad idea to install the longer banjo bolts *before* the threads strip.

Note: the JEC banjo bolts are nice and long, but the cross hole is still in the wrong place. Before installing, you will need to modify them per the guidelines above.

Sawyers warns that before you get all excited about installing the longer banjo bolts, you consider how much clearance you have to install them. "I trial fitted the tappet block back to the head to see how much room there was to get the banjo bolt back in, and the stock one is about the limit on length to clear the firewall on the rh bank. Groan."

There are ways to get longer banjo bolts in. The most obvious method would be to gently bend the oil line upward until it clears the back end of the tappet block, insert the long banjo bolt with one sealing washer around it, then gently bend it back to the proper position. Use a length of dental floss to hold the second sealing washer in place, get the banjo bolt started, then cut the dental floss and pull it out. This will work, but obviously you don't want to do it a dozen times; eventually the tube will crack and you will need a new one.

To ease this problem, you could unscrew the banjo bolt from the pedestal or unbolt the pedestal itself, which will allow moving the oil feed manifold around much more easily. This will allow moving the ends out from behind the tappet blocks more easily -- and if you're coordinated, you might consider putting the banjo bolts into the fittings for both tappet blocks at the same time rather than bolting one down and then bending the tube to install the second.

LEAKY OIL PRESSURE SENDER CONNECTIONS: The connection at the block at the rear center of the V is a larger banjo bolt. For this fitting, Help! number 66265, "Brake Hose Bolt Washers" are a perfect fit. They are described on the package as ID = 33/64", OD = 45/64". These same seals fit the bolts that hold the heat shields to the exhaust manifolds -- see page 296.

The seal on the oil pressure sending unit itself is not the same size as on the banjo fitting. The sending unit fitting is the same diameter as many common oil drain plugs, though, so it is easy to find a suitable seal in an auto parts store. Note, however, that if you're buying a new sending unit, it will usually come with a new sealing washer.

LEAKY OIL PRESSURE SENDER: When searching for sources of oil leaks, don't overlook the oil pressure sending unit itself, C46272. The unit can fail internally and oil comes seeping out of the electrical connector, a sure sign of trouble since there isn't supposed to be any oil within the electrical components in this unit. The author's car had this problem, and the gauge was still working just fine. The only solution is to replace it; a sender with silicone sealant around the connector is a sure sign that an incompetent mechanic has been involved.

For more on this sender, see page 53.

LEAKY OIL PRESSURE SWITCH: The oil pressure switch, which operates the warning light, is right next to the oil pressure sender -- and is even more notorious for leaking oil out through the electrical connection. The only solution is to replace it, but that's not difficult because the thread is standard and there are lots of cars that use very similar pressure switches. David Johnson says, "I screwed one from a Chevy in. The new one was a two wire type, so I simply connected one side to ground and it works fine."

OIL LEAKS AT FILTER HEAD ASSEMBLY: Peter Smith says "The oil would gather around the top of the filter less than a minute after starting the engine. I eventually took the head assembly off and found a blanking bolt fitted to the rear which had a failed fibre sealing washer. Replaced it with a copper washer - no more leaks. I had to take the head assembly off to see the bolt but when you know it's there it may be possible by feel."

OIL LEAKS AT CAM COVER/HALF MOON SEAL: Discussed on page 57.

OIL LEAKS AT TAPPET BLOCK: Discussed on page 68.

OIL LEAKS AT TIMING CHAIN TENSIONER ACCESS COVER: Before going any farther, please read the warning about having the cam covers off on page 57; the same warning about dropping parts inside applies here.

The access to the timing chain tensioner latch is via an opening on the timing chain cover, forward of the right bank and just above the support for the belt-driven fan. The purpose of this access is for locking or releasing the tensioner during overhauls; there is no need for periodic adjustment, as the tensioner is self-adjusting.

The rubber plug always seems to get hard and crumbly. People with the new one in hand sometimes assume there has been a material change, since the new one is soft and pliable while the old one appears to be Bakelite. Looking at the ears on the new one can also lead one to believe that it's a push-and-turn type of cover, like a radiator cap. No such luck; it's a simple round hole, and the ears are supposed to be flexed to get it in and out. The old one will probably have to be removed in pieces. If a piece or two falls down inside, don't worry about it, they're too soft to do any serious damage. They'll probably just come out in the next oil change; it's definitely not worth further disassembly.

Note that this is an opening into the crankcase and should be well sealed to prevent oil vapor leakage, as well as to keep the PCV system working properly to minimize oil leaks elsewhere. Chad Bolles suggests "...apply a thin coat of GM Gasket Sealing Compound part no. 1050026 (stuff never gets hard) and press in the new plug and you are good to go."

Jim Isbell didn't like how much grief was required getting the plug out after it had dried up, and determined it wouldn't happen again. "I have cut the tabs off of the rubber plug that fills the adjustment hole for the chain tensioner. I have made a simple aluminum "L" shaped piece that fits under a water pump bolt and holds the plug so it won't fall out."

If desired, the opening may be plugged with a compressible rubber type freeze plug. This may even be preferable to the original plug, since it will make a reliable airtight seal. Be sure that the plug does not interfere with the timing chain or the operation of the tensioner.

It isn't too difficult to make an aluminum plug for this hole with provision for fitting an O-ring for sealing. **Figure 2** shows a design.

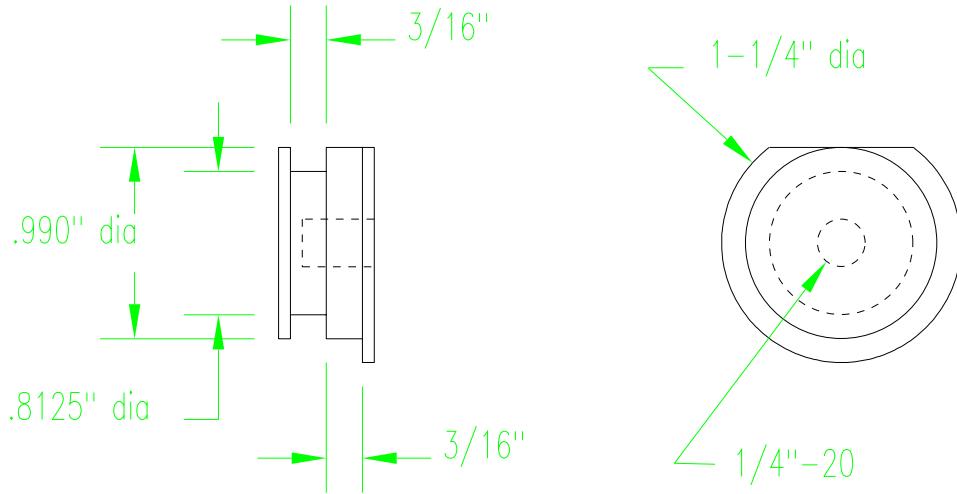


Figure 2 - Timing Chain Tensioner Access Hole Plug

One such plug was machined by Ron Morse and successfully tested on the author's car; you can see a picture of this installation at

<http://www.jag-lovers.org/xj-s/book/TensionerPlug.html>

Note that, even though this plug fits snugly in the hole when fitted with a proper Viton O-ring (#210), it lacks any positive retention and therefore might blow out if pressure builds in the crankcase for some reason. Since you don't want to lose it after paying to have it made, something similar to Isbell's little tab under a water pump bolt is in order to make sure it stays put. The threaded hole in the center is to aid in removal when you actually want to get it out; just screw in a 1/4" screw and use it to pull or pry on.

If you don't want to make your own, Ron Kelnhofer (page 669) has some for sale. His are very similar to the illustration shown except that he has added a retention scheme, a checkball that can be engaged to grip the side of the opening so a separate tab under a bolt head is not necessary. You can see a picture of his plug at

<http://neptune.spacebears.com/cars/engr/tension.html>

OIL LEAKS AT SANDWICH PLATE BOLTS: The bolts that hold the sandwich plate to the bottom of the block are threaded into holes that open at the top to the outside of the block; if you used bolts that were too long, the ends of the bolts would stick up through the flange and be visible from outside the engine. This arrangement was no problem with the oil pan used on the SIII E-Type, since the bolt heads were likewise visible from outside the engine and the gasket would seal between the pan and the block inboard of the bolt holes, so the bolts themselves would remain dry. When the sandwich plate configuration was introduced in the XJ12 and XJ-S, however, a widened oil pan was provided at the rear end of the engine and the heads of some of the bolts holding the sandwich plate to the block are completely enclosed within the pan. These same bolts also hold a baffle tray in place, but since everything is inside the crankcase, no gaskets are used.

The result is that oil can seep into the space surrounding the bolts and then upward through the threads and come out on the outside of the block. Not good. If the sandwich plate had been introduced with the V12 at the outset, they probably would have made the holes in the block "blind holes" so oil couldn't leak through; this was done in several other places, as though someone was thinking about it at the time.

Jaguar apparently figured out the problem -- in 1994. That's the date of Technical Service Bulletin 12-53, which describes a simple fix: Drain the oil, remove the oil pan, remove the guilty bolts, clean the oil off the bolts and out of the threaded holes, apply a thread sealant to the bolt threads, and reassemble. This is a snap, and well within the capabilities of anyone capable of changing their own oil -- and is convenient to do during an oil change, and won't even add much time to the job.

The TSB specifies that "Loctite Primer" be applied to the hole threads. Bob Gallivan says: "Loctite has a publication titled "Do It Right Users Guide". Listed under the category PRIMERS:

	<u>item #</u>	<u>size</u>
7471 PRIMER T [Acetone]	19267	1.75 oz
	22477	4.5 oz
7649 PRIMER N [Acetone]	21347	2.5 gm aerosol
	19269	1.75 fl. oz bottle
	21348	4.5 oz aerosol
770 PRISM PRIMER [Heptone]	18396	1.75 fl oz
712 TAK PAK ACCELERATOR [Isopropyl Alcohol]	20352	""

"They say to use the 7471 on oily threads, I'm guessing it's a cleaner."

Joe Bialy quotes a Loctite handbook on the spray version of 7649 Primer N: ""Cleans parts and speeds cure; use with any thread sealant". According to their handbook, it is required when threadsealing aluminum and stainless steel."

For sealing, the TSB specifies that Loctite 545 be applied to the bolt threads. Note that 545 would mean a sealant, not to be confused with the Loctite 6-series products that are threadlockers. Earl Huff found that Loctite 545 was an industrial product not generally available to the home mechanic, so he called Loctite for advice: "Their technical assistance people were very helpful and suggested where I could locate some of the stuff, albeit in a larger quantity than I'll need for several lifetimes. It seems that what is called Loctite 545 for automotive work is also known as Loctite "hydraulic-pneumatic sealant" at industrial supply houses (Part # 51456 or 81802). Then, after learning what I intended to use the stuff for, the very helpful fellow I spoke with said that Permatex silicone RTV sealant or even the #2 sealant would probably work just as well."

The TSB indicates that there are 9 bolts involved on the XJ-S but only 7 bolts on the XJ12. It's unknown where they got these numbers or why they would be different; on this author's '83, there are 8 bolts that required sealing.

The TSB mentions that the bolts and gasket involved were upgraded after engine 8S 86317 (or 8W 10641 on XJR-S cars), so if your engine is earlier than these numbers you're supposed to replace the bolts and use the newer style gasket EBC 9623 when reassembling.

It's probably not the same bolts that need upgrading and sealing. There are two types of bolts on and within the oil pan on a pre-metric engine (pre- 8S24175): 5/16"-18 Grade 5 bolts 1-3/4" long with spiral groove washers that go through the sandwich plate into the block, and 5/16"-18 washer-faced bolts 3/4" long that thread into the sandwich plate itself. The bolts that need sealing are the 1-3/4" ones with heads within the sump. The 3/4" screws have the dreaded triangulated threads that strip out holes in aluminum, so these bolts were probably the subject of that upgrade.

Chances are good that the bolt upgrades are similar to that for the cam cover (see page 57), so using the same strategies for non-Jaguar bolts described there would probably work here as well. You'll need nineteen 5/16"-18 bolts 3/4" long. Grade 5 hex head bolts would work well, Grade 8 even better. Since you probably won't have washer-faced heads, you'll need washers as well -- the 8mm spring washers described on page 26 will work nicely.

Although it's probably not necessary, you could also replace the 1-3/4" Grade 5 bolts with Grade 8's. You'll need fifteen. Finding 1-3/4" Grade 8 bolts is not always easy, so let me make it easier for you: get 2" bolts instead. They fit *better*. You can reuse the spiral groove washers.

Of course, you might also consider replacing all the bolts you can get to on the front half of the sandwich plate that aren't associated with the oil pan. On a pre-metric engine these are 5/16"-18 bolts 1" long and there are eighteen of them, but you probably won't want to try to get to four that are above the crossmember for the front subframe.

On metric engines, all of these bolts are probably 8mm instead of 5/16" and the lengths are multiples of 5mm. It's probably the same number of bolts of each length, though. Remember that metric class 8.8 is roughly equal to Grade 5 and metric class 10.9 is roughly equal to Grade 8.

When sealing and/or replacing bolts that hold the sandwich plate to the block, it'd be a good idea to do one at a time since you don't want to disturb the upper gasket.

SANDWICH PLATE GASKETS: If you're doing the job described above to seal the sandwich plate bolts, it makes sense to buy just the lower gasket. If you're addressing gasket leaks, one could argue that replacing the lower without replacing the upper is a waste of time. Of course, replacing the lower with the engine in the car is easy, replacing the upper is not. You could argue that replacing just the lower is worth a try, and if it doesn't work you can go back and do them both and buy a second lower gasket.

When you have the stamped sheet steel pan off, set it down right side up and clean up the flat upper surface. Inspect the holes closely. If they seem to be dished upward a bit from the bolt tension, set the ball end of a ball pein hammer in the hole and whack it with another hammer. The metal around the hole should end up slightly dished downward. When you tighten the bolts down the area will be pulled back flat, but compression will be applied more uniformly over the area of the gasket.

As a point of information: Jaguar didn't provide a sandwich plate between block and oil pan just to maximize leakage. The sandwich plate is structural; bolting it to the block makes the block assembly more rigid. Rigidity is very important; when an engine operates at high power, the pulses at alternating cylinders can cause the block to twist and flex. This can misalign the main bearings holding the crank and cause them to get wiped out. When a block is thick cast iron it might be rigid enough for everyday use, but when you're designing a long V12 block made of aluminum and intended for high performance work, you need to do what you can to maximize structural rigidity.

Craig Sawyers provides actual specs:

Torsional stiffness in lbft/degree

Bare block: 5445

Block with cylinder liners and sump: 40,830

Heads, block and sump: 111,700

"Now admittedly this was the original Series III E-Type engine, in which the sump was a large and deep aluminium casting. However, I believe that the general principle still holds: the sandwich plate is indeed structural."

Unfortunately, Jaguar may have dropped the ball here. If the sandwich plate is structural, the joint between block and sandwich plate needs to transmit shear loads. It should therefore have close-fitting dowels, probably a half dozen, to unite the block with the sandwich plate structurally. It doesn't, however, so only the bolts (which fit too loosely in the holes for transmitting shear loads) and the gasket itself hold the two parts united. The shear loads can be expected to be hard on the gasket, and putting a thick cork gasket in here in place of the thin OEM gasket would probably be a serious mistake. Reportedly a Ford engineer once opined that this joint will always be inherently prone to leakage.

SEALING THE DIPSTICK TUBE: The dipstick tube just slides into a tube on the crankcase and is held in place by a bracket bolted to the top of the head. It's not sealed. Of course, it'd be a nice idea to seal it; the fewer leaks, the better, and even if the dipstick itself doesn't seal perfectly (although it just might -- it is a decent design) it'd be a lot harder for oil to find its way all the way to the top of the tube than to leak out right there at the bottom.

Some ideas for sealing this thing: You might apply a sealant to the end of the tube before sliding it back in. Loctite 573 might be a good choice (see the section on sealing the tappet block on page 68). Or, you might fit a small O-ring around the tube before installing it, and make sure that the bracket arrangement holds the tube firmly so it applies a little

compression onto the end of the fitting on the crankcase. Of course, Viton is preferred. Or, if you can get your hands in there, you could slide a piece of hose over the joint and clamp it on both sides of the joint.

OIL IN AIR INTAKES: Robert Dingli explains the oil that always seems to collect in the air filter housings and around the butterflies: "What you are noticing is probably a mixture of a small amount of engine oil that has been forced out as a vapour from the crankcase by blowby gas which has then condensed within the inlet manifold. You may also get some residual fuel (usually the heavier fractions) leaving an oily film. This is normal even for new engines but will tend to get worse as the engine wears.

"On engines which have the inlet manifold sloping down from the head, there is usually quite a puddle sitting in the plenum. The first time I noticed this was when one of the vacuum lines became blocked. It turned out to be the line which connects to the underside of the plenum. I have since re-routed that line and plugged the connection. Whenever I remove the plug, a thick deep red oily mess dribbles out. The red colour is obviously the remnants of petrol (leaded petrol in Australia is coloured red) which has run down into the plenum after the engine has been stopped. The lighter fractions tend to evaporate when the engine is next heated.

"Very occasionally, I have been known to pour a small amount of petrol into the plenum to dissolve the goo and then drain from the lowest point."

FREEZE PLUGS: Apparently a US-only misnomer; English-speaking countries reportedly properly call them "core plugs". Some US parts places call them "expansion plugs". Alex Dorne clarifies, "I can tell you that the freeze plugs are not meant to rescue the block if the coolant freezes. Due to the casting process they were necessary to make mantling of the block possible." Of course, that doesn't mean they won't pop out when the coolant freezes! However, in warmer climates the most common failure is rust-through.

If you need to replace these plugs for whatever reason, you will find several versions available, including simple steel or brass cup-shaped plugs and copper or rubber assemblies with a bolt through the center for compressing the plug to expand it into the opening. Dorne: "Most common material seems to be steel for automotive use but when working in the marine business I found out that copper is used on "factory built" marine engines to prevent corrosion problems when fresh water cooled.

Note that the original plugs are concave side out, but replacements are installed the other way. "Installing the plugs is a piece of cake (if the block is out of the vehicle, of course). Place the plug in its seat, convex side out, hold a ball ended hammer in the center of the plug, give it a hit with a second hammer. This flattens the plug and increases the diameter a little bit. I think it's a good idea to use some non-hardening sealant on the seat before placing the plug."

If the cupped plug is a little too tight to install, it is a simple matter to make it a little smaller. Set the plug in a large socket or box end wrench, put a steel ball (or the head of a ballpein hammer) in the center and hit it with a hammer.

Since the Jaguar V12 has an open-top deck design, there is little reason for other casting openings and there are no plugs on the side of the block. There is one plug on the rear end of each bank, within the bellhousing. On the head, there are three 7/8" plugs on the exhaust side, four 7/8" plugs on the intake side (visible within the V), and one 1-3/8" plug at the back end.

PCV SYSTEM: The way a typical PCV system works is pretty simple: A scheme is provided that draws fresh air into one side of the crankcase and out another and into the engine. This serves at least three purposes: First (and foremost to emissions regulators) it prevents the vapors gathering in the crankcase from escaping into the atmosphere. Second, it provides fresh air inside the crankcase rather than yucky fumes, some of which may be corrosive or explosive. Third, the suction causes a slight vacuum within the crankcase, which causes leaks to leak air in rather than oil out. For these benefits, there are essentially zero disadvantages other than the minimal cost of the components. There once was a concern about effects on fuel mixture, but when carburetors were superceded by EFI that concern evaporated.

Dave Osborne says you can learn more about typical PCV systems at:

<http://www.filtercouncil.org/techdata/tsbs/94-2R.html>

Unfortunately, this all describes a typical PCV system -- not the one in the Jag. Rather than the flow-through scheme of a typical system, the V12 has only one opening into the crankcase. This vent is connected to a chamber built into the LH air filter housing. The chamber has a fairly large opening into the air filter housing itself. The PCV valve is *also* connected to this chamber. Flow-through ventilation of the crankcase is clearly not possible. It's doubtful such a system will apply a significant vacuum to the crankcase, other than when the LH air filter is plugged up. The only objective it will achieve is pollution control; vapors cannot escape the crankcase without going either into the air intake or into the inlet manifold.

LEAK CONTROL VIA PCV: In the July 1999 issue of Jaguar Driver magazine, Crispin Hales relates a story about a V12 E-type that had been converted from the original Zenith-Stromberg carburetors to SU's by a previous owner. The car leaked oil badly, and one by one all the leaks were corrected except for the rear main seal. After procrastinating for years about fixing the rear main seal, it finally occurred to Hales that perhaps the PCV system was at fault. Sure enough, whomever had converted the car to SU's had removed the PCV system in entirety. Simply installing a new PCV system caused the rear main seal to stop leaking.

It's unknown what the PCV system on the SIII E-type looks like, but it wouldn't appear that the system on the XJ-S would help reduce leaks this well. Of course, you should fix the leaks! But perhaps it'd be nice to achieve the leak reduction benefits of a typical PCV system on this V12.

It would be easy enough to make this system work like a typical PCV system: remove the PCV valve from the chamber on the LH air filter housing and plug that hole, leaving the crankcase vent connected to the air filter housing via the chamber. Install the PCV valve into the crankcase itself. That way, the PCV valve will draw air from the LH air filter housing into the crankcase through the metal mesh, through the crankcase, and through the PCV valve into the intake manifold.

Of course, there's no hole to connect the PCV valve to! You'll have to make one. As far away from the existing vent as possible is good, but not essential. You want to avoid any place where there's a lot of oil splatter that the PCV might suck up, but most engines put it right in the valve cover so installing it in the RH cam cover should work just as well. If you're good, you can drill a hole in the cam cover that's the same size as the hole in the chamber where the PCV valve was originally installed so you can install the same valve in the same grommet.

Other options would be to find a way to connect it to the plug for the timing chain tensioner or to a half moon seal. Either way would avoid cutting on expensive metal parts.

Remember that you're not bound by the original PCV valve. A check through the selection of PCV valves and grommets in an auto parts store may generate some ideas. Some PCV valves have a 90° fitting on them, which might be helpful.

If you manage to install the PCV valve somewhere in the right rear area of the engine, note that you should be able to take the tube connecting both intake manifolds to the PCV valve off and turn it around backwards and reinstall it, providing a ready connection to the right rear. Of course, you can just connect up some hoses to the same fittings and route them anywhere. Connecting to both manifolds is probably good, since you want to have the same effect on mixture on both banks.

PCV FOR WORN ENGINES: In the course of maintaining a slight vacuum in the crankcase, the PCV system must deal with whatever leaks exist to allow air into the crankcase as well as blowby from the piston rings. As the car gets worn, both of these leakages tend to increase, until eventually they overpower the PCV system capacity and the car starts blowing oil from every crevice. Obviously, it is of considerable importance that the owner take care to maintain the integrity of the crankcase containment; an opening into the crankcase will not only cause an oil leak at that location, but it will also allow air to enter and reduce the effective vacuum in the crankcase and thereby cause oil leaks elsewhere. A

classic location for such a leak on the Jaguar V12 is the timing chain tensioner cover (see page 44), but any opening into the crankcase will do it. Make sure your dipstick is seated properly, make sure your oil fill cap has a good gasket under it, etc., etc.

With a very worn engine, the piston ring blowby may overpower the PCV system even if all the crankcase openings are properly plugged. The EPA doesn't really care as long as the air intake to the crankcase comes from the air filter housing; when the vapors overpower the PCV, the excess comes out into the air filter housing and gets pulled into the engine anyway. It just makes the inside of the air filter housing grungy. The systems the EPA don't like are the ones with a vented oil filler, where the excess vapors get blown all over the engine compartment and out the bottom of the car.

Of course, you might not care for the main oil seal leaks that result when the PCV system is overpowered. It has been suggested that, even though an engine rebuild at this time is prudent, the addition of a second PCV system may help keep the oil leakage to a minimum until you can schedule enough time for an overhaul. Back in the days of carburetors, adding a second PCV system would have been troublesome because you would have to figure out how to get enough fuel into the engine at idle when all that intake air was bypassing the carburetor venturis. However, with EFI you really don't have anything to worry about; just install it and the EFI system will meter the fuel accordingly. You may have to adjust the idle speed screw a bit. Note that the piston/ring wear rates on the Jaguar V12 are so low that if you are considering this band-aid fix on an engine with less than 200,000 miles, you are advised to look for damage or leaks elsewhere first.

PCV VALVE: The genuine Jaguar PCV valve is part number C 44231, and the valve itself is stamped E7 AC 3848. This thing costs about \$40. That's extortionate.

Kelly Spongberg says, "I replaced ours with a generic jobber one made for older Ford V8 engines. It is exactly the same size, and seems to work fine."

A quick review of the selection of PCV valves at a local auto parts store revealed that it may be difficult to find a PCV valve that *won't* fit the Jaguar V12. There are a couple that appear nearly identical, such as the Fram FV202. There are a bunch more that are the same shape except they have a hose barb on the outlet end -- but since that end gets jammed into the grommet in the chamber on the LH air filter housing, you *won't* see it and it'll work fine. There are yet a few dozen other PCV valves that appear the same as these except that they have an "F connector" on them that allows the connection of two hoses; you can just pull the F connector off and install it in the Jag. There are even "generic" PCV valves that come with a selection of F connectors; throw all the connectors away and use the PCV valve as is.

Of course, there may be a good reason why there are dozens of PCV valves available that all appear interchangeable: they may have different innards, like different springs or port sizes so they flow differently at different operating conditions. Dave Osborne bought a valve that was visually nearly identical to the Jag valve for \$3. However, when installed the idle was 100 RPM lower than before. Apparently the Jag valve has a stronger spring in it that holds the valve a bit open at idle, while the Ford valve has a weaker spring and is totally closed off at idle.

Big deal? Perhaps not. You can simply readjust the idle. And, considering the way the PCV system works on this car, it's questionable if the PCV valve does anything of value anyway.

Fault Diagnosis

MISFIRE: With 12 cylinders, some people might not even detect a misfire. An easy way to check -- as well as to tell which bank is acting up -- is to fold a dollar bill in half and hold it over an exhaust pipe outlet and listen to the flapping that results; a misfire is usually obvious. Steven Draper adds, "According to the most recent Jaguar Repair Information Periodical, the official procedure is to use a one hundred dollar bill and send it to the dealer for evaluation. Unfortunately, the bill cannot be returned."

COMPRESSION CHECK: First, a brief description of how to properly perform a compression check on any car: The battery and starter must be in good condition. *All* of the spark plugs should be removed. Power to the ignition system should be disconnected, since an electronic ignition system may be damaged trying to fire with the spark plugs disconnected. And the throttle should be held at least part way open, usually by jamming something in the linkage. On a car with EFI, it would also be helpful to disconnect the power to the EFI system or fuel pump to prevent fuel flow. With a compression gauge fitted to one spark plug hole, the engine should be turned on the starter through several compression strokes, until the reading stabilizes at a peak value.

On the XJ-S, it would be most helpful to have the type of compression gauge that screws into the spark plug hole and has a lengthy hose. Trying to hold the press-in-place type on this engine is not easy. Also, since the A/C compressor usually has to be removed to get at the front plugs, you will probably have to run the test with a dangling drive belt; try to position it so there is no tension on it, and the crank pulley can turn within it without driving it.

On the US-spec pre-H.E. engine, the readings typically will be about 130-150 psi. The US-spec 5.3 liter H.E. engine has 11.5:1 compression, and will read about 200-220 psi. Note that readings will be lower at high elevations.

Keep in mind, however, that the absolute values are not as important as the relationship between them. There are dozens of factors that could affect the absolute values (including the calibration of your gauge), so if your readings are all a little higher or lower than the above, don't worry about it. But they should all be nearly the same; one significantly lower than the others is not a good sign.

If one cylinder reads low, it is customary to add a couple tablespoons of motor oil into that spark plug hole and test it again. In theory, the oil will temporarily seal bad piston rings but won't seal a burned valve, so this test may indicate the level of disassembly needed. Of course, the oil probably won't seal a burned piston or a hole in a cylinder liner, so the results are best taken with a grain of salt. Either way, the head has to come off.

LEAKDOWN TEST: The leakdown test is gaining in popularity among mechanics, who feel that it gives a better indication of the actual quality of the sealing of the compression chamber than the compression check. To perform a leakdown test, compressed air at a known pressure (usually 100 psig) is fed through a device with an orifice in it and into a cylinder via the spark plug hole. The pressure downstream of the orifice is measured, and the leakdown rate is calculated as the percent which the pressure dropped across the orifice. If the leakage out of the cylinder is very low, the pressure after the orifice will be very close to the pressure before the orifice, and the percent of pressure lost will be low. If the compression chamber has big gaping openings in it, the main restriction in the flow will be the orifice itself, and the pressure after the orifice will be closer to ambient -- and therefore the percentage lost will be much higher.

Note that, when doing such a test on the Jaguar V12, it'd be a good idea to take the oil filler cap off the left cam cover. We wouldn't want a well-sealed crankcase (hah!) to cause unwarranted favorable readings. Also, just in case there's a leak in a head gasket, the radiator cap should be removed to prevent pressure buildup in the cooling system.

Kyle Chatman points out that if the leakdown test finds excessive leakage in a cylinder, it *might* be possible to determine whether the leakage is from the rings, the exhaust valve, or the intake valve by listening closely at the oil filler cap, the air intakes, or the exhaust pipe outlets. And a bad head gasket might cause bubbles in the coolant (especially if it's the center cap that was removed) or other motion in the coolant level.

It's entirely possible that the leakdown test is highly regarded simply because it gives results in percent. It should be pointed out, however, that the percent has no real basis and is entirely dependent upon the size of the orifice in the test device -- and Randy Wilson says "and there is no such thing as a standard orifice size." In order to be able to compare the results of one leakdown test against another, it would be necessary to confirm that the orifices used were the same size and had exactly the same flow characteristics and that the same air pressure was used for the tests.

Wilson adds: "Next question is: How much air leakage is acceptable? This all depends on how big the cylinder is. The bigger the bore, the more ring area there is to leak by. Typically, the valves are bigger, too. Here we could really use a percent of leakage vs. base volume, but our tester is effectively measuring finite volume of flow."

There are other concerns involving leakdown tests. For one thing, since the engine does not turn during the test, it really only gives an indication of the leakage at one piston position. While this is usually adequate, it may fail to identify certain types of problems such as localized damage on a cylinder wall. Perhaps the careful mechanic could slowly turn the engine over by hand while doing the leakdown test, and watch the gauge for variance in the readings.

The leakdown test does have the advantage, however, that if a mechanic is using the same leakdown tester at the same pressure all the time, he can get a *real* good idea of just what condition cars are in. While compression readings will always vary from car to car, the percentage readings from his trusty leakdown tester should give very consistent indications on cars in similar condition regardless of compression ratio or other variables.

HEAD GASKET CHECK: Michael Neal suggests two methods of checking the integrity of the head gaskets. First, remove the rubber hood that connects the PCV system to the engine just forward of the oil filler cap, and look inside it. Milky deposits are an indication that water is getting into the oil, usually a sign of trouble.

For a more definite check, Neal recommends removing the spark plugs, pressurizing the cooling system to 15 psi, and leaving it overnight. Then have someone turn the starter while watching the spark plug holes. Mist (or worse, a solid stream of water) coming out of a plug hole means it's time for engine work.

Of course, pressurizing the cooling system usually calls for a special tool. It basically is an adapter radiator cap and a hand pressure pump; Stant is the common manufacturer and it runs \$60 to \$70. In a pinch you could tee into the small hose on the center fill pipe and apply pressure.

TAPPET NOISE: Roger Bywater of AJ6 Engineering and formerly with Jaguar engine development, says, "In fact a recognised source of tappet noise on the V12 is excessive side clearance of the tappet in the aluminium carrier allowing it to 'rattle about'. Remember the XK used cast iron tappet sleeves and they expand and contract at the same rate as the tappet so the clearance remained more or less constant. This does not happen on the V12 and the minimum diametral clearance is set by the need for a top size (high limit of tolerance band) tappet to not jam in a bottom size carrier bore at minus 40 degrees in a Canadian Winter. The other extreme of a bottom size tappet in a top size bore could well be quite sloppy when fully warm and the way the cam moves it around can be very critical. Cam profile, tappet clearance, side movement, rotation and rock-over at peak lift, as well as valve seating geometry, all come into what is actually quite a complex phenomenon. For the record the range of diametral tappet clearances involved run from about 0.0005" to about 0.002" at room temperature. I wonder how many engine builders have even thought about measuring such things?"

OIL PRESSURE: An oil-fed sleeve bearing, such as used in the main and connecting rod bearings of automobile engines, is an excellent device -- much more so than most people understand. When the parts are rotating, the parts ride up on a film of oil, much like skimboarders skim easily across very shallow water and seem to coast forever. When operating properly, the metal parts do not touch each other, and there is essentially zero wear. The friction is entirely within the film of oil.

This system doesn't work at a standstill, however, the same way the skimboarder will sink to the bottom when he stops moving. The entire reason engine bearings have a soft, replaceable surface is because they must ride on this surface for a very brief time at startup, before oil is pumped to the bearings and before the bearings establish a film to ride on. The hard steel surface of the crankshaft should slide on the soft bearing with very little wear on either, but startups still account for the vast majority of normal bearing wear.

The shearing action of the oil tends to heat it somewhat; there is very little heat generated from shear, however, and many cars get by without oil coolers. The main cause of heating of the oil is by contact with hot parts, notably the bottom surface of the pistons.

The pistons are likewise supposed to skim up and down the cylinders on a similar film of oil. It doesn't work nearly as well, though, since the piston stops at each end of its travel for an instant, and because there is a less positive flow of oil to this area.

This system also does not work very well for the contact between the camshaft and the followers. This is because the contact area is a very thin line rather than a broad area. If one of the two parts were as soft as the crankshaft bearings are, the force at the contact point would quickly tear it up. In the Jaguar V12, these parts are immersed in oil during operation. This ensures they are adequately lubricated, even during startup since the oil stays there, but it also generates more heat churning the oil.

There are two primary bearing failure modes in any engine that result from lubrication problems. The first and most easily understood is excessive wear and damage due to lack of lubrication. The second is bearing overheating due to insufficient cooling oil flow. These two are very different; in the latter case, the bearing may have enough lubrication to prevent wear, but gets hot enough to melt the soft bearing material because the same oil is staying in there and getting hotter and hotter, rather than cool oil flowing through.

All engines tend to display a drop in oil pressure at idle; the pump moves less oil when the engine is turning slower, but the openings through which the oil flows are the same size no matter what the engine speed. The Jaguar V12 is no exception, and sometimes shows lower oil pressure when hot and idling, especially when it has a few miles on it. The V12, when running on all cylinders, can idle very slowly, causing even lower pressure. This causes many XJ-S owners to panic, and some to take poorly conceived countermeasures.

There is no magic value for oil pressure. The only real need for any pressure at all is to get oil to all points in the engine, and this would only require a couple psi. Oil pressure is monitored simply to insure there is oil flow, which is essential.

If your car has always had low pressure at idle when hot, and it gradually over the years gets a little lower, don't worry about it. If it suddenly has much lower pressure than it used to, you may have a damaged bearing that is allowing oil to flow through too fast; the cause should be investigated. If your car suddenly has no oil pressure at all, stop *immediately*, do not drive it one more minute until the problem is located and corrected. Many motorists fail to understand the importance of this, so I will emphasize: If the red light on the dash comes on indicating that you have no oil pressure, it is not good enough to "take the next exit." You should pull over *immediately*, possibly even shutting the engine off while still moving. A towing fee, and even an illegal parking ticket, is a minor expense compared to an engine replacement, which is the inevitable result of driving with no oil pressure.

Do not add oil thickeners to your oil. While these may increase the indicated oil pressure at idle when hot, they do no real good and can do considerable harm. In particular, when cold the oil may be so thick that very little flows and most of the output of the oil pump is wasted through the pressure relief valve. While there is good pressure, there is little flow to the bearings, and they may fail due to lack of cooling flow before the engine and the oil warm up. This is also a good reason not to run the engine too hard until it is fully warmed up.

OIL PRESSURE SENDER: The oil pressure sender on the pre-'92 XJ-S is notorious for leaking; see page 44. It's also fairly well known for electrical maladies. Tom Mackie says, "My oil pressure sender is getting flaky. I connected an ohmmeter and found that rather than nice varying resistance readings, it sometimes goes open. Which makes me wonder how accurate this particular unit has been all along."

If the connector on top is loose, Mike Morrin provides some insight: "The connector moving around is due to some little plastic pegs broken inside, and will cause the sender to read low. You can uncrimp the top and get inside to glue it down." Since uncrimping is difficult, others suggest cutting right through the circumference of the can to get the top off, fixing the innards, and putting the top back on with aluminum tape or JB Weld or some other mechanical means.

Ed Sowell provides electrical data to aid diagnostics: "Here are the measurements from my sender and gauge, for what it's worth:

Oil pressure sender (markings: PTR 1001/10/EC 700kn/m², 29-7 Part #46272):

Engine off: 350 ohms

Cold engine idle: 80 ohms (I believe the oil pressure is about 60-70 psig under these conditions)

Oil pressure gauge:

290+ ohms = 0 psig

55 ohms = 50 psig

10 ohms = 100 psig

short to ground = off top of scale."

I'd like to be able to tell you what commonly available sending unit can be used for a substitute, but I can't; nobody's worked one out yet. The pre-'92 Jaguar V12 uses a 0-100 psi oil pressure gauge while Jaguar 6-cylinder cars use a 0-80 psi gauge, so senders from other Jags won't work. Before trying a sender from any other car, make sure it has the 0-100 psi range. Electrical oil pressure gauges with 0-100 psi ranges are very common as aftermarket items, though, so perhaps the sender from one of those will work. Summit (page 670) and Jeg's (page 667) offer many such gauges, or you can probably find a fair selection in a local auto parts store or speed shop. Unfortunately, the senders are often included with the gauge itself rather than sold separately, but you *still* might get off cheaper than buying the Jag part even throwing the gauge away.

There are two issues that must be addressed to get an aftermarket sender to work. The first is physically installing it. The threads on the bottom of the OEM sender are BSPP (see the section on the radiator drain plug on page 187), while the generic senders typically have 1/8" NPT fittings. You could buy a BSPP fitting and plumb a line to a remotely-mounted sender -- or just opt to replace the entire pedestal. It's possible the pedestal from the '92-on cars would work, or you could actually just *make* one from a block of aluminum. If you don't mind how it looks, you can simply plug the hole in the original pedestal by cutting off the bottom of the OEM sender, putting a bolt through the center, and screwing it back into the hole, and then tee off the fitting for the oil pressure switch (standard 1/8" NPT) to connect up a sender with NPT threads.

The second concern is finding a sender with the correct pressure vs. ohmage response. Unfortunately, neither Summit nor Jeg's provide such data; if you can't find such specs or talk a local shop into letting you check one out with a tire pump and a VOM, you may just have to take the risk and buy one to see what their electrical characteristics are.

For now, your best option may be to shop around the mail order places for the OEM part, since prices on this item seem to vary widely and it sometimes can be found for a quite reasonable cost.

If you have the '92-on with round gauges, you are in worse trouble. Read about steady oil pressure below.

REPLACING THE OIL PRESSURE SENDER: Julian Mullaney says, "Use a crow's foot and several thin extensions. It is a superb test of dexterity and patience, but I did it. To install the new one, I attached it to a coat hanger and started the thread that way."

Stefan Schulz says, "Have you tried a plumber's tool called a basin wrench? GBP5 at the nearest DIY store."

Craig Sawyers says, "What I did was undo the banjo bolt that links the camshaft oil feeds to the back of the alloy pedestal that holds the oil pressure sender. Then I undid the two 7/16" af bolts that hold the pedestal down and took the pedestal plus oil pressure sender out as a unit. Changed the sender, and reversed (as they say) the removal procedure. Made it all very easy, when originally it looked damned near impossible. The Jag ROM and Haynes were less than useless."

REALLY STEADY OIL PRESSURE: Bill Letter reports: "Today the kitty went in for a number of "adjustments", the most important of which was to determine why my oil pressure gauge always reads 58 psi at idle (hot or cold). On my last visit to the same dealer for the same problem, I was told that the gauge was working fine and according to Jaguar Spec. Today I was shown a TSB that explained that Jaguar changed the oil pressure senders on the XJ12 Sedan and XJS V12 (in 1996) to a new type which is actually not a sender at all. It seems (according to the dealer) that numerous

customer complaints of their oil pressure gauge reading too low (less than 25 psi) when hot at idle caused Jaguar to discontinue manufacturing the oil sender and instead replace it with an oil switch which acts like an idiot light (when there is more than 7 psi pressure it will always read 'ON' or in my case 58 psi, when there is less than 7 psi oil pressure it will read 'OFF' or zero psi). So it was explained to me that the updated oil switch was installed in my car last year.

"It is Jaguar TSB Number 15-13 dated 06/95 and covers all cars with V-12 engines and some AJ16 engines on the XJS (MY '95 on). They removed the senders and installed a simple switch because of customer complaints that the needle would read lower oil pressure when hot at idle!"

You may have difficulty trying to undo this "upgrade" since the real sender is officially NLA. Gregory Wells of Coventry West, Inc. explains in detail: "The sender issue is confined to '88-on XJ40 cars and '92-on XJ-S with 4.0L, 5.3L, and 6.0L engines (VIN 179737 onwards). Jaguar has superceded all sender numbers (viz. DBC4418, DBC5513, DAC7879, DAC11141, LMD5640AB) to JLM20791, which looks like the old C42200 (now superceded to LHD5642AA) switch for the oil pressure light on the Series III cars. Included in the bag with the sender is a small harness which seems to only have a resistor in it. If one orders any of the above five part numbers from Jaguar, a JLM20791 will be supplied. I've checked the '88-92 XJ40 fiche, the '93-94 XJ40 fiche, the '87-91 XJ-S fiche, and the '92-on XJ-S fiche and they all show gauge sender part numbers that eventually supercede to the on/off sender p/n." However, if you're persistent, you may be able to find a dealer or supplier that has some of the real senders in old stock."

Note that none of this seems to apply to the pre-'92 XJ-S.

There are two things to note regarding the '92-on senders vs. the pre-'92 senders that may be relevant: First, the pre-'92 sender (C46272) has BSPP threads and requires a sealing washer, while the '92-on sender has the same tapered pipe thread that the oil pressure switch has (1/8" NPT). Second, the oil pressure gauge on the pre-'92 dash is the vertical indicator with a 0-100 psi range while the '92-on dash has a round gauge with a 0-80 psi range. Together this may mean that a standard Ford oil pressure sender might work in this car.

ENGINE WORK

ENGINE OVERHAULS: If you take your XJ-S to a disreputable dealer with major engine problems, they may tell you that a fine machine like this cannot be rebuilt, and try to charge you \$10,000 to put in a new engine. Of course, one of the features that make this a fine engine is that it *can* be rebuilt. It is not a disposable engine; all wear items can be replaced. Even the cylinder liners can be easily replaced, so there is no need for boring and honing or for oversize pistons. Of course, if you've overheated the engine and warped the block, or you've had a major engine fire, you will definitely need a new motor.

If the engine has to be rebuilt but you aren't up to the task yourself, you may find it challenging to find a mechanic you feel is competent to do the job. Fortunately, if you live in the US, there may be an alternative to taking your chances with the local grease monkeys or a Jaguar dealer: Crow Engineering, 1-800-537-4146. This is a very interesting business run by a British guy named Stewart Plant who apparently spends a few months each year in the US. By appointment, he and an assistant will drive to your house and rebuild your engine in your garage. He arrives in a panel van with all the tools and parts needed and will typically finish the task in a week or so. He and his assistant sleep in the van; the only accommodation they ask from you is to use your shower. Their services are not cheap, but they're undoubtedly cheaper than paying a dealer for a new engine -- and you're more likely to be told *why* your engine was damaged and how to avoid it happening again.

Rebuilding by the home mechanic is not out of the question. It's imposing at first; the engine compartment is crammed quite full. But with this book, a repair manual of some sort, a good set of tools, and time and patience it can be done -- and the money saved will probably be enough to *pay* for that good set of tools! The biggest disadvantage of going this route is usually the time involved; typically, a mechanic will disassemble the engine, figure out what parts he needs, order the parts, and then wait, and wait, and wait for the parts to show up -- only to find out that a few of them are incorrect and must be returned and reordered. And, of course, on reassembly he will figure out what he forgot to order.

As a result, even though only a week or two of actual labor may be involved, the car may be scattered all over the place for a couple of months or more.

If you decide to tackle such a teardown, note that the V12 weighs something like 700 pounds as it is pulled from the car. You don't want to be working with flimsy hoists or engine stands; obtain the heavy-duty stuff, perhaps even items intended for trucks.

ENGINE ASSEMBLY LUBE: When an engine is first started after assembly is when much of the wear occurs -- in the several seconds it takes before oil pressure and flow to the bearings is established. To counter this problem, there is a product called "Penrite Camshaft & Engine Assembly Lube". This is made specifically for use on all plain bearings (mains, big ends, etc.) as well as on cams, when assembling a rebuilt engine. It claims to withstand loadings "greater than 200000 p.s.i.", which is almost 100 tons per sq. inch. It is an Australian product, but equivalents may be available in other countries.

Another idea is to simply fill the freshly-rebuilt engine with oil through the galleries instead of the filler cap, thereby lubing all the bearings before it ever turns over. All you need is a pressure vessel capable of holding at least 3 or 4 quarts with a tire valve at the top and a hose out the bottom with a selection of fittings that will thread onto the oil filter fitting. After reassembly, you thread the thing onto the oil filter fitting, put new oil in the tank, close it up, and apply compressed air to the tire valve. The pressure will blow the oil into the galleries and on into the bearings. After enough oil has been blown in to establish steady oil flow through the system, the feed is cut off before the tank empties and blows air into the galleries. Then install a new filter and add the rest of the oil necessary the normal way to establish the proper level in the crankcase prior to startup.

Andrew Holley describes what he did with a motorcycle engine: "What I did was get hold of an old fire extinguisher, the water/stored pressure type. Has about a 15 litre capacity; the handle has a tyre valve built into it with pressure gauge as well. After draining and cleaning, filled it with oil and attached the hose via a suitable fitting to one of the oil cooler lines. With about 60 psi of air in the tank, it forced the oil through all the passageways. Simple and effective."

Tom Amlie: "Prelubing a rebuilt engine is sometimes difficult, but in this case it was easy. There is a pipe plug on the little pedestal that holds the oil pressure sender and the idiot light switch. As best I could tell, it was 1/8 NPT. Got a cheap (\$13) plastic garden sprayer and cut the hose to match 1/8 pipe. Put 8 quarts through it. Worked great."

You might want to use a good assembly lube *and* pre-oil the engine before startup. Blowing oil into the galleries will do wonders for reducing wear in bearings and cam followers during that first startup, but you won't get any oil on the cylinder walls until the crankshaft is spinning. So having a good assembly lube on the cylinder walls is a good idea.

Engine Work -- Top

MANIFOLD CROSSOVER PIPE HOSES: On the author's '83, the intake manifold crossover pipe is connected to the manifolds with a short, straight piece of 1" hose at each side. However, sometime before '89, the assembly was changed so that pieces of hose with 45° bends are required. A cursory look at the two assemblies leads one to believe that the parts themselves are in fact unchanged, and the later cars were merely assembled with elbow hoses to relocate the crossover pipe higher across the back of the engine. This might actually be helpful in making condensation drain out of the crossover pipe back into the manifolds rather than into the vacuum line to the ECU, which really messes things up.

If you have the earlier straight hoses and need to replace them, it's obviously pretty easy to find pieces of 1" hose. As for the later parts, Jeff Elmore says, "The dealer quoted me \$22 apiece for these three inch long, 7/8-1" diam hoses with a 45 degree bend in it. Bennett Auto Supply had a Goodyear coolant bypass hose that fit perfectly for \$2.62 apiece. Part number #ggy 63064."

Whatever you fit, note that the vacuum inside these parts is considerable, and long unsupported sections of rubber hose will be sucked flat. With the earlier design with straight hoses, it appears to be sufficient to merely be sure to insert the hoses far enough onto the fittings that there is only a short area of hose that *doesn't* have fittings within it. If you must

have longer sections, you may need to insert a piece of wire coiled like a spring to hold the hose round, or perhaps just a short section of tubing.

RUNNING WITHOUT AIR FILTER HOUSINGS: Frank Perrick points out that if the engine is to be started without the air filter housings bolted on, the bolts themselves must be screwed in. The bolts that hold the air filter back plate onto the butterfly housings actually go all the way through the housings and are threaded into the intake manifold. If these bolts are left out, the holes provide a major butterfly bypass and the engine will overrev.

CAM COVER WORK: If you need to get down to the cam covers or beyond, Victor Naumann sends this awesome tip: Remove the PCV crossover manifold, fuel rail and injectors, air injection manifolds, both fuel pressure regulators, the ignition amplifier, the intake manifold crossover pipe, both butterfly housings, and both intake manifolds *as one piece*. Be sure to disconnect the butterfly return springs before lifting.

CAM COVERS OFF?: If you remove the cam covers for any reason that is not intended to involve further disassembly of the engine, it cannot be reiterated too many times that every bolt, nut, tool, or whatever that is in this vicinity should have a string tied to it with the other end tied to your finger. If a metal part falls down into the timing cover while you're fiddling around, see the section on timing cover removal on page 89. Peter Smith suggests "I shove a big rag down the timing cover on each side to catch the bolts if they fall. I find this to be a nerve-racking part of the job - if the damned things fall in it can really test your sense of humour!"

The repair manuals provide complete instructions for timing chain disengagement and camshaft removal, except they neglect to remind you that you might want to measure the valve clearances *before* disconnecting the timing chain and removing the cams. The assembly must be together to make the measurements, so measuring before disassembly will save you having to slap it back together to measure it later. Of course, if you plan on reseating valves and the like, the measurements won't do you any good anyway.

You *might* be able to replace the timing chain without removing anything beyond the RH cam cover. See page 91.

CAM COVER DECORATION: Some of us think those Jaguar decals on the cam covers are not in keeping with the general class of this automobile. One suggestion is to remove the decals and attach some brass insignias with screws -- making sure not to cause a leak. Might even find just the right key fob to use.

A suggestion from Steve Averill: "If you want to find something a little better looking than the Jaguar decal on the valve cover, why not either get it photo etched or alodyned? That'd be more apropos than sticking on something that'd probably wind up looking "tacked on" & you could pick any pattern that appeals to you."

If you have them off anyway and have a milling machine at your disposal, you might consider skimming the top of the ribs, leaving the black paint in the grooves between the ribs. It'll really make it look snazzy.

CAM COVER/HALF MOON SEAL: This joint is one of the most notorious sources of oil leakage on the Jaguar V12, although it's entirely possible much of that blame is misdirected; between the tappet block leaking (see page 68) and the banjo fittings leaking (see page 42), sometimes it's hard to be sure just how much of the oil is actually coming from the cam cover gasket or the half moon seal.

Many owners are surprised that the cam cover gasket is a thin piece of cardboard (or, later, a thin Gortex sandwich), expecting to see a thick layer of cork or some such. Of course, the thick layer of cork is called for on engines with stamped steel valve covers, but the cam covers on the Jaguar V12 are a quality aluminum casting with precision machined mating surfaces. A thin gasket should seal just fine. Of course, the original cardboard gasket won't, but it's not because it isn't thick enough; it's because it's a cheap cardboard gasket.

Most of the newfangled gaskets introduced by Ford are only moderately expensive, but the Gortex sandwich cam cover gaskets are obscenely expensive. Apparently as a result, some of the mail order places continue to stock the old paper versions. There is irony in that, since Ford updated nearly all the gaskets wholesale whether they were notorious for leaking or not but the ones that probably needed the update the most were the cam cover gaskets.

Also involved in this joint is the half moon seal, a semicircular rubber plug used at the back end of the tappet block to fill an opening made while machining the cam bearing journals. This plug is set in the opening, the cam cover gasket is set on top of it, and the cam cover is installed to hold them both in place. This is why I have listed the two items as a single section; it's not really valid to talk about the cam cover gasket in one section and the half moon seal in another, as the sealing of this joint involves them both -- and the bolts as well, discussed below.

Michael Neal reports that some of the aftermarket half moon seals shrink a lot after only a matter of months and create a leak, while the genuine Jaguar half moon seals don't shrink enough to cause a leak if installed as he describes below.

Technical Service Bulletin #12-35, which introduced the Gortex sandwich gaskets, specifies that no sealant be used on the cam cover gasket but that the half moon seal be coated with RTV sealant. Based on experience using the new gaskets, Neal recommends the following procedure for the cam covers: "After much trial and error and the monitoring of some cars for several years I have come up with some leak-proof techniques. Only use silicone on the rear of the gaskets. Use Hylosil (British-made white silicone) to seal the end. Use a lot. Coat the half moon seal all the way around. Also coat the ends of the gaskets on both sides and one inch toward the front. Assemble and wipe off the excess silicone. Let it set up overnight! Over time, the half moon seal shrinks and the silicone retains the oil proof seal." This procedure makes sense, especially the part about coating the gasket on both sides; since the gasket is not compressed above the half moon seal, a key problem will be the seal between the gasket and the cam cover itself in this area, *the other side of the gasket* from the half moon seal.

Neal's selection of Hylosil probably also merits noting. The ROM often calls for Hylomar for "dressing" gaskets, but it's just that -- a dressing. It won't provide a primary seal by itself, it is only intended to help a gasket provide a primary seal -- a paper gasket that is, it shouldn't be used on Gortex. If Hylosil is unavailable, it might be wise to find something comparable, some silicone sealant that will form and maintain a seal on its own.

While using the upgraded Gortex gaskets, genuine Jaguar half moon seals, and gooping everything up properly with Hylosil may result in a fairly durable seal, these measures still fail to address the inherent problem at this joint. In this author's opinion as an engineer, a truly reliable seal in this assembly is only possible through a fundamental change in the way these parts work together. A gasket -- any gasket -- will only seal properly when securely compressed between two hard surfaces. Above the half moon seal, the cam cover gasket is *not* compressed; the rubber plug does not provide a hard surface for the cam cover to press the gasket against. Instead, the rubber plug merely deforms a little, leaving the gasket locally uncompressed. Whatever goop is applied during assembly is likely to provide the *primary* seal, since even the Gortex sandwich gasket will not likely provide a secure seal under these conditions.

Somehow, this assembly needs to be altered to provide a rigid surface for the cam cover gasket to be compressed against. One idea, proposed but as yet untried, is to drill a hole through the new rubber half moon seal and put a bolt through it with a washer and nut on the outside. The head on the inside would need to be pretty broad and flat; perhaps a bolt intended for holding a toilet to the floor can be cut down to a suitable length. After the plug is installed and the cam cover is securely bolted down, the nut could be tightened down to squeeze the plug from the sides (you might want to cut flats on the end of the bolt to be able to hold it still while tightening the nut). Rubber is actually remarkably rigid in terms of hydrostatic compression, so squeezing the sides will make it expand forcibly in other directions and press very hard indeed on the tappet block and cam cover gasket, hopefully forming a secure seal. This idea has an apparent advantage: If the joint starts leaking later on, it may be possible to crank a little more on that nut and put a stop to it.

John Napoli says, "I figured it was better to fill them than to play games with those silly seals. Anyway, I filled the half moons up with Marine Tex. I clamped wood on both sides, faced with wax paper, and positioned so that the goo stood proud of the mounting face. After it set, I filed it down flush. Seems to have worked. I buy Marine Tex at marine supply stores." If you have the cam covers off anyway, you might want to go ahead and pull the camshafts and the tappet blocks so you can do this job on the bench. Marine Tex dries hard, hard enough to serve as a base for compressing the cam cover gasket properly. JB Weld might be an acceptable substitute, available in most auto supply houses. Napoli points out that the only reason you would ever need this opening again is for boring out the cam bearing

journals to an oversize, and if this is necessary then it won't be difficult to use the boring machine to remove all the Marine Tex. After completion of the reboring, you'll probably want to install some more Marine Tex!

Edwin Hyatt did this job: "Used two old credit cards and a couple of miniature C clamps on the outside and inside of the U and piled the JB on. Filed flat the next day."

This author went a more difficult but esthetically pleasing route and designed some aluminum plugs to replace the rubber half moon seals, and Ron Morse was kind enough to fab up a set for testing the idea. **Figure 3** shows the design.

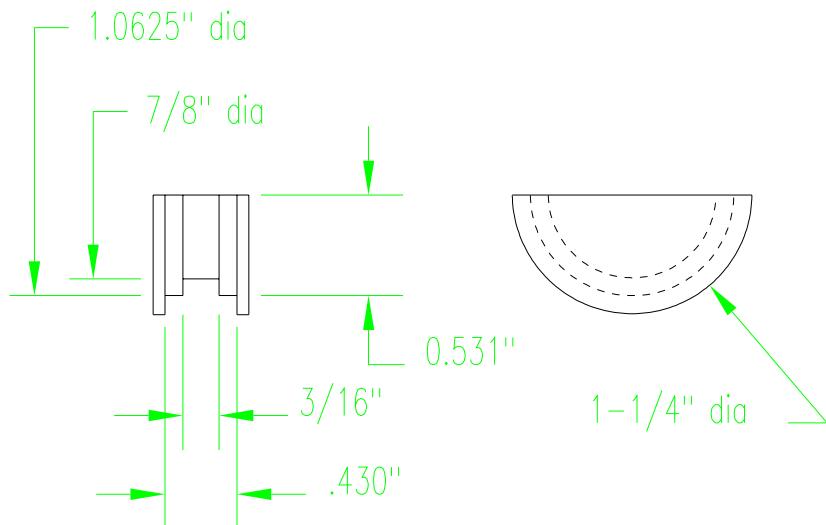


Figure 3 - Aluminum Half Moon Seal

There are no tolerances shown on the drawing, so a description of which dimensions are critical is called for. The 1.0625" diameter fits very snugly in the opening, and the opening itself is rather precisely machined as a cam bearing journal diameter. It might be acceptable to make this diameter a hair smaller, but it cannot be any larger or it won't fit in the hole.

The 0.531" height dimension is critical, since it locates the platform for the cam cover gasket to be compressed against. This dimension should be held even if the 1.0625" dimension varies.

The .430" width is necessary to fit around the boss on the tappet block. This dimension can be made larger, but if made smaller it can make the part difficult to install. Since the width of the boss was not held to tight tolerances by Jaguar, if possible you should measure it *before* having this plug made and widen that .430" dimension even more if necessary.

All the other dimensions are wide tolerance, almost anything close will work.

Of course, once you have replaced the rubber plugs with the aluminum, how do you seal the aluminum? The original design intent was to use a 1/8" cross section Viton O-ring cut in half. Unfortunately, this really doesn't work well; the O-ring halves cause the plugs to pop up while you're trying to finagle the cam cover and gasket into place, and if you just allow the cover to press the plug back into place you won't even know whether or not the O-ring ended up positioned properly until you start the car up.

Forget the O-ring idea. Seal this plug using a similar method as that used for sealing the rear main bearing cap to the block: Hold the plug in place and inject a silicone sealant into one end of the opening until it comes out the other.

Or, apply a coating of Loctite 500-series sealant to the curved mating surfaces before installing the plug. If you've had the tappet blocks off, you should have a suitable sealant on hand from sealing them to the heads (see page 68); if

it's good enough to seal that location, it certainly should seal this one. If this sealing method is chosen, you'd be better off omitting the O-ring groove from the plug design, perhaps saving a bit on the machining cost.

Or, you could consider installing the plugs with JB Weld or Marine Tex. Getting them out later might prove to be a challenge, but they shouldn't ever need to come out. Again, omitting the O-ring groove might be a good idea.

If you don't want to make these aluminum plugs, Ron Kelnhofer (page 669) has some for sale.

It has been suggested that it may be simplest to just heliarc weld the openings in the tappet block shut and machine the gasket surface. There is no way I would recommend this, though; the distortion likely to result from such welding would surely compromise the seal between the tappet block and the head as well as play havoc with the alignment and concentricity of the cam bearing journals and tappet holes.

Once you have provided a hard surface to compress the cam cover gaskets against, forget about gooping the Gortex gaskets as Neal recommended with the rubber seals. Gortex gaskets are supposed to be installed dry, and now they should be.

Once we've addressed the shortcomings of the half moon seal, we still have other problems to deal with. Neal says, "New bolts are also necessary. Unfortunately these parts are only carried by the dealer."

Before ordering bolts, determine whether your engine requires SAE bolts or metric bolts. Judging from the 1988 Jaguar Parts Catalogue, the change from SAE to metric took place with engine number 8S24175. The part number for the new metric cam cover bolts is FS-106251/J.

The replacement of the bolts may not be as much due to the excellence of the new bolts as to the lousiness of the old bolts. The original bolts -- both SAE and metric -- have a "triangulated" thread that presumably helps it to drive into the aluminum housing, but probably is also very effective at boogering the aluminum threads up. Martyn Sandbrook says, "I recognise these as "taptite" screws. We used to use these in the telecoms industry way back in the seventies. They are like selftappers but they "form" a thread rather than cut one and are supposed to be better. You don't see them these days. I thought they were junk when I first came across them. Seems strange to be using them in a leak-critical area as they only grip on the outer lobes once the thread has been formed and won't take much tightening torque."

If you'd rather not pay Jaguar prices here and seek other sources for bolts, note that 7/16" hex heads will not do, you can't get a wrench or socket on it; either 3/8" (or smaller) hex head, socket head (allen wrench drive) or Torx drive bolts will be necessary. And you might want to look at the access before you select bolt head styles, since you may want to retorque them a while after replacement. Of course, buying el cheapo grade-zilch bolts (like most slotted head screws) is not a good idea; not only will they rust pretty badly, they may not hold enough tension to keep the cam cover gasket from leaking.

An alternative bolt that would work on SAE threaded engines was found at a Home Depot in their "specialty fasteners" rack. It is called a "serrated flange bolt"; it has a 3/8" hex with a washer face and a row of serrations around the bottom of that washer face. The biggest problem will be finding enough of them to do the job; often such racks in hardware stores only contain a half dozen or so.

Another alternative SAE bolt: This author bought a box of 1-1/4" "alloy steel" 1/4"-20 "socket head cap screws" from a local industrial fastener supplier -- less than \$20 for a box of 100. These fasteners are jet black. Strength is not a problem, alloy steel cap screws are *stronger* than Grade 8.

The original SAE bolts were 1" long, so replacing them with 1-1/4" bolts provides enough length for some washers under the heads (and perhaps for thicker gaskets, if you find something non-OEM). There's no problem with bolts being too long, since the end just comes out the back side of the flange on the tappet block. Using the longer screws also makes use of all the threads available in the tappet block, including the ones at the bottom end that haven't been worn by the lousy OEM screws.

If you need M6 socket head or flange bolts, finding them locally may be more troublesome -- at least here in the US. Craig Sawyers says, "Well, here in the UK, the challenge is to find *non-metric* SS screws!" Again, going with slightly longer screws than the OEM 25mm items -- perhaps 30mm -- might be a good idea.

Dave Oxenreider says, "I found a whole slew of 18-8 stainless steel socket head cap screws in both metric and English in the McMaster-Carr catalog. Averaging about \$25 per box of 100." Joe Bialy opted for non-stainless (no good reason for stainless here, actually): "Part #91290A332 for \$7.34" See page 661.

Another source would be Barnhill Bolt; see page 660.

If you have a local Grainger outlet (page 661), the Grainger catalog doesn't seem to list any suitable M6 socket head screws but they carry "button head socket screws" which use a smaller Allen wrench but will work. The box of 100 screws 30mm long is stock number 3L184 and costs less than \$20.

On the other hand, if your cam covers need M6 screws, it might not need screws with unusual heads. The typical generic locally-available M6 screw has a 10mm hex head. It appears that a 10mm socket will actually fit in the recess, making the search for socket heads or flange bolts unnecessary.

An idea that might work with either 7/16" or 10mm hex head screws: If you can find some sleeves with a length of perhaps 10mm, 1/2", or 15mm, you could use them together with screws that are proportionately longer (40mm, 1-3/4", or 45mm) which would raise the location of the hex head enough to enable you to get a socket on it with less trouble. A cursory inspection of this author's engine indicates you certainly wouldn't want to go any longer than 15mm -- you'd start interfering with the bottom of the intake manifold. There is a spot at each end of each manifold where a bolt hole boss is provided (holds fuel pressure regulator at the front, other stuff at rear) and it might actually help to grind away a bit at the *bottom* of this boss. No reason not to, although it might not be that helpful either. The bigger problem is with the center runner of both the front three and the rear three runners on each bank, which go right over a cam cover bolt. Any taller than 15mm would most assuredly cause interference here.

If you can avoid interference, having the heads up higher might actually make it possible to retorque these bolts without pulling the manifolds off! It wouldn't be easy by any stretch, but it might be possible.

With the socket head cap screws, the author used split ring lock washers *and* flat washers. As noted on page 26, flat washers are *always* recommended when a bolt head or nut sits on aluminum. (Note: TSB 12-35 specifically prohibits the use of washers under the special Jaguar bolts in this location. Put that down as a fundamental disagreement between their engineers and this engineer -- and note that this engineer's cam cover bolts haven't come loose and the gaskets don't leak, claims which several other owners report cannot be made about the official Jaguar assembly procedure.) This author found some very suitable flat washers on a bubble card in a Wal-Mart: They are size 12, also known as 3/16". If you ask for 1/4" flat washers, you get washers that fit so loosely on the screw that it looks like a socket head might pull through the hole! Also, the OD of the standard 1/4" washers are bigger than the flat area on the cam covers, so you'd have to cut them down to get them in. Conversely, these #12 washers fit perfectly on a 1/4" bolt and are the correct OD for the cam cover flats. Make sure you find *cheap* #12 washers; better quality ones might have closer tolerances and not fit a 1/4" bolt.

Should you use lock washers? This author thinks so; after all, they can't hurt. Craig Sawyers replaced his cam cover gaskets with new paper gaskets, and they shortly began to leak; when he went back in there, he found the bolts loose. Why? Well, maybe it's because the paper gaskets compress and relax the tension on the bolts, and therefore switching to the Gortex sandwich gasket is the fix; or it may be because these bolts are simply too short to stay tight without lock washers (see page 26) or some other retention scheme. The situation is rife with opinions, but note that it's really hard to retorque these fasteners without removing the intake manifolds. This is not a place to save money or weight; if it *might* help avoid problems, do it.

You can buy enough flat washers and lock washers to do this job for less than two bucks total.

Another type washer that will work on the cam covers is the 1/4" spiral groove washer used in a couple other places on the V12 -- if you can find a supply of them. These washers serve as both a flat washer and lock washer in one. Also, the 6mm wavy spring washers mentioned on page 26 as a substitute for the spiral groove washers will work nicely.

There is one other benefit to going with longer screws with spacers. Longer screws have more "stretch" when tightened to a particular torque, and therefore hold tension better and are less likely to vibrate loose. It might still be a good idea to include lock washers, but providing yet another scheme to help keep tension on those cam cover gaskets can't hurt. The spacers might omit the need for flat washers, depending on the wall thickness of the spacers and therefore how well they distribute load onto the aluminum face.

As always, be sure to use anti-seize compound on the threads when assembling.

TSB 12-35 specifies that the cam cover bolts be torqued to 9.5-11.5 N-m (7-8.5 ft-lb). They didn't mention whether this was for the later metric bolts or the earlier SAE bolts, but hopefully it won't make much difference. It's also probably a good spec whether you're using their special bolts or some of the generic substitutes described above. It's not really a place where torque is critical, however; just tightening until they feel tight should be good enough.

TIMING CHAIN TENSIONER: To replace the tensioner requires removal of the timing cover which would put this section under "Engine Work -- Front". However, the problems occur when retracting the tensioner, which is usually done when removing the cams or the heads -- so it's here in the "Engine Work -- Top" section.

There are few design features of the Jaguar V12 as poorly conceived as the material the arch of the timing chain tensioner is made of. If you manage, on your first try, to retract the tensioner and reengage it successfully without breaking this arch, you should consider yourself lucky. The arch apparently works well when new but gets brittle with age or heat, and an old one can be broken very easily. Michael Neal, who works on Jaguars every day, says "I've become so paranoid of old tensioners, my failure rate has been very high as of late. I'm not too surprised though, most of the cars have been approaching ten years old. I've been as careful as possible, knowing exactly what I was doing, and have watched the damn thing crack on one of the pivots." Obviously, if you have the timing cover off for other reasons and the tensioner is intact but has a few years on it, it may be advisable to replace it anyway.

The problems may have to do with the V12's proclivity towards overheating. Craig Sawyers says, "The V12 chain tensioner is, according to the technical article that was published when the V12 was launched in the early '70s, made from molydisulphide-loaded nylon. Just looking up the spec for something else, I found that Nylatron GS is just such a material. All the characteristics that are listed makes this a sensible choice for the tensioner blade, apart from a continuous working temperature of 100°C maximum, with maximum non-continuous temp of 145°C."

"I'll wager that embrittlement of the blade is due to a combination of the oil environment *and* overheating. I have only the evidence of one piece of information: My engine had never overheated, and the blade, although grooved where the chain had worn it, was still flexible after 160,000 miles."

Other engines have arched timing chain tensioners in which the arch itself is made of spring steel. It would seem a simple matter to design a replacement arch for the Jaguar V12 tensioner made of spring steel, thereby eliminating the fracture problems permanently; if noise or wear is a concern, the spring steel arch could be faced with Teflon or some such. However, despite more than two decades of trouble with this piece of crap, apparently neither Jaguar nor any aftermarket companies have opted to offer an improved part.

You can see what this tensioner looks like at

<http://www.jag-lovers.org/xj-s/book/tensioner.html>

For those without access to the www I will attempt a description of the tensioner, since it is well hidden and its configuration may not be apparent until it is too late. Basically, the tensioner consists of a plastic arch that the timing chain slides over top of on its way from the crankshaft sprocket to the right side cam sprocket. This is the slack side of the chain, so it's the proper place to put the tensioner. Between the legs of this arch is a spring that pulls the legs together, making the arch steeper and taller and therefore taking up slack in the chain. The end of the arch nearest the crankshaft is located by a pin on the block, while the end near the cam sprocket has a steel foot attached that is free to slide up and down on the inside of the housing as the arch changes shape.

Alongside the spring is a latching assembly that consists of a rod that is attached near the pinned end of the arch and passes through a hole in a rocking latch attached to the steel foot on the other end of the arch. The aforementioned spring is actually attached to this rocking latch, slightly off center, so that it not only applies tension to the chain but also causes the latch to rock in the CW direction (as viewed from the front of the car facing rearward). This assembly serves two purposes: First, the rod going through the hole in the rocking latch makes a very effective one-way lock; the rod can easily slide in the direction that allows the tensioner to take up slack, but it *cannot* back up and allow more slack. Second, when the mechanic has manually retracted the tensioner, a step at the end of the rod provides a catch for holding the tensioner in retracted mode while working on the car.

When removing the camshafts or the heads, the tension on the chain must be disengaged. However, the chain is not removed; the sprockets are simply unbolted from the camshafts and supported in place by special brackets provided for the purpose. The heads are removed in this state, leaving the chain and sprockets hanging there in mid-air.

Before proceeding, please reread the warning on having the cam covers off on page 57. Also, don't do *anything* until you've read through this entire section and the following section on disaster avoidance and understood them.

To retract the tensioner requires a pair of tools collectively known as Jaguar tool JD.50. One tool is inserted from the top of the engine where the cam cover has been removed, underneath the cam sprocket, and hooks onto a hole in the steel foot at the top end of the tensioner; this tool is for pulling the tensioner back to the disengaged position, and has a handle shaped to rest against the top of the sprocket for leverage. The other tool is inserted through an access hole in the front of the timing cover and is used to manipulate the rocking latch. The rocking latch has a slot in it, 3/16" wide by a little over 1/2" long and roughly parallel to the chain line, for inserting this tool.

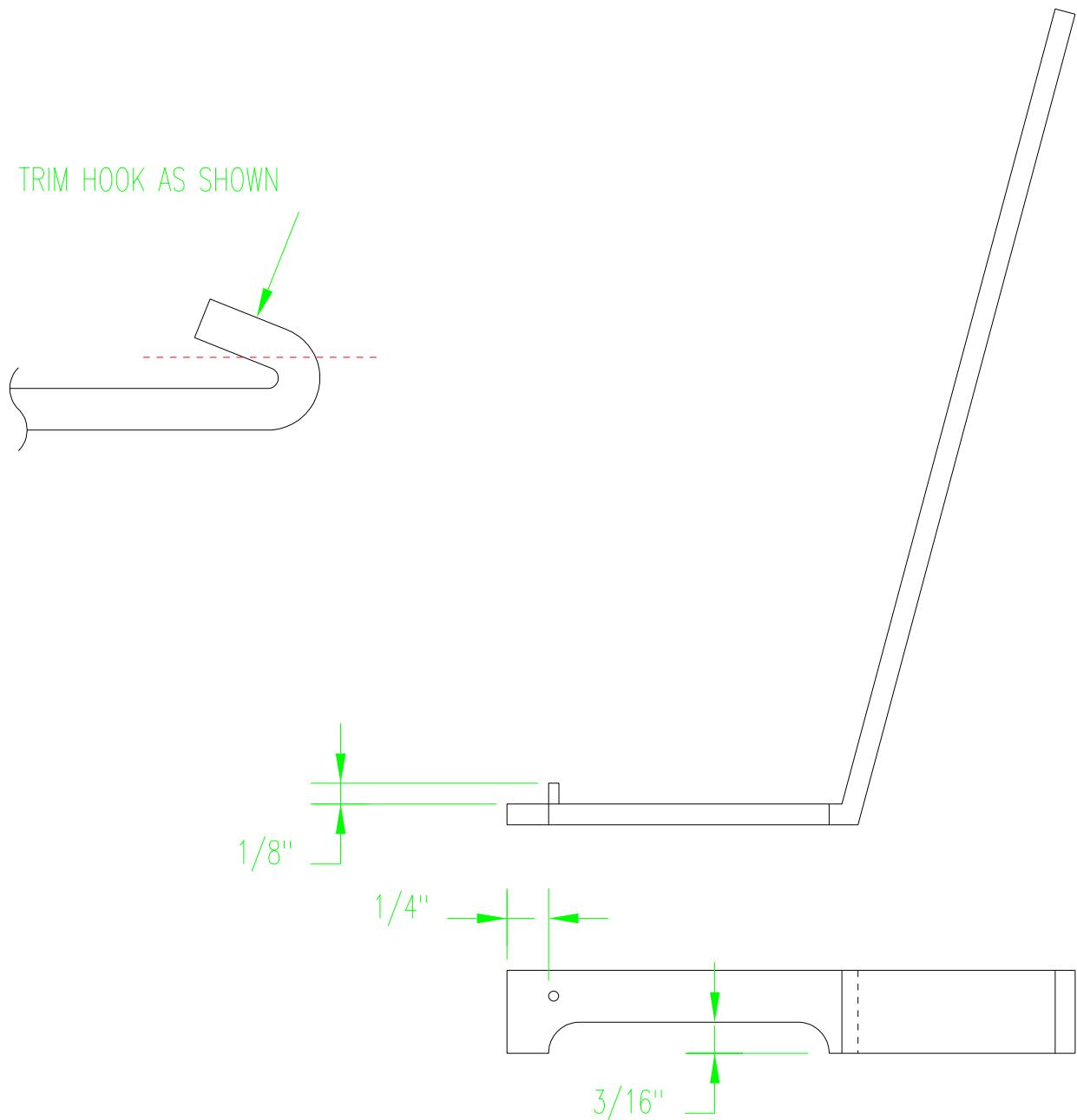


Figure 4 - Improvised JD.50 Tools

Improvising both tools is fairly easy. For the first tool, a sturdy hook is required; a standard battery hold-down bolt may be a good place to start, but you'll need to trim the hook as shown in **Figure 4** in order for it to fit the hole in the tensioner properly. Robert Louis Woodling says, "I used a long hanger for a peg board..." Adding a lever that rests on top of the sprocket isn't too hard, you can even make it out of wood; just drill a 1/2" hole near the center of a 1" x 2" board about a foot long, insert the battery hold-down bolt through it, and put a fender washer and a wing nut on the end. The hole needs to be about 1/2" to allow the battery hold-down bolt to tilt relative to the board.

Alternatively, Thomas E. Alberts says "I tried the lever style tool like the manuals show and didn't like it much. I made one with a long 3/8" bolt (~12in) and a steel tube (~1.5in dia). I formed a hook by grinding away most of the bolt head, padded one end of the tube and put it against the valve cover mating surface and with a washer and a nut on the threaded

end and the bolt running through the tube and into the chain tensioner, I was able to gently apply the required tension. It worked well."

For the rocking latch tool, it appears that a common screwdriver may be used if you can get it in there. A better idea may be a standard "brake tool", the lever used to turn the star wheel on self-adjusting drum brakes. You might also check to see what you have in tire irons, especially those intended for bicycles. And of course, one of those right-angle screwdrivers might work, especially if you can find a large one. You should note, however, that while these items may get the job done, none of them are likely to work smoothly enough for you to get a good idea of what you are doing to that tensioner by feel.

You can easily make a more suitable tool: Buy a piece of strip steel 1/8" thick x 1/2" wide (commonly available at hardware stores), and cut off a piece about 7" long. Then, about 2" from one end, make a sharp bend of something less than 90 degrees -- see **Figure 4**. Then cut away one side of the tool -- the side that will be pointed toward the cam cover opening -- about 3/16" as shown. This is because as you retract the tensioner, the latch moves upward with it and this side of the tool will contact the edge of the access hole. This contact confuses the "feel" and can leave you wondering if the tensioner is fully retracted or not.

Of course, you could avoid having to cut away the side of the lever by simply making it out of 3/8" wide strip steel to begin with. However, this is not recommended. The portion of the rocking latch above the slot is not very thick, so having a lever a full 1/2" wide to insert in the slot ensures that the tool contacts the rocking latch near the ends of the slot. If a narrower tool is used, applying torque to the lever can cause one edge of the tool to push up on this thin portion of the rocking latch near the center of the span rather than near the edge, greatly increasing the chances of actually breaking the rocking latch. Breaking this portion off doesn't really affect the normal operation of the latch, but it will make it even harder to release, and if that broken portion falls down into the crankcase you're gonna be upset about it.

The other feature shown in **Figure 4** is a small pin sticking 1/8" up from the surface of the lever. The purpose of this little pin is to prevent insertion of the tool farther than 1/4" into the rocking latch, where it may get involved with other parts. A tiny roll pin could be used here, or perhaps a small screw. You can even omit this feature, if you are careful not to jam that lever in farther than it needs to go.

Bob Gallivan reports: "The drum brake adjusting spoon is the right way to go, just under 1/2" wide, cheap & easy to drill a hole in for the roll pin stop."

The actual operation of disengaging the tensioner requires using both tools simultaneously. To begin with, I suggest using the latch tool by itself to try rocking the latch CCW just to get the feel of it. It will not rock very far, but it shouldn't take too much force to rock it, and you should be able to feel the spring. Old tensioners always seem to have bent or damaged rods or latches, and it's difficult to imagine how the damage occurs other than people applying *great* force to this rocking action. You should also note that, if everything is working properly, rocking this latch alone will have no discernible effect -- no clicks, pops, clangs, or anything else.

Don't bother testing the other tool by itself. Trust me, you won't be able to move the tensioner toward the retracted position without simultaneously rocking the latch CCW -- unless, of course, the tensioner is already broken.

Now, to actually retract the tensioner: First, rock the latch CCW and hold it rocked; it doesn't need to be held hard CCW, just so that it is prevented from returning to the CW position. With the latch so held, pull up on the retracting tool; you should feel it smoothly moving against a fairly stiff spring tension. In order to lock the tensioner in the retracted position, you will need to pull as far as it will go. At this point, it should suddenly become possible to rock the latch a bit farther in the CCW direction. While holding the latch firmly in this full CCW position, carefully release your pull; it should lock in that position. Once it does, you can rest assured it won't move by itself; you can go on and do other things.

When it comes time to reengage the tensioner, do not simply trip the latch to restore the tension; the tensioner will shatter like a dried twig, and you will need several bottles of high-octane elixir to get over it (see the section on timing cover removal on page 89). Use the special tools to gradually release the tensioner into its normal position. Pull on the tensioner to remove tension from the latch itself, and use the rocking tool to hold the latch near the center of a rock -- not fully CCW nor fully CW, sorta halfway in the middle. While holding the latch mid-rock (and perhaps rocking it back and forth a little), gradually release the pull; it may take a couple tries before the latch is successfully released and the

tensioner starts moving. Once it does, you may quit fiddling with the rocker altogether, it'll take care of itself, but continue to use the puller tool to gradually allow the tensioner to assume its final position.

TIMING CHAIN TENSIONER -- DISASTER AVOIDANCE: Jaguar designed the latch so that the tensioner must be retracted as far as it can possibly go before it can be locked in the disengaged position. This bends the plastic arch, normally fairly curved, into a nearly straight shape -- and therefore stresses it far beyond what it normally sees. Even if it doesn't break immediately, this stress may start small cracks that cause the tensioner to break shortly after reassembly.

Simple solution: *Don't* retract the tensioner! When it comes time to take the sprockets off the camshafts, just do so and set them on the holders -- allowing the tensioner to take up the slack in the chain. During reassembly, simply use the latch release tool to hold the latch CCW as you pull the sprockets back up into position on the camshafts. This method has been tried and works fine.

All this means you will only need one of the two tools shown in **Figure 4** -- and since you won't ever get near the fully-retracted position, you won't need to grind the side off the lever.

It is of utmost importance that the latch on the tensioner be rocked CCW in order to allow the tensioner to release the tension it took up during disassembly. In fact, it'd probably be a good idea to rock that latch on at least two separate occasions during reassembly. First, obviously, it should be rocked during the reinstallation of each sprocket. Finally, after the distributor has been reinstalled and there's no more need to leave the crank in a particular position, the latch should be held in the CCW position as the crank is turned by hand through a complete turn or two.

Failing to do this reportedly results in a whirring sound from up front when the engine is started. Amazingly, it apparently does not destroy the tensioner; just realize what you forgot, go back and rock that latch once, it goes "pop" as the excessive tension on the chain is released, and all is well. Craig Sawyers says, "Precisely what happened to me a year ago. Saga was that during replacement of skinny washers at oil feed, I stripped the thread in the back to the tappet block. Tore it off to get an insert put in, and when I got the thing back together there was a worrying whirring noise from the front of the engine related to the revs. Aargh. But - pulled the rubber plug and stuck a screwdriver in (using a piece of mirror and a flashlight to see exactly what was going on) and "pop" went the tensioner. All was A-OK after that. Now during the reassembly process I could've sworn that I'd released it -but obviously not enough."

CAMSHAFT SPROCKET REMOVAL: The V12 has a cute little bracket just forward of the camshaft sprockets that holds the sprockets (and timing chain) in place during removal of the heads or camshafts. The sprocket hubs have little stubs to sit on these brackets, and grooves for a clip to secure the sprocket on the bracket.

The clip, also known as tool JD.40, can obviously be improvised with sheet metal or even a normal 1/4" E-clip, perhaps with a 5/16" flat washer behind it. Note: The size of an E-clip is the size of the shaft it typically fits, *not* the diameter at the bottom of the groove it fits in. The diameter at the bottom of an E-clip groove on a 1/4" shaft is about 3/16", so that's the ID of a 1/4" E-clip. The stubs on the front of the cam sprockets are 5/16" in diameter, but they have exceptionally deep grooves and the OD at the bottom of the groove is about 3/16", so 1/4" is the correct E-clip size.

Note that if you purchase a "head set" -- a set of gaskets intended to include everything you need when you take the heads off -- the set will not include the locking plates for the cam sprocket bolts, C33917. You will need four new ones, so make sure to order them at the same time.

CAMSHAFT TIMING: The repair manual describes how to adjust the camshaft timing; this is just some clarification. To adjust the camshaft timing, obviously the chain can be moved over one tooth on the sprocket -- an extremely coarse adjustment. The camshaft sprockets have a splined inner hub that contains the four mounting holes. A circlip can be removed, allowing the separation of the inner hub from the sprocket, and the hub can be moved over one spline -- a fairly fine adjustment. However, the hub has an odd number of splines, so rotating the hub 90°, 180°, or 270° will effectively relocate the four bolt holes in 1/4-spline increments -- an extremely fine adjustment.

The engine is designed so that the crankshaft and the camshaft can be located where desired, the timing chain put in place and the tensioner activated, and then the mechanic can fiddle around with the sprocket hubs until the bolt holes line up. Jaguar provides an alignment notch on each camshaft and a special tool for setting the camshaft position. This special tool, C3993, costs under \$20 and is not easily improvised. It is recommended that anyone who has an engine apart far enough to use one have it on hand.

If the engine in question has a few miles on it, it may even be a good idea to go through the procedure of setting the camshaft timing while there. Wear in the timing chain will cause the camshaft timing to gradually move. What's worse, the timing of the right camshaft will move more than the left.

It is very important that you check the condition of the damper before relying upon it to set camshaft timing -- especially if it's a later car with the Bosch alternator, which tend to shear the damper as mentioned on page 87. If the damper shears while running it may squeal or affect battery charging but otherwise isn't too serious, but if you rely on the marks to time the camshafts and the marks are wrong due to a sheared damper you may crunch pistons against valves when you hit the starter.

TAPPET BLOCK REMOVAL: Sections 12.13.29 and 12.13.30 of the ROM describe how to remove the tappet blocks, and both procedures end with "Lift off tappet blocks carefully, retrieve tappets and valve adjusting pads." The Haynes manual provides a similar procedure. Both make it clear that the tappets must be reinstalled in the same locations they came out of, but if you yank that tappet block as described I dunno how you'll avoid having tappets everywhere. If you have a decent magnet on hand, it might be a better idea to use it to remove the tappets *before* unbolting the tappet block from the head. If you don't have a magnet, you might want to at least use a magic marker to mark the tappets before disassembly.

Sidetrack: If you need some really good magnets, tear apart a scrapped computer hard drive.

When reinstalling the tappet block, the manuals say you should tighten the bolts and nuts in order, but don't specify a torque. Later on, you'll be installing the bearing caps on the camshaft, and there is a *max* torque value specified there -- 9 lbf.ft. or 1,24 kgf.m. Since the nuts are the same size and all actually hold the tappet block to the head, it might make sense to tighten *all* of these nuts to the same specified torque. However, the fact that the cam bearing cap torque spec is a max rather than a range, plus that it's rather low for a 5/16" nut, indicate that this value is specified in order to prevent distortion to the soft aluminum bearing caps and probably isn't valid for the other tappet block fasteners. Hence, it may make more sense to use torque values specified for other typical 5/16" UNF nuts -- typically 11-13 lbf.ft. or 1,52-1,80 kgf.m. Later, while torquing down the cam bearing caps, you might wanna go back and retorque these other nuts and screws.

The upper row of fasteners on the tappet block are different, though. If the car is a pre-'84, they are a coarse thread rather than a fine thread, so the torque values aren't necessarily equal. The objective should be to achieve the same bolt tension, but the difference in threads means it will take a different torque to achieve the same tension. Judging from other similar applications, it appears that coarse thread fasteners should be tightened to a slightly higher torque than fine thread, so torquing these to perhaps 12-15 lbf.ft would be in order.

They are also socket head cap screws, meaning that it requires an Allen wrench to tighten or loosen them. Loosening is no problem, but tightening to a specified torque with an Allen wrench is tricky since you can't put your torque wrench on it. There are a handful of options, though. First and most properly, you can find a tool that looks like a short hex key built into a socket so it can be attached directly to a ratchet or torque wrench. These are fairly common, but the size needed here -- 7/32" -- is not quite so common. Sometimes you need to buy an entire set of these tools to get the one you need, and you are hereby advised that many such sets *don't* have the one you need! Be sure to check before buying. Discount Auto Parts sells a pack of four such tools on a card labelled "Brake Caliper Hex Bit Set" by Performance Tool, and one of the four is the 7/32" you need. These are really heavy-duty to fit 3/8" drive ratchets (most of these type tools fit 1/4" drive ratchets) and have an unconditional lifetime warranty.

Another option is to check for bits for electric screwdrivers. These bits are 1/4" hex shafts about 2" long to fit in the chuck of an electric screwdriver or drill, and there are all kinds of tips to drive almost anything. If you can find a bit

with a 7/32" hex tip on it, you can put it into the head of the bolt and drive it with a torque wrench connected to a 1/4" socket. Unfortunately, finding this particular type bit may prove a little difficult.

A third possibility is to cut a piece off the end of your 7/32" Allen wrench, stick it in the bolt head, and drive it with a torque wrench connected to a 7/32" socket. This makes for a really flimsy assemblage of tools, but it should work OK. Don't drop that little hex piece!

From '84 on, the socket head cap screws require a 6mm Allen wrench. It might actually be *easier* to find a 6mm hex driver that will attach to a torque wrench than a 7/32", but if not the above ideas will work -- just change the sizes accordingly.

These cap screws don't have any lock washers under the heads, since a lock washer wouldn't fit down in the hole. This doesn't seem to pose a problem, however; there are no reports of these bolts backing out.

Good luck torquing the bearing cap nuts to 9 lbf.ft. with a 150 lbf.ft. torque wrench, which is the only thing available at most auto parts stores. J. C. Whitney (page 643) offers a torque wrench with a 0-600 in.-lbs. (0-691 cm-kgs.) range, catalog number 15xx01148.

TAPPET BLOCK SEALING: There is no gasket between the tappet block and the head. Although this joint must be sealed to prevent oil leaks, perhaps Jaguar felt that the camshaft support and the valve clearances would not be secure enough with a gasket underneath the whole assembly.

So, how do we seal it? The ©1975 ROM, sections 12.13.29 and 12.13.30, says "Smear mating surfaces of tappet block and cylinder head with Hylomar." Michael Neal says, "Hylomar is a sealant that does not harden over time. It is still readily available and is blue in color. It is commonly used to seal the liners into the V12 motor and the cam towers to the heads. I've stopped using it to seal the cam towers because a good blast of carb cleaner or an aggressive steam cleaning can dislodge it and cause an oil leak that leaks directly onto the exhaust manifolds. Not only does an oil leak like this make a mess but it also causes the exhaust manifold gaskets to erode." Note: See page 97 regarding the liner sealing.

The Haynes manual merely says to use "jointing compound", perhaps recognizing the shortcomings of Hylomar for this application. According to Craig Sawyers, his repair manual (*Jaguar SIII Service Manual*, AKM 9006 Ed 5, ©1988) "...says to use Loctite 573. I used 574, which the Loctite website (www.loctite.com) has as practically the same stuff. TWR Jaguar in Oxford (Tom Walkinshaw's dealership, who manufactured the XJ220. I believe they know a thing or two about Jags) use 574."

A call to Loctite (1-888-LOCTITE or +1-203-571-5100) and a discussion with a tech rep revealed the following: First off, Hylomar (which is also made by Loctite, under license from Marston Bentley Ltd.) is intended as a gasket dressing, *not* to be used without a gasket at all, and is *not* recommended for this application. As Sawyers says, either 573 or 574 is suitable; the chief difference is in difficulty of disassembly, since 574 will glue the parts together pretty well while 573 is designed to be easier to get apart.

573 is bright fluorescent green and 574 is orange -- the stuff itself, not the tube it comes in. Loctite products all seem to come in red tubes.

Sawyers reports that you'll need about 50ml to do both banks. 573 in a 50ml tube is Loctite part number 21455 and 574 in a 50ml tube is part number 24018. Unfortunately, neither 573 or 574 is commonly sold in auto parts stores. Finding it will normally entail calling Loctite at the above number and getting the name and number of a local distributor; Loctite will not sell it direct. Neither of the substances is cheap, but worse yet you may end up facing a minimum order requirement of 10 tubes or some such, so you might want to talk your local Jag club into placing an order for the group.

Now, according to Neal, apparently Jaguar has changed its mind again about what to use on the tappet block/head joint -- perhaps because Loctite 573 and 574 are too difficult to find. "I'm more partial to Loctite 518 which, by the way, is red. Loctite 518 is a metal to metal sealer and dries to a rubbery texture. It is what Jaguar now recommends for sealing the cam towers to the heads. Most auto parts stores carry it, just get the big tube."

Joe Bialy says, "I have a copy of "Loctite Worldwide Design Handbook" 1996/97 edition. 518, 573, and 574 are all from the same family of gasketing materials. 573 cures slow and fills gaps up to 0.2mm. 518 has moderate cure time, fills gaps to 0.5mm. 574 is fast curing, good for 0.5mm gaps. They are intended primarily for structurally rigid close fitting flanges. Being anaerobic, they only cure between the flange faces. Excess material is dissolved in "most fluids" thus flushed away. "Passages or channels will not be blocked."

"The book makes no mention of Hylomar at all." Interesting, since Loctite manufactures Hylomar under license.

"I also saw a Jag tech bulletin (#12-51) that now specifies Loctite #518 for the tappet block-to-head joint. It was dated 8/94."

"Also according to their book for 510 type gasket compounds (509, 510, 518, 573, and 574): "Anaerobics cure rapidly between metal surfaces...To ensure gasketing success, all fasteners must be torqued to specification immediately (<3 minutes) after assembly". I dunno how you'd torque *any* assembly to spec within three minutes, especially one with as many fasteners as the tappet block-to-head joint, especially if you include the cam bearing caps in that spec. Nevertheless, the substances do seem to provide a good seal.

David Johnson points out that Loctite provides an online comparison of the various gasket-forming substances they offer at

http://www.loctite.com/literature_html/pdf/gasketingan.pdf

This is a .pdf file, which means you'll need Adobe Acrobat to view it -- but the Adobe Acrobat reader is free, if you don't already have it you should get it anyway.

Steve Cranswick suggests Loctite 5900, as described on page 40. I know, too many recommendations, but the point is: just about *any* Loctite 500-series product will probably work here. What *won't* work here is Hylomar, which is what is recommended in the early ROM's and was probably used at the factory on early cars.

Whatever sealant you end up using, think a little bit before applying it. There is no need to smear it all over everywhere, and in fact that type of application is not recommended because it can result in air bubbles. Keeping the bead thin might also help you get it compressed properly with the first few bolts before the sealant sets up. You also don't want to get any inside the tappet guides. The instructions on the tube of 573 say to apply a bead to one part only, which makes it easier to apply than Hylomar; trying to "smear" it onto the head itself would be tricky since all those studs are in the way. Basically, you need to apply one continuous bead of sealant completely around the edge of the tappet block, making sure the bead pattern is such that it will always contact a mating surface on the head. Some flat areas on the tappet block correspond to gaping holes on the head, so a random guess is *not* acceptable; make very sure you are applying the bead in the correct place. Pay special attention to the area of the inside corners right behind the cam sprockets, where the forwardmost cam bearing studs are located; each side of the tappet block requires a slightly different treatment, and the left bank is a bit different than the right.

Now, think a little more before applying the sealant. Note that the bead should be routed *inside* of each of the 10 holes (one row of 6 plus the 4 surrounding the sprocket) for the studs on which the nuts are located *outside* the cam cover. Unfortunately, depending on the casting tolerances of your particular tappet block, the amount of surface area just inside the 6 holes may be tiny indeed; you will need to exercise considerable care to make sure that particular location seals properly when assembled. Also note that the bead must be located *outside* of the other 20 holes, otherwise oil might get under a nut, run down a stud and leak out -- a serious potential on the studs that hold the cam bearing caps, since oil is being fed under pressure between those parts.

If all that wasn't perfectly clear, I have provided an illustration showing where that bead of sealant should be located; see **Figure 5**.

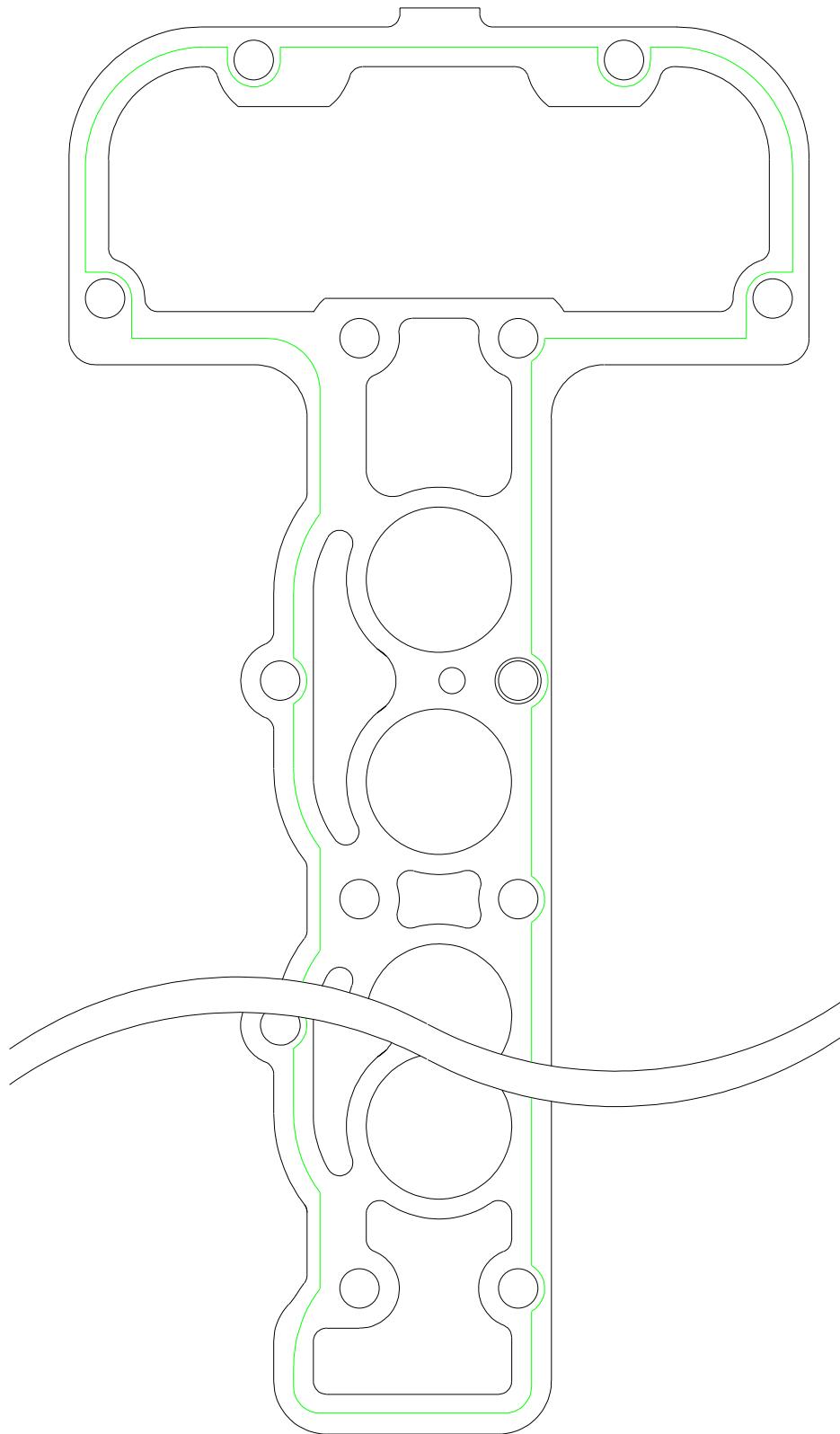


Figure 5 - Sealing the Tappet Block

If you have a pre-'84 car with 5/16" studs, the 4 studs surrounding the cam sprocket have been sealed with cap nuts and copper washers. However, if the bead of sealant is applied to the tappet block correctly inward of these studs and the cam cover gasket does its job, there will be nothing within these stud holes to leak. From '84 on, these 4 studs are metric and use normal nuts and spiral groove washers with no attempt at sealing the studs, so they must have figured out it wasn't necessary.

VALVE CLEARANCES: In order to adjust the valve clearances, you must tear a considerable amount of hardware off the top of the engine. Also, since adjustment is via shims, the measurements must be made, the assembly torn apart and the shims removed and replaced, and the gaps checked again after reassembly. The shims themselves cost about \$3 each. Having a dealer perform this work reportedly costs over \$600, and is probably a reasonable charge considering the number of hours that will be required. Before doing the work yourself, see the tip on clearing off the top of the engine on page 57.

The wear rate on this valvetrain is slow, so this adjustment doesn't need to be done very often. However, when they *do* need adjustment, it's likely because the clearances have closed up! Wear between cam lobes and tappets or between tappets and valve stems causes the gaps to open up while wear between valves and seats causes gaps to close, and apparently the latter is predominant in this engine. This means that there won't be an annoying ticking to tell you that the valves need adjusting.

If you wish to check clearances, it is recommended that you obtain a set of feeler gauges that has a bend in the blades. You can't get a straight blade in there, but sets are available wherein the entire set of gauges and the holder they come in are bent about 45° in the middle.

A minor tip: The valve adjusting pads come in sizes varying in .001" increments and (the genuine Jaguar parts anyway) indicated by a letter etched on one side of the pad. As a favor to the next guy who'll be working on this engine, install the pads with the letter facing outward (toward the tappet). Years later, the letter will still be legible. If installed with the letter facing the end of the valve, it will be difficult or impossible to decipher the letter later on.

Roger Bywater of AJ6 Engineering (and formerly with Jaguar) says, "we knew back in the 1970s that running with the exhaust valve clearances set at 0.016" gives a slight but measurable gain in mid-range torque and reduced fuel consumption. Noise is not excessive at this setting because the actual running clearance closes up with the higher temperature of the exhaust valves compared to the inlets which must be set as normal.

"Anyone wishing to measure a V12 cam, as I have done in the past, will find that the timing quoted for the H.E. occurs at 0.010" lift whilst the timing at the point at which 0.012" clearance is taken up is an almost unbelievable 36,78/78,36. The difference in overlap between 0.013" and 0.016" clearances is about 12 degrees so the need to avoid tight clearances will be obvious and although the extra lift may be insignificant it can profoundly effect the HC emissions generated, quite apart from the modest effect on torque. In my view the best compromise regarding noise and performance is to aim for 0.013" for inlets and 0.015-0.016" for exhaust which, because of greater expansion of the exhaust valve stem, results in a similar true running clearance for both.

"...If mid-range torque could be improved by just opening up the clearances, why did the factory not do it in production? Well maybe they did (I am not prepared to be more positive than that) - but you will not find any manual telling you so because the reason for doing it would have been to reduce HC emissions at a critical time, at the risk of introducing more tappet noise problems."

CYLINDER HEAD REMOVAL: First, a bit of clarification: It is possible to remove each head with the camshaft and tappet block in place, and this may make sense if the reason for disassembly is farther down. This is the procedure outlined in both the ROM and the Haynes manual. On the other hand, if you plan to work on the tappets or valves anyway, you might choose to remove the camshaft and tappet block *before* removing the head. It makes the head lighter for lifting, and it makes it safer to set down -- there won't be any valves sticking out the bottom.

The following are a few comments/corrections to the ©1975 ROM, Sections 12.29.11 and 12.29.12, along with corresponding sections of the Haynes manual:

In Section 12.29.11, which is about pulling the B bank head, step 19 deals with moving the transmission dipstick tube outta the way. The dipstick for the BW tranny is on the B side, but on the cars with the GM400 the dipstick is over on the A side, so this step needs to be moved to Section 12.29.12. The same thing might be said of step 14 in Chapter 1, Section 19 of the Haynes manual -- that it should be moved to Section 20 -- but if you have a later car, you should probably be following the procedures outlined in Chapter 13, Section 3 anyway.

In Section 12.29.12, which is about pulling the A bank head, step 5 says to remove the auxiliary air valve. The AAV is on the B side, and doesn't need removal for working on the A head only. The same correction applies to Chapter 1, Section 20, step 5 in the Haynes manual.

Steps 8 and 12 in section 12.29.11 and steps 10 and 14 in section 12.29.12 instruct you to position the engine at TDC on cylinder 1A (by using the cam aligning tool on the notches in the camshafts) and then unbolting the sprockets from the camshafts. You will find this job goes easier if beforehand you rotate the crank one full revolution from that position (TDC on cylinder 6A, notches on cams pointing downward towards the head) and pull two bolts and one locking plate off of each sprocket. They're easier to get to when pointing up than when pointing down. Step 7 of Section 12.13.01 and step 6 of Chapter 1, Section 10 of the Haynes manual hint in this direction without making it as clear as they might.

Both manuals talk about removing heat shields, but beyond the big obvious one on each side don't really clarify what they're talking about. In all probability they're referring to the heat shield on the downpipe on the LH side as well as the heat shields around the boots on the power steering rack. The heat shields on the rack need to be removed in order to deal with the downpipes.

Neither manual even mentions the front exhaust manifolds. It's probably a matter of choice; they can either come off with the head or separately. If left attached to the head, they provide a nice handle for grabbing, but they do make the assembly heavier to lift.

CYLINDER HEAD REMOVAL -- ENGINE IN CAR: The conundrum facing anyone pulling the heads with the engine in the car is the fact that the rear exhaust manifold on each side is too close to a portion of the chassis. If the head is slid up the studs with the rear manifold still bolted to it, it will hit the chassis long before the head clears the studs. This problem can be addressed in two ways: 1) the rear manifolds can be removed from the head first; or 2) the motor mounts can be disconnected and the engine moved around until the manifolds clear the chassis as the head comes off. Sections 12.29.11 and 12.29.12 of the ROM describe the first option. Section 12.29.12 for the A bank head also describes pulling the starter, which is probably entirely to gain access to the lower nuts on the rear exhaust manifold on that side; if the head is removed with the rear exhaust manifold attached, the starter does not need to be removed.

If you choose the path of removing the manifolds first, you'll run into the same problem: the chassis is too close. The manifold won't come over its own studs without hitting the chassis first. Of course, sections 30.15.10 and 30.15.11 of the ROM just list the step-by-step instructions as though each step is easily completed. After all the fun you'll have getting a wrench on the nuts on the bottom side of the manifolds, you'll be just tickled pink to find that you have to undo the motor mounts and tilt the engine *anyway*.

This manifold removal problem also has two possible solutions: A) move the engine on its mounts again; or B) unscrew the studs so the manifold can come out vertically without having to clear the studs. Of course, unscrewing the nuts is hard enough, unscrewing the studs is likely to be seriously difficult. Here's an idea: Remove all the nuts first, then back the manifold up against the chassis so you have a gap between the manifold and the head. Using a thin pair of pliers, reach between the gap and unscrew the top three studs and then the bottom three studs. This method has the advantage that you will be gripping the studs near the middle and therefore not boogering up the threads where they're actually used. Note that two of the studs on the bottom of each rear exhaust manifold cannot come out through the manifold; they will either have to be removed with the manifold or the manifold will have to be repositioned -- perhaps downward, perhaps tilted -- to get those studs out. All the while, keep in mind that you will have to put this manifold back on somehow.

Clearly, removing the heads by leaving the manifolds on the heads and tilting the engine has its benefits. For one thing, you can leave the starter alone, there's no reason to mess with it. This author got his heads off by unbolting the motor mount on one side, putting a jack under the front of the engine and jacking, causing the engine to rise and tilt. After one

head came off, the engine was lowered, the mount reconnected, the other mount unbolted, and the engine jacked back up so it tilted the other way to remove the other head.

David Johnson says, "It was easier for me to remove both motor mounts and *lower* the engine to get enough clearance." Johnson goes on to say that, even though he pulled the heads with the manifolds still attached, he went the other way on reassembly. "I did that because I couldn't get 2 nuts off the bottom because some &^%\$ had galled up the threads and the nut wouldn't come off, and the stud was trapped. Now that I replaced the studs with new, and with the ever-present anti-seize it was *much* easier to put it on after."

Whatever method is used to deal with the exhaust manifolds, make sure to take enough notes to be able to reinstall the heads and reassemble the car.

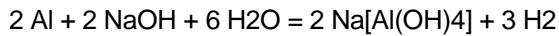
Tip: If the tappet block is off, you may find it helpful to unscrew and remove the rear pair of cam bearing cap studs to ease clearing things while getting the head in and out of the engine compartment.

STUCK HEADS: When you actually get to pulling the head off, if it's never been off before you'll probably find it stuck. In general, being stuck means one of two things: The head and block are glued together at the gasket, or the studs are stuck in the holes. The difference becomes evident when you actually get it loose: If it was stuck at the gasket, then once it's broken loose it slides easily off the rest of the way off the studs. This is typically *not* the case with the V12 heads, which have metal-faced gaskets that don't stick much, but the crud really builds up around the studs (several of which are immersed in coolant) and makes it difficult to get the head off every bit of the way. You might get it an inch up and *still* be having difficulty moving it.

This author will express an opinion here: The stuff plugging the openings around the studs is very likely the Barrs Leaks that Jaguar recommends putting in the coolant. Heads that have been off before and never exposed to Barrs Leaks again typically come right off without any more effort than lifting by hand. Of course, rust particles or other deposits in the coolant might also contribute to the jamming, but careful maintenance of the coolant seems to avoid those problems.

Loren Lingren sends this tip: "With all the nuts removed, try to wiggle the end of each stud by hand. The stuck ones will not move. Begin soaking each stud with a *good* penetrating oil. Get several 7/16 SAE nuts (Don't use the head nuts unless you have extras) and an air hammer with a tie rod tool attachment. The idea is to vibrate the studs with the air hammer, protecting the threads with the disposable nuts. Caution must be used *not* to bend the studs or gouge the head surface. Continue to apply penetrant as work is done. As the studs loosen, the penetrant will disappear down between the head and stud. I have used this procedure successfully for several years in removing even the most stubborn heads, 6 or 12 cyl, without any expensive side effects."

Other substances suggested for loosening the crud in the stud holes include oven cleaner, alloy wheel cleaner, phosphoric acid, Nitromors, lemon juice, and Coca-Cola. Dr. Karsten Eller, chemist, says to forget about the oven cleaner: "Oven cleaner is mainly caustic soda, i. e. NaOH. The sodium hydroxide attacks the protective alumina coating on the aluminium and also dissolves aluminium metal:



"Use of oven cleaner is therefore strongly dissuaded from."

Eller says acid will be fine, however. Mike Morrin says, "Someone suggested using phosphoric acid (rust killer) as it dissolves the rust without damaging the aluminium. He also suggested moulding little dams in plasticine to hold the stuff around the studs."

Regarding the use of Coke, Craig Sawyers says, "Now here's an interesting connection. Coke contains phosphoric acid (that is why it rots your teeth)." The stuff worked just great for James Dichter: "You know it's amazing what a little Coke will do. I'm beginning to wonder if we should be drinking this stuff. I'm also contemplating marketing it under a different name for the purposes of unsiezing head bolts..."

John Warr says, "Nitromors is not actually acidic - It contains dichloromethane, which will remove most hydrocarbon based gunge. It plays havoc with the skin however, and the vapour will go across most types of glove."

"I think alloy wheel cleaner will do the trick quite well."

Of course, another fine idea would be to unscrew the studs and take them out. Probably not even worth trying, though; you can't get very good access to the studs with the head in place, and they are likely to be trouble to remove -- see the section on replacing head studs on page 78.

The April 1987 issue of *Skinned Knuckles* magazine included an article on removing aluminum cylinder heads by Earl Reynolds. The primary suggestion is citric acid, with an editor's note mentioning phosphoric acid and Coca-Cola as well. But the article provides yet another idea: using an electric arc welder to heat the studs. "Attach the rod holder to the top of the stud and the ground clamp to any other part of the engine block. Run the machine for a minute or two and the stud will become extremely hot and expand in diameter, crushing the fuzzy corrosion products in the process. When the stud cools and contracts, a void space is produced between the stud and the cylinder head. One minute with the heat on and five minutes of cooling the cable down will do the trick." Note that, since there's probably no good way of knowing just how hot the welder got the stud, it'd probably be a good idea to replace all the studs that were heated in this way just in case they lost strength in the heating. With any luck, the heating also made it easier to unscrew them. It is suggested that you review the prices of these studs *before* you choose to attempt this method.

If persuasion fails, use force. Malcolm Scott suggests, "I bolted on to the exhaust studs a heavy metal plate that had sufficient rise in it so that I could use a hammer. This separated the head from the block and loosened the head from all studs along the exhaust side. However, two studs near the rear under the inlets were clearly holding things up. On the HE heads, the inlet tract protrudes over the smaller studs. I put the nuts back on the two offending studs and put solid packing between the nut and the bottom of the inlet. I then carefully wound the nuts off and the heads pushed off easily. Because the studs had grown into the head, they would not let go until the head was about 0.5 inch off. This required loosening of the nuts and adding solid packing (I used other nuts and washers)."

Richard Chapman suggests that you remove the cam so that all the valves are closed, then feed rope into the spark plug holes on cylinders 1 and 6. Turn the crank over and let the pistons push the head off. Might also work on cylinders 2 and 5.

John Napoli: "There is a technique that we used successfully on much lesser cars. The trick is that you need to try this before you disassemble very much. The trick is to loosen as many head nuts as you can access, and then run the engine!! One good stab of the throttle is usually all it takes. The head quickly 'pops' a bit. Shut it down and then remove the heads normally. You only need to loosen the nuts a couple of turns, and it often doesn't matter if you can't get to 'em all. We used to do this on engines where, for whatever reason, we anticipated problems in getting the heads off."

If nothing else works, John Goodman describes a homemade tool that *will* get the heads off. "1/2" steel plate slightly wider and longer than the cyl head. Drill two rows of holes down the centre to line up with the camshaft bearing cap mounting holes, bolt plate onto camshaft carrier using the existing bearing cap studs. Screw long bolts through threaded holes in the outside edges of this plate which line up with the cyl head retaining studs, the ends of these long bolts had "cups" to locate them over the cyl head studs. Next just torque down evenly with a few smacks from a BRO hammer and the heads come off." If you have the tappet block off, you might be able to use it as a template to mark where to drill holes in the plate.

Alternatively, a smaller, more compact set of tools that work essentially the same way as Goodman's massive plate can be fabbed up quite easily. First, purchase a length of steel bar 1/2" thick and 1" or 1-1/2" wide and cut two pieces 4-1/2" long from it. Drill two holes and drill and tap two other holes in each piece as shown in **Figure 6**. Into those tapped holes, thread 3/8"-16 bolts that are at least 5 inches long and threaded all the way to the head.

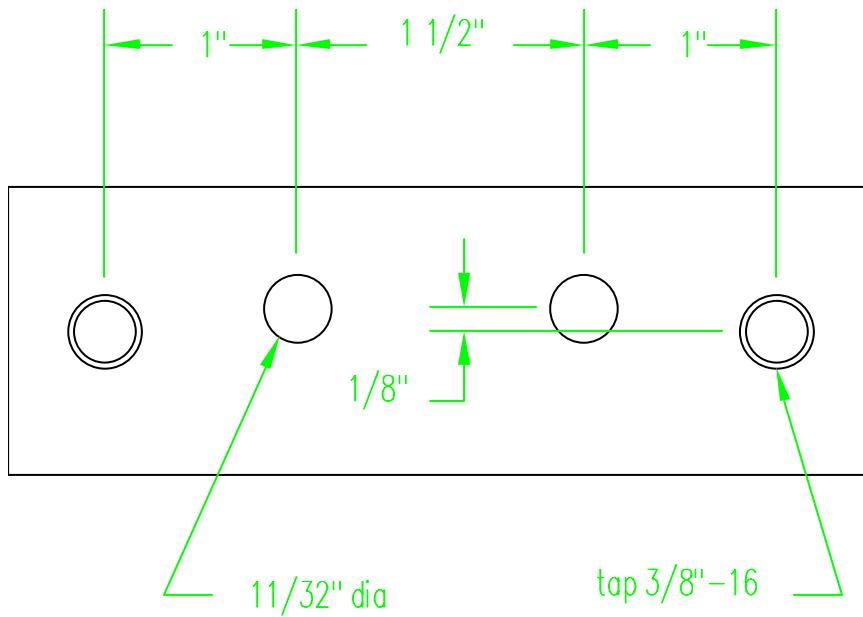


Figure 6 - Head Jacking Tool

If you want, you can use 3/8" fine thread bolts and tap the plate accordingly, or even 8mm metric stuff -- whatever is easiest to find in your area. You can use threaded rod, but you'll need to find a way to turn the threaded rod -- weld a nut onto it, bend it 90° at one end, whatever. If you don't have a tap or don't want to bother, you can just drill 3/8" holes and put nuts on the back side of the plate, but it'll make the tool a little clumsier to use.

The tappet block should be in place, and you'll need to remove the bearing caps and the camshaft. If you've already removed the tappet block, just slide it back on; without the tappet block, it's too easy to bend the studs using this tool. There are seven pairs of studs for cam bearing caps on each bank; this tool can be used on the 2nd, 3rd, 5th, or 6th pair. Fit these two plates to the 2nd and 6th pairs and put nuts on to hold them in place. You might need to put some spacers under the nuts on the studs -- 3/8" nuts work fine.

To begin with, install some generic nuts on the top of each of the four head studs that will be involved, threading them on only a couple turns. When the jacking screws are inserted into the center of these nuts, the nuts will keep the screws from walking off the end of the stud. However, when the head has been lifted to the point where these nuts keep it from coming any further off, you'll have to stop everything and remove the nuts. Things may be moving well enough by that point to continue without anything to hold the jacking screws centered, but if not a few small pieces of 7/16" ID tubing slid over the studs will help -- or maybe some 1/2" nuts. Once the jacking screws enter the holes in the head, there is no further need for such things, the head itself will hold the jacking screws aligned.

It may be possible to get a mildly stuck head loose with only one tool by fitting it to the 2nd pair of studs, getting that end loose, then relocating it to the 6th pair and getting that end loose. But since the trouble is likely to be from junk packed around the studs and will be trouble all the way up, it'll be a lot easier to make two of these tools and jack both ends simultaneously.

When jacking, take care not to allow the head to tilt inward or outward; tighten both jacking screws on each tool evenly. If the head cocks, it just jams worse on the studs.

Note that the weak point on these contraptions is probably the cam bearing studs themselves. Don't go cranking real hard; if the head just won't come loose, find a way to apply more lift elsewhere -- don't just pull the studs out of the top of the head. Since they're only attached to two studs each, these little tools won't apply the lifting force that Goodman's massive plate will, but it should get most heads off. If more force is required, two more plates could be fabbed and installed on the 3rd and 5th pairs of studs to apply more oomph. You could even fab a fifth plate with no 1/8" offset between the pairs of holes to use on the 4th (center) set of studs.

Matthias Fouquet-Lapar quotes the "XJ-S issue" (Volume 8 Number 3 January/February 1996) of *Jaguar World*, page 57 :

"Cylinder heads can be a nightmare to lift due to the inter-action of steel studs and alloy heads. However, Classic Spares do market a tool of their own design that makes light work of the job. Be warned, you will need it."

See page 642 for Classic Spares. There are also reports that John's Cars (page 668) offers such a tool.

ONE HEAD OR BOTH? If a valve seat drops in one bank, some people want to know if they can just pull the head from that bank and leave the other one alone. If the seat only drops a bit but stays in place, you might get away with it. If the seat actually falls out and breaks up, apparently not. Greg Wells of Concours West says, "If one or more seats has dropped and shattered, you must pull both heads, as the pieces will always have been tossed into the other head by the strong intake plenum reversions."

Aw, c'mon, that's gotta be BS! The two intake manifolds are completely separate, connected only by a 1" balance pipe. Parts of a valve seat would have to go through that balance pipe to get to the other side! "That's the only explanation I can offer. This is not based on supposition but is something I have witnessed several times. The seat pieces in the other bank (opposite the dropped seat) are pretty small and since the balance pipe is the only connection, I have to assume this is the case.

"The last one I recall had dropped a single seat on the LH bank. Two of the LH pistons had shard embedded in them; four of the RH pistons also did. The only seat missing was on the LH side and the broken seat pieces were small, on the order of 1/8" or so."

More testimony from Chad Bolles: "Yes, it is possible for broken pieces of valves and seats to end up on the other side of the engine. Been there done that."

And Roger Bywater: "What seems to cause it is that if the exhaust valve is unable to seat and if there is a vacuum in the inlet manifold then exhaust gas will get drawn back out of the exhaust manifold and backflow through the inlet valve when it opens. At moderately high engine speeds at light throttle this backflow could be quite considerable and might easily pull debris with it up into the manifold. The good cylinder bank will be pulling better vacuum so there will be flow across the balance pipe and if circumstances are right then bits will end up making the journey across.

"What seems at first to be impossible is actually not at all unlikely if the car continues to be driven in the damaged state."

SO YOU HAVE THE HEAD OFF: Be sure and clean up the spark plug threads while you have the head off. One excellent method is to get a suitable wire brush shaped like a "bottle brush" and screw the brush through the hole. Places that sell shotgun cleaning tools have an excellent selection of suitable brushes. When clean, the spark plugs should spin all the way down by hand. You might also want to address any spark plug threads that may be damaged; it's easier to install an insert now than later on when the engine is together.

If you have the A bank head off, it is suggested you go through the procedure of setting the location of the timing mark plate described in the section on ignition timing starting on page 121.

If the block hasn't been turned upside down in the midst of this job (!), there will be little puddles of coolant surrounding the liners. Make sure you get this coolant out, and then scrape the bottom of these pockets with something pointy. You'll probably find a lot of junk, perhaps looking like sand. It might actually be sand left over from the casting process. David Johnson says, "I discovered that there was no coolant flow around the last cylinder on my A side! The last liner is so close to the jacket that *yuck* had built up to the point that coolant would have had a hell of a time trying to flow around it. I'd bet only about 1/2 the liner had coolant touching it!" Whatever you find, get it outta there. Small accumulations probably don't hurt anything being there, but these pockets may serve a useful purpose in catching new crud floating around in the cooling circuit, and maybe once they're full stuff starts plugging the radiator or something.

On the bottom of the heads where they come in contact with the gasket, there are several openings for coolant to flow from the block through holes in the gasket and into the head. One row is round openings, the other row is oblong holes. Several of these holes may be rimmed with casting flashing; apparently the core meets the form right at the hole, and there was little effort to clean away the flashing at the factory. When the head is off, take a Dremel and clear away this flashing to ensure the holes are fully open. Might not be a big deal, but couldn't hurt.

With the Jaguar V12, with just the heads off you might be able to accomplish several things that would require opening the bottom end on other engines. The first possibility of note is that you can reseal the liners to the block. Use the liner retainers (or some reasonable facsimiles) to hold 11 liners in place. Turn the crank until the piston in the one unrestrained cylinder is at the bottom of its stroke, and then continue turning the crank while encouraging the liner to come up with the piston. When the piston is at TDC but still at the bottom of the liner, the ledge on the side of the liner that sits on the block will be higher than the head surface. You can then carefully clean the surface on the liner and the block, apply new sealant, and slide the liner back into place. David Johnson actually used this method to reseal a liner that had accidentally come loose, and ended up knocking a few more loose just to make sure they were all properly sealed. In fact, it might not be a bad idea to turn the crank a little with no retainers in place, just to see if any liners are loose enough to move. Or, succumb to the temptation to reseal them all whether they need it or not. See page 97 for notes on sealants to use here.

Now we move on into theoretical, since as of this writing the following ideas have not been tried and reported back on; attempt at your own risk. The next suggestion is that you may be able to replace the liners from above. This is a bit harder than the resealing idea, since it requires taking each liner completely out. The challenge is getting the piston rings back into the liners when reassembling, since even with the piston at TDC you're working in too tight a place to use a conventional ring compressor. However, you may actually be able to finger the rings into place one at a time. Squeeze the top ring, slide the liner down on it, and move on to the second ring. John Napoli suggests you might even go ahead and cut a small taper into the bottom end of the liner before installation to make it easier to get the rings in. Or, you might be able to fashion a homemade ring compressor that will work in this space, perhaps from a hose clamp and some shim stock, or maybe from a pair of needlenose pliers and some shim stock.

If that idea works, the next idea should work too: Replacing the piston rings. If you have the liner out and the piston is flopping around above the opening in the block, it shouldn't be too difficult to carefully remove the old rings and slip on some new ones.

I'd like to report that you could even replace the pistons themselves, but reportedly the piston does not come up high enough for the pin to clear the ledge that the liner sits on.

CLEANING HEAD STUD HOLES: Before reinstalling the head, it is of utmost importance that the holes for the studs be thoroughly cleaned. Any crud remaining in these holes may be kicked loose when the head is slid down over the studs and it might fall out the bottom and sit on top of the head gasket while you're closing it up, and you'll have a bad seal.

For cleaning the stud holes, a suitable item would be a wire brush shaped like a "bottle brush". If you're real lucky, you might find one in an auto parts store, and if you're even luckier it might be somewhere near the correct size. Forget about luck and visit any sporting goods store or department and look at the tools available for cleaning rifle and shotgun barrels. Outers and Hoppe's make cleaning tools involving 3-piece shafts and little copper wire brushes that screw onto the end for very reasonable prices. Buy one shotgun-cleaning brush assembly and additional interchangeable brass wire brush attachments for 10, 12, 16, 20, 28, and .410 gauge shotguns, and you'll be able to clean just about any size hole you encounter. You can opt for the rifle and pistol cleaning tools as well for cleaning smaller holes yet, but note that the threads on the brush itself might be different and therefore require either a different rod or an adapter. Also note that Outers and Hoppe's shotgun brushes are not interchangeable, so you'll need to choose one brand for all the brushes you buy.

As opposed to the items found in an auto parts store with handles that are merely a continuation of the twisted wires that form the brush itself, the shotgun brush assemblies have a finely machined 3-piece aluminum shaft. Hence, it becomes quite reasonable to chuck one section of the shaft up in the variable-speed drill and clean those stud holes up in a hurry!

REPLACING HEAD STUDS: Some of the head studs on the V12 are immersed in coolant. If the coolant has not been maintained properly (changed on schedule), some of these studs may get corroded. A small amount of surface corrosion is no big deal, but large-scale erosion can significantly reduce the cross-sectional area of the stud -- which is a formula for blown head gaskets.

Head studs can be thought of as springs. When you tighten the nuts to the specified torque, you are stretching these springs to a particular load value. Even though parts may expand a little with changes in temperature, the studs are designed to be long enough that this growth is minor compared to the stretch of the studs so the compressive force on the head gasket is maintained. But if the sides of the studs start corroding away, this preload is reduced. And if the engine is reassembled without replacing such corroded studs, it may prove impossible to apply the specified torque; the bolt may yield at the narrowed section first.

Peter Hyslop shares experience with these studs: "This applies mainly to old V12 engines (ie >20 years old) with a few miles on them and which have never been apart:

- 1) The studs can get stretched if over-torqued by some fool trying to take a short-cut on a head gasket leak ... this is an unusual degree of incompetence, so never use that mechanic again (and if you did it yourself, give up, there's no hope for you).
- 2) The studs immersed in the coolant can corrode and pit. The others are usually fine.
- 3) The studs immersed in the coolant can become adherent to the block and become brittle. Some of these studs stand a reasonable chance of snapping off when you try to remove them ... yes, you read it correctly, the stud will snap *before* the aluminium block gives way.

The solution:

- Make sure that you really want to go this far before you start, and are prepared to stick it out when the going gets tough.
- Leave the studs not in the coolant alone.
- Pull the studs in coolant only if corroded.
- Expect some of the corroded bolts to snap and land you with a big machinists' bill.

How do I know?...I'm up to my arse in the alligators right now with items two and three above (yup, snap, snap snap)!"

Note that the AJ6 6-cylinder engine used in some XJ-S's has an entirely different theory in head studs. They are designed to be tightened until they yield, which provides a very closely controlled amount of compression on the head gasket -- but requires that the studs be replaced whenever the head is pulled.

FIDDLING WITH THE TIMING CHAIN: If, for some reason, your timing chain isn't sitting on the sprocket on the holding bracket when you put the head on, David Johnson says, "if you have already installed cam, be sure that you take the moment and hook the cam chain over the bracket meant to hang sprocket on. I looked at it and told myself, "Why bother? I can simply reach down there and pull it up." Ain't so. The flange and bracket are just this much too close to squeeze the chain through."

CYLINDER HEAD NUTS/WASHERS: The thick washers under the 7/16" nuts are quite suitable for the job, and the thin washers under the 3/8" nuts under the intake ports seem to work well enough. The same thin washers used under the 3/8" nuts along the exhaust manifold edge of the head don't cut the mustard, though. They are likely to be "dished" where the nut has been pressing them down into the soft aluminum of the head.

To improve this situation, one of three tactics is recommended: Replace the washers with thicker washers; replace the nuts with washer-face nuts that will contact the original washer across most of its surface; or -- as a minimum fix --

install two washers under each nut. CarQuest auto parts (and undoubtedly some other better auto parts shops, but notably *not* some of the discount or bargain auto parts stores) offers a Dorman "manifold stud washer" number 685-050 which is quite suitable for this task. Note that these washers are not found on a bubble card on a rack, but rather in a case of heavy red and black metal drawers that form the Dorman display -- often found behind the counter. Look in the drawer labelled "manifold studs". This washer is about 1/8" thick (like the washers under the 7/16" nuts), fits very snugly around the 3/8" stud, and has a somewhat larger OD than the flimsy original washer.

TORQUING THE CYLINDER HEAD NUTS: The nuts holding the heads to the block, as in other engines, require careful torquing in progression to ensure proper sealing of the head gasket. However, there are two groups of head nuts on the Jaguar V12 that cannot be tightened with a socket on the end of an extension, meaning they are difficult to use a torque wrench on. One such group of nuts is the row of 9/16" nuts on 3/8" studs along the top edge of each head, within the vee; these are underneath the intake ports. The other group is the row of 11/16" domed nuts on 7/16" studs just under the tappet block on each side; these would be a snap if you were torquing the head nuts without the tappet block on there, but with the tappet block in place you can't get the socket over the nut.

This job calls for a tool called a crowfoot (or crow's foot) wrench. This tool looks like just the business end portion of a wrench with a square drive hole for attachment of a ratchet and extension. Since they are useful tools anyway and come in handy in other hard-to-reach places, it is recommended an entire SAE or Imperial set be purchased. If you wish to buy only the crowfoot wrenches you need for this job, Sears sells crowfoot wrenches individually. The nut and stud sizes mentioned above were apparently maintained throughout the life of the Jaguar V12, even when many of the other fasteners on the engine switched to metric.

There are actually at least three different types of crowfoot wrenches, so you might want to consider your choices before buying. The most common type looks like the business end portion of an open end wrench, so it can be slid onto the nut from the side. It operates on only two corners of the nut. The head area must be made fairly broad (like any open-end wrench) in order to give it adequate strength to prevent it from spreading and rounding off the nut under torque. Sears Craftsman crowfoot wrenches are this type.

David Johnson suggests that, if you can find a set, buy box end crowfoot wrenches, since the torque applied to the 3/8" head nuts threatens to spread the 9/16" open end crowfoot and round the corners of the nut. "Mine are from Snap On." He's right about the threat; this author used an open end set successfully, but there was clearly very little strength to spare. Box end crowfoot wrenches (like other box end wrenches) cannot go on a nut from the side, they must come down on top.

The third type crowfoot available is halfway between the open end and box end; they look like the business end of a "flare nut wrench". In other words, they look like the end of a box end wrench that someone has cut a slot through at the end. It looks like the crow was pigeon-toed; maybe they should be called pigeonfoot wrenches! They cannot go on a nut from the side, but they *can* go onto a bolt (or metal brake line) from the side and *then* come down on the nut from above. Most such wrenches are "six point", meaning they have five points -- the slot takes away one of the six points, so this type wrench operates on five corners of the nut.

There is another functional difference between the open-end style crowfoot and the flare nut style. The open end style is symmetrical when looked down on from above; if you flipped it over, it wouldn't make any difference (except for a raised area where the square drive attaches). So, you will need to have enough room to turn the nut 60° at a time, slide the wrench off and move it back to the next flat and go again. But the flare nut style, despite being a six-point style, offers another option. The square drive attachment is 30° off one flat of the hex, so if you can't turn the nut the full 60°, you can take the crowfoot off the end of the square drive extension, flip it over, and turn the nut the next 30°. That would make for a long, slow job of tightening a nut, but it'd be better than being unable to tighten it at all.

Finally, one more functional difference worth noting. The open end type of crowfoot wrench, like an open end wrench, can be used while held tilted a bit upward or downward from square on the nut. Since they only contact on two opposite flats, they can withstand a considerable amount of misalignment during use. With a crowfoot, this means that you don't need to be holding the ratchet extension perfectly parallel to the centerline of the bolt or nut, but you can tilt it away from that centerline or towards it a little bit. The box end or flare nut types of crowfoot, on the other hand, fit very securely on a hex. If misaligned, you won't even get it on. This can be a blessing or a curse depending on what you're

doing, but mark my words, whichever type you get you will eventually find a situation where you wish you had the other.

Although listed third here, the flare nut style crowfoot wrenches are perhaps easier to find than the box end style. John Robison says, "Here is the link for the set I bought..."

<http://tools-plus.com/hand-tools-wrenches--crows-foot-.html>

J. C. Whitney (page 643) offers both open end and flare nut style crowfoot wrenches in SAE or metric sets -- for about \$10 a set! Really high quality stuff, obviously.

When using crowfoot wrenches in conjunction with a torque wrench, the crowfoot should always be attached to form a 90° angle with the handle of the torque wrench. The effective lever length of the torque wrench (distance from the handle to the centerline of the bolt or nut being torqued) is not changed. If the crowfoot is attached in line with the handle, the lever length is altered, and the torque readings will be inaccurate.

For some reason, some people have arrived at the conclusion that extensions make a difference in torque wrench readings. They do not; use whatever extensions you need to to get the job done. Swivel joints *can* make a difference in torque readings; if you absolutely have to use a swivel joint with a torque wrench, at least attempt to hold it as straight as possible.

With the 11/16" domed nuts under the tappet block, the box end and the flare nut type crowfoot wrench may cause trouble. The problem at this spot is that the domed nut is tall and comes up pretty close to the surface of the tappet block. Since these two types of wrench have to go over the nut to get on, they must be thin enough to fit between the nut and the tappet block at that point. Craig Sawyers bought an expensive flare nut type -- actually a 12-point flare nut type -- that didn't work. By lining up the gap at the end, he could get it on, but as soon as he turned the nut he effectively trapped the tool; it wouldn't come off. "If you get one flat of turn on it, it won't come off the nut. If you back it off slightly so that it clears the nut, you can't get it back on for the next turn. Britool AFC687... This beast is 0.525" thick, and the diameter of the surround to the socket part is 1.275". The open end is 0.57" wide and parallel. And it is 12-point and was not cheap - I bought this sucker to do up those 11/16" nuts under the tappet block, and was not pleased when it didn't work out."

Sawyers found an alternative to the crowfoot wrench for the 11/16" domed nuts: "I ended up getting a friend with a lathe to turn a shoulder on a standard socket so that it would snug under the tappet block. Worked a treat." Of course, cutting on that fancy crowfoot probably would have worked, too, but the socket was cheaper -- and since it worked, the socket was arguably preferable to the crowfoot for this job. In fact, if you plan to retorque these nuts later, you'll find this modified socket *vastly* preferable. Basically, Sawyers machined the square drive end of the socket down to about as small as he could get it, leaving the large diameter portion as short as possible. "The part around the socket, 0.935" diameter (ie, as supplied) and 0.7" to the turned shoulder. The turned down part (where the 3/8" drive fits) is 0.67" diameter and 0.49" long from the shoulder to the top." Note that the 0.7" dimension is what's critical, and the maximum that will work may actually vary a bit from car to car. If you start with a socket that is too tall, you won't be able to cut the shoulder that far down without cutting the socket in half -- but you can shorten it up by simply grinding off the end of the socket until it goes on.

There are also problems using a crowfoot on the 9/16" nuts. These nuts sit in a ledge cut into the head, but Jaguar didn't cut the ledge any deeper than they had to. There's very little clearance between the points of the nut itself and the machined surface behind it. This is part of the reason the open end crowfoot threatens to spread; if you put the crowfoot all the way onto the nut, you can't turn it very far before the wrench runs hard against that machined surface, so instead you pull the crowfoot back a little and tighten the nut with the tips of the crowfoot. Using a box end, as Johnson recommends, will mean it needs to wrap all the way around that nut and therefore must be pretty thin-walled -- but box ends are generally pretty thin-walled, especially from companies like Snap-On. The flare nut style may have more troubles, since the claws of the crowfoot have to be beefier to make up for the loss of strength that comes from opening a gap at the end, and so may have trouble turning without jamming against the machined surface. It may be possible to use either box end or flare nut style crowfoot wrenches by fitting them to the upper half of the nut only, staying above the surrounding metal of the head; since they're grabbing 5 or 6 points they should still be able to apply adequate torque. Results may vary from casting to casting.

One other solution may be to replace the nuts with new nuts with the same thread but a smaller hex. Make sure they're Grade 8 or equivalent; you don't want cheap, soft steel nuts here.

Martin Karo: "Better than the crowfoot solution, Hazet makes a tool for precisely this purpose. It has 12-point box at one end; the shank is then bent vertically 90 degrees, and runs up 6 to 8 inches, depending on the size; then another 90 degree bend brings the shank back over the box end, and a 3/8" square drive hole is bored in, directly over the box end. This clears over-nut obstructions, and the torque values are correct no matter what the wrench angle. I rented one the last time I replaced a cylinder head, and it worked great. To buy, however, I dunno... if it's a Hazet, you can be sure it ain't cheap."

You could, of course, *make* a wrench that fits Karo's description. Find a box end wrench that fits the nut, and heat it up and bend it 90° straight up. Cut the other end off and weld on a socket, any socket, to provide a square drive connection.

The purpose of torquing head nuts to a specified value is to obtain a certain amount of tension on the studs themselves. Whether or not the threads on the nuts are lubricated makes a *huge* difference in how much tension results from a given torque, as does whether or not the contact between the nut and the steel washer it sits on is lubricated. Unfortunately, the manuals are not as clear as they might be on whether or not the specified torque is intended to mean with or without lubrication. In its section on General Fitting Instructions, the ROM does say "Always oil thread lightly before tightening to ensure a free running thread, except in the case of self-locking nuts." This makes sense, since tension obtained from lubricated threads is more consistent than from non-lubricated threads; if the threads aren't lubricated, there's no telling how much tension you'll end up with. There seems to be little or no official guidance for lubricating the washer face, though.

This author recommends you lubricate the head stud threads with anti-seize compound; this may not sound like oiling lightly, but the amount of friction in the threads when installing should be comparable. Plus, the anti-seize compound will ensure the threads are not damaged when retorquing or removing the nuts later on.

This author also recommends you apply a non-hardening sealant to the contact areas between the washer and the head and between the nut and the washer on the 7/16" studs *only*. On ten of the fourteen 7/16" studs per head, these contact areas seal the coolant circuit; that's why these nuts are cap nuts, since coolant can't leak through the threads on a cap nut (and you thought Jaguar used cap nuts to make it pretty!). While not originally intended as a lubricant, the sealant will provide a fairly consistent amount of friction between the nut and the washer and therefore a consistent application of tension to the stud. By using a non-hardening sealant, you hopefully leave open the possibility of retorquing later on -- although presumably you could retorque by removing the nut completely, applying fresh sealant, and reinstalling.

On the 3/8" studs, apply anti-seize compound between the washer and the nut. You can leave the contact surface between the washer and the head dry, apply sealant, apply anti-seize compound, whatever, it shouldn't make any difference.

Needless to say, if any of the threads on studs or nuts are boogered up enough that the nut won't spin on freely, they must be cleaned up or replaced before torquing.

When torquing down the nuts, aim for the low end of the spec range, and be alert for signs of stud yielding: the nut continues to turn without the torque increasing any more. If the specified torque is attained in a smooth and progressive manner, there is nothing else to worry about; the head is on and secure, and there is sufficient tension on the studs to make sure the head gasket will remain sealed. On the other hand, if either the threads or the washer face is assembled dry, you won't know how much of your tightening torque was lost there, so you won't know just how much tension actually got applied to the stud -- and therefore you won't know how long your head gasket is going to last.

VALVE REMOVAL: Jan Wikström says, "The normal generic valve compressor from K-mart will do fine; there's nothing special about the V12 valves." Apparently, K-mart is a quality tool source in Australia where Wikström lives; here in the US, the vast majority of valve spring compressors on the market are either cheap junk, designed specifically to fit a Chevy and nothing else, or both. Trying to use cheap junk on valve springs can be seriously dangerous; if that thing snaps loose or breaks while holding the springs fully compressed, it can fire keepers and collars around the room like bullets.

Some of these pieces of junk are intended to be operated from above only, which may be handy if you are trying to replace seals without pulling the heads, but these tools try to hook onto the coils directly; they compress part of the spring rather than the whole length of the spring, and they don't compress the inner spring at all -- you have to push down on the tool to get the keepers in and out. And you must hold the valve itself in place by other means, possibly applying compressed air to a spark plug hole or even inserting some rope and turning the engine around until the piston pushes it against the valve head.

If you have the head off, Gerald Foster recommends a valve spring compressor sold by Sears. It costs less than \$20, is a substantial tool that wraps around the head (like a big C-clamp) to push on the spring and the valve head at the same time, and is a Craftsman tool with a lifetime warranty.

When using the C-clamp type compressor, you'll find it helpful to tighten down on the spring a little bit and then give the top of the spring a little rap with a plastic hammer to pop the collar loose from the keepers. Then you can proceed to compress the spring further.

VALVE SEAT WORK: It's why you're reading this section, right? Well, when replacing the seat, the first thing you need to get right is the fit. In the General Specifications section of the ROM under "Valve Guides and Seats", there is a spec for "Interference fit in cylinder head" of 0.002"-0.006". This is *not* for the valve seats -- it's the spec for the valve guides. The correct interference fit, 0.003", is in the ROM, but not here; it's in section 12.29.18, step 14. It's followed by instructions to heat the head before installing.

The ROM also talks about two oversize seats being available, but here in the US good luck finding a machine shop that cares. The boring tool used to ream the hole in the aluminum and the sintered iron valve seats are both standards of some sort and they will use their own, not Jaguar's. If they're any good at their jobs, they will machine the ID and the seat area of their insert to the same configuration as the original so you really wouldn't know the difference unless you interrogated them about it. It's not like you have any good reason to insist on genuine Jaguar seats here; those were genuine Jaguar seats that fell out!

Craig Sawyers talks about the hot/cold fit: "Assuming that the temp difference between the seat and the head is 130°C, the differential contraction is 10ppm/°C and the seat OD is 1.5 inches, there will be a 1 thou interference under these conditions. If the seat was chilled in a freezer to -40°C, it would be a precise fit. Cooled to liquid nitrogen, it would just drop in."

"Machining to give a greater interference than 3 thou may be counterproductive, as the seat would have to be driven home, and shave the aluminium on the way in, reducing the interference again (to about 3 thou?)."

You need to make sure they cut the seat properly in order to ensure that the valve itself sits the same "depth" into the head, for two reasons. First, the position of the closed valve greatly affects the combustion chamber volume and therefore the compression ratio in that cylinder; the farther off it is, the more fiddling somebody's gonna have to do to cc the heads to make sure that each cylinder has the same volume. When you see what these guys do to get these volumes the same, you'll wish they had seated the valve right. Of course, the correct valve position may be even more important on the H.E. engine since they are part of the swirl configuration of the head.

The second reason has to do with adjusting the valve clearances. The shims are only available in a limited range of sizes, and grinding away on the valve stem is a no-no.

VALVE TRIMMING: After the valves and seats have been machined to renew the contact surfaces, the valve will obviously sit lower in the head. This closes up the valve clearances at the tappets. Jim Cantrell points out: "Often, people at this point will then cut the valve stem to get the additional clearance. This will then cause the valve stem's life to be reduced since the stems are hardened. This hardening only penetrates a few thousandths of an inch and cutting it off exposes the softer valve material." The proper solution to inadequate clearance is to replace the valve, the seat, or both.

SO YOU'RE DOING A VALVE JOB: To many of us, doing a valve job means pulling the heads off the car, taking them to a machine shop, picking them up later, and bolting them back onto the engine. However, the valves are a prime place for easy improvements when the heads are off. I will mention a few ideas.

The valve guides are sleeves that are press-fit into the heads, and protrude a little bit into the inlet and exhaust ports. Jim Isbell suggests that, before you install the valves, you take a hand grinder and grind off the protruding parts of the guides flush with the surface of the port.

The valves and seats on the Jaguar V12 are supposed to be machined with $44\frac{1}{2}^\circ$ angles. Most machine shops will suggest that the seats be “triple cut”, in which additional cuts are made at angles greater and less than $44\frac{1}{2}^\circ$ in order to control the width and location of the contact area. Typical angles for these cuts would be 32° and 60° and the contact area width should be about $1\frac{1}{2}$ mm wide. Chad Bolles suggests that a similar triple cut on the valves themselves would be beneficial.

John Milne suggests that, after the valve contact surfaces have been machined, some machinist’s bluing be applied and the valve trial fit to determine the location of the actual contact on the valve surface. Then, carefully avoiding the contact area, the inner edge of the machined surface should be blended to form a smooth continuous surface with the “tulip” shape of the valve. This helps the flow through the valve, since it makes a smooth passage instead of that corner. It also slightly enlarges the opening, since the smallest flow area when the valve is open is between this inner corner and the seat. “It’s kinda like getting a little extra valve lift for free.” Blending the inner edges of the machined surfaces of the seat may have similar benefits.

Of course, every high-performance enthusiast will suggest that you do a little “porting” while you’re in there. This means carefully enlarging the intake and exhaust passages. In the case of the intake passages on the Jaguar V12, however, this may produce undesirable results. These intake passages are designed to provide a certain amount of resonance-induced flow enhancement, and this requires that the flow rates be fairly high. Enlarging the ports makes for slower flow, which means better flow at high RPM but less boost at low RPM. In other words, enlarging the intake ports may increase high-speed horsepower at the expense of low-speed torque.

The next automatic suggestion is “polishing”. Quite literally, the passages may be polished using successively finer abrasive compounds until a mirror finish is achieved. This supposedly will reduce surface friction of the flow.

Before you reinstall the head, Jim Isbell suggests you “cc” it. This means that you measure the volume of each combustion chamber, and grind a little metal away here and there to make sure they are all the same. This makes for a smooth running engine. To measure the volume, you can set the heads upside down on a level surface and fill each chamber with a carefully measured amount of light oil.

Cc’ing must be done after the valves are installed for the final assembly. Clearly, if valves are ground or relocated after cc’ing, they will sit at a different level than they did before and this would significantly change the volume of the chamber. And this is the reason that cc’ing is recommended whenever the valves have been redone.

If you happen to be working on a pre-H.E., cc’ing doesn’t apply. The head is flat, so there are no chambers to cc.

TEFLON VALVE STEM SEALS: Michel Carpentier says, “Teflon valve seals are the way to go. They last forever, plus you can fit them on the exhaust guides as well. Less blow-by, reduced crankcase pressure, no more oil leaks, and cleaner oil to boot.

“Our engines came from the factory with 24 valves but only 12 valve stem seals. Jaguar probably realized that the British rubber intake rendition would soon fry on the exhaust side.

“Why would any (effective) exhaust valve seal affect crankcase pressure? When the exhaust valves open, gases gush out of the combustion chamber with tremendous pressure. Even though the valve itself acts as some sort of an umbrella, there is still a significant pressure differential between both sides of the exhaust guide. Any clearance between valve and guide will let exhaust gases into the crankcase area. Jaguar old trade secret to keep engines leaking oil!”

Of course, the decision to switch to Teflon seals, and to install 24 instead of 12, may not be quite that simple. This author had some discussion on the phone with the rep at Silver Seals about the differences between Teflon valve stem

seals and normal nitrile seals. There is apparently a functional difference: the nitrile seals always leak, and the leakage allows a small amount of oil down the valve guides to lubricate them. The Teflon items will not leak, so the valve guides run dry. According to the rep, this is a problem on some cars and not a problem on others. I'm betting it's not a problem on the Jag, since it uses good materials on both the valves and guides. Also, the action of the cam on the tappet applies no sideways load to the valve stem, as there is in any valve train with rockers. Still, recognize that you may be trading oil burning for faster valve guide wear when you install Teflon seals.

Does anyone make Teflon valve stem seals for the XJ-S? Carpentier: "Perfect Circle does, although unwittingly since I doubt they ever considered Jaguar engines as a possible application for their product. Our valve guide diameter is 0.502 to 0.501 in, that's essentially 1/2" or sixteen (16) thirty seconds of an inch. Valve stem diameter is 0.3092 to 0.3093 in, and that's within 3 thou of 5/16" or ten (10) thirty seconds of an inch. These dimensions are a bit unusual but luckily match those of the first generation Chrysler Hemi engines. Call Perfect Circle (they are a DANA subsidiary) and they will tell you: "Yes, we manufacture such Teflon seals, part number D1610, available at any NAPA auto store".

"There is a catch: if you go to NAPA and ask for this reference, they look it up in their computer and tell you it does not exist (never mind telling them what kind of car it is for...). The last time I was in the US, I finally found a place in Los Angeles that would order them for me. The seals actually came from a company called Silver Seals Products/Whip-L Products, Trenton, Michigan, 1-800-521-2936; their reference is DT1610 but the seals carry the Perfect Circle logo." This author called that 800 number, and had a set of 24 Teflon valve seals on order in a matter of minutes and in hand in a week at a cost of less than a dollar each. For those outside the US where an 800 number won't work, their regular phone number is +1 (734) 479-2255.

The OEM nitrile seals on the inlet valves are pressed over the valve guide until they snap into a groove around the guide just above the surface of the head. The exhaust valve guides have no such groove. This turns out to be a non-issue with the Teflon seals; these seals press fit onto the OD of the valve guide, and therefore do not use the snap groove. While the OEM seals are a simplistic piece of rubber, the Teflon seals include a metal ring on each diameter to provide a secure fit on the guide and on the valve stem itself.

Besides the diameters of the guide and stem, there are a few other things to consider whenever fitting a non-OEM valve stem seal to an engine. In this case, the OD of the base fits within the inner spring just fine. The Teflon seal is a little taller than the original seal, which makes for a really close fit; the valve lift is 3/8", and that's pretty much right where the valve keepers sit down on the top of the seal's lip. If you intend to run an aftermarket cam with more lift, you'll need to either use the shorter OEM seals or make some other changes, like shortening the keepers or the guides.

Installation is not as simple as with the nitrile seals. Carpentier: "You cannot push them in as you would plain vanilla seals. With your package you should get a clear and rather flimsy plastic tube closed at one end. Slipped over the valve stem, it protects the seal as you first push it over the stem end (push with your thumb with a slight rocking motion to get started) then slide it over the cotter groove. Trim this sleeve so it still covers the groove but does not stay trapped under the seal when fully home." Note: on the valve stems, just below the groove, the part number is engraved; might as well leave the sleeve long enough to cover the number too, just to make sure you don't damage the seals going over it.

"When you start, remember (24 times!) to put the spring seat first as it does not fit over the seal. This is especially important as a teflon seal cannot be removed without being destroyed: 1) it is hard to pull it from the guide without distorting it and 2) as it goes back over the cotter groove, the sealing surface between stem and seal will be damaged." Clearly, you need to have the valve in place before installing the seal and you can't remove it afterward, so make sure you are actually at the final assembly stage (all lapping completed, etc.) before installing seals.

"Now you need to push the seal over the guide. Use a tube (e.g. a deep socket) with ID greater than the narrow upper section and a rubber mallet. A first blow will get you over the guide chamfer, then tap it all the way in. Don't hammer too hard though or the upper portion will shear off as you hit bottom." Note: this author has done this job, and it's a lot easier than it sounds.

EXHAUST FLOW LIMITATIONS: Roger Bywater explains an inherent shortcoming of the H.E. engine: "The small and pocketed exhaust valves are the real problem and is why all the high performance racing V12s have been based on the old "flat head" design. Putting big exhaust valves in doesn't help because the chamber walls are so close and leave

no room for flow around the edge of the bigger valve head. In fact if the HE were not of abnormally high compression ratio, always a useful trick to get a bit more top end power out of an engine that doesn't breathe, it would struggle to produce the barely adequate power that it gives as standard. You can build an HE to 6 or more litres (we used to do a 6.3 using 98 mm bore and standard crank) but all you really get is more torque low down but not much more power."

Engine Work -- Front

CRANKSHAFT DAMPER/PULLEY REMOVAL: First note that, contrary to the repair manuals, it is *not* necessary to remove the crank pulley to get the water pump off.

Also note that what looks like a bolt head in the center of the crank pulley is actually a hex fixture for turning the engine by hand. Two smaller bolts must be removed to remove this hex, and the real pulley retaining bolt is underneath. Then one more note: Since you already have the belts loose or off, you can remove two more small bolts and remove the pulley from the crank damper entirely. This provides much better access to the big crank damper bolt so you can use a box end wrench or some such.

What size wrench fits that bolt head? Craig Sawyers: "That damned thread is a 7/8 inch BSF. The AF measurement is 1.300 inches for that thread. I got a 7/8 BSF, 3/4 Whitworth socket to do the job." See page 25 for more info on Whitworth/BSF, including ideas on finding tools.

If you can find a 33mm socket, it'll fit perfectly. Unfortunately, even numbers are the standard in larger sizes, so it's pretty hard to find anything closer than 32mm or 34mm. Hard, but not impossible; Jan Wikström says, "I have a cheap Taiwanese socket set from the flea market; it has every mm size from 12 to 35. There are far more sockets than the ISO standard sizes, but the odd ones can come in handy."

Apparently 33mm is a common size for truck lug nuts. Walter Petermann found this site that has 33mm sockets listed under "truck wheel sets":

Independent Equipment & Supply Co., Inc.
1-800-837-4343 (Continental USA) or (740) 776-2154
FAX: (740) 776-2429
http://www.indequip.com/grey3_4.htm
e-mail ies@indequip.com

Wonder of wonders, they sell 33mm sockets individually; you don't need to buy a whole set of truck lug sockets to get the damper bolt socket you need for your Jag. Their prices aren't bad, either.

You might want to avoid the smaller drive sizes here. Robert Warnicke says, "I broke two 1/2" drives before I finally removed the bolt with a pipe wrench."

If nothing else works, you can use a file or grinder on the hex to make a 1-1/4" or 32mm socket fit. You can just use a big adjustable wrench (or Warnicke's favorite, the pipe wrench) to get it loose, but you will still need to find a socket that fits to carefully torque it during reassembly -- which is of considerable importance, as described in the discussion of key failures below.

To loosen and retighten the bolt, it is necessary to hold the crank still. You can remove the starter to jam the flywheel, but that is definitely the hard way. An easier way would be to use the access hole on the left side of the engine, the one with a rubber plug and intended to provide access to the torque convertor mounting bolts. Michael Neal provides an even simpler access: Just remove the cover from the bottom of the torque convertor housing.

Of course, on my car I can just put it in 5th gear with the emergency brake on!

Matthias Fouquet-Lapar suggests: "Once you have removed the upper part of the pulley (the one which drives 3 belts), you can easily use its 2 screws to attach a home-made bar on the damper." This is perhaps the best method of all, since pulling this lever and the torque wrench together works really well when trying to carefully torque that bolt up on installation.

Besides holding the crank still, there's also the problem of getting the bolt loose. One idea that solves *both* problems would be to use an impact wrench -- the way an impact wrench works, the inertia of the crank is all that's necessary to hold it still. But there's not enough room in the car to use an impact wrench, so that will require either pulling the radiator or the engine.

Shane Mantoszko says "use a good long-handled socket/torsion wrench, put it on the front crank nut, brace it on a strong part of the engine bay, disconnect the coil, and then turn your ignition key for a few quick bursts, and viola, the crank nut will be loose..."

Dale Knaus says, "I used what we call a "slug wrench". It is a box end wrench made extra heavy with a striking pad on the other end. It is made to hit with a hammer to tighten and remove nuts. I borrowed the tool from the industrial plant where I work; they are probably available from industrial tool supply companies."

Regardless of how well these methods may work getting the bolt loose, remember that you'll still need to deal with reinstallation. Since the bolt torque is critical, you'll definitely need a suitable torque wrench and socket and you'll probably need that restraining lever Fouquet-Lapar suggests. All that being true, you might as well go ahead and acquire those items and see if they'll get the bolt off to begin with.

CRANKSHAFT PULLEY - SHEARED WOODRUFF KEY: Paul Konitshek, Michael Neal and several others report that the woodruff keys that align the crankshaft damper/pulley are a known problem area. The keys may become worn or totally sheared, allowing the pulley to reposition itself around the crank.

The immediate effect of this slippage depends on which ignition system you have. If you have a pre-1989 car with Lucas ignition, you might not even notice unless things get really bad and start chewing up parts. Neal reports: "It almost never gets to the point where the pulley comes loose." If it merely slips, it usually won't become apparent until you try to set the ignition timing; the timing marks are now completely wrong, so you'll get really confused. If you have the later Marelli ignition system, the damper slipping will immediately screw up the ignition timing since the sensors are on that damper.

Note that there are two keys used. There is a "split cone" that is similar to those used on industrial pulleys. The pulley fits onto the outside tapered surface of the cone and is aligned with one key. The cone slides over the crank and is aligned with another key. When the bolt securing the pulley is tightened to specification, the split cone compresses securely onto the crank like a collet in a chuck.

Roger Bywater, who was in charge of belt drives for the V12 at Jaguar at one time, explains: "The purpose of the keyway is purely for location and accurate alignment during assembly. In almost all assemblies of this type the key is not intended to transmit any torque, indeed it is not strong enough, the friction of the tightened joint is meant to do that. There must always be some clearance around the key so if the joint comes loose torsional vibes will always fret and destroy the keyway. Many later engines do not have keyways anywhere, relying only on friction. The Jaguar V8 camshafts are typical with the timing sprockets just placed on the end, timing marks all lined up, and nipped up very tight with a central bolt - that's it. If they come loose the sprocket can just spin round - only it never happens."

"The answer is to make sure the friction inside and outside the cone cannot fail so the bolt needs to be tight to the point of yield to keep the whole assembly under tension. Possibly the bolt tightening figure is marginal at the lower tolerance quoted of 125 ft-lbs so maybe the top figure of 150 ft-lbs should be the rule. In fact the AJ6 manual quotes 203 Newton Metres (with no tolerance) which equates to 150 ft-lbs for the same size bolt which seems to support this view." Note that the threads need to be "lightly lubricated" for the torque readings to be anywhere near correct; this author recommends anti-seize compound, which will also help get it apart next time.

If the torque is supposed to be transmitted via friction between crank and cone and between cone and damper, obviously it'd be a good idea not to put any anti-seize compound on those mating surfaces. In fact, you might want to be careful there's no oil on them -- although hopefully it'd get squeezed out while torquing.

So, if the torque is supposed to be transmitted via friction, how come the Jaguar V12 has a history of key failures here? Neal: "It seems only to happen if water has gotten into the nosecone on the crank. The area is always very rusty when the front pulley is removed. The woodruff key is either broken or eroded away from the rust." Of course, this area is

exposed to the elements, there's no keeping water out of it; whether or not these parts rust probably depends on whether the crank seal is keeping them well oiled. Perhaps they *all* rust, and Neal only notices the ones that have sheared keys are rusty because those are the ones he has to work on.

The failure history could be because the engineers at Jaguar screwed up, either underestimating how much torque this joint would need to transmit or overestimating how much torque the joint could handle. However, it's entirely possible that most or all of these failures came from somebody not torquing that damper bolt down adequately. Even presuming they were torqued correctly at the factory (!), mechanics are always fiddling around in this area -- such as when replacing a leaky crank seal. Perhaps some of the mechanics are not being as meticulous as they should be in applying full torque during reassembly. Take a lesson: make *very* sure you torque that bolt properly! Just zipping it on with an impact wrench is unacceptable.

Neal: "In some cases the slot in the crank is widened a bit but a new key usually secures it substantially." If the crank has been boogered up too much by the damper slipping, of course you have to install a new crank. Yeah, right. Even Bywater himself reassembled an engine with a damaged keyway in one of his AJ6 development cars by "drilling and pegging" the split cone during installation. "Obviously loctite or similar would create difficulties in any future strip down so if everything is clean and in good order and fully tight there should be no need for it. Where things are less than perfect then pragmatism must rule." It might help if you file the high points off the gouges on the crank and use a new split cone.

CRANKSHAFT PULLEY - GETTING THE KEY OUT: Sometimes the keys won't come out, notably the key on the crank itself. Suggestions include using a pair of angle cutters to grab it and walk it upwards, and using a suitable chisel to cut under the key to pry it out. The suitable chisel needs to be a hair narrower than the key, and can be made from old lathe bits or "cut nails". Cut nails are made from flat stock, giving them a sort of trapezoidal shape, and are really hard for pounding into masonry. Greg Guillaume: "Here's what I did: Get a 1" chisel, lay it on the crank, perpendicular to the crank, up against the key. Then whack away with a hammer on the opposite side of the chisel. The shape of the chisel is just right so it bites into the key, the 1" width hangs over the end of the crank, and you get a lot of room to swing the hammer. Of course, the chisel is a little beat up, but it worked great."

CRANKSHAFT PULLEY - SPLIT CONE PROBLEMS: Dan Jensen says, "The split cone was broken in three places. Rather than pay \$\$ for a replacement, I just stuck it back into the damper/pulley with Hylomar sealant and gently replaced it. It centered properly and has worked great for 35K miles."

CRANKSHAFT PULLEY - RUBBER DAMPER PROBLEMS: Chris Yewdall owns a '91 convertible, and started having noise when operating the roof. "When lowering the roof with the engine running, a squealing noise is heard from under the hood until the roof is fully lowered. After a few more months/miles the squeal happens most times you start the car for a few minutes until the revs build up as you drive away. Eventually, the voltage on the battery charge guage on the dashboard drops to 12V (about 1/4 of the way up the guage) and the battery goes flat. Occasionally, the alternator will charge normally or just below normal, particularly on a freeway journey."

Sounds sorta like a loose belt problem, but it wasn't. After wasting too much money on things like an alternator rebuild, the problem turned out to be the crank damper itself. When he got the failed part back from the mechanic, he reported on it: "On inspection, it is the bond between the inner pulley (which keys onto the crankshaft) and the rubber damper which has failed since the inner pulley rotates freely on the inner surface of the damper. The rubber has hardened to the point where it has cracked in lines between the inner and outer pulley. It feels more like bakelite or plastic and has no flex at all. Believe me, it's not hard to spin the outer by hand." The other three belts are driven by rigidly-mounted pulleys but the alternator belt is driven directly from the outer ring of the crank damper, so this rubber breaking loose causes drive problems for the alternator. A heavy alternator load, such as operating a convertible top, aggravates the problem.

If you're having trouble confirming if your damper has sheared, put a mark on the center portion and a mark in line with it on the outer portion. Run the car for a while, then shut it off and check the marks. If they are no longer aligned, you need a new damper.

Interestingly, this type failure was apparently unknown on the earlier cars with Lucas alternators driven by V-belts. Those cars also had Lucas ignition systems, and the timing marks for setting the ignition timing were on the outside edge of the crank damper. As a result, such a slippage between the inner and outer portions of the damper would have made correct timing impossible. Most of the cars with the later Bosch 115-amp alternators and ribbed belts (see page 529) also have Marelli ignition, and the timing is not adjustable -- but is established by a pickup at the front damper. This pickup senses trigger points attached to the inside portion of the damper, so they are unaffected by slipping of the outer ring and the engine runs normally.

It's easy to blame these damper failures on the higher loads imposed by the 115-amp alternator or even on some change in build quality between the V-belt dampers and the multi-groove dampers, but there is one more possible cause for these failures. As described on page 529, there is a flaw in multi-groove pulley design that results in them slipping and squealing even when the belt is tight. Obviously, most mechanics will address a squealing problem by tightening the belt -- and since that won't fix this problem, they may respond by tightening the bejeezus out of it. An overtightened belt applies a considerable radial load on the rubber portion of that damper, and this load cycles around the damper as the crank rotates. It would be logical to assume that such a cyclic load could rip that rubber loose from the metal in a fairly short while. All owners of Bosch alternators are advised to have that alternator pulley modified at the next convenient opportunity, and then adjust the belt to a reasonable state of tension.

FRONT OIL SEAL REPLACEMENT: Peter Cohen points out that the Jaguar repair manual's procedure for replacing the front oil seal involves removing the radiator -- which, in turn, supposedly requires depressurizing the A/C freon circuit. Boy, I hope you read this first! Depressurizing the freon circuit is totally unnecessary to get the radiator out (see page 189), and if you don't mind working in tight quarters, taking the radiator out is unnecessary to change the front oil seal. Matthias Fouquet-Lapar says, "I've done this in my garage without pulling the radiator. Once all the belt-driven hardware is removed, there is enough space. I did not even take out the fan shroud." Brian Sherwood says, "I replaced mine without pulling the radiator -- not very convenient, but possible. The most difficult parts were: 1. removing the old seal (finally had to prick a small hole in it, and screwed in a sheet metal screw to pull on), and 2. getting the pulley bolts thru the lock plate, pulley, and into the crank damper -- can't see these at all, have to do by feel."

Tom Amlie had trouble getting the new seal installed in tight quarters. "If I kept trying to do it like the books said, I would still be at it. Book says to tap the new seal in. Not possible. Go to Home Depot or similar and get a PVC drain pipe fitting (reducer) to fit the seal. Carve on it until it works. Then use that huge bolt that holds the pulley/damper to push it in. Works like a charm."

When you buy the front seal from Jaguar, you get the seal and the spacer sleeve it rides on in one box; this may be a recent development, apparently a new part number has been issued. Matthias Fouquet-Lapar says, "The new part at least includes the spacer. The part number is JLM 10613." However, if you buy a generic seal somewhere else (or maybe older stock from Jaguar), you'll probably get just the seal. You can look at the condition of your sleeve and see if you think this will cause a problem. Peter Smith says, "If the spacer appears worn it can simply be reversed on refitting because the seal does not ride at the half way point. The new seal will then ride on an unworn part of the spacer." Whatever, you will want to take the sleeve out, because the proper order of assembly is to install the seal and *then* install the sleeve.

You might also consider putting some sealant between the crank and the spacer prior to installation to prevent oil from travelling between the crank and the sleeve and leaking out the splits in the split cone under the pulley. There are no reports of leaks along this path, but if it did leak people would think it was the front seal, so who knows? Maybe it's a common leak!

Cohen adds, "Oh, and by the way, although the old spacer slid off, the new one had to be driven on. The dealer tells me they are all like that, and that they loosen up after time..." Who knows, maybe the new seal comes with a coating on the inside to seal it, the sealant goes away with time, and that's why Jaguars leak!

Also of note, illustrations in the repair manual indicate that the sleeve has a keyway, but according to Alex Dorne they lie; "The sleeve is not keyed."

V-BELTS: Most V-belts are available in either solid or notched varieties. There is no appreciable difference in strength, since the strength of all V-belts comes from a layer of cord unaffected by notches. The cord is in the outside edge, making that part stiff to force the softer, inner portion of the belt into the groove in the pulley.

The notches in the inner surface help the V-belt flex, and are beneficial when the belt must turn around a small pulley. It is therefore recommended that a notched V-belt always be used for the alternator belt on the XJ-S.

The notches in a belt can cause noise. For this reason, most V-belts use an unevenly-spaced series of notches rather than evenly-spaced because an uneven spacing eliminates whine. For the same reason, cooling fans have unequally spaced blades and tires have unequally spaced tread patterns.

POWER STEERING PUMP INSTALLATION: Jim Isbell points out that the bolt holding the belt tensioner to the power steering pump should be installed from the rear to the front. "The bolt, if put in from the back with the nut end toward the radiator can be removed with the pulley in place. If put in backwards it cannot be removed with the pulley in place."

FAN BELT IDLER PULLEY INSTALLATION: Jim Isbell says: "The bolt that connects the adjuster screw to the idler pulley must be put in from the back with the nut toward the radiator. If this is put in backwards the adjustment range of the idler is greatly reduced."

TIMING COVER REMOVAL: If you want to remove the timing cover to replace the front oil seal, don't waste your time; the front oil seal presses in from the outside, and Jaguar even provided some prying slots for removing the old one. See the info on seal replacement on page 88.

If you do need to remove the timing cover, Section 12.65.01 of the ROM lists 13 steps, the first two of which are as follows:

1. Remove engine and gearbox assembly from the car.
2. Remove cylinder heads from the engine.

Fortunately, there is an alternate method. To remove the timing cover with the engine still in the car and the heads in place, proceed as follows:

1. Remove the belts, fan and its mounting bracket, A/C compressor front bracket, and all the other ancillary stuff in the way.
2. Remove the front crank pulley -- see page 85.
3. There are three studs threaded into the timing cover that protrude upward through the front edge of each head. Remove the nuts and washers, then grab the studs with a pair of Vice-Grip pliers and unscrew them. Note: Some of the studs are trapped and cannot be removed; once these are unscrewed, merely retain them (with duct tape) in a raised position while the cover is being removed. Once the cover is off, they can be removed.
4. Remove the retaining bolts holding the timing cover to the block.
5. The timing cover is essentially pinched between the heads and the sandwich plate. Michael Neal, who is a Jaguar mechanic and uses this method regularly, says "I loosen as many of the sandwich plate bolts near the front as possible. I believe it works out to about 4 or 5 back, going between the subframe and the motor. I then use a Snap-On medium sized ladyfoot prybar and go in the hole

where the oil cooler adapter bolts onto the sandwich plate. I pry against the bottom of the tube that the adapter goes into and the inside of the sandwich plate. This pulls down the right front corner of the sandwich plate and allows some space for the timing cover to move. The prybar over-centers and locates itself while holding the plate down. It is very important not to pull down too far. The bolt holes are very prone to cracking and the break will spread out toward the center of the sandwich plate.” See page 92 if you wish to remove the sandwich plate entirely.

6. REASSEMBLY: Since your studs were all boogered up by the Vice-Grips, buy new studs with the same threads but longer. Saw or grind them off until they are 1/4” longer than the originals. Then, grind flats on this 1/4” to ease the reinstallation and any future disassembly. Be sure to clean up the threads so the nuts go on easily. Remember to slide the trapped studs in place before installing the timing cover. Be sure to use anti-seize compound on all studs.
7. Before reassembly, carefully trim the timing cover gaskets flush with the upper corner of the timing cover.
8. Since the head gaskets are not being replaced, it is a good idea to apply some sealant to the bottom of them to help them seal against the timing cover. The only stress on this portion of the head gasket is a slight crankcase vacuum; the integrity of the head/block seal is unaffected. Make sure to apply sealant in the corner of the two mating surfaces.
9. Neal provides this tip for getting the timing cover back in between the heads and sandwich plate: “On reassembly I use sheets of .003” shim stock on the upper surface of the sandwich plate gasket and the underside of the front of the head gaskets. You have to trim the stuff to clear, but it prevents damage to the gaskets and lets the timing cover slide back in easily. The head gaskets are...very prone to wrinkling if you don’t use the shim stock pieces to slide the cover back in.”
10. When threading the new timing cover-to-head studs into place, remember there is no reason to tighten them into the timing cover. As long as they have been threaded in several turns, the nuts will torque properly. Tightening the studs into the timing cover merely makes them harder to remove next time.
11. During reassembly, progressively tighten the timing cover bolts along with the nuts on the studs. The cover must be brought up against the heads as it’s being pulled against the block. Tightening one set before the others will cause leaks.

Note that if the engine is still in the car but the heads are off for some other reason, the timing cover should be removable without too much additional trouble, basically following the rest of the steps in the repair manual and skipping step 5 above. Hence, you might consider going ahead with removing it, replacing the chain and tensioner, checking out the oil pump, etc., depending on the age and wear on the engine. You might also consider installing the longer studs as described in step 6 above while you’re there.

TIMING CHAIN DAMPENERS: These are the steel plates mounted alongside the chain along several of the straight sections between sprockets. The Haynes manual, Chapter 1, Section 42, Step 5, suggests using quick-drying paint to mark their locations before removal. Craig Sawyers says, “Nice idea, but no dice. Have a look at the bare block and you will see that the dampers fit onto raised bosses. There is no accessible metal to either paint or scribe a line on to show the original position of the dampers.”

If you move them, the use of an elaborate (and undoubtedly expensive) special tool JD.38 is required to properly position them. Advice: Don’t move them!

You already moved them? Sorry, at present I can offer no help. I am including this section to describe what they are and how they work.

A roller chain is a fairly decent and reliable drive mechanism at low speed. However, 6500 RPM is another story; at higher speeds, chains can whip, flutter, buzz, and otherwise dance around their path around the sprockets. At certain

resonances, a chain whipping back and forth can cause very high tension stresses, resulting in damage to the chain, sprockets, camshaft bearings and tensioner.

These plates are designed to prevent this. If the chain is moving smoothly and along a straight line like it should, it shouldn't even touch the plates. But if it starts to whip, it hits a plate -- which absorbs the energy of the whip, and allows the chain to return to a calm motion.

Based on this theory, it would be logical to assume we could just bolt the plates on so that they are immediately adjacent to the chain without touching it. There are a couple problems with this plan. First, if you follow the official Jaguar assembly order, the plates must be installed and the timing cover bolted up before the heads are installed, so having the chain in place -- meaning the tappet blocks, camshafts, and camshaft drive sprockets in position -- is not possible. Of course, you could always trial fit the heads, tappet blocks, camshafts, sprockets, and timing chain in order to set the plate positions, then tear it all apart again.

On page 89 I describe how to remove the timing cover with the heads on and therefore there may be an opportunity to adjust the dampers with the chain in place -- although it may be a rare case when the plates need to be positioned but the heads *don't* need to come off.

The second problem is that I'm really not providing enough information for proper positioning. I'm only providing the theory; presumably, during development of this engine, the optimum positions of these plates were precisely determined, and they may be far more critical than simply "close to the chain without touching it." Improper positioning of these damper plates could be catastrophic, causing a broken timing chain which in turn causes pistons to impact valves in open position. You see, the real purpose of this section is not to save you effort; it's to discourage you from assuming the position of these plates is unimportant, skipping important steps, and causing yourself a great deal of heartache down the road.

TIMING CHAIN REPLACEMENT: The timing chain in the Jaguar V12 is a conventional double-row roller chain. Typically, the wear on chains of this type is much more significant than on the sprockets, and usually the chain can be replaced without replacing the sprockets. This is in sharp contrast to the "silent" timing chains used in many American V-8's, where it is customary to replace the timing chain and sprockets as a set.

Another characteristic of typical roller chains is that wear on the sprockets increases with the use of worn chains; if the chain is renewed regularly, the sprockets can last almost indefinitely. The Jaguar timing chain is so cheap that it is recommended that it be replaced whenever the engine is disassembled far enough to do so. The sprockets are so expensive that you will want to do whatever it takes to keep from having to replace them.

In general, the sprockets don't need replacing unless an inspection shows signs of serious wear -- one side of each tooth looks different than the other side.

Per Jan Wikström, "According to a Reynolds chain handbook that I mislaid some time back in the seventies, so my memory may be slightly off here, the way to determine whether a sprocket warrants replacement is to hang the new chain over the sprocket and apply a strong pull (that's an Imperial strong pull, not a US strong pull!) in the normal drive direction. If more than three links ride up noticeably on the teeth, the sprocket is too worn."

Supposedly, it may be possible to replace the chain itself by removing only the right side cam cover and without bothering the timing cover at all. Retract the tensioner, then break the chain on the top of the cam sprocket and connect the new chain to the end of the old one. Have someone turn the crankshaft slowly while you feed the new chain in and the old chain out, being sure to keep the cam sprocket engaged at all times. When you reach the other end of the old chain, disconnect it and connect the new chain back to itself. You may wish to ask if the new chain has a master link prior to buying it to make this job easier; supposedly, some do and some don't.

OIL PUMP CLEARANCES: If you happen to have the Haynes manual, the clearances specified for the oil pump don't seem to make sense. So, I will include the values from the ©1975 ROM here:

Driven gear to housing: < 0.005" (0.127mm)

Drive gear to crescent: < 0.006" (0,152mm)

End float - both gears: < 0.005" (0,127mm)

Note that, according to the ROM, all measurements are taken with the pump removed from the engine. Since the crankshaft is therefore not holding the drive gear in position, it is free to move as far away from the crescent as the tightness of the gear teeth will permit. It appears a rare case that it will meet the 0.006" limit; 0.040" is more likely! Despite the clarity of their measurement procedure, it is probable that the specified values represent clearances in place, with the crank holding the drive gear in its correct location.

Mike Morrin: "I cannot believe the figures in the Jaguar manual. The endfloat on the gears in my pump was over 0.020". At the time I was rather alarmed, as the engine had by all accounts only done 55,000 miles. I carefully inspected the old parts for wear, and found that the factory machining marks were still visible on the gears, and the wear on the pump housing was negligible. This pump must have left the factory with clearances way beyond the published limits. So I put the old pump back and crossed my fingers. The oil pressure seems OK (when measured with an accurate gauge).

Of course, if endfloat is the only problem, some of us have been known to skim a little metal off the mating surface of the housing to bring it back down. With a little care, it's even possible to perform this fix on aluminum housings by laying a piece of sandpaper on a plate of glass and sliding the housing back and forth on it.

OIL PUMP REPLACEMENT: According to Thomas E. Alberts, the 1992 upgrade of the V12 included a new design oil pump -- and that the old design oil pumps are no longer available. "The original part number is C38453 or C40177. That part was officially superseded by EBC3163 which is the pump for 1992 on. EBC3163 is supposed to fit the older engines but some pieces are required to adapt it. This pump is at least twice as expensive as the earlier version, and the adapter (they call it a pump collar) is \$45 plus some additional bolts are required."

Engine Work -- Bottom

Note: If you only need to replace piston rings and/or liners, you might not need to do bottom end work on the Jag V12. See the ideas on page 76.

OIL PAN REMOVAL: The crankcase bottom is actually two pieces, a pan and a sandwich plate. The pan, which exists only at the rear of the engine, comes off easily enough. However, any hope that this will get you anywhere is quickly shattered. The crankcase is fully baffled (necessary to prevent foaming, reduce heat buildup and power loss, and insure proper oil flow to the pickup in a high RPM engine), and there is one baffle the length of the engine that cannot be removed without removing the sandwich plate.

Contrary to the manual, the sandwich plate can be removed without pulling either the front suspension assembly or the engine out of the car. It's a real pain, though, so you might still consider one of those options. To remove the sandwich plate:

1. Unbolt the steering rack without disconnecting hoses, steering column or tie rods. Lower the rack a few inches and let it hang there.
2. Remove the fan to allow the engine to be raised without hitting the shroud.
3. Remove the nuts from the two main engine mounts, and use a hoist to lift the front of the engine as far as possible.

With all this done, the sandwich plate will just barely come out rearward. Putting it back in, with new gasket in place, will also be a lot of laughs.

While you're in there, replace all the O-rings you can find, such as those in each end of each oil tube. If they leak they just leak into the crankcase, but each leak reduces oil flow to the engine. Use Viton O-rings, so you won't have to go back in there anytime soon.

OIL PAN/SANDWICH PLATE BOLTS: Technical Service Bulletin 12-35, which introduced the upgraded gaskets used throughout the engine, also specified new bolts for holding the sandwich plate and the oil sump to the engine. The explanations given applied to both the sump and the cam covers, so it is probable that the same sort of generic bolt & washer substitution described at length for installing the cam covers starting on page 57 could also be applied here -- although these bolts are a size larger, so the specific parts mentioned won't do.

See also the notes on TSB 12-53 on page 45 regarding sealing the threads on the sandwich plate bolts with heads inside the oil sump.

TSB 12-35 specifies a torque of 21-27 N-m (15.5-20 ft-lb) on the sandwich plate bolts and oil sump bolts. No mention of later metric vs. early SAE bolts; hopefully, it's a reasonable torque for either. It's also probably a good spec whether using their special bolts or generic substitutes.

MAIN BEARING REPLACEMENT: If you find yourself needing to replace the main bearings without removing the crankshaft, the job can be accomplished the same way as most cars: Roll the upper bearing shell around and out. If it's difficult, insert a cutoff head from a nail into one of the oil passages of the crank and turn the crank to roll the bearing around. However, when installing the new bearings, remember that the Jaguar block is aluminum. It is recommended that the outer leading edge of the bearing shells be smoothed slightly with a file to prevent them digging into the aluminum when installing.

REAR OIL SEAL: If you think your rear oil seal is leaking, you might want to check again. The rope seal used up to VIN 160010 has proven to be very reliable indeed; an informal survey of owners on the internet indicated that the rear oil seal was often blamed for leaks, but the leaks were always later found to come from other sources. The upper mating surface of the rear bearing cap is one possible source, as Jaguar didn't see fit to seal it at all -- see **Figure 7** below. The sides of that cap were sealed with "hockey sticks" on early cars, but later assembly instructions call for injecting silicone instead; apparently the hockey sticks would dry up and harden and start leaking. Besides these possibilities right near the rear seal, there's also the half moon seals (page 57), oil pressure sender (page 44), tappet block banjo bolts (page 42), and a host of other items that may be leaking above or around the rear of the engine and dripping down to look like a rear oil seal leak.

If your rear oil seal is leaking, please see the note on the PCV system on page 48.

REAR OIL SEAL -- UP TO VIN 160010: Up through engine number 8S.66782, the rear oil seal was a "rope seal", a chunk of waxy rope crammed into a groove surrounding the crank journal. This is sometimes called the "two-piece seal" since there's one piece of rope crammed into the journal on the block to form the upper half and another piece of rope crammed into the bearing cap to form the lower half.

At first it seems apparent that the upper half of the rear oil seal cannot be replaced without removing the crank. However, Dick Russ reports that there is a tool called "Sneaky-Pete", P/N 2700 by the Lisle Company in Clarinda, IA, that will enable the seal to be replaced without removing the crank. The tool costs only \$6 or so and is available at Pep Boys, AutoZone, etc. It consists of a length of music wire and some tiny grippers that can be used to bite into one end of the new seal and pull it into place around the crank.

In the March/April 1995 issue of *Jaguar Journal*, Russ describes in detail how to replace this seal with the crank in place; the same article is reprised in the December 1995 issue of *British Car*. The procedure was developed by Phil Long and not only uses the Sneaky-Pete but also uses the seal from a 1968-78 Ford 460. The reasoning is apparently that the Ford seal is longer than the Jaguar original. After using the Sneaky-Pete to pull the new seal around the upper

half of the crank, the end that has been boogered up by the grippers of the Sneaky-Pete can be simply cut off. If a Jaguar seal is used, the gripper must be carefully removed and the seal backed into the recess, no easy task.

Russ also suggests that the cap be trial fit and torqued down, and then removed and inspected to make sure none of the seal is getting in between the joining faces of the cap and block and holding them apart. Any fibers or edges of the seal interfering with the fit can then simply be cut away before fitting the cap up final.

Note that Long's 44-step procedure was actually written for the Series III E-type, so a few of the steps need revision to apply to the XJ-S. For example, steps 6 and 39 deal with the E-type's oil-to-coolant oil cooler which doesn't exist on the XJ-S.

In the September/October 1995 issue of *Jaguar Journal*, John F. Quilter and John W. Yerger of Jaguar responded to the above procedure, claiming it was not only unacceptable but would invalidate the warranty on the engine. They insist that the only acceptable method of replacing this seal involves removing the crank so that a special Jaguar tool may be used to "size" the seal prior to assembly. The seal is not supposed to actually touch the crank at all, but to reside very close to it. The scroll carved into the crank then feeds inward, preventing oil from going outward. Contact will result in "burning", as confirmed by many who have found the white rope seals somewhat charred. Note that Roger Bywater seems to feel that the big problem is not burning of the seal itself, but burning of the rear main bearing; the crank rubbing on the rope seal gets the metal hot enough to damage the bearing.

Note that the original Jaguar seal is a waxy white rope, while the Ford 460 seal appears to be impregnated with graphite. Perhaps this helps avoid that burned look -- or camouflages it. There is at least one report of an owner asking for a seal for a Ford 460 and being handed something in a rubber seal; make sure what you get is in fact a dark-colored piece of rope.

If you are concerned about contact between the rope seal and the crank, perhaps a minor revision to the Sneaky-Pete installation is in order. It shouldn't be difficult to slip a piece of thin shim stock around the crank before pulling the new seal into place. This will not only hold the seal away from the crank a few thou and hopefully help the seal form to that shape much the same way as the special Jaguar tool would, but it also helps protect the crank while installing the seal. A similar piece of shim stock could be used when trial-fitting the bearing cap to "size" the lower half of the seal, where Long's procedure calls for the use of the special Jaguar tool.

Hey, if the engine is under warranty, let the Jaguar mechanics do it their way; it's their nickel. However, if *you're* paying, I'll bet you opt for the Sneaky-Pete. Jaguar's way requires removing the crank, which means pulling the engine and tearing it apart. Long's way only requires removing the oil pan and sandwich plate, not easy but possible with engine and transmission in place -- see page 92.

REAR BEARING CAP UPPER JOINT SEALING: When bolting on the rear bearing cap, think about how the sealing of the crankcase itself is accomplished. The oil seal theoretically forms a seal around the shaft, and the injection of silicone sealant effectively seals along the two sides of the bearing cap. However, the top surface of the cap is sealed only by the metal-to-metal contact. It is suggested that a thin line of sealant be applied to the top of the bearing cap, starting at the oil seal and ending at the silicone groove on each side, prior to assembly. See **Figure 7**. Be sure to use some type of sealant that won't space the cap away from the block, such as Loctite 518 or perhaps the Loctite 573 or 574 used on the tappet block (see page 68). Note that the sealing of this horizontal joint definitely calls for a *different* sealant than the two vertical joints, which need a silicone-type stuff such as RTV.

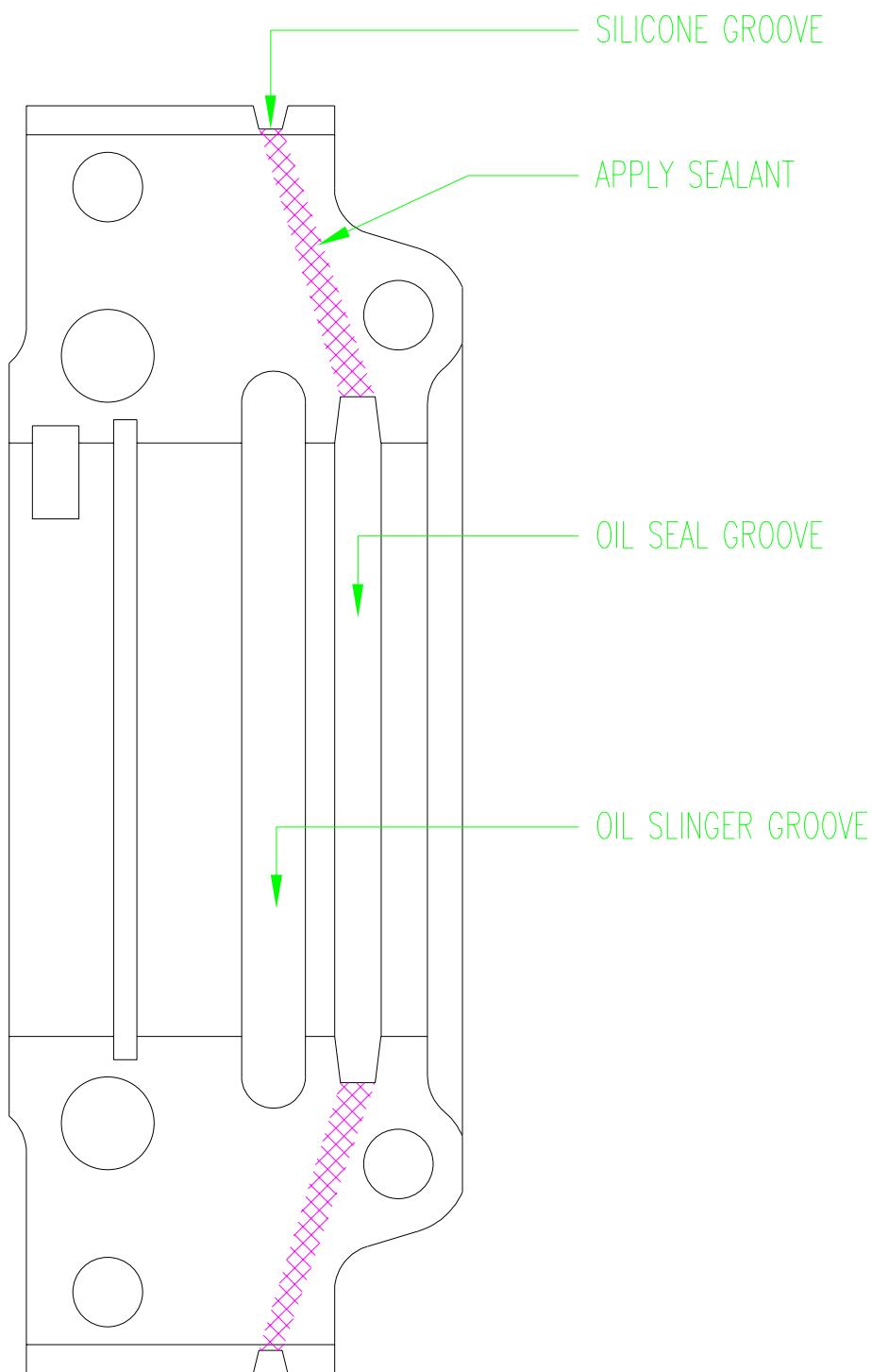


Figure 7 - Rear Main Bearing Sealing

REAR OIL SEAL -- VIN 160010 ON: According to Phil Bates: "In 1989, starting with engine 7P.02073, Jaguar fitted a new one-piece rear main bearing oil seal to replace the previous rope type." That 7P number refers to engines for the XJ12; for the XJ-S, Greg Wells says "My microfiche shows that the rope seal was used up to engine number 8S.66782 and that the one-piece rear main seal began at engine number 8S.66783." Jon Jasperson quotes a Jaguar TSB saying this corresponds to VIN 160010.

The TSB also calls for a new tool, JD 163, for installing or removing this new seal. Replacement of this later type seal does not require removing the engine or crank, but it does require removing the transmission.

Chad Bolles: "No way to retrofit, already tried that, block was recast. Crank was redesigned also. Seal is about 5-3/8's OD and 4-7/16's ID. Main bearing the same."

Unfortunately, the newer design seal seems to have its own problems. There have been several reports of it "blowing out", creating a *massive* oil leak. The seal itself appears undamaged (although most people will choose to replace it anyway after going through the effort of removing the transmission); it apparently simply pops out of its hole. Anyone with this type of seal who is working in the area -- because it blew out or for other reasons -- would be well advised to secure that seal. Perhaps a Loctite retention product would help make sure it doesn't go anywhere, or maybe it's possible to add some small screws around the edge to secure it in place.

PISTONS & CYLINDERS: In general, you can buy pistons for the V12, or you can buy cylinders with pistons. Generally, you *cannot* buy cylinders alone. Make very sure you don't need a cylinder before you buy a piston alone. You cannot get pistons oversized by a few thousandths for reboring cylinders; if the cylinder is worn or damaged, it must be replaced.

Fortunately, the cast iron used in the cylinders is apparently very hard and wear is usually insignificant in engines with less than 150,000 miles, in which case the pistons alone can be replaced. If rebuilding, the best policy for saving money may be as follows: Don't order parts until the heads are off. Check for a "ring ridge", the step created about 1/4" from the top of the cylinder by the wear from the rings. If a ring ridge is detectable, order new cylinders with pistons. If not, order pistons alone.

The pistons and liners are available in an "A" or "B" size, which differ by a microscopic amount. The difference is a result of tolerances in manufacturing, and neither is really considered an oversize for the other. Each piston *must* match the liner it's installed in. There is no reason not to ensure that all cylinders within the same engine match, although differences probably wouldn't be noticeable.

The alloy piston in the V12 has a couple of steel inserts cast into the inside of the skirt. These inserts are a thermal expansion control device; they not only help control how much the piston expands when hot, they also help prevent it from ovalizing, which most pistons normally do due to the geometry of the pin bosses. When the engine goes from cold to hot, this piston design helps maintain a close tolerance between the piston and the cylinder. This, in turn, reduces ring leakage, piston/cylinder wear and noise. The fact is, these items make forged aluminum pistons look like lawn mower parts. The owner seeking to replace the pistons would be hard pressed to find better ones than the originals.

ALUMINUM CYLINDER LINERS: Apparently aluminum cylinder liners are available for the Jaguar V12 from GKN Squeezeform in the UK. Such use would require the replacement of the pistons as well, since the stock pistons are designed (via the use of a special alloy, as well as steel expansion-control inserts) for the expansion rate of the stock iron liners.

Jeffrey Gram contacted Rob Beere Engineering, which reported: "In the 1980's the Jaguar Group C endurance racers used aluminum liners. It is actually not pure aluminum but a compound called nickasil or similar. This material is very light and is treated (don't know with what). In 1986-1988 the alu-liners were not used anymore for endurance races since the wear was too big and inferior to cast iron. Apparently this nickasil material has a tendency to pick up material

by which the pick-up process is accelerated and the material wears out quickly. The nickasil was only used on race engines with frequent liner renewal."

The V8 engine used in the XK8 and XJ8 comes with nickasil cylinders.

PISTON & CYLINDER CLEARANCES: According to Bob Tilley, "Under the Group C TWR build instructions for the V12, the piston to bore clearances for cylinders 1A through 5A and 1B through 5B is .0045-.005, whereas the clearance for piston to bore in cylinders 6A and 6B is .0055-.006."

These absolute values may be of little use to the normal V12 owner, since this is referring to racing engines where the pistons and the liners are likely to be significantly different than stock. The implications are fairly obvious, however: The rearmost cylinders are more likely to develop clearance problems due to poor cooling. There is no history of problems in the street application, but the information is included here for those who might make use of it. Perhaps the anal-retentive might choose to measure the clearances in their piston/liner sets and put the largest clearances at the back.

PISTON RING END GAPS: Technical Service Bulletin 12-33 is a correction to the piston ring end gap specs given in the ROM. It says, "Insert the correct piston ring end gap specifications into the XJS Repair Manual, sections 12.17.10, 12.25.26, 12.41.05 and the Piston Ring Data in section 05 (Engine Tuning and Data)." Well, it's already off to a bad start; 12.25.26 doesn't exist at all (at least not in the ©1975 ROM), 12.41.05 doesn't mention the end gap spec, and 12.17.10 refers to Section 05 -- which is an incorrect reference in both the ROM and the TSB, those specs are in section 04!

Which page in Section 04? Another good question. These pages are printed sideways, evidently copied from some other document. When you get to the bottom of the left column of page 04-5, proceed to the top of the left column on page 04-6. When you reach the bottom of that column, proceed to the top of the right column on page 04-5, and then proceed directly downward through the right column on page 04-6. It will be helpful to mark arrows on these pages to remember this.

The piston ring specs start at the bottom of the left column on page 04-6 and continue at the top of the right column on page 04-5. The gaps in question are actually near the top of the right column on page 04-5. Revise as follows: The spec end gap for the top ring should be 0.016"-0.021", and the spec end gap for the second ring should be 0.016"-0.026". The spec for the oil ring is not mentioned in this TSB.

TOTAL SEAL PISTON RINGS: Total Seal, Inc., makes a type of piston ring set in which the second ring is a two-piece ring. Effectively, it puts two rings in a single groove with the gaps staggered -- so gases cannot pass either gap. As a normal ring wears, the gap gets larger and the leakage increases accordingly. With Total Seal rings, the gap is covered by the second ring, so it won't leak no matter how much it wears.

Apparently, these rings are highly recommended by just about everyone who has ever used them -- including high percentages of competitors in several types of racing. Testing shows considerably less leakage even compared to new conventional rings. Not only will performance improve, but the reduced blowby should result in less contamination of the oil.

SEALING LINERS TO BLOCK: The liners (cylinders) are slid into openings in the block, and the head is bolted down on top of them. The upper portion of the liner is thick while the lower "skirt" is thinner, so there is a step on the OD where it goes from thick to thin. The thick portion of the liner is pinched between the head gasket and the ledge in the block, with the thinner skirt protruding down inside a bore in the crankcase. The head gasket seals the joint at the top, while the joint at the ledge at the bottom of the thick portion of the liner is sealed only with a sealant applied when assembling. There is very little pressure across this joint, but it nevertheless needs to be reliably sealed since there is coolant above it and the crankcase below. A sealing failure would result in coolant in the oil pan.

The ©1975 ROM, Section 12.41.05 step 74, says to use Hylomar when installing the liners. However, as described in the discussion on sealing the tappet block to the head on page 68, Hylomar is not recommended by its manufacturer for metal-to-metal joints since it is supposed to be a gasket dressing and will not harden; it eventually oozes out of joints, allowing them to leak. The ©1975 ROM recommends Hylomar for the tappet block as well, but later editions recommend Loctite 573 and apparently 574 or 518 will also work.

The liner-to-block joint, like the tappet block-to-head joint, is metal-to-metal. However, the later ROM apparently never changed its recommendation from Hylomar for the liner installation -- perhaps because any leaks that have occurred were not obvious and didn't result in complaints, or perhaps because the liner-to-block joint is a much higher compressive stress joint than the tappet block joint and therefore may be expected to seal reasonably well regardless of sealant -- the iron liner will just dig into the soft aluminum block. Regardless, Loctite 573, 574, or 518 should be a much better choice than Hylomar for sealing the liner-to-block joint. Even better: Based on the tech guidelines at <http://www.loctite.com>, the substance this author would choose to seal liners into the block would be Loctite 510 due to its higher temperature rating.

Joe Bialy points out that the application guidelines for 600-series Loctite products may be confusing. "The Locktite book specifically states that the 638 family of compounds (603, 620, 638, 641, 648, and 660) will "retain cylinder liners"." The Jaguar V12 liners are "cylinder liners", but 600-series Loctite products should *not* be used here. 600-series Loctite products are intended to *retain* the type of cylinder liners that are pressed into bores in a block. The Jaguar V12 liners are not pressed into bores; they are slip-fit into openings and securely held in place by the head. Retention is not an issue; the only necessity is sealing -- which calls for the 500-series products.

Just in case it isn't clear enough in the ROM: The sealant on the liner-to-block joint should be applied *only* under the step on the liner or on top of the ledge in the block, *not* down the sides of the liner or on the inside diameter of the bore in the block.

Performance Upgrades

COMBUSTION CHAMBER MODIFICATIONS: With an advanced combustion chamber design, the H.E. engine has 11.5:1 compression and runs on 89 octane unleaded (Unleaded Plus). Almost any mods to the engine internals would endanger the integrity of this design, and the owner would risk having to lower the compression radically and/or face buying octane boosters (\$\$\$). His fuel economy would get worse, and if he didn't do his job right his performance would get worse, too.

One modification possibly worth considering is to install the European pistons, raising the compression to 12.5:1. According to Chad Bolles, the only difference in the engine is the piston, which has a slightly different pin bore location. This change will obviously require higher octane fuel. The European XJ-S H.E. reportedly produces about 30 more HP than the US version, but much of this is probably in the lack of catalytic convertors and other emission considerations; Mike Morrin says, "I would estimate that the extra CR alone is worth 5-8HP."

ENGINE ENLARGEMENT: There are two ways to get more power out of an engine: tune it to obtain more horsepower per liter, and enlargement to provide more liters. Of the two, enlargement has some definite advantages: if the horsepower per liter is not changed significantly, the durability may not suffer; the "manners" of the engine, important in street applications, may remain as stock or even improve; fuel economy may remain nearly unchanged; and the use of higher octane fuel or octane boosters may not be necessary.

Indications are that the Jaguar V12 has a *lot* of room for expansion. A 5.3 liter (90mm bore x 70mm stroke) for two decades, it was enlarged by Jaguar in the early 90's to 6.0 liter (90mm bore x 78mm stroke). AJ6 Engineering (see page 663) once offered engines bored and stroked in sizes up to 7.1 liter and 405 BHP.

The room for expanding the bore seems to be limited to around 98mm. The stroke, however, can go a long way, and since it is so over-square to begin with, getting too under-square is not a problem. Bill White (see page 671) has

prepared a Jaguar V12 for use in a 3/4-scale replica of a Spitfire fighter plane. He expanded the bore and stroke to 96mm x 95mm -- almost an inch of additional stroke -- for a displacement of 8.4 liters! This was done without significant modification to the block, and the stock H.E. heads were used. At 3000 rpm, this engine produces 500 ft-lb of torque in naturally-aspirated form, and 820 ft-lb when supercharged as it is in the aircraft.

According to White, that isn't the limit by any means. He reports that an outfit in the UK called Forward Engineering prepares Jaguar V12's for use in offshore racing boats. They install a spacer 3/4" thick between the block and the head, and use liners the same amount longer than stock to provide longer cylinders. Longer studs hold the head on, and since 3/4" is the length of a link of the timing chain the addition of four links allows an otherwise completely stock timing chain scheme to be used. White says the engines so assembled are 9.3 liter, and are very successful at offshore boat racing.

Changes to the engine displacement require modifying or replacing the EFI. The stock EFI is hard to modify; it has a fixed (trimmable, but fixed) map for intake manifold vacuum and RPM versus fuel. If the displacement is altered, this relationship changes. One solution is an aftermarket EFI system that is completely programmable and re-programmable (see page 290). Most choose to ditch the EFI at this point for carburetors, introducing the problems outlined on page 289. And the emissions inspector will not smile at them.

LOTSA VALVES: There have been experiments to adapt the 4-valve DOHC head from the Jaguar AJ6 engine to the V12. The cylinder spacing and bolt patterns are the same -- according to Roger Bywater, not because the AJ6 was derived from the V12, but rather because there was a plan to put the V12's H.E. head on some versions of the AJ6. If the DOHC heads are just bolted onto the V12, on one side the intake ports will be on the outside and the exhaust ports will be toward the center -- not good. So, one of the AJ6 heads must be turned around backwards -- and some complicated fabrication work is required to get such things as the cam sprockets rearranged. Bill White (page 671) has worked with this idea, among others.

Steve Averill reports that the Autumn 1988 issue of Jaguar Quarterly has an article on "a 60 valve DOHC V12 that was under development by Warrior Automotive Research. They expected to achieve 100 bhp/litre in low tune with a 5.8l engine. The head had 3 inlet & 2 exhaust valves per cylinder." No word on what's happened since, but Warrior's phone number was given as 061-928 3284 in Cheshire if anyone wants to try a call.

BOOST: There has been at least one experiment in Australia in turbocharging the XJ-S, but the results were apparently not good. Officially the problems were blamed on the inability to assemble a drivetrain that would handle the 1000+ hp for more than a few seconds.

Chris Sleeman (also in Australia) reports on a 1998 endeavor: "When I picked up my Daimler Double Six yesterday from my local Jaguar specialist, he showed me an XJ-S he is working on. It is a '76 model, with a 6.8 Litre Twin Turbo V12. The motor was built by them, and the customer is apparently going to enter it into the Targa Tasmania in April. The motor is being dynoed next week, but they say it puts out around 700hp. It is running 0.8 bar of boost at the moment, and will be using Motec injection."

Somewhere out there, Bradley Smith is driving around his XJ-S with twin belt-driven Whipple superchargers.

NITROUS: Martin R. Fooks has a nitrous system in his XJ-S: "The Nitrous system was supplied by Trevor Langfield (page 669) and is a customized "High Power Nitrous" system. Because of the size of the hit to the engine (150BHP) they installed a progressive controller, which fits neatly in my car where the trip computer used to be. This enables me to control the way the extra power is delivered to the engine, such as starting power, ending power, time delay and time from starting level to ending level.

"I am very happy with the Nitrous installation, which really seems to be very smooth on the V12. Trevor's people have the computer equipment to work out power and 0-60MPH times and that is where the figures came from. As a side note, it ran 5.3 seconds 0-60 with a standard TH400 and only 75BHP jets in the NOS system instead of the 150 jets.

"Nitrous got a very bad press in the past, caused mostly by people adding too much power to their engines, or by not enriching the fuel mixture when the NOS was injected. The casualties in my case have been the torque converter and the rear IRS mounts, which were all bar 1 ripped off." (See page 373 regarding rear suspension mount weakness.)

"The engine is stock except for the exhaust and intake, and I have had no problems at all with it (unlike the torque converter).

"The builders of my system told me that they do not recommend putting any more than 50-75BHP into your engine without using a progressive system as avoidable damage to the engine could result.

"Their main concerns with adding 150BHP were not with the engine as they believe it to be a very strong and reliable item. The standard transmission and torque converter were their main objection to the increase which as it turns out was well founded."

"The amount of power provided in total by the NOS system can be changed by installing new jets at an English price of 7 pounds per pair, so if 150BHP proves too much to handle, you can always fit a smaller pair taking very little time and expense. 200BHP is the maximum obtainable by my kit. My suppliers stated to me that as a rule they do not fit systems with more than 50% of the original engine power (which is why I'm only using 150 Jets instead of 200). Obviously this is not the case if you bullet-proof your engine."

CAMSHAFT REPLACEMENT: Most performance enthusiasts will agree that replacing the camshaft (or camshafts; the Jag V12 has two, some cars have four) is the most effective way to change the performance of an engine. The entire personality of a car can be radically altered by merely changing the camshafts.

Chad Bolles reports that Isky makes high performance camshafts for the Jaguar V12.

Rob Beere Racing Services (see page 665) also offers hot cams, as well as tappet shims in extreme thicknesses that may be necessary for such installations.

Note that any camshaft alterations should be accompanied by an EFI system modification; there will be increased airflow at wide open throttle, but since the feedback circuit is disabled under those conditions the fuel supply will remain at the original fixed map with no trim. The engine will therefore run lean at full throttle, a situation that begs for burned pistons and valves.

There has been some confusion regarding the difference between pre-H.E. and H.E. cams, since published valve timing data on the two engines seemed to differ. However, Bywater points out that they actually use the same part number camshafts. "When the V12 was launched the valve timing was quoted in Walter Hassan's SAE paper 720163 as being 17,59/59,17. When the H.E. version was launched in 1981 the supplement to the manual quoted cam timing as 13,55/55,13. In fact, the same cam profile had been in use since the early 1970s and continued through into the 1990s under part numbers C42176/7, therefore all EFI V12s were produced with these cams. Now it is not widely known that for some time the V12 was mildly plagued with excessive tappet noise and in the course of dealing with the problem the quietening ramps on the cams were altered at least once around 1972-3. I was personally involved in an investigation into the causes of a spate of tappet noise around 1978 and am not aware of any cam change ever being made to the V12 in production for any other reason than to reduce valve gear noise."

"Measurement of true cam timing is not a straightforward matter and it has been accepted practice to measure from the point where the quietening ramp ceases and the lift curve proper commences. For those who are not familiar with the term, a quietening ramp is an area at the flank of the cam where the rate of lift is small, at around 0.0005" per cam degree, and to be fully effective must extend rather higher than the widest clearance likely to be encountered. The idea is that any reasonable running clearance found in use it will always be taken up at a predetermined velocity which should not give rise to noise. If the ramp geometry is changed, as we know happened on the V12, then the timing as measured at the top of the ramp could also vary and this accounts for the small difference of timing quoted at different times in its life."

Mike Cogswell elaborates: "Duration itself can be misleading, since almost nobody measures duration from the instant the valve leaves the seat until the instant it returns. Instead, duration is commonly measured at some point where there is

noticeable flow, albeit typically a very low fit. This is important, since different cam grinders measure duration at different lift, hence one man's long duration might be less than another's short duration. Caveat emptor, as always."

Bywater again: "It is perhaps of interest to note that over the years Jaguar used virtually identical valve timing on all their mainstream engines. Consider the following:

SS 2.5 & 3.5 litre	16,56/56,16
XK 3.4,3.8,4.2	15,57/57,15
V12	17,59/59,17 (13,55/55,13)

Clearly having found something that worked there was great reluctance to change from it, although the smaller displacement engines often had softer timing to beef-up the low speed torque as the following examples show:

SS 1.5 litre	10,50/50,10
XK 240 saloon	10,50/50,10 (5/16" lift)

Note also that hot cams might not have the expected effect. AJ6 Engineering (page 663) once offered a *milder* cam than stock, and the result was higher mid-range torque and a nearly one full second quicker 0-to-60 time. Bywater explains: "...we introduced some short duration cams for the V12 back in about 1984. They certainly boosted mid-range performance, especially appreciated with the 3 speed BW and GM transmissions, but suffered a marketing problem because they gave slightly less peak power so we eventually discontinued them. We sense that attitudes are changing and many drivers are realising that a performance gain around 40-70 m.p.h. is far more valuable than adding to a rarely seen top speed so we may well offer a modernised version of such a camshaft again in the near future."

TORQUE LINK: When the engine/transmission turns the driveshaft, the reaction is a twisting force trying to tilt the engine/transmission assembly on its mounts. There are only three mounts, two soft rubber mounts under the engine and the complicated spring assembly under the tranny. The tranny mount really does little to counter this force; the torque is entirely taken by the two motor mounts.

Since the mounts are soft, the torque can move the engine around quite a bit. If the car is not stock and producing more torque than originally intended, the left-side mount may actually be damaged since it is put in tension under extreme conditions.

A racing trick is to add a fourth connection between the engine and the chassis. By adding a link, torque can be taken up before the engine moves very far or stresses the mounts too much. Newer FWD cars are usually designed with such a link, but front-engine/rear-wheel-drive cars typically rely on rubber in tension.

Under torque, the engine twists, which means the top moves to the right, the left side moves up, etc. A link can be added anywhere that restricts this movement, but it is usually preferable to put it either on the left side of the engine connecting downward to the chassis, or from somewhere near the top of the engine connecting to the left side of the compartment. Either of these locations puts the new link in tension (preferable for such parts) and helps keep the motor mounts in compression (protecting the rubber).

Backyard mechanics have been known to accomplish this fix by bolting a length of chain between the left-side exhaust manifold and the chassis. Under normal conditions, the chain is slack and does nothing but rattle. When the engine tries to lift, the chain pulls tight and stops the motion. This method does work, but it is hardly a suitable fix for an XJ-S; the chain makes too much noise, and the sudden jolt when the chain gets tight is not conducive to an impressive ride.

To do a professional job, a better idea is to install a link made from threaded rod with some rubber bushings (available at any auto parts store), washers, nuts, and some fabricated brackets to provide holes for the bushings to fit into. Rubber bushings are essential, since a rigid connection would transmit vibration directly to the chassis. If necessary, shield the rubber parts from radiant heat from the exhaust system.

Alternatively, the ingenious mechanic may find a way to make a link from one of those FWD cars fit.

It should also be noted that the motor mounts on the XJ-S are not actually between the engine and the chassis, but between the engine and the front suspension subframe. This provides two layers of isolation between engine vibrations and the chassis: the motor mounts and the subframe mounts. Hence, adding a torque link from the engine directly to the chassis would defeat some of this isolation and perhaps expose the occupants to increased noise and vibration. If possible, it would be preferable to connect the torque link to the subframe as well. Or, use really soft bushings on it.

Intake Upgrades

AIR FILTER REPLACEMENT: K&N Engineering, Inc., makes permanent air filters consisting of special fabric sandwiched between aluminum mesh and treated with oil. They have much less flow restriction than stock paper filters while providing *improved* filtration. Tests on race engines show only a slight drop in power compared to no filters at all! Since these filters are permanent and cleanable, they can even save money in the long run.

The K&N part number is 33-2011 for any V12 XJ-S. Note that stock air filters changed when the ABS brakes were added; since the housing shifted forward, the blank-off area over the throat had to move rearward. The K&N filters have no blank-off area, so the same part number fits either application.

Note that the 33-2011 filters will also fit most XJ12's, but not the last couple of years. The XJ40- and X300-based XJ12's (1993-on) went to a remote filter housing similar to that used on the 6-cylinder XJ40 and X300, except that they have two of them -- one on each side of the car. If your car has air filter housings that are mounted right on the butterfly housings and uses filters that are 16.5" x 5.75", you need the 33-2011. If your filters are 8.37" square, you need 33-2003. The K&N catalog also lists a 33-2579 as fitting some V12's, but this is apparently an error.

IMPORTANT: The K&N's look like they can go in either way outward and either end forward, but you *must* install them with the flat side towards the butterfly. In other words, install the filter into the cover so it sits flush with the bulk of the element within the cover, and then install the cover onto the engine. Installing the other way, with the bulk of the filter nearer the butterfly, can cause the butterfly to get fouled with the filter element. This would be seriously bad, possibly causing the throttle to jam wide open. The concern is exacerbated with AJ6 Engineering's enlarged butterflies, but there's no reason not to be careful with the OEM butterflies.

Needless to say, if you've been running these filters the wrong way around, you should clean them before reinstalling them correctly. Otherwise you'll be putting the dirty side of the filter facing the butterfly.

Installed correctly, the K&N's don't seem to cause a problem with the OEM butterflies because they are pretty stiff. If you want to be safe, it is a simple matter to fab a device to positively keep the filter element and the butterfly apart. This author used stainless steel wire 1/10" (2.5mm) thick from an old radio antenna. Just fashion a loop in the wire to fit over one of the four bolts that hold the air filter housing to the butterfly housing, then a gentle arch over to the diagonally opposite bolt. Make sure the butterfly moves freely underneath the arch before buttoning up the assembly. If the air filter element decides to distort, the arch will keep it out of the butterfly.

The correct end of the K&N filter forward is not as critical, but you might as well get it right. The flat edge is a bit longer on one end than on the other, and the longer edge goes towards the front of the car.

Roger Bywater of AJ6 Engineering says, "...we gave up using K&N filters some time ago because they fall to bits around the edges where the air box clamps up. We raised the matter with K&N Europe, for whom we do consultancy work on occasions, but they claim not to be aware of the problem..." AJ6 Engineering now offers their own design permanent washable foam air filters.

Glen E. MacDonald notes, "Roger Bywater gave up using K&N filters because "they fall to bits around the edges where the airbox clamps up". True enough. However, I was determined not to trash an otherwise perfectly acceptable (and expensive to replace) pair of filters. The fix I found was to take four suitable lengths of windshield washer hose, split lengthwise. These are then slid over the edges of the filter, after cleaning off what's left of the 'bits' Bywater refers to. I made this alteration over 3 years ago and haven't had any problem since."

Of course, K&N filters come with a “million mile warranty”, so another option would be to gripe to K&N about the problem.

For some of us, performance is not the issue with air filters; the wear rate of an engine can be closely related to the filtration of the air intake, and any risk of inferior filtration would not be worthwhile. K&N claims that a NASCAR stock car fitted with its filters will outperform a car with no filters over a 500-mile event, since the deterioration of the engine due to contaminated air over 500 miles will exceed the power loss due to the intake restriction of a K&N filter. K&N claims excellent filtration -- although there have been some contradictory reports from other sources. K&N filters contain a layer of cotton soaked with sticky oil; as the air passes through the cotton, particles should stick to the oil. Such a system normally is not described as a particular size micron filter, since it really should stop *all* particles regardless of size. The stock paper filter, on the other hand, is a porous media filter, and particles below a certain size are free to pass right through.

Either K&N or the stock paper filter is probably acceptable from a filtration standpoint. However, speaking as an engineer, I must express doubts about the filtration efficiency of most of the foam filters I have seen (I haven't seen the AJ6 Engineering foam filters). A foam filter works on a similar theory as the K&N, the foam providing a media for the air to pass through that is coated with sticky oil. However, the passages between the cotton fibers on a K&N filter are very tiny indeed, it's hard to imagine how a speck of dust could get through without sticking, but some foam filters you can *see* through. And even some of those you can't see through appear to have passages that are quite large. And I've also seen foam deteriorate, with crumbs of foam breaking off and going into the inlet. And even if the chunks of foam don't harm the engine, note that each chunk leaving leaves an opening for more dirt to pass through the filter unimpeded.

OPENING UP THE AIR INTAKES: Each of the air cleaner housings has a long tapered tube with a relatively small opening for the air intake. The purpose of the small intake opening is to accelerate the air to near Mach 1 at wide open throttle. This prevents intake sound from coming forward through the intake. In other words, it makes the car quiet.

Unfortunately, the air is now moving fast, and there's an air filter up ahead. If the air is allowed to simply run into the filter, the energy associated with the speed will be wasted, and the result is a loss of pressure. Therefore, Jaguar provides the tapered tube to gradually and efficiently slow the air down, recovering most of the energy and pressure. Jaguar designed this tapered tube as long as they could fit under the hood.

Also unfortunately, once the air reaches Mach 1, the passage is “choked” and all the sucking the engine can manage will not increase the amount of air flowing through it. The opening therefore forms an absolute control on the maximum amount of air going into the engine -- and therefore the HP generated.

If you cut off this intake tube and form a large opening for the air intake into the air cleaner housing, you will eliminate this restriction. If you interfere with the mounting of the temperature sensor in the left side intake tube, relocate it into the housing itself (drill a hole and use a nut on the inside); it can sense the air temperature anywhere in there. Because the EFI system detects manifold vacuum, the system will automatically compensate for the increased airflow; no tuning modifications are required. There is no effect on emissions, so there should be no complaints from inspectors.

At part throttle (most of the time with an engine this powerful), the butterfly acts as an air-accelerating restriction, and no sound gets out anyway. The car will sound like it did before. However, when you open it up, you will be greeted with a sonorous growl from under the hood. This is a very sexy sound, but some Jag owners may not like it.

The performance improvement goes along with the noise. In any situation where there is still no sound, there is no change in performance either. When the engine growls, there is more airflow than there was before.

This mod will have no effect on fuel economy, except when you hear the growl; at that point, increased fuel use accompanies the increased airflow and increased power.

You can give this mod a trial run without much effort. Unscrew the air temperature sensor, then reconnect the wire to it and tape it down anywhere convenient. Then, remove both air filter covers and tie the air filters in place with some wire. This setup will provide the same performance (and a little more noise) than the intake tube removal described above.

OPENING UP THE AIR INTAKES - VERSION 2: AJ6 Engineering (page 663) has gone through several variations on air filter housing intakes attempting to provide an optimum balance between unrestricted flow and noise. What they now offer with their induction upgrade kits are replacement covers that appear largely unchanged from OEM except that there is an additional intake opening on the bottom with a hose leading to another little bellmouth intake mounted in the vicinity of the front anti-sway bar. Perhaps AJ6 Engineering will sell these covers separately, or perhaps one could just adopt the idea and fab similar additional intakes.

COLD AIR INTAKE: Any engineer will tell you that an internal combustion engine will run more efficiently (more power *and* better fuel economy) on cooler intake air. Most automobiles nowadays (including some Jaguars) have hoses directing cool outside air into the air cleaners rather than the hot air of the engine compartment. The XJ-S is a notable exception; perhaps they felt that the hoses would make their engine compartment less attractive.

While opening up the intakes on the air filter housings as described above, a flange can be provided for an intake hose. The author's installation used 3" exhaust pipe, but 2½" pipe would work nearly as well (still four times the area of the stock inlet) and would probably be easier to install. Intake hoses in many sizes can be found at most parts stores, and some have built-in clamps. Remember to provide flexibility in the system, since the engine moves around on its mounts.

All of that was easy. The hard part is routing the intake hoses somewhere. One possibility on the XJ-S is the back end of the headlight compartments. By making a hole and providing a flange for the hose (2½" or 3" pipe again), cool air can be routed from existing openings just inside the grille through the space behind the headlights and into the intakes. An opening must be made in an unseen panel within the headlight compartment to permit air flow. The modification will also require relocating the headlight relays. Be sure to clean up the intake path as well as possible when you're finished, and check your air filters for debris after driving a while.

On cars with ABS brakes, the air cleaner assemblies are essentially unchanged except that they are moved forward to avoid the brake system. The same basic mod works; the intake hose just needs to be a bit shorter.

The good news here is that this mod will reduce the noise from the Version 1 mod. The intake hoses, as well as the sheer length of the intake path, will help dampen the growl.

Since the EFI temperature sensor will detect the cooler intake air temperature, once again no tuning mods are needed. The cooler air provides improvements at all operating conditions, and will improve fuel economy. There is even less tendency to overheat. The only effect on emissions is a *reduction* in nitrogen oxide emissions.

Peyton Gill reports, "I used a Dremel to cut the horn out of the air filter cover and then rounded the "not so perfect hole" with a grinding stone mounted in a drill press. I did not use the exhaust pipe Kirby mentioned, I went to Home Depot and got 2 inch gray PVC couplings. The ones I got came from the electrical dept. The couplings I used have threads on one side and open for a PVC pipe on the other. The conduit works good because you can get a "nut" that fits the threaded side. This nut I'm talking about is more like a threaded ring, it is very common in the electrical conduit world. The rounded hole you leave when you cut the horn out is close to the same size as the threaded side of the coupling and the nut inside the air filter holds the coupling tightly in place. The hole I cut was not perfect so I sealed any openings with black RTV (silicon). I did have to relocate the ballast resistor pack on the right hand side and managed not to have to relocate the relays on the left hand side."

"I used a hole saw (maybe 2 1/4 inch) or whatever size slightly larger than the conduit coupling threads to cut holes in the panels behind the headlights. Since the hole was only slightly larger than the threads so they screw fairly tightly in plus a little more RTV to be sure they hold. I got a flexible hose from Pep Boys (they have hoses made for air filter intakes). I took my conduit coupling with me and found a hose that fit snugly over the pipe side. The hoses have clamps that snap into place and one of the hoses fit my conduit perfectly."

"All that was fairly easy; the good part comes when you attack the "hidden panel" described in Kirby's book. This panel is between the headlight opening in the front and where the hole was cut in the engine compartment. You can see it easily enough when the headlight assembly is removed. Seeing the panel is one thing, cutting a hole in it's another. There is not much room to work or cut. I got a 12 inch extension for my drill and put the hole saw on this and cut a couple 2 inch holes in the panel."

"The air temp sensor also has to be relocated. I drilled a hole in the air filter cover and placed the sensor in the direct air path. I did not have a nut with the same size threads as the sensor so I cut the fitting off the old horn and used it as a nut. I don't think the threads are anything special, I just did not want to make a trip to the hardware store to get one. I had to extend the wires a little."

Pictures of both the author's, Gill's, and several other installations can be viewed at

<http://www.jag-lovers.org/xj-s/book/ColdAirIntake.html>

John Goodman reports that sometime in the early 90's an access panel was provided within the front wheel wells to enable changing the headlight bulbs without removing the assemblies from the front. On the earlier cars, such an access wouldn't have helped because that panel inside the compartment would have blocked access anyway. So, in conjunction with providing the access panel, the unseen panel was also changed; it now has a "hand hole" in it. That being the case, the task of providing this cool air intake scheme might have gotten easier, since the hand hole should serve for an air passage.

COLD AIR INTAKE - VERSION 2: Scott Horner, apparently before he became aware of this book, designed his own cold air intake system: "I based the cold air intake on my car on a friend's XJ-S race car's set-up. He has approx. 4" tubing going into the front of the inner guards, with the air filters mounted within that panel (in front of the wheels). But this is a bit rough for a road car as all you can hear is induction roar..."

"For my car, I visited a panel beater friend to modify the guards, etc., as I wanted the mod to look as if it had come out of the factory..."

"I'll try and describe this without pictures...We used 2 1/2" tubing which is bent to come out of the inner guard and face up to the original air intakes, which have been cut down (with new tubing) to just a stub and attached via flexible tubing.

"Within the guard, the tubing is bent down (to vertical) which then meets up with another piece of tubing (via flexible hose) that is welded into the valance on the outer corners. These tube holes are cut just under the bumper, so are fairly unobtrusive and with the angle of them look fairly sexy anyway..."

"The great thing about them (apart from the cold air), is if you get someone to give the engine a rev while you've got your hand over one of the intakes, you can really feel the engine sucking! There'll be hell to pay the day I hit a sparrow!"

COLD AIR INTAKE - BOLT-ON VERSION: John Goodman reports: "My (unmodified) '89 XJR-S 6.0 has different air cleaner boxes (part numbers SPE 1008 and SPE 1009) with large bore intakes. These take I believe the standard air filters and fit the standard intake manifolds. In other words it's all simple bolt-on improvements for any V12.

"Even more interesting is a special very neatly designed radiator top crossbeam (part number SPD1164) which has quite large smooth oval air intakes incorporated in it. The air intakes in this crossbeam line up perfectly with the air boxes.

"It all looks very neat, but they are JaguarSport parts and won't come cheap!!!"

Regarding that top crossbeam SPD1164, Goodman adds: "I *think* the part no. has been superseded with SPD 1428. This is the part no. listed for '93 XJR-S (American spec). The only difference AFAIK² is that this part has mounting holes for the location of the Ign power amp, (necessitated because the manifolds were different) and rubber connecting hose. There is a good picture of this component in *Jaguar World* vol.2 no.2; anybody handy with a welder could modify a standard one."

IMPROVED THROTTLE BORES -- HOME MACHINIST VERSION: If you have access to a machine shop, you can make a minor improvement in intake airflow with little fuss. Remove the air filter housings, and remove the butterfly

² AFAIK is Internet shorthand for "As far as I know".

housings. You will need a #30 Torx screwdriver to remove the butterfly housings. NOTE: The ports the hoses connect to may look similar, but they may be different! Be sure to carefully record which hose connects to which port prior to disconnecting the hoses.

Referring to **Figure 8**, machine a rounded edge on the inlet into the butterfly housing. This modification should not be attempted by hand, as smoothness and consistency is important. It is important that the radius blend smoothly into the inner surface of the passage, but it will form an edge with the air filter mounting surface.

Before starting, ensure that the machining will not interfere with the butterfly seat nor with any of the vacuum ports near the butterfly seat; by avoiding machining more than 3/8" into the throat, problems should be averted. Also, avoid cutting into the openings for the two bolts that hold the butterfly housing onto the manifold; while doing so wouldn't cause any leakage, it may cause a whistle as the air flows past the opening. Keeping the outer diameter at 2-13/16" should be acceptable.

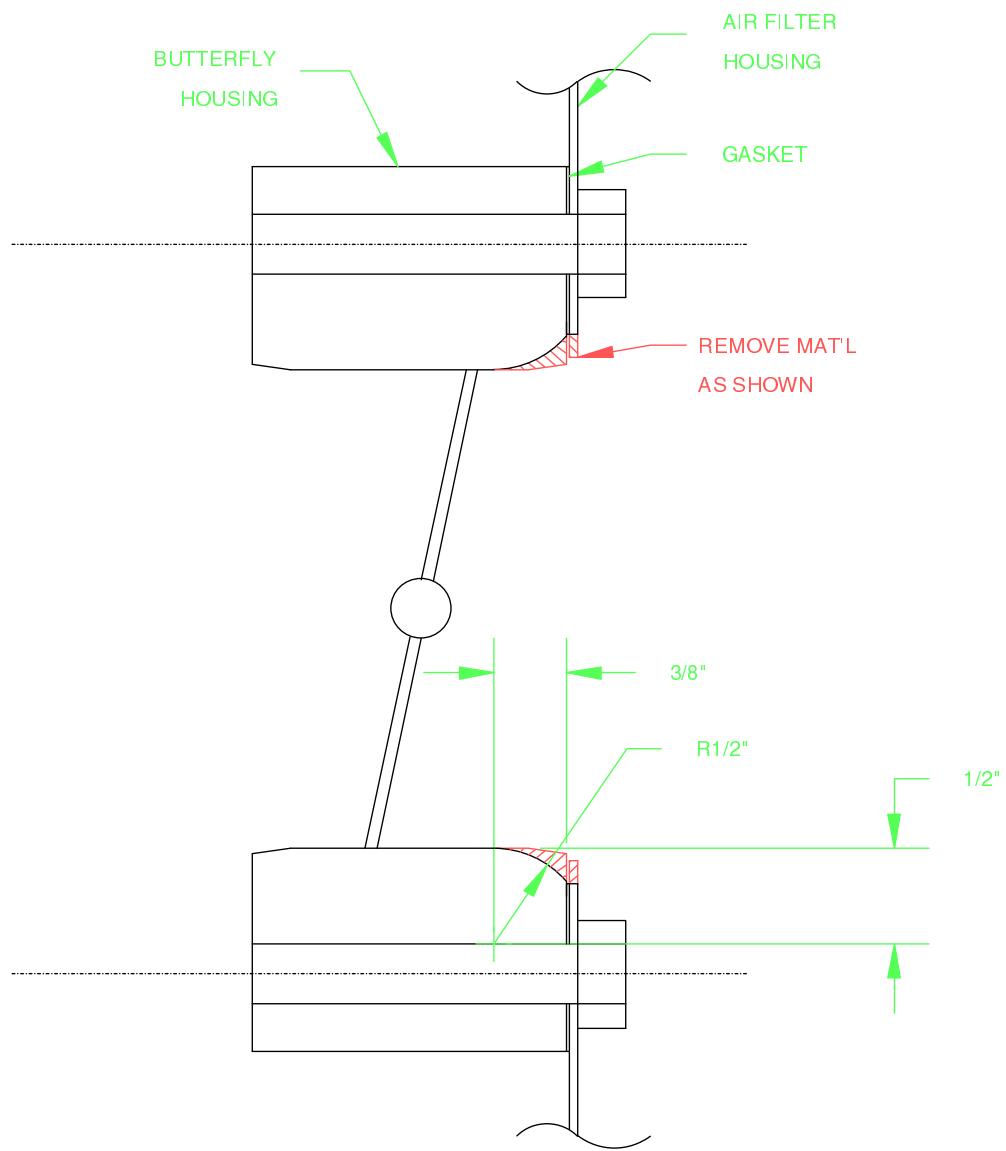


Figure 8 - Butterfly Housing Airflow Improvement

Enlarge the opening in the air filter housing to 2-13/16". The gaskets typically are already this size, but final trimming can be done after assembly by using a razor knife before installing the filter.

This modification has not yet been tried, so performance improvements are unquantified. In theory, this mod can provide an airflow improvement (and hence a horsepower increase) of several percent. Considering the proximity of the blanked-off section of the air filter, the improvement may be even more significant. There should be no change in

performance other than at wide-open throttle. Since the ECU senses and corrects for changes in manifold vacuum, no tuning changes are required.

ENLARGED THROTTLE BORES: AJ6 Engineering (see page 663) offers revised butterfly housings on an exchange basis in which the entire bore is enlarged from 2-1/2" to 2-7/8" (32% airflow area increase) and larger butterflies are fitted. Note that their kit includes low-loss foam filters and air filter housings with additional intake openings, fulfilling some of the other suggestions above. The kit also includes an electronic gadget to revise the ECU response, since the larger butterflies will have different airflow characteristics than the stock ones relative to throttle position. AJ6 Engineering claims a 20-25 horsepower increase with this kit.

Roger Bywater describes the product: "We produce the large disks ourselves by firstly, cutting blank disks out of brass sheet, then, using a special fixture we machine them to exact size and to get the correct closing angle in the enlarged throttle bore. They are not simply turned disks and it is important to get the geometry right so that the correct signal is generated across the throttle edge vacuum ports which are themselves critical on size and position. Boring out the throttle bodies exposes a larger diameter portion of the tapping so we install new tapping inserts drilled to produce the required vacuum signal from the larger passage."

"We also machine the spindle slots which otherwise would not accept the larger throttles and we then rebuild the whole assembly with new bearings and seals, centralise the disks and adjust to the requisite 0.002" closing gap.

"The radiused entry which we machine on the throttle body is important to ensure that the throttle bore passes the maximum flow by not creating turbulence at the entry point - which is what happens with square edged entry of the standard throttles. We supply a set of specially made gaskets to match the large bore where it joins the manifold and also for the larger radiused entry joint to the filter assembly."

Chris Carley says, "I bought just the throttle bodies without the filters or cans. I had to drill out the backs of the filter cans to 3-1/8" and also to my surprise had to grind out the tops and sides of the manifolds to match the ID of the throttle bodies. Note the bigger throttles will jam against the standard air filter at wide open - AJ6 & K&N clear though."

INTAKE MANIFOLD MODIFICATION: AJ6 Engineering (page 663) offers an enhancement called the Plus Torque Conversion where they cut the intake manifolds open and install little intake horns into the openings into each runner, then weld the manifolds back together. This apparently not only provides a smooth entry into each runner inside the manifold, but it also makes all 12 runners the same length -- by making the shorter ones (the middle four) as long as the longer ones (the outer two), thereby increasing the Helmholtz resonance benefits for all and enhancing the EFI system's feedback strategy to keep all six cylinders on each bank operating at an optimum fuel/air mixture.

David Buchner claims that the revised intake manifolds introduced in the early 90's -- identifiable by the huge "Jaguar V12" lettering across the top -- already have the improvements offered in the Plus Torque conversion.

Other Modifications

OIL COOLING: The standard oil cooler on an XJ-S is a "relief" unit, meaning it only cools the oil that doesn't go through the engine. However, as pointed out by Bob Tilley, the XJ-S sold in Germany is fitted with a "full flow" oil cooler system, and the parts are available through Jaguar. We can make assumptions about why the German cars would be different than other cars, possibly involving those Autobahns.

John Goodman adds, "It's worth pointing out to others who own later model V12's who may not be aware that *all* V12 HE engines after engine no. 8S44317 had full flow oil cooling, can't remember the year this was introduced."

Both oil systems, as well as almost any other in automotive use, work like this: Oil is drawn from a pickup in the sump into the oil pump. The oil pump is a positive displacement pump, meaning it will move a particular amount of oil for each rotation, regardless of how much pressure it has to apply to move it; if something gets plugged up or the oil is really

thick, the oil pressure could skyrocket, blowing seals, pipes, whatever. So, the oil goes straight from the pump to a pressure relief valve, which relieves enough of the oil flow to prevent excessive pressure in the system. The relieved oil goes back to the sump, while the remaining pressurized oil goes through the filter (which has its own relief bypass in the event of clogging) and into the galleries that feed the bearings, cam followers, and other parts of the engine requiring lubrication.

In the basic relief oil cooling system in the Jaguar V12, only the oil that is relieved by the pressure relief valve is piped to the oil cooler in front of the radiator, and from there back to the intake of the oil pump. In the full flow system used in German cars, the oil destined to go to the galleries is piped to the oil cooler at the front of the radiator and then back to the filter head assembly to continue through the filter and into the galleries.

Physically, the distinction is like this: in the relief system, oil feeds out of the outlet elbow at the bottom front of the filter head to the right side of the cooler. From the left side of the cooler, it goes to a fitting on the bottom front of the sandwich plate on the crankcase. It doesn't simply return into the sump here, but instead goes directly into the inlet elbow on the bottom of the oil pump. Hence, the oil pump actually draws suction from two places: the sump pickup and the return from the cooler.

The front of the full flow filter head has a pair of fittings that don't exist on the early style relief filter head and are sealed off on later style relief filter heads -- the change probably due to the desire to use the same casting for both relief and full flow filter heads. In the full flow system, oil to the cooler starts at one of these fittings on the filter head itself instead of the outlet elbow; the outlet elbow still exists, but the port on the front is sealed off. The oil feed is piped to the right side of the cooler. From the left side of the cooler, it goes back to the other fitting on the filter head. The oil pump therefore has only one intake, from the pickup in the sump, and the bottom of the sandwich plate either has no hole or has a blank-off cover on it.

The relief system has an inherent shortcoming in that it tends to vary the amount of cooling incorrectly. When the oil is cold, it is also thick, and the pressure relief valve has to relieve a great deal of it in order to limit the pressure. As a result, flow through the cooler is high -- precisely when not needed. On the other hand, when the oil is hot and thin, very little or none at all is relieved, and hence flow through the cooler is minimal -- precisely when it is most needed.

The full flow system always flows the oil through the cooler before it goes through the engine, so there is always cooling. And, the coolest oil in the system is the oil fed to the galleries, so it can be expected to reduce the incidence of burned bearings.

The relief system has another trait that causes consternation. In order for a relief valve to work properly, it really needs to relieve to a place of zero pressure -- such as directly into the sump. Because this system relieves through the oil cooler, there may be a significant amount of pressure on the back side of the relief valve -- the backpressure caused by the flow of thick, cool oil through the tiny passages in the cooler. The pressure of the oil the engine sees -- and therefore the gauge sees -- is the relief pressure of the valve *plus* the backpressure of the oil cooler. The backpressure of the oil cooler will vary *greatly* with oil temperature; when cool and thick, the pump will be trying to push a great deal of oil through it, but when hot and thin it may see little or no flow at all. The combination of the viscosity changes and the flow changes make for extreme backpressure differences. As a result, the oil pressure registering on the gauge will vary quite a bit more between cold and hot than on most cars. This doesn't seem to cause any harm, but it does cause owners to get overly concerned.

If you wish to retrofit the full flow cooling system to a car that came with the relief cooling system, you will need the following parts. The corresponding part numbers for the relief system are also shown:

<u>Part</u>	<u>Relief p/n</u>	<u>FF p/n</u>
Oil Suction Pipe	C35512	EAC6424
Oil Suction Elbow	C33869	EAC6422
Oil Suction Elbow Gasket	C31063	C31063
Relief Assembly	C42796 or EAC7755	EAC6398
Relief Outlet Elbow	C38802	EAC6789
Oil Cooler	C43923	CBC2692
Oil Feed Pipe	EAC1380	EAC8954

Oil Feed Pipe	C38074	CBC2690
Oil Return Pipe	C38075	CBC2691
Oil Return Pipe	N/A	EAC8956
Retainer	N/A	EAC6413
Bracket	N/A	EAC6414
Clamp	C34608 (1)	EAC6800 (2)
Sleeve	N/A	EAC6790 (2)
Bracket	EAC1381	EAC6419

Plus a few bolts, nuts, O-rings, etc., all of which can be purchased locally. If you're the industrious type, you can probably improvise all those clamps and brackets too.

You might also be able to avoid buying the relief outlet elbow; you can reuse the old one if you can plug the opening in it. You will have the part that screws into it, oil feed pipe EAC1380, laying around doing nothing if you want to cut the fitting off and make a plug out of it.

The 1987 Parts Catalogue shows the same sandwich plate used for both systems; a square blank-off plate EAC6420 and gasket EAC6421 are used to cover the unused hole under the oil pump elbow on cars with full flow cooling. In all probability, later on when all cars were fitted with full flow oil cooling, the sandwich plate was altered to omit the hole. But anyone doing the retrofit is probably going to prefer simply bolting on the blank-off plate to replacing the entire sandwich plate. And they could easily make a blank-off plate and gasket rather than buy them.

To replace all these parts would require pulling the sump off the engine to replace the oil suction pipe and the oil suction elbow. However, in theory anyway, these replacements may not be necessary, and the retrofit might be accomplished without pulling the sump. The difference in the oil suction elbow is that the one for the relief system has the second inlet on it, and this inlet is readily accessible via the opening in the bottom of the sandwich plate. If this second inlet is securely plugged, it will serve the purpose of the EAC6422 part. This can be done by making a suitable part that plugs both the second inlet on the oil suction elbow and the opening in the sandwich plate, or by using a separate plug -- perhaps like the rubber expansion-type freeze plugs -- on the suction elbow, along with a simple blank-off on the sandwich plate. In fact, the original sump inlet adapter C37882 can be used if you find a way to plug it. Going this route would not only reduce disassembly requirements, but it also eliminates the need for purchasing a new oil suction pipe, oil suction elbow, and oil suction elbow gasket -- as well as bottom end gaskets you'll have to replace when you open it up.

Note that the difference in the oil suction pipe -- which is, in fact, the pickup -- is unknown. But there is no reason to believe the one designed for the relief system won't work properly for the full flow system. Perhaps the design was changed slightly to fit the revised oil suction elbow.

OIL PRESSURE RELIEF HOSE: While fiddling with the sandwich plate off, Karl Huff was told by a Jaguar shop that "while I'm in there I should replace the oil filter pressure relief hose (?) with a new one from the 6 litre engine." This is probably referring to the question mark shaped line.

OIL FILTRATION MODS: Much of the following was pilfered from an article by Nigel Calder in the March/April 1994 issue of Ocean Navigator magazine. It was primarily about auxiliary engines for sailboats, but the issues discussed here apply to any piston engine.

Oil contamination is divided into two categories: chemical and physical contamination.

Chemical contamination degrades the oil, causing a loss of lubricating properties, and also may introduce substances that attack engine parts. Heat and age can cause oil to oxidize and thicken, encouraging the formation of sludges and varnish. Water can be introduced even in a tight engine by condensation within the crankcase, and causes emulsification. If there happens to be any sulfur in the fuel, some can find its way past the rings and combine with water to form sulfuric acid which promptly attacks engine parts. Unburned fuel coming past the rings also dilutes the oil, lowering its viscosity.

Chemical contamination is combated by additives in the oil. Eventually, however, the additives are consumed and fail to counteract the contaminants. At this point, the oil needs to be changed.

Physical contamination refers to metal particles and dirt in the oil. The metal particles come from wear between moving parts. The dirt comes through the intakes, and a portion makes it past the rings. The problem is obvious in that such particles will increase the wear on bearings and the like.

It is tempting to take comfort that the oil filter is preventing the particles from getting into the workings of the engine. Unfortunately, it is not as effective as one could hope. The typical paper-element oil filter will catch particles down to about 30 or 40 microns, but damage is caused by particles down to about 2.5 microns. These smaller particles build up in the oil and pass right through the filter, cycling through the engine again and again.

The full-flow filter cannot be made with a tighter mesh because the restriction to oil flow would be too great. In addition, if the filter gets clogged, either the element breaks open (dumping all the dirt into the engine), or the flow is inhibited. Usually a relief valve is provided to allow oil to bypass a clogged filter, allowing crud of all sizes to circulate through the engine.

There are two excellent ways to combat physical contamination. The first is by installing a bypass filter. A small percentage of the pressurized oil from the outlet of the full-flow filter is diverted into a separate filter with a tight mesh element to stop particles down to 2.5 microns, and from there right back into the sump. An orifice is provided to prevent an excessive amount of oil from taking this route, which might starve the engine. If the filter gets plugged, no problem -- the flow stops, and 100% of the oil goes through the galley as before. But as long as a small amount is going through the bypass filter, within only a few minutes *all* of the engine oil is cycled through it and the amount of suspended particles is greatly reduced.

The other method is essentially the same, except that the bypass filter is replaced by a centrifuge that causes the particles to collect on the inside of a spinning cylinder. These are typically only available for larger engines.

These solutions are even better than changing oil at short intervals. Even with frequent oil changes, particles appear in the oil immediately and continue to build up. The bypass filter, however, continuously keeps such particles from causing engine wear.

Note that a bypass filter does not address chemical contamination. Such an installation would be effective at reducing engine wear, but the oil needs to be changed at the same intervals to prevent the additives from failing.

An outfit called TF Purifiner (page 670) offers a package that includes a bypass filter system along with a small heater that boils off water, fuel, and coolant to minimize the chemical contamination so the additives last longer.

Surfing the WWW, Mike Claus found that other products are available from Baker Precision Bearing (page 665), Fram and Amsoil. "Fram offers an automotive by-pass filter in its product line that features a pleated-paper element and easy "spin-on" replacement similar to original-equipment-type units. Ask for the Fram "PB50" with mounting hardware.

"Amsoil's bypass unit is connected to the oil pressure sending unit and returns oil to the pan, thus requiring some mechanical ability or the services of your mechanic for the initial installation. The company states that its bypass unit, which employs a user replaceable, pressed-fiber element, refilters all the oil in an engine every five minutes, and keeps it analytically sparkling clean for the (recommended maximum) element life of 25,000 miles! It even extracts and contains any *water* that has (inevitably) condensed into the oil...which if allowed to remain in circulation will often result in the formation of corrosive acids."

Of course, one might immediately ask: if a bypass filter is such a good idea, why didn't such a quality automobile as a Jaguar come with one from the factory? Well, you have to consider the options the way the manufacturer does. The lack of a bypass filter will not cause engine failure before some extended mileage, especially if the owner has been paying the dealer for oil changes on a regular basis -- and even if the engine does fail due to dirty oil, the manufacturer is not likely to incur any liability. The additional cost, multiplying the cost per car times the thousands of cars sold, is significant. And the additional risk of failure -- one of the oil lines to a bypass filter blowing open or some such -- may be more than the company wants to accept. Just having to tell prospective buyers that there are *two* oil filters that need regular changing may be seen as a marketing disaster, especially in this era of drive-it-and-forget-it cars.

You, as the owner of the car, may think differently. You have a significant investment in your car, the risk of a blown high-pressure oil hose is no big deal to you (messy, but not particularly expensive), and you are the guy who will have to pay for a new engine when this one wears out. Basically, if you are the type to own a Jaguar for the life of the car, a bypass oil filtration system would be a wise investment. Of course, if you plan on selling the car soon, or plan to crash it rather than wear it out, it'd be a waste of money.

PRE-OILING BEFORE STARTUP: A lot of the wear on any engine occurs at startup, when the engine must run for a few seconds before oil pressure is established. Russ Lehman sends this tip: "I've got a "Pre-Luber" on my van because it only gets driven about once a week or so, and the pre-lube brings the oil system up to pressure by pumping oil through the engine before starting. These pumps are fairly common on marine engines for the same reasons.

"The pump is fed from a line attached to the oil pan and pumps into a tap where the oil pressure sender is attached. The pump allows oil to pass through the normal routes for normal engine operation, while not allowing oil to pass backwards through the pump (I think it's a piston pump). The motor is switched through the ignition key in the aux position (controlled by MOSFETS), and will stop when the engine ignition is switched on."

There are other systems, including a simple pressure reservoir that holds pressurized oil after shutdown. During startup, a valve is opened, pressurizing the system before the starter is engaged.

Note that such systems may be of limited benefit. While the bearings in the bottom end of the engine may experience much less wear, it is not usually worn bottom-end bearings that require an engine rebuild. More often, it's worn pistons/rings/cylinders that eventually convince an owner it's time for an overhaul, and a preoiler does little or nothing to reduce piston/ring/cylinder wear.

ADDING EMISSIONS CONTROLS: Huh? Well, Germany now has a taxation system that penalizes cars without emissions controls so severely that many German XJ-S owners are seeking to retrofit. For many years the German version had no catalytic convertors or oxygen sensors even though they were provided in the US.

According to Jeffrey Gram, the following outfits (all in Germany) will install emission controls in cars that were not originally equipped with them:

Ernst Apparatebau, Hagen, Tel +49 (0)2331 3600-0
GAT-Abgastechnik, Gladbeck, Tel +49 (0)2043 24021
Gutmann, Breisach, Tel +49 (0)7667 1091
G+M Kat, Gladbeck, +49 (0)2043 42410
HJS Abfgastechnik, Menden, +49 (0)2373 9870
Oberland, Garmisch-Partenkirchen +49 (0)8821 1036
Oettinger, Friedrichsdorf +49 (0)6172 7053-55
Walker, Viernheim, +49 (0)6204 738-0
Waschkuttis, Wiesenthal, +49 (0)9191 96495
Wurm, Stuttgart, +49 (0)711 420071.

IF ALL ELSE FAILS: Most Jaguar owners feel that if you want a Chevy, you should buy a Chevy. But there are those who think otherwise, and for them there are several outfits that offer kits for replacing the Jaguar V12 with a Chevy V-8. John's Cars (page 668) offers two kits for the XJ-S, one for a small block Chevy and one for a big block. Another outfit to check with is Jaguars That Run (page 667).

The 90° V-8 is an excellent engine layout; it has even firing order, and its primary and secondary imbalances are 100% correctable by simply casting counterweights into the crankshaft. The problems with the classic Chevy “lump” are not that it’s a V-8, or even that it’s cast iron; it’s problems are: A) It has pushrod-operated valves, which require compromises in cam profile, which in turn generally means it’ll either produce lots of power or have a good idle but not both; and B) It employs a timing chain with no tensioner, which results in an engine that runs rougher and rougher as it wears. Both of these problems were addressed and corrected by all major European automakers in the 1960’s, and by all Japanese automakers in the 1970’s. Both Ford and Chevy finally introduced V-8 engines with overhead cams and intelligent camshaft drive systems in the 1990’s, apparently in response to competition from Lexus and Infiniti.

Sir William Lyons, founder of Jaguar, apparently didn’t like V-8’s. When Jaguar bought out Daimler in 1960, Daimler had two V-8 engines in production, and Lyons scrapped one of these immediately and the other a few years later. When it became apparent that the venerable Jaguar XK inline 6 would no longer cut the mustard, Lyons responded with the V12.

If you must shoehorn a cast iron V-8 into your Jaguar, do yourself a favor and purchase some cast aluminum valve covers. They will absorb a lot of the noise of the valve train. A cast aluminum timing chain cover will also help reduce racket. Replacing the timing chain with something with less slop, like a set of gears, will make the engine run smoother.

Of course, a better idea yet would be to opt for the newer cast aluminum Y-block Chevy V-8’s. Not only are these engines far superior mechanically to the cast iron models (despite retaining the pushrod valve train), they also come with modern EFI and ignition systems and improved automatic transmissions.

IGNITION SYSTEM

SPARK PLUG REPLACEMENT: Note that this task is much easier on the pre-H.E. because the spark plugs are vertical. On the H.E., the plugs are tilted inboard just enough to make the job truly miserable. Most of the tips below were developed to deal with the H.E.

First problem is getting the plug wires off -- and back on later. Jan Wikström, who owns a pre-H.E.: “I’ve made up a pair of “pusher” tongs out of a bent piece of 4mm high-tensile fence wire. Same idea as the common barbecue tool, but the jaws originated as a short piece of 9mm copper pipe split lengthwise and brazed to the wire. This gets a good grip on the cable just above the rubber cap on the terminal. This tool needs to be bent to a slight angle above the jaws.” The same idea might work on the H.E., but expect to have to vary the details to make it work well.

If you have access to a wet/dry vacuum cleaner, use the hose with no attachments to clean around the plugs before removing them. Just poke the hose over the end of the plug. Compressed air can also be used. John Bertsche adds: “I came up with a cool tool for cleaning out the crud around (and in) the spark plug holes. A turkey baster -- pull off the bulb, duct-tape the other part to your shop-vac hose, and you’ve got a high-intensity, pinpoint (well, almost) vacuum nozzle that’ll fit right into the spark plug hole. Works great! You can use it to scrape dirt and crud out of almost any nook and cranny, and it won’t scratch the aluminum.” Note that you can purchase a set of small vacuum attachments at Wal-Mart intended for cleaning things like computer keyboards, and those attachments would also work well here.

Using normal tools, it generally requires removing the cruise control actuator and unbolting the A/C compressor on the H.E. to replace the 1A and 1B plugs. Matthias Fouquet-Lapar says, “Jaguar offers a tool, it’s in the rear-section of the XJ-S parts manual. It fits perfectly and you don’t need to remove the A/C compressor.” Steve Holst says, “I ended up using the official Jaguar spark plug removing tool that came with the tool kit to replace the plugs. It worked wonderfully and I didn’t need to move the A/C compressor one bit. I ended up unbolting the cruise bellows only. I’m very glad I gave it a try.” This plug wrench (CAC5368) comes in the XJ-S tool kit, but it’s amazing how often used cars don’t have a tool kit. If you need to buy the plug wrench, shop carefully; they supposedly can be had for under \$20, but Jaguar dealers have been known to ask much more than that.

Ah, but things are never that simple. Peyton Gill says, "The tool's socket well was too shallow for the NGK plugs I installed." Graeme Mawson concurs: "My car is an '85 V12 with NGK plugs; the tool provided does not fit over the plug, i.e. the stem of the plug is too long for the barrel of the tool! Perhaps there are two different tools!"

After much discussion about differences between types of spark plugs, it turns out that Mawson is correct -- there are two different tools. The earlier tool, CAC5368 -- used up until at least Peyton Gill's '86 -- will not fit a spark plug. However, sometime later Jaguar revised the tool so it *would* fit a spark plug. The two wrenches appear to be identical in construction, but the later version, CBC4096, has a hole in the top of the socket that goes all the way through; when a spark plug is in place, you can peer in between the pivot joints and see the top of the electrode. Brian Schreurs says, "It does not come with the T-handle so one would have to buy a piece of rod and cut to fit." The T-handle is C36612/2, a part number for a straight piece of steel rod.

Apparently, the spark plug tool part number was superceded again by CCC4813. It's not known what that difference is.

It may be possible to modify the earlier tool by simply drilling a hole through it. You'd hope that it's not -- you'd hope the tool is made of harder steel than that -- but in fact it appears pretty soft and cheap and may be drillable. John Bertsche says, "The factory tool I had in the trunk fit on them fine...just wasn't up to the stupendous amounts of torque required to crack them loose." David Littlefield says, "The factory tool is very cheaply made, frankly. Mine has a big sticker on it with a British flag and says "Thanks for buying British!" I kept ending the phrase in my mind with "in spite of the fact that you are spending half your weekend trying to change impossibly located spark plugs with the incredibly cheap, POS tool we supplied you.""

There are T-wrenches sold for 5/8" spark plugs, and a good one might actually do the job. Unfortunately, all this author has found are cheap ones -- even poorer quality than the Jag OEM tool -- and the swivel invariably breaks as soon as torque is applied with the swivel in any position other than straight, which makes them worthless for this task. Mawson says, "I have bought several box type tools to undo the plugs but as indicated above they always break or 'round off' long before all 12 plugs have been removed. Furthermore on the V12 without removing the likes of fuel lines, A/C compressor, cruise control, distributor or throttle mechanism, when the tool does break (with stupendous amounts of torque applied) it is more than likely that other things get broken as well (usually fingers or knuckles)."

Littlefield says, "Another suggestion for an under-the-compressor tool might be to cut down an old spark plug socket that has the flats on it, and maybe even enlarge the ratchet hole so it can fit further down the plug." Using this idea, Larry Barnes made a tool that actually works: "I took a regular spark plug socket and:

1. Removed the rubber thing in the inside.
2. Ground off *both* ends so an open-end wrench would still work on the top part, and the bottom would still come to the "nut" part on the spark plug.

"I use this modified plug socket for plugs 1A and 1B only. Works great without removing the compressor." On the H.E., make sure to start with a 5/8" spark plug socket; most spark plug sockets are 13/16". All in all, this is probably the best way to go; it is easy to find a 5/8" spark plug socket in whatever quality you desire, they don't cost all that much, and most of them have an external hex on the top. Once you get the socket suitably cut down to fit past the side of the A/C compressor and onto a plug, you can simply use a box-end or open-end wrench on the external hex to get the plug loose. Most importantly, if you're careful you can apply serious torque without the slightest sideways force on the plug; many owners have ended up with plugs broken off at the top of the threads, which is not fun to fix.

There is one more possibility in spark plug tools. J Harper points out that Eastwood Tools (page 654) offers a telescoping spark plug socket. This thing collapses into a little hockey puck which you position over the plug, and then telescopes into a socket shape around the plug. Cute.

Even with a workable tool, you might want to move the compressor anyway. Fouquet-Lapar, despite having the plug tool, says, "I still remove the compressor and the throttle pedestal, mainly to clean things up at the same time." Littlefield left the compressor in place and says, "after this experience, I think I know what surgeons go through during an operation. Working through a narrow hole with long instruments, trying hard not to break something vital. I was even using forceps to hold tubes and wires back to get to the areas I needed to go!" Craig Sawyers says, "I have that Jag tool. However, I have always found it impossible to use under the aircon compressor. The problem is that the swivel joint is operating very nearly through a right angle, and is very inefficient as a result. Besides which, even if it is possible to get

the plug out with the tool, it must be fraught with danger of cross-threading when putting it back, or replacing with new. In fact, the last XJS I moved the compressor out of the way to do the plugs (my brother-in-law's) had three chunks of broken plugs lurking under the condensor. So I now always move the compressor (a ten minute job) and the throttle pedestal (a further ten minutes) and make the whole process more clinical. Besides which, after vacuuming the crud from the centre of the V, you can then use a nice deep socket, and a torque wrench to get the things in "by the book".

If you decide to remove the throttle pedestal, John Napoli says, "Rather than removing the coil, throttle switch, etc. separately, consider removing the whole ball of wax as one. Simply remove the four bolts holding the throttle stand to the engine valley, and it all comes out as one."

You may run into problems getting those four bolts out as well. It's not too difficult to remove in the midst of an upper-engine teardown when you're taking everything out of the way anyway, but for the spark plug job you'd like to remove *just* the pedestal without removing things like the oil pressure sender. The problem is the two bolts at the rear side of the pedestal; they are easy to see, but not so easy to get a wrench on. First tip: obtain a 7/16" swivel socket -- or a 10mm swivel socket if the later engines have metric bolts here.

The first time you have the pedestal off, saw off the lugs on the right side that were apparently originally intended to hold a coil. That will make access a *little* easier next time.

Napoli decided to make some access holes in the pedestal: "On my car, I modified the throttle stand further to lighten it, improve airflow in the area, and make it easier yet to get in and out. I drilled a series of large holes all over. Cleaning it all up and polishing a bit makes it look nice, improves gas mileage, reduces emissions, and decreases quarter mile times."

Peter Cohen says, "The last time mine was out, I slotted the holes for the two rear bolts so that I could start the threads and then mount the pedestal."

As long as you're going to the effort of taking the plugs out, it wouldn't be a bad idea to go ahead and perform a compression check. It's a good way to keep a watchful eye on engine condition.

Before installing the new plugs, it is recommended the time be taken to carefully inspect the threads. Competition is fierce among the plug manufacturers and they generally cannot afford to spend a lot of time and effort making perfect threads every time. One small burr on a steel spark plug can wreak havoc on the threads in the aluminum head.

Be sure to use anti-seize compound on the threads. Do not use normal grease, as this may hamper proper grounding of the plug, and it also may get hot and form a crust that makes it even harder to remove the plugs. And do not use a graphite-based lubricant, as graphite may react with the aluminum and weaken it.

When installing spark plugs, it is helpful to use a piece of 3/8" hose to get them started. Press the hose firmly over the top of the plug and use the hose to feed them into place and thread them in finger tight. Then the hose can be pulled off and a socket used for final tightening.

There are warnings not to tighten the plugs past 8 ft-lb. of torque. 8 ft-lb. is not enough to turn the plugs loosely in the threads unless they have been recently cleaned and chased, but the point is well taken. It is an aluminum head, and tightening "three grunts" is both unnecessary and costly. Just tighten until you feel them seat, make sure they're snug, and quit.

SPARK PLUGS: A quick survey of a group of Jaguar experts clearly indicates that NGK is the plug to use. The study may have been unscientific and the reasons may have varied, but the consensus was clear and overwhelming.

The H.E. engine uses taper seal plugs; the pre-H.E. engine uses washer-seal plugs. For the H.E., NGK used to make at least two plugs, TR5 and BPR6EFS. Both were resistor type, but the TR5 was a "V-Power" plug with a little notch cut in the center electrode. Jim Moore says, "They go by numbers now; an NGK 2238 is recommended by NGK for my '85 XJ-S, turns out it has TR5 written on other end of box and on the plug."

There are many gimmicks used to sell spark plugs. One common feature that may be of some benefit: It is easier for a spark to jump to an edge or point than to a flat surface. This is why lightning rods are pointed. Many of the cute

configurations of spark plugs result in there being more edges on the electrodes instead of flat surfaces. The notch in the center electrode of the NGK V-Power plug is such a feature.

Supposedly, it's actually more important that the sharp edges be on one electrode than the other. With old-fashioned ignition systems, the center electrode was always the anode and the ground was always the cathode -- and the sharp edges really need to be on the cathode, which means they're on the wrong electrode with the V-power plugs. Apparently NGK fixed that; Richard Mansell quotes from a Jaguar publication on the changes for the 1992 model year:

"A new design sparkplug, BR7EF, incorporating a V groove earth electrode, is fitted to improve efficiency and provide better firing consistency."

Note that very little else changed about the Jaguar V12 for the 1992 model year; one can safely conclude that the upgraded spark plugs would work well in older H.E. engines.

NGK certainly isn't the first company to offer multiple sharp edges on the ground electrode. ND plugs have had a grooved ground electrode for years. A highly-advertised plug called the Splitfire charges several times as much as regular plugs for providing a couple of extra edges for the spark to jump to.

If you happen to have a distributorless ignition with double-ended coils (only offered on Jaguar V12's in the mid-90's, and only in the saloon) then half the plugs have their polarity reversed, and the sharp edges need to be on the center electrode again! You can't win.

Another idea in spark plugs that gained popularity in the 90's is platinum electrodes. Platinum is an obscenely expensive metal -- makes gold look cheap -- but it doesn't take much of it to make a spark plug electrode, just the tiniest dot at the gap. And that dot makes the plug last several times as long, which is the reason some modern cars can claim 100K miles before the first tune-up. Note that while platinum-tipped plugs may cost considerably more than standard plugs, they do not offer any improvement in performance at all; their entire benefit is in durability.

Following the crowd, NGK has introduced new plugs for the V12, similar to their earlier offerings but with platinum in the tips. As a result, it is increasingly difficult to find non-platinum NGK plugs. David Buchner doesn't like platinums because he feels you should get in there and check things more often than every 100K miles, but even with such an attitude one might be forced to use platinum plugs and just regap and reinstall them! Might wanna be careful about filing the gap, though; platinum isn't all that hard, a few passes with a file and the little dot might be gone!

Bosch Platinums were among the first platinum-tipped plugs to make a name for themselves -- and it was a bad name. Randy Wilson says "I've found that Bosch standard plugs do not perform quite as well as Champions or NGK, but are better than most common American plugs. I have, however, never had any success with their platinum plugs. If the engine is running well, they don't seem to make any improvement, and if the engine is not well, they foul easily and are not cleanable." But don't let the bad reputation sour you on either platinum or Bosch plugs; Bosch has since introduced the "Platinum +4" plug, which has four ground electrodes (more edges!) but also seems to have corrected the problems the earlier Platinums had.

There is no appreciable disadvantage to using resistor plugs. The resistance limits the current flow, which in turn reduces spark plug wear and radio interference. Prior to the actual spark, there is no current flow so the resistance has no effect on the voltage available at the electrodes.

SPARK PLUG GAPS: The proper gap for the H.E. engine is 0.025" -- you can confirm this by checking the decal on the underside of the hood. Most plugs come out of the box with a 0.032"-0.035" gap. The gaps *must* be checked prior to installation. Oversize gaps can cause poor performance at high RPM, but worse they can contribute to rotor failure and resulting catalytic convertor meltdown in cars equipped with Marelli ignition -- see page 154.

Reports are that some dealers are installing spark plugs with 0.035" gap. If your dealer is doing this, the least you should do is never darken his doors again. Better yet, file a complaint with the EPA, since spark plug gaps are an "emission critical" specification (that's why it's on the decal under the hood) and it is *illegal* for them to be violating it. If you happen to suffer a catalytic convertor meltdown as a result, *please* sue the dealer and help put him out of business.

STRIPPED SPARK PLUG HOLES: Since you have read this book, used anti-seize compound on the spark plug threads, and didn't overtighten, *you* will never strip spark plug threads. However, the PO³ or the idiot you've been taking the car to for service may not be so careful and leave you with plugs that simply won't come out without bringing the threads with them. Aaargh!

The official Jaguar fix involves recessing, drilling and tapping the holes for larger threads, installing an insert, and installing a small pin to prevent the insert from unscrewing. Note that the inserts will be different for H.E. and pre-H.E. engines, since the pre-H.E. used washer seal plugs while the H.E. uses taper seal plugs. Generic inserts may work fine, but regardless of insert used the head surface should be recessed prior to installation to ensure that the tip of the plug will be positioned at the same level as before. If the surface is not recessed, the plug will seat in a slightly retracted position and result in a lower compression ratio on that cylinder as well as possible effects on the swirl pattern in the H.E.

Mike Morrin reports success using helicoils to repair the H.E. plug threads -- something one wouldn't expect would work, since it would appear to require drilling out the hole far enough to destroy the taper seat. "If drilled carefully, about 30% of the taper seat is lost. I think the remaining seat is still enough for a good seal."

SPARK PLUG INDEXING: Does "anal-retentive" have a hyphen? If you answered yes, you may be interested in knowing that "indexing" spark plugs may improve performance in the H.E. engine. In the H.E. combustion chamber, the compression stroke squeezes the fuel/air mixture out of the area over the inlet valve and into the area over the exhaust valve, causing a swirl. This fuel/air mixture is swirling when the spark occurs. If the ground electrode on the spark plug happens to be positioned with its back side into the swirl, then the spark is partially hidden from the fuel/air flow, possibly hindering proper ignition.

To avoid this, mark the side of each spark plug with an indelible magic marker to indicate where the ground electrode is. The position you want to *avoid* is with the back side of the ground electrode aimed toward the nearest end of the head; in other words, you don't want the electrode on the spark plugs in the front three cylinders on the forward side and you don't want the electrodes on the spark plugs on the back three cylinders on the aft side. If any end up in these positions when installed, then exchange that plug with another.

Please do not use a lead pencil to mark the plugs. Graphite conducts electricity, and will cause "tracking" down the side of the ceramic and short out the spark plug. Your engine will run much worse than before you indexed the plugs.

SPARK PLUG WIRES: If your ignition wires need replacing, there's really no reason to buy the Lucas originals; several companies offer aftermarket sets to fit the Jaguar V12. Or you can purchase two 6-cyl or 8-cyl ignition wire sets from any auto parts store and combine them into a set for the V12. Here are some tips:

You can get anything from a roll of wire and a package of connectors all the way to completed, ready-to-install sets; I used a "semi-tailored" set -- one end of each wire comes with the spark plug connector attached, but you cut the other end to length and attach the distributor cap connector yourself. The wires on the V12 are shorter than most, and this permits the right length so you don't have lots of excess wire laying around.

Another feature to look for is the angle of the spark plug connector. Some are straight, some are 90 degree, a few are 45 degree. What the V12 needs is a slight bend; the ideal kit has connectors that are straight to begin with but can be bent to whatever angle is needed. This allows providing different bends at different cylinders -- working on these plugs, you need all the help you can get!

There is also the issue of bends at the distributor cap end of the wires. Some wires have straight connectors so they come straight upward out of the cap, while others have 90° bends here so the wires come off the sides of the cap. Either will work on the XJ-S, both are a pain to install and route.

³ "PO" is a car collector's term for "Previous Owner". It is often used with a derogatory connotation. Sometimes the abbreviation "DPO" is used.

There is also the choice between 7mm and 8mm wires. Ideally, one would choose 8mm wires, since the Jaguar ignition system is really hot and it's all but impossible to route the wires away from other things. Magnecor (see below) offers a 10mm set!

Most aftermarket kits seem to be bright colors. Deal with it.

Jim Belkoff writes, "I found that Pep Boys can special order a custom set of 8mm silicone wires that are made in the US by Borg-Warner. I paid the \$45 in advance and picked them up a day later. They are of high quality and include three wires with 90-degree plug boots (for the number one wires at the compressor and another location - your choice, I guess). The kit even came with a tube of dielectric grease."

"For those of you who don't like the bright aftermarket colors, take heart - this set has tasteful light grey wires, black plug boots and dark grey distributor boots.

"The length was very close on most, and exactly spot on with some of them. Even the ones that were a shade long weren't so huge that they flopped every which way. I have had problems with aftermarket wires in the past (mostly semi-custom 7mm sets) and these are the closest in length and the highest quality I have used so far."

John Smith of Brisbane, Australia says, "I noticed that most parts shops have made up spark plug wires in a variety of lengths. I bought a set, nice blue colour, that had 90 degree connectors for the distributor and straight connectors for the plug ends - the same as the original wires.

"I measured the various original wire lengths and these are:

1A	38cms	(15 inches)	1B	43cms	(17 inches)
2A	25	(10)	2B	35	(14)
3A	28	(11)	3B	17	(7)
4A	30	(12)	4B	25	(10)
5A	40	(16)	5B	38	(15)
6A	38	(15)	6B	46	(18)
Coil	19	(8)			

These wires were 8mm and fitted perfectly."

Greg Benjock bought an 8mm Belden Wire set from NAPA and was *not* very happy with it. "The custom ordered kit came with wrong terminations (all were 180deg). All 13 terminations on the distributor cap in fact must be 90 deg type. And terminations and boots for plugs 1A, 6A, 1B, and 6B are best fitted with 90 degree units. It looked very much like an inexperienced person put the job together." Of course, maybe the cap connectors are a matter of opinion; this author's are all straight connectors and work just fine!

All that said, it should be noted that the original Lucas wires are usually not very expensive; the only valid reasons for using aftermarket wires are availability, a need for a dash of color, and a healthy contempt for all things Lucas.

SPARK PLUG WIRE THEORY: When the 12V power to the coil is cut off, the magnetic flux causes a spike in the voltage at the high tension lead. When that voltage rises sufficiently to jump the gaps in that circuit (one between the rotor and cap in the distributor, another at the plug), current begins to flow.

Once a spark begins, the air is ionized at both gaps. This drastically lowers the electrical resistance of the gaps themselves. With 50,000 volts or so to work with, the current flow can rise dramatically. If allowed to rise unrestrained, this has several detrimental effects. First, the high current flow drains the energy stored in the coil quickly, so the spark doesn't last as long. Second, the high current flow tends to erode the spark plug electrodes faster than necessary. And third, the high current flow causes a considerable amount of radio interference due to EMI radiating away from the plug leads. Besides all these negatives, there are absolutely no positives. High current flow is not beneficial to the ignition process, only the voltage needed to start the spark is necessary. Advertisements talk about getting "energy" to the plug gaps (energy is voltage x current x time), but that's usually a sign of a company trying to peddle snake oil; the only place in an ignition system to be concerned about energy is in building up the field within the coil (the energy the Lucas "Constant Energy Ignition" and the GM "High Energy Ignition" are referring to).

It's easy to limit the current flow once the spark occurs, though: Put a resistor in the circuit. A resistor won't affect the onset of spark at all, because before the spark occurs there is no current and therefore the resistance is of no consequence. But once the spark begins and current begins flowing, the resistor comes into play and limits the current flow.

There are several places to put resistors in this circuit. Using "resistor" type spark plugs is common. Also common is the use of spark plug wires with a carbon-impregnated core, which offers some amount of resistance per inch of lead. Perhaps not so common, it is possible to purchase resistors that fit into the wire between the coil and the distributor.

Plug wires are all different lengths within the same car, so use of common plug wires will result in a different amount of resistance between one plug and another. This doesn't matter, as long as there is some resistance.

Some people think spark plug wires with copper conductors are a good idea. Clearly they fail to notice that such wires are generally the cheapest available -- yet do not come on *any* cars as original equipment. If used with non-resistor plugs, there will be no resistance in the circuit at all, and the plugs will be eroded quickly -- if the coil doesn't burn up first. Copper core plug wires should be avoided for all applications, except perhaps fitting a new lead to your timing light; the copper is easy to solder.

A more recent development is the spiral core plug wire. The core of these wires has a very fine stainless steel wire coiled into what looks like a long, skinny spring. Stainless steel isn't an excellent conductor as metals go, but it nevertheless would provide an essentially zero-resistance current path if it were straight; the current limiting factor here is evidently the coiling. Magnecon (page 657) offers such wires but is mum about the theories on which they work, claiming that too many competitors want their information. Judging from their descriptions, they appear they work like this: The spiral core behaves as a long inductance coil. Before the spark occurs, there is no current flow, so the inductance is of no concern -- same as the resistance in the standard setup. Once the spark begins, the high inductance of the leads prevents the current flow from rising instantly but permits it to rise gradually instead -- and the ignition coil runs out of energy before the current flow can rise to a dangerous level.

Magnecon claims several benefits to this design. One claim is that they will outlast the standard wires, because stainless steel is more durable than the carbon-impregnated silicone core. Another benefit is that these wires are more flexible, and several XJ-S owners have reported this is true and a blessing in the top of the V12. Perhaps the flexibility is a large part of their longevity as well, since neither stainless steel or carbon-impregnated silicone should deteriorate before the insulation layers do on either type wire, but bending the carbon-impregnated silicone wire too tightly will damage it for sure.

Magnecon also claims reduced radio and electronics interference. This is important because modern cars with EFI can get all screwed up if the spark plug wires emit enough EMI to cause spurious signals in pickup leads. The spiral core wires have the theoretical benefit that the magnetic field generated is aligned with the lead rather than radiating away from it in all directions. Franck Guilloteau says, "On their claims; the idle stumble that I had was reduced noticeably, but my stereo has developed an annoying noise....so much for RFI shielding!?" Perhaps a good idea would be to use spiral-core wires in conjunction with resistor plugs, just to be sure.

CAP AND ROTOR RENOVATION: Most of us just buy new parts periodically, but Danny Rearden says, "High tension ignition components such as distributor caps and rotors are generally only faulty if they are cracked, or have carbon tracks on the surface. Even both of these conditions are usually repairable if you are prepared to invest a few hours. My dad specialized in repairing obsolete vintage and racing ignition systems and magnetos where parts were completely unobtainable."

"Clean the part, first with solvent cleaner, then with strong hot detergent solution and dry thoroughly. Inspect *very* carefully, with a magnifying glass if your vision is not 20/20, looking for any surface marks which were not intended to be there.

"If there is no visible sign of high voltage tracking, go to polishing. Otherwise use a hobby knife and scrape the surface until you get to totally clean material, even if this means making a hole in the component."

“Grooves and holes can be filled with epoxy filler. We always used Epiglass Low Density Filler, designed for boat repairs. It seems to have very good thermal and electrical properties, and it does not run while curing. File and sand the repair back to original profile.

“Polish out any marks (both in the original part and any repair), using abrasive paste, such as perspex polish or cutting compound. These surface marks, if not removed, will be future failure points.

“If the part has a dull, porous look to the surface, a light spray of a suitable clear paint may be in order, but don't overdo it. If the repairs were to a visible part, then coloured paint can be used.

“In the 25 years my dad was doing these repairs, I can only recall 1 or 2 items failing again, out of several hundred, and these were subject to 'owner abuse'.

“The important things are:

- remove any trace of previous tracking
- polish or fill any holes, cracks or scratches which could accumulate dust and moisture
- stop moisture getting into the ignition in the future”

KEEPING THE IGNITION SYSTEM COOL: Possibly the worst area for heat problems is within the “V” on top of the engine. Early XJ-S's had so much trouble with cooking the ignition amp that Jaguar created a relocation kit to move it out of this area. Cracked distributor caps have been a problem. Seized centrifugal advance mechanisms are a problem. The wiring harnesses within the V always seem brittle. All of these are symptoms of excessive heat.

Maintaining a good airflow through the engine compartment does wonders for minimizing such heat-related problems on components. However, airflow to the V is largely blocked -- not by the A/C compressor so much as by the plate supporting the front of the compressor. See page 469 for notes on correct installation of this plate.

One simple way to improve things would be to cut a big hole in this plate. Be careful to leave enough metal to properly support the compressor, but this will still allow a substantial opening. Since this area is directly behind the main fan, the hole should allow some airflow under the compressor and throughout the V area.

IGNITION SYSTEM TYPES: There have been four distinct types of ignition system fitted to the XJ-S. The first two were Lucas systems, so you can't simply refer to the “Lucas ignition system” without causing confusion.

Up to 1982, the XJ-S was fitted with the same Lucas OPUS system that was used in the Series III E-Type. This system uses a plastic disk with 12 ferrite inserts within the distributor to trigger the ignition. From 1982 to mid-1989, the Lucas Constant Energy Ignition system (Lucas CEI for short) was used; this system uses a 12-pointed iron star wheel inside the distributor. These two systems can be distinguished by the amplifier; the OPUS amp is a finned aluminum block that may be located between the banks, on top of the radiator top support, or any of several other places; the Constant Energy amp is a black, flat rectangular item bolted to the top of the left side intake manifold.

It must be clarified that the most obvious distinction within the Lucas distributors has nothing to do with ignition types. Up until 1980, the XJ-S had a Bosch D-Jetronic EFI system that required a trigger board within the distributor and a rotor with a magnet in the counterweight. From 1980 on, the Digital P EFI system was used, and it merely picked up the ignition pulses -- no trigger board required. So, the same four screw holes in the distributor housing were used to mount a clear plastic anti-flash shield, and a new rotor with no magnet was used. A different cap was introduced to go with the new rotor. The OPUS ignition system, with the plastic wheel, continued in use for two more years.

The XJR-S was fitted with a Ztek ignition system.

In mid-1989, the Lucas Constant Energy Ignition system in non-XJR-S cars was replaced with the Marelli, which is an all-electronic system -- there are no mechanical or vacuum advance mechanisms, the timing is handled by an electronic control unit based on crank sensors. The Marelli system still uses a distributor, but it only serves to allow two coils to fire twelve cylinders; it does not include any timing or triggering functions. This distributor is very distinctive in that the

cap has connections for two separate ignition coils, one at the center and one off-center, and has no vacuum advance module.

There is a fifth type of ignition system fitted to the Jaguar V12, and that is a Nippondenso distributorless system used the last year the engine was made. However, reportedly this system didn't make it into the XJ-S; it was used exclusively in the last year of the XJ12.

IGNITION SYSTEM REPLACEMENT: Replacing an ignition system isn't automatically an improvement; exactly what an ignition system replacement accomplishes depends on what you are replacing and the sophistication of the system you're installing. The pros and cons of ignition system replacement are therefore covered within the discussions of each type of ignition system found on the Jaguar V12.

Lucas Ignition (OPUS and CEI - up to 1989)

IGNITION SYSTEM DESIGN: An ignition coil requires a certain amount of time to build up enough energy to produce a spark. The faster an engine is turning, the less time there is between sparks, so the output of an ignition coil starts to drop off. It is also apparent that the more cylinders there are, the less time there is between sparks, and the output of the ignition coil drops off even faster.

Another lesson in physics is that the higher the compression, the more resistance there is for electricity to jump a spark gap, so higher voltage is required.

The Jaguar V12 H.E. has 12 cylinders, turns at 6500 RPM, and has 11.5:1 compression, making it one of the biggest challenges for an ignition system in production automobiles. To cope with this, Jaguar has incorporated some sophisticated ignition technology. Also, Jaguar uses a spark plug gap of only .025" to make it easier for the electricity to jump the gap.

ROTOR REPLACEMENT: Replacing the cap is straightforward enough, but getting the rotor off is likely to be somewhat difficult since it tends to jam. All you can do is twist, rock, and pull, and hope you get lucky and don't break it. Or just have a spare on hand. On the Digital P cars, there's not enough room between the rotor and the anti-flash shield to get a good grip on it, so Ned Wesley says, "if you need to remove the rotor, the method I use is as follows: make two loops of string or wire about equal in length to the rotor. Place one loop over the front of the rotor and the other over the back. Bring the loops together so that pressure is applied equally to both sides of the rotor. Give the loops a slight tug and the rotor will come off."

If the rotor carrier shaft seems to want to come upward with the rotor, the rotor carrier shaft retainer is broken. You need to try to hold the rotor carrier shaft down while pulling on the rotor by inserting a screwdriver through an opening in the anti-flash shield or some such. This is a good idea anyway to *avoid* breaking the rotor carrier shaft retainer. Once the retainer lets loose, pulling upward on the rotor carrier shaft will stretch the centrifugal advance springs far below, and you will be in for a distributor recalibration.

IGNITION TIMING: The proper advance setting is indicated on a decal in the engine compartment. If it differs from the manual, believe the decal.

The next thing to confirm is that the woodruff keys that align the front pulley with the crankshaft are in good condition. They are a known problem, and clearly if the pulley is allowed to reposition itself on the crank, use of the timing marks will be a disaster. The woodruff key problem is discussed further on page 86.

Before you get under the car with the engine at 3000 RPM, you might want to note what the timing mark actually looks like on the damper. There is a simple line with the letter A next to it. Unfortunately, the timing indicator plate covers

most of this up, so when you're trying to set the timing all you see is the tip of each so it looks like VI. Trying to figure out whether you're supposed to be using the I or the point of the V to indicate the timing can be confusing. An illustration in the Haynes manual makes it clearer: You must use the I mark.

On the Jaguar V12, the timing indicator itself is adjustable. If there is any chance it has been tampered with (the oil pan and sandwich plate have been removed), then the position of the indicator must be calibrated before checking the timing.

The official method for setting this indicator is to do it when the right side (A bank) head is off. A dial position indicator can be set up to determine when the 1A or 6A piston is at TDC. If a position indicator that will fit through a spark plug hole is available, this same method can be used with the head in place by removing the spark plug from either cylinder 1A or 6A. Once TDC is determined, loosen the two sandwich plate bolts that hold the timing indicator plate in place, and slide the plate on its slotted holes until 0° lines up with the mark on the pulley.

If you happen to have the 1A head off and are going through this setting procedure, Craig Sawyers has an idea to make the setting more accurate -- or, conversely, to make it accurate enough using non-precision measuring tools: "The manual says to set piston 1A at TDC by using a dial guage, but even this is highly inaccurate. If the dial guage has an accuracy of 1 thou, this corresponds to a setting accuracy of 2 degrees for a 70mm stroke engine. If, with a screwdriver, you can guesstimate to say 0.5mm, the angle error will be nearly 10 degrees, all of which makes the slotted holes on the guage plate a bit of a joke."

"What I did when rebuilding my engine was this. When piston 1A is at TDC firing stroke, piston 6A is at TDC exhaust, and pistons 2A through 5A are half way. I forget which stroke they are on, but two of them are on their way up, and two are on their way down. So I set the crank up so that all four of these pistons were exactly the same distance down from the top of the cylinder liners. If this can be measured to 1 thou, the crank angle error will be 0.04 degrees. The trick is to carry out the measurement at the point of maximum sensitivity (half way down a stroke) rather than the point of zero sensitivity (top of a stroke)."

"I'm not sure how you could achieve this with the engine in and the heads on, but if you could fashion some feeler and probe the piston positions in 1A to 5A with an accuracy of 0.5 mm, you could set the position of the gauge to an accuracy of 0.8 degrees, which is more than adequate."

There is an alternate method to set the timing indicator that doesn't require the position indicator or removing the head. All that is required is a device that will obstruct the motion of the piston near the top of its stroke. Such a device can be made from an old spark plug by breaking the ceramic out of it and installing a bolt through the middle. Ideally, the length of the bolt into the combustion chamber should be just enough for the piston to hit it only a few degrees from TDC. If you make this device strong enough, it might also come in handy for removing the crankshaft pulley someday -- see page 85 -- although for that purpose it would be better if it hit the piston farther away from TDC.

Turn the engine a ways past TDC, and then screw this obstructing device into the spark plug hole of either 1A or 6A cylinder. Then turn the engine backwards until the piston hits the device and you can't go any farther. Note the reading from the timing marks. Then turn the engine forward through one complete revolution until the piston hits the device again, and note the reading of the timing marks. The two readings should be exactly the same amount before and after TDC. If they are different, loosen the sandwich plate bolts holding the indicator plate and move it an amount corresponding to one half the difference between the two readings.

Bob Egerton provides another method of finding the true TDC: "Get an old plug and beat out the ceramic centre. Then braze in a length of copper or other fairly small bore tube (you could probably use a really good-fitting bit of polythene tube if you cannot get access to brazing kit) long enough to see from where you are when turning the engine over by hand with your extra long wrench. Apply a small amount of soap or detergent solution to the end of the tube and *slowly* turn the motor forwards. When the bubble is largest you are at TDC." Note again that it may be easier to use the 6A plug hole than the 1A. And, obviously, there are many possible variations on this idea, including threading a fitting into the spark plug base and the use of a balloon instead of soap. Note that this method won't work if you're at the top of the exhaust stroke instead of the compression stroke, so if you seem to be having trouble you might want to give the crank one complete revolution and try again.

The ignition timing on the V12 is checked with the engine held at 3000 RPM. Although a pain, this method insures the timing is accurate at operating speed rather than at idle, where timing is less critical. However, proper timing by this

method requires that the tachometer be at least reasonably accurate. It's not very critical, since it would have to be in error by about 300 RPM to cause an error of 1° in the timing. Nevertheless, if one ever finds his car hooked up to one of those fancy, super-accurate computerized engine analysis machines, it is suggested that the location of the tachometer needle be noted when the engine is running at a real 3000 RPM. That point can then be held whenever the timing is checked in the future.

When checking the ignition timing on the V12, the vacuum line to the distributor vacuum advance *must* be disconnected and plugged. The vacuum advance capsule is at the bottom rear of the distributor, making it quite difficult to get to this line (the larger hoses connecting to the distributor cap itself are for the distributor ventilation system, and do not affect timing). Do yourself a favor and cut the vacuum line somewhere convenient and reconnect it with a small piece of tubing. From then on, all you have to do is disconnect it at the break and plug it when checking the timing.

Since the battery is in the trunk, connecting the power leads of the timing light requires ingenuity. The ground lead can be connected anywhere on the car. The positive lead must go to 12V, which exists at any solid brown wire. There are two terminals on the firewall adjacent to the valve covers, and a terminal on the back of the alternator -- all difficult to get at. Another solution is to use a pair of jumper cables from the battery in the trunk. Peter Smith: "I connect my timing light to the 12V power source at the headlights fuse box."

Since disconnecting the plug wire from cylinder 1A is difficult, disconnect the wire from the distributor cap instead; make a small jumper from an old ignition wire to use to connect the timing light. Or, just buy an inductive timing light. If it's more convenient, you can also check the timing using the signal from cylinder 6A.

Since you must crawl under the front of the car while an assistant holds the engine at 3000 RPM to read the timing, it is suggested you put an extra long ignition lead on your timing light so you can route it around the fender rather than feeding it through the engine compartment. Interference with moving parts at 3000 RPM would be memorable. Cheap ignition wire with metal conductor works well for making a long timing light ignition lead, and is available by the foot. Steve Chatman came up with another idea: "When checking the timing on the XJ12, I discovered that I was either going to extend the wire that clamps the plug wire or feed the light through the engine compartment. I didn't really like those alternatives and instead simply ran the timing light over and down the outside right front wing. From there, I could shine the light under the car, using my left hand. With my right hand, I held a mirror to reflect the light vertically. Worked fine and seemed very safe. Of course, you should correct for the increased distance traveled by the light, but you knew that. I was in a poorly lighted garage at night. Better lighting could make this approach difficult or impossible to use."

Michel Carpentier provides another way of dealing with the inconvenient location of the timing marks: "Make a pointer out of sheet metal, which you fit under one of the water pump nuts (pointing from above towards the crank pulley). Now position the crank so it is in firing position at 3000 RPM and put a dab of white paint opposite your pointer. From now on you can check your timing from above."

Timing is adjusted using a long screwdriver to turn a small eccentric cam on the side of the distributor underneath the cruise control actuator. There is a locknut on the adjuster, and this is a place where a crowfoot wrench will come in very handy.

The Jaguar V12 design eliminates most wear items that would normally cause ignition timing to vary, such as ignition points or sloppy camshaft drive systems. The only remaining reason for the timing to change would be wear in the timing chain itself, and the Jaguar timing chain normally wears so slowly as to be insignificant. If the timing in your car is way off, it is highly recommended you determine *why* rather than simply readjust it. For example: If your centrifugal advance unit seizes in the idle position, then when the car is revved to 3000 RPM the timing will be retarded by 15° or more. If you merely adjust the timing rather than correcting the problem, then the timing will be 15° too far advanced at idle!

If your eccentric cam timing adjustment won't go far enough, the distributor base must be repositioned. Remove the distributor cap and insert a long allen wrench to loosen the three mounting bolts at the very bottom of the unit. Rotate the entire distributor housing in the direction needed, then retighten. Please remember that this much adjustment should *never* be necessary, and causes should be investigated.

HOLDING A HIGH RPM: Michael Minglin sends a tip: "Every time I went to check the timing, alternator, etc. the book says to set the rpm to such and such. Reaching down to that auxiliary air valve when the engine is hot is not my idea of fun. What I did was to weld a nut on top of a short bolt. Threading a longer bolt into this nut gave me a "T" with a long top and short leg. The short bolt goes into the RHD throttle cable bracket (not used for anything on my '84 XJ-S). Then I use the long bolt to adjust the bell crank to the rpm I want. To make it even easier, I forced a short piece of vacuum hose onto the long bolt, at the head. This makes it easy to adjust the bolt with your fingers." This plan will work on either LHD or RHD cars, simply using whichever cable bracket is unused.

CENTRIFUGAL AND VACUUM ADVANCE DATA: When checking distributor advance versus tables, make sure you are looking at the H.E. or pre-H.E. tables, as appropriate. The H.E. system develops less advance in the centrifugal mechanism and more advance in the vacuum mechanism than the pre-H.E..

Page 05-1 of the ©1975 ROM and page 05-1 of the ©1982 Supplement list data for the centrifugal advance mechanisms for the pre-H.E. engine. Both of these charts include a listing that says "No advance below" in one column and "900" in the other column, which would seem to indicate that the entire chart is talking about the amount the advance changes from idle or static settings. However, Roger Bywater points out that this is not the case; the other entries in these charts are actual crank degree readings based on the proper 10° BTDC baseline timing at 500 RPM. For example, the chart in section 86.35.29/4 says that the distributor should advance 6.0-8.0 degrees at 1000 RPM; since these are distributor figures, that corresponds to 12.0-16.0 degrees at 2000 RPM at the crank, and when added to the 10 degrees of baseline advance we get the 22-26 degrees of advance listed in the charts. The charts would have been clearer if they had simply said 10° at 500 instead of that "No advance below 900" stuff.

Regarding the charts for pre-H.E. advance, Mike Morrin says, "I suspect the service manual only has data for one of the distributor variants fitted (probably C44663). The parts book shows that there were 5 different models of distributor fitted to pre-HE XJ-Ss, and I think that the only difference was the advance curves.

C.43735	Australia (this is the one with the peculiar vacuum retard system).
C.44663	California to car 2W54183
C.43735	California from car 2W54184
C.44663	CDN/USA to engine 8S5461 (ie the 4460th engine what year??)
	All other countries to engine 8S5202
C.46173	CDN/USA from engine 8S5462
	All other countries from engine 8S5203
DAC1609	California from engine 8S11161 and Australia from 8S11800
DAC1380	All other countries from 8S11262

"Note that my parts book does not cover the [pre-H.E.] Digital-P cars, so there are probably 2 more I have not counted.

"On reflection, I am surprised that there is not a clearly different distributor model (advance curve) for 8:1 and 9:1 compression engines. As far as I can see, the distributor seems to change according to degree of emission control, not compression. For example: Australia (9:1) and California (8:1) get the DAC1609, all other countries presumably including the UK (9:1) and the rest of the USA (8:1) get the DAC1380."

For our information, Morrin also provides part numbers for the distributors on the Series III E-Type:

C33148	up to engine 7S4663 (emission control) or 7S4879 (no emission control)
C37443	from above.

"The carburetted distributors of course have no FI trigger assembly."

TIMING THE PRE-H.E.: The procedure is described in the ROM, section 86.35.29/7. Basically, you disconnect the vacuum advance, lower the idle to make sure you're off the bottom of the centrifugal advance curve, and set the timing at 10° BTDC. Much easier than the H.E. procedure!

Unfortunately, there's probably a very good reason the H.E. went to setting the timing at 3000 RPM instead of at idle. Roger Bywater speaks of distributor build quality problems: "Back in the early 1980's we encountered V12 distributors which could over advance beyond spec by as much as 10 degrees at 6000 revs!" What this means is that with the timing set correctly at idle, it may still be way off at highway speeds. You're not likely to burn pistons at idle; it is far more important that the timing is correct at highway speeds. The H.E. procedure minimizes the implications of the problem: Even if the distributor isn't quite within tolerances, the timing will be correct at 3000 and will merely be off at idle instead. Much safer.

So, why don't we adapt the H.E. timing procedure to the pre-H.E.? That way, those cars will enjoy proper timing at highway speeds as well. Bywater: "What you are saying is absolutely correct and setting the timing at low speed before any advance takes effect is just about the worst way of doing it, but to be honest I've never really thought much about it before. In all normal operating conditions the advance could in theory be 4 degrees out yet still be within spec. Allowing for wear and tear, not to mention questionable original build quality, the error could easily be more than that."

All we need to do is figure out what the timing should be at 3000 (or some other point in the middle of the curve somewhere) and set it there. The fact is, we could provide a spec for timing at 2000 or 4000; it wouldn't make much difference. As long as it's set somewhere along the curve rather than at idle where you're not even on the curve, the advance will be much closer to correct where it's important than it would have been with the timing set at idle. Bywater suggests that it'd be best to check the timing right at the peak torque, since this is where it will be most critical due to maximum cylinder pressures. Ideally, the timing should be checked at *several* places to make sure none exceed an acceptable advance, but let's not get carried away.

To generate mid-curve timing specs, we can combine the idle timing specs with the distributor advance mechanism specs. The specs in the ROM for checking the distributor advance mechanism provide a 4° tolerance range. A 4° tolerance band may be good enough for checking to see if the distributor is working but it's not good enough for setting the timing; we need to know what point within these tolerances is the optimum timing point. We could assume that the tolerance is ±2° and specify timing based on the midpoint, but Bywater suggests this might not be right. "With regard to the tolerance spread it is worth remembering that all engines must be safe with the worst possible condition which implies that the most advanced point is the one to work from rather than mid-range. I am not sure how tangible the benefits would be but if it makes it possible to run safely with 2 or 3 degrees more advance than the overall performance, response and economy should be improved. I am sure it is worth trying but maybe a period of trial is called for with a few willing volunteers who can report back before advocating it on a wider scale."

Bywater went on to provide timing specs for all pre-H.E. V12's:

Carburetted V12's	35° BTDC @ 4000 RPM
D Jetronic:	33° BTDC @ 4000 RPM
10:1 CR pre-H.E. Digital P	24° BTDC @ 3000 RPM

Are these correct? You just can't get a better authority than Roger Bywater; he was the guy leaning over a screaming V12 in an engine testing room at Jaguar dialing the advance up and down by hand to *develop* these advance specs. But anyone can make a mistake. So, after you set the timing using these guidelines the first time, check the timing at idle. If it's only different by a couple of degrees -- notably if it's *more advanced* by a couple of degrees -- the spec was correct, get in the car and drive. If it's off by ten degrees, check to see if your advance mechanisms are working properly. If they're OK and the timing is really that far off, perhaps it'd be wise to rethink this whole idea before putting your foot in it.

Yes, the numbers for the pre-H.E.'s sound like a lot more advance than the H.E.; that's the nature of the beasts -- the H.E. gets less advance from the centrifugal mechanism and more from the vacuum capsule than the pre-H.E.

So, for those unfamiliar with timing the H.E., here's the procedure: Warm up the engine, disconnect and plug the vacuum advance, have an assistant rev the engine up a little past the specified RPM and then come back down to it and hold it there, and set the timing to the specified advance.

Of course, one problem is that the scale on the timing plate doesn't go far enough. So, set the crank at 20° BTDC and paint a new mark on the damper at 0°. Then you can use this new mark to set the timing at the spec minus 20°.

UNDERSTANDING THE VACUUM ADVANCE SYSTEM: Between August 1998 and June 1999, Kelsey Publishing (page 674) published six issues of a magazine called *XJS Bulletin*. Issues 1, 2, 3, 4, and 6 contain a series of articles called “Advancing by Vacuum” by Roger Bywater of AJ6 Engineering (page 663) that are arguably the best explanations of the vacuum advance systems used on the Jaguar V12 available. For those interested in obtaining back issues, here is a brief synopsis of what each issue’s article covered:

- Issue 1: General concepts of vacuum advance systems
- Issue 2: 1976-80 V12 vacuum advance systems, including California and Australia
- Issue 3: 1980-81 vacuum advance systems (pre-H.E. Digital P cars), Emission A and B
- Issue 4: Advance concerns related to the H.E. engine
- Issue 6: H.E. vacuum advance systems, Emission A and B

After June 1999, *XJS Bulletin* was discontinued as a separate publication and a distinct section of *Jaguar World* magazine was provided instead, with pretty pictures of cars but little in the way of useful technical information.

VACUUM ROUTING DIAGRAMS -- WHICH IS WHICH? Good question. The following is an attempt to clarify the applications of diagrams that appear in several documents; here’s hoping I don’t make any errors here, since that would really compound the confusion!

In the ©1975 ROM, there are no vacuum routing diagrams. For the vast majority of cars of the time, the routing for the vacuum advance was simple: Straight from the throttle edge tap on top of the right side butterfly housing to the distributor. The air pump, where fitted, was apparently uncontrolled -- on all the time. In California and Australia, the system was more complicated, but not covered in the ROM.

The ©1982 Supplement has two descriptions, one labelled “Emission B” and the other labelled “Emission A & C”. These both apply to the H.E. only, but the Emission A & C version only applies through 1982; for 1983, a vacuum regulator was added to the system.

The H.E. supplement in the back of the ©1984 Ed 4 includes a description of a system labelled “Emission A & C - Federal, Canadian & Japanese Specification 1983 on” which includes the vacuum regulator omitted in the ©1982 Supplement.

The Haynes manual (©1986) actually contains a fair assortment of vacuum routing diagrams, enough to put the ©1975 ROM and ©1982 Supplement to shame. Of course, they’re not labelled clearly enough, so here goes: Figures 13.29 and 13.30 apply to the 1980-81 pre-H.E. engine with Digital P injection. Figure 13.31 applies to the pre-1983 North American H.E. Figure 13.32 applies to the 1983-on North American H.E. Figure 13.33 applies to the Emission B (non-North American) H.E. Figure 13.33 is labelled that it applies to the Australian models, but it’s not the same system that Bywater’s *XJS Bulletin* # 2 article shows for the 1976-78 Australian cars; presumably it’s for the later H.E. models.

VACUUM ADVANCE MODULE: On most cars, it is a simple matter to determine if the vacuum advance module is intact: Connect a hose and, using your mouth, suck and watch the mechanism move. While in advanced position, put your tongue over the end of the hose and see if it holds vacuum and stays in position.

On most cars, but not on the XJ-S! On the H.E., there is a vacuum regulator in the line to the vacuum advance module, and such regulators cannot be depended on to work properly with no flow. Therefore, the vacuum advance module on the XJ-S has a deliberate bleed hole, so the module will not hold a vacuum even when in perfect condition.

According to Michael Neal, “The early units hold vacuum.” This makes sense; if the vacuum advance plumbing doesn’t include a vacuum regulator, there’s no need to put an orifice in the diaphragm.

Roger Bywater says, "Of course the high temperature situation also gives the vacuum capsule a hard time and they usually need replacing every couple of years or so but a lot of so-called mechanics seem to miss that one."

Note that a vacuum advance module that isn't leaking may still need replacement. Val Danilov says, "My diaphragm was fried rock hard, I broke it trying to test the rod movement (CRRRACK!), so I think it wasn't leaking."

The earlier vacuum advance modules came with an adjustment screw on the top. This screw permits adjustment of the limit of travel of the module -- but was supposedly set at the factory to the correct travel. This is not intended as a user-adjustable feature; the only reason to be messing with it is a suspicion that someone else has already messed with it. Later replacement modules don't even have the screw.

VACUUM ADVANCE MODULE REPAIR: The following procedure for rebuilding a vacuum advance module is credited to John Napoli and Val Danilov.

Before removing the vacuum advance module from the engine, you might want to take note of the best position for the vacuum line connection when it is reassembled. And after removing the vacuum advance module but prior to taking it apart, it is suggested that you first carefully measure the distance which the actuator rod extends out of the unit. Also, push the rod back into the unit (fully retracted position) and measure that as well.

Raw material is a generic replacement vacuum advance from a Chevy V8 -- dirt cheap at any auto parts store. Take the Chevy unit apart by prying open the case; Napoli suggests it may be easier to open the case by grinding the case all around its periphery to weaken the metal, but be careful not to get it too hot and damage the diaphragm. What you want to get ahold of is the diaphragm/rod assembly.

Open up the stock Jag vacuum advance by prying around the crimped-on case. In this case, you'd like to reuse everything *except* the diaphragm/flat link assembly, so try to do as little damage as possible to the casing; if you'll read ahead to understand how you'll be reassembling it, you may decide to simply cut or grind the lip off the edge to avoid mangling the dome itself. Even though the diaphragm/flat link won't be reused, keep it on hand for taking measurements.

Cut the rod from the Chevy diaphragm/rod assembly to the same length as the Jag original, then set it down on an anvil or something and pound a flat spot at the end with a hammer. No problem -- it's a Chevy part, remember?

Reassemble the vacuum advance unit using the new diaphragm/shaft assembly and all the old Jag parts. If the casing wasn't damaged when disassembled, you may be able to simply clamp the unit together and gently bend/hammer the dome shut. This works but the cannister will become work-hardened so you will never be able to do this repair this way again.

If the edges were too mangled (or you cut them off), drill the body and dome for eight fasteners; Napoli suggests 3/4" long 3-48 fillister head screws and nuts, but notes that the exact sizes aren't critical. Sandwich the body, diaphragm (poke a hole through for the screws with a needle), spring, and dome, and bolt it all together, being careful that the flattened section of the rod is aligned properly. This method has the distinct advantage that it permits repeated repairs later -- important, since the heat in the valley of the V12 will eventually bake the Chevy diaphragm as assuredly as it did the original.

Check that the unit responds to vacuum and pulls the shaft in.

Measure carefully the extended length of the rod, mark, and drill a hole in the flattened area the same size as the hole on the original part. Check the retracted length as well, and if there is an adjustment screw on the dome adjust it to provide the same total travel (if your extended length was off a little bit, make the retracted length off by the same amount; the variance can then be corrected by setting the timing normally). If you don't have an adjustment screw, don't worry about it, the total travel will probably be close enough.

Reinstall on the distributor. Be sure to check the timing; the timing procedure requires that the vacuum be disconnected, but the module still has an effect -- you might not have gotten that extended length as perfect as you thought you did.

Note that the original diaphragm may have had a tiny orifice built into it to provide a deliberate leak. This will usually be evident as a tiny hole through the metal disks on either side of the rubber diaphragm itself. The vacuum advance plumbing includes a vacuum regulator and such regulators don't work reliably when there is no flow, so the orifice is in there to provide a little flow. It appears that this orifice may not be necessary, since some genuine Jaguar replacement vacuum advance modules reportedly don't have it. If having an orifice proves to be necessary, it can be added anywhere in that branch of the vacuum advance plumbing; you might wanna make the hole in the dome rather than in the diaphragm itself. It might make more hiss, but you can seal it later if you decide to with a small piece of aluminum tape. Or you may be able to fit a separate device with an orifice with a tee connection into the vacuum line. You could, for example, take a piece of brass tubing, drill a tiny hole in the side, and connect it in the line *to* the vacuum advance module.

If, for some reason, you are unable to reuse other parts of the original Jaguar vacuum advance unit, you may be able to use the corresponding parts from the Chevy unit. Note, however, that doing so may result in differences in the advance curve and/or limits. Use of a different spring will change the advance rate. Use of a different dome with a different depth, and therefore a different place where the spring seats, will also affect the advance rate. And use of a different dome may also affect the retracted length, allowing the diaphragm to travel too far or preventing it from travelling far enough.

If the Chevy dome happens to include a limit adjusting screw, you may be able to adjust the full-retract position after assembly to make sure it is the same as the original was. If there is no adjusting screw, you might actually be able to add one, being careful to seal it when done to avoid vacuum leaks. If the Chevy dome is shorter and compresses the spring too much, you may want to add a spacer ring between the diaphragm and the dome to space the dome back. If the Chevy dome is taller and compresses the spring less, you might want to insert something within the dome for the spring to sit on.

Napoli adds, "I have seen in this month's Jeg's catalog (see page 667) that Accel manufactures a replacement Chevy vacuum advance that is adjustable. The ad copy states that the unit is adjustable for total advance and rate. It comes with instructions. The unit looks just like the generic replacement I used, so the same repair approach should work." This fancy aftermarket Chevy part is *still* cheaper than the stock Jaguar vacuum advance module by a long shot.

If you tore things apart and *then* read the suggestions to take measurements first, Napoli sends some reference measurements from a junk unit he had laying around: "For reference, the measurements were taken with 1/16" of the adjusting screw exposed. That is, from the face of the adjusting nut to the top of the unmolested screw is 1/16". Also, this is a stock '88 V12 advance (non-Marelli) from my donor engine and the unit does not operate (won't build vacuum). With the unit relaxed, the length from the end of the housing to the center of the hole in the actuating rod is exactly 2 inches. Full compression of the rod reduces the length by 5/16" (i.e., 5/16" maximum travel)."

VACUUM REGULATOR AND DUMP VALVE: A vacuum advance mechanism applies more advance as vacuum increases, which means there will be minimal advance at full throttle (to avoid knocking) and lots of advance at light throttle (where knocking isn't a problem, to provide optimum fuel efficiency). This also means a lot of advance at idle, but this can be problematic. The manifold vacuum at idle may vary as the RPM rises or falls a bit, and this will move the vacuum advance in a direction so as to accentuate those fluctuations. The result can be an unstable idle, sometimes even stalling.

The time-honored fix for this is to use a "throttle edge tapping" for the vacuum source. The vacuum line to the vacuum advance, rather than simply connecting to a port on the manifold, is connected to a port located near an outward-opening edge of the throttle butterfly. Whenever the throttle is open, the edge of the butterfly itself is on the air filter side of this port, so the port is seeing manifold vacuum. As the butterfly approaches the closed (idle) position, however, the edge of the butterfly passes over the port, leaving the port exposed to atmospheric pressure rather than manifold vacuum. The result is *no* vacuum advance at idle. This results in a stable idle, and also makes it a bit easier to adjust the timing -- you don't need to disconnect the vacuum line first. This setup was very common on carburetted American V8's of old, and unfortunately resulted in an entire generation of mechanics who don't believe it's necessary to disconnect the vacuum advance when setting the timing.

If you'd like your Jaguar V12 to operate this way, it's very simple. Just throw away all the vacuum advance control devices and connect a single hose from one of the ports on top of the right hand butterfly housing directly to the vacuum advance module. This will work fine, although the total lack of vacuum advance at idle will make it use more fuel and generate more waste heat when idling. This shouldn't be a problem; the cooling system should be able to handle the additional heat, and the fuel economy reduction is small -- especially if you don't sit around idling much. It may affect emissions tests, but ironically it may help them; in general, retarding timing seems to make it easier to pass emissions tests. Note that most of the 1976-80 V12 models (except California and Australia) apparently did operate their vacuum advance exactly this way, and some later models did as well except that they added controls to shut off vacuum when the engine was cold to help it heat up quicker.

With later models, Jaguar used a better idea here. Rather than providing *no* vacuum advance at idle, they provided a vacuum regulator to provide *some* vacuum advance at idle. Because the regulator provides a fixed amount of vacuum regardless of how the manifold vacuum is fluctuating, the instability problem is avoided. In such schemes, one hose to the regulator comes from the manifold itself to provide a vacuum source, while another hose connects to the throttle edge tapping to provide a "reference" to regulate to. When the engine is at idle, the manifold vacuum is high but the signal from the butterfly housing shows no vacuum, and the regulator throttles the vacuum to the advance capsule down to a fixed amount above that reference. When the engine is at part throttle, both the manifold vacuum and the signal from the butterfly housing show high vacuum, so the regulator does nothing; the advance capsule gets full manifold vacuum. At wide open throttle, both the manifold and the throttle edge tapping see very little vacuum, so the advance capsule doesn't get much either.

This is a really good system, providing a goodly amount of advance at closed throttle so the engine idles efficiently. It also results in less of a step coming off of idle; rather than the vacuum advance going from no advance to full advance all of a sudden, it merely goes from partial advance to full advance. The effect is smoother throttle response.

There is one problem, however: A vacuum regulator is a throttling device, and therefore cannot provide a great deal of flow suddenly when needed. The specific case of concern here is when the throttle is suddenly floored. In a car with simple hoses connecting to the vacuum advance capsule, the sudden lack of manifold vacuum would result in a similar lack of vacuum advance just as quickly, and the engine could proceed at full throttle with the timing properly positioned for that condition. But with this regulator in the line, a sudden opening of the throttle will require a second or two for the vacuum to bleed off the advance capsule through the regulator. For that second or two, the engine will be running at full throttle with too much advance, and the engine will be knocking something fierce.

The solution is another device, the dump valve. This is a vacuum-operated valve that merely opens the line to the vacuum advance capsule to atmosphere when there is no vacuum in the manifold.

There is one other minor detail, and that is the fact that a regulator generally works better with a little flow through it; it may have difficulty regulating vacuum in a deadheaded line. So, the vacuum advance capsule may have a tiny internal bleed orifice, small enough that the vacuum system can still apply a vacuum but preventing it from holding a vacuum.

A little guidance on plumbing: The North American models use a vacuum regulator EAC5157, and it has three hose connections. One connection is labelled "DIST", and this line is connected to the vacuum advance capsule; a tee in this line should lead to the dump valve EAC4069 and connect to the fitting farthest from the flat side. Another connection is labelled "CARB"; this should be connected to the throttle edge tapping, which is a port on the top of the right side butterfly housing. The third connection is labelled "DELAY", and this one should be connected to the intake manifold; it typically is connected through a whole series of valves and controls that provide less vacuum when the engine is cold. Basically, the regulator and the dump valve are the only things in the vacuum advance control system that are operating when the engine is warmed up; everything else in the plumbing has to do with cold starting.

Note that other markets use a different vacuum regulator, but the idea is the same.

The connection on the dump valve nearest the flat side should be connected to the intake manifold; in some cars it appears to be connected to the bottom of the right side butterfly housing, but this fitting is a ways behind the butterfly and will see manifold vacuum in all but nearly wide open throttle, and at wide open throttle it should see nearly atmospheric pressure either way.

The various emission control diagrams available invariably show the controls for the air pump on the same diagram, primarily because some of those vacuum control devices used for cold starting also affect air pump operation. Don't get confused; other than the fact that both systems are vacuum-controlled, they really have little to do with each other. The descriptions above only apply to the vacuum advance system.

15 MINUTE TIMER: The 15 minute timer is a feature of the "B Emission" H.E. cars, which means UK/Europe spec, 82-88 or so. If the coolant temperature is below 38°C when the car is started, the timer is engaged. This disables the vacuum advance at idle and runs the part-throttle vacuum advance through a delay valve for 15 minutes. If the coolant temperature is above 45°C when the engine is started, the coolant temp switch is open and the timer is not engaged. 38°-45°C is the "dead band" of this switch -- whether it's closed or open depends on which way the temperature is changing.

The timer itself is reportedly unreliable. Tony Bryant: "If anyone has a dead timer, it's probably due a blown up chip. From memory it a CMOS hex inverter chip with a floating input pin. Floating input pins on CMOS are just begging for a blown up chip. I replaced it with the 74HC equivalent, and tied the unused input to ground - before I ditched the whole system."

15 MINUTE TIMER -- DITCHING: The 15 minute timer apparently causes really bad fuel economy during those 15 minutes, especially aggravating for owners whose driving patterns happen to have them within those 15 minutes most of the time they are driving. Craig Sawyers says, "Admittedly, the V12 is thirsty, but a certain amount of that is to do with the 15 minute timer on the vacuum advance. Before that cuts in I get 14 (UK) mpg. When it cuts out it comes back to 19-20." Mike Morrin says, "My weekday commute is only 3.5 miles each way, the thermal switch operates after about a mile and totally disconnecting the 15 minute circuit gave me a 2 MPG overall improvement."

If you're sick of using so much fuel, disconnect the timer! The car will run just fine with full vacuum advance when cold, it just won't warm up as quickly. Since the timer energizes the 3-way solenoid valve, the 2-way solenoid valve, and the supplementary air valve (see page 284) and de-energizes them when the 15 minutes are up, you can merely disconnect the wires from the timer or the coolant temp switch and the car will never lack vacuum advance again. Mike Morrin says, "The easiest way to disable it is to just pull one of the wires on the thermal switch on the LH rear water rail." This is obviously easy enough you can try it and see if you like it.

Once you decide to make it permanent, you can make things neater by removing all of those valves and plumbing up the vacuum advance system with the same routing that existed when they were de-energized. You can also trashcan the timer itself if you want, and replace the coolant sensor with a plug.

The 2-way solenoid valve and the 3-way solenoid valve are involved in killing the vacuum advance at idle during cold starts, but the purpose of the supplementary air valve is to boost the idle RPM to compensate for the lack of vacuum advance. Disabling the cold start solenoid valves theoretically eliminates the need for this idle boost (the Auxiliary Air Valve is designed to deal with the cold engine), but if you find the car idling too slowly when cold you might consider leaving the supplementary air valve connected and disconnecting the solenoid valves only. In this regard, this system may serve as a patch for a weak or deteriorating AAV (see page 245).

The only problem with disconnecting this system is how long the engine takes to warm up. The vacuum advance makes the engine run efficiently, so it doesn't generate as much waste heat. Killing the vacuum makes the engine inefficient so it generates a lot of waste heat and warms up quickly. Richard Mansell says, "I disconnected mine recently and found that it seemed to take a lot longer to warm up. It is now reconnected. I may disconnect it again for the summer (if we actually get one this year)." Awwww, little Ricky's gotta have his heater working!

Sawyers suggests a compromise: "If you unplug the timer and link together the grey and pink/white wires, this connects the 45°C switch directly to the valves. So the valves will operate until the engine reaches 45°C and then switch off. I did this with my brother in law's XJS when his module blew." This is a really neat fix, since it means the car will get to 45°C in a hurry and then get good fuel economy from then on.

Of course, 45°C isn't all *that* hot, so the heater will still not be working as well as some might like. So, there are other possible fixes. The most obvious would be to replace the coolant temp switch with something with a higher cut-out

temp, like 70°C. It must be stressed that the switch really needs to cut out *before* the thermostat temp is reached; otherwise, there's a chance that the idle vacuum advance will *remain* disabled indefinitely!

Another idea would be to leave the timer in place but shorten that 15 minutes to something more reasonable like 5 minutes. Sawyers describes how to modify the OEM timer: "The counter is a 14-bit binary counter. The most significant bit is used to trigger the valves. So you can select a delay of 7.5 minutes by reconnecting diode D1 internally to pin 2 instead of pin 3 on the MC14020 timer chip. Or if you connect to pin 1, you get 3.75 minutes. You can get intermediate times by changing the oscillator frequency. This is set by the values of either C3, or R6/R7. The timing is in inverse proportion to the parallel combination of R6 and R7, and to C3. So halving the value of either will double the time, etc. For instance, changing R6 from 820k to 470k (leaving other components unchanged) will reduce the time from 15 minutes to 9 minutes." Of course, you could just try to find a replacement timer instead of getting into the schematics.

When considering shortening or eliminating the vacuum advance disable, one must consider its original intention. Unfortunately, there's no telling what that was. It looks like an emissions feature and in fact is part of the scheme called "B Emissions", but the UK and Europe supposedly had no emissions requirements at all when these cars were built. It could be argued that its purpose is to get the engine warm quickly to minimize wear, but one would have to remember why a cold engine has high wear: there's too much fuel running through it. Since this system clearly increases the amount of fuel running through it, it's questionable whether it does any good in that regard. All in all, the entire purpose of this system may be to make the heater work as quickly as possible. That's an expensive heater, especially since this thing provides 15 minutes of lousy fuel economy even in *warm* weather.

VACUUM ADVANCE MODULE -- PRE-H.E.: Mike O'Neill noticed that the vacuum advance module from an MGB will fit the pre-H.E. distributor. However, John Nuttall found that the MGB advance unit -- as well as some units for Triumphs -- look similar and will fit, but provide differing amounts of advance at different vacuum levels. So, if your engine is largely stock and you want to keep it that way, you probably should seek a Jaguar advance unit. On the other hand, if your engine is not stock and you need to provide nonstandard amounts of vacuum advance, this provides some places to look. Also, these units might provide materials for rebuilding your old vacuum advance module in much the same way Napoli used a Chevy part in the procedure described above.

VACUUM RETARD: According to the article "Advancing by Vacuum" by Roger Bywater in *XJS Bulletin* Issue #1, a vacuum retard module is typically connected to a throttle edge tapping on the *inward*-opening side of the butterfly. Hence, vacuum is applied at idle, but as the throttle is opened the edge of the butterfly passes over the port so it sees ambient air pressure. The system therefore provides a few degrees of retard at idle, but does nothing at other throttle positions. This helps make the engine idle better, since some engines have trouble igniting the charge at high vacuum; according to Bywater, the carburetted V12's fit into this category. By waiting until the piston is closer to TDC, the charge is more concentrated and compressed when the spark occurs. Obviously, such a retard scheme would help emissions at idle by ensuring good ignition.

Ian Macfarlane, regarding his 1985 XJ-S: "In Australia the distributor has a retard connection on the vacuum module which is supposed to operate for about 15 min. after starting via a solenoid valve. But the wire leading to the solenoid valve had been cut (as had the wire to the solenoid air switch). Thus, even though the distributor timing was correct with the vacuum tubes disconnected, the engine ran at about 6 deg retarded under normal conditions."

"Although this would not exactly apply to other emission systems it is another option for those with an overheating problem - if the vacuum system was not working properly it is feasible that overheating could occur due to retardation."

CENTRIFUGAL ADVANCE - SEIZING: At this point in this book, I used to report how the pre-Marelli Jaguar V12 centrifugal advance was highly prone to seizing. However, with more and more readers reporting back, I can say with relative certainty: Unless your distributor has been overhauled, *it is seized right now*. Period. This has proven to be a 100% failure rate, every time, every car, there simply is no doubt anymore. And a seized advance unit results in low power, overheating and major engine damage if not corrected. If you are not absolutely positive that your distributor has

been overhauled already, it is imperative that you schedule an overhaul as soon as possible -- and drive the car very gently or not at all until it's done.

Folks, this is probably the single most important item in this book. Centrifugal advance seizure may be the cause behind most of the problems the Jaguar V12 has -- overheating, dropped valve seats, etc. -- and the reason behind most owner dissatisfaction, low resale value, Chevy engine swaps, you name it. Is there any way I can convince you, the XJ-S owner, to take action *now*? If it'll make you feel better, give me a call, I'll tell you in person: Overhaul the distributor *NOW*.

Sad to say, reports are that this failure mode -- notorious as it is -- is *not* widely known among Jaguar dealers and mechanics. Despite the frequency of charging customers \$10K for a new engine, it has never occurred to many of these shops that the engine failures were preventable. Some people have reported that their Jaguar dealer overhauled or replaced several unrelated components before finally figuring out that the centrifugal advance was seized. Others *never* figured it out. Perhaps their fancy diagnostic computers don't blink "centrifugal advance seized". Perhaps they just like collecting those fees for new engines. Whatever, keep in mind that just because you have had your car "checked out" by the dealer doesn't mean you don't have the problem. It's not even a certainty that the advance is OK if you specifically asked them to check it; some of these mechanics don't even know how to check it. For those who have mechanical abilities, it is highly recommended that you check your centrifugal advance yourself, or better yet simply go ahead and overhaul it. If you aren't the type to get your hands dirty, it probably would be money well spent to have an independent shop confirm the first shop's conclusions.

John Napoli confirms this: "I know or deal with about a half-dozen repair shops. Some are run by friends (no chicanery ever) and the others, including my local Jag dealer, are pure business relationships. None of them ever heard anything about the chronic Jag problem of seized centrifugal weights. Not even the Jag dealer, although maybe they do know and don't tell. I'll go further and say that no Jag owner I've encountered has ever heard of it, either. You get these strange looks when you bring it up ("If I don't know, then it can't hurt me."). I find it hard to believe, but it looks like a lot of the information regarding the idiosyncrasies of these cars never reaches the people who can use it most. Perhaps this is part of the reason why so many Jag owners have bad experiences with repair shops."

The usual indications of a seized advance mechanism are an XJ-S that lacks power at higher RPM and a nasty tendency to overheat. In some cases, when the throttle is backed off suddenly there is a brief power surge before decelerating. If your car doesn't have the performance at higher RPM that it should, check the advance mechanism immediately; a distributor seizure is easily fixed, but warped blocks, dropped valve seats and burned pistons are much more expensive and are the inevitable outcome of continued operation.

To confirm for yourself that your advance unit is seized, remove the distributor cap. Attempt to turn the rotor counterclockwise. If operating properly, you can easily turn it about 11° (H.E.) or about 13° (pre-H.E.) against a spring. Note that this thing should feel really loose and ratty, and when you twist it and let go it should snap back with a metallic clink; if at all sticky or gummy-feeling when turned, time to overhaul. The forces that move this thing are balanced against each other, so a very slight difference is supposed to make it move; while the springs may seem mighty strong when you're fiddling with them, even a slight amount of drag or stickiness is enough to keep it from moving as it should. It may be movable by hand but not as far as it should or not as freely as it should. Unfortunately, in a book such as this it is difficult to convey adequately how to tell that an advance is gummy until a person has felt a properly-operating advance for themselves. This might be an excellent topic for a monthly Jaguar club meeting -- to have someone who knows what the advance should feel like check every V12 that shows up. Of course, if totally seized, the problem is obvious; you cannot move it at all except for backlash in the drivetrain.

Another method of checking for a seized distributor is to compare the timing (with the vacuum line to the distributor disconnected and plugged) at 2000 RPM with the timing at idle (under 900 RPM). The two readings should differ by at least 12° (H.E.) or at least 22° (non-H.E.). If they are the same or very close, the centrifugal advance is seized. If the advance at 2000 RPM is more than a couple of degrees different when you come *up* to that RPM from idle than it is if you come *down* to that RPM from 4000, then the advance is sticky; overhaul it.

OK, SO IT'S SEIZED -- NOW WHAT? To prevent/correct a seized centrifugal advance mechanism, it's necessary to overhaul the distributor, clean out all of the original lubricant, clean up the parts, and reassemble with a reliable

lubricant. Roger Bywater says, "Most of them probably run for years without the cap being lifted so by the time anyone does get round to it the spindle is likely to be running dry and getting built up with debris. Adding lube at that stage may well loosen the debris and aggravate the situation so really it needs complete stripping to ensure that it will not jam at some future time." Bywater, having worked for Jaguar, can be expected to blame the seizures on poor maintenance -- and perhaps he's correct. I personally suspect the original lubricant used at assembly was lousy, based on what the stuff looked like when I got my distributor apart! It really doesn't matter what the cause; either way, the distributor has to come apart.

Of course, you don't have time for overhauling. You will probably want to try the easy fix: Remove the distributor cap and rotor, and put some penetrating oil down the center and see if you can work it loose. If you are successful, it is recommended that you check its operation regularly -- or better yet, just go ahead and overhaul it when you get the chance. The results of operation with a seized centrifugal advance are simply too costly to ignore.

This is one place where getting a *new* part will probably not help. There is little wear in the distributor, and an overhauled and properly lubricated used part can be expected to last the life of the car. But a *new* distributor may have the same problem as the original distributor did. It is recommended that even a brand new in-the-box distributor be overhauled prior to installation (to get that lousy lubricant outta there).

The good news: The reported incidence of centrifugal advances seizing *after* they have been overhauled is nil. This may be because the original grease is the problem, and once it's removed the problem goes away. It may simply be because once the overhaul has been done the owner understands what's going on and lubricates it regularly. Whatever, once the distributor has been overhauled, there is apparently no reason to expect to ever have to do it again.

Randy K. Wilson points out that the problems with seized centrifugal advances on pre-H.E. engines may actually be different in nature. "From what I've seen the gummy advance problem is unique to the V12 H.E. distributor. Earlier distributors also had a problem with seizing, but these galled from a total lack of lubrication." Of course, this could mean that the H.E. only gets hot enough inside the distributor to turn the lubricant to varnish while the pre-H.E. got hot enough to burn the lubricant away entirely. Or, it could mean that Jaguar added grease to the assembly in response to the dry seizures, and the grease caused its own seizures.

DISTRIBUTOR REMOVAL: If the centrifugal advance is seized, or if you wish to prevent seizure in the future, the distributor should be removed and disassembled. It's not difficult, but it will help to read the following sections thoroughly *before* tackling the job.

Note: If you prefer, it is possible to rebuild the centrifugal advance mechanism with the distributor in place. It's easier to take it out and do it on the bench rather than leaning over the fender, though.

Before removal, care must be taken to ensure the distributor can be reinstalled with the gears meshed correctly so the rotor faces the same direction as before. If the crankshaft is not to be disturbed, this is very simple: Note the position of the rotor prior to removal, so you can be sure it is in the same position when reinstalled. It's a gear mesh and one tooth off would be obvious, so just note the position well enough you can make sure you are on the same tooth when reassembled.

Note: If you have the older Lucas OPUS ignition system, you are advised to position the engine at TDC on cylinder 1A, which is where the timing marks on the crank pulley line up *and* the rotor is pointing at the front left headlight. If the rotor is pointing at the right side door, you need to turn the engine around one full turn. The reason that this is important is that the OPUS has a wheel within the distributor that has three slotted holes that line up with the distributor mounting bolts in this position. Even if you can get it off without moving to TDC on 1A (by busting up the plastic wheel, for example) you're still gonna be in a pickle putting the rebuilt distributor back on without tearing it back apart or turning the crank while the distributor is out.

If you turn the crankshaft while the distributor is out, you face additional problems. The distributor turns once every time the crankshaft turns twice, and therefore the distributor must not only be lined up facing 1A while the engine is at 10° Before Top Dead Center (BTDC) but it must be on the correct stroke. If not, the spark plugs will fire at the end of the exhaust stroke instead of the compression stroke, and the motor will not run.

To get the setting right, cylinder 1A must be on the compression stroke when the distributor is installed pointing to 1A on the cap. If you know in advance you may be turning the engine, it is easy enough to avoid problems. While the distributor cap is off and the rotor is pointing at 1A and the crankshaft is at 10° BTDC, remove the oil filler cap. Reach beyond the front edge of the chain and mark the camshaft gear itself (the camshaft gear turns at the same rate as the distributor). You can use a dab of paint, or stake it, or whatever will give you a clear indication.

You might also want to mark the position of the base of the distributor, since it mounts on slotted holes. Ideally, the base should be mounted so the correct timing is near the center of the range of the eccentric adjuster, but to begin with it will be easier to put it back where it came from. Peter Smith: "I find that using typist's white out to paint across components can be helpful. It can be applied over slightly greasy surfaces and if precise alignment is necessary I can draw on it with a biro."

You can insert an allen wrench through the openings in the distributor and undo three screws and remove the distributor as a unit. However, for the purposes of doing the marking mentioned above, it may be preferable to proceed with the disassembly described below with the distributor still on the engine until you've removed enough parts to be able to mark the bottom of the housing on the inside.

DISTRIBUTOR DISASSEMBLY: Remove the rotor arm; see page 121.

Remove the EFI trigger board or anti-flash shield (whichever). The biggest problem with removing the anti-flash shield will be dropping the tiny screws and washers, but the trigger board causes more trouble. It is mounted with four tiny plastic screws, and Jan Wikström reports that the screws get stuck to the metal; "On my own experience of three distributors, you can expect to get two out intact. If you're *very* careful." He also reports that he has used metal screws in a pinch with no apparent problems. When installing the plastic screws, maybe it would be a good idea to use anti-seize compound, even though it looks silly on tiny plastic screws.

Richard Dowling dealt with the trigger board screws differently: "I think they were a puny 6BA or similar and I retapped the holes to M4 (about 2 times stronger) and fitted bigger nylon screws."

Next, remove whatever is used to trigger the ignition; on 1982-89 cars, you need to remove a C-clip, then slide off a wavy washer, then pry out a U-shaped pin. Finally, you need to slide off the iron star-shaped inductor rotor, being careful not to damage it or deform the points. Even more importantly, don't just pull upward on a sticky star rotor, because you may stretch the springs in the centrifugal advance mechanism underneath. Here's a method that seems to work: Lift gently on the star rotor a little bit and insert the claw of a claw hammer under the star rotor. Rest the head of the hammer on the edge of the distributor housing, but *do not pry*. While holding the star rotor in its slightly elevated position with the claw hammer, tap downward on the center of the rotor carrier shaft with a plastic-surfaced hammer. Once the end of the rotor carrier shaft is flush with the surface of the star rotor, if it still won't simply slide off you can position a small socket with an OD slightly smaller than the rotor carrier shaft on top and continue tapping.

On the pre-1982 cars, a plastic disk with 12 ferrite inserts was used; according to Jan Wikström, "Its hub is about an inch long (estimated; I've never seen an intact one) and all beneath the disk. It's a tight fit on the spindle and in its keyway. And the disk, which is all you have to apply force to, is about 3/16 in thick near the hub. On an old car like mine, the only way to get the disk out would be by breaking it up."

Fortunately, John Nuttall found a better way: "I discovered a technique for removing the circular plastic timing rotor which, according to Jan W in your book, often breaks under extraction. The idea is to undo the three screws which hold the movable part of the distributor body to the base. This can be done with the rotor in place. These screws have springs on them to allow the body to rotate when the vernier is turned. It is then possible to push upwards on the rotor with the body with the force being applied uniformly very close to the central shaft of the rotor - much better than pulling at the edge."

Unfortunately, Wikström counters: "It's better than fingers, although it still bears on the thin part of the disk outside the hub. But sure, it's worth trying before you break the disk up. One hitch: If you don't have the distributor with the little screw inside the top of the shaft, lifting the micro housing (charming name, isn't it?) will pull the centrifugal advance mechanism apart without shifting the disk." And stretch your advance springs beyond recognition. If you can't rely on the retainer to hold the rotor carrier shaft still, you must press down on the center shaft with your thumbs while pulling

up on the housing to get the disk off. Maybe some method involving tapping with a plastic-faced hammer will work here, too.

Whichever distributor you have, you must remove the three screws with springs and lift off the movable portion of the base to gain access to the centrifugal mechanism below. You could leave the pickup assembly in place, but on the 1982-89 it's in the way for getting to one of the screws with springs; since it's only two Pozidriv screws to remove the pickup assembly, that's the easy solution. Of course, it's a good idea to inspect the vacuum advance mechanism as well as the pickup module while you're there.

Note how the centrifugal weights and springs are installed. Being careful not to stretch them, disconnect the springs from the pivot posts for the centrifugal weights; Carlos Artal says, "Use a piece of strong, thin string (such as fishing line, etc. -- I used dental floss) to take away the springs without damaging them or overextending them. It works for mounting them too. Just get one extreme, and pull slightly outwards and up." You don't have to disconnect the springs from the posts on the rotor carrier base plate if you don't want to; you can just let them dangle. Yes, the two springs are different, but it doesn't matter which one goes on which weight.

Remove the felt from the top of the rotor carrier (if there is any) and observe the retainer underneath. This is a possible cause of trouble. The early cars had a screw there, but on later cars there's a nylon clip instead. The nylon clip is usually brittle and cracked, sometimes allowing the rotor carrier to rise on the distributor shaft and possibly causing interference damage down in the advance mechanism. If you don't have a screw, the procedure for removing the rotor carrier is to yank, which usually results in breaking the nylon clip.

Normally the rotor carrier shaft should slide off the distributor shaft at this point, but if it is seized some Liquid Wrench or other measures may be called for. Please try not to bend the distributor shaft -- it is remarkably thin within the rotor carrier. And don't grab the rotor carrier shaft with pliers or vice grips -- the metal isn't that hard, you'll booger up the surface, and then it will be difficult to get the plastic wheel or star wheel back on. Once apart, clean all the crud off the bearing surfaces. Decide for yourself whether Bywater or I am right, whether it seized due to lack of lubrication (dry) or a lousy lubricant (gummed or varnished).

There are photos of some of the parts within the distributor at:

<http://www.jag-lovers.org/xj-s/book/Distributor.html>

DISTRIBUTOR SERVICE KIT: A distributor service kit, part number DZB105, is available; it is often called an "anti-flash shield kit" since the anti-flash shield is the most obvious part in the bag. The kit contains parts usable on all pre-Marelli distributors. Stefan Schulz points out: "It's a Lucas part number rather than a Jaguar one. My friendly not-so-local Jaguar parts man couldn't find it on his system."

The mail order catalogs may not list what parts are supplied in this kit, so the list is provided here:

- Clear plastic anti-flash shield (used on 1982-89 only)
- Screws and washers for anti-flash shield (4 ea)
- Ignition pickup mounting screws (2 ea - used on 1982-89 only)
- Distributor cap gasket
- U-pin for reluctor positioning (used on 1982-89 only)
- Reluctor retaining clip and wavy spring washer
- Replacement carbon contact for distributor cap, with spring
- O-ring for distributor-to-engine joint
- Nylon rotor retaining clip (see note under DISTRIBUTOR DISASSEMBLY above)

It may not really be necessary to obtain this kit to perform a distributor overhaul. The O-ring can easily be purchased locally, and you'd be well advised to find a Viton one anyway. The rotor retaining clip, while not likely to survive disassembly, can be replaced with a couple of small washers and a tiny O-ring -- see CENTRIFUGAL ADVANCE REASSEMBLY below. The existing anti-flash shield, screws, cap gasket, U-pin, retaining clip, wavy washer, and carbon contact may all be reusable -- and if not, screws and washers can be purchased separately, a gasket can be

purchased separately from Jaguar (DAC4063) or cut from gasket stock, and a carbon contact can be pilfered from some other type of distributor cap.

In fact, the only part of this kit you're likely to really need is the anti-flash shield itself since the old one may be brittle and cracking. You could try buying it separately from Jaguar; it's part number AEU1722. Or you could try fabbing a flat disc from clear plastic and installing it with four long nylon screws and some nylon nuts to support it at the same level as the top of the original shield; you might drill the four holes in the housing out and tap them larger to permit using stouter nylon screws. You could try fabbing a shield from the bottom of a plastic container of some sort, again finding a way to hold it in place without creating an electrical path to ground. Finally, you could just omit the anti-flash shield entirely, since it's plausible that it's entire purpose in existence was to provide a purpose for the four screw holes that were originally intended to hold the trigger board on D Jetronic cars.

DISTRIBUTOR SHAFT SEAL: The Jaguar V12 distributor has had two common problems, centrifugal advance seizing and cracking distributor caps. Both of these problems have been attributed to crankcase vapors entering the distributor between the shaft and the housing. Supposedly the vapors condense into the type of varnish found inside engines, seizing the advance mechanism. Vapors collecting within the cap are ignited by the arcing of the distributor and cause an explosion which cracks the cap.

Both causes are in question. Hard deposits that seize the advance may very well be the original lubricant exposed to too much heat. And Jaguar's reported reason for venting the later distributor caps was to deal with high temperatures that caused the caps to crack, although clearly the vent system could also remove collecting vapors. It is noteworthy that the later, vented distributors are still prone to advance mechanism seizing, and the still later Marelli distributors are vented even though they have no advance mechanisms to seize. And the real source of the explosive vapors is the incompetent mechanic who has addressed a seized centrifugal advance by spraying WD-40 down the center of the shaft, which spun out and was ignited on startup and blew the cap apart.

There is a seal between the shaft and the distributor housing, but it gets hard and brittle, probably due to the heat in this area. If the distributor is being worked on, it might be a good idea to replace this seal. Note that removing the distributor drive gear retaining pin requires some grinding, and reinstalling the pin requires a tack weld to hold it in place. There's a bearing in there, too, you might wanna renew it while you're there.

RATTLY PARTS: Richard Chapman had another problem: "The pressed connection between the rotor shaft and plate where the springs connect was loose. I brazed it very carefully and that made the timing reading stable rather than flickering." This is not a rare occurrence; be sure to check your rotor carrier for looseness before reassembly.

THINGY: Highly technical term referring to a specially-shaped plastic thrust washer at the bottom of the rotor carrier shaft, just below the centrifugal advance weights. It has ears on it that appear to provide an inner stop for the centrifugal weights, apparently to reduce noise but effectively limiting how retarded the timing moves at idle. It's also a British non-metallic part, so it may be cracked or broken. Note: If you have the early distributor held together with a screw under the rotor instead of the nylon clip, you don't have a thingy and don't need one.

If you're lucky enough to have an intact thingy, you need to take care to reinstall it properly during reassembly. If you just look at it and line up the notches with the "wings" on the cam plate on the bottom of the rotor carrier shaft, there's a better than even chance you will have installed it wrong. There is a pair of pins on the thingy that hold it in position relative to the cam plate, and the correct position of these pins is shown in **Figure 9**. Note that for clarity the thingy itself is not shown, only its pins.

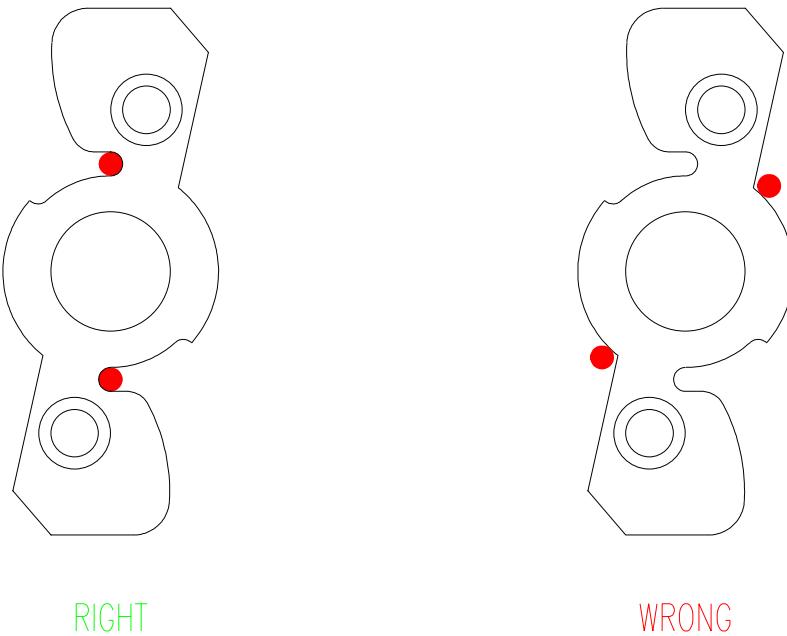


Figure 9 - Locating the Pins on the "Thingy"

If your thingy is toast, bad news: This part is apparently unobtainable. It's not included in the DZB105 kit. One frustrated owner reported: "I phoned Lucas Aftermarket Operations, Parts and Service (note: See page 655). Apparently, they have routine service parts which are readily available at most dealers, other service parts which they can provide part numbers for and which are often available, and then there are non-service parts which of course the thingy and the seal fall under. The parts did not show up on his drawings although he did have DZB105. He could see the shaft bearings in the drawing, but no seal and no plastic thingy. I asked what happens to parts that are not on their drawings anymore. I was advised that once it is not profitable to sell replacement parts, they are removed from the aftermarket listing and so, to Lucas Aftermarket the part numbers are no longer available. He told me that the part numbers could only be obtained from the factory drawings once they were declared non-service parts. He also advised that they factory would not talk to me about this because that is what Lucas Aftermarket is for. So, Lucas Aftermarket is apparently the only information source Lucas has for part numbers and they do not have these parts listed anymore."

You're screwed. The only option -- and it's a perfectly workable one -- is to install a generic 5/16" ID flat thrust washer in place of this thingy. Val Danilov adds "I wouldn't use any washer there larger than 0.5in OD, as it may interfere with the weights." The thrust washer also needs to be at least .060" thick, although if thinner you could merely stack two in there; the ideal thickness is around .078", but you could probably install anything up to about .120" without any problem. The loss of the inner stops for the centrifugal weights will evidently allow the timing to retard a fraction of a degree more at idle than before (timing is set at 3000 RPM, well out of the influence of this thingy, so timing anywhere except idle will be unaffected). There also might be some noise at idle with the weights hitting the metal shaft instead of the plastic stops, although how you would ever hear it above the general din of the engine idling is simply inconceivable.

Plastic, brass or bronze will work nicely; steel might gall against the other steel parts, and aluminum or copper may be too soft and wear quickly. Danilov doesn't like the idea of plastic, since this is the type of application where choosing the wrong plastic will result in a part that gets hard and cracks with age; he found a porous bronze thrust washer at an Ace hardware store with the 1/2" OD and was able to drill out the ID to the correct size. This sintered bronze bearing material is ideal, since the entire purpose of the material is for use as a bearing between steel parts. Another idea would be to buy a 5/16" ID - 1/2" OD bronze sleeve bushing and slice a suitable ring off one end of it

(if you find a place that sells them, you might want to pick up a couple more such bushings; see the section on throttle linkage bushing replacement on page 249).

CENTRIFUGAL ADVANCE REASSEMBLY: *Do not* grease the sleeve bearing area between the rotor carrier shaft and the distributor shaft before reassembly; this bearing should be lubricated with *full synthetic* engine oil *only*. Steve Holst shared his experience with the xj-s@jag-lovers.org discussion list: "I can vouch for having no grease put in the rebuild. I had my distributor rebuilt by my previous Jag mechanic before I knew of this list. About two years later it was seized up again. It didn't take long before that grease was gumming things up again. I have a feeling that most Jag mechanics assume that slathering on the stuff is the way to do this job. I cleaned it out myself that time and haven't had a problem since."

It is recommended that the pivots for the weights be lubricated with dry graphite only. The ends of the springs and the contact surfaces all the way around the cam plate on the bottom of the rotor carrier shaft may be lubricated with a high temp light grease such as automotive contact grease, but make sure not to apply so much that there is any conceivable way you could cause a seizure if this grease hardens. An unnamed source on the MG discussion list says, "Dupont makes a line of synthetic greases under the Krytox brand name which use a PFPE (perfluoropolyether) oil thickened with PTFE (Teflon). It is rated for continuous use up to 260°C and down to forty below zero and is chemically inert, so it won't react with anything which may come into contact with it (gas, liquid or solid). I think the GPL-225 would probably meet your needs, but something thicker (GPL-226) might be good, too. You should be able to get a 'sample' tube of this stuff for about \$10 or less. Check out:

<http://www.lubricants.dupont.com/>

Finding a replacement nylon clip apparently requires buying the entire service kit (see page 135), which you might want to consider anyway. However, considering the clip's failure tendencies, you may decide not to use it. It has been found that an excellent method to retain the rotor carrier is to insert a couple of small metal washers that fit within the carrier but around the top of the shaft, followed by a tiny, chubby O-ring. Snap the O-ring into the groove on the top of the shaft so that it retains the washers in place, which in turn retain the carrier. David Johnson says, "I found a #61 O-Ring at Home Depot was a perfect fit in the groove. It has the following dimensions: 9/32" x 5/32" x 1/16". The O-Ring has a slightly smaller diameter than the top of the shaft. When you get it on it seems to stretch until it is a perfect fit for the groove." For owners in the UK, Carlos Artal says, "The O-ring can be found in the generic O-ring packet they sell at Halfords. There are 2 boxes, one with large rings and one with small ones ; in the small O-rings one, there's a perfect sized O-ring." It might even be a good idea to try to find a Viton O-ring in this size, although since sealing isn't the issue and you'd be willing to buy a new O-ring whenever you take the distributor apart perhaps you don't care if it gets hard and brittle.

Another suggestion: Roger Bywater says, "Pulling the spindle apart invariably destroys the plastic retainer at the top but we find a small push on trim lock washer works just as well."

The washers need to have an OD less than 13/32" (10.3mm) but larger than 5/16" (7.9mm), and the ID needs to be at least 3/16" (4.8mm). Brass washers would be ideal; you don't need yet another source of rust in this assembly. Johnson says that Home Depot's 5mm plain zinc washers fit perfectly. "They are in the pull out boxes and not hanging on peg hooks. 4 per bag."

If these parts are installed properly the carrier should have a slight amount of up and down play, but if excessive there is the possibility the rotor carrier shaft might be able to slide up far enough to disengage the pins on the thingy down below. If the thingy moves while thus disengaged, the rotor carrier shaft might come back down and crunch it. This is unlikely to happen while running, but it might occur when somebody is trying to replace the rotor. To avoid the problem, install at least *two* washers under the O-ring. Better yet, do some trial fits while apart; first, try just the O-ring and washers on the distributor shaft to see how many will fit, then trial assemble the rotor carrier shaft, thingy, washers and O-ring without the centrifugal weights in the way and see if the pins on the thingy remain engaged when the rotor carrier shaft is lifted. When through with the trial, it should be possible to simply pull the rotor carrier shaft off, popping the O-ring without damage, but just in case it'd probably be a good idea to have a couple of spare O-rings on hand for such trials.

Once the rotor carrier shaft is in place and retained, you can connect up the centrifugal advance springs. On the heavy one, it is recommended that the elongated end be positioned on the outward post that a weight pivots on rather than the inward post on the rotor carrier shaft baseplate. It might not make any difference, but it'll make sure the tip of the spring doesn't touch the side of the rotor carrier itself. It'll probably be easier to assemble this way, too.

If there is no felt plug in the top of the rotor carrier shaft, install one -- or just jam a cotton ball in there. Something needs to hold some oil.

DISTRIBUTOR OVERHAUL -- PAY SOMEONE ELSE VERSION: Jeff Elmore points out that British Car Service (page 656) will overhaul your distributor for you. "I called them and they said that they do the whole seals, bushings and new springs. They said that they have an assortment of springs and they keep trying until they get the right advance curve."

DISTRIBUTOR INSTALLATION: Since you read this book first and marked the parts correctly, installation is a snap. If the crankshaft has not been disturbed, reinstall the distributor with the rotor pointing in the same direction it was before removal (Note: Correcting a seized advance mechanism may make the rotor point *slightly* differently, but it's real close. You'll know if you miss by one tooth on the drive gear). If the crankshaft was turned, remove the oil filler cap, turn the engine until 10° BTDC and the mark you made on the sprocket is showing, and install the distributor with the rotor pointing towards the 1A contact on the cap.

If you didn't plan ahead and the engine has been turned, it is not so easy. If you just take a blind shot at this you only have a 50/50 chance of getting it right. There is a mark on the jackshaft, but the jackshaft turns at the same rate as the crankshaft, twice the rate of the distributor, so that mark is of no help.

To ensure correct positioning, the 1A spark plug can be removed and the engine turned over with a thumb over the hole; the compression stroke can easily be determined. However, getting the 1A plug out and a thumb over the hole is difficult on the H.E. (it's much easier on the pre-H.E.). You might try Bob Egerton's bubble trick described in the section on timing starting on page 121. There are also whistles sold that can screw into the plug hole to report when you're on the compression stroke.

Craig Sawyers says, "...look down the hole. If it is on exhaust, you can just see the exhaust valve if you shine a light down the hole. If it is on ignition, you won't see any valve (they'll both be shut.)"

Mike Morrin says, "There is an easier way. Set the engine to TDC according to the mark on the crankshaft, get a short length of hose which will seal up against the spark plug hole, and blow into it. On the compression stroke, you should go red in the face."

Alternatively you can check cylinder 6A (right rear cylinder), which may be easier for any of the methods described above. This cylinder fires exactly one complete crankshaft rotation before and after 1A. Therefore, you can find the top of the compression stroke on 6A and then turn the crankshaft through one complete turn. Or, you can leave it there and install the distributor such that the rotor points to the 6A contact instead, exactly opposite the 1A contact.

To place the distributor housing in the right place on the slotted holes so the vernier adjustment has a usable range, merely align it with the marks you made before you took it out. You didn't mark it? Tsk, tsk. Read on.

Michael Neal claims, after working on these cars daily, that the optimum location of the distributor body on the three slotted holes is always the same. The correct position "is with the distributor body set at 3.5 degrees retarded at the adjuster. The centerline of the rotor will be 75% past the No. 1 line on the inner shield. The slots for the holddown allen bolts will be 2/3 past the allen heads. The tooth on the pickup will be roughly 5 degrees past the center of the pickup point. Note that the distributor turns anti-clockwise. This setting will give you near perfect timing almost every time with adjustments both ways. Other settings tend to give too much retard or advance with no adjustment."

PREVENTING THE DAMN THING FROM SEIZING AGAIN: After you've overhauled the distributor and fixed the seized advance, the rotor carrier/distributor shaft interface must be lubricated regularly; the Lubrication Chart in the ROM says two or three drops of clean engine oil in the felt under the rotor every 6,000 miles (every oil change - no, Quickie Lube is *not* likely to be doing this!). This is not easy, as it requires removing the distributor cap, which in turn requires removing the cruise control unit and all the ignition wires. This lubrication procedure is obviously very important; it is recommended that owners do it themselves, or make very sure their mechanic isn't skipping this part of the maintenance. Jan Wikström suggests installing a new felt pad, then taking it in for service. If the pad is dry when checked afterward, cease doing business with that shop. Perhaps good advice, but has a significant probability of eliminating every shop in the area from consideration!

Note that many XJ-S distributors don't seem to have any felt. Considering the known problems here, it'd probably be a good idea to put some in. Or, just a wad of cotton.

Since the seizing appears to be caused by the lubricant getting baked, normal "clean engine oil" might not be the best idea. I recommend that a synthetic engine oil be used, since it won't tend to varnish or sludge and withstands higher temperatures without breaking down. Soak the felt or cotton thoroughly every time you're in there, and make sure you're in there often enough. It might not need to be as often as every 6,000 miles -- especially if you're using synthetic motor oil -- but it's better to be safe than sorry here, so make sure you do it often until you personally have confidence that you can go longer between oilings without the thing drying out or gumming up.

It is suggested that spray lubricants of the flammable variety be avoided within the distributor. When running, there are sparks between the rotor and the electrodes in the cap; vapors will be ignited upon starting, ruining your day.

DISTRIBUTOR CAP REPLACEMENT: Randy Wilson has a low opinion of the aftermarket products, and recommends buying only the genuine Lucas parts: "The last time I checked, there was only one aftermarket cap available. I ordered in a lot of them... and every single one was defective in one way or another. Missing center buttons, missing vent tubes, pre-cracked, molded oval... Flimsy pieces. They're about 1/3 the price of the Lucas pieces... and not worth it." Note that the author has also purchased one of these aftermarket items, and in fact had trouble with the vent tubes simply falling off. Rendering it usable required careful application of JB Weld.

Jason Korke says, "I have found when I installed a replacement cap & rotor from "Standard" brand, they worked OK but the vent tubes broke off. I reinstalled the Lucas cap, and found no spark! Eventually I found the Standard cap & rotor will work and the Lucas cap & rotor will work, but do not mix the two brands."

DISTRIBUTOR CAP VENTING: The 82-89 distributor cap has two fittings for a positive ventilation system. Air is drawn through a small filter, through the distributor, and into the engine side of the air filter housing. The filter is normally found laying against the left wing at the crossbrace attachment, and sometimes concerns owners because it appears to have been disconnected from somewhere.

Reportedly this system was incorporated because the earlier distributor caps were cracking due to excessive heat, although some suspect removal of flammable vapors was the real reason -- see comments under **DISTRIBUTOR SHAFT SEAL** on page 136.

The connection to the air filter housing is not actually to the housing directly, but rather to a hose between the housing and the auxiliary air valve (see page 245). This is therefore a special molded hose with provision for a tiny fitting. The fitting itself is a plastic elbow, and is often found to be broken. It is not too difficult to find a suitable replacement, though, and you might even find a brass one. Or, you can forget the whole thing and install a generic piece of hose between the air filter housing and the auxiliary air valve, and install a small fitting right onto the inner side of the air filter housing for connecting the hose from the distributor.

The filter itself is no more complicated than it looks. Any generic fuel filter will serve as a replacement. Unfortunately, some people actually have trouble finding one; David Littlefield says, "These used to be widely available as a generic fuel filter. However, when I looked for one recently they were nowhere to be found. I finally ran across one at my local auto parts store, but not with the automobile fuel filters -- it was in the lawnmower parts!" Others suggest asking for a

fuel filter for a VW. Peter Havas got carried away and made a filter from a plastic film container stuffed with generic filter material (cotton, some types of vacuum cleaner filters, or the crankcase ventilation filters sold in auto parts stores will serve). He cut lots of little holes in one end, and cut a hole in the other end just a hair smaller than the OD of the hose and stuffed the hose into it. This arrangement allows him to service the filter by opening it up and cleaning or replacing the “element”.

Obviously, optimizing airflow and cooling would be a good idea, so replacing this filter before it gets significantly plugged up is recommended. If you drive in dusty conditions, take note.

If you would like to help this system out, reroute the intake filter to somewhere in front of the radiator. This will draw cooler air, and will also draw more air since this is a high pressure area. The cooler air should also help the electronic ignition pickup last longer.

It's possible that this ventilation scheme was retrofitted to earlier cars. It may also be possible to drill the older cap and fashion suitable fittings, one in the side for an inlet and one out the top for an outlet. A few pieces of hose, a fuel filter, and a connection to the engine side of an air filter housing and it's done.

Lucas OPUS Mark 2 (pre-1982)

LUCAS “OPUS” MARK 2 IGNITION -- DESCRIPTION: This is a brief description of how the pre-1982 ignition system works, based on the more detailed description in SAE paper 720163 on the development of the engine.

The pickup within the distributor consists of an E-shaped transformer with one input coil and two output coils. The input coil is on the center leg of the E and is fed a 600KHz input signal from the amplifier. The two output coils are on the outer legs of the E and are wired in series so that their outputs cancel -- provided the two sides of the transformer are equal.

When one of the ferrite inserts built into the plastic rotor in the distributor aligns itself with one side of this transformer, it magnetically completes the circle on one side of the E. Since the output coil on this side is now more closely coupled with the input coil than the other output coil, its output is greater -- and the two no longer cancel each other. A transistor in the amp is toggled by the resultant output signal, triggering a spark.

TROUBLESHOOTING: Jan Wikström sends this procedure for testing the OPUS ignition system:

1. Pull the lead from coil to distributor out of the distributor and jam it under a fuel pipe so there's a gap of about 1 mm (.04in) between the brass and the nearest engine part.
2. Crank the engine. Do you get fat, blue sparks in the gap? Then the ignition is OK and you need to troubleshoot the injection system. If not, continue:
3. Pull the spade connector off the coil terminal marked (+). Turn the ignition on, then test the power with a spare light bulb between the connector and engine bare metal (this is better than a voltmeter, because it will reveal a poor contact with insufficient current carrying capacity). Is the lamp bright? Then continue; if there's no voltage, check the ignition switch and all its wiring including the ballast resistor.
4. Touch the connector quickly several times to the terminal. Do you get a spark now? Then the pickup coil in the distributor or its wiring, or (less likely) the amplifier, may be faulty. If there's no spark, turn the ignition off and continue:
5. Get a test lead with alligator clips. Clip one end to bare metal on the engine, pull the tubular connector off the (-) terminal of the coil and clip the other end to that terminal.
6. Repeat test 4. If you get a spark now, the amplifier or its wiring is faulty. If you get no spark, the coil is dead.”

OPUS IGNITION AMPLIFIER RELOCATION: The OPUS ignition amplifier is a finned aluminum block that was originally mounted down within the galley between the cam covers. It gets cooked, primarily after the engine is shut off and all that heat from the block rises. Dick Russell says that intermittent failures characterized by the tach reading zero even when the engine is still turning are a sure sign the amp has failed.

Jaguar makes a kit to relocate this amplifier to the plate across the top of the radiator so it stays cooler. The kit includes a new amplifier and a new pickup for inside the distributor, and costs over \$300.

It is possible Jaguar includes the amplifier and pickup simply because the only time their mechanics get a call to relocate the unit is after the original unit has fried. On the other hand, perhaps the reason the unit was originally located in such a sorry place was because the wiring needed to be as short as possible, and the replacement amp and pickup have updated circuitry necessary for the longer wires. According to Jan Wikström, the plugs and wires used on the replacement kit are different than the original, indicating you're supposed to replace the amp and pickup together. However, he simply spliced wires and used his old pickup, and it worked fine. He notes, however, that the wire color codes changed; it is necessary to open the amp and verify where the wires go to ensure they are connected correctly.

Clearly, crosstalk between the 600 KHz input signal and the output wire back to the amp would be detrimental to operation, and such crosstalk could be easily caused by the wires merely being located too close to each other for too great a distance. Also, the output wire picking up any *other* signals -- such as interference from the ignition wires -- would be ungood.

Reportedly, some owners have relocated their original amps by simply lengthening the wires, and have been successful. Others have *not* been successful. At least one owner reports that the official Jaguar relocation kit caused the wires to pick up so much interference from the spark plug wires that the car wouldn't run, and he couldn't get the system to work until he *shortened* the wires back to the length of the original.

Russell recommends that ribbon wire with five or more conductors be used to relocate the amp. By using every other conductor, the unused conductors in between provide adequate spacing between the active conductors to prevent crosstalk and interference.

Russell also recommends relocating the amp to the firewall rather than the top of the radiator. In his car, the amp was affected by water and crud thrown up from cars in front of him. Fortunately, he was able to repair it by resoldering some connections inside.

Perhaps another solution is to leave the amp in the valley and attempt to keep it cool there. Fashioning a heat shield from sheet aluminum for underneath it will help. Also, see the suggestion on page 120 about cutting a hole in the A/C compressor mounting plate.

British Auto/USA (see page 641) claims to have "reinvented" this amp using modern electronics. The amp they offer, part number JLM368/R, looks exactly like the original and is supposedly durable enough that it may be located within the V; apparently some concours judges will subtract points if the amp isn't in its original location.

Of course, if you don't care about concours points, the best relocation idea is to relocate that OPUS system to a dumpster and replace it with an aftermarket ignition system. See page 144.

If you have a 1982-89 car with a black plastic amplifier mounted on top of the left intake manifold, you have the Lucas CEI ignition rather than the Lucas OPUS. There is no need to worry about relocating the amp.

IGNITION AMPLIFIER -- REPAIR: Referring to the OPUS finned aluminum ignition amp, Jan Wikström says: "As for the amplifier itself, there is precious little pottery involved. I opened up the suspect one (four small hex-head screws underneath) and found that while there's a silicon blob at the cable entry and a silicon slurp for a seal around the lid, the inside is empty and there is complete access to PC board and power transistor. No need to spend up on a new one if it goes belly up; this unit is eminently repairable."

Phil Stuart says, "There are four transistors in the early Lucas Opus ignition amplifier, one is a big one in a TO-3 casing for amplifying and 3 smaller ones for switching. I burnt up the smaller switching transistor. It's fixed and running now; the transistor we finally put in was a ECG128, NPN type. Cost \$2.95 CND. The original one was Germanium NPN; the replacement is silicon NPN."

PICKUP WIRING: Wikström warns: "One problem I've had on both cars is an intermittent break in one of the three ignition trigger wires coming out the front of the distributor, right in the moulded grommet. This seems inherent to the design, as the big, heavy three-pin connector flops around on loose wires and should cause metal fatigue as the wire bends back and forth. I have replaced the wires (solder joints inside the distributor) and applied spade connectors instead of the three-pin job."

COIL LOCATION: If you can't find it, you're in trouble. If you have the Haynes manual, the caption on the photograph labelled 10.2 on page 118 says it's "at the rear of the throttle pedestal" but it lies, it's at the front.

BALLAST RESISTOR PACK: The ballast resistor pack is shown as item 164 on the Jaguar wiring schematics. On earlier schematics, it is illustrated as a simple rectangular box with six wires connected to it, but on later schematics they show three resistors inside. It would probably have been better if they hadn't done that, because the simplistic 3-resistor illustration is incorrect and misleading.

Section 86.35.29/3 of the ©1975 ROM is titled "Ballast resistor check", and provides a simplistic continuity test. It provides a more detailed illustration of the ballast resistor pack -- also incorrect. Section 86.35.29/4, "Coil voltage check", Step #4 includes values for the resistors in the ballast resistor pack, but they're numbered "Resistor 1" through "Resistor 3" and "Connection 4" and "Connection 5" with no clue whatsoever what connections they're talking about. In section 86.35.29/10, in the latter half of Step #4, inexplicably buried in the midst of a coil/amplifier check procedure, the resistance values are repeated and the illustration is provided again -- this time with Connection 4 and 5 labelled, but you're still left to guess at the resistor numbers. The Haynes manual doesn't have any illustrations of the ballast resistor pack innards, just photos of the outside. Is it any wonder that this book has grown to over 681 pages? Anyhow, the easiest thing to do is to simply provide a new illustration, so please refer to the figure here instead of *any* of the illustrations in the manuals.

It should also be noted that some of the diagrams in the Haynes book have differing color codes on the wires; for example, Fig. 4.1 shows a UW wire where the XJ-S has a W/U, and a WU wire where the XJ-S has a W/SU.

Mike Morrin explains the tach connection: The power from the center left terminal through the $7.6-9.2\Omega$ resistor to the upper right terminal on the ballast pack diagram (which connects to the W/U wire) "...is the drive current for the output switching transistor. So, the tachometer gets its drive direct from the amplifier, not from the coil circuit."

"According to the parts books I have here, there was an early version, used 1971-72 which apparently did not have the tachometer connection, and the later version, which was used 1972-80." Morrin provides part numbers:

- E-type C35883 until engine 7S7559
- E-type C37759 from engine 7S7560

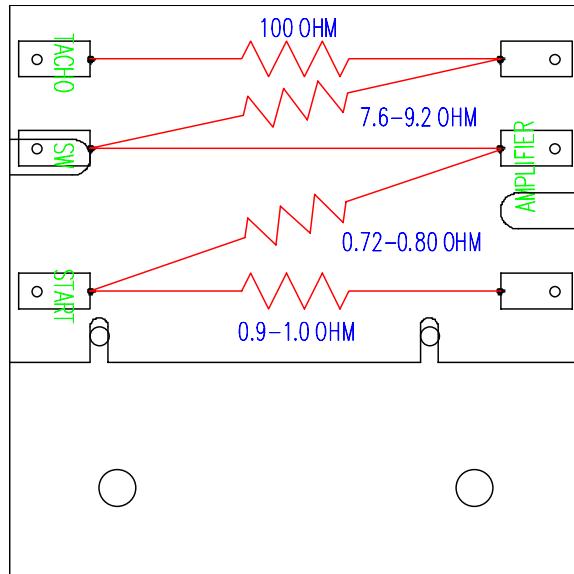


Figure 10 - OPUS Ballast Resistor Pack

XJ-S C37759 all

"C37759 is apparently Lucas 47229."

There is some discrepancy about the resistor serving the tach. The XJ-S ROM reports it as 100Ω , but the SIII E-Type ROM reports it as a straight-through connection, no resistor. This actually probably wouldn't make any difference to an electronic tachometer; the resistor merely limits current in the event of a short circuit or something. Could the part number change with engine 7S7560 reflect the resistor? Morrin: "Either way there is a mistake, it says:

"Connection 5 - Tachometer terminal and straight through internal connection (incorporated in later units marked 47227)."

That 47227 part is apparently a typo in the E-Type manual; it should say 47229, which is what is actually marked on the ballast packs.

"On reflection, I think the early unit probably had the straight through connection and the later unit the 100 ohm resistor. There does not appear to be any change in the vehicle wiring coinciding with the change in ballast."

Note that 86.35.33 describes how to remove the resistor pack. Evidently rocket science, don't tackle this job unless you are a very experienced mechanic. At least Jaguar didn't put any serious errors in this procedure.

If your ballast resistor pack has failed, it shouldn't be terribly difficult to put together a collection of generic resistors to replace it. After some discussion about a ballast resistor pack in which that $7.6-9.2\Omega$ resistor had blown, Gary Johnson suggested "Radio Shack (Tandy). They sell a 10 or 20 watt 8 ohm non-inductive resistor that sounds perfect for this application." For the main resistor serving the coil, there are a wide variety of ballast resistors available at any parts store since just about all cars used them up until the 80's; it should be easy to find one that will work.

TACHOMETER PROBLEMS: Both John Holmes and Jan Wikström had tachometers that didn't work, and both arrived at the same corrective action: they disconnected the tach signal wire from the ballast pack and connected it to the - terminal on the coil, where it's connected on every other car ever made. Holmes: "I just know how this is wired in other cars and did the simplest circuit possible to see if the tach worked. When it did, why change it again?"

LUCAS OPUS IGNITION SYSTEM UPGRADE: As mentioned above, British Auto/USA (see page 641) offers a replacement amplifier for the OPUS ignition system that supposedly is more reliable than the original. Supposedly. Steve S reports, "I had of those BA updated amps bought from SNG in UK fitted to my V12 E. The original OPUS amp did 20 years and 90k miles in the V and was still working when I took it out after hearing that it was unreliable. I thought I was going to "decrease chance of a breakdown". The SNG updated unit lasted about 3 years and 7K miles before failing in the classic opus failure mode - dies suddenly when hot. Fortunately because this was a USA inspired device it came with a lifetime guarantee (as against a UK guarantee of guaranteed until it breaks)."

LUCAS OPUS IGNITION SYSTEM REPLACEMENT: If you have any trouble with the original Lucas OPUS ignition system, it is recommended that you simply replace the entire system with a modern aftermarket ignition system. There are several available, and most of them can be purchased in entirety for less than replacing any defective *part* of the OPUS system. And the owners who have opted for such upgrades have universally reported better performance from their cars. Note: this recommendation does *not* carry over to cars with the Lucas CEI ignition; that is an excellent system and there is rarely any cause to ditch it.

Lucas designed the plastic wheel within the OPUS distributor with three slotted holes that enable the mechanic to insert an Allen wrench, loosen the three screws at the very bottom, and remove the distributor as a unit. If you install some sort of aftermarket system, you might want to consider whether or not you will be able to get that Allen wrench past or through whatever is used to trigger the pickup. Of course, it might not be your highest priority; you could always simply disassemble the distributor in place far enough to remove the wheel to gain access to the screws.

None of the common aftermarket systems will replace the EFI trigger board. The EFI is a separate system that just happens to have its trigger board inside the distributor. After you've removed all the OPUS junk and installed an optical wheel and pickup or whatever, you will need to put that trigger board right back in. If your trigger board is toast and you've priced a new one, that is definitely bad news. However, Jaguar's upgrade trigger board -- which uses Hall effect transistors instead of the reed switches used in the original -- seems to be reliable, so usually you only need to buy it once.

LUCAS OPUS IGNITION SYSTEM REPLACEMENT -- ALLISON/CRANE XR700: Allison was acquired by Crane. By whichever name, their XR700 is a popular replacement for the OPUS. Derek Hibbs reports: "My ign amp died as a result of convected heat last year. A reliable replacement unit was not available so the workshop installed a Crane Cams unit. The unit itself is located on the RHS air cleaner and it came with replacement pieces for the distributor because it uses an optical pickup."

Andrew Holley says, "I removed the Lucas (Prince of Darkness) system and fitted the Crane XR700-0300 system, took all of about 2 hrs. The car starts first time every time, and seems to run a bit more crisply. It has improved fuel consumption slightly, but the major benifit is that it now starts instantly , no matter the conditions."

Steve Douglass says, "After fighting problems (mostly heat related) with the original OPUS system on my car, I replaced it with a Crane Fireball system that I got from Terry's for \$124.00. The kit came with everything I needed to do the job along with good instructions. The system has an optical pickup that goes in the distributor and an amplifier that mounts on the firewall. Pretty much like what it replaces. I was able to install the thing in about 2 hrs and the car fired right up."

Paul Clarkson had a hell of a time with pickup mounting brackets inside the distributor and ended up having to fab and modify stuff, but he's apparently the only one; everyone else claims the system is a simple bolt-in. Emin Morali replied: "Try to assemble the optical pick-up unit without using any bracket. You use only two screws and it will fit perfectly in the place of original pick-up unit."

There is some confusion about which coil to use with the XR700. Clarkson reported, "I invested in a Crane Cams XR700 amp and PS91 coil. Here is a reply I received from the tech. dept. at Crane Cams in reply to my query about lengthening the pick-up leads (so I could locate it in a cool place):

"The XR700 is to be used with our PS20 or PS40 coil with the supplied ballast resistor that comes with them. The PS91 coil has such a low resistance that two ballast resistors are needed to keep the XR700 from overheating. This also kills off some of the spark power to the point of being worse than it would be if the proper coils were used. If you wish to keep the killer coil you will need to use the XR3000 amp that is designed to use the higher output coil. Please fix this before proceeding. You hook it up just as you see in the instructions and everything should be fine. You can also add to the length of the wires on the amp if they are of the same gauge and type of wire. Hope this helps. Tech support, Steve 4208..."

Again, Emin Morali responds: "When I fit Crane XR700, the car was hesitating to exceed 5000-5200 rpm with misfire at the engine. So I changed the PS20 with PS91 keeping the same OEM ballast resistor pack of my car, but adding a serial resistor of 1.4 ohm to protect XR700. No result, the same problem continued. This time I threw the 1.4 ohm resistor away and used PS91 with OEM resistor pack. My problem finished. However the possibility of damaging the amplifier pushed me to replace PS91 with a Bosch blue coil (also low primary resistance) by adding a serial resistor and no problem at all."

Clarkson says the XR700/PS91 setup was recommended by (now defunct) GT Jaguar. Paul Squire: "Quoting their website: "Gran Turismo worked very closely with Crane on these systems. The tech questions they receive about their systems for Jaguars are referred to us because they know we have more knowledge in this area than even they do.""

Terry's Jaguar (page 646) offers the Crane system, or you can also get it directly from Crane.

The Crane system comes with a disk with suitable slotted holes for access to the screws in the bottom of the distributor.

LUCAS OPUS IGNITION SYSTEM REPLACEMENT -- ALLISON/CRANE XR3000: Emin Morali says, "I had called a Crane dealer in Florida to ask him if I can use XR3000 with PS91. After he discussed the subject with a Crane tech., he told me that it won't work. I did not understand the reason why, however I had seen before in Crane web site that XR3000 may have compatibility problem with OPUS systems and was not recommended." Gee, it seems the Crane tech support keeps telling us not to do things that work fine; Bernard Embden installed the XR3000 and it seems to have worked out, although he put a lot of effort into locating the amp inside the car and making a bracket he liked for the optical pickup inside the distributor. You can view his installation at

<http://bernardembden.com/xjs/ingamp/index.htm>

LUCAS OPUS IGNITION SYSTEM REPLACEMENT -- LUMENITION: Welsh Enterprises (page 646) offers at least two different models of Lumenition electronic ignition system for the XJ-S, each featuring an optical pickup and compatible with their engine rev limiters.

LUCAS OPUS IGNITION SYSTEM REPLACEMENT -- LUCAS CEI: The later Lucas CEI system makes an excellent upgrade for the Lucas OPUS. Buying the Jaguar parts new would be more expensive than just going with one of the aftermarket systems above, but if you can find what you need in a junkyard you might get off pretty cheap. If you can't find the CEI ignition amp for a reasonable price, you can build one with a GM HEI module, a couple of resistors, a capacitor, a zener diode, and a suitable box to mount them in. You can use the Lucas CEI distributor, but you must install the vacuum and centrifugal mechanisms from the original distributor in it to maintain the correct advance curves for the pre-H.E. engine. You'll also need to omit the anti-flash shield used in the CEI distributor to mount the D Jetronic EFI trigger board, but they use the same mounting holes so that's easy. Make sure to use the earlier "green stripe" rotor as it has the magnet in it that drives the EFI trigger board.

Alternatively, you can reuse your OPUS distributor. You will probably need to modify it to install the CEI pickup, though. On the CEI cars, the pickup mounts on a metal plate that can rotate with the vacuum advance; on the OPUS cars, there's a fragile micarta part that rotates and holds the pickup. The body of the OPUS distributor includes a center section that this micarta part rotates around, and on the CEI distributor body this center section is gone.

According to John Testrake, SNG Barratt (page 645) developed a way to upgrade to the Lucas CEI while maintaining the appearance of the OPUS under the hood. "They have marketed it for Ser III E-types which are, of course, carbureted. I called them last year and asked if they could do it for an EFI engine. They said yes and that they were just bringing that to market. I think mine was the first one."

"They completely rebuilt the dist. from my car with all new parts and refitted it with the CEI reluctor and pickup. Then they swapped the internal parts of my amp with CEI parts and built in a heat resistant mounting. It's all designed to operate with the D-jet EFI and has all the original advance curves, trigger board and what not."

"And it uses one coil. It's a Lucas coil with bare aluminum case about 6" long and a white cap where the leads connect that says LUCAS. It mounts to the front of the throttle pedestal like the original. Pretty standard issue, I think and it comes as part of the kit."

"Everything looks like OPUS. Nobody can tell it has CEI inside. I'm hoping for a JCNA North American class 11 Championship with this car. So that's why all the fuss over originality."

Steve S, who reported above that he had purchased the British Auto/USA-upgraded OPUS amp from SNG Barratt and it failed on him: "SNG being good people exchanged it for one of the CEI units in the OPUS case - although the lifetime guarantee is not available with this new one. I gather the original unit was withdrawn because it was unreliable. With the kit you also get a new aluminium U-shaped resistor pack identical to the original and decent fitting instructions. You have to send your old distributor back in part exchange. The coil, OPUS style alloy box, and resistor pack have stickers on them in inconspicuous places warning that this is an updated system with a reference number for maintenance in future so standard parts do not get swapped back in."

LUCAS OPUS IGNITION SYSTEM REPLACEMENT -- \$\$\$: You could just go hog wild and install a fancy-schmancy modern high-tech ignition system. See the ideas for upgrading the Marelli on page 167; any of those systems can be used to upgrade the OPUS as well.

Lucas Constant Energy Ignition (1982-89)

LUCAS CEI IGNITION -- DESCRIPTION: The triggering mechanism for the Lucas CEI ignition system consists of a "star wheel", a wheel with 12 points on it, mounted on the distributor shaft with a "pickup" adjacent to it. There is a magnet and a coil in the pickup. A magnetic field is established in which the flux passes from one pole of the magnet through the coil, through the star wheel, and back to the opposite pole of the magnet. When a point on the star wheel aligns with the core of the coil, this magnetic flux has a nearly continuous path of iron and is therefore at its strongest. When the point is far away from the core of the coil, the magnetic flux is at its weakest because there is so much air space in its path.

Since a voltage is generated in a coil with a *changing* magnetic flux through its core, a voltage is generated in the pickup by the increasing strength of the magnetic flux as a point on the star wheel approaches the tip of the core. A voltage is likewise generated by the decreasing strength of the magnetic flux as a point on the star wheel moves away from the tip of the core -- but this voltage will be opposite in polarity from the first one. The pickup will therefore produce a voltage that suddenly reverses polarity as a point on the star wheel passes the tip of the core. The electronics within the amplifier module sense this voltage reversal to break the ground connection to the coil, triggering a spark.

But that's not all this system does. It waits a varying amount of time before reestablishing the ground connection to begin charging the coil for the next spark, getting the charging started ASAP at high RPM but waiting a bit longer to get started under idle conditions so as to minimize coil heating. It also monitors the current flow to the coil to make sure that it does not exceed a set limit, which might happen at low RPM when there is more than adequate time to build up a charge in the coil. If the current rises too much, the amp begins to cut back on the voltage applied, holding the current constant and preventing the coil from overheating.

Prior to systems with such features, coils had to be designed to handle high-current conditions at low RPM and had ballast resistors to limit the current. With the current control features, coils can be designed more compact and without the oil inside that was needed to keep them cool. They could also be designed with very low impedance in the primary coil without worrying about current overload problems, allowing much faster charging on 12 volts. Unfortunately, such coils weren't available when the Lucas CEI was introduced, so two conventional coils were wired together to accomplish the task. Later, after suitable coils became commonplace, Jaguar would replace the dual-coil setup with a single modern coil whenever a coil needed service.

During most operation, the ignition amp is merely switching the current on and off and is dissipating very little heat. However, at low RPM when it's having to cut back the voltage to limit the current in the coil, it's having to dissipate that extra power. It gets hot under such conditions. The amplifier is bolted to the aluminum intake manifold to try to dissipate some of this heat to the manifold and to the cool air passing within.

Roger Bywater: "The 12.5:1 compression of the H.E. was too much for OPUS to fire and in any case it was getting to be a bit primitive by that time as it had no means of current control other than via the ballast resistor."

TROUBLESHOOTING: Randy Wilson sends this procedure: "With the engine cranking, check for:

Power to the ballast source

Power to the coil + post

Ground switching on coil - post (if so, you should have spark)

Ground to amplifier case

"If everything passes except the ground switching on the coil, then it's in the amplifier or its wiring.

"A scope put on the pickup leads should give a modified sine wave pattern typical of magnetic induction sensor. At crank speed, I *think* it's around 1.5V peak-to-peak. No scope pattern is a bad pickup."

"I've never personally seen the pickup go bad, but have run into cracked wires in the pickup harness. Quite often jiggling the harness will cause the problem to "correct" itself; sometimes for many years. Everything working fine after doing the scope check is bad pickup wires."

If your car runs well when cold but gets uppity when hot and you suspect the ignition amp, you might try pouring some water on it to cool it off. If the car runs well again, you have definitely narrowed the search for a cause down to *something* in that little black box!

IGNITION AMPLIFIER -- REPAIR: The Lucas Constant Energy ignition amplifier is a black plastic box mounted on top of the left intake manifold. This unit is clearly labeled "Lucas" and "Made in UK". The mail-order catalogs call for a part number DAB106, and want serious \$\$\$ for it.

If you unbolt this unit from the intake manifold, turn it over, remove four tiny screws and remove the cover, you will see four components inside. The predominant component is a GM High Energy Ignition (HEI) module. This unit is so common that you can find it on a bubble card hanging from a hook in any department store with an automotive section -- for around \$20. Usually this amplifier can be repaired by simply replacing the GM HEI module for considerably less than the cost of replacing the whole unit.

Simple? Maybe not. Dave Johnson says, "The amp on my '84 died on me several years ago. I replaced the module with the equivalent GM module and it lasted 3 months. I replaced the zener and the capacitor with equivalents. I again replaced the module. This one lasted 1 month. I gave them one more chance (lifetime warranty) and it's worked for 4 years now. The moral of the story? I believe the modules available from discounters are marginal and you have to keep trying to get a good one. Since I didn't even consider buying a new amp from the dealer I can't rate their failure rate but a GM mechanic friend of mine kept after me that the modules I was getting were junk. He was right and I now have a working one. No more intermittent problems. Try another one." Note that sellers of expensive modules invariably claim theirs are better than the cheaper units, but users seem to report comparable failure modes; just keep replacing until you get a good one.

John Robison says, "Advance Auto has an electronic gizmo they can plug the GM unit into. It simulates loading at both low and high rpm (somehow) and then gives a pass/fail indication for both conditions." While it may hardly seem worthwhile to check a \$20 part rather than simply replacing it, such a test may go a long way toward confirming diagnoses.

Joe Bialy adds: "There are 5 connections on the GM HEI module. The fifth terminal is the ground for the module which is actually one of the mounting holes on the module itself. All of the coil current passes through this connection. If the ground terminal on the module itself is not secure, ignition problems will occur." Peter Havas adds, "The HEI's on GM engines sit atop the distributor cap, and the replacements must have a second ground wire or they burn up. I don't know why, but having had many GM trucks which suffered spontaneous HEI failure, it was revealed by the local GM garage that you must run a straight ground as well as the little flat strip to the HEI to keep it from burning up. This applies only to replacement units, and I have no idea why. It works though." There don't seem to be similar problems

in the Jaguar V12 application -- perhaps since the module is securely bolted to the aluminum intake manifold rather than to the distributor cap -- but it couldn't hurt to make sure the ground is solid while you're in there replacing a module.

The other components are a 1 microfarad condenser, a couple of resistors buried in a white rubber blob, and a zener diode mounted in the top of the case so the upper surface is actually visible from outside. The condenser may actually be a common source of trouble; there are at least two reports of it shorting out when warm, so the engine runs OK when cold but has trouble when warm. Since the condenser is connected to 12V, it shorting out causes it to get even hotter. Pouring cold water over the amp fixes the problem for a few seconds.

The condenser is apparently only a noise reducer, being connected to the +12V side of the coil. As such, just about any condenser would probably work. If you're looking for a replacement condenser, you might consider the one intended for use with the GM HEI ignition system. Auto parts stores sell a part labelled a "capacitor", but it's more than that. This part is a little harness that has a 2-terminal connector on one end that plugs onto the HEI module, a 3-terminal connector at the other end that plugs into the GM distributor, and a capacitor attached to the 2-terminal connector. One such part is made by Standard, part number RC-4. Joe Bialy says, "More than likely, the cap in the connector will work as well as the Lucas cap if it is wired identically. Noise suppression caps are not the most critical components in a system. Typically, -20/+80% tolerance items. I'd even bet an old "points" type would work just as well too." Peyton Gill says, "I replaced the condenser (capacitor) in the ignition amp about a year back. I used a condenser from a Chevy inline six distributor. As memory serves, it required removal of the mounting bracket which was soldered to the condenser body. It is a little longer but the diameter was about the same."

About the resistors, Walter Petermann says, "The white piece of rubber has 2 resistors in it. One is 10k, the other 6.8k. They are connected together at one end to terminal C of the GM module. This same terminal goes to the coil minus and the large diode. The other end of the resistors go to tach and fuel ECU (white/gray wires)" The 10K resistor connects to the tach and the 6.8K connects to the EFI ECU. On the ignition amp, both wires are the same color but the tach wire has a male terminal and the ECU wire has a female terminal; the wires they connect to are clearly distinguishable, since the ECU lead is a shielded cable and the tach wire is a plain W/S/U wire. Craig Sawyers points out that the 6.8K resistor is actually shown on the fuel injection system wiring diagrams. You can easily test the resistors without even unbolting the amp from the manifold; just disconnect the W/B wire from the ignition coil and the leads to the ECU and tach and measure from the W/B wire to each. If the resistor feeding the tach fails the only symptom would be a nonfunctional tach, but a failure of the resistor feeding the ECU will stop the car with conviction.

The trick to testing the zener diode is in recognizing that it only exists to protect the amp against overvoltage, which normally occurs only when the system is operated with a spark plug wire disconnected. Under normal conditions, it does nothing. So, to find out if it is causing trouble, merely disconnect it. If nothing changes, the diode is probably not the problem. If the problems go away, you can consider finding a replacement zener diode or simply leave it disconnected; if you choose the latter option, you might want to be careful not to operate the ignition with any spark plug wires disconnected from then on.

FIDDLING WITH THE GM HEI IGNITION MODULE: This author found a warning *inside* a Lucas CEI ignition amp that read:

CONTAINS
BERYLIA
DO NOT OPEN

Judging from the fact that this label was attached to the surface of the GM HEI module itself, the beryllia referred to is probably inside that module; there is nothing else within the Lucas ignition amplifier that appears to be this type of substance.

Beryllia is the oxide of Beryllium, and is used in a type of ceramic used to mount or encase electronic parts. This ceramic conducts heat very well, helping keep the part cool, while being an electrical insulator -- an unusual combination. Unfortunately, beryllium is really as dangerous as indicated. If you are inside the box repairing your amp, just remove and replace components. Don't go sawing open the GM module, the dust created can **kill** you. Patsy Lokensgard says, "Beryllium is nasty stuff. I used to work someplace where people worked with it, and there were many rumors about people who had died from exposure. For more information, check out

<http://tis-nt.eh.doe.gov/be/webdoc1.html-ssi>

“The health hazard information is towards the bottom of the page. I think it is a good description of the risks, neither overstating them nor minimizing them.”

Mike Morrin adds, “There is actually very little of it used in anything built in the last 20 years except high power transmitters and some specialised power modules. I am not sure about the GM ignition module, but if there is any, it is likely to be a pad under the power device about 2mm square and .5mm thick. Beryllium Oxide is very expensive, so the semiconductor manufacturers avoid it where possible, the safety aspects notwithstanding.”

MORE TECHNICAL INFO ON THE GM HEI: Motorola once offered a publication MC3334/D which provided “analog IC device data” on a chip they made, MC3334 (and a couple of variations) which was described as a “High Energy Ignition Circuit” and was apparently used within the GM HEI module. This document was very informative, not only on the circuit itself but on the entire ignition system it’s used in. Unfortunately, such info is apparently NLA; perhaps Motorola no longer makes that chip, leaving it to the aftermarket businesses.

ELECTRONIC IGNITION PICKUP: The electronic pickup used in the Lucas CEI distributor involves a magnet that is mounted with two screws. Be careful tightening these screws; the ceramic magnet is much more brittle than metal items, and can easily crack. If already cracked (notably around one of the screw holes), do not be concerned, it will not affect operation. However, be sure not to leave any chips in there that could come loose and move around within the distributor. It is better to discard small bits of the magnet that have broken away.

The pickup itself is apparently quite reliable, but there are a couple of indications that it may develop intermittent problems. Don Lawson of Northeastern Classics had a customer with a car that would run fine and then suddenly quit, and after a considerable amount of frustration they finally simply replaced the distributor in entirety -- and never had the problem again. The original distributor was sent to this author for analysis, but nothing could be found wrong with it. The pickup was monitored while immersed in water being brought to a boil, and it showed no problems. It’s possible the problem was elsewhere in the V and it was accidentally corrected while changing distributors.

Martin Walker had similar problems. “Mine would run fine if I kept moving, but let it idle for 30 minutes, or run it in slow traffic for a long time in hot weather and it would suddenly die. It would then not start for about 2 hours, and would then fire up OK and run well again. This cost me much time, money and aggravation, as it eventually did this some distance from home. The AA trailered it to the nearest Jag main dealer, who spent lots of my money in man-hours trying - and failing - to find the problem. I paid to have it trailered back to my garage, and replaced the ignition amp before turning to the pickup. I took it out and mounted it on a soldering iron - and at a consistent temperature (80-odd degrees, I recall) it would simply go open-circuit.”

Keith Morris concurs: “I believe that the epoxy in the pickup heats up and breaks a close tolerance gap. I have experienced this problem on an MGB and a Jaguar. A simple replacement of the part solved the problem.”

If you have decided that the pickup is a problem, don’t replace the entire distributor; the pickup itself is available at most auto parts stores, made by several different aftermarket brands. It’s not cheap -- over a hundred bucks -- but it’s cheaper than a new distributor.

Considering how many different cars use the same GM HEI ignition amp, it may be possible to find a cheap pickup that fits some other car and make it fit the Jag distributor. The ones that fit Chevy V8’s of the same era look totally different, but there are other pickups in the catalogs that do look fairly similar.

PICKUP GAP ADJUSTMENT: David Littlefield says, “The Haynes manual calls for readjusting the gap between the magnetic pickup and the iron star wheel with a plastic or non-ferrous feeler gauge. Believe it or not, these are readily available. I found some at Pep Boys hanging on a card beside other feeler gauges, I think they were made of brass.” Note: brass corrodes easily, and polishing removes a little metal so your feeler gauges would get progressively less

accurate. It is recommended that you spray a little WD-40 or something similar on each blade before tossing it back in the tool box, or take some other measures to prevent corrosion.

"Also, the Haynes manual says to turn the crank until one of the points on the star is next to the pickup so you can check the gap. *Unnecessary!!* Just remove the U-shaped thingy holding the star wheel in place and it will turn on the rotor carrier so you can get a point of the star in the proper position."

CONNECTORS: Mark Whitnell reports, "For the last several months the only way I could get it started was to use starting fluid. I checked out the spark since that was an area recommended by Kirby. The spark was very small and I suspect that the small spark could not ignite the gas but could ignite the ether (lower vapor pressure).

"I checked the distributor pick-up coil for the proper resistance according to Haynes (2.2K to 4.8K). I checked at the connector attaching to the ig amp first...very high megohms. Then I pulled the connector apart at the distributor. Checked the continuity of the wiring to the ig amp...checked ok. Then measured the resistance at the connector to the distributor...high resistance. Looking at the two prong connector...visually it looked fine. I went ahead and cut off the connector and measured resistance of the two wires to the distributor pick-up. Measured resistance... 3000 ohms within the range described in Haynes. Replaced the connector. Voilà, starting problem solved.. good spark, etc."

COILS: The Lucas CEI system uses two conventional ignition coils wired in parallel. The high-tension lead of the secondary coil is sealed off, and only the lead from the main coil is connected to the distributor. Between firings, energy is built up in both coils. When the 12V supply is broken ("the points open" in the lingo of the pre-electronic age), the energy stored in the secondary coil cannot escape through the high tension lead because it is sealed off, so the energy comes back through the 12V leads instead. The primary coil then not only has to release the energy it has stored itself, but also the energy coming back from the secondary coil. These two energies add to produce a powerful output at the high tension lead on the primary coil.

The secondary coil, located in front of the radiator, is *not* a spare or a backup; it is designed into the system for producing a good spark. If the secondary coil goes bad or gets disconnected, the performance will suffer; typically, the engine will top out at around 4500 RPM and won't go any faster. The secondary coil is not special, however, and can be replaced with a conventional coil provided the high tension connection is covered so that it cannot arc to ground.

Since mid-1989, XJ-S's have gone to a Marelli ignition system that also uses two coils. However, these two coils are totally separate; each one fires only six cylinders.

According to Alan Jenks, "Jaguar now recommends replacing both coils with a single "solid" (not oil filled) coil (#DAC 6093) that fits in place of the main coil. The aux coil and wiring is removed." Roger Bywater says, "The best coil to use on Lucas HE V12s is DAC 6093 (Ducelier coil - 0.62 ohms primary); only one needed and works well in place of earlier twin coil set up. If you can find another coil with primary winding resistance of 0.5 - 0.6 ohms maybe it is worth a try. If the resistance is any more than that it will not be able to build up enough coil energy to fire a spark at the higher end of the rev range when the coil "on time" is very short (about 1.4 milliseconds at 6000 revs). It might also struggle around the peak torque point. Although the V12 constant energy ignition module is fairly tolerant (it runs OK with the blanked second coil removed - albeit with a loss of spark energy) I have encountered some that behave very oddly if the coil is not the correct load match. The DAC 6093 might be a bit expensive but it does the job..."

He adds that the original parallel coil arrangement was "conceived when coils of sufficiently low resistance were not available."

John Goodman defends the earlier parallel coil setup: "The only difference (between the two coils) is the HT socket is sealed on the aux coil, and is no longer stocked by Lucas. The primary coil is still available from a Lucas distributor and is cheaper than the universal coil Jaguar sells to replace the two V12 coils. I am experiencing coil/ignition related problems on my car and have tried a few of these Ducelier coils (original equip on the XJR-S). I am convinced it is the coil causing intermittent starting and cutting out problems, thinking of resorting to the early twin Lucas coil system which never gave any trouble on previous cars."

Jim Isbell: "BTW, if you measure the primary, be careful because when you remove the meter the secondary sparks and it can really make you jump; also, when the field collapses you can feel the bite on the primary as well."

LUCAS CEI IGNITION SYSTEM REPLACEMENT: There is rarely any good reason to replace the Lucas CEI ignition system. The performance is excellent, and replacing with aftermarket rarely results in any improvement. The centrifugal advance mechanism is prone to seizing, but that's easily avoided with regular maintenance. The vacuum advance module fails after a few years in the heat in the vee, but it's not that expensive to replace; besides, most reasonably-priced aftermarket ignition systems continue to rely on the original centrifugal and vacuum advances anyway. Repairing a failed amplifier costs \$20 with parts available everywhere. The two coils are reasonably-priced and easily obtainable (or you can spend bigger bucks for a modern single coil). The only parts that are even remotely expensive to replace are those in the distributor, the star wheel and the magnetic pickup, but they rarely cause any trouble. The pickup itself is available at regular (non-Jaguar) auto parts stores for around \$100.

Terry Pegler: "I ordered the Crane XR/700, part number 700-0300 conversion system; it arrived the other day. The instructions on Page 1 state "If the distributor has a 3 terminal connector it is an OPUS system and you can proceed. If the distributor has a 2 terminal connector, it is not an OPUS system and you must use Crane HI-6R part number 6000-6400." Unfortunately, Pegler was replacing his CEI system due to a severely mangled star wheel and therefore had to wait until he could obtain that additional Crane part to get his car running again.

Of course, if you're a performance enthusiast, you might wish to replace the Lucas CEI with something more sophisticated or flexible. Most owners would not be enthused about upgrading to the later Marelli system because it's too expensive and failure-prone, but there are modern aftermarket systems that have all sorts of features. See the discussions on upgrading the Marelli on page 167; any of those systems could replace the Lucas CEI as well.

Marelli Ignition

MARELLI IGNITION: In this age of electronic wizardry, many modern cars have done away with the mechanical centrifugal and vacuum advance mechanisms and do the whole job with microprocessors. In some cars, the distributor is done away with altogether, and separate ignition coils are used instead.

Since Jaguar incorporated the Marelli ignition system in 1989, this is essentially the type of system used. There is no centrifugal or vacuum advance mechanism; the timing is all done electronically. However, rather than using lots of separate coils, the distributor was kept, using two coils and directing the spark mechanically. This distributor is clearly lacking many of the internal parts of the earlier models, since it no longer handles the timing functions. The rotor is actually two rotors in one, and the cap is two six-cylinder caps in one, so each coil is operated as though it is running a six-cylinder engine. The computer that handles the timing is located near the passenger's feet, and has a vacuum line to it.

The source:

Magneti Marelli S.p.A.
Viale Aldo Borletti, 61/63
20011 Corbetta (Milan) - Italy
+39-2/972001 FAX: +39-2/97200355
<http://www.marelli.it:80>

As of this writing, this WWW site doesn't have anything on the XJ-S ignition system; only general info on the company.

MARELLI OR NOT? If you don't know if you have a Marelli ignition system or not, measure the diameter of the cap. If it's around 4-1/4", it's a Marelli; the Lucas cap is about 5-1/2" in diameter. You can also check the height from the

mounting surface of the cap to the top of any one of the 12 spark plug wire connectors around the edge; the Lucas will measure about 2-1/4" while the Marelli will measure about 3-1/8".

If these descriptions aren't good enough, you can try looking at pictures at:

<http://www.jag-lovers.org/xj-s/book/LucasMarelli.html>

EFI TRIGGERING: The Digital P fuel injection system, in use on the Jaguar V12 since 1980, is triggered by the ignition system. With the Lucas OPUS and later with the Lucas CEI, this signal was taken from the - terminal of the coil, with a resistor in the line to limit spikes to the electronics. The Marelli has two coils, each of which see six cylinders of pulses, so the ignition ECU itself includes circuitry to provide a suitable signal to the EFI. Don Neff says, "This signal is carried by a small shielded wire from pin 24 of the ign ECU to pin 17 of the EFI ECU.

"The power amps above the radiator do not have any feedback, but the two ign coils each have one. The feedback from the A-bank coil goes to the tach and the feedback from the B-bank coil goes to the diagnostic socket. The engine continues to run if either ign amp is unplugged." As a result of the tach getting a signal from only one coil, a six-cylinder tach is used.

SIII XJ12: For some reason, the Marelli ignition system was not introduced in the XJ12 until the XJ40 version model came out in 1993. Roger Bywater adds, "What may not be so obvious is that the saloon standardised on the low compression engine at the same time that Marelli was introduced on the XJ-S. It is interesting that while the non-cat Marelli XJ-S used a completely different fuel map (DAC 6338) from other engines the non-cat saloon stayed with the same mapping (DAC 6336) that was used for the previous high compression engine. The cat saloon used the same ECU as had been used on the pre-Marelli / Lucas / cat low compression XJ-S (DAC 6335)."

CAP VENTING: The Marelli distributor is vented in the same manner as the Lucas distributor (see page 140), except that the vent connections are on the base rather than on the cap. Since there are no centrifugal or vacuum advance mechanisms, there are fewer reasons that Jaguar would have decided to provide this system. Either the cap needs cooling to prevent cracking, or explosions can be the result of fumes building up.

TUNE-UP PARTS: There is supposed to be a gasket under the Marelli cap, but the new cap doesn't come with one. Part # JLM-1910. Reportedly atrociously expensive, just like the cap itself.

TIMING: You don't really wanna adjust the timing on this thing, do you? Randy Wilson describes the XJ40, which is similar: "Spark timing is not easily adjustable. This car has a crank triggered digital ignition system. Timing changes would require moving the pickup and/or modifying the ECU."

On the other hand, there are two different timing maps built into the ignition ECU. Michael Neal says: "There is a nifty little jumper on the harness at the back side of the left intake manifold. Pull this sucker and your timing retards, perfect for those trips to Mexico. Usually the connector is red."

Mike Wilson quotes from a Jaguar manual: "Map Link Selector- This link permits the selection of either of (2) ignition maps contained in memory. If the link is in place the ignition map suitable for 95 Octane fuel is selected, and if the link is removed the ignition map suitable for 91 Octane fuel is selected."

Mike Wilson continues, "To find this "link" look behind the lefthand intake manifold. This link (barrel shaped and with two wires coming out of it. One is yellow, the other black) is usually wire tied to the Diagnostic Socket."

DISTRIBUTOR POSITION ADJUSTMENT: Randy Wilson, still talking about the AJ6 engine: “Jaguar has a special jig for doing this, but it’s not really needed. The whole purpose is to make sure the rotor is pointing to a wire lug no matter what the current computer-chosen timing is. On normal dizzies, the centrifugal advance moves the timing up... but it also advances the rotor by the same amount, as they are attached. No such luxury with the crankfire system.

“First mark the dizzy body directly in line with the #1 and #6 plug wires (note: 1A and 6A on the V12). Then remove the cap. Bring the engine up to TDC, noting which way the rotor turns. When you reach TDC, the rotor should be pointing at one of the two marks. It doesn’t matter which one (why we marked both). Now turn the dizzy body until the mark is just past the trailing edge of the rotor contact. Just past it, not more than a degree or two. In this position, the rotor contact will line up with the wire lug in cap in the timing range of about 5 to 40 degrees before TDC; the operative timing range of the engine.

“If the adjustment is off very far, the results will be subtle. The most likely thing is the rotor and cap will tend to burn a little uneven...biased against the direction of misadjustment. The cap and rotor will “wear out” a little faster. If the misadjustment is extreme... and I’m not sure it’s possible on the AJ6, there will be a misfire at the extreme end of the timing curve as the spark has to jump a pretty large gap inside.

“Next time, mark the position before you remove the distributor. This is one of those rare cases where “close” is good enough.”

Regarding the Marelli on the XJ-S: “Yep, ‘tis the same ideas and principles. I’ve never actually had to pull a Marelli distributor, so I can not comment on the *exact* position. You would mark 1A and 6A... and set things so the rotor sweep-by happened in the 10 to 30+ before range.”

MARELLI-CAUSED DISASTERS: The combination of Marelli ignition and catalytic convertors can, and often will, result in the destruction of the catalytic convertors and possibly the whole car. This is *not* a section of this book to be glossed over lightly! If you have a car with Marelli ignition and catalytic convertors, you need to take a proactive role in making sure your car doesn’t become a burned-out hulk in a junkyard somewhere.

CATALYTIC CONVERTOR MELTDOWN/FIRE (ONE-BANK FAILURE): While any misfire is a cause for concern with catalytic convertors (see page 297), the Marelli ignition system provides a unique and especially threatening possibility: running on six cylinders. While the various Lucas ignition systems were single 12-cylinder ignition systems, the Marelli is actually two separate 6-cylinder ignition systems. Hence, it is possible -- probable, even -- that sooner or later one of these ignition systems will fail while the other continues working. Since each half of the ignition system operates one bank of the engine, one entire half of the engine, along with its dedicated catalytic convertors and oxygen sensor, may see no spark all of a sudden while the other bank continues to run normally.

The V12 can be accurately described as two six-cylinder engines; each bank has the same firing order and the same natural balance as an inline six-cylinder engine (note: conversely, a V8 is *not* two four-cylinder inline engines). Hence, the V12 is actually driveable on six cylinders; rather than a “misfire”, it runs quite smoothly, and drivers who have not read this section may decide it’s not too serious and press on. According to LaRue Boyce, symptoms to look for include: “Loss of power, more gas smell but no noise, just the no power feeling. Oh, the loss of vacuum also causes the transmission not to want to shift. You will know when it happens, there is *no* power, just enough to get you to 45mph on flat ground.” Julian Mullaney says, “When my car started running on 6 it was *very* noticeable. I thought that the tranny was slipping at first because I had to give it so much throttle to get it moving.” Note that, with the typical failure mode described below, this typically happens all at once; there is no intermittent operation where it runs well most of the time and drops to low power on occasion. Once a bank shuts off, it’s gone for good.

Considering that people have been known to drive with seized centrifugal advances, inop vacuum advances, kickdown switches that don’t work, one of the two intake butterflies disconnected, or various other problems, perhaps it shouldn’t come as a surprise that some people would continue to drive with the engine only running on half its cylinders. There are lots of people driving around every day with their dashboards lit up like Christmas trees, and many drivers seem to feel that such things as idiot lights or drastic reductions in power are cause to visit a mechanic within a month or two,

whenever they get some time or money to spare. Unfortunately, the Marelli-equipped Jag V12 appears designed to remove such drivers from the gene pool!

Running a non-cat V12 with no spark on one bank fills the inop side of the exhaust system with fuel -- a disaster looking for a place to happen. Since the XJ-S exhaust system loops up and over the rear suspension, it should be able to hold several gallons of fuel before it starts pouring out the tailpipe! Since there is no spark in that bank at all, the owner might just get away with it -- but he'd better hope his ignition system doesn't mysteriously start working again! The same goes for a cat-equipped car that had an ignition failure when started from cold; the cats won't work when cold, so the fuel in the exhaust system on that side may never be ignited.

If the car is equipped with catalytic converters and they were hot when the ignition failure occurred, the cats will burn the fuel as it arrives, not only keeping them at operating temperature but getting considerably hotter in a big hurry. What's worse, if the car continues to be driven, more throttle will be applied to get any speed out of it, so even *more* fuel and air will be dumped into these cats. The inevitable result will be a cat meltdown within seconds. What's worse, often the cherry red-hot catalytic converters will ignite something, perhaps by melting through the fuel hoses that are above and not too far away. The car is immolated so fast you'll barely have time to pull over and get out.

You don't want to be driving on six cylinders, not even for a minute.

If you were dozing when you read those last few paragraphs, pinch yourself, clear your head, and go back and read them again.

DISTRIBUTOR ROTOR PROBLEM: Unfortunately, a one-bank ignition failure turns out to be a common occurrence on Marelli-equipped V12 Jags. Although anything that kills one side of the Marelli ignition system can cause the car to run on six cylinders and threaten a cat fire, there is one possible cause that clearly outweighs all others in terms of frequency of occurrence. Randy Wilson: "The most common failure, the one that *kills* the A bank, is the center post of the rotor burns through, allowing a ground path from the rotor contact straight to the distributor shaft." This characteristically results in a fire or meltdown in the right side cats only, since it is always the A bank ignition system affected. For a photo of a cut-away rotor that suffered this failure, see

http://www.jag-lovers.org/xj-s/book/Marelli_pix.html

CHEAP AFTERMARKET PARTS? The frequency of this failure has been blamed on aftermarket rotors. It is true that some of the aftermarket rotors are *highly* susceptible to failure, and have been known to fail within only a couple thousand miles after installation. Note, however, that similar rotor failures have been reported in genuine Marelli parts as well -- it just takes longer. No matter which rotor you obtain, you need to be aware of the symptoms of failure and know to pull over and shut the car off immediately.

It is a simple matter to tell if you have genuine Marelli parts: they say "Marelli" right on the part. Being marked "Made in Italy", coming from a Jaguar dealer in a Jaguar box with a Jaguar part number, or costing a king's ransom are *not* indications of the genuine article, because many of the knockoffs are made in Italy (the genuine Marelli items may actually be made in the UK!), Jaguar apparently offers any and all of them under their part number, and they are *all* expensive.

Rumors have been circulating for years that Marelli has ceased making the genuine articles and once the stock is used up only the aftermarkets will be available. These are apparently false rumors as of 2002. It's bound to happen eventually, though; even if Marelli is still making caps and rotors now, they will cease making them sooner or later -- the V12 has been out of production for years.

CORRECTIVE ACTION: There are many things the owner of a Marelli-equipped car can do to improve the situation, as described in the next several pages. Many of these actions address the tendency of the rotor to burn through. However, the owner should be aware that even if the Marelli system is rendered extremely reliable, it still inherently has

the potential of causing a one-bank failure and resulting catalytic convertor fire. The *only* way to eliminate that possibility entirely is to replace the ignition system in entirety, as discussed on page 165.

Since that is an expensive and involved proposition, for most owners the choice of action will be to take a few minor steps to minimize the chances of failure and simply be aware that a sudden loss of power is a good reason to pull over and shut it off. Other than the cap and rotor, the Marelli system is fairly reliable. If we can address the cap and rotor problems, perhaps the risk of cat fires becomes acceptable. Cat fires caused by one-bank failures might still be possible, but if the one-bank failures are very rare it might cease to be an issue.

CARRY A SPARE: You do *not* want to be stranded with a rotor failure, because that might tempt you to try to drive the car. Carry a spare rotor and the tools needed to install it. Learn how to replace the rotor at roadside, even if you normally don't do mechanical work yourself.

SCHEDULED MAINTENANCE: Don't wait for trouble before getting a tune-up. Replace the cap and rotor per the schedule recommended in the owner's handbook.

SPARK PLUG GAPS: When the ignition system turns off the current to the coil primary, the collapse of the magnetic field in the coil causes a rapidly rising voltage in the secondary (high-tension) winding. When the voltage is sufficient to jump the gap at the plug (and between the rotor and cap terminals in the distributor as well), it does so, and the voltage never gets any higher. This is why it's bad to have the ignition system operating without a spark plug connected; the voltage continues to rise and has nowhere to go, so it may reach high enough levels to damage electronics or to jump to somewhere *other* than at the spark plug. Similarly, if the plug gap is too large, the spark will require a higher voltage and will stress the dielectric strength of the rotor that much more.

LaRue Boyce says, "The Marelli gap is 0.025" or at least the decal on my '91 says so." However, some mechanics have been known to simply install the plugs with the gaps they come out of the box with, which usually means around 0.035". Even worse, too many outfits are disseminating bad info; Donald Anthony says, "I've been checking around for parts for the last few days and all (100%) of the spark plug sellers (napa, oriellys, pep boys, and all the local foreign parts guys) told me the proper gap is .035". I even saw it on their computer screens for all brands of spark plugs."

0.035" gaps are most certainly contributing to the frequency of Marelli cat meltdowns. If you don't change your own plugs, you might want to have a brief but serious discussion with your mechanic on this issue; see page 116.

ADDRESSING THE ROTOR PROBLEM -- POTTING: The problem is that the spark voltage is breaking through the layer of plastic in the center of the rotor and getting to ground via the shaft. The opening in the bottom of the rotor isn't just a simple hole the shape of the top of the shaft; it's actually an asterisk-shaped hole that contacts the hex-headed shaft only in the center of each flat, leaving a convoluted air pocket surrounding the top of the shaft. The arc seems to break through the plastic into this space and run along a surface of the plastic until it gets to the shaft. So one solution is to make it harder for electricity to go that route -- by adding insulating material in its way. In other words, we need to fill the space surrounding the metal shaft with something that won't conduct electricity -- a "dielectric" material.

There are several ways to add insulating material in this manner; in fact, there are products made specifically for "potting" electrical components. However, the simplest tact for use in this case was suggested by Julian Mullaney: "Why not just put a nice big squirt of RTV silicone in the new rotor just before installing it? Of course you would need to take care that air bubbles were not trapped in the cavity prior to installation. I think an excess amount would encourage air voids to be expelled (of course clean up excess ooze). It would form nicely around the complex rotor shaft, and cure in place. Most importantly, it would remain compliant, therefore not exerting any stress on the rotor. I would wipe some oil on the distributor post first so the RTV will not stick to the metal, thus allowing easier removal of the rotor at a later date."

Of course, this won't do any good if silicone isn't any good as a dielectric. So Mullaney "consulted with one of our resident Ph.D. material scientists to find the best dielectric barrier material for the interior of the Marelli distributor rotor. He (Trey Simendinger) prefers a silicone RTV material because it bonds well to the substrate, and will not delaminate due to temperature fluctuations. He recommended a GE brand silicone RTV standard window caulking material from a hardware store. Get a clear one because this will have no filler in it (better dielectric properties)." A clear material has another advantage: you can see any air bubbles. "Typical dielectric breakdown is 400 v/.001 inch for silicones versus ~200 v/.001 inch for air." Note: the dielectric properties of air are probably not the problem; it's more likely a film or dirt layer on the inside surface of the rotor or the general buildup of ozone within the distributor as a result of the arcing at the ends of the rotor, either of which can result in a dielectric strength far less than that of clean air.

"He says to wash the part with soap and water first to ensure a good bond of RTV to the plastic rotor material. He did not recommend potting compounds because they consist largely of filler materials like calcium which reduce the dielectric breakdown voltage and they do not bond well."

Another idea may be Permatex Flowable Silicone Windshield Glass Seal. It's clear, and it flows -- unlike most sealants (it's about the consistency of honey). The flowing is good because it will help get down into the nooks and crannies inside this rotor.

Larry Barnes tested this idea by potting a rotor that had already failed: "I used a clear silicone RTV sealant after cleaning out the black/burnt crud of the burned-through rotor and reinstalled it...works great!" Of course, for regular operation it's not recommended that RTV be used to repair burned rotors but rather to prevent burning on *new* rotors.

ADDRESSING THE ROTOR PROBLEM -- SHORTENING THE SHAFT: Since it is really the flange and two screws that hold the rotor in place, it's a good idea to cut part of the top of the shaft off. Enough should be left to center the rotor before the screws are put in, but it doesn't need 1/4" to do that. If the 1/4" high hex is cut down to 1/8" high it will still work, and that makes 1/8" farther that pesky spark has to jump to cause a short. If you then add silicone as described above, that's 1/8" more silicone the spark would have to burn through. Since the silicone has a dielectric rating of 400V per .001", adding about .125" of silicone will increase the number of volts the rotor can withstand by about 50,000!

Bob Krulish suggests cutting the shaft back even farther. "Cut off the end of the distributor shaft all the way to 1/8" below where the top of the rotor support sits. This would leave a 1/8" deep pocket when assembled. Make a shaft from Macor (machinable ceramic) 10mm in dia and long enough to seat into rotor with just less than 1/8" extending out (leaving a boss or pilot). Push the new macor shaft into the rotor and pot with silicon RTV."

ADDRESSING THE ROTOR PROBLEM -- SPACERS: Joe Bialy came up with another idea. Using some plastic stock of some particular thickness, fashion a spacer to hold the rotor higher -- and fashion another spacer to hold the cap the same amount higher, so the two line up with each other as intended. By spacing the rotor higher, it is moved farther away from the metal shaft -- and ideally more dielectric material is installed in between.

The spacer thickness should probably be between 1/4" and 1/2". Obviously, the plastic stock should be chosen to survive the environment, which includes temperatures near 100°C and exposure to hydrocarbons (oil and gasoline).

The spacer for the cap should be easy enough. From flat plastic stock, simply cut a ring with an ID of 3-3/4" and an OD of 4-3/4". Lay the distributor cap gasket on this and use it as a template to drill three holes. Install the cap using longer screws and two cap gaskets JLM-1910.

The spacer for the rotor is likewise pretty easy. From the same plastic stock, cut a ring with an OD of 2". Drill a hole in the center that fits snugly around the hex on the shaft. Use the rotor itself to locate and drill the two bolt holes; you'll need to make these holes large enough for the brass collars built into the rotor to sit down into.

If you want to get schnazzy, you could provide a plastic plug sticking up in the center to locate the rotor. However, it's not really necessary; the two screws will locate it adequately. You do want to fill the hole, though. So, during installation, pour the rotor *and* this hole full of silicone sealant. You'll need longer screws.

Again, cutting the top of the shaft down 1/8" will only help.

These spacers should last the life of the car. Whenever you're replacing the cap and rotor, just clean them up and put them back in.

In fact, you might consider potting the spacer under the rotor with JB Weld -- permanently affixing it to the distributor shaft.

AFTERMARKET DISTRIBUTOR CAP PROBLEM: Besides the problems with the rotor, there are also problems with Marelli distributor caps. However, these problems appear to only occur with aftermarket caps, and only certain ones; some care when purchasing should avoid trouble, as discussed below.

The problems with the cap soon become obvious: the cap chars and melts from the inside out around the base of the center post where the A bank coil wire plugs in. To see some photos of such problems, see

http://www.jag-lovers.org/xj-s/book/Marelli_pix.html

On the cheaper aftermarket cap, the carbon brush fits into an opening in the plastic of the cap at the top on the inside. There is a spring behind this carbon brush to hold it against the top center of the rotor. Inside the hole, there is an aluminum terminal built into the plastic that the spring pushes against and the wire snaps into on the topside. So, the spark from the coil comes through the wire, into the aluminum, through the spring, into the carbon, and on into the rotor, all by direct contact. The only arcing going on in the vicinity is out at the tip of the rotor.

The primary problem with the aftermarket cap is that the spring behind the carbon brush on the center electrode isn't long enough. If this brush is pushed all the way up into the cap, it barely comes back down to flush with the surrounding plastic. As a result, the carbon won't actually contact the top of the rotor, and the ignition pulses will be arcing from the carbon to the rotor -- perhaps aggravating the already weak rotor.

But the worse problem results if the carbon brush is *not* pushed up into the cap. Since the spring is too short, it doesn't make it all the way to the aluminum terminal. Instead, a wide spot in the spring fits snugly against the ID of the hole in the plastic, and acts like it is securely installed. Although it looks good to the mechanic, the ignition pulses will now have to arc inside the hole between the aluminum terminal and the upper end of the spring. This will chew up the spring in a hurry, making the gap get larger and larger -- and the arcs will heat things up in that little chamber, eventually melting the plastic and burning through the cap.

Obviously, as a minimum fix, the carbon brush and spring should be pulled out of the cap, separated, and the spring stretched. The spring is a loose fit in the hole at both ends, but there is a wide portion in the middle that fits snugly in the hole. You will find that twisting the spring counterclockwise makes it easier to remove and reinstall in the hole; a counterclockwise twist pulls the coils a little smaller. To get the carbon brush to snap in and out of the spring, turn it clockwise; a clockwise twist makes the spring coils larger. When done, the carbon should protrude at least 1/4" from the plastic each time it is pushed back and released. If you have a VOM, check the ohmage between the carbon itself (without compressing it back into the cap) and the electrode up on top. It should be well under 1Ω , but it won't be zero because carbon isn't really that good a conductor. If it's an open circuit (infinite ohms), you didn't get that spring seated against the electrode; pull it apart and try again.

While the spring stretch might render the cheap aftermarket cap workable, there is a far better fix: making sure the hole for the brush features a metal sleeve rather than simply being a hole in the plastic. Thus, the spring will make a good contact with the terminal whether it reaches the bottom of the hole or not; the wide portion contacting the sides of the hole serve as electrical contact. It also protects the plastic from heat, wear, etc. And the spring seems to be easier to install properly, since the wide portion is sliding on smooth machined metal rather than molded plastic.

This is an easy fix on the part of the manufacturers; they merely have to redesign the aluminum terminal to include a sleeve that extends all the way to the inside surface of the cap. And, believe it or not, they have made this fix. Andy Klopfenstein reports that "Apparently the manufacturer discovered the apparent flaw we have seen in the cap. This new cap has a different inner aluminum cross section. The new inner aluminum shank now comes all the way to the bottom of the center post (inside cap). You can see it when you look at the contact button. The contact button now slides up

and down in the aluminum shank." Hey, even the aftermarket caps aren't cheap; since you're spending good money, make sure you can see aluminum around the carbon brush within the cap as Klopfenstein describes before paying for a new cap.

If you are unable to find an upgraded cap or have a relatively new pre-upgrade cap and don't wanna throw it away just yet, the following fix to the pre-upgrade aftermarket cap is easy: Remove the carbon brush and spring. Fit a 9/32" bit into the drill, preferably a variable-speed critter so it can be run slowly. A drill press might also be helpful here. Drill right down the center hole inside the cap until you get to aluminum. Keep drilling until you are drilling the *bottom* of the hole, not just the sides. Then take a piece of 1/4" ID brass tubing (available at better hobby shops) and bevel one end's OD edge with a file. Poke this end into the hole, set the cap down on a firm surface, and tap the other end of the tube with a hammer until it seats securely in the bottom of the hole. If it fits tight, great; if it fits too loosely, pull it back out and apply a little JB Weld around the outside of the tube about 1/2" from the end (not at the very end!) so that it is smeared into the edge of the plastic as the tube is driven home. Let it dry. Then, using a Dremel with a cutoff wheel in it, cut the tubing off flush with the surface of the plastic. Clean up the edges a bit, then reinstall the spring and brush.

Regardless of what type cap you end up with -- even a genuine Marelli -- it wouldn't hurt to stretch the spring as described above, just in case.

THAT'S NOT ALL: George Schulte says, "I came out of a store after 15 min of shopping to see smoke billowing out of my hood. When I opened it the flames were pretty well involved. Luckily a fire extinguisher was close at hand. The fire began from the center of the distributor cap. The lighter cap besides being cheaper and lighter is also flammable. I noticed some arcing around the center hi voltage lead but didn't think too much at the time because the car was running fine. The plastic is not hi temp and the entire cap caught fire which spread to the rest of the wires in the area which spread out and melted the fuel hoses."

REPLACING THE DISTRIBUTOR: One method to eliminate the cap and rotor problems would be to eliminate the suspect cap and rotor altogether by replacing the Marelli distributor with two generic 6-cylinder distributors. Connect each coil to one distributor cap and connect the plug leads accordingly, and you'll be good to go. Since the timing is actually handled by the crank and flywheel pickups, coordination of two separate distributors is not a problem; they merely need to be close enough for the spark to jump to the correct terminal. One other plus: if you choose the right 6-cylinder distributors, caps and rotors will be a *lot* cheaper than the Marelli parts -- even buying two of each!

Really silly idea, right? Well, before you dismiss it out of hand, note that Mike Morrin points out that the Jaguar V12 was apparently designed for dual distributors! If you pull off the valley cover, you will find an extra bore for the jackshaft. The valley cover itself has a boss for a second distributor underneath the turntable pedestal, although it's not drilled. So maybe it's not such a silly idea after all.

Not easy, though. If you make this modification, you're gonna face two challenges: 1) coming up with a longer jackshaft with two distributor drive gears on it; and 2) devising a throttle linkage when you have a distributor where the turntable pedestal once stood.

Alternatively, it's been suggested that dual 6-cylinder distributors could be installed by fabricating a suitable base that mounts in the vee with a shaft driven by the OEM gear and a small toothed belt drive system to drive the two distributors. Or maybe a gear train. If the system requires lubrication, you could thread a fitting into an unused boss on the oil sender pedestal and run a tube feeding oil to this box, and design it to drain directly into the engine.

Interestingly, if you go this route, you may not need to buy two 6-cylinder distributors; you may only need to buy the caps and rotors. Simply design the drive system to hold the rotors and caps. There's no need for vacuum or centrifugal advance mechanisms and there's no need for points or a pickup. There's not even much need for a way to turn the distributor to line up the timing; just set the drive up so each rotor points at a cap terminal when a piston in that bank is at 10° BTDC, plug the wires in the right holes, and forget about it.

If you're really sharp, you might be able to devise this drive system to be really flat, holding the 6-cylinder caps only an inch or so above the valley cover. Then you can locate one where the OEM distributor was and the other one directly rearward, and devise a way to hold the turntable *above* it.

REPLACING THE DISTRIBUTOR #2: It might actually be possible to replace the Marelli distributor with some other type of 12-cylinder distributor. And we know where to find one that will fit perfectly -- the Lucas distributor! It'll bolt right in.

There is one problem, however: how to connect the outputs of two separate ignition coils to the single center post on the Lucas distributor cap. I wouldn't even have mentioned this entire possibility if Charlie Welkie hadn't pointed to the solution: an MSD Automatic Coil Selector, part number 8210. This item has suitable diodes inside, so you merely connect the HT leads from the coils to two terminals and connect a third HT lead from the third terminal to the distributor. Couldn't be easier.

You might also opt to just buy suitable diodes. There are reportedly diodes used in televisions, computer monitors, and microwave ovens that are rated at 15KV or more, and sell for only a couple of bucks each.

Even though it's not involved in timing, you should maintain the centrifugal advance mechanism in the Lucas distributor. The terminals are only 30° apart in the Lucas cap (as opposed to 60° apart in the Marelli cap), so it's helpful to have the centrifugal mechanism keeping the rotor tip aligned with the terminals in the cap throughout the advance range. You can discard the vacuum advance hardware. Obviously, you can discard the Lucas CEI pickup and star wheel. If you happen to use an early model distributor, you can discard the OPUS pickup and plastic rotor. You can discard the trigger board if there is one.

Before removing the Marelli distributor, position the crank at TDC on 1A, which is indicated by a mark on the front damper lining up with the sensor at the bottom. Pull the cap off and make sure the lower tip on the rotor points towards the notch in the housing; if it points the opposite way, turn the crank one full turn.

You need to position the Lucas distributor correctly, and you won't be able to use a timing light to do it. With the crank at TDC on 1A, position the distributor so that the trailing corner of the rotor tip lines up with the 1A terminal in the cap. It doesn't require great precision since it's not determining actual ignition timing; it's just making sure the rotor is positioned close enough that the spark can jump the gap.

Note that the spark plug wires do *not* go in the same places on the cap. On the Lucas cap, the 12 wires go in firing order. They do not on the Marelli; they are switching back and forth across the cap. #1A is marked on the Lucas cap, and the firing order is counterclockwise looking down, 1A-6B-5A-2B-3A-4B-6A-1B-2A-5B-4A-3B.

The distributor ventilation scheme connected to the base of the Marelli distributor, but connects to the cap on a Lucas. Reconnect accordingly.

After you've driven the car a while, pop the distributor cap back off and check where the arcing is etching the tip of the rotor. If it's distributed along the tip of the rotor, just put the cap back on. If the arcing is concentrated on one corner, turn the distributor a bit to try to get it towards the center of the tip. Clean the tip up a bit so you can check it again later. It may take a couple of tries to get the position right, but once you do you should be able to forget it for the life of the car.

Not only will this "retro retrofit" avoid the Marelli rotor and cap problems, but it's also likely to save the owner some money! A used Lucas distributor plus the MSD Automatic Coil Selector probably won't cost much more than a new Marelli cap and rotor, so it can be done instead of the next scheduled tune-up. And the *next* tune-up will be a bunch cheaper -- and you can even postpone it a long time, since the Lucas cap and rotor lasts nearly forever.

Unfortunately, MSD reports that the diodes within their Automatic Coil Selector are only rated at 12KV. In all likelihood this means it'll work fine, but if you ever disconnect a spark plug wire while the engine is running it'll probably fry something. It'll most likely fry the Automatic Coil Selector itself, and it might go farther and fry one or both of the Marelli ignition amps as well. Of course, this might still be a preferable situation to the Marelli cap and

rotor, which may fry the *car*. Just remember: if you make this mod, make sure to never run the engine with a plug wire disconnected. You might even want to make up a warning label to that effect.

DETECTING IGNITION FAILURES: As soon as the Marelli failure mode was discussed and understood on the online xj-s discussion list, several members proposed methods to detect such a failure and thereby avoid disaster. Andrew Corkan promptly designed a dirt-cheap circuit for detecting whether or not there are sparks going to each bank and providing a warning indication if they are not -- see **Figure 11**.

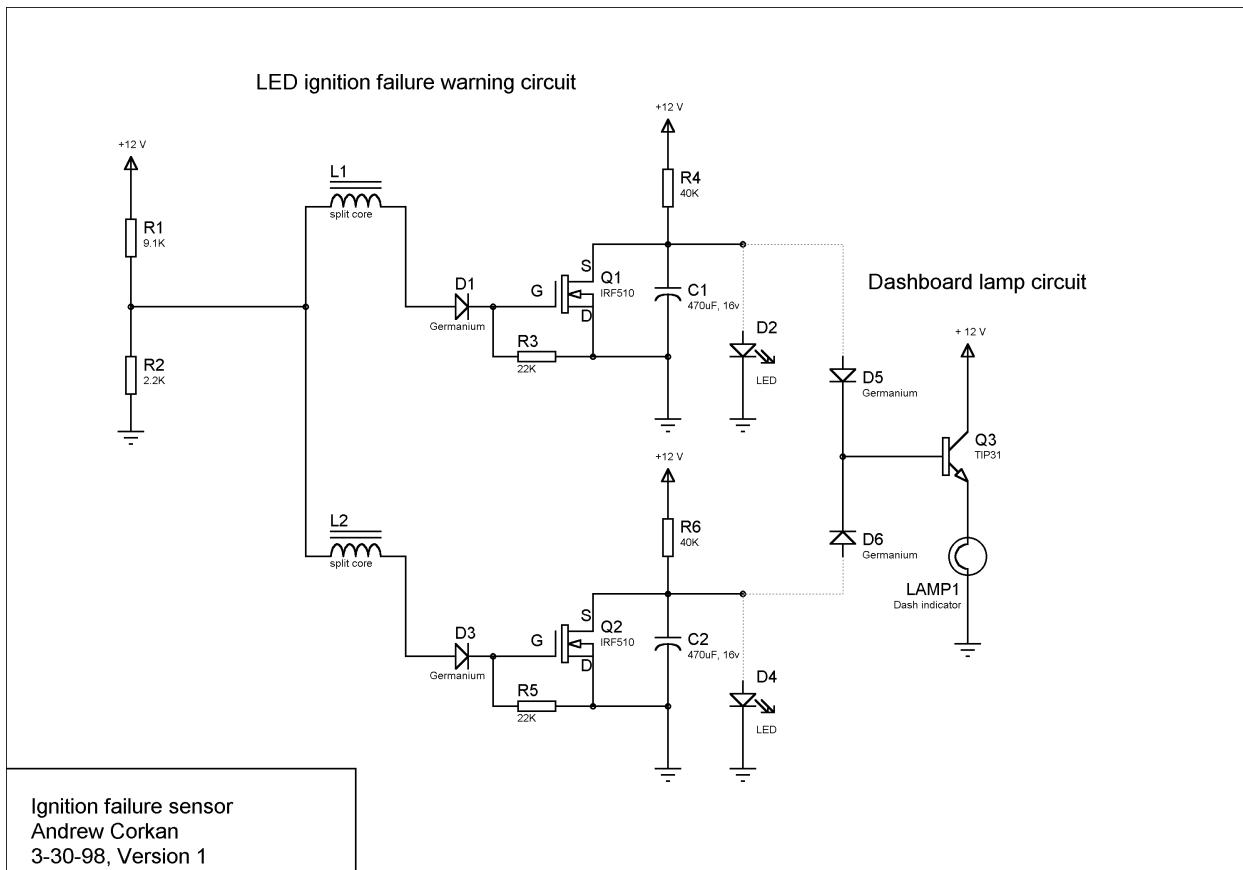


Figure 11 - Ignition Failure Sensor

Corkan describes his creation: "The circuit detects a spark in either bank by means of an induction pickup placed on a plug wire, similar to the ones used by tune-up timing lights. When a spark pulse is detected it shorts out an RC circuit that would otherwise cause an LED to light up."

"You have to make your own inductive pickup using a so-called RF choke (really just a two-part inductor core) and magnet wire. Open the core and remove half of it from the plastic holder. Wrap 50 loops of magnet wire around the half of the core still in the plastic holder. You do not want the magnet wire exposed in the engine so solder regular wire to it and pot that half of the pickup sensor, magnet wire and solder joint in RTV. The wires you solder on should be long enough to reach into the car where you will place the circuit. Replace the rest of the choke when you install it around the plug wire. The choke will fit around the plug wire, no need to remove the plug wire."

"There are two options for hooking up indicator lights (see dotted lines in circuit schematic). The first option is to use LED's. Just wire them as D2 and D4 and bring the wires into the interior. Kirbert⁴ suggested a second option of using the 'trailer' bulb in the dash as an indicator light. For this option you can wire up D5 and D6 to the base of Q3, which will in turn power up a 12 volt lamp." Note that in this latter case, a spark failure in either bank will light the same light; arguably, the driver doesn't really care *which* bank just failed, as long as the light tells him a bank just failed (with the Marelli rotor failures, it's always the A bank that fails). The owner may choose to use the trailer warning light, the seat belt warning light, or any other 12V light he wishes, and he may want to relabel the indicator accordingly, color it red, etc.

"All references in the schematic to "+12V" are to a switched (accessory) power source. When you hook things up you should see the lights come on when you move the key to 'accessories' but they should turn off as soon as you start the engine." Hence, no need to provide a separate bulb check circuit.

"All the parts for this circuit are available from Radio Shack (but our overseas friends should have no trouble finding these parts). In addition to what is listed here you will need wire to run from the sensors to the box you put the stuff in, and wires to run the LED's or the signal light into the dash (if you use that option). You will also want to get a small circuit board or breadboard and a little plastic box to put the circuit into; a 3 in. x 4 in. box is just fine."

<u>Part #</u>	<u>Value/type</u>	<u>Radio Shack #</u>
R1	9.1K	
R2	2.2K	
R3,R5	22K	
R4,R6	40K	
C1,C2	470uF, 16v	272-957
Q1,Q2	IRF510, N-Channel MOSFET	276-2072
Q3	TIP31 NPN Transistor (option B)	276-2017
D1,D3,D5,D6	Germanium Diodes	276-1123
D2,D4	LED, any kind will do (option A)	
L1,L2	RF choke (two part inductor cores)	273-104
LAMP1	Lamp on the dash (option B)	
Magnet wire	any kind will do	278-1345
Wire	any kind will do	
Box and board	any kind will do	

"It is easy to build, all you need is a soldering iron. It will monitor both banks and turn on a light if there is a Marelli boo-boo."

Different colored D2 and D4 LED's may be used for the indicator lights to indicate which bank, or red could be used for both to indicate trouble. As shown, the circuit monitors one plug wire (chosen at random) on each bank. One plug wire on each bank would be enough to detect the common Marelli failure (really, you might as well save your money on circuit components and just build one circuit to monitor the A bank), although you could get carried away and build 12 circuits instead of the 2 shown and install a complete set of 12 LED's if you wanna really be sure you detect any possible problem.

Corkan goes into more detail for those interested: "The circuit uses two identical channels for each bank. Pulses from the inductive pickups trigger the MOSFET transistors (Q1, Q2), which are sensitive to voltage. They are pretty standard N-channel MOSFETS that will trigger at about 3.0 - 3.5 volts. To make sure they work reliably with the faint pulses coming from the sensors, R1 and R2 provide an offset voltage of about 2.5 V. (If you can not locate the right MOSFET you may have to change the values of R1 and R2, they should be selected so they bias the sensor pickups to 1.0 V less than the MOSFET needs to trigger.)

The diodes (D1, D3) are very important. The diodes keep the voltage pulses from going back down the sensor wire, forcing it to drain more slowly through R3 or R5. Germanium diodes have a small voltage drop, unlike standard diodes.

⁴ "Kirbert" is Kirby Palm's online pseudonym.

If you do not use Germanium then you will need to increase the bias voltage on the sensors by about 0.5 V to make up for the additional voltage loss.

Each time the MOSFET's fire they short out the RC circuit formed by R4 and C1 (also R6 and C2). This RC circuit takes about two seconds to charge, and when it does voltage then flows into D2, lighting it up and warning the driver (or flowing through D5 to the NPN transistor which lights the lamp, etc...). When a pulse hits Q1 (or Q2) it drains C1 (or C2) preventing the indicator circuit from ever getting enough voltage to light. As long as there is a steady supply of pulses the RC circuit never charges and the light never lights."

The polarity of the pickups on the plug wires makes no difference, since the pickup will put out a voltage pulse in one direction when the spark starts and a very similar pulse in the opposite direction when the spark stops. Corkan: "...and thus the reason for the first diode. In fact the circuit is sensitive enough that polarity will not make a difference, even though you can see a small difference in the signal on an oscilloscope."

An alternative warning system idea would be to detect the overheating of the cat itself, as discussed on page 297. This has the advantage of indicating a problem no matter what the cause.

AUTOMATIC SHUTDOWN: Once you have some sort of failure detection system that will tell you that the Marelli has quit firing one bank, there is still the question of what to do with the indication. You could provide an idiot light, but anyone that drives despite a sudden lack of horsepower may likewise drive despite a warning light; some XJ-S owners allow others to drive their cars and don't want to have to lecture them on the importance of a particular idiot light each time. Another possibility is to have the sensor shut down the car. If Corkan's ignition monitoring circuit can light one of the dash indicators, it could just as well be used to operate a relay to shut off power to the ignition -- but you'd have to install the relay so that it doesn't cut off the ignition when the ignition switch is in the "start" position or you'll never get the car started. The OEM starter relay has a contact that will work perfectly, left over from the days when a ballast resistor was used with a coil but was bypassed during starting; just use the same contact to bypass the cutout relay.

A better idea, though, is to use the relay to shut off power to the EFI system or to the injectors themselves. That way starting won't be a problem; as soon as the starter turns the engine over and the system detects some ignition pulses, the EFI will be enabled and the car will start.

LIMP-HOME MODE: Automatically shutting off the engine in the event of six-cylinder operation protects the car but aggravates the driver, especially if it happens in traffic or in a bad neighborhood. A better idea is to shut off fuel to the bank that has lost spark, thereby making it *safe* to drive the car on six cylinders. That same relay idea should work for this, using Corkan's circuit with two separate Q3's (you can omit diodes D5 and D6 if each subcircuit controls its own Q3) to control separate fuel injector shutoff relays for each bank. Starting should take care of itself; as soon as sparks are detected in each bank, that bank's fuelling will be enabled and the engine will start.

The idea of shutting off fuel to one bank and continuing to run does have one important benefit: it is likely to provide a better cooldown of the overheated parts. Several owners, having already been made aware of the Marelli problems, nevertheless reported that the right side cats were cherry red hot by the time they figured out what was happening, shut it off, and got the hood open. When the engine is simply shut off under such conditions, the residual heat within the cat may nevertheless fry nearby rubber parts, sensors, etc. If the fuel is shut off and the engine continues to run, cooling air continues to flow through the engine compartment, and air continues to flow through the cylinders of the inop bank and out through the exhaust system. A running cooldown is better on the engine and ancillaries than a hot shutdown. Perhaps even if a sensor provided only a warning light indication, a switch could be provided to manually shut off fuel to the inop bank to allow the car to continue moving.

CATALYTIC CONVERTORS -- MELTDOWN/FIRE (SENSOR-CAUSED): Greg Maddison lamented a large loss to his wallet: "The front two had melted into a solid mass and the debris ruined the back two." Obviously, this symptom differs from the typical Marelli six-cylinder operation described above, since that will toast the cats on one side only.

"It seems there is yet another reason the Marelli system can cause a misfire that brings the cats up to kiln temperatures. This would be problems with the TDC sensor/magnets. There are 3 equally-spaced bar magnets around the crank damper and a sensor that "looks" at the magnets and sends a pulse directly to the Marelli computer. There is a specific air gap between the magnets and sensor that must be maintained for the system to work properly.

The Jag dealer replaced the damper/magnet assembly on my car saying the rubber had split. This caused the air gap to be too wide between one of the magnets and the sensor. They first tried to grind down the other two magnets and move the sensor closer (sounds like the damper deformed and became eccentric), only lasted 600miles so I had to have damper replaced. The dealer's mechanic explained to me that each magnet produces a timing pulse for 4 cylinders. If one of the pulses are missing, 4 cylinders don't get spark and send unburned fuel through the cats. The mechanic said that a different damper is fitted to cars with the 100-amp alternator (like mine) and fails more often than the older cars." Note: the 100-amp alternator requires a grooved belt instead of a V-belt, and the alternator belt is driven by the damper itself rather than the bolt-on pulley, so the 100-amp alternator does require a different damper. Perhaps it fails more often because of the increased torque load of the alternator being applied to the rubber.

"After removing the crank pulley they found the woodruff key sheared and cone split, pulley had rotated 6 degrees on the shaft. Mechanic says the Marelli computer can vary the timing up to +/- 28 degrees. So, at this point I don't know if they misdiagnosed the sheared key problem as a damper problem (they are claiming both are toast) all along. I can certainly understand how having the pulley rotate on the shaft can introduce timing errors on a Marelli car."

There are a few problems in the explanation offered by Maddison's mechanic. First off, the tabs on the pulley are attached to the center portion, not to the outer portion held in place by the rubber -- but they might still be damaged by the rubber shearing. Chris Carley explains: "The timing tabs are a ring with 3 tabs sticking out every 120 degrees bolted to the back of the pulley attached to the solid middle section and then the tabs are bent over the edge of the pulley. There is a 1/2 inch of pulley behind the alternator belt (ribbed), where these are bent over. If the rubber sandwich breaks down then the outside ring of the pulley will slop around and bash the tabs out, which could then hit the sensor (.028 to .042 gap). Whether that problem sheared the key - who knows?" Whatever, make sure your pulley is in good shape and securely torqued down (see page 86); somehow, problems here can evidently toast your cats.

CATALYTIC CONVERTORS -- MELTDOWN (SECONDARY DAMAGE): Greg Maddison says, "Also check the engine speed sensor located on the flywheel housing. It is a \$40 part located very near one of the catalysts. Mine melted when the catalyst overheated. After that the speed sensor became temperature sensitive, car ran well when it was cold. After it warmed up the car wouldn't develop any power and couldn't go over 40 MPH."

Tim Jones had another secondary problem. After having the cats replaced and the car put right, it started issuing white smoke from the right exhaust pipe. This is an indication of a blown diaphragm in the vacuum modulator on the GM400 transmission; the vacuum line sucks transmission fluid out of the transmission and into the right manifold, causing the smoke in the right bank only. Apparently the catalytic convertor meltdown generated enough heat to roast the vacuum modulator.

INTERMITTENT FAILURES: Greg Maddison suffered from electrical connections: "Occasionally when warm/hot the engine just stops. It will usually restart after a few tries or if left for a couple of minutes. It turned out to be the crankshaft sensor connector. I could jiggle the crank sensor and car would start again. If you have the Marelli digital ignition system you will have a crankshaft sensor and a flywheel sensor; engine will not run if the signal is interrupted from either. Look for a two-wire connector on the left front top of the engine; wires should be in a hard plastic wire protector running down the front of the engine to the back side of the crankshaft pulley. I found the contacts in this connector to be green and nasty. Cleaning with spray-on relay and contact cleaner cured the problem. Run the engine and wiggle this connector and see if it stops. Also check the flywheel sensor connector, it's on the rear top left of the engine, looks like the crank sensor connector and hard to get to."

Steve Sarmanian had the same problem, only different. "In the 2-wire upper connector of the front crank sensor (1 white wire, 1 blue), about 8 inches back into the top harness the white wire connects to the wire braid that surrounds the sheathing around the blue wire by a solder connection. That connection is protected by a clear plastic sheath (rubbery

plastic tubing about an inch long). The connection is bad, and bad from the factory. It fooled me the first time around because underneath the clear tubing the wiring looked good. But this time I split open the tubing with a razor blade and the white wire fell off the braid. There's no good mechanical connection there; when the loom is built they apparently just strip the end of the white wire, lay it on top of the braid and melt on the solder. The tubing holds the joint together. I confirmed that that was the cause of my problem: touch the wires, the car will start; separate them and the engine dies.

"The fix is to twist the sheath into a secure mechanical connection with the white wire, crimp it with a slip connector and then resolder. Problem disappeared.

"I unwrapped the rear sensor to check the braid connection on that one (near the firewall) and saw that someone had been in there before me with a mechanical fix, but no solder. I fixed it."

John J. Lynch had similar symptoms, but the cause turned out to be the crank sensor itself: "The problem went something like this:

- 1) Car started fine
- 2) Ran normally for 15 minutes
- 3) Died completely due to spark failure
- 4) Engine cooled down for 1-4 hours
- 5) Repeat step 1

"Turns out the Engine Speed Sensor was the *real* culprit. The specs say that the sensor should read about 700 ohms but when I measured it after the engine died I noticed it was only reading about 260 ohms. Since I had previously tested the sensor with an O-Scope and saw that it was producing the square wave I was expecting, I thought everything was fine. I was wrong. For some reason when the engine warms up the sensors resistance is dropping below 700 ohms causing the voltages that are delivered to the ignition computer to be way out of spec. Consequently the computer was shutting down the ignition amps. For kicks I decided to put a 500 ohm resistor in series with the sensor to validate my new conclusion and sure enough the car ran fine. As soon as I removed the resistor, the car died again. Problem solved!!!"

LACK OF OOMPH: Jim Householder reports on "a problem I had with my 1991 XJS; cost me a lot of money and stumped all the Jag mechs. At 4500 RPM the engine would just flatten out and go no more, but ran quite well up to this speed. The story is long and sad about trying to get it fixed but decided I would try it myself. Turns out that the number 2 coil was bad, not a big deal but seems none of the Jag pros had run into this problem." Interestingly, running out of juice at 4500 RPM is exactly what you would expect from a secondary coil failure on the earlier cars with Lucas CEI ignition, but it's not obvious how it can occur with the Marelli.

1992-ON: Richard Mansell quotes from a Jaguar Publication on the changes for the 1992 model year:

"The Marelli digital ignition ECU has been software upgraded."

REPLACING THE MARELLI IGNITION SYSTEM: Since the Marelli has some serious problems that can cause fires, obviously there is incentive to replace this system as a preventative measure. Those fires sometimes destroy considerable portions of the Marelli system itself, though, and Marelli hardware is quite expensive, so owners having already suffered such fires also seriously consider a change of system -- not only to avoid a repeat but because they have a budget for such a replacement.

If your objective is to avoid even the slightest possibility of a fire, you're out of luck; any car with any ignition system can have a fire if things go too far wrong. If your objective is to eliminate even the slightest possibility of having a one-bank failure of the type the Marelli system is infamous for, the only way is to replace the Marelli system entirely; as long as there's effectively two six-cylinder ignition systems, there will always be the possibility that one will fail while the other keeps working. Before you latch onto that for a solution, though, you might wish to review the first fact and

realize that the Marelli, if you can fix the rotor and cap problems, may actually be relatively safe. This author suggests your money might be better spent on an overtemp sensor for the catalytic converters.

If you have decided that two six-cylinder ignition systems are totally unacceptable, there are two other types of system that will work on a V12: a single 12-cylinder system or a distributorless system.

REPLACING THE MARELLI IGNITION SYSTEM PART I: The only replacement ignition systems that will eliminate the problems with the Marelli distributor are ones that eliminate the Marelli distributor. One idea is a distributorless system -- six double-ended coils, each connected directly to two spark plugs.

One source is Electromotive; see page 666. The installation manual for their HPV-1 includes instructions on how to install two six-cylinder systems on a V12. You are once again back to two six-cylinder systems, one of which can fail! But at least you won't have the Marelli rotor to worry about any more.

Another source is...Jaguar. As discussed below, the final few months of XJ12 production came with a Nippondenso distributorless ignition system. Yeah, that'll be a cheap retrofit. Judging from Roger Bywater's and Rick Wilder's descriptions of this system, it's two six-cylinder systems again!

A distributorless system can have a failure in one part of the system; for example, one of the six double-ended coils could fail, killing two cylinders in one bank. But that would cause a lumpy-running engine, hopefully getting the driver's notice. It wouldn't keep running smoothly as the Marelli one-bank failure does unless the three coils serving one bank happened to fail together, which is highly unlikely. But if the distributorless system actually consists of two six-cylinder systems -- as apparently many of them are -- you obviously could lose one control circuit and have a one-bank failure, just what you feared with the Marelli.

If the system you install happens to be a "total engine management" system (ignition and EFI together), you may be in luck. It's still likely to be two six-cylinder systems, but the ignition pulses from each six trigger the injectors for each six. So, if the ignition for one bank fails, it *might* cause the injectors for that bank to quit operating -- providing a safe limp-home mode.

REPLACING THE MARELLI IGNITION SYSTEM PART II: Another idea is to retrofit the earlier Lucas CEI system into the later cars. It's kind of a shame to replace the high-tech electronically-controlled Marelli with the comparatively archaic Lucas with its mechanical advance controls, but it will definitely eliminate the possibility of one-bank ignition failures. If anything in the Lucas ignition system quits working, the car stops; one-bank failures are simply not possible.

Note that the centrifugal advance mechanism in the Lucas distributor should be attended to prior to installation, as described beginning on page 131. This mechanism then requires periodic maintenance (oiling) to make sure it doesn't seize, but this isn't really a problem unless you don't do it.

This retrofit has the additional benefit of saving money on future tune-ups. The Lucas caps and rotors aren't cheap, but they're cheaper than the Marelli items.

Whit Coleman at British Parts International (page 641) reportedly has assisted several owners with installing Lucas ignition systems in Marelli-equipped cars -- *after* the fire. The motive was cost, pure and simple; after the car has suffered an engine compartment fire, it's cheaper to convert to a Lucas system than it is to buy the Marelli parts needed to get it going again -- possibly because the Lucas stuff is more readily available at junkyards. Coleman claims that people usually obtain an entire donor car to do this job.

Coleman asserts that the change requires replacing the EFI ECU and the associated wiring harness with the items used with Lucas ignition systems. He's not entirely sure why, but if you're using a donor car you've got those items on hand anyway. He also points out that you can then turn around and sell the EFI ECU that worked with the Marelli, possibly recouping a considerable portion of the cost of the donor car.

This author is not convinced that retrofitting the Lucas ignition system requires changing the EFI ECU and the harness. If I didn't have the replacement ECU and harness handy, I'd try running a shielded wire from the Lucas CEI ignition

amp to the footwell where the Marelli ECU was and connect to the suitable pin in the harness for sending the trigger signal to the EFI system and see if it works.

If that works, it'll also be possible to use the early OPUS distributor along with an aftermarket ignition pickup and amp like those suggested on page 144 -- but you'll want to recurve the distributor advance mechanisms to the curves used with the H.E. engine. If the ignition system doesn't provide a dedicated trigger signal lead, connect a wire to the - terminal on the coil and run it through a 600Ω resistor for a trigger signal.

Coleman also points out that this conversion will require changing out the tachometer, since a six-cylinder tachometer is used with the Marelli ignition. Again, if you have the donor car, this is no problem -- unless you have the later style dash and the earlier tach won't fit.

REPLACING THE MARELLI IGNITION SYSTEM PART III: As mentioned below, the XJR-S came fitted with a Ztek engine control system which utilizes a gutted Lucas distributor. The XJR-S is not a common model and the Ztek system controls both EFI and ignition, so installing this system in a regular XJ-S is likely to be costly. The Ztek system is supposedly programmable -- you'll probably need to reprogram it to work with a non-XJR-S engine -- but it's reportedly difficult to get the programming software from Ztek. All in all, this retrofit is probably not a reasonable option from a cost standpoint unless you happen to need a new EFI system as well, and even then it's not likely to be the cheapest alternative. Of course, if you happen to have a junked XJR-S laying around...

UPGRADING THE MARELLI IGNITION SYSTEM: Aside from fire avoidance and/or fire repair, some might opt to replace the Marelli system (or the Lucas systems, for that matter) simply to improve performance. There are several features that might be worth seeking. Some of the better aftermarket ignition systems have electronically-controlled advance, making them ostensibly similar to the Marelli -- but they almost invariably are programmable in order to be adaptable to different cars. This programmability might be of considerable value, especially if the engine is being modified. Some systems include knock sensors which will allow better optimization of the advance curves as well as automatic compensation for differing tankfuls of fuel. Some systems use six double-ended coils, thereby eliminating the need for a distributor.

The ultimate, perhaps, is the "total engine management" system. Such systems replace both the ignition system and the EFI ECU with an integrated, programmable control system. Some even integrate electronic control of an automatic transmission -- but obviously you'd need to upgrade the transmission to take advantage of that.

XJR-S Ignition

John Goodman reports that the XJR-S uses a Ztek ignition/fuel injection system -- see pages 286 and 672. "Basically it is a modified Lucas distributor; even the rotor arm is standard. However the vacuum and mechanical advance mechanisms have been removed (ECU-controlled vacuum sensor and programmed advance)."

"It has a magnetic "Hall effect" engine speed sensor and a similar timing sensor. The 'Hall' effect thing has an inner and outer wheel. The inner one has one notch and is the timing signal/ speed sensor, similar to the Marelli crank sensor, the outer star like wheel has twelve notches/spikes to control injectors."

"It appears that to set the timing exactly you really need the dealer to plug in the "JaguarSport magic laptop". In the set up screen there is a function <reference ignition timing>. This is where you set the distributor to the 10 degrees BDC at idle for the ECU to get its base line input. After exiting the screen the ignition timing reverts to the control of the ECU."

"So, under the ECU control, at idle you should be seeing 3.5 degrees and at 3000 rpm it should be around 18 degrees if the timing is right. It is a damn inconvenience not being able to check or set the ignition timing without the software."

The Ztek system continued to use the altered Lucas distributor even when the baseline XJ-S was fitted with the Marelli ignition.

Distributorless Ignition

The Jaguar V12 was fitted with a distributorless ignition system for a short time just before it was discontinued, but didn't make it into the XJ-S; Roger Bywater of AJ6 Engineering (page 663) says, "It was on the 300 range saloon and we have a dealer technical guide telling all about it. There were two amplifier modules driving two coil modules each containing 3 double ended coils for a bank of 6 cylinders. All driven by a Nippondenso Engine Management system."

Rick Wilder, who owns a '95 XJ12, says, "I had the impression that the distributorless ignition was only added in the 1996 MY. That erroneous impression was reinforced by alldata.com, which shows the Marelli ignition on my MY. I just took the valley cover off to see what's up and found the 2 coil packs, each with 6 spark plug wires attached, and no distributor."

COOLING SYSTEM

COOLING SYSTEM DESIGN: In most "water-cooled" cars, the cooling system consists of a circuit wherein a fluid is pumped into the portion of the block surrounding the cylinders, then up into the heads, then on to a thermostat, and from there through the radiator and back to the pump. The thermostat and housing are usually designed so that, when the thermostat is closed, the fluid is not deadheaded but rather bypassed to allow the fluid to circulate around between the engine and pump without going to the radiator.

The Jaguar V12, of course, is different. It has two thermostat housings, one at the front of each bank. The XJ-S radiator is a side-flow radiator divided into a top third and a bottom two-thirds; the end tank on the left end of the radiator either has an internal baffle one third of the way down, or actually consists of two separate end tanks. The coolant coming from the left bank, via the left side thermostat, enters at the top left and flows left-to-right through the top third of the core. Then the coolant from the right bank comes in, mixing with this already-cooled fluid. The mixture then flows right-to-left through the bottom two thirds of the core and on to the pump. Each thermostat also controls a bypass directly back to the pump inlet via a "cross pipe"; as the thermostats open to allow coolant to the radiator, these bypasses are closed off by a disk on the bottom of each thermostat.

It is unknown why Jaguar contrived a dual-thermostat system, but it was probably just to reduce plumbing -- not having to get the fluid from both banks back to a single thermostat housing.

Because the mixed fluid goes through the pump and to both banks, both banks are always seeing the same incoming coolant temperature. When the thermostats are closed and the fluid is bypassing into the cross pipe, both banks will also see the same flow rate, and therefore will warm up at the same rate. When the thermostats are fully open and the bypasses are closed, however, the left (B) bank will *always* see a lower flow rate than the right (A) bank, and therefore will run warmer. This is due to the radiator design; the fluid from the left thermostat outlet has to pass through the upper third of the radiator core to get to the exact same place the fluid from the right thermostat outlet goes to directly. As a result, the backpressure at the left radiator inlet will always be higher than the backpressure at the right radiator inlet. Since the flow to both banks is from the same pump and it is not a positive displacement pump but a centrifugal, most of the flow will naturally take the easier route through the A bank.

The action of the thermostats may accentuate the differential flow at operating temperatures. When the thermostats are only partially open, the bypass leads directly back to the pump inlet while the route through the radiator has a higher backpressure. As the higher backpressure begins to slow the flow in the left bank, the coolant arriving at the left thermostat begins to get warmer. As a result, it closes off the bypass some more, *further* reducing the flow in the left bank! Some have advocated installing a colder thermostat in the left side to compensate for the warmer running bank, but this would seem to be the exact wrong thing to do; it could arguably be better to put a *warmer* thermostat in the left

side so the bypass stays open and flow is maintained through the bank. Flow will be reduced in the radiator, though, possibly causing the entire engine to run hotter.

As long as the cooling system is clean and operating properly, the differential cooling flow between banks doesn't seem to cause any problem. However, there are three implications the XJ-S owner should be aware of:

- 1) The coolant temperature sensor for the EFI system is on the left thermostat housing. Since this side is running warmer than the right and the EFI system will be adjusting the fuel mixture for the entire engine accordingly, the right bank is likely to be running a little leaner than the left. Of course, on cars with Digital P EFI and oxygen sensors, the system will automatically correct the mixture on individual banks -- as long as you're in closed-loop mode. When you put your foot in it, you go into open-loop mode -- and when your foot is in it is precisely when you *don't* want to be running lean! You can only hope that the open-loop scheduling includes enough enrichment to overcome the effects of the temperature differential between banks. Again, as long as the system is clean and operating properly, there doesn't seem to be a problem.
- 2) The coolant temperature sensor for the gauge on the dash is on the right thermostat housing. This means that the left bank can have zero flow and be overheating severely, and the driver would have no indication from the dash as long as the right side still had good flow.
- 3) While the system works fine when clean and operating properly, the double-pass radiator scheme seems designed to accentuate any problems that develop. While the coolant flow is always lower through the left bank, the radiator getting obstructed internally seems to increase the difference in flow -- possibly because the flow from that bank has to go through twice as many passes of the obstructed radiator, or perhaps just because the thermostats are closing off the bypass fully. Whatever, the incidence of dropped valve seats or other overheating damage is much higher for the left bank.

Roger Bywater has a different theory about why the left bank seems to drop more valve seats: "If the V12 overheats for any reason B bank is likely to suffer more than A bank and I believe this is because A bank is fed from the low side of the water pump whilst B bank is fed from the top. Therefore any condition which might promote cavitation at the pump will have a more damaging effect on B bank." There are even those who suggest that the left bank suffers more than the right because the big belt-driven fan is blowing air over the right bank, although this is a minor factor at best. Rather than trying to decide *which* theory is correct, note that *all* these theories might have some validity! The B bank is definitely the one at risk.

Despite the shortcomings of the cooling system design, most experienced XJ-S owners agree: You can avoid trouble by scrupulously maintaining your cooling system. Many helpful tips follow. If you'd rather take a proactive stance and *correct* the shortcomings of this design, see pages 170 and 190.

HOW HOT IS TOO HOT? Just about the first question everyone asks is just how high the needle can get before it's time to start worrying. Unfortunately, all too often owners ask people who *should* know, including supposedly certified Jaguar mechanics, about their gauges reading halfway between N and H, and are told, "That's OK, they read there all the time, don't worry about it." These people are *liars*, and you can tell 'em Kirby Palm said so. Many, if not most, of the maintenance headaches occurring on Jaguar V12's can be traced to overheating -- not just one-time overheating, but long, persistent, chronic overheating, the type that can only happen when the owner is ignoring the gauge -- usually because someone told him it was OK. If anyone tells you your temp readings are OK, ask him if he will guarantee that and agree to pay for engine repairs when the valve seats drop.

Trying to get a handle on just what constitutes a reason to panic on the XJ-S temperature gauge has long been difficult, since reports from owners seemed inconsistent or contradictory. The gauge being an example of British electrics has only added to the uncertainty. However, by noting many such reports on the internet discussion list and following several of them while the owners checked things and made corrections, this author has been able to derive the following guidelines. Note that these descriptions apply to the vertical coolant temperature gauge found in the pre-'91 XJ-S; those with round gauges will most certainly see similar behavior in general, but presently I cannot provide specific indications as detailed as those below.

Some vertical gauges reportedly have temperature scales in degrees, while others have merely a C at the bottom, an N dead center of the scale, and an H at the top. This description will refer to the C-N-H scale but both type gauges are apparently identical except for the paint.

There are basically four situations that the vertical gauge will indicate:

- 1) If your car has a properly-operating cooling system fitted with 190°F (88°C) thermostats, the needle will always be sitting on the N when the car is warmed up. Perhaps just a hair to the high side of the centerline of the scale, but always within the width of the letter itself, never above it.
- 2) If your car has a properly-operating cooling system fitted with 180°F (82°C) thermostats, the needle will always be sitting about 1/4" below the N when warmed up.
- 3) If your needle seems to wander around a lot, you have air in your cooling system. See the section on filling and bleeding on page 173.
- 4) If your needle is above the N, your car is overheating. If your needle is halfway between the N and the H, your car is *severely* overheating. And don't worry about the needle being on the H; it will never get that far.

Note that these guidelines apply to the XJ-S as configured from the factory -- with the gauge sender located in the right side thermostat housing. As mentioned above, it's the left side that is likely to have overheating problems -- which may explain why trouble occurs when the gauge reads just above the N where any reasonable person would presume it's still within normal operating range. If the sender were moved to the left thermostat housing as proposed below, perhaps the gauge would have to be reading closer to the H to indicate serious trouble.

Believe it or not, it appears that the vertical gauge is actually quite reliable. In many (but not all!) of the reported cases of the needle being above the N due to problems with the gauge or sender, it was plainly obvious that there were gauge problems -- often with all four gauges, and sometimes pegging them against the upper end of the gauge seconds after cold start. More subtle faults in the electrics, such as corroded connections, always seem to cause the needle to read low (often all four gauges at once -- see page 545) or to not read at all, staying at the C end. A high temp reading that appears even remotely plausible is usually a cause for concern.

A lot of owners describe the situation when talking about their temp readings, such as how hard they've been driving down the freeway or how hot it is outside today. Unfortunately, such qualifiers are usually an indicator of trouble. Engine coolant temperature is controlled by the thermostats, and should not vary beyond their control range *regardless* of conditions. And their control range (from fully closed to fully open) is pretty tight indeed; it has been described as "three needle widths" of travel on the gauge. Since the cooling system should always have some margin (excess cooling capacity) so the thermostats can control the coolant temp, the indication should always be within this control range. If the gauge ever indicates more than a couple of needle widths above the regular operating temperature with whatever thermostats are installed -- including reading *on* the N with 180°F thermostats -- it means that the thermostats are no longer in control, they are wide open, and it's absolutely everything the cooling system can do to hold the temperature indicated. Obviously, if things get just a hair worse -- the outdoor temperature rises a couple of degrees, one more tube inside your radiator gets plugged up, you sit in traffic a few more minutes, whatever -- the temp is going to rise some more. Overheating damage is imminent, you need to be taking corrective action *now*.

The only way "corrective action" would include replacing thermostats if the thermostats are bad. Merely switching to colder thermostats is not corrective action; if the cooling system can't hold 190°F, it won't be able to hold 180°F either. Replacing 190°F thermostats with colder thermostats won't fix anything unless the 190°F thermostats were defective.

COOLANT TEMPERATURE SENSOR RELOCATION: As mentioned in the description of the cooling system above, the coolant temperature sensor for the EFI system is on the left thermostat housing while the coolant temperature sender for the gauge is on the right thermostat housing -- and both are on the wrong side. It would be better if the EFI coolant temperature sensor was on the right side and the gauge sender was on the left side, for two different reasons. As

a result, an owner could rationally decide to move the EFI sensor from left to right, or the gauge sender from right to left, or to move both, essentially exchanging the two. All moves are covered here; make your own choice.

It'd be really nice if both sensors were the same thread so you could just swap them. Unfortunately, the gauge sender is Smiths with a 5/8" UNF, 18 threads per inch, while the EFI sensor is Bosch, metric, 12mm x 1.5mm thread.

To move the gauge sender to the left thermostat housing, you're gonna have to drill and tap a 5/8"-18 hole. This will require two tools you probably don't have: a 9/16" drill bit, and a 5/8"-18 tap. 9/16" drill bits are not too difficult to find, but note that they are only available to fit 1/2" or larger drills! They make 1/2" drill bits with reduced shanks all the way down to 1/4", but the idea of a drill bit any larger than 1/2" reduced to 3/8" shank seems to have completely eluded the market. A 14mm drill bit might also work, but they aren't available to fit a 3/8" drill either.

One possibility is obviously to rent a 1/2" drill. Another idea: you can carefully grind six flats on the bottom 1/2" of the shank of the bit. Then you can chuck up a socket driver in your 1/4" or 3/8" drill, snap a socket onto the socket driver, and insert the hex on the bottom end of the drill bit into the socket. It might be a little wobbly, but if you drill the hole as large as possible with conventional drill bits beforehand (1/2"), this hokey arrangement should do an acceptable job of enlarging the hole.

This author bought a 9/16" bit with a 1/2" shank and three long flats to help it fit securely in a chuck. By grinding three short flats in between the existing flats, a 12mm socket fit quite well -- and doesn't hurt the bit one iota, since the original flats are intact and would still fit properly in a 1/2" drill.

Another option, of course, would be to replace the OEM gauge sender with a generic sender with similar electrical characteristics but threads that fit the existing EFI sensor port on the left thermostat housing. Good luck. If you wish to try this, note the OEM sender registers 412Ω at 40°C .

You can install the gauge sender anywhere in the left thermostat housing that will see coolant flow from the heads. It should not go in either the bypass passage or the passage to the radiator, since either may be closed off at one time or another. On a pre-8S44060 engine, the obvious place to put it is on a flat that was clearly intended for such a boss but never drilled, right on top and near the rear end of the housing. From engine 8S44060 on, there's already a hole here with a sensor in it, so this location isn't an option.

There's another flat surface apparently intended for a boss just rearward of the EFI sensor, but this port location connects to the bypass passage. Also, the boss is too small for drilling and tapping a 5/8" hole.

Another option, of course, is to just drill out the EFI coolant temperature sensor boss and retap it for the gauge sender. That leads to the next problem: you now need somewhere to put the EFI coolant temperature sensor. And over on the right side is ideal.

There are at least two existing ports on the right side; the one where the gauge sender goes, and the one where the thermotime switch goes. On the author's '83, there is no thermotime switch; there is a plug in the hole. Doesn't help, unfortunately; both holes are too large for the EFI coolant temperature sensor. So, you have two options: either drill and tap one of the existing holes out to a significantly larger size, install a plug, and drill and tap the plug to fit the EFI sensor; or just install a suitable plug in the old gauge sender hole and drill and tap an entirely new hole in the coolant manifold for the EFI sensor. There are a couple of locations that will serve. Note that the EFI sensor could just as easily go on the *rear* coolant manifolds.

For a plug for the old gauge sender port, I'd suggest: another sender. In fact, just leave the original sender there and buy a new sender DAC2583 for the left side. The senders are less than ten bucks each.

In fact, as long as you have two gauge senders, just install another wire and a switch somewhere so you can switch from one to the other to monitor *both* sides of the engine with the same gauge. If you go this route, you might want to replace an original C40106 sender with another DAC2583 just to make sure any difference in indicated temp is due to a real difference in temperature rather than a difference in sender.

If you have just read through this section and have decided to make this mod, note that unless you can figure out how to use taps and drills down in some fairly tight places, you will need to remove the thermostat housings to do the drilling and tapping. Probably the easiest way to do that will be to remove the air filter housings and then unbolt the entire

manifold assembly -- thermostat housing, coolant connecting pipe, and rear coolant manifold -- and move the entire assembly rearward far enough to disengage the hose connecting the thermostat housing to the crossover pipe. So, while you're preparing for this job, go ahead and buy a total of eight coolant manifold gaskets EBC 9634, two air filter housing gaskets EBC 9635, and both thermostat cover gaskets EBC 8330 and EBC 8331. You may also want to get four "top hat" seals C37990 for the coolant connecting pipe, and maybe an AAV gasket C42165 or whatever a newer gasket number is. And you will want to get a new copper washer for reinstalling the EFI sensor, C2296/3, although you can probably find a suitable sealing washer locally. Reportedly a new gauge sender comes with a washer, so if you don't remove the existing sender you won't need to buy one separately.

BLOWING COOLANT: In general, if you are blowing coolant, your car is running too hot. If you have a pre-H.E., pressure relief at the radiator cap on the header tank on the left wheel well will blow coolant or steam out the little tube into the wheel well. Note that, if you fill the system right up to the cap, it will blow a little coolant the first time you run simply due to expansion. You should be able to tell when it's actually overheating, since it will blow much more energetically.

If you have an H.E., pressure relief at the radiator cap on the header tank on the left wheel well will cause coolant or steam to blow into the plastic "atmospheric catchment tank" within the compartment behind the left front wheel. This tank, in turn, overflows via a tiny tube out the bottom of the car at the very rear of the left front wheel well. If the tank is empty or nearly empty, you may not be able to tell that the cap is relieving pressure; steam may condense within the plastic tank, and nothing visible comes out the tube. If the overflow tank is totally full -- which it can get to if the owner continues to top up the system on a regular basis -- any pressure relief can push liquid out of this tube, even if it's steam that's coming out of the header tank. And, again, if the system is topped up, it may push a little liquid out the first time it's run without overheating.

Finally, as noted on page 178, the overflow tube coming out of the atmospheric catchment tank is a classic example of poor design, so more than likely any flow out of this tank will be all over the inside of that compartment and come leaking out of nooks and crannies, such as out the joint between the rocker panel and the fender.

OVERHEATING DAMAGE: In any aluminum-block engine, severe overheating can result in a warped block or warped heads, which in turn normally call for an engine replacement. In the Jaguar V12, a more common symptom of an overheated engine is a dropped valve seat. Since the heads are aluminum, the valve seats are sintered iron rings that are pressed into the aluminum. Since iron and aluminum have different coefficients of thermal expansion, overheating will cause a loose fit and the seat can just fall out. After that, it holds the valve part way open and bangs around in there. Amazingly, reports of broken valves are rare; more often the owner who continues driving despite the annoying ticking under the hood allows the valve to beat the seat to pieces, which in turn bang up the piston, the other valve, and the head.

Do not continue to drive when the car is overheating. If no other options are available, drive it short distances at a time, shutting it off and allowing it to cool before starting again. And don't continue to drive if it sounds like a Chevy with bad lifters, either -- you've already dropped a seat, but you might as well quit before you do even more damage.

If at all possible, don't shut off the engine when the car is overheating; many have reported that's when the valve seats drop -- when the engine is stopped. Instead, find a water hose and leave the engine running as you hose down the radiator through the front grille. Once the temp gauge comes down, then shut it down -- and call a tow truck, do not start it again until you have addressed its overheating problems.

OVERHEATING -- H.E. vs. PRE-H.E.: Roger Bywater indicates that the pre-H.E. cars had some tendency to overheat: "With regard to the marginal cooling at sustained high speeds the H.E. had a slight advantage in that the higher compression ratio raised the thermal efficiency and reduced the heat losses to the coolant. It was also noticeably over-fuelled at high revs which must have helped further and the problem, slight though it was, seemed to be solved. Distributor build quality was also better by this time."

OVERHEATING -- CAUSES: Believe it or not, the XJ-S H.E. does not overheat when it's running right -- and this from an owner who lives in Florida! If yours tends to overheat, don't ignore it. Check the following, all of which are described further in this book:

- 1) The cooling system must be properly filled with no air in it.
 - a) The system must be filled with the proper coolant mixture and bled correctly to begin with, which requires disconnecting a hose at the heater valve (not mentioned in the manuals).
 - b) The automatic air purge system must be working properly to *keep* air out.
 - i) The banjo fitting on top of the radiator is probably plugged if it hasn't been modified.
 - ii) The line to the atmospheric catchment tank may be obstructed or kinked.
- 2) The radiator must be clear, no blockage or sludge; unfortunately, this is difficult to check conclusively on the XJ-S without removing it from the car and removing the end tanks. Crud in the radiator will cause overheating under all conditions, but usually more at speed than at idle. Experience indicates that any radiator maintained following the owner's handbook guidelines for more than ten years is likely to be plugged.
- 3) Suspend the thermostats in a pan of water on the stove and bring them to a boil. Do not let them contact the bottom of the pan. If the thermostats are not visibly wide open by the time the water boils, replace them. Their usual failure mode is to open only slightly.
- 4) Retarded timing will cause overheating under all operating conditions. See the sections on ignition timing beginning on page 121.
 - a) A seized centrifugal advance mechanism may be seized at any position from idle to max advance. Usually, it will be correct at one particular RPM, retarded everywhere above that RPM, and overadvanced everywhere below. Conditions with retarded timing will cause overheating. Conditions with overadvanced timing can also cause overheating but usually not as severe; the more obvious problem is knocking. See page 131.
 - b) A blown vacuum advance module will cause timing to be retarded at low throttle while correct at full throttle, so the car will overheat more when driving gently.
- 5) There may be debris obstructing airflow through the radiator, such as dirt and leaves -- either plugging the fins themselves or within the space between the A/C condenser and the radiator. See page 193.
- 6) A bad fan clutch causes overheating *only* in stop-and-go traffic or other conditions where motion of the car doesn't provide enough air flow. See page 205.
- 7) The fan shroud needs to be properly installed and sealed up against the back side of the radiator. See page 215.
- 8) The fan shroud flaps should be intact and free to flap as intended. If they are missing, overheating when stopped and idling is likely.
- 9) There needs to be foam surrounding the radiator to prevent air from bypassing it. See page 215.
- 10) Front spoiler -- it must be there, and it must be properly mounted. See page 216.

While all of the above items point to common faults, it must be said that far and away the most common cause of overheating on XJ-S's that are ten years old or more is a plugged radiator. If you are having cooling problems, address the easy items first, but you might as well go ahead and plan to remove the radiator and have it rodded, recored, or replaced.

FILLING THE COOLANT SYSTEM: The ROM and the Haynes both provide a detailed coolant fill procedure and give dire warnings about engine damage caused by hot spots if the procedure is not followed. Allow me to add: they ain't kidding. Reportedly, one indication that the system has not been properly filled and bled is that the coolant level light comes on every now and then while driving. Another is a temp gauge that seems to wander around.

Of course, you could just take your car to the Jag dealer and let the experts change the coolant so you don't have to worry about it, right? Get real. Stefan Schulz: "In my experience (in the bad old days, that is, when I still let garage mechanics near my car), they never seemed to follow this procedure because the coolant level light would behave as you describe after they messed with the cooling system. When I started doing my own maintenance and followed the procedure *to the letter except for the leak sealer* I never got the low coolant light on when the engine was running."

Steve Gallant: "Same for me here. My car was serviced by a very reputable main dealer as part of a pre-purchase service. After receiving the car, I noticed the low coolant light came on on my first drive. I performed the factory procedure for filling/bleeding, and the light was extinguished. I must have added close to a quart of coolant. So even dealers don't take the necessary time to perform this operation 100% successfully."

Wally Magathan: "My car was also serviced by a reputable dealer, but I didn't know it was routine for them to ignore the bleed procedure until now. I've now bled the system, put in almost a gallon, and hate to think what's been going on in the engine in the month since they "fixed" my radiator hose."

Jim Isbell provides a great tip on filling the coolant system: "Getting the water into the system has always been a problem on the XJS because of the two fill points. I always tried to do it on level ground before and spent many minutes shaking the car to get all the air out of the system. Today, just by accident, I was parked in the driveway with the nose of the car elevated and I didn't feel like moving it. So I pulled the cap on the header tank and filled the car (about two quarts) then I pulled the cap on the crossover pipe and added another quart. The air bubbled out quickly and the car was completely full in no time. I recapped both vents and it's finished. From now on I will park the car with the nose uphill when I fill the radiator."

The engine is deliberately designed for the coolant to flow upward with no air pockets, but when parked on level ground it just barely flows upward. Tilting the nose up should make the air clear out a *lot* better. Offhand, it's probable that you can't have the nose *too* far up until the air bleed port on the top left of the radiator is *higher* than the fill opening on the crossover pipe.

Be sure to bleed the air out of the heater circuit while filling the cooling system. See below.

AIR BLEED VALVE: At the top left corner of the radiator is a small fitting used to allow air out while filling. Mike Morrin says, "The first few XJ-S (1975 model year) left the factory with a threaded plug." Then they switched to a little winged valve for most pre-H.E. cars -- but for H.E.'s, they went back to the plug. Morrin: "The owner's handbook and manual give instructions for both types of fitting." Both items were the same thread, 1/8" BSPP -- so if you're here in the US, don't lose that plug! If you'd prefer the convenience of the valve, C45587, it will fit where the plug fits; the valve sits a little higher and therefore closer to the hood, but this doesn't seem to be a problem.

AIR BLEED AT THE HEATER VALVE: There is none, but there should be. Since the line comes out of the right side coolant manifold, goes upward until it gets to the heater valve and then downward until it connects to the bottom left corner of the radiator, it forms a big bubble when filling the coolant system. Therefore, you need to disconnect a hose at the heater valve to let the air out when filling. A disconnected hose creates two openings, one on the end of the hose and the other on the end of the fitting it was attached to. As you fill, coolant will start to pour out of one of the openings first; put a thumb over that opening and continue to fill until coolant starts to pour out of the other opening, then reconnect the hose.

Of course, it'd be more convenient if there were actually a bleed port. Douglas Dahl says, "2 clamps and a \$0.99 5/8" connector at any auto parts store. It is the same as the T's used in the flushing kits out there and comes with a screw top." These black plastic "flushing tees" are commonly available in 1/2", 5/8", and 3/4" size, and you'll need the 5/8" for this job. The straight section of the tee has hose barbs of the specified size while the connection off the side is a male garden hose fitting, and it comes with a blank-off cap with a rubber washer inside. It really could not be any simpler to install or use. If your local auto parts store doesn't sell these flushing tees individually, it may sell the flushing kits which contain three tees -- one of each size -- plus one cap and a few other items, all for less than five bucks so it still won't break you. Note: you might want to check the passages inside the tee for plastic mold flashing before installing.

Please note that installation and use of an air bleed in the heater circuit does *not* mean you don't need to follow the prescribed procedure for filling and bleeding the cooling system. You will still get air in the system when filling; we just hope that you will trap *less* air in the system by bleeding air from the heater circuit.

When filling the cooling system, it is suggested that you run the car for a few minutes with the climate control system off. With it off, the heater valve will remain open, so the cooling system will have a chance to push the air pockets out of the heater circuit. With the system on, it may just close that heater valve as soon as the engine is started unless it's cold enough out for the system to call for heat.

ANTIFREEZE: Don't operate the Jag or any car without antifreeze in the cooling system. The name "antifreeze" is an unfortunate misnomer, and pure water is a totally unacceptable coolant -- even in Hawaii. Antifreeze not only prevents freezing, it also retards corrosion and crud buildup, helps prevent boilover, and serves as a water pump seal conditioner. Running pure water will result in early water pump seal failure. Also, replace the antifreeze annually, because the inhibitors in it wear out and it becomes corrosive.

Scott Fisher sends the following wisdom: "In the context of the automotive cooling system ethylene glycol is not an anti-corrosive agent; it is in fact corrosive. To offset this fact, manufacturers add anti-corrosives (inhibitors) to the glycol. These preparations, while in good condition, perform well in both minimizing corrosion and preventing freezing of the coolant. However, over the life of the coolant the anti-corrosion properties of the inhibitors are depleted."

"Water aids corrosion in three main ways: 1) bringing free oxygen in close contact with the metals so that corrosion (oxidation) can occur. 2) Water is conductive. Once water has been flowing in your cooling system for some time, its conductivity will rise as it picks up metal ions. The water may serve to promote electrical activity which may erode metals by galvanic action. 3) Some of the metal ions in the water may also react directly with the metal surfaces.

"Apart from supporting the above three processes, ethylene glycol has the added unfortunate property that it oxidizes through several stages to oxalic acid. The products of ethylene glycol oxidation by oxygen and subsequent reactions include: aldehydes, carboxylic acid, nitric acid, glycolic acid, glyoxylic acid, oxalic acid, formaldehyde and formic acid. Most of the series of oxidation products to and including oxalic acid are directly corrosive to metals. Added to this, oxalic acid is highly toxic.

"To combat the above acids and other corrosion activity, antioxidants and alkaline formulations are added to the glycol mix. These include many compounds which are used in cooling systems where antifreeze properties are not required and include primary, secondary and tertiary amines; organic and inorganic phosphates, silicates cresols and other phenolic substances; a wide variety of sulfur compounds; soaps; alkali metal salts; and borates.

"These inhibitors slow down the corrosion process caused by the glycol and the water. They may coat the metal surfaces and prevent corrosion by passivation. Passivation is the process where a protective film forms on the metal which prevents further contact with the solution. Unfortunately, in all coolant preparations (with or without glycol) the inhibitor system (during engine operation) is being continuously depleted in the performance of these actions. For this reason, proper cooling system maintenance is critical.

"One aspect of cooling system maintenance that we can all easily follow is to minimize "aeration" of your coolant. Aerating accelerates the uptake of free oxygen from the atmosphere. As free oxygen is one of the essential ingredients for corrosion, the importance of minimizing it's uptake is clear. To this end you should make sure all your hoses are in good condition and clamped tightly. "Closed systems", where an expansion tank and recovery system closed to the atmosphere is used, also help in this regard.

"If you overheat (boil) glycol-based coolants they must be replaced immediately as this accelerates the oxidization process of the glycol to acids."

LONG LIFE COOLANT: Peter Cohen says, "I noticed that the manual called out "phosphate free" coolant. The statement I am referring to is on Page 26-03 of Volume 2 of the XJS Service Manual (JJM 10 04 06) under the heading "ANTIFREEZE". The V12 HE motor is essentially unchanged since long before the existence of non-phosphate

coolant. Ergo, the Jaguar V12 has been doing fine on normal coolant for all these years, so why ask for non-phosphate now?"

"After much searching, the only non-phosphate stuff I could find at the time was Prestone 460 Long Life coolant. The Prestone 460 has the distinct disadvantage of being brown, so now coolant leaks are the same color as oil leaks (and the same color as rusty old coolant). I have since found Texaco Havoline Long Life, which is orange."

Jim Belkoff answers, "Beyond the phosphate-free issue and the long-life issue, Texaco Dex-Cool (and I assume the Prestone equivalent) contains no silicates. From what I understand, silicates are abrasive and gradually eat away at water pump seals. Texaco and GM have done tests to prove this new coolant results in fewer water pump replacements.

"The reason the new coolant lasts so long is the carboxylate inhibitor system that's added to the base ethylene glycol. I would suggest taking a look at Texaco's website (www.texaco.com).

"This stuff is compatible with regular coolant, but the long-life properties are somewhat negated."

How important is phosphate-free coolant? Apparently we should ask the folks at VW and Saturn. Belkoff: "I don't know about Jaguar, but VW has been specifying non-phosphate coolant since at least 1982." Cohen: "In their first year of production, Saturn recalled and destroyed all of the first cars they sold because "they were shipped with the wrong coolant, which could destroy the engine block". Given that they could simply have issued new motors, this was an impressive waste of money."

WATER: The antifreeze needs to be mixed approximately 50/50 with water, but if you care about your cooling system you might want to be careful about what water you use. The garden hose may be convenient, but it's not necessarily healthy for the car. The biggest problem to be concerned with is dissolved solids, that stuff that's left in a pot after you boil water away. Since boiling is often going on alongside the hottest parts of the engine (cylinder liners, head), this same stuff is left there. As a scale on the metal surfaces, it can insulate them from the coolant and make the cooling system less effective. When the scale flakes off in chunks, it can find its way into the radiator and plug up some of the tiny tubes. Finally, the scale is somewhat abrasive, and therefore is not particularly good for the seal in the water pump.

This problem might be considered minor. There are only about two gallons of water introduced to the system at each coolant change, and that amount of water only has a finite amount of dissolved solids in it. This appears to be the attitude the auto manufacturers take, since there are no radiator hose filters in a car from the factory (see page 183). However, if you change your coolant often or use really crummy water, you might be contributing to the plugging of your radiator. If your car loses coolant and you add water daily from a garden hose, you might as well go ahead and pull your radiator and have it rodded out.

To minimize problems with dissolved solids, you should use distilled water, deionized water (also known as demineralized water), or water that's been purified using a reverse osmosis process. All three types are generally available at the local grocery store for perhaps 75 cents a gallon; at some places, you can take your own jug and get it even cheaper from a dispensing machine. Deionized water is sometimes called "purified water", and is usually labelled that it "serves distilled water uses".

Grocery stores also sell various types of drinking water, including spring water. These may not be any better than the tap water, since they may contain lots of dissolved solids -- they just contain dissolved solids that taste good.

Other processes advertised include ozonated water, which is a process to kill germs, and carbon filtered water, which is a process to remove volatile compounds that affect the flavor. Neither process has any significant benefit for cooling system use. The first time the engine is warmed up to operating temperature, the germs will be dead and the volatile compounds will have boiled away and been removed from the system by the air purge system.

There are arguments about using rain water or condensate from an A/C system. The argument is that they are both "distilled"; however, the other side of the argument is that they apparently pick up quite a load of dissolved solids somewhere along the way, either from pollutants in the air or from dust or whatever. Look at the container that collects the water and judge for yourself if it's OK for the inside of your cooling system to have similar stuff in it.

Peter Smith reports from "...a series of brochures from Tectaloy. It says "the preferred water is demineralised. Do not use spring or bore water." The brochure illustrated that the corrosion effects on welded aluminium were serious, and that as little as 1 volt earthing through the cooling system could chew out an aluminium radiator in weeks (probably do the cylinder head a power of no good as well). It also notes that true distilled water is getting harder to obtain due to the cost of production and the energy required in the distillation process. Also "if you believe rain water is the answer just reflect for a second on the damage it does to gutters and tanks, and they're usually galvanised against corrosion. Spring water is totally unsuitable as it is full of minerals and salts". Summary was that distilled, demineralised or reverse osmosis water were the most suitable."

One thing you should definitely not use is "softened" water from one of those water softeners that is recharged with salt. Dave Lokensgard says, "Never use softened water in a cooling system containing aluminum. Water softeners are ion-exchange units, not de-ionizing units. The main bad actor coming from the water in aluminum corrosion is the chloride ion, and water softeners work by replacing all anions in the water (negatively-charged ions, like phosphate, sulfate, and so on) with chloride, and all positively-charged ions with sodium ion. This is why they are recharged with salt (sodium chloride). So softened water is the worst thing you can use in a cooling system."

Jason Korke: "The coolant I bought was designed to be mixed with water. It was made by Castrol which in Australia is I believe fairly well regarded. It wasn't cheap! The bottle said, "Mix with demineralized or soft water. It is unknown why Castrol's directions would say such a thing; perhaps they meant naturally soft water (water with few minerals) as opposed to softened water (water in which the minerals have been exchanged for salt).

If you work in a science lab, an electric power plant, or some other type of industrial facility that uses clean water, you may actually be able to get ahold of some *really* pure water -- something chemically much closer to unadulterated H₂O than the distilled, deionized, or RO stuff you can buy locally. Believe it or not, this may not be good. Pure water is a solvent; it would actually be quite effective at corroding your aluminum, iron, and brass parts if it weren't for the protective additives in the antifreeze. So, although the total lack of dissolved solids is nice, perhaps it'd be better if you added some dissolved solids before using; drop a few chunks of scrap aluminum and copper into the jug and let it sit a while before using it in your cooling system.

If you want to learn more about water, there is a "WaterNet" forum on the Internet.

If you use long-life coolant, you are changing coolant less often -- and therefore introducing less crud into the system. However, perhaps the makers of the long-life coolant have already taken that into account in their formulation; Jim Belkoff says, "You should use distilled water with Texaco's Dex-Cool. This stuff is factory fill in pretty much all current GM cars and trucks and the owner's manuals suggest using distilled water. In fact, Texaco sells Dex-Cool in a ready-to-use 50/50 concentration that uses de-ionized water. Considering the stuff lasts 5 years/150,000-miles from new, I think it's worth the extra bother." Interestingly, the directions on the jug of Dex-Cool specifies "clean tap water".

RADIATOR CAPS: The XJ-S H.E. has two radiator caps, but only the one on the header tank (left side of the engine compartment) is actually meant to operate as a conventional radiator cap; namely, to control the pressure in the system. The one on the cross pipe (at the top right of the engine) is really just a place to add coolant, using a standard radiator cap because they're available. If one or both of the caps go bad, they may be replaced with standard coolant-recovery radiator caps.

The early XJ-S H.E. originally came with two different caps that were chained in place to make absolutely sure you didn't mix them up. However, as Alex Dorne points out (and Jaguar eventually figured out), there is no opening out of the chamber between the lower seal and the upper seal in the fitting on the cross pipe. As a result, it doesn't really matter what pressure rating the cap is you install there; the upper seal will totally seal that opening, no pressure relief is possible. The cap on the header tank will always establish the pressure limit within the cooling system. So, Jaguar now offers two identical caps as a replacement so it doesn't matter if you mix them up.

Nowadays all radiator caps are coolant-recovery type, but I will point out the difference anyway. In non-recovery systems, any coolant that was relieved by the radiator cap merely blew overboard, and when the system cooled back down air would be drawn back in. Radiator caps made for non-recovery systems usually had a brass diaphragm under

the top cover that primarily served as a spring to keep the cap from rattling; it didn't matter if it didn't seal, since coolant was just going overboard and air was being sucked in anyway.

In a recovery system, coolant released is collected in a reservoir and sucked back into the system on cooldown. While the configuration of the radiator opening hasn't changed, it now becomes more important that the top cover of the cap actually seal. When the engine is cooling down and drawing coolant back in, any leaks at this joint will cause it to draw air instead. So, modern coolant-recovery caps have a rubber seal in place of the brass diaphragm. Since this type cap works just fine on non-recovery systems, it is doubtful if anyone actually makes the older style anymore.

COOLANT RECOVERY SYSTEM: Hey, all cars have them nowadays, it's not rocket science. Each time an engine heats up, the expansion and pressure buildup blows air, gasses, and coolant past the radiator cap and into a recovery tank, where the air and gasses bubble to the top. When the engine cools down, the contraction draws coolant back from the bottom of the recovery tank. However, on the XJ-S the coolant return line from the pressure cap to the "atmospheric catchment tank" behind the left front wheel is unusually long. Since the expansion/contraction of an engine only moves a little water at a time, it requires several thermal cycles to purge the air out of the hose (unless you overheat and blow steam). Each time you open the pressure cap, you allow the water to drain into the atmospheric tank and the line to fill with air. If you keep opening the pressure cap to check the level, it will never get a chance to work properly.

Even the tiniest leak in the coolant circuit will screw up a coolant recovery system. You may not be concerned about a very slight loss of coolant, but you should be. The engine takes several hours to cool down, so the rate at which coolant is drawn back from the recovery tank is glacial indeed. With even a tiny leak in the system, this suction will draw in air from outdoors instead. Once you have pockets of air in the system, the next event in your life will be an engine rebuild. Steve Haley says, "I found that even being a cup and a half low on coolant makes a big difference in the location of my gauge needle."

ATMOSPHERIC CATCHMENT TANK: On the H.E., the atmospheric catchment tank is a plastic container located directly behind the left front wheel, within the bodywork. "Atmospheric" means that it's not pressurized; it's basically an open container to pour coolant into. To get to it, remove the left front wheel and remove the sheet metal panel at the rear of the wheel well.

The vent on the atmospheric catchment tank is somewhat unusual. On most cars, the coolant recovery container is within the engine compartment, and when it overflows (like, when your car is overheating big time), the fluid coming out the vent just dribbles out onto the ground. In the XJ-S, however, such leakage would result in antifreeze throughout the bodywork -- unacceptable. So, the container has a vent line that is routed out the bottom of the car. For this vent to work as intended, the container must be airtight. The design is really lousy, however, and it is likely to leak throughout the bodywork when overheating anyway.

To prevent such localized flooding, try this idea: install a pan underneath the atmospheric catchment tank to catch any coolant that spills out of it, and provide a drain from this pan out the bottom of the car.

According to Mike Morrin, the pre-H.E. doesn't have an atmospheric catchment tank; relief from the radiator cap on the header tank just drains into the wheel well. He suggests that an overflow tank might be a useful retrofit. Considering the problems with the OEM tank noted above, it might be wiser to simply purchase a generic "coolant recovery system" such as those offered by J.C. Whitney. Note, however, that such generic tanks may be designed to overflow all over the place rather than out a tube; either mount them somewhere that this isn't a problem, or provide a tray to catch the overflow and route it out the bottom of the car. Tank volume may also be a concern, so if given a choice get the largest container you can find.

ATMOSPHERIC CATCHMENT TANK FILLING: Ideally, you'd like to have a minimum of a couple of inches of coolant in the bottom of the atmospheric catchment tank. However, you'll notice there's no convenient way to put any coolant in it! Apparently, Jaguar expects you to just add coolant at the header tank, and eventually some of it will get

into the catchment tank eventually. Or maybe you're supposed to disconnect the hose from under the cap on the header tank, put a funnel in the end and hold it high and fill it that way.

Steve Haley had a better idea. "I added a fill hose which I ran back out through the same hole as the others." This would give you a filler location in the left rear corner of the engine compartment. Note that the point where this hose enters the atmospheric catchment tank should be airtight, so if it overflows the excess coolant will come out the vent line behind the LF wheel rather than pouring all over everything.

Even with such a nifty filler scheme, you still don't have any good way to tell what the level is. If you arrange your filler hose to end about two inches above the bottom of the tank, you can find out by blowing into it. If you hear bubbling, the level is at or above the end of the hose, and you don't need to add coolant. If the blowing just whooshes into the tank freely, you need to add coolant. If you think you might have too much coolant in it, you might even connect a siphon and drain the excess through this hose; when it gets down to the two-inch level, it will suck air and automatically quit siphoning.

COOLANT RECOVERY HOSE: The line from under the radiator cap on the header tank to the atmospheric catchment tank is anything but simple -- or reliable. In the engine compartment, where you can see it with the hood open, it is a sturdy thick-walled 5/16" hose. When it gets into the compartment behind the LF wheel well, where you can't easily inspect it, it connects to an adapter that steps the size up to 3/8", which then connects to a length of thin-walled rubber tubing (which actually appears smaller than the 5/16" hose). This 3/8" hose then bends downward 90° and into the atmospheric catchment tank.

One common problem is that the thin-walled tubing may get kinked making that 90° bend -- sometimes because somebody has fiddled with the hose in the engine compartment and pushed more of it into the hidden compartment, tightening up the bend. Michael Aiken says, "My coolant recovery hose was kinked as it enters the atmospheric bottle. This made the recovery system totally inoperable and could lead to more severe damage anywhere in the cooling system, as this is the only way pressure is vented as the coolant expands."

"It can easily be tested by disconnecting the hose at the top of the neck of the expansion tank and blowing in the hose. It should offer little resistance to air flow and you should hear a gurgling sound behind the LF wheel. I applied 30 lbs of pressure and no flow. It was really kinked. It could also possibly be broken which is not as severe but could lead to slow coolant loss. The hose is a soft rubber and makes two 90° turns in 5 inches. The second turn (the one that kinked) has a radius of less than an inch. I cut the hose off just above the bottle cap, installed a 90° 3/8" heater elbow (plastic) and a non-cramping heater hose back to the original connector. Cost less than \$4.

"If I were reading this I would take the 2 minutes and check it out. Unlike most cars this recovery system is completely out of sight and problems are likely to go undetected. This hose is really flimsy (unlike the hose from the tank neck into the wheel well which seems very strong) and just fell apart as I took it off."

Another problem is the little adapter, which is steel and therefore subject to corrosion. Craig Sawyers reports, "Mine was rusted solid inside, and so totally inoperative." Steve Haley says, "The short metallic slightly conical connector was completely plugged with corrosion. The hose into the tank crumbled in my hands...and the metal brackets were rusted and in pieces."

Yet another concern: The end of the rubber hose inside the atmospheric catchment tank obviously needs to be open, both to allow coolant out and to suck coolant back in. In some cases, the hose blows coolant just fine, but when sucking the tip of the hose gets sucked onto the bottom of the tank (or even onto the side, if someone is really unlucky). It then can't pull in any more fluid even though surrounded by fluid, so the system pulls in some air from somewhere else instead -- or starts sucking radiator hoses flat, which is also trouble.

The fix is easy: pull the hose out of the atmospheric catchment tank, and redesign the tip of the hose so it can't possibly get sucked onto a surface. One idea is to punch a 1/4" hole through the hose crossways about a half inch from the tip. This will prevent the hose from sucking up the bottom 1/2" of the fluid in the atmospheric catchment tank, but typically you'd rather not suck up the dregs anyway.

When fooling with the coolant recovery hose, remember that the hole where it enters the top of the atmospheric catchment tank is supposed to be airtight so that fluid won't overflow out that point if the tank gets full.

AIR PURGE SYSTEM: When coolant is added to a cooling system, there is always some air diffused in the liquid. Over time, this air will come out of solution and rise to the top of the liquid, forming air pockets. To avoid creating hot spots (since the air won't cool the metal adjacent to it as well as the liquid would), the idea is to design the system so the air will collect in a spot where it won't do any harm so the owner can deal with it at his leisure.

In old pickup trucks, the top of the radiator was the highest point in the cooling system. As a result, any air in the system would tend to collect right under the cap; all the owner had to do was top it up on occasion and the rest of the circuit would remain air-free. Unfortunately, when Jaguar designed the XJ-S, the hoodline of a 1950 Ford pickup was not considered acceptable; not only would the top of the radiator have to be so low that it would not be the highest point in the system, but it wouldn't have a cap on it either. Hence, more elaborate measures were necessary to continuously purge air out of the system.

These measures changed with the introduction of a second radiator cap on the bypass pipe with the introduction of the H.E. Mike Morrin says, "The Pre-H.E. XJ-S has only the cap on the header tank. The level of the cap is marginally below the radiator vent valve (with the car on level ground)." There was a small tube from the top right corner of the radiator over into the top of the header tank on the left wheel well. The bottom of the header tank was connected into the return line from the heater line, which is essentially the suction side of the pump. The pump operation would therefore draw a flow from the top of the radiator into the header tank. Within the header tank, the air would tend to rise out and collect under the radiator cap while liquid coolant went out the bottom back into the circuit. The owner simply tops up the system every now and then to keep air out.

With the H.E., it was decided to add a second fill cap on the bypass pipe. This formed another high spot where air would collect. So, the air purge tubing from the top of the radiator to the header tank was modified to include a hose connection for a line from a tap just under this second cap. Unfortunately, this complicated matters; the bypass pipe is connected to the suction side of the pump, so it's at low pressure. So, the coolant and air is likely to flow *into* the fill connection rather than out toward the header tank. To make the air purge system work right, connections to the header tank were revised. Rather than simply relying upon the suction side of the pump to draw coolant, an ejector was incorporated into the air purge tubing to provide even more suction so as to pull air out of the cap fitting on the bypass pipe. To operate this ejector, a hose was provided from the left side thermostat housing (high pressure) and there's a special connection on the bypass pipe directly into the suction side of the pump to get the lowest pressure possible. The high flow resulting is routed through the ejector to provide as much suction as possible. The connection to the heater return line was eliminated; the heater line merely passes underneath the header tank on its way to the radiator outlet.

Correction: The ©1982 Supplement, page 26-1, Fig. 2 showing the cooling system schematically shows the ejector (item 18) incorrectly; the line from the radiator and the line from the left side thermostat housing are interchanged. Simply look at the tubing on your car to see the correct scheme. The same schematic with the same error is included in the Haynes manual, page 334, Fig. 13.6.

The XJ12 with carburetors has a second radiator cap on the bypass pipe, but lacks the ejector-based air purge scheme. Its air purge scheme operates similarly to the pre-H.E. except that it's connected to the coolant passages in the induction housings rather than to the top of the radiator.

On the H.E., in addition to the ejector scheme, a "water valve" EAC4168 was installed in the air purge connection to the bypass pipe. This is basically a check valve that allows air to flow out towards the header tank but won't allow coolant to flow from the top of the radiator into the bypass pipe. This water valve is built into the fitting on the bypass pipe itself. This requires a 3/8" fitting at that end, and since the air purge tubing is 1/4", Jaguar uses a special hose that's 1/4" on one end and 3/8" on the other. Of course, if you want to replace the hose, you can use a piece of 1/4" hose, a piece of 3/8" hose, and an adapter. Tony Bryant says, "I've brazed a 3/8" fitting onto the bleed pipe to be able to use "standard" 3/8" heater hose here."

If your water valve is toast and you can't find a replacement, you can use a generic in-hose check valve, but be sure that the unit you select opens *very* easily since the ejector will not provide enough suction to overcome a heavy spring. Bob

Lovell points out that McMaster-Carr (<http://www.mcmaster.com>) offers a wide selection of check valves; the best choice would probably be number 47245K23. However, better yet would probably be to make a check valve from three successive sizes of brass tubing and a steel ball. Most commercially-available check valves consider a positive closure of utmost importance, but in this case total cutoff is not as important as ease of opening. Don't install a spring in your assembly, just let the ball roll back and forth, and install it nearly horizontally.

If the air purge system doesn't seem to be keeping air out of the space under the cap on the bypass pipe, it may be a sign that the radiator is plugged. A plugged radiator will cause the pressure at the top right side of the radiator to be higher than it should be. As a result, coolant will be coming out the banjo fitting faster than it should, possibly overwhelming the air purge ejector and preventing any purge from the bypass pipe connection.

In either the pre-H.E. or H.E., the air purge system is attached to the radiator at a banjo fitting at the top right. This banjo fitting has a design defect in that the hole through the side of the bolt itself is too close to the head, so it doesn't line up with the annular groove in the fitting properly. This exact same flaw is found in the banjo bolts on the back end of the tappet blocks and is discussed at length beginning on page 42; the same modification should be done here to improve flow, reduce the tendency to get plugged up, and make sure the air purge system works as intended. The banjo fitting on the radiator is longer and has finer threads than those on the tappet blocks, but it is the same diameter.

If you don't want to modify that banjo bolt yourself, Ron Kelnhofer (page 669) offers a replacement banjo bolt of his own design. It is made of brass rather than steel, and it has the cross hole correctly located when used with the included copper washers. You can look at a pic of this bolt at

<http://neptune.spacebears.com/cars/engr/banjorad.html>

While the defective banjo bolts on the oil lines don't seem to cause obvious problems, this one tends to get plugged up and completely shut off the air purge system from the radiator. David M. Johnson says, "After Kirby's info on the banjo bolt being blocked, I took note and disassembled the bolt this weekend. Guess what, the holes in the bolt were blocked with crud. One of my cars was making a disgusting moaning sound for the first minute after start up; the moaning sound (trapped air) is now gone. Thanks Kirby, I would not have found that on my own."

Craig Tims had more serious problems. After having the radiator rodded and the thermostats replaced at the dealer, the car continued to overheat. He eventually found that the new thermostats had no jiggle pins and the banjo fitting was totally plugged. After clearing and modifying the banjo fitting and correcting the thermostats, his temp gauge stays where it should be. While such details may sound minor, Tims' example should illustrate just how important it is to have a working air purge system to keep air out of the coolant circuit.

Using thick sealing washers under the head makes the hole misalignment worse, so Jaguar provides really thin washers that tend to leak. Once the modification to the bolt is done, the thick copper washers commonly found in auto parts stores can be used for better sealing. This banjo fitting requires three seals, and the plug at the top left for venting the radiator when changing coolant requires one more of the same size. If your local auto parts store has a rack of red cards titled "Help!", it probably has a package of sealing washers that are perfect for these fittings: part number 66272, labelled "Brake Hose Bolt Washer". It says they are ID 25/64" and OD 5/8".

Depending on personal preference, you might consider fiber washers instead of copper. This might be especially advantageous on the plug at the top left of the radiator, since you may be opening that one more often and fiber washers can be reused if care is taken while copper washers must be replaced (or annealed) each time to seal properly. 3/8" fiber washers may be difficult to find in an auto parts store even though they carry lots of larger ones for oil drain plugs. Lowe's carries suitable fiber washers in its specialty fasteners section, part number 838050.

LEAK SEALERS: Mike Wilson says, "Here is what my 1990 XJ-S Drivers Handbook (publication number: JJM 18 02 03/00) states on page 176: "Two 135 ml bottles of Jaguar Radiator Leak Sealer or Barrs Leaks *must* also be mixed with fresh anti-freeze".

Folks, this horrible recommendation probably ranks as the second biggest problem facing the XJ-S owner after the centrifugal advance seizing problems. Many Jaguar mechanics owe their livelihood to this terrible advice, since a high percentage of their work is traced to this stuff plugging up the bottom half of the radiator and contributing to Jaguar's

reputation for overheating problems. Please, do *not* use any leak-sealing substance within the V12 cooling system. If the system leaks, fix it.

To follow this advice, you're gonna have to keep the car's cooling system away from Jag dealers. Craig Sawyers reports: "Here's a horrible thing. I bought Jag antifreeze, determined I wasn't going to run the risk of damaging my glitzy re-built V12 with the wrong stuff. Anyway, my dealer casually tossed in a Jaguar box marked "2xJLM 636". "What is this?" say I. "Oh - corrosion inhibitor". That sounds good I think, particularly given the recent thread on water types for radiator use, and electrolytic corrosion. Well, guess what is in the box? Two nicely packed bottles of (unmarked) Barrs Leaks. AAARGH! Will they *never* learn! Needless to say, they are still in the box, and will never even have sight of my rebuilt rad."

If the car is more than a few years old and having overheating problems, it's not a bad idea to just take the radiator to a shop and have it rodded to restore its effectiveness -- especially if you're not the original owner and the previous owner may have been using leak sealers. John Napoli reminds you to clean out "the engine block, heater core and don't forget to remove and flush the expansion tank -- these are commonly forgotten repositories of Barrs Leaks."

OTHER THINGS PLUGGING YOUR RADIATOR: Another major source of particles for plugging the tubes in the radiator is rust scale, which primarily comes from four items in the XJ-S cooling system: the header tank, the cross pipe, and a coolant connecting pipe on top of each head. Replacing some or all of these items with non-steel substitutes would reduce or eliminate this source of crud. See pages 195, 198, and 201.

FIXING A PLUGGED RADIATOR: Once you come to the realization that your radiator is plugged, there are generally five things you can opt to do about it. The first is to go down to the store and buy some product intended for "flushing" cooling systems and use it according to the directions. A quick survey of owners on the internet indicated that this *never* does any good. Paul Bachman says, "I was told by a good source (must have been good 'cause I can't remember who it was) that since the advent of aluminum engines and aluminum radiators there are no longer any radiator flushing products that do anything useful at all. It seems the chemicals that used to do a fairly good job of cleaning out a brass/copper radiator cause serious corrosion to aluminum. Soo... rather than face complaints (lawsuits?) from people who don't read directions, all such useful products just quietly disappeared from the shelves about 15 years ago. I believe he went on to state that the antifreeze additives that were capable of keeping a brass/copper radiator free from blockage were deleted at about the same time.... thus the reason why most of our radiators are blocked or becoming blocked. From my experience (from before 15 years ago), I have to say that this theory seems to have merit."

Unfortunately, the next four options all involve removing the radiator. Deal with it.

The second option is to have the radiator "boiled". This involves dunking the radiator in some kind of vat full of chemicals and cooking it for a while. Again, a survey of owners indicates that this only *rarely* works with the XJ-S radiator, possibly because of the types of junk that typically plug it. Considering how much effort it was to get it out and put it back in, you might want to rethink this option.

The third option is to have the radiator "rodded". In this case, the radiator shop removes the covers on each end of the radiator and rams a rod through each tube from end to end, cleaning all the accumulated deposits out. He then solders the covers back on and pressure checks the assembly. This *usually* does the trick, although there have been a few reports when it didn't; it may depend on how skilled your local radiator shop is. Jim Isbell says, "Some shops don't know that to properly clean it *both* tanks have to be removed. If they only do one and you don't see any improvement it just might be because it wasn't cleaned properly."

Keep in mind that rodding does *not* render your radiator as good as new; the passages are unplugged but not all deposits can be cleaned away, and some parts may be stressed or weakened during the procedure. Sometimes the shop will even report that the radiator is toast and cannot be rodded, and suggest option number four.

The fourth option is to have the radiator "recored", which means they take the end covers off and solder them onto a new center section entirely. Apparently all brass radiators are made of comparable configuration cores, so the shop will be able to find a suitable core. You need to ensure the new core is at least as good -- and possibly better -- than the

original was. Any upgrade generally involves the number of “rows” the core has. There is also a difference in fin spacing, but if given a choice you should probably opt for the bigger fin spacing; the amount of cooling capacity is a secondary concern compared to the likelihood of the fins getting plugged with debris, and it’s difficult enough to hose out the radiator on this car.

The fifth option, of course, is to have the radiator replaced. You can opt for an OEM radiator, which works just fine as long as it’s kept clean inside and out. You can also opt for some sort of upgraded radiator, including brass radiators with more rows or aluminum radiators.

John’s Cars (page 668) offers “super-duty” radiators to fit the XJ-S, including a 5-row unit for the pre-H.E. car. If your radiator needs replacing anyway, it’s worth considering.

Aluminum radiators deserve a special mention. They are OEM equipment on a lot of modern automobiles precisely because they are cheap. Aluminum does not conduct heat as well as brass, but experts contend that an aluminum radiator does cool at least as well as the brass radiators because brass radiators are soldered together and the solder doesn’t conduct heat well at all. The aluminum radiators are welded together, so they are all-aluminum (the mass-production aluminum radiators on some cars have plastic end tanks, but that’s not important here).

The number of rows of aluminum vs. brass radiators becomes an involved discussion. The reason brass radiators vary the number of rows is to be using standard size tubes for all radiators, but makers of aluminum radiators happily provide *larger* tubes, thereby providing a comparable amount of surface area with fewer rows. With any luck, it might render them less apt to get plugged as well.

Some people also value the fact that an aluminum radiator weighs less than a brass radiator, but to make a fair comparison one would have to consider the volume of coolant inside as well as the weight of all the attachments and fittings involved; for most of us, this concern is not foremost in our minds at this point anyway.

Finally, note that an aluminum radiator apparently cannot be rodded or recored, so if you don’t keep your cooling system clear of obstructions the next cleanout will involve replacing the radiator *again*.

If you’re doing any of this work on your radiator, you should be installing coolant filters to make sure that it doesn’t get plugged again -- probably within minutes of starting, as all the crud in your block gets up and moves into your freshly-cleaned radiator. Also consider the other items on the checklist on page 190.

COOLANT FILTERS: Everybody who has taken their XJ-S radiator to a shop and had it rodded out has been told that it was really plugged up. The Jaguar recommendation to use Barrs Leaks in this system is often blamed, but there are apparently other contributors as well. Rust scale coming off the inside of the header tank and cross pipe is a source of crud. Some mechanics use too much silicone sealant so it leaves a bead around the joint, and later on this bead peels off and starts looking for a passage to plug. And those who replace their coolant often but mix it with hard tap water are introducing a whole new supply of minerals with each change; when the engine heats up, all these minerals deposit on hot engine parts as a scale, and then break off in chunks and reconvene in the radiator.

Why don’t they make a “last chance” filter to install in the upper radiator hose to catch all this junk before it can get into the radiator and plug things up? There are no small passages in the engine, the chunks could just flow right through the block, but catching them before the radiator should greatly extend the time between roddings.

They do. In fact, it’s a fairly popular idea among car enthusiasts, so there are several different model filters available. Brian Schultetus provided one source:

Gano Filter Company
1205 Sandalwood Lane
Los Altos, California 94024
+1 (650) 968-7017

This company makes a filter that is essentially a conical screen in a tube. The basic model is a clear plastic tube so you can see the filter getting crunched up and know when to take it out and clean it, but some people don’t like plastic so they offer a brass tube model as well. They also claim that the screen is made of the same copper alloy as the radiator itself,

so it also serves as a monitor for corrosion. And they point out that merely having the clear tube can provide considerable information on what is going on in the cooling system.

The filter comes in three sizes, and of course they expect most customers to buy one per car. The V12 has two upper radiator hoses, though, so you will need two filters. The hoses are 1-1/4" ID, which corresponds to Gano's "small" size filter.

If you're worried about flow rates through those screens, Damrel suggests using the next size up Gano filter, the "medium" size filter. "I made up a couple of custom hoses and put the old hose over the radiator and thermostat housing nipples to make up the difference." This author uses the small Gano filters with no problem, but it certainly couldn't hurt to be using the next larger size.

Gano filters do a great job of keeping the radiator clean, but they must be cleaned out periodically to keep from becoming obstructions themselves. Removal, cleaning, and reinstallation is a snap, except that it requires draining about one gallon of coolant and replacing it afterward. If you have the later XJ-S with no radiator drain, this could prove a pain. So, if you have the radiator out to be rodded (!) it's suggested you have a drain port added. Another option might be to install a fitting in the lower radiator hose to facilitate easier draining. An even better idea might be to tee into the heater hose at the bottom left corner of the radiator, install a short hose out the bottom of the car and put a plug in the end.

Even if you have an earlier car with a drain valve, periodic cleaning could prove messy and wasteful of coolant. Hence, the idea presented in the section starting on page 187 of providing a fitting with a piece of hose with a plug at the end is recommended. This makes it very convenient to just drain a gallon into a clean jug, service the Gano filters, then put the gallon right back in.

Tony Glavocich points out that the clear Gano filters can be helpful in diagnosis: "If you have Gano filters, you might just tie some white string to the screen filter, then you can monitor when the stats are opening. That is how I discovered my problem. I was also able to see a difference in flow between the two sides by observing the string. The string thing is something that I would suggest to anyone with Gano see-through filters."

One final note on Gano filters: Don't get ripped off on the internet. Apparently somebody named Robert Fornof in California registered the URL <http://www.ganofilter.com> and claims to be an "authorized distributor" while selling Gano filters for considerably more than Gano sells them for. It's cheaper to use the telephone and call Gano direct.

Peter Smith says, "I have found another source of coolant filters here in Oz and apparently they are exported to USA & UK. The manufacturer is

Tefba
122/124 Silverdale road
Silverdale NSW Australia 2752
Phone: 02 4774 2022
Fax: 02 4774 2777

"It consists of a black nylon moulded body which resembles a jam jar approx. 2 inches (50mm) diameter by 2 inches high. It has a screw lid and the inlet and outlet pipes come in at base level such that the side elevation resembles an inverted "T". When you unscrew the lid you look down inside and see a stainless steel filter screen placed across the flow path of the coolant. The filter screen is bent to form a delta shape or arrow head pointing in the direction of the flow. This provides a filter element size effective of approx. 6 square inches. The filter mesh hole size is about twice the size of the tea strainer we have in the kitchen.

"There is a problem IMHO with this item in stock form for V12 Jag use which I believe can be overcome. The stock item has the filter mesh so sized as to leave a 0.25 inch gap at the top. I located the designer and he explained that this was done on purpose to prevent total blockage of the filter. This I believe would work OK if the filter was mounted up level with the return pipe to the header tank of a vertical flow radiator which we of course do not have. The Jag mod would be to blank off the 0.25 inch gap with preferably a taller filter screen.

"I have installed two of these on my XJC and they look pretty neat. It is easy to check the screens by undoing the screw tops and there is a spigot which is attached to a disc which sits at the bottom of the pot. You use this spigot as a handle which lifts out the disc with the screen sitting on top plus the crap.

John Ashcroft found a US distributor for Tefba filters:

Musselman Distributing Co.
3340 Chimney Rock
Houston, Texas 77056
1-800-354-3254 or +1 (713) 974-9022
Fax: +1 (713) 974-4485
e-mail: musselmandist@usa.net

Ashcroft also found an easy fix for the Tefba elements being too short: "the element does end about 3/16" below the cap, but the disc is about 5/16" below the in/outlet. I just put a 3/16" thick O-ring under the disc, raises the screen to the cap." Chip Wikan adds, "a trip to the local Advance Auto Parts found an O-ring, part # 64630.1, dimensions 30mm x 36mm x 3mm which elevates the "grudge" tray perfectly flush with the top of the filter."

All in all, the Tefba filter has proven to be the item of choice. By installing them in the highest horizontal portion of each upper radiator hose, owners have found that they can check the screens without draining any coolant first -- and so have taken to checking them once a week, rendering the fact that they are not clear so you can see crud buildup a moot point. The only complaint about the Tefbas is that the cap sometimes becomes really difficult to get loose, which some owners blame on the lack of lubricity of the long-life coolant. Applying a little water pump lubricant or some such to the threads might help some, but you might also consider this when installing and arrange the filter such that you can get a big pair of pliers or a pipe wrench onto the cap. And, of course, don't overtighten the caps; Don Buresh suggests it's like installing an oil filter, "go 1/4 turn past seated and no more, otherwise it will be a real bear to get off."

Unlike with the Gano filters, there is no benefit to getting the Tefba filters to fit a larger hose. With the Tefba, you get the same size container with the same screen in it, it just has bigger fittings on it.

There are yet other sources of coolant filters. John Goodman says, "I noticed on the AC Delco website they have screw-on coolant filters (like oil filters). Paper filter with mesh so if they do clog up the paper busts leaving the slightly coarser mesh to still catch the big bits..."

There's another product made in Australia by:

Coolfilter Australia
151 Bushmead Road
Hazelmere WA 6055

Unfortunately, one customer had problems with the Coolfilter product. "It consists of a conical plastic material which has a series of steps. The idea is you cut it off at the appropriate shoulder to suit the ID of your hose. I fitted new hoses and the there was no appropriate shoulder; one shoulder was too big and caused the filter to buckle and the next shoulder too small. The step sizes go from 1.1" to 1.3". The new hoses I have are 1.2" ID. The Coolfilter is very flimsy and cannot push the hose out to accommodate the 1.3" step and of course the 1.1" step is too loose.

"Also, I believe the holes are too large (tea leaves would go straight thru), it would only filter out large particles. The Coolfilter has slots which are 13mm long by 1.5mm wide tapering down to 1mm. The slots are in between each size step and running lengthwise. I have run the vehicle with the Coolfilters installed (as best as achievable) for about 50 kilometers and they have captured no crap at all. Either I have a clean system or they pass the crap thru the slots and gaps created by the buckling of the OD."

Tom Bennett says, "Make your own filters! I bought a couple of very fine mesh SS tea strainers, a little bit of cutting and shaping, ended up with 2 "chili" shaped strainers that fit into the top inlets of the rad. Work great! I open them up about once every 3 months, although the crud is getting less. First time I looked, there was about a teaspoonful of crap in each!"

You can look at some coolant filter installation photos at

<http://www.jag-lovers.org/xj-s/book/CoolantFilters.html>

One easy mistake to make is to service the radiator now and worry about installing coolant filters later. If you're having your radiator rodded or replaced, you should go ahead and put in coolant filters *now* to protect it from the junk that's still sitting in your engine waiting to get at it! Don't wait until after you reinstall the radiator and run the engine -- in the first five minutes of running, a whole pile of crud will get pumped into your nice clean radiator. Much of the crud in the cooling system is heavier than coolant, and so sits in low spots within the engine and won't move unless the flow is really high -- but your radiator is plugged, so the flow is *never* high enough to move it. Then you clean the radiator, and the first time the thermostats open there's more coolant flow through the system than it's seen in years! It stirs up all the crud laying around and pumps it right into the radiator.

Bob Gallivan: "I bought these some months ago & finally got around to putting them in & already I can see what looks like a gray crud through the filter. I'm sure that the *new rad* at this very moment is harboring this crap that has migrated there before I installed the filters."

Richard Damrel: "Had my radiator rodded out in May of this year, now it seems to need it again according to my mechanic. The radiator shop says it's not uncommon for a massive build-up of scale or corrosion to be transferred from the block to the radiator. Seems to me that it should be much easier to change a few filters every now and then rather than pull the radiator twice a year."

Douglas Dahl: "I had to have my radiator rodded right after I got the car (about 6,000 miles ago). This last week, it was pulled again. No Barr's leak is allowed within 50 yards of the beast and I put the Gano filters on this time. I just ran it for less than five minutes and both filters seem to be completely clogged. Tomorrow, after it cools, I will clean them out and see how long it takes to clog them again, and so it will go until they need no further cleaning."

A couple of owners have expressed concern that they will never be able to drive their cars for more than a few miles without having to clean coolant filters. When first installed, it's a good idea to check them *within the first five minutes* after the thermostats open, and continue to check them in relatively brief intervals until they look like they're willing to remain unplugged for a while. Rest assured, sooner or later you will get most of the crud out of the system and they will run clean for months at a time.

HEATER HOSE FILTER: Gano (see above) also offers a small filter assembly for installation in the line to the heater core, pointing out that the same crud that plugs radiators can also plug heater cores. Your immediate reaction might be "Who cares? If the heater core gets plugged, it doesn't damage the engine." However, you might want to rethink that reaction. The heater core getting plugged might not damage the engine, but it'd still be no picnic to fix.

Unfortunately, the Gano heater hose filter assembly is only available in brass -- no clear plastic version offered -- and therefore must be disassembled to check for pluggage.

On the plus side, you don't need to get this item from Gano; it's available in any hardware store! All it requires is a pair of fittings for a 5/8" garden hose, and one of those hose washers with the built-in conical screen intended for supply hoses for washing machines and dishwashers.

Garden hose fittings generally come in three flavors: The plastic junk, the slightly better "corrugated" brass (made of brass sheet metal formed to shape), and high-quality fittings machined from solid brass. Besides being considerably more durable, the solid machined brass items also typically have flats around both male and female fittings, making it much easier to tighten and loosen. This being the US, most consumers are morons who buy the cheapest junk available and most retailers are also morons who cater to this stupidity rather than making the slightest effort towards educating their customers on why a better product is the wiser buy. So, the solid machined brass items can be a little hard to find.

Home Depot carries an excellent set. Made by Nelson, item N-1558 B, "5/8" Brass Hose Repair -- Extra Heavy Duty Rod Brass" contains a male fitting, a female fitting, two SS worm screw hose clamps, and one rubber washer -- in other words, everything you need except that you'll need to pitch the simple washer and install a screened washer instead. This set costs about \$5, and the screened washers are perhaps 3 for \$1. With a little shopping you can actually find screened washers in two or three different screen grid sizes; the ones with the biggest holes are suggested -- the fine ones

are *really* fine. After screwing the two fittings together with this screened washer in the middle, just cut the heater hose between the engine and the heater valve and install this assembly with the clamps.

Despite the temptation to use big wrenches on the flats on the machined brass fittings, be careful not to overtighten. It's not too difficult to cut right through the rubber outer circumference of the screened washer. After all, the washer was designed for the fittings to be hand-tightened, so it's really soft rubber.

Cleaning this filter is easy, since you can easily install the fittings at the *very* highest point in the system and not even have to do any draining. Just unscrew the two hose fittings from each other, clean out the screened washer, and reassemble. In actual practice it often proves easier to loosen the hose clamps and remove the entire assembly for cleaning than to just unscrew the halves in place.

Will the screen in the line reduce flow to the heater core? Perhaps. Here in FL, we couldn't care less; any flow at all is enough, and most of the time we'd rather have *less* flow. But you guys who live in the less habitable climates might be concerned about installing this screen. I have this suggestion: Install the screen assembly, and then when winter approaches unscrew the fittings and replace the screened washer with a normal hose washer. That way, you get filtration in the summer, full flow in the winter. With any luck at all, the filtration in the summer will take enough of the crud out of the system that there won't be any pluggage during the winter.

Such a screen installed in the heater line might actually save your radiator! Since this essentially becomes a "bypass filter" arrangement, eventually this tiny screen should remove most of the crud circulating around the closed coolant circuit. The only problem will be the crud that jams tubes in the radiator before ever going through the heater hose, but if you're concerned you should be buying the radiator hose filters described above. The other shortcoming is that, since this screen is so small, it's likely you'll have to clean it out a lot of times right after installing it until you get the system pretty well cleared up.

RADIATOR DRAIN: Up until somewhere around 1988, the XJ-S was fitted with one of the most obnoxiously overdesigned radiator drain cocks in automotive history: a metal drain valve at the bottom right corner of the radiator, operated by a lever that extended up to just below the upper hose fitting. Evidently, the image of luxury is supposed to include being able to drain your coolant while wearing a tuxedo. For all this effort and expense, Jaguar couldn't bring themselves to provide an outlet out the bottom of the car, so opening the drain valve causes coolant to pour all over the structures in the area and dribble out wherever the catch pan isn't. The end of the valve is a spherical shape with a funny flange, making it rather difficult to attach a hose, but it's possible with enough determination.

Before you get too involved with that drain cock, let me provide a description of what you're getting into. The drain cock itself is a solid brass tapered plug valve that turns 90° from full open to full shut. There is a spring on the bottom that "loads" the tapered plug to keep it sealed; the seal is brass-to-brass, there are no elastomers inside the valve. There is also a little diamond-shaped washer that fits on a shoulder with two flats that limits motion to 90 degrees. This valve is probably repairable from most of its typical failure modes, which is an option you may want to keep open; read on before doing anything irreversible.

Unscrewing the valve from the radiator may be the first irreversible thing you do. It is not a tapered thread; it is sealed by a fiber washer. But when tightening down, the valve *must* end up oriented properly to align with the remote handle. To accomplish this interesting feat, Jaguar appears to have used two tactics: First, the fiber washer may in fact be two or more fiber washers, indicating the assembler may have added washers as required to get the proper alignment. Second, the fiber washers are thick and compressible, so there is some considerable range of tightness that will ensure a seal; the assembler can tighten until it lines up, and leave it. If you take it out, what do you suppose are the odds that it will line up properly *and* seal reliably when you reinstall it? Fortunately, the size washer needed is the same as those used on many oil drain plugs, so you should be able to obtain a good supply of fibre washers of various thicknesses from local auto supply houses.

If you decide to go ahead and unscrew it, here's a tip: the hex size is 19/32", but if you don't have a wrench that size a 15mm makes a good fit. It may be helpful to unbolt the fan shroud and back it away from the radiator a bit to permit use of an open-end wrench, since even a crowfoot won't work well in this space.

Before you reinstall the drain cock, here's another tip: The hole in the end of the valve is 5/16" to a depth of about a quarter inch, and then 1/4" the rest of the way through the valve. With a propane torch, it is a fairly simple matter to solder a short length of 5/16" OD brass tubing into the end of the valve to provide something to attach a hose to. The hose can then be routed out the bottom of the car, making draining the coolant a lot neater and easier to collect and dispose of properly. Since there are no nonmetallic parts inside the valve, you don't even need to take it apart to solder on it, but you almost might as well -- it's only one cotter pin. Something to keep in mind: the radiator moves around a little on its rubber mounts, the oil lines move around a little with the engine moving on its rubber mounts, and the front subframe moves a bit on its rubber mounts. Make sure there is adequate clearance around the valve and attachments so they aren't subject to impacts or rubbing due to these various motions.

Let's say your radiator drain valve is toast and you have decided to replace it. Ed Sowell ordered one from Jaguar: "Problem is, it is not the same as the original, even though the part number is correct. Apparently Jaguar found a new source. The valve is different in several ways. In fact, the only similarity is that it is a 1/4" BSNB thread, about the same length. The plug is held with a nut rather than a spring and cotter pin. The important differences are:

- The diameter of the bore is 3/16", whereas the original is 5/16". Slower drain time, but would work. Also, with the original I can jamb a 5/16" plastic hose barb fitting into the outlet to allow coolant recovery (as opposed to washing down the front suspension and splashing on the floor). With the 3/16" bore, it appears impossible to attach a hose.
- There is a handle instead of the tongue on the stem. Consequently, the extension for above-car operation of the valve cannot be attached. Very bad. You have to get under the car to operate it, and there appears to be no way to avoid being drenched when you open it! Could be used, but nobody would want to. Might as well just slash the lower hose!
- Due to the height and length of the handle, it can not be installed in the radiator while it is in the car. No matter which way I set the handle, it bumps into something, e.g., the sub frame, or the oil cooler line. It might work if it was screwed in before dropping the radiator into the car.

"I find it had to believe Jaguar would say this was a replacement for the original. They must be blind."

So, now you're in the market for something non-Jaguar to fit that hole. Go ahead and measure the threads; they are 13.16 mm OD and 19 threads/inch. As mentioned above, it is not a tapered pipe thread; it's a washer-sealed installation like an oil pan drain plug. Tony Bryant in NZ says this drain fitting is "1/4" BSP (British Standard Pipe). Very common in this part of the world. Cost me less than \$1 for a brass plug. Any competent hydraulic fitting supplier should be able to find one, or at least a thread adaptor. BSP is extremely common here, but NPT is a lot more difficult, but still possible." Well, here in the Bubba Belt in the good ol' USA, my local hydraulic fitting shop calls it BSPP (British Standard Pipe - Parallel, as opposed to a tapered version) and charged over \$5 for a fitting for connection to a 1/4" hose -- and only had that one type of fitting on hand to choose from. The hole through the middle is only about 1/8", so it would drain very slowly indeed; this fitting was clearly designed for hydraulics, not radiator drains.

The closest thing you're likely to find in auto parts stores in the US is a 1/4" NPT (tapered), but it will *not* fit properly -- it's 18 TPI.

Bryant also suggests that the coolant drain plug on the block (note: not the one on the radiator) of many Japanese cars is BSP, although the tapered version. Still, the tapered plug may be usable to plug the parallel fitting on the XJ-S radiator.

Another option: find a way to use the original valve as a plug. It's solid brass and very meaty (weighs about five pounds, I think) so it should be easy to work with. One possibility is to cut the valve portion off, just leaving the hex and threads, so it looks like a plug except it has a 1/4" hole through the middle. So, you can put a stainless steel or brass bolt through the middle and tighten a nut down on the other end, and use the assembly as a conventional plug -- just remove the whole thing when you want to drain the coolant. If you wanna get fancier, you can tap the hole in the center for a threaded plug instead of using a bolt.

Of course, using a simple threaded plug as a radiator drain is messy. For neater work, you can solder a piece of brass tubing into the hole in the plug, connect a piece of hose to it, route the hose out the bottom of the car, and plug the end of the hose with something. Then when you want to drain the coolant, you don't even need to open the hood -- just reach underneath and remove the plug from the end of the hose. You can stick with the 1/4" hole in the plug, but it might be a

better idea to enlarge the hole to 5/16" and use larger tubing and hose; it'll drain quicker and larger chunks of crud can pass through.

A similar idea might be to drill and tap the hex portion and screw in a common fitting. It's too small to fit a 1/4" NPT fitting, but a 1/8" NPT will fit nicely. One might think that draining through a 1/8" NPT fitting would take forever, but believe it or not you can find fittings with 1/8" NPT on the outside and a clear hole through the middle that's larger than 1/4"! One such fitting is made by Brass-Tite!, part number 43275, and has a 1/8" male NPT on one end and a 3/8" hose fitting on the other; it is perfect for this task.

Yet another option would be to make the piece of the original valve into an adapter to fit a standard drain cock. This would involve drilling and tapping for the threads of whatever drain cock you buy. Most of the universal ones seem to fit a 1/4" NPT, but you'll need to choose a smaller drain cock with a 1/8" NPT. You also need to choose your drain cock carefully, since many of them have a moving plug at the inner end that would require more space inside the hole than you'll be able to provide within that chunk of the original valve.

If you have the radiator out, you can get more radical: toss the original drain cock in the trash and drill out the threads in the boss on the radiator and retap it for something readily available. The fitting on the radiator appears to be pretty meaty, so it could be drilled and tapped for something considerably larger than the stock drain cock.

WHAT RADIATOR DRAIN? Somewhere around 1988 -- possibly coinciding with the introduction of long-life phosphate-free coolant -- Jaguar went from the overdesigned drain cock to no drain cock at all. On later cars, it is necessary to disconnect the lower radiator hose to drain the coolant. Wearing a tux is not recommended. In fact, this author once suggested to an owner that he do this task au naturel, and just jump in the shower afterwards.

Joe Montgomery suggests another way to get most of the coolant out of later cars: "Having seen at the local shop the way coolant goes everywhere when the bottom radiator hose is pulled and since the storm drain that would collect it is a straight shoot to the bay, I found a better way. I got about 2 feet of 1/4" copper tube and 4 feet of plastic tube that would fit over the end from Home Depot. By inserting the copper tube through the bleed hole on the right hand side of the radiator I was able to siphon better than 3 1/2 gallons into a bucket for recycling."

Another suggestion: if you can locate a suitable tee, you can cut the bottom radiator hose and install the tee with two hose clamps and use the tee to drain the coolant. There is a similar tee used for adding a coolant heater in subfreezing climates; perhaps that tee could be used.

Something to note: the lower radiator hose does not connect to the bottom of the radiator in an XJ-S. It's perhaps four inches from the bottom at the left side. So, if the only way to drain and flush the coolant is by disconnecting this hose, you will *never* get the junk outta the bottom four inches of the radiator! And the connection is on the downstream side; anything larger than the tiny passages in the radiator core will pile up on the upstream side indefinitely. Hence, if you have the radiator out for service, you might consider having a drain fitting added at the bottom right corner.

RADIATOR REMOVAL: Both the official Jaguar manual and the Haynes manual state that removing the radiator requires discharging the air conditioner freon circuit. They lie. In fact, as Jim Isbell reports, "In the Haynes manual there are 21 steps under section #21 that describe the removal. Steps 1, 3, 5, 9, 10, and 11 are all unnecessary." Most are merely extra work, but discharging the freon is a waste of serious money.

Both manuals also provide the same illustration which shows the radiator sitting on top of the oil cooler. This may be the case for cars that weren't equipped with air conditioning, but for the rest of us the oil cooler is in front of the radiator, and the A/C condenser is on top of it.

Forget the manuals and just dive in. The radiator comes out vertically upward, leaving the A/C condenser and oil cooler in place. Drain the coolant and disconnect the hoses, remove the air purge system tubing from the top of the rail over the radiator, unbolt the A/C dryer from the rail and leave it hanging, unbolt the fan shroud, and remove the rail. Either remove the hood, or simply remove the grille, disconnect the struts, and tilt it forward until it rests on the bumper.

Disconnect the hoses from the transmission cooler and the wire from the coolant level sensor (early models only) and whatever other little things are hanging on, and pull the radiator out straight up.

Now, if you have an early model such as Bernard Embden's '78, things are a bit more difficult. "The radiator has two brackets welded to the bottom. The oil cooler is bolted to these brackets. To remove the radiator the oil cooler lines must be disconnected and the radiator and oil cooler removed as one unit. Once removed, the oil cooler can be unbolted from the radiator brackets."

Embden recommends changing things while you're in there. "Why does the damn oil cooler have to be bolted to the radiator? After removing the radiator I decided I was not going thru this again. I went over to the radiator and sawed off the two tits (sorry, "oil mounting brackets") that the oil cooler bolts to. Now properly motivated, I fabbed two brackets out of 1/2 inch wide, 1/8 thick flat iron available at any hardware store. I offset the brackets (wider). Made two 1-1/4 inch straps. Bolted one end to the oil cooler mounting bracket, the other to the brackets that I fabbed up. This was so the brackets would fit below the still existing part of the bracket that remains on the bottom of the radiator. (I was concerned about clearance). Two bolts per side, drilled the holes thru the boxed lower radiator support. Brackets had to be angled slightly (hammer took care of that). Now the oil cooler and A/C condenser sit where they should be with the radiator *out*."

RADIATOR WORK CHECKLIST: If you have to pull the radiator out for any reason, you should take advantage of the opportunity to do *all* of the following:

- 1) Rod, recore, or replace the radiator.
- 1a) Consider converting to a single-pass system; see below.
- 1b) If the coolant level sensor is located in the radiator, have the radiator shop plug the hole and relocate the sensor to the header tank -- see page 198.
- 2) Clean fins of A/C condensor and oil cooler.
- 3) Consider revision of radiator drain scheme -- see page 187.
- 4) Revise air bleed banjo fitting -- see page 180.
- 5) Install foam in all undesirable air paths -- see page 215.
- 6) Install coolant filters -- see page 183.

You might also consider the opportunity to replace the front oil seal on the engine or to check that the bolt holding the crank damper on is properly torqued (page 86).

IMPROVING THE ONE-AND-A-HALF-PASS RADIATOR SCHEME: As mentioned in the cooling system description beginning on page 168, the OEM radiator in the XJ-S will result in the left bank running warmer than the right. If you'd like both banks running at the same temperature, it will be necessary to revise the system so that both thermostat outlets see the same backpressure. Perhaps the simplest and most straightforward method to accomplish this would be to increase the backpressure on the right side thermostat outlet. Performance outfits like Summit Racing (page 670) offer flow restrictors for cooling systems, but their intentions are different and the parts may be difficult to adapt to the Jaguar V12. Perhaps the better tact would be to simply adopt the idea, and provide a simple orifice in the upper right radiator hose or radiator inlet. We have no idea what size the orifice should be, unfortunately; if someone wants to take the effort to install pressure taps and experiment, the orifice should be just the right size that the pressure at both thermostat outlets is exactly the same -- but even with that criteria, the desired orifice size may vary with radiator condition and possibly even engine RPM.

This author installed a 1/2" stainless steel washer in the right side radiator hose as an orifice. The OD of a standard 1/2" flat washer proved to be exactly the same as the OD of a 1-1/4" Gano filter (see page 183), so a couple of tiny holes were drilled in the edge of the washer and it was screwed to the inlet end of the Gano filter with the existing screws that

hold the Gano filter together. The ID of the 1/2" washer is 14mm. The car ran fine and stayed cool, as evidenced by the gauge sender in the right side thermostat housing; thus we can conclude that a 14mm orifice is large enough, although we really cannot decide if it is small enough without measuring the effect on the left bank temperature.

A slight improvement upon the simple orifice idea would be to add a crossover connection between the two upper radiator hoses. This should not be done without installing the orifice, because it would allow the fluid from both sides to simply skip the upper 1/3 of the radiator core. The orifice will help encourage some coolant to enter the left radiator inlet and go through the upper portion of the core. If the orifice is sized properly, there should be little flow in this crossover; it could conceivably be smaller than the radiator hoses themselves. But it being there will help compensate for the orifice size being a little off, or changes in the radiator pluggage, or engine RPM.

ELIMINATING THE ONE-AND-A-HALF-PASS RADIATOR SCHEME -- HOME VERSION: The optimum fix for the XJ-S cooling system would be to eliminate the one-and-a-half-pass scheme altogether and plumb this cooling system the way Jaguar should have in the first place. If you're handy with a propane torch or have a radiator shop willing to do some fiddling, you may be able to modify the OEM radiator to make it a single-pass. You will need to remove and cap the upper left inlet, and install a second inlet on the right side header tank just a couple inches down from the existing inlet. Remove and throw out that hokey radiator drain lever if your car has it (see page 187 for ideas on the radiator drain). Also, you need to make the left end of the radiator into a single tank the full height of the core. The radiator on this author's car has a single left end tank with a partition hidden inside, so you can remove the tank, remove the partition dividing the upper 1/3 from the lower 2/3, and reinstall the tank. Other owners have reported their radiators have two distinct tanks, an upper 1/3 and a lower 2/3. This latter type would obviously require more effort to convert into a single left side tank, such as perhaps adding a pipe between the two.

This change, of course, would require routing the outlet of the left thermostat housing over to the right side. A simple pipe or hose supported along the back edge of the upper radiator support is one idea. When plumbing the two inlets into the right side, take care not to create air pockets; having the coolant going downhill to enter the radiator will probably trap air in the hose. It will be helpful to install the second radiator inlet as high as possible. It will probably work best to connect the right thermostat outlet to the lower of the two inlets. Another idea might be to have the radiator shop install a single, larger inlet instead of two 1-1/4" inlets, and use a tee to connect the hoses and feed them into the single inlet. If you cannot devise a routing that will push air bubbles on into the radiator inlets, you will need to provide an air bleed port at the high point where a bubble might get hung up.

Alternatively, you can convert to a single-pass system without modifying the radiator at all -- or even removing it from the car! Rather than removing the partition in the left tank, simply install a tee in the lower radiator hose and route a hose from the left inlet (which will now be a secondary outlet) down to it. Tee the two thermostat outlets together and feed them into the single inlet on the right side; this inlet is large enough to handle all the flow, but don't obstruct the line with coolant filters or other restrictions; install your coolant filters in the two separate hoses from the thermostat housings instead (in fact, you may use a coolant filter to double as a coupling to connect two radiator hoses together to accomplish the routing required for this job!).

When converting to a single-pass setup, note that you will also need to change the air purge system a little bit. The banjo fitting at the top right of the radiator will work better now if it is relocated to the top left -- so simply exchange the banjo fitting with the air bleed port. You can simply cut the long metal tube and reconnect it with a piece of 1/4" hose and a pair of EFI clamps, making it a *lot* shorter than it was. You will also need to figure out how to route the connection from under the center radiator cap over to this location. It may be possible to cut the tube near the tee at the left side and flip the whole thing over and reinstall it, putting the banjo fitting at the left but leaving the long tube going across the top of the support rail and connecting to the hose from under the radiator cap in nearly its original position. The short tube that originally connected the hose from under the radiator cap to the banjo fitting can now be used to connect the banjo fitting back to the tee at the left side with a short piece of hose.

If you get rid of the one-and-a-half-pass scheme, you can forget about relocating the coolant temperature sensors as described on page 170. The only reasons to do that were due to the differential cooling, which you will have eliminated. Of course, if you've already done it, you can leave it alone; for similar reasons, there's no point in changing it back.

ELIMINATING THE ONE-AND-A-HALF-PASS SCHEME -- AFTERMARKET VERSION: The simplest way to alter the OEM cooling scheme would be to replace the one-and-a-half-pass radiator with a suitable single-pass radiator with one large or two small inlets on the right side and a single outlet at the bottom left, right where the OEM outlet is. Chad Bolles and Bradley Smith have both gone this route, and their costs for a custom-made aluminum single-pass radiator actually compare favorably with buying a new OEM radiator from Jaguar!

Bolles and Smith had to discuss the radiator design at length with the people building it for them -- but you don't have to! Be Cool now offers aluminum radiators to fit the XJ-S; they are still "custom" in that they are designed specifically for the XJ-S and they are not actually built until you order one, but they already have the design on record -- you just order the part number of the radiator you need. Be Cool actually offers four part numbers, all of which end in 082 which is apparently Be Cool's indication that it fits an XJ-S. 62082 is the radiator that most XJ-S owners will need; it is a bare aluminum radiator for an XJ-S with an automatic transmission. 63082 is the same radiator, except that the aluminum is polished (Be Cool caters to the show car crowd, so all of their radiators are available with a polished finish). 60082 is a radiator for a manual transmission car, lacking the transmission cooler and therefore a few bucks cheaper. 61082 is the manual transmission radiator in polished form. All of these are single-pass radiators with a single large inlet at the top right, since Be Cool would have nothing to do with that silly one-and-a-half-pass idea.

I know what you're thinking: "The Jaguar parts books indicate that many different radiators were used over the years. Which one does the Be Cool radiator replace?" The answer: all of them. To illustrate, the following are the differences in the Jaguar OEM radiators:

- The very early cars had the oil cooler supported by the radiator. However, this is a really horrible arrangement to work on, and most owners who get in there find a way to convert the oil cooler mounting scheme to be more like the later cars; see page 189.
- The low coolant sensor was installed in the right front corner of the radiator up until sometime in the mid-80's, then was relocated to the header tank. Regardless of where yours presently is, it would be a good idea to relocate it to the header tank; see page 198.
- Up until the mid-80's, the transmission cooler had barbs protruding from the back side of the right header tank and the lines from the transmission were connected by sliding the hoses over the barbs and clamping. Later cars had threaded holes, and pipe thread fittings on the ends of the transmission lines were screwed in. The Be Cool radiators for automatic transmission cars come with threaded holes, which allows the owner of an older car with hoses and clamps two options: he can screw standard fittings into the holes and connect up the hoses with clamps, or he can replace his lines with the later lines with threaded fittings at the ends.
- Sometime in the late 80's, Jaguar eliminated the hokey drain cock and provided no drain at all! Be Cool took an interesting approach here; they provide a drain scheme based on the early radiators, complete with the cute little lever -- but they also provide a rationally-designed drain on the left end of the radiator.

It may even be possible to fit the Be Cool radiator to an XJ12, but that hasn't been confirmed.

Finally, note that there were apparently radiators with either four- or five-row cores, and owners get very concerned about how many rows they end up with when recoresing or replacing a radiator. Well, the Be Cool radiator is two-row -- but that only illustrates the shortcomings of this method of specifying a radiator. With brass radiators, each tube is perhaps a half inch wide by 1/8" thick, so a core that is two inches deep can fit four rows. However, Be Cool uses tubes that are a full inch wide and also a bit thicker than 1/8", so two rows provides at least as much surface area as four rows of the tiny brass tubes. Also, the brass tubes are so tiny and flat that you'd be lucky to fit a fingernail file into one, but the aluminum tubes have much larger passages so they are far more difficult to plug up.

Be Cool guarantees a 20-40° temperature drop over 4-5 row brass radiators. Just how you'd ever make such an evaluation is uncertain, but at least they appear willing to stand behind their product. By their estimation, this radiator should be good for up to 600 cubic inches and 1000 hp.

As of this writing, Be Cool reportedly does not offer any help in connecting the two 1-1/4" thermostat outlets into a single larger radiator inlet; apparently you are on your own there, although it wouldn't be a great surprise if they start making a suitable accessory. Until they do, one idea would be to have a weld shop make up an aluminum tee and connect it with suitable radiator hoses. An improvement on that idea would be to make it a wye instead of a tee for

better flow characteristics. Another idea would be to actually make a manifold that reaches across the engine compartment, so you only need short pieces of hose to connect it up. And yet another idea would be to create a tank or container of some sort with two 1-1/4" lines in and one larger line out; a photo of a racing XJ-S in the May 2000 issue of Jaguar World shows such a tank, and it has a radiator cap on top -- and the radiator cap on the crossover pipe has been omitted.

Be Cool's web site is at <http://www.becool.com>. Their products can be ordered through Summit Racing, page 670.

The author will take this opportunity to express an opinion: it may not be worthwhile to run right out and purchase a Be Cool radiator to replace a good condition OEM radiator, but if the original radiator is done for, anyone paying good money for a *new* OEM radiator when the Be Cool radiator is available for a comparable price ought to have their head examined.

ELIMINATING THE ONE-AND-A-HALF-PASS SCHEME -- OTHER IDEAS: Another option would be to replace the one-and-a-half-pass sideflow radiator with a simple custom-made downflow radiator. This would result in an upper header tank all the way across, so the two inlets could be right where they are. The bottom outlet would probably have to change; it'd add complexity to try to get the outlet several inches up the left side where the OEM outlet is. It'd probably be easier and better to just provide an outlet at the bottom and use a generic flex hose to connect it to the pump inlet. Flex hoses are usually better in this location anyway.

Believe it or not, the Series III E-Type used a downflow radiator exactly as described. It's not known why Jaguar decided to cause all sorts of trouble by providing the XJ's with the one-and-a-half-pass sideflow radiator instead.

RADIATOR MOUNT BUSHINGS: The radiator is mounted on four rubber bushings, two at the bottom (C43577) and two at the top (C38333). If you wish, you may replace these by visiting your local discount auto parts store and looking through the selection of PCV valve grommets that are usually on a display rack in bubble packs. There is one intended for a Toyota that will serve quite nicely in both positions. It doesn't have as large a weight-bearing surface as the Jaguar originals, but it's not made of British rubber either.

By the way, there are several possible explanations for why the radiator is mounted on rubber bushings, including to allow for thermal expansion and to protect the fragile radiator from chassis flex and vibration. However, one plausible explanation is that it is to electrically isolate the radiator from chassis ground. Since the radiator is largely brass or copper while the engine block is aluminum, and the engine must be grounded, grounding the radiator would complete a circuit through the coolant causing electrolytic corrosion somewhere -- probably inside the block! Several owners have checked and confirmed that their radiators are not grounded; the rubber mounts, the rubber hoses, the foam packing, the fact that the fan shrouds are bolted to the rail instead of the radiator itself, all add up to complete electrical isolation. Unfortunately, the heater core -- also brass -- is quite effectively grounded.

RADIATOR OBSTRUCTIONS: One possible cause of overheating problems is that the outside of the coil or the spaces between the fins has been plugged with crud so air can't flow through. Since the fins in the A/C condenser coil and the oil cooler are coarse but the fins in the radiator itself are much finer, the blockage may be dirt jammed in the radiator fins while the condenser and oil cooler still look clean. One great way to avoid this problem would be to spray a garden hose through the radiator from the engine compartment forwards every time the car is washed to prevent any buildup. Unfortunately, the design of the fan shrouds and the tightness of the engine compartment conspire to make this task all but impossible, so more likely it's going to have to be addressed by a periodic disassembly and service.

Worse yet, Jaguar does a poor job plugging the gaps around the condenser and oil cooler, so really big things like leaves get blown through the gaps and into the space between the condenser and radiator. The problem is often a massive collection of debris between the condenser and the radiator, where it's really miserable to get to.

John Bertsche provides a procedure: "Well, I really didn't feel like pulling the radiator this weekend. I came up with an alternate plan, which may or may not be useful to those of you with my problem.

- 1) Put the front of the car on ramps. Take off the spoiler, if you're lucky enough to have one. Take out the lower splash panel/lower center valence, or whatever you prefer to call it, if it hasn't rotted into swiss cheese from all the wet leaves that have collected between it and the oil cooler after all these years.
- 2) After liberal use of Liquid Wrench, use your sturdiest pair of vice grips to loosen the two large Phillips-head screws holding the oil cooler to the brackets attached to the frame. Once they're loose, you can try using an actual Phillips-head screwdriver to take them all the way out. (Ed. note: they're not Phillips, they're Pozidriv -- and using the correct tool may eliminate the need for the vice grips.)
- 3) Carefully pry (on the brackets, please, not the cooling fins!) the oil cooler away from the radiator just enough (about 1/4 inch) to get a straight piece of coat-hanger wire (a foot long or so) up in between the oil cooler and the radiator, and *gently gently* use the coat hanger wire to brush the debris out of the space. If your car is like mine, it will look like the tobacco inside a cigarette (about a carton's worth).
- 4) Use a blower, like your shop-vac, to blow forward through the radiator (like back-flushing the air flow) to loosen any crud that's trapped in the radiator fins. You can hold the oil cooler away from the radiator a little bit while you're doing this with sticks or whatever (again, levering only against brackets, not cooling fins!). You'll be surprised at the amount of junk that flies out. Thousands of insect wings, bits of leaves, styrofoam, paper, etc.
- 5) There's quite a bit of space between the A/C condenser and the radiator, but virtually none between the oil cooler and the radiator (at least on my car). So, as you clean out the bottom section, the debris from up above will fall down into the gap you're creating. Make sure you alternate between using the blower and the coat hanger a few times to get everything cleared out.
- 6) Put it back together and take the car out for a beer. You should notice a big improvement in cooling. I estimate my radiator was about 30-35% blocked.

"I'm pretty sure this took longer to write than it did to do (except for step 6). It may be worth a try (easy fixes first!)"

Instead of the coat hanger wire, Paul Gill says, "A plastic mini-blind slat is great for this."

Matt Dillon suggests another method: "Take the top holder off of the radiator so that you can spread it apart from the A/C condenser and clean out the junk that's in between them. I found a whole boatload of stuff in there." Removing the upper rail requires removing the air purge tubing, which in turn requires draining a little of the coolant. Think of it as an opportunity to modify the banjo fitting on the air purge system (see page 180) and install foam to prevent it getting plugged again (see page 215).

Before you decide that you're done, try to shine a light through the radiator. You might try laying a piece of paper on one side and see how much light shines on the paper. The task may still require a mirror and/or a tiny, bright light on the end of a long, bendable wire, or maybe you can shine enough light through the condenser and oil cooler. If you still can't get the enough of the crud out to see light everywhere, it may be necessary to drain all the coolant and pull the radiator out to clean the fins themselves. Think of this as an opportunity to have the radiator rodded (see page 181) and to revise the drain scheme (see page 187).

PREVENTING RADIATOR OBSTRUCTIONS: Colleen Melton suggests you install a screen in front of your condenser/oil cooler to keep crud from plugging things up. "A simple piece of fiberglass window screen (darker color such as charcoal or black look less obtrusive) run in front of the heat exchangers works great at keeping leaves, bugs, etc., from clogging up the works. My car has such a screen installed, we've done it on all our vehicles for quite a few years. Ours is secured at the top by clamping under the A/C drier clamps, and at the bottom by pinching between the panel below the lower grille and the radiator lower support. Cost is next to nothing and we have more time to work on other things, rather than cleaning out crud to prevent the dreaded overtemp blues."

Of course, you could just opt for one of those bug screens that wraps around the nose of the car and clips onto the front wheel wells.

HEADER TANK: The header tank is susceptible to rust perforation. The good news is that the later and cheaper tank fits better. The filler is curved to clear the air cleaner that is set forward to clear the ABS unit. The newer tank is about half the price of the older one and has studs instead of bolts to mount it.

Unfortunately, it is still made of steel, which means it will eventually rust through again and the rust flakes will plug up your radiator. Better idea: Call Cathouse Spares in Sydney, Australia (page 642) and order their stainless steel version. This is one example where an international phone call and overseas shipping are definitely worthwhile.

Mike Morrin went another route: "I could not find a supplier of pre-H.E. expansion tanks. So I eventually had a local radiator shop make me one in brass, using the original fittings and brackets. He quoted (and I paid) US\$130, but I think he lost money on it because of the labour involved."

As Morrin notes, there are minor variations between header tanks. Most notably, the pre-H.E. has a fitting on the bottom for teeing into the line from the heater core to the radiator outlet, while the later cars have a upward-angled fitting at the bottom front corner for connecting to a fitting on the later crossover pipe right at the suction side of the pump. If you obtain the later type header tank, you can fit it to the earlier car by simply installing a generic tee in the heater hose and running a hose from the upward-angled fitting to it -- or you could spring for a new crossover pipe at the same time (also in SS from Cathouse Spares) and hook it up as in the later cars.

Much later header tanks may also come with an opening for the coolant level sensor, relocated from the front right corner of the radiator. If you have a chance, you should probably relocate your sensor to this hole. If you can't get around to it just now, buy a new sensor and grommet and install them and do the rewiring later. Sooner or later, you'll probably have the radiator out for rodding and you can have the original sensor location sealed up at that time.

THERMOSTATS: the Jaguar V12 engine requires little air bleed valves in the flange of each thermostat to allow air to bleed out of the system. The early OEM thermostats had "jiggle pins", a pin with a rubber ball on one end, loosely retained in a hole. Douglas Dahl points out that many aftermarket thermostats, and possibly even the later OEM thermostats, have upgraded the design: "There are no more wiggle pins. They use a check ball and tiny cage over the hole. It looks much more sturdy than the old kind." Same thing only different, either design will work.

Try not to buy thermostats without jiggle pins or air bleed valves. If you tell the parts clerk the model year of your car and he returns with thermostats without such features, try giving him a later model year -- say, 1991. The design of the cooling system didn't change, but for some reason some of the computer listings in the parts stores lists thermostats without air bleed valves for early cars and with air bleed valves for later cars. If you must buy aftermarket thermostats that have no wiggle pins, drill a 1/8" hole in the flange; the small leak might keep the engine from warming up quite as fast, but at least it won't drop valve seats due to air pockets. Install the thermostats with the jiggle pins or holes at the top.

The Jag V12 also requires thermostats that have a post on the bottom with a spring-loaded disk for closing the bypass passage when the thermostat is open. Believe it or not, there are aftermarket thermostats purportedly intended for this car that don't have these attachments. Do *not* buy any such thermostats. There are acceptable aftermarket thermostats available, if you don't find them at first try another store.

NOTE: Don't try to operate this engine without thermostats. The thermostats must be in place to prevent the coolant from taking a short circuit and bypassing the radiator. Incidentally, it's not really a good idea to operate *any* liquid-cooled engine without a thermostat.

If you're in the market for thermostats, make sure to check the computer or applications listing to get the correct type for the Jaguar; don't just pick up something that looks right. Julian Mullaney says, "First time around went to Pep boys and got some new t-stats that looked exactly like the originals. It wasn't until after putting them in water and looking at the amount of travel they open and the amount of spring compliance on the back close-off disc that I noticed they were different. They look identical, but they move differently. This is real important because that disc has to close off the crossover pipe properly. Went back and got some other t-stats that looked the same but had the right amount of travel. You can check it by taking it out of the package and just forcing it thru the motions to check travel length, etc."

This is not to say they must look identical to the originals. Bob Gallivan: "Just received a set of 88 deg C t-stats (Calorstat made by Vernet in France). These appear to be different than the 88 deg t-stats I replaced last year (Waxstat).

1: the vernet came with rubber ring gaskets that fits the outer edge of the disk.

2: overall length:

Vernet is 51 mm.

Waxstat is ~49.55 mm.

3: the valve (?) width

Vernet is ~23.25 mm

Waxstat ~17.8mm"

THERMOSTAT TEMPERATURES: The bulbs in thermostats work by taking advantage of the step increase in volume that accompanies a phase change, in this case when wax melts. Before the wax begins to melt, there is little plunger movement. As the wax melts, the volume of the wax increases, pushing the plunger out of the bulb and opening the poppet. Once the wax is completely melted, the plunger stops moving. The temperature at which the plunger moves is a function of the specific compound of wax used. The small changes in volume with changing temperature when the wax is entirely solid or liquid are insignificant, and since the bulb itself is changing volume at a comparable rate, they may not move the plunger at all.

The proper way to mark a thermostat is to indicate its "control range", the temperature at which it cracks open and the temperature at which it is fully open -- which, on the Jaguar V12 thermostats, is the point at which the bypass port is fully closed. However, the thermostat manufacturers generally don't do this; thermostats are commonly rated with a single temperature, with no indication whether this indicates the crack-open temperature, the fully-open temperature, or some temperature in between. The Jaguar literature (including the Haynes manual) does, however, specify "opening" and "fully open" temperatures for thermostats -- leaving the owner trying to figure out which thermostat in the store corresponds to the specs. The general consensus seems to be that the "early cars" were originally fitted with 180°F (82°C) thermostats, while the "later cars" were fitted with 190°F (88°C) thermostats. The change may have coincided with the introduction of the H.E., but it may have changed at different times between North America and other markets.

The ambiguity in the rating scheme seems to allow for some funny stuff, though. The Robertshaw thermostats offered by Discount Auto Parts are available in 160°F (71°C), 180°F (82°C), or 195°F (91°C) ratings; their computer describes the 195°F items as being "closest to OEM specification", and these are the ones generally kept in stock. Peter Cohen says, "195°F is the standard opening temp for American cars nowadays. Those responsible for spec-ing products at certain manufacturers are probably just going on automatic pilot." More likely, they're just making thermostats for the Jag using the same wax bulb used on their products for other cars rather than having to make a separate line of wax bulbs. Cohen continues: "Beck-Arnley, Motorcraft, and Motorad list 192 degree thermostats." Perhaps the same idea, except these companies chose to split the difference between 190°F and 195°F for their wax bulbs!

James Teston says, "F.Y.I: A '92 has as standard (owners manual) 90°C (194°F) but you can get up to 205°F 'stats for this year. There are no listings this high for the '83." I just love it when application listings give totally different data for an '83 than a '92, ignorant of the fact that the engine is totally unchanged.

You can apparently forget about relying on the thermostat manufacturer's qualitative description of the temperature rating. A review of the offerings of several companies' 180°F thermostats revealed that many of them described this as "standard temperature" or "O.E." (which it is neither for most XJ-S's), a few described it as "medium temperature", while a great many described it as "high temperature" -- an interesting outlook, since it is the coldest thermostat that should ever be considered for this engine.

There is really little functional difference between 180°F (82°C), 190°F (88°C), 192°F(89°C), and 195°F (91°C) thermostats, although as noted on page 169 they will result in different gauge readings when the cooling system is

working properly. In theory, the warmer thermostats should provide better fuel economy, and those who live where it snows report they will make the heater work quite a bit better.

There are also 160°F (71°C), 165°F (74°C), and 170°F (77°C) thermostats available, generally described by the manufacturers as “low temp”. None of these should be used in the Jaguar V12. They certainly won’t help anything in any car, but in this case they might actually cause problems; they may cause the engine to run cold enough that the EFI system is working on an enriched part of the fuelling map that it was never intended to use continuously, and you may get bad fuel economy, low power, spark plug fouling, etc. If it gets too far onto the cold fuelling map, it may actually run rich enough for excess fuel to rinse the oil off the cylinder walls, greatly reducing the engine life. Also note that the AAV (page 245) won’t fully close until 80°C, so you may also get an inconsistent idle trying to run colder.

The fact that the EFI coolant temp sensor and the AAV are both on the left bank and the left bank runs warmer than the right bank may confuse this issue a bit. Some people have installed low temp thermostats with no apparent ill effects, but this might be due to the fact that the left bank is running warm enough to put the EFI in a viable control mode and to fully close the AAV anyway. If the EFI sensor is moved to the right bank as discussed on page 170 or the cooling system is modified to eliminate the differential cooling between right and left bank as discussed on page 190, the EFI sensor and AAV may actually start seeing temperatures as cold as the thermostat spec -- and might start showing symptoms of running too cold. If this happens, the solution is obviously to replace the thermostats with units in the 180-195°F range.

THERMOSTAT SEATS: Jan Wikström reports that “The seat of the thermostat bypass (supposed to close when the thermostat opens) in the thermostat housings is subject to erosion. Inspect and fit a bronze seat if necessary.” It’s not known how common this erosion is, but if significant erosion is present it will definitely reduce cooling efficiency. Jan made a bronze seat by machining a pipe fitting and then machining a suitable recess in the thermostat housing to press it into. Other options would include building up with weld material and remachining or simply replacing the thermostat housings.

Rob Weiss-Malik says, “When I took the t-stats (which I had recently replaced) out again and inspected them I found that the somewhat spherical washer (valve?) at the back end of the t-stats (the one that seats against the coolant return opening when the t-stats open) had very faint off-center circular wear scratches on it. Upon checking the recessed sockets that the t-stat flanges seat into I found that they contained gritty deposits of a grayish material that I could scrape off by using a small flat screwdriver.

“After seeing this I temporarily reinserted the t-stats back in the sockets and it immediately became apparent that they were not seating perpendicular to their sockets!!! This resulted in the back valves not seating the right way against the back opening when the t-stats opened and in turn causing the ring shaped seating marks (scratches). These conditions apparently lead to some of the flow not going to the radiator but going straight back to the engine with a concurrent rise in temperature. Please note that the amount of gritty material at the seats was very small, and yet it caused a large of amount of deflection in the alignment of the t-stats (sufficient to cause bypass of flow). I also religiously maintain the proper proportions of antifreeze in the cooling system, and the radiator was re-cored about 15K miles ago.

“The fix consisted of thoroughly scraping (without scratching) the recessed sockets with a flat screwdriver to remove all of the deposits. This was followed by light sanding with very fine (600 grit) sandpaper. Then the t-stats went back in. Now my gage sits below N and does not creep up into the gray-hair zone.

“By the way, the symptoms of this condition were that the gauge would first stabilize a quarter way below N and then would very slowly creep up past the N setting over a period of 15 to 30 minutes. The physical evidence for this condition were the deposits themselves (you can see them easily, assuming you can cram your head that low under the bonnet!!!) and the ring shaped seating marks on the back valve. This was an easy fix and I would recommend it as a routine maintenance procedure whether or not your cat is overheating.”

NOT-SO PRESS FITTINGS: Stefan Schulz found that the 1/4” connection on the top of the left side thermostat housing had come loose. This fitting is connected to a hose that goes to the air bleed piping on top of the radiator, and

normally operates at cooling system pressure. "The only thing that held it in place was the slight force exerted by the hose pressing on it from above!"

This is the only failure report on this particular fitting received by this author. However, this type of failure is not unknown, so it's a good idea to check for them anywhere dissimilar metal tubes are press fit into housings. If you find a press fitting that's come loose, it's usually easy enough to drill and tap the hole and install a threaded fitting.

BADLY LOCATED FITTINGS: The right rear coolant manifold casting has locations for three bosses. On this author's '83, the manifold has a vacuum switch in the front boss and the hose supplying the heater is connected to a boss in the second; the third is blank, undrilled. On Jason Philbrook's '89, however, there are sensors in the first two bosses and the heater hose is connected to the third. This puts the hose fitting too close to the insulation on the structure of the car, and the engine moving on its mounts caused the corner of the insulation to wear a hole in the hose and cause a leak.

See COOLANT CONNECTING PIPE below for ideas on providing new taps along the pipe itself, allowing you to plug this one and not use it any more.

COOLANT LEVEL SENSOR: On early cars, it's at the front right side of the radiator, where it's very hard to find unless you have the hood off. Sometime in the early 80's, it was relocated to the header tank, where it's a lot easier to get to. If you have a car with the earlier sensor location, at a convenient opportunity you should relocate the sensor to the header tank. Simply drill a hole in the header tank about 3" above the bottom and insert the existing sensor with a new grommet, and find some way to seal the hole in the radiator.

This sensor is nothing more than a pin that makes electrical contact with the fluid itself. The resulting ohmage reading is processed by an electronic gadget, C42294, into an on/off signal to the dash indicator light. If this gadget fails, note that some GM cars use exactly the same type of level sensing system. Their sensor won't fit the Jag, but the electronic box should work.

FINDING LEAKS: Michael Bucklew says there's a product to help. "The item is for checking for coolant leaks on the whole system. A kit comes with a ultraviolet dye that is circulated through system. Shut down, and hand pump up the pressure. With a blacklite the coolant leaks look like neon lights. Typically, kits comes with the lite and dye. I think the price is around 60 bucks at "better auto stores"."

COOLANT CONNECTING PIPE: On top of each head there is a coolant pipe, C42595, that connects a manifold at the rear of the head to the thermostat housing at the front. It is a straight steel pipe with a small shoulder at each end to hold itself and the sealing bush in place.

Of course, being steel it is subject to rust and corrosion. The outside merely looks ratty; the inside, which usually rusts worse than the outside, dumps flakes of rust into the coolant circuit and helps plug up your radiator.

There is an easy way to make a nice replacement. Drop by an air conditioning repair shop or supply house, and pick up a length of 5/8" ID (3/4" OD) copper tubing as well as a fitting or two. Note: air conditioning systems typically use the odd eighths sizes of tubing to differentiate them from water piping.

Cut the tubing the same length as the original. Cut the fittings to make rings and use a propane torch to solder them onto the tubing to form shoulders. If you take the effort to polish it up a little, having the copper tube across the top of each head looks really snazzy. Since this tube is mounted in rubber at both ends and has no direct contact with aluminum parts, galvanic corrosion is no more of a concern than in the copper radiator.

If you need additional openings into the cooling circuit for adding or relocating sensors or taps, one possibility would be to assemble copper coolant connecting pipes as described. Then, carefully noting where there is room for such things, you can install a tee in one of these pipes. A simple "sweat" tee would make an excellent connection for the heater hose,

leaving the threaded openings in the manifold itself available for sensors. Or, you could solder in a cast bronze tee with a threaded connection. And, of course, you can install more than one tee if it would be helpful.

Al Askevold has another idea: Make pipes from Schedule 40 pipe. But wait a minute! In copper piping we needed 5/8", but Schedule 40 only comes in 1/2" and 3/4". Fortunately, 1/2" Schedule 40 has no dimensions anywhere near 1/2". Askevold: "Schedule 40 is OD 0.840, ID 0.622, with a wall thickness of 0.109." So, cut 1/2" pipe to length and then machine the OD down to 3/4" at the ends to fit the seals.

But Schedule 40 is ugly! Yeah, it's typically galvanized cast iron, and the black iron is just as ugly. But if you shop around, you can find it in solid brass or stainless steel. The stainless steel Schedule 40 is not very pretty since it is unfinished, but as long as you're machining it anyway you could give it a skim cut over its entire length to polish it up. Askevold points out that stainless steel pipe is available from McMaster-Carr (page 661), but the shipping will probably bankrupt you; better to buy locally if you can find it.

COOLANT CONNECTING PIPE SEALS: Part number C37990, commonly referred to as a "top hat seal", is actually the same seal used on the electric fan control thermal switch on the early XJ-S, and may even be used on other types of British cars. This seal can be used only once -- it says so right on the seal itself. When installed and the engine is run, this seal seems to bond itself to the pipe and makes a very effective seal. Unfortunately the steel pipe will then rust, eventually breaking this seal. So, every time you're working in this area, you'll probably be well advised to replace these seals while there, cleaning up the OD of the pipe before reinstallation.

Unless you go with the copper pipe replacement described above. In this case, the seal bonds itself very well to the copper, it never rusts, and it can be a real pain to try to pull apart during the next overhaul. Solution: don't ever take it apart again! Since it will never leak if undisturbed, every time the engine is worked on simply remove the entire water rail assembly -- thermostat housing, pipe, and rear manifold -- as a single unit and set it aside for reinstallation later.

The top hat seals are expensive if purchased from Jaguar. There are aftermarket versions available for only a couple of bucks each, though; they reportedly don't have the writing on them. It's not known if there is any functional difference in the rubber compound, but the cheap items are likely to work fine here -- this is not a difficult connection to seal once the rusty pipe issue is dealt with.

COOLANT CONNECTING PIPE SEAL REPLACEMENT: Odysseus Marcopolus passes along this idea: "Many thanks to Phil Prince's tip about not having to remove either of the manifolds to get the pipe out. All I needed to do was:

1. Drain coolant.
2. Remove air filter housing.
3. Grab pipe w/vicegrips and shove it into the back manifold until the front end was free; then pull forward and out. (I needed to whack the vicegrips a couple of times w/ a hammer to get the pipe moving.)
4. Remove seals from manifolds.
5. Cleanup pipe with grinder/wire wheel (just didn't have time to fab something new).
6. Place new seals in position.
7. I coated the pipe ends with gasket dressing.
8. Push pipe into rear manifold until there's enough room to get the front end in and position the pipe.
9. Refill coolant and replace air filter housing."

Of course, this is not likely to work as well with the copper pipe described above as it does with the OEM steel pipe; not only will you bugger up the copper pipe with the vicegrips, but the soldered-on shoulders will make it quite difficult to push the pipe into the rear housing to remove. You could, of course, simply leave the shoulders off, since the pipe

should remain in place just fine without them and then you could replace the seals using this method. Mark the pipe with a marker so you can tell when it's positioned properly at installation.

This replacement method should work with the stainless steel pipe if you machine the OD of the stainless steel pipe to the same dimensions as the OEM steel pipe. You could even taper the step in diameter to make it work even easier.

Of course, when all is said and done, it's not really all that difficult to remove the thermostat housing. And having either the copper or stainless steel pipe in place is likely to avoid the need to replace those top hat seals nearly as often.

RADIATOR HOSES: The hoses in the Jag are not significantly different than any other car. For locations where the shape of the hose is not too critical, go to the local parts shop and ask to look over their selection of molded hoses. Find one with the right diameter, and with a section that will fit where you want it to. It is helpful to have the car there, and a shop that will let you take the hoses out to the car and look at them. Buy the hose and cut it to the length and shape you need and discard the rest. This method is usually cheaper than either buying the Jag hoses or using flex hose, and is very aesthetically pleasing. Note: You will probably not find a hose with the exact same shape as the original. All that is important is that the two ends will connect properly, and that the hose doesn't run into anything in between. Also keep in mind that the engine moves around a little on its mounts, while the radiator stands still; a little room for flexibility in the radiator hoses is helpful.

Peter Smith: "the top left hose is the same shape as (in Australia) a Holden 186 or Mazda 929 late 80's."

Peter Cohen says that the Goodyear catalog lists "a single XJS radiator hose, the one for the upper left. Goodyear part number 61267, cost \$6.39. It has a slightly tighter S bend than the original, and appears to be about an inch too long at the front end (so was the Mackay). Same wall thickness as the original. The Goodyear catalog also had a note that this item is also available in "Hi-Miler"."

Cohen also provides Beck-Arnley hose numbers:

Upper Left	142-4555
Upper Right	142-4548
Lower	142-0702

Cohen also ran across an Australian brand. "I didn't like them much. The upper left developed a hole, and the lower was not shaped quite right, so it rubbed on a bolt on the motor, and began wearing a hole in itself. It had to be tie wrapped out of the way."

Auto parts stores offer a wide selection of molded heater hoses too. The question-mark-shaped section of hose that connects the heater return pipe to the outlet of the radiator, CAC 5125, can be neatly replaced by a hose number 303675.

GENERAL WATER HOSES: Harry Trafford suggests better-than-stock cooling system hoses: "Gates makes a cool flexible, wire-inserted hose for bends that would kink regular hose. I think the old name was "Red Stripe", but don't know if the name has changed. The other type I'm using is Gates "Vulco". No wire, but extremely strong."

WATER PUMP REMOVAL/CROSS PIPE INSTALLATION: What the Jag manual calls the "cross pipe" is the pipe that connects the two thermostat housings to the water pump inlet, and has the fill cap on top. It is variously called a crossover pipe, a bypass pipe, and several unprintable names. Note that the air balance pipe at the top rear of the engine connecting the two intake manifolds is also called a crossover pipe; try not to get confused.

The repair manuals indicate that the crank pulley must be removed to remove the water pump, but the cross pipe can stay where it is. However, according to Jim Isbell, "The water pump will come out and go back in without removing the crank pulley. But the pump will not go back on with the crossover pipe connected if the pulley is still on as you have to snake it in over the pulley and the crossover pipe would be a big impediment.

"So having said that and realizing that you are now going to replace the crossover pipe with the water pump already installed, there is only one way:

"Lubricate all three of the pipe connections (on the two thermostat housings and the water pump) liberally with 3M water hose sealer. Then lubricate the three matching pipe ends on the crossover pipe with the 3M stuff. Now slip the new, cut to the proper length, hoses onto the crossover pipe. Put two clamps onto each of the three hoses, not tight, just enough so they don't slide off. The two clamps on the right side should be placed so the screw is on top when installed and slightly back. The clamp on the thermostat housing on the left side should be so that it is on the bottom and slightly back so there is enough room for a screwdriver angled down below the header tank. The two clamps on the water pump hose should be on the left side of the hose slightly back so the screwdriver is angled to the left side of the car. If you set the clamps up this way you will save a lot of grief later on.

"Now push the hoses up onto the crossover pipe as far as they will go. Next place the center (water pump), hose onto the water pump tilting it and the crossover into position. It will take a little pushing and prying with a screwdriver, but it's not too bad and the hardest part is done.

"Now, pull all the three hoses into approximately the correct position and lightly tighten the clamps. Now make sure the small pipe on the top of the crossover is clear of the big bolt on the block so that the hose to the overflow tank can be put on without being in a position to rub a hole in it. Tighten all six clamps and you are done."

Lenny Berk did this job, and had the following suggestion: "Removing the engine breather filter housing (two bolts) made my life a little easier to get the crossover pipe in." The breather housing is the thing on the front of the left head, just forward of the oil filler.

Berk also was less than satisfied with the lubricating qualities of hose sealer when fitting the cross pipe. Suggestions for alternatives include water pump lubricant, intended as an additive to coolant. Care must be taken when selecting a lubricant, since the wrong stuff may attack the hose material or otherwise screw up the cooling system.

This author found another way to install this pipe: remove the engine breather housing, and unbolt the A/C compressor and shift it rearward a couple inches. Then, fit the left end of the cross pipe to the hose on the B bank thermostat housing with the right end of the cross pipe up in the air. Then swing the pipe down, inserting the fitting into the hose on the water pump as you do. Finally, connect up the right end, which is easy. Tighten the clamps and reinstall the breather housing and the A/C compressor.

When installing this cross pipe, try not to insert it too far into the hose connecting it to the water pump. Positioning the cross pipe a hair too low makes it considerably more difficult to get a socket on the bolts holding the front support plate for the A/C compressor. With the cross pipe properly located, the bolts holding the bottom of the support plate to the engine are easily accessible below the pipe, and the bolts holding the compressor to the support plate are easily accessible above it.

A/C V-BELT RUB: If the V-belt rubs against the cross pipe, it's because the cross pipe wasn't installed correctly. There are no brackets to hold this cross pipe in position; it is held only by the hoses connected to it. If it rubs the V-belt, the ends of the cross pipe were not inserted far enough into the hoses connecting to the thermostat housings. Usually, the clamps can simply be loosened and the pipe pushed into the proper position, and the clamps retightened. Note Jim Isbell's warning above to take care not to install it too far rearward causing the small hose to the header tank to rub on the crankcase breather mount bolt.

CROSS PIPE REPLACEMENT: If you've had the cross pipe out, you've probably been alarmed at its condition. It's cheap steel, and usually is so pitted and corroded that it's amazing it doesn't leak like a showerhead. It also is reportedly atrociously expensive from Jaguar, and you really don't want to be searching the junkyards because the ones you find there are likely to be just as corroded. Mark Jackson suggests an alternative: "Cathouse Spares offers a third-party solution. Cathouse can provide stainless steel rails acquired from an anonymous source for about \$AUS135 (~\$US95) plus the usual costs of mail & handling. I've seen one and it looked pretty good - had all the

belts and whistles - just a little "choppy". The angles from memory were mostly welded instead of smoothly bent, but it looked pretty spiffy anyway." Cathouse Spares is listed on page 642.

Of course, it's just plumbing. You could conceivably make your own. One possibility is to find suitable copper piping and fittings and solder or braze the whole mess together. The fill cap might be a bit of a challenge, but there's no good reason it has to be a conventional radiator cap; any opening with a suitable watertight cap should work. Or perhaps you could rip a radiator cap connection off the top of a brass radiator and solder it on. The trickiest part may be at the pump inlet itself, where the connection from the header tank seems to protrude down the center of the pump inlet connection. It's not known how critical this is, since all lines lead to the pump inlet sooner or later; perhaps a simple cross fitting would work.

You might even be able to replace the entire cross pipe assembly with straight sections of tubing, tees, and suitable hoses and clamps. Note that this is the suction side of the pump, so it might be a good idea to use hoses as short as possible and insert metal coils to prevent collapse.

CROSS PIPE HOSES: John Napoli decided to cut pieces from commonly available hoses to connect the cross pipe. "I did find Dayton hose numbers D71458 (smaller ID hose [to heads]) and D71316 (large ID hose [to water pump]). These were fairly inexpensive. They may not be the cheapest or the best donor hoses to use, but they seem ok. The smaller hose has enough material to cut at least four hoses, and the other two, so I will have a complete set of spares." All of the cross pipe hoses are short, straight sections, so it's probable there are dozens of readily-available hoses that can be cannibalized similarly.

WATER PUMP LUBRICATION: On the top of the water pump is a setscrew with a locknut on it. This setscrew is to prevent the outer race from rotating in the housing, and either inserts into a hole in the bearing or tightens onto a flat. If it inserts into a hole, you can remove the setscrew and screw in a zerk fitting (available at any hardware or auto parts store -- yes, it's even the right thread), and then you can grease the bearings with a grease gun. Be sure to reinstall the setscrew when you're done.

WATER PUMP SEAL FAILURE: In the water pump housing there is a small drain hole that leads from the space between the seal and the bearing out the bottom of the pump. As a result, when the seal fails the coolant comes out the bottom rather than *through* the bearing. This is actually fairly standard practice in water pump design.

WATER PUMP REBUILD PARTS: If you are visualizing a water pump seal as similar to, say, the simple crankshaft lip seal on the front of the engine, allow me to improve your mind. A water pump seal is *considerably* more involved. It consists of a non-rotating face that is spring-loaded in the axial direction (parallel to and surrounding the shaft) to hold it against a rotating seat. These two parts run against each other with spring pressure holding them in contact, so they are made of materials that should provide long wear as well as a good seal: a carbon face against a stainless steel seat in good ones, a plastic face against a brass seat in cheap ones. And, of course, the level of polish of both surfaces is important, so the rotating seat is replaceable and is sold as part of the seal.

There is an elastomer involved, but only to connect the spring-loaded face to the seal housing so that it is free to move axially to contact the seat but fluid won't leak around behind it. The elastomer is therefore not really a wear item, although it certainly can be the item that deteriorates!

The housing material is sometimes specified, commonly either brass or stainless steel. It's hard to care; the housing isn't going to be the part that fails. I suppose it may be important in industrial applications with corrosive fluids.

The Jag water pump seal is an industrial standard; it can be found in any industrial equipment supply store, such as Grainger, as a type 68 shaft seal. In fact, Grainger offers two seals that will fit: Catalog #1R306, which has a black plastic seal face and a Buna diaphragm and is rated -40° to 225°F, and #1R324, which has a carbon seal face, a Viton diaphragm, and is rated -20° to 350°F. The Viton one costs ten bucks more than the Buna. Both of these Grainger seals

have stainless steel rotating seats. After buying a rebuild kit to get the bearing, Sean Straw described the seal included as having "...the characteristic *plastic* seal ring material, meaning these are likely the Buna version. The seal face is *very* different in quality vs. the Viton one I purchased. If you're a stickler for precision, get the Viton one -- the differences are *not* just in the seal rubber - the face of both the seal and the seal washer are *much* better in precision on the Viton - it's *polished*, whereas the Buna is a bit more coarse looking (it doesn't look super porous, but it is obviously not polished). How much of a difference it'll *really* make in this application is questionable, but for the cost of parts, I think it is worth it."

Straw goes on to report that the seal has an industrial standard designation: RS 80613. "That's the Buna version -- append a V for the Viton one."

When the author's pump needed rebuilding, it was because that diaphragm in the seal had failed; it's unknown just how prevalent this failure mode is, but why not go with the Viton seal and not worry about it any more? 225°F isn't all that far from the operating temperature of this engine, not even considering its tendencies to exceed that operating temperature. Meanwhile, if you ever exceed the -20° limit on the Viton seal, you'd better have a good antifreeze mix.

The bearing is also a fairly standard item, similar to those used in many common water pumps. In case you're not familiar with water pump bearings, the outer race is a long cylinder as though there are at least two rows of balls or rollers inside. The shaft itself is part of the bearing, and presumably the inner race is machined directly onto this shaft. Straw provided the critical dimensions for the Jaguar part: the bearing outer race is 1.500" OD and 2.1280" in length. The shaft is 4.9025" long overall, with 1.7745" of this protruding from the rear of the bearing. The portion of the shaft protruding from the rear has an OD of 0.6300" to fit the seal and to press fit into the impeller. 1" of the shaft protrudes from the front of the bearing, and this portion has an OD of 0.7500" to press fit into the pulley flange.

Finding a bearing supplier may be difficult, however. The easiest way to get one may be to purchase a rebuilt water pump for another type car from a discount auto parts store and remove the new bearing (and perhaps the seal as well) from it. After rebuilding your water pump, return the disassembled pump along with your old bearing for the core refund.

When used in a Chevy or some such, this bearing would be press fit into a cast iron housing. On the Jaguar V12 water pump, however, apparently a press fit into aluminum wasn't considered reliable, so in addition to the tight fit a small threaded stud is screwed into the side of the housing and into a recess in the side of the bearing outer race to positively hold it in place. All such bearings seem to have a hole or notch that will work, possibly originally intended to line up with grease fittings in other applications; if you happen to find one that's totally smooth, you could easily grind a small flat on it.

Rebuild kits for this pump are available at reasonable prices. Straw reported that the kit he received from XK's Unlimited (page 647) included the bearing, seal, impeller (cast iron), two gaskets, and a replacement stud and nut for holding the bearing in the housing. The author purchased a kit elsewhere and received only the bearing and seal, so take note and ask what is included before ordering.

Despite all the above availability, Dan Jensen suggests you forget about rebuilding the pump yourself and simply buy a rebuilt pump. It isn't that much more money, and unless you have things like presses around it's easy to screw up a DIY rebuild job. Don't even ask Jaguar for a new pump, though -- you can't afford it.

WATER PUMP REBUILDING: Some, but apparently not all, water pumps have a single countersunk Pozidriv screw. According to Thomas Alberts, it is a common mistake to overtighten this screw, resulting in a fracture of the aluminum casting surrounding it. Apparently the casting was designed for a non-countersunk bolt, and adding the countersinking makes the metal too thin for serious tightening. If you wanna make sure the pump doesn't leak, use a good sealing compound; don't overtighten this screw.

WATER PUMP CORROSION: There is apparently some history of the water pump housing getting corroded; nobody seems to know if it is as a result of pump cavitation, bad antifreeze mixture, or what. Randy K. Wilson says, "The place at which they corrode away is at the lower part of the water pump cavity. This is behind the impeller area, but not the

working side of the impeller. The area should be a fairly low flow area on the high pressure side of the pump. But it's close enough to the output side of the impeller that turbulence could be present.

"Whatever the cause, I do see the corrosion pitting often enough. There may be a clue in that it's not very often when merely changing water pumps; I see it on engines being rebuilt. Engines get rebuilt because they have done some high mileage, or have been abused/neglected."

FAN TIP RUB: If the tips of the blades on your fan show signs of rubbing, the problem may be in the transmission mount -- see page 314. If you have a metal fan, you can hear it happen: you nail it from a standing start, and get a deafening screech from under the hood like all hell broke loose. A bad, or an incorrectly assembled, transmission mount allows the engine to pivot around on the engine mounts, causing the fan to rub.

A fan tip rub may also be caused by a failure of the left side motor mount. When stomping it in low gear, a lot of torque is applied to the drive shaft. According to Newton, this means that the same amount of torque is applied to the engine/transmission assembly in the opposite direction. The engine tries to tilt to the right, applying tension to the left motor mount that was really designed for compression only. If this rubber mount is torn, the entire engine will lift right up off its mount, causing the fan to rub.

PLASTIC FAN CRACKING: Issue 68 (June 1996) of Australian Jaguar Magazine: "Graham Cummins has recently found that the main plastic fan on the H.E. is prone to cracking and breaking up which can cause immense damage under the bonnet." Any guesses as to how Mr. Cummins discovered this problem? Are you gonna find it the same way?

Mark D. Stoner did. "My yellow fan decided to explode one day when shifting at full throttle from 1st to 2nd gear. Put a nice dent in the top of the hood along with shredding the steel fan shroud and blowing a *huge* hole in the radiator."

Lee Opausky wrote: "Yes, the yellow plastic fan is cracked at the front. When questioned, the shop foreman of one prominent Jag dealership told me not to worry, the crack on his XJ-S is $\frac{1}{2}$ " wide!" More proof that you can't trust the dealers for good advice.

Jim Isbell ordered a replacement fan, and reports that the fan he was shipped did not look like the original. "It is black and has a flat center metal piece. The old one was white (now yellow) and the center piece was dished. The old one had a lower aspect ratio (short and fat) to the blades while the new one has the higher aspect ratio (long and skinny). The black flat one makes up for the "dishing" by offsetting the plastic instead." With any luck at all, this means that Jaguar has recognized the problem and redesigned the fan, and this new one won't have cracking problems. By the way, some of us believe the original fan was yellow to begin with, not white.

The black plastic fan may be an improvement, but to be safer still it may be preferable to just go ahead and replace the belt-driven fan with electric fans as described beginning on page 209.

FAN CLUTCH TYPE -- EARLY VS. LATE: The early XJ-S fan clutch mounts with one bolt, the later with four. Mike Morrin points out that his ROM (Ed 4) appeared to have the two confused. "On page 26-3, section 26.35.21 appears twice, once titled "FAN AND TORQUATROL UNIT (Early Cars)" and then titled "FAN AND TORQUATROL UNIT (Later Cars)". The diagrams and text for these sections appear to be transposed, as the section for "later cars" matches my 1975 car (as well as the illustration in the 1980 edition of the parts catalogue)."

On second thought, maybe not. Morrin continues: "I am now sure that the version with the 4 bolts holding the clutch on to the pulley is the early version used on the carburetted XJ12 (and never on the XJ-S), as I now have one of these (XJ12) engines with fan clutch. My "spare" 1973 XJ12 engine has a fan clutch with 4 bolts holding the clutch to the pulley. The clutch has "HOLSET HUDDERSFIELD" cast on the front of it. The illustrations both clearly show metal fans."

So, apparently, this is what we have: The early XJ12 had a 4-bolt fan clutch with a metal fan. When the XJ-S was introduced, it came with a 1-bolt fan clutch and a metal fan. In 1979, this was replaced with a 4-bolt fan clutch with a plastic fan.

There are photos of the guts of a 1-bolt fan clutch at:

<http://www.jag-lovers.org/xj-s/book/FanClutch1.html>

And there are photos of the guts of a 4-bolt fan clutch at:

<http://www.jag-lovers.org/xj-s/book/FanClutch.html>

OPERATION -- 1-BOLT CLUTCH: The 1-bolt fan clutch is a study in simplicity; the hub that is bolted to the pulley is a simple disk inside an aluminum housing filled with thick goo. There aren't even any bearings; the disk itself serves as a goo-lubricated bearing.

FAN CLUTCH CHECKING -- 1-BOLT CLUTCH: It would appear that the only plausible failure mode would be for one of the seals to fail and the goo to escape, and there are reports of such failures; the goo leaves a track on the outside of the clutch and perhaps spattered around the engine compartment. Such a failure should be apparent when turning the fan by hand; either the resistance is "jerky" or inconsistent, indicating some of the goo is gone, or it spins effortlessly, indicating all of the goo is gone.

It's plausible, though, that the goo may break down with time or mileage. Typically, a highly viscous fluid has long molecular chains, and subjecting such a fluid to shear gradually breaks those chains and makes the fluid less viscous; this is one of the reasons you change your oil regularly. If the same thing happens to the goo in a fan clutch, it may lose its effectiveness as mileage is added up even if the seals remain intact. Ed Sowell says, "I am a great fan (no pun intended!) of changing the clutch. It had a very good effect for me, even though there was no external evidence of mine being worn out. It is my opinion that the commonly cited fan clutch tests are meaningless."

OPERATION -- 4-BOLT CLUTCH: The later 4-bolt fan clutch is a thermostatic type, meaning it engages more firmly to blow more air when the air coming through the radiator is hot. As opposed to the simple 1-bolt fan clutch, this thing is remarkably complicated. It functions by having a chamber at the front, divided from the driving impeller by a panel. When the engine is cold, two thermostatic elements -- one obvious coil on the front and a simple bimetal strip inside -- conspire with centrifugal force to move the goo out of the impeller area and into this chamber, thereby largely disengaging the clutch. When it gets hot, the thermostatic elements allow the goo to move back into the impeller area, providing a firmer engagement and faster fan speed.

FAN CLUTCH CHECKING -- 4-BOLT CLUTCH: If the problem isn't obvious (totally seized, freewheeling, etc.) it's very difficult to tell when a thermostatic fan clutch is bad. How it feels when turned by hand depends largely on how hot the clutch was when the engine was last turned off, since the goo won't move from chamber to chamber when the engine isn't running. Just playing with it when cold can move some of the goo around, causing it to change feel while you're studying it. Reportedly the best indication the clutch is bad is that the car is running hot in stop-and-go traffic -- although, obviously, that might be caused by any of several other problems. Typically it's when the owner can't find the problem and replaces the clutch in desperation and the car quits overheating that we learn that the clutch was bad.

The thermostatic clutch may be complex, but it still involves thick goo -- and therefore the goo may be subject to the same molecular breakdown as that described for the 1-bolt clutch above. Hence, it may make sense to replace it every x miles (perhaps every 60K miles or 100Km) whether it looks bad or not.

Of course, if the clutch is completely locked up, it's shot. This is often the result of a bearing failure; the 4-bolt clutch has a single ball bearing in it. Some people are tempted to continue driving with a seized fan clutch, because it moves so much air and keeps the engine cool. However, it is not recommended for three reasons. First, it makes a lot of noise.

Second, it uses a lot of energy, enough that you will be able to notice a drop in fuel economy if you're following the numbers closely. And third, if it's the plastic fan, it's likely to come apart since the fan will be turning a lot faster than it is intended to. When a couple of plastic blades bounce off the bottom of your hood and leave a nice dent, you'll wish you had sprung for a new fan clutch.

There is, believe it or not, at least one more failure mode of this fan clutch. Marty Sullivan had the bearing fail in his fan clutch so it didn't hold the fan centered properly. At highway speeds the unbalance vibrated the entire car. This was tricky to diagnose since it looked OK when the engine was off and felt OK when turned by hand; it was only by watching it wobble at idle you could figure it out. Of course, this problem is likely to damage the fan support bearing if not corrected quickly.

The difficulty in determining whether a fan clutch is operating properly is just one reason why replacing the belt-driven fan with an electric fan as described on page 209 makes sense. You can easily tell when an electric fan is operating properly.

FAN CLUTCH REPLACEMENT: If it is determined that the fan clutch is a problem, there are several possible courses of action: the fan clutch can be replaced with a new one; it can be replaced with a substitute; or the entire belt-driven fan scheme can be chuck and electric fans installed. Your local parts shop is unlikely to carry a Jaguar fan clutch, so you will have to consult a Jaguar parts supplier (and spend some serious cash) to exercise that option. Substitutes are discussed below. Replacing the belt-driven fan with an electric fan is discussed starting on page 209.

Of course, you could bolt on a fixed or flex-blade fan and eliminate the fan clutch altogether. However, this results in slightly worse fuel economy and a considerable amount of noise (whine). Most would consider the noise unacceptable in a car such as the XJ-S.

The electric fan is probably the best overall solution, and will result in better fuel economy and more power. There may be slightly more noise at idle (depending on the fan you use), but much less noise at higher RPM. It is unknown why Jaguar doesn't use this system to begin with; perhaps they don't like the sound an electric fan makes. Or, perhaps they wanted to minimize the use of Lucas and Bosch components.

FAN CLUTCH INSTALLATION -- FOUR-BOLT TYPE: Dan Jensen suggests that, when reinstalling the fan clutch, "Use nyloc nuts on the fan-to-pulley studs. It is a real pain to install both a lock washer and nut on the end of the four studs with *very* little clearance. Having just a nut to worry about dramatically lessens the problem. I have never had them come loose in any of my three Jags."

FAN CLUTCH SUBSTITUTION -- ONE-BOLT TYPE: The early XJ-S, from introduction through 8/79, was fitted with a fan clutch, part no. T55C, with a single bolt on the front to hold it on. These also used a metal fan blade, C39831.

Mike Morrin notes: "The early XJ-S fan clutch appears to be identical to the unit used on a Rover 3500 SDI. This might not be very helpful in the USA, but they are relatively common in the UK and some other countries. When the fan clutch on my XJ-S was found to be seized, I bolted on the Rover part (no modifications) and have had no problems. The Rover plastic fan is different to the Jaguar's."

It *might* be possible to retrofit the later type clutch EAC4751 and plastic fan EAC3265 (or the substitutes suggested below) to the earlier XJ-S by purchasing the pulley EAC3438 and the bearing EAC3437. You might also need bushing EAC4382. The question is whether or not the bearing housing is the same, or will at least position the fan properly.

FAN CLUTCH SUBSTITUTION -- FOUR-BOLT TYPE: Later XJ-S's used a fan clutch that mounts with four bolts to the front of the drive pulley. This is the prevalent style on US automobiles, leading one to consider the possibility of low-cost substitutes. However, the fan clutch market is full of niggling little details, so one must check several dimensions carefully to make sure a substitute will fit:

- A) The pilot hole in the center of the shaft must fit snugly around the stub in the center of the mounting flange. A hole too small won't go on, and a hole too big won't center the shaft properly.
- B) The mounting bolt pattern must be workable. This generally isn't too critical, because they all seem to use four bolts and the aftermarket clutches provide radial slots to fit nearly any pattern.
- C) The shaft must be of comparable length. Too long will press the fan into the back of the radiator. This dimension doesn't need to be exact, merely close enough to prevent interferences and keep the fan within the shroud for maximum efficiency.
- D) The bolt pattern for mounting the fan to the clutch must match.
- E) If the fan has a recess for the clutch housing, the clutch housing must fit within the opening.

The auto parts houses normally have a cross-reference chart that lists the above dimensions for the fan clutches available. If you compare the clutch from your car to their chart, you can determine what can be used.

If you find a clutch that is suitable except the pilot hole is too big, it would be a simple matter for a machine shop to fabricate a bushing to adapt. Some Jaguars come with such a bushing, EAC4382; perhaps this bushing can be used to adapt an aftermarket clutch. Its ID is 5/8", OD is 3/4". Michael Neal suggests you be sure the bushing is correct and necessary before pressing it into the clutch, since it can be difficult to remove.

David M. Johnson found a substitute, a Hayden 2747. "This is a Ford/GM heavy duty clutch, all the dimensions match except it is a little longer, i.e. the clutch bolts on directly with *no* modifications. The existing fan will bolt directly to the clutch. The advantage of this clutch is that it will turn at 90% of the pulley RPM. The standard duty units only turn at 75% of the pulley RPM."

Now, if you have replaced your yellow fan with the later design black plastic fan -- or wisely plan to (see the section on fan cracking on page 204) -- Johnson has bad news: "The two fans (yellow and black) are interchangeable if you have the original Jag fan coupling. The GM fan coupling I stated was a replacement only works with the yellow fan because the centre boss is a larger diameter (approx 7.5 inches). The black fan is OK with the jag clutch coupling, but will not fit the GM fan clutch substitute, because the black fan centre boss is only 6.5 inches diameter, i.e. the GM fan clutch fouls with the fan blades. I went out this weekend in search of a clutch coupling for the black fan, but cannot get an exact match with the Jag original, because all the ones that fit the bolt holes and centre boss are more than 6.5 inches in diameter." Understandably, the original style fan is no longer available, so obtaining a new one of the crack-prone design is not an option.

Of course, another option would be to find a fan from some other car and make it fit the clutch and the car. One possibility: the XJ6 fan! This fan looks just like the original white XJ-S fan, complete with the hub that provides enough space for a substitute clutch, but the OD is larger -- 17-3/4" as opposed to the 17" fan used on the XJ-S. So, you'll have to trim 3/8" off the tip of each blade and then rebalance it.

Another possibility may be to modify the later design black plastic fan. The design of this fan involves a plastic cylinder with the blades protruding outward, but the blades also protrude inward perhaps a half inch. It's these inward-protruding stubs that cause the interference with the larger generic fan clutches. Emile Desroches reports that carefully marking and trimming these stubs will permit fitting the Hayden 2747 clutch described above: "I used a Dremel "MotoTool" which is a small hand held grinder designed for hobby work and a small circular saw blade, but it can be done with a sharp knife or a file if you're patient. This procedure takes about an hour. I feel the results (needle well below N) are more than worth the grief of the installation."

Another alternative for using a non-OEM fan clutch: You can usually find a way to use whatever fan was originally designed to mate to the clutch you are using -- which means you don't have to restrict yourself to clutches with the same fan bolt pattern. A procedure is described below.

1. Go to your local junkyard and buy a fan that fits the clutch, basic Ford or Chevy; preferably with unequally-spaced blades (reduces whine) and preferably with aluminum blades (easier to cut).
2. Trim the tips of the new fan until it is the same diameter as the original. After cutting, round the corners and file the edges for safety.

3. Bolt the sucker together and check for interferences. Noted possible interferences include the water pump pulley and an oil line across the bottom. The oil line may be bent and repositioned, or both interferences may be corrected by trimming or notching the blades. Obviously, trim all blades exactly the same way. It's helpful to cut out a cardboard template the shape of one blade and use it to mark each blade for trimming.
4. Remove the fan from the clutch. Set the fan on razor blades centered on opposing bolt holes to check the balance. Trim a little metal from the blades on the heavy side until it balances. Rotate 90° and balance the other way. Make sure it balances both ways when completed.

A fan clutch that has the same pilot hole diameter, a slightly longer shaft length, and a different fan bolt pattern was found at AutoZone. It is made by Imperial, part number 215038. Since the offset of the mounting flange of the junkyard-purchased fan was less, the fan blades themselves end up in exactly the same place. The longer shaft also makes it a lot easier to get the mounting bolts in. It is believed this clutch, with a modified fan from a junkyard, will fit all the XJ-S's from 8/79 on.

Since the aftermarket clutch was designed to turn a 19" fan while the original turned a 17", the aftermarket clutch engages more forcefully than the original. This assembly will therefore make more noise (whoosh) than the original. But it will *reliably* keep the engine cool.

Some aftermarket fan clutches come with a lifetime warranty. But even if yours doesn't, you still can replace it much more easily next time, since you will already have a suitable fan and/or bushing.

FAN BEARING: The fan on an XJ-S is mounted on a dedicated bearing instead of on the water pump as in most front-engined RWD cars. The bearing appears to be similar to those found in several types of water pump, except the shaft on one end is too short to mount anything on. Perhaps a suitable water pump bearing can be found and the unused portion of shaft cut off (be careful not to get the shaft too hot and damage the seals!). Since finding the bearing itself may be hard, perhaps the most expedient procurement method would be to buy a suitable rebuilt pump, remove the bearing, throw the remains of the new pump along with the shot Jag bearing back in the box and return it for the core refund. Some rebuilt pumps available in auto parts shops are *really* cheap.

A better alternative is to chuck the engine-driven fan and install an electric fan as described below.

IDLER PULLEY BEARING: The repair manuals indicate that the idler pulley for the fan drive belt is attached to its support arm with a nut within a recess on the back side. On the author's '83, the assembly looks just like the pictures except there is no nut; the end of the shaft is flush with the surface within the recess. Apparently the bearing itself is not intended to be replaceable; the parts suppliers offer only the entire arm/pulley assembly, EAC8097.

Bernie Embden reports that the early arms were made of aluminum; later idler arms are iron. Bernie's car is a '78 (and has a nut), so apparently the early design was used at least that late. Mike Morrin has two early cars and one has a nut and the other does not, but both have aluminum arms, so there are apparently at least three configurations: Aluminum with nut, aluminum without nut, and iron without nut. "The 1980 XJ-S parts catalogue shows the part number of the assembly as being C39875, with no separate part numbers for the pulley or arm (and no nut)." This might be the aluminum without nut part number, with the EAC8097 reflecting the change to iron.

Daniel Pontes had a shot bearing in the idler pulley, and rebuilt the water pump thinking that's where the noise came from. "This pulley mounts on the water pump so a stethoscope is useless. Disconnecting belts and running the engine is also a waste of time. The only way to track the source is a manual shake with your hands on each and every pulley.

"A few phone calls later I find out that this pulley is very costly and very hard to come by. Since it is only the bearing that goes I thought it should be no problem to put a new one in. Yea right!! My fix-

1. find a new FAG bearing # W52315-1.

2. Have your machine shop press out the old bearing out of the pulley, mark which side faces the front.
3. The shaft is only peened onto the arm, it comes out easy enough.
4. The new bearing has a long and short shaft on either side of the outer race. This is a water pump bearing and the shaft is the inner race.
5. Have the machinist chuck the long end into a lathe and dress the short shaft to fit into the idler arm.
6. Press the pulley back on with the front side facing the front.
7. The goal is to get the pulley as close as possible to the arm without rubbing.
8. Press the pulley with the new bearing into the idler arm.
9. *Do not peen this bearing onto the arm. It will break.* TIG weld it into place-- it can always be drilled out if it fails again.
10. Cut the long end of the bearing shaft as close as possible to the outer race of the bearing and dress it .
11. Install your new idler.”

Of course, welding is not likely to be good for the seals and lubricants within that bearing or the temper of the shaft -- and would be especially difficult if the arm is aluminum. Perhaps while the machinist is working on dressing that shaft, he can provide a retention scheme -- like threading it for a nut.

Note that the fan clears the front of this assembly by only a small amount, so it may be advisable to check the clearance of the new assembly by spinning the fan around by hand *before* starting the engine.

This may start sounding like a broken record, but rather than repair the idler bearing, you might consider tossing the entire engine-driven fan scheme and installing an electric fan as described below.

ELECTRIC FAN SUBSTITUTION FOR BELT-DRIVEN FAN: The best solution for fan clutch problems, cracked fan blade problems, and idler arm problems is to install a large electric fan (or two large electric fans) and remove the fan, clutch, mounting assembly (shaft & bearings), belt, and idler pulley altogether -- and perhaps the little stock electric fan as well. The Jag V12 is a hot beast, so the biggest electric fans that will fit should be used; a single 16", dual 14"s, etc. One benefit: we have all heard stories about how much power the belt-driven fan uses or even how much the belt itself uses, but the 16" electric fans typically draw about 10 amps -- meaning they use only about 1/8 horsepower when they are on. And if you control them properly, they're not on when not needed.

There are lots of places to purchase electric fans. Most local auto parts stores carry them, as well as J. C. Whitney (page 643). Some of the best selections are from Jeg's (page 667) or Summit Racing (page 670). Harry Trafford points out there are at least two retailers on the www that specialize in electric fans:

Fluidyne:	http://www.fluidyne.com/
Scott's Fans:	http://home.earthlink.net/~scottsfans/

1-800-544-5596

If you are shopping for a new fan, note that the Imperial brand electric fans are reportedly unreliable; you'd be well advised to avoid that make. Ed Hyatt: "I have had two Imperials fail and the problem was the glue that they use to hold the magnets to the case. The glue fails and the magnet attaches itself to the rotor, shorting out everything and blowing the fuse."

Also note that Hayden 16" fans come in two models, one with considerably higher airflow than the other. The high airflow model has comparable airflow to most other aftermarket 16" fans, but is more expensive than most. The lower airflow model is comparably priced with the others, but its airflow is pathetic by comparison. Haydens are reportedly very quiet, though, perhaps due to their sickle-shaped blades. One more concern here is that the two different models are visually almost identical, and on store shelves it's entirely possible that someone has switched fans around in the

boxes in order to get the high airflow fan for the lower price -- leaving you to pay the higher price for the low airflow model without even knowing you're getting gyped.

One thing to look for in electric fans: a grille to keep your fingers out of it. Some have it, some don't. If you're the kind of person that worries about such things, you might want the grille. The rest of us most definitely do *not* want the grille, since it reduces the airflow by a considerable amount.

Peter Cohen offers another possibility: "Went shopping in the wrecking yard the other day. I came home with a 16" electric fan from an '83 Buick Regal (\$20). This fan has a ring on the outer edge that is attached to the fan blades, and rotates with it. It is secured by three metal rods that go from the motor housing to two points on the lower radiator support brace, and one to the upper support brace. Interestingly, it also uses a ballast resistor, and 3 wires. One wire is ground, one goes through the ballast resistor, and one bypasses the ballast resistor, presumably to make a two speed fan." This author visited his local junkyard and found similar fans in a Delta 88, a LeSabre, and a Toronado, except that they had plastic support structures instead of the metal tripod. All had the same resistor arrangement for two speeds. The key is apparently to look for large FWD GM cars with a transverse-mounted V6, but note that the exact same fan can also be found on the V6 Pontiac Fiero. Smaller FWD GM cars have a 14" electric fan, and RWD GM cars use belt-driven fans. The GM electric fans are not very compact; the total depth is around 5 inches, as compared to about 3 inches for a typical aftermarket electric fan, but once the stock belt-driven fan and support are removed there is plenty of room in the XJ-S. Tip: take a 10mm socket and ratchet with you to the junkyard. Note: the GM fans do not have a grille to keep fingers out.

When you buy an electric fan from a reputable junkyard, they will typically mark it. That way, you can take it home, test it and see if it works properly, and bring it back if it doesn't and exchange it for another. This is actually a better policy than some stores that sell *new* parts, since many places have a no-return policy on electrical stuff. Needless to say, you are advised to test any and all electric fans as soon as you can, perhaps using jumper cables; you don't want to fabricate shrouds, bracketry and wiring and *then* find out the fan doesn't work.

Electric fans can sometimes be mounted on the front of the radiator (if you can deal with the diagonal strut on the XJ-S), opening up considerable working room in the engine compartment. Many aftermarket fans are designed to be installed on either side of the radiator; to mount in front, typically the blade must be removed, turned around, and reinstalled, and the wiring must be reversed to run the motor in the "blow" direction rather than the "suck" direction. Note that a fan on the front side and blowing should have a minimal shroud so as not to block air flowing into the radiator due to vehicle motion, but a fan on the back side and sucking needs a larger shroud to draw air from a large area of the radiator. The shroud that's integral with an aftermarket electric fan is usually inadequate for use on the back side; what's really needed is a rectangular shroud to cover the entire radiator -- or, if multiple electric fans are used, an entire section of the radiator.

Installation of electric fans requires more thought than simply slapping a fan in there. For example, consider the space between the A/C condenser and the radiator: with a blower fan in front, the air might come through the condenser, go sideways within this space, and come back out forwards through a different part of the condenser -- providing excellent A/C but leaving the engine uncooled. Similarly, a sucking fan can pull air from the engine compartment through the radiator backwards, across the space, and back through the radiator to the fan -- leaving the A/C condenser without airflow, and eventually overheating the engine from recirculating the same air over and over. If the space between the condenser and radiator is open to outside, things get even worse. In the XJ-S, one tempting possibility is to mount one 16" electric fan in the existing shroud on the right side of the radiator (replacing the stock belt-driven fan), and a second 16" fan on the left front of the radiator blowing through the A/C condenser; this would make sure that both coils get airflow. Another possibility is to just replace the belt-driven fan with an electric and leave the small electric fan and the entire shroud assembly as stock.

John Napoli went this latter route, and reports on the process: "Removing all the stock stuff is a bit of a pain -- there is not much room to work, the process is iterative -- but it all comes out. You'll have to replace a couple of the water pump bolts that went through the idler pulley bracket with shorter bolts. Remove the radiator while you are at it to clean out the leaves in between the rad and the condenser -- I seem to recall that if you pull the rad first it is easier to get out the stock fan."

"I kept the stock electric fan and added the second inside the shroud of the old mechanical fan. The fan shroud is split from the factory (little fan and big fan) so this is real easy. I used an 'S' bladed fan from a Hot Rod supplier - 1-800-strt-rod or some such - it is the largest one they had (17" or 18"). Any fan of similar size should be fine; you can get them from Pep Boys or JCWhitney. Be sure to run the fan before installing it. Some are out of balance. Mine was, and you would not believe how annoying it is! I had to balance the blade (wrapped solder around the light spots and used weatherstrip adhesive to lock it in place) but it would have been better to start with a perfect unit.

"I made brackets to hang it off of the stock shroud. It fits in there nicely and the underhood appearance and access is improved. *Do not* under any circumstances attach the fan to the radiator core with those silly little plastic thingies! The Jag radiator is softly mounted to absorb vibration. Use those shortcuts, and the new fan will quickly work loose.

"Performance has been fine as measured on accurate mechanical water temperature gauges. I like overkill, though, and may some day add one or two little pushers in front of the condenser." Note: a better way to evaluate fan adequacy would be to measure the temperature of the *air* coming through. A marginal capacity fan may keep the coolant within limits but the air coming through the radiator will be really hot, while an excessive amount of airflow will reduce how much the air heats up. Of course, comparisons would have to be done on similar days with the engine running under similar conditions.

This author also installed a 16" electric fan in place of the belt-driven fan, but went a slightly different route than Napoli. Rather than adapting an electric fan to the opening in the existing shroud, a new section of shroud was fabricated. This is remarkably easy, since the XJ-S shroud is actually two sections, with the left 1/3 containing the small electric fan and a set of flaps while the right 2/3 has the hole for the belt-driven fan. By keeping the left 1/3 but making a new right 2/3, it was possible to provide a hole the correct diameter to fit the electric fan. The right 2/3 piece of the shroud was made at a sheet metal shop by merely folding three sides of a flat piece of sheet metal, and cost \$20. There are photos of this installation on the www at

<http://www.jag-lovers.org/xj-s/book/ElecFan.html>

If you are removing the stock mechanical fan bearing support, you will need two studs 4-1/4" long with 5/16"-18 (coarse) threads on one end to continue to hold the water pump properly. The other end of each stud can be either coarse or fine thread, since it gets a nut and you can use whatever nut matches. Good luck finding such studs! Alternatively, you can use threaded rod cut to length, or you can cut the original stud shorter and thread it. Or, you can just stack washers on the existing stud if you don't need clearance in the area for the motor on your electric fan. You will also need two 5/16"-18 bolts 1" long, but those are easy to find.

Even though the addition of an electric fan may reduce the total hp drain on the engine, it will definitely add to the load on the alternator. If you have a Lucas alternator with 66 or 75 amp capacity, this mod may push the total electrical load over the alternator capacity; when the A/C compressor kicks on and brings on both electric radiator fans with it, the system voltage drops and the lights dim. Hence, it might prove necessary to replace the Lucas alternator with the later 115-amp Bosch (see page 529) or a 100+ amp GM (see page 531) to maintain voltage under all operating conditions.

CONTROLLING ELECTRIC FANS: Electric fans can be controlled by either of several mechanisms. The simplest method is to wire the fans to run whenever the ignition is on. This is wasteful, however, since the fans are only needed when the car is standing still or moving slowly. It also may cause the engine to run cold, or take too long to warm up, in cold weather.

The electric fans could also be connected to the existing electric fan control system, which automatically operates when the engine is hot or when the air conditioner compressor is operating. Note that replacing the single tiny fan with a couple big ones requires more electrical work than simply installing a larger fuse in the #1 position in the headlight fusebox; the stock wiring, even if it doesn't burn up, will provide too much resistance and the fans won't run as fast as they should. Some suitably heavy wiring should be run from the bus on the firewall to the new fans, using a separate relay for each fan. Napoli: "I wired the new fan simply: I added a relay that is picked up by the stock (ie, little) fan coming on. The power for the new fan is routed through the relay from one of the 12 volt feeder wires located near the relays at the upper rear corner of the right fender. You can get fancy and route alternative feeds from the A/C compressor or a dashboard switch, but if you do you may need a diode to prevent backfeeding something else."

Yet another possibility is to add another fan switch into the coolant system. Jaguar makes a suitable housing for a switch for the Mk III E-type, C34005, that fits into a radiator hose, or maybe you could get lucky and find a switch that will fit one of the unused ports in the water rails on top of the heads. Or, there are switches sold for electric fans that just strap to the outside of a pipe, so you could just attach it to one of the coolant pipes -- or oil pipes, for that matter. With any such switch, one of two fans can be connected to the stock wiring and the other to a separate switch. This would result in the two fans operating separately, and only one running when only a small amount of airflow is needed (since one fan will always come on before the other). The dual circuit also provides a measure of redundancy, since one of the fans would provide some cooling in the event of the failure of the other circuit.

The fans could also be controlled via an air temperature sensor in the air coming through the radiator. This method is often used by the aftermarket fans, providing a switch that mounts right on the fan housing. Note that if the fans are mounted in front of the radiator, the sensor must be moved to behind the radiator to work properly. This method scares me, since I always wonder what would happen if there is no air coming through the radiator -- like, the car is stuck in traffic and there's a slight breeze from behind.

Yet another control system would be to provide a "paddle" switch that shuts the fans off when the airflow due to car motion is adequate. There don't appear to be any such items commercially available, but making one would not be difficult. A pivot with a paddle on one side and a tiny counterweight on the other, balanced to eliminate inertia effects, could be installed in the area behind the front grille. The arrangement could be rigged to operate a conventional microswitch with contact ratings sufficient to operate the fans directly, or a relay could be incorporated. Using an ohmmeter or a light bulb, the car can be tested and the switch adjusted until it operates at a suitable speed, about 30-40 mph. This system would still operate the fans when the engine was cold, but would function properly with the air conditioner; the air conditioner requires airflow when running even when the engine is cold, but the motion of the car above 30 mph will be adequate; turning the fans off is OK.

Finally, remember that you can use a *combination* of the above schemes; for example, you could use a paddle switch along with a temperature sensor to prevent the fan from operating when moving fast *or* when the engine is cold.

If the control scheme used allows any possibility that the fans will be off when the car is idling, be sure to incorporate circuitry to run at least one fan (preferably *all* fans) whenever the air conditioner compressor is operating (similar to the present wiring for the small stock electric fan). On some later XJ-S's, the small stock electric fan does *not* come on with the compressor, but remember that this is assuming a belt-driven fan that is always turning; regardless of the stock wiring, if the belt-driven fan is removed you *must* provide fan operation when the A/C compressor is engaged, regardless of engine temperature or outdoor temperature.

One final note: another nice feature of electric fans is their ability to run after the engine is shut off. The biggest heat problem in the XJ-S is heat soak after shutdown. The small electric fan already can provide some relief if the coolant is hot enough for it to be on when the car is shut down, but having multiple electric fans and multiple control schemes provides more possibilities for addressing this issue. It might even make sense to provide an air temperature sensor at the upper rear of the engine compartment to control post-shutdown fan operation. Or, maybe using a hot-start sensor in the fuel rail to control a fan would help with hot starts *more* than the way it's normally used (to alter fuelling).

ELECTRIC COOLING FAN: Here we're talking about the small OEM electric fan, not the replacements for the belt driven fan described above. Yes, it's atrociously expensive. But it doesn't do anything any other 12V, 11" diameter electric fan won't do; substitutions are in order. Be sure to include a system of rubber mounts, similar to the Jag originals, to minimize noise.

One possibility is to buy the 11" electric fan from J. C. Whitney, 38xx3020A, remove the fan/motor from the shroud and figure out how to mount it. Depth won't be a problem, it's really flat. But you don't really have a good opportunity to look at it before you buy it to decide if you can make it fit.

A Subaru fan will work with minor blade trimming and a homemade mounting adapter plate. The bad news is that a Subaru fan ain't cheap either, but at least it can be found in a common junkyard.

Alex Dorne fit an electric fan from a Saab 900 Turbo and says it "replaced, and even looked better, than the original when in place. The diameter was perfect, giving about 1/4 of an inch air around the propeller. And after removing a

metal protective ring around the prop I could use what was left of the mount and bolt the fan to the shroud using the upper rh and lower holes. I also think this fan flows more than the original since it's designed to cool a Turbo engine all by itself."

"The Turbo fan motor is flatter than on the non-Turbo because the lack of space between the radiator and the engine... the flatter design leaves even more space between the fan and the engine in the Jag than the original fan did."

John Goodman reports that the XJR-S has a different 11" fan than the basic XJ-S: "Seven blades high CFM part no. EBC 4553. No part no. listed for the fan shroud so would imagine it could be retrofitted." You can draw your own conclusions about why Jaguar would go to the effort of providing a different fan.

ELECTRIC RADIATOR FAN SWITCH: There are apparently at least three different switches that have been used in the XJ-S. Up through VIN 101854 (mid-'79), switch EAC1322 pressed into a rubber grommet in the water pump inlet. I think this type of switch is called an "otter switch". From VIN 101855 to VIN 151087, switch EAC2510 threaded into roughly the same location on the pump inlet, so clearly the pump inlet was changed to provide a threaded hole. After VIN 151087, switch DBC2145 was used. It is unknown what the difference between the last two switches is, since they both fit into a threaded hole; perhaps they turn the fan on at different temperatures. Peter Cohen says, "The thermal fan switch from my '89 XJ-S says 85° C. It also says 909-6 and EAC2510."

The difference between EAC2510 and DBC2145 might also be in the connector styles. Cohen reports: "Beck-Arnley lists the same part number for the 85-91 XJ-S V12 as for the 88-90 XJ40. This part is actually an XJ40 part. It has two wires that are potted into the switch itself, leading to a cylindrical plastic connector (2 inches long by 1 inch diameter). This part can be used in the XJ-S V12 by cutting off the connector, and attaching blade connectors to the switch wiring. This part *may* also be correct for the 92-96 4.0L XJS 6 cyl.

"The Jaguar dealer quoted \$122.50 for the XJ-S switch. The Beck-Arnley part is just under \$30. Here are the catalog listings for some other sources for XJ40 fan switches that should be in the same price range:

Beck-Arnley
XJ40 and 85-91 V12 201-1151

Four Seasons (Division of Standard Motor Parts)
XJ40 36538

NAPA
88-90 XJ40 FS-222

Note that the original switch has connectors right on it -- which is a real pain to get the spade connectors on and off of. Since this XJ40 switch has wires that you put spade connectors on the end of, it should be easier to connect the harness to.

Would the XJ40 switch replace both the DBC2145 and the EAC2510? Unknown. However, Cohen claims the elbow itself, EAC3195, apparently didn't change, so it should thread in.

If you have an early car, do you really want to put in a new otter switch? Well, if it were my car, I wouldn't. Instead, I'd consider buying a new pump inlet EAC3195 (or threading the hole where the rubber grommet went) and fitting the later switch. Failing that, it may be possible to wrap a piece of bailing wire around the inlet elbow to securely hold the otter switch in place, but make sure that the bailing wire doesn't short out the connectors on the switch.

ELECTRIC RADIATOR FAN RELAY: As mentioned on page 522, the electric radiator fan relay is an SPDT relay (red to indicate it's different), meaning it has a central fifth terminal labelled 87a - a NC contact. In this particular application the 87 contact is 12V power and the 87a contact is connected directly to ground. As a result, if a relay with

two 87 terminals or one 87 and one 87b terminal is plugged in, a direct short will result and fuse #1 in the headlamp fusebox will blow immediately.

The NC contact shorts the fan motor to ground when not operating. It's not known why Jaguar did this. If a 4-terminal relay that has no center spade terminal is installed, the system seems to work fine; the fan operates normally when on, and the fact that the fan is not grounded when off doesn't seem to make any noticeable difference. However, it seems unlikely that Jaguar would have gone to the effort of supplying the grounding circuit without a good reason.

ELECTRIC FAN DIODE PACK: The blue item mounted on the top left side of the engine compartment just rearward of the diagonal strut looks like a relay, and has the same spade terminal layout as a relay, but it's not a relay at all; it's the diode pack for the electric fan. The terminals are numbered simply 1, 2, 3, 4, and 5. You can easily pry the box open with a small screwdriver and inspect the layout inside.

Diodes merely allow current in one direction only. When testing this pack, you should be able to get current to flow from terminal 3 to terminal 1 but not the other way around. You should also be able to get current to flow from terminal 5 to terminal 4 and from terminal 2 to terminal 4, but not the other way on either. This description uses the accepted definition of current as flowing "from" a + terminal to a - terminal. Note that some meters may not incite a diode to flow in *either* direction when set to a standard ohmmeter setting; if the meter does not have a setting for testing diodes, it might be better to use a battery and a light bulb to test.

In case you haven't developed a healthy disrespect for Lucas engineering yet, here's another example of their handiwork: the wires that connect to terminals 1 and 3 are both GN, but they are different and you'd better not mix them up! Likewise, the wires that connect to terminals 2 and 4 are both LG, but don't mix those up either!

If you've already disconnected them and gotten confused: on the author's '83, the GN wire that connects to terminal 1 is actually two wires attached to the same spade connector, while the GN that connects to terminal 3 is a single wire. Likewise, the LG wire that connects to terminal 2 is actually a pair of wires, while the LG that connects to terminal 4 is a single wire. Here's hoping other cars are the same!

I will describe more elaborate tests, in case the above proves inadequate. If you apply 12V to a GN wire and the electric radiator fan starts running, that wire connects to terminal 1. If the clutch on the A/C compressor engages, it connects to terminal 3. If the engine is cold and you turn the ignition on and read 12V at a LG wire, it connects to terminal 2; if not, either a fuse is blown or it connects to terminal 4.

Just when you thought you had these things figured out, Jaguar goes and does something totally unexplainable. Michel Carpentier reports on the diode pack in his Daimler Double Six: "The blue box is clearly the same as described in your book: one diode with anode in 3 and cathode in 1; two diodes with anodes in 2 and 5, common cathode in 4. But it provides the logic for the headlamp wash/wipe system. 2 is connected to a blue/red wire (high beam), 5 to a blue/white wire (low beam), 4 goes to terminal 85 of the wash/wipe relay via a blue/red wire. 1 has a green/blue wire going to one of the washer pump terminals. 3 has two green wires, live when ignition is on. Terminal 86 of the headlamp wash/wipe relay is connected to the other terminal of the washer pump (common to windshield and headlights) and to the windshield washer switch. When you push the windshield washer switch, terminal 86 of the headlamp wash/wipe relay is grounded and the pump operates via diode 1/3. If the headlights are off you get normal windshield washer operation. If they are on (either low beam or high beam) 4 is live so the relay is energized: the headlamp wiper motors kick in and valves open, squirting fluid on the outer headlights. Much ado for a perfectly useless gadget!"

"Back to the cooling fan. Against the radiator is a small harness which comprises the following: A green/brown wire running from a connector on the RHS of the radiator (said connector linked to A/C compressor clutch) to terminal 86 of the red fan relay. Somewhere in between, this wire is cut and a small PCB (about 30x8mm) holding a diode soldered in, with the cathode towards the relay. Terminal 86 of the red fan relay is also connected to the thermostatic switch by a green/white wire. A black wire connects terminals 85 and 87A to ground. A brown/green wire comes from the main harness on the LHS (live at all times) and goes to terminal 87. Another small PCB (exactly 32x10mm) is also buried inside the harness. It holds two diodes with a common cathode connected to the thermostatic switch by a green/orange wire. One anode has a red wire going to terminal 30/51 and thence to the fan motor. The other anode is connected to

the main harness by a green wire (live when ignition is on). This harness is held together by the usual weaving: outwardly there is no way you can tell that it is so electronically sophisticated as to contain 3 diodes!"

Craig Sawyers says, "Curiously, it seems that some detail went into the choice of diodes in the fan control and headlamp wiper circuits (the blue box with four terminals). The diodes are all soft recovery devices, which are specifically designed to eliminate fast voltage spikes when they switch off (caused by junction capacitance in the diode itself). I took the lid off just out of curiosity some time ago, and they are all quite distinctive (BUV something or other). When I looked them up they are quite specifically soft recovery diodes each with different ratings, designed to reduce the transient interference when they switch off. I was quite surprised at the obvious care that had been taken in the choice of components."

Peter Cohen talks about the later cars: "The facelift model cars have a different setup to the 1991 and earlier cars. The later cars have a completely different diode pack. It will be in approximately the same location. Most relays are manufactured by Hella or Bosch. If you see a component made by someone other than Hella or Bosch in that general vicinity, it is worth a look. It will have one BG and two LG wires."

LATE MODEL ELECTRIC FAN OPERATION: Bruce Segal reports: "I believe Jaguar changed the design in 89 so that the fans no longer come on with the A/C compressor." Wise? Many owners don't think so, and rewire the fan the way the earlier cars were wired so the small electric fan comes on with the compressor.

FAN SHROUDS: The fan shrouds ensure that air drawn by the fans comes through the radiator rather than other places. If the fan shroud is not installed properly and held securely against the back of the radiator, then air from the engine compartment can be drawn in by the fans. This short-circuits the airflow and reduces the amount of air coming through the radiator.

Anytime there are two fans and one may be on while the other is off, it is also important that the fan shrouds provide a separation between the two so that air draw by the running one doesn't simply come backwards through the non-running one.

FAN SHROUD FLAPS: At the lower left corner of the XJ-S fan shroud are a couple of rubber flaps. These are designed to allow air to flow rearward through the openings in the shroud but not forward. At speed, the air coming in the front of the car and through the radiator merely blows these flaps open. At a standstill, when the fans are trying to draw air through the radiator, these flaps shut to prevent the fans from drawing air from the engine compartment instead.

They're as simple as they look. If they are damaged or missing, it is easy enough to make replacement flaps from an old inner tube, or even old shoe leather.

FOAM IN AIR PATHS: In order to ensure that air coming in the front of the car goes *through* the radiator, any passages *around* the radiator must be plugged; air would much rather take an easy route, so even a small gap will allow a large portion of the airflow to bypass the actual heat transfer area. Also note that the space between the radiator and the A/C condenser/oil cooler must be sealed all around, so that the fans draw air through the A/C coil rather than in through a leak path. And, of course, air coming in the front of the car should be compelled to go through the A/C condenser/oil cooler rather than sneaking past it as well.

There is a second reason to apply the foam in the nooks and crannies around the A/C condenser and oil cooler. As mentioned on page 193, the space in between the condenser/oil cooler and the radiator itself is often found to be plugged up with debris. While the difference in coarseness between the condenser/oil cooler and the radiator may permit a particular range of grit sizes to get in there, the fact is that this space is usually found to be full of leaves -- far too large to have passed *through* the condenser coils. They can only be getting in there by sneaking through openings that should have been plugged with foam. There is usually a horizontal gap between the top of the oil cooler and the bottom of the condenser that may be the prime culprit in this regard.

Jaguar used foam to plug some of these openings -- a British nonmetallic material. If your radiator seems to have no such foam anymore, Thomas Alberts says, "Most of the mail order places do not carry these "gaskets" (as they are called in the parts book), however they can be purchased from Jaguar dealers for a few bucks. The part numbers (for my 1987 XJ-S) were CAC2321 for the side and CAC3821 top & bottom."

Alternatively, go to the building supply store and purchase one package of 2-1/4" x 2-1/4" x 42" foam intended for sealing window air conditioners and at least one package (maybe two) of 1/2" thick 3/4" wide weatherstripping foam tape. For the tape, you may have a choice between "open-cell poly" and "closed-cell vinyl"; either will probably work fine. You may also buy a couple other thicknesses of foam weatherstripping while you're there, just in case.

Doing a proper sealing job is easier if you have a lot of stuff apart in this area. For example, having the fan shrouds removed helps, and having the radiator upper support rail off is also a big help. Ideally, do this job while you have the radiator itself out. But if you're not doing that kind of work today, don't postpone sealing the openings until you do; do your best with what you can, and if necessary buy some more foam later when you have things apart.

If you have the radiator out, start by applying the foam tape to seal the bottom of the radiator between the rubber support grommets and outside the grommets to prevent air from sneaking by under the radiator.

If you have the upper support rail off, check the width of the gap between the oil cooler and condenser. Then lift the condenser a bit, attach a strip of foam tape weatherstripping of suitable thickness to the bottom edge of the condenser, and set it back down.

Cutting the 2-1/4" foam with a razor knife, install a piece on either side of the radiator to fill the huge gaps there. Install the foam in front of the radiator itself, beside the A/C condenser/oil cooler. If positioned properly, it will seal against both by fitting snugly against the ends of the A/C condenser and against the front of the header on each end of the radiator. Make sure the pieces stand high enough that the upper radiator support rail sits down on them when installed. The foam can be fit behind the supports for the front bumper crash absorbers all right, but you'll have to end it where the pipes connect to the oil cooler. Then cut a couple more chunks from the remainder of the 2-1/4" foam to fill in the openings *under* the pipes to the oil cooler.

From the remainder of the 2-1/4" foam, cut a piece about 6" long and then cut it lengthwise at a slight angle to create two wedge-shaped pieces of foam. Use these to fill in the space on each side near the top where the 2-1/4" foam wasn't fat enough to completely fill in the space. If you have wiring or hoses passing through here, you can arrange them to go between the pieces of foam so they are nicely supported. You can cut suitable recesses in the pieces of foam to make way for the freon line coming around the top right end of the radiator.

Looking through the lower grille in front of the car, you will notice that there are two more gaps created by the fact that the oil cooler is not as long as the A/C condenser. Cut two blocks of foam and insert them by reaching right through the grille.

If the upper radiator support rail is off, make sure to seal it against the top of the radiator, against the top of the A/C condenser, and against the top of the fan shroud before reinstalling it. The top of the A/C condenser in particular may have such a huge opening that it doesn't even appear sealable; you may need to stack 1/2" foam tape two or three layers high to fill the hole.

FRONT SPOILER: It's important to have the front spoiler in place. Engine cooling relies on air coming in through the radiator, and it must have a place to go. The XJ-S does not have vents through the hood or out the sides, so all this air must go out the bottom. The front spoiler is designed to direct air either into the radiator or around the sides of the car, and to restrict air from going under the nose of the car as much as possible. This results in low pressure under the car, so the air going through the engine compartment can easily flow out that way.

However, if the spoiler is missing, air can flow right under the nose of the car unimpeded. This increases the pressure under the front of the car, which in turn resists the outflow from the engine compartment. The air coming in through the radiator cannot escape as easily, and builds up pressure in the engine compartment. The resulting backpressure prevents as much air flowing through the radiator. It also tends to cause significant lift on the front end (try multiplying a very

small pressure over the entire area of the front half of the car; the total lift can be very large indeed) and can cause the car to "wander" at high speed.

HEATER CONTROL VALVE: See page 459.

Post-Shutdown Cooling

It is commonly acknowledged that the worst cooling problem the XJ-S has is not when running but after shutdown. The small electric fan runs after shutdown if the thermal switch has it running when the engine is shut off, but once the switch cuts out -- which it does all too soon, since it is reading coolant temperature at radiator outlet -- it will not come on again. 700 pounds of hot engine plus hot exhaust manifolds and hot catalytic converters tend to raise the underhood temperatures after shutdown considerably higher than they ever were while running, and there are indications that parts of the engine itself get hotter after shutdown as well.

There are three problems generally associated with post-shutdown heating: Dropped valve seats, hot start difficulties, and heat-stressed engine compartment components. The exact mechanism of dropped valve seats is unclear, but several owners have suffered dropped seats *after* a hot shutdown rather than while running. The other two problems are clearer, and result from the high temperature of the air surrounding the engine -- and all the extraneous components that are heated by the air. Since there is no longer fuel flow in the rail, the fuel sitting in it gets hotter and hotter, causing serious hot start problems that Jaguar has addressed with a couple different types of fuel rail temp sensor providing fuel enrichment. The post-shutdown underhood temperatures are clearly a key cause of deteriorated hoses, brittle wiring, short-lived electrical components, and a host of other traditional Jaguar afflictions.

This section includes several ideas for dealing with the post-shutdown temperatures. Most address primarily the temperature of the *air* within the engine compartment, which may or may not have a significant effect on the temperature of the heads themselves in the vicinity of the valve seats.

HOOD VENTS: Just the ticket for letting the heat rise naturally out of the hood after shutdown. It's a body modification, so it's discussed further on page 436.

ELECTRIC COOLING FAN BOOTSTRAP CIRCUIT: The electric fan includes a "bootstrap" circuit, so that if the coolant is hot enough for the fan to be running when the engine is shut off, the fan will continue to run until the coolant temperature switch shuts it off. Once off, the bootstrap circuit drops out and the fan cannot start again, no matter what.

Other cars -- notably Japanese and other FWD 4-bangers -- have cooling fans that cycle on and off for quite a while after the engine is shut off. Clearly, they are wired so that the fan will run if the thermostat calls for it, regardless of whether the ignition is on or not. It is also evident that they *come* on -- indicating that once they shut off the first time, they may still be needed again. Probably the engine heat soaking through the compartment.

Why did Jaguar provide this bootstrap circuit, rather than just wiring the fan to run when needed like the Japanese cars? There would be two possible results if the bootstrap weren't in there: 1) The fan would never come on after shutting off the first time -- meaning that the bootstrap circuit was unnecessary; or 2) the fan *would* come on after shutting down, which means it *needs* to come on and the bootstrap circuit is contributing to the cooking of the engine parts!

The only plausible explanations: A) Jaguar was afraid the Lucas thermostat would fail in the on position and kill the battery; B) they didn't feel that a fan kicking on and off in the parking lot was in keeping with the proper Jaguar image; or C) they were worried about liability from someone having their fingers in there when a fan came on unexpectedly. Stuart Barnes adds D) "Many car alarms are voltage sensing and although they can cope with a voltage rise (to allow an electric fan to run and then stop) a lot of the aftermarket varieties can't cope with the voltage drop that would occur when the fan came back on."

For those of us who are more concerned with the life of our machines, keep our fingers out of moving machinery as a force of habit, and don't have such alarm system concerns, it might be a good idea to rewire that circuit to run the fan whenever necessary. It's easy to do: On the left side of the engine compartment is a small blue box that looks like a relay, but it's the diode pack (see page 214). Pull the LG wire off of terminal 4 and connect it to a 12V power supply. There is a 12V supply available at the solid brown wires at the headlight fusebox just a few inches forward of the diode pack.

Note that, if you have headlight washers and wipers, the blue box might not be the fan diode pack. See page 214.

ENGINE COMPARTMENT AIR TEMP SENSOR: Another way to get the electric cooling fan to run longer after shutdown might involve adding an air temperature thermostat within the engine compartment -- preferably high and rearward, where the post-shutdown cooking problems are the worst. This thermostat could be set at a much lower temperature than the one in the coolant and still wouldn't come into play while the car is moving or the engine-driven fan is circulating air. But if the air starts getting hotter after shutdown, it can come on -- even if the coolant in the water pump isn't that hot -- and flow some cool air through the engine compartment.

Imperial makes a dandy little "Adjustable Thermostat for Electric Cooling Fans", number 226203, available at Discount Auto Parts. It's really an air temp thermostat. It has a remote bulb sensor and includes instructions for mounting right on the back side of the radiator core, but you could mount it anywhere -- even on the underside of the hood! The thermostat is adjustable from 248°F to 32°F, and the contacts are heavy enough to control fans directly without relays.

ELECTRIC COOLING FAN POST-SHUTDOWN TIMER: Michael Aiken's plan: forget relying on temp sensors and simply provide a timer that runs the fan for a fixed amount of time after shutdown. Aiken used one of the existing 10-minute seat heater timers to provide this fan operation, and provided the wiring scheme shown in **Figure 12** which automatically starts the fan running on the timer whenever the engine is fully warmed up and shut off. Aiken points out that this is not an unheard-of idea; the Nissan 300ZX uses a similar scheme with a 17-minute timer.

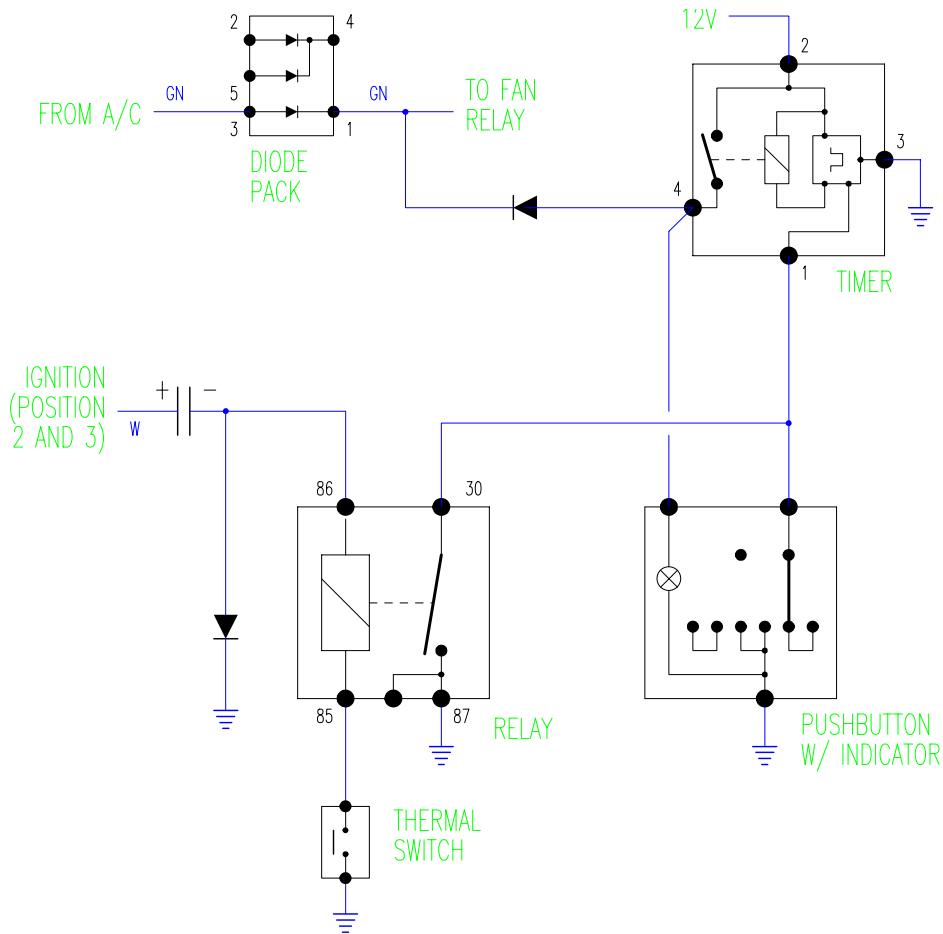


Figure 12 - Post-Shutdown Cooling Fan Timer

Aiken describes this scheme: “The timer is activated by grounding pin 1 and then releasing it. It will not activate if pin 1 is held to ground. I left the manual switch (on the side of the console) wired in so the light would show when the fan is on, but that is optional.” Having the pushbutton may have an additional benefit: you can push the button to force 10 minutes of fan operation whenever you wish. This might be handy if, for example, you get stuck in downtown traffic; you can simply tell the fan to run continuously for 10 minutes rather than cycle on and off with the thermostatic switch operation.

“The capacitor is a 2000 μ fd electrolyte and the diode is 3 amp. The capacitor attaches to ignition key 12V output in position 2 and 3. This is important to keep the fan from coming on during startup (position 3).” Ed. note: the wires that meet this criteria are white, as has been indicated on the schematic. They are connected to terminal 3 on the ignition switch.

“When 12V is applied to the capacitor it charges through the diode. When the ignition is turned off the capacitor discharges back through the relay momentarily (about .5 seconds) activating it and starting the timer relay. The fan runs for 10 minutes and then shuts off. The thermostat in the ground leg prevents the capacitor discharge if the engine is not yet warmed up. The capacitor does hold the charge and will discharge later if the temp reaches the set temp -- even several minutes after shutdown. I set my temp at 180°F.”

The schematic shows the output of the timer (pin 4) connected through a diode to the wire from terminal 1 on the diode pack to the fan relay, so it will directly close the relay and operate the fan. Radio Shack catalog number 276-1661 will serve nicely for this diode as well as the other one used in this scheme. In this application on the timer output, the diode only serves to make the indicator light show that the timer is engaged. If this diode is omitted, the system will still work

just dandy but the light will be on whenever the fan is running, even if it is the A/C compressor control or the stock coolant switch operating it.

If you happen to have one of the later cars where the A/C compressor does not bring on the electric fan (as Aiken has), you don't have to buy a new diode for this task; there's an unused one in the diode pack. Just connect pin 4 of the timer directly to terminal 3 of the diode pack.

Aiken also points out that this scheme doesn't have to control the small stock electric fan; it could be used just as well to control an aftermarket electric fan, or anything else electrical you'd like to run for 10 minutes after shutdown. The use of a marine bilge vent fan has even been suggested. It's probably not a good idea to operate a large fan or multiple fans; it shouldn't take much airflow to keep the underhood temperatures within reason, and you don't want to strain the battery. The fact is, the stock Jag small fan is probably perfect for this job.

Since Aiken used the seat heater controls, the schematic shows the timer and the pushbutton with indicator light as they appear in the Jaguar seat heater schematics. Of course, if you'd rather leave your seat heaters wired as originally intended -- or if you have an earlier car that doesn't even have seat heaters -- you can simply buy a new timer from Jaguar, or perhaps a generic timer (or maybe the one from a Nissan!). You can simply leave the pushbutton and indicator light (and the related diode) out of the circuitry altogether if you wish and connect terminal 30 of the relay directly to pin 1 on the timer. Or, you can buy any generic momentary pushbutton switch; don't let the excessively complicated Jaguar illustration fool you, that heater switch is just a normal momentary single contact switch with a built-in indicator light. If it's only the indicator light you want, you can skip the switch altogether and simply buy any generic 12V indicator and connect it to pin 4 on the timer and to ground and mount it anywhere convenient -- or you could wire it to one of the unneeded warning lights in the dash.

Aiken apparently left his timer where it was originally mounted behind the dash, but if you're installing a new timer you can pretty well choose anywhere to install it. Other than 12V power -- any brown wire -- the only thing you really need is access to a suitable white ignition wire, and they are all over the car -- even going to the EFI power relay in the trunk. There is also one to the ignition system on the engine, so it's possible to install all of this stuff someplace near the fan itself -- perhaps in front of the radiator, or in the compartment behind a headlight -- and not have to run any wires into the passenger compartment, provided you don't want a pushbutton or indicator light.

FUEL SYSTEM

Tank, Surge Tank, Pump, Lines

ENGINE FIRES: The early Digital P XJ-S's (early 80's) had a problem with engine fires. There was a recall to address the problem in which the fuel rail on the engine was replaced; the newer design is indicated by rectangular tubing, while the pre-recall rail was made of round tubing. All Digital P XJ-S's were subject to this recall, but indications are the recall was not as conscientiously applied outside the US. Unfortunately, word is that the recall is "closed" and dealers will no longer perform it. If you have a Digital P with round tubing in the fuel rail, you probably should consult your favorite junkyard and collect all the parts that look different and perform the recall yourself. Note that the D Jetronic still uses a fuel rail with round tubing.

Leaking fuel in an engine compartment is remarkably difficult to ignite. Usually there have been obvious odors and visible leakage for some time. Please do not ignore fuel odors; the XJ-S shouldn't have any.

MORE ENGINE FIRES: The later XJ-S also has a reputation for engine fires, also from the fuel lines! Peyton Gill reports on "an XJ-S that had a little pyrotechnics under bonnet. I asked the guy about it and he said that the fire was put

out within 30 sec (owner had a fire extinguisher) and the estimate to repair was \$2000.00. There was not that much damage. The cause of the fire was the ignition coil wire was about 1/4 inch from one of the fuel injection lines (between rail and injector). The ignition wire had been arcing to the line and eventually worked its way through. I guess the physical damage and ozone created by the arc eventually broke down the line."

Julian Mullaney adds, "There was a recall for cracked injector hoses and injector bodies. Ozone from the distributor leads causes the perished plastic. The recall replaces the lead with a shorter one, and replaces the injector. They looked up my car (vin no.) in their database and the fix had already been done a long time ago, however the problem persisted.

"The problem was ozone deteriorating the injector hose on the right bank second cyl. from the firewall. It produces a cracked surface of the rubber hose. You should look carefully for this, it's not easy to spot.

"The dealer said that they were instructed to look for visual damage to the hose and replace injector if needed. "If" is the key word here. However, if it looked good, they could get away with only changing the HT lead to a shorter one (thus not close to the injector) and leave the original injector hose. This leaves the chance that damage could have occurred to the hose but it's not visible yet, leading to the following chain of events:

- upon initial recall they only replace the HT lead
- then the hose continues to deteriorate from initial ozone embrittlement;
- then you see the damage to the hose a year or two later;
- pyrophobia sets in;
- then you call the dealer;
- then they tell you sorry, the fix has already been done;
- then you find that the recall was done sloppily;
- then you get pissed off;
 - a) then you think about fixing the problem yourself
 - b) you call the dealer again and insist they fix it again properly
 - then dealer calls Jaguar to authorize 2nd repair
 - they say OK
 - you get it fixed for free

"Option b) worked fine with me, my local dealer was very good about it."

Ron White adds, "I checked the recall database and the recall only affects 1989-91 XJ-S models; this is a result of: "The high tension lead from the ignition coil can move from the production location closer to the #4A fuel injector hose. Vehicle description: coupes and convertibles with Marelli ignition systems.""

STILL MORE ENGINE FIRES: Just when you think you have the situation under control, the government throws another monkey wrench in -- this time in the form of oxygenated fuels, required in California and many metropolitan areas. Stephen Wood says, "We starting in Spring 1996 having a substance called MTBE -- methyl tutol-buytol,ethonal, something like that -- blended with our gas to help reduce emissions. Hopefully they will be taking it out soon, as there has been a major hubbub about it here. You see, it also melts things, like fuel lines, carburetor gaskets, (especially the old rubber/cork type), fuel tanks, brazing material solder, etc.

"Last summer car fires were up significantly all over the state, including my brother's '69 Camaro (it was restored). MTBE melted through the carb gaskets on his vintage Holley and *poof*.

"At that point it got serious, and I checked my fuel lines, and sure enough, they were going way squishy from the inside out. In other cars we have seen it also has melted injector seals.

"If you ask the insurance companies they have had a slight increase but nothing to worry about. No problem, right? *Wrong!* Most of the cars affected are cars that the insurance industry won't provide fire, theft and vandalism coverage on anyway. If you ask the CHP and the firemen, they know that last summer was a major problem."

So, you need a new type of fuel hose, right? "The problem with the hose issue is that the rubber manufacturers are not going to gear up for a California-only issue. However, some of the new cars have fuel lines made out of a tygon derivative, a newer plastic that is more resistant to these blended fuels (New LT1- LT4- and LS1 GM motors). I don't think there is a crossover app. as of yet, tygon is a bitch to work with and has the characteristics of polypropylene tubing, i.e., firm and not clampable. You have to use special fittings with it.

"There is supposed to be some new silicone-based flexible "rubber like" fuel line coming out soon from Gates or Goodyear but I haven't seen it. So for now, I have been keeping an eye on the situation and checking all pressurized fuel lines every month, and replacing them every 6 months (I have done this three times now). Vent lines are ok from when I replaced them 6 months ago. I have been changing fuel filters every 45-60 days (preventative mania), making sure to cut open the old filter to see if anything weird develops like little bits of rubber hose.

"I will have to take my gas tank out this summer, and have it boiled and welded or just put in a new one. The corrosion around the outlet is growing and I think it is melting through the solder. I may just JB Weld it or something."

FIRE EXTINGUISHERS: After reading the previous few pages, you have probably come down with a healthy dose of paranoia regarding fires in the XJ-S. A fire extinguisher is cheap, and may come in handy.

Ron White had a fire in his car, and thanks to having a fire extinguisher in the trunk and knowing how to use it, his car survived with almost no damage. "I have seen engine fires in other cars and have seen people make the mistake of flinging their hoods (these were American cars) open, only to have the fire flare up 5 or 6 feet because of the added oxygen. I opened the bonnet just enough to get the nozzle of the extinguisher in, and gave it a good squirt. I then cautiously opened the bonnet up and seeing no flames opened it up all of the way and gave it a *real good squirt!*" White's extinguisher happened to be a Halon type which works wonderfully and leaves no crud on the engine but is bad for the ozone layer and is in the process of being outlawed. Experts seem to feel that a common powder type fire extinguisher would probably work just as well, the only disadvantage being that you'd have a job getting all the powder out of the engine compartment afterward.

One more note: White's car is an '86, meaning it's late enough to have had all the updates to correct the early fuel rail problems and too early to be covered by the recall for the later cars with the Marelli ignition. "It appears that the cause was a cracked body on an injector, and it was squirting fuel directly on the distributor!" That fire extinguisher is sounding like a better idea all the time, isn't it?

John Napoli suggests a built-in system like those found on race cars: "It should be a lot easier to extinguish a fire within the closed confines of the engine compartment with the bonnet closed, and you could certainly react a lot quicker than, say, opening the bonnet, saying "Oh, sh\$t", running for the boot, trying to find the fire extinguisher that is underneath all your luggage, meanwhile the bonnet is open and the flames are getting higher..." Of course, keeping the extinguisher on the floor in front of the front seat may help.

Emile A. DesRoches says, "If anybody is really interested in a real "racing car" fire control system (sanctioning bodies require a system plumbed in to spray at the engine, fuel cell and driver's lap area), they can be obtained from such organizations as Racer's Wholesale in Atlanta. From experience as an SCCA tech inspector, I can say that they may make a mess, but they work and clean up is inevitably less expensive than replacing a fried V12 motor."

FUEL HOSE MAINTENANCE: The best way to deal with engine fires is not to have one! If you have any doubts about the condition of the fuel hoses in your car, replace them. Based on experience from the online discussion list, it would be an excellent idea to replace *all* of the fuel hoses in the car at least once every ten years; you can do it every five years to be on the safe side.

In some locations, there is a fuel line assembly that consists of hose crimped onto metal lines; in such cases you can just buy new Jaguar fuel line assemblies, but it's cheaper to buy generic hose and install it in the existing lines with suitable clamps (see below). The hardest part would be getting the original crimped fittings off, but the second time you do the job it'll be easier since you'll only need to loosen clamps. Don't overlook the sections of hose in the lines looping over the rear suspension on each side of the car.

In other places, you will be replacing pieces of hose with clamps on the ends. In yet other locations, you may need to replace hoses that don't seem to be attached at all -- they are merely pressed onto the fitting; please read the following sections to understand how these work before tackling the job.

FUEL HOSE CLAMPS: If you live in the US and walk into an auto parts store and ask for a hose clamp, you will be handed a stainless steel band with a series of angled slots through it and a worm screw attached to one end. These "aircraft type" clamps are excellent -- for lines about 3/4" in diameter and larger. Although they do sell small clamps in this style, they do not work well on hoses as small as the fuel lines on the XJ-S. There are simply too many "corners" within that circle as it is snugged up, and although it may seal at first while you're looking it may leave local areas that aren't securely compressed against the fitting and will start leaking later when you're not looking.

If you live in the UK and ask for a hose clamp, you might get a "Jubilee" clamp or something similar. These are also stainless steel worm screw clamps, but instead of angled slots in the band it has little raised lips for the screw to engage. These are better than the US aircraft type clamps on small diameters, but still not good.

To assure a good, reliable seal, you're going to need some clamps that securely compress the hose onto the fitting uniformly all the way around. While the worm screw types are not recommended, there are several other types that will work fine. Many auto parts stores sell "EFI hose clamps", which consist of a steel band with a small screw and nut that draws it tight. They come in various sizes, and you need to carefully select the size you want; these type clamps will only fit the size hose intended, you cannot just keep screwing them down smaller like a worm screw clamp. Unfortunately, you're not likely to find these type clamps in stainless steel, so it is advisable to carefully apply anti-seize compound to the threads on that tiny screw if you ever want to get it loose later.

Sometimes EFI clamps are offered in a package with the hose; make sure you have suitable clamps on hand or can buy them separately before buying EFI hose *without* the clamps. Jim Taylor says, "I replaced the originals on my (then) 16-year-old '76 XJ12C. I obtained two Volvo FI hose replacement "kits" (part number 273680-9). Each kit contained the appropriate number of short rubber hoses and neat little black painted hose clamps (not worm gear type) for a Volvo six cylinder car. This fix didn't cost very much. My receipt (dated 3/4/92) shows I was charged the grand sum of \$6.11 per kit." Of course, similar kits may be available from other car makes as well.

John Ashcroft, who lives in Australia, says, "If you have screw (worm drive) clamps and have an engine fire, the insurance company *will not pay*. You have to have EFI clamps on fuel lines."

There is also a type of clamp that works similarly to the EFI clamp described above, except that it has two loops of wire in place of the steel band. These seal pretty well, but they're not very pretty and they really mangle the hose. They don't seem to come in stainless steel either.

Greg Price says, "The Series III XJ6 has some nice fuel injection hose clamps, and my local Jag tech recommends Mercedes fuel injection hose clamps."

Stefan Schulz says, "Here in the UK, Farnell offer stainless steel hi-torque hose clamps which are The Biz. Highly recommended. Farnell Industrial are on telephone [+44] 113-2636311." Schulz adds that he does *not* recommend the fuel injection clamps from a Volvo.

Tom Mackie says, "I find most conventional "clamps" to be a little unsightly. So.. There is a clamp used in the repair of shop air hoses as well as on oxy/acetylene hoses (if that's not a high fire hazard application, I don't know what is). These clamps do not have a screw/nut on them. They are a single usage item. They are a formed metal band, with an outward flare/dimple/nipple (I have no idea what to call it) on each side. These simply slide over the hose, are placed into position, then using pliers, these nipples are squeezed, compressing them, which in turn tightens the clamp. No screw/nut sticking out, getting in the way, cluttering appearances etc. Definitely not self loosening. Removal is with side

cutters.. Just snip off one side and bend it open. These are cheap.. so making them disposable is not a big deal. This I would use on the injector end.

"I was considering another crimp style, but for the fuel rail end. There is what I'll describe as a "cup" shaped unit, which I believe is sorta an aeroquip fitting. I have to confirm this yet, but I believe you could use any hose with the appropriate size "cup" and have it crimped into place. The minor catch is that you either need the special tool which applies pressure to about 6 locations at the same time, or you have the fittings shop do it by taking them the fuel rail. These are semi-permanent, and removal is with a hack saw, which destroys the hose. This is why I'm thinking of using these on the fuel rail side, and the removables on the injector side. Again, no screws sticking out, etc. Nice-n-neat."

Note that the problem of worm screw clamps causing leaks is not unique to the EFI fuel system. One should also take note of the types of clamps used on the fuel tank vent system, the power steering hoses, the transmission cooler hoses, and just about anywhere else that small diameter hoses are clamped. Leaks at some of these locations may be less disastrous than a fuel system leak, but you'd still rather not have any leaks.

NON-CLAMPED HOSE CONNECTIONS: Now that you know all about what type of clamps to use, let's discuss not using them! There are two types of hose barb used in the fuel systems on the XJ-S, and one of them *must* be clamped while the other should *not* be clamped.

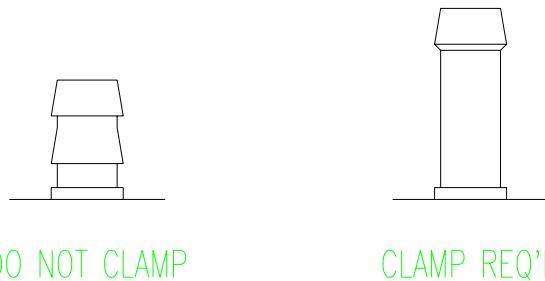


Figure 13 - Fuel Hose Barbs

With the barb shown at left, the hose is installed by merely pushing it onto the barb. It works kinda like a Chinese finger trap; the hose slides on easily, but if you try to pull it off it grips onto the barb and won't let go. These fittings typically come with a dished washer or cup that must be slid into place before pushing the hose on, but these items do nothing more than hide the cut end of the hose. Hydraulic hose shops have push-on fittings with flimsy plastic dished washers.

Proper use of a hose clamp requires the smooth cylinder of the type shown at right for the clamp to compress the hose against. If a clamp is applied to the barb shown at left, it will compress the hose against the points on the ridges and possibly damage the inner liner of the hose.

Believe it or not, the non-clamped type provides a much more reliable seal.

Typically, you will know which type you're dealing with before removing the old hose by looking at what's on there from the factory. If there's no clamp, it's the type that doesn't use a clamp. If it's the type that needs a clamp, there will be some form of clamp -- or a cup-shaped piece of metal that is "swaged" onto the end of the hose to compress it onto the barb. The decorative cups on the non-clamped barbs sometimes look similar, but it is obvious that they are not swaged; in fact, you can spin them around with your fingers.

The problem, of course, with relying on the existing situation as an indication of barb type is that someone may have gotten in there before you and added clamps where there shouldn't be any.

Note that you may have a mix of clamped and clampless fittings. Steve Douglass says that both the injectors and the rail on his '76 have swaged cups on the hose. John Ashcroft says that his '80 needs clamps on the rail but not on the injectors. On the author's '83, the entire injector/rail assembly uses clampless fittings, but the connections at the fuel cooler still require clamps.

Regarding pressure ratings and the security of push-on connections: A shop frequented by this author has a tester, and in their spare time they test things to failure just for grins. The 5/16" cloth-surface push-on hose described below was tested, installed as intended on a push-on fitting. It held to 1200 psi, and then the hose ruptured near the end of the barb. The push-on connection never came apart.

FUEL HOSE TYPE: The XJ-S features Electronic Fuel Injection, and EFI systems operate at higher fuel pressures than carburetors did: 30-50 psi vs. 5 psi. Ordinary "fuel hose" was designed for 5 psi -- do not use it anywhere in this fuel system. Most auto parts stores now carry "EFI hose". It is more expensive, but a fuel fire is no fun. The basic generic EFI hose *looks* like standard hose; you will need to read the printing on the rubber surface to know you've got the right stuff. Look for either "EFI" or "Fuel Injection" or some such clear indication of its suitability for fuel injection systems, or for a working pressure rating higher than 100 psi.

If you have clampless hose connections (see above), generic EFI hose will work fine -- but there is yet a better idea. If you find an industrial hose distributor or hydraulic hose shop, they can sell you what they refer to as "push-on hose", hose that was designed for these type connections. Push-on hose is available in two different styles: smooth rubber surface or cloth surface. They both have basically the same specs; in fact, nobody seems to know why anyone would choose one over the other. It probably has something to do with abrasion resistance or some such.

The rubber surface push-on hose usually has a bunch of markings on it, including a pressure rating in the order of 350 psi, but it probably does *not* use the term "EFI". There is a spec number on there, and you're supposed to look it up in reference books to determine suitability for particular applications. It *is* suitable for automotive EFI systems.

The cloth surface hose this author found has far less text on it. Duh! It's harder to write on cloth! The letters are really big to be readable, and all it says is "WEATHERHEAD 5/16 H10005 D 09/14/98". The pressure rating on this hose is actually lower than the rubber surface hose (250 psi) even though it looks a lot tougher than the rubber surface hose. You cannot squeeze this hose flat with your fingers. Weatherhead H100 series hose has a nitrile inner liner suitable for use with non-oxygenated automotive fuels.

Note that there are a few places on the XJ-S where one end of a hose is a push-on connection and the other end requires a clamp. The push-on hose is suitable for these applications; it can be reliably clamped on suitable barbs.

The Weatherhead cloth surface hose is more expensive than the rubber surface: \$2/foot. Don't be intimidated by the fact that Jaguar wants many times that much for their "original" hose; it's no better, and it's arguably not as good. Weatherhead is one of the most respected names in the industrial hose business.

You can also buy fancier hose. Bill Fernandez says, "There is a lot of stuff available out there, aero hoses, rubber, etc. High quality cloth braided German fuel injection rubber hose is what I ended up using. This is the same equipment used in BMW and Mercedes, they don't go bad period. I have a 1975 CSi (BMW) with the original cloth braided hoses with 325k original miles and not a single leak or hint of gas yet."

"The H.E. Bosch injectors are designed to use slip-on rubber injector hoses. The aero style will require lots of modification to both the injectors and the fuel rail to get them to work. The aero stuff is very pricey and just not worth it aside from looks."

FUEL HOSE SIZES: There are some weird fuel hose sizes around, and Jaguar sells some of them! The original hoses on the fuel injectors appear to be something like 7mm or 9/32". There's no telling what the engineers at Jaguar were thinking, but note that the injectors themselves are made by Bosch -- and have barbs designed to fit an 8mm hose. The barbs on the square-tubing rail and on some of the lines to and from the rail are also designed to fit an 8mm hose. When you have the old hose off, it is a simple matter to measure the diameter of the straight-sided portion of the barb between the ridges to confirm what size hose is needed. 5/16" is 7.93mm and will fit just fine.

Some people have found 8.5mm hose -- sometimes at a Jaguar dealer. Don't use it on the XJ-S; there are no fittings on this car that call for this oddball size.

The problems begin when the novice mechanic finds out how easy it is to push the new hoses onto these barbs. They just slide right on -- and then won't come off. But somehow it just doesn't seem right, and smaller hose is purchased and crammed onto the barbs with great effort and sometimes even boiling the hose prior to installation or other extreme measures that are only too likely to damage the hose or shorten its life.

Resist such thinking. The hoses are *supposed* to slip on easily. Why would Bosch design an attachment scheme that requires lots of effort on an assembly line? When 5/16" or 8mm hose is used on the clampless connections on the XJ-S, they simply do not leak. There is no problem there; the leaks the car is plagued with come right *through* the hose when it dries up and cracks.

INJECTOR HOSE REPLACEMENT: The hoses most likely to need replacing are the short hoses from the rail to the injectors themselves, probably due to exposure to heat or the corona of the spark plug wires.

This job is a cinch. If you're doing all 12, you don't even need to remove the injectors, but you will need to depressurize the fuel system. You will be spilling a little fuel, so take suitable precautions. Disconnect the inlet and outlet lines to the rail, and remove anything that goes *over* the rail.

Measure the lengths of the hoses; on the D Jetronic cars all 12 are the same, while on the Digital P cars the rear 10 are all the same and the front 2 are longer. You don't want them too long because the rail may hit the hood, and on the H.E. it will hit the kickdown switch. Craig Sawyers says, "I measured the length of the fuel injector lines when I disassembled them to be close to 2 inches - so that is what I cut the new ones to. Well, that is a tad long. I only discovered that when I bolted the throttle cable back on, and the kickdown switch plate sat at a jaunty angle, and wouldn't go level. If I were doing it again I'd cut the hoses to 1.75 inches and give everything a little more clearance." Rod Wright agrees: "I also cut my hoses 2" long when I replaced them. In addition to the interference with the kickdown switch bracket, the bonnet was making contact with a point on the fuel rail about 1" aft of the 1B injector hose barb. I noticed matching shiny spots on the rail and bonnet caused by the slight movement of the engine. Not wanting to chafe a hole in the fuel rail, I cut new hoses 1.75" long. This alleviated both problems."

After measuring, cut all twelve hoses through the middle. Any fuel remaining in the rail itself will dump out, so you might want to choose a suitable hose to cut first and quickly aim it into a jar. You might then try cutting a hose at the other end of the rail and blowing through it to clear out as much fuel as possible. After cutting the hoses, lift off the rail, leaving the injectors in place.

Remove the pieces of the old hose from both rail and injectors. If there are crimped metal collars (early D Jetronic), you will need to cut through one side of each collar and spread it a little. On the later style clampless assemblies, don't lose the dished washers. Try to do as little damage to the barbs themselves as possible. Richard Fields says, "I used an X-acto knife (available at any hobby shop) to remove the hoses, after fighting them with a razor knife. The X-acto blade I used was shaped like a cats-Jaguar?-claw and could get in behind the washers very easily. It made cutting the hoses off a snap!" John Ashcroft says, "Used a electric soldering iron to burn the old hoses off of injectors with no damage to barbs."

Ken Gray elaborated on that soldering gun idea: "You poke the hot tip of the iron into the fuel line just above the top barb and push it down the length of the fuel hose and into the seemingly useless cupped washer at the base where you just work the tip around a bit to completely sever the hose. The whole process takes a few seconds due to the very hot tip of the weller. You can grab hold of the barbs immediately after hose removal and they are barely warm. I would not use any other method now as the soldering iron works perfectly without any damage to the barb or internal platics of the injector. You do however need to use the correct soldering iron; I ended up using a Weller electric iron which seems to have a temperature control in the tip. I must also say that I have not been able to reliably regenerate the tip for soldering purposes. This is not a problem because the tips are readily interchangeable."

Buy some suitable 8mm or 5/16" (7.9mm) -- reread the section above on making sure you have the correct type hose. Cut new pieces of hose the same length as the originals. Note that it may be tempting to make all the hoses a little longer than the originals, but you may end up with the rail contacting the hood.

Install the pieces of hose onto the rail first; if the rail has clampless barbs, remember to put the dished washers in place. Position clamps or dished washers (whichever is appropriate) onto the injectors, and then push the entire rail down onto

the injectors one bank at a time. On the Digital P, you can leave the 1A and 1B hoses alone until last. Tighten clamps if you have them, reconnect the fuel inlet and outlet, start it up, and check for leaks.

HOSE ASSEMBLY REBUILDING: Many of the lines (fuel, power steering, etc.) in the Jag consist of metal tubing with threaded connectors and a short length of hose in the middle somewhere, all sold under one part number. When it's been in there too long and has dried up and started leaking, the section of hose can easily be replaced with the EFI hose or other suitable hose along with suitable clamps. It is suggested that before you cut the original hose off, you place measured marks on the tubes on either side of the hose so that when you reassemble, the same overall length can be established. You should also put alignment marks, so the new assembly won't be twisted. Finally, if the hose is within sight of the exhaust system or other hot parts, it might be better to wrap it with some aluminum foil to prevent the radiant heat from cooking the new hose.

Some hose assemblies in the fuel system have clampless barbs to connect metal tubing to hose, similar to those fittings on the rail described above. However, these may have a deep cup covering the end of the hose instead of the dished washer used on the injector hoses. This deep cup can make it a bit more difficult to get the old hose off. To make life easier the next time you replace hoses, you might want to order some of the dished washers used on the injectors, EAC7876, and reassemble the fuel lines with these instead of the cups. That will also make disassembly easier *this* time, since you can just cut the cups off to get them out of your way.

If you reuse those cups, note that when putting the new hose on you may have trouble telling if it's on all the way. So, prior to assembly, slip the cup onto the end of the hose and mark on the hose so you'll know when it is fully inserted into the cup. This is especially important with a really thick-walled hose like the Weatherhead cloth-surfaced stuff described above, because it fits so tightly in the cup that it makes it very difficult to get on the barb.

The threaded fittings on the ends of some of these lines have brass compression seals. The good news is that these are the very same seals that are commonly used on household plumbing, so they are available at any hardware store. The bad news is that the tubes are so soft that the compression of the seals sometimes has necked the tube, and you can't get the old seal off nondestructively. Often, reinstalling the tubes with the old seals will result in a leaktight connection. If this doesn't work, buy new tubing and use new seals and the old threaded nuts. You may have trouble finding new nuts of the same thread.

FUEL SUPPLY CHECKING: It is often useful to know if the fuel supply to the injectors is working properly. To do this, Robert Dingli suggests installing a fuel pressure gauge: "I bought a VDO fuel pressure gauge for about Aus\$40 and connected it to the fuel rail where the cold start injector was once supplied. I believe any pressure gauge designed for hydrocarbons would be suitable and other brands sell for much less. My gauge is mounted in the engine bay as I am paranoid about high pressure fuel entering the cabin.

"There are a couple of things to note about connecting the gauge:

- use high pressure fuel line and fittings.
- don't mount the gauge on the engine as vibration will kill it.
- use a restrictor in the line as the pressure fluctuations will also kill the gauge."

If you have the Digital P system, ideally you'd use a gauge that reads the difference between the fuel rail pressure and the intake manifold pressure. Since the fuel pressure regulators are referencing manifold pressure, this should result in a steady reading at all operating conditions and any variation is a sign of trouble. If you use a regular guage that references ambient atmospheric pressure, the fuel rail pressure will go up and down as the intake manifold vacuum varies, so you will have to monitor both and do a little math to make sure things are operating properly.

FUEL ODORS: Jaguars seem to be prone to fuel odors; the XJ-S was even recalled to provide a more positive vapor recovery system (see page 241). Please note that while Jaguars often smell like fuel, they're not supposed to; it is an indication of a problem, and should be addressed.

One excellent suggestion is to trot the car right down to your local Jaguar dealer, or anyone else with the equipment to test automotive emissions. The testing equipment includes a probe that is inserted in the tailpipe to detect unburned hydrocarbons (fuel). This probe is real handy for finding fuel leaks anywhere in the car.

There is a relay in the trunk through which the EFI controls the fuel pump. If you remove the relay and jump connectors 86 and 87, the fuel pump will run whenever the ignition is on. This is useful for searching for fuel leaks without having to leave the engine running.

There are a couple typical places to check for sources of odors: fuel-soaked carpet padding, a tank that develops a hole by rubbing on a steenkin' rivet, a tank that has developed stress cracks, a tank that has simply rusted through, old hoses either in the trunk or over the IRS, and even a plugged or disconnected drain from the fuel filler compartment. All are covered in the following sections.

SMELLY CARPET PADDING: The fuel filter is the size of a Coke can and is located behind the spare tire in the trunk. When this filter is replaced, it is all too easy to spill its contents within the trunk. The nature of the foam padding under the carpet is such that once this happens, your trunk will smell of fuel for all eternity. The only suggested fix is to replace the carpeting and padding. It is recommended that before the filter is replaced, and before any repairs to the fuel system in the trunk are carried out, the carpet be removed.

STEENKIN' RIVET: On the underside of the car there are numerous lines that are held to the car with little clips and rivets. One of these rivets is in the panel the tank sits on, and sometimes the weight of the tank compresses the pad enough that the metal tank contacts the tip of the rivet. After some vibration, the contact can wear a hole in the bottom of the tank. Once the tank is drained and removed, it is a simple matter to patch the hole (there are types of epoxy sold that will work well) and find an alternate way of supporting the line under the car.

STRESS CRACKS IN TANK: Officially, the recall supposedly was to prevent excessive pressure/vacuum cycles on the tank, resulting in stress cracks. Obviously, this is something else to check on your tank.

RUSTY TANK: Chad Bolles reports that the seal around the rear windshield starts leaking, and the water soaks the sponge under the tank and causes the tank to rust. Chuck Sparks reports that external rust on the bottom of the tank where it sits on that foam is far and away the most common cause of fuel leaks in the trunk he has seen. The author's car didn't have any leaks there, but it did have some rust -- and there were no signs of any leakage from the rear windshield.

LEAKY FUEL LINES: As described above, there are several fuel lines that include a piece of hose in the middle of a metal tubing assembly. When old, these hoses often weep fuel rather than burst outright. In fact, they may leak so slowly that they never appear wet; the fuel evaporates faster than it leaks. Just about the only indication of trouble is the odor.

Two of the hoses that need attention are not in the trunk, but rather under the car and over the rear suspension. The line over the right rear axle is the pressure line to the engine, and the line over the left rear axle is the return line to the tank. If the hose section of either line develops leaks, it seems to cause odor in the trunk more than anywhere else for some reason.

Check all of these lines with the pump running, and replace any hose you even suspect of being the cause of odors. Better yet, just replace the hose sections if they are older than ten years or so.

Both hose sections over the IRS are actually fairly easy to replace. Both lines connect at threaded fittings at the forward corners of the trunk floor, and both have couplings just forward of the IRS. Before removing the right side one, depressurize the fuel system, and before working on either, pinch the appropriate fuel lines in the trunk and in the engine compartment (if the tank hasn't been removed and the system totally emptied).

This author found the one on the right side a bit easier to do than the one on the left, because there were more other things in the way on the left side -- but some of these things, like the handbrake cable, may switch sides on a RHD car so others may have different challenges. On the author's '83, the fuel line assembly on the right side came out as a unit, so it could be rebuilt and reinstalled easily enough.

The line on the left side takes a little more thought. First, there is a plastic clip up at the top of the arch holding it in place. If it's not broken to begin with, it's easy enough to break it; it is only too apparent that it's not necessary to hold it in place. Second, the short section of metal tubing on the rear end is hook-shaped, so it isn't likely to feed out over the IRS. Instead, after disconnecting both ends of the line, pull it rearward a bit and use a razor knife to slice through the hose itself. Then remove the rear section rearward and the front section forward.

To rebuild and reinstall it, start by cutting a piece of new hose a couple of inches longer than the original hose. In fact, note how much of the straight section of the hook-shaped metal portion is exposed beyond the end of the hose, and cut the new hose longer enough to cover almost the entire straight section. Install this new hose on the front metal section of the line with an EFI clamp, making sure that the screw portion of the clamp is positioned downward and a little inward because the top and outer side will be against the inside of the bodywork. Stick a plug in the end of the hose, then feed the hose into position from the front until the end of the hose comes out on the back side of the IRS where you can get ahold of it. Clean the entire straight portion of the hook-shaped section in preparation for having a hose slid onto it. Put an EFI clamp over the tube, remove the plug in the end of the hose, then push the tube into the hose and continue to push until things begin to line up. Loosely assemble the coupling at the forward end. When the tube has been pushed into the hose far enough that the threaded end lines up properly with the fitting on the trunk floor, position the clamp near the end of the hose and tighten it down. By using a longer piece of hose here, the clamp is located such that it can easily be tightened below the corner of the chassis and the screwdriver can be held within the wheel well.

When you tighten the threaded end into the fitting on the trunk floor, you will need to have an assistant hold the end of the line on the inside of the trunk in the correct position. Failure to hold the lines in position while tightening will result in distortion of either the hose over the IRS or the hose in the trunk or both.

STINKY FUEL LINES: Believe it or not, a major cause of fuel odors in the trunk is apparently the use of the wrong type fuel hoses in the area. They're not leaking; the odor seeps through the material of the hose itself. You can tell this is the problem by wiping your finger on the surface of the hose, walking a few feet away, then smelling your finger. If it smells like fuel, that's the problem. Interestingly, while the human nose detects these odors quite readily, the emissions probe always seems to come up empty.

FILLER CAP CONNECTION: It appears that Jaguar addressed part of the problem of hoses that stink by their design of the fuel filler pipe. The filler itself inserts into the opening in the tank with a really fat O-ring for a seal, and then the entire assembly is enclosed in a short section of 2" hose. If the fat O-ring works, the 2" hose only serves to keep the assembly together, not to contain fuel or odors. Hence, this assembly may have been designed because Jaguar couldn't find a 2" hose that wouldn't stink. Therefore, if you have odors, you might consider pulling this assembly apart and replacing that O-ring, which is part number C46157.

The clamp on the hose connection to the tank is accessible from within the trunk by removing some carpet, and then you can pull the filler out through the filler door by removing three screws.

FUEL FILLER CONFIGURATION: In the 70's, the fuel filler pipe on the XJ-S had a flange on it and was rigidly mounted inside the filler compartment with three screws. This author's '83, however, has no flange; all it has is a small tang that apparently engages a small bracket to prevent the filler pipe from rotating when the cap is tightened. The same

three screws are used instead to fasten a metal collar that holds a rubber boot around the filler pipe. Hence the filler pipe is actually mounted flexibly, as it can move around a bit in the boot, the O-ring seal at the tank, and the hose clamped onto its outside.

FUEL FILLER UPGRADE: The fuel filler on the XJ-S -- at least this author's '83 -- is the old style that turns 1/4 turn. Not only is this a lousy design, but it's also difficult to secure; Jaguar offers a locking variety, but believe it or not the locking variety is officially not supposed to be used in the US -- apparently it doesn't seal as it should, and therefore won't meet EPA emission requirements. Roger Bywater says, "Most lockable caps have a tang which engages with the underside of the filler neck so the sealing arrangements are probably unable to withstand any significant vacuum or pressure and are just able to stop fuel sloshing out."

On later models, Jaguar made the door over the filler lockable, which eliminated the need for a locking gas cap.

Walter Acker IV points out that it is a simple matter to ditch this dinosaur and install a modern filler from a junkyard. The filler on his '76 is different than the later designs (see above), but the general idea should apply equally well to either type. Just peruse the local junkyard until you find a car with a modern tighten-until-it-clicks fuel filler cap on a filler pipe that looks like it would work in the XJ-S. Remove it, pay the junkyard the five bucks or whatever, then take it home and make it fit. Acker used a Ford filler to upgrade his '76. "The Ford filler that I had put in is just soldered at a radiator shop. I was not specific enough about the position of the Ford filler in the Jag neck to them. You must explain where the bottom of the Jag unit is so that they can line up the Ford unit so that the drain holes in the Ford unit are in a proper position so that the fuel will drain into the tank if there is any leftover in the neck system. The collar on the Ford neck is of the wrong size (smaller) and at the wrong angle for a Jag XJ-S so it must be removed completely so that the Ford unit will slip inside of the Jag unit.

"I checked with the state of California smog reps and they said that it is not a legal modification so if it is detected by a smog rep then the car may not pass smog in CA." Damn shame these guys are so picky, since this cap upgrade will *improve* the car's emissions. "The smog police will give you a problem but the normal smog techs just remove the cap and see it is threaded and test it without ever calling the officials for clarifications."

"The one thing that I like is the fact that when you go to a parts store they have a new style of gas cap. It is called a Prevent which is a pressure release type so that you can release pressure buildup before there is a problem when removing the cap for fuel filling."

Note that you need to pay attention to how high the new cap sits; you don't want to go through the entire modification only to find that the filler door won't close. And having to hack a side off the new cap will reduce the esthetics of this upgrade considerably. Note, however, that the tighten-until-it-clicks cap can merely be turned a couple more clicks if the problem is a corner or something that obstructs the door.

Bernard Embden -- who owns a '78, also with the earlier flanged-type filler pipe -- reports: "A visit to the junkyard resulted in the removal of the fuel neck and cap from a 1987 Ford (hacksawed the fuel pipe right out of the trunk- lucky no sparks). I cut approx 2 inches from the filler tube, and the same from the Jaguar fuel filler pipe. Keep your existing flange that mounts the pipe to the body. You will need to modify it somewhat. Make your cuts dependent on whether you will keep the existing flange or not. Off to the welder. Two trips later (he had no way to pressure test the weld) and I was ready to install. The Jaguar filler pipe is quite large, approx 2 inches I.D. The Ford pipe is 2 inches O.D. This made the welding quite easy because one pipe fits inside the other. Remember to change the tank gasket (large "O" ring thingmajij). No leak, no drips, no fumes. One of those projects that made so much sense that I should have done this years ago."

Regarding finding the right one in the junkyard, Embden says, "Most filler pipes started small and stayed small. However some started larger and then became small. On these you only need the first few inches so it doesn't matter."

This author made this upgrade, but my '83 has the later style filler pipe with no flange. I believe this makes the upgrade *easier*, since you don't need to worry about the alignment of the flange when you have the two pipes brazed together. And, without a flange, if the cap ends up too high for the door to close you merely loosen the clamps and slide the filler pipe a little farther into the tank.

David Low points out that the XJ40 has the tighten-until-it-clicks type of filler, and suggests that it may be adaptable to the XJ-S "if you're handy."

A locking gas cap for the tighten-until-it-clicks type filler is readily available, and appears to seal just fine. These later caps won't ding the paint as badly when you drop them, either, since they are plastic and weigh less than the old metal 1/4-turn caps.

FUEL FILLER DRAIN: Derek Hibbs says: "The answer for my fuel smell was simple: the fuel cap overflow pipe was disconnected and any spillage during refueling was draining directly into the boot/trunk instead of onto the ground. Reconnected the overflow pipe and no smells (I also take more care when refueling)."

VAPOR RECOVERY SYSTEM: See page 241, including the notes on the gas cap on page 242.

When a recall was applied to the vapor recovery system (page 241), one change done was to remove a hose that vented the carbon canister out the bottom of the car. It just opens into the bodywork cavity now. This demonstrates an interesting attitude; of course, if the system is working as it should, there shouldn't be any odors coming out of this opening. But if, on the off chance, some gasoline vapors make it through this canister, you might be happier if you installed a new hose venting it overboard.

FUEL TANK REMOVAL: Possible locations for leaks include the fuel tank itself, located over the rear axle. It is accessible by removing the spare tire and some other stuff, then pulling the carpet out. Tank removal is pretty straightforward until you get to the last step. The tank sits on a 1/4" layer of foam, and is often bonded to the foam from years of sitting on it so there's no way you can slide it out. Chuck Sparks offers a solution: a machete! Just slice through the foam from wheelwell to wheelwell, and the tank will come right out. You're probably going to want to replace that foam anyway; if the tank has been leaking, it's probably smelly.

FUEL TANK LINING: The fuel tank in the XJ-S is made of stamped sheet steel. This is a good, solid material for fuel tanks used in cars that are intended to be discarded in ten years or so. Unfortunately, many Jaguar owners are obstinate enough to want to keep their cars longer than that. As a car approaches "collector" vintage, the shortcomings of a steel fuel tank become increasingly apparent. It may develop leaks due to rusting from the inside out; it may develop leaks due to rusting from the outside in; it may develop leaks due to stress cracking; and it may shed enough rust scale from the inside surfaces to plug the fuel pickup, resulting in fuel starvation at high power, which in turn results in burnt pistons.

If you already have such problems, you need to do something -- but if you don't have such problems, you might still consider making some preventative measures at some convenient opportunity. A popular strategy -- for owners of any old cars with steel fuel tanks, not just Jaguars -- is to apply a coating to the inside of the tank. Most such coatings will not only prevent future problems, but they will usually seal up minor leaks. John Whitehead says "I have used gas tank sealer from Bill Hirsch Automotive (see page 650), with great success. I put it in the fuel tank of my '67 XKE which had a number of pinhole-size leaks. Previous attempts to coat the outside of the tank were not as successful. The tank sealer is gasoline and alcohol resistant. A quart can is sufficient as only a thin film is coated to the inside of the tank. I am not sure of the product's chemistry, but it dries to a white Teflon-like film." Obviously, major cracks or holes will require more extensive repairs.

Other sources of similar tank sealer materials include Red-Kote by Damon Industries, Renu (page 654), Eastwood (page 654), and Avon in England. Most modern sealers claim to be suitable for gasohol, but you might want to ask to make sure. Oxygenated fuels, octane boosters, lead substitutes, injector cleaners, and anything else you may be tempted to put in there are also things to ask about. The Hirsch, Red-Kote, and Eastwood sealers (and perhaps others) use methyl ethyl ketone as a solvent, which means you need to avoid putting anything with MEK or acetone in it in your tank. Note that, in the case of oxygenated fuels, lining the tank may be an improvement; MTBE will attack the brazing on a steel tank.

Several people have reported using POR-15 to coat the inside of their tank. It may not be specifically intended for the purpose, but nobody has reported any problems.

You should be warned that lining your own fuel tank is *not* an easy job for the novice. Obviously, the tank must be removed from the car, but that's not the hard part. The inside of the tank must be scrupulously cleaned prior to applying the liner, and cleaning is a serious challenge on the XJ-S tank -- even for shops with lots of experience cleaning and sealing fuel tanks. The XJ-S tank has so many baffles inside that, looking into the filler and fuel level sender openings, you will not be able to see more than perhaps 1/4 of the total interior surface of the tank, even with mirrors. You can just forget about brushing, scrubbing, sandblasting, or the like. The only way you're gonna do anything inside this tank will be by putting things in, shaking it around, and pouring it out.

Bill Eslick: "Many years of racing (Midgets and Sprint cars) have given me opportunities to learn how to clean a fuel tank. Solution: Three pint-sized cartons of BBs. Pour them in the tank and shake the shit out of it. If you are going to coat the thing then shake it dry. Rinse with lacquer thinner, and shake again. This is tedious but works remarkably well. Be sure you use BBs; lead shot can get lodged in baffles, etc. because it's so soft. Also, any errant BBs can be pulled out with a magnet."

A report from this author, who has tried BB's: if you put a BB in the XJ-S tank, you *will* be using a magnet to remove it. They will not come out any other way. That doesn't necessarily preclude the use of BB's; once you figure out how to use a magnet effectively, it only takes a couple of hours (!) to get a few thousand BB's out of the tank.

Unless things are really bad in there -- lots of loose scale -- most owners would be well-advised to use only liquids in this tank. Still, this is not a simple matter of pouring out the gas and pouring in the sealant. Mike Aiken provides the guidelines recommended for use with the Eastwood product:

1. Wash tank with hot soapy water, then rinse out with a garden hose.
2. Metal wash diluted in 2 gallons of water. Slosh, 5 minutes a side, slosh. This is supposed to remove contamination from surfaces and inhibit flash rust. Says it contains alkali surfactants(?)
3. Rinse with garden hose.
4. 1/2 gallon of muriatic acid obtained locally. Slosh until gray appearance.
5. Rinse with garden hose.
6. Rust remover (phosphoric acid). Rotate until all surfaces are contacted and uniform gray appearance(?). Dump out.
7. 1 quart of acetone obtained locally. Slosh on all surfaces (no specified time). Dump out.
8. Do step 7 again.
9. Sealer. Rotate all around. Let stand 8-10 minutes on each side. Dump excess. A white coating should exist on all surfaces of the tank. Says it contains methyl ethyl ketone.
10. Allow to dry (open) for 48 hours before use .

"If you dumped all this crap in the ground you would have another "Love Canal". It says to dispose of "stuff" according to local law."

The instructions that come with other products may not be as extensive, but they *should* be. Simply applying a single cleaning product prior to lining may work on a *new* tank, but it's likely to result in troubles down the road if done to an old tank with a few years' accumulation of surface rust and gasoline varnish inside. The lining may not stick securely in spots, then later peel off and plug up the pickup.

Aiken: "The key, I believe, is the first step (Ed. note: he means step 2), which is to get all the varnish and other goop off the metal. Rust (and some metal) will be removed by the muriatic acid, but the acid will not remove non-metallic stuff. The cleaner supplied by Eastwood softened but did not remove all the gasoline residual (varnish, etc). Where I could see it I could scrap it off with a stick, so it was not yet removed. So I added a step. With most of the cleaner still in the tank, I added a gallon of acetone. Sloshed it around then let it sit for about two hours, then sloshed it again. It worked.

If you see anything but gray metal (maybe some rust and corrosion is OK) the process will fail. The muriatic acid will not remove non-metal stuff, and the liner will only adhere to pure etched metal.”

The steps above describe a “metal wash” with “alkali surfactants”, but in reality any automotive cleaner/degreaser that can be poured into the tank, sloshed around, and drained out will work well. The objective is to get any varnish and goo out, so make sure that you accomplish that.

The muriatic acid is for getting the major metal corrosion off. Muriatic acid is available at building supply stores (it’s used to clean brick walls) and at swimming pool supply stores (used to control ph in pools). The concentration commonly available is 20° baume, which is a suitable strength for this job. Most shops -- as well as the guidelines above -- suggest using a half gallon, but on this tank a full gallon is advisable because the interior of the tank is so convoluted that there may be spots you don’t get to with less liquid inside.

Muriatic acid is nasty stuff; Aiken says, “muriatic (hydrochloric) acid is potent and very caustic. Emission of chlorine gas is lethal. You must wear rubber gloves and a mask and be outside.” Arranging to be upwind is helpful, too, even if it requires a fan.

Phosphoric acid is available in several products for treating surface rust, including Opho and Right Stuff De-Ruster, available at auto parts stores. It chemically converts rust into something inert and paintable. Note that Naval Jelly is also a phosphoric acid-based rust treatment, but unusable here because it’s too thick to slosh around inside; you need a thin liquid here.

Note that there should be no rinsing with water past step 5. The residue of the phosphoric acid treatment is removed with the acetone. After rinsing and draining (several times for maximum effect), any remaining acetone will evaporate completely in minutes, leaving the tank clean, dry, and ready for lining.

Tip: each time you put a liquid in, you’re gonna have to drain it out. And there is only one opening into the XJ-S tank that will drain the last pint or so, and that’s the fitting for the main line to the surge tank -- the one that’s intended to be a drain. All the other openings are nothing but frustration, nothing ever seems to pour out of them except when you don’t want it to!

A popular idea is to use heat -- either to make the various cleaning agents or acids work better, or merely to dry the inside of the tank after rinsing. If a really big oven is available, this might work pretty well -- but the more common procedure is to use a torch to heat the outside surface of the tank. One should be aware that this method might be perfectly workable on other tanks that are mere cans, but on the XJ-S tank such torching will clearly have more effect on the outer shell than on the baffles within.

Also note that you will only be able to visually inspect or physically touch a small percentage of the inside of an XJ-S fuel tank. That means that you must rely on liquids to accomplish everything you need to accomplish. Trying to scrub the areas you can see will only keep you from being able to judge the success of your work by looking at the areas you can see! Treat the entire tank the same way, and then you can conclude that the entire tank is done when the visible areas look done.

When the liner is poured in, you need to slosh it around to coat all the inside surfaces and drain out the excess. Good luck! First off, the stuff doesn’t really “slosh” since it’s a little too thick; it might help to dilute the liner with some MEK or acetone prior to pouring it in. Even if you render it sloshable, it’s still difficult to coat all those internal baffles; as you rotate the tank over and over, the fluid pours past the baffles without really getting up on them. Of course, the baffles are not a leak concern, but you would like to prevent them from rusting anyway.

When you open the tank up to drain the excess liner, you can just prop it up and let it pour out -- and it’ll pour for two hours. Alternatively, you can just drain for five minutes -- getting most of what you will ever get out -- and then tip the tank over to let the remainder run back across surfaces inside to make the coating a little thicker. If you will tip the tank to a different position every few minutes, you can avoid the lining puddling in any one place.

Of course, while you’re lining the tank, it would also make sense to line the surge tank -- which is easier to do, although again it’s not as easy to drain as you might think. The drain plug in the bottom won’t drain the lowest half inch of liquid! You have to tip and tilt the surge tank to get everything to drain out of the big pickup opening, and all the liquids like to flow around the opening rather than draining out it.

And you might also want to consider lining the vapor separator, although it's a bit tougher because the biggest opening into it is a 5/16" hose connection.

If all this sounds like too much for the do-it-yourselfer, there are places that will do it for you. You can usually find a local shop that does this sort of work, although the one found by the author had never heard of phosphoric acid, had been applying liners over bare metal with surface rust for 25 years. For a more reputable shop, you can contact Moyer's Fuel Tank Renu (page 654) about shipping your tank to them for work.

Although this section was written with the XJ-S coupe fuel tank in mind, it's probably equally applicable to the convertible and cabriolet. The Hess & Eisenhart is another animal, since it has two tanks; the upper one is a modified version of the coupe tank and the lower one is completely custom.

FUEL TANK COATING: As mentioned above, a common cause of fuel leaks in the XJ-S is rust on the *outside* of the tank -- specifically, the bottom. Therefore, even if you're not interested in lining the inside as described above, you might want to tackle the job of making sure the outside doesn't rust. The tank still has to come out, but beyond that this job is obviously much easier. Simply clean off any existing surface rust (and possibly the paint if you want, meaning you can sand-blast the whole outside if you wish), treat it with a phosphoric acid product such as Ospho or Naval Jelly, and then coat it with something that will make really sure it won't rust. Automotive undercoating is a popular idea, as is POR 15. Undercoating is available in spray cans from automotive stores. You can't see the tank after it's installed, so appearance is not an issue; you just want to make very sure it will never rust again.

Note: when you first remove the carpet and look at the tank in place, what you may think is rust may be the remnants of the glue that once held the carpet in place. Be sure you're really looking at rust before you panic.

AN OUNCE OF PREVENTION: Reread the sections above, and note that you can positively eliminate *any* possibility of fuel leaks or odors by addressing *all* of these concerns at once! Take the tank out, coat it outside and in, replace all fuel and vent hoses with new, and reassemble. It would take a few days, largely because lining and coating the tank require several steps of cleaning and coating and letting them dry overnight. If you're not willing to try lining the inside of the tank yourself, doing all the other tasks would still be worthwhile.

FUEL PICKUP: Leonard Berk's XJ-S would run fine when first started, but after a half hour it would start to lose power, eventually coming to a stop. After shutting it off and letting it sit for a minute, it would start and run fine for another half hour. It turned out the problem was dirt in the small surge tank in the trunk. As the engine ran, the dirt would gradually collect on the screen on the pickup and plug it. When the engine was shut off, the dirt would fall back to the bottom of the tank. This is not a freak occurrence; in fact, it is one of the most common failure modes on the Jaguar XJ-S! This same problem happened to this author's '83 and several others have reported it as well.

In fact, it's common enough that it even caught Jaguar's attention. This pickup screen plugging is a very rare example of a problem that has been recognized and addressed by Jaguar. In Issue No. 2 of the XJS Bulletin, Ray Ingman of Classic Spares, Inc., reports that Jaguar issued a replacement pickup screen with a considerably larger screen area. The part number is CBC5649. Anyone working in the area should definitely upgrade.

Ingman apparently doesn't think a lot of this fix; his impression is that the larger area won't prevent it from plugging, it'll just take longer. He may be right, but he might not be. For one thing, the suction at the screen is a function of the screen area, so a screen with more area will have less suction at the surface -- so *maybe* the junk won't have as much tendency to stick. Another possibility: It may be that the larger screen has so much area that it's effectively unpluggable -- you could cover the entire surface with crud and it would still be able to pull enough fuel through the nooks and crannies between chunks to maintain flow and keep running.

John Goodman owns a 1989 XJR-S 6.0 litre: "I have just cleaned out my sump tank, no signs of a filter!" Who knows, maybe Jaguar decided it was more trouble than it was worth.

There is some experience to indicate that the plugged pickup problem is often accompanied by a failed fuel pump. Perhaps the plugged pickup causes the pump failure. Be aware that when you find the pickup problem you may also have to replace the pump before the car runs right again. Apparently, if you can hear the pump whining when driving, you can count on it. Perhaps the cost of this pump is one good reason to check the pickup *before* you have problems.

OK, you're thinking to yourself that you don't have the symptoms of a pickup problem, but you'll now be able to recognize it if it happens and know how to fix it when it does. John Himes would probably suggest you think again. If the sump pickup can get plugged badly enough to shut down the engine, what happens when it's plugged a little less than that? Let's say it's just a little bit plugged, not enough to affect engine operation at 60 MPH but enough to start limiting fuel flow at full power. Just as you're really getting into the interesting areas of the speedometer, the pressure in the fuel rail starts to drop off. The engine starts to run lean just when it can do the most harm; lean mixtures at full power are a recipe for disaster. And you're into the open-loop range of operation, so the oxygen sensors are not able to correct the lean mixtures. Himes was cruising along at 140 MPH, and the next thing you know he was facing several months of down time and several thousand dollars in mechanic's bills to fix a couple of burned pistons. Now, lemme ask again: are you *sure* your fuel pickup is in good shape? In fact, *everyone* with the earlier style pickup screen should definitely upgrade; go ahead and order the part *now*.

Kevin Darling claims that his car starts more easily since he cleaned up his pickup, and has a lower, more stable idle. Neither of those effects can be easily explained, but improvements are always welcome.

There is, of course, another way of dealing with the problem: discard the OEM screen altogether and install an inline screen in the hose between the surge tank and the pump. This would have the advantage that, once this screen had collected a lot of crud, you could clean or replace it and get the crud *out* of the system once and for all. With the OEM setup, you're probably leaving a lot of crud inside the surge tank even when you clean it as best you can. Also, with an inline screen you may be able to pinch the lines and service it without having to drain the surge tank. Finally, if you get a screen assembly with a clear housing, you'll be able to see if it's dirty.

The line between the pickup and the fuel pump is 1/2", and finding a fuel filter or screen assembly with 1/2" fittings may be difficult -- and you certainly don't want to step down to smaller fittings, since the entire objective is to minimize restriction in this suction line! Keep looking; Chad Bolles says NAPA carries fuel filters with 1/2" barbs. This author found a suitable unit a local parts store; it's a Wix filter, number 33299. Less than ten bucks. It has an all-metal housing. It's a pretty compact unit, helping ease installation a bit.

It'd be a good idea to pick up some 1/2" fuel hose while at the store. EFI hose is not necessary, this is a low-pressure application. You also need to get two additional clamps; EFI style clamps would be great, but 1/2" hose is actually big enough that regular worm screw clamps work just fine.

The OEM fuel hose goes from the pickup tube to the pump inlet, only about four inches with a 90° bend -- too close to put this filter in between. Instead, use a new piece of 1/2" hose to make a big circle from the pickup tube barb CCW past the pump inlet, down, back to the right, up, and back left into the fuel pump inlet. Then install your filter anywhere in this loop that's convenient. Probably three feet of 1/2" hose total, but absolutely no sharp bends.

Wrap some foam around the metal filter so it won't rattle and clang against the floor or battery support. I used the 1/2" foam tape used for sealing doors. After encircling each end of the filter with foam strips, I added some electrical tape to hold it in place.

There are also various types of high-performance or specialty filters that might be used. Holley makes a unit called a Volumax that includes a cleanable 60 micron screen element. It comes with either 8AN or 3/8" hose barb fittings that screw into the housing, but 8AN is 1/2" so you might be able to find 1/2" hose barb fittings to screw into the housing.

Heavy equipment places that work on trucks and bulldozers may have suitable filter assemblies that can be fitted with cleanable screens, but they are usually big industrial contraptions and will be difficult to locate in the XJ-S. They also have threaded connections, so you'll have to install some suitable fittings for connecting the hoses up.

FUEL PICKUP - SALOONS: Saloons -- either XJ12 or XJ6 -- don't have a surge tank, but they nevertheless have the same problem with clogged fuel pickups, one per tank. Without having read this book, Chuck Sparks came up with a

remarkably similar fix as that described above, fitting two generic fuel filters in the lines between the tanks and the selector valve.

MONITORING THE PROBLEM: From a fail-safety point of view, this surge tank pickup situation is bad. Regardless of which pickup screen you have installed or how often you clean it, there is really no way to know if it's plugged until you notice the symptoms -- and the first symptoms are likely to be low compression readings in a couple of cylinders! The only reason this isn't commonly considered a disastrous situation is that the only way you're gonna do any damage is to be driving the car hard -- and with an engine this powerful, driving that hard is usually pretty rare. If you *do* drive your car hard -- and why else would you own a Jaguar? -- it'd be nice to have some indication that the fuel supply is holding up *before* you burn pistons.

Two methods come to mind. The first would be to install a fuel pressure gauge or sensor in the rail. This would be complicated on the Digital P system, since the rail pressure varies with manifold vacuum. Either the gauge would have to be a differential pressure gauge with the other side connected to the manifold, or the driver would have to mentally correct the readings while driving to be able to figure out if the pressure is adequate or not. Either way, routing pressurized fuel lines into the passenger compartment is a bad idea, so you'd probably want a remote readout so you can leave the sending unit in the engine compartment. It just keeps getting more complicated the more you think about it.

The simpler and better method would be to install air/fuel indicators. See page 35.

SURGE TANK DRAINING: John Goodman says, "What I did was to clamp the fuel hose from the tank to the sump with some vice grips, start and run the engine till it stalls which soon empties the sump."

Goodman's car is an XJR-S, which may have some differences from other XJ-S's in the surge tank; this idea probably won't work too well in cars like the author's '83. There are two lines from the tank to the surge tank. One is the main feed line, but the other is more involved. It looks like a vent line at the surge tank, since it comes out the top of the surge tank, but it goes into the main tank about two inches above the bottom. What actually happens inside the tank is that this line loops upward to a point near the top of the tank, where it opens into the tank -- but the return line from the engine compartment also loops up to the same point and feeds into this open pipe. So, you will have to run the engine until it burns all the fuel in the surge tank, because the pump will be feeding the same fuel back into the surge tank until it's all consumed. You don't want to pinch off that vent line, because then the pump would pull a vacuum on the surge tank and cavitate long before it empties the surge tank.

The intended method of emptying the surge tank is to clamp only the main line from the main tank, and then remove the rubber plug in the floor underneath the surge tank and open the drain in the bottom of the tank. The drain fitting works kinda like a big brake bleed nipple; you don't need to remove it, just loosen it a coupla turns. Unfortunately, the drain never lines up with the hole in the bottom of the car very well; you might want to consider enlarging the hole and using a larger plug. Hopefully, one way or the other, you can push a short piece of 5/16" tubing onto the drain fitting to route it out the bottom of the car and into whatever container you'll be collecting it in. Kevin Darling says, "An 11/16" wrench easily opened the sump drain from within the trunk."

Since the vent line actually opens near the top inside the main tank (as opposed to where it looks like it goes) you only need to make sure the fuel level is below that level so it sucks air instead of fuel. Just plan on this job when the tank is less than half full. Of course, you can do it when it's full; it's just that you will first have to drain the main tank down to the level of the vent before the surge tank will empty.

Another idea is to pinch both lines and open the drain. It'll drain slowly since you have the vent pinched off, but you can just go do something else and let it gurgle until done. Or you can go ahead and disconnect the line to the pump which will provide a vent and then it will drain faster. One thing to note here: Even with the line to the pump serving as a vent, the surge tank might not drain too quickly. The pickup is not configured well as a vent; air bubbles won't pass through the pickup screen well. If it's plugged, even worse. Darling says, "What I didn't expect was that very little came out the bottom of the sump tank, even with the fuel pump hose disconnected, until I opened the locking ring." You might want to blow on the pickup tube to speed the draining process a bit. Just going ahead and opening the locking ring might be messy.

By far the easiest way to work on the surge tank is to drain both the main and surge tanks; that way you don't have to pinch off any hoses. Simply drive the car until there is less than five gallons of gas in it. Then set a five gallon gas can in the trunk, disconnect the fuel line from the fuel filter, feed it into the can, and hotwire the fuel pump. Let it run until the tank is empty, but shut it off quickly when it starts sucking air.

SURGE TANK DRAIN UPGRADE: Somewhere along the line, the drain plug in the surge tank changed from C41803 to CBC4518. The newer drain plug is magnetic, while the earlier item was a simple plug. If you are working in the area and find no magnetism in your drain plug, you definitely should opt for a replacement; any particles that stick to that magnet are particles prevented from plugging the pickup screen.

The 1988 Jaguar Parts Catalogue lists only the first part number, but later editions apparently confused things a bit. Wally Magathan says, "According to my parts manual, RTC9900CA, Jan 1989: on page 2D 05, there is a diagram of the sump tank, with the drain plug part annotated as having been replaced by a magnetic plug. One puzzlement, however: the diagram is indicated to pertain to cars equipped with 3.6 engines only. There is no diagram labeled for use with 5.3 engines." Kevin Darling responds: "This puzzled my local Jag dealer as well. But the RTC9900CA parts book is wrong, since both my 1985 and 1990 V-12's have the sump tank."

Supposedly the CBC4518 plug will fit all the earlier cars.

If you're cheap, of course, you could always simply drop a magnet into the surge tank while working on the pickup. It might be more challenging to clean, but it should do just as good a job of keeping ferrous particles off the pickup screen.

SURGE TANK VENTING: The vent line from the surge tank doesn't go to the vapor separator, as one might expect. Instead, it connects back into the main tank about 2" above the bottom. However, this is not a simple opening into the tank. Inside the tank, this fitting continues as a tube that makes a couple of bends and terminates with an open end pointing upward a couple of inches from the top of the tank.

Meanwhile, the fitting for the return line from the engine compartment is at the bottom left rear corner of the tank. Inside the tank, this fitting continues as a tube that runs across the rear of the tank -- there are actually a couple of clips brazed to the inner surface of the tank to hold the tube in place -- and then bends upward and terminates with a 180° hook that pokes its end down *into* the opening of the pipe from the surge tank fitting described above. The connection of the two pipes is not liquid-tight; if you tip the tank over and pour a liquid into one of the fittings, it will leak out of the connection within the tank. But it doesn't appear to be a *very* loose fit; the tube from the return line appears to nearly fill the opening in the end of the tube from the surge tank vent.

In other words: the fuel returning from the engine compartment passes *through* the main tank but really goes directly back to the surge tank, with a leaky connection inside the main tank to allow air to bleed out or something.

Mike Morrin provides a possible explanation for this Rube Goldberg: "Let's say you are nearly out of fuel, with a little fuel still sloshing around the bottom of the main tank. You park, with the engine running on the side of a road with a lot of camber so that all the fuel runs to one side of the tank. The main outlet from the tank is now above the fuel level. The engine can keep running (or restart) for as long as there is fuel in the surge tank."

"With the arrangement you describe, the engine can keep running until all of the fuel in the surge tank is burned in the engine. If the return pipe just went to the main tank, the fuel circulated by the pump would all end up in the main tank, and the surge tank would be empty in a minute or so."

Apparently something about this system didn't work as intended, though; in Issue No. 2 of the XJS Bulletin, Ray Ingman reports that Jaguar issued a kit to provide an additional vent for the surge tank, JLM 2163. The kit includes a replacement pickup tube that features a vent connection. A line from this connection is simply teed into another vent line up near the vapor separator.

Ingman describes the incentive for this fix as a "problem of fuel vaporization within this tank under adverse, e.g. hot, climatic conditions. This results in flat spots and hesitation in engine performance."

SURGE TANK VENT CONNECTION: There are three threaded fittings on the fuel tank in the '83 coupe. The main drain line from the tank to the surge tank requires a 13/16" wrench and the return line from the front of the car requires a 19/32" wrench -- both readily available at most hardware stores. However, the fitting where the surge tank vent connects to the main tank requires a 1/4" Whitworth/5/16"BSF wrench.

FUEL PUMP CONTROL: On both the Digital P system and the earlier D Jetronic, the fuel pump is controlled by the EFI ECU via a relay in the trunk. The ECU contains a circuit that determines whether or not the engine is actually running and shuts off the pump if it has been motionless for more than a couple seconds. You can observe this circuit working by turning on the ignition without starting the car, and listening to the pump run; it should shut off in a couple of seconds.

Note: there have been some reports that owners have gotten the idea that they are supposed to wait until the pump stops running before starting the car. This is not the case; the fuel pump control circuit is only provided as a safety device. When starting, the key should be turned from off all the way around to start promptly.

The fuel pump control circuit is unreliable in the 6CU ECU, and sometimes will fail to keep the pump running more than a couple seconds regardless of whether the engine is running or not. Typically, the starter is engaged, the engine fires, the starter is released and the engine quickly dies -- misleading the mechanic to believe that the problem is related to coming off the starter circuit. Of course, like most electronic failures, it can be intermittent -- runs perfectly for a while, then dies, then inexplicably runs perfectly later.

If you'd like to test this circuit to determine if this is your problem, simply remove the fuel pump relay in the trunk (the one without a red mark on it) and put a jumper into the socket between terminals 86 and both 87's. This will allow the pump to run whenever the ignition is on. If the car now runs perfectly, the fuel pump circuit in the ECU (or the relay itself) was the problem. AJ6 Engineering, Corsaro, Beckman, or any other place that repairs ECU's should be able to fix this problem for far less than the cost of a new ECU. If you're willing to risk the odds that you will be in an accident where you are knocked unconscious, a fuel line is severed, and something ignites the leaking fuel, you can leave this jumper in place permanently. Note also that if you happen to have a leaky injector, turning the ignition on without starting the engine can fill a cylinder with liquid fuel, causing considerable damage the next time the starter is engaged.

You might also consider upgrading to the later 16CU ECU. See page 276.

FUEL PUMP NOISE: Noisy fuel pumps are a very common complaint. Goodman suggests: "it may not be the pump causing the noise; try the hose clamps on the fuel outlet pipes from the pump vibrating against the boot floor or battery stand. The fuel filter may be blocked causing strain on the pump or the filter may be vibrating against the tank or spare wheel, steel fuel lines vibrating under the floor etc."

Another likely cause of pump noise is a plugged pickup or other restrictions on the suction line to the pump. See FUEL PICKUP, above.

FUEL PUMP FOREIGN OBJECT DAMAGE: Steve Holst had a fuel pump totally seized by a tiny strip of cellophane, possibly from a wrapper or maybe the edge of the Lucas label on the side of the pump. For those of us who like to tinker, it's possible to fix this problem by completely disassembling the pump and removing the cellophane strip -- but just your luck it'd be a metal chip or a piece of sand and the impeller will be scored beyond repair. The message is clear: make very sure nothing can get into that pump inlet except fuel! Fortunately, the line between the pickup screen and the pump itself is very short and simple. Just make sure that there's nothing within that little stretch of plumbing and you'll be OK.

FUEL PUMP VARIATIONS: Peter Smith says, "The pump motor is used on several cars including Volvo, but the rotors are said to be different to provide different flows for different cars." Just in case there is any misunderstanding, let me make the implications here perfectly clear: the fuel pump is *not* an item that you should replace with a pump from a different car just because it looks the same. If you install a pump with a lower flow rate, the car might run fine at normal speeds but run lean when floored and the ECU is operating in open-loop fuelling mode. The result will be burned pistons. There won't be any warning prior to burned pistons.

Goodman reports: "The latest XJ-S's had pumps *inside* the fuel tank, so Jaguar may have done this for noise related problems. I suspect that these pumps are lower output because the '93 model XJR-S had twin in-tank pumps, and must be ordered in a matched pair."

FUEL LEVEL SENDER: It's discussed on page 548.

FUEL COOLER: Many people see that the air conditioning circuit in the Jag includes a fuel cooler, and assume that this is a high-performance trick. Dragsters often include an ice bucket in the engine compartment to cool the fuel on its way to the engine to get more horsepower.

It's a great idea, but unfortunately not the case. The fuel cooler in the Jag is in the return line going back to the tank. The pump moves much more fuel than is normally needed and most of it recirculates. The fuel being heated while passing through the engine compartment as well as the pumping energy itself would eventually heat up the fuel in the tank significantly, possibly causing vapor lock problems and problems passing EPA emission requirements -- heated fuel gives off more vapor. The cooler is to counteract the heating effect. This may help explain why the ventilation system has the A/C running during most conditions.

Why Jaguar doesn't put the cooler in the supply line and reap both benefits is anybody's guess. Perhaps it's more difficult to make a cooler to operate at the higher fuel pressure on the supply side.

FUEL COOLER - CONVERTIBLE: According to Michael Neal: "This vapor lock problem was such a problem that the convertibles were modified to keep the A/C compressor running all the time. The aerodynamics on the convertibles caused the engine compartment to run even hotter than the coupes. With the A/C compressor running the fuel cooler kept the fuel temp to a decent level."

FUEL COOLER - 1992-ON: Richard Mansell quotes from a Jaguar publication that was sent to him: "It is titled "Technical Guide - The New XJ-S 1992 Model Year Preliminary Information". In it there is a paragraph about the fuel cooler deletion, it says:

"With the introduction of the in-tank fuel pump, the fuel cooler is deleted. This affected the characteristics of the system so that a muffler is added in the line to reduce noise and vibration."

"I wonder why adding an in-tank fuel pump should allow the deletion of the fuel cooler. It also says in another section:

"As a result of the deletion of the fuel cooler, it is necessary to introduce a redesigned hot start system. The thermal vacuum valve fitted to pre-92 MY vehicles is replaced by the following components:

1. Fuel rail temperature switch. The electrically operated switch enables the fuel rail pressure to be increased when the fuel temperature exceeds 70 degrees Centigrade at hot starting.
2. 45 second timer module. The timer limits the time for which the increased fuel pressure is applied.
3. Solenoid vacuum valve. This controls the vacuum signal driven by the fuel temperature switch and the 45 second timer.
4. Vacuum delay valve. This controls the way the extra pressure is applied at hot starting to give a decayed reduction in fuel pressure over 45 seconds, after which the pressure is switched to normal."

Tank, Surge Tank, Pump, Lines: Hess & Eisenhardt Convertible

FUEL TANKS: This section is of no use to coupe or later convertible owners, but it is reportedly difficult for H&E owners to find information on how this system works so a description is included here. According to Mike Cogswell, “In order to make room for the folding top and its mechanism H&E had to take the standard tank and cut part of it off. It would appear they literally cut the tank and welded in a sloped section. To regain fuel capacity, they added a second tank under the parcel area, basically where the rear seat would have been in a coupe. The upper tank is about 14 US gal. and the lower is about 11.

“As you know, the standard tank has a sump from which the high pressure fuel injection pump draws its fuel. Since the second tank is lower than the first H&E added two concentric hoses. The larger outer hose allows fuel to gravity drain into the lower tank from the upper (which is where the filler neck is located.) Consequently, the lower tank is always full until the upper tank goes dry. Meanwhile, a small submerged pump constantly pumps fuel from the bottom tank to the top tank via a small tube that is located in the center of the large drain hose. The fuel is dumped into the upper tank’s sump, where it is available to the main fuel pump. The submerged pump can pump fuel faster than the engine consumes it, but any in excess of the sump capacity will drain right back into the lower tank. Both pumps only run when the ignition is on and the standard pump circuit is energized, so all the regular safety interlocks still work.

“Each tank has its own fuel level sending unit. The upper unit is apparently the standard XJ-S tank unit. The lower one is similar, except the mounting plate is horizontal instead of vertical. The two gauges are wired in series. There is a small circuit board in the H&E harness that theoretically turns on the low fuel level light.

“My gauge is wildly inaccurate. Because they are in series I’m guessing that my top one basically hits bottom well before the bottom one starts to drop. As a result, my gauge is very non-linear.”

Tim Blystone points out that since parking the car nose-down on an incline will cause the fuel to drain toward the forward tank and away from the sump, the auxiliary pump might not keep up when the tank is less than half full. “All of the early tank designs will stall on a sufficient incline.”

“H&E went through a couple of different configurations. The main difference is the dams added in the interior of Jags original tank.”

FUEL HEATING PROBLEMS: The stock Jaguar fuel pump moves far more fuel than the engine normally needs with the excess returned to the tank. Since this heats the fuel somewhat, a fuel cooler is included in the return line, using the A/C freon circuit to provide cooling. On the H&E, however, the problem is exacerbated by the fact there are *two* pumps running full time, coupled with the fact the car is a convertible so the top may be down and the A/C *off* on warm days! Tim Blystone: “Normally this presents very little problems until the A/C goes on the fritz, or you have one of H&E’s earlier designs. If it is summer, the top is down... the A/C system is off. No cool fuel. Vapor lock from hell.”

FUEL SYSTEM MODS: Tim Blystone: “My modification puts the plastic hose from the H&E fuel cell directly into the supply for the sump tank. A new and longer piece of hose is required. Fuel is pumped by the H&E pump directly into the Jag sump tank and bypasses the need for the tank to be gravity filled. There is a return to Jags original main tank from the sump tank so there is no excess pressure in the sump. The result is a fuel system that doesn’t have the H&E problem with steep inclines or die dead in the middle of a hot southern day.”

GAS CAPS: The single gas filler on the H&E is the same as the two on an XJ6.

Vapor Recovery System

VAPOR RECOVERY SYSTEM: When the car is running and drawing fuel out of the tank, there must be a vent system to allow air into the tank to prevent a vacuum from being created. It is no longer acceptable to merely have a small hole in the gas cap; such methods allow fuel vapor to escape into the atmosphere all the time, whether the car is running or not, and would contribute to air pollution. Raw gasoline is a serious air pollutant, and besides that it smells bad.

Unless you live in California or somewhere else where they have intelligently-designed gasoline pumps, you pump 20 gallons of fuel vapor out into the air every time you pump 20 gallons of liquid gasoline into your car. It is simply inexcusable that, decades after the public became aware of the problems of air pollution, every filling station in America doesn't have the same vapor recovery filling systems that California has. But, back to discussing the fuel tank vent system in your Jag.

Avoiding polluting the air via a properly-designed fuel tank vent scheme is easy and doesn't hamper the performance of the car one iota. The only disadvantage to the owner is in the initial cost of installation, but since the car comes with the system from the factory and has therefore already been paid for, there is no reason to remove or disable it.

In simplest terms, a "vapor recovery system" connects the fuel tank vent to a carbon canister. Air can flow freely through the canister into the fuel tank, but when vapors from the fuel tank try to escape through the canister they are absorbed by the activated charcoal. Of course, the charcoal can only absorb so much fuel. Therefore, whenever the engine is running, there is a system by which the engine draws fresh air through the canister. This draws the vapors back out of the charcoal and burns them in the engine.

When the car is not run for extended periods of time, the amount of vapor generated in the tank could be considerable. Gradual changes in ambient temperature and barometric pressure would cause the vent system to "breathe", running a large amount of vapors through the canister. To absorb all this vapor, the canister would have to be prohibitively large. To reduce the amount of vapor the canister has to deal with, there is a "2 psi valve" in the vent line between the fuel tank and the canister. This valve will allow air to flow in either direction, but only after a certain pressure or vacuum has been reached. If the contents of the tank expand and try to escape out the vent, it will prevent any flow until the pressure reaches 2 psi or so, and then it will allow it to pass to prevent damage to the tank or hoses. Similarly, if the contents of the tank contract and try to draw air in through the vent, the valve will prevent any flow until the vacuum reaches a set value -- usually lower than the pressure value -- and then it will allow it to pass to prevent the tank from collapsing. As a result, the vast majority of the smaller expansions and contractions do not open the valve at all, and the amount of vapor the canister must absorb is greatly reduced.

Of course, this means that at any given time the fuel tank and hoses may be slightly pressurized, even when the car is not running. Even the tiniest leak anywhere in the system may become quite significant.

VAPOR RECOVERY SYSTEM -- AFTER RECALL: The original XJ-S vapor recovery system pretty well followed the description above. However, there was a tendency for the tank to develop stress cracks from excessive pressure fluctuations as well as indications it did not vent as well as intended (including numerous complaints about fuel odors), so there was a recall to address the system. In general, the recall involved the installation of a "Rochester valve" in place of the 2 psi valve. David M. Johnson: "The Rochester valve (Part CBC 7714) is a cylindrical disk (approx 2 inch diameter) with an inlet from the fuel tank vent pipe and outlet for the vent to connect to the carbon canister. A third outlet at the top is to connect to the manifold vacuum." A Rochester valve works the same way as the 2 psi valve when the engine is off, but when the engine is running the vacuum signal pulls the Rochester valve wide open to freely vent the tank.

The recall also installed one or two (depending on VIN) vacuum-operated purge valves to provide a positive purge when the engine is running. The left side throttle butterfly housing was replaced with one that had suitable taps for controlling the Rochester valve and purge valves.

For those who have disconnected the vacuum lines from the butterfly housing and want to reconnect them properly, I can give this guidance based on the dealer instructions for the recall that installed the system in the first place: Among

the two vacuum hoses that go from the butterfly housing to the area in front of the left wheel well, one is supposed to have a black and white delay valve in it, hanging in the vicinity of the coolant header tank. A hose from the black side of this delay valve should be connected to the front port on top of the left butterfly housing. The hose with nothing in it should be connected to the rear port on top of the butterfly housing. Of course, there were several variations on this system as applied to different cars, but I think that description should cover most of them.

The carbon canister, the Rochester valve, the purge valves, and the associated plumbing are all located forward of the left front wheel; remove the forward panel of the inside wheel well to inspect. The only part of the vapor recovery system not in this location is the vapor separator, which is high in the right side roof pillar on the coupe.

VAPOR RECOVERY SYSTEM -- CHECKING: If your XJ-S has the Rochester valve, the first check is quick, simple, and clear: with the engine running, open the fuel cap. There should be absolutely no “whoosh” or any other symptom of pressure equalization. If there is a whoosh, either the Rochester valve isn’t working, or the system is plugged somewhere.

The second test requires more judgement. After parking for some time, a little whoosh is to be expected, but too much whoosh means the system is plugged. David M. Johnson says, “A simple check is to open the tank cap after standing for some time on a hot day. A huge whoosh and an oil canning sound means the valve is not working -- the vent is connected wrong, or the vent is blocked. If you have *no* whoosh then the vent pipe or fuel tank is leaking, and the car will either have a fuel leak or a fuel vapor smell.”

In the US, part of the judgement call involves the little trap door in the filler that prevents you from inserting a nozzle containing leaded gasoline. Since you can no longer buy leaded gasoline, nozzle notwithstanding, this thing is a relic of a bygone era and could be removed without concern. But if it is there, it effectively restricts vent flow when the cap is removed, and may make a short whoosh into a longer whoosh. Conversely, if the trap door is gone, a long whoosh may seem deceptively short.

“It is important to disconnect the Rochester valve and check it opens at 2 psi and under vacuum. Also note the Rochester valve must be connected in the correct direction.”

The bad news: Apparently, the vapor recovery system on the XJ-S is unreliable. Many owners have reported problems, usually indicated by a large “whoosh” even when the engine is running, but often dismissed as “normal” until the gas tank cracked or other dangerous symptoms arose. Fortunately, if the symptoms are recognized and addressed promptly, it’s never difficult to make the system work as it should; it’s simply not that complicated or expensive to fix.

BACKUP FOR ROCHESTER VALVE: The entire point of the Rochester valve is that the tank should be freely connected to the carbon canister when the engine is running. It is a simple matter to make sure that happens: just tee into the vent lines before and after the Rochester valve and connect up a solenoid valve to bypass it. Connect the solenoid valve to a switched power source so it is energized whenever the ignition is on. That will ensure proper venting when the car is running.

To ensure proper venting when the engine is off, you can install a 2 psi valve in another bypass around the Rochester valve. If you don’t have a 2 psi valve, you can probably get one from just about any car in a junkyard; most cars use a simple system similar to the pre-recall scheme in the XJ-S. Or perhaps you can buy a Jaguar part, CBC6820.

Obviously, another option would be to install a second Rochester valve around the original.

FAILSAFE FOR VAPOR RECOVERY SYSTEM: There are reportedly several different gas caps used on these cars; some OEM, some aftermarket. Some of them are a total seal, but others have a pressure/vacuum relief valve built into them to serve as a safety in case the vapor recovery system gets plugged. Good idea! If your gas cap is a total seal type, you might want to replace it. But if you have the pressure/vacuum relief valve type, it may defeat the second system test described above.

On the other hand, if somebody has drilled a hole in your cap, you definitely should replace it.

Jason Korke was looking for the source of fuel odors: "I realised that the smell tended to come when (a) I did a hard right hand turn, especially at a roundabout and (b) when the tank was pretty full. I think I've found the culprit: fuel is leaking *through the keyhole* of the filler cap." Yes, that cap should be replaced too.

Patrick MacNamara: "I had the cap with no lock when I first bought the car. It used to really vent when I opened the cap for refills. This past summer, I bought the official Jag locking cap for security reasons and it no longer vents when opened. I also sometimes get the fuel smell from the same source as Jason with a full tank. I think the keyhole does not seal well at all or has a pressure relief valve through it." Patrick needs to check his cap *and* his vapor recovery system.

VAPOR RECOVERY SYSTEM -- MAINTENANCE: The vapor recovery system, including the carbon canister, is normally maintenance-free. Activated charcoal can absorb and release fuel vapor forever, it doesn't wear out or get "full". However, there are filter elements within the canister (after all, it is an air intake) that may eventually get clogged, and the carbon itself may eventually get contaminated with fuel additives or other non-petroleum substances, so it is recommended the canister be replaced once in a great while.

If you're *really* a skinflint, the carbon canister can be opened and the filters replaced. There are two, one at the top of the charcoal and one at the bottom -- you must dump all the charcoal on a newspaper or something. Both filters can be neatly replaced with coffee filters. The canister can be held shut with aluminum tape when reassembled.

The carbon canister itself has an opening on the top to atmosphere, and three fittings on the bottom (note: the canister may be mounted upside down, so top may mean bottom and vice versa). The fitting labeled T is connected to the fuel tank, via the appropriate valves and the vapor separator. The fitting labeled P is the purge line to the engine. The fitting labeled C is capped off; it originally was the connection for venting the float bowls of the carburetors, but they are history. Note: if you fit carbs, do not simply open this fitting and try to use it; a screen has been omitted inside as well, and you will draw carbon granules into the floats.

One of the possible causes of the common fuel odors is the location of the canister in the XJ-S. On most cars, it is located in the engine compartment where any escaping fumes will simply be blown away by the flow of air through the radiator. But in the location in the bodywork forward of the left front wheel, there is no such flow. The vapors may gather in the bodywork and eventually work their way to the passenger compartment. Of course, there aren't supposed to *be* any fumes escaping, so this is a secondary problem. However, it might be a good idea to connect a length of hose to the atmospheric vent on the canister and route it out the bottom of the car.

Another possible failure mode is that the engine is not properly purging the canister. If the engine is not drawing air through the canister when running, the canister will quickly become saturated with fuel and will cease to absorb, and any further fumes coming down the vent line will escape to atmosphere.

VAPOR SEPARATOR: In the XJ-S, there are several vent lines from the fuel tank. They all are routed to a small vapor separator high in the bodywork to the right and above the fuel tank. This small metal contraption is intended to allow most fuel vapor to condense and drain back into the fuel tank. The vent line to the canister is routed from a point high in this separator, so fuel vapors must be very determined indeed to make it past this point.

Note that the vapor separator has been blamed for many problems. Since it is steel, it is prone to rusting. If a hole rusts through it, fumes will be vented into the bodywork. Also, rust particles may fall inside it and plug the tiny vent passages and hoses.

Vapor Recovery System: Hess & Eisenhardt Convertible

VAPOR RECOVERY SYSTEM -- INCORRECT PLUMBING: David M. Johnson owns two H&E's, and reports: "I found that on *both* of my cars the fuel vent systems were plumbed *incorrectly* (not done by my local dealer). The carbon canister under the front left wheel arch is connected to a vent pipe from the fuel tank, and a vent pipe to the PCV valve next to the LHS air intake. The two vent pipes were wrongly connected, i.e. the fuel tank vent was connected to the valves for PCV pipe (two valves operated by vacuum from the LHS manifold), and the PCV vent pipe was connected to the Rochester valve that should be connected to the fuel tank vent.

"So what's the big deal? Well, the valves that would normally operate the PCV valve only open under vacuum when the engine is *running*. When parked and sat in the sun the tank *cannot* vent! I tested these valves with 10 psi and still the valves would not open. The tank is now a sealed container with fuel vapor inside! There are only two things that can happen:

- (a) The tank will build up a severe pressure and will rupture in time due to fatigue at the weakest location. A pressurized gas vapor canister in my car/garage does not give me a good feeling!
- (b) If you are lucky, one of the vent pipe/fuel connections will leak to relieve the pressure and cause a fuel leak and/or a fuel vapor smell. I am still not keen on this option with the car in my garage!

"If the tank is connected correctly to the Rochester valve, the valve will open at approx. 2 psi to relieve the pressure in the tank, and also opens under vacuum. This stops the tank venting under all conditions and hence does not overwhelm the carbon canister.

"Of course my vent works perfectly now, no gas smells and no severe pressurization of the tank, just a small woosh when I open the tank cap. I wanted to pass on this info to others, since I consider this a dangerous fault, in this case not a design fault but an incorrect installation by the Jag dealers on *two* cars! Very ironic since the recall was to *solve* this problem."

"This recall was Hess specific (recall (C002) XJ-S purge kit (Feb 1990). If you check the recalls on XJ-S 86-91 you will find there were similar problems with the regular XJ-S but a different fix. The mod was estimated to be 4.35 hrs for later Hess cars to install Kit JLM2046 and conduct a fuel system integrity test.

"The diagram (figure 6, page 8 of 23) showing the valves and carbon canister connections is not very clear because the fuel vent pipe connections are only partly shown, but the PCV pipe vent connections are clearly shown. I deduced these pipes were incorrectly attached by testing all the valves to determine how the vapor system functioned. I called the Jag dealer the next day to get a copy of the fuel vent recall, and hence confirm the connection was incorrect.

"I do not think the two cars were fixed by the same dealer for the recall. One car is from New York, and the other is from California. That is why I suspect other cars could also be connected wrongly!"

Throttle Linkage, Idle Speed Adjustment

IDLE SPEED ADJUSTMENT: On each butterfly housing, there is an adjustment screw that a lever contacts when the throttle is at idle. These are *not* to be used for setting idle speed. If they have been disturbed, the linkage must be readjusted as described on page 251.

Underneath the rear end of the left intake manifold there is an aluminum housing with two hose connections; one that goes up to the back end of the manifold and one that goes forward to the air filter housing. This contraption is called the auxiliary air valve, or AAV for short. Just below the connection leading to the air filter housing is a bolt. This bolt, believe it or not, is the idle speed adjustment. The bolt itself obstructs an air passage, so the farther the bolt is

unscrewed, the more the passage is opened, and the faster the engine idles. It's not real convenient to get to, but a ratchet and a long extension with a swivel at the end will do it.

There's a photo of the adjuster at:

<http://www.jag-lovers.org/xj-s/book/IdleScrew.html>

On this author's '83 (as well as in the photo), the adjuster is a 12mm thread with a head barely larger than the threads, so the head requires a 13mm socket to fit. However, Craig Sawyers reports that later versions (including replacement valves to fit earlier cars) use a metric threaded adjuster with a much larger head: "The old one is indeed metric, M12, but metric fine thread. It is however a special, with a 13mm AF head (standard is 19mm AF). New valve 12mm over the threads, 1.75mm thread pitch and 19mm AF. That is a standard metric M12 bolt. Truly huge by comparison. Jag/Lucas have clearly economised by using a standard M12 coarse thread bolt with the standard head. Adjustment sensitivity with the coarse thread is just fine."

AUXILIARY AIR VALVE: The auxiliary air valve (also called an "extra air valve" in Jaguar repair manuals) is in the same housing that the idle adjustment screw is on, and is supposed to open when the engine is cold to keep the idle up. It contains a bulb similar to those found in thermostats that protrudes down into the coolant rail on top of the B bank head. A rod from this bulb pushes a piston up a cylinder against a spring, covering an opening in the side of the cylinder that allows air into the engine.

Although they share the same housing, the idle adjustment screw and the cold idle function of the AAV are separate. The screw obstructs one passage allowing idle air into the manifold, and the piston controlled by the bulb obstructs a different passage allowing idle air into the manifold. Hence, if the cold idle piston jams wide open, closing the idle adjustment screw will still usually not bring the warm idle down within reason.

The bulb may look similar to a thermostat bulb, but it is *not* the same; see the description of the operation of a thermostat bulb on page 196. A thermostat goes from fully closed to fully open in only a few degrees; the AAV needs to move gradually from open to shut over a range of 80°C or more. So, where the thermostat bulb has wax in it that changes phase, the AAV bulb contains an oil; it probably works by simple thermal expansion. For more on this, visit

<http://www.jag-lovers.org/xj-s/book/AAV.html>

Michael Aiken says, "I believe there are many versions of the AAV depending on many variables and the correct one for your model is necessary. My parts manual (which is for 87 to 89MY) shows no less than four part numbers for the extra air valve for the V12: Two for up to SN 8S.57761 and two after 8S.57761. The other variable is emission code." Mike Morrin calls that "an example of the later parts books not showing the details of early cars. The June 1980 parts book shows C42164 used initially on all cars, then progressively replaced for various markets between 8S.5203 and 8S.11800 with EAC1405 and EAC1590, which were in turn superceded by EAC2273. Interestingly, EAC2273 did not supercede C42164."

Based upon inspection of several part number AAV's, it is apparent that the relationship between temperature and piston location is the same for all. The bottom end of the bulbs are all marked "-30". The only difference between part numbers is the configuration of the opening in the side of the cylinder that the piston slides over. By shaping this port properly, the engine designer can provide whatever airflow/temperature relationship he needs. The port shapes used on Jaguar V12's actually vary considerably; the web site mentioned above includes photos and dimensions of ports from various AAV's.

There are two common failure modes for the AAV; the piston gets stuck, or the bulb gives out. If the piston gets stuck, possible solutions are obvious: disconnect the outlet hose and spray a bunch of solvent or carb cleaner into it, or take it off the car and soak it in solvent. Mike Morrin says, "Going along the non-destructive path, if you look down the bore, you will see some smallish holes drilled in the piston. I managed to fit a long self-tapping screw into one of these, and used it to pull the piston up against the spring a few hundred times, while applying WD40 to wash out the crud. It seemed to work, and I have had no problems in the following 12 years."

If the bulb gives out, chances are it will do so gradually, and the result will be that the piston sits lower and lower at a given temperature. Craig Sawyers, who lives in the UK, hot-water-tested a new AAV and found that it was totally closed by 80°C. He also tested an old but “working” second-hand AAV that appeared to be of identical construction, and it had the exact same sort of characteristics except shifted upward in temperature; if you extrapolate based on the positions he measured up to the boiling point of water, it wouldn’t fully close until nearly 110°C.

Since a lower piston opens the port more, the cold idle will get higher and higher as the bulb gets weaker; when the port is no longer fully closed at operating temperature, the warm idle will start to rise. For a while, this can be countered by screwing in the idle adjuster, but eventually the adjuster will be all the way in and the idle will still be too high. Once it gets above 1800 or so, the overrun cutoff will start cycling the engine RPM up and down from 1100 to 1800. To make sure the AAV is the problem, remove the left side air filter cover and element, start the car and let it warm up, and check how much air is entering the hole where this valve is connected. You might even try covering the hole entirely; since the warm idle air also goes through this opening, the engine RPM should fall to below a normal warm idle or even stall, although it will be sucking air through the distributor vent scheme like crazy. If the idle drops a little but remains high, your idle speed problems are probably from a vacuum leak somewhere else, your butterflies are not closing properly, or your overrun valves are opening when they shouldn’t.

Based on observations of several AAV’s, it appears that the condition of the bulb can be easily verified: remove the outlet hose, and measure from the upper edge of the outlet fitting down to the inside bottom surface of the piston (which has several holes in it; make sure you’re measuring to a surface between the holes). This dimension should be 70mm at room temperature. If it’s more like 72mm or more, it’s weak.

Note that looking into the inlet fitting at the port might not be a good indicator of bulb condition. Some of the port shapes are fully open at room temperature, while others don’t fully open until freezing. Boiling won’t necessarily help either; most AAV’s are fully closed by 80°C, but at least one type still has a portion of the port uncovered and apparently modulates the idle speed at operating temperatures.

It is considered good practice to replace thermostats whenever the engine has been overheated. Considering the similarities of construction of the AAV, it probably should be replaced whenever the engine is overheated as well. Of course, a new AAV costs a hell of a lot more than a new thermostat. Just the same, overheating is only too likely to be shortly followed by AAV trouble; there are two seals in the base of the AAV around the bulb that are made of nitrile, and they get just as hard and brittle as a nitrile O-ring when things have been hot. There is a sleeve inside the bulb that is probably nitrile as well.

Would you install a used thermostat in your car? Of course not. The idea of installing a used AAV may be just as misguided, even though they are atrociously expensive. Philip Jones says, “I spent a day pulling 4 off a local breaker’s stock and found none satisfactory.”

AUXILIARY AIR VALVE -- REBUILDING: If you need to replace the thermal capsule in your AAV, the biggest challenge will be finding a suitable replacement bulb. As mentioned above, a bulb from a thermostat will *not* provide the same response. Richard Guevin suggests you check:

Corea Electronics Corporation
138-5, sosabon-dogn, sosa-gu,
puchon-city kyonggi-do, Korea Zip Code: 422-233
ph: 82-32-346-3665 FAX: 82-32-346-5326
<http://www.corealec.co.kr>
e-mail: cecgj@netsgo.com

Guevin specifically suggests the item shown at http://www.corealec.co.kr/viewproduct_2_e.html.

Of course, you might opt to use a thermostat bulb anyway. Rather than holding a nearly constant idle during warmup, the idle will gradually rise until the thermostat temperature is reached, and then it will quite suddenly drop to a warm idle. If this is acceptable -- and it certainly is preferable to an OEM bulb gone bad, in which the idle *never* comes down -- just try to find the coldest thermostat bulb you can, so the idle drops *before* operating temperature rather than *at* operating temperature. And make sure the thermostats in your engine are hotter than the bulb in the AAV.

On the series of web pages starting at <http://www.jag-lovers.org/xj-s/book/AAV.html>, procedures are presented for rebuilding the AAV. If at all possible, review this site prior to tackling the job; the photos will be helpful. The short version of the procedure: Put the AAV in a press and push the outlet fitting down until you push it *through* the housing and push the baseplate out the bottom. Press the bulb out of the baseplate upwards, which will destroy a peened-over edge and ruin a flat washer holding the bulb in place. Applying sealant, install your new bulb and retain it using whatever you will trust to work; a 1/2" stainless steel flat washer with a series of tiny holes drilled around the outer edge held in place by a circle of #4 stainless steel screws threaded into the baseplate is a good plan, but make sure the holes in the baseplate don't break through to the other side or they will cause a coolant leak. After cleaning up the piston and other internal parts and making sure they move freely, reassemble by pressing the baseplate in the bottom and the outlet fitting/cylinder in the top. Apply some Loctite 518 around the edge of the baseplate before pressing it in to help make sure it won't leak coolant. Make sure to stop pressing the outlet fitting at the right place, which should be where the inside bottom of the piston is 70mm below the top edge -- unless you've used some other sort of bulb, in which case you might want to stop pressing a little sooner, drive the car for a while and see how you like it, and if it's not right just pull the hose off the top and tap the outlet fitting in a little farther until it behaves the way you want it to.

Some suggest polishing a bit off the OD of the outlet fitting/cylinder to change the press fit to a slip fit, and then retain it with screws through the side of the housing. This makes it a bunch easier to get apart *next* time. A little sealant would make sure it doesn't leak air, but really it wouldn't be a big deal if it did; you'd just have to adjust the idle screw to compensate.

John Ashcroft of Melbourne, Australia, says, "H&H Spares do a c/o for \$90 AU, trade price; they have someone rebuild them so the bits are available somewhere. Put one of their exchange units in about 5yrs ago and it's still working fine." See page 647 for H & H Prestige Spares.

AUXILIARY AIR VALVE -- CHEAP FIXES: If your AAV isn't sticking but exhibits the "tired" behavior described above, Roger Bywater suggests a fix: "It does seem that the range of movement can change with age possibly due to very slight leakage from the bulb. In such cases it is quite feasible, after assessing the amount of correction required, to just press the top further into the casting body in a vice (with a socket or tube over the bulb) to get the thing operating back in range. Obviously it has to be checked in boiling water before and after and it needs to be done with care because it is all but impossible to get it back if it goes in too far."

"Don't go blaming Jaguar or Lucas for this valve and its foibles, although most of them run for years without trouble. It was a Bosch invention."

Faced with a completely failed AAV, Jan Wikström simply started the car and let the AAV suck a small rag into the opening in the air filter housing to plug the port. If the rag is small enough, it could conceivably plug the port without interfering with the warm idle adjuster. Of course, if it's too small it'll pull it *through* the port and into the engine. I'd suggest something around 2 inches square.

With a little more disassembly, you can do a better job of plugging it. Take the hose off the inlet fitting and jam a plug in there. By making the plug short enough, you should be able to push it past the warm idle passage, which comes off the bottom of this passage, and plug the cold idle port only.

Really cheap and easy: jam a cork into the hole into the opening in the air filter housing. The problem with this is that it will suck through the distributor vent scheme like crazy to maintain idle. Still, if you have a problem on the road, this might be a quick fix until you get home and can do something better.

All of these last fixes, of course, completely eliminate any idle boost when cold. Interestingly, several owners have reported that this doesn't seem to hurt anything! The V12 will idle at 300 RPM with no problem. Some cars have another means of boosting the idle when cold, namely the solenoid air switch at the front of the right intake manifold. This thing stays open for 45 seconds on US-spec cars and 15 minutes on UK/Euro spec cars, both to compensate for a disabled vacuum advance at idle; you might consider re-enabling that vacuum advance at idle (see pages 284 and 130) while leaving the idle boost functional.

Finally, of course, an entire separate cold idle scheme could be provided; John Napoli says, "just get one or two vacuum solenoids. Wire to toggle switches, pipe the air thru an inline fuel line filter (or plumb to air box) and go to town. These

thingies are real cheap. Get generic units unless you have some Jag take-offs in your junk box.” For fancier work, you could install temp switches in the coolant circuit to operate these solenoids automatically. By using different temp switches, the idle could drop in steps as the engine warms up and the solenoids shut off in sequence.

IDLING ON ONE BANK: Kurt Hill has a very early XJ-S, and the AAV plumbing looks like the illustration in Section 19.20.16 of the ©1975 ROM or Fig. 3.52 in the Haynes manual -- which don’t resemble the plumbing in the later cars at all. In this early layout, there is a tee on the outlet of the AAV, with one fitting connecting to the crossover pipe while another connects to a hose that goes forward underneath the left side intake manifold and connects into it from the bottom.

Hill’s problem was that the car ran great at speed, but idled on the right bank only -- and flunked an emissions test big time because the EFI system was still squirting fuel into the left bank that wasn’t firing. It turned out that a PO had replaced the hose from the AAV underneath the left manifold with generic hose, and since it has to make a 90° turn, it kinked as soon as manifold vacuum was applied to it. Since this is not only the idle air supply to the left bank but also the crossover pipe, the left bank got no air. Since this hose was hidden under the manifold, it was a difficult problem to locate; when the engine wasn’t running, the hose looked fine.

The easy fix: replace the hose with a molded hose with a 90° bend in it, which is what the car originally came with. Better fix: install a metal spring inside the hose to prevent collapse. Better fix yet: replace the hose with a section of copper piping with a 90° elbow, and connect it at both ends with really short pieces of hose.

Those with later cars don’t need to worry about running on one bank at idle (unless they have Marelli ignition!), because the crossover pipe is no longer part of the AAV plumbing but a separate entity. But any hoses under manifold vacuum are always cause for concern for sucking flat.

OVERRUN VALVES: If the throttle is closed at an elevated RPM, the manifold vacuum can exceed that normally found at idle. Under such high vacuum conditions the fuel/air mixture being introduced into the cylinders, even at the proper ratio, can be so rarified that it cannot be reliably ignited with an ignition spark. If that cylinder full of unburned mixture is then exhausted, it dumps quite a load of raw hydrocarbons into the atmosphere. However, as Roger Bywater points out, an even worse result (from the car owner’s standpoint) is what happens when the mixture is later ignited within the exhaust system; it can blow the mufflers open. This igniting within the exhaust is what causes the “backfire” upon deceleration that is characteristic of some cars -- mostly pre-EPA cars.

“The purpose of the over-run valves is to limit the vacuum that the engine can generate on the over-run because it was generally considered that when vacuum exceeds about 22" Hg the charge density is so low and contaminated by exhaust residuals that combustion ceases to take place effectively. The over-run valves therefore ensure that any mixture entering the engine is dense enough to fire.”

At the front end of each intake manifold on the Jaguar V12 is either a blank-off plate or a little housing with a stub hose connection to the air filter housing. The little housings contain the overrun valves. They are a spring-loaded poppet valve that should open only when the manifold vacuum is higher than a set amount more than idle vacuum. Basically, this limits the manifold vacuum to a level where ignition is reliable. It also tends to make the engine feel as though it has no “compression” on deceleration -- basically, the throttle is being opened a little. In fact, on some other automobiles, the same effect is achieved by physically opening the throttle.

Does your car have overrun valves? Apparently, it depends on whether or not your EFI system incorporates another method of addressing the same problem: overrun cutoff, in which the fuel injectors are shut off under deceleration (see page 255). Bywater: “When the EFI V12 engine was first introduced it had over-run valves and did *not* have over-run cut off. Cut off was introduced in some markets in about 1977-8 and the over-run valves, being no longer necessary, were therefore deleted on the respective cars. I cannot be sure from memory if US Federal emission cars were included but it is possible that they continued without cut off. All manual transmission cars continued with over-run valves because they did not have cut off as it caused unpleasant driveline shunting. Manual ECUs also gave slightly different low end fuelling being able to run at full throttle below the stall speed of a torque converter.”

"Cut off on the D-Jetronic system was effective at all temperatures unlike later Lucas Digital cars in which cut off was inhibited at low temperatures, necessitating the return of over-run valves.

"I think it is correct to say that if a D Jetronic engine has over-run valves it would not have over-run cut off, unless of course someone has swapped the ECU at some time.

"In fact, the over-run valves were notorious for losing spring pressure and causing a high or erratic idle speed. The practical solution was to just tighten the nut about 2 turns." Basically, adjust it just tight enough that the valves are closed at idle -- which can be confirmed by putting a finger over the hole in the filter housing with the engine idling. "Setting the over-run valves by checking with finger over the hole is as good as any method. As long as they don't leak at idle but work when you blip the throttle and release it to create an over-run condition they will be OK. You will probably hear them anyway. Again from memory I think they were meant to start to open at 20" Hg but by their nature they are more a sort of progressive leak rather than a step change device so manifold vacuum could exceed this value to a small extent."

ACCELERATOR PEDAL -- EARLY MODELS: Mike Morrin says, "The Jaguar pre-HE service manual seems not to have been updated from 1975 to 1981, which is fine for my car, but I have seen a few things which are obviously wrong for most of the pre-HE cars. A minor example of this is the RHD accelerator pedal assembly: The only type shown in the manual was only fitted to the first 200 cars."

THROTTLE CABLE -- ELECTRICAL PROBLEMS: Ron Brock says, "The starter was acting as though I had a low battery. After replacing the battery to no avail, I started in on the starter. The car would crank over fine sometimes and other times it would barely turn. After receiving several "tips" about checking the electrical connections, I went thru them from the battery forward.

"My problem became clear one night in the garage, I was attempting to start the car with the bonnet up, and it was just dragging. It was then that I noticed a whiff of smoke coming off the back of the engine. I walked around to the front of the car to determine what was "smoking," it was the throttle cable, and was it *hot* (by the way this also solved my sticking throttle problem). It seems that the engine was grounding itself thru the throttle cable. I was unable to remove and clean the standard grounding strap at the engine, so I added a second strap that I purchased from NAPA for \$4 and the car has been fine. Absolutely amazing. I would seriously recommend that anyone have starter/charger problems explore this cheap and easy fix first." See page 514.

THROTTLE LINKAGE BUSHINGS: There is a throttle shaft on each side of the engine, parallel to the heads, that transmits throttle motion to the butterflies. The rear end of this throttle shaft, along with some linkage, is supported by a plate bolted to the rear of the intake manifold. There is a rubber bushing in the plate for the shaft to turn in. This bushing is probably shot -- British nonmetallic parts again. This bushing will dry up, crack to pieces, and fall out, leaving the throttle shaft to wallow around in the opening. In fact, this is another example of a 100% failure mode in the XJ-S; if you haven't already replaced the bushings, they are probably bad right now. The effect on the throttle operation is not good, as it tends to screw up the sync of the two butterflies with each other and with the throttle pot in the turntable. There are also reports that this problem can have adverse effects on emissions tests, especially if one bushing is gone and the other is still on the job.

The part number for the original Jaguar rubber bushing is C34388. However, I don't think anyone in their right mind would recommend the original bushing -- it's rubber, for heaven's sake. Rubber throttle linkage bushings are a relic from cars with rigid linkages from the pedal to the carbs; since the engine moved around on its mounts, some means had to be provided to connect the pedal on the car to the butterflies on the engine without the engine's motion affecting the throttle position. The solution was to have one rotating shaft with one end mounted on the car and the other mounted on the engine; the pedal was connected to a lever right next to the mount on the car, and the butterflies were actuated by a lever next to the mount on the engine. The pedal twisted the shaft which opened the butterflies, and engine motion would rock the shaft back and forth without twisting it. Rubber bushings were needed at the ends of such shafts to isolate engine vibrations from the rest of the car, and to allow the small angular motions of the shaft without any binding.

None of this applies to the XJ-S. The motion of the engine relative to the car is dealt with via a throttle cable. The linkages where the bushings are used involve shafts that are mounted at both ends from the same intake manifold, so there is no relative motion. Totally rigid bearings will work fine.

This application really begs for nylon bushings, but bronze bushings would probably work just as well if you can install them so they wouldn't rattle or jingle. The shaft is 5/16", and the hole in the plate is 1/2". With a little looking, it should be possible to find a suitable generic bushing to use here. A bushing with a single lip will work; retention won't be a problem since it is effectively trapped.

Replacing this bushing looks difficult; it appears to require removing either the throttle body or the linkage support plate, either of which is a pain. You may choose to remove the linkage support plate, since it will permit you to fiddle with the bushing installation away from the car -- or take it with you when shopping for a bushing. If you go this route, make sure to have two EAC2650 gaskets on hand for each side; see page 39.

David Littlefield describes a shortcut: "I was able to replace both my bushings today in my '88 XJ-S without removing either the throttle body or the linkage support plate. I first loosened the pinch bolt on the short rod that is between the bushing and the throttle body. I then removed the spring clip that holds the spacer that fits against the bushing. By sliding both the spacer and the pinch bolt as far as I could towards the front of the car, I was able to gain enough clearance to push the rod towards the rear of the car for the ball end of the rod to come out of the throttle body fitting.

"Once I had the rod out of the car, I was able to move the pinch bolt even further back-- past the knurled portion and right against the shoulder. I then took the new bushing to my bench grinder. I carefully ground down almost all of the lip on the beveled side. I put the bushing on the rod, then fitted the rod back in the car, pushing the rearmost end in first and then putting the ball end in the throttle body fitting. I then pushed the bushing into place, while still on the rod. Removing almost all of the beveled lip on the bushing allows the bushing to be pressed into place while on the rod, since distortion of the inner diameter of the bushing is minimal. Replacing the spring clip behind the spacer and resetting the pinch bolt completes the procedure.

"As stated in the book, a bushing with a single lip will work since the bushing is effectively trapped. There are no real worries about the bushing slipping back on the rod because the spacer and spring washer hold it in place.

"I used the factory bushing for this procedure, but I see no reason why it wouldn't work with others." Littlefield gets two demerits for replacing a British nonmetallic part that failed with another part just like it -- but at least, using his method, it won't be too difficult to replace them again.

Jeff Elmore offers a *different* shortcut: "I remembered someone saying that it was easy if you did (something) and slid the shaft back through the throttle housing. Well, after some contemplation, I figured he meant removing the screws from the shaft-to-plate and sliding the plate out of the shaft and sliding the shaft forward through the housing. Well, it worked like a charm and the bushings were replaced in about 20 minutes."

If you'd like to try a more expedient fix, John Napoli describes a method he credits to Gerry Duff: "We just cut a couple of pieces of rubber hose. Slipped right onto the shafts, and is the right OD. No tools or disassembly needed. Been working fine for almost a year, and when they wear out 5 minutes to do it again. When the repair was done, the rubber hose sections were left long enough so that they could be turned around if excessive - and quick - wear was realized until a more conventional repair could be effected. Last week I asked the owner how it was holding up. He pulled the hoses, and stated that there was no visible sign of wear at all -- he had never needed to turn 'em around." Note: this author tried using this method on a friend's car, and couldn't get it to work. It apparently requires a particular type of hose we didn't have on hand; we were trying to use fuel hose, which was a little too fat to fit through the hole properly and tended to "walk" off the shaft when the throttle was moved repeatedly. Napoli suggests that the hose used with success may have been vacuum hose.

As Leslie Winfield discovered, a generic bushing with no lip will work if you can figure out how to hold it in place -- and can make installation almost as easy as Duff's fix. "I purchased a 1/2 inch x 5/16 inch bronze bushing 1 inch long, and two 1/2 inch outside snap-rings. I ran a 5/16 bolt through the bushing, pinched it with a nut & chuck it in my drill press (poor man's lathe). I shaved about .005 inch off the OD with a flat file, used a hacksaw with a 24 tpi blade to cut a groove about 3/32 of an inch from each end deep enough for the snap-ring, and then cut the bushing into two halves. With a little fiddling, the snap-ring can be threaded to the inside of the support plate, the bushing can be slid over the

shaft and through the hole in the support plate (grooved end first), and the snap-ring positioned into the groove on the bushing. The bushing is now captured on the shaft, and almost no play is observed with this setup. It doesn't look too bad, cost \$1.07, and it should last as long as my '79 XJ-S does." Of course, if you happen to have purchased bushings with a flange, you can still use this method by cutting the groove in the opposite end from the flange. While buying these bushings, you might want to buy a spare one in case you ever need to replace the thingy in your Lucas distributor -- see page 136.

Home Depot offers a nylon part that can be installed exactly the same way that Winfield installed his bronze bushings. It's stock number 30699 87298, described as "1" x 1/2" SPACER - NYLON". All of Home Depot's "nylon spacers" are marked for their OD and length, with no marking on the package at all about their ID; there are several ID's available, including 1/4", 5/16", and 3/8", but other than the stock number they are all marked the same. If they happen to be out of the 5/16" ID bushings, you could purchase the 1/4" ID bushings and carefully drill them out.

After bushing replacement, the linkage should definitely be adjusted as described below.

THROTTLE LINKAGE ADJUSTMENT: If the butterfly stop screws have been disturbed, the linkage bushings have been replaced, or any other tinkering has been done that could mess up the linkage adjustment, it should be readjusted. Also note that several owners have found that a rough idle cleared up when this procedure was undertaken, even though one wouldn't expect it to make any difference; the crossover pipe should deal with any imbalance between sides.

I'd like to simply dump the description of this procedure off on the repair manuals since any decent repair manual would provide a step-by-step procedure that's easy to follow, but unfortunately the procedures described in the ROM (Section 19.20.11 followed by 19.20.05 -- not 19.20.25, as is indicated in Step 10 even though such a section doesn't exist) is only barely discernible and the one in the Haynes manual (Chapter 3, Section 47 followed by Section 37) is bloody awful. I will endeavor to explain the process here more clearly.

In further developments, the mid-90's cars with OBD II required much more careful adjustment to avoid fault warnings. TSB #19-36, dated 10/95, says: "Diagnostic Trouble Codes (DTCs) may be set if both throttle valves are not synchronized to begin opening at the same time. The Manifold Absolute Pressure (MAP) sensors will detect a difference in pressure between the two intake manifolds, which leads to the setting of DTCs.

"The most common codes found are: P1106 P0106. The following DTCs may also be set: P0107, P0108, P0125, P1107, P1128. Poor throttle valve synchronization may also cause customer complaints of poor driveability and idle quality."

TSB #19-36 provides improved procedures for adjusting the throttle linkage on the OBD II cars, but it can be applied to all V12's with EFI. As a result, these improvements have been incorporated into the following descriptions of the adjustment procedures. Joe Bialy and Richard Mansell provided some interpretations of this TSB. Mansell says, "I suspect there are different TSB's for the different models. I guess the contents are the same but for a start the throttle pedestal is different on my '96 XJ12 compare to the XJ-S I owned so the picture with the TSB is different."

The linkage requires five distinct adjustments, which must be done in order because each affects the others. Proceed as follows:

Before starting, remove the air filter covers and elements. It is highly recommended that you clean the throats before proceeding, using some sort of solvent (see THROTTLE STICKING below) to get the areas where the edges of the butterflies contact the housings nice and clean. Rather obviously, check the condition of such things as the linkage bushings (see above) before doing the adjustment.

Disconnect the crossrods from the throttle pulley by prying them off the ball joints.

Loosen the locknuts and turn in the butterfly stop screws until they don't interfere with the butterfly motion. Make sure the stop screws turn easily enough to turn with your fingers; if they're hard to turn, you may need to take them out and clean up the threads.

Loosen the clamp on the lever at the rear end of each butterfly shaft, directly below the crossrod attachment. This lever is clamped onto a splined section of the butterfly shaft, and since the clamp takes on some toothiness the first time it's

tightened it tends to move in snaps. While holding the butterfly closed move the lever at least one snap in the open direction, both to ensure you have the clamp loose and to make sure the stop within the linkage here isn't interfering with the butterflies closing.

Adjustment 1: Loosen the screws holding each butterfly disk in its shaft, gently press the butterfly closed so that it makes secure contact all the way around, then retighten the screws. This centers the disk in the opening.

Adjustment 2: Set the butterfly stop screws. This screw prevents the butterfly from quite fully closing; if it closed completely, it could easily jam, especially with temperature changes such as shutting off a hot engine and then trying to start it the following morning.

To adjust the stop screw requires a 0.002" feeler gauge. The earliest Jaguar repair procedures specified a 0.004" (0.105 mm) gauge, but after 1978 it was changed to a 0.002" (0.05 mm) gauge -- which works fine for the earlier cars.

Insert the feeler gauge at the bottom, push the butterfly firmly closed on it, and give the feeler a little tug so the butterfly grips on it. Note that the butterfly should grip the feeler *securely*; if everything is right, it'd take a firm pull indeed to get it out. If it seems to slide out with some smooth resistance, it's probably not gripping it correctly but rather just getting close enough to be bending the feeler around the curvature of the throat. Make very sure there are no throttle stops keeping the butterfly from closing fully on the feeler.

While pulling gently on the feeler, turn the stop screw with your fingers just until the butterfly starts to let go of it. Try it a couple of times until you get the feel of the process, at least well enough that you can do both sides the same way.

Without moving the stop screw from this position, take your fingers off of it and put an open-end wrench on it. Tighten down the locknut while holding the stop screw still with the wrench.

From the TSB: "An improved factory procedure for setting the throttle stop screws, using an air flow measuring gauge, was introduced during the 1994 MY production of V12 engines. All 1995 MY V12 engines are set at the factory using this method." Many garages actually have this air flow measuring device since it is indispensable for synchronizing SU and Zenith Stromberg carburetors. It should work fine here, although you might need to remove the inner half of the air filter housing to be able to get it to sit on the intake properly -- and then you'll need to plug the bolt holes, since they create a vacuum leak. If going this route, you should set one butterfly stop screw per the directions above and then set the other butterfly stop screw to flow the same amount.

Adjustment 3: Adjustment 3 is officially to position that lever against its own stop, take up all the backlash in the coupling under the butterfly stop screw, then tighten that clamp back down. However, it moves in snaps -- you'll never get it to clamp down exactly where there is no backlash. So, hold the butterfly against its stop screw and move the lever towards its own stop until it snaps as many times as it's going to. Tighten the clamp down. When done, the linkage at this corner of the engine should have a bit of backlash: move it one way and it opens the butterfly, move it the other way and it sits on its own stop, and there should be a little movement in between. Again, make sure the stop in this linkage isn't what's stopping the butterfly itself.

Adjustments 1-3 should be performed on both sides of the engine, and obviously everything should end up as close to the same from one side to the other as possible. If nothing seems to feel the same way on the second side as it felt on the first, you probably should start over and do them both again.

Adjustment 4: Adjust the throttle crossrods. Obviously, you will need to put them back on for this procedure. Graphite lubricant is recommended in the ball joints, but it is *not* recommended that you lube them now; the powder might interfere with the adjustment. Rather, adjust the crossrods then snap them back off to apply a little graphite.

Position a spacer 2mm (0.079") thick between the turntable and its idle stop. A 2mm allen wrench works if you have one, but whatever you use try to make sure it doesn't fall down into the nether regions somewhere. The spring tension will hold a 2mm allen wrench in place during this job, but just the same it'd be a good idea to either tie a string to it or at least have the other end over the turntable pedestal itself rather than hanging out over the cliff.

Loosen the locknuts on the crossrods and adjust each link such that the butterfly is just starting to open with that 2mm spacer in place. The thread on one end of each crossrod is LHT, so with both locknuts loose you can just turn the rod itself to make it longer or shorter. They even provide a knurl to help you turn it easily.

“Just starting to open” is a bit tricky; if you have good light, you can carefully watch the lever lift off the stop screw on the butterfly. However, a better idea is to install that .002” feeler gauge between the lever and the stop screw and allow the return spring to hold it. Position it so it’s hanging over the throttle body rather than straight up. Now turn the crossrod just until the feeler gauge falls down against the throttle body.

Tightening the locknuts requires three hands: one to hold the 1/4” wrench holding the ball socket still, one turning the 5/16” wrench to tighten the locknut, and a third to keep the crossrod from turning as you tighten. If you have a third hand available, a pair of pliers might be preferable to expecting to hold the crossrod still with fingers. If you don’t have a third hand available, a pair of vice grips will work if you carefully prop them on the fuel rail.

Make sure the ball sockets end up properly oriented 90° to each other when the locknuts are tight. The flats on the one at the turntable end should be horizontal and the flats on the one at the outboard end should be vertical.

When done, check your work: put that .002” feeler gauge in the butterfly stop on each side (or one in both sides, if you have two .002” feeler gauges) and very slowly and carefully turn the turntable (without touching the crossrods themselves) until the feeler gauge drops. Note the gap between the turntable and the idle stop when they drop. Officially this backlash at the turntable stop is to be between 0.062-0.094” (1.57-2.39mm)(the .002” feeler gauge adds a bit to this, but it’s negligible).

Also make sure the two butterflies open as close as possible to the same time. If they don’t, the TSB allows an additional 0.030” of turntable travel to get the second throttle to move off its stop.

Adjustment 5: Loosen the locknut on the full throttle stop screw on the throttle pulley, and back the stop screw away. Hold the pulley in full throttle position, noting that the butterflies are both full open. Adjust the stop screw until it just touches the pulley and retighten the locknut. This stop screw merely prevents stress on the linkage while the engine is at full throttle and the kickdown switch is in operation, and is not meant to restrict full throttle.

Ensure that the throttle moves freely through the full range of motion. Finally, check for no gap at the turntable stop with the throttle in the closed position. If the cruise control cable is too tight, it can restrict the throttle linkage moving fully to idle.

You will need to warm up the car and readjust the idle speed, since the butterfly stop screw positions have been altered.

THROTTLE STICKING: Apparently, all cars have occasional problems with throttle sticking due to buildup on the butterfly itself. A butterfly cleaning procedure from Randy Wilson: “You are cleaning the throttle plate and surrounding area. The edge of the butterfly and the area of the housing right around it will be covered in black goo. Prop the throttle open and wipe the stuff out with a rag. Use the weakest solvent you can to get it clean. I start with a “WD-40” grade oil, and go to carb cleaner if it’s really bad. Oven cleaner is out. Sand blasting is not needed or recommended.

“Warning: Some non-Jag cars, notably later Fords, have a teflon coating on things in an attempt to reduce this problem. Most solvents will damage this coating.”

THROTTLE LINKAGE LUBRICATION: Jan Wikström says, “The ball-joints shouldn’t be lubricated at all, unless you want to give them a dusting with Teflon or graphite. The reason is that grease hardens and oil or grease picks up dust from the air, increasing linkage wear *and* friction.

Electronic Fuel Injection

If you wish to understand or troubleshoot the Jaguar XJ-S electronic fuel injection system, it is highly recommended that you obtain a copy of “Understanding Electronic Fuel Injection, Ignition and Engine Management” by Roger Bywater and available from AJ6 Engineering (page 663). The book is written as a primer on EFI in general, but since Bywater’s

expertise comes from years of working for Jaguar many of the examples presented happen to be Jaguar systems. Often, it seems he is talking about these cars in particular.

According to Dick White, "There is a book 'Bosch Fuel Injection and Engine Management' which I found very informative. It contains many references to Lucas." It is available from EWA (page 674), among other sources.

FUEL INJECTION SYSTEM TYPES: The 1976-80 XJ-S used a type of Lucas fuel injection system based on the Bosch "D-Jetronic" design. From 1980 on, the cars used a system referred to as a "Digital P", also based on a Bosch design. The two systems are completely different. Among the differences: The earlier D-Jetronic system used a trigger board within the distributor operated by a magnet in the rotor; the later Digital P system simply derives its triggering from the ignition pulses. The D-Jetronic has a "throttle switch" in the turntable on top of the engine that provides an on-off pulse about ten times as the throttle moves from idle to full open; the Digital P has a "throttle potentiometer" in the same location, providing a smooth varying resistance as the throttle moves. The fuel regulators on the D-Jetronic system maintain the pressure in the fuel rail at a constant value, while the regulators for the Digital P system vary the fuel rail pressure according to intake manifold vacuum.

The D-Jetronic has no oxygen sensors, lacking the sophistication for feedback control. The North American Digital P has two oxygen sensors, one in each exhaust downpipe, and Roger Bywater reports that the ECU will control the mixture in each bank separately. The Digital P systems in countries without emission regulations had the feedback capability omitted from the ECU, and had no oxygen sensors.

Bywater elaborates on the various systems: "D-Jetronic ran from 1976 to 1980 in the XJ-S but, just to confuse things, ran until 1981 in the saloon. Digital P 6CU first appeared in July/August 1980 on the 10:1 compression flat head engine rated at 300 b.h.p. in the XJ-S. Most XJ12 saloons continued with the earlier 9:1 D-Jetronic engine until the arrival of the H.E. engine in July 1981 but a few saloons were fitted with the 10:1 engine and Digital P. I understand that the improved fuelling accuracy of the Digital P EFI system was what made the higher compression engine viable.

"The 10:1 engine performed very well and was certainly the most lively version of the 5.3 ever produced but there were two things which could make it a bit fragile at sustained high speed. Firstly the cooling ability of the radiator was a bit marginal, secondly the distributor build quality was not too good and we measured errors of up to 10 degrees excessive advance at 6000 revs, which is obviously likely to cause trouble. Not surprisingly, there were tales of piston failures on German Autobahns.

"Those early 6CUs triggered from the coil negative terminal and the ECU was protected internally from the high voltage firing spikes by a 100K resistor in the input circuit. This was not necessary with the Constant Energy system introduced for the H.E. and was replaced by a link. Another important difference, apart from the fuel requirement of the 10:1 engine being different from that of the later H.E., was that full load fuelling was set into the mapped fuelling values so there was no need for a separate full load enrichment switch circuit. This means that fitting an ECU intended for an H.E. car to one of these engines is likely to magnify any tendency to burn pistons because the full load condition will be excessively weak. A number of people have found this out the hard way. Strangely the ECU seems to survive the high voltage firing spikes despite not having the protection resistor.

"The H.E. engine arrived in July 1981 in both the XJ-S and XJ12 saloon so that is when D-Jetronic really ended."

INJECTOR GROUPING: The wiring harness is set up to operate the injectors in four sets of three. However, within the ECU these circuits are combined to form two sets of six. In the early D-Jetronic systems, each set of six injectors included three on each bank, and this injection pattern is explained in great detail in the repair manuals. However, in the later Digital P systems (which include oxygen sensors), each group included all six injectors from a single bank so the ECU can monitor the oxygen sensors separately and control the mixture of each bank as a group.

OVERRUN CUTOFF: On the Jaguar V12, some EFI systems feature overrun cutoff and some don't; see the section on overrun valves on page 248.

When the foot is all the way off the throttle but the engine speed is well above idle, the pilot is clearly not interested in power; any fuel provided is a waste of fuel and an unnecessary contribution to emissions. So, if the ECU detects that the throttle is at idle and the RPM is above some set point (1500-1800 or so), fuel to the injectors is totally shut off. As the RPM drops past another set point nearer to idle speed (1100-1300 or so), the fuelling is turned back on to provide a smooth transition to idle -- or to rev it back up to the cutoff RPM. Roger Bywater: "It's easy enough to check on the car by just flicking off one throttle pushrod and opening that throttle to lift the speed without the throttle switch being moved (assuming the switch is set correctly)."

Regarding which EFI systems have overrun cutoff, Bywater says "...all 6CUs do indeed have over-run cut off above approximately 1500 r.p.m. but it is activated not only by a closed throttle signal from the throttle potentiometer but also by the vacuum signal. On a Federal 6CU cut-off commences at nominally 17.5" Hg and fuel reinstates when the vacuum falls to 15" Hg. Cut off on European versions is active over a wider vacuum band which also varies with engine speed."

"16CUs only need the throttle closed signal to activate cut-off above the required speed."

This feature can easily confuse the novice mechanic that may not be familiar with it. What will sometimes happen is that the car is running poorly, and the idle screw will have been opened up to maintain a reasonable idle speed. Then the problems with the engine are corrected, and the engine then tries to idle faster -- but hits the cutoff RPM, shuts off, drops back to the cut-in RPM, kicks back on, and sits there cycling up and down indefinitely. The mechanic thinks he has really screwed something up this time and begins all sorts of ill-conceived corrective measures when all he really needs to do is close down the idle screw a bit. It's even more confusing, of course, when the overrun cutoff feature is temperature dependent so it doesn't cutoff when the engine is cold but starts cycling upon warmup.

Another common cause of trouble is the infamous auxiliary air valve (page 245). The car is running fine one day, but the next day the auxiliary air valve sticks open and the engine starts ramping up and down upon warmup. The mechanic drives himself crazy trying to figure out the ramping, while what he really should be looking for is the cause of the high idle.

For the overrun cutoff feature to work right, the ECU clearly needs to know the throttle is at idle. On the D Jetronic, there is a special contact in the throttle switch for idle. In the Digital P, the throttle pot must be adjusted properly (page 277).

EFI GROUNDING PROBLEMS: Michael Neal sends this experience: "...the radiator had been replaced and a ground for the fuel injection harness at the right front of the engine compartment had not been re-secured. It had blown two ECUs before I found this. I don't know why but it took the ECU a week or two to blow. After I replaced the ground and ECU there were no further problems."

Reportedly, if the engine clearly is running very rich or possibly won't even start because it's too rich, it's time to start looking for grounding problems in the EFI wiring. John Napoli relates one experience: "Although ground to the ECU was one of the many things we had checked early on, the owner later went further and checked the ECU connector. He found an intermittent ground on pin 1 at the connector. This pin, according to our schematics, should ground to the frame of the car at the ground points near the battery. This wire was identified in the loom and a splicer to ground added. The car started fine and at this point is OK."

ELECTRONIC CONTROL UNIT: The following is a list of the ECU part numbers, hopefully mostly correct. Thanks go to Jeffrey Gram, AJ6 Engineering (page 663), and other sources.

D-Jetronic: Type 3CU LRZ103 and LRZ113?

Digital P: Type 6CU catalyst version: DAC 2597 and DAC 3586

non-catalyst version: DAC 2596 and DAC 3062

Type 16CU catalyst version: DAC 4118, DAC 4585, DAC 6335, and DAC 6337

These are the low compression version - presumably 11.5:1

non-catalyst version: DAC 4119, DAC 4478, DAC 4586 and DAC 6336

These are the high compression version - presumably the 12.5:1

Additionally, there is a low compression non-cat version: DAC 6338.

For one year (1981), the XJ-S had Digital P EFI on a pre-H.E. engine. Clearly, the fuelling maps for such a car would differ from those for the later H.E., and the ECU's would not be interchangeable. It's not known if any of the part numbers above apply to the pre-H.E. Digital P.

Note also that the Marelli ignition system provides a cleaner signal to the EFI system, so the ECU's fitted to Marelli-ignitioned cars have less filtering in the signal input circuitry. This may help account for the profusion of 16CU part numbers listed above. The pre- and post- Marelli ECU's are *not* interchangeable.

Richard Mansell quotes from a Jaguar publication on the changes for the 1992 model year:

"The new fuel control system, the Lucas 26CU, replaces the 16CU and provides the following benefits:

- Improved starting performance at all temperatures.
- More efficient engine operation during warm up.
- A diagnostic facility which stores fault data for later retrieval.
- Low quiescent current drain.
- Eprom socket to allow modifications.
- JDS diagnostics serial link.
- Fuel used output.
- Enhanced software.
- Enhanced limp home capability.

With the pre-facelift ECU, (Lucas 16CU), one injection is delivered per engine revolution. In the facelift condition, the Lucas 26CU, there are three injections per engine revolution. The number of pulses is reduced to one per revolution after a set number of injections.

After-start enrichment - The enrichment is now coolant temperature dependent. It decays away over a number of engine revolutions instead of over a time period and is no longer linked to cranking fuelling so that better calibration is achieved.

Acceleration enrichment is reduced; calibration is improved; over enrichment is bettered in the occasions where the driver opens the throttle very quickly.

Full load Enrichment - Where full load enrichment was determined by vacuum operated switches sensing inlet manifold depression, it is now determined by throttle potentiometer position and engine speed.

There is a single 2.5 bar mini fuel pressure regulator instead of two."

Roger Bywater continues: "The 26CU controller introduced in 1991 for 1992 model year was superseded by the 36CU type part way through 1993. 36CU was the next stage of development of the 16CU, 26CU theme and was itself superseded at the end of 1994 by the much more advanced Pecus / Nippondenso system of full engine management."

The people at John's Cars (page 668) say they will test your ECU for you, free of charge. They are confident you will eventually be buying something. They add, however, that since testing requires a car, there may be a few days' delay until they have a car with the correct system on hand for the testing.

Of course, you can probably learn a lot yourself if you have a friend with a car similar to yours. Swap the ECU's and see how many problems go with them.

If your ECU gives up the ghost, please see the comments under Performance Mods (page 290) before spending the major \$\$\$\$\$ for a new one. Also, you might want to contact AJ6 Engineering listed on page 663, or Corsaro Electronics on page 657.

If you wish, you can open the ECU easily enough; it is a simple cover-body-cover sandwich with several screws holding it together. Note that a couple screws have aluminum caps that serve as a tamper indication; it might be wise to inquire about policies regarding exchanging an opened unit before opening.

Take precautions to avoid static electricity discharges while inside this unit. Usually, it is sufficient to keep one hand on the chassis while working.

EFI WIRING HARNESS TROUBLESHOOTING: Matthias Fouquet-Lapar suggests "one thing I would do is to put in fixed resistors for the various sensors direct at the ECU connector" to find out if there's a problem in the harness.

INJECTOR CONNECTORS -- D JETRONIC: The connectors on the early cars are a simple plug that inserts into a rectangular recess on the injector. If you need new connectors of this type, Ed Sowell says you can get them at NAPA. "They have what they call "harness rebuild" parts which is a selection of connectors and pigtail wires with various connector styles. You buy the connector body and the pigtailed separately, and assemble. Be sure to ask for "harness rebuild parts," as you will get nowhere asking for injector connectors. The NAPA numbers are:

housing 2-17411 (this is the plastic connector body)

contact 2-17421 (this is the pigtail with the connector attached-- 2 req'd per connector)

Also discovered that NAPA has the contacts themselves without the pigtail wires."

Tom Simon says, "I have located a source for the injector connectors for pre-HE engines. They were ordered from Fuel Injection Corporation in California. Their web site is www.fuelinjectioncorp.com. The connectors are part number 920155B; they are black rather than the original white. The terminals with no wires are 920121B. They also have the boots (920125B) for the connectors. I ordered 20 connectors, 14 boots, and 50 terminals. The total order including shipping was less than \$35.00."

INJECTOR CONNECTORS -- DIGITAL P: Apparently Bosch decided the simple rectangular plug wasn't secure enough, so they developed a much more sophisticated connector for the Digital P system. These connectors are a rectangular hard plastic box that fits around the connector on the injector, and they have an external spring to provide snappage. These connectors simply pull off, although they can be a real bear sometimes. It might not be a bad idea to apply a little grease or something to that spring or the little point that it snaps around to help get it off next time.

These same connectors are also used on the Digital P temperature sensors.

According to Peter Cohen and others, NAPA offers this connector in parts or as an assembly. The assembly, with pigtailed hanging out, is part number 2-17424. In parts, the numbers are

Housing - 4 per box 2-17416

Spring Clips - 25 per box 2-17417

Terminal Ends - 25 per box 2-17418

Michael Bucklew says, "The NAPA parts did not fit due to the lip around the bottom that holds the spring clip. My plugs do not have the lip around the bottom. The NAPA parts were \$14.49 each for the plugs." It's unknown if Bucklew's comments apply to the pigtailed assembly, the individual parts, or both, but at that price who cares? That's too much.

Rue Palmer says the problem is that is apparently the wrong NAPA part number. The connector you need is NAPA part number 2-17427. He describes this as a "Wired Housing (a wired connector minus the spring clip). I had to use the spring clips from the old injector connectors because the new connectors don't come with them."

Lucas lists the parts this way:

housing	526 8917	comes in packages of four
contact	526 8918	comes in packages of 25
spring	526 8930	comes in packages of 25

The Lucas parts, as would be expected, fit fine; this author used them on my harness rebuild.

It appears that the complete connector with pigtails is the most common way to find these parts. Discount Auto Parts also carries Caltherm, item number 08653, "GM Multi-Port Fuel Injector Connector". Costs less than two bucks each.

Cohen: "Other vendors are:

Conduct tite: Fuel Injection Repair Socket #85850

Dorman: Connector kit #643-463"

John Robinson adds, "Beck Arnley makes an OEM copy connector w/pigtail: 158-0017."

Ed Forman says, "I looked at several parts stores, found some that looked like they would work at an Auto Zone store. But the back stuck out too far and hit the plate that holds the injector in place. In desperation I went to a Jag dealer, they had the same type as the Auto Zone store. But I found the right ones at an Auto Value store. They are made by Parts Master part # 84059, they work great. About \$3.00 each, that's better than \$12.50 at Jag."

Patrick MacNamara says, "Best deal I have found on the injector connector housings is from Del City. They were only \$1.03USD each and are complete with 6" pig tails, #73522. No boots though." MacNamara ditched the pigtails since he wanted to use high-temp wire, which meant he needed terminals separately: "The terminals for the injector housings are available from your local Volvo dealer at about \$.75CDN each (Cable terminal #V0978258-2). The terminal connectors from Volvo are nifty two piece quality looking terminals and don't look as cheap as the ones installed by Del City with their pigtails. They have the double OEM crimp with one on the insulation and one on the actual wire which if I understand correctly should negate fatigue. The terminal crimp part seems to be referred to as an open barrel arrangement necessitating special crimping pliers."

So, Patrick, why didn't you get the housings from Volvo as well? "I had purchased one to trial fit it to the Jag injector. They are of a superior design in terms of positive locking with a nice button for release as well as being made from what looks like high impact resistance plastic. Unfortunately the button release and lack of half moon cut out negates the fit onto the angled injector port."

None of the above items seem to include the rubber boot that covers the joint between the wires and the plastic connector. Gregory Wells says, "Wurth markets the rubber boot and as with all Wurth parts, they're expensive. I think the Wurth part number is 5-7120, but I'm not real sure of that. Wurth distributes hardware and shop supplies to repair shops via independent salesmen and as far as I know does not distribute to the retail market, so if you want to chase these down call import repair shops to see if Wurth calls on them."

Rue Palmer says you can get the boots from NAPA: "Harness Boots (for those who want the original rubber boot- 2 per box): 2-18414"

MacNamara adds, "Boots are also available from Volvo at \$1.84CDN each (Housing cover #V0967340-1). These fit the Del City Bosch connectors very well but are slightly shorter than the Jag OEM ones. They are also much sturdier looking."

If you can't find the boots, screw it; the harness will work just as well and just as long without them, and probably look just as good or better. Keen Young says, "My solution was 1/2" shrink tube over 1/4" shrink tube. Put them both on the wires, solder on the connector, slide the small tube up to the connector, slide the large tube over the small one and over the connector, heat. If you look *really* closely, you can tell it's not factory. Got the tubing at the local surplus store for \$.20/foot."

It's also apparently possible to upgrade this connector. Since it's used on so many types of car and has been for so long, it's to be expected that companies have come out with improved versions. Mike Waldron says, "Autotronic Controls, makers of MSD Ignitions (<http://www.msdisgnition.com>), make weatherproof (don't need no stinkin' boot) connectors

for Bosch style injectors. These are designed to be removable from the injector, thus they don't break! The part number for a bag of eight is: 2400"

Unfortunately, Tom Bennett says, "Nice connectors, only problem is they do not fit! The lock/unlock mechanism gets in the way with the injector hold down. Nice for the other sensors though." Hmmmm; sounds like the ones Forman found at the Jag dealer.

Robinson, who works at Bosch, says, "Delphi/Packard Electric makes a great connector that I believe will fit:

15305086 - connector body

12176636 - terminal

12176807 - seal

15326238 - spring

"These are for the new GM eco-tech V6 wire harness. Anybody who carries AMP products should be able to get them."

You could just drop into a junkyard and buy a bunch of connectors; lots of cars use Bosch injectors and most of them don't cook them like Jags do. Guy Poppe says, "I gathered 12 from the junkyard from GM cars. Nice and sturdy and clip on -- great. The connectors are too big as they strike the mounting plate. Tried a Chrysler connector from my '94 LHS and they fit. They look different than the GM or Jag ones but again better quality."

INJECTOR CONNECTOR REPLACEMENT: In case you're trying to keep straight which wire goes to which side on each injector, Keen Young says, "No polarity. The injector doesn't care which side is ground (earth)."

Bill Farnsworth: "Last month I changed all my plastic injector connectors without removing the existing leads. I replaced all 12 connectors in 3 hours. Knowing a bit about connectors and wiring kinda helped too. Here is how I did it:

"Tools required:

Small flat blade jeweler's screwdriver

Small utility or x-acto knife

Hot air (750w) heat shrink gun

A three foot length (appr.) of 1/2 in" shrink tubing

1 Tube silicone glue/sealer

"Remove the connector from the injector. With the utility knife cut away the existing heat shrunk rubber from around the base of the connector leaving enough to maintain a base of rubber against the connector. You will notice that there is a small amount of epoxy glue holding the rubber to the base. Work the rubber and connector back and forth (like snapping a crab leg) until the glue releases. Turn the connector toward you and inside you will see a small slot above each lead. Insert the small jeweler's screwdriver into the slot; this releases the tab holding the lead to the connector. You can pull the lead out now. If it doesn't release, work the screwdriver around until it does release. Or you can just break the old connector off; it's toast anyway.

"What you have left is a clean wire with two leads, and a 3" length of Jaguar rubber boot, all intact. Neat!! If the leads aren't clean, now is the best time to clean them with alcohol.

"Now, slide a 4" or 5" length of 1/2" shrink tubing over the leads and boot. The tubing has to be long enough to go over the entire boot and cover both ends by at least a half an inch to prevent water seepage. Next put a small amount of silicon glue/sealer around the base of the boot that meets up with the base of the connector. Be careful not to get any sealer on the leads.

"Now take the *new* connector and push the leads thru the end until they seat. The base of the connector will mate up perfectly with the boot and the glue will seal up the end of the connection (just like original).

"Slide the tubing up and over the boot and over the base of the connector until it clears the lip by the same distance as the original (look at the next injector connector). Take up your heat gun (a hair dryer might work, but probably doesn't have enough directional control.) and warm up the shrink tubing until you have a perfect fit around the connector and boot and wiring at the other end. Take care to not melt other wiring in the area. Aluminum foil works as a good heat shield/deflector. Move onto the next injector. The first one will take you a while. Once you get a feel for how everything comes apart and goes together, then the whole process will take you 5 minutes per injector."

IS YOUR INJECTOR HARNESS COOKED? Surprise, surprise. Craig Sawyers explains: "As some of you will have found, the insulation on the wires under the hood gets really brittle with time, and cracks. I was just browsing the Farnell catalogue (major electronic component supplier), and their selection of "automotive cable" uses PVC insulation, with a maximum temperature spec of 70°C. Interesting, think I. In fact, most PVC insulation conks out at 70°C. Some special UL-rated cable goes to 90°C (or 105°C if it won't be moved while it is hot, some hope on an engine). So it is practically guaranteed that the insulation will fail on a Jaguar, even if it doesn't overheat! This is particularly true of the V12, where both major engine harnesses run smack down the centre of the V."

Is this a serious problem? It's just cosmetic, right? You don't care except the wires look bad, right? Well, ask Rue Palmer, who had a sudden loss of power and immediately pulled over and opened the hood to see what was the matter: "It looks like one of power wires in the injector harness shorted out due to the PVC wire insulation becoming brittle and cracking, which then melted most of the insulation from the wires to the right bank injector harness. It appeared that when the harness shorted it caused all the injectors in the right bank to go to a continual spray condition which flooded out the right bank and dumped raw fuel into the exhaust system. Upon examination the next morning, both the right exhaust and the engine oil had gas in them.

"Additionally, gas sprayed into the engine compartment caused by the injector located at "5 A". It had a hole melted in the housing of the injector body. None of the fuel lines appeared to have been damaged but I replaced them all anyway. To this day we don't know why we didn't have a massive engine bay fire. The wire in some places was glowing when we lifted the hood. I don't think the fire extinguisher that I carry would have put it out if it would have ignited."

Funny thing: the only reason Palmer pulled over that quick is because he had read this book, and thought he was experiencing the Marelli failure described on page 154. His car doesn't have Marelli ignition, though, which was the first clue that this problem was different.

Half the wires in the injector harness are connected to 12V power, and the other half go to the resistor pack and then on to the ECU in the trunk. If any of the latter half short to ground, 12V power will be applied continuously to an entire bank of injectors. This will flood out the bank, but worse it will cook wires and melt injectors because these circuits are not designed to have 12V on them for longer than a couple of milliseconds at a time.

Still, reports of this cause of engine fires are not common -- which makes sense, actually. Once the fire starts, all the insulation in the V will be burned away and the wires scorched, so it will be impossible to diagnose this cause. Palmer is probably an *extremely* rare case for having caught it before ignition.

Sawyers: "It wouldn't be so bad if they had been routed along the fuel rails." Actually, this is fix #1 -- relocating the injector harness *before* it gets cooked. This author moved it off the bottom of the V and up just an inch or so, fastening the harness clips under the intake manifold nuts rather than under the bolt heads holding the valley cover on. This gets it out of the oil deposits and keeps it a lot cooler without changing the appearance of the engine significantly. If you're unconcerned about appearance, it is a simple matter to relocate the harness right up on the fuel rail and tie it in place with zip ties.

If your harness is already cooked, consider fix #2 -- rebuilding the harness using better wire. Sawyers: "The real McCoy seems to be Raychem Flexlite High Performance wire. This stuff is double insulated, with a primary insulation of radiation crosslinked polyalkene, and a jacket of modified PVF2. Operates at up to 125°C and has excellent chemical resistance (ie oils for us) (they say). The problem? It is a factor of ten more expensive than standard automotive cable. This means (in US speak) about \$1 a yard for the most common gauge."

Another possibility is Teflon-insulated wire. If you find a source, buy it and use it. Of course, asbestos-insulated wire would work great, but isn't recommended anyway.

Del City (page 657) offers “cross-linked polyethylene” insulated wire which is supposedly good to 177°C (350°F). That oughta be enough!

Del City will add stripes to wires if you want, but it’ll probably entail minimum order sizes beyond reason for the home mechanic. If you find sources of small lots of color-coded wire, good for you, but if you’re limited in colors you can color code them with pieces of heat shrink tubing, or even type up little labels and fasten them to the wires with clear heat-shrink tubing. If you wanna get fancy, there are professional wire labelling products available.

To end up with a reliable injector harness, you can either rebuild the one you’ve got or make an entirely new one from scratch. Either way is about the same amount of effort, but rebuilding the existing one requires less thought. Just mark which plug goes to which cylinder, then take the whole thing off and lay it out on the bench. Strip all the wrapping. One by one, cut out the dried, cracking sections of wire and replace them with new sections. Use heat-shrink tubing to seal all soldering jobs. Of course, you may choose to replace injector connectors while you’re at it -- see above.

Making a new one from scratch is not only not really any more difficult, but it results in a considerably neater appearance and more pride in the accomplishment. Again, take the harness off and lay it out on the bench and strip the wrapping. But in this case, merely inspect it to see how the wires are routed and connected, measure the lengths, and make an entirely new harness. If you wanna get professional about it, you can lay down a sheet of plywood and hammer nails into it as a guide to making the new harness, but this really isn’t called for on a one-time job.

There are even a couple of minor changes you might make to your new harness. When this author did this job, one change made was the location of the section of the harness that passes from the right bank over to the left bank side. On the OEM harness, this bundle of wires passed under the A/C compressor. The new harness was altered slightly to have this bundle pass to the rear of the compressor and under the cruise control bellows instead, a much more convenient location.

You probably won’t be able to find a replacement for the big plug at the right side fenderwell, but the original one is probably OK due to its location away from the serious heat; you can merely dye it off and splice it into the new harness assembly. If you would rather replace it, you can get some generic connectors and replace the connector on the end of the harness on the right fenderwell that the injector harness connects to. You need connectors with at least five terminals (the original has eight, but you can combine some). You can, of course, connect them up with multiple smaller connectors, or even a bunch of individual spade connectors, but that would look crummy. Perhaps the best connectors available are called Delphi-Packard automotive connectors; they are commonly used in modern GM cars, and they are completely sealed so they won’t corrode. They are likewise available from Del City; you can use either a single 6-pin or two 4-pin connectors for this job. If you choose to use two 4-pins, you might actually opt to create two completely separate injector harnesses, one per bank.

Del City also sells new high-temperature loom, but if you want you can just bundle the wires with zip ties every few inches and leave them visible.

If you’d like to review some photos of the injector harness work, visit

<http://www.jag-lovers.org/xj-s/book/InjHarnessRebuilding.html>

I know what you’re thinking: “Too much effort; I’d rather just buy a new harness.” Wrong. First off, you clearly have no comprehension of just how far Jaguar can gouge the customer for a few wires and connectors; once you price this item, after they pick you up off the floor you *will* be shopping for wire and a soldering gun. Second, remember that a new Jaguar harness is made from the same cheap PVC-insulated wire the original harness was, so all that money only buys you a temporary fix -- it will soon be cooked again. Better to do it yourself and do it right.

Also note that the injector harness accounts for most of the wires in the V, but not all. Once you’ve got the injector harness fixed, you’ll probably want to similarly upgrade the other wires in the area.

RELAYS: There are several relays involved in the EFI system. They are discussed along with all the other relays in the car starting on page 521.

FUEL INJECTORS: If your engine is running or idling rough, one possible problem is a plugged or bad fuel injector. This may be indicated if the misfire always seems to be the same cylinder, although a bad spark plug or wire or mechanical problems in that cylinder are other possible causes. One-cylinder problems have different symptoms than they would have on a carburetor system, because a misfire in one cylinder causes the fuel and oxygen to enter the exhaust unburned. The oxygen sensor will pick up the excess oxygen, and the ECU will conclude that the engine is running lean. The ECU will then richen the mixture to all 6 cylinders on that bank, and then the whole bank sounds bad, not just one cylinder. If you have catalytic converters, they might start getting toasty as well -- see page 297.

If you have a trip computer in the car, chances are pretty good that the indicated fuel mileage doesn't agree with the actual mileage determined by the odometer and the fill-ups. However, the error should be pretty consistent -- off by about the same amount every time you check. There have been some reports that a sudden change for the worse -- the actual fuel economy gets quite a bit worse while the trip computer is still indicating about the same as before -- may be an indication of an injector gone bad. The trip computer calculates fuel usage based on what the injectors are *supposed* to be flowing, not what they actually *are* flowing, so when an injector jams open or starts leaking the fuel mileage goes to hell while the trip computer still thinks everything is fine.

If you suspect there is a problem with an injector, John Keppler suggests you use a stethoscope first. "I started the engine, then using a mechanic's stethoscope, listened to each injector. I could hear every one loud and clear except 5A, which was dead silent. I found the bad injector in seconds with a mechanic's stethoscope."

If you have an injector that doesn't seem to be working, pull the connector off and check the windings with a VOM. The windings on an injector should measure 2.4Ω at room temperature, and must not be shorted to the injector body.

You could get lucky like Keppler did. "I pulled the plug on my 5A injector and measured its resistance. The cheap meter I was using read 2.9 ohms. That looked reasonable. I then measured the voltage across the plug contacts with the engine running. I can't remember the voltage I got, but it was identical to the 1A connector (the most accessible plug to use as a reference). At this point, I plugged the injector back in and started the engine. With the stethoscope I could tell that it still wasn't working. Then I tried tapping 12 volts directly across the injector. The injector clicked! Loud and clear! So I once again plugged in the injector and started the engine. This time, I could hear it working just fine with the stethoscope, and the engine ran smooth. I can only assume that I either had a bad contact at the plug that got cleaned up by repeated unplugging and plugging, or the injector was just plain stuck, and hitting it with a good shot of 12 volts freed it up."

If you're not as lucky as Keppler, purchase one of the many fuel injector cleaners available that can be added to the gas tank. The common advise on how to use in-the-tank injector cleaner is -- as concentrated as possible. Run the car down to 1/4 tank, then add the injector cleaner, then run it down to nearly empty before refilling.

If that doesn't fix the problems, the next step is to take the car to any place that specializes in fuel injection work. They can flush the injectors with a cleaner by just connecting a line to the fuel supply line and running the engine.

If this doesn't work, the next step is to depressurize the fuel system, disconnect the supply and return hoses, remove 24 nuts and remove the rack of injectors as a unit. Take it to the same fuel injection shop and have them flush it in a rig. With it separate from the engine, they can use much more powerful cleaners than they can on the engine. Best of all, even if their cleaning doesn't fix the problem, they will be able to tell you if any injectors are bad and which one; they can actually watch them spray on the bench.

If you're the adventurous type, you might try testing the injectors yourself. Unbolt the set from the engine and raise them up a few inches while leaving the fuel supply and return hoses connected. Jumper the relay in the trunk to allow operation of the fuel pump with the engine off. *Immediately* check that no injectors are dribbling fuel. Place a small glass jar around one injector. Connect a couple wires to this injector, and give it a quick zap with 12 volts. Note: do not leave 12 volts connected continuously; only give the injector instantaneous jolts. Observe the performance of the injector. Repeat for all injectors; you can empty the glass jar back into the tank between tests. Obviously, any injector that seems to perform differently than the others is suspect. No smoking is suggested during this procedure, and it would also be wise to avoid electrical sparks.

Tony Gardner reports that J. C. Whitney offers a device for doing such tests called an Injector Inspector. "This device is hooked up to the battery and one can select various combinations of pulses to operate individual injectors. They suggest using it with the injectors in-situ and timing pressure drops but I did not find this very convincing."

"Back lighting with a flashlight is helpful. You can also rig the device to facilitate pumping cleaner through each injector." If you can devise a pressure container with one line in the top and another out the bottom, you can fill it with flushing fluid and connect the fuel line in the top and let the fuel pump push it through the injectors.

The injectors can be replaced individually, and there is nothing wrong with replacing only the one that's gone bad. Replacing the whole set is expensive, and usually not warranted.

The only differences between injector part number 0 280 150 163 (1985-91 front two), and 0 280 150 164 (1985-91 rear ten) is the length of the piece of hose attached to them. These injectors were fitted as a recall to cars with injector part number 0 280 150 105 (1980-85), so those injectors have no functional difference either.

The D-Jetronic cars had either 73143A/0 280 150 023 or 73143B/0 280 150 035 injectors. Some reports indicated that the last three digits indicate an orifice size difference, but Roger Bywater of AJ6 Engineering assures us that the number reflects a minor design change only and that all of these injectors have the same flow specifications. Note that the D-Jetronic injectors do *not* have the same flow rate as the Digital P injectors.

Richard Mansell quotes from a Jaguar publication on the changes for the 1992 models:

"New smaller lighter fuel injectors allowing the fitment of a lower mounted fuel rail, giving improved control of fuelling at small pulse widths."

Fuel injectors tend to be blamed for a lot of problems, probably more than they actually are responsible for. Michael Neal (Jaguar mechanic) says: "The only failed injectors I have seen have been from running water through them or running a car with a blown head gasket to death."

FUEL INJECTOR PULSE CHECKING: Robert Dingli suggests "an oscilloscope or a smart DVM with pulse width or duty cycle readouts can be used to check the injector electrical supply. Some modern ECU's can detect whether an injector is unplugged (or short circuited) and thus it's best to connect the electrical apparatus in parallel with the injector." Michael Neal says the injector pulse width should be around 3 milliseconds at idle.

John Keppler suggests you could go with what you have and check the injector pulse with an old-fashioned dwell meter. Hey, you're not using it anyway; if you still have any cars with points, it's high time you installed electronic ignition modules in them. Keppler points out that a dwell meter is merely a 12V duty cycle meter with scales in degrees instead of 0-100%. Disconnect one injector connector and connect the two leads from the dwell meter to it -- which may require sticking some small flat metal things into the plug. Ideally, buy a new Bosch plug and create a jumper to connect the dwell meter while leaving the injector connected. Fire the engine up and see what happens. Remember to check both circuits (there are two, one per bank on the H.E. and all mixed up between banks on the pre-H.E.).

At this point, I cannot offer any guidance on just what kind of readings to look for. Remember that, while point dwell should stay relatively constant with RPM, injector pulses will indicate a "dwell" that varies with engine RPM and load. Just check the dwell meter readings on someone else's car as a basis of comparison; it probably doesn't even need to be a Jaguar, since pretty much any fuel injector should be seeing the same kind of injector pulses.

INJECTOR SEALS/NOISY FUEL INJECTORS: Each injector is mounted with two rubber rings, a small one at the tip and a large one around the body. These rubber parts isolate the injector from the manifold. There are two reasons you might want to replace your injector seals. The first is noise; Hunt Dabney says: "On the noise issue, I just replaced all of the injector seals and rubber mounts. My injectors are now *really* quiet!" The other reason, of course, is to eliminate vacuum leaks; the smaller ring at the tip is obviously critical for sealing the intake manifold, but the larger is also important for holding the injector securely against the smaller.

Frank Perrick points out that these seals are available at any auto parts store since they are standard Bosch items. The seals come in packages to service four injectors, so you will need three kits for the V12. Here's a tip for getting the guy

behind the counter to get you the right parts: When he types all the make and model data into the computer, one of the screens he will face is where he must select the type part you're looking for. One choice is "fuel injector/carburetor gaskets", but if that selection is made it will come up with some obscure part number and claim it's not available. If, on the other hand, he selects "fuel injectors", it will come back with a listing for the "fuel injector seal kit". Or, Perrick suggests you can just carry an injector in there and say "I need these gaskets".

John Napoli found a different kit: "Standard Motor Parts SK-3 does the trick -- handles four injectors (eight rings -- 4 big and 4 little) for less than \$4.00 US." A similar kit, the one carried by AutoZone, is GP Sorensen part number 800-9207. The kit offered by Discount Auto Parts is Tomco part number 27013.

However, not all kits are the same; some carry parts besides the two rubber rings. One such kit is Beck/Arnley # 158-0021 vp 1; B.J. Kroppe says, "The kit included the small, square-sectioned seal between the injector tip and plastic cup, as well as the large rubber washer which I believe isolates the clicking injector from the rest of the engine. The last bit that was in the Beck-Arnley kit was the tiny (nylon?) mesh filter that fits into the top of the injector fuel inlet. This is a neat design."

Kroppe also found a set from Python Injection, Incorporated, part number 200-120, with even more parts. "Description: large injector washer (isolator), square section o-ring seal, mesh injector inlet filter, injector tip cup (does not fit Jaguar injectors)."

You might wish to make the extra effort to find seal kits with pintle caps -- see below.

FUEL INJECTOR PINTLE CAP: You can't see this thing when the injector is in place, since it is on the end buried in the intake manifold. When you take the injector out, though, it is the plastic cap that completely surrounds the injector with a hole at the tip where the pintle is. The original pintle caps are a tan color, and reportedly not very reliable; you're likely to find them damaged. Richard Chapman says, "I got black caps in my seal kit, along with the 2 rings. Just pulled off the old ones with pliers and a twisting motion - not too difficult, just a bit nervous on the first one. I could not have reused the old caps once removed. It was difficult to get the new ones to fully seat inside the recess where the injector tip meets the injector body - lots of fiddling needed except on the 2 different ones which fitted with ease!!! Weird."

Paul Hackbart says, "The pintle caps are not for spray pattern but for heat protection. To replace them I used a little mm socket so not to damage the solenoid tip and tapped it back on to click into place. I would replace the pintle caps regardless. When I did mine, 3 or 4 were cracked and most of them at the end were missing. The original orange ones are not recommended as all pintle caps by Bosch are black/heat resistant."

IDLE STUMBLE: A stumble may be a sign of an intake manifold leak. Since the EFI senses manifold vacuum and meters fuel accordingly, it would make sense that an intake manifold leak would only cause a high idle, not a stumble or misfire. However, a manifold leak that is near the intake of one particular cylinder apparently has more effect on that cylinder than on others, and can cause an individual cylinder to run lean. This may be quite serious, since a lean-running cylinder is a candidate for a dropped valve seat -- a very expensive problem. If a leak is suspected, a can of WD-40 makes an excellent leak locator; simply spray on each area while the engine is running and see which spot makes a difference when sprayed on.

The gaskets between the intake manifold and the heads are common leak sources. It appears to be necessary to retighten the manifold-to-head nuts occasionally, especially shortly after a reassembly. In fact, just go out to the garage *now* and torque 'em all down.

D-Jetronic

RECOMMENDED READING: Roger Bywater wrote the definitive guide to the D-Jetronic system, published in Vol. 2, No. 2, *Jaguar Quarterly* (now *Jaguar World* -- see Kelsey Publishing, page 674), 1989. It is *highly* recommended that owners of cars with this system obtain a copy of this article.

Ed Sowell says

<http://www.914fan.net/djet.html>

is a site providing info on the D-Jetronic system in the Porsche 914 by Kjell Nelin. The EFI systems from that era were similar, so this makes good reading for the early XJ-S owner.

TRIGGER UNIT: The trigger unit originally fitted inside the distributor had magnetic reed switches and a three-wire connector that plugs into the EFI wiring harness. However, the replacement trigger unit uses Hall effect circuitry and has a fourth wire, separate from the connector; three-wire units are no longer available. The fourth wire must be connected to a 12V power source that is switched on with engine ignition. Unlike reed switches, the Hall effect sensors require a power supply.

Reportedly, the official Jaguar procedure is to connect this wire to the white wire at the ballast resistor. This, in fact, should provide the proper switched 12V source -- on paper, anyway. However, Ray Reynolds reports that the 12V available at the ballast resistor was so noisy that it caused the injectors in his car to fire wildly, resulting in flat spots and even stalling at some throttle positions. He simply reconnected this wire to a more reliable 12V source and his problems cleared up.

Jan Wikström points out that if you have the Hall effect unit, the testing procedure in the ROM won't work.

TRIGGER UNIT CONNECTORS: Peter French claims to be one of the few people that still has reed switches in his car rather than the Hall effect sensor. "I also had a good problem earlier with the 3-way connector to the injector switches. The centre (0v) pin had two wires going to one pin and they were "over-crimped". One wire had broken such that the reed switches had no common return unless the idle switch contact on the throttle switch was closed. Net effect was that the car would start and idle fine but cut out as soon as the throttle was opened!"

MANIFOLD AIR PRESSURE (MAP) SENSOR: One man's pressure is another man's vacuum. Yes, the conditions within the intake manifolds on non-supercharged engines are commonly referred to as vacuum, but engineers normally refer to air pressures in terms of absolutes rather than relative to atmospheric, so the sensor measuring the air pressure within the intake manifolds is referred to as the "Manifold Air Pressure" sensor.

Mike Morrin: "I would strongly recommend that all owners of cars with this system periodically check the manifold vacuum sensor for internal leaks. I stress this because when I needed a replacement for mine, I was told that new units are no longer available for the "early" calibration systems, and so I needed to find a good used one. This resulted in me driving around London (I was officially in the UK on business) for 2 days sucking on manifold vacuum sensors at all sorts of dodgy Jaguar parts shops. Of the dozen units I saw, only 5 did not leak, and only one of these was the correct calibration for my car. There are obviously a lot of cars on the road with leaky sensors."

"The sensor is the aluminium cylindrical thing right in the front right hand corner of the engine compartment. The test is simple, disconnect the center hose from the tee piece between the manifolds (above the distributor) and suck on it as hard as you can, there should be no hissing sound from the sensor unit. Then stick your tongue over the end of the pipe while releasing the vacuum in your mouth. The hose should stick to your tongue for several seconds before it (the hose) drops off.

"Internally the sensor has a barometer bellows, but there is an extra brass (?) diaphragm which provides the vacuum seal. This diaphragm flexes every time the manifold vacuum changes and it is not surprising that metal fatigue sets in and causes a split around the outer edge. This is an example of Bosch design which would make Lucas look good (if Lucas had not insisted on sticking their name over the Bosch logo!).

"If the sensor is leaking, then the engine will be running rich, particularly at part throttle, but this varies depending on the size of the split in the diaphragm.

"I did attempt to repair my faulty manifold sensor, both by adding a rubber diaphragm and by soldering up the split in the brass diaphragm, but both of these repairs resulted in a significantly lean mixture."

Roger Bywater of AJ6 Engineering (page 663): "If there is a break in continuity to either winding on the pressure sensor the entire system will be dead. Really all that most people can do is check the two windings for isolation and resistance (nominally 350 ohms between terminals 8,10 & 90 ohms between 7, 15) and the assembly as a whole for a vacuum leak. Obviously that will cause excessive richness at light load whilst full load will be unaffected, although in practical terms a minor leak may not be all that important. Electrical failure is extremely rare and I don't suppose the aneroid bellows fail very often, unlike the full load diaphragm on the European version which is prone to splitting around the edge (which can be repaired by careful soldering in the early stages. These devices come apart quite easily once the 4 rivets are drilled out. The pressure sensor being effectively a variable inductance transformer, function testing would entail firing pulses or low voltage AC through the primary winding and measuring what happens at the secondary. In fact the most practical way to test one is to link it to an ECU on a bench rig representing the vehicle installation (such as we use) and measure injector pulses at different loads at a set speed. Obviously not many people will be able to use either method."

D-JETRONIC REPLACEMENT: Roger Bywater of AJ6 Engineering (page 663) says "it is not that bad a system and shouldn't be that troublesome really if it is properly set up (correct throttle balance is vital). Although odd bits like trigger boards and pressure sensors do fail occasionally, and injectors tend to jam if exposed to water contamination, the ECUs don't often go wrong (unlike early HE 6CUs) and really the wiring and connectors are the main problem areas as they age. It is a lot easier to go over the connectors, cutting back the wires and soldering them to the terminals, than to strip the lot out and install a new system.

"If the system is beyond economic repair and really does need to be replaced then I would have thought that by far the easiest route would be to simply fit all the hardware, including manifolds, plumbing and Constant Energy ignition, from any HE engined car from 1981-88 and use a 16CU controller (1986-91) and have us install the correct program for the early flat head engine (Super Enhanced option available). This setup has been used successfully on a number of V12 E types converted from carbs to EFI and has the great advantage that all the parts are familiar and easily available.

"Aftermarket ECUs sound great but in practice involve a lot of time and effort to get right and would be hard to justify for a standard engine. It would definitely involve rather more than "just wiring in a new processor" and any improvement in performance or fuel efficiency would be minimal.

Cold Start Injectors

SCHEMATIC CORRECTIONS: In the Haynes manual 478/49015, you should mark Fig. 10.124 and 13.92 at the thermotime switch #298 to show a ground connection on the line at the bottom between the heater and the contact. Without this ground shown, it's *really* difficult to figure out what's going on!

Also note that the thermotime switch contains a thermal switch and an electric heater. The schematics make it look like a relay. It should show a resistance rather than a coil.

Note also that Section 19.22.32 of the ©1975 ROM shows a schematic of the cold start injector system that is poorly labelled at best. It shows "12V" connected to 86C via a WR wire, when it would have been much clearer to mark the wire "from starter relay" -- there's no power on it except when the starter is engaged. The thermotime switch is at the

bottom left, unlabelled and no innards shown. The cold start injectors are at the bottom right, unlabelled and no innards shown. The cold start relay is at top center, unlabelled with the innards shown incorrectly; since it shows five terminals including an 86C, it is evidently attempting to illustrate the system with a bootstrap circuit (see below), but there are no internal diodes shown and there is no internal connection to terminal 86. Ken Gray and Roger Bywater claim the illustrations in the same section in other ROM's such as the early XJ12 ROM show the non-bootstrap relay (four terminals) largely correctly.

COLD START RELAY VARIATIONS: Basically *all* of the schematics showing the cold start injector system on the D Jetronic EFI system show the cold start relay as a simple relay: one coil and one contact, 4 terminals. If the car is really wired that way, the cold start injectors will *only* operate while the starter is engaged. This makes good sense; once the starter is released, it can be presumed that it's because the engine has fired and therefore there is no more need for the cold start injectors to be spraying. In this configuration, the only reason the thermotime switch cuts off after a few seconds is to prevent flooding in case the owner holds the starter on for a long time.

Ken Gray says the early cars were wired differently, though: "In reality, (76 model XJC5.3 Oz spec & also 75 Daimler Double Six brit spec.) the relay is a five terminal relay. It has two internal diodes, and the extra contact is labelled 86C. Diode 1 goes from 86C to 86. This allows current to flow to the relay coil from the start relay ie when the engine is cranking. Diode 2 goes from 87 to 86. This allows current to flow into the relay coil from the main injection relay to allow the cold start injectors to stay energised after the starter has been dis-engaged. Diode 1 blocks any current from feeding back to the starter solenoid once the starter key has been released. The thermotime switch opens after it has timed out and the injectors are de-energised."

Basically, what Gray is saying is that the relay has a built-in bootstrap circuit; once it has been energized by the starter being engaged, it will hold itself energized even after the starter is released until the thermotime switch shuts it off. If your car has such a relay, the schematics should be altered to look like **Figure 14**.

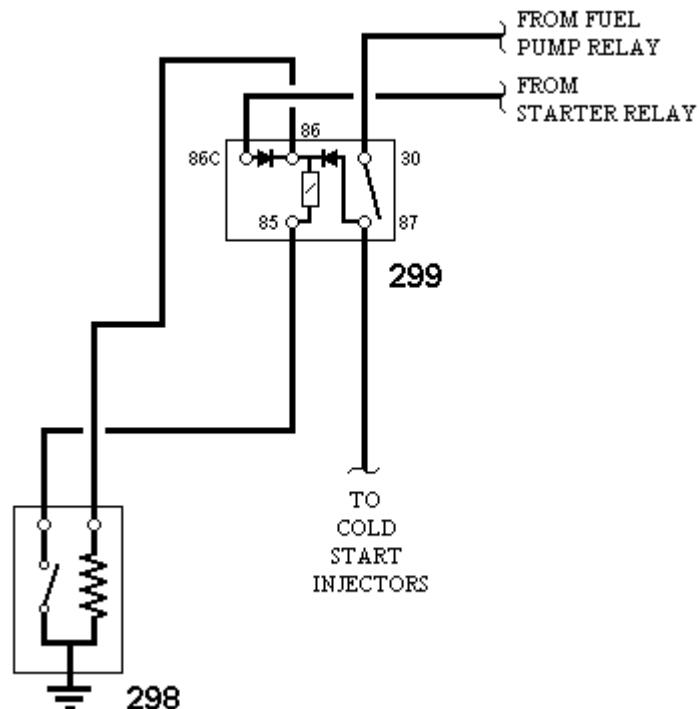


Figure 14 - Alternative Cold Start Relay Schematic

Interestingly, while the Jaguar cars with this system were reportedly connected this way, it would actually make more sense to connect the wire to the heater in the thermotime switch to 87 on the cold start relay instead of 86. It would function exactly the same way, but there wouldn't be as much current going through the diodes. Roger Bywater found schematics of other cars with similar Bosch EFI systems that were wired that way.

The diagrams that this schematic revision might apply to are as follows: In the ROM ©1975, the "Fuel Injection Schematic" following Section 86, and whatever diagram shown in section 19.22.32, as discussed above. In the Haynes manual 478/49015, Fig. 10.121, 10.124, 10.129, 13.92, and 13.96. Check your own car, and if it has the relay described, mark the appropriate schematics accordingly.

Gray: "The relay is a Bosch manufacture with the Lucas sticker stuck on the side. The Bosch number is 0 332 003 028 - 12V, 10A. The Lucas marking is 25RA which I think is the series (not serial) number, because all the relays that are in the same can configuration bear this number, and 33353A which I believe is the important part number."

Gray goes on to point out that the Haynes manual clearly shows the 5-terminal relay he's talking about in Fig. 3.50. He claims this relay is also illustrated in his XJ12 ROM; "My ROM is the red covered Jaguar XJ12 /Daimler Double Six version. Publication Part No. E190/4." Section 19.22.31 of the XJ-S ROM ©1975 shows the cold start relay, but not clearly enough to indicate how many terminals it has.

If your car has the relay Gray describes, it will be a large metal can that looks similar to the starter relay with individual wires connected to spade terminals and it will have a terminal labelled 86C. If your car has the simpler system illustrated in the schematics, it may have 5 terminals but one will be labelled 87a or some such; there will be no 86C.

Roger Bywater isn't thrilled with the bootstrap concept used here: "I know what can happen when the cold start injector(s) are allowed to spray with the engine running. A weak 'spit back' can ignite the fuel from the cold start injector which then becomes a rather noisy blow lamp inside the manifold. A single plenum engine would immediately stop then would easily restart probably without the condition even being recognised. A V12 could have one bank 'lit up' inside but the other bank would keep it running, after a fashion, until the thermotime switch trips out when things revert to normal."

COLD START PROBLEMS: William F. Trimble says, "My Haynes manual for the V12 (yeah, I know ... :-) suggests to remove the thermo-time switch altogether if you have cold-start problems." This author's Haynes manual says "A problem can occur on 1980 models causing stalling immediately after cold start. This can be overcome by removing the cold start relay..."

John Braybrooks says, "I have a 1982 XJ-S in Victoria, British Columbia, Canada. I keep my car in a garage and one recent winter my son drove it out so that he could use the garage space to work on his 1929 Model A. When he finished he returned the Jaguar to its rightful location. Next day my wife also moved the car to facilitate sweeping the floor and again returned it. Next morning when I tried to start the car there was no life. I called local Jaguar specialist, Paul McKay, and he immediately diagnosed the problem as flooding. He came to my house and replaced the spark plugs which were the least difficult (5) and we were then able to get the engine running on those cylinders, later more and more came on line until all was well. He informed me that this was a characteristic of this engine and it was not unusual for the dealers to experience this problem with brand new vehicles loaded on and off transporters during the winter. Under the right conditions the cars would not start when delivered to the dealer. Paul warns that if this does occur and you are able to get the engine running of a few cylinders *do not* "gun it" otherwise the unburned fuel will be burnt in the catalytic convertors and the excessive heat could cause a meltdown. If I have to move my car for very short periods in cool weather I now always let the engine run until it is thoroughly warm."

Roger Bywater explains: "That's a familiar story. Back in the early 1980's they had new H.E.'s doing that even in our mild winter after being shuffled around the factory car parks a few times before delivery. That's why they got rid of the cold start injectors after a period of just having the connectors taped back for the dealers to hook up before delivery to the customer.

"Whilst it may be the case that the H.E. V12 is more prone to cold plug fouling than some other engines, doing repeated cold starts in very cold conditions without getting to even part warm is maybe asking a lot of an elderly car probably

with shaky HT leads and things. If I had to move any car, not just a Jaguar V12, repeatedly in severe conditions I would at least let it run to near fully warm every other time then rev it up two or three times to make sure it was clear."

Digital P

FUEL SUPPLY SCHEMATIC CORRECTION: Fig. 3 on page 19-3 in the ©1982 Supplement and Fig.13.18 in the Haynes manual as well as the same diagram in the Handbook purport to illustrate the fuel supply system for the Digital P. In fact, it's quite accurate -- if you never had the fuel rail recall performed on your car. Since all cars should have had the recall done, the left half of this illustration should look like **Figure 15**.

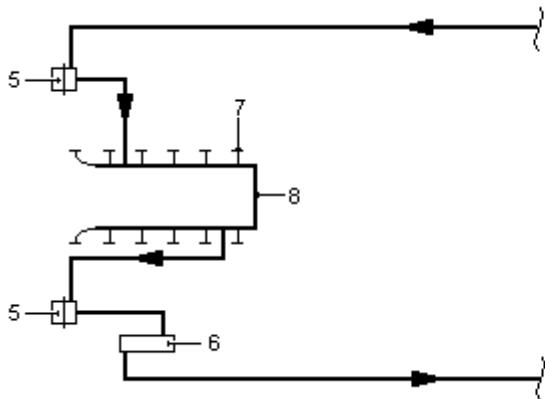


Figure 15 - Digital P Fuel Supply Schematic

There are now two pressure regulators (although the bottom one in the illustration is actually the only one that regulates pressure), and the cold start injectors are gone. Note that for the 1992 model year, Jaguar went back to having a single pressure regulator.

Fig. 4, 18, 20, and 21 and sections 19.60.01, 19.60.03, 19.60.04, and 19.60.05 in the ©1982 Supplement as well as Fig. 13.13, 13.14, 13.22, 13.23, and much of the text in Chapter 13, Sec 5 in the Haynes manual likewise reflect the pre-call fuel supply system.

HOT STARTING: The fuel cooler works great when the engine is running, but is worthless after the engine is shut off. The heat rising from the engine heats the fuel in the rail, which is not moving. If the engine is started about a half hour after shutoff, it may have difficulty starting.

Jaguar has provided two different fixes for this problem. Both involve a temperature sensor in the boss on the left side of the fuel rail; the boss has no opening into the fuel, but the sensor has a copper bottom that presses against the rail to sense the temperature. The boss itself seems to exist on all XJ-S H.E.'s, since a recall replaced the rail after the hot fuel problems were found.

The earlier type sensor is electrical, and is connected in line with the inlet air temperature sensor for the EFI system. The later type sensor has vacuum connections, and is connected between the intake manifold and the left side fuel pressure regulator.

CLOSED-LOOP OPERATION: The earlier D-Jetronic EFI systems were strictly open-loop. This means that the ECU contains a schedule of values (a "map") for how much fuel the engine gets at a given operating condition, and that's final. The Digital P systems in markets that did not limit emissions likewise were open-loop only. For North America and other markets where emissions were regulated, however, the Digital P system featured a closed-loop fuel control.

There is still a map providing “baseline” fuel scheduling, but there are also oxygen sensors in the exhaust system that monitor the exhaust for excess oxygen. If an oxygen sensor finds excess oxygen, the ECU presumes the engine is running too lean and trims the fuel scheduling a little richer. If it doesn’t find excess oxygen, it presumes the engine is running too rich and trims the fuel scheduling a little leaner. The oxygen sensors are essentially an on-off device -- they either detect oxygen or they don’t -- so the closed-loop control mode is neurotic, always either correcting one way or the other; it is never satisfied. When operating normally, it is constantly cycling from a hair rich to a hair lean and back again. As a result of this constant feedback correction, the engine is always kept very close to stoichiometric fuelling in this mode.

Oxygen sensors are also known as Lambda sensors; Lambda (λ) is the Greek symbol generally used to denote relative air/fuel mixture, with $\lambda=1$ corresponding to stoichiometric, $\lambda>1$ meaning lean, and $\lambda<1$ meaning rich.

Of course, stoichiometric is not necessarily ideal. For max power, you’d like it a little rich. At max power, it’d better be a little rich, because running near stoichiometric is a good way to burn pistons. So, there are two switches -- a roller microswitch on the turntable and a vacuum-operated switch nearby -- either of which will kick the EFI system out of closed-loop mode at high throttle. This causes it to run on the baseline map with no trim, which is of course designed to be a little rich just for this purpose.

A photo showing the microswitch can be seen at:

<http://www.jag-lovers.org/xj-s/book/Microswitches.html>

Michael Neal sends this info on checking the Digital P EFI system: “Monitoring O² sensor feedback voltage just lets you know the EFI is in closed loop operation. This should be checked with a *high* input impedance digital volt meter. A cheap meter will fry the system. Check the voltage at the O² sensor connector with the sensor hooked up and the engine running. The voltage will fluctuate from 0 to 1 V. With a fairly fast updating meter you should get a voltage swing of at least .3 V. A .1 or .2 V swing shows a problem with the O² sensor, open loop operation, or a problem with the sensor driver in the ECU.”

Robert Dingli says: “It is pretty obvious when the system goes into closed loop control. While the open loop controller may be tuned to near lambda = 1 the voltage output will ‘flicker’ around 0.5V or else sit at a low or high output. When under closed loop control, the perturbation due to the closed loop system can be clearly seen as a low frequency oscillation in the output.”

Before checking that sensor output voltage, take note: if your car has a red 2-conductor socket on the end of a wire near the ECU with a jumper in it, you will need to remove the jumper to get it to go into closed-loop at idle in neutral or park. See below.

Besides monitoring the oxygen sensor outputs, you could also check for closed loop operation by monitoring the feedback voltages within the ECU itself. No, you don’t need to open it up -- Jaguar provided a 4-connector plug in the trunk near the ECU specifically to enable monitoring of the feedback signals. See page 274.

OPEN-LOOP OPERATION IN PARK OR NEUTRAL: One pertinent fact regarding oxygen sensors: they have to be hot to work. The Jaguar V12 at idle with no load and the timing properly advanced is turning over so easily that the exhaust may not be hot enough to keep the sensors working. When the sensors quit working, the closed-loop control will richen the engine up, and the idle speed will start to drop off. Sometimes the sensors will start working again, and the closed-loop control promptly leans it back out, and the idle comes back up. You can end up with an unstable idle. Typically, if you put the car in gear, the load of the torque convertor is enough to keep the exhaust warm and the sensors working, so the idle is steady.

To avoid the unstable idle problem, early emission-controlled Digital P cars had the starter inhibit switch on the shift lever also connected to the EFI system. In Park or Neutral (starter permitted), the EFI operates in an “open-loop” control mode, where the oxygen sensors are ignored and the EFI controls to a fixed fueling map. When in Drive or any other moving gear (starter inhibited), the EFI operates in “closed-loop” mode, adjusting the fuel mixture to obtain the correct oxygen sensor feedback.

Owners subject to emissions testing need to be aware of this. The regulations require the car to meet emissions in D, which it will if it's running right -- but unless the idle mixture has been properly adjusted, it might not meet them in N or P because the EFI system is in open loop and is not correcting for rich or lean fuelling. Of course, Jaguar's stand is simple: bring the car in and let our authorized service technicians adjust the idle mixture. Once properly adjusted, it won't matter if the system is in closed loop or not, since the mixture is right and needs no correcting. However, if they test for emissions in N or P in your area and you don't feel like having the idle mixture adjusted right now, you can just pull a jumper from a red 2-connector socket near the ECU in the trunk to put the EFI into closed-loop mode in N and P. If the emissions testing is done in D on a set of rollers or some such, you probably don't need to worry about it, but it couldn't hurt to pull the jumper anyway.

Starting with VIN 134286, the XJ-S was fitted with "3-wire" oxygen sensors. These work the exact same way as the single wire sensors, except that they have a built-in electric heater. The heater keeps the sensor working at all running conditions. Eventually the circuit that puts the EFI into open-loop at idle in Park or Neutral was eliminated as well as the jumper in the trunk, but this change didn't happen at VIN 134286.

When the 3-wire sensors were first introduced, Jaguar wanted \$150 each for replacements -- and even finding a generic replacement could cost considerably more than the older 1-wire sensors. As a result, some owners installed 1-wire sensors in their cars, and either just put up with unstable idle problems or fiddled with timing or idle mixture to avoid them. If you have a car that should have 3-wire sensors but you find 1-wire sensors in it, you probably should go ahead and install 3-wire sensors; they're no longer expensive. At least put the right sensors in when the 1-wire sensors die of old age. After you get the correct sensors in, you might want to check the timing and adjust the idle mixture just in case they were fiddled with to deal with an unstable idle. And if you have to adjust either of those, you'll probably need to reset the idle speed afterward.

OXYGEN SENSORS: First, a clarification: these sensors don't sense oxygen; they sense the *absence* of oxygen. Essentially, a Lambda sensor is a battery that generates a voltage based on the potential difference between the oxygen outside the exhaust pipe and the oxygen (or lack thereof) inside. If there is oxygen on the inside, there is oxygen on both sides, so the potential difference is zero -- no voltage. When there's no oxygen on the inside, there is a difference between inside and outside and the sensor puts out something a little under 1 volt.

What happens when your oxygen sensors go bad? Well, obviously they will put out no volts regardless of oxygen in the exhaust pipe. The EFI system will either decide, based on the lack of voltage, that the car is running lean and will trim it in the rich direction, or it will default to the baseline schedule with no trim. Roger Bywater: "Later fault logging systems would just ignore a faulty signal, flag a fault warning and either run at mid-range as mapped or run 'safe rich' depending on the strategy." Either way, it's gonna run rich. This is a relatively safe failure mode, as running rich can cause rough running or bad fuel economy but it usually won't cause permanent damage to anything. It sure will impact your fuel economy, though.

Oxygen sensors are available at local parts stores. There is no need to insist on a Jaguar part; a generic replacement sensor will work fine. Brian Sherwood suggests Bosch universal sensor p/n 11025 for the earlier one-wire sensor. Take an old sensor in with you (if possible) to make sure the new ones are the right thread. Don't worry if the fluted sensor portion doesn't look exactly the same. If the wire is the wrong length or has the wrong connector on the end, use a crimp connector to connect the new sensor with the wire cut off the old sensor; the generic sensors usually come with suitable crimp connectors for this purpose.

You really don't want those generic one-wire sensors though. What you really want to do is retrofit the later 3-wire heated sensors. See below.

A generic sensor may come out of the package with the wire wrapped tightly around the body of the sensor itself. Don't unwrap it yet! This wrapping makes it possible to use a normal deep socket to install this sensor, rather than the special sensor sockets sold with a slot down the side for the wire. Of course, on the XJ-S it's not too difficult to just use an open end wrench.

The installation of an oxygen sensor is one of the *most* important places to use anti-seize compound -- see page 28. Fortunately, the sensor manufacturers know this, and even the cheapest generic sensor usually comes with anti-seize compound already on the threads and a little plastic cover over the threads to keep it there until ready for installation.

OXYGEN SENSOR WARNING LIGHT & SERVICE INTERVAL COUNTER: The package a generic oxygen sensor comes in may say something like "Remove negative battery cable for 15 seconds to clear codes" but this won't turn off the dash warning light -- at least, not on the pre-90's XJ-S. The dash indicator on the early 80's XJ-S isn't really a "fault code" per se. There's no point to disconnecting the battery on these cars; it'll just force you to reprogram your radio stations.

An oxygen sensor failure causes the engine to run rich, which results in high emissions. The EPA requires that emissions systems have to work for 50,000 miles, but the 1-wire sensors needed to be replaced every 30,000 miles. To meet the EPA requirements, up to VIN 134285 Jaguar provided a warning light on the dash that lights when the EFI system detects a bad sensor -- right? Wrong. The light is there, but it's only a counter that tells you that you've driven 30,000 miles since the last time the counter was reset -- which, hopefully, was the last time the oxygen sensors were replaced. The "service interval counter" that turns on the light is connected to the speedometer sender, not the EFI system. Your sensors may still be just fine when the light comes on -- or they may have given up the ghost 10,000 miles back! There *are* reports of the oxygen sensors failing before the counter turns the indicator on. It is recommended that the sensors be replaced when the light tells you to, and if the car doesn't appear to be running correctly don't overlook the possibility that they have gone bad even though the light hasn't come on yet. The test of the closed-loop operation described above will tell you if they aren't working. Another clue: the fuel economy will take a precipitous drop if they aren't working, like 2 mpg or more.

The service interval counter is in the trunk, hidden under the carpeted panel on the left side near the filler cap; you need to remove a carpeted panel in the forward left corner of the trunk to get to it. The rearward-facing end of the black plastic box has an electrical multiconnector, a metal device that looks like a solenoid, and a single-wire connector. If you lean your head in a little farther, you'll see that towards the right (and hidden around the corner of the panel the counter is mounted on) there is also a small protrusion pointing rearward with a tiny white plastic tip on top. To reset the timer to zero when you replace the sensors, use a pointy object to push the *center* of this white plastic button in (a long ways, like a half inch) until you hear the thing reset.

If all that wasn't clear enough, you can look at pictures of the service interval counter at:

<http://www.jag-lovers.org/xj-s/book/ServiceIntervalCounter.html>

Another option, obviously, is to simply unplug the service interval counter. Or remove the light bulb.

Note that the service interval counter described only appears on cars with oxygen sensors up to VIN 134285 -- the end of the 1986 model year. 3-wire sensors were introduced with the beginning of the 1987 model year, and they last 60,000 miles between replacement. Since the EPA only requires that the emissions systems work for 50,000 miles, the service interval counter was omitted.

There was a different type of "service interval counter" behind the dashboard in the early pre-H.E. cars that obviously has nothing to do with oxygen sensors since those cars didn't have any.

The mid-90's cars come with the OBD or OBD II features required by California law, and therefore have fault codes to indicate when sensors aren't working.

3-WIRE OXYGEN SENSORS: Starting with VIN 134286 -- the beginning of the 1987 model year -- the XJ-S came with "three-wire" oxygen sensors with built-in heaters to keep them at operating temperature even when the exhaust is relatively cool. Such sensors were expensive at one time, but Tomco part number 11014 is available at Discount Auto Parts for only about \$40 each. Rusty Beard found another generic: "The Part # is 341-90-06."

Regarding wiring up the generic 3-wire sensor, Peter Cohen says, "I bought a pair of Tomco (boxed as Lucas) 3-wire oxygen sensors. These come with 2 white wires and one black wire. The instructions say to hook black to black and

white to either of the white wires. Only problem is, there are no white wires on the Jaguar. It has one black, one G and one NS." Rusty Beard explains how to connect it: "Black wire to G (to ECU). The white wires to Black and NS (This is just a heater circuit.)"

RETROFITTING 3-WIRE OXYGEN SENSORS TO EARLY CARS: It's a very good idea to retrofit the 3-wire sensors into the earlier cars that came with 1-wire sensors. Even discounting the lower emissions, better fuel economy, smoother idle, and other possible benefits of upgrading, installing 3-wire sensors can actually save you money; the 1-wire sensors have a useful life of 30,000 miles, but the 3-wire sensors have a useful life of 60,000 miles -- apparently because the heating helps prevent the buildup of deposits.

Randy Wilson reports on replacing one-wire sensors with three-wire sensors in his 6-cyl sedans: "I did it to get the O² sensor up to temp, period. I run tri-Y headers on my cars, which puts the tap point for the O² sensor (the collector) a fair distance from the engine. It's enough distance that, combined with headers not retaining the heat in the exhaust stream, the sensors would cool off too much at around-town cruise speeds."

"This will not get you into closed loop any quicker. The ECU will not go closed loop until the engine reaches a critical temp. But it will help in making sure the sensor signal during low-load closed-loop cruising is valid."

You will need to provide a 12V power source to each oxygen sensor heater. In the later cars that came with 3-wire sensors, the power comes from the fuel pump relay -- which means it shuts off after two seconds if the engine is stalled for any reason. Whether or not this is of any importance, it's not difficult to use this same wiring scheme on earlier cars. Even though the fuel pump relay is at the wrong end of the car, there is an NS wire from this relay to the solenoid air switch at the front end of the right side air filter housing. The two heated sensors will draw less than 5 amps total, and this existing circuit can easily handle that much additional load. Simply splice into that NS wire anywhere convenient and run leads to both oxygen sensors.

Once you have converted to 3-wire sensors, you can leave the open-loop circuitry at idle in Park or Neutral alone, or you can pull the shorting plug in the trunk to allow the car to run in closed-loop at all times like the later cars. You also can decide what to do with the service interval counter in the trunk; you can leave it there and merely reset it without replacing oxygen sensors every other time it goes off, or you can simply remove it and throw it away and just remind yourself to replace the sensors every 60,000 miles.

OXYGEN SENSOR TESTING: MOTOR/AGE Magazine gives the following instructions for testing an oxygen sensor itself:

"An oxygen sensor can be tested safely with a digital voltmeter, but an analog (needle type) voltmeter will *destroy* the sensor in a heartbeat. A simple bench test has been suggested by Tomco Carburetors to check O² sensor function. All you need is a vise, digital VOM and a propane torch.

"Lightly clamp the oxygen sensor in the vise with the sensor flutes facing upward. Attach the digital VOM leads to the sensor. If the sensor only has one lead, attach the VOM ground to the sensor body." Ed. note: connecting the VOM ground to the sensor body is the way to connect *all* sensors used on Jaguar XJ-S's. If there are three wires, two are for a heater; only the signal wire should be connected to the VOM.

"Set the VOM on the 2V scale, then light the propane torch (using regular heating tip) and apply direct flame to the tip of the sensor flutes. The voltage should rise to about 0.8-0.9V within 60 seconds. Move the flame away quickly from the sensor tip and the voltage should drop drastically; move the flame back and forth and the voltage should respond quickly. If the changes aren't almost instantaneous, it's time for a new O² sensor."

David Littlefield says, "AutoZone claims they will check your oxygen sensors on their equipment for free as part of their customer-friendly tool lending program. I think other parts places might do this as well, but I haven't tried it."

FEEDBACK MONITOR SOCKET: Near the ECU within the trunk is a 4-connector socket on the end of a harness with a dummy plug in it. Two connectors are a black ground wire and a KB wire with battery voltage on it. The other two connectors provide a voltage between 0 and +5V (relative to the black ground wire) that corresponds to the amount of correction the ECU is providing in its attempts to maintain the proper Lambda feedback. The GW wire (pin 4 on the ECU) is for the A bank and the GK wire (pin 10) is for the B bank.

While there is a special Lucas tool that plugs into this socket, Roger Bywater points out that an ordinary voltmeter can be used: "On a 6CU the monitors are voltage outputs. On a 16CU the monitor outputs are square waves which can be converted to a voltage reading by placing a 47 μ F capacitor across the voltmeter leads."

Now, trying to make sense of what voltages you find. First off, you need to figure out whether the EFI system is operating in open-loop or closed-loop mode. If the engine is cold, it will be in open-loop mode. If the car has a jumper in a red 2-connector socket at the end of a wire near the ECU and the shifter is in P or N, it will be in open-loop mode at idle. You will need to pull the jumper to get the system into closed loop at idle with the shifter in P or N. If the car is a later model with no jumper near the ECU and is warmed up, it will be in closed-loop mode.

If the ECU is in open-loop mode, both connectors should be reading a rock-solid voltage; this voltage will be 2.5V on the 6CU as well as the 26CU and later ECU's, but it's lower on 16CU ECU's. Walter Petermann explains: "The μ P on the 16CU does not put out a 0-5V signal. I just checked it with the scope, and it's about 3.8v max." Since the open-loop voltage is at the halfway point on the range, it will be about 1.9V on a 16CU. Whatever the open-loop voltage is, it is the voltage that indicates the ECU is providing no correction at all to the fuelling; whatever the baseline fuelling map calls for is what the engine is getting.

If the ECU is in closed-loop mode and the system is operating correctly, the voltages should be fluctuating up and down cyclically. Roger Bywater says, "print this out and pin it on the wall:

Low Lambda = weak exhaust = ECU corrects rich = monitor rises

"Lambda voltage is low when fueling is weak so the ECU reacts by correcting rich. The monitor then moves high (6CU), or increases the high part of the duty cycle until continuous high (16CU), with full rich correction. The monitor outputs go low when the ECU is correcting by weakening (i.e. Lambda high = rich exhaust)."

If the ECU should be in closed-loop mode and the voltages are held solid against one extreme or another or are stable at the open-loop voltage, something's wrong with the car.

OPEN-CIRCUIT AT THE OXYGEN SENSORS: If you disconnect the oxygen sensors, the ECU will interpret the lack of voltage as a sign of lean operation and trim richer, right? No. Roger Bywater explains: "There is some circuitry which applies a mid-range bias to the inputs through some quite high value resistors." What this means is that, when the oxygen sensors are working properly, they overpower this mid-range bias circuit to send feedback signals to the ECU. But when the oxygen sensors are disconnected, the mid-range bias circuit provides a backup signal for the ECU to work with. Since it is mid-range, the feedback response is neutral, and the feedback monitor voltages will hold steady at the open-loop voltages. In short, disconnecting an oxygen sensor effectively puts the ECU into open-loop mode.

Interestingly, if you have a 16CU ECU, the same cannot be said for disconnecting the ground shield on the oxygen sensor wires. Bywater: "The bias network is grounded externally via pin 23 through the Lambda screen so if that ground connection is lost the bias goes high and causes the 16CU to trim rich if the Lambda sensor is still connected. If the sensor and ground return are both lost it all sits at mid-range. The 6CU does not seem to react at all to disconnection of ground to pin 23, it still drifts to mid-range as do the monitor outputs."

IDLE MIXTURE ADJUSTMENT: The Electronic Control Unit for the EFI system is in the right side of the trunk, and there is an opening in the ECU casing -- usually facing downward near the rear end of the box as it is mounted. Roger Bywater: "There is a rubber cap and possibly a metal tamperproof plug inside which can be persuaded out with a fine screwdriver, a turning motion and a little patience. The ECU needs to be removed for this really. Then the spindle is accessible."

The real challenge, of course, is getting a tool in the hole to be able to turn the knob. Bywater: "It is exactly like a radio volume control shaft - 1/4" diameter with a flat on it. If the correct tool is not available it just needs a short piece of tube to slip over the spindle then just carefully indent one side to engage the flat. Travel is about 3/4 turn. You cannot do any damage by turning the idle fuel adjustment (it moves in ratchet clicks either way) other than by excessive force."

This adjuster affects the *baseline* fuelling map (before Lambda correction) at idle. If you've read the previous few paragraphs, perhaps you have already figured out how to adjust it. First, you need to make sure your engine is actually *at* idle; check the voltage at the throttle pot as described on page 277, and adjust it if it is not correct. Adjusting the idle mixture will be frustrating if the ECU thinks the engine is actually off idle. You also should ensure that the idle RPM is correct.

Once idle is established, you should look at the voltages at the feedback monitor socket while in open-loop mode to determine what the open-loop voltage is -- it should be 1.9V on a 16CU (with the 47 µF capacitor across the connections mentioned above) or 2.5V on all other ECU's. Then, if the car has the red 2-conductor socket on the end of a wire with a jumper in it near the ECU, you will need to pull the jumper to put the EFI system into closed-loop mode at idle in P or N (with the engine fully warmed up, of course). This should start the feedback voltages cycling. Monitor the voltage on one of the two feedback voltage connectors and adjust the idle mixture knob until the readings are cycling around the open-loop voltage. Then reconnect your VOM to monitor the other feedback connector; if its voltage is also cycling around the open-loop voltage, you're done. If its voltage is cycling above or below the open-loop voltage, adjust the mixture until both sides are about the same amount off in opposite directions. Now you're done. If you had to pull a jumper, reinstall it.

What do you do if the 1-wire oxygen sensors cool off and quit working during this operation? Good question. The best advice -- short of retrofitting 3-wire sensors -- may be to rev the engine up for a few seconds to heat them back up, then drop to idle and check the setting before they cool off again.

Bywater elaborates: "The need for adjustment in Lambda mode is because if the ECU has to apply a lot of correction the Lambda swings make the idle unstable and it hunts up and down in time with feedback."

Note that the described procedure will result in nearly stoichiometric mixture at idle without closed-loop correction, which should pass emissions tests -- but might not provide the smoothest idle. For a smoother idle in P or N, you might consider adjusting it a little rich, although in closed-loop mode (as soon as you shift into D) the ECU will just pull it back to stoichiometric anyway.

The idle mixture needs to be adjusted periodically as the engine wears. As the engine gets worn, it develops progressively less and less manifold vacuum at idle. This reduced vacuum is picked up by the MAP sensor in the ECU and interpreted as meaning the engine is drawing more air, so it responds with more fuel -- and the engine starts to run rich at idle. Adjusting the idle mixture will bring it back into line.

ECU INTERNAL CONNECTIONS: The harness connects to the ECU with a 35-pin connector. However, within the ECU itself, many of the wires from the harness are simply connected together. When trying to figure out how things work, it may be helpful to know what wires are connected internally. To save you the trouble of opening it up to see, I will provide the info here based on the ECU in my '83 (part number DAC 2597). The following groups of connectors are all wired together inside the ECU:

1-2-19	(ground)
8-9-27-28	("B" bank injectors - open)
11-29	("B" bank injectors - hold)
12-30	("A" bank injectors - hold)
13-14-31-32	("A" bank injectors - open)
16-17-34-35	(ground)

On the schematic in my repair manual, I have drawn boxes around each of these groups to remind me of these internal connections.

ECU INTERCHANGEABILITY: The Lucas 6CU and 16CU ECU's are "pin-compatible", meaning you can replace one with the other without making any other changes -- provided that everything else in the car is the same, such as engine compression. Don't try putting an ECU from a 12.5:1 spec car into an 11.5:1 car. The 26CU is not interchangeable with the 6CU/16CU.

The 6CU has a reputation for poor reliability, especially in the fuel pump control circuit -- see page 238. Walter Petermann (Corsaro, page 657) thinks the fuel pump control circuit is just the most obvious symptom of trouble; "Most of my work comes from wholesalers, so I get boxes of them without any reference to what the customer's problem was. In general, they have any combination of the following due to solder joints:

- A few % lean due to bad solder joints in the power supply
- Full lean intermittance on Map sensor
- One or both O² circuits not tracking properly
- Dead or intermittent (chattering) fuel pump circuit

"A rough guess is that about 10% have only a bad fuel pump circuit. Out of these I'd say that on more than 80% you can induce one or more of the other failures by just flexing the circuit board."

"You shouldn't pay more than \$100 for a used 6CU unless it's been rebuilt by someone who knows what they're doing. The best replacement would be a 16CU. They are a much safer buy "used" than the 6CU's." Not only do the 16CU's appear to be far more reliable, they also have significantly better processing and programming built in.

HOT ECU'S: No, not stolen. Walter Petermann reports that *some* 16CU's have microprocessors inside that get very hot when running. Apparently several different type microprocessors were used, and one type in particular pulls half an amp and therefore gets quite toasty. The good news: apparently it doesn't hurt anything; while the 16CU has the occasional microprocessor malfunction just like any comparable electronic equipment, there's no significant history of heat-related failure. Just the same, Petermann likes to take one of two actions when he finds one of these hot ECU's. His preferred fix is to replace the microprocessor with one of the type that doesn't get so hot. "Unfortunately the thing has 64 legs and they are soldered on both sides (and through the hole) of the board. Replacing them takes almost as long as rebuilding a 6CU. It's something you never seem to get comfortable doing. There's traces running between the pads on both sides of the board. If someone wants to try it, the replacement chip is an NEC D78C10AGQ."

His other fix is to install a 12V cooling fan (commonly available for cooling computer CPU's) inside the ECU. The fan is installed entirely within, there are no openings made in the case; it merely circulates the air around inside the box, thereby moving the heat from the chip to the aluminum case more efficiently. "Yes, it's a PC fan. It comes with a finned aluminum heat sink and claws to attach to a chip. Unfortunately the uP in the ECU is not the correct size, so the heat sink is not used and must be removed. You can glue the fan in place on the side of the ecu about 1/4" above the microprocessor. There's a convenient small ledge running along the center line of the ecu case that it can also be glued on for extra strength. Power can be taken from the filtered 12V source of ECU pin #22. This is on the yellow 'tubular' cap C304 on the end that's close to the center-line of the ECU. Ground goes to pin #35."

THROTTLE POTENTIOMETER: If your XJ-S has ragged throttle response as though it has a bad accelerator pump, here's some news for you: it doesn't have an accelerator pump. However, the throttle potentiometer, located underneath the throttle pulley on top of the engine, can cause similar symptoms when bad. When operating properly, the resistance across this pot varies smoothly as the pulley is rotated. If it is breaking up, it confuses the EFI computer on accels. The EFI computer, using inputs from the oxygen sensors, can usually keep the engine running reasonably well at constant throttle, but it stumbles during throttle changes.

The original 1980-88 pot, 73200 or EAC2670, is both unreliable and expensive. Sounds like a Lucas part, but it's actually made by Bourns. Clearly, simply stamping "Lucas" on the top has an effect on reliability!

THROTTLE POTENTIOMETER ADJUSTMENT: When you replace the throttle pot, the Jaguar manual says you must adjust it using their special electronic tester. Below is the alternate method.

The throttle pulley assembly must be unbolted from its tower to adjust the pot, meaning the linkages to the butterflies are disconnected; but the idle stop is part of the throttle pulley assembly and therefore is unaffected. You can even start the engine in this condition, as long as you don't go above idle.

Have the ignition on, and the throttle pot assembly rotated to the idle stop. The engine may be running or not. Connect a digital voltmeter (the old needle type just won't do -- go to Radio Shack and fork over the \$40) to the red and yellow leads from the pot without disconnecting the pot from the harness. This can be done by pushing the probes under the insulation on the connector.

Adjust the pot by loosening the three small mounting screws and rotating the pot until the voltage reading is within 0.32 - 0.36V. Tighten the mounting screws and reassemble. Make sure the reading remains within limits when the linkage is all together and the engine is running at idle.

THROTTLE POTENTIOMETER REPAIR: If you wish to attempt to repair the throttle pot, Matthias Fouquet-Lapar sends a procedure: "Carefully undrill 3 plastic melt points from the bottom. After about 2 mm you'll see a screw. Using a small screwdriver undo these screws.

"Open poti. It's actually a very good quality poti, (double contacts), but clearly showed excessive wear on light part throttle position. Using my VOM I could find several places where the carbon really had gone away.

"Mmmmh. I decided to cut off the 4 contacts, shorten them by about 1 mm and resolder them, so they would end up on the unworn surface. This is a pretty sensitive operation, be sure that you feel confident that you can handle it. You need some good small tools, a fine solder iron, some PCB cleaner *and* a very quiet hand.

"Resolder everything, adjust contact height as before to have the correct pressure when putting it back together. Also check if the contacts are really off the worn track.

"Put it back together, check again with a VOM. Smile, since you just saved a bunch of money."

"Total repair time was about 2 hrs. However, I think one can do this kind of repair only once, or maybe a single contact could be used instead of two, giving a potential of a third repair."

This author has had two throttle pot failures so far. In one of them, the conclusion was that the problem with this pot is that the wipers have little points on them so they contact the resistance track in a very narrow groove. Although the track itself is quite wide, the wipers cut little narrow grooves through it until they're riding on the ceramic below. I fixed it by replacing the wiper in entirety! I made a whole new wiper out of brass stock (available at any hobby shop) and fixed it to the plastic rotor with two tiny flush-head screws. The wiper configuration is completely different, with wiper arms cantilevered from one end rather than the double-ended wipers of the original, but most of the difference was simply to make it easier for me to make with hand tools. The significant difference was that each contact touches the track with an area of metal about 1/8" wide rather than the point used before. Basically, the individual wipers were shaped by bending the end to form a folded edge. The pot was temporarily assembled with a piece of fine sandpaper laid over the track, and the rotor turned back and forth a few times to polish a smooth contact surface on the wiper.

Paul Bachman says, "this thread reminds me of a repair that I once did to a mechanical television tuner with a similar failure mode. I went down to the local jeweler and bought some small scraps of 24k gold (about \$2) and soldered them to the wipers. This provided a low resistance contact with very low wiper friction. Never had another problem."

Of course, wiper modification doesn't always work. Peyton Gill: "I had hoped to be able to repair the pot by relocating the contacts on unworn surface. When the pot was opened I found that the contacts had worn through the conductive surface. One set of contacts had worn so long on the ceramic substrate as not to be usable... As worn as the old pot was

I'm surprised that it didn't cause more problems than it did. The nature and extent of the wear would lead me to recommend that everyone check their pot with a VOM."

In the author's other pot failure, the resistive coating that the wiper slides on was properly positioned to overlap the metal conductor at one end of the travel, but at the other end it barely touched the metal -- and was making intermittent contact as a result. Solution: go to an auto parts store and buy a kit for repairing a rear window defroster. This kit includes a remarkably tiny bottle of copper-colored paint, a tiny brush, and a template for repairing the conductor lines on a rear windshield. Using the tiny brush, apply some of this paint on the metal conductor and overlap it just slightly onto the resistive surface. The result is a very reliable connection.

THROTTLE POTENTIOMETER REPLACEMENT: If rebuilding the pot simply isn't going to work, Jon Heflin suggests you replace it with a better pot -- from Jaguar! From 1988 on, the XJ-S was fitted with a red pot, EAC9634, that is electrically similar but has a much better reputation for reliability. While the earlier black pot was made by Bourns and had Lucas printed on it, the later pot is apparently actually made by Lucas and has the name in raised letters. It is not a direct replacement because it requires replacing a couple of other parts to make it fit, so if you go to the Jag dealer and ask for a new pot for your model year they will still sell you the old style pot. However, the new red pot costs so much less than the Bourns pot that you can buy the parts needed to make it fit and you'll still be out less cash total. Heflin says the red unit is "far superior in design and quality, it's even spring-loaded so as to assure it returns to exact same starting position. I discovered that all that is necessary in order to use the updated unit is simply obtain the new style throttle shaft, shaft adapter, press pin, and an aluminum adapter to which the pot mounts. The old style pot mounts with 3 screws and the new with 2. The total for all the upgraded parts plus a new pot was right about \$100."

Kelly Spongberg says, "After many false starts, I did acquire all the necessary parts to put the new style "red" TPS on the V12. The parts are as follows:

<u>Part #</u>	<u>Description</u>
EAC-9634	Potentiometer
EAC-9567	Adaptor
PA-103161/J	Pin-Spring (came only as bag of two?)
EBC-3568	Coupling
EBC-3566	Throttle shaft

"One strange note, EAC-9567 fits, but with only two of the three bolt holes lining up. It works fine with the two bolts, just seems odd they would make a new adaptor for this upgrade and it not be perfect. Perhaps it fits the 6.0L as well, or is from that car's parts??

"Both the local Jaguar parts departments were caught unaware that the original black TPS has been discontinued, and also that more than one part was required to install the red unit."

The "throttle shaft" is the steel part visible on top of the turntable and held to it with two screws; you can remove the two screws and slide it right out. The only difference in the one for later cars is the configuration of the bottom tip. The "adapter" is a sleeve that fits the bottom of the throttle shaft and the top of the shaft on the red pot. The "pin-spring" is a standard roll pin. You can see photos and illustrations of these parts at

<http://www.jag-lovers.org/xj-s/book/ThrottlePots.html>

Patrick MacNamara says: "The Bourns type throttle potentiometer is no longer available from Jaguar. The dealer did not know if the two pots were interchangeable electrically and neither did British/Auto USA. The dealer actually had no suggestion other than to try an aftermarket supplier for the old Bourns pot. Thanks very much! I actually had to provide him with the part numbers for the upgrade.

"The 87-89 parts catalogue lists coupler and drive shaft for the new style throttle pot as EAC 9568 and EAC 9566 respectively, but these have been superseded by EBC 3568 and EBC 3566. The strange thing is that if you pull up EAC 9568 on the Jag parts computer it will list it as still available, but if you pull up EAC 9566 it says it has been superseded by two parts EBC3568 and EBC3566 which are clearly the coupler and drive shaft.

"My 87-89 parts catalogue does not show the VIN changeover numbers for the new throttle pot, but does state engine number changeover as 8S61794."

THROTTLE POTENTIOMETER SUBSTITUTION: It's a potentiometer, and potentiometers are available at any electronic supply house for pennies. Right? Well, not right. The resistance range of this pot is no problem; the rotation range is. This pot must run through its entire range in 90° of rotation, and most generic pots from electronic stores have something near 270° of rotation. Because this pot is used as a "voltage splitter" with 5V applied to the full range and the wiper picking off nearly zero volts at idle and nearly 5 volts at full throttle, you cannot merely use 90° of a 270° pot -- no matter what the pot's rating is.

AJ6 Engineering offers a throttle pot kit that involves a little gearbox. As the throttle turns 90°, the pot turns 270°, allowing use of the commonly-available and cheap generic pots. Roger Bywater says their kit "just fastens in place of the original and actually costs less than the factory potentiometer on its own. Then if a replacement potentiometer is needed a few years down the line - not that ours is any less reliable than the others but none of them last for ever - it will only cost £35 (at today's prices)."

Another solution for a misbehaving throttle pot is replacing it with a pot from another type car. Brian Sherwood relates his experience: "From my spare parts pile I found a TPS from a Ford, an '83 3.0L V-6, I think; part number E7DF-9B989-AA. It turned in the proper direction, same degree of travel (90 degrees), and had the same resistance as the original at both ends of its travel (from .05 to 3.5K ohms). But no, it doesn't bolt right up. I cut a slot in a steel bushing to fit the drive lugs inside the Ford TPS. The other end of the bushing I crimped down to fit the D shape of the shaft on the bottom of the throttle pedestal, that the old TPS used to fit over. A piece of aluminum strap was used to clamp the Ford TPS to the bottom of the pedestal. The TPS fits snugly in the recess underneath, and loosening the strap allows adjustment. I cut the wire and plug from the old one, crimped on some female spade lugs to fit the terminals of the Ford unit (would have been neater to use the proper Ford plug, too, but I couldn't find that.) Red wire=wiper, green=high side of pot, yellow=low side of pot. With new TPS plugged in and ignition on, I adjusted the TPS to give .36 volts measured between red and yellow wires, at idle position. Bolted everything down, and went for a test drive -- worked great. Only difference from the original is that now it doesn't surge at cruise anymore!"

Gill, having failed to repair the pot, then went looking for a replacement pot: "What type Ford is it for? That's the same question the guy at Pep Boys asked! I told him it was for a V12 Jag (always enjoy the expressions I get from these counter guys).

"The pot I got at Pep Boys is a Borg-Warner part #EC1046. This was matching cross reference from Brian Sherwood's Ford part #. The only challenge was machining a coupling to go between the throttle assembly which has a shaft with a flat and the pot which has a hollow shaft with two splines within. I took an old worn out 1/4 inch drive socket (5/16) and drilled out the drive end so I would at least have a little flat on one side for the throttle assembly shaft. The other end I took a file and worked a slot on each side to go up into the splined hollow shaft of the pot. Crude but effective.

"I reused the wiring and connector off the old pot. The replacement pot has three small male spade connectors which I had the luck of having the correct size female ends. About 1/2 size of standard spade connectors."

Despite all these success stories, this author was unable to find a workable Ford TPS at a local parts store. There were many, many Ford TPS's to choose from, and basically all of them had the requisite total resistance, but all had too much resistance at the idle end of their travel -- the wiper was physically prevented from getting anywhere near the 0Ω end, and in fact won't get near enough to attain the 0.32-0.36V adjustment at idle. Of course, you can just forget about that adjustment, which will result in the EFI system operating in "run" mode at all times, even at idle, and never actually going into "idle" mode. This may be acceptable, although it may result in an unstable idle, especially in earlier cars with unheated oxygen sensors.

A better solution appears to be to select a GM throttle pot instead. Some GM throttle pots have a simple metal lever on the shaft, so all you have to do is devise a lever on the Jag turntable shaft to engage it and a plate to mount it on. The GM pots all seem to have plenty of range for the idle adjustment. Be sure to select one that turns the correct direction; some of them may rotate the other way!

Also try to choose a pot that's relatively small and compact. If you select one with something hanging out the side too far, then trying to adjust the pot's position at idle may have it running into one of the four posts supporting the turntable assembly. Interference can be avoided by carefully aligning the shafts when making the coupling so that the pot is swinging in between the support posts, but it's a pain trying to keep such things straight in your head; better to choose a pot that could spin all the way around without hitting anything so you don't have to worry about it.

Regardless of which pot you select, David Johnson came up with an excellent method of mounting it. Basically, unbolt the turntable support from the four studs it stands on and take off the sleeves that establish the turntable's height. Cut all four sleeves into two pieces each. Slide one piece onto each stud, and then slide on a rectangular mounting plate you have fabbed up. Slide on the remaining portions of the sleeves, and bolt the turntable support back on. "The kerf was exactly the thickness of the aluminum sheet (3/16), so everything reassembles as if the plate was meant to be there." You can establish the vertical location of this mounting plate by choosing where you're going to cut the sleeves in two. And you can provide suitable holes and slots in the plate to securely support the pot and allow adjustment of the idle position. In fact, it wouldn't be too difficult to apply this method to installing the later Jaguar pot EAC9634 in case you want to save the cost of their adapter, and it would probably result in a more professional-looking installation!

Roger Bywater of AJ6 Engineering reports, "Some years back when we needed a clean throttle signal we used a 5K wire wound pot on a bracket attached to the LH air filter ahead of the throttle and connected onto the end of the throttle spindle by a short length of 5/16 bore hose and clips. Might be a cheap solution to renewal of original."

That idea of using fuel hose as a coupling is a good one -- regardless of where you mount the pot. A pot doesn't take much torque to turn, so the friction in a hose coupling will easily drive it. It doesn't matter if the shaft has a flat or a pin hole or whatever, just slide a length of hose over it and clamp. And the flex of the hose will correct for misalignments.

THROTTLE POTENTIOMETER UPGRADE: Matt Emmons thinks that using a potentiometer here is a bad idea due to inherent wear problems on the wiper. He thinks a Hall Effect sensor would be more reliable because it has no wipers; it works via a magnet moving over a circuit.

Yeah, right. Where are you going to find a Hall Effect sensor that will go in here? And who's going to figure out how to connect it to the Digital P ECU so it works right?

Folks, you simply have to see this to believe it. It's very difficult to find a generic potentiometer that can be adapted to the Jaguar throttle linkage, but it's no problem at all to find a Hall Effect sensor that will fit perfectly! Emmons provides a few web sites:

<http://www.electrocorp.com/o1-4.html>
<http://content.honeywell.com/sensing/prodinfo/solidstate/>
<http://www.nasatech.com/Briefs/Oct99/MOC10991.html>
<http://www.clarostat.com/NEWhalleffect.htm>
<http://www.wabashtech.com/throttle.htm> <http://www.beiduncan.com/html/news/>
http://www.delphiauto.com/pdf/intellek/rotary_sensor.pdf
<http://www.aecsensors.com/sensors/noncont.htm>
<http://www.bourns.com/bournsautomotive/tps.html>

Note that last one is actually Bourns. "There are more. The Honeywell site was particularly informative about Hall Effect devices in general.

"Most of the manufacturers would not sell them to me in such small numbers, but the one I got is made by Clarostat. It's called HRS100 Hall Effect rotary position sensor and I bought it from Allied Electronics. Here's a link to their catalog page with details of the device:

<http://www.alliedelec.com/catalog/pf.asp?FN=630.pdf>

Connecting it up? Believe it or not, you just connect it up. While the pot took the 0 and +5V leads from the ECU and split off a voltage from somewhere in between, the Hall Effect sensors use the 0 and +5V to power the electronic circuitry and generate a signal between 0 and 5V depending on position.

What's more, Hall Effect sensors are apparently cheap -- cheaper than the OEM pot.

It would not surprise this author to learn that some of the Ford and GM TPS's described above are actually Hall Effect devices. Some of them don't feel as though there's a wiper involved when you have one in your hand.

THROTTLE POTENTIOMETER -- LATER CARS: Charlie Fritz says, "the 95 XJS has a double potentiometer in the TPS with one signal for the transmission and the second for the ECU as before. It has six wires as in the attachment, but I don't know which goes where or how to set it."

HESITATION: Mark Sampson had a bad battery in his car. "I was also experiencing some hesitation when warm, it has also gone away with the new battery. Interesting."

Don Snyder: "My car would occasionally hesitate, and sometimes die, when accelerating while the engine was hot. I replaced the oxygen sensors and added a bottle of injector cleaner, and have not had the problem since then."

INJECTOR RESISTOR PACK CONNECTIONS: The resistor pack for the injectors seems to be fairly reliable, but unfortunately the wiring to it is typical Lucas. Tom Amlie, who has a Ph.D. in Electrical Engineering and entirely too much time on his hands, relates an interesting failure mode that kept his car from starting: "Put an oscilloscope on an injector. Instead of a clean negative-going pulse, it oscillated like crazy. Took the ECU apart and traced the circuits until I understood how it works. There are four power transistors, two for each bank. The "ON" transistor slams the injectors on with full voltage to overcome the inductance. The emitters of the "ON" and "HOLD" transistors are tied together and go to a 0.2 ohm power resistor to ground. When the current to the injectors reaches about 3.5 Amperes, the voltage across this resistor is fed back to a circuit which cuts off the "ON" transistor. Then (in theory) the current through the "HOLD" transistor is adequate to keep this voltage to about 0.6 volts and keep the "ON" transistor off. All of this depends on proper resistances and tight connections.

"Get real! This stuff says "Lucas" all over it! The four precision resistors in the pretty box on the right side just aft of the radiator are connected with an 8-pin plug with round pins, far inferior to the American practice of using rectangular blades with much larger contact area and heavier contact pressure. I must admit that the box is a pretty casting and nicely finished. The "Lucas" decal must be worth a lot, but it is a piece of crap.

"What happened is obvious: The "ON" transistor did its thing and turned itself off. The "HOLD" transistor couldn't pull enough current because the resistance was too high. The "ON" transistor comes back on, switches itself off, the cycle continues, and no fuel flows.

"All is not lost. Clean the contacts and use a very sharp X-Acto blade to spread the split pins a thousandth or two. Don't overdo it and don't cut yourself.

"Wonder how many ECU's have been rebuilt because of this. To be fair, the workmanship in the ECU is superb. Must be made by Bosch."

EFI WIRING CHECK: Tom Amlie goes on to suggest a general check of the Digital P wiring: "Disconnect the ECU and measure every pin going back into the car with a VOM. Using a long wire with a small alligator clip to reach to the front of the car you can measure the continuity of every wire in the bundle. In particular, make sure that the pins that are supposed to be ground are really ground. A little corrosion can cause a lot of misery. The pins for the "HOLD" transistor should measure close to 7.2 ohms referenced to the power pin on the main relay which is also in the boot. You can also easily tell if the injector harness or one of the injectors is open by measuring from the "ON" pins to the same relay."

AIR TEMPERATURE SENSOR: In the ©1975 ROM, page 19.00.07 and section 19.22.23 show charts of air temperature vs. ohms for the purpose of checking the sensor mounted on the left air filter housing. These charts apply to D Jetronic systems; if you have a Digital P system, these charts are not valid. The correct resistance for the Digital P air temperature sensor, part number 73197, at room temperature is around 2800Ω .

COOLANT TEMPERATURE SENSOR: As opposed to the air temperature sensor discussed above, apparently the charts of coolant temperature vs. ohms shown in the ©1975 ROM, page 19.00.08 and section 19.22.19, apply equally well to both D Jetronic and Digital P coolant temperature sensors.

According to the Jaguar literature, the coolant temperature sensor provides a “minor” trim to the fuel schedules. However, when the sensor fails open circuit or the wires to the sensor are broken or disconnected, the trim turns out to be major indeed. An infinite resistance tells the EFI system that the coolant temperature is a zillion degrees below zero, so it responds by making it overly rich. Not just a little bit overly rich; the car may not even start, and if it does start it’ll run very badly and pour out clouds of smoke. And it just gets worse as it warms up, if you can keep it running that long. David Johnson: “When I had a bad wire going to my sensor the smoke was so bad I swore I blew the head gasket. In a matter of 20 seconds there was so much smoke that I thought I had a fire!”

An open-circuit coolant temperature sensor failure happened to this author, and he was able to diagnose it quickly using his own book! One thing that caused some consternation, though, was the fact that the smoke was a light gray color; as any good mechanic knows, running too rich causes black smoke. Johnson: “When I took automotive theory (years ago) the instructor told us white “smoke” meant water. Black smoke meant gas and blue smoke meant oil. I also remember him telling us that on a *really* rich mixture the color is grey. Hard to tell from “white” but it was because the engine is running almost as a fogger.”

One would think this would still be obvious due to the smell of unburnt fuel, but that wasn’t apparent either. Johnson: “The smoke had almost no smell.” The smoke from this author’s car had an odor, but it wasn’t strong and not clearly raw gasoline. The only plausible explanation so far is that the ignition within the cylinders burns the most volatile compounds most readily, pumping the less smelly fractions of the gasoline out as an unburnt mist.

Just the same, it probably wouldn’t be a good idea to be smoking around the car. If the air pump is diverting (the engine is warm), there’s no chance of fire within the exhaust system or catalytic convertors simply because there’s no oxygen in there; it was all used up in the cylinder. But once the smoke clears the end of the exhaust pipe, there’s no shortage of oxygen in the surrounding air. Things could look like the Hindenberg disaster if you get careless.

If the air pump is operating, it would make sense that the symptoms might be different. The engine wouldn’t run any better, but the dense smoke could be replaced with a red-hot exhaust system or catalytic convertors. Just in theory, mind you; there are no reports confirming this actually happening to anybody.

The coolant temperature sensor and wiring also suffers intermittent failures, with some Jaguar owners actually monitoring readings while driving to confirm that the problems were caused by this sensor. One of the connectors should give ~ 2.4 volts with the ignition on and the engine cold (the other one gives 0 volts) and gradually decrease to ~ 0.95 volts at normal operating temperature. Sudden changes in voltage mean the sensor is breaking up.

Michael Neal: “Don’t use Lucas brand. Get a Bosch part, cheaper and better.” Good luck figuring out which Bosch part to get. The following part numbers have been suggested as being usable:

73198 -- original Jag part, 1979-89

SNB 802 -- often listed as a superceding number for 73198

0 280 130 023 -- what XK’s Unlimited ships when you order an SNB 802

EAC3927 -- what the 1987 *Parts Catalogue* specifies for all engines

DAC4737 -- Jag part, 1989-on -- reportedly offered as replacement for 73198 on earlier cars

0 280 130 055 -- reportedly an exact replacement, but available only in Germany and very expensive

0 280 130 026 -- apparently differs slightly in tolerance, but definitely works well

The sensor should cost about \$30. If someone tries to charge you over \$100, it's time to look elsewhere.

Note that the D-Jetronic system uses sensor 73142, and it appears this is *not* the same critter, not interchangeable with the later sensor.

MANIFOLD AIR PRESSURE (MAP) SENSOR (Digital P): The MAP sensor for the Digital P system is *within* the ECU in the trunk, so a vacuum line is run the length of the car. On page 343 of Haynes manual 478/49015 it states, "Commencing with... vehicle identification number XJS 107102, a vacuum reservoir has been located adjacent to the ECU to eliminate resonance from the inlet manifold vacuum sensor pipe". This reservoir is a plastic chamber about an inch in diameter and three inches long, fitted in the line just before it connects to the ECU. Would installation of a similar reservoir help earlier Digital P cars? Who knows?

ACCEL PROBLEMS: Vince Chrzanowski reports that his car wouldn't start accelerating until a couple seconds after he floored the accelerator, even if the tranny kicks down. Otherwise, the car seemed to run fine. "The vacuum line to the ECU in the trunk was partially blocked. A shot of compressed air cleared it out, and everything went back to normal."

RICH RUNNING: Richard Chapman sends this tip: "If you're getting rich running and fouling check to see if the pressure regulators mounted on both ends of the fuel rail are leaking fuel into the manifold via the vacuum line which connects between the reg and the manifold. With the engine idling pull off the hose at the reg, the engine speed will increase with the extra air entering the manifold through this pipe so block it with something. After running the engine for a minute or so you may notice the presence of some petrol coming from the regulator vacuum connection. If so replace it. They are not the same unit despite similar looks."

INJECTION SIGNAL FAILURE: Chrzanowski sends this report on a problem with his car: "It seems that the engine revs information is sent to the ECU from an amplifier unit atop the engine. The signal is sent via a thin shielded wire. Unfortunately, the wire is routed near some very hot areas and that heat melted the insulation between the center conductor and the shield, shorting the signal to ground. Replacing the defective section of wire restored the signal. In talking with some other local Jag owners, I've found that this is not an unusual problem."

It's not; in fact, this author had the same problem. One of the W/S wires from the Lucas ignition amplifier rearwards towards the firewall connects to what appears to be a solid white wire but then disappears into a harness wrapping in which it is the only wire. This white wire is actually a coaxial wire, a tiny conductor surrounded by insulation, a grounded shield, and more insulation. Within that harness wrapping, the insulation gets brittle and starts cracking, and the outer layer of insulation being cracked only encourages the inner layer to crack at the same spot. Eventually, the thin conductor begins to short out against its own shield -- often intermittently. Sometimes you can wiggle that wire and make the problem come and go. All the while, the harness wrapping hides the wire's condition from view.

Since there is a resistor inside the ignition amp to limit the effect of such shorts, the ignition system continues to work, but the injectors don't fire since the signal isn't making it to the EFI ECU. That's why the problem is listed here in the EFI section; you can review the related ignition system issues on page 148.

If you suspect trouble in this wire, you might unplug this connector from the ignition amp and the big connector at the ECU in the trunk and check between pins 18 and 23 for continuity, which would indicate a short. However, since the short is only too likely to be intermittent and therefore look perfect while you have a VOM in your hand, you probably should go ahead and peel that wrapping off this wire near its connection to the amp. If you find the wire inside cracked and brittle, keep removing the wrapping until you get to non-brittle wire, then cut it off and splice on a length of new

shielded wire. It doesn't need to be as skinny as the original stuff, but it'd be nice if it was more heat-resistant. Don't ground the shield; it is grounded at the ECU, and grounding at two different places can cause ground loop problems wherein the loop picks up interference and then transmits it into the conductor it's supposed to be shielding.

IDLE STUMBLE: The mid-80's H.E. tends to "stumble" at idle when warm, even when it runs perfectly smoothly when cold or at higher throttle. This appears to be normal, although it is definitely disconcerting to an owner that spent the kind of money this car costs and expects better from his 12-cylinder engine. Fuel injector cleaning and/or replacement, spark plug replacement, and oxygen sensor replacement have no effect.

The only thing that might help is to readjust the throttle linkage as described on page 251, starting with the butterfly stop adjustments.

SUPPLEMENTAL AIR VALVE / SOLENOID AIR SWITCH: In addition to the coolant-operated Auxiliary Air Valve under the back end of the left intake manifold (page 245), the H.E. has an electrically-operated air valve at the front end of the right side air filter housing. The first challenge is to get the name right. In most places in the Supplement to the ROM as well as in the Haynes manual and in the Electrical Guide, it's called a "Supplemental Air Valve", but in the emission control diagrams it's called Item H: "Solenoid Air Switch". Most people seem to prefer Supplemental Air Valve, so that's what it'll be called in this book. Please remember that it's not the same thing as the Auxiliary Air Valve. Obviously, these names are often shortened to SAV and AAV.

To avoid future confusion over the name, it is recommended that you go through all the emission control diagrams in your manuals and scratch through the words "solenoid air switch" for item H and write in "Supplemental Air Valve". This would include page 17-1 in the Supplement to the ROM and Fig. 13.31, 13.32, 13.33, and 13.34 in the Haynes. Also note that all these diagrams seem to indicate that the valve is physically nearer the rear end of the manifold, but it is in fact near the front.

The Supplementary Air Valve allows air to go from the air filter housing directly into the right side intake manifold, bypassing the butterfly, and therefore boosts the idle; the balance pipe serves the left bank. The original intention is to serve as part of a cold start scheme; a timer kills vacuum advance to the distributor so the idle speed drops, and this valve brings the idle speed back up. The inefficiency of this mode of operation makes the engine warm up faster and helps catalytic convertors (on cars so equipped) to light off faster.

Operation of this valve is described in the discussion of the H.E. emission controls in the Supplement and the Haynes manual, where it is item H on the schematics. On B Emission cars (UK and elsewhere) the solenoid air switch is operated for 15 minutes if the coolant was below 45°C at startup. On A and C Emission cars (North America) it's operated for 45 seconds regardless of coolant temp. The timer -- either 45-second or 15-minute -- is located above the passenger side footwell, just inboard of the fuse block.

Another correction to note: according to the Digital P EFI schematics (Fig. 13.9 and 13.11 in the Haynes), the SAV and the "Vacuum changeover switch" are controlled by an oil temperature switch. As of yet, nobody has reported finding an oil temperature switch in an XJ-S.

On later cars, somebody at Jaguar got the wise idea to use this existing valve to help stabilize the idle when the A/C compressor kicks in. If the cold start timer activated the SAV by sending 12V to it, it'd be simple enough to connect the wire from the A/C compressor clutch to it as well with a diode or two to prevent backfeed. However, that's not how the timer controls the SAV. The SAV is provided 12V whenever the fuel pump is running, and the timer provides a ground connection to open it. So, just connecting up the wire from the A/C compressor clutch won't work; instead, the wire from the clutch goes to an "idle relay" and the relay in turn provides a ground circuit for the SAV.

But Jaguar went yet one more step. If the car is in Neutral or Park, opening this valve when the A/C compressor kicks in boosts the idle too much. So they provided an "idle override relay" to prevent the SAV from boosting the idle when the starter safety switch indicates the shifter is in N or P.

Victor Naumann adds: "Idle relay (black) and idle override relay (blue) are located on the left side of the radiator support in front of the A/C suction hose."

If your solenoid air switch is NFG, it's not really designed to be repairable. If you want to give it a try, the way to get it apart is to grab the two hose nipples and pull them directly apart. It's gonna take quite a pull, it'll probably require a puller of some sort plus a good way to grip those nipples without ripping them to shreds.

Michael Minglin says, "Best price I could find on a supplementary air valve was \$139. I decided that was too much, considering it was a simple 12V normally closed valve with 3/8" hose nipples. Checked with a local industrial valve supplier and found a 12V normally closed valve with 3/8" hose nipples for \$26.70. These valves come with interchangeable coils; 12V, 24V, etc."

The Grainger catalog doesn't have anything that perfect, largely because most of their stuff -- even with interchangeable coils -- is either 24V, 120V, or 240V. You can get there, though: purchase their stock no. 2G485, about \$32; the catalog says it's only rated for ambient temperatures up to 122°F, but it'll hold up in the Jaguar engine compartment as well as most of the other stuff in there. Plug the "exhaust" opening on the valve. Then drop by your local auto parts store and buy two brass fittings with a male 1/8" NPT on one end and a 3/8" hose nipple on the other. These are Brass-Tite number 43275. Screw these fittings into the valve, install it where the original was, and connect the wires. It doesn't look anything like the OEM valve and it may not provide exactly the same amount of idle boost, but it'll work.

For a slightly neater appearance, replace one of those straight brass fittings with a 90° fitting. This will make the hose to the bottom of the intake manifold shorter and more direct.

For a *much* neater appearance, purchase Grainger stock no. 2G491 instead. Buy only one brass fitting -- the 90° one is best -- and a couple of suitable bolts and nuts. Yank the funny rubber bellows-looking grommet out of the air filter housing and drill suitable holes and bolt this valve directly to the housing. Locate it carefully so it doesn't interfere with all the other stuff in the area. It might be nice to cut out a suitable gasket, but an even better idea is to install an O-ring between the valve and the air filter housing. Make *very* sure the nuts can't come off the bolts inside the air filter housing.

If you decide that your substitute valve -- or the OEM valve, for that matter -- provides more of an idle boost than you need, it should be a simple matter to restrict the flow through this passage a bit. If you're inventive, you can devise an arrangement with a screw obstructing the passage that allows you to adjust the amount of idle boost.

INTAKE MANIFOLD SHORTCOMINGS: Bill White, an expert on the Helmholtz theory of intake manifold design, notes that the intake runners to the corner cylinders on the Jaguar V12 are longer than those serving the center eight cylinders. He performed single-cylinder rig tests on the different runners and found that, at the tuned frequency of the manifold, the corner cylinders produced 8% more torque than the other cylinders. This means that these corner cylinders are getting a larger charge of air than the others. One would expect that at other frequencies the corner cylinders would get *less* air than the others.

If this were a carburetted or throttle-body EFI engine, this wouldn't really make much difference. However, being a multi-port EFI, each cylinder gets the same amount of fuel. Since these corner cylinders are getting a different amount of air, they are running leaner or richer than the other eight.

If your system has oxygen sensors, they will sense oxygen from the leanest cylinders and control the fuel supply to maintain stoichiometric there; the other cylinders will simply run a little richer than stoichiometric, which shouldn't hurt anything except a little fuel economy and emissions.

Roger Bywater of AJ6 Engineering (and formerly an engineer with Jaguar) notes: "In this connection I would point out that sample cylinder heads were regularly checked in the flow room at Jaguar and it was not unusual to find a variation of 10% between the flow capacity of individual ports due to core shift on any one head... Also in about 1975 I remember carrying out some tests with calibrated injectors which showed a wide spread of exhaust CO emissions largely due to flow variations from cylinder to cylinder following no particular pattern. This was part of an investigation into why B cylinder bank was always a worse HC emitter than A bank. In fact it had nothing to do with airflow or mixture

strength but was a result of the direction of piston rock at TDC relative to the spark plug position. These sort of things are not at all unusual on any production engine of the period.”

What can you do? Actually, there is a fix for the intake manifold shortcomings -- offered by Roger Bywater of AJ6 Engineering! It's called the Plus Torque Conversion, and is described on page 108.

Cold Start Injectors

COLD START INJECTORS: The schematics in the manuals show that the cold start injector system was carried over to cars with the Digital P EFI. However, the only Digital P cars with cold start injectors today are apparently the 10:1 compression ratio pre-H.E. models. H.E. cars don't ever seem to have cold start injectors; some early cars came with them, but they were all removed when the fuel rail was replaced on a recall. The square cross section fuel rails now used on H.E.'s has no provisions for cold start injectors; there is a different square cross section rail with connections for cold start injectors that was retrofitted into the 10:1 cars. Some early H.E.'s may still have a harness and a relay in there doing nothing. Early H.E.'s have little covers over the holes in the intake manifolds where the injectors once were, while later cars don't even have the holes.

If you have an H.E. with no cold start injectors, you can scratch through the cold start injection system consisting of the thermotime switch 298, the cold start relay 299, and the cold start injectors 300 on the following schematics: In the ©1982 Supplement or Supplement A, the diagrams on pages 19-1 and 19-2. In the Haynes manual 478/49015, Fig. 13.9, 13.10, 13.11, 13.12 and 13.93.

Early 3.6 AJ6 Engines

Roger Bywater of AJ6 Engineering (page 663) reports that the 1983-87 3.6 AJ6 engine with Lucas 8CU EFI has a problem with worn engines. A worn engine draws less vacuum at idle, but since the 8CU bases fuelling on manifold pressure, it believes that the lower manifold vacuum means the engine is drawing more air and responds with more fuel -- making the engine run overrich. Since these cars lack Lambda sensors for trim it cannot correct itself, and the car runs worse and worse. Bywater says owners complain of “shunting” in trailing throttle, bad idle, and failing MOT tests due to excessive CO in the exhaust, even though the engine is not really all that tired and rebuilding doesn't appear justified. Of course, at full throttle the wear problems are insignificant and the engine runs fine.

Bywater suggests that disconnecting the vacuum advance from the throttle edge tapping and connecting it directly to intake manifold vacuum -- and readjusting the idle mixture and speed accordingly -- may help as a temporary measure if the engine isn't too bad. For a more permanent fix, AJ6 Engineering offers an ECU modification wherein a trimmer screw is added that can be used to correct for engine wear -- and can be corrected back in the event of an engine rebuild.

XJR-S

John Goodman reports that the XJR-S has Ztek ignition and sequential fuel injection -- see pages 167 and 672. “It is essentially the same injection system off the '80's group "C" Le Mans race cars. Jaguar made a big thing about publicising it. But I suspect TWR had a load of spare bits left over and needed something to do with them!”

“Also there are two power resistors on the R/H front inner wing.

"I thought Jaguar's claims for improved fuel economy was bullshine, but it is more economical than my previous H.E."

Emile DesRoches says, "The XJR-S Product Support Manual lists special software along with a serial port connector whereby a laptop computer can be connected to the Ztek engine management computer (unique) fitted to the XJR-S to perform various diagnostic, calibration functions. Apparently this software was originally provided to dealers upon request from Jag North America for repairing these beasts."

Goodman: "The ECU can be reprogrammed with different fuelling and timing if only we had the software! And it is not Jag Dealer software, they only have the standard tune parameters!"

Fault Codes

The later cars come with JDS (Jaguar Diagnostic System) or OBD II (On-Board Diagnostics version II) as legislated by the California Air Resources Board (CARB). When those fault codes appear they can cause consternation -- that's what they're for. The owner's handbook provides a list of codes, but of course it never seems to provide enough real guidance. Hopefully some of the reports included here will help.

Defective relays and/or their connections are a known cause of fault codes, as mentioned in the section on relays beginning on page 521. Barry Ewen says, "When I bought my car 2 yrs ago it had fault code FF67 on it and we swapped the air injection relay with the horn relay; the fault went away and the horn worked too."

Charles Randle says, "I was out to my dealers today and read up on the EPA ordered recalls for all 6.0 V-12 cars. With a '94 XJS with JDS, all I get is a replacement of all major grounding connections. But all 95-96 OBD II cars get a free Oil and Filter change; and replacement of *all* EPA components that have set an OBD II code. Also the EPA warranty has been extended to 150K miles. So if anyone out there hasn't registered their after market car with Jaguar as the present owner; don't pass this up.

FF 3 -- COOLANT TEMP SENSOR: Mark Barker reports on his 6-cyl: "Trip computer displays "FF 3" (Coolant temp sensor failure), when the electric fan motor is dying. Just happened this evening. I suppose coolant temp *is* related to cooling fan.

"Certainly *was* the motor -- brushes gone. I mean *gone*, too. Big pile of black dust fell out of disassembled motor followed by broken bits and pieces sticking to magnet. Found some brushes in scrap motor I had, oiled the bearings. Back together, no more "FF 3". Strange, but true."

FF44 AND FF45 -- OXYGEN SENSORS: Sam Emrick says, "Late-models (at least) seem to have a common problem with bogus O₂ sensor failure code reported (FF44 or FF45). My '94 had this problem."

Charles Randle talks about a recall: "It plainly says for my JDS codes that FF44 and FF45 codes are being caused by poor grounding connections rather than bad O₂ sensors. I wish I had known that before changing them out a few months ago." Since grounds are a common cause of trouble in the Jaguar XJ-S, just go ahead and add a ground strap as suggested on page 514.

FF67 -- SECONDARY AIR INJECTION SYSTEM: Charles Randle says, "My '94 6.0 started having FF67 set a couple of months ago. I read up on it in the ROM, which tells me just enough to understand a dozen things that may cause the problem. However, there is one ambiguous sentence that is a large gray area, so I took it to my local dealer after talking to the Lead Technician on the phone. The simple things I could check myself I did. I determined the Air was coming on and apparently in the right (as printed) sequences. The tech spent an hour verifying this on the JDS, and

called Mahwah. Two days later they faxed a "Decision Chart" and a possible problem/solution. It seems the PMCF on all the 6.0's might have come from the factory with the PROM set too sensitive. During any of the secondary air functions the PROM is looking for a certain voltage from both O₂ Sensors. If it doesn't see a signal of this magnitude, it sets FF67. And that is all it does. It doesn't go open loop or any other deregulating function. The bottom line is, the dealer gave me the "Decision Chart" and said I really didn't want to pay him \$78.00 an hour to verify 3 pages of decision charts. He also gave me a mail for service procedure to send the PMCF to Delphi Diesel Systems for testing and installation of a less sensitive PROM. To date I haven't either completed the Chart or contacted Delphi. The JAGUAR NA procedure when the cars were under warranty was to have the dealer ship the PMCF to Mahwah, who then sent it to Delphi and it was returned to the dealer COD for work/parts/shipping. For the time being, I am resigned to ignoring the FF67 and dumping the code each time I won't be using the car for a while. There is no way to disable the PMCF signal without disabling future serious codes that you might want to be notified of."

Michael Hahne concurs: "My '94 XJ12 has the same FF67 deal. I replaced the O₂ sensors and had the recall done, and it still shows up once in awhile. I talked with several knowledgeable folks who said it's probably clogged Air Injection rails. It's a nasty job to clean these out, but hardly necessary for the kind of driving we do. It's mostly an emissions thing. I've driven mine that way, occasionally clearing the FF67 code, for 10's of thousands of miles. No troubles. I drive my '94 XJ12 from Chicago to New Orleans almost monthly. My car now has ~90,000 miles. I drive it daily to and from work, a round trip of ~160 miles. Just drive the beast, and don't worry."

FF69 -- DRIVE/NEUTRAL SWITCH: Alan Baker says, "This is a common fault on the XJ40's of that era, (they use the same ECU). I'm told that the 'erroneous' Code 69 is caused by the battery voltage dropping too much during cranking. It may be worth checking the battery terminals and connections for corrosion or possibly changing the battery if it is of some age."

Gregory Wells adds, "I was always told the FF69 involved the way the key is turned to start the car. If you grab the key and turn it to the start position in one motion, the FF69 can be set. If you grab the key, turn it to the run position and pause for just a brief moment before continuing on to the start position, the code won't set. I was told that the ECU circuitry would not "see" the voltage level it was looking for if you passed through the run position quickly, rather than pausing briefly, and this is what triggers the FF69 code.

"This isn't supposition, as we have many, many reports from customers that this procedure does keep the FF69 from being set. The nice thing is that it costs nothing to try it."

CLEARING FAULT CODES -- 6-CYL: Gary Penovich says, "On a '94, you can clear the fault code from the ECU without disconnecting the battery. It's a piece of cake. Open the dash trim panel that's underneath the passenger airbag by pulling down on it. Unscrew the passenger heater vent cover. Remove the small trim panel from around the heater vent. You should see a purple connector attached to a yellow(?) wire. The connector has only one conductor in it, and it isn't connected to anything. Short that conductor to ground for 3 seconds. It will clear the fault code. The process may be the same for all AJ6 powered XJS, perhaps AJ16 as well."

"I have actually moved the connector outside of the trim by running the wire through the vent cover. Now, I can access it simply by swinging the dash panel downward. It comes in handy after disconnecting sensors while the engine is running. The ECU will flag a fault even if the key is on with the engine off!"

Passing Emissions Tests

If your car is too old and tired to pass a required emissions test, you should have it corrected. However, if you don't have the time or money to get this done right now, John W. Himes makes the following suggestion: "I add a gallon of

denatured alcohol to the tank. This makes a very clean burning fuel. The car does not run as good with that in the tank, but it passes emissions very well."

Harry Trafford says, "I have used 99% isopropanol at 12% with some success. Brings down the CO%. Yes, the percentage is high and the idle had to be adjusted to keep running, but these were desperate people. I had them add 46 oz. to make 3 gal. of premium. After the test, they just bought more gas to dilute the alcohol and readjust the idle."

"I used 2-propanol because it's what was available at the time. I also had methanol, but it's corrosive and not a good thing to put in British cars."

Alcohol tends to be hard on some rubber products in the fuel systems of earlier cars, and British non-metallic parts have enough trouble without adding to their woes. Therefore, it is not suggested that you use this method more often than necessary.

Another idea used by some is to retard the timing a bit before the tests. You can't retard the timing by turning the distributor on a car with Marelli ignition, but Jaguar thoughtfully provided a jumper that can be pulled to operate the Marelli ignition system on a slightly more retarded map.

Trafford continues, "I bought a CO analyzer, too. It's a "Gunson's Gastester". This unit is not a professional system, and you need a lot of patience because it must clear to 0 after you make any adjustment. Says it reads in 1 minute, but I gave it more. It looks and feels cheap, but it worked for me by just following the directions. It's made in England."

"Here is the address for the guy that sells the "Gunson's Gastester" CO analyzer in Pennsylvania. He will answer your e-mail.

Ray at: r.d. enterprises, ltd.
290 Raub Road, Quakertown, PA 18951 USA
phone: +1 (215) 538-9323 fax: +1 (215) 538-0158
e-mail: rdent@rdent.com

Fuel System Upgrades

CARBURETORS: Replacing the EFI with carburetors is not recommended. Carburetors have several disadvantages: First, a standard carburetor does not correct for changes in altitude, temperature, fuel density, or other variables that make an engine run at less than optimum performance. Corrections usually require an excessive amount of complication in the carburetor design.

Second, since the carburetor relies on a pressure reduction due to drawing air through a venturi, there is always a flow restriction due to the venturi. Using a carburetor with a larger venturi reduces the loss, but the airflow at idle is so small that they have difficulty drawing fuel consistently, and a rough idle and poor low speed performance is the result. The American solution was the progressive 4-barrel, which uses one set of venturis at low speed and an additional set at high speed.

Third, carburetors tend to have problems ensuring proper fuel/air mixtures at all cylinders. With most arrangements, the corner cylinders on a V-8 tend to run leaner, because the path for the fuel/air mixture to get to them is more convoluted, and the fuel gets left behind and drawn into a nearer cylinder. Such problems would be even more serious on a V12.

Problems occur when a cylinder runs lean; burned pistons usually result. In the old days, the engines would simply be adjusted rich enough to avoid any problems. When environmental regulations and fuel efficiency demands rendered this solution unacceptable, the incidence of burned pistons increased.

The time-honored solution to this problem was multiple carburetor systems. The intake path for each cylinder must be similar, and sometimes even a dedicated barrel for each cylinder was used (Webers, etc.).

Obviously, fixing all these problems simultaneously would involve a truly elaborate carburetor system, possibly requiring multiple, progressive barrels for each cylinder.

EFI systems generally come in two types: throttle-body and multi-port. Each type will correct the first and second problem of carburetors, because all EFI systems automatically correct for variables and no EFI requires a venturi. The throttle-body system, which consists of a single injector in the same housing as the butterfly valve, shares the same distribution problems as carburetors, but is much simpler and cheaper than multi-port.

Multi-port EFI, what the Jaguar comes with, is the ideal fuel supply system. Since the injectors serve each cylinder individually, there is little chance of a cylinder not getting its share.

The only disadvantage of EFI is the difficulty in modifying it -- which, of course, the EPA considers an advantage. However, contacting AJ6 Engineering (see page 663) will likely alleviate all such concerns; they will modify ECU's for very reasonable fees.

EFI SYSTEM REPLACEMENT: Electromotive Inc. (see page 666) makes a system called the TEC-I (TEC stands for Total Engine Control) that replaces the EFI computer and the entire ignition system as well. It's got more modern and comprehensive electronics than the Jaguar original, including an optional knock sensor. Also, it is programmable using a PC-compatible computer, allowing the owner to customize the operation to suit his needs. It's not cheap; but if your ECU has already died and you're looking at the cost of the Jag original to get running again, it starts to look cheaper. And if you're having ignition problems as well (this system renders the entire distributor superfluous, you might as well put in a blank-off plate), it starts to look downright reasonable.

If you are performing serious engine modifications, this system is just the ticket. Since it can be calibrated, you are not restricted to the original response curves on your non-stock engine.

AJ6 Engineering (see page 663) also makes replacement EFI systems and components, and will modify the stock ECU on an exchange basis. According to Jeffrey Gram, "if experimenting was wished they could do a single EPROM version , which has up to 8 MAPs. It would be possible to switch between the MAPs if the ECU is depowered between switches by means of a "dial". AJ6 do such programmes to experimenters which then have 8 maps to choose from trying to find the best setting."

Scott Horner found an aftermarket system in New Zealand:

Link Electro
243D Annex Rd
Christchurch, ph +64 3 348-8854

"From them you can buy the ECU, Ignitors, Injector Ballast and Tuning Module (a handheld LCD interface) & the Crank Angle Sensor... You still need to supply a lambda sensor (aftermarket Bosch will do), and the coils...On my car, we used VN Holden Commodore (Australian GM car) coils, 2 coil packs. The Holden uses the Buick 3.8 liter engine, so it's presumable the coils would be available in the US in some form. I have heard these coils only last about 20,000km, but we'll see.

"Any 3 or 6 pack coil combination would do, I have heard Audi have a very tidy solution..."

Robert Dingli reports: "Here in Australia there are many, many aftermarket injection ECU's available. I've tested many of them in cars and on the bench and have found most of them to be garbage. Common faults are production quality, lack of temperature compensation and other instabilities, and general difficulties with setting up a system from scratch. Basically you get what you pay for. A \$2000 Motec or Autronics unit is highly recommended over sub-\$1000 Injec, Linx EMX, Microtec or Haltec. The expensive units also control ignition. The Motec, Autronics and Haltec require a portable PC (to be added to the cost if not available) to make proper adjustments."

"As far as "high performance" chips are concerned, I'm rather skeptical as to their worth. The problem (??) with modern day EFI systems is that they are very close to optimum, being a fine balance of performance, economy and exhaust emissions. Some of the chips available advertise that the systems will still comply with pollution levels. The specs reveal that power increases are only in the order of a few percent for most cars."

“Systems where chip changes may actually make a noticeable difference are:

- Systems with electronically-governed rev limits.
- Racing use where pollution isn’t a concern.
- Turbo cars where the electronically-governed boost limits are raised.
- Electronic ignition systems without knock sensors where the timing maps can be advanced to take advantage of better quality fuels.
- Electronically-controlled auto gearboxes where upshift points are raised.
- Older poorly-calibrated systems, e.g. SIII XJ6 Jags set up for cold climates but being run in warmer climates.”

According to Ken Wallace, “If you live in a regulated area the smog police will not approve of any of this even if it improves your emissions. You can have your installation certified, but this is very expensive like more than \$10,000 from what I hear.”

Robert Gee adds a warning about aftermarket EFI systems: “I worked for a car manufacturer who made their own injection systems (Rover MEMS). One or two people had fitted MEMS to their own cars, mostly for competition use. One guy had a modified peugeot 205 GTi with one in. He had spent a fortune on the thing.

“Now, given that this guy had access to rolling roads, vehicle calibration experts and the like, the driveability was never perfect (an important Jaguar feature - low throttle response crucial on an auto). Also he went through about 3-4 tankfuls of petrol doing the calibration (not too bad at US petrol prices I suppose - more than the cost of an ECU at UK prices). And this was still with the very fine tuning carried out automatically (This was done with some special adaptive software we were working on which used the lambda sensor feedback signals to adjust the fuelling maps).

“To cap it all, when he came to sell the car it was quite hard since it was non-standard and hence not supported by any garages.

“Put it this way, I could have converted my XJ-S 3.6 to full sequential injection with fully programmed ignition for next to no cost - but preferred to keep it standard and I probably would not have got it any better than the Lucas P digital.

“If there one thing I learnt at Rover it’s that the low throttle drivability is what separates a good car from a bad one - and it also takes about 95% of the engineering effort. Anybody can make a car which goes well at full throttle - and I suspect it’s the latter market at which the after market fuel injection systems are aimed.”

FUEL INJECTOR ORIENTATION: Strictly a cuteness mod here. Of the 12 fuel injectors on the XJ-S, some have the electrical connector pointing rearward and some have it pointing forward. If you wish, it is possible to reorient any fuel injector to point either rearwards or forwards, even the two front ones -- the connector will easily fit under the arc of the fuel hose.

To reverse the orientation of an injector is not easy unless you happen to be replacing the hoses *or* the rubber seals, in which case it’s a snap. While the large rubber seal is off or the hose is disconnected, take the plate that retains the injector off and flip it over. Twist the injector around on the hose. The wiring harness will usually reach either side of an injector, but note that some harnesses are really brittle and fiddling with stuff like this may be asking for trouble.

There’s not much good reason to do this. Perhaps you have an idea on how to make it easier to get to the spark plugs. Or, maybe just for a symmetrical look, you’d like the front 3 on each bank to face rearward and the rear 3 on each bank to face forward.

AIR INJECTION

The tubes on the air rails insert into holes in the intake manifolds leading some to believe it's somehow involved with the intake system, but it's not; the lines go through the intake manifold mounting flanges into the heads and terminate within the exhaust ports. The purpose of the air injection system is to provide oxygen in the exhaust stream to enable the catalytic converters to work.

AIR INJECTION PUMP: Roger Myers reports that the air pump on the XJ-S can be replaced with a GM unit. Take the old one to your local parts shop and ask them to give you one just like it. Chuck Sparks says that A-1 (a rebuilder) lists it as part number 32128.

GETTING THE AIR INJECTION SYSTEM TO ACTUALLY WORK: John Napoli adds, "I have had the opportunity to see the air rails from Jag engines -- both 6 and 12 cylinder versions. Very often, the cars have brand new air pumps and diverter valves and hoses -- so someone spent a good penny replacing all that stuff. And on every one, the air rail tubes (where they stick into the head) were completely coked up. You would need some really ambitious air to get through all this!! Moral of the story: if you are going to maintain your air pump system, don't forget to do the obvious and simple and remove and clean out the air rail tubes. Otherwise you are just wasting time and money."

You'll also probably need to clear out the passages within the heads. There's nothing complicated about those passageways, they are straight shots into the exhaust ports. You can clear them out with a drill.

AIR INJECTION PUMP CONTROL: Roger Bywater says, "the 2-3 seconds delay on the diverter valve was because of a controlled leak across the actuator diaphragm which allowed the valve to progressively reapply air injection while the manifold was still under high vacuum. I seem to remember that removing the neoprene cover nipple from the actuator stub pipe prevents this leak from building up a balancing vacuum on the reverse side of the diaphragm, thereby totally disabling the air injection system. We sometimes made use of this to take a before-catalyst gas sample from the air rails, fittings having been added for that purpose.

"In fact there can be more to this diverter valve business that is not readily obvious and it can have advantages even with over-run cut off. In the over-run condition the injected air from the pump becomes quite a high proportion of the total through-put so if no fuel were present, as would be the case with over-run cut off, the catalyst would lose temperature quickly. Having a diverter valve to temporarily dump the excess air gives the catalyst an easier time, with less steep temperature cycling and helps to maintain catalyst effectiveness when the fuel reinstates."

AIR INJECTION PUMP WASTE OUTLET: On the H.E., the air pump only delivers air to the exhaust system during warmup; once the engine is warm, it wastes the air into the right side air filter housing. Michael Aiken points out that it is plumbed "to the engine side of the filter. *Unfiltered air* is being pumped directly into the engine - and this is very dirty air coming out of this pump! I would recommend that the wastegate tube be removed from the air cleaner housing and the opening in the housing blocked." Aiken adds that the filth coming through this line was actually visible on the inside surface of his air filter itself. He also points out that, in addition to the dust that the air injection pump may be pumping into the intakes, the pump itself is junk and may start pumping bits of itself into the intakes at any time -- rust particles, bearing bits, whatever.

It's possible that the waste line was routed to the filter housing to reduce noise, but if noise is a concern it should nevertheless be rerouted to the *outside* of the filter, not the inside.

AIR INJECTION NON-RETURN VALVE: Roger Bywater: "The reason for the check valve in the air rail was not because exhaust back pressure could exceed the pump pressure, but to prevent exhaust backflow into the pump if the drive belt should fail."

Bruce Battles says that the Jaguar non-return valve "without the T-splitter is a GM part (check valve) Part # STI AV7. Just keep your T-splitter and install on the new GM check valve." Chuck Sparks provides a couple more part numbers: Tomco 17001 and Std Parts AV-7.

AIR INJECTION SYSTEM REMOVAL: Removing this system is not recommended, as this would be a modification of an emission control system and would be illegal in many areas. Too bad, too; this system accounts for a great deal of plumbing under the hood as well as a belt-driven load on the engine. And on the Digital P cars, it only functions when the engine is cold -- the pumped air is wastegated after the engine warms up to prevent interference with the operation of the oxygen sensors. And removal would be so easy: mounting a generic adjustable idler pulley in place of the pump (being sure to mount the idler low enough that the belt clears the fan belt idler) and plugging the holes in the intake manifold. A different A/C belt might be needed.

Of course, some people insist on genuine Jaguar parts. Peter Smith: "I removed my air injection system and used a jockey pulley to carry the V-belt. These pulleys were standard equipment on English cars which did not have to meet emission requirements in the early days and some of these jockey pulleys may still be available in wrecking yards in England." Smith went on to provide enough data from the parts books to create a parts list:

C36014	Pulley
C37886	Hub
C37889	Bearing
C23128	Setscrew
C37879	Bearing Holder
C37875	Bracket

plus an assortment of generic bolts, nuts, etc., that you can get locally.

The 1987 Jaguar Parts Catalogue lists some different part numbers:

EAC4185	Pulley
C37886	Hub
EAC3042	Bearing
C23128	Setscrew
EAC3041	Bearing Holder
C37875	Bracket

Even when removing the air pump from an earlier car, it might be wise to order the later parts. Maybe they were updated for some good reason.

Also note: according to the '87 Parts Catalogue, the pulley used as an idler is the very same part number that's used on the air pump -- so you can skip buying EAC4185. It's a fairly safe bet you could skip buying pulley C36014 for an earlier car as well, since it fits on the same hub.

You can also probably skip buying the bracket C37875 if you're willing to add a couple of inches of spacers around the pivot bolt for the air pump.

John Napoli offers a suggestion for plugging the air injection holes in the intake manifold: "Buy 1/4" nail anchors from Home Depot. They are aluminum and look like a large pop rivet. Get them 1" long. Cut them back to 5/8" long with a band saw or hack saw (only cut the body, don't worry about the 'nail'). Put the two o-rings from each air tube on the shank of the anchor. Smear on some engine-grade silicone. Insert into the manifold and hammer down the nail all the way. Omit the 'plates' and retighten the intake manifold to the engine. Looks great and works great." This mod is likely to require an extra washer or two on each stud, since the studs may not be threaded far enough to tighten the nuts down on the manifold flange with the plates omitted.

Napoli: "Here is the info on the nail anchors I used -- the ones I got at Home Depot:

Star Anchors and Specialty Fasteners
1/4" by 1"
2615-32178 (part number)
31916 26096 (number under bar code)

"This is for a box of 40. Enough for 3 V12s and 1 Opel Kadette."

Michael Aiken's local Home Depot apparently carries similar anchors in a different package: ""Red Head" light-duty anchors. They are 1/4" x 1" hammer-set anchors used for anchoring to concrete. They are easy to install just as John says. They come in a package of 14 -- perfect for a V12 as long as you don't screw up more than two. I have two spares. The part number is 11234. They are in the fasteners dept."

An addendum to Napoli's idea: While Home Depot only carries 1" anchors, 3/4" long hammer drive anchors are available at some other hardware stores, usually in the bin right next to the 1" ones. Since the flange on the intake manifold is about 7/8" thick, these anchors can be used without cutting them shorter.

If you set about removing pump, valving, plumbing, and rails with the engine in the car, you will find it very difficult indeed to remove the pipe that goes from right behind the air pump along the bottom right side of the engine and emerges behind the turntable. Some have resorted to ripping this pipe to pieces to get it out. The easiest solution is to simply leave it there. If you ever have the right side exhaust manifolds off for some reason, you can remove it then.

REPLACING THE AIR PUMP WITH A GM ALTERNATOR: If finding or fabricating an idler pulley to replace the air pump is too fiddly for you, note that installing a GM CS130 alternator in place of the air pump is *easier* and probably cheaper. This replacement is described starting on page 535. The GM alternator not only serves as an idler but also eliminates the need for the Lucas alternator and its V-belt in the process.

AIR INJECTION -- 6.0 ENGINE: Charles Randle says the air injection system in the 1993-on 6.0 engine is different; "Suggestions like do away with the system with an idler pulley is not an option."

EXHAUST SYSTEM

MANIFOLD/DOWNPIPE NUTS: The nuts that hold the downpipes to the manifolds look like an extra long nut. They actually contain a self-locking helicoil, a special type of helicoil in which a couple of the coils near the center are deformed to provide some friction when turning. These helicoils are held within the nut by a staking on each end that deforms the thread just beyond the end of the helicoil. Whenever these nuts are removed and reused, it is recommended this staking be checked, and re-staked if necessary.

The helicoil design means the parent metal of the nut is thinner than normal nuts. This is countered by the nut being so long. If overtorqued, these nuts will split lengthwise, and internally grip the socket used to torque them. If this occurs, of course, the nut must be replaced. The stud is a normal fine thread, so a normal nut will fit. It is recommended that a stainless steel or brass nut be used due to corrosion problems at red-hot temperatures, and a locknut or lockwasher be used since a normal nut lacks the self-locking feature of the original. Obviously, a locknut that uses a nylon insert for self-locking is unacceptable.

Thomas Alberts says, "I have purchased the long nuts with the helicoil inserts from a Jag dealer, but since then I've seen them at Western Auto hanging on the pegboard in a bubble pack."

Some auto parts stores sell “stud nuts”, nuts intended for use on exhaust manifold studs. Generally, they are longer than normal nuts and made of solid brass (no helicoil insert).

Another type of nut that looks right is the coupling nut sold in hardware stores for connecting lengths of threaded rod together. These are typically coarse thread, but even if you replace the stud these nuts would probably not work well. They are generally mild steel, so they aren’t very strong and will corrode something fierce on an exhaust manifold.

Getting the exhaust manifold/downpipe nuts on and off seems imposing, but it usually can be done easily enough. The two outer nuts on each side can usually be loosened with a box end wrench and a lot of patience, and the two inner nuts can be loosened from underneath the car with a socket, universal, extensions and ratchet. Michael Minglin suggests, “For the outside studs I bent a box end wrench into kind of a “Z” shape so I could slip one end over the nut from the top of the car. I welded an old socket onto the other end so I could use another wrench for leverage, and use a torque wrench to put it back together.”

An even better idea: find a 9/16” “distributor wrench”. These wrenches are designed to tighten and loosen the bolt underneath a distributor on American cars, and therefore have a deep zig-zag to them.

Be sure to use anti-seize compound when assembling, whether using original nuts or substitutes.

Interestingly, Jaguar provides four threaded holes in each header when only two studs are used. If the threads in one pair of holes get boogered up, it should be possible to install studs in the alternate two holes, and rotate the loose collar on the downpipe 90° and reinstall.

TRANSMISSION/EXHAUST PIPE BRACKETS: When considering the mounting of exhaust pipes, it must always be kept in mind that the engine moves around on its mounts. When power is applied in low gear, the entire engine/transmission assembly can tilt significantly to the right. Typically, exhaust systems are rigidly mounted to the exhaust manifold and unsupported from there to the rear of the car, where they are supported by soft rubber mounts. The intention is that the pipes will flex enough over this length that the engine can move without damage or fatigue.

The XJ-S, of course, has a problematic transmission mount (see page 314). Problems with the transmission mount can cause the engine to move more than intended, increasing the stress on the exhaust system.

The XJ-S also has several joints in the exhaust system around the catalytic converters, which happen to be in the middle of the unsupported span. These joints can vibrate loose under the stress. Add to this the fact that the catalytic converters themselves get very hot when running, and are made of a high-temperature, brittle material. There are reports of the catalytic converters actually cracking within about 50K miles.

Jaguar’s solution is to add a pair of small brackets from the torque converter cover to the pipes. The intention is to render the portion of the exhaust system between the manifold and the catalytic converter rigidly attached to the engine/transmission assembly, thereby seeing no stress. The flexing of the system would have to occur from this point rearward.

This solution is mediocre at best. On earlier models, the torque converter cover is made of sheet metal; it is not strong enough for this load and generally ends up pretty mangled. The fix also causes noise; some of the vibration is transmitted to the sheet metal cover, adding a tinny sound to the car.

Later, a beefier cast cover was used. This may represent a solution to the problems, or at least part of one.

EXHAUST PIPE UNIONS: The three-bolt flanged joint in the exhaust pipe just forward of the rear axle is a very interesting device. The seal within it serves as a sort of ball joint. The angle of the pipes at the connection can be changed by tightening some of the flange bolts while loosening others. This enables corrections to alignment so the exhaust system doesn’t bang against anything.

Unfortunately, few muffler shop weenies have ever seen such a feature. If they just zip the nuts on those bolts with the air wrench and proudly announce they finished the job in under 30 minutes, it’s not likely things will line up.

If you have disassembled your exhaust system at this point and need to reassemble it properly, you will find it most helpful to have an assistant -- or a jackstand, if you are short of assistants -- hold the forward end of the rear muffler up in its proper position while you tighten the three bolts on this fitting. When you think you are done, grab the pipe and give it a good shaking. If it bangs anything, you're not done.

EXHAUST SYSTEM ASSEMBLY: Jan Wikström sends this procedure for assembling each side:

1. "Hang the bent pipe in place. Make sure the insulating compressed-fibre bead is in place inside the rubber. Smear Loctite exhaust joint compound in the joint and offer it up to the flange. Do the screws up looser than finger-tight."
2. "Insert the second muffler and engage its hanger. Smear the Loctite stuff on the sliding joint and join it up."
3. "Push in a finger-thick stick (conveniently brought by crazy dog) on each side of the tail muffler to jam it in the centre of its asbestos-lined pocket."
4. "Push the bent pipe clear of the brake calipers and jam in another stick between the pipe and the bleeding nipple."
5. "Shove the front muffler over and up until it sits right with another finger-thick stick between it and the heat shield. (memo: get a bone for the helpful dog)"
6. "Look at the tail muffler to check that it isn't sitting too high or low through the see-saw action of the pipe. Waggle the pipe accordingly."
7. "While holding everything in place, tighten up the flange bolts about half tight."
8. "Fit clamp and slot cover piece, liberally smeared with you-know-what. And do up the sliding joint about half tight. Check that both hangers have ample space for the pipe to move."
9. "Remove all sticks, hold your breath and check clearances. If the exhaust can shake normally on the hangers without touching anything, tighten flange and clamp fully. If not, first apply brute force as required..."

"The Loctite stuff is great; when the heat comes on, it foams to maybe three times its volume and makes a tight seal. A tap with a hammer will break it when you want to open the joint."

HEAT SHIELDS: The Jag seems to have them everywhere: those hokey little pieces of sheet metal that seem to do nothing but get in the mechanic's way. Not so! While some performance cars are designed to go fast for the magazine road test and never see 100 mph again, the Jaguar is designed for the Autobahn -- not just 140 mph, but 140 mph all day. Under these conditions, the exhaust manifolds and downpipes can get red hot. Items that hot radiate heat (emit heat as infrared light - you can feel it from a distance). The belts, electrical insulators, boots, hoses, O-rings, etc. (all of which happen to be black) absorb this radiant heat and cook. The heat shields are not there for passenger protection or to aggravate the mechanic; they are necessary to prevent the rubber and plastic parts from destruction.

Particular attention should be paid to the heat shields around the catalytic converters, because they get hot even when you're driving slow. If these heat shields are not in place, the boots on the steering rack (\$\$\$!!!) won't last long.

Heat shields are no more complicated than they look. You can easily make them out of scrap sheet metal. Hoses and the like can actually be provided considerable protection by merely wrapping them with ordinary aluminum foil.

HEAT SHIELD BOLT SEALS: The heat shields over the exhaust manifolds on the H.E. are held on by two bolts of different sizes. The larger rear bolt is actually a plug for a port into the exhaust tract, presumably because Jaguar used the port in past models or anticipated the need for such a port at one time or another.

This fat, stubby bolt is sealed with a copper washer. If your local auto parts store has a rack of red cards titled "Help!", it probably has a package of two sealing washers that are the correct size: number 66265, "Brake Hose Bolt Washers", ID = 33/64", OD = 45/64". These same seals fit the banjo bolt under the oil pressure sender -- see page 43.

CATALYTIC CONVERTORS: According to Randy Wilson, the XJ-S has "two different types of catalysts in series. The first cat after the engine is a three-way. The second is a single function reduction cat." Since it is a dual exhaust system, there are two of each for a total of four catalytic converters.

There is a honeycomb insert in the downpipe, immediately adjacent to the exhaust manifold. This is part of the catalytic converter system.

Note that sometime in the 90's, perhaps with the introduction of the 6.0 in 1994, the catalytic convertors were upgraded with new designs that are far less restrictive. These new models reportedly do not have the honeycomb within the downpipes themselves.

CATALYTIC CONVERTORS -- MELTDOWN/FIRE: When a cylinder fails to fire, the unburned charge of fuel and air is pumped into the exhaust system. If the catalytic convertors are up to temperature and operating, they will "burn" this mixture, and get hot as a result. If there's a lot of misfiring going on, there is a risk of a serious fire starting at the cats and possibly destroying the entire car. Roger Bywater expounds at length on this concern: "Back in the 1970's when I was working in Emission Control Dept. at Jaguar one of my responsibilities was complying with Japanese Heat Damage Tests. Amongst other things this meant having a catalyst overheat warning system (via a thermocouple in the cat) and the test procedure called for one spark plug to be disabled while idling to prove the system worked. The mixture from the dead cylinder would then be burnt in the catalyst which would obviously get a bit hot. On the old oxidising catalyst systems this was not unduly dramatic, but even so because the carb XJ6's had the cat well back under the car, if driven any distance in this condition, they could end up with the rear seat springs popping through the top of the seat!"

"Now when we started using Lambda sensors on the 4.2 EFI engine the situation changed alarmingly. When a plug was disabled the Lambda sensor would detect the spare oxygen from the dead cylinder and the system would react as if the fuelling was too weak so swung to the rich limit in trying to correct it. The catalyst now would be getting a supply of air and extra fuel and would start to glow in no time at all, even at idle.

"Of course the main reason the cat got hotter on the 4.2 EFI with Lambda was not so much because of having feedback as because it was a lot nearer the engine than had been the case with the oxidising cats. Also one cylinder out on a 4.2 6 cyl puts through a lot more fuel than one out on a 5.3 12 cyl so the 4.2 cat had a lot more to burn.

"In fact on the carb engine with oxidising cat we had to disable 2 cylinders to provoke the cat to overheat enough for the test. On the EFI with a 3 way cat one cylinder was more than enough and we had to keep reconnecting the lead periodically during the test to stop the cat rear cone temp going over 1000°C, and remember this was at idle!!!

"I am sure this is far from unique to Jaguars and is made worse by the presence of a pressurised fuel supply with the potential to make sure almost any underbonnet fire will have catastrophic consequences.

"Really if any catalyst car develops a misfire it should not be driven. It is a bit like when the oil warning light comes on - driving another couple of miles could prove to be very costly! It is perhaps realisation of this sort of problem that prompted California ARB to come up with OBD & OBD2 with the requirement for really powerful fault monitoring techniques."

See page 154 for warnings on how faults in the Marelli ignition system can burn your car to the ground and page 164 for how overheating cats can cook the Marelli crank sensor.

CATALYTIC CONVERTOR TEMPERATURE MONITORING: The regularity of the Marelli distributor rotor failures (see page 154) has resulted in suggestions for monitoring the temperature of the catalytic convertors in hopes of

avoiding expensive damage. This plan has a distinct advantage over monitoring the various possible causes of overheating, since it will alert the driver to overheating problems in the cats irregardless of whether Marelli is at fault or something else. A jammed fuel injector, a faulty fuel regulator, ECU problems, any number of things can cause a catalytic convertor to run hot, and with a large engine such as the Jag V12 it doesn't take too large a problem to cause some serious overheating.

There are lots of ways to monitor cat temperature. Some sort of fusible link -- perhaps even homemade, like out of silver solder or something -- could be installed on or near the cats that would melt and break a circuit when the link's melting temperature was reached. Some sort of bimetal strip or coil could be used to open and close a contact at a certain temperature. A thermocouple or two could be installed in, on, or near the cats. There are optical sensors that will detect and measure infrared radiation. For a really half-assed indicator, a pair of normal insulated wires could be twisted together and installed so that a hot cat would melt the insulation and cause a short.

The first problem is figuring out what temperatures we're talking about. Bob Gallivan forwards a guideline: "This is from "How to Tune & Modify BOSCH Fuel Injection" by Ben Watson: The minimum operating, or light off, temperature of the converter is 600° F, with an optimum operating temperature of about 1,200-1,400° F. At a temperature of approximately 1,800° F the substrate will begin to melt."

In Japan and the Middle East, catalytic convertor temperature monitoring systems are required by law -- so you may be able to obtain the necessary parts from Jaguar. Richard Mansell says, "Browsing through the '87 XJ-S parts manual I have found the bits and pieces used for the catalyst monitoring on the Japanese spec cars. They appear to use a catalyst mounted thermocouple, DAC1226, along with a little black box, DAC6943, known as "Module-catalyst switching". Also listed on the same page are sensor-thermal, DAC1043, which appears to be bolted to the floor although it does not say where. There is a harness, DAC3573, to plug it all together."

Andrew Corkan and others have pointed out that you can "buy a commercial dual-needle exhaust temperature monitor from Summit Racing. About \$250 US, works but has a big goofy dial you will have to mount." See page 670 for Summit.

Michael Aiken suggests, "If people are serious about monitoring cat temperature there are relatively inexpensive probes and gauges - they are used on snowmobiles to monitor exhaust gas temp for tuning. They even have digital gauges. They can be found at any snowmobile (motorcycle) shop or snowmobile catalog.

"I looked into a setup in a catalog I have. A dual analog Westach gauge (one 2" gauge, two needles) goes for about \$85, a 3" gauge is \$100. Two probes (\$30 ea) would be \$60 for a total of \$145 to \$160. The two needles in the gauge point at each other and should register the same under normal operating conditions. One rising significantly above the other would indicate a problem! The probe is mounted in a 3/16" hole with a stainless steel clamp (no welding). The gauges read from 400°F to 1600°F. The only problem I see is the leads to the gauge from the probe are only 4 feet long. It's not far from the exhaust in a snowmobile to the gauge panel."

Corkan again: "A DIY thermocouple option accessible to everyone might be to get K type thermocouples (~\$20 each). Then get a specialized thermocouple amplifier (Linear Tech #LT1025 is a cheap option, ~ \$10 each) and wire the output of the amplifier to a comparator (a cheap one from Radio Shack) that will turn on a light when the amplifier output goes above a certain point."

Since there may be some question about just how hot is too hot, John Arthur suggests, "What we need is a reference temperature. Fortunately the excellent design of the car means that one has already been provided at enormous expense. That's right -- the other cat! What is needed is a measurement of the difference of temperature between the 2 cats. There are industry standard thermocouples that are used in labs and workshops for measuring oven temperatures. Some are simple and could be clamped to the outside of the cat and others have a threaded boss that would be best screwed through the exhaust just behind the cat. Connect 2 of these thermocouples, one per cat, back to back and the voltage developed across the ends will be proportional to the difference between the temperatures of the 2 cats. You have to take the thermocouple wires back to the electronics but they are available with a length of 2 metres which should be enough. These things are reasonably linear and a temperature difference of, say, 300° Celsius would give an output of around 12 millivolts. Some enterprising electronics guy could doubtless produce a simple amplifier that would enable a warning light or buzzer to sound. Two amplifiers and 2 gauges and you could read the actual temperatures. There are even ICs available which compensate for the slight non-linearities of the thermocouple.

"I have found a reference to Analog Devices AD595 as a thermocouple amplifier for Type K thermocouples. However these cost over 12GBP plus tax in 1996. A simple generic op. amp. such as a 741 or equivalent would cost pence/cents and do the same job of alerting you to a major temperature difference."

Note that monitoring *only* the difference in temperature may not be a good idea, since failure modes other than the Marelli rotor failures may threaten both cats equally. The typical cause of high cat temps is a misfire, and a misfire on both banks can cause cat overheating on both banks. In fact, such a failure mode is described on page 163.

CATALYTIC CONVERTOR NOISES: Gerald Foster reports, "The dealer is turning out to be not so dumb. If I had gone with them I would have saved buying a power steering pump and water pump the independent dealer sold me. (Yes, a bad cat can sound like a grinding power steering pump)."

CATALYTIC CONVERTORS -- CHECKING: Greg Maddison suggests that you can visually check the front cats for plugging by disconnecting the pipes between the first and second cat, unscrew the oxygen sensors, and insert a small light into the hole. "I used a small Mag light with the shade removed." Looking into the back end of the cat, you should be able to see the light through the core.

CATALYTIC CONVERTOR REBUILDING: Greg Maddison says, "The original Jag parts are \$800 each so you can see how changing all four would be quite an investment. I found a company that rebuilds them for much less than new ones cost, they are called Jag Services." See page 644.

AFTERMARKET CATS: LaRue Boyce says, "Caution on the aftermarket cats! Both pieces were not "true" and couldn't be joined together without a lot of modifications."

GENERIC CATS: Generic cats are available from J. C. Whitney for, like, fifty bucks each. Sure, you have to figure out how to plumb them up, but considering the cost difference you have plenty of incentive.

CATALYTIC CONVERTOR GUTTING/REMOVAL/REPLACEMENT: Catalytic converters are not inherently particularly restrictive in an exhaust system; in a properly-designed system, removing the cats has very little effect on performance.

Unfortunately, this is not a properly-designed exhaust system. The general consensus is that the stock exhaust system on the XJ-S is very restrictive, and the cats are a key part of that restriction. Simplest fix: take off the downpipes and cats and bash all the innards out of them and reinstall.

Of course this will reduce the restrictions considerably, but for the optimal flow it'd be nice to have smooth pipes instead. One possibility is to replace the US-spec downpipes with the European versions that have no catalytic honeycombs inside. Unfortunately, they don't have oxygen sensor ports either, and it'd be nice to maintain those. However, oxygen sensor ports are commonly available from places like Jeg's (page 667) or Summit (page 670) and can be welded into the downpipes.

If you must face the emissions inspector, neither of those options will be acceptable. There are others that might be, however. First, you could consider fitting some aftermarket catalytic converters, preferably something broad and flat to fit under the car and less restrictive than the originals. Or, you could consider retrofitting the later OEM cats to the early car! According to John Napoli: "I happened to be at my local Jag dealer as someone was taking delivery of a new pair of V12 head pipes. I noticed that these pipes did not have the corrugated metal inserts in each of the four down tubes. These inserts are ostensibly part of the catalyst system, and are present on many V12s (including my '82 XJ-S H.E.). Anybody who has seen head pipes with these inserts in place would reasonably conclude that they add a lot of restriction

to the exhaust. The replacement pipes I saw today have a different shape to the cats -- more streamlined and seemingly smaller than the cylindrical cats on the head pipes with the inserts. The parts man said that both types of pipes are available (with the inserts and without), both are fully certified smog-wise, and that the design without the inserts is considered a better performer because of the reduced back pressure. The downstream cats are required with both designs. I did not inquire as to price, but it seems that anyone replacing their cats should consider these replacements, as the Jag V12 rewards you for anything that helps it breathe better."

EXHAUST PIPE TIPS: The XJ series Jaguars have a unique style of tip on the exhaust system, a sort of S-shaped extension that places the outlets right out on the corners of the car. This is not a mere styling feature; these tips were supposedly designed to correct a problem with exhaust fumes recirculating back into the car. The shape puts the outlets out into the airstream coming around the car rather than into the dead air space behind the car. If you wish to replace these extensions with some generic replacement tips, be prepared for fume problems when driving.

Of course, the aerodynamics are significantly different between the various XJ models and all of them have the S-shaped tips. While the fume problem may be the case with some of them, it's not likely to be the case with all of them. Some people claim to have no problems, while others complain bitterly of the odors. Pay your own money, take your own chances.

You might not really want to replace them anyway. The generic pipe tips available locally are usually cheap chrome-plated steel, and the chrome comes off quickly and the steel underneath rusts away to nothing. The stock Jaguar tips are made of stainless steel, so there is no plating to flake off. No matter how dirty they get, they can always be made to look new again with a little work with some Comet cleanser.

J. C. Whitney offers stainless steel exhaust pipe tips, basically a 9" long straight piece of stainless steel pipe cut off either straight or at an angle at the end and held in place with two setscrews. The ones to fit "1-5/8" to 1-7/8" OD pipe" will fit the stock XJ-S muffler nicely; catalog number 12xx0949U for the straight cut end, 12xx0952Y for the angle cut tip. Note that the outlets on the mufflers are turned down slightly, so these tips will not sit horizontally but will angle downward a bit.

TAIL PIPES: Ernie Laprairie reports: "Just had two dual-tip Pacesetter resonators installed instead of the bulky Jag style. Looks great and still quiet, only about 8 inches long plus chrome double tips on each side."

ADDING A CROSSOVER PIPE: One typical performance enhancement to dual exhaust systems is to add a crossover pipe: a connection between the two exhaust streams to permit each exhaust pulse to escape through both systems. This idea has been used with dramatic results on V8's, and many cars come with them from the factory.

There may be precious little performance improvement from adding a crossover to a V12, though. First off, six cylinders per bank results in smoother exhaust flow than four, so the pulse flow benefits of a crossover are smaller. The exhaust pulses on a V12 alternate between banks while there are successive pulses on the same bank on a V8, which is another reason the crossover helps the V8 so much.

There is another reason to consider a crossover, though: sound. Without a crossover, the note from each pipe is that of a six-cylinder; with a crossover, each pipe sounds like a 12-cylinder. The Series III E-type was fitted with a crossover pipe, and Roger Bywater claims it was strictly to make the car sound proper.

To avoid screwing up the EFI, a crossover should be installed after the oxygen sensors.

A crossover has two disadvantages: First, it can make the exhaust system, already a pain to work on, even more difficult to assemble and disassemble. Second, being able to check the exhaust from each bank helps with engine fault diagnosis. Both of these problems can be minimized by including a flat face flange in the crossover, and making a flat blank-off plate that can be bolted into the connection when doing engine analysis.

Summit Racing (page 670) offers “balance tube kits” for less than \$50. These require no welding to install; simply cut sections out of each pipe, install tees with clamps, and install a connecting pipe with clamps.

MUFFLER REMOVAL: AJ6 Engineering (page 663) offers a pair of “Silencer Substitute Pipes” to eliminate the mufflers forward of the IRS. They claim a 15-20 hp gain for this change; they also mention the inevitable change in exhaust note.

Members of the xj-s@jag-lovers.org discussion list generally report that removing the mufflers forward of the IRS and replacing them with straight pipes or less restrictive mufflers results in only a slight increase in sound, and the sound that results is pleasant. However, removing the mufflers rearward of the IRS and replacing them with straight pipes or less restrictive mufflers usually makes the car unacceptably loud, and the sound is not pleasant.

If your objective is the sound, consider modifying the intake system first as described on page 103. The sound that results is wonderful, and only appears at serious throttle; at light throttle or idle, it makes no sound difference at all.

LARGER PIPES: AJ6 Engineering (page 663) offers a “Large Bore Exhaust System” and claims improvements of 20-25 hp. They mention that this may only be justifiable if the entire system needs replacement anyway.

AJ6 notes the inherent difficulty with fitting anything really big through the IRS. If you’re that kinda guy, you can forget about ground clearance and just run some big pipes *under* the IRS. This also eliminates several bends in the piping, further reducing restriction. Note that the IRS subframe is mounted on rubber and moves around a bit, so pipes going under the IRS should *not* be attached *to* the IRS -- unless attached with rubber mounts.

DRIVETRAIN

The XJ-S was originally fitted with a Borg-Warner Model 12 automatic transmission, but in 1979 this was replaced with the GM400 automatic. In the mid-70's reportedly 352 XJ-S's were fitted with 4-speed manual transmissions and the official Jaguar repair manual dedicates an entire section on maintenance, but there is precious little information available on that tranny for inclusion in this book. The XJ-S's fitted with the six-cylinder AJ6 engine were available with a 5-speed, but there is no info herein on that tranny either.

SHIFT CABLE -- ELECTRICAL PROBLEMS: William F. Trimble reports: "The Jag would not start -- nothing when the key was turned to the start position. Shortly thereafter smoke started coming out of the shifter quadrant on the console.

"We took part of the console apart and found that the shifter cable had melted, freezing the car in park. A check underneath revealed that the lockout switch and wiring looked OK, and that there were no obvious problems with any of the wiring under the car." Eventually, the problem was found: a loose ground cable. "The high current load imposed by the starter could not get through the loose ground cable. The current chose the next best available route, which was through the shifter cable to the body." This problem is reportedly common enough that some parts clerks are familiar with it.

Avoid this problem and install an additional ground strap. See page 514.

BORG-WARNER MODEL 12 TRANSMISSION

BORG-WARNER/GM400 BOLT PATTERNS: The bolt pattern for the transmission/engine attachment is the same for the BW12 and the pre-1993 GM400, and apparently was the same for the Series III E-type with manual transmission. However, when the GM400 was incorporated, the dowel pin arrangement was changed. Robert C. Warnicke: "I have a '73 pre-H.E., '84 H.E., T400 and BW sitting in my carport. The bolt patterns appear to be the same. The H.E. has two dowels on the back that are much bigger than the dowels on the pre-H.E. At least one of these dowels is in a different place as well. I don't know how important the dowels are with all the bolts, but one will have to be removed off the pre-H.E. for the T400 to fit, and the other will be loose in the T400 hole unless something is fabbed to make it fit tight."

It is possible to remove the dowels and bolt a transmission to an engine despite dowel pin conflicts. However, the alignment of the engine/transmission mating may not be as good. If misaligned, the flexplate may flex at each revolution, and will quickly fail. It might be a better idea to have a machine shop fabricate a "stepped" dowel, large diameter on one end and small diameter on the other, for the dowel holes that line up.

Scott Horner points out there is also a difference in the end of the crankshaft. The crank that mates to the GM400 has a relatively large pilot diameter in which the protrusion on the front of the torque convertor sits. The crank that mates to the BW12 has a smaller pilot diameter. When faced with this problem, he was able to machine the stub on the front of his GM400 torque convertor to fit the BW12 pilot hole on the crank.

BAND ADJUSTMENT: Michael Neal offers this tip: "If you attempt your own band adjustment on the B/W don't overtighten them. The car will come to a very sudden halt. A quick adjustment: tighten them finger tight and back off the adjuster 3 flats."

WARMING UP THE TRANSMISSION?: According to a tip passed on from the Heart of America Jaguar Club, if you have a Jaguar with a Borg-Warner automatic transmission (pre-1979 XJ-S), you should let the car idle in neutral for 10-20 seconds before driving. This is because a one-way valve that prevents fluid from draining from the torque converter is unreliable, and the torque converter may have drained. The fluid pump does not function in park, so it must be in neutral to do any good.

FLUID: If you have the early XJ-S with the Borg-Warner automatic, the owner's handbook specifies Type F fluid. However, there are reports that some Jaguar dealers refill these transmissions with Dexron anyway, because they feel their customers appreciate the smoother shifts resulting from the slipperier fluid. This might not be a good idea, since firmer shifts cause less wear.

GM400 TRANSMISSION

GM400 AUTOMATIC TRANSMISSION INTERCHANGABILITY: It is well known that the later XJ-S's are fitted with the GM400 automatic transmission. What is less known is that this transmission (through 1992) has a housing designed specifically to mate with the Jaguar V12. Because the GM400 has an integral bell housing, a GM400 from any other car will not fit.

The innards are interchangeable, though, so even though it's not easy to replace your transmission, it is easy to have it rebuilt. It's not even particularly difficult to remove (as transmissions go) and there are several access panels under the interior carpet to make maintenance easier.

If the tranny is apart, it is recommended that the sprags be replaced with high-performance aftermarket models. The Jag is hard on even the trusty GM400, and has a tendency to tear it up.

As a result of a complete revamp, the 1993-on 6.0 liter V12 has a standard GM engine/transmission bolt pattern. Cars with this engine come with a 4-speed version of the GM400.

GM400 - MINOR DIFFERENCES: John Goodman reports: "I may be wrong here, but I *think* Jaguar revised the tranny a few times throughout its history. My '88 car shifted much faster with less "slurr" than my friend's '84."

Richard Mansell says, "The Collectors guide does mention that "the GM400 transmission was recalibrated for improved responsiveness" from 88MY."

Goodman adds that the GM400 in the XJR-S has different shift characteristics. "The factory-modified GM400 came as standard on the 6.0L XJR-S from '89 to '93 Part no. SPE 1027. The owners handbook says "JaguarSport modified shift points". In my car ('89) I would consider under normal driving the shifts to still be quite soft, under hard acceleration they are by no means harsh, but seem to be a little quicker. However, what is noticeable is its ability while in drive to kickdown into first at higher road speeds, (up to about 38-40 mph); this is quite useful."

"The bell housings are different because it no longer needs the Marelli speed sensor. The valve body is changed and recalibrated and a different spring in the rear accumulator (whatever that is). The XJR-S manual and all the other related bumph I have collected makes a *big* point of stating it is unique."

Richard Mansell says, "As well as suspension mods the SportsPack modifies the gearbox change points. This means that the car will change down into first at up to 49mph (standard GM400 - 30mph) and down into second at up to 98 mph (standard GM400 - 85mph). During full throttle kickdown acceleration the car will also hold first up to around 64mph and second until around 105mph."

Besides these functional differences, there are also physical distinctions -- including the shape of the pan and therefore the shape of the gasket that fits. John Himes: "If you are looking to fit a new filter or shift kit on your General Motors Turbomatic 400, check the serial number for the date of manufacture (first 2 numbers), or at least the shape of the pan. Pre-88 models are a little different than 88 and newer."

DEXRON II/III FLUIDS: John Horner passed along this info from "an applications specialist at Texaco's lubrication division.": "Since Type A, Type A Suffix A, DEXRON, DEXRON-II and DEXRON-IIE fluids are obsolete, customers with transmissions calling for any of these earlier vintage fluids should use DEXRON-III. DEXRON-III fluids are designed to be back-serviceable for automatic transmissions used in passenger cars and light trucks manufactured since 1949.

"There are a few synthetic DEXRON-III ATFs available but they may be hard to find. They are also more expensive than mineral-based ATFs. Synthetic transmission fluids basically share all the same advantages that synthetic motor oils enjoy over conventional mineral-based oils. These include improved low-temperature fluidity, oxidation stability and reduced volatility.

"Compared to the old Type A fluids (and even newer generation fluids such as DEXRON-II or IIE), a mineral-based DEXRON-III fluid will help prolong the life of a transmission. DEXRON-III fluids retained the low-temperature fluidity of DEXRON-IIE fluids and incorporated major improvements to the frictional stability, high temperature oxidation stability and material compatibility.

"For your information, and as a point of reference, when GM introduced DEXRON-III fluids they increased the drain interval to fill-for-life under normal service and 50,000 miles for severe service."

John T. Horner adds: "Mobil lists a Dexron type synthetic ATF. Check the web site at:

<http://www.mobil.com/>

"I think most of the other synthetic providers also have competing products."

FIRMER SHIFTS IN A BOTTLE: The owner's handbook specifies Dexron 2D or Dexron III automatic transmission fluid for the GM400 transmission. Draining this fluid and refilling with Type F fluid will result in firmer shifts. The Type F fluid is less slippery.

Alternatively, there are aftermarket fluids available that are less slippery than either Dexron or Type F, resulting in firmer shifts yet.

DRAIN & REFILL CAPACITY: The repair manuals seem to agree that a drain and refill of the GM 400 transmission will require 9.6 US quarts or 19-point-something US pints. However, Larry Barnes reports that it only took about 6 US quarts on his car. Reason unknown, but it probably had to do with not fully draining the torque convertor or the transmission cooler.

GM400 FLUID AND FILTER REPLACEMENT: Before buying a new pan gasket, note the shape of the gasket needed; as noted above, they aren't all the same.

Since the GM400 has no drain plug, draining the fluid requires removing the pan. To remove the pan, the forward mounting bracket must be removed. Therefore, changing the fluid and filter in the GM400 transmission requires complete removal of the transmission support -- see page 314. The correct reassembly of this system is not obvious, and non-Jaguar (Aamco?) mechanics will often reassemble it incorrectly, and perhaps even omit some of the parts. Taking this book along to the shop may be helpful; having an experienced Jaguar mechanic service your GM400 transmission may be the best course of action.

Steve Kennedy adds worse news: apparently some shops have figured out that they can drain the fluid without removing the transmission mount by simply bending the pan down. When all done, simply bend it back into place (probably with some sealant, since you can't replace the gasket this way), reinstall the bolts and refill. He suggests you question the shop closely to make sure this isn't what they have in mind.

If you're doing the job at home, Richard Chapman has a suggestion: "You can avoid a lot of mess by pumping out the trans before you remove the pan; this method does not get out all the fluid and leaves a bit less than 1" in the pan. This is enough to get it off cleanly if you can keep it level. Method: disconnect the lower cooler line (beside the alternator) either at the trans pipe end or the radiator end. Regardless the lower pipe from the trans is the outlet. The other end will dribble a bit, so have a plug handy. Do whatever to run a tube from the lower line into a 1-2 gallon can. Run the engine at idle and the trans internal oil pump will pump fluid into the container, when it starts to sputter, you're done - takes less than 1 minute.

"Before doing this run the engine a few minutes if it has stood for a while. This will ensure there is some lube in the trans. Do not rev the engine, idle only as the fluid returning from the cooler is used to lube the bearings in the trans and with this all disconnected there is none."

Alan Jenks reports that B&M Racing (see page 664) offers a drain plug kit (B&M #80250) which can be fitted while the pan is off. Also, J. C. Whitney offers two replacement oil pans for the GM400 with drain plugs, one "original capacity" and one that's 1¼" deeper for "extra capacity". They're both chrome plated, and cost only about twenty bucks. Larry Barnes reports that "...I purchased a J.C. Whitney chrome transmission oil pan (standard size) with a drain plug ("GM TH400 Original capacity"). It did *not* fit. Bolt pattern was correct, but the pan was not deep enough for the filter. So, if you are thinking of getting the same pan, get the 1.25" deeper than original "extra capacity" oil pan."

Steve Chatman retorts: "I ordered one of the chrome-plated over-size transmission pans from J. C. Whitney as mentioned in The Book. At least with a Series II XJ12, it doesn't fit. The pan contacts the exhaust pipe and, even if you try to insulate that, the bolts along one side would be inaccessible. I regret not ordering the regular size. Thinking back to the comment in the book, the author said that it didn't fit over the filter, right? Well, neither does the original. I believe that both push the filter up slightly." Aaaargh! Maybe better just stick with the stock pan and add a drain plug kit.

If you're more worried about fresh fluid than filter blockage, one of these changes might be a worthwhile investment. If you do your own work it might still be a worthwhile investment even if you pull the pan every time, since you can drain it first and then remove an empty pan rather than a full one.

Peter Cohen says, "A few years ago, I was availing myself of the free half hour inspection that Jag dealers were doing to try to bring in service revenue. The mechanic spotted the cork gasket on my oil pan, and commented on its "aftermarket" nature. He said that the real Jag gaskets were better, because the cork tended to leak (mine was, in fact, leaking in a minor way). Since then, I have used Jaguar trans pan gaskets, even though they cost more than the filter kit. IMHO, it has been worth it."

The filter is held in place by the O-ring on the suction tube on one end, and a bolt at the other. This bolt is shouldered so it cannot be tightened down on the filter, so the filter is free to rattle around a little. This is apparently deliberate; there are no parts missing. Randy Wilson says "That bolt is shouldered for a reason, though I can not tell you exactly why. All GM trannys of that general era use a floating filter that sort of lays in the bottom of the pan. At least the 400 has a positive bolt. Others use a cheesy spring clip."

GM400 SLIPPING: It is occasionally reported that the GM400 transmission slips; sometimes when cold, in first gear, or under other specific circumstances. Leonard Berk reported that his slipped until he deliberately overfilled the transmission fluid, then it worked fine. Randy Wilson provided this explanation:

"On GM vehicles, a loose/fallen filter is a normal occurrence, and is known for causing weird problems. The most common problem is the transmission briefly finding neutral right after a hard turn. Most THM transmissions, the 400 included, hang the filter low in the pan. The filter is supported by the o-ring on the pickup pipe (pipe from filter to valve body), which snaps into a machined groove at one end and a steel clip at the other end. If the o-ring is bad, or the filter has fallen, the fluid pickup point is effectively raised to the bottom of the valve body, about an inch up from the filter."

Jim Cantrell provides more elaboration: "The o-rings on the filter and at the pump inlet are known to leak in cold weather which results in pump cavitation. Pump cavitation can usually be heard - a whining sound of the pump. On the 400 in the cold (talking 40°F and below), it will usually last about 30-60 seconds. It still moves since it's actually pumping oil. It's just sucking in air from the o-rings and this gives the cavitation.

"Second hypothesis is that once cold, the o-rings leak and air leaks into the oil pickup tube and drains the oil. The result is the pump runs dry until oil starts flowing."

Since the GM400 dipstick has warnings not to overfill, perhaps overfilling should be done only as a diagnostic measure. If it fixes the problem, suspect a dropped filter. Just go ahead and change the filter (and O-ring!) and fluid.

Wilson adds that slipping is not good on the transmission, and the sooner it is corrected the less damage will be done.

KICKDOWN: Since there seems to be a lot of confusion about this term, I will first endeavor to define it. Kickdown does *not* refer to the normal downshifting of the transmission due to increased throttle (reduced vacuum). Kickdown refers to the *forced* downshifting of the transmission by a very definite pressing of the accelerator pedal all the way to the floor, and pushing it hard enough to operate a separate "snap" that the driver can feel when the pedal is moved the last quarter inch or so. It is intended to be a distinct enough feel that the driver can easily choose whether he desires kickdown operation or merely full throttle without kickdown.

In the case of the pre-1992 Jaguar with the GM400 transmission, kickdown is accomplished via a microswitch mounted on the throttle cable attachment at the turntable. A photo of this microswitch can be seen at:

<http://www.jag-lovers.org/xj-s/book/Microswitches.html>

After the throttle is wide open and the turntable is against the stop, further pressing of the pedal can move the turntable no more. Instead, the cable housing moves in the opposite direction against a very strong spring, strong enough to ensure that the driver must really want it to move. When the cable housing moves against this spring, a microswitch closes a contact sending current to a solenoid within the GM 400. This solenoid causes the transmission to downshift *now*. At any reasonable speed, it will downshift to at least 2nd; below 30 mph or so, it'll downshift all the way to 1st, and the engine will scream.

The results should be obvious and dramatic. Unfortunately, all too often this system doesn't work, and the owner doesn't even know it; since the vacuum modulator will cause the transmission to downshift under heavy throttle, they presume that everything is OK. It is easy enough to test, though; with the car shut off, make sure pressing the accelerator hard operates the microswitch on the throttle cable as it should. Make sure you know what it feels like to press the accelerator all the way *without* kickdown as opposed to *with* kickdown. Then, take the car for a drive. If there is an eye-popping difference between full acceleration with kickdown and without kickdown, it's working as it should; if you have a hard time telling the difference, it ain't working. If you're not sure you can distinguish the feel of the pedal, simply disconnect a wire from the microswitch on the throttle cable housing and go for a drive; if you can't tell the difference when you stomp it, it ain't working.

If it doesn't work, check fuse #5; there should be power to the kickdown switch on the LG/W wire when the ignition is on.

If that's OK, check that the kickdown switch itself makes good contact. Physical adjustment may be necessary, since problems may be caused by the switch not positioned correctly or the roller arm bent.

Next, check the inhibit switch on the shifter. One of the microswitches (hey, the car is covered with them) within the console and operated by the cams on the shifter is a microswitch that closes only if the shifter is in D. This prevents the operation of the kickdown solenoid in any gear other than D. Note that this same switch also prevents operation of the cruise control in any gear other than D, and it does so by grounding a signal line from the cruise control *through* the solenoid in the transmission! Problems with this inhibit switch may be mechanical in nature as well; it might not be positioned properly for the cam to operate it reliably.

The next possibility, as Greg Meboe points out, may be that the wire at the transmission isn't connected right. "The kickdown connector on the outside of the transmission case had two separate connection points on it, in the shape of a

"T". The vertical connector which "bisected" the horizontal connector was the kickdown one. I had been explicitly told that the horizontal connector was the proper one to connect the kickdown wire to, so that's what I did. When I took apart the tranny, I saw that the horizontal connector went to what looked like some type of sender on the valve body, whereas the vertical connector (which I hadn't used), went to the kickdown solenoid."

For the final test, it helps to be under the car with your ear near the transmission and all quiet in the area. Have an assistant turn on the ignition, put the shifter in D, and operate the kickdown switch, and you should be able to hear the solenoid within the transmission click. If there's no click, make sure you are getting 12V at the wire to the connector; if so, time to drop the pan and replace the solenoid.

Believe it or not, it can pass all those tests and *still* not work. It's possible for the solenoid within the GM400 to audibly click and yet not provide a kickdown. However, if you get a click when stomping the pedal and the kickdown still doesn't work, you can be confident that the problem resides inside the transmission and that you'll need to drop the pan to fix it.

Richard Mansell quotes from a Jaguar publication on the changes for the 1992 model year:

"The kickdown switch is no longer located in the underbonnet area but is changed to the XJ6 type and is positioned under the accelerator pedal."

VALVE BODY REMOVAL: Tom Bennett passes on this tip, which he claims to have gleaned from a Chilton's: "If you leave the solenoid bolted and then undo the valve body bolts about an 1/8" and gently push on the steel spacer edges so that it just separates from the valve body, it is possible to remove the transmission valve body without the check balls flying out! When you remove it completely the steel spacer stays in place and so do the balls."

GOT BALLS? Some GM400 transmissions have six check balls in the valve body, and some have seven. Note that the versions with seven balls, apparently 1987 on, also use different valve body gaskets. Compare your new gaskets to the old gaskets *very* carefully to make sure you have the right ones.

CHEAP GM ACCUMULATOR: Sandy Gibbs reports, "My tranny (GM400, 1987 XJ-S) went belly up. I took it to the shop for a rebuild. The mechanic showed me a small plastic cuplike looking thing which he said had caused my transmission to burn up. He claimed this piece (called the accumulator) was usually the problem when a GM400 dies. This information was confirmed by the owner of the parts place (which deals exclusively in transmission parts) where I bought all my parts for the rebuild. GM knows about the problem and now supplies an aluminum accumulator which won't break. It seems to me that anyone who plans to have some transmission work done anyway might want to invest in a new accumulator."

Thomas Alberts adds, "You are talking about an accumulator piston. One of the two accumulators has a plastic piston that can fracture with fatigue after high miles. It is a common failure mode. The piston breaks leaving a 1/2" hole that hydraulically "shorts out" parts of the transmission logic and leads to clutch packs burning up. It prevents kickdown and can cause second and (I think) first gear to engage simultaneously forcing one of the clutches to slip in second. It is pretty easy to replace the piston with the transmission in the car. It involves removal of the oil pan and valve body. I wouldn't advise everyone to rush out and do this, but if you are ready to replace filter and fluid it would be worth the extra effort to put in the aluminum piston."

SOFT SHIFTS: Yes, those gentle shifts are suitable for the Jaguar image of luxury. Unfortunately, they are apparently to blame for the GM400's poor durability record in this application. Per Jim Cantrell: "Old transmission types know this phenomenon well. Take a cadillac with the same transmission as a truck and the cadillac will last half as long. You can tell when you pull the pans on those bux luxury cars - lots of transmission dust in the bottom (clutch wear). Seems that grandma and grandpa would rather have to replace the transmission every now and then than to have their butches bumped during shifts. I guess that this allows them to have a deeper sleep while careening down the highway."

If durability is more important to an XJ-S owner than the gentle shifts, use of alternative fluids (see page 305), boosting the line pressure (see below) or installation of a “shift kit” may be in order.

RAISING THE LINE PRESSURE: Tim Blystone sends this idea in response to the suggestion of using Type F fluid on page 305: “The F-Type fluid is somewhat thinner and is supposed to allow the tranny to shift faster and more positively. It does no harm and neither have I ever been able to see any good it does either. I would rather use Dexron 3, remove the pump and replace the pump pressure spring with a new red spring. Used in Corvettes. This will raise line pressure and make the whole thing shift more positive.”

SPEED SELECTOR CABLE TRUNNION MOUNT: This is the little bracket that holds the shift cable housing to the transmission housing. The bolt that holds the trunnion mount to the tranny housing goes in from above, and cannot be removed from underneath the car. The only way to remove it is to remove the console, shifter mechanism, and a panel underneath to get at the bolt. It is suggested that if you ever have an opportunity, cut a hole in the panel inside the console and fit it with a rubber plug or cover, so the trunnion mount bolt can be removed by simply lifting the console cover (three screws) and removing the rubber plug.

If you are trying to remove the engine/transmission assembly and must disconnect the speed selector cable, the above trunnion mount problem may appear to be a real holdup. It is not, however. The attachment of the swivel joint to the end of the cable is a removable clamped-on device. Simply loosen the two hexes from each other, and the entire joint slides off the end of the cable. Then the cable can be slid through the trunnion, allowing the removal of the engine/transmission from the car.

ADDING A TRANSMISSION COOLER: In the May 1995 issue of Australian Jaguar Magazine, John Pearson says “Most Jaguar engines run fairly warm...and transmissions prefer cool running, so you may consider incorporating a neatly positioned transmission oil cooler...This is especially recommended on V12 powered cars with the GM T400 ‘box...’”

GM400 TRANSMISSION MODS: Helpful sources include B&M Racing (page 664), TCI (page 671), and Turbo Action (page 671).

GM400 TRANSMISSION SHIFT POINT MOD #1: The 5.3 liter Jaguar V12 was designed prior to the fuel crunch of 1973 and has “over-square” engine dimensions -- the bore (90 mm) is considerably larger than the stroke (70 mm). Such a design is conducive to high performance at high RPM and is therefore ideal for racing applications, but results in poor low end torque. However, to optimize fuel economy, it is best if an engine is turning rather slowly, so the stock GM400 automatic transmission is set up to keep the V12 in the RPM range where its performance is poorest.

The point at which the GM400 shifts is determined primarily by a governor that responds to engine RPM, and is varied by two things: 1) a vacuum modulator that makes the car upshift promptly when vacuum is high (light throttle); 2) an electrical switch on the throttle linkage that forces the tranny to downshift, and remain in lower gears until 5000 RPM, when the pedal is pressed all the way to the floor (“kickdown”).

The vacuum modulator is a bolt-on device on the right side of the transmission. *Some* of these modulators are adjustable by removing the vacuum hose and inserting a straight blade screwdriver into the vacuum fitting. Turning the adjustment changes the preload on the spring, therefore altering the shift points.

The vacuum modulators are available in several sizes, and since they are a standard GM part, are found in any auto parts store for reasonable prices. In general, the smaller they are, the more vacuum required to make the tranny upshift, so the longer the car will remain in the lower gears. Of course, it is recommended that you make sure to buy one that is adjustable.

Alan Jenks “fitted a B&M adjustable vacuum modulator (B&M #20234). This fits all TH400’s.”

Rather than buying a smaller modulator, Greg Meboe modified his existing one: “I needed to increase the spring pressure against the diaphragm. I did this by collapsing the modulator body around part of the spring in a vise, effectively shortening the working length of the spring. I imagine I took about 30% of the travel out of the spring. This had the effect of *increasing* the effective spring rate. The vacuum modulator modifications produce an upshift between 500 and 1500 rpm’s higher than before, depending on throttle position.”

GM400 TRANSMISSION SHIFT POINT MOD #2: For absolute maximum performance, shift points should be selected that surround the peak on the horsepower curve -- without exceeding the redline, of course. The engine should be allowed to run past the power peak, so that when shifting the engine doesn’t drop back too far below the power peak.

The published stats rate the Jaguar V12 at 5000 RPM. With the large steps between gears on a three-speed transmission, the engine should be taken to the redline of 6500 before shifting to optimize performance.

The GM400 slushomatic transmission, of course, was designed with the 1950’s-design pushrod V8 in mind. Not only does it normally shift at relatively low rpm, it absolutely *refuses* to allow the engine to rev beyond 5000 rpm; it will shift at this point even if you have selected low gear with the lever. The above modification to the vacuum modulator will not affect the limit where the GM400 will force a shift.

The governor assembly is contained under a sheet metal cover on the right rear side of the transmission, and there is an access cover under the carpet of the XJ-S to get to it. If you remove the governor and grind a little weight off of each of the counterweights, the engine will shift at higher RPM under all conditions. This modification will allow the engine to run faster than 5000 RPM, where the stock GM400 will force a shift no matter what.

It may make sense to modify the governor as described, and install a *large* vacuum modulator to keep the light-throttle shifts at a reasonable RPM.

According to Chad Bolles, the GM400 in the 1991-92 XJ-S was programmed differently than earlier cars, providing higher RPM shifts under power, better downshifting, and holding low gear forever if the shifter is held in 1st. It may be possible to retrofit the changes into earlier cars (replace the governor, etc.) or to buy the later transmission and retrofit it.

GM400 TRANSMISSION SHIFT POINT MOD #3: If you want serious performance from your XJ-S, install one of the many available “shift kits” for the GM400. Keep in mind when you select your kit that your objective is to allow higher RPM shift points at full throttle (when the kickdown switch on the throttle cable is activated) or when manually shifting; High RPM shifts when taking it easy are of little benefit and will hurt fuel economy and passenger comfort. Many shift kits offer more firm shifting, some shift at redline at all times (!) and some even render your car a 3-speed manual.

Most shift kits can be installed by simply lowering the pan from the transmission and removing the valve body within. Replace a few springs and the like, and reassemble. See the notes on page 304 regarding the differences between pre- and post-1988 GM400 transmissions.

Alan Jenks reports on a “Shift Improver Kit” from B&M Racing to the Turbo Hydromatic 400 automatic transmission. There are two kits, one for pre-1988 TH400 (B&M #20260) and one for post-1988 (B&M #20261). The kit can be fitted in two forms, either ‘heavy duty’ (stage 1) or ‘street/strip’ (stage 2). Stage 1 provided firmer shifting without compromising the quality of the ride, which is what I wanted.”

Per Chad Bolles: B&M makes a product called a Transpak, “with this you can set up the trans to shift like you want, from very hard, to normal street.” B&M also makes a Racing Kit, “this is a race *very hard* shift kit (neck snapping).” Finally, in what should probably be listed as GM400 Transmission Mod #3A, there is a replacement valve body. “The B&M valve body changes the shift pattern to 123NRP instead of PRN321.”

Jim Hall says, “I installed a TransGo competition shift kit recently. In addition to very positive shifting, it has the added benefit of allowing downshifts to 2 and L at any speed. I’m delighted with it.”

Jim Cantrell says, "The TH400 in modified form normally has a whine in first gear. This is the planetary gears. I don't really understand why, but installing a shift kit seems to increase the whining. It is considered normal behavior and at least on the one I have, has gone nearly 100k miles with no problems."

Jan Wikström had his local tranny shop "lock up the freewheel on 1st gear, which gives me respectable engine braking and a better "feel" in the really low-speed twisty bits. Caution: it's now possible to engage 1st at any speed..."

Paul Burke reports on "some information regarding "tweaking" of the GM400 box. It describes removal of four of the six balls, shift improver plate (different valve body transfer plate) and plugging one of the passages. The article was in *Musclecar Review*, February/March 1997 starting on page 58." Sean Straw adds, "The publisher's (lackluster) website is at:

<http://www.d-p-g.com/musclecar/>

The back issue can be ordered by calling: 01 (941) 683-8807."

TORQUE CONVERTOR REPLACEMENT: First off, you might wish to note Roger Bywater's comments on the stock GM400 torque convertor on page 32.

There are torque converters available that have a higher "stall speed", which sorta means they engage at a higher RPM. This is wonderful for the Jaguar V12, but does require removing the tranny to change. According to Thomas E. Alberts, "B&M tells you to try for 500-750 RPM less than the RPM at peak torque."

Michael Kenrick reports that the torque convertor from a 3.8 Buick Regal Turbo can be used to provide a more suitable stall speed.

According to Chad Bolles, the later model XJ-S uses the HI-Stall convertor. "It is the same converter used in the 427 L-88 and LS6 and LS7 Chev, flash stalls around 2600-2800rpm, the difference being the Jaguar converter has 6 lugs on it where the Chev has 3." He adds that a Chevy convertor may be used in the Jag, leaving the other three bolt holes unused. Reportedly, some GM torque convertors use six bolts as well.

Bolles also explains the difference between stall speed and "flash stall". Stall speed is the RPM the engine runs at continuously if the brake is held and the accelerator is floored in gear. Note: this is very hard on the equipment, and causes a lot of heat in the transmission; such tests should only be done for a couple seconds, and the car should be driven around at normal speeds for a while afterward to allow the transmission fluid cooler in the radiator to cool the transmission back down. "Flash Stall, hold the brake, trans in gear, quickly mash the acc pedal, watch the Tach, it will flash to about 2500-2800 rpm, but if you just hold the brake and ease the acc pedal down the converter will not reach the same rpm before it tries to spin the rear tyres. Don't ask me why, I just know that that's how it works."

GM400 RATIO CHANGE: Thomas E. Alberts says, "...I agree that the standard gearset is poorly matched to the XJ-S... Note that the modified gearsets, like TCI's, lower the second gear ratio as well as first. Observe:

	TH 400	TCI gearset
1st	2:48	2:75
2nd	1:48	1:57
3rd	1	1

I think it would make a very nice improvement and without any sacrifice of top end speed."

ADDING OVERDRIVE TO THE GM400: John Goodman has heard about "overdrive units manufactured by American Overdrive Inc. designed for autoboxes, GM400 included? This effectively changes your GM400 into a six speed.

“Two possibilities here would give much better acceleration. The unit can be supplied with the internals reversed so you have underdrive first, underdrive second and underdrive top. Or install a lower axle ratio and leave the overdrive in and switch it out for “Sport Mode”.”

ALTERNATIVE TRANSMISSIONS

TH700R4: One way to deal with the shortcomings of the GM400 or BW12 is to replace it with the more modern TH700R4. One large benefit is that the TH700R4 will provide much better performance from a standing start: the torque convertor provides a larger effective reduction, and first gear is much lower than the GM400’s 2.40:1. Plus, it has four gears, including an overdrive 4th. The overdrive 4th can enable the installation of a lower final drive ratio, making the get-up-and-go better still without sacrificing the top end cruise.

John’s Cars (page 668) provides the adapter hardware necessary to fit the TH700R4 to the Jaguar V12 5.3. Scott Horner says that Dellow (page 666) does as well, and Chad Bolles of Jaguar South (page 667) announced his adapter: “Just think, XJ-S’ers: 30% lower rpm at 80 mph -- that means about 1900 rpm. Gas mileage up around 20 to 30%. 0-60 times in the 6 second bracket. Tyre smoke from the stoplite. A loss of about 30 to 50 lbs by getting rid of the Turbo 400.” XK’s Unlimited (page 647) offers a “conversion kit”.

If you have the ‘94-on 6.0 V12, you probably don’t need an adapter; the TH700R4 will probably bolt right up, since those engines have a standard Chevy bolt pattern. You probably aren’t as interested in the swap, though, since the 6.0 also comes with the improved 4-speed GM400 and enough torque for respectable takeoffs.

MANUAL TRANSMISSION: The shift points, cruise speed RPM, fuel economy and top end can all be optimized by replacing the GM400 or BW12 with a manual transmission. This is a major task requiring the installation of flywheel, bell housing, clutch, clutch pedal, console modifications, speedometer fiddling, etc. Changing the final drive ratio (differential gears) should be considered, since 5- and 6-speeds generally have an overdrive top gear and the final drive ratio is already tall enough.

Jaguar did make a few XJ-S’s with a 4-speed manual transmission, but these were early cars. The transmission and clutch were similar to those used in the SIII E-Type, but those cars are valuable today. Trying to obtain the hardware needed to convert *your* XJ-S to a manual transmission from either source is likely to be difficult and expensive. Besides, you end up with only 4 gears. For most people, it makes more sense to adapt a modern 5- or 6-speed from some other model car.

The author of this book *has* performed this modification on his car, using a 5-speed Borg-Warner NWC transmission from a Camaro and making a lot of components from scratch. Now such a task is much easier, because you can purchase many of the necessary components or even entire kits for this conversion. General info for those considering such mods follows, much of it provided by Mike Frank.

There are five transmissions commonly considered. One is the Borg-Warner NWC 5-speed, which comes in Camaros, Mustangs, and several other vehicles; it has an integral shifter (no external linkage), and there are a couple different locations for this shifter. Reportedly the Mustang shifter configuration is better for the XJ-S than the Camaro configuration. This tranny is adequate for a stock XJ-S V12 but may be marginal if extensive engine mods are done. There are lots of ratios available.

There are 5-speed conversion kits using the “JT5” transmission, which is supposedly the same thing as a BW NWC only different. Only conversions for E-types and other older Jaguars are mentioned, but since the E-type SIII V12 is included, it may be possible to figure something out for the XJ-S. JT5 kits are offered by Terry’s Jaguar (page 646) and Vicarage (page 654).

Another possibility is the Borg-Warner 6-speed used in the Dodge Viper and the later Firebird, Camaro and Corvette models. It has some advanced features such as carbon composite synchros. This is a massive tranny, and will probably handle whatever a Jag V12 can be made to dish out. There are a wide variety of ratios available.

The third possibility is a Getrag 5-speed. It is supposedly also adequate for all conceivable uses. The Getrag is a novelty in the US, but is reportedly fairly common in Europe. SNG Barratt (page 645) offers kits using this transmission; again, only E-types are mentioned, but the SIII V12 is included.

The fourth possibility is the Tremec 5-speed, described by Jim Swarr: "Tremec is owned by Dana Corporation which is well known worldwide for its transmissions and rear axles. The Tremec 3550 and TKO is their performance line of transmissions. Tremec made the famous Ford "top loader" 4-speed. This is a modernized version of that with an overdrive. It has a heavy duty aluminum case, rollerized gears and internal rail shifter. The gear ratios are 3.27, 1.98, 1.35, 1 and .68. The only gear ratio option is a .82 overdrive. It is a very strong transmission; I have one in a customer's 750 hp drag car. I would suggest that you use the TKO because it has a bigger input shaft and output shaft. A bellhousing needs to be fabricated (welding a plate to a stock bell) for your car to fit a Ford transmission, or if you can adapt it for a Chevy 4-speed I can convert the Tremec to fit into the Chevy bell. If you have any more questions please call me at 610-489-4029 anytime after 10:30AM EST."

Concerned about the toploader's reputation for notchy shifting, Inder Singh says, "In a followup question on the subject, Mr. Swarr assures me that Tremec has made a number of improvements to its shifting characteristics."

Keisler Automotive Engineering & Electric (page 668) offers a kit using the Tremec TKO, and Conversion Components Ltd. (page 665) offers a Tremec kit.

The fifth possibility is the Toyota Supra transmission -- but apparently there is confusion about *which* Toyota Supra transmission. There are three general types. The first type is generally referred to as the W58, although technically there were W55, W57, W58, and W59 transmissions differing chiefly in ratio only. This transmission is described as "an all-alloy case 5-speed and can be distinguished by 9 bolts and 2 dowels holding the box to its bellhousing." There are four possible stick positions: 18", 19", 20-1/2" and 21", as measured from the front of the box.

If you get your own Supra W58 tranny from a junkyard, note that before installation it is recommended to remove the front cover of the transmission which holds the input shaft bearing and the input end of the layshaft and replace the light-duty layshaft bearing with a generic industrial-duty bearing of the same size -- a five-minute job. Reportedly the bearing that's in there has 8 balls, and the generic bearing will have 12. Winston Good reports: "After much trouble I thought I should include the part number that I found to do this 5 minute job: KOYO BLO6307NR C3. The box I got says 6307. I believe the NSK number is HR6307NX. All the specs are at the NSK website. Mine took longer than 5 minutes since the press is at the machine shop."

Dellow (page 666), sells kits to install a W58 in a Jaguar. Note that, despite the fact that Dellow is located in Australia, getting all the hardware needed from them might still be cheaper than buying the transmission itself locally.

Dellow also offers some Supra 4-speed boxes.

Conversion Components, Ltd. (page 665), also offers 5-speed kits using Toyota Supra gearboxes. They modify the shifter location to make it more ideal for installation in the Jaguar.

There is also some history of the Toyota "steel case" 5-speed from Celicas, Crowns, Coronas, Cressidas, etc., being used in Jaguars with success, even though it is described as not quite as strong as the Supra. This tranny has 7 bolts holding it to the bellhousing.

W58 transmissions have a long and glorious history of successful use in Jaguars with 6-cylinder engines. They have also been used behind V12's and the owners have been happy with them -- at least, up until they broke. There are reports of failure. If a V12 has a Supra transmission behind it that hasn't broken yet, the W58 may in fact be up to the task, or maybe the owner has just been lucky so far -- or maybe it isn't a W58. Which brings us to the second type of Toyota Supra transmission.

According to Tony Bryant, the W58 was only used in non-Turbo Supras and a 2L Twin Turbo model sold only in Japan. From 1986 to 1993, the 2.5L Twin Turbo and 3L Turbo were fitted with the R154 transmission. "The R154 has huge

& wide gears. It has inch deep ribbing all over the case. It is 50% heavier than the W58. Makes the W58 look like a dinky toy. There is *no* parts interchangeability. Not even close. I've had them both apart at the same time. A friend with a Tremec came over to have a look. He said the Tremec has noticeably smaller gears."

The third type of Supra transmission is the V161 six-speed used on the 3L Twin Turbo from 1993 on. Bryant: "The V161 is different again, apparently even stronger than the R154."

So, if you're considering putting a Supra transmission in your XJ-S, there are people that will suggest a W58 transmission and even outfits that will sell you a kit to use one. But, really, if you're going to that level of effort and expense, it really only makes sense to insist upon the R154 or V161.

Once you decide on a tranny, there are details to deal with. John Napoli tells us about Tilton (page 671): "They cater to the racers. They sell a full range of bellhousings for the V12 that accept popular manual transmissions. You can even get a small-diameter, multi-plate clutch with a small, reverse-rotation, gear reduction starter that mounts backwards on the bellhousing, alongside the transmission. Imagine -- starter changes in the XJ-S without removing exhaust pipes, and from inside the car!! Be still my heart."

Jaguar made a lot of manual transmission XJ-S's -- with the AJ6 engine. Still, maybe some parts would be helpful for the V12 conversion. Chad Bolles reports, "The pedal box from the 5sp XJ-S will fit any XJ-S, but the problem is it will only work on an XJ-S with ABS, and I have found no way to make it work on a non-ABS car." Aaargh! Note that that AJ6-powered XJ-S existed in Europe before the advent of ABS brakes, so perhaps there is still a possibility there.

Vintage Jaguar Works (page 646) offers a pedal box with clutch pedal and master cylinder.

AJ6 Engineering (page 663) suggests that the ECU needs the overrun cutoff disabled "to avoid driveline shunt at low speed." AJ6 Engineering also can remap the fuelling to deal with wide open throttle below 2000 rpm -- a situation that simply cannot exist with the A/T so the original map may not have been optimized all that well in this realm.

One final note: The mid-80's US-spec XJ-S EFI operates in closed-loop mode in D and in open-loop in P or N. There's a reason for this; it can develop an unstable idle in closed-loop without the load of the torque converter. If you install a manual transmission, you may need to operate in open-loop all the time (which is terrible for fuel economy) or find some other way to switch from open-loop to closed-loop. Or, you can operate in closed-loop all the time and work to minimize the idle instability; upgrading to 3-wire oxygen sensors might help. Adjusting the idle mixture trim on the ECU may help.

TRANSMISSION MOUNT

Yes, the transmission mount in the Jaguar XJ-S deserves its own section in this book. This mount would have made Rube Goldberg proud. The design utilizes a spring to take the weight of the transmission, as opposed to the rubber supports used on most cars. It also has a vertical post assembly containing a "special washer with rounded edges" within a rubber bushing. This assembly allows a very limited range of motion: some vertical travel to allow the spring to work via the post assembly sliding up and down within the bushing; very little horizontal or axial travel, since the special washer fits snugly within the bushing; and a little tilting (torque reactions) via the special washer behaving as a ball joint within the rubber bushing.

The desire to use a spring doesn't adequately explain the complexity of this assembly, however. It's possible that there was also a safety objective. In the 70's Volvo was advertising that their transmission mounts would guide the engine under the car in a front-on collision instead of the engine coming into the passenger compartment, and perhaps Jaguar had similar intentions in mind. The part that connects to the bottom of the center post is sometimes called a "collision plate", although it's also called a "tie plate". Perhaps crash safety is a plausible explanation for the complexity, but it's certainly not obvious how this design makes the car any safer in a crash.

Note: If you disassemble the mount and lower the transmission significantly, Thomas E. Alberts suggests you take care that the top of the engine does not damage the heater valve.

If you have the mount apart, consider servicing the driveshaft U-joints while you're there. See page 321.

RUBBER BUSHING & SPRING CUP REPLACEMENT: Finding the rubber bushing (CAC3227) or the rubber spring cups (CBC2517) in place and intact appears to be a rare occurrence. They are often missing, damaged or mislocated, evidence of previous mechanics working in the area who didn't understand how the support goes together. Even if the parts were installed properly, they are often severely deteriorated, sometimes to the point where there's little evidence they were ever there beyond a puddle of rubbery goo in the bottom of the spring support. Some people claim their original parts were made of foam rubber, but apparently this is a material breakdown of the solid British rubber that makes it crumble so as to appear to be a deteriorating foam material.

To properly install a new rubber bushing requires removal of the spring support; you cannot simply jam the rubber bushing in from below. With the spring support removed, install the rubber spool into the center boss so that one lip of the spool is on top of the support and one lip is within the recessed opening on the bottom. It should be securely snapped in place in the boss.

If you are disgusted with the lack of durability of the spring cups, you can easily make substitutes by slitting rubber or vinyl tubing lengthwise and slipping it over the end coils. Note that there are supposed to be spring cups on *both* ends of the spring, but apparently the upper one is difficult to get in so mechanics leave it out. John Whitford, installing a new CCC6759 spring, says, "There were seats on both ends of the spring I pulled out. The top one had been badly mangled by the motion. I left off the top seat when I refit the spring. I tried to fit it (by itself) around the raised part of the spring retainer and it was stretched and distorted when I got it all the way around. I'm sure the spring popped out of the old one and then chopped it up. Everything went back together just like the book and as of the first test, I'm clunkless." Maybe the new spring was designed long enough to be used without the upper cup.

Paul Hackbart notes that John's Cars (page 668) offers replacement bushings and spring cups: "The transmission mount bushing from John's Cars is no different in design. Both the bushing and the cup at the end of spring are for sale in polyurethane." Polyurethane would seem too stiff for the bushing, but LaRue Boyce says, "I put in the John's Car bushing last month and it works great." Since this bushing must be squished to be installed in the support boss, having it made of something as stiff as polyurethane would obviously make it more difficult to install. Boyce adds, "...it is a little difficult. I tried a vice, etc., but the only way I could get it in was to use lots of oil on the bushing and angle it in and press with a flat screwdriver. Not very scientific but it finally went in. Mine works great and I have no complaints, much better than the handful of part that fell out. It appears to be made of the same stuff as John's steering rack bushings." Note that, if you must lube it to get it in, it'd probably be a good idea to use a special lubricant made for polyurethane since some hydrocarbons will attack polyurethane. Hackbart adds, "The trans. mount bushing from John's Car's does not come with that special red grease used with polyurethane however. It is the same type of grease included with rebuild kits for brakes; you can get it at any auto parts store."

XK's Unlimited (page 647) also offers polyurethane spring buffers and center bushings.

POLY BUSHING FAILURES: Paul Hackbart also reports on a failure mode of the John's Cars bushing. If the transmission is forced to the upper limit of travel (such as by running over something that hits the bottom of the tranny and knocks it upward), the washer (double washer on the GM400 mount) at the bottom of the post -- which is supposed to provide a bump stop limit to upward travel by hitting the bottom end of the bushing -- can actually push the center portion of the bushing right through the boss on the spring support, shearing off the outer flange of the polyurethane bushing and leaving it rattling around the bottom of the post.

This problem may actually occur with the stock rubber bushings as well, we just wouldn't know it because they end up in too many pieces to figure out what happened. Such shear damage could probably be avoided with either type bushing by replacing the bottom washer with a fender washer with a larger OD, so that it contacts the full surface of the end of the bushing rather than just the center portion of it. Since the outer portion of the flange will be put in simple

compression in such a configuration, it should render the bushing safe from shear damage. Note that the washer used shouldn't be too big or it might contact the inside surface of the "dome" on the tie plate and make noise.

Note also that the reason the GM400 mount uses a double washer is probably to limit the upward travel to about 1/16" less than it would be with a flat washer, so if you're installing a flat fender washer you should do something to similarly reduce upward travel. One idea would be to cut the sleeve on the post about 1/16" shorter and install a small 1/16" thick washer on the post *under* the flat fender washer (just above the tie plate), which would work. Another idea would be to cut a large rubber disk out of a truck tire inner tube, put a hole in the center, and install it on the post around the lower sleeve. That way, when the transmission moves upward, the flat washer will hit the bottom end of the bushing with a thin layer of rubber in between, softening the impact and limiting the upward movement. Most of the time, this rubber disk will simply sit on top of the bottom washer and do nothing. If the hole in the rubber disk is made just a hair smaller than the OD of the sleeve, it can be pushed onto the sleeve and will stay in place by itself while you install the rest of the parts.

TRANSMISSION MOUNT SPRINGS: Mike Morrin: "The BW12, GM400 and manual springs are different parts; the BW12 spring is painted black/yellow, the GM400 spring is painted black/red. The manual transmission spring is black/blue." See more info on the GM400 spring on page 319.

Borg-Warner Transmission Mount

This author owns a car that came with a GM400 transmission, so the section on that mount is more comprehensive than this one on the BW transmission mount. The concept behind the BW mount is obviously similar to the mount used in the later GM400 cars, so it is recommended that the BW owner go ahead and read the section on the GM400 transmission mount and study the illustration. Maybe later versions of this book will contain a similar illustration of the BW mount.

We're not totally helpless on the BW mount, though; following are some notes. While the center post in the GM400 mount is attached to the transmission with two bolts through an aluminum base plate, the center post for the BW is a simple double-ended bolt that threads directly into the transmission case. A dish-shaped spring seat is held in place by the BW post, while the base plate of the GM400 post serves as its upper spring seat. Since the BW post doesn't have the shoulder that the GM400 post has, an additional sleeve must be used *above* the "special washer" to provide the proper shape for the bushing to slide up and down against. Fig. 1.7 on page 24 of the Haynes manual, as is typical, leaves one of the two sleeves and the special washer out altogether. However, Fig. 1.12 on page 29, although showing the mount for a manual transmission, shows the two sleeves and special bushing correctly.

The upper end of the rubber bushing impacting the base plate of the GM400 post provides a downward bump stop limit to the mount's travel, but the BW post doesn't have a base plate so a special "double washer" is installed between the uppermost sleeve and the hex on the post itself to serve as a bump stop. As shown in the illustration on page 318, the surface of the GM400 base plate is not flat but rather a bit conical, perhaps to soften the blow when the rubber bushing hits it. The double washer used at the top of the BW mount has a similar shape, as Mike Morrin describes: "It is 2 washers spot welded together, the first is a 1/8" thick flat washer with 1/2" ID which fits the spigot, and a 2" OD. The second has a 3/4" ID which just fits over the sleeve, a 2" OD. The second washer however has a profiled thickness which is 1/4" thick near the centre and tapers down to a thickness of 1/8", 1/4" from the outside edge, and is flat from there out. The same part is used on the BW66 in the XJ6."

Don't get confused by the various diagrams and exploded views, many of which are incorrect. Mike Morrin says, "The problem is that the XJ-S and e-type parts books show the double washer on the top, but the XJ12 parts book shows the double washer on the bottom. I have seen them assembled both ways." Fig. 1.7 in the Haynes manual likewise incorrectly shows the double washer at the bottom.

Both the GM400 and the BW mount schemes have a washer at the bottom end of the post to serve as an upward bump stop limit to the mount's travel. The one on the GM400 is a "double washer", but it's not like the one described above;

it's a simple matter of two flat washers welded together. The bottom washer installed on the BW post is a simple flat washer.

I'm sure you've been following all that perfectly, so I don't need to explain how to assemble the mount -- but I will anyway. For cars fitted with the BW automatic, the double washer must be positioned on the post *before* the spring support is installed, since it cannot be inserted through the bushing later. Mike Morrin says, "I sat the double washer on top of the bushing"; this may be an excellent method, since the spring support isn't all that heavy and if the double washer falls off you can simply try it again. After the spring support is bolted in and the jack is removed so the tranny is sitting on it, the order of parts installed on the post is sleeve, rounded-edge washer, sleeve, double washer, collision plate, nut.

GM400 Transmission Mount

The Borg-Warner transmission mount was complex enough, but when the same idea was adapted to hold up the GM400 transmission it got even more confusing. A picture is worth a thousand words here. Exploded views abound but many seem to be missing a few parts, which doesn't help someone trying to figure out how it goes together. **Figure 16** is a section drawing of the assembly, in hopes that it will be of some help.

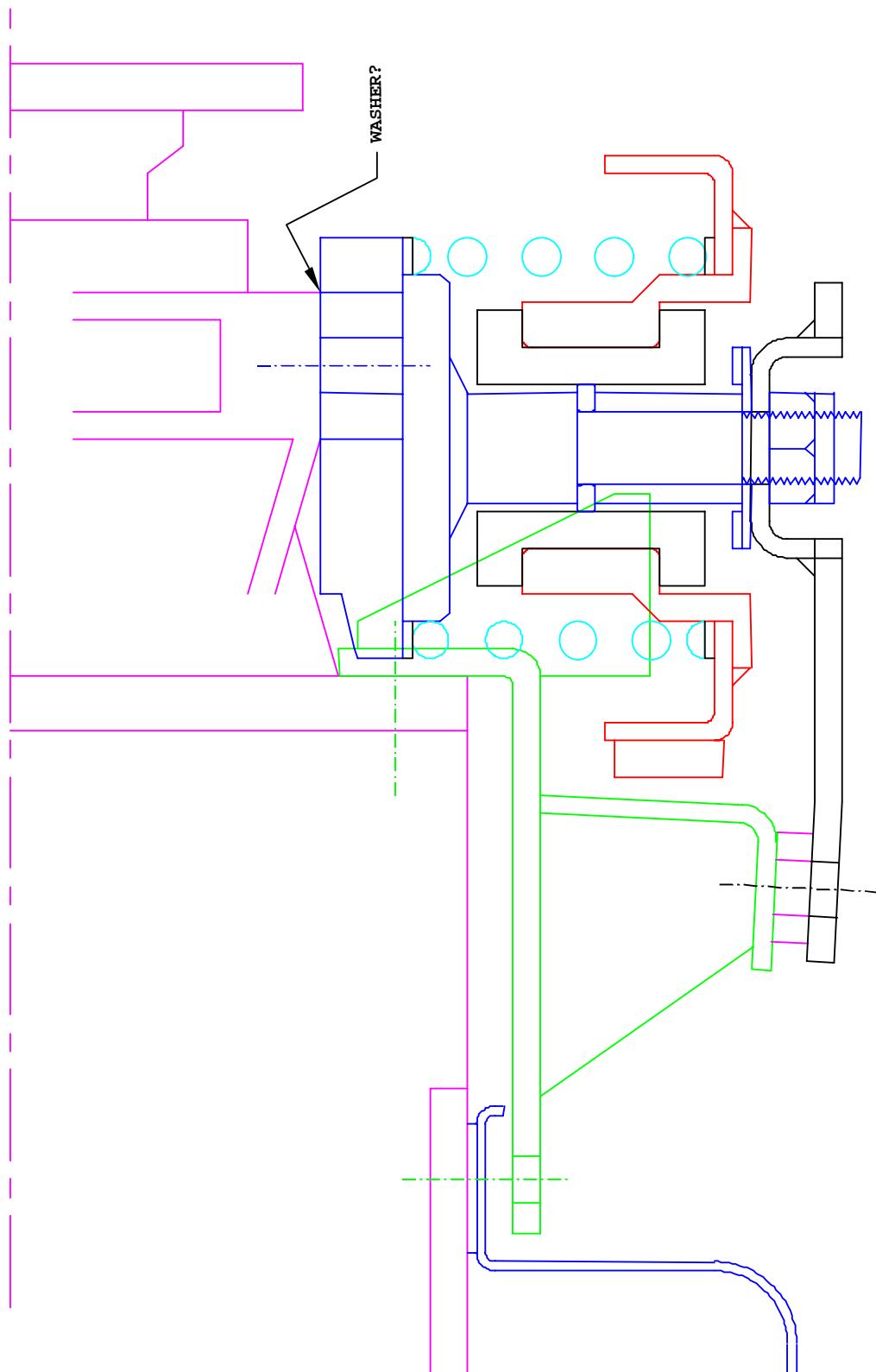


Figure 16 - Assembly of Transmission Mount (GM400)

Note that almost everything in this diagram is attached to the transmission itself, which means it moves up and down with the transmission as it bounces on the spring. The only parts in this diagram that are motionless relative to the chassis are the spring support, the bushing within it, and the bottom coil of the spring. There is a major support plate rearward of the spring support that is not shown in this diagram for clarity, but it's one of the most obvious things in your way when you're under the car.

Also note that the two rearward arms on the spring support attach to the support plate with 1" spacers.

SPRING: Michael Neal reports that the GM400 tranny support spring (CAC2327) does not hold up well, and recommends it be replaced every 30,000 miles (when the tranny fluid and filter are supposed to be changed). Apparently it gets weaker as it gets older.

Peter Cohen reports that the springs changed part numbers a few times, perhaps indicating Jaguar's attempts to improve this thing's durability. "CAC2327 superceded to CAC2327/1 and then superceded to CAC2327/1**" He reports that the CAC2327/1* "is a thicker coil!!!"

John S. Whitford says, "I bought a new spring because the one I pulled out was only 3 9/16" high. Jaguar has a new part no. CCC6759 for the spring and it was exactly 3 3/4" high. It even had paint codes on it like the front road springs do. Blue and Violet. No clue what they mean though." Neal responds: "That is the number of the only spring I've been using for a few years now. It is the latest and greatest unit but still collapses easily."

John's Cars (page 668) offers a replacement spring that is supposedly better than the Jaguar springs. Brian Radovich of John's Cars: "The only difference I spec is a high silicon steel which has a much better tensile life than the Jag bit."

Unfortunately for John's Cars' reputation, the vendor making springs for them reportedly made a batch of the springs out of the wrong wire, making the springs too stiff. This may seem counterintuitive, but imagine how your car would ride if you installed springs in the suspension that held the car up in the air and the suspension hard against its stops. This is exactly what happens here; the transmission mount only has about an inch of travel and the spring is supposed to support the weight of the tranny in between the stops (as shown in **Figure 16**), but the overstrong spring held the transmission up against the upper stop. This, of course, causes all the vibrations of the engine/transmission assembly to be conducted directly into the chassis. Owners who installed the faulty John's Cars spring have had to disassemble their transmission mounts to reinstall the stock spring. A stiffer spring could be used provided it is also shorter so that it still holds the transmission in the correct position, but such was not the case with this spring.

Radovich found the problem and corrected it, so you should now be able to get a usable spring from John's Cars: "I will warranty any spring I have sold - and any poly mounts that have suffered as a result."

GOT A COUPLE EXTRA WASHERS? There have been several reports of washers being found between the vertical post and the housing of the transmission (see **Figure 16**). Reportedly, with the mount assembled correctly it was still possible for the forward U-joint on the drive shaft to hit the support plate, causing a "clunk". The washers were added between the post and the transmission housing to hoist the transmission by the thickness of the washers, just enough to eliminate the clunk.

GM400 TRANSMISSION MOUNT REASSEMBLY: The two rearmost pan bolts should be double-ended bolts with the head in the middle, so that after installing the pan there are studs available for holding the forward bracket in place. If such bolts are missing and unavailable, normal bolts can be used by inserting suitable washers between the bracket and the pan. The washers should total 3/16" thick. A better idea might be to thread nuts onto studs, screw the studs into the tranny, and then tighten the nuts to hold the pan on securely while leaving the other end of the stud to hold the tie plate in place with a second nut.

While apart, the spring support (CAC2438) should be cleaned to remove all the crud that has collected in it. The crud often appears to be the dissolved remains of the original rubber parts, but we will endeavor not to draw any conclusions about Jaguar's materials engineers. The crud must be removed to allow the spring and lower spring cup to seat properly.

The transmission must be jacked all the way up into the tunnel before the spring support is installed. Once the spring support is securely bolted into place, then the jack can be lowered, allowing the transmission to sit on the spring and the center post to protrude through the bottom.

Easier said than done, of course. With the transmission jacked up hard against the tunnel, bolting the spring support in place may still be difficult. Paul Hackbart came up with a nifty solution, but you need to have one of the better floor jacks to do it: "Larger jacks have a removable/floating circular dish piece that raises the car. Well (Dummy!) simply remove disk leaving 3/4-1" hole. The long bolt goes straight through the hole as the mount is jacked/pressed up and is perfectly balanced allowing you to tighten all 4 mounting bracket bolts. So, allow one jack and 2x4 to hold up tranny under sump and your larger one with dish removed exposing hole to jack up mount."

Once the spring support is bolted in and supporting the tranny and the jacks have been removed, the assembly of the parts on the center post is as follows: the first item to be installed should be a special washer that has rounded edges, C29011; it will need to be crammed into the rubber bushing somewhat. Next is the sleeve, C30157. Third is a part that looks like two washers welded together; it should be installed with the larger opening facing upward. Then the tie plate is installed, followed by the large self-locking nut; there is no washer directly under the nut.

If the special washer C29011 is missing, a 1/2" splitring lock washer bent flat will serve.

Two small spacers should be installed between the tie plate and the forward bracket. If they are missing, 3/8" washers totaling 1/4" in thickness may be used.

After assembly, there should be no more than 3/4" between the tie plate and the bottom of the spring support. Check that the transmission moves freely on the mount; since the spring is soft, you should be able to bounce the entire engine/transmission assembly up and down a little with your hands. If it appears to be immovable, something is not right. It also should not clunk when moved.

Gerry Halpern had a howling noise coming from the transmission area on acceleration. "I got a copy of the assy drawing from a local parts guy and reinspected it again this weekend, frankly hoping to find somthing that I had installed incorrectly. Alas, I couldn't find a thing wrong. Laying there on my back looking up at the trans mount I pushed upward to make sure that I got movement; sure enough, it seemed to move OK. However, I decided to loosen the 4 bolts holding the mount, then moved the trans up and down. I could see the mount move and realign itself. Voilà! I could now move the trans quite freely up and down. I tightened the mount bolts and sure enough problem solved. Point to be made is that the trans mount should be positioned so that the mount can be moved easily up and down against the spring pressure. Two of the bolts are awkward to get at with the exhaust in place and there is a great deal of tolerance in the bracket slots making it easy to misalign."

Keeping in mind that the engine/transmission is entirely supported and positioned by the two motor mounts and the transmission mount, misalignment of the transmission support might be due to problems with the motor mounts. If the transmission support doesn't wanna line up, maybe the thing to do is loosen the motor mounts and see if you can realign *them*.

VARIATIONS: On page 49 of the Haynes manual, there is a picture labelled "49.5A Aluminum spigot bolted to transmission" (all the photos in the Haynes manual reflect parts from a Daimler Double Six with a GM400 transmission, obviously pre-1985). The post shown in **Figure 16** is steel, so if this spigot is really aluminum it's something different. It also appears to have the entire external shape of the post incorporated in the post itself, so there's no need for a "special washer" or a sleeve. Mike Morrin says, "The GM400 mount in the pre-H.E. parts book shows the spigot with the ridge machined into it, there being no part numbers for the "special washer" or sleeve." If that's actually the case, the reassembly instructions above are correct except that you can leave the special washer and sleeve out of the order. On the other hand, maybe what you *really* want to do is find the later design steel post; it's unlikely the design was changed without a good reason.

Sometime in the 90's, the post design was changed again. This final configuration had the external shape of the early aluminum post so no special washer or sleeve is needed, but it is made of steel.

Paul Hackbart says there also may be a difference between the way the steel posts are constructed. They all consist of a steel shaft pressed into a cast aluminum base, but some have a set of splines visible around the edge of this press fit. This may reflect a problem with the shaft breaking loose and turning while the mechanic was trying to tighten or loosen the self-locking nut -- but it's also possible that all post assemblies have splines and it's just that some extend up far enough to be visible.

TRANSMISSION MOUNT SUBSTITUTION: If you simply cannot figure out how to get the transmission mount back together despite all the guidance above, there are ways to substitute a more simple and basic mount scheme. John's Cars (page 668) offers a "no-nonsense" transmission mount, but you might not even need that; Chad Bolles says, "The extension housing for the Turbo 400 in your car is nothing but a Chev part. On my car I removed *all* the nuts, bolts, brackets, and the rest of the crap. I went to Parts America (Western Auto) and found a rear mount that fit a Buick, had two (2) holes in it and one stud. I then made myself a new rear crossmember, and reassembled the whole deal. Now I can change trans fluid without removing the rear mount."

Of course, Jaguar didn't provide such an involved mount scheme for nothing. One of their reasons was that a spring absorbs vibration better than a block of rubber. Imagine, if you will, how well your car would ride if you took the springs out of the suspension and replaced them with big blocks of rubber. Dan Jensen says, "I cannot comment on the GM 400 mount offered by John's Cars. I can comment on the effect of a TH 350 in my '83 XJ6 with the John's Cars rear transmission mount for this unit. There is noticeably more vibration transferred to the car. While John's claims this should not be the case (transmission the cause?), I prefer the factory mount." Other owners, however, claim they cannot feel any degradation in smoothness with the John's Cars mount -- perhaps because their original mount was assembled incorrectly! We'll never know for sure; you'll have to take your own chances if you decide to go this route.

DRIVESHAFT

SLIP JOINT ALIGNMENT: Craig Sawyers suggests that when removing the rear suspension, it's easier to just yank the drive shaft apart at the slip joint than to unbolt it from the final drive unit. "There is a pair of arrows stamped on the two halves so you get the splines aligned and end up with a balanced driveshaft. Both halves are balanced dynamically at the factory. The arrows are faint; I marked mine before disassembly, before I noticed the arrows after cleaning it up."

UNIVERSAL JOINTS: The XJ-S was clearly not designed with ease of servicing the forward drive shaft U-joint in mind. Applying a grease gun to the zerk fitting, as well as removing the drive shaft itself, require the transmission mount to be removed; if you have it out anyway, you may wish to address the drive shaft. However, drive shaft inspection also requires that the main support plate be removed. Jaguar provided two bolts up within the tunnel to make sure this task was as unpleasant as possible.

According to Chad Bolles, the U-joints in the drive shaft are a GM standard, and Spicer 5-153X or Tru Cross 153 will fit. The U-joints in the rear axles are also a standard; Spicer 5-160X or Tru Cross 160 will fit. All of these should be available at your local auto parts store.

Some mechanics claim that having a grease fitting on a U-joint does more harm than good. In theory, if the seals in the U-joint are any good, it will never need regreasing; if the seals are bad, regreasing won't help for long. And undisciplined use of a grease gun is the best way to destroy the seals. Even if you're careful with the gun, it's more than likely that the grease injected will all go to one bearing and leave the other three ungreased; it's a path-of-least-resistance kind of thing. If you believe all that, you might as well choose replacement U-joints that have no zerk fittings and save a couple bucks.

FINAL DRIVE

REAR SUSPENSION/DIFFERENTIAL REMOVAL: It's discussed on page 357.

DIFFERENTIAL TYPES: The XJ-S has apparently been fitted with at least two different differentials ("final drive units" for you Brits). From 1976-1985, the differential was a Salisbury 4HU Powr-Lok that came with either 3.07:1, 3.31:1 (1976-1982), or 2.88:1 (1982-1985) ratios.

From 1985-1987, a 2.88:1 Dana unit was used.

Now, follow closely. From 1987 to 1993, the XJ-S was fitted with a GKN Power Lock differential with a 2.88:1 ratio. The 87-93 differential is essentially the same item as the pre-85 differential (a speedometer sender was added; see page 547). According to Richard Griffiths, in the meantime Salisbury had been bought out by GKN. Later, GKN was bought out by -- wait for it -- Dana! But this was apparently after the XJ-S changed to outboard brakes. Dana (<http://www.dana.com/>) grew to be a huge corporation with annual revenues in the billions.

In this book, we will use the same convention that is commonly used among Jaguar owners: the pre-85 unit *and* the 87-93 unit will be referred to as a "Salisbury", regardless of whether it was actually made by Salisbury or GKN. The 85-87 unit will be referred to as a "Dana".

From 1993 on, the entire rear end of the XJ-S changed. A suspension similar to that on the XJ40 was used, with outboard brakes rather than inboard. Along with the engine being enlarged to 6.0 litre and the fitting of the 4-speed GM 400, a 3.54:1 final drive was used.

Apparently the AJ6-powered XJ-S's, 3.6 or 4.0 litre, all have 3.54:1 final drives.

All XJ-S differentials are "limited slip", although the feature has often been given different names.

The official Jaguar service department repair procedure for final drive units is to replace them as a whole.

SALISBURY VS. DANA: Differences between the Salisbury and the Dana include:

- On the Salisbury, the bearings on the output shafts are held in the case with five bolts. On the Dana, the bearings on the output shafts are held in place with three bolts.
- The Dana has no drain plug.
- The input flange on the Salisbury is circular. The input flange on the Dana is rectangular.
- With the Salisbury, the inboard brake calipers are bolted to lugs on the flanges holding the output shaft bearings, with the bolts installed from the inboard side outward. With the Dana, the inboard brake calipers are bolted to bosses on the case itself, with the bolts installed from the outboard side inward. In order to access those bolts, the Dana is fitted with brake rotors with access holes.
- The limited slip internals of the Salisbury are the "disc type", while the limited slip parts of the Dana are the "cone type".

Greg Wells of Coventry West says the gears from a Salisbury will not fit the Dana case.

DANA QUALITY: The Dana unit has a bad reputation. Apparently, the lack of a drain plug and the fewer bolts on the output shaft bearings gave an initial impression that it was "cheap", and Jaguar's return to the Salisbury unit after three years convinced many that there was something wrong with it. However, there's no telling what supply problems Jaguar

was dealing with in the mid-80's, especially with a buyout going on at Salisbury, so there may be other explanations for the flip-flop.

Apparently, the real problems with the Dana are not in mechanical shortcomings in the unit itself, but rather in support and maintenance. Ian Hissey says, "I have just removed the Dana diff from my XJ-SC, and replaced it with an overhauled Salisbury. A number of reasons, including changing from 2.88 ratio to a 3.31 ratio, but also, here in Aus the cost of replacement bearings, etc., for the Dana was extortionate, more than double the Salisbury, and also the Dana is not a true limited slip, has a cone arrangement, which is not as effective as a Salisbury LSD." Note that Hissey's preference for disc-type limited slip over cone-type is not universal; it's apparently a good topic for argument among performance buffs.

Greg Wells of Coventry West says, "The main problem with the Dana as we see it is that it is different and requires special Dana-style rear brake rotors." Note that the only difference between the rotors used with the Dana and the rotors used with the Salisbury are the access holes, so the Dana ones could be used on the Salisbury. It would therefore make sense to stock only the Dana style, but Wells says the ones with holes cost significantly more than the ones without holes so they stock both. Obviously, you could buy the cheaper Salisbury rotors and drill access holes in them for use on a Dana.

"That, plus the fact that it doesn't have a drain plug and people thus change the diff lube even less often compared to the Salisbury. Our rebuilder, Dick Maury, says that the L/S clutch setup in the Danas is not quite as good as a Salisbury in his opinion and that the carrier may not be as strong, but he also points out that we have seen Danas in 6.0L TWRs, so they obviously can handle the power." Apparently, the items that fail on the Dana are "those silly little clutch retainers", whatever that means.

DANA DIFFERENTIAL SERVICE: When working on a Dana unit, you can get the seals from Jaguar, bearings from a local bearing house, and the clutches, shims, and those silly little clutch retainers from any performance shop that has access to Dana rear end parts. When ordering, they will usually ask for a ring gear diameter and an "axle" spline count.

DIFFERENTIAL BREATHER: John Goodman reports on special parts for the XJR-S: "Looking through the parts list I notice that there is a revised diff cover with additional baffles. <Quote manual> ..."the diff rear cover is redesigned to improve breathing at high road speeds. The altered baffle plates direct oil flow so that turbulence is kept away from the oil breather.""

DIFFERENTIAL OIL CHANGE: Getting the fill plug out is no picnic. It has been suggested that removing the center reinforcing plate under the final drive unit (14 bolts, 6 with nuts) may be worthwhile. Don't worry, the whole car won't fall apart while the plate is out.

Many Jag owners suggest a length of plastic hose and a squeeze bottle for topping up or filling up the final drive unit. The hose should be long enough to feed out the right side wheel well so the oil can flow downhill.

Brian Sherwood points out that if you open the boot, remove the spare tire, and peel back the matting forward of the fuel pump, there is a round metal plug; removal of this plug provides access to the fill plug on the differential. "I just popped it out with a screwdriver, did my lube thing, then pressed the plug back in with some RTV around the edge."

Note that while the diff can be topped up with conventional gear oil, a drain and refill requires an additive for limited-slip units.

According to a salesman at Quality Jaguar, the XJ-S final drive unit uses both natural leather and natural rubber seals. Therefore, synthetic lubricants are *not* recommended. It is recommended that synthetics be avoided in the special additive as well.

DIFFERENTIAL GASKET: British Auto USA (see page 641) offers a differential cover gasket (part number 3931) that is supposed to be better than the original -- thicker and better material.

TEFLON: Dennis Hurvitz reports: "While having a quickie lube joint change the oil in my wife's car (ok, I was pressed for time), a guy pulled up in an older Mercedes to thank the manager. Seems the Mercedes guy had a differential whine and the manager recommended replacing the differential fluid with some new mixture containing teflon. The owner made a point of thanking the manager, because the problem (sound) mostly went away!"

Unfortunately, lubricants containing teflon are not recommended for limited-slip differentials, and all XJ-S's have limited-slip differentials. Still, if you're facing a diff rebuild anyway, perhaps you can add the teflon to quiet the whine and do without the positraction until you get around to having the diff rebuilt.

INPUT FLANGE RETAINING NUT: It's a really big nut, obviously it should be tightened down really tight, right? Wrong. This nut is used to set the preload on the input shaft bearings. Between the bearings is a "crush sleeve", and during assembly this nut is tightened just enough to provide the proper bearing preload while compressing this sleeve. If the nut is overtorqued, the entire final drive assembly must be torn down to install a new crush sleeve.

DIFFERENTIAL OUTPUT BEARING FAILURE: One of the common failure modes of the Jaguar differential unit is the failure of the bearings in the output shafts, possibly because these bearings take lateral loads imposed by the working of the suspension. Whatever, the failure is usually indicated by clunks from the rear when driving or the tire rubbing the wheel well where it formerly had clearance. Checking by grabbing the top of each rear wheel and shaking vigorously in and out clearly indicates a problem. Closer inspection shows that the output shaft is free to move in and out, and the only thing limiting movement is the brake disk banging back and forth within the caliper!

According to Jan Wikström, "it's very likely that all you need to do is replace the bearings and seals. This is not difficult, but you'll need to take the rear subframe off your car. You *can* do it from underneath, but that probably takes longer because of the difficulty in getting the brake calipers off and back on. Besides, taking out and dismantling the complete rear suspension gives you a great opportunity to check *everything*."

The output shaft assembly for the Salisbury differential is available as a pre-assembled unit under a single part number: AEU1802 for the right side, AEU1803 for the left. This simplifies repair considerably; by getting this assembly pre-made, the mechanic doesn't have to fiddle with bearing preload, crush sleeves, etc., he just removes the old assembly and bolts in the new. Obviously, there is a core charge on the old assembly, so it can be rebuilt with new bearings and seals.

CLUNK: Julian Mullaney shares an unpleasant experience: "I had a clunk on my '87 XJ-S from the rear end. My clunk was because the diff itself was loose in the mounts. The mounts in this case were 4 cone-shaped bolts which attach the inner lower wishbone mounts to the diff casting. The bolts screw right into the diff, and are wired in place. These bolts had just become a bit loose even though they were still wired together from the factory. The constant rocking with power on/off had worn the fit between bolts and casting. You can easily check for this by jacking the car up high, putting the trans in P, crawl under and look for movement in the joint while violently rotating the rear tires back and forth." This is reportedly a fairly common problem; it should be noted that proper torquing and lockwiring of these bolts is very important. Many owners use Loctite on the threads as well.

Jan Wikström adds, "If the PO has omitted the security wires on the bolts, they come loose - and then the U-shaped shims fall out and the diff is *really* loose.

"The inner pivot bracket is shimmed to the diff to line up with the pivot mounting holes in the cage; with the bolts tight, the pivot spindles should slide in and out easily. If those inner pivot carriers aren't correctly shimmed, it's jolly well impossible to get the trunnion bolts out without slackening the diff bolts - which is *very* hard to do because the trunnion bolts block access to the bolt heads. You need a very thin open-ended spanner."

"My second XJ had pivot spindles that couldn't be moved; somebody had botched the assembly and just forced the whole thing together without shims. I had the devil's own time finding a thin enough spanner to loosen the mounting bolts enough to slide the spindles out."

"To get this right requires an extra step in the assembly procedure: you measure the space between brackets and diff (bracket mounting bolts finger-tight, bottom plate out) and get spacers to that thickness. Now, there's not a hell of a lot of space between the suspension arms and the bracket-to-diff bolts; unless you have some extremely thin spanners (and thin fingers to get the locking wire on), you now need to pull the inner pivot spindles. Put the spindles back in without the suspension arms and tighten the bejesus out of those bolts (the torque is in the book); now try the inner pivot spindles. If they don't slide out easily, you need to tinker with those shims. Apply lock wires and assemble the inner pivots.

"Now bolt on the bottom plate; you'll find that the complete assembly is rigid.

"Another thing I noted on that car was that the final drive had been flopping around to such an extent that the rear sub-frame was fractured on top, where the four top final drive mounting bolts are (invisible without taking it out). There's a (1/4 in? 5mm?) steel plate inside the double-walled top of the sub-frame (as I found when I welded fatigue cracks in my first one); the retaining bolt heads have an underside taper matching a taper in this plate. With your diff slopping back and forth, there is good reason to suspect fatigue cracks in the top."

FINAL DRIVE RATIO CHANGE: There are many ratios available to fit the Salisbury final drive. However, be aware that if the ratio is changed significantly, the differential carrier will also have to be replaced. Since the lower ratios (higher numbers) require a smaller pinion, the ring gear needs to move closer to center to mesh properly. This could be accomplished by making the ring gear thicker or adding a spacer, but instead a replacement carrier is used with the mounting flange in a slightly different position. Unfortunately, the carrier costs more than the gears.

If you have the Dana final drive unit, Greg Wells of Coventry West reports that he can only get one set of gears to fit: 2.88:1. So, step #1 for changing the final drive ratio is to replace the Dana unit with a Salisbury. Wells adds that, thanks to the popularity of that change, Coventry West can no longer offer core credit on Dana final drive units -- they have more on hand than they can use. So, changing the final drive ratio on a Dana-equipped car means buying an entire new Salisbury final drive unit outright and simply discarding the Dana -- an expensive proposition indeed.

SUSPENSION & STEERING

GREASE (ZERK) FITTINGS: Unlike the newer American “low-maintenance” cars, the Jag has zerk fittings all over the suspension. Periodically it should be gone over with the grease gun, but please be conservative. It is tempting to grease fittings too often and to pump too much grease, which will destroy the seals or gaiters on the joint.

The following is a list of the grease fittings on the car:

- All six universal joints -- good luck getting at the forward one on the drive shaft (see page 321). The protective covers on the rear axle U-joints have openings for greasing, but they may not line up. You can relocate them as necessary.
- All four corners of the flat plate under the differential (lower swingarm inner joints). There are holes in the plate for access to the zerk fittings.
- The needle bearings in the lower pivot joint of the rear hub carriers; the fittings are just inside the rear wheels at the bottom.
- Both front hubs. The fitting is on the side of the hub near the outer cap. With some wheel designs, the wheels do not need to be removed. Rumor has it these fittings have been deleted in later cars.
- Both upper front ball joints -- remove the front wheels for access. If these ball joints have been replaced with XJ40 ball joints, there are no grease fittings.
- Both lower front ball joints. The fittings point inward, underneath the car. If these ball joints have been replaced with XJ40 ball joints, there are no grease fittings.
- Steering rack -- see note on page 347.

Also, the rear wheel bearings should be greased by removing the small cap on the hub carrier and spooning a little grease into the hole. Don’t overgrease, because the excess merely spins out and coats the inside of your wheels.

The pre-1983 Jaguars also had zerk fittings on the tie rod ends, but the later cars were fitted with “improved” tie rod ends with no such fittings.

The ball joint zerk fittings are designed with a relief system to prevent the grease gun from applying too much pressure. Under the fitting itself is a plastic washer that covers the relief hole. When the joint is full of grease, any additional greasing will force the plastic washer to bend, allowing the grease to come out adjacent to the fitting itself.

When installing the zerk fittings on these ball joints, note that overtightening the fitting onto the plastic washer will deform the washer and open the relief hole.

Michael Neal sends this tip on lubricating the lower ball joint: “If the grease comes out from behind the plastic washer as soon as you apply it then the passage is plugged. The best way to clean the passage is to remove the lower plate and zerk fitting. Ream out the passage and apply some grease to the cup before reassembling. The grease in the passage hardens after a relatively short amount of time and plugs the passage.” It is possible to remove this cup and clean it out without getting involved in the access and rebuild procedures discussed on page 339; Put a jack under the spring pan on the A-arm and jack it up, bend back the locking tabs and unbolt the cup, clean it out, regrease, and bolt it back on with the same shims in place.

Craig Sawyers pointed out that it might also help to unload the ball joint. James Berry says, “The grease finally went in, as Craig Sawyers suggested, if the car is jacked and the weight is taken off the hub. With the grease gun attached to the zerk, under pressure, the hub was moved right and left until finally the grease gave up and went where it was supposed to (I think).” It can be surprisingly difficult to get grease into this joint, even with the taper pin disconnected from the hub carrier! The pressure of the grease itself tends to press the ball against the upper ball seat, totally sealing off the path the grease needs to pass through. It may work best to have the weight of the car on the wheels and turn the steering back and forth while greasing -- if you can figure out how to accomplish that.

See the note on lubricating the water pump on page 202.

Don't overlook the zerk fittings themselves as a possible source of trouble. Each zerk fitting has a tiny spring-loaded ball check valve to allow grease in but not out. It is susceptible to corrosion and jamming. They are also easily damaged by impact.

RIDE HEIGHT: XJ-S owners are often concerned about whether the car is actually supposed to sit that low, or if something is wrong. The ROM describes a check, but it presumes you have original tires with full tread. It also presumes you have "slip plates", devices you set the front tires on so they can slide around and not bind the suspension travel. The following is a derived procedure that subtracts the tire rolling diameter out of the equation in order to determine if your car is sitting at the "correct" ride height for the tires you have on it, and all it requires is a level section of concrete.

Position the car on level ground with nobody in it, no heavy stuff inside or in the trunk, a full tank of gas, the emergency brake off and the shifter in N. Push the car back and forth a few feet. When pushing rearwards, push on the front bumper and deliberately bounce the front of the car a little while pushing. When pushing forwards, push the rear bumper and deliberately bounce that end as well. This is to make sure the car is fully settled in its position.

Measure the height to the center of the front wheels. With any luck, they should be the same, but if they vary slightly determine the average.

Subtract 6-3/8" from this height. This gives you the correct height above the ground for the flat bottom of the cross member between the front wheels.

If all four tires are the same, use the same front wheel center measurement (do *not* measure the height of the center of the rear wheels) and subtract 4-7/8". This will give you the correct height above the ground for the edges of the plate between the rear wheels with a full tank of gas. If all four tires are not the same, what do you care what the correct ride height is?

So much for the "correct" ride height. Now, to describe what you actually have, a story from B. J. Kroppe: "My former supervisor (a Jaguar employee) did vehicle packaging for the F-Type. He started with XJ-S drawings and came across some things which didn't add up. So he went to the assembly plant and measured some XJ-S vehicles and compared them to the drawings. He discovered that the cars being produced (this was mid-late 1980's) were very much lower than the drawings said they should be.

"After some investigating he learned that over the years more features had been put on the car, making it heavier, but springs had not been changed to accommodate for the added weight, thus causing the lower ride height in the actual cars vs. what the drawings were saying."

In practice, it appears the XJ-S may ride about a half inch lower than the "correct" ride height, even when new. If yours is significantly lower than that, however, it's probable that either the shocks or the springs need replacing.

SAGGING FRONT END: If your Jag seems to be riding low on the nose end, a likely culprit to check is the front shock absorbers. The XJ-S uses gas shocks, in which the damping fluid is held under pressure by a small amount of gas within the chamber. A side effect is that the pressure causes the shock to try to extend. This extending force helps raise the car a little, especially when the suspension is soft. The Jag was designed for these shocks, and if they lose pressure, the nose sags. Since the pressure may be lost while the fluid is still present, the low nose may be the first sign of failing shocks. Of course, the rear shocks are also gas type and may cause the same problem, but it doesn't seem to happen as often.

If the front sags and the shocks aren't the problem, see Craig Sawyers' comments on rust problems on page 345.

SHOCK ABSORBERS: To check the front shocks, jack up the car and remove the front wheel. From inside the engine compartment, remove the locknut, nut, rubber doughnut and seat from the top of the shock absorber. Then reach into the wheel well, grab the top portion of the shock and pull it downward. If it is in good shape, it should move downward

smoothly with a hiss, and when released should move smoothly but forcefully back to its full extended position by itself. If the motion is not smooth, or the shock compresses easily and quickly with no damping effect, or fails to extend itself when released, replace the shocks.

The traditional tests of shock absorbers involving pushing the car down and noting its recovery or noting the car's reactions over bumps are not entirely applicable to modern gas shocks. If a gas shock loses its gas charge, it may still appear to pass these tests; if it still has fluid in it, it will still provide some damping. The damping effectiveness is greatly reduced, however, and will get much worse over a series of bumps. And, as noted above, the car's ride height will be affected. There seems to be no substitute for disconnecting the shocks and checking them by hand. Checking the rear shocks will require a spring compressor to remove the springs from the shocks.

The original shocks on the XJ-S are Boge. Shocks are also offered by Unipart, Spax, Armstrong-Girling, Bilstein, Monroe, Gabriel, KYB, and Koni, some of which are actually reasonably priced. The only consistent reports received by this author regard the Gabriels -- consistently negative. They should probably be avoided, despite their lifetime guarantee.

Monroe, sold by NAPA and many other auto parts outlets in the US, used to offer reasonably-priced, serviceable shocks for the XJ-S. However, reports are that they came up with the "Sensatrac" design and it went to their heads, and their prices are no longer reasonable.

Terry's Jaguar Parts (page 646) offers some "competition gas-filled shock absorbers" with adjustable spring supports and spherical bearing mounts.

Matthias Fouquet-Lapar points out that Bilstein is now online:

<http://www.bilstein.com/>

"There is lots of tech info."

RIDE HEIGHT -- HESS & EISENHART CONVERTIBLE: The H&E seems to ride low even when the shocks and springs are in good order, especially at the rear. This is apparently because the H&E is heavier than the stock coupe, but the springs were not altered.

One possible solution is suggested by John Warr: "The shox recommended by Koni for the front of the XJ-S are gas charged, those for the rear are gas charged, adjustable spring height." Terry's Jaguar also offers "competition" shocks with adjustable spring supports. Coupled with the fact that Jaguar provides shims for the front springs, it may be possible to set the ride height of both ends where the car looks right.

Of course, another possibility may be to use the springs from an XJ12.

VIBRATION AT PARTICULAR SPEEDS: This is a common complaint with the XJ-S, with owners frustrated that wheel balancing or other efforts have no effect. Marty Sullivan fixed the problem on his H&E convertible with a correct alignment; see below. The H&E also has some dynamic absorber weights mounted behind the headlights, so an investigation of vibrations should include a check to make sure they are mounted properly. Chris Carley, who owns a '91 (factory) convertible, fixed his problem by replacing "the S-rated Dunlop Qualifier tires 235/60 15 that came new with car with Yokohama AVS V-rated 235/60 15. Well - why didn't I do this a year ago? The shakes are gone, the car steers & brakes much better. Also rides smoother and sits at a better ride height. I noticed the shakes were less when it was cold (read Florida 60°F), so I can only assume they flexed too much when warm and went out of round?"

ALIGNMENT: First off, note that while many cars are aligned only at the front, the XJ-S requires that all four wheels be aligned. Although there is really only one adjustment at the rear (camber), it is likely to take most of the mechanic's time if any adjustment is necessary; it requires that the driveshafts be unbolted from the differential unit and shims changed.

Randy Wilson sends a warning to be careful which alignment shop you choose to align a Jaguar: "The generic American tank has shims to align the front suspension camber and castor. These shims are placed at both the front and rear pivots of the upper control arm. By adding or subtracting shims equally at both ends, you change the camber. By adding or subtracting shims at one end only, you change the castor. Jaguars do not work this way, but look like they do to the uninitiated. The Jaguar has shims at the upper pivot just like the Chevy/Ford above, but they must be used as camber adjustment only with equal amounts of shim change at both front and rear pivots. The castor adjustment is done by a separate set of shims at the upper ball joint. If some hack jumps in there and adjusts camber and castor by staggering the pivot shims, you will end up with a car with a sort of correct alignment (dynamic castor gain will not be as Jag intended), but the car will just eat upper control arm bushings."

"The good news is that the XJ front subframe is one stout critter. Unless it has been seriously whacked, it is rare for camber or castor to need adjusting. Alignment is usually just a matter of setting the toe correctly after the latest steering rack change/rebuild."

Peter Havas adds, "It is easy to remove the two bolts holding the carrier, and dropping the washers behind the spring tower, or confusing the number which go on each side when you re-assemble. Additionally, I have taken some front ends apart which have been re-aligned in the states, and "U" spacers were substituted for the originals to save time. These fall right out when the bolts are loosened." They also have a nasty habit of falling out when driving; if you don't believe that, just check out how many alignment shims you can find laying on any stretch of road.

The castor is adjusted by rearranging the shims either in front of or behind the upper ball joint -- but the *total* number of shims surrounding that ball joint should always be four. Just move them from front to back, don't remove any or add any to the total.

There are reports that the spec books in the alignment shops consistently list the wrong alignment specs for Jaguars. Just to be sure, take your own repair manual with you, and if the numbers that you have disagree with those they have, insist they use yours. They shouldn't care, it's your car and your money.

The XJ-S really needs to be aligned according to the procedures outlined in section 57.65.04 of the ROM -- namely, that the ride height must be restrained at a specified position for the alignment. The standard alignment shop shortcut of aligning the car at whatever ride height it sits at is *not* acceptable; both the front and the IRS geometries change with ride height, and many (most?) XJ-S's don't sit at the correct ride height by themselves. Failure to establish the correct ride height during alignment may result in a shaking in the front end at 50-60 mph -- a notorious problem in the H&E convertible, perhaps because the H&E convertible is also notorious for a low ride height.

If you're gonna pay good money for an alignment, you might as well insist it's done properly. Of course, it's not likely the alignment shop you choose will have the special tools used to establish the ride height on Jaguars -- unless you go to a dealer. So, if you're going someplace other than the dealer for the alignment, you'd be well advised to take the tools with you -- and the instructions from the repair manual showing how they're used.

The tools for setting the ride height of the front suspension are made from short lengths of tubing, and there's enough info to make them provided in section 57.65.04 of the ROM. The tools for setting the ride height of the rear suspension are a pair of metal hooks, and are described only as Jaguar tool no. JD.25. These would be even easier to make than the tubes, if only you knew what the key dimension was -- and just what is this book for, anyway? **Figure 17** should provide the info needed.

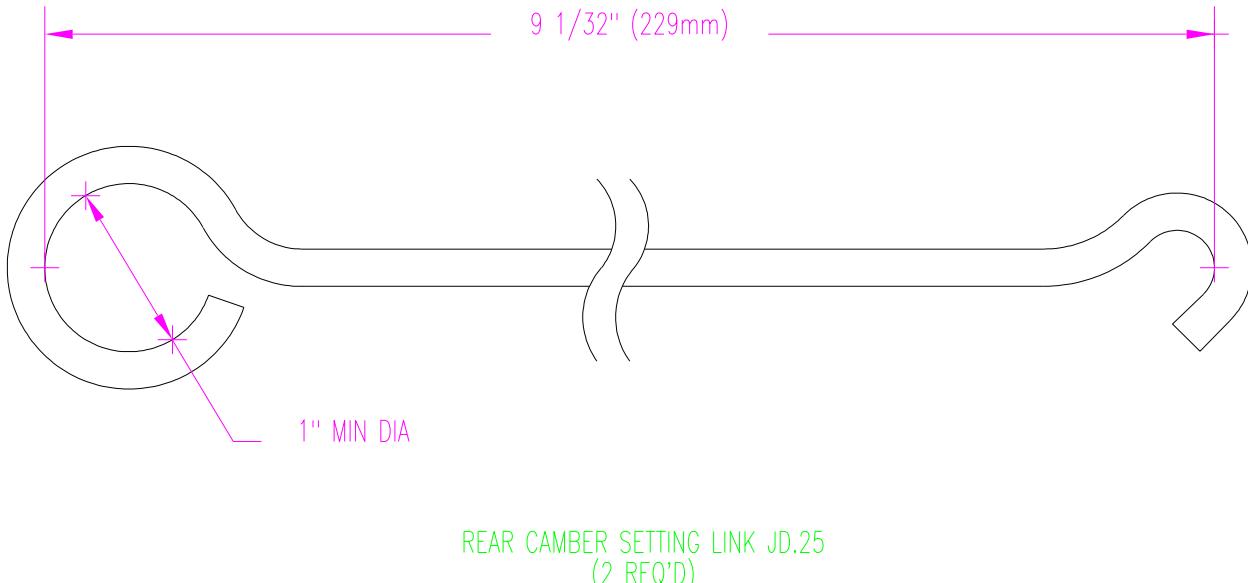


Figure 17 - Jaguar Alignment Tool JD.25

Note that although the official Jaguar tools are made from a single 9/32" steel rod suitably bent, there's no reason you shouldn't be able to screw together suitable tools from eye bolts, threaded hooks, threaded rod, and some coupling nuts - all available at any hardware store for peanuts. Remember that you'll need to make two.

These tools might actually be a suitable thing for local Jaguar clubs to keep on hand for the benefit of their members. Apparently, these exact same tools have been used on all Jaguars that use the same IRS as the XJ-S -- which means all E-types, all XJ6/12 SI/II/III -- basically all Jaguars made for about four decades. In fact, the dimension shown in the drawing was provided by Michel Carpentier, who got it from a Mk10 service manual. At the time the Mk10 was made, the tool was called a J25; the tool names were changed to JD after Jaguar bought Daimler.

When *either* end of a Jaguar is being aligned, the ride height setting tools should be in place on *both* ends.

In what must be considered a serious shortcoming, the Haynes manual does not discuss this ride height setting procedure at all, and lists an incorrect tool number (JD21 -- actually the number for a bushing tool of some sort) without going into any detail about using it. It suggests that alignment is not for the home mechanic, but provides a few generic guidelines for what is done -- just enough to get you in trouble. If you have only the Haynes manual, it is recommended that you obtain a copy of the alignment instructions from a Jaguar ROM or shop manual before having an alignment done by a non-Jaguar shop.

Finally, note that most of the above info probably applies only to the pre-1993 XJ-S with inboard rear brakes. From 1994 on, a completely different IRS was used with outboard brakes, and it presumably requires different alignment procedures.

If you'd like to try tackling the alignment job on your own, Tony Watts points out that there is a description of how to perform your own alignment with simple tools on the WWW at:

<http://www.vtr.org/maintain/diy-alignment.html>

ANTI-ROLL BARS -- WHAT THEY DO: An anti-roll bar (also known as a sway bar or anti-sway bar) is simply a spring that resists one wheel from traveling up or down without the wheel on the opposite side moving likewise. For a car to lean, one wheel must go up (relative to the car) while the other goes down, so the anti-roll bar is a spring that resists leaning. This has many benefits, including reducing the shift of the center of gravity caused by the leaning, and better traction and tread wear due to keeping the car, and therefore the tires, upright in a corner.

It is a good idea for the roll stiffness to be balanced between the front and rear end of a car. If one end is stiff and the other isn't, then when the car tries to lean in a corner the outside tire on the stiff end takes all the load while the outside tire on the other end takes it easy. Typically, this will cause the tires on the stiff end to behave poorly and wear rapidly. In general, adding roll stiffness to one end of a car helps the handling of the other end.

If the front end is stiffer than the rear, then the car tends to understeer, or plow its way through a turn. This is the accepted norm here in the US. In this case, when the car doesn't seem to be going where the driver wants it to go, he merely turns the steering wheel farther -- a design considered defensible in this age of litigation. If the car has balanced anti-roll stiffness or is stiffer at the rear, there is the possibility that the car will oversteer in a corner -- the rear end will swing out. The correction is to turn the steering wheel in the direction of the slide -- a design considered indefensible in court, and possibly exposing auto manufacturers to liability.

For those who prefer to drive a car rather than have the car drive them, adding a rear anti-roll bar to an understeering car is a good idea. The car will have more neutral handling characteristics. Also, there is a more "precise" feel to the steering, even when driving slowly. In general, the car will feel more stable. And the front tires will usually wear much longer, and wear less on the edges and more uniformly across the tire.

Ah, but what about the ride? When driving over two-wheel bumps (such as speed bumps), the anti-roll bar merely turns on its pivots, and the ride is unaffected. When driving over one-wheel bumps, however, the motion of the wheel over the bump will have a more pronounced effect on tilting the car. This effect can be quite noticeable. In cases where a series of one-wheel bumps are encountered, the occupant can feel downright jostled, especially if the added anti-roll bar is very stiff.

The above is a very brief discussion of anti-roll bars. A more complete discussion would include the effects on particular types of suspensions, most notably suspensions with shortcomings that an anti-roll bar tends to compound. Also, some cars have suspensions with an inherent anti-roll stiffness, and don't require a separate bar. However, the Jaguar suspension has no such situations, so there is no need for further discussion here.

It should be noted that anti-roll bars are customarily described by their thickness, this being an indication of their stiffness. However, the thickness of an anti-roll bar can only be used for comparison against the thickness of another anti-roll bar that mounts the same way on the same end of the same type car. Because of differences in the leverage of the anti-roll bar linkage as well as in suspension geometry and center of gravity, a 1/2" bar may be quite stiff on one car while a 1" bar may be barely adequate on another.

ANTI-ROLL BARS -- WHAT YOU'VE GOT: Really good question, actually, since apparently there are a lot of different configurations. Most of the info in the chart below was provided by Chad Bolles.

	Front Anti-roll Bar			Rear Anti-roll Bar		
	P/N	dia.	Bushing P/N	P/N	dia.	Bushing P/N
1975-82 5.3	C36887/1	7/8"	C32925	C42178/2	9/16"	C44931/2
1982-87 5.3	C36887/1	7/8"	C32925	None	n/a	n/a
87-on 5.3, 6.0	C36887/1	7/8"	CAC4651/7	None	n/a	n/a
5.3 SportPack	CBC5579	1"	CBC5580	C42178/3	5/8"	CBC4901
6.0 SportPack	CCC7198					
4.0 Coupe	C36887/1	7/8"	CAC4651/7			
4.0 Convertible	C36887/2		CAC4651/6			
4.0 Cpe SportPack	CCC7197		CBC5580			
XJ6	C36887	3/4"	C30502	None	n/a	n/a

Typically, the brackets holding the anti-roll bar bushings will not change with bar size; the outside of the bushing remains the same, only the size hole through the middle varies, so the same bracket can be used throughout. Note that the brackets for the front anti-roll bar on the XJ-S were originally C30500 (r) and C30501 (l), but after VIN 179737 changed to CBC5336 (r) and CBC5337 (l). Some of the same bushings were used before and after this change, so either set of brackets is apparently compatible with any bushing.

ANTI-ROLL BARS -- SUGGESTED CHANGES: As noted above, the 1982-on baseline XJ-S has a 7/8" front anti-roll bar only, and understeers accordingly. However, cars prior to VIN 106452 came with a 9/16" rear anti-roll bar as well. These parts can be added to the later XJ-S, and were designed by Jaguar to provide balanced handling when used with the stock front bar. The radius arm assemblies must be replaced to provide attachment points for the anti-roll bar, or attachment points can be welded onto the existing radius arms. The mounts on the underside of the car were still being provided as late as 1988 and possibly later: a reinforced area with two studs on each side of the car, just above the radius arms.

For the pre-1982 anti-roll bar assembly, the part numbers and quantities are as follows:

<u>ITEM</u>	<u>P/N</u>	<u>QTY</u>
Radius arm assy	C41831	2
Rear Anti-roll bar (9/16")	C42178/2	1
Bushing	C44931/2	2
Bracket	C42114 or C3054	2
Link	C42907	2

This is a really light bar, and the change in ride from adding it is minimal. It does help the handling considerably, however.

While adding a light rear anti-roll bar can do wonders for the balance and handling of a street car, it by no means eliminates body roll entirely, and certainly will not make an autocross champion out of the XJ-S. For those who wish to get serious about cornering, an excellent plan is to replace the 7/8" front bar with a stiffer one, and to install a suitably heavy-duty item in the rear to match.

"Sportspack" models come with a stiffer front anti-roll bar, and a rear anti-roll bar that is stiffer than the pre-1982 model described above. The part numbers are as follows:

<u>ITEM</u>	<u>P/N</u>	<u>QTY</u>
Front Anti-roll bar (1")	CBC5579	1
Front bushing	CBC5580	2
Radius arm assy	C41831	2
Rear Anti-roll bar (5/8")	C42178/3	1
Bushing	CBC4901	2
Bracket	C3054	2
Link	C42907	2

Addco (see page 663) offers a 7/8" rear bar, along with a 1" front bar. Note that a 7/8" rear bar would be almost four times as stiff as the 5/8" bar that comes on the Sportspack! It is clear that the two Addco units are intended to be used together; Addco does not offer a rear bar suitable for use with the stock front bar under the mistaken assumption that all XJ-S cars come with a stock rear bar as the pre-1982 models did.

Unfortunately, since their kit assumes the existence of a rear bar, it doesn't include the links and other parts needed to connect the rear bar to the rear suspension of later cars. To use their kit it will be necessary to purchase the links from Jaguar, and the radius arm assemblies will need to be either modified or replaced. When ordering, check that the Addco kit comes with a bracket (a bushing will be included, since it is larger than stock); if not, the Addco "D" series or "W" series are suitable brackets.

Gran Turismo Jaguar (now defunct) offered anti-roll bar kits for the XJ-S with two features of note: First, the rear bar appeared to have an end link assembly that mechanically attached to the radius arm without needing to weld on an attachment. Second, while their bars could be installed the same way the OEM bars were installed, they could also be set up with "slider links" that provide an adjustment to the anti-roll stiffness. Basically, instead of the link being attached to an eye at the end of the bar, it is attached to a clamped-on clevis that can be slid along the bar and tightened down where desired. By changing the effective lever arm in this manner, the anti-roll stiffness can be varied quickly and easily -- perhaps even just to switch from street use to a weekend autocross, or even to optimize for one racetrack or another.

POLYURETHANE SUSPENSION GOODIES: Polyurethane (or urethane) is much stiffer than the rubber used in the OEM mounts and bushings. It is also more durable. And, due to the nature of aftermarket supply vs. original Jaguar parts, considerably cheaper.

Craig Sawyers says that Classic Spares (page 642) offers several parts. "They are called Superflex, polyurethane, and come from Australia originally. They are sort of a translucent purple colour. Bottom wishbone (i.e. swingarm) bushes, top bushes, rack bushes and anti-roll bar bushes too."

It would probably be a good idea to update all comparable parts on both ends of the car at the same time. Stability at speed in a softly-sprung car requires a careful balance of compliance in suspension parts and tires, and making one end stiffer while the other is still soft may result in dangerous instabilities.

Front Suspension

CLUNKS - FRONT: If something in the front goes "clunk" when you drive over a bump, check the rubber bushings on the top of the front shock absorbers. British non-metallics again. Any generic rubber shock bushing will do, and will do better than the original. David Littlefield says, "Generic replacement bushings are available in the "Help!" section of your local auto parts store. Look for the area with a variety of parts on red cards. The part number is 31018 and they

come two to a pack. The pack also says "Ford/Mercury" on it, so if you can't find the "Help!" products, perhaps you can ask for a Ford/Mercury replacement. You will need two cards (or four bushings altogether). I paid \$2.58 per card at Pep Boys. I would describe them as being about the size and shape of a medium sized mushroom cap; only, of course, with a hole through the center.

"Replacement is a breeze. I did both sides in a little over an hour. The biggest operations are jacking up the car, removing the tire, and removing the hinged side of the air filter on each side. Removing the old bushings and installing the new ones is a straightforward and simple procedure." Note: you can easily compress and release the shock while you're there, thereby checking that it's in good shape -- see page 328.

"The old bushings were the consistency of foam rubber after five years and about 25,000 miles. These were Jaguar replacements done after the car had traveled 32,000 miles over four years on the factory installed bushings.

"Bottom line: About \$5.00 and an hour and a half of my time for a fix that should hopefully last a long, long time. This versus about \$25 in parts and \$75+ in labor to the dealer for a fix that would last, at most, about 30,000 miles."

Note that the XJ-S has steel washers that fit between the bushings and the chassis; purpose unknown, but it won't hurt to put them back in with the new bushings. Littlefield says, "The real purpose of the washers seems to be to let you know your bushings are bad by clanking around and driving you nuts until you replace them!"

Some people want to know just how much to tighten the nuts when putting in new bushings or new shocks. The answer: all the way. The posts on top of the shocks have a shoulder, and the nuts should be tightened until they sit down on this shoulder.

Another common cause of clunks is loose diagonal supports across the top of the engine compartment. Make sure the bolts at both ends are tight.

Also check for a failed subframe mount. When the rubber within the mount is torn but still in place it would seem that it shouldn't make any sound, but it does. There are two doughnut-shaped mounts at the front, and two V-shaped mounts near the steering rack. If the rubber is torn or otherwise damaged, they should be replaced.

FRONT SUSPENSION CHECK: You may be confident that your front suspension is just fine, but this test is so quick and easy you might as well try it. Stand beside the car and grab the top of a front tire and shake it vigorously in and out. If everything is OK, the only thing you will feel is the flexing of the tires, and you will hear nothing.

If you feel any slop, or you hear a "clunk" back and forth, your front suspension is *not* up to snuff. You should check the following items, which are discussed in more detail below:

- 1) Adjustment of the wheel bearings.
- 2) Condition of the ball joints, upper and lower.
- 3) Wear groove on bottom of front axle.
- 4) Bushings at inner end of upper and lower swingarms.
- 5) Front subframe mounts.

Perform this test and correct any problems noted before having your car aligned. The repair or replacement of ball joints, tie rod ends, swingarm bushings or subframe mounts normally requires realignment, and it's a shame to have to do it over.

Peter Havas says passing the shake test doesn't necessarily mean all is OK: "The suspension is too heavy to give any accurate indication by shaking it. Okay, if we're talking metal to metal, then yeah give it a shake. But a dried out bushing, frozen on the inside won't move. Bad lower wishbone bushes don't display any bad behaviour at all when pushed around. I would suggest:

"Uppers: Remove the wheel. As the bushing is a mushroom shape and protrudes from the yoke of the wishbone, check that the lip holding the metal backing plate is not torn or worn to the point that you can peel it back from the plate. The

plate at the end should be uniformly held in by the rubber. Check for obvious cracking, and if the bushing is rust coloured, or seems to seep rust from the mating surfaces around the yoke, or the backing plate. Insert a longish bar diagonally through the upper wishbone, and flex the fitting to check for any undue movement, water seepage, or cracking.

"Lowers: On the steering wheel side (rhd or lhd) check that the rear bushing is dry. If it is oil soaked, dig around the nut to see if the bush has become spongy. For the other bushes: ensure that the wishbone is centered on the fulcrum, and no rubber is protruding around the castellated nut. Remove the split pin and nut on the front two bushes, and check that there is no rust between the fulcrum (carrier) and the bush. With the car supported on jack stands, put a length of 2x4 under the lower wishbone and lift while an assistant checks that there is no play in the bushes. If no assistant is available, feel for play or obvious shifting when the suspension is moved. Using the same longish bar from the upper test pry the wishbone directly away from the fulcrum to see if there is any play."

"The lower bushes, especially in the front, tend to freeze to the fulcrum and "squash" for lack of a better term. The constant chaffing heats the rubber so it starts to come out around the nut on the end. Usually after many miles, the set of the wishbone on the fulcrum is evident. It really starts to show when someone has changed to nice sticky tires, and the suspension is doing all the work it can. Because of their tendency to freeze up, they often don't display any movement at all when static, and people tend to pass them up: "If it ain't broke don't fix it.""

It should also be noted that, contrary to common belief, a car will not periodically require realignment for no good reason. If a car was correctly aligned at one time and no longer is, it is because parts are either worn or damaged, and merely realigning without addressing those parts is unwise.

FRONT HUB REMOVAL: Michael Neal suggests the brake caliper *not* be removed when pulling the hub, to avoid fiddling with steering lever shims (see page 406). Instead, unbolt the disk from the hub by inserting a socket through an opening in the dust shield. Then, remove the hub leaving the disk in place.

That works, but really fiddling with the shims isn't bad.

If you do separate hub and rotor, it's probably a good idea to mark it first so you get it back together the same way. Couldn't hurt, and may help avoid brake shudder problems.

FRONT WHEEL BEARINGS: According to Chad Bolles, the XJ-S uses standard front wheel bearings, available in any auto parts store. The pre-1977½ XJ-S outer is an A-2, the inner is an A-6. The 1977½-up car uses A-13 for the inner, A-12 for the outer.

FRONT WHEEL BEARINGS/SEALS SERVICE INTERVAL -- ABS-EQUIPPED CARS: Bruce Segal reports from Canada: "Jaguar was recommending that the front wheel bearing seals be replaced every 15,000 mi (24,000k). At the same time the bearings should be looked at and replaced if there is any evidence of water ingress. I don't know if this applied anywhere besides Canada. We found that after going to this procedure front wheel bearing failures disappeared."

Stefan Schulz provides a possible explanation: "It could well be the likelihood of contaminant ingress that causes Jaguar to specify the change interval. The grease seal at the inside of the front hubs was changed with the advent of ABS. The pre-ABS grease seal looks like it will properly do the job, since it sits firm in the hub casing and its sealing lip rotates (and presumably experiences friction and wear) over the relatively smooth surface of the stub axle. The post-ABS grease seal works the other way round, it sits on the hub carrier and its lip touches the hub proper which rotates relative to it. The hub's inside surface in that area is nothing like as smooth as the sub axle's surface, so I'd expect that grease seal to fail much earlier."

"I have had my XJ-S for almost three years and 42,000 miles now. R&R'd stub axles and front wheel bearings when I bought it and bearings again about 10,000 miles ago. They needed it."

Segal again: "In my environment (winter, salt, water) the new type seals do not provide a long term solution -- thus Jaguar Canada's very short replacement recommendation. We've found that quite often the bearings had started to rust front the salt water getting past the seal."

If you have an ABS-equipped car, perhaps while you have the hub off for an overhaul it'd be a good idea to polish up the contact surface on the hub to help seal life.

FRONT AXLE WEAR: The inner races of the inner front wheel bearings tend to turn on the axles. As a result, they eventually wear a groove in the axle, on the bottom where the load is. This allows the wheel to wobble even when the bearings are adjusted properly, and your Jag starts driving like a Pontiac.

To check for problems, remove the front hubs and check the stub axles for a wear groove. Run your fingernail along the bottom of the axle from the upright outward. If your fingernail catches at all, the axle should be replaced.

According to Richard Griffiths, the inner race is *supposed* to rotate on the axle. This distributes the wear evenly around the inner race rather than concentrating it on the bottom. "With proper lubrication, heat treat and tolerances etc., the effect of a "walking" inner race on the axle is a beautiful mirror-like burnished surface, not galling and wear as some have noted."

Well, there's little an owner can do about heat treat or tolerances, and on the XJ-S inner race rotation is clearly a problem -- and bearing wear is *not* a problem. So it makes sense to ensure that the inner races will *not* turn by using Loctite 640 or some similar high-strength bearing retaining substance. This may shorten the life of the bearing by some negligible amount according to some engineer's theories, but in the real world it will positively eliminate the wear on the stub axle. Use it on the inner race of the outer bearing, too, since it has been known to have the same problem. Adjust the front wheel bearings as described below.

FRONT WHEEL BEARING ADJUSTMENT: Section 60.25.13 of the ROM, Step #4, indicates that the front hub bearings should be adjusted to attain end float measurement of 0.002"-0.005" (0,05mm-0,15mm). However, Technical Service Bulletin 57-15 revised the end float spec to 0.001"-0.003".

If you don't happen to have the type of dial indicator needed to measure end float, this author recommends the following procedure: Tighten the retaining nut to perhaps 20 ft-lb while turning the hub to make sure everything is seated properly. Loosen the nut then spin it back on until it seats, normally a very distinct point; *continue to tighten* about 1/10 of a turn while turning the hub. Fit the lock and install the cotter pin.

This may seem tight, and in fact may be tighter than the official Jaguar procedure (measuring end play) would result in. Any bearing expert will tell you that proper operation of a roller bearing requires some preload. When tight, the weight of the car is distributed among the rollers. When loose, the slop allows the load to be taken by only one or two rollers at a time, and the unloaded rollers may slide rather than roll.

Another method that has been suggested is to tighten the nut to 25 ft-lb while rotating the hub and then back the nut off one flat.

If you're using Loctite on the inner races as suggested above, you might opt to apply the Loctite to the inboard race, assemble, tighten the nut to 25 ft-lb while rotating the hub and leave it there long enough for the Loctite to set. Then pull the nut and outboard inner race back out, apply Loctite there, and then do your final assembly and adjustment.

Note that having the bearings adjusted too loosely -- as well as having a grooved front axle, as described above -- would be detrimental to seal life. And the seals on the ABS-equipped cars may be marginal already, as mentioned above.

FRONT WHEEL BEARING CAPS: Apparently, some bearing caps are a total seal, while others have a small hole in the middle. It is suggested that if you have wheels that don't keep dirt out of this area, put a small piece of aluminum tape over the hole. Or, just pry it off and take it down to the local auto parts store and buy a generic replacement.

CHECKING OF BALL JOINTS AND TIE ROD ENDS: To test joints such as these, it is helpful to find a convenient way to “shake” them, or to move them in such a way that will cause them to slop one way and then the other. In the case of tie rod ends, this is easily done by moving the steering wheel back and forth just a little. With ball joints, if the front tire shaking described under FRONT SUSPENSION CHECK on page 335 caused a “clunk”, that same motion will work for this test.

This test requires two people. Place a single finger on the joint in question in such a way that one side of the finger is against the hardware on one side of the joint, and the other side of the finger is against the other side. While holding this position (may be difficult, since the car should be sitting on its wheels) another person should provide the shaking motion. If the joint is OK, no motion can be felt between the two parts. If the joint is loose, a human finger will easily detect the slop. Typically, any slop at all is unacceptable, the joint should be replaced.

With either ball joints or tie rod ends, though, the more common indication that the joint needs replacement is that the protective boot is torn open. On the joints on most cars, the boot is not replaceable, and the joint will last as long as the boot -- so when the boot goes is when the joint gets replaced. This is true of the Jaguar tie rod ends as well, but not necessarily the ball joints; since they have replaceable boots, it's possible to keep replacing the boots until the joint itself wears out.

ANTI-SEIZE COMPOUND: See description on page 28. This note is to point out that many suspension components involve tapered fits, such as the ball joints and the front axle in the hub carrier. It is suggested that anti-seize compound be used on the tapers themselves as well as the threaded nuts. It does no harm, and can make the assembly much easier to get apart in the future. In tapered fit applications, care should be taken to ensure the entire fitting is thinly coated, since the anti-seize compound will not be spread during assembly as it is on threads.

BALL JOINT GAITERS: The gaiter used on the original Jaguar ball joints is a Rube Goldberg assembly in itself, and the parts are available separately. The gaiter itself (C43216) is a clear flexible plastic item, with a steel ring molded into it to make the small opening fit snugly around the ball shaft. The gaiter fits into a plastic collar (C22970) which the Haynes manual calls an “insert”, and a rubber ring (C22969 -- looks like a skinny O-ring) fits into a groove on the gaiter to hold it snugly into this plastic collar. The plastic collar snaps onto the ball joint itself. If you are replacing the gaiter and don't have a rubber ring, you can simply tie the gaiter to the plastic collar with some wire. The same gaiter assembly is used on both upper and lower ball joints.

Note that the plastic collar only goes on one way. There is a barely-perceptible ridge around the ID on one side, and that side must be installed toward the ball joint. The ridge snaps into a groove on the ball joint, leaving the collar situated such that it can be rotated on the groove. If you try to install it upside down, you will have to jam it hard against the housing and you may still not manage to get it to snap into place correctly.

In the Haynes manual, Chapter 11, Section 10, steps 2 and 3 tell you to remove the retaining ring, gaiter, and collar separately. You may be able to remove these three items together as one part -- or as a handful of chunks, as is typical. However, during reassembly it may be necessary to install them separately because the collar can be a bit of a challenge to get snapped onto the ball joint.

This author's experience is that this transparent gaiter has a life expectancy of less than five years. The clear plastic turns dark brown, then rots and falls out in crumbs. As with any grease-filled assembly protected by a boot, once the gaiter rips open and sand and water get in, the ball joint itself is quickly ruined. Since the gaiters are available separately, you can make the ball joints last almost indefinitely by replacing the gaiters *before* the old ones get rotten and rip open.

The gaiter provided in the QH lower ball joint rebuild kit (see below) is different than the original. It is a solid black rubber item with no metal reinforcement. A metal clip is provided in the kit to be used in place of the rubber ring on the large opening. The QH kit does *not* include a new plastic collar, which leads to a question: are you supposed to reuse the original plastic collar, or are you supposed to use this gaiter without the collar? It really doesn't work well *either*.

way. Here's what seems to work best: using a small pair of snips, carefully trim the flange on the side of the collar that ends up inside the gaitor down to about half its original breadth. Now the black rubber gaiter will fit it properly.

The black gaiters in the QH kits are also British, and don't seem to last much longer than the clear plastic Jaguar originals. They dry rot and start cracking at the seams. In addition, they are rather poorly designed; they are a simple dome shape with a hole in the top, and this shape doesn't really flex properly when the ball joint is swivelled to one or the other extreme position. The pulling to one side tends to pull the small hole around the tapered post hard enough to stretch it open and allow dirt to get in. Fortunately, this gaiter works well enough in the nearly centered positions where the joint spends 99% of its time.

Chuck Sparks suggests that a thin layer of red Girling "rubber grease" (see the discussion on brake caliper assembly on page 398) be applied to the inside surface of the gaiters prior to assembly. The idea is that this coating might help keep the grease from your grease gun from contacting the rubber the gaiter is made of. Since the two may not be compatible, keeping them apart may make the gaiter last longer. Well, maybe a shaky theory, but applying the red grease couldn't hurt.

There are better solutions to the gaiter situation here. One would be to find a non-British gaitor from some other application that fits. Mike McLaughlin says, "Once again I'm reminded of a product out of marine catalogs... There are available several sizes of black, flexible bellows that may be far superior to the automotive product. They are used to route the marine steering arm, throttle and gearshift cable ass'ys through bulkheads to the outboard engine and in some applications, house a u-joint and/or exhaust gasses to the outdrive (volvo, mercruiser). A poke about in a marine supply house may well reveal the ideal product..."

If you can't find a good gaitor that fits, you can fabricate your own gaiters from shoe leather or inner tubes or something. It's really not difficult, and it's especially not difficult to do better than the OEM items.

The best solution, though, is to replace the ball joints in entirety with the XJ40 items as described on page 341.

LOWER BALL JOINT ACCESS: The overhaul procedure in 60.15.13 says to disconnect the brake line and the tie rod end. Both are unnecessary unless you really prefer to work on the bench. Obviously you need to be careful not to stress the brake line.

The Haynes manual, Chapter 11, Section 10, Step 1 tells you to remove the stub axle carrier as described in Section 8. Section 8 tells you to remove the brake caliper and the hub/disk assembly, both of which are unnecessary for ball joint work. It also suggests separating the upper ball joint from the stub axle carrier, but if you're not working on that ball joint at this time it would obviously be much easier to separate it from the A-arm by removing the two bolts and keeping track of the alignment shims.

You can pretty much ignore the directions in the repair manuals and simply follow the following steps. Obviously, start by putting the front of the car on jack stands and removing the road wheel. The steering must be turned back and forth a couple of times, so it's really easier (and safer) to lift the entire front end of the car and place on stands rather than trying to lift just one corner. Note that the car will probably get lifted off those jack stands at various points in this process and set back down on them.

Once the lower ball joint is apart, there will be nothing to prevent the road spring from snapping the lower swingarm downward around its inner mount bushings. To keep the car's weight on that spring, support the suspension with a jack under the outer corner of the spring pan on the lower A-arm. Stay away from the lower ball joint.

Before disconnecting the upper ball joint, you need to make sure there's no load on it. This is important when taking it apart, but it's even more important when reassembling; it's really difficult to insert the bolts in the holes while lifting the car with one hand! If the rubber bumpers in the upper A-arm are on their stops, the road spring may be pulling the A-arms down and applying tension to the upper ball joint. Jack the lower A-arm up until the spring is compressed far enough that the rubber bumpers on the upper A-arm are not touching their stops. This may require jacking a pretty long ways, nearly standing the car on its opposite corner. Dale Knaus says, "The way I change the ball joints is to start by blocking the opposite rear corner of the car at the jack point. By blocking under the opposite rear, the jack will lift more

of the car and compress the spring more.” Others suggest adding weight to the corner of the car you’re working on, such as placing bags of feed or cement on the fender.

Once you know the upper ball joint is unloaded, separate the hub carrier from the upper A-arm. You can remove the nut and use a ball joint separator to pop the tapered pin loose from the hub carrier, but if you’re not planning on servicing that upper ball joint it’s easier to simply remove the two bolts holding the joint to the A-arm (make sure to note where the alignment shims go). You’ll need to turn the steering a bit towards that side to get the outboard bolt out.

Tilt the top end of the hub carrier outward to get access to the nut on the lower joint ball pin. Loosen the nut a few turns but don’t remove it. You need to loosen the nut far enough to get past the nyloc insert so the nut turns freely; once the tapered pin is popped loose it’s free to spin, which may make it difficult to remove the nut if it won’t spin easily on the threads.

Use of a fork-type ball joint separator on the lower joint will not only destroy the old gaiter, but the plastic ring and the upper ball seat as well. The fork type separator doesn’t work very well here anyway; better to have the screw-type separator on hand. Even better, usually you can get it apart without using any separator tool; jam something between the inner corner of the hub carrier (right next to the lower ball joint) and the A-arm, and forcefully rock the upper end of the hub carrier outward. Once it pops loose, the hub carrier will fall, and if it still has the brake assembly on it it’s quite heavy; that’s why you loosened that nut but didn’t remove it!

If you’re careful, you can accomplish all this without disconnecting the tie rod or the brake line; it might help to turn the steering wheel one way or the other. Of course, this implies you’re willing to rebuild the ball joint right there. If you prefer to carry the hub carrier to the bench, obviously you’ll need to disconnect the tie rod and brake line and bleed the brakes once you’ve reassembled everything.

If you separated the upper end by unbolting the ball joint, use one of the upper ball joint bolts to connect the *inner* end of the upper ball joint to the *outer* holes in the upper A-arm. This provides a convenient support for the hub carrier once the lower ball joint is apart. If you popped the pin loose at the upper ball joint, you can slip it back together and install the nut loosely, or use more conventional means such as hanging the hub carrier with wire. Once the hub carrier is supported, you can remove the nut on the lower ball pin entirely and proceed to rebuild the ball joint.

LOWER BALL JOINT REBUILDING: The original lower ball joint is a rebuildable assembly, with parts books showing part numbers for the individual components; apparently there is no single part number for the overall assembly. Before the advent of the XJ40, Jaguar offered a rebuild kit for the lower ball joint, part number 12803. That’s not a misprint; for some reason, there is no C or other letters before the number.

The lower ball joint from the XJ40 (the 1988-on XJ6) is a one-piece throwaway item (see below) that will replace the entire ball joint assembly on the XJ-S, and costs less than the Jaguar rebuild kit. Hence, Jaguar reportedly no longer makes such a kit, and authorized repair shops merely replace the joint with the XJ40 item.

However, an aftermarket parts company, Quinton Hazell, makes a rebuild kit for the original rebuildable ball joint; the part number is QSJ221RK or something like that. QH’s prices for this kit are much more reasonable than the Jaguar parts prices ever were, and it is cheaper to use this kit to rebuild your ball joint than to install the new XJ40 unit. It’s still a better idea to go with the XJ40 joint, though, because it comes with a better gaiter.

The original, rebuildable lower ball joint is assembled with shims to provide a properly snug fit between the ball and the socket. It should be noted that these shims are intended to provide a proper fit at assembly, *not* for removing the slop from a worn joint. If a joint develops slop, it should be rebuilt with new parts or replaced entirely, not merely readjusted.

The ROM, Section 60.15.04, describes re-shimming the lower ball joint without disconnecting it from the stub axle carrier, but frankly this is questionable; you will have a difficult time determining the correct snugness of that ball joint without being able to manipulate the ball pin by hand. Besides, you probably need to replace the gaiter while you’re in there anyway, so use the overhaul procedure in 60.15.13 instead.

When rebuilding the lower ball joint, don't lose the shims that come out. Although the QH kit includes shims, there may not be enough to provide all new shims.

Bernard Embden suggests: "I found that, under pressure, grease was spitting out between the shim and one lower ball cup. Putting a straight edge against the ball joint surface at the knuckle revealed an uneven surface which had to be trued up before completing the rebuild. I believe that these lower ball joints are subject to a lot of abuse as the car runs over debris, etc. Checking with a straight edge should be part of any rebuild."

It is recommended that you trial-assemble the ball joint dry (no grease) in order to establish the correct shimming. It's amazing how grease can make a sloppy joint feel tight.

Thoroughly grease the ball and socket parts prior to final assembly. Although the joint has a zerk fitting, its use is no substitute for proper greasing at assembly.

LOWER BALL JOINT SUBSTITUTION: As mentioned above, the lower ball joint from the XJ40, part number CAC9937, will replace the original ball joint on the XJ-S perfectly. This ball joint is made by Lemförder in Germany; the Lemförder part number is 030 260 004 834. It has no grease fitting, it's not rebuildable and the gaiter is not considered replaceable (not available separately) -- but it's still the better choice in ball joints! The gaiter built onto the Lemförder ball joint is an excellent design, shaped like a bellows to allow the joint to move back and forth without stressing the rubber or pulling open a gap. It also has metal spring rings at both ends to hold it snugly to the joint.

So, your choice seems to be: replace the gaiters on the original ball joints every five years, or replace the entire joint with the XJ40 part and forget about it for some time -- perhaps ten years anyway.

The XJ40 lower ball joint also provides a bit more clearance for aftermarket wheels.

When installing the XJ40 ball joint, the shims from the original joint are not used. They were only needed to provide internal clearance in the rebuildable joint.

When replacing the rebuildable ball joint with the XJ40 ball joint, note that the upper ball seat of the original ball joint must be removed. It's a metal ring, and it actually looks like it could be an integral part of the hub carrier, but it's not; it's pressed in from below. Charlie Marino suggests using the old ball pin as a tool for removing it; "I placed the ball end of the ballpin on the upper seat from the top and hit downward into the seat with a hammer. About 4 medium hits drove the seat out through the bottom of the stub axle carrier."

UPPER BALL JOINT REPLACEMENT: The official repair manual calls for "Steering Joint Taper Separator JD.24", but we don't need no steenkng separator! Put the car on jackstands and remove the wheel. Put a jack and block of wood under the lower ball joint and jack it enough that the rubber bumpers on the upper A-arm are not touching the subframe. Loosen the nut on the upper ball post several turns, but do *not* remove it. Lower the jack so that the rubber bumpers sit on the stops and the full spring force is applied to separating the joint. If you're lucky and the previous mechanic used anti-seize compound on the taper, you'll hear a pop as it comes loose. If more difficult, a little judicious tapping on the side of the hub carrier may help.

Make sure to note where the shims are located between the arms and the ball joint. Even if you plan to have the car aligned, at least it will drive better on the way to the shop. The shims are supposed to lift right out, but they weren't made quite right; they tend to catch the bolt on the inner corner on the hook-shaped end. If this corner is filed slightly, reassembly will be easier.

UPPER BALL JOINT SUBSTITUTION: On the original XJ-S upper ball joint C23024, the gaiter C43216, plastic ring C22970 and rubber ring C22969 are exactly the same parts as those on the lower joint -- see the discussion on page 338.

This means the gaiter is replaceable as it is on the lower joint, but it also means it will need replacing on a regular basis. Other than gaiter replacement, this ball joint is not rebuildable like the lower joint.

As with the lower ball joint, the XJ40 upper ball joint CAC9938 (made by Lemförder) is a better choice; in fact, many parts houses may automatically ship you this part when you order an upper ball joint. The gaiter on the XJ40 upper ball joint is just like the one on the XJ40 lower ball joint: not replaceable, but a much better design than the XJ-S gaiter. Like the XJ40 lower ball joint, the XJ40 upper ball joint has no grease fitting. The Lemförder part number is 027 260 005 834.

UPPER BALL JOINT -- SLOPPY MOUNTING: Walt Osborne of Vintage Jag Works (page 646) points out that the original upper ball joint on XJ's was mounted with a pair of long 3/8" bolts while the XJ40 upper ball joint is mounted with long 10mm bolts. As a result, when the XJ40 upper ball joint is installed in an earlier car using the original bolts, there is about 0.020" slop in where it will get positioned as the bolts are tightened down.

This is not exactly the world's most pressing problem. Wherever the ball joint is when it is snugged up, having the car aligned will deal with it. There are only two situations where this slop can have a detrimental effect: 1) If you hit a pothole so hard as to slam the ball joint against one limit of this slop or the other -- move it despite how tight the bolts are holding it still -- it could affect your camber. 2) If you work on your front suspension for some reason and unbolt the ball joint and reinstall it, it may not end up in exactly the same place. In either of these cases, we're talking about a worst-case scenario that the ball joint will relocate by 0.020" -- barely noticeable.

However, Osborne also points out that fixing this slop is pretty easy. Merely drill out the holes in the swingarms to 10mm, file the openings in the four alignment shims per side a hair bigger, and install the XJ40 ball joints with 10mm bolts.

First challenge: finding a 10mm drill bit. In the US, good luck! Fortunately, you can forget it. Mal Stewart reported, and this author has confirmed, that 10mm bolts will fit in the holes in the swingarms without drilling. They're snug -- in a couple of places, I had to polish the inside of a hole a bit with sandpaper -- but you certainly won't need to use a 10mm drill bit. I did opt to chamfer the edge of the hole under the bolt head to make sure the head seated properly.

Second challenge: Finding suitable bolts. Of course, you could try getting the OEM bolts for an XJ40 from Jaguar. Osborne suggests using generic 10mm bolts of the correct length with the head of the outboard bolt rounded off for clearance as the original bolt was.

The two bolts are different lengths. 100mm is just about perfect for the inboard bolt; I found that Grainger (page 661) has both 100mm and 105mm bolts, with the 105mm bolts being significantly cheaper! They work fine, the extra length is no problem.

You'll probably have to buy 80mm bolts for the outer bolts, but 80mm is too long; the correct length for the outboard bolt is about 68mm. You might get away leaving the bolt 80mm long, but it might catch on the brake disc dust shield near full steering lock, so just to be safe cut the extra off.

You will probably want Grade 8 bolts for this job -- but metric bolts are not rated the same way as SAE bolts. What you want is Class 10.9, which is essentially equivalent to Grade 8. Don't get confused by metric Class 8.8, that's essentially equivalent to Grade 5.

I had difficulty finding 10mm nuts in Class 10.9, so I used Class 8.8 nuts. The strength of the nut is nowhere near as important as the strength of the bolt in this application. The Class 8.8 nuts are available in many places; I found nyloc nuts at Home Depot.

You don't care if the bolts are regular, fine, or extra fine thread as long as the nuts fit the bolts.

I had to file the alignment shims a bit to get them to fall into place properly. The slots are big enough to fit the 10mm bolts, but it won't fit both at the same time! The solution was to file the slot on the inboard end of each shim a bit deeper, so it gets a little closer to the other slot. It took perhaps 30 seconds with a round file.

Both the bolt heads and the nuts I used fit 17mm wrenches. That's considerably larger than the 9/16" OEM bolts and nuts, and raises clearance concerns with the outer bolt. After installation and before reinstalling the wheel, have an assistant turn the steering lock-to-lock while you watch the hub carrier rotate around the upper ball joint. The clearance conditions vary somewhat with suspension extension, so place a floor jack under the lower ball joint, lift it up a bit, and

have the assistant turn it lock-to-lock again. Also note that the clearance varies somewhat with the locations of the alignment shims, so if you have the car aligned you might want to check it again.

Here's an interesting option: replace *only* the inboard bolt on each ball joint with the 10mm bolt, leaving the original 3/8" bolt in the outboard location. The single 10mm bolt will eliminate all the slop in the horizontal direction and half the slop in the vertical direction -- but the horizontal direction is the only direction that affects alignment. This will save you having to buy 80mm bolts, shorten them and round the head, and worry about clearance.

Bob Higgs has another method: "You can do as I did, that is to take a strip of .010" stainless steel shim, wrap it around the 3/8" bolt making a tube shape and inserting this in the upper ball joint mounting hole. You can then use the old 3/8" bolts, no drilling no filing no rounding off required."

Sounds simple enough -- but Higgs doesn't tell you where to obtain .010" stainless steel shim stock. You can buy it at Grainger or MSC or similar industrial supply outfits. It ain't cheap -- but if you're looking to save money you could get the non-stainless stuff. FYI, the ball joints are a bit more than 1-1/8" wide, so that's how long your tubular shims will need to be.

Higgs also fails to mention exactly how you "wrap it around the 3/8" bolt making a tube shape". This task is definitely easier said than done. Maybe there's a special tool available somewhere, but if you're working with normal hand tools you'll probably end up wishing you had just sprung for the 10mm bolts.

One option there would be to cut a strip of stainless steel shim stock about 1/4" wide and several inches long and wrap it spirally to form the shim you need. Since it's just taking up space, the spiral form will work just as well.

Another idea would be to get some thin-walled metal tubing, such as brass tubing from a hobby shop, with an ID of 3/8". Since the OD of such tubing is usually some even amount larger -- the OD of the brass tubing from a hobby shop will be 7/16" even -- you can then just use a 7/16" drill bit to ream out the hole in the XJ40 ball joint. Slide the tubing into the hole and mount the ball joints with the original bolts.

FRONT SWINGARM BUSHING CHECKING: The front swingarm bushings may be checked using similar methods as the ball joints, except that the bushings include some rubber so there will be some slight motion even in a perfectly good joint. Usually, the best indication that a swingarm bushing is bad is that some of the rubber is hanging out of it.

LOWER SWINGARM BUSHING REPLACEMENT: Craig Sawyers provides some insight into removal of the lower pivot shafts on this elite precision automobile: "Be prepared for a very sweaty hour or two. Get yourself a four pound lump hammer and batter the living daylights out of it. Be of strong heart and right arm - the SOB's will come out. They rust into the metal sleeve in the bushes. Once it starts to move, you will need a long drift to continue driving it through the hole in the suspension (I used a loooong socket extension I have)."

Of course, the bolt will be mushroomed at the end after the abuse you offer it, and you'll need two new ones - they are about £15 each."

"After I spent a cheerful day exercising my arm, and patience, removing mine, I happened to be at the Jag dealer. I was collecting some parts, and chatting to Colin (the workshop head). In the background there was this fearful BANG, BANG, BANG then a rest pause, then BANG, BANG..."

"Good grief, Colin - what on earth are you guys up to?"

"Front lower wishbone shafts - sometimes takes hours of that treatment before they move. Sometimes we even have to take it in shifts as each of us tires...."

Uhhhhh, do I even have to suggest that anti-seize compound would be a good idea when reassembling?

SPRING REMOVAL: If you're working on the lower swingarm bushings, trying to adjust the ride height, or any of several other operations, you will need to remove the front road spring -- safely. Needless to say, it is a very strong

spring, and care must be taken to either gradually release the compression on it or to hold it securely compressed so that it cannot break loose.

Ideally, you should use a spring compressor that fits this assembly, but that may be difficult to find -- the front spring mounts on the XJ-S seem designed to confound most standard spring compressors. The official Jaguar tool is a threaded device that goes up the middle, but is reportedly so large and bulky that it requires the car be on a lift, not merely on jackstands.

Carlos Artal says, "Get a thick, long threaded rod (size unimportant, but as thick as you can). Get 6 large washers that will fit on the rod, and are at least 5cm diameter. Finally; get some nuts for the rod (if the rod is as thick as mine, the nuts were size 16 metric). I got 4, and you'll see why.

"On the upper part of the x-member, just put some rag under the washers (3) and insert the rod vertically, then insert 2 nuts from the top, so they rest on the washers.

"From the underside, use 2 little blocks of wood, which fit into the "circular pan" the shock base has, and then put on the other 3 washers, and 2 nuts.

"To disassemble, just tighten the lower nuts until you can undo the bolts in the pan." Then back the nuts down to lower the pan until the spring is completely free. "Just one warning!; when you think the spring is completely sprung, keep on going, these puppies are big and dangerous (my first one jumped 2 meters!)

"To assemble, with the same setting as above, the problem is that the spring will make the pan wander from side to side. I used 3 thin rods as "guides" for the entire pan." Others use long bolts or threaded rod screwed into the holes in the swingarm as guides, but note that having anything threaded tends to make the pan hang up on it; it's better to have something smooth.

Dennis Kindig used a similar procedure, and offers these variations: "You may want to fiddle with a piece of bar stock cut at the proper angle and placed between the washers on the rod and the spring pan to help align the pan with the wishbone. There is an angled section of cylindrical bar stock on the "official" tool (\$420 US, by the way) that accomplishes that. I also found that wedging the rod (I used a socket stuffed in there) so that it stayed at the *outer* end of the oval hole in the spring pan gave me more leverage (it pulls to the inside under tension)."

Joe Bialy describes a totally different spring removal method: "Use three pieces of threaded rod about a foot long each. 3/8-24 fine thread. Remove three pan bolts, install the rod with nuts to hold it all together. Remove the other 3 bolts. Slowly and uniformly back out the nuts on the three rods. The pan will back out with them. Reverse the process to install." The problem, of course, is finding threaded rod in fine thread; Bialy says McMaster-Carr (page 661) carries it.

Other suggestions include tying the spring in the loaded position while it's sitting on its wheels and *then* jacking it up -- please be very careful tying it, and make good and sure whatever you use is strong enough for the job. And keep your body parts outta the way anyway, just in case it breaks loose.

Michael McLaughlin says, "Herein is the no brain / no pain / no danger / no unusual tools (requires two jacks and a nut splitter) front spring liberation. Find the complete story at:

<http://www.jag-lovers.org/lists/archives/xj-s/199802/msg00542.html>

"Chock rear wheels and jack car (not wheel). Turn steering to allow access (to left for right wheel). Remove front road wheel. Insert "low" jack under spring pan; raise jack under spring pan and lower car jack until car weight is borne entirely by road spring (and 3 other wheels!). With nut splitter crack in two places and remove upper balljoint retainer nut (not the nuts on the two bolts holding the balljoint). Raise car jack and lower spring jack slightly. Secure axle stub upright to vehicle w/ shock cord or rope to protect brake line. Continue to raise car / lower spring until all is clear. Spring can now be removed, noting position of spring spacers." Obviously, you don't really need to split that ball joint nut, you can simply unscrew it. I don't see why removing the two bolts holding the ball joint won't work just as well.

Jan Wikström says, "I have removed and installed front springs with the jack method, unscrewing nothing at all except the spring pan retaining nuts. The only difficulty can be compressing the spring enough when it goes in with spacers; a couple of large volunteers (or four sacks of whatever) on the front wing will do nicely; the alternative is to use temporary

4" long studs. This also helps guiding the spring pan on to the studs, which can otherwise be tricky as the spring must be bent fairly severely.

"I stress that there is no risk at all of the spring going sproing; it is completely restrained by the spring tower and the lower A-arm. Just make sure the jack is solidly based for the first part of the compression."

RUSTY FRONT SUBFRAME: Craig Sawyers says, "The front sub-frame has a rust pocket at the top of the spring mount. If it rusts through, the spring breaks through, and the car rides low, lower, lower still as the rust progresses."

FRONT ANTI-ROLL BAR BUSHINGS: If you wish to replace the front anti-roll bar mounts with aftermarket units, there are a couple problems to note. First, the top (bottom? It's mounted upside down) of the arch of the stock bracket clears the subframe by only about $\frac{1}{4}$ ", and the subframe moves around a little on its soft rubber mounts so the $\frac{1}{4}$ " clearance is minimal to avoid banging. To be acceptable, the height of the arch of the bracket must be $1\frac{1}{2}$ " or less.

The second problem is that the bolt holes on the brackets are staggered, with the forward stud being located outward from the centerline of the car and the rearward stud being located inward. As a result, the stock brackets have two different part numbers; C30500 for the right side, and C30501 for the left.

The Addco (see page 663) catalog indicates their "D" series fits the front of the XJ-S, but these brackets definitely will *not* work. The bushings themselves *might* be usable with the stock brackets, but it will require some serious trimming on the bushings at least. Addco's catalog does not seem too reliable.

Just when things are looking difficult, however, a solution comes along. Addco offers a bushing and bracket set that will fit the front of the XJ-S *perfectly*. The brackets needed are their "S" series brackets, but that doesn't tell the whole story; their "S" series designation indicates only that the brackets have offset holes, but they have many different types of "S" series brackets to fit different cars. The set that fits the XJ-S perfectly is the set that was designed for the 1967-68 Chevrolet Impala, although (hopefully) you can now merely ask for the ones that fit a Jaguar XJ-S and get the correct items. The bushings themselves are their "W" series bushings.

Addco bushings come with no split in them, as though you are supposed to feed them on from the end of the bar. This is really difficult, as the urethane is stiff indeed and the end of the bar has a formed eye. The bend isn't easy to get around either. It is a simple matter, however, to cut a split into one side of the bushing with a razor knife so you can just spread it open and pop it into place around the bar. Addco includes a small package of special grease with each set of bushings, and applying a little of this grease to the razor knife makes cutting even easier. Since the loads on the front bushings are vertical, the ideal place to make the split is on one side of the bushing. Use of a saw is not recommended, since you don't want to *remove* any material, you just want to cut it. The bracket will hold the split bushing securely -- in fact, considerably more securely than the original Jaguar split rubber bushing was held.

If polyurethane still isn't stiff enough for you, you can fab up "mounting blocks" that are basically two halves made of aluminum with a hole through the middle the size of the bar.

POLYURETHANE ANTI-ROLL BAR END LINK BUSHINGS -- FRONT: J. C. Whitney, Addco, and many other aftermarket sources also offer polyurethane end link bushings, again as a stiffer and more durable replacement for original rubber items. These end link bushings are applicable to the front of the XJ-S, replacing C10996; it would be necessary to cut about $1\frac{1}{4}$ " off the back end of the bushing to make it the correct length. Addco also offers entire end link assemblies, with the $3\frac{3}{4}$ " size being the correct length to replace the parts (C10996, C46186, C33682, and C11045) on the front of the XJ-S.

Randy Wilson reports problems with using urethane end link bushings, however, the relative angles between the bar and the end link and between the end link and the control arm vary considerably with suspension travel, and the rigidity of urethane end link bushings apparently results in the end link itself being bent back and forth, resulting in it breaking very shortly. Wilson has broken both the original Jag links and the aftermarket links by using urethane bushings. He claims some success with modifying the urethane bushings by machining them to allow more room for flexing, but the jury is

still out on long-term results. Perhaps sticking with rubber items would be wise here. Generic rubber end link bushings are available at most auto parts stores; again, it is necessary to cut part of the generic bushing off with a razor knife to make it the correct length.

Both J. C. Whitney and Addco offer adjustable end links, which have a spring within the assembly that can be adjusted to absorb some of the motion and soften the effects of a stiff bar. The spring may also allow the urethane bushings to back away enough to avoid the end link failure problems described above.

Steering

SHIMS: The steering lever attaches to the hub carrier with two bolts. At the rear (longer) bolt, there is a shim (it looks like a thin washer) that goes between the steering lever and the brake caliper. *Don't lose it!* Omitting this shim at reassembly screws up your alignment and distorts the steering lever. See the further discussion on these shims on page 406.

STEERING COLUMN INSTALLATION: If you have lowered your steering column, Rob Reilly sends this tip for reinstallation: "When putting back the steering column use a little rubber cement to hold all the washers in place. Leave the bolts loose and pull the column back about 1/4" before you tighten them; if you don't, you will get binding in the lower column universal joint and bumpy steering."

STEERING COLUMN: The Jaguar Parts Catalogue lists the "upper steering column" as a safety item; it's designed to collapse in a collision. Apparently you're not supposed to fiddle with it, just replace it as a unit. Richard Dowling says there is a plastic section in here designed to absorb energy in a crash: "The plastic shaft appears to be moulded in situ since it has spigots of plastic sticking out of it which lock it in position since they engage in small holes in the tube. These are effectively shear pins, since a moderate force on the plastic shaft will push it up the tube."

He found his to have been already sheared, he expects as a result of work he was doing in the area. "It was a year ago so I do not recall exact details, but the jist of it was that at some stage I had probably sheared off the pins trying to get the universal joint splines to line up at the bottom end of the column. That can be hard work in a very confined space, but I am no Tarzan hence it is obvious that the shear pins are not real strong.

"Most of the mechanism is hidden inside the outer case of the column assembly. Design details are nonexistent in the ROM, and fig. 11.34 in my Haynes manual is the best illustration. You can figure out how to pull the complete assembly apart, no rocket science, but it is fiddly. If the shear pins are shot the column is still useable, since friction tends to hold the plastic shaft in position. It will not ride up the column, since the universal joint and bearing at the bottom prevent this. However, when my steering wheel became sloppy (not dangerously, just a little disconcerting) I found the bottom bearing had dropped out of the column outer casing since the plastic shaft had migrated downwards. You can see in Haynes' fig 11.34 a plastic bush just above the splines. The bush is a push fit in the bottom end of the column outer case, but it can drop out if the shear pins let go. This appears to be the only problem from failed shear pins. However, it needs a quick fix because if it drops too far it may bind up the 2 universal joints in the lower part of the steering.

"The fix is to take a wormdrive clip that will clamp on the lip of the bush which is the same OD as the column case. This way you can almost clamp the lip to the case, but to make it better buy a flimsy clip and try and bend the edge of the worm drive clip down so it acts as a shoulder to go over the lip. Maybe with a strong clip you could put a few saw cuts around one edge and bend it down easier to make a shoulder. This is an improvisation with column still in car. If the column is out of the car some other improvisation will be even more secure." Another idea might be to use the worm screw clamp to hold another strip of metal securely to the outer diameter of the housing and bend the edges of that strip down over the lip of the bushing to hold it in place. All of this can probably be done with the column in place, no need to take it out.

"One tedious way to fix this may be to strip the column assembly down again and put a few small screws or roll pins through the tube holes to hold the plastic inner shaft, sufficient to hold the plastic in place while remembering they have to shear in a crash."

STEERING RACK LUBRICATION: According to the John's Cars catalog, using the zerk fitting on the steering rack does more harm than good, and they remove them during their rebuilds. Others have reported no problems, but obviously one would be well advised not to get carried away with the grease gun. Stefan Schulz reports: "Perhaps even Jaguar realized that eventually, mine (CBC5708) doesn't have that fitting any more."

STEERING RACK LOWERING: Contrary to the instructions in the manual, the steering rack can be lowered far enough to work on the mount bushings without disconnecting either the hydraulic lines, the tie rods or the steering column. The only difficult part is access to both ends of the three mounting bolts.

The steering rack is mounted on slotted holes. You'll have to trust me on this, because they're not slotted far and the entire slot can be hidden behind the flat washers under the bolt heads. The intent is to be able to position the rack properly with respect to the lower A-arm mounts, and there is a special Jaguar tool used to check for proper position when reinstalling. Presuming that you don't happen to have this tool laying around the house, it is suggested that you carefully mark the position of the mounting bolts within the slotted holes prior to unbolting the rack. When reinstalling, simply put it back where it was.

Any time the steering rack is lowered for inspection or repair, it is wise to disconnect the bolts mounting the power steering cooler to the subframe. The pipes on this unit are very fragile, the hoses are short and often stiffened by age and heat, and a new cooler is of course more than \$100. It can generally be repaired by any reputable radiator shop, however.

Chuck Sparks suggests that, while the rack is down, you spread the bosses on the subframe a bit to ease reinstallation. Install a piece of 5/16" threaded rod through a boss with a flat washer, two nuts, and another flat washer in the middle. Spin the nuts outward until they are holding the flat washers against the sides of the boss, then continue to turn them to force the sides apart.

STEERING RACK MOUNT BOSS CRACKING: John Smith suggests you check the front suspension subframe for cracking around the steering rack mount bosses while you have the rack lowered. "The kerbside (passenger side) mounting was cracked along the inside (closest to car centre) 2 inch vertical weld to the subframe and also the half inch horizontal weld on the subframe lip. In other words, the inner vertical of the mounting bracket was broken away from the subframe."

Smith's local Jag supplier, as well as others, suggest this cracking is due to the stiffer aftermarket rack mounts. It can't be directly due to the stiffer mounts, since they won't change the loads on that boss -- in fact, they probably reduce the impact stresses since the rack isn't banging around in there as it does with the OEM bushings. However, the cracks may be caused by installers using the bolts to pull the sides of the bosses in to meet the aftermarket bushings rather than space them properly with 5/16" fender washers. Or, since the car is actually driveable for a change, the driver may be driving it harder. Whatever, the possibility of cracked bosses is certainly no excuse for sticking with the crappy OEM bushings; have a welder repair and reinforce those bosses if necessary.

STEERING RACK MOUNT BUSHING REMOVAL: John's Cars offers a rental tool for removing the original bushings from the rack. It is extremely helpful, especially when working with the rack hanging under the car where a bench press won't help.

You can improvise such a tool using two 3/8" drive sockets (one with an OD a hair smaller than the bushing, one deep and large enough for the bushing to fit inside it), a long 5/16" bolt or piece of threaded rod with nuts and washers. It's

not always a snap, though; getting them to stay aligned and not cock sideways or jam can be a challenge. John Tompane says, "I was experiencing what others reported, the 'pusher' socket was getting out of line. My solution - I purchased two bronze thrust bearings at the hardware store for a couple of bucks. These look like top hats from the side, or a cylinder with a shoulder. This fit into the 1/2" socket and did two things, one it kept the 1/4" bolt in alignment. Second, the shoulder rests firmly on the back of the socket providing a solid base to torque the nut/bolt. Result = worked like a charm. Without the bearings I wasted hours trying to get the easy one out (passenger side) and quit for the night. After getting the bearings, all three came out in a snap."

Jim Warren went another route: "I used the two socket method. I ground the thrust edges of the pusher to remove any roundness. There is very little of the bushing outer sleeve to push on, and with the factory rounded edges, the socket can easily get cocked slightly and not push squarely."

Another possibility: You can cut through the rubber and remove the guts of the original bushings and then use 1/2" drive sockets with a 1/2" bolt! Or 3/8" drive sockets with a 3/8" bolt. Either should hold the tools together and aligned more securely than a 5/16" or 1/4" bolt through 3/8" drive sockets, and obviously you'll have less concerns about strength with the heavier bolts.

Not everyone has to work so hard, though. Tom Bennett says, "The two socket method worked splendidly for me - no tendency for the pusher socket to get cocked at all. I don't know if it helped, but after the initial tightening of the bolts/sockets, I gave the bolt head a firm smack with a hammer as a little encouragement to break whatever bond there might be. This is the kind of job that you expect to be a real problem. I pictured hours under there with hammers/chisels/drills/saws/etc. You can imagine my delight as I watched all 3 bushings slowly slide out one by one."

A method to avoid: Some people cut the rubber and center sleeve out, leaving only the outer sleeve, then insert a hacksaw and cut through the sleeve on one side; the sleeve can then be collapsed and removed easily. If done carefully enough, it appears to work fine, but a small nick on the aluminum boss on the rack can cause a stress crack later. Using a drill or other means to destroy the original bushing involves similar risks.

Another method to avoid: using a hammer. You're just asking for damage to that aluminum rack.

An obvious method to avoid: Heating the aluminum up to get the bushings loose. Unbelievable as it may seem, some people are willing to try this. The facts that the housing is aluminum which conducts heat *very* well, the seals inside are rubber, and a rebuild costs as much as a three-day ocean cruise for two apparently never occurs to them.

STEERING RACK MOUNT BUSHING INSTALLATION: Don't!!! The Jaguar steering rack mounts are *crap*, pure and simple. Do not install any such bushings, period.

STEERING RACK MOUNTS: Even if the original Jaguar steering rack mount bushings in your car are in fine shape, the steering response is awful. The stock mounts are very soft, which by itself is not necessarily bad. However, for some reason Jaguar chose to position the mounts parallel to the steering forces, so they are loaded axially (shear) rather than radially (compression). See **Figure 18**. There are bumpers (flat washers with a layer of rubber on one side) on either side of the mounts to limit the side-to-side motion of the rack. This design results in a nonlinear response: When you turn the wheel gently, the steering is somewhat unresponsive, since the mounts flex and absorb most of the steering motion. When you turn hard enough that the bumpers are contacted, the steering suddenly becomes much more responsive. The inconsistency of response makes it difficult to steer smoothly, especially when driving hard; the car seems indecisive about how much it wants to turn.

Besides providing lousy response when new, the OEM mounts are also known for a lack of durability, and of course when they come apart they come apart all at once. Ray Johnson says, "everything was fine and then the next thing I knew I was tacking a 4200# sailboat down the highway."

On the XJ-S discussion list on the Internet, this author mentioned the possibility that this inconsistent response might actually be dangerous, especially with drivers that *never* drive hard and therefore are taken by surprise in the first panic situation they encounter. Of course, the first panic situation may rip the mounts apart -- but do you really care exactly

why the mounts don't work right in the first panic situation? Jim Downes responded: "Many (too many) moons ago when I was a student, I worked part-time at a Jag/Rolls dealership in Ireland. Occasionally, a customer's Jag would be towed in after a very bad crash. Most customers complained of an apparent loss of directional control during (as Kirby correctly identifies) a 'panic' situation. In almost every case, the bushings were worn and behaved exactly as described above. Absolutely all of the senior mechanics there felt that the bushings were dangerous after a few months of use."

The solution is to replace the steering rack mount bushings with ones that are not merely stiffer but of a totally different design. This modification is so common that virtually every aftermarket business dealing in Jaguar stuff offers a kit. The John's Cars design (see page 668) subjects the elastomers to compression only, and eliminates the inconsistency in the steering response. They use polyurethane, making the mounts stiff but not totally rigid. The entire kit is about \$50, and well worth the money. A similar kit is the Mackay Sure Trak A1598U, available from BPI (see page 641). XK's unlimited (see page 647) offers a kit of slightly different design made of delrin, but the function is similar.

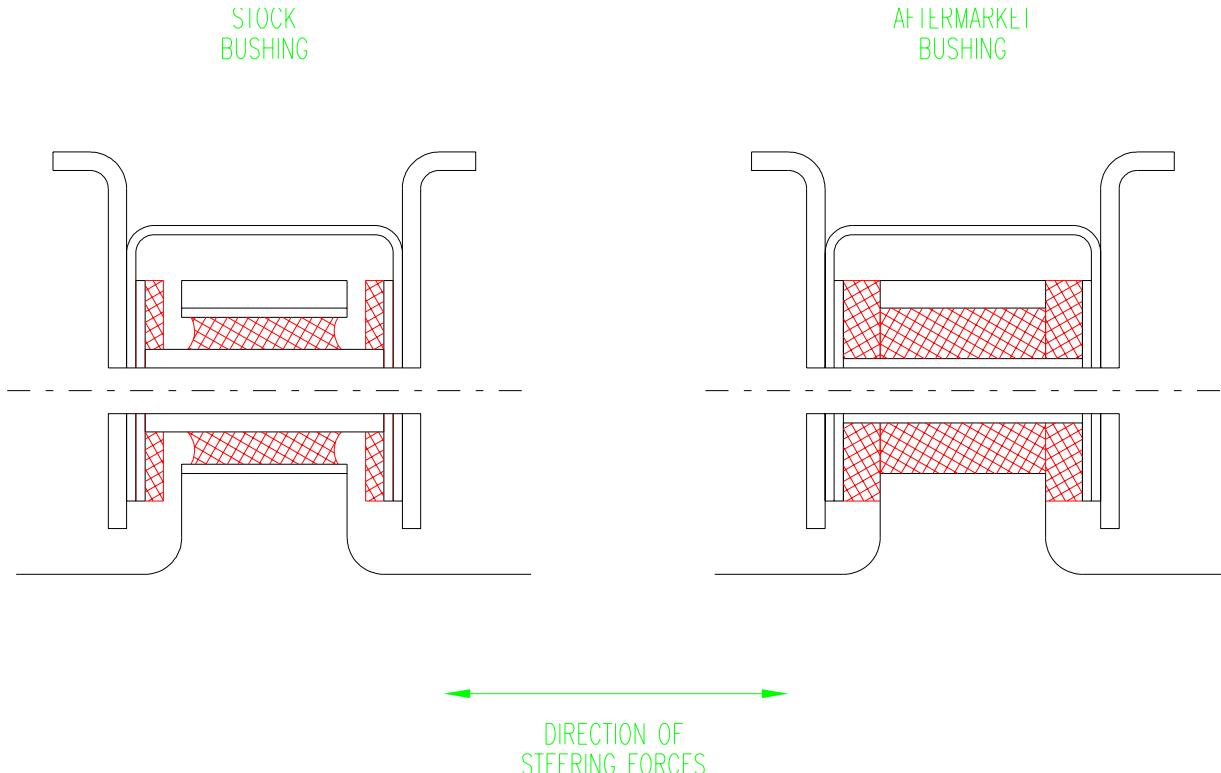


Figure 18 - Original vs. Aftermarket Steering Rack Mounts

Folks, please take this recommendation seriously: even if the stock bushings have not yet failed, even if they are *brand new*, replace them with aftermarket bushings as soon as possible. If you are determined to keep your car "original", please yank those original junk bushings out and carefully box them away for future concours events, and install some good mounts for any actual driving you may do. Downes concurs: "Regardless of perceived 'quality' of feel, when I move the wheel expecting a twenty degree turn, that's what I want, not fifteen or twenty five degrees depending on side-loads, braking loads, road camber or any of the other variables that can influence the 'mood' of the original bushings."

The stock assembly includes a sheet metal U-channel that fits around both bushing assemblies on the driver's side, holding the whole mess together as you offer it up to the car. When you lower the rack, this piece might stay up there; pull it out, it's helpful for installation. The aftermarket bushing set from John's Cars includes a new one of these pieces - very nice, since the old one might be a little mangled.

Because there has been some confusion due to inadequate instructions provided with these kits, one thing needs to be made very clear: when these aftermarket bushings are installed, they should fit snugly within the bosses on the subframe.

There should be no gaps or spaces whatsoever. If the boss is wide enough that the bushing assembly fits with space left over, some 5/16" fender washers should be installed to fill the gaps. The mounting bolts should be *tight*, compressing the boss (Slightly! That's why you need to add fender washers if necessary!) onto the ends of the metal tube within the bushing.

Jaguar itself offers a stiffer mount scheme in its "SportsPack", using one normal mount (CAC 1635) and two special ones (CBC 5928 or CBC 9107). While an improvement, this scheme still maintains the lousy shear-loaded design, and it is still a better idea to get the aftermarket kits instead; they are easier to install (no press fit required, since there is no shear loading) and a good bit cheaper.

The urethane (red) mounts don't last forever, however. Lee Opausky reports: "Installed 5 or 6 years and 40 M km ago, John's poli bushing failed in the last 3 weeks at a very rapid rate. The steering wheel yesterday went to a "full half turn/no change in direction" mode from somewhat loose steering 3 weeks ago. This part was very good to us for many years since it first replaced the "British rubber" and I have no probs with the quality of the part. What I find intriguing is the rapidity of the failure with practically no warning signs. 3 mos ago I had these guys out when the rack had to be lowered to install a new starter, and a visual did not reveal any signs of fatigue. Now they are literally mashed with only the outer rim in one piece - like a slice of orange peel."

"The poli bushings were of orange color and gave excellent service for 5 or 6 years. No oil or other chemical came into contact with these parts (clean car) and all 3 seem to have been affected at the same time to the same extent." Of course, one wouldn't expect just one or two to be affected; when the rack decided to move sideways, it must take out all three to do it.

Larue Boyce: "I installed John's Cars steering rack bushings in my '91 in January of 1998 at 98,368 miles. I replaced them with the black ones from Welch Jaguar in Dec of 2001 at 140,439 miles when I replaced the rack with a rebuilt from Coventry West. I think the bushings did a great job and were worn out after 42,000 miles along with the heat from the motor and Florida. The bushings had worn, discolored and the end pieces separated into several "O" s."

So far, durability seems to be an issue in urethane aftermarket mounts but not delrin (grey) mounts, and may be due to this being a poor environment for urethane. Jim Cantrell says, "The melting point is about 350°F and the maximum recommended service temperature is 250°F. Above this temperature, the esters boil out of the matrix and brittleness follows. However, they rate poor in resistance to hydrocarbon exposure, acids, synthetic lubricants and hydraulic fluids. Could be something there in the engine compartment besides heat that degrades the material."

Bolles suggests that instead of replacing the original mounts, you merely insert washers on either side of them to reduce the side-to-side travel; washers from mag wheel lug nuts work well. This makes the original mounts last indefinitely, since they hardly move.

Another idea may be to cut out some hard rubber pieces -- preferably with some cord for strength, like old tires or drive belts -- to install on either side of the original mounts, providing a compression member to restrain the side-to-side motion. Make sure to fill the space, leave no gaps; for the rack to move *at all*, it should be compressing material. You might consider removing the OEM rubber-faced washers on each side of each mount and installing fender washers instead along with a broad flat chunk of hard rubber the same or larger OD as the mounting lug and perhaps 1/4" thick.

Since the three mount bushings work in unison, the stiffness of the rack mount system can be controlled by altering just one, two, or all three mounts. However, this author recommends you treat all three bushings the same so as to distribute the load equally on all three mount lugs on the rack rather than concentrating the load on one or two lugs. An alternative idea is to stiffen the two mounts on the driver's side and allow the one on the passenger's side to remain flexible; some suggest this will minimize stresses due to differences in thermal expansion, allowing the passenger's end to "float" a bit while the driver's end remains firmly anchored. It's not likely there are any significant stresses due to thermal expansion here, though; stiffening all three while making sure the fender washers are positioned properly to avoid stressing the lugs when the bolts are tightened should work best.

STEERING RACK MOUNT BOLTS: If you happen to be working on the rack with either the engine or the front subframe out of the car, you may be able to put the bolts in any way you wish. But for the benefit of those who work on the car later, please install the upper mount bolt on the driver's side from the outside inward, and the lower bolts on both

sides from the inside outward. This makes it much easier to install or remove the rack with the engine and front suspension in the way.

If you must replace the mounting bolts, be careful not to use bolts that are too long. When complete, be sure the upper bolt on the driver's side does not protrude too close to the engine block, since the engine moves on its mounts and will beat against the bolt. And the lower bolts should not protrude too closely to the lower A-arms, since they are likewise mounted on rubber and may move during operation.

STEERING RACK REMOVAL: If you have to totally remove the steering rack, one problem is how to remove the pinch bolt that connects the steering column swivel joint to the tower shaft. Remove the oil filter first, then turn the steering wheel until the pinch bolt is positioned where you can get at it.

Also note that the pinch bolt must be completely removed for the swivel joint to be disconnected from the tower shaft. The tower shaft has a recess the bolt fits through; merely loosening it will not permit removal.

You might find it helpful to carefully mark the relative position of these parts prior to disassembly.

STEERING RACK TOWER SHAFT SEAL: This seal is prone to leakage. John's Cars (see page 668) offers an aftermarket seal that is supposedly better than the original. It better be, it's quite expensive.

Reportedly, one problem associated with this seal is incorrect installation by driving it too far into the housing. Be sure not to drive it any deeper than it needs to go.

STEERING RACK REBUILDING: Judging from the experience of other XJ owners on the Internet, you're going to need a rack rebuild sooner or later. They start leaking power steering fluid out of the boots. Replacing the boots won't help, they have deliberate drain holes in them! They're not supposed to hold fluid, they just keep dirt out. The fluid is supposed to be kept in the rack by seals on each end of the power piston itself. If the boots are filling with fluid, rack rebuild time. Of course, there are products on the market that you can supposedly pour into your power steering system to stop leaks, but these will be a temporary fix at best.

There is a "seal kit" available for the steering rack. Note that reportedly the tower shaft seal is *not* included in this kit; check with your source and order the tower shaft seal separately if necessary.

A high percentage of people who have rebuilt their own steering racks have reported failure on the first try, and all for the same reason: when installing the rack bar through the seal on the driver's side end of the rack, the teeth on the rack bar ruined the seal. This typically results in ordering an entire new seal kit to obtain this one seal, and greater care the next try. The repair manual calls for wrapping the rack with tape prior to sliding the seal over it; apparently this is the minimal precaution, experience says to lube it up as well and exercise extreme caution during assembly. It has also been suggested that the seal and the part it mounts into be slid over the rack separately and then assembled, since installation in the housing makes the seal more difficult to work with.

Even with care to not damage that seal on installation, your rack rebuild still might not be successful; you may still have fluid in the boots within seconds after startup. Gregory Wells of Coventry West, Inc. (page 642) says, "We rebuild a large number of Jag racks each month and we find that the wear causing the leaks is usually not just the seals; the sealing surfaces wear, too. And unless these are checked and dealt with in one way or another, the rack will probably leak immediately or sooner than you'd like. Modern elastomer seals tend to wear the metal sealing surfaces more than the old natural rubber seals. We have polishing equipment we use to polish the seal surfaces; if they are too worn to polish out the grooves without reducing the diameter of the shafts below what we feel are minimum specs, we replace the part from the usable spares pile."

POWER STEERING BOOST REDUCTION: Many drivers object to the inert feel of the overboosted power steering, and seek ways to reduce the assist. One of the simplest cures is to install a smaller diameter steering wheel; Momo and

others make aftermarket wheels and adapters. The owner of a later car, of course, has a driver's side air bag to contend with.

John Goodman points out that the XJR-S has reduced power assist, and it may be possible to retrofit the valve body onto the steering rack in the regular XJ-S. "I don't think the racks have changed much, the valve is probably interchangeable. Reduces assistance by.... well, you need two hands to turn the wheel at standstill, normal round town corners are OK. On the road it is noticeably heavier but much improved."

"SPC 1034 is the part no. for the rack valve from an '89 parts list."

"SPC 1286 is the part no. for complete rack from '92 parts list."

"SPC 1158 is the part no. for the rack valve again '92 parts list."

"The rest of the steering is std. Front springs/shocks are unique XJR-S items though."

The XJ-S owner is advised to only consider the boost reduction mods *after* replacing the rack mounts with aftermarket items. The rack mounts are the cheaper mod, they will usually provide the feel the driver is looking for -- and they make it easier to take the rack in and out to make further mods like the valve replacement.

STEERING WHEEL ALIGNMENT: If your steering wheel is cockeyed when driving in a straight line, your problem may be in the relationship between the steering wheel and the rack, or between the rack and the front wheels. Jaguar has provided a nifty method of determining which. If you remove the grease fitting from the steering rack, a dowel (or special Jaguar tool no. 12279) can be inserted to engage a notch in the rack. When the notch is lined up with the grease fitting hole, the rack is centered. The steering wheel can then be lined up properly. Once this is done, a misalignment when driving straight (be sure you're on a level road, and not in the right lane of a road that is crowned) calls for correction at the tie rods. If the correction is minor and you are confident that the alignment is otherwise OK, this can be done by carefully marking both tie rods and adjusting both of them the same amount.

Franck Guilloteau says "that "special tool" can easily be replaced with a screwdriver (torx T20 for example) that has the same ID of the zerk (sp?) grease fitting on the steering rack - remove the fitting, insert the screwdriver - move the wheels until it drops in a rack groove - the rack is centered!"

TURNING RADIUS: Dan Jensen reports, "I recently replaced the power steering racks in my '83 XJ6 and '84 XJ-S with rebuilt units. After changeout, I noticed a significant, and undesirable, increase in the turning radius on the XJ6. This often made it difficult to make U-turns without backing up, and complicated parking. A check with my local Jag specialist revealed the source of the problem. Some point along the line, Jag added rack travel limiters as part of the inner ball joint lock tabs. These were apparently installed to preclude potential rubbing of the tires on front end components after Jaguar changed the recommended tire size from 205/70 to 215/70. I don't know if this applied to the XJ-S as well, which had 215/70s specified. By pulling back the inner ends of the rack boots, I could see the thicker locking tabs. I unscrewed the inner ball joints and replaced the wide tabs with the narrower tabs. This caused no noticeable change in toe-in since the thickness of the locking tab between the rack and ball joint is the same on both varieties of tabs. This was a 10 minute job and fully restored the tighter turning radius I was used to. I have not noticed any rubbing of tires on components with the 215/70's on the car. If others have what feels like a wide turning radius, you might want to examine one side of your rack to see what tabs are used. Apparently rack rebuilders are not always careful about the VIN number and rack changes, but I cannot see how the limiters served any real purpose and, in fact, created a bit of a hazard in my case when making U-turns."

POWER STEERING PUMP: According to XKs Unlimited, there have been three different power steering pumps used on the XJ-S. Prior to 1976½, the part number was C28457, and the pulley was retained by a single nut in the center. From 1976½-1980, part number C45540 was used, and the pulley was bolted to a hub on the shaft with three bolts. Also, the high pressure line connection is sealed with an olive, visible when the hose is removed. From 1980 on, part number EAC3167 was used and this pump looks just like its predecessor except that the high pressure line is sealed with

an O-ring. This last pump is referred to as the "metric pump". The same three units were used on other Jaguars of similar years.

The XJ-S power steering pump is a standard GM Saginaw unit. However, it is uncertain whether the Jaguar system operates at the same pressure as a GM; so, if you replace the original unit, it is suggested that you remove the pressure control valve from the Jaguar unit and install it in the new one. The pressure control valve is easily removed by removing the outlet fitting and shaking the unit until it falls out.

POWER STEERING PUMP TENSIONER BOLT: The eye end of the threaded tensioner for the power steering pump is held to the engine with a double-ended bolt, C36196, through the timing chain cover. Several people seem to have one problem or another with this bolt. Peter Havas says, "I happen to be past master at this one, having had my pump come adrift at eye-watering speed. The beast is a long bolt, with a 13mm head 8mm shaft, fine thread. I had mine shear off at the front cover. My fix was to purchase a length of 8mm threaded rod, and insert it into the hole, then double nut the bolt to the front cover, and finally re-assemble the eye bolt adding another nut at the end." Note that on early cars, this is probably a 5/16" UNF bolt instead of an 8mm. Craig Sawyers: "Watch the nut though; the old one on mine was (uniquely) BSF thread. The new replacement one was UNF. Don'tcha just love it?"

Havas: "As an aside, check the two *big* bolts holding the pump bracket to the engine. My back bolt sheared off completely."

POWER STEERING FLUID: According to the owner's handbook, you're supposed to put the same type fluid into the power steering unit that you put into the automatic transmission. This is interesting, since the early cars with the Borg-Warner automatics called for Type F fluid while the later cars with GM400 automatics call for Dexron 2D or III, and the power steering system didn't change. Apparently any ATF will do in the power steering system.

Apparently Type G fluid was called out in some owner's handbooks for the power steering. "Type G is an obsolete designator for Dexron. It's so obsolete that nobody remembers what it was."

See the discussion on Dexron ATF's on page 305.

On the other hand, maybe you shouldn't use any sort of ATF in the power steering system. Jeb Boyd says, "I do believe you would be better off using power steering fluid in your power steering system. I was led to believe a few years back when they were experimenting with various formulae for ATF that the additive that was P/S compatible was no longer in ATF. I have been using power steering fluid exclusively ever since with no problems."

Joe Bialy concurs: "I can't speak for Jaguar, but I do know for a fact that late model Ford Escorts had different fluids for the P/S and automatic transmissions when they left the factory. I was never able to get a technical explanation other than it affected the long term well being of the vehicle."

Jim Isbell says, "A neighbor was having trouble with a leaking power steering rack on a 1990 Continental. He is a shrimper and on his boat he uses a power steering pump connected to the engine to drive a hydraulic motor for retrieving his nets. In that pump he uses 30 wt motor oil. So when his car's steering started to leak he decided to try 30wt motor oil. It cured his leak. I was skeptical of the life of the system with 30 wt motor oil in it but his experience with the boat made me take a "wait and see" attitude.

"Well, two months later it's still leak free and still working.

"But...something more interesting to me was that when I started reading on the fluids that were allowed in the steering and autopilot on my boat I noticed that the list, which starts with automotive power steering fluid, goes on to include motor oil of varying densities as well as almost any other semi-oil fluid you can imagine. In other words, it's not very particular what you put into it. So maybe using motor oil to cure leaks in the power steering isn't so crazy after all."

DRAINING POWER STEERING FLUID: Craig Sawyers says, "In trying to find the source of my leak, I found if you disconnect the hoses at the rack, it just obligingly trickles out (up your arm). I realise that is easier in the UK, where you can get easy access to the unions, than in the US where they are well inaccessible."

POWER STEERING FLUID LEAKS: If your power steering system leaks, you should fix it. Yeah, right! You're just gonna keep adding fluid, aren't you? Well, there is no shortage of products that claim to stop leaks in power steering systems -- but apparently there is only one product that actually *will* stop leaks in power steering systems. John T. Richardson: "I've came across a product that worked well for me on stopping power steering leaks and want to share it: Lucas power steering sealer. While the name might scare you off, their product contains no electricity so it should work. Their product appears to be a really thick, red coloured oil.

"I recently purchased a '91 Ford Explorer w\143K miles and a massive power steering pump leak. It had to be filled up daily and always left puddles of fluid when stopped. I tried this "snake oil" and the second bottle did the job. I never expected such results! No more leaks and the outside of the pump seal is only "damp". Since then I have been using Lucas power steering sealer to top off the Jag pumps on an as-needed basis and that frequency has gone down."

Joe Montgomery: "Having tried about every power steering sealer made, forget them all except Lucas. I found Lucas at the local Pronto Auto Parts. It is as thick as honey on a cold day."

George Harris: "*It works!* As a last resort, just until I get around to finding those d**n leaks, I thought I would try a bottle. I had to drive my '88 XJ6 (XJ40) because the 'S' was off the road for rad R&R. The PS reservoir was empty, so I emptied the bottle in it. That brought it up to 'full cold'. Since then, 2 weeks ago, I haven't had to add any PS fluid! Normally that's at least one complete refill. Since then I did the same to the 'S', and same story! Now does Lucas Oil Products make a stop leak fluid for the tranny and engine?"

No, it's not the Lucas we all know and love; the company that makes this stuff is:

Lucas Oil Products
13365 Estelle Street
Corona, CA 91719
1-800-342-2512 Fax: +1 (909) 270-1902
<http://www.lucasoil.com>

The "Power Steering Stop Leak" is available in *some* auto parts stores, including CarQuest. When this author asked about it, the salesman was very enthusiastic about the product, claiming that if your power steering pump was old and worn and making noise you could add this stuff while the engine is idling and the noise will go away while you're adding it. The directions on the bottle are simple enough: whenever the fluid level is down, top it up with this stuff. Keep doing that until the level doesn't go down any more. The bottle claims that "Results are usually immediate."

Lucas reportedly makes a good injector cleaner and hypoid oil, too. Greg Meboe: "The lady behind the counter swore by them, and said that the store stocked them for trucking fleets."

Dennis Kindig went another route: "I had been nursing a power steering leak for over a year that required topping up an almost empty pump every week or so. I switched power steering fluids and the leak has gone away. I'm using Valvoline semi-synthetic power steering fluid with conditioner and stop leak (I can't remember whether the name is SynChron or SynPower, sorry). This looks like standard power steering fluid so I don't feel like I'm pouring oil in my system. It took a few weeks for everything to dry up but it did eliminate my leaks."

Peyton Gill didn't fare as well. "I tried something similiar to what Dennis described. It may have been a different product because it was clear and very low viscosity...like water. It was made by Valvoline and the label stated it was for steering rack leaks. Well as usual I should have left well enough alone and added this product to stop a slight leak. Guess what happened??? Starting leaking like crazy."

POWER STEERING HOSE/TUBE CONFIGURATION: The Jaguar Parts Catalogue ©1987, page 1G 07R, shows simple power steering piping for RHD cars in the illustration: lines go from pump to rack to cooler and back to pump.

On the author's '83 LHD, the lines go from the pump to a metal tubing loop across the bottom front of the front suspension subframe and back, then to the rack, cooler and back to pump. Jon Schrock says, "Jaguar changed the part for the XJ12 in April, 1978 (Service Bulletin 78-F-1) "to reduce high pressure noise" and presumably did it to the other models about the same time. Specifically they went from a 14 inch line to a 40 inch one. Both my '85 XJ-S and '77 XJ12 have the longer line, but I suspect the latter acquired it after it left the factory."

The author found it helpful to remove the screws holding this loop to the front of the subframe, put 1/4" spacers behind them, and put them back in. With the loop held tightly to the surface of the subframe, dirt would get caked all around it until you'd have to dig to see the tube. With the tube held 1/4" away from the surface of the subframe, the dirt seems to fall away rather than build up. The loop is probably not intended to provide any significant cooling -- there is still a dedicated cooler in the low pressure side of the circuit -- but improving airflow around this tube couldn't hurt.

POWER STEERING HOSE/TUBE REPLACEMENT (US-SPEC LHD): Valery Danilov says, "The high pressure hose next to the exhaust manifold was cooked, and although appeared OK, was leaking badly. After wiping it clean, I was able to see the ATF come right through the surface (not a single crack, but rather sponge effect!!!). I would recommend you guys check yours, if it's not leaking, then wrap it with aluminum foil or something."

William Earl says, "I just got my 1990 XJ-S back from the shop where I had two of the power steering hoses replaced. When I brought my car in, there was a 1988 XJ-S getting the same hoses replaced, and when I picked up my car, there was third XJ-S due in the next day for the same problem. I am adding these hoses to my periodic maintenance list, probably at an 80000 mile interval. The problem seems to be heat in the manifold area, even with the insulation around the hose."

Danilov: "I bought a new hose from NAPA. It is a simple bolt-on, replacing 2-piece original with a NAPA 1-piece design. The new hose is identical in all respects to the old pipe-hose-pipe assembly, except that it cannot be taken apart. It came in a fancy box with a new o-ring included. Part number is NPS 7-1974."

Jim Moore adds that Jaguar has apparently combined those two pipes too: "My high pressure side used to be a two-piece arrangement. Six years ago I replaced the half that went from the rack to join up with the front half. Jag only sells the one piece now, but it was worth it; car used to growl at low rpm and hard turning, like parking. The growling is gone now."

Miles Milbank had to replace this line, too. "My problem is that my hi-press hose has been worn thru where it crosses over the sharp (!) fluid cooler fins in the return line - what a monumentally stupid design." Randy Wilson retorts: "The faux-pas is with whoever did the last bit of work on the p/s hose. The factory hose, with the original interlocks in place, clears the cooler just fine."

Wilson goes on to describe the replacement procedure: "Disconnect the hose from all other points. Drop the rack down and back until you can get at the fitting. I do not remove the cat. It is *not* easy, especially starting the new hose without crossthreading the fitting. Make sure the interlocks hook together properly. Aftermarket hoses often do not have the interlock, and require some serious bending to duplicate the OEM hose. If the steel tube at the rack end of the hose is straight, it is wrong."

Of course, if the problem is with the hoses and not the metal tubes or fittings, you can rebuild these lines using suitable hose and EFI clamps, similarly to rebuilding the fuel lines (see page 227). Although the pressure in power steering lines is higher than in the fuel lines, it's no higher than any other hydraulic hose application; any industrial hose supplier can provide hose suitable for use with power steering fluid. Greg Meboe says, "I just brought my old hose into a farm supply place and they made a new one for me in a matter of minutes. Cheap too." The low-pressure line from the cooler back to the pump is nothing but hose and clamps to begin with.

POWER STEERING HOSE/TUBE -- THE METAL PARTS FAIL, TOO: Craig Sawyers says, "Mine seeps around where the pipe unions go into the pinion housing. Fortunately on UK cars, these are easily accessible. However, I've had them off a couple of times, and retightened them to varying degrees and it still leaks. I threw in the towel and took the car to TWR Jaguar (Oxford UK) to have a chat with Denis, their chief technician. Without even looking, he

pronounced that the flared end of the pipe was cracked! "Common problem" quoth he; "I bet you found that the more you tightened it, the worse the leak got." Yup. "and that it seeps around the pipe." Yup. "If you undo the unions, and clean them you will see a very fine crack on the flare". Well, I haven't tried that yet, but I think he is probably right. Looks like I'm in for at least one new hose."

POWER STEERING HOSE/TUBE CHAFING (RHD): Stefan Schulz reports on chafing problems on his RHD car: "...above the rack on the left is where the pipes go to the power steering pump. On mine there is a designed-in problem where one of the pipes chafes against a bolt head. This cost me two replacement pipes before I figured out what was going on. No way to get around it with the Jaguar original parts.

"My steering rack is a CBC5708N, which is the UK (RHD) sports pack rack. The pipe is part of the high pressure hose assembly CAC3654 (same as the plain XJ-S). Calling it either hose or pipe is misleading because it consists of alternating sections of hose and pipe.

"One of the pipe sections either constantly chafes on or occasionally rubs against a bolt head near the upper left side of the rack, as seen from underneath the car facing forward. The severity of the chafe will depend to some extent on how much either end of the hose assembly is twisted against its fittings during installation. The design fault appears to lie in the fact that the offending section of pipe is dead straight (which is cheap) as opposed to having a slight bend to clear it (which costs at least an extra GBP0.02 to manufacture).

"Funnily enough, inspection of hoses and pipes for chafes *is* a part of the 7,500 miles maintenance schedule. No prizes for guessing why, in case any more such design gems lurk in the car.

"My workaround, which operates entirely satisfactorily, is to put a hose clip around the chafing area of the pipe, to check it every time I get under the car and to replace it when necessary. So far I only needed to do it once, after about two years of service. The pipe still is as new.

"A hydraulics shop could easily make up a properly formed section of pipe, probably at a fraction of the cost of a Jaguar original as well."

Rear Suspension

REAR END ALIGNMENT: There's no such thing as castor on non-steering wheels, and toe-in is not adjustable on the rear of the XJ-S; if it's off, something is bent. The only alignment adjustment available at the rear is the camber, adjusted by replacing shims between the inner end of the axle and the brake disk. The more shims put in, the more the top of the rear wheel tilts outward.

Note that there are usually some shims between the brake rotor and the differential unit. These are to locate the rotor properly between the calipers, but also affect the camber as well. If working in this area, always make sure all shims are reinstalled properly. If your objective is to relocate the brake rotor without affecting the camber, move shims from inside the rotor to outside or vice versa, but do not add or subtract any shims to the car. If your objective is to alter the camber without relocating the brake rotor, add or subtract shims from outside the rotor and do not disturb the shims inside the rotor.

Randy Wilson offers this advice: "Camber is not a constant. The camber control is taken on two pivoted arms (of unequal length) so that the camber can change on a predetermined curve based on suspension position.

"It is very unlikely for the camber to change from factory specs unless one of three things happens: either something is bent, someone left some shims out during a differential or brake service, or the ride height is wrong. The #1 cause is the last, sagged rear springs. So, when you are told that the rear camber is off, investigate the static ride height before investing a lot of time/money in shim swapping." Better advice: don't make *any* decisions about adjusting shims without ascertaining the alignment properly, which means to lock the suspension height using the specified tools; see page 329.

CLUNK - REAR: See the section on page 324.

REAR SUSPENSION SUBFRAME/DIFFERENTIAL REMOVAL: To work on the differential, as well as many tasks relating to the rear brakes, it is necessary (or merely preferable) to lower the entire rear suspension assembly out the bottom of the car. Fortunately, this is nowhere near as difficult as it appears. It is suggested you read through the tips on removing the inboard rear brakes starting on page 409 before starting this job.

The basic idea is to put the rear of the car on jackstands, position a floor jack under the center of the IRS, unbolt it from the car, lower it and roll it out from under the car. The first challenge: You need to get the rear of the car high enough to get the suspension out from underneath. To get it out the rear of the car, the lowest point of the bottom of the trunk needs to be higher than the height of your floor jack when fully collapsed plus 13". Plus an inch for fudge, just to make sure.

As soon as you get the car propped up and the rear wheels off, the next thing you should consider doing is removing the grease fittings at the bottom of the hub carriers. They'll get busted up sooner or later if you leave them in there.

The next challenge will be getting a jack that can get high enough to hold the subframe up while you take the mounting bolts off, and then lower it far enough to get out from under the car -- which means a stroke of 13" or more. If your jack isn't up to the task, Jan Wikström says "You'll need to shift the subframe in two lifts. I use a 5" thick wooden block on the jack and rest the unit on two cement blocks halfway up."

"You need a friend to stabilise the subframe as you move it down and up (and help you lift it to the workbench; that sucker is *heavy*). To make the job a lot easier, take the spring/shock units out first and refit them last."

When ready to lower the IRS, Jim Isbell describes locating the jack: "Make sure it is under to the point of almost being too far forward. The cage will try to roll forward if the jack is too far back as it is front heavy." The balance point appears to be perhaps three inches forward of the axles.

Some owners have reported good results with putting the wheels back on during removal; that way, the assembly can be rolled out from under the car. It will require positioning the car on even taller stands, though. Disconnecting the spring/shock units from the lower swingarm first helps because it allows the suspension to squat.

Note that the suspension assembly, standing on its wheels, will show a distinct tendency to roll over. If you try to keep it from rolling over by holding onto the radius arms, you may find that the radius arms can swivel around their attachments to the lower swingarms without warning and the assembly rolls over anyway, probably onto your toe or some such. John Napoli suggests "let it flip upside-down. Now you can wheel it anywhere you like, wheelbarrow-style, using the trailing arms as handles."

If you're going to position the suspension assembly upside down -- either during this rolling or later when working on it -- you might consider capping the vent on the final drive unit so you won't leak oil everywhere.

If you can't get the car very high, the suspension assembly may need to come out the side rather than the rear. If you position something with wheels under each hub carrier and lower the suspension onto them, you can then pull your floor jack out the rear and roll the suspension out the side. Bob Gallivan says, "I dropped it onto my creeper on one side of the center of the diff & a moving dolly on the other side. Worked like a champ. Rolling it out the side is the way to go."

Craig Sawyers suggests you don't use the kids' skateboards, though. "My thought exactly the first time I tried this. Miserable failure; totally unmanoevable - works like two independent bogies. Impossible for one person to handle, and requires an act of coordination beyond anything mere mortals can achieve if two try it. Complicated by the fact that the top of the board is resiliently mounted to the wheels, so it tilts in weird and unpredictable ways."

Of course, just using the floor jack from the side instead of the rear might work. Sawyers: "I found just balancing it on the head of a trolley jack and rolling it under the car worked just great."

When several members of the online discussion lists tackled IRS removal, there was a lot of discussion of details. When the smoke cleared, it turned out that several of the problems discussed were related to the XJ saloons rather than the

XJ-S; the IRS is identical, but a couple of detail differences apparently cause consternation when removing the IRS as a unit.

The first issue discussed was the need to remove the stainless steel exhaust tips, apparently because they protrude through holes in the bodywork on the saloon. Removal is one of the steps listed in the Haynes manual as a precursor to removing the rear mufflers themselves. On the XJ-S, there is no problem here; you can leave the tips on if you want and remove the rear mufflers with them attached. In terms of repair manual correction, this means that Section 28 of Chapter 11 in the Haynes manual should include a note that Step 2 of Section 27 can be omitted in XJ-S work.

The next item was what to do when the rear mufflers won't come off! If the pipes won't come apart at the forward end of the rear mufflers, the obvious solution is to remove the rear mufflers *with* the IRS. Again, removal of exhaust tips is necessary on the saloon and not necessary on the XJ-S -- but you might choose to remove them anyway to keep them from getting dinged up. Jim Isbell explains this procedure with the saloon: "It is complicated greatly if, like me, you're not able to remove the tail pipes because it's then necessary to slide the cage forward as it drops so that the tail pipes will drop free in the rear. As the cage goes forward it hits the front exhaust pipes and the drive shaft so those have to be kept out of the way." David Littlefield points out that none of this is a problem with the XJ-S: "The cage will just drop straight down, the muffler/pipe/tailpipe combination won't hang up on anything."

"This combination is best left in the cage until it is on the bench. Then disconnect the lower fulcrum pin from the shocks and push down the axles. This will allow removal of the pipes without too many contortions. Replacement is reverse of removal. I put the whole rear muffler/pipe/tailpipe assembly back into the cage before refitting to the car. The mufflers actually provided some leverage to wrestle the whole thing around. It helped to temporarily hang the over-the-axle pipe on its rubber mounts to keep the mufflers from dragging around and from accidentally falling out."

The next issue involved exactly how to disconnect the mounts holding the subframe to the car along the upper edge of the wheel well. There are four mounts, two on each side, and the questions involve whether to unbolt the mounts from the subframe so they stay on the car or to unbolt the mounts from the car so they come away with the subframe. Littlefield explains: "In my correspondence with Jim Isbell, we determined that it is difficult to get at the rear mounting bracket to chassis bolts (two in each bracket) on the XJ6 and that the Haynes manual recommends removing the suspension cage to mount bolts (three on each bracket) instead -- but just on the rear. On the XJ-S, I had no problem getting to the bracket to chassis bolts on all the brackets. Not a big deal, but I think it might be a bit easier moving things around if the bracket to chassis bolts are the ones undone." On the saloon, Isbell seems to feel that it is important to unbolt the forward mounts on both sides before working on the rearward ones; on the XJ-S, it's hard to see how the order would make any difference.

Franck Guilloteau says, "I believe that there is one important step that need to be added before dropping the cage. Loosen the nuts that hold the half shafts to the differential. If yours are as tough as mine were when I did the camber change (first time), removing them with the cage off is no fun exercise. I forgot to do it the second time when I dropped the cage. Fortunately I hadn't removed the hand brake calipers and was able to use a long pipe clamp to compress the calipers and stop the shafts from rotating. Even with anti-seize compound it was no picnic (air tools did help though). If you have removed the brakes....well good luck!!

"Using a 20" extension and 11/16" deep socket (not to forget the long pipe to use as leverage at the end of the ratchet) you can remove/loosen up 3 of the bolts that hold each half shaft (remove the u-joint cover and rotate shaft until you can get to the nut - use the hand brake to stop rotation). The 4th bolt which has a zerk fitting in the way so you need a shallower socket. It should come last in the removal sequence." Of course, you might opt to temporarily remove the zerk fitting to get the socket on the nut.

Littlefield: "Or, you can put an open-end wrench on the nut, turn the drive shaft until the end of the wrench contacts the cage and stops the drive shaft from turning. Then take a breaker bar or other long lever and turn the hub by using the lugs. With that kind of leverage, the nuts should break away pretty easily. It is a good idea to put the lug nuts on to prevent damaging the threads. I own an impact wrench and an air compressor, which helped, but there is one nut that is under a zerk fitting and I used the above method for it."

GETTING THE RADIUS ARMS OFF: The ©1975 ROM, section 64.35.28, step 4, describes disconnecting the rear anti-sway bar link from the radius arm. Most XJ-S's don't have a rear anti-sway bar, so you can skip this step.

The point where the front end of the radius arm attaches to the lug on the bottom of the car is a notorious spot for difficulty of removal. There's usually a goodly amount of rust involved. Mike Morrin describes his preferred method of removal: "I have found that the "no muss, no fuss" way to break the bushes from the body involve the use of a lever or pry-bar with the end shaped so that it will go through the hole in the bush, allowing a lot of leverage between the inside of the bush and the mounting thingy on the bottom of the car. I tried most of my (extensive) collection of C spanners in this role, and found a BSW spanner which looks about 60 years old, and has just the right curve on the outside of the C that when one jaw is poked in through the hole in the bush, the outside of the C makes contact with the thingy. The spanner handle is pushed upward (maybe encouraged with a BFH), and the bush just pops off. Because the joint is tapered, it seems you need to apply enough pressure to start to deform the inner ring of the bush before it will move."

Miles Milbank offers an alternative method: "Remove all the pertinent fasteners. Place a small hydraulic bottle jack on top of the radius arm and unscrew the jack's adjuster to contact the underside of the subframe mount and jack it up until the large rubber mount is well stretched. Spray liberally with Liquid Wrench or other penetrating oil from all sides, including inside from underneath where the main bolt was extracted. Walk away and do something else for awhile until you hear the assembly pop apart, and the bottle jack crash to the floor. Repeat for other side. If it doesn't work within an hour or so, one can come back every so often and apply a bit more: 1) penetrating oil 2) jack pressure and, finally, 3) a few helpful taps at the fitting to encourage it to give way. One time I have hooked a slide hammer to the lip inside the fitting where the main bolt had lived, and the most stubborn radius arm immediately came off."

John Napoli describes a method that works for him, but note that it involves removing the entire rear subframe: "The car should be supported by 2 jackstands at the rear lifting points. Get the cage ready for removal: brake lines, emergency brake cable, exhaust pipes opened (exhaust pipe(s) in front and the resonators in back -- the over-the-axle pipes can stay in place). You don't have to remove the driveshaft -- it will pop at its slip-joint. If your car has a two-piece shaft, remove the plate holding the carrier to the unibody.

"Place your floor jack under the cage. Remove the safety brackets and main bolts holding the trailing arms to the unibody. Don't try to remove the trailing arms, though. Remove the bolts holding the cage to the unibody (the four rubber mounts). The mounts will stay on the unibody for removal/replacement later if needed. Lower the cage so the weight is on the trailing arms. You want 'a lot' of the weight of the cage on the trailing arms, but not all of it.

"Take your air hammer, and put a blunt chisel in it. Place the tip of the chisel between the trailing arm and the body (you and the air hammer are standing perpendicular to the car -- you do this from the side, not underneath!). Let the air hammer rip, not enough to cut the metal, just enough to vibrate things a bit. The trailing arms will pop off as nice as you'd please."

If you intend to remove only the radius arms and leave the rest of the subframe attached to the car, you might be able to modify this procedure and make it work. If you disconnect the radius arm at the swingarm first and find a way to pry it downward, you'd be applying essentially the same loading to the attachment.

Obviously, during reassembly it'd be a good idea to use anti-seize compound on this connection to make it easier to get apart next time.

REAR SPRING/DAMPER DISASSEMBLY: The obvious way to disassemble the springs from the dampers on the rear end is to remove the damper with the spring installed, then use a spring compressor on the bench to separate them. However, Ian Macfarlane provides an alternative procedure: "To change the rear shock absorbers without using a spring compressor, the springs can be held in the compressed state by fitting four elongated "C" shaped brackets (two per spring) over the centre 80% of the spring with the car jacked up under the suspension (preferably with a load in the rear of the car to maximize spring compression). Then, when the car is jacked up under the body, the springs will remain partly compressed and the shock absorbers can be replaced relatively easily."

REAR WHEEL BEARINGS: According to Chad Bolles, the bearings in the rear wheel carriers are a Bower/BCA part number 18590-18520 for the inner, and 18690-18620 for the outer; available in any auto parts store.

Getting the old bearings out is always fun. Jim Schultetus says, "A neat way to remove the bearing cups is to weld a bead around them with an arc welder or a mig welder. Let it cool down a bit and they will fall out as the weld bead will shrink the cup as it cools. Freeze the new cups and tap in." Not sure I'd go this way in aluminum housings; use at your own risk.

REAR AXLE FAILURE: Jan Wikström reports on his problem and solution: "The stub axle in the hub carrier (the bit that turns in the rear wheel bearings) is splined for the hub and has a large thread and castellated nut on its outer end. This thread comes right down to the splined part with no fillet whatever and creates a horrendous stress concentration at the end of the thread. Mine suffered a fatigue fracture in consequence; my local parts pusher tells me this is not uncommon, as one would expect from such an elementary error, especially if the nut is overtightened. Accordingly, I ground and polished a shallow rounded groove at the base of the thread of the new part... (see **Figure 19** and **Figure 20**, illustrations graciously provided by Wikström).

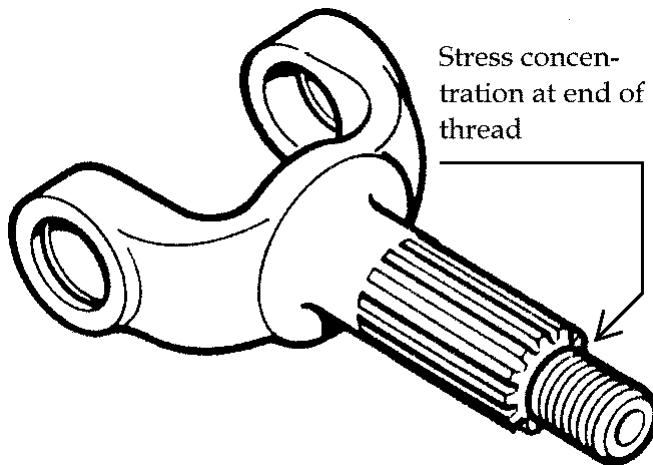


Figure 19 - Rear Stub Axle Failure Location

"The next time you do the rear wheel bearings or U-joints, I strongly recommend having the stub axles checked and modified; any competent engineering shop will know about stress relief. Modifying parts of the Jaguar may be sacrilege to some of us, but fine as the design is, it isn't perfect..."

If the stub axle has already broken, it is possible to fix it by drilling and tapping a hole in the end and using a bolt and washer instead of the nut. GT Jaguar (now defunct) offered a grade 8 bolt and a specially designed washer for this purpose, and you could easily come up with suitable parts from local sources. This fix may also be used as a preventative measure, since cutting off the stub and drilling for the bolt eliminates the stress concentration in the original part as well as the shallow groove does.

Perhaps one thing to note is that GTJ offered these parts at all; that would seem a serious indicator of just how common this problem is, and how important it is to address it.

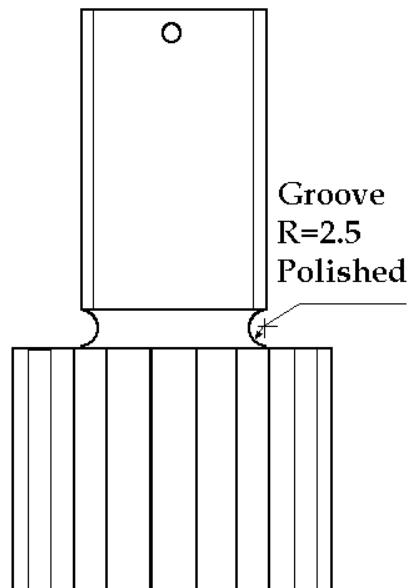


Figure 20 - Rear Stub Axle Modification

REAR HUB CARRIER CRACKING: Joe Bunik reports that the cast aluminum hub carriers on his car had a crack in the area just above and outward of the fulcrum shaft. The crack was parallel to the fulcrum shaft, but just far enough above it to be in the structural portion between the fulcrum shaft bearings and the wheel bearings. What with the rough

surface on the cast aluminum combined with the dirt and grime normally covering it, it is entirely too easy not to notice a crack like this. There are some photographs of such a crack on the WWW at

<http://www.jag-lovers.org/xj-s/book/HubCarrierCracks.html>

Such a crack is disconcerting to say the least, and many owners will feel compelled to order replacement parts immediately. However, the crack in the hub shown in the pictures at the WWW site does not appear to be the result of stress; rather than starting at an edge and working across the part as one would expect of a stress crack, it appears to start and end in the middle of the part. It therefore appears to be a casting flaw caused by cooling the casting too rapidly or unevenly. Subsequent reports from owners and mechanics seem to indicate that these cracks are not uncommon and haven't been known to result in structural failure.

REAR SWINGARM OUTER PIVOT: The connection between the outer end of the swingarm and the lower end of the hub carrier involves a pair of tapered roller bearings. These bearings are lubricated via a grease nipple in the bottom of the hub carrier and are sealed with a felt ring.

The design of this pivot joint allows the bearings to be adjusted with shims to be *tight*. When correctly assembled, they roll firmly; there should be no slop or rattling whatsoever. This pivot joint holds the alignment of the rear wheel; any slop means that the wheel is sloppy in which direction it aims.

REAR SWINGARM OUTER PIVOT - GREASING: The grease fitting is obvious, dead center bottom on the hub carrier. But just what good does it do? Patrick MacNamara says, "the relief port for the grease pressure is only about 1" away from the nipple (center of swing arm about 90° around the fulcrum from the nipple facing inboard) adjacent to the hollow end pipe of the lower arm. When cavity is full, it just vents out of the hole and fills the hollow longitudinal portion of the swing arm and no old grease will be pumped out. The only way to get rid of the old grease is disassembly."

On the author's '83, MacNamara is incorrect. There is a cast-in boss facing inboard, but the hole in it has a bottom; it does not open into the pivot joint area. There is a grease relief, though, just *above* this cast-in boss. It points upward and inboard at about a 45° angle. It's a 3/32" hole, completely obscured by all the dirt and grime that has accumulated on that surface of the hub carrier. In other words, MacNamara was in error regarding the location of the grease relief, but he was correct that it was there -- and in its effects.

You might consider plugging the grease pressure relief port. A 1/4" long #4 self-tapping screw will work nicely -- two per car. This will at least help keep dirt and water out.

If you plug the relief port and then use a grease gun to force grease in there under pressure, it'll push against the felt seal. Will it ooze through the felt seal? Maybe; at least, any air in the area will push through the felt. Hence, you *might* actually achieve some beneficial lubrication with the grease gun. I wouldn't count on it, though; you're still not likely to improve the lubrication in there without disassembly.

If you install oil seals as suggested below and plug the grease vent and then force grease in there with a grease gun, you'll probably destroy the oil seals. Your chances are a little better that the grease will just push past the seals if you install them backwards as Ron Moore suggests, but not much better. If you feel compelled to use the grease gun, you might be best advised to remove the vent plug first, then put it back in when done.

Better idea: Richard Dowling reports, "Of all the 24 bearings in the IRS and diff I only had 4 bad ones, namely the outer fulcrum tapered rollers. There was plenty of grease in the bearing cavity, but that around the bearings themselves was pretty old since the new grease goes in the zerk and out the vent next to it.

"In my stripdown I put 2 zerks in for each wheel hub to force grease through the bearings, and a vent hole on the outer side of the fulcrum bearings to ensure grease from the central zerk can exit only after going through those bearings. All this is dead easy when the whole shooting match is cleaned up and on the bench. What about the fulcrum area on your car which is probably like my XJ6, not giving any trouble, but a future concern?"

"When I had my XJ-S fulcrum stripped I measured all the items accurately and made an Autocad file (see **Figure 21**) of the bearing area. From that I could see a possibility of drilling a small hole through the standard assortment of spacers and felt seals into the area next to the bearing race to make a vent, all without stripping the assembly. This morning I tried it on my XJ6 and it works.

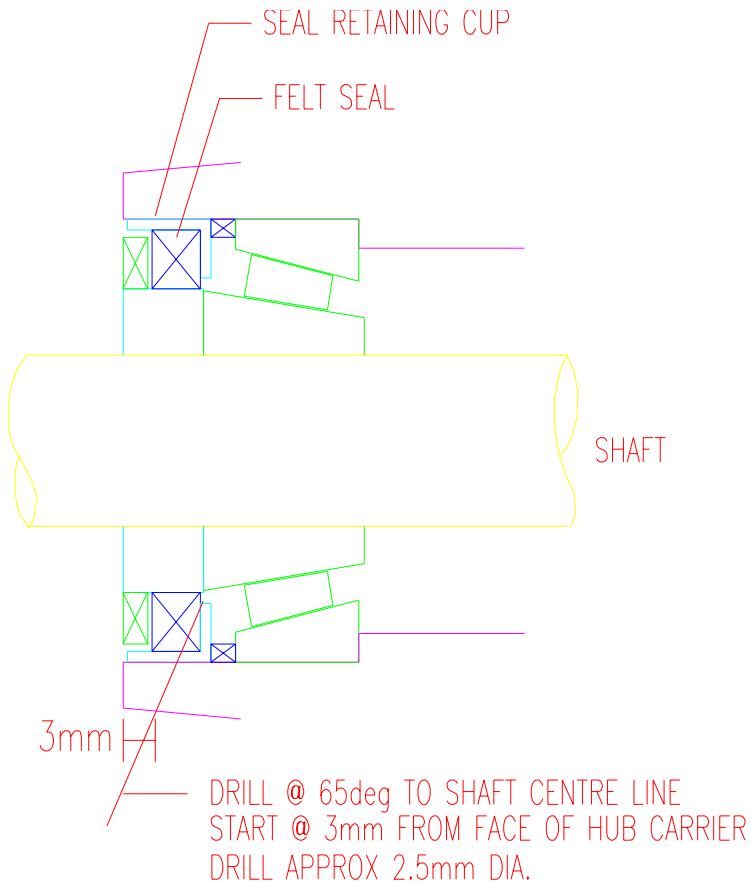


Figure 21 - Rear Outer Pivot Grease Vent

"You take the wheel off, and drill a hole about 2.5mm diameter starting at 3mm from the machined end of the alloy casting. The drill must be at an angle of 65deg to the centreline of the 5/8" shaft running through the bearings. The 3mm and 65deg are moderately critical. I drew an angle of 65deg on a piece of paper and put it under the hub to give me a guide as I drilled.

"On the first one I broke the drill because I was in a hurry. You drill about 5mm though alloy then you hit the mild steel cup that backs the felt seal. You go through the first face of that cup which is parallel with the shaft since it fits the bearing bore, then you hit the felt seal and a little further on you hit the return face of the cup which is at 90deg to the shaft centreline. This latter face is hit at an acute angle of 25deg which is where I broke the tip off my drill. If you exercise patience and take about 5 or 6 minutes to drill each hole, backing off as you break into the felt seal, then going carefully for that return face, it is no problem. Total drill depth is around 12mm.

"As soon as I thought I had broken through I put my grease gun on the zerk and tried it. That also pumps out the swarf. In any event, looking at the pounding on my XJ-S bearing, a small piece of swarf most likely would make no difference. However, if you grease the thing every 6 months you are pumping grease in a direction that takes the swarf out of the bearing - that will be the least of your worries.

"Small self tappers were used to seal off the vents. I found on my XJ6 that as I pumped, no grease came out of the Jag supplied vent next to the zerk; it must be well and truly blocked. I got plenty of grease out my new vent holes. At first

very old and stiff grease, then newer grease sitting in the centre of the cavity, then new moly grease. I also loosed off the 5/8" shaft nuts and rotated the shaft to rotate the bearings which spreads grease and spreads the wear pattern.

"Now I know how it should be done, I guess an hour would cover the job for both wheels. You might want a spare drill, it is not too hard to break one. That is no tragedy, it just means you have an extra hole which may or may not penetrate the bore."

Since lubrication is a challenge, it might help to use the most suitable grease rather than simply whatever's on hand. Richard Griffiths says, "EP should be fine; in my view grease for this application requires:

High viscosity base oil at operating temp.

Water resistant filler

Oxidation inhibitor additive

Corrosion inhibitor additive

"Other additives such as Moly are of no significance for this application. In my experience Moly was usually specified for sliding applications; in this case the trick is to keep the rollers actually "rolling" under high oscillating loads while maintaining the oil film. EP should do better here."

REAR SWINGARM OUTER PIVOT - OIL BATH LUBRICATION: Getting grease right into the contact points between rollers and races is an iffy proposition at best, especially the rollers that happen to be at the top. Unlike wheel bearings or other applications, the motion of the bearings themselves cannot be expected to help move the grease around to where it's needed; these rollers don't move as far as the spacing between rollers.

Richard Griffiths proposes a novel solution: "Two things we know for sure; EP additives work and channeling can occur in "thick" greases leading to lube starvation failures. So if I had your set up with the better seals, I would consider using a hi visc EP oil instead of grease. Highest stuff that will still pour at say -10°F."

Obviously, having the oil seals installed on the pivot joint as described on page 367 is essential for this idea; the OEM felt seals will simply allow oil to ooze out, and the last thing a Jaguar needs is another oil leak. The oil seals should be installed flat side out, since they will used to hold oil in -- exactly what they were designed to do!

Also, you need to use sealant when assembling. Apply sealant to both sides of *everything* in the stack along the fulcrum shaft to make sure oil can't leak along the shaft to get out. And before the oil seal is pressed into the hub carrier, some sealant should be applied in the recess.

Having an oil-filled assembly sealed airtight would not be good, so using a screw to plug the grease vent as described above is not recommended. As with other containers holding oil such as the GM 400 transmission or the differential, the ideal arrangement would be for the joint to be fitted with a breather that allows the chamber to be vented while keeping oil in and water and dirt out. There are a couple of ideas here. One is to drill the existing grease vent hole out to a larger size and then thread it to hold a fitting of some sort -- possibly the same fitting as the one used on the differential. Another is to press in a small tube and connect a hose to a remote breather, similar to that used on the GM 400; such a remote breather would need to be secured to the hub carrier so it doesn't flap around too much when the wheel bounces over bumps in the road. Remember to make sure the breather connection doesn't interfere with the axle U-joint or its cover; an elbow fitting may be in order. The simplest idea is probably to simply drill the existing grease vent hole bigger but only part way down, not all the way through, and then jam a piece of felt or a cotton ball in the hole.

Richard Griffiths says, "One of those breather plugs with the sintered "filter" center piece would be neat also. See the stuff from the Stewart Warner or Tedeco companies for example."

When devising a breather, remember that you will also need to be able to put oil into this compartment. If a really small (1/8" or so) breather is devised, you'll probably need to make a second hole so you can add oil to one hole while air comes out the other. If you make the breather hole large enough, you may be able to feed a tube down through it so you can feed oil in through the tube while air escapes around it; a capillary tube on a syringe would work well. If you can figure out how to get the oil in via the zerk fitting, great, but otherwise you might want to remove the zerk fitting and

plug that hole with a screw. Again, the enlarged hole with felt or cotton jammed in it provides the simplest solution: remove the felt or cotton, fill up the chamber with oil, and jam the felt or cotton back in.

When set up this way, you want the assembly *full* of oil; that's the only way oil will get to the rollers at the top of each bearing, since they don't spin. Griffiths points out you want to keep the seal lips wet, too. So, add oil until it appears at the breather. This will still leave some air pockets, but driving uphill or downhill will help make sure those upper rollers get oiled every now and then. Driving over bumps may splash some oil around in there.

Tom Wilson says, "Thoughts on oil filled hubs bring back a time when Bell Helicopters figured out that the oscillating movement of the pitch change on the rotor blades would tend to work the lube out of the needle bearings and would allow metal to metal contact. They went to great lengths to seal the blade grip to yoke contact point, and even supplied a clear reservoir so one could easily check the oil level in the grips. It was for the most part a failure and you will usually only see a UH-1 with an oiled head in a museum. The point of this tirade is simply that on a worst case, that being an oscillating load the oiled bearing was replaced by greasing. Replacing the felt wiper with a rubber lipped seal and using a synthetic grease like Mobil (that horrible red stuff you always see being slung out of the heads of Bell helicopters) will almost guarantee that the wheel bearings will outlast the rest of the car."

REAR SWINGARM OUTER PIVOT - SERVICING: Do your pivot joints need attention? Probably. Patrick MacNamara's did: "Old bearings were completely shot. The worst were the ends closest to the front of the car. The starboard side inner race was almost a rusted solid mass and the outer race was pitted and dented. There had been so much movement that it had chewed and straightened one of the annular spacers. The yaw I used to experience when letting off the gas at speed is now gone as well as a little rear end steer/swaying when changing lanes at speed. I think these things should be disassembled and regreased as well as rotated a few degrees every few years."

Greg Meboe had sloppy bearings. "This can be noticed as a light to medium growling vibration as you're driving on the freeway. This occurs only during the transition as you gently press and release the throttle. This can be misdiagnosed as a differential problem. To test, jack up one side of the car under the steel lower suspension arm, then remove the wheel. Pry a flat-blade screwdriver between the aluminum hub carrier and the steel lower suspension arm. Try to wiggle the carrier forward and backward, while the suspension is at ride height. Otherwise, you can look for evidence of scraping between the carrier and the lower arm."

If you only need to rebuild the outer pivot joint, here are some things you *don't* need to do: You don't need to drop the rear suspension cage. You don't need to fiddle with the shocks and springs. You don't need to fiddle with the radius arm. You don't need to mess with the rear anti-sway bar, if you have one.

The fact is, working on the outer pivot is pretty easy; just slide the axle out of the hub and remove the fulcrum shaft from the pivot, and you can work on the hub carrier on the bench while leaving the swingarm in the car. This hub carrier removal is clearly described in Section 64.15.01 of the ROM, but is not as clear in the Haynes where the section on rebuilding the outer pivot itself follows a section on removing the entire swingarm from the car. This seems to imply that outer pivot work requires removing the swingarm from the car first, and that would involve some serious work. Removing the swingarm is totally unnecessary; if you're using the Haynes, just follow steps 1, 2, 5, 6, 7, and 8 of Chapter 8, Section 4. Then you can begin taking the pivot apart according to Chapter 11, Section 22, and as soon as the fulcrum shaft comes out you can relocate the hub carrier to the bench.

The hub carrier removal procedures call for removing the cotter pin and the castellated "Jesus nut" holding the axle in the hub. If you just happen to have wheels that permit access to this nut, it's easier to break it loose *first* while the car is still sitting on the wheels.

The procedures also call for a special Jaguar tool JD.1D to get the axle out of the hub. A generic hub puller will do -- but you might not even need a puller at all, it might just slide out. If you can get the Jesus nut off while the wheel is still on -- or put the wheel back on afterwards -- you can yank outward at the top of the wheel to jar it loose.

Still sounds like too much effort? Then forget removing the hub carrier; rebuild the outer swingarm pivot right there on the car! Patrick MacNamara says, "Very simple job to replace the fulcrum bearings without disconnecting the hub from the splined axle. I just laid an 18" 2x4 across the lower arm fork and rested the hub carrier on its side on the 2x4 for the pounding out of the old bearing cones."

Section 64.15.07 of the ROM and Chapter 11, Section 22 of the Haynes manual provide step-by-step procedures for rebuilding this pivot. However, many owners have expressed confusion; in fact, apparently Jaguar was confused, because there are different procedures described in the manuals for different cars that all use the same rear suspension assembly. John Napoli says, “I have opened up three fulcrum assemblies on three different Jags (my XJ6, my XJ-S and another) and each had the parts in a different sequence, none of them matching the various and sometimes ambiguous manuals.”

The confusion is also partly because you need something more than step-by-step procedures -- you need to know what the hell you’re doing! There are two separate shimming procedures involved. Both are described in the following pages; once the objectives are understood, the step-by-step instructions should begin to make more sense. **Figure 22** shows the assembly, assembled at the right and the individual parts to the left indicating the order of installation. The fulcrum shaft has been omitted, since it makes the diagram clearer and you know where the fulcrum shaft goes.

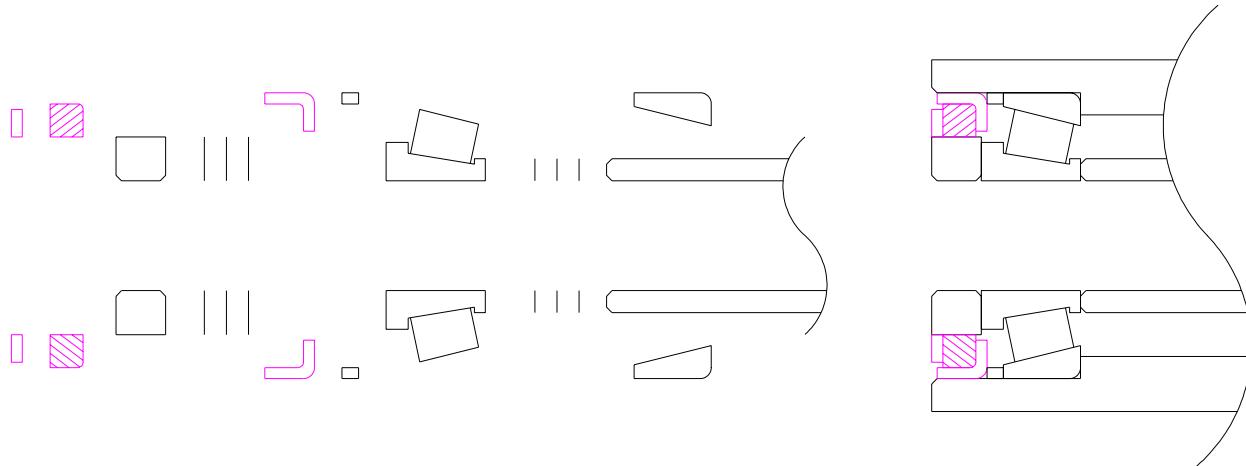


Figure 22 - Rear Swingarm Outer Pivot Assembly

Section 64.15.07 of the ROM includes instructions for rebuilding the outer pivot and for rebuilding the wheel bearings, all in the same sequence. That only causes more confusion; although both bearing assemblies are within the same hub carrier, they are unrelated operations and should have been described separately. If you are only rebuilding the pivot joint, you only need concern yourself with steps 1-3 and 18-31. The Haynes manual does describe them separately -- in fact, in separate chapters, as the wheel bearings are covered in Chapter 8.

Disassembly is fairly straightforward until right after you remove the felt seal ring itself. There is a metal ring with an L-shaped cross section (looks like an oil seal with the rubber part missing) that the felt seal ring sits in, and this ring is pressed into the hub carrier. There doesn’t seem to be any non-destructive way to get it out; you just have to put a screwdriver in there and pry, which will usually mangle it beyond reusability. So, if you plan to rebuild using the OEM felt seal scheme, you probably should order four new rings C20179 in advance; Craig Sawyers says, “this is an expensive part - the price I have is £7 (about \$10) each, and there are four on the car.” Better idea: rebuild using the oil seal scheme described below, which doesn’t require these rings.

While you have it apart, take a flat file and file a small bevel on the inside corner of the outboard ends of the swingarm fork. Don’t make it at 45°; rather, make it nearer to parallel to the flat inside surface of the fork tine, perhaps a 10° angle. These bevels will make it easier to get the hub carrier back into place in the fork.

The outer pivot reassembly calls for a “dummy shaft”, JD.14. John Robison suggests you use a 5/8” wooden dowel. Cut it to exactly 6” long. Note that a 5/8” wooden dowel may not be machined all that precisely, so trial fit it through a new bearing before you get started. If it fits snugly at all, spend a few seconds with some sandpaper on it. It needs to be a slip fit, so it’s easy to slide in and out of the bearing assembly. If it’s humid out, you may need to sand it some more.

Richard Dowling had another idea: “In my collection of rubber items I had some 5/16” ID rubber fuel hose that was near as dammit 5/8” OD. This made excellent dummy shafts, especially for the inner fulcrum shaft that needs a real belting to get back into position. With hard dummy shafts that belting can easily propel the dummy out and drop a big

collection of seals and spacers all over the bench. The rubber dummy is much less likely to be inadvertently propelled and thereby helps keep your blood pressure low.”

The fulcrum shafts in the author’s ’83 have a little dowel tip on one end. Purpose unknown. If installed pointing to the rear, it may permit the use of a simpler ride height setting tool than the one shown in **Figure 17** on page 331. Other than that, the fulcrum shafts can be installed with this tip pointing forwards or rearwards, it won’t make any different to the pivot joint itself.

REAR SWINGARM OUTER PIVOT - BEARINGS: Craig Sawyers says, “Jag supplied a couple of cut-outs on the inside of the hub so you can get a brass drift in to knock them out. Of course, that will be buried in grease, so you have to go by feel, but it is not a difficult job.” It helps somewhat to have a drift that’s shaped just right at the tip, so you might consider grinding the tip a bit -- flatten one side, etc. Also, it doesn’t need to be brass unless you plan to reuse the bearing; a steel rod will do. And make sure to switch back and forth between sides with *every* whack; you don’t want to get that race cocked sideways.

Generic bearings can be used, of course. Gregory Wells says, “Inner cone and bearing is Timken 03062, outer race is Timken 03162, for Jaguar p/n C-16029.” Duncan Williamson indicates that NSK bearings use the same numbers. Ron Moore says “These are the same bearing and cap as those fitted to the Triumph Herald front wheel bearing outer.” Moore is in New Zealand; if you’re in the US, it might be more useful to know that it’s also the same bearing as the outer front wheel bearing on the Triumph Spitfire and TR6 which were actually imported to this country.

Wells, a Jaguar parts vendor, adds, “Don’t assume that because these bearings can be ordered by numbers from a bearing house that they will automatically be cheaper than from the parts peddlers like ourselves. Jag vendors will be cheaper than bearing houses on the Jag-specific bearings a goodly percentage of the time.”

Sawyers: “Replacing is easy. Stick the hub in the oven (I waited until my dearly beloved was out) at 100°C. Put the bearing track in the freezer. The two parts just drop together, and then tighten up as the assembly cools down. When it is cool, give the track a knock or two with a drift just to confirm it is completely seated in the recess.”

Conversely, Patrick MacNamara -- who didn’t remove the hub carrier from the car so it couldn’t very well go in the oven -- used a length of threaded rod with nuts and washers to pull the bearing races into place.

The author used a similar method, except using the fulcrum shaft and nuts themselves. You *will* need two 5/8” flat washers with a 1-1/2” OD, and it’s nice to also have two 5/8” flat washers with a 1-3/4” OD. Use the 1-3/4” OD washers to pull the races in until they are flush with the ends of the hub carrier, then switch to the 1-1/2” OD washers for the rest of the way. The threads on the fulcrum shaft aren’t very long, so you have to stop a few times and add more spacers. The old bearing inner races make fine spacers.

REAR SWINGARM OUTER PIVOT - REPLACING BEARINGS WITH BUSHINGS: Tapered roller bearings work best when rolling continuously; the motion helps feed grease in between the contact areas, and the continuous motion ensures a uniform wear track. But the bearings in this pivot don’t roll far enough. Hence, the wear is not uniform, but rather in local spots on the race. And the grease can get pushed out from between the contact points, piled up between rollers, and the contact points actually run dry. The result is a pattern of dimples on the bearing races.

Greg Meboe agrees: “As a mechanical engineer, I must say that the choice to use tapered roller bearings in the hub pivot area is poor, really poor. A roller bearing is designed to roll continuously, not sit in a static position. This pivot has a high amount of stress on it during acceleration, braking and cornering, yet never turns more than one or two degrees total! As a result the race become brinnelled, indented by the rollers which press but don’t turn.” Note: the roller bearings in this location are not only subject to brinnelling (impact damage), but also “false brinnelling”, which is a wear pattern that looks like brinnelling but involves no impact. Doesn’t really matter which, either way the bearings are ruined.

Gran Turismo Jaguar (now defunct) offered a kit to replace the tapered roller bearing idea entirely with brass bushings. Concours West (page 659) offers urethane bushings. Either of these has the considerable benefit of being an order of magnitude easier to install, since there is no need for adjustment and fiddling with shims.

However, whether or not going to bushings is actually an improvement is far from clear. First, note that the entire point of renewing these bearings is to eliminate sources of slop in this joint, but you cannot adjust the slop out of bushings. If the bushings don't fit *very* snugly on the fulcrum shaft, the slop may get worse rather than better. And even if the bushings are really snug, of course, any wear in those bushings would cause slop -- if you're unlucky, more slop than would be caused by the wear rate of the OEM tapered roller bearings.

There's also the question of the quality of design and construction. For example, the OEM assembly provides a stack of parts all the way through the assembly so that the fulcrum nuts can be torqued down tight without being concerned about distorting the fork on the end of the swingarm. The same stack clearly won't work since there are no longer any inner bearing races, so a well-designed bushing set would either provide a single sleeve to surround the fulcrum shaft and fit inside the bushings, or short sleeves for use with the OEM spacer tubes. Steve Stewart says, "The solid bushes I put in the E-type were from Classic Jaguar in Texas (www.classicjaguar.com). No sleeves at all. The shafts fit straight through the bushings which are a nice push-in fit to the hub carrier and wishbones." Apparently you must be careful not to overtorque the fulcrum nuts so as not to distort the swingarm.

Seals are apparently another issue. Stewart continues: "I don't believe that grease retention is as good as the roller bearing set up though as there are no seals used. Also instruction to grease these every 3000 miles or so."

Actually, urethane or nylon bushings might be better than brass or bronze. With plastic, it may be possible to assemble a really tight fit, and wear could be minimal if the load distribution is within the capacity of the plastic. The plastic bushing might serve as a seal without requiring a separate seal; it might even be molded with a sealing lip. It still should have a metal sleeve around the fulcrum shaft, though.

All in all, it might be best to just maintain the OEM roller bearings properly and replace them periodically when they get worn. They are not expensive, and replacement is pretty easy.

REAR SWINGARM OUTER PIVOT - SEALS: One common suggestion here is to reverse the felt seal and cup during assembly, but this is probably because the exploded diagram in the Parts Catalogue shows the felt seal and cup backwards and these people have just figured out the way it's *supposed* to go.

Even installed correctly, there is considerable history of rust, corrosion, and water damage with the outer pivot bearings. Craig Sawyers says, "The truly awful felt seal ships water like you would expect; it simply acts like a wick."

In his column "Tech Talk" in Edition 82 of The Jaguar Magazine, Ron Moore recommends the seal C20178, its container C20179, and its retaining washer C20182 be omitted; if you printed this book in color, these parts are shown in magenta in **Figure 22**. In their place, Moore recommends a "common oil seal PR6354" be installed instead -- backwards, with the flat side of the seal facing the bearing.

More info on that seal: PR6354 is a Repco part number, and it cross-references to a Federal-Mogul/National 471652 or a C-R 11124. Timken also calls this seal a 471652. The dimensions of this seal are 1.125 x 1.624 x 0.250. Duncan Williamson says that Farrell Bearings Ltd stores in New Zealand provide a seal number TC12044 23560R. Sawyers reports that Classic Spares (page 642) offers an "outer fulcrum bearing kit" that includes the bearings, an assortment of shims, and suitable oil seals instead of the OEM felt seals.

Moore has a point about that backwards installation. Seals are normally used to keep fluids *in*, but in this case they are used to keep fluids *out*. The main lip within such a seal, which has a spring behind it, will hold fluids securely in the direction that would result in fluids coming out the flat side, but not as securely in the direction of fluid entering the flat side.

That wisdom notwithstanding, this author is going to recommend that you install the oil seal forwards, with the flat side on the outside. Modern oil seals have two lips, the main one facing one way and a tiny one facing the other way, and either one of these seals -- facing either way -- is likely to seal far better than the felt seal assembly ever dreamed of

sealing. But perhaps more importantly, installing the oil seal flat side out would seem to provide better protection from physical damage; most of the delicate parts of the seal are enclosed behind the metal surround.

Moore also suggests that the spring on the seal be removed and replaced with an O-ring BS024. This is probably just because, with the backwards oil seal installation, the spring will eventually rust away since it is on the side of the seal exposed to the elements. A suitable O-ring sold at Discount Auto Parts is made by O-Tite!, number 64024; it is 1-1/8" ID, 1-1/4" OD, 1/16" thick. It even comes in packages of four. Of course, you can omit the O-ring substitution and just leave the spring in there; it'll probably last ten years, perhaps long enough you'll need to be back in there to replace bearings anyway.

If you install the oil seal flat side out, you should *not* make this O-ring substitution for the spring. Rust won't be a problem, since the spring will be inside the assembly and presumably well greased. But the grease used may attack the nitrile of an O-ring.

There is a spacer C20180 within the OEM assembly that holds the outer ring C20179 surrounding the felt seal away from the bearing. A similar spacer is called for with the oil seal, but the oil seal is narrower than C20179 and therefore needs a wider spacer. You have several options. First and perhaps easiest, you can wrap a length of 0.064" steel wire (14 gauge) around a big socket to form a loop, and install it alongside C20180. Since C20180 is about 0.095" wide, this will make the total about 0.160" wide, about right. **Figure 23** shows the oil seal and the wire loop spacer in red. Another option would be to cut a strip of sheet metal about 0.150" wide and wrap it around a big socket to make a loop and use that -- and throw C20180 away.

Sawyers provides another option: "Classic's verbal instructions for their kit of bits is to throw everything away except the seal track (C16628). You just tap in the new grease seal until it is flush, or slightly recessed from the face of the hub." That'll work if you're careful and don't tap it in too far.

When you're putting all this together, remember that water is sneaky. With a good lip seal keeping the water from getting in between the seal and the seal track, that water might still sneak in there between the ID of the seal track and the fulcrum shaft itself. Hence, it would probably be a good idea to put some sealant between the seal track and the fulcrum shaft, although it's not clear how to get any to stay in there through the process of inserting the fulcrum shaft while driving the dummy shaft out.

A better idea may be to apply a sealant such as Loctite 518 to both ends of the distance tube, both ends of each inner bearing race, both sides of each seal track and both sides of every shim. This way, when the assembly is tightened up, all those joints will be sealed. Water could conceivably get in along the fulcrum shaft, but it couldn't get from there to the outside of the stack of parts along the shaft where the bearings and grease are. A workable plan, but be careful not to slop too much sealant on any of those parts; you don't want a lot of sealant squeezing out and getting into the bearings.

While you're being so careful to keep water out, note that Jaguar provided a nice little hole above the grease fitting to let in plenty of water. See the section on greasing these bearings 361.

REAR SWINGARM OUTER PIVOT - SHIMS: As described below, there are two separate and distinct shimming procedures involved in rebuilding the rear swingarm outer pivot joint. These two operations require two different shim designs; both need to fit on a 5/8" shaft and both require an assortment of thicknesses for adjustment, but the OD's of the shims need to be different. Craig Sawyers explains Jaguar's shim numbering scheme: "The parts book has two distinct types of C16626:

C16626/1	0.003"	for fork centring
C16626/2	0.007"	for fork centring
C16626	0.003"	for preload
C16626/3	0.007"	for preload

Preload shims: O/D 7/8", I/D 0.695 (11/16" clearance)
Centring shims: O/D 1-1/8", I/D 0.695 (11/16" clearance)

"As you'll see, the preload ones are real skinny, with a wall of rather less than 3/32", as compared with the larger ones with 9/32"."

"Centring" is gonna play hell with my spellchecker; why can't the Brits learn to spell?

The shims used for setting the bearing preload *must* have an OD smaller than 15/16" or they will interfere with the free movement of the bearing roller cage. Shims with an OD smaller than 1-1/8" would work as fork spacing shims, but they will weaken the assembly somewhat; best to use the intended items.

A comment from the author as engineer: The guy at Jaguar who decided to give these two distinct and non-interchangeable types of shims the same part number with different suffixes deserves a thump on the head.

Note that you *will* need some preload shims to do this job. The selection procedure involves assembling the bearings with too many preload shims, measuring the slop, and removing shims accordingly. You can't do that if you don't have too many shims to begin with. Just order a couple of each of the four shim part numbers while ordering the other parts you'll need, and just put it down as the cost of a rebuild.

Of course, you can find generic shims. Grainger (page 661) offers an "arbor shim assortment", stock number 3L739, for less than \$10 that contains 19 different thickness 5/8" ID shims. The OD is 1", which really isn't right for *either* preload shimming or fork shimming, but you could conceivably cut the OD down to use them as preload shims.

You could also make shims, of course, by simply cutting them out of steel or brass shim stock.

You need to know just how thick your shims are, so you know how many to remove to set the preload correctly. It's probably not a good idea to rely on Jaguar's indication that its shims are 0.003" and 0.007"; Patrick MacNamara says, "My C16626s came from the dealer at .004". This author measured his brand new shims as 0.004" and 0.006". If you can, measure yours for yourself.

REAR SWINGARM OUTER PIVOT - BEARING PRELOAD SHIMMING: The first shimming procedure involved in the rear swingarm outer pivot assembly is to preload the tapered bearings properly. When you tighten the nuts down on the fulcrum shaft, you're gonna be jamming the cones of both tapered bearings down tight into the cups, so there is a "distance tube" -- or maybe two distance tubes end-to-end -- that space the cones apart. Shims C16626 (.003") and C16626/3 (.007") need to be selected and installed to space the cones the precise amount necessary to provide the correct amount of preload; too many shims and the bearings will be rattle, too few and they will be jammed too tight. The shimming procedure is described in Section 65.15.07 of the ROM in steps 18 through 28, and also in the Haynes manual, Chapter 11, Section 22, in steps 10 through 16. Basically, the idea is to put the assembly together with too many shims, measure the axial play, and then take it apart and remove shims equal to the play plus .002" -- yes, the assembly should be two thousandths *tight* when done.

Both the ROM (step 22) and the Haynes (step 14) mention using an inner swingarm pivot thrust washer in this trial assembly; you measure the play between the washer and the edge of the hub carrier with feeler gauges. Obviously, if you don't have the inner swingarm pivot apart, that washer isn't available -- and you aren't going to want to take it apart just to borrow that washer for a minute. All you need is a flat washer with a 5/8" hole in the middle and an OD of at least 1-3/4". Note, however, that it would be best to have a really *good* flat washer, as anything flimsy or with a rough or uneven surface may affect the feeler gauge reading -- and you're looking to get the shim measurement right, not just close. You might opt to file or machine on the face of that washer facing the hub carrier to get it as flat and true as possible. Also: mark both the washer and the hub carrier housing so that you are always using the feeler gauges at the same spot.

Of course, you could measure the end play using other methods. You can set up a dial indicator, for example.

The shims can be installed anywhere in the stack between the bearing cones -- at one end, the other end, or in the middle between the two distance tubes -- and it will accomplish the same thing. The manuals describe putting them in the middle between the two distance tubes (steps 27 and 28 in the ROM, step 11 in the Haynes). However, at some point Jaguar figured out that manufacturing one long tube requires less machining than two short tubes. The Parts Catalogue,

©1987, shows it as a single long tube C.16623/1. In fact, every XJ-S owner who has reported says they found a single long tube rather than two short tubes. So, just put the shims at one end or the other; it doesn't matter which end.

The cross-section diagrams in the ROM show a shim in the center between two short tubes. If you have one long tube, don't waste too much time trying to figure out what that drawing is trying to show you there.

The ROM recommends tightening the trial assembly to 97-107 ft-lb, and the Haynes recommends 95 ft-lb. Basically, this is final assembly torque. Here, I will differ with the official recommendations and suggest you do *not* tighten the trial assembly that much; go to 40-50 ft-lb only.

Here's the reason: at trial assembly, you will be turning the two nuts against each other, and somewhere in the stack between them there must be slippage. This slippage will probably occur at the shims. In achieving full assembly torque, the thin shims may decide they've had enough and get ripped out of the stack forcefully by the shear loads. This isn't a problem at final assembly, because the ends of the swingarm fork are involved; they positively prevent any twisting within the stack, and force the nuts to slip on the swingarm fork faces as they are tightened. The shims won't be harmed by pure compression.

REAR SWINGARM OUTER PIVOT - SWINGARM FORK SHIMMING: The second shimming job isn't as critical as the bearing preload; the idea here is merely to make the bearing/seal stack nearly the same as the width of the fork on the swingarm so that as the nuts are tightened down the swingarm doesn't get distorted. Basically, insert shims C16626/1 (.003") and C16626/2 (.007") until the hub carrier fits snugly between the ends of the swingarm; put in as many shims as you can and still fit the hub carrier into the swingarm fork. And put some of the shims at the front and some at the rear in order to position the hub carrier approximately centered in the fork.

This shimming procedure is described in the ROM in Section 64.15.01 in step 10. Or, I should say, *isn't* described in step 10. It just says to put the shims in. The description in the Haynes, Chapter 11, Section 22, steps 18 and 19 is *much* better, brief as it is.

Richard Dowling says, "When it was time to check for the large shims which ensure the assembly is a neat fit in the fulcrum fork, I first put all the bearings etc. into the hub and tried that in the fork. It is just too clumsy and difficult to make sure the bearings are tight and at the same time check the end float for shim size. Instead I went back to just putting the bearings, spacers and shims on the shaft and torquing it up with some spacers. I then offered the shaft up to the fork and checked with feeler gauges. Of course the shaft is not fully into the fork but it is easy to handle and measure. On final assembly it is simple to see if you got that wrong, either the hub fit into the fork is too tight or there is obviously too much endplay."

Both the ROM and the Haynes seem to imply that these shims get installed between the hub carrier assembly and the swingarm fork, and the exploded diagram in the Parts Catalogue confirms it. *Don't* put them there! Install these shims *inside* the oil seal track, between the oil seal track and the bearing.

REAR SWINGARM OUTER PIVOT ASSEMBLY: Confused? Yeah, that's understandable. So, here is a brief summary of the assembly procedure using the oil seal in place of the felt seal. Refer to **Figure 23**, which shows the assembly together at the right as well as the individual parts to the left -- indicating the order they should be installed. This procedure assumes that all parts are clean and ready for assembly, and whatever you decide to do with the grease relief vent has been done and any metal chips or whatever have been cleaned out.

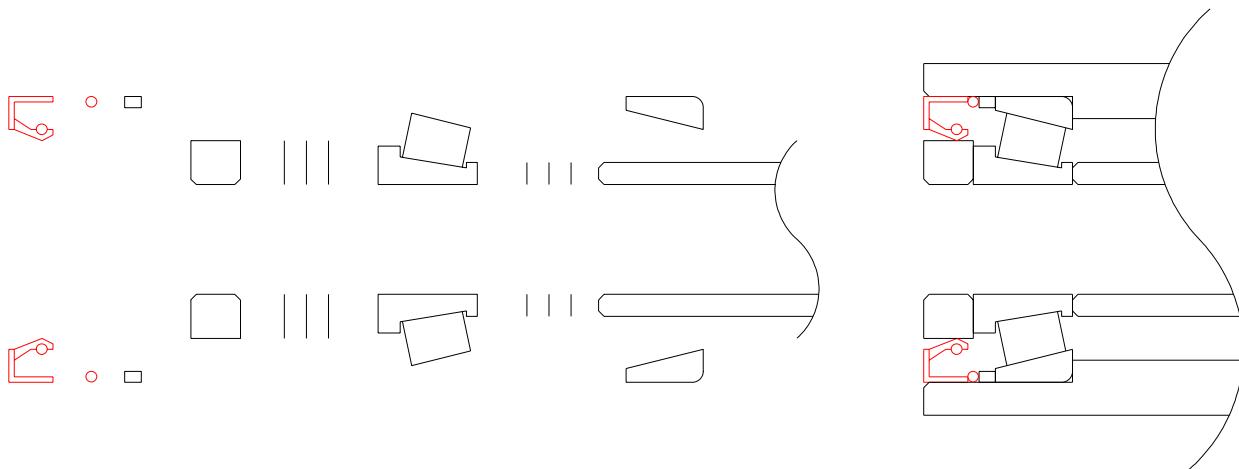


Figure 23 - Rear Swingarm Outer Pivot Assembly w/ Oil Seal

- 1) Install the outer races.
- 2) Trial-assemble the center stack using the real fulcrum shaft, distance tube, preload shims, bearings, seal tracks, one 5/8" fender washer, the inner races of both the old bearings as spacers, and the nuts. Use 0.010" more preload shims than came out of it. Tighten the nuts to around 40 ft-lb and measure the end play.
- 3) Take it back apart, and remove preload shims equal to the end play plus 0.002".
- 4) Reassemble the distance tube, selected preload shims, and bearings, using the dummy shaft this time.
- 5) Divide the fork spacing shims that came out of it into two nearly equal groups. Insert one group of fork spacing shims against each bearing, and put the seal tracks in.
- 6) Trial fit the hub carrier to the swingarm fork again. If it isn't a snug fit, you need more shims. If the clearances between the edges of the hub carrier and the inside surfaces of the swingarm fork aren't nearly equal front and rear, you need to redistribute the fork spacing shims.
- 7) Insert the skinny spacer ring C20180 in each end against the outer bearing race, along with an additional spacer made by forming some steel wire about 0.060" thick into a ring.
- 8) Remove one of the seal tracks. Push the seal track into the center of an oil seal, and check it carefully to make sure the lips are positioned properly on the track. Install the pair together, carefully tapping the seal in until it seats on the spacer rings. Repeat for other end.
- 9) Install the hub carrier in the swingarm fork. Insert the fulcrum shaft, pushing the dummy shaft out the other side. If the fulcrum shaft starts to hang up on a shim inside somewhere, merely turn the shaft to screw the shaft past the shim.
- 10) Install washers, the link to the shock absorber bolt, and the nuts, and tighten.

REAR SWINGARM INNER PIVOT: Unlike the tapered roller bearings at the outer end that are sealed with felt, the bearings at the inner end are non-tapered needle bearings and sealed with rubber rings with an X-shaped cross section. These seals don't really seem to be a problem. The rubber sealing rings can be replaced with an O-ring in a pinch, but the OEM rings C17213 are probably better.

The bearings will still have the wear problems associated with non-rolling roller bearings. Gran Turismo Jaguar (now defunct) offered brass bushings to replace these needle bearings; you could probably have bronze bushings fabbed up at any machine shop. Since the OEM roller bearings are not tapered and have no adjustment, you should be able to easily attain comparable or less slop with bushings as with the OEM bearings.

IRS UPGRADES: When searching the various sources for products to improve the XJ-S suspension, keep in mind that the Jaguar rear suspension has been largely unchanged since the introduction of the E-Type. This assembly is very popular with the hotrod and custom car types. As a result, ads for parts for improving this suspension can occasionally be found in some decidedly non-Jaguar publications.

CHEAP REAR SUSPENSION UPGRADE: On the SportsPack, the bushings at both ends of the radius arms are different. The bushings at the small end are made with a stiffer rubber. However, the bushings at the front end are the same as on the standard XJ-S except that they are rotated 90°. These bushings have two holes through the rubber, and on normal cars the holes are aligned with the radius arms so that push/pull forces apply directly at the holes. On the SportsPack, the holes are aligned crossways to the radius arms, so push/pull forces apply to solid rubber. If you'd like your IRS to be a little stiffer, you could apparently do some good with a press without even buying any new parts.

REAR ANTI-ROLL BAR BUSHINGS: If you are adding a 9/16" bar to the rear of a car with no rear bar or simply wish to replace the existing bushings on a pre-1982 model, in place of the stock bushing C44931/2 and bracket C42114 you can use a generic 9/16" polyurethane bushing and bracket assembly available from many aftermarket sources. J. C. Whitney (see page 643) offers "A" and "B" style "ProThane" bushing/bracket sets (see Dee Engineering, page 666), with the "B" type being a little larger and more substantial. The "B" bushing must be modified slightly for the XJ-S by cutting notches along the bottom edges, but polyurethane is easy to cut with a razor knife or hacksaw so it only takes a minute and this makes an excellent installation. The "A" type would probably also work in this application.

If you are adding a heavier rear anti-roll bar or replacing the stock bushings on a Sportspack model, Addco (see page 663) also offers polyurethane bushing kits in sizes 5/8" and up and in several different styles. Their "B" series is their "small shoulder style"; their "D" series is the larger, heavier unit with no shoulders; and they also have a "W" series that is a large shoulder style. Any of these can be made to fit the XJ-S rear, although the "B" series requires that the slotted holes be elongated a little with a round file to fit over the studs. The "D" and "W" come only in urethane, while the "B" normally comes with rubber bushings but can come fitted with urethane if you ask. The "W", being similar to the J. C. Whitney "B" type described above, may require the same minor trimming on the urethane bushing. Addco's catalog lists their "B" for the rear of the XJ-S, but the "D" or "W" are actually better choices.

As with the Addco front bushings, cutting a slit in the polyurethane rear bushing will make it much easier to install and won't hurt anything. At the rear, the loads are vertical but the bushings are mounted at an angle, so the cut should ideally be made at an angle so it is located horizontally when installed.

ANTI-SWAY BAR END LINK BUSHINGS: If your XJ-S has an OEM rear anti-sway bar, the "dogbone" end links (C42907) that connect it to the radius arms come complete with pressed-in bushings; when they are shot, Jaguar expects you to purchase the entire dogbone. Joe Bialy found the individual bushings, though: "Try C10940. They're \$3.57 each from Welsh. I think they're an E-type part, but they are an absolute perfect press fit into the dogbone."

If this is true, maybe somebody makes a urethane part for an E-type that could be used here. Or, maybe a larger bushing intended for something else could be machined down for use here.

It isn't all that important anyway; the OEM bushings are actually pretty stiff. The real problem is in the radius arm bushings; see below.

GT Jaguar (now defunct) offered a rear anti-roll bar kit in which the end links appeared to be totally rigid, having metal ball-and-socket joints at both ends. Note that, if a lack of harshness or noise is important, it may not be necessary to have soft components at *both* the end links and the center mounts; rigid links at the ends may work fine for street use if combined with rubber or poly center mounts. One would expect, though, that using rigid end links together with the rigid blocks for center mounts might be best considered a competition-only configuration.

REAR ANTI-ROLL BAR MOUNT STIFFNESS: While you are trying to stiffen the mounts of the rear anti-roll bar to increase its effectiveness, note that the end links on this bar don't connect to the hub carriers. They connect to the radius arms, which in turn are connected to the hub carriers via a very soft bushing. Hence, even if you make the anti-roll bar mounts and end links totally rigid, much of its effect will still be absorbed in the soft bushings at the rear end of the radius arms. Conversely, if you replace the soft bushings at the rear end of the radius arms with something more rigid, you will suddenly find your rear anti-roll bar more effective. Note that the bushings at the rear end of the radius arm on the SportsPack models are stiffer than the basic units.

REAR SUSPENSION REINFORCEMENT: Among those who have developed more torque at the rear wheels of a Jaguar, the rear suspension cage mounts are a known weak spot. If your car can smoke the back tires, it apparently can also rip these suspension mounts fairly readily. According to Mark McChesney, "There are hard rubber mounts available from SNG Barratt" (see page 645). British Auto USA (page 641) also offers a set "in a bonded neoprene of higher durometer than stock."

However, the problem isn't really with the stock mounts; it's a result of the way in which the rear cage is supported -- which is in turn a result of the way the rear suspension works. Since the lower swingarms swing about a pivot parallel to the centerline of the car, the hub carriers need to move only vertically and laterally through the suspension travel range. The radius arms, however, pivot around their forward mounts and therefore try to pull the hub carrier axially forward and back a little as the suspension travels. If all of the mounts and pivots were totally rigid, the whole suspension would seize up. Since the cage is mounted at the top with four rubber mounts that are fairly close together, the entire cage is free to tilt slightly forward and back to allow the radius arms to pull the hub carriers forward and back a little. Also, the rubber mounts at both ends of the radius arms are very soft, so they can give a little to reduce the hub carriers axial motion.

This all works very well under most conditions, but doesn't take to drag racing well. The radius arms are supposed to absorb the forward loading at the hub carriers, and also prevent excessive tilt of the cage assembly -- they attach to the lower swingarms, but those in turn are rigidly pivoted (needle bearings) at the diff to only move up and down and not forward or back, so cage rocking should be effectively limited. However, the radius arm mounts are soft and a lot of torque apparently causes the entire cage to flex and twist, and the upper cage mounts seem to suffer.

The best solution appears to be to add some sort of additional link to accept the torque loads within the cage while allowing the stock mounts to deal with weight loading only. Several of the aftermarket outfits reportedly offer some sort of kit along these lines.

REAR SUSPENSION GEOMETRY CHANGE #1: The combination of rigid needle bearings and soft rubber mounts in the rear suspension assembly have a net effect of pulling the rear wheels forward a little as the suspension travels either direction from normal ride height; effectively, the hub carrier rotates about an axis that is roughly a line from the inner end of the lower swingarms through the forward mounts of the radius arms -- an axis that is at a rather severe angle to the centerline of the car. In other words, as the wheel moves away from level, it also moves forward and turns in a little, providing a little rear-wheel steering. The effect of this stock design is to provide a lot of stability on the freeway, making the car impervious to crosswinds and the like. (And you thought it was just because the car is heavy? Get real.)

In racing, such stability due to rear wheel steering is also desirable, but to a much lesser extent -- a lot of it tends to make the car corner poorly when fitted with racing tires and driven near the limits of adhesion. So, the radius arm is often altered to move the forward pivot closer to the centerline of the car. The axis of suspension travel is still a line from the inner end of the swingarms to the forward mounts of the radius arms, but since the forward mounts of the radius arms are closer to the center of the car, this line is much closer to parallel with the centerline of the car. This reduces the rear wheel steering effect and allows the driver more control over how the car drives at the limit of adhesion. According to Mark McChesney, "Terry's (page 646) is now selling a full kit to convert to a diagonal radius link (with diff cage supports). I'm not sure the kit will work on an XJ-S, I think it's intended for E-types."

REAR SUSPENSION GEOMETRY CHANGE #2: The Jaguar IRS is commonly used on hot rods, Cobra replicas, and other custom applications. In these applications, it is typical to mount the differential rigidly to the chassis of the car and eliminate the radius arms altogether, in order to provide the cleanest and most visually attractive chassis. Some people advocate making the same change to the stock Jaguar; the components are certainly strong enough to do this. However, this is a radical geometry change from the stock IRS in the XJ-S resulting in no rear-steering stability whatsoever and will make a quite noticeable change in the handling of the car. Also, having the diff rigidly mounted will result in more gear noise and road noise transmitted into the car.

In both the hot rod and Cobra applications, the suspension is normally sprung so stiffly as to not move much anyway, you're driving a go-kart rather than a car, suspension geometry is not an issue. The Jaguar XJ-S is an excellent handling car even though it is softly sprung. If you wish to maintain this, you should not consider eliminating the radius arms.

Wheels and Tires

ALLOY WHEEL SEIZING: Believe it or not, one of the places where Jaguars are known to have seizing problems is between the alloy wheel and the hub. Robert Woodling suggests use of anti-seize compound on the mating surfaces, especially at the hole in the center of the wheel.

If your wheel is already stuck, you might as well try loosening all the lugs about two full turns, take the car down off the jack and drive it up and down the street. Swerve left and right a couple of times. Of course, if the tire is flat you won't want to do this -- so you might want to check if your wheels are stuck *now* and take corrective measures *before* you're stuck on the side of the road with a flat tire.

WHEEL INTERCHANGABILITY: When Jaguar introduced the Anti-lock Braking System (ABS) in the XJ-S, they also introduced the "lattice" alloy wheels. Some reports at the time suggest these changes were related; apparently, the "domed starfish" wheels used on earlier cars would interfere with the ABS hardware. The bolt pattern, offset, width, and other dimensions remained unchanged, so the lattice wheels can be used on earlier cars. But if the reports are true, the domed starfish wheels cannot be used on later cars.

XJR-S WHEELS: John Goodman reports that the XJR-S uses "8" wide special alloys (the front and back wheels are not interchangeable because of different offsets.)"

SPOKE WHEELS: Yes, a Jaguar with real wire wheels really looks good. Unfortunately, it generally doesn't drive worth a hoot. The spoke wheels available have a reputation for trouble. Spoke wheels were a good idea in the '50s when Jaguars needed to maximize air flow to cool their brakes. Since that time, two changes have conspired against spoke wheels:

1. The advent of tubeless tires. Many spoke wheels won't work with tubeless tires, so you must install a tube. A tube installed in a speed-rated tire (the XJ-S should be fitted with V-rated tires) completely negates the rating, and renders the tire unsafe at speed. Don't drive fast with inner tubes in your tires!
2. The advent of low, wide tires. A spoke wheel is a reasonable structure when it's tall and skinny, like a bicycle wheel or the automobile wheels of the '50s. But it is a structurally poor design for modern low, wide wheels.

Furthermore, Jaguar XJ wheels need an offset (distance from mounting surface to centerline of wheel) of around $1\frac{1}{4}$ ", which is not conducive to spoke wheel strength. It requires all the spokes to be crammed together near the outer edge of the wheel rather than centered and optimally oriented for strength.

Spoke wheels tend to need truing on a regular basis. This is not a job for the home mechanic, and finding someone who can do it right is a challenge. Often the wheels must be returned to the manufacturer for truing. Truing will obviously require removing the tire, remounting the tire afterward, and rebalancing -- so it probably would make sense to plan on a wheel truing whenever new tires are fitted.

Modern spoke wheels normally have stainless steel spokes, which is a big improvement over earlier designs. However, spoke wheels generally still have chrome-plated steel rims and centers, leading to rust problems, flaking chrome, and associated air leakage at the tire/rim seal.

By the way, if it's a weight reduction you expect, forget it. There is nothing lightweight about spoke wheels.

It should also be noted that since the spoke wheels are more flexible than alloy, the handling will suffer somewhat. With a car this heavy, the difference in the way the car corners is noticeable. You may even get sounds, as the spokes strain and creak with the load.

Note that older Dayton wire wheels had 60 spokes while later designs have 70 spokes, with the 70-spoke versions reportedly better. John Tompane says, "The 70-spoke wheels weren't available until I think '89. I have 70-spoke Dayton's on my wife's XJ6 and they have been trouble-free for years. When I got the new XJS it came with the same wires already on the car. Since I sometimes drive harder than my bride, I had planned to replace them with sport lattice wheels like I had my '88. But frankly, so far they have been great. I've pushed them pretty hard and they have stayed in balance. I think I'm going to keep them at this point. If I were going to race, autocross or really push the car hard for long periods it would be stupid to use them. They aren't designed for that. But for everyday driving and little spirited driving they're pretty damn good. Not great, but not nearly as bad as advertised. The 60-spokes were true nightmares (or is it untrue nightmares?) and should be avoided at all cost."

Peyton Gill counters: "The Dayton's which failed on my '86 XJ-S were 70-spoke. The point of failure was the wheel. Cracks formed between the spokes. In some cases the cracks meet from one spoke to another. The car had not been subjected to any abusive or aggressive driving."

"I bought my XJ-S from my sister who bought it new. She had one wheel self-destruct when a car pulled in front of her. She did not hit the car but the action of hard braking caused one wheel to collapse."

There are (or were at one time) also 50-spoke wire wheels made by TrueSpoke. Brett Kelien says, "I have had enough problems out of 60-spoke Dayton's and TrueSpokes to say they will never be on a car of mine. I have broken them going down the highway. On the good side Dayton did make me a good deal on the 70-spoke wheels which I really like."

Actually, it appears that Dayton will make anyone with their 60-spoke wheels a good deal. Steve Gallant says, "I called Dayton Wire Wheels and found that they would not repair the wheels under any circumstances. However, they would replace them with new ones for a very low price. And these new ones had both a larger spoke diameter and more spokes. Dayton was trying to get these wheels out of circulation by offering good replacement deals. I'm sure they could see the liability issue coming to bite them in the ass sooner or later with wheels not sufficiently strong for the intended application."

For more info, surf to

<http://www.daytonwirewheels.com>

and drop them a line. Or contact their warehouse distributor, Floristar, at 1-800-782-7050.

So, if spoke wheels are so much trouble, why did Jaguar fit the car with them? The answer: they didn't. If you have wire wheels, they were either installed by the dealer or by an owner. Jaguar wouldn't wish those things on you, and won't accept responsibility for problems you have with them.

Now, despite the problems mentioned above, many XJ-S owners will use wire wheels anyway. They came with the car and you don't feel like paying for a good set of alloys; you bought them before you read this book; or you just like the looks regardless of the problems. Whatever, I provide the following tips for those who insist on driving around on wires.

Dayton wheels apparently come with stainless steel lug nuts. These sound like a really good idea, but for some reason they tend to gall the threads on the Jaguar studs. The problem may be avoidable by the use of anti-seize compound and/or chasing the threads in the lug nuts with a tap before use, but if you don't want to take the chance you can purchase generic 1/2" fine thread chrome-plated steel acorn nuts at just about any auto parts store. You will usually have a choice of shoulder length, so you need to check the thickness of the flange on the wire wheel before buying. The chrome-plated nuts match the chrome-plated center of the wire wheels better than the stainless steel nuts! Remember to make sure that you have an emergency tire wrench in the boot that will fit your lug nuts, since the aftermarket nuts are likely to have a different hex size than the Jaguar OEM nuts.

If you need to buy replacement center caps for wire wheels, note that the center caps may be something that looks like a big nut or it may look like a 3-bladed knockoff. The item used on the TrueSpokes looks like an 8-sided nut. Regarding Dayton's, Gallant says, "The 60-spoke wheels came with the hex caps, the 3-spoke knock-off spinner was optional and could be purchased separately from Dayton." Note that the knockoff style caps seem to get lost regularly, so if you have this type you might want to check the attachment scheme. If they attach with a bolt, use Loctite or some such, or even better figure out how to apply locking wire.

Note that there are at least two configurations of Dayton knockoff; Michael Mongelli explains: "I have, if you can believe it, two different types of spinners on my wheels. The one that fits best is 2 1/2 inches in center diameter; the blades are 2 inches. The other type is about 3 inches in center diameter with a shoulder; this one fits but it requires a round shim that fits over the wheel center to make it tight..the blades are 2 1/8".

CHROME PLATED ALLOY WHEELS: Nope, these didn't come from Jaguar! Chrome plated alloy wheels, like spoked wheels, are trouble; Jaguar would never provide them from the factory and won't warrant them. The dealers, on the other hand, are only too happy to take the wheels off the brand new cars in their showroom, send them off to some disreputable plating shop, and pass the costs on to the new Jaguar buyer. If your chrome-plated wheels are more than a few years old, you will probably note flaking chrome. Mark Stoner says, "My XJ-S has the chromed starfish wheels and they are nothing but trouble. The chroming was done by the dealer and all chroming is not done with equal quality. My problem is that the chrome starts to peel (mainly on the inside of the tire) and causes bad corrosion. I couldn't get one wheel to hold air so I had the chrome turned off of the bead with a lathe. It still leaked so I put a nice bead of silicone on the beads and it seems to be working as a temporary fix."

Rod Fleming, who worked with chrome-plated alloy on motorbikes, says, "When you chrome a piece of steel, the first layer you apply is copper, which sticks well to steel. This is very thin, and serves only as a bed for the next layer, in order to make it bond well. This next layer is nickel, which is black until polished. This layer is quite thick and it is this which actually protects the underlying steel. The nickel needs the copper layer; it won't stick to steel, but it sticks like the proverbial to copper.

"In the early days of the car industry, the nickel was then polished to give a lovely silver sheen. However, nickel is very soft, will wear through easily, and goes black with oxidation. So in the 1930's people started putting a layer of chrome on top. Chrome is very hard and durable and will stay bright, but, and it's a big but, it's porous. It offers no weather protection at all, and the layer that is applied is very thin. So "chrome plate" is actually a complex interaction of the properties of several metals applied in very thin layers.

"Now the trouble is that you can't, try as you like, get that all-important copper layer to stick to aluminium alloy. So you have to get the nickel to plate directly onto the alloy. This it is not very happy to do. The bond is okay for say, engine components or interior applications, but leave it out in the salt and rain, not to mention the gritblast of road use, and it will come off in short order. As soon as it is penetrated, the underlying alloy starts to swell and oxidise, popping off more plate, and pretty soon you've got the shameful mess we all recognise.

"In addition, the thickness of the nickel layer is important; if it is not thick enough, then it will fail. Nickel is expensive, and platers have been known to cheapskate...this is why you can leave a '74 Norton Commando out in the rain for years and still have decent chrome, yet a '74 Moto Guzzi's chrome would have turned to brown lizard-skin after two weeks. (Not that any you see today will be wearing the original stuff.)

"I doubt if the effect has much to do with differing thermal expansion rates; we are only talking about a few microns thickness here. At least, no one ever mentioned it, and I would expect it to be more of a problem on engine parts -- but these, as I said, seem to suffer less.

"As for rechroming/chroming, old chrome (and the nickel, etc.) is removed the same way it goes on: just by reversing the electroplating current. The electroplater uses it again. Not really a problem.

"The real issue with any kind of chrome plating, by the way, (leaving aside the specific issues above) is polishing the metal to be plated. The slightest blemish will show; indeed it will be greatly magnified by the plate. Also, a smooth surface is important to the long term integrity of the plate as it is very difficult to build up a decent thickness on high points. Frankly the thought of polishing a lattice wheel properly fills me with dread!

"It's hard to find a plater whose work is good enough for restoration use, largely because of the polishing; it's all man-hours, and they cost. Most platers are used to doing new bath taps and the like, not polishing the pits out of already well used components.

"Stripping and lacquering wheels is definitely a better idea than chroming; in the UK at least there are many firms who will do this very cheaply and who turn out a very high quality finish."

WHEEL SIZES: Over the decades that the XJ-S was offered, tires were gradually becoming lower profile -- wider and/or not standing as far above the rim (which requires a larger diameter wheel to maintain overall diameter). This is a *good* thing; shorter and wider is more stable than taller and skinnier. Basically, Jaguar cars came fitted with the best arrangement of tires and wheels commonly available at the time -- but as the best arrangement available kept changing over the years, the tires and wheels fitted to Jaguars changed to keep up. In general, owners of older cars can improve their cars considerably by moving to the later tire and wheel configurations.

The wheels used on the pre-H.E. XJ-S are 6" wide. The wheels used on the H.E., both the "domed starfish" pre-ABS and the "lattice" on ABS cars, are 6½" wide. Owners of pre-H.E.'s, therefore, might consider installing later wheels onto their cars. While ½" may not sound like much, a wider wheel provides the casing of a tire more stability. The difference is noticeable, even if you reinstall the same tires.

The wheels on some late-80's/early 90's XJ6 (XJ40) models are 7" wide, and will bolt onto the XJ-S. This gives owners of all XJ-S's with 15" wheels an option for wider wheels yet. The 7" wheels work very well with the 235/60 tires.

D. C. Cook (see page 665) offers some snazzy 7.5x16" and 8x16" wheels for Jaguars, and you can also get 16" wheels directly from Jaguar; 90's XJ-S's and XJ12's came from the factory with 16" wheels. In fact, if you go shopping for aftermarket wheels, you may find that 16" is the way to go; the aftermarket shops seem to offer more in 16" than 15". But besides the wheel availability, it also may be easier -- and cheaper! -- to find speed-rated tires in 16" sizes to fit the Jaguar. Specifically, the 255/50R-16 size is suitable, and is widely available for less money than V-rated 15" tires. John C. Palm reports that "Corvettes used 255/50-16's from '83 to '87. Camaros & Firebirds have long used 245/50-16's."

And, yes, you can go beyond 16" and install 17" or even 18" wheels on an XJ-S. In fact, the Aston Martin DB7 -- which was based on the XJ-S floorplan -- comes with 18" wheels, and these wheels will fit the XJ-S. Justin Pashley reports that buyers of DB7's quite often opt to install custom wheels on their brand-new cars, so the OEM wheels are commonly available in the UK as "take-offs" for reasonable prices. "I use a 225/40-18 tyre which look great. I have had no problems with clearance." Note that the DB7 wheels have a smaller offset (14.5mm) than XJ-S wheels, which means that the 225mm tires are about the widest that will fit without flaring the fenders.

Paul Hackbart adds, "There is the Aston Martin wing emblem on the center cap. It is the same diameter as the plastic Jaguar face on OEM center caps."

James Dichter says, "Very important!!! If you are considering Aston-Martin DB7 wheels make sure they are stamped "1G" on the inside back of the rim. If the rims are not stamped then they are *defective*! The wheels will bend out of shape when driven over rough surfaces. This was just brought to my attention by an Aston-Martin/Jaguar dealership." Pashey looked into this and reports that "defective" may not be the right word; the earlier wheels are fine, but it was

found they can be damaged by hitting a curb or pothole at speed so AM beefed them up a bit. The 1G apparently indicates the heavier version.

The bolt pattern on Jaguar wheels is the same as on some full-size Chevys. However, the offset (the distance from the mounting surface to the centerline of the wheel) is 28.5mm, or about 1" greater than most Chevy wheels. If a set of typical Chevy wheels is mounted on an XJ-S, they will stick out the sides of the car, since they will be located 1" farther outward.

The world of Chevy wheels is not that simple, though. Some Chevys have different offsets than others; some cars even have different offsets in front than in back. And aftermarket Chevy wheels can be anything, since sometimes additional width is added entirely on the inside, increasing the offset by 1/2 the additional width. With a little care, it is possible to find aftermarket Chevy wheels that will work on a Jaguar. If the wheel has enough meat to it, it may also be possible to machine off some of the mounting surface, thereby increasing the offset.

When fitting non-Jaguar wheels, it is highly recommended that the center hole fit snugly around the pilot diameter on the hub. While some wheel manufacturers claim the wheel will be held satisfactorily by the lugs themselves, this is a much looser tolerance arrangement and has been known to cause problems. If you buy wheels with too large a center hole and have problems, it is possible to have a machine shop make a set of plugs that will provide a proper size center hole in the wheel, and then you will need to get the tires rebalanced with these plugs in place.

The lower ball joint from the XJ40 (the 1988-on boxy XJ6) will replace the ball joint on the XJ-S. The part number is CAC9937. According to XK's Unlimited, this will provide more clearance for wider wheels. See page 341.

ALLOY WHEELS -- AVOIDING DAMAGE AT TIRE SHOPS: The specified torque on lug nuts on earlier Jaguar alloy wheels is 45-50 ft-lb., and 75 ft-lb. on later ones. This impresses some people as not being very tight. However, higher torque is unnecessary and causes damage to the aluminum wheels; this is true of all alloy wheels, and in this day and age your tire store should know better. If the shop installs your wheels with an air wrench, tell them where to get off and take your business elsewhere.

There are now machines in better tire stores that mount tires on wheels by gripping the wheel from the inside with soft grippers and never touching the wheel's pretty outside surface. Check out the price lists for new Jaguar alloy wheels and decide for yourself if it's worth finding a store with this equipment.

You might also want to watch how the wheels are mounted on the balance machine. Some shops will happily spin a retaining ring onto the machine that presses down on the face of your wheel, sometimes leaving little dings wherever it touches. The gorillas in the shops normally don't consider this significant and act perplexed when you object.

WHEEL STUDS: The studs on the front end of an XJ are different than the studs at the rear. The studs at the front work like Chevy or Ford studs, with a head and a knurled interference fit. To replace them, you have to separate the brake rotor from the hub -- which means you might as well have the assembly on the bench and be repacking wheel bearings while you're at it. Thread a scrap nut onto the stud and whack it with a hammer to remove. To install a new one, lube the threads well and use a nut and a couple of washers to pull it in.

If you need new studs for the front end, it is possible to find Chevy or Ford studs that will work. The 1/2"-20 threads are common on American cars. What you'll have more trouble with is the head; Chevy and Ford studs typically have a square corner under the head, but the Jaguar front wheel studs have a countersunk style taper under the head. Chuck Sparks points out that this really doesn't hurt anything; find a stud the right length, right thread, and the correct shoulder diameter and pull it in, it'll work fine. However, it's really not too difficult to chuck the studs up in something and grind a small taper on the underside of the head so they actually fit perfectly. Tip: I found that the shaft holding my grindstone was 1/2"-20, so I merely removed the grindstone and used a lug nut to hold a stud onto the end of the shaft. Fire up the motor and hold a file or stone against it, voilà! Tapered head. It doesn't need to be a full taper; just a little bevel on the bottom corner so it sits flush against the countersunk hole will do it.

The studs at the rear are 1/2"-20 thread on both ends with a little shoulder about 1/2" from one end. These are threaded into the hub and staked on the back side to keep them from coming out. In theory you need to have the hub off to replace them, not to thread them in but to do the staking; there's a shield in the way when assembled. You can just screw them in on the car with Loctite studlock and they'll work fine, but each time you have the wheel off make sure the stud is fully seated and secure before putting the wheel back on.

With the hub on the bench, the way to do that staking would be to screw nuts onto all five studs and set it down on a hard surface. Unscrew the nut on the stud getting smacked a little bit to make sure it's firmly against the surface, not held aloft by the other four nuts. That way, the force of a smack will be transmitted straight from the stud to the nut and to the deck, rather than stressing the threads in the hub. The original arrangement uses a cute X staking, like a chisel whacked once and then turned 90° and whacked again, but really you can use a punch stake if you just make a little circle of punches on the end of the stud.

There is one plausible scheme to use non-OEM studs here. Buy generic studs that have a very long 1/2"-20 end and cut them to the overall length you need. Then cut a shallow rounded-bottom groove 1/2" from one end, making sure not to cut beyond the base of the threads; the threads don't really contribute to the strength of the stud, but you don't want to neck down the solid core of the stud any. Fashion a bit of 1/8" wire into a loop that will just fit inside the recess on the hub. Cut this loop in half. Screw in your stud (with studlock on the threads) and hold the two halves of this wire ring into the groove as it pulls into the recess in the hub. This will work sorta like the collets on a valve keeper and trap it all together in the recess. You can stake it if you have the hub off. This all works, but really it's usually easier just to buy the OEM studs.

There are those who don't care for the threaded-and-staked attachment scheme at all; there's not much thread holding the wheel to the car. If you need to replace the rear studs, consider drilling out the threads and boring the holes to a suitable diameter to fit pull-in studs like on the front. You will then need to carefully trim the heads so they don't interfere with the shield on the back side. Even better idea: rather than bore out the threaded holes, drill entirely new holes in between them, leaving the original threaded holes in case you ever want to return to the original configuration.

If the pull-in type of studs get loose in their press fit, the result is usually an obnoxious ticking when rolling slowly. This isn't normally a problem with the XJ with alloy wheels since the lug nuts should be installed with a torque wrench. A gorilla in a tire shop using an impact wrench can screw them up, though. You can tell which ones are screwed up because you can usually wiggle them a bit with your finger. The only solution that seems to work is to replace the studs.

Race cars often have the heads of the studs welded to the hub so they won't get pushed out during a fast tire change in a pit stop. It's not recommended for street cars, though; welds can cause localized stresses and cracks in the hub, and may also cause some distortion.

LONGER WHEEL STUDS: The OEM studs are kinda short; the fronts protrude about 1" from the wheel mount surface. Whether or not you'd like longer wheel studs may depend on the type wheels and lug nuts you're using. If your lug nuts show, you probably have acorn or dome nuts and they may bottom out on longer studs before tightening onto the wheel. You might still be able to use longer studs, but you'll need to be careful and measure the depth of the lug nuts you'll be using with them.

On the other hand, the author's car has a hubcap covering everything and would *definitely* be better off with longer studs. The "Majestik" wheels (from a '90 Vanden Plas) come with black nuts threaded clean through, but when tight the end of the stud is still way down inside the nut! It's better to use longer studs so they protrude through the nuts so you're using all the threads in the nuts.

For the front, you can find an auto parts shop that has a red-and-black metal cabinet of Dorman fasteners and look for stud #258. As described above, it will work OK as is or it will fit perfectly if you grind a taper under the head. When installed, these studs will protrude about 1-5/16" or about 5/16" longer than the originals.

For the rear, Chuck Sparks points out that XJ40 rear wheel studs are exactly the same as XJ-S rear wheel studs except they are 1/4" longer. The part number is CAC 3878.

Of course, there are Chevy and Ford wheel studs in obnoxious lengths like 3", apparently for racing applications. These can be installed using the same methods described above, and then you can cut them down to whatever length you desire.

WHEEL BALANCING: Incompetence is rampant in the retail tire industry, at least here in Florida. Left to their own devices, most of the meatheads in a tire store will happily mount your Jaguar alloy wheels on a balance machine incorrectly, give them a static balance only, then beat the weights onto the rim with a BFH.

The first challenge is getting the wheels mounted on the balance machine correctly. When you mount the wheel on a machine that spins it to check the balance, it must be mounted centered properly -- meaning centered the same way it is centered on the car. On the XJ-S (and on just about any other car), correctly-fitting wheels will be centered by the back side of the center hole fitting closely around a machined diameter on the hub. If the wheel is a style in which the center hole is a couple of inches deep and has a motif cap clipped into the outer opening, note that the inner half inch or so of the center hole of the wheel has probably been carefully machined, while the rest of it may not have been machined as carefully or even machined at all. In the worst case, the two portions of the same hole might not even be concentric, although one would hope that they are very close. The point is, the wheel needs to be held centered on the inside portion of the center hole -- not the outside portion, nor any other part of the wheel. The inside portion of the center hole is how the hub on the car holds the wheel centered, so it must be the basis for the balance machine to hold it centered as well. As you watch the balance machine operator pick through the selection of adapters he has to mount your wheels on his machine, you will understand why it is important to keep an eye on what he's doing and raise objections if he's doing it wrong.

There are two basic types of imbalance. The old-fashioned bubble balancing, which engineers refer to as static balancing, only corrects one type of imbalance -- the type that causes the wheels to hop. This is generally adequate only for wheels that are very narrow, and should be considered unsatisfactory for any modern automobile.

The other type of imbalance, dynamic imbalance, is the type that causes wobble. A wheel that is statically balanced may still be dynamically imbalanced by having a heavy area on the outside edge of the wheel and an equivalent heavy area 180 degrees away on the inside edge. Although the wheel would appear balanced on a bubble machine, when spinning the two diagonally opposite heavy areas cause the wheel to wobble. It's usually not too noticeable on the rear wheels, but on the front wheels it can cause steering wheel shudder. And you may eventually wanna rotate the rear wheels to the front, so it's kinda nice to have them all correct.

To correct a dynamic imbalance requires that weights be placed in two separate planes -- usually (but not necessarily) the inside and outside edges of a wheel. It requires more lead than static balancing. It also requires a machine that actually spins the wheel; the bubble balancer is out. Use of these machines has come to be called "computer balancing". However, note that a switch on the machine allows the operator to specify a static balance only, so asking for "computer balancing" does not guarantee a proper dynamic balance.

The meatheads generally understand that the owner of alloy wheels is not thrilled about balance weights on the visible outside surface of the wheel. They will often ask: "Do you want the balance weights hidden inside the wheel?" and when you answer "Yes" their response is to set the balance machine on "static" and apply all the balance weights to the inside rim of the wheel. This actually makes the dynamic imbalance worse, since even in the days of the bubble balancer the operator knew to put half the weight on the inside edge and half on the outside.

Insist on watching what is going on. The machines normally operate in "dynamic" mode, and there are two displays showing the amount of weight that needs to be added to each side of the wheel. There is also a button or switch marked "static", and when selected the machine will read imbalance values on one display and the other display will go blank. If you see this happen, you need to politely interrupt the balance operator and instruct him to put it back in dynamic mode.

At this point, there will probably ensue a discussion with the balance operator. He will often insist that you have two choices: either you want a static balance, or you have to put up with weights that show -- but he is wrong, you are not limited to those choices. If this discussion deteriorates into an argument, you may have to take your business elsewhere until you find a balance operator willing to work with you to get the balance right.

Eventually, it will probably be necessary to show a balance operator how to do his job. Set in dynamic balance mode, the machine will specify the amount of weight to be applied to each side of the wheel, but you're not going to be applying any on the outside surface. Instead, select a piece of "stick-on" balance weight of the size specified by the machine for the outside edge, but install it on the ID of the rim as far outward as possible, right up against the inward side of the center structure. Then install the weights on the inside edge using either clip-on or stick-on weights, whichever you prefer.

If you have a 5-spoke wheel or some such, you can take this idea one step farther and hide the stick-on weights behind the spokes -- even if the machine tells you to put them between spokes where they show. Simply split the balance weight into two portions, and put portions behind the spokes on either side of the correct location.

Usually, after spinning the tire once more, the machine will indicate that the wheel is balanced. However, in theory both installing the outer weights a couple of inches inwards and splitting a weight into two pieces and spreading it actually require slightly more weight to be used. You can either anticipate this and use a slightly larger weight than the machine calls for to begin with, or you can wait and see if the machine tells you you didn't install enough. Either way, always insist that the balance machine indicates zeroes (0.00 or "Ready" or whatever) on *both* indicators before the wheel is taken off the machine and installed on the car. At this point, the balance operator will probably be astounded; he has never seen an alloy wheel get a workable dynamic balance without the weights showing, and is wondering why nobody showed him how to do it before.

There are newer balance machines that actually have both of the procedures described above built into the machinery. They can properly balance the tires by applying weights in any two planes, not necessarily the outer edges; the desired location for the weights is a separate setting in the balance procedure. They also can "split" a balance weight callout into two smaller weights, telling the operator where to put them both. But if you understand what's going on, you don't need to find this fancy machine; the more basic dynamic balance machine will do the job.

Finally, if you are less than impressed with the competence of the shop balancing your wheels or of the condition or calibration of their balance machine, you can ask to have one of your just-balanced wheels put *back* on the machine and spun up again. Balanced is balanced, folks: if they've done it right, it should come up all zeroes again, even if mounted rotated to a different position on the machine or even mounted on a *different* balance machine altogether. If it comes up calling for weights, either their centering procedure for installing the wheel on the machine is NFG, or their balance machine is out of calibration, or something else -- but you don't really care what, you only know that you are *not* getting a viable balance job here, you might as well head on to another shop.

BALANCE WEIGHTS -- STICK-ON VS. CLIP-ON: Steel wheels commonly use "clip-on" weights that are hammered onto the rim. Some alloy wheels are designed with a rim that can accommodate clip-on weights, but they may not attach as well to the thicker aluminum. And use of a hammer to install is not good for aluminum, especially if the meathead responds to difficulty with a bigger swing.

When the steering on an XJ-S is turned full lock, the clearance between the inside edge of the wheel rim and the front anti-roll bar is very small. If wider-than-original wheels are used, clip-on balance weights may actually hit the bar, resulting in a blip-blip-blip as you roll around a tight turn. And, of course, the balance weights may actually get ripped off.

The proper balance weights to use on alloy wheels are called "stick-on", and are attached to the inner surface of the wheel with a layer of foam tape attached to the back side of the lead weight. One problem is that they are not reusable; once peeled off, the tape is not reusable, and the shops customarily throw them away. I guess using generic foam tape has not occurred to them, or just isn't worth it, even though they often complain loudly that these weights are expensive and charge the customer accordingly.

The problem is exacerbated by the meathead not knowing how to use the machine properly and having to do a by-guess-or-by-gosh balance job. With the clip-on weights, he can just keep prying them off and reinstalling them until he gets it right, but he can waste a lot of stick-on weights. An intelligent operator, of course, will be able to set the machine up properly and get the correct weight applied the first try.

Owners of alloy wheels should always insist on dynamic balancing using stick-on weights in two planes within the wheel -- one near the inner edge, and one just inside of the outer face of the wheel. Since these planes are closer together than the edges of the wheel, more lead will be required to correct imbalances. But the weights won't show, and nobody will need to use a hammer to install them. Always insist that the balance machine shows zeroes on both indicators before the balance is accepted.

The only real problem with stick-on weights is a reputation for getting lost. Since clumps of mud and other debris sometimes gets dragged around the inside of the wheel and jammed between the wheel and the brake caliper, the foam tape can be ripped away. Two suggestions are in order, and neither is likely to be done by the tire shop, so the owner should bring the materials necessary and do them himself while the wheels are off: First, mark the locations of the stick-on weights with a permanent marker. Then, secure them with a piece of aluminum tape (available at air conditioning shops). Don't use duct tape; it quickly dries up and falls off, often taking the balance weight with it. The aluminum tape appears to be light enough to not affect the balance when added; or, to be safe, you could simply add a dummy piece of tape on the opposite side of the wheel.

WHEEL MOTIFS: If you wish to replace the growler motif on an 80's XJ-S wheel, you'll find that the puddy tat itself and the retainer holding it are two separate parts. The puddy tat is C42191 or CAC6502 or CBC2660, and the retainer is CAC5073. However, in the late 80's Jaguar switched to a single-piece item, CCC6347. The one-piece motifs also fit the earlier wheels, but may not match the two-piece motifs well; you'd probably be well-advised to get a set of four.

Also note that Jaguar apparently had some really bad quality control problems with the one-piece motifs around 1990; some of them look really bad, with the puddy tat face distorted as though it has melted, and some of the motifs even fall apart and lose pieces on the highway. Within a couple of years after that, the motifs started looking a lot better, with a clearly-defined and attractive puddy tat face.

The one-piece motifs are available in five different colors; if you need to buy a couple anyway, you might consider finding a color you like.

TICK, TICK, TICK: Chip Lamb had an irritating tick from one of his wheels. He was all set to tear into bearings when Roger Homer pointed out that it may just be the Jaguar logo in the center of a wheel cover coming loose. "Pulled both hubcaps - it *was* the kitty on the right rear. Quick fix with duct tape and some black RTV!"

TIRES: If you want to maintain the originality of the tires on your car, you'd better take them off *now* and store them in the attic! Tire manufacturers change their models regularly and discontinue the older designs. The XJ-S has been out of production long enough that it's unlikely you'll be able to find an "original" new tire for any of them, even the mid-90's models. If you drive your XJ-S, you will *have* to find a modern tire to fit.

Be very careful when mixing tire types, sizes or makes on a Jaguar. The XJ-S and the XJ6 have a suspension design in which the entire suspension assemblies are attached to the car with flexible mounts, and the relative stiffness of the mounts is premised on all the tires being the same. Mixing tire types, even outwardly similar ones, can result in dangerous instabilities in this suspension system. This is no joke; having one type of perfectly good tire on one end and another type of perfectly good tire on the other can result in you being rudely introduced to a tree when you aren't even travelling that fast. If you must put different tires front and rear, take the car for a test drive and put it through its paces away from traffic and trees before accepting the arrangement as safe.

The problems with mixing tire types, combined with the fact that tire manufacturers are constantly discontinuing tire models as they design newer and better tires, means that you will probably want to keep an eye on your wear rates and rotate tires as required to get them all to wear out simultaneously. If you wear out the pair on one end first, you are not likely to find a replacement pair of the same model, so you will be well advised to replace all four tires with a new model -- and you'll end up pitching two tires with good tread still left on them.

When replacing tires as a set, you don't have to stick with the brand of tire that came on the car. In fact, it may be better to change brands according to Michael Neal, who works on Jaguars for a living: "I've seen hundreds of the 215/70 Pirelli P5s rip out at the sidewall near the bead. These are the original equipment tires on the US-spec XJ6 Series 3s and early XJ-S's. Sorry, but I would not even consider buying a set of these. The 235/60 P600s had the same problem." Reportedly the still-later Pirelli P4000's were better.

If you have internet access, you can check for tire availability and prices online. Peter Cohen suggests

<http://www.tirerack.com>

and David Littlefield suggests

<http://www.tires.com>

"This is the website for Discount Tires Direct, an online version of Discount Tires stores. The Discount Tire site will allow you to look up the right size tire for your vehicle.." Note that there's an option for checking the local dealers or Discount Tires' mail-order service, and you want the latter; the pages for the local dealers only lists tires that are kept in stock by the local dealers, and you want to consider special-order stuff for a Jag.

It is impractical to list the attributes of particular tires in this book, because tire models change so often. All the tire companies have been bought out by other tire companies anyway, it's nearly impossible to tell which company is actually making your tires any more.

TIRE SIZES: According to Mike Morrin, the pre-H.E. XJ-S was fitted with 205/70-15 tires mounted on 6" wide wheels. A 225/60-15 tire would be effectively the same diameter and a little wider.

The early US-spec XJ-S H.E. was fitted with 215/70VR-15 on 6½" rims. Later models came with 235/60VR-15 tires, still on 6½" rims. In theory these H.E. sizes are a hair larger diameter than the pre-H.E. tires, but there reportedly was no corresponding change in suspension or speedometer.

If your car still has 70-series tires, when they wear out you probably should replace them with 60-series tires; the additional width is beneficial for stability, and there is no appreciable disadvantage with modern tire designs.

Still later cars came with 16" wheels.

The tire size code works like this: The first three digits, such as 215, is the width (mm) of the tire at the widest point -- the middle of the sidewall. It is always rounded to a number ending in 5. The two digits after the slash, along with an implied decimal point, gives the aspect ratio: the height of the tire above the rim divided by the width described above. For the 215/70VR-15, this is .70, and the height of the tread above the rim is $215 \times .70 = 150\text{mm}$. If there is no aspect ratio indicated within the tire size, the aspect ratio is .80. The R in the tire size merely indicates it is a radial tire; it is sometimes omitted. The -15 indicates it fits a 15" wheel.

The one thing you normally don't want to change is the overall diameter of the tire, since this would affect your speedometer and odometer readings as well as your ride height. Changing the ride height can have adverse effects on the suspension geometry, even if you don't mind the altered ground clearance. To maintain overall diameter when you go to a wider tire, you also have to change the aspect ratio to a lower value. It is easy enough to calculate the overall diameter given the size; just multiply the width number by the aspect ratio, multiply that result by 2, and add the diameter of the wheel (remember to keep your units straight!). However, remember that the number you started with, the tire width in mm, was rounded to a number ending in 5, and may not even be *that* accurate. The aspect ratio is likewise subject to some creative estimating by the tire manufacturer. Trying to draw conclusions about a quarter inch this way or that is just silly. There are online tire size calculators that give you the results out to several decimal points, but don't be fooled into thinking that there is really any such accuracy involved. And remember that, once you figure out the diameter, you're gonna set the car down on this tire and squish it a bit, throwing all your calculations into the wastebasket!

In general, tire manufacturers increase the width number by 20 while decreasing the aspect ratio number by 10 to provide the equivalent diameter tire in a wider size; this is true even if the math doesn't really come out right -- they make the tires the right size and round the numbers to these sizes anyway.

Tire manufacturers list a "loaded radius" in their specs, the distance from the ground to the center of the wheel with weight on it. This measurement is meant to include the deformation of the tire under load so the consumer can determine the actual ride height, and is usually far more accurate than trying to use the tire size formula since there is no rounding involved in the numbers given.

If you have access to the WWW, there is an online tire size calculator for determining which size tires will replace stock sizes. The URL is

<http://www.dsm.org/Fun/TireSize.html>

Today, you really don't need to worry about arithmetic. If you want to move to a wider size tire, you can merely opt for a "plus zero" size on any tire selection listing.

Regarding what will actually fit: In general, the widest tire you can fit on the XJ-S seems to be around 235 or 245, depending on the profile details of the particular brand of tire. However, a slightly wider tire can be fit at the rear by increasing the offset of the rear wheels. The XJR-S took this tact and used rear wheels with 33mm offset and is fitted with 255's at the rear -- but don't try that without either going to the larger offset or flaring the fenders. Since you don't want to change the offset of the front wheels that way, this tactic requires two different pairs of wheels, and rotating becomes problematic.

Within each wheel well at the rear, directly above the hub carrier is a rubber bumper attached to the subframe. At full suspension compression, the top of the hub carrier smacks this bumper. The E-type guys (who have trouble fitting tires wider than 180mm) remove this rubber bumper to allow the installation of wider tires. They then install rubber doughnuts around the shafts of all four rear shock absorbers to provide a bump stop. This idea should work on the XJ-S as well -- but you'll need to increase the wheel offset to widen the tires in the inboard direction without widening them in the outboard direction and rubbing the fenders.

TIRE SPEED RATINGS: If you live in some parts of Europe, you are required by law to fit tires with suitable speed ratings for your car. In the case of the Jaguar XJ-S, that means a V rating or better.

Interestingly, the V rating has changed over the years. In the 80's when many of our Jaguars were built, a V rating meant the tire was rated for 220 Km/h, or 137 mph. Today a V rating means the tire is rated for 240 Km/h or 149 mph. Just as well, since this rating better fits the capabilities of the Jaguar anyway.

The speed rating also used to be indicated within the tire size, as in 215/70VR-15; such were the specifications called out in the glovebox and owner's handbook for the author's '83. This has changed as well, though, and now the speed rating is listed with the load index (see below) adjacent to the tire size, as in a 98V. There remains a special rating called a Z rating that calls for the letter Z to appear within the size; sometimes this is called a ZR rating, since the Z is followed by the R for radial. You can learn all about speed ratings and other tire specifications from dozens of places on the internet.

For Jaguar XJ-S intents and purposes, a tire with a speed rating of V, W, Y listed with the load index and/or a Z in the size is acceptable. Any lower speed ratings (H, U, T, S, whatever) will be illegal in some areas and should be used with caution anywhere else.

Speed ratings are intended to indicate suitability for Autobahn-style driving -- continuous high speed. Generally, the limiting factor is heat buildup in the tire. High-speed-rated tires either run cooler or are made of higher-temperature material, or both. Much of the heat generated is dissipated to the air *inside* the tire and away through the rim, so inner tubes invalidate the ratings (the flexing of the inner tubes themselves *adds* to the heat buildup). There are also concerns about how patching holes affects speed ratings; it is recommended that the owner check the literature that comes with the tires before opting for a low-cost "plug" repair to his tires.

Since the flexing of the tire is what generates the heat, tire manufacturers usually achieve a high speed rating by making the sidewalls stiff. Therefore, the high-speed-rated tires drive differently than normal tires, even at low speed. For this reason, many recommend the V-rated tires even to those who don't drive fast. This is especially true for the XJ6 and XJ-S, because the soft suspensions get downright mushy with the softer, lower rated tires. There are reports that S-rated tires used on these heavy cars will flex so much that they will wear out quickly.

The heat buildup due to tire flexing is also the reason you must have fully inflated tires when driving fast. Blowouts aren't caused by the tire pressure being too high; they're caused by the structure of the tire failing due to excessive heat. If you're going to go fast, it would be better to err on the side of too much tire pressure than too little.

As the tread wears, the speed rating of the tire will actually improve. A thinner carcass generates less heat when flexing and dissipates heat better. There have been promotions claiming street tires were successfully used for racing; in these cases, typically the outer half of the tread was shaved off before the tire was even put on the car.

The Pirellis and Goodyears that came with these cars were designed with a luxurious ride in mind. Most 60-series tires with a V rating, however, are designed with performance in mind, which makes sense to everyone except a Jaguar owner. The original Pirellis and Goodyears are NLA, so any suitable replacement tires are likely to result in better traction and handling but perhaps at some sacrifice in ride quality.

TIRE LOAD INDEX: The load index is a number between 0 and 270 that indicates the load-carrying capacity of the tire at max pressure. There doesn't seem to be any rhyme or reason to the load index numbers themselves; you have to find a chart to determine the rating in pounds or kg.

Iain Burgess says, "The 89 model owners manual says we need a load rating of 98 (745kg) for a 235/60R-15 and 97 (730kg) for the 215/70-R15." It's unknown why the requirement would be different for different size tires on the same car, but the skeptical among us would suggest it's because they are promoting a particular brand of tire rather than providing an honest minimum specification. The fact that their specs would seem to be far in excess of what would reasonably be expected may lend support to this theory: a load index of 98 means the tire is rated for 1653 pounds -- far more than adequate for each corner of a 4000-lb car with 800 pounds of people and luggage in it.

Remember, though, that most of us don't run our tires at the maximum rated pressure; we run them at pressures considerably lower than that, so some margin in the load index would be a good idea. If you install tires with a load index in the 80's the rating is marginal for this car and you might want to keep your pressures up -- especially when loading lots of people and luggage.

This is yet another reason to upgrade to 16" wheels. Burgess claims it's far easier to get tires with adequate load indexes in 16" sizes.

TIRE WEAR RATINGS: They sound useful, don't they? Gary Penovich says, "You can't compare the wear rating from one manufacturer to another. For some stupid reason, that number is relative *only* to tires from the same manufacturer."

UNIDIRECTIONAL: Some modern tires are "unidirectional", meaning they are intended to roll in only one direction. They have a distinctive tread pattern intended to efficiently clear water at speed. This must be a good idea, because racing rain tires all look like this. The disadvantage is that you cannot rotate tires left-to-right without pulling the tires off the wheels and remounting. Since rotating front-to-rear is usually what you want to do anyway, this doesn't present a problem.

Obviously, if you use a unidirectional tire as a spare it'll be on the correct side on one side of the car and wrong on the other side, so be careful about which side of the car you run over nails with! Seriously, they'll work fine rolling backwards, they just won't clear water as well at speed. If you have one rolling backwards, be careful in the rain.

Typically, all four tires in a set of unidirectional tires are actually the same tire. They must be installed so they all roll forwards, so the right side of the tires on the right side of the car will be visible while the left side of the tires on the left side will show. This means the labelling on the sidewalls is the same on both sides of each tire so it looks the same on both sides of the car; the manufacturer cannot put raised white letters on one side or some such and give you the choice of mounting them facing inward or outward.

Despite the similar appearance on each side, the serial number -- which includes the date of manufacture -- is only on one side of each tire, so they'll be easily readable on one side of the car but you'll need to look on the inside on the other side of the car.

ASYMMETRICAL: Asymmetrical is not the same thing as unidirectional. Asymmetrical tires are different on the inner edge than on the outer edge. Sometimes it's just the tread pattern -- closer to a "slick" on the outer edge for cornering with bigger grooves at the inner edge for water clearing -- while some tires actually have different rubber compounds on the different sides.

If your tires are just asymmetrical, you could rotate them all around the car since once mounted on the wheels correctly the inner edge will be the inner edge wherever you put them. However, most asymmetrical tires are also unidirectional. This means you cannot rotate them side-to-side, period; while you could rotate the unidirectional tires side-to-side by remounting them on the wheels, doing this with an asymmetrical tire will put the inside edges on the outside. Asymmetrical-and-unidirectional tires must actually be different tires on the left and right side; if ordering online or some such, be sure to order two lefts and two rights.

TIRE AGE: You might want to be careful about buying tires that have been sitting on the dealer's rack for several years. David Littlefield says, "If you read the fine print in the tire warranty, it will tell you that the warranty for tread life and defects is only good for a *maximum* of five years from the date of *manufacture*. Thus, when you buy a three-year-old tire your actual warranty is only two years."

The concern about buying old tires may be news to some people, but it's a legitimate concern here. The tires that fit the XJ-S with 15" wheels are fairly unique; in fact, the 235/60R-15's appear to be a Jaguar-only application. Hence, it's entirely plausible that the tire dealer -- or the supplier he gets his tires from -- has had that set of tires sitting around for too long waiting for a Jaguar owner to sell them to. While buying tires for your Toyota might not raise such concerns, you might want to pay attention with the Jag. Fortunately, the tires that fit the XJ-S with 16" wheels appear to be shared with Camaros and Firebirds, so old stock can be expected to be less of a problem. Opting for 225/60R-15's may avoid problems as well, since this size is reportedly used on Mustangs.

The date of manufacture is also included in the data written on the side of a tire. Prior to 2000, the last three digits following the DOT serial number were two digits for week of year and one digit for year. If there is a little triangle after these three digits, the tire was made in the 1990's; if not, it was made in the 1980's. Starting in 2000, it became the last four digits, two digits for year.

15" TIRE AVAILABILITY: All of the above seems like a lot to think about, but when you get to the tire dealer and actually try to buy tires you may find things get a lot simpler. The tire companies make tires to fit cars rather than in a general range of sizes and specifications, so the tire dealer just types in your make and model and up pops the tires intended for use on your car. For example, for the '83 the computer will list all the 215/70R-15's as original size, 235/60R-15's as a "plus zero" size, and various 16" tires as "plus one" and 17" tires as "plus two".

Once on that computer, you'll find that most of the 235/60R-15's have a load index of 98. That's correct, the tire companies intend them to fit Jaguars. Interestingly, many of these tires are not V-rated; they presume you don't need the speed rating in the US.

If you have trouble finding 60-series 15" tires, Wade Ramsey suggests: "215/65-15's will work as well. What I mean by "work" is the outer diameter for both tires is almost identical. The 235/60-15 OD is 26.10 inches, 215/65-15 OD is

26.00 inches, while the OEM 215/70-15's OD is 26.85 inches. The reason I mentioned this is simply to let others know that there is an *abundant* supply of 215/65-15's available in H and V speed ratings."

Another option is to go to the plus-zero size tires appropriate for the pre-H.E. -- 225/60R-15. These tires invariably have a load index of 95, apparently because they are intended for a Mustang and that's what Ford says is the load index needed on that car. This is still a load rating over 1500 pounds per tire, seemingly plenty for an XJ-S and possibly even for a Jaguar saloon. And many of the tires available are V-rated or better, often Z-rated.

As of this writing, this author would recommend you go to the 225/60R-15 when you get a chance. Not only is the selection far greater, but there is less chance that the tire model will be discontinued within six months of buying the set leaving you screwed when you tear up one tire on a pothole.

It's easier and often cheaper to buy tires with adequate speed and load ratings for 16" wheels than for 15" wheels. Since this is likely to be more and more true in the future, anyone considering buying new wheels would be well-advised to opt for 16" wheels.

TIRE PRESSURES: John Goodman says, "Most of us here (UK) have long junked our 15" wheels and run 16" or 17" rims, but the less competitive drivers, or those who do a lot of city streets always keep the tyre pressures down quite a bit. We run them up to 8psi lower than the handbook stated figures. My handbook says 35psi front and 32psi rear, so I run at 30 front and 27 rear. On 245/50 or 225/55 x 16" this gives only *very* slight loss of handling at extremes of cornering, but a very noticeable improvement in ride comfort. Has no effect on tyre wear either. This was a local Jaguar dealer recommendation!!!" Note: perhaps a workable plan for those who value ride quality, but high continuous speeds should be avoided without full pressure. Also note that lower pressure will provide less protection for your rims, so don't drive over curbs at speed.

Goodman's car is an XJR-S, perhaps explaining those high tire pressure recommendations; the earlier plain-vanilla XJ-S's recommended rather low tire pressures (on narrower tires to boot!) and then recommended you go to higher pressures if driving fast.

Regardless of the peculiarities of one XJ-S vs. another, one thing must be pointed out: the nearly religious devotion many automobile owners pay to the "recommended tire pressures" is *completely* uncalled for. As long as you don't exceed the pressure limit written on the side of the tire itself, tire pressures can be varied considerably to provide the owner with the desired performance and ride. If the handling balance doesn't seem right to you, you can also vary the front/rear pressure distribution to alter it.

For optimum tire wear, an excellent plan is to keep an eye on the wear at the edges of the tires vs. the center. If they're wearing faster in the center, lower the pressure; if they're wearing faster at the edges, raise the pressure. This helps configure the car for the owner's driving style, since a driver that corners hard will scrub the corners of the tire more and *should* be using higher pressure. It even helps compensate for drivers that dive into turns as opposed to drivers that accelerate through turns, since the different styles will cause different tire wear patterns and correspondingly altered pressures. Of course, bad alignment or other complicating factors can easily screw up the data.

Rob Ward tried to follow that guidance and ended up with tire wear in the center of the tread of his Goodyear Eagle NCT 235/60ZR-15 rear tires despite low pressures. In response, someone posted this excerpt from a discussion on a Porsche list: "My info, which is slightly counter-intuitive, is that fatter tires need slightly higher inflation pressures to stiffen the tire carcass and prevent the centerline bulge that causes premature wear in the middle of the tire. Apparently, the theory is that no matter what you do, fat tires will tend to higher diameters at speed in the middle of the tread, due to centrifugal force when you twist it up. Increasing the tire pressure tends to stiffen the tire, preventing the center bulge, rather than accentuating it as one might expect. It's actually enough more complicated than that that you need empirical data to come to any kind of useful conclusion. I put 42-44 psig in my 245/45x16 rears and they have always seemed to wear evenly."

If you can't tell, the XJ-S is nose heavy, and one would expect that the front tires will always need more pressure than the rears -- unless you're carrying sandbags around in the trunk.

Paul Bachman says, "The strangest thing happened yesterday. I was checking the tire pressure on the XJS and discovered that they were quite low at about 28 PSI. After bringing them up to proper pressure (32 PSI), the minor (but irritating) shudder in the brake system completely disappeared! Coincidence? I don't think so."

WINTER TIRES: In some US states, you are required by law to have either snow tires or "all season" tires on your car during the winter months. According to Bill Weismann, "For a tire to be labeled "All-Season" it must be labeled (By federal law...) "M+S" on the sidewall.

"It's a lot more than tread design that qualifies a tire as an all-season; the main problem with High Performance tires is that they have to be at somewhat high temperatures in order for them to "stick". An all-season tire usually offers two features for it to work in the snow.

- 1) A tread compound that will remain pliable in the cold (below 40° F or so..)
- 2) A tread design that will work in snow."

Europeans laugh at the idea of all-season tires. For people in places like Norway, an all-season tire means it sucks in all seasons. If you get only a couple of weeks of inclement weather per year a set of all-season tires is a good option, but if you get a serious winter where you live you should opt for a separate set of wheels and tires for winter. Some tire stores and garages offer to store your alternate set of wheels for you.

As long as you're going with a separate set of snow tires for the winter, you should also note that, in snow, the narrower the tire the better. For the XJ-S you'd want to go back to the 215/70R-15's and possibly even to a 195R-15. You also will want to find some really junk wheels since snow, sand, and salt make both steel and alloy wheels look really crummy very quickly. Stainless steel wheels would be ideal, but apparently the wheel manufacturers haven't figured that out yet.

Carefully consider your options. Winter driving often involves snow, ice, mud -- as well as a fair portion of nice clean pavement, since many road departments are really good at keeping roads clear. One highly-rated type of snow tire is called a Blizzak which has a porous compound that grabs snow and holds on until it looks like your tires are made of snow; they work really well on dry snow, but are reportedly not much good in mud, wet snow, ice, or dry pavement, and they wear quite rapidly on dry pavement.

Studs are another option that the owner might regret. Great on ice, but not particularly beneficial anywhere else. Also, they will damage pavement, so they are frowned upon or banned outright in some areas. They also have a detrimental effect on the rolling resistance of the car, so your fuel economy gets much worse and the car feels like the brakes are dragging or something.

As far as speed ratings go, snow tires typically have a speed rating of Q. Don't drive them fast. A rubber compound that works in freezing weather will *not* like the heat generated by high speed.

BRAKES

BRAKE FLUID: Use DOT 4. Period.

DOT 5 BRAKE FLUID: Many people swear by “Dot 5” silicone-based brake fluid, and others swear at it. Silicone brake fluid does not absorb moisture, does not harm paint when spilled, and has a very high boiling point. It is also non-toxic.

Some of the arguments are based on it not absorbing moisture. If there is no water in your brake system to begin with, theoretically none will get in by being absorbed by the fluid in the reservoir. But if there is water in the system to begin with, the silicone fluid will not absorb it, and it may puddle in local spots and cause corrosion.

Silicon fluid absorbs more air than conventional fluid, meaning that the brake pedal will feel spongier, even when fully bled. Of course, this will not be apparent at first, since it takes some time to absorb air within the reservoir and for the air to diffuse throughout the system.

It is important that the two types of fluid not be mixed. Silicon fluid is less dense than normal fluid and won’t mix with it, so it is theoretically feasible to fill the reservoir with silicon fluid while bleeding the conventional fluid out at the wheels. If you’ve had the calipers apart, you probably don’t believe this; maybe it’d be better to only change fluid types in the midst of a full caliper rebuild.

The name is a deliberate misleader. DOT 3 and DOT 4 brake fluids are referred to as such because they conform to Department Of Transportation standards. “Dot 5” silicon-based fluid, however, is a trade name, not a DOT standard. There are even reports that DOT has now issued a standard #5, and it is *not* for silicone-based fluid but for something else.

Older (pre-XJ-S, actually) Girling systems require DOT 4 fluid to keep the natural rubber seals pliable to seal properly. Some components are reported to get hard when exposed to silicone fluid; others are reported to absorb too much silicone and swell so much as to jam the works.

According to Jim Beckmeyer, who had a master cylinder resleeved: “White Post (page 653) said that the warranty would be voided if I used DOT 5”. Draw your own conclusions.

WHEN TO BLEED BRAKES: Bleeding the brakes is essential after disconnecting brake lines in order to get air out of the system and ensure a “hard” pedal. Bleeding is also a periodic maintenance action, sorta like changing the oil; brake fluid absorbs moisture, either that was already within the system or from the air in the reservoir, and this moisture is not good for the insides of the brake cylinders. Moisture also lowers the boiling point of the fluid. Also, the fluid eventually becomes contaminated with tiny particles of metal from wear within the cylinders, and the particles only serve to accelerate the wear. So it is beneficial to occasionally bleed the brakes even if there is no air in them, and to bleed them enough that the entire system is filled with fresh fluid.

Steve S says, ‘In Delphi-AP Lockheed tech notes I came across the following quote:

In addition to regulations that define performance hydraulic brake fluids are required to meet international standards with regards to their colour. The following classifications have been established:

- less than 0.006 Abs Colourless
- 0.006-0.100 very pale straw
- 0.101-0.197 pale straw
- 0.198-0.296 straw
- 0.297-0.397 very pale amber

- 0.398-0.530 pale amber
- 0.530-0.800 amber

The figures relate to Abs (absorbance units). Delphi Lockheed ensures its colours conform by using an in-house absorbance scale at 455nm with a 1cm cell.

End quote.”

This means that the color of the brake fluid indicates how much moisture it has in it. So, it needs to be close to “colourless”; if it’s closer to “amber”, it’s time to bleed that stuff out and get new, dry stuff in. Of course, you can’t see the color of the fluid anywhere except in the reservoir, but that’s where moisture typically gets into the system in the first place.

Modern brake fluid reservoirs are translucent white plastic. This is so that you can see not only the level but also the color of the fluid without removing the cap, since removing the cap introduces more air and moisture into the system. Of course, with the OEM reservoir on the pre-ABS XJ-S, the reservoir is vented anyway so it will gradually gain air and moisture even if you don’t ever remove the cap; see the idea for replacing the reservoir on page 550 if you’d like to correct this shortcoming.

BRAKE BLEEDING: Before beginning the bleeding procedure, remove all of the old fluid from the reservoir using a turkey baster or something. And, of course, get any dirt or crud out that you can. It simply doesn’t make sense to try to pump that crap through the system to get it out; get it out the easy way, and fill the reservoir with fresh, clean fluid before starting.

Bleeding the old-fashioned way requires two people. One person sits in the car and “pumps” the pedal to get the pedal up where it belongs, and then holds pressure on the system while the other person opens one of the bleed screws to allow the fluid to squirt out. A small piece of hose routed into a container helps reduce the mess. When the bleed screw is opened, the pedal will go to the floor, and the person in the car must *keep* it there until the bleed screw is closed once again; if the pedal is allowed to rise, it will draw air back in through the bleed screw. After the bleed screw is closed, the pedal is pumped back up and the cycle is repeated. If a clear hose is used on the bleed screw, it is easy to see when the crud is gone and clear fluid is coming through. You must pause every now and then to top up the reservoir with fresh fluid.

If you want to make things easier or require only one person, there are numerous gadgets available to help. Dan Welchman suggests the “Eazi-bleed” kit: “I think they’re made by Gunsons but I’m not sure. This device uses your spare tyre as a compressed air reservoir which pressurizes a large plastic brake fluid reservoir via a hose and footpump-style valve connector. A tube dips into the bottom of this reservoir and feeds fluid up to an air-tight cap that screws onto your brake fluid reservoir on the car (the kit comes with a wide range of different caps and rubber gaskets to fit most cars).

“Once you’ve fitted this and got it air-tight you can bleed the brakes by just opening each of the nipples and letting the fluid flow out until it’s bubble free (or longer if you’re changing the fluid). No pumping, no assistant needed, and no worrying about having to top up the reservoir for fear of running out of fluid and pumping air through the system. They’re extremely cheap and work pretty well.”

Brian Schreurs reports: “I shall quote directly: “One of the hottest new items at the SEMA [Specialty Equipment Manufacturers Association] show (winning the ‘Best Engineered New Product’ category) was Russell Performance Products’ Speed Bleeder brake bleeder screw. This unique product replaces the stock bleeder screw on your car, truck, or motorcycle. It has a patented, internal, spring-loaded check ball that permits air and fluid to escape when the pedal is depressed, but automatically seals when the pedal is released.” They are supposedly available nationwide, but if all else fails the company can be contacted directly at

225 Fentress Blvd
Daytona Beach, FL 32114
+1 (904) 253-8980

Ed. note: Speed Bleeders are offered by Griot's Garage, page 661.

Walter Acker IV notes that Speed Bleeders are made from 303 stainless steel. He also provides internet source info:

e-mail: Speedbleeder@ameritech.net

<http://www.speedbleeder.com>

BRAKE PAD WEAR WARNING SYSTEM: The XJ-S doesn't have one! What a cheap car. Even the author's mid-80's Hondas have little warning squealers on the pads; when the lining gets too thin, the squealer contacts the spinning rotor, and the resulting racket is usually enough to get the owner to visit the shop and complain even if he has no idea what the squealer is for. The Jaguar XJ40 goes a fancy-schmancy route, and actually has little electrical contacts in the pads connected to a warning light on the dash. But the XJ-S has nothing, zilch, nada; the first indication the driver gets that the pads are worn is the expensive sound of steel pad backing plate against iron rotor. Ray Thackeray says, "I was shocked to find my 1995 XJ-S didn't have pad warnings - I just had to replace the disks because I started grinding."

Of course, many Jaguar owners would replace the rotors when replacing pads as a matter of course, so saving the rotor may not be an issue. But steel against iron also provides really lousy braking, so it is a good idea from a safety standpoint to replace the pads before the linings are gone. Not only will steel on iron reduce braking effectiveness, but the fact that it will probably do it on one wheel before the others may also surprise you with a violent pull.

The XJ-S owner would obviously be well-advised to inspect his linings every now and then -- even though it requires getting under the car to inspect the rear ones. The lining on new pads is 3/8" thick. The Jaguar literature specifies a wear limit of 1/8"; this is apparently conservative since the linings are only 2/3 used up, but they are cheap so replacing them at this point is a reasonable policy. Note also that the rear pads could theoretically be used right up to just before the steel backing plates hit, but the fronts have anti-rattle clips that sit against the pad and will be the first thing that hits the rotor when the linings get thinner than the wire that clip is made of.

Actually, there may be another reason to replace pads with that much thickness left on them. Roger Bywater says the 1/8" minimum thickness is "to retain adequate heat barrier to the fluid." In other words, the facing material itself serves as a layer of insulation to keep the heat generated at the friction surface from getting to the brake fluid. Of course, if you always drive gently enough that the brakes never get very hot, you might not care.

If you keep track of your pad wear rate and don't change your driving style, you can usually predict fairly well when you need to start checking for worn pads. Of course, it still wouldn't hurt to check them every now and then; it's a good way to catch other problems such as leaky calipers or sticking caliper pistons.

CHOOSING NEW PADS: Choosing new pads is largely a matter of matching the product to your driving style -- which means that you, as the owner of the car, should be involved in the decision. Merely allowing a mechanic or dealer to install whatever pads they normally provide is not necessarily the best way to maximize your driving pleasure and safety.

Much of the discussion of pads -- and brakes as a whole -- centers on the issues of how well they perform when hot vs. when cold. So, the first thing that needs clarification is just what is meant by "hot" and "cold". We are talking about when the *brakes* are hot or cold, not the engine. If you've been driving down the freeway at 70 mph for the past hour, your brakes are cold -- but if you just used them hard once coming to a stop on the exit ramp, they are now hot. Whether or not brakes are hot depends only on how hard you have been using them in the past few minutes. And they cool down faster if you've been moving than if you've been parked.

It's simply amazing how many "experts" miss this very simple point. If your brakes don't work right the first time you apply them in the morning but work fine the rest of the day, that has nothing to do with hot vs. cold. You have some other problem, possibly a sticking caliper, but very likely either your pads or rotors are rusting and the first application in the morning scrapes all the surface rust off.

Obviously, if you are going fast enough, the *first* application of the brakes could result in hot brakes by the time the car comes to a stop. The most severe test on level ground, though, is in accelerating to around 60 mph and coming to a halt

repeatedly. If you accelerate to higher speeds, there is more time between applications to cool down, and more airflow around the car to help cool the brakes. Of course, the real torture test for brakes is going down a mountain, where you can easily perform such a test without even using the engine -- or worse, using the engine to accelerate to 60 mph much faster than you could on level ground -- and then using the brakes repeatedly or constantly to limit speed. It is not reasonable to expect Jaguar -- or *any* automobile company -- to design brakes that will withstand whatever downhill road you can possibly find. If you are going down a hill that is clearly beyond the norm, either proceed slowly (which allows the brakes more time to dissipate heat), or downshift to a lower gear to use engine compression to absorb some of that energy.

Just driving around town, gently applying the brakes when you come to a stoplight, etc., results in cold brakes at all times. The only time Granny will *ever* experience hot brakes is if she goes down the mountain road, which of course makes it all the more dangerous since she probably has no idea what she's doing nor what to do when her brakes begin to fade. Driving that Cadillac at 25 mph may make some sense after all.

From a safety standpoint, for street use it is of utmost importance that the brakes work well when cold. Your typical panic stop is done with cold brakes. This should be kept in mind when considering new pads.

In simplest terms, people talk about three types of brake pads: organic, metallic, and semi-metallic. Organics are best considered a cold-stop pad only. They have four advantages: 1) They generally require the least pedal pressure for a given braking action, making them popular with Granny and her arthritic legs; 2) They wear themselves out without doing much damage at all to the rotors; when replacing organic pads, not only may you not need to replace rotors, you may actually get away without even having them turned! 3) They are quiet; you basically cannot hear the brakes in operation; and 4) They are cheap.

Their disadvantages show as soon as they get hot, though. Organic pads have a relatively low melting point, and the melting point is what results in "brake fade" -- the friction surface of the pad melts, lubricating the brake. When this happens, the driver still feels a "hard" pedal, but the car doesn't want to stop. Organic pad materials don't conduct heat very well, either, and this results in the fade being very sudden and complete; the brakes at one end of the car go from working properly to basically not working at all very suddenly and with little or no warning. And when the brakes at one end quit, the other end (which is usually pretty hot by now already) takes up the additional load and promptly fades as well. The suddenness of the transition from good brakes to no brakes is arguably as much of the danger as the fact that they fade at all.

The other extreme is metallic pads. The friction material on such pads is typically sintered iron or the like. Having the melting point of iron, such pads are pretty much impervious to fade up to the point where iron melts -- at which point your rotors are in trouble! This makes metallics the traditional choice for racing, but unfortunately they have disadvantages for street use. First, they tend to build up a surface layer of rust -- which can cause really serious problems on that first stop in the morning. Second, they require a good deal more pedal pressure to effect a stop -- which the racers actually consider an advantage, since the higher pedal force makes it easier for them to modulate their braking. But Granny probably won't like it. It was a much larger problem prior to the advent of power brakes, of course. Third, their coefficient of friction is generally higher when warm than when cold (the iron gets "softer" as it gets hotter, giving it more grip), so stopping the car when the brakes are cold -- which is basically every stop in typical street use -- requires that much more pedal effort. Fourth, they make a considerable amount of noise. We're not talking about squealing here; squealing can be a problem with any pad, but is easily corrected with the proper application of anti-squeal compound to the back of the pad. The noise we're talking about here is a scraping sound, the sort of sound you'd expect from metal-on-metal. Fifth, metallic pads play hell with the rotors; whenever the pads are replaced, you'll be replacing the rotors as well.

Semi-metallic pads have a friction material that is typically an organic material with particles of metal interspersed through it. To a certain extent, this represents a cross between the organic and metallic pads; when the organic portion fades is just when the metallic portion is getting heated up enough to work best, so with any luck at all (or careful design on the part of the pad manufacturer) the pads will seem to work equivalently well either hot or cold. There's more to this than the simple mixture of friction materials, though: the metal particles -- which often look like shavings -- help to conduct heat away from the contact surface, and therefore help keep the organic material cool and resist fading. Some semi-metallics appear to have copper in them instead of iron, apparently trying to maximize this effect -- or maybe just to avoid the rusting problems. With either copper or iron, semi-metallic pads not only have far greater resistance to

fading than organic pads, but when they do fade they seem to do so gradually, telling the driver that he's getting close to trouble and perhaps should take caution.

Of course, in this day and age this discussion must be considered oversimplified at best. There is also a type of pad referred to as "low-metal", apparently similar to semi-metallic only leaning closer to organic. Kevlar, basically a type of really strong plastic, is available in pads. Asbestos is still around, but nowhere near as popular as it once was -- but you can get pads made with ceramic fibers which behave very similarly to asbestos, some suggest even to causing similar health problems. You can now get pads with carbon in them; carbon has a much higher melting temperature than iron but doesn't conduct heat well at all. You can even get carbon-carbon pads (carbon fibers bonded together with a carbon substrate) which will hold together until the rotors melt -- which, of course, helps explain why many racing venues have gone to carbon rotors as well.

In the US, the DOT now requires that new pads be marked with a pair of letters indicating their coefficient of friction (CF). The first letter is the CF at room temperature, and the second letter is the CF at 600°F -- which is not really all that hot as brakes go, possibly indicating DOT's concern with panic stops rather than performance under severe or racing conditions. Whatever, if you have power brakes it's probably of little concern to you just what the letters are; if the CF is low, you just push a little harder on the pedal to stop the car. Your bigger concern should be that the two letters are the same. If the first letter indicates a higher CF than the second, these pads fade a little by 600°F, which is a pretty low temp to be fading at. If the first letter is lower than the second, these pads don't work as well when cold as when hot. Of course, being only one letter off or so is probably not a big deal.

You might also note that the letter E in the DOT designation indicates a CF that is fairly close to bare steel-on-steel. If you are the type that never checks for pad wear until disaster strikes, this might actually be important. The XJ-S has no warnings of pad wear until the lining is gone, and when that happens you will be running steel-on-steel -- and probably on one wheel first. If the linings have a CF a long ways from that of steel-on-steel, your brakes suddenly pull to one side -- if it's the front brakes, probably pretty severely. If the CF is E, though, it stops pretty well the same way it did before, it just makes a lot more noise. Still, this is a minor point at best; the better idea is to be inspecting the pads periodically and replacing them before they're gone.

You also want the front pads to match the rear pads to maintain brake balance (the importance of brake balance is discussed on page 402). This important criteria is confirmed by Jaguar; with VIN 109447, the XJ-S switched from organic pads to semi-metallic pads from the factory, and notes in the parts list indicate clearly that if one end of an early car is upgraded to semi-metallics, the other end must be upgraded at the same time. It is of considerable importance from a safety standpoint that the pads behave similarly both hot and cold. At the very minimum, the CF letter designations on the pads should be the same for the front and rear; better yet, just use the exact same brand of pads on both ends of the car.

It has come to this author's attention that many so-called experts consider it a good idea to use semi-metallic pads at the front and organic pads at the rear, "since the fronts run hotter." This dangerous concept is apparently so popular that many shops don't even discuss it with their customers, they just go ahead and install the pads accordingly! For your safety, this is one place where you need to have a discussion with the shop working on your car. If they subscribe to this idea, tell them in no uncertain terms that you do *not*, and insist upon matching pads front and rear. If they have a problem with that, take your business elsewhere.

BEDDING IN NEW BRAKE PADS: The frequency of this complaint, on Jaguars as well as other cars, indicates that the following advice should be followed closely. Allan Charlton explains: "My son works in a car parts firm, and they have had disk pad bedding-in problems. It seems that the new asbestos-free pads need to be bedded-in properly or they can cause damage. In their experience (mostly VW Golf, but also BMW and M-B) disks were blued and warped, but the following procedure has eliminated the problem entirely.

"Accelerate to 60 km/h. Use moderate brake pedal pressure to slow to 5 km/h. Do not stop the vehicle, but accelerate to 60 km/h again. Repeat ten times, with about 500 metres between applications, then stop and let the brakes cool." Note: it's probably not really a good idea to stop. A better idea would be to continue driving for at least ten more minutes or so, allowing the rotors to cool while turning rather than while parked.

"Use the brakes moderately for the next 300 km, and do not get them hot. After that, they should be OK. The procedure is intended to be used when you first install the disks--it won't repair damage already done."

Peter Cohen adds, "Jaguar actually includes a paper with approximately these instructions in the box with their brake pads."

It's not entirely clear just what this is supposed to accomplish. The iron rotors are not the problem. The cast iron either has casting stresses, or it doesn't; if it does, they're gonna warp the first time they get hot, and a bedding-in procedure won't stop that. If they run straight and true, you can warp them by overheating them and then parking or otherwise abusing them, but under normal circumstances they will work fine for their life -- even if used hard.

The problem is apparently in the pads themselves. One idea may be that the pads are not perfectly flat and mated to the surface of the rotor to begin with, and such a procedure is needed to get them applying consistent friction across the surface -- but it's not clear why you couldn't get there by just using them for a while rather than needing to do this bedding-in procedure.

There is something about new pads that isn't good. Apparently, the manufacturing process results in the surface of a new pad that is different than the interior of the pad, in much the same way that the surface of concrete is smooth while the interior is full of rocks. This virgin surface may not only result in different braking characteristics when new than after bedding in, but it may cause some other detrimental effects. Apparently one problem is that this new surface may deposit substances on the rotor, and only in some places rather than all over. Then, with continued light use, the areas where the deposits are protected from rotor wear while the uncoated areas wear, and from then on the inconsistent wear patterns result in pulsing brakes -- even after the deposits are gone.

Starting with VIN 125760, the XJ-S came fitted with "scorched" pads. It is unknown whether or not this was intended to address the new pad problems, but it's not likely they did it for nothing! Various aftermarket brake pad companies offer "burnished" pads or "machined" pads, either of which may be methods of getting rid of the virgin surface before installation.

BRAKE HOSES: All automobiles have flexible hoses connecting the hard metal brake lines on the car out to the brake calipers that are bouncing up and down with the wheels. Most cars have one hose per wheel, but Jaguars with inboard rear brakes are a little different; since the brakes are at the final drive unit rather than bouncing up and down with the wheels, a flexible hose to each rear wheel is not required. However, since the entire subframe is attached to the car with rubber mounts, a single flexible hose is used to connect from the car to the subframe. Hence, there are three hoses on the XJ-S with inboard rear brakes: two front and one rear.

As one might expect, such hoses won't last forever. Like other items made of rubber in the car, they need to be replaced periodically -- preferably *before* they fail in this case.

The OEM brake hoses come with a stripe down the side. It's there for a reason: so you can tell if you're twisting the hose as you install it. Make sure you don't.

The front brake hoses on the XJ-S come with a coil around them. This helps prevent kinking as the steering and suspension move, and it also help protect the hose from abrasion if a tire manages to rub against it. On some of the original hoses, this coil was plastic. On replacement hoses, it's often steel. Either seems to work fine. However, it's a simple matter to unwind the plastic ones off the old hoses, while the steel ones get thrown out with the hoses. If your old hoses have plastic coils, you might want to keep them just in case you ever need to install them on replacement hoses.

BRAIDED BRAKE HOSES: When replacing hoses, owners often seek something *better* than the OEM -- usually deciding right off that braided stainless steel hoses simply *must* be better. Unfortunately, that is usually false; the OEM hoses may look plain, but they are excellent and safe, and one should be very careful indeed that replacing with something prettier isn't taking a serious risk.

Mike Morrin says, "In *this* country (New Zealand), stainless steel braided flexible brake hoses are illegal." Brian Schreurs adds, "They were in the US as well, until quite recently, for the simple reason that they could not be made (or

no one was willing to make them) to federal DOT standards. Just in the last couple of years a company has started making DOT-legal steel braided brake hose."

Jim Downes explains: "I have seen steel braided lines being the cause of the suspension of an aircraft's airworthiness certificate. This resulted from specific, documented cases of the line flexing due to movement and vibration. In turn the braiding cut the internal material. The other argument against steel braid is that its presence is useless as a means of containing any liquid, yet it prevents any kind of inspection of the internal components."

Apparently, the DOT-approved lines are teflon tubing surrounded by braiding. The teflon tubing is fully capable of holding the fluid pressure without the braiding, but is susceptible to stone damage so the braiding serves as physical protection. The stainless steel braiding won't chafe the teflon, either, it will simply slide back and forth on it without discernable damage.

When ordering aftermarket brake lines, you need to double-check that what you are ordering will fit -- see

<http://www.jag-lovers.org/xj-s/book/SSBrakeHoses.html>

for details on why. For the front of the XJ-S, each of the two front hoses needs to be about 18" long tip-to-tip and have 10mm x 1.0 threads on both ends. For the rear of the pre-1994 XJ-S, the single hose used needs to be 10" tip-to-tip and has the same 10mm x 1.0 threads. Besides the thread requirements, the fittings also must be "bulkhead" fittings, meaning they must have the extra length necessary to insert them through a bracket and thread a nut down to hold them securely and still have enough thread left to attach the rigid line without the coupling nut bottoming on the mounting nut. Of course, if you plan to replace the hard lines that these hoses connect to or change the mounting scheme, you can end up with whatever fittings and lengths you wish.

Note also that some suppliers provide braided brake hoses with AN fittings on the ends and some screw-on adapters to connect to the fittings on the car. This is not really a problem as AN fittings are quite reliable, but nevertheless it would obviously be preferable to get hoses with the correct fittings so adapters are not necessary. Walter Acker IV found a company that will provide such hoses custom-made:

Baker Precision Bearing Company
1-800-959-7757
e-mail: Baker16@ix.netcom.com
<http://www.bakerprecision.com>

"The cost of the hose was less than the price of a new rubber hose." In order to get them right, Baker Precision wants you to ship them one of your old hoses.

Either the OEM rubber hose (which actually is a very tiny plastic tube surrounded by a very thick rubber casing) or the teflon surrounded by braiding is probably an excellent hose material for the application, but the attachment schemes used to fasten these hoses to the fittings seem to differ. Of the braided hose assemblies I have seen, the braid/hose is slid over a barb and a separate sleeve is crimped down onto the outside of the braid to secure the hose to the barb. As a result, the entire weight of the hose is supported by the barb itself -- and the barb is pretty tiny on a brake line. One could easily envision this barb snapping off if the hose has been bouncing around for a while or something yanks on it hard enough. One could also envision the hose pulling off of that barb, or being blown off by high pressure. The chances of these problems occurring may be small, and nobody has reported such problems, but nevertheless it's something to think about.

Conversely, the OEM hose has a vastly superior attachment scheme. The hose is once again crimped onto the barb, but the sleeve that is crimped around the hose is not a separate item -- it is part of the fitting itself. Hence, the crimped sleeve provides mechanical support for the hose and securely prevents it from being pulled off the fitting or blowing off. If you hooked a tractor to this hose, you'd probably rip the hose apart before you got it to come off the fitting.

If you can find a braided hose made with the same type fittings as those used on the OEM hose, go for it. If you can't but nevertheless insist on replacing the OEM hoses with braided hoses, *don't* try to use hoses that mount the same way the OEM hoses mount. Instead, find a way to support the braided hoses by installing support clamps around the hose itself rather than holding it by the fittings at the end. This may require devising some custom support brackets, bending or replacing some of the OEM hard lines, and getting braided hoses a little longer than the OEM hoses.

BRAKE CALIPER JAMMING: Supposedly a fairly common problem on Jaguars, even though looking at the way the calipers are designed it's difficult to imagine how the pistons could jam. Jan Wikström says, "Crud in the cylinders. I think the mechanism is that the crud settles to the bottom and gets sticky, so when pressure is applied the piston tilts and jams -- and once it's jammed, more crud settles in the baps and keeps it that way. I had that on both front brakes, as I discovered when the brakes started pulling to the right. I had to use the Big Bad-Assed Pry Bar to shift one inside piston on the right and three out of four on the left. Once I had managed to shove them in, compressed air would (reluctantly) move them back out, but to restore them fully I had to split the calipers and clean the bores as well as the pistons. Mega-gunge, collected since 1977..."

I'd like to suggest that regular flushing of the brake fluid -- bleeding old fluid out and new fluid in -- would keep the calipers free of this mega-gunge, but it is clear from the configuration of the calipers and ports that the stuff won't come out without a rebuild; the bleed port is at the top, so it will clear air, not mega-gunge. However, what regular brake fluid flushing *will* do is help keep moisture out of the calipers. Moisture, absorbed in brake fluid that's been in there too long, causes the insides of the iron calipers to rust, and the rust particles undoubtedly contribute to the mega-gunge.

BRAKE CALIPER DETERIORATION: The author had a brake caliper fail after 17 years. Obviously, therefore, it would be a good idea to rebuild the calipers *before* they are 17 years old to avoid nasty surprises while driving. I can confirm that when the one failed, the other three on the car wouldn't have been far behind if I hadn't gone ahead and addressed them all.

The pistons are chrome-plated steel, so the recess in the side facing the pads rusts big time -- but who cares? The outside surface of the piston, which is where the seal rides, is completely enclosed behind a boot, and hopefully coated with some red grease besides. Between the boot and grease outside the seal and the brake fluid (flushed regularly) inside the seal, the piston should stay functional forever.

The boot, however, will not. Either from age or from the brakes running hot (or just from being British rubber!), the boot will eventually deteriorate. Once it is old and rotten, it *still* might work a good long while if it never moves -- meaning the pads don't wear so the pistons don't come too far out of their cylinders. Once the pads wear close to their 1/8" service limits, the pistons protrude from the cylinders a bit, stretching the boots -- and pulling open tears in them if they are old and rotten. Once opened to the elements, water gets in and washes the grease out. This, in itself, is not noticed by the driver, since the seal keeps the water out of the fluid and the brakes continue to work fine. However, the chrome-plated pistons start to deteriorate on the important outside surface; the chrome starts to flake off and the steel underneath starts to rust, causing more chrome to flake off. If it doesn't cause brake failure out on the road, it most certainly will cause brake failure the next time the pads are replaced and the rusty exposed portion of the piston is pushed back in past the seal.

If you rebuild your calipers and replace the boots *before* they tear open and expose the pistons to the elements, the pistons might last forever -- which makes that caliper rebuild significantly cheaper. So, learn from my mistakes and subtract a few years from 17 and plan on a caliper rebuild when the boots still look good.

If you replace your pads before they get anywhere near their wear limits, you may be able to go longer between caliper overhauls because you're not stressing the boots as much. It's probably not worth it, though; the boots probably won't last much longer, and pad changing isn't that minor an operation since you need to remove the rotor and turn or replace it each time.

BRAKE PAD RETAINING PIN CLIPS: Now that you are fully aware of the importance of the boots on the caliper pistons, note that the little clips on the brake pad retaining pins tend to poke holes in those boots! Aaaaaargh! Basically, the ends of the clip can hang over the edge of the boot, and then as the pads wear and the pistons protrude farther, the boot is pulled into the ends of the clip.

At first blush, it seems easy enough to install the clips turned either this way or that and thereby avoid problems. However, whichever way the clips are installed, the pins can still rotate far enough to poke holes in the boots. The only

way the clips could be installed to avoid boot damage is from the inside out, and that appears to be either difficult or impossible to do.

Here's the simplest solution: Take some steel wire, 16 gauge seems about right, and form a ring that fits snugly around the pin. Slide it onto the pin and up against the head prior to installing the pin. Now, when the clip is installed, it will be held close to the inner surface of the caliper. It will be held close enough that it will be *beside* the edge of the boot rather than *over* it. Hence, you will have to turn the pin to the correct position to install the clip, and once installed the pin will not be free to rotate.

Richard Dowling came up with another fix: After installing the clips, he tied the loops on the two clips to each other with a thin piece of wire. By pulling those loops towards each other, the pointy ends are kept away from the boots.

Another idea might be to simply toss the clips and use lockwire in those holes. Or perhaps tiny cotter pins, if you can figure out how to install them properly without damaging the boots.

On the rear calipers, there is yet one more possibility, and that is to buy or make longer pins and drill holes in the opposite end from the head. Then you can install the clips on the *outside* of the caliper where they can't do any damage. Unfortunately, this idea isn't as workable for the front calipers due to the configuration of the outside surface of the caliper.

BRAKE CALIPER DISASSEMBLY: The repair manuals suggest using compressed air to get the pistons out. This works pretty well on the first piston -- provided the pistons are not seized in the cylinders. Unfortunately, when a piston is seized, the non-seized pistons will be the first to move, and you'll be left with a piston stuck in a caliper and open cylinders where the compressed air blows out. To get the stuck piston to move, you would need to securely plug the empty cylinders (with the pistons) and plug all but one of the brake fluid passages while applying air to the one remaining.

If you get into such problems, you're probably going to want to separate the caliper halves anyway. If so, forget about the compressed air trick. Once separated, turn a caliper half over and clamp the lip of the piston in a vice. Then carefully twist the caliper back and forth as you slide it off of the piston.

The ROM says: "CAUTION: Under no circumstances must the caliper halves be separated." The page of directions that comes with the Lucas rebuild kits says the same thing, and since this appears to be a generic set of directions ("Publication XZB214"), it probably indicates a general rule that you shouldn't separate the halves of *any* brake caliper. Nobody seems to know where this rule comes from, but it is clearly BS -- at least as applied to the calipers on the XJ-S. Many people have chosen to ignore this warning because separating the halves is obviously necessary to properly clean up the cylinders, and there have been no reports of problems. There is a seal issue on the front calipers, however -- see page 407.

The tool of choice for removing the old seals from their grooves in the cylinders is a dental probe with a slightly curved needle point -- but a straight pin is almost as good. Just stick the point into the rubber itself and use it to peel the ring out of the groove; you're just throwing the seal away anyway. This method cannot possibly damage the surface of the metal in the caliper unless you really screw up with the pin and scratch something, so with any care at all it'll be perfect. The same cannot be said for using a screwdriver or some such to try to get under it and pry it out.

BRAKE CALIPER RESTORATION: Old brake calipers are commonly restored to usable condition by the fitting of brass or stainless steel sleeves. However, notice that this will serve no purpose on an XJ-S. First, sleeving is normally done on aluminum cylinders where wear can be a concern in long-term use, but the Jaguar calipers are cast iron. Second, sleeving is normally only called for when the caliper is NLA, because buying a new caliper generally costs less than sleeving. At least as late as 2000, Jaguar XJ-S calipers were still readily available and reasonably priced.

However, the most compelling reason not to bother sleeving XJ-S calipers is because of their design! As Chad Bolles points out, "Take a look at the design of the caliper. You will note the piston has *no* seal on it, the seal is in the body of the caliper itself. Therefore if the bore of the caliper is rusted and pitted it would make no difference, 'cause the seal

rides on the piston not the bore.” As a result, the sealing surfaces in these calipers can be completely renewed by simply replacing the pistons -- and the pistons are available separately for this purpose. Just ream any big chunks of corrosion out of the caliper so the piston doesn’t hang up on them and reassemble; pitting or the like inside the cylinder does no harm.

STAINLESS STEEL CALIPER PISTONS: The caliper pistons that come in the XJ-S are chrome-plated steel. On this author’s ’83, a brake failure resulted when these pistons rusted and the chrome flaked off, causing a fluid leak past a seal -- but the car was 17 years old when this happened, so it’s hard to fault the chrome-plated steel pistons for lacking durability. Just the same, I will be using stainless steel pistons from now on, so I never have to worry about that particular cause of brake failures again.

Greg Wells points out that calipers assembled with stainless steel pistons seem to go through seals quicker, though. An investigation soon revealed the reason why. The chrome-plated steel pistons are as smooth as a baby’s bottom; they have a ground finish, not commonly seen on chrome-plated parts (chrome is usually polished, not ground). The stainless steel items, on the other hand, have an as-machined finish that, although very pretty, is quite rough; if you run your fingernail down the side of the piston, it “sings” to you as the nail runs across all those tiny machining ridges. As these pistons slide back and forth as the brakes are applied and released, they will file away at the seal.

At P&WA where this author once worked, the finish on parts that rubber seals moved against was considered critical, requiring essentially a mirror finish. It is therefore recommended that, if you plan to install stainless steel pistons, take the time to polish the outside diameter on them before installation. This will require a buffing wheel and some buffing compound suitable for use on stainless steel; using a hand cloth and a jar of household silver polish won’t get it. When buffing, hold the piston against the wheel so that the wheel is buffing either axially or diagonally along the surface of the piston, not circumferentially; you want to polish those machining grooves out, not enlarge them!

About 30 seconds on the wheel makes the surface *feel* considerably different, although it doesn’t look much different. The fingernail still sings, but it doesn’t sing anywhere near as loudly and it somehow seems less harsh -- sorta like the difference between a new file and a worn file. This 30 seconds of work per piston would probably triple the lifespan of seals in the caliper.

With perhaps ten minutes per piston, they actually *look* a bunch smoother; maybe not mirror finish yet, but the singing when a fingernail is run down it is almost gone. The problem here is that the job takes patience, because the pistons get too hot to touch after a couple minutes on the buffing wheel, so you’ve gotta set them down and go check your e-mail or something. You could just dunk them in water to cool them, but I chose not to mix water with the polishing compound.

I have been unable to measure any diameter change associated with this polishing.

Obviously, when done these pistons must be cleaned *very* thoroughly to remove all traces of that polishing compound. Wouldn’t be good in a brake system.

BRAKE CALIPER PARTS CLEANING: Using the wrong solvent here could be bad, and water might not be too good an idea either. Fortunately, any auto parts store sells a spray can of brake parts cleaner. In fact, they often seem to offer two types of brake parts cleaner, often made by the same company; one that’s a basic cleaner, and the other is more environmentally-friendly or something. They both seem to work pretty well, and they evaporate quickly without trace.

BRAKE CALIPER ASSEMBLY: FYI, the calipers in the XJ-S, both front and rear, correspond to illustration “D” on the generic page of directions that comes with the Lucas caliper rebuild kit. The new seals go in either way, there is no inside or outside to them. The groove itself has a tapered bottom, which tilts the inward edge of the seal up against the piston so it seals properly.

The Haynes manual implies you should use only brake fluid when assembling pistons into calipers: “Dip each piston in clean hydraulic fluid and enter it squarely into its cylinder.” Many mechanics concur that the only substance that should be used when assembling pistons in brake calipers is brake fluid. It doesn’t work too well, though; brake fluid tends to

run right off of clean steel or stainless steel, leaving the assembly basically dry while you're trying to slide the piston through seriously tight new seals.

The ROM has a better idea: coat the seals and pistons with Girling disc brake lubricant. Time was when a Girling rebuild kit came with a small packet of "red grease" for this purpose, but the modern Lucas rebuild kits do not include such a packet; you need to buy some separately. Craig Sawyers says, "I have a tube of the stuff, and the data sheet for the different greases right here. It is Girling PFG102, described in the table as:

Rubber Grease (red), For use on rubber items in or near to DOT brake fluid.

For use on hydraulic units in direct contact with brake fluid, providing extra protection against corrosion and ingress of dirt e.e. packing dust covers of master cylinders and brake piston dust covers.

Warning - not other grease to be used in these areas.

"It is, well - dark cherry red and greasy!"

Another tube of red grease was labelled "Genuine Castrol Girling Rubber Grease -- Specially prepared by Castrol for Girling". The only number on the tube is "Code 64947010". It might be worth noting that this tube appears quite old; Sawyers' report above probably refers to a more recent product.

If you can't find the genuine Girling red grease, be *very* careful about substitutes. There are substances intended to lubricate pistons in calipers during assembly, and there are substances intended to lubricate pads in calipers or the slides on floating calipers, and these are *both* commonly described as "brake caliper grease". However, the latter substance is usually black (it contains graphite) and will say on the package "Do *not* use on internal caliper parts." Chuck Sparks won't even use packets of red grease if they're not properly labelled from Girling; he'd rather use the stuff in the tube, since he *knows* that is the right stuff.

It appears to be a common belief that silicone lubricant may be used for assembling pistons into calipers. Nobody seems able to point to any official recommendation, though, and some mechanics suggest it is dangerous at best. Jeb Boyd says, "I don't know if that would be from the same family as silicone brake fluid, but I do know that mixing silicone brake fluid with glycol based fluid produces a gelatinous mess that will trash a hydraulic system in a hurry. I would steer clear of silicone grease...unless you are using silicone fluid." Play it safe and use the recommended red grease.

Although the ROM advises coating the seal and the piston with grease, you might consider coating more than that. If you coat the inside of the cylinder, it should help the piston slide into place without scoring. And if you coat the lip area of the piston, it should help the boot slip into place better -- but be sure to remove any grease from the surface that contacts the pad, since you should be using a different substance there. If you coat the areas of the piston and caliper under the boot but outside the cylinder seal, maybe it will help keep things from rusting, and perhaps catch any dust or rust scale that happens to get in there and prevent it from getting into the seal. Finally, you might consider using this grease on the threads of fittings and bleederers.

Richard Dowling reports that there is one place you probably do *not* want to apply red grease. "The shoulder around the bore, which takes the outer part of the boot, saved Girling a few cents by not having a groove machined onto it. Hence the boot is retained by friction between the rubber and the shoulder, with the large circular clip applying the force. No groove means if you grease the boot it slides off very easily, and I doubt if it would stay put for long." It actually might not be a bad idea to apply some sort of sealant here to help the boot stay in place. A sealant resistant to brake fluid is not necessary since it should never *see* any brake fluid, so any sealant that won't attack the rubber of the boot will do.

CRC makes a substance called "Disc Brake Quiet" that is red and comes in a 4-oz. plastic bottle. This stuff is intended to be applied to the back side of brake pads immediately before installation, after which it dries to a rubbery glue that bonds the pads to the pistons. I do *not* recommend the use of this stuff on the pads in the XJ-S, because it also bonds the pads to the boots -- and as Dowling says, those boots aren't held down very well, so as the pads wear they can end up pulling the boots off the calipers. However, it might make good sense to use this stuff when installing the boots! Just apply a small bead around the shoulder before installing the boot with its clip.

WARPED ROTORS: The way to check for warped rotors is to mount a dial indicator on the upright or axle and position the tip against the friction surface of the rotor. As you turn the rotor around, ideally the needle should stand still. Moving less than 0.005" is good. Big swings back and forth are bad, and will result in pulsing or shuddering brakes.

Some people suggest that warped rotors are caused by tightening down the rotor attachment bolts or the wheel lug nuts too much. This is hogwash, pure and simple, but if you don't think so it's still a simple matter to avoid the problem. Simply use a torque wrench to attach the rotor to the hub. If you aren't already using a torque wrench to mount the wheels, well, shame on you.

Warped rotors are usually caused by defective rotors. In the most obvious incarnation, the guys making the rotors machined them crooked. Such mistakes should result in the rotors being returned for credit and a vow never to use that supplier again. In a less obvious cause, the casting of the iron rotor itself prior to machining is faulty and results in residual stresses in the metal. Then the rotor is machined straight, but the first time the rotor gets really hot these stresses relax, and the rotor warps. It will shudder from then on. If the warp is in the friction area of the rotor, you can merely have the rotor turned and it'll completely fix it; the residual stresses are gone, it will never warp again. However, if the distortion included the hub mounting area, you'll either need to remachine that as well or toss it and get a better rotor.

Casting iron is not rocket science; it's been done for thousands of years, and every casting company knows how to do it correctly to avoid residual stresses. The problems occur when they put their profit margin ahead of quality control and start taking shortcuts in the casting process. If you buy rotors that warp the first time you get them hot, do us all a favor and return them for credit. Allowing companies to get away with making substandard products doesn't help anybody.

Yet another possibility involves rotors that are straight with no residual stresses, but have non-homogeneous metallurgy. A little carbon here and there can make some portions of a cast iron rotor something closer to hard steel. Such hard areas not only have different coefficients of friction that result in pulsing brakes, but they also wear at different rates. When one area wears faster than another, they gradually become effectively warped and start shuddering.

It is possible to warp good rotors. Typically, it requires getting them very hot and then letting them cool with an asymmetrical force or load on them. That asymmetrical force can be gravity, if the car is parked rather than rolling; if you get the brakes really hot, make sure to drive a few miles to let them cool off prior to parking. Another possible cause is a stuck caliper piston, which will first help get the rotor too hot in the first place and then hold a pad jammed against it while it cools.

Of course, there are dumb things too. If you leave the car parked for years, the rotors may rust everywhere except where the pads sit. When the brakes are next applied, the rust is all sloughed off, leaving high spots where the pads were. If parked in a flood-prone area, the rotors may rust on the bottom half!

ROTOR TURNING: Rusty Beard says, "I took the front rotors off to get them turned. I went to the NAPA parts store (a reliable U.S. chain) to get the rotors turned, and the parts clerk looked up the Jaguar in his book. The book was footnoted that the rotors could not be turned, but *only* replaced. Further, the minimum tolerances were not even printed, just left blank. Thus, he would not do the work. I went two doors south to a brake shop and that man had the book with all the minimum tolerances printed, and no further notes. He did the job, and I got my car back together."

This problem probably stemmed from the bonded laminate rotors used at the rear; see page 408. It shouldn't relate to the front rotors, which are a conventional cast iron vented rotor design and can be turned like those on any other car. In fact, it shouldn't relate to the rear rotors if the original laminated rotors were replaced with solid rotors at some earlier time, which would be obvious because they don't have the loose iron ring around the outer edge.

BRAKE SQUEAL: Dean Gosselin sends this tip: "I have traced a major source of brake squeal on my 1991 XJ-S to a tire clean/shine product called "Formula 2000". After 4-6 weeks of not using this product the brake squeal is nearly gone. I traced this cause to the spray-on tire cleaning product after my father used the stuff on his Audi and it immediately resulted in major squeal under braking."

If you're not using tire cleaners and still have a brake squeal problem, there are three distinct types of products available to address it. One is a substance that you spray on the back side of the pads and allow to fully dry before installation. Typically this stuff is blue. It dries to form a tacky layer that serves as a damper between pad and piston. The second type is a red goo that comes in a 4-oz plastic bottle that is applied to the back side of the pad immediately before installation, and dries to bond the pad to the piston; as mentioned under BRAKE CALIPER ASSEMBLY above, this stuff is not recommended for the XJ-S. The third type is an aluminum shim material that is cut to shape and stuck onto the back side of the pads.

Some owners, however, report that the final fix for squealing brakes was to replace the pads with a different type. Notably, the organic pads tend not to squeal, while some types of semi-metallic pads squeal like crazy. Since organic pads are undesirable from a performance and safety standpoint, there's something to be said for insisting upon semi-metallic pads from a reputable maker.

DIRTY FRONT WHEELS: Dust from the front brakes tends to get the wheels dirty, especially if you use them hard. There is a device available to prevent this problem. It's called KleenWheels, and it's essentially a disk that seals the wheel on the inside so the dust can't come out through the openings. They are available at many auto parts stores. Ed Avis reports that the no-name "turbo-vented dust shields" sold by J. C. Whitney, catalog number 78xx6976BF, are in fact genuine KleenWheels. He also provides the info on the company itself:

KleenWheels
5000 Oakes Road, Suite H
Ft. Lauderdale, FL 33314
+1 (954) 791-9112

It would be logical to assume that cutting off this airflow path would result in a reduction in brake cooling, and therefore poorer braking performance under severe, repeated braking. However, most users don't notice any detriment -- perhaps because they never use their brakes hard enough for overheating to be a problem. The primary cooling airflow is from the inboard side of the brakes to the inside of the hub and outward through the vented disk. The warmed air can then go either out through the wheel or inward under the car. The use of KleenWheels prevents the first exit, so all the air goes inward. So, the use of KleenWheels won't reduce the airflow to the brakes, but it may cause more of the warmed air to recirculate back through the brake again. Considering the airflow underneath the car during any activity where hot brakes are a concern, this is probably insignificant.

BRAKE PERFORMANCE IMPROVEMENT: Brakes *will* get hot; that cannot be avoided, since the entire point is to absorb the energy of the vehicle's forward motion and convert it into heat. The differences in how well brakes accomplish this generally result from A) how much mass there is to absorb the heat (only works once, though; the mass won't help the second time if it's already hot), B) how well the brakes dissipate the heat they have absorbed to the surrounding air, and C) just how hot the brake components can get before problems occur. In general, automotive brakes intended for street use are designed with enough mass in the iron rotors to absorb the energy of one stop, and then they are supposed to dissipate that heat to the air before the *next* stop. If the rotors aren't heavy enough, they'll fade during the first stop. If there isn't enough cooling airflow, they'll fade during subsequent stops. You can improve brakes greatly by replacing parts such as pads and brake fluid with items that work at hotter temperatures, but eventually you will only be able to improve so much without either increasing the rotor mass or the cooling airflow. Since makers of road cars typically concern themselves with the first stop, it's more likely that airflow is needed than additional mass.

Remember that the amount of energy brakes must be able to dissipate rises with the square of the vehicle speed. Stopping a car from 120 mph requires dissipating four times the energy as stopping the same car from 60 mph. Slowing a car from 120 mph to 60 mph requires dissipating three times the energy as stopping from 60 mph. If you plan on stopping from top speed, keep this in mind. If you plan to soup up your car so the top speed is considerably higher than stock, take note. Fortunately, when speeds are high is when there's plenty of airflow around to help cool the brakes, so with careful airflow and duct design you can obtain a significant amount of brake cooling during the *first* stop.

BRAKE BALANCE: Ideally, the relative action of the front and rear brakes should be balanced properly so that when the brakes are applied hard enough to approach the limits of adhesion, the limits of adhesion at both ends are approached at nearly the same time. Having one end lock up the tires while the other end is still not braking very hard is not good.

In the simplest arrangements, such balance is achieved by careful design. The designers of the car, hopefully using some actual road testing as a basis, design the front brakes and the rear brakes properly to obtain the correct balance. Typically, the diameters of the pistons in the calipers or the diameters of the pistons in the master cylinder are adjusted to obtain the desired balance. This is the idea behind the design of the XJ-S brakes, at least in the author's '83.

The racer's method of accomplishing the same thing is to install two separate master cylinders side by side, one serving the rear brakes and one serving the front. A beam connects the plungers of the two cylinders, and the pedal is connected to the center of this beam -- or a little off center. By moving the pedal connection closer to one side or the other, the proportion of force applied to each master cylinder can be easily varied. The driver takes a few laps and then gripes to the mechanic that one end or the other is locking up, and the mechanic adjusts the pedal connection accordingly.

Once the proper brake balance is established, it is important not to screw it up by doing something silly like using different type pads on one end than the other. The brakes in the XJ-S were designed for similar pad materials at both ends, so if you use metallic pads at one end and organic pads at the other, the balance will be a mess.

Of course, the proper balance is not a fixed thing. On dry pavement, heavy braking will result in a considerable shift of the weight forward onto the front wheels, endowing those tires with better traction. So, the proper balance on dry pavement is with the front brakes doing considerably more than half of the braking. But what happens in the wet? Or worse, in snow or icy conditions? In such cases of reduced traction, there will not be as much shift forward of the weight of the car, and proper balance would be closer to equal between front and rear. But such a simple system as that found in the '83 XJ-S will still provide the same balance as on dry pavement, so one could expect the front tires to lock up first under icy conditions.

There are ways to deal with this. In many automobiles, there is a device called a proportioning valve that is incorporated into the hydraulic line to the rear brakes. When the brakes are applied lightly, as one would do in snow or ice, the full pressure from the master cylinder is applied to both the front and rear brakes. When the brakes are applied more forcefully, however, such as when trying to stop quickly on dry pavement, the proportioning valve only permits a certain amount of pressure to the rear brakes and no more. In such cars, it is appropriate to design the actual brake hardware with the balance a little stronger to the rear. When applied lightly in snow or ice, the rear brakes will thus be stronger than the fronts, which is helpful in such conditions. The proportioning valve then limits increased braking at the rear to avoid locking the rear wheels under hard braking in dry conditions.

The author's '83 has no such proportioning valves. However, Figure 9.11 in the Haynes manual shows such a device -- of course, the British can't use conventional names so they call it a "Pressure Conscious Reducing Valve" or PCRV. So, apparently some XJ-S's or XJ12's come fitted with such a device.

Yet another method to accomplish a similar benefit was used in two British sports cars owned by the author in years past. Instead of having a brake booster between the pedal and the master cylinder as on the XJ-S, the pedal assembly and master cylinder were the same arrangement as a non-boosted brake system. The Girling booster was an in-line device -- pressurized fluid coming in one end resulted in boosted pressure coming out the other end. Neat, because it could be mounted anywhere. But these boosters were mounted in the lines to the *front brakes only*. As a result, when the brakes were applied lightly, the rears would come on strong first. But as more pedal pressure was applied, the booster would increase the pressure to the front brakes.

Of course, modern cars all have ABS -- which doesn't change a thing! It is still important to have a good balance on your brakes, since you don't want to lock up either end and get the ABS system involved before the other end is doing its part.

Snow and ice aren't the only conditions where the OEM brake balance might not be appropriate. If your car was designed decades ago but you have mounted some modern super-sticky tires on it, you may be able to stop considerably faster than the designers of the car expected you to. As a result, you will get *more* weight shift towards the front than they planned for, and may end up in a situation where the rear tires are skidding while the fronts still have more traction

available. To optimize your braking system under such conditions, you would need to alter the balance to either reduce the braking effect at the rear or increase it at the front.

It should be noted that proper brake balance is important for reasons other than avoiding wheelskid. When using the brakes hard, as when going down a mountain road, the amount of braking done by each wheel is what determines how hot each brake gets. If one end of the car isn't doing its share of the braking, the other end is going to get hotter than it should -- and possibly get into brake fade sooner than you would like.

When modifying or upgrading the braking system, many owners are justifiably concerned about effects on their brake balance. Regarding the vented rear rotor upgrade described beginning on page 412, there is good news -- or bad news, depending on your viewpoint. Since that upgrade uses the OEM caliper pistons to push the OEM pads against a rotor that is the same diameter as the OEM rotor, it cannot possibly affect the brake balance of the car. The only way it could is if the vented rotor were made of a significantly different material than the OEM rotor, but hopefully they are both something close to basic cast iron. From a performance standpoint, the only thing the vented rotors accomplish is to keep the brakes cooler so they can be used harder without fade. When used lightly, this upgrade should make no difference at all. Of course, if your solid rotors are covered with oil and the vented rotors prevent oil from getting on the friction surfaces, the upgrade will most certainly affect the brake balance -- putting it back where it was supposed to be!

If you wish to alter the brake balance, you will need to either A) change calipers to something that has a different effective piston area; or B) change rotor diameter. You could also change pad material, but most people concerned with serious braking select pad material for the best fade resistance they can get rather than to adjust balance. You can also change the *size* of the pads or the breadth of the swept area of the rotor (either change will typically require a caliper replacement) but such changes are more likely to affect the ability of the brakes to absorb heat than to actually affect brake balance.

CROSS-DRILLED ROTORS: There are three topics that should never be discussed in polite company: religion, politics, and cross-drilled brake rotors. Talking about cross-drilling brake rotors always seems to start an argument. There is little doubt that cross-drilling rotors makes them a bit lighter, but other than that everything is opinion. Brian Schreurs says, "I race GM F-bodies at the club level (i.e., budget). Improved braking on a car with a reasonable system to begin with is found almost entirely in the pad selection, *not* the rotors. Those in my club who have tried drilled or slotted rotors have switched back to normal ventilated rotors. The surface tricks are prone to premature cracking and shortening the life of the pads, with no appreciable benefit in braking to make up for it. Outfits such as Baer will try to talk a customer out of buying drilled rotors if the car is intended for the track."

"We (being my club) regard drilled and slotted rotors as appearance items only, harmless on the street but worthless and bordering on dangerous on the track. Our formula is: race compound pads (or an aggressive street pad, depending on application), steel braided lines (for pedal feel and protection from debris), ATE Super Blue fluid (resists boiling), stock ventilated rotors (durable and cheap), and whenever possible, *ducting*."

Others, of course, argue that cross-drilling rotors helps clear dust from the face of the pads during heavy braking and thereby improves braking. Still others argue that the objective is to clear gasses that are generated by the friction. And proponents, of course, claim that their brakes were vastly improved after drilling, and point out that many exotic cars come with drilled rotors.

Whichever, cross-drilling should perhaps be reserved for solid rotors such as the OEM rears on the XJ-S. Christopher Riek says, "*Do not* cross-drill your ventilated brakes! Doing so allows air to be sucked in through the holes and would destroy the effectiveness of the venting. It's like putting a squirrel-cage blower in a chicken-wire housing -- it spins fast but doesn't blow much air."

Henry Fok adds, "When some motorcycles switched from solid rotors to crossdrilled (without changing anything else), brake pad life decreased by half."

"It is also thought, in some quarters, that crossdrilling can eventually lead to worse brake performance if the drilled holes load up with debris."

GROOVED ROTORS: Providing grooves across the surface of a brake rotor supposedly has similar objectives to cross-drilling, but with less tendency to cause cracking. However, it has the minor disadvantage that the benefits (if any) vary with wear and resurfacing; as the rotor gets thinner, the grooves get shallower. It has the significant advantage, though, that it could conceivably be done to vented rotors without affecting the airflow through the internal passages.

BRAKE UPGRADE HARDWARE: For brake upgrade stuff, you can check AP Racing at

<http://www.apracing.com/car/index.htm>

or SPV Racing at

<http://www.spvracing.com/>

or Harvey Bailey Engineering (page 664), or Rob Beere (page 665).

Master Cylinder/Reservoir/Booster (non-ABS)

BRAKE FLUID RESERVOIR CONNECTION HOSE: To make the brake fluid reservoir fit under the hood, Jaguar uses a remote reservoir connected with metal lines and short pieces of flexible hose. If these hoses need replacing, do not use conventional fuel line; the brake fluid attacks the fuel line material, and the result will be darkened fluid with lots of crud in it.

The fact is, none of the hose commonly sold at an auto parts store will serve. Also, nylon tubing is unsuitable; the brake fluid soaks right through it, and then it hardens and shrinks.

Of course, using Jaguar original hose is not recommended, as it is a British non-metallic product. After all, you are now having to replace it. But there are other cars that also use hose to connect a remote reservoir to the master cylinder, including Mercedes, BMW and Fiat, so you can check other dealers for suitable hose. Andrew Weinberg says, "Volkswagen Beetles also use a remote reservoir, and the hose stocked for that application works perfectly... The hose is available from any VW supply shop. The only hitch is it's a (nice?) blue color."

Non-automotive hose is also a possibility. You can visit an industrial supply store and attempt to find a clerk who knows his stuff, or a reference manual that lists acceptable applications for different hose materials. Commercially available air hose works well in this application; it is red with a black inner lining, and is sold in many hardware stores. It's so cheap that many Jaguar owners can't believe it could ever work. The inner lining is EPDM, which is compatible with brake fluid. Note that this hose will *not* withstand the pressures seen in other parts of a brake system, such as the lines from the chassis out to the brake calipers on the suspension; air hose can *only* be used on non-pressure portions of the brake system such as the reservoir connections.

Keep in mind that this application sees *no* pressure, so high-pressure brake or hydraulic hose is unnecessary and will only make it very difficult to install over the plastic fittings. Some suggest that you use lines that will hold perhaps 30 psi in case you ever want to "pressure bleed" the system, but just about any hose will handle 30 psi.

While you're replacing the hoses, you might consider tossing the original metal tubes and simply run the new hoses all the way from the reservoir to the master cylinder. This makes for a cleaner appearance under the hood. You need to take care, however, that the engine shaking on its mounts doesn't cause the corner of the air filter housing to rub on the hoses and eventually cut a hole in them. If it did, the reservoir would drain and the warning light would come on in the dash before there were any operational problems with the brakes, but you still wouldn't be happy with brake fluid all over the engine compartment peeling all the paint off the chassis.

BRAKE FLUID RESERVOIR LOCATION: A brake fluid reservoir must be located above the master cylinder so that fluid will gravity-feed into the master cylinder and air bubbles in the master cylinder will rise into the reservoir. Unfortunately, the remote reservoir location on the pre-ABS XJ-S is stretching the definition of “above”. It works OK when kept topped up, but if you ever have air in the hoses or master cylinder for whatever reason it is suggested that you unbolt the reservoir from its support bracket and position it about six inches higher, merely allowing the hoses connecting it to the master cylinder to flex. With it in this position, operate the brake pedal a few times. You might also just wiggle it a little. With any luck at all, any air in the hoses or in the master cylinder will bubble up into the reservoir. Once all the air is cleared, you can bolt the reservoir back onto its bracket.

BRAKE FLUID LEVEL SWITCH: Hey, it's electrical, so it's discussed on page 550.

BRAKE FLUID RESERVOIR CAP FAILURES: Apparently the cap occasionally breaks into a center portion and an outer portion. According to Michael Neal, “This is a problem and tends to reoccur if you don't modify the reservoir. This is on the pre-abs XJ-S brake reservoirs. Usually just flattening the sharp vertical ridge on the reservoir with a file will do it.”

Better fix: replace the entire reservoir with one from a Mitsubishi. See page 550.

MASTER CYLINDER REBUILDING: There was an “early” type master cylinder used before 1977½, and a “later” type used up until the advent of ABS brakes. However, apparently not all of those “later” types were the same. In the Jaguar manual section 70.30.09, step 14, a seal is installed on the secondary piston with the lip facing forward. In step 15, a second seal is installed in a second groove facing rearward. Chapter 9, section 7, steps 13 and 14 in the Haynes manual say essentially the same thing. However, some master cylinders only have one seal on the rear end of the secondary piston rather than two. The one in the first step is the one that was omitted; if only a single seal groove is available, the lip on the seal should be installed facing rearwards. Of course, if you have purchased overhaul kit #M7673, you will have one seal left over.

POWER BRAKE SERVO: The (non-ABS) servo assembly comes apart in the center, by twisting one half until the retaining tangs line up with the cutouts. There is a special tool for this job, but Bruce Hayes reports the tool can be improvised. He carefully mounted the master cylinder in a vice, and fashioned a tool to attach to the studs on the housing to turn it.

Front Brakes

FRONT BRAKE PAD GROOVES: Some of the pads offered for the front of the XJ/XJ-S have grooves across them. Ferodo pads, for example, have two parallel grooves across the face of each pad the short way; each groove is about 1/8" wide, and they are about 1-1/16" apart. These grooves might help with cooling, or getting dust out from between the pads and the rotor, or letting water get out on rainy days, but Chuck Sparks says the primary objective is to prevent squealing; the grooves break up the long, solid surface of the pad into three separate shorter panels.

If you get pads without grooves, you might opt to cut your own grooves. Brake pad facing material is not difficult to cut; a hacksaw will do it. The Ferodo pads are not grooved all the way to the backing plate; the grooves stop about 1/16" short of the base plate.

FRONT CALIPER REMOVAL: The front brake caliper is attached to the hub carrier with two bolts. The steering lever is likewise attached to the hub carrier with two bolts. And, just to make things interesting, one of those bolts is shared; there are a total of three bolts, two short and one long. Some of these parts are clearly illustrated in the ROM: the hub carrier (also called a stub axle carrier) is shown at the beginning of Section 60 under "Accidental Damage". The steering lever is shown in Section 57.65.01. The way the three components come together is shown as clearly as can be expected in Section 70.55.02 or Section 57.55.29.

When removing the long bolt, don't lose the shim that falls out. See below.

The two short bolts are the same length. However, the short bolt holding the upper end of the caliper to the upright has a smooth shank and safety wire holes in the head. The short bolt holding the forward end of the steering arm to the upright looks like a regular high-strength bolt, threaded to the head and no wire holes. I guess brakes are considered critical and steering isn't.

Removing two bolts will get the caliper loose -- but won't get it off. There is also a hard brake line wrapped in a semicircle between the outer end of the brake hose and the port on the lower end of the caliper, and this line is firmly attached to a bracket that is attached with the two bolts holding the steering arm. Hence, if your objective in being here is *not* to rebuild or replace the caliper you will want to remove all three bolts in order to get the caliper to come off with its hard brake line attached. Otherwise, you'd need to disconnect the line and get involved in brake fluid. By unbolting the bracket you can hang the caliper by a wire to avoid stressing the hose and just bolt it back on when done.

Remember to turn the steering back and forth while trying to remove and reinstall the forward steering arm bolt. Otherwise, the shock absorber is in the way.

FRONT BRAKE CALIPER SHIMMING: As mentioned above, there is a shim (or a couple of shims) between the steering arm and the brake caliper at the long bolt. The objective of this shim is to compensate for variations in the thickness of the caliper mounting lug to avoid stressing the steering lever as the bolts are tightened. If your plan is to take things apart and put them back together with the same hub carrier, caliper, and steering lever, you need to take care not to drop or lose those shims when you take the long bolt out. If you put it back together with the same shims in place, you should be OK.

If you do plan to replace something -- exchanging the caliper for a rebuilt, for example -- you will need to measure for the correct shim thickness. Mount the steering lever with its short bolt tight and the long bolt threaded in but not tightened; you may want to fit a flat washer on the short bolt between the dust shield and the steering arm to make up for a bracket attached to the caliper being omitted here. Measure between steering arm and upright at the long bolt, and subtract the thickness of the caliper mount lug to determine the shims needed.

New shims are available from Jaguar in two thicknesses: C44146/1 is 0.004" thick and C44146/2 is 0.010" thick. It's really nothing more than a thin flat washer, so you could just buy arbor shims locally or cut washers out of shim stock.

Whenever changing shims or anything else involved in this steering arm attachment, the car will need a new alignment afterwards.

It is apparent that the shimming between the caliper and steering lever was originally the only place shims were intended to be used here. Step 4 of Section 70.10.10 and step 3 of Section 70.55.02 in the ROM clearly indicate this is the only place to be looking for shims upon disassembly. However, apparently Jaguar decided that shims might also be needed between the caliper and the upright, either to center the caliper or to align it properly. There's no excuse for the machining incompetence that would require shims here for either reason, but Craig Sawyers and others report that their cars came with shims in these locations. Steps 10-14 of Section 70.10.10 and step 5 of section 70.55.02 discuss shims between caliper and upright for centering and aligning the caliper.

The Parts Catalogue doesn't list any shims for between caliper and upright, but obviously the shims intended for between caliper and steering lever will serve.

It's pretty easy to get shims in between the caliper and steering lever. Getting shims between caliper and upright is nowhere near as easy.

If you add shims between the caliper and the upright, you need to be *removing* the same thickness of shims between the caliper and the steering lever!

FRONT BRAKE ROTOR REPLACEMENT: Jaguar chose to bolt the rotor to the inside of the hub flange, rather than the outside like some cars. As a result, the hub must be removed to get the rotor off.

The various manuals suggest unbolting the rotor from the hub during this process by inserting a tool through the opening in the dust shield. However, Nance O'Neil points out that there is no need to unbolt the rotor before removal, and instead the hub/rotor assembly can be removed as a unit and then disassembled on the bench. Either way, the brake caliper must be unbolted from the upright.

John Himes adds a tip: "The 5 bolts that hold the rotor to the hub assembly can be very stubborn, especially when working alone. If you place the wheel face down, then place the lug nuts through the holes, now you've got a nice big vice to hold it in place without buggering up anything."

Matthias Fouquet-Lapar has an alternative suggestion: "I actually took the hub out and put the disk in a large bench vice. When I mounted the new disk, I simply used the old brake pads to protect the disk from the vice."

If you intend to have the rotor turned, don't separate the rotor from the hub. Leave them together; you get a more accurate turning job by allowing the machine shop to mount the assembly by the hub.

FRONT BRAKE CALIPER SEPARATION: On the front calipers, fluid communicates between the two sides via drilled passages through the caliper halves themselves. Hence, there are seals between the two halves to prevent leakage. If you separate the caliper halves, you'll want to put it back together with new seals. Note, however, that the square-section O-ring seals used between the halves may be difficult to find, and the Lucas caliper overhaul kit SP2887 does *not* include them. A normal nitrile O-ring -- square-section or not --- won't work; if you don't believe me, put one in a jar with some brake fluid and watch it for a few weeks.

Chuck Sparks says the seals are Lucas part number 67320782. The package these seals come in says they are .325ID, .495OD x .070, but measuring one found it to be .079" thick. Basically, they are 1/2" OD, 1/16" thick (the ID doesn't really matter as long as there's a hole). Each front caliper needs two, so you need four per car. The burgerflippers in the local auto parts store are likely to give you a blank stare when you ask about such seals, but according to Rob Reilly you can get them from John Farrell (page 661). John Robison says, "XK's unlimited sells the caliper seals separately."

It's also been suggested that you can find suitable seals at a Chevy dealer.

Coventry West (page 642) sells an O-ring, 1/2" OD and 1/16" thick and made of EPR. Apparently this works OK; according to their rep, "The o-ring will seal better on uneven surfaces than the square seal. We've never had a problem with the o-rings sealing. Not a single warranty or return." Nevertheless, most mechanics would probably agree that the original Lucas square-section seal is preferred. It does provide an idea for buying seals locally, since any industrial O-ring supplier can presumably provide EPR O-rings.

Brian Schreurs found that Motorcars Ltd. (page 644) lists a "caliper half O-ring" part number IN101648.

Joe Bialy says, "If you want to cut your own gaskets, McMaster Carr sells EPDM rubber sheeting, a 12" X 12" piece 1/16" thick is \$3.78. Part #8609k31. I'm sure they'd have the cutters too. I don't know if it's applicable for this, but they also sell 1/2" OD X 1/16" width EPDM O-rings." See page 661 for McMaster-Carr.

On the rear calipers, the fluid communicates between the two halves via an external hard tube so there are no issues with seals.

FRONT BRAKE HOSES: The front brake hoses have coils around them to prevent kinking and to protect the hose in case of a tire rubbing against it or debris flying around in the wheel well. On the '83, the coil around the original hose is plastic about 1/8" thick. Replacement hoses, however, as well as the originals on some other year cars, come with a

steel coil around the hose. Obviously, the plastic coil won't rust -- but if your steel coil is rusty enough to be a concern, it's probably time to replace your brake hoses anyway.

Ed Sowell says, "The new hoses I got came w/o coils. I reused my original plastic ones." This is a workable plan, since it is a simple matter to wind the plastic coil off the old hose. If your old hoses have steel coils, though, they apparently cannot be removed without destroying them or the hose itself. Since it probably would not be a good idea to operate the vehicle without coils at all, if you don't have the plastic coils you should either make sure your new hoses come with coils or try to get some plastic coils from a junkyard. And if you're replacing hoses with plastic coils with new hoses with steel coils, you may want to wind the plastic coils off the old hoses and store them away in case you need them *next* time you replace hoses.

FRONT BRAKE COOLING -- '92-ON: The 1992-on XJS comes from the factory with air scoops for the front brakes built into the front spoiler. According to David Buchner, it also comes with an inlet built into the dust shields on the front brakes themselves. To obtain the same sort of ducted cooling that race cars have, all you need to do is connect flex ducts from the back side of the spoiler to the dust shields on the brakes, and tie them up so the front tires won't rub them when turned full lock. Simple. The opening at the back side of the spoiler is a rectangle, but you might actually be able to find a section of flex duct sold in auto parts stores for engine intake ducts that has a rectangular end on it. Otherwise, any place that sells air conditioning supplies can provide a small sheet metal transition piece for connecting a round duct to a rectangular opening.

TWR FRONT BRAKES: Alan Heartfield owns an '85 TWR, and relates the following info from a TWR brochure: "This document states that the front rotors are 295mm X 35mm. The calipers are AP Racing 4 pot solid calipers." Obviously, this may provide some guidance to anyone looking to upgrade the front brakes on a non-TWR XJ-S.

Inboard Rear Brakes

REAR BRAKE HOSE: There is a single hose on the driver's side connecting the line from the car to the line on the subframe. This hose, CBC1393 or CAC6143 or GHP65, is unique to the XJ-S; the saloons use a different hose.

INBOARD REAR BRAKE ROTORS: The OEM rear brake rotors are described as "externally damped". This means they have an iron ring around the circumference that actually fits rather loosely. If the disk tries to "ring", this ring will rattle, and the rattling will absorb the energy trying to cause the disk to ring. IOW, the iron ring is to help keep the brakes quiet.

Michael Neal pointed out that the OEM rear brake rotors are a "sandwich" construction. This probably has something to do with fabricating a disk with the external iron ring. "The stock rear rotors have the actual thin outer rotor surface attached to a solid core. These thin outer surfaces are very brittle and break easily."

There are also reports of the ring breaking and coming out and jamming things up.

When rebuilding, Neal recommends the use of aftermarket rotors made from a single chunk of iron. Often, when you order new disks, suppliers will send you these aftermarket rotors without even asking; the aftermarket parts are what they stock. The aftermarket rotors don't have the iron ring, but nobody seems to have noise problems with them. The aftermarket rotors are arguably quieter, since the loose rings on the OEM rotors sometimes jingle when you close the car door or the like.

"Never turn the rear rotors, the oem style rotors are sandwiched construction and would probably self destruct when you put a bit to them. The aftermarket style could probably take one light surfacing but it just isn't worth it, price them sometime, they aren't that much."

Randy K. Wilson concurs: "Don't bother turning the rear rotors. It's around eight hours of labor to get the things out. If they are bad enough to require turning, the labor involved warrants replacing them with new ones. Besides, it's rare for those rotors to be torn up and still be turned down and remain in spec."

INBOARD REAR BRAKE ROTOR REMOVAL: The instructions in the manuals are for removing and replacing the rotors with the rear suspension subframe in place. However, many suggest dropping the entire subframe to make the job easier -- and dropping the subframe is really easy, much easier than most people expect; see page 357. Note that, regardless of whether the subframe is in the car or not, the lower swingarms will either have to swing down a *long* ways or be removed altogether to get the rotors out. This means that the shock absorbers will have to be disconnected from the lower swingarms, so you might as well get to it. It also means that the tie plate on the bottom center of the subframe will have to come off, because the swingarms hit it before they swing down far enough. All in all, a case could be made for leaving the subframe in place if you're not doing other work that requires dropping it; at least, with it attached to the car, you don't have to worry about how to support it while working on it!

If you have the cage out, swinging the swingarms down far enough to get the rotors out means you have to get the cage a couple of feet off the ground -- and supported in such a way as to allow the swingarms to swing down. Peter Cohen suggests, "since the cage is out, just tilt the cage backward so that the input shaft is facing up, and then swing the swingarms to your heart's content." Note, however, that before doing this you will need to either cap the differential vent or drain the differential, or it's gonna drain itself!

The ROM, Section 70.10.11, Step 8, says that after you remove the nuts holding the axle inner U-joints to the brake disc and output shafts, you are supposed to "Tap disc mounting bolts towards final drive unit." Those bolts are welded to the output shafts; if you manage to tap them towards the final drive unit, you have screwed up big time! The Haynes manual, Chapter 9, Section 12, Step 8, contains similarly erroneous instructions.

The rotors will not come out without removing the calipers. Hence, before tackling the job of rotor replacement, read on about two different methods for disassembly of brakes mounted on a Salisbury final drive unit as well as the disassembly of brakes mounted on a Dana final drive unit.

DANA VS. SALISBURY: Much of the work on the inboard rear brakes is dependent on which type differential you have; see page 322. If your car is in the 1985-88 range, check your differential before ordering parts or planning your work. It's fairly easy to check: if the differential has a drain plug, it's a Salisbury; if not, it's a Dana. If it's '84 or earlier or '89 or later, you can safely presume it's a Salisbury. You have to check in the '85-88 vintage because the official Jaguar repair for a Dana is to replace it with a Salisbury.

INBOARD REAR BRAKE CALIPER REMOVAL (SALISBURY): Removal of the left inboard rear brake caliper is straightforward using the steps described in the manuals. However, removal of the right inboard rear brake caliper might be considerably more tricky due to the proximity of the pinion shaft of the differential. The pinion is located to the right of center so there's lots of room on the left side, but the right side is tight. Specifically, the lower bolt holding the caliper to the output bearing flange is trapped and won't come out other than with the caliper itself, and it just barely comes out *with* the caliper! If the bolt was a quarter inch shorter this job would be a snap -- but you don't wanna shorten the bolt!

The particulars here vary from car to car, so some people won't even understand what the problem is while others will have trouble. This author couldn't get that caliper out for two days -- and then it finally came right out without doing anything noticeably different! Peter Cohen says, "Correct! I have had experience with that bolt. There is a single caliper position and bolt angle at which it will come out, and when it does, it happens so unexpectedly that you will not remember what you did."

Here are some tips that might help. When trying to get the caliper out, hold the upper end of the caliper rearward -- toward the disc. Once you've moved the bottom of the caliper forward and upward and reached the point where it doesn't want to move any more, twist the forward edge of the caliper (the edge where the pad retention pins go) in the outboard direction, away from the differential pinion. If you can't twist it far enough to get it to come loose, you may need to remove the nuts holding the axle and rotor to the output shaft to allow the rotor to wobble a little.

INBOARD REAR BRAKE CALIPER REMOVAL (SALISBURY W/ BREMBO ROTORS): If you obtain Brembo replacement brake rotors for a Salisbury, they come with a pair of large access holes drilled in the mounting flange -- and no explanation. Tim Dapper figured out what they were for: Using the access holes, you can remove the five bolts holding the output shaft bearing assembly onto the differential. Remove the exhaust pipe hanger attached to the top of the cage with two bolts. Then slide the output shaft bearing assembly out of the car with the rotor and caliper still attached! The caliper mounting bolts can then be dealt with on the workbench.

The shims between the rotor and the output shaft obstruct the access holes a bit. Before installing the shims, cut suitable notches in them. Dapper suggests that if you find your car already has rotors with access holes but they are obstructed with the shims, it's easier to break out the Dremel and trim those shims in situ than it is to remove the brakes using the method described in the ROM.

When working on the handbrake caliper, you'll want to have the new rotor securely bolted to the output shaft. Since the axle isn't in place, the nuts won't thread down far enough to seat on the rotor; you'll need to provide some washers or spacers.

Obviously you need new O-rings for reinstalling the output shaft bearing assembly. This should be considered a *benefit* of using this method; any opportunity to seal that thing up better is good.

"But what good does this do me? The old rotors on my car don't have the access holes." Dapper nevertheless suggests you get Brembo replacement rotors with access holes. That way, you can sweat and cuss and skin knuckles getting the calipers and rotors off, then take the output shaft assemblies out, then assemble them all together with the new rotors on the bench and reinstall them as a unit. "I must admit I was quite surprised when the whole thing just slid into place. A little jiggling is needed to get the splines to align. This is *so* much easier than dealing with the caliper bolts and no clearance!"

When installing the five bolts in the output shaft bearing assembly, you must screw each one all the way down before turning the rotor to install the next. There is precious little room between the heads of these bolts and the heads of the axle bolts on the back side of the output shaft flange. If you start turning the rotor around with the bolts only part way in, you can get it jammed and have to struggle with an open-end wrench to get moving again.

INBOARD REAR BRAKE CALIPER REMOVAL (DANA): If you have a Dana final drive unit, trying to make sense of the disassembly procedures in the ROM will only cause confusion. The manuals describe the Salisbury attachment in which the brake calipers are bolted to the inside of the flange holding the output shaft bearings in the final drive unit, and therefore the bolts back out towards the centerline of the car. On the Dana unit, however, the calipers are bolted to the side of the final drive housing itself, so the bolts point the other direction -- they back out towards the sides of the car.

There apparently are no Jaguar publications describing the removal of the brake calipers from the Dana differential. Fortunately, it's not difficult to figure out once you're in there; in fact, it's easier than working on the Salisbury. Jim Moore says, "Bolt access holes exist in the rotors and you can see them if you slide back the dust covers on the axles. Not mentioned in Haynes, not obvious whilst on your back with halogen lamp heating up the back of your head." Use these access holes to remove the two bolts holding the caliper in place. Once the caliper is off, you can then remove the rotor.

If you're ordering parts beforehand, make sure you get rotors with the access holes if you have the Dana final drive. Such rotors are usable on the non-Dana cars as well, although the access holes won't serve any purpose.

If you've ordered the wrong rotors and don't have time to exchange them, Tony Bryant says, "you *can* use the non-holed rotors on the Dana diff. It's just a royal PITA to juggle the caliper bolts into place, and then do them up with a open ended spanner. But it can be and has been done..." Really, if you have the non-holed rotors you might be better advised to take them to a local machine shop and pay them to put holes in them while you wait. There are dimensions in **Figure 24** that will help, even though the two-piece rotor hub looks different.

DANA VS. SALISBURY/BREMBO ACCESS HOLES: With OEM rotors, the difference between Dana and Salisbury rotors is obvious: the Dana has access holes. With the aftermarket Brembo rotors, the difference is no longer so obvious. John Wynne says, "I purchased both sets of rotors. *Both* sets had the access holes in them. The only difference was the location of these holes."

Charlie Welkie says, "Guess which (Brembo) rotors I got first! Yes, the ones with holes that didn't work -- they were too close to the center of the rotor. They were completely on the flange surface. Try as I might I just couldn't get the caliper bolts in. By now I had determined that I had a Dana and the rotors went back for exchange. The replacements went in very smoothly (perhaps due to all the practice I had by now). They have access holes out further that are partly on the flange and partly in the stepped portion of the rotor.

"The Altrom number for Brembo rotors for the Dana diff (hole spacing further apart) is 094-1106. The other - smaller spacing - number is 094-1104."

Both sets of access holes are shown in **Figure 24**; the holes closer to the center are for Salisbury diffs, and the holes closer to the outer edge are for Dana. You can check the dimensions to determine which access holes you have -- or you can just lay the rotor on the paper and see which holes line up.

5/8" SOCKET: Whether you are using the access holes to get at the caliper mounting bolts on a Dana final drive or to get at the output shaft bearing bolts on a Salisbury, the tool is the same: a 5/8" socket. Various reports, probably reflecting variations in hardware, describe the access holes as being anywhere from 7/8" to 1". If they happen to be 7/8", you will need the right socket to fit. A high-quality six-point socket will usually fit through a 7/8" hole with a bit of wiggle room, but a clunky 12-point from Taiwan hasn't got a chance. If the access hole happens to be located a hair off so the bolt head isn't perfectly centered under it, well, things just get harder.

I'd suggest you buy a thinwall socket, except that thinwall sockets are also usually deep sockets -- and you'd be better off with a short socket here. It's best to just shop around with a dial caliper in your hand and buy the smallest OD short 5/8" socket you can find.

Remember: 5/8" is functionally the same size as 16mm. So, check the other drawer in the toolbox for sockets that might work before heading for the tool store. And while you're at the tool store, that gives you more sockets to check for a small OD.

Of course, you could just make sure that the access holes on your rotors are large enough -- by boring them out, if necessary. Going to 23mm, 15/16" or even all the way to 1" will provide enough clearance for the bulkiest of 5/8" sockets.

ONE MORE DISASSEMBLY METHOD: In addition to the two disassembly methods for the Salisbury and one for the Dana described above, there is one other method that should work for either: splitting the caliper. Remove the bridge tube connecting the two halves of the caliper, and remove the pivot pin for the outboard handbrake caliper. Remove the four large bolts holding the halves of the caliper together, which allows you to remove the outboard half of the caliper from the car. Then you can remove the rotor, which will permit better access to the bolts holding the inner half of the caliper in place -- whether Dana or Salisbury.

BRAKE COOLING: If you regularly drive your car hard enough to get the brakes hot, you would be well advised to improve the cooling air flow to the final drive area. A scoop on the bottom of the car directing air up into this space might help; the Series Three E-Type came with such scoops, and it was a lighter car.

UPGRADING TO VENTED ROTORS: Jeffrey Gram installed vented rear brake rotors in his car. The interesting thing was his reason for doing so: to reduce the tendency for the brakes to cook the final drive seals. He expects that the use of vented rotors, even if braking performance is insignificantly improved, will extend the life of his final drive unit. Jan Wikström -- who drives a long, twisty mountain road to work -- also installed vented rotors: "They worked well. The old brakes worked pretty well too, and I certainly never got them hot enough to induce fade, but the oil seals didn't last, and they seem to last well with the ventilated disks."

There is yet another possible reason for upgrading to vented rotors. The author noticed that the outboard pads were much more worn than the inboard pads, and Andreas Boedenauer explained: "I owned a couple (about 15) of Citroens with inboard front brakes. All of them had almost unworn inboard pads (lubed with oil from the diff) even when the outboard pads were completely gone. You only had some wear on the inboard pads on a brand-new car (the first 2 years). I doubt that the differential -- especially the output shaft -- on a Jaguar is 100% dry and without any greasy surface. Maybe I am wrong and there are Jags with immaculate bone-dry new or rebuilt differentials on the road -- if yes, I want to see them."

What does this oily brake situation have to do with vented rotors? Because vented rotors may avoid the problem. When oil comes out of the differential output shaft seal, some of it runs along the shaft to the disc and ends up running down the inboard disc surface. But with vented rotors, it will come to the inner end of the air passages through the rotor before it gets to the inboard friction surface. The oil will then pass through the air passages all the way to the outside edge of the disk, completely bypassing the friction surfaces. Hence, if your diff output seals leak, having vented rotors can improve your braking considerably, even when cold.

If you're interested in upgrading to vented rotors, there are kits available. See XK's Unlimited (page 647), Terry's Jaguar (page 646), or Bob Greene Developments (page 667). All of these kits provide ventilated rotors (which inherently must be thicker than the OEM solid rotors), spacers to put between the halves of each caliper to provide clearance for the thicker rotors, and several small parts that are necessary as a result of the caliper widening.

Brian Schreurs says, "I talked to Terry's about their kit two days ago. According to them, their kit makes *no* accommodation for the handbrake whatsoever; they assume you're not going to be using it." So, if you'd like a working handbrake, you might want to consider other kits -- or consider the possibilities described below for obtaining the handbrake parts you need.

If you ask around, you may find negative reports on vented rear brake kits for Jaguars. This is because GT Jaguar (now defunct) offered vented rear brake kits that were garbage -- they didn't fit right, you had to grind on your final drive output shafts to bolt them in, they came with distorted hubs that caused runout in new rotors, etc., etc. Perhaps this helps explain why they are now defunct. Whatever, note that these problems have *only* been reported with the GTJ kits; the kits from all other vendors reportedly fit and work well.

If you wish, you can upgrade to vented rotors without a kit. All you really need are the rotors themselves and a few minor knickknacks. This has the potential of saving a little money or a *lot* of money, depending on your abilities to fabricate parts yourself as opposed to employing a machine shop to do the fabrication work.

This author has installed such a do-it-yourself rear brake upgrade (making small parts but hiring a machine shop for the hubs), and will provide considerable detail here; if you're not interested, skip the rest of this section.

The rotors described here are two-piece style -- as are the rotors in *most* (not all) of the kits mentioned above. Two-piece rotors are largely unknown in production automobiles where obviously it is cheaper to set up a casting process to create the entire rotor as a single part. However, two-piece rotors are very common in the performance and competition arenas, where they are well proven. In their simplest incarnation, they provide a simple benefit: the outer portion of the rotor, the part that has the cast-in ventilation passages, can be machined from a standardized casting (or even from brake rotors designed for other cars) rather than requiring a custom casting for each application. The center hub portion of the two-piece rotor assembly, commonly called a "hat" because that's sorta what it looks like in most applications, is a non-wear item that sports most of the unique features -- bolt patterns, offsets, pilot diameters, etc. -- that make a rotor assembly a custom fit to one car or another. Not only does using a two-piece rotor make it cheaper to obtain the custom rotor design needed, it also makes it considerably cheaper to maintain: when the rotors get worn, only the standardized outer portion needs to be replaced.

There are other features often incorporated into two-piece brake rotor designs including aluminum hats to save weight, "floating" attachment schemes to better deal with thermal expansion issues, carbon outer discs to save weight and work at higher temperatures, etc. For our purposes, we'll be sticking with a basic design to keep the costs within reason; the ventilation is the feature we're looking for here.

Alan Heartfield found a company that'll provide special-order outer discs:

Essex Parts Services Inc.
 2350 Industrial Park Blvd
 Cumming, GA 30041-6460 (US)
 770-889-4096
 fax: 800-335-7223 or 770-889-5256
<http://www.latemodel.com/essex/>

There are other companies that can provide such discs, including Wilwood.

Ordering discs through Essex involves filling out a "Custom Brake Disc Order Form" which they can fax to you. In the middle of the form there is a chart where you must fill in "Nominal Dimensions" of the discs you need. Fill the form in as follows:

ØA OUTSIDE DIAMETER	B THICKNESS	ØC EYE DIAMETER	ØD FLANGE INSIDE DIAMETER	E OFFSET	MOUNTING HOLES			APPROX. WEIGHT
					NO.	DIAMETER	ØM PCD	
10-3/8"	3/4"	6-3/4"	4-3/4"	3/8"	8	5/16"	5-3/8"	

The rest of the form is fairly self-explanatory -- name, address, credit card number, etc. I recommend you opt for no cross drilling and no face grooves. I also recommend opting for straight vanes, since curved vanes result in the left rotor being different than the right, probably more expensive, and of dubious benefit in this application.

Essex will quote you a price once they get the form. I try to avoid quoting prices in this book, but you'll be happy with Essex's quote.

Next you need a pair of "hats" to mount the discs on. For the Jaguar with inboard rear brakes, the term "hat" is not appropriate; they are basically a flat disc with a step machined in one side. Just take a copy of **Figure 24** to your friendly neighborhood machine shop and ask for two, please.

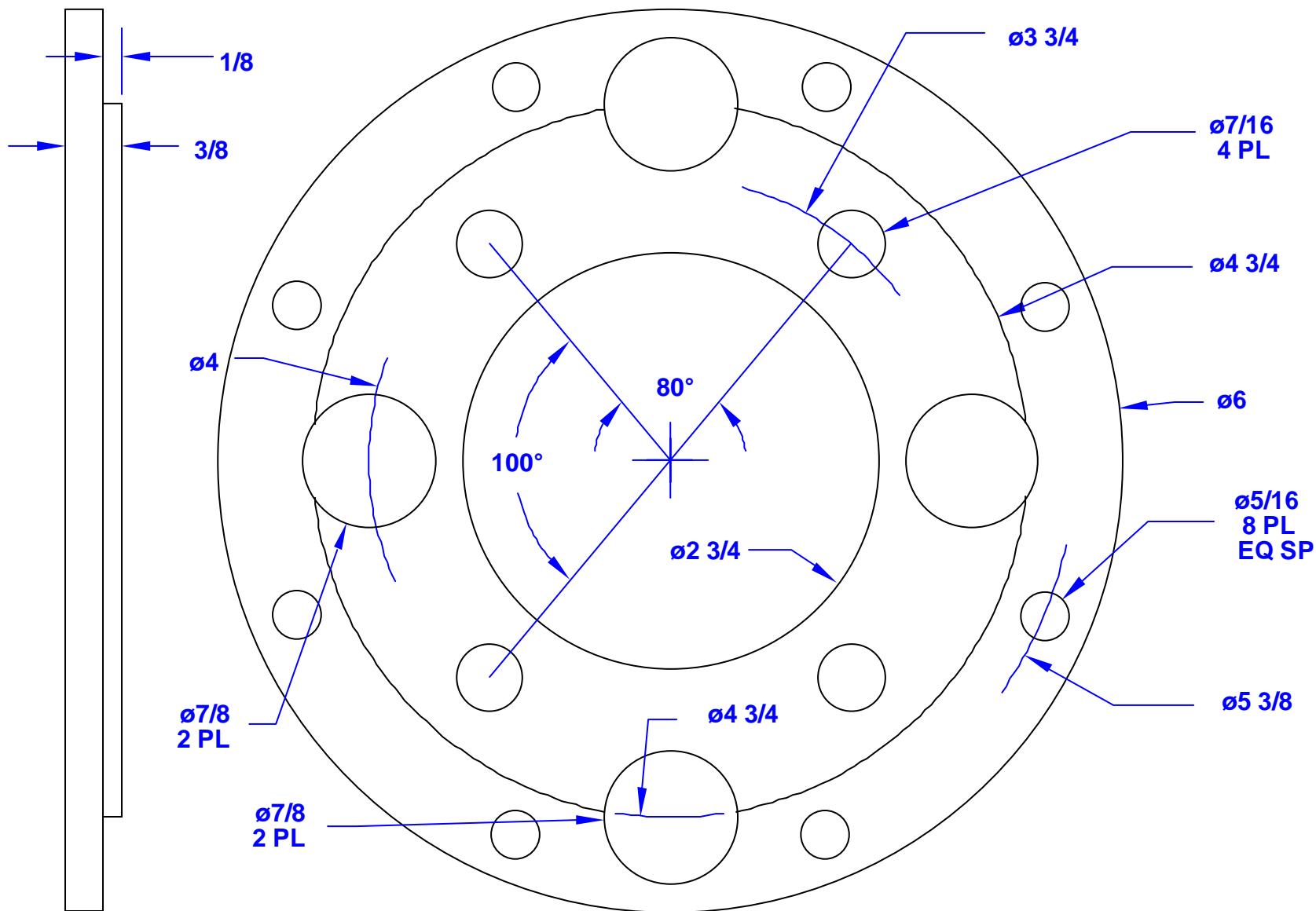


Figure 24 - Hub for Vented Rear Brake Rotor

If you aren't in a hurry, you can wait until you get the discs in hand and take them to the machine shop along with your old solid rotors and **Figure 24**. Machinists appreciate having the mating parts to check dimensions against. However, they don't really need anything but the drawing, so if you're in a hurry you can get them working on the hubs right away.

Make very sure to clarify to your machinist that all three flat surfaces on this part must be flat and true, as close as he can get them. That means that all three surfaces must be machined; you cannot hack this part out of a rusty plate with an acetylene torch and expect acceptable runout when you install your discs.

As a guide to cost estimating: When I had a pair made, the shop charged me for 5.5 hours machining time plus a pittance for the metal. Mine were made from 1/2" steel plate; you might be able to save a little machining time by starting with 3/8" steel plate, since the machinist won't have to hog off so much metal. However, by the time the hubs have been "skimmed" on both sides to make sure they are flat and true, they will be a little thinner than 3/8". As a result, you will need to add a couple shims C33440 to avoid altering the rear wheel camber.

You can make these hubs out of either steel or aluminum. Aluminum costs a few cents more in material, but the machine shop might give you a break on the machining since aluminum is easier to cut.

The two 7/8" holes closest to the OD of the hub are helpful to those with the Dana final drive unit. The OEM Dana rotors have two similar holes in them to access the caliper mounting bolts; the parts cannot be assembled without the access holes. It is not absolutely necessary to provide similar access holes in a two-piece rotor; you can gain access by separating the disc from the hub. The holes make things easier, though. If you have the Salisbury final drive these holes will do nothing for you, you can omit them if you wish.

Note that the Dana access holes are located differently than on an OEM Dana rotor; they are rotated 90° around the hub. Brian Schreurs developed this idea for relocation to make it possible to remove the calipers without removing the rear axles first. With the original location, the U-joint on the axle obstructs the access hole. With the location shown, the U-joint still obstructs the access hole -- but once the axle is disconnected at its outer end, you can swing it out of the way without removing it. The shims on either side of the rotor obstruct this revised access hole location, so trim the shims prior to installation.

You might look for a 5/8" socket with an external hex on the back end so you can turn it with an open-end wrench. Spark plug sockets have this, but they're too long. There are some odd tool designs that feature an external hex on the back end of a short socket for one reason or another, though. If you find such a socket, you might be able to snake it under the U-joint and into these relocated access holes and turn it with an open end wrench, allowing you to remove the caliper without having to disconnect the outer end of the axle from the suspension. Alternatively, you might just grind flats on a standard socket, or drill cross holes in it and turn it with a bar.

The two 7/8" holes closest to the ID allow for removing the brakes from a Salisbury final drive as a unit along with the output shaft bearing assembly, same as with the aftermarket Brembo rotors as described above.

Note that, if the disc being used has a continuous ID of 4-3/4", it will obstruct all these access holes. To make them usable, the disc needs to be scalloped between holes. Fortunately, Essex scallops their discs without even asking.

Read the notes above on making sure you have a 5/8" socket that will fit easily through these 7/8" access holes. If you prefer, make the access holes a bit bigger in your hubs, like 23mm or 15/16".

If you have a Salisbury final drive unit, you can omit the Dana access holes when making the hubs; they will do nothing for you. If you have a Dana final drive unit, you can omit the Salisbury access holes; they will do nothing for you -- although you might consider the possibility that your Dana gets replaced with a Salisbury in the future. Finally, if you have either the Salisbury or the Dana, you can omit all the access holes if you wish, since it is possible to rebuild the brakes on either final drive without access holes; simply remove the bolts holding the outer disc to the hub and remove the hub, leaving the disc in place within the caliper, and this will provide all the access you need to get to the bolts behind the rotor. In fact, Alan Heartfield's TWR came new with a Dana final drive and two-piece vented rotors with no access holes. Having the access holes makes things easier, though.

Ask if the company providing the discs will also make the hubs for you if you send them the drawing. Brian Schreurs found that Essex will, and for an excellent price, too. In addition to simplifying the procurement process and obtaining a good price, they can also make sure the two parts fit together properly.

Note that if you keep this car long enough to wear these rotors out, the only thing you will need to renew is the discs from Essex -- send that form in again. The hubs will last forever.

To assemble the discs and hubs, you will need 16 bolts and 16 nuts -- 5/16" Grade 8. 1" is the length needed, but 1" bolts are typically threaded all the way to the head. Since it is good engineering practice to have a smooth shank within the joint between such parts, you'd be better off to find bolts about 1-1/2" long and cut them down to 1" to get a smooth shank between 1/4" and 1/2" long. You need self-locking nuts, but don't get nyloc -- things might get too hot here for the plastic inserts.

There are other ways to obtain suitable rotors for this project. According to Chad Bolles, "The rear rotors on a Maserati Quattroporte are vented and are the same pattern as the Jag. The calipers are the same as a Jag, but with a spacer to make up for the wider rotor." Unfortunately, a www search found a price for Maserati rotors well over \$400 each. There are reports that Aston Martins also use a similar rear brake except with vented rotors; Bill Sotiras says, "Aston also moved the rear caliper setup from in front of the final drive to the rear, for better accessibility (from under the car). They used to have an inspection plate under the back seat." Unfortunately again, there are also reports that owners of these cars converting to the Jaguar solid rotors because their replacement vented rotors are so expensive! If you know of any Aston Martin or Maserati owners, you might tell them about Essex and the two-piece rotor design described above; it might fit their car perfectly and save them considerable money at rotor replacement time.

Terry's Jaguar also sells their one-piece rotors individually, apparently as wear replacements for owners who have installed their kit.

On to the other brake hardware you will need to use your vented rotors. You will need spacers to widen the calipers. These can be made from 1" wide 1/4" thick steel stock, or from any 1/4" steel plate you happen to have lying around. They can also be made of 1/8" thick or even 1/16" thick stock; just make more of them and stack them up. When you split the caliper halves, it will be apparent where these spacers go and what shape they need to be.

You need 8 new bolts to hold the caliper halves together, longer than the originals. 3/8"-24, 2-1/2" long, Grade 8.

You need pad retention pins that are 1/4" longer than the original pins. You can buy such pins from Jaguar; the ones for the front of the XJ will fit perfectly! They are part number 12798. Or you can just make some pins out of long 1/4" bolts (you'll need a smooth shank about 3" long) or even from 1/4" steel rod if you want. If you go with steel rod and therefore end up with headless pins, you will need four more retaining clips just like the ones that are in there.

The main calipers have a bridge pipe that connects the sides. Since you have inserted a spacer, this pipe needs to reach a little farther. Fortunately, it is a simple matter to bend the pipe a little bit to make it fit.

You'll need to deal with the bronze fork on the handbrake calipers. This fork is supposed to hold the handbrake pads away from the rotor, but just a little bit -- and to take a permanent "set" as the pads wear. Since you must cut this part in half to get it on the widened calipers, you must come up with a way to hold each half still so it cannot turn around the pivot pin, which would defeat its purpose. Jan Wikström just brazed in a spacer. Other ideas include fashioning a plate to go over it with a lip that prevents the halves from turning, or ordering four bronze forks and cutting a long half from each one in such a way that they interlock when bolted into place.

Alan Heartfield's TWR has a bronze fork in which the holes had been slotted outward to the ends. I do not recommend this; the tines of the fork are attached here, and cutting open the loop at each end of the fork weakens this attachment and results in the fork bending here as the handbrake pads wear rather than bending over their length as they are supposed to. Obviously, you also have to bend the fork to begin with with this idea. Better to cut the fork in half and space it.

If Aston Martins and Maseratis came with similar brake calipers already spaced, perhaps parts suppliers for those makes can provide a bronze fork of the correct dimensions.

You also need to address the issue of locking the handbrake pivot pins so they don't unscrew; the original locking plates won't work. You can drill the heads for lockwire -- if you're really good with a drill; for most of us, that job will require a drill press. Or you can make your own locking plates from sheet metal. You can combine this homemade locking plate with the plate needed to hold the bronze fork halves if you want.

Alan Heartfield reports that his TWR does have a locking plate. Apparently TWR either found or made a locking plate to fit. No known Jaguar part number, though. Again, perhaps finding out what Aston Martin or Maserati did here would be informative.

Some seem to feel that just omitting the locking plate and tightening the pins securely is good enough. I would not recommend this; the length of the pivot pin between the thread and the head is far too short to expect enough "stretch" to ensure the pins won't loosen during thermal expansions, and even if it was, this is not a good place to rely on simple bolt tension to ensure nonrotation. The handbrake calipers are rotating around these pins; if they develop a little friction in that pivot, they can be trying to forcibly unscrew the pivot pins! This assembly calls for a positive retention feature of some sort. Lock washers or Loctite are better than nothing, but we are talking about brakes here, do you want to take chances on something that *might* hold?

Regardless of whether you buy a kit or assemble your own vented rotors, the lower swingarms may contact the wider discs during assembly. This must be corrected by some minor grinding on the arms themselves. The problem is obvious; bolt the rotor to the output flange on the diff, try to swing the lower swingarm up into place, note where it hits the rotor, and grind metal away from the swingarm until it clears. This doesn't seem to cause any problems -- this swingarm has plenty of strength to spare!

Chances are pretty good that your exhaust system looped through the rear cage very close to the bleed screws on the calipers -- and you just moved those bleed screws 1/4" in the wrong direction. You will find it helpful to disconnect the exhaust pipes at the adjustable joint just ahead of the IRS and at the front end of the rear muffler and realign them from scratch. If you have the older style assymetrical exhaust pipe supports within the cage, as discussed in the ROM Section 30.20.02, you should install them the *opposite* way as shown in that section in order to position the exhaust pipes farther outboard by about a half inch. Supposedly later cars have a symmetrical support, so it won't matter which way it is installed.

When installing the pads, install the new longer pins in the upper end of each caliper from the inboard side outward. Installing the other way may make them difficult to remove later because the exhaust pipe is in the way. Install the pins in the lower end of the caliper from the outboard side inward, since the nose of the differential will prevent installing the other way.

This entire vented brake rotor upgrade is documented in photographs at

<http://www.jag-lovers.org/xj-s/book/InboardBrakeUpgrade.html>

MORE SERIOUS REAR BRAKE UPGRADE: The rear brake upgrades mentioned above involve a set of spacers and other small parts to reassemble the OEM calipers wider to fit the wider vented rotors. Alternatively, any of several high-performance brake manufacturers could provide a completely new rear brake system, complete with fancy racing calipers -- all of which would obviously cost more. However, if your calipers need rebuilding or replacing, you need to add the costs of repair to the costs of the upgrade kits before comparing to the cost of an entirely new brake system.

RETROFITTING OUTBOARD BRAKES: When the Jaguar XJ-S was raced competitively, sometimes the inboard rear brakes were relocated to outboard (whenever such modification wasn't against the rules, of course). The move to outboard seems a bit odd since theoretically inboard should be the better configuration from a performance standpoint, but apparently there were at least two other factors involved. First, the inboard location is prone to getting oil on the brakes, either dripping off the differential or being blown back from the engine compartment. Second, in any race longer than a few hours, a heavy car such as a Jaguar will probably need to replace brake pads during a pit stop -- and having to replace inboard rear brake pads will result in a long pit stop indeed.

Moving the inboard brakes to outboard makes some sense to the everyday driver, too. It will certainly make brake service easier.

If you feel the need, it shouldn't be too difficult to retrofit the outboard rear brakes from the XJ40 or mid-90's XJ-S to the earlier cars. A cursory inspection of the rear hub carrier from an XJ40 indicates it is a bolt-on retrofit to the XJ-S

suspension. If you don't have ABS, just leave the sensors out. Chuck Sparks says that this retrofit may require the use of the XJ40 axle assembly, though. Or, perhaps just the outer stub shaft -- but Sparks says the U-joints are different, so mating them up might be difficult. Just grab the entire axles while you're in the junkyard.

Note that when the XJ-S went to outboard rear brakes, it was first fitted with solid rotors, and later upgraded to vented rotors. You might prefer to pirate parts from a later car with the vented rotors.

Retrofitting the outboard brakes should actually make the rear end of the car ride a hair higher, since it is taking the weight of the brakes themselves off the rear springs and putting it directly on the tires. There also may be a slight difference in the center distance between the outer swingarm pivot centerline and the hub centerline, with the XJ40 being about 1/4" shorter -- which should also raise the rear ride height by about 1/4".

Obviously, after all this fiddling is done, you'll need to realign the rear suspension.

Handbrake/Parking Brake/Emergency Brake/Whatever

In the ROM, under "General Specification Data", page 04-2, the handbrake is described as "Mechanical, operating on rear disc pads". Technically correct, but perhaps misleading; they operate on their *own* rear disc pads, not on the main pads operated by the footbrake.

CABLE ADJUSTING: In short, don't. The cable adjuster is right behind the lever under the carpet on the XJ-S (different location on the XJ12, which has a pull handle under the dash), but is not intended to need adjusting as the pads wear. The handbrake calipers have a self-adjusting feature and should maintain proper operation of the handbrake throughout the life of the handbrake pads. If the handbrake seems to need adjustment, the self-adjuster has probably seized. You should address this; don't try to get by by adjusting the cable.

Of course, if the calipers have been out for service or some nimnul has been fiddling with the adjustment, the cable may very well need adjustment. Section 70.35.10 of the ROM stipulates that the handbrake lever should be released and the cable adjusted so there is some detectable slack. This is misleading. There are two different situations possible, and I shall explain how to adjust the cable under both conditions.

If the calipers have just been serviced and reinstalled, the self-adjusters within the handbrake calipers are presumably adjusted fully out and a new bronze fork has been installed in each side to hold the new handbrake pads well away from the rotor. With the cable not yet in place, the handbrake caliper levers will be pulled outward against their stops by the spring on each side. Note their position; in fact, you might simply measure the distance between the two cable clevises. Install the cable, and then adjust the cable to just pull these levers *off* their stops. The tension of those two springs should be applied entirely on the cable, not against the stops within the calipers. If the springs are permitted to pull the levers against their stops, it tends to rock the caliper and pads such that one pad rests against the rotor, which can cause squeaks as well as premature handbrake pad wear. And, of course, since the caliper will adjust to compensate for that wear, it will continue to wear until it's metal-to-metal.

Adjusting the cable this tight will not cause the handbrakes to bind if they aren't binding to begin with. The self-adjusters work when the travel of each lever exceeds a certain amount; it doesn't matter if they start at their stops or a little off their stops. If the levers never release past a given point, they will never adjust to be binding at that point.

If the system is together and operating but you just read that description above and now realize that your handbrake cable is adjusted too loosely -- the levers are sitting against their stops when released and the cable is slack -- you'd like to adjust the cable tighter. Unfortunately, presumably by now the handbrake adjusters have worked, so tightening the cable adjuster now may cause the pads to drag -- and this is what the instructions in the ROM are warning against.

You have two options. One is to take the handbrake calipers back out and reset the adjusters back to fully out and start over. Presuming you don't wanna do that, your most viable option is to adjust the cable tighter gradually, making sure not to cause the pads to drag.

If the cable is really sloppy, you can take all the slop out of it right away. As long as you're not pulling the levers off of their stops, you're not really making the handbrakes any tighter, you're just taking slop out of the cable. Once you have the cable tightened to the point where the levers are beginning to come off their stops, then you must be careful. Tighten the cable adjuster only a little bit farther, and check that the wheels still turn freely. Then leave it alone for a while, allowing the pads to wear a little; you might even opt to make some of your stops while driving by using the handbrake to help it wear a bit faster. Try not to ever pull the handbrake handle hard enough to cause the adjusters to tighten up. Then, when you can get the handle up to the first click without any noticeable drag, go back in and adjust it a bit tighter. Repeat until the levers are just off their stops with the handbrake released.

By the way, the ROM fails to mention that the way to get at that adjuster is to unbolt the seat belt from the floor on the driver's side.

DISCONNECTING THE HANDBRAKE CABLE: In the Haynes manual, Chapter 9, Section 18, step 5 describes disconnecting the handbrake cable from a caliper operating lever by extracting a split pin and a clevis pin. The arrangement they are describing is illustrated in Fig. 9.18. Must be an XJ12 thing, because the handbrake cable on the XJ-S isn't attached that way. The ROM shows the connection correctly.

In the ROM, Section 70.55.04, steps 1 and 2 describe peeling back the carpet near the handbrake handle and backing off the cable adjusting nuts. This is totally unnecessary; just make sure the handbrake is in the completely released position. If the cable is adjusted properly, it should not require loosening in order to disengage or reengage the cable at the levers on the brake. It should be possible to pull the levers together enough to pop the cable off or to pop it back on. Note that it will require moving *both* levers, however; one is operated by the cable itself and the other by the housing moving the opposite direction, but both movements will be needed to disengage the cable.

Step 4 in the ROM starts with "Using suitable lever..." in describing how to disconnect the handbrake cable from the caliper arm. Any sort of lever is unnecessary; the cable is easily disconnected by hand without tools. Merely pull the two levers towards each other and pop the cable tip out of the block at the end of the caliper arm on the passenger's side. Then pry the little rubber boot off the end of the cable housing at the block at the end of the caliper arm on the driver's side (as mentioned in step 5), and slide the cable housing back and out.

HANDBRAKE CALIPER REMOVAL: Both the ROM and the Haynes describe how to remove the handbrake calipers without dropping the rear subframe from the car. Jan Wikström describes the work: "It's a fairly tinkery job, and definitely easier the second time... If you have a reasonable manual with a good picture of the system, patience is really all you need (you'll be working by feel as you can't see the upper side of the handbrake bits)."

Note that the reinstallation is considerably trickier than the removal. The pivot pins in the main caliper that the handbrake caliper attaches to also hold a bronze fork with tines that insert into holes in the top of each caliper half. The purpose of this bronze fork is to act as a spring to pull the pads back off the disk a little bit -- but just a little bit. As the handbrake pads wear and the caliper moves closer to the rotor, it pulls the bronze fork far enough to deform it -- which leaves it just the right shape to pull the pads back just a little bit again.

So, to ensure proper operation, this means that prior to assembly the tines on the bronze fork should be positioned to hold the handbrake calipers away from the rotor a little bit. Simultaneously, the caliper adjuster itself should be adjusted to hold the pads away from the rotor a little bit. So, after the calipers are in with the fork properly installed, the lever on each handbrake caliper can be manually actuated a few times to allow the self-adjusters to bring the calipers back up near the rotor -- and properly "set" the bronze fork to be applying the correct amount of retraction. Manually operating the levers also serves to confirm that both adjusters are working prior to connecting the cable.

Several owners have reported errors in installing the pivot pins -- missing the entire inner boss on the main caliper, apparently. Bob Gallivan says, "Not only will they thread in but they *look* to be correct while missing the lower hole completely. Been there & have the crick in my neck to prove it..." After Carlos Artal was told this might explain the problems he was having, he reported: "I put the car on ramps again, and proceed to take the h/b calipers off. Well, not 1 or 2 of the fixing bolts were out of place, but 3 of them were, with just one poor guy left there to do all the work!"

Another common problem is that the tines of the bronze fork end up on the disc side of the caliper -- against the disc side of the pad backing plate -- instead of in the holes in the caliper where they belong.

Tip: Use a pair of 1/4" rods about 3" long to assemble the calipers instead of the pivot pins. This allows you to install the calipers with these substitute pivots first, then finagle the bronze fork into place (since there are no heads on the substitute pins), and finally to carefully remove the substitute pins one at a time and replace them with the actual pins. You can grind a tapered end on the substitute pins to make insertion easier; in fact, you could use 3/16" or 6mm rods just to make insertion really easy.

If you have the main caliper out, by all means take advantage of the situation and trial-assemble the handbrake calipers on it before putting it in the car.

HANDBRAKE PAD CHANGE: Since the handbrake calipers on Jaguars with inboard rear brakes are separate from the main calipers, they also use dedicated pads. Really, these pads should *never* need replacement -- what are you doing, using them to slow going downhill or something?

The lining on new handbrake pads is about 7/16" thick, all the way across. However, since the calipers pivot around the attachments on the main caliper, as they wear they become tapered. This is normal, don't panic. If they get worn too far, though, the rear end of the caliper will hit the rotor. The service limit of 1/8" on the main pads is probably a good number for these pads as well, but you need to be measuring the lining thickness at the thin end.

Technically, the handbrake pads could be removed and reinstalled without taking the handbrake calipers out of the car. Unfortunately, that won't do any good, because to install *new* (thicker) pads you will need to readjust the self-adjuster and install a new bronze fork. In other words, the handbrake calipers have to come out.

Do you really need a new bronze fork, or can you just rebend the old one? Well, if the handbrake pads are not being replaced, you only need to spread the bronze fork a little bit prior to reinstalling, and you will probably get away with it. If you're replacing the handbrake pads, though, you will have to spread the bronze fork all the way back to its as-new shape. Mike Morrin says, "Really *bad* idea. I have seen a couple of cases where the fork has broken due to metal fatigue. In itself not a big problem, but both times the rotor was destroyed before the fault was noticed. Always replace the forks when you have the hand brake calipers off. They are cheap."

When you go to removing the pads from the handbrake calipers, the ROM, Section 70.40.04, says "remove nut and spring washer securing pads to brake pad carriers, remove pads." The Haynes says the same thing in Chapter 9, Section 18, step 10. Removing that nut and spring washer is unnecessary; merely loosen it two full turns and the pad will slide right out, leaving the bolt, nut and washer loosely in place. They even provided a little hole at the top center of each pad to make it easier to grab and pull out. Of course, the new pads come with new screws in case you want to replace them, but there's really no need unless you strip them or something.

Just getting the nuts loose may be a challenge, though: The nut is 0.325" (8.25mm) across the flats. This isn't even a standard Whitworth size! Craig Sawyers says, "The nuts that secure the handbrake pads to the arms are 2BA. And *only* a 2BA socket will get in there to remove the nuts." Paul Burke says, "BA stands for British Association - believe it or not. BA threads start at size 0 (zero) which is the biggest, and the bolts and nuts get smaller as the number gets bigger."

Well, at least you know what to look for. This author used an 11/32" socket which worked but didn't fit too well; a 21/64" would have been better, if such a thing exists.

The bolt that this nut threads onto has an unusual head, but the threads are standard 10-28 fine thread. So once you get those weird nuts off, you could put normal-sized nuts on to replace them -- but that might not work well, either. The nut on the outboard side fits down into a well, and installing a nut with a larger 3/8" hex will probably mean you can't get a socket or wrench on it. This author found an excellent solution: the nuts used on military jet aircraft are extremely high strength and high temperature, yet they are very tiny and require a 12-point box end wrench or socket to install. If you can find a source for such nuts, they are highly recommended for this application. And you can leave the spring washer out, since the military nuts are self-locking. You will need to find 12-point sockets or box-end wrenches in 1/4" or 5/16" sizes; Snap-On makes them. I can guarantee they'll be easier to find than 2BA -- at least here in the US.

The facing of the handbrake pads is a rectangular shape with a corner cut off diagonally. The end with the corner cut off diagonally must go towards the rear of the car, or away from the pivots on the main caliper.

HANDBRAKE CALIPER REBUILDING: Jan Wikström says, “The self-adjusting ratchet mechanisms in the pad holders are quite likely to be clogged with semi-carbonized grease and dysfunctional; open the pad holders up, clean out the ratchet mechanism and grease very lightly with high-temp grease or MoS₂ (molybdenum disulfide). Drowning them in grease as the factory did is just silly; the ratchets may rotate one turn every few months and don’t really need lubrication.”

Mack Kamna describes rebuilding the handbrake calipers on Jaguar inboard rear brakes: “In the past my parking brake lever had to be pulled quite a ways to be effective. I found the self-adjusting nuts to be galled up with dry grease and very tight on adjuster bolt threads. I cleaned them up and dressed the gear teeth with a small file, then greased both the adjuster bolt threads (using C5A, anti seize), and the adjuster nut gear teeth (Hi-temp brake grease). I then installed the handbrake mechanism assembly with new retraction plates, and adjusted the handbrake “system” per the manual. When I pulled the handbrake lever, you could hear the adjusters smoothly clicking, and the pad assemblies tightened right up. I make no claims on my choice of lubricants; none of my 3 reference books on this maintenance task mention lubrication, they have just worked well for me in the past.

“...With the lever released there is *no drag* on the rotors, yet it only takes three clicks to make the wheels unmoveable by hand. I hope this can be of help to those of you who like myself have long suffered anemic handbrakes.”

This author went a different way with lubricants, and lubricated everything in the handbrake caliper self-adjusting mechanism with graphite only. Graphite is good to extreme temperatures, won’t ever dry out (it’s dry already!), and won’t collect dust and grit. The only concern is that it might not protect ferrous parts from rusting, and then the rusting could cause the adjuster to seize up.

THE ULTIMATE SOLUTION TO HANDBRAKE PROBLEMS: Some so-called “Jaguar experts” actually recommend removing the handbrake calipers from the inboard brakes entirely and throwing them away. This is probably because they can’t figure out how to assemble them correctly. Obviously, it is irresponsible to recommend that an automobile owner simply remove a piece of safety equipment, but it is interesting to note that the handbrake calipers *can* be removed without adversely affecting the operation of the foot brake. The Jaguar is a rare example of a car on which this is possible.

TWR Rear Brakes

The rear brakes on a TWR are essentially the same idea as the do-it-yourself mod described starting on page 412; in fact, the www site listed includes a page of pictures of the rear brakes on Alan Heartfield’s TWR.

If you own a TWR and need new rear rotors, Heartfield found a company that’ll provide special-order outer discs for reasonable prices:

Essex Parts Services Inc.
2350 Industrial Park Blvd
Cumming, GA 30041-6460 (US)
770-889-4096
fax: 800-335-7223 or 770-889-5256
<http://www.latemodel.com/essex/>

Heartfield used Essex just to get replacement disks for his TWR since it proved easier and cheaper than trying to find genuine TWR parts. There are other companies that can provide such discs, including Wilwood.

Ordering discs through Essex involves filling out a “Custom Brake Disc Order Form” which they can fax to you. In the middle of the form there is a chart where you must fill in “Nominal Dimensions” of the discs you need. Fill the form in as follows:

ØA OUTSIDE DIAMETER	B THICKNESS	ØC EYE DIAMETER	ØD FLANGE INSIDE DIAMETER	E OFFSET	MOUNTING HOLES			APPROX. WEIGHT
					NO.	DIAMETER	ØM PCD	
10-3/8"	0.78"	6-3/4"	4.90"	0.39"	6	1/4"	5.50"	

The rest of the form is self-explanatory -- name, address, credit card number, etc. You can opt for tricky stuff like cross drilling or face grooves if you want. Essex will quote you a price once they get the form.

Note: the design shown starting on page 412 is *not* exactly the same as that used in the TWR, so don't use the Essex order form shown there for getting replacement discs for your TWR.

Heartfield's TWR happens to have a Dana final drive unit. With the TWR vented rear brake design, it appears that the calipers were offset inboard by about 1/8". This may have been accomplished by milling 1/8" off the calipers themselves or off the mounting bosses on the Dana final drive unit. If you need to replace either the calipers or the final drive unit on a TWR, you should check these parts carefully to see if the replacements will need to be modified accordingly. If the Dana final drive is replaced with a Salisbury (the standard repair procedure) it would appear that 1/8" spacers would be required between the calipers and the output shaft mount flanges -- spacers that would probably be *lots* of fun installing. If you run into stuff like this, you might opt to rebuild the calipers or final drive unit rather than replace them -- or you might opt to machine a 1/8" step in the inner hubs of your rotors like the ones shown on page 414, since the purpose of that step is to provide an assembly that doesn't require offsetting the calipers.

Outboard Rear Brakes

Chad Bolles says the outboard brakes used on the later XJS are exactly the same as those used on the XJ40. Stephen Gibson says, “Outboard brakes on the XJS started at VIN 188105 with the solid rear disc for the 4.0 and 6.0 litre. The vented rear discs came in at VIN 198335.”

Handbrake/Parking Brake/Emergency Brake/Whatever

The handbrake used with the outboard brakes on the later XJS is actually a drum brake within the center portion of the disk rotor. Stephen Gibson says, “The outboard handbrake mechanism and shoes are identical for the XJ40 and XJS installation. When the vented rear discs came in the same handbrake mechanism and shoes were retained. They naturally have the same part numbers.”

ABS Brakes

Antilock Braking System (ABS) brakes have gotten a lot of press. Essentially, the system involves sensors in the wheels that sense when a wheel has stopped turning and releases the brake on that wheel. When the wheel resumes turning, the

brake is reapplied. If the brakes are applied forcefully enough, this results in a “pulsing” as the brakes to each wheel are cyclically applied and released.

When initially developed, ABS was expected to provide a considerable safety benefit; in fact, many auto manufacturers pursued development of ABS in expectation that it would later be required on US cars. After a few years of voluntary application (typically on higher-end cars such as the XJ-S), accident statistics failed to confirm any safety benefit, so proposals to require ABS have been stifled.

In a straight line on dry pavement, ABS brakes do little good; a car with comparable conventional brakes can stop in essentially the same distance. However, the application is different; on the car with conventional brakes, the driver can achieve the best stopping distance by applying the brakes as hard as possible without locking the wheels, and many skilled drivers are very adept at doing so. On the car with ABS brakes, the driver might as well simply jam the pedal as hard as possible and let the ABS work. While this was originally expected to be one of the safety benefits -- the driver no longer needs to be skilled at braking -- it is theorized that this is in fact one of the reasons the statistics haven’t panned out; the driver is still trying to modulate the brakes carefully as before, and he and the ABS system don’t work together well and result in longer stopping distances.

In a straight line on wet pavement, ABS has little benefit as well. Since the car does not stop as quickly, there is less weight shift from rear to front, and a set of conventional brakes with fixed proportions between rear and front may lock the front wheels. However, the vast majority of conventional braking systems had addressed this problem decades ago, providing more rear braking at light pedal pressures with the emphasis shifting forward as the pressure increased. Perhaps the biggest benefit of ABS here is control, since a car with the wheels locked may turn sideways on slick pavement.

In a straight line with water or oil only on one side of the car, ABS offers a *major* benefit. If the conventional brakes are applied hard, one side of the car will slide and the car will turn violently. Alternatively, if the brakes are not applied that hard, it takes a long distance to stop. ABS allows the brakes on the dry side to be applied hard while the brakes on the wet side are kept from sliding, and the car can be brought to a rapid halt in controlled fashion.

In a curve, ABS provides perhaps its greatest benefit. If conventional brakes are locked in a curve, the car will slide in a straight line, which runs it off the side of the curve and into a tree or over a cliff. Skilled drivers know this and *never* apply the brakes hard in a curve; they will aim the car straight, even if it’s aimed off the road, before applying the brakes hard. With ABS, however, it is perfectly workable to apply the brakes hard in a curve, since the wheels won’t lock and control will be maintained. Since the curve causes a weight shift to the outside, the outside brakes can be applied forcefully without locking the lightly-loaded inside wheels. However, this is yet another possible reason that ABS hasn’t lived up to its promise of increased safety; drivers may still refuse to apply the brakes hard in a curve.

Loose-packed snow, gravel, or the like, may be one of ABS’s most notorious shortcomings. On such surfaces, the quickest way to stop a car is often to lock up the wheels and let them dig in. However, ABS prevents this from happening, so the car seemed to roll along forever, pulsing all the way. If the car ahead doesn’t have ABS and has dug its wheels in and stopped in short order, this can be a real problem.

Of course, stunt drivers don’t care for ABS. When you see those guys in the movies spin the car around backwards and take off in the other direction, rest assured they do not have ABS; that 180° spin requires that the steering wheel be turned first one way, then the other way hard and the brakes locked. With ABS, they’d probably just drive off the side of the road.

ABS brakes were introduced on the XJ-S in mid-1989.

BLEEDING: Stefan Schulz points out that the bleeding procedure for ABS brakes is neither obvious nor similar to normal brakes. “Details are in section 70.25.02 of the service manual. Most ABS repair operations refer specifically to these procedures, so I guess they’re kinda important.”

ALWAYS USE DOT 4 FLUID: Greg Meboe clarifies: "ABS systems call for (and need) DOT 4 fluid. Not DOT 3, not 'DOT 5' (silicone). This is not the same thing as the early British systems. The fluid required in the 50/60's cars must be compatible with the rubber used. The fluid readily available in the US for this just so happens to be DOT 4 spec. ABS systems require the boiling point (wet) of DOT 4 fluid, and don't care about being compatible with old British rubber."

Jeb Boyd elaborates: "Do not use anything but Castrol GT LMA DOT 4 fluid. As far as the earlier (non-ABS) cars go, I have heard *great* reports on the Valvoline synthetic fluid. I feel that the risks involved in the Teves system if something goes awry are so great that I would be afraid to use anything but what is specified. I have used the Castrol fluid in every car I have owned for twenty years and have had zero problems. I feel it is the only fluid to use and it works great, so I have never experimented with a replacement.

"I would never presume to tell anyone what they must do, but one of my customers just paid \$4000 to have a new brake actuator replaced on his '90 due to seal failure. The seals failed due to fluid contamination from the wrong brake fluid. I don't know what kind of fluid, and I can't prove it, but I know that the local Jaguar dealer did it. They are a Ford store with a Jaguar franchise; Tauruses and XK8s are worked on side by side in their shop. That, IMHO, is *not* a good thing. So if a Jag dealer can poison a brake system by not being careful, I will not be the one to experiment with fluids. The label says it is compatible but will they pay for your ABS system if it trashes it? Or will they say that it must have been your fault? I'm not willing to take the chance."

Reportedly, Pat Goss, the host of the TV show Motor Week, said the following: "Never use silicon brake fluid in an ABS system! [Silicon] brake fluid doesn't like the pumping action of the ABS pump. The pistons move so rapidly that it causes the silicon to foam and all of a sudden you have aerated fluid and you have a pedal that's on the floor."

PAD CHANGE: If the car has ABS brakes and the calipers are pressed back, fluid within the calipers is forced back up the lines and into the master control system. Since the fluid that has been within the calipers for some time often has a high degree of contamination (wear particles from the cylinder walls, etc.), when this fluid is backed into the controls it tends to cause problems -- and very expensive problems at that. It is suggested that when pressing the calipers back (like when installing new pads) to open the bleed port and allow the fluid to drain rather than pushing it back up the lines. In fact, cautious mechanics will actually clamp the hose to make sure none of the junk can back up into the ABS system.

Perhaps this isn't a bad idea with *any* brakes.

ABS TESTING: Michael Neal writes: "I do extreme situation ABS test on cars during major services. I get quite a few surprises. Even from a moderate speed of 45 mph I've had cars yank the steering wheel out of my hands and the car ends up rotating 30 or 40 degrees. This is usually caused by a sticking piston or slide on a caliper."

Pat Goss, the host of the TV show Motor Week, reportedly advised to "exercise" the ABS at least once a month on a gravel road or in a wet parking lot -- meaning, jam the brakes and let the ABS kick in.

BLACK BALL REPLACEMENT: The ABS system includes a black ball that serves as a pressure reservoir to allow the brakes to operate about a half dozen times after the pump has been shut off. This accumulator contains a diaphragm and a charge of nitrogen. If the incidence of failure reports on the online discussion list is any indication, if you have an ABS system you will be replacing this black ball sooner or later.

With a brand new accumulator, Stefan Schultz says the ABS pump "comes on about every eight to nine "normal" brake uses or every three times I push the pedal down all the way and release."

When the diaphragm charge is deteriorating, the pump will kick on more often. When it comes on every application or runs constantly, you need a new accumulator. Rusty Beard: "This is a primary concern. I have had the brakes *totally fail* due to my own negligence. The equipment gets hot, as the pump is not engineered for 100% duty. Please know how active your brake pump is. If it is extremely active, call your favorite parts supplier and buy a new pressure bulb, *like right now*."

OK, so where do you buy a new black ball? It's Jaguar part number JLM1907; the dealer will charge you about \$200. You could go to the source; Peter Cohen says, "The ABS Accumulator Ball is made by Lemfoerder Metallwaren GmbH, 28036 Bremen, Germany. Part Number is 834 000 008 if you happen to be in a place where you can buy or order Lemfoerder parts."

But there are lots of cars that have ABS brakes, and there are even lots of cars that have Teves ABS brakes. Including GM cars. Joe Calandriello says, "The original accumulator ball can be replaced with an AC Delco part #25528382. It can be bought at any GM dealer for around \$156.00, which is quite a bit cheaper than the original ball. Napa also said they could order it, but their price was about \$177.00. I replaced mine with the AC Delco and the #'s stamped on the ball were the same and both said made in Germany; looked identical to me."

Andrew Weinberg confirms it's not just an interchangeable part, it's the *same* part: "The GM part is identical to the Jag; virtually every marking on the two parts (and there were about 4-5 different number sequences) are the same, including a pressure rating- 210 Bar. I also checked the threads -- they are the same, and the GM part also has the same hex drive in the top. It does have a spiffy yellow warning label on it that's different, but who cares? This is an original part for the Buick Reatta. This was for my '89 convert, but I imagine it is the same for all XJ-S with the Teves system. Check it out. And the price is only \$87 or so."

Bryan LaPlante says, "I not long ago replaced my ABS accumulator ball in the '90 XJ-S -- with a ball listed for the Pontiac 6000. Probably same as the Reatta part, but a lot cheaper car! Took a bit of cross-number checking, but it bolted up fine and looks identical."

Hey, we're talking Delco here; there are people selling parts *cheap*. Peter Cohen says, "You can buy the ABS accumulator from Keltner's Automotive (800) 666-3311 (<http://www.keltners.com>) under AC Delco part number 25528382 for US \$72.62." Hey, don't hold this book to the price, but clearly it pays to shop online.

Another option, believe it or not, is to have the original ball renovated. Alan Baker says, "I've recently had the sphere re-charged by Pleiades UK (01487 831239) for about 1/3 cost of a new one. Note that they are more used to re-working the XJ40 sphere which has a larger diameter thread, so be aware. The spheres lose around 10% pressure every year. As long as they aren't completely de-pressurised they can usually be re-charged. Look into the sphere, the diaphragm should be seen easily if there is pressure. If the diaphragm is all the way in, chances are the sphere is scrap."

Beard described how to remove the ball; basically, you apply the brakes *hard* about 50 times with the ignition off to bleed off any pressure in the system. Then you wrap a rag around the threads to catch fluid (it will leak some), then unscrew the old ball and screw on the new one.

Peter Cohen says, "When I did mine, I mistakenly took it to mean "put a rag underneath the threads". Since what happens is that fluid sprays out from 360 degrees, Rusty's instructions are spot on. Just don't misread them."

Schulz feels the spray is due to inadequate pumping. "The ROM says to discharge the brake accumulator by stomping on the pedal twenty times before attacking it. I stomped on the pedal forty times for good measure and still, when I unscrewed it, brake fluid squirted out far and wide. Not good. Make that sixty *full-pedal-travel* stumps next time."

Cohen: "I don't think the number of times you pump the pedal has any effect. I think I pumped 50 times. The key is to wrap the threaded portion of the ball in a rag to absorb the fluid."

Schulz adds, "The ROM also says that the brake pedal should go hard when the accumulator is discharged. With the new accumulator the transition from soft to hard on discharge is sudden and noticeable; with the old one it wasn't."

Schulz also notes that discharging the accumulator will raise the fluid level in the reservoir. If it's too high to begin with, it "results in a nice little fountain of brake fluid out of the valve in the reservoir cap when you discharge the accumulator."

Do you need to bleed the system afterwards? Cohen: "Prior to changing my black ball, I put the question to the list about whether or not bleeding was necessary. The answer was "not necessary". That didn't seem right to me, but, following ball replacement, the brakes worked fine without bleeding."

Schulz disagrees. "The repair procedure in the ROM does not suggest bleeding anything after replacing the accumulator. Since the pedal was ridiculously spongy after I did the work, I bled pump, fronts and rears anyway. Pedal

was firm afterwards. Bleeding should be part of the job.” Of course, it’s possible that Schulz’s system would have bled itself within a few minutes of running if he had left it alone.

WHEEL BEARING FLOAT: LaRue Boyce says, “If you have trouble with the ABS unit, check out the front wheel bearing float; it will cause the sensor to report brake problems when it is working fine.”

BODY

1991: For the 1991 model year, the body of the XJ-S was significantly altered. The most obvious differences were the totally different taillight arrangement with new “neutral color” taillights that don’t look red until they come on, and rocker panels that flared toward the wheel wells rather than being perfectly straight. But despite the outwardly similar appearance of the rest of the car, supposedly almost every panel was altered, so purchasing any replacement body panels will probably require specifying pre- or post-1991.

The more significant change, as far as buyers of used cars are concerned, is that beginning with the 1991 body style revisions the entire body was supposedly made from galvanized steel.

RUST: The following is a description of where to keep an eye out for rust on an XJ-S, courtesy of John Butler, Mike Morrin and others:

- The joint between the rocker panel and the rear fender.
- Lower (i.e. closing) edge of boot (trunk) lid on the inside.
- Top dead center of rear wheel arches.
- Around rear bumper side-arm mounts (and along the horizontal seam behind them; Check inside the boot).
- The lower edge of the panel below the centre section of the rear bumper.
- Around tail-lights; just below them down the seam there and just ahead of them on the rear wing.
- If your back window rubbers are softening check for:
 - accumulation of water in the deep wells on either side of the boot (trunk).
 - water trickling down inside, down the back of the rear seat back and accumulating in the spongy sound-deadening underneath.
- Around the radius arm mountings -- structural
- On the front wing, just ahead of the front door hinge and just above the rocker panel.
- The front end of the sills (or the front of the footwell), behind the front wheels.
- Front footwells under the carpets (wet carpet rust).

Now, about those radius arm mountings. The way *most* owners find out they have a rust problem here is that the car starts wandering aimlessly at speed! The front mounting for the radius arm -- adjacent to the rear jacking points -- rips out of the bodywork along with a large section of sheet metal, allowing the rear wheel on that side to pretty much go where it wants. How does *yours* look?

John Nuttall adds, “I found two places where rust, if left untreated, could cause serious damage:

1. Chassis rail/tunnel area. By the chassis rails I mean two heavy gauge steel members that run from near the back of the floor right to the front of the engine compartment. These rails form the backbone of the body. The floor and tunnel are made from two separate pieces, one for each side, joined at the top of the tunnel. There is a step in the lower part of the tunnel. The chassis rail is welded to three faces of this step. The lowest part of the rail is horizontal and extends under the floor about two inches. The two are spot welded together. On my 1987 shell the rail was not formed properly so that the part of the rail under the floor slopes downwards to the outside. Looking under the car I can see a gap between floor and rail that was not filled by sealer. Looking at the floor from above I can see depressions in the floor at each spot weld where the tongs of the welder forced the thinner floor metal down to meet the rail.

The consequence of all this is that rust has started in the space between rail and floor and has spread to the vertical part of the step in the tunnel to such an extent that rust is visible on this part of the step when viewed from inside the car. The rust is eating away this part of the floor/tunnel stamping.

The serious implications to the structural integrity of the body are obvious. This fault appears to be caused by improper manufacturing of the rail and lack of quality control, and it probably occurred on other vehicles.

2. Front lower outer seat belt anchorage. On the '77 and '79 cars this anchorage is a nut welded inside the vertical face of the inner sill. Presumably it was thought that this was not strong enough, and at some point before '87 the anchorage was moved to the sloping part of the floor adjacent to the sill. A thick plate was welded and bolted to the underneath of the floor to reinforce the area. Unfortunately, the floor has a ridge in at this point and there is a gap between the floor and the plate here. The undercoating has proven inadequate to stop rust between plate and floor. This rust has spread between undercoating and floor. Rust is visible from the inside on parts of the floor, which means that rust has eaten through the floor. The strength of the anchorage is clearly at risk. This fault is mainly due to poor design, I would think, and it is certain to be present on many other vehicles.

"I urge owners of cars that might be affected by these problems to inspect their vehicles. Inspection from the inside requires that carpet and insulation be removed."

RUST AVOIDANCE - TRUNK LID: Julian Mullaney sends this tip: "Beginnings of rust under the lowermost lip of the trunk (boot) lid. There are not enough drain holes here where the two sheets of steel are spot welded. I will drill a couple more drain holes."

RUST AVOIDANCE - TAILLIGHT AREA: Julian Mullaney points out that water may collect behind the taillight fixtures, since there is no drain from this area. If it appears to be a concern, perhaps the best solution is to merely coat the metal with something to prevent rust, since it doesn't show.

The gaskets around lenses on cars generally follow one of two schools of design: they either attempt to totally seal thereby not allowing water in, or they include a notch at the bottom to allow water to drain out. This author's observations and experience indicate that the second idea is more often successful. Jaguar, of course, uses the first. To drain the water from the area behind the taillights, the gasket between the fixture and the body can be cut prior to installation to form a drain channel. If done at the bottom corner near the boot lid, it will scarcely be noticeable.

RUST AVOIDANCE - GENERAL: Car enthusiasts generally recommend a product called Waxoyl (see Brit-tec, page 651) for treating the areas of bodywork prone to rust. According to Frans Hoekemeijer, "It can be painted or sprayed. It can be thinned with "white spirit", which evaporates rather quickly. Only a very thin layer is sufficient to protect metals against corrosion as the molecules are polarized and cling to the surface through electrostatic action, in the same way water molecules do unfortunately. It sets to a waxy substance. If used on the outside of the underbody of the car it has to be renewed every so often."

In the UK, Waxoyl sells a "pump kit" which screws onto to can of Waxoyl and you manually pump it and it becomes a spray gun. It comes with a thin lance so you can poke it into various holes and get good coverage. Pete Hamel says "It's quite thick at normal temperatures so you can either thin it with white spirit or immerse the can in a bucket of hot water to make it more sprayable.

"The beauty of it is that you do not have to completely clean all dirt off the surfaces you apply it to as it creeps into small crevices and through dirt. It's good for hard to reach areas. You can also apply it over surface corrosion (remove any flaking rust). It does leave a slightly waxy/sticky surface though so you don't want to use it anywhere that appearance matters."

There are some people advertising in *Jaguar World* who come to your house and treat the car for you.

Another product favored for protection is called P.O.R. 15. According to Vince Chrzanowski, "A customer once painted the exterior of a car radio with POR (don't ask me why). When we tried to remove the stuff, we found it was nearly like porcelain in hardness and durability. We had to change to a more aggressive abrasive in the bead blast cabinet. I hope never to see POR on a radio again, but wouldn't mind it on the frame of my Mark IX."

PAINT: Jeffrey Gram reports: "Here in Europe many cars imported from the US are eventually repainted, and even many professionals are not aware of a pitfall in this area. According to a local "spritzer" the paint used on US cars are of a different and higher elasticity than Europe paint to be able to cope with extreme temperature variations causing expansion and contraction of the body sheet metal. If a US paintwork is spraypainted with EU paint, cracks will appear since the EU paint cannot cope with the expansion and contraction of the US paint layer. The solution is to either repaint from bare metal, or to spraypaint the US paint with a couple of layers of "bridging paint" before the new paint layer."

FASTENERS: All fasteners on the exterior of a car need to be stainless steel. On the XJ-S, it appears that most of them are -- if nobody's been working on your car. If there's a chance that some of yours have been replaced by some repairman or PO that didn't know any better, check all of them with a magnet (a magnet won't attract stainless steel) and replace any that are not stainless. This includes all the screws holding lamp lenses on. Here in the US, another good indicator is to carefully inspect the cross drive head; if it's Phillips, it is not the original screw -- the original screws were Pozidriv.

This author was unfortunate in that the turn signal bulbs in my front bumper had not burnt out in a long time. I say unfortunate because the screws that hold the lenses on had corroded and seized so badly they had to be drilled out -- four out of four, 100%. These screws were plain steel; since it is probable that Jaguar originally fitted stainless steel screws to these lenses, I may have been a victim of a previous repair. If your screws are still removable, I highly recommend you check to make sure they are stainless, and if not to purchase four 10-32 x 1-1/4" Phillips drive oval head stainless steel screws to replace them with. Even with stainless steel screws, be sure to apply some anti-seize compound when reinstalling -- the clip nuts are not stainless.

Here in Bubbaland, 10-32 stainless steel screws are difficult to find, so I replaced the elaborate clip nuts on the bumper with conventional #10 clip nuts (available at auto parts stores) and bought some #10 x 1 1/4" stainless steel Phillips drive oval head sheet metal screws at a marine supply store. I never have to worry again about getting them out.

Stainless steel fasteners can be found at most marine supply stores and many better hardware stores, although fine thread or metric sizes are often a challenge.

ADHESIVES: According to Charles Daly, "A call to 3M produced the following info: If it's neoprene, as in a fitting, washer, etc., then 3M-8001 (Neoprene) is best. If it's weatherstripping type application and the rubber is EPDM (Ethylene Propylene Diene Monomer) (which is what most auto weatherstrip is) then use 3M-80119 (which is called weatherstrip adhesive)."

WATER LEAKS - A/C SYSTEM: Bob Tilley investigated the cause of water leaking from his air conditioning system during rainy weather. It turned out that the plastic cover over the windscreen wiper motor had deteriorated and started breaking apart -- a common problem discussed on page 569. In Tilley's case, the various parts of the cover found their way into the drain pipes that feed from the wiper area through the engine compartment and out through the wheel wells. The drains end with a rubber elbow, and the plastic parts got lodged in it and plugged it, causing the wiper compartment to fill with rainwater and start draining into the air conditioner. Tilley recommends that the drains be fully disassembled to ensure that all plastic scraps (as well as leaves and other debris) have been cleared.

WATER LEAKS - FLOOR: Hunt Dabney reports: "At some time in its past, someone lifted my car improperly. This caused the seams at the front of the floor, both sides, to become separated just enough for water to wick in during heavy rains. No apparent structural damage, but lots-o-wet-carpet. I sealed this from below with silicone seal, and while at it popped out the drain plugs from each floor section, cleaned them and reinstalled them, also with silicone."

WATER LEAKS - DOORS: Ian Finlay suggests applying talcum powder to the seals, then closing the door and applying a hose. The talcum should make the location of the leak obvious.

WATER LEAKS - A-PILLAR DRAIN: At the corners where the rain gutters meet the windshield, the seal appears to have a gap underneath the chrome trim. This is deliberate, providing a drain for this area of the roof down the inside of the A pillar. It'd be a bad idea to try to seal it up.

Pat Johnson was getting rainwater on the floor, and finally figured out it was coming from these drains at the top front corners of the roof. Water that finds its way into these drains -- a goodly amount, to be sure -- is supposed to run down the pillar between the chrome trim piece and the structure and through the bodywork in front of the door. Somehow, it was being diverted inside the structure, and ended up in the carpet instead. The solution involved removing the chrome trim piece covering the A-pillar. "Being a novice at this, I was a little (a lot) scared to start removing rivets. They look so permanent! But I bit the bullet and started drilling. It was easy! I found gaps between the body and the molding. After calling a glass repair shop and getting some silicone, I went to work. I filled all the crevices and opened the drain hole. I then refit the chrome and put my first rivets in. I must say, I think I did a pretty good job. It looks just like new and the lake is gone.

"It is supposed to drain in front of the door. Leaves and some other unidentifiable gunk were plugging it. The channel was also narrower than I think it was supposed to be due to the black rubber material under the chrome spreading toward the center."

Harry Trafford elaborates: "After drilling out the little pop rivets, carefully pry the chrome off. It will come off. I used a small stiff detailing brush to clean it all up under there. I took a very small screwdriver and ran the blade under the gasket edges to clean them out. A lot of dirt was removed. I purchased a tube of Permatex Auto Glass Sealer, then using the screwdriver end, I gently lifted the gasket edges, sliding the tip down the glass and followed right behind it with the sealer. The sealer is thin and is supposed to run into the crevice. If you get the sealer smeared all over, use acetone or nail polish remover to clean it up. *Do not* get acetone or nail polish remover on the car's paint!"

"I used small 1/4" to 3/8" sheet metal screws to reattach the chrome strips on the "A" pillar. Works fine." Stainless steel is recommended.

WATER LEAKS – FRONT WING ATTACHMENT: In the December 1996 issue of Jaguar Enthusiast magazine, John Wood describes tracking down and correcting a leak from the "wing rail", which made it into the area beside the footwell and managed to soak the carpets. This particular problem was apparently aggravated by body work done on the sill.

WATER LEAKS -- MIRRORS: Emile A. Des Roches says, "My wife's XJS had a seemingly "irremovable" white mineral dripline under the outside mirrors -- the only blemish on her 16,000 original mile '95 XJS coupe. After many experiments with paint rejuvenation problems the blemish was removed -- until the next rainstorm. It seems that water builds under the mirror, minerals gather from the various metals involved in the plating process, screws and blind nuts holding the mirror to the body and the oxidized product finds its way out under the black plastic piece separating the mirror from the door.

"The fix is to disassemble & clean the back side of the door mirror/plastic escutcheon assembly, then to put RTV or similar sealant around the inside of the black plastic escutcheon. After a couple of months, it worked so well that I tried it on my car too. Incidentally, the excess H₂O will drain into the door and out the bottom drain holes harmlessly."

This author has never had this problem; when I first got the '83, the black plastic gaskets were so badly deteriorated that they were immediately replaced with pieces of rubber cut from an old inner tube. Since the rubber is more pliable than the plastic ever was, it apparently sealed effectively without the addition of sealant.

Des Roches responds: "OK, I admit to cheating and using "black again" on the crappy-looking grey plastic escutcheon. As I recall from my friend's mid-'80's S, the newer cars have a thicker (about .4") escutcheon around the outside mirror. Wish I had thought of the rubber however."

SUNROOF -- FACTORY OR DEALER ADD-ON? The question of whether the XJ-S ever actually was fitted with a sunroof from the factory always seems to generate more argument than definitive answers. Whether or not any sunroofs were actually built into the car at Coventry, it is apparent that many of the sunroofs that came on new cars were installed by dealers to boost sales. In this case, each one may be different. Steve Draper, who owns an '88, says, "I note that in my XJ-S manual, the sunroof switch is located on the center panel between the window switches, on the same plastic panel. In my car, the switch is under the steering wheel, and when viewed closely has the aftermarket name on it. An easy indicator of factory installation may be the switch (which I wish was on the center panel)."

"I, Chad Bolles, do hereby state for the record once and for all that Jaguar *did* offer a sunroof in the XJ-S and I do not care what anybody else says. Quoting from Jaguar XJ-S Drivers Handbook publication part no. JJM 18 02 03/85, in the index section 5: "Fittings - Sunroof-Coupe: page 71" and on page 71 we see how to operate same and on page 72 we see how to operate in the manual operation mode. If those who know everything had taken the time to look in the parts book, part no. RTC9888CE dated August 1987 on page 2J 11L you would see part no. BBC2682 and I will be damned if it doesn't look like a sunroof and even has the title "Sunroof" and uses part no. JLM440/ND Headlining Cloth. Then try page 2J 11R and what do you know all the pieces for the roof are listed. Next try page 2J 12L and I will be darned all the elec pieces are listed there.

"The roof was offered as an option in 86 and from then on as a kit."

WATER LEAKS - SUNROOF: At least some of the sunroofs installed, as well as the ones fitted to the XJ6 at the factory, use drains on the front corners to route water down the A-pillars and out the bottom of the car. These drains are thin and easily plugged with debris. If a wire is used occasionally to keep them clear, the tendency of the sunroof to leak water to the interior is greatly reduced.

There also may be some problem with the connection between the sunroof and the drain tube. It may be helpful to inspect the connection and, if necessary, apply some sealant.

SUNROOF REMOVAL: Since sunroofs for XJ-S's don't exist, your ROM may not tell you how to remove it; so, here are instructions provided by Murray Trotter. Note that these instructions actually apply to the XJ6, but apparently the sunroofs are similar. Also note that when he says "hood lining", he means the headlining. "To remove the metal outside skin of the sunroof, slide back, undo the phillips head screws along the front edge, slide roof forward, on switch until almost closed, lift up front of roof and pull forward, back edge is clipped in. Take care not to lift roof too high otherwise you will mark it on the outside edge of the roof. Quite simple to remove with a bit of care."

"The actual body of the roof is a little bit more difficult, removal of the hood lining is required. First remove the outside rim around the hood lining; this requires removal of the sunvisors, etc. Then prise all the covered mouldings off carefully. This is hard to do and I always seem to end up breaking a clip or two. The actual lining can then be dropped. It is glued around the outside edge. Careful with this one, it is easy to rip the lining. You will then see the the actual sunroof is all one unit which has four metal brackets, like legs coming off it. These are pop-riveted to the inside edge of the roof; drill these out, and you can drop the whole thing out as unit. Don't forget to unplug the wiring."

WATER LEAKS - CONVERTIBLE TOP: Julian Mullaney says, "I've never had a single drop come in my 1991 XJ-S Convertible, but I did adjust the top to fit tighter. This is simple, just screw in the hooks a turn or two on each side of the

top rail. This makes the top clamp harder to the windshield gasket. When I did it, it eliminated a small squeak when body flexing over bumps.”

WATER LEAKS - WINDSHIELD: Most modern automobiles glue the windshield to the structure and then attach a piece of trim over top to conceal the joint. You can tell such arrangements because the glass itself has a black pattern printed on it; the black is to keep the sunlight off the glue, which would cause it to deteriorate. Supposedly the Jaguar XJ-S went to this sort of attachment scheme in the 90’s.

On the earlier cars, Jaguar actually used a real rubber gasket that fits around a lip on the car and fits around the edge of the glass, holding it in. The seal is called a Clayton-Wright type seal, meaning that it involves a locking strip; the seal and glass are installed, and then a hard plastic strip is pressed into a groove in the seal which jams it firmly against the glass. If you remove the four stainless steel trim pieces, the locking strip is hidden underneath. Once you remove the locking strip, the glass can be removed and reinstalled fairly easily.

In an article in the February 2002 issue of Classic Jaguar World, Ray Storer of National Windscreens Romford points out that water can get in between the laminates of a windshield and cause whitening of the glass. To prevent this -- or prevent it from getting any worse once it's already begun -- Storer applies liquid rubber to the edge of the glass itself.

If you’re lucky, you may be able to stop your leaks without removing the glass. Remove the stainless steel trim remove the locking strip, and then it’s a simple matter to pry the edge of the seal away from the glass. Clean all the crud out, clean it all really well with alcohol or some such, then apply some clear flowable windshield sealant and jam the plastic strip back in. As the strip presses the seal hard against the glass, the flowable sealant will ooze out. Wipe off the excess, reinstall the stainless trim strips, and you should be leak-free.

You’re supposed to use a small loop of metal wire to reinstall the locking strip. The loop fits into the slot and the strip passes through the opening, so just sliding the loop along the slot puts the strip in place. You can buy a special tool, but you can also just make one from a coat hanger.

WINDSHIELD SCRATCHES: Chip Lamb suggests: “I was told Bon-Ami household cleaner works *great*. Removes pits and scratches. Removed the scratches made by my windshield wiper ends on my Saab 1991 900 2 or so winters ago. Worked like a charm.”

Somebody else suggested toothpaste -- the abrasive kind, not the gel kind.

WINDSHIELD REPLACEMENT: Chad Bolles says, “What you really need is a glass shop that knows what it is doing. The seal will not fit if you install it on the glass out of the car, it will be loose, but once installed will be tight. The seal must be sealed to the body and to the glass itself, if the glass shop says anything different, then take your car elsewhere, they do not know what they are doing. The factory manual says to seal it that way.”

Mark West concurs: “My experience with a new windshield in my ’89 XJ-S, installed by the *dealer*, was enough to convince me that a broken windshield is equivalent to a blown engine in terms of severity. Three tries, two new seals, a glass shop that claimed to know what they were doing but installed it with the seal in upside down once (gave the car a sort of “Mickey Mouse” ears), and gallons of antacid later, I finally had a windshield that didn’t leak, seemed to fit okay, didn’t make too much noise going around corners, and was generally 80% acceptable.

“Don’t think that Joe’s Local House of Glass can do the work. You’ll hate yourself in the morning.”

HOOD GAS STRUTS: If you’re tired of your XJ-S hood falling on your head, but don’t want to pay the \$\$ for new Jaguar struts, Herbert Sodher provides a suggestion. There is a device made by Pylon called Lift Lock, and it is sold at auto parts stores as well as Wal-Mart and Kmart for about \$8. It is a device which is clamped onto the plunger of the strut, and has an arm that slides along the outside of the strut housing as the hood is opened. When fully open, the arm clears the end of the strut housing, falls against the plunger, and jams against the end of the strut housing to hold the

hood up. To close the hood, the arm must be manually lifted to clear the end of the strut housing. Since the device is an unobtrusive black, it is suggested that the arm be painted a bright color to make it more noticeable. Sodher judges that, in the event a hamhanded mechanic does a pull-up trying to close your hood, the \$8 device would break before the \$1200 hood suffered any damage.

Peyton Gill came up with another idea: buy a "split bolt connector" of a suitable size and install it on the strut plunger. A split bolt connector is a device used to connect two copper electrical cables. They are made of solid copper or bronze, so it probably won't even scratch the strut plunger. Just raise the hood, slide the connector down, and tighten the nut. When you want to lower the hood, just loosen the nut, slide the connector back to the far end and tighten it down there.

If you want to replace your struts, you can use a reasonably-priced aftermarket strut intended for another type car that will work on the XJ-S. Aftermarket struts such as Motormite's "MIGHTY LIFT!" (lifetime warranty!) are available in discount auto stores for about \$20 each. Of course, you can have a discussion with your local junkyard as well. For the late 1976-on XJ-S, the gas struts for a Chrysler LeBaron Hatchback (MIGHTY LIFT! no. 95018) are close to the original length and can be made to work with a few 3/8" washers. Larry Barnes adds that the struts he fitted to his wife's '92 "are mfg. by "STEDY LIFT", PN# D072-157, \$19.99 and they come with a Life Time Warranty."

Note that aftermarket struts are a good deal more powerful than stock struts. This is OK for most cars; customers are happy when the hatchback on their LeBaron opens more forcefully than it ever has. However, it may cause minor problems on the XJ-S. While you no longer will have problems with the hood closing on your head, you may have trouble closing the hood; you probably will have to hold the hood down against the latches while operating the lever under the dash, and in the worst case you may require an assistant on the other side of the car to get the hood closed.

You should always replace both struts together; one strut stronger than the other distorts the hood, and it bangs the fender on one side when closing.

Note that the pre-late 1976 XJ-S used a different strut.

Michael Neal says that Jaguar is now making struts with a built-in locking device to hold the bonnet open even if the gas pressure is gone. Your only remaining problem will be getting your fingernails under the edge of the bonnet to lift it up.

LONGER HOOD GAS STRUTS: With the stock struts, the bonnet doesn't open very far, making it a pain to work in the engine compartment. Jaguar apparently limited the range of opening because the bottom center of the grille contacts the top of the front bumper. However, Michael Neal points out that the contact doesn't appear to do any harm!

John Napoli figured out how to replace the stock struts with longer ones so that the bonnet opens a reasonable amount without having to disconnect the struts. The first step in replacing the struts is to make sure your bonnet will open far enough to use them; the alignment of the bodywork varies slightly from car to car, and breaking the front grille will not make you very happy. So, with the aid of an assistant, disconnect the struts and gradually tilt the bonnet farther and farther toward vertical, keeping an eye on the grille/bumper contact. See if you can open the bonnet enough that the mounts for the struts are separated by 22-1/4".

Note that there may also be a minor interference between the hinges and the plastic filler piece between the bumper and the car. If there is a problem here, the openings in the plastic for the hinges can be enlarged slightly.

If this much opening presents no problems, go to your local auto parts store and purchase a pair of aftermarket struts intended for a 1984-85 Honda Accord 3-door. They are made by Pro Lift, part number 92307, or by Motormite, part number 95038. The ends of these struts are thinner than the stock Jaguar struts, so you should add some spacers to the mounts to make sure the body of the strut doesn't contact the mounting brackets. Actually, suitable spacers may come in the package!

The XJ-S requires a strut that will collapse to 13-1/4" or shorter, and the application catalog lists the Honda struts as having a minimum length of 13.4" -- too long. However, measuring the struts themselves indicates they will compress as far as 13", perhaps even a hair under. Therefore, they work fine, and hold the bonnet a lot farther open than the stock struts. If yours end up not quite short enough, you should be able to make them work by elongating the holes in the ends a little with a file.

Note that the OEM Honda struts will *not* work. The struts needed are those sold as aftermarket replacements for the Honda, not the original struts.

Here's the measurement from the corner of the opening for the hood to the corner of the hood when fully open with these new struts: 46.5" Go measure yours!

PROTECTING THE HOOD STRUTS FROM HEAT: Michael Neal claims that heat in the engine compartment will toast most aftermarket struts, and that only the Jaguar originals will do. Of course, the aftermarket struts have a lifetime warranty and the Jaguar struts don't. And the Jaguar struts seem to fail as quickly as any, while several owners have reported long-term success with the aftermarket struts. However, heat probably is a serious concern here, and it's easy to provide any strut with a measure of protection by merely wrapping it with some aluminum foil. In this case, it is very convenient, since the width of aluminum foil matches the length of the strut nicely; just tear off about six inches from the roll, and wrap it around the strut, crimping it a little near the bolted end to keep it in place.

GETTING THE HOOD OUTTA YOUR WAY: On most cars, if the hood is in your way when working, the option is to remove it. With the XJ-S, however, there are several options in between. Michael Neal found that if the gas struts are disconnected, the hood can be opened to a nearly vertical position, greatly improving conditions for the mechanic. The plastic grille contacts the front bumper, but that doesn't appear to hurt anything; the grille simply flexes.

Neal commonly disconnects the struts when working on customers' cars, holding the hood in a wide-open position by removing a rubber plug forward of the strut mount and propping the bottom end of the strut, with the bolt, in this large opening.

Jim Isbell points out that another option is to remove the grille first. Then, with the struts disconnected, the hood can be opened to vertical, and the front edge rests on a rubber portion of the front bumper. Putting a cloth in between may be wise, and providing a prop so the wind doesn't blow it down on your head would be nice.

When using any of the above methods, keep an eye on the plastic filler panel just under the grille. It has openings for the hood hinges, but the openings may not be large enough for the wider opening and the plastic may crack. It may be helpful to remove this piece, or to enlarge the openings in it.

HOOD POP: John Napoli says: "Here's a cool mod for your XJ-S. It works best if you have good hood (bonnet) gas struts, and really well with the generic (Honda) replacement listed in Kirby's book."

"Remove the hood safety latch. Just pull the pin and it comes off. There are not many failure modes on an XJ-S where you need this feature anyway, so I wouldn't worry about it being gone."

"Now, when you want to show off your V12, just pop the release handle from within. The hood rises silently and majestically. Everyone is impressed. Men stand in awe. Women weep. Children cheer. Way cool."

HOOD LATCH: Up until at least 1993, the XJ-S was fitted with a hood latch that is closed from the inside; set the hood down on the latches, and operate the lever on the inside to pull it shut. Starting in '94 or '95, the XJ-S was fitted with a hood latch that works more like a typical American car, you slam it to shut it.

Of course, anyone familiar with the newer cars will now join the list of boneheads that will be slamming the hoods on the older cars. Anyone meeting the engineer responsible for this revision, please give him a thump on the head for the rest of us.

HOOD ORNAMENT: The flat disk emblem on the hood with the pudgy-tat face (commonly referred to as a "growler") apparently may be either blackened silver or blackened bronze in color, but it is supposed to be blackened. The one on

the author's '83 is metal so polishing may be possible, but Stefan Schulz reports that his is plastic and therefore should *not* be polished lest the plating be removed to expose the bare plastic.

LEAPER: Most Jaguar owners feel that the "leaping cat" hood ornament looks really bad on the XJ-S. If you just gotta have one, note that it would be wise to remove the disk emblem and install the leaper in its place, keeping any additional drilling located so that reinstallation of the disk would cover it up. Also note that the leaper is available in a couple of sizes, and the smaller ones will be less obnoxious in this application.

Finally, note that hood ornaments are regulated as safety hazards in some areas. In order to minimize harm to pedestrians you run over, they may be required to be mounted on springs or some such. This not only makes installation more complex, but it also makes it easier for a thief to steal the ornament.

Most leapers are made to be mounted on a nearly level surface, so on the XJ-S they appear to be leaping downhill. However, Michael Kenrick reports on one made specifically for the XJ-S: "It's modeled on the early MkV (?) version and sits on a round base that is directly interchangeable with the authentic OEM bonnet badge, bolted from underneath. And the plinth is beveled to take account of the sloping bonnet. Contact:

Bill Tracy
4050 Red Rock Lane
Sarasota, FL 34231 US
+1 (941) 924-9523

"I have one mounted on the hood: it certainly looks very good, and adds a subtly different character to the car."

UPPER RADIATOR GRILLE: If you have a pre-1992 car, face it: your old grille looks pretty bad. The chrome is flaking off, and it's cracked in several places. And a new one is expensive. The solution: install the 1992-on grille.

The newer grille makes a substantial difference in the appearance of the car. Where the earlier cars had the all-chrome plastic grille with chrome frame, three horizontal chrome ribs, two vertical chrome struts on each side, and the V12 badge in the center, the '92-on grille is all black with a single chrome strip across the top edge. There is no V12 badge. The chrome strip makes a match with the narrow chrome strip across the top of the bumper, surrounding the grille top and bottom.

Another difference is the profile. The earlier grille forms a distinct angle from the nose of the bonnet downward and rearward. The '92-on grille is more "bulged" giving a rounded profile.

The '92-on car also came with oblong composite headlights that bulged, so the front of the headlights forms a continuous surface with the front outline of the grille. How well the bulge of the new grille matches the non-bulged four-lamp headlight bezel is therefore a point of concern. The bulge of the '92-on grille results in the ends of the grille protruding farther forward than the headlight bezel, so the *edges* of the grille are clearly visible. These edges of the grille were presumably never intended to be visible, since they would be covered by the bulging composite headlamps. However, the appearance of the ends of the grille are quite acceptable indeed, since the chrome strip continues around the corner and the black plastic surface is still black there. The only problem -- and it's a minor one indeed -- is that the black plastic ends just a hair short of where you'd like it to, leaving a triangular opening at the bottom rear edge of the end of the grille. You've gotta be looking for a problem to notice it. But having compared this configuration against what the factory-designed earlier grille did here, I can't say it appears any less deliberate or properly fitting.

Photographs of the '92-on grille installed on the author's '83 are available on the WWW at:

<http://www.jag-lovers.org/xj-s/book/92Grille.html>

As far as mounting goes, the '92-on grille mounts a little differently but can be adapted. The '92-on grille mounts with 5 screws, two on each end and one at the center top, all installed pointing towards the rear of the car. The earlier grille installed with 6 screws, two at the outer ends near the bottom pointing rearward and four along the top edge pointing upward. These upper screws screw into plastic inserts that snap into square holes on the bonnet. The outer two inserts

correspond to notches in the '92-on grille and can remain, but the two inner mounts interfere with the '92-on grille since there are no notches in the grille to clear them and the plastic inserts stick down from the bonnet 1/8" or so. Simple solution: pry the plastic inserts out of the holes and throw them away. None of the four will be used again, so you might as well pry them all out.

The next thing to do is trial fit the new grille. It should be held in position so that its top surface fits snugly against the mating surface on the bonnet. With it held so, the necessary alignment of the mounting brackets will be apparent. The outer bottom mounting holes on the '92-on grille appear to be in the same place as on the earlier grille, but when fitting one realizes that the grille is not in the same place. The bulge has resulted in these mounting holes being about a half inch farther forward than the brackets the old grille mounted on. You can deal with this by stacking washers and using a long screw if you want, but that's not the way I do things. The mount bracket itself is an absurdly simple item bolted to the hinges, so I merely unbolted them and made new ones a little longer.

Just behind the upper edge of the grille is a flange on the bonnet, completely hidden by the grille. Simply drill three holes in this flange directly above the upper mounting holes in the new grille and fab brackets to screw to the flange. Add standard clip nuts to these brackets and install the grille with 5 black trim screws.

With the '84 Honda Accord struts described above, the hood opens a *lot* farther than stock. With this new bulged grille, the bottom center of the grille most definitely *does* contact the rubber on the top of the front bumper when open. Doesn't appear to hurt anything. It flexes a bit, no problem.

One of the prime reasons to consider the '92-on grille is that it is structurally a *vastly* superior item. Where the earlier grille had spindly little ribs, this grille's ribs are substantial, and appear designed to survive bird hits. Where the earlier grille had chrome on plastic that flaked off, the only chrome on this grille is a separate piece of metal that is mechanically attached to the plastic grille. Add to these facts that the '92-on grille costs *half* what the earlier grille costs, and you have enough data to make your own decision.

Another possibility is the JaguarSport XJR-S grille, which has no chrome at all. You could paint the chrome strip from the '92-on grille for similar effect; a really durable trim paint is suggested, since if you use ordinary spray paint every bug hit will leave a shiny spot. You could also opt for the '92-on grille and find a way to cover the chrome strip with black tape or some such.

HOOD VENTS: Lots of people feel that providing vents in the hood of the XJ-S might help with cooling problems, as well as look neat. It probably wouldn't do much for cooling when moving, but it might have considerable benefits after the car is parked -- allowing all the residual engine heat to rise out of the compartment rather than just building up in there and cooking the wiring and hoses.

Of course, cutting holes in the XJ-S hood is a non-reversible act, so a good job is essential; cutting rectangular holes with a Sawzall and slapping on a pair of stamped steel residential air conditioning grilles with pop rivets ain't gonna help your resale value.

Marty Sullivan suggests that the hood vents from a Datsun 280Z might fit the XJ-S perfectly. They are separate parts (not an integral part of the hood) so perhaps they could be removed from a 280Z in a junkyard and installed in suitable holes cut in the hood of an XJ-S with little fuss. They could be painted flat black before installation so they'd look like they match the center air grille, and you wouldn't have to paint the whole car.

Derek Spicer says, "I have seen an XJ-S with an early model Honda Accord hood vent fitted to its hood up near the windscreens on the hood. It's a very natural fit and looks as if it was supposed to be there."

Paul Bachman says, "I have been trying to lay my hands on some hood scoops from a 1988 Turbo Thunderbird. These also appear to be of proper size and shape to retrofit in an XJ-S."

Stephen Wood adds more details: "I looked at some different vents recently in a junk yard recently, that would / wouldn't work:

‘79-83 280 ZX (FI Car): Description: Semi Triangular Black Plastic, but the plastic in them is not very good so if you are in a sunny climate they will be brittle. Replacement part is pricey and supposedly not available from the dealer (Nissan Dealers are scum...). However "Tweeks Ltd." does stock all of that stuff.

"80-83 280 ZX (Turbo-FI Car): I am still trying to find a 280 ZX turbo in a junk yard (I will be going again this weekend) that has a different vent, and see how they attach. They only have one vent on the passenger side of the hood but they look pretty neat, a NACA scoop followed by a grille. If you could find two of them, you could locate them further forward in the XJ-S hood and have "Ram Air" (oooooh cool.)

"The 75-78 280Z vent is different right from left, and would require modification and "dremeling" and is really small, I'm not sure if it would make a worthwhile difference (to vent or not to vent, that is the question).

'Idea: the 78-81 Camaro Z28 had some fenderwell vents on the side, top rearward portion of the fender; those may be big, but you could mount them on the hood of the XJS.

"1989-92 Firebird: Small hood vents in front nose portion, could be cool. I need to get dimensions.

"1979-84 Mustang GT. Cowl hood type. Mounts with 4 bolts and allows removal of block off plate for a 1"x18" opening. This is severe but could be helpful in hot climates."

You should remember that openings in the hood will allow rain in. Many cars -- including Jaguar E-Types -- have rain collectors underneath their hood louvers to divert rain into drains and out the bottom of the car. If you just cut holes in the hood and call it a day, the rain may find its way to an exhaust manifold and create a large cloud of steam. That might be a little more drama at the stoplight than you need. And that's not to mention the effect of rain on electrical hardware and other stuff in the engine compartment.

One other concern I can foresee is that add-on vents might protrude into the engine compartment an inch or so, and maybe hit something -- like the diagonal struts. Best to double-check clearances before cutting.

FRONT SPOILER: Fido may have only cost his owners \$10 at the local pound, but he becomes quite costly when you run him over with the Jag. The front spoiler, when removed by force, often takes the bottom panel and the front section of the two front wheel wells with it. The spoiler was expensive enough; the package of four parts starts getting into some real money.

You will need to get the original spoiler BD45624 from Jaguar to make the car look right. However, the other three pieces (BCC4462, BAC4350, BAC4352) really don't show, so you can make substitutes. A tough plastic is recommended, as any sheet metal or fiberglass would get banged up too quickly in this application. 3/16" black ABS sheet plastic seems to be ideal, making these parts somewhat heavier than the originals.

For those who can't find such plastic, it can be ordered from:

Freddie's Plastics, Inc.
P.O. Box 1319
Plant City, FL 33564-1319
(813) 754-5567 FAX: (813) 754-0943

They sell it only in 4' x 8' sheets, enough to do several Jags. They may cut it into quarters for ease of shipping; this requires that the bottom panel be made as two pieces, which may be preferable anyway. Some aluminum angle (used to connect the bottom panel with the vertical wheel well panels), some screws, some clip nuts and a couple hours fabricating are all that is needed to make a satisfactory installation. One such installation has already survived a 'possum at 100+ MPH.

DOOR HINGE SPRINGS: The springs in the upper door hinges that hold the door open tend to develop rust problems, which in turn causes cracks to form at the stress points; they break and fall out with a clank, and then the door is always closing on you when you're trying to get in and out of the car. If your car has not yet developed such problems, you

should make an attempt to prevent rusting on the two lower corners of these springs. Paint them, coat them, grease them, something.

If your springs have already failed, you can buy a replacement hinge. With luck, maybe you can buy just the spring itself; Robert Hyndman says, "I had a broken door spring on my '87 XJ-6 when I bought it. I purchased a door spring from Johns Cars..." (see page 668)

Of course, if you get more of the same springs, they may just break again. A better alternative may be to *make* one. To make a replacement spring, buy some 1/4" music wire from a hobby shop. Normal 1/4" steel rod won't do -- music wire is extremely high strength, necessary for a spring. Suitable 1/4" spring material may also be available from a junkyard as the straight springs used to hold the trunk lid open on many cars. Bend and cut the wire to the same shape as the original spring, except replace the bottom two 90° bends with one continuous U-shape. This will reduce the stress concentrations caused by the 90° corners. Be careful to get the distance between the vertical portions of the spring right; a slight difference has a pronounced effect on how firmly the door stays open. Please be careful bending 1/4" music wire or spring; it is extremely strong, and care must be taken when bending it to keep it from springing loose and injuring you.

The door must be removed from the car to install the new spring. Don't try to do this alone unless you don't care about your bodywork. It is best to have at least two helpers to hold the door while you remove the nuts and washers from inside the footwell. Before installing the new spring, it should be protected from rust -- its biggest threat.

DOOR HANDLES: John Butler sends this tip: If you need to replace a door handle (apparently not that rare; they tend to break) and try to buy a used one, be sure to get one with a key. If not, then there are two designs of lock. On one you can spring a little shim in the barrel; the barrel withdraws and a key can be cut. In the other you can spring the shim but the barrel won't withdraw unless it is turned, meaning you must have the key already.

Alternatively, you can buy two locks, demanding a discount because there are no keys. On one, save the barrel by destroying the handle; on the other, save the handle by destroying the barrel. Have a key cut and combine parts to make one door handle assembly.

Mack Kamna says, "Always save the best key to have copies made from. In an ideal world one would save an original "uncirculated" key for this purpose. Replace a key when it starts to show rounding of the edges, or any scarring. Keys are much cheaper than lock assemblies."

"The only lubricant to use in the tumbler mechanism is molybdenum disulfide, as it does not attract dirt and allows the naturally-occurring metal particles to dissipate. It can be found under the trade name Dri Slide and many other names. It can also be purchased in both aerosol and "squeeze cans". I normally spray it in all my tumblers, (ignition, doors, trunk, etc.) about every six to nine months. The process is as follows: Shake the can *very* well, as it tends to settle worse than any other product I have seen. Using the applicator tube spray short burst(s) into lock mechanism, while moving the applicator in and out. Immediately afterwards, insert the key and turn a full rotation, repeat the key insertion several times. In addition, on some sticky locks I have sprayed it onto the key."

"Caveats: It is smelly stuff, use as sparingly as possible. It also helps to do it on a nice day so you can air the car out afterwards. Keep a rag or paper towel handy, and make sure you check the key the next few times you use it for residue before tossing it into your nice sportcoat pocket. I find the aerosol spray is messier, but it does seem to "free up" sticky locks better than the other types."

DOOR HANDLE LINKAGE CLIPS: The door handles and locks in the XJ-S involve rods that connect the inside controls with the latch and the like. These rods have a 90° bend at the end which is inserted through a hole in a lever and retained by a clip -- similar to just about any other car on the road. The clips on the XJ-S, however, are unusual. With most cars, the diameter of the rod and the size of the hole in the lever are the same, and the clip is a carefully shaped piece of spring steel that surrounds the lever, has the tip of the rod inserted through it, then snaps onto the straight section of rod to hold it in place. With the XJ-S, there is a plastic bushing involved. The hole in the lever is therefore larger than the diameter of the rod. Also, the clip does not surround the lever, but instead relies on the plastic bushing to

hold it to the lever. To assemble, the metal clip is offered up to the lever and the plastic bushing is pressed through the clip and the lever, snapping into place. Then the rod is inserted and the the clip snapped onto it.

The bushing probably would prefer to remain motionless relative to the lever, and simply let the rod rotate within it when the parts move. The clip, however, is securely snapped to the rod and therefore moves with it, but is retained *between* the bushing and the lever. Since the bushing hence has parts rotating both inside and outside, it tends to move with the rod, and wears on its outside diameter. Of course, when it wears through, the linkage starts rattling, and sometimes will even fall out of the lever since the bushing was the only thing holding it together.

If you drop into your favorite auto parts store, you will find assortments of metal door linkage clips for sale. None of these clips will fit the XJ-S; all of them are intended for use without any plastic bushings, and therefore have the hole where the rod is inserted the same size as the rod -- not big enough for a bushing. If you find a really big clip, it might fit the bushing, but it's too big to clip onto the rod. Besides, it's probable that it's the bushing you really need, not the clip.

It is possible to replace the bushing alone by purchasing some of those plastic nuts that press into a hole and accept a self-tapping screw. You will need to bore the center out to the diameter of the linkage rod, and then slide the part onto a #8 screw, hold it in place with a nut, and chuck the assembly up in a lathe or drill and cut the OD down to fit the hole in the lever. You may also need to trim the flange down, since the plastic nut will typically have a large square flange that won't sit properly against the clip.

NAPA sells a "Door Latch Rod Retainer 735-2637" for "Ford, Lincoln, Mercury". This one-piece clip is entirely made of plastic, and functions very similarly to the combination of bushing and clip in the XJ-S. This particular part fits the XJ-S rod diameter perfectly, but the OD of the integral bushing is too large -- about 6.5mm, as opposed to the hole in the Jag levers being about 5.5mm. The simplest solution here may be to chuck the entire clip up on that #8 screw and cut the OD down.

That may not be the best solution, however. It's entirely probable that the OD of this bushing was established by engineers at Ford who knew better than to make the walls of that bushing as thin as Jaguar made them. Note that you are having to replace that Jag bushing. Hence, it may make more sense to enlarge the holes in the Jaguar levers to fit this clip without modification. Unfortunately, most of the levers within the XJ-S door are not accessible for drilling without a considerable amount of disassembly.

There are ten bushing/clips per door, including one in the inside locking lever that's a little different than the rest. Also note that the ones on the driver's side are likely to be more worn than those on the passenger's side.

SIDE MIRRORS: Martin Fooks wanted his car to look stylish, so he installed side mirrors from a Pontiac Fiero. "The mirrors are fairly easy to fit as only one of the 2 bolt holes has to be slightly widened and the angles of the mirrors to the car are just about perfect. My car used to have manual adjustable mirrors and the electric wires for the Fiero items come through the hole that the manual rod used to use."

"The mirrors are bolted to the doors from the inside, thus (unknowingly at the time) removing that easy route into the XJ-S. (ed. note: see "Breaking In" on page 439)

"As I did not have electric mirrors before, I used the complete Fiero harness and switch, although as you will be aware electric mirror wiring is hardly a challenge..."

If you have WWW surfing capability, you can take a look at Fooks' car at:

<http://www.geocities.com/motorcity/8382>

BREAKING IN: If you get locked out, Victor Naumann provides this tip: "you can unscrew the outside mirror, and carefully reach through with a long blade and flip the lock handle to unlock." This works entirely too well. If you happen to have a Slim Jim (the long blade that is inserted between the glass and the seal -- standard car thief's tool), it works just fine too.

If it's the boot you're locked out of, Cliff Sadler says "The latch is held in by two sheet metal screws. If you ever need to get into a locked XJS trunk, simply grab the handle, and pull straight up with a snap; then, replace the screws with bolts." If you use really good bolts, maybe this won't work as well next time!

WINDOW GLASS: Reportedly, some XJ-S windows have the metal "runner" riveted to the glass through two small holes about 1/4 inch from the bottom; in this setup, pulling on the window is a very bad idea -- it will break easily, since the rivet holes form a starting place for cracks. Later ones are glued, making the glass itself much less likely to fracture.

If you have to replace a window, make sure the correct one is ordered -- with or without rivet holes.

REAR QUARTERLIGHT REMOVAL: Both the Haynes manual and the Jaguar repair manual describe removing this glass, but the descriptions vary. Both start by removing interior trim panels, but then the Jaguar manual says "Using suitable tool prise rear quarter glass and rubber from body." The Haynes manual says "With an assistant pressing the glass outward, peel back the rubber weatherseal from the body at one corner until the glass can be pushed out of its frame." The Haynes method works fine, no "suitable tool" required.

SIDE VENTS: The vents on either side of the C-pillars (the "buttresses" on the XJ-S) are functional. When the A/C system is blowing outdoor air into the interior, these vents are allowing air back out. They also allow air out when a door is being shut, preventing that obnoxious problem of doors that won't shut unless a window is rolled down. The actual route the air takes begins with mesh grilles in the top of the cubby holes above the rear armrests. From there it goes through the bodywork, through a set of three flaps on each side of the car, and then out the slot on the outside.

The repair manuals provide no information on how to get these vents apart. So, the following is from Mike Morrin:

1. Remove the quarter side window glass and rubber (see above).
2. Remove the little chrome corner piece at the bottom rear of the vent cover (nut reached from inside boot).
3. Pry off the chrome strip at the rear edge of the vent cover.
4. Drill out the rivets which held the chrome strip and rivets which are behind window rubber.
5. Remove the cover piece.
6. Remove another 6 rivets holding the vent assembly into the car.
7. Lift out assembly and wonder why you went to so much trouble.

Note that the rivets under the chrome strip not only go through the center of the retaining snaps themselves, but also through three tiny washers behind each one of them. Don't lose the washers; they are there to keep the rubber seal from being crushed by installation of the rivet.

Despite Morrin's skepticism about the value of this job, the flap assembly within this vent may actually need attention. Each of the three flaps consists of a metal plate with a layer of foam on the face, suspended from a piece of cloth. There is a foam bumper on the back side to keep it from making noise when it opens forcefully enough to bang the housing. All of this is British non-metallics, so the foam face has long since rotted away and the metal plate itself is closing over the opening. This makes a quite distinctive racket, especially when closing a door.

The flaps themselves are also installed with pop rivets. It is a fairly simple matter to drill them out and rebuild each flap, using materials that hopefully will be more durable and quieter. You might wanna have some headliner material handy; it might make a suitable face material. The type of nylon fabric used to make backpacks and light jackets might work well as the "hinge", but I simply used vinyl upholstery material; make sure that whatever you use doesn't crinkle or otherwise make noise as it flexes. A can of 3M's "Super Trim Adhesive" #08090 will also be helpful. For the bumpers

on the back side, some 1/8" thick 1/4" wide foam tape weatherstripping will do nicely, sold in building supply stores for sealing windows and doors. Get the heavy-duty high density closed cell stuff, this is no place for the flimsy foam.

You might find it helpful or necessary to remove a cover from the flap assembly that is held on with staples. Therefore, you might want to have a box of 1/4" length Monel staples that fit your staple gun on hand. Monel staples are considerably more expensive than normal staples and a lot harder to find, but they won't rust.

There are (or were) a couple of strips of foam seal along the back side of the cover, but they have dried up and fallen off. They can easily be replaced with some 1/4" thick 1/2" wide weatherstripping, similar to that described above except the next size thicker.

To reassemble, you're gonna need a lot of 1/8" pop rivets (1/4" grip length) -- at least 24 per side of the car. The original rivets are a special type with a closed end, intended to prevent leaks. These type rivets are very expensive and difficult to find, and it's not like anything here is truly airtight. The only conceivable reason for using these rivets is to avoid a whistle, but if you're concerned you can accomplish the same thing by covering each rivet with a piece of aluminum tape or some silicone sealant.

The four rivets underneath the rearmost chrome strip must fit inside the snaps for the strip, and chances are the rivets you have won't fit. It is a fairly simple matter, however, to chuck the rivets up in your drill and file the head diameter down a little bit.

These same four rivets end up recessed within these snaps. This presents another problem, since the "anvil" of the rivet gun must sit squarely on the head of the rivet when installing, and of course that anvil isn't small enough to fit within the snap. So, you will need a little sleeve to fit around the nail of the pop rivet when riveting, or a few very tiny washers will serve. You must be careful not to lose them after each rivet pops.

TAILLIGHT REFLECTORS: Many people fail to realize the importance of the reflectors to the appearance of taillights, turn signals, etc. Jaguar XJ-S reflectors are mostly chrome-plated plastic, which is fairly durable; but the chrome sometimes deteriorates, and the neutral plastic color is only a fair reflector. Also, the metal panel that separates the taillights from the brake lights can get pretty dull.

To make your taillights look good, you should restore the effectiveness of the reflectors. You can cover them with aluminum foil or aluminum tape. The best method, however, is to mask the bulb sockets and paint the reflectors with flat white spray paint. Flat white gives a more diffuse appearance to the light, which is prettier than the bright center appearance of the original. If you want to make the light even more diffuse, you can paint a white spot on the bulb to prevent a direct view of the filament.

BRAKE LIGHT LENSES: There's a little panel with a chrome frame along the inside edge of each pre-1991 taillight lens that may or may not have paint on it. David Cleary explains, "The center section of the boot lid was painted black up to about 1977, at the same time the B posts were chrome, and the lenses were also black." Mike Morrin says, "I think that they only had the black paint on the boot lid between the tail lights for 1975 and 76. I presume the paint on the lenses was deleted at the same time. The parts book shows that the part number changed at 2W4023(RHD) and 2W54660(LHD). I presume that this is the same change."

What it changed to is not as clear. This author's '83 had silver paint, while later cars just left the underlying chrome uncovered. Cleary says, "Both my 79 and 82 cars came with silver finish on the rear lenses. I have only ever seen the silver finish lenses available from the factory. No spares or autojumble retailer has them, only the black or chrome."

"At a recent autojumble I wanted a pair of rear lamp lenses. I noticed that the early ones with a black finisher were much cheaper than the ones with the chrome (£15 a pair rather than £25). With 10 minutes work and some careful application of thinners you can save yourself £10 by removing the black paint to reveal the chrome - simple eh?"

The silver paint comes off just as easily. I said this author's lenses *had* silver paint. They don't any more -- one look at someone else's car with the bare chrome, and that silver paint was outta here.

The panel in question is actually a separate piece from the lens itself. The chrome plating is applied to a metal panel, and then the panel is attached to the plastic lens assembly with press-on clips. If the nonremovable clips are removed (!), it's a lot easier to work on getting the paint off -- you can dunk the whole thing in a can of solvent. Or, Cleary says you can "Use masking tape to protect the chrome when using thinners. That way you don't have to remove the bit from the lens and chance breaking it."

If you're having the car painted, you might consider something really radical: mask off the chrome rim and the rest of the lens and have them prime and paint those panels the same color as the car. This will give a unique look, since none of the XJ-S's apparently came from the factory with this panel painted body color.

THIRD BRAKE LIGHT CUTENESS: John Himes sends this tip: "If you wanted to get creative, remove the entire housing and place a piece of custom cut metal or cardboard or something with the leaper cut out, paint black and place against the window. Now when you brake, instead of just a light there, you will be showing a glowing red leaper to all that you leave behind."

LICENSE PLATE LIGHT LENSES -- PRE-1992: This lens is actually an assembly of two parts: the lens itself, and an opaque white plastic hinge that the lens attaches to. The hinge is provided to facilitate bulb replacement, since it's not all that easy to get a screwdriver into this area. Both the lens and the hinge are often problem areas. Patrick MacNamara says, "British/Auto USA flyer has an XJ-S license plate light repair kit which includes the flexible plastic hinge piece, lens and bulb." See page 641. Chuck Sparks points out that the lens is the same item as used for license tag light lenses on the '74-76 MGB and the '75-76 Midget; it is offered by Victoria British (1-800-255-0088) as part number 0-6912 for less than ten bucks.

The bulb holder is integrated into the lens, which is unfortunate; otherwise, it would be a simple matter to replace the lens with any flat piece of transparent plastic. As it is, such a replacement of the lens requires figuring out some other way to hold a bulb.

One repair possibility is to simply buy a suitable automotive light fixture, throw the original hinge and lens away and mount the entire fixture within the space. The space is shallow, but the sheer variety of aftermarket light fixtures available means that something can usually be found to fit. Be sure to check truck stops, which sell a wide variety of "marker lights" for the corners of tractor trailers.

Alternatively, you can *make* something to hold the bulbs; this author simply made some connectors that clip onto both ends of the bulbs the way a fuse is held in a fusebox and mounted them with suitable plastic cut to serve as insulators. Remember, whether you buy or make, there's no good reason to stick with the original style bulbs; any 12V bulbs of comparable wattage that can be made to fit in the space should work.

Once you've fabbed bulb holders, you will need to provide lenses. This author purchased a small piece of plexiglass (Lucite) at the local building supply store, 8" x 10" x 0.093", for less than \$2. It comes with either thin plastic or paper on both sides to protect the finish (paper is better); leave the stuff on until *after* you have finished cutting and drilling. It's really easy to cut and drill. Trapezoidal pieces were cut with two holes each to replace the hinge *and* the lens with a single piece. When done, one side was sanded with 320-grit sandpaper to provide a "frosted" appearance; the other side could be done to make it even more frosted, but going to a coarser grit makes the individual scratches too prominent and a finer grit seems to not do enough. Finally, the edges of this lens could be wrapped with strips of aluminum tape or (better) stainless steel tape to make it look more professional, but in this author's opinion the finished product *already* looked neater and more esthetically pleasing than the original cobbled-looking assembly. These lenses are not all that prominent, although they are plainly visible when the trunk is open and are apparent in the reflection in a well-cleaned rear bumper as well.

Julian Mullaney: "I also made replacement lenses for my old XJS. It is better if you use polycarbonate (Lexan) instead of acrylic (Plexiglass). Unlike acrylic, polycarbonate can easily be cut with scissors (or metal snips) without cracking. It can also be folded along a straight line without heating."

If your lenses are not that far gone, Ed Avis provides a fix for the hinge itself: "I removed the old flaps and used them to trace the pattern onto a plastic VCR tape case and simply cut out new flaps. The nice hinged cover on the tape case served the same purpose as the hinge on the original flaps. Total cost of the repair was about \$1 for the tape case.

Mullaney has his own ideas for that hinge, too: "PET (polyethylene terephthalate sp??) is very good for this application too. This is what Coke bottles are made of. A good source for this is the large clear bottles with spring water at the supermarket. Although a bit on the thin side this is what I used."

CHROME-PLATED PLASTIC: If you ever find yourself needing to remove chrome plating from plastic, John Goodman suggests: "You can probably remove the chrome by removing the paint underneath, with oven cleaner, or any of those concentrated cleaners containing sodium hydroxide. Wear eye protection and rubber gloves. Liberally spray the part with the goop, seal it in a plastic bag, and wait.

"I haven't tried oven cleaner to remove chrome from plastic, but I have used it to remove paint from plastic. Works like a charm, doesn't harm the plastic. Model railroaders use it on their delicate miniatures"

See COTECH, page 652.

BUMPER VARIATIONS: In some countries that don't require high-impact bumpers, the XJ-S has been fitted with lighter, less obtrusive bumpers. The front bumper is fairly thin, and the turn signals mount on the bodywork rather than in the bumper. The locations for the turn signals are clearly evident on US-issue vehicles, hidden underneath the heavy bumper.

Scott Horner says, "if they are UK based, then the difference in Pre-'82 to post-'82 is in the bumpers...Pre-'82 (Pre-HE's) used the impact absorbing bumpers without chrome tops...the same for all markets; but at the H.E. for all markets (except the USA) Jaguar fitted slimline bumpers without the impact absorbers.

"This means that most trim kits like the TWR & XJR-S packages sit very close to the body and don't use the rubber bumper beam cover - which I've seen on some US kits...."

For the US, the bumpers changed in 1982 as well -- but both pre-82 and 82-on were impact-absorbing type. Section 76.22 of the ©1975 ROM obviously applies only to the pre-82 bumper design, but the ©1982 Supplement covers the revised design.

Note that the 1982 bumper change also entailed a change in the front turn signal assemblies.

LICENSE PLATE FASTENERS: No matter how pretty your Jag is, having streaks of rust on the tag streaming downward from the attachment bolts doesn't help. There is apparently no consistency in attachment schemes here, it looks like each dealer fastened the tags whatever way he saw fit -- and rare indeed is the dealer that springs for proper stainless steel fasteners. It shouldn't be too hard to find some stainless steel fasteners that will serve. On the author's '83, the tag was held on with chincy sheet metal screws directly into the metal of the trunk lid, so a nice chrome license plate frame was added with four stainless steel screws.

REMOTE TRUNK RELEASE: Bob Whiles says: "There are several "Trunk Release Module" kits on the market. All you get is the actuator (solenoid), a button, fuse holder and wire. But Chevy has a pretty nice - heavy duty - one in some of their "upper" models. Just look for a Monte Carlo or above in the junkyard. All you will need then is a momentary button, wire and fuse/holder. Cheaper and better than the kits."

REAR SPOILER: Welsh Enterprises (page 646) offers a rear deck spoiler for the XJ-S. JaguarSport does too, and John Goodman reports: "There are actually two types of (JaguarSport) deck spoilers available. The post-'92 deck spoiler has more "sweeping ends" to compliment the revised tail lights and I'm not sure, but maybe an integrated brake light."

Several of the vendors listed starting on page 663 also offer spoilers, some with slightly different styles, so hopefully you can find one that suits you.

Note that rear deck spoilers have a hole for the antenna to poke through. Also note that rear deck spoilers are attached to the trunk lid while the antenna is attached to the fender, so opening the trunk with the antenna up won't work. If you are concerned about this, the Jaguar fix is to provide a wiring change so that when the trunk is opened and the light comes on, the antenna goes down. This could easily be done by anyone; it only requires a relay.

Now, if you have the earlier XJ-S, you know those springs that hold the trunk lid up when open? Do you think they will still hold the trunk lid up with the additional weight of the new spoiler on it? Not likely! Reportedly, the fix is to fit the earlier cars with gas struts, just like the later trunk lids have. Goodman again: "The struts and the relay with harness come with the spoiler if you buy them from a Jag dealer."

STYLING KITS: Several outfits, including Welsh Enterprises (page 646), JaguarSport (page 8), and several other vendors in the listing starting on page 663, have developed styling kits with components to add all around the bottom edge of the bodywork -- from the bumpers downward at both ends, and along the rocker panels under the doors. Some kits cover the bumpers, while others mount underneath the bumpers with the bumpers protruding through.

The Welsh kit supposedly fits any XJ-S 1982-on, apparently due to some problem with bumpers on earlier cars. John Goodman says (regarding the JaguarSport versions), "There are three different body kits, pre-'92 and post-'93 US with rubber bumpers and '93 UK."

Michael Minglin reports: "I have installed a ground effects kit (body styling kit) that I purchased from the dealer. From the pictures it appears to be the same kit Welsh is offering. The kit installs over the shock absorbing beams on my '84 XJ-S. The chrome top trim and the black rubber end pieces are removed. I find this preferable to the newer kits that do not have the shock absorbing beams protruding through the spoiler. It may not look as nice, but it provides excellent protection in the event of slight bumps, like backing into a post I didn't see. The kit is fiberglass and would easily crack if it was not for the shock absorbing beams.

"The negatives on this kit are: You have to be very careful when pulling straight into a curb, or one of the concrete parking curbs in parking lots. The front spoiler is so low it will hit the curb and break. This point must be stressed when leaving the car at a shop or using valet parking. In addition I have noticed that the engine runs a little warmer on the open road since I installed the kit. It seems to restrict the airflow somewhat. But, it sure makes the car look great.

"FYI, this kit is manufactured by Arden, a German company." Arden is listed on page 664.

LUGGAGE RACKS: Herbert Sodher wanted to make his car look different, and found that a luggage rack designed for a 1968-75 Corvette will fit on the XJ-S trunk lid nicely. He chose a really nice stainless steel model rather than the basic chrome. He opted not to use the mounting scheme included, since it was intended for fiberglass; instead, he visited a good hardware store and purchased some stainless steel flush head sheet metal screws. He carefully measured locations and drilled some small pilot holes, and with very little effort was receiving complements on the appearance of the installation.

MUD FLAPS: If you drive in mud, snow, slush, etc., you probably are sick and tired of cleaning the slop off the car. The place to get mud flaps for your Jaguar is at the Jaguar dealer. In fact, the panel behind the front wheels already has a set of square holes for mounting the flaps.

H.E. VS. V12 EMBLEM: If you feel that "V12" is a more descriptive emblem than "H.E.", you may be happy to learn that the V12 emblem is available as a stick-on item, and will perfectly cover the holes used to mount the original H.E. emblem. If you purchase the V12 emblem (part number BEC4717 - don't get the earlier 4-piece emblem), merely pry the H.E. emblem out, clean the surface, and stick the V12 emblem on.

COLOR COORDINATION OF WHEELS: Coordinating the color of the wheels with the body color of the car -- via some accents in the pattern or the like -- can make a dramatic improvement in the appearance of any car. This is almost never done at the factory, presumably because tracking different colored wheels to make sure they end up on the correct color cars on the assembly line would require too much extra cost and effort. If you have to have your wheels repainted or powder coated anyway, consider asking the shop to apply an accent color that matches the color of the car.

If your car happens to be red, green, black, or grey, this color coordination of the wheels might be easy! Just replace the little growler emblems with ones that match! Richard Mansell points out that Jaguar offers wheel emblems "in the following 5 colours: Silver/Green, Gold/Ruby, Silver/Ruby, Black/Gold, Grey/Silver (Jaguar), Gold/Ruby, Grey/Silver, Black/Gold (Daimler)." Available at the dealer. The Silver/Ruby part number is MNA 6249EA.

Apparently Jaguar's intent was not color coordination, which may explain the limited selection of colors. David Buchner says, "each year model has its own color. '94 uses red..." Maybe more colors will be available in future years! The early H.E. domed starfish wheels came with a two-piece emblem (growler and retainer) while the 90's Jaguars use a single-piece emblem, but the single-piece item fits the domed starfish wheels just fine.

WHEEL ARCHES: These are bright metal trim pieces that fit around the edges of the wheel wells; they are available in either chrome or gold. They are another item about which opinions vary, with many owners finding them gaudy and tasteless while others love them. Of course, if the edges of the wheel wells are where your car is rusting, you might suddenly decide they look good!

John Dyson says, "I have the chrome wheel arches on my '91 "Classic Collection." It is my impression that they are part of the limited edition trim which includes chrome wheels, gold bonnet badge, leather interior with contrasting piping, and "Classic Collection" badge on right rear."

CONVERTIBLE RIGIDITY: In the old days, cars had a rigid frame and the body merely went along for the ride; chopping, removing, or otherwise screwing around with the bodywork did not functionally affect the car. However, a frame is now considered a waste of steel, space, and money, and the body of the car is usually the stress-carrying structure.

About the same time this change was taking place -- early 70's or so -- convertibles also disappeared, largely in anticipation of safety regulations that never actually materialized.

In the 90's, the convertible made a comeback -- including the lovely XJ-S version. Unfortunately, the stressed-body concept doesn't take well to a convertible; removing the roof removes a great deal of the structural rigidity, and such cars often end up weighing considerably more than the hardtop versions due to added structural reinforcement needed elsewhere to compensate.

Early XJ-S convertibles were structurally good but not great. With the bodywork revisions in mid-1991, mounting points were added under the car for a system of front and rear cross-bracing to add rigidity. This renders the structure truly excellent. Unfortunately, the 1988-1991 convertibles lack the mounts for installing the bracing.

The cross-bracing can be added to earlier cars. A kit including all the parts is available from Classic Engineering (see page 665), but installation involves some welding. They are reportedly working on a similar kit for the rear bracing, but the front is the more important.

According to Julian Mullaney, the rear brace is very similar to the front, but fashioning mounting points is harder. "This brace mounts on the chassis in front of each rear wheel and crosses to attach on the opposite side, behind the rear end cage on the bottom of the trunk (boot). This is where the problem is. In the new cars, the trunk well is stamped with two downward pointing depressions to which a brace can be bolted. In the early convertibles some sort of stand-off (about 2-1/2 inches deep) must be mounted to the bottom of the trunk-well in order to attach the brace."

Meanwhile, similar cross-brace kits are available from Harvey Bailey Engineering, page 664, but theirs apparently require no welding. Chris Carley installed both front and rear cross-bracing: "Heck knows why it works but it really does make the car feel so much more solid. When you hit a bump you just get a normal tire thump - no rattles or shakes. It also improves the handling, which surprised me; feels like much less roll and more firmly planted. Fitting: front was dead easy; need 1-1/8" socket for subframe mounts. The rear fitting is just fiddly to get the thread started in a blind hole (took hours and lots of 4-letter words)."

MAKING YOUR OWN CONVERTIBLE: Discussing chopping the top off a coupe, Scot D. Abbott says "I've seen several XJ-S coupes made into convertibles. I also saw several XJ-S bodies cut apart just for examination and have experience evaluating convertible conversions. IMHO, changing the XJ-S unibody to open configuration must be done with some care to minimize strength loss, and reasonable stiffening elements can be added back to make a sound car. This must be done properly and can be done in many ways.

"Roof removal is *not* necessarily the main thing that can take away body integrity/strength in a conversion. I cut the roof off an XJ-S, towed it on a dolly 2000 miles, and still the door gaps remained the same. I could raise the car with a jack and not twist or deform it significantly differently from an XJ-S with its roof intact. Please note that I kept the sundeck/rearward bulkhead intact.

"Compromise of the rear sundeck/rear bulkhead system or removal of the rearward bulkhead (i.e. the sheetmetal wall behind the rear seats and between the rear wheel wells) from the XJ-S makes the car very flimsy, especially to torsion stress, and it permits undue flexure during motoring which will likely fatigue the sill/floor joints with time.

"Removing the rearward bulkhead is done to make room for a large power top to fold down. An alternative to this is to use a compact folding top and thus avoid creating the basic problem.

"A commercial version of this conversion design strategy is available locally (Driver's Seat of Delaware, Inc., Box 542, Montchanin, DE 19710, 302-998-7889)."

STATION WAGON: See Lynx Motors International Ltd., page 669.

XJSS: A radical kit car based on the XJ-S offered by Autostyle (page 664). Pat O'Keeffe got the literature, and reports that the blurb says:

PREPARATION: The bonnet (hood), boot (trunk), bumpers, lights, front wings and doors are unbolted. The rear wings and roof are removed. Note that the windscreens pillars and glass are not disturbed. The tubular sill reinforcer, which is supplied, is fitted. The fuel tank is adapted. The rear boot lid support assembly, which we supply, is fitted.

ASSEMBLY: The one-piece front body section is fitted. The bonnet is fitted. The one-piece rear body section and sill covers are fitted. The boot lid is fitted. The XJSS door skins are fitted and the doors returned to their original locations. The lights and number plates are fitted.

PAW PRINTS: Cats love cats; those flea-bitten varmits just love to stroll around on your freshly-washed Jaguar with their filthy paws and leave little prints all over it. Aside from solutions involving firearms, the following suggestions have been made:

Peter Cohen says, "There is a product called a ScatMat. You place it on the car, plug it into the mains and it administers (chuckle) a mild electric shock to the little bugger. I actually own one of these devices. The bad news is: 1. The cat figured it out and just doesn't step on it. 2. My wife drove off with it still on the car. I found it 2 weeks later in the bushes, 3 streets away. My only workable solution is: the Jag goes in the garage, the cats may not go in the garage."

Chuck Wood says, "I know some of you will laugh, but it really works if you have cats that know they should not be on the car and get off when you come out or you yell at them. I took a motion detector which had two lights. I took one

light out and put a receptacle in it. I then recorded my voice on tape very sternly telling the cats to get down using the word No and whatever other words that they are used to hearing when they are doing something they should not be doing. The recording was about 5 minutes long. Set the motion detector for about the shortest time on and position the sensor to pick up anything moving on top of the car. It should not go off when the cat walks on the floor any where. When this is set correctly, the cat gets on the car which activates the sensor which turns on the light and activates the recording telling the cat to get down or off.. It shuts off in about 5 seconds. The recorder is in the play mode all of the time. It really works well if the cat is conditioned to knowing it should not be up on the car.”

David Danvers says, “I have sprinkled red cayenne pepper around my carport to keep them away...it is a great deterrent and cheap...go lightly so you don't track it in the house or car and re-apply after it rains....they'll get the point pretty quick...” Apparently, the reason this works is because the first thing the cats do when they get settled on the car is to start licking their paws.

Stefan Schulz suggests, “Dihydrogen Monoxide, the colder the better, and lots of it. Apply by slinging it with a bucket. They will get the message. It also goes some way to remove the paw prints.”

INTERIOR

Note: The instrument panel is discussed on page 544.

CHANGES FOR 1988: The interior was significantly changed for the 1988 model year. Changes included:

Chincy plastic door sills replaced with beautiful chrome-plated steel sills with "Jaguar" written in them.

Painted metal "ski slope" (panel surrounding the shifter) replaced with wood burl version. The cruise control switch was relocated from the shifter pedestal down to the ski slope itself.

New seats with heaters and electrically-adjustable lumbar support. Switches are on the sides of the console.

New steering wheel.

LEGROOM: If you are tall, you may be pleased to know that the front seats in the pre-'88 XJ-S's have two sets of mounting holes. The cars came from the factory with the seats mounted on the forward holes. Simply unbolt the seat rails from the floor, turn the seat over and unbolt the rails from the seat. Remount the rails to the seat using the alternate set of holes, and the seat will adjust farther rearward.

Note that the '88-on seats don't have the second set of holes and are bulkier to boot, making it much more difficult for the larger driver to fit. When Jaguar incorporated electric motors in the seat adjustments in the early 90's, they got bulkier still.

Tall people should also avoid the H&E convertible. Relocating the seat mounts rearward will do no good, because the housing for the convertible mechanism limits rearward motion of the front seats.

SEAT RAIL SPACING: John Nuttall notes that the seat rail spacing on pre-'88 cars was 17½" while on later cars it was 16½". Obviously, the seats will not be interchangeable.

SEAT MOUNTING BOLTS: On the early cars such as the author's '83, the four bolts that hold the front seat rails to the floor tend to be aggravating. The front two bolts go into rectangular block nuts that do *not* hold themselves in place, although it usually isn't too difficult to hold them in place with a large screwdriver until you get the threads started. The rear bolt near the door threads into a trapped nut that can move around for alignment. The rear bolt adjacent to the console is threaded directly into a boss welded to the floor; since this is the only corner that cannot be moved for alignment, this is the one that locates the seat. When putting the seat in, it is a good idea to get all four bolts started before tightening any, and then tighten the rear one near the console first.

Mike Wilson reports that both rear nuts are firmly attached on the 1990 model, neither one can move around for alignment. Still, it would probably be better to have all four bolts started before tightening any, and tighten the rear two first.

To make the job a little easier, you can replace the two rectangular block nuts at the front with clip nuts that will hold themselves in place. The clip nuts are described as an "extruded U nut, 5/16 Regular" or "Long". The "regular" means that the clip part is 5/8" deep, while the "long" has a clip about 7/8" deep. Suitable U-nuts were bought at Lowe's and made by Curtis Industries, Inc., Eastlake, OH 44095. The Curtis part number is 838758 for the regular and 838759 for the long. Similar U-nuts are also sold by auto body parts shops, with the regular having a part number 4016.

The best course of action seems to be to have a selection of regular and long U-nuts on hand to do this job. On the author's car, the regular fit the locations near the doors while the locations near the console required the long. You don't

wanna use the long on the locations near the doors if you don't have to, since they would protrude more than necessary and possibly hurt someone's ankle or run pantyhose.

Of course, strength here is of some importance; you don't want that seat coming loose in an accident. However, even though the U-nuts are extruded from sheet metal, they are probably *stronger* than the original rectangular block nuts -- which are made of something related to silly putty. Since the U-nut is a clip, it is made of spring steel and therefore quite strong. And the extruded threads are perhaps twice as long as the threads on the rectangular block.

Since U-nuts seem to only come in coarse thread and the original mounting bolts are fine thread, you will have to replace the front two bolts as well to get the U-nuts to work. The shape of the head of the bolt is crucial, since the wrong shape may obstruct the adjustment of the seat. The bolt to use with it is a "socket head cap screw, 5/16-18 x 1". Curtis part number 835558, but this is a fairly common critter and can be found most anywhere. This is driven by a 1/4" Allen wrench. The original lock washer may be used with this bolt.

On the earlier cars, these bolts were Pozidriv #3 head. This makes them quite difficult to get really tight, especially the rear ones since it may be difficult to get a screwdriver to engage the bolt head straight on; if you have Pozidriv bits for a changeable-tip screwdriver, you might try using one with a 1/4" box-end wrench or a 1/4" socket with a ratchet here. Later cars use Torx T-40 bolts instead, a big improvement. The Allen drive cap screws also work quite well; if you have the Pozidriv, you might consider picking up some 3/4" long fine 5/16" fine thread cap screws for the rear locations, making all four removable with an Allen wrench.

SEAT DIAPHRAGM: If you take the seat out and turn it over, you will find that the bottom cushion is supported by a rubber diaphragm stretched across the frame and hooked on with hog rings. This diaphragm is classic British non-metal stuff and is rotten and torn, and that's why you seem to sink farther into the seats than you did when you were younger. Ron White says, "They are available for the Jag from BAS Ltd." See page 649. Note that this is valuable information; apparently many Jaguar suppliers (including the dealers) will not sell you the diaphragm, they want you to buy the entire seat cushion assembly.

Still, installation is no picnic. The foam of the cushion is glued to the diaphragm, so replacing the diaphragm will entail carefully cutting the foam away and gluing it to the new diaphragm. You'll need good glue, like 3M Super Trim Adhesive #08090.

Note also the above comment about the seat rail spacing change. It is unknown whether a different diaphragm is called for between the two types of seat, but some owners have commented that the diaphragm was really tough to install, requiring serious pulling -- but maybe it's supposed to. Also, there are reports that the replacement diaphragm required a somewhat different mounting hole pattern in the frame, so a few new holes had to be drilled.

This author took a different route and left the old tired diaphragm in place and reinforced it with a piece of plastic sheet above it (between it and the foam) and a webbing woven of curtain rod cord underneath it. The webbing is remarkably easy to do, just loop back and forth between the same hog rings that hold the diaphragm itself, stretch it tight, and tie it; it might be advisable to do this while the diaphragm is still in good shape, thereby postponing the cushion regluing considerably.

COMFORT: Some of us prefer the bottom portion of the front seat to be inclined somewhat; this helps hold the occupant in position with less effort on his part, as opposed to having to brace one's feet against the floorboard to keep from constantly sliding forward. This is especially a problem if you like the seat back reclined somewhat.

The seats in the '83 XJ-S have no angle adjustment on the bottom. However, a small amount of incline can be permanently added by inserting a few 5/16" washers under the front end of the seat rails, around the front mounting bolts. It wouldn't be a good idea to add more than 1/4" or so since you may start distorting the rails, but 1/4" can make a dramatic difference. If you need more, you can also insert washers between the upper rails and the seat itself. Beyond that, you need to make some tapered washers to be able to bolt the rails to the floor without distorting them.

LEATHER: Robert Olman of New York sends this tip. If your leather interior has areas where the dye has worn through and the color of bare leather is showing, it can be re-dyed. The original leather, by Connolly Leathers, is painted with dye rather than vat dyed like other cars -- if you look at the back side of the leather, you see the undyed color. Connolly uses a lacquer-based dye; you'll need 2-3 pints for the entire interior. Before using, you must determine which pieces are leather and which are vinyl, as the lacquer-based dye will destroy vinyl (Some XJ-S's are all leather, others have vinyl in areas that don't contact humans such as the sides of the seats). Or, you can use a non-original non-lacquer-based dye.

You might want to remove seats, console, etc. from the car to make the job easier. Clean the leather with lacquer thinner, sand it lightly with fine sandpaper to remove the shine, then clean again with lacquer thinner. Then apply the dye evenly, perhaps in two coats.

If it is humid, it will take a long time to dry. Heavy coats will also require a long time. Heavy coats in damp weather may require a week to dry.

If you would rather spray the dye, you will have to remove all items from the car, thin the dye with 5-7 parts thinner to 1 part dye, and apply many thin coats. It will require more dye due to waste. Many marine supply shops sell disposable aerosol sprayers (about \$6) with replaceable aerosols (about \$3). You'll need about three aerosols.

A complete restoration kit is available directly from Connolly (see page 649), with instructions.

Note that Jaguar has used at least three different colors called "biscuit". To get the correct one, you must specify model and year.

FOOT ROOM: The footwells are tight enough; does the brake pedal have to be so big? Of course not! It doesn't have to be any bigger than a brake pedal in a manual transmission car. John Ashcroft says, "Just a small mod: cut 20mm off each side of the brake pedal to gain much needed foot room. What a difference it made!" Note that you don't even have to cut equally off each side: you can cut entirely off one side if you'd like.

Tip: Go to the auto parts store *first* and check out the sizes of replacement brake pedal pads available. Choose the size you want, take it home, and then trim your pedal to match.

You can take the brake pedal out fairly easily, if it will make it easier for you to trim.

INTERIOR WOOD: There are two different types of wood commonly used in the XJ-S interior, elm burl and walnut burl. The elm burl is a light honey color, while the walnut is dark. Neither type holds up well in direct sunlight, so it is recommended that all XJ-S owners purchase sunshades to put in the windows when parking in a sunny parking lot -- especially if you have a later car with the wood ski slope, which is positioned to get more direct sunlight than any wood trim in the earlier cars.

INTERIOR WOOD WORK: Gene Halaburt says, "An excellent article on wood finishing for Jaguars appeared in the October 1996 issue of "Jaguar Enthusiast" Magazine. Written by John Sundberg dba "A&B Leather & Wood Renovation." (see page 648).

INTERIOR WOOD TRIM REFINISHING: Rick Lindsay provides this suggested procedure for refinishing the wood trim:

- Sand the veneered wood *very* carefully with 200 or 400 grit paper removing only enough wood to freshen the surface. Even with 200 grit sandpaper it is easy to cut through the thin veneers used in britcars - especially on edges. I've found it better to leave a bit of the 'old finish' than to sand thru the veneer and have to stain the substrate. Pay particular attention to edges that should be left crisp - not rounded. It adds a professional look. Always sand linearly, not in circles.

- Clean and tack cloth the fresh wood. I use the vacuum cleaner to suck the sanding dust up out of the cracks and pores in the wood. It's remarkable how much comes out!
- Dilute into a clean glass jelly jar about a half jar of MinWax brand exterior Spar high gloss urethane. To that, add an equal amount of new clean mineral spirits. Mix well (stirred, not shaken).
- With a small fine brush, paint the wood surface. The fresh wood will soak up the thin urethane mixture like a sponge. This is, of course, the idea.
- Allow to dry 24 hours.
- Sand lightly (basically to remove high spots) with 400 grit paper.
- Vacuum clean.
- Repeat about 5 times to build up a thick coat. By this time the pores in the wood should be completely full; if not, you're not done with the diluted coats.
- Sand the last time with 400 grit paper to a matte finish.
- Here's where things have to be *really* clean. In a clean environment away from all dust, spray the wood with MinWax brand exterior Spar high gloss urethane straight from the spray can. A thin, smooth coat is fine.
- Allow to dry 24 hours.
- Carefully wet sand with 1200 grit paper. The kind used to 'block' or 'color sand' a new paint job is best. After all, that is what you are doing.
- I only use two coats of spray because finish is all that you are adding.
- Block again carefully, polish as if it were a new paint job. Buff if you have the courage. I do it by hand as a buffer in my hands is a license to screw up royally.
- Finish the job with a coat of Carnauba.
- Admire and drink beer.

Alastair Lauener provides an alternative method of stripping the wood: "I used a chemical called Nitromors, a paint stripper, water soluble, to strip off all the old varnish, and washed under cold water. I tested on an old spare dash first. Careful not to let the wood get too wet. Allow to dry out for a few days. Be careful not to scratch it."

'88-ON SKI SLOPE: Removal of the earlier metal ski slope was obvious, three screws. With the wooden ski slope, however, the screws are hidden. Matt Dillon reports: "In order to remove it, you need to take out the lighter and cruise switch. This gives you access to the bolt on each side that hold the ski slope in place."

John Keppler: "I would like to suggest an alternative approach. The cruise control switch and the cigar lighter are held in place with plastic tabs that are bevelled to snap on, but not to snap off. I don't believe you can reasonable expect to pry these fixtures off without breaking at least one of the four tabs on each (as I ended up breaking one of mine). I would suggest instead the the ashtrays be removed first. The bolts that secure the console lid are mounted horizontally with their heads pointed toward the car's center immediately next to the electrical fixtures. They hold the console with a vertical tab which has a slot that slips down over the bolt. The bolts only need to be loosened to remove the lid. Reach back through the ash tray openings in the lid with a 5/16" wrench to loosen the bolts. Once the lid is removed, you have a much better chance of removing the CC switch and cigar lighter without damage. Reinstall the ash trays, remove the electrical items, and reinstall the lid. Then the bolts are easily accessible for tightening, and the wiring is easy to reattach."

The wooden ski slope is notorious for cracking and peeling, perhaps because it gets more direct sunlight than the other wood in the interior. Dillon suggests a repair: "The ski slope is a piece of metal that has the wood veneer glued to it. I took a belt sander to it to remove the old veneer. I ordered the veneer from Constantines and re-applied it as per their instructions. The veneer was a little lighter than the rest of the wood, so I used a little stain to darken it up a little. I then

found an epoxy based clear coat to put a thick shiny finish on it. Much easier than applying coat after coat of varnish or polyurethane. This is a pour on finish and has held up very well so far. I did this about a year ago, so obviously I haven't been able to duplicate 8 years of having the sun cook it, but am hoping that it will last.

"I did go to the dealer to price a new one. They told me somewhere around \$250 and couldn't guarantee that it would come even close to matching the rest of the wood. The wood veneer from Constantines cost me about \$25 with the can of veneer glue to go with it. The epoxy coating was about \$10 more. Aside from being a whole lot cheaper, it allowed me to get the color very close." Constantines is on page 649.

"I called them and just asked them for a piece of their "premium" burl walnut veneer and gave them the measurements. I specified a piece much larger than what I actually needed just in case the edges were a little rough. They sent me 3 pieces. In order to make it fit, I used 2 of the pieces with the seam running straight down the middle. It wasn't obvious to me, but the original Jag piece also had a seam in the middle. The pieces are matched, so it looks really nice. The left side is a mirror image of the right side. There were a couple of knots in the veneer, but I liked that. They're very helpful, and I'm sure that if you send them a piece, they'll try to match it."

CONSOLE PANEL: For those of us who own an '83 XJ-S, removing the panel from the top of the console is easy and obvious -- there are three clearly visible screws. However, John S. Whitford has an '89 with one of those newfangled wood veneer panels, and apparently somebody decided that visible screws would be passé. "The cruise control switch and the cigar lighter can be pried out and that exposes a sheet metal bolt into the console wall locking down the lid on each side. Getting those out allowed me to raise the lid and slide it back some and there are two pegs on the front edge of the cover that fit under the radio-A/C cover."

ADHESIVES: If you're doing interior work, you need to know about adhesives. The following is from Timothy J. Hesse; "I am the product marketeer for the ITSD Industrial Aerosol Adhesives and I formerly was the product marketeer for Auto Trades Aerosol Adhesives."

"74 Foam Fast Adhesive is an excellent foam bonding adhesive which performs well up to about 120°F. Above that temp, the adhesive will soften, and with sufficient stress, you can pull the foam apart. It is possible to experience up to 150+ degrees in a closed car, and the seat part does see a fair amount of stress when a person is sitting on it.

"Another 3M product which is a good foam bonder and has 160° temp resistance is General Trim Adhesive, pn 08080, which is sold by the Automotive Trades Division. This would be a better product to try for seat bottoms.

"76 is a good product--but does *not* have very good plasticizer resistance. Vinyl material is typically loaded with plasticizing oils, and in time these plasticizers migrate from the vinyl to the adhesive, and they soften the adhesive to the point the adhesive becomes very soft and gummy and "lets go". 76 has 160°F temp resistance and would work on foam bonding, but vinyl bonding would not be a long term success.

"A better product for bonding vinyl is Super Trim Adhesive, pn 08090, also sold by Automotive Trades Division. Super Trim is a neoprene-based contact adhesive in an aerosol can. It has 200°F temp resistance, and is plasticizer resistant. In fact, Super Trim is very good for reattaching vinyl tops, vinyl trim, etc. in auto restoration projects."

HEADLINER: Apparently, if you don't want to have headliner trouble with an XJ-S, you'd better get a convertible! They all seem to fall down sooner or later, and the roof light is poorly placed to help keep the headliner off your head when it does.

The material used in a headliner is a fabric bonded to a thin layer of foam. The failure mode of headliners (not just Jaguar) is that the foam rots and falls apart. While it appears tempting to just find some way to glue it back up (and there are people who are willing to sell you products to "inject" glue in there with), the fix will not last; once the foam is shot, gluing it back together only makes it fall apart again above or below the glue layer.

The only real solution is a new headliner. Fortunately, this problem affects cars other than Jags, and a competent craftsman can usually be found locally to do this job well for a reasonable cost.

You will be given the choice of insisting on genuine Jaguar headliner fabric or just installing a generic material. You should have learned about British non-metallic materials by now; if not, let me point out that you are *replacing* a genuine Jaguar headliner! True, it appears that American headliners fall too, but it isn't any sooner than Jaguar ones. The only reason to get the original material is to match the color perfectly, but most of us aren't that picky about headliner colors.

While this is a good example of work best left to professionals, there are those who want to try doing it themselves. Frank Perrick says, "The trick is to buy only 3M spray adhesive and read the can. There is only one 3M adhesive recommended for this job. The wrong can will say 'not for head liners', and the first hot day you will be wearing your headliner. Headliner kits including fabric and clips are available at local auto parts stores." The correct stuff is Super Trim Adhesive #08090.

By the way, the headliner fabric in the XJ-S is bonded to a piece of stiff cardboard or fiberglass. It is somewhat of a challenge to get this thing out of the car; the Jaguar manual specifies removing the windshield! Apparently, that isn't really necessary; Rob Ward reports: "You need to get someone to support the other side while you turn it through 90 degrees. Moved the seats back and lowered the headrests, moved steering wheel fully in. Mine came out through passenger door no problems. (RHD)" Regardless of the methods attempted, everyone who's tried it agrees you will need at least two people.

Richard Dowling offers some guidance for fiberglass repair of that headliner structure: "I pulled the old headlining and used a fibreglass repair kit to beef up the crumbling edges of the moulded roof panel. That was a big mistake, because the rear edge of the moulded panel fits into a slit in the rear window seal. Now my panel is a bit thicker around the edges and perhaps 5mm longer. It pushes the new and pliable rear seal outwards even with the window in place. This has distorted the seal, although it does not leak. The problem is the distortion does not allow me to put the bright trim pieces back in."

FACIA: On the dashboard, just below the speedometer and tachometer on either side of the steering column, there is a panel covered with a fuzzy black fabric intended to be nonreflective to prevent glare on the gauges. This fabric tends to come apart after a few years' exposure to sunlight. To replace it, visit any shop that installs automobile headliners. These two pieces would qualify as scrap to them, you might even get it for free. Take the panels out, remove the old fabric and install the new with contact cement.

GLOVEBOX: The lining on the inside of the glovebox is -- you guessed it -- headliner material.

MOTORMOUSE SEAT BELTS: John S. Whitford relates his experience: "The passive restraint shoulder belt (that I hate), got stuck in the engaged position. I just unsnapped the belt and forgot about it. But it kept trying to return to the disengaged position and that eventually ran down the battery. When I connected the recharged battery back up, I heard it straining, and a little fiddling got it unstuck."

Sean Straw's motormouse seat belts went nuts. "I've noticed on more than one occasion the passenger side passive seatbelt decide that it wants to freak out as it is closing - it reaches the (upper) stop point, then backs off as much as a couple of inches, then reactivates to the stop point again. Back and forth. It'll do this as much as a dozen times (usually less) then stop and act normal. The same thing has occurred on the driver side perhaps twice. Less occasionally, the passenger seatbelt will not actuate until the driver side door has been closed. I can count the number of times this has happened in the past five months on two hands. This seatbelt weirdness only occurs when the vehicle is at a stand still, and just after I've inserted the key into the ignition -- it isn't as if I'm driving along and it freaks out."

Bob Morazes says, "I have a 92 VDP with the same bizzare seat belts."

John Wynne says, "I had a similar situation with my seat belts. Only the driver's side was affected, but not only did it joggle the belt back and forth, it would also trigger the door open buzzer and activate the interior lights. The first time it happened was late at night during a heavy rain storm and it scared the hell out of me. Lights coming on and buzzers going off are not an expected event on the highway."

"It was only occurring during and after heavy rains so I unwisely ignored it for a while, until the day the belt started to move into its open door position and suddenly changed directions pinning me so hard into my seat that I thought it was going to dislocate my shoulder. The retractable portion of the seat belt located to the rear and right of the drivers seat had finally siezed from all the erratic passive belt movement. I was surprised to find that the belt motor had that much force to pin me into the set like that. To top it off I was going about 45 mph into a pretty sharp turn. Talk about panic!"

"Basically, what I'm trying to say is don't be dumb like me and let it act weird until a mishap like mine. I was really upset with myself when I found that the cause of all the mayhem was the driver's side door plunger. You know, the one that activates the open door buzzer, turns on interior lights and causes the seat belt to retract. I can't believe the symptoms were so obvious and I ignored it for almost a month."

"It might be one location for you to check out before digging under the dash or inside the track mechanism. The way I tested mine since things seemed fine with a multimeter, was to tape a quarter to the metal plate on the door which contacts the door plunger. This forced the plunger to seat a little further and eliminated the problems. A local parts store had a suitable replacement for about \$2."

The good news: According to John Alexander, since the motormouse seat belts are supposed to be a substitute for air bags, they are "warranted for life in US -- had mouse motor repaired and car washed gratis by my dealer."

Morazes agreed. "My Jag dealer replaced them for free. Yes, I said *free*. Its not every day that you get a free trip through the dealership."

Charles Maraia wasn't happy with the warranty: "I took my '88 to the dealer and they said the motor is warranted, but nbo the other parts. Well, guess what? They found fault with all the switches and on. Cost me over \$100 to fix a warranted item. And I still pull the fuse! That won't happen again."

Maraia may have been ripped off, but it doesn't always happen. Ned Wesley says, "I took my '88 in to purchase the seat belt assemblies and was told move the car in line for service. The service manager attempted to operate the belts. When they would not operate, the entire system was replaced at no cost to me. The right and left side seat belts had an invoice of \$1,900 for parts and labor. I believe that the motors are invoiced at \$500 U.S. each."

REAR SEAT SHOULDER HARNESSSES: The 1983 XJ-S doesn't have rear seat shoulder harnesses, it has lap belts only. However, it has the *mounts* for shoulder harnesses, hidden behind the rear quarter upper trim pad. Since studies have indicated that wearing a lap belt only in a rear seat is *more* dangerous than using no restraint at all, those who actually have occupants in the back seat might want to consider adding shoulder straps.

MORE WOOD: Since more is obviously better, the tasteful touches of burl wood in the interior of the XJ-S can be supplemented with other panels ad nauseum. The '88-on wood veneer ski slope reportedly will *not* fit the earlier cars -- the console itself was changed at the same time; however, Autostyle Ltd (page 664) can provide wood veneer ski slopes to fit any XJ-S. They also offer burl wood panels to replace the radio facia, the little panels around the headlight switch and ignition switch, and the panel surrounding the gauges within the dash, as well as burl wood shifter knobs.

DOOR SILLS: The '88-on metal door sills are a *lot* more impressive than the earlier plastic items. There's no reason they shouldn't fit the earlier cars, although there are no reports as of yet of anyone actually retrofitting.

While the plastic sills were one-piece, the metal sills have separate finishing caps at both ends and a series of clips underneath. Richard Mansell provides a parts list: "The part numbers for the coupe are:

Tread plate LH	BDC 4643
Finisher end	BDC 9742 (RH front, LH rear, 2 required)
Finisher end	BDC 9743 (LH front, RH rear, 2 required)
Clip for tread plate	BBC 9853 (total of 10 required)"

Note that the sills for the convertibles are different. On the other hand, one might presume that the H&E convertible probably uses the same sills as the coupe.

Mansell also reports that there are aftermarket firms in the UK offering metal sills.

CUP HOLDERS: The XJ-S doesn't have one! What a cheap car. Gary Penovich says, "I definitely needed a cupholder in NYC. How else was I gonna drink, drive, and give somebody the finger at the same time?"

There are lots of cheapie drink holders available; a visit to any truck stop or auto parts store should reveal a wide selection. For something a little nicer, Dave Osborne suggests you check out

<http://info@drinkholders.com/>

They offer a nice drink holder that mounts on either a vertical or horizontal surface, adjusts to hold any size cup securely, and folds out of the way when not in use. There are pictures of some of the upholstered single drink holders installed in Jaguars, but forget about the Jaguar page and look at the Land Rover page instead. There you can see pictures of single and double drink holders finished in burl.

One place to consider installing a foldable drink holder might be the inside surface of the glovebox door. On the '83, the glovebox door has a pop-up mirror on one side and nothing on the other, so you could install a drink holder on -- or in -- that other side. But if it's a surface-mount, you might even mount it on the pop-up mirror.

One of the best ideas is to refab the ski slope with simple recessed cup-shaped cup holders where the ashtrays are. Suitable cupholders are available at marine stores, since apparently it's common practice to cut holes in your boat and slap one in. You need to be careful to find one of a suitable depth, but there's one at

<http://www.marineeast.com>

that appears to be about right.

Your only problem then will be: whattaya do for ashtrays? But this is a much easier problem, since ashtrays can be installed in vertical surfaces -- such as the door panels. It should be easy enough to find suitable ashtrays in any junkyard. There are even ashtrays sold at

<http://www.westmarine.com>

that are designed to fit into a cupholder! Of course, if you're a nonsmoker you can just forget it.

CLIMATE CONTROL

PERFORMANCE CHECK: On max cool, this system should provide air at the center vent in the dash in the upper 30's F. Steve S says, "My '85 XJ-S with R12 achieved 35°F at the vents, at idle, doors open, fan auto, max cool on a UK 70°F day after I'd topped it off in July of this year."

If your car ain't getting that cold, it ain't working right. There are a few things to check. First and foremost, while the system is trying as hard as it can to cool, check the sight glass at the receiver/dryer along the front edge of the radiator upper support rail. There should be *no* bubbles visible in the glass -- zero, zip, nada. If there are *any* bubbles, the freon circuit is undercharged. See page 474.

If the charge is OK, other things to look at include the adjustment of the linkages on the Delanair MkII system (see page 494) and checking for leakage through the heater valve when closed (see page 459).

SYSTEM TYPES: From the inception of the Jaguar XJ-S until 1987, a climate control system known as the Delanair MkII was used. In 1987, the Delanair MkIII was introduced, and continued in use until the XJ-S ceased production. The housing within the dash was a sheet metal assembly painted gloss black in the MkII, while the MkIII is largely plastic. The MkII is controlled by a single servo assembly via a conglomeration of linkages within the right side of the console, while the MkIII uses multiple local servos and controls. Both systems underwent several detail changes over their production lives.

The compressor and freon circuit is essentially common to both systems, as are a few other things. Within the dash, however, the two systems are totally different. So, the climate control tips are divided into three sections: Things that are common to all systems, things that pertain to the MkII only, and things that pertain to the MkIII only.

Was there a MkI? Yes, but it was used in SI XJ6 and XJ12 saloons only; it had been superceded by the MkII prior to the introduction of the XJ-S. Hence, it will not be addressed in this book. Mike Morrin says, "The MkI system did not have an electronic amplifier and servo, and relied on a thermostatic bellows controlling a set of vacuum valves for temperature and air flow control." It also had considerably less cooling capacity.

The 1995-on XJ12's, which are based on the X300 body, use the climate control system that was introduced with that body. It's not Delanair. Obviously, it likewise is not covered in this book. It has an electrically-operated heater control valve, as opposed to the vacuum-operated valve used in the XJ-S. It also features an electric pump in the heater line.

POLLEN FILTERS: Richard Mansell reports: "If you are interested you can get pollen filters for the ventilation system. I have no idea how or where you fit them but according to a Jaguar accessories brochure from 1997 three are available:

93.5-96	JLM11696
92-93	JLM11355
Pre-92	JLM11108

One might expect that these pollen filters would only fit the Delanair MkIII system, so that "Pre-92" probably really means 87-92. If you have an older car, at least ask first before spending the money.

Common Features

WINDSHIELD FOGGING: If your windshield fogs up more than it should, the first thing to do is determine if the fogging is on the inside or the outside -- wipe your finger on it, or turn on the wipers. If it's on the outside, the problem is that your air conditioner is pumping very cold air through the defroster vents, chilling the glass and causing condensation on the outside. There are two common causes for this malady:

First, the flap that is supposed to close off the defroster vents is not closing properly, or the sealing foam on the surface of the vent has rotted away. In the MkII system in the XJ-S, the flap is operated by a vacuum capsule immediately to the right of the center facia vent, but it's really difficult to get to without pulling the dash (note that the MkII system in the saloon is different in this respect, having a vacuum capsule on each side). The flap itself is basically impossible to work on without a total disassembly of the dash, including purging the freon system and pulling out the entire A/C assembly. Sometimes the problem is the hinge the flap moves on, a cheap plastic item that should be replaced with something more substantial if you ever have the opportunity.

Fortunately, the second cause is more common (on the MkII, anyway): the linkage controlling the entire A/C system is misadjusted, causing the air coming through the upper half of the system to be colder than it should be. Readjust the control linkage as described on page 494.

If the fog is on the inside of the windshield, it is usually due to one of two causes: either the condensate drains are plugged up causing the system to fill with water, or the heater core has sprung a leak. To determine which, John Shuck sends this tip: "This sounds crude, but wet your finger and touch the window. Taste your finger now. If it tastes sweet, that's antifreeze that's coming from guess where....heater core."

CONDENSATE DRAINS: All air conditioning systems must have a condensate drain to drain the water that condenses when the air is cooled. The XJ-S has two -- small plastic tubes protruding downward and ending well above the exhaust system on either side of the transmission. When working properly, these tubes will be dripping water on the exhaust pipes during muggy weather. However, when the lines plug up, the water fills up inside the A/C system, causing wet spots on the carpet, reduced airflow, etc. It will sometimes dump water on the driver's or passenger's feet when cornering. It also appears to be the culprit in a strong tendency to fog up the windshield immediately upon starting the car after it was recently shut off.

From under the car, run a piece of stiff wire up through each of the tubes until it goes all the way into the A/C unit. Compressed air might also work. Since Jaguar made these tubes entirely too small (they are twice this diameter on most cars) they get plugged easily and need to be opened up regularly.

If your drains are plugged beyond this simple repair, Hunt Dabney provides a description of more serious work: "Remove the side panels from either side of the transmission tunnel (the ones that have the vents in them). On the left side, if you look at the front-most 'corner', all the way to the left when viewed from the side, you should see a rubber reducing nipple attached to the lower portion of the compartment containing the A/C coils. This has a piece of 3/8" poly tubing protruding from the bottom, down and through a grommet which passes through the top of the transmission tunnel. This one is easy to get to and remove. To replace, use new hose clamps, and possibly silicone seal if the grommet has problems (or a new grommet).

"Above this point is a duct, about 4" in diameter and which extends under the dash from the heater a/c unit to the left side dash vents. By rotating the end a bit cew, it may be withdrawn from the heater box. This will allow you to look in the box and inspect for dust and debris. Clean out through here if you can.

"The right side is very similar, but the A/C servo linkages may get in the way and require removal. In fact, it may be necessary to remove the servo unit. Getting in through the duct, as previously described, is workable, but you have to remove the glove box."

According to Larry Lee, the drains may be getting plugged with bits of the foam insulation used in the system; being British non-metallic material, it rots and falls into the drains. The insulation itself is not worth replacing unless you're doing other major work, because it requires tearing the dash and A/C system apart.

Note that Technical Service Bulletin #8218 describes a problem with the condensate drains after the airbags were introduced in 1989 and up to VIN 165565. Apparently a revision of the A/C system was necessary, and as a result

excess sealant on the drain separator plate may plug the drains. After VIN 165565, the sealing was omitted. Later, after VIN 168340, an additional hole was provided in the separator plate.

PLUGGED CONDENSATE DRAINS -- PREVENTING SECONDARY DAMAGE: Hunt Dabney says, "Last time the drain tubes clogged up on mine, it dumped quite a bit of water over the servo and ruined the feedback pot. I made a mylar shield to prevent this from happening again. I took a sheet of 6mil mylar (used to use for PC board layout before CAD), cut it so that it would fold over the servo assy from the mounting surface side, with tabs folding over the corners and openings where required to clear the operating levers, cable and tubing. Then, crease the folds, install over the servo and reinstall the servo cover. I cut an opening where the foam "friction" piece that pads between the servo and the mounting surface go, so that it would not slide due to the mylar."

See also the note on the official Jaguar protection for the stereo on page 614.

HEATER CONTROL VALVE: The Jaguar heater control valve is a vacuum-operated pot metal contraption located in the dead center of the firewall, under the rear loop of the fuel rail. It consists of a metal cylinder with a hole through it within a ported housing; the cylinder is rotated to align the hole with the ports to allow flow, and rotated so the ports face the blank sides of the cylinder for shutoff. This valve is expensive, difficult to get at, and prone to corrosion and seizing.

Note that a heater valve should provide a total 100% shutoff of water when vacuum is applied; if it is leaking when closed, even slightly, it introduces quite a lot of heat into the climate control system when it is supposed to be in full cool mode. While the supply air from the vents may still seem cool thanks to the operation of the flaps bypassing the heater core, the system won't work as efficiently as it should. When in doubt, test it; connect the valve to a 5/8" garden hose with a hose clamp, turn on the water faucet, and suck on the vacuum line with your mouth. If the flow doesn't completely shut off, you need a new valve.

It's a fairly simple matter to remove the intake manifold crossover pipe, and doing so may provide vastly improved access. On the '83 XJ-S, the mount bracket is held to the firewall with two bolts that thread into nuts welded onto the firewall. However, Michael Bain reports that some models use nylon nuts within the wiper motor area. In this case, it may be easier to remove the intake grille/wiper motor assembly and unbolt the heater control valve from the back side, but if the nuts aren't nylon you won't get anywhere going that route.

Do not simply eliminate the valve and plug the hoses. The hot water supply is necessary for proper operation of the climate control system, even when it's in cooling mode. A temperature sensor in the heater core will limit the blower operation if the water isn't warm enough.

When the Jaguar valve causes problems, whatever you do, don't replace it with another valve just like it! That metal thing is junk. A better option is to go into an auto parts store and ask for a heater valve for a Jaguar. Some stores may stock the original, but most places -- notably the cheaper places -- will hand you a generic heater valve such as one made by Factory Air, part no. 74803. This valve is made almost entirely of plastic, and costs only about \$10. Although some people don't like plastic, the design of this valve is so superior that it is undoubtedly the most reliable choice. This is a domed poppet valve rather than a rotating-cylinder valve, so the reliability of a total shutoff when closed is much better. Discount Auto Parts and Pep Boys sell this valve, and they always seem to have it in stock.

Note that any vacuum-operated heater valve with 5/8" fittings that is open when there is no vacuum applied will work. This valve does not throttle; it is strictly on or off, and the temperature modulation is controlled with flaps inside the car.

Note that the vacuum hose in the XJ-S is 1/8" while the connection on the Factory Air valve is 1/4". You will probably not want to try to stretch a 1/8" vacuum hose over a 1/4" connection, so plan accordingly and buy an adaptor and a short piece of 1/4" vacuum hose while you're in the store.

Also note that the plastic valve is so lightweight there is no need to mount it; it can be merely suspended in the hoses. Take advantage of this fact and relocate it towards the passenger's side of the engine compartment rather than trying to put it anywhere near where the original was. This will require some 5/8" heater hose and clamps, and perhaps a "hose repair kit" for joining two hoses together, so pick all this stuff up while you're at the store as well. Note that, in addition

to straight 5/8" heater hose, most auto parts stores have a large selection of "molded hoses", 5/8" hoses with sharp bends and curves formed in them. You might consider choosing a couple of these and using them to make your heater valve relocation look more professional.

Getting to the OEM valve is a pain -- so Peyton Gill came up with another idea: abandon it in place. As long as it doesn't leak externally (they usually don't) and it's not stuck shut (they usually aren't) then simply disconnect the vacuum line (leaving it open all the time), cut the heater hose somewhere over near the right side, install a new valve, and connect the vacuum line to it.

BLOWER FANS: The XJ-S uses two fans, one on each side. Therefore, there is one more failure mode possible than on other cars. If your A/C is putting out cold air but doesn't seem able to cool the car, check that both fans are working. If one runs and the other doesn't, the system appears to be working but capacity is severely reduced. Since both fans feed a common plenum, failure of one fan reduces airflow at all outlets but does not affect one outlet more than another. When both fans are working, airflow is quite forceful indeed at high speed, and cooling should be more than adequate.

The blower assemblies are different between the earlier system and the Delanaire MkIII, but they are similar enough that the discussions in the next few paragraphs apply to either.

BLOWER MOTORS DISCONNECTED: The wires to the blower motors go through a grommet into the blower housing and then attach to the motor itself with spade connectors. Duncan Smith had troubles here: "The +12V spade connector had detached from the post on the motor due to the wiring harness being too tight. Fix: unbind the harness, pull the connector through further until there was a bit of slack and rebind."

BLOWER FANS - REMOVAL: The blower housings are outboard toward either side of the car and connected to the center core with flexible rubber ducts. To remove each blower assembly requires removal of the underscuttle cover, fusebox, a couple wires, one vacuum line and two bolts.

In the Jaguar repair manual, one step in removing the blowers is to open the recirculation door and block it open. The next step listed is to remove the bolts holding the blower in. Please do not infer from this sequence that the blower retaining bolts are within the recirculation door; the door must be blocked open simply because it is linked to the outdoor air intake, which must be closed to prevent hanging up while the fan is being removed. The blower retaining bolts are on the outside of the housing and are obvious. Both steps are necessary but unrelated.

Duncan Smith says, "Clothes pegs are perfect for holding the lower door open."

BLOWER FANS - MAINTENANCE & REPAIR: Take the blower assembly out (it's easy), then take it apart to get the blower out (also easy) and remove the impeller from the motor shaft. Look at the motor and see if there's any obvious damage, like wires hanging out, burnt windings, foreign object damage, etc.

The blower motors are not overhaulable. The motor itself is held together by peening over some tangs, and reassembling would be difficult. However, it is possible to repair many problems the motor might encounter.

Since the British engineers saw fit to make these completely open motors exposed to whatever dust and debris comes through the ventilation system, it may be helpful to remove lint and foreign objects from the inner workings of the motors.

Since the bearings are exposed as well, some fresh lubrication will be welcome, but don't over-oil the rear bearing; excess oil may find its way onto the commutator, gumming up the works. Use a light machine oil, like sewing machine oil.

If the motor looks OK but is seized, force it -- whattaya got to lose?

Remove the C-clip from the shaft, and remove the stack of washers against the front bearing; be sure to keep track of the washers and the order they are installed in. Turn the shaft and observe the front bearing, which should remain motionless within the housing. If the bearing turns with the shaft, a positive anti-rotation modification is called for. One method is to drill a hole through the steel housing and into the bronze bearing and install a tiny self-tapping screw. Make sure the tip of the screw doesn't contact the shaft itself, and that the head doesn't interfere with the C-clip and washers.

Pull the little covers off the brushes and remove them. If they are too short, replace them; don't bother trying to find original Jaguar brushes, just find some slightly larger at a motor or vacuum cleaner shop and file them down to size.

While the brushes are out, use a VOM to check the continuity at the segments of the commutator. There should be some form of continuity between any two segments you test. If you find a segment that doesn't seem to connect to anything, you're in trouble. If you can see why (a winding disconnected or some such) you can decide for yourself if it's possible to fix. Don't use any solder, it won't take the heat, connections must be made mechanically or by tack welding.

If you're like me, you'll grind a small flat on the shaft for the setscrew in the impeller. I just don't like setscrews on a plain shaft.

Before reassembly, inspect the condition of the three rubber mounts. If they are dry and hard or crumbling, renew or fashion suitable replacements from grommets, hose, whatever.

If your blower fans are toast, Vicarage (see page 654) carries replacements at reasonable prices.

BLOWER FANS - REINSTALLATION: The rubber duct may be a neat feature, but it can be a real pain to reinstall. To make life easier, attach the duct securely to the blower assembly before installation. I suggest the use of aluminum tape.

VACUUM: The control system relies on a supply of vacuum from the engine, and stored in a reservoir. As Tom Wagner discovered, it pays to make sure the supply is working before troubleshooting the rest of the control system. There is a check valve in the line to allow the reservoir to hold vacuum when the throttle is opened, and this check valve stuck shut -- preventing either the reservoir or the control system from getting any vacuum.

VACUUM CHECK VALVE: One might expect that the normal failure of the vacuum check valve is that it fails open, but Mike Morrin had the opposite problem. "My A/C system has always had marginal performance of the vacuum actuators, with the heater valve (new) and centre vent flaps always slow to operate. I got tired of the centre vent taking 5 to 20 minutes to open.

"Tonight I decided to check the vacuum non-return valve, which seemed to be working. While trying to decide what to do next, I was sucking on the non-return valve, and it occurred to me that I was sucking rather hard before any air got through.

"On impulse I tried to pull the valve apart to see what was inside, but it was too tight (or glued together). I then poked a piece of steel wire in the end where the air goes in, and there was a small click. That must have been the rubber thingy unsticking from its seat, because the valve is now much easier to suck through (but only one way). After refitting, all the vacuum actuators are now working like clockwork.

"That is the easiest repair this week.

"The XJ-S help book mentions that these valves sometimes block up completely, but this was only partial, and seems to have been fixed by a poke in the eye with a blunt stick."

CENTER VENT: The center dash vent on most XJ-S's has three sections: a section on the left and right ends that can be adjusted to aim where desired, and a center section with no adjustability that simply blows straight rearward. Here in

Florida where the weather is both hot *and* humid, this center portion can blow enough cold air straight back to cause the rear windshield to fog up -- which is a real pain, because the rear window defroster has a timer and won't stay on indefinitely, you have to keep turning it on and off to maintain visibility in the mirror! Those who don't have fogging problems still dislike that center vent blowing air to the rear, since only sadists ask anyone to actually sit in that rear seat.

Peter Cohen confesses, "Over the years, I have developed the unconscious habit of driving with my elbow resting on the console, arm up, and my hand positioned as a diverter to direct the cool air toward me."

Emile A. Des Roches suggests two possible fixes: "The Cheap Solution -- Lift off the surrounding wood (gently); the plastic vent will come out with gentle even pressure. Cut a piece of relatively stiff black cardboard to the height of the inside (towards inside of dash) vent and to a width roughly 2" narrower than the width of the center vent. Place same (black side facing cockpit) in the vent and reassemble. This solution performs the same function as resting one's hand in the air to divert air towards the driver and is far more sanitary."

This author made a similar modification to his center vent, except he used black plastic instead of cardboard and shaped it into a V so it would more definitely deflect the air to the sides. Using the simple flat piece may cause more blockage rather than deflection -- which may be desirable since it would result in more air flowing out all the other vents.

To all this, Franck Guilloteau adds: "While my car is an '85, the wood trim is in immaculate condition and I found that after several unsuccessful tries it wasn't worth the risk of breaking or chipping the trim. I resorted to an alternative method of removing the two directional vents of the main center vent. A small screwdriver, X-acto blade and minimum dexterity will do the job in five minutes. Directional vents have a small leaf spring that increase the friction and hold them in place; it can be pushed out prior to removing the vent. These openings allowed me to slide black cardboard (or plexiglass covered with black felt in my case) and wedge it in place from behind. All told a really "cool" mod."

Des Roches continues: "The More Problematic Solution -- Replace the center vent with one from a very late XJS. At some point after 1993, the center vent design with moveable vanes at the edges and fixed vents at center was replaced with a design that consists of two (no space between) adjustable vents. This is a direct (no trimming) replacement for the earlier unit which presumably could be obtained from either Jaguar spares or a wrecking yard." Dean Gosselin adds that the part no. is BEC-26361.

Dan Jensen adds, "I changed out the center vent on my XJ-S... It makes a dramatic difference in the amount of cold air that can be directed over the driver and/or passenger. I would offer one additional note to the installation instructions. While the replacement vent has the same width and height as the original in my car, it was approximately 1/8 in. deeper. The extra depth resulted in the vent face extending out a comparable distance from the metal dashboard and prevented the wood fascia from sitting firmly against the dash. As a result, I had to get out a wood rasp and file off 1/8 in. around the inner perimeter of the vent. This took about 15-20 minutes, including the time needed to get all the little specs of plastic off the louvers when I was finished. In addition, it was necessary to file two small central notches in the metal dash to accommodate two added bulges in the new vent. This took no more than a minute or two with small round file."

Samuel Louw provides an incredibly detailed description of this job, in response to the concerns that many people had about damaging their wood trim: "It is really simple and you don't have to be an engineering genius to be able to do this. The most scary part is actually to remove the wooden center fascia, since this holds the vent in its place. It really sits tight. There are four metal springloaded pins that are attached to the backside of the fascia and are pushed into four holes which are in the metal dash plate behind the nice wooden fascia. When the fascia is replaced, the four metal pins are pushed into their holes and the springloaded clips are compressed, not in the direction of the pushing action but by the sides of the holes, since the clips are V-shaped. Now when you want to remove the fascia, you first have to overcome this spring action. Since you think the fascia is waferthin and will break, you might want to give up, but that piece of wooden fascia is almost 8mm thick in places. You have to open the glove compartment and slide the blade of typically a steel table knife underneath the fascia. Then you must start wedging it away from the dash. The right side steel pins are app 5mm away from the top and bottom of the fascia and app 35mm in from the glove box side from where you will be wedging. The left side bottom pin is also app 35mm from side, but the top pin is app 70mm from the side and in the area where the fascia is only about 13mm wide. Be careful of breaking the wood there. I hope that by knowing beforehand how things look at the back it will make you more comfortable to do the job."

"The new vent has four small plastic flanges with holes in it, two per side along the two long horizontal sides of the vent. The flanges are about 10mm x 10mm. They have to be removed, since the pre-'93 cars do not have holes through

which the vent is fixed in position. This is definitely not needed, since the vent is held in position by the center piece of wooden facia, and that really sits tight. So, you have to remove those flanges (can be broken off carefully with normal pair of pliers) and then just file the leftover away.

"The other small job is also due to a small difference on the new vent, but again, this is small and easy to do. The new vent has two small D-shaped bulges on both sides. This will most probably interfere with the metal plate of the dash where you have to push in the vent. Just mark the position of those bulges and file away the notches in the metal plate (About 5mm wide and 3mm deep and halfround shape; use small round file).

"I did not notice the problem of the new vent being deeper than the original, as was noted by Dan Jensen. Thus I did not have to do that filing to make it less deep. My new vent pushed in all the way until it settled against the rectangular sponge seal and there was no interference with the wooden fascia due to a bit of vent protruding. If you do find this problem, just file away the required amount from the rear of the vent.

"The correct Jaguar part no for the new vent is BEC26361. Do remember to buy the new foam seal as well. You are not likely to save the old seal, as it will have rotted and deformed.

"You will have complete control over the direction of air flow both up and down and to the sides. If you live in an area with hot weather as I do, it is essential. You won't believe the difference."

AIR CONDITIONER COMPRESSOR: Up through 1992, the Jaguar A/C compressor was labelled "Harrison" but was in fact the standard GM item referred to as an A-6 -- and therefore comparatively cheap to replace. In fact, it is generally recommended to simply replace the compressor rather than attempt even the simplest repairs. After a few years, the O-rings start to fail, and each time you correct a leak you must have the system evacuated and recharged. With the current regulations on R-12 refrigerant, the cost of a single charge can exceed the cost of the compressor. If you are having the system recharged anyway and the compressor is more than seven or eight years old, it might be wise to simply replace it even when it is still working fine.

Although you can find an A-6 compressor *really* cheap, Randy Wilson says, "The compressors should be good for *many* years. Continuous failures are not the fault of them being rebuilt units. It's the fault of them being cheap quasi-rebuilt units. This is a fairly major problem we fight in the auto industry. I can buy these A-6 compressors from a local distributor for \$49 per unit in very small lots... with no core return. These units, I can tell you from experience, have an average life expectancy of around a month. Many fail the first day. I have found a rebuilt compressor that I like. It's a *lot* more expensive. But I haven't had one of them fail yet."

James Teston describes a quality rebuilt compressor: "There should have been a nitrogen charge under pressure in the compressor that gave off a distinctive hiss when you loosened the cover plate. This is to prove to the installer that the unit is 100% leak proof. Kind of like the tin vacuum safety lid on grocery jars in reverse."

Before selecting a rebuilt compressor, read about the clutch below.

The threads on the replacement compressor are likely to differ from the original, in which case you will have to replace the mounting bolts. In particular, the two mounting bolts at the bottom rear and the long bolt that holds the inlet and outlet connections in place are 10mm on the OEM compressor and may have to be replaced with 3/8" bolts (either fine or coarse, they vary) when installing a replacement. 3/8" is only slightly smaller than 10mm, so sleeving will not be necessary. Also, the small front mounting bolts are 8mm x 1.0 (metric fine thread) and may have to be replaced with 5/16".

Aggravating the thread situation is the fact that rebuilt compressors tend to be delivered with the threads all boogered up, and covered with paint besides. This makes it difficult to tell which thread it is, since *no* bolt wants to thread into it. It's no fun getting to these bolts when they're down in the vee, so you're advised to determine what threads they are while the compressor is on the bench and to chase the threads with a tap so the bolts go in easily.

The new A-6 compressor also may not fit the protection switch that was in the original compressor. Read the section on the COMPRESSOR PROTECTION CIRCUIT on page 468.

The A-6 compressor is supposed to have a pressure relief valve screwed into the back end. If the rebuilt you get happens to have a plug in its place, transfer the pressure relief valve over from the old compressor. If the thread isn't right, Peter Havas suggests you just swap out the entire rear plate of the compressor! The XJ-S has a history of problems getting enough air through the condenser/radiator to keep the high side pressures down, so this is one car that really needs to have that pressure relief valve in place.

From 1993 on, a Sanden compressor was used. While many may bemoan the discontinuation of the excellent A-6, the Sanden likewise has an excellent reputation among A/C mechanics. Note that fitting a Sanden to an earlier car would probably require replacing the hood as well; the later hoods have a different shape primarily to accommodate the AJ6 engine, but they allow room for a larger diameter compressor on the V12 as well.

COMPRESSOR CLUTCH: The assembly built onto the nose of the compressor is the clutch, the system that engages or disengages the drive as the climate control system calls for cooling. When disengaged, the compressor is nothing more than an idler pulley. When engaged, the drive plate on the very front of the compressor is turning with the pulley, making it very easy to visually confirm operation. If the engine is not running, you can still confirm operation; when the clutch is disengaged, you can turn the drive plate fairly easily, turning the compressor. When engaged, you can't turn the compressor by hand because it's locked to the belt drive, you'd have to turn the engine.

The clutch is magnetic. Under the pulley is a coil that is energized when engagement is called for. This magnetizes the pulley. The drive plate contains a rubber isolator to absorb vibration and also features three straps riveted at one end to the rubber isolator and at the other end to the clutch face plate itself. These three straps can flex to allow the face plate to move forward and aft fairly freely, but they're springy and tend to pull it forward away from the pulley. The magnetism pulls this face plate against the front surface of the pulley, engaging the drive. This is a steel-against-steel friction drive.

The clutch is serviceable separately from the compressor. A replacement clutch can be purchased from local auto parts stores, and the old clutch removed and the replacement installed. This does not involve disturbing the freon circuit.

A replacement clutch may include the drive plate, the pulley, and the coil, or it may include just the first two items; if you need a coil, you should ask. Note that the A-6 compressor has been used on *lots* of different automobiles (not to mention road graders, agricultural machines, you name it) but there were several different pulley arrangements involved. Since the replacement clutch includes the pulley, you'll need to find the correct type. It's still very common, since it was used on several GM cars; the computer terminals in the auto parts store should bring up the correct item.

You can buy a new clutch, or you can buy a "rebuilt" clutch. A clutch having been rebuilt *should* mean at least four things: First, the steel-against-steel friction surfaces on the drive plate and the pulley have been machined to render them flat and new-looking again. Second, the rubber in the drive plate has been replaced; the rubber is bonded to the hub of the drive plate on one side and to a flat steel disk on the other, much the way a motor mount is made. Third, the pulley should have a new bearing in it. Finally, if it comes with a new coil, presumably that has new windings inside.

Why am I telling you all this? Because apparently you need to know. A properly rebuilt clutch costs as much as some of the rebuilt compressors discussed above. When buying a rebuilt compressor, you apparently can get any of at least four different treatments of the clutch on that compressor. One option is that you can buy a rebuilt compressor without a clutch, apparently so you can install your own. This is probably for mechanics who want to make sure the clutch is good and installed properly; it's not likely anyone would opt to reuse their old clutch with a compressor replacement. Second, you can get a rebuilt compressor with a rebuilt clutch. Third, you can get a rebuilt compressor with a new clutch. And, finally, believe it or not, you can get a rebuilt compressor with a non-rebuilt clutch!

Yes, that last option is totally unacceptable. You can easily tell what's up with the rebuilt compressor someone is trying to foist upon you. First off, you can look carefully into the gap between the plate and the pulley and see if the surfaces appear to be freshly machined. Second, you can look at the layer of rubber built into the drive plate. It'll be coated with new black paint, but don't let that fool you. If it's new, the rubber will be a neat shape with clean edges. If it's an old part with fresh paint, the rubber may be distorted, bulging on the sides, maybe even cracked. Send that compressor back, and don't consider any other compressors from that rebuilders.

The incidence of rebuilt compressors with non-rebuilt clutches may explain a couple of the other options available. Getting a compressor without a clutch enables the mechanic to install one himself, so he knows what parts were going in. Getting a rebuilt compressor with a *new* clutch is perhaps a response to mechanics getting rebuilt compressors and having the clutches fail shortly thereafter; it's possible that a rebuilt clutch would have been just as good, but they didn't realize the clutch on the compressor they were installing had not been rebuilt, so they conclude that a rebuilt clutch is unacceptable.

Of course, it's also possible that rebuilt clutches *are* unacceptable -- or, more likely, *some* rebuilt clutches are unacceptable; perhaps some rebuilders don't bond rubber to metal well or use weak rubber or some such.

BELT WIDTH: Automotive V-belts are commonly available in two different widths. The narrower belts, often used on alternators and the like, are about 10mm wide and the edges of the matching grooves will be 10mm apart. The wider belt, typically used to drive A/C compressors and other heavy loads, is 13mm wide. In modern parlance, the part number of a 10mm belt will usually have a 15 in it somewhere, while a 13mm belt will have a 17. I hope that makes perfect sense to you.

The other three digits are the length in tenths of an inch. So, a 58-1/2" belt 10mm wide is a 58515 from some makers, a 15585 from others. A 58517 or 17585 is the same length but a 13mm belt.

If you're fiddling around with accessory drives, the crank pulley on the XJ-S has grooves designed to work with either width belt. A 10mm belt will sit deeper in the groove, so the crank pulley effectively becomes a smaller diameter pulley -- moving the 10mm belt slower than a 13mm belt would move in the same groove.

COMPRESSOR CLUTCH REMOVAL AND REFIT: The SIII XJ6 ROM includes instructions on replacing the clutch and so does the 4-volume XJ-S Service Manual. However, the author's XJ-S ROM does not and neither does the Haynes. Since these are the manuals most owners are likely to be relying upon, instructions are provided here. Of course, these are presented differently than those in the Service Manual.

A warning, though: this is commonly regarded as a difficult task with considerable risk of failure. There are many people with experience at this job thanks to this being a GM product, and you might be wise to seek out such an experienced person rather than try this yourself.

First off, the Service Manual says you need to discharge the freon and remove the compressor to the bench. False -- although you may need to unbolt the compressor from the engine to move it around a little.

To R&R the clutch you will need two special tools: a puller to get the drive plate off, and an installer to put it back on. Four Seasons and Factory Air both offer such tools with numbers 59509 (puller) and 59502 (installer), while Discount Auto Parts offers Cool-Aid! tools 34460 (puller) and 34461 (installer). The tools are around twenty bucks each; the installer is a bit more expensive since it includes a ball bearing. Both tools are also commonly included in collections of automotive air conditioning tools, some of which use a couple of generic tools with lots of different attachments to adapt to various types of compressor.

Some auto parts stores will rent or loan these tools to you for free. Or, maybe not. AutoZone includes the puller in its collection of rental tools, but not the installer. They refer to the puller as their rental tool number 27002.

If you don't have the puller, it might help to know that the internal threads the puller screws into are 7/8" x 14 TPI, which is the same as a 1/2" NPT except for the taper. Hence, you can screw a piece of pipe into this hole. If the pipe hits bottom before the tapered threads tighten up, cut a bit off the end of the threads. At this point, you may be tempted to attach a slide hammer or other apparatus for yanking, but note that the Service Manual includes warnings that applying loads to the shaft can cause damage inside the compressor. The thing to do would be to screw a fitting of some sort into the hole and thread a bolt through the center of that fitting to make a tool that works just like the official tool, pushing the shaft out the center of the drive plate.

If you don't have the installation tool, you can use an internally-threaded sleeve and a threaded rod or stud to extend the threaded end of the shaft and use a nut and some washers to pull the drive plate on. The challenge is finding a sleeve

with an internal thread of 3/8" x 24 TPI and an OD less than 1/2". Good luck! You might find a long nut or coupling nut, but you'll probably need to grind the points off the external hex to get it to fit. Another idea might be to get a small piece of tiny pipe or sleeve and use a tap to thread the inside.

Incredibly, there's actually a plausible solution here. Discount Auto Parts sells a package of two "Shock Stud Extenders", Superior no. 13-6501, for about four bucks. These things are intended to screw onto the top stud on a shock absorber for rednecks doing heinous things with the ground clearance on their pickup trucks, but the threads are correct for our purposes. They have an external hex that will have to be ground down, but that wouldn't be too difficult. You get two tries, too.

You will also need snap ring pliers -- big ones.

First you need to remove the nut that's down in the hole in the center front of the drive plate. It may be a 9/16" hex, but on the author's car it was a 14mm hex. The socket used doesn't need to be a special thinwall model, but it can't be a big bulky thing or it won't fit in the hole. The nut is regular right-hand thread, 3/8" x 24 TPI (NF).

Next you need to use the puller. If you're lucky, the puller you have will fit between the compressor and the radiator upper rail. If not, you'll need to unbolt the compressor to tilt the nose up to work on it. That's not too difficult to do, and it gives you better access to what you're doing anyway.

Once the drive plate is off, a large and obvious external snap ring must be removed to allow the pulley and bearing to come off. The bearing is not a very tight fit on the compressor, so once the snap ring is off it shouldn't be too difficult to remove. Perhaps a few taps with a plastic mallet or a hammer and wooden drift will help.

The replacement clutch should come with a new bearing already in place in the replacement pulley, but if you need to get at it for some reason: the bearing is pressed into the pulley from the front and is held in the pulley with a barely-noticeable wire snap ring. Walter Acker IV says "The bearing number should be an A/C delco 15-2802."

Once the pulley is off, another large external snap ring must be removed to get the coil off.

It appears that the replacement coil could be installed with the terminals facing several different directions, so make sure they point where you need them to.

Before installing one of these large snap rings, look closely at it. The flat side of the snap ring needs to go against the part being held in place. The other side has a bevel around the ID, and this bevel not only makes the snap ring easier to install but also helps it hold the part snugly. After installing, tapping around the circumference of the snap ring to make sure it's fully in couldn't hurt.

If installing the replacement pulley requires tapping, *do not* tap on the flat friction face; the wire snap ring holding the bearing in the pulley may not appreciate it, and neither will the bearing itself. You need to tap directly on the inner race of the bearing, which means you need to have a sleeve with a 1-5/8" ID to use as a drift. A PVC pipe fitting worked well for me.

The key that goes on the compressor shaft is square, 4mm on a side. It's also bent. No, it isn't damaged; the Service Manual says that it is deliberately bent to hold it in its groove during assembly.

Before reinstalling the drive plate, you need to put the key in place. The Service Manual says to fit the key into the drive plate, and then line it up with the keyway in the shaft during assembly. Unfortunately, if the key is installed in the drive plate it will interfere with the installer tool. The key must be positioned in the keyway on the compressor shaft. And if you do that, the key will probably fall out while you're trying to install the drive plate. It appears that the most reliable method is to position the key in the drive plate but as close to the back end as possible. Put the drive plate onto the shaft, lining up the key, and use the installer tool (threaded onto the shaft as far as possible before it hits the key) to pull the drive plate on just a little. Then remove the installer tool and use a hammer and a nail to drive the key back into the groove on the shaft until the end is flush or below the shoulder on the shaft. Then screw the installer back on, being able to thread it all the way down this time, and continue pulling the drive plate into place. The instructions in the Service Manual say you're supposed to install the tool, push the drive plate on a little, take the tool off, check the key to make sure it's in place, then reinstall the tool and push the drive plate the rest of the way on; perhaps they were inferring that you should be driving that key into its proper position.

The thrust bearing that comes on the Cool-Aid installer tool is a real cheap POS and may not survive the first drive plate installation. Here's my suggestion: the first time you put the tool on, omit the bearing and use a 5/8" flat washer instead.

After you remove the tool to drive home the key, put the tool back on with the bearing *and* the flat washer -- perhaps even *two* flat washers if you've got room, one on each side of the bearing. This will prevent the housing of the cheap thrust bearing getting crunched and allowing the drive plate to get cocked during installation. Hold the washers centered until the tool snugs up to hold them in place; if allowed to lay against the threads, they will scrape the threads as the tool is used.

Of course, you could simply provide a *good* thrust bearing.

As mentioned above, applying axial force to the shaft is verboten. Standing the entire compressor in your press to push the drive plate on is not recommended.

The instructions in the Service Manual indicate you're supposed to use the installation tool to push the drive plate on just until the gap between the friction faces is 3/32" or so, then remove the installation tool. The drive plate is pushed the rest of the way into position with the nut. Forget that; use the installation tool to position the drive plate exactly where you want it to end up. Don't rely on the nut moving the drive plate on the shaft at all. Even if it would (which it won't -- see below), turning the nut against the front surface of the hub galls it up and may prevent it going on as far as it needs to. There's a reason the installation tool includes a ball bearing.

According to the Service Manual, the desired gap between the friction surfaces is 0.56-1.45mm (.022"-.057") -- but really, the objective is as small a gap as you can muster without the surfaces contacting when the clutch is disengaged. If you close down the gap too much and the pulley starts dragging, use the puller tool to back it off a bit. In fact, that's really not a bad installation procedure: Install it too far until the pulley drags, and then install the puller and pull just until it spins freely.

The Service Manual says to install the nut narrow boss end first and tighten it down to 15 ft-lb. If you do this, the nut won't get within 1/8" of an inch of *touching* the drive plate. The diameter of the narrow boss end of the nut is small enough for the center hub of the drive plate to pass right over it, and only the tiniest portions of the points on the nut hex could actually contact it. Since the narrow end of the nut will contact the shoulder on the shaft and won't go any farther, the nut will be stopped long before the points get near the drive plate. The only plausible objectives would be to "catch" the drive plate if it decides to slide off -- which it won't -- or to prevent the key from sliding out.

If you'd like the nut to actually help hold the drive plate in place, look carefully at the shoulder of the shaft after the drive plate has been positioned properly with the installation tool. If the shoulder on the shaft is within the hub itself, put a flat washer on the shaft. This washer needs to have a 3/8" ID and a 3/4" OD. Then screw the nut on flat side first. Tighten it down until it gets snug, indicating it has pushed the washer against the hub, and quit. Don't even think about tightening it enough that it might move the drive plate and close up the gap.

If the shoulder of the shaft is protruding from the center of the hub, you'd need to provide a sleeve that sits inside the opening on the front of the drive plate and has an ID of at least 1/2" to fit around the shaft. You might cut a ring from a piece of 5/8" copper pipe. You'll probably need to cut a notch in this sleeve to fit around the key unless you shortened the key before you started -- which isn't a bad idea; the key being a little shorter won't hurt anything. Install this sleeve, then the flat washer described above, then the nut flat side first and tighten gently as described above.

You could reasonably opt to forget all that and just thread the nut on as the Service Manual says -- or even just leave it off. The retention that matters here is the press fit. The pulley on the water pump is held only by a press fit, the impeller in the water pump is held only by a press fit, the hub holding the fan clutch is held only by a press fit, clearly if a press fit isn't reliable we're in big trouble.

FRONT SEAL REPLACEMENT: The Service Manual provides instructions for replacing the front seal on the A-6 without disassembling the compressor. The first step is to remove the drive plate of the clutch as described above. The rest of the procedure involves several special tools. It's doubtful that this would ever be a worthwhile undertaking, since fiddling with that seal requires discharging the freon circuit -- at which point you might as well just slap in a rebuilt compressor.

COMPRESSOR PROTECTION CIRCUIT: Just below the inlet and outlet connections on the A-6 compressor is a sensor held in place with a C-clip, with a wire connected to it. On the 1983 XJ-S, this is a thermally-operated switch that shorts to ground in the event that there is trouble with the freon system. The shorting causes a resistor within a three-connector fuse assembly to heat up, which in turn causes a fuse to melt, breaking power to the clutch and disengaging the compressor. This is a common arrangement on GM vehicles, and the fuse assembly is readily available. The fuse is usually attached to a mounting hole on the compressor itself.

Do *not* connect the fuse backwards. There is a little tang on the center connector that is intended to indicate which way the plug goes, but it's not very foolproof. If you install it backwards, the clutch will not engage and the fuse will blow immediately.

A replacement compressor is likely to have an aluminum blank-off plug in place of the fault sensor. It is probable that you cannot install the thermal type sensor in place of the plug because there has to be a suitable opening underneath the plug for the tip of the sensor, and there often isn't. However, the sensor wire can just be left disconnected and the system will work fine -- there just won't be any protection for the compressor if the system loses freon. In fact, it is just as well to remove the fuse assembly as well and run the power wire directly to the compressor clutch. Since the standard procedure is to replace the compressor in the event of freon loss anyway, this may be acceptable.

There is a second type of protection switch available: a pressure-operated switch that supplies a ground to the compressor clutch when the freon circuit pressure is normal. This second type is the best to use; the early system with the thermal fuse is temperamental at best. The pressure switch has a plastic body, as opposed to the thermal type which has a metal body with a heat probe protruding into the compressor. Since the pressure sensor has no protruding probe, it can be installed in a replacement compressor in place of the aluminum blank-off plug. According to Stefan Schulz, Jaguars began being fitted with this type from the factory in the mid-80's.

Note that the thermal type switch is normally open and connects to ground in the event of trouble, while the pressure type is normally connected to ground and opens in the event of trouble. To use the pressure type protection switch, modify the harness so the power goes straight to the clutch and the ground terminal of the clutch is wired to the pressure switch; a three-connector fuse is not needed.

If you live outside the US, the A-6 compressor is anything but cheap. Someone could make a million buying compressors in the US and selling them overseas. In any event, after paying top Euro or Rasbutnik or whatever for a new compressor, you're not likely to want to forgo the protection circuit -- but it may be difficult to find either type sensor or the three-connector fuse. Mark Barker of the UK found a solution: "An alternative to factory (one-time acting) thermal fuse is to fit a resettable thermal cutout. It's a small round thing with spade tags and a small red reset button. You glue it (epoxy is fine) to the side of the compressor and it is wired in series with the clutch. Test the wiring by running with one of the spade tags unplugged."

"In the UK it is available from RS Components (<http://rswww.com>) as stock no. 228-2513 (for a 70°C one) at 3 UKP." Sean Straw adds, "For worldwide (except USA) affiliates, check out

<http://www.rs-components.com>

"They list numbers for offices in different countries." Robert Egerton adds, "If you are in the UK the retail outlet of RS is called Electromail and you can get them on 01536 294555."

Of course, 70°C is too low. "I found this can trip during a 'pull down' on a hot day." Mike Morrin says, "The compressor (at least on my car) routinely gets to 85°C. Everything in the valley is over 75°C on a hot day." Barker responds, "The sensor is also available as a 90° and higher too, on the same page. Similar part nos. What we need to sort out now is which of the available trip temperature ones is best to use."

Barker adds one last note: "Note that after I did all this, the air-con chap who gassed my system told me there was a retrofit which had high (overload) and low (lost charge) pressure sensors which would be even better; sorry I don't know any more about it."

If your compressor is simply getting too hot, see the section on high freon pressures on page 476.

AIR CONDITIONER COMPRESSOR CONNECTOR & DIODE: It would be helpful to have a diode wired into the compressor clutch connector; see the discussion on inductive loads on page 518. Of course, the Jag doesn't come with one. However, if you go into an auto parts store and ask for the special connector that plugs onto a GM compressor, the connector comes with a diode built in. One such part is made by Conduct-Tite, part number 85143, found in an AutoZone; another is made by Factory Air, part number 37201, found in a Discount Auto Parts. Dennis Kindig, who owns an '87 XJ6, says, "I used this connector to replace my original wiring when I changed compressors and converted from the thermal fuse arrangement to the high-side low pressure switch."

Of course, you can accomplish the same objective by simply buying a suitable diode at Radio Shack and adding it in to your existing wiring.

AIR CONDITIONER COMPRESSOR FRONT BRACKET - A-6: The front end of the A/C compressor is supported by a plate bolted to the front of the timing cover. This plate is *not* symmetrical; it goes in only one way. If you put it in backwards, your compressor pulley won't line up right with the belt. The objective of the asymmetry is to position the compressor a little to the left of center so that the drain plug on the A-6 doesn't jam into the A bank head. The bracket at the rear of the compressor is asymmetrical also, but you couldn't install it backwards if you tried.

AIR CONDITIONER COMPRESSOR - MOVING OUTTA YOUR WAY: As in most cars, the compressor is connected with flexible hoses. This enables some movement of the compressor for such jobs as replacing the spark plugs without disturbing the freon system. Several people, including Victor Naumann and Harry Trafford, have pointed out that a block of wood positioned between the V and the top of the radiator can be very helpful to hold the compressor forward and above its normal position while you're working.

AIR CONDITIONER COMPRESSOR - REMOVAL AND REFITTING - A-6: In order to correct for tolerance in dimensions such as the overall length of the compressor, the holes in the rear compressor support where it is bolted to the valley cover are very slightly slotted, so the rear support can be slid back and forth a bit and then the bolts tightened down. So, whenever the compressor is replaced with a different one or the valley cover has been removed, the proper way to reassemble would be to leave these two bolts loose until the compressor is in place and the bolts at the back end and all four bolts in the front support plate are tight, then tighten the two bolts holding the bracket to the valley cover last.

When you are not fiddling with the valley cover bolts or replacing the compressor with a different one, lifting and reinstalling the compressor without loosening those bolts seems to work well enough if you do things in the right order. Always loosen the two bolts that attach the front mounting plate to the timing cover before lifting the compressor out. During assembly, always have all four bolts at the front (two holding the plate to the timing cover, two holding the compressor to the plate) in place but loose while tightening the bolts in the rear support. Be sure to reconnect the ground wire.

COMPRESSOR HOSE CONNECTIONS: The freon lines connecting to the GM A-6 each have a hexagonal block on the end that fits against the rear plate of the compressor. There is an O-ring in a recess on the back of the compressor that this block fits against, and a single bolt between the two ports pulls a 1/4" thick racetrack-shaped bar against the back side of the hexagonal blocks to hold them firmly against the O-rings and ensure a seal. This same bolt also holds the bracket that mounts the cruise control actuator.

That 1/4" thick bar, C36983, sure looks like a sturdy and massive part -- but it's not. When this system is worked on, more often than not that part is found to be bent in the middle when removed -- and of course the mechanic turns it over so it gets bent back the other way when reinstalled. People leaning over the engine compartment to work on the water

pump, etc., and pushing on the hoses apply a terrific amount of leverage towards tilting those hexagonal blocks and breaking the O-ring seal underneath.

Why would GM design something so prone to leakage? Well, perhaps it was a mistake -- but it was a mistake they corrected. Later GM cars don't use these two separate blocks with a 1/4" plate holding them in place. Instead, they make both connectors into one large connector about an inch thick that the bolt holds in place directly. That way, there's no way it'll get distorted -- even if made entirely of aluminum, as most later ones are.

This author relocated the cruise control actuator elsewhere and made a thicker bar to replace the 1/4" thick bar. There's no need for the racetrack shape; simply take a piece of 1-1/2" x 1/2" steel bar, cut a 3" piece off, and drill a 3/8" hole in the middle. With the large flat washer and the cruise control bracket omitted, the original bolt was the correct length to hold this thicker bar. And there's not a chance in hell it'll bend; you can feel the difference just tightening it up.

If you are not relocating the cruise control, it still might be a good idea to fab a thicker bar for this retention. The entire cruise control actuator will be relocated rearward by the amount of additional thickness in this bar, so if you go with 1/2" as I did the actuator will be positioned 1/4" farther rearward than before. Check carefully to make sure it all fits without running into the distributor cap, as taking that bar back out entails discharging the freon circuit. You probably should also provide a bolt that's longer by 1/4" so you're not relying on too few threads in the back of the compressor. An even better idea would be to replace that bolt with a stud; seat the stud fully, then hold the plate in place with a nut.

An alternative idea might be to purchase a second 1/4" thick bar C36983 -- or make one. Then install the two bars with the cruise control actuator bracket sandwiched in between, which will hold it in exactly the same place as before. Again, you'll need a longer bolt.

AIR CONDITIONER COMPRESSOR OIL CHARGE: Section 82.10.14 of the ROM explains how to deal with a compressor delivered with oil in it. However, a typical rebuilt compressor will nowadays be delivered without oil since there are three different types of oil (mineral, ester, or PAG) that you may end up using. Read the tag on the rebuilt compressor.

If it is dry, follow the directions in steps 12-15 of Section 82.10.20 -- but note there's an error there. In step 15, it twice refers to the amount of oil removed in step 14. It should refer to the amount of oil removed in step 13 both times; that's why you were measuring in step 13.

These directions -- as well as the directions that come with the new compressor -- involve draining the oil out of the old compressor to measure how much was in it. Nowhere does it provide any clue *how* to drain the oil out of the old compressor -- or from which opening. James Teston says it's really all openings: "Pull the compressor off, keep it horizontal, and drain the oil you have in it out from the drain plug on the bottom of the sump. Then flip it vertical and drain it from the pressure and suction ports. Then put it any which way and rotate the clutch quickly to blow out whatever oil might be left."

They also tell you to add a similar amount of oil back into the new compressor, again with no clue on how to accomplish this. If you don't do it right, you may end up with oil all over the place -- and no idea how much is in and how much is all over, which would be bad. This author recommends the following: Add no more than three or four ounces to the compressor while it's on the bench. This may be added through the drain plug or it may be added into the suction port while turning the hub of the compressor to suck it in -- but don't turn it more than about one full turn or it'll start pumping it back out the pressure port. Put the caps back on the ports, or go ahead and connect the hoses and cap the ends of them. If time permits, leave the compressor sitting nose-down for a while so the oil can collect around the front seal. Install the compressor. If you need to add more oil, disconnect the suction hose from the fuel cooler, hold this end upward and pour the oil into that end of the hose. Turn the compressor by hand to get this oil into the compressor.

Teston points out that, since the oil circulates around the system, as long as you have some in the compressor when you start it up you can add oil pretty much anywhere. "The A6 has a sump, so the correct amount of oil will eventually find its way into it if you can't fill it all at once. Just add some to each section as you put them back together. Don't dump any directly in front of the expansion valve or put a large slug in the bottom of the condenser."

Finally, just before startup be sure to turn the compressor over by hand a dozen or more full turns to make sure it's not liquid-slugged with oil.

FITTINGS: When buttoning up parts of the freon circuit, please remember that the sealing of these connections does *not* depend on getting the nut tight enough. As parts are assembled, an O-ring is compressed between the OD of the tube and the ID of the fitting, and it's this compression that provides the seal, not the tightness of the nut. The nut merely keeps the assembly from rattling or blowing apart. Just tighten it down snugly and quit; there's no need to be grunting on it and many good reasons *not* to be grunting on it.

PLUMBING -- EARLY CARS: Bernard Embden says, "The fuel cooler on the air cleaner is standard equipment on the post-H.E.'s I believe. Coventry West said that original A/C parts for the pre-H.E.'s were no longer available. Not wanting to have hoses made up, I just scrapped my A/C system altogether and went with the hoses/fuel cooler etc. from the 1988 model."

In this day and age, it perhaps wouldn't make sense to update to the hoses from the 1988 model which was also originally fitted with R-12. A better idea would be to have the original hoses rebuilt with barrier hoses as described on page 481.

FILTER/DRYER: Apparently, the receiver drier unit on some Jags has O-ring fittings; on other Jags, the unit has flared fittings on it. Either drier should be readily available, it is not a special Jaguar part. Be sure to install the replacement in the correct direction (they always have flow direction arrows on them); the location of the sight glass may not be a good indicator, since there are reports of the sight glass being on either the left or right end.

EXPANSION VALVE: The expansion valve on this system (at least on the '83) is fairly standard; if you look through an A/C shop's parts book you will find there are several interchangeable part numbers, including some from Japanese cars. But further, there are several other part numbers that represent similar expansion valves except that the capillary tube and/or sensor tube are different lengths. The expansion valve called out for the XJ-S has very short tubes, since the places they go are only a couple inches away. But it still may be beneficial to get an expansion valve with longer tubes just to make it easier to install.

Also, some of the expansion valves have the capillary tube attached on different sides or at different angles. Selecting the optimum arrangement here can also ease installation considerably.

The expansion valve may be a common configuration, but it's certainly no fun to get at. I will provide a few tips that hopefully will be of some help. Obviously, don't even consider this job without removing the balance pipe between intake manifolds first. If you still have a heater valve in its original location, you might choose to remove it -- and don't put it back, install the generic version elsewhere instead as described on page 459. Remove the hose that goes to the fuel cooler, both to get it out of the way and to install a new O-ring in it while you're here; advice on removing it is under "Hose Removal" below.

The body of the expansion valve is L-shaped and has male threads on both ends. Hence, the line going into the evaporator behind the firewall has a trapped nut on it. The hex on this trapped nut is 7/8". To get this nut loose, you'll be having fun just finding a wrench to get on it. Chuck Sparks suggests an offset box end with a bit of the box cut out to make it look like a flare nut wrench; slip it over the body of the expansion valve itself, then slide it rearward onto the nut. It's possible to do it with other tools, but this is perhaps the slickest way.

You'll also need a wrench that fits the body of the expansion valve itself. There's a hex on it, but for some reason it doesn't seem to be any standard size. You probably can't get a monkey wrench on it, so the wrench to use is either a 5/8" or 16mm open end. It's a bit loose, but it'll work.

To break the nut loose, Sparks suggests you disconnect all the other lines to the expansion valve first. Then put your modified offset box end wrench onto the nut and turn it to the right (facing the firewall) just enough to take up the slack. Then, using the 5/8" or 16mm wrench, turn the expansion valve itself to the left. This way, Sparks argues, you'll have less chance of damaging the line on the evaporator -- which would be seriously bad.

The nut on the tube coming down on top of the expansion valve requires a 3/4" or 19mm wrench. A crowfoot works great here. If it's really tight, be sure to hold the body of the expansion valve; don't just break the tube off the evaporator. Some expansion valves have a hex below the threads, others have only two flats parallel to the sides of the valve body; either way, it'll be a 1/2" that fits. If you can't get a wrench on it, perhaps you'd be well advised to grip the body with a pair of vicegrips or some such, destroying it if necessary -- you're taking it out, and you won't be reusing it. Far better to ruin a scrap expansion valve than your evaporator. And you won't have a problem putting the new expansion valve in, because there's no need to get that nut that tight.

The nut attaching one sense tube to the return line requires a 9/16" wrench -- but you knew that already from checking the one on the replacement expansion valve.

The other sense tube has a little coil on the end that must be installed against the pipe coming out of the evaporator, and it must have some insulation put over it so that it senses the temperature of that pipe and not the surrounding air. On most cars, this coil is merely strapped to the pipe with a tar-like stuff. However, on the XJ-S there is actually a little boss built onto the evaporator outlet fitting just for this coil. Once you get the old tar stuff off, you must loosen two Pozidriv screws to get the old coil to slide out. Fortunately, this clevis is positioned horizontally so the screw heads face straight up, making it a fairly reasonable job to get a screwdriver on it.

New tar stuff would be good, but other methods of insulation would also work. You can wrap it with foam strip insulation, or you can even spray Great Stuff around it and let it set up in a clump. You can carefully cut a piece of 1/2 pipe insulation (looks like a foam tube slit down one side) to fit, wrap it around and tape or strap it in place. Just make sure that that little coil is as cold as the pipe (which is cold!), not as hot as the engine.

REFRIGERANT LEAKS: Michael Minglin says, "A possible solution is a refrigerant additive available from Cryo-Chem Int'l at 1-800-237-4001. It is called Cryo-Silane and reportedly seals small refrigerant leaks, without clogging the system. It is guaranteed to seal and hold for one year any a/c system that takes longer than six hours to leak down. As I said I have not yet tried it, and it isn't cheap, but this may be the answer to small hard to find leaks."

"On the matter of hard to find leaks, with the a/c service gauges hooked up it is impossible to find leaks in the service ports or valves. If your mechanic cannot clearly show you the leak, have him disconnect his service gauges and check the service port valves before starting to change out expensive hoses and parts."

HOSES: You might be considering rebuilding your hose assemblies because the hose portion is old and rotten, or you might be considering it because you're converting from R-12 to R-134a refrigerant. If you're doing the conversion, see the notes on page 481.

Most A/C shops claim to be able to rebuild hoses. Some hoses are more difficult to rebuild than others, and the more difficult ones require a special crimp tool that, while reasonably priced as shop tools go (no power, hand operated), was introduced later. If the A/C shop is working with the older style crimp tools, it cannot rebuild some hoses. The usual result is that they will cut the fittings on your old hose and braze on sections of tubing that their tools can crimp a hose onto. This looks like crap when done, but it does work.

If the fittings on your hoses happen to be aluminum, *only* the newer tool will work, since brazing is out and the older tool will crush the tube. If the A/C shop doesn't have the newer crimp tools, they will claim that the hose cannot be repaired and order you a new one from Jaguar and collect their markup on the part.

How does any of this apply to the Jaguar? It probably depends on the vintage. This author's '83 had non-barrier hose assemblies with steel lines with threaded hose connections (as described on page 481), so rebuilding with barrier hoses

required cutting and brazing. I suspect later XJ-S's came with aluminum tubes with barrier hoses with crimped connections, so brazing should be neither possible nor required to rebuild.

Peter Cohen provides these words on rebuilding hoses: "Take the whole car to the shop, not just the hoses. A/C hoses have almost no ability to twist, and since all but one hose on the V12 have angled connections the odds are that the hose shop will not get the angle right unless they assemble it on the car, put paint marks on the pieces to show the exact positions, and then take it back into the shop to crimp it. The shop I used was reluctant to even make the hoses because of all the come backs from wrong angles."

Actually, you can avoid that problem. The angles at which hoses are crimped to fittings is only a concern when there are angled fittings crimped to both ends; the relationship between the two ends must be correct or you'll have to twist the hose to get things to line up. If there's an angled fitting at one end only, there's no problem; you can simply rotate the entire hose to fit. Of the three hoses on the XJ-S, the high pressure hose from the compressor to the condenser and the low pressure hose from the fuel cooler to the compressor each have a straight fitting on one end, so there is no problem. The only hose with angled fittings at both ends is the hose from the firewall to the fuel cooler, which has 45° fittings at both ends. Solution: rebuild that hose with a 45° fitting at the firewall end and a straight fitting at the fuel cooler end. It will fit *better* this way.

Assemble these parts to attain an overall length of 23", measured in a straight line from end of tube to end of tube (a corner on the end with the 45°). This is about 1-1/4" shorter than the OEM hose that came on this author's '83. The length is somewhat critical, more critical than the lengths of the other two hoses. Ideally, find a way to either measure or trial fit to find the correct length on your car, since your engine may be positioned within the engine compartment differently than mine. Resist the compulsion to make the hose a bit longer "just in case", because too long is a real problem here.

You could forget about crimping and rebuild your own hoses using clamps -- if you have crimped connections to begin with. Tony Bryant says, "I went to my local air con place, picked up 2 metres of R134a rated barrier hose in the correct diameter for <\$10, went to my local hydraulic hose place (who wouldn't/couldn't crimp the aluminium fittings), and picked up some top quality stainless hose clamps. These are high pressure items, not worm gear clamps, and use a bolt and cylinder arrangement to forcefully clamp. They also have a continuous band. Each <\$5. I replaced the high side hose using these items, after *carefully* cutting the old hose off the aluminium fittings. Holds pressure perfectly."

The high pressure hose assembly is 1/2", so the hose that fits it is 13/32". The low pressure hose assemblies are 5/8", so the hose that fits them is 1/2". Don't ask me to explain that.

HOSE VS. THROTTLE: Peter J. Havas provides a warning: "If you're not careful, and I wasn't, you can push the low pressure tube down and it will foul the left side throttle arm from the spindle, and lock open in traffic! Neat, huh? Use a wire-tie to secure the hose to the diagonal brace for safety." Please take this warning seriously; Havas isn't the only XJ-S owner who has found his throttle jammed wide open due to the hose fouling the left side throttle linkage.

Tying the hose to the diagonal brace would seem to be the obvious solution, but when working with the hose that goes from the firewall to the fuel cooler remember that the firewall doesn't move and neither does the diagonal brace -- but the engine does move around on its rubber mounts. Strapping the hose to the diagonal brace would seem to be an excellent plan for making sure the engine motion doesn't stress the fitting at the firewall, but be sure to leave enough flex between there and the fuel cooler for engine motion. If the hose assembly is short enough, it may be preferable *not* to tie the hose to the diagonal brace.

The hose being too long, as this author's OEM hose was, probably aggravates the fouling problem. Too long makes it want to loop up high, but then the hood is closed on it -- forcing it both downward and contorted. If yours loops up like that, you might want to try just pushing down on the high part of the loop with your hand and see what happens -- and remember that the loop changes shape as the engine moves around on its mounts.

Perhaps a far better method of keeping the hose from fouling the throttle linkage would be to provide a shield over or alongside the throttle linkage at this point. A small bracket could be fabricated from sheet metal to form a small shelf of sorts that the hose can rest on and slide around on with engine movement and be absolutely prevented from getting into the linkage. Such a bracket could be designed to be installed under the heads of the two upper screws holding the elbow

to the rear of the LH intake manifold -- or, perhaps a better idea, it could be designed to be installed sandwiched between the elbow and the manifold with an additional EAC2650 gasket. The gasket itself could be used as a template to fab the lower portion of this bracket, and the upper portion is a simple 90° fold to form the shelf -- or perhaps just an edge with a slit piece of small plastic tubing on it for the hose to rest on. Be sure to dial the throttle back and forth to check for unobstructed motion when done.

If Jaguar had decided to address this concern, it would have been a simple matter to design the plate holding the linkage at that corner to include this foul-prevention feature.

HOSE REMOVAL: On this author's '83, the hoses on the low pressure portion of the circuit (either end of the fuel cooler) has nuts on each end with a 27mm (1-1/16") hex on them. Presuming you don't have open-end wrenches in that size, you're going to be using the monkey version.

Problem: the connection at the firewall is gonna be a bear to get a monkey wrench on. It calls for a crowfoot wrench -- but you're not going to find one of those is 27mm or 1-1/16" easily.

The solution is as close as the local hardware store. It's called a basin wrench. Now, here's what you're gonna do: you're gonna peer down into the area under the balance pipe where this connection is, then you're gonna go down to the hardware store and look in the plumbing department at a basin wrench, and you're gonna say, "Man, I gotta get me wunna those!" And not just for this job, either; a basin wrench is quite obviously one of those tools you'll wonder how you ever got by without. It's sort of a crowfoot version of a pipe wrench; it has a pair of jaws that will grip when you turn it in one direction, no matter what. It's quite handy at removing sensors, too.

There are three types. One has a shaft perhaps a foot long with a T handle at the top; the jaws at the bottom can flip around the end to reverse direction. This costs about \$15. Another type is the same thing, but the shaft is extendable; this costs about \$20. The third kind is just the jaws themselves with a 3/8" square hole so you can use it with your ratchet and extensions; you reverse it by pulling it off the extension, turning it over, and inserting the extension the other way. Not only is this the cheapest version (about \$10), but it also takes up the least space in your tool box.

An example of that last type is made by Superior Tool Company of Cleveland, Ohio (1-800-533-3244, <http://www.superiortool.com>), Model No. 03820, "Ratchet Jaw Basin Wrench Attachment" and is sold at Lowe's. It claims to fit 1/2" to 1-1/4" hex and square nuts.

While you're shopping, also note that basin wrenches come in at least three sizes. The one described is the smallest and perhaps the most useful for Jaguar work, but it probably wouldn't hurt to have the larger ones around.

A basin wrench works perfectly on that hose connection. Note, however, that you still need a 13/16" crowfoot on a separate ratchet and extension to hold the fitting still while breaking this big nut loose; if you don't, you may break the fitting off the evaporator, and if that happens -- trust me on this --you *will* end up deciding that air conditioning is just a frivolous luxury you don't really need. Fortunately, a 13/16" crowfoot is not hard to find.

LEAKY SCHRADER VALVES: The guy who works on my A/C for me has a tool for replacing the Schrader valve in an R-12 service port without discharging the system! It screws onto the port, then allows you to unscrew the valve from the fitting within a glass housing so nothing leaks out. Put a new valve in, problem solved. Only a little squirt of freon is lost when you remove the tool, the amount that filled the volume of the tool itself.

FREON CHARGING: It would normally not be within the scope of this book to describe how to charge a freon circuit, since it should be common knowledge; almost every automotive A/C system is charged basically the same way. However, here in the Big Bend region of Florida, it is somewhere between difficult and impossible to find an auto A/C shop that will actually charge a freon system fully.

Sometimes the shops install a specified weight of freon and declare it charged, apparently unaware that the sight glass is the *final* say on the matter; if the spec says one amount and the sight glass says that ain't enough, the sight glass is

correct. Other times they charge until they reach a specified pressure on their gauges and declare it charged, apparently blissfully unaware that pressures are only an indication of temperature in a freon circuit, not of the amount of charge. If the pressures are too high, it's because something is too hot -- usually, in the case of the XJ-S, there isn't enough air flowing through the condenser in front of the radiator, so the condenser is getting hot and not cooling the freon enough. But this is no reason to undercharge the system; rather, it's a reason to investigate and correct the airflow problems at the condenser; see page 476.

There are mechanics that advocate undercharging the freon system because it helps keep the engine from overheating. An undercharged freon circuit will not operate nearly as effectively, so it won't reject as much heat from the condenser, so the air entering the radiator is not as hot to begin with. Makes perfect sense. And if your mechanic thinks this way, I recommend you leave his shop posthaste and never return.

After a shop does work on your A/C system, you should check the sight glass to confirm that it is fully charged. If not, you can go back and bitch about it -- but that's not likely to work since they know it all and you are a lowly customer who doesn't know anything. If all else fails, obtain a license to purchase freon and "top up" the system yourself. Michael Minglin found a page on the WWW "for those of you who would like to be able to purchase R-12, R-134a, or just about any other kind of coolant, to do your own A/C repairs:

<http://www.epatest.com>

"At this website you can download the EPA section 609 manual free, take the test online for under \$10, and print out an instant temporary EPA certification certificate, if you pass the test. The actual certification card is mailed in about 30 days." This author now has his card; the online test works just fine -- but the price had gone up to \$19.95. The author has also used his card to buy 12-oz. cans of R-12 at AutoZone, which also works just fine.

Note also that it is an open-book test -- which, when working online, means that while taking the test you can click a button to review the manual. Since computers are very helpful, note that you can cut-and-paste a string of words from the question and use it to "find in page" the exact same string of words in the manual in a matter of seconds. It is *really* easy to pass this test.

R-12 is not cheap, but is available locally. The hose, valve, and fitting you'll need to connect a freon can to the car and charge it costs perhaps five bucks. All that fancy equipment you saw at the shop -- the set of two gauges on the long hose, the vacuum pump, etc. -- is unnecessary for topping up.

So, allow me to describe the procedure for topping up a freon circuit: Connect a can of freon to the low pressure fitting on the car. On the XJ-S with the A-6 compressor, the low pressure fitting is the one on the line from the fuel cooler to the compressor. It is suggested that the valve on the filler hose be cracked open just enough to hiss a little while connecting to the car, as this will help blow air out of the fittings themselves while connecting and therefore keep it out of the circuit. With the system running at full cool (fans on high, doors open), hold the can upright and open the valve and allow the system to draw the freon gas into the system. This will cause the can to get cold as the liquid freon in the can boils off and is sucked into the car. The rate at which freon enters the system is a function of how warm that can is, so if you heat it a little it'll fill faster. Don't use a torch or anything, but holding it in your hands (if you can stand it) will work, as will holding it near warm parts of the engine. Keep filling until there are no bubbles visible in the sight glass, then close the valve, disconnect the hose, and cap the fitting. If you wish, it won't hurt anything to add a little freon *beyond* the point where the bubbles disappear -- say, less than half of a 12-oz. can -- but don't stop *before* the bubbles disappear.

Don't turn the can over. This allows liquid freon into the system instead of pulling gas in. It is a trick used by some A/C mechanics to fill faster, but it risks getting liquid into the compressor -- especially with the connection as close to the compressor as it is on the XJ-S. Just take your time and leave the can upright.

Charging the system from scratch is more involved, requiring a vacuum pump to draw down the system to a nearly total vacuum. You can buy a vacuum pump that operates on compressed air from Harbor Freight Tools (<http://harborfreight.com>) for \$10 plus S&H, but if you don't have an air compressor (and this thing requires a pretty large one, 4.5 cfm at 90 psi or so), a suitable vacuum pump will probably cost you more than it's worth; you'll opt to just take the car to a shop for this work.

Some suggest ripping the compressor out of a refrigerator and using it as a vacuum pump. This might work, but then again, it might not; that's a compressor, not a vacuum pump, there's no telling how much vacuum it can pull. Squirt a little oil into the suction line on the refrigerator compressor before connecting it up reportedly helps it pull vacuum better. If you have a suitable vacuum gauge connected you'll know how much vacuum you get.

There is a time element involved in pulling vacuum on the system. It's not just that you pull enough vacuum, but you also must hold that vacuum for a minimum amount of time. This is because the vacuum is causing moisture within the system -- including within the dryer -- to boil off and get pulled out as vapor. Since some of the water vaporizing removes heat from the rest of the water remaining and causes it to get very cold, it doesn't want to vaporize. The vacuum must be held long enough for the remaining moisture to warm back up to room temperature and boil away. Using a hair dryer on components of the system will help, especially if you're trying to do this job on a cold day.

The fastest way to do this, of course, is to fire up the vacuum pump and let it run continuously for at least an hour, preferably several hours. You can accomplish the same thing by letting the pump run for a few minutes to pull a good vacuum, then valving the system shut and turning off the pump, and coming back every hour or so and running the pump a few more minutes. In fact, if you leave the gauge in place, that's how you tell when you're done: when you come back after an hour and the vacuum is still as low as you left it. The moisture vaporizing will diminish the vacuum, so if the vacuum holds there's no moisture remaining in the system.

If you don't get as good a vacuum as you should, there is another way to help purge impurities from the system. After you've pulled the best vacuum that you can from one service port, connect up a hose to the other service port and allow some non-contaminant gas to fill the system and dilute the remaining contaminants. Nitrogen is ideal, refrigerant is also good and is convenient. Once the system has some gas in it, fire up the vacuum pump and suck it out *again*. This way, whatever the vacuum pump fails to pull out is mostly innocuous gas anyway rather than contaminants. Of course, you could repeat this two or three times to really get things pure in there, but it's a matter of diminishing returns.

HIGH FREON TEMPERATURES AND PRESSURES: Same thing, folks; within a properly-charged freon circuit, pressure is a function of temperature. When charging or checking a system, the A/C mechanics keep an eye on the high side and low side pressures.

Unfortunately, an XJ-S sitting and idling is likely to develop really high high side pressures. High enough to concern the A/C mechanics and cause them to stop filling the system even though it's not really fully charged and the sight gauge is still bubbling, not clear. This is not a good solution, since an inadequately-charged system won't cool efficiently and will generate excess heat in the compressor.

The way to lower high side pressures is to increase the airflow through the condenser coil in front of the radiator. The airflow is marginal in an XJ-S at idle, since the engine turns slowly and the belt-driven fan doesn't move much air and the electric fan isn't much help. Leaves and debris packed in the air path, notably between the condenser and radiator, reduce airflow. But worse yet, the foam that originally surrounded the radiator and condenser is likely to be deteriorated or missing altogether; the tendency of the XJ-S radiator to get plugged up means that it is removed for renovation periodically, and some morons claiming to be mechanics deliberately leave the foam out during reassembly, claiming it is unnecessary. As a result, the air the fans are pulling through the radiator is taking the easier path *around* the condenser, and airflow *through* the condenser is nil. This can result in high side pressures that are not only high but appear to be rising without limit. Of course, when the car is moving at 60 mph the airflow through the condenser is fine, but this won't help get the system properly charged.

As you stand looking into the engine compartment, the problems of airflow through the coil are not obvious. The fans are obviously turning, and most A/C mechanics naturally believe that if the fans are running the airflow is OK. They are not likely to correctly diagnose the problem as missing foam packing, even though they may comment that the symptoms resemble what happens when the fans aren't working.

Make sure your condenser, oil cooler, and radiator are properly packed with foam to prevent air bypass. See page 215. Make sure the fan shroud flaps are working, too, as described on page 215. Then, once you have the airflow moving through the condenser like it's supposed to, have the system checked and fully charged as necessary.

When checking A/C system pressures with the car idling, it's also a good idea to have a box fan standing on the ground in front of the car blowing into the front grille. If you wanna cheat, you can even spray a garden hose into the front of the car, which should bring the freon pressures down considerably.

FREON REPLACEMENT: Production of R-12 has been prohibited since 1995, the price for the remaining stocks and recycled R-12 is high and can only be expected to continue to rise, and many XJ-S owners are finding it advantageous to convert the system to an alternative refrigerant.

The most popular scheme is to convert to R-134a refrigerant. This decreases the capacity of the system somewhat, but since the A-6 compressor is adequate to cool a Chevy van it's not likely to lack ooomph in this application.

Another option is R-406a. More expensive than R-134a, but is not only a drop-in replacement for R-12, it also *increases* the capacity of the system by a few percent. There is more info available on the WWW at:

<http://www.worldserver.com/r406a/>

Other possibilities include a host of substitute refrigerants such as Freeze-12, FRIGC FR-12, Hot-Shot or GHG-X4 (GHG in honor of the chemist who put the formula together, George H. Goble), supposedly direct replacements for R-12 with little or no conversion necessary. Any search of the WWW is likely to turn up a flurry of information on R-12 substitutes. Or call McMullen Oil at 1-800-669-5730 or Monroe Air Tech at 1-800-424-3836.

Tony Bryant touts the advantages of converting to "a non-EPA-controlled refrigerant": "Use 30% BBQ propane and 70% camping gas (make *sure* it's iso-butane, not n-butane). Or just buy a bottle of commercially available refrigerant of roughly this composition. Some states don't allow these blends but they are available commercially and are apparently quite popular, especially in Australia. They work very well, at least as well as R-12, and are practically free. Also they have no problems with moisture contamination. Flammability is obviously a potential issue, but don't let that hold you back. All vented compressor oil is flammable anyway."

There is one overriding advantage to choosing R-134a over all of the other substitutes: it can then be serviced by any auto A/C repair shop in town. Shops are required to have a separate refrigerant recovery system for each type of refrigerant they deal with, and they all have such recovery systems for R-12 and R-134a. Peter Cohen says, "Since every damn one of these refrigerants requires distinct fittings and separate recovery equipment, most shops will only service R-12 and R-134a. People have been scared into believing that no one will fix their car if they have a problem away from the shop that did it in the first place."

CONVERTING TO R-134a: Converting the R-12 system in the XJ-S to R-134a is covered in some detail here. Conversions to other substitutes are not covered at all; you're on your own.

In its simplest incarnation, converting an R-12 system to R-134a requires the following four steps, outlined in any kit available in any auto parts store:

- Evacuate the system, recovering and recycling the old R-12
- Install conversion fittings to the high and low side ports
- Recharge the system with one 11-oz. can of ester oil and the proper amount of R-134a refrigerant
- Apply a sticker indicating the conversion

In addition, many experts will tell you that you need to:

- Replace the hoses
- Flush all the old oil out of the system
- Remove components (compressor, condenser, etc.) and manually drain the old oil out of them
- Replace the O-rings

- Replace the shaft seal on the compressor
- Replace the compressor
- Replace the expansion valve
- Replace the dryer
- Replace the condenser
- Install a high pressure limit switch
- Replace or adjust the compressor cycling switch

I hasten to point out that many of these additional requirements were originally touted by experts when the ban on R-12 was first proposed without any experience to back them up. Now that R-134a conversions have been done for many years, experience has shown that each and every step is absolutely necessary *and* that each and every step is a complete waste of time and money -- depending on the individual situation. Of course, many people will insist one way or the other on each one, largely depending on whether or not they've ever had a problem doing a retrofit. In the following sections I endeavor to explain each concern in enough depth that you understand how the concern applies to your car.

Note that shops who offer to do such retrofits face considerable risk when quoting a price for the basic steps; if it turns out that some of the additional steps are necessary, they could be in for serious losses. Keep that in mind when you negotiate with a shop to do such a retrofit, and try to indicate a willingness to accept that additional steps may be called for and to pay for them. If you don't, the shop is only too likely to quote you an up-front price *including* all those steps whether they prove necessary or not.

I also hasten to point out that the basic steps described in the kits presume that you are converting a perfectly working R-12 system. I'm gonna go waaaay out on a limb here and presume that you are *not* planning to convert a perfectly working R-12 system; the only reason you're in here at all is because something broke. That being the case, note that repairing a damaged system and recharging with a different refrigerant than it had before can result in inevitable uncertainties about just what caused what if the system fails to perform as expected. Keep that in mind when negotiating with a shop to do the repairs, remembering that they will be inclined to quote an up-front cost to cover any and all contingencies -- including the possibility that you, the customer, will be dissatisfied with the performance of a perfectly-functioning R-134a system.

Finally, note that -- as explained in the sections below -- there are some concerns unique to the Jaguar XJ-S when doing an R-134a retrofit. Many shops may have had bad experiences doing such retrofits on XJ-S's or have heard about other shops that did, and may quote you an outlandish price or refuse to work on the car altogether.

Jaguar offers a retrofit kit; the part number is JLM 11610 for the 1993-94 XJ-S with a Sanden 709 compressor, and JLM 11611 for the 1979-92 cars with the Harrison compressor. To quote from Technical Service Bulletin #8239: "The primary changes involve the replacement of the existing compressor lubricating oil with an oil compatible with both HFC R-134a refrigerant and with the residual R-12 lubricating oil. It is not possible to completely flush R-12 type lubricating oil from the refrigerant system prior to changing to Ester oil and R-134a. Additionally it is necessary to replace the input shaft seal of the compressor with a seal compatible with the R-134a refrigerant and oil."

For a little more Jaguar perspective, Richard Jackson provides the following excerpt from the August 1993 version of the ROM:

CLIMATE CONTROL SYSTEM INTRODUCTION

The climate control system fitted to the 1994 Model Year XJS has many features which make it unique. These differences demand changes to current system maintenance and rectification working practices.

Feature

- 1.. Refrigerant HFC 134A (Hydro flourocarbon, non ozone depletory).

- 2.. PAG (polyalkylene glycol) synthetic compressor lubricating oil.
 - 3.. Dedicated and improved compressor for HFC 134A refrigerant.
 - 4.. Quick fit/release self sealing charge and discharge ports.
 - 5.. Dual pressure switch to control compressor (incorporated into liquid line).
 - 6.. Clamp retained 'O' ring seals at the expansion valve and evaporator.
 - 7.. All aluminium evaporator matrix and pipework.
 - 8.. Aluminium receiver/dryer (without sight glass) and HFC dedicated desiccant.
 - 9.. Parallel flow extended height condenser.
 - 10.. Single muffler situated in suction hose.
 - 11.. Improved electrical system connectors.
 - 12.. Improved system control panel.
-

"The key point to note from the above is that Jaguar have gone to some lengths to change the system for R-134a in comparison with the earlier R-12 systems. In addition this updated system is fitted with a Sanden SD-7H15 compressor with capacity of 155 cm³ / 9.5 cu inches per revolution (the same capacity as the Sanden 709 fitted to the R12 4.0L XJS)."

If you'd like more information on R-12 to R-134a conversions, there is a Q&A at

<http://www.aircondition.com>

SERVICE PORT FITTINGS: Regulations require that a different and non-interconnectable type of service port be used with each different type of refrigerant. So the service ports on an R-12 system are different than the service ports on an R-134a system; the R-12 service ports are externally threaded, while the R-134a service ports are a quick-disconnect design with an internal thread to hold the caps on. When you are converting an R-12 system to R-134a, you must adapt the R-12 service ports or replace the hoses in entirety to provide R-134a ports.

If you're buying new hose assemblies as part of your conversion, simply order the correct hoses and they will come with R-134a service ports. If you're intending to use the hoses that were used with the R-12 -- or to rebuild them with new barrier hose sections while keeping the old metal tubes and fittings -- you will need to screw adapters onto the service ports to render them R-134a service ports instead of R-12 service ports.

This would be simple enough if there were only one type of R-12 service ports, but no such luck. Obviously, it would make sense if the high pressure service port was different than the low pressure service port so you couldn't mix them up. It may be obvious to you and me, but apparently it wasn't obvious to somebody way back when because up until 1976 the two ports on an R-12 system were exactly the same. In 1976 somebody's lawyers pointed out the financial implications associated with freon cans exploding in customers' hands and the high pressure port on R-12 systems was changed to make it different than the low pressure port. In the US, anyways. Then in the 90's GM apparently decided that wasn't good enough and changed the design of the high pressure port again. Throughout all this, the low pressure port remained unaltered.

You need the correct adapters for the type R-12 fittings you have. You have a mid-80's XJ-S so you need the 1976-on versions, right? Wrong. Mike Aiken says, "The Jaguar A/C fittings are pre-1976 standards. Both hi and low sides are the same size, 7/16-20." Jaguar may not be the only import that stayed with the obsolete standard; some kits to adapt these fittings are described as "pre-1976 and Europe" or "pre-1976 and some late model imports".

So, you need to check carefully that the kit you purchase contains the correct adapters -- specifically, that it has the correct high pressure adapter. Note that "fits most cars" usually means it does *not* contain the correct adapter; their definition of "most cars" apparently means "cars built after 1976 in the US" because such kits typically contain the

1976-on adapter and the GM mid-90's adapter but not the pre-1976 adapter. If both service ports are the same on your XJ-S, look for packages of adapters that indicate they fit pre-1976 models.

Aiken goes on to point out that, for the initial charging with R-134a, you don't even need the high side adapter. Charging is done through the low pressure port and those are all the same on R-12 systems, so any kit includes a suitable adapter. You'll need to have the high pressure port adapter on there for future servicing, though.

Interdynamics offers a kit, part number CSR-7, that includes a single can of ester oil and an assortment of port adapters. It includes adapters for basically anything, including the correct adapters for the XJ-S. Discount Auto Parts offers this kit for about \$24. It doesn't include the freon itself, but perhaps more interesting is the fact that it doesn't include the valve and hose assembly you need to charge the system.

Interdynamics also offers several bubble packs of adapters. Their part number VA-LH9 includes *only* the correct adapters for the XJ-S. Discount Auto Parts wants only \$7 for this. Buying this package and a separate can of ester oil is therefore considerably cheaper than buying the CSR-7 kit above.

There are also adapters offered with a 90° elbow in them. Just in case you need it -- which you could on some cars if the R-134a fitting ended up in a position where you couldn't jam the quick-disconnect on properly. That doesn't appear to be a concern on the XJ-S, however.

R-134a adapters are supposed to be unremovable once installed, and this is accomplished via some red glue on the threads.

Since the two R-12 ports are the same on the XJ-S, I will explain clearly which is which. The port on the line from the fuel cooler to the compressor -- on the port side of the compressor -- is the low pressure port and therefore should have the smaller diameter R-134a adapter with a blue cap screwed onto it. The port on the muffler on the starboard side of the compressor, on the line going to the condenser in front of the radiator, is the high pressure port and should get the fatter adapter with a red cap screwed onto it.

LOW PRESSURE PORT ADAPTER: The R-12 ports on the car each have a Schrader valve (tire valve) that seals the freon inside unless the pin in the center is depressed. An R-134a low pressure port is a relatively small diameter fitting, smaller OD than the R-12 threaded fitting, so the adapter must hold the R-134a fitting out off the end of it. Of course, that'd make pushing the pin within the R-12 fitting down inside difficult.

The solution used on the Interdynamics low pressure port adapter is to install a floating pin in the center of the adapter. If you hold the low pressure port adapter up to your ear and shake it, you can hear it rattling around in there. There are no springs or seals involved. When this adapter is properly installed, pressing on the end of this floating pin will depress the pin in the center of the Schrader valve in the R-12 fitting below.

If you'll look at the low pressure port on the XJ-S V12 -- the port on the tube connecting to the left side of the compressor, coming from the fuel cooler -- you'll note that it points upward. As discussed above, the R-134a low pressure port adapter sticks off the end of the R-12 port -- and then there's a cap that screws onto that. Altogether, the adapter and cap sticks up perhaps 3/4" farther than the R-12 port and cap did. You might complete the job and close the hood on this project only to be rewarded with a dent sticking up in the middle of your hood! And just because it clears when the hood is closed doesn't mean you're out of the woods, either; if the engine lifts off its mounts -- especially if the left mount fails -- the engine could jam that fitting into the hood when you trounce on the throttle. All in all, there is a good argument here for ordering new R-134a hose assemblies, or at least this one, since that fitting will be shorter.

Alternatively, of course, you could modify that tube while rebuilding the hoses, either replacing the R-12 port with a brazed-on short R-134a port or at least relocating the R-12 port somewhere more convenient. Or just abandon that port in place and add a new R-134a port somewhere else in this line. Or, considering how common the GM A-6 compressor is, find a low pressure line from a different type car -- possibly in a junkyard -- and adapt it to the XJ-S.

You might be tempted to try rotating the hose assembly around the connection at the back of the compressor just a bit to lean this fitting over on the side. The problem there is that you will be leaning the service port towards the 1B fuel injector hose. Keep in mind that the quick-disconnect fitting that connects to an R-134a low pressure service port is

fatter than the one that fits an R-12 port, so you need *more* clearance around that port, not less. Also note that the R-134a quick-disconnects come in brass or plastic versions, and the plastic versions are even fatter than the brass. You may find that you need to roll that hose the other way to pull the service port farther away from the 1B fuel injector hose!

Since the Schrader valve remains in place within the R-12 port, here's the easiest solution: Carefully pry the O-ring out of the low pressure port adapter and unscrew the floating pin device. Then use a pistol cleaning brush of an appropriate size (about .41 caliber) to scrub all the red stuff out of the threads. Put the O-ring and floating pin device back in. Use some anti-seize compound for good measure, but apply it *only* to the male threads on the R-12 port to make sure it can't get inside the system. Service the system, then remove the adapter and put the R-12 cap back on. Store the adapter in the glove compartment. Apply a label explaining clearly that the adapter needs to be removed before closing the hood.

Interdynamics is not the only company making port adapters. Interdynamics adapters are aluminum, but there is also a retrofit kit offered by Castrol (yes, the motor oil company) that comes with brass adapters. The Castrol R-134a low pressure port adapter looks very similar to the Interdynamics adapter except made of brass -- but that's not the only difference. Rather than using that cute floating pin idea, the Castrol adapter has a Schrader valve built in. You must remove the Schrader valve in the R-12 port prior to installing the adapter. Hence that idea of removing the adapter when closing the hood will *not* work.

HIGH PRESSURE PORT ADAPTERS: There are at least two types of high pressure port adapters that will work on the XJ-S. The first type looks similar to the low pressure port adapter described above except larger -- but it works completely differently. While the Interdynamics low pressure port adapter contains a floating pin, their high pressure port adapter contains an actual Schrader valve. Shaking reveals no rattle, since a spring holds the valve firmly seated. With this type, you are supposed to remove the Schrader valve from the R-12 port before installing the adapter.

The fitting for the R-134a high pressure port is larger than the low pressure port, large enough to fit around the threaded R-12 fitting rather than out in front of it. So, eventually somebody figured out that you could skip building a tall high pressure port adapter with the Schrader valve inside and instead just provide a short adapter that screws around the R-12 port and uses the original Schrader valve in its original location. Very slick, actually. This author actually found kits on the shelf that showed the first type of adapter on the box and in the instructions but contained the second type of adapter and a separate slip of paper indicating the substitution.

The high pressure service port on the XJ-S is located where either type of adapter should fit without hitting the hood. If you are concerned, just make sure to get the second type which is no taller than the R-12 port, just fatter.

HOSES: The concern here is that the molecules of R-134a are smaller than molecules of R-12 and may actually leak right through the materials used to make R-12 hoses. So, even without being able to positively identify a leak, the system seems to bleed down over time.

Bob Staff presents a dissenting view: "Barrier hoses are not required for a conversion to R-134a. Experience has shown that the systems operate fine without them. The age of your car may lead you to consider hose replacement." Staff is certainly not alone in that view. Some suggest that while in theory the non-barrier hoses will leak, in practice the oil in the system tends to coat the inner walls of the hoses and seals them. Others claim that the system will leak, but will only leak a few ounces per year, so it's cheaper to just top it up every now and then than to replace the hoses.

If you buy a hose today -- even one with R-12 service ports on it -- this is a non-issue; all modern automotive A/C hoses are "barrier" type, meaning they are made with materials that won't leak any type of freon. And at some point in time that probably became the case with the OEM R-12 hoses on a Jaguar XJ-S. However, there was a time before that when the XJ-S came with non-barrier hoses. How do you tell what type hoses you have?

It's in the connections between the hose and the metal pipes, and in the type of hose itself. With this author's '83, two hoses were non-barrier and one was barrier -- probably indicating earlier service work. The two non-barrier hoses had a cloth surface -- black, but reportedly red became standard later on. Barrier hoses, on the other hand, seem to always have a smooth black rubber surface. It may say "Barrier" right on it, too.

Barrier hoses are nearly always attached to the metal tubes with a crimped collar. The one on the author's '83, however, was attached with worm screw clamps -- funny worm screw clamps with a tang hanging off that positions the clamp properly over the barb within. These worked fine on my car, and reportedly work fine in general.

My non-barrier hoses did not have crimped connections, although other non-barrier hoses may have. If a hose connection is crimped, the crimped collar is steel. My hoses had steel tubes with aluminum collars, and the collars had a big hex on the outside. These collars were jammed up against a smaller hex on the tube itself. It looks like perhaps the aluminum collar was crimped with a tool that forms a hex. Incorrect; the hex is to get a wrench on it! This whole thing is a threaded connection.

The large aluminum collar has a very coarse left-hand thread on the inside that threads onto the outer surface of the hose. In the small end of the aluminum collar there is a very fine right-hand thread that the steel tube screws into. The end of the steel tube, the part you can't see, has a long smooth taper followed by fine threads right up to the underside of that small hex. The collar is threaded onto the outside of the hose while the pipe is threaded into the center, jamming that taper into the ID of the hose and compressing it within the sleeve. Very secure; in fact, you'll probably have trouble getting it apart. You need to hold the hose itself and the pipe still (clamp the hose in a vice and use a wrench on the small hex on the pipe) and turn the aluminum collar in the direction that should unscrew it off the end of the pipe. This is the same direction that will unscrew it off the hose, so turning the collar in this direction will pull the tapered end of the pipe out of the hose.

That all may have seemed like useful info, but it's probably not. The R-12 hose these fittings were designed to work with is no longer manufactured (although there are generic hoses that will work just as well, if you feel the need to rebuild an R-12 hose). The barrier hose will *not* work with these connections. You are screwed.

Fortunately, as long as the tubes are steel, any industrial hose shop can come to your rescue. They simply saw off that hokey threaded fitting and braze on a barb and crimp the barrier hose to that. It's not even particularly expensive. As an example, I had the two low pressure hoses rebuilt, and the only fitting they had to cut and braze was the one that connects to the compressor with the service port on it; the other three fittings were replaced with brand new aluminum fittings. The total for two new hoses, three new fittings, one braze job, and four crimps came to less than \$50.

I can't prove it, but I highly suspect that if your XJ-S has aluminum tubes, it also already has crimped connections and barrier hoses.

See page 472 for general guidelines on A/C hose rebuilding.

You can simply purchase new hose assemblies from Jaguar with either R-12 or R-134a service ports on them -- if you're made of money. Or you can purchase them from John's Cars (page 668), reportedly much cheaper. Remember, it doesn't matter which type service ports it has, a new hose will be the barrier type.

OIL: There are three types of oils to discuss here. The oil used with R-12 is called mineral oil. There are two types of oil used with R-134a called ester oil and PAG oil. There actually appear to be two versions of that last one, PAG 1 and PAG 2.

Mineral oil is worthless in an R-134a system. The oil within a freon system is dragged around the circuit by the freon with the sole purpose of lubricating the compressor. In order to get to the compressor, it must mix properly with the freon and travel with it. Mineral oil will mix with R-12 and travel around the circuit, but it won't mix with R-134a; it just settles to the bottom of the condenser or wherever and the compressor seizes up. So, you must use either PAG oil or ester oil in a system with R-134a.

If you leave the old mineral oil in there settled to the bottom and then use ester oil with the R-134a, you may be in trouble. Mineral oil won't mix with R-134a, but it does mix with ester oil. The result is that the ester oil ends up all dissolved in the old mineral oil, and they both settle to the bottom -- and your compressor runs unlubricated. Just how much trouble you end up in apparently depends on exactly how much mineral oil got left in the system. If you think you'll be leaving a significant amount in there, you should plan to use PAG oil -- which doesn't mix with mineral oil and therefore will lubricate the compressor no matter what.

The recommendations of “experts” fall into two camps here. The major automakers, laying out shop procedures for the mechanics in their dealerships to conduct R-134a retrofits, recommend that the system should *not* be flushed and PAG oil should be used with the R-134a. They claim, as in the excerpt from Jaguar above, that this is because it’s not possible to flush all the mineral oil out. Skeptics believe they actually have other reasons. For one thing, not having to even try to flush saves the shop time and effort. But perhaps more importantly, not having to deal with the solvents necessary to flush an R-12 circuit keeps the EPA, the fire department, and the A/C component manufacturers off their backs. In years past, substances used to flush R-12 circuits have included R-12, mineral spirits, and a host of other substances, all of which were trouble one way or another -- and some of which were arguably of limited effectiveness in getting the old mineral oil and contaminants out.

Everybody except the major automakers suggests that you flush the system and then use ester oil with the R-134a. For one thing, suitable solvents for flushing are now commonly available -- although they’re not cheap. You can buy flushing solution in any auto parts store for around \$15/quart.

For another thing, the mineral oil takes up space within the system; the less mineral oil that’s in there, the more R-134a you’ll be able to put in. Note that for some reason R-12 systems often seem to have a lot more mineral oil in them than specified. Apparently each shop that works on the system tends to put more oil back in than they took out, probably just to be on the safe side. The massive accumulations of oil over the years of service detract from the performance of the system -- and adding in the ester oil on top of it may result in very poor performance indeed.

There are also theories that the mineral oil, when not being suspended by R-12 any more, tends to coat the inside surfaces of the condenser and evaporator, impeding heat transfer and reducing the effectiveness of the system. When somebody complains that converting to R-134a resulted in less cooling capacity than R-12, it’s more likely they’re experiencing these sorts of problem than seeing the true difference in the refrigerants.

Note that you’re not supposed to flush through either the compressor or the dryer. Plan accordingly.

If you intend to continue to use non-barrier hoses with the R-134a, it’s also not recommended that you flush the hoses. The solvents will remove the mineral oil from the inside surface, increasing the likelihood that the hoses will leak R-134a.

This system will require about 10-12 ounces of oil. It will require this much ester oil regardless of how much mineral oil you believe may remain in the system, because the mineral oil doesn’t count when R-134a is the refrigerant. Ester oil comes in pressurized cans containing oil plus some R-134a; the 11-ounce can provides 8.5 ounces of oil, and the 4-ounce can provides 2 ounces of oil. If all you’re doing is converting a working system, one can of each size would be a good oil charge.

If you’re replacing the compressor, it is generally recommended that you put some liquid oil into it prior to installation. Ester oil is also available as an 8.5-ounce can of liquid for such purposes.

If the compressor has too much oil in it while it’s being installed, some of it may leak out when the caps are removed from the suction and pressure ports to connect the hoses. Aside from being messy, having an unknown amount of oil leak out means that you won’t know how much oil remains inside. James Teston suggests “Depending on what you are taking apart, you may be able to connect the high and low pressure hoses to the compressor end before you install the compressor.” He suggests you can tighten the attachment bolt enough to effect a seal but loose enough that you can reposition the hoses the way you want them after the compressor is in place.

This author recommends the following procedure for adding ester oil to a dry compressor being installed in a flushed system. First, with the compressor on the bench with the nose downward and the ports upward, put some liquid oil in the suction port -- but no more than three or four ounces. You may need to turn the hub at the front a bit to get even that much oil to go in, but don’t turn it more than one full turn because it’ll start pumping the oil out the pressure port. Reapply the caps or install the hoses and cap the other ends of the hoses; ester oil will absorb moisture from the air, and you want to minimize that happening. Ideally, let the compressor sit nose-down for a while to allow the oil to seep down towards the front seal. Install the compressor. Then with the suction line disconnected from the fuel cooler (disconnect it if necessary), hold that end of the hose upward and pour the rest of the oil from the 8.5-ounce can directly into the end. As it flows down towards the compressor, turn the hub of the compressor slowly by hand to help draw it into the works.

After the system is buttoned up and evacuated, add another 2 ounces of oil while charging by connecting a 4-ounce can to the low pressure service port.

O-RINGS: The O-rings used in an R-12 system will not dissolve upon contact with R-134a. That's not the concern; the concern is with the size. If you take two identical O-rings and dunk one in R-12 and the other in R-134a and leave them a few months, the one in R-12 will end up a bit larger than the one in the R-134a.

Imagine the O-rings in your system are in good shape, rubbery and pliable, and are properly compressed between surfaces in their respective installations. Then the R-12 is replaced with R-134a and the rubber shrinks a bit accordingly.

Will this cause a leak? Probably not. The compression of O-rings is generally far more than the shrinkage caused by the refrigerant change. Hence, the kits don't mention having to replace O-rings.

Now, imagine the O-rings in your system are old and tired. They've been in there for a few years being subjected to heat soak every time you park the car in the sun on a hot summer day. If you could pull them out and hold them in your hand, they wouldn't have a round cross-section; they've taken on the distorted shape they got from being compressed. They're still not leaking, though. Now, when you replace the R-12 with R-134a and they shrink a bit, are they gonna leak? You betcha!

Before you go worrying a great deal about this issue, note that all of the O-rings in the XJ-S are relatively easy to get to and replace. Well, except perhaps those at the expansion valve -- but you may be replacing the expansion valve as well after you read about it below.

Yes, there are special O-rings made for R-134a conversions. They are typically green -- but the green is merely a light dusting of chalk, you can rub it off and the O-ring is black underneath. The green coating indicates that this O-ring is a hair fatter than the standard O-ring, making it compress properly in grooves sized for standard O-rings exposed to R-12.

The dust also helps you get the parts together, which may otherwise be a little difficult with O-rings that are fatter than the assembly was intended to fit.

Jonathan Sterrett says, "There is no incompatibility between the refrigerant types and the O-rings in question, but rather between the early R-134a lubricants (PAG) and O-rings used in R-12 systems. The new ester oils are compatible with the O-rings from R-12 systems."

COMPRESSOR: There are two concerns in the compressor: O-rings and the shaft seal. The O-rings are discussed above. You're not likely going to take the compressor apart to replace O-rings, but as suggested before it's not likely you're converting to R-134a for nothing -- you have probably decided to convert in the midst of a compressor replacement! If so, don't worry about the O-rings; any rebuilt compressor will have been assembled with suitable O-rings.

Joe Bialy says, "Jag sez that only Sanden units need to have their shaft seal replaced for R-134a retrofits. The Harrison does not require any modification at all."

EXPANSION VALVE: The general discussion on the expansion valve is on page 471. The expansion valve is a throttling valve that responds to pressure. As discussed in an earlier section, pressure within a closed freon circuit is a function of temperature. The expansion valve is trying to hold the evaporator at a pressure corresponding to a temperature in the 30's F.

Now you go and replace the R-12 with R-134a. The pressure in the system is still a function of temperature, but it's now a *different* function of temperature. The expansion valve is still trying to hold the same pressure, but that pressure no longer corresponds to a temperature in the high 30's F. It apparently corresponds to a temperature in the 50's, if the reports from people who have done this conversion are any indication.

Once again, the switch to R-134a is blamed for a loss of performance -- but it's not the R-134a's fault, the wrong expansion valve is in there! Regardless of "capacity", the system should provide air in the upper 30's F when lightly

loaded. If the wrong expansion valve is used, it'll never get colder than 50's F regardless of load. This isn't a capacity issue, it's a control issue -- the expansion valve is not controlling the freon flow properly.

Ed Sowell reports that the expansion valve he got for his conversion was clearly labelled as being for R-134a. It's not likely anyone would bother with such marking if the expansion valves weren't different for R-12 and R-134a.

Again, the kits don't mention replacing the expansion valve. Perhaps they consider 50°F air cool enough. It's not really, though, since it won't dehumidify as well and it will require more fan speed to achieve comparable cooling. If you want this system to work right, replace the expansion valve.

Having to replace the expansion valve might, at first blush, seem a powerful argument for going with Freeze-12 or one of the other refrigerants that claim to be a functional equivalent of R-12 and therefore don't require an expansion valve change. Not only is the R-134a expansion valve perhaps \$35, it's also a serious PITA to get to in the XJ-S. There's one more factor to consider, though: if you're replacing the compressor and the rebuilt compressor you get has any sort of warranty on it, that warranty always requires that the dryer and the expansion valve be replaced along with the compressor. Since the rebuilt compressors seem to vary greatly in quality and reliability, that warranty is important. You probably want to replace the expansion valve. And be sure to keep the receipts for both the expansion valve and the dryer, especially if you buy them somewhere other than where you get the compressor.

DRYER: The general discussion on the dryer is on page 471. When converting to R-134a, the desiccant inside the dryer must be compatible with R-134a. Apparently all modern dryers are compatible with either R-12 or R-134a, but some original dryers may not be compatible with R-134a. At this point, if there's still a dryer in there that's old enough it might not be compatible with R-134a, replace it.

Again, the kit doesn't mention replacing the dryer. They are describing replacing the refrigerant in a perfectly working system, one that hasn't sprung a leak. They're apparently also presuming the system is new enough that the dryer is compatible with both refrigerants. If your system has been opened or sprung a leak and lost all the freon, you probably should replace the dryer anyway.

CONDENSER: The nature of R-134a is such that, when an R-12 system is converted, it will demand more from the condenser. If no other changes are made, that means that the condenser will run a bit hotter; the temperature will increase until it can transfer enough heat to the air to meet the load.

Again, pressure in a closed freon circuit is a function of temperature. With the condenser running warmer, the high side pressures will be higher. R-134a operates at higher pressures at the *same* temperature, so higher temperatures are a double whammy pressure-wise. No, the kits don't mention doing anything about this; presumably most systems can take these changes without damage.

Allow me to remind you that high side pressures are already a known concern with the XJ-S. You can review this problem on page 476. When you consider that the car may already be stressing the compressor to the breaking point, switching to R-134a is just asking for trouble.

If you have the stock belt-driven fan and everything else in the airflow situation is OEM, personally I would recommend that you do *not* switch to R-134a without addressing the condenser situation. Sure, if your fan clutch is in perfect condition, the idle isn't set too low, the foam surrounding the radiator and condenser is intact, there are no leaves or debris in there plugging up the airflow path, etc., etc., you *might* be able to get away with it. You're still likely to have a system that performs poorly, though. And the fact that the condenser is dumping more heat in front of the radiator isn't going to help your engine cooling, either.

There are two ways to increase the condenser capacity to avoid problems. The first is to replace the condenser itself with a bigger one -- more rows or whatever. Jaguar apparently went this route when they introduced an R-134a system in the XJ-S in 1994, so you might actually be able to purchase a higher-capacity condenser from Jaguar that will fit.

The other way is to increase the airflow over the condenser. The cheap and easy way would be to add a "pusher" electric fan on the front of the condenser blowing through it. You can simply wire a relay to operate these fans

whenever the compressor is engaged. Or, you can take the opportunity to have them also come on whenever the small OEM electric fan comes on, so they can do double duty and help keep the engine cool as well.

Of course, you could go ahead and replace the belt-driven fan with a powerful electric fan or any of the other various suggestions along these lines presented beginning on page 209.

If you have one of the later cars that doesn't bring on the small OEM electric fan when the compressor comes on, by all means revise that wiring so the fan comes on. Arguably should be done regardless, but with the conversion to R-134a it becomes doubly important.

Chuck Sparks suggests that, while you have the system torn apart anyway, take the condenser out and give it a good scrubbing to get all the road grime off the outside. This will make it transfer heat better. Of course, one could argue that it would merely give you false confidence in your system, since obviously it'll have more road grime on it sometime after you get this system together and running.

HIGH PRESSURE CUT OUT SWITCH: If you read that last section on the condenser, perhaps you understand why some suggest installing a High Pressure Cut Out (HPCO) switch that disengages the compressor if the pressure exceeds a certain value. If the condenser capacity problem isn't addressed, such a switch will likely result in the compressor cycling on and off. Basically, the condenser will get hotter and hotter until the switch shuts the compressor off, then the condenser can cool off until the compressor comes back on. This will provide cooling, just at a reduced capacity. It also may cause premature failure of the compressor clutch, what with all that cycling.

Of course, you really should address the condenser issues as described above. It won't hurt to install the HPCO switch anyway, but if you do the condenser job right it'll never come into play.

If you're not confident of your condenser/airflow situation, by all means install a HPCO switch. If the pressure exceeds the pressure relief valve on the back of the compressor, it will piss away your freon until the pressure drops to safe values. After that your system will remain undercharged and *never* cool as it should, even when there is adequate airflow through the condenser! With the high pressure switch, the compressor can be shut off to limit pressure without losing any refrigerant which leaves it properly charged so it can cool properly when pressure isn't an issue -- such as when the car is moving at highway speeds and there is gobs of air flowing over the condenser. With any luck at all, the high pressure switch will only come into play when the car is idling at a stoplight in hot weather.

"Muxika" describes the HPCO switch: "...a cut off switch connected in series with the A/C clutch set at 350 psi. (GM/AC Delco part # 15-5514)." The GM part number is 15981985. A search of the www turned up switches that cut out anywhere from 325 psi to 410 psi. As reference: Ideally the high pressure side should operate around 250 psi, and anything over 325 psi should be considered overheating. The pressure relief valve on the back of the A-6 compressor is supposed to open at approximately 430 psi.

Any suitable HPCO switch has either internal damping or a wide dead band or both to make sure the compressor doesn't cycle on and off too quickly.

White Industries (<http://whiteac.com>) also offers such a switch, part number 03245-SP. You can also get one that's made by

FJC
Post Office Box 499, Mt. Mourne, NC 28123-0499
101 Commercial Drive
Mooresville, NC 28115
704-664-3587 Fax: 704-664-5522
<http://www.fjinc.com/>

Their HPCO switch part number is 3245. Hmm. Seems related to that White Industries number.

As long as you're plumbing in an HPCO switch, you can plumb in a switch that does more. You can purchase a "binary safety switch" which not only shuts off the compressor if the pressure is too high but also shuts it off if the pressure is too low -- which would mean the freon has all leaked out. Later XJ-S's come with a low pressure switch already built

into the back of the compressor, but if you have an earlier car with a 3-terminal fuse you might want to consider a binary safety switch and abandon that 3-terminal fuse idea -- especially if your replacement compressor doesn't have the correct type port to fit the temperature switch that operates the 3-terminal fuse.

You can also opt for a "trinary switch". Besides the two functions of the binary safety switch, the trinary switch will also bring on an electric fan on when the pressure rises above 220 psi. That means it only runs the fan when truly needed rather than whenever the compressor is on.

There are dozens of places that offer binary and trinary switches, often specifically intended for particular cars -- none of which ever include Jaguars. For our purposes, you can use a generic. You can get one from

Hot Rod Air, Inc.
9330 Corporate Drive, Suite 308
Selma, TX 78154
Orders: 1-877-693-3200
Tech: (210) 651-0040 Fax: (210) 651-0070
<http://www.hotrodair.com/>
E-Mail: sales@hotrodair.com

Once you pick a switch, you must connect it into the high pressure line. There are at least four ways to do this. One option is to purchase a "saddle clamp" that clamps onto the outside of a tube and then a pin is screwed down to puncture the tube underneath. GM dealers have such a saddle clamp, part number 15985307.

Another option is to purchase a tee that is fitted to the high pressure service port and provides a switch port and a new service port. Conveniently, these are available that screw onto the R-12 port and provide an R-134a port, so it replaces the high pressure port adapter. Make sure to get one that fits the pre-1976 R-12 high pressure port which is a 1/4" flare fitting. White Industries offers a suitable tee, part number 02638-SP. FJC also offers the correct tee, part number 2638. Hmm, they seem related again.

As an aside here, several companies offer a selection of "service port extension hoses". These are hoses about a foot long that you screw onto a service port and leave in place permanently, and use the other end of the hose as your service port. The intent is to deal with service ports that the automaker chose to put in totally inaccessible locations. There are no such access problems on the XJ-S, the service ports are right up top -- but you might opt to use one of those service port extension hoses to locate your service port adapter tee and HPCO switch somewhere where the hood won't slam on it!

Another method for connecting your HPCO switch is with a tee that is installed at a hose connection. On the XJ-S, this would have to be installed at the right front corner of the engine compartment where the high pressure hose connects to the line to the condenser. The hose connects to the tee, the tee screws onto the condenser line. It effectively makes the hose a little longer, but that shouldn't hurt anything. Hot Rod Air offers such a tee.

A fourth method is a tee that is spliced directly into the high pressure hose. It'll require a crimping tool to install, but if you have a crimping tool it may be the cheapest option.

Pressure equals temperature in a closed freon circuit. So, in lieu of a pressure switch, you could install a temperature switch. This might be easier as an add-on, since a temperature sensor can be strapped onto the outside of a tube rather than having to be connected into the line itself.

COMPRESSOR CYCLING SWITCH: Some automobiles have a "cycling switch" that turns the compressor off when the low side pressure gets too low. Pressure corresponds to temperature in a closed freon circuit, so what it's really doing is preventing the evaporator from getting too cold and possibly icing up. Since switching from R-12 to R-134a changes the pressure/temperature relationship, you need to adjust or replace this switch so that it cycles the compressor off at the correct temperature.

The XJ-S doesn't have a compressor cycling switch. Instead, it uses a Ranco thermostat that directly measures the temperature of the air coming off the evaporator and cycles off the compressor if this air gets too cold. So there is no need to worry about this when changing refrigerants.

CHARGING: Charging is fairly straightforward, and is described in the instructions that come with any kit. Note that the instructions will include putting a large can of ester oil in via the low pressure service port, but if you've replaced the compressor you should have already added 8.5 ounces of oil in liquid form so you will only be adding a small can at most at the port.

The rule on R-134a is to fill with 85% by weight of the amount of R-12 the system used. The Jaguar V12 with the A-4 compressor uses 2.5 lb of R-12, so it should take about 34 oz. of R-134a. Buy three cans.

Many people conclude that since it takes fewer ounces of R-134a than it took in R-12, you're not supposed to fully charge the system with R-134a until there are no bubbles in the sight glass. This is incorrect; no gaseous refrigerant in the liquid line is a fundamental requirement of a properly functioning freon circuit regardless of what type of refrigerant is used. The reason we use only 85% as much R-134a is because R-134a is less dense than R-12.

There are warnings everywhere that the sight glass is not a reliable indicator of proper charge with R-134a. There are two reasons for these warnings. First, PAG oil will tend to fog over the sight glass under certain conditions, which means you won't be able to see any bubbles whether they are there or not. Obviously, if you planned on relying on the sight glass and neglected to keep track of how many ounces of R-134a you've been putting in, you're screwed. So warnings are in order: keep track of how much R-134a you're putting in, because the sight glass is not a reliable indicator of proper charge. You didn't think about it meaning it that way, did you? Fortunately, the fogging problem apparently doesn't apply to systems using ester oil.

The second reason does apply. If the condenser is inadequate for use with R-134a and you don't install an HPCO, you will end up with a system that is either undercharged or overheated. Undercharged is better. So, while ideally the system will have an adequate condenser and run pure liquid in the liquid line, you may be compelled to undercharge the system and put up with the (considerable) reductions in performance in order to limit the high side pressures. A better idea would be to install a HPCO switch as described above and fully charge the system -- but if the condenser shortcomings are not addressed, it's going to be cutting off the compressor a *lot*.

As with R-12, you will need a device to connect the cans of oil and refrigerant to the low side port in order to charge it. Unlike with R-12, you have more choices here. With R-12, there was really only one type: a brass valve that attached to the top of the can with a little spike that punched a hole into the top connected to a short length of hose with a brass threaded coupling on the end to connect to the port.

With R-134a, you can get a very similar filling kit of similar construction for a few bucks. Of course, it's not the *same* kit; the one for R-134a fits a different type port on the car, and it also fits a different can. Cans of R-134a have a little threaded nipple on top to connect to.

Besides that type, there's also a similar device made entirely of plastic.

Perhaps most intriguing of all, though, there is a device that attaches directly to the can and you turn the can over and jam it down onto the quick-disconnect port. No hose, no valve. I suspect you are not supposed to use this type to fill the system, since you could easily introduce liquid refrigerant into the low pressure port. It appears that this type is chiefly used for such things as adding dyes or sealers to the system.

If you want to be more professional and careful about what you're doing, you want to have a "manifold" which is an assembly with three hoses, two gauges, and an assortment of valves. One hose connects to the low pressure service port, another connects to the high pressure service port, and the third connects to the vacuum pump or the freon tank or whatever you happen to be fiddling with. Once connected up, you just open and close valves to service the system. Very slick. And, perhaps more than the home mechanic is interested in paying.

There is a lower-cost solution for the home mechanic. There is a package offered that contains one gauge that measures both pressure and vacuum. It comes with the same type of short hose described above for the filling kit, with a quick-

disconnect on the end for connecting to the low pressure service port. But the package also contains an adapter: a quick-disconnect that connects to the high pressure service port and presents a low pressure service port to connect your hose to! That just seems wrong somehow, they went to all this trouble to provide different ports so you couldn't possibly connect the freon can to the wrong port and have it explode in your hand, and then they go and make this adapter that allows you to do it anyway! But as a practical matter it's a cheap way to use one hose to connect a gauge to either port, just don't do anything stupid.

Delanair MkII (up to 1987)

TRAINING MANUAL: Jaguar, back in the days of British Leyland control, issued a "British Leyland Service Division Dealer Training" manual, "Aid # S1002" on the Environmental Control System. Although it's described as intended for the "Jaguar XJ6, XJ12 Series Two", the same basic system was used in the pre-1987 XJ-S. This book is long out of print, but if you happen to find a dealer or mechanic with one you definitely want to have a copy made.

SCHEMATIC CORRECTIONS: This clarification applies to the "Air Conditioning" diagram in at least one early-80's edition of the owner's handbook as well as Figures 10.125 and 13.94 in Haynes manual 478/49015. There is a BU wire that comes from the left connector on the M1, M2, and High speed relay coils and eventually ends at the low speed switch (192D). Another wire, no color indicated but I'm betting it's black, comes off the left connector on the Low speed relay coil and wraps around the bottom of the entire schematic, clearly the ground for everything. At the top left corner of this diagram, it appears these wires are connected -- but they are not. A little Liquid Paper is in order to make this clear.

HEATER CORE REPLACEMENT: The heater core ("heater matrix" for you Brits) in the Delanair MkII has integral pipes that extend through the firewall, where hoses connect it to the engine cooling system. To get it out intact requires disassembling the entire dashboard and A/C system, including discharging the freon circuit.

Michael Neal recommends shortcircuiting the heater core removal to keep from pulling the dash apart. The instrument pod must still be removed, and dropping the steering column down is required. But total disassembly can be avoided by cutting the pipes and installing the new core using short pieces of hose with clamps. Neal is an official Jaguar mechanic and highly recommends this method; there is nothing wrong with using heater hose for such an application, and disassembly of the entire system is likely to cause further problems unless done by an experienced Jag mechanic.

Greg Price sends a detailed checklist: "To those who have to replace their heater cores and want to cut the pipes rather than disembowel their entire interior, the procedure is pretty straightforward with the following caveats:

1. You don't have to take the driver's seat out, but it might make a more comfortable working environment.
2. The steering column must be removed in order to make room for the heater core to slide out. The steering column is held up under the dash by four bolts. These bolts have spacers, washers, seating rings and a steel piece that holds the nuts. Before removing the steering column, take out the tach and speedo, then look inside with a flashlight to see where all of the little spacers and miscellaneous bits go. Take notes. As soon as you start to remove the four bolts, all of those bits bail out.
3. Take a Polaroid picture of the heater mechanism area before you start taking things out. If you can't buy or steal a Polaroid camera, draw a very detailed map of the area, and pay attention to what goes under or over what.
4. As you remove the screws and such, tape them to a sheet of paper in the order that they were removed. It makes the orderly reassembly that much more orderly.
5. Buy the best hose clamps you can find. Get those swedish jobs that you can torque down with an impact wrench.

6. Use silicone to seal the hose to the pipes.
7. Cover everything. Twice. Brass shavings fly everywhere when you cut the pipes (especially if you use a pneumatic cutoff tool). Silicone always ends up everywhere except where you want it.
8. Be mindful of the hazard light switch. It's easily mangled. I think mine will hold together (I hope).
9. Plastic wire ties are great for holding all of the excess wiring and plumbing up out of your way.
10. Don't drain your cooling system like the manual says. Pull off the heater hoses, plug them temporarily, then blow the remaining water out of your heater core with compressed air. Keep your face away from the outlet.
11. Watch out for the fiber optic line going into the ignition switch cover. Remove the switch cover and tape it up out of the way with the fiber line before you drop the steering column.
12. If your cruise control doesn't work, now is a good time to check the steering column wiring and speed set switch.

"The entire procedure took me about 3 and a half hours (including a short dinner break), which beats the hell out of disassembling the dash and console."

STUB DUCTS: The stub ducts that the rubber ducts connect to are easily removable; just twist CCW. This can be really handy for getting to some things, such as the 12V terminals on the firewall. Richard Mansell says, "these can also be pulled off to get at the top of the A/C drain tubes." To reinstall, just offer them up to the holes and turn around until they pop into place, then turn them CW to lock.

BLOWER FANS - INDIVIDUAL SPEEDS NOT WORKING: The four blower speeds are controlled by four relays built into a single unit that is located adjacent to the left side footwell; the footwell register and the small padded cover must be removed to get at it. If one of these four relays quits, one speed of the blowers no longer works, and the A/C system just skips over it from the next lower speed to the next higher speed and back. The result can be a little disconcerting, since the bigger change in speed is quite noticeable, and since it may be more change than necessary the system can end up cycling back and forth between the two speeds a lot when it would have been happier just staying at the middle speed. Even worse, if it happens to be the "low" speed relay that fails, the A/C compressor can be operated without a fan running which is not good on the equipment and may cause the compressor to kick in and out on its own thermostat trying to prevent iceup.

This four-relay assembly appears to be a common failure: this author has had three of the four relays inside it fail, and others report similar results.

I took the box apart and fixed it each time. The unit is tough to get out of the car, but once out it is a simple matter to bend the plastic edges back and pry open; you might even try bending the edges back and prying the base out *without* removing it from the car, since the base will carry all the important parts and you'll simply leave the plastic housing in place. Be careful; the NW wires connecting to the terminal with the screw (and several of the components inside, if you don't disconnect this wire before opening) are hot at all times unless you have disconnected the battery.

The coils are designed to be on continuously, so they don't burn up; the problem always seems to be broken connections. The thin wires from the relay coils break off of the terminals, and soldering them back on makes it work as good as new. However, there is a theory that these long thin wires spanning considerable distances within this assembly are the cause of the problems; a vibration in the car, perhaps at a particular speed or engine RPM, may resonate these wires like guitar strings and break them off.

So, instead of just reconnecting them, fix the problem. On each coil, the skinny coil wire comes out of the coil and is wrapped a couple of times around a plastic lug on the side of the coil before running off to the terminal. Solder a larger gauge wire to the terminal and route this larger wire to the plastic lug on the relay and wrap it around a couple times,

then solder the end of the coil wire and the new thicker wire together right next to the lug. Hence, the thick wire spans the distance to the lug, and the thin coil wire is well supported.

Alternatively, just replace the individual relays that go bad. Brian Sherwood "Found a portion of the fan control relay was inop, no fan on "low". Removed four wires from bad portion of relay block and plugged into a generic 12-volt relay with spade terminals; fan works fine now. Fan control relay is located in center console, LH side under heater unit."

The four relays are located at the four corners of the unit. The "low" relay, at the bottom right corner as you look at it, seems to be wired with four wires as Sherwood described. The other three relays, however, each have two wires going to them, plus there are two commons going to the whole set of three. A large NW wire provides 12V power to all three contacts to power the blowers. A small BU wire provides a common switched ground for all three coils. The signal to the relays comes via BY, BG and BW wires, and the power to the resistor pack and blowers is via larger U, R, and GS wires.

If the low relay fails, you can replace it with a standard automotive relay, such as those sold for driving lights; merely remove the four wires from the box and connect the B and NY wires to the coil and the NW and Y wires to the contacts, as Sherwood suggests.

If one of the other three relays fails, you can still replace it with a standard relay. Connect a wire from the BU wire to one side of the coil (without disconnecting the BU wire from the other relays on the board), and simply pull the BY, BG or BW wire off the terminal on the faulty component and connect it to the other side of the coil. Connect a heavy wire from the NW wire to one side of the contacts (again leaving it connected to the other circuits), and pull the U, R or GS wire from the terminal on the faulty component and connect it to the other side of the contacts.

Either opening the box and correcting the problems or replacing the relays with individual SP relays would probably save a lot of money; generic "driving light relays" will work fine for only a couple bucks each. It's likely to cause less trouble, too; most of the aftermarket generic relays are quite reliable. You certainly don't want to buy a replacement four-relay unit from Jaguar -- after all, the original one is causing trouble, and the replacement isn't likely to be any better. In fact, it might not be a bad idea to simply yank the entire block out of the car and replace it altogether with four generic relays at the first sign of trouble.

Note that British Leyland Service Division Training Manual S1002 on the Environmental Control System shows a separate low speed relay and a box containing three relays; since the manual is intended for the XJ6 and XJ12 Series Two, this probably describes an early arrangement. The wiring schematic appears unchanged, however, and the replacement of individual speed relays with separate units will work just as well.

BLOWER FAN RESISTOR PACK: Component #188 on the schematics. Physically, this unit is mounted in an opening high on the left side of the A/C system, above the heater core pipes. Access to the resistor pack is poor, to put it mildly. If it must be removed, it is suggested that the left side blower assembly be removed first. It is also suggested that a hole be drilled in a piece of structural sheet metal to allow a Pozidriv screwdriver to be used on the upper mounting screw.

The speed of the blower fans is controlled simply by connecting the various resistances in series with the blower motors. These resistor packs are installed in the airstream from the blowers so that the airflow will keep the resistors cool. If the blowers seize or otherwise fail to move air, the result is often a cooked resistor unit due to lack of cooling combined with the high current load due to the mechanical problem.

If one is really cheap or in a hurry, the unit can always be repaired using Nichrome wire from an old toaster or some such, or even by twisting severed wires back together. Do not use solder, as it will melt; all connections must be mechanically attached. Exact resistance values are unimportant, since being off a little will only make the fans run a little faster or slower than original. Note that this unit is so difficult to get to that it would be nice to make *real* sure it doesn't fail again.

BLOWER FAN RESISTOR PACK -- FUN WITH SCHEMATICS: Some A/C system schematics, including Fig. 10.125 in the Haynes, show the blower fan resistor pack (component 188) incorrectly. They show the GS wire to the fan motors themselves being connected to one end of the three resistances, as though all three resistances operate in series. In fact, the GS wire connects between the 0.85 and 0.425 resistances. In M1 speed, power is supplied to both ends of the resistor pack (Y and U wires) so that the 0.85 resistor operates in parallel with the 0.425-1.275 pair. In M2 speed, power is supplied to the R wire in addition, so the 0.85 resistor is now operating in parallel with the 0.425 alone.

The “Air Conditioning” system schematic in the ROM at the end of section 86 as well as Fig. 10.130 in the Haynes show the fan resistor pack correctly.

Also of note, the schematic in the ROM and Fig. 10.130 in the Haynes show one additional circuit by which the high speed position of the control knob will, via diode #D4, operate the M2 relay. Reason unknown; it almost appears to be a backup in case the high speed relay fails.

DEMIST DUCT VANE: The ROM, Section 82.25.21, step 35, says “Ease demist duct vane securing studs from screen rail and recover demist duct assembly.” John Nuttall felt this was unclear, so when he finally figured out what it was talking about he provided the following explanation. Note that this applies to his 1977 XJ-S.

“Removal of this vane uncovers a screw which secures the unit to the car body just below the windshield. The main difficulty with the manual is that it does not make clear just what is the demist duct vane, and I don’t think the official name is a very good description. It turns out that this object is a piece of vinyl covered rubber about 34 in (85 cm) long, 3/4 in (2 cm) thick, and 3in (8 cm) wide in the centre, tapering at the ends. Along its back face is screwed (with 13 screws) a plastic air deflector to direct air to the windshield. This vane fills in the gap between the centre of the fascia and the windshield.

“To remove the demist duct vane you must undo two screws placed vertically downwards at the ends. With the windshield in place it is impossible to do this with a conventional screwdriver. I was able to turn these screws with vise grips. The underside of the vane has two prongs about 17 in (44 cm) apart which engage slots in the unit below.”

CONTROLS: Rob Reilly provides the following system description: “Outside air is drawn in through the grille in the center of the cowl between the bonnet and the windshield. Vacuum operated flaps on the fan motors close off this outside air under certain conditions and draw air instead from inside the car (known as the recirculating mode).

“From the fan motors the air goes through rubber branch hoses to the front chamber of the heater unit. Here *all* the air passes through the air conditioning evaporator and gets cold (if the compressor is on). Then there are four flaps controlled by mechanical linkages which can be seen on the right hand side of the unit. These control what percentage of the air passes through the heater core and becomes warm (if the water valve is open and the water is warm) on its way out to the vents.

“The upper front (meaning toward front of car) flap (“upper bypass flap”) opens or shuts off cold air to the dashboard side vents, center vent, and windshield defrost vents. This air has *not* passed through the heater core. Clockwise is open, counterclockwise is closed, viewed from the right hand side. The center vent and windshield defrost vents also have vacuum-operated flaps.

“The upper rear flap (“upper heater flap”) opens or shuts off warm air, which *has* passed through the heater core, to the same upper vents as the first flap. Clockwise is closed.

“The lower rear flap (“lower heater flap”) controls warm air to the lower vents on the sides of the transmission hump and to the duct hoses going to the rear vents under the center console armrest. Clockwise is open.

“The lower front flap (“lower bypass flap”) controls cold air to the lower vents. Clockwise is closed.

“On the left side is a vacuum actuator and linkage which, when the selector is on DEFROST, will be up (vacuum off) and prevents the bottom heater flap from opening.

"There is a servo motor on the lower right which operates some more micro-switches, vacuum line valves, and mechanical linkages, and is in turn controlled by the temperature setting and several temperature sensors through the amplifier and relay on the lower left.

"The left hand knob (temperature control) turns a variable resistor. The resistor should have a resistance of zero ohms at the 85 degree mark and 10,000 ohms at the 65 degree setting. There are three solder pins on this thing, one of which should not be used. If you had a high resistance in the circuit the unit would think you're asking for cold air and would turn the stepping motor to give it to you.

"The small device mounted on the lower tube of the heater core is a temperature-controlled on/off switch which disables the blowers until the water warms up." Actually, it limits the blowers to low speed.

CONTROLS -- VACUUM LOGIC: The following logic chart was graciously provided by John G. Napoli:

Jaguar Climate Control Vacuum Logic -- Representative of 1982 XJ-S HE

Compiled by John G. Napoli

	<i>Control:</i>	Vacuum Switch		Cam Switch		Vacuum Solenoid
	<i>Item Controlled:</i>	Screen Flap	Lower Heater Flap	Water Valve	Center Dash Flap	Blower Flaps
FULL COOL	Control Status:	On On		Open	Open	Energized
	Item Status:	Closed	Open, and overridden by flap	Closed Open		Closed
	Vacuum Status:	Vacuum	Vacuum	Vacuum	Vacuum	Vacuum
FULL HEAT	Control Status:	On On		Closed	Closed	De-energized
	Item Status:	Closed	Open	Open	Closed	Open
	Vacuum Status:	Vacuum	Vacuum	No Vacuum	No Vacuum	No Vacuum
FULL DEFROST	Control Status:	Off Off		Closed	Closed	De-energized
	Item Status:	Open	Closed	Open	Closed	Open
	Vacuum Status:	No Vacuum	No Vacuum	No Vacuum	No Vacuum	No Vacuum

Notes:

In FULL COOL, recirculation is enabled because the vacuum solenoid is energized. A NORMAL A/C mode is therefore implied with the vacuum solenoid de-energized.

In FULL COOL, everything gets vacuum.

In FULL DEFROST, nothing gets vacuum (default system operation if system fails).

In FULL HEAT, only the items fed by the vacuum switch get vacuum.

The vacuum switch is attached to the right hand climate control knob (Positions: Low, Auto, High, Defrost).

The cam switches are part of the servo. The servo is mounted on the right of the climate control unit under the dash (next to the right hand occupant's left shinbone).

The vacuum solenoid is mounted on the left of the climate control unit under the dash (next to the left hand occupant's right shinbone).

Water valve is located on center of firewall in engine compartment.

Dashboard may have to be removed to access flaps. Always check operation of and adjustment of servo linkages when troubleshooting this system. There are two blowers (left and right). Check them both!

Some later XJ-S's may have a manual override enabled by pulling the right hand climate control knob out and turning. Reference to this feature was seen in a 1983 XJ-S Owner's Manual.

CONTROL MICROSWITCHES: The right side control knob has microswitches behind it that are often found to be the source of trouble. However, Ron Whiston points out that the problem is often not a failure of the microswitches themselves, but simply that they are incorrectly positioned relative to the cam; turning the knob doesn't move the switch enough to make it click. Even though the mount holes are not slotted and are not intended to provide any position adjustment, merely loosening all the mount screws and holding the switches inward while tightening them back down will often correct all problems.

TEMPERATURE CONTROLLER: Reportedly, the wirewound pot has problems. See Exotic Auto, page 657.

CONTROL LINKAGE ADJUSTMENT: The ROM describes an adjustment procedure that is unclear and covers only a couple of the adjustments needed. The illustrations are tiny and poorly labeled. Below is a procedure that should enable a more complete adjustment of the linkage. See **Figure 25** and **Figure 26**.

While performing these adjustments, keep this concept in mind: The difference between a flap being fully open and 90% open is insignificant; there is a lot of airflow in either case, and the passenger will not be able to detect a difference. On the other hand, the difference between a flap that is fully closed and one that is slightly open is *huge*. Therefore, the objective of the adjustment procedure is to make sure that all flaps close fully, and how far they open will be of little concern.

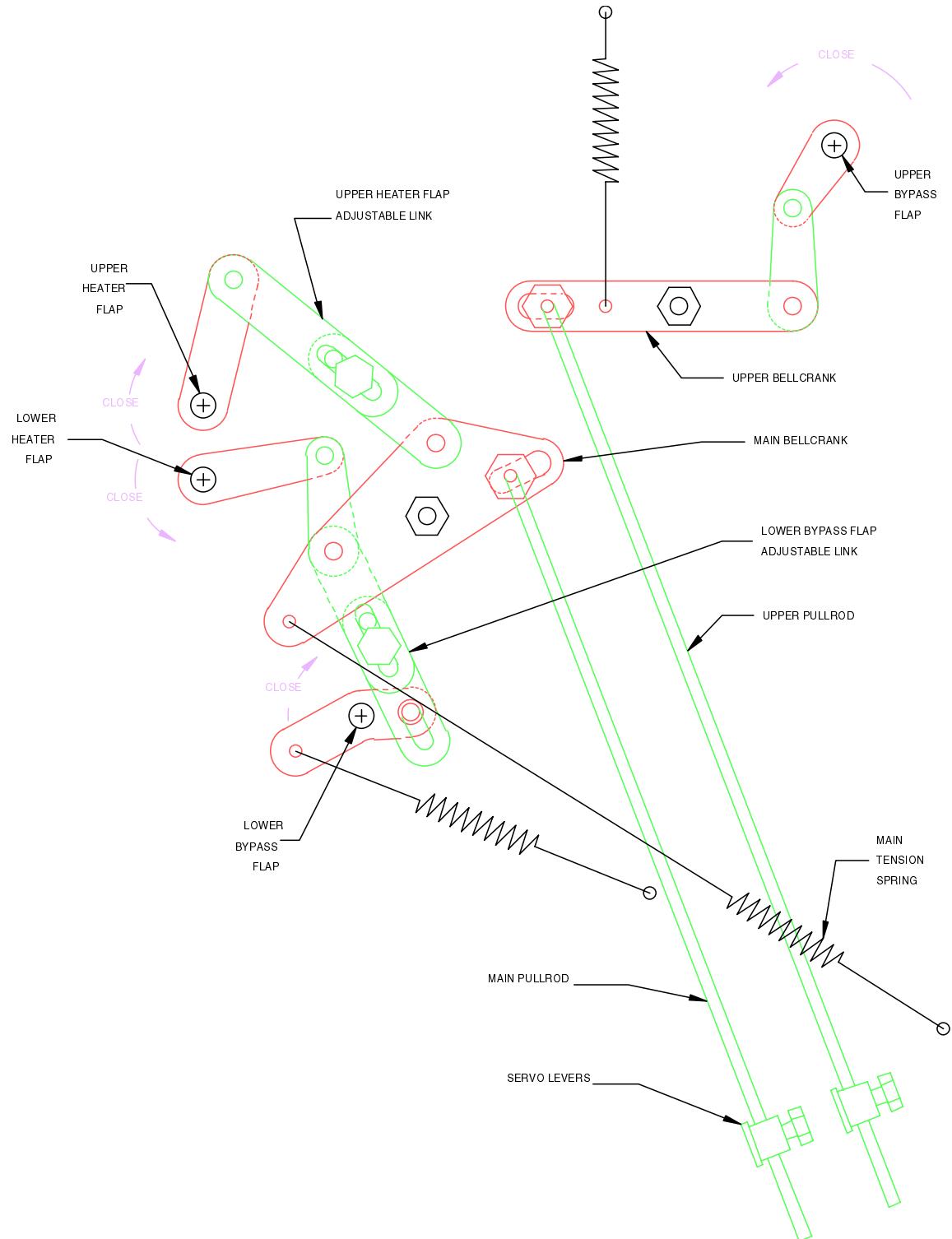


Figure 25 - Climate Control System Linkage -- Early MkII

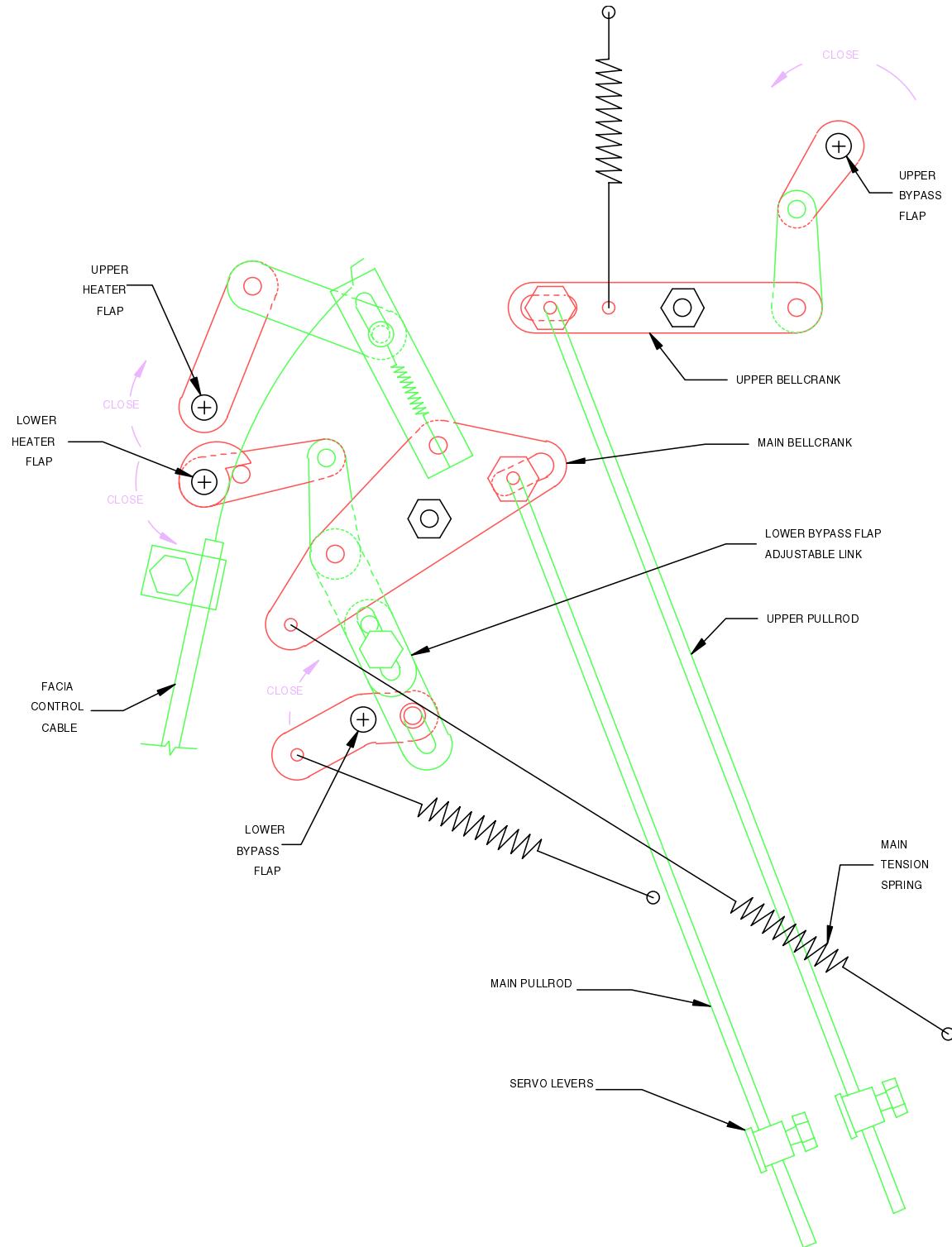


Figure 26 - Climate Control System Linkage -- Later MkII

1. Remove the glove compartment, the “underscuttle casing” (panel above the footwell) on the right side, and the grille and padded panel on the right side of the transmission tunnel.
2. Remove the short steel duct that serves the footwell grille. Be careful not to drop any screws into the works.
3. Loosen the locking screw on the lower bypass flap adjustable link. Loosen the locking screw on the upper heater flap adjustable link if there is one; if the car has a facia temperature control (a slider under the stereo), it will not have an upper heater flap adjustable link as the facia control takes its place. Loosen the locking screws on both pullrods where they connect to the servo control levers.
4. Move the servo to the full cool position, which is where the levers on the servo are held at their most downward position. Note that the pullrods are normally held upward by the linkage springs; with the linkages disconnected, the servo levers will fall down regardless of servo motor operation. You must pull upward on them with your fingers to determine what position the servo is actually in. Note also that operation of the servo doesn't move the levers continuously from one extreme to the other, but rather goes back and forth somewhat; be sure the motor has moved all the way to the extreme position that holds the levers in the downward position before proceeding.

To move the servo, disconnect the main electrical connector to the servo unit, which is a 13-wire connector in the same general area you're already working in. Connect 12V power across the solid purple and solid red wires; if the battery is connected, 12V power is available at the nearby fusebox, at fuses 2 or 3 (RHD cars) or fuses 13, 14, 15, or 16 (LHD cars) so it's a simple matter to run a jumper from the fusebox -- or simply from the cigar lighter, and connect the other wire to ground. If the battery is disconnected, a 9V battery will also work well, running the servo a little slow but it gets there. To run the opposite direction, reverse the power.

5. Turn the main bellcrank clockwise until the lower heater flap is held firmly shut; it may be easier if the main tension spring is disconnected. Hold the main servo control lever up. Tighten the locking screw on the servo lever.
6. If the car has no facia control, hold the upper heater flap in the fully closed position (clockwise) and tighten the locking screw on the adjustable link.

If the car has the facia control, move the slider to the full right position. Loosen the clamp holding the cable housing, and move the cable housing until the upper heater flap link forms a straight line. Lock the cable housing into this position.

To check the operation of the facia control, move the slider to the left. The upper heater flap should fully close, and further movement should be taken up by the spring in the linkage.

7. Move the servo to the full heat position (levers in their highest position).
8. Turn the lower bypass flap to the fully closed position (clockwise). While holding this position, slide the adjustable link to its longest possible length and tighten the locking screw.

The lower bypass adjustable link has a slotted opening to allow the flap to be farther closed than the linkage calls for. To check that this slider works properly, move the servo off the full heat position. Turn the lower bypass flap towards closed, against the force of its spring. The lever should move smoothly in the slotted hole. If it doesn't move smoothly the linkage is probably misaligned, causing it to jam. Determine which way the parts are misaligned. Take the lower bypass adjustable link apart by removing the locking screw entirely and removing the screw holding the lever to the flap. Once out of the car, carefully bend the parts to correct the misalignment. Reinstall, readjust, and check for proper motion again.

9. With the servo in full heat position, allow the spring to turn the upper bellcrank clockwise until the upper bypass flap is closed. Hold the upper servo lever up and tighten the locking screw.
10. Reassemble and test drive.

Note that on later cars there is a vacuum actuator on the left side that holds the lower heater flap closed when the defrost is called for. Vacuum permits lower heater flap operation, lack of vacuum prevents it. To observe the operation of this

actuator, it will be necessary to remove the underscuttle casing on the left side. There is no real adjustment necessary, however, since it is either on or off. Make sure there are no wires or anything obstructing its motion.

Note that the connection of the pullrods to the bellcranks is a nut-bushing that is fitted into a slotted hole on the bellcrank. The procedure above does not address location of the nut-bushing within the slotted hole. This position determines the sensitivity of the system; if the motion of the servo causes the flaps to move too much, the nut-bushing should be relocated farther away from the pivot so that the same amount of pullrod motion won't turn the bellcrank so much, and vice versa if the servo doesn't move the flaps enough. It is recommended that these nut-bushings not be tampered with. If their position is altered, the entire linkage adjustment procedure above should be repeated.

CONTROLS - RANGE PROBLEMS: Olov Carlsson sends this comment: "I had a problem with the temperature control knob being out of range. Even when I put it in the coldest position, the system wouldn't cool properly. It did work, however, which I determined by using the cigarette lighter and holding it under the interior temperature sensor. This sits in a hole that can be felt under the dashboard centre shelf. When doing this the system adjusted itself and cranked out wonderfully cool air."

"There is an adjustment for this on the amplifier unit. I turned it to the cold end position, but this wasn't sufficient to bring the temperature control knob properly on scale.

"My final solution to this was to connect a 10 kohm resistor in parallel with the external temperature sensor, which is mounted inside the right side external air intake. Careful analysis of the circuit diagram and the wiring allowed me to put the resistor alongside the internal temperature sensor. I connected a wire to the appropriate lead on the amplifier unit, the result being that the new resistor effectively was in parallel with the external temperature sensor. This one, by the way, did measure the correct resistance (the same as the internal sensor, when they both had the same temperature). This brought the adjustment on the amplifier unit into range making it possible to calibrate the temperature control knob."

TOO MUCH COOLING: Mike Morrin says, "If the system works properly for a while (10 minutes) and then drifts slowly towards full cooling, then the fault is likely to be in the plumbing to the in-car air temperature sensor. This is a reference to a couple of cases I have heard of where the rubber connector inside the dash had come adrift so that the air temperature *inside* the dash was being measured. There is no cold air supply inside the dash, just heat soak from the engine and heater unit, causing the measured temperature to creep higher and higher, and the A/C to pump full cold into the car."

TOO MUCH HEATING: Tom Bennett says, "Note that the function switch removes the supply from the temperature control circuit when in the DEF position, and this causes the system to move to full heating, so a faulty function switch can cause the system to stay on full heating. But, I was getting considerable air flow from the side and center vents when it was in full heat mode."

Mike Morrin explains: "Yes, because the function switch also has a vacuum valve which directly controls the demist flaps, and is independent of the electric circuit."

SERVO REPAIR: Mike Morrin says, "After cruising for an hour at about 70 mph. with the A/C on (of course), the system all of a sudden went to full heat. I fooled around with the temp selector and after several minutes it went back to normal operation.

"It turned out to be a faulty feedback potentiometer in the servo, so that the amplifier thought the system was on full cold, so was sending the system to full warm. To check this you need to leave a voltmeter connected to the feedback circuit (as per instructions) and see if the voltage goes the right way or the wrong way when the fault occurs.

"The actual fault on mine was that the feedback potentiometer is a wirewound type, and the wiper arm had worn through the wire right at the end of its travel. I did a quick fix by painting some silver loaded paint onto the end of the winding, and it has survived for 3 months so far, I expect another 10 years out of it."

RELAY CHATTER: Mike Morrin, who owns a 1975 XJ-S, reports on "a tendency for the amplifier relays to chatter after moving the servo. An oscilloscope across the supply lines showed noticeable spikes when the amplifier relays operated. I have managed to significantly improve this by fitting a 1000 uF 50V capacitor across the 12V supply close to the amplifier. The amount of relay chatter is reduced by about 80%. I can confirm that driving the car today, the operation of the servo system was smoother than previously."

CONTROL AMPLIFIER REPLACEMENT: Aftermarket A/C control system amplifiers are available for those who either don't wanna pay Jaguar prices or don't expect that a new one of the same type will last any longer than the original did. See H. D. Rogers & Sons on page 662 or Welsh Jaguar on page 646.

CONTROL AMPLIFIER REPLACEMENT -- CHEAP VERSION: Mike Morrin suggests, "...a double pole switch (like a window lifter switch) can be arranged to drive the servo manually." Simply connect 12V power through the switch to the red and purple wires on the servo connector; the two positions of the switch should provide power in opposite polarities. Label the button "cooler" and "warmer" or some such.

NAPOLI MOD: The idea of this mod is simple enough: provide a switch to enable operating the climate control system without the compressor when cooling is not needed. John Napoli says, "You are basically adding a switch in series to the inline fuse for the compressor located on the transmission tunnel near the air flap linkages." The wire in question is a GN wire.

Note that operating with the compressor off will not only result in no cooling, but will eliminate the ability to dehumidify as well. In high humidity situations, you will probably need to turn the compressor back on to prevent window fogging and other humidity problems. You will definitely need it on if you use "defrost" mode to clear condensation on the inside of the windshield.

Also note that operation of the system in hot weather with the compressor off might cause the "Auto" mode to increase fan speeds, since it's trying to cool and the servo is moving to ever more powerful cooling modes to try to lower the temperature. However, normally the occupants will want to switch the compressor on long before this happens. Even if it did happen, it's simple enough to switch to "Low" mode.

There is a fuel cooler in the freon circuit, and shutting off the compressor will obviously result in a loss of fuel cooling. According to Roger Bywater, "the fuel cooler was added as an emission device, not because of fuel handling difficulties like vapour lock, although this could happen on early cars before the fuel rail temperature sensor was introduced. The high underbonnet temperatures of the V12 always resulted in a lot of heat being transferred to the tank with the recirculating fuel and I recall measuring over 60°C at the tank which means a lot of vapour can be given off. To pass a full EPA emission test for certification there are strict limits on the evaporative emissions of the whole vehicle (including adhesives, plastic mouldings, paint, etc.) and the fuel cooler eased this situation by reducing fuel vapour loss. This is why all cars for the USA market had air conditioning - they were not certified for sale without it. Also the convertible would have to have the compressor running continually because the air con would probably not be used with the top down." Hence, the Napoli mod might technically be considered detrimental to the emissions control systems of the car. Note, however, that you would normally only switch the compressor off on days where the weather was cool anyway; presumably, the fuel needs cooling the most on the same days that you do, when you will have the compressor on.

The guys who have computers in their cars report that shutting off the compressor results in an instant fuel economy increase along the order of 2 mpg. As always, your mileage may vary, and in this case some of that benefit may

deteriorate as the fuel in the tank gets warmer; warm fuel hurts engine efficiency. And if you roll the windows down, all bets are off; open windows are detrimental to aerodynamics, and if you're travelling at highway speeds the benefits of turning the compressor off and opening the windows may be a wash.

One final note: The stock system will already shut off the compressor under either of two conditions: 1) the air coming through the evaporator coil is too cold, or 2) the system is calling for max heat. Hence, the Napoli mod should not actually increase the heating capacity of the system; when max heat is needed, the compressor is off anyway. If this mod does noticeably improve heating performance, there is something wrong in the control system; I'd recommend adjusting the flaps per the procedure on page 494.

GARDNER MOD: The system is clearly designed with the intention that you will *always* have the climate control system on when driving; when the system control knob is turned to the “OFF” position, the fresh air/recirculation flaps are moved to recirc position, positively closing off the intake of fresh air. Tony Gardner’s mod lets you drive along with the climate control system switched off and still have nice fresh air wafting through the dash vents. The Gardner switch removes the ground from the vacuum solenoid controlling the fresh air flaps, allowing the flaps to open and fresh air to enter the cabin.

The vacuum solenoid in question is readily accessible; simply remove the grille and pad on the left side of the console, and the vacuum solenoid is mounted just forward of the four-relay box. Simply disconnect the ground wire, and connect it through a switch.

The Gardner switch will hold the fresh air vents open regardless of whether the system is on or off, but when the system is on there isn’t much point. During normal operation, the system almost always keeps the fresh air intakes open; the only time they are closed are during max cool and max heat, which are relatively rare. However, as noted above, the Napoli mod may cause the control to run to max cool far more often, so the Gardner mod may come in handy to use in concert with it.

For winter use, Gardner himself provides the following tip: “If the climate control is set to heat (to adjust the flaps) and then switched off, warm air flows through the fresh air ducts. The vent mod does not replace AC, therefore it actually works better in winter than summer.” Note that when the system is switched off, the heater valve remains open for coolant to freely flow through the heater core; Gardner’s idea of setting the temperature to full heat and then shutting the system off merely leaves the flaps in a position to guide the wafting air through the heater core. If the temperature is set to full cool and the system is shut off, the flaps will remain in a position to bypass the airflow around the heater core.

GARDNER/NAPOLI MOD COMBINATION: Tom Bennett was concerned about locating a profusion of switches in his XJ6. “If you combine both of these mods on the same switch (double pole, the circuits must be kept separate!) you can eliminate one of the switches and simplify operation. In one position the switch would make both the Gardner and Napoli circuits (just as in the factory configuration), in the other position the switch would break both circuits (invoking both the Gardner and Napoli mods). Here is the way this works under the 3 main operating modes of the A/C system:

A/C System Off - The normal factory system configuration includes vacuum solenoid energized (fresh air flaps closed), and no power to compressor of course (except late XJ-S convertibles). If you open the combination switch (Gardner and Napoli circuits), vacuum solenoid loses its ground (fresh air flaps open). Napoli circuit has no effect since there is no power to compressor anyway. If you close the combination switch, the vacuum solenoid closes fresh air flaps (just like factory configuration), and makes the Napoli circuit (which has no effect since the A/C system is off and no power is available to the compressor).

A/C System On - Normal system configuration (except at full cooling) includes vacuum solenoid de-energized (fresh air flaps open), and power available to compressor. Opening the combination switch cuts power to the compressor (just like the solo Napoli switch), and has no effect on the vacuum solenoid which is de-energized anyway (except at full cooling, see below). Closing the combination switch allows power to

the compressor, and makes the circuit for the vacuum solenoid (which is de-energized anyway so there is no effect).

A/C System in Full Cooling - At full cooling the combination switch will be closed of course, so you'd have power to the compressor and the vacuum solenoid energized to close the fresh air flaps for recirc and max. cooling.

"As I said earlier, I'd rather not add another switch which isn't necessary and which requires additional thought and manual intervention (lessee... if I have the Gardner switch closed, should I open the Napoli switch, etc.?) It seems easier to say "I want fresh air only, open the combination switch with the A/C system off" or "I want everything but compressor, open the switch with A/C system on." or "I want normal operation, close the switch.""

GARDNER/NAPOLI MOD COMBINATION SWITCH: John Smith sends this suggestion: "The interior drivers lamp switch, the push on/push off switch next to the interior light switch is - you guessed it - a double pole switch. I have seldom used this switch for its intended purpose as it only provides minimal lighting.

"I removed the switch, and to give it a 'genuine' A/c switch appearance I installed the letters 'A/c' behind the switch window.

"To do this the switch must be carefully dismantled by drilling out the flaring of the small rivet and removing the rivet. This will allow the small side cover to be removed. Do this *carefully* because there are three springs and two copper contacts which will be loose inside and you need to note their position for reassembly.

"This will give access to the switch inner and allow you to gently prise off the front cover revealing the silhouette indicator piece of plastic with the lamp emblem. You will also see three small rectangular opaque plastic light diffusers. If you want a better looking and better lit switch - do not re install these. I also recoated the inside of the poorly painted white areas with liquid paper.

"On my bubblejet printer, I printed 'A/C' using an 18pt Arial bold font with white print and black background.

"I carefully scraped away the lamp emblem, leaving a small cleared rectangle to allow enough backlight through for the 'A/c' label which I glued to the front over the scraped and cleared space. I sprayed the front with artist's clear fixing spray and reinstalled within the front switch cover and then reassembled the switch. Make sure you don't put the 'A/c' label upside down. The little red window is at the bottom and the green at the top.

"When refitting the switch side panel, make sure the hook on the piece of spring wire attached to this panel, engages in the in/out white plastic mechanism. A very small self tapping screw will replace the rivet.

"Wiring is as follows. Cut the connector wires about one inch back from the connector. Put the connector to one side. Get hold of the cut loom wires and join the purple and the purple/ blue wires together. Tape off the ends of the black wire and the purple/white wire. These are not positive leads but it is best to tape them out of harm's way.

"Now the connector. Prise the connector cover open and relocate the brass terminal loop attached to the purple/blue wire from position 7 to position 9 alongside the purple wire. To check the wiring is correct, attach the connector to the switch and make sure there is continuity between the purple and purple/blue, and continuity between the black and purple/white when the switch is pushed in to the on position.

"To complete the wiring, hook up the vacuum (fresh air) wiring to the purple and purple/ blue wires and similarly, the A/c clutch wires to the black and purple/white wires. I soldered the joints and insulated them with heat shrink tubing to make a secure neat job.

"Reinstall the switch and it looks and works in a totally professional way."

NAPOLI'S MOD TO THE GARDNER MOD (!): "Instead of wiring the Gardner switch to cut out the ground, wire it to apply power to the solenoid. Then, whenever you want recirc, regardless of the mode the climate control system is in, you can get it. You also preserve full Gardner functionality with the climate control off -- just switch off the

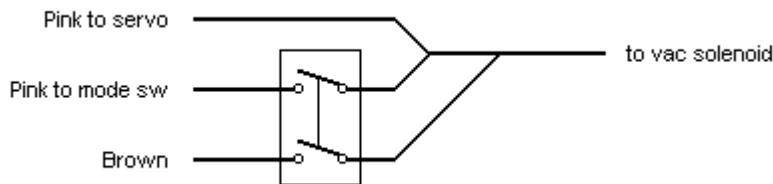
switch.” Essentially, the regular Gardner mod switch is OPEN/AUTO, while in this scheme it is OPEN/CLOSED -- complete manual control of the recirc flap.

SAWYERS MOD: The Sawyers mod is really another variation on the Gardner mod, providing improved control over the recirc flaps. It requires a two-pole switch. Craig Sawyers says it “does exactly what you want. Position 1, recirc under all conditions. Position 2, fresh air when mode = “off” and normal Delanair operation in any other mode switch position.” Since “normal Delanair operation” means that the system is in fresh air mode nearly all the time but will go into recirc mode under the most extreme circumstances, the switch becomes a “fresh air/recirc” switch that the system has the capability of overriding when it really needs to in order to maintain temperature control.

“Unplug the pink connector at the solenoid (it has two pink wires going into it), and unplug the servo multi-way connector on the opposite side of the car. Now chomp *one* of the wires going into the solenoid female spade connector, and find out which one of the two wires you now have connects to the pink wire on the servo connector. That is the wire you *don’t* want - the one you *do* want actually goes to microswitch C in the mode switch assembly, which you can’t physically get to without dismantling the car. Note that you actually want a break in the *correct* pink wire - so you might have to resolder the one you just snipped, and snip the other one.

“Now take your two-pole switch and common up the wiper. Connect that common point to the vacuum solenoid end of the correct broken pink wire. Connect the NC (or NO) end of one pole to the other end of the pink wire. Connect the other NC (or NO) to the brown wire mentioned in my earlier post. Now plug both spade connections back onto the vac solenoid.

“Here’s what the scheme described above looks like electrically:



“In operation, one switch pole interrupts the +12V feed that comes from the mode switch when in the “off” position. It is really identical to the Gardner mod but with the switch in a different wire. The second pole of the switch is used to apply +12V to the solenoid when the mode switch is in any other position. So with both switches open, you get no +12V to the solenoid with the system “off”, and the solenoid under servo control with the any other mode position (Gardner when “off”, servo control in any other mode position). With both switch poles closed, you get +12V through the pink wire with the mode “off”, and +12V from the brown wire in any other mode switch position (recirc no matter what). Just to complete the description, mode microswitch C takes a fused +12V from the fusebox and either connects it to the pink wire when “off” and to the brown wire in any of the other four mode switch positions.”

BERNETT MOD: Tom Bennett explains his mod: “The Gardner mod opens the fresh air vents with the system turned off. My mod disables the fans and compressor with the system turned on. So I have fresh air and control of cabin temperature using the temp control knob.

“My mod requires switching open two circuits; one at the Water Valve Temperature Switch, and another at the feed to the Water Temperature By-Pass Switch in the servo unit (the brown wire at connector P2 near the servo).” Bennett describes how to test this operational mode by merely disconnecting two wires, so you can decide for yourself if you like it well enough to go ahead and install a switch:

- 1.) Remove the left hand console side casing and the underscuttle casing. The Water Temperature Switch is located above the black footwell vent. It’s attached to a water pipe and has two connectors attached to it.

One connector has two brown wires, the other has two brown w/ yellow stripe wires. Undo the connector with the brown/yellow wires.

2.) Remove the right hand console side casing. Find connector P2. It's located down low and aft. It's a circular white connector, maybe an inch in diameter with about 10 wires. Cut the brown wire between the connector and the servo unit. Cut it in the middle so you'll be able to connect to it later. Careful, don't cut the brown/yellow wire by mistake. You want the solid brown one.

"That's it. Try it out. Turn the ignition on and the mode switch to Auto. (If you have the Gardner and/or Napoli mods, switch those off) The servo unit should respond to the temp control knob, the blowers and compressor should be off, and if you're moving, fresh air, conditioned according to the setting of the temp control knob, will be flowing through the dash and footwell vents. Defrost position on the mode switch should still function.

"Why it works: The system is designed such that the heating mode is disabled (no blowers or compressor) until the coolant comes up to temperature. This prevents a blast of cold air in your face when you first start the car on a cold morning. After several minutes of running, the coolant warms up and the system clicks into action. This is controlled by the Water Temperature Switch. This switch closes when the coolant reaches 40°C/103°F and allows the system to operate normally.

"Now, just as you don't want a blast of cold air in a cold car, you do want a blast of air immediately when you start up a car that's been sitting in the sun on a hot day. This is accomplished by a Water Temp By-pass Switch and some fan switches in the servo unit. These are powered when the system is in cooling mode no matter what the coolant temperature is. So they override the above Water Temperature Switch. These switches are powered via the brown wire at connector P2.

"So, opening the circuit at the Water Temperature Switch disables the blowers and compressor in heating mode, and cutting the brown wire at connector P2 disables the blowers and compressor in cooling mode. In both modes the temp control knob, in-car and ambient temperature sensors, servo motor, fresh air flaps, etc. still function.

"All that remains is to come up with a convenient way of doing the above switching. I'm presently operating the mod with a double pole toggle switch. Opening the switch shuts down the blower fans and A/C compressor, but still keeps the fresh air flowing and the temperature control knob and servo unit functional. Close the switch and the system goes back to normal operation.

"I envision using this mod as my on/off switch. I'll leave the mode switch in Auto, and this switch open in all but extreme conditions. When I need max heat or A/C, I'll close my switch and the system will operate normally with both blower fans and A/C compressor."

Delanair MkIII (1987-On)

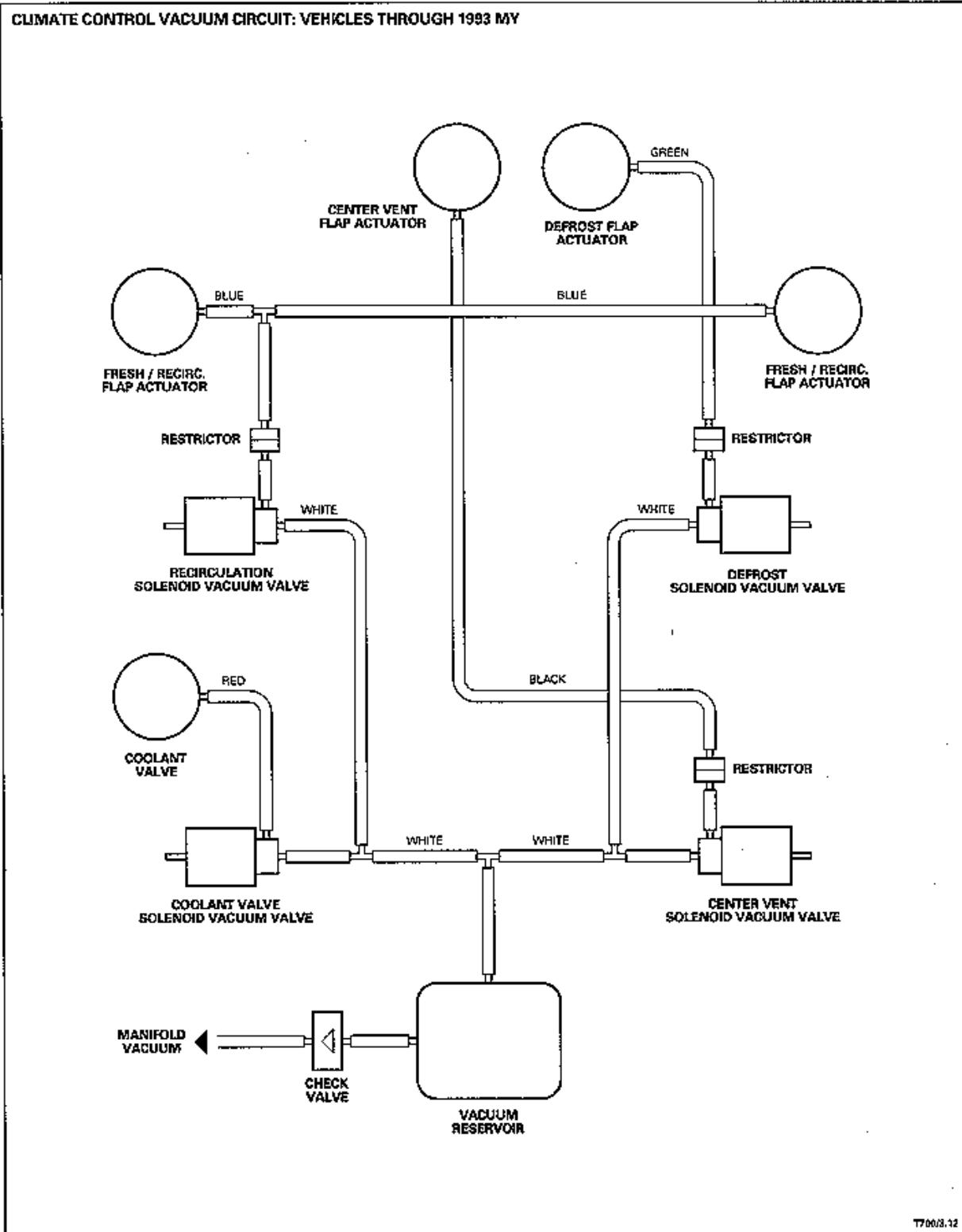
PARTS: Parts for the MkIII system are notoriously expensive. Per Hal Rogers, "the Delanair heater unit is made/supplied by Delanair of England. Many aftermarket companies have attempted to obtain parts directly from Delanair but they cannot sell directly because of contractual obligations to Jaguar."

PARTS CONFUSION: According to Technical Service Bulletin #8228, there is some confusion as to which A/C ECU goes with which water temp switch and in which car. According to their guide, the trick is to check the wires at the water temp switch on the left side of the evaporator case. If the wires to this switch are slate and black, the correct ECU is CAC 8032, the correct water temperature switch is JLM 763 (red), and the harness part number is JLM 1170. If the wires are green and black, the correct ECU is DAC 7601, the correct water temperature switch is JLM 2121 (black), and the harness is either JLM 10393 (all convertibles and 1992-on coupes) or JLM 10394 (1991-92 coupes). We all clear on that? Good.

VACUUM SCHEMATIC: Finding a vacuum schematic seems to be difficult, so I have included two here -- courtesy of Victor Naumann.

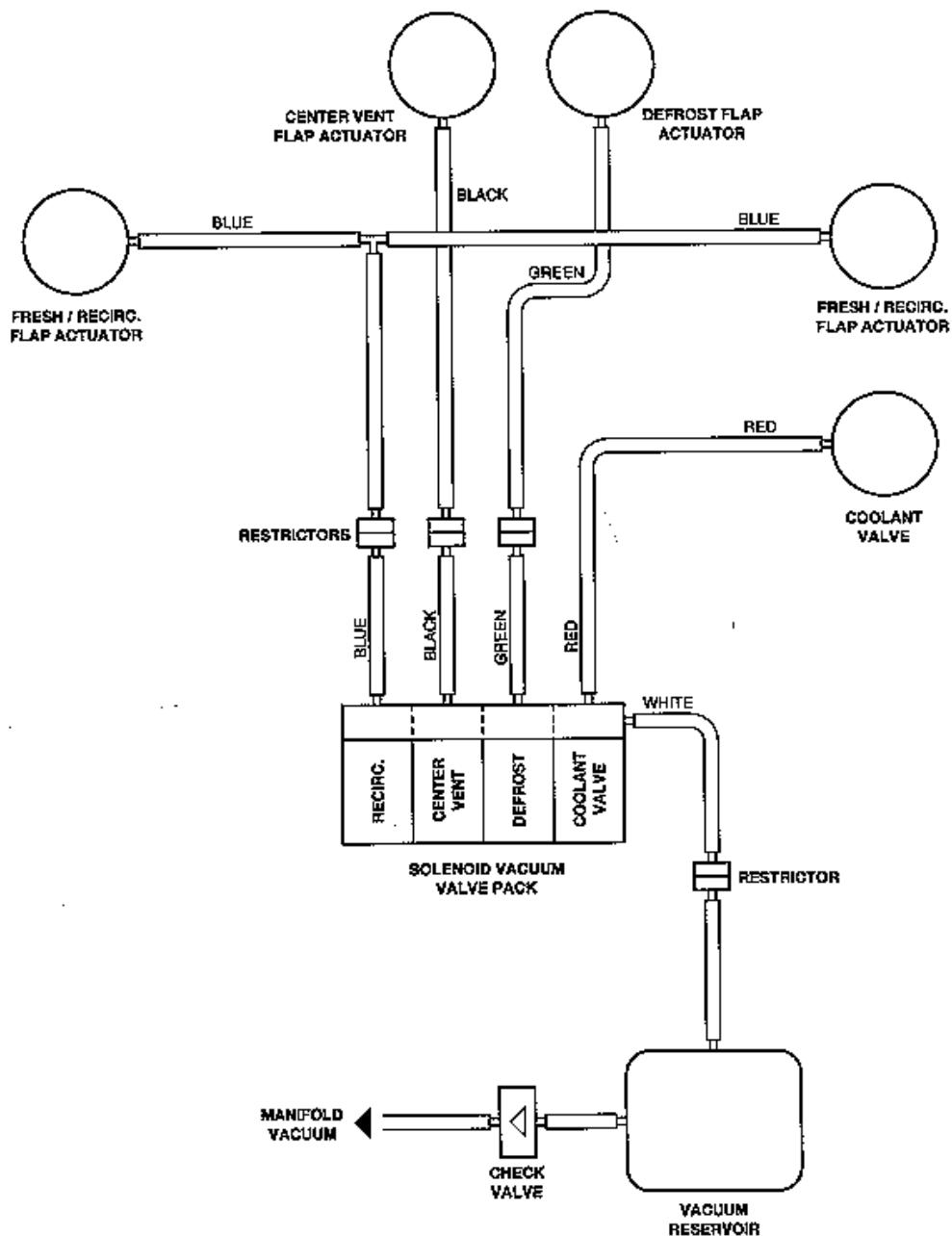
Mark III Climate Control

Vacuum System



Mark III Climate Control

CLIMATE CONTROL VACUUM CIRCUIT: VEHICLES 1994 MY ON



BLOWER FANS: According to Randy Wilson: "Jaguar doesn't sell the blower separately. They sell the complete blower unit: housing, motor, fan, and electronics! Yes, there are electronics buried inside that blower case. Plus, just to add a bit more, the right hand box carries the ambient temp sensor. There are also two relays inside the box." The blower assembly is reportedly incredibly expensive.

BLOWER SPEED CONTROL REPAIR: Stefan Knappe saved himself a lot of money: "I noticed that the right fan (it's got two, left and right) did not work except when the fan speed was set to max. I took the blower motor out, which is rather easy on the right side of a LHD car, finding a little solid state circuit located in the intake part of the fan. This circuit gets information from the A/C computer and regulates the fan speed unless the setting is to max, which actuates a little relay situated in the blower case too. I found out that the power transistor on this little circuit was blown. I went to the Jag service asking whether this is available separately. But, you might have guessed it, the blower is only available as a complete assembly, being very expensive. So I went to an electronic store and bought a transistor equivalent to the type built into the fan-circuit (Texas Instruments #2N6284). I soldered it in, put the stuff together and the fan worked from that time on without problem."

Martin Sellars adds, "Air con blowers: these devices contain an electronic circuit which gives speed control for all settings but "high". This comprises a Darlington transistor 2N6284, a 68 Ohm 2.5Watt resistor, a 1N5401 diode and a small glass diode, probably 1N4148 or 1N914. All these parts are easily obtained cheaply from electronic component outlets (example; in the UK Farnell Electronic Components, +113 2636311, but ask for a catalogue to get the right order numbers). Blowers that won't run at low speeds almost always have a failed transistor, but replacing that alone won't always fix the fault. The resistor is there to protect the transistor from voltage spikes produced by the motor, so check the value and replace if it isn't right (most hobby multimeters have an Ohms measurement feature). The small diode feeds the blower motor voltage back to the A/C computer, and has steel leads which corrode away, breaking the connection and preventing speed control from working. I replaced mine with 1N4004 types, which are much more rugged, more easily handled, and cost just a few pennies more. These diodes are fitted with their cathodes (marked by a bar on the body) towards the transistor collector (the steel case). The 1N5401 diodes are very rugged, and unlikely to need replacing. When fitting new diodes or resistors, don't try to fit them inside the blower interior, like the originals, where they are prone to corrosion. Fit them on the solder side of the PCB (having snipped out the old parts) and then cover them with the original plastic flap using some tape.

"I also fitted new brushes to the blower motors, using power drill spares filed down to the right size (Kirby's tip!).

"Inside the blower assembly is the high speed relay, which is also prone to dirt and corrosion. Standard car accessory shop units can be used here, but check the pinout - I think they are not standard, I had to rewire mine. Considering the cost of a new unit, changing the parts mentioned above gives "as new" performance at a tiny fraction of the cost."

COMPUTER PROBLEMS WITH BLOWER CONTROL: Stefan Knappe cheated on this one: "Another problem I had on a friend's car, on which one fan did not work. After checking the fan, I found that the A/C computer (located on the right hand side of the centre console, take cover underneath glove box out) delivered signal to one fan blower only, the other signal line being dead. Computer gone (at least in this respect). I asked for the price of a new one and decided immediately to go for another solution. Since I'm not so deep into electronics to repair this difficult thing itself, I had another idea. I cut the signal line which was dead and connected it (the line to the blower) with the good one for the other side. Both fans worked again. Risk was that the computer will be damaged on the good side due to higher current delivering two circuitries, but on the other hand the thing was already gone... This solution proved to be okay, since it still works and the repair has been done three years ago.

"Caution: Don't check power output anywhere in the system with a lamp or bulb, use a voltmeter 10 M Ω impedance, otherwise you may damage the computer!!"

TEMPERATURE SENSORS: Martin Sellars says, "Temperature Sensors: the Delanaire system uses three, all are electrically identical. They measure ambient air temperature (mounted on the RH blower housing), in car temperature (above the glove box, behind a small aperture in the dash) and on the evaporator. These have three wires to them, power (5Volts from the ACC), ground, and the output wire. The output voltage is very closely controlled at 2.785V at 0°C and rising by 0.01V per degree C. So, a sensor at 20°C (about 68°F) should read 2.985V, and at 30°C (about 90°F) should read 3.085V, and so on. I found these can be measured reasonably easily with a standard 20k/Volt moving needle "hobby" type multimeter, at least well enough for fault finding purposes."

Richard Mansell quotes from a Jaguar publication on the changes for the 1992 model year:

"The air-conditioning in car sensor now uses the motorised aspirator/sensor from the XJ6 allowing a more accurate reading of the true temperature of the cabin which will be less susceptible to drift or overshoot."

DUMB PROBLEMS: Martin Sellars: "My car showed very erratic operation of the A/C, sometimes OK, sometimes wrong settings (hot on hot days and vice versa!), sometimes no action at all. This fault might have been blamed on the computer - but in fact it was due to moisture coming out of the evaporator, and running down the RHS of the transmission tunnel onto the single in-line fuse holder that carries the supply current to the A/C computer. The contacts had corroded slightly, breaking the supply current, and giving intermittent operation of the A/C. A new inline fuse, plus fixing the drainage, solved the problem."

WHILE YOU HAVE THE BLOWERS OUT: Martin Sellars: "While the blowers are out, access to the evaporator is much easier. The four short tubes which couple the evaporator body to the rubber blower ducts can be twisted slightly and removed. This allows slight access to extract some of the gunge and detritus that blocks up the drainage system, causing wet carpets, rusty floors, and other problems."

HEATER CORE REPLACEMENT: Those who must replace the heater core should thank their lucky stars if they have the Delanair MkIII system. A major design feature of this system is the ease of replacing this core, a major task on the earlier cars. The Delanair MkIII system has bolt-on pipes for the heater core, eliminating the need for the "shortcut" pipe-cutting procedure devised for the earlier system. Also, Per Michael Neal, "The heater core is removable from the right side. There is a large piece of black tape, similar to electrical tape, that covers the access panel. Removal of the core is simple as unbolting the pipes, pulling the glovebox and access cover and removing the core." This eliminates the need for removing the instrument panel and dropping the steering column, as on earlier models.

HEATER CORE PIPE ATTACHMENT BOLTS: Per Julian Mullaney, "There was a problem of dissimilar metals causing corrosion of the bolts which attach the pipes to the brass core. The pipes and heater core are brass, the screws holding them together were steel. I guess stainless bolts would be better. You could replace them as a preventive measure."

HEATER CORE PIPE ATTACHMENT O-RING SEALS: Per Julian Mullaney, "The O-ring seal used at the connection point appears to be of a terrible design. A mechanic once told me that these O-rings always go first."

For anyone who doesn't think the resultant leaks would be a big deal, Mullaney adds: "This leak really screwed up a lot of stuff under there. The drips ruined the A/C amp, connectors, and my CD player."

Apparently Jaguar realized the seriousness of this problem. According to Michael Neal, "Jaguar has a gasket to replace the O-rings. It is shaped like the mating pipe of the heater core and is made out of a silicon/rubber type material." The part number for the gasket is JLM 759; you need two to do the job.

According to Mark Roberts, the "condensation deflector shield" being added to systems by Jaguar (see page 614) is actually a result of these connections leaking on radios!

HEATER CORE: Peter Cohen found this note: "When stock of this heater core is depleted use part number JLM 11343. The pipes that are bolted to the JLM 11342 must be removed and re-attached to the JLM 11343 because they have a different angle than the pipes on the JLM 11343. This mild modification is necessary because of the price differential between the JLM 11342 & JLM 11343."

Steve Gibson explains: "Both parts *are* still listed by Jaguar at the present time. The JLM11342 Heater Matrix was fitted to the XJ12 Series III 1985 onwards as well as the XJ-S 1987 onwards. The JLM11343 Heater Matrix was fitted to the XJ40 1987 to 1993. The JLM11342 is just short of being twice as expensive as the JLM11343 unit, so I should forget about "when stock is depleted" and if you have need of a replacement get the later unit and save yourself some money."

ELECTRICAL

COLOR CODING: In electrical diagrams, this book uses the same wire color coding scheme as Jaguar uses in their manuals. If two colors are indicated, the first is the base and the second is the stripe. If three are indicated, the third is a spiral stripe. The color codes are as follows:

N - brown (*not neutral!*) - usually 12V power

B - Black - usually ground

U - blUE

K - pinK

S - Slate (British for gray)

G - Green

Y - Yellow

O - Orange

R - Red

W - White

P - Purple

Jaguar also throws an L in occasionally to indicate a Light color.

If you want to know more about wire color codes, perhaps you should consult BS-AU7a, "1983 Colour Code for Vehicle Wiring", British Standards Institution, 2 Park St., London W1A 2BS. Tom Bennett points out that an extract from this code is available on the WWW at:

<http://www.dimebank.com/tech/LucasColours.html>

This site also says you can get suitably color coded wire for harness repairs from British Wiring (page 656), British Pacific (page 656), and Narragansett Reproductions (page 657).

WIRING DIAGRAMS: If you're going blind staring at the diagrams in the ROM, Michael Frank sends this tip: "Wiring diagrams in the following sizes (prices in British Pounds):

500mmx353mm £9.95 + £1.50 postage

594mmx420mm £12.95 + £2.00 postage

840mmx594mm £19.95 + £3.00 postage

1180mmx840mm £34.95 + £4.00 postage

Available for most classic Jags, with XJ and XJ-S available soon. The diagrams are laminated in plastic and color coded to match the actual wiring. The supplier is:

Classic Graphics
11 Springhill Grove
Stockton, Cleveland TS17 OYW
England

ELECTRICAL GUIDES: Jaguar offers booklets full of schematics for the electrical systems; these don't seem to have a title, but they are generally called "Electrical Guides". Of course, you want to know which one to get, but that's a little complicated. Allow me to explain: One of these booklets says "Publication S 57", "Revised 7/88", and has a leaper on the cover. Inside, it has three sections: Series III XJ6, XJ-S through 1987 MY, and XJ-S 1988 MY. Each has its own table of contents. Hence, when you buy a copy of "Publication S 57" and tell the seller what kind of car you're buying it for, you probably won't get the entire booklet; you'll only get the section you need. Since the cover doesn't mention the models covered, you get a copy of the cover and one of the three sections and the impression that you have gotten the entire book. This isn't really a problem except that owners of pre-87 H.E.'s, '88 H.E.'s and Series III XJ6's all own "Publication S 57" and wonder what the other guy is doing with it.

Also: that one section may claim it covers "XJ-S through 1987 MY", but it lies. It only covers H.E.'s, so it really covers only 1982-88. If you have a pre-H.E., you may be out of luck here; presently there is no comparable help for the pre-H.E. There is enough difference between the pre-H.E. and the H.E. that trying to use Publication S 57 on a pre-H.E. will cause more confusion than it clears up.

Richard Mansell provides a comprehensive list of Electrical Guides for the XJ-S:

S 57	XJ6 Series III, 1987 & 1988 XJS Electrical Guide
S 57/89	1989 MY XJS Electrical Guide
S 57/90	1990-91 MY XJS Electrical Guide
S 72/92	1992 MY XJS Electrical Guide
S 72/93	1993 MY XJS Electrical Guide
S 72/94 4.0L	1994 XJS 4.0L Electrical Guide
S 72/94 V12	1994 XJS 6.0L Electrical Guide
S 72/95 4.0L	1995 XJS 4.0L Electrical Guide (thru VIN 198334)
S 72/95 V12	1995 XJS 6.0L Electrical Guide (thru VIN 198334)
S 72/96 4.0L	1995/96 XJS 4.0L Electrical Guide (VIN 198335-on)
S 72/96 V12	1995/96 XJS 6.0L Electrical Guide (VIN 198335-on)

This author has the 82-87 section of S 57; it is a loose-leaf binder containing 25 pairs of figures. In each pair, the first figure is a schematic of a particular electrical subsystem, and the second figure (on the facing page) is a plan view drawing of the engine or car indicating where the individual components are located. Some of the illustrations are 8½" x 11" and some are larger fold-out pages. This is *very* useful information, but note that the publication does not include any text at all; no descriptions of how systems work, no troubleshooting info, nothing. Since the supplements to the ROM *do* include such descriptions and troubleshooting info, they are perhaps the more useful guides even though the schematics are not as clear and complete.

Peter Cohen adds, "...the S57/year wiring diagrams are put out by Jaguar Cars of North America, and would not cover RHD or be available in the UK. OTOH, they are just books, easy to ship (and light), and should be duty free. I'm sure Jag Services would post one anywhere if you paid by credit card."

Regarding the electrical guide for his '90, Mike Wilson says, "They now come with a Supplement that includes corrections for the following:

- Fig 2.1: Added Diode to Neutral Switch circuit
- Fig 2.2: Added Diode to Component location
- Fig 6.2: Added Shorting Plug behind Fog Light Relay
- Fig 11.1 & 12.1: Corrected the Titles for Coupe and Convertible
- Fig 15.1: Ground Code Correction for heated rear window

Fig 20.2: Cruise Control, Resume switch and set switch locations reversed

Fig 22.1: Door Lock Terminal Identification added

Fig 25.1: Added Diode to EFI and Emissions diagram

Fig 25.2: Added Diode component location

Fig 6.1: New wiring diagram for Fog Lamps

Fig 20.1: New wiring diagram for Cruise Control

Both publications are numbered: S-57/90."

Jeff Strom mentions another source of electrical info: "The Mitchell manual is a publication of all the wiring diagrams for all vehicles. The older version that was printed had better information than the CD-ROM version out now. These are bought by shops and customer service folks that need the electrical information and not the mechanical information. Cost is in the \$1200 range with quarterly updates, covers *all* cars and trucks."

JDS: Later Jaguars are fitted with connections for an electronic diagnostic system. A knowledgeable mechanic, who shall remain nameless here, sends the following words:

"JDS stands for Jaguar Diagnostic System. Basically it is a processor that ties into the serial ports in the car wiring. However good this may sound, it is no more than a glorified wiring diagram. It sends you down the circuit you are checking and you end up more often with a car that is torn apart and not fixed. All Jaguar dealers in the US were forcibly recommended to purchase one of these \$23,000 units back in the late 80's."

"The new P.D.U. diagnostic unit which is supposed to be the new JDS is a self-contained unit that can be taken on road tests. Gen Rad is the manufacturer of both of these machines. The P.D.U., already dubbed as "Pretty Damn Useless", is a very complex unit. It uses CD-ROMs instead of 3.5 floppies. The screen is about 4" square, green display. It is a very difficult unit to use. The techs that have been to school for the P.D.U. still have very little understanding of it."

OPTICAL FIBERS: If the wire is solid dark gray, it may not be a wire; it might be an optical fiber. Illumination of the air conditioning control panel is via a single light bulb in a housing in the console, with the light carried by fibers to the various locations. This makes the whole panel dark with a single bulb failure, but it's a cinch to replace the bulb; just remove the ski slope (3 screws on early cars, see page 452 for later models) and replace the bulb inside the fiber optic unit within the console.

Don't cut those fibers; they're not easy to splice. They are a little brittle, so don't bend them too sharply either. They tend to get in the way when working on the radio, so be careful.

If you need to disconnect one from the fixture at either end, don't just yank. Insert a tiny screwdriver into the slot along the side of the socket and twist to spread it a little, and the fiber will come out easily. It has a little brass fitting on it with a lip. To put it back, simply press it in until it clicks.

Note that the sockets on the bulb housing are not all the same. If you open it up and look inside, you will note that some of the sockets feature a colored filter. Which socket used will determine what color light comes out the end of the fiber.

If you need to try to splice a fiber, Don Mathis of the Lightguide Media Department at AT&T Bell Labs says: cut the ends of your plastic fibers with a razor blade. This should give a very smooth cut. You need to butt the two fibers together while you epoxy them in that position. A "V-groove" works well. If you come up with a means of clamping the two fibers together mechanically, index match grease between the ends helps to decrease the loss. Silicone grease, clear, works well. Vaseline is not bad either.

If all else fails, Edmund Scientific has the fiber for approximately \$.70/foot for 0.040" diameter. You can also get genuine Jaguar fibers from several mail order outfits, but they aren't cheap.

WIRE SPLICING: Making durable, reliable wire splices is essential to working on a Jaguar; there are a great many electrical circuits, they tend to be rather complicated, and the Lucas components cause enough trouble. When troubleshooting, it is important to be able to eliminate a previously-made splice as a possible fault.

First, it is helpful to have a pair of wire-stripping pliers around -- a *good* pair. A good wire stripper will remove insulation from the tip of a wire neatly, doing much less damage to the conductors than you can do with a razor blade, or your teeth, or whatever. However, a cheap wire stripper, especially one in which the stripping slots don't line up properly or are not sharp enough, can cut half the copper strands while removing the insulation.

When splicing wires together, the best way is to solder them -- if they won't be exposed to a great deal of heat, which may melt the solder. A soldering gun of about 140W capacity is recommended; soldering irons are intended for circuit board work, and do not work well doing wire splicing. On larger wires, an iron may not provide enough heat to make a secure connection. And, the intermittent nature of wiring harness repair makes the instant heating of the soldering gun a big help. Even the little light bulbs usually found on soldering guns tend to be helpful in automotive work.

If your soldering gun isn't heating like it should, loosen the nuts holding the tip and retighten securely. These are electrical connections (a soldering gun is a transformer that provides low voltage and high current through the tip to heat it), and they need to be *tight*.

Regardless of whether the solder used says "resin core", you should use a separate tin of resin flux. The first time you use it, you will know why this is recommended; relying on the resin in the solder doesn't work nearly as well. Do not use an acid flux; it is intended for copper pipe connections, not electrical work. And, before doing any soldering, always dip the tip of the gun in the flux and apply a little solder to the tip as it heats up.

Another workable splicing method, and the method to use when exposure to heat is a factor, is to use a crimp-on connector. If the crimp-on connector is the uninsulated variety, it may be possible to combine methods; crimp the connector to the wires, and then apply solder.

Crimp-on connectors can be purchased in automotive stores, often in a package along with other types of crimp-on terminals. Some of the connectors will have a built-in piece of insulation, while others are bare. Keeping a selection on hand is a must.

Most of the available electrical connectors work well, but there are a couple specific types to avoid. One to avoid is a tap connector that consists of a plastic device that is placed over an existing wire, a new wire is put in place alongside it, a slotted metal guillotine blade connector is squeezed into place with a pair of pliers, and a cover is folded over and snapped in place. While slick, this connector makes weak and unreliable connections, especially on unusual wire sizes.

Where possible, avoid the use of electrical tape. With age, it tends to harden, while the adhesive gets gooey. After some time, tape on connections can be found to have fallen off or slid up the wire, leaving the conductor exposed. If electrical tape must be used, it should ideally be stretched a little as it's applied; the stretch will pull it tightly around the conductors, helping prevent its coming loose anytime soon.

Please don't use friction tape. Electrical tape is solid plastic, while friction tape is black cloth. Friction tape is not intended for electrical work.

If you are connecting separate ends of wire or can slip something over the wire from an end elsewhere, the best insulation method to use is heat-shrink tubing. Heat-shrink tubing is available at some auto supply stores, hardware stores, and building supply stores, but the best place to buy it is at an electronics store. At the better electronics stores it can be purchased in 4-foot lengths and in a great variety of sizes. It also comes in various colors, including near-transparent so you can see how lousy your soldering job was.

Select a size of heat-shrink tubing slightly larger than the insulated wire, and cut a piece a little longer than your splice will be. Slide this piece onto one of the wires before you connect the wires together. After soldering, slide the tubing over the connection and use a cigarette lighter or match to shrink it down snugly. Heat-shrink tubing can also be used to insulate uninsulated crimp-on wire connectors.

CONNECTORS: Since the basic wiring connectors themselves are among the worst features of Lucas engineering, it is recommended that the owner keep a supply of Molex connectors (such as those sold at Radio Shack) on hand. When a connector is intermittent or is otherwise causing trouble, don't try to clean it up; simply cut the sucker off and install a suitable Molex connector in its place.

Some hardware or building supply stores carry a substance for preventing oxidation and corrosion of electrical connections. One such substance is called Ox-Gard, by Gardner Bender Inc. of Milwaukee; it comes in a 1 oz. tube and has the consistency of grease. Since Jag electrical connections tend to corrode, it is suggested the owner keep a tube of this stuff around and use it. The first place to apply it is on both ends of each fuse you can find.

Tom Wagner says, "I have a number of associates that actually grease the lamp socket base. They swear that it keeps the moisture out and prevents rust. I have no empirical data to confirm this and really don't have the guts to try an experiment. I have noted however that some cars (especially Fords) have a type of white grease packed into the connectors. Unfortunately every time I have seen this material it is because I have been replacing the device, so I don't know if the device has failed due to it or whether it is just a normal failure."

GROUNDS FOR COMPLAINT: This author has noted several places in the XJ-S where a ground connector is attached to the chassis with a bolt or screw that also holds a harness strap. The harness strap is plastic, and is held *between* the ground wires and the chassis. This is NFG for at least two reasons: First, it means that the only way the ground connection can possibly be made is through the screw itself, which is less than half as reliable as a properly seated ground connection. Second, since the strap is plastic, the screw simply cannot be tightened securely as that would only crush the strap.

The car has enough electrical problems. It is recommended that whenever such a ground connection is found, it should be revised. One method is to provide two separate screws, one for the harness strap and one for the ground. Be sure to scrape all the paint away under the ground connection before reinstalling it. Maybe a little anti-seize compound would help, too -- both in assuring a good electrical connection and in keeping the bare metal from rusting.

So far, such ground connections have been noted on the wheel wells just behind the headlight housings on both sides, and inside both doors near the hinge end.

MORE GROUNDS FOR COMPLAINT: Colleen Melton says, "the front subframe is grounded to the chassis through the ground straps (two straps, 1 from chassis to subframe, 1 from subframe to engine)." Mike Morrin responds, "You just made the light go on for me. I always wondered why my car has a ground strap with both ends bolted to the subframe. There is another strap from the engine to the chassis." Morrin had been driving around with an ungrounded subframe due to somebody arranging these straps incorrectly. There have been multiple reports of these straps being connected incorrectly or missing altogether.

Having the subframe ungrounded may have little effect, but having the engine ungrounded is a disaster. Check out the history of engine grounding problems through the throttle cable (page 249) and shift cable (page 303). Just go ahead and buy a suitable ground strap and install it in addition to the existing one. Convenient places to install a new strap include between a bolt on a front anti-sway bar mount bracket and anything on the bottom front of the engine on whichever side you choose -- power steering pump mount bracket, alternator mount bracket, wherever you find the right size bolt. Remember to provide enough slack for the engine to move around on its mounts without straining the cable.

SPADE TERMINAL INSULATION: In the places that the XJ-S has female spade terminals to connect to male spade lugs on a device -- such as on the starter relay at the right rear corner of the engine compartment -- the female terminals on the ends of the wires have a milky white plastic sleeve that snaps in place over the terminal to prevent accidental shorts. These insulators are guilty of misleading in two different ways: 1) When the terminal is pushed onto the spade lug on the device, the lug may enter the insulator between the flat side of the terminal and the sleeve rather than into the terminal itself. This may actually feel like it was inserted properly, and will usually provide a connection when tested --

but it will be intermittent, and you will have problems sooner or later. 2) When the connector is pushed onto the spade lug, the terminal itself may slip backwards within the insulator without being noticed. It looks like it's in place, but the terminal itself is actually only touching the tip of the spade lug, again making an intermittent connection.

A very workable plan is to take these insulators off and throw them away, and insulate the female spade terminals using heat-shrink tubing.

If you are installing new female spade terminals on a wire, it is suggested that you use two different sizes of heat-shrink tubing to insulate them. This works far better than the little plastic collars that come on crimp-on terminals, so it is suggested you rip the plastic collars off and use this method instead. This also allows you to solder the wire to the terminal after crimping for a more secure electrical connection. To insulate the terminals, take a piece of heat-shrink tubing about 1/2" long and a diameter that will fit over the wire itself as well as the crimp end of the terminal and slide it onto the wire before attaching the terminal. After crimping and soldering, slide this piece over the crimp connection and use a match to shrink it down onto the crimp itself, leaving just the spade terminal exposed. Then cut a piece of heat-shrink tubing of a diameter that will fit over the female spade terminal itself about 1/2" long and slide it on until the end is flush with the business end of the terminal, and shrink it in place so that it covers the terminal and overlaps the first piece over the crimp. The end result is a two-level insulation job that looks professional and even provides a measure of strain relief to the wire connection.

It's possible to do a similar two-level insulation job to a male terminal using a very short piece of the larger heat-shrink tubing, but it doesn't surround the terminal itself when disconnected, so unplugged terminals involve some risk of bumping into things and shorting. It works just splendidly when plugged in, though.

CONTACTS: Vince Chrzanowski of Baltic, CT restores old auto radios for a living. He recommends *Channel Master COLOR* contact Shield, Silicone Base, which is available at most electronic supply houses. Model 9101 is the 16-oz. can; model 9100 is a 6-oz. can of the same stuff. He claims many rocker switches, even many of those that appear to be broken, can be fixed by spraying this stuff through the cracks without even removing the switch from the panel!

Chad Bolles likes LPS 1. "It is greaseless and does not attract dirt and is made for elec systems." Tom Wagner adds, "CRC has a chemical for cleaning too."

Tom Wagner warns against confusing electrical contacts with connectors and using the wrong product: "My major concern is that folk will generically use contact cleaners without actually knowing that fuses and the like are actually connectors. Never, I repeat, *never* use a contact cleaner on them. They are for rotary switches and will do more damage than good. Often a cleaning with alcohol and a clean business card is all that is needed. There are chamois on sticks for cleaning VCR heads at Radio Shack that are excellent. Never use a Q-Tip, they will leave material behind. For pin connectors, clean all the dirt you can out and use alcohol followed by air to take any surface residue out. Then a simple repeat removal and insertion of the connector a number of times is often all that is needed. Stubborn cases usually require more drastic means. A typewriter eraser used gently is a very good burnisher. Round wood toothpicks can be used to clean the female part of sockets.

"Check for broken or cracked parts. They can also show where failures might be; the electronic circuits very seldom break down, but sometimes the plastic they are attached to allows the connections to fatigue, resulting in poor connections."

SWITCHES: If you're looking for generic switches to fit the existing cutouts in the console or dash panels, Craig Sawyers explains your problem: "The aperture is 22.5x30mm, and you will find that the vast majority of rocker switches are 22.5x27.2 (or very close). What you need is a switch specified as "European cut out", which is 22.5x30mm. Now I'm in Europe, and why these switches don't dominate the market is anybody's guess."

ROLLER MICROSWITCHES: The microswitches on the throttle linkage and on the shifter look tricky with their little rollers and all. However, they are in fact a standard item, and are readily available at your local electronics store -- complete with identical rollers.

POTENTIOMETERS: Tom Wagner says, "There is another product for variable resistors like volume controls and air position sensors. It is a pretty good "stop gap" solution for intermittent radio controls and sensors, but has to be sprayed directly on the carbon track. It does work, have used it for years on noisy radio controls. Check the can and be sure that it is for controls not switches. In the old days we used "carbon tetrachloride" (just tapped the shop fire extinguisher), but that wrecks your liver and can actually be absorbed through the skin. Illegal and dangerous!"

ELECTRIC MOTOR LUBRICATION: Stefan Schulz and Chuck Johnson Jr. forwarded this procedure, originally from Chuck Johnson Sr., for oiling a "permanently lubricated" electric motor: "It is possible to lubricate a 'permanently' lubricated bearing by oiling the wicking that surrounds the bearing. To do so take a sharp awl (punch) and with a hammer punch a hole into the 'bell' shaped cover over the bearing housing. Do this through the vent holes in the motor and *not* in the end of the motor itself. The wicking is housed on the inside of the motor in a 'bell' shaped tin cover so it is easy to poke a hole in it. Then just take an oil can (I use a PLEWS oiler so I can get some volume in there but almost any oil can that can put some pressure on the oil will work), and 'flood' the wicking. This way you do not have to take the motor apart to get the bearing soaking in oil. After this you can periodically lubricate the bearing by just re-flooding the wick through the hole you have made. This technique works with all motor types, auto as well as small appliance and large appliance motors."

The bearing cover that you are punching a hole in is very thin metal, much thinner than the housing of the motor itself. If you punch near the center, you may hit the bearing itself, and possibly damage or misalign it. Punch the hole near the outer edge of the cover; there will be nothing under there except the felt that's supposed to hold oil.

Of course, some motors don't have suitable vent openings, so you may have to open the motor anyway. This method still applies, though, since the bearing inside is almost always retained by a permanently-attached cover of this sort and oiling is almost impossible *without* punching a hole.

Another favorite item for applying the oil is a hypodermic syringe, preferably one with a fat needle. With a little luck, you can buy one in your area without being arrested for drug abuse.

Now that you have a procedure, you can oil motors periodically or you can wait until they seize up. Your choice. Do you really believe "permanently lubricated" means forever?

In the specific case of the XJ-S electric radiator fan motor, Schulz adds "the motor is of the "definitely no user serviceable parts inside, so do not open me" variety. Then again, you can open the thing by forcing the pry slots at the top and close it again by replacing the cover and punching down a bit more metal from the side. Look at one and you'll see what I mean." Of course, bending the metal back and forth regularly might result in needing a new motor sooner than not oiling it at all. In these cases, you might try a different idea: drill a hole through the housing itself, aiming for the same area adjacent to a bearing, and apply oil without disassembly. If it is important to keep water or dirt out of the motor, cover the hole with a piece of aluminum tape when you're done.

WIRING HARNESS RENOVATION: Richard O. Lindsay sends this innovative method: "Tie the harness into position with tie-wraps thereby preserving all of the original bends and more importantly, break-out points. Remove all of the jacket leaving the wires only in position. This is a good time to clean and degrease all of the insulation. Then cut each wire, one at a time, about a foot or so back from the connector end. This cut should be well back into the jacket away from the breakout point. This allows you to splice in a piece of generic wire of the appropriate gauge and turn the original cut off wire around leaving the nice clean color-correct wire sticking out. The addition of a correct connector makes for a functional harness that, when vinyl wrapped, will look new and be color code correct!"

Dave Covert sends the following: "The cloth cover is not something you can really buy, but must send your harness to a shop and have it wrapped. The shop has a braiding machine that weaves 32(?) strands of cotton thread around the bundle. Sixteen strands in a clockwise direction, sixteen strands in a counter-clockwise direction. The cotton strands are usually black, but if your original harness had a colored tracer thread(s), send a sample along with the harness and the shop will switch some of the 32 strands out for colored strands to match the original tracer. The shop will also want you to mock up your harness with a few pieces of electrical tape to hold it in the proper shape."

"Cost is modest, and varies a bit from shop to shop. I had good conversations with two different shops, each with different pricing schemes. The first shop was Class-Tech of Bend, Oregon, 1-800-874-9981. The second shop was Harnesses Unlimited of Oreland, PA, (610) 688-3998."

If a complete rewrap isn't called for, Bruce Snyder sends these suggestions: "I've had a lot of success with the large sizes of heat-shrink tubing available at electronics suppliers. It's available in long lengths and a large variety of diameters, and looks quite nice when installed. Of course, you have to be able to slip it over the wires. The other thing that has worked well for me is the dry vinyl and cloth wrapping tape from Eastwood, and the cold shrink tape. These work very well, and have no adhesive to make that sticky mess we all love so well. These all take a little time to install, but look good, are durable, are considerable cheaper than a new harness and don't involve extricating the old harness for re-wrapping."

If your problems happen to involve the injector harness, read all about it under the EFI discussion starting on page 257.

RODENT DAMAGE: One of the members of the XJ-S online discussion group happened to mention that his wiring had been damaged by rodents, and it was simply *amazing* how many members responded with similar experiences! Apparently Lucas wiring, along with all its other shortcomings, is found delectable by rats! The problems usually seem to occur up in the V between the heads; it's probably a nice, warm, cozy spot for a rat to curl up in, and there's an assortment of tasty wires to chew on. Simon Gray reports, "I spent yesterday replacing spark plug leads, you guessed it, *mice*. It may have been a rat, either way it took one night to eat through four cables and totally ruin my day (I had renewed them three months ago)." They don't limit themselves to spark plug leads, either; there are also reports of chewed fuel injection wiring and ignition pickup wires.

Matt Dillon suggests, "My solution was to leave a cheap radio on in my garage all the time. Apparently the mice don't like the noise. My radio's been on for 2 years without any further rodent attacks. Until I started playing the radio, my cat was attacked twice!!!"

Perhaps you should get a cat to protect your cat, Matt.

MAIN 12V BUS AND TERMINALS: On most cars, the battery is in the engine compartment, so it is pretty obvious where 12V comes from and how to tap into it. On the XJ-S, however, the battery is in the trunk. There is a *serious* cable coming from the trunk along the bottom of the car and up to a post on the firewall, directly under the rear bolt attachment of the left side diagonal strut. From that point there is a short bus directly across to a similar post on the right side. Both posts actually mount in plastic insulators through the firewall, and protrude through on the interior side of the firewall to provide similar attachment points for electrical loads inside. Basically, everything in the car is powered from these two posts. Both ends of both posts are covered with rubber boots. If you need to tap into a 12V supply to power a new stereo or something, these posts are the place to connect to.

Note that there are *no* fuses in this supply; if you get a screwdriver between any metal on the car and one of these posts with the boot pulled back, you are gonna make some serious fireworks. It is *highly* recommended that the battery in the trunk be disconnected prior to fiddling with those posts.

The nuts on these posts -- both ends of both posts -- have a hex that is 0.525" (13.3mm) across. That's right, the only thing in your tool box that will fit is a pair of pliers! Craig Sawyers tells us these nuts are 1/4" Whitworth - 5/16" BSF wrench size, even though they are neither 1/4" Whitworth nor 5/16" BSF threads. See page 25 for help finding a wrench or socket.

If you're not interested in buying oddball tools, perhaps the easiest thing to do is to get the nuts off with pliers and then file the flats down until a 13mm socket will fit. Or, just replace the nuts with normal coarse-thread nuts; the post is 5/16" with 18 TPI, the same number of threads per inch as 5/16" SAE coarse thread, although the thread face angle and root details may be different. Brass nuts are recommended, even though the originals appear to be plated steel. If you're concerned about the perfect mating of threads, you might consider replacing the post in entirety, if you can find a piece of 5/16" brass threaded rod and a selection of nuts.

CONTROLLING INDUCTIVE LOADS: This book is not intended to be a primer on electrics, but in this case a review of some basics is warranted. Inductance is the characteristic of an electrical circuit that causes it to resist changes in current flow. If the current is zero and trying to get to 3 amps, it will take a little time to get there because of inductance; similarly, if the current is 3 amps and trying to get to zero, it will take a little time to get there, too. Inductance can be thought of as "inertia" of electrical current; it takes time to get it moving, and it takes time to stop it.

Inductance is a result of the relationship between electricity and magnetism. When current flows through a wire, a magnetic field is built up around the wire. Since the magnetic field is actually a form of stored energy, it takes some time to build up that energy, which means it takes some time for that current to get going. Similarly, when the current is cut off, the magnetic field remains briefly, but in collapsing attempts to maintain the current in the wire.

Once you understand the nature of inductance, you really don't need to have written data on components to know which ones have high inductance; it's the ones that involve wire wrapped around an iron core to form a magnet. Such loads are called "inductive loads", even though they always have some measurable resistance. By comparison, a light bulb is called a "resistive load" because it has lots of resistance and very little inductance. In an automobile, electric motors (fans, wipers, pumps, etc.), solenoids, and the A/C compressor clutch are inductive loads; ironically, the relays handling such loads are also inductive loads in themselves, although obviously on a smaller scale.

When you initially "turn on" an inductive load by closing a contact, things work well. The current is initially zero and builds smoothly to steady current flow. When you shut it off by opening the contact, on the other hand, things can get very messy indeed. The current in the inductive load attempts to continue flowing, but the circuit has been broken so it has no place to go. The dead-ended current results in a sudden spike in voltage between the ends of the coil, which means a sudden spike in voltage across the contacts. This spike has the opposite polarity of the power that was previously connected; if it was +14.4 volts, it is now negative volts, and it can be many times higher than 14.4 volts.

This spike is really quick. So quick, in fact, that a set of relay contacts opening that may look instantaneous to the human eye looks like a train slowly pulling out of the station to this spike. When the contacts first break open, the voltage will rise so quickly as to jump the gap long before the contact has time to move a couple of thousandths of an inch farther away. The result is arcing at the contacts as they open, which of course chars the surface of the contacts and wears them away over time. Some electrical switches and control devices actually have two separate contact ratings, one for resistive loads and one for inductive loads -- and the inductive load rating will always be lower, reflecting the additional stress of breaking contact with inductive loads.

Is this a problem? Well, you might want to think about that. If the contacts controlling the inductive load are in a standard relay in a place that's easy to get to, probably not; the contacts within a standard relay are often much heavier than called for and may last the life of the car, and if they eventually crap out a new relay costs \$3. On the other hand, if the contacts are within something expensive and/or difficult to get to (the climate control system, for example), you might prefer that the arcing was avoided. The serious concerns arise when the loads are controlled by transistors rather than mechanical contacts; some of those electronic control boxes are astoundingly expensive, and reverse voltage spikes don't do them any good at all.

Fortunately, controlling these reverse voltage spikes is really easy. All that's required is a diode, which is an electronic component that permits current to flow freely in one direction but blocks its flow in the other direction. They are also called rectifiers. Just wire the diode across the terminals of the inductive load; when the power is disconnected, the current flowing in the coil will simply come out one end of the coil, through the diode, and back in the other end of the coil. This provides a path for the residual inductive current to take without having to jump the gap at the contacts. The voltage spike is almost entirely eliminated, reduced to the gate voltage of the diode -- something less than one volt.

It is obvious which way to connect the diode; if you connected it the other way, it would form a bypass around the load when the power was turned on (and usually a direct short to ground, so your diode vaporizes in short order or a fuse blows somewhere). The symbol for a diode includes what looks like an arrow pointing in one direction; this is the direction that current will be allowed to flow from + to -. So, the diode will need to be installed around a load with the arrow pointing towards the +12V power source so current won't flow through it when the power is on. Some diodes are marked with a simple band at one end; this end should point towards the +12V power source.

Alan Heartfield says, "On modern cars with electronic circuitry, a diode should be placed around every inductive load, even relay coils. In fact, P & B and Bosch sell 'ice-cube' relays with the diodes built in. These are used as standard on most modern transit vehicles to protect the electronics. The diode doesn't only protect the switching device, but also reduces RFI (caused by arcs) and eliminates large reverse polarity voltages from migrating around the car, potentially (pun intended) punching pin holes in insulation and reducing the life of electronic parts."

So: would it be a good idea for owners to add such diodes to earlier cars that didn't come with them? Like they say about chicken soup: it couldn't hurt. Diodes are cheap; you can get small ones suitable for relay coils from Radio Shack for 25 cents each or so. The biggest expenditure on your part would be the time and effort to install them. For that reason, you might consider just buying the later design relays that Heartfield mentions and just swapping them out. Note that a basic relay will work no matter which way 12V is connected to its coil, but once a diode is involved polarity becomes important; you might want to check that the +12V connection is on the correct terminal before plugging in the uprated relays. If not, you'll need to reverse wires, which can usually be done by popping the 85 and 86 spade terminals out of the socket, interchanging them, and popping them back in.

If you decide to buy diodes, you're gonna want to know what to look for. Diodes seem to come with lists of specifications as long as your arm, but many of them are unimportant in this application. One specification that is important here is the Peak Inverse Voltage (PIV), which obviously needs to be higher than the 14.4V that the diode will be subjected to -- but it's difficult to find a diode with a PIV rating less than 50, so this isn't a problem. The continuous current rating is unimportant, this diode will never see a continuous current. The surge current rating needs to be at least equal to the continuous current draw of the inductive load it's attached to, but the loads on relays are some fraction of an amp while the larger loads may be a few amps, and the surge ratings on even tiny diodes can be 30 amps or more. All in all, it's hard to go wrong; just select some tiny diodes for the relay coils and something more substantial for motors and other loads, and they'll work fine.

Finding a suitable diode for the A/C compressor clutch is especially easy. See page 469.

If you will compare the electrical schematics of early XJ-S's with those for the 90's models, this is one of the changes you will note; circuits containing a diode and a resistor have been added around many relay coils. Why the resistor? That brings us to more electrical theory. The magnetic field built up within the inductive load is a form of stored energy, and sooner or later that energy must be dissipated. If a simple diode is wired across the load, then when the power is cut off the current will continue to flow around the circuit until the energy is dissipated in the resistance of the wire and the diode itself. This might actually take too long; to give the ultimate example, a similar process is used in charging a superconducting magnet, and in that case the current continues to flow indefinitely when the power source is disconnected. Some inductive loads have relatively heavy wire and low resistance, and so may take some number of milliseconds to decay. This can have detrimental effects. In the case of a relay, the slow dissipation of the magnetic field may cause damage to *its* contacts as they slowly drag open instead of popping open as they should. In the case of fuel injectors, Roger Bywater says, "Some years ago we measured injector closing action which with injectors like those on the V12 normally takes about 1 millisecond. Putting a flywheel diode in slows the injector closing down to about 3 milliseconds which is why you never see diodes used that way on injector drive circuits."

If you install a resistor in series with the diode, the initial current flow when power is disconnected will be unchanged; it is still the same amount of current that was flowing when power was on. However, this current is now flowing through an additional amount of resistance, which means it is dissipating more energy. The current flow will drop off more quickly. Electrically, the way to envision this is that the current through the resistor results in a voltage drop across the resistor -- which means we have reintroduced the reverse voltage spike, only now hopefully at a tolerable level. Since the initial current is a fixed value, the higher the resistance, the higher the voltage. The voltage then acts against the flow of current and brings it to a stop; the higher the reverse voltage spike, the quicker the current stops.

The ultimate case would seem to be an infinitely large resistance: leave the diode out altogether. Infinite resistance results in an infinite voltage spike, which in turn stops the current in zero time. Doesn't happen in practice, however. What really happens is that, at the instant the contacts break, the voltage spikes high enough to jump the gap. As the gap between the contacts continues to widen, the current continues to jump it (helped by the generation of ozone), until the energy has been dissipated in bridging this relatively large resistor. In other words, the energy stored in the inductive load has been used to vaporize a few molecules off the surface of your contacts. Meanwhile, the high voltage spikes haven't done any good for the insulation in the wiring, and it'll eventually start to break down.

So, you don't want too much resistance. If the resistance was about the same as the resistance in the inductive load itself, then the reverse voltage spike would be about 14.4V -- which the electrical system is clearly capable of handling without damage. In practice, you can always go with a resistance a couple times larger than that of the inductive load itself, since the wiring and components will be designed to handle much higher voltage than 14.4V.

Note that the amount of energy dissipated in the resistor itself is exceedingly small and brief. Like the diode itself, the resistor can be tiny. A 1/4-watt resistor or even smaller will do.

Keep in mind that installing a resistor with the diode only makes sense on inductive loads where it is important to quench the magnetic field quickly, such as on relays. It shouldn't be necessary on electric motors, since the momentum of the rotor will keep it rotating several orders of magnitude longer than the effects of inductance will last. Similarly, the A/C compressor clutch probably doesn't need to disengage suddenly, since it will spin for a bit when disengaged due to momentum anyway, and the coil releasing the engagement a couple of milliseconds more slowly probably won't make any difference.

Now, note that if the resistor is high enough ohmage and high enough wattage, you can leave out the diode and simply wire a resistor across the coil terminals! This will waste electricity, because whenever the power is on to the relay coil it will also flow through the resistor with no diode to stop it. The resistor now needs to be large enough to handle that current on a continuous basis rather than just the instantaneous spikes -- but resistors are cheap, so this is plausible. While a resistor with a low enough resistance to suppress the reverse voltage spikes on a large inductive load would waste a lot of electricity, a resistor across a relay coil could have high enough resistance that the wasted electricity could be considered insignificant. The scheme has the advantage of making polarity unimportant, so power can be wired to the coil and resistor in either direction without blowing out a diode.

Bosch appears to have adopted this strategy on later relays, building a resistor right into the base of the relay. One such relay, having a gray plastic housing and number 0 332 204 159, shows a device wired across the coil in the schematic on the case but doesn't indicate what the device is; it's shown as a simple rectangle rather than a resistor or diode symbol. However, a dissected relay revealed that the device was a 630Ω 1/2-watt resistor. At 14.4V, this resistor would waste only 0.023 amps. Such a resistor would theoretically permit a reverse voltage spike of about 107 volts as connected across the 85Ω coil in the relay. Presumably, this spike is considered a reasonable balance; a lower ohmage resistor would permit a smaller spike but would waste more electricity. Using a diode would permit use of a lower ohmage resistor for a smaller spike without wasting any electricity, but requires care in connecting to observe correct polarity.

There are other ways to deal with reverse voltage spikes in inductive loads, including installing zener diodes (which will "clip" the voltage spike at a particular level) and capacitors (which will absorb the energy and then send it back through the inductive load, resulting in a resonance wave back and forth until the energy is dissipated by resistance in the winding). Craig Sawyers likes the zener diode: "This might actually be an improvement over the resistor, for the following reason. The reverse voltage is in direct proportion to the rate of collapse of current. With a resistor, the voltage drops as the energy is dissipated, giving rise to an exponential fall in current and voltage. With a zener, the current will collapse faster, because it will attempt to hold a constant voltage of (say) 36.7V until the current is truly minute (microamps)." Zener diodes are cheap, but a bit more difficult to find than simple diodes and resistors.

One application where the simple diode and resistor won't do is on reversible motors, such as electric windows, electric seat adjusters, automatic antennas, and electric mirror adjusters; the diode will conduct when the motor is running one direction. One possibility is to wire in a resistor without a diode, as described for relays above; since most reversible motor applications are only operated for a few seconds at a time, the wasted electricity can be considered insignificant even if the current through the resistor is significant. You could actually put the diode back in if you want, just to eliminate the waste of electricity in one direction.

Perhaps a more esthetically pleasing solution would be to install two zener diodes, each with a zener voltage somewhat greater than the 14.4V that the motors run at, wired in series but arranged with opposite polarity across the motor terminals. Any voltage spikes that exceeded the zener voltage plus the bias voltage of the other zener diode (about 0.6V) would be clipped; otherwise, the pair of zener diodes would do nothing. Offhand, going to such efforts might not seem worthwhile; if you think so, please see the section on window switch problems starting on page 557.

There are a few specific inductive loads in the XJ-S you don't need to worry about. One is the injectors. Bywater: "The old V12 D Jetronic amplifier has a 'snubber circuit' on each of the injector drives consisting of a 6.8 μ F capacitor and an 11 Ohm resistor in series. This has the effect of softening the induced voltage spike but still allows the reverse voltage to build up to oppose current flow. It might be expected that this arrangement would promote oscillation but that does not seem to be of much consequence."

"The 6CU and later V12 systems have 47 volt Zener diodes which clip the induced voltage spikes. This is a good solution because it provides rapid build up of reverse voltage, protects the output transistor from an excessive voltage spike, yet does not provoke oscillation."

Another non-concern is the fuel pump relay. Bywater again: "Both 6CU and 16CU have a protection diode on the pump terminal already. Failure is usually caused by either a dry joint or a component failure and has nothing to do with the relay."

If you have the earlier solenoid type door locks, you don't have to worry about them either. They are never connected to system voltage! They are operated by power from discharging capacitors, so their current drops off gradually as the capacitor discharges.

If you have an early car with the solenoid-park wiper motor, there's one place you *do* need to install a diode. See page 573.

One final note: Even with diodes, resistors, zener diodes or whatever in the circuit limiting the reverse voltage spikes, it is still unwise to have a single set of contacts operating both an inductive load and an electronic device. Alan Heartfield: "The insulation will handle it, not being polarity sensitive, but if it finds its way back to any collector-emitter junctions, they will not handle any reverse voltage spikes. Neither will the input circuitry of many integrated circuits. And the effect can be cumulative. A semiconductor will deteriorate due to overvoltage and/or reverse voltage effects." If you must have a switch or relay control both an electronic device and an inductive load, it is advisable to select a double-pole control device and use a separate contact for each.

Relays

RELAYS: There are relays all over the XJ-S. On the '83, most are a Bosch 12V 30A SPST relay number 0 332 014 113, and are a small metal box with four spade terminals labeled 30/51, 85, 86, and 87. 85 and 86 are the coil connections, 30/51 is the common contact, and 87 is the Normally Open (NO) contact. The typical layout of these terminals is shown in **Figure 38** on page 629.

These relays apparently conform to a standard, and are readily available at any auto parts store. Often, the aftermarket relays are labelled for use in controlling driving lights, and may be found among the driving light kits instead of under general electrical components. They are usually entirely black plastic, and they often have an integral mounting lug. And of course, an aftermarket electrical device is likely to be as good or better than a British original (although not all -- this author found a particular type relay made in Italy and sold at AutoZone that wasn't worth a damn, three in a row failed quickly).

If you are installing or relocating relays note that relays are not watertight, even when they appear to be. Bosch relays have a distinctive little hole in the bottom. Their durability will be greatly enhanced if you will install them with the spade terminals pointing downward, so that dripping water can't get in and any moisture that does get in can drain out.

Unfortunately, the XJ-S is covered with exceptions to the common relay description above. Following are descriptions of several components that *look* the same and will fit in the standard socket, but are *not* the same and exchanging may cause problems or even shorts.

FIFTH SPADE TERMINAL: Many relays have a fifth spade terminal centrally located in the base in the middle of the other four; **Figure 38** on page 629 shows a terminal 87a in this location. When replacing relays, it is of considerable importance that the new relay has the same type terminal in this central location. Common designations for this fifth terminal include 87, 87a, and 87b -- and these are *not* interchangeable. In most cases, a relay with a fifth spade terminal can be used to replace a relay with only four, as the socket or plug will usually have a hole or slot for the unused spade to protrude through, and the basic four are nearly always the same regardless what the fifth terminal is.

SECOND 87 TERMINAL: Some relays in the XJ-S (and some of the aftermarket generic equivalents) have a second terminal 87 in the center of the base. This terminal is connected internally with the first 87; it merely serves as a second connection to the same contact. Although internally the same, one should be careful about replacing a relay with two 87 terminals with a relay having only one; the socket may have a wire that connects to the central spade, and it will not be connected if the terminal is not there. At this point, the solution is usually a simple matter of trading one relay with another to get a relay having both terminals where it is needed. It would also work to simply splice the wire going to the second 87 terminal into the wire going to the first 87 terminal.

SPDT RELAYS: The radiator fan relay, SRB411, has five spade terminals on the bottom, and the terminal in the center is labeled 87a. This relay is bright red -- Lucas' way of indicating "Hey, dummy, this relay is *different!*". A close inspection of the schematic on the housing shows that this is in fact a SPDT relay, and the 87a is a Normally Closed (NC) contact.

A SPDT relay might not be quite as common as the typical SPST relay, but it's close. Finding substitutes is not difficult, although a generic driving light relay won't serve here. If you don't wish to buy the Lucas original, you can look for a Bosch, Hella, or Potter & Brumfield. Per Bob Whiles, the part number for the Bosch is 0 332 204 105 and for the Potter & Brumfield is VF4-45F11; this author suspects Bosch numbers 0 332 204 109, 0 332 204 125, and 0 332 204 159 would work as well. Per Volker Nadenau, the Hella part number is 4RD003 520-13. All of these will plug right into the red socket.

DPST RELAYS: Some relays, including Bosch number 0 332 015 006 and 0 332 015 012, have an 87b terminal. This connects to a second NO contact. Note that this is not the same thing as having two 87 terminals; while the relays with two 87 terminals have both terminals connected to the same contact, this relay actually has two separate contacts. Here's the distinction: when the relay is energized, the same connections are made as in the relay with two 87's, but when unenergized, the 87 and 87b terminals are *not* connected to each other. In some instances, this may make no difference, and perhaps a relay with an 87b terminal can be used to replace a relay with two 87's, but be very careful replacing a relay with an 87b with a relay with two 87's -- something might backfeed through the 87 terminals on the relay and cause malfunctions.

In addition to variations in the fifth spade terminal, there are other variations among relays -- and things that look like relays.

EFI MAIN RELAY: On the Digital P EFI system diagrams, item #312 is the "main relay". This relay is mounted in the trunk near the ECU, right alongside of the fuel pump relay. Don't mix up the two relays; the fuel pump relay is a standard relay, but the main relay, Bosch #0 332 014 112, looks like a standard relay but it has a diode installed

internally in series with the coil. This difference is clearly indicated on the little schematic embossed in the side. They also paint a colored diagonal stripe across the top to indicate it is unusual.

The purpose of the diode in this relay is reportedly to protect the expensive EFI system from boneheads hooking up the battery backwards. If the battery is connected backwards, this diode will prevent the relay from operating, so the ECU will not get any power.

In this case making a special relay was totally unwarranted; a normal relay can be used by simply adding a suitable diode in the wiring *to* the relay.

FEEDBACK MONITOR RELAY: On the Digital P EFI system diagram for the North American "Emission A" spec, item #355 is the "feedback monitor relay". This relay is mounted under the black plastic cover at the right rear corner of the engine compartment, alongside the starter relay and the cold start relay. The cold start relay is a standard relay, but the feedback monitor relay is anything but -- don't mix them up. The feedback monitor relay, Bosch #0 332 014 411, has a diode mounted internally in parallel with the coil. Beyond this difference, however, is the fact that the connections on the base are rearranged, with one of the coil terminals and one of the contact terminals being interchanged compared to standard relays. The schematic embossed in the side shows the component clearly, and there is a diagonal paint stripe across the top to indicate it is unusual.

The feedback monitor relay is illustrated in the schematics as a normal relay. It's not known if some earlier cars use a standard relay here.

There was no real need for a special relay here; a normal relay with an external diode would work fine. If you choose to substitute, however, be sure to rearrange the terminals in the socket to the standard relay positions.

ELECTRIC FAN DIODE PACK: The electric radiator fan diode pack is the blue block at the left edge of the engine compartment that looks like a relay, but isn't. It's described on page 214.

Editor's Note: As a Mechanical Engineer, I have to express an opinion here: the guy who decided it was a good idea to make several totally different and non-interchangeable components all fit in the same socket should be stood up against a wall and shot. There is simply no excuse for this level of incompetence.

LATE MODEL RELAY PROBLEMS: Michael Neal warns: "I just wanted to advise the list of a known problem with late model Jags, roughly '93 and later. They have several Hella brand relays in various places for different components. Underhood usage of them seems to be the worst problem. The XJ-S and XJ6 use them extensively on everything from A/C clutch control to EFI main relays. Hella apparently came out with a replacement to "fix" the failures. They haven't been working. Whenever I have a strange problem come in, 90% of the time it's been one of these damn relays. Unfortunately I'm forced to replace them with what Jaguar provides so that's what they get. The relays are developing bad contacts and overheat, failure is usually intermittent. Most of these relays have a light blue case. You can troubleshoot them by pulling the relay and jumping between the 30 and 87 terminals."

Leonard L. Peake adds, "There is a Jaguar "Service Bulletin" in regards to all relays on 1993 cars that have a date code before "183" stamped on the side."

Gary Penovich says uppity relays cause fault codes. "To prevent it from happening again, you may want to replace the blue relay(s) with the updated black ones. You should at least pull *all* your underhood relays, spray the sockets with electrical contact cleaner, and buff the grunge off of the relay contacts with an emery board. I'll bet they're covered in grunge and corrosion."

SHOPPING FOR RELAYS: Finding a parts store employee here in the Bubba Belt who even knows what a relay is, much less whether or not it is the configuration you need, can be a challenge; "What kinda car is that fer?" as he prepares to type on his computer terminal. Actually, the best place to look for relays is in a junkyard; just about all cars use relays for one thing or another. They are often hidden inside fuseboxes or other compartments. European cars often use Bosch relays. All European automotive relays seem to have a little schematic on the outside (the Japanese sometimes use relays with a totally different configuration and no schematic), so it is a simple matter to confirm whether or not a relay has the desired terminals. This author had no trouble finding relays that have the 87a (NC) terminal. If you need a relay with only a single 87 terminal and don't care what the fifth terminal is or even if there is one, almost any relay will work; they all seem to have the basic 87 terminal.

If you find relays from late model cars, the schematic on the side is likely to show an internal diode or resistor wired around the coil (between the 85 and 86 terminals). No problem; in fact, this is likely to be an improvement! See the discussion on controlling inductive loads on page 518.

If all else fails you can go to an electronics store and buy a generic "ice cube" 12VDC relay and solder short jumper wires to suitable spade connectors to plug into the original socket. "Ice cube" relays are called that because they have clear plastic rectangular housings so you can see the innards; no schematic on the case required, you can *see* what the terminals are connected to! Ice cube relays may have as many as four sets of contacts, and they always have both NC and NO contacts on each one. If you buy a relay with more contacts than you need, just wire them all up to provide extra current capacity.

STARTER RELAY: Also called the "ballast resistor starter relay" in the Haynes repair manual. Item 194 on Jaguar wiring schematics. It is Lucas style 22RA, Lucas part number 33356 or SRB301, Jaguar part number C36611.

Most of the Jaguar schematics show this relay's internals unclearly or even as a simple box with five terminals and no indication what goes on inside. If you have a copy of Publication S 57, the "Electrical Guide", the relay is shown in painstaking detail in Figures 2.1, 3.1, 4.1, 24.1, 24.2, 24.3 and 25.1 -- incorrectly every time. The relay is shown as having only a single contact connected to terminals C1 and C4, while in fact there are two separate sets of contacts within the relay. C1 and C4 are not connected to each other when the relay is not energized. Also note that the C1 contact is heavier duty than the C4 contact, so even though schematically it appears you could interchange them, it probably wouldn't work long if you did.

If you're having problems getting your starter to respond, perhaps the first thing you should do is attend to the spade connectors that attach to this relay. See page 514.

Dick Broxon of Cincinnati reports that his '88 XJ-S would fail to start on damp mornings. It wouldn't even turn over, it would just click. It would start later, though, when things had warmed up and dried out. He removed the plastic cover from the relays under the hood on the right fender and sprayed them with a product called WIRE DRYER by *Snap*. He has not had a problem since. The starter relay, of course, is under the cover mentioned.

Moisture is not the starter relay's only problem. It often turns out to be the culprit in a car that won't start, or will fail to start *sometimes* and then work perfectly later. To test, take the relay out of the car and apply power between the W1 and W2 terminals; you can jumper from a car battery, or you can just poke a 9V battery down onto the terminals. You should get a click. Then connect an ohmmeter between C1 and C2, and check that the circuit closes when the relay is energised. On this author's relay, the resistance measured was random: less than 1 ohm one time, 25 ohms the next time, infinite ohms (open circuit) the time after that. Click that relay a few times to make sure it makes good contact every time. Note that clicking it a couple dozen times seems to clear it up so it makes good contact each time, but you probably shouldn't rely on it staying good at that point. If it doesn't seem to be making good contact the first few times, it probably won't make good contact the night you're out on a date with the girl of your dreams.

It may be that the contacts within the relay get a little charred. It is possible to take the relay cover off, clean it up, and reassemble. Unfortunately, this apparently doesn't work for long. Bill Farnsworth says, "I did that first. A couple weeks later I found myself in a parking garage, as the best dressed mechanic in Redmond, WA. bent over the engine compartment wearing a tux..." This author tried it too, with a remarkably similar experience to show for it.

Just replace the stinkin' relay. Your local auto parts shop can probably order it for you, and it'll cost you only about \$60.

Ouch. OK, now we're looking for reasonably-priced non-Lucas substitutes.

STARTER RELAY SUBSTITUTE (OPUS): Ask any auto parts shop for a starter relay for a Chrysler -- apparently just about any Chrysler from the late 70's. The particular starter relay this author found was made by Wells, number CR620. This relay is electrically identical to the Lucas item; it's just cheaper and better.

The terminals are *not* labelled the same, of course -- and they are not arranged the same way on the base either, so you can't plug the wires on by location. Here's how to connect things up:

<u>wire color</u>	<u>Lucas terminal</u>	<u>equivalent Chrysler terminal</u>
BG	W1	I
WY	W2	G
WR	C1	EGR/SOL
N	C2	BATT
WU	C4	BAL

The Chrysler relay is physically pretty similar to the Lucas, but the mount bracket attached to it is different. You could just drill a new hole in your Jag and screw it down, but note that it'd probably last longer if it was mounted right side up with the terminals pointing down. This author noted that the bracket on the Lucas relay was tack-welded to the casing. I ripped it off, drilled some 1/8" holes in it and pop-riveted it to the bracket on the Chrysler relay. Then I bent the Chrysler relay bracket down 90°, which put it in just about the same configuration as it had been on the Lucas relay.

An alternative idea would be to open the new Chrysler relay (looks easy) and pop-rivet the Lucas bracket right to the case. The Chrysler bracket, which is held on by rivets, can be removed and discarded and the holes covered. Reassemble and install.

The Chrysler relay is also a bit larger than the Lucas -- which may entail some fiddling if you want to get that hokey plastic cover back over it. I managed to get the cover back on; it wouldn't go on the OEM mounting holes, but it wasn't too difficult to move it over a bit, drill two new holes and screw it down. The upper edge is now not as close to the wing as it used to be, so you can see a bit of the bracketry by peering down in between. But it looks OK.

An alternative idea here would be to simply fab up a new cover with a hair more space than the OEM cover. Just find a plastic box and start cutting sides off of it.

One other minor difference of note: The Lucas relay appears to be a sealed box, but the Chrysler relay has a tiny filtered vent on the side of the cover. Hmm.

Lucas starter relay: special order, sixty bucks. Chrysler starter relay: on the shelf, eight bucks. You decide. Wanna guess which one will be more reliable?

John T. Richardson found yet another substitute relay: "a Sorensen SR-17 relay, cost was \$6 at Checker Auto Supply. While this is not an exact drop-in replacement, it does mount in the space available and anyone with a VOM can decide the correct wiring terminals. Mine has been in service for over a year with no problems."

STARTER RELAY SUBSTITUTE (CEI AND MARELLI): The Lucas CEI and Marelli ignition systems control the coil current electronically and therefore have no ballast resistor -- and therefore no need for a contact in the starter relay that bypasses a ballast resistor. Nevertheless, Jaguar continued to use the same Lucas relay; in fact, parts lists seem to indicate they used it throughout the production life of the XJ-S. So, you can still opt to replace it with the Chrysler relay described above for the OPUS cars. There are some wiring changes from the pre-H.E. so here's the connection chart for H.E. cars:

<u>wire color</u>	<u>Lucas terminal</u>	<u>equivalent Chrysler terminal</u>
WB	W1	I
WY, WU	W2	G
WR	C1	EGR/SOL
N	C2	BATT
WU	C4	BAL

The C4 terminal doesn't do anything on the Lucas relay, and the BAL terminal won't do anything on the Chrysler relay.

Not only is the C4 terminal still there, but the WU wire that went to the ballast resistor is still there as well -- at least on this author's '83. In fact, there are two WU wires; one is connected to the C4 terminal and goes nowhere; this is the one that used to go to the ballast resistor on the OPUS ignition system. The other WU goes to the cold start timer, but it doesn't connect to the C4 or BAL terminal; instead, it is connected to the W2 or G terminal along with the WY wire.

The G terminal on the Chrysler relay only has one spade, so while you're at the parts store you might want to pick up some of the doublers used to connect two female spade connectors to a single male spade terminal. Or you can simply make up a short jumper with two male spade connectors and one female spade connector all tied together.

So, you have a C4 contact that does nothing connected to a WU wire that goes nowhere. That leads us to another possibility in starter relays: a relay that doesn't have the ballast bypass contact at all. Again, a Chrysler relay fits the bill; just ask for a later year, somewhere in the mid-80's or so. Chrysler likewise had gone to electronic coil current control and done away with ballast resistors, so they deleted that contact from their relays. The terminals are the same as the chart above except there's no BAL. Just tuck that unused WU wire under something and forget about it.

Of course, once you've omitted the ballast bypass contact, you're really just dealing with a plain ol' SPST relay. *Any* 12VDC relay will work as long as the contacts are rated for enough amps. It's not known how many amps the starter solenoid pulls, but it's entirely probable that a regular 30-amp automotive relay would work. The W1 and W2 connections become 85 and 86, C1 becomes 30/51, and C2 becomes 87.

OTHER SWITCHES AND RELAYS INVOLVED IN STARTING: If you are trying to use the EFI wiring diagram in the ©1982 Supplement, page 19-1, or Figures 13.10, 13.12, or 13.93 in the Haynes repair manual to diagnose starter problems, you may be getting very confused. These diagrams indicate that the only thing that disables the starter relay is the "start inhibit switch" (on the shifter, also called a "neutral switch" or "automatic gearbox safety switch", item 75 on Jaguar schematics) via the "feedback monitor relay" (also called an "inhibit relay" or "feedback inhibit relay", item 355 on Jaguar schematics). Why is a starter-disabling relay called a "feedback monitor relay"? Judging from the diagrams it appears that the neutral switch on the shifter was originally intended to prevent starter operation in gear, but it's also needed to switch the EFI from open-loop to closed-loop operation -- and it only has a single contact. So, instead of adding another switch or providing one with more contacts, they installed this relay. Since the relay likewise only has a single contact, it is used to control the starter, while the signal to switch the EFI -- being very low current -- is taken *through* the relay coil. When the neutral switch is closed, the BG wire is grounded, the relay closes, and the EFI signal input sees 0V; when the neutral switch is open, the relay opens and the starter won't work, while the EFI signal input sees 12V in the ungrounded BG wire.

In the "UK & Europe" diagrams on page 19-2 of the ©1982 Supplement or Figures 13.9 and 13.11 in the Haynes, there's no such thing as closed-loop operation and therefore no switching it on and off, so the feedback monitor relay is omitted and the starter relay is simply grounded through the neutral switch. The starter wiring circuit on page 86-7 of the ©1982 Supplement shows this non-US layout with a simple connection from the starter relay through the neutral switch to ground.

According to *all* of the diagrams mentioned above, the inertia switch will not affect the starter operation. On Bill MacDonald's '85 as well as this author's '83, the inertia switch *does* disable the starter. Apparently, the correct wiring schematic for these cars is the one shown in Figures 2.1, 24.1, 24.2, and 24.3 of Publication S 57, "Electrical Guide".

Basically, the difference is in how power is routed to the inhibit switch; the EFI diagrams show power coming straight from the ignition switch, but the Electrical Guide shows it coming from the inertia switch, which is also controlling the main relay in the trunk. So, if the inertia switch is tripped, not only is the fuel system shut off, but also the starter won't operate.

STARTER SYSTEM TROUBLESHOOTING: MacDonald suggests the ultimate test to determine whether your starting problems are caused by something in the relays and wiring or by the starter itself: "Try bypassing the thick brown with the thick white/red wire at the starter relay. If the starter does not crank then it's your starter!" Or the heavy cable wiring from the battery to the starter.

If the starter itself is working and therefore you must have a problem in the wiring to it, the next thing to try is to disconnect the WB wire from the W1 terminal on the starter relay, and connect a ground wire to the W1 terminal instead. If the starter now works like it should, your starter relay is OK (or intermittent!) as well as the wiring from the ignition switch; you now need to be looking at the inhibit relay (under the same cover as the starter relay), the neutral switch on the shifter, and the inertia switch.

Starter

Greg Meboe and Michael Neal report that Jaguar provided a new design starter beginning in 1988 that features a gear reduction drive. This starter will fit earlier V12's, and is smaller, lighter, more reliable, and just all-around better.

STARTER REMOVAL: Both the ROM and the Haynes manual list several steps involving the steering column. This must reflect RHD cars; you don't have to mess with the steering column at all in a LHD car.

David Johnson wants everyone to be aware that the upper bolt holding the starter in has a 12-point head, and therefore requires a 7/16" 12-point socket. The manuals simply say to remove the bolts. "You can't really see the bolt head even with a mirror. So because most bolt heads are 6 point, I tried for what seemed like days with several different size sockets."

"Also I learned *not* to remove the transmission dip stick and tube. What a mess! I guess with the car up on ramps the fluid ends up being significantly higher than the bottom of the tube."

STARTER SLOW TURNING: Mike Morrin: "Check that the engine grounding cable (underneath on the left hand side) is not loose or damaged. This is not particularly an XJ-S fault, but it was loose on mine, and I would have been really mad if I had pulled the starter before discovering it."

The fact is that lots of electrical gremlins have been traced to faulty grounds, a lot of them to this strap in particular -- see pages 249, 303 and 514.

Of course, when a starter is turning slowly, most mechanics will check the battery terminals for corrosion. On most cars, one cable goes straight from the battery to the starter solenoid and the ground cable usually connects nearby, so a bad connection would almost have to be at the battery. On the XJ-S, however, the power to the starter comes from the battery along the bottom of the car and up to the left side terminal post on the firewall, then over to the right side terminal post on the firewall, then down to the starter solenoid. Weak connections can therefore be at either terminal post on the firewall as well as at the battery. See page 517 for more on those terminal posts.

Alternator

If there is any indication that your alternator is having trouble (not charging, low voltage, etc.), you should have it attended to immediately. If caught soon enough, it can be repaired or rebuilt. If left alone, it self-destructs and a new one is required.

One indication your alternator has had it is that the alternator warning light stays on after the engine is shut off.

ALTERNATOR EXCITATION: The field on the XJ-S alternator is excited through the “ignition” warning light (fifth from left on the author’s ’83, has a little picture of a battery), so if this light is burnt out or disconnected charging may be intermittent. According to Randy Wilson, “A common enough design. Lots of alternators will respond like this... some would never charge. Here’s what happens: the alternator needs a signal to indicate the key is on, and a power source to boost itself into a charging condition... bootstrapping, if you will. This power requirement is low enough that a lot of alternators use the power flow *through* the charge light for this purpose. This is called the exciter. And, in reality, key on is not really an important condition to the alternator. You just don’t want to be driving the exciter full time, lest your battery will go flat overnight. Once the alternator is charging, it becomes self-exciting, and no longer needs or uses this external power source (oversimplification). Thus the light goes out.”

“The exciter is used to induce enough of an electromagnetic field to start the current generation. However, there is always some residual magnetism floating around in a used alternator. With this residual, the alternator can generate a little bit of current, if you spin them fast enough. In the case of Lucas (and others) the current needed to self-excite is fairly low -- low enough that the current from the residual magnetism can meet the demand. This usually happens at 2500-3000 engine rpm. And as soon as the alternator is up and charging, operation is as normal. You don’t have an outside exciter source, but you don’t need it any more.”

Jaguar may have provided a fail-safe here. The electrical diagrams show a 100Ω resistor in parallel with the alternator warning light, which would seem to mean it would get some excitation current even when the bulb is burnt out.

ALTERNATOR TROUBLESHOOTING: Michael Minglin says, “I really like the factory manual’s instructions for checking maximum amps output. Even If I could reach down there to remove the plastic cover, I could not see to connect a jumper between “F” and “-”. My solution was to remove the alternator and attach wires from “F” and “-” and run them out of the back of the alternator, up the inside of the fenderwell, with a male and female connector on the end by the cross brace. Now to jump the regulator all I have to do is connect the connectors. I’m not sure it is worth pulling the alternator just to make these connections, but I will never put in another alternator without this modification.”

If your alternator doesn’t seem to be charging like it should and you can’t find an electrical cause, don’t overlook the mechanical problem described on page 87 -- especially if it’s a later car with a Bosch alternator and a ribbed alternator belt, and especially if it’s a convertible.

RELOCATING DIODES: An alternator contains a full-wave rectifier, which is an assembly of six diodes that convert the alternating current produced by the windings into direct current for powering the electrical loads in an automobile. Conveniently, these devices are built right into the alternator, so service is simple: just remove the bad alternator and install a good one.

Unfortunately, the heat inside the Jaguar engine compartment is not good for electronic semiconductor devices such as diodes. The alternator has a cooling fan and the diodes are built into a heatsink, but when it’s hot everywhere in the engine compartment such efforts will do no good.

If you’re sick and tired of replacing diodes (or alternators), one possible solution is to open the alternator up, take the diode assembly out, and relocate it to some remote location where things are cooler. You will need to provide a small fan to keep them cool (they generate a good deal of heat on their own!), but a 12V computer fan is cheap and workable.

Craig Sawyers sizes the wires needed: "the current from each of the three phases to the diode pack will be around 1/3 of the total output current. In the US, this would be known as 12 AWG, in Europe 3mm². The output cables to the battery post would have to be rated at the full 120A. A double run of 8 AWG (8.4mm²) would do this nicely (it will handle 150A)."

Another nice feature of this mod is that you no longer need to use expensive Lucas diodes; you can buy a diode pack used to rebuild any generic alternator of comparable or greater amperage -- the GM ones are really cheap in the US. You could also opt to improve the alternator by using Schottky diodes, which have a lower threshold voltage and therefore rob the alternator of less of its power and generate less heat.

And don't forget: if you locate the diode pack somewhere convenient, it should be a *lot* easier to work on than the alternator, which is a real pain to get to.

LUCAS ALTERNATOR: From the introduction of the XJ-S until engine number 8S57571, it was fitted with one Lucas alternator or another -- 66-amp on the pre-H.E., 75-amp on the H.E. There are also reports of Motorola alternators on these cars, possibly even fitted from the factory. Bob Johnson says the number is A5000/12.

If you're interested, there is a performance chart for the 75-amp alternator at:

<http://www.jag-lovers.org/xj-s/book/Lucas75Aalt.html>

If a Lucas alternator seems to be charging intermittently (fully charging one minute, discharging the next as indicated by the voltage gauge) or has simply stopped charging but has no shorts or burnt wiring, it might be fixable by replacing just the regulator itself. This is much cheaper than replacing the whole alternator, and is easy to do by removing the plastic cover from the back of the alternator.

BOSCH ALTERNATOR: Beginning with engine #8S57572, the XJ-S was fitted with a Bosch 115-amp alternator. This alternator is driven by a multi-groove belt instead of the V-belt found on earlier cars. Since the alternator is driven from the crank damper itself rather than from the pulley that bolts onto it, this change involved the replacement of the earlier crank damper C36013 with one with the multi-groove pattern, EAC9248 (replaced sometime thereafter with EAC9693 to fit a timing disk for the Marelli ignition). The pulley part number didn't change.

ALTERNATOR LOAD DUMP MODULE: Reportedly, the 115-amp alternators fitted to the late 80's XJ-S will not begin to charge until the engine has been revved up. Although not really a problem, it is somewhat irritating to see the charge light on when everything else seems OK. According to Michael Neal: "Actually, there is a fix for this. There is a device called an alternator load dump module that was fitted to the later XJ40's and XJ-S's with the high output alternator. Fitting the module will fix the problem. The load dump module will cause the alternator output to function properly at idle without having to raise the idle speed." The part number for the 115-amp dump module is DBC 5896.

NOISY ALTERNATOR BELT: If you have the later Bosch 115-amp alternator with the multi-groove belt, chances are that sooner or later you will have trouble with that belt squealing. Neither tightening the belt nor even replacing it will help for long. The problem here is a flaw in the design of the multi-groove pulley -- not just this one on the Jag, but basically with all multi-groove pulleys. The author discovered this design defect on his '84 Honda Accord (his '83 XJ-S has V-belts), but the problem has been confirmed on the later Jaguars as well.

V-belts and multi-groove belts work basically the same way: a V-shaped section of belt is wedged into a mating groove in a pulley, and the load is transmitted by friction. The wedging action is what provides enough friction to handle the load. A conventional single-V belt wears on the sides, making it narrower and therefore sitting deeper in the groove, so it needs periodic tightening. This works fine until the belt either breaks or is so worn that it sits in the bottom of the groove instead of wedging between the sides, in which case it will slip badly.

The multi-groove belts, unfortunately, cannot wear anywhere near that much before they begin to slip. In fact, after the pulley itself has a little wear on it, they cannot wear *at all* before they begin to slip -- the brand new belt will slip almost immediately. This is because the belt will contact the pulley on *top* of the ridges between the grooves and ride on these edges rather than wedging down into the grooves. Sitting up on these smooth edges, it can barely transmit any power at all without slipping. In fact, even when it's not squealing it's probably still slipping.

It is easy to confirm this is what's happening: look at the alternator pulley with a flashlight. If the top edges of those ridges are bright and shiny, you've found the problem. Usually, the inside surfaces of the V's are much duller, sometimes even rusty, indicating the belt isn't even touching them.

The fix is easy, too, except that it requires getting that pulley out -- which isn't easy. With the pulley removed from the alternator, mount it on something that will spin it (a lathe, or find a way to chuck it up in a drill if you don't have a lathe) and grind the edges of those ridges down. See **Figure 27**.

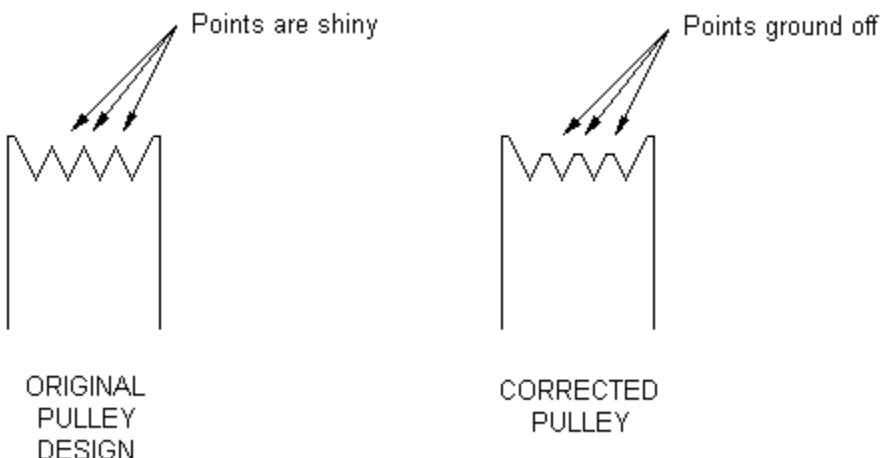


Figure 27 - Multi-Groove Pulley Correction

Don't worry about grinding off too much. Yes, you are reducing the contact area of the wedge area, but the fact is that once the belt is actually wedging rather than skimming around the ridges, contact area isn't a problem -- the multi-groove belt will easily handle all the load of the alternator and then some without complaint. Just make sure to grind the ridges down enough that they won't be a problem any more, even with a worn belt.

Obviously, the grooves on the damper pulley itself would benefit from similar treatment. It's not really called for, however; the larger diameter means that the belt generally won't slip on this pulley, even when it *is* riding on top of the ridges.

There is yet another possible cause of alternator belt squeal. See the report on failed crankshaft dampers on page 87.

RETROFITTING THE BOSCH ALTERNATOR TO EARLIER CARS: The alternator mount bracket EAC4181 was replaced with EAC9320 at the same time that the Bosch alternator was fitted. Perhaps the purchase of this bracket will permit the upgrade of the earlier cars to the Bosch unit. Since they all use internal regulators, the wiring connections should be fairly straightforward.

To deal with the multi-groove pulley on the Bosch, you can either purchase and install a new crank damper, or you can simply replace the pulley on the Bosch alternator with a V-belt type. Note that there *might* actually be some problem with this latter scheme; historically, alternators driven by a single V-belt never exceeded 60-70 amps or so. Larger alternators used two V-belts prior to the introduction of the multi-groove belt.

Scott Horner of New Zealand retrofitted the Bosch alternator to his UK-spec pre-H.E. XJ-S. "The Bosch alternator is bigger than the Lucas and Motorola in most dimensions. This meant having to drill out the original mounting bracket

‘swing’ (technical term!) hole, definitely needs to be done using a drill press. Trying to find a replacement pivot bolt with a larger diameter was entertaining; I eventually got a suitable bolt from a motorcycle store (but that could just be good old NZ and the complete lack of parts).

“The unit I got had a grooved belt pulley originally (although the Jaguar parts manual lists both grooved and V-belt) so I had to remove this and fit a normal V-belt pulley. The shaft size on the Bosch is larger than the Lucas and Motorola, so you can’t use the original. I was lucky enough to be able to rummage through a collection of dead Bosch alternators, which all have the same shaft size, and found a suitable replacement, even down to the offset (so the belt lined up with the crank pulley).

“I was able to re-use the original power connectors on the back of the alternator (although I had to drill these out as well to make them fit).”

ALTERNATIVE ALTERNATORS: Regarding the whole general idea of replacing one alternator with another, John Napoli offers a viewpoint: “It is a good idea, IMHO, to go with a common alternator for your geography. Volts are volts, what you want is dependability and maintainability. A large Lucas infrastructure exists in Britain. In the US, a large infrastructure exists for GM stuff. The same can probably be said for other marques, but I have GM experience, and there is no shortage of ridiculously cheap GM components in the States!”

Alternators are rated according to the number of amps they can produce. There is no such thing as too many amps; since the regulator will limit voltage to a set value, an alternator with excess capacity will simply put out whatever is necessary to meet the load. The only reason to opt for fewer amps is to save money, since higher-amperage alternators generally cost proportionally more. A good rule of thumb, obviously, is to provide at *least* as many amps as the alternator the car came with was rated at. Before you decide how many amps are enough for you, you might want to read the sections on high-wattage headlights (page 605) and electric cooling fans (page 209) and think about whether you might add loads in the future. You might also think about whether you’ll be considering a high-power sound system.

Note that in the old days when engines had carburetors and windows had cranks, a typical alternator might be rated at 40 amps or less. In modern automobiles with EFI and electric everything, the capacity of alternators has increased considerably. Meanwhile, the designs have become more efficient, so they don’t appear any larger than their predecessors -- often smaller, even.

Any 12-volt internal-regulator alternator of suitable amperage would serve in the XJ-S if it could be mounted. Unfortunately, an easy bolt-in substitute apparently does not exist; the mount scheme is different on GM alternators, a Chrysler alternator won’t come close to fitting in the space, and several Japanese units will bolt up but the belt will be misaligned. Nevertheless, several schemes have been cooked up for installing a GM alternator as described beginning on page 534. But first we’ll tell you more about GM alternators.

GM ALTERNATORS: Considering the Lucas reputation for excellence and reliability, there is a considerable likelihood that sooner or later you will consider putting a GM alternator in your XJ-S. So, some background knowledge of GM alternators is in order.

There are lots of varieties of GM (Delco) alternators, but for our purposes there are six basic “types” that we might consider for the XJ-S: The SI-10, the SI-12, the SI-15, the SI-17, the CS130, and the CS130D. All six mount basically the same way, which is *not* the same way the Lucas alternator mounts. This is why such a retrofit either requires the John’s Cars GMALT alternator bracket or fiddling with the air pump bracket.

When talking about GM alternators, positions of the tensioner lug and the regulator terminals are defined by clock positions looking at the rear of the alternator with the pivot lug pointing downward (6 o’clock). Some GM alternators have the tensioner lug at 12 o’clock (“straight across”), some have it at 10 o’clock, some have it at 2 o’clock; the CS130 is available with tensioner lugs at 10 o’clock *and* 2 o’clock. The lugs (both pivot and tensioner) can extend farther from the centerline of the alternator on some models, termed a “long lug” case. However you decide to mount your alternator, you might want to drop into an alternator rebuild shop and review the lug schemes available to select a configuration that will fit best.

The regulator terminals can also be located in any of several clock positions, but who cares? Connect the wires to whereever they end up.

The SI-10 comes in amperages up to about 70, and can be rebuilt to put out over 100 -- but the shops don't recommend this and even refuse to do it. Apparently when this alternator is set up for high current it won't charge well at idle, and they get nothing but complaints from customers.

The SI-12 looks to the untrained eye to be the same thing as the SI-10 -- in fact, many of the parts are interchangeable, and one shop reported that they occasionally find rebuilds that have SI-10 and SI-12 parts mixed up in the same alternator. One visible difference is that the SI-10 has a metal fan blade while the SI-12 has a plastic impeller that looks like a solid disk with openings around the edge. The core parts of the SI-12 are much better than the SI-10, though; this alternator comes standard up to about 108 amps, and can be rebuilt to put out 140 amps -- a very common rebuild for folks that have high-power sound systems in their cars. It reportedly charges just fine at idle.

The SI-15 is physically quite a bit larger than the SI-10 or SI-12, and the SI-17 is difficult to tell from the SI-15. These typically can be had up to about 108 amps as well. A suitable unit can be purchased by going into an auto parts store and asking for an alternator number 70897. Note that if you're planning to hang the alternator off the bottom of the air pump bracket as described below, the SI-15 or SI-17 will probably not fit; it's too big, it might run into the chassis, possibly when the engine moves around on its mounts. Better to choose an SI-12, CS130, or CS130D alternator for such an installation.

When fitted with an internal regulator (the only configuration that should be considered for the XJ-S, since the Lucas is also an internal regulator type), all four of the "SI" alternator types above will come with three terminals. The big one is the main power terminal that is connected directly to the battery with heavy wires. The other two are 1/4" spade terminals numbered 1 and 2. You can buy a standardized two-terminal plug to connect to these terminals on a GM alternator at any auto parts store, but you can also use normal insulated female spade terminals.

Terminal 1 is a "sense" connection; the regulator will control the alternator's output to maintain a constant voltage (13.6V or so) at this terminal. The simplest method of connection is simply to connect it to the big terminal mere inches away on the back of the alternator, which will work fine; the Lucas alternator did this internally.

But this isn't the optimum configuration. The reason a separate sense connection is provided is so you can run a separate sense wire directly to the battery terminal; that way, the regulator will be sensing the voltage right at the battery, and will push the alternator's output a little higher to overcome the voltage losses in the wiring between the alternator and the battery. Going all the way back to the battery would be inconvenient on an XJ-S, but it's not too difficult to connect this sense wire to the main power bus post on the firewall. Since the cable between there and the battery in the trunk is seriously massive, the losses there are likely to be minimal. However, the wiring between the alternator and that post includes some marginal size wires (unless you've upgraded them) so sensing beyond these losses may be beneficial.

Note that section 86.10.01(b) of the ROM describes a method for checking the losses in this line on the XJ-S; the same test will work with the GM alternator, regardless of where the sense wire is connected. The Lucas setup merely accepts losses up to 0.5V while the GM setup tries to overpower them, but in either case excessive losses in this circuit are not good.

Terminal 2 connects *either* to the indicator light on the dash *or* to a switched ignition power supply, depending on the alternator and the car, but apparently any of them will work connected to an indicator light.

There are also a few GM "SI" alternators that come with one more terminal for connection to a tachometer.

The CS130 is a newer GM design, used on most GM cars from 1987 into the early 90's; there is also a CS121, but it's hard to tell the difference, and apparently cars with fried CS121's are often advised to replace them with a CS130. The CS130 is physically smaller than *any* of the "SI" alternators described above. It has *two* cooling fans -- one external metal fan on the front, and another fan inside the housing at the rear. These alternators are rated at 85 to 105 amps in stock form, can be rebuilt to put out 140 amps, and charge like a sumbitch at idle. They are *all* internal-regulator type; apparently they assume you know that, because none of the books or catalogs tell you.

I know you don't think the physical size is a big deal, but let Arthur Blackwell improve your mind: "the alternator is *much* smaller physically and did not require dropping front suspension pieces to put in place."

The CS130 alternators come with some interesting variations in main power connections. Some have a basic stud, while others have a protruding rectangular block that a screw is run through crosswise. Whatever, it shouldn't be difficult to finagle a connection to the battery in the XJ-S.

The CS130 comes with a special regulator connector: a rectangular block with four pins in it -- one large one and three smaller ones. The big one is the sense wire, similar to terminal 1 on the earlier GM alternators. You don't need to connect it to the main power connection three inches away because GM has thoughtfully done that for you internally. Apparently, if you connect up a sense wire, it will override the internal sense connection. Hence, it is an *optional* sense connector; you can connect it to the main bus for optimum performance, or you can just forget about it and it'll work fine.

The small pin right next to the big one goes to the ignition switch on cars without a dash indicator light. The middle small one goes to a dash indicator light on cars so equipped. It's not known what the farthest small pin is for, perhaps a tach connector.

For clarity: you only need to connect up the main power cable and connect the middle small pin in the plug to the existing wire for the dash indicator light to get the CS130 alternator to work in the XJ-S. If you get the plug with the alternator from a junkyard, it's probable the plug will only have that one wire!

If you don't get a connector with the alternator, auto parts shops sell a variety of connectors to fit the CS130 regulator socket. You will need to get one from somewhere -- generic spade terminals won't work here. There are plugs available with four wires, one to each pin. There are plugs with only three wires. There are adaptors (short harnesses with a connector on each end) for retrofitting the CS130 into cars *without* dash indicator lights that originally had the earlier alternators with 2-wire connectors. And there are adaptors for retrofitting the CS130 into cars *with* dash indicator lights that originally had the earlier alternators with 2-wire connectors. Three out of these four will work on the XJ-S (you won't want the adapter for cars without dash indicator lights), so choose the cheapest one of the three. If it's the adapter you buy, just cut off the 2-wire connector and use the CS130 connector end.

If the CS130 in hand has the connections in an inconvenient position, the pulley can be removed with a 24mm socket and an impact wrench, then the case separated by removing the three bolts using an E8 Torx socket. Then the front case can be rotated to any of three positions and reassembled. Since the front case includes the mounting lugs, this effectively rotates the rest of the alternator, including all the terminals on the rear end, in 120° increments.

Note that GM alternators can be fitted with either a single-groove pulley or several different widths of multi-groove pulley -- and of course most modern GM cars come with serpentine belts, so finding an alternator with a single-groove pulley in the junkyard might be difficult. The pulley from the Lucas alternator will *not* fit. However, finding a single-groove pulley for a GM alternator shouldn't be too difficult or expensive, and they can be swapped out in a minute.

There are some reports that GM alternators all have problems with the rear bearing. SI units came with a needle bearing, apparently a source of trouble. The CS130 comes with a ball bearing at the rear, a considerable improvement -- except that they used too small a ball bearing. The CS130 has also developed a reputation for lack of durability, apparently frying something in the electronics every 50K miles or so on the American cars they are fitted on. This being an American product, there are aftermarket fixes: J. C. Whitney (page 643) offers a "Quick Start 'Iceberg'" rebuild kit, 81xx5780U, which provides improved rectifier cooling and a larger rear ball bearing for the CS130 alternator. If you are paying good money for a rebuilt alternator from a reputable shop, you may want to insist upon such improvements at the outset.

J. C. Whitney also offers a kit, 81xx5781B, to convert the CS130 to 140 amp capacity. This is not necessary with a stock XJ-S, but if you've added loads such as an electric radiator fan or a big sound system, it's something to consider.

Besides the SI and the CS130, GM also offers the CS130D, described on the Oakville Starter Alternator Ltd. "Tech Talk" web page: "The CS130D is the revised version of the CS130 and uses the same alternator connections although the connector has been slightly modified to reduce corrosion. Some GM vehicles as early as 1994 may have come equipped with this alternator. The joke in rebuilding circles is that the "D" in CS130D stands for "Different" because although the CS130D is supposed to be a close cousin of the CS130, internally they are totally "Different" - there are no interchangeable components. In reality the "D" stands for "Dual Internal Fan". The CS130 also had dual fans - one

external (behind the pulley) and one internal (inside the alternator near the rectifier). In the CS130D, both fans are internal - there is no external fan behind the pulley. This is the easiest way to distinguish the two alternators.

"One of the new features on the CS130D is the alternator's internal temperature sensor. The regulator will sense the alternator's internal temperature and *shut the charging system down* if the unit reaches 280°F. The dash light will also come on. This of course will prevent overheating and prolong alternator life. This also means that if this alternator is overloaded (by a bad battery or an ear-bleeding stereo, etc.) it will shut off! No longer will roasted alternators be returned to us for warranty. The downside of this feature however is that diagnostic problems could occur. Imagine, a hot July day stuck in traffic - air conditioner is on full. Suddenly, the alternator stops charging and the idiot light comes on. The customer pulls off the highway into your shop and sits for 45 minutes before you can check it. When you check it you find that the alternator charges fine. The regulator had shut the alternator down after it exceeded 280°F; once the vehicle cooled, the alternator started charging again. There is nothing wrong with the vehicle or the alternator."

In NW Florida in 1998, the price for a rebuilt GM alternator -- of whichever type -- was in the vicinity of \$1/amp. Actually a little less than that without core charge, but you might not wanna sell off your Lucas for the core value of a Delco so you may prefer to pay the core charge.

Michael Aiken points out that if your car came with the Bosch 115-amp alternator instead of the Lucas, you might be *reducing* your capacity installing a GM alt -- and the Bosch seems to be far more reliable than the Lucas, so you may not be improving reliability significantly either. Of course you can opt for a GM alternator up to 140 amps.

ALTERNATIVE ALTERNATOR INSTALLATION: A non-Lucas alternator won't simply bolt in where the Lucas alternator comes out, so you'll have to do something to mount it. The following sections describe several ideas for installing alternative alternators -- all of which happen to be GM alternators. But the same ideas might apply to other alternative alternator installations, even though details may differ.

GM ALTERNATOR INSTALLATION -- WHERE THE LUCAS WAS: One possibility involves making an entirely new bracket to fit whatever alternator you choose. However, the existing alternator mount bracket is rather convoluted and is involved in supporting the air pump as well, so it would be no simple task to fashion a replacement. It might be worth it, though; the cost of a new Lucas alternator would pay for a GM alternator *and* a very expensive custom-made bracket, and the *next* alternator replacement would be cheap.

Fortunately you can skip the fab work and just *buy* a new bracket. John's Cars (page 668) offers a bracket to fit a GM Delco alternator, complete with a suitable wiring connector. Their catalog number for it is GMALT. Michael Minglin says, "A little pricey, but well-designed and went in without any problems."

GM ALTERNATOR INSTALLATION -- HUNG OFF THE AIR PUMP BRACKET: It's possible to hang a GM alternator from the bottom of the air pump bracket instead of from the alternator bracket. The air pump bracket is steel and can easily be altered to hold a GM alternator close enough to the original position that the stock adjuster can be used. The attachment of the adjuster to the front of the engine is a block on a single bolt that can be loosened and repositioned to accommodate the new alternator position.

Jim Schultetus describes the method he used: "the original alt bracket was removed along with the alt and a rough dimension was taken from a reference point off the bracket to the alt pulley and from the front of the bracket to front edge of the original Lucas pulley. With these dimensions the CS130 was positioned next to bracket and two straps about 1-3/4 inches long were made of 1/4 in. steel about a inch wide with a 3/8 in. hole drilled in one end of each. These two straps then where bolted to the Delco alt and positioned on the original bracket tube of about a inch in diameter. Using the original measurements taken from the Lucas alt in original position I welded the 2 straps to the tube. Bolted bracket back to block, installed CS130 and used original tensioner setup and belt. Took about 1 1/2 hours."

Another variation on this idea would be to bolt or weld steel plates to the surface of the flanges on the air pump mount extending downwards, and drilling holes for a pivot bolt through them.

Here's another idea for modifying the air pump bracket to hold a GM alternator that doesn't involve welding: Drill a set of holes for a second pivot bolt, this set close (*very close*) to the bottom edge of the bracket and between the engine and the stiffening tube in the bracket. Swing a GM alternator from this pivot, spacing it back from the forward face of the bracket the proper amount to align the belt -- about 3/4". A "long lug" alternator (see GM alternator descriptions above) would probably fit best. The only problem with this idea is that the alternator probably won't be able to swing through many degrees between hitting the air pump bracket on either side of the pivot, so you'd need to select exactly the right length belt. A little filing here and there may permit a few more degrees of swing.

The Lucas alternator, using the GM alternator terminology, has the tensioner lug at the 2 o'clock position. Since the various methods of supporting the GM alternator from the air pump bracket position the pivot outward and upward from the original pivot for the Lucas, using a "straight across" (6:00 and 12:00) lug arrangement should put the tensioner lug in nearly the same position as original.

Don't just run a pivot bolt through the bracket and tighten a nut on the back side; you'll distort the sides of the air pump bracket. Insert the pivot bolt through the front flange of the bracket, through some spacers selected to provide belt alignment, through the pivot lug on the GM alternator, through a washer , through two nuts, through a washer, then through the rear flange of the bracket and into another washer and nut. First, snug up the rearmost nut, but don't overtighten it -- you don't want to distort the bracket. Second, tighten the nut just forward of the rear flange back against the forward side of the rear flange, so those two nuts are tightened down against each other with the rear flange in between. Finally, after adjusting the belt tension, tighten the forwardmost nut forward, pulling the alternator lug snugly against the forward flange of the bracket.

If your pivot bolt isn't threaded the entire length, you may need to add some spacers between the back side of the alternator lug and the nut that tightens down on it.

REPLACING THE AIR PUMP WITH A GM ALTERNATOR: If you happen to be using your car for competition or other applications where the air injection system is unnecessary, ripping the air pump out and putting a GM alternator in that spot to maintain tension on the A/C compressor belt makes sense. It looks especially attractive when you realize that the mount schemes are similar; a small GM alternator will fit right onto the air pump mounting bracket, you only need to add a few spacers on the pivot bolt behind it.

A short-lug CS130 alternator with a tensioner lug at 10 o'clock works just fine mounted on the air pump bracket in the OEM location, and does not interfere with the tensioner clevis, radiator hoses, or thermostat housing. A CS130D should fit just as well.

Alternators driven by V-belts, including the Lucas on the XJ-S as well as GM alternator applications using V-belts, generally use a 10mm wide (15 series) V-belt. The air pump and the air conditioning compressor on the XJ-S use a 13mm wide (17 series) V-belt. If you install a CS130 alternator in place of the air pump and driven by the same belt as the compressor, you need alternator pulley part number 24-1104. Other GM alternators probably need the same pulley. Unfortunately, you're not likely to find this pulley in a junkyard, but it can be ordered through any alternator shop for perhaps \$15. This pulley is 3-1/4" in diameter, which is larger than most pulleys for 10mm belts, which means the alternator will turn slower -- which may have implications on charging at idle. That's tough; this pulley is this big for a reason, namely that a 13mm belt really shouldn't be bent any tighter than that.

The tips of the cooling fan on the alternator might hit the upper corner of the front leg of the air pump bracket. To preclude this possibility, slip the pivot bolt through the air pump bracket with a washer under the head, mark a semicircle around the edge of the washer, and grind off the portion of the bracket outside this mark.

The pivot on the air pump is 3-3/4" long, but the pivot lug on a GM alternator is only 2" long. You can fill the extra space within the bracket with a stack of washers if you want. If you want a more professional appearance, drop into a bicycle shop; many 10-speeds use a 10mm rear axle and have spacers on the derailleuer side of the rear wheel that will serve quite well here. Or you can get some more of the spacers used by Jaguar on the banjo bolt at the top right of the radiator; it's part number CAC4559. All of the spacers should go behind the alternator pivot; with it butted up against the front leg of the air pump bracket, the belt lines up perfectly.

The rear leg of the air pump bracket has a sleeve fitted where the pivot bolt goes through -- just like any other similar bracket. This sleeve is intended to be pulled through the bracket leg as the pivot bolt is tightened so that the air pump (or whatever) can be snugged up without bending the bracket itself. Make sure that your spacers are long enough that this sleeve is not pulled all the way through the bracket and the nut contacts the bracket leg itself. In fact, you might opt to push that sleeve rearward in the bracket before you start fitting spacers to give it more capacity to take up slack when tightening down the pivot bolt.

Unfortunately, the pulley on an alternator is smaller than the one on the air pump, which moves the portion of the V-belt between the crank pulley and the alternator up a little -- possibly right into the idler arm for the belt-driven fan. David Osborne didn't have a problem. "I did the CS130 alternator-in-place-of-air pump conversion with great success. The replacement (shorter) belt (Dynacraft 59017) successfully clears the idler arm by about 3/16 inch." Alas, others haven't been so lucky, and when you realize you've got interference there it can bring this pleasant little job to a screechin' halt.

To avoid this interference problem, it helps to mount the alternator with its centerline as low as possible. That's why you want a CS130; its small diameter keeps the centerline closer to the mounting bracket. You also most definitely want the short-lug version.

The 24-1104 pulley may also help with the interference problem. Using this slightly larger pulley will move the belt a hair away from the interference.

You'll need to figure out what length V-belt you'll need; with the CS130 alternator and 24-1104 pulley, the 59017 mentioned by Osborne above (or a 17590, same difference) works fine on the author's car with no belt-driven fan and hence no interference concern. Going to the long side helps with the interference problem, as swinging the alternator farther away to tighten a longer belt also moves the belt farther away from the idler arm. Going too long, however, will bring the alternator close to the side of the engine compartment and possibly cause a whack when the engine twists on its rubber mounts. That's another reason to choose a CS130; it's small size allows you to pivot it farther outward without contacting the fenderwell.

Once you find a belt length that works, John Napoli says, "Note the number (length) of the new alternator belt and scratch it into the fender of the car."

You might also find that going with a different length fan belt may help the interference issue by moving the idler arm out of the way. Of course, the *best* way to avoid the interference issue is to toss that belt-driven fan and idler hardware over the hedge and install an electric fan as described on page 209. As long as you're installing that big-amp GM alternator, why not put it to good use?

With a CS130 with the tensioner lug at 10 o'clock, the existing tensioner arrangement for the air pump will work just fine. If you use some other configuration and the alignment of the tensioner bracket gives you any trouble, take the tensioner bracket off the front of the right bank and replace it with the tensioner clevis formerly used with the Lucas alternator at the bottom right corner of the engine. This will require a 1/4" thick stack of washers under one end since the alternator tensioner clevis was designed to sit on an uneven surface.

See page 293 for removal of the rest of the air injection system.

REPLACING THE AIR PUMP WITH A BIG-ASS GM ALTERNATOR: John Napoli doesn't cotton to those newfangled itty-bitty alternators, he prefers the earlier clunkers. So he installed a "large case" GM alternator, which you can buy for a song since nobody else wants them any more. Mounted on the air pump bracket, the tensioner lug was too high and cocked the tensioner rod in the clevis on the front of the right bank. It also interfered with the right side radiator hose and thermostat housing. And the centerline of the pulley was so high that interference with the fan belt idler was a definite problem.

Napoli solved all these problems by making a simple plate to relocate the air pump mount bracket downward. "Take the steel bracket that supported the base of the air pump. Take a piece of flat steel or aluminum sheet (I used aluminum) about 5/32" thick (you want stiffness but too thick and you'll need longer bolts, and who needs the extra weight) to use as an adapter plate. The piece should be as wide as the stock air pump bracket and twice as long (high)." That plate will need to be 4" wide and about 5½" long. Of course, using a thicker plate and buying longer bolts (you'll only need

two) will also work; the one thing you *don't* want to do is use bolts that are too short, since they are threaded into aluminum.

"The stock air pump bracket has four bolts that secure it to the side of the block (via an aluminum block bracket casting itself attached to the block with two large bolts). The plate you'll make will be drilled for six bolt holes, and is mounted sandwiched between the alternator (via the steel air pump bracket) and the block bracket. The upper two holes are used to bolt the adapter plate to the upper two holes of the block bracket. The middle two holes are used to bolt the air pump bracket and adapter plate to the lower two holes of the block bracket. The lower two bolt holes of the adapter plate bolt the air pump bracket to the adapter plate. Got it? Use the air pump bracket as a pattern for the bolt holes on the adapter plate.

"Bore a large hole in the top center of the adapter plate to clear the forward bolt that attaches the block bracket to the block -- once again, use the air pump bracket as a guide. Polish the adapter plate to a high gloss to add several miles per hour."

REPLACING THE AIR PUMP WITH A GM ALTERNATOR -- OTHER IDEAS: If you're removing the air pump and need to install a GM alternator to serve as an idler, you can hang the alternator off the *bottom* of the air pump bracket as described on page 534. The difference: with that installation, the air pump stays and the alternator is spaced rearward from the front of the bracket to align the alt pulley with the groove on the damper. But with the air pump removed you'll want to install the GM alternator right up against the front of the air pump bracket so the pulley lines up with the A/C compressor pulley.

You might consider flipping the air pump bracket upside down. This will require drilling one large hole to clear the head of a bolt on the alternator bracket underneath.

ALTERNATOR POWER WIRING: After you've got the GM alternator bolted in, you'll need to connect the big power lug to the main power line to the battery -- which means either to one of the two posts on the bus on the firewall or to the post on the starter. The original alternator was connected to the post on the starter with two wires, but those wires may not be long enough to reach the new alternator location. David Osborne says, "An extension of the power cable from the alternator was required and a bubble-wrap Exide #6915608 6 gauge Quick Splice Battery Cable did the trick."

The wiring from the main power connection on the alternator needs to be suitable for handling the rated output of the alternator *continuously* in an already hostile environment -- things are hot in there *without* any current in the wires! If you are replacing a 66- or 75-amp alternator with something over 100 amps, you will be loading the wiring and connectors with more current than they were intended to handle. You may find that the two large wires are *already* a bit charred at the back of the alternator.

If you install a more powerful alternator, you really should upgrade these power leads while you're at it. Just replacing these two large wires with two larger wires would be tough, since they go through a conduit to the starter terminal; you basically need to pull the exhaust system from that side to work on it! Better idea: simply install an *additional* heavy wire from the main terminal on the alternator to the main bus on the firewall. Just route it along the right side wheel well, making sure to leave enough room for the wire to flex as the engine moves around on its rubber mounts. Joe Bialy provides some guidance on what size wire is adequate: "#6 gauge would be great, #8 is acceptable, #10 marginal. Three #14's are a wee bit better than one #10. Three #12's would work like one #8."

The wiring from the starter terminal to the main bus and then all the way back to the battery is already more than adequate, of course, since it must handle starter current -- several times what alternator current will ever be.

Another idea: if you install an electric radiator fan with a control relay, you could run a wire directly from the alternator to the power input contact on that relay. That way, the fan (usually more than 10 amps) is powered directly through this wire, and the load in the other wiring is reduced accordingly. Of course, you can provide similar wiring to the OEM electric radiator fan relay and the headlight and fog light relays.

ALTERNATOR GROUNDING: Keep in mind that the full rated amperage of the alternator -- 66 or 75 amps with the OEM Lucas up to over 100 amps with the Bosch or GM alternators -- is expected to go through the bolts that hold the alternator to the side of the engine. Believe it or not, these bolts are not always up to the task -- especially if there's a bit of oil, Loctite, or corrosion involved.

Rick Holland learned that there are reports of serious problems with grounding the GM CS130 alternator in particular. "Alternators supposedly were failing because of insufficient electrical grounds to the rear case of the unit. My 2nd unit, a rebuilt from an outfit named "Columbia", said to install a heavy wire from the case to ground and cited a service excerpt allegedly from GM stating that a conductivity problem had been encountered with their "black oxide" mounting fasteners. The recommended fix was to install a heavy ground strap from the usually unused ground boss on the back of the alternator (heat sink side of case) to an appropriate clean spot on the engine. I used a basket weave ground strap with tinned ends." This is a cheap and easy way to make sure your alternator can send full rated current to the car -- regardless of which type alternator you have.

Also keep in mind that the same current must then get from the engine block to the chassis; see the comments on adding a ground strap on page 514.

Of course, even grounds that are not directly involved with the heavy current can cause flaky symptoms since they may effect the alternator's internal regulation. David Littlefield apparently had such trouble: "I found that my gauge showed "discharge" most of the time. For a long time, I ascribed this to just being another unreliable gauge.

"On my '88 there is a black plastic shield covering a bracket with some electrical connections on the inside of the passenger side (LHD) front fender, towards the back of the engine bay. I removed that cover and found a couple of ground wires connected to the bracket. I cleaned a goodly amount of corrosion off these connections and off the brass (?) screw that held the bracket to the chassis. Now, even at idle, the gauge shows "charge.". I wish I had figured this out earlier, it might have saved me the cost of a new battery and a new alternator. I'm convinced the old alternator died because of it, and it killed the battery, in turn.

"There was no indication that anything was wrong, besides the gauge reading low. Those of you that find your battery going flat overnight or similar symptoms may want to try this fix before removing the alternator. Or if you are replacing your alternator, be sure to clean up these contacts to keep from killing the next one."

CHARGING VOLTAGE AND TEMPERATURE COMPENSATION: Irrespective of Napoli's claim that "volts are volts", there actually is a design difference between British volts and Detroit volts -- or between early 80's Lucas volts and late 90's GM volts, anyway. Section 86.10.01(c) of the ROM describes checking the regulator in the Lucas alternator for holding output between 13.6 and 14.4 volts. When operating properly and within their load limits, the Lucas alternators seem to hold voltage near the low end of this range, around 13.6-13.7 volts. According to Michael Aiken, the later Bosch alternator behaves similarly; "My 115 amp Bosch on my 89 XJ-S charges at 13.67 volts measured at the battery."

It turns out, though, that the ideal charging voltage for the typical automotive lead-acid battery depends on the temperature of the battery; the lower the temperature, the higher the charging voltage needs to be to maintain a good state of charge. Modern GM alternators, including the CS130 this author installed, have "temperature compensated" voltage regulators inside, meaning that the charging voltage is varied depending on the temperature of the air surrounding the alternator. On the author's car, the CS130 charges at 14.3V when started cold and the alternator is at room temperature, and the voltage drops back to about 13.8V as the engine warms up. If the car ran hot, the voltage would probably get even lower.

Of course, the reason GM alternators include this temperature compensation is that they presume the battery will be seeing the same ambient temperature as the alternator because it's in the same engine compartment. But the battery in the XJ-S is in the trunk, so really you'd be better off *without* the temperature compensation. The original Lucas alternator evidently had no temperature compensation, but it charged at only 13.6V all the time; apparently it was designed for the battery to be in the engine compartment (as on Jaguar saloons and other cars using the same Lucas alternators) since it regulates at the voltage suitable for hot engine compartment temperatures. Since there are quite a few applications where the battery is installed in a cool location (marine applications, for example), perhaps Delco or

others actually make a regulator that lacks temperature compensation; if you find one, opt for it. However, just installing the typical temperature-compensated GM alternator will generally work fine since the warmed-up voltage of 13.8V is still as high as the Lucas ever charged.

Combined with the sensing location difference discussed above, the installation of a GM alternator may result in the entire electrical system operating nearly a full volt higher than it ever did with the Lucas alternator in place. This has no detrimental effect since the electrical components were all designed to operate up to that voltage anyway, but it does make lights noticeably brighter, window motors zip quicker, blower fans blow harder, etc.

Don Neff says, "Jeep/Chrysler alternators also compensate for temperatures. My newer Jeep has a thermocouple under the battery to measure its temp instead of relying on the alt's temp. This alternator with remote temperature sensing might be a better choice for the XJ-S with its battery in the trunk."

Battery

When your battery needs replacing, you will find that the XJ-S uses an unusual battery -- and that Jaguar wants \$\$\$\$ for it. The Jaguar battery comes with an enclosed vent connected to a tube to route the vent out through the floor of the trunk. Batteries are normally in engine compartments which are well ventilated, and things still corrode right around the battery. A trunk is not ventilated at all, so the battery vapors will corrode the whole trunk. Harry Trafford reports: "the DPO let the Jag dealer in Miami install a new one. The dealer installed a standard Interstate mega-something and charged him \$150 US for a \$59 battery! The thing out-gassed into the boot and now I have a *major* rust repair job ahead of me. And no, the little red plastic Jaguar vent cover does not work. There are large rusted out areas up in the buttresses and along the boot area on either side of the lid, including the area between the rear glass and boot lid. The only thing keeping out the rain is the paint. Push a finger into any of those places and you'll be looking at the spare tire. We're not talking pinholes here."

Worse yet, batteries emit hydrogen gas when charging, so you run the risk of blowing the trunk lid off your car.

According to Randy Wilson, an Audi 5000 battery (Audi put the battery in the passenger cabin, so it has similar venting provisions) will fit with the addition of a half inch plywood shim.

Wilson also reports that Interstate offers an add-on vent kit for their batteries. And there are some marine batteries with vent provisions.

Charlotte Hand reports that the make of batteries sold at Pep Boys, Pro Start, offers a "group size 34" battery for the XJ-S, complete with the proper vent provisions. There are apparently at least two to choose from, the cheapie and the high end.

Robbin Lewis says, "Sears now sells an "International" DieHard Battery that is an almost exact match to the original Jaguar battery, but at a much cheaper price. The only thing I had to do was move the 90 deg. fitting from the right side to the left... easy to do. Just swap the blank plug on the left side with the angle fitting on the right."

Delco Freedom batteries, as well as *some* Champion batteries, come with a flat top vent/cap assembly that has a vent opening on each end. Each is sort of a flat oval shape, but it is possible to connect tubing to them. Hopefully this is a trend among battery manufacturers; being able to remotely vent batteries is a plus, and it can't cost them much to provide the capability. Other Champion designs -- many of which are alongside on the same shelf, sometimes sharing the same part number -- have obscure venting, apparently coming out of wherever around the vent caps, and clearly impossible to properly seal.

A flat-top Champion model 78-2 fits the '83 XJ-S *perfectly*. It is a simple matter to fashion a suitable vent scheme with some 1/4" ID clear vinyl tubing and a plastic tee. This battery comes with an 84-month warranty, 24 month free replacement, 36 months free jumpstart, and is rated at 950 cranking amps at 32°F and 770 cold cranking amps at 0°F.

The catch? Model 78-2 is a side-terminal battery! The original top-terminal cable ends must be cut off and side-terminal cable connectors installed. They cost only a couple bucks, the cost is no big deal. In truth, the XJ-S looks like it was designed for side terminals; there is precious little room for top terminals, requiring an unusually short battery height-wise. There's plenty of room on the front, however, and use of side terminals allows this full-size battery to fit under that plastic cover.

A more traditional design battery can be made to serve, but you must find a way to vent the fumes outside of the trunk. Find or make a cover to completely enclose the vents on the top of the battery (being selective when you buy the battery may help here), or an airtight container for the entire battery. Connect a vent tube and run it out through the floor of the trunk. B. J. Kroppe suggests "install a DIN cover over your battery. (DIN battery covers are found on BMWs and Mercs)."

With careful selection, the vent cover from the old Jaguar battery can be used on a generic replacement battery. Georges Krcmery says: "The EXIDE Mega-Cell # E42 50W has a rectangular slot around its filler caps which exactly matches the vent cover with only a slight adjustment: I had to cut off about 1 cm of the slot's lip to accommodate a similar widening under the nipple of the vent cover. It then snapped right into place. The battery is about 1/4" too wide to fit in the tray. Fortunately, the bottom of the battery has extra plastic on each side and it is possible to carefully saw off 1/8" on both sides to make it fit."

Michael Neal recommends a battery made by Optima (see page 658). This is a lead-acid unit but uses six separate coils instead of plates; it uses a gel electrolyte and is sealed, no vent required. "So far they have proven nearly indestructible." The Optima is not cheap, but reports are unanimous that it *is* worth the money -- it lasts so much longer than a conventional battery that its real cost is comparable.

David Littlefield elaborates: "Optima only sells two batteries for passenger cars, one with side posts (800U) and one without (800S). Either will work fine in the Jag, since the one with side posts also has top posts. These batteries are both red-topped; Optima also sells a yellow top battery that is designed for deep-cycle operation, such as in electric golf carts. You don't want the yellow ones." Optima also makes blue-topped marine batteries.

William Noorloos adds his experience with installing this battery: "...when I walked towards the trunk with the Optima in my hands it jumped the remaining 3 feet all by itself into position, and just sat there waiting to be connected! It's a total fit. 100% No fiddling. As a bonus the original Jag venting thing (Non-metallic British part *and* Lucas, but it has not broken yet) fits 100% over the Optima's 2 emergency pressure relief valves. So in the event of an alternator thinking it has to drive standard household appliances, and thereby blowing the battery, the (probably messy) inside of your expensive Optima will not end up in your trunk."

Whatever battery you use, you will want to reinstall the plastic cover over it. If you can make use of the original battery hold-down bracket, it may make life easier. With the Champion 78-2 described above, it would fit except that it blocks off the vents, and the tangs protruding downward on either end of the battery interfere with a built-in handle on the battery. Easy enough to cut the tangs off. The vents require a little more care, however; cutting enough of the bracket to clear the vents might render it two pieces! However, with judicious cutting, the top edge of the bracket can be notched all the way around the corner and part way down the side, leaving a portion of the side intact. If the height comes out too low it'd be a simple matter to put something *under* the battery to space the battery and bracket up enough to hold the plastic cover properly.

Alternative plan B is to forget the stock bracket and simply fashion a bar across the top of the battery. Longer J-bolts can be used, and two 1/4" holes made in the top of the original plastic cover. Then, after the battery is secured with nuts and washers, the cover can be installed and additional nuts -- real pretty cap nuts or threaded knobs, they show within the boot -- can be used to secure the plastic cover.

FYI: the battery compartment in the '83 XJ-S is 10 inches by 6-3/4 inches. The ideal battery height must be shorter than 8 inches, terminals included. The height to the flat top of the Champion 78-2 is 7 inches, and it fits with room to spare. It is *highly* recommended that you confirm the size of the compartment in your own car before shopping for a battery; the various documentation on what size battery to use, including those cute computerized battery selector displays, seem to be wrong more often than they're right.

One general observation about car batteries and warranties: There are some excellent \$60 batteries out there with 60-month warranties (or longer). However, some \$60 60-month batteries are actually a scheme to sell you a \$40 battery every 3 or 4 years; it dies, you bring it in and complain, and they happily install another battery just like it and charge you the "pro-rated" cost based on how long it lasted -- about \$40. If you think about it, you'll realize they could just as well claim the same battery is good for 20 years and charge you \$240 for it -- you'd still end up bringing it back every three or four years and paying about \$40 for a replacement. The only thing you're buying by paying more than \$40 for the battery is the "hook" that convinces you to keep buying the *same* battery rather than trying some other make to see if it lasts longer. If you buy a 60-month battery and it dies without due cause in far less time, you might be well advised to simply write off that warranty and buy another make -- unless, of course, you don't mind having to replace your battery every 3 or 4 years.

There are some people who select batteries on the basis of cranking amps. The logic works like this: The car only requires a certain number of cranking amps to start, and almost any battery will start the car when new. However, as the battery ages, its cranking capacity diminishes with time, until eventually the battery will no longer start the car. The more cranking amps the battery has to begin with, the more it can deteriorate before replacement is required. This theory assumes a lot, including that different batteries deteriorate at comparable rates and that the battery doesn't suffer other types of failure such as internal shorts. As such, this theory probably doesn't apply to unusual batteries such as the Optima, but may be a fairly valid method of comparing conventional batteries.

But to this theory must be added another monkey wrench: In order to maximize cranking amps, the plates within batteries must maximize surface area, which is done by making them look like grids or screens rather than plates. With successive charges and discharges, these grids get more and more deformed (metal is etched away when discharging, plated back on when recharging, possibly in a different place than it was before), possibly reducing the cranking capacity faster than flat plates would. Also, the grids might fracture more easily with vibrations, causing internal shorts.

BATTERY TERMINALS: If your XJ-S has the original battery terminals on the ends of the cables in the trunk, the 5/16" nuts used to clamp those terminals down on the battery posts require a 1/4" Whitworth wrench size. See page 25.

BATTERY HOLD-DOWN NUTS: Also Whitworth.

DEAD BATTERY PROBLEMS: If your battery is dead after the car sits for a few days, it's time to check for current flow when everything is supposed to be shut off. Craig Waterman says, "On Monday mornings the battery would be flat. When I replaced the bulbs in the boot lights I did not think to check that the switch was closing and with a washer under each screw it is now turning off. So if your battery is going flat check that boot light switch." Of course, you normally have the trunk lid open when checking battery drain current and therefore have to have the boot lights disconnected by other means, so this particular possibility may be easily overlooked.

AVOIDING A DEAD BATTERY: Scott Jarvis suggests: "You can order a Battery Buddy from Outer Banks, (800) 682-2225, part # batbud. It mounts to the side of your battery and monitors the voltage. When the voltage drops below a set level, it automatically switches off to preserve the battery. You just reset a breaker and away you go! Many of the Boating catalogs should carry this and you may find a better price."

Kyle Chatman responds: "You can also try Priority Start from BLI International, Dept HR12, 17939 Chatsworth St., Ste. 521, Granada Hills, CA 91344, 800-780-8276. It monitors voltage drain when the switch is off and disconnects the battery if it gets too low."

Ned Blagojevic counters: "This is available in a kit form from Jaycar Electronics (Sydney), kit number KA-1739. The kit was published in Electronics Australia (Jan 92 issue). It connects to the accessory line and measures line voltage. If voltage drops to preselect limit between 10.9 and 11.9 it shuts off the flow. The kit includes a relay and specs."

John Setters provides a different alternative: "Here in NZ an enterprising company called PowerBeat has been formed to manufacture the answer to starting problems. They have developed an automotive battery which I believe is in two portions - one section runs the general electrics, the other is reserved exclusively for engine starting. The URL for PowerBeat is <http://www.powerbeat.co.nz>."

Sears also sells a battery with a switch on it, so you can switch to a "reserve" and get started.

Fuses and Fuse Blocks

If your XJ-S is old enough to have glass tube fuses, take note: the UK uses a different definition of the rating for these fuses than the US does. The US rating is for how much current the fuse will carry without blowing; the UK rating is for the amount of current to blow the fuse within a certain time. The difference is about 2:1. Simon S. Johnson sends the following data: "...the source: a 1974 edition of "Buss Fuse Car and Truck List" which has on the back cover a section call "Foreign Car Fuse Replacement Data," -- foreign to the US, that is. It states that "English standards differ from US standards. This accounts for difference in ampere ratings." Then it provides a list:

<u>English Type</u>	<u>Buss Replacement</u>
50 amp	AGC 30
35 amp	AGC 25
30 amp	AGC 20
25 amp	AGC 15
20 amp	AGC 10
10 amp	AGC 7 1/2
5 amp	AGC 3

You may find that your fuses have a little paper label inside with *both* ratings; a Lucas rating (British) and a "continuous" (American) rating.

If your car uses tubular glass fuses and the ROM specifies an amperage, it's in the British rating; you will have to correct per the chart above to use the correct American fuse.

UPGRADING TO PLASTIC FUSES: Older XJ-S's have glass tube fuses, both in three main fuseboxes and in several inline locations throughout the car. Later cars have plastic fuses, the type found on most modern cars with the amp rating clearly marked on the top and color-coded as to amperage as well; these are called ATO/ATC fuses or "blade" fuses. Now, there are those that will look at the plastic fuses and pronounce them "cheap" -- and they'll be correct, they are certainly cheaper to make than the glass tube fuses. But don't confuse "cheap" with "inferior" -- the plastic fuses are *much* better than the glass tube fuses. The small spade terminals make much more reliable connections with the fusebox than the metal caps on the ends of the glass tube fuses do. And even when the connections are working just fine on both, the plastic fuses cause less voltage drop in the circuit.

If you are new to Jaguar ownership, you're probably thinking, "Yeah, right. The glass tube fuses worked just fine in all sorts of cars for many decades, they can't be that bad, I'll just clean them up every now and then and not worry about it." If you feel that way, go ahead and skip the rest of this section -- but remember it's here. You'll be back.

While you're pondering the superiority of plastic fuses over glass fuses in general, allow me to point out the superiority of generic fuse blocks over the OEM fuseblocks in the XJ-S. While the fuse blocks in most cars are something you never pay any attention to, the fuse blocks in the XJ-S are a known trouble source. This author had troubles with the #1

fuse location in the headlamp fuse block in my '83, the fuse that serves the small electric fan and the horn. It seemed that every time I checked, this circuit was not working -- and I got to where I would tap the horn regularly to check. When it quit, usually the fuse itself had failed -- not blown, but rather had lost continuity within one of the end caps. Since the small fan was in fact a heavy-duty critter from a Mercedes, I thought maybe it drew too much power, so I went to a bigger fuse. No help, quickly failed again, again not by blowing but by coming disconnected internally. Went to a larger fuse still, and the fuse block itself started to melt and issue smoke! A fuse holder should *never* get hot -- it should either say cool or the fuse should blow -- I decided there was too much resistance in there somewhere and abandoned this socket. I pulled that pair of wires out and installed an ATO/ATC fuse in an inline holder as a quick fix, and installed a 20A fuse. No further problems.

Unusual problem? Iain Burgess: "I had similar problems with the A/C blower fuse in the main fusebox on my XJ6. The plastic around the terminals that held the fuse eventually melted, for some reason, the contacts in the fuse box would heat up, regardless of whether the fan was blowing maximum or minimum. The fuse would eventually fall out and the blowers would stop working (Lucas's second line of defence??) The fuse never blew. Irrespective of the current draw, there seemed to enough resistance between the fuse and the contacts to generate enough heat to melt the plastic. I replaced the fuse a number of times, cleaned the contacts with contact cleaner, sand paper, you name it, but it still got hot. I fixed it like you did, replacing that section of the fuse box with an inline spade fuse - no further problems. None of the other fuses in the box were affected either."

Donald Neff: "You are on the right track - the heat is caused by the resistance of poor contact. But as you know, since you cleaned the fuse tabs and holder sockets, it is not the fuse contacts. They are probably the best contact in the system at any time.

"I'll bet it is the wire-to-fuse holder connection. These are usually poorly crimped connections with no protective covering. They work fine when new, but deteriorate slowly over time. Eventually the wire collects a high-resistance coating of oxide between it and the metal of the fuse holder creating a hot resistor at that point.

"I cut the wire back to clean copper and pry the crimp open to remove the corroded section. After cleaning the crimp tabs I insert the clean wire, recrimp it and then *solder* it. The solder not only provides more surface area for current flow, it (crudely) seals the copper from oxidants. It has worked well for me for a few decades."

Larry Lee talks about his 1979 XJ6: "The S2 fusebox can be the source of a variety of seemingly unrelated electrical failures, thanks to an interesting design. Several circuits are supplied by one wire from the battery in some cases. Electricity is supplied to adjacent fuse sockets through the ends of the fuses themselves. Corrosion can be a killer here. Be sure all of your sockets and the ends of your fuses -- particularly the ends on the "supply side" -- are clean. I had a glitch involving my A/C and wipers a while back that was caused by this."

Walter Acker IV points out that it's not that big a job to replace your old-style fuseboxes with new fuseboxes that use the better plastic fuses. Obviously, one method for upgrading to the later style fusebox would be to obtain the fuseboxes used in the later XJ-S. However, this might not be as helpful as one might expect. For one thing, the electrical stuff apparently changed rather significantly over the years, and the later fuseboxes are likely to have fuses for components and wiring that didn't even exist in the earlier cars. Second, when Jaguar changed fusebox styles, they also changed the mountings, so you may have to do more upgrading than you planned just to get them installed.

The best and easiest solution is to use generic fuseboxes. In fact, Walter Acker IV and this author recommend basically the same type aftermarket fusebox in particular. One source is

Painless Performance Products
<http://www.painlesswiring.com/>

Phone: +1 817-244-6898
Sales: 1-888-350-6588 sales@painlessperformance.com
Tech: 1-800-423-9696 tech@painlessperformance.com

This outfit offers several models of fuse blocks, with many having wires pre-attached and even pre-labelled as to which fuse serves what load, and some even have a relay for providing a switched source without loading up the ignition switch and existing wiring. But for our purposes, Acker recommends the part number 30002. This is a simple 4-fuse block, but it costs less than \$8 and it has a clever arrangement by which you can assemble blocks together to form an 8-fuse block

or a 12-fuse block or any multiple of 4. It also has no wires connected, just the terminals that snap into the box, preferred by people like Acker and myself who would rather terminate wires than splice them.

A tip on acquiring such fuse blocks: Painless recommends you buy from their authorized distributors, and one of their authorized distributors is AutoZone; they don't stock the Painless items, but will order them for you. But if you just walk back to the rack, you'll find the exact same 4-fuse block -- except that it's made by Conduct-Tite!, part number 115280, and sells for less than \$4! Such a deal!

The terminals that are used in these fuse blocks come in a strip of four. Hence, if you're dealing with one common power source, you connect one wire and pop the entire strip into the block and go to work on the other four. If you are fusing four separate power supplies, you merely snip this strip of four into four individual terminals and wire each one separately and snap them into the block. However, Acker points out that you must be careful not to cut away too much of the strip. It is the breadth of this strip that prevents the terminal from passing through the block, so if you trim too much of it away you can end up trying to pull a fuse and getting the terminal and wire coming right out of the block with it. Just snip about a 1/8" wide section out between the terminals to avoid them contacting each other and leave it at that.

"But the OEM fusebox has five fuses." Well, you can use one of these 4-fuse blocks and add an inline fuse holder separately. A better idea, though, is to install two blocks and use the extra fuse locations as places to hold spare fuses -- or replace some of the inline fuses in the car such as the one to the radio or the one to the A/C compressor.

When done, be sure to use your computer to slap together a chart of your new fuse locations, print it out so it looks professional, and install it adjacent to the new fuse block for future reference.

Instrument Panel

VERTICAL VS. ROUND GAUGES: Earlier XJ-S dashboards have four small gauges that are rectangular and the needle moves vertically. When the bodywork was revamped in 1991, however, Jaguar went with a revised dash with all round gauges. According to Alan Akeister, "There is a company in the UK, however, who can convert older models to dials. They are called Autostyle Ltd." See page 664.

Unless stated otherwise, most of the tips that follow refer to the earlier style instrument cluster with four small vertical gauges.

INSTRUMENT PANEL REMOVAL: Section 88.20.01 of the ROM and Chapter 10, Section 69 of the Haynes manual describe how to get the instrument panel out. Note that both say you need to remove the underscuttle casing on the driver's side, but this really isn't necessary unless you drop something. Both manuals also mention having to disconnect the speedometer cable from the right angle drive, but they must be talking about early cars -- the '83 has an electronic speedometer, there is no cable.

INSTRUMENT CLUSTER SNAP-ON COVERS: At each end of the row of warning lights is a snap-on cover that hides the screws that hold the warning light lens assembly as well as the screws holding the entire instrument cluster in place. On this author's '83, these covers had distorted with age and lost their snappage, so they loosely rattled around in the openings. Shipping crates are often banded shut with 1/2" wide straps made of really hard steel, almost like spring steel; I cut a piece of that strapping about 2" long, bent it up 90° at each end, trimmed it a little to fit and inserted it between the retention prongs on the snap-on cover. The metal thus provided a backing spring pressing the plastic prongs back out to their original positions, restoring the snappage. Since I cut the ends just short enough that they didn't quite reach the end of the plastic prongs, the sharp edge of the steel dug into the plastic a little so the tension held the metal piece itself in place -- although it wouldn't be hard to add some double-sided foam tape between the center section

of the steel and the back surface of the cover to make sure it doesn't go anywhere. My covers now hold themselves firmly and properly to the dash.

GROUNDS FOR COMPLAINT: There is only one ground wire to the instrument cluster; it's the contact on the smaller of the two harness connectors that is separated from the rest by an omitted contact. This single contact provides the ground connection for everything on the cluster -- gauges, indicator lights, illumination lights.

If you'll trace the conductor from the socket, you'll find that about an inch away it becomes a very narrow conductor indeed. Without having done any analysis of the load carrying capacity of that section of copper foil, let's just say that having all the 2.2W dash illumination lights on might result in a measurable voltage drop in this area -- which would screw up the gauge readings.

The fix is easy: provide an additional ground. Pick one of the several other screws on the flexible circuit that makes a ground connection, and attach a wire to it and connect it to ground behind the dash. Use of a spade connector will allow the instrument cluster to be removed and installed easily as before.

Instruments and Gauges

FLAKY INSTRUMENTS: There are four vertical gauges in the center of the instrument panel on most older XJ-S's, and they are unreliable -- not because they quit working altogether, but because they never seem to provide consistent readings. Brian W. Rice writes: "All gauges in my 85 XJ-S read low by 25% when I acquired the car several years ago. I did some tests by lifting No. 4 fuse and applying a variable voltage to the dead end from a power supply, making sure not to exceed 15 volts. With precisely 12 volts applied the voltmeter showed about 9V. The fuel gauge also only indicated 3/4 with a full tank of petrol." These problems are because the wiring *to* these gauges is a disaster, with at least *four* likely locations for poor connections on each lead to each gauge.

Even if you don't think you have a problem with the gauges, it is suggested you do a minor overhaul and cleanup of the instrument cluster anyway. It's really easy, anyone can do it, and it'll only take a couple hours even if you're really milkin' the job.

First, remove the instrument cluster from the dash -- see notes above. Second, remove five screws from the back side and separate the front cover from the rear housing of the instrument cluster. This will give you access to all the innards.

Now, if you have a VOM, you should be using it. Check the ohmage of each circuit from the socket where the wiring harness plugs in all the way to the brass nuts on the screw posts on the side of the gauge itself. Of course, these circuits should read zero ohms, or maybe some really small amount like 0.1Ω if you have a sensitive digital VOM. Basically, they should read pretty much the same thing you read if you just connect the leads of the VOM together.

You're likely to find some poor connections indeed. This author found circuits with more than 2Ω . That may not sound like much, but it's a *lot* for a circuit that isn't supposed to have *any* measurable resistance. Of course, if you don't have a VOM, just dive in and fix all the connections described below as though they are all bad.

The first likely source of trouble is the harness connectors themselves. The entire panel is wired with a clever flexible printed circuit, and the harness sockets are formed by folding portions of this flexible circuit into a hole and pushing the plugs in; the connections on the sides of the plug make contact with the bare copper on the flexible sheet. There's not a whole lot you can do here other than clean up the connections a bit (rub with fine sandpaper or the like) and perhaps apply some Ox-Gard to prevent further corrosion, but if some of the circuits are really messed up, here's a tip: places that do stained glass work use thin copper foil tape, and some of this tape might be usable to fix a damaged connection on that flexible circuit. Another idea is a hobby shop; places that sell stuff for model trains and the like sometimes sell copper foil conductors for sticking down on a surface and then painting over so there are no wires visible.

Each of the four vertical gauges is connected to the flexible circuit with screws with stainless steel wavy washers under the heads. Here's the second likely spot for a bad connection. If you're in a hurry, you might just loosen the screws a

bit and retighten, since that will usually make a good connection for a while. For a more permanent solution, there are several suggestions. Besides polishing up the copper surface, you might consider replacing that wavy washer with something with a little more "bite". Basic steel is not recommended, though; this is one place you don't need rust. Some hardware stores sell bronze lock washers; if you find some in a suitable size, they'd probably work well. You'll need at least 29 of them. Alternatively, you might just take a pair of pliers to those wavy washers and make them *more* wavy. Rice makes another suggestion: "I was able to repair by soldering tinned copper wire to the flexible circuit board tracks being careful not to melt the plastic flexible board and fashioning the wire into circular washers to go under the terminal nuts thus establishing good contacts again." If you try this, you might want to go to the effort of removing the entire flexible circuit from the cluster so you can solder on it separately, avoiding the possibility of melting the plastic housing itself.

If you have trouble getting either of these first two type connections working reliably, you could just get PO'd, yank the entire flexible circuit and throw it away, and wire the entire cluster with wires with loop connectors and the like. Your biggest problem will probably be making connections to light bulbs -- and there are a *lot* of connections to light bulbs! You might consider applying a small strip of that copper foil tape on each side of each socket and install a self-tapping screw through it into the plastic to attach your wires to. You can dyke off the plugs on the harnesses and install generic Molex connectors to connect to your wires.

The screws for the gauges appear to simply screw into a tapped hole in the plastic housing. How can that make an electrical connection? Looking at the other side, each gauge is mounted on a small printed circuit board (this one's rigid) with three broad copper conductors. This PCB fits into a slot and is held in place with two small clips. When the screws are threaded in from the back side, the threads dig into the copper conductors on the face of this PCB -- that's correct, the third likely place for a bad connection. Of course, one possible fix here is to use a longer screw so it screws farther up the side of that PCB and contacts it with more threads; again, a screw that's likely to rust is not recommended, brass screws might be a good idea.

Remove the two or three connection screws and two clips on a gauge and lift it out. You will note that the gauge is mounted to the little PCB with three brass nuts and wavy stainless steel washers. This is likely bad connection number four; it may not appear as likely to cause trouble as the first three, but in fact on this author's car these nuts were the worst problem!

The fix for the last two types of bad connection is one operation. Remove the three brass nuts and separate the PCB from the gauge itself, being careful not to drop the small panel behind the PCB or a mysterious clip around one post that seems to do nothing but provide proper spacing. Set the gauge aside; if it's been working at all, it's not likely there's anything wrong with it. Polish both ends of each conductor on the PCB, then set it down on a flat surface and apply some solder. It solders really well. Build up a ring of "tinning" around each post hole, and tin an area at the end of each conductor for those screws to dig into. When cool, wipe away any excess resin and reassemble. You can easily do one gauge at a time so you don't mix anything up.

GAUGE REPAIR: All four vertical gauges are of similar design: two stationary coils at 90° to each other, and a heavily damped rotor. Automobiles have always used damped gauges; not only does it reduce the likelihood of damage from vibrations in the car, but gauges zipping up and down make drivers nervous.

Val Danilov reports, "Once I was sure that the oil gauge was faulty and not the sending unit, I pulled the gauge out of its housing by removing 3 screws from the back of the plate the gauge was attached to, as well as 2 metal clips. It's pretty much self-explanatory once you get to it. Once the gauge was out, in good lighting, you can see several hair-thin metal wires that run from the winding to 3 metal posts on the periphery of the gauge. The wires are soldered to the posts in such a way that they appear to be misplaced (as if they should extend farther to some other point), when in fact they are simply so small that you cannot easily see the points of attachment. When trying to move them with a tiny screwdriver, I found one wire which was loose. I used a regular soldering iron to affix the wire back on the post. Voilà! Problem solved.

"When the gauge is out of the instrument cluster, it is very easy to test it with a 12 volt supply by simply connecting one of the electrodes to +, while grounding the other electrode. Note: the gauge has 3 electrodes (nuts on the threaded ends of the posts), do not use the middle post. The post nearest the bottom of the gauge is ground."

85 MPH SPEEDOMETER: Regarding why some XJ-S's came with 85 mph speedometers, Randy K. Wilson says, "It affected 80, 81 and 82. It may also have been in during 83... not sure." This author's '83 has a normal speedometer -- but perhaps it was retrofitted.

David Berman adds, "It resulted from a regulation from the US National Highway Transportation Safety Administration (NHTSA) during the leadership of "safety-czar" Joan Claybrook, during the regulation-happy Carter administration. The purpose was to prevent kids from being enticed by the "century" mark. It was effective for the 1980 model year.

"The regulation was thankfully scrapped in 1983 as part of a regulation-reduction program of the first Reagan administration. Most non-US vehicles returned to "real" speedometers for the 1984 model year, but US manufacturers retained the 85 mph speedos, at least for their high-volume car lines, for a very long time."

If you don't like the 85 mph speedometer, it can simply be replaced with a normal speedometer from a different year. John Napoli says, "I did this on my car about a year ago. Bought a 160 mph unit from a junkyard. Installed easily and works great." Of course, the replacement speedometer will likely have a different odometer reading, and you'll just have to deal with that.

INTERMITTENT SPEEDOMETER: Several owners have reported on electronic speedometers that work sometimes, other times they sit at 0. Robert Louis Woodling says, "If the wires sag on the exhaust the insulation melts and the speedo stops working. The intermittent symptoms could be the beginning of insulation meltdown or a poor connection."

SPEEDOMETER/CRUISE CONTROL/TRIP COMPUTER/SERVICE INTERVAL COUNTER SIGNAL: That's right, the speed signal goes to as many as four separate places. This signal got to its destination by at least three different methods over the life of the XJ-S. The early cars had cable-driven speedometers and service interval counters; a cable came off a small angle gearbox on the side of the transmission, went to the service interval counter, and another cable went from there to the speedometer. Walter Acker IV says, "On my '76 XJ-S the cable driven service interval counter is behind the dashboard in the area of the radio." The cruise control had its own sensor on the front end of the drive shaft. Of course, there was no trip computer on these early cars.

The angle gearbox was apparently customized to utilize the same components with the GM400 that had been developed for use with the BW12; it not only provides a ratio change, but it also converts to a different type speedometer cable -- the threaded coupling is different, and the size of the squared section on the end of the cable itself is different.

Early 80's cars switched to an electronic speedometer that got its signal from a pulse generator that mounted on the very same angle gearbox. The mechanical service interval counter under the dash was replaced with an electronic service interval counter located to the trunk. The cruise control was altered to utilize the same signal, eliminating the need for its own sensor. The two wires that connect to the pulse generator are 12V power and signal.

The pulse generator changed part number in 1984 with the introduction of the trip computer. Ron Whiston says the differences are obvious, the color is different, the plug is different, but the dealer may still hand you the wrong one. It's best to take the old one with you when buying a replacement.

Peter Morris provides some suggested tests for this sending unit: "Check the transducer by getting under the car and pulling the unit, spinning the drive while someone verifies speedometer movement. This is not a conclusive test, however. If there is no movement, another check, also performed under the car, is to disconnect the transducer, and connect a pair of clip-leads to the chassis-side connections. Clip one clip-lead to a heavy screwdriver and the other to a file. Drag the screwdriver across the file while someone watches the speedo. If there is speedometer indicator movement, then you can reasonably assume the wiring and connections to the speedo (and trip computer) are good. The next logical step would be to replace the transducer."

From VIN 134286 on -- the beginning of the 1987 model year -- the 1-wire oxygen sensors were upgraded to 3-wire oxygen sensors. This change eliminated the legal requirement for a service interval counter, so it was omitted. See page 272.

In the late 80's, the pulse generator on the transmission was eliminated in favor of a sensor on the final drive unit. While the transmission-mounted pulse generator was a shaft-driven device, this later unit has no moving parts; it is a simple pickup mounted adjacent to a toothed flange on the ring gear carrier inside the differential. The pickup does not produce a usable signal by itself, however; it's connected to a "speed interface unit" (so named to distinguish it from the "interface unit" used to process fuel injector pulses for input into the trip computer), and the speed interface unit in turn provides a signal to the speedometer, cruise control and trip computer.

SPEEDOMETER SENDING UNIT 90° ADAPTER: John Shuck sends this report: "I've actually repaired these little expensive jobbies. Take apart the crimps and inside is a small square piece of metal that actually does the drive and is probably sheared. Now go to a speedo shop and have them square you a piece of speedo cable about 2 inches long. They put the round cable in a die.. hit it with a big hammer..bingo..square. Cut this to length with a die grinder and reassemble."

Another possibility might be to find the right size square key stock. Industrial supply houses usually have a good selection.

SPEED WHILE STANDING STILL: Technical Service Bulletin J85/28 addresses "Speedometer Needle Movement - Vehicle Standing". This TSB was issued in April of 1985 (shortly after the introduction of the trip computer) and the specified repair involves the trip computer, so apparently there was a spurious signal problem with the new speed circuitry for the trip computer. The cure is to pull the trip computer out of the dash and splice in a capacitor between the yellow wire on one harness connector and the black wire on the other harness connector. The capacitor is described only as "Lucas 60600903".

The yellow wire is the pulse signal to speedometer, trip computer, service interval counter and cruise control, and the black wire is ground. A capacitor installed in this way is simply a filter for spurious signals that may be affecting all four of those systems.

TACHOMETER ZEROING: Bob Gallivan reports that "my tach was out of whack, reading low ~ 750 rpm. Found that it can be zeroed in by a white plastic lever that sits ~ at the 6-10 O'clock position on the back of the tach face. While in the car it can be adjusted using some lock wire to pull the lever (up or down)." Note that Gallivan's car is an '84, and this author's '83 has no such plastic lever.

OIL PRESSURE SENDING UNIT: Many people confuse the two separate items on the XJ-S, both located at the top rear center of the engine, just below and behind the turntable. The smaller item is the warning light sender, and is a relatively cheap item. The larger part is the sender for the gauge, and it is more expensive and less likely to be available at a generic auto parts store.

The sending unit is a simple variable resistor. Jim Isbell says "I have opened up one from a series 3 XJ6 and found a mechanical diaphragm to wirewound pot contraption. It essentially acts as a variable resistor that shows high resistance at low pressure and low resistance at high pressure."

Mike Cogswell reports that earlier Jaguar senders were different than the later -- and they shouldn't be mixed. "Turns out that the S2 E-Types (and probably XJ-6s of the same vintage) used 80 psi gauges while the V12s used 100 psi gauges. The gauges are identical except for the markings, but the senders are different since they are the same resistance at different pressures."

FUEL LEVEL SENDER: Gregory Wells of Coventry West, Inc., says, "Regarding the fuel level transmitters, I trust everyone is aware that these are notorious for the floats becoming partially filled with fuel and thus giving a very false reading. In the last three years, I don't think we have changed a tank or transmitter without finding that the hollow float

was partially full of fuel. I have seen people throw away the hollow plastic float and replace it with an appropriately-sized cork to eliminate the problem.”

This author found some fuel in his float when lining the tank, but not much; perhaps 1/10 full. Still, it seemed the thing to do to do something about it, so I drilled a very tiny hole in one end, squeezed the fuel out, then plugged the hole with a #2 (tiny!) stainless steel screw. The screw was 1/4" long to begin with, but I cut it shorter so it was barely any longer than the wall of the float was thick. Then I coated the entire float with the same stuff the tank was being lined with; the tiny screw was backed out far enough to get some of the liner on the threads, then seated again.

I didn’t expect this to make any difference -- but I was wrong. It made a *big* difference in how the fuel level gauge read. Previously, filling the tank resulted in the gauge reading on the F, perhaps a hair under. The level would drop fairly quickly to 1/2 full, then drop more slowly for the bottom half of the gauge. After draining and sealing the float, filling the tank resulted in the gauge reading quite a ways *above* the F, probably pegged. And it seems to move linearly from full to empty. Similar results have since been reported by Steve Holst and others.

Len Olsen provided an easier fix: go down to your local Ford dealer’s parts department and ask for part number C0AZ-9202-B. This is a brass float that will fit the XJ-S sender with only minor spreading of the wire loop at the end of the arm. It also costs less than five bucks. It reportedly comes in packages of two for some reason, so how much you’ll pay may depend on whether you can convince the Ford dealer to break open a package.

Peter Cohen adds, “For what it’s worth, the second character is a zero, not the letter O. In Ford part number parlance, that is the first year that the part was used. In this case, probably 1990.”

This is perhaps one of the easiest fixes on the XJ-S. Drive the car until the tank is nearly empty, then peel back the carpet in the trunk and remove the sender. Replace the float and reinstall.

Earl Huff says, “I replaced the fuel sender float on my 1985 XJ-S a few days ago with the recommended Ford float. The good news is that it was easy, all went well, and the gauge for the first time reads as it properly should. The puzzling part is that the original float appeared to be perfectly intact with absolutely no gas inside it. Does anyone have any idea why the new float made a difference? I guess there is really no reason to seek an answer to this being that the problem is solved. However, I would certainly advise anyone to go ahead and replace the float even if the old one looks fine.”

Apparently Jaguar became aware of this problem and did something about it. Around 1987-88, the hollow cylindrical plastic float on the fuel level sender was replaced with a solid float that looks like a bicycle pedal. The Ford brass float won’t fit -- but there shouldn’t be any need to fit it.

Also note that the fuel level senders used in the H&E convertible are totally different, and the Ford float can’t be used there either.

Another plausible method of improving fuel level sender performance would be to fit a weak spring to the arm. The spring should be weak enough that when you hold the sender in the same position it’ll be in the car, the weight of the float will still overcome the spring and move the arm to the bottom of the stroke. But the spring should take *some* of the weight of the float, so when it sits on the surface of the fuel in the tank it sorta bobs on top rather than being nearly submerged.

VOLTMETER ACCURACY: If you’re not sure to trust your voltmeter, Michael Minglin suggests “Pick up a cheap cigar lighter adapter, clip the leads and connect to a voltmeter. This will allow you to monitor the voltage, with reasonable accuracy, under different driving conditions.”

If the voltmeter proves inaccurate, read the section on FLAKY INSTRUMENTS on page 545.

Warning Lights

IGNITION (ALTERNATOR) LIGHT: See page 528.

OVER VOLTAGE LIGHT: Yes, this is a different item than the alternator light. On the author's '83, the alternator light is the fifth from the right and has a lightning bolt on it. The overvoltage warning light is the fifth from the left and has a little picture of a battery on it. It comes on when the voltage exceeds some set value, around 15.6V according to Joe Bialy. In other words, it tells you when the regulator in the alternator has failed causing the alternator to overcharge. The voltmeter should confirm the problem.

Bialy provides some tests: "The OV unit looks like a big old time thermal blinder unit. It's mounted right by the main fuse panel on the driver's side, plugs into a three terminal socket. Take its R/B wire to ground and see the light come on bright. If you have a variable DC supply, break the white wire and feed it varying voltages to see it in action."

BRAKE FLUID LEVEL SWITCH: The switch in the cover for the brake fluid reservoir is supposed to light an indicator on the dashboard when the level is low. The rubber cover over the connectors has a bump in the center. Pressing the bump forces the float downwards and closes the contacts, providing a circuit and bulb test.

Unfortunately, the switch is garbage and the indicator may never come on, or may stay on all the time. The float for the switch is a piece of cork, which rots, soaks up fluid and sinks, etc. The protective metal cover over the cork float gets full of junk and jams the float. The contacts within the switch are exposed to the air and fluid within the reservoir, and, despite evidently being silver plated, get corroded and fail to make a connection.

The cork is easily replaced with one from a wine bottle, and the metal cover's problems are solved by removing it and throwing it away. The contacts themselves can be serviced by using a tiny screwdriver to pry the switch assembly out of the top of the reservoir cover; don't lose the little metal sleeves that keep the contact screws from tightening down onto the plastic. But all such efforts won't solve the basic problem: you should not trust your life to that switch.

The Jaguar repair manuals indicate that either this switch or the pressure differential sensor will turn on the warning light, but after VIN 107981 the differential pressure sensor was deleted and replaced with a couple of simple fittings on the brake lines. So, the fluid level switch provides the *only* warning you are likely to get prior to actual brake failure. This switch therefore needs to be ultra-reliable, since it is rarely tested and failure to work when needed can be *fatal*. While it's easy enough to get it working with the procedures above, there's no good way to get it to *keep* working. The switch is crap, pure and simple.

The only truly safe solution is to replace it, lock, stock, and barrel, with something reliable. Something reliable was suggested by Walter Acker IV: the brake fluid reservoir from a Mitsubishi, which comes with the typical Japanese ultra-reliable floating-magnet switch built in. A suitable remote reservoir is used on several Mitsubishi's, including the 93-96 Mirage 1.8L 2-dr, the Gallant 89-2/93, some later Gallants, and all Eclipses 90-99 and probably later. Basically, find a Mitsubishi in the junkyard and check!

If you happen to find a Mitsubishi with ABS, the reservoir is similar except that it has an extra part in it. Doesn't hurt anything; it will work too if that's what you find in the junkyard.

If you want a *new* reservoir, the part number is MB534534, and costs less than \$40 -- but you'll have to order it through a Mitsubishi dealer. This part number includes the reservoir itself, cap, diaphragm, float, and switch, but not the mounting bracket nor the hoses.

The Mitsubishi reservoir actually looks very similar to the OEM Jaguar reservoir. The wires for the fluid level switch go to the bottom instead of the top, since the switch is magnetic and is actually *outside* the reservoir. Only the float -- with magnet -- is inside.

The mounting bracket used to hold the reservoir in a Mitsubishi is not readily usable in the XJ-S; it will be easier to fabricate your own. Joe Bialy says, "I mounted it in *exactly* the same place the old one was at. A simple "T" shaped

piece of sheet metal bent 90 degrees to mount in the 2 existing holes. Then wrap a 3" hose clamp around the whole thing." This is an excellent plan; this author used it in my '83, but rather than a simple "T" I designed the bracket shown in **Figure 28** to hold the reservoir a bit more securely.

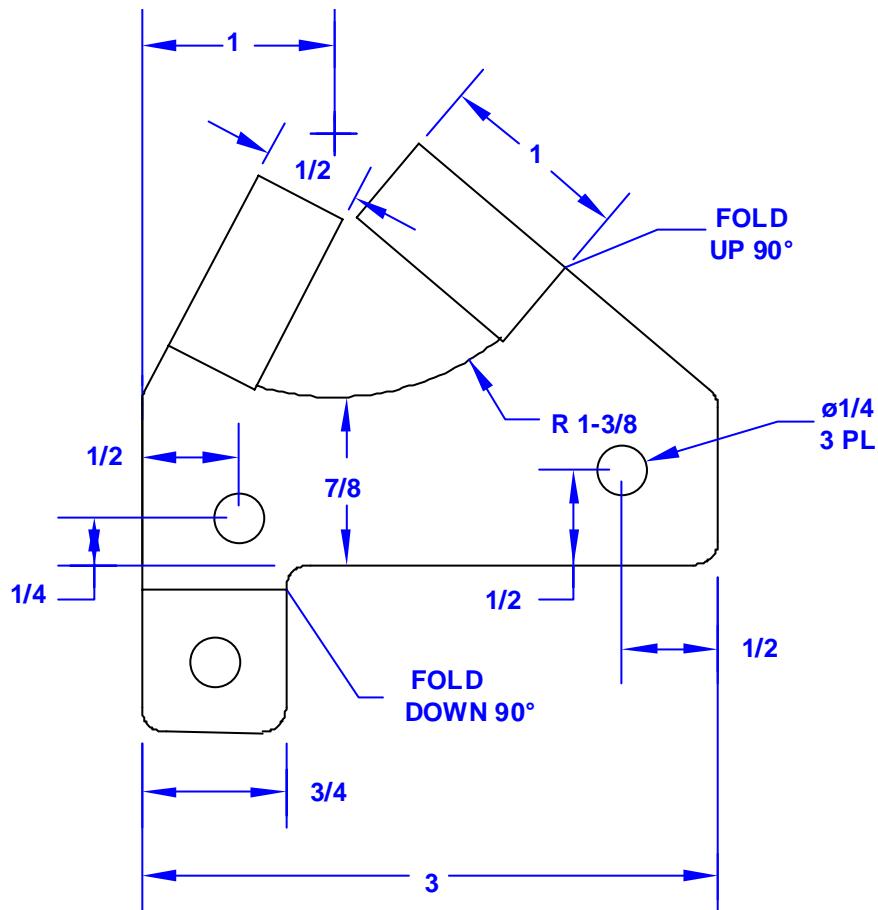


Figure 28 - Bracket for Mitsubishi Reservoir

If the MicroSoft gods are smiling down on us today, **Figure 28** will print in actual size. So, just load a piece of sheet metal into the ol' inkjet and let 'er rip!

The bottom of the reservoir should be flush with the top of the existing support bracket, but the hose clamp will need to go around the reservoir about 1/2" up from the bottom; hence the two "legs" on this bracket being 1" tall. There is even a little ridge on the Mitsubishi reservoir -- it's actually the "MIN" level line -- that will neatly sit on top of one of these legs so it cannot slide downward.

The asymmetric design of this bracket serves to mount the Mitsubishi reservoir about 1/2" closer to the power brake booster than the original reservoir was. This provides more clearance to the throttle cable, as well as making it a bit easier to wrap your hand around the cap when unscrewing it.

The bent-down tab at the lower left in the diagram is simply to provide a place to fasten the wire connector down. If you wish, you can omit this tab and just slice the bracket straight across the bottom edge, and provide other means of fastening down the connector -- or just let it dangle. A generic strip of steel with 1/4" holes can be used by merely bending it 90° in the middle and mounting it under the same mounting bolt that holds the reservoir bracket itself.

The design shown above is for a LHD car. Those with RHD cars will probably need to make a mirror image of this bracket -- which means cut out the exact same piece, but bend the two mounting tabs down instead of up and the wire connector tab up instead of down.

The hose fittings on the Mitsubishi reservoir are 10mm, while the fittings on the Jag master cylinder are 1/4". You will need to devise a way to connect these sizes up. A 3/8" air hose will fit the Mitsubishi reservoir just fine. The simplest idea is to use two different sizes of hose with an adapter in between.

Another idea would be to take a short section of 1/4" red air hose and peel the red outer layer off, slide the black inner layer over the 1/4" fittings, slide the 3/8" hose over that, and clamp.

Another solution might be to purchase some 5/16" OD steel tubing and some 3/8" OD steel tubing, both of which are available at auto parts stores as pre-made fuel lines. Cut two 3/4" long sections from each. Slide a short piece of 5/16" tubing over the reservoir end of each one of the 1/4" metal tubes used to connect the OEM reservoir to the master cylinder, slide a short piece of 3/8" tubing over the piece of 5/16" tubing, and braze or silver solder both pieces in place. Then you can connect the metal tube to the Mitsubishi reservoir with short pieces of 3/8" hose, and you can connect the other end to the master cylinder exactly the way they were before. Be sure to check the braze jobs for leaks before installing.

Yet another idea would be to obtain a set of the plastic elbows that fit the Mitsubishi master cylinder and find a way to fit them to the Jaguar master cylinder. The elbows actually appear remarkably similar except for the fitting size and the fact that the Mitsubishi parts have a tab through which a Phillips screw is installed to make sure they don't go anywhere. There's no way to use that screw idea on the Jag, so the tab can either be cut off the elbow or just left there to hang off the side doing nothing.

The Mitsubishi cap is clearly marked to use DOT-3 only or DOT-3 or DOT-4 fluid only, plus some stuff in Japanese. If you wish, you can cut those markings off -- they are raised letters on a flat surface. Then you can print out a circular label with directions to use DOT 4 only along with a Jaguar leaping cat on a piece of peel-and-stick label material loaded into your inkjet, cut it out, and stick it down on top of this surface.

Connecting up the wires for the switch is not a big challenge. If you dye off the connector from the Mitsubishi harness in the junkyard, you can just splice it onto the Jaguar harness (cutting off the spade terminals). Many junkyards don't like you cutting harnesses, though. Still, this T-shaped connector must be a common shape, because many people manage to find one that fits. If you can't, don't fret -- the female spade connectors on the Jaguar harness will actually plug right to the Mitsubishi connector. It doesn't matter which wire is connected to which terminal.

Besides having a level switch that will actually work when you really need it to, there's another nice benefit of this reservoir replacement. The OEM Jaguar reservoir is vented by letting air into the fluid, but the Mitsubishi reservoir has a diaphragm in the cap. As the fluid level drops, this diaphragm moves with it, maintaining separation between fluid and air. As a result, the fluid will absorb much less air and moisture, and require bleeding less often.

Also, installing a Mitsubishi reservoir will solve problems with the OEM reservoir cap cracking.

MITSUBISHI RESERVOIR PROBLEMS: Ain't this a kick in the pants! You go through the effort of replacing the OEM reservoir with the Mitsubishi, and find that it has problems too! Fortunately, its problems are not life-threatening and are easily corrected.

As mentioned above, the cap used on the Mitsubishi reservoir has a diaphragm built in to keep air away from the brake fluid. On Mitsubishi's made before 1992, the cap itself has three small tangs inside and the diaphragm has three mating notches around the outer edge to prevent the diaphragm from turning around inside the cap as you screw the cap on. Unfortunately, what actually happens is that the diaphragm distorts at the notches while tightening, gets cockeyed, and loses the seal. Result: air is allowed into the brake fluid. In other words, when this thing screws up, it vents the brake fluid reservoir the same piss-poor way the Jaguar reservoir was *designed* to!

Mitsubishi's solution was to redesign the cap and diaphragm, omitting the tangs and notches altogether. Who cares if the diaphragm rotates a little while the cap is being tightened? If you happen to find yourself with a reservoir with the old style distorted diaphragm, you can fix it by purchasing a new cap and diaphragm from your friendly Mitsubishi dealer -- but the two parts will cost as much as a new reservoir with cap and diaphragm! If you wish, you can purchase just the diaphragm and carefully cut away the tangs inside your old cap. The diaphragm part number is MB895813.

So, if you go scrounging in the junkyard for a Mitsubishi reservoir, you might want to check that the cap and diaphragm are the updated design without anti-rotation tangs around the edge. There should be only one notch, for venting the space *above* the diaphragm.

ALTERNATIVE MITSUBISHI RESERVOIR: Walter Acker IV went on to discover yet another type reservoir that can be used to replace the pre-ABS reservoir in the XJ-S. This one is also from a Mitsubishi, but from their pickup truck instead. The reservoir is rectangular rather than round, and is smaller than the round one, but will still work fine. The cap is black rather than the white one found on the round reservoir, and the reservoir Acker found doesn't have the problem with the tangs around the edge of the diaphragm -- but it's unknown whether that's simply because the one he found was a post-correction model or whether the pickup truck never had this design flaw in the first place. It still has 10mm fittings, so it will require the same hose adaptors described for the round reservoir above.

BRAKE WARNING LIGHT: Mike Morrin warns of another reason the brake warning light may seem to have failed in the "on" mode: "When I got my car, the warning light was on, but the handbrake adjusters (on the rear calipers) were seized. Fixing the adjusters put some extra tension on the cable, and the warning light switch then started working."

Trip Computer

VARIATIONS: The trip computer for US-spec cars has a different part number than trip computers used elsewhere. Since the Km/miles switch is readily apparent on all, Walter Petermann says, "It's probably due to the gallons. Inside the trip computer there's a jumper labeled 'imp'. All the trip computers (US) I've seen have this jumper missing."

SPEED SIGNAL: See the section on the speedometer signal on page 547.

TRIP COMPUTER FUEL MILEAGE: The CATALOGUE reports that erratic fuel mileage readings can be caused by a poor connection at the fuel injector resistor pack.

TRIP COMPUTER FUEL CALCULATIONS: Craig Sawyers: "One of the niggly things that didn't work was the fuel related aspects of the trip computer. Mileage, fine; clock, fine; fuel, nada.

"The trip computer gets its fuel signal from an "interface unit" mounted near the ECU. It is a plastic case, with four connections. Power (green) and ground (black), a line from the fuel injector feed for the resistor pack (yellow/green to pin 29 of the ECU) on the B bank, and a line that goes to the trip computer (orange). When you get the lid off this box (drill out four copper rivets), you find a more complex circuit than you expect, based around a quad op-amp and eight transistors. (Op-amp is short for operational amplifier. The "quad" bit just means that there are four of them in one 14-pin package.)"

"To cut a long story short, including tracing out the arcane circuit and rigging up a pulse generator to mimic the injector signal, the op-amp was history. The op-amp is a LM2902N, and is a generic part (the one that came out was Texas, the one that went back was Fairchild). I just bought mine from Farnell."

"Cost of op-amp, £0.29UK. Result, source of joy! I don't know what Jag would have charged me for a new one, but it certainly wouldn't have been within two orders of magnitude of 50 cents."

Is there a way those without pulse generators, oscilloscopes and the like could determine that the op-amp or even the entire interface unit is in fact their problem? "Not easy. The input signal is taken from the ECU, and is the injector

drive to the resistor pack. This goes from 12V to 0V for the duration of the injector pulse. The output of the interface unit looks like a pulse-width modulated signal. Maybe the interface unit counts the pulses, and uses that to estimate the fuel consumption. I haven't gone into that bit of it at too much depth; working is working.

"Assuming that the other functions of the trip computer are OK, that power is present, and that a connector hasn't fallen off, I'd suspect the interface unit. Also given the low cost of the chip, and that everything else in there looks pretty bullet proof, I think I'd advise stuffing a new chip in (the right way round!) and see what happens."

The op-amp is soldered to the board. "The easiest way to get a chip out if you don't have a solder sucker is to use a small pair of cutters to snip each pin at the chip package itself. Then pull each pin out of the board separately with a small pair of pliers while heating the pad with a soldering iron."

Edwin Hyatt tried this fix. "Thanks to Craig, I now have a fully functional trip computer, having recently fixed the fuel consumption part of the display. The IC in the interface unit was the culprit, and at a cost of \$1.29 at Radio Shack, it is by far the lowest cost repair to date. If the fuel related part of your trip computer is not working, this more than likely is the cause."

EXTRA CONNECTORS: The author's '83 has two 3-conductor connectors behind the dash in the vicinity of the top left corner of the glovebox, with blank-off caps on them. One is red with Y, O, and two G wires, and the other is black with P, RU, and two B wires; the P wire is from an inline fuse connected to an N wire. These connectors are apparently for the trip computer -- although this car doesn't have a trip computer. There are also connectors near the ECU in the trunk for connecting to the fuel interface unit, which likewise doesn't exist.

Electric Windows

There are reportedly three different types of window motor used in the XJ-S coupe: A Delco unit up to 1987, a different Delco unit 1988-89, and a Bosch from 1990 on. The early Delco motor has a large cylindrical housing, while the 1988-89 Delco unit has a smaller, more rectangular housing -- perhaps better described as a cylinder with two flat sides. Both of these are held together with a pair of long bolts.

The convertibles, of course, have another motor operating the rear windows, and apparently have different units in the doors as well.

Peter Cohen provides some part numbers: "The January 1987 - January 1989 parts book lists the non-convertible window motors as: Left: JLM975, Right: JLM974, and the regulators as Left: BCC5775 and Right: BCC5774. Convertible is listed as Motor: Left: JLM1496, Right: JLM1495, with the convertible regulator listed as Left: BDC5079, Right: BDC5079.

"The right side Delco motor that I removed had a paper label with the number 20060098 above the numbers 121 and 30P8 (the left side label was illegible).

Unfortunately, problems are reported with all types, even though none of them are Lucas. Some of the problems discussed below apply to all, and some apply only to particular units as noted.

ELECTRIC WINDOWS -- KEYLESS OPERATION: Some of us prefer the electric windows to be operable whenever we're in the car, not just when the ignition is on. If you share this preference, there is a "window lift relay" under the passenger's side of the dashboard that provides power to the windows whenever the ignition is on. All you have to do is remove this relay and connect the power wire directly to the wire to the windows, and the windows will operate whenever the buttons are pressed. Since the buttons are inside the car anyway, it's not exactly a security risk.

SLOW-MOVING WINDOWS: The early Delco windows always move slowly. This tip is from Leonard Berk: His windows operated very slowly, so he sprayed WD-40 down the frames without even dismantling the doors. The windows operate like new. Perhaps WD-40 isn't the ideal substance since the odor may be objectionable to some people, but it is worth noting that lubrication may be in order. Victor Naumann says, "Try not to use oil in the channel, it destroys the rubber. Silicone spray or graphite works OK. WD-40 is a great lube, but not for rubber, it makes it swell. Jag makes a very expensive lube called Glietmo, but I prefer silicone."

Paul Bachman says, "In my experience, lubricating rubber window guides is only a short term solution and seems to aggravate the sticking in the long run (gets gummy as it inevitably dries out). I have had very good success lubricating the guide rails on electric windows (including my 85 XJ-S) with graphite. It is difficult and a little messy to get it rubbed into the right places, but once in place it works for a long, long time."

On the author's car, one reason for slow windows was that the little roller that slides in the track at the bottom of the glass had gotten all screwed up -- see below.

John Himes talks "...about possible fixes to the drivers window not going all the way up without using their hand. On my 88 XJ-S, the problems was that one of the screws was removed by a PO, or had fallen out over time that mounts the window motor to the door & the others had become loose. The motor assy. would move when you raised or lowered the window. After tightening the screws & new lock washers (with the window all the way up so it would fit correctly), the window now goes all the way up & I no longer have the fingerprints on the window (inside anyway)."

John Setters reports: "Two problems caused my drivers side window not to close fully without assistance:

1. Window motor mounting had come loose.
2. The lift assist coil spring was binding on itself.

"Firstly remove the door trim panel - the hardest part! I found that I needed to close the window fully before tightening the motor mounting bolts. This is the way to assure correct positioning of the closed window. Do this by applying upward lift with your hand under the slide rail at the lower edge of the glass. Then tighten the bolts.

"Complete lift was hampered by lack of spring tension. Although well lubricated by grease too much friction existed. I applied spray CRC to the spring then operated the up and down movement to work the CRC into the spring coils. Heh presto it all works fine now."

John Napoli suggests adjusting the track at the rear of the window. There are two screws that hold this section of channel in place; one is under the door panel near the bottom rear of the door, and the other is clearly visible on the end of the door above the latch. The track is removable to facilitate replacing the glass. The bottom screw has a very large washer on it and fits through a large hole in the door sheet metal, so the track can be moved around quite a bit before tightening it down. The upper screw doesn't have as much room to move, but can still move a little. It is helpful to loosen both screws at the same time to fully investigate the range of possibilities.

Napoli also suggests "If you can't find an adjustment that solves the problem, replace the lining of the rear channel. Jag sells a replacement channel. I suspect that good old aftermarket channel felt can be installed in the old channel assembly." The problem with old channel felt is that the fur wears off, allowing the glass to rub directly on the rubber underneath. The friction is hence much higher than it should be.

If you have the early Delco window motors, once you have addressed all the possible problems listed above, your windows will still move slowly. The final solution is to install a relay control system; see below.

WINDOW/TRACK SEPARATION: John Napoli says: "I once had a weird window failure in my car. The PO had replaced the rear window channel on the drivers side. One day I lowered the window and *thunk* -- the window drops down out of sight. Opened the door up and found that the metal channel that the glass rides in had been pulled away from the glass. It was as if the glass had a positive stop on the way down. The motor kept on pulling the glass down after it hit the stop and pulled the arm off. Put it back together and it soon happened again. I solved the problem by taking the glass out, supergluing the arm to the glass (in the correct location!) and installing a sophisticated support that the steel arm would hit when the window was lowered. It was a carefully shaped chunk of 2x4. You need to glue the

channel to the glass in addition to adding the stop because if the channel is loose on the glass it will eventually slide sideways and prevent the window from opening or closing properly. The glue locks the channel in position and the stop prevents the window from dropping too far and allowing the motor to pull the channel away from the glass.

ELECTRIC WINDOW REGULATOR DRIVE ROLLER PROBLEMS: The little roller on the end of the motor arm on one window in the author's '83 XJ-S was FUBAR. Basically, the shaft the roller turns on is attached to the arm like a rivet, and this attachment worked loose, allowing the roller to cock sideways and jam in the track on the window. As the motor forced it back and forth in the track, the edges of the sheet metal track chewed the plastic roller all to bits. No, you can't buy a new roller from Jaguar -- they want you to buy the entire window regulator mechanism. The '83 has the early Delco regulator, but all of the regulators have rollers of some type and may occasionally have similar problems.

For anyone with a lathe and some plastic stock, it would be a simple matter to make a new roller. Unfortunately, I don't have either. I went to a building supply store and looked through their collection of rollers intended for sliding closet doors, drawers, shower doors, etc. I immediately noted two concerns: 1) the roller in the Jag window was smaller than any of these; and 2) the roller in the Jag window has a sort of offset -- the bearing surface isn't in the center of the roller, but over to one side. In the Jag, the pin is shaped like the head of a flush head bolt, so that no part of the pin extends beyond the roller and jams into the track. Only a select few of the rollers in the building supply store had a similar feature.

I selected a package of "Closet Door Hardware" described as "No. 8544, 7/16" Offset Hanger Pr." and made by Door Products Inc.; I'm sure there are generic equivalents in just about any such store. This package contains two hangers intended for the top of a hanging, sliding closet door, each with a little roller to fit into a track. The 7/16" refers to how much the offset is, no importance here. In fact, the entire hanger is forfeit except for the roller itself. There are probably several other types of hangers, with various offsets, all using the same or similar roller. It is necessary to grind off a rivet flare to remove the roller from the hanger.

The roller acquired is the smallest I found, but still too large; it is about 20mm in diameter, while the Jaguar window roller is about 17mm. However, it was a simple matter to mount the new roller onto a 1/4" bolt, chuck it up in a drill, and grind off the outside edge until it was the correct diameter. This roller, along with the Jaguar original, is illustrated in **Figure 29**.

This roller also had the offset bearing, although it was not as long as the Jag original. When assembling, it was necessary to add a few washers behind it to space it out the same distance from the arm as the original had been. I made washers out of plastic so they wouldn't jingle. I also made sure their OD was small enough to not interfere with the window track.

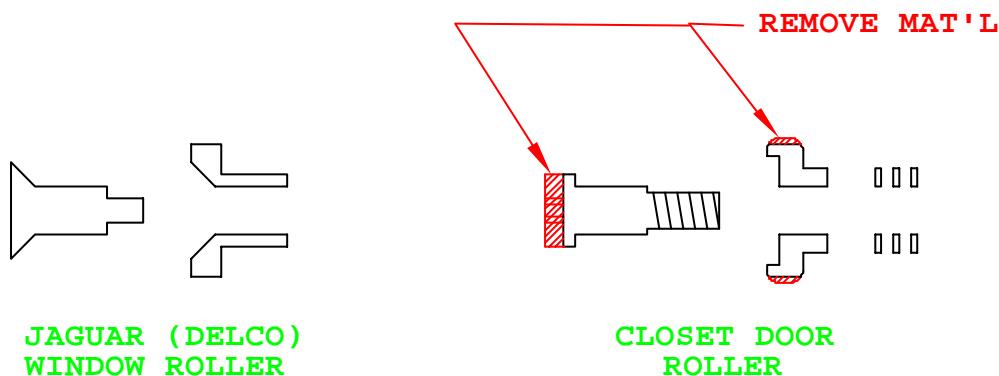


Figure 29 - Original Window Roller and Cheap Substitute

I also was able to find a shoulder bolt, or "axle" bolt, that I was able to modify for use. It was an Allen socket head bolt with a 1/4" diameter shoulder 3/8" long, and a 10-24 threaded end beyond that. If I had intended to use this bolt to hold the original Jaguar roller, I would have had to grind a taper on the bottom side of the head to match the tapered surface within the roller and allow the head to recess far enough into the roller so as not to protrude at all.

For this new roller, however, the problem was different. The new roller has a recessed opening for the head of the original pin that held it, but it's flat-bottomed, not tapered. There is therefore no reason to grind on the bottom side of the head, but the top side protrudes entirely too far -- this head is much taller than the recess is deep. So I had to grind about half of the height of the head off. This removed the entire Allen socket, leaving me no way to tighten it. So I cut a straight slot across the top for use with a screwdriver.

When assembling, I put the roller and the homemade plastic washers on this shoulder bolt, screwed on a nut, inserted it through the hole in the arm, and put another nut on the back side to hold it. When tightened up, this positioned the roller about the same distance from the surface of the arm that the original had been.

I chose not to install this roller in the original hole in the regulator arm. Instead, I drilled a new hole 1" closer to the motor itself, making the arm effectively 1" shorter, in hopes of improving the leverage the motor has moving the window. This worked perfectly, but since the arm is 15" long to begin with, this provides only a small percentage improvement in leverage. Still, it's easy to do, and every little bit helps.

Of course, the window motor and regulator assembly is an AC Delco; perhaps you can figure out what other cars it was used in and find a cheap replacement in the local junkyard.

ELECTRIC WINDOW SWITCH PROBLEMS: Reports of switch problems are more common with earlier Delco units. That may be partially because the cars are older or that there are simply more of them, but the early Delco system definitely suffers from overloaded switches. The switches are inadequate for the inductive load involved and the contacts get burned. Even though the later Delco and Bosch motors are physically smaller, they still move the windows at a good clip and probably draw a comparable amount of current; we'll probably hear more about switch problems in later cars as the years go by.

Bob Colson of the Jaguar Club of Southern Arizona points out that the window lift switches can be taken apart. First, remove them from the panel -- easiest to do by first removing the panel so you can push them out from behind. Then, by spreading the housing slightly, the rocker itself can be popped out. Then the parts can be cleaned up and repaired as needed. The two rocking contact plates are symmetrical but only one end of each gets worn, so the plates can be reversed to extend their life. The cruise control on/off/resume switch is constructed similarly.

Phil Patton adds: "Usually it seems the plastic things on the ends of the springs wear unevenly for some reason. When cleaning the switch replace the one from the left side to the right and vis-a-vis."

Another solution is to replace the switches with generic double pole/double throw self-centering rocker switches with better contact ratings. The difficulty here, obviously, is getting them to look right. Phil Patton sends this tip: "I have found a switch which is less expensive, IMHO looks much better, and I am positive will last much, much longer. This part fits the existing hole perfectly and has a small, coloured illuminated strip across it, making it easy to find in the dark. It is rated at 20 amps @ 12 volts and is (unlike the Jag switch) completely sealed so that dirt cannot contaminate the contacts. The part is GC number 35-3565 (green light) or 35-3570 (red light). They should be available from any decent size electronics parts house. The only modification necessary to use this part is to cut off the plug on the wiring harness and replace it with push-on lugs on each wire. If you don't like the light then just don't connect it."

Stephen Wood says, "I replaced the power window and power lock switches in my '76 XJ-S with '82-92 Camaro/Firebird units, \$10 ea. new and they work great. I had to make a wiring jumper and a sub plate for mounting, but they function better than the Jag ones ever did."

A preventative measure may be to install a pair of zener diodes at each motor. See the treatise on controlling inductive loads starting on page 518.

Perhaps the best solution, and one that maintains the original appearance, is to install relays to operate the windows and operate the relays with the stock rocker switch. See below.

WINDOW CONTROL RELAY INSTALLATION: Both the dragging windows and the burned switch contacts are symptoms of the same problem: The switches are inadequate for the load. The high resistance, due to marginal,

overloaded, or charred contacts, results in less than ideal power to the motor and causes the contacts themselves to fail often. This author measured the voltage at the window motor with the window trying to close, and it was less than 8 volts -- and dropping below 7 volts as the motor struggled. This operating voltage means the motor is only developing about 45% as much power as it would at 12V.

A set of window control relays will provide full battery voltage to the window motors, eliminating the losses in the wiring harnesses and switches. See **Figure 30**. Two SPDT relays will be needed for each window, an “up” relay and a “down” relay, and each will need to have serious contacts -- at least 10-amp rating. Since the current needed to operate the relays is minimal, the rocker switches should last forever -- even if they’ve already been abused and cleaned up a couple times.

The XJ-S comes with a relay referred to in the Jaguar literature as a “window lift relay”; all this relay does is turn off power to the windows when the ignition is off. I will continue to use that term when referring to that relay, and will call the new relays being added in the following scheme “window control relays”. Try not to get confused.

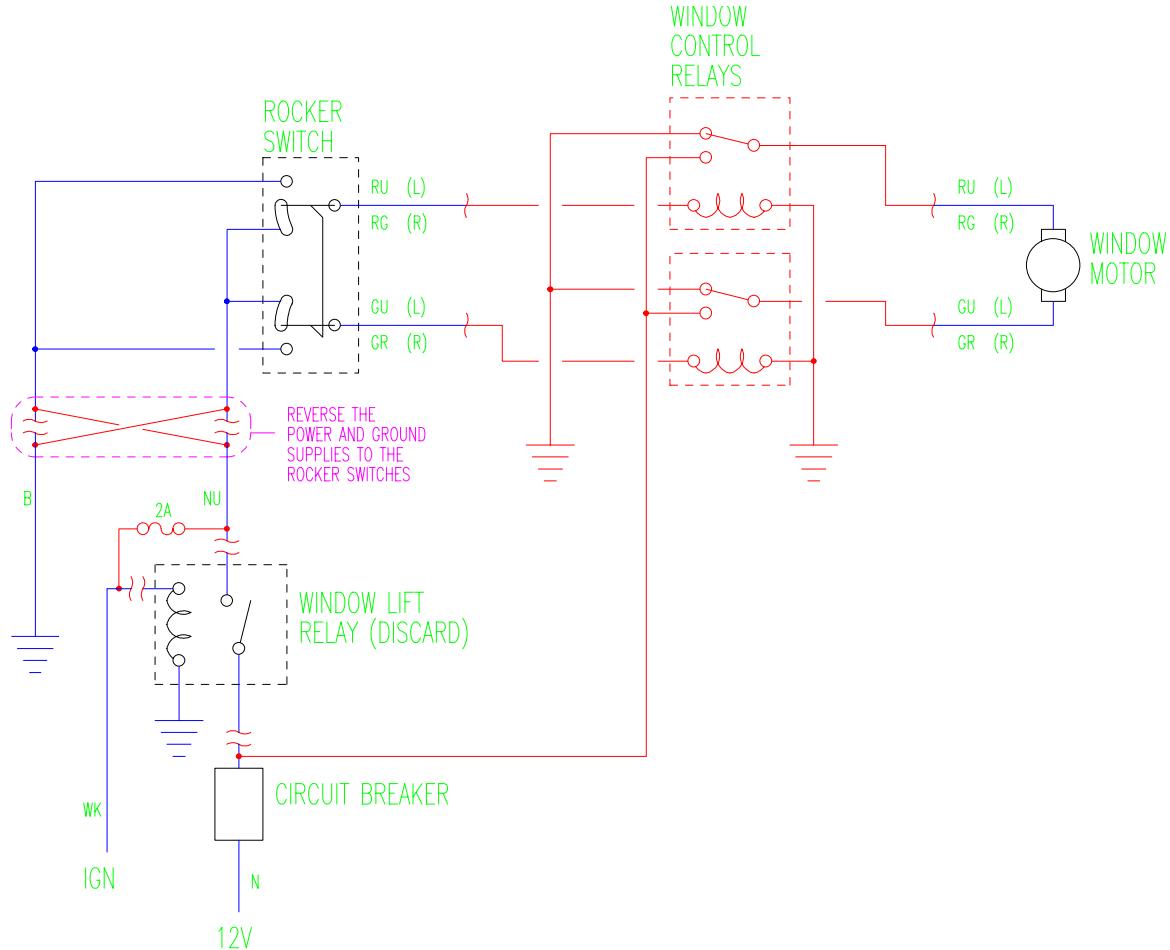


Figure 30 - Window Control Relay Wiring

Since window motors are permanent magnet motors, the direction they run depends on the direction of current flow. The wiring within the motor itself is *not* grounded. To run one direction, the switch grounds one motor lead and applies 12V to the other. To run the other direction, the same switch grounds the second lead and applies 12V to the first. The window control relays should be wired to do the exact same thing. In the wiring scheme shown, the normally-closed contacts on the relays ground both leads of the motor when the relays are idle, and each relay switches one lead to 12V power when energized.

A massive power wire -- 12 gauge or so -- must be routed to the window control relays directly from some heavy-duty source (any big, fat brown wire). You can toss in an inline fuse for safety, but it's probably a better idea to use the original thermal circuit breaker; it will do a better job of protecting the motor from overheating if the power is left on (somebody sets a book on the switch).

For the passenger's side window, it is quite convenient to use the existing 12V power source and circuit breaker for the windows, leaving the breaker mounted right where it is; just connect a new wire with a 1/4" spade terminal to the output side of the breaker and route it to the new relays.

For the driver's side, it may be preferable to just buy a new circuit breaker and power it from a lead to the fusebox; this would eliminate the necessity to run a heavy wire from the existing breaker on the passenger's side across the car to the driver's side. The original "Otter" circuit breakers are inordinately expensive and of unknown rating (apparently big enough to allow both windows to run at once, probably too big to properly protect a single window motor), but generic circuit breakers are available in auto parts stores in 10A, 15A, 20A, 25A and 30A ratings for around \$5 each. The 10A should work for one window motor; this author used one and it has never tripped. All of these generic automotive circuit breakers are "thermal" type, as opposed to the electromechanical circuit breakers typically used in homes.

For the relays, 12V DPDT relays with 15-amp contacts from Radio Shack, cat. no. 275-218, will serve nicely. Since SPDT relays will do the job, wire both contacts together; two 15-amp contacts working together definitely should handle this job!

The sockets that Radio Shack sells for these relays are not recommended; buy a handful of 3/16" spade terminals instead. Radio Shack seems to only offer 3/16" spade terminals in a box with a lot of other connectors, and since you need 16 of them you'll be buying a lot of boxes. If you go to an auto parts store, though, you may be able to buy a box with the correct "crimp-on" terminals alone. Even if the terminals come with plastic insulating collars, it is suggested you rip the plastic collars off and throw them away, solder the wires to the terminal after crimping, and insulate them with 3/16" and 1/8" heat-shrink tubing.

Since SPDT relays will work, automotive relays are another option -- if you can find some with an 87a (NC) terminal. Most of the relays sold in auto parts stores (usually for controlling driving lights) have two 87 (NO) terminals and no NC terminal, which won't work. Suitable relays include the one used on the XJ-S electric radiator fan, SRB411, and all of its substitutes listed on page 213.

Another option would be to use two normal driving light relays (no NC contacts) instead of each SPDC relay. Rocking the button should operate both relays, and one should make the power connection while the other makes the ground. This wouldn't make any sense if relays were priced the way they should be, but the fact is that you might find two driving light relays are *cheaper* and/or easier to find than one SPDT relay.

Automotive relays require 1/4" spade terminals, which are a good deal easier to find than the 3/16" terminals needed for the Radio Shack relays. Again, insulate them with heat-shrink tubing, 1/4" and 1/8" this time.

The relays can be located anywhere between the switch and the motor; simply break into the RG and GR (right side) or RU and GU (left side) wires from the rocker switch to the motor and wire in the relays as shown. Within the door itself is one possible location; in this case, a massive ground wire should be routed back into the car -- relying on ground contact through a door hinge is not recommended. Also, before closing the door up, it'd be a good idea to fasten the relays down (possibly with foam tape) and tie the wires down, and run the window up and down and operate all the latches to make sure the wires aren't in the way of moving parts.

Another possible location is adjacent to the footwells; you can intercept the wiring near the door hinge by removing the kick panel on the side of the footwell just forward of the door (2 screws). There is a pocket that looks like it was made for these relays behind the kick panel. There is a door lock relay in the same space, but it isn't taking up all the room. The wires from the door all go through this space, and there are a lot of them -- stereo speaker, electric mirrors, puddle light, door lock, and window. They are also plenty long enough, making it a simple matter to cut into the two window wires and install the relays. This location makes it unnecessary to have to route heavy 12V and ground wires into the door, or even to take the door panel off.

The relays can also go within the console if preferred, although that reuses a lot of the original wiring to the motors and reduces the potential benefits of installing really heavy power wiring.

It doesn't make good electrical sense to use the existing circuit breaker to protect the wiring to the rocker switches and new relays, since that's a heavy duty breaker and they are now a low-power circuit. Instead, provide an inline fuse to the rocker switches; a 2A or 3A fuse should be plenty to power the relays. Physically, this means that the NU line from the window lift relay to the rocker switches is disconnected from the relay and connected to a fuse instead.

Remove and discard the window lift relay, it won't be needed any more; the window control relays themselves will accomplish its task. Unfortunately, the window lift relay doesn't have a NC connection, so it cannot be reused as one of the four window control relays.

Where the power to the other side of the fuse comes from is a matter of preference. If you wish the system to work the way it originally did (windows won't move unless the ignition is on), then connect the WK wire that originally controlled the window lift relay to the fuse, as shown in **Figure 30**. If, on the other hand, you'd rather the windows worked whenever you hit a button regardless of ignition, just connect the fuse to a constant 12V power supply -- and there happens to be one right nearby, connected to the input side of the circuit breaker.

A minor complication: One might assume that the window rocker switches are a center-off, DPDT operation, and the wiring diagram for the window circuits in the ©1982 Supplement is obtuse enough to let you go on thinking that -- but they are not. Each rocker switch is actually two individual SPDT switches, neither of which is center-off; both have NC and NO contacts. With the rocker in the center position, the NC contacts on both switches happen to be connected in such a way as to send 12V to both leads to the motor. Since 12V at both leads results in no current flow, the motor doesn't move. When you rock the switch, one of the two internal switches disconnects the 12V source and connects that motor lead to ground, while the other internal switch doesn't move -- hence, the motor runs. **Figure 30** shows the switch schematically correctly, although it doesn't really indicate the actual physical operation properly.

All of this is normally just fine, except that all those leads are hot all the time. Something to keep in mind while working in the area, especially if you have bypassed the window lift relay so the windows are operational at all times with or without ignition (see page 554).

With the window control relay installation, however, these hot leads cause the relays to be energized when the windows are not moving. Rocking the switch causes one relay to *un*energize, and the system will in fact work just fine; the relays will just get warm. However, if you have wired the system so that the windows can be run with or without ignition (see above), the relay coils would be draining the battery when the car is parked. Ungood.

The solution is to exchange the 12V and ground connections to the rocker switch so that both motor leads are connected to ground when the rocker is centered -- just like you'd have expected Jaguar to do in the first place. You can make this change by cutting and splicing wires, but an easier way is to move the connectors around on the block connector that plugs onto the bottom of the rocker switch, putting the NU wires back where the B wires were and vice versa. If you have the switches with six round posts on the bottom, it is a simple matter to pop the connectors out of the block connector with a piece of 3/16" OD brass tubing (available at hobby shops); just insert the tubing into the round hole around the outside of each tubular connector, and it will compress the tangs on the sides of the connector itself and allow the connector to be pulled out the back side. Then they can merely be pushed back into the proper holes until they snap into place. If you have the later style switches you should be able to do something similar. Note that, for operating window control relays, the ground wires could simply be removed since they are not used.

Exchanging the power and ground wires may even be desirable *without* installing window control relays, since the windows will still run exactly the same way; you just won't have hot leads when working on the car any more.

When fiddling with all this wiring, rewiring, relay installation, etc., etc., trying to keep track of which circuit will move the window *up* versus which one will move the window *down* will drive you nuts. Instead, just forget about it. When you're all done and everything is working fine, if the button must be rocked the wrong way to move the windows, just turn the connector around on the bottom of the rocker switch. If you prefer, you can reassemble the console but leave the rocker switches hanging out of it by the wires; when you're ready to test it, just hold one rocker switch in your hand and push it one way or the other and note which way the window moves. Then turn the switch whichever way is correct and snap it into the panel.

This author has installed window control relays in my '83 XJ-S. I can report that the modification is a resounding success; the windows now zip up and down like they should. It is now clear to me that this is yet another modification that should be done by *all* XJ-S owners ASAP, before their stock window switches bite the dust from overload.

ELECTRIC WINDOWS -- EARLY CIRCUITRY: According to the ©1975 ROM, "Selections can be made on one switch at a time, the driver's switch over-riding the other panel switch", possibly to avoid overloading the circuit breaker. However, the ©1982 Supplement shows no such override and both windows on this author's '83 run at the same time. Randy Wilson says, "The SII XJ6, and early XJ-S, were set up in the manner your book describes. The switches are double pole, triple throw (down, pass-through, up). With this early system, you could only run one window at a time. And, if a switch failed such that the pass-through didn't work, all windows downstream also quit. Since the most used window, the L/F, is also first in the daisy-chain, it's not uncommon to see a SII with *no* working windows. This went away (all switches wired in parallel) with the SIII. I'm not sure exactly when the S changed over, but it was certainly by the time the H.E. was introduced."

If you have an early car and are having trouble with this system or these switches, the ideal solution might be to simply install the window control relay scheme described above and delete that daisy-chain nonsense. If your original switches can be made to work at all, they can be wired to operate the relays, and you will no longer be limited to one window at a time. Since you would be providing new and substantial power wiring to the window motors, there's no risk of overloading any existing wiring.

PRE-88 GEARS: Replacement gears are available separately. The motor/regulator assembly consists of a motor with a worm gear built into the output shaft, a housing that holds a gear/coupling assembly, and an arm with a gear rack. If your problems happen to involve that gear/coupling assembly, you're in luck! Chuck Sparks found out that the part is available in auto parts stores. It's called a "window lift gear kit", and it's made by Pronto, part number 42-90. It is described as applying to "any GM window regulator using a 46-spline, 12-tooth gear". It is described as fitting GM electric windows in cars and trucks from 1956-80.

There are no splines involved; there are two gears, a metal 12-tooth gear that engages the arm and a plastic 46-tooth gear that the worm gear drives. In between the two gears is a coupling assembly with a rather massive spring in it. All mounted on a short shaft. It's this entire assembly, both gears and the coupling mounted on the shaft, that comes in this kit. Cost is about \$20.

A real cinch to install, too -- once you get the regulator out of the car. It's obvious, just take a cover off the housing, remove the old gear, install the new, reassemble.

PRE-88 WINDOW MOTOR REPLACEMENT: They are Delco, so you can get them from a Chevy in any junkyard in America, right? Apparently not. The window motors in the XJ-S are made by "Delco of England" and seem to be a little different than generic GM stuff.

Still possible, though. Don Lawton: "My Jag had the cylindrical Delco motors. I found that I was able to replace the motor/gearbox assembly with a Delco module off GM/Oldsmobile cars from around the mid-1980's. The unit is not the same as the Jag one, but the pinion has the same gear size; i.e. it fits the jag regulator sprocket. The unit also has a slightly different bolt mounting pattern, but a few minutes of work with a round file on the regulator plate enabled it to fit just fine.

"Another good point is that the passenger side GM regulator motor fits the driver's side on the Jag; i.e. you can get one that is less used and in good shape. The GM unit is slightly longer than the Jag so it sticks up a bit higher in the door, but tucks in nicely behind the mirror switches.

"I picked up several good GM regulator units from a local 'dig-it-out-yourself' auto wrecker for CDN \$10 each, so I anticipate unstuck windows for the remaining life of my car!"

Since the indications are that GM changed their window motor design in 1981 and Jaguar followed suit in 1988, it's entirely possible that a junkyard window motor from a pre-81 GM car would fit the pre-88 Jaguar even better -- maybe with no modifications at all. On the other hand, perhaps it's a good idea to upgrade to the later style motor.

1988-89 ELECTRIC WINDOW MOTOR FAILURES: On the '88-89 Delco units, the housing on the motor itself gets loose and jams the rotor, or lets water in. Victor Naumann says, "I have replaced a lot of motors that the back has fallen off of and water has ruined."

Steven Draper reports, "After taking the door apart, I noticed that the case on top of the window motor that holds the magnets is held on by only two bolts. The rear bolt had slipped some, and could not be tightened completely because of the soft metal. The bit of play between that casing with the magnets and the internals of the motor that spin about was enough to cause the motor to only work when you beat the side of the door. I inserted a slightly larger bolt with a nut on the bottom. I was able to put the new bolt in without taking the motor out. Believe it or not, the window now rockets up and down. If you've got a window that doesn't want to go up and down and tapping on the door helps, this could be your problem." If you can't find a suitable long bolt, consider threaded rod with a nut at both ends.

"It was interesting because the case had four bolt holes but the motor part with all the gears in it only had two holes for the case to attach to." It might not be a bad idea to put some aluminum tape or silicone sealant over the unused holes to keep water out.

"BTW, on the Delco motor, if you put the stator on reversed from how you took it off, the motor does the opposite of what the switch intends." Actually, this is probably true on *any* window motor. Might be a good idea to mark which way the case goes before disassembly, although you could conceivably just turn the switch around in the console.

1988-89 ELECTRIC WINDOW MOTOR REPLACEMENT: Peter Cohen reports, "'88's & '89's are known to have problems with the window motors. I have an '89 XJ-S and have replaced both window motors with the new style Bosch motors. I highly recommend them. The windows just zip up and down like they never did with the Delco motors. If you have an extended warranty, this should be a no brainer -- make them buy you the new motors. If the warranty company won't come through, sue their no good ass in small claims court.

"Some other insights into the window motor upgrade:

"1. When this upgrade first came out, it was only sold as a complete motor/regulator assembly. It is now available as two separate parts.

"2. When I bought my left side assembly a few years ago (about \$325 then), two of the holes on the motor seemed not to line up with the holes in the black sheet metal panel in the door, & I had to drill new ones. This was not a problem with the right side, separate motor & regulator assembly which I bought in April, but I did have another problem: Both the regulator and motor shipped to me as right side were actually left side. The regulator assembly was in a sealed Jaguar package with the correct Jaguar part number for the right side. I took this to the local Jaguar dealer who cheerfully swapped it for a left side regulator, without my asking, and without asking where I got it. Being so successful with the regulator, I took the motor to another Jag dealer. Now, here's where it gets interesting. The motor came in a Bosch box, so I was a little nervous about trying to swap it at a dealer. I brought in the motor without the box, and again, the dealer swapped it without my asking. However, the number on the motor was different enough from the one I brought in that it wasn't just the difference between left and right. Also, the motor from Jaguar comes with 3 torx screws, and while the Bosch unit had no external wiring at all (just tabs to connect the wires), the Jaguar issue not only has the wires, but they are potted onto the motor. This leads me to believe that there is a standard issue Bosch motor that we can buy and adapt, even if Bosch won't sell the Jaguar number.

"3. There is a different type of plug on the Bosch motor (although still only 2 wire). You can cut & splice your old wires, or Jaguar sells a clean little adapter assembly to do it right. I have done it both ways, and both work. The adapter is \$40, so you really have to want it."

"A few weeks ago, I found myself in a Mercedes repair shop, and noticed a window motor lying on the table. Dang if it didn't look exactly like the one I put in my XJ-S. Which leads me to speculate: How many other cars use the same motor? Audi? BMW? Volvo? Saab? Opel? A wrecking yard Bosch motor in conjunction with a new Jaguar window regulator may be just the ticket for replacing those crappy Delco motors without bleeding from the ears at Jaguar's price."

"The Bosch motor's drive gear has a different number of teeth, so the regulator gear of the Delco won't mate with it, thus the need to replace the regulator."

BOSCH ELECTRIC WINDOW GEAR FAILURES: On the 1990-on Bosch units, the gears strip. Matthias Fouquet-Lapar says, "I almost fell flat on my face when the workshop told me that the window motor for a '91 XJ-S was more than \$800! They found a way to adapt the older motor type. They told me that there is some nylon drive gear which easily breaks and there is no good fix available, so they retrofitted the older type motor. It seems to require some major rework to the window mechanism though." Considering all the trouble Peter Cohen went to in upgrading his Delco motors to the later Bosch (see above), he probably doesn't want to hear that shops are doing the reverse.

Hugo Guerra reports that the window motors from a '76 fit just fine in his '90.

ELECTRIC REAR WINDOWS -- CONVERTIBLE: Trish Duffy says, "On the convertible, the two back windows automatically retract when the hood/top is lowered, and close when the hood/top is raised. These back window motors *can* burn out if the top raise/lower switch is held "on" for too long."

Larry Barnes says, "My 1992 convertible has a "Delco of England" window motor for the Rear\Side windows. I tried to order just the motor, but Jaguar wanted to sell me the whole shooting match (with regulator) for \$360. I found a local motor shop the would rebuild the motor."

There apparently are other problems with these windows, though. Andrew Corkan says, "I have a '91 XJ-S convertible and the rear window, lowered automatically when the hood (convertible top) is lowered, stopped working. The window remained up, but otherwise the operation of the hood was not affected. I tested the usual, relay and fuse, etc..."

"Following the Jaguar service manual, 1974-88, vol 4 page 76-11, I removed the rear quarter trim panel. I then removed the plastic motor cover. It is held in place by both adhesive and three plastic button fasteners. I missed one fastener and broke the thin plastic cover. I also unplugged the two motor wires.

"The failure was in the gearbox on the motor. The gearbox has a thin metal plate that covers a worm gear on the motor coupled to a plastic gear that couples to the window movement linkage. I removed the four bolts that hold the window linkage to the body. I lowered the window half way by hand and rotated the linkage to remove it from the recess in the body. (I did not remove the rear storage compartment or the hood lift linkage as stated in the service manual.)

"I don't know why the gearbox failed. The gear box contains a rubber coupling consisting of 6 pie-wedge shaped sections that couple a three-pronged part on the plastic gear with a three pronged part on the metal shaft that runs out the back of the gear box. These wedges had popped out and knocked off the gearbox cover. It appears that the window motor is just run for a fixed amount of time and there is no switch to stop it, so maybe the rubber parts were just squeezed out when the motor stalled at the end of the travel. I saw no limit switches.

"I jammed the rubber back in place and replaced the metal cover and peened that back into place. When reinstalling the motor it is important to run the hood up or down so that the other window is in the halfway position (as per the service manual). This puts the window linkage in a position that allows access to all three mounting bolts for the gearbox. I repacked the gear box with general purpose grease, and added lithium grease to the linkages.

"It worked fine 6 times (up or down) last weekend. So far so good.

"The critical and possibly breakable part appears to be the plastic gear in the gearbox. All other parts are robust metal or easily cut rubber. If you find these gear boxes, keep the parts.

"The motor looked generic. If it fails it should not be too tough to find a substitute, just be sure you save the worm gear that is on the shaft.

"My time was 3.5 hours, mostly trying to figure out which screws to remove and how to remove the linkage. Next time it will take about 1 hour."

Larry Barnes says, "I just got to repair the *left* rear window motor on "her" '92 Convertible. I also had this same problem with the *right* rear window motor. Dare I say it, "a design flaw"??? No, couldn't be..."

"Seems in the gear box (the flat lid pops off for easy access) there is a ring gear and a worm gear and a output linkage linked to the ring gear with a 1/4" flat/round rubber pad/shock absorber. Well, there are three little "ears" on the rubber shock absorber that will break off and, get caught in, and jam up the works (always with the window in the down position when you are 40 miles from home and it's pouring down rain). They seem to have no other practical use!"

"The fix is: Remove the FOD, spin around 3 times anti-clock wise, and reassemble. Everything works great again..."

ELECTRIC REAR WINDOWS (CONVERTIBLE) -- ACCESS: Julian Mullaney says, "I was buggering about with my XJS Convertible rear windows which wouldn't work properly (just like everyone else's) and noticed that the panel that covers the motors is held in by several screws, one of which is behind the window glass. If the window ever gets stuck in the up position, or any position except all the way down, this screw would be utterly inaccessible, i.e. behind the glass. This means that the interior leather panel could not be removed and the motors could not be accessed at all. One would be truly screwed if this were to happen. I think I will leave these screws out next time. There are enough other screws holding the panel in place."

Andrew Corkan responds, "It happened to me. I went to my basement and found a philips screwdriver tip, the kind you buy in packs of 6 for driving drywall screws with your electric drill. I then went to my local Service Star store and bought a strip of steel, 1/2 inch wide and 1/8 inch thick. I cut the philips part off the driver and drilled a hole in the strip of metal and brazed in the stub of the philips screwdriver into the hole. This gave me a right angle screwdriver, with a bend able handle, that was flat enough to get into the space. I could rotate the screw 90 degrees at a time and it took 15 minutes to get it out! If you do this be sure to file all the sharp edges off the metal; I then wrapped the metal in plastic tape to prevent damage to the leather. Before I replaced the screw I cut it off so it will only take two rotations to get out of the hole. Now that I think about it, maybe I will replace it with a hex head screw, easier to turn."

Electric Mirrors

ELECTRIC MIRROR DISASSEMBLY: Sorry to say, the electric mirrors were never intended to come apart. Here's how they went together: The plastic rim was put into place, then the motor assembly was put in over it, and then three screws were put in through holes in the mirror platform to hold all that to the housing. Lastly, the glass itself was mounted on the platform with foam tape -- completely covering the access holes to the three screws. Your chances of getting the glass to peel off of the plastic platform without breaking it are slim. Of course, if the entire reason you're reading this paragraph is because your glass is broken and you wanna know how to replace it, that's the trick -- just bust the glass into lots of little pieces until you can poke holes in the foam tape to get to the mounting screws.

If you don't wanna break the glass, you have a bit of a task ahead. Fortunately, you can easily see just how difficult it is before you even start. Run the electric mirror to the full up position, and pry it upwards a little more with a screwdriver and look under it. You will see two Phillips head screws. These two are not that difficult to get to. Run the mirror to full down and look between the top and the edge of the housing, and you should see the third Phillips screw dead center. This one's a real pain, since it's farther away from the edge than the lower two. Trust me, getting these three screws out and back in is the only difficulty with removing the motor assembly; if you can figure out how to do that, the rest is cake. The mounting lugs on the motor assembly are open slots, so removing the two bottom screws and just loosening the upper one may work.

As long as you have the thing out, a couple of suggestions: First, the plastic rim may have flashing tabs around the edge of the inner rectangular opening, notably at the 3 o'clock and 9 o'clock positions. These tabs may interfere with operation of the mirror, and should be cut off. In fact, it isn't a bad idea to use a sharp blade to cut about 1/8" off the right side of this opening, enlarging the entire rectangle.

Second, the motor assembly mounts with three lugs, but there is a fourth unused lug that gets in the way during assembly. You may want to just cut this fourth lug off to ease reassembly. It does nothing for operation, though, so you also might just leave it alone.

Third, the bottom center portion of the plastic rim distorts, so the screws tend to pinch the mounting slots right on the edge rather than getting a secure grip. My solution for this was to attach a 1½" length of popsicle stick to the bottom center of the housing with a piece of aluminum tape. This holds the plastic rim up into the proper position while the bottom two screws are tightened.

Note that the motor assembly itself is also permanently assembled, by melting tabs. You'll have to grind them off to get it open, and then contrive some other method to hold it shut again.

The motor assemblies for the left and right sides are exactly the same, not mirror images or anything.

ELECTRIC MIRROR ADJUSTMENT SWITCHES: When the parts man at a Jag dealer was asked about these joystick switches, he had the part number memorized! We're talking *junk* here, and they charge \$85 *each* for the two of them. Note that for '92 the joysticks were replaced by a fancy electronic adjustment scheme, and the following ideas do not apply.

Note: The mirror circuits are always hot, even with the ignition off. 12VDC won't electrocute you but it may cause burns or blow a fuse, so you may want to remove the appropriate fuse or disconnect the battery before working in this area.

Glenn Waterfield sends a description of how to rebuild the joysticks: "I was able to *very* carefully remove the pins holding the body of the switch together and strip down the pieces and clean the corrosion off them. To re-assemble the switch I did not want to try to reuse the metal pins that originally held it together since I will probably have to clean them again, so I found a tap just barely larger than the pin hole, a 4-40 I think, and carefully tapped the hole and put in three 4-40 nylon machine screws. If you try this I would recommend a clear work area with no carpet to drop the unbelievably tiny bits and pieces into."

If you'd rather just get rid of the junk switches, the following is a replacement scheme.

1. Make a flat rectangular panel to replace the original chrome escutcheon. You can make this out of anything you think would look good in your car -- chrome-plated steel, sturdy plastic, sheet metal covered with leather, elm burl, etc.
2. Go to an electronics supply store and buy four toggle switches. They need to be "mini" or "submini" ("micromini" will also work if you find any, but you need to drill smaller holes in the panel), "DPDT momentary center off". This means that they not only need to have three positions, but need to return to the center position by themselves when released. The current here is very low, a 3-amp rating will do. Once you find such switches, they should be only about five bucks each. Technically, a DPDT momentary center off rocker switch would also work -- if you can find one small enough to fit four of them in the car.
3. You may also want to buy some Molex connectors, such as Radio Shack catalog no. 274-236 and 274-226, to replace the hokey originals.
4. Mount the switches on your panel. The upper two should be mounted vertically and the lower two horizontally, since there will be one up/down switch and one left/right switch for each mirror.
5. A soldering iron or gun is required here. Connect wiring as shown in **Figure 31**. Note that each wire connects to two terminals.

If you'd like to see a photo of the author's installation, go to:

<http://www.jag-lovers.org/xj-s/book/MirrorSwitch.html>

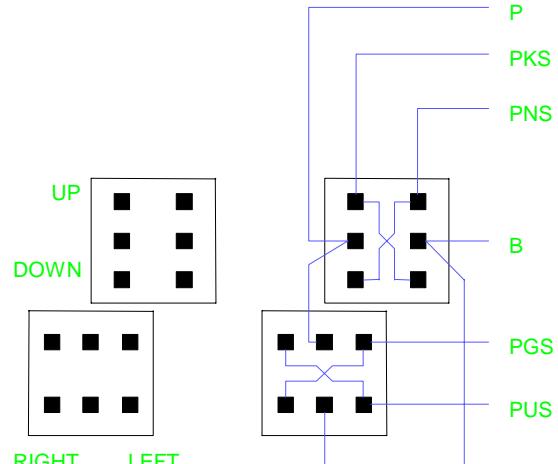
It is also possible to use only two DPDT momentary center off switches instead of four by adding a DPDT switch (non-momentary) to switch from left mirror to right. With this selector switch, a center off position provides a "lock" so the mirrors cannot accidentally be moved; while not strictly necessary, it wouldn't cost anything, either type switch is readily available.

Glen E. MacDonald went this route. "Not wishing to junk the chrome escutcheon, I used the three switch alternative, ie. two of RS 275-637 (one each for vertical and horizontal adjustment) and one of RS 275-626 (to switch between left & righthand mirrors). I found that the former switches could be very tidily mounted where the original joysticks were (in the escutcheon) by utilizing suitable diameter caps from magic markers, pared for length and drilled to accept the switch. The mirror selection switch is small enough to mount unobtrusively in the leading edge (front portion) of the escutcheon. It works like a charm and, in my opinion, looks quite professional!" **Figure 32** is based on MacDonald's input for wiring these switches. MacDonald cut the connectors off the original switches, and therefore the illustration shows the connectors and the wire colors from the original switches as well as the harness wire colors -- note that some mirror joysticks may have P wires instead of R.

Note: the author's local Radio Shack claims they no longer offer the 275-637 momentary switches nor any acceptable substitutes, but similar switches are available at most other electronics supply houses. A suitable switch is made by GC, part number 35-018.

It may also be possible to utilize the mirror switches from some other car. More and more cars use electric mirrors these days.

Once your mirror control switches are operational -- original or replacement -- it would be a good idea to wrap some plastic around the assembly before installing to keep rain that gets past the window seal from getting into the switches and corroding the contacts.



Wiring for left mirror shown; wiring for right mirror is identical.

Figure 31 - Electric Mirror Switch Wiring

Door Locks

There have been at least three different electric door lock schemes used on the XJ-S. The pre-H.E. had solenoid-operated locks powered through a pair of relays, one for lock and one for unlock, and controlled by a center-off rocker switch on the console. One relay is located on each side of the car within the footwells. It is this system that is described in Section 86.25.00 of the ROM. This system was apparently worthless from outside the car, but Mike Morrin says it isn't too difficult to add an aftermarket remote control locking system to it.

With the H.E. came a more automated version of the same solenoid scheme. Each solenoid had an arrangement of microswitches, capacitors, diodes and resistors added so that each solenoid could control the other solenoid. The relays that formerly were controlled by a rocker switch were now activated by a capacitor discharging through the coil. As a result, the rocker switch on the console was eliminated; moving either lock, either by the key from the outside or by

moving the lever on the inside, would actuate *both* locks. This is the system that is described on page 86-23 of the ©1982 Supplement, although it also shows a boot lock that apparently didn't really exist until much later.

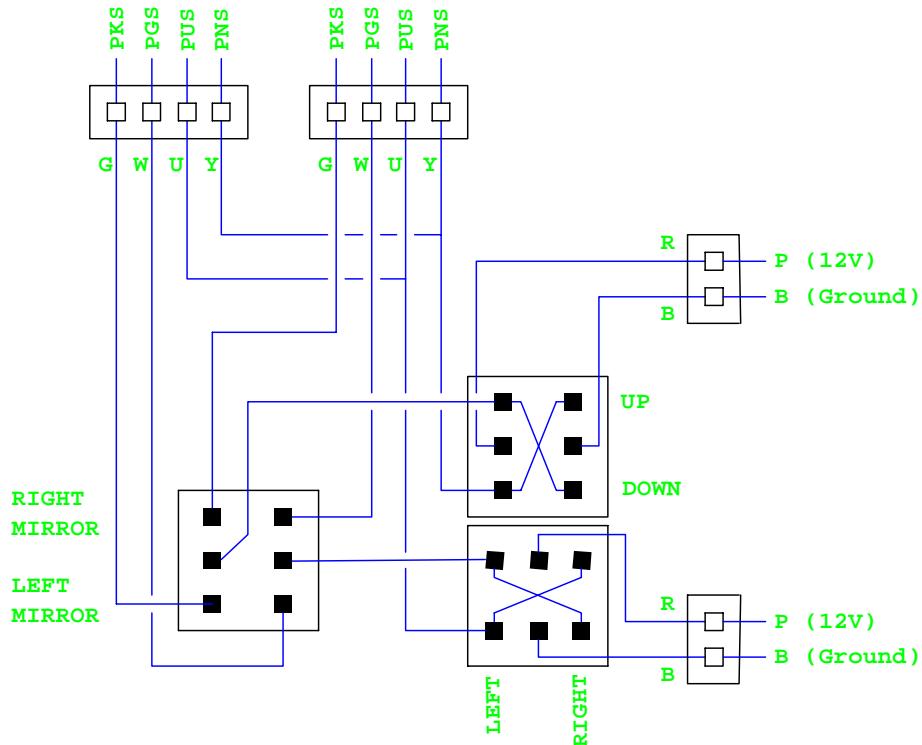


Figure 32 - 3-Switch Mirror Wiring

Finally, the solenoid type locks were replaced with motorized locks. The difference is readily apparent; before the change, the door locks operated with a clunk. After, there is a quick whirring sound as they lock and unlock.

Robert Warnicke: "If you care, some of the early saloons didn't have electric locks at all, or at least my '73 XJ12 doesn't."

Note that the Haynes manual is totally worthless on door locks.

If the locking system isn't working right, one obvious thing to do would be to remove the door panels and lubricate all the joints in the linkages and make sure they're all adjusted properly and moving like they should. Mack Kamna says, "As in the case with all lubrication, use the stuff sparingly. If you use excessive amounts, by giving the "grime" something to stick to, you are creating the very thing that you are trying to prevent: abrasion and thus wear of the parts." See also the note on the linkage clips on page 438.

Julian Mullaney reports on the locks going nuts in his '91 convertible, apparently the motorized type: "All three solenoids went rapidly from lock to unlock for about ten seconds, even after I removed the key from the barrel!! This wouldn't stop until I replaced the key in the lock and forced it to stop oscillating. I almost expected it to blink its lights, start up, and drive away without me. Weird." Randy Wilson explains, "Nah, not weird. It's fairly common with that era XJ-S, and more than a little amusing to play with. On those cars, the power lock sensors are not position dependent; rather, they are motion dependent. What happens is a lock mechanism gets a bit stiff. You unlock the door, the sensor detects the motion and all drivers go towards unlock. The stiff mechanism causes the lock linkage to deflect a bit from the load. When the driver deactivates, the linkage springs back a bit. The sensor sees this motion as travel in the lock direction, and kicks the drivers into lock mode. Linkage deflects, drivers disengage, linkage springs back, sensor sees motion in unlock direction, drivers go to unlock.... repeat until end of battery. Or until you jam down on the linkage long enough to ride out the cycle."

"The cure is to remove both door panels and clean and lube the lock system. The gumminess is usually in the striker assembly."

There have been a couple reports of people getting out of their Jags while leaving the engine running, and when they closed the door they could hear the click as the car locked them out. The cause is unknown, but be forewarned. Also, see "Breaking In" on page 439.

BOOT LOCK: According to Mike Cogswell, electric boot locks were introduced in 1989 models. According to his dealer, they cannot be retrofitted to earlier models.

Note that the later cars with electric boot locks have a 3-position keyhole. This is explained in the owner's handbook, but who reads those things? If the battery is dead and you obviously need to get into the boot to do something about it, turning the key either left or right won't work; you need to turn the key to the middle position, straight up. Mark West says, "The lock has two functions. The first is to override the electronic lock, in case you want to keep a nosy valet out of your goods. The second is to allow you to actually open the trunk using the trunk latch without having to operate the door locking mechanism. When the key is turned to the middle position the trunk latch may be operated independently of the electronic locking mechanism. Using the key in this manner, you can open the trunk without unlocking the rest of the car. It's a time-saver if you haven't installed an auxiliary alarm system. If you *do* have an alarm, don't try this without disabling your alarm. It makes a very loud noise... kinda embarrassing in a shopping mall parking lot."

"It will only work with the larger of the two silver keys. One is the "valet" key and only opens the doors; it is smaller and has the concave butt end. The other key, which is larger and has a convex end, will operate the trunk lock, gas cap, glove box, etc."

KEY FOB LOCK: According to Mike Cogswell, the key fob security systems were introduced in 1989 as a dealer-installed option. Apparently these cannot be fitted to earlier models.

ALARM SYSTEM RESET: Victor Naumann provides a resetting procedure: "Each year is different; try disconnecting the battery, wait 1 minute. Reconnect the battery. If the lights flash and sounder beeps every few seconds you are halfway home. Have all your remotes, security looks for five signals. You must press each remote at least once and all of them for a total of five presses. The security should work then. If the sounder does not sound , you may need to disconnect the security backup battery next to the security ECU and the do the process."

Windshield Wipers

There have been three distinct types of wiper motor used in the XJ-S. In the earliest models, a Lucas wiper was used that incorporated a parking solenoid inside that pulled the wipers into a parking position that was beyond the regular wiping limit. Later models used a different Lucas motor that had no parking solenoid but ran the motor in reverse to park. Finally, around 1987 an Electrolux motor was introduced.

Note that Jaguar made a regular practice of replacing the early solenoid-park Lucas motor with the later reversing-park Lucas motor. They do *not* simply plug in, so Jaguar dealers were provided a "blue box" that allowed the earlier controls to operate the later motor.

BLADES: First, a clarification of terminology. "Wiper blade" means the entire apparatus at the end of the wiper arm. The little rubber strip that actually contacts the glass is called a "refill". Don't blame me, I didn't come up with this.

The OEM blades on the author's '83 were really garbage: a simple pair of levers with a spring at the pivot point. These were replaced with some Anco aftermarket units which are much better, having a multiple beam arrangement to distribute the load over the blade edge.

The OEM blades on the '83 have a pin protruding from the side of the center hinge that clips into the side of the arm. A perfectly workable attachment, but unfortunately largely unheard-of today. However, it was common enough at one time that some aftermarket blades came with little pins that would snap into the blade and allow it to be attached to these arms. This is no longer popular, but many auto parts shops still have a collection of these pins in a drawer behind the counter. After all, 99% of the customers buying replacement blades didn't need the pins and just tossed them over their shoulders on the way out of the store. Once you have a pair of pins, you're good for the life of the car; the pins won't wear out, so you can use them with whatever blades you ever install in the future. Most of the pins are steel, but some were stainless steel; if you're going through a box in an auto parts store, you might opt to keep looking until you find a pair of the stainless ones.

The OEM blades were both the same length, but when I was buying aftermarket Anco blades I installed a 14" blade on the driver's side and a 15" blade on the passenger's side. The 14" blade allows the driver's side wiper to park without contacting the A pillar. Also, having wipers of different lengths reduces the tendency to chatter -- which is why many modern cars come with two different size blades from the factory.

The Anco blades held the edges against the windshield better and wiped better when it was raining -- but when it started to dry up, the wipers wouldn't park! The motor didn't have enough ooomph to move them. This led to a relay installation, as described on page 576, which fixed that problem.

Reportedly the OEM wiper blade design was changed shortly after '83.

WIPER MOTOR REMOVAL: Removing the wiper motor involves removing the entire intake grille assembly in front of the windshield. It doesn't look hard, but there may be trouble; the two fasteners closest to the windshield actually involve a rubber isolation mount, and trying to unscrew the nut may just rip the mount apart if you are unlucky today. Fortunately, it isn't too difficult to improvise a replacement mount scheme using a small bolt, a couple nuts, and a rubber grommet or two. It probably wouldn't be a good idea to rigidly mount the grille, though; Jaguar probably used the rubber mount for a reason.

WINDSHIELD WIPER MOTOR COVER: Under the grille, Jaguar provided a cover over the wiper motor to keep the rain off. If you're wondering where your original cover went, you need to read about water leaking in through the A/C system on page 429. This plastic part does not hold up in sunlight.

Providing a new plastic cover from Jaguar over the assembly would help for a while, but then it will just break up and plug the drains again. The aluminum tape suggested below is likely to be the prime protection for the motor in the long run. This author didn't even bother installing a cover and simply relied on the tape, painting it black so it would look OK from outside the car. It has worked for a decade.

Chuck Sparks suggests that you can buy a new cover and fiberglass it before installation to render it impervious to sunlight. Just coat it with resin, sprinkle on some loose fibers, and apply another coat of resin. Trim the edges up to make it look pretty, then paint it.

Jim Belkoff says, "John's Cars sells a replacement cover made out of genuine American plastic. I think it's worth the nominal cost." John's Cars is on page 668.

Chuck Roach says: "I went to my Jag dealer to pick up a new cover and the parts/service manager told me to forget it and just use an old one-gallon plastic bottle and cut it to fit and hold it in place with cable ties. Worked great. Will probably last as long as the original." I disagree; it's likely to last a good deal longer than the original.

Of course, you could probably fashion a cover from a thin piece of aluminum. Or find a metal can about the right size and shape and cut it out to make a metal cover. Or fashion a cover from a section of aluminum rain gutter. The possibilities are endless, just use your imagination.

WINDSHIELD WIPER MOTOR WATER DAMAGE: The housing of the Lucas wiper motor is not waterproof, and it's sitting right under the grille, exposed to the elements. To protect it, Jaguar provides a plastic cover over the motor to keep water from falling on it. There are also two large drains from the wiper motor compartment out through the engine compartment and out into the front wheel wells that should prevent any standing water from accumulating in this area. Unfortunately, the cover is usually history (see above), the compartment drains are often plugged because that's where the cover ended up (see page 429), and the wiper motor has ceased functioning due to water damage.

If you have trouble with the wiper motor, it's not too difficult to rebuild. First, mark the housing before taking it apart, indicating the alignment of the cylindrical can, the gearbox, and the end cover. There actually already should be marks, but they may be barely noticeable; at least notice them and how they line up before disassembly. The parts must line up the same way when reassembled.

When apart, sand any accumulation of rust off the large cylindrical diameter of the rotor, the surface that passes very close to the magnets in the cylindrical can. You can use sandpaper; it's just iron. You might even mask the ends off and apply a thin coat of rust preventative paint here, but make sure it's not too thick and try not to get any paint anywhere else such as on the segmented copper commutator or the bearing surfaces of the shaft. Also clean all rust particles out of the cylindrical can, which will require some patience since they will stick to the permanent magnets inside so you must grab each particle to remove it; sometimes the use of masking tape is helpful.

Herman Green adds his experience: "I took the motor apart and found that one of the magnets had come loose and had jammed the armature. The magnets are glued in with what seems to be some kind of silicone. Rust had crept under the bond and it gave up. I marked the location of the magnets with a file and measured the distance from the end of the housing to the top of the magnet, so I could put them back in the correct position. I also marked the magnets as to their location and orientation. If they're put in wrong, the motor will either run backwards or lock up. I then removed the magnets and cleaned them and the inside of the motor housing with a sanding flapper wheel in a drill motor. I then mixed up some JB Weld and glued them back in place. When gluing the magnets in, use a clamp of some sorts to snuggle them in tight. If not, you may not be able to get the armature back in! Once cured, I painted it with rustoleum to prevent further rust, and put it back together. Works great and should last a long time."

Clean up the brushes, which tend to jam when they've been wet for a while; make sure the brushes slide freely. If the brushes are worn (too short), replace them; there's no need to go looking for genuine Jaguar parts, just find any place that sells electric motor brushes (vacuum cleaner repair shops, starter/alternator shops, etc.) and buy some brushes that are a hair larger and file them down to fit. Carbon takes only seconds to file to size. Note that the "third brush" in the Lucas wiper motor is a tad unusual in that it has one half of the tip cut away; make a similar notch on your homemade replacement.

If you're not up to that sort of work, Walter Acker says, "The brush plate is available from the dealer. It is normally a special order that takes time to get."

Lubricate the bearings with something that won't dry out and get gummy. Synthetic motor oil is probably as good a lubricant as you will find. However, take care not to get too generous with the lubricants at the commutator end of the motor; if the lubricants ooze their way onto the commutator, it'll screw up the motor and you'll have to come in here again and clean it up.

The most difficult part about reassembling a commutator motor is holding the brushes in a retracted position while you slide the rotor into place. Usually some small pieces of wire are helpful, but remember you have to get them *out* as you're closing it up.

After reassembly, it wouldn't hurt to seal the top of the motor with aluminum tape (available where air conditioning supplies are sold -- it's used to seal ductwork) to help prevent water from getting in. Don't cover the bottom; leave the openings uncovered on the bottom so that condensation drains out. And, of course, attend to the cover and compartment drain problems so you don't have a repeat of your troubles.

The solenoid-park Lucas motor, the reverse-park Lucas motor, and the Electrolux motor differ in detail, but the same type of repair and renovation should have similar results.

WINDSHIELD WIPER PARK POSITION: On the author's '83, the wipers park to the left. Apparently some other cars have wipers that park to the right, but there doesn't seem to be any rhyme or reason to it.

The XJ-S wiper pivots are symmetrically located in front of the windshield, unlike any automobile on which an engineer thought about it for two minutes before designing it. As a result, the tip of one wiper bumps into the windshield frame when parked. Page 214 in the Haynes says to install the arms so the blades are parallel to the bottom edge of the screen when parked; that may work on the XJ12 but you really can't do that on the XJ-S on the side the wipers park pointing towards; the bottom end of the blade hits the chrome trim and the tip hits the A pillar. Avoiding these contacts requires positioning that wiper to park up high so it doesn't hit the frame; in the "Supplement for Later Cars" section, the Haynes actually provides an illustration with dimensions for positioning the wipers this way. Unfortunately, it looks stupid and obstructs the line of sight.

One way to improve this is to modify the wiper arm that points toward the A pillar to be shorter. This requires carefully unfolding the sheet metal where it is wrapped around the strut, and drilling out the rivet just above the spring attachment. Then the strut can be cut about an inch shorter, drilled and bent to form a new spring attachment, a new rivet hole drilled, and then the strut can be reattached with a new rivet (a pop rivet will do) and the sheet metal re-crimped around the strut. A little flat black paint, and no one will know the original design was so poor. With the shorter arm, the left wiper can be positioned much closer to the bottom of the windshield. Note that the shorter wiper will not reach as far toward the top of the windshield either, but this doesn't seem to pose a problem.

You can accomplish very close to the same effect by merely installing a shorter blade on that arm. A blade one inch shorter will pull the tip away from the A pillar the same amount as shortening the arm by 1/2". Unfortunately, it also reduces the area of the windshield that gets wiped. This may or may not be a problem for you.

Another improvement can be made by bending the arm slightly. The arm that parks over the other is cranked a little bit, but the one that parks pointing toward the A pillar is straight. Take that straight one, mount it in a vice, and crank it kinda like the other one. It's not difficult even though it looks difficult, you're bending a flat bar the hard way, but the metal is soft and bends easily. This bend allows you to set this arm to park lower without the bottom end hitting the trim at the bottom edge of the windshield -- but it does nothing for the contact with the A pillar. So, it's a good plan to make *both* changes -- shorten the arm a bit and crank it a bit.

Another possible solution is to alter the wipers so they park on the passenger's side. In the case of the later Electrolux motor Stefan Schulz says this can be done by merely opening the motor gearbox and moving the park cam 180 degrees, but it doesn't look that easy on the Lucas motors. You will need to purchase Jaguar wiper arms that have the bend the opposite direction. Of course, after all this the wipers will still be just as obtrusive, but they will be aggravating the passenger instead of the driver.

Windshield Wipers -- Lucas Solenoid-Park

SOLENOID-PARK OPERATION: Mike Morrin reports on the early XJ-S wipers: "The wiper in question has a highly (over) engineered parking facility where on the parking stroke, the blades go an extra 5 degrees or so, which pushes them off the screen onto the chrome strip. In the parked position, the blades are on the glass for about half their length, and on the chrome strip for the other half. Definitely further out of the driver's field of view than where you would put them on a normal wiping stroke. The early cars had this feature; the pictures in the pre-HE parts book and the service manual both show the solenoid (although it is not labelled in the parts book and the service manual calls it a switch)."

The "Extract 3" wiring diagram in the back of Section 86 in the ROM and Fig. 10.128 and 13.96 in the Haynes manual include schematics for this system. The solenoid is not labelled, but it's the coil-lookin' thing alongside the motor.

Richard Dowling describes how it works: "In "OFF" position (park position) no power is applied to the motor or solenoid. In "LOW" or "HIGH" speed position +12V is applied to the motor windings through yellow (high speed) or red (low speed) wires." Note: the low speed wire from the stalk switch to the bulkhead connector is ULG and from the bulkhead connector to the microswitch it's blue. Inside the microswitch it does nothing but come out another terminal, and from there the low speed wire to the motor itself is red on Dowling's car, but in Fig. 13.96 of the Haynes it's BLG. Doncha just love Lucas wiring?

"As soon as the motor moves away from the park position the microswitch is closed and this maintains +12V on the "2" contact of the stalk switch." Note that Fig. 13.96 in the Haynes numbers the terminals on the stalk switch differently for some reason, with the terminal that gets 12V from the microswitch being number 1 instead of number 2.

"The motor shaft has a small worm which drives a large gearwheel. On the gearwheel a cam is mounted, and this cam has a pin which connects to a crank arm. The cam is concentric with the gearwheel in normal wiper arm motion. As the cam and gearwheel rotate the crank arm moves the wiper arms in an arc over the windscreens.

"When the stalk switch is returned to "OFF" position, +12V from "2" contact will both maintain the low speed motor winding energised and also energise the solenoid. The solenoid operation activates a catch to engage a spring loaded lever on the cam. This in turn forces the cam into eccentric operation on the gearwheel, which moves the crank arm over a longer stroke and thus activates the microswitch to open the "ON" contact and hence remove power from "2" contact on the stalk switch. The motor winding and solenoid are then de-energised and the wiper arms are in the park position.

"As soon as the motor starts up again the eccentric cam rotates to its normal concentric position on the gearwheel.

"The microswitch position is adjustable in a slot with a small screw to determine where it stops the crank arm. Opening the "ON" contact stops the motor which stops the crank arm.

"The microswitch body has 8 "faston" terminals, but only 2 terminals are effective. Those 2 are the common pole of the switch and the "on" contact. The other terminals are only for interconnecting wires."

Morrin: "It is nearly a good design, suffering only from the poor thermal design of the solenoid, and perhaps the parking switch should have been operated by a cam on the driven gear, rather than by a switch on the sliding link thingy."

Note: the cars with the solenoid-park wiper motors did not have an intermittent mode. This may help explain the changeover to the reverse-park motor used later, since the solenoid-park scheme would probably not work well being parked every ten seconds or so.

WON'T PARK: Dowling: "I have had problems from time to time with the wiper stopping as soon as I select "OFF" on the stalk switch. This is most likely because grease in the microswitch is preventing +12V from reaching the "ON" contact. I have tried to pull apart the microswitch but it resists the effort.

"A mod to use a small generic roller lever operated microswitch would be good. A quick look told me it would be a fiddle to do it.

AVOIDING THE WON'T PARK PROBLEM: Dowling says the microswitch has caused him trouble. He says the microswitch won't come apart. He says it wouldn't be easy to replace the microswitch with something generic. And Jaguar took to replacing these wipers in entirety with the later reverse-park wipers; buying a new microswitch is likely to get more and more difficult as time passes.

If you want to keep this system working, you need to keep that microswitch working. Unfortunately, its job is to break contact to not one but two inductive loads: the solenoid and the motor. As discussed beginning on page 518, inductive loads tend to cause charring on contacts when disconnected -- but it's really easy to prevent this by adding a diode. You should add a diode here. Now.

When looking at the wiper motor assembly, there are two wires that go from the microswitch to the solenoid: one blue and one brown. This is a convenient place to add the diode: between the blue and brown wires, with the point or stripe on the diode towards the brown wire.

This isn't the only place it could go. It could also go inside the car in the wiring to the stalk switch. It needs to be wired in between the RLG wire and ground, with the point or stripe towards the RLG wire.

Remember that even though you might be installing this diode in the wires to the solenoid, it's not just spikes from the solenoid it'll be absorbing; it'll also be absorbing spikes from the motor, which is connected in parallel to the solenoid when the microswitch turns them both off. So, you need to make sure this diode is big enough to handle that job. As described in the section on installing such diodes, none of them ever need to be very big, but don't put a really tiny one here.

Note: The relay installation described below will also help the microswitch last longer -- but it's no substitute for installing this diode. The diode is probably more important to this switch's life. Of course, doing both would be a good plan.

WON'T STOP -- CAUSE #1: Dowling: "If the microswitch is too far down its slot, or the switch contact does not open, the motor and solenoid stay energised and the wiper arm will not park. In fact the wiper will operate whenever the ignition is on. This is a very obvious fault and may burn out the solenoid if it is not fixed promptly." By promptly, he means within a minute or so. As Morrin mentions below, if it won't stop you need to move the stalk switch back to low speed position to avoid frying that solenoid.

WON'T STOP -- CAUSE #2: Morrin: "Unfortunately, a little bit of dirt or grease in the wrong place is enough to stop the solenoid pulling in all the way, which prevents the eccentric gear mechanism from pushing the wipers off the edge of the screen, which means that the parking switch doesn't get activated, which means that the wipers keep going and going and..... fried solenoid."

The parking solenoid gets fried "because it is designed to be energised all the time while the wipers are switched off *and* are not parked. The designer thought that this period would be only a couple of seconds, and designed the solenoid with thermal capacity for about 30 seconds.

"If you do have an early car (pre H.E.) with this facility, if the wipers ever keep running after you have turned them off, then put the switch back into the ON position, or the solenoid will burn out within a minute or so. Remove the wiper blades if it stops raining." Uhhh, it might help to shut the car off to do this. Once the wipers are in the trunk, you can start it back up and drive off with the wiper motor whirring merrily away. Alternatively, you might simply opt shut off the ignition when the wipers are in the right place, and then remove the correct fuse before starting it back up. Fuse 9 should do it.

"If the solenoid has not melted, the parking function can probably be restored by carefully dismantling, cleaning and reassembling the solenoid."

If the solenoid *has* melted: "I stripped off the old wire, and built up the melted plastic core with epoxy filler, then filed it back to shape. The solenoid is wound with 0.16mm (0.0063") copper transformer wire. I didn't count the turns, but it does need to be neatly layer wound or you cannot fit enough turns to get the required magnetic pull."

QUICKIE FIX FOR FRIED SOLENOID: Morrin: "I found that the parking switch is adjustable, and by trial and error found a position where the wipers would stop more or less at the bottom of the screen when switched off, even with the parking solenoid removed. This solution was almost perfect except that with the blades fitted so that they parked at the bottom of the screen, they did not wipe all the way to the passenger side of the windscreen."

This quickie fix might even be considered better when using the single-wipe facility. Per Morrin, the correctly-operating solenoid system "takes about half the period of a normal stroke to move the wipers through the first 5 degrees, and you need to hold the switch for that period of time."

UPGRADING TO LUCAS REVERSE-PARK: If you're interested in upgrading an earlier car with the later wiper motor, Scott Horner describes "the little Lucas blue box modification - this plugs into the original wiring loom and fits into any tight spot under the dashboard. This was offered by Jaguar to make the windshield wipers park on pre-H.E. cars, when used in conjunction with an H.E. wiper motor."

RELAYS: The early XJ-S is notorious for powering high-current loads such as electric windows and windshield wipers through tiny contacts and long, skinny wires. The result is a 14V load that is trying to operate on 8V or some such, the rest of the voltage being lost in the controls and circuitry. If your wipers are dragging, the solution is to provide a relay scheme to provide solid power directly from the main power bus and use the original control wiring only to control the relays.

Dowling suggests there may be another good reason to install relays: to help the stalk switch last longer. It'll also help the microswitch in the motor last longer. If either of those switches ever gives out on you, you're gonna wish you had ponied up the ten bucks for relays when you first read this.

It's very simple to install relays on the solenoid-park motor, only requiring two relays -- one for low speed, one for high. There are three wires from the microswitch to the motor itself. One of these is a ground wire; Dowling says that one is blue. For each of the other two, pull the spade connector off the microswitch and connect it to a normally-open contact on a relay. Connect the terminal on the microswitch to one coil terminal on the relay. Connect the other coil terminal on the relay to ground; that third wire on the motor is a ground, so you can splice into that or piggyback onto the terminal it connects to. Connect a stout 12V power lead to the other side of the normally-open contact.

Obtain that stout 12V power from the main bus on the firewall. You'll need to provide a fuse within the engine compartment where it's easy to get to, and then run the lead into the wiper compartment and install the relays in there somewhere they won't get immersed when it rains.

The third wire from the motor needs to be a good solid ground. It might help a little to provide an additional reinforcement ground right there in the wiper compartment. Simply tie in another wire and screw the other end down to the body somewhere.

If you'd rather work behind the dash, these relays can just as well be installed in the wiring from the stalk switch. Merely cut the ULG and YLG wires and splice in the relays, using the lead from the stalk switch to power the relay coil and the contact in the relay to send solid 12V power on to the wiper motor. You can get the stout 12V power from the main terminal post on the firewall near the climate control system.

Windshield Wipers -- Lucas Reverse-Park

SCHEMATICS: The reverse-park wiper system is shown schematically on page 86-15 of the ©1982 Supplement to the ROM. Apparently the only place it's shown correctly in the Haynes is in Fig. 13.91 -- which is a wiring diagram for the saloon. Whatever, you can simply refer to **Figure 34** below and ignore the relay additions to see how the car was originally wired.

WINDSHIELD WIPER CONNECTOR AND HARNESS: Once you have the grille out, you will find that the wiper motor plugs into a socket on a panel inside the grille compartment. Jaguar uses a really nice 8-conductor plug to connect five wires. You might find it helpful to know which wire on the schematics connects to which conductor on that plug. **Figure 33** is an illustration of the connector on the panel in the author's '83, viewed as though you were standing on the engine looking at it. The circles represent brass posts.

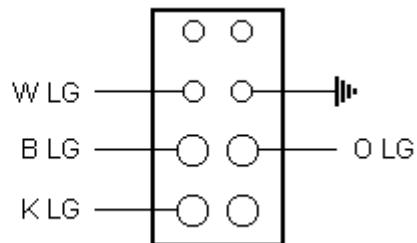


Figure 33 - Windshield Wiper Connector

Of course, the connector on your car may be different than the author's '83, so you might need to confirm those connections with a VOM. With the ignition switch turned to ACC, the W LG post should register 12V with the wiper switch in fast mode only. The B LG post should register 12V with the switch in slow mode only. The K LG should register 12V with the switch in intermittent/flick or off modes only. Turn the ignition off, and using ohmeter or continuity mode, you should get continuity between O LG and B LG posts in intermittent/flick and off modes only. Obviously, the ground terminal should register continuity to ground.

Also on the author's '83, there is a harness that starts with the plug that connects to this socket on the panel and plugs into the motor itself. At the motor end, it becomes evident that the wire colors in this harness do not correspond to the wiring schematics -- they are solid-color wires. And the plug is enclosed so you can't tell which wire goes to which connector by looking. It's not too difficult to determine which wire is which using a VOM, though:

Yellow	=	W LG
Green	=	Ground
Brown	=	B LG
Red	=	O LG
White	=	K LG

WINDSHIELD WIPER MOTOR DURABILITY: A design problem with the Lucas wiper motor is that the drive gears at the wiper arm shafts are plastic. Wear is a reported problem, and can be aggravated by operating the wipers on a dry windshield. It is suggested that the XJ-S owner use Rain-X or similar product on the windshield on a regular basis. This will make the water run off so the wipers need not be used as often, and it will also make the surface of the glass more slippery, so the wipers move more easily.

WINDSHIELD WIPER PARKING: If your Lucas reverse-park wipers don't park, you may be tempted to start tearing the wiper motor apart to work on the parking contacts -- but you would be forgetting that this is Lucas you're dealing with. As Mark Roberts found out, the problem is every bit as likely to be within the stalk switch. "Because the wipers would park in intermittent mode, I was skeptical about the problem being with the parking micro switch, but checked it anyway. Micro switch was fine. The problem was traced down to the stalk switch. In the off position, pins 5 & 6 (ULG & BLG respectively) are supposed to be shorted together, to provide a ground path for the motor. They are also

supposed to be shorted when in intermittent mode for the same reason. On my switch, 5 & 6 were shorted in intermittent mode, but *open* in the off position...no ground, no work."

Dan Jensen provides more info: "There is a simple in-car test to determine if the switch is the problem. After turning the wipers off and having them stop midstroke, simply push down slightly on the stalk toward the intermittent position (but not the "locked" intermittent position). If the wipers park, it is the switch."

Jensen had this same problem on three different Jaguars! "Unfortunately, after disassembly of the switch in my '81, I could not come up with a successful way to repair it. The cause seems to be slow deformation over time of the plastic slide that supports the copper contacts in the switch. The slide is held against the stalk by a rather stiff spring that apparently leads to an inexorable depression in the plastic slide contact surface. At ~\$100-125/switch, I will probably just live with the problem."

Tom Amlie says a new switch might not even fix it. "Ordered a new switch for \$82. It was defective straight out of a sealed green box with the leaper on it. Took the old one apart. It has a flat plastic card with indentations in it. In the indentations are little pieces of copper. As the card moves in and out, the little pieces of copper are supposed to make and break connections as necessary. Trouble is, they are not anchored in any way and fall out. A few drops of crazy glue on the copper pieces and glued the thing together. Worked fine. This was my first experience with the "Prince of Darkness". I think you are too easy on Lucas in your book."

This author had the same problem and managed to fix it by disassembling the switch. Reassembly requires some ingenuity. A 2-1/8" length of 1/2" aluminum angle and two 1-1/2" #6 screws works well. Cut some plastic away on the back side of the switch, then lay the angle against it and insert the screws through holes in it and into the threaded mounting holes in the switch housing. The screws will protrude through the front, where you can use the ends to mount the switch back in the column with a couple of nuts and lock washers. The metal angle will help prevent the plastic housing from deforming and allowing the contact problems described above.

WINDSHIELD WIPER ARM MOUNT: The wiper arms are mounted on the shafts with a taper fit, held tight with a nut that is hidden by a plastic cover. The plastic cover can be simply swung up to reveal the nut, and if desired can then be pulled directly off; it just snaps into place. The nut really should have a washer under it; if not, the 8mm wavy spring washers described on page 26 will work well.

The base portion of the arm is made of aluminum, and a slight growth or wallowing of the tapered hole is an occasional problem. Contrary to expectations, this cannot be dealt with by merely tightening the nut further or stacking washers. The nut bottoms on a shoulder above the taper, and the arm remains loose.

There is a second result of this problem. When the nut pushes the arm too far down onto the taper, the bottom of the arm can pinch the rubber shield against the mount bushing and bind up the movement of the wiper. These motors have enough trouble moving as is, they don't need binding on top of it. After installing the arms and tightening down the nuts, grab the rubber shield between two fingers and try to turn it on the shaft. If you cannot turn it, it's probably binding.

These problems can be easily corrected. Cut a 1/4" wide arc from thin sheet aluminum (beer can for minor problems, old real estate signs if more thickness is needed) and roll it into a conical shim. Installed between the shaft and the arm, it will provide a tight fit.

PITIFUL WINDSHIELD WIPER OPERATION: The performance of the early/mid-80's Lucas wipers is really sorry. They behave as though they are "dragging themselves into the grave." And switching from slow to fast speed makes so little difference you'd hardly notice it. This problem is similar to that causing the slow electric windows (see page 557), so a similar solution is recommended: a relay scheme should be incorporated to provide solid 12V power directly to the wiper motor without having to go through the stalk switch and the skinny wiring to get there.

Figure 34 is a schematic for installing up to three relays in the reverse-park Lucas wiper system. It should be noted that an owner can choose to install any one, two, or all three of these relays to improve his wiper performance. To explain:

due to the way the control system works, both the 12V power and the ground connections go through the stalk switch and the wiring in between. It is probable that there are just as many volts lost in the ground wiring as in the power wiring. To improve any individual mode, one could install a relay to provide solid 12V power or one could install a relay to provide a solid ground connection, but for truly optimum performance one should install *both*. In **Figure 34**, Relay 1 provides one good connection for all modes; Relay 2 provides the other good connection for fast speed mode; and Relay 3 provides the other good connection for slow speed, intermittent, flick, and park modes.

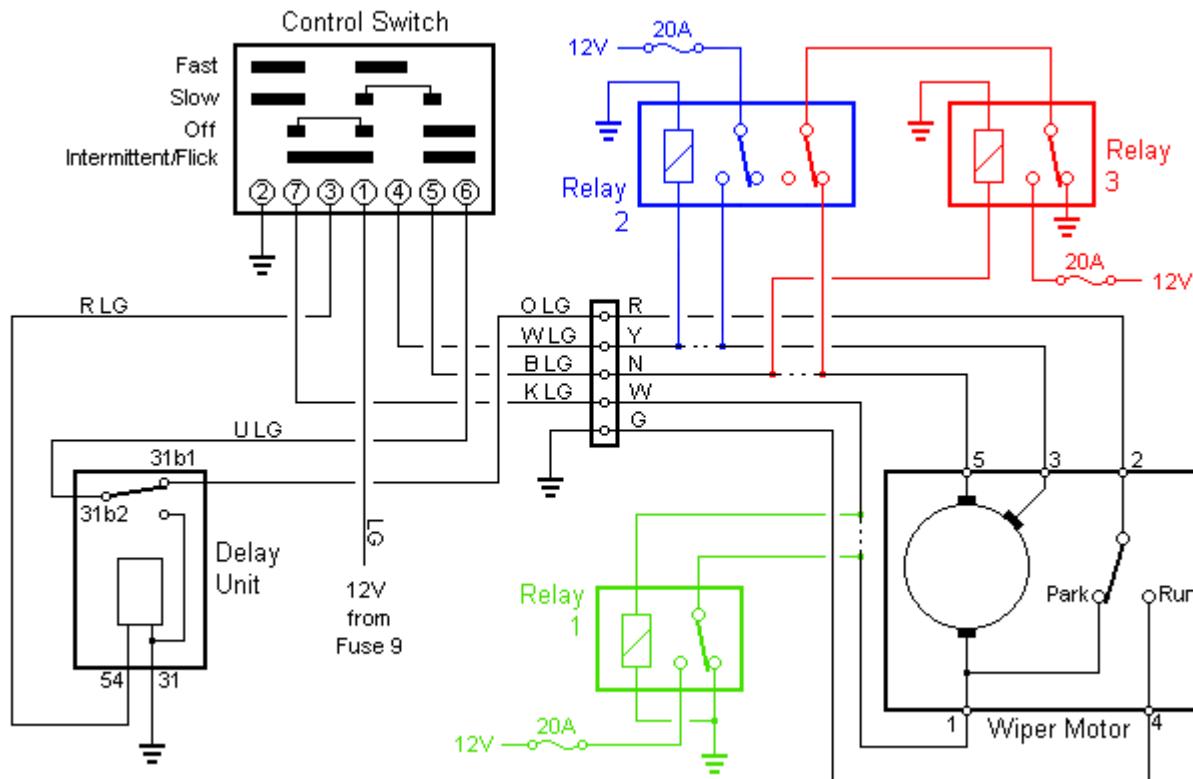


Figure 34 - Windshield Wiper Relays

Installation of all three relays should also make the stalk switch last longer, since it will no longer be carrying the heavy current.

Relay 1 and Relay 3 both must be SPDT relays (with 87a terminals -- see page 522).

Note that the second set of contacts in Relay 2 is really part of the Relay 3 scheme; if Relay 3 is not being installed, a SPST relay (common automotive relay) can be used for Relay 2.

If Relay 3 is being installed, a separate SPDT relay can be added with its coil wired in parallel to the coil in Relay 2 rather than trying to find a suitable double-pole relay. This means that four automotive relays -- three of which must be SPDT -- can be used, and there is no need to try to find a double-pole relay with 20A contacts.

If Relay 3 is the *only* scheme being implemented, it will require two relays -- the one labelled Relay 3 and a SPDT wired as the right half of Relay 2 in the schematic, with the coil connected to the Y wire without breaking it.

Figure 34 shows a 12V power supply connected through a 20A fuse for each relay, but this is mainly for clarity and simplicity of illustration. In practice, a single 12V power supply should be run for all relays, and a single 20A fuse should be used; only one relay will be drawing current at any time. Note that the label on the fusebox may indicate a 35A fuse is needed for the wipers, but that reflects the difference between UK and US fuse standards (see page 542). If you are using UK-rated fuses, you should use a 35A.

In application, the power for the author's installation came from one of the main posts on the firewall, and a wire was run through one of the bolt holes originally used to mount the heater valve (which had been replaced and relocated -- see page 459). A couple of layers of heat-shrink tubing were applied around the wire at that point to protect it from rubbing inside the threaded hole. The ground wire was attached using a bolt threaded into the other mounting hole for the heater valve. Note that later cars have plastic nuts pressed into holes to mount the heater valve instead of the welded-on nuts on the '83, so the plastic nuts should be removed and a grommet and a bolt and nut should be used for the power and ground wires instead. If you still have the original heater valve in place, you could just drill new holes -- but, seriously, it would probably be a far better idea to spend the ten bucks on a new heater valve.

The fuse I used is a modern blade type, and was located in the engine compartment to make it easy to replace if necessary. The relays themselves were installed within the wiper compartment, but far to the right and high up under the bodywork to protect them from rain.

There is a cable, DAC2644, that plugs into the bulkhead connector within the wiper compartment and into the motor itself -- see page 575. As a result, you can cut this cable and splice in the wiring to connect up these relays without fiddling with either the wiper motor itself or the wiring behind the dash; the only reason to open the door on the car is to turn the wipers on to test them out! The most challenging part of the job is getting the wiper grille out and back in when done.

Note that Relay 1 and Relay 3 will be energized when the wipers are off. This is not really a concern, however; relays are designed for continuous operation, the coils take very little power, and the relays will be deenergized when the ignition key is turned off.

Relay 3 only helps the modes where the wipers are supposed to be operating slowly. This may sound silly -- if you want more speed, just switch to fast speed! -- but in fact getting the slow speeds to operate smoothly and powerfully without the typical pitiful straining could be considered worthwhile. There's no danger of the motor running too fast; slow speed is provided by the design of the motor, so although it will be faster than the dragging OEM setup, it will still be slower than fast mode.

In fact, Relay 3 may be the *most* important scheme to install because it's involved in the wipers parking. Park is one of the slow modes that isn't helped with the high speed relays, so when the glass gets dry putting it in park may cause them to drag or even stop altogether without making it back to park position. This is really bad, because the power is left on in the motor.

If you install all three relays as illustrated, Fuse #9 in the main fusebox will no longer carry any serious current; it will be powering only the three or four relays you have installed and the delay unit. You can remove the 20A or 35A fuse and install a 3A fuse.

Windshield Wipers -- Electrolux

Beginning around 1987, the XJ-S was fitted with an Electrolux motor. This unit has metal gears at the wiper arm shafts, as opposed to the plastic gears on the Lucas. There are few reports of problems, so it must be a fairly reliable unit. Stefan Schulz says "The parts guy at my local Jag dealer says that it is *not* a drop-in replacement for the Lucas one."

If the Electrolux motor drags, adding a relay scheme may be helpful as it is with Lucas motors. However, somewhere in the late 80's or early 90's Jaguar (or Ford) realized the error of their ways and began providing relay schemes for heavy loads in their cars from the factory. Which happened first, and whether there's any such thing as a car with Electrolux wipers without relays, I don't know. If your Electrolux wipers drag, that might be an indication.

Windshield and Headlight Washers

These systems have changed considerably over the years. The pre-H.E. windshield washer is a simple tank with a simple, separate pump that draws fluid from a sort of dipstick tube inserted in the top of the tank. Both pump and tank are located at the rear passenger's side corner of the engine compartment. If that pump quits, a generic replacement such as those available at any parts store will work fine. The one sold by Wal-Mart, Wiper Mates #5101, also has the same electrical connector layout so the connector on the Jag wiring harness will plug right on. Polarity is important, but it is correct. Apparently there's some sort of standard for plugs on washer pumps.

On the H.E. up until VIN 110190 (mid-1983), the tank and pump are still on the passenger's side rear corner of the engine compartment but the windshield washer pump (DAC2403) is mounted horizontally and is attached directly to the bottom of the washer fluid tank itself. It actually screws onto the tank; the opening in the tank has a rubber grommet in it, and there's a plastic nut on the inside held in place by three rubber tangs on the grommet itself. The pump has a threaded inlet end and is installed by rotating the entire pump, screwing it into that nut and compressing the grommet.

When installing an aftermarket pump in a system like this, the recommended method of plumbing is to leave the toasted OEM pump in place and just tee the new pump into the line from it. Fine and dandy -- except that the primary failure on this author's pump was the shaft seal between the pump and motor, which allowed the fluid to drain through the motor and out the electrical connectors. Leaving it in place was therefore not an option, unless I could find a way to seal it. Didn't like that option anyway, so I removed all that junk and worked on connecting a pickup hose to the opening in the tank.

A suitable grommet can be found at the auto parts store on the rack of "PCV valve grommets". The one that fits a 1970-84 Toyota fits just fine. Next challenge: something to fit *into* this grommet. My choice was a PCV valve! They're cheap, so I just selected a plastic one, drilled the big end open and let the guts drop out, and plugged it in; it proved watertight. A 1/2" nylon tubing fitting would probably work too. Of course, the fitting on the other end is still pretty large, so stepping the hose size down to the 1/8" for the inlet of the aftermarket pump is still necessary.

Another option might be to jamb the hose itself into the grommet on the tank so the grommet seals against the outside surface of the hose. You could even feed the hose on into the tank and out the filler opening, then jam a fitting or a piece of brass tubing into the end of the hose to spread it a little larger and firmer than the bare end of the hose would be, then pull it back into the grommet until it "wedges" into place.

From VIN 110191 to VIN 148781, a different tank with a different type pump is used, but still in the same basic location.

Apparently, headlight washers were not available before 1982 or so. From their introduction up until VIN 148781, cars that have washers on the headlights have a single tank with two pumps. This tank still fits in the passenger's side corner of the engine compartment, but it is larger than the single-pump tank and has a more elaborate mounting scheme. The tank shown in the '88 Jaguar Parts Catalogue is labelled DAC2853, but Martin Hargreaves reports that the later Parts Catalogue (RTC9900CA) shows a tank number DAC4368. These two tanks appear exactly the same in the illustrations; the actual difference is unknown.

From VIN 148782 on, the tank (DAC4732/2) and pump is located in the compartment forward of the right front tire; this configuration is much more complicated, requiring a separate filler tube and cap and a special vent. Cars from VIN 148782 on with headlight washers have a similar tank (DAC4732/1) with two pumps.

From VIN 110191 on, the same type pump is used regardless of the tank configuration: DAC2876. This pump doesn't screw in like the earlier pump, but rather simply presses into a grommet. This is a common configuration; Alex Dorne says, "It is VDO part number V246 003, also found on:

Audi 100, '77-'92

BMW 3 series, '80-85

BMW 5 series, '82 - '87

Saab 99, '78 - '84

Saab 900, '78-'84

Volvo 300 Series (European) '82-'89

Volvo 400 Series (European) '87-'96

VW Golf / Rabbit '81-'86

Most of these are prime wrecking yard material." Mike McLaughlin adds, "on my '85 XJ-S H.E. a Volkswagen Jetta pump (\$20USD) is a drop-in replacement, both to the reservoir and the Lucas plug!" If a generic aftermarket pump is used, it should be easy enough to find a fitting that will plug into the same grommet and connect to a hose to the pump.

The saloon is apparently a different matter. The Haynes manual indicates the tank used with headlight washers is in the fender, and since the Haynes manual is ©1985 that means this move was made a few years before a similar move in the XJ-S. Also, the Haynes says it is installed in the left side fender, while in the XJ-S it went into the right side fender.

HEADLAMP WIPER/WASHER DIODE PACK: Read all about the electric radiator fan diode pack on page 214.

ACCESS TO WASHER TANK IN FENDER: Regarding the VIN 148782-on configuration, Michael Wilson says, "You have to remove the front stone guard to gain access. And trust me, it's much easier to remove the wheel to gain access!"

WASHER NOZZLES: According to Richard Mansell, the single-post windshield sprayer in the center of the air intake grille was replaced by two separate sprayers in mid-1987. These later nozzles are heated to prevent freezing. Jaguar didn't see fit to change the casting of the grille itself, so it retained a boss location in the center even though it wasn't drilled and had nothing installed in it.

Martin Hargreaves reports that the two separate sprayers changed again. "First later type has a plastic top which breaks easily when adjusting, and the hose attachment is straight (i.e. points down) and metal. This is DAC 4244. The newer type is metal at the top, and the hose attachment bends through 90 degrees and is grey plastic (possibly fitted over the original type fitting). This is DAC 6398. From my dealer DAC 6398 is UKP 28 plus VAT. Each."

Chuck Sparks says a large part of the problems with nozzles come from people using tap water in the washer system. After use, the water in the tip of the nozzle evaporates and leaves its minerals behind. In no time at all, the tiny passages are plugged. Really, folks, the \$1/gal for washer fluid is money well spent.

WASHER SYSTEM CHECK VALVES: In some XJ-S's, Jaguar used inline check valves in the lines to the nozzles. Judging from the parts catalogs, this is related to the pumps used; the early external pump had one, the early H.E. screw-in pump didn't, the later push-in pumps did again. Maybe some pump designs didn't include check valves within the pump while others did.

They're easy to test; just remove them from the line and try blowing through them in both directions. They should feel wide open in one direction, totally plugged the other way. When they quit working, the only fix is apparently to replace them. Since they will have the same effect regardless of where they are in the line, you might consider relocating them; being plastic, they don't like sunlight and they don't like engine heat.

The check valves used on the pre-H.E., GWW504, are different than the check valves used on later cars, DAC2963. A check valve is a check valve; since both items fit the same type hose and handle the same type fluid, they logically should be interchangeable. Chuck Sparks claims the early design simply falls apart after exposure to heat or sunlight, so perhaps replacing with the later item is in order.

The early system with the dipstick hose pickup in the tank also has a check valve right at the end of that pickup. It's similar to the GWW504 except one side of the housing is missing so it can pick up fluid right into the check valve itself. Of course, you should still be able to substitute check valves; having an inlet that happens to be able to connect to hose shouldn't hurt anything.

WASHER FLOW RESTRICTORS: Although not shown in the parts catalogs, John Goodman insists there are flow restrictors in the lines to the nozzles on some cars. Even if they work OK when new, they may get plugged up and too restrictive as they get older. If you find them, you might consider simply removing them. "On some cars it's under the air intake grille so isn't easily spotted."

WASHER FLUID LEVEL WARNING LIGHT: The washer systems used in VIN 148782 on with the tank in the right front fender have a level sensor that operates an idiot light on the dash, presumably because it's not practical to simply look at the tank to make sure there's enough fluid in it. Michael Wilson says, "I just spoke with my local Jaguar dealer (Barrier Motors) this morning, and they told me that you can no longer purchase the "low level" sensor alone. It is now officially listed a NA (Not Available). Now, you must buy the entire reservoir bottle with the sensor built in. It does not come with the pump motor. Apparently you can utilize the unit off the old one. The entire assembly runs a whopping \$155.00. Thats a lot of money to spend just to have an idiot light come on!"

WASHER MODIFICATIONS: John Goodman says, "Washers and wipers have improved over the years, but it was quite common in the early '80's to modify the washer systems on cars that were prone to greasy windscreens (my Jensen Healey was prone to this as the dirty air from under the bonnet would exit in front of the screen). We would take a small bore copper pipe from the washer pump and wrap it around the exhaust manifold or heater hose, connect a "T" piece with two lengths of small bore black nylon air hose routed through the body and taped to the windscreen wipers with numerous fine holes strategically directed. Add lemon juice to the washer water."

This author suggests wrapping that tube around the exhaust manifold wouldn't be good, since it would boil all the fluid away. Wrapping around a heater hose or pipe is a better idea; this would heat the fluid to near the same temp as the coolant, warm but below boiling -- and it might not heat it at all if the heater valve is closed, which would indicate a warm day. Might do wonders for clearing ice from the windshield -- or might just crack the windshield.

Light Bulbs

Light bulbs are discussed here. The taillight lenses and the like are discussed in the section on the body; see page 441.

If you can't find a bulb locally, you can order whatever bulbs you're ever likely to need from:

Lamp Technology, Inc.
1645 Sycamore Ave.
Bohemian, NY 11716-1729
1-800-KEEP-LIT
+1 (631) 561-1800 Fax: +1 (631) 567-1806
<http://www.lamptech.com>

BULB NUMBERING SCHEMES: Europe and the US use different schemes to number automotive bulbs, but a lot of the bulbs have equivalents. In Europe -- and in the Jaguar manuals -- light bulbs (and fuses) are specified by a three-digit number. Often, the manufacturer will be indicated by letters preceding the number; for example, a Unipart bulb may be number GLB 233, but it could be replaced by any bulb number 233. While the Jag manuals often indicate GLB numbers, I will endeavor to indicate only the three digit number in this book.

Here in the US, automotive light bulbs are typically packaged on cards in parts stores, clearly labelled by the US number and "12V" -- but no clue at all about what amperage or wattage they are. Sometimes, if you're real lucky, you'll find the

candlepower -- but that's only loosely related to wattage. However, the parts stores will usually have a book behind the counter that gives complete data on the various bulbs available: voltage, wattage, life rating, candlepower, filament shape, etc. The only thing the books won't tell you is the European equivalent.

Of course, I try to actually be helpful in this book, so I will endeavor to give US equivalents to the European numbers where I have been able to figure them out. Note that some of the data below includes the wattage as listed on a specification sheet, often to two decimal places; rounding is definitely in order for general use, especially since the Jag bulb charts usually don't specify wattage closer than to an even watt.

The specification sheets also give rated voltages for automotive bulbs generally between 12.5V and 14.4V. On the cards, these are all called "12V".

The Jaguar Parts Catalogue, August 1987, seems to take a more objectionable tact and lists only Jaguar part numbers for many light bulbs. There are no light bulbs in the car that were developed especially for Jaguar; all bulbs can be replaced with generic equivalents. Some that have been identified include:

Jaguar P/N	Euro equiv.	US equiv.
C9126	382	1156
C38966	286	
C43898	987	
JLM293	254	
JLM9587	207	
JLM9589	233	1893
JLM9590	239	11004
JLM9591	265	GE DE7576
JLM9592	273	
JLM9594	380	1157
JLM9598	411	H1
JLM9600	501	168
JLM9601	989	

See the specific application notes below to fill in those blanks for US equivalents.

MINIATURE BAYONET BULBS: Miniature bayonet bulbs are the flashlight-size bulbs with a cylindrical base with two pins on the sides. They are sometimes simply referred to as "bayonet" bulbs -- including in the Jaguar bulb charts -- but this is technically incorrect, since "bayonet" actually refers to the larger bulbs of similar design such as most taillight bulbs. 13-14.4V miniature bayonet bulbs available in the US include:

<u>NUMBER</u>	<u>WATTAGE</u>
756	1.12W
1813	1.44W
1892	1.73W
1815	2.8W
1891	3.36W
1889	3.78W
1816	4.29W
1893	4.62W

All of the above bulbs are bullet-shaped; the glass capsule is about the same diameter as the base. For places where space isn't a problem, there are also the following miniature bayonet bulbs with a larger spherical glass capsule:

<u>NUMBER</u>	<u>WATTAGE</u>
57	3.36W
257	3.78W
1895	3.78W
293	4.62W

The 1895's are sometimes available in colored versions.

If you visit a marine supply store, you will find an assortment of high-power miniature bayonet bulbs. In addition to reasonably-priced 12V5W bulbs, there are some atrociously high wattage bulbs with proportionately large glass capsules, up to 20 watts. There are also some halogen bulbs in 5W, 10W, 15W and 20W, some of which are a little odd-looking but they are all about the same physical size as the tiny bullet-shaped bulbs. Some of them aren't even labelled halogen, but rather labelled only for some particular application, a depth finder or something. Of course, you can tell they're halogen by the price. As a bonus, all of the bulbs sold at a marine supply store are corrosion-resistant for marine use.

FIBROOPTIC SOURCE BULB: This bulb is a miniature bayonet type. The bulb charts in the Jag manuals list a 254 or 989, depending on which book you look at, and describe it as 5 or 6 watt, again depending on which chart you believe. 254 is a festoon bulb, so that's wrong.

Note that 5 or 6 watts is high wattage indeed for a miniature bayonet; the 6 watt is higher than any in the chart above. Clearly, this particular application requires some serious light. Either the 1893 or 293 listed above probably fits the bill as 5 watts, meaning you'll get satisfactory light. If the various things lit by the fiberoptic source have always been too dim for you, though, a visit to the marine supply store may be in order; one of those 5W halogen bulbs might be just the ticket to liven up that dash. Going to much higher wattage than recommended would probably melt the fiberoptic unit housing, so don't get carried away.

SIDE MARKER BULB: In the US and some other countries, the lights on the front and rear ends of the car are required by law to be visible from off to the side of the car. The taillights on the XJ-S meet this requirement, since they wrap around the corners. The front markers are in the bumper, however, and therefore cannot be seen from the side. To meet the requirement, a separate side marker light is provided just forward of the front wheel on each side. On the SI/II/III saloons, the lights on either end don't wrap around the corners, so there are separate side markers on both ends.

The side marker on the XJ-S takes a miniature bayonet type bulb. The bulb charts in the Jag manuals list a 207 or 233, depending on which chart you look at, and describe it as 5 watt. This author's '83 was fitted with bulbs labelled 233 and 12V4W.

Several of the bulbs listed above would make suitable substitutes. If you don't really care how bright your side markers are, you can replace these bulbs with different wattage bulbs; however, you need to be concerned about whether the bulb failure sensors work properly -- see below. These side marker lamps are monitored by the same bulb failure sensors as the front parking lamps, and reduced wattage bulbs may result in bulb failure indications on the dash. If you wish, the sensors can be adjusted for the new current level.

Judging from the typical condition of the original bulbs, the corrosion resistance of marine bulbs might be helpful in these side markers.

A piece of 5/16" hose may be helpful in getting the side marker bulbs in and out.

CIGAR LIGHTER BULB: One bulb chart in the Jaguar repair manual says the miniature bayonet bulb for the cigar lighter (643) is 22 watt. I don't think so -- it should say 2.2 watt.

BAYONET BULBS: All the bulbs in the pre-1991 taillights and front turn signal housings are bayonet type, although some are single-filament and some are dual-filament. On the dual-filament bulbs, one pin on the base is positioned differently than the other to ensure you install it correctly.

REAR TURN SIGNALS, BRAKE LIGHTS: In the US, for these applications calling for the single-filament bulb number 382, use the 1156 -- very common, can be found in any auto parts store or Wal-Mart.

FRONT TURN SIGNALS: The bulb chart on page 04-3 of the ROM ©1975 calls for GLB 380, describing it as "Double filament - Italy only". It lies; it should say US/Canada only, Italy uses the single-filament 382. Among the electrical diagrams following Section 86 of the same book is another bulb chart, and this one describes the GLB 380 as 21 watts, when it should say 21/5 indicating that it is a dual-filament bulb.

In the US, for the dual-filament 380, use the 1157 -- perhaps the most common taillight bulb there is.

Another common -- and very similar-looking -- dual-filament taillight bulb in the US is the 1034. If you try to use 1034 bulbs in the XJ-S, the indicator on the dashboard may only light the first blink, or not at all, when you operate the turn signals. This is the bulb failure indication for the turn signals. Since the 1034 bulbs are lower wattage, the reduced current causes a bulb failure indication.

If you want brighter turn signals, J. C. Whitney (page 643) offers a 30/8W halogen 1157 bulb, catalog number 81xx0439B, that they claim is 50% brighter than the standard 1157.

TAILLIGHTS: In the US, for the taillights (smaller bulb on the outer corner of the taillight housing), use number 89 even though it's slightly more powerful (8W) than the 5W number 207 specified in the charts.

BULB FAILURE SENSORS: There are bulb failure sensors in the trunk up behind the lip on both sides, as well as under the right side dashboard. The ©1982 Supplement says there is only one under the dash to serve the lights on the front of the car, but it lies; there are two, one serving the front right and one serving the front left. They all look the same: a small metal box with three terminals. The current to a light goes in one terminal and out another, heating up a conductor inside. When it gets hot enough, a bimetal strip bends enough to break the third connection to the dash

indicator. This is why it takes a few seconds for the indicator to go out when you turn on the lights. If a bulb burns out, the reduced current doesn't heat the bimetal strip enough, so the indicator stays on.

If your dash indicator is staying lit for unknown reasons, the first thing to do is check that all the lights on the car are of the correct wattage; a lower-current bulb can fool the units. Then, find each unit and disconnect the indicator wires (WS) one by one until you find which unit is keeping the indicator on.

If one of the units isn't working right, they can be adjusted. There is a tiny screw on the box near the terminals, sealed with a drop of glue. When you're absolutely sure all the bulbs are working right, leave the lights on for a couple minutes. Turn the screw clockwise until the dash light comes on, then counterclockwise just until it turns off. Be careful not to touch ground with the tool used to adjust the screw.

There is a different type of failure sensor on the brake lights, but it operates the same dash indicator. With the ignition on, headlights off, handbrake applied, and the brake pedal pressed, the indicator should come on; if it does not, there's a bad circuit or bulb in the brake lights.

The indication that a turn signal bulb has failed is that the turn signal dash indicator just blinks once, or not at all, while the functional bulbs on the outside of the car continue to blink properly.

FESTOON BULBS: Festoon bulbs are the tubular bulbs with a pointed connector at each end. Here in the US, they are described as "SV8.5mm", 8.5mm being the diameter of the connector at the end. In addition to the wattage, you need to pay attention to the overall length measured from point to point. There are at least two different length festoon bulbs used in the XJ-S, 1.45" and 1.75". Sometimes festoon bulbs are clamped at the ends while other times they are held by the points; in some cases below, I mention which method is used.

BOOT LAMPS: The XJ-S used miniature bayonet bulb number 989 in the trunk up to 1982. From 1982 on it used festoon bulb number 239 (5W). The overall length of this bulb is 1.45". In the US, 11004 is a perfect replacement.

Note that the 1982-87 Hella boot lamp assemblies are not symmetrical, although they appear to be at first; the bulb itself is held closer to one side of the lens than the other. The lamp should be installed so that the bulb is held farthest away from the center of the trunk. This fixture holds the bulb by the points.

From 1987 on, the same lamp assemblies were used in the boot as in the interior.

INTERIOR LAMPS: The Jag bulb charts say the interior lights are either number 272 (10W) for early cars and 254 (6W) for later cars. Other sources offer 265 for cars up to VIN 100349 and 239 for VIN 100350 onward, corresponding to a change in the fixture itself. 265 is apparently 1.75" long, while 239 (the same bulbs as the boot lights '82-on) is a 5W bulb 1.45" long.

If you have an earlier car with 1.75" bulbs and want 10W replacements, you can buy GE bulb number DE7576. There are also bulb numbers 211 or 212 that will physically fit, but the wattage is unknown. 211 bulbs are also available in pretty colors, if you want to get tricky. 10W 1.75" festoon bulbs are also available in marine supply stores.

If you have the later fixtures and a 5W bulb will do, the 11004 will work. If you want to try a 10W, there is also a 11005 available -- but you might want to keep an eye on them that they don't melt the fixture.

The later lamps (all four corners of the interior use the same fixture) clamp onto the ends of the bulbs.

ROOF LAMP: The bulb in the roof lamp is supposed to be 10W, and is 1.75" long. The Jag bulb charts seem to leave the number column blank, but other sources suggest number 265 here. This atrociously expensive Hella fixture holds the bulb by the points. The GE bulb number DE7576 is a perfect replacement.

BACK-UP LAMPS: The books say the bulbs in the back-up lights are number 273, 21W. You can also find similar bulbs in 18W; close enough, especially if you replace both together. These festoon bulbs have a total length of 1.75". The glass portion itself is also much larger in diameter than the connectors, giving it a bulged look.

Either the 18W or 21W bulbs are hard to find in the US; you will probably need to find a place that specializes in import light bulbs. One alternative is the marine supply stores, which carry a 15W bulb the same shape and size. Or, you could substitute the non-bulged 10W 1.75" bulbs commonly available and call it a day.

LICENSE PLATE LAMPS: The license plate lights require festoon bulbs 1.45" long. The Jag bulb charts call for a 254 (6W), but other sources offer the 239 (5W) for this application. If 5W is acceptable, the 11004 bulb will serve. You can go up to the 10W 11005, but I'm betting you'll melt the lens.

CAPLESS BULBS: What the Europeans call a capless bulb is called a wedge bulb in the US. Capless bulbs have no base at all; the bottom of the glass capsule itself is formed into a flat edge and the wire conductors coming out of the capsule are wrapped around the edge.

The following is a chart of some US wedge bulbs, 13-14.4V:

<u>NUMBER</u>	<u>WATTAGE</u>
658	1.12W
160	2.66W (long life)
161	2.66W
158	3.36W
184	3.46W
124	3.78W
194	3.78W
196	3.78W
558	4.29W
192	4.29W
193	4.62W
168	4.90W
175	8.12W

Numbers 168 and 194 seem to be the most readily available.

The auto parts stores also carry a halogen capless bulb that will fit into the same socket. The number is 2040, but as usual there's no clue about the wattage on the package.

PUDDLE LIGHTS: The door edge lamps, also known as puddle lamps, are a 5W capless. They're not even listed in the bulb charts in the Jag books, but the Haynes manual says it's number 501. US number 168 is perfect.

The access is kinda neat; you remove one screw from the bottom, then slide the lens off rearward.

INSTRUMENT PANEL LIGHTS: The instrument panel illumination lamps are supposed to be a capless 2.2W, number 987. In the US, finding a 161 would be good, 160 would be better. Or, you could try something with higher wattage and hope nothing melts or burns up in there.

INSTRUMENT PANEL ILLUMINATION IMPROVEMENT: John Napoli suggests you disassemble the pod, and clean all the dust out of the warning light boxes and the like. "If you also want to improve lighting, remove the four green lenses. The instruments will be that much more brightly lit at night. You can probably also fit brighter bulbs, if you so desire."

Gordon Clefton made a less radical fix than simply removing the green lenses. "I removed each green lens (two screws), drilled five holes into the plastic, cleaned the plastic, and then replaced the green lens. The pattern was one hole at the end and four holes around the side. I am pleased with the results; the panel still has the Jaguar green glow, but all the instruments are very readable."

Another method for making lights brighter would be to improve reflectivity. White paint helps, Liquid Paper works well, or you can apply small pieces of aluminum tape. For the illumination of the big gauges, there is an easy reflectivity improvement that can be made. The cowling around these two gauges, just outside the face itself as you're looking at it, is a single piece of white plastic that has been painted a dark grey on the surfaces that show. The reason they didn't just make it out of dark grey plastic is because the back side of this part that doesn't show is supposed to be white to reflect the light from the green-lensed illumination bulbs. Unfortunately, someone in the paint shop must not have understood this too well, because large areas of the back side of this part may be painted dark grey as well. So, take a piece of sandpaper and remove the dark grey paint from the back side, especially on the bevelled section surrounding the gauge. Or, if it's easier, you could just paint over it with white paint.

Keith Morris says, "If you will notice there is a cutout on the back plane of the large gauges that can accept another green lens and bulb setup. I obtained these extra lamps at my local Jaguar dealer and added them. They simply plug in - the electrical connections are present in the circuit sheet. The gauges are now brighter." This author's '83 has no such openings for additional bulbs, but Bob Gallivan says his '84 "has 3 extra holes for the lights."

Walter Acker IV, who has an early car, found an even more extreme method of getting better instrument illumination. He found a light bulb that is physically larger than the original, yet fits in the same socket. "The new bulb is #921, but you will be able to install the new bulb from the front only. The new bulb is too big to insert from the back, but can be installed from the front if you make sure to hold the sockets from the back with your finger to keep the bulb socket from pushing out the back.

"I found that the sockets pull on the copper part of the plastic board. When you have the plastic off of the back half of the dash cluster, if you chamfer the ends of the holes where the socket goes in very carefully you can reduce the pulling effect on the copper part of the plastic circuit board."

THIRD BRAKE LIGHT BULB REPLACEMENT: It may not be obvious at first, so John Himes sends this description for getting to the bulbs: "Feel or look on the underside of the cover; there are 2 black indentations on each side of the cover. Place your fingers on each of these, or you can also do one at a time. Press up on the indentation which is a sprung black square button that keeps the cover from rattling off. After you remove the cover, you have access to the bulbs. They are in gray plastic holders that you turn 1/2 turn to release."

THIRD BRAKE LIGHT RE-INSTALLATION: Apparently the things fall off. And apparently most glues don't work very well for putting it back on. Ray Schmitt says, "'GOOP' worked for me in that application. It's clear like silicon but stickier and sets up firmer. I had "Marine GOOP" on hand but I think the other types are much the same. Available at most hardware stores."

John Kjallberg says, "Try some window stop leak, silicone windshield and glass seal; this is flowable so look out for drips. You will have to support it for a day. I had no luck with other fixes."

INDICATOR LIGHT BULBS: The tiny bulbs used in the row of indicator lights at the top of the dashboard are "miniature capless", similar to capless but a bunch smaller. 14V versions are available at auto parts stores in the US in several different wattages:

<u>NUMBER</u>	<u>WATTAGE</u>
18	0.56W
73	1.12W
37	1.26W
74	1.4W
70	2.1W

Since the Jaguar bulb chart calls for a 1.2W, numbers 37 or 74 should make good substitutes -- but you also might consider varying the wattage bulb for your own preferences, like making the oil warning light real bright, less important lights dimmer, and the turn signals real bright so you can see them at all!

To get these bulbs in and out, it helps to have a pair of hemostats (a "roach clip" to you 70's potheads) with electrical tape wrapped around the jaws.

TRIP COMPUTER SCREEN ILLUMINATION BULB: Robert Weiss-Malik found a replacement for the tiny light bulb that lights up the indicator screen on the trip computer: "I am happy to report that the bulb that I found at Radio Shack works just fine (so far anyways). The Radio Shack bulb is called a "bi-pin lamp". It is rated at 12 volts and 55mA. The part number is 272-1154."

Headlights

BRIGHTNESS: Jon Jackson and others point out that dim headlights may be the result of bad grounds. "On my '87 there is a ground under the hood to the left side of the radiator. There are several ground wires that go to this same point. Cleaned it up a bit and all is great."

HEADLIGHT TYPES: There were at least five distinct headlight schemes used on the Jaguar XJ-S over the course of its production life -- not including the fact that there were both LHD and RHD versions of many of these, if not all. In the US, four round headlights were used up through 1991, and oblong Carello headlights with plastic lenses were used from 1992 on. In Europe and most other markets, the XJ-S has been fitted with oblong headlights since its introduction -- but there were three different versions: Cibies with glass lenses and two bulbs per unit on the early models, Cibies with glass lenses and a single bulb per unit throughout the 80's, and finally switching to an E-code Carellos with plastic lenses at the same time the US cars switched to DOT-approved Carellos for 1992.

If you need to replace a headlight bulb, the Jaguar repair manual and the Haynes manual are both worthless; their bulb charts are all screwed up on headlights. In the sections on each type of headlight beginning on page 598, this book will tell you not only what type replacement bulbs are called for but also what substitutions and upgrades you might wish to consider.

HEADLIGHT REPLACEMENT: If you have the four round sealed beam headlights, obviously you are supposed to remove the faulty unit and replace it in entirety. In all four of the oblong headlight designs, however, correcting a burnt

bulb means replacing a relatively small globe plugged into the back side of the reflector. On the pre-90's non-US cars with Cibie units this was a real pain because the entire headlight assembly had to be yanked out of the car in order to get to the bulbs. However, according to John Goodman, Jaguar addressed this sometime in the early 90's: "I just changed the front aluminium splash guards in the wheel arch behind the headlights. The part has been modified from the original one, it now has a removable access panel (which can be removed with the splash guard installed) to enable easy change of the headlight bulbs."

If you want easier access to the back of your Cibies, you can order the updated panels; "I just ordered one for a '89 XJ-S. I thought the parts guy had goofed, but he assured me this supersedes the old type." Unfortunately, this might not get you anywhere, since there is a stiffening panel behind the headlight and ahead of this wheelwell panel, and you might have to cut a hole in it to get to the bulb from behind. Goodman elaborates: "There is another "panel" behind the headlight, but this must be revised as well on later cars! It has a hand-sized hole stamped in it with turned over edge, either for strength or to avoid cutting one's wrist while removing the bulb holder. It is quite easy to fumble about and change the bulb if the wheel is turned in."

HEADLIGHTS USING REPLACEABLE BULBS: Whether your car takes H1's, H4's, or 9004's, keep your grimy paws off those little halogen bulbs. The oil from your fingers on the surface of the quartz capsule insulates it and prevents it from dissipating heat as it should. The result is that the bulb burns out very quickly, whereas normally these halogen bulbs will last considerably longer than a conventional sealed beam. If you accidentally finger the glass, clean the surface with some alcohol before installing.

There is one significant concern of headlight assemblies with replaceable bulbs: the owner may simply replace the bulb whenever it burns out, and neglect to notice when the housing itself is deteriorating, the reflector gets all rusty, or the lens gets broken. Since the reflector and the lens are critical to proper illumination, the conscientious owner will replace the housings whenever the performance is adversely affected.

PILOT LIGHTS: "Pilot" is UK-speak for the small bulbs within the headlight assemblies that are used to make the headlights glow when the headlights are not on. In the US, old VW Beetles used to have them, and many cars with the new composite headlamps have something similar. Daniel Stern says, "In most of the world, they're called "city lights". In the UK, they're referred to as "sidelights" (which is confusing, because they face *front*, not to the side.) This is the European equivalent of the US "parking" lamp. European-specs vehicles do not use amber parking lamps, but rather use white city lights."

The Jaguar repair manual variously describes their pilot bulbs as no. 15602, 4 watt, Osram miniature bayonet, or 223, or 233, depending on whose misprint you believe. This sounds the same as the side marker bulbs 233 (see page 583), but I haven't seen them personally and don't trust any of this literature any more, check the actual bulb itself before buying.

Vince Chrzanowski (who is using the Euro-spec Cibie headlights in North America) says "The pilot lamps I use are #1893. I use them in all my radio 12-volt applications because of their long-life rating."

Daniel Stern: "Note that city lights *are* a legal form of parking lamp in the USA and Canada. Parking lamps can be amber *or* white, and they are permitted to be nested with the headlamps. The latest XJ sedans use city lights rather than amber parking lamps."

Stern offers several advantages of city lights over the US-style parking lights: "If a headlamp ever malfunctions, oncoming traffic still sees you as a double-track vehicle. Plus, it makes your front turn signals much clearer because they now go "bright-off-bright-off" instead of "bright-dim-bright-dim" when the lights are on. Yep, another aspect of lighting that the Europeans got right and we didn't. City lights are especially useful if you have fog lamps. On foggy days, you can put on the city lights which will show other drivers very clearly where your car is, and switch on the fog lamps so you can see."

PROTECTING HEADLIGHT LENSES: If you have the Cibie glass headlights and don't like the idea of paying Jaguar for new ones, Griot's Garage (page 661) offers a way to protect them. It's a clear layer of vinyl that you peel-and-stick to the front of the lens and then trim around the edges. This is likely to be very effective, since even the slightest cushioning is likely to prevent most stones and the like from damaging the glass.

Griot's also sells a thinner version for fog lights and turn signal lenses, but claims the product is not for use on polycarbonate lenses. That leaves owners of the Carello lights out in the cold.

HEADLIGHT WIRING: The headlight and fog light wiring diagram on page 86-11 in the ©1982 Supplement contains just enough miscues to make it really difficult to follow. Mark the following to make it a little better:

- On the key, items 20 and 21 are the fog lamps at the front, and items 22 and 23 are the rear fog guard lamps. They could have been drawn more clearly, too, either showing the lamps or not rather than showing some and showing arrows to others. 20 and 21 should look like a matched pair, and so should 22 and 23.
- On the pre-1992 US-spec car, there are two LH main beams and two RH main beams, so items 8 and 10 should be doubled. This is not true for cars with oblong headlamps, however.
- There should be a capacitor shown wired between terminals 31b and 81a on the headlamp relay, item 4.
- On the US-spec car, the rear fog guard lamps, items 22 and 23, don't exist.
- On the author's 1983 US-spec car, the fog lamp switch, item 18, doesn't exist.

Note that the lack of a fog lamp switch makes it impossible to operate the front fog lights. Also, putting the headlamp switch into the #3 position (see below) activates the inhibit relay and therefore locks the headlights on low beam, but the power sent to the rear fog lights does nothing -- they don't exist. Sorry to report, this is not just an error in the schematics; this author's car was actually wired that way, and although it had front fog lamps from the factory there was no way to turn them on. It is, however, a fairly simple matter to move the RY wire from fuse #1 to fuse #6 to get the front fog lights to work when the headlamp switch is put into the #3 position. Be sure to leave the existing RU wire on fuse 6 to operate the dash indicator.

For owners of the US-spec car, **Figure 35** is a replacement for the diagram, based on the author's 1983 H.E.

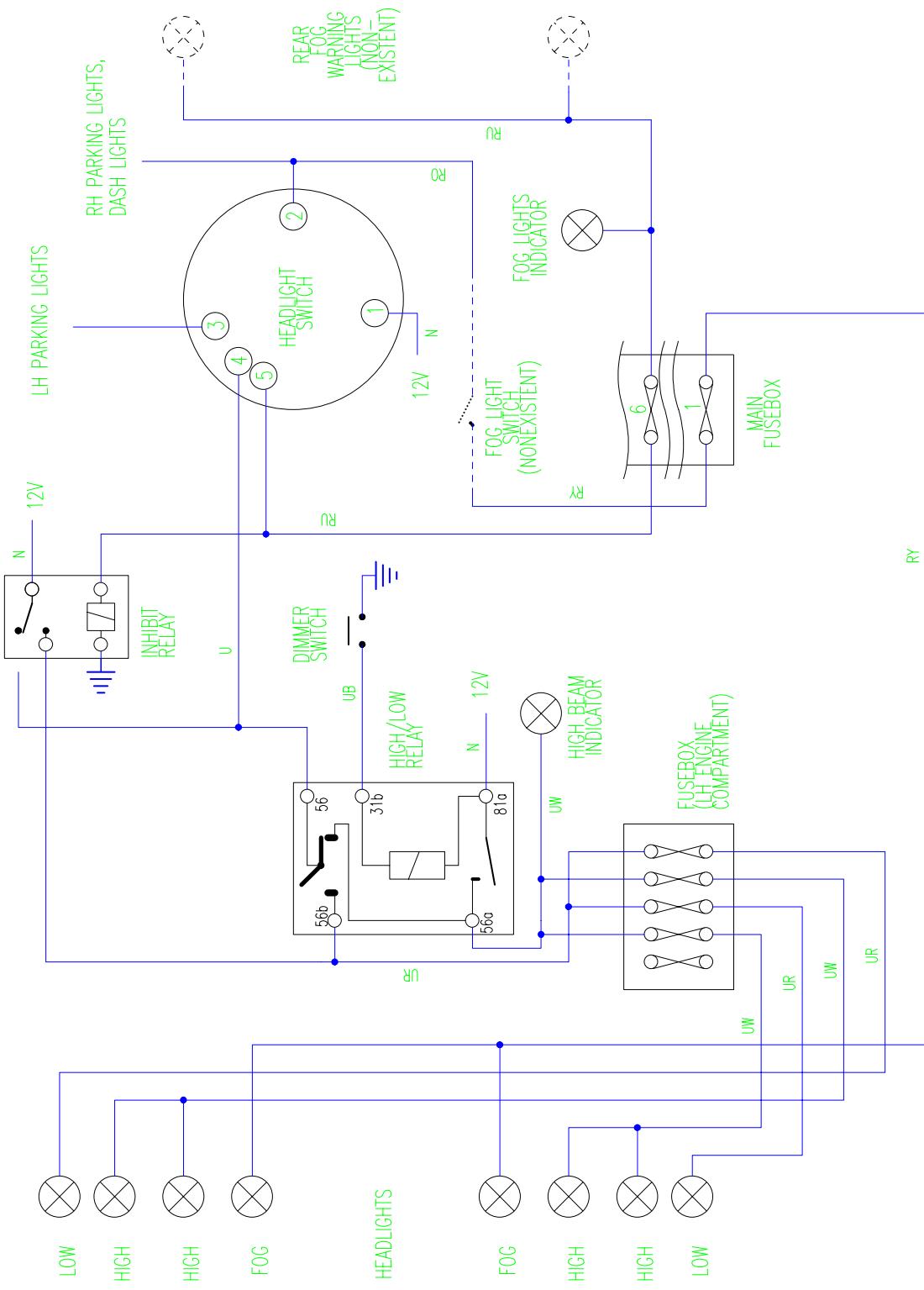


Figure 35 - Headlight and Fog Light Wiring

The headlight switch in the US-spec 1983 H.E. has five positions, three above and one below the off position. To get into the top or bottom position requires pushing the knob in while turning. The connections made in the positions are as follows:

- 3: 1-2-3-5
- 2: 1-2-3-4
- 1: 1-2-3
- 0: No connection
- 1: 1-2

The -1 position, connecting only the dash lights and right side parking lights, apparently serves no intended purpose; as wired, all the parking lights come on due to backfeed through the bulb failure sensors. After a few seconds for the bulb failure sensors to warm up, the left side parking lights dim. If an owner wished, however, it would be a simple matter to rewire the right side parking lights to terminal 3 and use the -1 position to operate the dash lights only.

Other headlight switches are different, however. John Himes says that on his US-spec '88 the positions are:

- Off
- Parking lights only
- Headlights
- Headlights & fogs
- Fogs only

John Goodman reports "On UK cars the fog/driving lights are operated on the rotary dash light switch.

- 1= side/park
- 2= headlights
- 3= head & fog/driving lights
- 4= side/park & only fog/driving lights

...and there is a push facility that works when in position 2-4 for the rear fog warning lights fitted in the rear bumpers."

HEADLIGHT SWITCH KNOB REMOVAL: To remove the headlight switch knob, you must depress a button in the shaft that is behind the surface of the dashboard and points down. To reinstall, you merely need to push the knob on, because it is shaped to slide over the shaft button and snap in place.

HIGH/LOW BEAM RELAY: Also known as the main/dip relay. In some manuals, the schematics of the high/low beam relay (Jaguar part no. C38616) show the components between connections 56, 56a, and 56b to be a normal set of relay contacts. This is *not* actually the case. This device is an electrically-operated rocker switch; when the coil is energized, the contact is switched from one side to the other, and remains there when the coil is de-energized. Next time it's energized, it flips back. Jaguar wants some serious \$\$\$ for that relay.

Roger Homer reports that other cars use a similar relay. "The Headlight Relay is the same as the one on an early model Torana (General Motors Aust). They used the same high/low switching system, the relay I found is made by SWF (Germany?) part no stamped on relay is R200.867."

Ray Reynolds provides another report: "I found a compatible unit that dropped right in. I had to drill an extra mounting hole in the fenderwell to bolt the new relay in, but all the connectors plugged right in, and it all fit under the stock relay housing (with a little bending around of the headlight wires). The relay itself looks like a Potter & Brumfield, and was part #PBS89R from Micro Alarm (in Vernon, CA). It has 2 microswitches on top that do the actual power switching." Reynolds notes that this relay does not provide the pull-to-flash feature the stock relay does, but it would be easy enough to add a normal relay with the coils wired in parallel to provide this function. "Since the plunger is visible, you might be able to bolt another microswitch to the bottom of the relay so that it is activated when the relay is tripped for the flash feature."

If your high/low relay has given up the ghost and you can't find a reasonably-priced replacement, an alternate scheme using three conventional relays and a diode is shown in **Figure 36**. Note that wiring (and related contacts) indicated by heavy (red) lines must be suitable for headlight current, 30 amps or so. All other circuits are less than 3 amp. For the diode, a Radio Shack cat. no. 276-1661 will do nicely. Of course, you will need to figure out where to mount these relays; perhaps in the space behind the left headlights.

As with any such circuit, a single multi-contact relay may be replaced by multiple single-contact relays by simply wiring the coils together. This may make sense here, allowing the use of SPDT 30-amp relays along with tiny "ice cube" DPDT relays instead of trying to locate DPDT or 3PDT 30-amp relays.

The only functional difference with this circuit from the original is that your headlights will always be on low beam when you first turn them on.

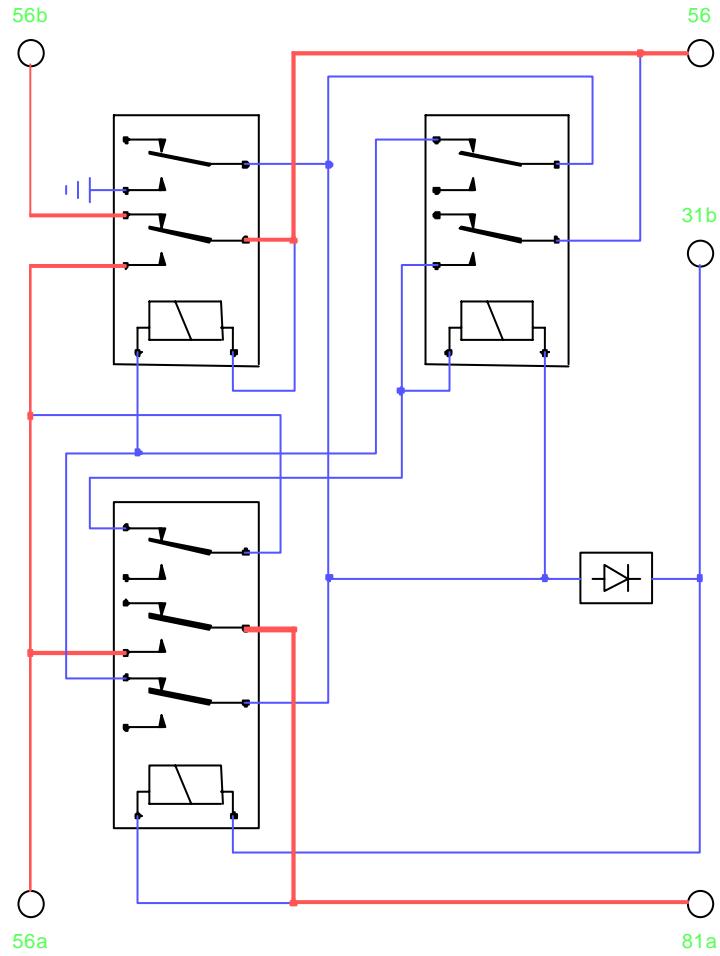


Figure 36 - High/Low Relay Replacement Scheme

HEADLIGHT BUZZER: The XJ-S doesn't have one! What a cheap car. To add one is easy. You need a 12 volt buzzer such as catalog no. 273-055 from Radio Shack, and a rectifier (or diode) such as catalog no. 276-1661. For the buzzer you can also use any buzzer you've ripped out of a car, such as those pesky seat belt buzzers.

Connect one of the headlight wires to one end of the rectifier. Connect the other end of the rectifier to one lead of the buzzer. Connect the other lead of the buzzer to one of the ignition wires. Both of these wires are near each other under the dashboard -- from the headlight switch and the ignition switch.

A rectifier allows current to flow in only one direction. If you have wired it correctly, when both the ignition and the headlights are on, there is no current flow because both wires are at 12 volts. When the ignition alone is on, there is no

flow because the rectifier stops it from flowing that way. When the headlights are on but the ignition is off, current flows and the buzzer buzzes. If the buzzer buzzes when the ignition is on and the headlights are off, reverse the rectifier.

Jan Wikström did it a different way: "Pulling the key out also operates the switch that controls seat belt warning etc. As my car doesn't have those, I've used it to operate a "headlights on" warning buzzer."

Connie Vloutely says, "I have been wanting to do this for a long time but could not find chime element suitable for automotive use. One that works on 12 Volt DC. I hate buzzers. I found one in the local radio shack store P/N RS-273-071."

HEADLIGHT UPGRADES: When you're driving your Jag down some desolate two-lane blacktop road at 140 mph on a moonless night, it's helpful to be able to see where you're going. Unfortunately, not all headlight systems are up to the task. If you have the US-spec four round headlights with the original sealed beam units in place, I suggest you slow down.

Even if you obey all posted speed limits, you will be amazed at what an adequate set of headlights will do for the pleasure and enjoyment of nighttime motoring. Where you used to have to squint and stare in hopes of seeing things in time to avoid hitting them, you can now sit back and relax. In fact, you may come to fully appreciate the advantages of nighttime driving, with the reduced traffic and cooler temperatures.

RELAY INSTALLATION: If you wish to improve the headlights on your car, the *first* thing you should do is install a set of control relays. This will improve the light output of the stock headlights, whatever type they are, and may just satisfy your need for better light -- and is a perfectly legal modification. If you decide to replace your headlights with something with higher wattage (as suggested on pages 602, 604, and 605) you will *not* be happy with the results unless you install control relays; the additional losses in the stock wiring due to the increased current flow will rob you of any increase in light output.

The whole idea of installing relays is to get as much of the battery/alternator voltage to the headlights as possible, since a small reduction in voltage makes a big reduction in light output on incandescent lights. Low voltage also causes incandescent lights to appear yellowish, which diminishes visibility even more.

Your objective, therefore, is to provide wiring that gets the power from the battery/alternator to the headlights with big fat wires and as directly as possible. Unfortunately, that wasn't the objective of the guy who designed the wiring for your car; his objective was to provide wiring as simply and cheaply as possible, and sized just big enough to keep it from melting. So, the stock wiring goes from the bus on the firewall down to under the dash, through the headlight switch, back to the front left corner of the car, through the main/dip relay and the headlight fusebox, then out to the four headlights -- all with wires that are barely adequate for the sorry headlights that came with the car.

A simple confirmation of the problem is to remove the headlights from their mounts while leaving them connected, start the engine, turn on the headlights and measure the voltage right at the connections on the back of the bulbs. The voltage there should be within a half a volt or so of the voltage measured between the terminal on the firewall and the chassis under the same conditions (headlights on, engine idling). If the voltage is much lower, the installation of relays will help the light output considerably. If you'd like to confirm where the losses actually occur, measure between different points along the line, starting with the terminal on the firewall and including both ends of each fuse in the headlight fusebox as well as the terminals on the headlights. If you measure the voltage between the terminal on the firewall and the power connector on the headlight, you will be measuring the *total* loss of the wiring system except for the ground circuits. You can also measure parts of this loss, such as between the fuse and the headlight, between the firewall terminal and the fuse, even across the fuse itself. If you measure the voltage between the ground connector on the headlight and the chassis of the car, you will be measuring the losses in the ground wiring (which are significant -- the ground wiring is inadequate, too).

If your voltage losses are too high, the solution is to disconnect the wires from the headlights and connect them to the coils of relays, run a massive power wire from the terminal on the firewall to the common contacts on the relays, and run substantial wires (with suitable fuses) from the contacts on the relays to the headlights. Thus you operate only these new

relays with the original wiring, switch, and main/dip relay, and the serious current for the headlights themselves takes a much more direct route from the battery/alternator through the contacts in the new relays straight to the bulbs.

This mod only requires the locating of relays and running a serious cable from the terminal on the firewall to wherever the relays are; this author used a 4 gauge, but a 6 gauge cable would actually be enough. The relays should be mounted somewhere near the headlights to minimize wire length; perhaps within the boxes directly behind the headlights themselves. John Napoli suggests a big fuse in that cable, since the relays are likely to be located out at the front corner of the car and may be shorted by a relatively minor collision, and the shorting of such a major cable may cause serious problems.

Technically, you can do this whole job with only two relays, one for low beam and one for high beam, but it may be preferable to use two for high beam to keep from overloading the contacts on a standard 30-amp relay. Note that simply wiring two relays in parallel may not have the desired effect of doubling the contact capacity, since one will always close a millisecond before the other and thereby take all of the arcing load. A much better idea is to separate the wiring to the high beams and have each relay handle half the headlights. That way, each relay will only see half as much load, and if one circuit fails it only kills half your high beams rather than all of them.

Of course, you'll probably want to install a relay for the fog/driving lights as well.

Having four individual fuses on circuits that operate nothing but relays is definitely overkill. On the XJ-S, it makes more sense to continue to use the existing headlamp fusebox to serve the headlights themselves, so the relays should be wired into the circuits *before* the fuses. On the '83, the headlamp fusebox can be fiddled with by drilling out the two rivets that attach the mounting bracket to the fenderwell. The bracket isn't welded to the flange on the edge of the engine compartment, just folded over it. Removing the rivets allows the bracket to be lifted away, which in turn allows the fusebox itself to be turned over and the wiring rearranged. You can reinstall the bracket with a couple of screws, making it easy to work on in the future. Later cars have all sorts of variations in the fusebox in this area, but any of them can be altered as necessary.

Tip for those with the 4-headlight system: The existing wiring from the fusebox to the high beams on each side of the car is inadequate for both high beams, but it's good enough for one. So, one possibility is to run a new wire (about 12 gauge) to each side of the car with a new inline fuse for one of these high beams and reuse the existing wiring and fuse holder for the other high beam. The small wire from the 3-prong connector right behind the headlights to the headlight that's getting a new wire should be tied back into the other headlight at the socket, so that both of these skinny little wires are serving one headlight.

This type of reconnection requires popping the spade terminal out of the headlight socket, soldering the second wire to it, and snapping it back into the socket. Each spade terminal has a little tang on the back that holds it into the socket, so you need to insert a pointy object between the plastic and the terminal itself to depress this tang to remove the terminal. You will also want to bend this tang back into position before pushing the terminal back into the socket, so it securely snaps into place.

Of course, when done changing which fuse serves which headlamp you will probably need to revise the fuse sizes in the headlamp fusebox. It's easy enough to divide the wattage of each headlight by 12 volts to determine the amps that it will draw, and install a fuse suitably sized to serve.

On the other hand, it might be easier to forget all that fiddling with the original fusebox and wiring and simply remove the fusebox in entirety and throw it away and run wires directly from the relays to the headlights with inline fuses, and install an inline fuse for the electric fan. If your car is old enough to have the round tube fuses, this isn't a bad idea; those things make lousy connections and are always corroding and getting intermittent. The later style fuseboxes with the plastic blade-type fuses are better. You could, of course, install a generic blade-type fusebox that serves all your new headlight and fan wiring for a neat installation.

Be sure to provide adequate ground wires on the headlights as well. That's easy to do, by either adding additional wires or just replacing the ground wires entirely and connecting the new wires to a screw into the chassis, of which there are several handy right around the headlights.

While relay installation may involve a couple hours of fiddling, it is a very cost-effective improvement. The relays themselves typically cost less than five bucks each, and wire and fuses are also cheap.

RELAY INSTALLATION -- SIMPLER VERSION: Mark Barker provides a simpler method of improving the power supply to headlights on his web site. Rather than using separate main and dip beam relays as described above, Barker installs a single relay in the wiring to the OEM main/dip beam relay. "Unplug the thick blue wire in the middle of the dip/high relay. This now goes to one of the new relay's coil tags; the light switch only has to operate this relay now. Thick brown wire all the way from the main bus on the firewall, (under 14mm AF nut, using a ring tag) to one of the new relay's closing contact tags. Another short piece of brown wire from the new relay's other closing contact to the exposed tag of the dip/high beam relay the blue wire came from, using the appropriate crimps. Finally, a piece of black wire from the other coil tag to a nearby earth, using a ring tag." Ed. note: actually, you might want to make that short piece of brown wire a short piece of blue wire to keep the color coding consistent.

This single-relay method is clearly simpler to implement than the multiple-relay method described above. Both methods eliminate routing the heavy headlight current through the headlight switch on the dash and out to the front of the car through the OEM wires, which is the portion of the circuitry where the lion's share of the voltage loss occurs. The single-relay method continues to run the heavy current through the OEM main/dip relay and all the OEM wiring to the headlights beyond that, which unfortunately is still pretty skinny. Also, there's no convenient way to divide the load for two relays, so if the total headlight load approaches or exceeds 30A it would be a good idea to find a relay that's rated for higher current. Altogether, this option might be advisable only for those who want full power to stock headlights, while those intending to install high-wattage bulbs (especially four of them!) might be better advised to use the multiple-relay scheme above.

The single relay only closes once when the headlights are turned on, so the relay itself may last longer than the ones in the multiple-relay scheme that open and close whenever the driver switches from main to dip beam and back. The main/dip relay costs a *lot* more than a couple more generic relays, though, so the multiple-relay scheme may be cheaper in the long run due to increasing the life of the main/dip relay -- especially if high-wattage bulbs are used that exceed the rating of the main/dip relay contacts.

SO YOU ALREADY HAVE RELAYS: Sometime in the early 90's Jaguar got wise and provided headlight relays from the factory. If you own such a car, you don't have to worry about the headlight wiring. Right?

Maybe not. As discussed above, the purpose of installing relays is to provide the most direct connection to the battery/alternator possible using heavy wires to minimize voltage losses. The Jaguar factory relays may take the long routes through the dash switch out of the circuit, but that doesn't mean they're using adequate size wire. Daniel Stern says, "I have yet to encounter the vehicle with truly *adequate* wiring from the factory. Best I've seen is "passable", and that is rare."

Wires to individual headlights should be 12 gauge, and wires that power two or more headlights should be 10 gauge or larger. Before you decide your wiring is fine, you might want to check what gauge wire Jaguar decided to connect those relays up with. If the wires from the main bus to the relay contacts and on to the headlights themselves is still the 18 gauge stuff they use for nearly everything else, there is room for improvement there. You can either rip that stuff out and install adequate wire in its place, or you can simply add wires in parallel to the existing wires. And don't forget the ground wires to the headlights.

Such work is likely to help the stock headlights considerably, but it is even more important if you decide to install high-wattage headlights.

UPGRADING HEADLIGHTS -- LEGAL CONCERNS (US): Before considering any headlight upgrades, it might help to know a little about the evolution of headlight laws here in the US. David Berman says, "In the 1920s and 1930s cars did not have sealed beams, they had headlamps with reflectors, lenses and replaceable bulbs similar to today. However, they had a serious problem with oxidation of the reflectors which dimmed the lights, and no amount of bulb replacement (which US drivers did regularly!) would help. Sealed beams were standardized in the US in 1939 and solved the problem entirely by eliminating the opportunity for reflectors to oxidize. They were such an improvement that sealed beam retrofit kits were made for earlier cars, even for the Ford Model A which had gone out of production in 1931."

By the 1950's and 60's, laws had been established requiring all cars in the US to have one of two types of sealed beam headlight systems: two 7" round headlights or four 5 $\frac{3}{4}$ " round headlights. It was this requirement that ruined the appearance of the Jaguar XJ6/XJ12, designed to have two 7" bulbs plus two 5 $\frac{3}{4}$ "; for the US market, the two 7" had to be replaced with 5 $\frac{3}{4}$ " with a filler ring around them. It also is the reason the early US-spec XJ-S has two round headlights on each side instead of the "Euro-style" oblong single lamp assemblies.

DOT also limited the light output of headlights on both high and low beam. The headlights also had to have three little bumps on the front, used to check alignment. On top of all this were general prohibitions on more than four headlights or six head/auxiliary lights on a car.

Sometime in the 60's they prohibited glass covers over the headlights. This changed the appearance of the Jaguar E-type and the Volkswagen Beetle.

In the early 70's, they added two arrangements of rectangular sealed beam headlight systems to the approved list.

With the advent of energy conservation concerns, the automotive manufacturers were finally able to convince US legislators in the mid 1980's to drop the requirements for using standardized sealed beam headlights and permit the use of "composite" headlight assemblies in the name of better aerodynamics. These headlights have a lens/reflector assembly that was custom-designed for the car (and usually atrociously expensive), and the bulb itself is a smaller quartz-halogen item that plugs into the reflector from the rear. Berman: "Given the serious reflector problems in the 1930's and the dramatic improvement wrought by sealed beams, you could hardly blame the DOT for taking a long time to be convinced that the proposed new generation of reflectors wouldn't become oxidized and therefore the sealed beam requirement could be lifted."

Unfortunately, apparently the US DOT couldn't be convinced to legalize the *same* composite headlights that had been successfully used in Europe and everywhere else in the world for decades, so the US-spec cars got their own style of composite headlights. To this day, to be fully legal in the US, your headlight lenses need to say "DOT" on them. And most US-spec headlights seem to still have three little bumps for alignment even when the front of the headlight is sloped so some bumps are actually rearward from others. There are still limits on light output.

I dunno what DOT's priorities are, but it's obvious that they don't include providing good visibility at night or in rain. Not to put too fine a point on it, DOT-spec headlights *suck*. And just to show that this is not a "grass is greener" thing where everyone thinks people somewhere else have it better, John Warr from the UK says, "You guys in the US have to drive with the *most* appalling lights I have ever come across. To someone used to Euro lights, the first experience of US lights at night in the rain results in a puzzled driver standing in front of his hire car trying to work out what he has not turned on."

E-CODE: While the US DOT conspires to keep drivers in the dark, the European standards for headlights have evolved based on input from major headlight and driving light manufacturers in an attempt to provide truly excellent lighting. Headlights meeting these "E-code" standards are indicated with a capital letter E and a number with a circle around it on the lens. According to Daniel Stern, the number indicates the country in which the headlight was certified to meet the code.

There are E-code headlights designed to replace any standard sealed beam used in the US, and they always seem to have a distinctive pattern on the lens: there is a trapezoidal area between the center of the lens and the edge on the driver's side, with the fluting at an angle. These lights have a distinctive pattern on dip beam, sending light down to both sides and up towards the side of the road but *not* up towards oncoming traffic.

Stern maintains a site on the WWW that, among other things, describes the advantages of E-code headlights over DOT headlights in considerable detail:

<http://lighting.mbz.org/tech>

Before jumping in and upgrading your headlight system, you might want to check the regulations in your state. Or, you might wanna simply note how few citations are handed out annually for illegal E-code headlight assemblies and decide whether or not you wanna chance it. Stern says, "The fact of the matter is that back in the '70s when all cars had

sealed beams, E-code lamps stuck out like sore thumbs. But today, with the proliferation of so many different headlamp designs, together with the elimination of headlamp inspections in at least 48 states, nobody knows or cares what kind of headlamps you're running." So, what's the bigger risk to *you*: getting a ticket, or being unable to see where you're going after sunset?

Stern also notes: "If you live in the US states of Oregon, Washington, Alaska or Massachusetts, or in the great nation of Canada, then E-code lamps are 100 percent legal."

Note that many of the "H4 headlights" sold by J. C. Whitney (page 643) are actually low-end E-code units and are described as "for off-road use." That is how they can sell headlights that are technically prohibited on public highways in the US; why the upper left cutoff on low beam would be helpful in an off-road application is never explained.

There are a couple other tricks that have been used; when "sealed beam" headlights were required, J. C. Whitney sold some "sealed beam H4" headlights; the rubber boot had been glued on over the bulb socket making the whole thing sealed. When the H4 bulb burned out, you just cut the boot away and put in a new bulb.

LEGAL CONCERNS -- JAPAN: The author is no expert on Japanese automobile regulation, but it is clear that there are some legal issues involving headlights. According to the H.E. Parts Catalogue ©1987, Japan-spec XJ-S's up to VIN 118583 (1986) used unique oblong headlight assemblies and unique headlight bulbs. From VIN 118584 on, Japan-spec cars used the same headlights as other RHD countries. Mike Morrin says, "Interestingly, the 1980 parts book shows the Japan market having US spec headlights (including LHD sealed beams!!) I presume the actual lamp units were replaced with Japanese ones on arrival in Japan." Maybe not; Japan reportedly got a lot of US cars shortly after WWII -- largely from American occupants bringing them over for their own use -- and apparently set up its specs to permit use of American LHD cars on its roads where people drive on the left.

Several people, including Daniel Stern, confirm that the pre-1986 Japanese headlights were really bad, comparable to the US sealed beams in their ineffectiveness.

If you have a pre-1986 Japan-spec XJ-S, you might want to consider upgrading it to the UK-spec headlights which are apparently legal there now. Or you can consider the other upgrades mentioned in the following sections, but be sure to check the local regulations first.

SOCKET MELTING: One possible problem with high wattage bulbs is melting of the plastic socket that plugs onto the back of the headlight. The solution to that problem is easy: remove the socket and install the spade connectors individually. One idea might be to push the spade connectors all the way through the socket and out the other side before connecting to the headlight; that way, the wires going through the socket would clearly indicate which spade connector goes to which terminal, but the plastic socket itself would remain dangling on the wires a few inches away from the headlight.

Four Round Headlights -- US through 1991

The four round headlights used on the US-spec XJ-S up through 1991 are sealed beam halogens, available at any auto parts store. The outboard units (sealed beam 5 $\frac{3}{4}$ " round halogen main/dip 35/35 watt⁵) are H5006, and the inboard (sealed beam 5 $\frac{3}{4}$ " round halogen main 50 watt) are H5001. And yes, I have listed the correct wattages for these units, despite the various Jaguar literature listing the outers as 37.5/50 or 37.5/60. The non-halogen equivalents for the outboard position ("tungsten", number 4000) are 60/37.5 watt, but aren't recommended for anybody; you only find them in dark corners of auto parts shelves covered with dust. The corresponding tungsten sealed beams for the inboard position are number 4001, 37.5 watt, also not recommended.

⁵ When listing wattages of high/low beam headlights, I endeavor to list the main beam wattage first, the low beam wattage second. The J. C. Whitney catalog often lists them the other way around.

FOUR ROUND HEADLIGHT IMPROVEMENT: If you have the four round sealed beam halogen headlights, your headlights suck -- trust me on this. Daniel Stern suggests that one quick and easy improvement might be to merely replace the outer high/low beam units with H5009's instead of H5006's. These are 50/40W instead of the H5006's 35/35W. Unfortunately, they are apparently pretty difficult to find. "I can supply a lot of "unobtainium" bulbs, but not H5009's." Another possibility may be the 50/50W H5812, "although now we're back to the theoretical, because H5812's aren't in current production."

If you actually want to see where you're going after dark, the sealed beams gotta go.

FOUR ROUND HEADLIGHT UPGRADE: The easiest, cheapest *and* most effective improvement is to replace the sorry sealed beams in the outboard position with far superior 5 $\frac{3}{4}$ " round E-code units using H4 halogen bulbs. Not legal on US roads, but unlikely to draw the attention of Smokey. These assemblies can be purchased from J. C. Whitney for less than \$20 each (H4 bulb included!) and will fit right into the outer (main/dip) headlight fixture with no modifications and no other parts to buy.

The standard H4 bulb is 60/55W, which is a significant boost over the 35/35W main/dip sealed beam halogens. But the chief advantage of the E-code units is that they have much better focusing patterns; on low beam, you can pull the car up to a wall and see that the pattern provides a distinct cutoff to the upper left (on LHD cars), while still providing plenty of illumination down and to the right. The result is that oncoming traffic gets blinded less on low beam, despite the higher power of the H4 bulbs.

H4 bulbs produce a brilliant white light. This is a wonderful benefit, even beyond the actual light output. Having everything in front of the car lit up with white light instead of the yellowish light of conventional headlights seems to make everything clearer.

With the legalization of composite headlights in the US come the "9003" and "HB2" bulbs. These are both exactly the same as the standard H4 except that they are DOT approved. All three designations are commonly available, and replacement bulbs can be found in the local auto parts store or Wal-Mart; H4's are sometimes sold as "motorcycle" headlight bulbs, and may actually cost more than the identical 9003's right next to them.

Note that this author has purchased a set of 5 $\frac{3}{4}$ " round H4 units from J. C. Whitney, and the lights that arrived are labelled "Maxtel™ by JF", are made in China, and have "E3" in a circle on the lens.

Daniel Stern says that, as with anything else, you get what you pay for when buying E-code headlamps, and suggests you pony up for Cibie or Hella units rather than the J. C. Whitney no-names. "Genuine European E-code headlamps perform much better than the knockoff items, which often have counterfeit E-marks and actually haven't been tested or approved at all." This all may be true, but even the no-name E-code H4 units are a damn sight better than the sealed beams ever dreamed of being, so it all comes down to how much you're willing to spend for how much improvement you want.

FOUR ROUND HEADLIGHT UPGRADE #2: It may be important to some to know that, while the H4 hi/lo headlights fit perfectly, their external appearance may be slightly different than the original sealed beams. Where the sealed beam has a domed glass lens, the Maxtel has a "squared" lens with a shoulder that protrudes straight out of the retaining ring perhaps a quarter inch and then a very slightly domed front, nearly flat faced. You can take a look at these headlights mounted in the author's car at

<http://www.jag-lovers.org/xj-s/book/H4Headlights.html>

I think they're really pretty, but if you just get two for the outer high/low positions it might not be considered an ideal match for standard sealed beams in the inner two positions.

Good solution: get four, and use the exact same lights in the inner position by using only the high beam filament of the H4 bulb. The author did this, so you can see how it looks on the site above. If you are the type of person to keep spare

light bulbs handy, you will only need to carry one type of H4 bulb to fit all four lights. And if a low beam filament burns out, you can just trade bulbs around and use that one for a high beam only.

Installing a high/low unit into the high beam (inboard) position will require cutting a relocated notch in the support ring behind the headlight. As you look into the hole where the headlight goes, the notch at the upper left is in the wrong place and a new one needs to be cut about a half inch clockwise. You can hold the new high/low headlight up to the fixture, fit the other two feet into the appropriate notches, and mark where you need to cut a new notch. Alternatively, you could just buy a couple new mount fixtures originally intended for the outer positions and mount them in the inners. The electrical plug will work fine as is; the two-connector plug will fit directly onto the three-connector H4 bulb and operate the correct filament.

FOUR ROUND HEADLIGHT UPGRADE #3: Instead of installing H4 hi/lo headlights in the inboard positions and using only the high beam filaments, you can replace the inboard sealed beam units with E-code high beam assemblies that use H1 halogen bulbs. H1 bulbs are also available anywhere that sells auto parts. H1 high beams have the advantage that, since the reflectors and lenses don't need to be designed to facilitate both high and low beam operation, they can be fully optimized for truly excellent high beam operation. Daniel Stern recommends this method: "H4 high beam: Lots of midrange fill light. Dedicated high beam: *Long-range throw*. It's best to have both types." Since the only advantages of using four H4's are minor (fewer spare bulbs required, perfect appearance match), he has a point; if you'd like more "midrange fill light", you can just upgrade the H4 bulbs in the outboard headlights (see page 605) rather than installing additional H4's in the inboard headlights. Plus, you don't have to modify the notch in the support ring to install the H1's.

Unfortunately, J. C. Whitney doesn't carry H1 high beam $5\frac{3}{4}$ " round units, so you'll need to look elsewhere. Stern describes E-code $5\frac{3}{4}$ " round units from Cibie and Hella: "The Cibie lamps are convex (dome) face lamps, like the original sealed beams. The Hella lamps are flat-faced." H4 high/low and H1 high beams are available from both companies. Stern goes on to note that the Hella H1 is truly flat-faced while the Hella H4 has an extending lip around the edge (similar to the Maxtels described above) so the two Hellas don't really match each other perfectly. "The difference in lens technique between the Hella H4 and the Hella H1 creates a difference in installed appearance between the two adjacent units. The Cibie H4 and H1 both use convex lenses of the same curvature. Whether this is of concern to you is a matter of individual taste.

"The Cibie H4 high/low units are equipped with city lights." Hey, there's an interesting possibility for modification of US-spec cars: disconnect the parking light filaments in the front turn signal bulbs and wire up pilot lights within the headlights instead. The pilot lights would be perfectly legal, but unfortunately they'd draw attention to the E-code H4 headlights which aren't.

The various nuances of the Cibie and Hella headlights are discussed in great detail on Stern's web site at

<http://lighting.mbz.org/tech/info/headlights/>

"There is a potential design compromise in the Cibie lamps. The Cibie H4 weathershield can be installed in any clock position, so one must pay careful attention to putting it on such that the moulded-in word "TOP" is at the top, else risk water entrapment and shortened reflector life."

FOUR ROUND HEADLIGHT UPGRADE #4: John Goodman: "I would prefer the outer lamps to be the permanent dipped beam units as in the BMW's, i.e. The H1 single filament bulbs, because the reflector shape is different being solely designed for dipped use only, gives a better light pattern. This arrangement needs mods to the headlamp relays so they stay on when the inner main beam units are activated." No problem; a jumper between terminals 56 and 56b on the main/dip relay will do it.

Daniel Stern reports that Cibie produces a low-beam-only H1 E-code unit that will fit in the outboard position on the four-headlight XJ-S.

HEADLIGHT AIMING -- FOUR ROUND HEADLIGHT SYSTEM: A nifty feature of having four separate headlights is that you can get creative aiming them. The outer high/low units probably should be aimed pretty much as normally specified to ensure that oncoming drivers are not blinded. If E-code units are installed, this becomes both more important and more acceptable, since the E-code lights have a very sharp cutoff indeed; a little too high and you're blinding people, a little too low and you're not lighting the road very far ahead, but just right and you get excellent visibility for low beams. Unfortunately, aiming the low beams accordingly will determine where the high beams end up, so you have limited options there. Fortunately, E-code high/low units seem to provide excellent high beam patterns when low beams are aimed properly -- as opposed to some US-spec sealed beams where you aim the low beams and the high beams are shining up into the trees or some such so you have to pick a compromise somewhere.

The inner high beam units have more flexibility. If it is presumed that they are never on when there are cars out there that may be blinded, you can aim them pretty much whichever direction you wish.

Of course, once again there are legal issues. Even though the high beams are only used when nobody is around but you, the US DOT still requires you to aim them the way they think they should be aimed. Again, this probably won't pose a problem in most areas; cops generally only issue tickets for poorly aimed headlights where someone is driving a car that's been crashed and one of the lights is aiming at the ground or off at 45° or some such. If you have vehicle inspections, though, headlight aiming is one of the things they typically check so you would have to aim the headlights the specified way before an inspection and put them back the way you want afterward.

FOUR ROUND HEADLIGHT REPLACEMENT: You can replace the four headlights with one or the other of the Cibie oblong headlight designs used in Europe. Not legal in most US states, but will provide better lighting -- although not as much better as installing E-code H4 round units as described above. Hence, the only real justification for going this route is if you happen to prefer the appearance of the Cibie oblong headlights.

Since the body panels are the same between US and Euro cars, this will be a bolt-in replacement -- but you will probably have to buy quite a few parts, including the mounting brackets that hold the headlights within the compartments and the trim pieces at the front.

Note that, if you get the Euro lights, you can also opt for the wiper/washer system for them, and even a *heated* wiper/washer system to prevent freezing of the washer fluid.

By replacing the four round sealed beams with far better headlights, we have vastly improved the lighting without having significantly changed the outward appearance of the car. If you *still* want better visibility you can add driving lights, but it's a better idea to opt for non-standard H4 or H1 bulbs -- see pages 602 and 605.

Cibies with two H1 bulbs -- non-US through 1980

The early non-US XJ-S has Cibie headlights with glass lenses and metal reflectors and uses two H1 halogen bulbs plus one "pilot" bulb on each side. This is the assembly shown in the Haynes manual, but John Goodman points out "The drawing of the XJ-S headlight bulb on page 198 (actually 197 in my book) looks like it was taken from a 1980 <UK> owner's handbook. But it's been edited to fit the page and you only have half the picture!!! What you are looking at here is a 1980 or earlier headlight, the bulb shown is a main beam single filament H1. What is not shown is an identical bulb which installs in an identical hole immediately underneath for the dipped beam."

Mike Morrin calls this early unit a "biode": "It is the term (probably trademark of Cibie) for headlight units with separate reflectors and bulbs for high and low beams. I think it is a condensation of "bi-reflector iodine". The term was widely used in Europe back in the 70s, but I suppose not in the US as they were illegal there then. Back in the 70s, the British *always* called Quartz Halogen "Quartz Iodine"."

Morrin describes the early unit in more detail: "Low beam uses the back of the headlight shell (as per the later units). The high beam reflector is in front of this in the lower half of the unit. There is actually an adjusting screw which allows the vertical angle of high beam to be adjusted relative to low beam. The glass has CIBIE IODE in the centre of the casting. Most of the bottom half of the lense is clear, with fluting only directly in front of the high beam bulb. It is interesting that Cibie used Iode in the trademark on the lamp. I am sure that their after-market dual-reflector lamps of the same vintage were known as Biodes."

"The high beam has quite a narrow vertical spread, and really needs the low beam to be simultaneously lit up for close-in lighting. The early cars came already wired this way. The wiring diagram in my manual shows a dotted link across the low beam contacts on the relay.

"These are actually very good lights, except that they are very prone to oxidising of the reflectors."

H1 bulbs are typically 55W and have a small circular metal base with one straight side at a 45° angle to the single spade terminal pointing straight off the bottom. The headlight housing must have a suitable ground connection, since there is none on the bulb itself. H1 bulbs are readily available in auto parts stores. In Europe, the bulb number is 411. Note that the illustrations in the manuals seem to indicate that H1 bulbs have an external conductor around the outside of the capsule itself and entering in the front of the glass, but the bulbs actually for sale in the stores don't have this; all conductors are inside the glass.

HIGH-WATTAGE H1'S: The standard H1 is 55W, but 100W versions are available in most auto parts stores and J. C. Whitney sells 100W and 130W versions. A 130W H1 bulb is available at Wal-Mart for five bucks -- but not in the automotive section. It's sold in the sporting goods department. It's called "Night Blaster" A-709 and is described as a 12V spotlight bulb; only on the back of the card does it casually mention that it will fit any application calling for an H1 bulb.

CIBIE REFLECTOR DETERIORATION: The Cibie oblong headlights reportedly suffer from deterioration of the reflector, especially the early dual-H1 units. This deterioration kills the headlight effectiveness. Considering the cost of replacement units, many owners seek methods of renovating the reflectors in their otherwise operable headlights. It is possible to separate the lens from the reflector; there is a glue joint that can be cut through without too much trouble. However, Daniel Stern suggests that it'd be a better idea to just go ahead and spring for the replacement headlights: "Anyone who gets the notion that chrome plating will do the trick ought to know the reflectivity of the very finest quality chrome is 62 percent. Headlamp reflectors done properly have a reflectivity of 98-99 percent." Obviously, stuffing aluminum foil or aluminum tape in there isn't gonna cut the mustard, either! Stern also points out that doing a proper reflective coating application on a one-off repair of old units will usually cost more than just buying new units.

EARLY CIBIE REPLACEMENT: If you have the early dual-H1 units and need replacements, you probably should consider the later single-H4 units. A couple of owners have reported finding out that their cars had the dual-H1 on one side and the single-H4 on the other, indicating that a PO must have replaced one. Obviously, it can't be too difficult to replace one type with the other.

Another option is to replace the Cibies with the four headlight scheme as described on page 603.

Cibies with one H4 bulb -- non-US 1981-91

From 1981-91, non-US cars used Cibie headlights with a single H4 bulb and two pilot light bulbs on each side. Allan Charlton says the lights on his '78 have the circle-E symbol indicating E-code specification (see page 597). "It's E2 in a circle. The E2 also appears in a smaller circle with an A above, and in a small square with an A above (Actually, the A is so small that, in the poor light in my garage, it could be an R, but I think it's an A)."

H4 bulbs have a large circular metal base with three alignment tangs, one larger than the other two, and a 3-prong plug that will fit the same socket as a US-spec sealed beam -- three large (5/16") spade terminals arranged as three sides of a square. If your headlights use H4 bulbs, they are readily available -- or you can use HB2 or 9003 bulbs, which are exactly the same. In Europe, these bulbs are called 472. The French cars use a 476 for the yellow color.

SEALING NON-SEALED H4 HEADLIGHTS: H4 headlight assemblies are nothing resembling sealed; in fact, the back end is open enough you might consider it ventilated. To prevent moisture getting in and deteriorating the reflector, the assemblies include rubber boots that fit over the back end of the headlights. Note, however, that installing this boot will keep the assembly warmer; this doesn't normally pose a problem, but if you're using the big-wattage bulbs you might consider the tradeoffs between how hot the bulb gets and how big a problem moisture is.

Other cars, including Hondas, use rubber boots that appear remarkably similar on normal sealed beams. Perhaps one of these boots could be used when the original H4 boots are damaged or missing.

CIBIE REPLACEMENT: John Goodman reports from the UK: "Jaguar enthusiasts here actually change to the four headlamp system because of improved lighting available." Goodman isn't talking about installing the four crummy sealed beams used in the US; he's talking about installing four 5 $\frac{3}{4}$ " round E-code units with H4 bulbs -- meaning the UK car goes from two H4 bulbs to four. He describes the kit from Jaguar, JLM 10357: "All 4 lights are the same and still use the H4 bulbs. A link wire supplied with the kit only enables the outer lights on dip. Could easily be wired for both pairs on dip, but would screw up the dim/dip and not sure if it's legal. Looks like it's been done this way for simplicity of owner installation. Although it remains a mystery why the genuine Jag kit did not have dedicated driving lights for the inner pair with H1 bulbs."

"If you have converted to four headlamps, the headlamp washer/wipers are now redundant, but you can utilise the additional separate pump for the headlamp washers (modify the wiring) to power one side on your screen washers, works well." Of course, this only works if you have an '88-on car with two separate nozzles -- or have added a nozzle in addition to the original single one.

If you convert to four round H4 headlights, you should read the section on that headlight arrangement starting on page 598.

UK DAYTIME RUNNING LIGHTS: There is a circuit in the mid-80's-on UK cars only that operates the low beams at reduced power to provide a running light-type illumination, apparently as a result of some law. Richard Mansell quotes "my owners manual which states: In the UK the headlamps are automatically switched ON in a dimmed dipped beam mode when the side lights are switched ON and ignition switch is in position '2'. This prevents the vehicle being driven with side and tail lamps only." John Goodman says it is "Controlled by a relay thingy by the headlamp fusebox (this on UK cars came in around '86 '87)."

Goodman continues: "It gets all screwed up if you try to install non-standard brighter wattage bulbs." Regarding the kits available in the U.K. to convert to the US-style four headlight system, he says "When I converted my previous XJ-S to 4 headlights the dim system still works because all 4 lights are the same and still use the H4 bulbs. All lights have dual filament bulbs, so 4 x 55W on main beam, however only the outer ones are ever wired up for dipped beam (not sure if this is a legal reason)."

If you happen to have such a UK-spec car and don't want to convert to four headlights, one nice option is the 100/55W H4 bulb from Wiko mentioned above. Since the low beam is still 55W, same as the stock H4's, the dimmed dip feature will still work as intended.

DOT-approved Carello -- US 1992-on

Composite headlights -- as opposed to sealed beams -- were finally legalized in the US in the name of energy conservation via improved aerodynamics, but that doesn't mean European headlights are now legal. After all, the US DOT couldn't possibly accept headlights that have proven excellent in Europe for decades. So, the 1992-on US-spec XJ-S has a new type of oblong headlights that say DOT on the lens. Emile A. DesRoches says the lights are made by Carello, and have plastic lenses with three little bumps for aiming. "The Carello light housings appear to be completely polycarbonate with reflectors of the same material plated and apparently epoxied to the lens in order to provide a leak free seal (no apparent O-ring, but it appears there's a ridge where the parts join). These things are very strong/resistant to scratching, etc. I've taken several stones without mishap and what appeared to be a nut or bolt at high speed (yes, I got to the track late and stupidly neglected to tape the headlights -- this from an SCCA tech inspector, yet). I expect it would be possible to separate the sections with use of the proper solvent."

Side note: per Daniel Stern, "Carello is a trademark of Magneti-Marelli SpA., Italy." That's right, the headlights are made by the same company that makes the ignition system! They have a plant in the UK, which is why the headlights are marked "Made in UK".

The Carello headlights come with a nifty adjustment scheme: the up/down and left/right adjusters are readily accessible from under the hood. There is no need to pull trim off or try to jam a screwdriver through narrow access slots to aim the headlights.

CARELLO BULBS: The US-spec Carello headlights are fitted with 9004 bulbs. These bulbs have a large plastic base with a fat O-ring and a D-shaped 3-terminal socket, and are 65/45W.

I will repeat: the US-spec Carello headlights use 9004 bulbs. I am *sure* of this. But if you start checking other sources, you're probably going to develop some doubts. Gary Penovich says, "Every website that I visited showed the USA spec 94MY using an H4/9003 lamp. The Osram/Sylvania website shows the incorrect fitting for a 94 as 9003." Hey, don't believe me -- but at least pop the access cover out of the wheel well and pull a bulb out and *look* at it before mail-ordering something you can't use.

CARELLO UPGRADES: When Jaguar was finally permitted to quit using those lousy round sealed beams, the headlights improved greatly, right? Daniel Stern says, "This is a tremendous, tremendous *retrograde* step in headlamp performance. The transverse-filament 9004 performs worse than many of the old sealed beams, even. The 9004 system is inherently *bad*. Poor luminance from the filaments, *huge* amounts of "noise" from 2nd-, 3rd- and higher-order filament reflections off the bulb walls, nearly impossible to control filament placement once the bulbs have been cycled on and off a few times, oodles of wasted light with transverse filament especially in rectangular or oblong reflectors...this junk was one of Ford's so-called "Better ideas" in 1983. Shame on them."

David Buchner describes the Carello headlights that came on his '94: "When you turn them on, you get a vague impression of some light." Buchner also owns an earlier XJ-S with four round sealed beams, and reports that the Carellos are "*much worse*." That's pretty bad indeed, since the four round sealed beams suck.

For a wattage boost (illegal on US roads), J. C. Whitney offers 9004 bulbs in 100/55W and 100/80W versions. Stern: "Badly-made 3rd-world overwattage 9004s (*all* of them...no reputable company makes such a product) have insanely high internal pressure and frequently turn into shrapnel grenades (hopefully inside a headlamp so the destruction is only to the bulb and headlamp...otherwise grievous injury can occur when flying hot glass hits flesh or eyes). *Vastly* increased glare for other road users and backdazzle for the driver...thermal damage to plastic headlamp parts...melted headlamp connectors (tiny contact pins in 9004 base). Brighter bulbs in bad headlamps don't make good headlamps...just bright bad ones."

Note that, as of this writing, this author has received several reports of use of 100W bulbs in Carello headlights and no reports of melted parts, but this nevertheless must be considered a try-at-your-own-risk idea. Unfortunately, Buchner tried high-wattage 9004's and reported that they had very little beneficial effect.

The most effective method of upgrading the US-spec Carellos would be to replace the units with the E-code Carellos. Not legal on US roads, but not likely to attract attention and certainly a great improvement in lighting.

Trying to retrofit any of the other headlight schemes found on earlier model XJ-S's is likely to be problematic; Jaguar changed the entire body at the same time they introduced the Carellos, and the new body panels may not even provide mounting points for other headlight schemes. Besides, nobody with Carellos really wants to sacrifice that nifty aiming scheme.

Another option, obviously, would be to add driving lights. In fact, this is arguably the most viable option here. The driving lights should be wired so that you can leave them off and use the dimmer switch to switch from low beam to high beam and back, or turn them on and use the dimmer to switch from low beam to high beam plus driving lights. Then you can use the dimmer to switch back and forth between low and high beam in traffic situations where a car with good headlights would only need low beams, and switch on the driving lights when you're alone on rural highways and really need to see. And driving lights are perfectly legal.

E-code Carello -- non-US 1991-on

At the same time the US got the DOT-approved Carello headlights, other countries got E-code Carellos. These can be distinguished from the US-spec Carellos by a marking on the lens: "E11" in a circle. Also, the E-code headlights don't have the three little ticks that DOT requires for aiming. Besides these minor appearance differences, there is a major difference: the E-code Carellos use H4 bulbs instead of 9004's. Per Daniel Stern: "9004 headlamps are not permissible in most of the world, and E-code headlamps are required in most of the world."

If you need better lighting, consider the nonstandard H4's discussed below.

More Headlight Improvement Ideas

HIGH-WATTAGE H4'S: Of the five headlight schemes the XJ-S came fitted with, two used H4 bulbs -- and the discussions above suggest replacing the other three with systems using H4 bulbs! H4 systems provide excellent lighting -- but there is still room for improvement. One way to get better visibility yet is more wattage. J. C. Whitney offers H4 bulbs in 100/80W, 130/90W, and 165/100W. The 165/100W's are kinda pricey, but the others barely cost any more than standard H4's. You can even get the 5 $\frac{3}{4}$ " round E-code assemblies from J. C. Whitney with the 100/80W or 130/90W's already installed for only an extra buck or two.

Also, Vince Chrzanowski reports that he found 100/55W H4's at his local electronics wholesaler: Eiko Order Code 01019-BP. Eiko products are distributed by:

Wiko, Ltd.
10490 W. 164th Pl.
Orland Park, IL 60462

And, no, he claims there is no typo, the name of the company is one letter over on the keyboard from the name of the product line.

Daniel Stern advises that "good quality European bulbs cost no more than Chaiwanese stuff from JCW or Wiko, and the wattage ratings on European bulbs are actually correct. The knockoffs are almost always quite a large bit lower than stated, never higher. This is not the case with European-made bulbs."

Note that the light output of incandescent light bulbs is not necessarily proportional to wattage; usually the higher wattages are *more* efficient. Suffice it to say that high-wattage H4 bulbs will definitely do the trick. On high beam the reflection from a brand-new road sign can be a little blinding. And when you flash at someone to move over, they move over!

Of course, nonstandard H4's are harder to find when one burns out -- but if you buy a spare or two, they don't take up much space in the trunk or glovebox. Or, you could just buy a normal 60/55W H4 from a local store to tide you over until you can get a new specialty bulb shipped to you.

HIGH WATTAGE HEADLIGHTS -- POWER SUPPLY CONCERNS: Since watts = amps x volts and automotive bulbs are 12 volt, a 100W bulb will draw over 8 amps and a 130W bulb will draw nearly 11 amps. Four 130W high beams will draw over 43 amps, or 29 amps more than the stock sealed beams did. You might wanna consider the capability of your alternator; the later XJ-S was fitted with a 115-amp unit, but the earlier ones had 66-amp or 75-amp Lucas units -- and you've still got electronic fuel injection, windshield wipers, A/C system fans, etc., etc. to provide power for. Still, this usually doesn't present a problem, perhaps because you can't use high beams too much due to oncoming traffic, there's usually no point to using high beams in the rain when the wipers are going, and since it's cool after dark the A/C fans are always on low speed.

You also need to consider the wiring and fuses. See the suggestions for installing relays on page 594.

BLUE BULBS: There are two distinct types of bulbs that can be referred to as "blue bulbs". The first one has a dichroic filter coating on the bulb that makes it appear gold. You have to hold the bulb up to the light and look through it to see why it's blue.

Are these bulbs a good idea? The answer is a clear and resounding no. In headlamp design, the bulb and the reflector/lens arrangement must be designed to work together, and in the case of halogen headlight arrangements that design is based on the bulb being clear and nonreflective. Introducing a filter coating does more than simply reduce the amount of light emitted (it is a filter, remember, its function is to absorb light); it also introduces a reflective surface within the system that causes light to scatter off in directions that the headlight designer was trying very hard to preclude.

There's no shortage of bad things to say about this crap, but the following excerpt from a NHTSA document sums it up pretty well: "These bulbs began to show up on cars and trucks in early 1998, shortly after the introduction of HIDs on more expensive cars. Having noticed this, NHTSA lighting engineers who regularly participate in SAE Lighting Committee meetings asked committee members to discuss the science, engineering, optics and other aspects of these new bulbs. Those engineers were mostly ignorant of the existence of those bulbs in the U.S. market. Upon being shown one of the suspect bulbs, all were surprised by the orange metallic interference coating that was present on the entire surface of the bulb capsule because they did not believe that it would allow a headlamp to perform properly. During that meeting, a test was performed on the bulb in a headlamp, comparing it to the OEM bulb for the headlamp. When set up in a photometry laboratory, the colored bulb reduced peak intensity in the seeing light area of the beam by two-thirds, markedly increased the glare intensity in the area where preceding and oncoming drivers' eyes are typically located, and the total volume of light emitted by the headlamp dropped by almost half. The beam emitted using the colored bulb, shining on a white measuring screen in the lab, showed a psychedelic array of colors, ranging from white near the hot spot to reds, greens, golds, blues and magentas, in vast areas of the beam. It was remarkably different than the performance of an OEM bulb. While the laboratory at which the meetings were held did not test the colored bulb/headlamp combination for compliance with FMVSS No. 108, the plot of its intensities showed that it was incapable of complying."

These things should be banned -- and they are. Daniel Stern: "Simply put: They are *illegal* in all of the US and all of Canada, Australia, Europe, Japan... A halogen or tungsten bulb that emits blue light is deemed a blue light, and is illegal on non-emergency vehicles in Europe, the US, and Canada."

The package on a set of Crystal Blue 9004's in a local store says they are DOT approved in small letters on the back of the card, but clearly warns on the front that they are for show car use only and that local laws should be checked before installing. The bulbs themselves say nothing at all. You don't need to check the local laws; they are illegal on the road -

- any road. And while using Euro-spec H4 headlights in the US might not get the cops' attention, these bulbs are obviously and obnoxiously blue. They also increase glare on other drivers -- including cops -- so harassment from law enforcement can be expected to be constant and unceasing. As it should be.

NOT-SO-BLUE BULBS: The second type of "blue bulb" doesn't have the dichroic filter coating that gives the golden appearance, but rather a simple light blue tint on the glass. The objective is white light, not blue. These are a better idea than the golden bulbs described above. Stern again: "They come in 9004, HB2 (H4), 9005, 9006, 9007, all DOT-approved."

They're still not a good idea, though. Stern goes on to say, "The question of whether these filtered lights might be better has been tested by good researchers, and they find not only that any theoretical advantages vanish when the context of the study is actual driving tasks on actual roads -- that is, no seeing benefit -- but also there is a glare disbenefit with such filtration. Just say NO to blue-filtered lights of any kind."

It is this author's opinion that the popularity of blue-tinted lights -- other than with morons who care more about being "cool" than about safety -- is largely a result of the poor wiring in most automobiles, which causes headlights to operate at reduced voltage and therefore appear yellow and weak. Before considering any blue crap, please install relays or upgrade the wiring as discussed beginning on page 594.

YELLOW BULBS: Yellow is a legal color for headlights, with some areas permitting a yellowish shade of white while others permit downright yellow. This is for good reason; Daniel Stern says, "Until the mid 1990s, headlamps in France were required to produce yellow light. This was accomplished in one of several ways: yellow headlamp lens, yellow glass balloon in front of the bulb, yellow glass balloon as part of H4 bulbs, and dichroic filter coatings on halogen bulbs. This last method was the best, since it produced the required yellow color with very little loss in absolute light intensity. Yellow glass filters caused up to a 15 percent reduction in absolute intensity. In the mid '90s (1994, if I recall correctly) the yellow-light requirement was dropped for new cars in order to bring France into line with general European Community regulations. Yellow bulbs can still be had and used on pre-'94 cars, however.

"It's not directly apparent that yellow is a magically great color for lights. It's what happens when you subtract blue from an auto lamp. Blue is the shortest wavelength and, as such, scatters the most readily. When blue light strikes water (rain, fog, snow) it scatters in all directions and makes on-road vision very difficult. Blue also is a very difficult color of light to look at if it is at all intense...it stimulates the reaction we call "glare".

"So the French figured to remove the blue from the output spectrum of their vehicles' front lamps. The opposite of blue being yellow, the result was French yellow headlamps. There haven't been any recent comparative studies, but yellow lamps always subjectively ranked as decidedly better in poor weather and lower in glare than white ones, and this matches my own experimental experience with fog lamps and headlamps that produce yellow light.

"One problem with this conclusion as applied to headlamps in France is that the dichroic technology came along very shortly before France rescinded the yellow-light requirement. Therefore, the lamps that were being compared with white lamps were almost universally yellow by dint of earlier methods (yellow glass) which reduced the absolute intensity of the beam, which may or may not have had a large part in reducing the glare. Because the requirement for yellow light no longer exists (though such light is optional in many countries) we probably will never know the vagaries of the answer to this question. Suffice it to say that yellow light makes a better fog lamp if you intend to use the fog lamp in poor-visibility conditions without any drawback in dry conditions, and modern dichroic techniques of "yellowing" the light take away some of the drawbacks (reduced amount of light) that used to be a problem with yellow lights.

"These days there are quite a number of dichroic (yellow-pass) lighting products on the market. There are bulbs with this coating, as well as auxiliary lamps whose lenses are so treated. There's nothing the matter with doing it either way (though my preference is for the coating to be on the bulb, because this makes it easy to switch between clear/white light and yellow light as desired).

"There are two commonly available levels of dichroic-filter coating strength on auto headlamp bulbs: A light coating which "skims" the highest-frequency blues off of the output spectrum, causing a yellow-tinted white light, and a heavier

coating that blocks all of the blue frequencies from being output, causing the full-depth *yellow* light that we used to see in French headlamps. The deeper yellow tint is more effective at cutting through obscured environments (rain, fog, snow, dust), but the lighter coated bulbs meet international definitions of "white" light for headlamps. I've done considerable experimentation with various mixes of bulbs and my own preference for maximum visibility in bad weather is:

- Lightly-filtered headlamp bulbs to produce legally-white light that gives considerably less glareback in bad weather
- heavily-filtered fog lamp bulbs to produce yellow light that does not glare back at all in bad weather (full-strength yellow is legal in auxiliary lights)

"I like clear bulbs in driving lamps, because if you're worried about glareback, you're not using your driving lamps!"

So if the bulbs with blue dichroic coatings appear gold when you look at the bulb itself, what do the bulbs with yellow dichroic coatings look like? "The legal-yellow ones reflect a light purple, while the full-tint ("French") yellow ones reflect a deep blue."

HIR: Howard Chu mentions another advance in headlights: "GE's HIR bulbs, which have a bulb coating that reflects infrared. This again allows visible light to escape unhindered, but keeps more heat in the bulb. The point here is that the filament glows because it's hot, so if you can keep more heat in the bulb, you can keep the filament glowing brighter with less electricity."

"XENON" HALOGENS: Nathaniel Musselman found that Hella offers bulbs that look and work just like standard H1 or H4 bulbs except that they have xenon gas in them. They claim that the use of xenon gas improves light output and eliminates UV radiation that may damage plastic lenses and housings. Hella describes these bulbs on their web site at:

<http://www.hella.co.nz/xenon.html>

Note that this site claims repeatedly that these bulbs are a plug-in upgrade, but that's because the site is in New Zealand and the guys setting it up forgot that the World Wide Web is world-wide; if the car is US-spec, they will definitely not plug in unless you have already upgraded to E-code headlight assemblies.

Daniel Stern says, "The gas mix in such a bulb does have a higher percentage of Xenon, but it's not exclusively Xenon. Also, the gas mix in the new type bulbs is under higher pressure. This allows the filament to run hotter, which produces more light. It's not a knock-your-socks-off improvement, but it is certainly noticeable."

"The newest types of bulbs all use this new gas mix formulation (which also is under a higher pressure). For instance, the H7 is one of the newest headlamp bulbs. All H7 bulbs have this newly-tweaked, higher-pressure gas mix, and the results have been good, with the H7 achieving a higher luminous flux (amount of available usable light) from a given wattage (55w in this case) than was achievable in a bulb of this general type with the old gas mix under the old lower pressure. So after a few years' experience with H7s, the manufacturers have moved to update the older traditional bulb types with the new gas mix under the new, higher pressure."

HIGH INTENSITY DISCHARGE (HID): Gas-discharge xenon lights, such as the strobe bulb in your timing light or camera flash, work by firing an arc through a tube containing xenon gas. HID headlights work similarly by providing a continuous arc to provide a continuous light. These lights have no filament; the arc travels through the gas itself to produce the light. The same arc provides high and low beam; the arc is physically moved from one position to another by application of a magnetic field, so the light doesn't really turn on and off when switching between high and low beams but rather "moves". The HID headlight system provides a purplish light and gives more light than halogen headlights for one third the wattage.

Daniel Stern: "HID headlamps, which have a bluish appearance, are legal. It's because they're not actually blue, they just appear more blue than the halogen lamps surrounding them. They are higher in blue and blue-green wavelengths, but this is specifically noted and approved in CMVSS108 and 108.1 (And, for US readers, in FMVSS108)."

J.C. Whitney (page 643) offers an HID conversion kit that will fit any headlight that uses H1, H4, or 9004 bulbs -- which, when combined with the earlier suggestions to replace the round sealed beams with H4 units, means you can fit them into *any* XJ-S. Cost is a mere \$800 per kit -- and you'll need two kits if you plan to do four headlights.

Worth it? Apparently not. Stern again: "There are many unsafe, illegal and noncompliant products on the market, mainly consisting of an HID ballast and bulb for "retrofitting" into a halogen headlamp. Often, these products are advertised using the name of a reputable lighting company ("Real Philips kit! Real Osram kit!") to try to give the potential buyer the illusion of security. While some of the components in these kits are sometimes made by the companies mentioned, reputable companies like Philips, Osram, Hella, etc. *never* endorse this kind of "retrofit" usage of their products.

"Halogen headlamps and HID headlamps require very different optics to produce a safe and effective -- not to mention legal -- beam pattern. It is not some great feat of upgrade engineering to put an HID capsule where a halogen bulb belongs, it is just plain foolishness. Some types of halogen headlamp bulbs (9004, 9007, H3) use a transverse (side-to-side) and/or offset (not directly in line with the central axis of the headlamp reflector) filament, the position and orientation of which is physically impossible to match with a "retrofit" HID capsule. Even those halogen headlamps that use axial-filament (9005, 9006, H1, H7) bulbs are not safely or legitimately "convertible", regardless of what kinds of clever products the junk vendors come up with.

"The most dangerous part of the attempt to "retrofit" Xenon headlamps is that sometimes you get a deceptive and illusory "improvement" in the performance of the headlamp. The performance of the headlamp is perceived to be "better" because of the much higher level of foreground lighting (on the road immediately in front of the car). However, examining isoscans of the beam patterns produced by this kind of "conversion" reveals *less* distance light, and often an alarming relative minimum where there's meant to be a relative maximum in light intensity. When you *think* you can see better than you can, you're *not* safe.

"It's tricky to judge headlamp beam performance without a lot of knowledge, a lot of training and a lot of special equipment, because subjective perceptions are very misleading. Having a lot of strong light in the foreground that is on the road close to the car and out to the sides is very comforting and reliably produces a strong *impression* of "good headlights". The problem is that not only is foreground lighting of decidedly secondary importance when travelling much above 30 mph, but having a very strong pool of light close to the car causes your pupils to close down, *worsening* your distance vision...all the while giving you this false sense of security. This is to say nothing of the massive amounts of glare to other road users and backdazzle to you, the driver, that results from these "retrofits".

"In order to work correctly and safely, HID headlamps must be designed from the start as HID headlamps. The only safe and legitimate HID retrofit is one that replaces the *entire* headlamp -- that is lens, reflector, bulb...the whole shemozzle -- with optics designed for HID usage. It is possible to get clever with available products, such as Hella's modular projectors available in HID or halogen, and fabricate your own brackets and bezels. But just putting an HID bulb where a halogen one belongs is bad news all around."

ALTERNATIVE CONTROL SCHEMES: Besides upgrading the hardware in the headlight systems, there may be benefits to changing the ways in which the headlights can be operated. It would be possible to add dozens of schemes here, each complete with wiring schematics, thereby significantly adding to the poundage of this book. Rather than going that route, I have decided to merely put forth some of the more intriguing ideas that have occurred to me or have been sent to me, and leave it to the owner to figure out how to implement them if he so desires. Basically, any of them can be achieved with a switch or two, a couple of relays, and a couple hours of fiddling with the wiring.

John Napoli suggests rewiring the car so that the low beams remain on when the high beams are on, so all the filaments are putting out light. The early European headlamps with two H1 bulbs did this from the factory, and show how easy the rewiring is -- simply adding a jumper between terminals 56 and 56b on the main/dip relay. However, perhaps it should

be noted that those early cars had separate bulbs for high and low beams, while later cars have both filaments within the same bulb. Overheating or early bulb failure might be the result. Hence, try this modification at your own risk.

If you have the 4-headlight system, Daniel Stern suggests you can go nuts with control schemes: "In a quad-round system, there are four holes and *six* filaments. Nobody ever said you have to have two matching pairs of lamps, or that you can't rewire the setup to create 3 beam distributions rather than just two (or even *five* if you're adventurous)." Just as an illustration, one of Stern's alternative setups is to provide three levels of light: standard low and high beams, plus a "mid beam" arrangement with the outer headlights on high beam but the inner headlights off. This setup makes good sense if the inner high beams are an H1 assembly with really long-range capability, and it only requires one switch and a relay. Using all four high beams will provide truly excellent visibility while you are alone on the road but the H1's can be turned off to avoid blinding another driver you are following at a distance while still keeping the outer headlights on high beam to provide good visibility at closer ranges. And since you have switched from four headlights to two, that guy thinks you have switched to low beam already and doesn't get mad at you for blinding him.

Fog/Driving Lights

FOG LAMPS -- DEFINED: In the US, fog lamps are yellow illumination lamps mounted low on the front of the car to provide visibility in foggy conditions. However, in some other countries, fog lamps are markers mounted at the rear of the car to enable other drivers to see *you* in foggy conditions. Naturally, Jaguar is only moderately helpful in keeping these two applications distinct in their manuals and schematics. In this book, "fog lamps" shall always refer to the yellow lights at the front of the car; when talking about the lights at the rear, the term "rear fog lamps" or something of the sort will always be used.

FOG LIGHT SHORTS: Jim McGuinn reports that he had an intermittent short circuit in the fog lights that he found was the rear of the bulb socket assembly arcing to the housing. A bit of electrical tape solved the problem.

FOG LIGHT KIT: While fog lights were standard equipment on XJ-S's for many years, Bill Kubida reports that somewhere around '93 they became an option -- and therefore Jaguar started offering an official fog light kit. "The addition of the front fog lights requires the addition of a suitable switch to the array of existing switches. For reasons known but to God and Jaguar, the addition of the single additional switch requires the following:

- a) removal of the switch block to the left of the trip computer which has a button for the rear screen heater and another for the rear fog lights. This switch block is then replaced by a new one having a front fog light switch and a rear fog light switch;
- b) removal of the switch block to the lower left of the steering column which has a button for the hazard warning lights and a blank-out plate. This is then replaced by a second switch block having a hazard warning light switch and another for the rear screen heater.

"I am certain that if we put a Cray IV to work on it for a couple of years a more complex system could be figured out, but personally, I doubt it."

AFTERMARKET FOG LIGHTS: If your car didn't come with fog lights, or your original fog lights met a curb, you don't really need to contact Jaguar; fog light kits are available everywhere, and any rectangular model can be installed under the front bumper and look fine on the XJ-S. It's a good idea to check on the availability of replacement lenses, since they are prone to damage. You might also check to see if the lenses are thick and substantial to resist all but the most powerful impacts. And you might check the availability of covers.

You might also wanna check the quality of the light and the pattern. As with most things, you get what you pay for. A good fog light will direct the light downward around the front of the car, staying under layers of fog if possible; a cheap fog light will leak light upward causing glare.

If cheap is what you're looking for, Wal-Mart and AutoZone offer "Blazer" driving/fog light kits. These sets are amazingly cheap -- barely more than the value of the H3 bulbs included. If you break a lens, the replacement lenses are for sale right next to the light kits on the rack!

If you're looking for good fog lights, the systems using the dichroic filters described by Daniel Stern on page 607 are the way to go.

When installing fog lights, be sure to provide a suitable ground connection -- directly to the base of the bulb itself, if possible.

FOG/DRIVING LIGHT BULBS: Fog lamps or driving lamps are usually fitted with either H2 or H3 bulbs. H2 bulbs appear to be mounted on a metal blade while H3 bulbs have a circular metal base with two notches, one rectangular and one semicircular, and a short wire attached with a spade terminal at the end. Both are typically 55W.

FOG/DRIVING LIGHT BULBS -- MORE POWER: 100W H2 bulbs are available from J. C. Whitney. 100W H3 bulbs are available at many auto parts stores, and you can get 130W versions from J. C. Whitney.

ALTERNATIVE CONTROL SCHEMES -- FOG LIGHTS: To see in fog, it is essential that the fog lights be the *only* lights on; main or low beams just cause glare. The simplest modification for US-spec cars would be to disconnect the RU wire from the inhibit relay, which causes the fog lights *only* to operate on the top position of the headlight switch. Once that change has been made, it would be just as well to remove the inhibit relay entirely as it serves no function.

A more elaborate idea for convenient fog light operation is to rewire the car so that you can put the headlight switch in one position and use the stalk switch to flick back and forth between low beams with fog lights and fog lights only. That way, when you come out of the fog bank, you can just flick the stalk to bring on the low beams for better visibility in clear air, and just as easily turn them back off when you encounter the next patch of fog. There's really no need to be able to get to high beams without putting the master lighting switch in another position, since whenever there's fog around you won't be driving fast enough to need high beams.

Note that you might need to check local laws here. At one time it was illegal in some states to drive at night with fog lights only, fog or not. Hopefully, more rational legislators have repealed such laws... what am I saying? There's no such thing as rational legislators, or the stupid laws wouldn't have been written in the first place! Maybe you can get by with a set of pilot lights; maybe the cops are stupid enough to think the headlights are "on" -- at least long enough for you to get past.

FOG LIGHT AIMING: Since you aren't that concerned with distance (you won't be driving that fast in fog) but you are concerned with curbs and the like, you may want to aim your fog lights a bit skewed -- each one aimed a few degrees to the side. Aiming them crosseyed accomplishes the same thing, just using the left light to illuminate the curb on the right side of the car. Whatever you do, though, don't aim them upward; ideally you want absolutely no light above bumper level, even 100 yards out.

DRIVING LIGHTS: Everyone knows that driving lights are white and fog lights are yellow. Many people know that driving lights focus light far ahead while fog lights spread it low around the front of the car. What many people seem not to know is that fog lights are mounted low on the front of the car, as close to the ground as possible, while driving lights need to be mounted high. Above the bumper at least; rallye cars mount them on the roof!

In other words, the lights mounted under the front bumper on the XJ-S really need to be fog lights. Fog lights will work great here; driving lights won't.

Of course, the reason you want driving lights is because you hate the looks of the yellow lenses. If so, here's a better idea: Install a set of modern fog lights with clear lenses and the dichroic filters right on the bulbs themselves -- which appear blue when the lights are off. These are better than the old yellow fog lights anyway.

Or perhaps you want driving lights because you can't see well enough with just the headlights on. This may be a valid reason if you have the US-spec Carello headlights, but with any of the other configurations of headlight on the XJ-S you'd be better off upgrading the headlights themselves as described in the earlier sections.

If you must install driving lights, kits are available everywhere. Perhaps the best place to mount them on the XJ-S would be within the upper grille.

As always, you get what you pay for; really good driving lights will provide a carefully-controlled pattern of light down the road, while cheap ones will just throw light everywhere and cause glare in rain and the like.

DRIVING LIGHT AIMING: How you aim driving lights will perhaps depend greatly on the light pattern they provide. If they project a tight beam, you'll probably want to aim them straight down the road to take advantage of that pattern. If they just provide a flood of light in the forward direction, though, you might consider aiming them crosseyed or skewed so they help illuminate the sides of the road in curves.

ALTERNATIVE CONTROL SCHEMES -- DRIVING LIGHTS: If the car is fitted with driving lights, it might make sense to rewire the XJ-S so that all the headlights and driving lights work at once. In fact, later US-spec XJ-S's came with a master lighting switch with an additional position that operates all six lights. It may be possible to retrofit this switch into the earlier cars. Or, you can simply rewire the "inhibit relay" scheme in the earlier cars, allowing high beams and driving lights to be used simultaneously; it might also be a good idea to add relays to prevent overloading any circuits.

With the options available for improving the headlights, there really is little reason to operate the driving lights simultaneously to get *more* light; you should be able to get plenty of light from the main beams. However, the driving lights might make excellent "cornering lights" if you aim them towards the sides of the road.

In many US states, there once were laws that prohibit there being more than four headlights on a car. Jaguar's intention for the inhibit relay was to prevent use of the high beams while the fog/driving lights are on, thereby making the 4-headlight US-spec car comply with the law. It is unknown how these laws have evolved now that the law requiring standardized headlights has finally been eliminated (thank God!). The owner is advised to check his state's current regulations before rewiring for all six lights to operate at once.

If your desired wiring scheme requires another switch, John Goodman points out that the UK cars have a different headlight switch which can be pushed in to turn on "fog lights" at the rear of the car; this push facility could be used for whatever your little heart desires, leaving your dash uncluttered with additional switches.

Horn

Steve S had his horns quit working, and found that the problem was a lack of ground connection at the steering column. There is a little copper spring that rides on the rotating shaft in the center of the column to electrically connect it with the outer casing -- but the outer casing may not be securely grounded! "I've run a separate earth from outer column to car body and everything's OK again."

"I couldn't find any proper earth wire from outer column to body; looked like Jag relies on the four bolts which hold the column to the body. I gave these 4 bolts an extra tweak but it didn't make any difference. I ran a 3" long wire from a convenient bolt head (looked about m4) on the plate on the front of the steering column lock mounting plate to a cluster of 4 black wires joining together at a 4 way bullet connector coming from the column stalk switch area."

Radio/Sound System

INTERCHANGEABILITY: Greg Meboe says, "During the 70's and 80's, the sedans and XJ-S's used the same radio, exactly. Until 1988 of course, when the radio in the sedan had a curved faceplate to match the new dashboard."

RADIO WIRING DIAGRAM: Greg Meboe adds, "On the top of my '84 cassette player which I removed to install the DIN radio, there was printed a nice wiring diagram for the color codes of the Jag radio circuit. I haven't been able to find this in the general manuals, and it's valuable information for anyone who is installing an aftermarket radio in their Jag."

RADIO REMOVAL: Steve Broady, regarding the late-80's radio: "Assuming your radio is a Blaupunkt made in Korea, you will need to cut a coat hanger into 2 pieces like a pair of U's to push into the front plate holes to remove radio from bracket. When you pull the radio out of the dash watch for ground strap on left side as bolt protrudes into bracket." Note that what Broady describes is actually a fairly common type of mounting, and the little U-shaped pokers are actually available separately at auto audio stores.

RADIO SECURITY -- REMOVABLE FACEPLATES: According to Greg Meboe: "The 86 Jags came with the removable-face tape deck, a design which has made radio repair/replacement outfits a lot of money due to its low service life. The face comes off to ward against theft, but the connectors for the face don't seem to cut the mustard."

Vince Chrzanowski, who repairs and restores old car radios, says, "The faceplates can't be repaired by ordinary mortals. The commonest failures are not in the LEDs, but in the surface-mounted integrated circuits which are hidden under mounds of epoxy. Additionally, the slide controls are among the most failure-ridden we've ever seen. But the faceplates *can* be purchased in repaired form. Our source for rebuilt faceplates is Southern Autotronics in Virginia (1-800-446-2880, usual disclaimers apply). The last time I purchased one, the technician indicated that they were in short supply. That was about two years ago.

"The 9500 series radio was, in my opinion, not nearly as reliable a radio as the so-called *lesser* 8600 series. After struggling for a few years to keep the 9500 alive in my '85 XJ-S (faceplate, tape deck and pc board failures), I opted for the 8600 and have been perfectly happy ever since. Actually, the 8600 is much easier to use and much safer to operate on the road."

RADIO SECURITY -- CODES: Somewhere around 1986, Jaguars came with a radio that had another security feature: if the power was disconnected, the radio would never work again unless the correct security code is entered. Presumably, people who steal radios won't steal one they can't use.

Of course, you can choose any repair procedure in the manual, and chances are the first step is to disconnect the battery. If you already went through this and your radio is now nonfunctional (or you have stolen such a radio), you apparently will need to contact your friendly dealer to obtain the security code. You may also need to provide a serial number that begins with "B" that is on the case of the radio.

If you would like to avoid the grief, reportedly there is a product on the market that can be plugged into the cigarette lighter. It uses a 9V battery, and will keep a small amount of power on the system while the battery is disconnected. It will supposedly keep the radio operational, stations programmed, etc.

CONDENSATION DEFLECTOR SHIELD: Apparently, either plugged condensate drains in the A/C system or leaking heater cores have a tendency to dump water on the stereo -- and some of those stereos ain't cheap! So, Technical Service Bulletin #8685 says essentially that a "condensation deflector shield" *must* be installed on all XJ-S vehicles prior to VIN 163790 whenever the mechanic is working in the area. The part number for the deflector is CBC 9193, and it appears to be *very* easy to install, requiring only 0.10 hours.

SPEAKERS: The '83 XJ-S comes with a decent sound system, except that it lacks tweeters. It is highly recommended that if your car doesn't have tweeters, buy some and add them. You can just add two in the front -- some people feel that only bass notes should come from the rear to give the impression that you are "facing the orchestra" -- or you can add one at all four corners to provide a complete surround sound. Just wire them in parallel with the existing speakers. If there are any induction coils in the line to the existing speakers (they are sometimes installed in a fuse holder), wire the tweeters in *before* these, so the induction coils serve the existing speakers only.

There are many types of tweeters available. The best kind are a 1" or smaller dome tweeter; some may have a dome made of plastic or even titanium, but either way they provide excellent high frequency sound and excellent dispersion. The size refers to the size of the dome itself, but nevertheless the entire thing is pretty small -- and they're usually fairly inexpensive as well. The sound from tweeters is pretty directional, so some tweeters come with a mount that allows you to aim them -- but even if you just mount them flush in the doors, the sound will be vastly improved over no tweeters at all. Be sure to get 4 ohm tweeters; the 8 ohm tweeters are intended for home systems. Dynamic tweeters will usually come supplied with a capacitor; wire the capacitor in series with the tweeter. This forms a filter that keeps the bass notes from being applied to the tweeter, which might burn it up.

Another good option is to go to Radio Shack and buy piezo tweeters, Cat. No. 40-1383. The nature of a piezo tweeter means that you don't care about ohmage or filtering, just wire them in. They're cheap, sound good, and are almost impossible to damage.

MAKING THE AFTERMARKET RADIO FIT: Greg Meboe provided some guidance on how to get a fancy new stereo to fit in my old Jaguar. "Your car is an '83, so it would have originally been fitted with a two-knob cassette player with manual pushbuttons for play, ff, rr, and eject. This radio was fitted from '82 to '84, inclusive. The metal facia panel (fibre-optic panel) which was fitted with this radio has a cutout which resembles a side view of a foot-long hot dog stuffed into a normal-size bun. Starting in model year 1985, Jaguar began to fit the more modern, rectangular faced radios which use a large, rectangular facia cutout. The fibre-optic panel fitted to 1985 and newer sedans and S's will therefore accommodate any modern DIN radio without modification. The radio mounting scheme for the Jaguar was the same throughout the years, so a person could install a 1985-on Jaguar radio in their pre-'85 car just by fitting the later style fibre optic panel." This panel is shown on the "Heating and Air Conditioning-Controls" page of the Parts Catalogue (besides framing the radio, the panel also holds the knobs for the A/C system). The part number of the 1986-on panel is DAC3418.

"For the structural mounting of the radio, modern aftermarket units seem to have a series of standard 8mm mounting holes on the side. I made up a set of steel brackets to fit these standard holes, and mount the radio in the fashion that Jaguar intended -- with the nylon push fasteners in the front."

BLOWING FUSES: Typically, the first time you crank up the volume on your high-powered aftermarket stereo system, it'll go silent on you. Sean Straw says, "There are three fuses associated with your stereo - the fuse in the passenger side fusebox (RADIO/CIG LIGHTER), the fuse on the stereo itself (well, any self-respecting stereo will have one), and one

on the line between the two, which as the manual describes, should be in the console (actually, the Jaguar service manuals claim it is "behind the stereo").

"I'd installed a new stereo, and I had it turned up a bit, then switched to the cassette, and it just blinked out. After some probing around, I determined that it was the fuse between the stereo and fusebox, and located it roughly forward of the cruise control switch on the console (underneath the driver-side console ashtray). It will require that you remove the console veneer entirely.

"I found the fuse wiretied closely to a bundle, as well as electric taped over the fuse housing to another line (dunno why - I eliminated the tape when I was in there). I found a 2A fuse in there, but the manual calls for a 1A - both of which are odd, given that the stock Jaguar stereo had a 10A fuse on it -- fused to that same power input as the inline fuse is on (as versus the ignition/accessory input which tells the stereo to wake up). I checked with the local Jaguar dealership and he said there shouldn't be a problem for that line to carry 10A, so I switched the inline fuse to a 10A and the stereo works fine."

Actually, the situation could use a little more explanation. The Haynes manual and the ROM seem to talk only of a "radio" and otherwise provide little info on wiring of the stereo system, but with almost any system there are actually two separate power supplies: a switched and an unswitched. The unswitched is connected to the battery at all times while the switched turns on and off with the ignition key. In the old days when things were simple, the unswitched line drew only a tiny amount of power, since all it did was maintain the settings on the tuner presets and the like; the switched line, which powered the amplifier itself, the tape drive mechanism, and anything else you didn't want on when the car was off, drew the relatively heavy current. Hence, the switched line would be fitted with a 10A fuse or some such, while the unswitched line would get only a 1A.

Then the serious autosound buffs came up with the idea of installing huge capacitors in the power supply to a stereo system. These "stiffener capacitors" can range from 0.25 farad (already larger than most any other capacitor used anywhere by several orders of magnitude) up to 1.5 farad; the rule of thumb is 0.001 farad for each watt of amplifier power. These capacitors are typically about the size and shape of a 12-oz. beer can, and some stereo buffs connect up entire banks of them! Their purpose is to maintain a rock-steady voltage supply to the stereo when the stereo itself calls for a sudden surge of power, such as when a heavy bass note is hit.

The problem is that such capacitors cannot be on a switched line. In fact, installing them in a car requires some care in pre-charging through a resistor before connecting, or something will get fried. Once installed, they must remain in continuous connection with the battery at all times, and disconnecting the battery for servicing the car requires discharging and recharging through the same resistor when reconnecting. If installed on the switched circuit, the first time you hit the ignition key the contacts within the ignition switch would weld themselves into a handsome little glob.

As a result of these developments, the modern stereo systems have changed the standards. They still require a switched and an unswitched power supply, but in order to take advantage of stiffener capacitors and other power supply upgrades, the heavy current is taken from the unswitched line. The switched power supply now becomes merely a "signal" that the ignition is on, and therefore draws almost no power.

Obviously, if you remove an original deck that drew its amplifier power through the switched line and install a newer deck that draws its amplifier power through the unswitched line, the first thing that's gonna happen is you're gonna blow the tiny fuse that was originally intended only to maintain station presets. Straw's dealer is correct, almost any circuit in the car will handle a 10A fuse without trouble, so you can merely replace the 1A inline fuse with a 10A to make your new deck work. On the other hand, you might opt to run a new heavy-duty power supply wire from one of the two main terminals on the firewall directly to your new deck to make sure it's not starved for amps when you're rockin' out.

CD CHANGER ADDITION: David Brown sends this info on installation of a CD changer in the boot: "I believe all post-'88 cars are pre-wired. Depending on what year you have, a 7-pin DIN socket (that's what we call it in the UK anyhow) will be found in different places in the boot (trunk).

"... a Clarion changer unit will plug straight in and you're all set.

"For a Philips or Alpine unit, you have to disassemble the plug on your CD changer and rewire a couple of pins around. Basically you can *control* the unit as it is currently wired, but you would hear nothing. The head unit expects the sound signals to be traveling down some otherwise unused pins. Simple experimentation shows what they are.

"On my Philips unit, I had a DIN plug which carried the instructional/power signals and had separate phono/tulip plugs which carried the sound. I patched those sound signals back into the DIN plug at the 11 and 1 o'clock positions. You could find out which pins *should* carry the signal by half connecting the CD changer to the cars socket, such that the changer works but you can still see the pins. Then dab each pin with a phono cable until you hear the music come through. Then you'll know which DIN pins are expected to carry the sound signal."

If you have this connector, the stock Jaguar stereo includes controls to operate these CD changers remotely.

CD CHANGER ADDITION -- FM MODULATOR TYPE: If you have an earlier car that isn't pre-wired for a CD changer, you can still add one by getting the type that splices into the FM antenna. This is convenient, since the antenna on the XJ-S is in the trunk. Such systems inherently lack some of the high frequency response of a directly-wired CD player, but it'd be the rare individual indeed who could tell the difference.

Bill MacDonald says, "All CD changers have a gain control for the output to the FM modulator. The little silver box that has the antenna wires and data and power connections contains the modulator on older Sonys. New models of all brands seem to be building the modulator on the circuit board right inside of the changer. You can adjust the gain either by an adjustment that is made for you to adjust the gain on the box or open it up and you can adjust a universal gain or a single left and right gain. You are supposed to match the FM volume equal to the CD volume, but it's your choice.

"You can also adjust the frequency deviation and offset; a lot of radios are not tuned exactly as they should be and sound scratchy or "s" words sound horrible. Be very careful and use plastic adjustment tools and I only recommend this if you have patience and dexterity because you can also detune the carrier and pull it out of PLL stereo mode. But if you sit in the middle of a quiet car with no noise around you and relax and adjust the modulator with your ears you can tune it in to sound a lot better than what it was factory adjusted to."

HEAVY-DUTY POWER: If you're installing a whopper of a sound system, you might consider replacing the Lucas alternator with a GM alternator as described beginning on page 531. This would permit installation of a reasonably-priced 140-amp alternator.

If 140 amps isn't enough, you may want to note the idea of replacing the air pump with a GM alternator discussed beginning on page 535. While the intention there was to eliminate the original Lucas alternator, there's no reason this same modification couldn't be used to fit the XJ-S with *two* alternators. Connecting two alternators to a single electrical system is reportedly unwise, but providing two entirely separate electrical systems is reportedly a fairly common exercise in the world of high-power sound.

Antenna

TYPES: In general, two types of antenna ("aerial" in the Jaguar parts books!) were used in the XJ-S. Up through VIN 123280, a Merlin antenna DAC3542 was used; this is a remote unit in which the drive assembly is buried under a panel in the right side of the trunk, and a cable housing connects it to the mast. From VIN 123281 on, a Hirschmann antenna DAC3579 was used; this has a black plastic rectangular housing. It is not remote, the drive assembly is right where the antenna is.

Richard Mansell says "I have a feeling the XJ40 uses the same electric aerial as the later XJ-S's." Actually, not quite right; the XJ40 uses a Hirschmann antenna DBC5101, but this unit looks almost exactly the same except for the electrical connection. It even uses the same replacement mast.

ANTENNA VS. SPOILER: Richard Mansell: "When you have a boot spoiler it's a bit of a problem as the mast goes through a small hole in the spoiler!" John Goodman explains: "On the boot spoiler equipped cars there is an additional relay wired into the boot light switch. The idea is that when the aerial is extended, radio and ignition on, lifting the lid very slightly causes the boot light to come on and the aerial to retract (after the stupid 4 second delay)."

ANTENNA MAST LUBRICATION: Michael Minglin says, "Porsche dealers sell a small foil packet with an oil soaked swab inside. This is to lubricate the antenna shaft." Hal Rogers (see page 662) adds, "Jaguar also sells a similar lubricating pack as well. A number of Jaguar specialists (like myself) carry it. It is very inexpensive." Considering the wealth of information listed below on repairing the antenna, maybe this lubrication is a good idea.

MERLIN ANTENNA DRIVE WIRE REPLACEMENT: Steve Leamy says: "Some models use a plastic drive wire instead of metal; you can repair these with weed eater line but you have to remove the motor base and ant to service it."

Dan Jensen tried using 0.080" grass cutter line, and it didn't work. "The main problem was it was stiff enough when coiled into the tight end of the coil guide that it popped out between the guides and jammed. I think having a material that (a) is reasonably flexible, (b) is tough enough to stand repeated uncoiling and coiling, and (c) has an o.d. near 0.125 are all important. I see no reason why grass cutter string would not work, but the o.d. needs to be close to 0.125 in. Note that the original extend/retract cable has a small hole in the center, i.e., it is *very* thick-walled tubing vs. flexible rod."

"I also tried PTFE (Teflon), but it quickly failed due to the repeated flexing. Ultimately, I used 0.125 inch flexible polyethylene rod purchased from a local valve supply company. This has worked without problems."

MERLIN ANTENNA MAST REPLACEMENT: Hal Rogers of H. D. Rogers & Sons (page 662): "It does not have a replaceable mast, never did."

ANTENNA CLUTCH ADJUSTMENT: Steve Leamy sends instructions on adjusting the drive clutch, apparently on the Hirschmann antennas but perhaps applicable to all: "This repair covers ant that just won't quite make it up or down and still makes a clicking noise before stopping.

"You want to get to the side of the unit that looks like a cup and has a screw in the middle of it. Remove the screw and the cover and you will have now exposed the clutch drive for the ant. On the shaft in center you will find a locking nut which you will now back off 1 or 2 turns, now grip the metal clutch and tighten 1/2 turn. Retighten locking nut and prop unit up so you can test it. Turn key on and radio and ant will raise in 15 to 20 seconds, once ant reaches full height you should hear 3 bumps and ant motor should shut off. Turn key off and ant should go down completely and 3 bumps and motor will cut off. If ant still does not go full up or down adjust clutch in quarter turns until a full stroke is attained.

"On 88 and above XJ's I have found three different manufacturers of ant in the cars I have serviced the but all of them use some type of clutch system and can be fixed by resetting of the tension on it."

HIRSCHMANN ANTENNA MAST REPLACEMENT: While the Merlin mast is driven via a plastic wire, the Hirschmann mast is driven by a plastic strip with a row of teeth down one side. These teeth engage a drive sprocket inside the unit.

A repair kit is available for Hirschmann antennas, including the mast and the plastic gear rack. The Jaguar part number is DBC2200. According to Hal Rogers, "The mast is the same for some German cars."

John Goodman suggests: "Replace the mast the easy way!!!

- “1. Undo mast securing nut on top of wing/fender(leave unit intact in car).
- “2. Get helper to switch radio on, while you pull up on the mast, the motor will extend the mast right out of the car complete with nylon cable.
- “3. Put new mast into hole, get helper to turn radio off, motor will pull new mast into hole, tighten securing nut.”

HIRSCHMANN ANTENNA -- BROKEN DRIVE COG: Samuel J. Louw shares his experience on his '89 XJ-S with the Hirschmann antenna: “I tested it with the cover off and saw that the motor was driving the gear, but that the second gear driving the antenna was not turning. I took the two gears apart and found the plastic pin transferring the driving force from the drive gear via the internal spring to the antenna gear broken off. The first glue attempt was unsuccessful, but on second attempt I enlarged the hole, which the plastic pin already has, a bit and fitted a small self-tapping screw, together with some steel epoxy. Antenna is working fine now. Glue and screw just needs to be flush with the gears.”

HIRSCHMANN -- OTHER FAILURES: Most automatic antennas have a motor with a worm gear on the shaft that drives a wheel connected to the spool that winds the mast up and down. The Hirschmann has a difference: instead of the worm gear being on the motor shaft, it's alongside the motor and there is a tiny toothed belt driving it. So, if the thing isn't working, it may be because this tiny belt has snapped.

ANTENNA REPLACEMENT: The original Jaguar antennas are incredibly expensive, even when the mail order shops put them on sale. If you're not real concerned about originality, you can replace either the Merlin or Hirschmann antenna and its delay relay with any of several antennas from J. C. Whitney or any local auto parts store for around \$40. It won't have that 10-second delay before going down, but nobody's ever figured out what that's for anyway.

If you're replacing a Merlin, there are aftermarket antennas with remote drive arrangements available for a few more bucks if you'd like to locate the drive in the same place the original was. Hal Rogers of H. D. Rogers & Sons (page 662) says, “The unit that we sell which is a replacement unit, not exactly the original, and you may need a fitting kit as well...It replaces DAC3542 or DAC4090 Jaguar part number.”

You don't really need a remote type unit, though; you can install a cheap replacement with the motor right on the bottom of the mast rather than remotely connected, so it's in plain view within the trunk. You can fashion a cute housing or cover around it if you wish. Typically, a remote drive antenna is used where space is a problem, but it's not a problem in the XJ-S; there's no telling why Jaguar selected the remote Merlin unit for its early models.

When selecting an antenna, always insist on one that is “fully automatic”, meaning it raises or lowers automatically when the radio is switched on or off; the “semi-automatic” antennas are electric motor driven, but you must control them manually from a rocker switch installed somewhere. The difference is only a couple bucks, so it's not worth the effort to install and use a semi-automatic.

Also note that the ideal extended length for an FM antenna is about 31”. Any shorter *or longer* will give less-than-optimum FM reception.

The aftermarket fully automatic antennas usually have two wires aside from the coax cable itself, one that should be connected to 12V power and one that should be connected to a signal wire from the radio. If you are installing a generic antenna, remove the original antenna along with the green delay relay attached to it. Connect the WK wire in the car to the signal connection on the antenna. Connect the NP wire in the car to the 12V connection on the antenna. If the antenna came with a fuse in the line you can include it in the circuit, but the XJ-S already has fuses in the circuits so you can just discard it if you'd prefer. If the antenna has a black wire, connect the black wire in the car to it; if not, make sure the housing of the antenna motor is grounded to the car, either by the mounting scheme or by connecting the black wire to it.

Also, both the original antennas as well as the aftermarket units have a drain tube to dispose of rain water that runs down the antenna into the housing; route the drain tube somewhere outside the car.

The antenna installation instructions also direct you to adjust the antenna trimmer on the radio. However, if your radio has an electronic tuner (digital display instead of mechanical needle), it probably has no such adjustment.

If you really like that 10-second delay, you can opt to keep the green relay in the circuit. Leave the WK and NP wires connected to the delay relay the way they originally were. Provide a connection from the NP wire to the 12V power connection on the antenna, which may require tapping into a line. Then connect a wire from terminal 4 on the delay relay (where the UW wire was originally connected) to the signal wire on the antenna. Tom Graham says, "The Jag relay spade connector we want will have voltage (battery) on it when the radio is on. Check this with a volt meter to chassis ground. Then turn the radio off, the voltage will drop off in about 15 seconds (this is how the delay works)." Note that terminal 5 on the delay relay, where the UR wire was originally connected, is not used in this scheme.

Miscellaneous Interior Stuff

SEAT HEATER: Later XJ-S's come with a seat heater, and apparently it lacks reliability. Stefan Schulz sends a description of the repair of this unit:

"The seat is connected to the car electrics through three different connectors, one for the seat belt logic (cable runs under centre console, pull carefully to expose connector), one for the lumbar pump, and one for the seat heater. The latter two are under the seat and can be accessed most easily by moving the seat as far to the rear as possible.

"Having disconnected the seat heater connector, check with a voltmeter whether it delivers power when the seat heater is switched on. If it does, the problem is somewhere in the seat. Remove seat.

"Turn seat upside down in a clean area. Locate the connector that connects the bottom seat heater in series with the one in the backrest. Pull it apart. Use an ohmmeter to figure out whether the bottom or the backrest heater is faulty.

"If the bottom heater is faulty, remove the black rubber cover from the bottom of the seat. See where the heater power supply wiring enters the bottom cushion ? Good. Carefully pull it apart at that point, exposing the top of a cheap and nasty heater element.

"Cut the top covering of the heater element to one side of the thermostat and flip it over to the other side to expose the thermostat element. Don't cut it away, you'll need to put it back later.

"There are three joints within the seat heater element. Orange/slate wire to thermostat, thermostat to heater element, heater element to black wire. Examine all three joints. Note that they get hot (hey, they're part of a heater) and are moved and flexed constantly. Solder joints should never be used in areas that get hot or which are under mechanical stress like the one these wires are experiencing. So what did the cheapskate Jaguar designers use? Exactly. The thermostat is cheap too, and its connection lugs will be badly oxidized.

"Take out the thermostat and subject it to the usual boiling water/ice water routine to test it. Check with an ohmmeter that it opens when in hot water and closes when in cold. Being more precise with a cheap part like that is a waste of time. If you find that the thermostat is faulty, you'll see that it is not a Jaguar part. Jaguar wants you to replace the entire heater and cushion assembly. But this 'stat doesn't do anything any other 45°C/12V/10Amp bimetallic 'stat wont do, so get a replacement from an electronics shop if necessary.

"Solder the thermostat back in, using weapons-grade solder wire with a high silver content and consequently high melting point. You did remember to dry and clean the connection lugs first, of course. Re-solder the third connection (heater to black wire) as a matter of course.

"Squeeze the thermostat back into the cushion, make sure that none of the heater wires touch it. Put back the top covering using *solvent-free* glue and a staple at the end. If you use glue containing solvent, you will find that that works the same way as the naturally occurring rot of the seat foam, only a lot faster - seconds instead of years. Use an ohmmeter to check the resistance offered across the seat heater connector now - it should be about 1.8 ohms.

"Refit all the other components by reversing the removal sequence. Put the seat back in the car and connect it (remember the seat belt logic connector!)"

GLOVEBOX LIGHT: The XJ-S doesn't have one! What a cheap car. It's easy enough to install one, though. Just buy a suitable light fixture at your favorite auto parts joint, and install it in the top of the compartment just behind the latch. Wire it into the interior light switch just to the left, so when the switch is operated it will turn on both the right front interior light and the glovebox light.

In the author's '83, there is an unused 2-conductor connector hanging out of the harness directly above the glovebox -- you'll need to take the glovebox out to see it. The wire colors are R and B. This may have been intended to power a glovebox light at one time. The B wire is a ground, and the R wire comes from fuse #15 in the auxiliary fusebox -- which is the fuse to the right front parking and marker lamps. Hence, if a glovebox lamp were to be powered from this connector, the lamp would be on whenever the parking lights are on. If you don't like that, you would need install a glovebox door switch in the circuit so the lamp was off unless the glovebox was open.

There are other implications of using that connector. Any current drawn through it comes through the bulb failure sensor for the right front corner of the car. Hence, the increased current could fool the sensor into indicating that the bulbs are all OK when, in fact, one is burnt out. If you don't provide a glovebox door switch, you probably should readjust the tiny screw on the bulb failure unit to put its sensitivity back where it belongs.

To avoid getting confused by voltmeter readings, remember that bulb failure sensor has resistance in it. On the author's car, the voltage at that connector was about 10V while the battery was at a solid 12V.

Yet a third power source possibility is a dedicated power source with a switch -- a glovebox door switch or even just a manual toggle inside the glovebox. There are lots of solid brown wires in the area; all of them have 12V whenever the battery is connected, and all of them have enough capacity to handle a glovebox light with no sweat. The main firewall power terminal isn't too far away, but you'll have to remove the rubber duct to get to it.

CIGARETTE LIGHTER: Apparently, some XJ-S's were equipped with some sort of non-standard cigarette lighter. This causes two problems: first, when the element in the lighter quits working, it's hard to find a replacement; and second, it may prove problematic to plug accessories into the cigarette lighter hole. If you are having either of these troubles, the easiest solution is to drop by any auto parts store and buy a generic cigarette lighter and install it, and throw that hokey Jaguar one out.

WHERE IS LUCAS TODAY? "Lucas merged with the Varity corp in Sept. '96. Varity is what was left of Massey-Ferguson after it was chewed up along with Kelsey-Hays. The president of Varity is now in control of the new LucasVarity and it seems that he has no love for Lucas or the name. US automotive operations will cease in the next few months for Lucas and will only be represented by a company called AutoSpecialty which was just recently acquired and based in LA CA. which will market no Lucas product but will be owned by LucasVarity. AutoSpecialty supplies undercar and braking products. LucasVarity will continue for a while in Europe but a team is taking surveys at present for a new name for the merged company, and it won't be Lucas."

Cruise Control

PRE-1992 VS. 1992-ON: Richard Mansell quotes from a Jaguar publication describing the changes for the 1992 model year:

"New cruise control: The V12 models now feature the Hella speed control system as fitted to the pre-92 MY 3.6 coupe in place of the AE Econcruise system. This gives more logical layout, more accurate control of speed, the addition of a cancel function."

As of now, this book only addresses the pre-1992 cruise control.

PRE-1992 CRUISE CONTROL: Thanks for the following procedures for troubleshooting the Jaguar cruise control system go mainly to Tom D. Graham.

CRUISE CONTROL DESCRIPTION: An electrical signal from the drive train provides the signal about how fast the car is going. On early XJ-S's there was a dedicated sending unit near the input flange on the differential unit. Later XJ-S's split a signal from the speedometer transducer on the transmission. On still later models, the transducer is built into the differential unit itself. See page 547 for notes on these senders.

The signal is processed by the cruise control electronic speed control unit. The speed control unit directs the amount of vacuum in the bellows unit and the bellows unit operates a cable to the gas pedal/throttle.

Within the bellows assembly are two solenoids, one which normally (cruise control off) vents the bellows to atmosphere and the other which normally seals off the vacuum line from the intake manifold. The "vent solenoid" is connected to the yellow/white and black wires, and the "vacuum solenoid" is connected to the yellow/white and yellow/black wires. When the control unit calls for speeding the car up, 12V is applied to the yellow/white wire, activating both solenoids. The vent is sealed and the vacuum line is opened, and the resulting vacuum within the bellows pulls the cable, applying throttle. The speed control unit modulates the ground connection of the vacuum solenoid to apply the proper vacuum to maintain a constant speed.

On the brake pedal housing is a switch that breaks the yellow/white wire whenever the brakes are applied, effectively shutting off the system and allowing the throttle to return to idle. This is actually a back-up feature; the power from the brake light switch is also sent to the speed control unit, which is supposed to drop the power to the yellow/white wire. Note that if the brake light circuit fails and doesn't put the cc into decel mode and the backup switch is the only thing that disables the actuator, as soon as the brake pedal is released the cc will resume and the car will accelerate.

As the result of a recall, there is yet another back-up device installed in the vacuum line to the bellows unit. This device is designed to seal the vacuum line and vent the bellows unit in addition to the solenoids.

CRUISE CONTROL ADJUSTMENT: If the cruise control is adjusted correctly, when the set switch is pressed the system will maintain the speed the car was doing at the instant the button was pressed. If adjusted incorrectly, it will maintain either a higher or lower speed. Hence, the test procedure is drive the car on a straight and level road and press the set switch, allow the speed to settle about ten seconds, and press it again. If adjusted properly, it can be set over and over and still maintain the same speed. If incorrectly, the repeated sets will result in gradually higher or lower speeds.

If adjusted incorrectly, adjust the speed control unit until correct; it is a simple matter to have the speed control unit hanging under the dash (it is located above the passenger side footwell) and the necessary tools along for the test drive, and preferably an assistant driving. Although the repair manual describes a method of adjusting the cruise control, some of these units have no obvious adjustments. If you pry the box open, however, there are two adjustable pots on the circuit board. The one to adjust is the one in the corner, farthest from where the wires enter the box. NOTE: The adjuster is *very* sensitive; it is difficult to move it a small enough increment.

SERVO TROUBLESHOOTING & REPAIR: If you have an ohmmeter, unplug the connector to the bellows unit and check the resistance across the bellows solenoids, yellow/white to black and yellow/white to yellow/black. Each solenoid should register 25-30Ω.

Connect the black wire from the unit to chassis ground and the yellow/white wire to 12V using a jumper wire. You should hear a click. Disconnect the black wire from ground and connect the yellow/black wire to ground, and once again connect the yellow/white wire to 12V. You should hear another click. This verifies that both solenoids are moving.

Connect both the black and yellow/black wires to ground and the yellow/white to 12V to activate both solenoids, and suck on a hose connected to the bellows unit. You should be able to move the bellows. If you can't seem to suck anything, the vacuum solenoid isn't opening (or the hose is kinked or plugged). If you seem to suck air easily without accomplishing anything, either the vent solenoid isn't closing or the assembly is leaking.

The following comments apply to the older cruise control actuators that had a bellows that looked like a bellows, and a flat metal disk that the cable attached to. Newer cars use a different actuator, and some even attach directly to the turntable -- a no-no with the older throttle cable design.

This cruise control actuator can be disassembled easily. Remove one bolt at the front end and disconnect the throttle cable from the disk at the rear end (don't lose the little cable attachment thingy!) and remove it from the car. Then peel the bellows away from the disk the cable attaches to, and away from the solenoid housing the same way.

These units seem to have several common failure modes. The first and most obvious is that the bellows leaks around the edges where it snaps over the metal disks; even a small leak is enough to render the system totally inoperative. If this problem is suspected, it is a fairly simple matter to peel the bellows off at both ends, apply some silicone sealant, and reassemble.

Another common problem is the bellows itself develops a tear or leak. You can easily check if the rest of the system is operational by patching the leaks, using a bicycle tire patch kit, tape, or whatever. It may not last, but it will tell you if the rest of the system is OK.

It has been suggested that using Son Of A Gun or some similar substance on the bellows may help protect the rubber from aging.

Gregory Andrachuk describes repairing another failure mode, sticky solenoids: after taking the bellows off, "I simply lubricated them *liberally* with Liquid Wrench (like WD40, but has Teflon). The cruise functioned *perfectly...*"

Yet another common failure is that the tiny rubber seats on the solenoid plungers fall off, and the solenoids no longer seal the ports. To repair this failure, merely glue the rubber seat back on the end of the plunger. After removing the bellows, the solenoids can be removed by prying them out of the housing to get at the plunger. If you've lost or damaged the rubber seat, use a hole punch on a bicycle inner tube to make a new one. Make sure the sealing surface is flat and smooth before reassembly.

It must be pointed out that a failure of a cruise control could be dangerous, although that would typically require the two openings to atmosphere to fail closed *and* the opening to vacuum to fail open -- highly unlikely. You should make repairs carefully, using a very reliable glue (such as JB Weld) to hold the rubber seat on the rod. Use of unreliable glue such as cyanoacrylate (superglue) is not recommended.

Robert I H Egerton adds some tips for putting the solenoids back in. "When I put em back they didn't work. Eventually I realised that the horseshoe-shaped bits of copper or brass under them are springs which hold the moving core down so you must ensure that they clip into the core when you put em back. I get my pension at Xmas so it took me some little time to suss it out ."

CRUISE CONTROL CABLE ATTACHMENT: Bill Trimble managed to lose the little part that screws onto the end of the cable to connect it to the bellows unit. "I took the car over to Rick the Mechanic's to see if he had any ideas, and sure enough he remembered that one of the local auto parts places had barrel connectors for hood release and choke cables. I bought one for a couple of bucks and we fitted it in about ten minutes, the only modification needed was to

gently pry out the round end on the bellows side to fit the wider diameter of the new barrel connector. We also wrapped some safety wire around it so that if the cable slips out again, the connector won't fall out.”

Safety wire is tricky to get right here. Before trying to assemble this thing, take the tiny screw out of the barrel connector, push it through a tiny piece of cardboard, and screw it back into the barrel. That way, when your grip on the thing fails, the barrel will only drop 1/4” and sit right there on the loop instead of falling into the dark abyss. A washer would work, too, but it'd jingle with engine vibrations.

Another idea would be to tie a piece of string to the screw, and tie the other end to the bellows end plate itself. You could actually do that before taking it *apart*.

HEAT SHIELD INSTALLATION: There's a heat shield attached to the bracket that wraps around the bellows and holds the cable housing. This heat shield should be underneath the bellows to protect it from radiant heat from the engine. Steve Wilke's car had it on top when he got it. If your car has been similarly misassembled, you'll want to correct it.

SERVO RELOCATION: To get that bellows assembly to last longer, it would probably be a good idea to relocate it somewhere cooler; this will not only keep the actuator cooler, but it will make working on the distributor easier. Ron Whiston relocated his to the area in front of the radiator, mounting it on the same bolt that holds the horns. He fabricated a new cable, similar but longer. He notes that removing the mount bracket, which is held to the back of the A/C compressor with the same bolt that holds the hoses on, will require recovering and recharging the freon circuit -- a lot of extra effort and expense. Therefore, he suggests you can either wait until you're working on the freon system anyway, or you can fabricate a new bracket and abandon the original one in place until the opportunity arises to remove it.

BELLOWS REPLACEMENT: Jim Isbell says, “If you ever do this make sure you get the metal ring out of the center fold of the old one and put it into the new one which may not have the ring in it.”

SERVO REPLACEMENT: If you have to buy a new servo unit from Jaguar, be prepared to open your wallet a long way. You may find better prices if you shop around, though; Randy Wilson says “Those of us not locked in to the Jag parts distributing system, i.e. the independents, have an alternate source for this servos, plus we can get the bellows as a separate service item. They still aren't cheap, as they come through a different British car parts network (RR!), but the servo is about half what Jag wants.”

CRUISE CONTROL TROUBLESHOOTING -- WIRING AND SWITCHES: To check the wiring, disconnect the wiring connectors at the speed control unit. The speed control unit is located just under the fuse panel above the passenger footwell. It has two electrical connectors, a nine pin connector and a single pin connector. Pull the connectors apart and perform the following checks on the wires going out to the car, not to those going into the speed control unit. Make sure that the bellows unit three wire connector is connected properly if it was disturbed by previous testing.

Connect one lead of a volt/ohmmeter (VOM) to a convenient car chassis metallic ground, and test to make sure you have a good ground using the ohm setting on the meter. The other meter probe will be used on the pin connectors. Unless stated, all measurements are made with the ignition off.

- 1) Set VOM to ohms and test the black wire; it should check as zero ohms, since it is a ground wire.
- 2) The yellow/purple wire is connected to the “inhibit switch” mounted on the gear selector; this switch opens to allow the cruise control to work only when the selector is in D. The same switch serves to allow the kickdown solenoid in the GM400 transmission to be activated only when the selector is in D. As a result, when the

selector is not in drive, the wire is not truly grounded; it is routed through the kickdown solenoid in the transmission to ground, which is effectively grounded as far as the sensitive speed control unit is concerned. With the selector in P (or anywhere other than D), check that the yellow/purple wire reads low ohmage; it might not be zero, but it should be low. With the selector in D, it becomes open; check that it measures infinite ohms.

If the console is opened, the physical operation of this switch can be observed. These type microswitches, complete with the rollers, are available at electronic shops.

- 3) The black/pink wire is connected to the set switch on the turn signal stalk. It normally reads as open (infinite ohms) but should indicate zero ohms while the set switch is pushed. See below.
- 4) The black/slate wire is connected to the master control switch just behind the selector lever on the console. It should read open (infinite ohms) when the switch is in either ON or OFF position and zero ohms when the switch is moved to RESUME.
- 5) The yellow/white wire connects to the two bellows unit solenoids through the brake-operated switch which acts as a backup to cut out cruise control when brakes are applied. It should read the $25\text{-}30\Omega$ of the vent solenoid. When the brake pedal is pressed, it should read open. Note: the brake pedal switch intermittently shorting to ground is a known problem, so you might want to wiggle the brake pedal while here and see if you can get this wire to read zero ohms. If it does -- even for an instant -- read the section on fried ECU transistors below.
- 6) The yellow/black wire is connected to the vacuum solenoid. It should read $50\text{-}60\Omega$; this is because both solenoid coils are in series to ground referenced to this wire.
- 7) The yellow/orange wire actually connects to two different pins at the speed control unit connector. It is connected to the master control switch. Turn the ignition on, select a suitable voltage scale on the VOM, and check that this wire reads 12 volts with the switch in the ON position (center) and zero volts with the switch in the OFF position.
- 8) The green/purple wire is connected to the brake light switch. Normally, this wire should read zero volts; when the ignition is on and the brake pedal is pressed, it should read 12 volts.
- 9) The yellow wire to the single connector is the signal from the pulse generator mounted on the transmission. Pulses from this wire signal the cars' speed to the speed control unit. This pulse signal also works the speedometer, so if the speedometer is working it is likely that the pulse is also getting to the speed control unit. However, the presence of the pulse at this connector can be checked. Connect a voltmeter to chassis ground and the connector pin. Drive the car, and even at very low speed the signal will measure around 4 volts AC. And the voltage does not increase with speed.

SET SWITCH GROUND: The set switch on the stalk has a ground wire within the column that connects with other grounds. This wire has a nasty tendency to break off right where it attaches to the stalk, rendering the entire cruise control system inoperative. Any scheme that will provide a ground wire connection to the stem of the stalk itself will fix it. The broken wire can be spliced, or a new wire can be clamped onto the stalk just inside the column housing.

BRAKE PEDAL SAFETY SWITCH ADJUSTMENT: There are two different switches used on XJ-S's, but both need to be open when the brake pedal is depressed and make a connection when the brake pedal is released. One type switch is located on the brake pedal housing within the engine compartment, right next to the driver's side bonnet latch. It is threaded into the housing with a locknut. The locknut can be loosened and the switch screwed in or out until it works properly. The other type switch is located in the footwell, and its operation is obvious.

CRUISE CONTROL TROUBLESHOOTING -- SPEED CONTROL UNIT (IN CAR): If the bellows unit is OK and no problems are found with the cruise control wiring or switches, the only remaining component to check is the speed

control unit. The tester shown in **Figure 37** is simple to make, requiring only two flashlight bulbs, two resistors and some wire. It is also used for the bench test of the speed control unit.

Notes-

- a) Length of the three wires is about three feet each.
- b) The two bulbs are 3V flashlight type PR2.
- c) The 33Ω and 22Ω resistors are 1/2 watt or larger.
- d) The bulbs and resistors are soldered as shown.
- e) Small alligator clips will help in connecting.
- f) All components can be purchased from Radio Shack, about \$6.

Mount this assembly on a piece of cardboard about 4 by 6 inches.

Disconnect the connector from the bellows unit and connect the three wires from this tester to their respective colors on the wiring harness (not to the bellows unit). The bulbs and resistors take the place of the two bellows solenoids so that we can observe the operation of the speed control unit. Route this assembly out from under the hood and use a windshield wiper to hold it against the windshield so you can observe the bulbs while driving.

Next go for a drive. At about 30-40 mph push the “set” cruise button. The bulb on the left (33Ω) should light but rather dimly and stay lit. This bulb is taking the place of the yellow-white solenoid that closes the bellows to the atmosphere.

The right bulb should light but flicker, and, as you slow down the bulb will light brighter, and as you speed up it will grow dimmer. This bulb is taking the place of the yellow-black solenoid that controls the vacuum from the engine.

If this bulb test circuit works, then the speed control unit and associated wiring/switches are good. If this test fails then the speed control unit is possibly at fault.

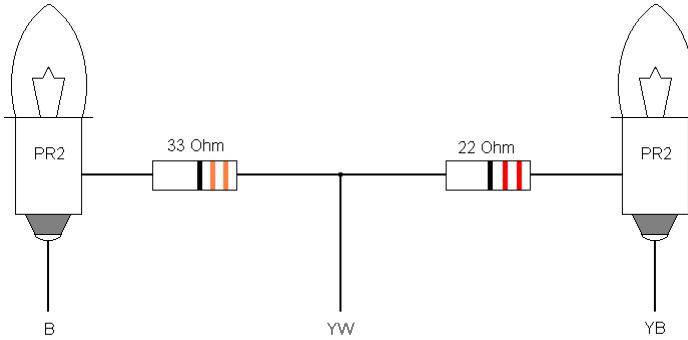


Figure 37 - Cruise Control Test Circuit

CRUISE CONTROL TROUBLESHOOTING -- SPEED CONTROL UNIT (ON BENCH): Bench testing the speed control unit is not complicated but you do need some experience working with electronic circuits. Essentially, what we do is connect up the speed control unit with power and grounds as it would be in the car, then feed it a pulse generation to simulate speed and observe its operation with the above two-bulb tester. Thus, to perform this bench test you will need:

- 1) 12V battery source
- 2) about 8 alligator clip leads, mini-size with boots
- 3) a sine wave frequency generator.

First, fuse the 12v battery supply with a 1 amp fuse; this will hopefully save you from any nasty smokings. The speed control unit should only draw around 1/2 amp.

Working with the speed control unit and its associated nine pin connector make the following connections:

- 1) Black/red and brown go to battery ground (negative).

- 2) Brown/black is not connected (simulating the inhibit switch in drive).
- 3) Brown/white is not connected (used only for “resume speed”).
- 4) Brown/yellow is attached to a clip lead but left open (it is the “set speed” switch).
- 5) The two-bulb tester is connected, black to battery ground, middle wire to yellow/white, and outside wire to yellow/black.
- 6) Yellow and black/green are connected to positive 12 volts.

This completes the basic wiring of the speed control unit. Next a pulse must be sent into it via the single green wire connector to simulate the car speed. A simple sine wave generator that can put out 5 volts at 60 to 200 Hz will work. The generators’ signal lead is connected to the green wire connector and the ground to battery ground.

With all connections in place and the signal generator set at 80 Hz, and 5 volts, touch the brown/yellow wire to ground for a second and remove it. This simulates pushing the “set speed” switch in the car. The two bulbs should light with the left one remaining steady while the right one changes its flickering as the signal generator frequency is lowered or raised. If not, replace the speed control unit.

FRIED ECU TRANSISTORS: One of the two switches on the brake pedal is a “last chance” safety feature for the cruise control system; it is connected between the system ECU output and the actuator itself, and when the brake pedal is pressed it positively disconnects power to the actuator no matter what else is going on. Such disconnection of the ECU output doesn’t hurt anything. The problem is that the switch is Lucas and may occasionally short the ECU output to ground, which *does* cause damage; the direct short flows too much current and blows a transistor or two in the ECU. It’s not terribly difficult to fix the ECU, but if you don’t address the switch problems it’ll just get blown again. Even if your cruise control is working, it might not be a bad idea to check the switch and make appropriate corrections to prevent trouble.

The switch in question is item #2 in the speed control schematic on page 86-13 in the ©1982 Supplement, and is connected into the YW wire between the ECU and the actuator. Hence, when you find the switch, it will have YW wires on both terminals. It doesn’t matter which wire connects to which terminal on the switch.

Note, however, Jaguar has used two different types of switch (in two different locations) in this circuit, and only the one used in XJ6’s and XJ12’s apparently has a problem with shorting to ground. The switch used in the XJ-S, C42525 or SMB420, is shaped like a bolt and is located on the left side of the pedal box inside the engine compartment. This type switch appears to have no problem. The troublemaker is DAC1895, used in the saloons. This rectangular switch mounts down in the footwell. Craig Sawyers helps identify it: “On the side of the switch I could easily see were the numbers 1533447, which isn’t a Jag number, so it must be Lucas’s code to hide the guilty.”

What to do about the switch? There are many possibilities, starting with merely replacing it with a new one. Bruce Segal says, “We got into the habit of always replacing this switch when replacing the ECU. Comebacks went way down.”

Sawyers found this fix unsatisfactory. “Some dumb-ass designed the switch body out of steel, which is firmly earthed. So when the plastic button wears a little in its guide, the conducting end wobbles sideways and shorts to the case. When I replaced my switch to cure this problem, I found the *new* switch could be coaxed to short by wobbling the plastic button. At that point I threw in the towel, pried the case off, and formed some thin card to fit around the inside of the case and prevent shorting once and for all. No problems since.”

Another possibility, obviously, would be to replace the switch with something non-Lucas. It is a very simple switch, so perhaps a suitable substitute can be found. The contacts must be open when the button is released and connected to each other when the button is pushed. Make sure neither terminal connects to ground under any circumstances.

Another possibility would be to install a totally different kind of switch, perhaps in a different location. A microswitch with a long integral lever could be used, which allows the large motion of the pedal to reliably operate the switch. Just make up a little bracket to hold it where the pedal arm will hit it when it’s in the fully released position.

Yet another idea would be to install a relay. You can connect the YW wires to the C and NO contacts of the relay, and provide ignition-switched 12V to one side of the relay coil and connect the other side to one terminal of the pedal switch. Connect a wire from the other terminal of the pedal switch to ground. That way, a short to ground in the switch would look just like the switch is closed, enabling the system but not hurting any components. Things would still work even if shorted when the pedal is pushed, because this is merely a safety feature; the primary means of entering disable mode when the brake pedal is pushed is via a 12V signal from the brake light circuit.

Finally, you could simply omit the switch altogether and just connect the YW wires together; as mentioned above, the system will still work normally since this is only a safety device. It's a rather important safety device, however, so this method is not recommended.

Once you have the switch problems corrected, you'll need to fix the fried transistors in the ECU. Segal says, "I've found that most of the time (except when you really need it) the cruise ECU's can be repaired by replacing two of the transistors inside. They are in the lower left hand corner of the board. The board is arranged so that the wiring harness comes off the left side. The transistors are labelled ZTX650 and ZTX750. They can be replaced by Motorola MPS650 and MPS750. Very easy and very cheap." (Ed. note: these transistors are nothing fancy, your basic three-legged items soldered to the board. They are also quite tiny, you'll need a magnifier to read the numbers on them.)

"The ECU part number is DAC4293. The older part number is DAC3672. The DAC4293 definitely can be fixed, I don't remember if the older one uses the same circuit." (Ed. note: The ECU in the author's '83 is DAC3134 and contains these same transistors.)

"By the way the original transistors are Zetex ZTX650 and ZTX750. Digi-Key (<http://www.digi-key.com>) sells Zetex so these parts should be available through them. You can use ZTX750 and ZTX751 as well."

Walter Petermann adds, "I use ZTX753 for the power out to the yellow/white wire, and ZTX653 for the control signal on the yellow/black wire. They are rated for 2amps (6amps peak). Digikey (800 344 4539) stocks them at \$0.78 under the above part #. They have a minimum order but I don't know what that might be."

SURGING WITH TURN SIGNALS: The author of this book may be the only owner who's ever had this problem, but I'll report on it anyway. Whenever cruising with the cruise control set and a turn signal was first turned on, the car would surge forward briefly. Then, after the EFI ECU was modified to provide better throttle response, the car would surge on each blink of the turn signals! Once the turn signal was cancelled, the car would return to its original set speed -- a clear indication that the problem was not due to a crossconnection between the set switch and the turn signal switch, since a "set" signal would cause the car to increase speed and *Maintain* the increased speed after the signal is removed.

The problem was eventually traced to a poor connection providing power to fuse 5 and on to the turn signals and also, via fuse 17, the G wires powering the cruise control system. The high-resistance connection caused the voltage to fluctuate more than a volt at fuse 17 when the turn signal blinked on and off.

In this particular case, the problem turned out to be within the ignition switch itself; it was pried open and the contacts cleaned and the problem was cured. Theoretically, any bad connection along the way would have the same symptoms, such as corrosion at fuse 5.

CRUISE CONTROL REPLACEMENT: Larry Lee sends this description on how to replace the Jaguar cruise control system with a generic Dana unit: "The particular unit I installed was purchased from Sears, Model 318.20309. This model came with a turn signal lever that can replace an existing one (if no other switches are on it), but Model 318.20308 included a clamp-on control switch. Other than the control switch design, the two units are identical. The manual for this unit does not say "Dana" anywhere in it, but I recognized the system as very similar to other Dana units (also purchased from Sears, but marked "Dana Electronic Speed Control Kit 250-1000") I had installed on other cars as far back as 1978. There have been some changes over the years -- such as a change from two driveshaft magnets to one, and deletion of an inertial deceleration switch -- but all of them that I have seen are installed essentially the same way." Note: apparently Sears no longer carries these units, but they -- or something similar -- may be available elsewhere.

"The installation manual is quite complete and easy to follow. It includes an electrical schematic and a pictorial drawing that shows how the various components and cables connect. The cable plugs are all different, so improper connections are difficult to make.

Follow the manual instructions to install:

Driveshaft Magnet

Road Speed Pick-up Coil

Servo

Disengagement Switch & Valve Assembly (Brake Switch)

"Some judgment must be exercised when mounting the various components."

The Disengagement Switch & Valve Assembly mounts on the brake pedal. When the brake is applied, it breaks an electrical connection to ground, killing the cruise. Besides that, it also vents vacuum to the system, making doubly sure it is off. Considering the fact that the stock XJ-S already has a switch mounted on the brake pedal housing for disabling the cruise control, it may be tempting to discard the Dana unit, plug the vacuum dump line, and just connect the wire to the stock Jaguar switch. Note, however, that the Jaguar switch works the wrong way; it breaks contact when the brakes are released, and connects to ground when brakes are applied. Therefore, a relay would be required to use this switch. Considering the effort required as well as the reduction in safety due to lacking the vacuum dump, it's probably better to simply use the Dana parts.

The driveshaft pickup is normally mounted right behind the transmission. However, considering how difficult it is to get around the transmission mount on the XJ-S, it may be preferable to mount it at the rear end of the driveshaft adjacent to the differential. If possible, the pickup should be attached directly to either the transmission or differential in order to move with them on their soft mountings; if mounted on the surrounding bodywork, the transmission or diff -- and hence the drive shaft with magnets on it -- may move around relative to the pickup, possibly interfering with the signal.

The Dana kit Lee describes attaches only one magnet to the drive shaft. While he reports no noticeable balance effects from attaching the small magnet to one side, those who are concerned may easily add a dummy weight to the opposite side when installing.

Note that any cruise control servo should be attached to the throttle linkage in a similar manner to the original. On the early XJ-S, it may be helpful to unbolt the throttle pedal assembly from the firewall and lift it out to look at it. If the cable connection is relocated to the turntable at the top center of the engine, operation of the cruise control may cause the throttle cable to come undone or jam; however, later cars were designed to permit attachment here.

Locating the servo unit itself may be challenging. The original mounted just forward of the distributor -- and you are replacing it, presumably because it didn't survive the heat in this area. If the cable is long enough, the best place is probably out in front of the radiator. You could get creative and make up your own extra-long cable, or find a way to connect the end of the Dana cable to the end of the Jaguar cable and use both!

Whichever Dana kit is purchased, the control switch assembly won't look all that great in the XJ-S interior. Worse yet, the original set switch (on the turn signal stalk) and ON/OFF/RESUME switch (on the console) will no longer be used, leaving either unused switches or gaping holes where they once were. The following is based on Lee's method for using the original Jaguar set switch and ON/OFF/RESUME switch in place of the control switch that came with the kit. This will maintain the appearance of the Jaguar interior, but it requires the purchase of a relay. Note: the illustration shows the terminal layout for an automotive relay, but any 12V SPDT relay will work. If an automotive relay is used, make sure it has the real 87a connector (normally closed contact). Many standard automotive relays, notably driving light relays, actually have two 87 connections and no 87a connections, which won't work. See the notes on the radiator fan relay on page 213.

Remove the 4-wire plug from the Dana control switch cable, and connect the Jaguar switches to the plug as shown in **Figure 38**. This sketch shows *only* the wiring that differs from the Dana (Sears) schematic in the area of the control switch; basically, the section of the Dana schematic from the four-connector plug onward should be replaced with this sketch.

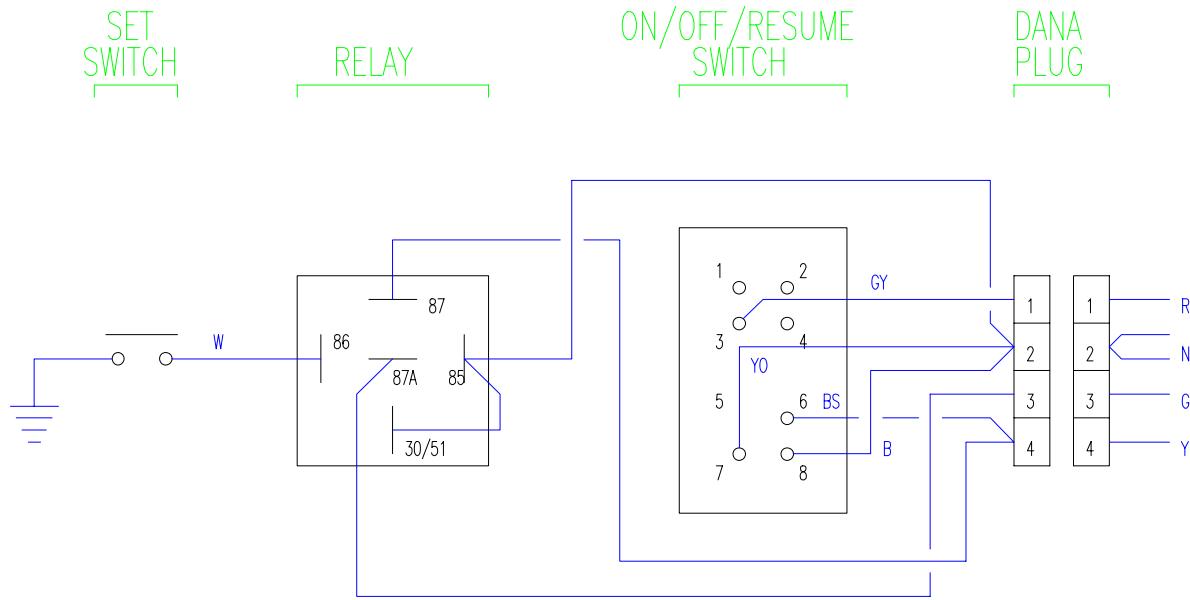


Figure 38 - Wiring for Dana Aftermarket Cruise Control

"How the Jaguar switch functions replace the Dana switch functions should be clear from the Dana schematic. The Jaguar switches are physically located in two places, but that makes no electrical difference. A good ground for the Set Speed switch is essential (as is a good ground for the Servo), but it can be located just about anywhere."

For clarity, Lee describes the operation of the Dana control switch that is being replaced: "It is a single piece that contains two separate switches, but they share a couple of wires. (For convenience, I'll refer to the wires by the numbers shown on the connector.) One is a momentary push button that is NC across wires 2 and 3. When pressed (SET/COAST), it opens between 2 and 3 and closes between 2 and 4. Actually, releasing this button is what engages the control and determines the speed setpoint. The second switch is a slide switch that has three positions. In OFF, no connections are closed. In ON, a detented position, wires 1 and 2 are closed. This same switch can be pushed momentarily (spring return) into RESUME/ACCEL position, which maintains the 1-2 closure and also closes between 1 and 4."

For those whose parts don't look exactly the same as those in the illustration, a description of the contacts made may be helpful. First, the relay: 85 and 86 are the coil connections, 30/51 is the common contact, 87 is the normally open contact, and 87a is the normally closed contact. On the ON/OFF/RESUME switch, placing the switch in the ON position connects contacts 3 and 7. Pressing the RESUME maintains the 3-7 connection and momentarily connects contacts 6 and 8.

"Once the unit is installed, the check-out procedure described in the manual should be followed without any changes. Use the electrical schematic to sort out any errors in the new wiring. Hopefully, this will not be necessary."

"The pictorial drawing in my manual showed one *unlabeled* adjustment screw on the Regulator." Note: the adjustment screw referred to here is on the side of the regulator box, to the left of the "Centering Adjust" screw. "It should be labeled 'Minimum Speed Adjust.' The manual describes how to make all set-up adjustments. I set the Minimum speed at 30 mph, which enables the unit to maintain a set speed anywhere between about 30 mph and 90 mph. Others may prefer a different range."

"Once everything has been tested and adjusted, push the Regulator and excess wiring up behind the underscuttle panel below the steering wheel. I have not found it necessary to fasten the Regulator to anything."

"One should now be able to enjoy miles of foot-off driving!"

Note that while this installation maintains the interior appearance of the Jag, the Dana cruise control does not work exactly the same; it has more features. First, the stock Jaguar set switch is just that, but with this Dana system it becomes a set/coast switch; if pressed and held when the system is engaged, the car will slow down, and a new cruise speed will be set when the button is released. Second, the resume position on the control switch becomes a resume/accel; if held down, the car will speed up.

One other issue: The original Jaguar cruise control system includes a switch on the shifter to ensure that the car is in D before engaging the cruise control. The Dana aftermarket cruise control lacks such a safety provision, probably because there is a built-in electronic control to prevent the engine from racing if the cruise control is engaged while in neutral; there is a step in the instructions for testing the regulator to ensure engine racing does not occur. The system also supposedly will not permit engagement below an established minimum speed, so engaging in neutral would evidently require attaining highway speed and then moving the shifter to neutral.

If the safety features that are good enough for Dana are good enough for you, the YP wire from the shifter switch may be simply abandoned. However, this same switch also ensures that the car is in D before sending power to the kickdown switch on the GM400 transmission. Therefore, the switch itself and the other two wires connected to it -- a LGW wire to the kickdown switch and a BW wire to the solenoid within the transmission -- must be left in place for the kickdown to function properly.

If, on the other hand, you insist upon restoring this safety lockout, another relay will be required -- a DPDT this time. A 12V power supply should be fed through the shifter switch to operate the relay. When in D, one pair of contacts on the relay should provide the same connection between the kickdown switch and the transmission solenoid that was provided before. When in any position other than D, a totally separate set of contacts should be wired in series with the disengagement switch on the Dana system.

STORAGE

This section provides tips for storing an XJ-S for extended periods.

GUMMY FUEL: Walt Osborn of Vintage Jag Works: "We have the third car in the shop this year with stuck valves. This is becoming more of a problem as people collect more cars than they can take care of. Some of the cars have been sitting for several years and the gasoline evaporates and leaves behind a syrupy varnish-like substance which gets on the valve stems in the cylinder head and causes them to stick in their guides. They stick in the open position, the owner attempts to start the car and/or turns the motor over with the starter, and the piston fouls the valve. Now the engine may start and run for a time and then start missing. The miss is usually a bent valve."

FUEL STABILIZING: Fuel reportedly doesn't store well, it goes "stale". Fuel lines and other components may be affected by "varnishing".

In the old days of carburetors, it was usually recommended to cut off the fuel supply and run the engine until the fuel lines and float bowls are empty. Unfortunately, this is more difficult to accomplish on an EFI system -- and may do more harm than good. The electric fuel pump is immersed in fuel, and running it for any length of time with air in it is probably not advisable. The worst thing for injectors is water, so condensation in empty fuel lines wouldn't be good.

The local auto parts store sells fuel stabilizers that can be added to fuel. Before storing a car, add some fuel stabilizer to the tank and drive the car for a while to get it circulated throughout the fuel system. Gregory Wells says, "Sta-Bil is one brand and these things are almost always available at boat dealers, since they are highly recommended for use in boat engines stored over the winter."

ENGINE FOGGING: The auto parts stores sell aerosol foggers for preparing engines for storage. For the Jaguar V12, you will need two cans of aerosol fogger and three people. When ready to park it, take both air cleaner covers off and disable the ignition and EFI -- you can disable both in one move by disconnecting the white/slate/blue wire to the ignition amp right on top of the engine. Have one person stand on either side of the car with a spray can of engine fogger in hand while the third person holds the throttle open and turns the starter. A good blast for a few seconds in both sides at the same time. Turn off the starter and foggers at the same time, so you don't run any fresh air through behind the fog.

When it comes time to drive the car again, it is generally considered a good idea to change the oil promptly. There may have been condensation during storage, which will contaminate the oil.

TIRES: The following was attributed to a Yokohama tech rep: "He recommended two methods for storing vehicles. First, inflate the tires to 65 psi and leave the weight of the vehicle on the tires. 65 psi? Modern tires will accept 65 psi for storage without damage. You just can't drive on them at this pressure without damage. He did caution, however, that old stamped steel rims may not be able to take this pressure without damage. His second recommendation was to keep the tires at the proper inflation pressure and to remove the weight of the vehicle from the tires (ie. put the car on jack stands).

"The tech rep stated the reason for these two alternatives was that all tires contain nylon (typically, the nylon covers the steel cords and keeps the steel cords from working their way through the tread). The nylon will develop a flat spot. The colder the temperature, the faster and more pronounced the flat spot will be. Jag owners in Edmonton, Alberta, and Bismarck, ND should have first hand knowledge of this.

"A final recommendation, store the vehicle in a dark, well ventilated, cold room. Light (specifically ultra-violet light), temperature, and moisture will damage the vehicle finishes and rubber over time."

CAR COVERS: The general consensus is *not* to use car covers for long-term storage due to their adverse affect on ventilation. Car covers are apparently better left to daily use only.

BATTERY: Herbert Sodher hails from the cold North where people store their Jaguars all winter and drive less valuable vehicles in the snow. When stored that long, the battery in the XJ-S tends to go dead. The alternator, clock, and some stereos and security systems put a small drain on the battery when the car is parked. Jaguar recommends disconnecting the battery if stored more than a month, but that may be assuming too much about the condition of the battery and how easy the engine will be to start. And, disconnecting the battery requires resetting the clock, all the stations on the digital radio, and possibly some security stuff, all of which is a pain.

Sodher suggests the owner go to an auto supply store and purchase an on-board, fully automatic trickle charger and install it in the car. One called the Mity-Mite is made by Schumacher Electric Corp., is rated at 1.5 amp, and costs around \$30. This unit is so small that Sodher attached it right to the front of his battery with Velcro, and the battery cover will fit over it (his battery is not the original -- it may require a different location for the Jaguar battery). It comes with eyelet connectors that can be connected directly to the battery terminals. Merely remove the nut on the clamping bolt from each terminal, put on the connectors, and reinstall the nuts. The unit comes with a one-foot power cord, just enough to feed outside the battery box. When parked for extended periods, merely run an extension cord into the trunk. The unit will automatically charge the battery as required, and won't overcharge it.

MODIFICATIONS

ROUTING WIRES, HOSES, ETC.: John Napoli says, "A really easy way to run wires or hoses or whatever across the firewall on an XJ-S is to go through on the passenger side (Federal models) access plate where the pedal box would be on a Brit version. To get to it, remove the windshield washer reservoir (under the hood on the passenger side). Now remove the bracket and the plate. Plenty of ways to run your wires through there! Note that there is another vacuum reservoir for the climate control system underneath, as well."

GARAGE DOOR OPENER INSTALLATION: Paul Bachman says, "I took my garage door opener and replaced the battery with a 9 volt regulator (about \$0.50), and installed it inside the center console. Apparently, the entire wiring harness becomes an antenna, because the range actually increased (I expected it to be worse) when I buried the transmitter in a basically metal box. Sure is nice not to have that stupid transmitter in my way any more. I will install a third window switch between the two existing ones for the control.

"The 9 volt regulator (LM7809) is a very simple three terminal device in a large transistor package (TO-220). It is available or can be ordered at any electronics store for under \$1. One terminal goes to ground, one terminal goes to a switched 12 volt (+) source (can be found at the cruise control switch) and the third will provide a regulated 9 volt source. The 9 volt source is connected to the (+) battery terminal or soldered to the appropriate place on the PC board of the transmitter. The (-) battery terminal is, of course, connected to any handy ground (same place as the ground on the regulator). If you can handle a soldering iron, it is quite simple.

"This project is particularly practical if you have a garage door transmitter with a case that is broken and needs to be replaced anyway."

WEIGHT REDUCTION/RELOCATION

The XJ-S is a heavy beast. Let's face it, it's a luxury car, not a performer. The best way to aggravate the Corvettes would be to pull about 800 pounds out of this car. If you can do without the electric windows, electric door locks, stereo system, 5 mph bumpers, air conditioning, back seat, spare tire, carpeting, sound insulation, etc., etc., then go for it.

Another popular way to reduce weight is to replace components with lighter versions. Chad Bolles has replaced the radiator with an aluminum model, the bonnet with a fiberglass one, the A/C compressor with a smaller model, and other mods. Effective but expensive.

When making weight reduction modifications, bear in mind that such mods will affect acceleration in the non-wheelspin realm by the proportion of total weight of the car; removal of 200 pounds will improve acceleration by 5% in a 4000-lb car. In conditions where the wheels spin, weight reduction in the front of the car will help slightly, weight reduction in the rear will hurt slightly. Weight reduction has almost no effect on top speed (other than how long it takes to get there). Weight reduction has a similar effect on maneuverability as installing bigger tires; it may be negligible if the present tires are adequate. Although it might feel different (and that alone may justify the modification), the actual timed performance may be insignificantly changed.

Also bear in mind that the springs, shocks and other components are designed for a 4000-lb car. If the weight reduction is significant, the car will effectively be sprung more stiffly and will ride higher. If the stock springs are cut shorter to bring the ride back down, it will increase the stiffness even more. All of this may be considered desirable in a car as soft as the XJ-S.

Weight reduction from points high on the car is preferable, since it will lower the center of gravity and make the car lean less in corners. It is even beneficial to relocate components lower on the car.

Weight reduction at the extreme ends of the car is also preferable, because it reduces the moment of inertia of the car. In other words, it reduces the car's tendency to resist beginning to turn when going straight, and its tendency to keep turning when beginning to straighten out. It is beneficial to relocate components from the ends of the car to more centralized locations.

If weight is removed entirely from one end, it can change the balance of the car. Since the XJ-S is obviously nose-heavy, it would be helpful to either remove weight from the nose or relocate components to the rear of the car.

Weight reduction on rotating parts, such as engine/drivetrain moving parts, wheels and tires, brake rotors, etc., can have a much greater effect on performance than general weight reduction throughout the car.

COLD WEATHER

ENGINE HEATERS: If you live where it gets cold and use your Jag in the snow, it is highly recommended that you invest in an engine heater. While preventing engine damage due to frozen coolant is the most obvious objective, those in the know point to many other advantages to engine heaters. They reduce engine wear because running a cold engine results in accelerated wear. They save fuel since a cold engine burns a lot of fuel. They save wear and tear on the Lucas starter. And they render the cabin heater operational much sooner.

The ©1981 handbook says, "Provision is made on the right-hand side of the cylinder block for the fitment of an engine heater element obtainable from your Dealer under part No. C34403 - 110 volt." Apparently the handbook lies. C34404 is the correct part number for the 110V heater element, but the Parts Catalogue indicates that it's installed in the lower radiator hose. There's no place in the block to put it.

Jaguar provides part numbers not only for the heater and the elbow it fits into, but the two halves of the lower radiator hose as well:

Heater element (110V)	C34403
Heater element (220V)	C30381
Elbow	C36996
Hose - radiator to elbow	C41103
Hose - elbow to water pump inlet	C41099

It's interesting that the elbow is just that; it replaces one of the bends in the single-piece lower radiator hose.

If you're not enthused about the Jaguar offerings, there are several types of generic engine heaters available in various wattages. There are heaters that replace a freeze plug, although that option probably wouldn't work too well on the Jaguar V12 due to the lack of freeze plugs in accessible locations. There are heaters that are installed in a radiator hose, some of which include a pump to circulate the coolant. There are heaters which attach to the surface of the oil pan, and there are dipstick heaters. Some heaters have thermostats to turn them on when it gets too cold, and some have timers that will warm the engine in time for you to drive it.

Of course, there are two schools of thought on the use of an engine heater. Some recommend having it on whenever it gets below a particular temperature. This makes sense if it gets *really* cold where this car is parked. Hopefully, if you have the proper anti-freeze mixture, you won't need to worry about this possibility unless your Jag is parked outdoors in the Arctic. If so, building a garage with gas heat might be cheaper than paying the electric bills on the block heater.

The other popular idea is to turn the heater on some amount of time before you're gonna need the car, thereby having it partially warmed up and ready to go. This will prove *much* cheaper than starting the car and letting it warm up, both in terms of cost of electricity vs. gasoline and in wear and tear on the engine.

In either scheme, remember that the Jaguar V12 is 700 pounds and it's made of aluminum which conducts heat very well. You're probably going to need the biggest wattage heater you can find. Or, perhaps a better idea, two heaters; perhaps one in the lower radiator hose and one in the oil pan.

There are some who claim that the dipstick heaters, especially high-wattage ones, can be harmful to the oil and result in accelerated breakdown.

Those who live in cold climates already know one method that is *not* recommended: build a campfire on the ground, then roll the car over it. Every winter some morons make the paper by burning their cars to the ground.

RADIATOR COVERS: Would you believe your car can overheat when it's freezing out? The answer is definitely yes. The radiator is designed to efficiently transfer heat to the incoming air. When very cold outside, the coolant in the radiator may be cooled to the point where it begins freezing, and a slush containing chunks of ice starts collecting at the bottom. When the chunks get big enough, they can plug up the hose taking the coolant back to the engine. Once the flow of coolant stops, the coolant in the radiator freezes even more solidly -- and the coolant in the engine overheats.

If it's really that cold, the best prevention is to block some of the air coming through the radiator. This is easily done with a piece of cardboard. You'll be amazed at how much blockage is necessary to restore proper operation; it seems you have to cover three quarters of the radiator.

If this proves to be a regular problem, there are actually products available that provide a radiator cover that is adjustable from within the passenger compartment by means of a cable.

OIL: Many winter drivers have found that use of synthetic oil helps with cold weather operation. Synthetic oil apparently does not thicken as much as natural oil when cold.

John Goodman: "A tip passed on to me many years ago was to put a waterproof thermal jacket over the oil cooler in the winter months (bit hard to get at in a Jag !)"

FROZEN DOOR LOCKS: You're freezing, and you can't get into your car! A revolting development. Jim Wood says, "There are little black boxes - somewhat near the size of your car door lock "beeper" - that has a little round rod that fits into your key opening and its sole purpose is to heat the key opening up & melt the ice - in just a few seconds - at least in New York's coldest weather so my sister and bro-in-law say - so that your key will turn and open the door lock. They've been using these battery-operated things successfully for years. They fit very well just in the palm of your hand. They're not very expensive either!!! I'd keep a spare battery in my pocket or purse tho just in case - *not* inside the glove box ..."

LPG

People in Australia and some other areas like to convert their gasoline-powered automobiles to run on Liquified Petroleum Gas (propane) because it winds up costing about half as much in fuel costs to drive their cars. A complete coverage of all the implications of such a modification would add considerably to the already hefty poundage of this book, but mentioning a few of the concerns is in order. John Fergus says, "I would recommend you get a copy of *Propane Fuel Conversions* by Jay Storer (SA Design Books); this will tell you in detail all you need to know."

Eric Vuurman describes an LPG system: "The conversion leaves the original setup *unchanged* and the car can run on both LPG and petrol. Changing from one to the other is a matter of turning a switch on the dash (while driving!). The LPG-unit basically consist of:

- Pressure-tank (50 - 120 liters)

- evaporation unit
- 2 shutter-relays to change from LPG <--> Petrol
- nozzle between air-intake and carburetors.

"LPG is loaded into the tank by an outside mounted filling cap, no mess, no smell or fumes in the car. During operation, liquid LPG flows from the tank to the evaporation unit under natural pressure. In this unit the LPG evaporates into gas. The unit is heated by the cooling system of the engine (LPG needs heat to change from one phase to the other). The gas flows from this unit to a special "nozzle" piece that is placed between the air filter and the carbs. The control of the gas flow is achieved by a combination of vacuum and throttle control. In this way the engine is fed with a mixture of air/lpg and the carbs do not need to add anything to it."

Stig Abrahamson describes the installation on his Daimler Double Six: "Gas is fed via a solenoid operated valve to the vaporizer which is located next to the brake servo. Gas is then fed via adjustable orifices to mixers located between the air filter and throttle bodies. The mixers are simple venturis and draw gas in proportion to the air flow through the throttle. Switching between petrol and LPG is simply done by switching off the main ECU relay and switching on the solenoid LPG valve."

Peter Cave says, "The simple venturi mixers that I have seen have all been mounted on the engine side of the throttle body."

COST BENEFITS: LPG costs less per gallon than gasoline, but that's only part of the story. There is less energy per litre in LPG, so your Km/litre numbers will reportedly drop by perhaps 10-15%.

Of course, you will also need to estimate the costs in additional maintenance (or reductions in maintenance!), and balance all of that against the cost of system installation. The cost of a professional conversion seems to be in the range of \$2500US, but clearly you will need to check local sources for better estimates.

TAXES: A large part of the advantage of LPG is in the difference in taxation compared to gasoline. Since LPG is used to run stoves, heaters, and the like, it generally is not subject to "road use" taxes. As the LPG conversions get more popular, however, it can be expected that the governments will decide to close this particular loophole -- and eliminate much of the cost benefits you hoped for when you spent your money on the conversion! Governments may decide to start taxing all LPG or to find a way to tax only that used in automobiles, but one way or another they will get their cut.

SPACE: An LPG conversion takes up space in the car, already at a premium in the XJ-S. Eric Vuurman says, "The main disadvantage is the space taken by the tank." Peter Smith adds, "I imagine in the XJ-S the tank may restrict access to the petrol tank/spare wheel."

Even accepting the loss of trunk space, John Fergus says, "The main problem is finding room to place the converter. The converter may be known in the US as a vaporizer/regulator. Basically the liquid propane is warmed by the circulation of engine coolant and this converts the propane to a gas vapor. If it was allowed to vaporize without the heat it would freeze the lines. The LPG systems are very simple but there is really a space problem in the engine bay of the V12 XJS. One installer I spoke to recently said he puts it next to the brake reservoir on our right hand drive cars and the rest is fairly straightforward. I have yet to see a car under the bonnet to see how tight it is but I can't see that there will be enough room there."

SAFETY: Arguably a non-issue; after all, driving around with 20 gallons of liquid gasoline in a flimsy sheet metal tank isn't exactly the safest thing you can be doing, so having a heavy-duty pressure vessel containing a flammable gas may be considered an *improvement* in safety. Eric Vuurman says, "It is extremely safe. There are very simple but strict safety measures that apply to both the installation and the operation. LPG tanks will survive the most severe crashes and to date no report is known of any tank exploding after a crash."

POLLUTION: There are limited-production cars that are imported into the US in small numbers and meet the EPA requirements by converting to LPG! Stig Abrahamson says, "My car is a Daimler Double Six 1980 Series 3, Pre H.E. Digital P injection and the 10:1 engine. It started its life in Germany and was imported to Sweden in 1983. During that time Sweden had very peculiar emissions regulations shared only by Switzerland. A loophole made it possible to import cars and convert them to LPG. This is what happened to mine. The conversion was made with the sole purpose of getting it past the emissions test. I can have the engine running in my garage (door open of course) without feeling any odours apart from burnt oil dripping from various leaks.

"LPG in Sweden is now almost extinct. I happen to live close to one of the five filling stations in the country."

Where this author used to work at Pratt & Whitney Aircraft, the fork lift trucks used indoors ran on LPG to avoid indoor air quality problems. Honda has developed cars to run on LPG to meet the Very Low Emission requirements proposed for some areas.

Note also that LPG doesn't have any additives like gasoline does; it wouldn't be a good idea to put additives in a fuel that might be used to grill hamburgers.

POWER: Along with the reduction in Km/litre, there is also an estimated reduction in power of about 10% when operating on LPG. Many drivers claim they don't even notice.

Stig Abrahamson adds, "One advantage is that it has a sharper throttle response on LPG compared to petrol."

OPERABILITY: Eric Vuurman says, "LPG gives *instant* smooth engine running. Especially with older engines/carbs in a wet/cold climate this is a huge advantage. There is no need of mixture adjusting with (automatic) chokes or other gadgets when the engine is cold. Just start the car and it runs great."

IDLE: Stig Abrahamson explains: "In order to feed the engine a combustible fuel air mixture all of the air has to pass the mixers between the air filter and throttle. This makes it impossible to use the AAV since it bypasses the left hand throttle and thereby reduces the amount of fuel delivered to the engine as well as upsetting the balance between the banks.

"Solution to this was to plug the AAV and set the idle using the stop screws on the throttles and balancing them with a standard carburetor balancer. When this was working I had to find a way of increasing the idle when cold. My solution was to carefully adjust the throttle linkage and add a solenoid to the central butterfly and energize this via a small thermostat opening at 60°C and preventing the throttles from closing against the stop screws when the engine is cold. This gives me only one step in increasing the cold idle but it works reasonably well.

"Another minor problem was the PCV valve which also bypasses the throttle. I have strengthened the spring a bit to prevent it from opening at idle."

John Fergus counters, "I have often thought of blocking the AAV to see if this would give a stronger idle when cold but have not done so yet. My '78 XJ-S has no mods to the AAV or the PCV and it idles quite well in all circumstances. However I do find it necessary to start the car on petrol for the first time each day as the LPG does not fire up a cold engine as instantaneously. The one limitation is that it is not possible to get a high idle, e.g. more than 650 rpm, without opening the butterflies a little but I have resisted this as I still want to drive on petrol. Overall I believe the AAV operation seems to help the cold idle by somehow dragging the extra LPG past the butterflies. Perhaps the warmer weather in Australia doesn't place such demands on the cold start system."

OCTANE: LPG has gobs of octane, something like 110. Simply not a problem any more. However, it also has different flame propagation characteristics, which means that the ignition timing curves might need a little massaging to

optimize performance. Peter Smith says, "There is a compromise to make between the two fuels because LPG requires more initial spark advance and less further advance than petrol, so usually the timing is set a few degrees advanced. There are a couple of aftermarket black boxes which will try to reduce this compromise and Mallory used to make a good one."

ENGINE DURABILITY: As mentioned above, LPG has no additives. This concerns some people, and some even recommend that the car be run on gasoline on occasion to ensure that parts such as valve seats maintain a proper coating of whatever benefits the gasoline additives are supposed to convey. However, note that such advice may apply better to engines with soft cast iron heads without valve seat inserts than to engines such as the Jaguar V12. After all, the Jaguar V12 has always been suitable for operation with lead-free gasoline (the valves and seats used in US-spec cars operating on unleaded gasoline exclusively are exactly the same parts as used in V12 everywhere else).

Peter Smith says, "I have put more than half a million miles on LPG/petrol (dual fuel) cars and can tell you it's a better fuel for long life. Being dry, it doesn't wash the lubrication off the upper cylinder walls like petrol does. The plugs last longer although it needs a higher quality spark to ignite, so it won't like worn plug leads."

Eric Vuurman says, "I have a 1969 Volvo 164 on LPG. It has been running for 345000 km without any trouble or major engine work."

OIL: The oil manufacturers offer special motor oil for engines running on LPG. The reasons are uncertain, but most people with LPG conversions just use the oil and don't ask questions. LPG is reportedly easier on oil; it comes out looking as good as it went in.

IGNITION: Stig Abrahamson says, "The LPG/air mixture acts as a better insulator than petrol/air which puts additional strain on the ignition system. I had a problem with the old coil and replaced it temporarily with a generic one, worked fine on petrol but not on LPG. The original works though..." This being the situation, those with Marelli ignitions might want to take note and make sure to do the "silicone squirt" to avoid catastrophic failures described starting on page 154. Of course, they should anyway!

DIAGNOSTIC BENEFITS: John Fergus says, "It is useful as a diagnostic tool when trying to isolate problems with the engine tuning as you can switch between petrol or LPG."

CLOSED-LOOP CONTROLS: John Fergus (in Australia, where LPG conversions are big business) says, "There is a system available which consists of an O₂ sensor and a control module whereby the module will allow a direct feed of extra LPG to each mixer via a small additional hose when the O₂ sensor measures a lean mixture. Another firm does a similar system but instead of running extra gas when lean it controls the vacuum being sensed at the converter and makes the converter supply extra gas. All very simple and very effective and if the vehicle is a pre-H.E. without sensors then you end up with a computer-controlled fuel system better than the original Jag one."

WHERE TO FIND HELP, PARTS, ETC.

This section of this book provides a listing of some mail-order outfits and the like, along with choice comments. Note that this is *not* intended to be anything approaching a comprehensive list; it merely provides contact info for some of the more commonly referred-to sources and a few sources that provide difficult-to-find stuff. Inclusion in this book does *not* imply endorsement of the firm by this author, nor does exclusion imply that a supplier is somehow unacceptable or substandard. In general, outfits that concentrate on local business -- as opposed to nationwide or worldwide shipping and support -- are not included here, but such outfits may very well provide the best support for your particular needs.

Many mail-order joints advertise in the Hemmings Motor News, so pick up a recent issue to get the latest info.

DEALERS: Any Jag dealer can provide a pamphlet listing all the Jaguar dealers in the U. S. and Canada. If you think about it, this is a useful pamphlet to have -- a dealer isn't always easy to find when you need one. Dealers will usually ship parts, so they are another mail-order resource. Remember, if the dealer is shipping from another state, you save on state sales tax -- which will help pay the shipping charges.

Some dealers have an 800 number, good only in their home state or local area. At least one dealer's parts department has such a number and does not publish it. If your nearest dealer is a long distance call, be sure to tell them it's long distance; perhaps they will invite you to call back on an 800 number. Be sure to have a notepad ready!

TELEPHONE NUMBER CONVENTIONS: Throughout this listing, I have endeavored to use a notation for phone numbers that is apparently common in Europe. The first character is a + which indicates that you must begin by entering an "international access code", which are digits you must dial in order to begin an international call, and which vary considerably depending on where you are calling from; here in the US, you generally must dial 011, while in the UK you must dial 00. In Australia, the international access code is reportedly 0011.

The next one or two digits are the "country code", followed by a space. The country code for the US and Canada is 1, for the UK it's 44, for Australia it's 61 and for New Zealand it's 64. A more complete listing of country codes is generally found near the front of any telephone directory.

What follows on a US phone number will be the 3-digit area code, in parentheses, and then the 7-digit phone number itself. For UK numbers, the area code and number are listed, but no parentheses.

Now, the idea behind listing numbers this way is to provide all the information necessary to call these numbers from anywhere in the world. However, it becomes the responsibility of the reader to interpret this information somewhat in order to make a call within his own country or local area. For example, a person in the US calling a US number should know that he can forget about the international access code and country code and merely dial a 1 (or any of an entire smorgasbord of long-distance access codes in this day of deregulation) followed by the area code and number. A person in the UK dialing a UK number should know that he can drop the international access code and country code but must add a 0 before the number. Obviously, those who actually live within a stone's throw of the place being called may be able to drop even more digits and make a local call.

The 800, 877, and 888 numbers are another matter. These are toll-free long distance numbers, but they reportedly only work from within the US. Hence, they are listed as 1-800-xxx-xxxx, the way they must be dialed in the US to work properly.

Some notes regarding phone calls to the UK: On August 5, 1994, exchanges in the UK changed. For the most part, the change was simply to add a 1 at the beginning of the exchange, although a few exchanges changed entirely.

Paul Garside sends this explanation of the phone number conventions in the UK (prior to the addition of the 1): "Major city (e.g. London, Birmingham, Edinburgh, Glasgow) phone numbers used to be of the format:

<2-OR 3-DIGIT CITY CODE> <3-DIGIT AREA CODE> <4-DIGIT NUMBER>

All other towns and villages in Great Britain used the format

<4-DIGIT AREA CODE> <5- OR 6-DIGIT NUMBER>

These are all generally 6-digit numbers now. The spaces are also shown as dashes. There is no significance to either, they are merely for ease of reading."

In the UK, a company's literature often lists the phone number including the beginning 0. Remember that when calling from other countries, this 0 should be omitted.

INTERNATIONAL CREDIT CARD USE: If you have a credit card, you will find this is one of the neatest features of owning it. Charging a foreign purchase to a credit card gets the seller paid in his native currency, and gets you the best exchange rate available automatically -- the charge shows up on your statement in your currency. The credit card companies can offer the optimum exchange rates because they don't have to keep a pile of foreign currency on hand to do so.

TAXES: Those who purchase parts within the European Union must pay a Value Added Tax (VAT) of 17.5%. However, orders shipped outside the EU are exempt from this tax. If you are ordering from elsewhere and someone tries to charge you VAT, they are trying to rip you off. According to Stefan Schulz, this is a common scam.

Before getting into the listings of retailers, some numbers of general interest to Jaguar owners:

JAGUAR CARS LTD.

Browns Lane, Coventry CV5 9DR (UK)
+44 24 7640 2121

The source!

JAGUAR UK

<http://www.jaguarcars.com/uk/>

Mainly info on current models, but genuine Jaguar parts and accessories can be ordered.

JAGUAR DAIMLER HERITAGE TRUST

Jaguar Daimler Heritage Centre
Browns Lane, Coventry CV5 9DR (UK)
+44 24 7620 3322 FAX: +44 24 7620 2777
<http://www.jdht.com>

or

C/o Jaguar Cars Limited
Browns Lane, Allesley, Coventry CV5 9DR
+44 24 7640 2125 FAX: +44 24 7640 5581

"The Trust is a subsidiary of Jaguar Cars Limited." Outwardly, this appears to be just a car museum adjacent to Jaguar's original facility, but in fact it's much more than that. It appears that JDHT is determined to do whatever needs doing for the owners of older Jaguars. Among other services, they offer "Genuine Jaguar Engineering approved parts for classic Jaguars..." In other words, they may be the *only* place to get the part you need. They have even posted notices in Jaguar World magazine asking for ideas on parts that need to be *improved*.

JAGUAR OF NORTH AMERICA

Leonia, NJ
+1 (201) 592-5200
+1 (201) 818-8500

JAGUAR CARS, INC. -- PUBLIC RELATIONS
Mahwah, NJ
+1 (201) 818-9770

AUTOSEARCH LIMITED
PO Box 2032
Westfield, MA 01086
e-mail: SCOTTMCCON@aol.com

"We have a database of all dealers and manufacturers that sell car parts at retail, wholesale, and discount. We know of every supplier of aftermarket, performance, restoration, new, used, replacement, nos, car care, audio, etc. in the country and can supply a list for any make, year or model. If interested please send \$6.00 to the address above. We will send your list within one week of receipt. Please provide make, model, year and the general description of parts wanted."

NEW PARTS

BRITISH AUTO/USA
92 Londonderry Turnpike
Manchester, NH 03104
+1 (603) 622-1050 FAX: +1 (603) 622-0849
1-800-4-JAG-PTS

Apparently formerly known as British Auto Interiors, but has branched out to the rest of the car. Per Chip Weems: "They do their own direct importing, and in addition to interiors they are into fabricating a bunch of their own repro items. They are also a fairly large restoration shop, and when I've had trouble with installing some part, Tom will call in one of the mechanics to give me free advice over the phone."

BRITISH PARTS INTERNATIONAL
8101 Hempstead Road
Houston, TX 77008
1-800-231-6563
<http://www.motorcarsltd.com>

Franck Guilloteau says: "They apparently have an extensive stock pile of both new and used parts for models from early XK-E onwards with a comprehensive (250 page) catalog to boot. However, for prices you have to call, they are quite competitive."

BRITISH VINTAGES
645-D Tank Farm Rd
San Luis Obispo, CA 93401
1-800-350-JAGS or +1 (805) 541-5986

CATHOUSE SPARES

176 Liverpool Rd.
Enfield 2136
Sydney, NSW, Australia
+61 2-9747 2144 Fax: +61 2-9747 3212

Mark Jackson says this outfit sells locally-made stainless steel coolant cross pipes and header tanks to fit the XJ-S -- and for reasonable prices to boot. "Darn things are painted black - should have left them brushed SS!!"

CLASSIC COMPONENTS

Tower House, Teesside
International Airport, Darlington DL2 1PD (UK)
+44 1325 332505 FAX: +44 1325 332405

CLASSIC SPARES LTD/CLASSIC ENGINEERING

Unit 4 Brook Road, Britannia Road
Waltham Cross, Herts EN8 7NP (UK)
+44 1992 716236 FAX: +44 1992 788424
<http://www.jagweb.com/classicspares>

New and used parts, aftermarket parts, Jaguar-based kit and replicar support.

COVENTRY WEST, INC.

2101 Randall Road
Lithonia, GA USA 30058
+1 (770) 484-6500 FAX: +1 (770) 484-1419
1-800-331-2193
e-mail: sales@coventrywest.com
<http://www.coventrywest.com>

New, rebuilt, and used parts.

EAST COAST JAGUAR

802 Naamans Road
Wilmington, DE 19810
Tel: 1-800-475-9257 or +1 (302) 475-7200
Fax: +1 (302) 475-9258

Shameless bragging from the proprietor himself, John DiGiacoma: "New, used and remanufactured parts for all Jaguar models from 1940s to present. Many hard-to-find parts. Supplying restoration and repair shops and enthusiasts nationwide and abroad for more than 15 years. Water pumps, wiper motors and steering racks rebuilt. Brake parts resleeved. We are also a service shop with a very knowledgeable staff having over 20 years experience servicing, rebuilding and driving Jaguars."

ENGEL IMPORTS

5850 Stadium Drive
Kalamazoo, MI 49009
1-800-253-4080 or +1 (616) 375-1000

This is a Jaguar dealership. They will ship parts, and their 800 number is good country-wide. If they don't have the part you seek, they have access to a computerized system that theoretically will find it at any dealer in the US that has it.

EUROPEAN AUTOPARTS SPECIALISTS, INC / AUTO DOCTOR

23151 Telegraph Road
Southfield, Michigan 48034
+1 (248) 353-1592 or +1 (248) 355-2730

They have no catalog, but they can still get most parts to you as cheap as anybody. They have a \$50 minimum order, however.

EXOTIC AUTO PARTS

Anaheim, CA
1-(800)-231-3588
+1 (909) 946-1809

AL HOGAN'S AUTOJUMBLE

Mansfield, Ohio
+1 (419) 524-1088

This is a business that specializes in buying out old stock from dealers. The owner Al Hogan is very knowledgeable about British car parts.

INTERNATIONAL SPARE PARTS

1-800-243-0073

J. C. WHITNEY & CO.

1917-19 Archer Avenue
P. O. Box 8410
Chicago, IL 60680
+1 (312) 431-6102
<http://www.jcwhitneyusa.com>

Also known as Warshawsky/Whitney. The quintessential mail-order auto parts company. Occasionally they go into receivership and pocket your money, but most of the time they are acceptable. Very few Jaguar parts (oil filters, etc.) but they have a large selection of generic items. Once you get on their mailing list, you will never be lacking for scrap paper to light your fireplace. Brainless order-takers. You can call in the middle of the night for good long-distance rates. They will not tell you brand names.

A good rule of thumb: don't ever order the *cheapest* part available from J. C. Whitney. If there is a choice, choose what they would describe as "better" or "best".

Their catalog numbers generally have two numbers, two letters, four numbers, and a letter. The first two letters (3rd and 4th characters) vary depending on what catalog you're reading from, but the rest of the number stays with that part as long as they carry it. Hence, throughout this book, wherever a J. C. Whitney catalog number is listed, the 3rd and 4th characters are normally shown as "xx" -- you should fill in letters from the catalog you have when ordering.

JAG SERVICES

16820 South Lathrop
Harvey, IL 60426
1-800-842-0912
+1 (708) 331-9151

Fax: +1 (708) 331-9404

"He will call you back; he will have the part; he will know exactly what you're talking about; his price will be cheaper than the dealer; he will have genuine Jaguar parts; and he'll ship today."

From another customer: "I haven't been so satisfied with anyone's service for a long time. They really live up to their word, I always get everything when I am told I'll get it. Plus, they wreck many used Jags, and they only sell new genuine Jag parts in Jag boxes. Plus, I can't find any place that is cheaper, they have very reasonable prices, and know exactly what they are talking about."

JAGUAR ALL-PARTS

Berkeley, CA
+1 (510) 548-8748

Jaguar parts. According to Thomas Alberts, offers replacement antennas and antenna repair kits.

JAGUAR DENVER

1-800-426-4515
Lucas, Girling, Jag parts.

OLAF P. LUND & SON

2-26 Anthony Road,
Saltley, Birmingham B8 3AA (UK)
+44 121 327 2602 FAX: +44 121 327 6284

Free catalog.

MOTORCARS, LTD.

8101 Hempstead Road
Houston, TX 77008
1-800-338-5238 ext. 570 FAX: +1 (713) 863-8238
<http://www.motorcarstltd.com>
e-mail: info@motorcarstltd.com

Jaguar and Rover parts.

MOSS MOTORS

PO Box MG
7200 Hollister Ave.
Goleta, CA 93116
1-800-235-6954

New and repro parts.

NORMAN MOTORS LTD.
100 Mill Lane,
London NW6 (UK)
+44 171 431 0940 FAX: +44 171 794 5034
Worldwide shipping.

NOS LOCATORS
587 Pawtucket Ave.
Pawtucket, RI 02860
+1 (401) 725-5000
New parts, also fasteners.

GREGORY W. PRICE & COMPANY, LTD.
3134-C Rufina Street
Santa Fe, NM 87505
1-888-JAG-BITS FAX: +1 (505) 466-9315
<http://www.rt66.com/~gprice/specials.html>

Q.C.R. MOTORS LTD
Whitacre Road
Whitacre Road Ind. Estate
Nuneaton
Warwickshire CV11 6BU (UK)
+44 24 7638 5296 or 7632 5577 FAX: +44 24 7664 1211
<http://www.cix.co.uk/~qcrmotors/>

According to Jaguar World magazine, this company was once known as the people who did bodywork on TWR and JaguarSport models, including the XJ220. Needless to say, they still take pride in their body shop. However, they have apparently taken on a new role: warehousing and distributing parts for older models that Jaguar doesn't want to be bothered with any more, most notably the XJR-S and other specials but also the earlier basic XJ-S. They not only have things like the molded bumper overriders, they also have the original tooling so if they run out they can make more. They also have the special mechanical parts for JaguarSport/TWR/XJR-S cars such as pistons, camshafts, 5-speed gearboxes, brakes, exhaust systems and wheels. The good news: Q.C.R. reportedly sells these parts cheaper than Jaguar ever did! But if you order your parts from Jaguar now they just buy from Q.C.R. and happily slap on their markup.

SNG BARRATT
The Heritage Building, Stourbridge Road,
Bridgnorth, Shropshire WV15 6AP (UK)
+44 1746 765 432 FAX: +44 1746 761 144
e-mail: barratt@barratt.co.uk
<http://www.barratt.co.uk/>

Searchable parts list, on-line ordering, etc.

TERRY'S JAGUAR

117 East Smith Street
Benton, IL 62812
1-800-851-9438 or 1-800-447-4587 (orders only)
+1 (618) 439-4444 (info) FAX: +1 (618) 438-2371
E-mail: FastCats@terrysjag.com
<http://www.terrysjag.com>

Free catalog with excellent photos of many items; good selection of high performance parts. Also, you can download an electronic catalog from their WWW site.

Kyle Chatman: "I recommend you buy from someone other than Terry's Jaguar because of their shipping policy. I had to wait two extra days and my wife and I had to rearrange our schedules so that an adult could be here to receive and sign for a brake rotor. UPS has a category of delivery that "means the driver must receive an adult signature and hand the package(s) to a person." I called Terry's today to explain that the restriction was causing me trouble and I was told that it was their policy and they would ship no other way. Even though you pay the shipping, they won't ship it they way you request. Terry's suggested I have the part delivered to my place of work. Oh yes, that's considered outstanding behavior in my office. Anyway, if you have a choice and don't have an adult at home all day, every day, I recommend you buy from someone else."

THOROUGHBRED CARS

Tennessee
1-800-338-7783
e-mail: Tbred@ix.netcom.com
<http://thoroughbred.com>

VINTAGE JAGUAR PARTS

Ray and Walt Osborn
1390 West Highway 26
Blackfoot, Idaho 83221 USA
+1 (208) 684-4767 or +1 (208) 684-3554
Fax: +1 (208) 684-3386
e-mail: General Information: ray@vintagejag.com
Sales: sales@vintagejag.com
<http://www.vintagejag.com/>

WELSH JAGUAR ENTERPRISES, INC.

223 North 5th Street
P. O. Box 4130
Steubenville, Ohio 43952
1-800-875-5247 or +1 (614) 282-8649
FAX: +1 (614) 282-1913
<http://www.classicar.com/vendors/welshjag/welshjag.htm>

Catalog available.

XK'S UNLIMITED

850 Fiero Lane
San Luis Obispo, CA 93401
1-800-444-JAGS (1-800-444-5247)
+1 (805) 544-7864 FAX: +1 (805) 544-1664
<http://www.xls.com>
e-mail: xlsunltd@aol.com

Catalog available (a few bucks, refundable first order), full line of parts. Takes great pride in their restoration shop. Will restore individual components, such as resleeving brake cylinders in stainless. Offers a nice vented rear brake disk kit.

USED/REBUILT PARTS

ENGLISH SWEDISH CAR SPARES

Alpharetta, GA

1-800-241-1916

Per John Napoli: "Great selection of XJ parts."

H & H Prestige Spares Pty Ltd

17/21 Eugene Terrace
Ringwood, Victoria 3134 Australia
+61 3 9870 0542 Fax: +61 3 9879 6603
<http://www.prestige-spares.com.au>
e-mail: info@prestige-spares.com.au

Jaguar parts and accessories, new, used, and rebuilt. Will ship overseas -- handy, since they seem to be the only source for rebuilt AAV's.

JAGUAR HEAVEN

1433 Tillie Lewis Dr.
Stockton, CA 95206-1130
info: +1 (209) 942-4524
orders: 1-800-969-4524 FAX: +1 (209) 942-3670

Used parts recycler.

JAGUAR MOTOR WORKS

3701 Longview Dr.
Atlanta, GA 30341
1-800-331-2193
+1 (404) 451-3839 FAX: +1 (404) 451-7561

Used XJ parts recycler, rebuilt parts.

JUST JAGUAR

2/8 Cooling Road
Frindsbury
Rochester
Kent ME2 4RG (UK)
+44 634-296860 Fax: +44 634-294195

Patrick O'Keeffe says, "A contact that I have found very useful for their expertise and massive stock of second user parts."

XJS BREAKERS

+44 1992 768007 or +44 1860 255700 (UK)
Ask for Alan.

SPECIALTIES

Interiors

A&B LEATHER & WOOD RENOVATION

1 Dampler Road
Coggeshall, Colchester CO6 1QZ UK
+44-137-656-1586

AUTO INTERIORS OF EUROPE

1790 E McFadden, Unit 107
Santa Ana, CA 92705
1-800-533-2886

KENT BAIN

1785 Barnum Ave
Stratford, CT 06497
+1 (203) 377-6745

Custom interiors, seat rebuilding and repadding.

G. W. BARTLETT CO., INC.

1912 North Granville Avenue
Muncie, IN 47303-2701
1-800-338-8034 or +1 (317) 289-1586
FAX: +1 (317) 289-1251

Interior and trim parts. Sells original specification Jaguar interior kits and components. Free catalog and material samples.

BAS LTD. JAGUAR TRIM SPECIALISTS
250 "H" Street, Unit 8110
Blaine, WA 98231
1-800-661-5377

BRITISH AUTO INTERIORS
See BRITISH AUTO/USA, page 641.

CERTAINLYWOOD
13000 Route 78
East Aurora, New York 14052-9515
+1 (716) 655-0206 Fax: +1 (716) 655-3446
info@certainlywood.com
<http://www.certainlywood.com>

Not a Jaguar specialist, but a good source of wood veneer.

CONNOLLY LEATHER LTD.

Wandle Bank
Wimbledon, SW19 1DW (UK)
+44 181 542 5251

If you will cut a sample of your original leather from under a seat and send it to these folks along with £37.80, they will send you a renovation kit containing lacquer, hide food, stockinette, and comprehensive instructions.

ALBERT CONSTANTINE AND SONS

2050 Eastchester Road
Bronx, New York 10461
1-800-223-8087 or +1 (718) 792-1600
FAX: +1 (718) 792-2110
<http://www.constantines.com>

Not a Jaguar specialist, but an excellent source of woods and veneers of all types, wood finishing supplies, etc. Free catalog.

COVERLAY MANUFACTURING INC.

4017 Hwy 67 N
San Angelo, TX 76905
1-800-633-7090 Fax: +1 (915) 658-8885
e-mail: coverlay@coverlaymentf.com
http://www.coverlaymentf.com/dash_covers/jaguar.html

Walter Acker IV says, "The top cover of the dash is cracked in a few places. I found a product that hides the problem. The company called Coverlay supplies an ABS plastic cover that fits perfectly on the dash of my 1976 XJ-S."

CROFTGATE
UK
+44 1706 216096
Leather dye kits.

THE FINISHING TOUCH
Unit 17, Broadfield Lane Ind. Est.,
Boston, Lincs PE21 8DR (UK)
+44 1205 369239

Stainless steel door sill protectors

BILL HIRSCH AUTO
396 Littleton Avenue
Newark, NJ 07103
1-800-828-2061 or +1 (973) 642-2404
FAX: +1 (973) 642-6161
e-mail: hirschauto@aol.com
<http://hirschauto.com/home.html>

This outfit has original Connolly lacquer-based dye for the leather interior, as well as non-lacquer-based dye, leather crack filler, and Connolly Hide Food. They also offer products for etching and coating the inside of a fuel tank to seal leaks.

H. P. CO.
1079 Colonial Club Dr.
Harahan, LA 70123
+1 (504) 737-4691

Burled walnut dashboards

JAGUAR INTERIORS OF ENGLAND
PO Box 47
Muncie, IN 47308
+1 (317) 289-9901
Carpeting and upholstery

KELLER ASSOCIATES
PO Box 2833
Saratoga, CA 95070
+1 (408) 370-3705

Burl walnut dashboards.

LEATHERIQUE LEATHER RESTORATION PRODUCTS
PO Box 2678
Orange Park, FL 32067-2678
+1 (904) 272-0992 Fax:
e-mail: lrpltd@aol.com
<http://www.Leatherique.com>

The owners of this business happen to own Jaguars -- they must have taste! Some of the pics on their www site actually show Jaguar interiors as examples, even though they may not be labelled as such. "We manufacture custom color match leather dyes for RR/B, MB, Jaguar, and many other autos. We work with museums, restoration shops, and do it yourselves. We've been around for 30 years and have a well known product. Our Rejuvenator Oil restores strength and suppleness to leather and imparts a nice natural, new leather fragrance, without any fragrance additives."

RAU RESTORATION

2027 Pontius Avenue
Los Angeles, CA 90025
+1 (310) 445-1128
wcrau@rau-autowood.com
<http://www.rau-autowood.com>

Fax: +1 (310) 575-9715

Specialists in automotive woodwork of all kinds. Besides offering restoration of Jaguar wood trim, they also offer walnut burl steering wheels made from original steering wheels and walnut burl cellular telephone casings. They will happily send photos of their handiwork. From such photos, it becomes clear that their woodwork is far better than the Jaguar original work, and in fact they offer to bleach and yellow the new veneer "to look more like the old finish" for a small additional fee.

Body

BRIT-TEK

New Hampshire
+1 (603) 437-1584

According to Bruce S. Murray, this is a US distributor of Waxoyl, a popular rustproofing substance. "You need a spraying kit; or you can use your wife's garden sprayer."

CAR CARE SPECIALTIES

P.O. Box 535
Saddle Brook NJ 07663
Phone: +1 (201) 796-8300 Fax: +1 (201) 791-9743
E-Mail: carcaresp@aol.com
Owner: Larry Reynolds

28 page catalog. According to Gene Halaburt, "They sell high quality car care products from 3M, Black Again, Harly Products, Lexol, Masury, Meguiar's, Oil Flo, One Grand, P21S, Porsche Car Care, Ritz, Sonax, Surflex, Tony Nancy, Wurth and Zymol. The first 16 pages give a detailed description of products and prices, and the remaining pages offer excellent advice on 1) washing cars 2) Tire/Rubber and Vinyl Treatment, 3) Care & Feeding of Leather/Vinyl, 4) Paint Chip Repair, 5) Paint Cleaning, 6) Protecting Finish, 7) Care & Feeding of Wheels, 8) Repairing Damaged Wheels, 9) Engine Cleaning, 10) Care & Feeding of Convertible & Soft Tops. The advice Larry gives is very "hands on" and practical - showing pluses and minuses of products and techniques."

COTECH - Eric H. Slabaugh
1805 Little Orchard Street #100
San Jose, CA 95125
+1 (408) 977-0400 or +1 (408) 977-0820

"Coating Technology for the Auto Restorer". According to Andrew E. Kalman, this outfit can refinish chromed plastic parts: "Their process is *not* a chroming process. Rather, they vacuum-deposit aluminum on the stripped part and then spray a clear polyurethane over it.

"I inspected several parts (hubcap, grille, taillight cluster) and was suitably impressed. The finish on these parts was very nice - perhaps not as "hard" looking as chrome, but very reflective, with a bit of depth, and extremely uniform in their color. Basically, it looks like polished aluminum with a protective clearcoat on it. They generally do plastics and pot metals, in aluminum, gold, copper or titanium nitride.

"XJ-S headlamp buckets are \$75 each, grilles \$120. This seems to compare favorably with new parts. 50% down at time of order. He quoted me 3-4 weeks. It's cheaper if you deliver the parts pre-striped (they get charged \$45 to strip the grille, for instance)."

BARRY HANKINSON, LTD.
15 Copse Cross St.
Ross-On-Wye, Herefordshire HR9 5PD (UK)
+44 1989 565789 FAX: +44 1989 567983

Trim kits.

INDUSTRIAL PLATING COMPANY
Frank Aguilar, President
San Carlos, California
+1 (415) 593-1046

A small company that does mainly industrial plating for the surrounding Silicon Valley high-tech firms. They do all plating to military specs. Supposedly base their prices on the actual effort involved rather than the cost of new Jaguar parts, so are much cheaper than most. Unclear on whether they will actually do business by phone and mail; best to call and ask nicely.

INTERMARQUE AUTO PARTS
Houston, TX
1-800-666-8700
Parts and sheet metal.

MARTIN E. ROBEY SHEET METAL ENGINEERS
Pool Rd, Camp Hill Industrial Estate,
Nuneaton CV10 9AE (UK)
+44 24 7638 6903 FAX: +44 24 7634 5302
<http://www.martinrobey.co.uk/>

The *manufacturer* of Jaguar body panels!

METRO MOULDED PARTS, INC.

11610 Jay St.
P.O. Box 48130
Minneapolis, MN 55448 USA
1-800-878-2237 or +1 (612) 757-0310
FAX: +1 (612) 757-2803
e-mail: sales@metrommo.com
<http://www.metrommp.com>

According to Tom Carney, a supplier of body seals and gaskets with any extensive line of Jaguar-specific items. "Not just weather stripping but a lot of other stuff like stabilizer bushings, air filter to carb gaskets, window channels, headlight gaskets, etc. etc."

PENINSULA IMPORTS

3749 Harlem Rd.
Buffalo, NY 14215
1-800-999-1209 or +1 (716) 833-3000

Body and rust repair panels.

PII DISTRIBUTING

PO Box 27358
Houston, TX 77227-7358
1-800-231-5836 or +1 (713) 975-6272

Genuine Jaguar parts, sheet metal.

TOWER PAINT

Custom Spray Can Dept.
1-800-779-6520

According to Mark Wentworth, this place "will put *any* paint into a spray can. I got the paint codes from my '67 122S and my '80 245, called them, and they sent me 12-ounce cans of the right match. They also provide an *exact* matching service if you can ship them a part, like the fuel filler door or some such item. If you are afraid that the "spray bomb" will not yield good results: I can't tell the factory job from the spray can (They use a very nice nozzle)."

Restoration/Rebuilding

WHITE POST RESTORATIONS

White Post, VA 22663
+1 (703) 837-1140

Antique auto restorations. Will resleeve brake cylinders with brass liners.

IMPERIAL MACHINE CO.

621 S. 112th St.
Lincoln, NE 68520
+1 (402) 488-9450

Resleeves brake cylinders in stainless steel. Credit cards not accepted. You must enclose a check with the master cylinder including shipping cost.

KIRK'S AUTO REFITTERS

3019 Mississippi Ave
Davenport, IA 92506
1-800-547-5747

According to Zahid Ahsanullah: "His work quality is superb and he seems to know a lot of new and used parts vendors out there. He will meet or beat any price you can quote him. I like to support small businesses and he's on my good list."

THE EASTWOOD COMPANY

580 Lancaster Avenue
Malvern, Pennsylvania 19355-0714
1-800-345-1178
<http://www.eastwoodcompany.com>

This is a mail-order outfit specializing in automobile restoration tools and products. They also carry Colourtune, a device to allow viewing the combustion through a spark plug hole.

GAS TANK RENU USA

12727 Greenfield
Detroit, Michigan 48227
e-mail: DanRenu@aol.com
<http://www.gastankrenu.com>

A product to line fuel tanks.

MOYER'S FUEL TANK RENU - Joseph H. Moyer or Sandra Lee Moyer

2011 Western Avenue
Greensburg, PA 15601
1-800-328-9550
e-mail: slmoyer@westol.com
<http://www.gas-tank.html>

Gas tank repair and restoration specialists. Mail order operation; you ship them your tank, they renovate it to much-better-than-new condition, and ship it back to you. Guaranteed to never rust.

VICARAGE (USA-Holland-UK)

USA: +1 (305) 444-8759 FAX: +1 (305) 443-6443
e-mail: vicarage@ix.netcom.com

<http://paradise.net/vicarage>
<http://www.oslonett.no/home/nick/vicarage.html>

"Restoration & enhancement specialists"

Exhaust

BELL SILENCER MANUFACTURING -- Roy Gibbons
Phillips Lane, Old Town,
Swindon, Wiltshire
+44 1793 619234 FAX: +44 1793 532946
Stainless exhaust systems. Part of Bell Silencer Services Limited, Swindon.

DICK AMES
608 Ft. Williams Pkwy
Alexandria, VA 22304
+1 (703) 370-3097
Stainless steel exhaust systems.

BORLA INDUSTRIES
Oxnard, CA
+1 (805) 983-7300
Stainless exhaust.

COVENTRY S LTD.
6406 85th Place
New Carrollton, MD 20784
1-800-537-4146
Stainless exhaust systems.

STAINLESS STEEL MUFFLER CORP.
3032 Genesee St.
Buffalo, NY 14225
+1 (716) 893-2116
Stainless exhaust systems.

Electrical

LUCAS AFTERMARKET OPERATIONS, PARTS AND SERVICE
UK
+44 121 506-5000

ASOM ELECTRIC

1204 McClellan Dr.
Los Angeles, CA 90025
1-800-424-2766 or +1 (310) 820-3720
FAX: +1 (310) 820-5908
email: asomelect@aol.com

"We are an auto electrical rebuilding shop, dealing mostly in Lucas and Bosch. We rebuild electrical components including starters, alternators, generators, regulators, fuel pumps, wiper and window motors. We have a large supply of Lucas parts in stocks, including many discontinued pieces. We have been in business for 36 years."

BARLEY CREEK ENTERPRISES/JAGUAR

869 Pioneer Drive
Lebanon Junction, KY 40150
+1 (502) 543-2932

According to Robert Woodling, "Jaguar radios were manufactured by AutoSound Inc. (ASI) from 1981-86 model years. ASI went out of business in 1986. All the parts were purchased by Mike Lanham of Barley Creek Enterprises/Jaguar. Mike will repair these radios for a *very* reasonable price."

BECKMAN -- Bob or Donna

+1 (919) 381 2700

Repair ECU's. According to Walter Petermann (who is a competitor -- see Corsaro below): "They know what they're doing."

BRITISH CAR SERVICE

Tuscon, Arizona (USA)
+1 (520) 882-7026
www.britishcarservice.com

Rebuilds distributors.

BRITISH WIRING INC.

20449 Ithaca
Olympa Fields, IL 60461
+1 (708) 481-9050

Per Lauren Pratt, "For individual wires of nearly any size and color code and terminals, boots, etc."

BRITISH PACIFIC LTD

3317 Burton Avenue
Burbank, CA
1-800-554-4133

CLASS-TECH

62935 Layton Ave.
Bend, OR 97701
1-800-874-9981

Dave Covert says "If you need a harness wrapped.. I would recommend you give these guys a call..."

CORSARO ELECTRONICS - Walter Petermann
1302 Waugh Drive #273
Houston, TX 77019
+1 (713) 503-0097
email: corsaro@airmail.net
<http://www.corsaro.com>

According to Vince Chrzanowski, they repair Jaguar EFI ECU's for reasonable prices. "I called and spoke to Walter Petermann and made arrangements to FedEx the package on a Monday. Walter got the package Tuesday morning, repaired the ECU, and shipped it back the same day." They also repair climate control and blower ECU's.

COVENTRY ENGINEERING
9500 SW Martha St
Tigard, OR 97224
+1 (503) 620-9482
Wiring harnesses.

DEL CITY
2101 W. Camden Road
Milwaukee, WI 53209
1-800-654-4757 Fax: 1-800-431-1293
<http://www.delcity.net>

Wire, high-temp wire, connectors, relays. Can provide stripes and spiral stripes. Has branches around the US.

EXOTIC AUTO
Myrtle Beach, SC
+1 (803)-236-9005

Johnny Vaught reports on an A/C system fix: "One of the most common problems on the cars is the temperature controller, and specifically with one component, a wirewound potentiometer. Exotic Auto persuaded a company to reproduce the pots and now offers a cleaning, rebuilding and calibration service for the modules."

GLOBAL METRICS, INC.
Belmont, CA
+1 (415) 592-2722 or 1-800-227-9981
Supplier for the Bosch fuel injector harness plugs.

MAGNECOR
+1 248-669-6688 Fax: +1 248-669-2994
<http://www.magnecor.com>

Makers of spiral core spark plug wires. Offers a custom set for the Jaguar V12.

NARRAGANSETT REPRODUCTIONS
Box 51
Wood River Junction, RI 02894
(401) 364 3839

NISONGER INSTRUMENT SALES & SERVICE

570 Mamaroneck Ave.
Mamaroneck, NY 10543

+1 (914) 381-1952 FAX: +1 (914) 381-1953

According to Walt Morris and Rob Reilly, this outfit does a good job refurbishing gauges.

OPTIMA BATTERIES

San Jose, CA
1-800-292-4359
<http://www.optimabatteries.com>

Unusual sealed battery with gel electrolyte. Excellent warranty, but more importantly an excellent battery! Call for a local dealer, or visit an Interstate battery dealer.

RHODE ISLAND WIRING SERVICE

P O Box 434
West Kingston RI 02892
1-800-241-1955 or +1 (401) 789-1955

Per Lauren Pratt, "For a special harness of your design that is any length, wire size, color code, or any combination thereof, along with any terminal and connector or boot, and loomed in whatever color and pattern you may wish. They will even re-loom your harness in the original colors and pattern."

THE WIRING HARNESS COMPANY

UK
+44 1332 810052

Per Craig Sawyers, "When Lucas stopped braiding looms, the proprietor (Peter Newall) bought their braiding machine and the database. So he can re-build any harness that Lucas used to do to original specs. They have just done a superb job for me by re-building all the engine and engine bay looms on my V12 Saloon to as-new condition."

Steering/Suspension/Final Drive

APPLE HYDRAULICS

715 Route 25A
Miller Place, NY 11764
1-800-882-7753 or +1 (516) 744-9627

Rebuilds Armstrong, Girling shocks.

ATLANTIC ENTERPRISES

221 Strand Industrial Dr.
Little River, SC 29566
1-800-654-7565 FAX: +1 (803) 399-4600

Rebuilt steering racks, steering pumps, seal kits, polyurethane rack mounts.

QUALITY JAGUAR/CONCOURS WEST INDUSTRIES (Michael Bontoft)

306 Dwight Rd.
Castle Rock, WA 98611
+1 (360) 274-3373 Fax: +1 (360) 274-3376
<http://www.ciinc.com>

Formerly in Costa Mesa, CA. This firm specializes in Jaguar rear suspensions. For those of you who are unaware, the Jag IRS has been *the* item for hot rods for 25 years. From this catalog, you can order Jag rear ends chrome plated, cadmium plated, powder coated, narrowed (to fit wider wheels), with different gear ratios, etc, etc. You can even order an entire IRS with no original Jaguar parts, including a final drive unit that uses Ford 9" differential parts; this assembly was featured in the September 1994 issue of Street Rodder. The company also offers front suspensions, high performance differentials, and aftermarket bushings.

R.E.S. (Rear End Specialists) (Jim)

26489 Ynez Rd. Ste.c-143
Temecula, Ca. 92591
+1 (909) 693-5340 Fax: +1 (909) 699-1836
na617@aol.com

"R.E.S. specializes in rebuilt suspension components. We offer the following services: rebuilt differentials, ratio changes, rebuilt hub assemblies, rebuilt brakes, rebuilt complete rear suspensions, and differential parts, all at exceptional prices."

SPEEDWAY MOTORS

300 Van Dorn
P.O. Box 81906
Lincoln, NB 68501-9896
+1 (402) 474-4411 FAX: 1-800-736-3733

This is a mail-order outfit for hot rods. Since the Jaguar rear suspension is popular among the hot rod crowd, the catalog offers such things as finned aluminum final drive covers, nylon radius arm bushings, brakes, shocks, etc.

UK AXLES

Unit 20, Wyvern Way,
Uxbridge, Middx (UK)
+44 1895 272464 Mobile: +44 860 702801

Axes, differentials, ratio changes. Overseas enquiries welcome.

Wheels

THOROUGHBRED MOTORS / Rodney Dessberg

2035 Cornell Street
Sarasota, FL 34237
+1 (941) 955-5960

Rodney specializes in wheels. He does a good business putting aftermarket wheels on Jags and keeping the stock wheels, and therefore has an incredible selection of stock wheels to unload at good prices. He also does other work with Jags and other neat cars.

BRITISH WIRE WHEEL

1650 Mansfield St
Santa Cruz, CA 95062

1-800-WIRE WHEEL or +1 (408) 479-4495

Dayton and Dunlop wire wheels, tires. *The place to go for correct reconditioning of your JagWires. Please see comments on page 374!*

DAYTON WHEEL PRODUCTS

115 Compark Dr.
Dayton, OH
+1 937-461-1707

Fax: +1 937-461-1815

PRISTINE

South Milton Keynes (UK)
+44 1908 282628

Refinishes alloy wheels.

Miscellaneous

AAPAK

1845 North Grand Avenue
Phoenix, Arizona 85007
1-800-832-5544
+1 (602) 254-1116

Fax: +1 (602) 252-5065

<http://www.aapak.com>

Air conditioning stuff.

BARNHILL BOLT CO. INC.

2500 Princeton NE
Albuquerque, NM USA
1-800-472-3900 or +1 (505) 884-1808
<http://www.fastenerwarehouse.com/barnhill/index.html>
e-mail: ross@barnbolt.com

BRITISH TOOLS AND FASTENERS - PHILIP BROWN

2030 Andre Ave.
Los Osos, CA 93402 USA
http://www.mrcybermall.com/machine_tool_parts/
boltnut@ix.netcom.com
1-800-587-0475 FAX: (805) 528 0358

BRITISH TOOL COMPANY

891 Houseman NE
Grand Rapids, MI 49503

Whitworth tools. Also makes special factory tools originally made by Churchill in England. Will buy unused or obsolete tools for British cars. Has an engineer on staff and a machine shop, will design and make large or small items for special projects.

JOHN FARRELL

57 D Alder St.

West Babylon, NY 11704

1-800-454-7977 or +1 (516) 454-7977

Chiefly an E-type specialist, but can provide the square-cut O-ring seals that are needed between halves of the front brake calipers on the XJ-S.

GRAINGER

1-800-CALL-WWG

<http://www.grainger.com>

Industrial supplies. 350 locations in the US, Canada, Mexico and Puerto Rico.

GRIOT'S GARAGE

3500-A 20th Street E.

Tacoma, WA 98424

1-800-345-5789

Tools and automotive accessories. According to Rob Westcott, "Beautiful stuff if you have really deep pockets." Free catalog.

HITCH-WEB

Southern California

1-800-300-4067 (orders)

+1 (818) 787-3186 (info) (8-5 Pacific time)

<http://www.hitch-web.com>

e-mail: info@hitch-web.com

Offers a trailer hitch to fit the XJ-S. Specifically, a DaLan Class 1 Receiver #DA247272~C4620, rated at 200 pounds tongue weight and 2000 pounds towing capacity.

McMASTER-CARR SUPPLY COMPANY

PO Box 440

New Brunswick, NJ 08903-0440

+1 (404) 346-7000 or +1 (330) 995-9555

Fax: (404) 349-9091

<http://www.mcmaster.com>

atl.sales@mcmaster.com

A supplier of industrial stuff. Can order online. Will accept credit cards. Catalog weighs about 20 pounds.

METRIC & MULTISTANDARD COMPONENTS CORP.

120 Old Saw Mill River Road
Hawthorne, NY 10532
1-888-966-MMCC (1-800-966-6622)
New York:
1-800-431-2792 Fax: +1 (914) 769-5049
Chicago:
1-800-221-4469 Fax: +1 (630) 655-9062
Dallas:
1-800-527-5177 Fax: +1 (972) 870-1154
Atlanta:
1-800-444-9560 Fax: +1 (770) 935-9511

Obviously a source for metric stuff, but the "multistandard" includes British standards like BSPP.

NORTHWEST TRANSMISSION PARTS

6347 Fair Ridge Road
Hillsboro, Ohio 45133
+1 (513) 927-5366 or +1 (513) 442-2811 or 1-800-327-1955

"An excellent source of parts for all automatic transmissions including specialized items for Jaguar BW transmissions."

GUNSON LTD.

Pudding Mill Lane
London E15 2PJ (UK)

UK source for ColourTune, a device that can be screwed into a spark plug hole to watch the combustion and determine if the mixture is correct.

PEGASUS AUTO RACING SUPPLIES

1-800-688-6946

Hylosil and Hylomar sealants.

H.D. ROGERS & SONS - Hal Rogers

3418 Barksdale Blvd.
Bossier City, LA 71112 US
+1 (318) 742-3651 FAX: +1 (318) 742-5044
e-mail: hdrsons@iAmerica.net
<http://www.hdrogers.com>

"I try to offer very competitive pricing on original equipment and reproduction (aftermarket) parts. I can also offer many factory Jaguar packaged products at discounted prices too (just not as discounted as other items). Most of what I stock is mechanical, hydraulic, electrical, accessories, books, manuals (not stocking much body/trim but can s/order).

"I directly import parts in many instances and can even special order directly out of the UK should some need it. I can supply virtually any currently available part as well as lots of old NOS pieces too."

"We sell an excellent aftermarket a/c amplifier unit for the XJ (original part number is C45402). The unit comes with a 5 year warranty. We import the amplifiers from Australia. They are quality pieces and are not common in the USA. Other USA suppliers offer aftermarket amplifiers too but I believe ours is the best one for the money." They also sell antennas and antenna repair kits.

VALEO CLIMATE CONTROL

New Road
Ammanford
Dyfed.
South Wales SA18 3ET
+44 1269-3131 Fax: +44 1269-591269
or
HEOL-Y-MINYDD
Gorseinon
West Glamorgan
South Wales SA4 1XX
Tel: +44 1792 898855

According to Alan Akeister, took over Delanair, makers of XJ-S climate control system.

PERFORMANCE/MODIFICATION

ADDCO

715 13th Street
Lake Park, FL 33403
1-800-338-7015

Addco makes anti-roll bars for anything with four wheels, and at reasonable prices. They offer a 7/8" bar for the rear of the XJ-S and a 1" bar for the front. They evidently based their offerings on the pre-1982 XJ-S (which came with a rear bar), because both bars are intended to replace existing bars, not install where there was none before. As such, the rear anti-roll bar kit does not include links and other parts that will be necessary on the 1982-on car. Also, both bars are much stiffer than stock; they don't offer a soft rear bar to complement the stock front bar. They have now been informed of the error of their ways, and perhaps they will respond with a from-scratch kit as well as a more limber rear bar for the 1982-on XJ-S.

AJ6 ENGINEERING/Roger Bywater

60 Henshall Road, Bollington,
Macclesfield, Cheshire SK10 5DN (UK)
Tel/Fax: +44 1625 573556
aj6eng@jagweb.com
<http://www.jagweb.com/aj6eng>
<http://www.insites.co.uk/classic/jaguar/aj6>

This outfit offers all kinds of aftermarket inlet systems and various EFI system modifications and improvements for both V12 and 6-cylinder XJ-S's. Of note, they will fix faulty ECU's on an exchange basis for reasonable prices. They also offer EFI diagnostic equipment. Jeffrey Gram says they can "rebuild any 6CU or 16CU to either low or high CR, with or without catalyst and that we should take care not to pay too much for an ECU, AJ6 has loads on stock."

Richard Mansell reports: "The AJ6 website lists the following acceleration figures for the various mods they sell.

	40-60	60-80
Standard	6.7	6.9
Super Enhanced ECU	5.0	5.76
+ Large Throttle kit	4.5	5.45
Full Plus Torque kit	4.1	4.94

This author has corresponded with Bywater at length, and will add the following personal recommendation: Roger Bywater worked in the engine development department at Jaguar when the V12 was being developed. He left Jaguar in the late 70's to form AJ6 Engineering. There probably is no higher authority on the Jaguar V12 to be found.

ARDEN AUTOMOBILBAU GmbH

Untergath 175, D-47805 Krefeld (Germany)
Ph: +49 2151 37230 FAX: +49 2151 372323
<http://www.arden.de>
arden@arden.de

Exclusive alloy wheels, wood trim including a wood rim steering wheel with airbag, wind deflector for convertibles, suspension and body styling mods. Most spectacular offering is an XJ-S estate car (station wagon). They also make an XJ-S with a back seat. Steve Gallant says, "Arden is the only Jaguar-only dealer in Germany and is a TUV-approved 'tuner'. They manufacture all kinds of specials, including a coupe version of the XJ-S without the flying buttresses (looks kinda like the convertible with its top up - very attractive - see it in Skilleter's book on XJ-S's)."

AUTOSTYLE BY PAUL BANHAM

Unit 14, Castle View Business Estate, Gas House Road,
Rochester, Kent, ME1 1PB (UK)
+44 1634-840530 Fax: +44 1634-844424
autostyle@jagweb.com
<http://www.jagweb.com/autostyle/index.html>

According to Alan Akeister, can convert older dashboards to the later style round dials, and add extra wood inserts to dash facias, around heater and radio controls, and to ski-slopes (the area around the shifter). Veneer refurbishing and replacement veneer pieces. Body styling kits, bumpers, spoilers, etc., even an entire kit car called an XJSS. Hardtops for convertibles.

Note: There has been a report of difficulty dealing with this outfit; shoppers are advised to check the dispute resolution policy on their credit cards before ordering, especially with overseas orders.

Also note that some customers have complained that veneer pieces didn't match as well as they had hoped, even when a sample of the original had been sent to Autostyle. The usual complaint was that the Autostyle veneer was darker than the original.

B&M RACING AND PERFORMANCE PRODUCTS

9142 Independence Avenue
Chatsworth, CA 91311
e-mail: bmperf@pacificnet.net
<http://www.bmracing.com>

Not a Jaguar specialist, but offers high-performance parts for the GM400 transmission. Free catalog.

HARVEY BAILEY ENGINEERING

Ladycroft Farm, Kniveton, Ashbourne
Derbyshire DE6 1JH. (UK)
+44 335 346419 FAX: +44 335 346440

According to Jeffrey Gram, "Handling kit for Jags consist of revalved Bilstein or Koni dampers and stronger anti-roll torsion bar and rear torsion bar. Very good results with 23% uprating of the rear spring rate." Also offers a front cross brace for the XJ-S convertible as well as a "rear anti-tramp frame".

BAKER PRECISION BEARING

2865 Gundry Ave.
Long Beach, CA 90806

Distributors of the Oberg Filter, a bypass oil filter system which employs a reusable, ultra-fine stainless steel filtering element, and uses an adapter plate for simple and straightforward installation either in place of, or in addition to, the spin-on filter.

ROB BEERE RACING SERVICES

Unit 1 Priority Mill, Charter Avenue,
Coventry CV4 8AF (UK)
+44 2476 47 33 11 FAX: +44 2476 47 33 22 Mobile: +44 860 675001

Lightened flywheels, hot camshafts, other high-performance engine and suspension parts.

CLASSIC ENGINEERING

Unit 4, Brook Road, Britannia Road,
Waltham Cross, Herts EN8 7NP (UK)
+44 1992 788967

Offers a kit to install the 1992-on structural cross-bracing to a 1988-1991 XJ-S convertible.

CONVERSION COMPONENTS, LTD.

17 Victoria Street
Waihi, New Zealand
+64 7 863 8509 Fax: +64 7 863 6354
sales@conversioncomp.co.nz
<http://www.conversioncomp.co.nz>

Offers three different 5-speed transmission kits for the V12 XJ-S: one using the Toyota Supra transmission, one using the Toyota 'Big' Supra transmission from the 3L Twin Turbo Supra, and one using the Tremec. On the Supra transmissions, the shifter location is modified to 390mm from the engine face, much closer than on any stock Supra transmission.

D. C. COOK (Lee Underwood)

UK
+44 1302 329672
e-mail: Jaguar@ivity.demon.co.uk
<http://www.demon.co.uk/dccook-jaguar>

Offers aftermarket wheels for Jaguars in a variety of styles and finishes. WWW page includes pictures of wheels.

COOPERCRAFT

Westwood, Broadclyst
Exeter EX5 3DH (UK)
+44 1404 822100 FAX: +44 1404 822102

Aftermarket brake calipers, and some modified rear brake cylinders.

DEE ENGINEERING

Costa Mesa, CA

+1 (714) 979-4990

Makers of "ProThane" urethane suspension parts, including anti-roll bar mounts, end link assemblies and individual bushings, shock absorber mount bushings, bump stops, tie rod end boots and coil spring dampening inserts. Some of their parts are sold by J. C. Whitney.

Their "B" style anti-roll bar mount bushing and bracket will, with a little trimming on the corners of the urethane bushing itself, fit the rear of the XJ-S very well; for a 9/16" bar, the part number is 19-1127, and for a 5/8" bar it's 19-1128. It does not appear that any of their anti-roll bar mounts are well suited to the front end of the XJ-S.

Thanks to Thomas Alberts for this info.

DELLOW AUTOMOTIVE PTY LTD

37 Daisy Street

Revesby, NSW 2212 (Aus)

PO Box 43 Revesby North 2212

+61-2-9774-3873 fax: +61-02-9774-4783

Per Michael Frank, these are specialists in installing Toyota Supra 5-speeds in Jaguars. They will sell a kit either with or without the transmission itself, and will ship worldwide. "The kit includes bell housing, clutch, pressure plate, rear crossmember, speedometer cable, pushrod, yoke, and clutch fork, etc." "They also supply a "Qik-Shifter" which reduces shifter throw by 50%."

DOUBLE S

UK

According to John Goodman, these makers of stainless steel exhaust systems "...make a large bore sports system for the XJ-S. They also make stainless steel headers as well, though they are not cheap they were prepared to sell direct, which at the time was priced significantly lower than the prices quoted from the Jag tuning companies (cuts out the middle man!).

"Apparently the headers are a pig to fit because you have to jack the engine up one side at a time, but when installed there are no clearance problems other than they won't fit LHD cars. The big bore system fits either the standard front pipes or the headers (may be different versions)."

British Auto/USA (page 641) distributes Double S products in the US.

ELECTROMOTIVE INC.

14004-J Willard Road

Chantilly, VA 22021

+1 (703) 378-2444

<http://www.electromotive-inc.com>

<http://www.emi.cc/products.htm>

This company offers aftermarket electronic fuel injection and ignition systems suited for the XJ-S.

EREBUNI CORP.

+1 (718) 387-0800

Per Brian Schreurs: Offers body styling mods.

BOB GREENE DEVELOPMENTS

Unit 9, West Court, Buntsford Park Road
Bromsgrove, Worcestershire B6O 3DX (Birmingham area, UK)
Ph: +44 1527 873716 / 832453 FAX: +44 1527 575403

Offers vented rear brake rotor kits. Jeffrey Gram: "For the front there is a bigger disc kit with 4 pot aluminium calipers for 15" wheel: 12" disc, 2 thicknesses: 28 or 32 mm; 16-17" wheels, 13" disc; 17-18" wheels, 14" disc (full race version).

HYPER

Unit 7, Stationfield Industrial Estate,
Kidlington OX5 1JD (UK)
+44 1865 842557 FAX: +44 1865 842558

Several different body styling changes including spoilers and a wide-body conversion. Split-rim alloy wheels, manual and automatic gearbox conversions, exhaust systems. Agents in South Africa, Hong Kong and France.

JAGUAR SOUTH - Chad Bolles

306 Valcour Road
Columbia, SC 29212
+1 (803) 798-3044 FAX: +1 (803) 798-4512
e-mail: jaguar@bbs.clynx.com

Bolles has a great deal of experience in racing and high performance work, and also has a great many contacts for buying hard-to-find stuff or having special things made. He has made many more radical performance mods to his own street XJ-S than those suggested in this book, and is building an XJ-S dragster using the V12 engine.

Bolles can provide a few choice items for reasonable prices, such as a V12 crank with an 80mm stroke that uses Chevy connecting rods and an adapter plate for connecting a Chevy bellhousing (auto or manual) to the 5.3 engine.

Also reportedly can provide genuine Churchill Jaguar special tools at excellent prices, depending on the current pound/dollar exchange rate.

NOTE: This is one of at least two firms in South Carolina named Jaguar South.

JAGUARS THAT RUN

P.O. Box 66
Livermore, CA 94550
<http://www.jagsthatrun.com>

Specialists at putting Chevy V-8 engines into Jaguars, pickup trucks, etc. Also offers manuals on doing the job yourself, including "Jaguar V8 Conversion Manual" by Mike Knell.

JEG'S

751 East 11th Avenue
Columbus, Ohio 43211-2695
1-800-345-4545 FAX: +1-614-299-4444

A supplier of Chevy aftermarket stuff. Free catalog.

JOHN'S CARS, INC.

800 Jaguar Lane
Dallas, TX 75226
1-800-866-5247 or +1 (214) 426-4100
FAX: +1 (214) 426-3116
e-mail: conversions@johnscars.com
<http://www.johnscars.com>

This place is best known for Chevy V8 conversions for Jags. Still, their catalog contains some useful stuff such as an improved design steering rack mount, as well as several tidbits of helpful information. They also have a good assortment of used parts. "Our replacement parts (poly rack bushings, poly trans mounts, A/C hoses [R134 compatible], PS hoses, etc.) are engineered beyond OEM specifications and all carry a lifetime warranty."

JUST JAGS

Rycroft Villa
24 Proffit Street
Walsall, West Midlands WS2 8AZ (UK)
+44 1922 637779 Mobile: +44 831 506722
e-mail: justjags@yahoo.co.uk
<http://jagweb.com/justjags/index.html>

Body styling components. Offers bumper covers, a "boot infill panel" that replaces the boot plinth and provides a smoother appearance around the licence tag, and a boot lid spoiler with an LED 3rd brake light built in. If you're in a country that requires rear fog guard lights, the bumper covers have no in-bumper provision for them. There is reportedly carbon fiber involved, as opposed to the simple fiberglass of some other products.

K & N ENGINEERING, INC.

P.O. Box 1329
Riverside, California 92502
1-800-858-3333 (tech info)
1-800-700-7281 (dealer locations)
e-mail: KNFilters@AOL.com, 75463.3471@Compuserve.com, or TSVU79B@Prodigy.com
http://www.motorville.com/kn_home/kn.html

Manufacturers of low-restriction permanent air filters consisting of a layer of oiled fabric sandwiched between aluminum mesh. For a 132 page, full-line catalog, send \$3.50.

KEISLER AUTOMOTIVE ENGINEERING & ELECTRIC -- Mr. Shafi Keisler

Knoxville, Tennessee USA
+1 (423) 982-8198 phone/fax
E-mail: skeisler@icx.net
<http://www.keislerauto.com>

A selection of well-engineered performance and upgrade parts for the XJ-S. Offers a 5-speed manual transmission conversion kit based on a Tremec TKO unit, with bellhousings to fit either the 5.3 or 6.0 engine. Also offers a 5-speed kit for the 4.0.

RON KELNHOFER

8219 W. Bradley Rd.
Milwaukee, WI 53223-3286
Phone: 414-355-7441 Fax: 414-355-4901
E-mail: rkelnhof@execpc.com

Offers improved banjo bolts, half moon seals, and timing chain tensioner access plugs.

KOENIG SPECIALS GMBH

Flösserfasse 7
D-8000 München 70 Germany
+49 89/724970
Telex 528145 koevm d
Telefax +49 89/7238813

Phil Stuart: "I have a König (Koenig in the US) modified XJS. This includes body modifications, engine mods, interior mods and suspension mods." Stuart notes that the engine mods included nitrous oxide injection and sodium filled titanium valves. "My car is registered here in Canada as a Koenig Wildcat, not as a Jaguar XJ-S."

TREVOR LANGFIELD

Doncaster, England
phone: +44 1302 834343
"High Power Nitrous" systems.

LISTER OF NORTH AMERICA

1912 Granvill Ave.
Muncie, IN 47308
1-800-338-8034

High performance accessories.

LYNX MOTORS INTERNATIONAL LTD.

68 Castleham Road
St Leonards on Sea, East Sussex TN38 9NU (UK)
+44 1424 851277 Fax: +44 1424 853771
enquiries@lynxmotors.co.uk
<http://www.lynxmotors.co.uk>

Makers of the Lynx Eventer, an XJ-S made into an "estate car" -- or what we Americans would call a station wagon. Hatchback and all.

MOTEC

<http://www.motec.com>

Manufacturers of aftermarket EFI systems. Per Ken Wallace, "This appears the ultimate. Quite expensive."

PAECO IMPORT PARTS

2400 Mountain Drive
Birmingham, AL 35226

1-800-326-6401 - orders only +1 (205) 823-7278 - Everything else

According to Michael Neal: "They offer a wide range of performance parts and machine work as well as complete engines. The Jag V12 is available up to 532 hp with their stage 4 engine. Their solid copper gaskets may be worth checking out. Paeco claims they are virtually blow-out proof."

PURADYN

3020 High Ridge Road
Boynton Beach, FL 33426
1-800-488-0577
+1 (407) 547-9499
<http://www.tfpurifiner.com>
info@puradyn.com

FAX: +1 (407) 547-4025

PURADYN EUROPE LTD. (TF PURIFINER)

Centrax, Shaldon Road
Newton Abbot, Devon
TQ124SQ, England
+44-1626-52251 FAX: +44-1626-56592

Produces a package for maintaining clean oil; includes a bypass filter and a heater to boil away contaminants.

RED LINE SYNTHETIC OIL CORP.

3450 Pacheco Blvd.
Martinez, CA 94553
+1 (510) 228-7576

Makers of a product called "Water Wetter" that supposedly will improve cooling efficiency. Included in their line of synthetic lubricants is a product called MTL (Manual Transmission Lubricant), an oil specifically designed for synchros. They also make synthetic transmission fluids. According to Dean Gosselin, "Red Line puts together a nice package of technical data which they mail for free upon request."

SUMMIT RACING

Akron, Ohio
+1 (330) 630-3030
<http://www.summitracing.com>

High performance parts for Chevys and the like. Getting a free catalog is compulsory, even for Jaguar owners.

CLIVE SUTTON

14 Kingsbury Trading Estate
Church Lane, London NW9 8AU (UK)
+44 181 200 4455FAX: +44 181 200 4094

Offers a handling package for the XJ-S, as well as other "enhancements". Also is a dealer for AJ6 Engineering products.

TCI

One TCI Drive
Ashland MS 38603
+1 (601) 224-8972 FAX: +1 (601) 224-8255

High performance GM400 transmission parts.

TILTON ENGINEERING

+1 (805) 688-2353 Fax: +1 (805) 688-2745

Bellhousings, lightweight flywheels, heavy-duty starters (for difficult-to-start souped-up engines), multi-plate clutches, etc. for the Jaguar V12. Per John Napoli: "Their stuff looks very good -- I've seen it on a number of race cars -- but it is a little pricey."

TOTAL SEAL, INC.

11202 North 24th Avenue, Suite 101
Phoenix, Arizona 85029
1-800-874-2753

Makers of a unique type of piston ring that provides a much better seal than conventional rings. These rings are very popular in racing.

TURBO ACTION

1535 Owens Rd.
Jacksonville FL 32218
+1 (904) 741-4850 FAX: +1 (904) 741-4853

GM400 high performance parts.

W.L. WHITE (Bill)

1013 Ferry Road
Christchurch, NZ
Phone/Fax: +64 3-3321546

For the Jaguar V12:

7.5 liter overhaul kit (HE & Pre-HE) which has to date been supplied as short engine (on exchange basis) but can be supplied as partially assembled kit. All kits are supplied with cast alloy deepened & gated sump.

8.4 liter under development.

Deepened and gated alloy sump kit available separately.

Induction Systems:

12 Throttle Body 95° manifolds (45-48mm) for XJ-S. Length = 220mm from port face.

Four plenum cast alloy 45mm interior parabolic manifolds designed primarily to take advantage of "pressure wave" or sonic supercharging theory, but will also function as high flow manifold for larger engines.

Four plenum injection manifold available for V12 E-Type and can be used as "low profile" arrangement for other purposes.

High flow single plenum manifold to run larger engines with standard layout. This alloy casting has the same runner design as four plenum manifolds.

Complete tuned engines can be supplied if required with management systems to accommodate fuel requirements and prevailing emission standards.

Management Systems that embrace M.A.P., T.P.S. (or combination), multi coils, advance curve manipulation and oxygen sensor open- and/or closed-loop operation. Oxygen bas parameters are adjustable.

"Also of interest, he will be working on a 6.5l - 7.0l diesel version of the Jaguar V12. He estimates around 200 hp and envisages it will be used for marine applications."

Mike Morrin talked with White, and reported that "Bill has got most of the parts ready for his quad cam V12; he has (typically) done a very thorough job, involving new castings for the timing cover and each end of the 'turned' XJ40 head. I presume this will become another standard conversion."

ZYTEK SYSTEMS

London Road
Bassets Pole
Sutton Coalfield
West Midlands B75 5SA
+44 121 3232323
<http://www.zytek.co.uk/>

Makers of fancy electronic control systems for automobiles -- including the engine management system used on the XJR-S.

ACCESSORIES

JAGUAR MOTORING ACCESSORIES

606 N. Milpas St.
Santa Barbara, CA 93103
+1 (805) 966-7158 FAX: +1 (805) 564-4118

Has Mini-Mag flashlights engraved with the Jaguar logo, Jaguar Christmas ornaments, many other accessories.

TS IMPORTS/MOTORING EXTRAS

+1 (419) 384-3022 FAX: +1 (419) 384-3272
Orders only: 1-800-543-6648

Key fobs, T-shirts, patches, etc.

PUBLICATIONS & PERIODICALS

AMAZON.COM

<http://www.amazon.com>

The world's biggest and most famous bookstore.

AUTO BOOK CENTER (formerly HYDRO-E-LECTRIC)

45-A Morton Station Road
Charlton, MA 01507
+1 (508) 248-0850
1-800-448-6244

According to John Horner, carries "Shop manuals; parts books (a great resource); sets of service bulletins; also owner's manuals for most Jags. The shop manual, parts manual, and Borg-Warner transmission manual were all good quality full size reprints. The reprints are spiral bound, which is very practical for an owners manual. Also, the quality of printing is quite good with all diagrams very clear and readable."

ROBERT BENTLEY, Publishers

1033 Massachusetts Avenue
Cambridge, MA 02138
1-800-423-4595 or +1 (617) 547-4170
e-mail: sales@rb.com
<http://www.rb.com/catalog.htm>

Jaguar factory shop manuals, parts catalogs, and driver's handbooks.

BOOKSPEED

10 Barley Mow Passage
Chiswick, London W4 4PH (UK)
(+44) 0181 994 7054 Fax: (+44) 0181 995 2624
e-mail: bookspeed@bookspeed.win-uk.net
http://w3.win-uk.net/cars/bks_welj.htm

Source for an extensive collection of Jaguar books and manuals.

CLASSIC MOTORBOOKS

729 Prospect Avenue
P.O. Box 1
Osceola, WI 54020-0001
1-800-826-6600 Overseas: +1 (715) 294-3345

The actual company name is Motorbooks International, and they publish books under this name. Classic Motorbooks is one of their retail divisions. They are not affiliated with the UK or Australian companies with similar names.

HAYNES PUBLICATIONS INC

861 Lawrence Drive
Newbury Park, California 91320 (US)
e-mail: info@haynes.com
<http://www.haynes.com>

Source of the Haynes workshop manuals.

HAYNES PUBLISHING GROUP

Sparkford Nr Yeovil
Somerset BA22 JJ (UK)

HEMMINGS MOTOR NEWS
Box 100
Bennington, VT 05201

KELSEY PUBLISHING LTD
PO Box 13
Westerham, Kent TN16 3WT UK
+44 1959 541444 Fax: +44 1959 541400
e-mail: jagworld@aol.com
Publishers of *Jaguar World* and *XJS Bulletin* magazines.

MOTORBOOKS INTERNATIONAL
See Classic Motorbooks, above.

MOTOR BOOKS
233 Military Road
Cremorne 2090
Sydney, New South Wales, Australia
+61 2-9909-1144

Stefan Kjellberg: "They seem to have a good selection of Jag manuals & books."

EWA & MINIATURE CARS USA, INC. (Eric Waiter)
205 Route 22 East
Green Brook, NJ 08812
Orders only: 1-800-EWA-4454 (1-800-392-4454)
email: ewa@ewacars.com
FTP: [ftp.ewacars.com/pub/ewacars](ftp://ftp.ewacars.com/pub/ewacars)
<http://www.ewacars.com>

The US distributor of *Jaguar World* and *Jaguar Automobilia Collector* magazines, as well as a lengthy list of other British automotive magazines. Also issues a quarterly listing of automotive scale models, books, handbooks and manuals, general autobooks, videos, even books about models!

MODELS

It is not likely you will find a model of the XJ-S in your local K-Mart. However, if you find a hobby shop that will special-order models, Hasegawa makes several XJ-S models including some models of XJ-S race cars. Hasegawa model CA-1 is a 1:24 scale stock street model. This is apparently a model of the Japan- or UK-issue car, as it is right-hand drive, the wipers park to the right, and it has the European style single headlight units. For those of us who haven't built a model in 20 years, the price causes sticker shock: about \$25. But it is remarkably detailed and accurate, including a complete interior with all gauges, switches and pedals, and an engine accurate enough for you to learn where things are you can't see in your engine compartment. The rear suspension is complete with individual shock absorbers. The wheels are the older 5-point domed alloy style. The tires are rubber and actually say "Pirelli P5" and "215/70VR15" on them.

JAGUAR MODEL WORLD

P.O. Box 40,
Hornchurch, Essex RM11 3LG (UK)
FAX: +44 1708 475993

All the obscure Jaguar models you could possibly want.

MODEL EXPO, INC.

Dept. HMN33, P.O.Box 1000
Industrial Park Drive
Mt. Pocono, PA 18344
1-800-222-3876

Dealer for Burago die-cast metal models, 1:18 and 1:24 scale.

TOYS FOR COLLECTORS

P.O. Box 1406
Attleboro Falls, MA 02763
+1 (508) 695-0588

\$5 catalog.

EXOTO TIFOSI

+1 (818) 305-1358

According to Mike Plechaty: "Models in various scales of just about everything ranging in price from \$16.95 to \$25,000, or so. The catalog is 268 pages 8-1/2x11 format complete with b&w photos & costs \$7."

EWA (see listing under Publications, page 674)

INTERNET SOURCES

There are many valuable Jaguar-related resources on the Internet. In addition to the sources described below, e-mail addresses and WWW URL's have been included in the listing of sources where applicable.

Please note that many functions on the Internet are case-sensitive; typing capital letters in commands, addresses, or the like when lower-case letters are required (or vice versa) will often result in failure. Always enter addresses and commands *exactly* as they are written.

Author of this book: See flyer page at the front for e-mail address.

Walt's Jaguar Tip of the Week: You can subscribe to receive Walt Osborn's free tips by writing to ray@vintagejag.com.

Discussion lists: If you have access to Internet e-mail, you can join a "list". A list is a system by which an e-mail message is forwarded to everyone on a mailing list automatically. Such a system facilitates group discussions, with

everyone's questions, comments, and expertise being read by everyone else. There are thousands of such lists, covering almost any conceivable topic from camels to rock groups.

Most lists have one address to send messages to the list members, and another address to send subscription requests or other administrative stuff. Some systems are fully automated, requiring a specific format subscription request. If you're having trouble, most lists have an "admin" that can be contacted by addressing a message to the same address as the list itself preceded by "owner-"; for example, you can contact the admin of the xj-s list by addressing your message to owner-xj-s@jag-lovers.org. Please remember that admins are typically volunteers.

All of the lists described here are free of charge; the term "subscribe" means merely to add your own e-mail address to the distribution list, and is not meant to imply that you need to write a check or anything.

Most lists also offer a "digest" option in which all the messages are saved up for a specified time and then sent as one long message. There is no less text involved; "digest" doesn't mean it's edited or shortened in any way, just that it's all put into a single message. There is no value in this unless your Internet Service Provider charges on a per-message basis or some such.

Also note that many lists have alternative methods of subscribing that make use of the World Wide Web; just surf to a site and sign up for a list by simply filling in a few blanks. The jag-lovers lists mentioned below have such an option; just visit

<http://www.jag-lovers.org>

and sign up for the lists of your choice online.

When you first subscribe to a list, you will automatically be sent an introductory message containing instructions on how to unsubscribe, "netiquette", how to find FAQ's, etc. Please read the guidelines carefully before jumping in and offending all the other subscribers.

Note that most -- possibly all -- of the lists run on the jag-lovers server are set up so that they will not accept a message for posting from a non-member; if you want to post a question, you must subscribe first. It's easy to do, and you can always unsubscribe shortly thereafter just as easily.

Here are some lists that may be of help to the Jaguar XJ-S owner:

xj-s: A list specifically intended for Jaguar XJ-S enthusiasts can be joined by sending a message to:

majordomo@jag-lovers.org

with the words "subscribe xj-s" or "subscribe xj-s-digest" in the body of the message. Note that the "Subject" header is ignored, the command must be in the body.

To send messages for distribution to the group, address them to:

xj-s@jag-lovers.org

An opinion from this author: if you own an XJ-S, it is *highly* recommended that you find a way to subscribe to the xj-s discussion list and to search the list archives. If necessary, buy a computer and learn how to use it. It is no exaggeration to claim that the benefits of list membership will most certainly pay for that computer in short order.

v12-engine: A list specifically intended for Jaguar V12 enthusiasts can be joined by sending a message to:

majordomo@jag-lovers.org

with the words "subscribe v12-engine" or "subscribe v12-engine-digest" in the body of the message.

To send messages for distribution to the group, address them to:

v12-engine@jag-lovers.org

In general, it's a good idea for owners of V12 XJ-S's to subscribe to *both* the xj-s and v12-engine lists, and post questions relating to the engine on the v12-engine list and questions relating to the rest of the car on the xj-s list. Owners of XJ12's should sign up for the v12-engine list plus the "xj" list, which is where SI/II/III XJ6's are discussed; between the two lists, they should be able to obtain answers on the various parts of their cars. Owners of 6-cylinder XJ-S's should sign up for the xj-s list plus the "modern" list; the modern list includes XJ40's, so the AJ6 engine is commonly discussed there.

There are several other Jaguar-related lists at this same server. To obtain a complete listing, send a message to that same majordomo address and type "lists" in the body of the message. Or, visit the WWW site mentioned above.

british-cars: Another list, intended for enthusiasts of all British cars, can be joined by sending a request to:

british-cars-request@autox.team.net

Messages to be distributed to the group can be sent to:

british-cars@autox.team.net

They mostly discuss MG/Triumph/Healey/Rover etc., but Jaguars are included occasionally.

LIST ARCHIVES: Discussion lists will usually maintain a set of archives, so that "newbies" can read the discussions that have occurred in the past -- thereby minimizing the need to dredge up old topics again. For most lists run through a majordomo, you can obtain an index of the archives by sending a message to the majordomo address with the words:

index <listname>

in the message body, where <listname> is the name of the particular list you're interested in. Once you have received the index, you send another message to the majordomo with the words:

get <listname> <filename>

The filenames will usually indicate a date, so you can tell which archive you're getting. Since you don't have to wait for someone to write back with a reply to your question, quite often downloading the archives and doing a search of them for keywords will find an answer *faster* than just posting a question to the list.

Some lists also maintain a file called "CONTENTS" or some such. If found and downloaded (using the same "get" command described above), it provides a much better way of finding the particular archive you need, since it includes information on the topics covered rather than just the date.

If the list in question maintains a web site, web-browsing capability can make searching list archives much easier than fiddling with the majordomo. Just visit the site and follow directions.

Note that the jag-lovers site includes archive browse and search facilities, and this is the *only* way you will get to visit their archives. It requires a sign-in, primarily to verify that you understand the legal ramifications of using info found there.

USENET NEWSGROUPS: Don't confuse discussion lists with UseNet Newsgroups; the functions are similar but not the same. With a discussion list, messages posted to a central server are forwarded to every e-mail address on a subscription list. With newsgroups, messages are posted to a newsgroup, and various "news servers" all over the world periodically obtain copies of all the messages in particular newsgroups for review by users who have authorized access to that news server. When you first connect to a news server, you can obtain a list of all the newsgroups it carries, which may be as many as 30,000 -- yes, being able to automate a search will be helpful! Once you select a newsgroup you're interested in, you can obtain a list of all the subject headers for all the messages currently posted to that newsgroup. Then you can select which messages you actually want to download and read. Messages are automatically deleted after

some set amount of time to prevent the system from loading up with obsolete messages. There are usually no archives kept.

The news servers are supposed to be local to minimize data transfer over the Internet; messages are distributed automatically to all news servers carrying that newsgroup during periods of low traffic. Users are usually only authorized to use a particular news server that is associated with their ISP. If that news server doesn't happen to carry the newsgroup the user is interested in, he has to complain to his ISP to see if he can convince them to start carrying it.

There is special software available for viewing newsgroups, although modern web browsers often include a newsgroup viewing utility. If you use them a lot, a software package such as News Xpress is recommended.

At this writing, there are no known Jaguar-related newsgroups. There have been discussions about starting one, though, since they handle heavy message loads better than discussion lists.

FTP SITES: An FTP (file transfer protocol) site is a location on the Internet where directories of files can be accessed and downloaded to your own computer. On automotive-related sites, such files will often include collections of Frequently Asked Questions (FAQ), pictures (GIF and JPEG files), lists of parts and service suppliers, and other items of interest. Almost all FTP sites allow logging in as "anonymous" and entering your own e-mail address as a password.

Some systems provide Internet e-mail but don't provide access to FTP sites. For such situations, a system has been established wherein access to FTP files can be accomplished via e-mail; files are "mailed" to your address. To get instructions, send e-mail to:

server@ingr.com

with "/HELP" in the body of the message. The server will automatically send you the help file with further instructions.

british-cars: This group maintains a collection of files on an FTP site:

triumph.cs.utah.edu (155.99.208.4)

The british-cars files are in directory /pub/sol/, with picture files in directory /pub/sol/Images/.

WORLD WIDE WEB: If you have WWW-browsing capability, the number of sites of interest to Jaguar owners seems to grow every day. The "address" for a WWW site is called a URL, and it begins with http:// followed by a server name and perhaps a subdirectory and filename.

Also note that, in this Word 97 document, URL's have been formatted as hyperlinks -- which makes them blue and underlined. It also means that, if you are viewing on a computer with a properly-installed browser, you can merely point-and-click on one of these hyperlinks and it will automatically start the browser and take you to that site. Of course, if you're reading this book on paper, it's just a pretty blue color.

Some URLs of interest to Jaguar owners:

Jaguar: Jaguar has its own WWW site:

<http://www.jaguarcars.com>

jag-lovers: The jag-lover's discussion lists maintain a site on the WWW:

<http://www.jag-lovers.org>

The jag-lover's site contains links to just about everything else on the WWW pertaining to Jaguars. Archives for the jag-lovers.org discussion lists are browsable and searchable. This author also maintains a recent update to this book, along with a collection of photographs relating to things discussed in the book, at the jag-lovers site.

XJR-S: Steve Gallant set up a site for discussion of all things XJR-S:

<http://www.jaguarsportxrsownersclub.com/cgi-bin/ubb.cgi?Ultimate.cgi?>

Parts Interchange Guide: David J. Shield has an online guide to substituting readily-available parts for Jaguar XJ6 parts. Many are equally applicable to the XJ-S:

http://www.mich.com/~kroppe/jaguar/XJ_Parts.htm

DealerNet - The Virtual Showroom: DealerNet can find Jaguars for sale in your area:

<http://www.dealernet.com/>

Alldata: Alldata maintains a list of the Technical Service Bulletins (TSB's) on many cars, including Jaguars, and provides access for a fee. They maintain a page on the WWW and allow users to see what is available for their car as well as provide trial access. Their WWW page is at:

<http://www.alldata.tsb.com>

Jaguar Chat Room:

<http://www.classiccar.com/chat.htm>

Thanks to Mike Frank for this tip.

Michael Minglin points out that there is an online ongoing discussion of air conditioning issues at:

<http://www.aircondition.com/wwwboard/index2.htm>

Kirby Palm's Home Page: Includes a guide on proper Jaguar etiquette:

<http://www.nettally.com/palmk/>

INTERNET RELAY CHAT: IRC is a special application of the Internet that requires WWW browsing capability *plus* special IRC software. Suitable software can be downloaded from several places on the WWW, including

<http://www.mirc.co.uk>

With IRC, usually you log into one of several IRC networks (all of which reside on the Internet) and join in on real-time discussions with other people who happen to be there at the same time. Each network offers a huge selection of "chat rooms" to choose from, each dedicated to a specific topic; if you want, you can apply to get new chat rooms created.

The jag-lovers discussion list has set up its own chat room, but it is *not* carried by the various IRC networks. Rather, it is available *only* via the jag-lovers server itself. The standard IRC software can be used, but it's also possible to join in from the jag-lovers web site using an interface available there. The IRC software is more convenient, though, so if you get into the chat habit you probably should go ahead and download it.

This, of course, is not exactly the busiest chat room on the net. In general, the subscribers to the lists post a message declaring a time that everyone is to meet for a chat. Most other times, this chat room will be totally empty.

CLUBS

The scope of this book includes assisting the Jag owner in getting in touch with his local club. However, it is not practical to list all the Jaguar clubs in the US or the world. The list for the US alone is about 50 pages, and since it already exists, it would be redundant to attempt to establish a second listing.

Jaguar Clubs of North America (JCNA) maintains the list of clubs in the US. To obtain a copy of the list, as well as other Jaguar club info, contact:

Karen Miller
Jaguar Journal
P.O. Box 220
Stormville, NY 12582
+1 (201) 818-8500

or:

Jaguar Clubs of North America, Inc.
555 MacArthur Blvd.
Manwah, NJ 07430-2327
+1 (201) 818-8144 FAX: +1 (201) 818-0281

If there is no local club near you, you can join JCNA "Membership-At-Large" (M-A-L). Contact:

Jaguar Clubs of North America, Inc.
Jerry and Sue Parkhill
9472 Woodbine St. S
Chilliwack, BC V2P 5S4 Canada

For club info in the UK, contact:

Jaguar Enthusiasts' Club Ltd.
Thelma Brotton
Stoneycroft, Moor Lane, Birdwell
Barnsley, South Yorkshire, S70 5TZ
+44 (0)1226 740754 (9am to 9pm) Fax: +44 (0) 1226 293581
Mobile: +44 (0)374 125765

Actually, JEC can provide some parts -- such as a longer banjo bolt for the back end of the tappet blocks. Accept credit cards, will ship worldwide.

Jaguar Car Club
Barbary, Chobham Road, Horsell,
Woking, Surrey GU21 4AS
+44 1483 763811

Membership secretary: Jeff Holman.

And, just because Willem Noorloos was nice enough to provide the information, here are the three clubs in the Netherlands:

Jaguar Daimler Club Holland, Rotterdam, F. Verbrache, 010-4821212
Jaguar Drivers Club, Aalter, J. v/d Elst, 09 374 11 71
Classic Jaguar Club Z-Limburg, Heerlen, A. Wolfs, 045-5229965

HERITAGE CERTIFICATE

You can obtain the production records on *your* Jaguar. Quoting from the application form: "A JDHT Heritage Certificate is a Certificate which gives all the relevant information on your car taken from the original records. It will confirm the original build numbers and colour scheme, give the dates of build and despatch, as well as the original destination of the car. Where recorded, the name of the first owner and the original registration mark are also included on the Certificate."

Cost is £30.00 as of mid-2001. You must provide a photocopy of your registration or some other proof of ownership or existence of the car.

Contact:

Jaguar Daimler Heritage Trust, Archive Department
Jaguar Cars Ltd.
Browns Lane, Coventry CV5 9DR (UK)
Phone: +44 24 7620 2141 or 2743 Fax: +44 24 7640 5581

From Brian Sherwood: "I recently sent for a certificate for my '84 XJ-S from JCNA, trying to confirm that several pieces of optional equipment were factory or TWR options.

1. You have to send them all the eng/trans/body/VIN numbers- they will "verify" them (?).
2. Took six weeks to receive reply.
3. Certificate does not say anything about optional equipment. Doesn't even say what dealer initially sold the car.

"Unless you have a collector's class early car (XK, etc.), save your money for parts."