

Brake booster rebuild notes from others

... finally caved and started overhauling the brake booster O-ring, which I suspected was the cause of the slight Pentosin leak underneath the car.

I dutifully pulled everything apart and discovered a shrunken O-ring rattling around in its groove. Replace it with the NAPA 727-2222 part, or tried to. Discovered that if you don't have the set screw flush with the booster bore, pushing the oversized O-ring in will nick it as it passes over the set screw hole. A new leak will ensue shortly. I recommend deburring the set screw hole prior to pressing in the new, and slightly oversized, O-ring.

So, having figured that out, I reassembled the whole thing and pressurized. Now I'm getting a small leak, but I suspect it's from the front cup assembly's (see red below) shaft seal bushing.





Well, just finished R&R the plunger/shaft seal. Removal was pretty easy having made a kluged-up removal mandrel consisting of a long 1/4" screw, some washers and a bolt, combined with a semi-deep socket:





I threaded a large washer onto the "inside" facing of the seal, pulled the screw through the seal and mounted a 15/16" socket (1/2" drive) onto the "nose" of the cup to provide some area to pull the seal. Again, another washer and then finally the nut:



You might notice that clamp around the nose of the cup. I **lightly** crimped an Oetiker 22mm clamp for provide strain support for all these operations, but in reality you probably don't need one if you proceed very carefully.

With a decent number of wrench turns, the seal is smoothly pulled from the cup nose recess. Part 1 is now complete:



Installing the new seal was, frankly, a bitch. I tried doing the screw/socket/mandrel thing in reverse, but the seal's rubber coating buckled severely as it was forced into the cup bore. The bore is undersized and relies on the compressibility of the rubber coating to squeeze into the bore and provide a tight seal. So, after a few e-mails to the ATE Brake Booster Brain (i.e., Bill Fox), the classic "shop vise squeeze" technique was tried.

Bill recommended sanding down the lip a bit to provide some bevel to help start the new seal into the bore. Some 150 grit sandpaper did the trick. Next I placed a 32mm 1/2" drive socket into the big end of the cup. The socket protrudes from the cup and rests on the first shoulder inside the cup, and takes the compressive forces that the rather fragile lip might bear. On the seal side, I placed some flat shim steel to evenly distribute forces over the width of the seal. Next I placed the seal on the bore lip, dribbled some dish soap over the

seal, and wound up the vise while heating the neck of the cup with a hair dryer to provide some expansion (another suggestion from Bill). The seal moved smoothly into position. I had to push the seal completely home using a small socket that matched up with the O.D. of the seal. Again, a little force from the vise did the trick.



The new seal feels much, much tighter around the plunger. We'll see if it solves the problem. Stay tuned.

So, if you're getting the classic dribble from the booster weep hole, obviously you should change the O-ring. But as you disassemble the entire gizmo, carefully check down into the neck of the cup for any accumulations of Pentosin. I had some sloshing around down by the plunger seal. Not thinking, I simply passed it off as some stray fluid buildup. Dumb.

Also, here's another trick to disassemble and reassemble the cup. I took a 32 mm 1/2" drive short socket with a 6" extension and inserted into the cup prior to releasing the set screw. Makes it easy to walk/rock the always-stuck cup out the first few millimeters, and then once it starts out, to hold it against the considerable spring pressure:



It also helps installing the cup with the new O-ring. Line up the cup so the cast index tab meets up with the recess in the casting, compress the spring, and slightly rock/tip the cup back and forth to start it into the bore. That 1/2" extension gives you some mechanical advantage.

<http://denmark.esar.org.uk/car/servo/>

ATE Brake Servo Rebuild

Servo Removal



Linkage



Brake pipes



Servo removed

1. Pump brake pedal until it goes hard
2. Remove spring clip from bottom of linkage pin and remove pin
3. Remove split-pin and spring
4. Syphon out brake fluid from master cylinder reservoir
5. Disconnect brake lines from master cylinder
6. Disconnect hydraulic pipes from servo
7. Remove 4 bolts holding servo in place (loose nuts on back)
8. Remove servo & master cylinder

9. Place servo in a vice and remove the two bolts holding the master cylinder to the servo

Servo Disassembly



[Set screw](#)



[All parts](#)



[Large piston](#)



[Small piston](#)



O-ring groove & backup ring

WARNING: The set screw is all that holds the servo components in, there is a large spring that will try and throw the components all over the place when you remove the set screw!

1. Loosen set screw half a turn using mole grips
2. Place servo on workbench master cylinder side down, push down with considerable force, remove set screw and slowly release downward force
3. The servo components may be stuck in place by dried up hydraulic fluid, if so carefully prise out the plastic insert by placing a flat bladed screwdriver through the hole in the side of the plastic insert. At some point you'll break the resistance and if your not careful, everything will go flying. To prevent this place a pile of rags against a wall and place the servo an inch away so that the rags/wall prevent everything coming out.
4. Gently remove remaining components, a pair of long-nose pliers wrapped in rags works fairly well.

Oil Seal & O-Rings



Old oil seal size



[Old/new oil seal 1](#)



[Old/new oil seal 2](#)



[Old/new o-rings](#)

Oil Seal Replacement



Removing old seal



Seal removed



Pressing in new seal



Seal pressed in



Seal replaced

WARNING: The plastic insert is old and brittle and irreplaceable (short of a visit to a local machine shop), you really don't want to break it!

1. Place a hose clamp around the neck of the plastic insert to prevent it expanding too much and shattering while removing the oil seal.
2. With a flat bladed screw driver and small hammer, repeatedly hit the back of the oil seal on the same side until it rotates out. Be gentle, it took me the best part of an hour
3. Thoroughly clean the plastic insert with a lint free cloth
4. Lubricate the new seal with fresh ATF
5. Press new seal in with a vise. I found it was necessary to start the seal off at a very slight angle to get it started and then straighten it up by pushing/pulling on the block of wood in the vise at the seal end

O-ring Replacement



Piston o-rings



Input shaft o-ring



Plastic insert o-ring

1. Remove the o-rings with the proper tool or a small flat-bladed screwdriver wrapped with several layers of selotape
2. Lubricate new o-rings with fresh ATF and install

Reassembly



Reassembled

1. Thoroughly clean everything with a lint free cloth
2. Insert small spring and large piston, it may take a bit of force to get it seated properly, once it's properly seated it should return by the spring pressure if you press it down
3. Insert small piston into large piston
4. Insert input shaft into case
5. Place spring seat over small piston, stack up spring, washer and plastic insert
6. Rotate the whole thing so the plastic insert is on the workbench and press the case down over the plastic insert and secure with the set screw. It's useful to have a flat-bladed screwdriver to hand as the plastic insert has a habit of twisting slightly as the case is brought down. Placing the screwdriver through the hole in the side of the insert will bring it back into line.

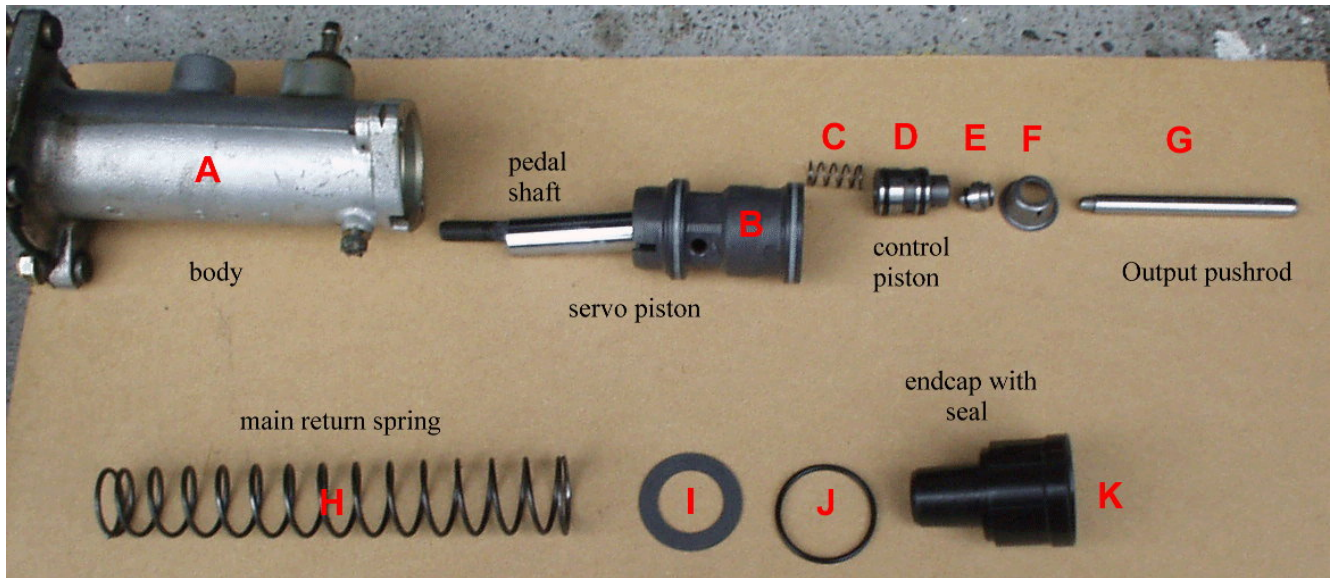
Reinstalling

Reinstalling is the reverse of removal, make sure the input shaft fork goes into the brake pedal linkage correctly before bolting the servo in place as it's next to impossible to do afterwards (yes, I did forget).

Breakdown of the H31 brake booster

While I had the chance, I thought I'd take the old ATE H31 booster apart to see if they are really as "unrebuildable" as everyone says...

Here's the exploded view:



.. Original reason for failure: leaking from the brake master cylinder end, eg a failure of the seal in the low-pressure endcap K to the output pushrod G.

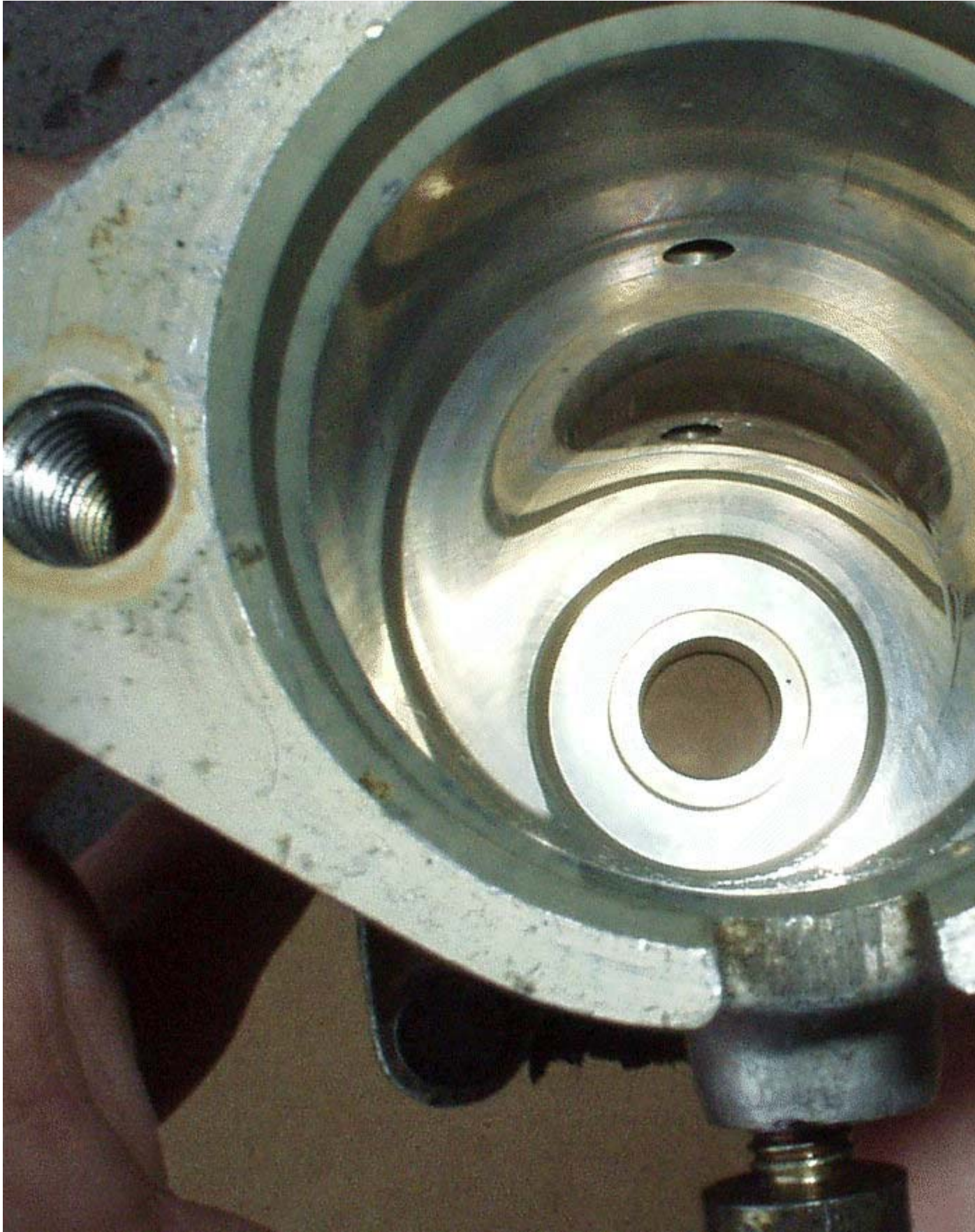
Quick thoughts on rebuilding:

- a) if your booster was leaking from the pedal shaft, the high pressure seal needs to be replaced with the new polyurethane unit (Beware - some oil present in the felt ring under the rubber cap is normal - mine was "misted" or just oily)
 - b) check the body for scoring in the bore
 - c) check the white high pressure seal rings on the servo piston
- If any of a, b or c are bad, I'm guessing they're not common to find replacements for...
- d) see if you can get a replacement seal for the endcap, K, and some oil-resistant adhesive to seal it in. I've not tried this, but K shouldn't see much more than atmospheric pressure anyway
 - e) get the other 4 internal o-rings (J, 2 from D, 1 from E) and replace

How to get it apart

To get your booster in this state, you've got to use vice-grips to loosen that little grub-screw on the bottom of the body - it holds the endcap K in against the pressure of return spring H. **BE CAREFUL** - that's a powerful spring, so use a rag over the end to stop bits flying and don't put your face close!!

As far as rebuilding chances go, the bore in the body A and the pedal shaft coming from the servo piston B are all in great, unscored condition - I guess the special hard-teflon (I ****think**** it's teflon) seals - the white rings on B, and another in the body - are OK, and helped this. They aren't standard, off-the-shelf parts, and if they were damaged I'd say you would have a hard time replacing them. Here's the bore of the body, for reference:



The main culprit for rebuilding would be the endcap K - here's some close-ups, the seal seems to be a normal kind of seal, but possibly glued into the plastic endcap itself:







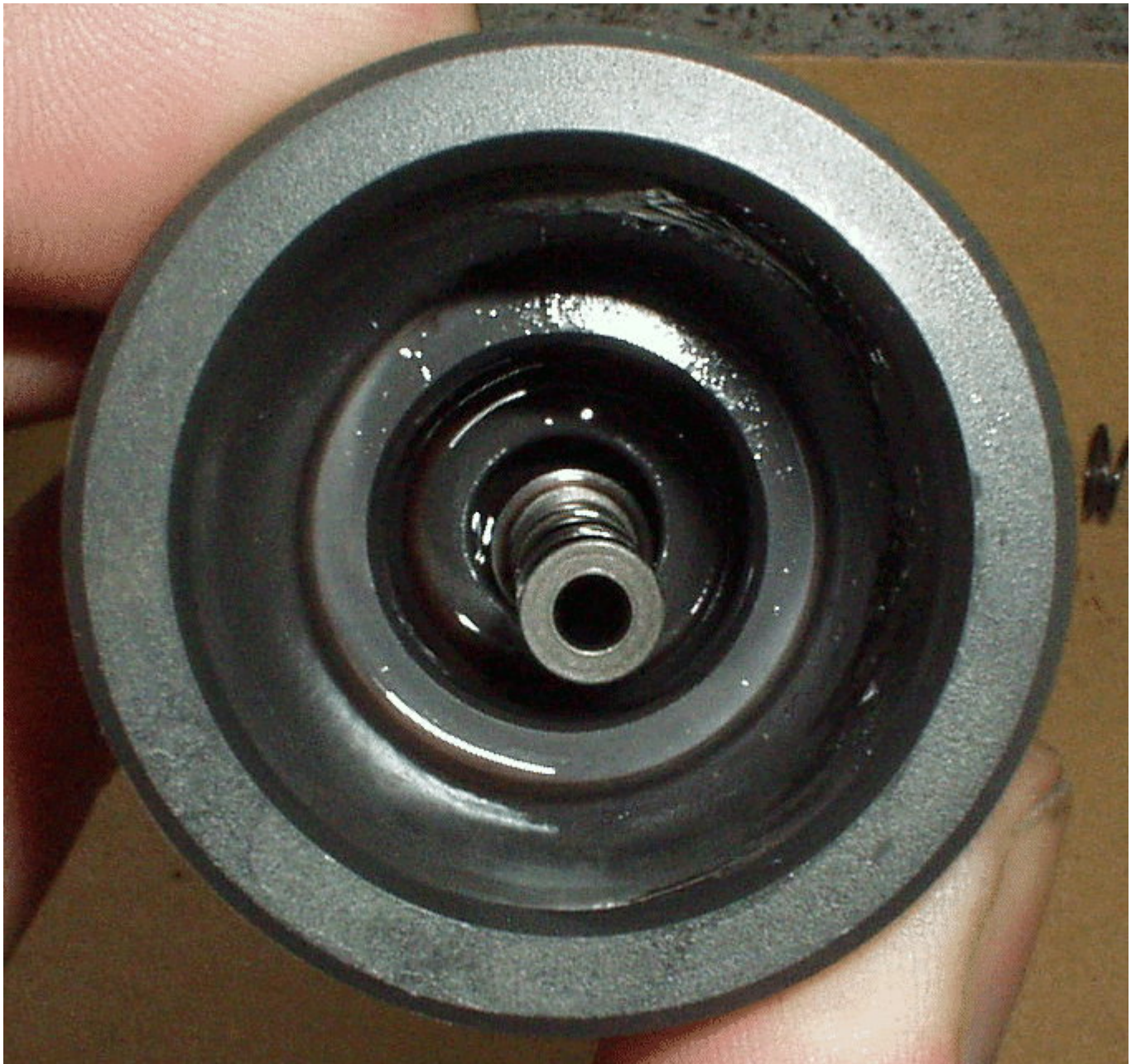
Remember too that the seal for the outer edge of the endcap (to the bore) is via o-ring J which is compressed between the step on the endcap inside end and the spring-seat washer I.

All the other items do have varying seals, but all of the common o-ring types - since we're using common ATF I don't think they're any special material, probably just normal neoprene. The control piston D has 2 on it; it's usually stuck inside the servo piston B, with the pushrod seat E stuck into its end (E has one o-ring on that "stuck" end). Wiggle the end of the piston, and spring C will push the lot out.

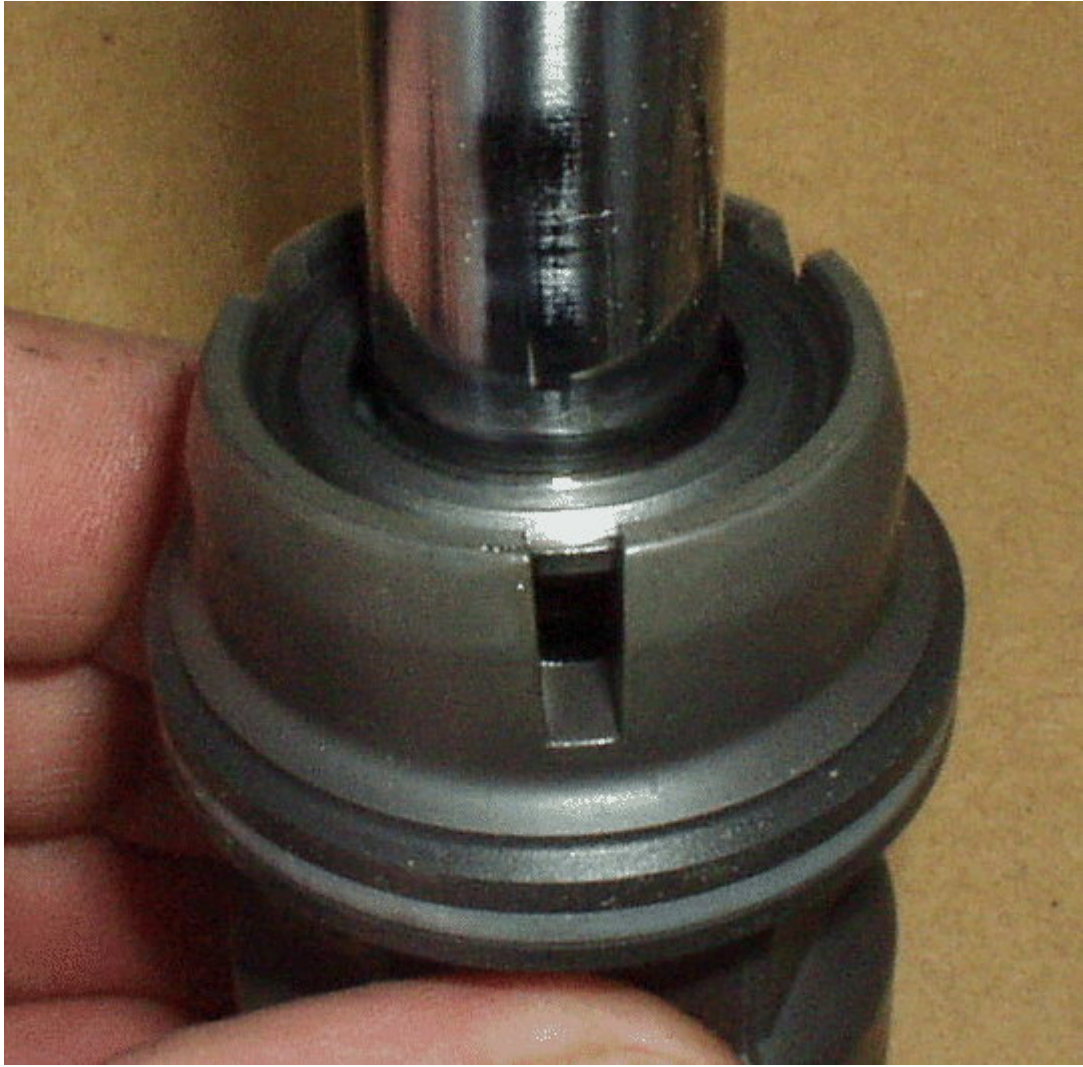
Here's these parts in close-up:



And here's where they fit into:



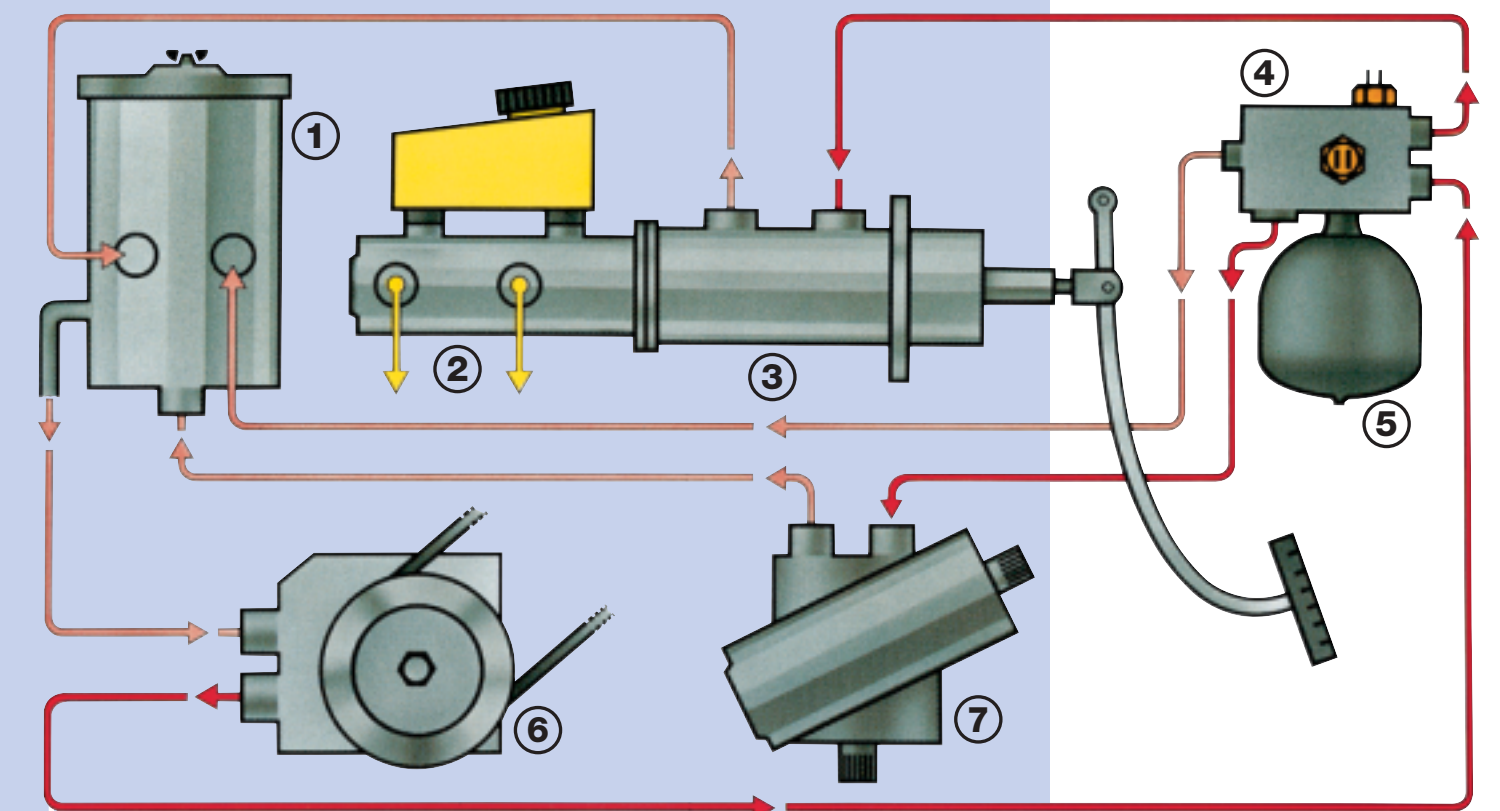
Still thinking on the rebuilding side, here's the details of the high-pressure end of the servo piston: I think this end is not dismantlable, it seems to be "staked" (eg edges stamped over) together.





Umlaufstellung

- ① **Vorratsbehälter**
- ② **Tandemhaupt-
zylinder mit Aus-
gleichsbehälter**
- ③ **Hydraulischer
Verstärker**
- ④ **Druckgesteuerter
Stromregler**
- ⑤ **Hydrospeicher**
- ⑥ **Lenkungs-
pumpe**
- ⑦ **Servolenkung**



Funktionsschema der hydraulischen Bremskraftverstärkeranlage





This month I want to discuss a somewhat vintage BMW power brake system, the H31 “Hydro Boost” power brakes and steering system. BMW has always been a leader in technology and never was this more evident then when they introduced the H31 system in the E23 seven series cars in 1977. As is still typical the technology that was debut on the flagship Seven series became a proven design and used on various Five, Six and Seven series cars ending on the Eight series before being phased out with the last of the Eight Fifties in the mid nineties. Over the years I have received a great deal of calls and e-mails regarding the diagnosis and repair of this system. I will attempt to clarify some of the misconceptions and advise on accurate, straightforward diagnosis.

Unlike almost every other power assist braking system that uses engine vacuum to create the boost, the H31 system used hydraulic pressure from a special power steering pump to create the assist needed. This system allowed for more available assist that was highly controllable in a smaller package then any vacuum boost system available at that time. Soon after its introduction, BMW coupled its race proven BOSCH ABS technology to offer a braking system that became the performance standard that other manufactures where judged by.

Over the years the H31 system has caused a number of headaches for techs who where attempting to diagnosis this very sophisticated hydraulic system. Most of these headaches are due to a lack of understanding of the basic principles of operation. The original repair information involved the use of very high pressure gauges to test the pump output and the pressure controlled flow regulator known as the DS Regulator with its attached accumulator better known as “the Bomb” because of its cannonball shape. I have found the use of these gauges to be unnecessary in all but a few rare cases.

The most common failure of this system is the accumulator (the bomb). It is a round steel chamber with a high-pressure nitrogen filled balloon built inside it. On a normal working system, as the pumps hydraulic pressure builds up it moves fluid into one side of this sphere displacing the balloon and storing pressure and a volume of fluid. Over time the balloon loses its nitrogen charge causing the sphere to lose its spring affect of storing the pressure energy. The simple test of the bomb is to run the car for a minute to allow the pressures to normalize then shut off the engine and then pump the brake pedal until all power assist is lost and the pedal becomes hard. Typically a good accumulator will give you about eight pumps of the brake pedal before you loose assist. A bad one will be hard after one pump and the accumulator needs to be replaced. The second part of the test is to check the DS regulator. Again run the motor briefly to build pressure then shut it off. Now wait five minutes before applying the brakes. You should have at least half the pumps with assist that you had when you did the test the first time. If not the valves in the DS regulator are leaking down to quickly. The DS regulator cannot be serviced and would need to be replaced.

The common symptoms of a failed accumulator can be an intermittent brake warning light that can come on when the brakes are applied, or a too soft brake pedal that does not improve after bleeding the brake hydraulics. A good check for the brake hydraulics is to pump the pedal till all boost is gone, then if the pedal is still spongy then the problem is in the brakes. Other issues common to the booster system are leaking pressure switches at the DS regulator and leaks at the hydraulic booster. The brake booster leaking will vent power steering fluid (either ATF or Pentosin depending on the system) at a drain hole between the booster and the master cylinder.

The power steering pump supplying the pressure for this system has a maximum operating pressure of about 130 bar (1900 psi), however the working pressure for the H31 system is regulated at 35 57 bar and only needs about ten percent of the fluid volume that is needed for the power steering. With that in mind it is obvious that any problem with the pump pressure or volume would show itself first as a problem in the power steering.

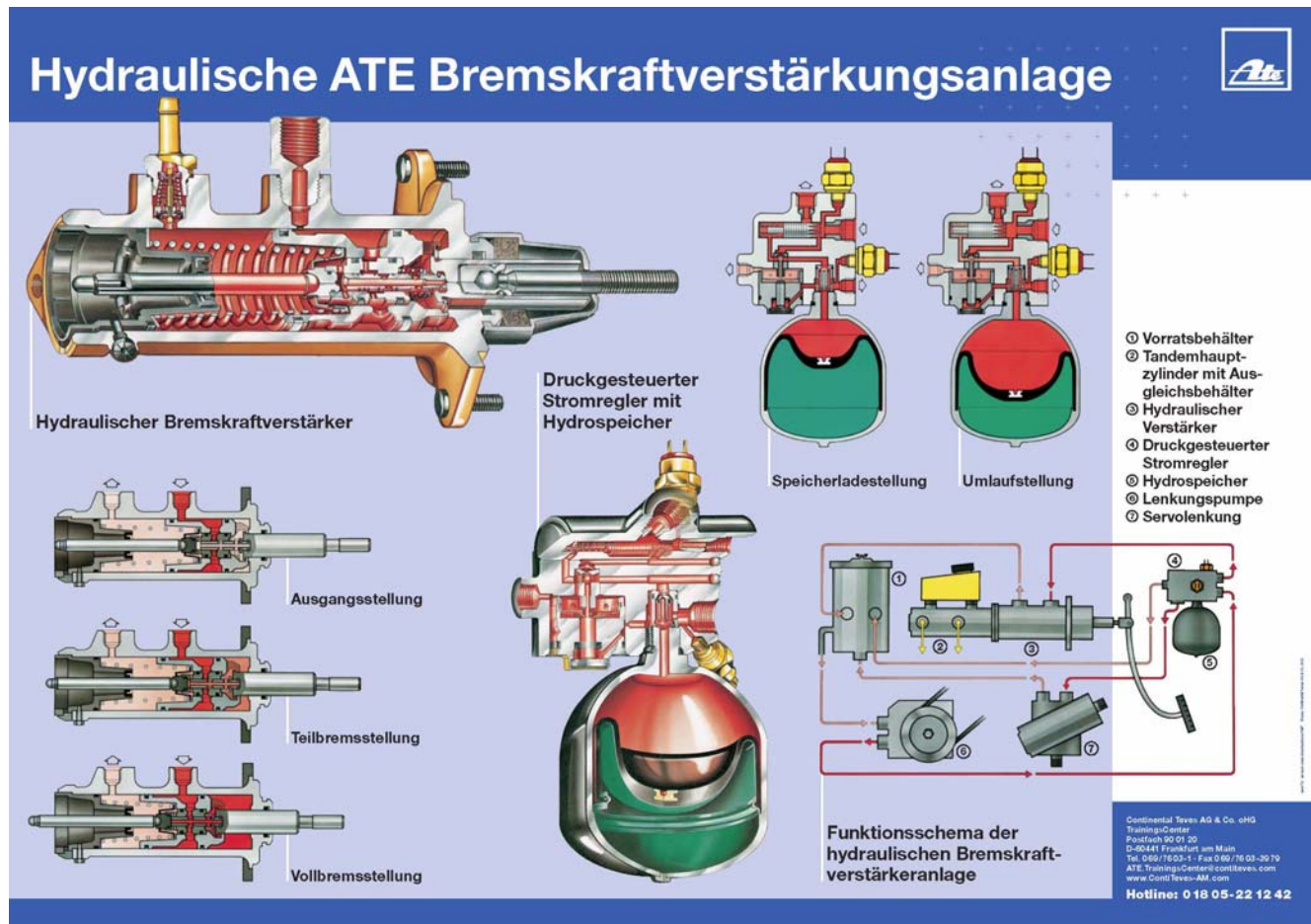
To properly check the fluid level you must have the engine off, pump the brakes until the assist is gone then remove the cover from the reservoir. The fluid should be at the top of the screen. If not top off with the correct fluid for your car, most early cars used ATF but later BMW's went to Pentosin fluid, do not mix them and NEVER use brake fluid in the pump hydraulics. Brake fluid will destroy the seals in the H31 system and ATF or Pentosin will destroy the seals in the brake hydraulics. They are separate systems and do not share fluids, IF IN DOUBT ADD NOTHING. If either system is contaminated by the other it can be very expensive to fix and potentially dangerous.

My last set of problems, are usually listed as power steering complaints. This system uses a very high-pressure,



high volume pump; any leaks in the system can be a big mess fast. Many of these cars develop noises in the pump and the pump is replaced only to find that the noise is still there! The problem is from air being pulled into the pump through loose hose connections on the inlet hose between the pump and the reservoir. The leak can be so small it will not lose any fluid but still allow air to be sucked in when the car is running. This problem is exaggerated by the fact that the filter in the reservoir has probably never been serviced and is plugging up with debris. Finally you must consider the condition of the drive belt, a belt failure will immediately cause a loss of power steering and the brakes will only have the stored pressure of the accumulator to assist you for stopping.

You can only imagine heading to the braking zone at turn three of BIR in your E28 M5 only to find that the belt broke. You would have no power steering and no power brakes if the accumulator were bad. No more M5, Bad day, really, really, bad day.



Method of operation of the hydraulic brake servo unit

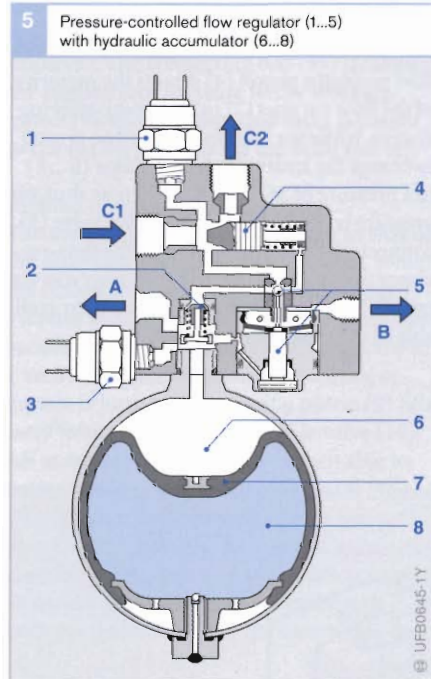
The hydraulic brake servo unit is identified by the number 7 in the diagram of the system (Figure 4).

Fig. 5

- 1 Circulation-pressure warning switch
- 2 Non-return valve
- 3 Accumulator-pressure warning switch
- 4 Flow-regulator piston
- 5 Changeover valve
- 6 Hydraulic chamber
- 7 Diaphragm
- 8 Pneumatic chamber

Ports

- A to brake servo unit
B to oil reservoir
C1 from power-steering pump
C2 to power-steering servo



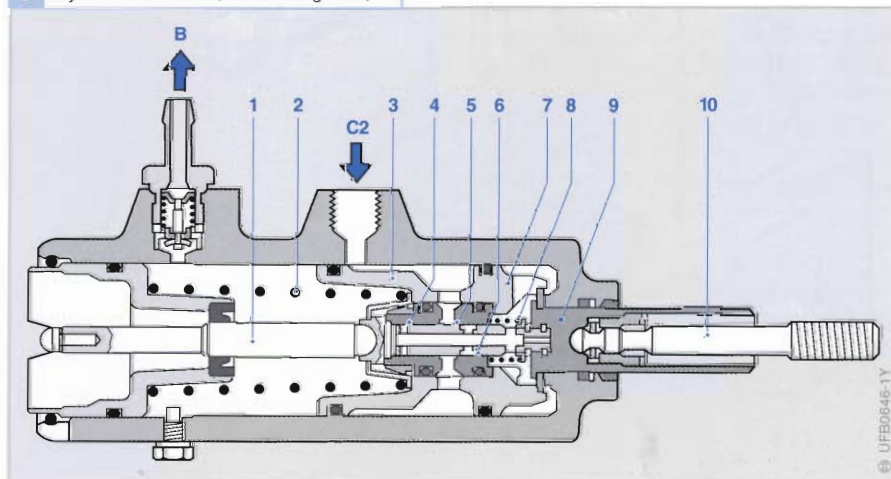
6 Hydraulic brake servo (in non-braking mode)

Fig. 6

- 1 Push rod
- 2 Return spring
- 3 Transfer piston
- 4...6 Control edges
- 7 Control piston
- 8 Compression spring
- 9 Actuating piston
- 10 Connecting rod

Ports

- B to oil reservoir
C2 from pressure-controlled flow regulator



Non-braking mode

The control edges (Figure 6, Items 4...6) block the inflow of hydraulic oil from the pressure-controlled flow regulator via port C2 while allowing unpressurised oil to flow out of port B to the hydraulic oil reservoir.

Normal braking mode

The foot pressure applied by the driver is transmitted to the actuating piston (9) which moves the control piston (7), thereby shifting its control edges. As a result, pressurised oil from the pressure-controlled flow regulator is allowed to enter the servo via port C2 and outflow of oil to the reservoir via port B is blocked. The pressurised hydraulic oil acts on the transfer piston (3) and the actuating piston (9) as an assisting force supplementing the foot pressure applied by the driver until a state of equilibrium is reached with the output force from the master cylinder acting on the push rod (1).

Emergency braking mode

The control edges (5, 6) are in such a position that they allow totally unrestricted through-flow of pressurised hydraulic oil. As a result, the maximum degree of power assistance is obtained.

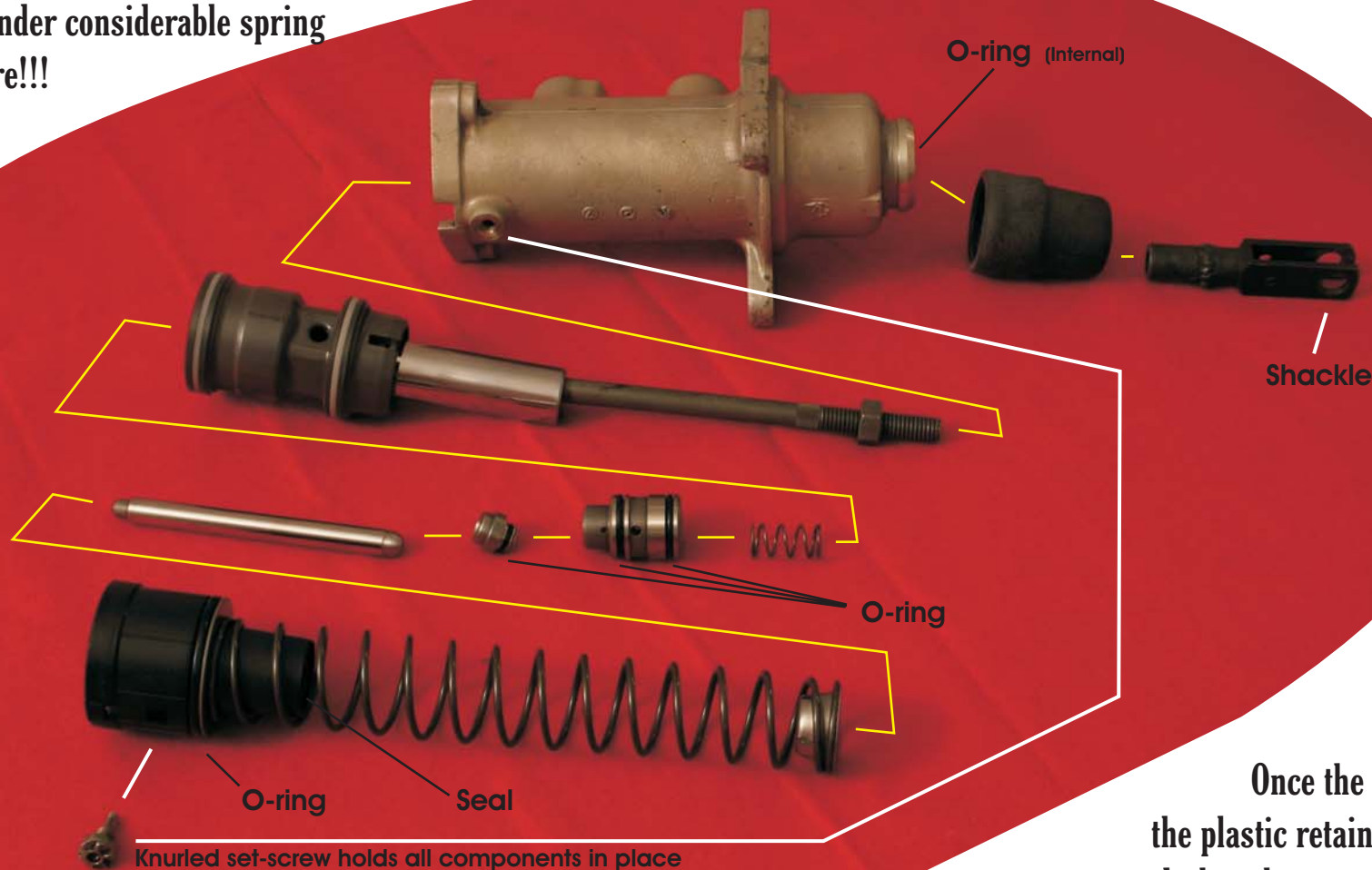
Later style ATE Brake Servo

- * Remove clip and pin from brake pedal inside the car.
- * Place catch pan under car and several adsorbent rags beneath the work area.
- * Remove lines from brake master cylinder, and then the master cylinder itself.
- * Remove fluid supply line from brake master cylinder - to - clutch master cylinder, and carefully place master cylinder aside (this will be MESSY).
- * Remove the hydraulic lines from the top of the brake servo, wrap them and tie them up or they will gravity-drain the whole system.
- * Remove the brake servo by loosening the four bolts that hold it to its mounting (there are nuts on the back)
- * Drain hydraulic fluid from the servo into an appropriate container, use a cookie sheet or similar to catch any leftover fluid at you disassemble the servo.
- * Unscrew the shackle from the end of the plunger shaft and make note of its position so your pedal height will remain consistent after reassembly.
- * Using vise-grips loosen the knurled set-screw on the bottom of the servo but DO NOT back it out until you brace the black plastic retainer.

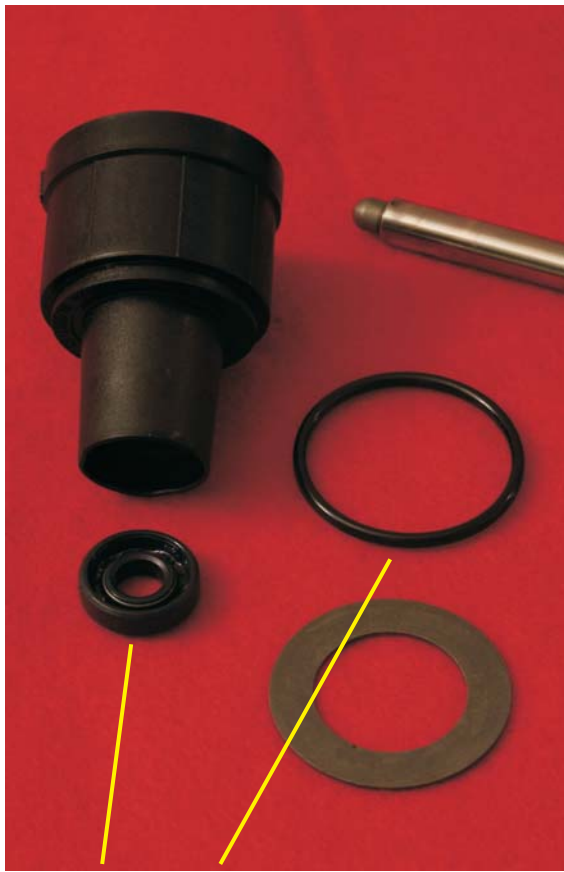
Brake fluid REMOVES PAINT !!!!

The contents of the servo are held in place under considerable spring pressure!!!

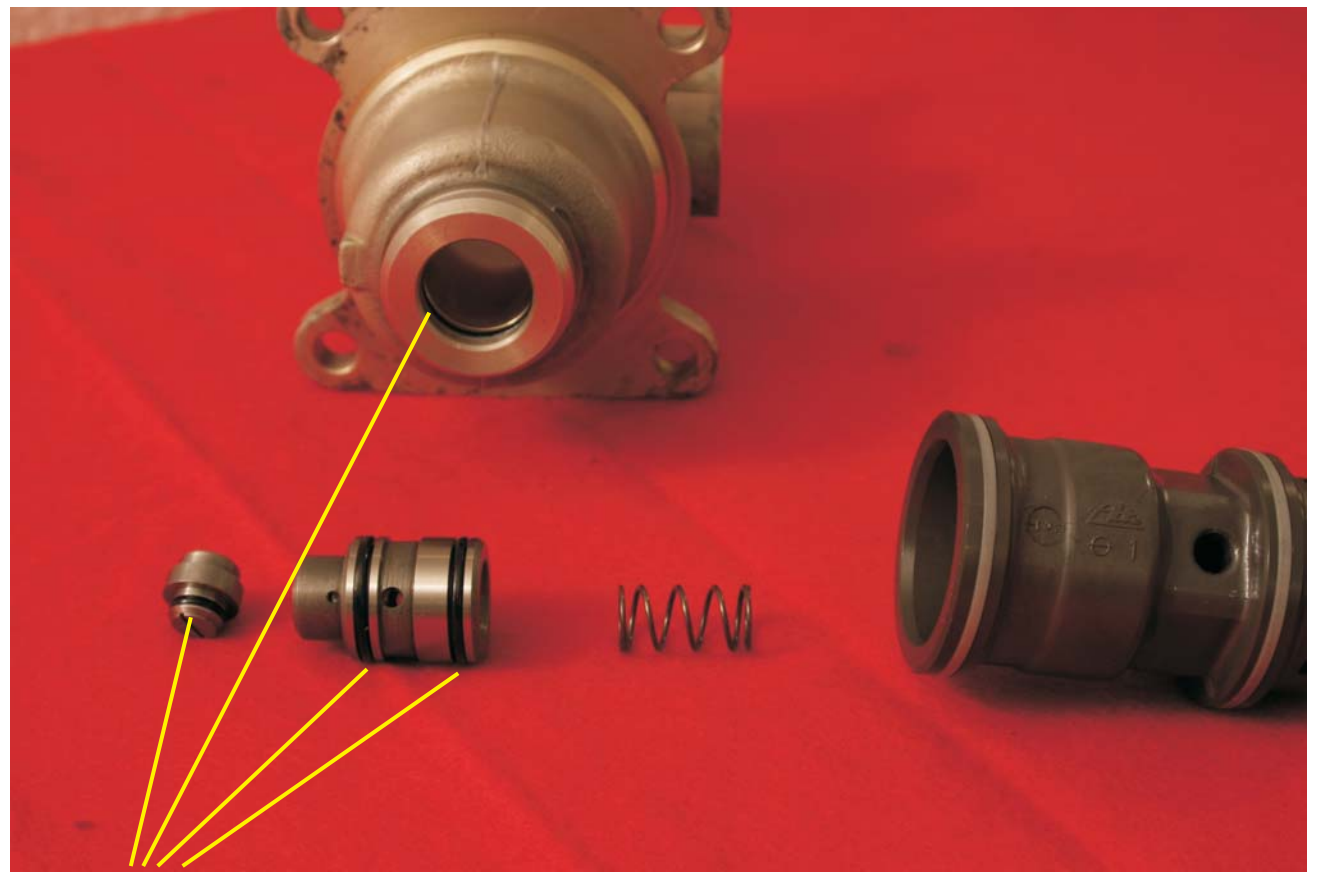
Be prepared for any / all of the components to jump out as the set-screw is removed!!!



Once the set screw is removed and the plastic retainer / main spring assy are removed, the other components will pull out with varying resistance, nothing else secures them further.



Remove seal and o-ring from plastic retainer



Remove o-rings from plunger components and servo housing itself



These are the new parts, replace them after a thorough cleaning of the components with a lint-free rag

Reverse these steps to reassemble your brake servo.

Coat the new seal and o-rings with fresh hydraulic fluid as you install them.

It may help to have someone assist you when compressing the plunger assy into the housing its not easy to overcome the main spring pressure with one hand while installing the set-screw although it can be done alone.

I assume no liability with this guide, service this component at your own risk.