This page will cover required parts and proceedures I used to do a complete overhaul of the roof and tonneau hydraulics. I have absolutely no training or credentials related to this field. Thus, everything presented here is informal in nature, and is for educational purposes only. Should the reader attempt to duplicate any part of this procedure, he/she shall be assuming responsibility for any personal injury or property damage suffered as a result.

So...why do you want to do this? Your roof works ok, your car has been well maintained, and you don't have any real leaks. Well, pretty much all of the seals are rubber, and they *will* wear out over time. Also, hydraulic fluid absorbs water, and with water comes dirt.

The abuses my car suffered are well documented elsewhere on this site. Hopefully your car isn't this bad, but I'll bet you've still got some of this crud lurking in the unseen places in the cylinders and reservoirs.




This fluid should be tinted slightly red or yellow. It should not be black, and there definitely should not be chunks of debris in it. If your fluid is clear, this indicates the possibility of someone having topped the system off with DOT brake fluid. This actually happened on my car.
What I unfortunately do not have a picture of is the coating of black sludge that was in my pump reservoirs.

I had three other motivators for overhauling the system.

1. I had a hole in one of the roof cylinder lines
2. The overall poor condition of the car. Everything was suspect. I only want to do this once, so I was going to do everything.
3. There was enough hydraulic blow-by that the tonneau could not support itself for any length of time. I believe the roof would have been in similar condition had it worked at all.

Index

Tools required

You don't really need much in the way of special tools. There is a mix of metric and SAE in the hydraulic system, along with the various Torx screws ASC decided to use. The only 'special' tool I can suggest is some kind of sturdy pick for getting some of the hard to reach seals. I picked up a dental pick at a flea market. Harbor Freight might sell them too.

System Removal

Fortunately, the roof and tonneau systems are completely independent of one another, and both can be removed from the car without disconnecting any of the lines. If you take your time, you shouldn't spill a drop of fluid inside the car.

The first step in getting everything out is removing the trunk carpet (all of it), back seats (upper folding portions and the bottom pad) and the rear speaker/seat belt panels. You'll also need to remove the rear speakers. The service manual covers all of this stuff pretty well, so I'm not going to go over it here. Basically, everything rearward of the front seats will be coming out.

Roof system removal

You pretty much NEED an assistant for this portion of the job. Make sure the quarter windows are open (retracted) and the header is unlatched.

Hopefully your tonneau still holds pressure well enough to support itself in the full open position for about 30-60 minutes. If not, you'll need a 2nd assistant or some creativity. In my case, I was able to use some cord to tie the tonneau to the drive rail for my garage door. You can use a prop rod later in the process, but during the roof system removal, you'll be manually opening and closing the roof. The trunk needs to be empty for that.

Step 1:
Check to see if your flipper door cable is interfering with the drivers side hydraulic line. During normal operation, the cable should go over the lines. For the hydraulic removal, it'll need to go under.

This will not work. For disassembly, the hydraulic tubing inside the corrugated sleeve needs to be above the cable. Not below it. However, this is the correct arrangement for normal operation.

If you need to re-route it, open the roof enough that the tension is off the cable. Remove the cotter pin and dowel, and re-route the cable under the tubing. Temporarily re-install the cotter pin and dowel.

Step 2:

Open the roof completely, either manually or using the control switch. Follow the roof piston from its location behind the rear speaker, up to where it joins the roof. You'll need a T40 Torx bit and a 12mm wrench to unbolt it. Make sure your Torx bit has a good, solid grip on the bolt. If you strip this bolt head, you will be in deep trouble. I'd actually recommend buying a brand new T40 just for this job. It's cheap insurance. Mine was extremely tight. Remove the bolts from both sides of the roof. Once the bolts are removed, retract the cylinders. If your system has no power or pressure, you'll need to find a way to do this by hand. If you do it by hand, make sure the power/manual knob is set to manual.

Step 3:
Remove the bolt from the base of the cylinder, immediately below the speaker. There's an access hole cut into the body to allow access to this bolt. Use a 14mm socket. Once both bolts are removed, leave the cylinder in place in the body, taking care not to pinch the hydraulic lines.

Step 4:

Work with your assistant to bring the roof to the halfway point. If you've ever operated the roof manually before, you'll notice it moves a lot more easily without the cylinders attached. CAUTION: With the cylinders disconnected, there is NOTHING to support the roof in anything other than fully closed or fully opened. Make sure that someone has a SECURE grip on the roof at all times, or that you have a VERY well supported brace!

You'll need to remove the hydraulic lines from the plastic body clips along the way. You may also need to disconnect certain wiring harnesses or latch control cables in order to free the lines. I'd recommend scouting this out before attempting to remove the cylinders from the body. With the roof securely supported in the middle of its travel, slide the entire cylinder (with the lines still attached) up out of the body and lay each one in the trunk. The hydraulic lines are flexible, but only to a point. By very careful not to kink them if you plan to re-use them. Do not support the cylinders by the hydraulic lines. The roof cylinders have some considerable weight to them.

Once the cylinders are in the trunk, make sure no hydraulic lines or wiring is in the path of the roof. Work with your assistant to close the roof. It is not necessary to latch the header or close the quarter windows unless you're going to drive the car.

Step 5:

Remove the roof hydraulic pump. There's one T40 bolt and one rubber fitting holding it to the body on the bottom. On the 'arm' that holds the hydraulic manifold, there's a Dual-Lock pad holding the bracket to the body. (Don't confuse this with the pad that holds the manifold to the bracket) Use a thin flat head screwdriver to separate the Dual-Lock. Disconnect the pump from the wiring harness. I've found a thin flat head screwdriver helps with the latch on the stubborn connector. Don't forget the silver ground strap running between the pump and the roof ECU. You can remove the ground strap from the pump by removing the reservoir screw. You won't lose any fluid.

Check to make sure the entire system is free of the body. Make sure all hydraulic tubing is free of body clips and not trapped behind any wiring harnesses or control cables. Once you're certain there are no obstructions, remove the pump, lines and cylinders as one assembly. Set it off to the side.

Tonneau system removal

Step 1:

Find some way to support the tonneau in the full open position. In my case, I used some string looped over my garage door rail and tied off to the tonneau latches. You can also use a prop rod for this portion of job. Just make absolutely certain that it is SECURE. *Once the hydraulic cylinders are removed, there will be absolutely nothing to prevent your tonneau from crashing into the rear of your car if your support gives way!*

Step 2:

Remove the clevis pins from the tonneau cylinders. Work a screwdriver under the clip that wraps around the cylinder rod, and rotate it up. Work the clevis free from the cylinder yoke and the tonneau lift bracket. You may need to gently shake the tonneau to release some of the tension on the clevis.

Step 3:

Remove the 3 nuts that hold the cylinder bracket to the body. Support the cylinder while removing the bracket. Set the cylinder and bracket aside, taking care not the kink the lines.

Step 4:

Remove the pump, using the same procedure as the roof pump. It is secured by one Torx bolt, one rubber foot, the Dual-Lock pads, the electrical connector and the ground strap.

Step 5:

Make sure the tubing is free of any body clips, electrical harnesses, and control cables. Remove the pump, lines and cylinders as an assembly.

Tips:

With the cylinders removed, the tonneau is extremely 'floppy'. The hinges offer NO lifting assistance. It's not heavy, but do not be caught off guard if you remove your support.

I didn't like the idea of leaving the tonneau open when I wasn't actively working on the car. Close the tonneau latches manually, and then lay the tonneau down on top of them. You can then open and close the tonneau by hand at will, and you won't have to fiddle with the manual latch release or the power system (which is now throwing a bunch of errors since you've removed most of the system)

Rebuild procedure - preparation

The rebuild sections will be presented in no particular order. I'll leave it to the reader to determine what works best for their particular situation.

Be warned. This WILL be messy, no matter what you do. I was able to drain the bulk of the fluid into an oil drain pan ahead of time, and I still made a mess. Try to find a large metal pan to do your work in. Until you've got a given part completely disassembled AND thoroughly cleaned, leave the part in the pan. Residual fluid will leak out of it via air pressure equalization, capillary action and simple gravity. You WILL have puddles. Plan ahead.

Good quality latex gloves are a must for this project. Buy a box. You'll go through quite a few before this is over.

Also keep this in mind. Even the smallest movement of the pistons will create a little burst of air. This will force fluid out of the fittings. Even if you think there's no fluid left, you'll be unpleasantly surprised to find a little blast of fluid vapor proving you wrong. Wrap a disposable shop towel around the fittings when moving the pistons.

Any time you're working with the cylinders, take great care to not scratch the rods, pistons or interior walls of the cylinders.

I used blue shop towels and brake parts cleaner to clean out all of the internal parts of the cylinders and pumps. All internal parts were coated with fresh hydraulic oil prior to reassembly.

Rebuild procedure - roof cylinders

Parts required:

Piston seal (1x per cylinder) - Crown seal, CP-326 (SKF)
Rod seal (1x per cylinder) - U12-0.75 (SKU 193817?)

Head o-ring (1x per cylinder) - Missing from notes

The yoke for the roof cylinders is held on with an Allen bolt. Fortunately, APW provided a flat spot to attach a wrench for assembly and disassembly. Also note the brass hydraulic fitting on the left side of the cylinder.


Here's the interesting part of the roof cylinders. The break them down, you need to remove the brass fitting in the photo above. Then, you push the top part of the cylinder down into the body of the cylinder. I used a deep well socket and a rubber mallet for this step. Drive the cap downward until you expose the snap ring.

The top 'cap' assembly is wedge shaped. When it sees hydraulic pressure from below, the top cap is forced upward, which wedges the snap ring between the cap and the mating notch in the cylinder body. Once you drain the oil out and push the cap down into the body, it comes apart fairly easily.

Remove the snap ring. If you can't get a grip on it, look for a small hole in the cylinder body thatl ines up with the snap ring notch. Insert a punch into this hole to force the snap ring away from the notch, allowing you to get a grip on it with pliers.

Once the ring is out, pull back up on the main rod. The whole cap and piston assembly pops right out. The hole seen in the photo is where the brass fitting threads in. The big white seal is some sort of felt. It prevents debris intrusion. I have been unable to find replacements for these. Flushing them out with brake parts cleaner and then soaking them in fresh, clean hydraulic fluid seemed to do the trick though. There is a smaller version of this debris seal inside the cylinder cap to seal off the piston rod.


So long as the yoke is removed, the piston rod will easily slide free of the top cap. There is no need to remove

the piston from the rod.

The piston seal is a "T" seal, with plastic backup rings. Those rings are split on one side. Remove the backup rings, and then use some sort of hook or dental pick to get behind the T seal and slide it off also.

The hydraulic shop I used for most of my replacement parts recommended these crown seals as an upgrade. The *PDF* explains how they function. The replacement seals were a perfect fit, but they are TIGHT. They do not stretch easily, nor should they.

OEM T-seal with plastic back-up rings on the left, aftermarket crown seal on the right.

You need to get the square edge of the seal fully seated in the piston groove, and then slowly 'walk' the seal down onto the piston. Work in small steps, and make sure to continually square up the seal with the groove so it seats cleanly. If the seal does not seat cleanly, you won't have enough slack to get the last half inch or so into place.

Take your time and work carefully. For me, this was the hardest part of the entire job. The factory style T seals would probably be easier to work with. In hindsight, I'm glad i went with performance over convenience.

I've read that pre-heating the seal in hot water can help with installation, but I didn't try that on mine.

Once the seal is installed, and the cylinder body is thoroughly cleaned, coat the piston and the cylinder bore with fresh hydraulic fluid. Make sure the entire inner surface thoroughly coated. Insert the piston into the bore, making sure to keep it square. Inserting the piston at an angle could cause it to scrape the cylinder wall. Drive the piston all the way to the bottom of the cylinder.

Due to the tight crown seals I used, I had to use a rubber mallet to get the seal to collapse into the cylinder. Stock style T seals may not be as bad. My stock seals were so badly worn that the piston moved freely with fingertip effort.

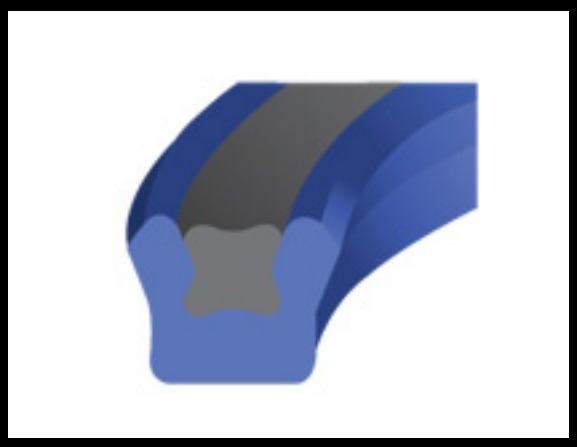
The top of the cylinder has its own annoyances. The outer o-ring install is simple, as is the outer debris ring. Just make sure not to stretch either one far enough to damage it. Especially the fiber debris ring, since you'll be re-using it.

Inside the top assembly is another, smaller debris ring. You can use your pick to remove that. Further down (towards the interior of the cylinder) is another seal. Before removing it, make sure you're committed to

replacing it. If you use a pick, you're virtually guaranteed to damage the old seal during removal.

The seals I chose have an inner reinforcing ring with an X profile. As fluid pressure is exerted on this inner ring, it forces the outer seal to swell and force itself against the outer walls as well as the piston rod.

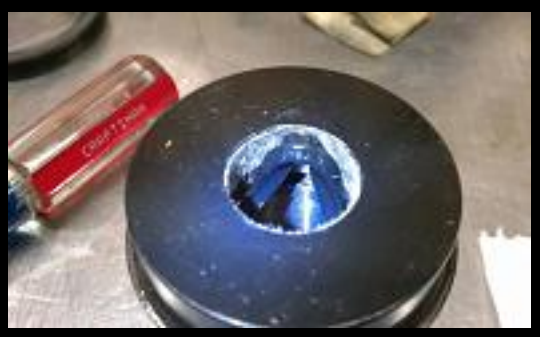
Make sure to install the seal in the correct orientation. The inner reinforcing ring has to face towards the interior/bottom of the cylinder.



(Loaded U seal. No higher resolution available)

This was the 2nd hardest part of the rebuild for me. You have to gradually work the new seal up into the mating notch, being careful not to pinch it hard enough to damage the rubber or twist the inner ring. Work slowly with the blunt end of the pick or a similar tool. Stop frequently to check and make sure the inner ring hasn't popped loose of the main seal body, and that none of the rubber is pinched or folded over. If you see things are getting twisted, gently pull the seal out and start over.

If you try to install the seal from the top, it may help to install the debris ring first, so that the seal doesn't try to get caught up in the installation notch for the debris ring.



Once the seal is installed, coat the inner bore of the cylinder top cap with hydraulic oil, and install it over the top of the piston rod. Make sure the threaded port for the hose fitting is in line with the hole on the cylinder body. Slide the top cap down far enough to reinstall the snap ring.

Install the yoke on the piston rod. Pull the piston up until it hits the bottom of the top cap, and then keep pulling until the top of the top cap slides upward and is flush with or slightly past the top of the cylinder body.

Depending on how tight your seals are, you may need to run some long screwdrivers or dowels through the yoke and the mounting boss on the bottom of the cylinder, and then brace the cylinder like an old style bicycle pump. Pull upward to seat the top cap.

I was originally concerned with how tight mine was, but my roof cycles normally and well within the specs described in the manual. There's 1200-1400 psi applied to each cylinder during operation. Snug is better than loose.

The last thing to do is reinstall the 90* fluid fitting. Make sure the threads are clean and dry. Coat them in a thread sealer compatible with hydraulic fluids, and let it dry according to the instructions on the package.

Rebuild procedure - tonneau cylinders

Parts required:

- Piston seal (1x per cylinder) - PS1800-24 Glass Filled PTFE Piston Assembly 1.500 X .116/.121W; 1.190 GR/ID The O-Ring Store
- Piston o-ring (1x per cylinder) - AS568A Dash Number 110, Material Buna-N 70 shore The O-Ring Store
- Rod o-ring (1x per cylinder) - AS568A Dash Number 112, Material Buna-N 70 shore The O-ring Store
- Square profile cap seal (1x per cylinder) - SN70128 The O-Ring Store

First thing to do here is remove the yoke from the piston rod. On mine, I used a section of old alternator belt to pad my Channel-lock pliers. Grab the piston rod with the pliers, and unthread the yoke. Mine had some thread locker, so it was a bit of a challenge. Also, remove the bent washer.

Next up, unscrew the top of the cylinder. One of mine was fairly easy. The other one was a monster. It seemed to have some sort of adhesive holding it to the cylinder body.

I don't have much advice to give here other than to be careful not to damage the top cap. It's some sort of

reinforced nylon or plastic. I've seen suggestions for using a 1/4" socket in the pivot point on the cap to gain additional leverage. In my case, the only thing that worked was repeated applications of brute twisting force.

Caution: If you decide to clamp the cylinder for any reason, **do not** do so in the center part of the body. You can easily deform the cylinder.

The top cap has 3 seals. One is a debris seal, which I didn't replace because I couldn't find a replacement. Another one is an o-ring that seals against the piston rod. The third is a square profile o-ring that goes between the top cap and the cylinder body.

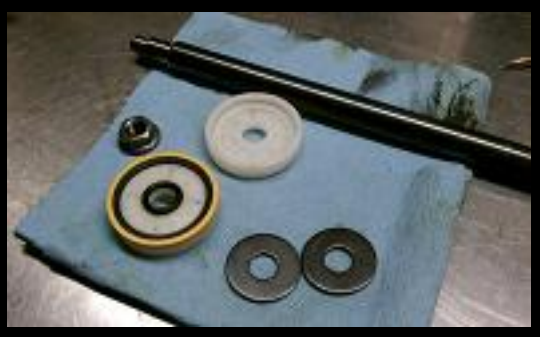
Seal has been partially pulled out of its groove.

This is the overview of the parts. Credit goes to Jim Watkins for this photo.

The tonneau piston is held onto the rod by a nut. When you remove the nut, the piston splits into an upper and lower half.

There's an inner o-ring to seal the shaft to the piston, there's an outer o-ring, and then a hard blue seal between the o-ring and the cylinder inner wall.

The piston parts in my cylinders were white plastic. I didn't realize that until I cleaned all the gray sludge off.



Before cleaning, and after.

The new piston seals are a different color and have a square profile backup ring rather than a round one. But they seem to work just fine.

Reassembly of this piston is a breeze compared to the roof cylinders. Just coat everything in hydraulic oil, and make sure none of the rings get pinched during assembly. When installing the nut, torque it down until it is tight, but don't go so far that you crack the piston. I wish I had a torque spec for this. I used a dab of blue loctite on the nut just in case.

Working the piston back down into the cylinder is easier than it looks. The top of the cylinder is slightly tapered, but not quite enough that you can just drive the piston home with a mallet.

Instead, make sure everything has a coat of hydraulic oil on it. Seat the piston until it stops, then tilt it SLIGHTLY on an angle. Just enough that the bottom edge of the seal starts to seat.

Next, work around the edge of the seal with the blunt flat side of a screwdriver. User your other hand to keep constant downward pressure on the piston and rod. It's difficult to describe, and unfortunately I don't have a picture. Basically, just keep nudging the seal inward towards the piston until the whole thing pops into place.

It'll take a while and you'll probably be frustrated, but it WILL go.

Assembling the top cap is pretty much self explanatory. Make sure not to twist the piston rod o-ring. Seat the square ring all the way in the top cap. Then reinstall the cap onto the piston rod and cylinder assembly, taking care not to cross-thread it. Tighten the cap down until both hydraulic tube fittings are in line with each other.

Reinstall the bent washer and yoke.

Rebuild procedure - manifolds, pumps, and lines --Pumps

Parts required:

Pump shaft seal (1x per pump) - O-Ring Loaded Square Profile Lip Seal 3/8" ID X 5/8" OD X 1/8" Height X 1/8" Width. McMaster-Carr part# 9505K15
Reservoir o-ring (1x per each pump) - OD: 2.9" cross-section: 0.135"
Reservoir fill plug o-ring (1x per pump) - Missing from notes

A note about the motor assembly used in the pumps. They were originally manufactured by the Tru-Torque division of Leeson Electric of Sedalia, MO. The part number is 970.622. They are rated to operate at 13.5V. Applying positive voltage to the red wire will cause the motor to rotate clockwise, as viewed from the end of the shaft. Replacement parts (brushes, bushings, etc) can be had from most places that sell or service Leeson motors. Places such as IBT, Motion Industries, or Applied Industrial Tech, among others. This information was obtained from the label shown below, and from subsequent emails to Leeson's technical support.

Special thanks to Emilie at Ground Zero Performance for this photo

Per the factory service manual, the pumps and manifolds are *not* interchangable. Prior to any disassembly, mark the pumps and manifolds in multiple places to insure they go back where they came from. I used painters tape and a Sharpie to mark my parts. It held up to the hydraulic fluid fairly well. Any other markings can be removed with brake parts cleaner once reassembly is complete.

There are two o-rings and one seal on each pump. The reservoir o-ring, the fill plug o-ring, and the pump shaft seal.

To remove the reservoir, remove the 4 screws that hold it to the pump body. Drain off any residual oil, and then clean out any sludge with a disposable brush and some solvent.

On the rear of the pump, where the wire harness enters the pump motor, there are two very long bolts. Remove these, and then the pump will split in half. Slide the motor casing off, being careful not to lose the springs for the motor brushes. There is also a small silicone or teflon bushing at the base of the motor. Finally, remove the motor core and shaft from the pump body.



The shaft seal is held into the pump body with a snap ring and a washer. Upon removing the snap ring and washer, you may find the seal looks nothing like the replacement that's been speficied. Both of my Spyder pumps and my identical junkyard Camaro pump had these lower quality seals. The seal specified in the parts list came directly from Leeson Electric, and I'm taking that as authoritative. My only guess for the cheaper seals found in some of the cars is that APW decided to pinch pennies somewhere along the line.

Anyway, wet the new seal with hydraulic fluid, and install it with the wider lip facing towards the pump reservoir. You'll feel it snap into place. Install the snap ring and washer.

You'll probably want to install the cleaned reservoir and new o-ring at this point, as it'll make assembling the

motor body easier. Lube the reservoir o-ring and install it on the pump body. Next, lower the pump body down into the reservoir, taking care to make sure the o-ring isn't pinched. If it is, gently work it into the reservoir with a blunt, flat blade screwdriver. If you force it you'll risk damage to the o-ring or worse, the reservoir itself. Once everything is lined up correctly, it'll just pop into place with minimal effort.

Assembling the motor casing and the pump body is best done with three hands. Since we only have two, we'll do the best we can.

First, make sure the brush springs are installed in their channels, and then slide the brushes all the way in. Make sure the silicone bushing is in place, and then drop the motor core into the base plate. Slide the motor casing over the core and down onto the base plate. The magnet will try to grab at the motor core, so do your best to keep the core seated in the base plate while installing the case. There are alignment notches in the base plate, casing, and pump assembly.

Look at the end of the motor shaft, and notice it has two flat sides. Look down into the pump body and make note of where the flat spots are on the pump gear. Try to line up the shaft and the gear so they fit together during insertion.

Install the pump motor onto the pump body, and then back it off just enough to see down into the pump motor. Insert the long bolts, and use the gap between the pump body and the motor casing to line up the bolts with the threads. Once you've got them aligned, run the bolts in for 2-3 threads.

Flip the pump over and repeat for the 2nd bolt. Before tightening everything up, make sure the base plate and pump body tabs align with the notches in the motor casing. Once you're certain everything is lined up, tighten the bolts.

--Manifolds

Parts required (total if doing both manifolds):

(2x per manifold) - 1.8mm cross section x 10mm ID, Material Buna-N 70 shore. The O-Ring Store
(1x per manifold) - 1.8mm cross section x 6.7mm ID, Material Buna-N 70 shore. The O-Ring Store

I would highly recommend buying extras. It's very likely you will damage one or more when reassembling the manifold. O-ring assembly lube would probably also be a good idea.

Per the factory service manual, the manifolds are NOT interchangable. Mark them prior to starting work.

There should be no need to remove the brass hydraulic fittings unless they are damaged.

The hydraulic manifolds have 3 o-rings each. All three o-rings are seated on the shaft at the base of the power/manual knob. This shaft is held in with a snap ring on the back side of the manifold. To remove this snap ring, use a small, thin screwdriver. Be careful not to deform the snap ring.

Once the snap ring is off, gently tap the shaft out from the back of the manifold. The entire shaft and knob assembly is plastic, so be careful not to damage it.

Use a pin or pick to pull the old o-ring off the side of the shaft, and to remove the o-rings from the top and bottom of the shaft. Coat the new rings in hydraulic fluid or o-ring assembly lube. Try to get them seated in the grooves as far as possible. Also coat the inside bore of the manifold in hydraulic fluid or assembly lube.

Align the tip of the power/manual knob between the two markings on the manifold label. The knob only has 90 degress of travel, and can only be installed within within that range.

Genrly insert the shaft into the bore, taking care not to pinch any of the o-rings. Use a slight back and forth motion and minimal downard pressure to let the shaft 'walk' itself down into the bore. If you encounter resistance, don't force your way past it. It probably means one of the o-rings has caught on the lip of one of the internal passages. If the resistance suddenly goes away, odds are you chipped one of the o-rings and now you have a loose fragment of debris. Remove the shaft, clear out any debris, replace the damaged ring, and try again. I went through 3 of the shaft side o-rings before I got the technique right.

Once the snap ring notch has cleared the back side of the manifold body, cycle the knob from power to manual and back again a few times to make sure everything is seated. Again, if you encounter any resistance or sudden lack of resistence, you may have chipped an o-ring. Once the knob moves smoothly to both stops, reinstall the snap ring.

--Lines

Parts required:

Newage Plastics Nylon-12 High Pressure Flexible Tubing .170" I.D. 1/4" O.D. working pressure = 450 psi @ 70*F US Plastic online catalog

Parker CompressAlign 61CA-4 nut and sleeve assy. Lesman Instrument Company
Parker CompressAlign 63PT-4-40 tube insert. Lesman Instrument Company

The number of hydraulic fittings required will depend on how much of your system you're rebuilding. I don't have an exact measurement for either the individual tube lengths or the total length of tubing required.

Parker Compress-Align Catalog

On my car, I replaced every line longer than 6 inches. That's everything except the two short lines that run between the pumps and manifolds. The only reason I didn't replace those was to maintain the color coding for which pump port moves the pistons in which direction. Had I been able to locate translucent tubing, I'd have kept the color coding all the way through the system, and replaced everything.

As it was, this was the best I could do given the nearly complete lack of information about the OEM parts. All I knew was that it had to have a working pressure of 450 PSI.

I found what I believe to be a fairly close match without having to buy a 1000' spool. $40 for 100' wasn't bad. I still have plenty left over it anyone would like some.

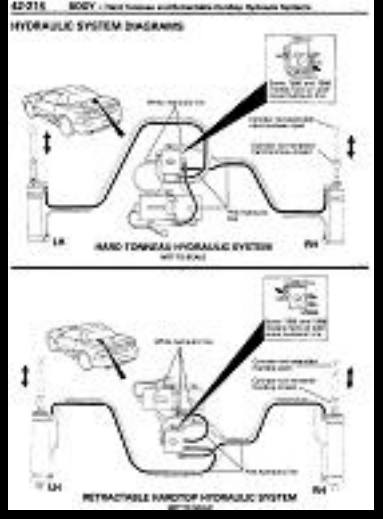
The fittings were a bit easier to match. They're Parker CompressAlign fittings. Unlike typical compression fittings that have separate nut and compression ferrule, these are all one integrated assembly. That makes them a breeze to assemble. The only other thing you need is a brass insert for the tubing to keep it from deforming.

Expect some hiccups if you try to order from Lesman. Their online cart doesn't have an option for 'personal', so they expect a tax ID for a business. I was able to pay the sales tax sepatately, but it took a 2nd payment and another day of email and processing time. I would think that any Parker dealer should be able to get these fittings.

Tubing assembly was very easy. The tubing can be cut with a sharp utility razor. Do your best to make the cut 90*, but don't obsess over it. Thread the sleeve down onto a fitting (like one of the 90* fittings on the cylinders) until it's finger right. Install the tube insert into the tube, and then slide both down into the nut until it bottoms out. Tighten the nut one turn with a 1/2" wrench. The nut and sleeve will now be trapped on the tube.

I didn't bother trying to measure the old tubes for length. I loosely installed the cylinders and pumps after everything was cleaned and assembled, but before I had put any fluid in. Then I installed a nut onto one end of the tubing, and threaded it onto a fitting on a cylinder. From there, I ran the tube back to the distribution manifold. Once I was relatively confident I had the length right, I cut the tube free from my spool, installed the 2nd nut, and threaded it onto the manifold. The service manual hydraulic diagram was indespensible here.

This should go without saying, but triple check your hose routing. Having the hoses routed wrong could cause severe damage to the car and/or personal injury.



After everything was installed and routed, I used small zip ties to start bundling each pair of tubes for each cylinder. You can do final routing once it's all in the car for good. For now, the goal is just to keep things organized. Once that was done, I removed each system from the car just like I did when I first started, without disconnecting any tubes.

Post rebuild - Bleeding

Per the factory service manual, adjustment bleeding can be accomplished with the system in the car. However, for a more thorough bleeding, it is recommended to remove the cylinders to allow gravity to aid in the bleeding process. It may be possible to accomplish this with the system still in the car, but everything I will describe is with the system removed.

Arrange the cylinders in a drip pan in case of any leaks, and place the pump at least a foot above the cylinders. If necessary, weigh down the lines so that they're also below the level of the pump. Using a turkey baster or large syringe, fill the pump reservoir with hydraulic fluid. Don't top it off, but don't worry about going over the top fill line right now. It'll take a few cycles to pump up the cylinders. Leave the fill plug off. You may also want to place some rags or a pan under the pump in case it leaks or 'burps'. Place a clean rag over the fill plug port so that any fluid burps don't splatter.

To cycle the pump, jump the lead directly to a car battery. I used a mating connector and short section of wire which I salvaged from a junkyard Camaro convertible. If your cylinders are retracted, you'll need to jump the x wire to the positive terminal. If the cylinders are extended, you'll need to apply positive voltage to the y wire.

Run the pump just long enough to get the reservoir low, but not empty. For the first couple attempts, you won't see any movement at the pistons. Periodically fill the reservoir to about 3/4 and keep cycling the pump in one direction until the pistons start to extend (or retract). The motion will not be smooth at first, and the pump may make quite a bit of noise as air is expelled from the system.

Once the pistons have reached the end of their travel, reverse the battery polarity and cycle the system in the opposite direction. As the air eventually bleeds out, the motion of the pistons will smooth out and the pump noise will be consistent.

Once you see and hear minimal air being bled off, run the system through 3-5 more full extend-retract cycles. On the final cycle, leave the cylinders retracted for installation in the car. Fill the pump reservoir to the upper fill line, and install the fill plug.

Post rebuild - Install

Resintall is pretty much the reverse of removal. The only real challenge I faced was getting the roof cylinders reattached to the roof linkage. I had to have my assistant hold the roof in the half-open position while I used the battery to gradually extend the cylinders out to a point where I could reach the yoke and bolt.

After installing the pumps and cylinders and tightening all the bolts, manually move the roof and tonneau to the closed and latched position. Start the engine, and attempt to open the roof. Again, having an assistant to either work the roof switch or watch for faults (leaks, binding parts, etc) is very valuable. You may want to stop the tonneau and the roof part way through each of their travels to inspect for leaks, and to make sure they are holding pressure and staying open on their own.

Once you're satisfied everything is operating properly, run the roof through the auto config procedure using the TopLink software.