

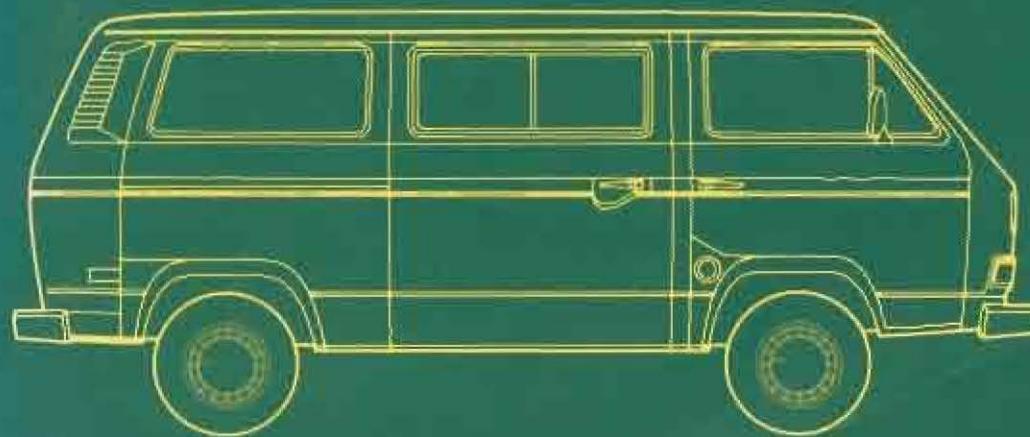
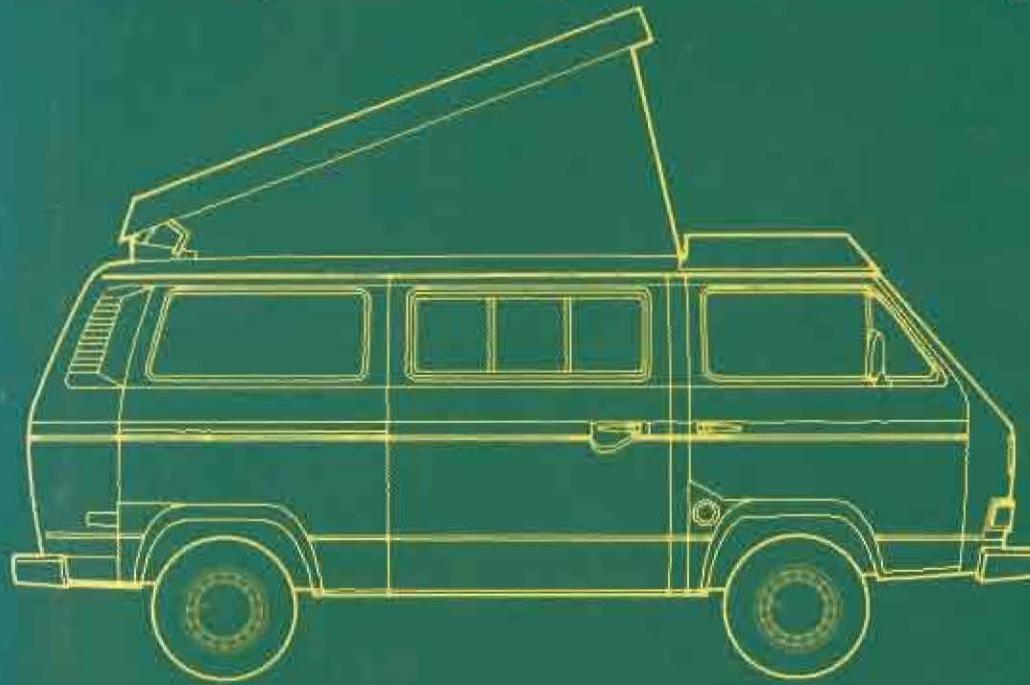


# VOLKSWAGEN VANAGON

**Official Factory Repair Manual**

1980, 1981, 1982, 1983, 1984, 1985,  
1986, 1987, 1988, 1989, 1990, 1991

**Including Diesel, Syncro and Camper**



**Robert Bentley**



# Volkswagen Vanagon

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**1980, 1981, 1982, 1983, 1984, 1985,**  
**1986, 1987, 1988, 1989, 1990, 1991**  
**Including Diesel, Syncro and Camper**

**Robert Bentley  
Cambridge, Massachusetts**



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#### **WARNING—Important Safety Notice**

Do not use this manual unless you are familiar with basic automotive repair procedures and safe workshop practices. This manual illustrates the workshop procedures required for most service work; it is not a substitute for full and up-to-date information from the vehicle manufacturer or for proper training as an automotive technician. Note that it is not possible for us to anticipate all of the ways or conditions under which vehicles may be serviced or to provide cautions as to all of the possible hazards that may result.

The vehicle manufacturer will continue to issue service information updates and parts retrofits after the editorial closing of this manual. Some of these updates and retrofits will apply to procedures and specifications in this manual. We regret that we cannot supply updates to purchasers of this manual.

We have endeavored to ensure the accuracy of the information in this manual. Please note, however, that considering the vast quantity and the complexity of the service information involved, we cannot warrant the accuracy or completeness of the information contained in this manual.

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Your common sense and good judgment are crucial to safe and successful service work. Read procedures through before starting them. Think about whether the condition of your car, your level of mechanical skill, or your level of reading comprehension might result in or contribute in some way to an occurrence which might cause you injury, damage your car, or result in an unsafe repair. If you have doubts for these or other reasons about your ability to perform safe repair work on your car, have the work done at an authorized Volkswagen dealer or other qualified shop.

Part numbers listed in this manual are for identification purposes only, not for ordering. Always check with your authorized Volkswagen dealer to verify part numbers and availability before beginning service work that may require new parts.

Before attempting any work on your Volkswagen, read the warnings and cautions on pages ix and x and any warning or caution that accompanies a procedure in the service manual. Review the warnings and cautions on pages ix and x each time you prepare to work on your Volkswagen.

Special tools required to perform certain service operations are identified in the manual and are recommended for use. Use of tools other than those recommended in this service manual may be detrimental to the car's safe operation as well as the safety of the person servicing the car.

Copies of this manual may be purchased from authorized Volkswagen dealers, most automotive accessories and parts dealers specializing in Volkswagens, from selected booksellers, or directly from the publisher by mail.

The publisher encourages comments from the reader of this manual. These communications have been and will be carefully considered in the preparation of this and other manuals. Please write to Robert Bentley, Inc. at the address listed on the top of this page.

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Manufactured in the United States of America

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# Foreword

Service to Volkswagen owners is a top priority of Volkswagen organization and has always included the continuing development and introduction of new and expanded services. In line with this purpose, Volkswagen United States, Inc. has introduced this Volkswagen Official Factory Repair Manual.

This Vanagon manual covers the model years 1980 through 1991 including Air-cooled and Water-cooled Gasoline Engines, Diesel Engine, Syncro and Camper. This manual was specifically written to cover U.S. and Canada models only.

For the Volkswagen owner with basic mechanical skills and for independent garages, this manual gives all the specifications and procedures that were available in an authorized Volkswagen service department as this manual went to press. In addition, the Volkswagen owner who has no intention of working on his or her vehicle may find that reading and owning this manual will make it possible to be better informed and to discuss repairs more intelligently with a professional automotive technician.

This manual has been prepared from the repair information that the Volkswagen organization provides to its own factory-trained technicians and has been developed primarily with the professional automotive technician in mind. The aim throughout has been clarity and completeness with step-by-step procedures and accurate specifications.

The Volkswagen owner intending to do maintenance and repair should have a set of metric wrenches and sockets, a torque wrench, screwdrivers, and feeler gauges, since these basic hand tools will be used for a majority of the repairs described in this manual. Usually, the text will note when a repair requires special tools.

This manual is organized so that, whenever possible, when a change has been made within a model year, the vehicle identification number (VIN) of the first vehicle with this change is given. The digits you need to know for this parts and service information are taken from the seventeen digit VIN number. If, for example the VIN is WVWZZZ24ZBH000001, you will need only nine of the last eleven digits of this number—or, more specifically, the digits 24 B 000001. Your Volkswagen's VIN is found on the left doorjamb and on a plate mount-

ed on the driver's side of the instrument panel padding where the number can be seen through the windshield. The VINs assigned to Vanagon models for the years 1980 through 1991 which are covered by this manual are:

1980:	25_A_000001	to	25_A_999999
1981:	25_B_000001	to	25_B_999999
1982:	25_C_000001	to	25_C_999999
1983:	25_D_000001	to	25_D_999999
1984:	25_E_000001	to	25_E_999999
1985:	24_F_000001	to	24_F_999999
	25_F_000001	to	25_F_999999
1986:	24_G_000001	to	24_G_999999
	25_G_000001	to	25_G_999999
1987:	24_H_000001	to	24_H_999999
	25_H_000001	to	25_H_999999
1988:	24_J_000001	to	24_J_999999
	25_J_000001	to	25_J_999999
1989:	24_K_000001	to	24_K_999999
	25_K_000001	to	25_K_999999
1990:	24_L_000001	to	24_L_999999
	25_L_000001	to	25_L_999999
1991:	24_M_000001	to	24_M_999999
	25_M_000001	to	25_M_999999

We have endeavored to ensure the highest degree of accuracy possible. When the vast array of data presented in this manual is taken into account, however, no claim to infallibility can be made. We therefore cannot be responsible for the result of any errors that may have crept into the text. The Publisher encourages comments from the readers of this manual in regard to any errors and, also, suggestions for improvement in the presentation of the technical material. These communications have been and will be carefully considered in the preparation of this and other manuals. Please write to Robert Bentley, Inc., Cambridge, Massachusetts 02138.

Volkswagen offers extensive warranties, especially on components of the fuel delivery and emission control systems. Therefore, before deciding to repair a Volkswagen that may still be covered wholly or in part by any warranties issued by Volkswagen United States, Inc., consult your authorized Volkswagen dealer. You may find that he can make the repair either free or at minimum cost. Regardless of its age, or whether it is under warranty, your Volkswagen is both an easy vehicle to service and an easy vehicle to get serviced. So if at any time a repair is needed that you feel is too difficult to do yourself, a trained Volkswagen technician is ready to do the job for you.

**Robert Bentley**

# Please read these warnings and cautions before proceeding with maintenance and repair work.

## WARNING—

- Some repairs may be beyond your capability. If you lack the skills, tools and equipment, or a suitable workplace for any procedure described in this manual, we suggest you leave such repairs to an authorized Volkswagen dealer service department, or other qualified shop.
- Volkswagen is constantly improving its cars. Sometimes these changes, both in parts and specifications, are made applicable to earlier models. Therefore, before starting any major jobs or repairs to components on which passenger safety may depend, consult your authorized Volkswagen dealer about Technical Bulletins that may have been issued since the editorial closing of this manual.
- Do not re-use any fasteners that are worn or deformed in normal use. Many fasteners are designed to be used only once and become unreliable and may fail when used a second time. This includes, but is not limited to, nuts, bolts, washers, self-locking nuts or bolts, circlips and cotter pins. Always replace these fasteners with new parts.
- Never work under a lifted car unless it is solidly supported on stands designed for the purpose. Do not support a car on cinder blocks, hollow tiles or other props that may crumble under continuous load. Never work under a car that is supported solely by a jack. Never work under the car while the engine is running.
- If you are going to work under a car on the ground, make sure that the ground is level. Block the wheels to keep the car from rolling. Disconnect the battery negative (-) terminal (Ground strap) to prevent others from starting the car while you are under it.
- Never run the engine unless the work area is well ventilated. Carbon monoxide kills.
- Finger rings, bracelets and other jewelry should be removed so that they cannot cause electrical shorts, get caught in running machinery, or be crushed by heavy parts.
- Tie long hair behind your head. Do not wear a necktie, a scarf, loose clothing, or a necklace when you work near machine tools or running engines. If your hair, clothing, or jewelry were to get caught in the machinery, severe injury could result.
- Do not attempt to work on your car if you do not feel well. You increase the danger of injury to yourself and others if you are tired, upset or have taken medication or any other substance that may keep you from being fully alert.
- Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the car. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.
- Catch draining fuel, oil, or brake fluid in suitable containers. Do not use food or beverage containers that might mislead someone into drinking from them. Store flammable fluids away from fire hazards. Wipe up spills at once, but do not store the oily rags, which can ignite and burn spontaneously.
- Always observe good workshop practices. Wear goggles when you operate machine tools or work with battery acid. Gloves or other protective clothing should be worn whenever the job requires working with harmful substances.
- Friction materials such as brake or clutch discs may contain asbestos fibers. Do not create dust by grinding, sanding, or by cleaning with compressed air. Avoid breathing asbestos fibers and asbestos dust. Breathing asbestos can cause serious diseases such as asbestosis or cancer, and may result in death.
- Disconnect the battery negative (-) terminal (Ground strap) whenever you work on the fuel system or the electrical system. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.
- Batteries give off explosive hydrogen gas during charging. Keep sparks, lighted matches and open flame away from the top of the battery. If hydrogen gas escaping from the cap vents is ignited, it will ignite gas trapped in the cells and cause the battery to explode.
- Connect and disconnect battery cables, jumper cables or a battery charger only with the ignition switched off, to prevent sparks. Do not disconnect the battery while the engine is running.
- Do not quick-charge the battery (for boost starting) for longer than one minute. Wait at least one minute before boosting the battery a second time.
- Do not allow battery charging voltage to exceed 16.5volts. If the battery begins producing gas or boiling violently, reduce the charging rate. Boosting a sulfated battery at a high charging rate can cause an explosion.
- The air-conditioning system is filled with chemical refrigerant, which is hazardous. The A/C system should be serviced only by trained technicians using approved refrigerant recovery/recycling equipment, trained in related safety precautions, and familiar with regulations governing the discharging and disposal of automotive chemical refrigerants.
- Do not expose any part of the A/C system to high temperatures such as open flame. Excessive heat will increase system pressure and may cause the system to burst.
- Some aerosol tire inflators are highly flammable. Be extremely cautious when repairing a tire that may have been inflated using an aerosol tire inflator. Keep sparks, open flame or other sources of ignition away from the tire repair area. Inflate and deflate the tire at least four times before breaking the bead from the rim. Completely remove the tire from the rim before attempting any repair.
- Some cars covered by this manual are equipped with a supplemental restraint system (SRS), that automatically deploys an airbag in the event of a frontal impact. The airbag is inflated by an explosive device. Handled improperly or without adequate safeguards, it can be accidentally activated and cause serious injury.
- Greases, lubricants and other automotive chemicals contain toxic substances, many of which are absorbed directly through the skin. Read manufacturer's instructions and warnings carefully. Use hand and eye protection. Avoid direct skin contact.

continued on next page

# Please read these warnings and cautions before proceeding with maintenance and repair work.

## CAUTION—

- If you lack the skills, tools and equipment, or a suitable workshop for any procedure described in this manual, we suggest you leave such repairs to an authorized Volkswagen dealer or other qualified shop.
- Volkswagen offers extensive warranties, especially on components of fuel delivery and emission control systems. Therefore, before deciding to repair a Volkswagen that may still be covered wholly or in part by any warranties issued by Volkswagen United States, Inc., consult your authorized Volkswagen dealer. You may find that he can make the repair for free, or at minimal cost.
- Volkswagen part numbers listed in this manual are for identification purposes only, not for ordering. Always check with your authorized Volkswagen dealer to verify part numbers and availability before beginning service work that may require new parts.
- Before starting a job, make certain that you have all the necessary tools and parts on hand. Read all the instructions thoroughly, do not attempt shortcuts. Use tools appropriate to the work and use only replacement parts meeting Volkswagen specifications. Makeshift tools, parts and procedures will not make good repairs.
- Use pneumatic and electric tools only to loosen threaded parts and fasteners. Never use these tools to tighten fasteners, especially on light alloy parts. Always use a torque wrench to tighten fasteners to the tightening torque specification listed.
- Be mindful of the environment and ecology. Before you drain the crankcase, find out the proper way to dispose of the oil. Do not pour oil onto the ground, down a drain, or into a stream, pond or lake. Consult local ordinances that govern the disposal of wastes.
- On cars equipped with anti-theft radios, make sure you know the correct radio activation code before disconnecting the battery or removing the radio. If the wrong code is entered into the radio when power is restored, that radio may lock up and be rendered inoperable, even if the correct code is then entered.
- Connect and disconnect a battery charger only with the battery charger switched off.
- Do not quick-charge the battery (for boost starting) for longer than one minute. Wait at least one minute before boosting the battery a second time.
- Sealed or "maintenance free" batteries should be slow-charged only, at an amperage rate that is approximately 10% of the battery's ampere-hour (Ah) rating.
- Do not allow battery charging voltage to exceed 16.5 volts. If the battery begins producing gas or boiling violently, reduce the charging rate. Boosting a sulfated battery at a high charging rate can cause an explosion.

**WARNING —**

- *Automotive service and repair is serious business. You must be alert, use common sense, and exercise good judgement to prevent personal injury and complete the work safely.*
- *Before beginning any work on your Volkswagen, thoroughly read all the Cautions and Warnings listed near the front of this manual.*
- *Always read the complete procedure before you begin the work. Pay special attention to any Cautions and Warnings that accompany that procedure, or other information on a specific topic.*

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**WARNING —**

- *Automotive service and repair is serious business. You must be alert, use common sense, and exercise good judgement to prevent personal injury and complete the work safely.*
- *Before beginning any work on your Volkswagen, thoroughly read all the Cautions and Warnings listed near the front of this manual.*
- *Always read the complete procedure before you begin the work. Pay special attention to any Cautions and Warnings that accompany that procedure, or other information on a specific topic.*

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# Vanagon Quick Data

## 1980 through 1991

<b>Engine—Assembly</b>	<b>Group 10</b>	<b>Exhaust/Emissions</b>	<b>Group 26</b>
<b>Compression pressures</b>		<b>tightening torques</b>	
Air-cooled—AFC		exhaust system	20 Nm (15 ft-lb)
nominal	6-9 bar (87-131 psi)	fasteners (M8)	55 Nm (40 ft-lb)
minimum	5.0 bar (73 psi)	oxygen sensor	50 Nm (37 ft-lb)
max. difference			
between cylinders	3.0 bar (44 psi)		
Water-cooled—Digitel/Digitant			
nominal	10-13 bar (145-189 psi)		
minimum	8 bar (116 psi)		
max. difference			
between cylinders	3.0 bar (44 psi)		
<b>Tightening torques (installing engine)</b>			
Air-cooled—AFC			
engine to trans	30 Nm (22 ft-lb)	<b>firing order</b>	1-4-3-2
engine carrier to mount	25 Nm (18 ft-lb)	<b>tightening torques</b>	
trans. mount	30 Nm (22 ft-lb)	spark plugs	
torque converter		air-cooled	30 Nm (22 ft-lb)
to drive plate	30 Nm (22 ft-lb)	water-cooled	20 Nm (15 ft-lb)
<b>Diesel</b>			
engine to trans			
M10 fasteners	45 Nm (33 ft-lb)		
M12 fasteners	80 Nm (59 ft-lb)		
engine mounts	85 Nm (63 ft-lb)		
support member	45 Nm (33 ft-lb)		
fuel line unions			
to injection pump	22 Nm (16 ft-lb)		
Water-cooled—Digitel/Digitant			
engine to trans	30 Nm (22 ft-lb)		
engine carrier to body	25 Nm (18 ft-lb)		
trans. mounts	30 Nm (22 ft-lb)		
torque converter			
to drive plate	20 Nm (15 ft-lb)		
<b>Crankshaft, Crankcase</b>	<b>Group 13</b>	<b>Clutch</b>	<b>Group 30</b>
Air-cooled—AFC		clutch pressure plate	
<b>tightening torques</b>		to flywheel	25 Nm (18 ft-lb)
connecting rod	35 Nm (26 ft-lb)		
case halves			
small	20 Nm (15 ft-lb)		
large	30 Nm (22 ft-lb)		
flywheel to crankshaft	60 Nm (44 ft-lb)		
	plus 1/4 turn (90°)		
torque converter drive plate			
to crankshaft	90 Nm (66 ft-lb)		
<b>crankshaft end play</b>			
new	0.07-0.13 mm (0.003-0.005 in.)		
wear limit	0.15 mm (0.006 in.)		
<b>Diesel</b>			
<b>tightening torques</b>			
main bearing cap.	65 Nm (47 ft-lb)		
connecting rod			
two different types	see Repair Manual		
flywheel to crankshaft	75 Nm (54 ft-lb)		
<b>crankshaft end play</b>			
new	0.07-0.17 mm (0.003-0.007 in.)		
wear limit	0.37 mm (0.015 in.)		
<b>Water-cooled—Digitel/Digitant</b>			
<b>tightening torques</b>			
connecting rod			
1980-1985	45 Nm (33 ft-lb)		
from 1986	30 Nm (22 ft-lb)		
	plus 1/2 turn		
case halves			
small	20 Nm (15 ft-lb)		
up to engine # DH 027 404	35 Nm (26 ft-lb)		
from engine # DH 027 404	45 Nm (33 ft-lb)		
from engine # MV 041 599	50 Nm (37 ft-lb)		
flywheel to crankshaft	60 Nm (44 ft-lb)		
	plus 1/4 turn (90°)		
<b>torque converter drive plate</b>			
to crankshaft	90 Nm (66 ft-lb)		
<b>Cylinder Head</b>	<b>Group 15</b>	<b>Manual Trans.</b>	<b>Groups 34/35</b>
<b>Diesel</b>		refer to Repair Manual for specifications	
valve clearance (engine warm)			
intake	0.20-0.30 mm (0.008-0.012 in.)		
exhaust	0.40-0.50 mm (0.016-0.020 in.)		
<b>tightening torques</b>			
cam bearing cap	20 Nm (15 ft-lb)		
<b>Lubrication System</b>	<b>Group 17</b>	<b>Automatic Trans.</b>	<b>Groups 37/38</b>
<b>Air-cooled—AFC</b>		ATF	Dexron® or Dexron II®
oil capacity		ATF capacity	
with filter change	3.5 L (3.7 US qt)	refill	3.0 L (3.2 US qt)
without filter change	3.0 L (3.2 US qt)	dry fill	8.0 L (8.4 US qt)
<b>tightening torques</b>			
drain plug	25 Nm (18 ft-lb)		
<b>Diesel</b>			
oil capacity			
with filter change	4.0 L (4.2 US qt)		
without filter change	3.5 L (3.7 US qt)		
<b>tightening torques</b>			
drain plug	25 Nm (18 ft-lb)		
strainer plug (bolt)	13 Nm (9 ft-lb)		
<b>Water-cooled—Digitel/Digitant</b>			
oil capacity			
with filter change	4.5 L (4.7 US qt)		
without filter change	4.0 L (4.2 US qt)		
<b>tightening torques</b>			
drain plug	25 Nm (18 ft-lb)		
<b>Cooling System</b>	<b>Group 19</b>	<b>Front Suspension</b>	<b>Group 40</b>
<b>Diesel</b>		<b>tightening torques</b>	
coolant pump V-belt		axle nut	350 Nm (258 ft-lb)
deflection	10-15 mm (3/16-9/16 in.)	brake caliper to steering knuckle (Vanagon)	160 Nm (115 ft-lb)
coolant capacity	16.0 L (16.9 US qt)	from 1986	220 Nm (200 ft-lb)
coolant reservoir cap		brake caliper to wheel bearing housing	
release pressure	1 bar (14 psi)	Syncro	250 Nm (185 ft-lb)
<b>tightening torques</b>		wheel lug bolts	
coolant pump pulley	20 Nm (15 ft-lb)	1980 to Nov. 1984	170 Nm (125 ft-lb)
thermostat housing	10 Nm (8 ft-lb)	from Nov. 1984	180 Nm (133 ft-lb)
thermoswitches	30 Nm (22 ft-lb)		
<b>Water-cooled—Digitel/Digitant</b>			
coolant pump V-belt		<b>Rear Suspension</b>	<b>Group 42</b>
deflection	10-15 mm (3/16-9/16 in.)	constant velocity (CV) joint lubricant	
coolant capacity	17.5 L (18.4 US qt)	lubricant (per joint)	90 g
coolant reservoir cap		type	G6 grease
release pressure	0.9-1.5 bar (13-17 psi)	<b>tightening torques</b>	
<b>tightening torques</b>		CV joints	45 Nm (33 ft-lb)
thermostat housing	10 Nm (8 ft-lb)	rear axle nut	500 Nm (360 ft-lb)
<b>Fuel Supply</b>	<b>Group 20</b>	<b>Brakes</b>	<b>Group 46</b>
fuel tank capacity (including reserve)		brake caliper guide pin bolts (always replace)	
Vanagon except Syncro	60 L (16 US gal)	from 1986	35 Nm (26 ft-lb)
Syncro	70 L (18.8 US gal)	brake pad minimum thickness (without	
reserve	10 L (2.5 US qt)	backing plate)	2 mm (0.079 in.)
<b>Diesel Fuel Injection</b>	<b>Group 23</b>	<b>Heater Booster</b>	<b>Group 82</b>
idle speed	800-850 rpm	refer to Repair Manual for specifications	
maximum speed			
(no load)	4800 ± 50 rpm		
<b>tightening torques</b>			
glow plugs	40 Nm (29 ft-lb)		
<b>Air Conditioning</b>	<b>Group 87</b>		
From 1986			
refrigerant capacity	1450 grams (50.75 oz)		
refrigerant oil quantities			
evaporator	2.02 oz		
accumulator	0.3 oz		
high-pressure hose	0.3 oz		
low-pressure hose	0.3 oz		
compressor	5.07 oz		
<b>Electrical System</b>	<b>Groups 90-97</b>		
refer to Repair Manual for specifications			

VW Part No. LPV 800 148

Bentley Stock No. VV91

ISBN 0-8376-0336-6

**Robert Bentley**

Information that makes the difference™

# Index

<b>Identification (Numbers/Codes)</b> — Automatic transmission 4 — Compression pressure values 2a — Engine 2 — Front final drive Syncro 3b — Manual transmission 3, 3a — Type/Model/Assemblies 2 — VIN (Vehicle Identification Number) 2	<b>Ignition distributor and settings</b> — Air-cooled AFC Can/USA, not Calif. 8 California 9 — Water-cooled Digijet 10 — Digifant 11	
<b>Lifting Vehicle</b> — Hoist/Floor jack 5	<b>Technical data</b> — Digifant 12	
<b>Towing</b> — Procedure 6, 7		

# General

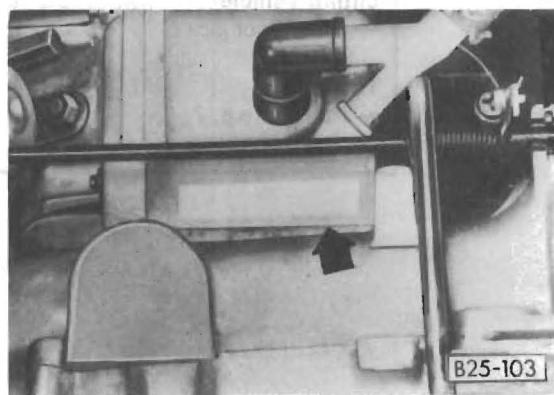
Type/model: Type: 25

Model: VANAGON/VANAGON SYNCRO

Assemblies	Code letters	BHP (SAE)	RPM
Engine (air-cooled) 2.0 Liter (AFC)	CV	70	4200
Manual Transmission - 4 speed (091)	DK	—	—
Automatic Transmission (090)	NG	—	—
Engine (Diesel) 1.6 Liter	CS	50	4200
Manual Transmission - 4 speed (091)	DM/DZ	—	—
Manual Transmission - 5 speed (094)	DX	—	—
Engine (water-cooled) 1.9 Liter (Digijet)	DH	80	4800
Manual Transmission - 4 speed (091/1)	DU/ABD	—	—
Automatic Transmission (090)	NH	—	—
Engine (water-cooled) 2.1 Liter (Digifant)	MV	95	4800
Manual Transmission - 4 speed (091/1)	ABD/ACW	—	—
Automatic Transmission (090)	NK	—	—
Manual Transmission - Syncro 5-speed (094-4WD) (with differential lock) (without differential lock)	AAN/AVN AAK/AVV	— —	— —

**CAUTION**  
**SYNCRO TRANSMISSIONS**

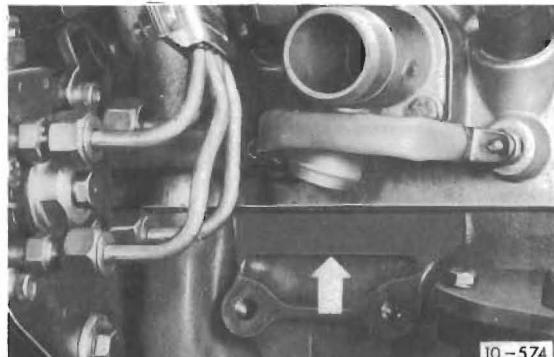
When checking engine performance,  
only use dynamometer designed to  
brake all four wheels at the same time.



**Engine number (Gasoline)**  
• stamped on crankcase below breather (arrow)



**Vehicle identification number (VIN)**  
• on dashboard on driver's side (arrow)



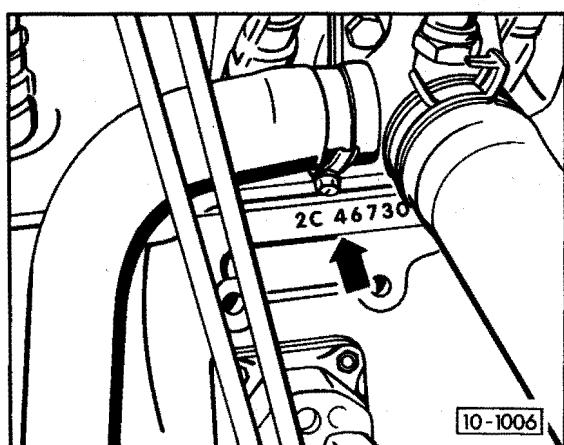
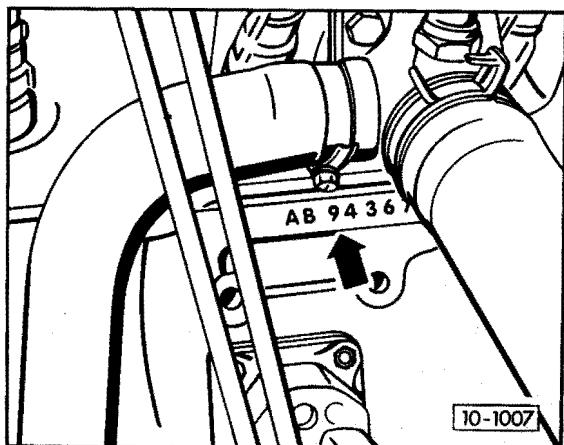
**Engine number (Diesel)**  
• on engine block (arrow) between injection pump  
an vacuum pump

Beginning May 1987, engine codes are now either a two letter combination or a combination of one number and one letter.

Engine code continues to precede the engine number.

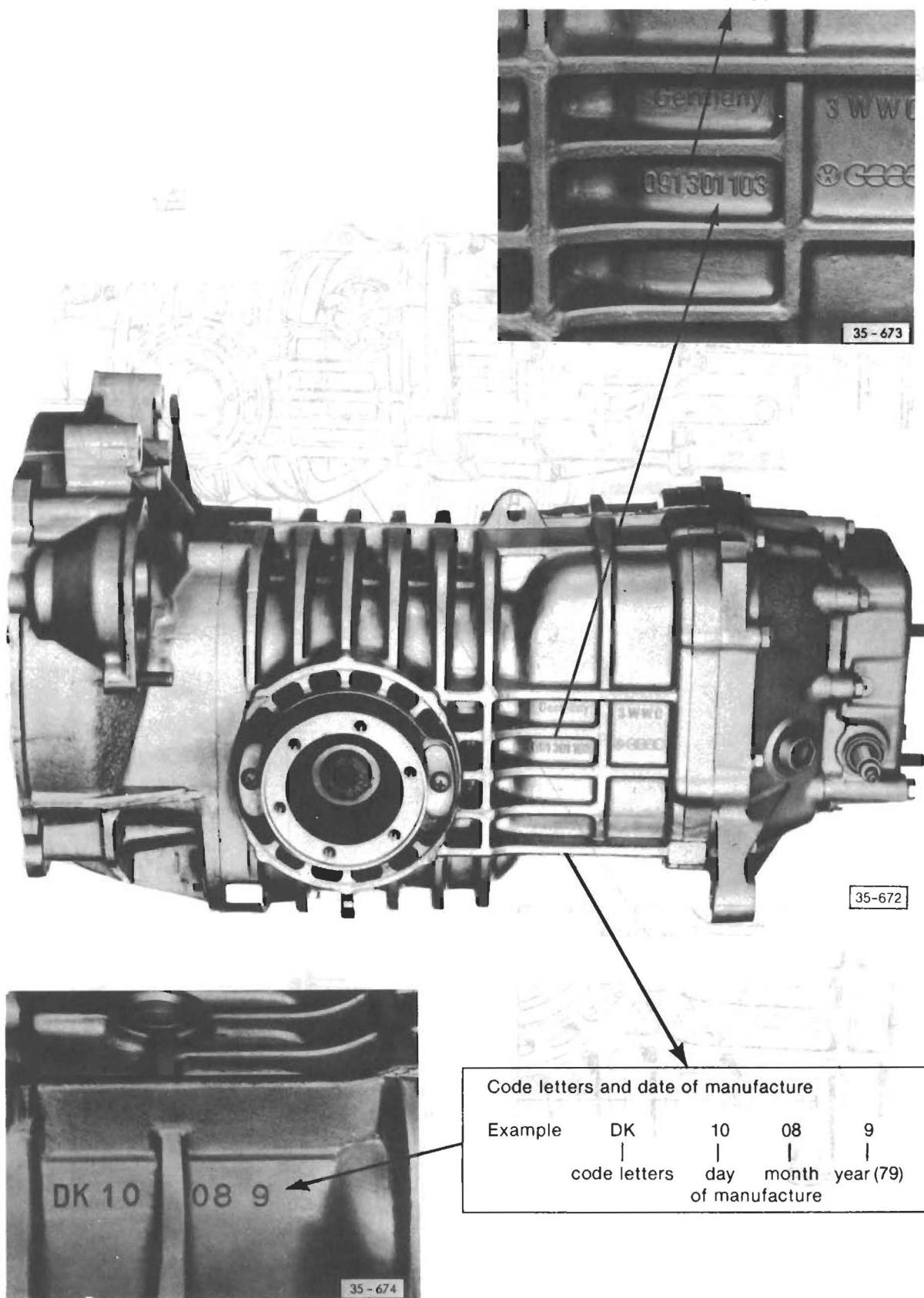
**CAUTION**

Engines with identical code **DO NOT** necessarily have identical specifications.

**Compression pressure values**

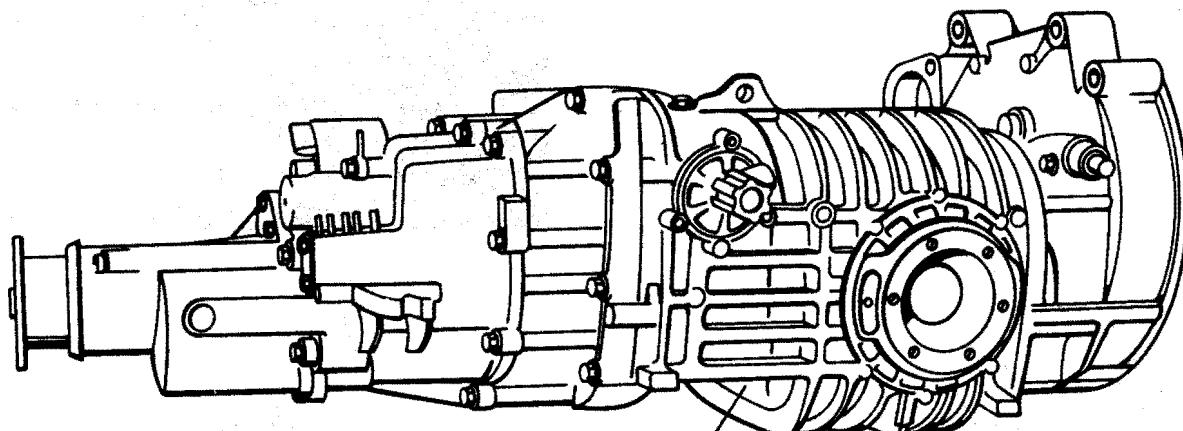
Engine codes	CV	DH, MV	CS
Compression pressure values bar (psi)	6 - 9 (87 - 131)	10 - 13 (145 - 190)	34 (493)
Wear limit bar (psi)	5 (73)	8 (116)	26 (377)
Maximum permissible difference between all four cylinders bar (psi)		3 (44)	5 (73)

## Manual Transmission Type 091

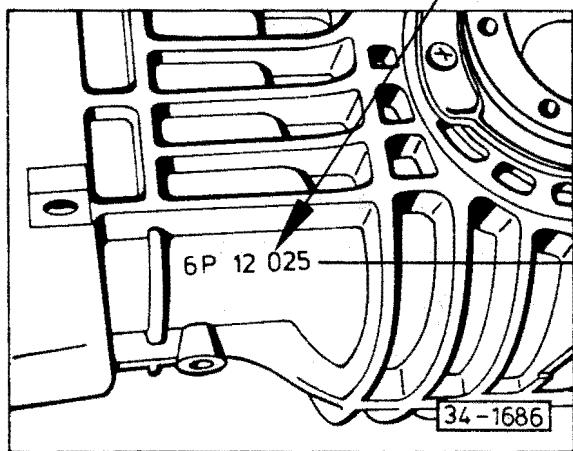


# General

## Manual Transmission Type 094



34-1685



Gearbox code letters and date of manufacture:

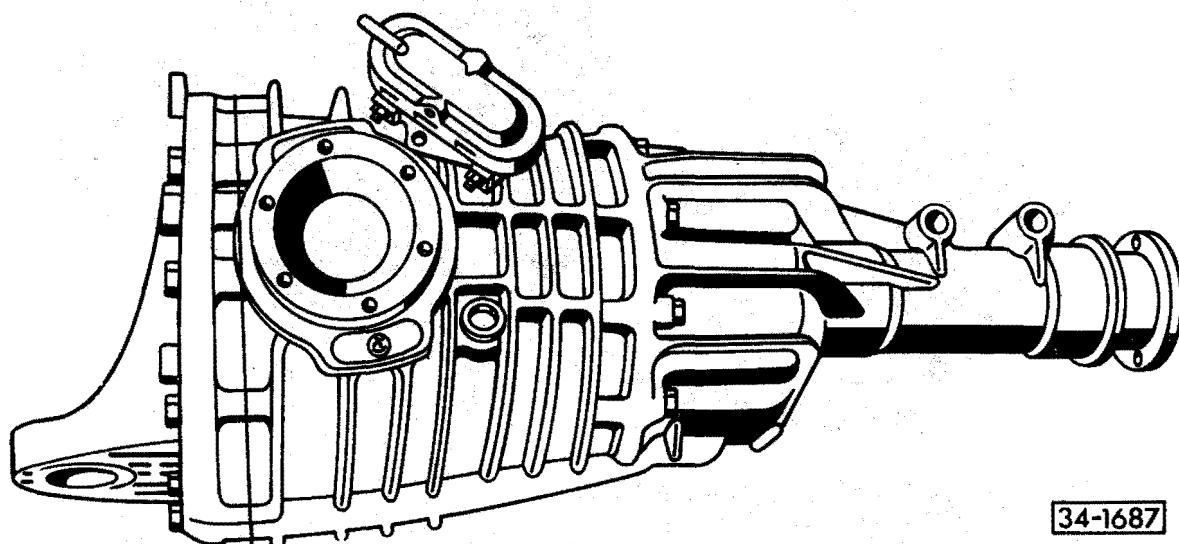
Example:	GP	12	02	5
	Code letters	Day of manufacture	Month	Year (85)

**3a**

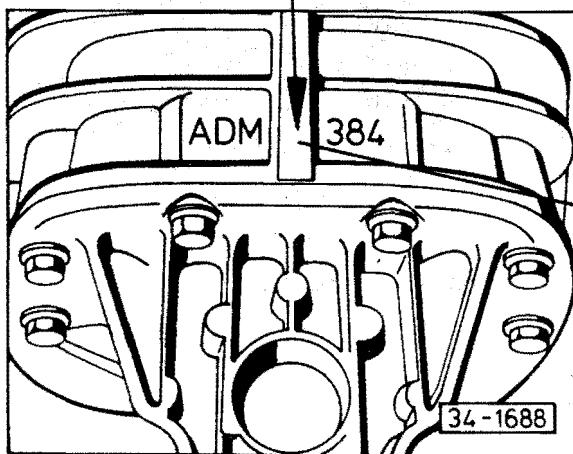
Manual transmission code letters

5-speed

## Front Final Drive



34-1687

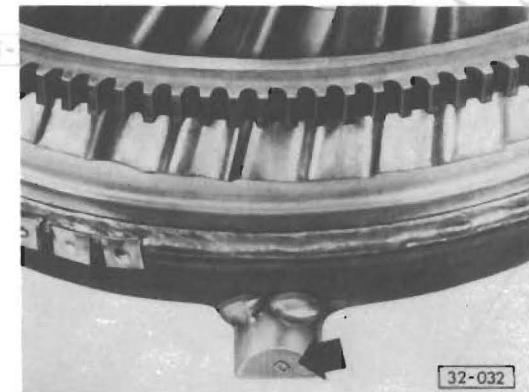
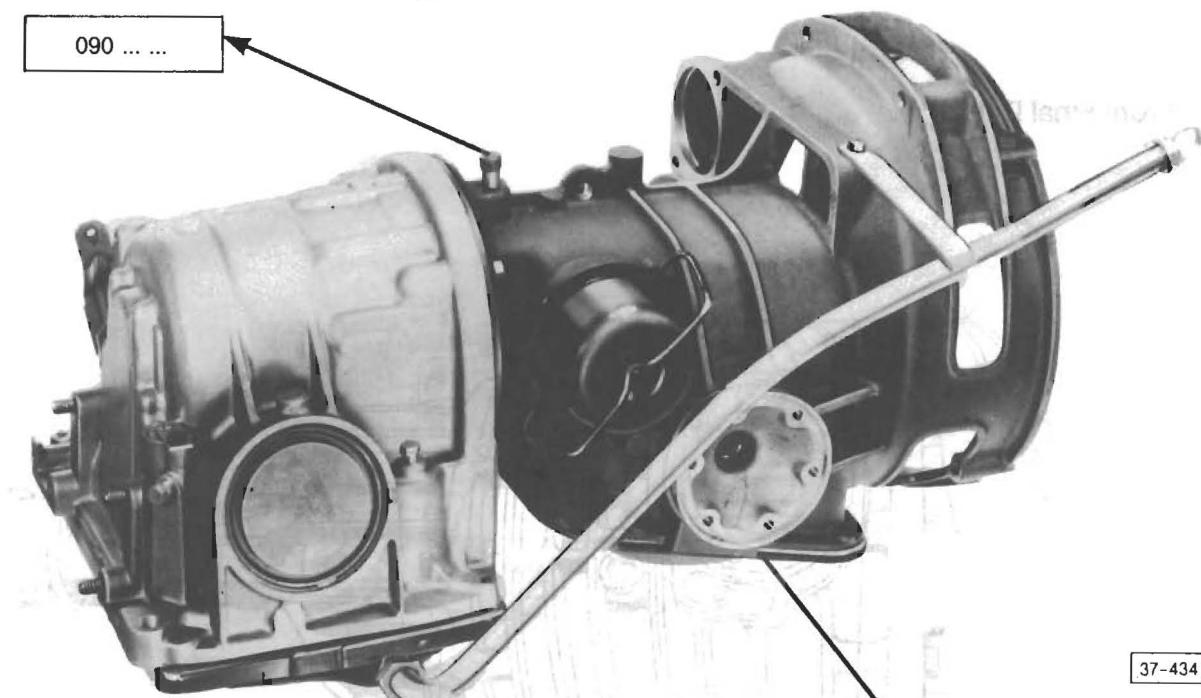


Front final drive code letters and date of manufacture

Example:      ADM                  384  
                  Code letters            Manufacturer's consecutive no.

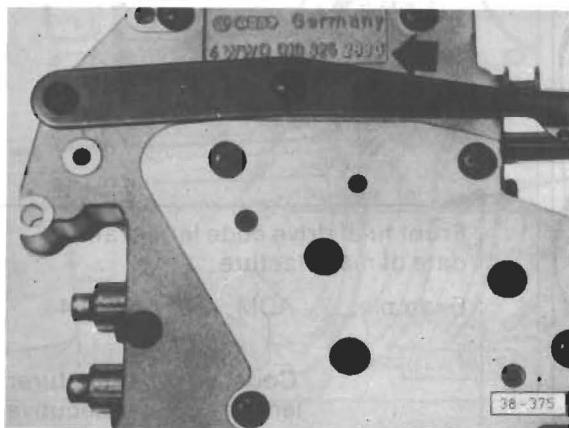
# General

## Automatic Transmission Type 090



**Converter code letter**

- letter D or Z on lug ( arrow )

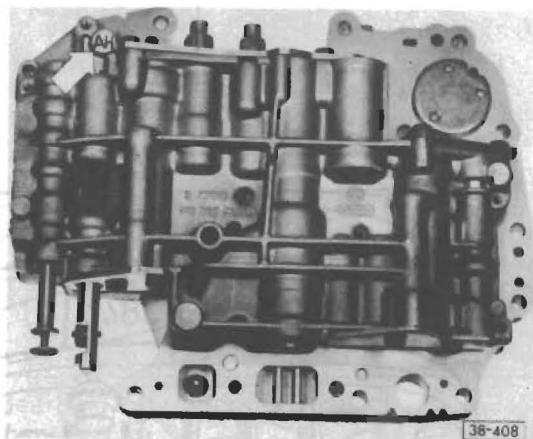


**Transfer plate identification**

- part number (arrow)

Code letters and date of manufacture

Example	NG	15	08	9
code letters	day	month	year (79)	
	of manufacture			



**Valve body code letters**

- on boss (arrow)

## Lifting vehicle with hoist/floor jack

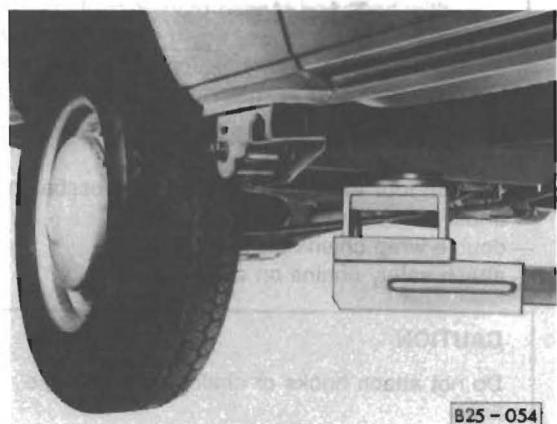
### CAUTION

Before driving onto lift, check for clearance between lifting arms and tires to avoid cutting sidewalls.  
Extend arms and check to see if arms are long enough to contact lifting points.  
Lift only at points shown



### Front

at crossmember next to jacking port



### Rear

at rear crossmember or rear leaf walls or jacking height

### Note

When lifting vehicle with floor jack, use same lifting points as with hoist

### CAUTION

Do not lift vehicle by engine, transmission or front suspension. Doing so may result in damage to components

DO NOT LIFT VEHICLE  
BY ENGINE, TRANSMISSION  
OR FRONT SUSPENSION.

DO NOT LIFT VEHICLE BY  
ENGINE, TRANSMISSION OR  
FRONT SUSPENSION. DOING SO  
MAY RESULT IN DAMAGE TO  
COMPONENTS.

B162-00-0000-0000  
015-0000-0000

B25-076-00-0000-0000  
015-0000-0000

# General

## Emergency Towing

### Note

All towing procedures are based on use of typical sling-type tow truck equipment. If other types of towing equipment are used, these procedures may not apply.

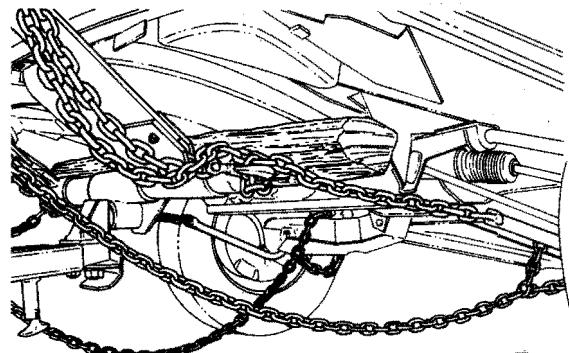
- whenever possible, tow with rear wheels off ground
- if car with **automatic transmission** must be towed with front wheels lifted because of extensive damage, dollies should be used under rear wheels if towing speed will exceed 30 mph or distance over 30 miles. Exceeding these limits will damage transmission
- selector lever must be in "N" position when moving car with automatic transmission with rear wheels on ground

### WARNING

Always secure front wheels with an external steering wheel lock when towing with rear wheels off ground.

Never use ignition steering lock to secure front wheels.

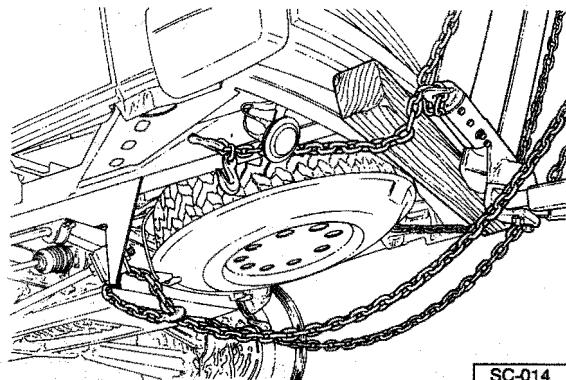
Never allow passengers to ride in towed vehicle



00-A189

### Front hook-up — all models thru 1985

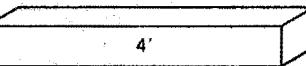
- attach grab hooks under lower control arms outboard of shock absorber mounts (as shown)
- place 4x4 wooden crossbeam under spare tire
- place tow bar under 4x4
- double wrap chains on tow bar
- attach safety chains to lower control arms (as shown)



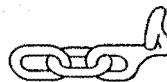
SC-014

### Front hook-up—From 1986 m.y.

- remove front license plate/bracket if interfere with front hook-up



4 x 4 x 48" cross beam



T-hooks

00-A294

- attach T-hooks (above) to tie down slots in long members (as shown)
- position four foot long 4x4 wooden crossbeam under bumper (as shown)
- double wrap chains on tow bar
- attach safety chains on axle platform

### CAUTION

Do not attach hooks or chains around brake lines

- raise vehicle to allow four inches clearance between tires and road

### Towing speed/distance

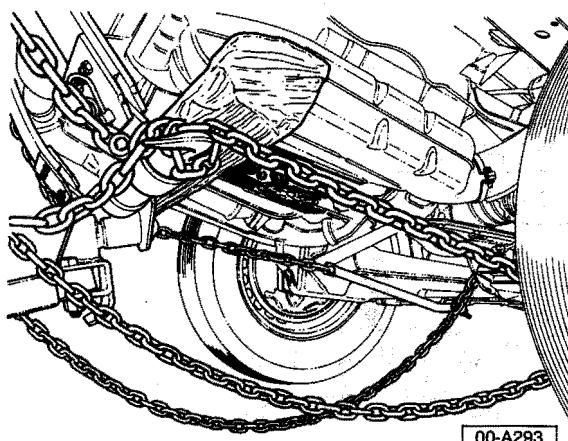
#### Front tow — all models EXCEPT Syncro

##### Automatic transmission

30 mph (48 kmh) for up to 30 miles (48 km)

##### Manual transmission

50 mph (80 kmh) for up to 50 miles (80 km)



#### Rear hook-up — air cooled gasoline models only

- attach grab hooks to trailing arms
- place 4x4 under engine carrier to space tow bar away from heat exchangers
- attach safety chains to trailing arms

#### Rear hook-up — water-cooled/diesel models

The Vanagon cannot be towed with conventional sling-type towing equipment to avoid damage to valance panel.

### Vanagon Syncro

#### Front/rear hook-up

The Vanagon Syncro cannot be towed with conventional sling-type towing equipment nor with wheel lift equipment or wheel dollies to avoid damage to the all-wheel drive system.

- use flat-bed tow truck only.

### Flat Towing

Vehicles with automatic transmission may be towed forward (in driving direction) at speeds up to 30 mph for maximum of 30 miles

#### CAUTION

Towing vehicles at more than 30 mph and/or for distance greater than 30 miles with rear wheels on ground will damage automatic transmission due to lack of lubrication

If towing speed will be greater than 30 mph or distance greater than 30 miles, temporary modifications to vehicle are required as follows:

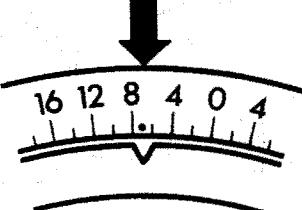
#### Work sequence

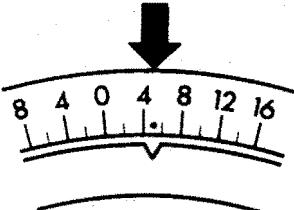
- remove drive shaft assemblies
- seal drive shaft flanges against water and dirt
- wrap drive shafts and store in vehicle

#### Manual transmission (including Syncro)

There are no restrictions on speed or distance when towing manual transmission cars behind other vehicles

# General

Engine code letters	CV
Distributor (Part No.)	022 905 205S
Ignition timing	7.5° BTDC
Timing mark location: crankshaft pulley	 26-050
Idle speed manual automatic Vacuum hose disconnected	800- 950 rpm 850-1000 rpm
Dwell angle new points wear limit	44-50° 42-58°
Centrifugal advance (crankshaft degrees) start	1000-1200 rpm
	9-14° at 1600 rpm
end	21-25° at 3400 rpm
Vacuum advance start	107-147 mbar (80-110 mm Hg)
end	266 mbar (200 mm Hg) 8-12°
Spark plugs Bosch Beru Champion	W 145 M2. W 8 CO 145/14/3L N 288
Spark plug tightening torque	30 Nm (22 ft lb)
Spark plug gap	0.6-0.7 mm (0.023-0.028 in.)
Firing order	1 — 4 — 3 — 2

Engine code letters	CV
Distributor (Part No.)	039 905 205C
Ignition timing	5° ATDC
Timing mark location: crankshaft pulley	 28-071
Idle adjustment Vacuum hoses connected Idle stabilizer plugs removed and connected together	850-950 rpm
Dwell angle setting	not adjustable
Centrifugal advance (crankshaft degrees) start	1050-1300 rpm
	9-13° at 1600 rpm
end	21-25° at 3400 rpm
Vacuum advance	
start	90-160 mbar (70-120 mm Hg)
end	240-280 mbar (180-210 mm Hg) 9-12°
Vacuum retard	
start	90-160 mbar (70-120 mm Hg)
end	200-280 mbar (150-210 mm Hg) 11-13°
Spark plugs	Bosch Beru Champion
	W 145 M2, W 8 CO 145/14/3L N 288
Spark plug gap	0.6-0.7 mm (0.023-0.028 in.)
Spark plug tightening torque	30 Nm (22 ft lb)
Firing order	1—4—3—2

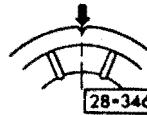
**Transistorized ignition system cautions**

Do not connect any condenser/suppressor or test light to terminal 1. Do not connect test instruments with a 12 volt supply on terminal 15 of ignition coil. Do not crank engine before high tension wire of distributor cap (terminal 4) is connected to ground with jumper wire (example: compression check etc.). Do not replace installed coil—211 905 115 C—with conventional type. Do not leave battery connected when electric welding

on car. Do not start engine after heating up to more than 80°C (176°F), example: paint drying booth. Do not wash engine when it is running. Do not use battery booster longer than 15 sec. nor exceed 16.5 volts with booster. Allow 1 minute pause between boosting attempts. Do not disconnect battery while engine is running. Disconnect plug to ignition control unit when car has to be towed.

# General

---

<b>Engine code letters</b>	DH
<b>Distributor (Part No.)</b>	025 905 205 D
<b>Ignition timing</b>	$5 \pm 1^\circ$ ATDC
<b>Timing mark location: crankshaft pulley</b>	
<b>Idle speed</b>	$850 \pm 50$ rpm
<b>Vacuum hoses connected</b>	
<b>Idle stabilizer control unit</b>	electrical plugs disconnected from unit and connected together
<b>Centrifugal advance (crankshaft degrees)</b>	
start	1050-1150 rpm
	16-20° at 2400 rpm
end	21-25° at 3800 rpm
<b>Vacuum advance</b>	
start	190-230 mbar (14.0-17.0 cm Hg)
end	360 mbar (27.0 cm Hg) 12-16°
<b>Vacuum retard</b>	
start	100-220 mbar (7.5-16.5 cm Hg)
end	260-360 mbar (19.5-27.0 cm Hg) 9-11°
<b>Spark plugs</b>	Bosch Beru Champion
	W 7 C 0 14 L-7 C N 288
<b>Spark plug gap</b>	0.7 + 0.1 mm (0.028 + 0.004 in.)
<b>Spark plug tightening torque</b>	20 Nm (14 ft lb)
<b>Firing order</b>	1-4-3-2

## Engine Assembly

### Index

#### **Engine (Air-cooled AFC)**

- Removing 10.2
- Installing 10.5

#### **Engine (Diesel)**

- Removing 10.6
- Installing 10.7

#### **Engine (Water-cooled Syncro)**

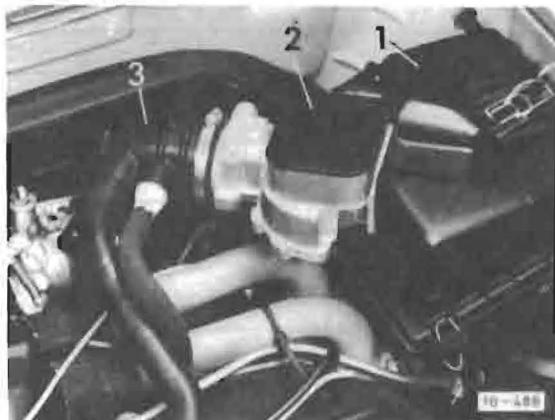
- Removing 10.8
- Installing 10.10

# 10 Engine-Assembly

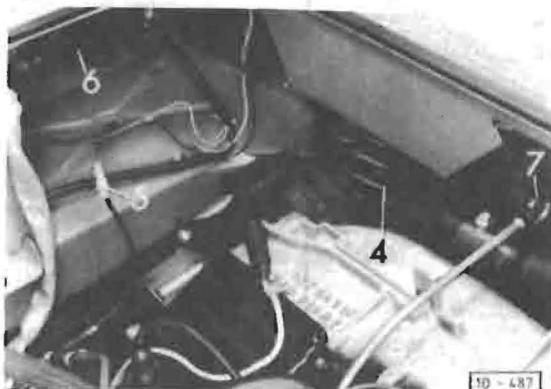
## Engine, removing (Air cooled-AFC)

### Work sequence

- disconnect ground cable from battery



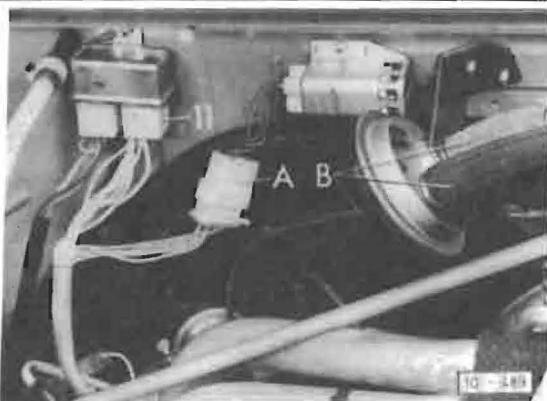
- detach air cleaner 1 with air flow sensor 2 and air intake duct 3



- remove rubber boot for heater booster 4
- disconnect wire for alternator 5
- disconnect plug 6 at control unit
- pull engine oil level dip stick 7

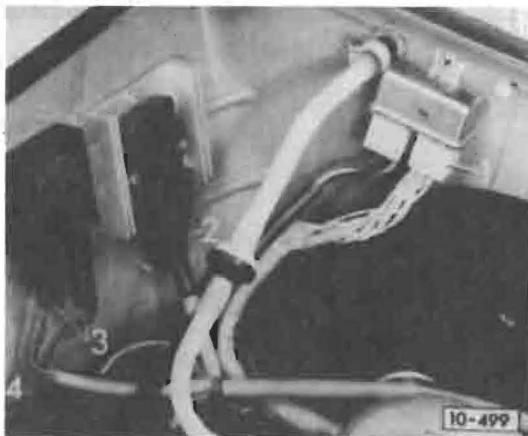


- disconnect wires at
  - ignition distributor 8
  - engine oil pressure switch 9
- disconnect vacuum hose 10 for brake booster



- disconnect following:
  - plug 11 at double-relay
  - plug A for resistors
  - hoses B at deceleration valve

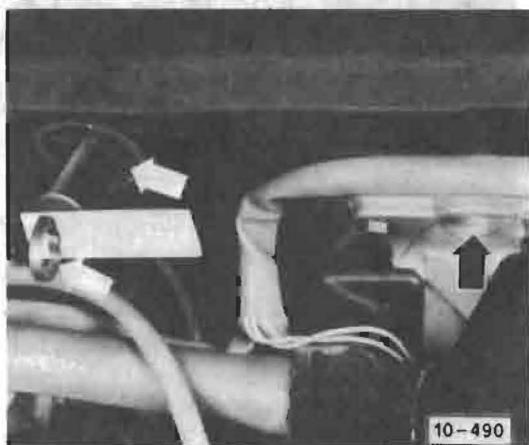
### California only



- disconnect following:
  - plug 1 at double-relay
  - plug 2 at Hall control unit
  - plugs 3 at idle stabilizer
  - wire connection 4 for oxygen sensor

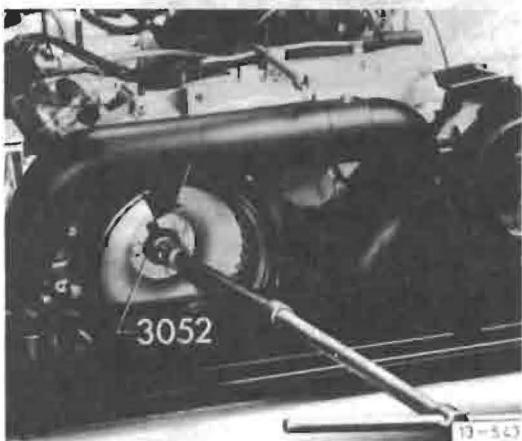


- remove nuts 12 of upper engine mounting bolts
- disconnect accelerator cable 13

**Automatic transmission**

10-490

- remove plug (black arrow) on top of transmission housing
- pull ATF dip stick (lower white arrow)
- remove ATF filler tube grommet (upper white arrow)



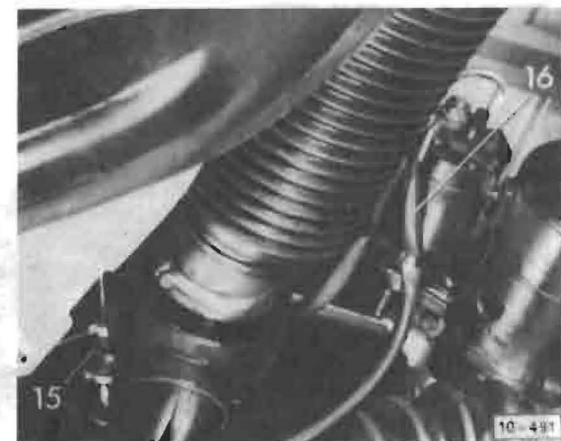
10-543

- remove three 8 mm bolts of torque converter through hole on top of transmission housing
  - use adaptor 3052, extension and T-handle to turn crankshaft of engine
  - make sure pin (arrow) engages in recess of cooling fan hub



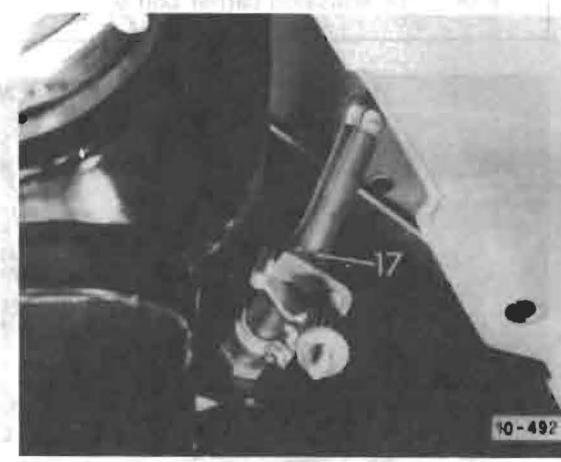
10-493

- remove heater flap housing bolt 14



10-491

- block fuel line 15 with clamp
- disconnect wiring 16 on starter



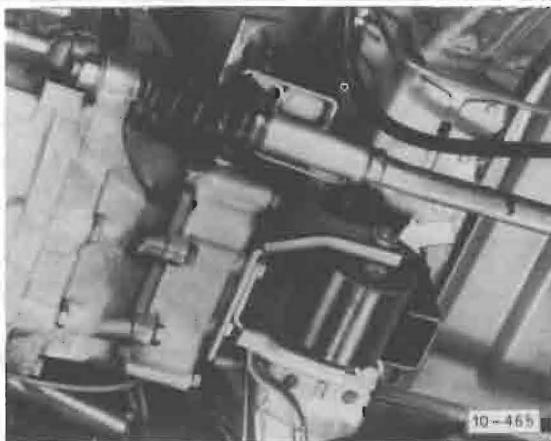
10-492

- block fuel line from pressure regulator 17 with clamp

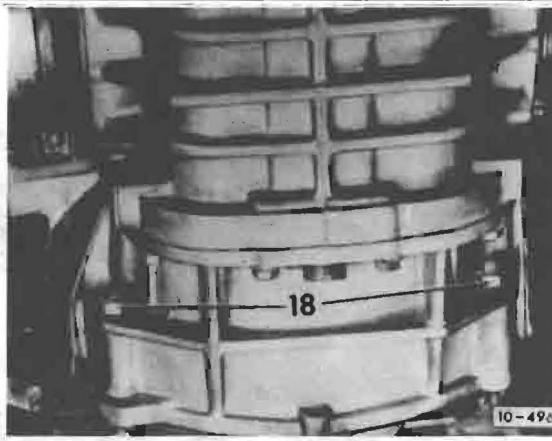
**Note**

To gain access to bolts of torque converter, engine must be rotated until each bolt appears in hole on top of transmission housing

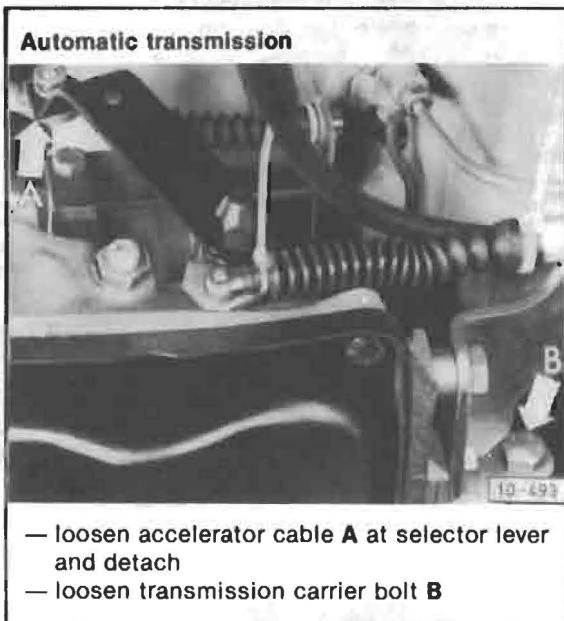
# 10 Engine - Assembly



— loosen transmission mount bolt (arrow)



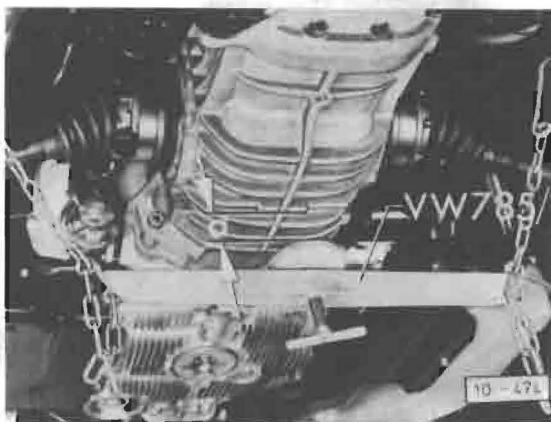
— remove nuts 18 from engine mounting bolts



— loosen accelerator cable A at selector lever and detach  
— loosen transmission carrier bolt B



— remove bolts 19 from engine carrier  
— lower engine/transmission assembly until transmission rests on support VW 785/1  
— remove engine from transmission  
— lower engine with floor jack



— support transmission with VW 785/1  
• when attaching keep distance  
  a = 80 mm (3 1/4 in.)  
— support engine with floor jack  
• use adaptor VW 612/5

**Engine, installing**  
(Air cooled-AFC)

Proceed in reverse order of removing and note following:

- check clutch release bearing for wear, replace if necessary
- lightly lubricate splines on main drive shaft and contact points of clutch release bearing/clutch release lever with MoS<sub>2</sub> grease
  - do not lubricate clutch release bearing guide sleeve
- always replace all self-locking nuts

**Manual transmission**

- adjust accelerator cable at full throttle position

**Automatic transmission**

- adjust accelerator cable

**Tightening torques:**

- |                                   |                  |
|-----------------------------------|------------------|
| • engine to transmission          | 30 Nm (22 ft lb) |
| • engine carrier to mount         | 25 Nm (18 ft lb) |
| • transmission mount              | 30 Nm (22 ft lb) |
| • torque converter to drive plate | 30 Nm (18 ft lb) |

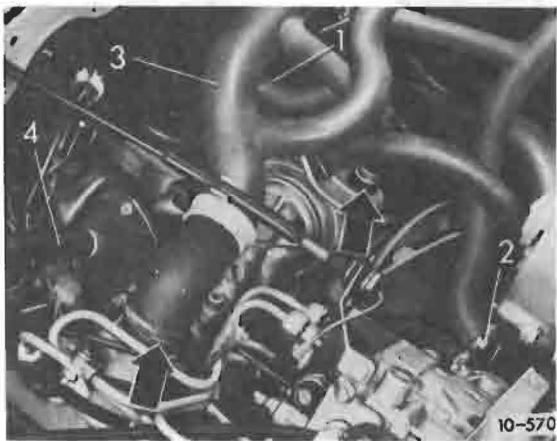
# 10 Engine - Assembly

## Engine, removing

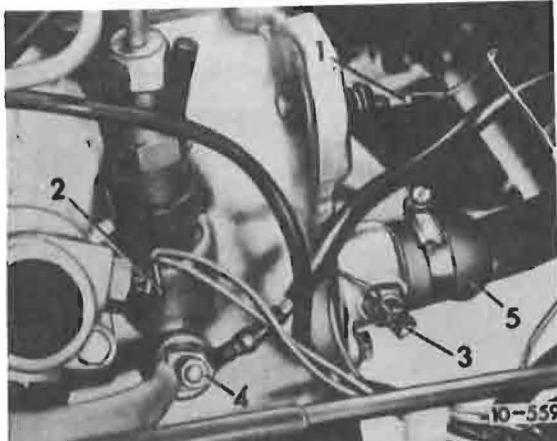
### CAUTION

Coolant/antifreeze **must not** be reused when replacing engine, cylinder head, cylinder head gasket, radiator and heater core.

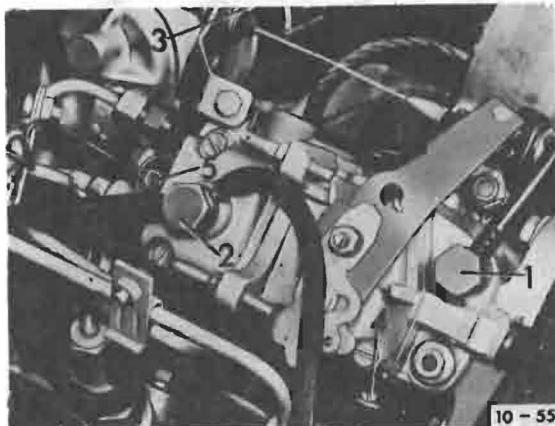
- disconnect battery ground cable
- remove top of air cleaner
- remove lower engine cover
- open coolant expansion tank cap



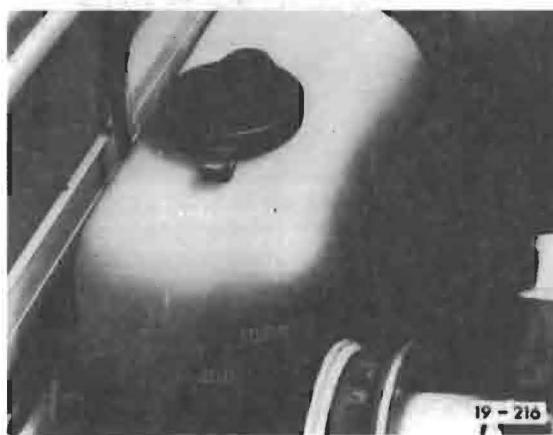
- disconnect lower hose from waterpump at connecting pipe 1 to radiator (see caution)
- disconnect center hose 2 from waterpump
- disconnect hose 3 from cylinder head (lower arrow) and from oil cooler (upper arrow) and move it to one side
- remove vacuum hose 4 from vacuum pump



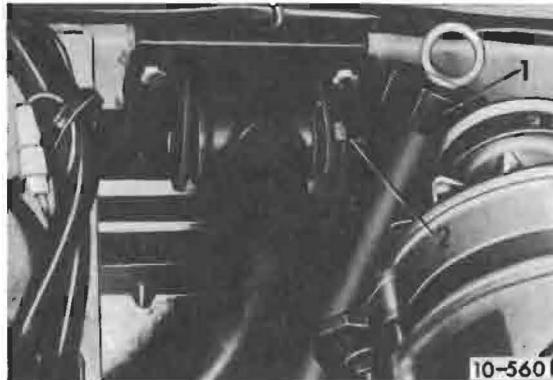
- disconnect wiring from:
  - oil pressure switch 1
  - temperature sensors 2 and 3
  - glow plugs 4
- remove coolant hose 5



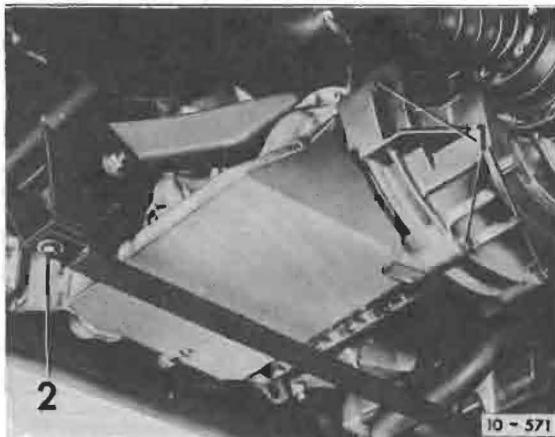
- remove fuel supply line 1 and fuel return line 2 from injection pump
- disconnect accelerator cable from pump lever and remove retaining clip 3 at bracket and place cable to one side
- disconnect cold start cable at lock screw 4
- remove retaining clip at bracket and place cold start cable to one side
- disconnect wire 5 from fuel shut-off solenoid



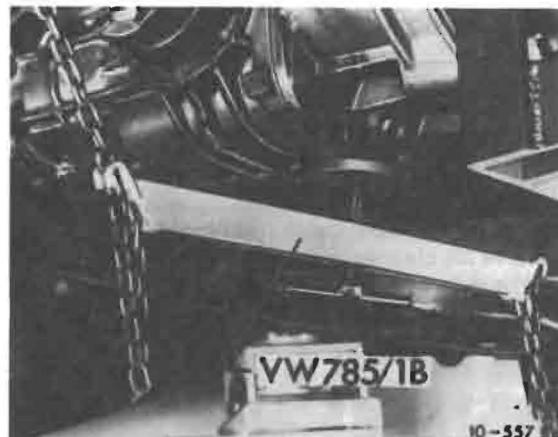
- remove coolant reservoir



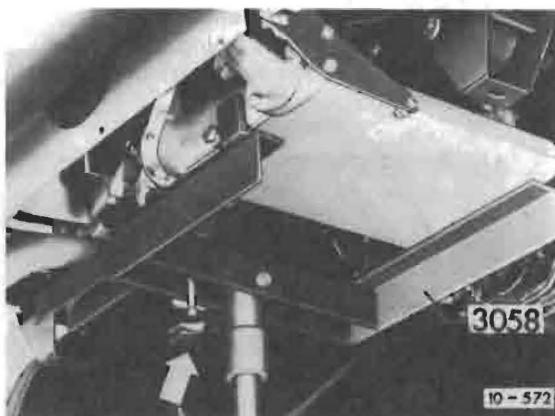
- remove cap with dipstick 1
- remove nuts 2 from rear engine mounts on left and right sides, but leave bolts in



- remove all 7 engine/transmission mounting bolts 1
- remove support member bolts 2 and remove support member



- support transmission with VW 785/1B
- remove engine from transmission and lower it out of vehicle



- support engine with engine crane and adaptor 3058
  - angle of engine to transmission can be adjusted by turning knob (arrow)



- remove nuts (arrow) from front engine mounts on left and right sides
- remove bolts from both front and rear engine mounts
- lower engine/transmission assembly until engine can be separated from transmission

## Engine, installing

Proceed in reverse order of removing and note following:

- adjust angle of engine to transmission before joining engine and transmission

### CAUTION

Do not interchange fuel supply and fuel return pipe union screws. For identification, fuel return pipe union screw is marked with OUT on hex. head. Fuel return line also has smaller diameter than fuel supply line

- adjust cold start cable, see Repair Group 23
- refill coolant, see Repair Group 19

### Tightening torques:

• engine to transmission		
M10 bolts	45 Nm (33 ft lb)	
M12 bolts	80 Nm (59 ft lb)	
• engine mounts	85 Nm (63 ft lb)	
• support member	45 Nm (33 ft lb)	
• fuel line union screws on injection pump	22 Nm (16 ft lb)	

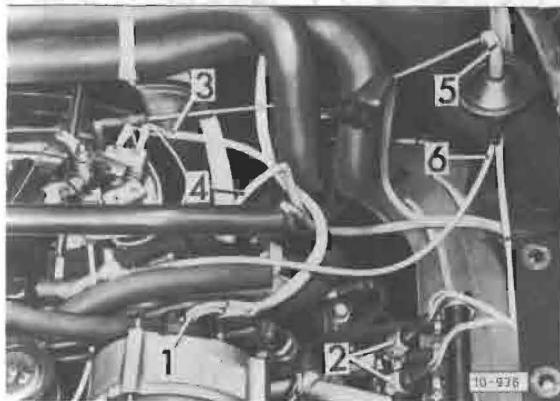
# 10 Engine - Assembly

## Engine, removing

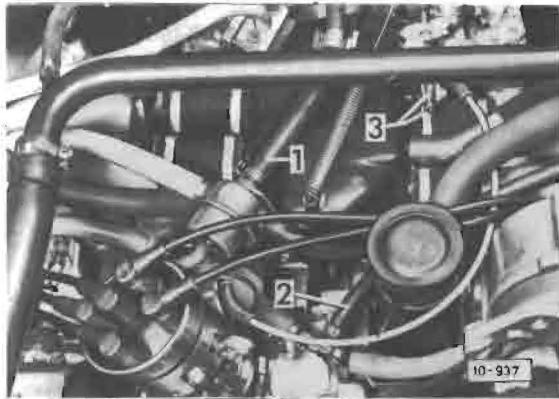
### CAUTION

Coolant/antifreeze must not be reused when replacing engine, cylinder head, cylinder head gasket, radiator and heater core.

- disconnect ground cable from battery
- remove air cleaner with air flow sensor and air intake duct



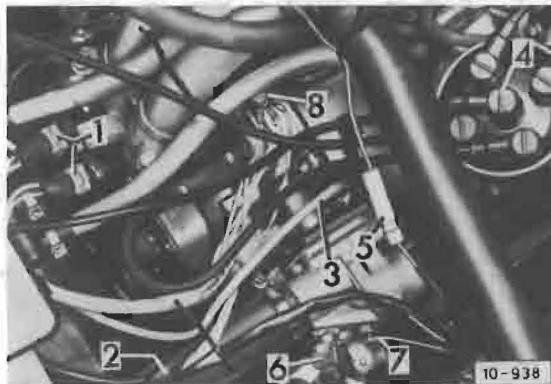
- disconnect wire 1 at alternator
- disconnect following:
  - plugs 2 at injectors
  - plug 3 at throttle valve switch
  - plug 4 at auxiliary air regulator
- disconnect hoses 5 and 6 at charcoal filter valve



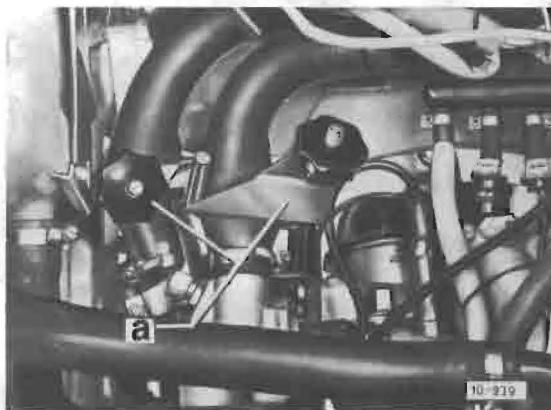
- disconnect and plug fuel hoses 1 and 2
- remove accelerator cable from throttle valve lever

### Automatic Transmission

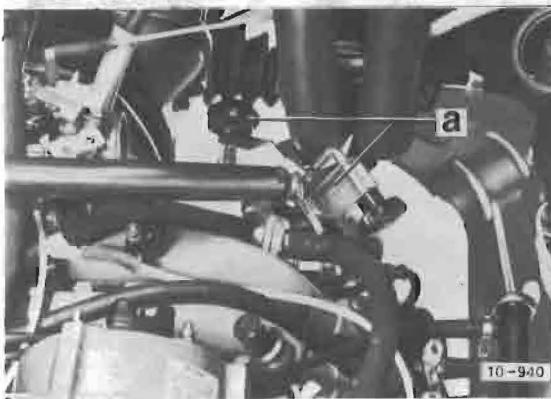
- remove circlip and spring 3 from accelerator rod



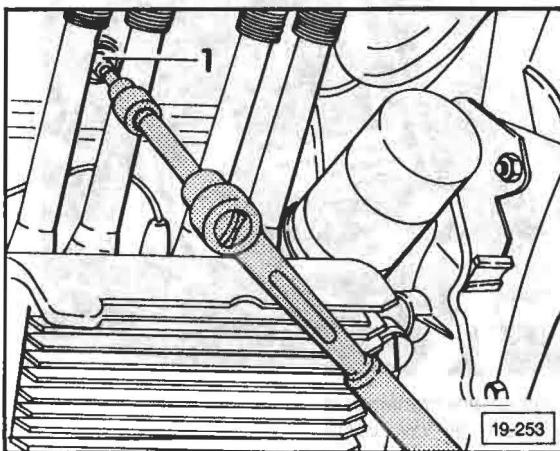
- disconnect following:
  - plugs 1 at injectors
  - plug 2 at oxygen sensor
  - plug 3 and 4 at ignition distributor
  - plug 5 at oil pressure switch
  - plug 6 at temperature sensor
  - plug 7 at temperature sender
  - plug at coolant level warning switch (not shown—located in coolant expansion tank)
- remove ground connectors 8



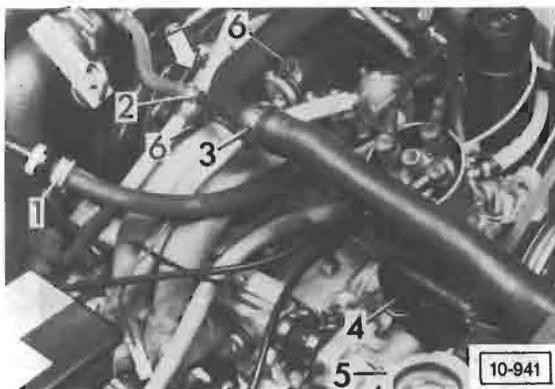
- block coolant hoses with clamps a
  - a = universal clamp—local supply



- block coolant hoses with clamps a
  - a = universal clamp—local supply
- open coolant expansion tank cap



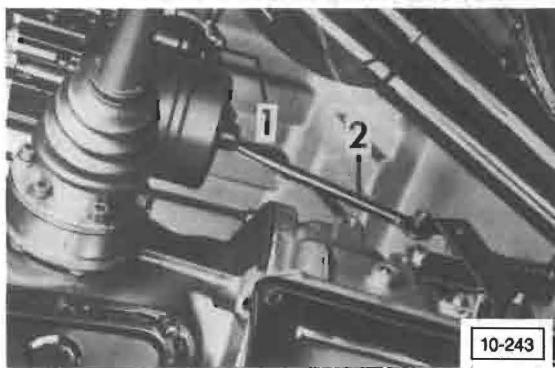
- remove drain plugs 1 at cylinder heads and drain coolant



- disconnect brake booster line 1
- disconnect coolant hoses 2, 3 and 4
- remove coolant expansion tank 5
- remove engine/transmission bolt/nut 6 on left and right sides

#### Automatic Transmission

- remove three bolts which attach torque converter to drive plate through hole on top of trans. housing (**arrow**)



- disconnect wiring 1 at starter

#### Automatic Transmission

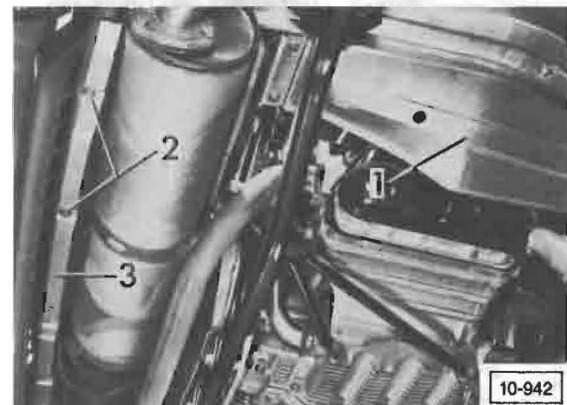
- remove accelerator rod 2

#### Vehicles with power steering

- remove power steering pump with hose left attached, and place in engine compartment.

#### Vehicles with air conditioning

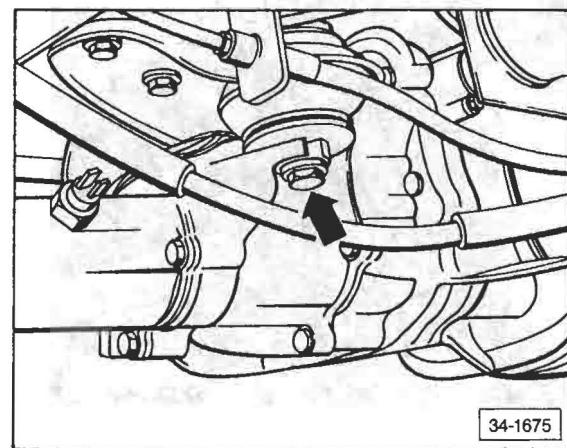
- remove compressor with hoses attached and place in engine compartment.



- remove plates 1 on left and right sides
- remove bolts, 2, do not remove plate 3

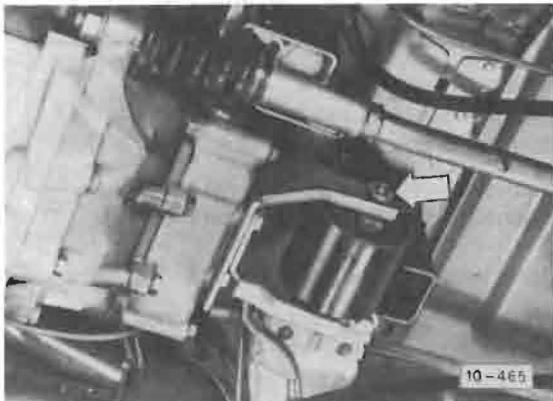
#### Syncro only

- remove rear skid plate under engine/transmission

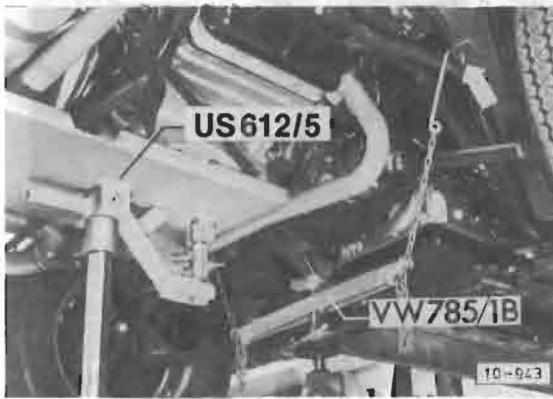


- loosen mounting bolts for front transmission bracket **three turns** (**arrow**)

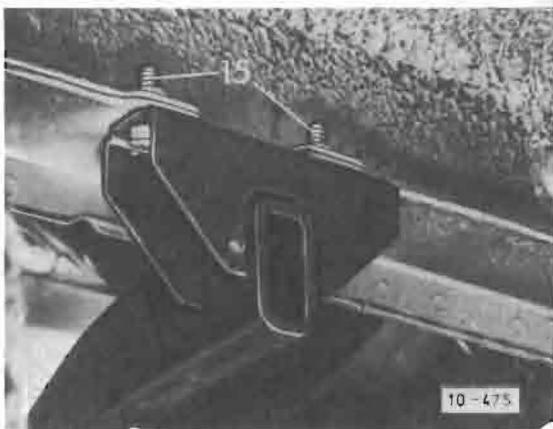
# 10 Engine-Assembly



— loosen transmission mount bolt (arrow)



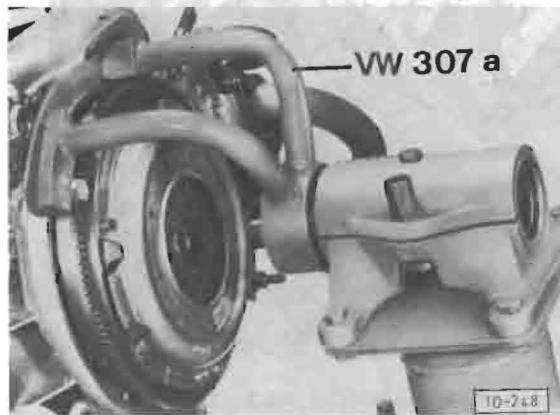
- attach VW 785/1B so that distance between support pad and transmission housing is about 120 mm (4 3/4 in.)
- support engine with US 612/5 and floor crane



— remove engine carrier bolts 15



- lower engine/transmission assembly until transmission rests on VW 785/1B
- when lowering, adjust angle of inclination on floor crane head and keep wiring harness aside so that it can pass oil filler tube
- remove nuts 2 of lower engine mounting bolts
- remove engine from transmission and lower it out of vehicle



- mount engine on repair stand with engine holder VW 307a

## Engine, installing

Proceed in reverse order of removing and note following:

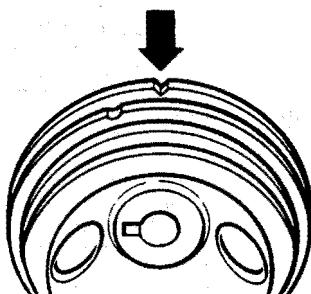
- check clutch release bearing for wear and replace if necessary

### Syncro only

- clean joining faces of engine and transmission and lightly coat joining surface of engine with silicone adhesive seal Part No. AMV 176 000 05
- lubricate clutch release bearing and main shaft splines lightly with MoS<sub>2</sub> grease (do not lubricate guide sleeve for release bearing)
- replace all self-locking nuts on engine mounts
- check and adjust, if necessary, accelerator cable/throttle controls, see Repair Group 20

### Tightening torques:

• engine to transmission	30 Nm (22 ft lb)
• engine carrier to body	25 Nm (18 ft lb)
• transmission mounts	30 Nm (22 ft lb)
• torque converter to drive place	20 Nm (15 ft lb)

Introduction	October 1985	
Engine code	MV	
Part no.:	Ignition distributor	025 905 205 M
	Digifant control unit***	025 906 022D old 025 906 022/022A new
Ignition timing	Checking value	3° ~ 7° before TDC
	Adjusting value	5° ± 1° before TDC
Timing mark location		 <span style="border: 1px solid black; padding: 2px;">28-390</span>
RPM*	2000 - 2500	
Ignition adjustment**		
-- timing map --	RPM	Approx. 3000
	Degrees	35 ± 5°
RPM limit	Switch-off RPM of digifant control unit	RPM
		5600
Firing order	CYL.	1 - 4 - 3 - 2
Spark plugs (tightening torque: 20 Nm (14 ft lb))	Bosch Beru Champion	W 7 CCO 14L-7CU, 14L-7C N 288
Spark plug gap	mm (in)	0.7 ± .1 mm (0.028 ± 0.003 in)

\*) Engine oil temperature 80° C, (176°F) connector of temperature sensor II disconnected with engine running.

\*\*) Engine oil temperature 80°C, connector of temperature sensor II connected.

\*\*\*) When replacing control unit always replace old control unit with newer version.

#### CAUTION

Part numbers are for reference only. Always check with your parts department for latest part information.

# General

## Technical data/specified values

Engine code	MV
Type	2.1 liter 70 kW, 90 SAE net HP
Introduction	October 1985
Part no.	
Control unit	025 906 022
Ignition timing	check spec. adjusting spec.
	3-7° before TDC 5 ± 1° before TDC
• Test and adjustment conditions	no.
idle adjustment	1 and 9
idle rpm	880 ± 50 rpm
CO content	0.7 ± 0.4 Vol. %
• Test and adjustment conditions	no.
	1 to 6, 7, 8

### Conditions and requirements:

- 1 — engine oil temperature min. 80°C (176°F)
- 2 — electrical consumers turned off
- 3 — crankcase breather hose on oil breather removed and closed tightly
- 4 — throttle valve switch turned on (continuity)
- 5 — idle stabilizer OK (valve vibrates and hums)
- 6 — ignition timing setting: OK
- 7 — connector (single connector) for idle stabilizer control valve disconnected
- 8 — with ignition OFF, disconnect connector (single connector) for oxygen sensor
- 9 — with engine running, double connector for temperature sender disconnected and rpm increased to 2000-2500 rpm by depressing throttle

# Engine Crankshaft Crankcase

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### Diesel

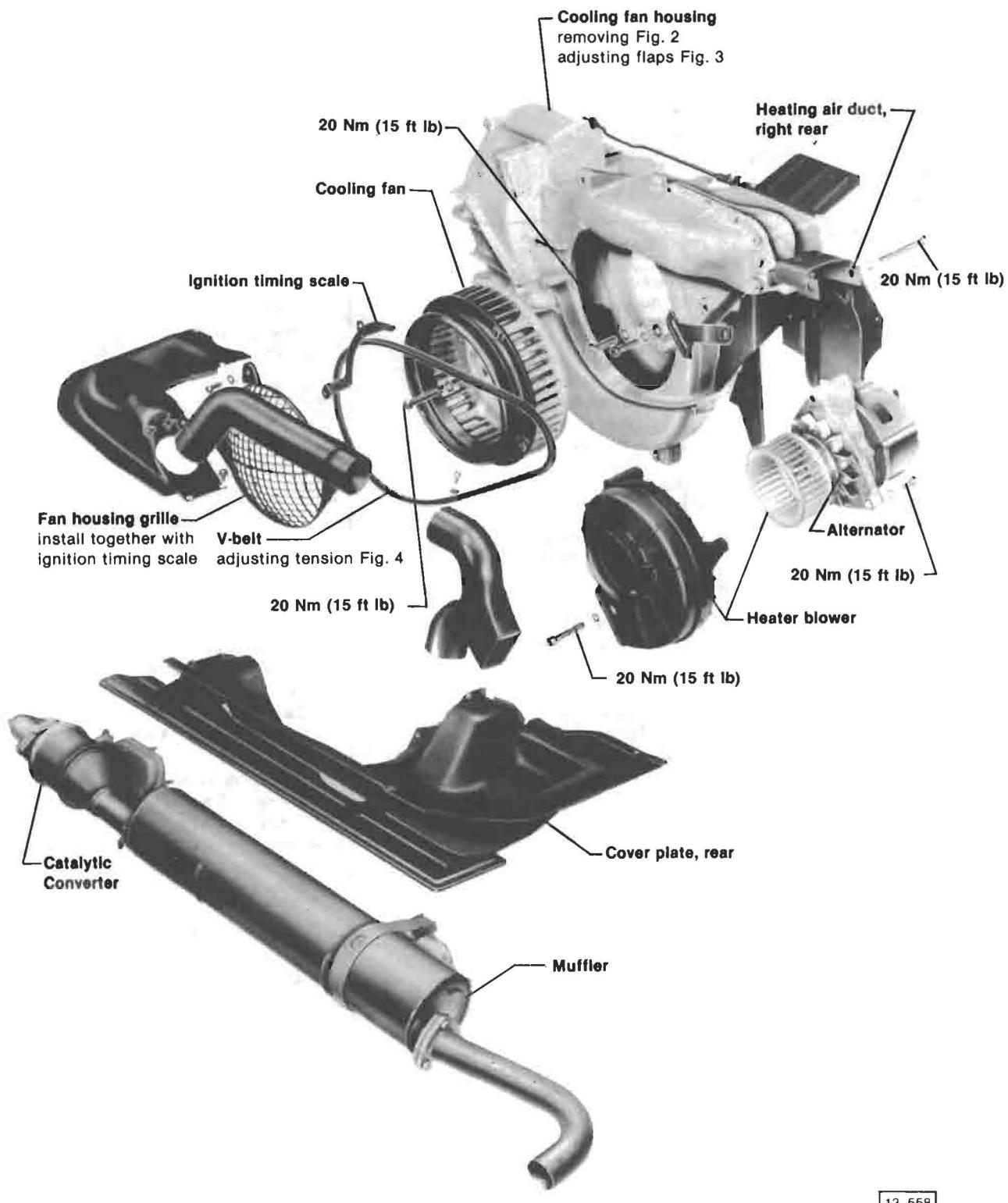
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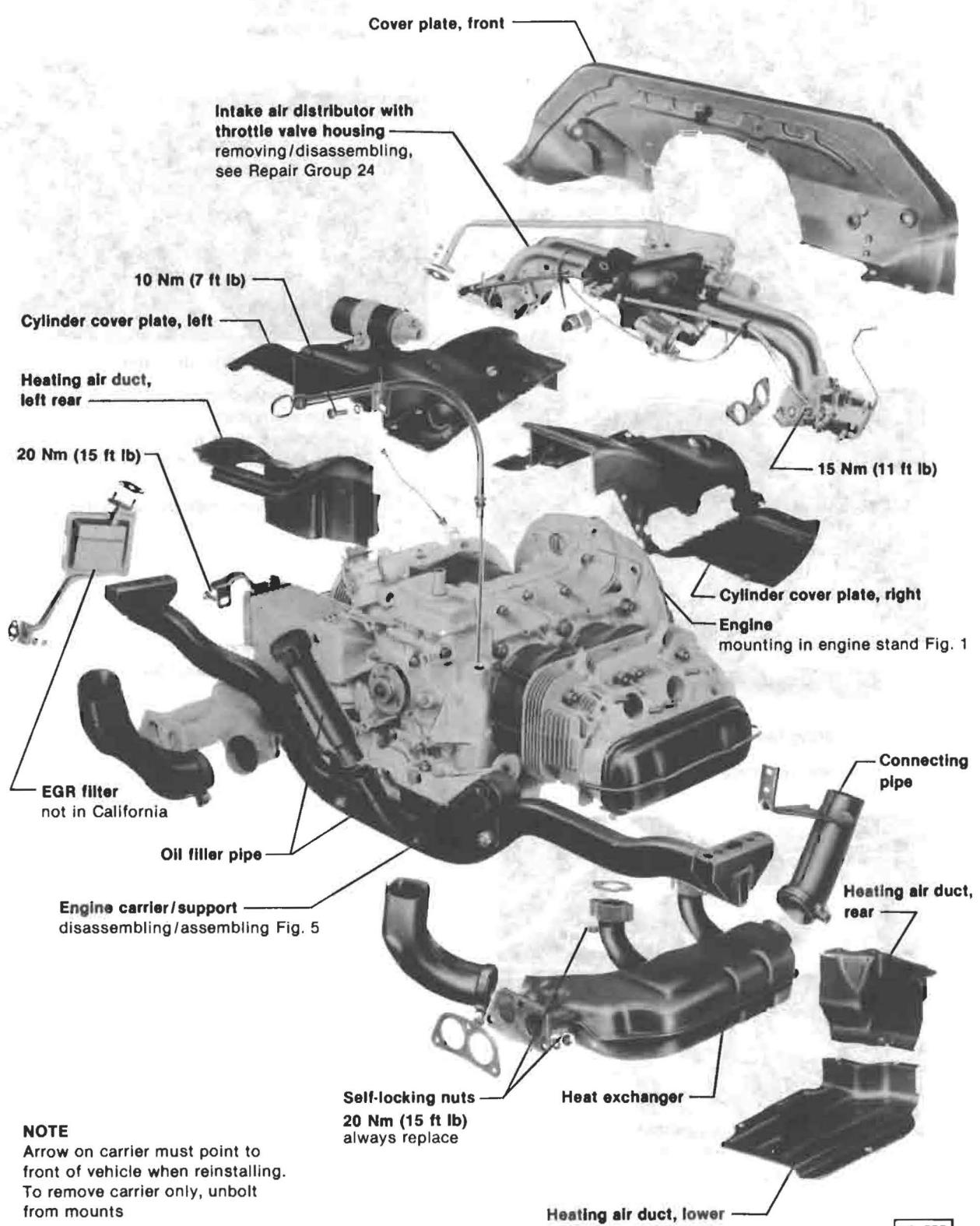
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# 13 Engine - Crankshaft, Crankcase



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# 13 Engine - Crankshaft, Crankcase

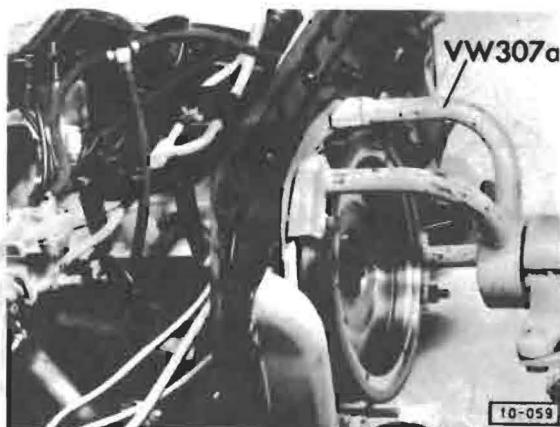


Fig. 1 Engine, mounting in engine stand

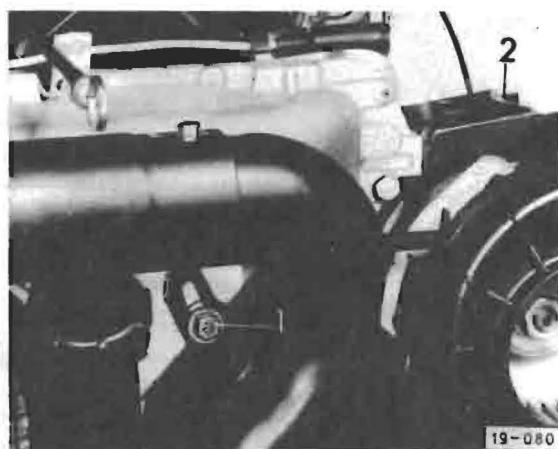


Fig. 4 Alternator V-belt, adjusting

- after loosening bolts 1 and 2, move alternator to tension V-belt
- tighten bolts 1 and 2 to 20 Nm (15 ft lb)
- check belt tension by pressing belt firmly in center
  - deflection: approx. 10–15 mm (3/8–9/16 in.)

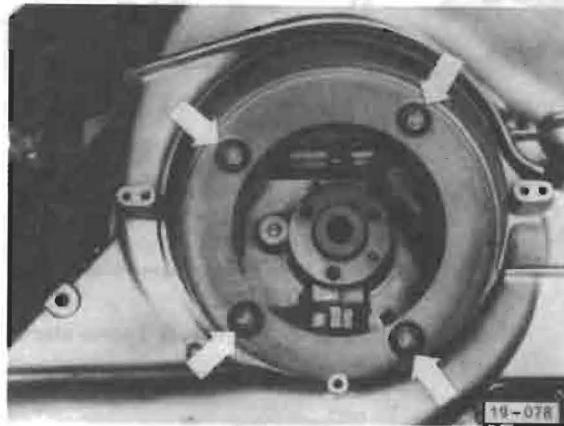


Fig. 2 Cooling fan housing, removing

- remove bolts (arrows) and detach

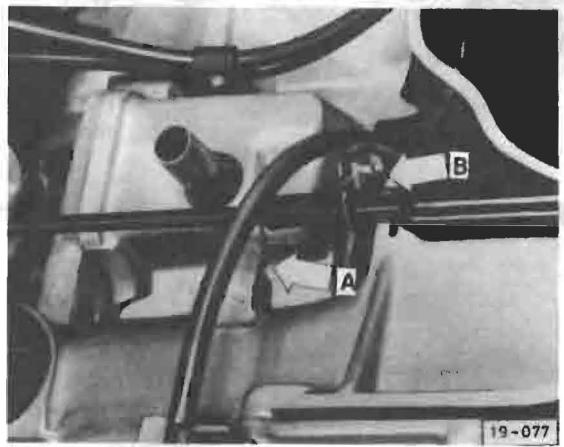
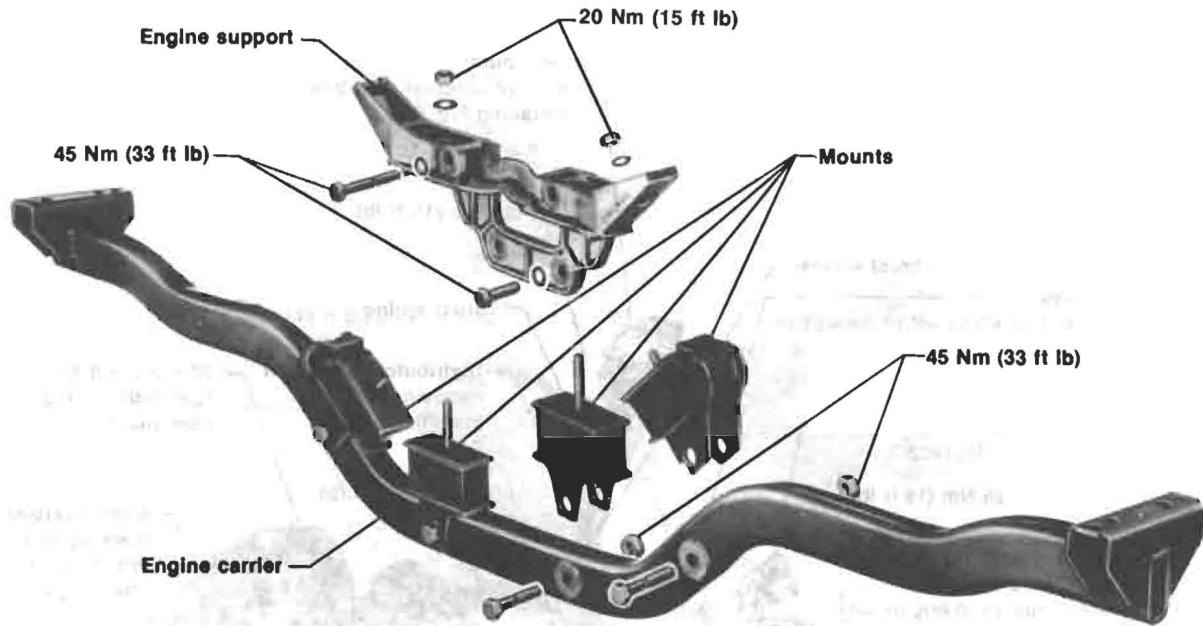


Fig. 3 Cooling air flaps, adjusting

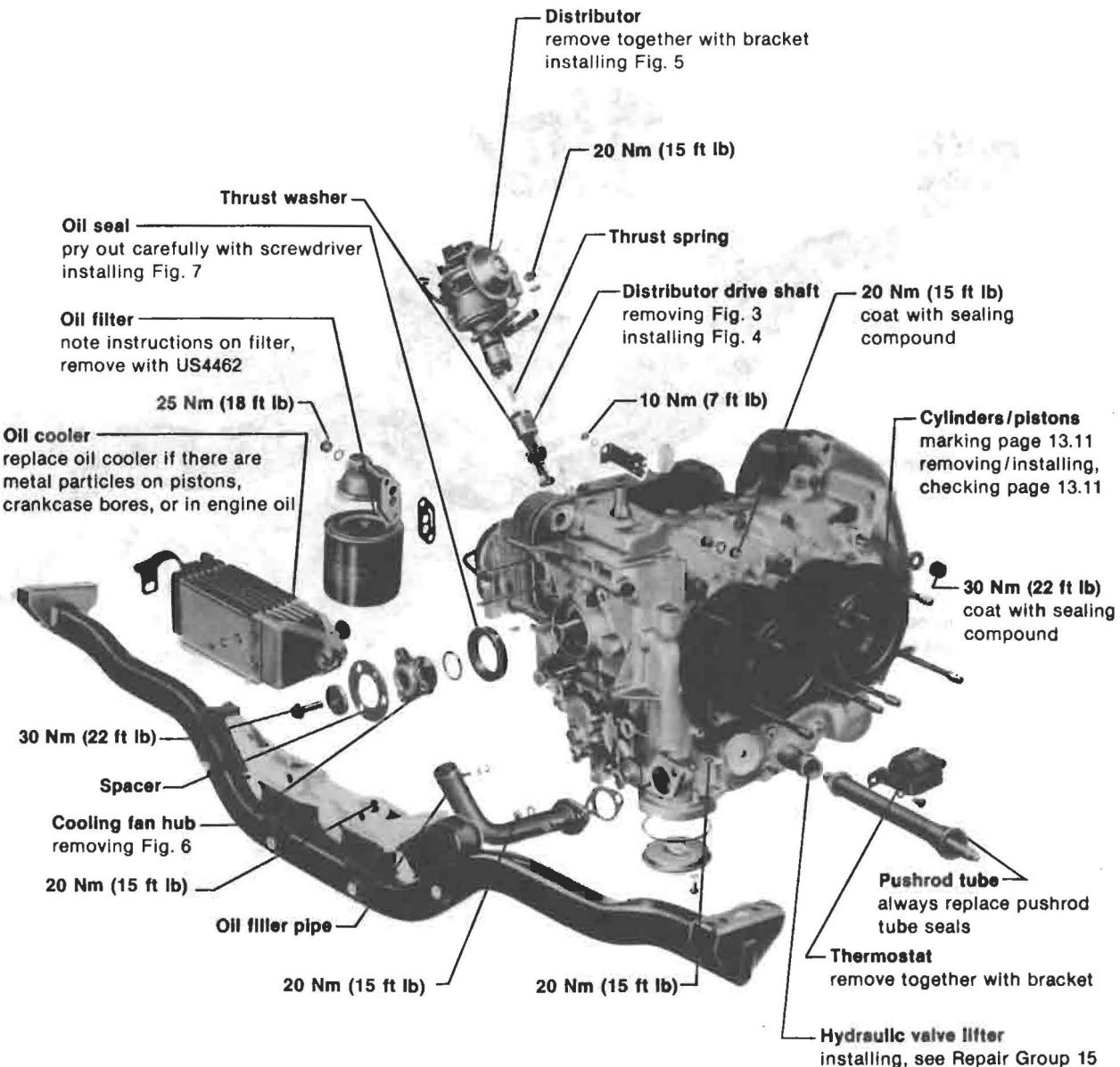
- bent ends of return spring must rest on boss of cooling fan housing (arrow A) and on cable guide (arrow B)
- press flaps into closed position and tighten cable clamp



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**Fig. 5 Engine carrier/support,  
disassembling/assembling**

# 13 Engine - Crankshaft, Crankcase



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**WARNING**

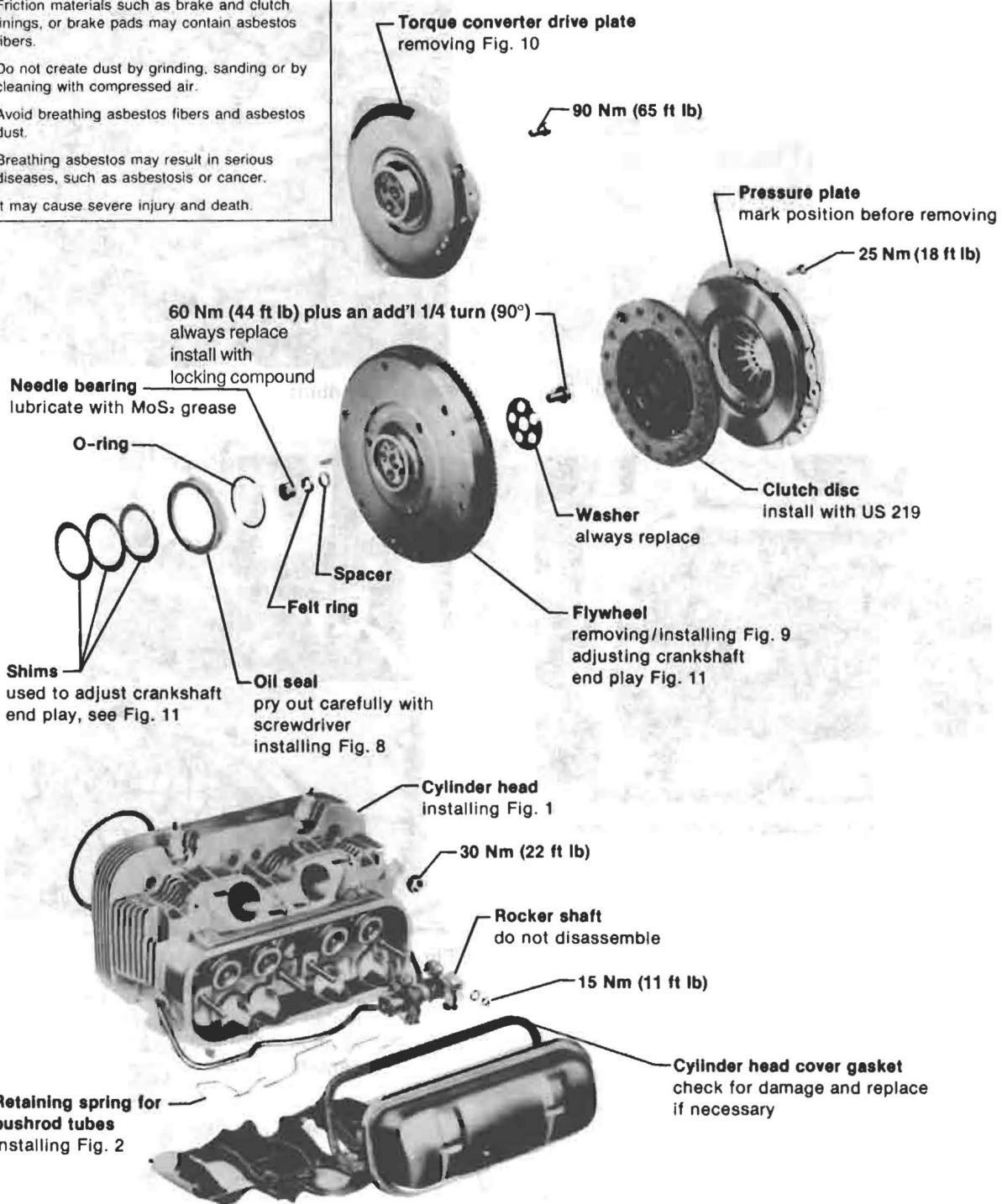
Friction materials such as brake and clutch linings, or brake pads may contain asbestos fibers.

Do not create dust by grinding, sanding or by cleaning with compressed air.

Avoid breathing asbestos fibers and asbestos dust.

Breathing asbestos may result in serious diseases, such as asbestosis or cancer.

It may cause severe injury and death.



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# 13 Engine - Crankshaft, Crankcase

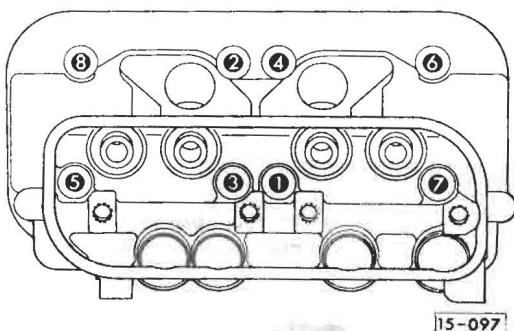


Fig. 1 Cylinder head, installing

- hand tighten nuts to align components, then torque to 30 Nm (22 ft lb) in sequence

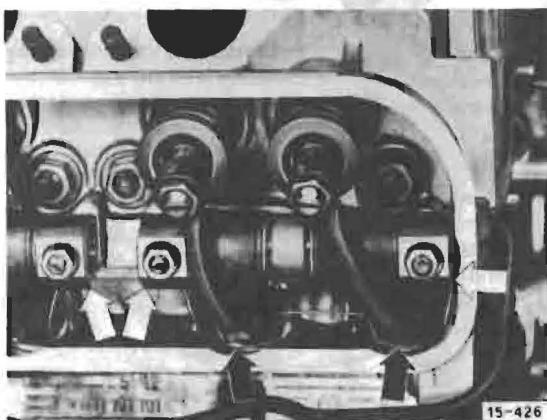


Fig. 2 Retaining spring for push rod tubes, installing

- spring must rest on tubes (black arrows) and engage supports (white arrows)

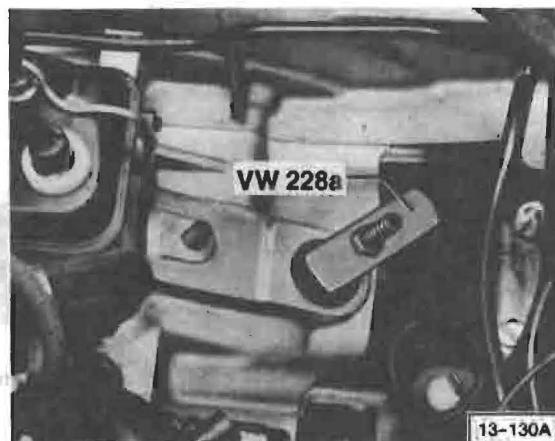


Fig. 3 Distributor drive, removing

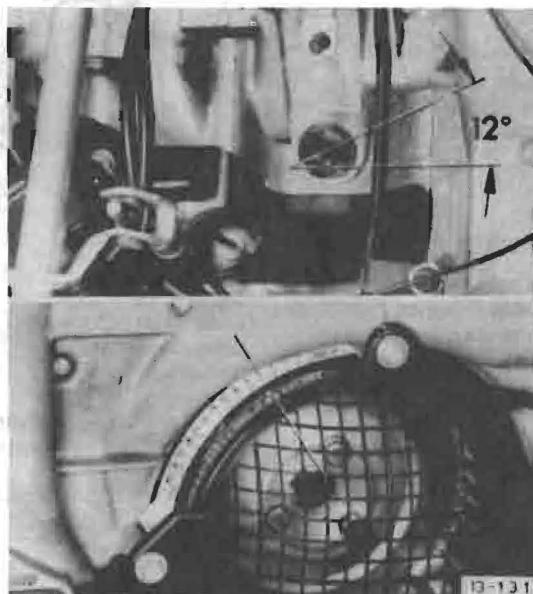


Fig. 4 Distributor drive, installing

- set crankshaft to TDC on cylinder No. 1
- install drive shaft so that offset slot is at an angle of about 12° to engine centerline (small segment to coil side)



Fig. 5 Distributor, installing

- set cylinder No. 1 to TDC
- turn rotor until mark on rotor is in line with mark on distributor housing (cylinder No. 1)

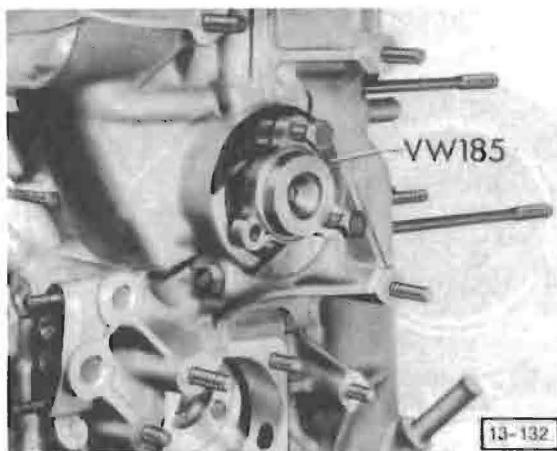


Fig. 6 Cooling fan hub, removing

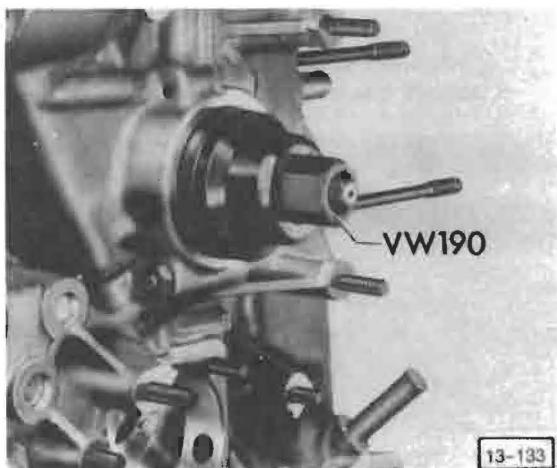


Fig. 7 Crankshaft oil seal, cooling fan side, installing

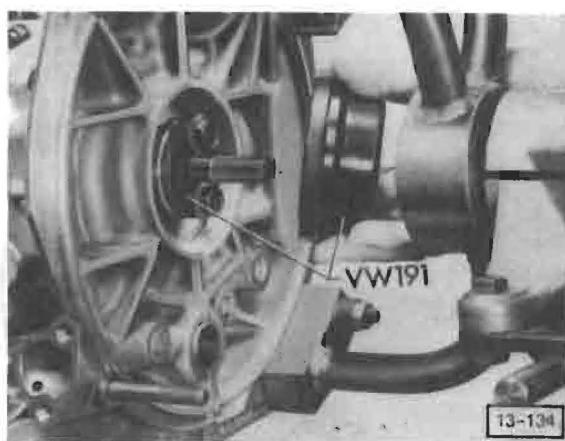


Fig. 8 Crankshaft oil seal, flywheel side, installing

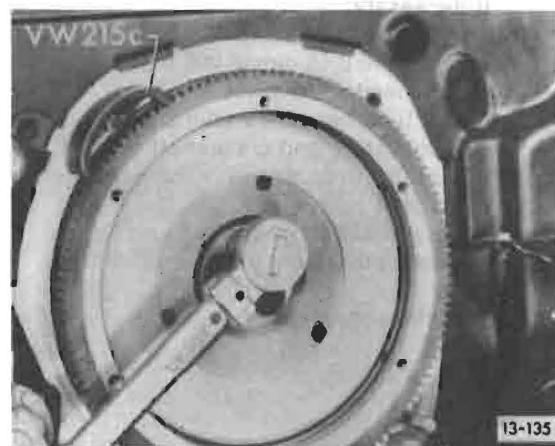


Fig. 9 Flywheel, removing/installing

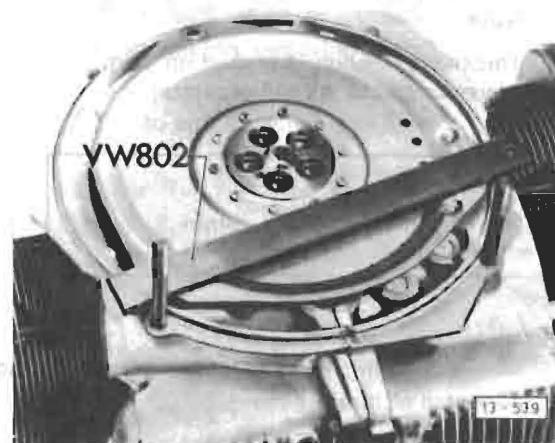


Fig. 10 Torque converter drive plate, removing

# 13 Engine - Crankshaft, Crankcase

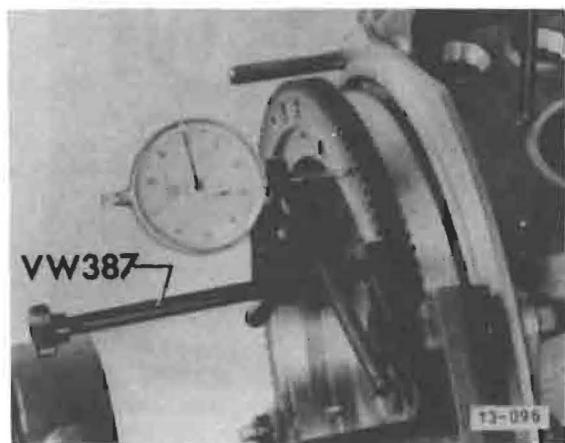


Fig. 11 Crankshaft end play, checking/adjusting

- check crankshaft end play and adjust if necessary
  - new: 0.07–0.13 mm (0.003–0.005 in.)
  - wear limit: 0.15 mm (0.006 in.)
- if NO, proceed as follows:
  - install flywheel with **2** shims but **without** O-ring and crankshaft oil seal
  - mount dial indicator with bracket on crankcase
  - move crankshaft in and out and measure movement (crankshaft end play)
  - determine thickness of **3rd** shim

## Example

dial indicator reading    0.44 mm (0.017 in.)  
specified end play    – 0.10 mm (0.004 in.)  
thickness of **3rd** shim    0.34 mm (0.013 in.)

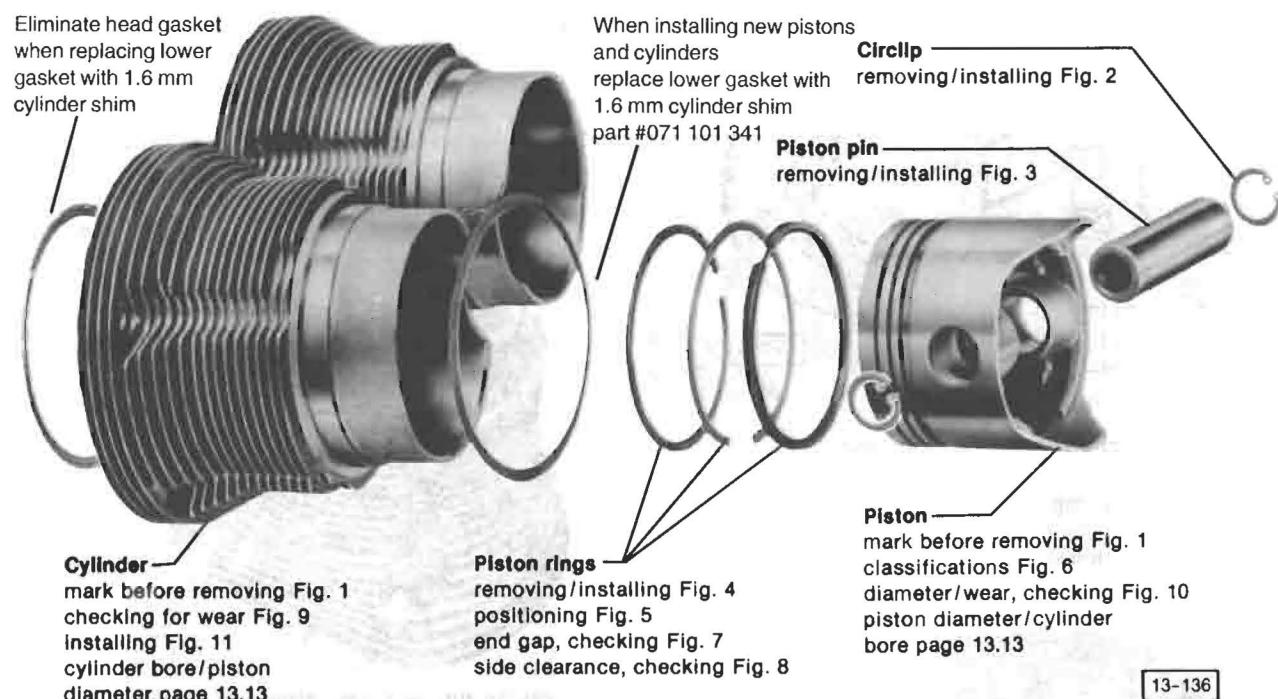
## Note

Thickness of shim is etched on shim.  
Always recheck with micrometer

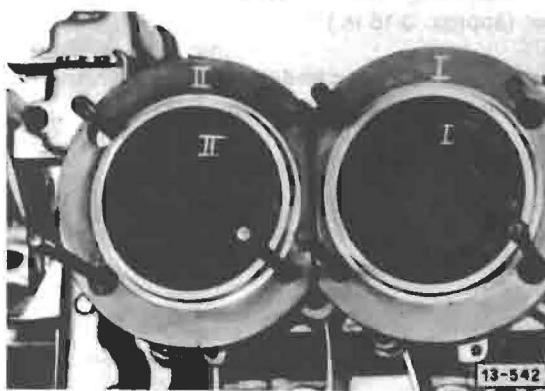
### CAUTION

Always install **three** shims to obtain correct crankshaft end play

- remove flywheel
- install O-ring, crankshaft oil seal and felt ring
- install all **three** shims
- install flywheel
- tighten bolts to 110 Nm (80 ft lb)
- recheck crankshaft end play

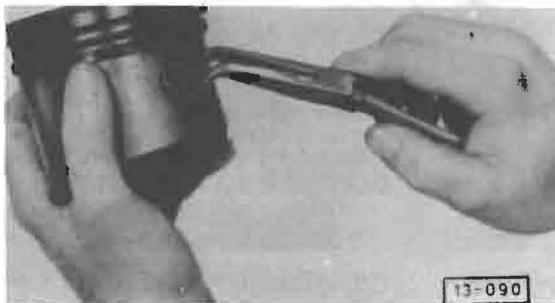


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#### Note

Before removing, mark matching numbers on pistons and cylinders



# 13 Engine - Crankshaft, Crankcase

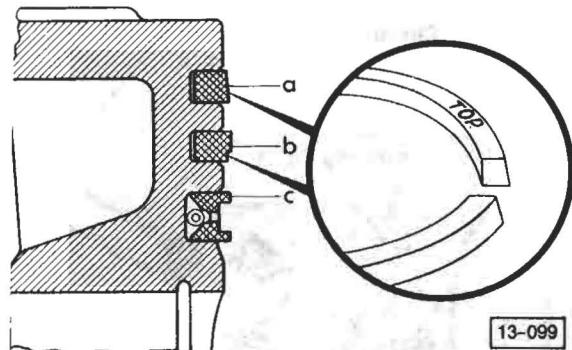


Fig. 5 Piston rings, positioning

- TOP mark on piston rings must face top of piston
- a = top ring
- b = middle ring
- c = oil scraper ring

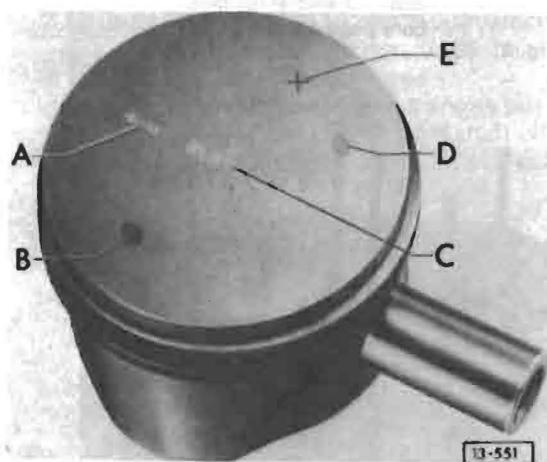


Fig. 6 Piston, classifications

- A = arrow must point toward flywheel when installing
- B and C = piston diameter in mm (blue or pink paint dot indicates matching size)
- D and E = weight group
  - (brown) = 474 – 482 grams
  - +(gray) = 482 – 490 grams



Fig. 7 Piston ring end gap, checking

— push ring into cylinder about 4–5 mm (approx. 3/16 in.)

	ring end gap	wear limit
upper/middle ring:	0.40–0.65 mm (0.016–0.026 in.)	0.90 mm (0.035 in.)
oil scraper ring:	0.25–0.40 mm (0.010–0.016 in.)	0.95 mm (0.037 in.)



Fig. 8 Piston ring side clearance, checking

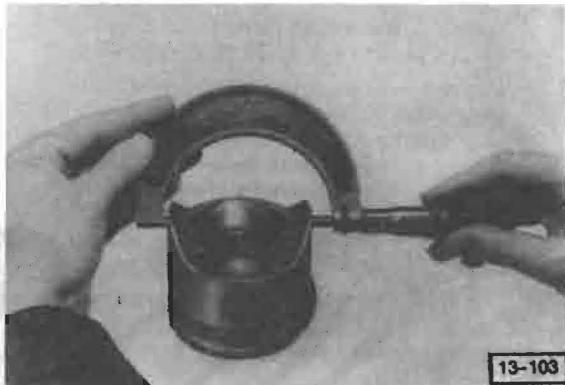
	clearance	wear limit
upper/middle ring:	0.04–0.07 mm (0.002–0.003 in.)	0.12 mm (0.005 in.)
oil scraper ring:	0.02–0.05 mm (0.001–0.002 in.)	0.10 mm (0.004 in.)

**CAUTION**

If measurement of piston/cylinder shows that clearance is close to 0.2 mm (0.008 in.), piston/cylinder should be replaced by set of same size group (standard or oversize). Weight difference of pistons must not exceed 10 grams.

If cylinder of damaged piston shows no wear, install new piston of appropriate matching size.

Cylinders/pistons must be of same size group.

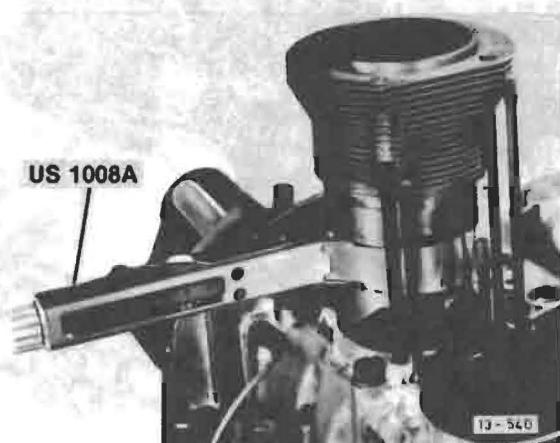


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**Fig. 10 Piston, checking diameter/wear****Cylinder bore/Piston diameter**

	Cylinder bore (mm)	Piston dia. (mm)
Standard (94.0 mm)		
blue	93.992-94.008	93.97
pink	94.002-94.018	93.98
1st oversize (94.5 mm)		
blue	94.492-94.508	94.47
pink	94.502-94.518	94.48
2nd oversize (95.0 mm)		
blue	94.992-95.008	94.97
pink	95.002-95.018	94.98

- measure at bottom of skirt approx. 16 mm (3/8 in.) from edge (diameter stamped in top of piston)
- clearance new: 0.02-0.05 mm (0.001-0.002 in.)
- wear limit: 0.2 mm (0.008 in.)



13-540

**Fig. 11 Cylinder, installing**

- piston ring end gaps must be offset 120°

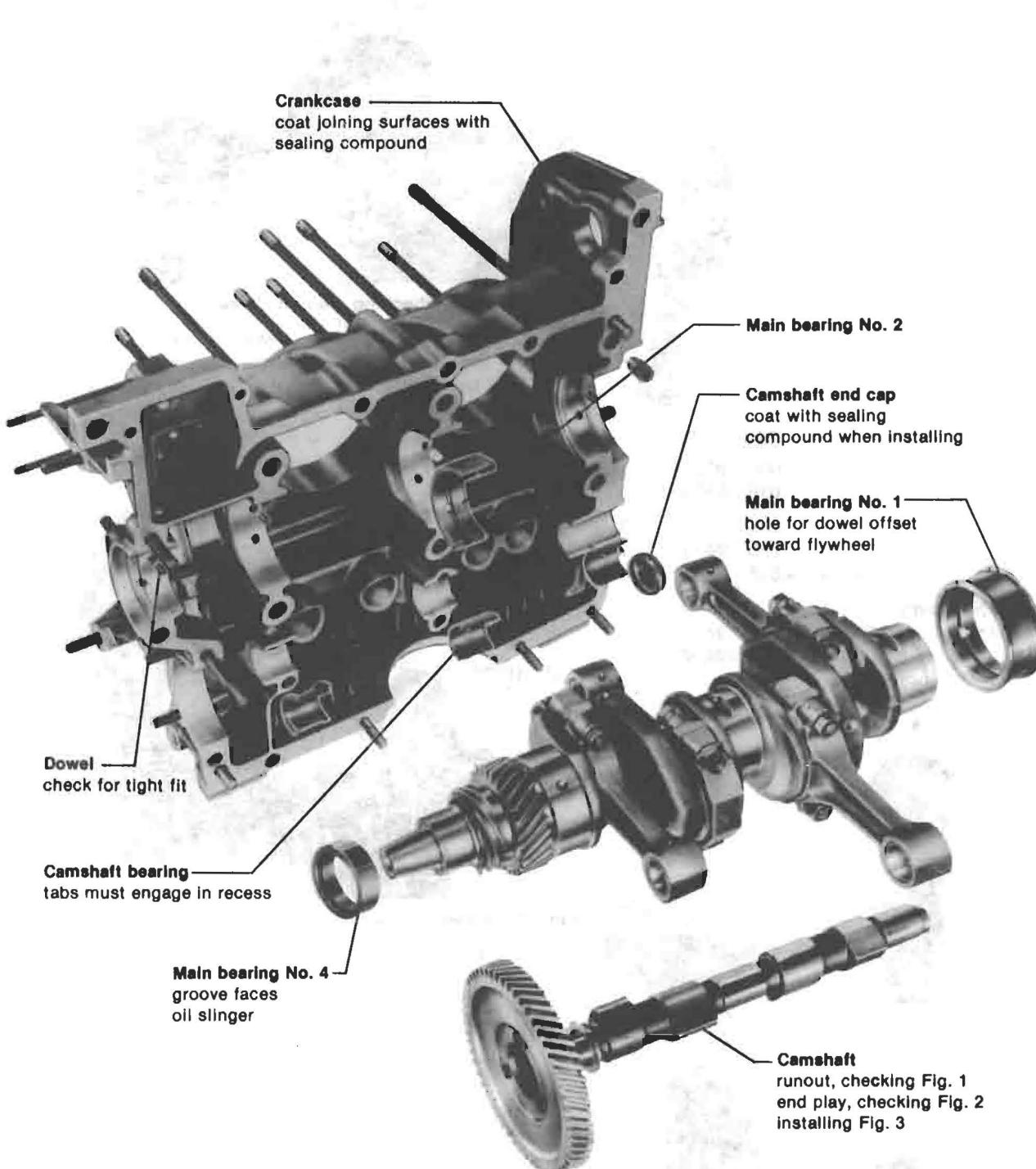


13-102

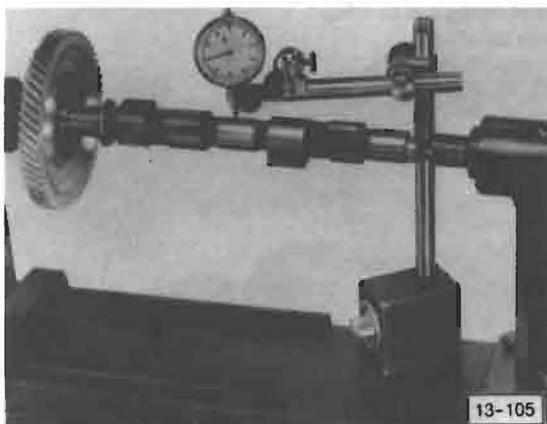
**Fig. 9 Cylinder, checking for wear**

- measure 10-16 mm (3/8-5/8 in.) from top

# 13 Engine - Crankshaft, Crankcase



13-545



**Fig. 1 Camshaft runout, checking**

- wear limit 0.04 mm (0.0015 in.)

— turn crankshaft backward

- camshaft must not lift out of bearings
- if camshaft lifts out of bearings, install camshaft with smaller timing gear

#### Note

To obtain specified backlash, camshafts with various size timing gears are available.

Markings are on **inner face** of timing gear.

#### Example

"-0.1", "+0.1", "+0.2", indicates in 1/100 mm how much pitch radius differs from standard pitch radius "0"

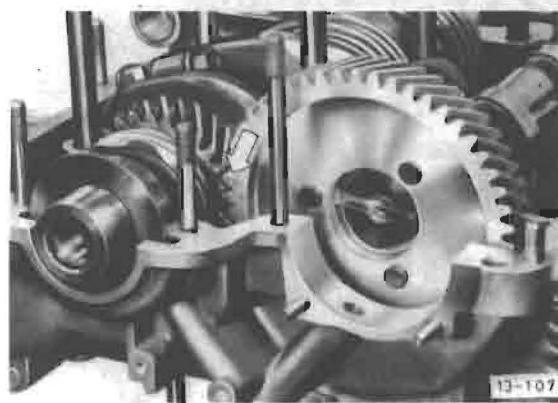
#### CAUTION

Mark 0 on **outer** face of camshaft timing gear is timing mark and must not be confused with markings on **inner** face. Crankshaft timing gear is available in one size only



**Fig. 2 Camshaft end play, checking**

- wear limit 0.16 mm (0.006 in.)
- if out of specification, replace camshaft bearings



**Fig. 3 Camshaft, installing**

- mark on camshaft gear tooth must be between marks on crankshaft gear teeth
- check backlash of timing gears
  - 0.0-0.05 mm (0-0.002 in.)
  - backlash must be hardly noticeable

# 13 Engine - Crankshaft, Crankcase

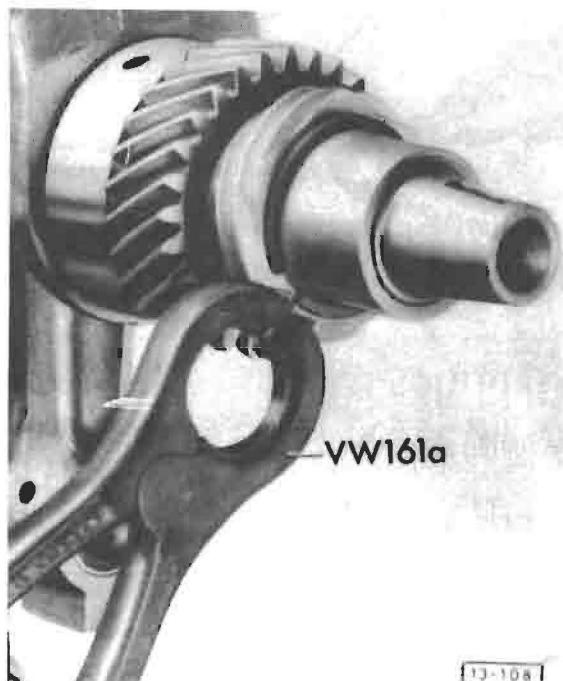
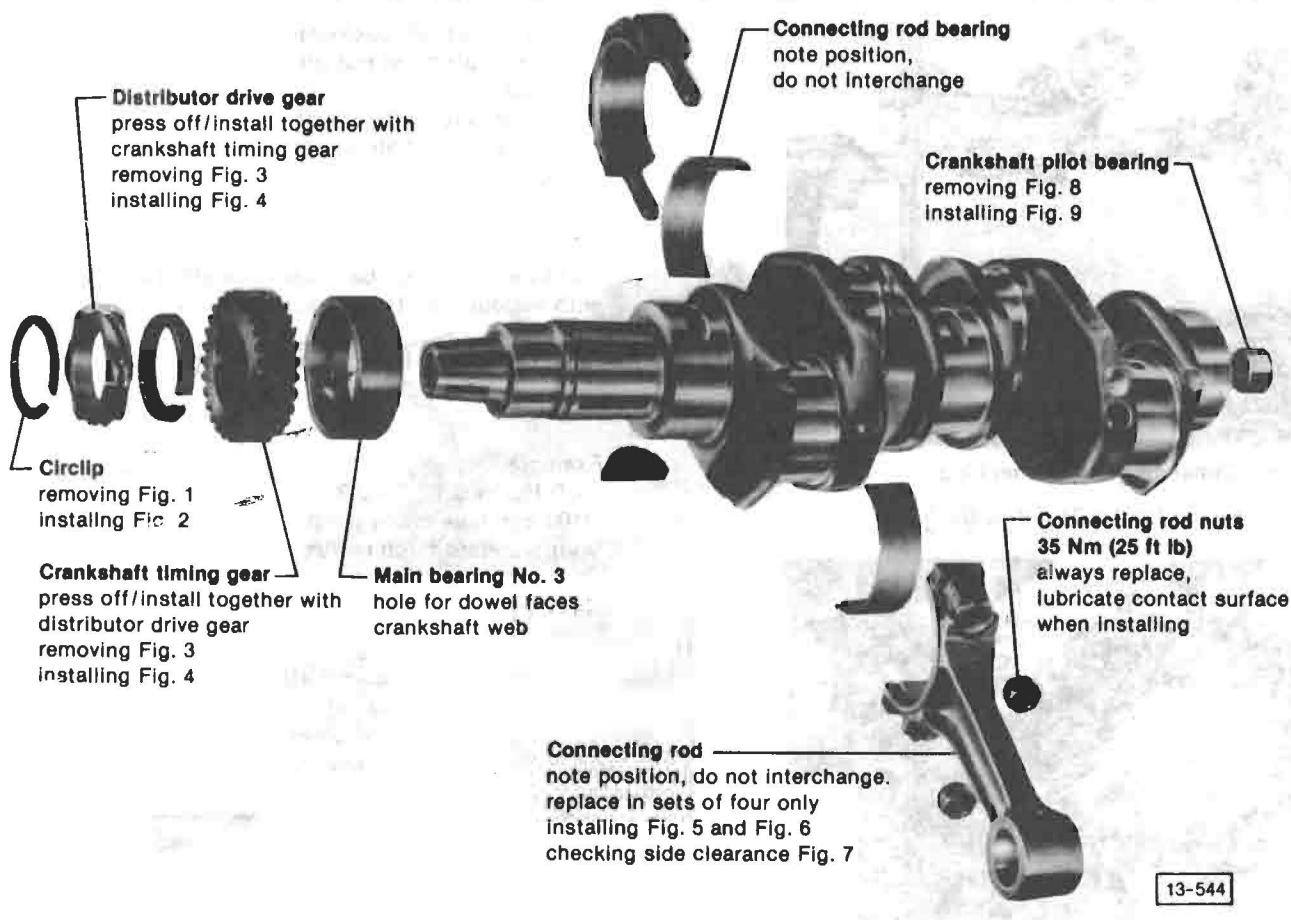


Fig. 1 Circlip, removing

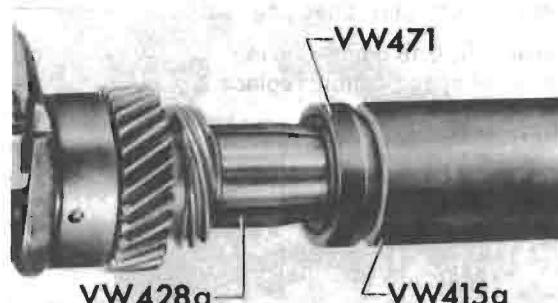


Fig. 2 Circlip, installing

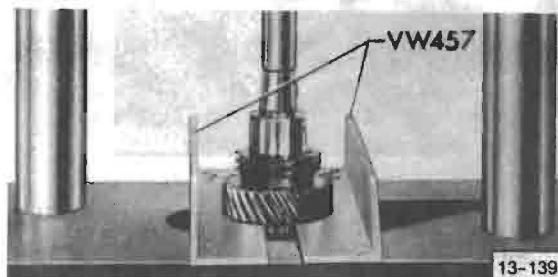
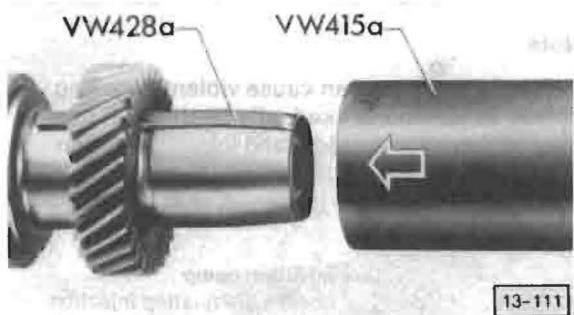


Fig. 3 Distributor drive gear/crankshaft timing gear, removing



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**Fig. 4 Distributor drive gear/crankshaft timing gear, installing**

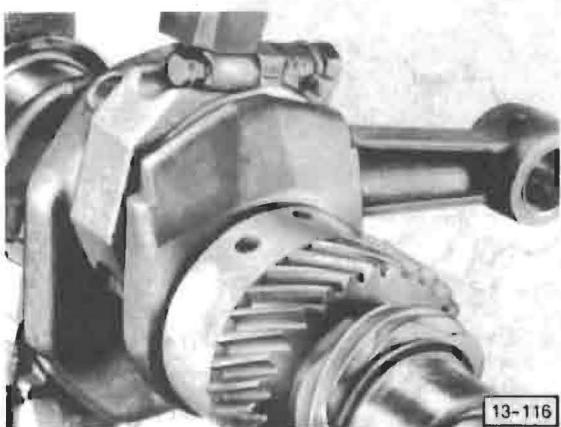
- heat gears to approx. 80 °C (175 °F) before installing



13-114

**Fig. 5 Connecting rod, installing**

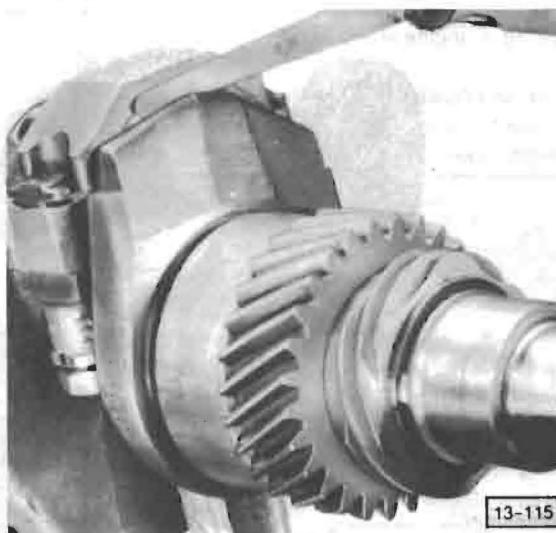
- numbers (arrow) on rod and cap must be on same side



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**Fig. 6 Connecting rod, installing**

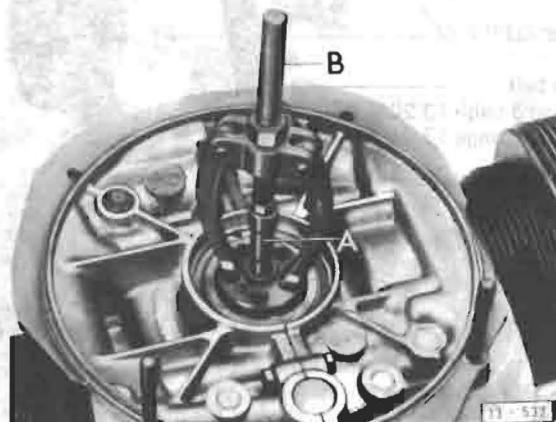
- lightly tap both sides of connecting rod with hammer to eliminate slight pinching of bearing shells when installing connecting rod



13-115

**Fig. 7 Connecting rod, checking side clearance**

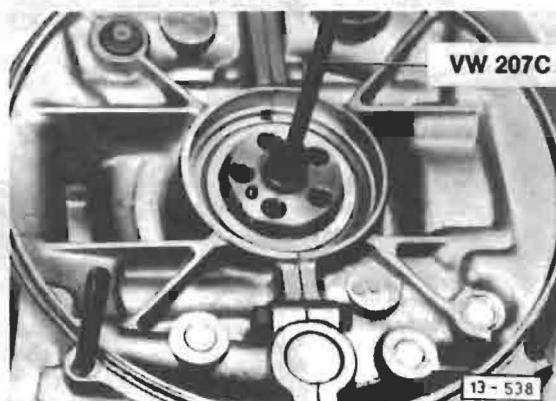
- wear limit 0.7 mm (0.028 in.)



11-532

**Fig. 8 Crankshaft pilot bearing, removing**

- A = US 8028
- B = US 1039 & US 1039/3



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**Fig. 9 Crankshaft pilot bearing, installing**

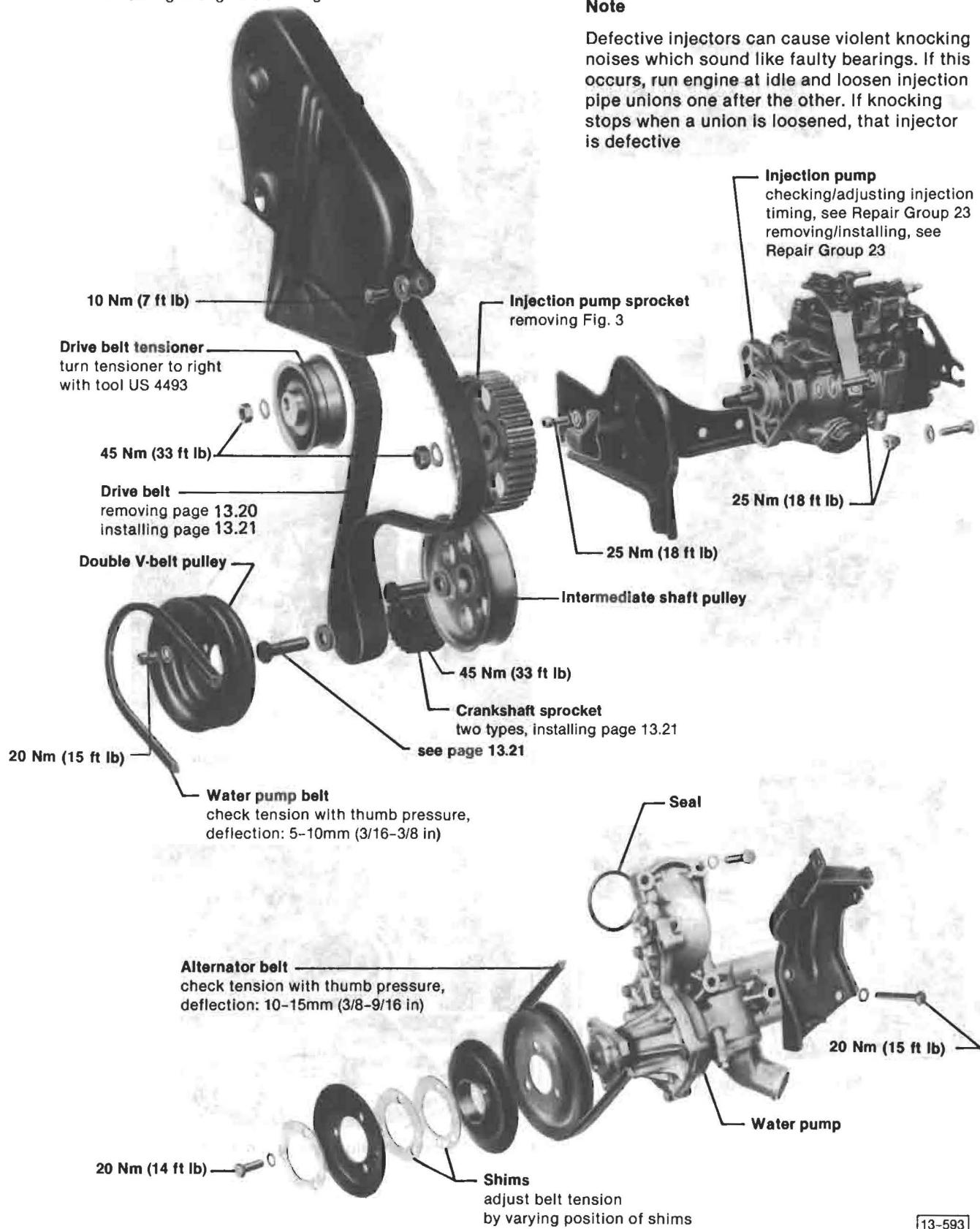
- lubricate with MoS<sub>2</sub> grease when installing
- markings on bearing cage must be visible when installed

# 13 Engine-Crankshaft, Crankcase

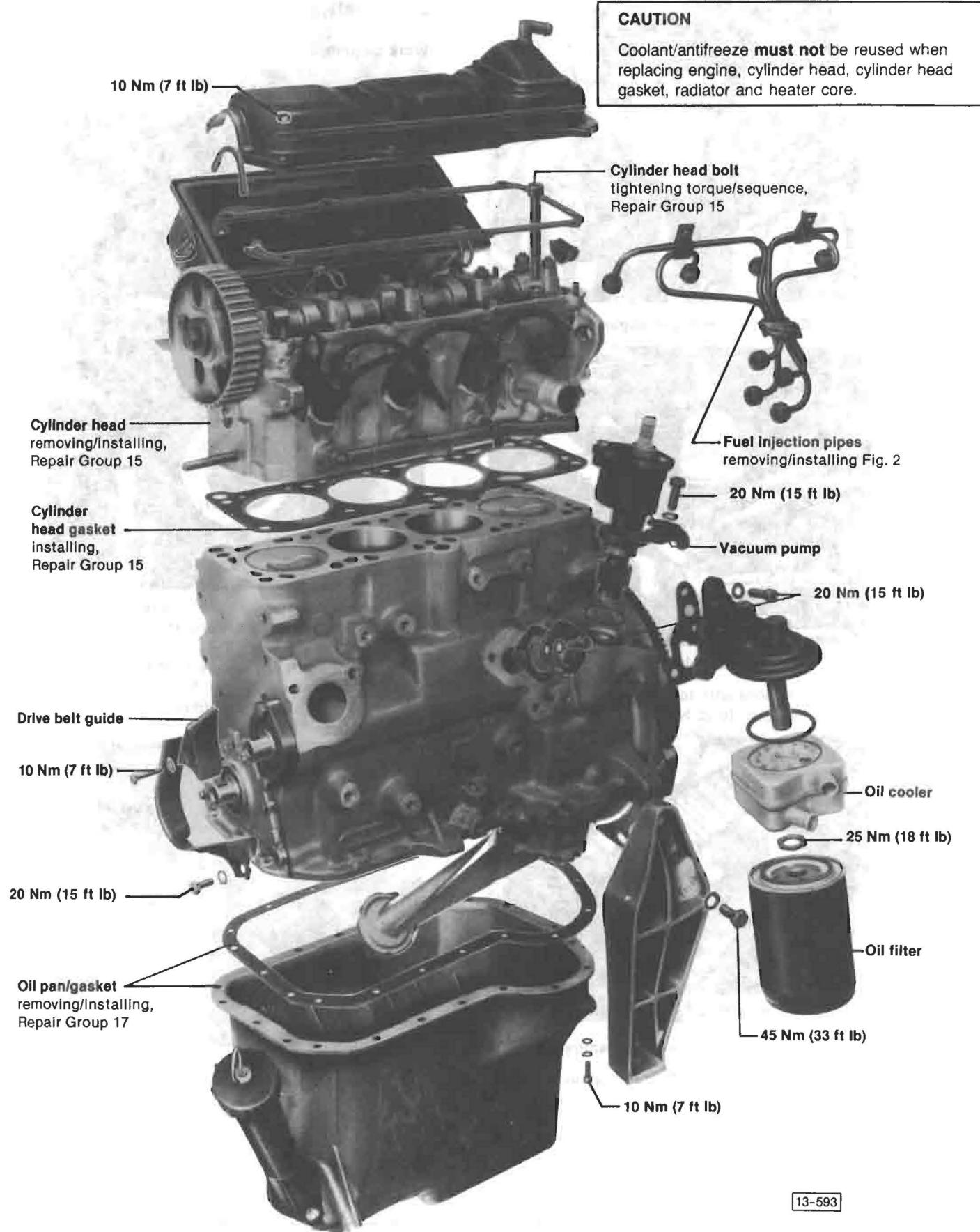
**Engine**  
mounting in engine stand Fig. 1

## Note

Defective injectors can cause violent knocking noises which sound like faulty bearings. If this occurs, run engine at idle and loosen injection pipe unions one after the other. If knocking stops when a union is loosened, that injector is defective



13-593



13-593

# 13 Engine-Crankshaft, Crankcase



Fig. 1 Engine, mounting in engine stand

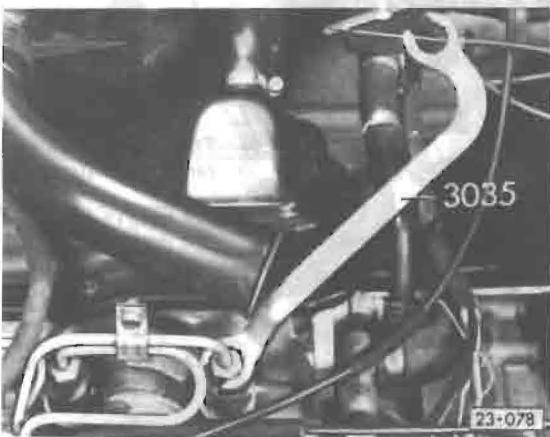


Fig. 2 Fuel injection pipes, removing/installing

- remove with tool 3035
- tighten to 25 Nm (18 ft lb)

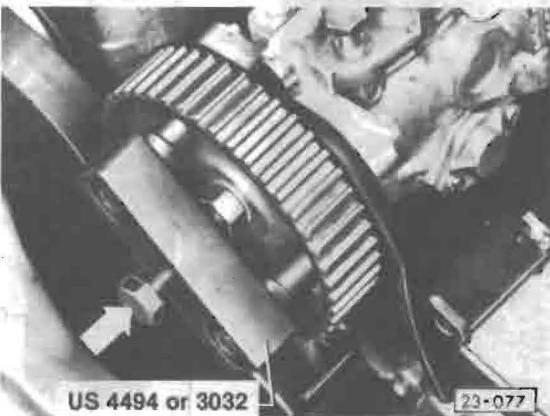


Fig. 3 Injection pump sprocket, removing

- loosen sprocket retaining nut slightly
- carefully apply tension with puller
- hit puller spindle head (arrow) with light hammer taps until sprocket loosens from injection pump shaft
- remove puller and nut
- remove sprocket by hand

## Drive belt, removing

### Work sequence

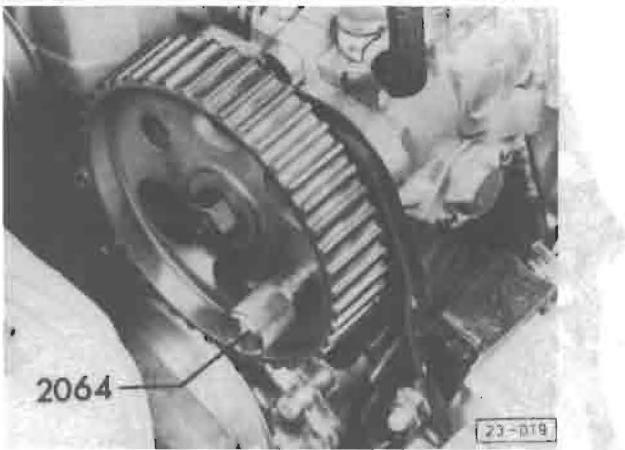
- remove bolt cover and valve cover



—turn engine to TDC arrow on cylinder No. 1 and fix camshaft in position with tool 2065A

—align tool as follows:

- turn camshaft until one end of tool touches cylinder head
- measure gap at other end of tool with feeler gauge
- take half of measurement and insert feeler of this thickness between tool and cylinder head
- turn camshaft so that tool rests on feeler
- insert second feeler of same thickness between other end of tool and cylinder head



- lock injection pump sprocket in position with pin 2064
- check that marks on sprocket, bracket and pump body are aligned (engine at TDC)
- loosen tensioner
- remove V-belt pulley from crankshaft
- remove drive belt

## Drive belt, installing

### Work sequence

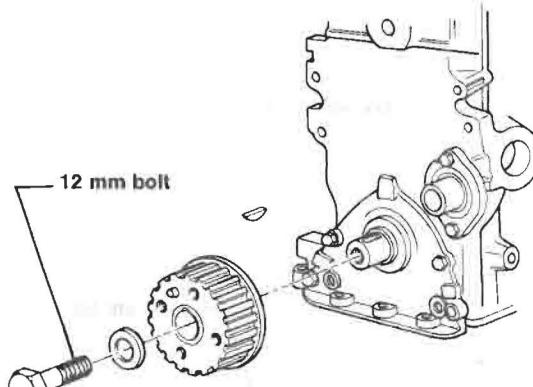
- check that TDC mark on clutch pressure plate is aligned with reference mark
- loosen camshaft sprocket bolt 1/2 turn and loosen gear from camshaft by tapping with rubber hammer
- install drive belt and remove pin 2064 from injection pump sprocket
- tension belt by turning tensioner to right



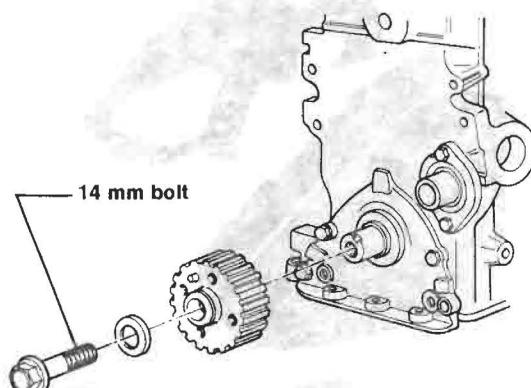
- check that on VW 210, scale reads 12-13
  - check belt tension between camshaft sprocket and injection pump sprocket
- tighten camshaft sprocket bolt to 45 Nm (33 ft lb)
- remove tool from camshaft

- turn crankshaft 2 turns in direction of engine rotation (clockwise)
- strike belt once with rubber hammer between camshaft sprocket and injection pump sprocket
- check belt tension again
- check injection pump timing, see Repair Group 23

## Drive belt sprocket bolt, tightening



**Old Version**  
150 Nm (108 ft lb)  
with locking compound



**New Version**  
200 Nm (148 ft lb)  
lubricate threads before installing

Shown above are the two versions of drive belt sprocket used on Diesel Vanagon. Ensure that the correct tightening torque specification is used when repairing these engines.

# 13 Engine-Crankshaft, Crankcase

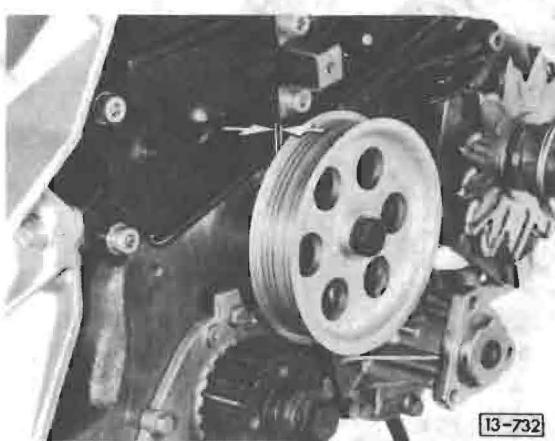
## Fully closed drive belt cover

Beginning in February 1984, the Diesel engine has been produced with a fully closed drive belt cover.

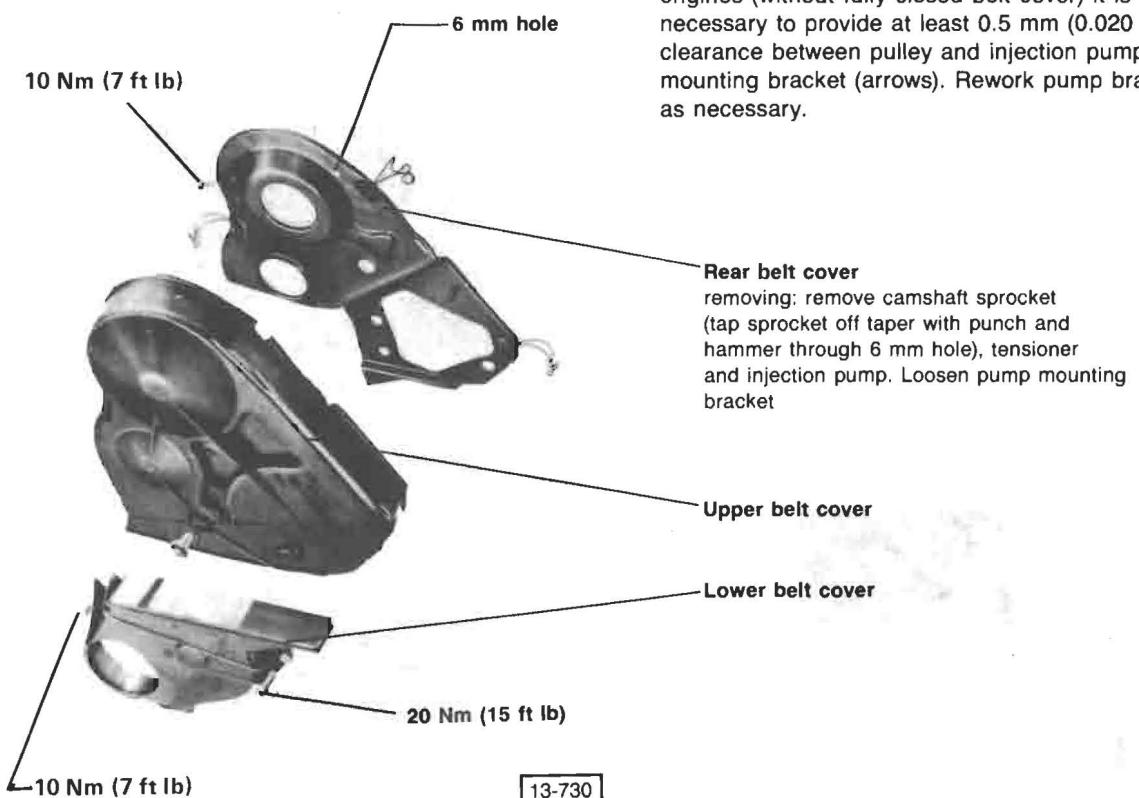
Additional new parts include a revised injection pump mounting bracket and intermediate shaft pulley. The pulley now mounts closer to the engine block.

### Note

Only the new version pulleys will be supplied as service parts.



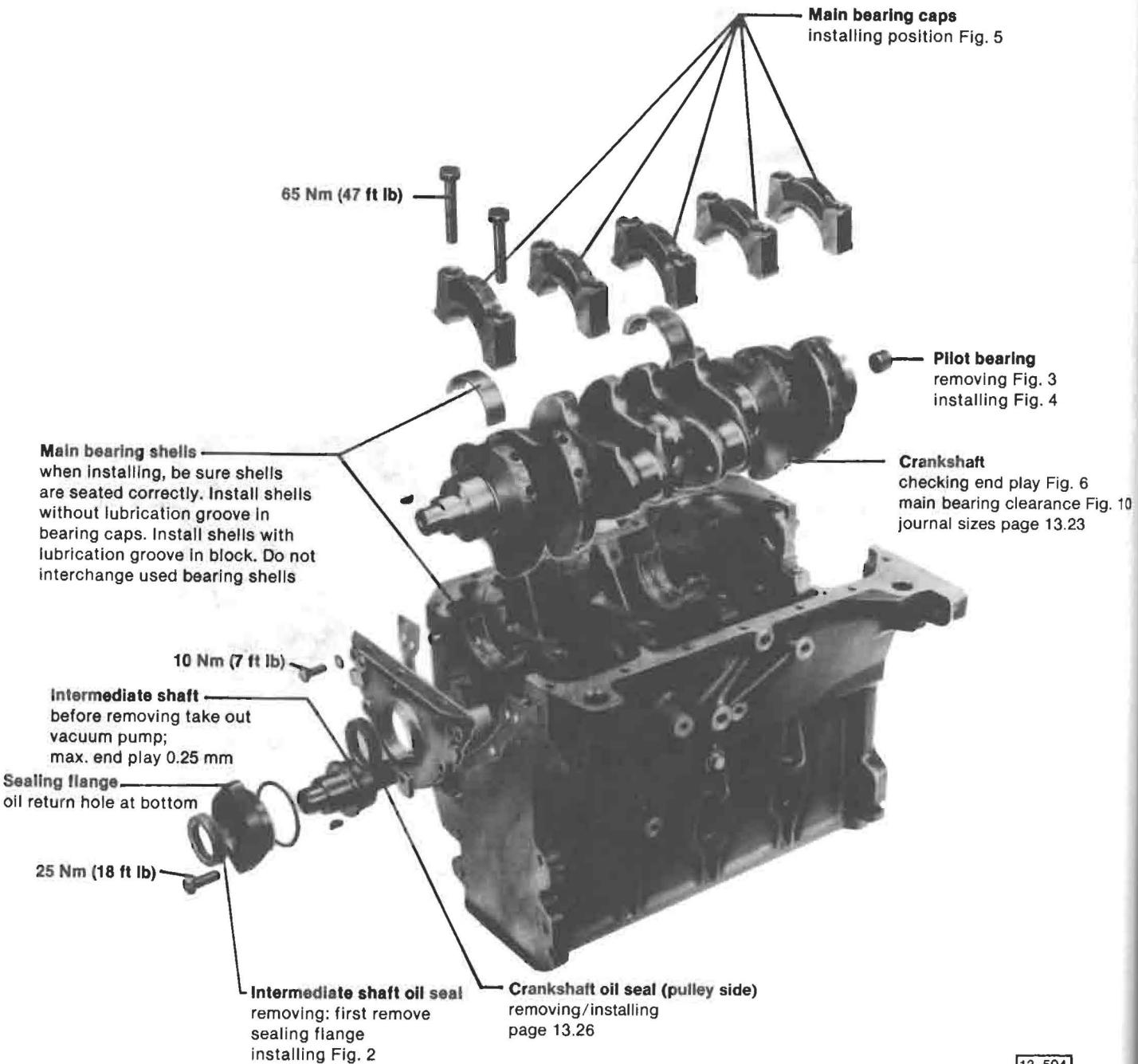
When installing the new version pulley in earlier engines (without fully closed belt cover) it is necessary to provide at least 0.5 mm (0.020 in.) clearance between pulley and injection pump mounting bracket (arrows). Rework pump bracket as necessary.



# 13 Engine-Crankshaft, Crankcase

## Note

Defective injectors can cause violent knocking noises which sound like faulty bearings. If this occurs, run engine at idle and loosen injection pipe unions one after the other. If knocking stops when a union is loosened, that injector is defective.



13-594

**WARNING**

Friction materials such as brake and clutch linings, or brake pads may contain asbestos fibers.

Do not create dust by grinding, sanding or by cleaning with compressed air.

Avoid breathing asbestos fibers and asbestos dust.

Breathing asbestos may result in serious diseases, such as asbestosis or cancer.

It may cause severe injury and death.

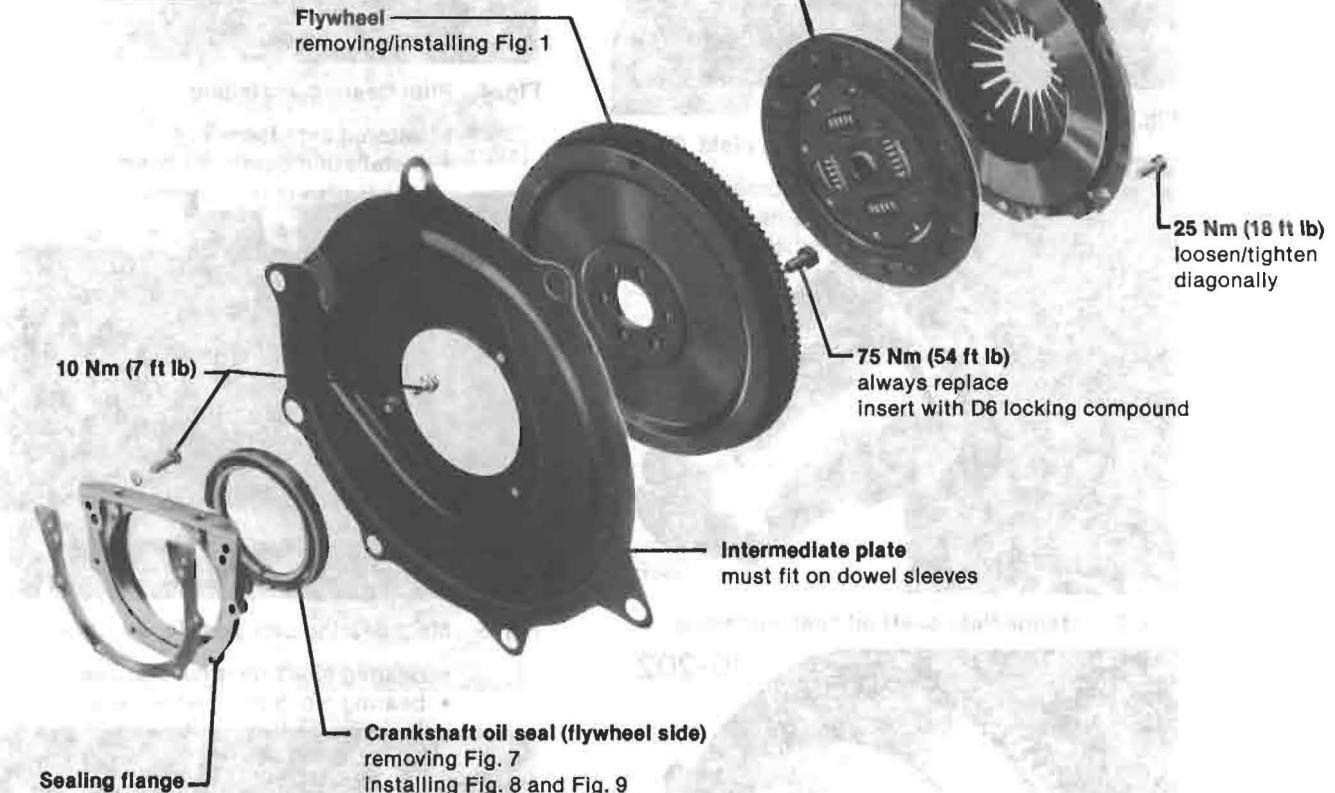


Fig. 10

13-594

**Crankshaft journal sizes (mm)**

Stage	Main bearing journals	Max. out of round	Connecting rod journals	Max. out of round
Standard	53.96–53.98	0.03	47.76–47.78	0.03
1st undersize	53.71–53.73	0.03	47.51–47.53	0.03
2nd undersize	53.46–53.48	0.03	47.26–47.28	0.03
3rd undersize	53.21–53.23	0.03	47.01–47.03	0.03

**Note**

3 undersizes of bearing shells available in graduations of 0.25 mm

Diesel

Flywheel

13.23

# 13 Engine - Crankshaft, Crankcase

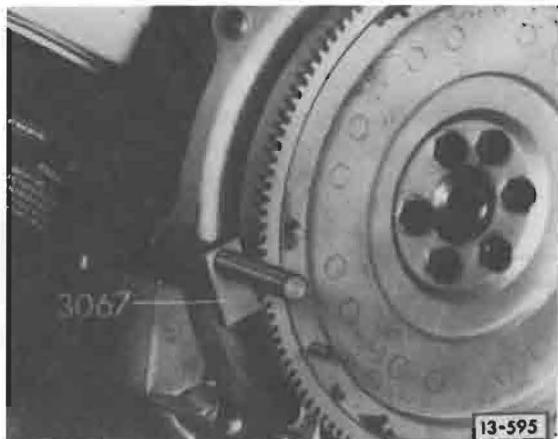


Fig. 1 Flywheel, removing/installing

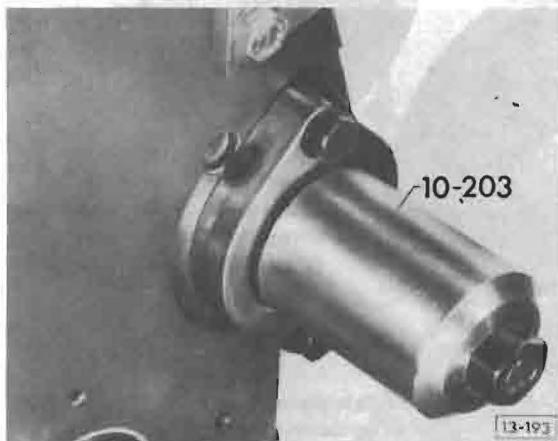


Fig. 2 Intermediate shaft oil seal, installing

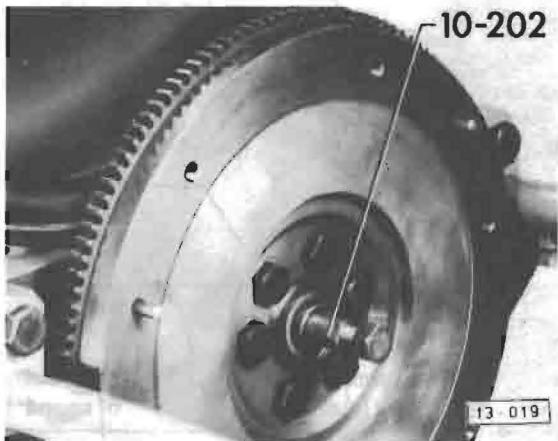


Fig. 3 Pilot bearing, removing

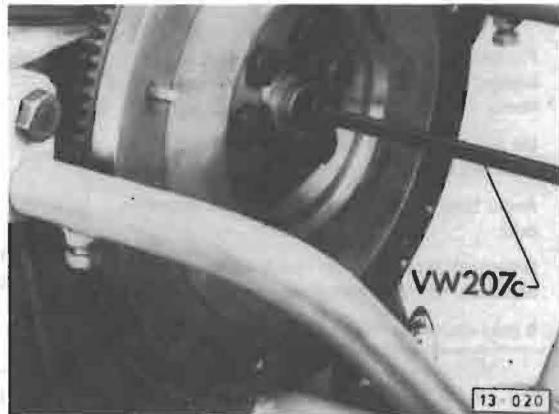


Fig. 4 Pilot bearing, installing

- lettered side faces out
- installation depth = 1.5 mm (0.060 in)

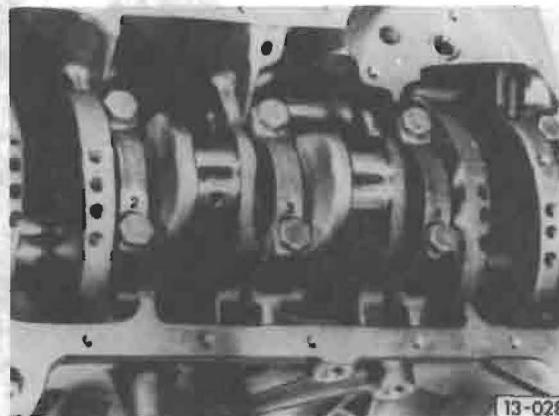


Fig. 5 Main bearing cap, positions

- bearing No. 1 on drive belt side
- bearing No. 5 on flywheel side

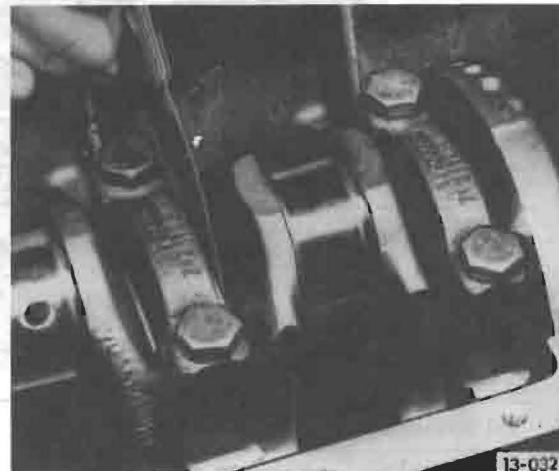


Fig. 6 Crankshaft end play, checking

- check with feeler gauge on main bearing No. 3
  - new part = 0.07–0.17 mm (0.003–0.007 in.)
  - wear limit = 0.37 mm (0.015 in.)

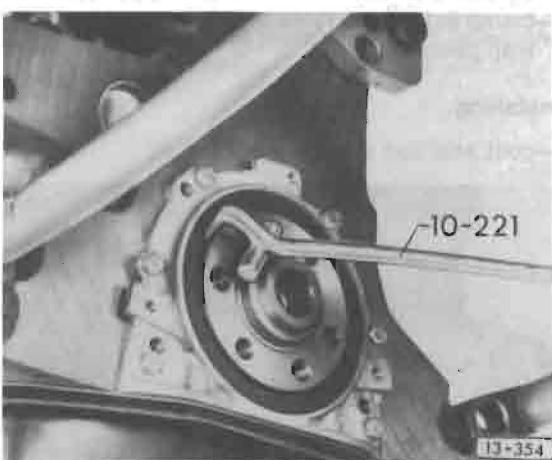


Fig. 7 Crankshaft oil seal (flywheel side), removing



Fig. 8 Crankshaft oil seal (flywheel side), installing

—center with sleeve first

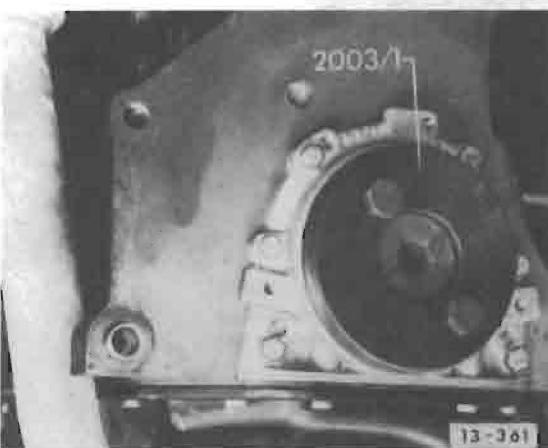


Fig. 9 Crankshaft oil seal (flywheel side), installing

—press in seal until fully seated

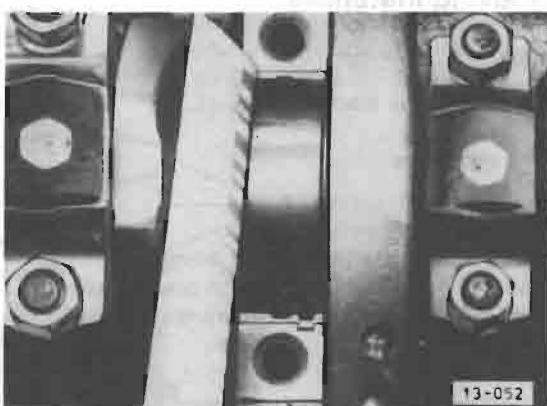


Fig. 10 Main bearing clearance, checking

- remove bearing caps
- clean shells and journals
- measure clearance with Plastigage
  - new part: 0.03–0.08 mm (0.001–0.003 in.)
  - wear limit: 0.17 mm (0.007 in.)

**CAUTION**

Do not turn crankshaft

# 13 Engine - Crankshaft, Crankcase

## Crankshaft oil seal (pulley side), removing/installing

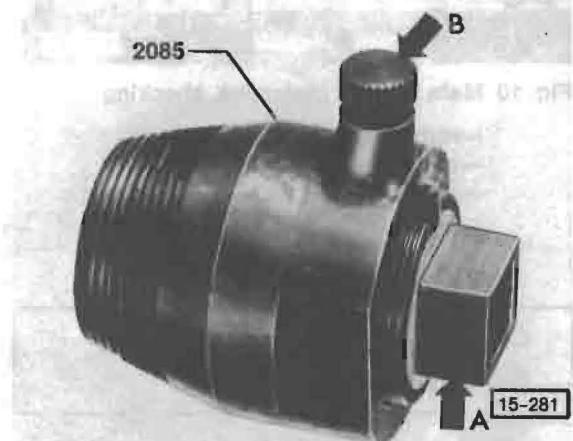
### Note

Puller 2002 may also be used

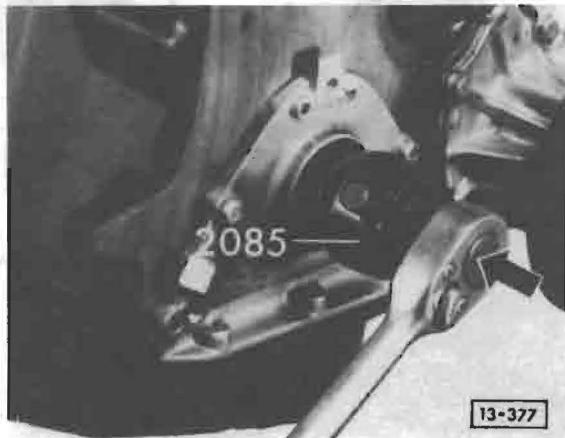
### Work sequence

#### Removing

- remove drive belt cover and drive belt
- remove drive belt sprocket on crankshaft
- remove woodruff key from crankshaft



- unscrew inner part (arrow A) of oil seal extractor 2085 2 turns (approx. 3mm/1/8 in.) out of outer part
- lock in position with knurled screw (arrow B)
- to guide extractor, screw sprocket bolt into crankshaft until it projects about 20 mm (3/4 in.)
- lubricate threads on tapered end of seal extractor

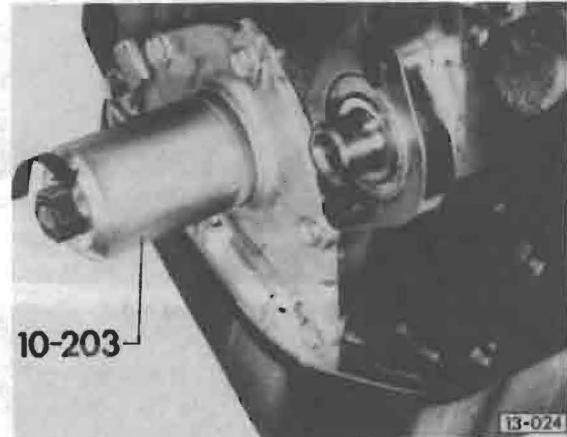


- position seal extractor and screw it into oil seal as far as possible by pushing firmly in direction of arrow

- loosen knurled screw and turn inner part in against crankshaft until oil seal is pulled out
- clamp extractor in vise and remove oil seal with pliers

### Installing

- coat seal lips with oil

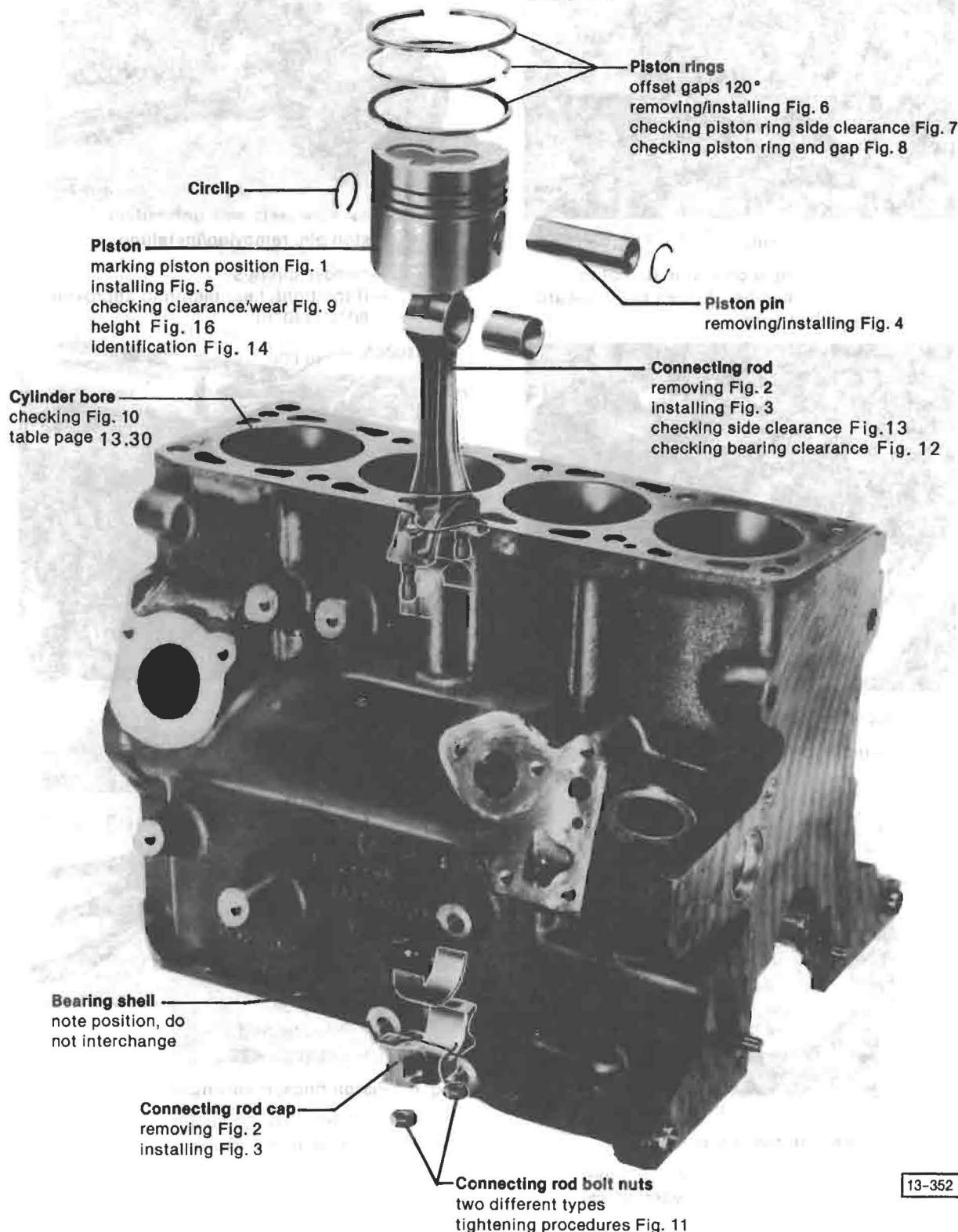


- press in seal to a depth of 2 mm (0.080 in.) below outer edge of cover
- use washer from sprocket bolt between bolt head and tool

## Note

When installing new pistons or short block, check piston height to determine head gasket thickness, see Fig. 15 and Fig. 16

Defective injectors can cause violent knocking noises which sound like faulty bearings. If this occurs, run engine at idle and loosen injection pipe unions one after the other. If knocking stops when a union is loosened, that injector is defective.



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# 13 Engine - Crankshaft, Crankcase

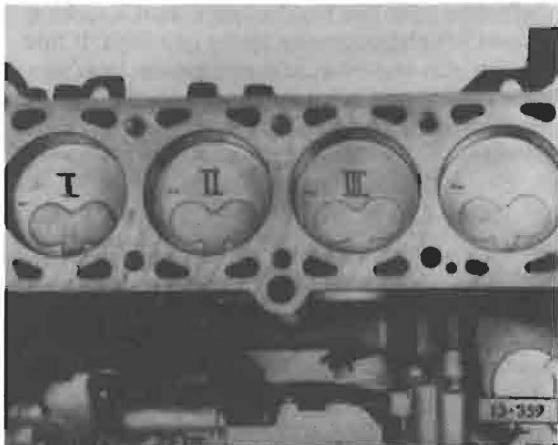


Fig. 1 Pistons, marking

- mark number on piston to match cylinder number. Arrows point toward drive belt side



Fig. 2 Connecting rod, removing

- mark rod and cap before removing

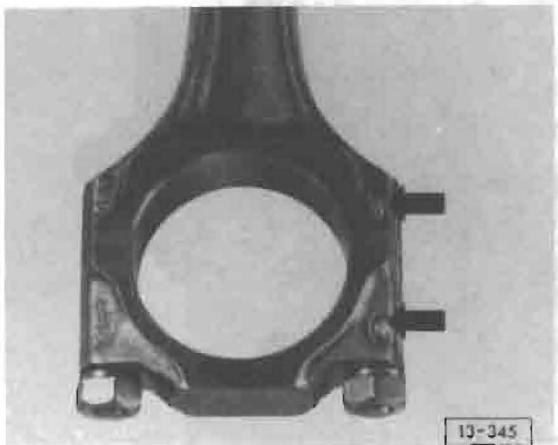


Fig. 3 Connecting rod, installing

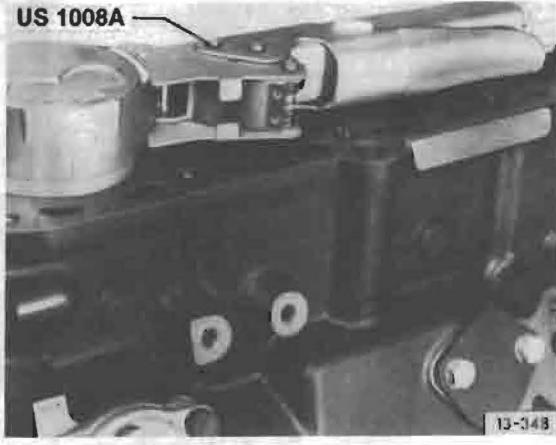
- casting marks and retaining lug for bearing shell face toward intermediate shaft (arrows)



13-347

Fig. 4 Piston pin, removing/installing

- remove circlips
- if too tight, heat piston to approximately 60 °C (140 °F)



13-348

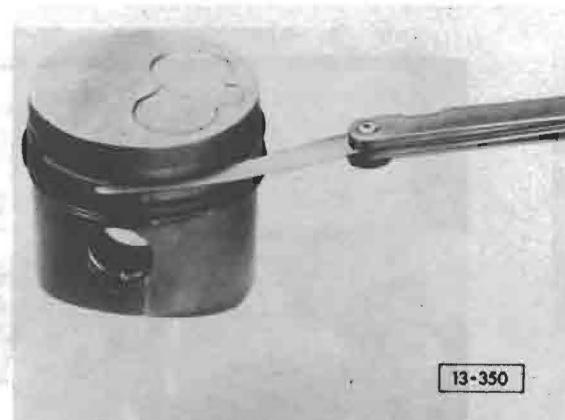
Fig. 5 Pistons, installing



13-349

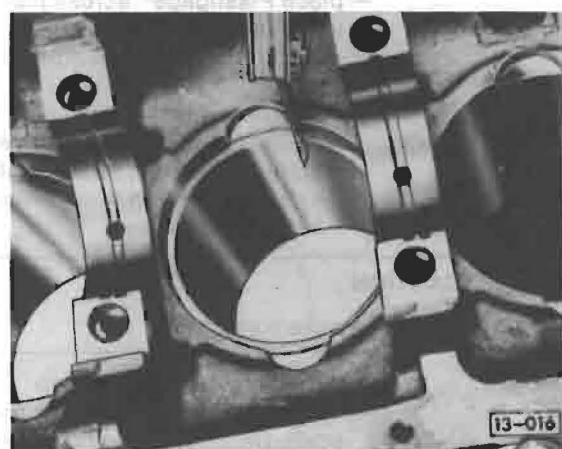
Fig. 6 Piston rings, removing/installing

- “Top” marks on piston rings must face toward piston crown



**Fig. 7 Piston ring side clearance, checking**

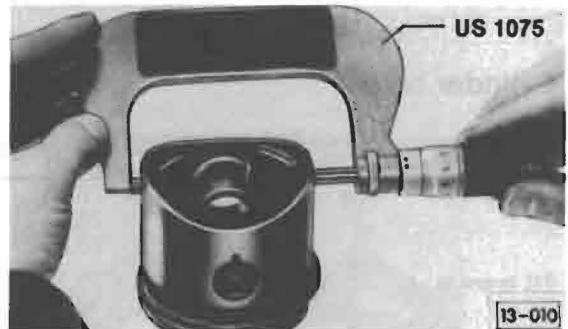
	<b>Clearance</b>	<b>Wear limit</b>
Upper ring	0.06-0.09 mm (0.002-0.004 in.)	0.2 mm (0.008 in.)
Lower ring	0.05-0.08 mm (0.002-0.003 in.)	0.2 mm (0.008 in.)
Oil scraper ring	0.03-0.06 mm (0.001-0.002 in.)	0.15 mm (0.006 in.)



**Fig. 8 Piston ring end gap, checking**

—push ring down squarely into cylinder until it is about 15 mm (9/16 in.) from top edge

	<b>Ring gap</b>	<b>Wear limit</b>
Upper and lower rings	0.3-0.5 mm (0.012-0.020 in.)	1 mm (0.039 in.)
Oil scraper ring	0.25-0.40 mm (0.010-0.016 in.)	1 mm (0.039 in.)

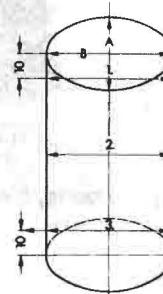


**Fig. 9 Piston, checking for wear**

—measure about 15 mm (9/16 in.) from lower edge

## Piston diameter

	<b>Piston dia. (mm)</b>	<b>Cylinder bore (mm)</b>
Standard	76.48	76.51
	76.49	76.52
	76.50	76.53
1st oversize	76.73	76.76
	76.74	76.77
	76.75	76.78
2nd oversize	76.98	77.01
	76.99	77.02
	77.00	77.03
3rd oversize	77.48	77.51
	77.49	77.52
	77.50	77.53



13-086

**Fig. 10 Cylinder clearance, checking**

—measure at points 1, 2 and 3 first in direction A then direction B

1 = 10 mm (3/8 in.) from top

2 = middle of cylinder wall

3 = 10 mm (3/8 in.) from bottom

- piston to cylinder clearance  
new part: 0.03 mm (0.0011 in.)  
wear limit: 0.07 mm (0.0027 in.)

## Note

Do not measure when block is mounted in repair stand as measurements may be incorrect due to distortion

Diesel

Piston rings  
Piston  
Cylinder

**13.29**

# 13 Engine - Crankshaft, Crankcase

## Cylinder bore

	Bore (mm)	Piston dia. (mm)
Standard	76.51	76.48
	76.52	76.49
	76.53	76.50
1st oversize	76.76	76.73
	76.77	76.74
	76.78	76.75
2nd oversize	77.01	76.98
	77.02	76.99
	77.03	77.00
3rd oversize	77.51	77.48
	77.52	77.49
	77.53	77.50

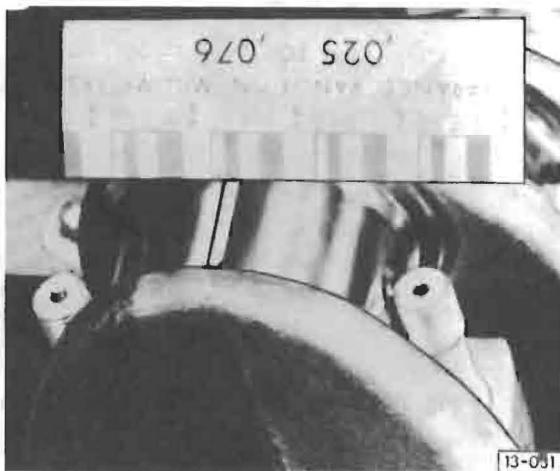


Fig. 12 Connecting rod bearing clearance, checking

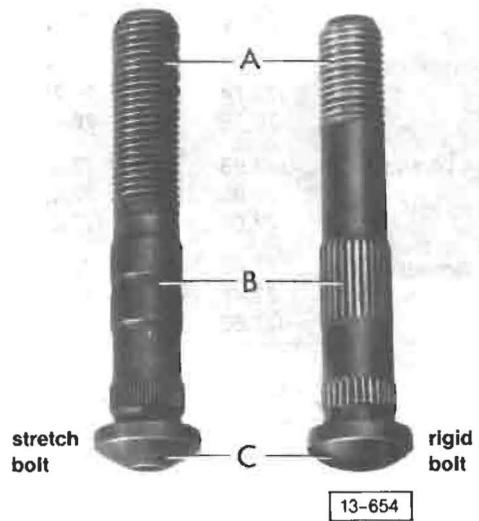


Fig. 11 Connecting rod bolts, identification/tightening procedure

stretch	rigid
25mm (1.0 in.)	15 mm (9/16 in.)
smooth	serrated
conical	half round

### Tightening procedure

#### stretch bolt:

- lubricate contact face of nut
- tighten to 30 Nm (22 ft lb)
- then tighten nut 1/4 turn (90°) more

#### rigid bolt:

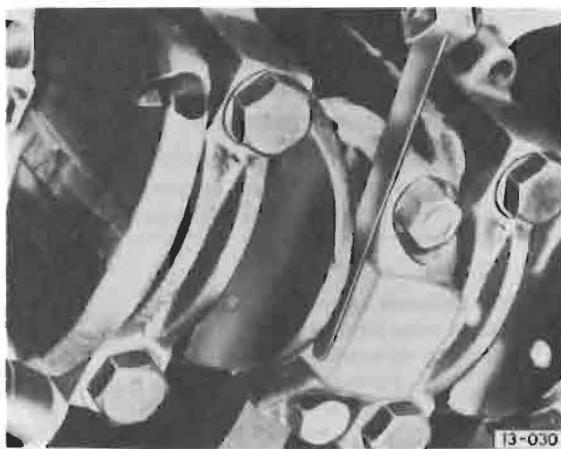
- lubricate contact face of nut
- tighten to 45 Nm (33 ft lb)

- remove connecting rod cap
- clean bearing shell and crankshaft journal
- place Plastigage® across journal
- install cap and tighten nuts
  - if rigid bolts, tighten nuts to 45 Nm (33 ft lb)
  - if stretch bolts, tighten nuts to 30 Nm (22 ft lb) (to avoid stretching bolts, do not turn stretch bolt nuts extra quarter turn when measuring bearing clearance)

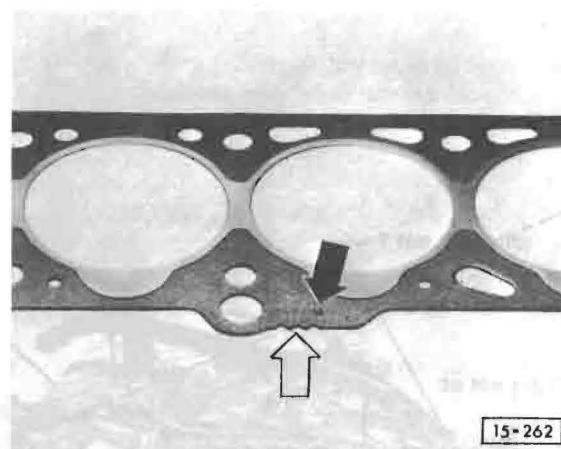
### CAUTION

Do not turn crankshaft

- remove connecting rod cap
- compare width of strip with measuring scale; figure on scale gives bearing clearance
  - new part: 0.028–0.088 mm (0.0011–0.0034 in.)
  - wear limit: 0.12 mm (0.0047 in.)

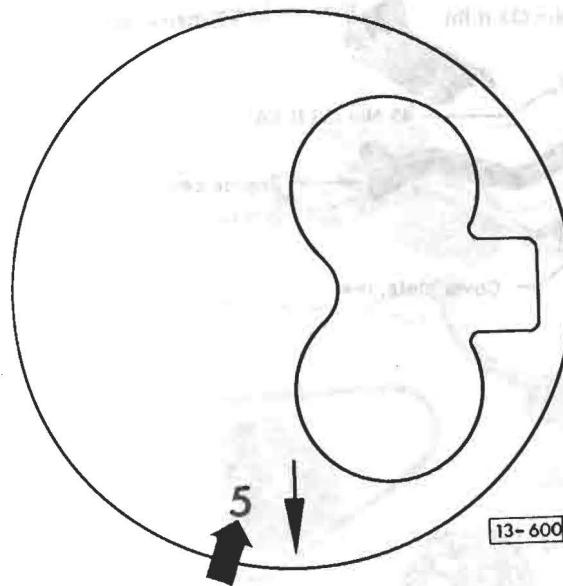


**Fig. 13 Connecting rod side clearance, checking**  
wear limit: 0.37 mm (0.014 in)



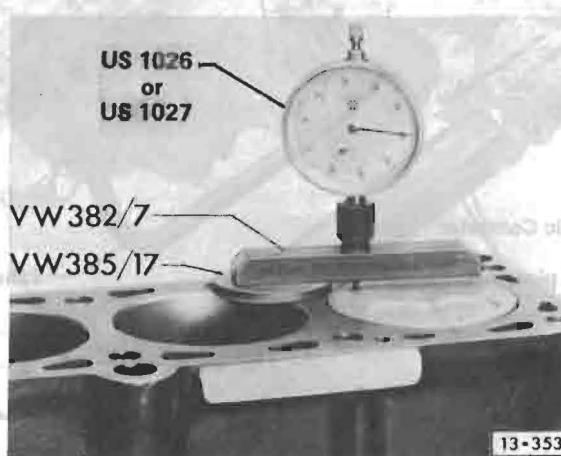
**Fig. 15 Cylinder head gasket, identification**

white arrow = identification notches  
black arrow = part number



**Fig. 14 Piston identification**

- pistons are marked with figure 5 next to installation direction
- arrow must point to drive belt side



**Fig. 16 Piston height, checking**

Piston height of **ALL** cylinders must be measured when installing new pistons or short block.

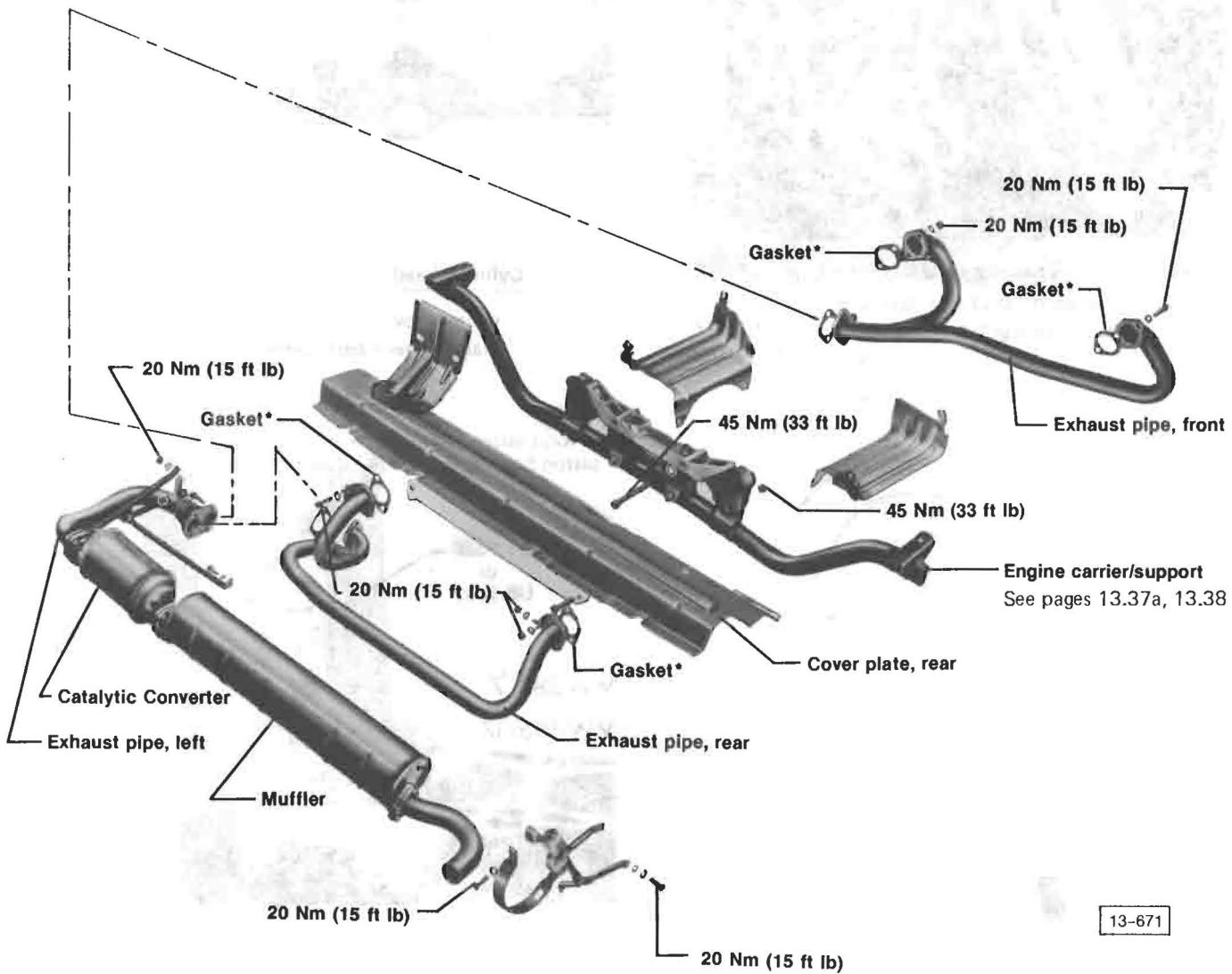
Head gasket is selected based on cylinder with **HIGHEST** piston height.

Thickness of gasket (mm/in.)	Piston height (mm/in.)	Identification notches in head gasket	Part No.
0.63-0.82 (0.025-0.032)	1.4 (0.055)	1	068 103 383 L
0.83-0.92 (0.033-0.036)	1.5 (0.059)	2	068 103 383 M
0.93-1.02 (0.037-0.040)	1.6 (0.063)	3	068 103 383 N

# 13 Engine-Crankshaft, Crankcase

## Note

Arrows on carrier must point to front of vehicle when reinstalling.  
Remove carrier as complete assembly



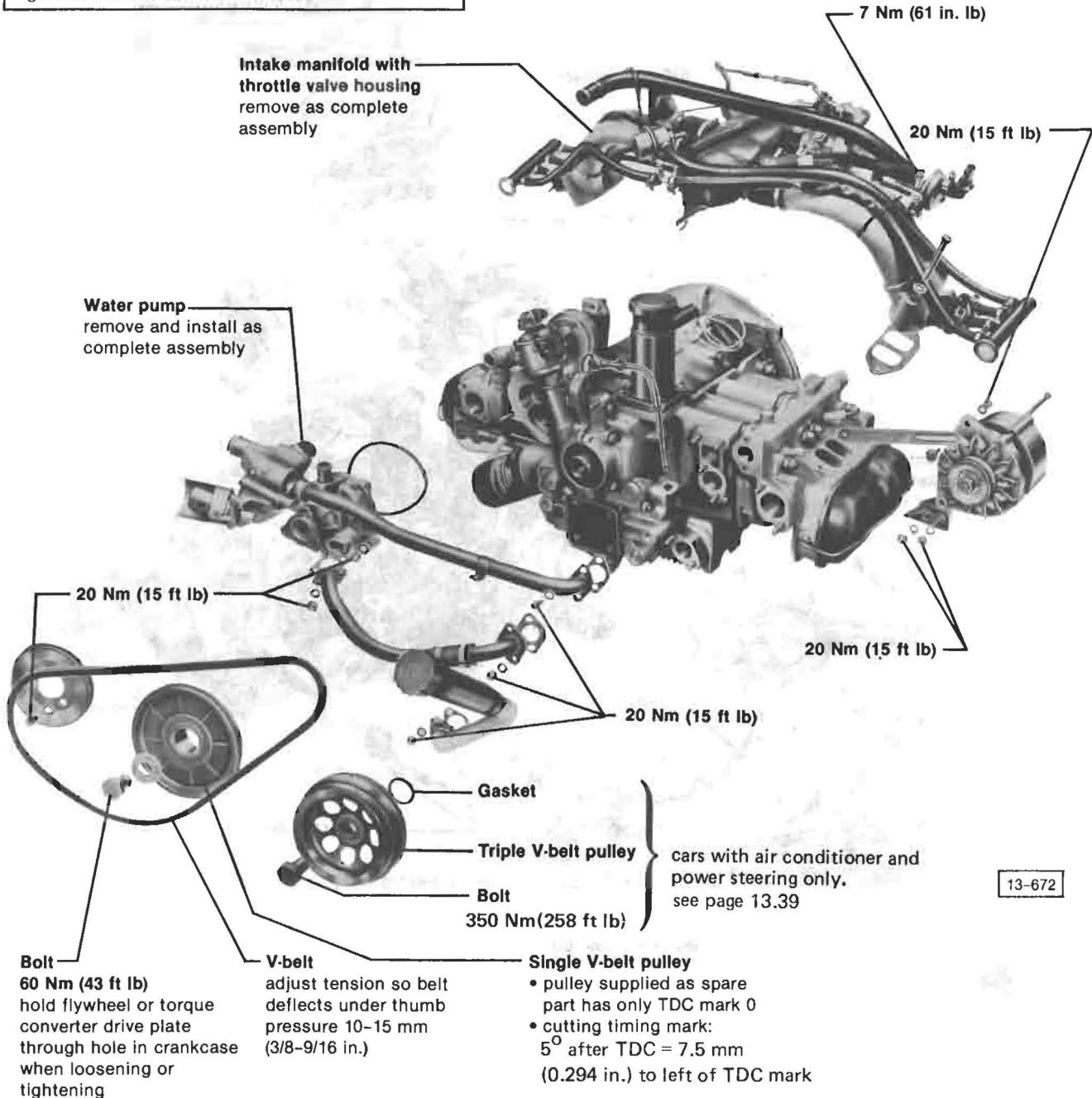
\*metal surface faces cyl. head

**Note**

Tighten all hoses with hose clamps

**CAUTION**

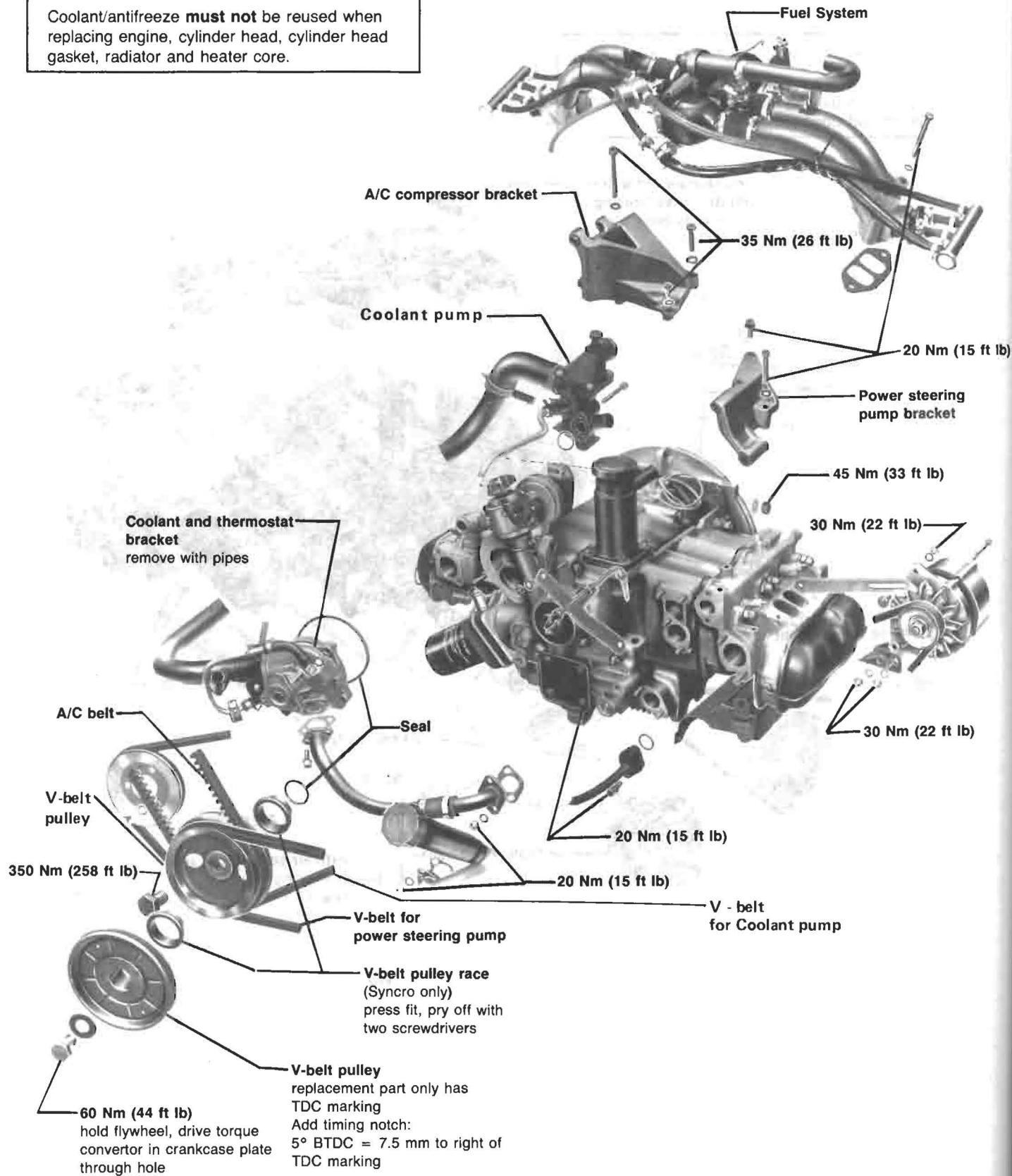
Coolant/antifreeze **must not** be reused when replacing engine, cylinder head, cylinder head gasket, radiator and heater core.



# 13 Engine - Crankshaft, Crankcase

## CAUTION

Coolant/antifreeze must not be reused when replacing engine, cylinder head, cylinder head gasket, radiator and heater core.



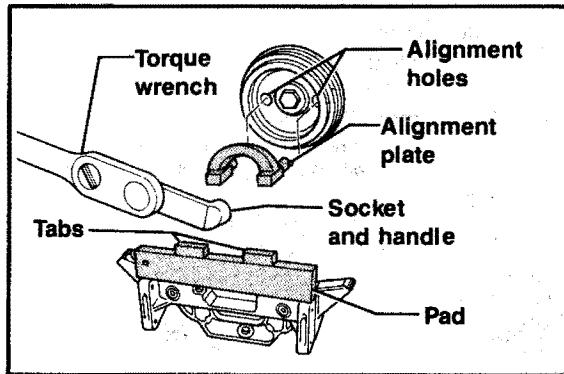
### Removal of three groove pulley

Retainer tool 3149 is required to hold crankshaft from rotating while removing/installing the three groove pulley.

It consists of three separate pieces:

- alignment plate
- pad
- socket and handle

#### Work sequence



- loosen power steering pump, if applicable, remove V-belt from crankshaft pulley
- loosen A/C compressor, if applicable, remove V-belt from crankshaft pulley
- loosen alternator, remove V-belt from crankshaft pulley
- unscrew coolant expansion tank, lay to one side
- remove expansion tank bracket
- remove retaining screws and bolts from exhaust heat shield
- reposition heat shield down and under its original position

#### Note

When tool 3149 is used, it will not be necessary to remove muffler.

- rotate pulley so both **alignment holes** are horizontal
- insert **alignment plate** into pulley
- place pad across engine mounts with tabs pointing upward
- attach socket and handle
- remove crankshaft pulley bolt and pulley
- installation of three groove pulley is in reverse order

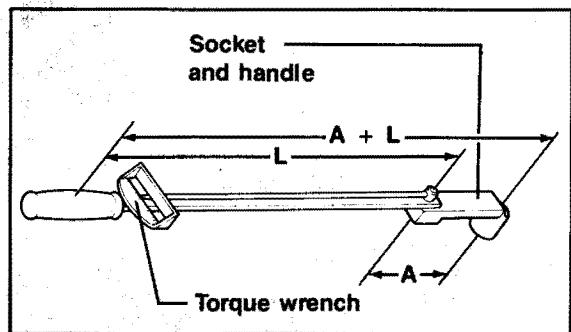
#### CAUTION

Tightening torque applies **only** when socket and handle is used in alignment with torque wrench.

**Correct torque wrench setting must be calculated to achieve 350 Nm (258 ft lb) at crankshaft pulley bolt.**

— torque crankshaft pulley bolt to 350 Nm (258 ft lb)

#### How to compute torque when using adapter



$$TA = \frac{TW \times (L + A)}{L} \text{ where:}$$

TA = Torque at end of adapter

TW = Torque wrench scale reading

L = Lever length of torque wrench

A = Lever length of adapter

Example:

TA = Unknown

TW = 100 lb.-ft.

L = 15 inches

A = 7.5 inches

Now use the formula as follows:

$$TA = \frac{TW \times (L + A)}{L}$$

$$TA = \frac{100 \times (15 + 7.5)}{15}$$

$$TA = \frac{100 \times (22.5)}{15}$$

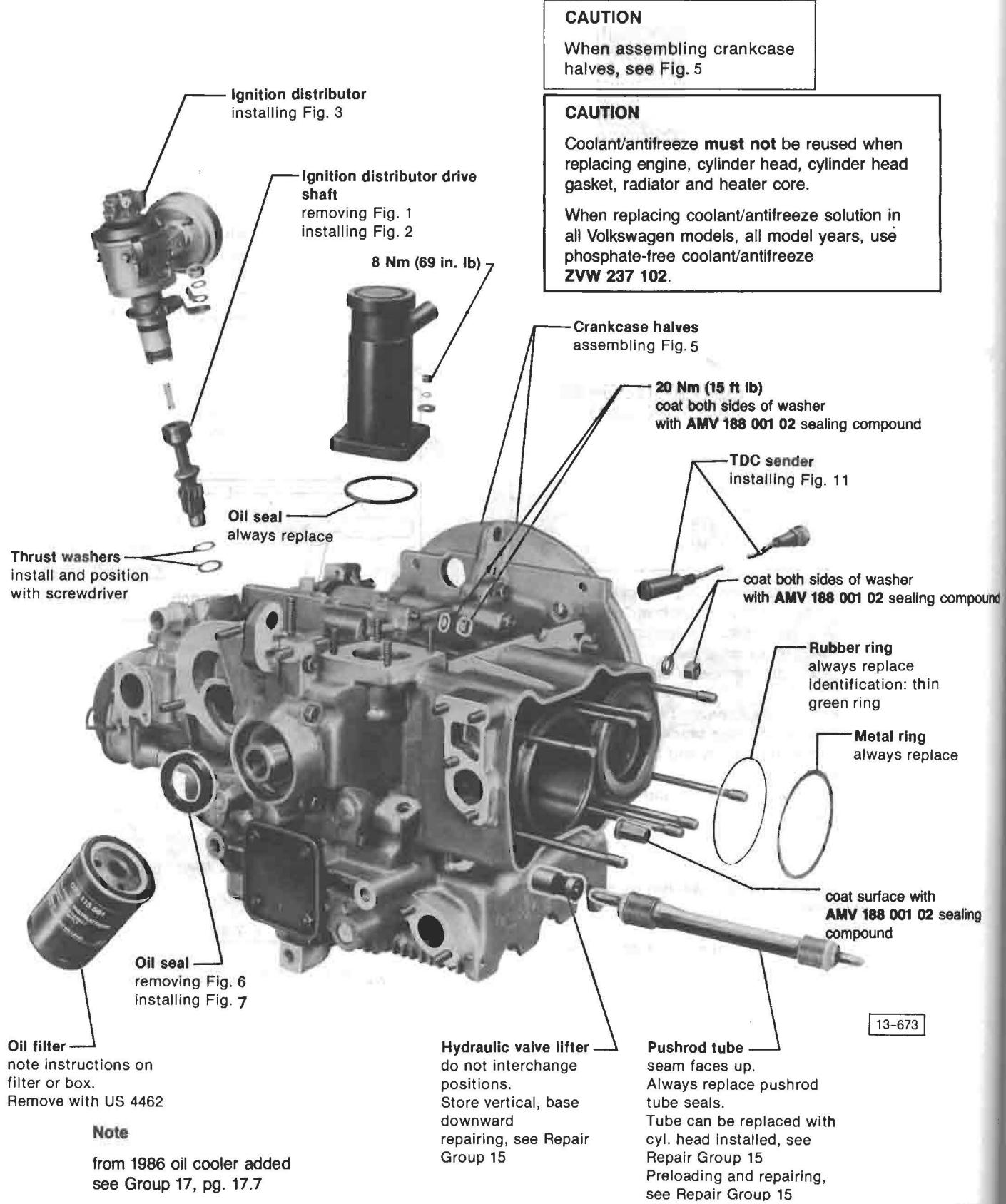
$$TA = \frac{2250.0}{15}$$

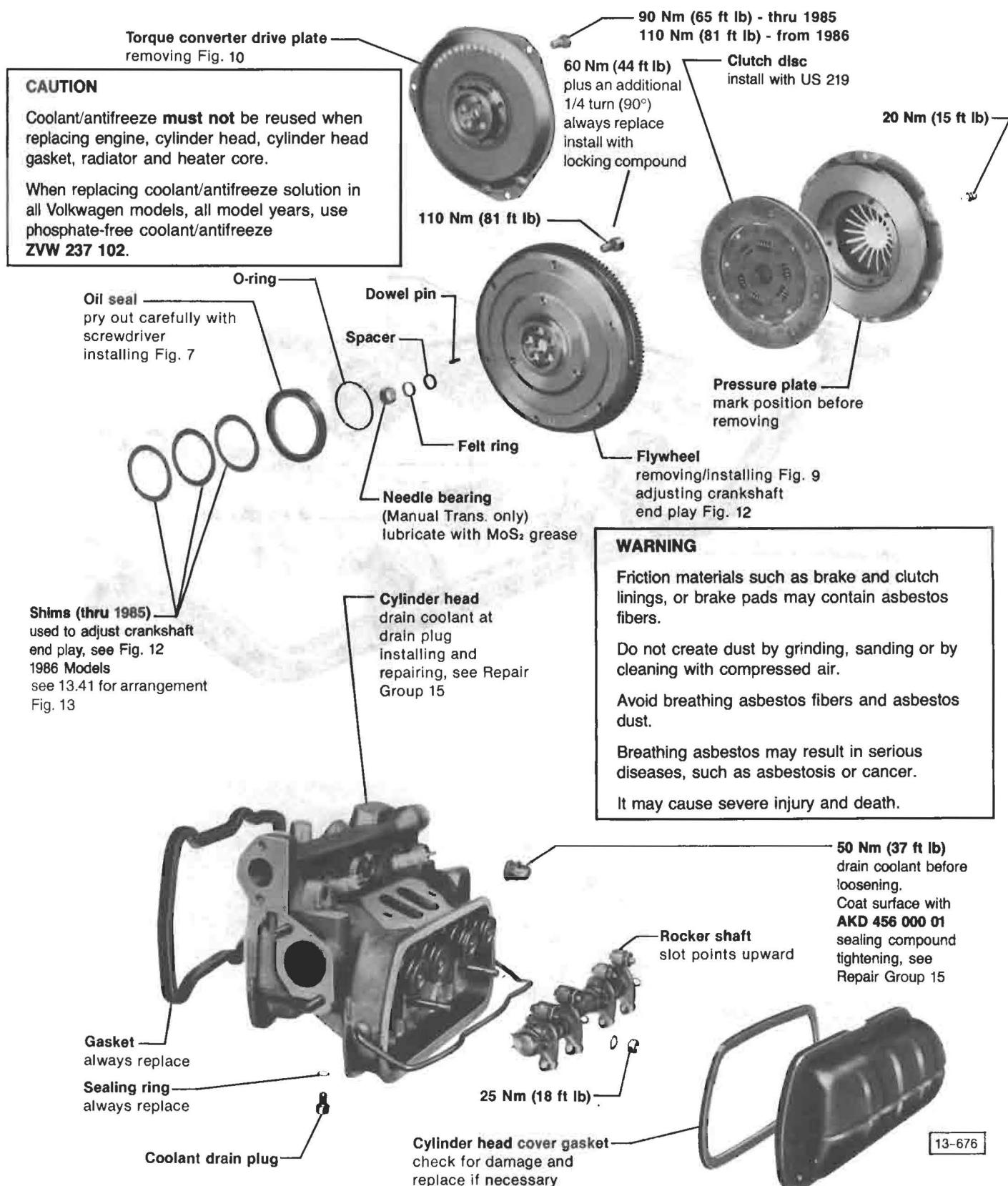
$$TA = 150 \text{ ft-lb.}$$

- adjust all belts to specification

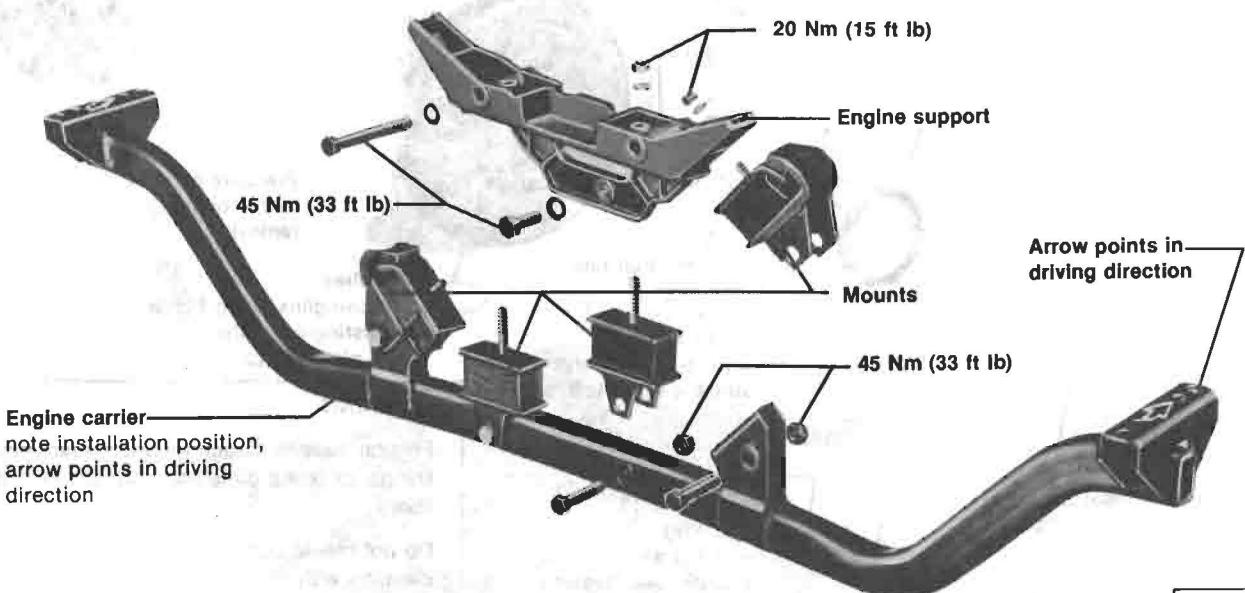
- top off coolant level in expansion tank

# 13 Engine—Crankshaft, Crankcase





# 13 Engine-Crankshaft, Crankcase

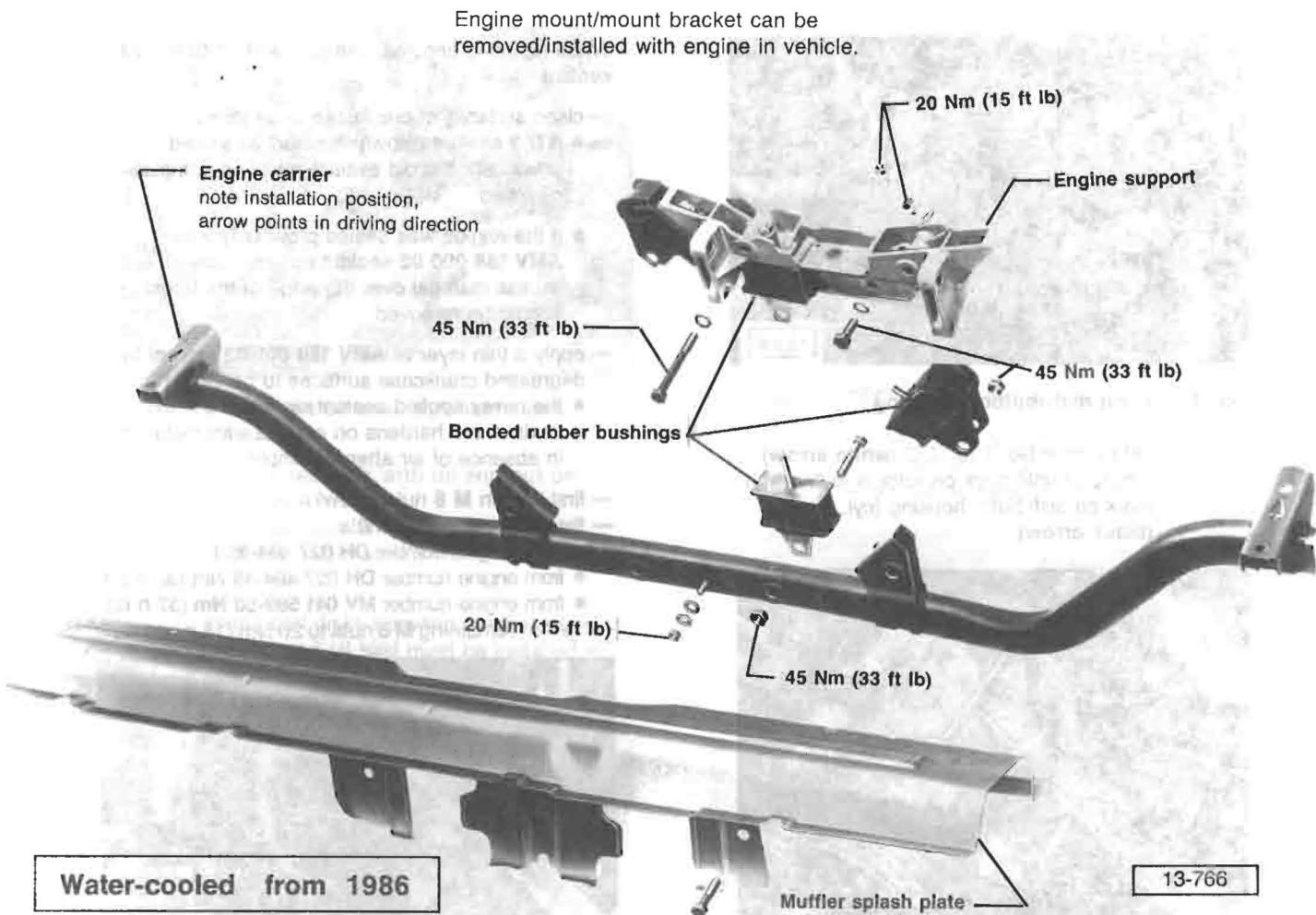


**13.37a**

Engine, carrier/support  
Engine, disassembling/assembling

Water-cooled

1983-1985



### Engine, disassembling/assembling — All-water-cooled

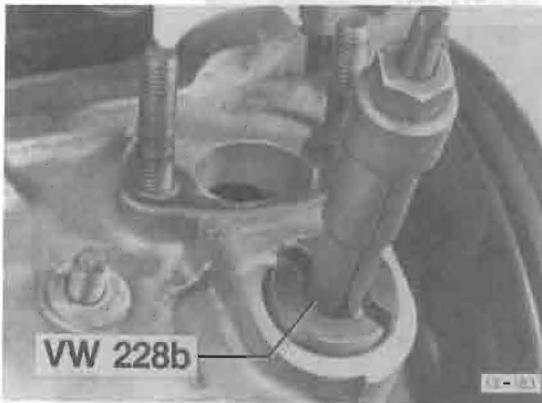


Fig. 1 Ignition distributor drive shaft, removing

— use puller as shown

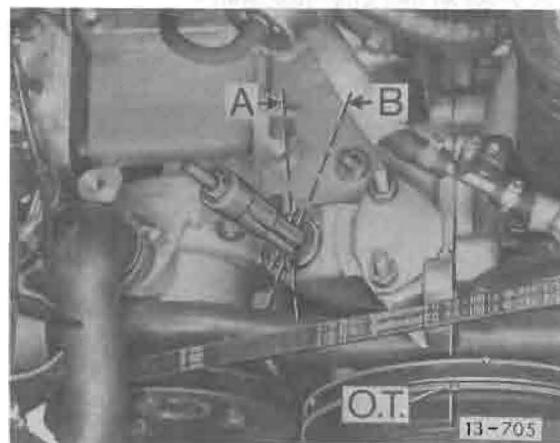


Fig. 2 Ignition distributor drive shaft, installing

- set crankshaft to TDC on cyl. No. 1
- install drive shaft so that offset slot faces bolt (arrow)
- small segment faces water pump
- A = inserted position
- B = installed position

Water-cooled

Engine, carrier/support  
Engine, disassembling/assembling

13.38

# 13 Engine-Crankshaft, Crankcase

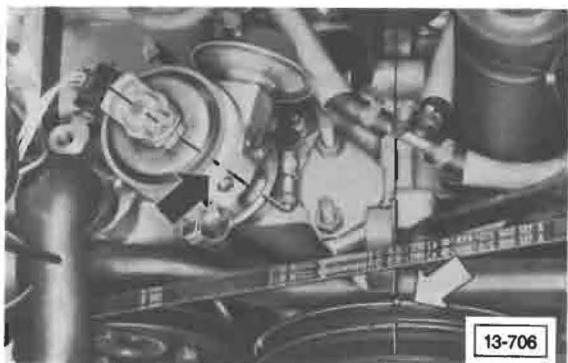


Fig. 3 Ignition distributor, installing

- set cylinder No. 1 to TDC (**white arrow**)
- turn rotor until mark on rotor is in line with mark on distributor housing (cyl. No. 1) (**black arrow**)



Fig. 4 A/C compressor V-belt, tightening (if applicable)

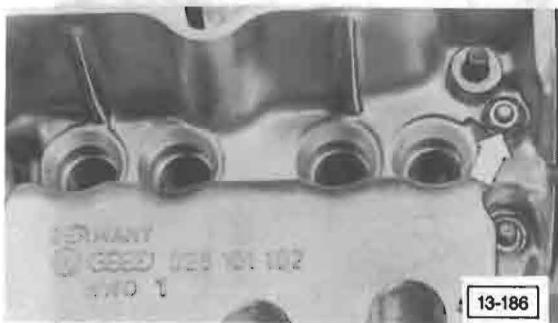


Fig. 5 Crankcase halves, assembling

## Note

AMV 188 001 02 sealant is now being used when assembling crankcase halves.

When repairing engines, use only **AMV 188 001 02** sealant.

- clean surfaces of crankcase to be joined
  - if **D 3** sealant (brownish color) was used previously, the old sealant **must** be completely removed
  - if the engine was sealed previously with **AMV 188 000 02** sealant (green colored), only excess material over the edge of the housing should be removed
- apply a thin layer of **AMV 188 001 02** sealant to degreased crankcase surfaces to be joined
  - the newly applied sealant dissolves the old sealant and hardens on contact with metal and in absence of air after assembly
- first tighten **M 8** nut (**arrow**)
- then tighten all **M 10** nuts
  - up to engine number **DH 027 404-35 Nm (26 ft lb)**
  - from engine number **DH 027 404-45 Nm (33 ft lb)**
  - from engine number **MV 041 599-50 Nm (37 ft lb)**
- tighten remaining **M 8** nuts to **20 Nm (15 ft lb)**



Fig. 6 Crankshaft oil seal, removing

- pry out

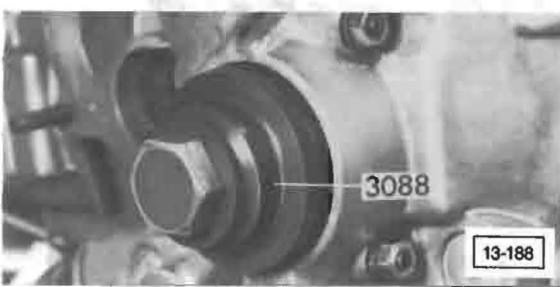


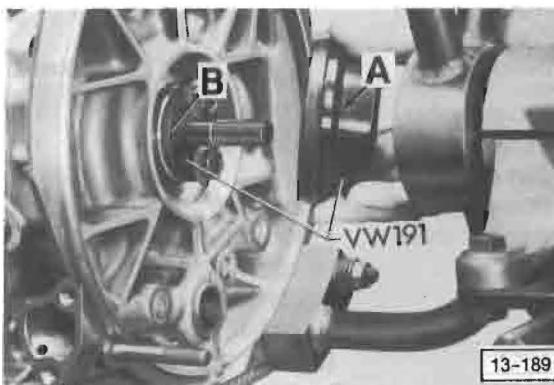
Fig. 7 Crankshaft oil seals, installing

## Single pulley

- coat seal lips with oil and install seal with **3088** and pulley bolt without washer (**3162** in Syncro)
- then tighten bolt **with washer** until stop

## Triple pulley

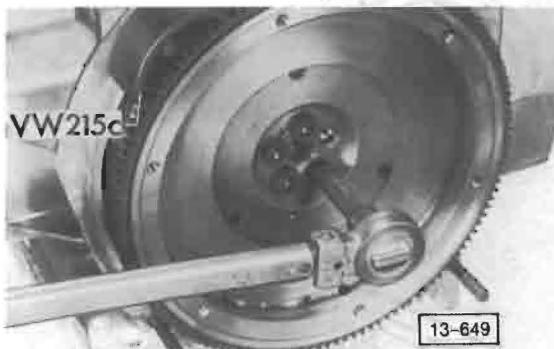
- coat seal lips with oil and install with **3088** and pulley bolt **without washer** and tighten bolt until stop



**Fig. 8 Crankshaft oil seal (flywheel side), installing**

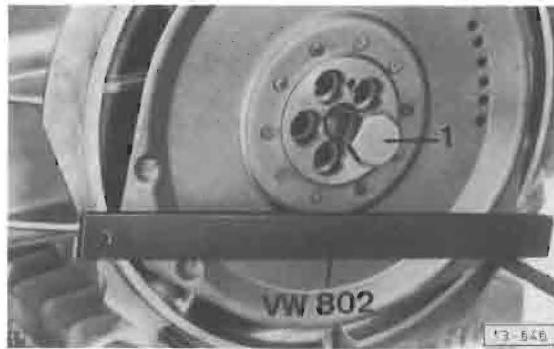
- coat seal lips with oil and put on guide **A**
- screw base **B** into crankshaft and press in guide **A** with seal until seated

shims and disks between crankshaft bearing and oil seal must be installed in correct order. See Fig. 13.



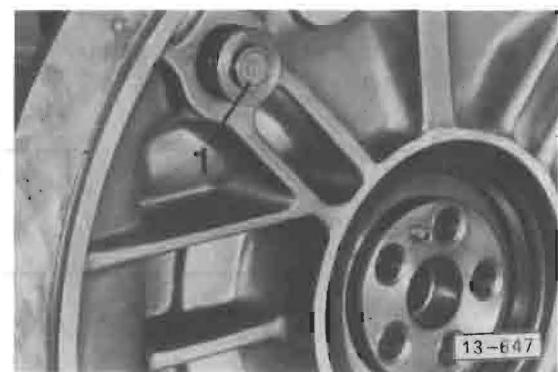
**Fig. 9 Flywheel, removing**

- lock flywheel with tool



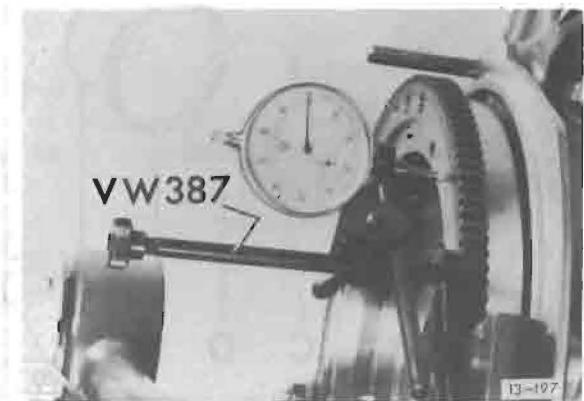
**Fig. 10 Torque converter drive plate, removing**

- lock plate with VW 802
- to remove, screw in bolt **1**  
(M 18 x 1.5 x 60). Thread length of bolt  
must be at least 45 mm (1.77 in.)



**Fig. 11 TDC sender, installing**

- use piston pin and plastic hammer to drive TDC sender in until stop
- do not damage inner ring 1



**Fig. 12 Crankshaft end play, checking/adjusting**

- check crankshaft end play
  - new: 0.07–0.13 mm (0.003–0.005 in.)
  - wear limit: 0.15 mm (0.006 in.)
- if out of specification proceed as follows:
- install flywheel with 2 shims but **without O-ring** and crankshaft oil seal
- mount dial Indicator with bracket on crankcase
- move crankshaft in and out and measure movement (crankshaft end play)
- determine thickness of 3rd shim

#### Example

dial indicator reading 0.44 mm (0.017 in.)  
specified end play – 0.10 mm (0.004 in.)  
thickness of 3rd shim 0.34 mm (0.013 in.)

Shims C on vehicles from 1986, see Fig. 13

go to next page

# 13 Engine - Crankshaft, Crankcase

## Note

Thickness of shim is etched on shim. Always recheck with micrometer

## CAUTION

Always install three shims to obtain correct crankshaft end play.

- remove flywheel
- install O-ring, crankshaft oil seal and felt ring
- install all three shims
  
- install flywheel
- tighten bolts to 60 Nm (44 ft lb) plus an add'l 1/4 turn (90°)
- recheck crankshaft end play

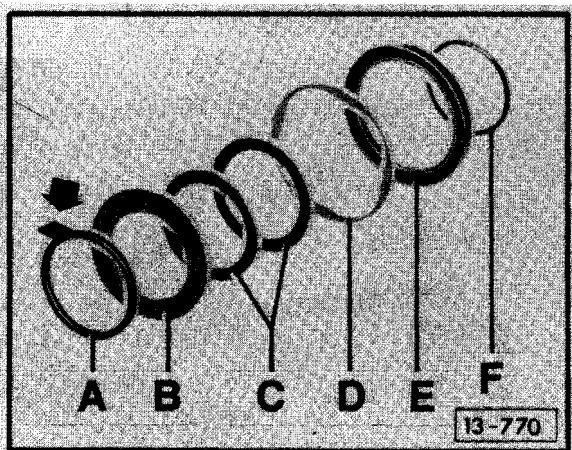


Fig. 13 Shim arrangement (from 1986)

- A = Thrust washer
  - lip points toward crankshaft bearing
- B = 0.81 mm shim
- C = 0.75 mm shims
- D = 0.94 mm
- E = Oil seal
  - pry out with screwdriver
- F = O-ring
  - always replace

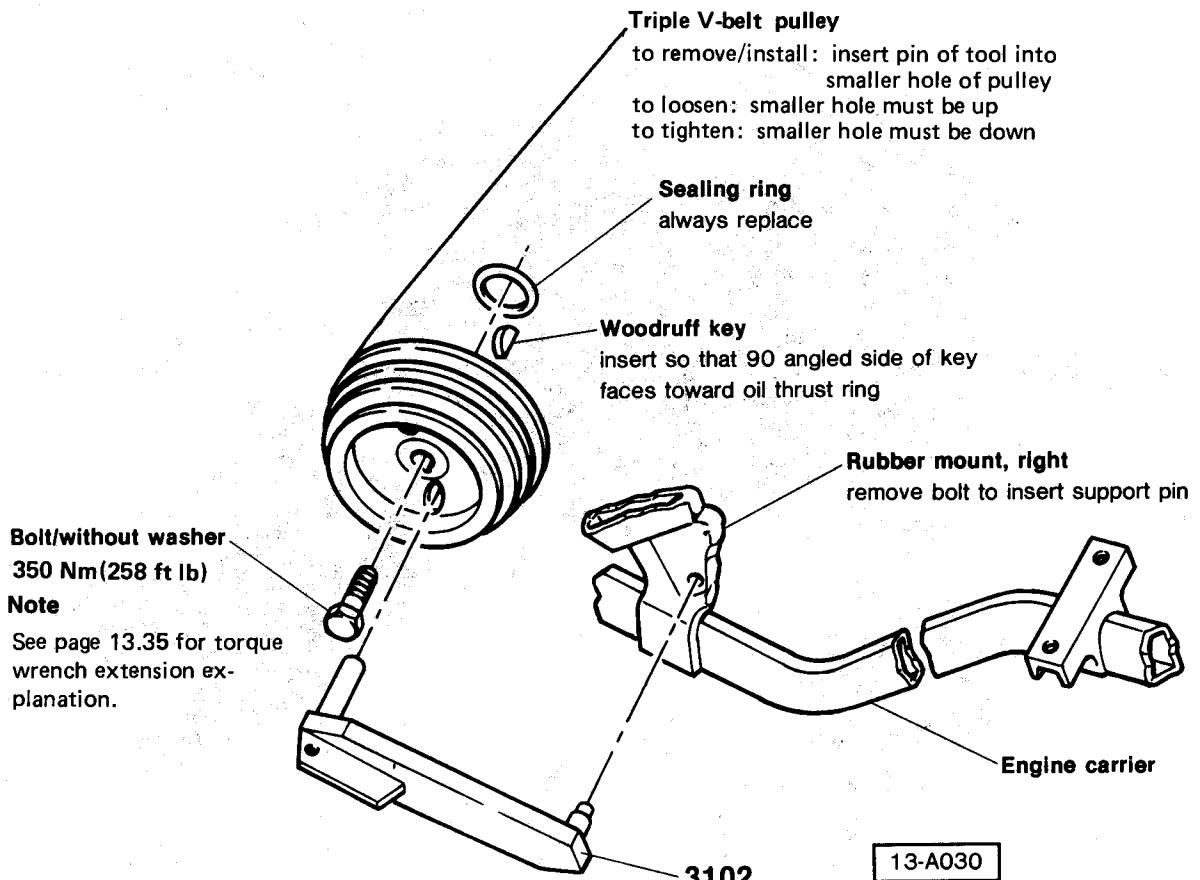
Apply light film of oil on **both** sides of thrust washer A.

Install with lip (arrow) pointing **toward** crankshaft bearing

- press shim B to A
- install flywheel **without** O-rings, E, F
- mount dial indicator with bracket on crankcase
- Proceed to determine thickness of shim C (see fig. 12)
- remove flywheel
- install shims C, D, and oil seal E
- install flywheel with F
- tighten bolts to 60 Nm (44 ft lb) plus an add'l 1/4 turn (90°)
- recheck crankshaft end play

## Parts required

Description	Part no.	Quantity
Thrust washer	025 105 283	1
81.0mm (3.2 in.) diameter shim	025 105 281	1
75.0mm (3.0 in.) diameter shims (0.30mm thickness)	021 105 281 021 105 283	2
	(0.32mm thickness) 021 105 285	
	(0.34mm thickness) 021 105 287	
	(0.36mm thickness) 021 105 289	
	(0.38mm thickness) 021 105 291	
	(0.24mm thickness) 025 105 635	
94.0mm (3.7 in.) diameter shim	025 105 635	1
Oil seal	029 105 245 B	1
O-ring	021 105 279	1

**Note**

Triple V-belt pulleys supplied as spare parts have only TDC mark 0. Cut timing mark same as single V-belt pulley, see page 13.33

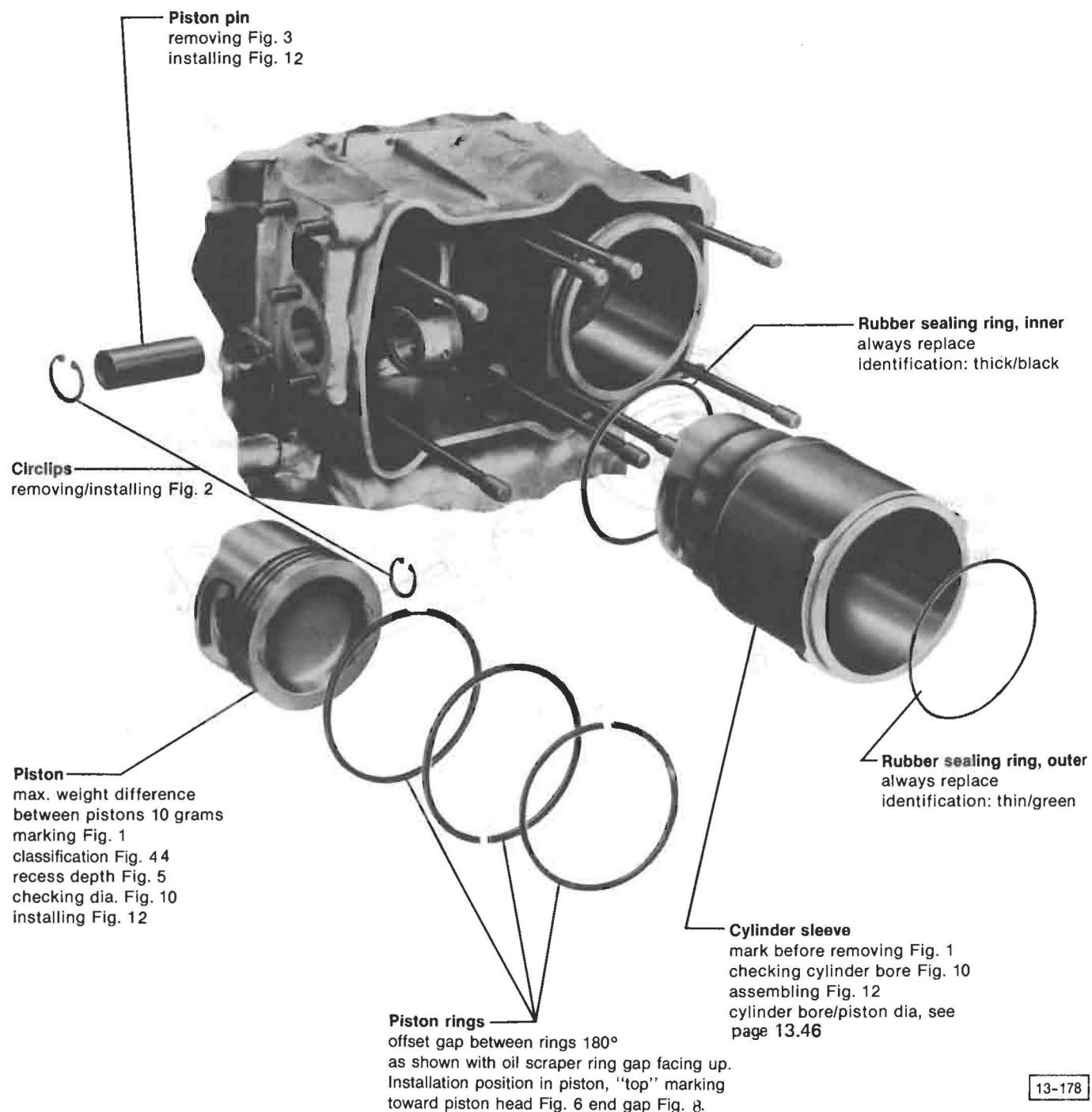
# 13 Engine-Crankshaft, Crankcase

## Note

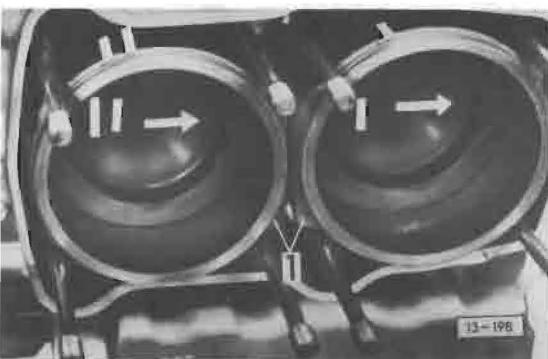
Remove deposits (scale) from cylinders/crankcase and cylinder head

## Note

Before proceeding with repairs, verify availability of all tools.



13-178



**Fig. 1 Piston/cylinder sleeve, marking**

- arrow points to flywheel
- before removing, mark matching numbers on pistons and cylinder sleeves
- cylinder boss 1 faces inward



**Fig. 2 Circlips, removing/installing on V-belt side:**

- with piston at TDC, pull out cylinder sleeve with 3092 until piston pin circlip visible (arrow)
- at flywheel end:**
- with first cylinder sleeve removed



**Fig. 3 Piston pins, removing**

- remove pins as shown (arrow)

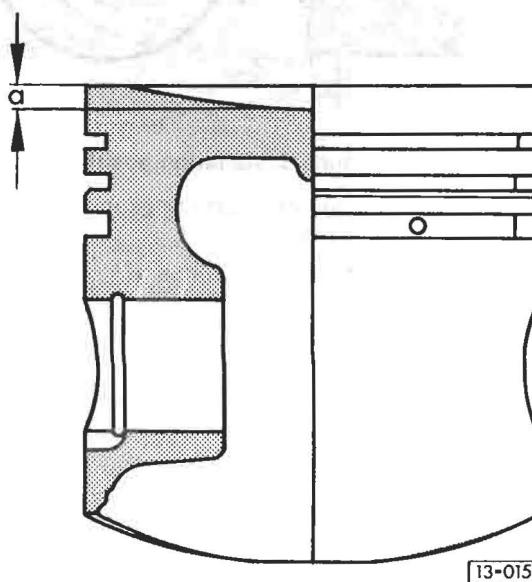
**Note**

If piston pin cannot be pulled out of piston, remove 3091 and remove burr in piston pin bore with reamer 3153.



**Fig. 4 Piston classifications**

- A** = arrow (stamped on) must point toward flywheel when piston is installed
- B** = paint dot (blue) indicates matching size
- C** = weight group (+ or -) stamped on
  - weight = 448–456 grams
  - + weight = 457–464 grams
- D** = piston size in millimeters (see table on page 13.46)



**Fig. 5 Piston recess depth**

- measurement **a** = 11.65 mm (0.458 in.)

# 13 Engine-Crankshaft, Crankcase

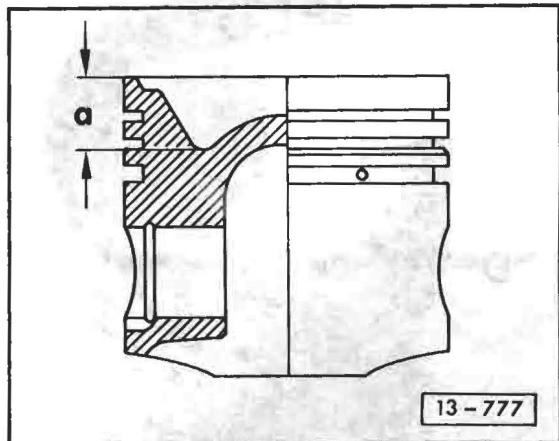


Fig. 6 Piston distinguishing characteristics  
- 2.1 L Digifant/Syncro only

engine code	dimension 'a'
MV	15.5 mm

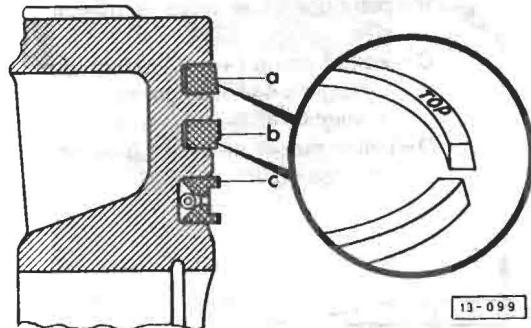


Fig. 7 Piston rings, installation position

- TOP mark on piston rings must face to top of piston
- a = upper ring
- b = lower ring
- c = oil scraper ring



Fig. 8 Piston ring end gap, checking

- push ring in squarely from lower cylinder opening about 4-5 mm (3/16 in.)
- measure gap with feeler gauge

ring end gap	wear limit
upper ring = 0.30-0.45 mm (0.012-0.018 in.)	0.90 mm (0.035 in.)
lower ring = 0.30-0.50 mm (0.012-0.020 in.)	0.90 mm (0.035 in.)
oil scraper = 0.25-0.40 mm ring	0.95 mm (0.037 in.)

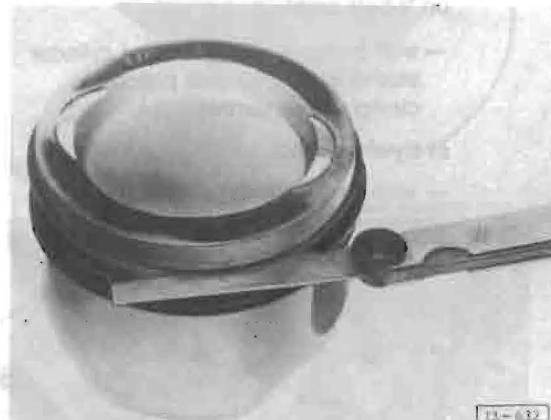
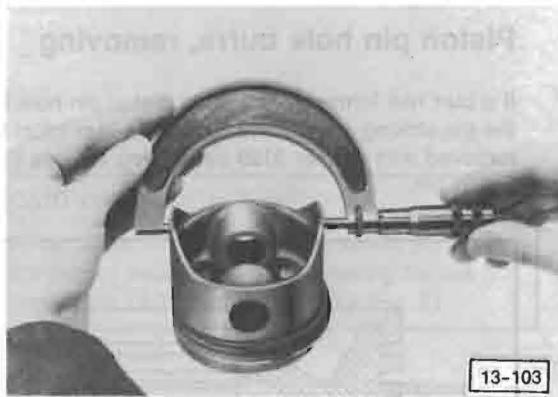


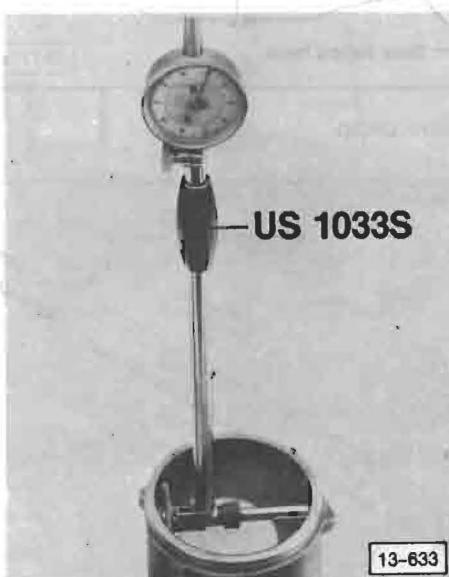
Fig. 9 Piston ring side clearance, checking

clearance	wear limit
upper ring = 0.05-0.08 mm (0.002-0.003 in.)	0.12 mm (0.005 in.)
lower ring = 0.04-0.07 mm (0.002-0.003 in.)	0.10 mm (0.004 in.)
oil scraper = 0.02-0.05 mm ring	0.10 mm (0.004 in.)



**Fig. 10 Piston, checking diameter/wear**

- measure at bottom of skirt approx.  
15 mm (9/16 in.) from edge  
(diameter stamped in top of piston)

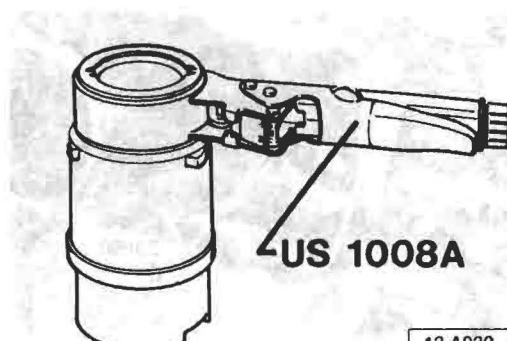


**Fig. 11 Cylinder sleeve, checking for wear**

- measure 10-16 mm (3/8-5/8 in.) from top  
• piston to sleeve clearance is sleeve  
diameter minus piston diameter  
**new** = 0.03-0.06 mm (0.001-0.002 in.)  
**wear limit** = 0.2 mm (0.008 in.)

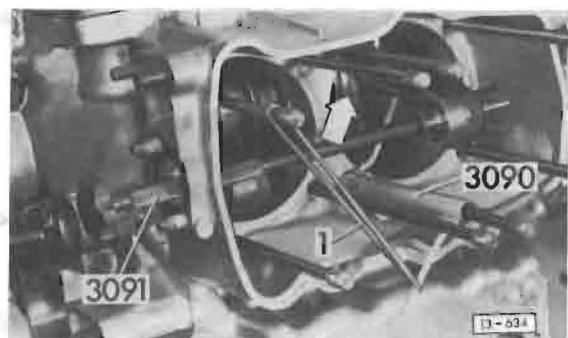
#### Cylinder sleeve bore/Piston diameter

size	color	cylinder diameter	matching piston diameter
standard	blue	94.005-94.016 mm	93.98 mm
1st oversize	pink	94.016-94.027 mm	93.99



**Fig. 12 Piston and cylinder sleeve, installing**

- replace rubber sealing rings for cylinder sleeves:
  - cylinder head end = thin ring (green)
  - crankcase end = thick ring (black)
- install piston into cylinder sleeve  
(flywheel side first)
  - arrow on piston points toward flywheel
  - gap of oil scraper ring must be to top
  - piston ring gaps offset by 180° (see explosion view)
- insert circlip for piston pin on flywheel side of piston



**Fig. 13 Piston and cylinder sleeve, installing**

- note markings on connecting rod support 3090
  - R = right side of engine
  - L = left side of engine
- push connecting rod support onto center stud so finger of tool supports connecting rod; then secure it with rubber band 1 to prevent it from slipping
- align connecting rod such that piston pin can be installed through hole in housing
  - crankshaft must be at TDC
  - lug on rod faces up

# 13 Engine – Crankshaft, Crankcase

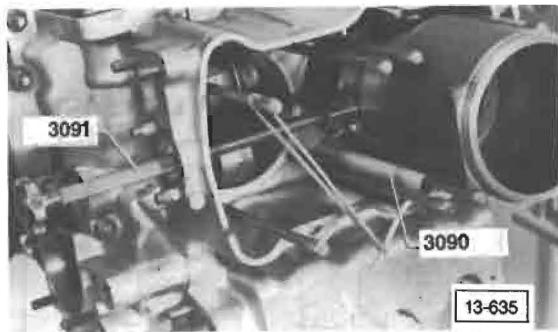
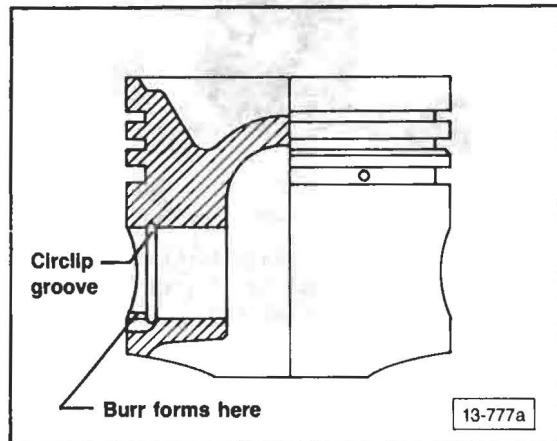


Fig. 14 Piston and cylinder sleeve, Installing

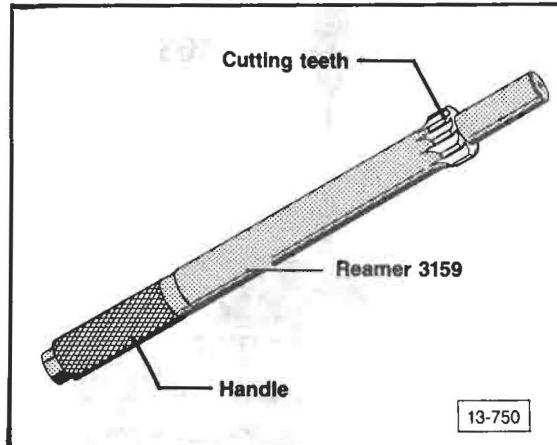
- install piston pin with 3091 and insert circlip

## Piston pin hole burrs, removing

If a burr has formed in the outer piston pin hole from the pin striking against the circlip, the burr must be removed with reamer 3159 before you remove the piston pin.



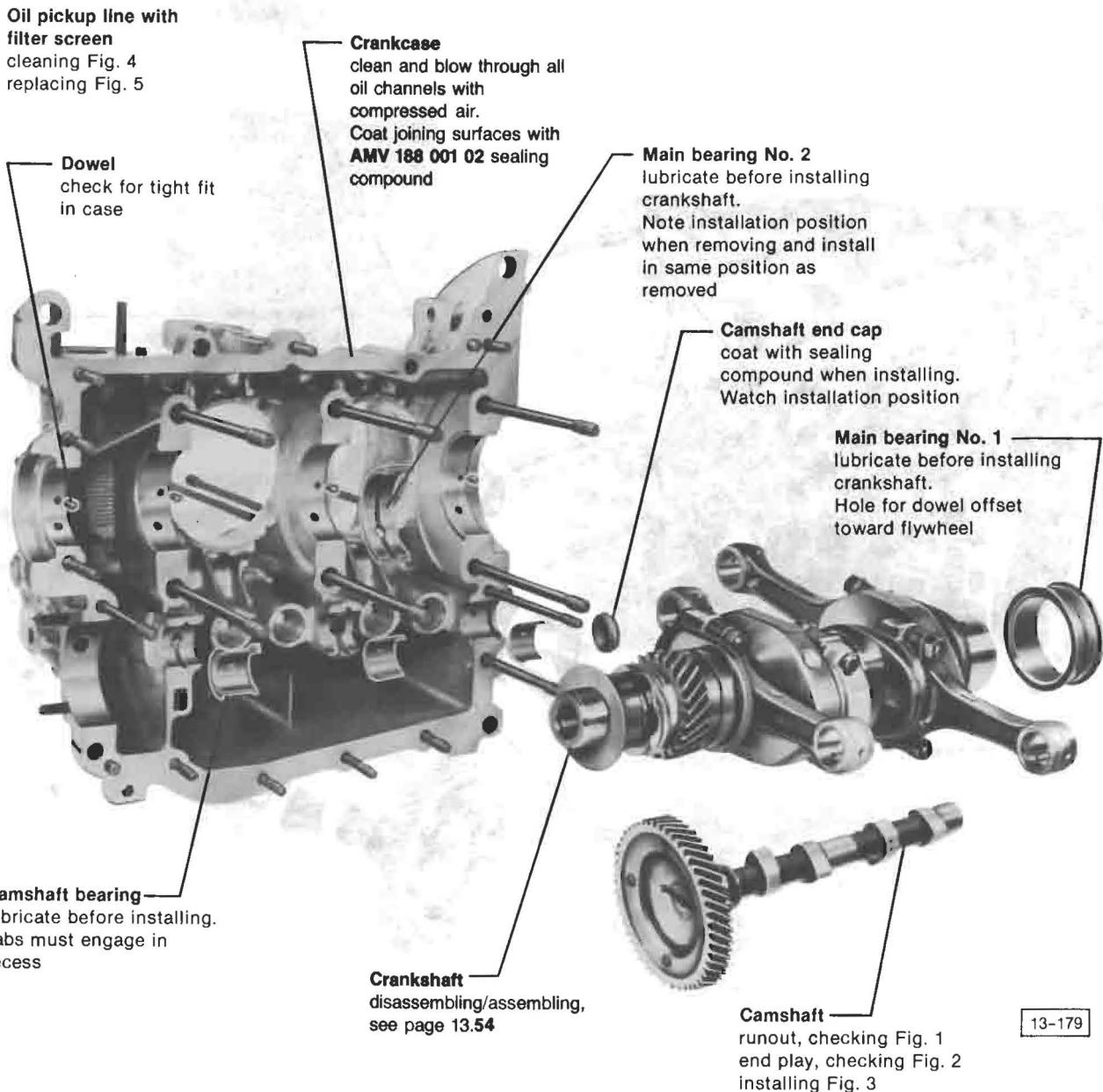
- remove circlip



- insert reamer 3159 into piston pin hole
- remove burr with reamer
- remove piston pin with tool 3091

**CAUTION**

When assembling crankcase halves, observe tightening sequence and tightening torque (see page 13.36 and page 13.39, Fig. 5)



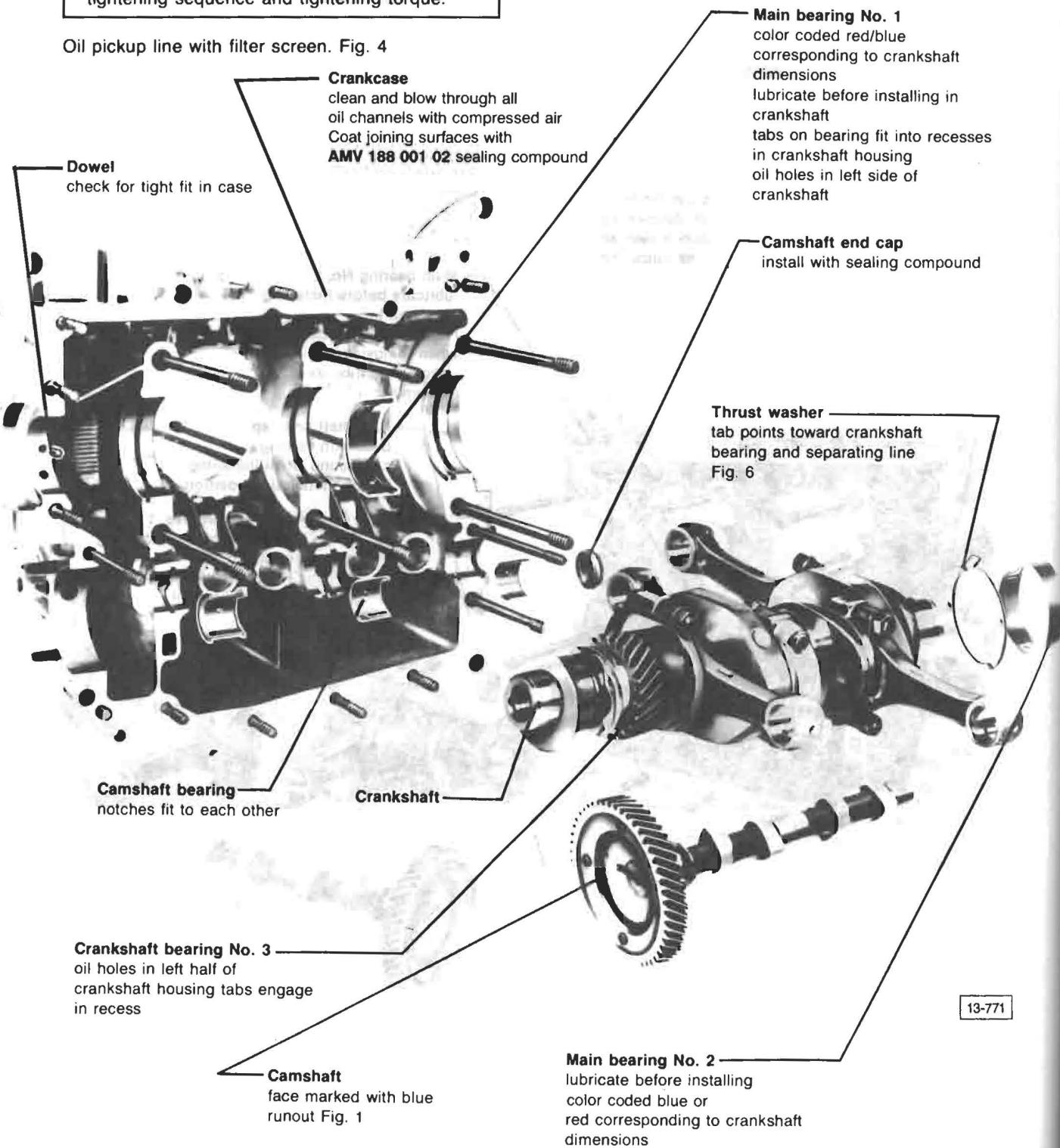
13-179

# 13 Engine – Crankshaft, Crankcase

## CAUTION

When assembling crankcase halves, observe tightening sequence and tightening torque.

Oil pickup line with filter screen. Fig. 4



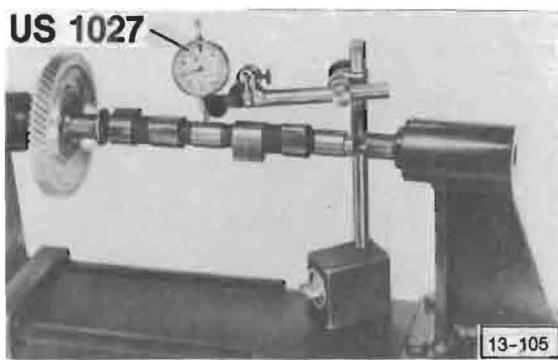
13-771

**13.49**

Crankcase  
Crankshaft  
Camshaft

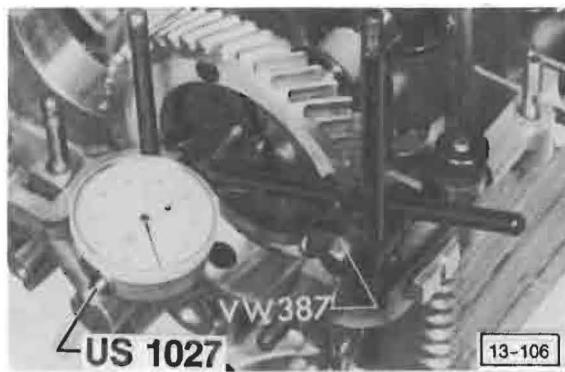
Water-cooled from 1986

E-1



**Fig. 1 Camshaft runout, checking**

- wear limit 0.04 mm (0.0015 in.)



**Fig. 2 Camshaft end play, checking**

- wear limit 0.16 mm (0.006 in.)
- if out of specification, replace camshaft bearings



**Fig. 3 Camshaft, installing**

- mark on camshaft gear tooth must be between marks on crankshaft gear teeth (arrow)
- check backlash of timing gears
  - 0.0–0.05 mm (0–0.002 in.)
  - backlash must be hardly noticeable

- turn crankshaft backward
- camshaft must not lift out of bearings
- if camshaft lifts out of bearings, install camshaft with smaller timing gear

#### Note

To obtain specified backlash, camshafts with various size timing gears are available. Markings are on **inner** face of timing gear

#### Example

"-0.1", "+0.1", "+0.2", indicates in 1/100 mm how much pitch radius differs from standard pitch radius "0"

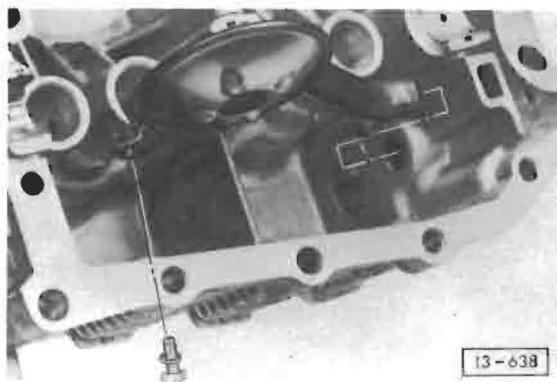
#### CAUTION

Mark 0 on **outer** face of camshaft timing gear is timing mark and must not be confused with markings on **inner** face. Crankshaft timing gear is available in one size only



**Fig. 4 Oil pickup line with filter screen, cleaning**

- clean oil channels by blowing through with compressed air (arrow)



**Fig. 5 Oil suction line with filter screen, replacing**

# 13 Engine-Crankshaft, Crankcase

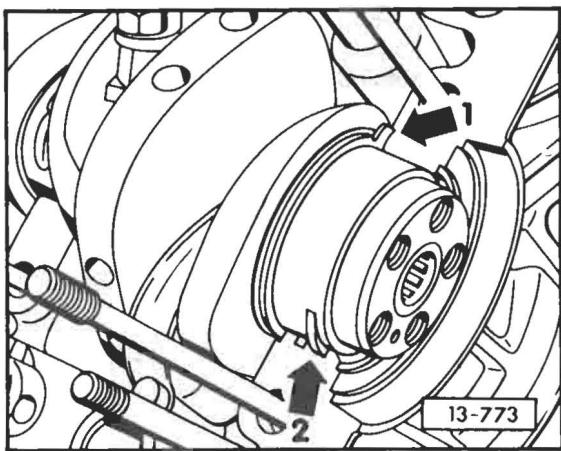
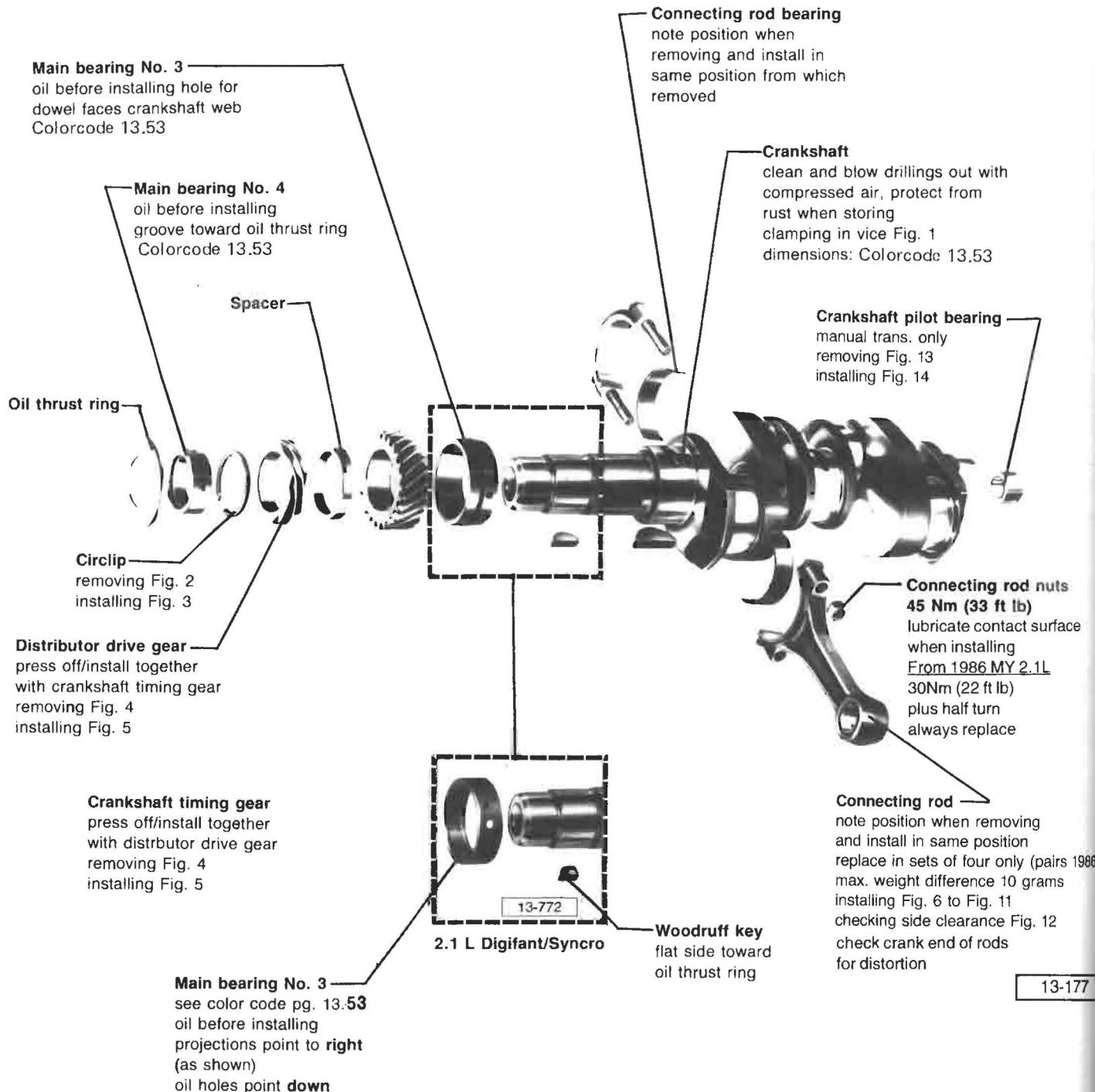


Fig. 6 Thrust washer and main bearing 1,  
installing

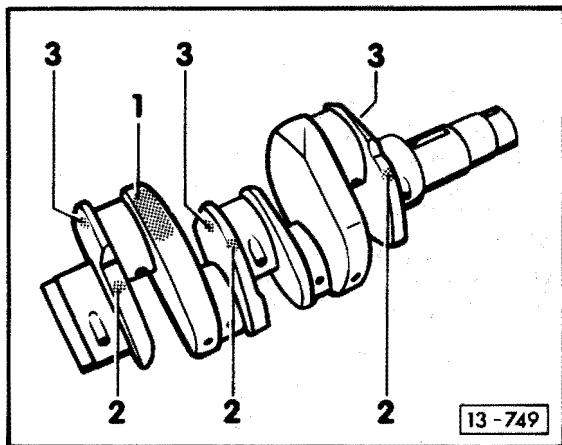
**Arrow 1:** projection on thrust washer points toward  
main bearing and separating line of  
crankcase.

**Arrow 2:** projection on main bearing fit into  
notches in crankcase. Oil holes are in left  
half of crankcase housing.

# 13 Engine - Crankshaft, Crankcase



13-177

**Crankshaft color code**

- 1 = Color code **green** (2.1 L engine-Digifant/Syncro)  
 2 = Color code **blue or red** (crankshaft code/size)

**Note**

On some crankshafts the blue or red code can appear in position three.

**Crankshaft journal sizes (mm)**

	Bearing No. 1	Bearing No. 2	Bearing No. 3	Bearing No. 4	Connecting rod
Standard size (thru 1985)	59.980-59.990 (marked: blue dot)	54.971-54.990	54.980-54.990 (marked: blue dot)		
2.1 L Digifant, Syncro	59.971-59.979 (marked: red dot)	54.980-54.990 (marked: blue dot) 54.971-54.979 (marked: red dot)	54.971-54.979 (marked: red dot)	39.984-40.00	54.983-54.996

**Note**

If crankshaft has blue or red dot **only** main bearings with same color code can be used.

Code for main bearings, 1, 2, 3 = 001 (blue), 004 (red)

# 13 Engine-Crankshaft, Crankcase

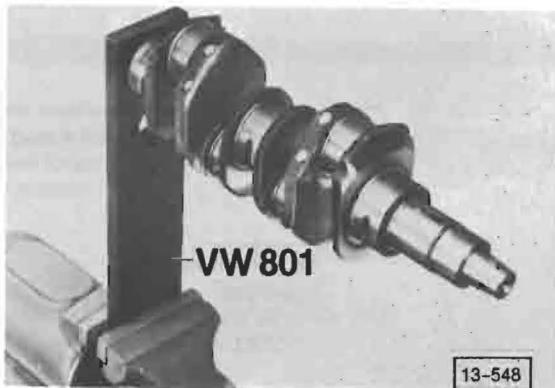


Fig. 1 Crankshaft, clamping in vise



Fig. 2 Circlip, removing



Fig. 3 Circlip, installing



Fig. 4 Distributor drive gear/crankshaft timing gear, removing

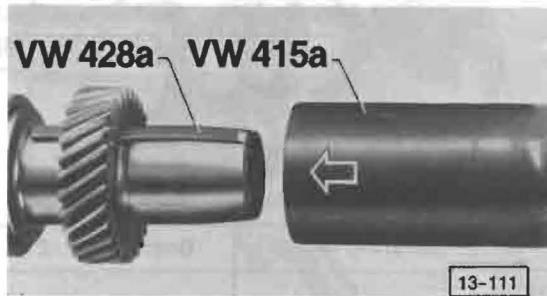


Fig. 5 Distributor drive gear/crankshaft timing gear, installing

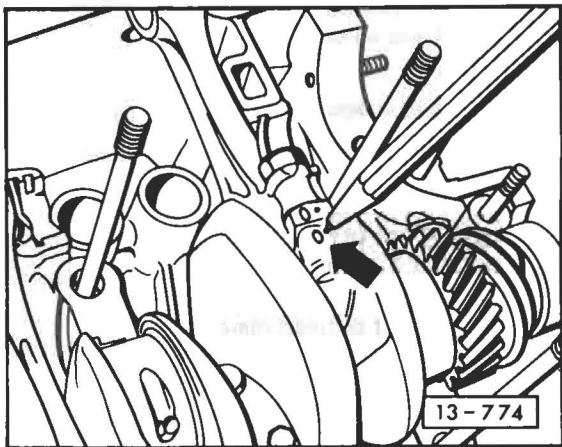
— heat gears to approx. 80 °C (175 °F) before installing



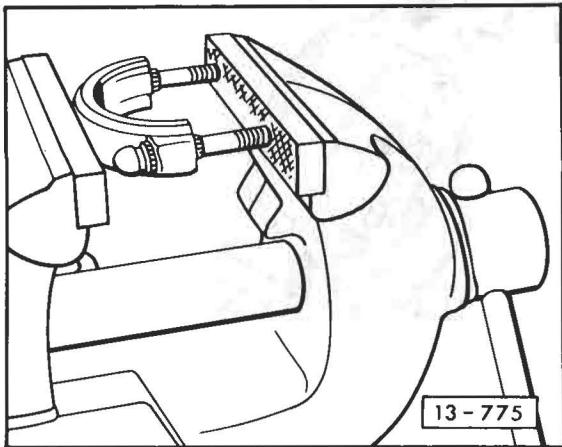
Fig. 6 Connecting rod, installing

— numbers (arrow) on rod and cap must match and be on same side

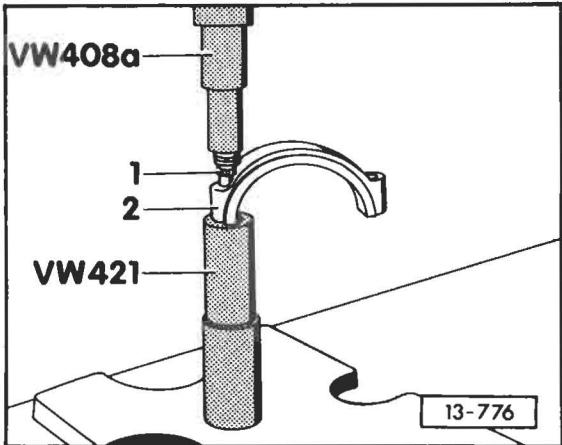
**Connecting rod bolts, removal/installing  
2.1L Digitant/Syncro**



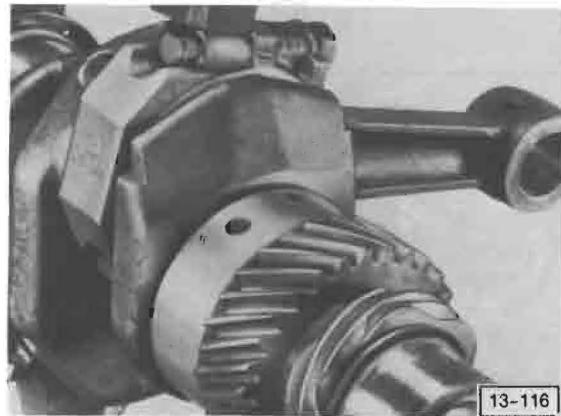
**Fig. 7** Mark matching connecting rod/bearing cover with cylinder



**Fig. 8** Connecting rod bolts, removing

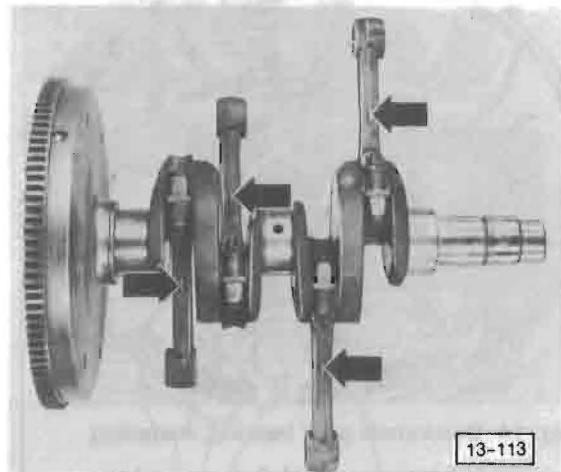


**Fig. 9** Connecting rod bolts, installing



**Fig. 10** Connecting rod, installing

- lightly tap both sides of connecting rod with hammer to eliminate slight pinching of bearing shells when installing connecting rod



**Fig. 11** Connecting rods, installation position

- forged mark on rods (arrows) must face up when rods are installed



**Fig. 12** Connecting rod, checking side clearance

- wear limit 0.7 mm (0.028 in.)

# 13 Engine-Crankshaft, Crankcase

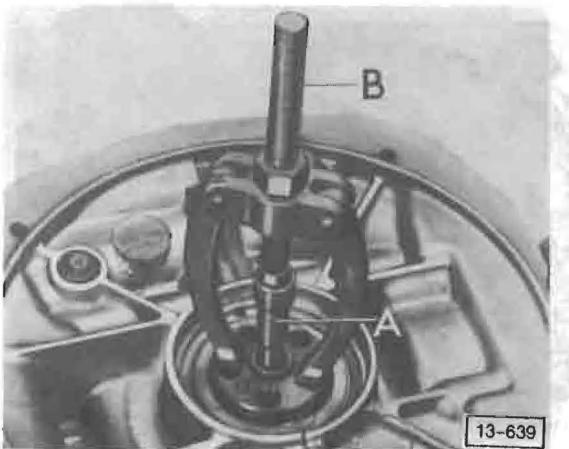


Fig. 13 Crankshaft pilot bearing, removing

- A = US 8028
- B = US 1039 & US 1039/3

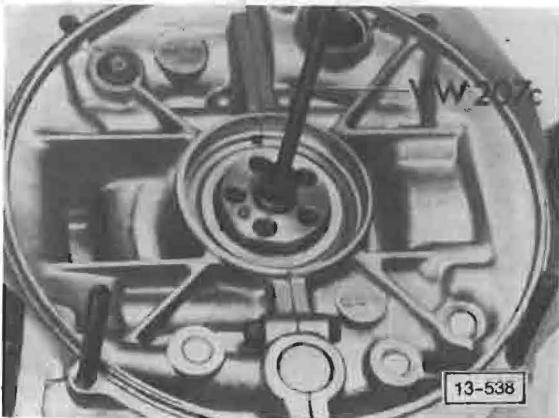


Fig. 14 Crankshaft pilot bearing, installing

- lubricate with MoS<sub>2</sub> grease when installing
- markings on bearing cage must face outward

## Replacing 1.9L crankcase

Effective immediately, the replacement crankcase for 2.1L waterboxer engines will also be used for 1.9L waterboxer engines.

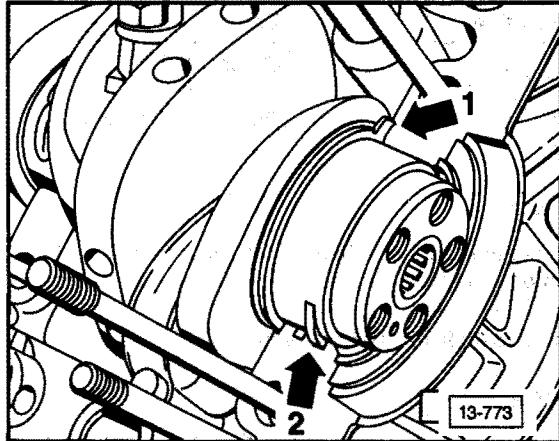
When replacing the 1.9L crankcase note the following:

### Intake air distributor

Install intake air distributor 025 133 055 B when changing from a 1.9L crankcase to a 2.1L crankcase.

### Thrust washer and main bearing 1

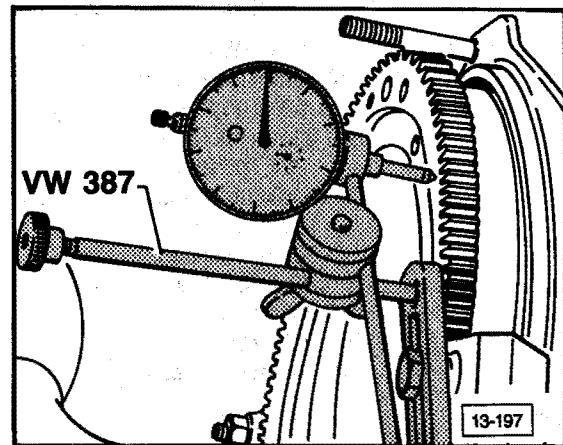
#### Installing



**Arrow 1:** Tab on thrust washer points toward main bearing and separating line of crankcase halves.

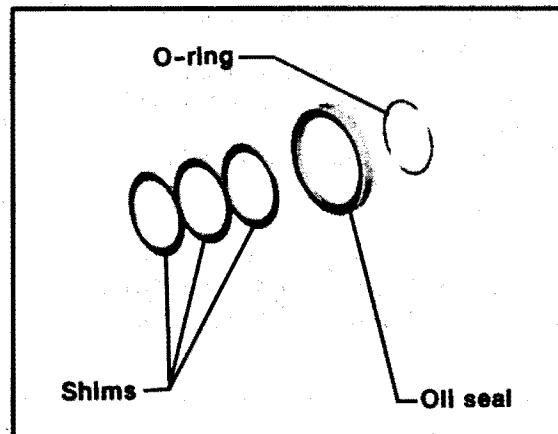
**Arrow 2:** Tab on main bearing fits into notches in crankcase. Oil holes are in left half of crankcase housing.

### Crankshaft end play, checking



- check crankshaft end play (main bearing 1 without shoulder)
  - new: 0.07-0.13 mm (0.003-0.005 in.)
  - wear limit: 0.15 mm (0.006 in.)
- if out of adjustment, adjust

### Crankshaft end play, adjusting



### Shim arrangement

#### Note

Shims are available in different thicknesses. Thickness is etched on each shim.

#### Oil seal

- pry out with screwdriver
- O-ring
- always replace

# 13 Engine - Crankshaft, Crankcase

## Parts required

Description	Part no.	Quantity
75.0mm (3.0 in.) diameter shims	021 105 281 (0.30mm thickness) 021 105 283 (0.32mm thickness) 021 105 285 (0.34mm thickness) 021 105 287 (0.36mm thickness) 021 105 289 (0.38mm thickness) 021 105 291 (0.24mm thickness)	3
Oil seal	029 105 245 B	1
O-ring	021 105 279	1

- check crankshaft end play
  - new: 0.07–0.13 mm (0.003–0.005 in.)
  - wear limit: 0.15 mm (0.006 in.)
- If out of specification proceed as follows:
- install flywheel with 2 shims but without O-ring and crankshaft oil seal
- mount dial indicator with bracket on crankcase
- move crankshaft in and out and measure movement (crankshaft end play)
- determine thickness of 3rd shim

### Example

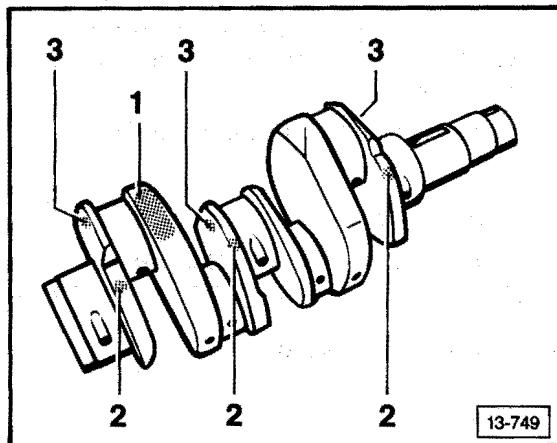
dial indicator reading      0.44 mm (0.017 in.)  
 specified end play      –0.10 mm (0.004 in.)  
 thickness of 3rd shim      0.34 mm (0.013 in.)

### CAUTION

Always install three shims to obtain correct crankshaft end play

- remove flywheel
- install O-ring, crankshaft oil seal and felt ring
- install all three shims
- install flywheel
- tighten bolts to 60 Nm (44 ft lb) plus an add'l 1/4 turn (90°)
- recheck crankshaft end play

## Crankshaft color code



13-749

Position	Color
1	Green (2.1L crankshaft only)
2	Red or blue (crankshaft journal size)

### Note

On crankshafts the blue or red code can also appear in position three.

### Crankshaft journal sizes (mm)

### Note

If crankshaft has blue or red dot only main bearings with same color code can be used.

Code for main bearings; 1, 2, 3 = 001 (blue), 004 (red)

Bearing no.	Standard size	Grinding dimensions
1 (Flywheel side)	60.00 (blue or red dot)	59.980-59.990 (marked blue dot) 59.971-59.979 (marked red dot)
2, 3	55.00 (blue or red dot)	54.980-54.990 (marked blue dot) 54.971-54.979 (marked red dot)
4	40.00 (no color code)	39.984-40.00 (no color code)
Connecting rod	55.00 (no color code)	54.983-54.996 (no color code)

## Engine Cylinder Head Valve Drive

### Index

#### Air-cooled

- Compression pressure checking 15.2
- Cylinder head assembly 15.2
- Gasoline additive reducing carbon deposits 15.25
- Rocker arm shaft installing 15.3
- Valves assembly 15.2 dimensions 15.3 guides 15.4 hydraulic lifters 15.6 seats, refacing 15.4 springs 15.2

#### Diesel

- Camshaft assembly 15.10 end play 15.15 oil seal 15.15 radial clearance 15.15a run-out 15.15
- Compression pressure checking 15.16
- Cylinder head assembly 15.8 bolts 15.9 distortion 15.14 gasket 15.9
- Valves assembly 15.10

#### Water-cooled Syncro

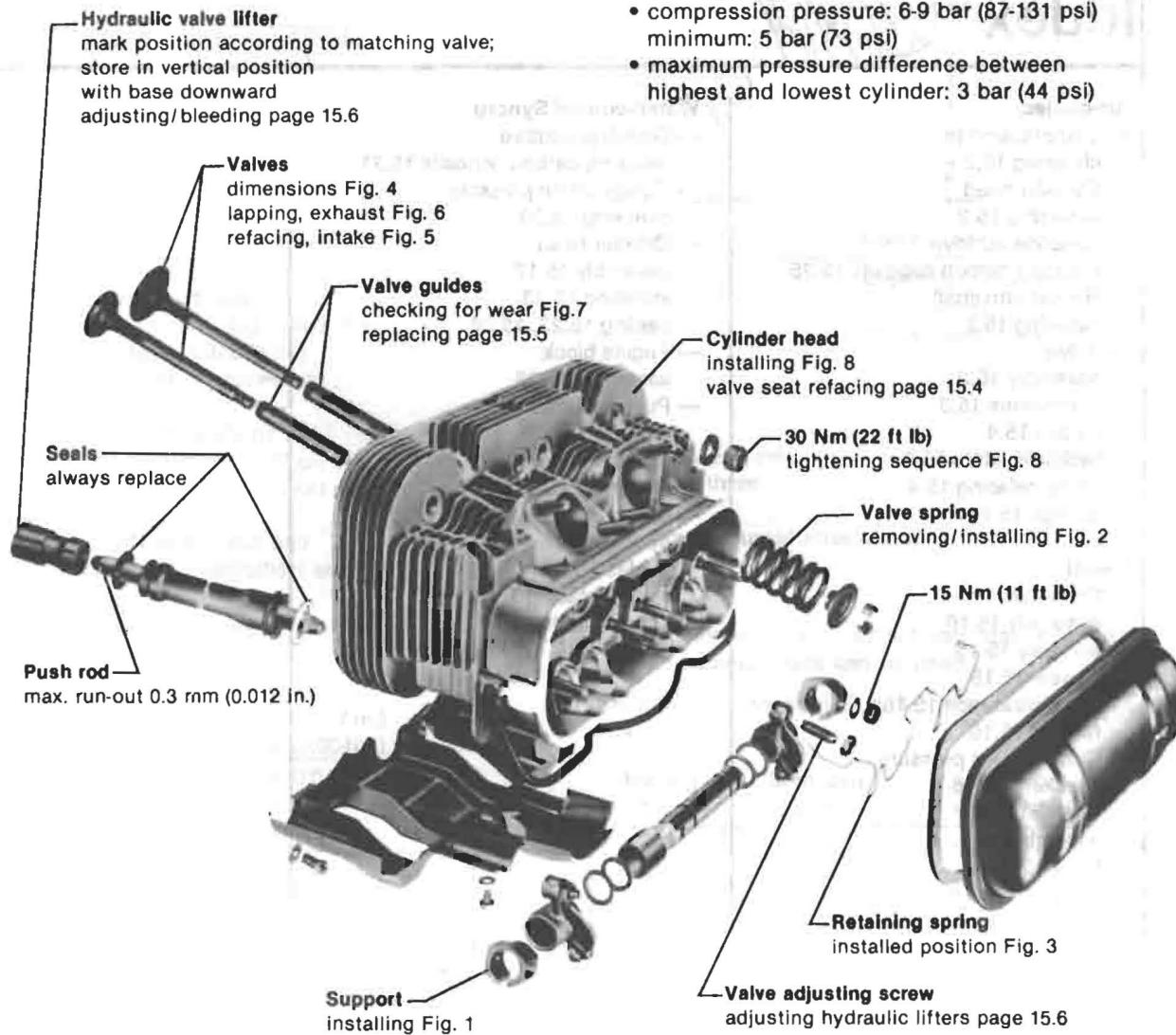
- Gasoline additive reducing carbon deposits 15.31
- Compression pressure checking 15.20
- Cylinder head assembly 15.17 installing 15.23 sealing 15.23, 15.26
- Engine block assembly 15.22
- Pushrod tubes replacing 15.25
- Valves assembly 15.18 dimensions 15.18 hydraulic lifters 15.23 guides 15.20 seats, refacing 15.18 springs 15.18

# 15 Engine-Cylinder Head, Valve Drive

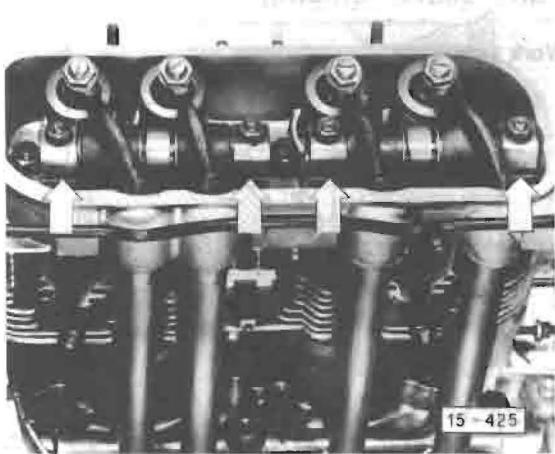
## Compression, checking

### WARNING

On vehicles with electronic ignition, disconnect terminal 4 on ignition coil and connect to ground before performing compression test

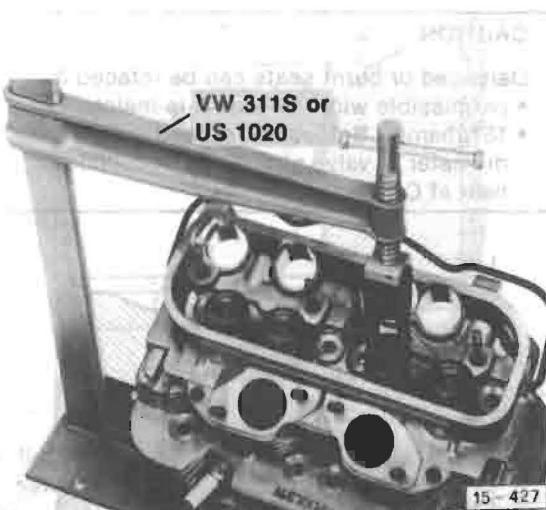


15-429

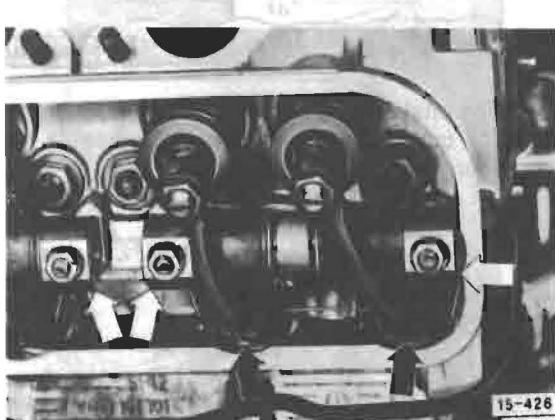


**Fig. 1** Rocker arm shaft supports, installing

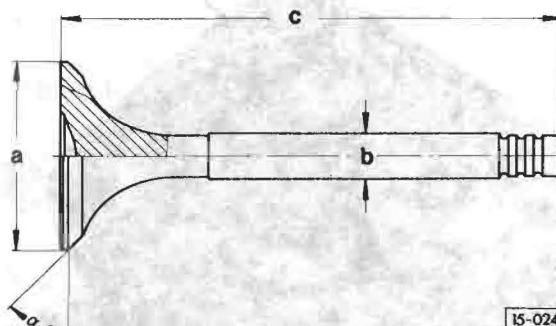
- slot downward (arrows)
- chamfer outward



**Fig. 2** Valve spring, removing/installing



**Fig. 3** Retaining spring for pushrod tube, installed position (arrows)



**Fig. 4** Valves, dimensions

#### Intake valve

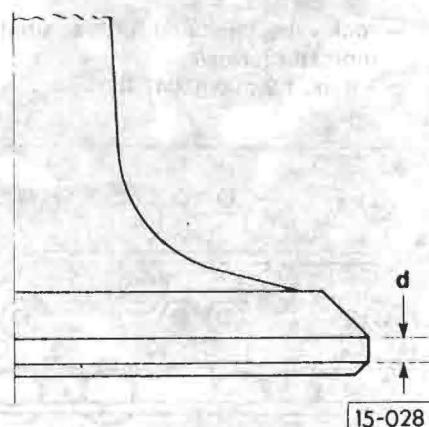
**a** = 39.3 mm (1.547 in.) diameter  
**b** = 7.95 mm (0.313 in.) diameter  
**c** = 115.4 mm (4.540 in.) length  
**d** = 29°30'

#### Exhaust valve

**a** = 33.0 mm (1.299 in.) diameter  
**b** = 8.92 mm (0.351 in.) diameter  
**c** = 115.4 mm (4.540 in.) length  
**d** = 45°

#### CAUTION

Do not rework **exhaust valves** by machine;  
lap by hand only



**Fig. 5** Intake valves, refacing

- check stem diameter
- grind seat angle to 29°30'
- valve margin **d** must not be less than 0.5 mm (0.020 in.)

# 15 Engine-Cylinder Head, Valve Drive

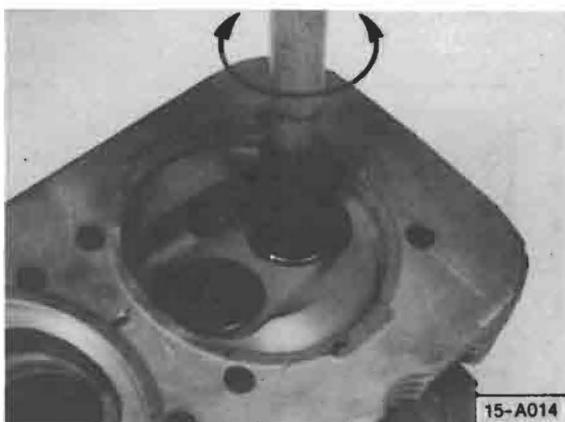


Fig. 6 Exhaust valves, lapping

— lift and turn frequently

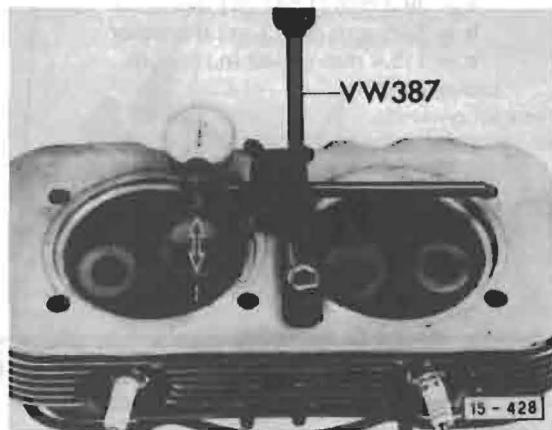


Fig. 7 Valve guide checking for wear

- remove carbon
- insert new valve into valve guide
  - valve stem must be flush with valve guide end
- rock valve back and forth against dial indicator (arrow)
  - max. 1.2 mm (0.047 in.)

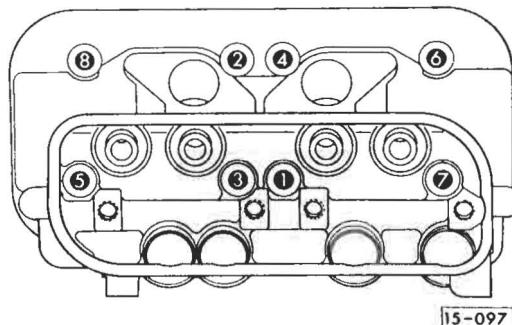
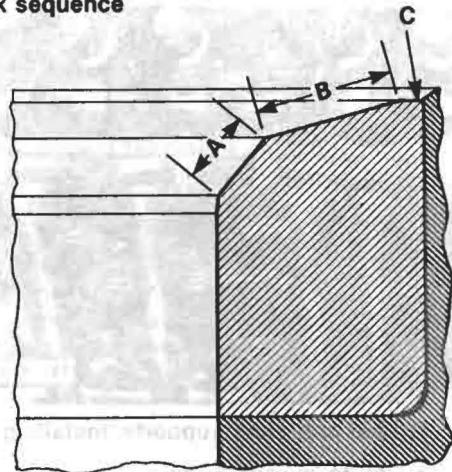


Fig. 8 Cylinder head, installing

- tighten nuts lightly by hand
- torque in numbered sequence to 30 Nm (22 ft lb)

## Valve seats, refacing

### Work sequence

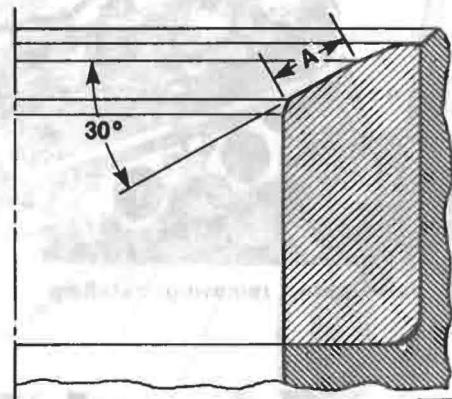


15-A019

### CAUTION

Damaged or burnt seats can be refaced if:

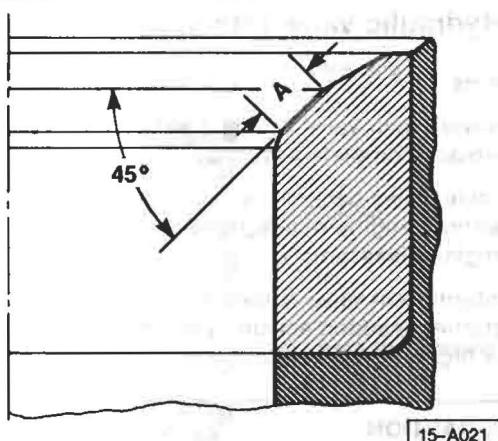
- permissible width of seat **A** is maintained
- 15° chamfer **B** does not exceed outer diameter of valve seat insert in cylinder head at **C**



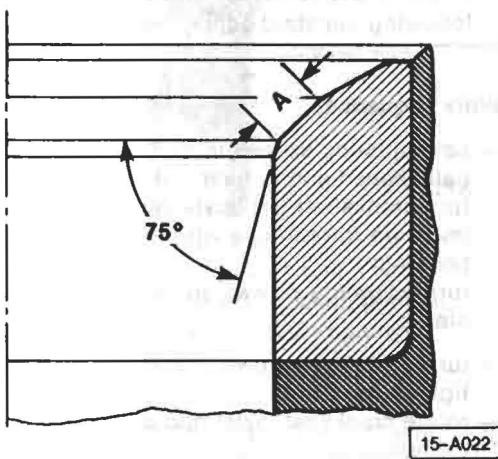
15-A020

### — reface Intake valve seats **A** to 30° angle

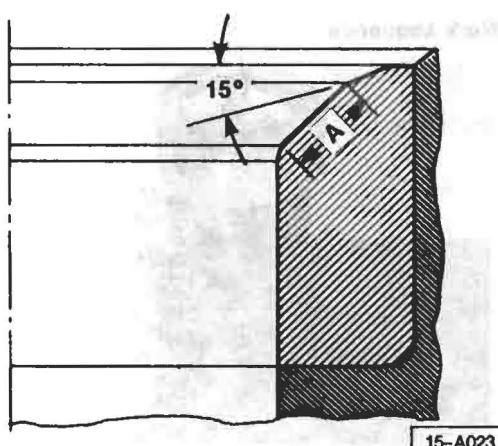
- stop cutting as soon as complete seat is cleaned



- reface **exhaust** valve seats **A** to 45° angle
  - stop cutting as soon as complete seat is cleaned



- lightly chamfer edges of intake and exhaust valve seats **A** with 75° cutter

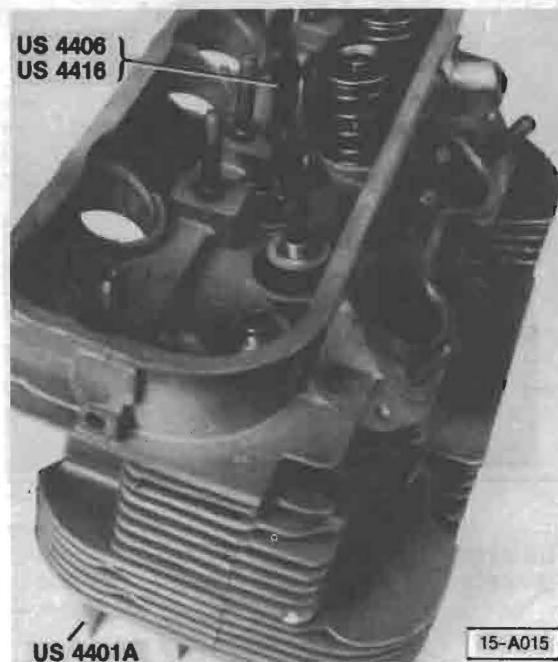


- using 15° cutter, narrow **intake** valve seat widths **A** to 1.8-2.2 mm (0.070-0.086 in.)
- using 15° cutter, narrow **exhaust** valve seat widths **A** to 2.0-2.5 mm (0.078-0.098 in.)

## Valve guides, replacing

### Work sequence

- clean cylinder head
- check for cracks in head and in valve seats



- mount head on US 4401A
- drill guides with shouldered drill to depth of 40-50 mm (1.575-1.968 in.)



- drive out remaining part of guide
- go to next page

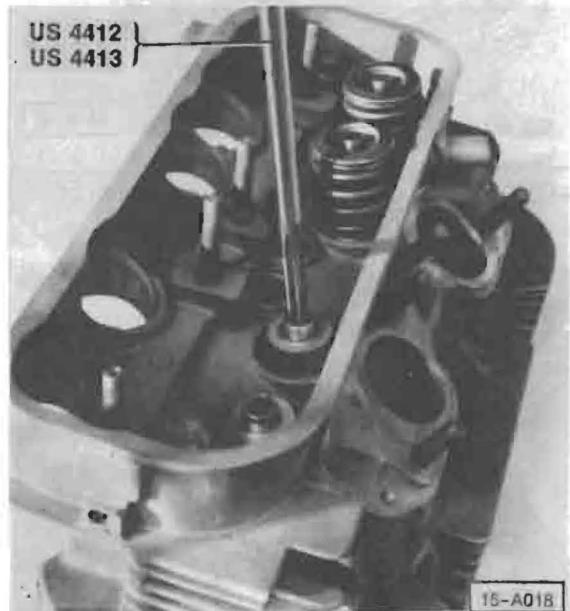
# 15 Engine-Cylinder Head, Valve Drive



— coat new guide with engine oil and press in

## CAUTION

Do not use more than 2 tons of pressure



— ream guides to size  
• use cutting oil

## CAUTION

After valve guides have been replaced,  
valve seats must be refaced

## Hydraulic valve lifters, adjusting

### Note

Never repair valve lifters; if worn or damaged, replace complete assembly.

Valve lifters can be removed and replaced without engine removal and without major engine disassembly.

Intermittent valve noises are normal upon starting, sudden acceleration, high temperatures or high engine speed

## CAUTION

If metal particles are found in oil pan, remove, disassemble, clean and reinstall all valve lifters from position removed

If rocker shafts have been removed, following standard adjustment is necessary

### Work sequence

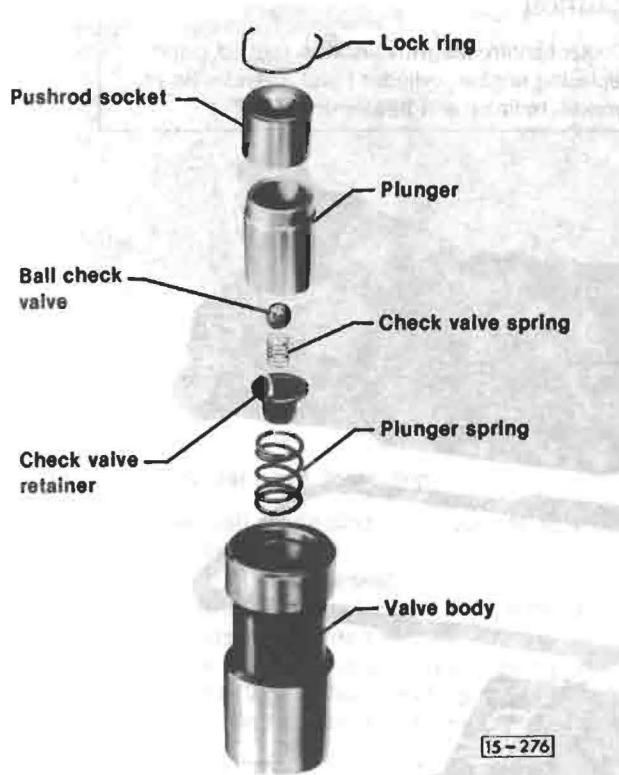
- set adjusting screws in rocker arms so that ball shaped end is flush with surface of arm
- turn crankshaft until cylinder No. 1 is at TDC (mark on rotor in line with mark on distributor housing)
- turn adjusting screws so they just touch valve stems
- turn adjusting screws 2 turns clockwise and tighten locknuts
- rotate crankshaft 180° and adjust next cylinder
- repeat until all cylinders are adjusted

## Hydraulic valve lifters, bleeding

### Work sequence

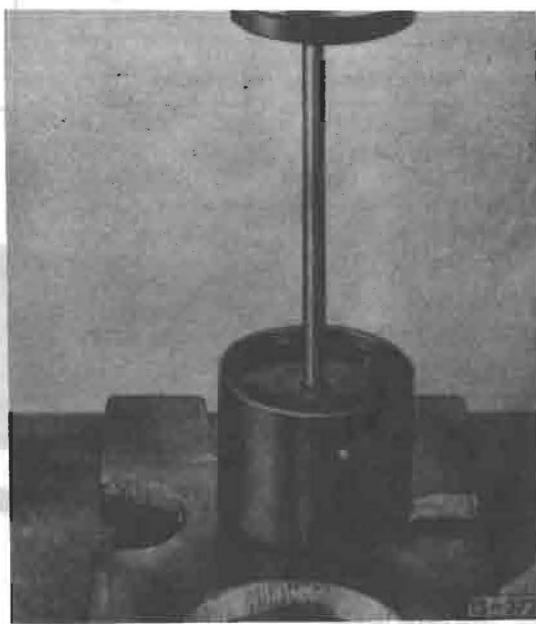


- before installing, check that valve lifter is bled correctly
  - check by applying firm thumb pressure on push rod socket in direction of arrow. Resistance should be felt
- if NO, bleed lifter as follows:

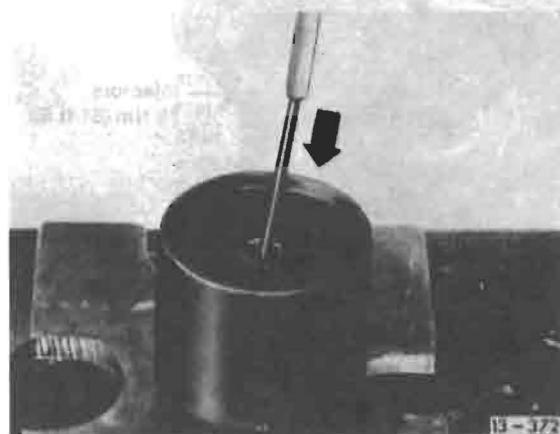


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- fill tin can with engine oil
- cut an old Type 1 pushrod in half
- remove lock ring, pushrod socket, plunger, ball check valve with spring and plunger spring from body
- place valve lifter body in tin can
  - body must be completely covered by oil
- insert plunger spring, check valve retainer, check valve spring, ball check valve and plunger into valve body



- insert pushrod socket
- place valve lifter (leave in can of oil) in press and force down slowly with Type 1 pushrod until lock ring can be installed
- install lock ring



- open valve with scribe (arrow), so that oil can flow out of lower part of plunger

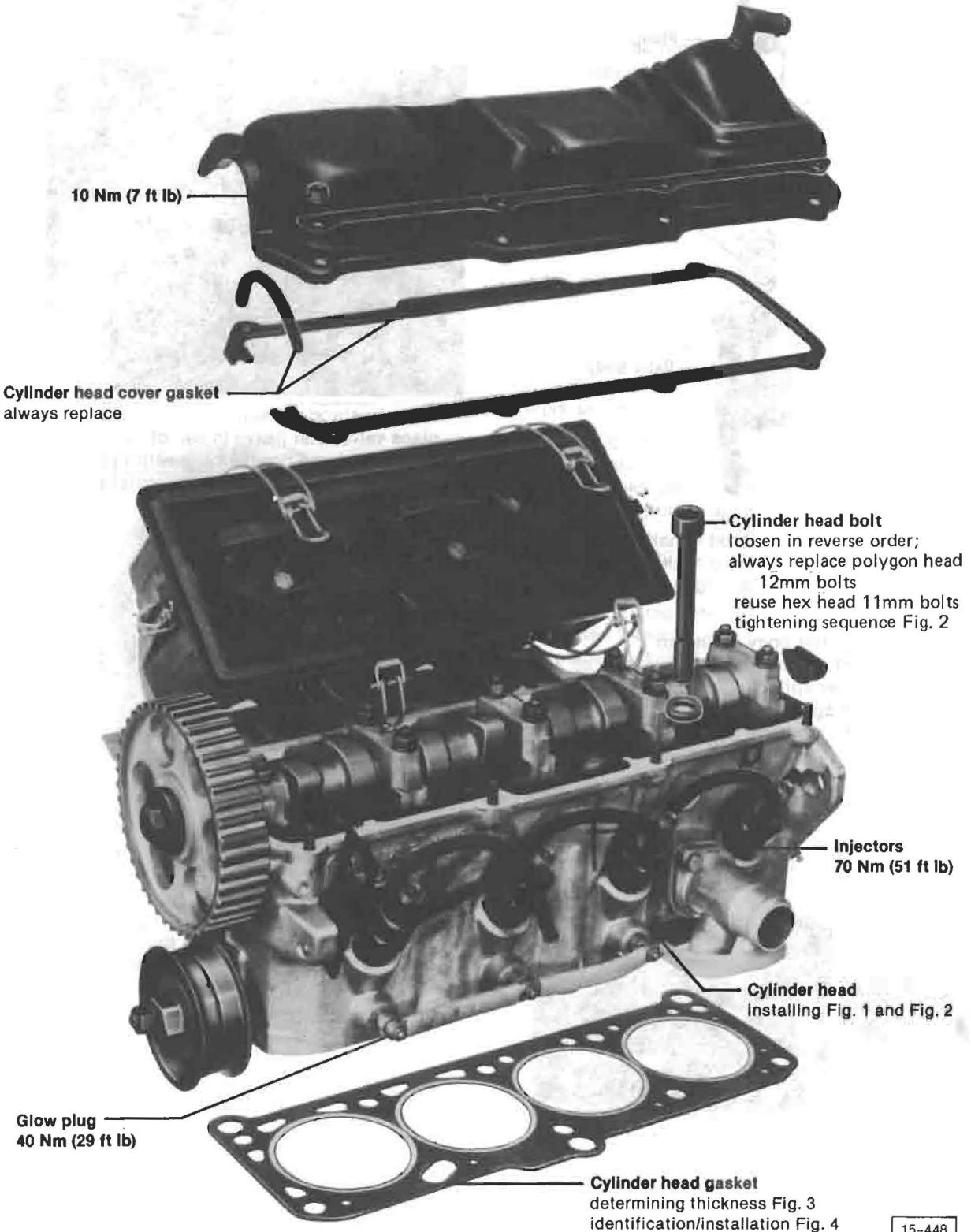
# 15 Engine-Cylinder Head, Valve Drive

## CAUTION

Diesel cylinder heads **cannot** be resurfaced

## CAUTION

Coolant/antifreeze **must not** be reused when replacing engine, cylinder head, cylinder head gasket, radiator and heater core.



15-448

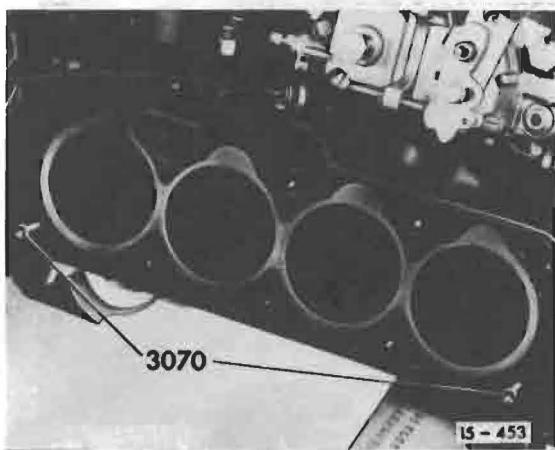


Fig. 1 Cylinder head, installing

- Install guide pins from tool set 3070 as shown
- install head gasket
- install head and insert other 8 head bolts and tighten by hand
- remove guide pins with tool and install other 2 head bolts and tighten by hand
- tighten head bolts, see Fig. 2

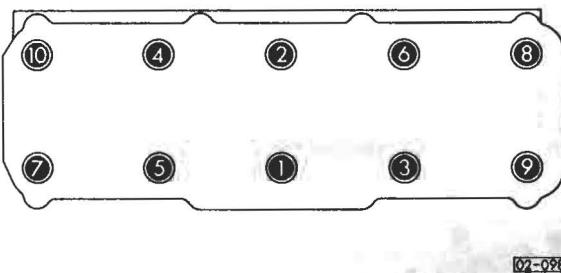


Fig. 2 Cylinder head bolts, tightening sequence

- with engine cold, torque cylinder head bolts in sequence in following steps:  
step 1 to 40 Nm (30 ft lb)  
step 2 to 60 Nm (44 ft lb)  
step 3 to 75 Nm (55 ft lb)
- after step 3, turn bolts in sequence with breaker bar  $\frac{1}{2}$  turn ( $180^\circ$ ) further (two  $\frac{1}{4}$  turns are O.K.)
- run engine until it reaches normal operating temperature (engine oil temperature  $50^\circ\text{C}/122^\circ\text{F}$  or when radiator fan starts running)
- stop engine and retighten head bolts in sequence  $\frac{1}{4}$  turn ( $90^\circ$ ) further with breaker bar without first loosening them
- after about 1000 miles (with engine either cold or warm) retighten cylinder head bolts with breaker bar, turning bolts in sequence  $\frac{1}{4}$  turn ( $90^\circ$ ) without loosening them and without interruption

**Note**

Head can be removed and installed with engine in car.

Removing and installing drive belt—see Repair Group 13.

Before working on head, remove injectors and glow plugs.

Every time head is removed, cylinder head bolts must be torqued, and again after about 1000 miles as described above

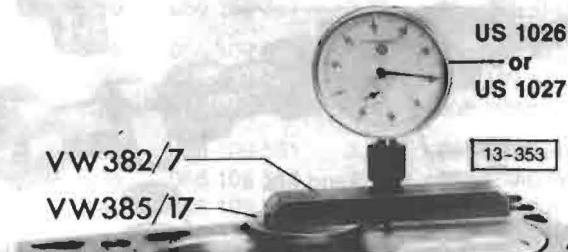


Fig. 3 Cylinder head gasket, determining thickness

- piston height must be measured when installing new pistons or short block and head gasket selected
- measure piston height and select gasket from following table

Piston height mm (in.)	Identification (notches in gasket)	Part No.
0.63-0.82 (0.025-0.032)	1	068 103 383 L
0.83-0.92 (0.033-0.036)	2	068 103 383 M
0.93-1.02 (0.037-0.040)	3	068 103 383 N

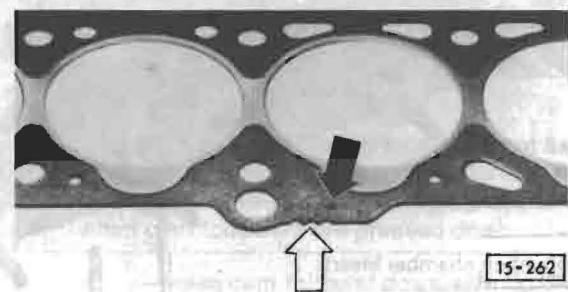


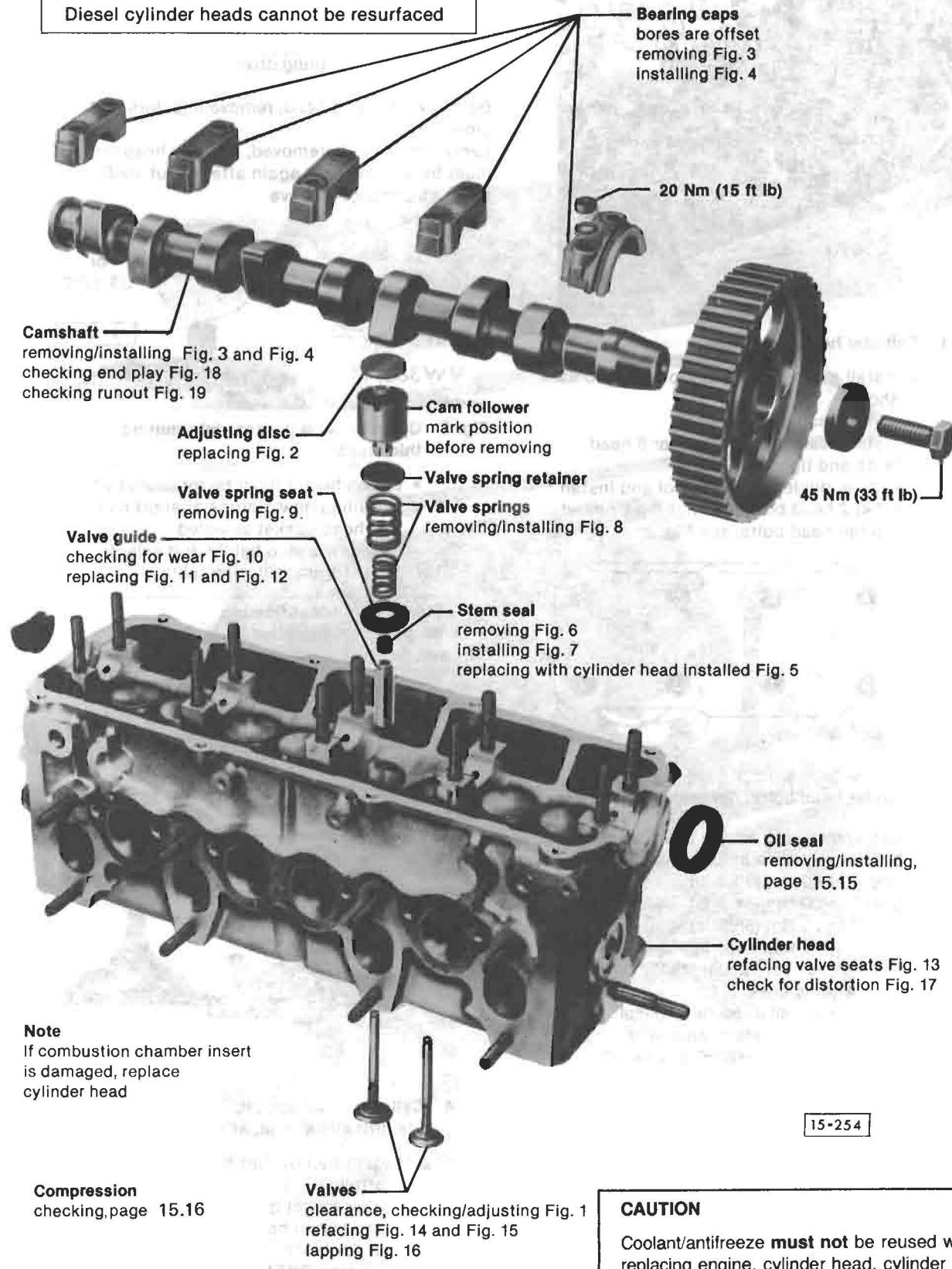
Fig. 4 Cylinder head gasket, identification/installation

- identified by Part No. and notches (arrows)
- always select gasket thickness according to piston height above top of cylinder block
- marking **OBEN** on gasket must face cylinder head

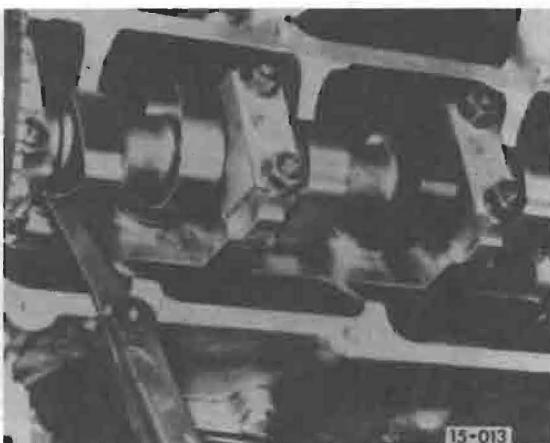
# 15 Engine-Cylinder Head, Valve Drive

## CAUTION

Diesel cylinder heads cannot be resurfaced



15-254



**Fig. 1 Valve clearance, checking/adjusting**

**Warm**

- warm up engine. Cylinder head moderately warm. Coolant temperature above 35°C (95°F)
- turn camshaft by pushing vehicle in 4th gear. Cam lobes of valve to be adjusted should point upward
- check that valve clearances are:
  - Intake: 0.20–0.30 mm (0.008–0.012 in.)
  - Exhaust: 0.40–0.50 mm (0.016–0.020 in.)

**CAUTION**

Do not turn camshaft by mounting bolt.  
This will stretch drive belt

- if measured valve clearance is larger than given tolerance, remove existing adjusting disc and insert thicker disc to specification (see Fig. 2)
- if measured valve clearance is smaller than given tolerance, remove existing disc and insert thinner disc to specification (see Fig. 2)

Example	Intake	Exhaust
specified clearance	0.20–0.30 mm (0.008–0.012 in.)	0.40–0.50 mm (0.016–0.020 in.)
measured clearance	0.35 mm (0.014 in.)	0.35 mm (0.014 in.)
Insert disc that is thicker	0.10 mm (0.004 in.)	0.10 mm 0.004 in. thinner

**Cold**

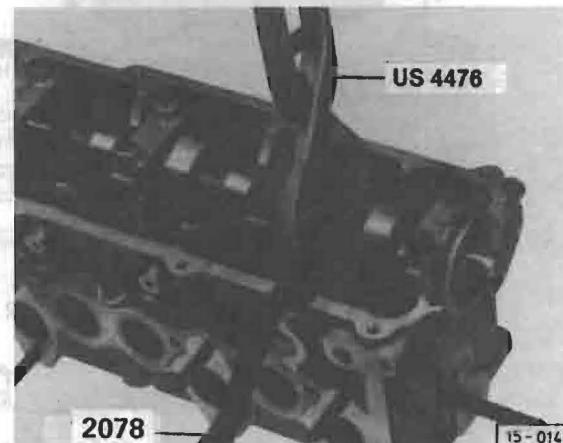
- with engine cold, check that valve clearances are:
  - Intake: 0.15–0.25 mm (0.006–0.010 in.)
  - Exhaust 0.35–0.45 mm (0.014–0.018 in.)

**Note**

After cylinder head repairs, valve clearance must be checked and if necessary adjusted after 1000 miles. Adjust to mid-point of range

**Valve adjusting discs**

Thickness	Part Number	Thickness	Part Number
3.00	056 109 555	3.65	056 109 568
3.05	056 109 556	3.70	056 109 569
3.10	056 109 557	3.75	056 109 570
3.15	056 109 558	3.80	056 109 571
3.20	056 109 559	3.85	056 109 572
3.25	056 109 560	3.90	056 109 573
3.30	056 109 561	3.95	056 109 574
3.35	056 109 562	4.00	056 109 575
3.40	056 109 563	4.05	056 109 576
3.45	056 109 564	4.10	056 109 577
3.50	056 109 565	4.15	056 109 578
3.55	056 109 566	4.20	056 109 579
3.60	056 109 567	4.25	056 109 580



**Fig. 2 Valve adjusting disc, removing/installing**

**CAUTION**

When adjusting valves, pistons **must not** be at TDC. Turn crankshaft about 1/4 turn past TDC so that valves do not contact pistons when cam followers are pressed down

- press cam follower down with 2078
- remove valve adjusting disc with US 4476

**Note**

Thickness of valve adjusting disc etched on underside. When installing be sure that markings face downward (toward cam follower). Discs can be reused if not worn or damaged. Use tray 10-212 for storing discs

# 15 Engine-Cylinder Head, Valve Drive

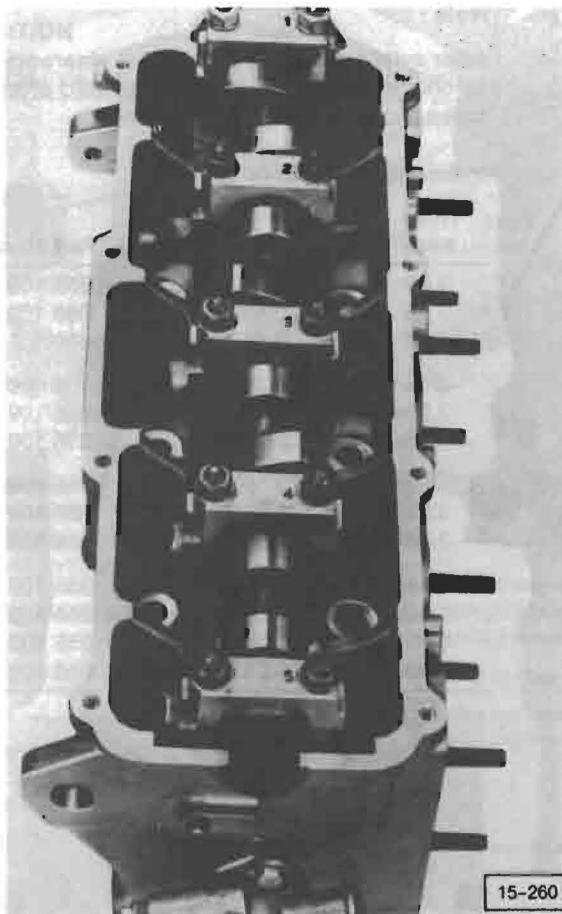


Fig. 3 Camshaft bearing caps, removing

- remove bearing caps 5, 1 and 3
- diagonally loosen bearing caps 2 and 4

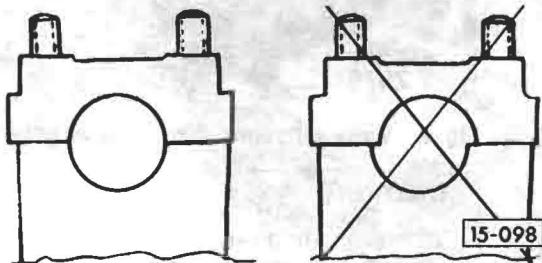


Fig. 4 Camshaft bearing caps, installing

- lubricate bearing surfaces and cam-shaft journals
- install caps in proper order—observe off center bearing position; numbers on bearing caps are not always on same side
- lightly tighten bearing caps 2 and 4 diagonally
- install caps 5, 1 and 3
- tighten all camshaft bearing cap nuts to 20 Nm (14 ft lb)



Fig. 5 Valve stem seal, removing (with cylinder head installed)

- remove camshaft, adjusting discs and followers
- turn crankshaft until piston of cylinder concerned is at TDC
- remove valve springs with VW 541
- replace valve stem seal

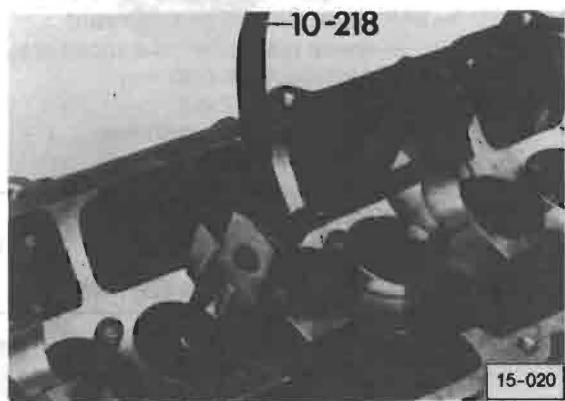


Fig. 6 Valve stem seal, removing

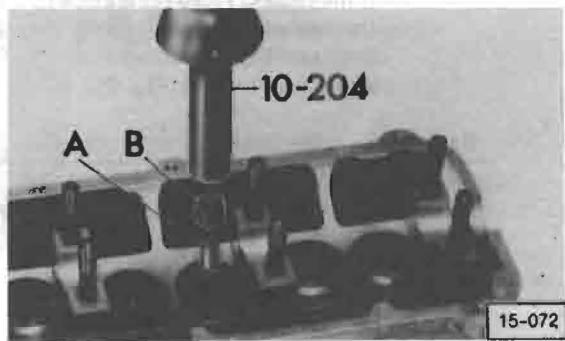
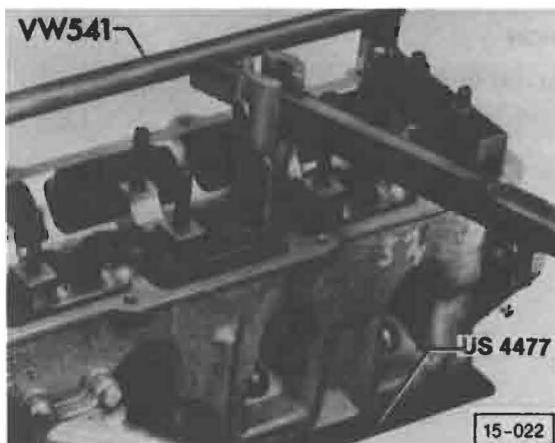


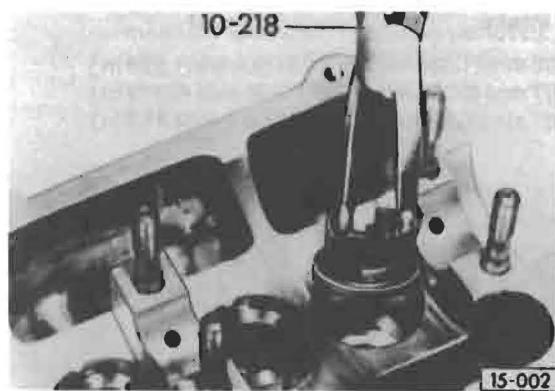
Fig. 7 Valve stem seal, installing

- slide plastic sleeve A onto valve stem
- lubricate valve stem seal B
- push seal carefully onto valve guide using plastic seal protector, otherwise seal will be damaged and engine will use too much oil

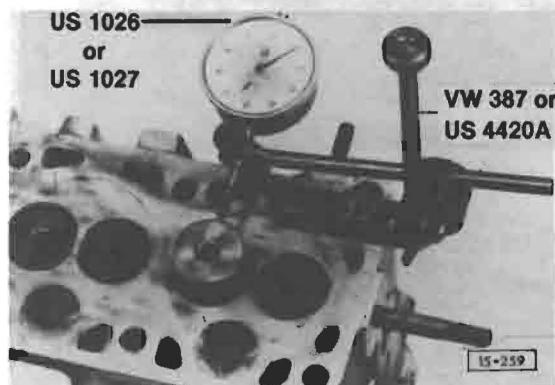


**Fig. 8** Valve springs, removing/installing

—first install US 4477 under cylinder head

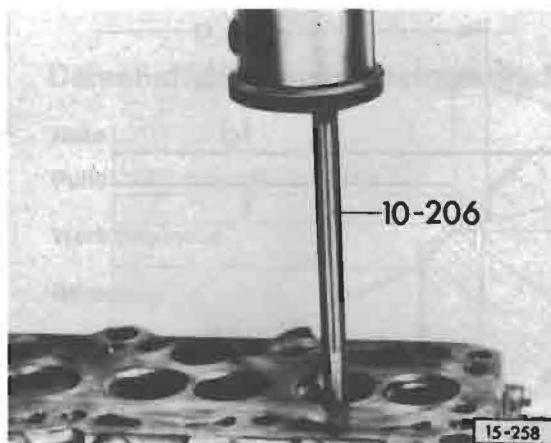


**Fig. 9** Valve spring seat, removing



**Fig. 10** Valve guide, checking for wear

- remove carbon
- insert new valve into valve guide
- valve stem end must be flush with valve guide end
- rock valve back and forth against dial indicator. Dial Indicator reading shows valve guide wear
- dial indicator reading = max. 1.3 mm (0.051 in.)

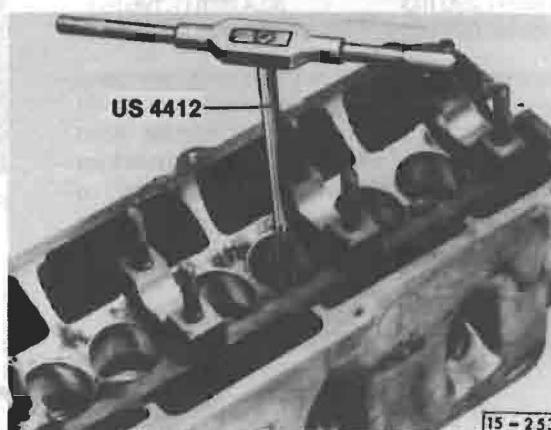


**Fig. 11** Valve guide, replacing

- first check cylinder head for cracks or excessively worn seats
- press worn guides out from combustion chamber side
- coat new guides with oil and press into cold cylinder head from camshaft side. Press guides in as far as they will go

**CAUTION**

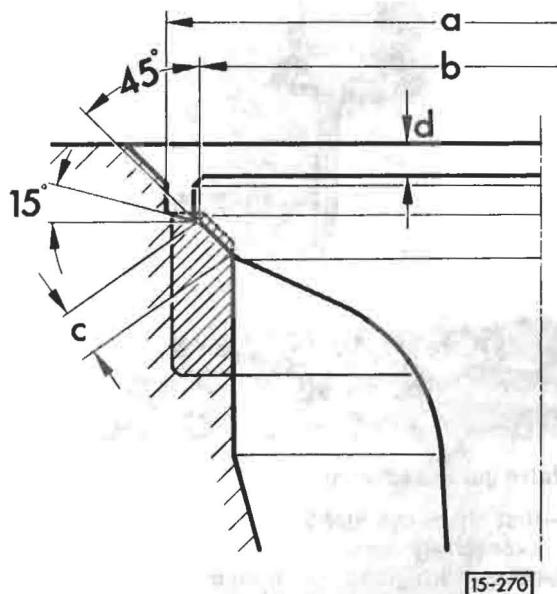
Once guide shoulder is seated do not use more than 1 ton pressure or guide shoulder may break



**Fig. 12** Valve guides, replacing

- ream guide by hand using proper cutting lubricant

## **15 Engine-Cylinder Head, Valve Drive**



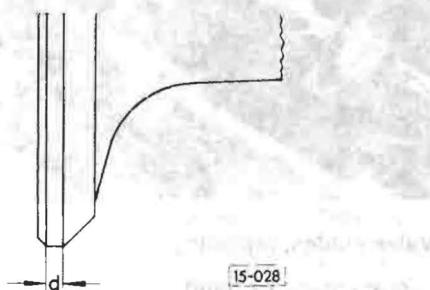
**Fig. 13 Valve seats, refacing**

- seat refacing pilot must be properly installed  
Valve seat angle =  $45^\circ$   
Correction angle =  $15^\circ$   
Dimension d must not be more than 1.5 mm (0.059 in.)

Intake	Exhaust
<b>a = 35.2 mm (1.384 in.)</b>	33.2 mm (1.306 in.)
<b>b = 32.8 mm (1.290 in.)</b>	30.4 mm (1.196 in.)
<b>c = 2.0 mm (0.078 in.)</b>	2.4 mm (0.096 in.)

### Note

Valve seats which are worn or burned can be refaced provided that correction angle and seat width are maintained. Otherwise, cylinder head must be replaced.

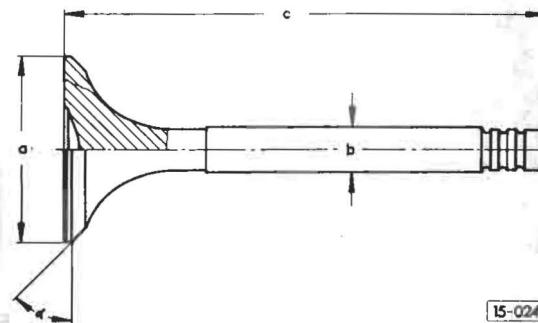


**Fig. 14 Intake/Exhaust valves, refacing**

- valve margin  $d$  must not be less than 0.5 mm (0.019 in.)

**CAUTION**

**Do not reface exhaust valves on a machine.  
Lap them in by hand only**



**Fig. 15 Intake/Exhaust valves, refacing**

## **Intake**      **Exhaust**

$$\begin{aligned} \mathbf{a} &= 34.00 \text{ mm (1.338 in.)} & 31.00 \text{ mm (1.220 in.)} \\ \mathbf{b} &= 7.97 \text{ mm (0.314 in.)} & 7.95 \text{ mm (0.313 in.)} \\ \mathbf{c} &= 104.8 \text{ mm (4.125 in.)} & 104.6 \text{ mm (4.117 in.)} \\ \alpha &= 45^\circ & 45^\circ \end{aligned}$$



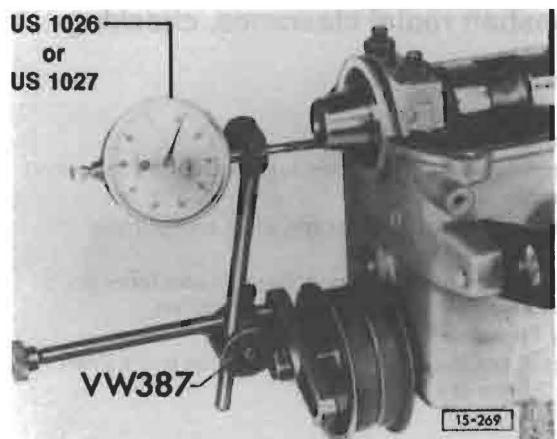
**Fig. 16** Valves, lapping

—lift and turn regularly



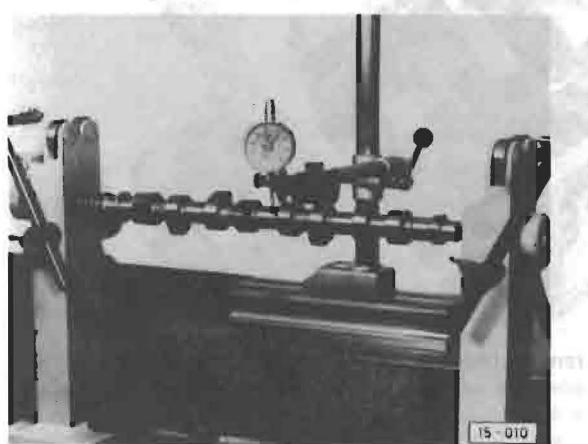
**Fig. 17 Cylinder head distortion, checking**

- max. 0.1 mm (0.004 in.)
  - Diesel cylinder heads cannot be resurfaced



**Fig. 18 Camshaft end play, checking**

- measure with cam followers removed and caps 1 and 5 installed and torqued
- check that end play is not more than 0.15 mm (0.006 in.)



**Fig. 19 Camshaft runout, checking**

- max. 0.01 mm (0.0004 in.)

## Camshaft oil seal, removing/installing

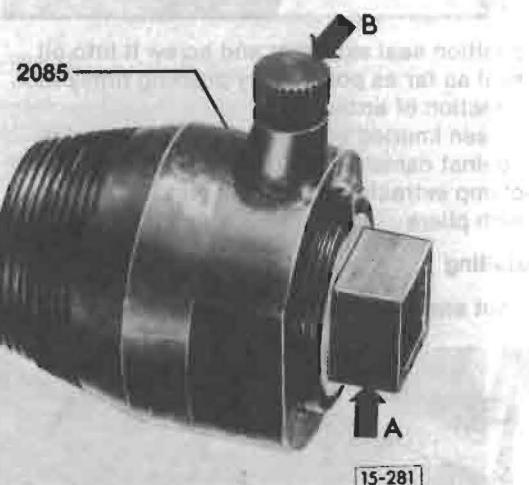
### Note

Puller 2002 may also be used

### Work sequence

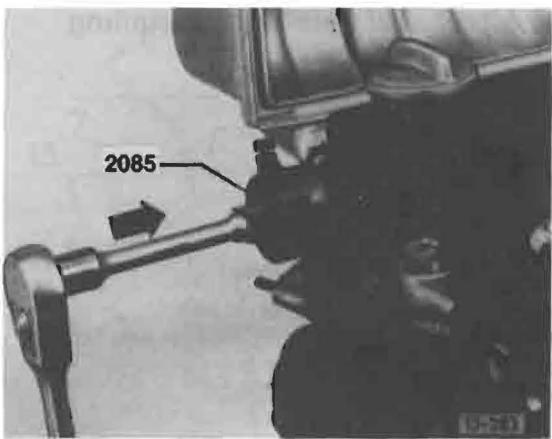
#### Removing

- set engine at TDC for cylinder No. 1
- remove drive belt cover and drive belt
- loosen camshaft sprocket bolt 1/2 turn and tap sprocket with rubber hammer
- remove bolt and sprocket



- unscrew inner part (arrow A) of oil seal extractor 2085 2 turns (approx. 3mm/1/8 in.) out of outer part
- lock in position with knurled screw (arrow B)
- to guide extractor, screw sprocket bolt into camshaft until it projects about 15 mm (5/8 in.)
- lubricate threads on tapered end of seal extractor

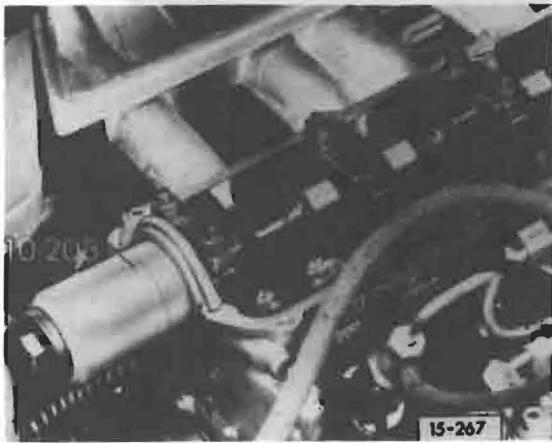
# 15 Engine-Cylinder Head, Valve Drive



- position seal extractor and screw it into oil seal as far as possible by pushing firmly in direction of arrow
- loosen knurled screw and turn inner part in against camshaft until oil seal is pulled out
- clamp extractor in vise and remove oil seal with pliers

## Installing

- coat seal lips and outer edge of seal with oil



- press seal in flush

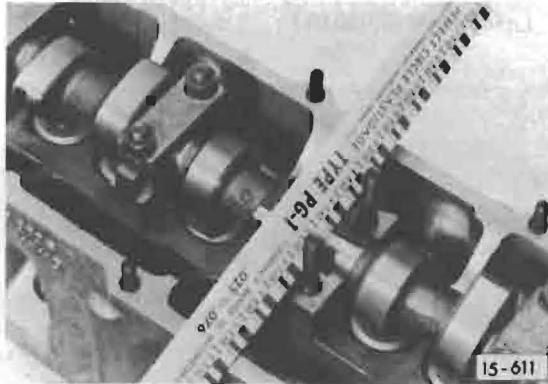
## Camshaft radial clearance, checking

### Work sequence

- remove camshaft sprocket
- remove camshaft and cam followers (mark followers)
- remove oil seal
- clean camshaft bearing caps, seats and journals
- place camshaft on cylinder head so cam lobes do not touch valve spring retainers or valves
- lay Plastigage® across journal
- install bearing caps in correct position and tighten to 20 Nm (14 ft lb)

### CAUTION

Do not rotate camshaft.



- remove bearing caps
- compare width of Plastigage® with measuring scale  
wear limit – 0.1 mm (0.004 in.)

### Note

If this limit is exceeded, check the radial clearance again with a new camshaft.

If the clearance with a new camshaft also exceeds the wear limit, the cylinder head must be replaced.

- after completing repairs, check and adjust valve clearances

# 15 Engine–Cylinder Head, Valve Drive

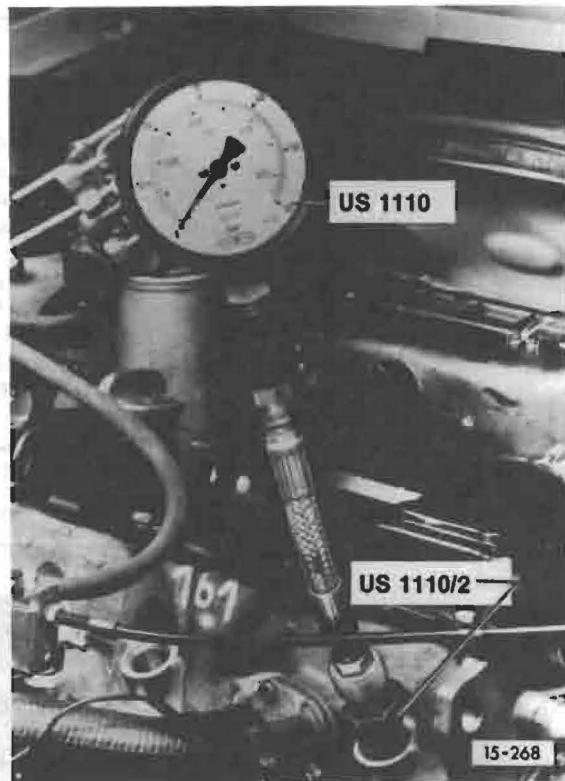
## Compression (Diesel), checking

### Work sequence

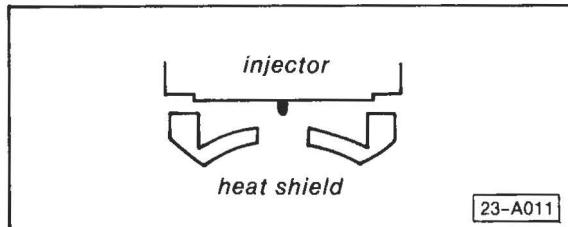
#### CAUTION

To avoid damage, keep injection parts clean when removing, installing, disassembling and assembling

- engine oil temp 30°C (86°F)
- disconnect wire from fuel shutoff solenoid on injection pump and insulate
- clean all injector pipe fittings
- remove injector pipes with tool 3035
  
- disconnect fuel return hoses
- remove injectors using US 2775 or equivalent
- remove heat shields
- place old heat shield in cylinder to be checked



- screw in adaptor and compression tester
- set parking brake and place transmission in neutral
- operate starter
  - 28–34 bar (406–493 psi)
  - maximum pressure differential between highest and lowest cylinder, 5 bar (73 psi)
- repeat for other three cylinders



- install new heat shields as shown
- reinstall injectors and tighten to 70 Nm (51 ft lb)
- reconnect fuel return hoses
  
- reinstall injector pipes and tighten to 25 Nm (18 ft lb)
- reconnect wire to fuel shutoff solenoid on injection pump
- start engine and accelerate a few times to clear air bubbles

**Note**

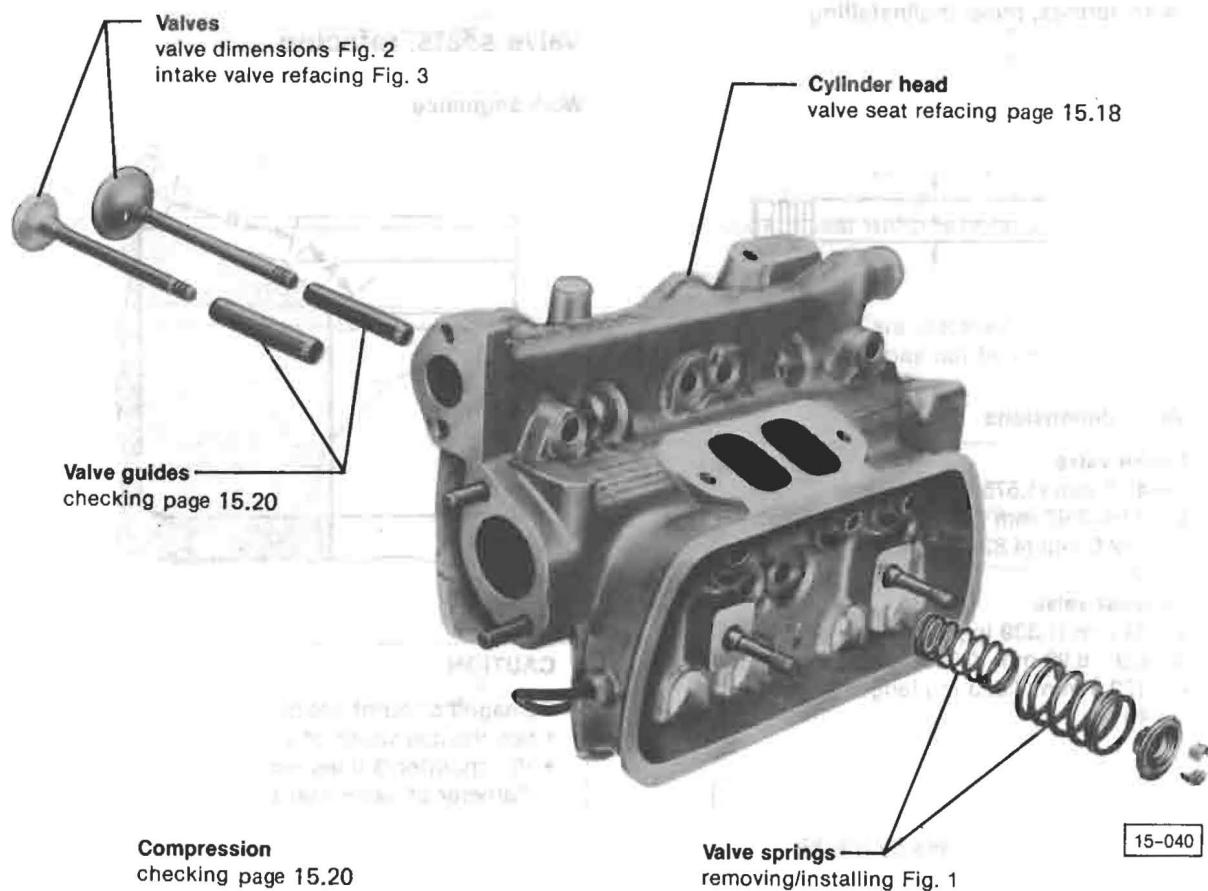
Cylinder heads with cracks between valve seats or between a valve seat and spark plug thread can be used again without reducing service life provided that cracks are small and not more than 0.5 mm (0.019 in.) wide or that only first coil of plug thread is cracked

**Note**

Cylinder head can be removed and installed with engine installed

**CAUTION**

Coolant/antifreeze **must not** be reused when replacing engine, cylinder head, cylinder head gasket, radiator and heater core.



# 15 Engine-Cylinder Head, Valve Drive

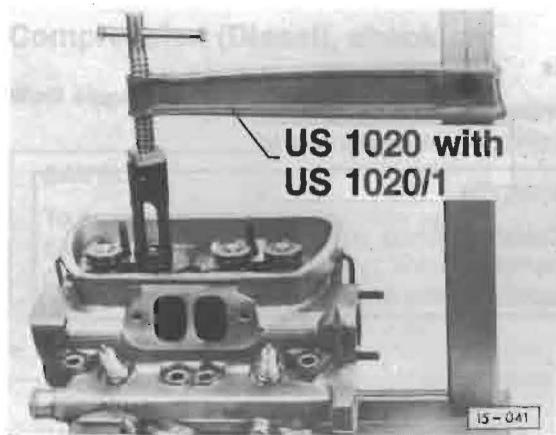


Fig. 1 Valve springs, removing/installing

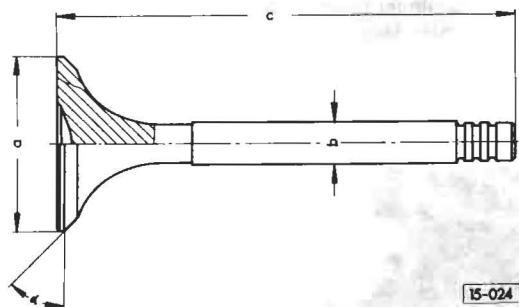


Fig. 2 Valve, dimensions

#### Intake valve

$a = 40.0 \text{ mm (1.575 in.) diameter}$   
 $b = 7.96\text{--}7.97 \text{ mm (0.313\text{--}0.314 in.) dia.}$   
 $c = 122.5 \text{ mm (4.823 in.) length}$   
 $\alpha = 45^\circ$

#### Exhaust valve

$a = 34 \text{ mm (1.339 in.) diameter}$   
 $b = 8.91\text{--}8.92 \text{ mm (0.3508\text{--}0.3512 in.) dia.}$   
 $c = 122.5 \text{ mm (4.823 in.) length}$   
 $\alpha = 45^\circ$

#### CAUTION

Do not rework **exhaust valves** by machine,  
lap by hand only

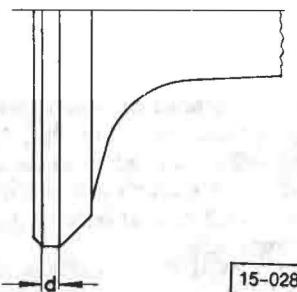
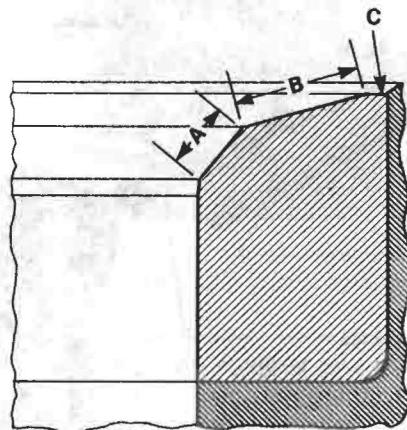


Fig. 3 Intake valves, refacing

- valve margin  $d$  must not be less than 0.5 mm (0.020 in.)

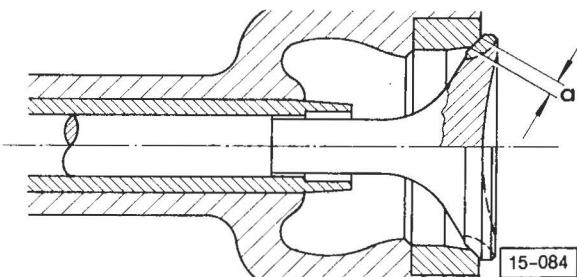
#### Valve seats, refacing

##### Work sequence



#### CAUTION

Damaged or burnt seats can be refaced if:  
 • permissible width of seat A is maintained  
 • 15° chamfer B does not exceed outer diameter of valve seat insert in cylinder head at C

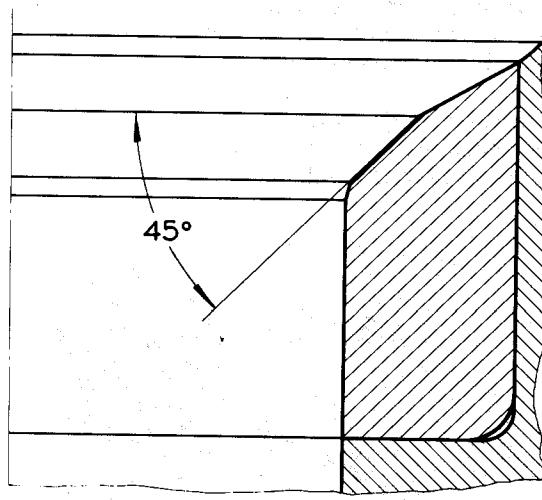


— seat width  $a = 1.4\text{--}2.5 \text{ mm (0.055\text{--}0.098 in.)}$

## 15.18

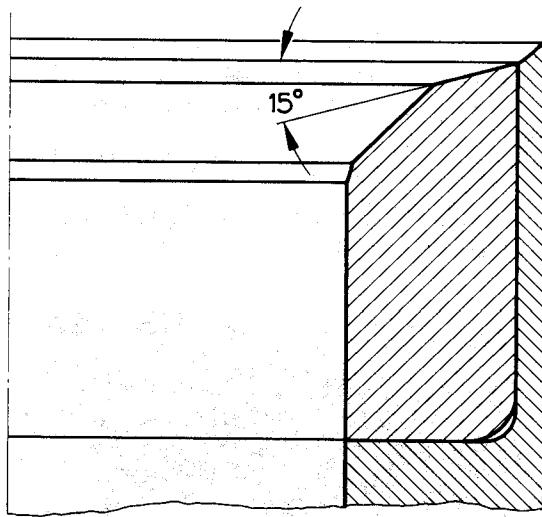
Valves/springs/dimensions/  
refacing

Water-cooled



15-085

- reface valve seats to  $45^\circ$  angle
  - stop cutting as soon as complete seat is cleaned



15-431

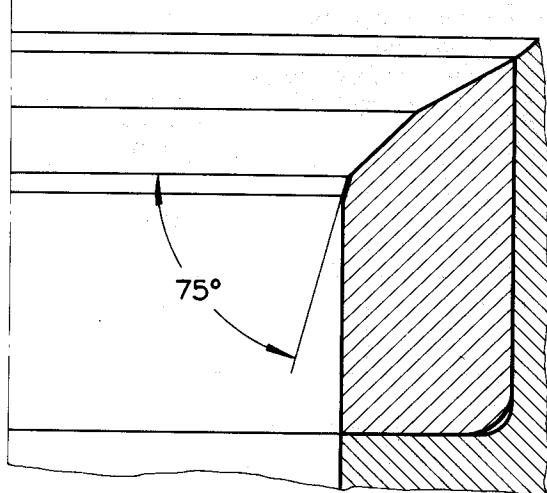
- reface surface to  $15^\circ$  angle
  - chamfer upper edge of valve seat until correct seat width is obtained

**Note**

When new valves are installed in properly reworked seats, it may not be necessary to lap in valves

**CAUTION**

After lapping valve, remove all traces of grinding paste



15-086

- reface surface to  $75^\circ$  angle
  - slightly chamfer lower edge of valve seat

# 15 Engine-Cylinder Head, Valve Drive

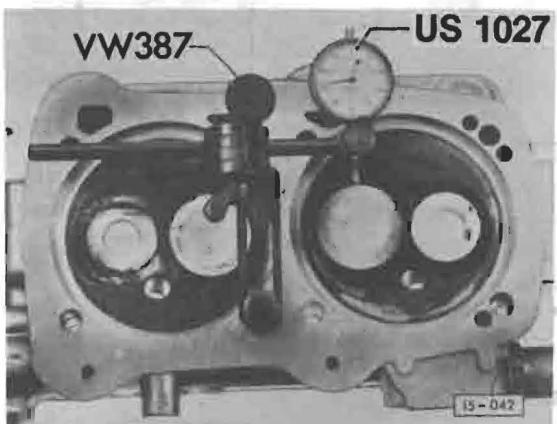
## Valve guides, checking

### Note

When repairing engines with leaking valves it is not sufficient to rework or replace valve seats and valves.

It is also necessary to check valve guides for wear.

This is particularly important on engines which have considerable mileage.



- remove carbon
- insert new valve into valve guide
  - valve stem must be flush with valve guide end
- rock valve back and forth against dial indicator (arrow)
  - max. 1.2 mm (0.047 in.)

## Compression pressure, checking

- engine oil temperature minimum 30 °C (86 °F)
- throttle valve open fully (accelerator pedal in full throttle position)

- remove all spark plugs
- disconnect coil wire at ignition distributor and connect to ground with clamp



- check compression with tool US 1120
- operate starter until tester no longer indicates a rise in pressure

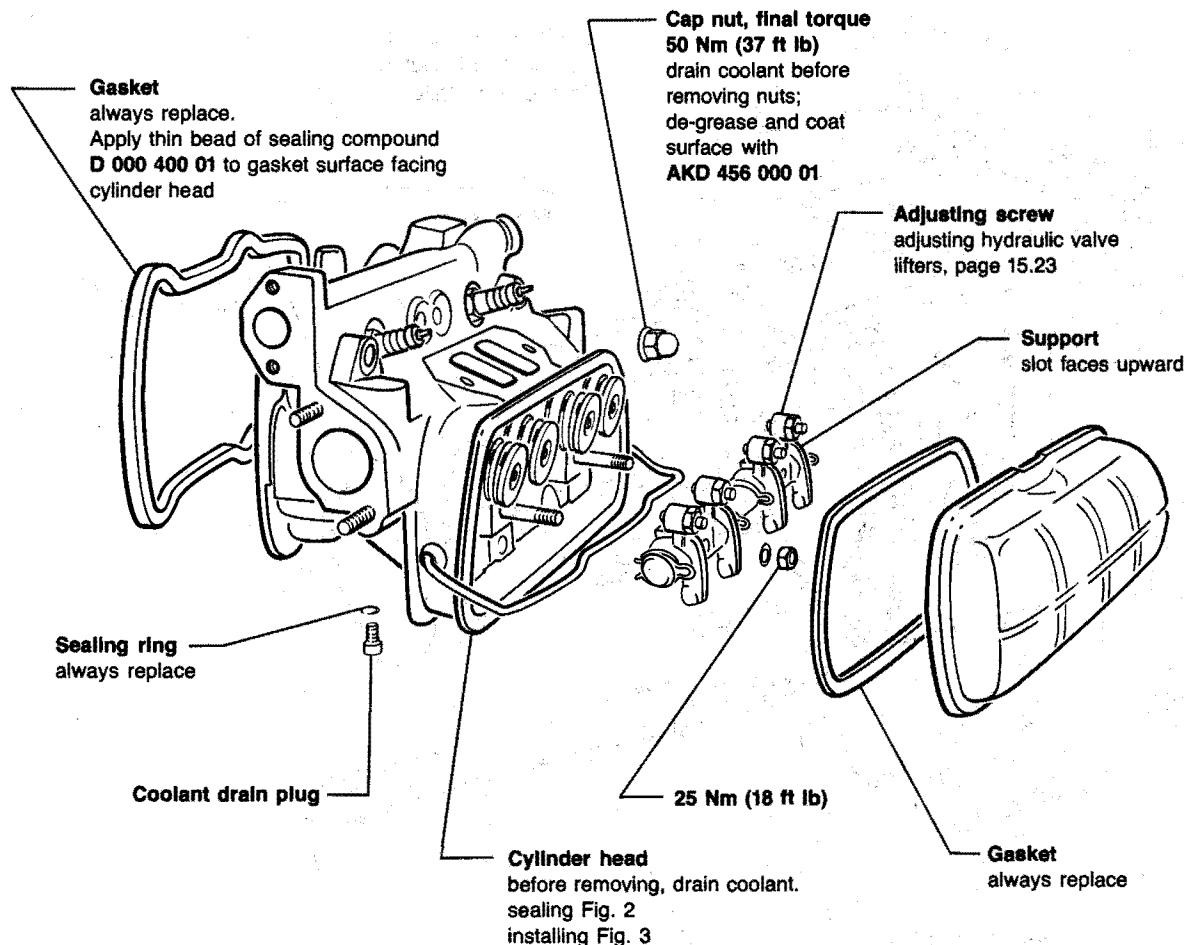
### Compression pressure values

Engine code	Compression pressure
1.9L	10 – 13 bar (145 – 189 psi)
2.1L	
Minimum	8 bar (116 psi)

## CAUTION

Coolant/antifreeze must not be reused when replacing engine, cylinder head, cylinder head gasket, radiator and heater core.

When replacing coolant/antifreeze solution in all Volkswagen models, all model years, use phosphate-free coolant/antifreeze only,  
ZVW 237 104.



15-633

# 15 Engine—Cylinder Head, Valve Drive

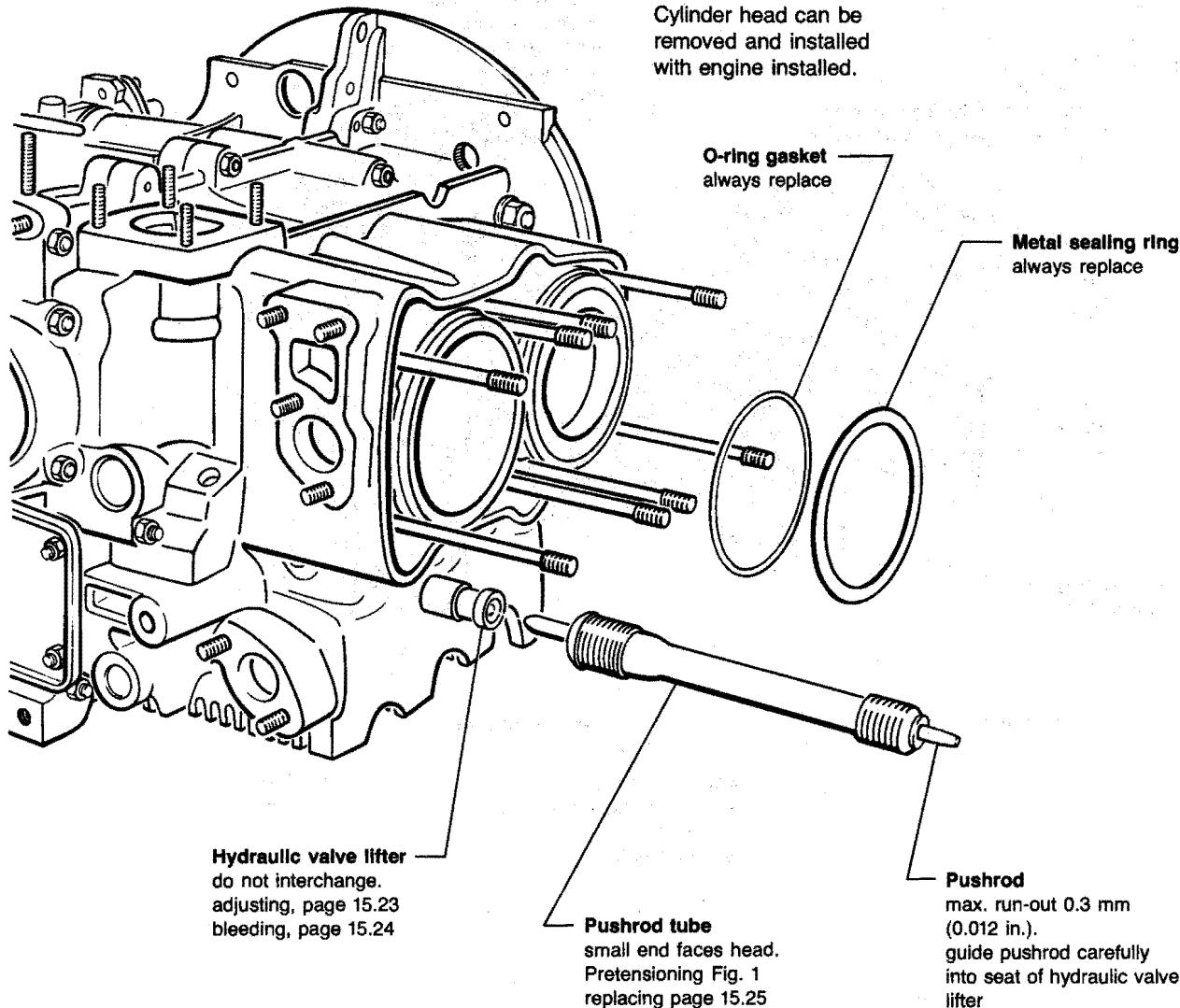
## CAUTION

Coolant/antifreeze must not be reused when replacing engine, cylinder head, cylinder head gasket, radiator and heater core.

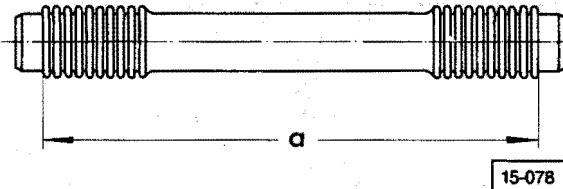
When replacing coolant/antifreeze solution in all Volkswagen models, all model years, use phosphate-free coolant/antifreeze only.  
**ZVW 237 104.**

## Note

Cylinder head can be removed and installed with engine installed.

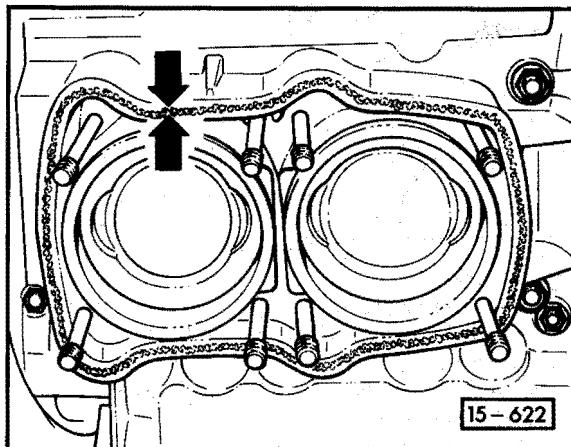


15-632



**Fig. 1 Pushrod tube, pretensioning**

- pretension tube to correct length
- a = approximately 194 mm (7.6 in.)
- when installing, seam faces upward and small end to cylinder head
- always replace sealing rings, head gasket
- pushrod tubes can be replaced with engine installed



**Fig. 2 Cylinder head, sealing**

#### Applying sealant D 000 400 01

To improve sealing of painted/unpainted sealing surfaces on cylinder head, use D 000 400 sealant.

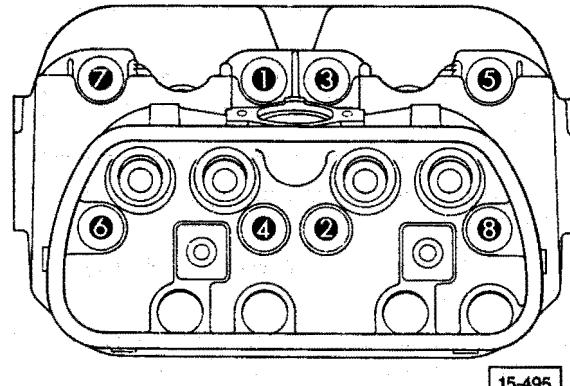
- if paint is damaged, clean cylinder head sealing surface with fine sand paper
- clean sealing surface with solvent
- apply 1 to 2 mm (3/64-5/64 in.) bead of sealing compound D 000 400 in the center of the new water jacket gasket (**arrows**)

#### CAUTION

**DO NOT USE TOO MUCH SEALANT.**  
Excessive sealant could plug cylinder head coolant passages or hydrolock cap nuts.

#### Note

Cylinder head must be installed within 45 minutes of the sealant application.



**Fig. 3 Cylinder head, installing**

- tighten cylinder head at stud 1 with cap nut just enough so that all remaining 7 cap nuts can be installed
- coat surface of cap nut with AKD 456 000 01 sealing compound

#### Torque sequence

#### CAUTION

Do NOT use click type torque wrench. Use only beam or dial type wrench.

**First stage:** tighten cap nuts in numbered sequence (see above) to 10 Nm (7 ft lb)

#### Note

Be sure that push rod tubes are properly seated.

**Second stage:** tighten cap nuts, in numbered sequence to 50 Nm (37 ft lb)

- recheck final 50 Nm (37 ft lb)
- reinstall push rods, rocker arms
  - push rods must be properly seated before tightening rocker arms
  - torque: 25 Nm (18 ft lb)

## Hydraulic valve lifters, adjusting

#### Note

Never repair valve lifters; if worn or damaged, replace complete assembly.

Valve lifters can be removed and replaced without engine removal and without major engine disassembly.

Intermittent valve noises are normal upon starting, sudden acceleration, high temperatures or high engine speed.

# 15 Engine—Cylinder Head, Valve Drive

## CAUTION

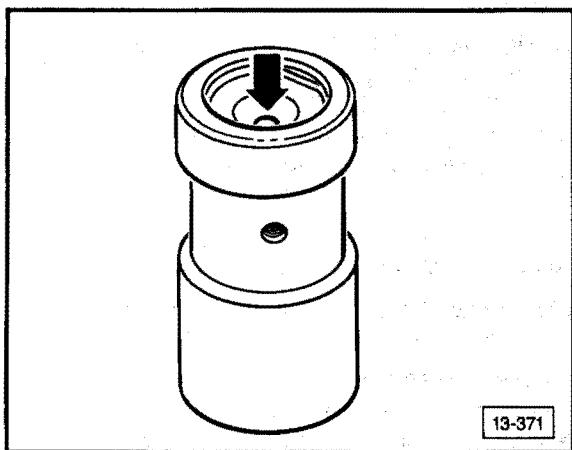
If metal particles are found in oil pan, remove, disassemble, clean and reinstall all valve lifters from position removed.

- guide pushrod carefully into socket of hydraulic valve lifter

If rocker shafts have been removed, the following adjustment is necessary:

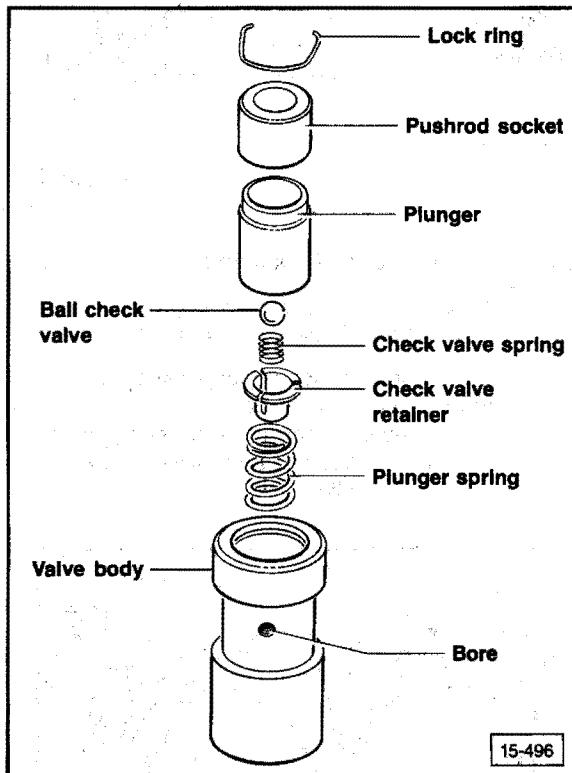
- backout adjusting screws in rocker arms until ball shaped end is flush with surface of arm
- turn crankshaft until cylinder No. 1 is at TDC
  - mark on rotor in line with mark on distributor housing
- turn adjusting screws in until they just touch valve stems
- turn adjusting screws 2 turns clockwise and tighten lock nuts
- rotate crankshaft 180° and adjust next cylinder
- repeat until all cylinders are adjusted

## Hydraulic valve lifters, bleeding

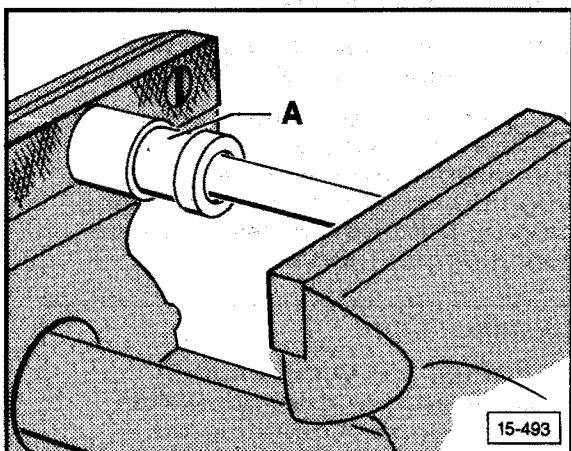


- before installing, ensure valve lifter is bled correctly
  - check by applying firm thumb pressure on push rod socket in direction of arrow. Lifter should not move.

If NO, bleed lifter as follows:



- pry out lock ring
- remove pushrod socket, plunger, ball check valve with spring, check valve retainer and plunger spring from body
- fill valve lifter body with oil up to bleed hole
- insert plunger spring
- install plunger with ball check valve, spring and valve retainer and push downward; at same time, open ball check valve with scribe

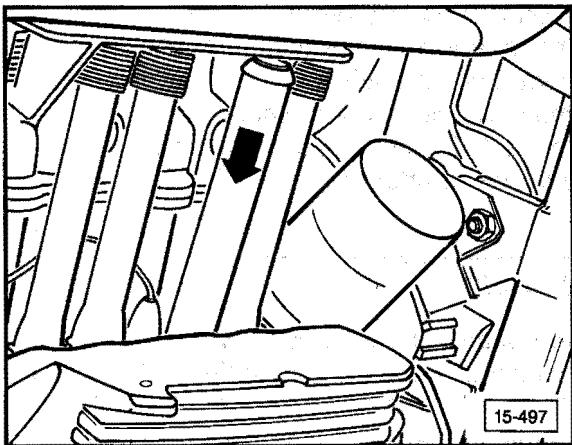


- insert pushrod in socket and slowly press together with valve guide or sawed-off pushrod in vise (bore A must face upward) or in press until lock ring can be installed
- install lock ring

**Pushrod tubes, replacing****Note**

Pushrod tubes supplied as replacement parts can be installed with engine in place.

- remove valve cover
- remove rocker arm shaft, pull pushrod out
- remove lower cover plate
- remove defective pushrod tube with pliers or screwdriver



- squeeze new pushrod tube together and insert with new sealing rings as shown (**arrow**)  
(tube seam faces upward, small end to head)
- insert pushrod and install rocker arm shaft

**CAUTION**

Guide pushrod carefully into seat of hydraulic valve lifter.

If pushrod rests on edge of lifter basic setting will be incorrect and lifter will be damaged when engine is started.

- adjust hydraulic valve lifters, see page 15.23

# 15 Engine—Cylinder Head, Valve Drive

## Cylinder head, resealing

### Note

To reseal cylinder heads, follow this procedure. Always do both sides. Cylinder heads can be removed without removing the engine.

### Removing

- disconnect battery ground strap
- remove rear mattress (where applicable), carpet, engine cover
- remove air cleaner assembly
- remove A/C compressor from bracket, leave hoses attached

### WARNING

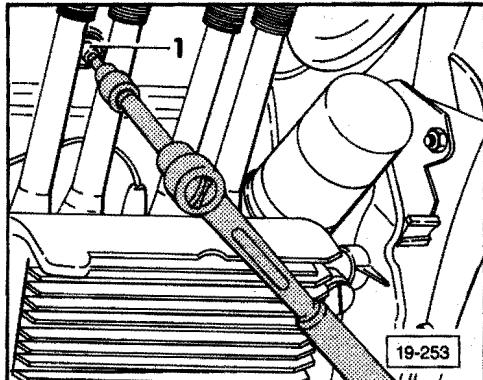
Fire hazard. Do not smoke or have anything in area that can ignite fuel.

- remove left/right fuel rails, injector ground wires and intake manifolds
- remove left/right splash shields
- remove push rod tube shields
- disconnect oxygen sensor
- remove coolant drain plugs 1 at both cylinder heads, drain coolant from engine
- drain engine oil, remove oil filter

### Note

Do not reinstall oil drain plug until repair is completed.

- remove spare tire cover under front of vehicle, disconnect coolant hoses
- reconnect radiator coolant hoses
- close spare tire cover
- remove coolant pump



- remove exhaust system, including cross-over pipes, muffler with converter and exhaust heat shield
- remove crankshaft pulley
  - see Repair Group 13
- remove power steering pump
- remove coolant cross-over pipes at front/rear of cylinder head
- remove valve covers, rocker arms, push rods, oil filler pipe

## Note

Mark push rods for reinstalling to original location.

- remove cylinder head cap nuts, push rod tubes and cylinder head
  - stuck cylinder sleeves may be removed by lightly tapping with small solid rubber mallet
- clean old gasket material from cylinder heads, engine block, valve covers
- inspect sealing surface of cylinder head, replace if pitting or cavitation present
- mark matching numbers on piston/cylinders
- pull out cylinder sleeves with tool 3092 until piston circlip is visible
  - see Repair Group 13
- remove piston circlips, wrist pins with tools 3091, 3159
  - see Repair Group 13

## Installing

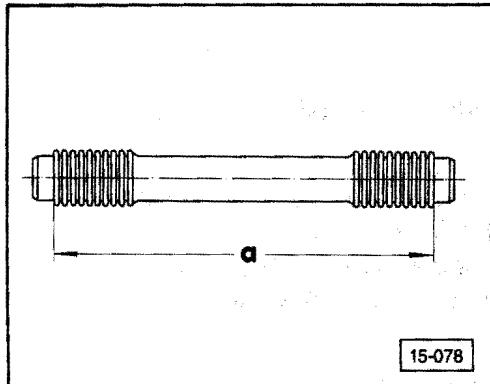
### CAUTION

Always replace gaskets, seals, O-rings, lubricants.

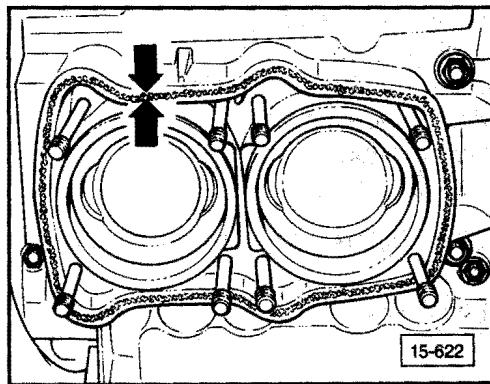
### CAUTION

Part numbers are listed for reference only. Always consult with the Parts Department for latest information.

# 15 Engine—Cylinder Head, Valve Drive



15-078



15-622

- inspect cylinder head studs for corrosion, and replace as required
- clean wrist pins, cylinder sleeves, pistons
- replace both cylinder sleeve O-rings
- reinstall piston and cylinder sleeve onto corresponding connecting rod
  - install wrist pin to connecting rod
  - see Repair Group 13
- clean push rod tubes, rocker arms, valve covers, cylinder head cap nuts
- measure and adjust push rod tubes to length **a**
  - a** = approximately 194 mm (approximately 7.6 in.)
- install new cylinder head gasket

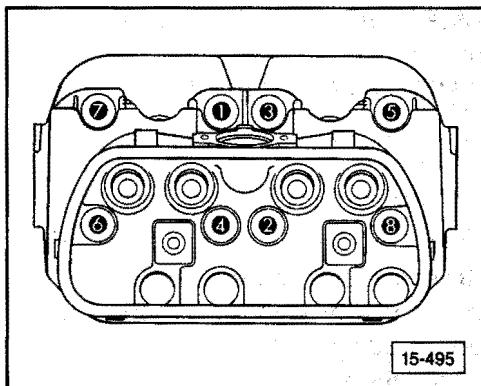
## CAUTION

Do not use too much sealant. Excessive sealant could plug cylinder head coolant passages or hydrolock cap nuts.

- apply cylinder head sealant Part No. D 000 400 01 in 1.0-2.0 mm (3/64-5/64 in.) bead (**arrows**) in center of gasket side facing cylinder head
- install cap nut location in 1.0 mm (3/64 in.) bead
- reinstall cylinder heads, push rod tubes, seam side up

## CAUTION

DO NOT use click type torque wrench.  
Use only beam or dial torque wrench.



- tighten cylinder head at stud 1 with cap nut just enough so that remaining 7 cap nuts can be installed

## Torque sequence

### Note

Ensure that push rod tubes are properly seated.

**First stage:** tighten cap nuts in numbered sequence to 10 Nm (7 ft lb)

**Second stage:** tighten cap nuts in numbered sequence to 40 Nm (30 ft lb)

**Third stage:** tighten cap nuts in numbered sequence to 50 Nm (37 ft lb)

- recheck final 50 Nm (37 ft lb)
- reinstall push rods, rocker arms
  - push rods must be properly seated before tightening rocker arms
  - torque: 25 Nm (18 ft lb)

## Hydraulic valve lifters, adjusting

- back out adjusting screws in rocker arms until ball shaped end is flush with surface of arm
- turn crankshaft until cylinder No. 1 is at TDC
  - mark on rotor must be in line with mark on distributor housing
- turn adjusting screws in until they just touch valve stems
- turn adjusting screws 2 turns clockwise and tighten lock nuts
- rotate crankshaft 180° clockwise and adjust next cylinder
- repeat until all cylinders are adjusted

# 15 Engine—Cylinder Head, Valve Drive

- reinstall all other components in reverse order of removal
- check expansion tank pressure cap with **VAG 1274/99**

## CAUTION

Coolant/antifreeze must not be reused when performing this procedure. When replacing coolant solution in all Volkswagen models, all years, use phosphate-free coolant **ZVW 237 104**.

- reinstall coolant drain plugs between cylinders
- refill with coolant
- reinstall engine drain plug, refill with oil
- reconnect battery ground strap
- remove radiator grille
- raise front of vehicle approximately 40 cm (16 in.) under cross member
- bleed air from coolant system
- lower vehicle to ground
- reinstall radiator grille
- pressure check cooling system for leaks with tool **VAG 1274/99**
- check and adjust engine specifications, as necessary

## Gasoline additive

"Autobahn Gasoline Additive" has been tested by Volkswagen, and found to be effective in reducing carbon deposits that result from fuel and lubricating oil residue. The additive works best with unleaded gasoline, but also works with leaded fuel.

"Autobahn Gasoline Additive" is supplied by Volkswagen of America under Part No. ZVW 246 001.

### Note

Read product label for additional information. Read all cautions and warnings.

#### Caution

Do not exceed this recommendation:

Oil change interval	Max. Treatments between oil changes
Miles	2
5,000	4
7,500	

Excessive carbon deposits reduce engine performance by:

- idle hunting (idle speed goes up and down)
- poor hot or cold starting (starter cranking takes longer)
- engine run-on (dieseling)
- pinging during full-throttle acceleration

To help clean out carbon deposits and minimize future carbon build-up:

- make sure that ignition and fuel systems are adjusted to specifications
- add one (1) 20 oz. bottle "Autobahn Gasoline Additive" to fuel tank. Fill tank completely. Do not refill until the gauge reads "1/4"
- use only gasoline with a detergent additive package. Information about fuel composition is available from any gas station or from the station's fuel supplier.

#### CAUTION

Part numbers are for reference only. Always consult your Parts Department for latest information.