**'87 Intake Removal, Repairs, Installation Procedure (w/pics)**

By Dwayne



http://rennlist.com/forums/928-forum/477170-87-intake-removal-repairs-installation-procedure-w-pics.html

This information is so good and well documented that I decided to save a copy and avoid it getting lost at some point in time.

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Executive Summary:
We bought Virginia ('87) last October and even though she only has 35K miles, she's always had a rough idle particularly when cold (even the PO had been battling the problem). She also had OPG leaks, PS hose leaks, and coolant leaks at the water bridge. So, in November, I decided to get to know the S4 engine since I had not done any major repairs on the S4 (except Motor Mounts on Idaho) and I wanted to learn.

I wanted to post this thread primarily for the other newbies, such as myself, that have never done this job before and would like to have a step-by-step guide. WARNING: this is a long, picture intensive thread - over 630 pictures in this step-by-step guide.

I finished up at the end of December having completed the following:

Intake & cam Covers: Removal, replaced ISV, new hoses, vacuum elbows and manifolds, fuel lines (with Roger's kit), flappy bearings, throttle plate bearings, Powdercoating, new heater valve, knock sensors, all new gaskets

TB/WP: new timing belt & waterpump, accessory belts, A/C Compressor, new o-rings for A/C hoses, expansion valve, receiver drier, rebuild of TB tensioner, Oil pump o-rings, replacement/repair of PS reservior hoses.

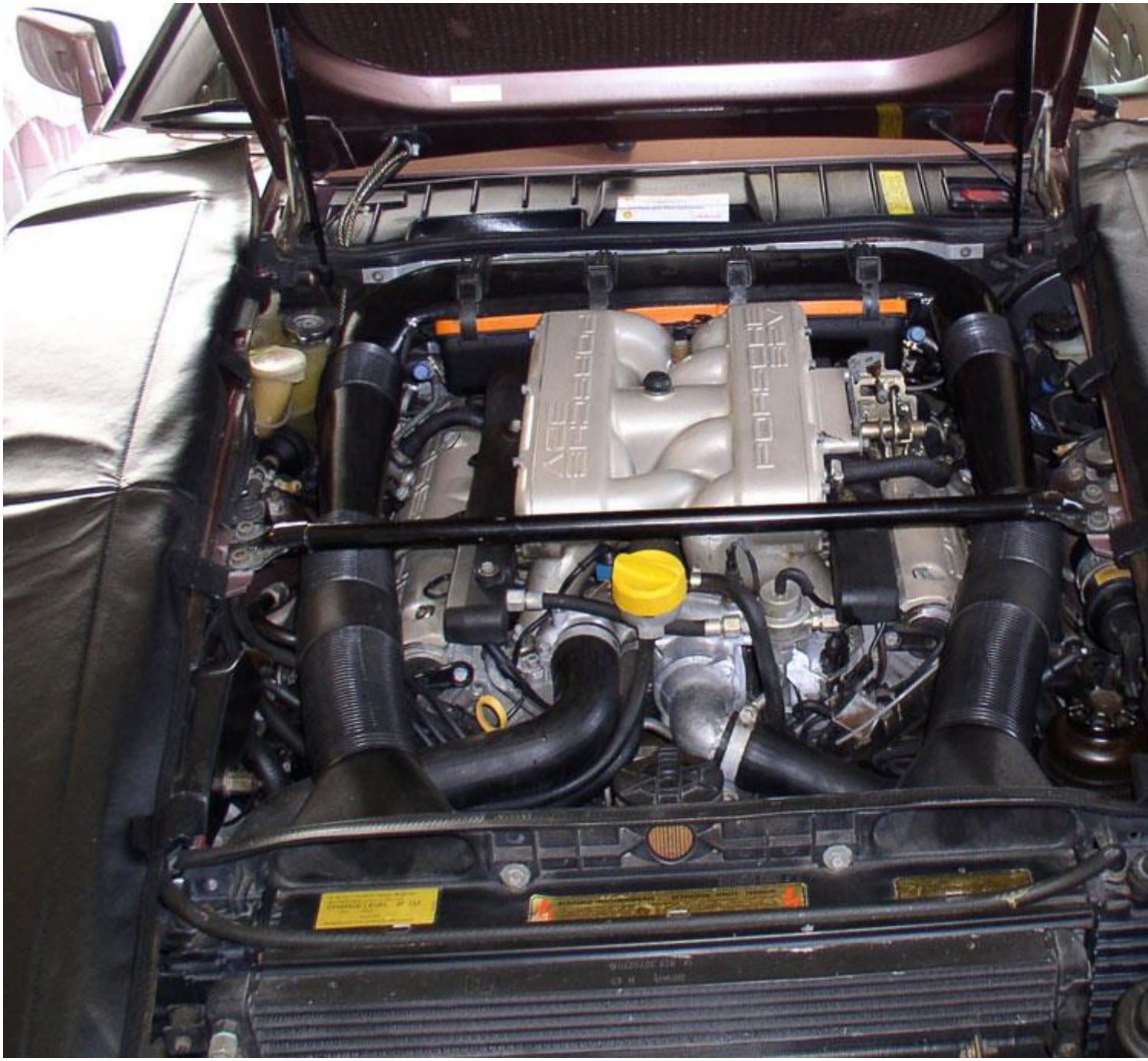
Motor Mounts and OPG: R&R of motor mounts and install of silicone OPG with studs (Roger's Kit), replacement of PS hoses to steering rack

HVAC: leak testing and R&R of comb flap and footwell flap diaphrams, blower motor removal, evaporator cleaning, resistor pack removal/adjustment, center console mount repair (Nicole's kit)

Hood: removal and R&R of hood pad (Nicole's kit)

So, after a couple of months and 3400+ pictures later, she's running better than ever and smooth as silk. But only after learning a few surprising things along the way which I will share soon enough. This post deals only with the Intake Job. I plan to post separate threads on the TB/WP work, the MM and OPG, HVAC and Hood repairs to make it easier to search and find this material.

First, the summary eye candy - the before and after.
The pictures don't show it but the paint on the intake and cam covers had become "blotchy" and yellowing. Most of the anodized metal parts appeared to have light salt water spray corrosion from winter driving on snow/salted roads?



Here I'm into the intake job and half way into the TB/WP task. At this point I began working on the MM and OPG - that job was a lot easier when the engine was already in this state.



And the finished product. I really liked the powder coating finish for a couple of reasons. The finish is called silver vein and is textured silver/black. The dark color hides the dust and dirt more than the ligher finishes and the textured finish hides the imperfections in the castings. Had to go with yellow on the "32V" to match the oil filler cap and dip stick and other engine decals.




Things that should be looked at closely on the intake job include: Flappy diaphram for leaks, Throttle Position Sensor, Knock Sensors, Hall Sensor, Crank/Flywheel Sensor, Idle Stabilization Valve (ISV), all hoses and connections for false air (intake vacuum) leaks because most of these are only accessable when the intake is off (or partially off) and all of them are easier to address/fix when the intake is off. Before getting started with the tear down, there are a few tests than can be run very simply on a few of these components (flappy diaphram, TPS, and intake vacuum leaks). I ran the flappy and TPS before getting started and also ran them afterward to compare results. I wished I had run the vacuum leak test before getting started to compare before and after but alas, newbism strikes again! First the flappy diaphram test:

After removing the rubber cap, I marked the top of the flappy assembly with a vertical line.



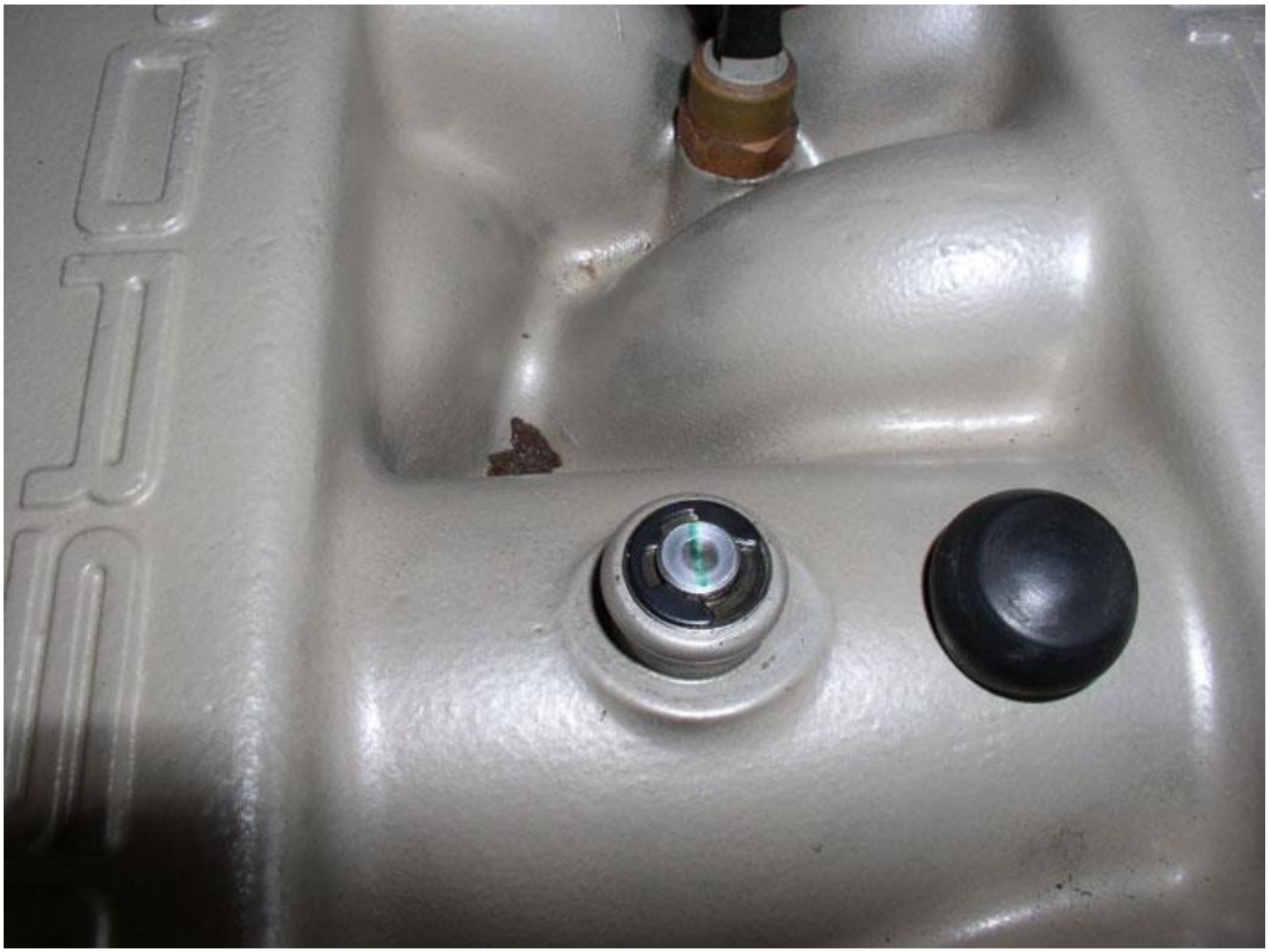

Next, disconnect the flappy vacuum hose at the vacuum solenoid located on the driver's side front cam cover.



Connect your Mitivac vacuum pump to the elbowconnection....



....and note the starting position of the line on the flappy assembly



Pump the vacuum until you see the line move.

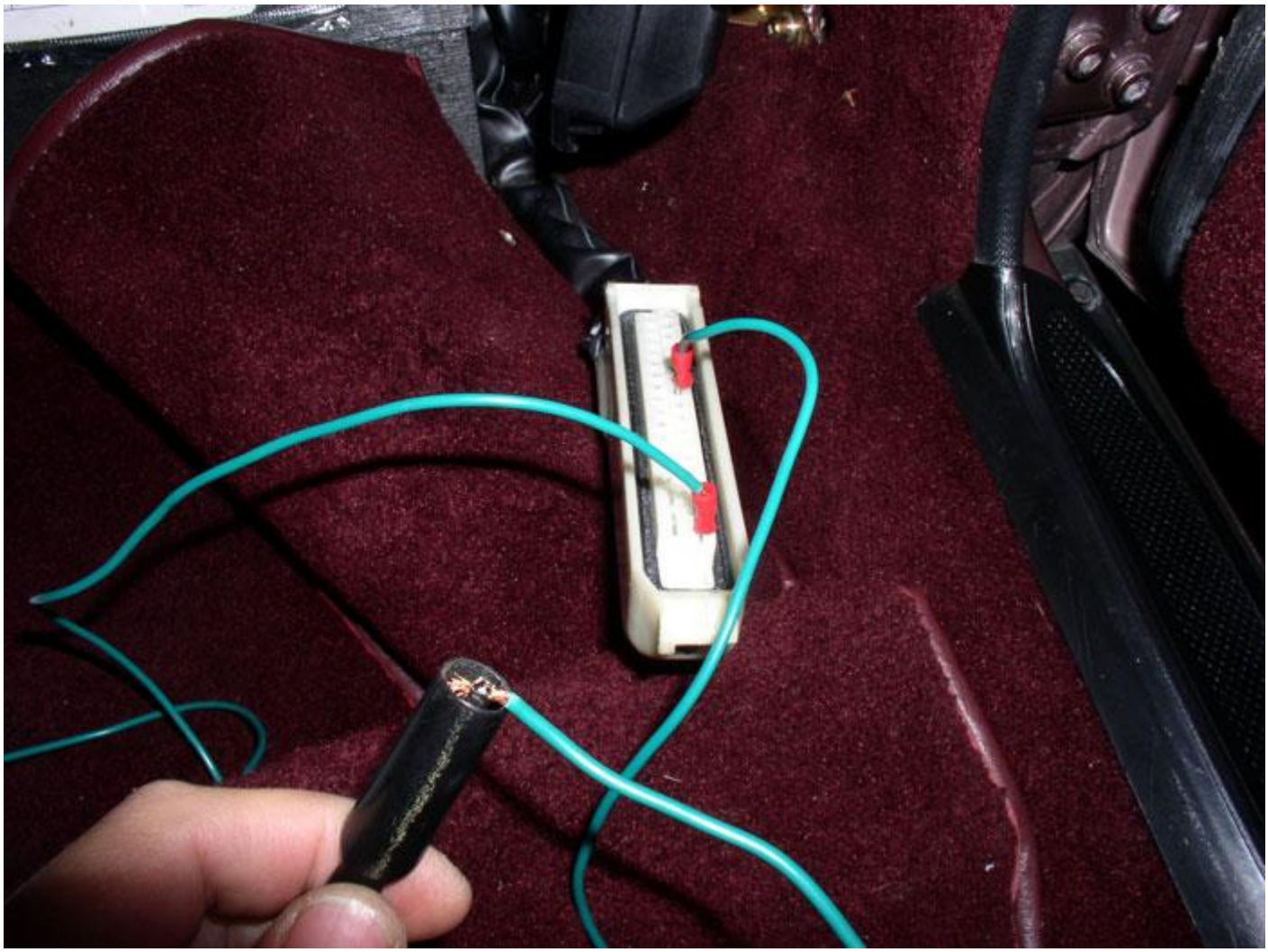



Continue to pump vacuum until you see the line stop moving. It hit the limit at about 8 inches hg. At this point, leave the hose connected and see if the diaphram holds vacuum. If it doesn't hold vacuum or you notice the flappy has difficulty opening all the way (sticking), make a note and you will be able to investigate further when you have the intake off. If it doesn't hold vacuum, don't assume it's the diaphram, it may be vacuum line leaking under the intake. If it works fine, this will provide a baseline for how it was working before taking it apart. When you put it back together and it doesn't work the same or as well, you'll know something is amiss.




Another test worth performing before teardown is the Throttle position sensor or idle/WOT switch. When working properly, the idle contact informs the computer when your foot is off the accelerator and a different injector/fuel map is to be used. It's most noticeable when your driving at highway speeds and let up off the accelerator. The car deaccelerates significantly faster (until engine rpms drop to about 1100) because the computer shuts off fuel to the injectors. The Wide Open Throttle (WOT) contact, when operating correctly, tells the computer when to provide full fuel enrichment and ignore O2 sensor inputs for maximum performance (hence, the reason it only comes on when you nearly floor the accelerator).

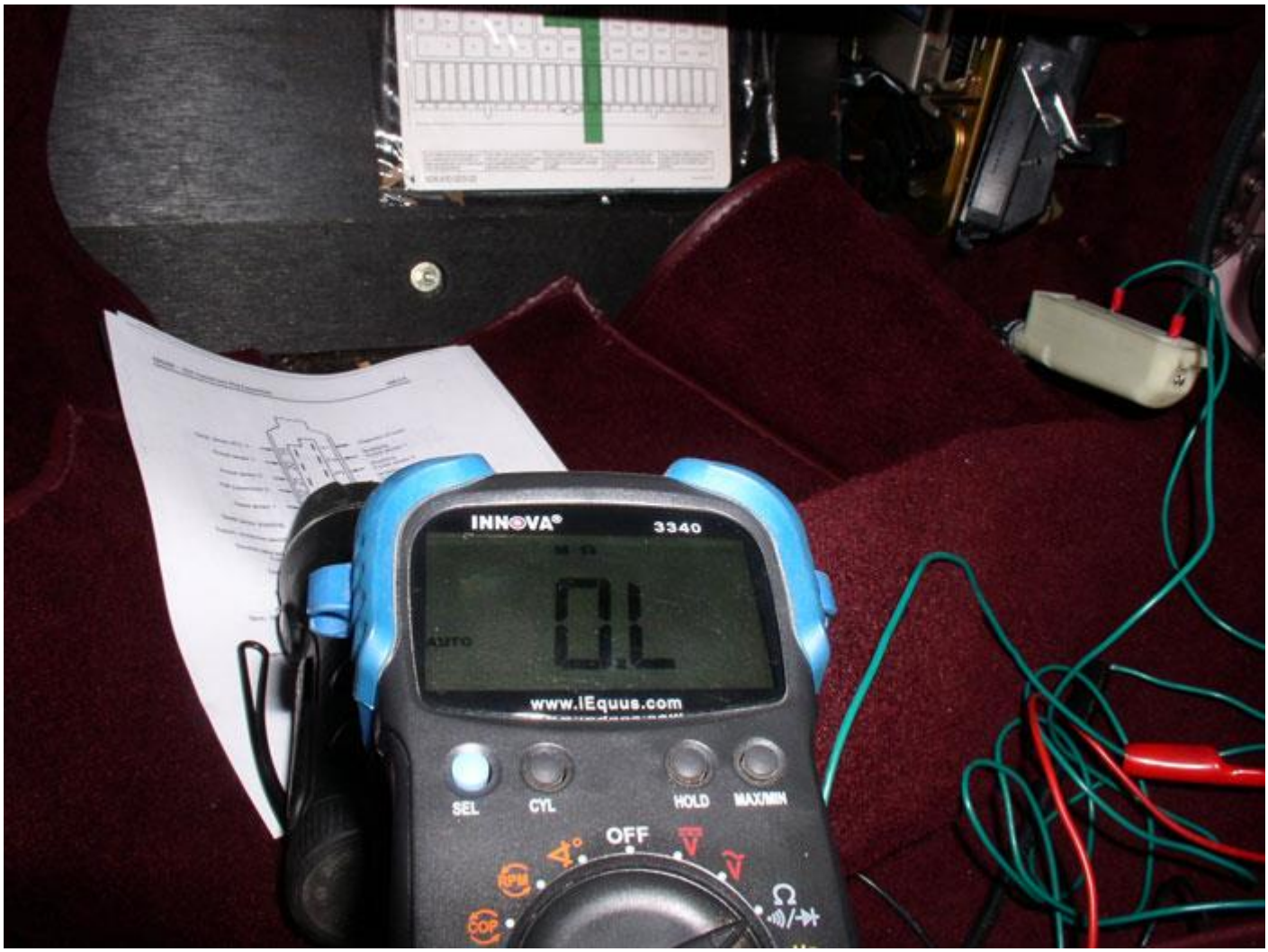
You can perform this test by removing the EZK or LH plugs (after disconnecting the battery negative terminal) and connecting your ohm meter. I fashioned test leads using small blade connectors on one end of electrical wire for insertion into the computer plug connections and the other end to the meter. To test the Idle contact using the EZK plug, connect to pins 18 (ground) and 8. I also tested using the LH plug and you should get the same readings (which I did). The LH pins are 5 (ground) and 2.



The reading should be less than 10 ohms. It's 0.5 ohms here - closed circuit - working here.



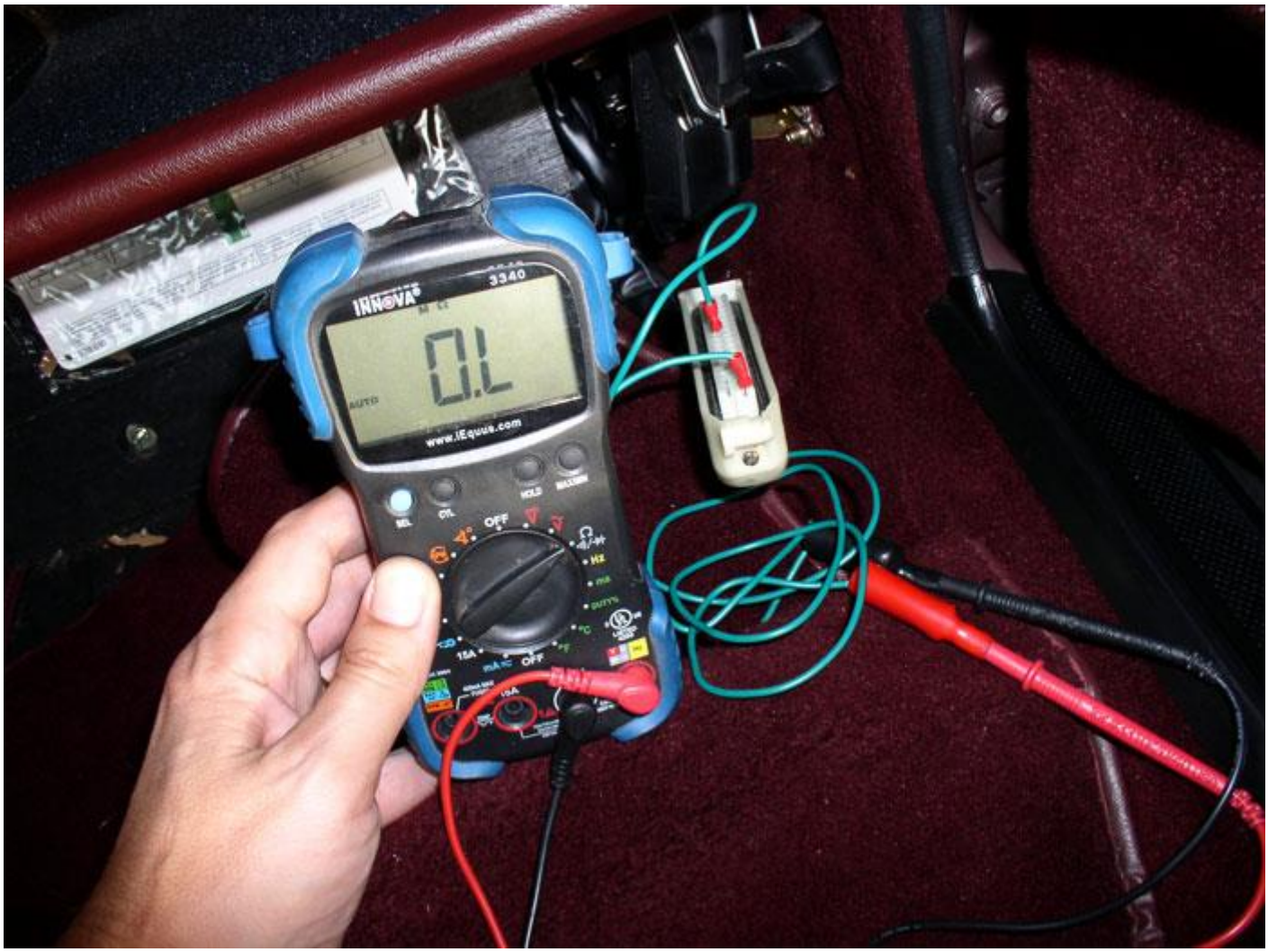

Then press down on the accelerator slightly and the ohm meter should read infinite ohms - open circuit - working here.




Next, test WOT. Connect to pins 18 (ground) and 26 on the EZK plug. When testing on the LH plug, use pins 5 (ground) and 3.

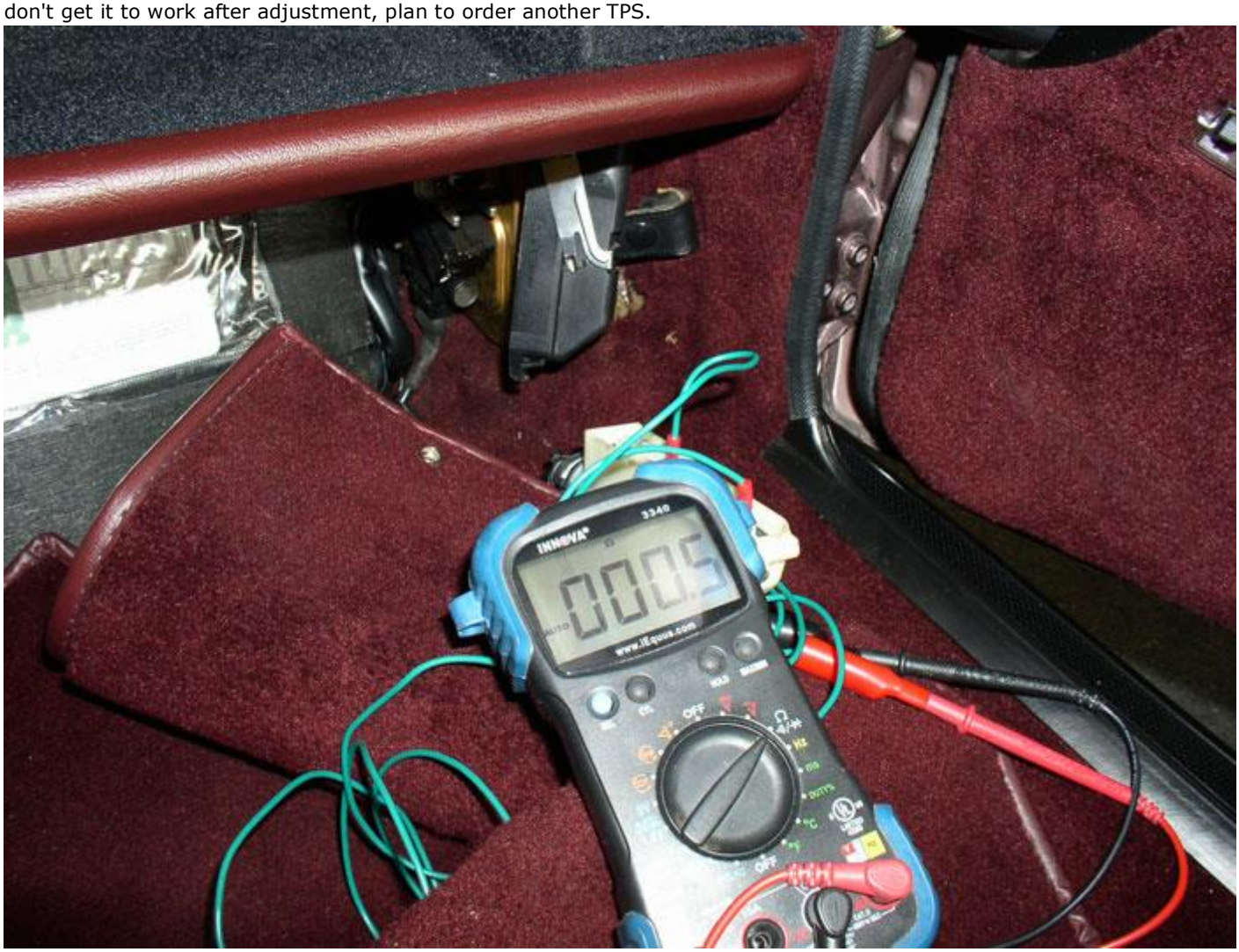


The reading should be infinite ohms - open circuit - when the accelerator is at rest/idle (works here)




Press the accerator down until it reaches the floor and note when the ohms change. At about 2/3 or 3/4 travel from idle to the floor, the ohms should change to less than 10 ohms (0.5 ohms in this case). Mine closed circuit at 3/4 travel (works as it should). If you don't get these readings, first look at the throttle cable bracket at the side of the intake for loose or slack cables. At first, I had to adjust mine (tighten the accelerator cable) because the WOT wouldn't close until nearly accelerator at the floor. After adjustment, everything worked fine. If you

don't get it to work after adjustment, plan to order another TPS.




**Testing for Intake Leaks**

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I would recommend testing for vacuum leaks before the teardown so you can compare the results after it's put together. Another purpose of pre-testing is it will allow you to focus on an area for investigation for leaks if you're having trouble pinpointing a leak before taking the intake off. I ended up with leaks after I put it all back together and used the tester below to help find them. Had to take it apart again (several times) to get all the leaks.

I had seen previous posts about making the vacuum/pressure device that allows you to pressurize/depressurize the intake system. Shocki had a great design and pics of one and so did others here. This design is very similar to those. THANKS for sharing!

So it was off to Home Depot to find the parts. In total, everything to make this device cost less than $20. You'll only need 4 parts plus some thread sealant (I used teflon tape). 1) the 3" to 2" rubber adapter with clamps, 2) 3/4" PVC male threaded adapter, 3) 2" to 3/4" threaded female PVC plug, 4) low pressure propane/natural gas guage (with 3/4" female threads). Here's what I used:




The 3" rubber adapter will be a tight fit on the MAF so you can use some lubricant. I used silicone lube but VERY LITTLE. In fact, after I applied it, I wiped it down with cloth to get any excess off. Too much lube and the rubber adaptor will come off under pressure.




Next, fit the adapter to the MAF. I had an extra MAF sitting around not being used so I just leave it attached to the device permanently. Otherwise, you can remove your MAF and attach it to the adapter.



Then apply teflon tape to the 3/4" threaded adapter and ...



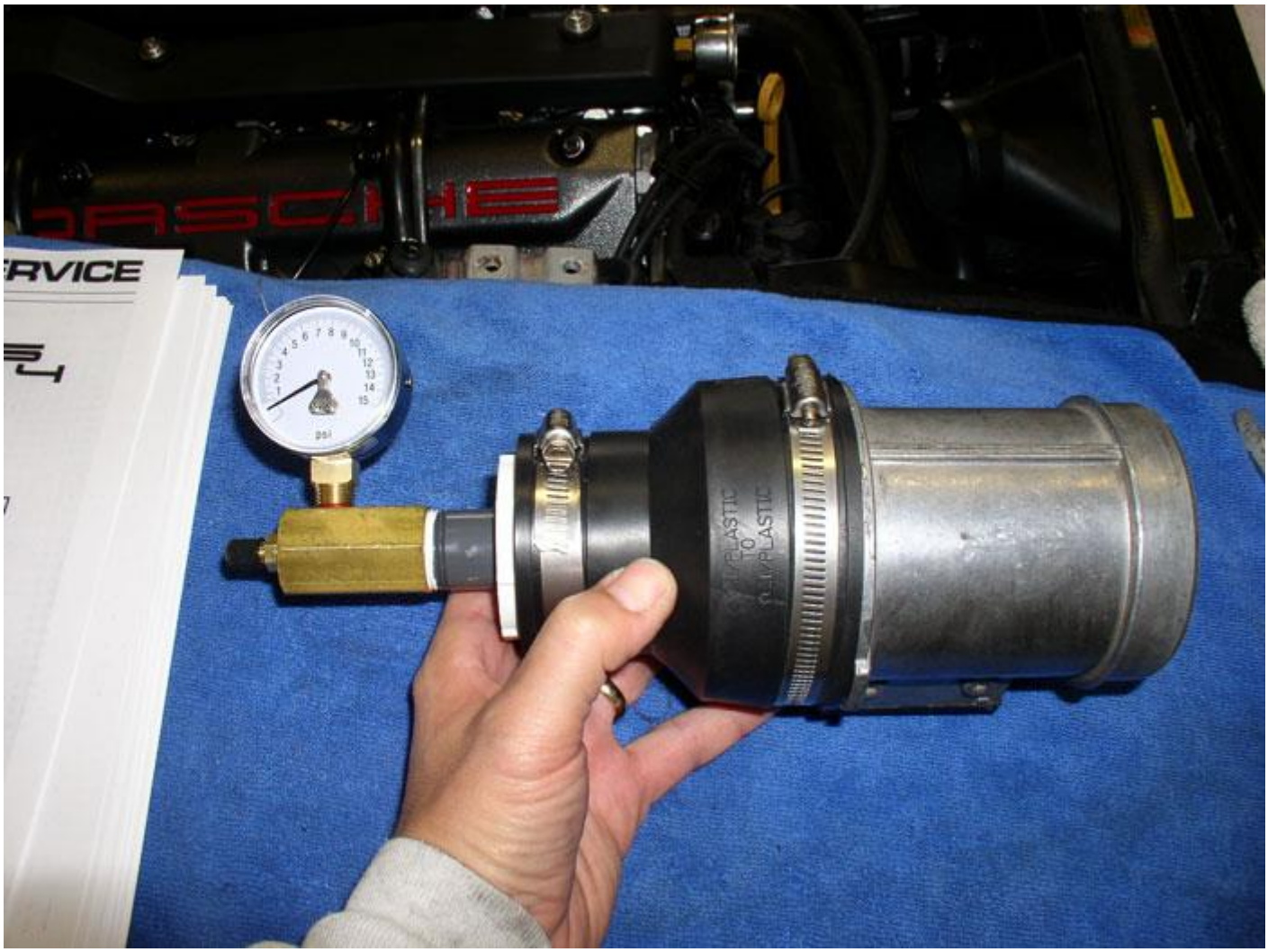

...fit it into the 2" PVC plug and tighten




Next, attach the gas guage to the other end of the male PVC threads using teflon tape.




Finally, attach the 2" PVC plug to the 2" end of the rubber adapter and tighten. You are now ready to attach the MAF back to the throttle body and pressurize with an air compressor. I only needed to pressurize to 2.5 PSI and the low pressure guage is great for getting accurate pressure without overpressurizing the system. I had several significant leaks after I put the intake back on - would go from 2.5 PSI to zero in about 10 seconds - car ran like crap. After chasing down all the leaks, going from 2.5 PSI to zero took 4 minutes! Close enough for me!




Now, before going on to the procedure for intake removal, repair and installation, I'd like to recognize the folks that provided great insight and information on how to do this job. I found a writeup by David Chamberland that was TREMENDOUS and I used it as my guid through this process - an excellent piece of work! THANKS David!! There were also numerous posts about flappy bearings, intake leaks, ISV replacement with pics and discussions from several here that I found most helpful to me before getting started. I wanted to say THANKS for the great resource (I can't remember all the names - I'm sure I would miss somebody if I tried.) Of couse thanks to our vendors who supplied all the parts!

Speaking of parts:
After you've tested for and identified leaks, you'll have more information to order the correct parts. I did not have the equipment to test the Hall sensor or the Crank/Flywheel position sensor or the knock sensors but the connections were badly damaged on the knock sensors so they went on the order list. The Hall sensor and crank position sensor connections looked good so I waited until I could dig into it for a closer look before ordering those parts. One good philosophy I usually subscribe to is simply replace everything that is original or broke while you're in there because the car is 20 years old and it's great having peace of mind. That's a philosophy I would recommend if you don't want to get stranded somewhere or don't mind redoing some work 6-12-24 months later. I replaced most things but a few I left alone (such as the hall sensor, the TPS, and the crank position sensor). These looked great to me and the car does only have 35K miles on it. It's more of a personal decision.

With that being said, I've compiled a list of parts for consideration for replacement while your on this job. I supposed you really don't HAVE TO replace anything, if you don't want to. But I tried to prioritize the list in order of things that are STRONGLY recommended to replace on the job down to things that may not need to be replaced and are personal preference.

Here's the list (you should verify part numbers with PET and your vendor because I do make typos - these are for and '87):
Intake to Heads Gasket (2) 928.110.580.02

Throttle Body to Intake Gaskets (2) 928.110.637.02
Intake side cover plate gasket (passenger side) 928.110.713.01
Intake side cover plate gasket (driver's side) 928.110.714.01
Thrust ring (rubber gaskets) for intake nuts (10) 928.110.694.01
Flappy Bearings (2) INA part number HK10122RSFPMDK (Roger has these)
Throttle plate bearings (2) INA Part Number (same as Flappy Bearings)

Cam Cover Gasket Set 928.104.447.09 98 (should come with the following)
Cam cover gasket (2) 928.104.447.09
Rubber Thrust Rings (26) 928.104.115.02
Sealing ring (washers) (12) 900.123.144.30
Spark Plug sealing rings (rubber) (8) 928.104.443.08
Rear coolant port gaskets (2) 928.106.167.01
The kit will come with cam seals/plugs which I did not use in this procedure.

O-rings for cam cover ports for PCV elbows (pass side) and plugs (driver's side) (4) 17mm X 2.5mm

Hoses and Gaskets:
Fuel hose kit from Roger
ISV to Air Guid Cowl 928.110.174.09
ISV to throttle body 928.110.633.00
Front PCV Hose 928.107.445.02
Rear PCV Hose 928.110.432.01
Oil Breather Housing to Air Guide Cowl (Oil filler neck base to throttle body) 928.107.313.02
Oil filler neck to fuel vent solenoid to intake (3-way) 928.107.603.00
Air Guide Cowl to Brake booster venturi 928.110.224.00
Plenum (forward of cable bracket - driver's side) to brake booster venturi 928.110.220.0
Venturi to brake booster 928.110.663.00
7-way vacuum manifold at rear of engine 928.110.441.02
4-way vacuum splitter at brake booster (couldn't find a number but Roger has it)
Vacuum elbows (10) 928.574.717.02
Oil Filler Cap O-Ring 999.701.846.40

For the water bridge:
Water Bridge to Block O-Ring 53mm X 7mm 999.701.627.40
Water Bridge to Heads gasket (2) 928.106.227.00
Thermostat rear seal 928.106.163.00
Thermostat O-Ring front seal 999.701.632.00

Bonded rubber buffer for the fuel rails (attach to intake) (4) 931.110.191.00
Heater water control valve 928.574.573.04

ISV 928.606.161.01
Knock Sensors (2) 911.606.141.00

I ordered/replaced all the parts listed above for this job. If you want peace of mind and want to replace the following, they should also be included:
Throttle Position Sensor 928.606.157.00
Crank Position sensor (couldn't find a part number)
Hall Sensor 944.606.170.02
Flappy vacuum unit under the intake 928.110.160.00

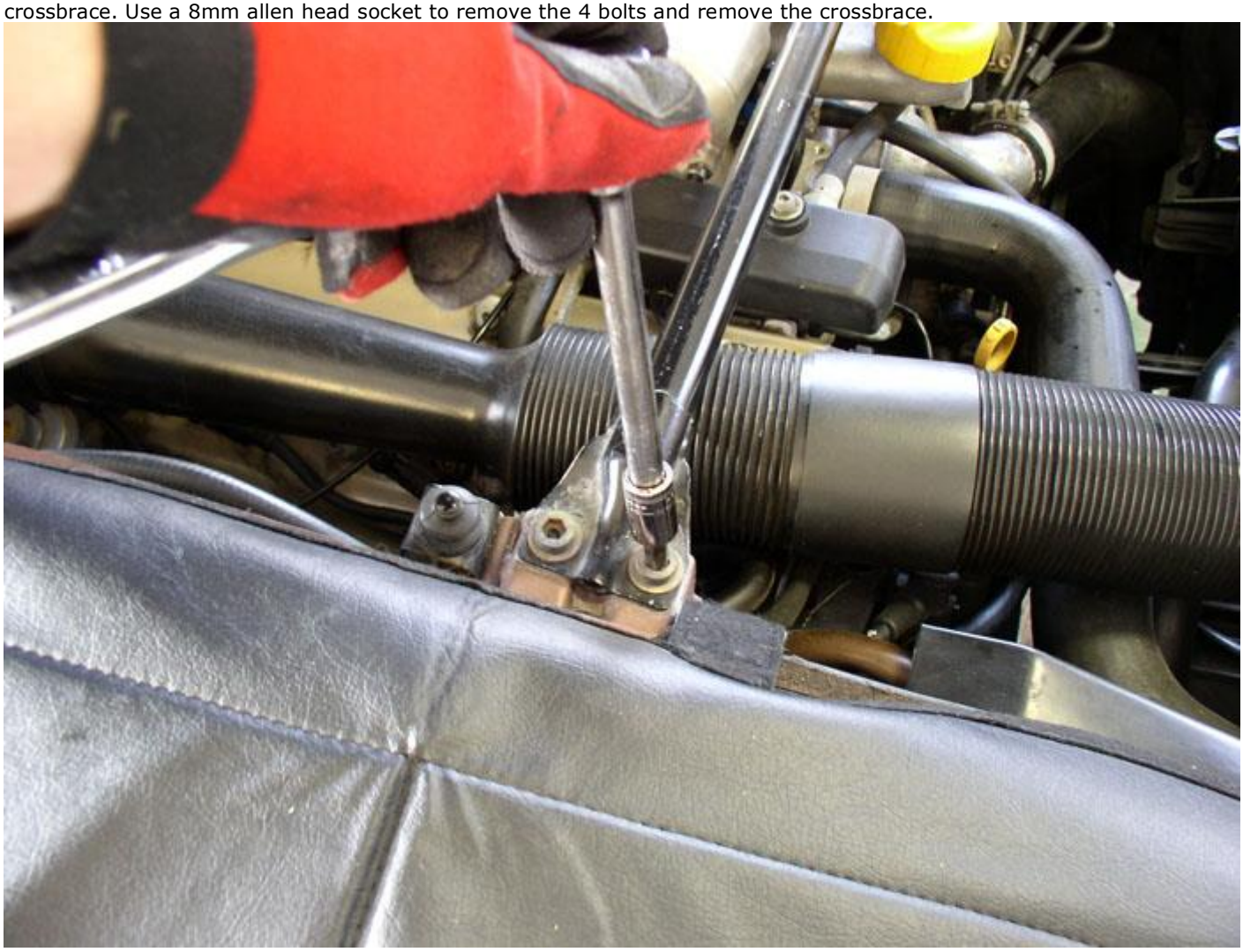
Other supplies you will find useful for this job include:
Silicone lubricant
Sensor safe, oil resistant silicone sealant
Dremel 9901 Tungsten Carbide bit and a Dremel tool, of course
Buffer with wire brush wheel
Auto enamel touch up paint (for detail painting of intake, if desired)
Utility knife
Vacuum pump
long flexible magnetic pick up tool

Most common tools used on this job will be:
8mm, 10mm, 13mm sockets with 3 inch, 6 inch extensions and universal elbow, you'll also need 19mm and 22mm deep sockets
15mm, 17mm, 19mm combination wrenches

4mm, 5mm, 6mm, 8mm allen wrenches both key wrenches and socket versions
Phillips and flat blade screwdrivers
Long neck needle-nose pliers

Car service covers are HIGHLY recommended.

Now, on to the procedure. Since it is likely you will drop bolts and things while working, it's recommended that you raise and support the car and remove the belly pans. Before raising the car, the Workshop Manual recommends removing the engine crossbrace while weight on wheels. So now is a good time to remove the crossbrace. Use a 8mm allen head socket to remove the 4 bolts and remove the crossbrace.



I use PorKen's lift bars and Harbor Freight 6-Ton heavy duty jack stands to raise and support the car - one of the best investments I've made.
Once you have the car raised, disconnect the negative battery cable if you have not already done so from the testing earlier.

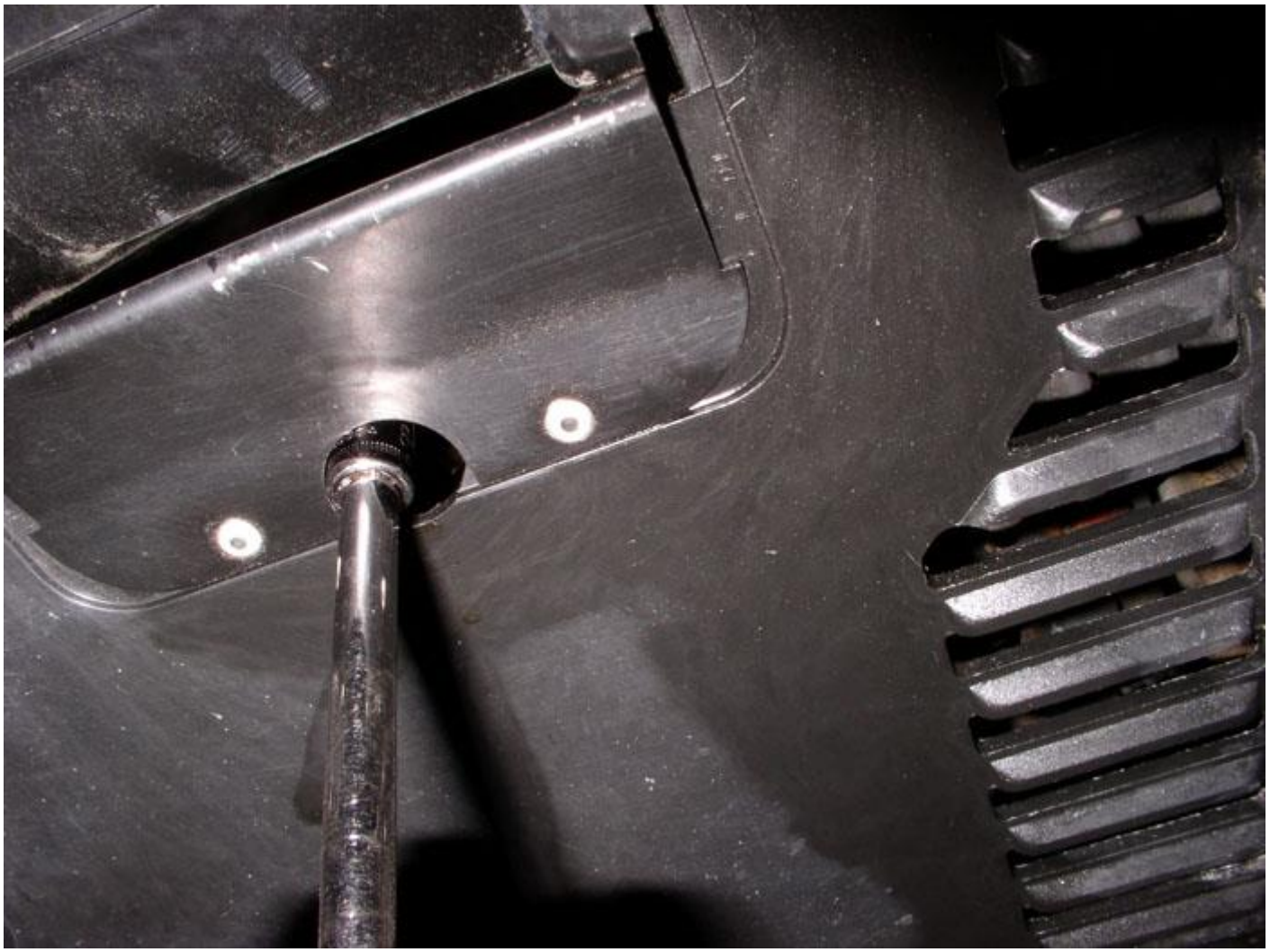
First, under the car, remove the rear belly pan.



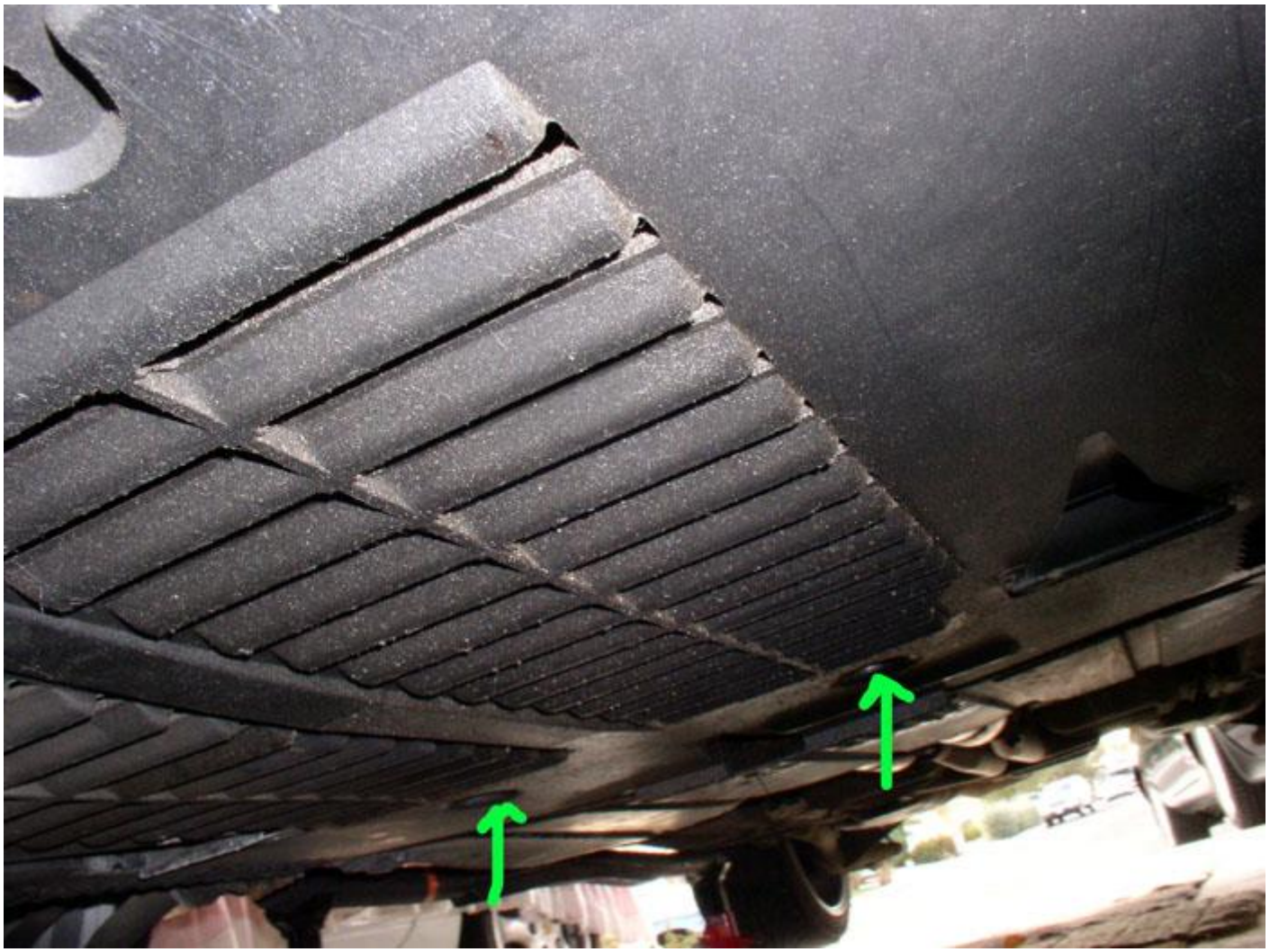
All screws are 8mm hex except for 2 10mm bolts on the forward belly pan.



After the rear pan is removed, start on the front pan. Don't forget these two hidden 8mm screws....



The 2 10mm bolts are located here (green arrows)



After the front pan is removed, keep the hardware together for the intall. During this job, I bagged all hardware in ziplock baggies with descriptions. I would highly recommend this approach or another that would allow you to keep parts together.




Next, install the service covers.



The hood lining was disintegrating so I decided to replace it with one of Nicole's kits. So I removed the hood as it would make the intake job go easier as well as working on the HVAC blower motor and evaporator and resistor

pack later.



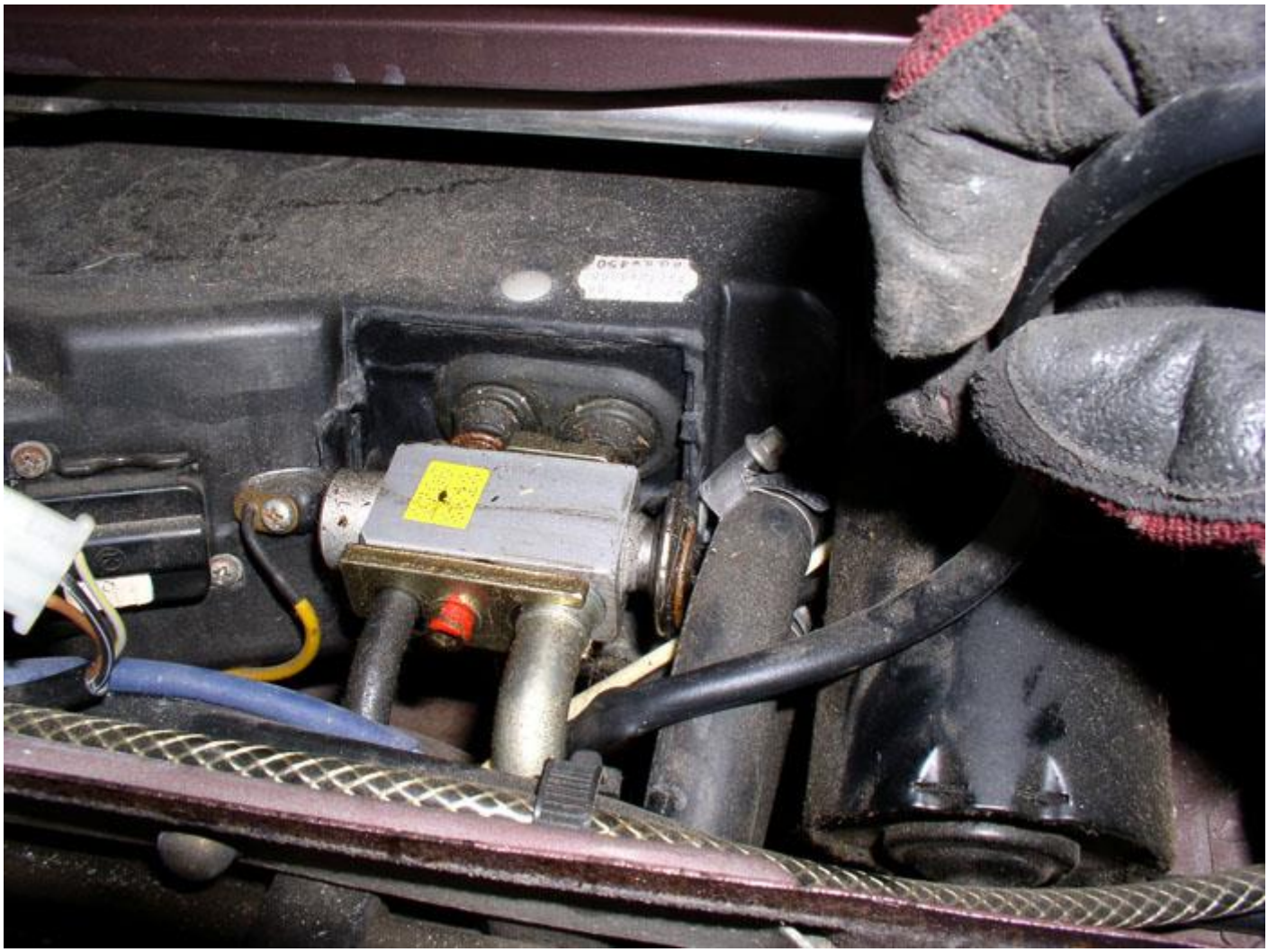
Removing the hood is easier with 2 people but can be done with one which is what I did here. First, remove the wiper motor and blower motor cover by lifting up on the rubber trim side to seperate it from the firewall and pull forward.



Follow the electrical wiring from the hood and disconnect the 3-pin and 2-pin electrical connectors - one wire on each side of the hood.



You may have to "un-route" the driver's side electrical wire from under the A/C lines so it is free to move with the hood.



Next, disconnect the two wiper washer fluid supply lines. On mine, one connection was external to the cover plug and the other was internal. Mark one of the lines with tape to indicate whether it was the interal or external connected line so you can connect it back the same way on install.



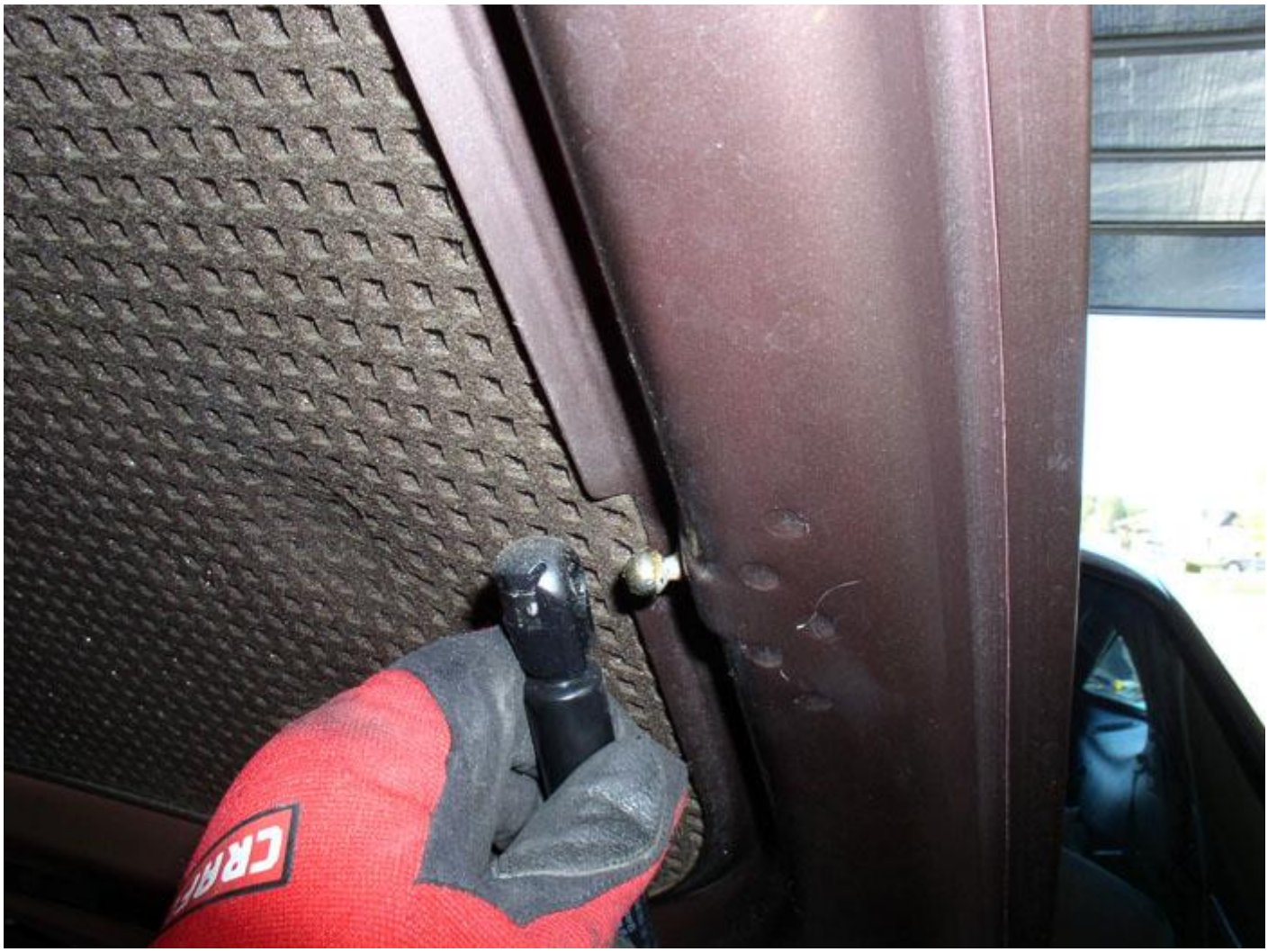
It is best to mark or photograph the orientation of the hood bracket to the hood before disassembly so you can install the hood "in the neighborhood" of where it was originally on install and fine tune from there. Also, don't wash the area around the hood bracket when you have it off. Sometimes the dirt lines will outline the location of othe bracket for you when your ready to install.



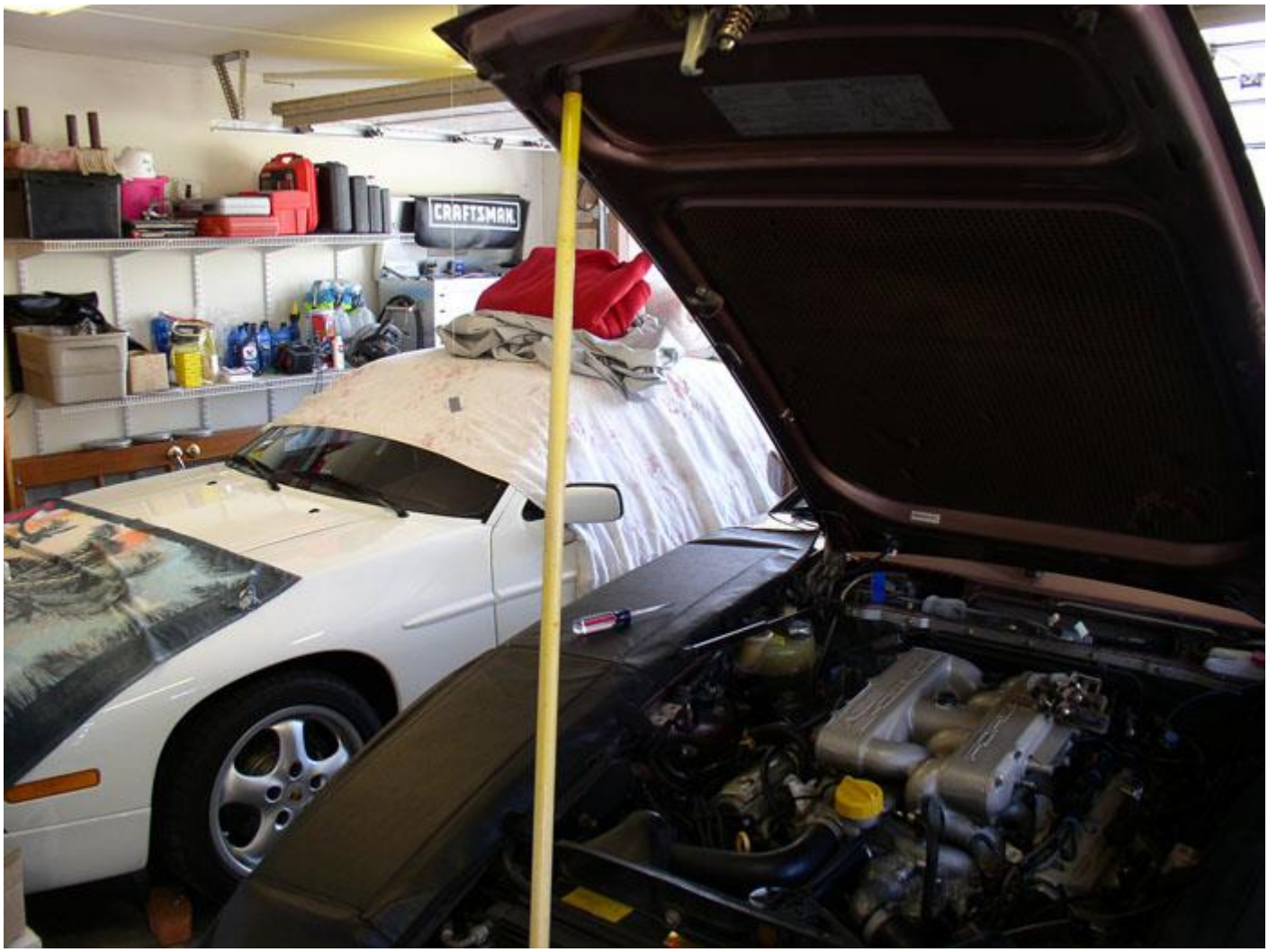
Next, detach the hood shocks. You can use a small screwdriver or a pick tool to pry the spring clamp away from the shock mount. With the clamp pulled away....



...pull the shock away from the hood. Do the same for the other side but be prepared to support the weight of the hood after you disconnect the last shock.



Next, support the hood with a 3'-4' rod or pole




Finally, use a 13mm socket to remove the 4 hood bolts (2 each side). My hood had spacers between the bracket and hood so be prepared to catch those when you remove the bolts. If you're doing this by yourself, I place towels between the hood and exposed fender locations such as near the windshield and at the front hood latch so as not to scratch any body paint. You will need to support the hood with one hand while removing the last bolts with the other.



Remove the intake air tubes.



Remove the air filter cover.....



...don't forget the air pump feed hose underneath the passenger side of the air filter cover. You can loosen the clamp with a screwdriver first. Then remove the cover and air filter.

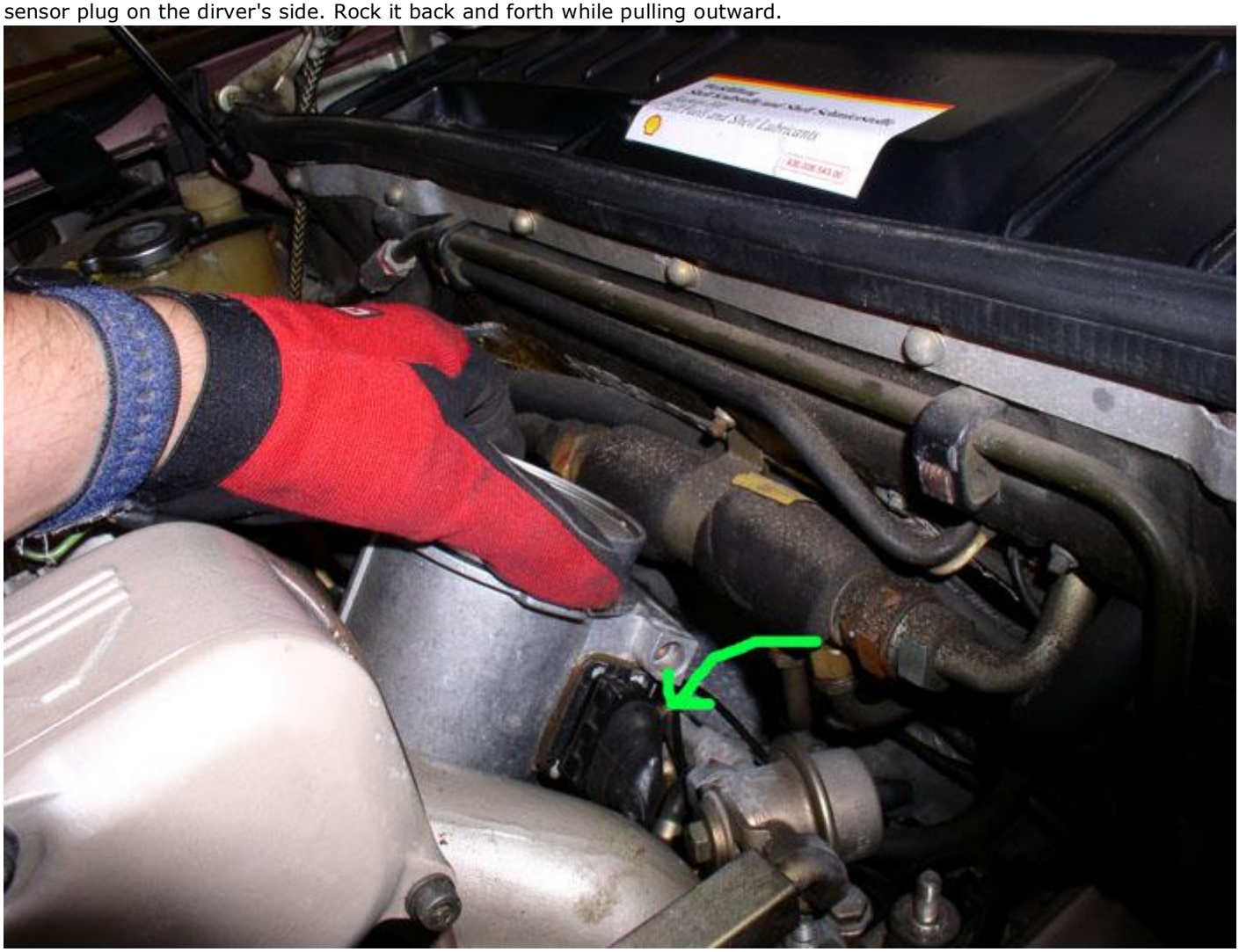


The air box that houses the filter is secured by 4 10mm nuts - 2 on each side. Remove these. Two of the studs are connected to the fuel pressure regulator and dampers bracket underneath the air box and the other 2 are connected to the exhaust tester tube brackets. After the nuts have been removed, you can lift out the air box.



Remove the MAF. You may need to loosen the band clamp at the air guide cowl using a stubby screwdriver or small socket with universal elbow. Mine came out without having to loosen the clamp. Next, disconnect the MAF

sensor plug on the dirver's side. Rock it back and forth while pulling outward.



In order to remove the cables bracket from the intake, you will need to disconnect the accelerator cable from the cables bracket. Pull the ball connector at the end of the cable away from the bracket.



Then depress the tabs on the accelerator cable plastic lock and push the plastic lock back out the bracket - toward the windshield. I used a screwdriver to work one side out first then the other.



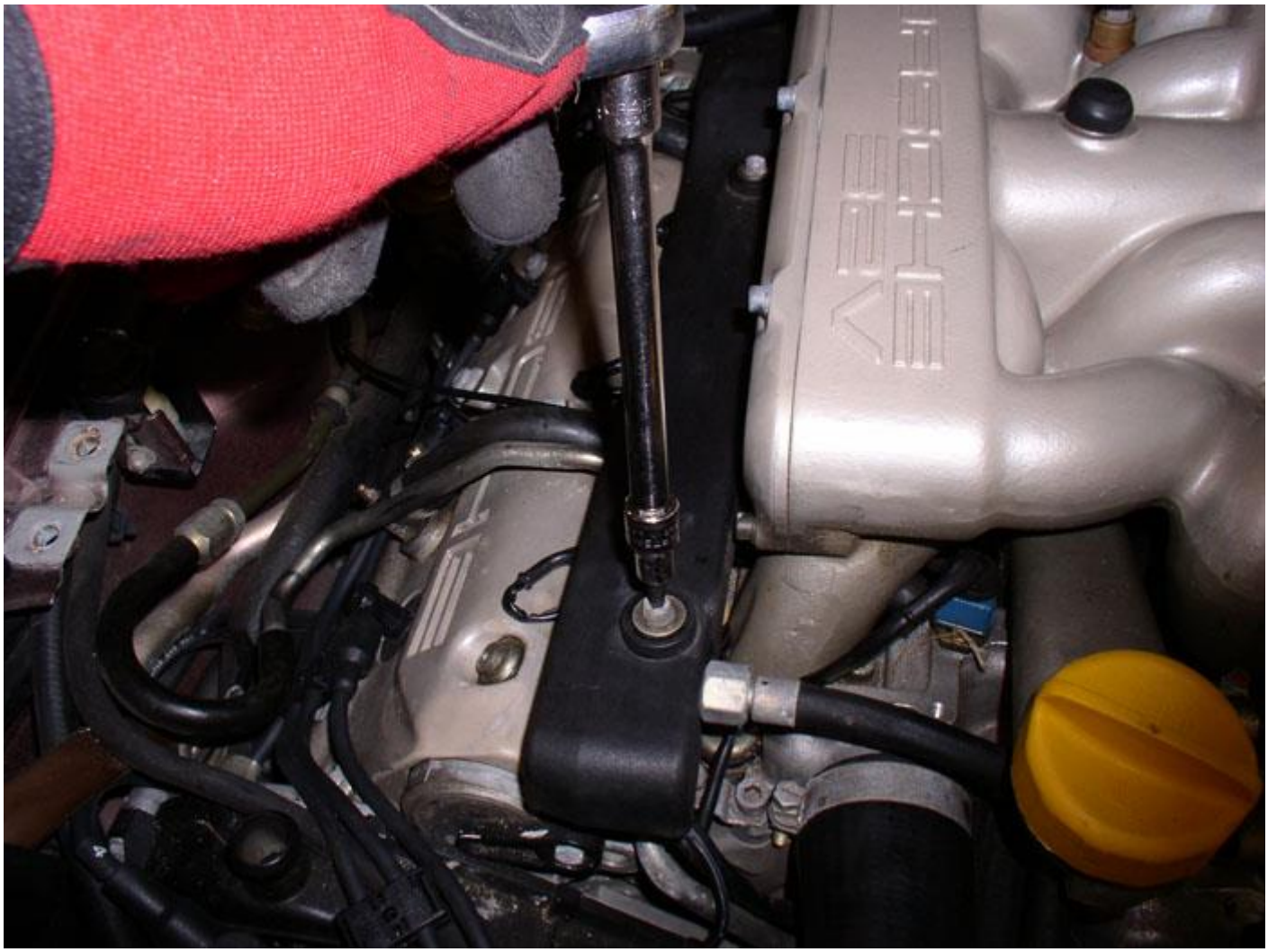
You now have access to the 3 13mm bolts that hold the bracket to the intake. Remove these next and place the bracket out of the way (either on the cam cover or back behind the intake (where the MAF use to be)



Next, remove the intake hose to brake booster venturi using a screwdriver.



Now, remove the fuel rail covers. Each is secured with 2 5mm allen head bolts. Remove these bolts. The passenger side rail will simply lift up to remove. While....



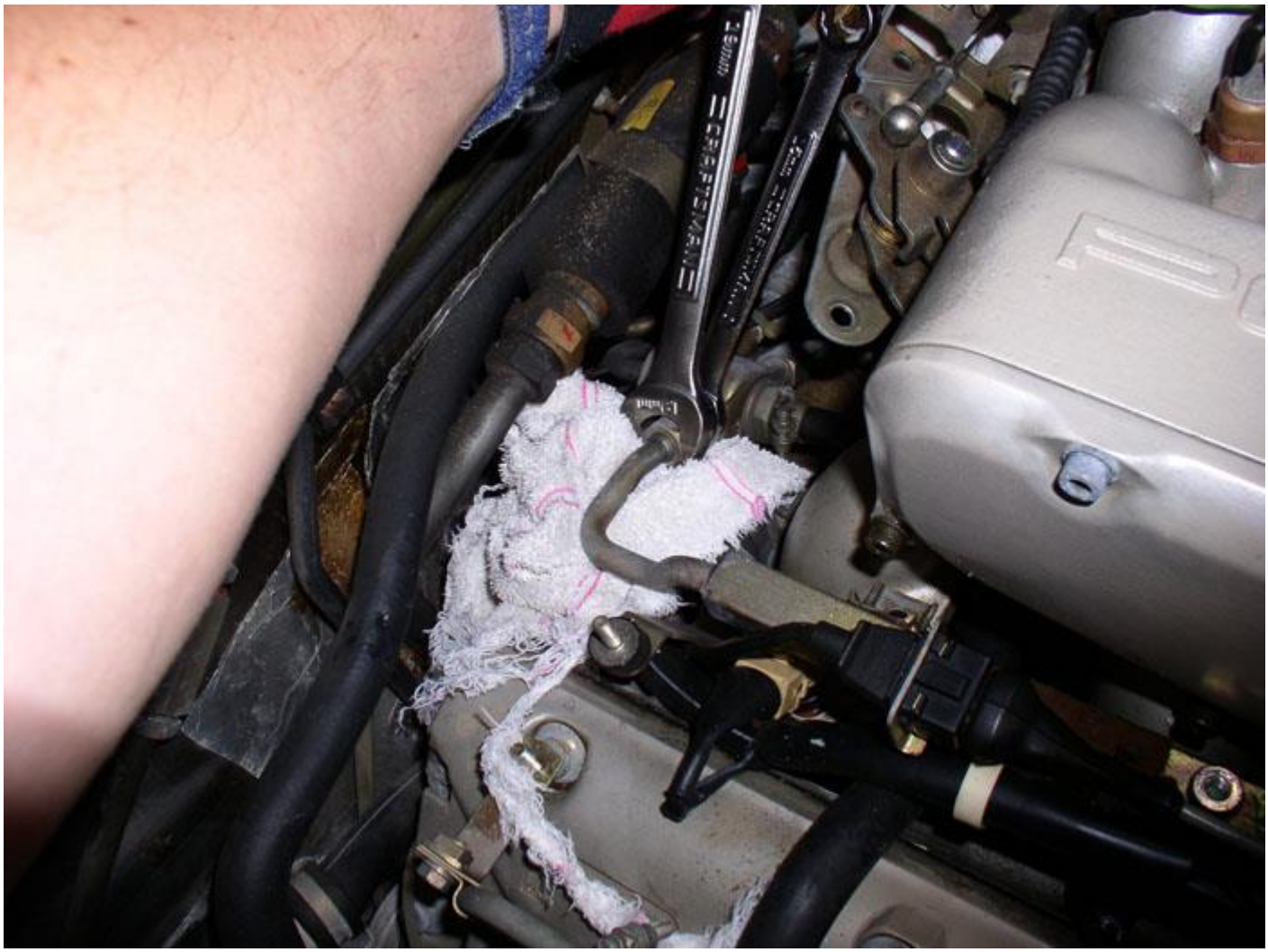
...the driver's side cover requires you to slide it out toward the front of the car. The insulation around the fuel rail was all missing on Virginia.



Next, disconnect the fuel rails. First, the the driver's side front. Place a thick, absorbant towel under the connection to catch fuel left in the lines. It's best to wait several hours since the car was run to disconnect the fuel lines so the pressure will go down. At the fuel pressure damper use a 15mm wrench to counterhold while using a 19mm wrench to loosen and disconnect. Loosen slowly in case the lines are still pressurized.



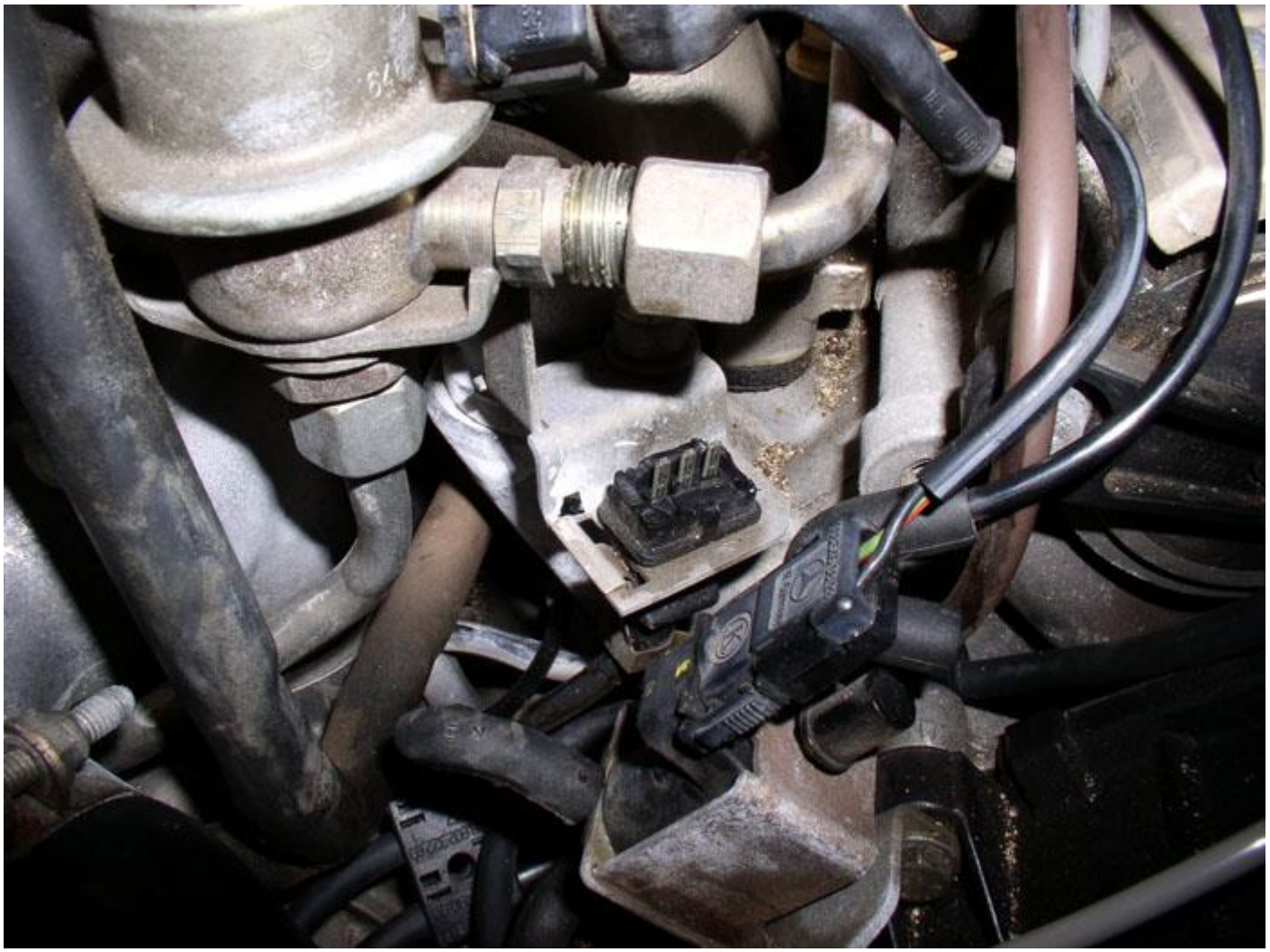
Disconnect the fuel rail at the rear fuel pressure damper (driver's side) and the fuel pressure regulator (passenger side shown below). Using 15mm and 19mm wrenches again. Use a towel to catch escaping fuel.



Disconnect the passenger side knock sensor from the harnes and fuel rail. You can see that my sensor plug had melted and was no longer holding together.



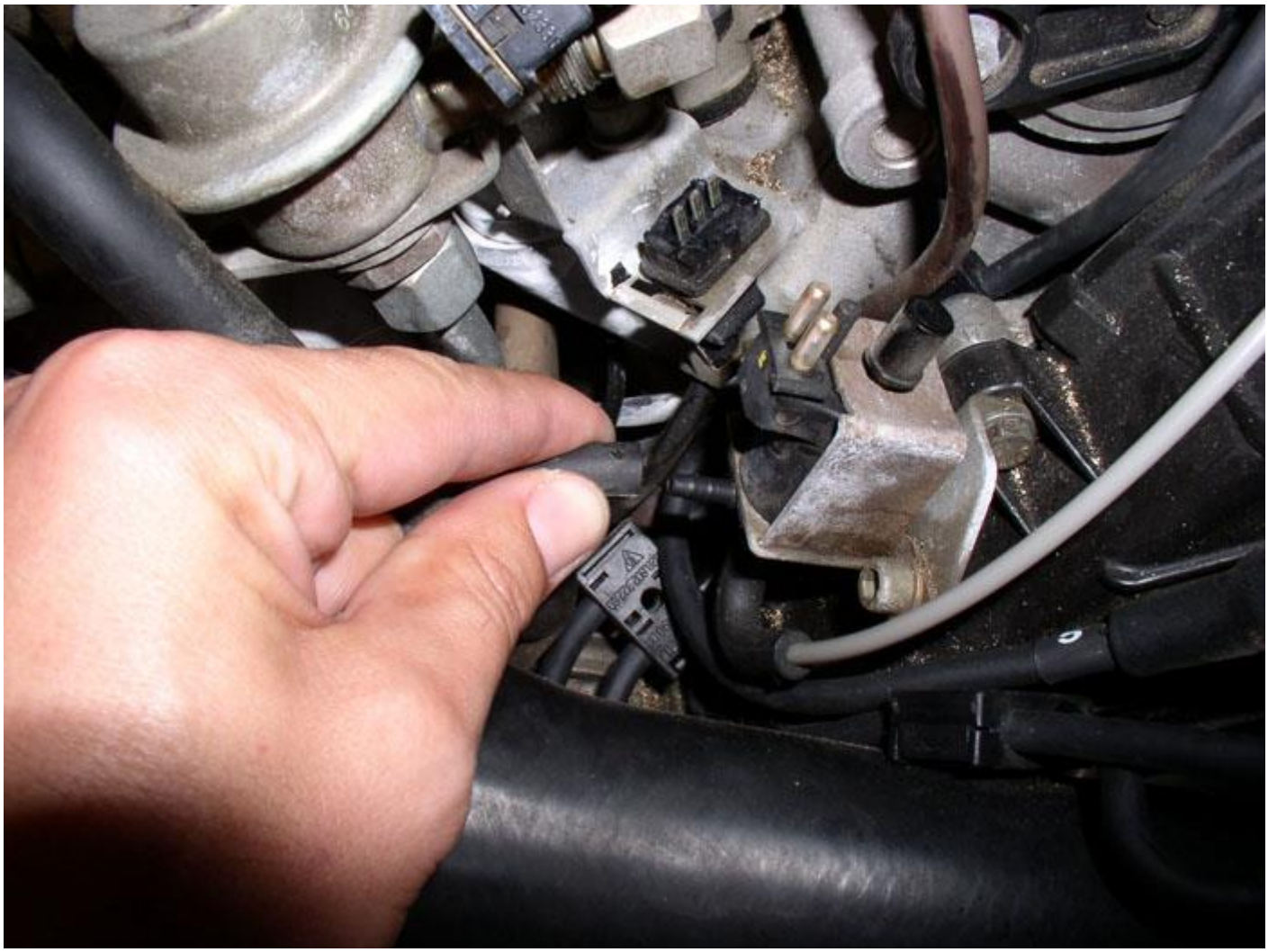
Disconnect the front knock sensor plug from the wiring harness. Same story here on mine with the melted plug.



Disconnect the electrical lead to the flappy vacuum solenoid.



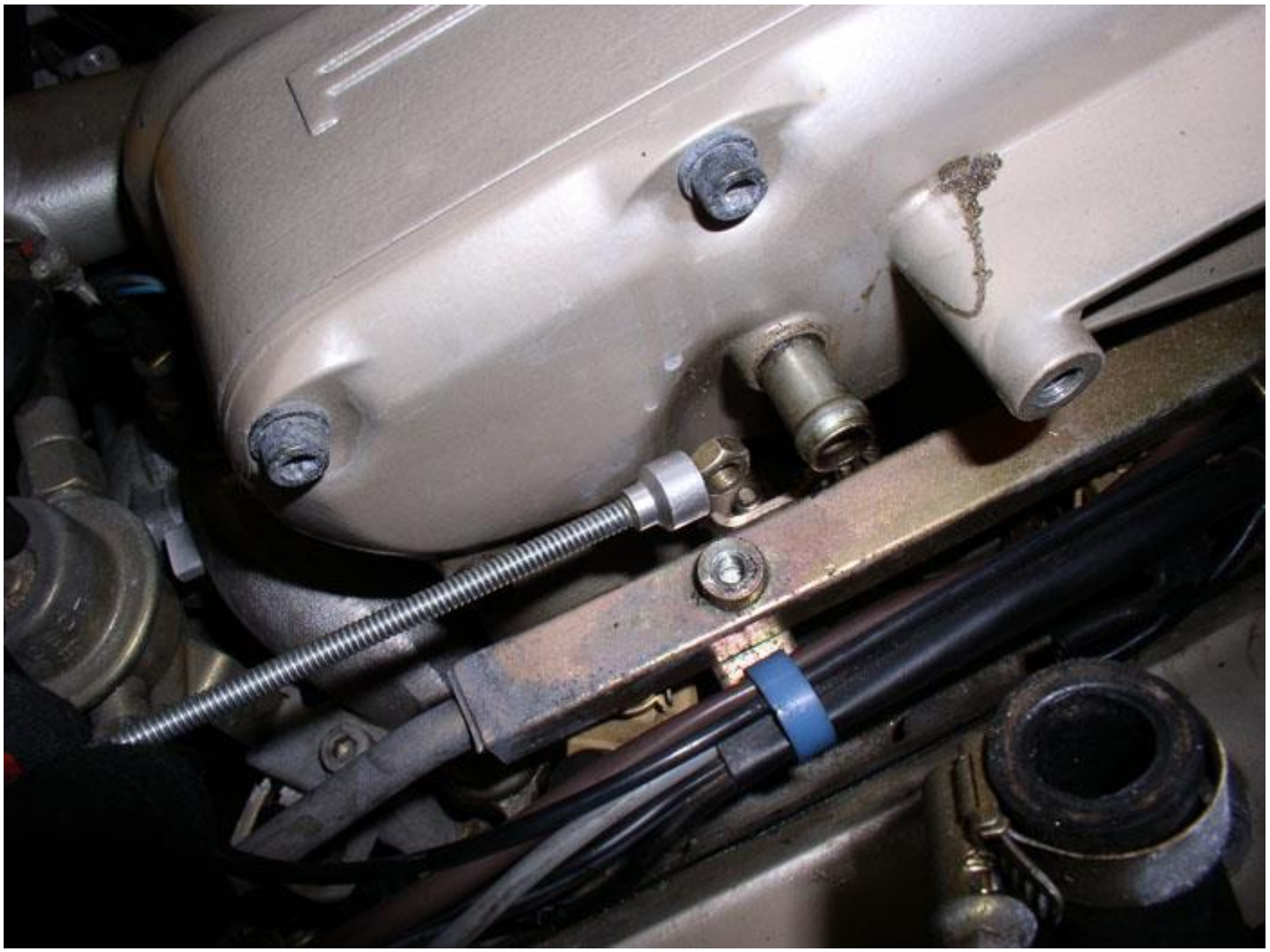
And the vacuum elbow from the solenoid to the flappy diaphram.



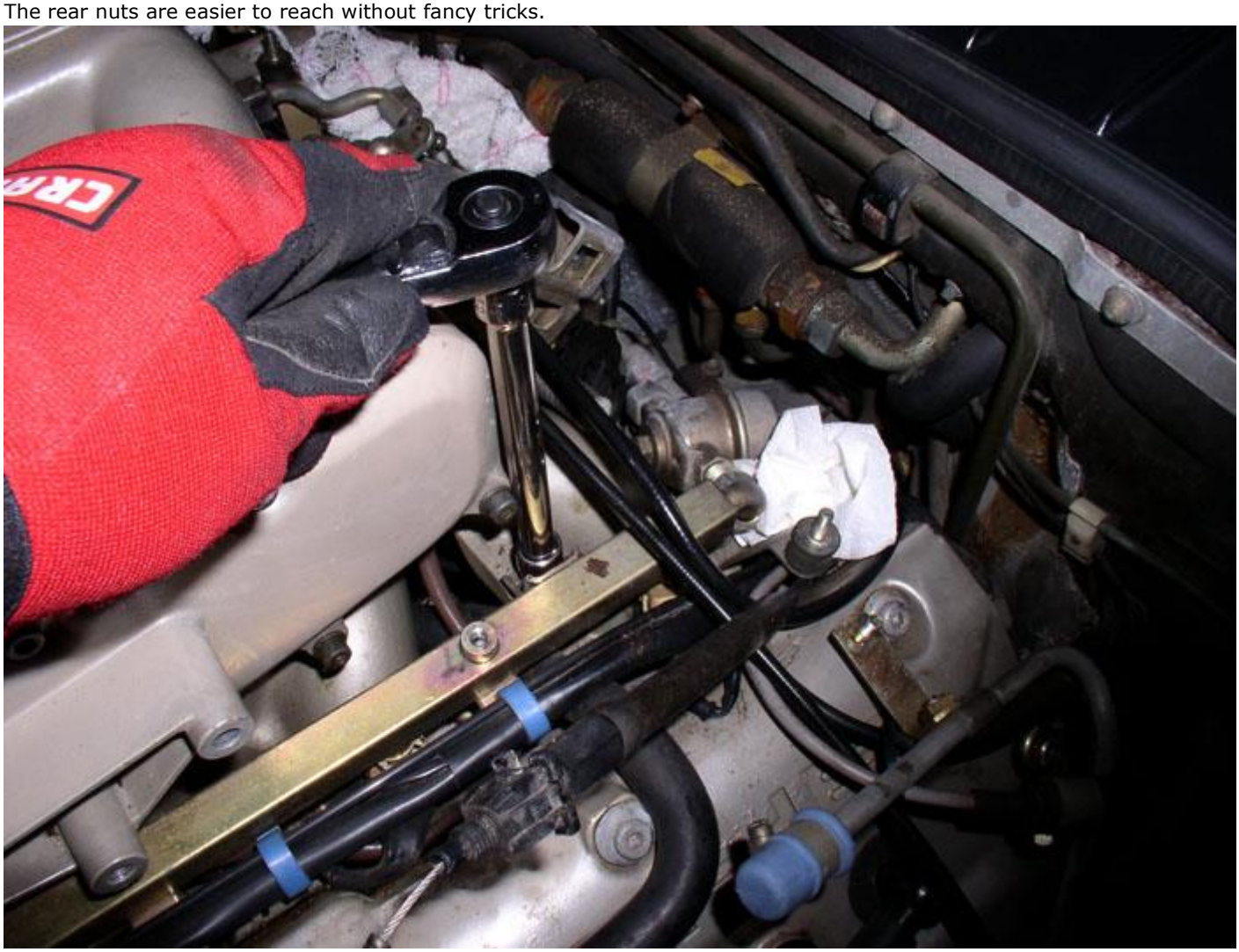
Remove the fuel rail mounting nuts located at the intake runners. Use a 10mm socket on the nuts.



Since these are in a hard to reach place, you can magnetize your socket to make sure the nut comes up with your socket. Or you can use your flexible magnetic pick up tool to fish the nut out.



The rear nuts are easier to reach without fancy tricks.



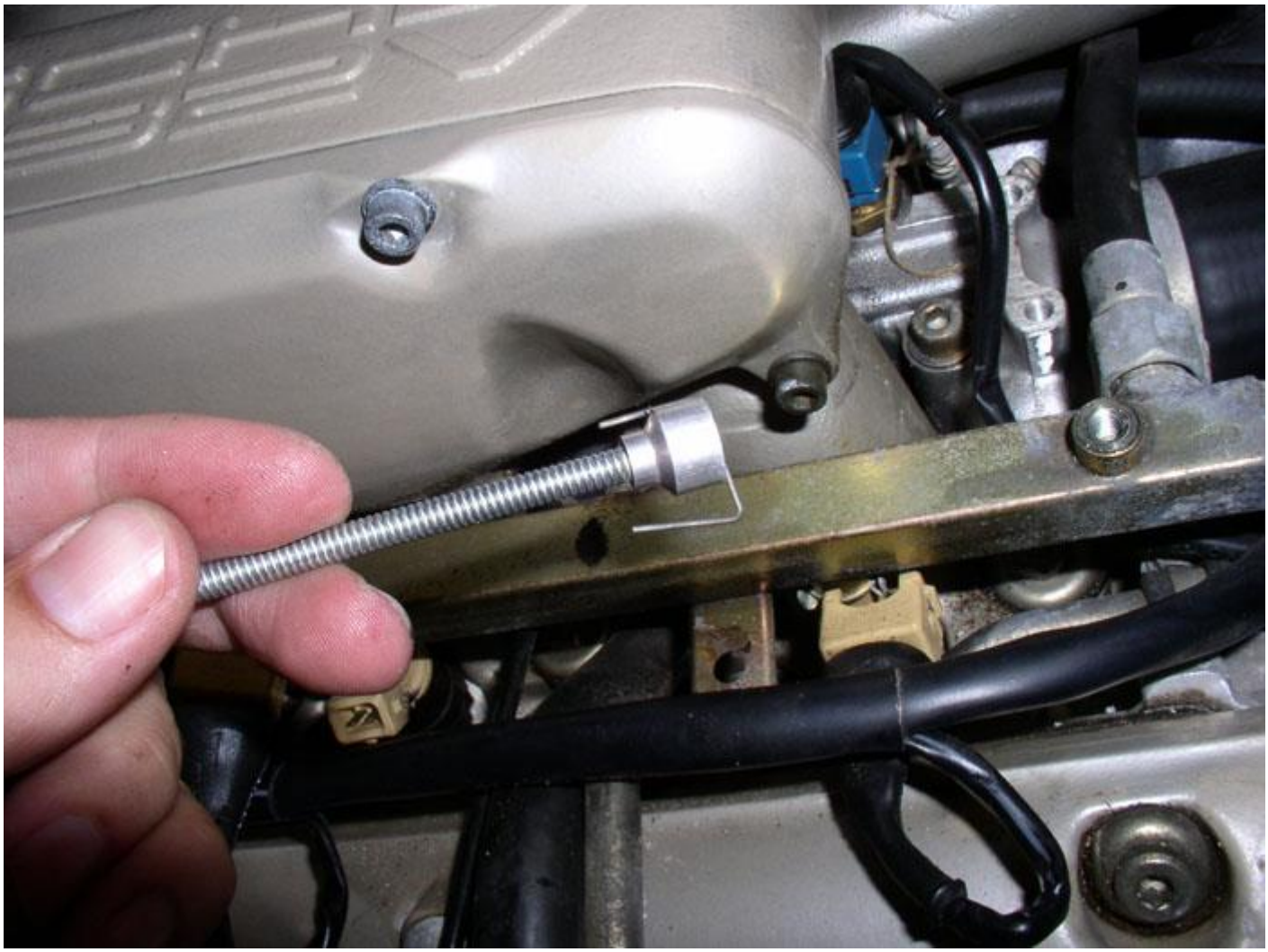
Remove the harness clips from the fuel rails. These tend to be very brittle and will easily break. All of mine were still in tact but broke when I tried to remove them.



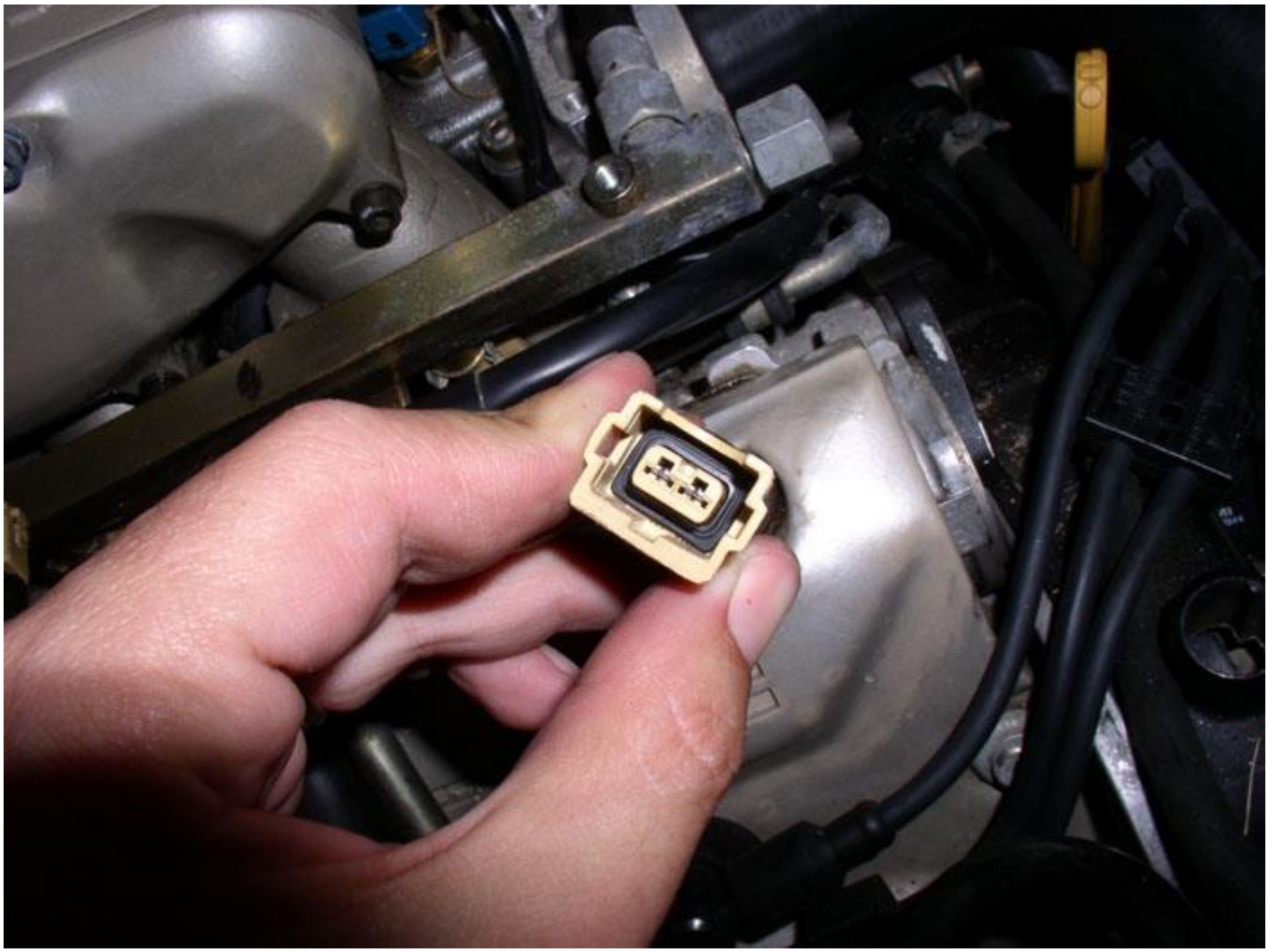
Next, disconnect the fuel injector harness connectors at each injector. I simply used my thumb and index finger to grip and pulled toward me while rocking side to side.



Oddly enough, these injector connectors had an unusual wire clip. Most that I have seen had curved ends on them that secured them to the plastic housing. These did not and therefore, fell out of the connector housing easily. Use the magnectic pick up tool to fish them out if they fall out. As a precaution, I removed any clips that did not fall out because I didn't want them falling into the heads while removing the intake later. Store them together in a baggie.



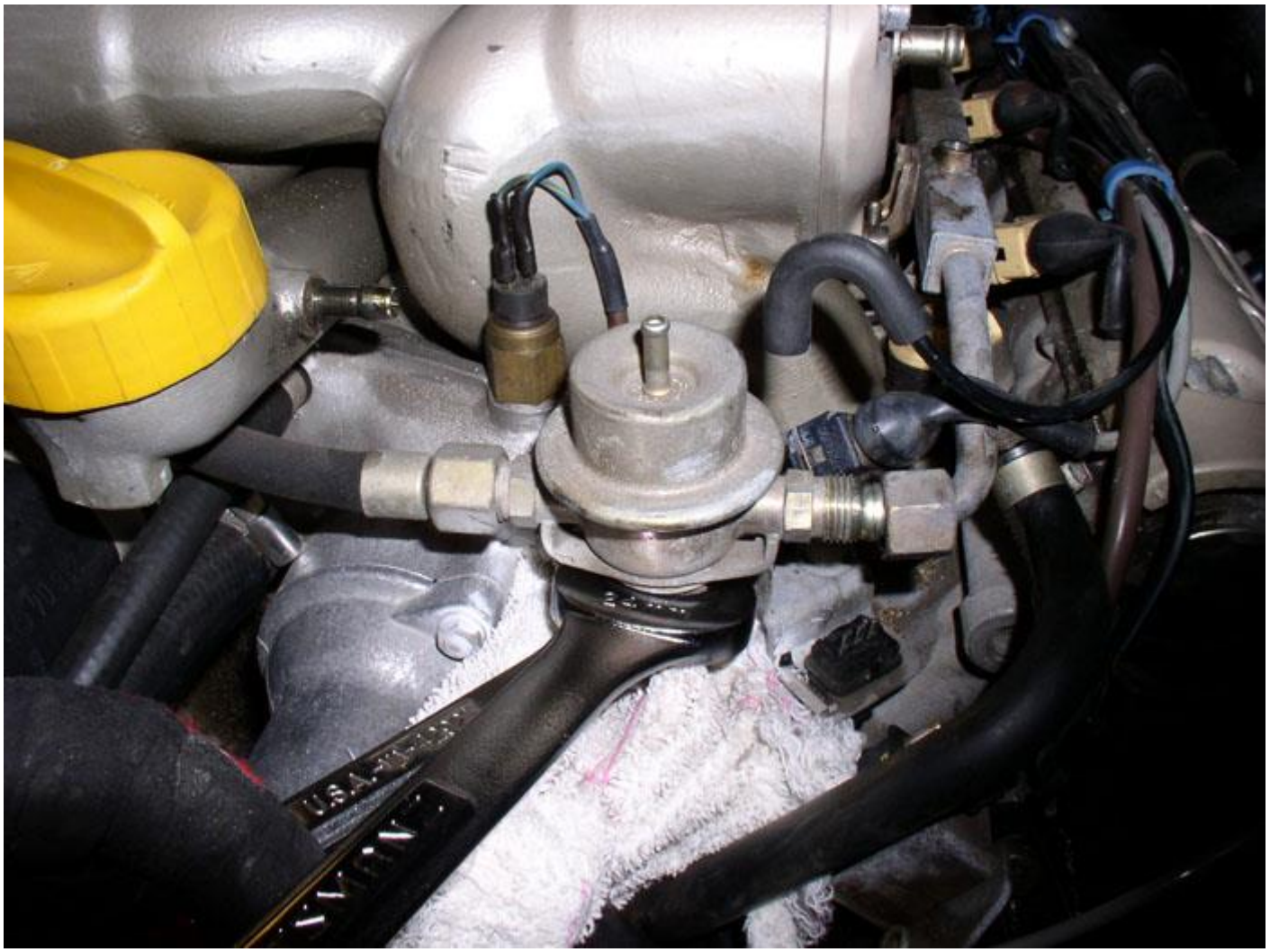
Inspect the injector connector gasket for condition.



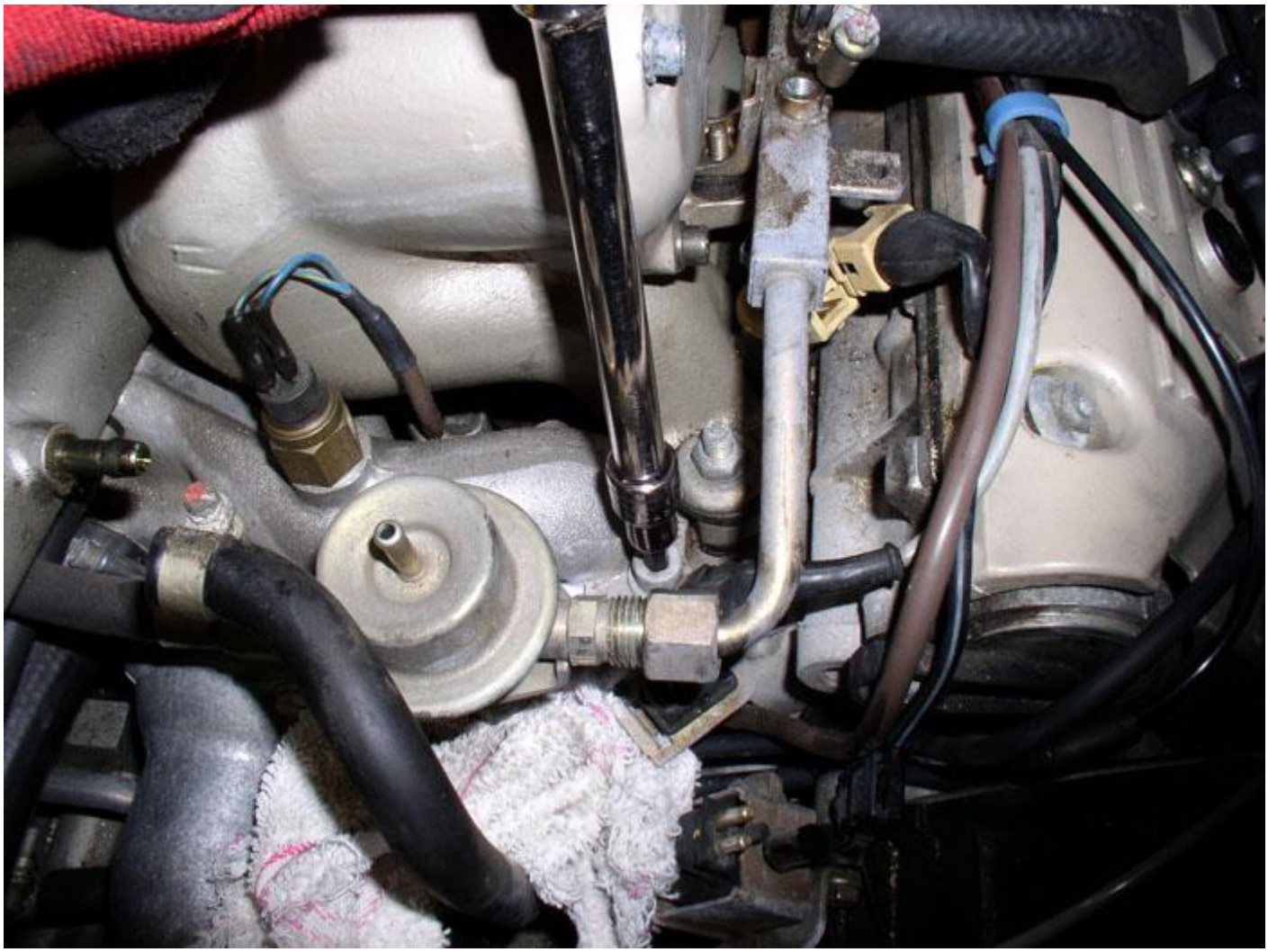
Next, remove the oil filler neck hose (a 3-way hose) that leads to the fuel vent solenoid and the other end leads to the intake.



Disconnect the front fuel pressure damper using a 24mm wrench to counterhold and a 19mm wrench to loosen the fuel line nut. Use a towel to catch escaping fuel.



Remove the one allen bolt that holds down the fuel pressure damper bracket to the water bridge. It takes a 6mm allen socket.



The fuel rails are now ready to pull out. There's a couple of ways you can do this. One way is to simply lift up the rails with the injectors attached. Sometimes the injectors can be firmly attached to the intake so will require some care to pry up. Another way that I have never tried before but tried this time is to remove the clips that secure the fuel injector to the rail and lift the rail up leaving the fuel injectors behind. To use this method, pry the injector retaining clips away from the rail using a flat blade screwdriver. Remove all eight this way.



The fuel rail can then be lifted out without much upward force required.



I left the front fuel hose attached to the pressure damper because at the time, I wasn't sure if I was going to replace the fuel lines. Later, I decided to replace the lines and disconnected the hose.



Bag the fuel rails to prevent dirt from contaminating the rails and pressure damper.



The fuel rail mounts to the intake were hardened and split in two. Only one was left in tact. So all 4 were replaced.



If you are not planning on sending your injectors off to be cleaned, you can cap the injectors with vacuum plugs to project them from getting dirt in them.



Also, cap the Fuel Pressure Regulator and rear pressure damper with vacuum plugs.



I found fuel injectors easier to remove one a time since they were firmly planted rather then 4 at a time with the

rail. Grip the injector and work side to side while pulling upward.



Inspect the injectors as you pull them out. Mine were covered in gunk at the pintle cap but the pintle end seemed to be fine.



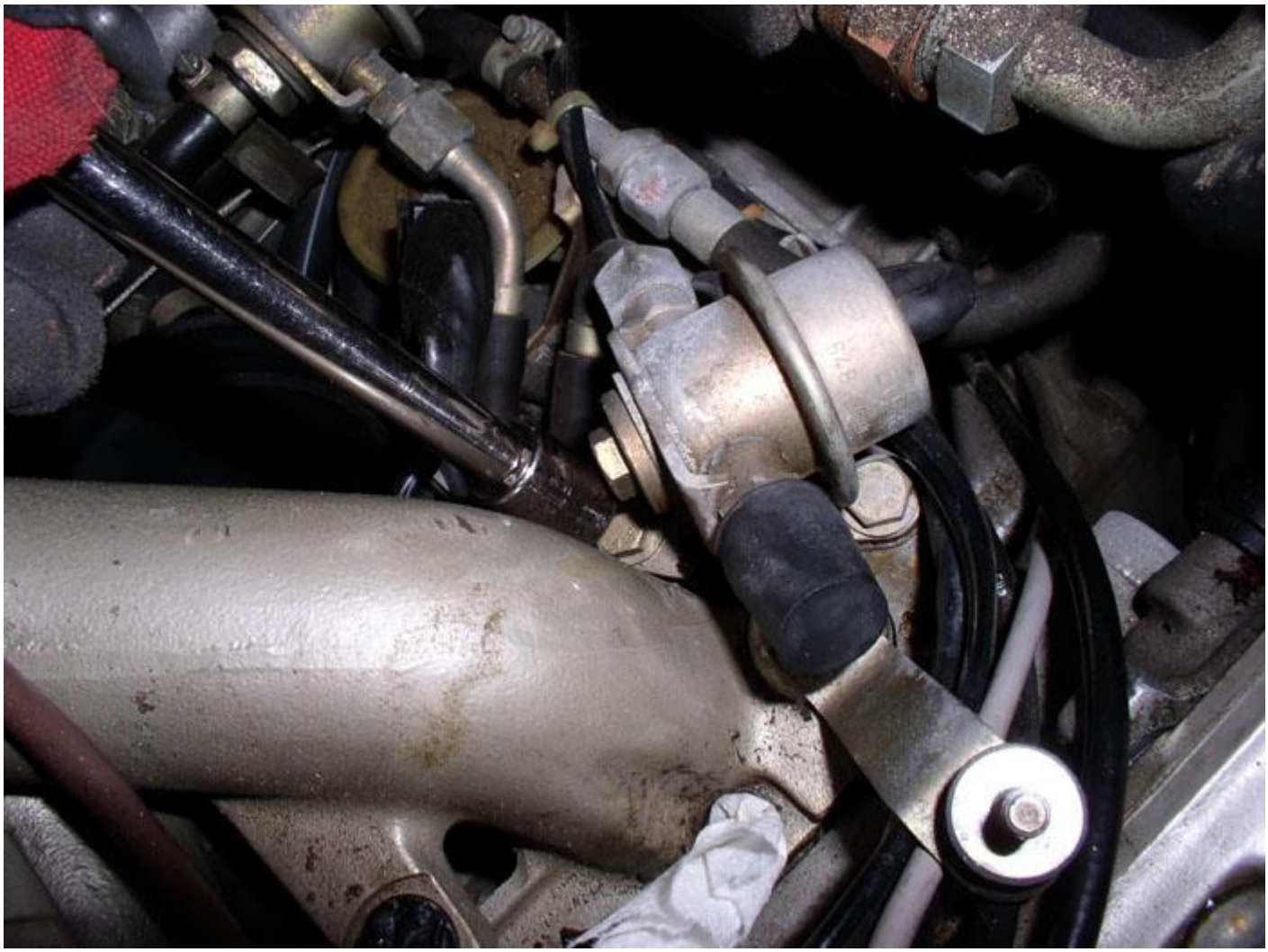
I decided to send the injectors off to Witchhunter for cleaning even though the PO had them cleaned back in 2002. Either way, bag and number the injectors. I prefer to number the injectors so I can put them back in the same cylinder on the install.



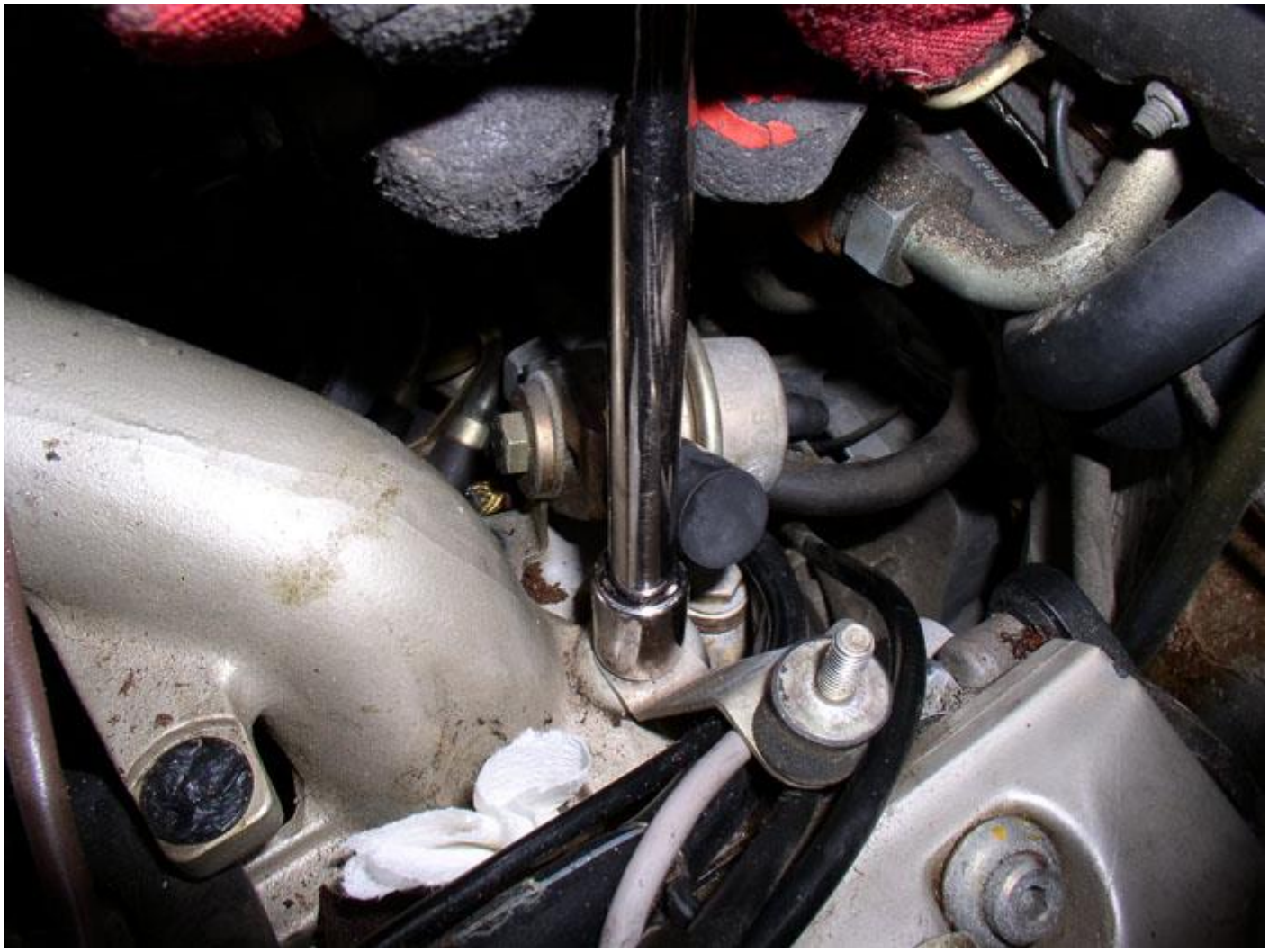

Plug the FI holes after removing the injectors to prevent debris from entering the head. I used strips of paper towel.



Next, remove the rear fuel pressure damper and fuel pressure regulator mounting bolts and nuts. These are 13mm bolts and nuts. One bolt and one nut for each fuel device. First the bolt that holds the damper bracket to the rear coolant port.



The damper nut is next and holds the damper bracket to the intake mounting stud. The nut is a locking (tension) nut.



Do the same for the fuel pressure regulator on the passenger side. Then move the assembly out of the way - toward the firewall.



Next, begin removing the intake mounting nuts. There are 10 total, 5 on each side. They are 13mm locking (tension) nuts. You already removed one when you liberated the fuel pressure regulator and damper brackets. Only 8 to go. On the driver's side, use the socket extension (6") and universal elbow to get at the nuts under the cable mounting bracket.



On the passenger side, one of the intake mounting nuts will require you to remove one of the allen head bolts to the side cover plate. It interferes with getting the socket on the 13mm nut. Remove the side cover plate allen head bolt with a 5mm allen head socket.



Using a screwdriver, loosen the hose clamps on the two PCV hoses at the passenger side cam covers and remove the hoses from the cam cover elbows.



Re-route both of the PCV hoses so they are on top of the wiring harness.



Disconnect the vacuum line elbow from the air pump diverter valve.



Disconnect the vacuum line elbow from the fuel tank vent diaphram that resides next to the coolant reservior. Label at least one of the hoses in order to keep them from getting mixed up on the install. If not, you can always follow the vacuum hose routing diagram to ensure the lines are connected correctly.




Loosen and remove the fuel inlet line clamp bolt. Use a 10mm socket with extension. This clamp needs to be removed in order for the front intake runner to clear the fuel line on removal.



Disconnect the throttle plate cable by pulling or prying the ball connector at the end of the cable toward the throttle body.

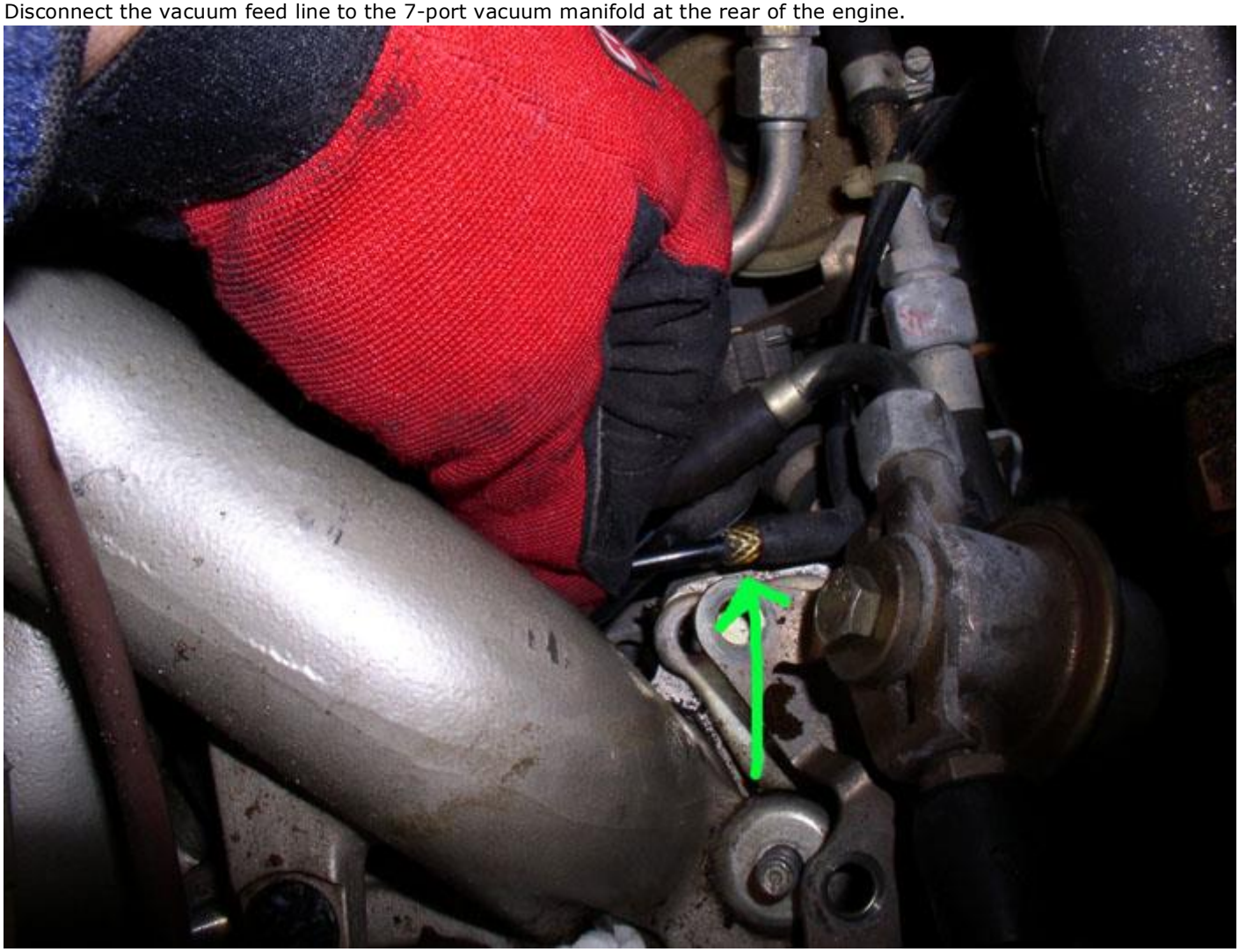


Loosen the clamp and disconnect the hose at the brake booster venturi that leads to the air guide cowl. Route

the disconnected hose from the cowl so it's on top of the wiring harness.



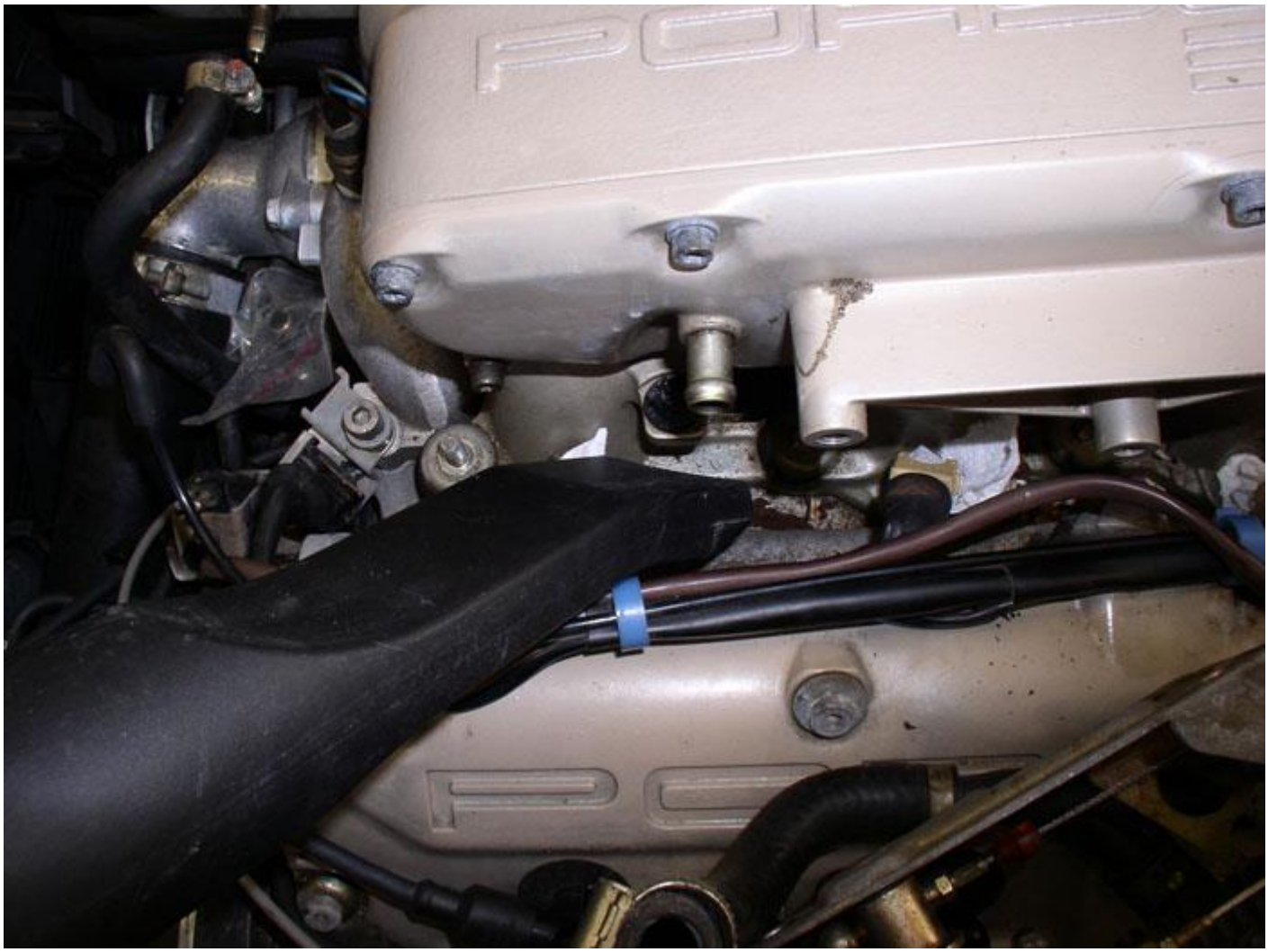
Disconnect the vacuum feed line to the 7-port vacuum manifold at the rear of the engine.



Disconnect the wires from the air temp sensor on the top of the intake. These are spade connectors and it doesn't matter which wire goes to which terminal so no need to mark these.



Before prying the intake up from the heads, it's a good idea to vacuum out any loose debris from around the bottom of the intake runners so that it doesn't fall into the heads while you're manuevering the intake around in the next few steps.



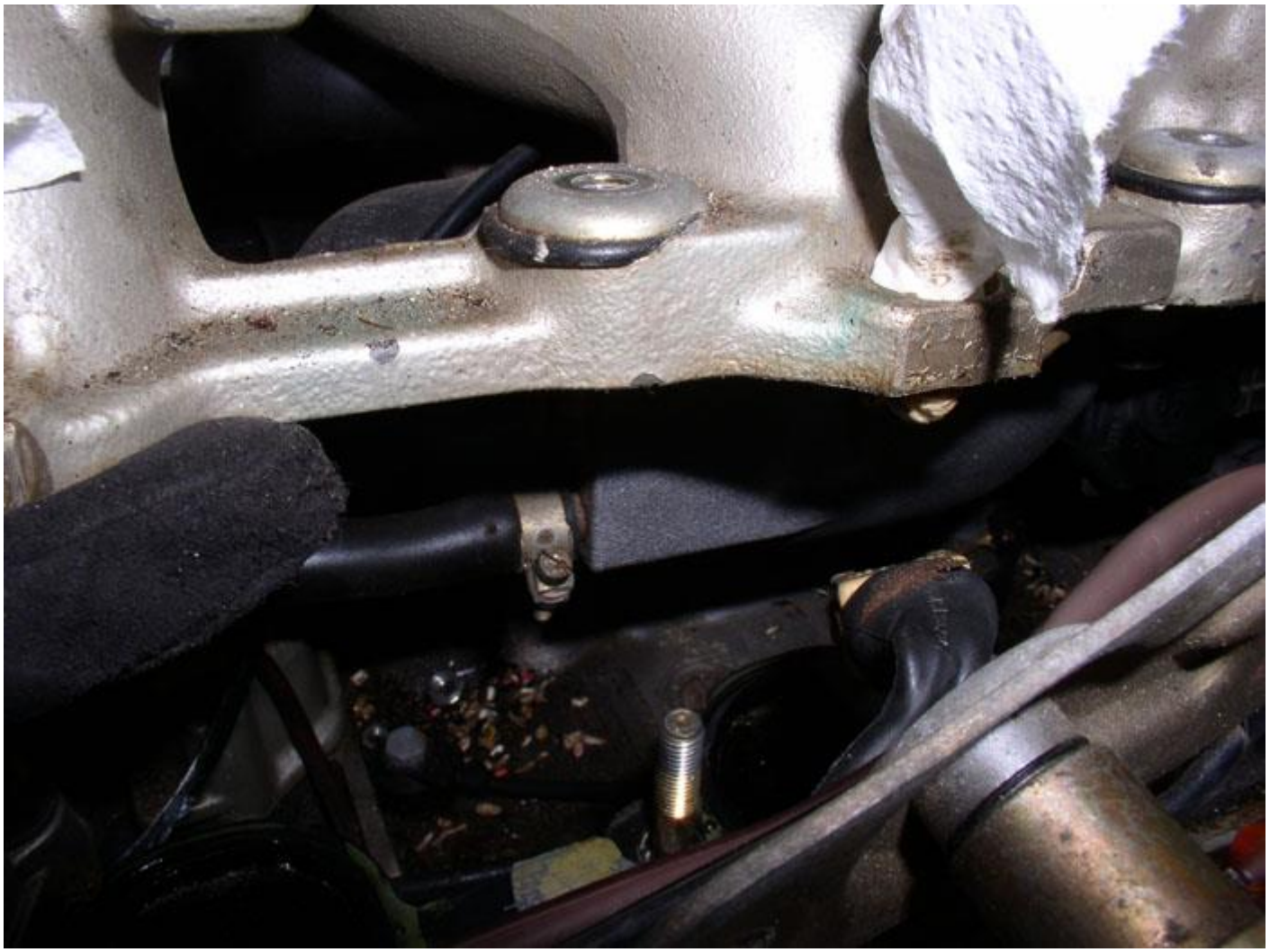
The intake may have taken a liking to the heads and won't want to come off easily. I used a short 2X4 and long prybar to lever some force from underneath the intake to break the intake free. You can place the 2X4 on the head casting that protrudes out from under the cam cover about mid way on the head (where the 2X4 is shown here) rather than resting it on the cam cover.



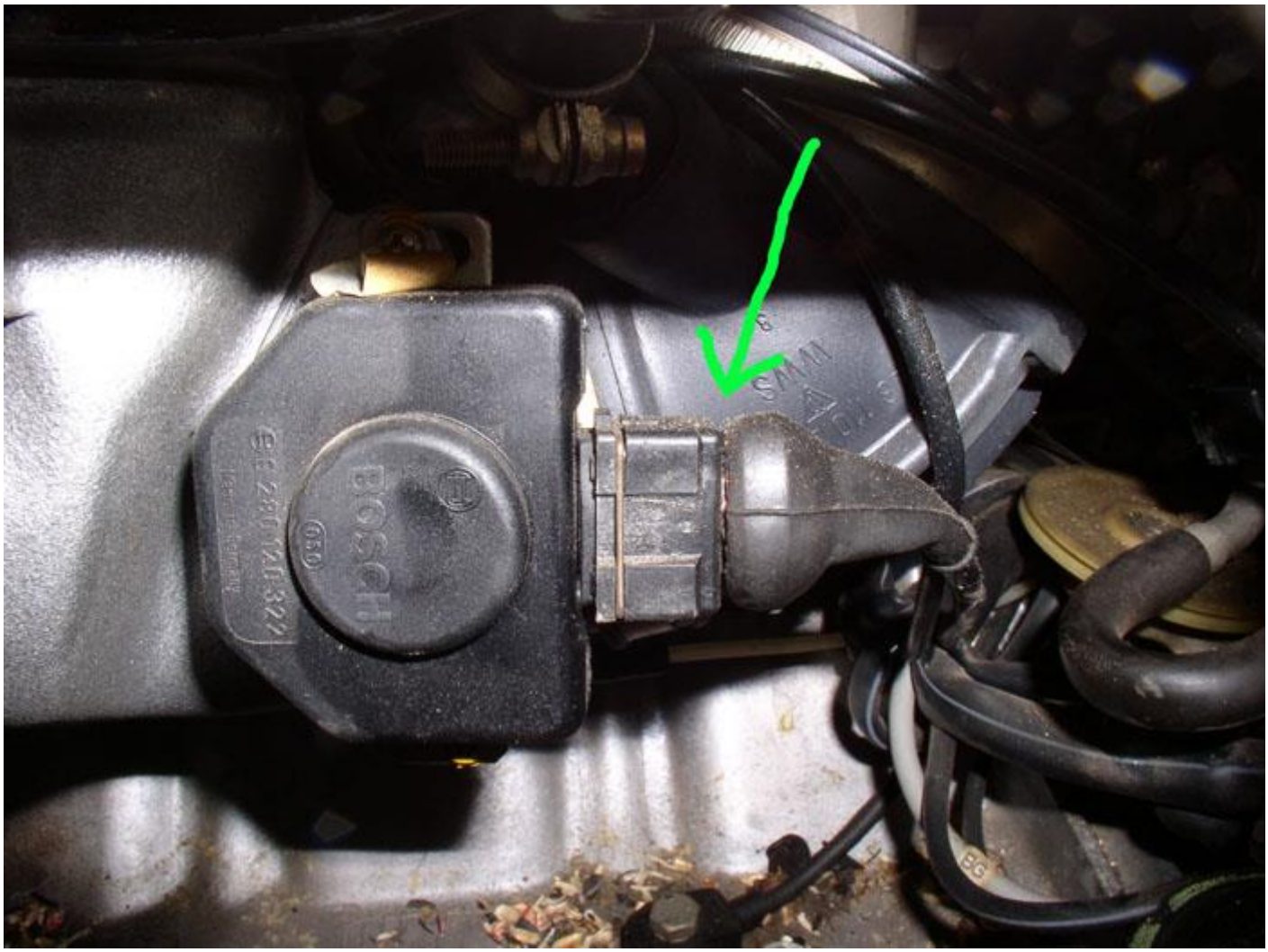
Once the intake is free, lift it up enough to rest it on top of the intake mounting studs. This will allow you some room to remove a few more connections before extracting the intake.



Next, you'll need to disconnect the hose that arrives at the intake from the oil filler neck and fuel vent solenoid (the 3 way hose). Use a flat blade screwdriver and lift the driver's side of the intake slightly to gain a little work room.



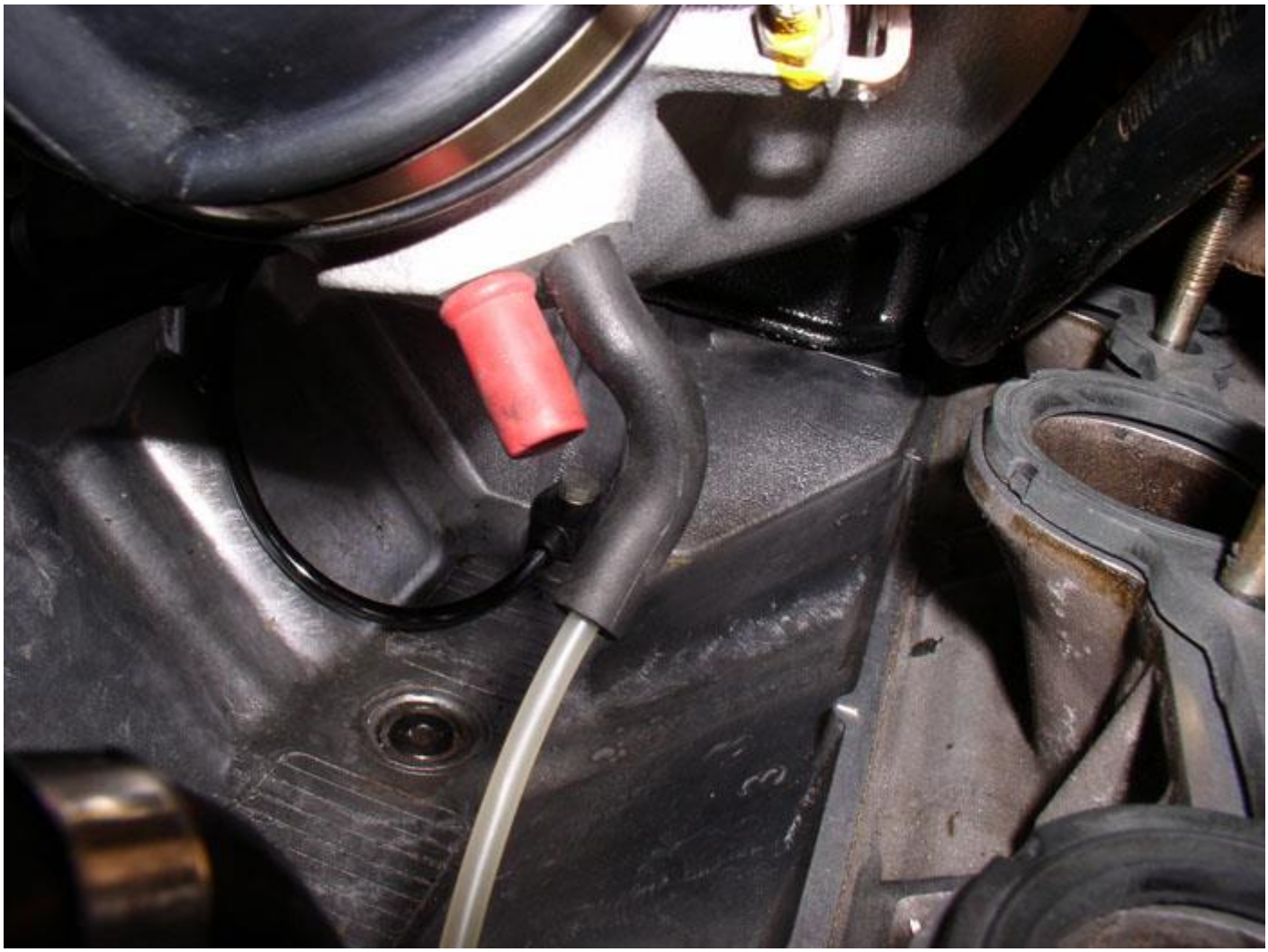
Now, while you're still on the driver's side, remove the Throttle Position Sensor electrical connection. Lift the intake slightly to gain work room and grasp the connector and pull rearward while rocking up and down.




Now over to the passenger side. You'll need to remove the breather hose that arrives at the Air Guide Cowl from the oil filler neck base. It should be the hose that is closest to the firewall but you can confirm this by tracing it. The other hose at this "Y" connector is the breather hose that runs to the cam cover - you can leave that one attached. Loosen the clamp with a screwdriver and disconnect the hose.



Next, lift the passenger side of the intake up enough to gain access to the underside of the throttle body and you will find an elbow and vacuum line that runs to the air pump diverter valve. Disconnect the elbow from the throttle body.



Now to disconnect the ISV electrical plug. There is a special tool called for in the WSM but I didn't have one and couldn't locate one easily - although I believe you can get them. I used an extra long pair of needle nose pliers with a 90 degree bend at the plier ends. At this point, the only connection left is the ISV electrical plug. Lift and rotate the intake so you can see/access the plug to the ISV. I rotated it toward the driver's side because I'm right handed and this provided a good orientation to access the plug with my right hand.



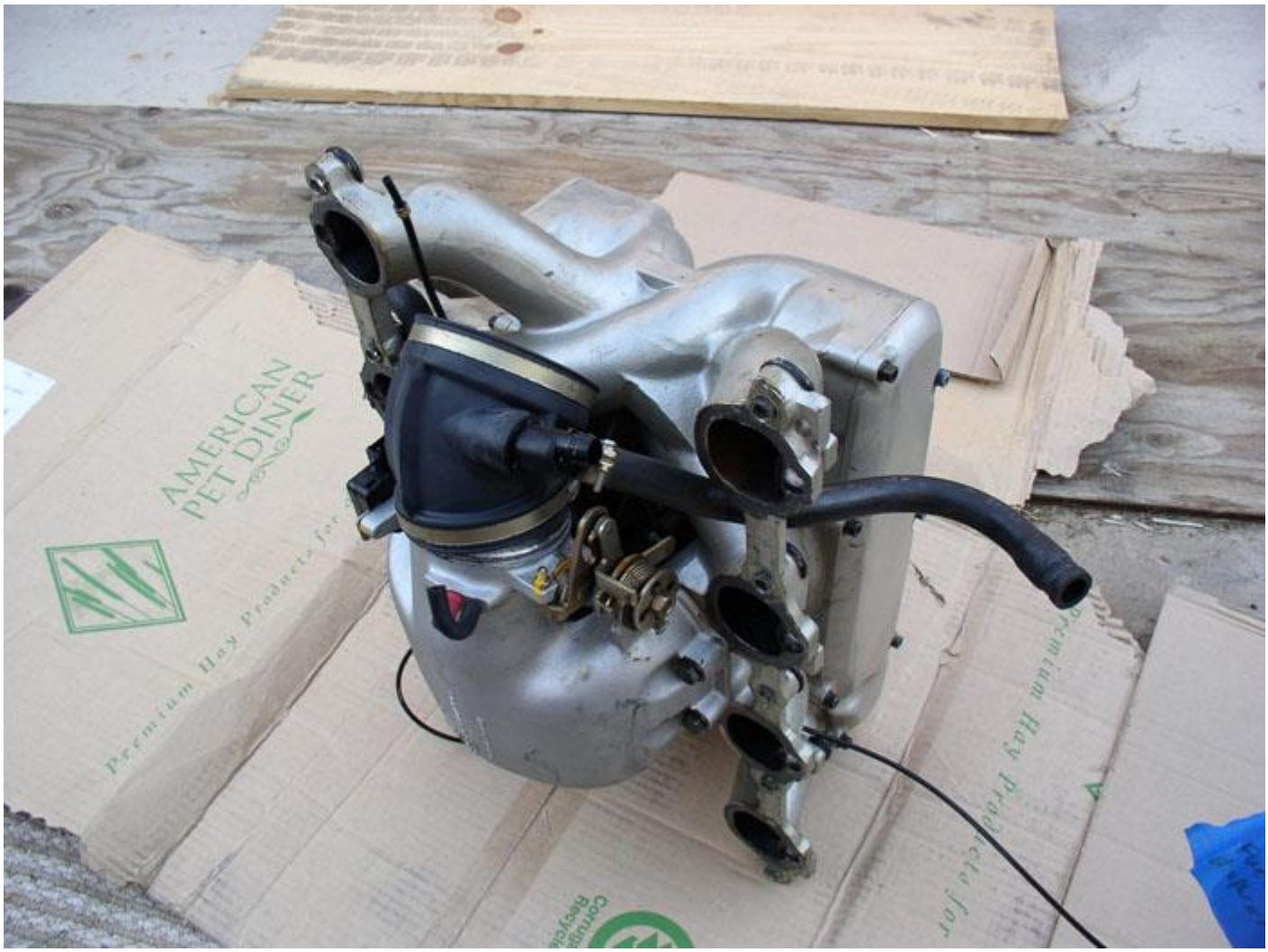
Use your tool of choice (or hand if it's small enough) to reach in and grasp the connector and pull while rocking side to side. If you're using pliers, be careful not to grasp too hard because the plug housing on the harness end may be brittle and could break.



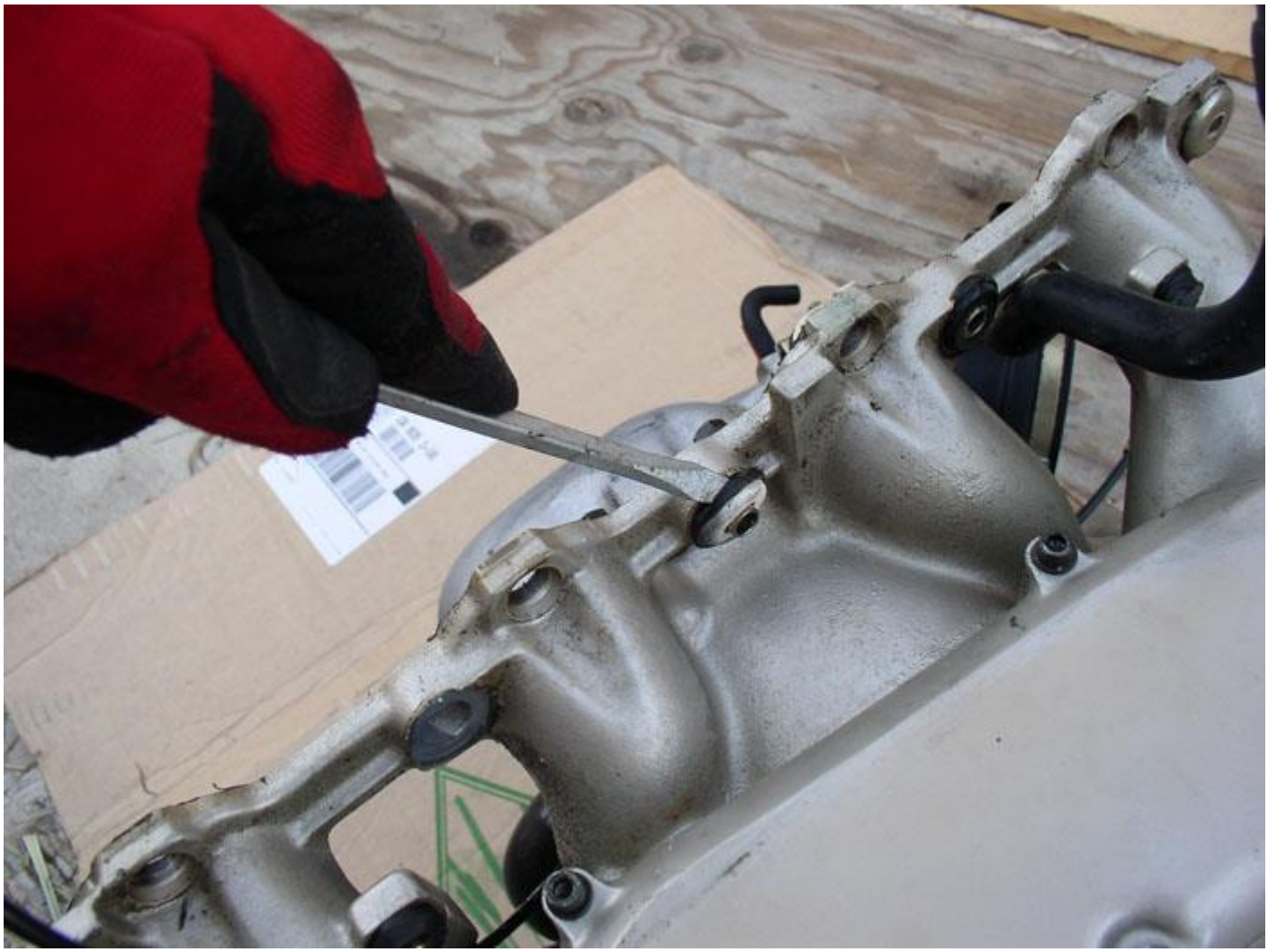
With the ISV plug disconnected, you should be able to lift and remove the intake. Immediately plug the intake ports on the head to prevent debris from falling into the head - or worse, combustion chamber.



Now you can stand the intake on end to remove a few more parts. I needed to completely disassemble the intake because I planned to refinish it. I chose to go the Powder Coating route rather than paint.




First, remove the intake to head thrust washers. There's 3 parts to these - the metal umbrella cap, the rubber thrust washer, and the metal sleeve insert. They may come of in one piece or in separates. Mine were firmly attached to the intake so I used a screwdriver to carefully pry them off.

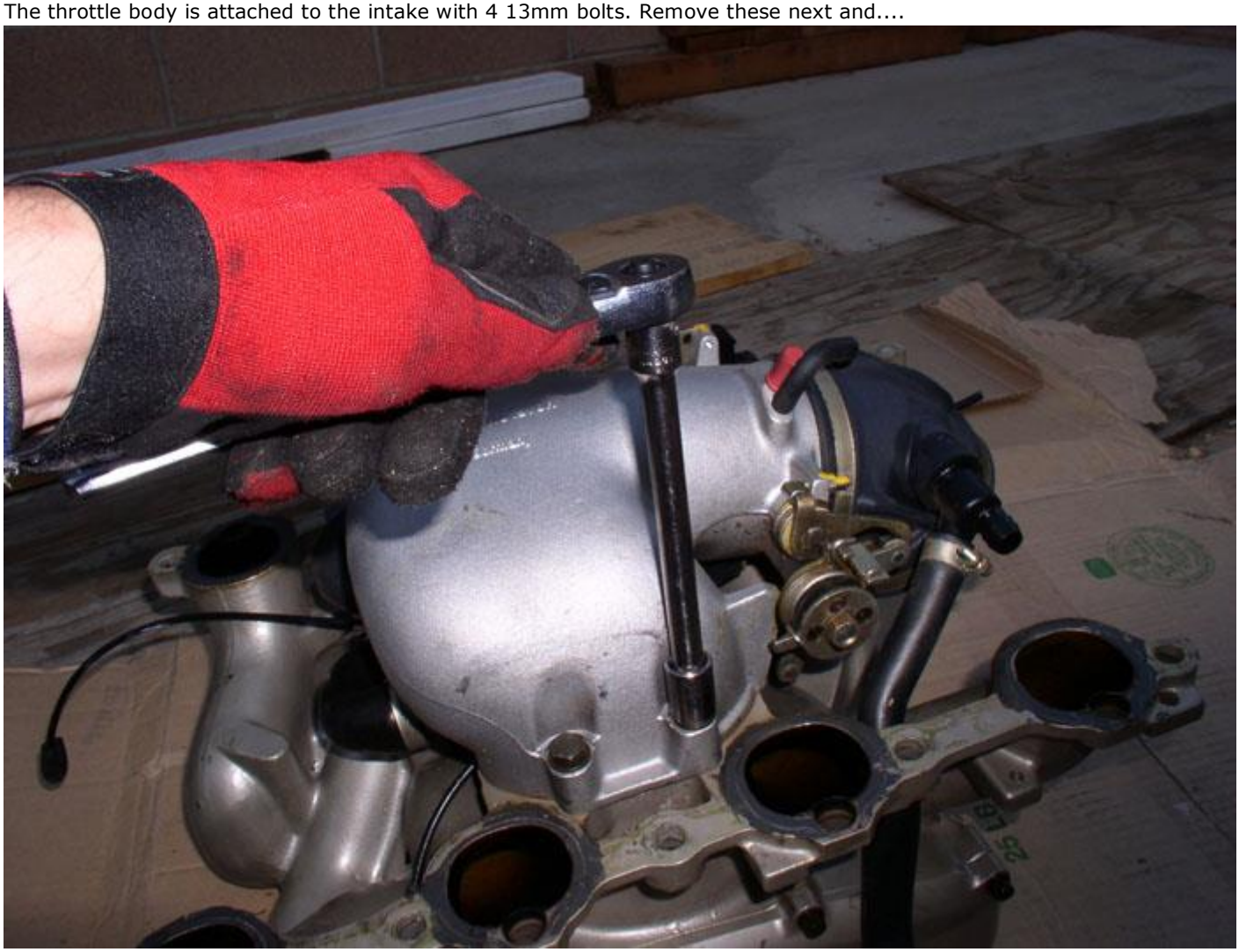


Also remove the fuel rail mounting studs from the intake (4). It's a rubber bushing with threaded studs on both

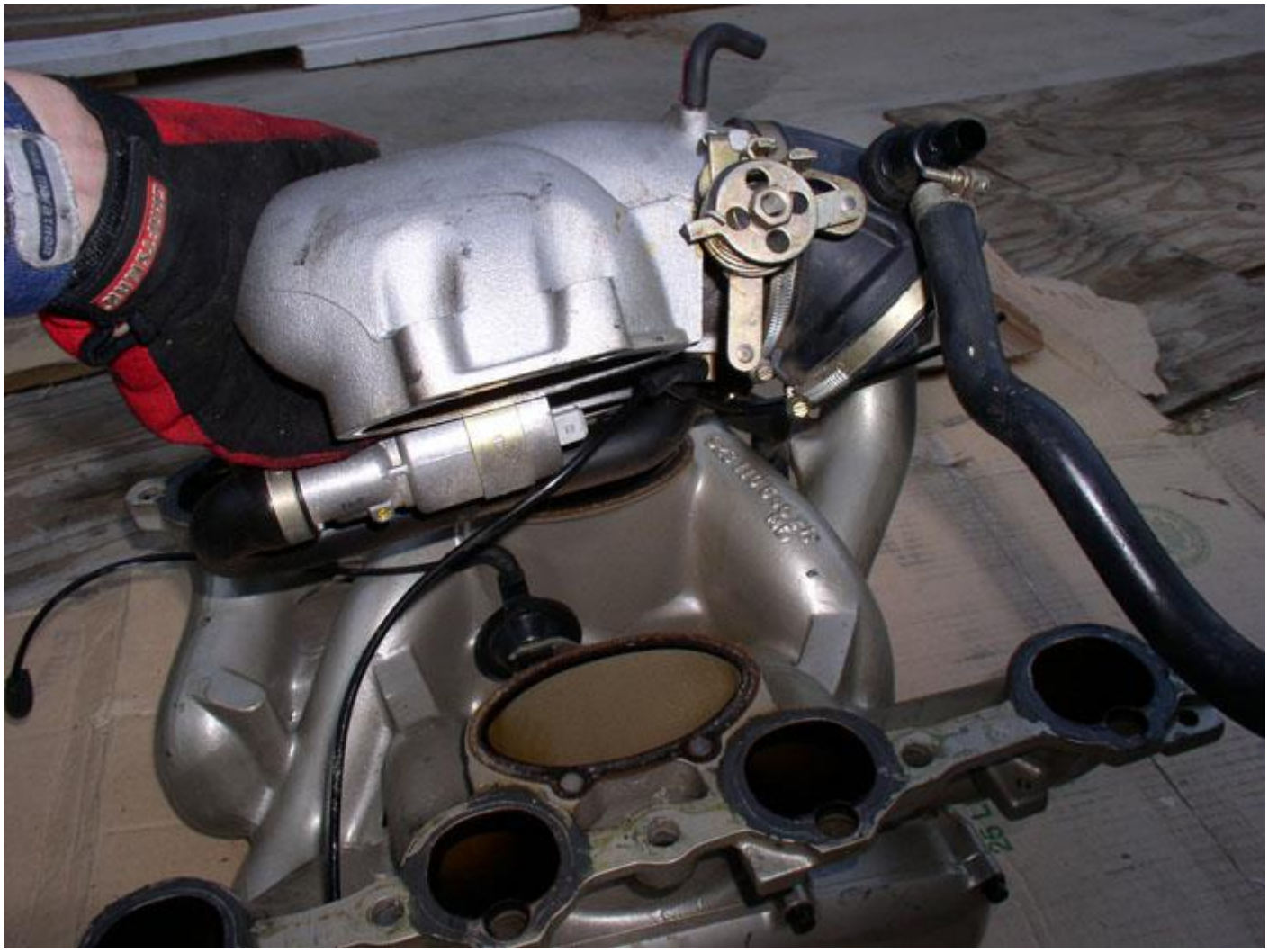
sides. Use a pair of pliers to grip the rubber bushing (or what's left of it) and unscrew from the intake.



The throttle body is attached to the intake with 4 13mm bolts. Remove these next and....



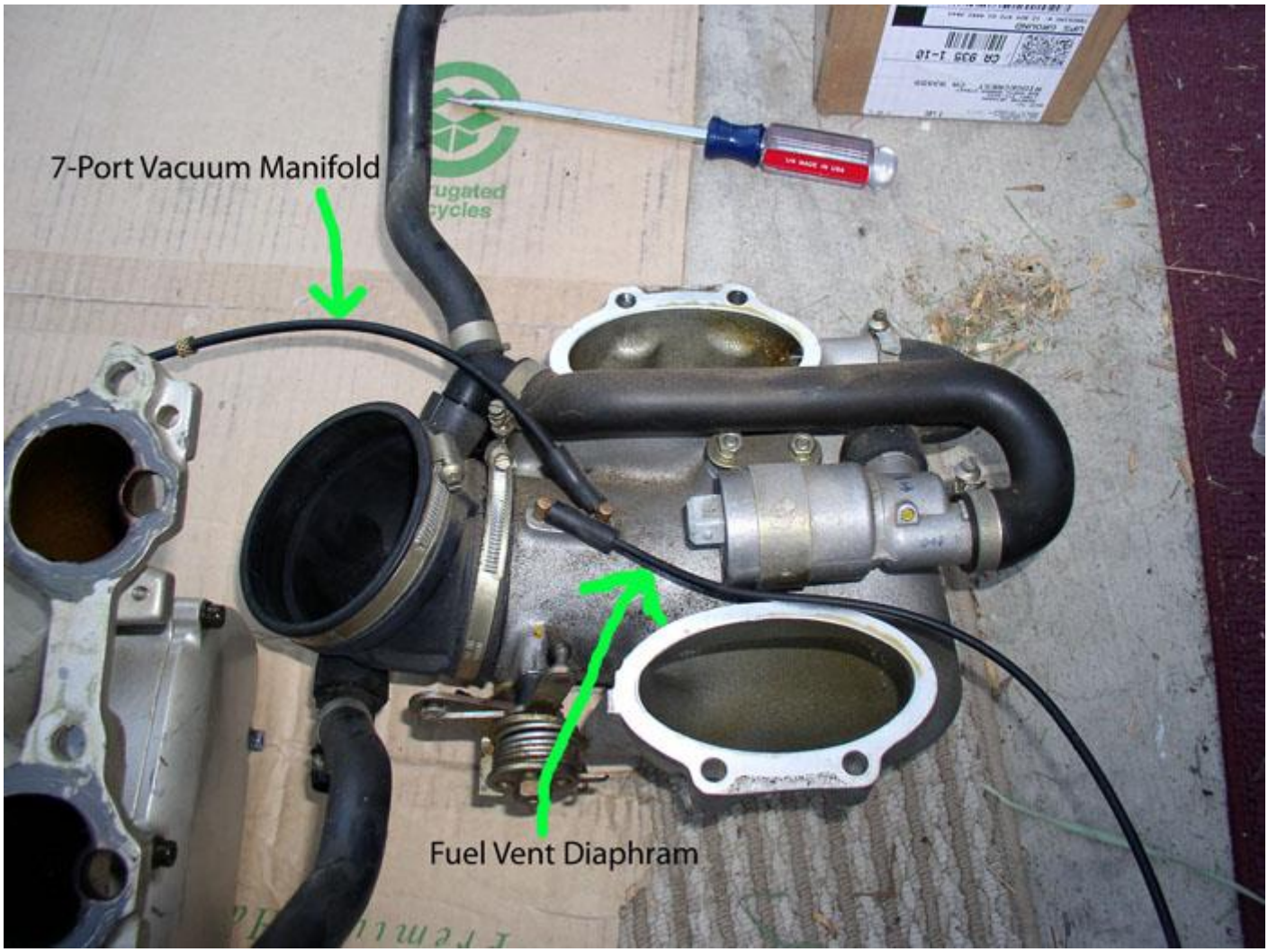
...the throttle body should come right off with no resistance. You will need to guide the breather hoses still attached to the air guid cowl through the intake runners as you're removing the throttle body.



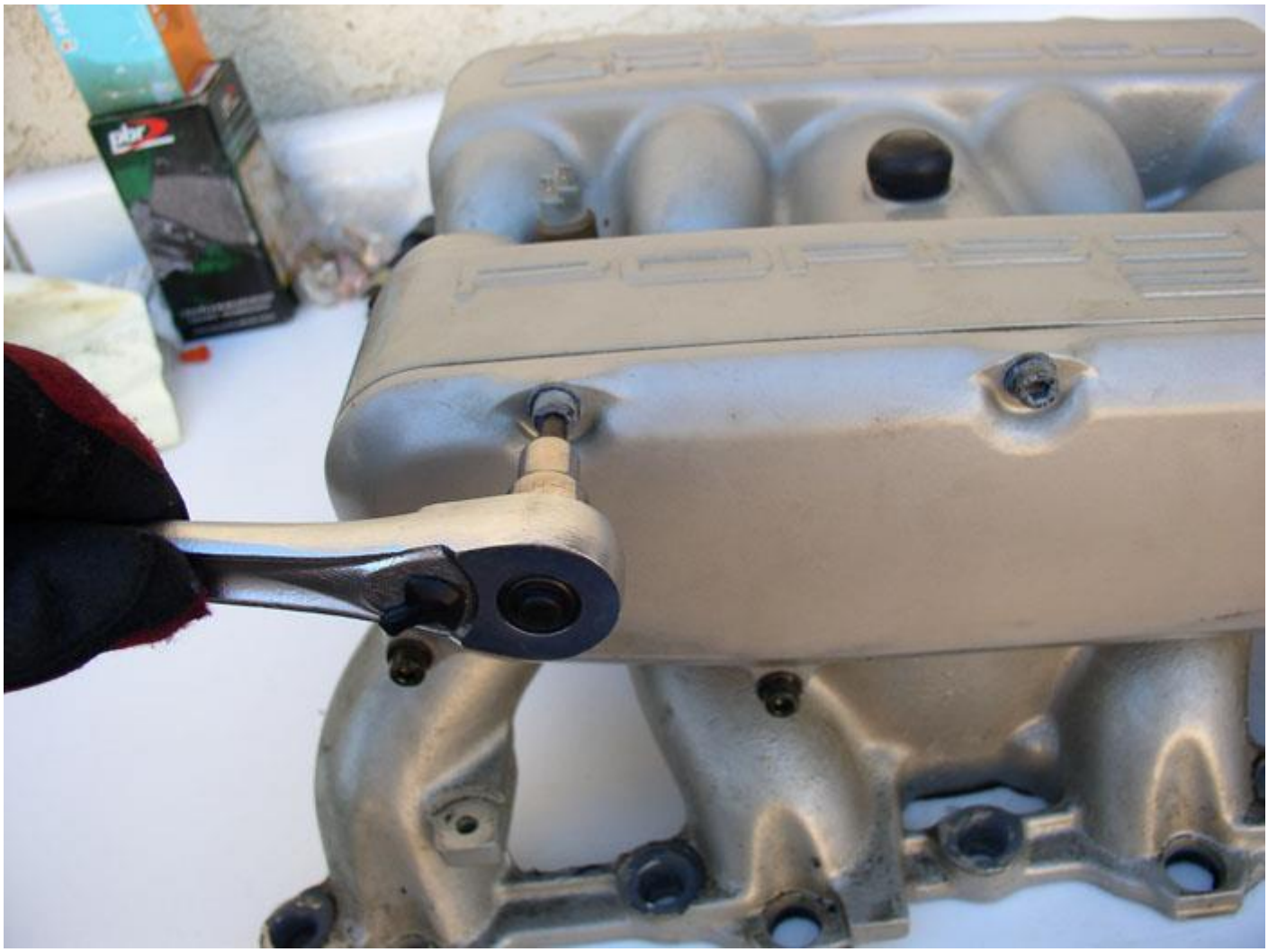
You should now have access to the flappy vacuum unit. If your tests earlier showed a leaking or sticking unit, you can inspect for leaks with the elbow and vacuum line here and remove the elbow from the unit and hook your vacuum pump directly to the diaphram and test for leaks. If the unit is leaking, put it on lthe order list.



Under the throttle body you can inspect the ISV and hoses. There are two vacuum lines attached to the throttle body. The shorter line coming out the left goes to the 7-way vacuum manifold while the longer line goes to the fuel vent diaphram that is located next to the coolant reservoir.




Next, remove the intake side cover plates. Use a 5mm allen head socket.



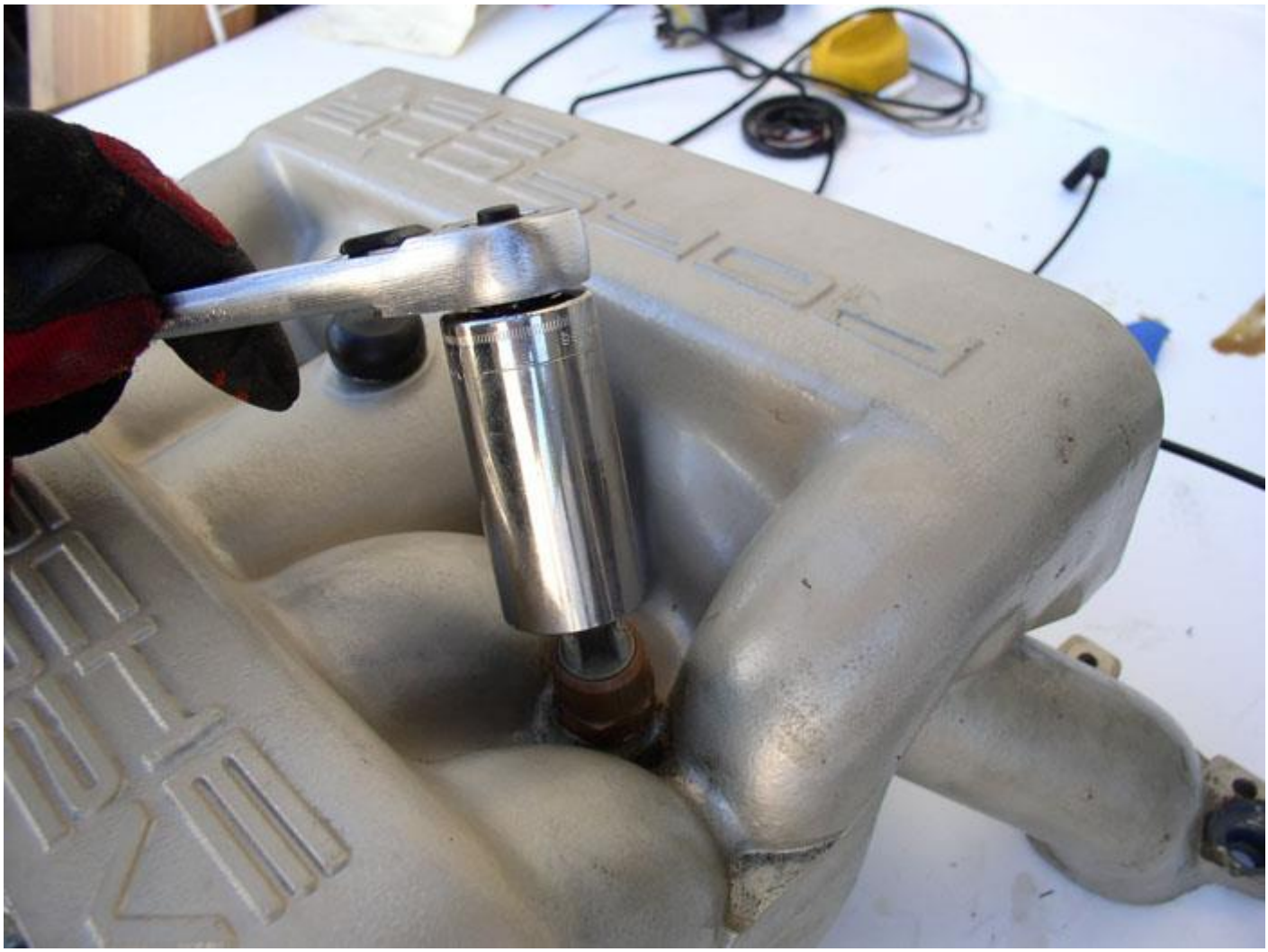
Gently pry up the cover plate with a flat blade screwdriver being careful not to mar the mating surfaces.



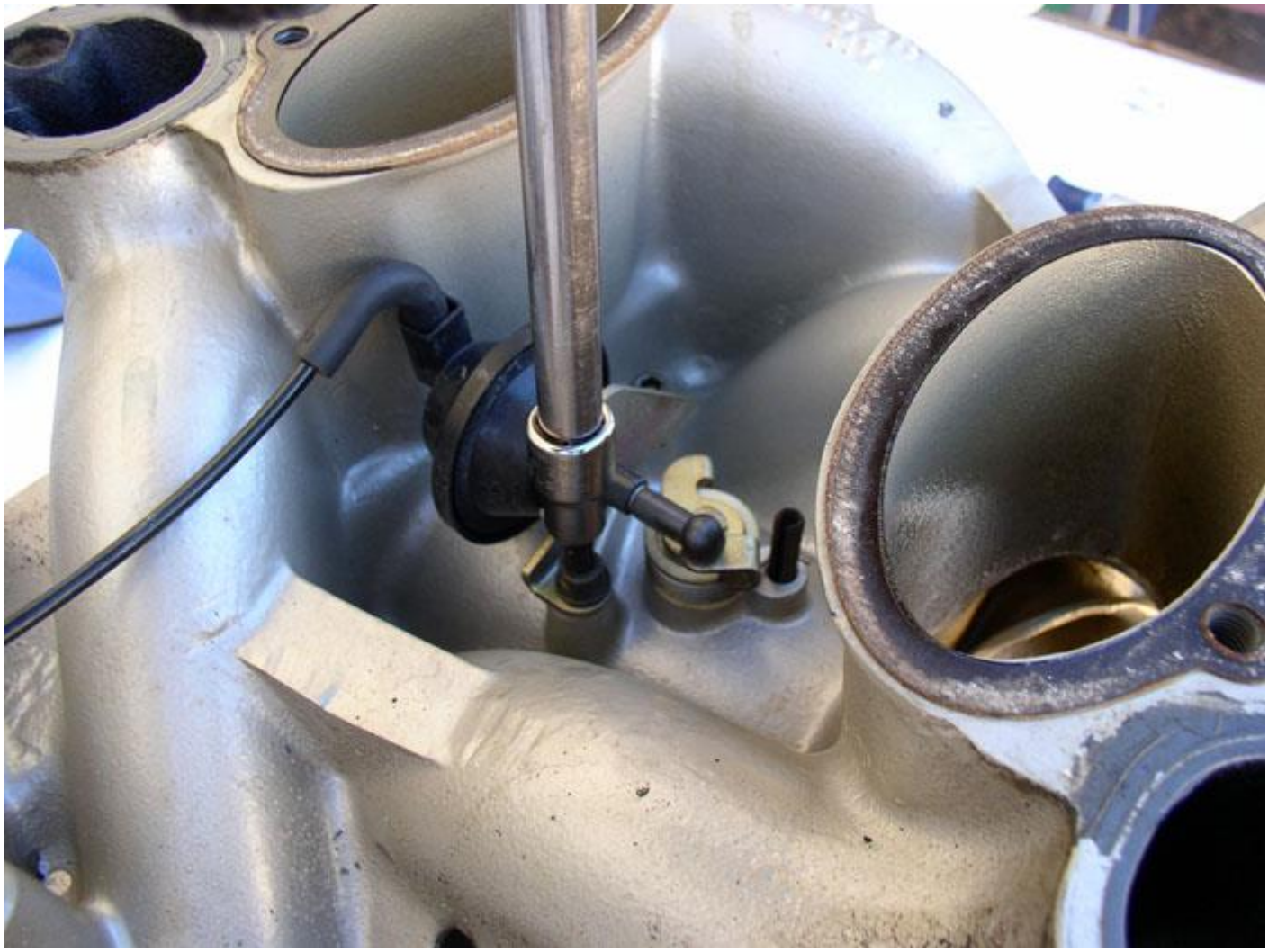

Once the plate is removed, you can see the internals of the intake including the flappy plate. If you noticed the flappy diaphram was sticking while operating it with the vacuum pump, you can investigate here by operating the vacuum unit with the vacuum pump and watching where the plate is getting hung.



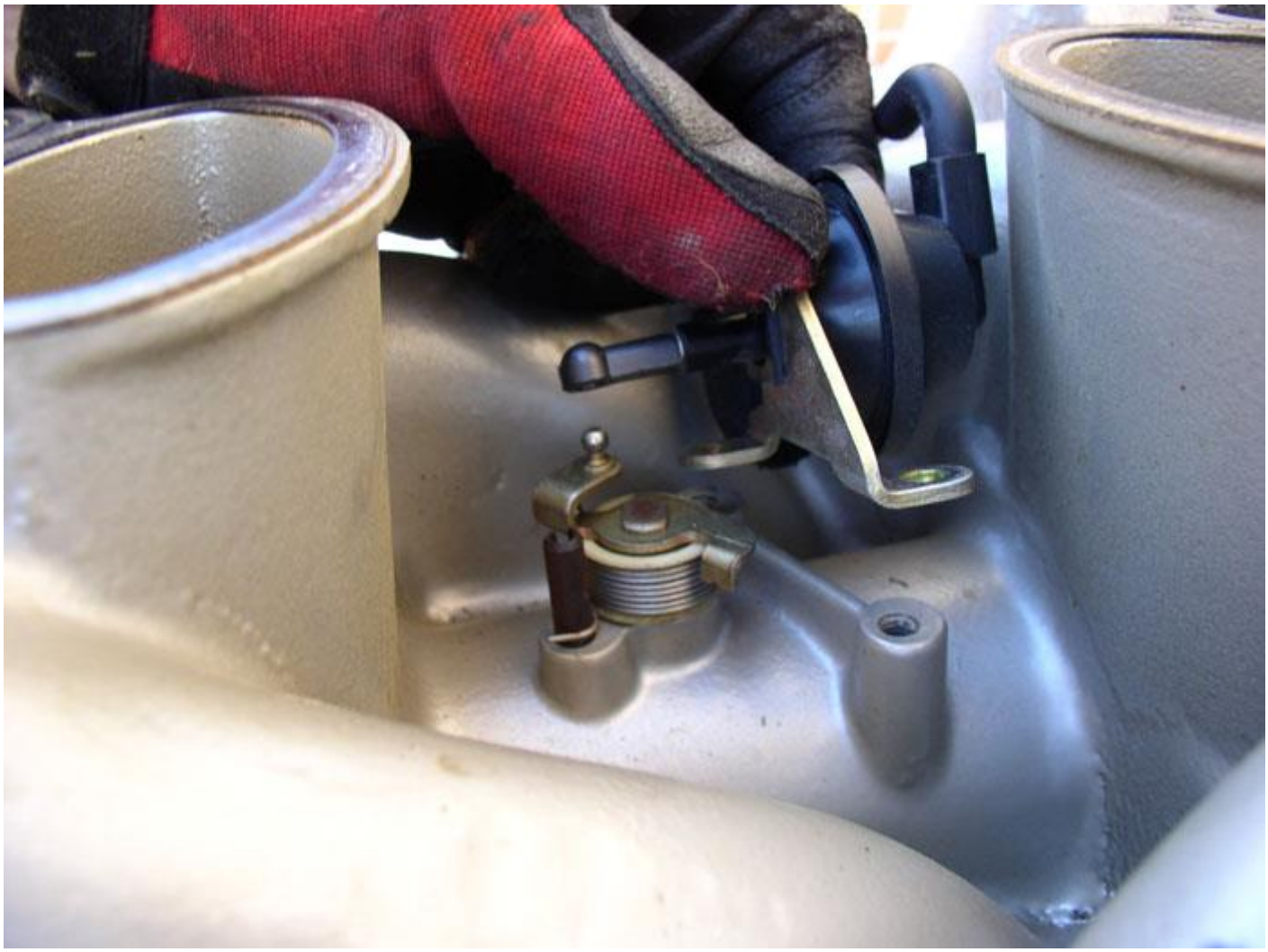

Next, remove the air temperature sensor from the top of the intake using a 22mm deep socket.



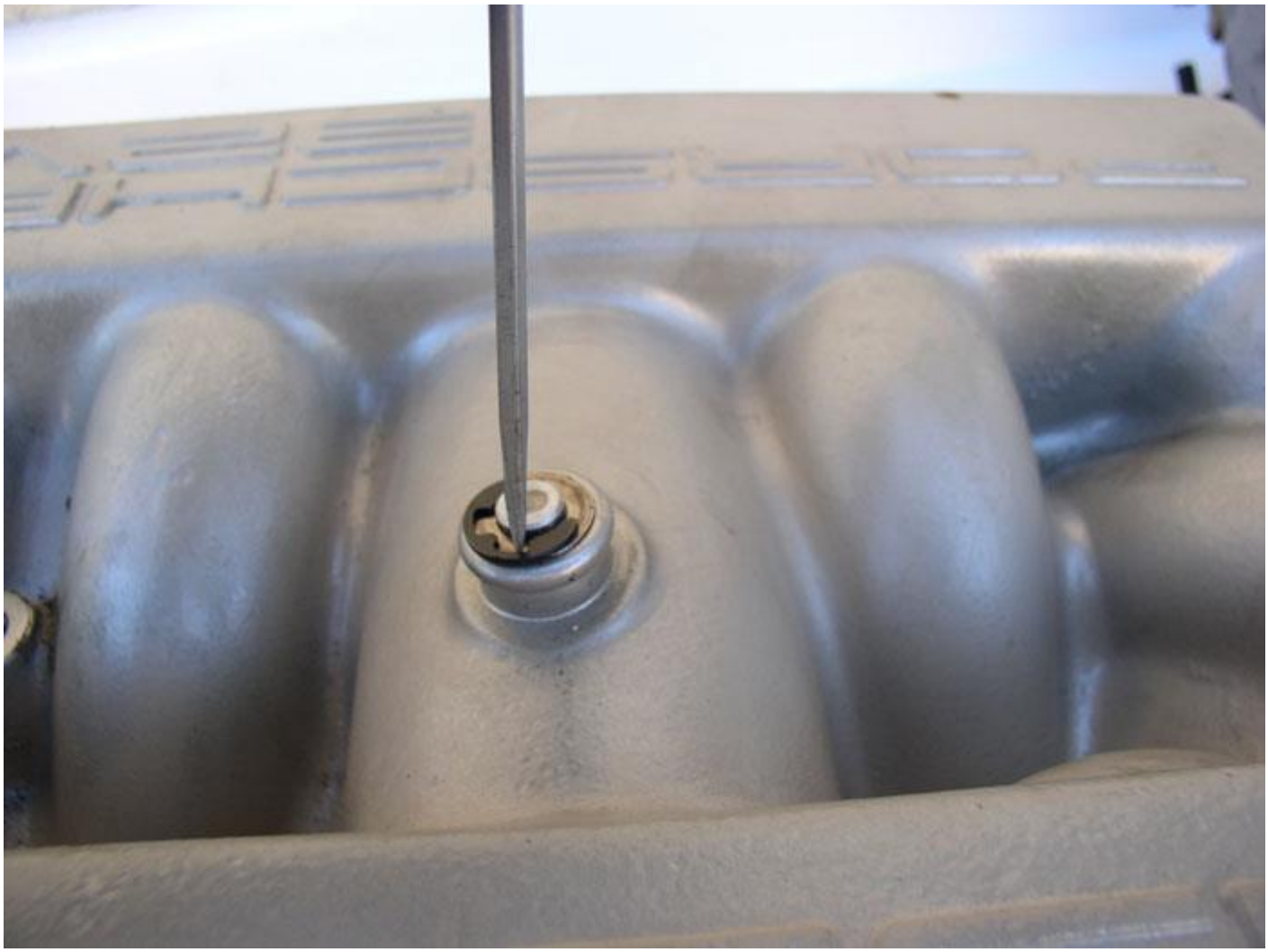
Now, remove the flappy vacuum unit. It's attached to the throttle body by two 5mm allen head bolts. Remove both of these.



Then, detach the ball connector on the diaphram from the lever arm of the flappy and remove the vacuum unit.



Remove the spring clip from the top of the intake using a flat blade screwdriver and be careful to catch the clip if it flies off.



Remove the washer.....



Next, remove the flappy plate screws with a flat blade screwdriver.

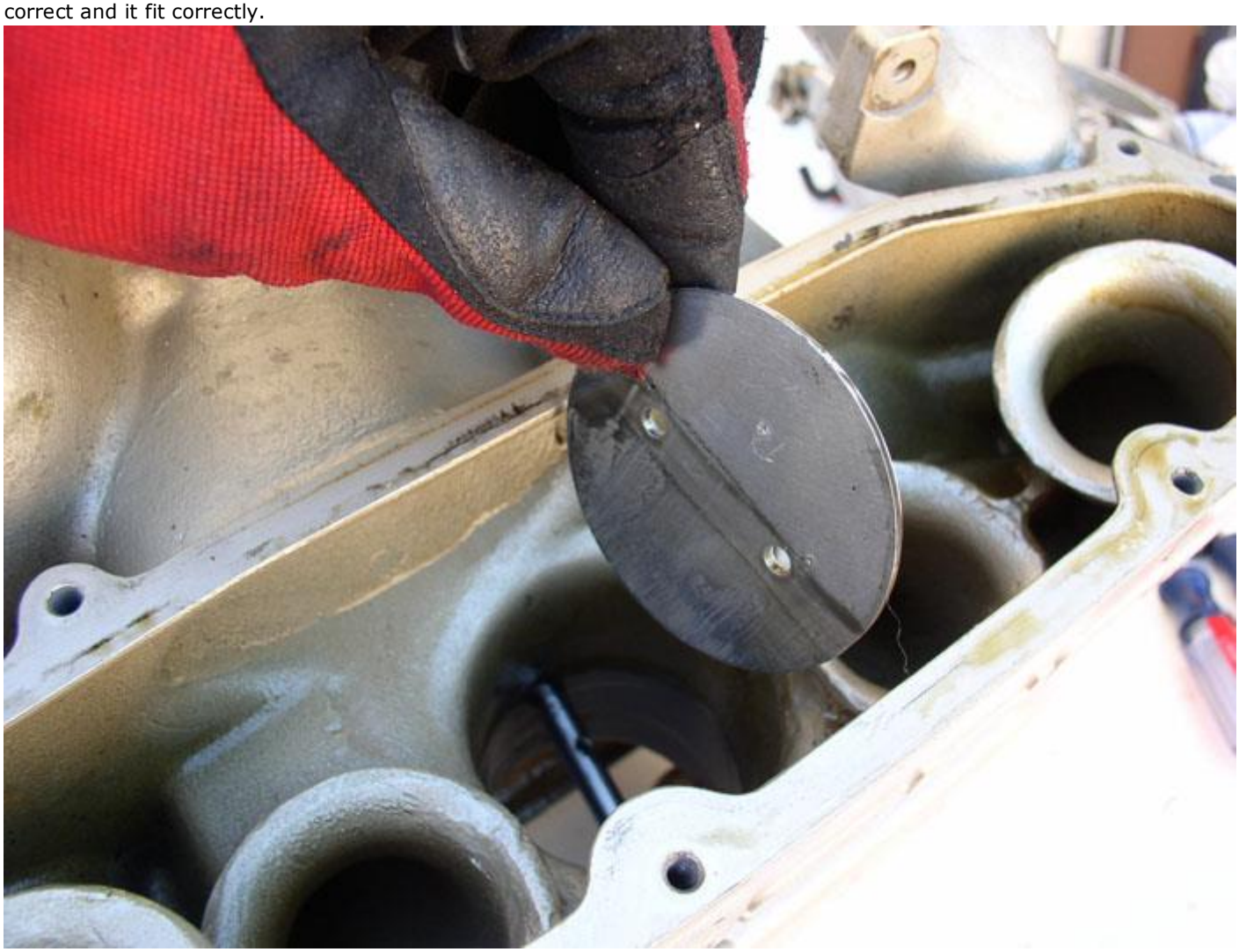


Then, rotate the plate 90 degrees.....



...and pull the flappy plate out. Note that the edges of the flappy plate are camfered slightly in order to seal better. It will be important to put the plate back in the the correct orientation. You can note the orientation by marking the plate directly with a marker or piece of tape (e.g., "driver's side" for the side that faces the driver's side of the car). Or, if you're feeling confident at this point (having removed your first intake), leave it unmarked and make sure the camfer is correct when you re-insert the plate back in. This is what I did but I found I still had a 50% chance of getting it right since the plate can be flipped like a coin and it can be rotated (like a wheel) 180 degrees. It didn't fit right at the first attempt to re-install so I flipped it like a coin, rotated it so the camfer was

correct and it fit correctly.

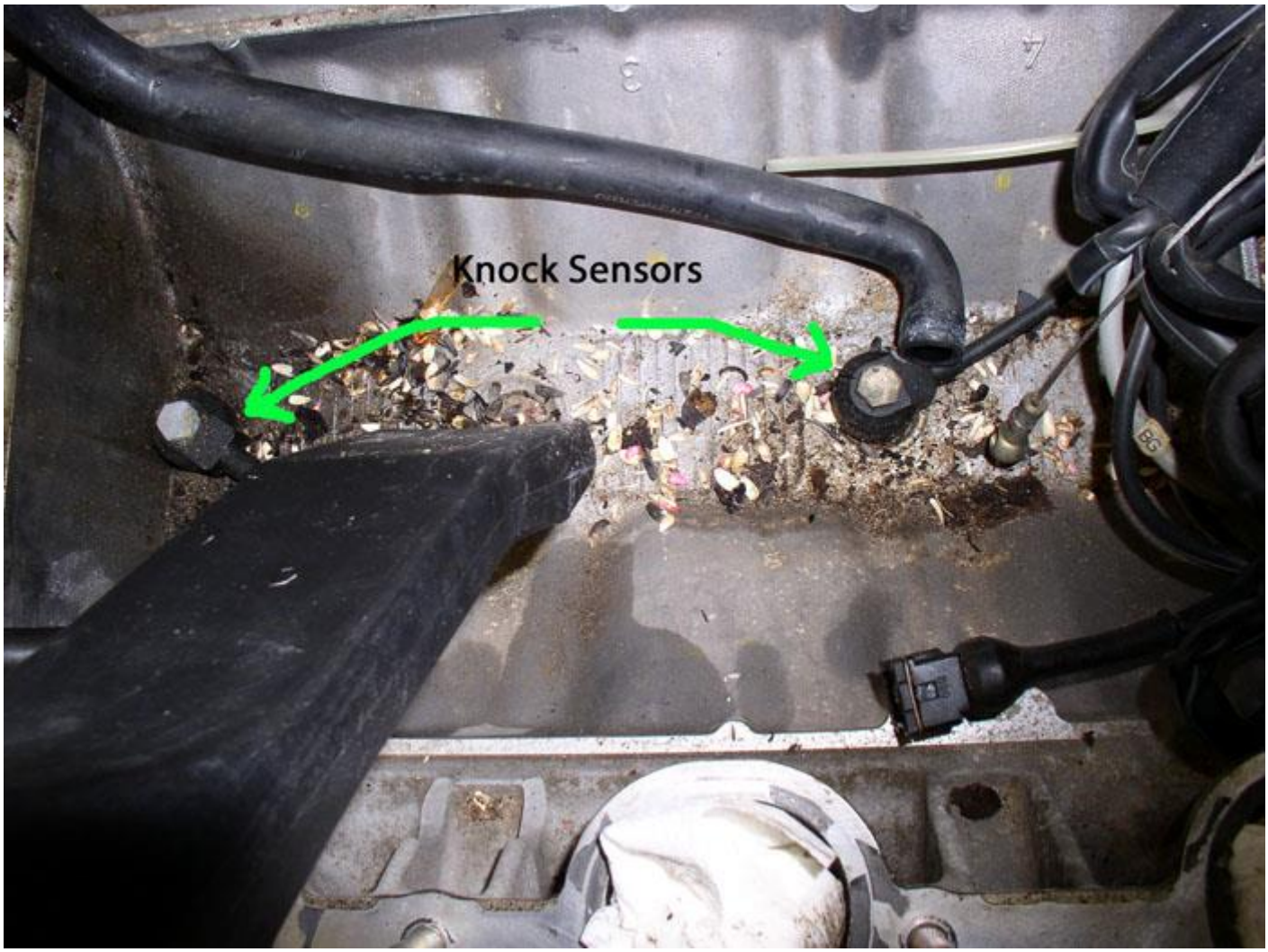


After you've taken out the flappy plate, pull the flappy spindle out from the bottom of the intake. Keep the spindle, washers and spring intact in a platic baggie. I have pics later of how mine went back together, if needed. You will notice a set of pressed in needle bearings at the top of the intake and at the bottom of the intake. These seem to do alright with age but the seals tend to wear out, dry out, disintegrate. There is a single seal for each bearing (top and bottom). When they no longer seal against the flappy spindle, it can be a source of false air, or vacuum leak. Roger sells new bearng units which have double seals - so twice as many seals as original. We'll be replacing these as well a little later in this post.

Being a newbie, I left the bearings in for the powder coating process not knowing how to take them out. After doing some research on Rennlist, I ran across a post from Shocki where he recommended leaving them in for powder coating so the bearing housing will act as a mask to keep the PC from getting in the bearing seat. Then just plan on replacing the bearings when the intake comes back. I felt much better! THANKS, Shocki!



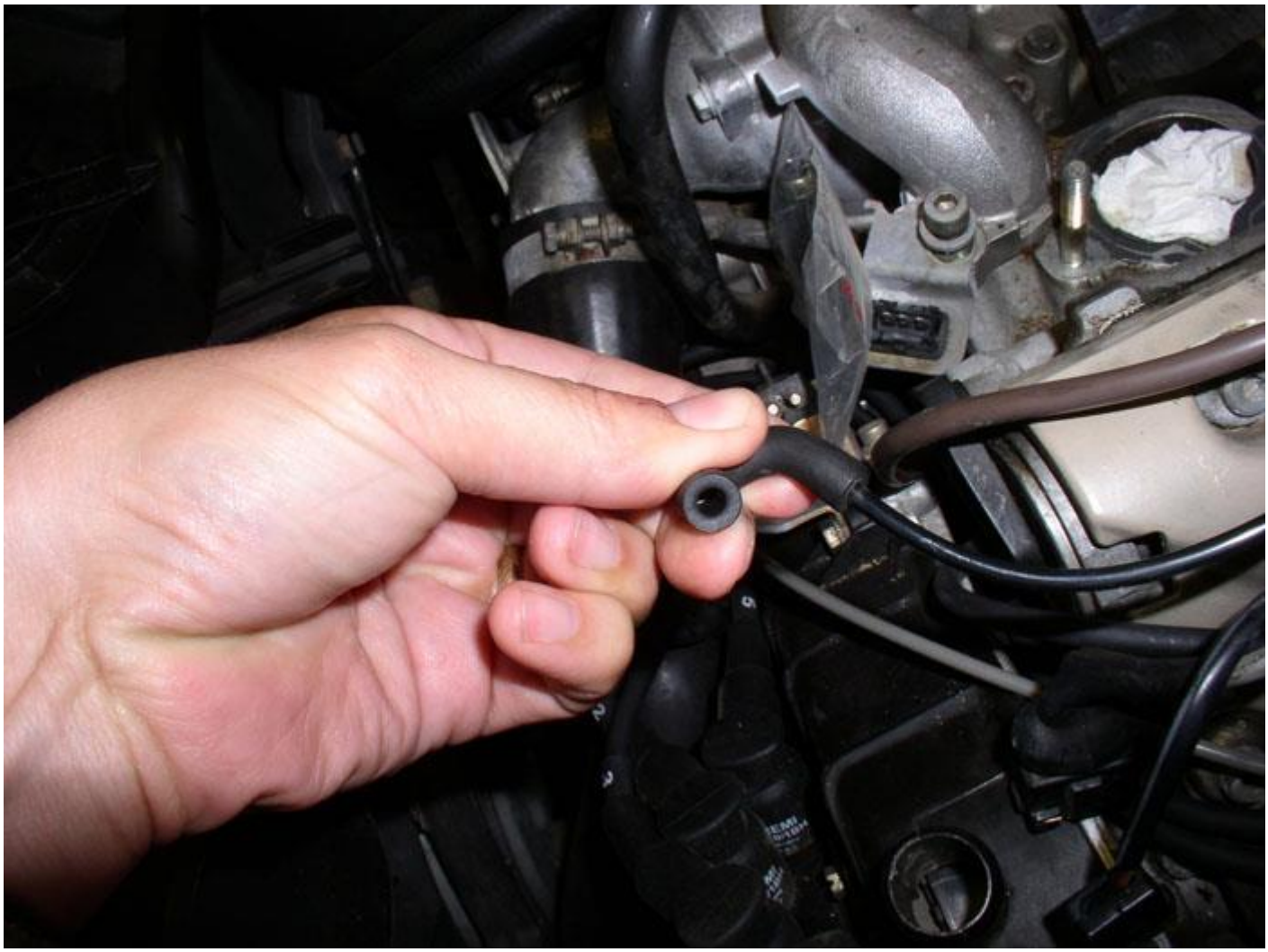
Now, back to the block. Vacuum the loose debris, if any, and perform any cleaning you might want to do while the old knock sensors are in place. We will be replacing the knock sensors on this job.



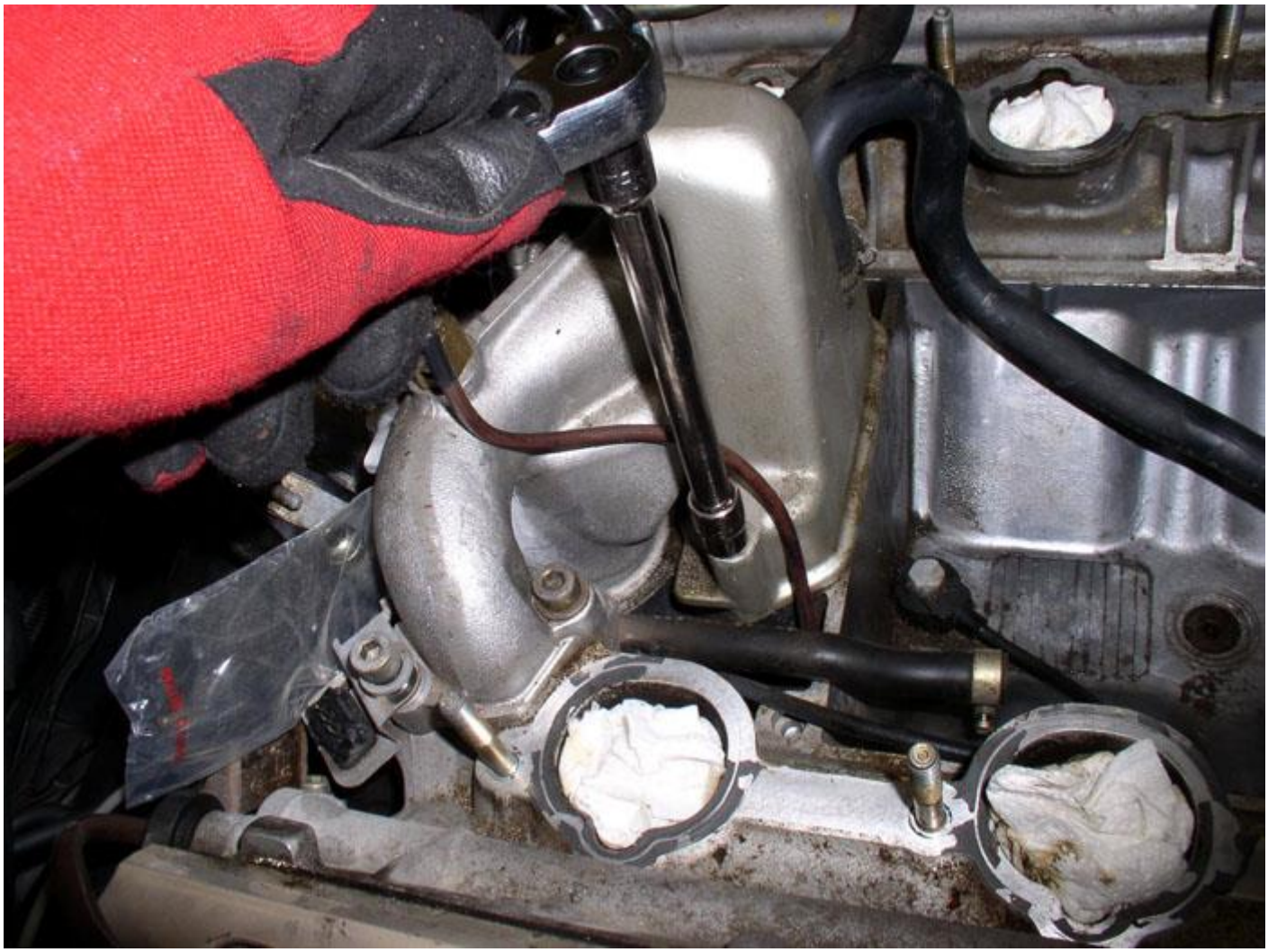

With the intake off, now's a good time to look at the hoses and vacuum lines for wear and possible replacement. If you're not planning on simply replacing everything as described early in this post, you'll want to check the hoses for cracks, bulges, soft spots, etc. I checked for softness by pinching them and then bent them like a pretzel to see if any cracks would show up. They all looked pretty good. At first, I thought I would just replace the worn ones. But after I saw the deep impressions the hose clamps made on most of the hoses and also noting that the original hose clamps seem to be designed to have a limit on clamping (i.e., the clamp would easily bottom out and with moderate force, I could twist the hose on some examples), I decided to simply replace all the hoses - so they went on the list.



After inspecting the elbows, I came to the same conclusion. Although the elbows did seem to be in better shape than the hoses, I replaced them anyway. Again, a matter of personal preference.



Removing the oil filler neck and water bridge are not mandatory while removing the intake. However, if you are experiencing leaks or planning on painting/powder coating, they'll have to come off. To remove the oil filler neck, remove the two 10mm bolts that hold the base to the block.



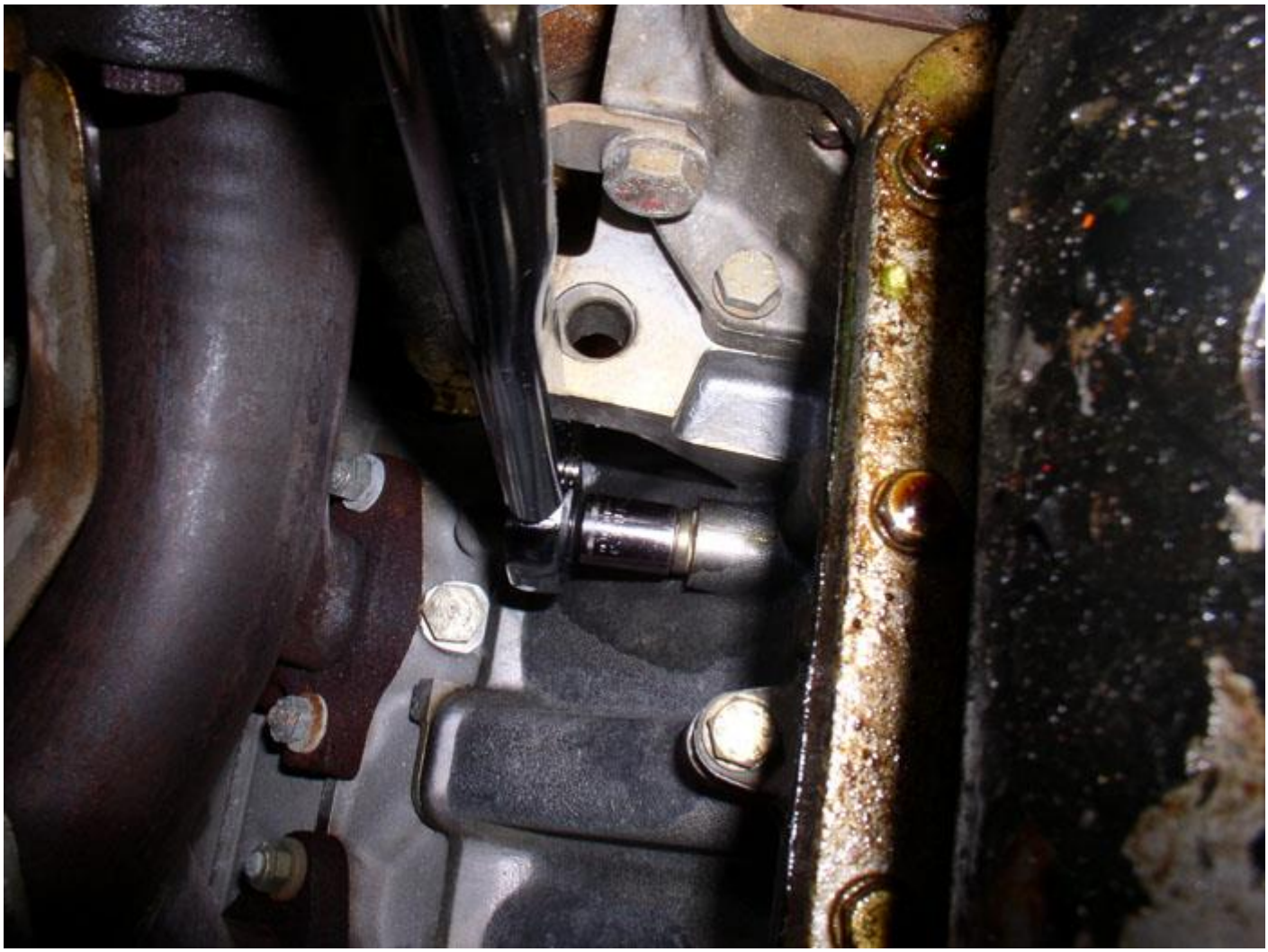
Carefully remove the filler neck from the block ensuring nothing falls into the crankcase. There is a baffle/gasket between the filler neck base and the block. Here it is still attached to the base of the filler neck. On this '87, it is a thin metal plate with an embedded gasket ring. I understand the part is no longer available but we'll talk about this item later.



Directly after removing the filler neck, you can look down into the crankcase for anything unusual. Then stuff it with a clean rag to prevent debris from falling in.



Next, the water bridge. It's a good idea to drain some of the water from the radiator - enough to empty the reservoir - and the block so you don't have too much coolant leaking out when removing the bridge. Since I was also going to be doing the Timing Belt and Water Pump and removing the radiator as part of the job, I emptied all the coolant from the block and the radiator and the reservoir. You can drain the block by locating the drain plugs from underneath the engine. It's a 13mm bolt located toward the rear of the engine. There is one one each side of the block. Place a bucket under the engine at proximity and remove the drain plug. The drain plug comes with a sealing ring. Since these did not look like they have ever been removed, I re-used the sealing ring with no problems. However, if you would like to replace the ring, they can be ordered. When the block is finished draining, you can re-install the drain plugs and torque to 25.8 ftlbs, or 35 Newton meters.



Next, loosen the upper radiator hose clamp using a screwdriver or 10mm socket and remove the hose.



Loosen the bleeder hose clamp with a screwdriver and remove the hose.



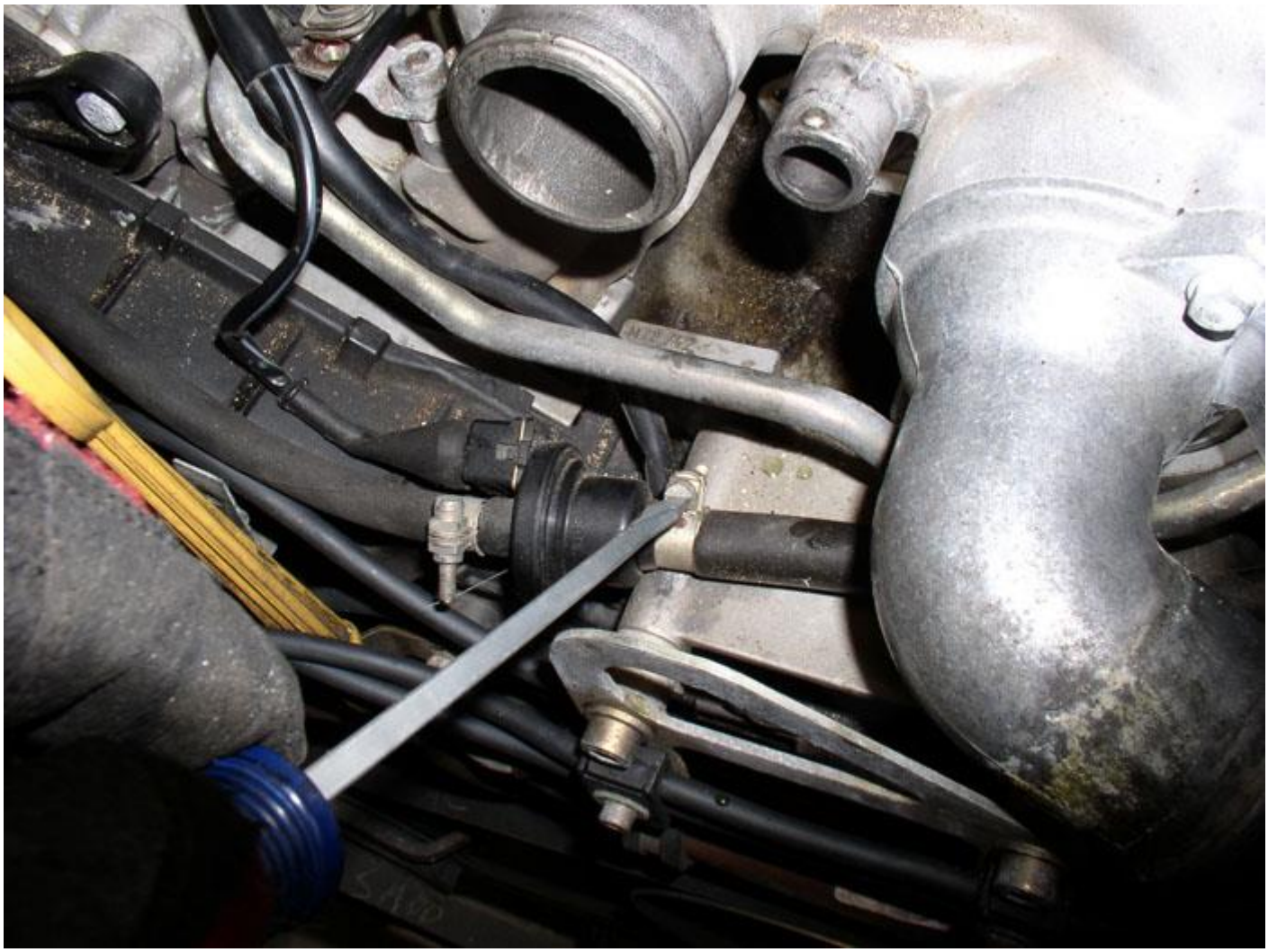
Loosen the heater return hose clamp with a screwdriver and remove the hose.



Loosen the lower radiator hose clamp using a screwdriver or 10mm socket and remove the hose.




It is not necessary to remove the 3 way hose that leads from the fuel vent solenoid (pictured here) and goes to the oil filler neck and bottom of the throttle body as part of the intake removal. However, I replaced this hose as part of the intake job, so now is a good time to get it out of the way. Loosen the clamp and pull the hose off and remove the 3 way hose .

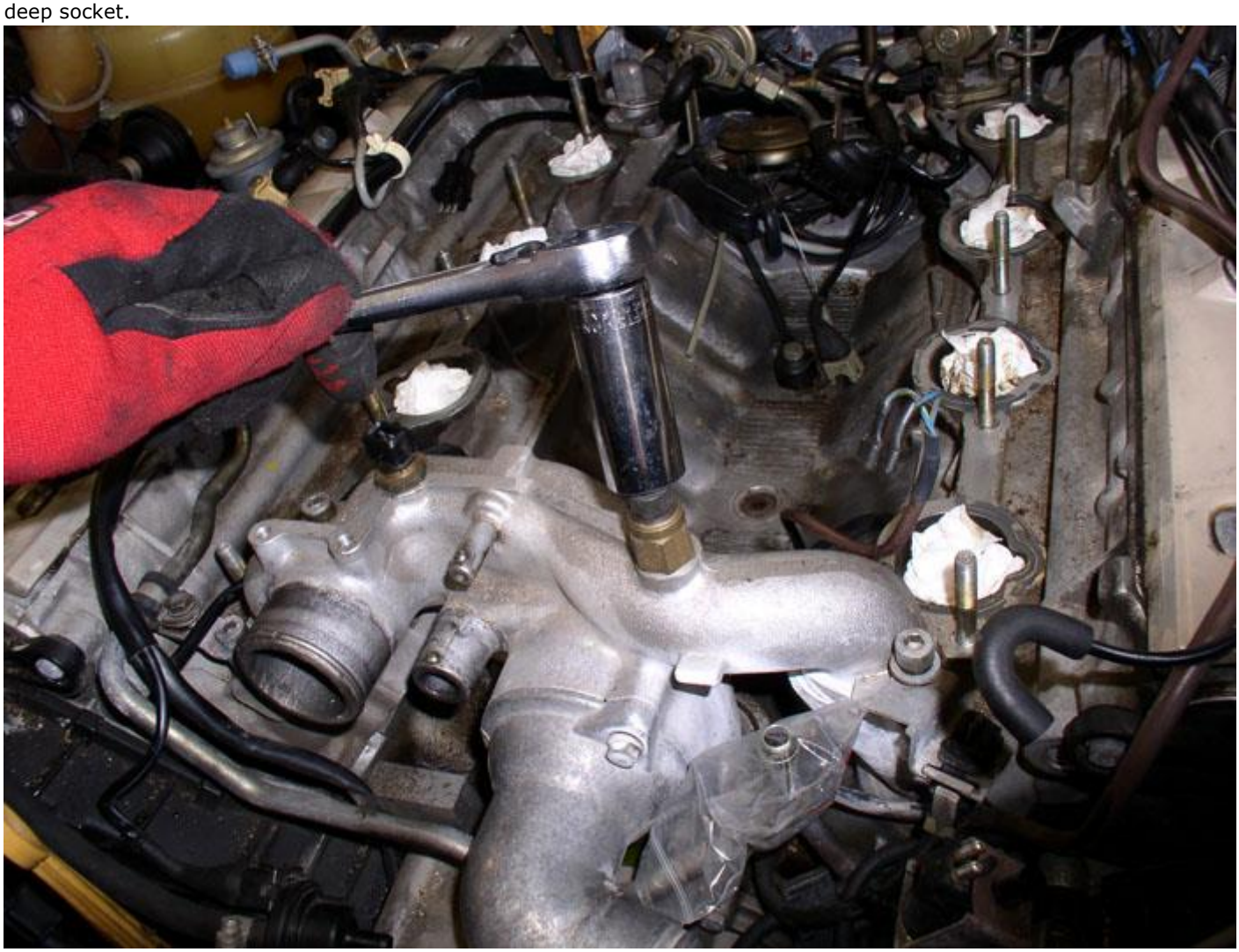


I found it easier to loosen the two 10mm bolts on the thermostat housing elbow while the water bridge as still attached to the heads - for stability. You do not have to remove the elbow, just loosen the bolts.

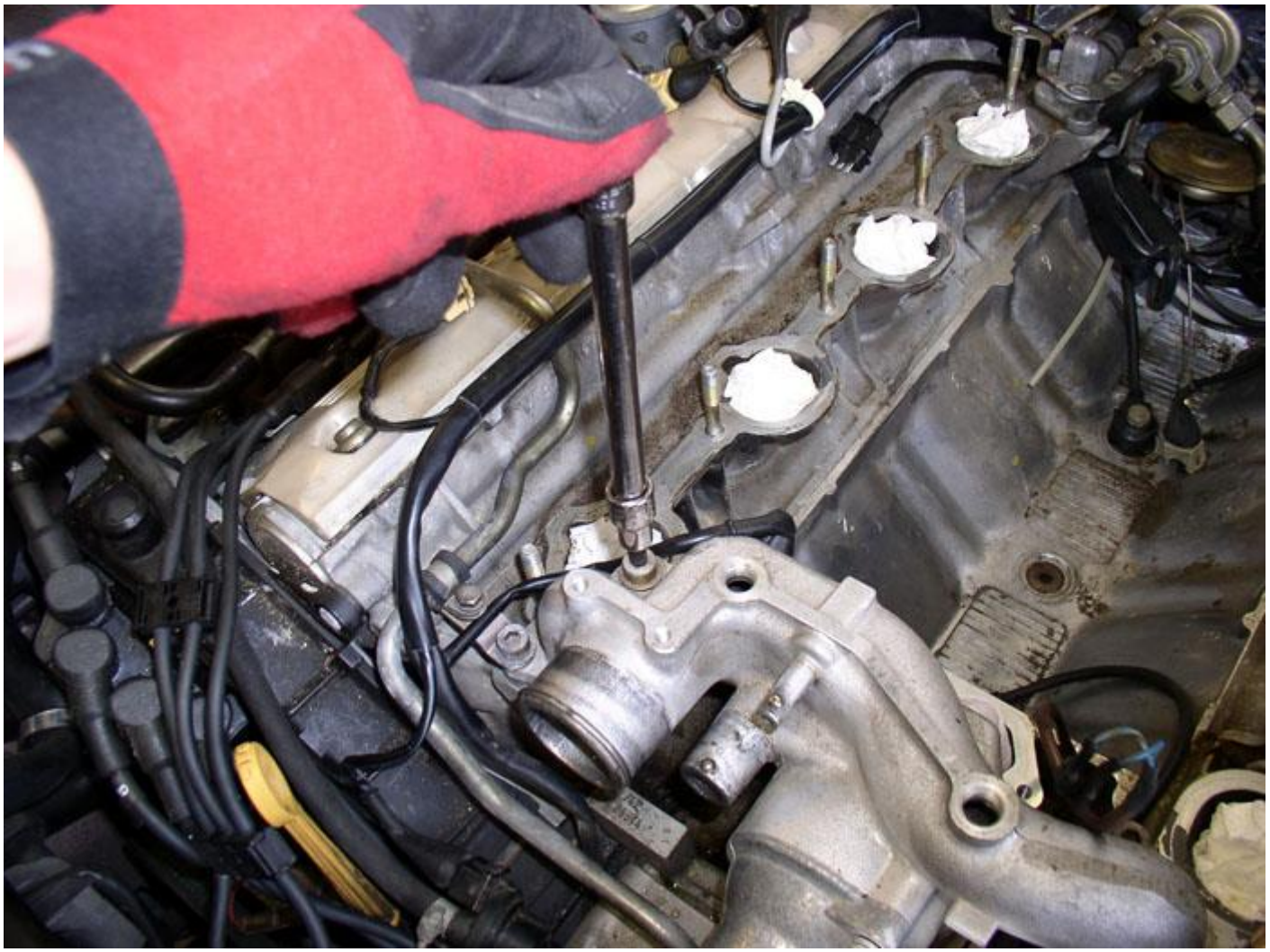



If you're sending the water bridge in for powder coating or painting, remove the temperature guage sending unit and the Temp II sensor unit from the water bridge now while it's still attached to heads for stability. Use a 19mm

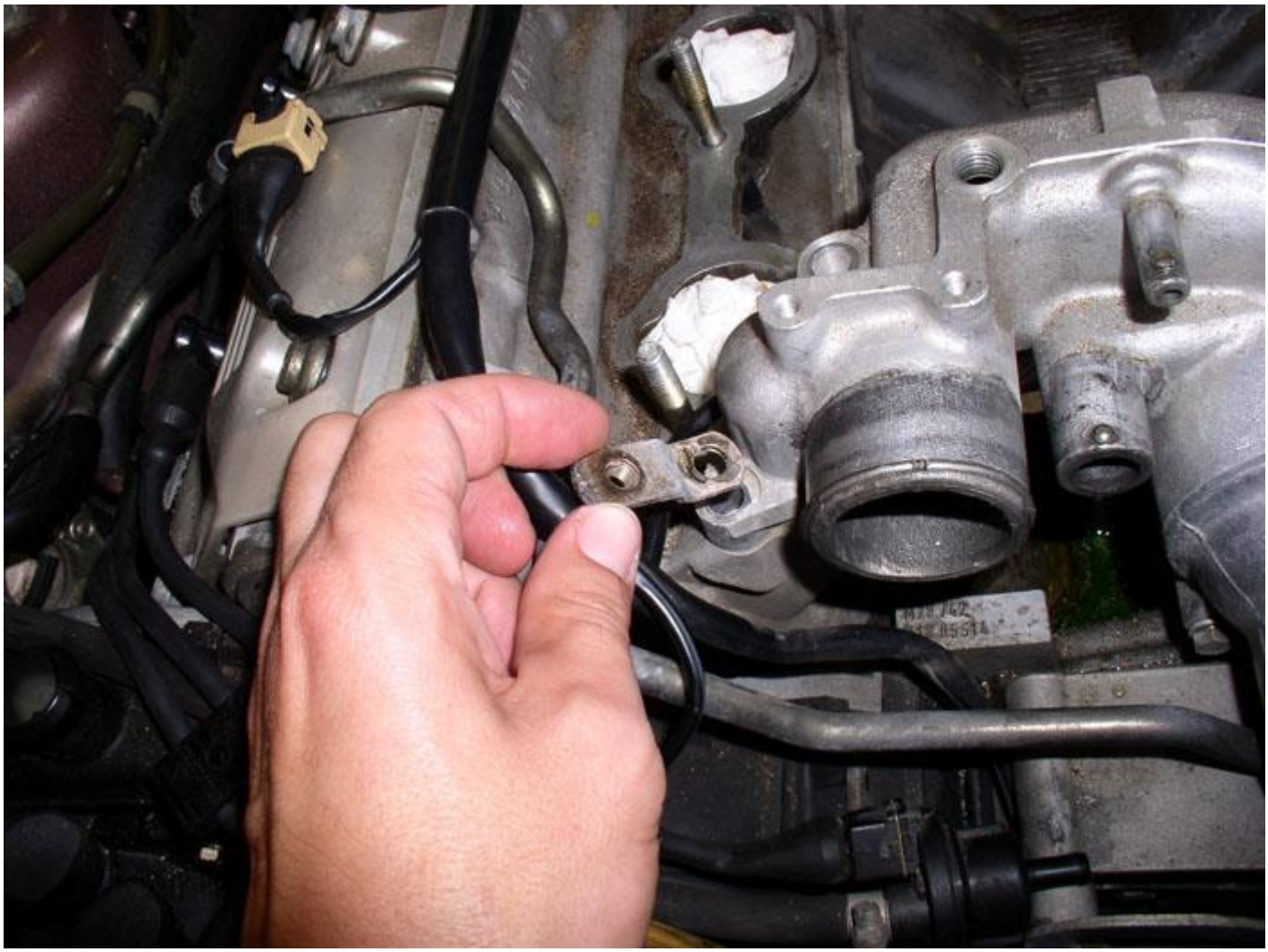
deep socket.



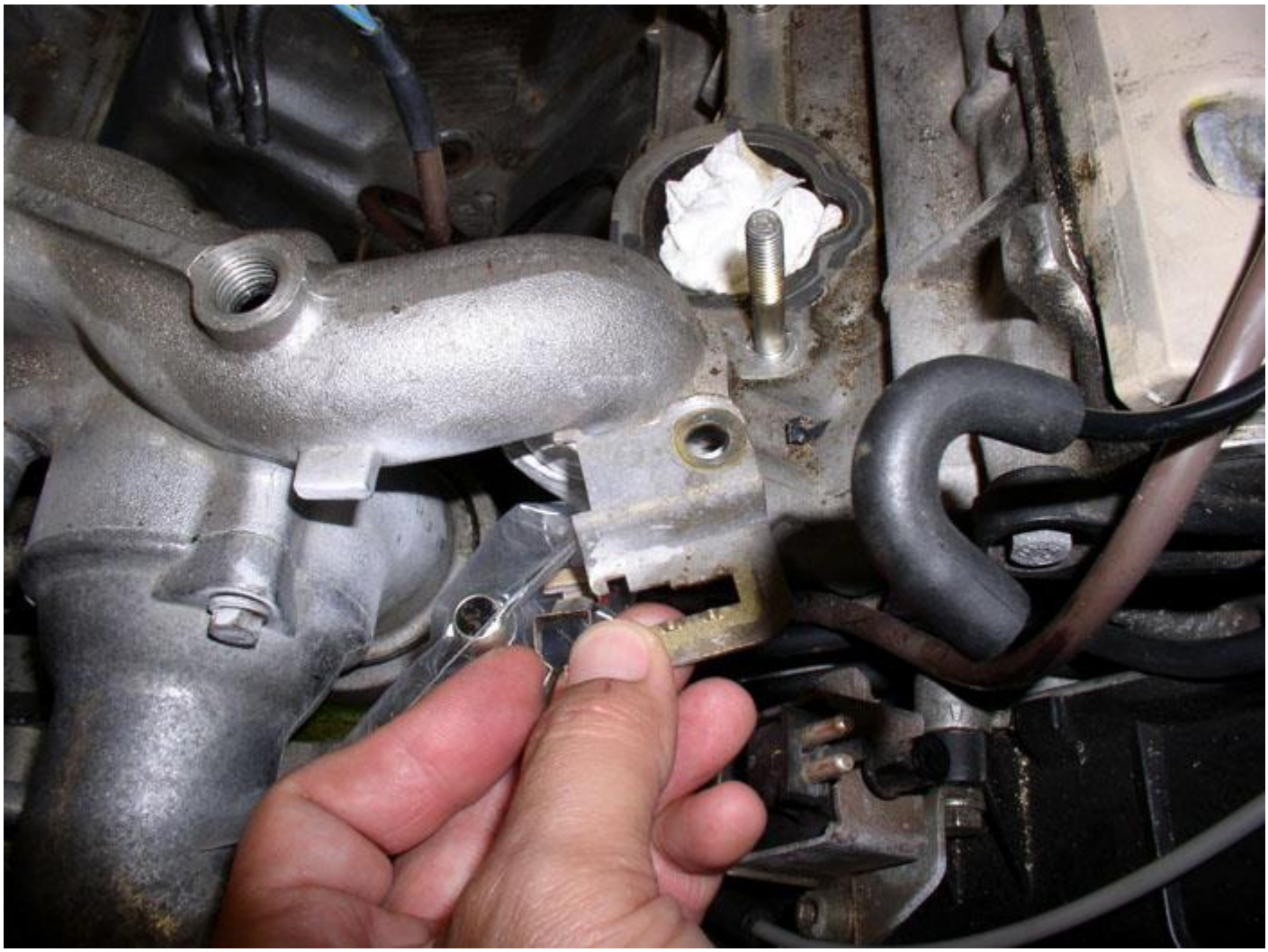
Now you can remove the 6mm allen head bolts that secure the bridge to the heads. You will find one of the bolts is longer than the others. The bolt pictured here under the socket, is 70mm in length while the other 3 are 35mm in length.



Remember to include the the fuel line bracket in the baggie with the water bridge bolts.....



...as well as the knock sensor bracket on the driver's side. Also included with the bracket is a metal clip - barely visible in this picture, next to my index finger - that holds the sensor in the bracket.



Now you can remove the water bridge from the block.



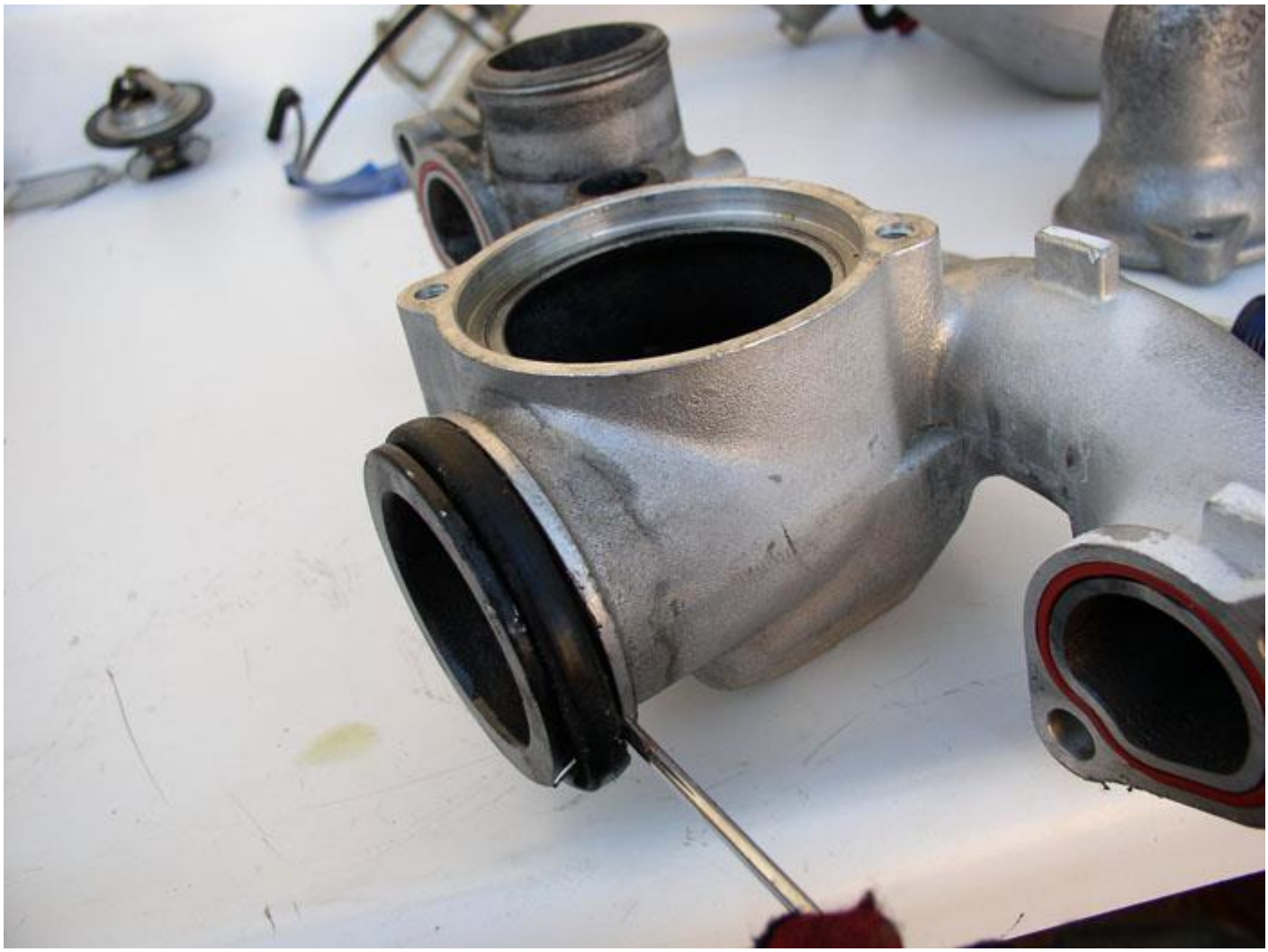
And immediately stuff the hole with a clean rag to prevent debris from entering the water pump.



Next, I disassembled the waterbridge in preparation for powder coating. After removing the previously loosend 10mm thermostat elbow bolts, remove the elbow and pull out the thermostat and o-ring.



Then remove the bridge to block o-ring at the bottom of the bridge. I used a pick tool to get under the o-ring and pull it over the bridge flange. Also, remove the red bridge to heads gaskets (one on each side).

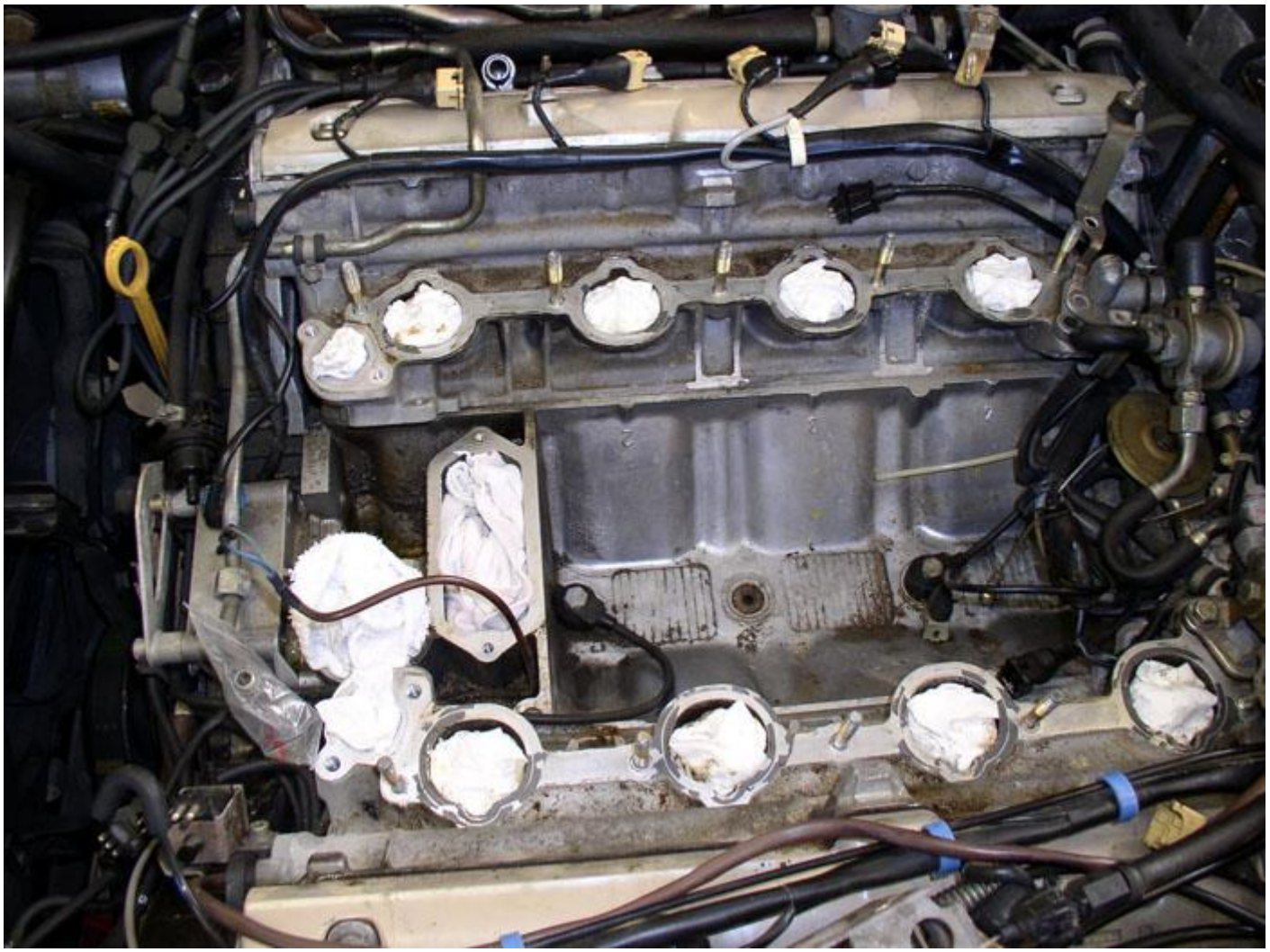


Lastly, remove the rear thermostat seal. I found a screwdriver and hammer to work well and removing the seal. Be careful not to mar the mating surface of the housing. Place the screwdriver, oriented as in the picture, against the seal and tap with a hammer to distort the seal as pictured. Then use a pair of pliers to pull out the seal. Now

the waterbridge is ready for powder coating.



The last thing remaining to include in the intake refresh for powder coating are the cam covers. At this point, the engine should look something like this.



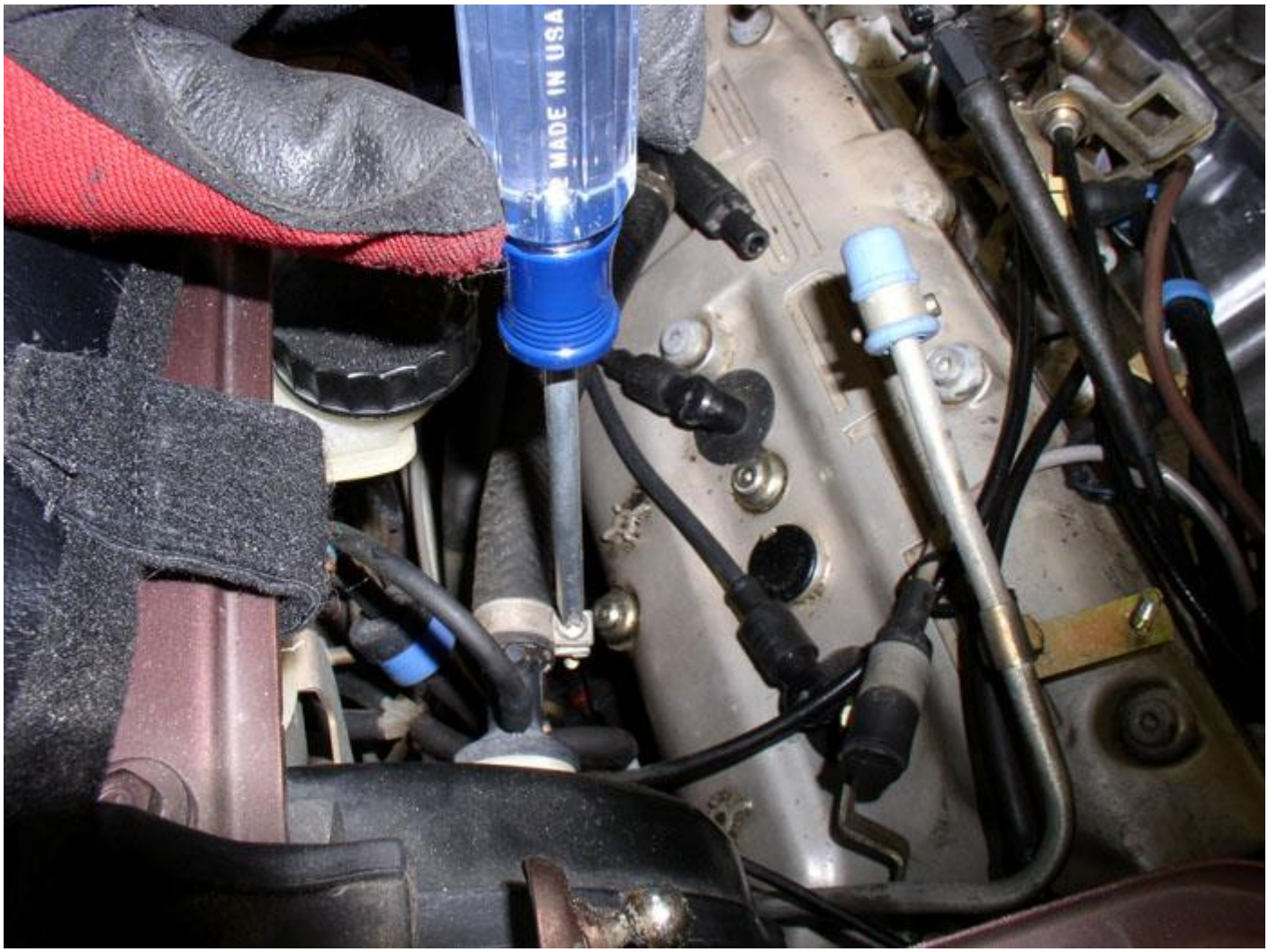
Start by disconnecting the fuel supply line at the passenger fender wall. Use a 19mm wrench to counterhold and a 17mm wrench to loosen the compression nut on the metal side of the fuel line. Use a towel under the connection to catch escaping fuel. After the line is disconnected, remove the fuel line. Also, cap the fuel supply line with a vacuum plug. I didn't cap mine right away but did later on.



I disconnected the fuel vapor solenoid so I could get the hose out of the way and be able to maneuver the harness more freely. I also knew I'd be needing to disconnect if for the TB/WP job coming up next so now seemed like a good time.



Next, disconnect the brake booster to vacuum ventri hose on the driver's side at the brake booster using a phillips screwdriver and remove the hose.



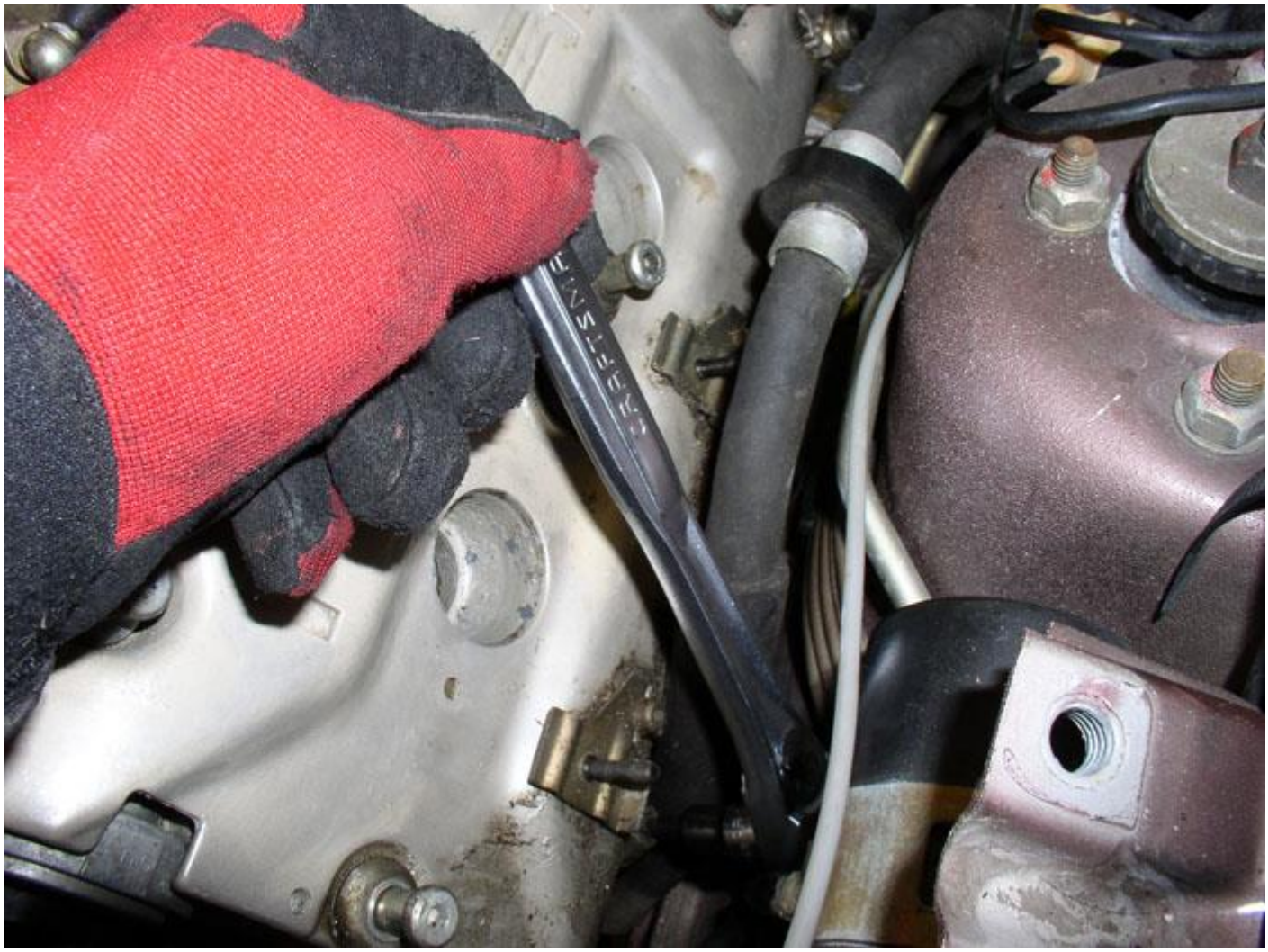

Remove all 8 spark plug wires at the spark plugs. First, disconnect the spark plug wire harness clamps from the hold down brackets on the cam cover. Then pull the plug connectors from the spark plugs as shown. Finally, lay the wires at the front of the engine out of the way.



You can begin loosening (but not removing) the cam cover bolts starting with the driver's side. There are 13 bolts. Each is a 5mm allen head bolt. I found the allen socket with extension to work well for the easily accessed bolts - the top and middle bolts.



The lower 4 bolts are a little more difficult. The front one you can get at with the socket with no extension.



For the next two (middle) lower bolts, I had to use a 5mm allen key wrench. Unfortunately, this goes slow since you can only turn the bolts about 1/3 of a turn at a time while holding the Power Steering hose out of the way. But be patient, take breaks and you will get it to the point where you can loosen the final distance with your fingers.



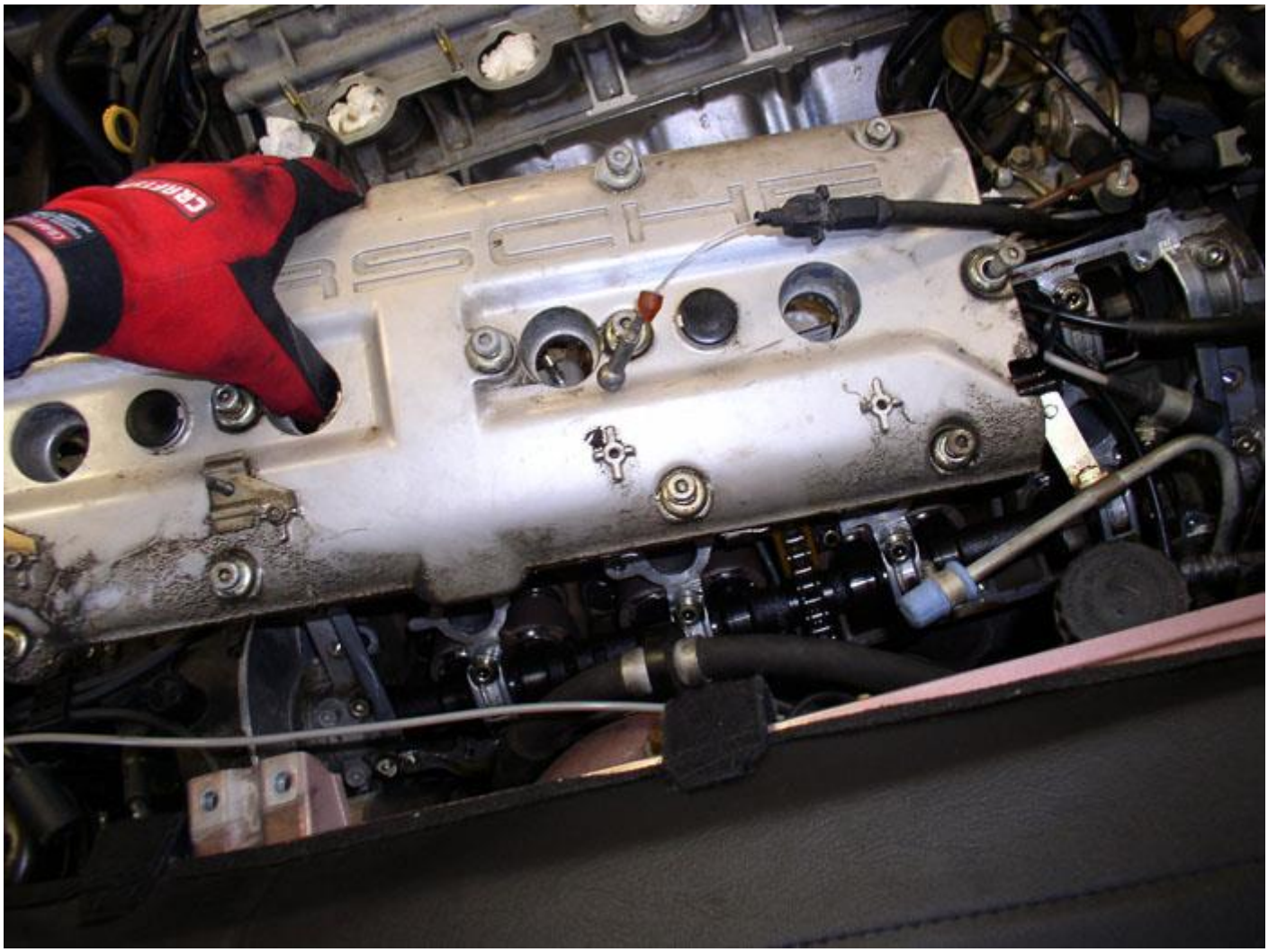
The rear, bottom bolt can be accessed using the allen socket with universal elbow and extension, as pictured.



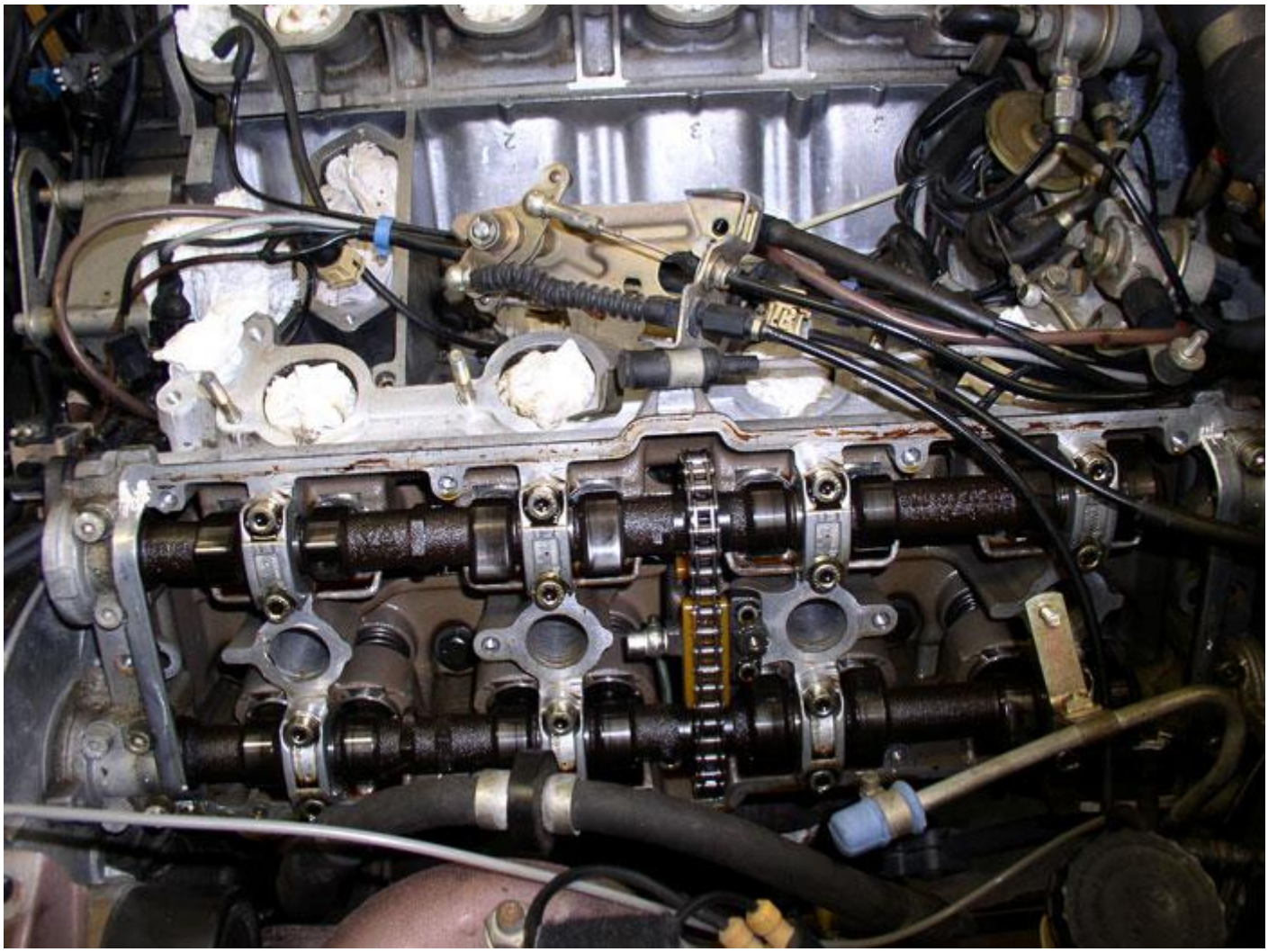
With all 13 bolts loosened, you can use a screwdriver to lever off the casting tab on the head (as pictured) to carefully pry the cam cover up.



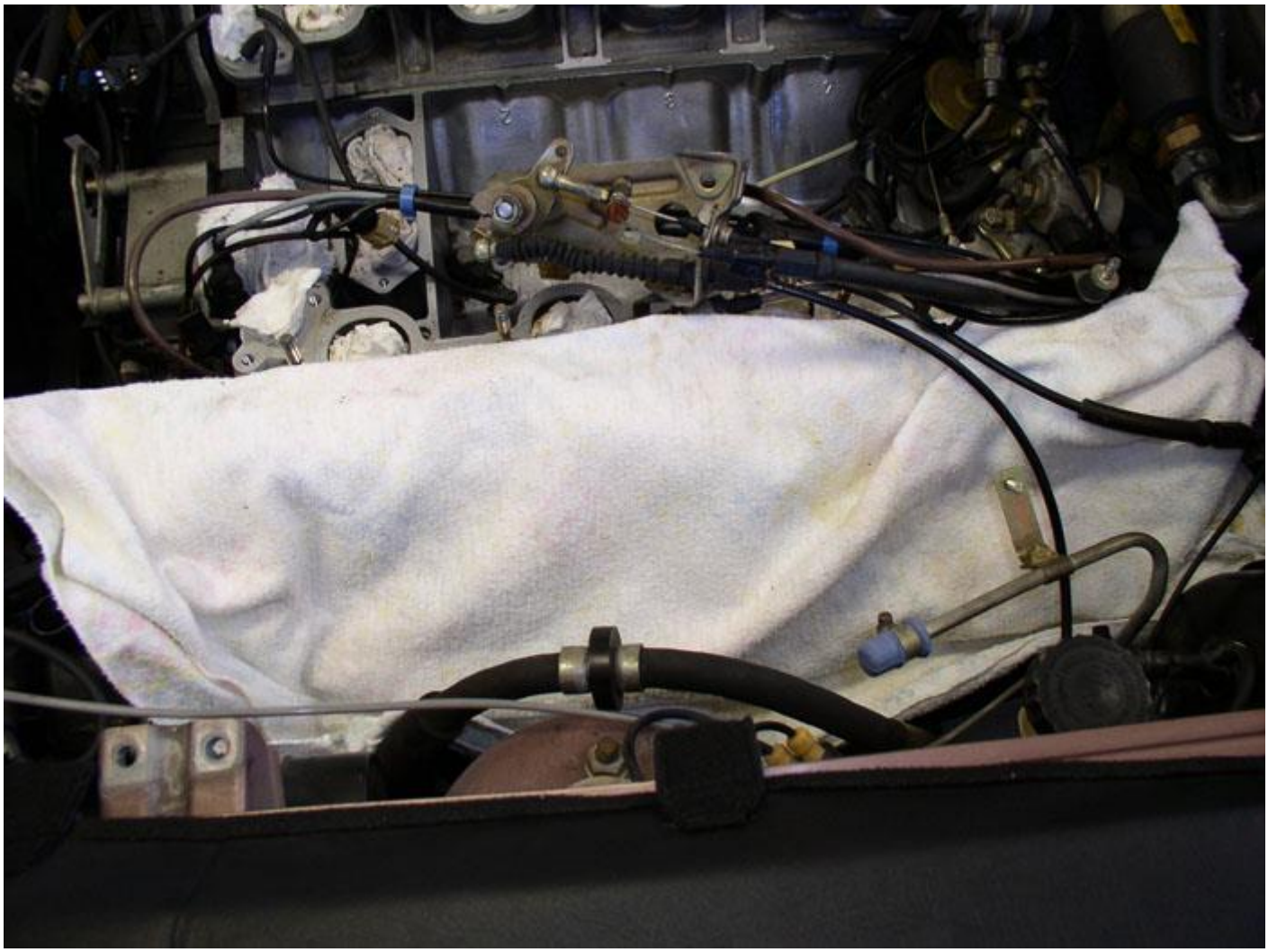
Once the cover is broke free, you can maneuver it up and away from the head being careful not to drop anything into the exposed cam workings below.



Now you can inspect the cam workings to make sure nothing foreign dropped in.



And immediately cover the exposed cams with a clean towel. Place cables on top of the towel.

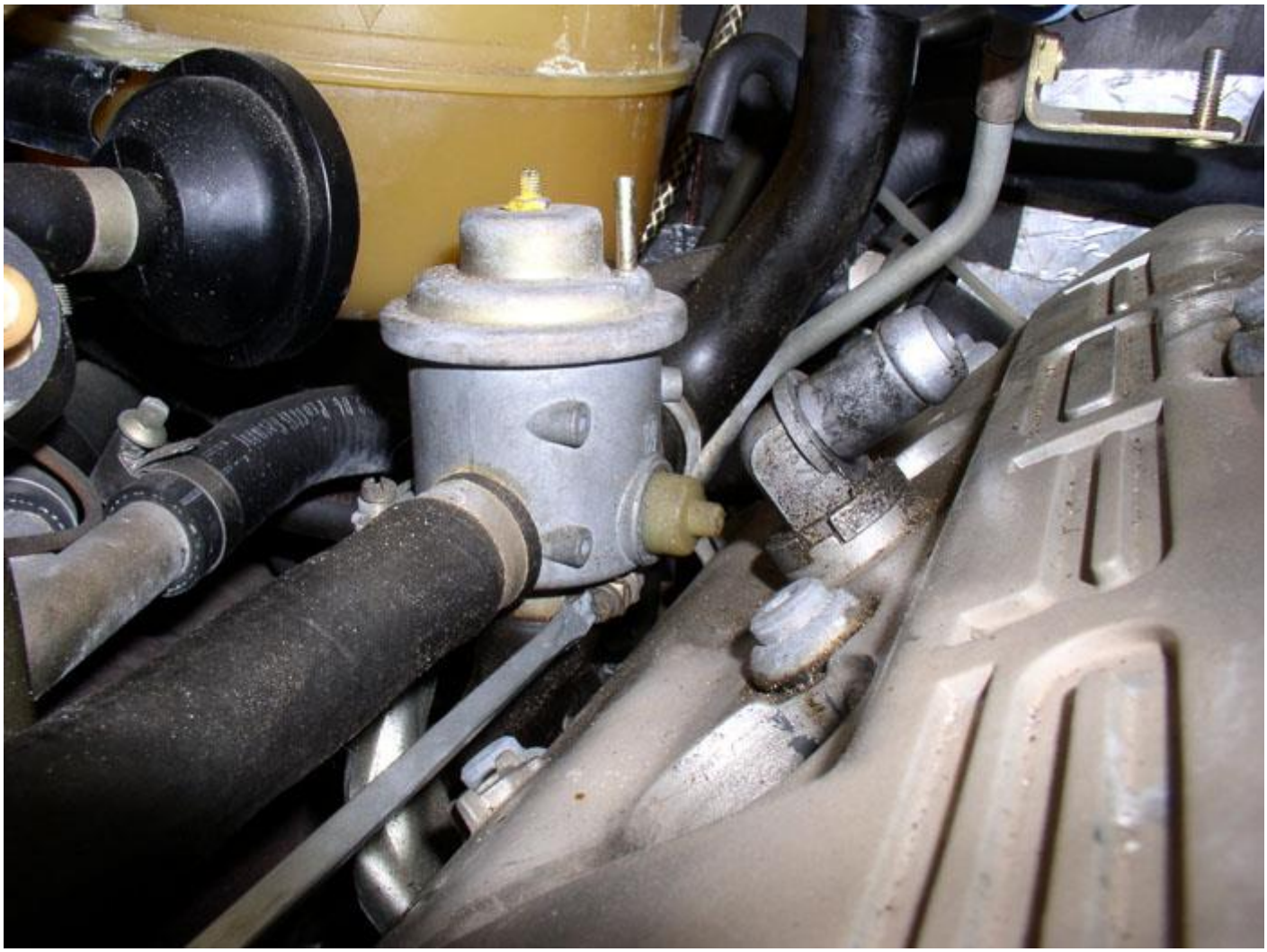


Now the passenger side. I found it necessary to remove the air pump diverter valve. Start by removing the two 10mm bolts that secure the valve to the mounting bracket. A gear wrench works well here.



Next, loosen the bottom hose clamp with a flat blade screwdriver and lift up on the diverter valve to separate it

from the lower hose.



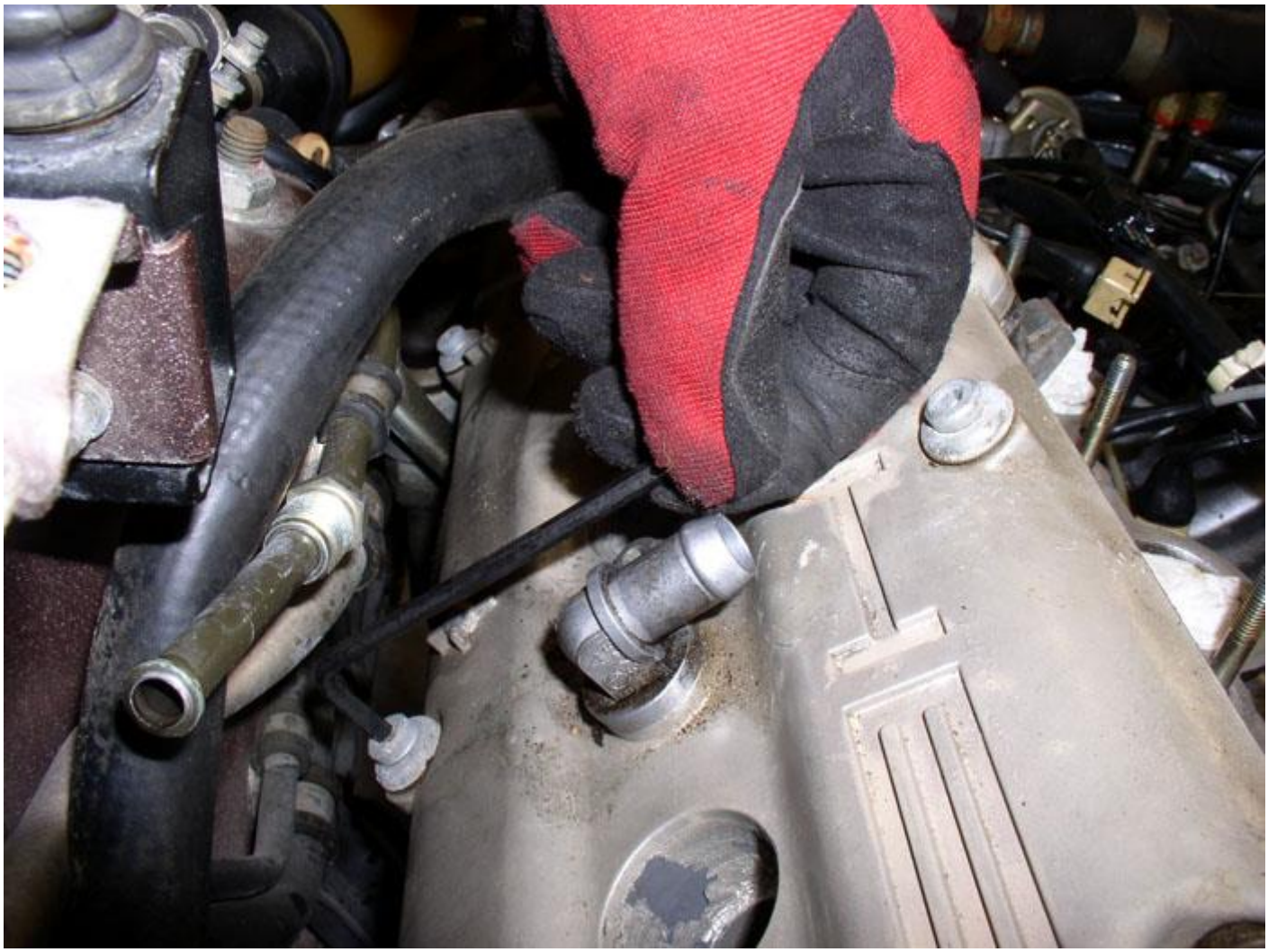
You can remove the spark plug harness brackets from the cam cover using a 4mm allen key wrench. There are two brackets on each cam cover.



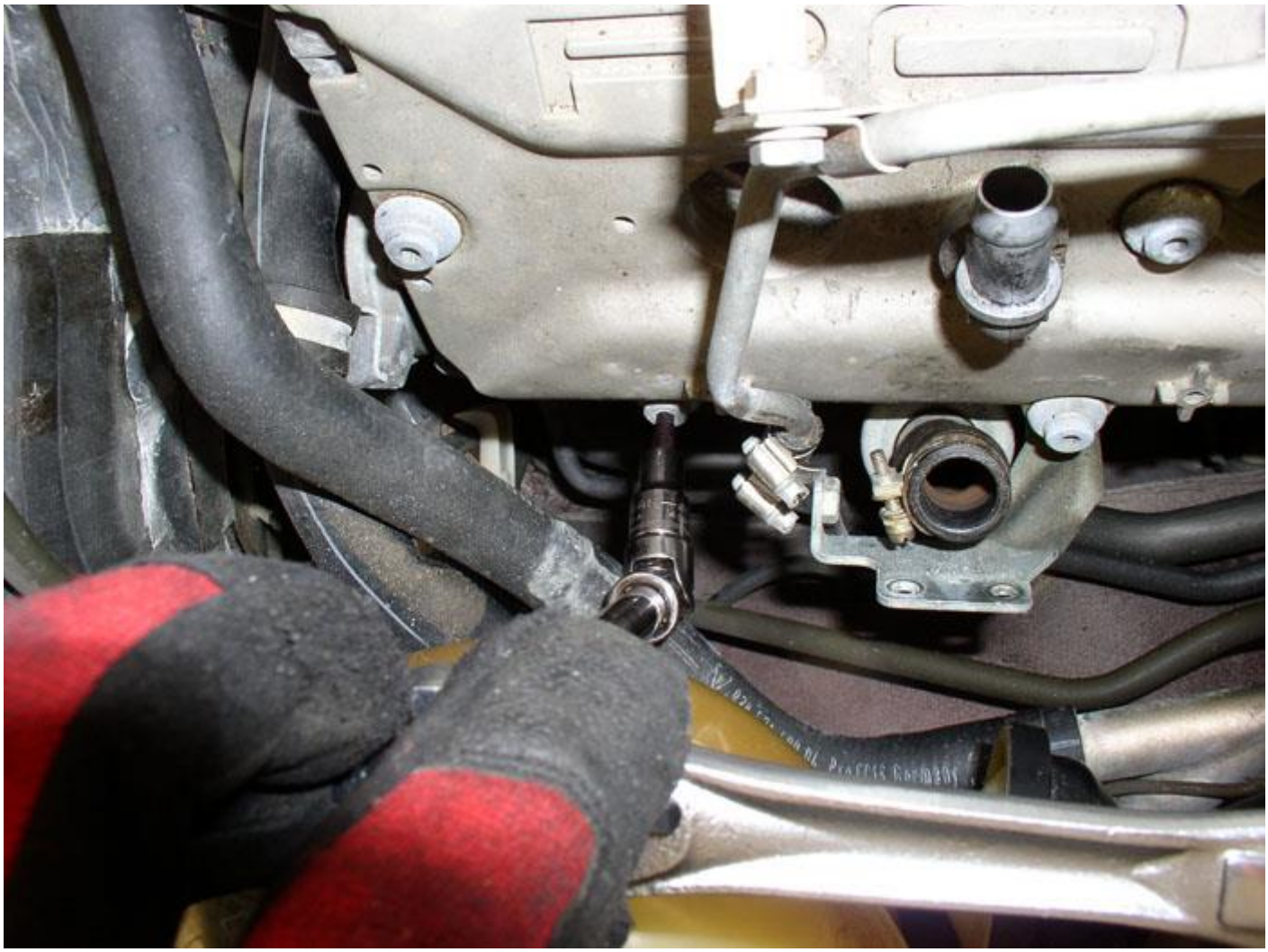
Like the driver's side, there are 13 5mm bolts to loosen on the passenger side. The top row and middle row of cam cover bolts can be easily accessed with the allen socket as before. The bottom 4 require a little extra work. The front bolt can be accessed using a 5mm allen key wrench and can be loosened with the engine lift bracket in place. It will take patience since you can only turn the bolt about a 1/4 turn at a time.



The next bolt in line at the bottom row can be accessed with the allen key wrench - with patience.



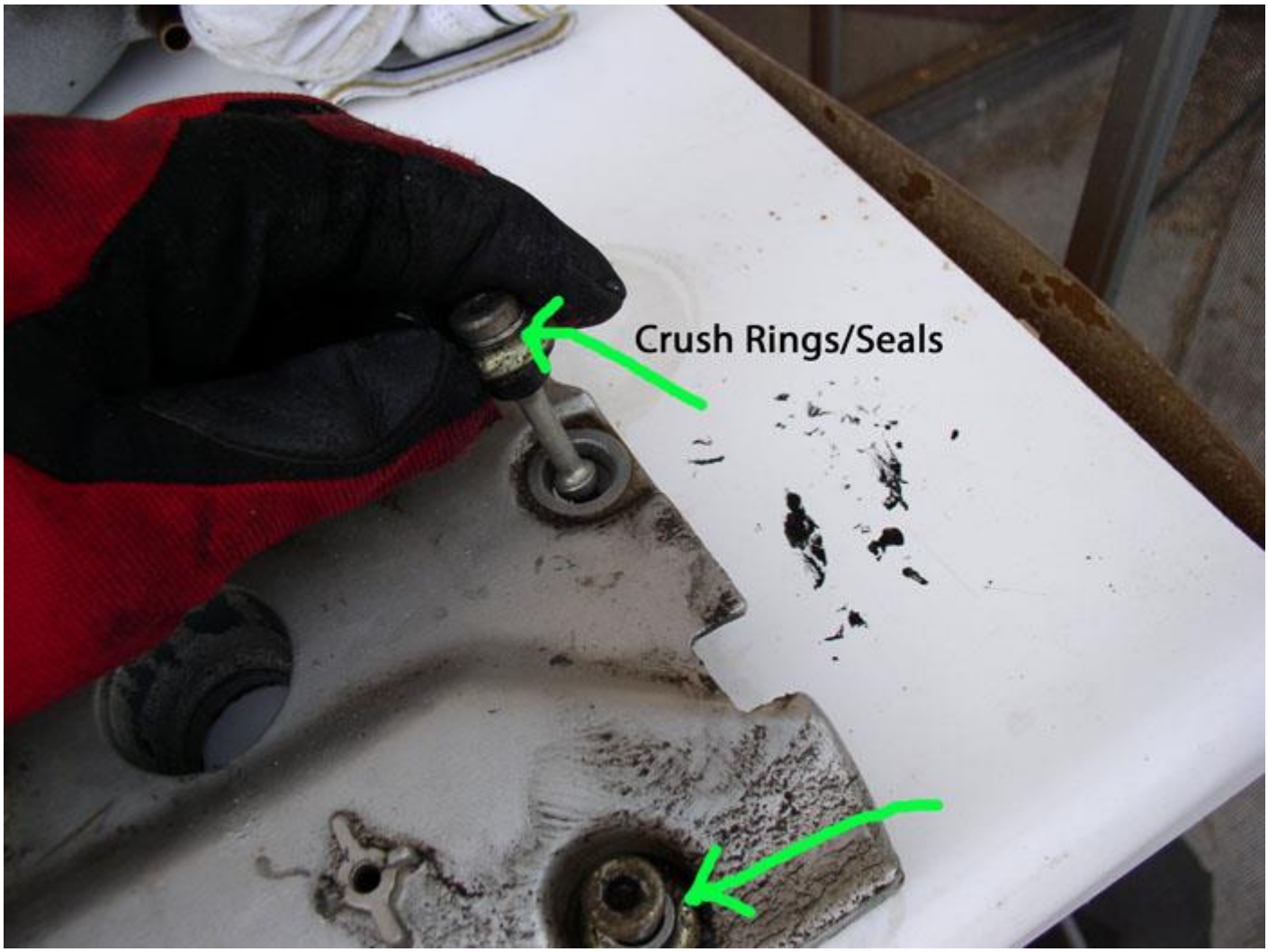
The last bolt on the bottom row can be accessed with the allen socket, universal elbow and extension.



To get at the third bolt on the bottom row. I removed the air diverter valve bracket from the head. It's attached to the head using two 13mm bolts that can be accessed from underneath the car using long extensions (12" and 6") and universal elbow. After the bracket is unattached from the head, you can push it out of the way while you access the cam bolt using the allen socket, extension and universal elbow.



Now you can break loose and manuever the cam cover off the head in the same fashion as on the driver's side. Remember to cover the exposed cams with a clean towel. With both cam covers off, you can remove the bolts an other components in preparation for powder coating. Start with removing the bolts.There are 3 parts to each bolt - the shoulder bolt itself, an umbrella cap washer, and a rubber thrust washer. The exception is there are 6 bolts that have sealing rings between the bolt head and umbrella washer. Note that these six are the 4 bolts at the bottom row of the cam cover and the two end bolts of the middle row. As noted by Dave C. and Bill Ball, you may not find these sealing rings on your cam cover if you have an '89 or newer S4. They seem to be common on '87 and even '88. If you do find them on your cam cover and they are not in the locations described above, and you are certain that your cam covers have never been removed since factory installation, note the location of the bolts that have the rings so you can put them back as the factory installed them (THANKS Dave and Bill!). Otherwise follow the pattern described above for re-installation as it matches the factory service bulletin. Finally, note that 4 of the 13 bolts are shorter than the others. These 4 bolts go into the four corner holes in the cam cover.




The other bolts do not have the sealing rings.



On the driver's side cam cover, remove the breather hole plugs by first removing the circlip that secures the plug to the cover. Use appropriately sized circlip pliers. There are two of these.



When the clip is removed the plugs simply pop out. Each plug seals with an o-ring - which is on the order list. Also, remove the 4 rubber spark plug sealing gaskets from the cam cover. Note that the sealing gaskets have a sealant (white in this case) applied to them.



Here's the items you should have removed from the driver's side cover. All will be reused except for the breather hold plug o-rings, spark plug sealing gaskets, and cam cover bolt thrust (rubber) washers.



For the passenger side cam cover, the two breather elbows use a different means of attachment. Each uses a nut with locking tine washer as shown. Look at the nut closely and you will see a notch cut out and a tine from the washer bent down to lock it into place. You can bend the tine up that is locking the nut in place with a flat blade screwdriver.



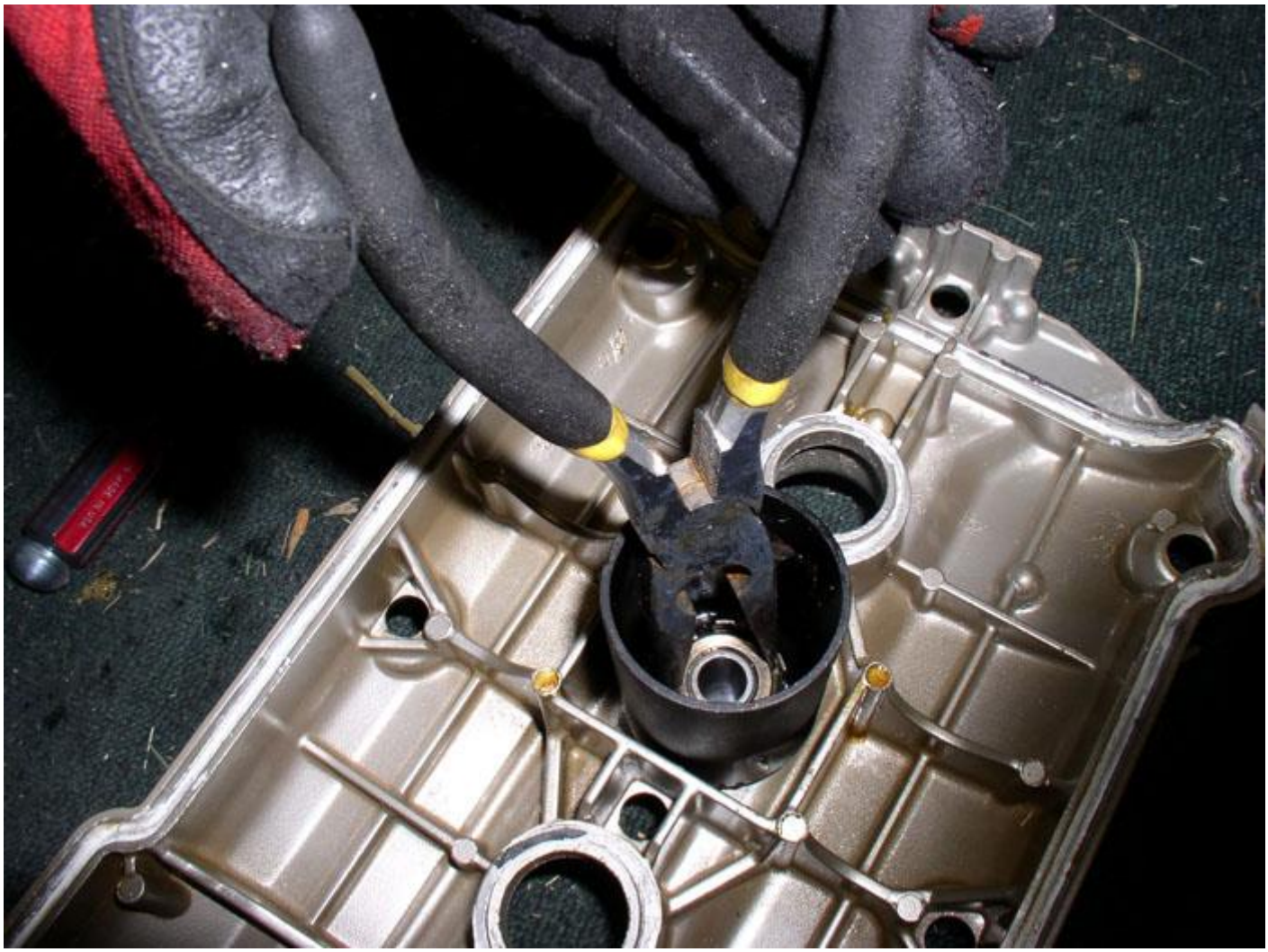
Then use pliers to loosen and remove the nut. Then remove the tined washer.



The elbow can then be removed from the top side of the cover. Each elbow also seals with an o-ring that is the same size as the breather hole plugs removed from the Driver's side cam cover.



The rear elbow removal is slightly complicated by the existence of a tube surrounding the nut and tine washer. The removal process is the same as the other elbow. There is enough room to pry away the locking tine and also room enough to use a pair of pliers in the tube to loosen and remove the nut. Proceed with removing the nut, tined washer, tube and elbow.



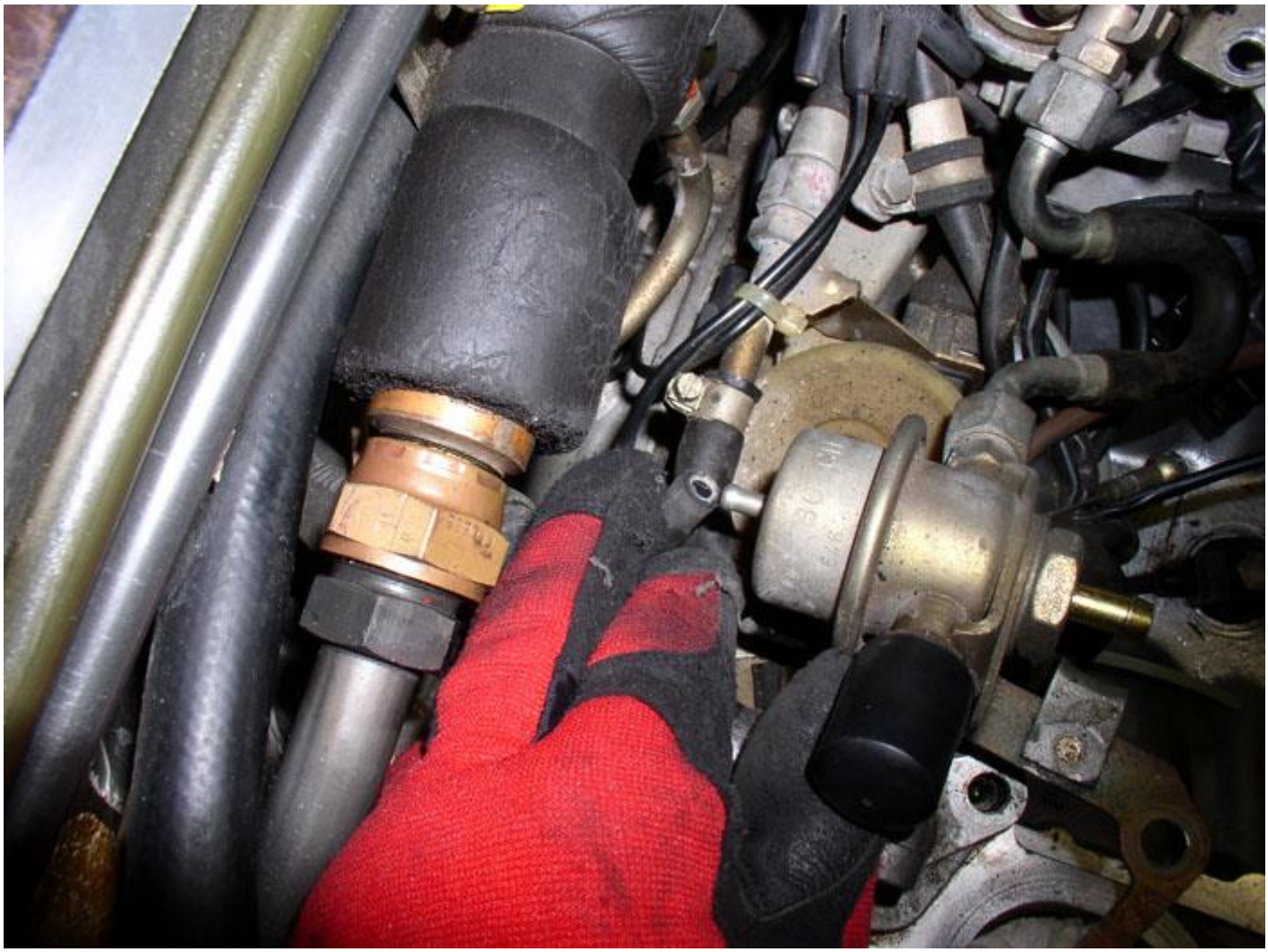
Now the cam covers as well as the other components of the intake refresh are ready for the powder coaters. Here's all the components I sent to Olympic Coatings in southern California. I even included the cross brace and the cam cover bolts and umbrella washers.



Now that the intake parts are at the Powder Coaters, you can spend some time inspecting and repairing the fuel hoses and heater water valve. First, remove the FPR and FPD assembly by loosening the clamp at the FPR outlet and removing the hose from the FPR.



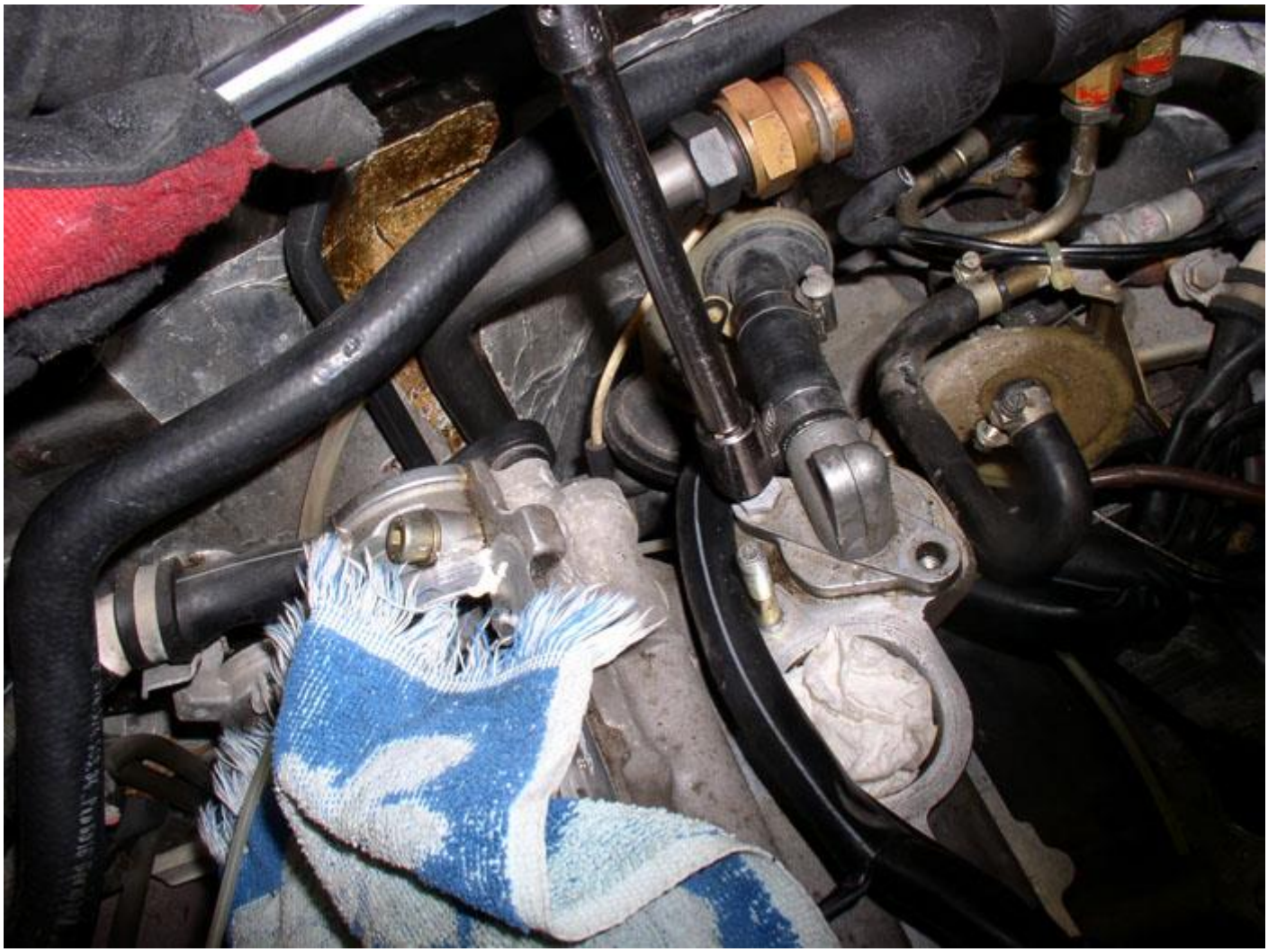
Then, remove the vacuum elbows from the FPR and the FPD. Now the assembly can be removed for work later on.



Inspect the Fuel return hose that was connected to the FPR. Mine looked fine but when I tried to straighten it, it split. It was at this point I decided to use Roger's fuel hose repair/replacement kit which I already had on hand. However, this particular hose I decided to order since it was moulded for tight radius corners. The rest of the hoses I used Rogers Kit.



Next, we'll remove the heater water valve and test. Start by removing the remaining 13mm bolt securing the adapter plate to the head. You already removed the other bolt earlier.



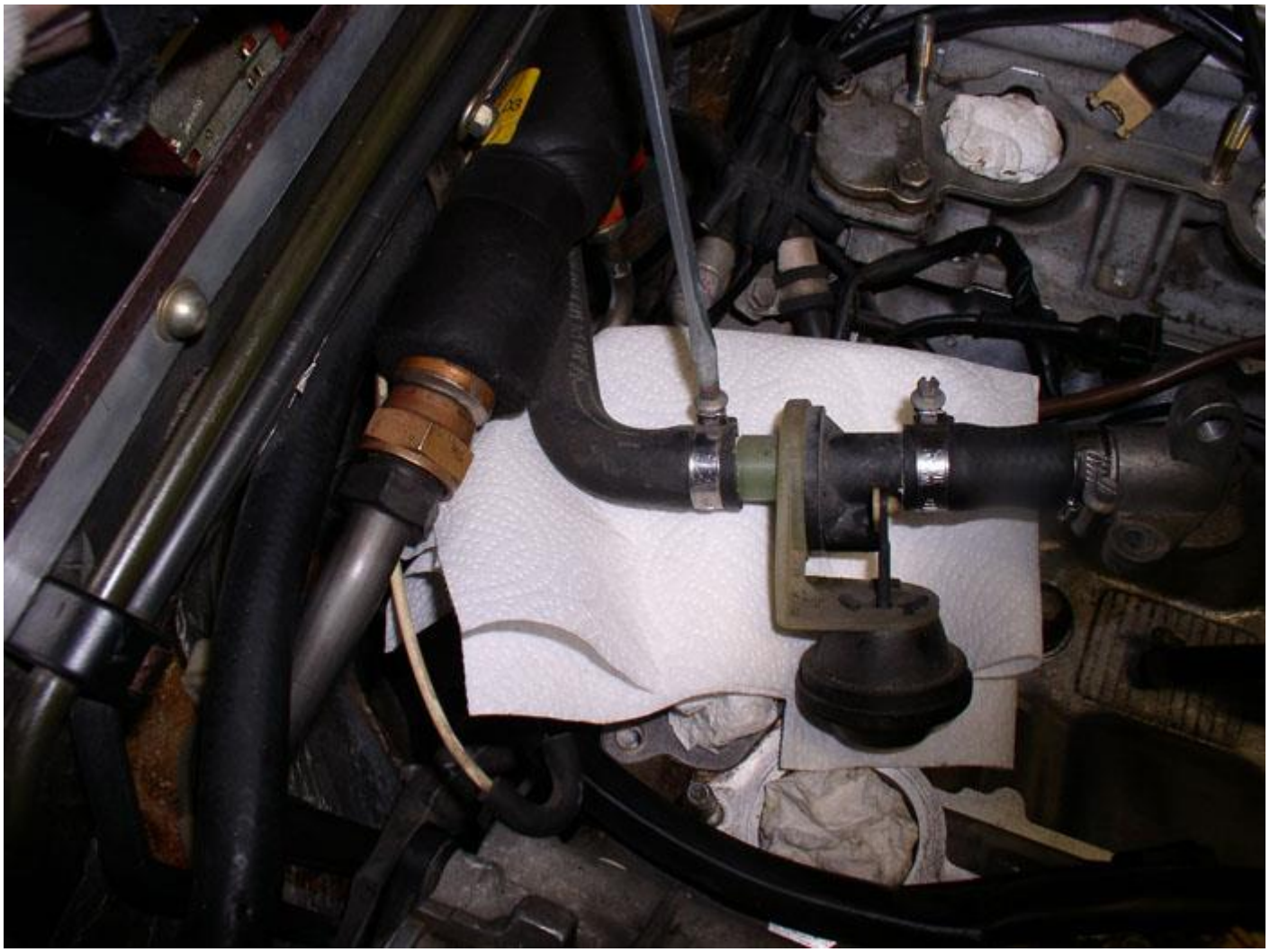
Lift the adapter plate away and plug the water port in the head with a clean rag to prevent debris from enter the cooling system.



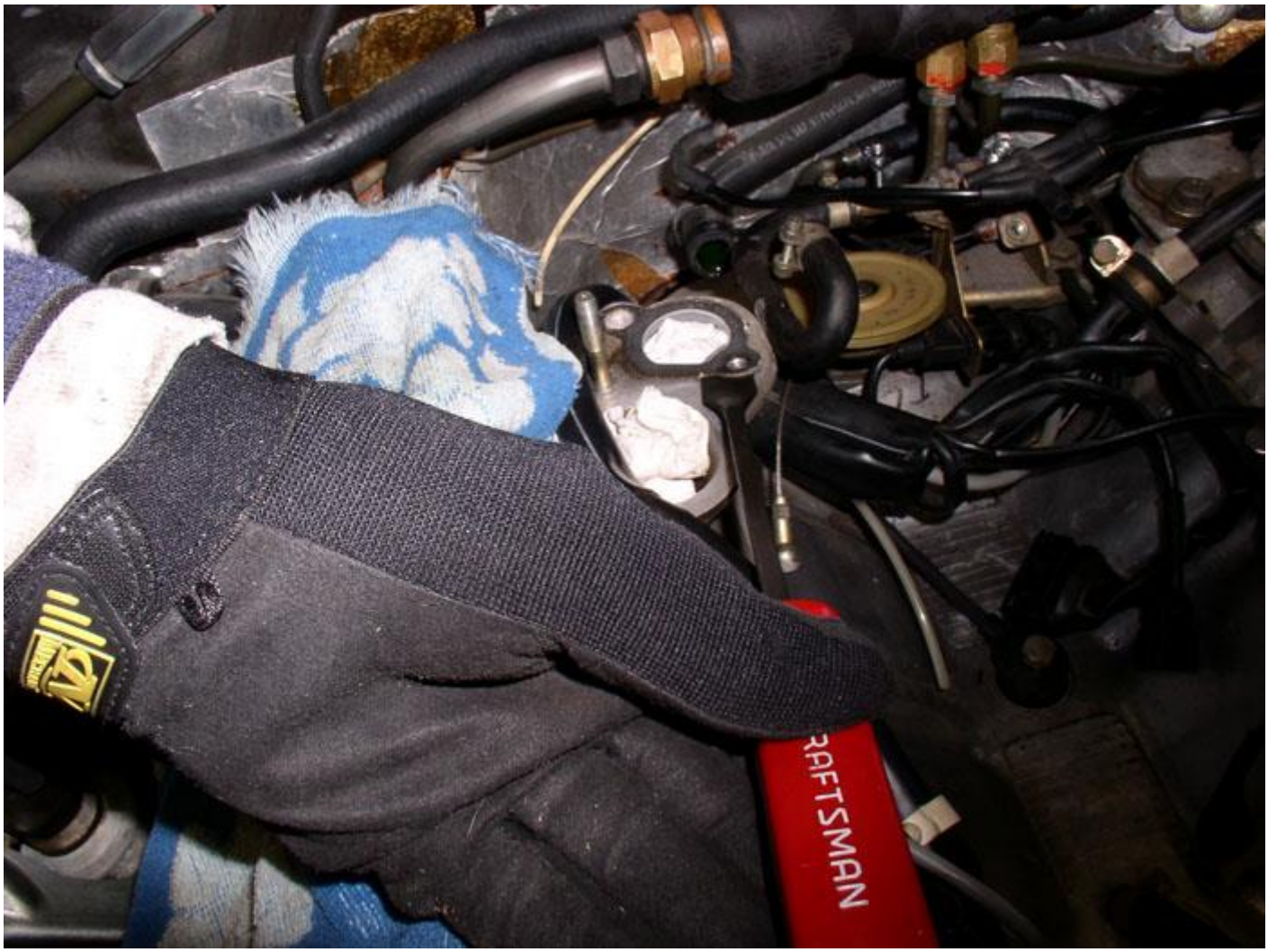
Pull the heater valve assembly forward and disconnect the vacuum elbow from the vacuum diaphram.



Pull the assembly a little more forward and loosen the clamp at the rear of the assembly with a flat blade screwdriver. Disconnect the hose and remove the assembly.



Use a gasket scraper to remove the old gasket from the head and clean the mating surface.



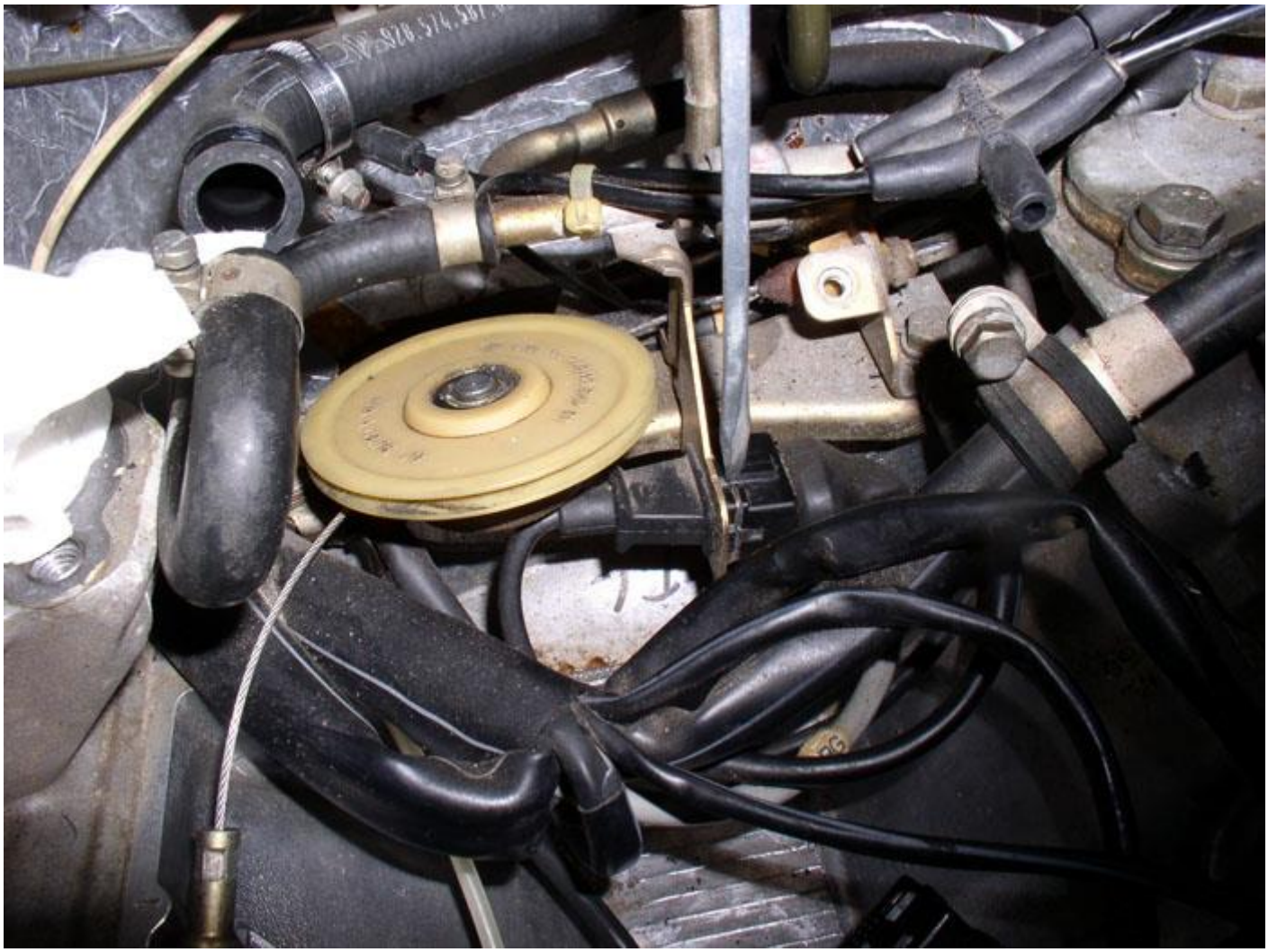

You can connect the vacuum pump to the heater valve diaphram and check the valve for proper operation - it should open and close fully. Also, check to see if it will hold vacuum. You can also fill the tube with water while holding upright to see if it will hold water with the valve closed. I did all of these test on mine and discovered that the diaphram had a slow leak and the valve also leaked water. So the valve went on the parts list.



Next, we'll inspect the Crank Position Sensor (CPS) connector plug at the wiring harness. To get to the plug, you will first need to remove the harness clamp located just above the CPS connection to the wiring harness. It's a 10mm bolt that holds the harness clamp. Remove the bolt and push the harness out of the way.



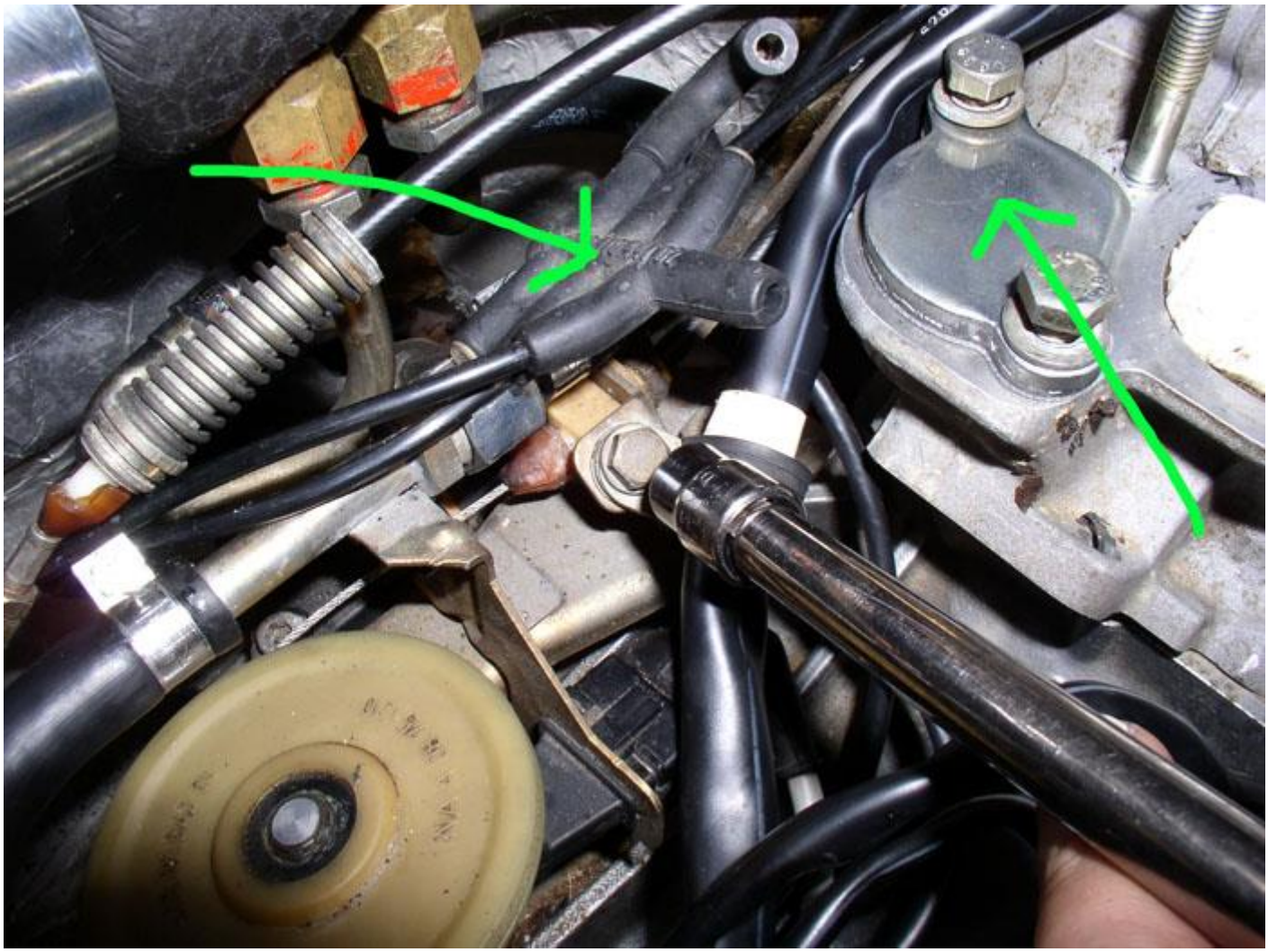
Underneath the harness, you will see the CPS connector to the harness. The harness portion of the connection is pointed to by the screwdriver in the picture. The other side is the plug from the CPS. Disconnect the harness side of the connection by grasping it with your fingers and pulling while rocking side to side.



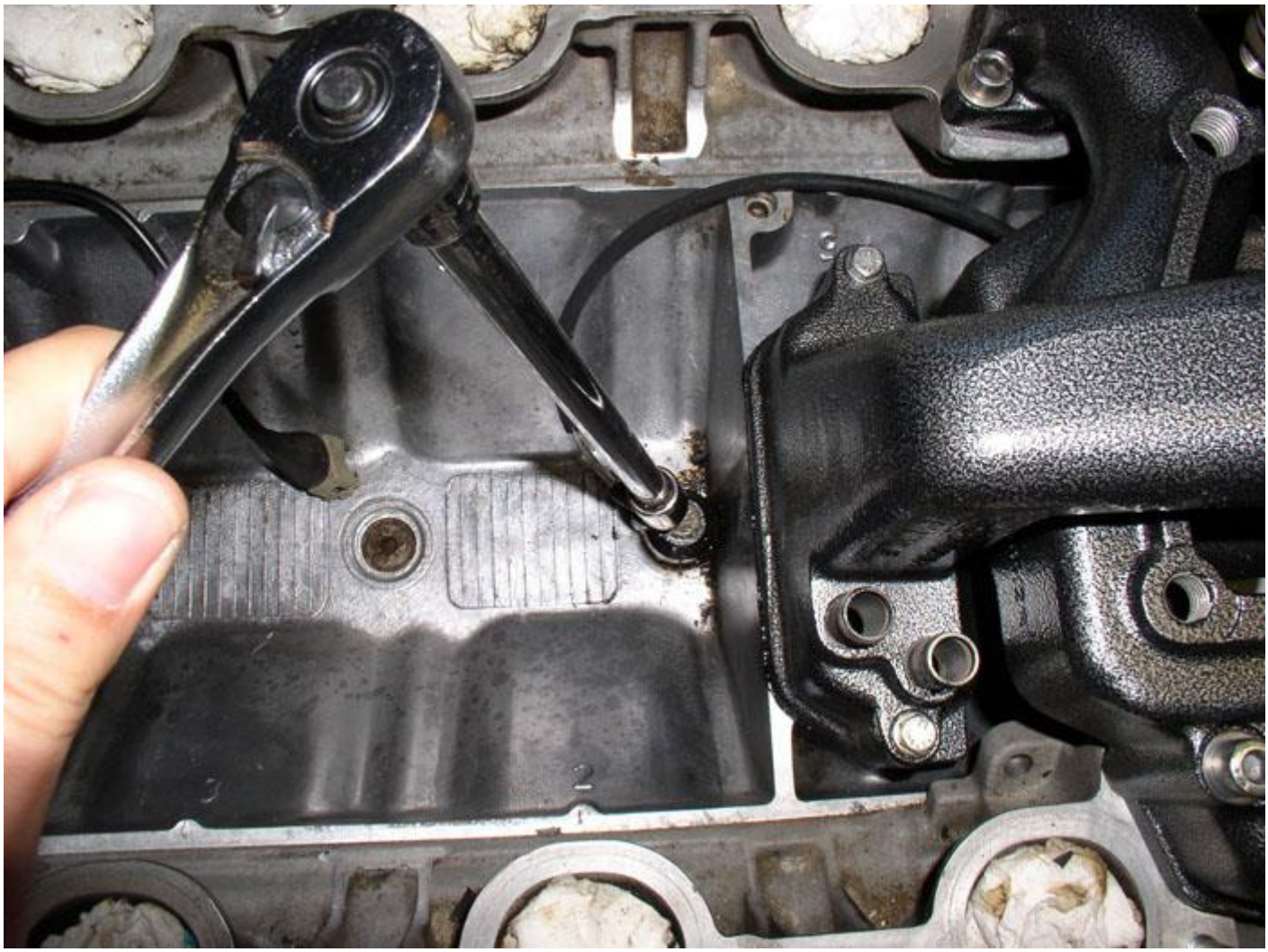
After the connection is unplugged, you can remove the CPS plug from the bracket and inspect. Unlike the knock sensor plugs, this one was still intact and solid and the electrical blades were clean. Therefore, I decided to keep the original. If you are planning on relacing the sensor, it simply needs to be unbolted from the block. Trace the wire from the CPS plug to the sensor and disconnect if replacement is desired.



I reconnected the CPS plug to the harness, re-positioned the harness and tightened the 10mm clamping bolt. At this point, it's a good time to replace the gasket on the other coolant port opposite the one that the heater valve is attached to (see right arrow). This is especially true since we broke the 20-year old seal on the gasket when we removed the 13mm bolt that was holding down the Fuel Pressure Damper (FPD) earlier. Remove the remaining (rear) 13mm bolt, remove the plate and plug the port with a clean rag, scrape the old gasket off, clean the mating surface just as you did on the passenger side. You will notice that the rear bolt is 3mm longer than the front bolt (25mm long vs 22mm). Place a new gasket on the head and place the cover plate on the gasket and secure with the two 13mm bolts but don't torque down the bolts yet. The other repair worth doing is replacing the 7-way vacuum manifold (see left arrow). The two lines on the left of the manifold go to the FPR and the transmission. One port is plugged. The two lines on the right side of the manifold go to the rear FPD and the front FPD. One port is plugged. Remove the vacuum lines and plugs and replace the manifold with the new one and reconnect the vacuum lines and plugs.

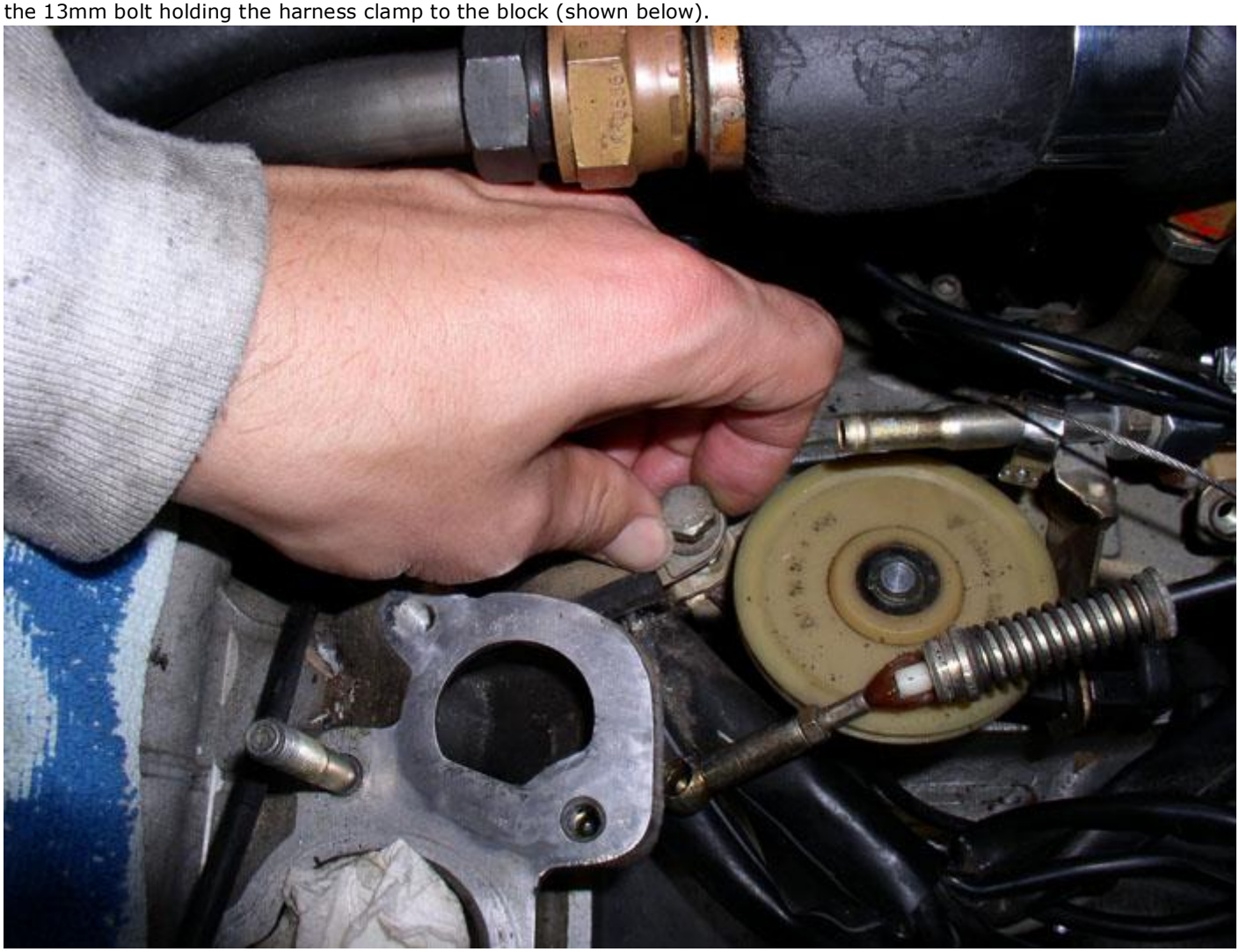


Next, we'll replace the knock sensors. Each is secured with a 13mm bolt. The front knock sensor is easiest. Remove the bolt and the sensor. The bolt was installed with blue threadlocker so it was a little stiff to remove.

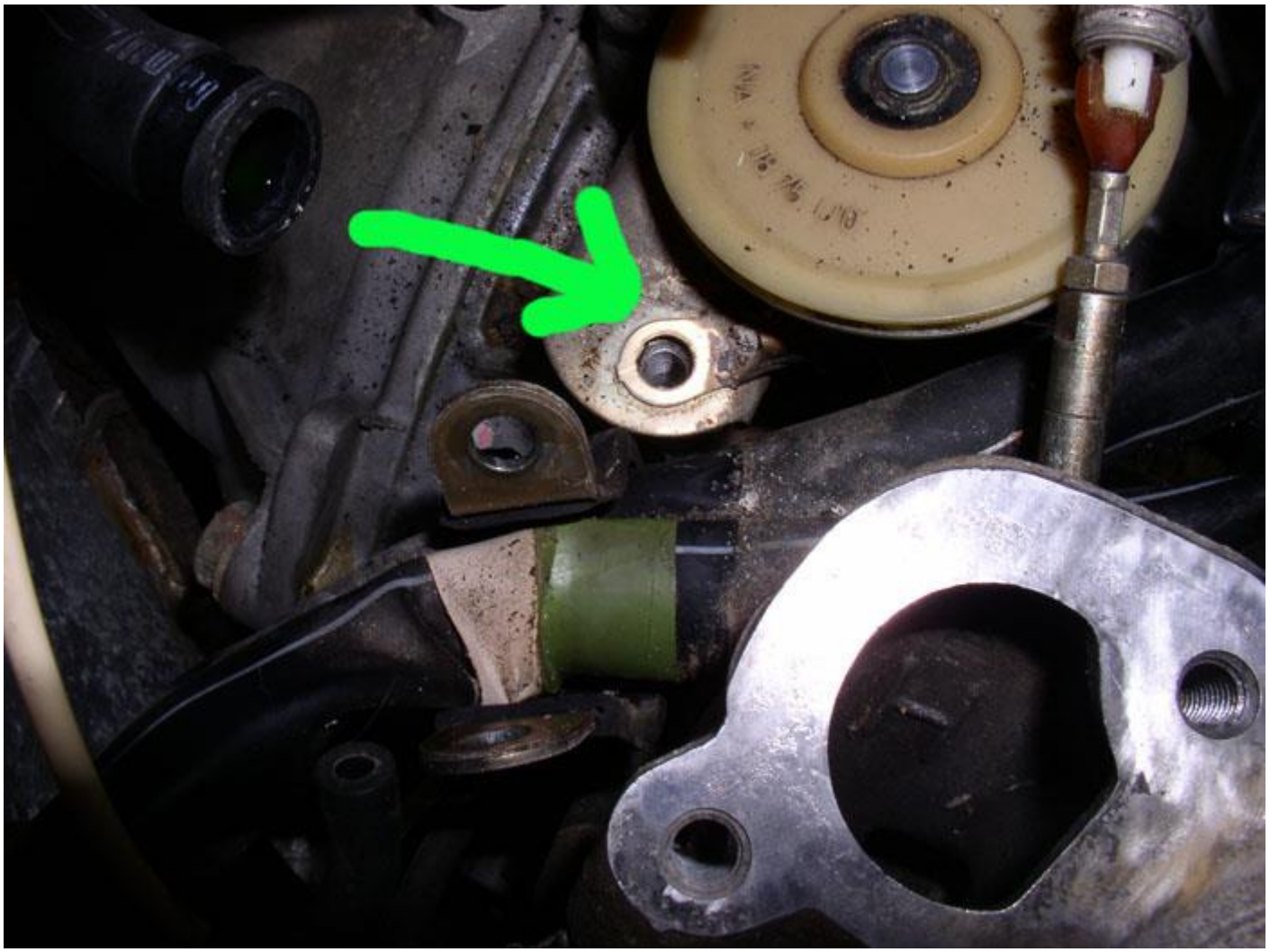


To remove the rear knock sensor, you will need to remove the rear harness clamp because the knock sensor wire is clamped down with the harness. First, remove the FPR outlet hose (the one pictured earlier that was split) by loosening the hose clamp and removing the hose. Then using a 13mm socket with extension, loosen and remove

the 13mm bolt holding the harness clamp to the block (shown below).



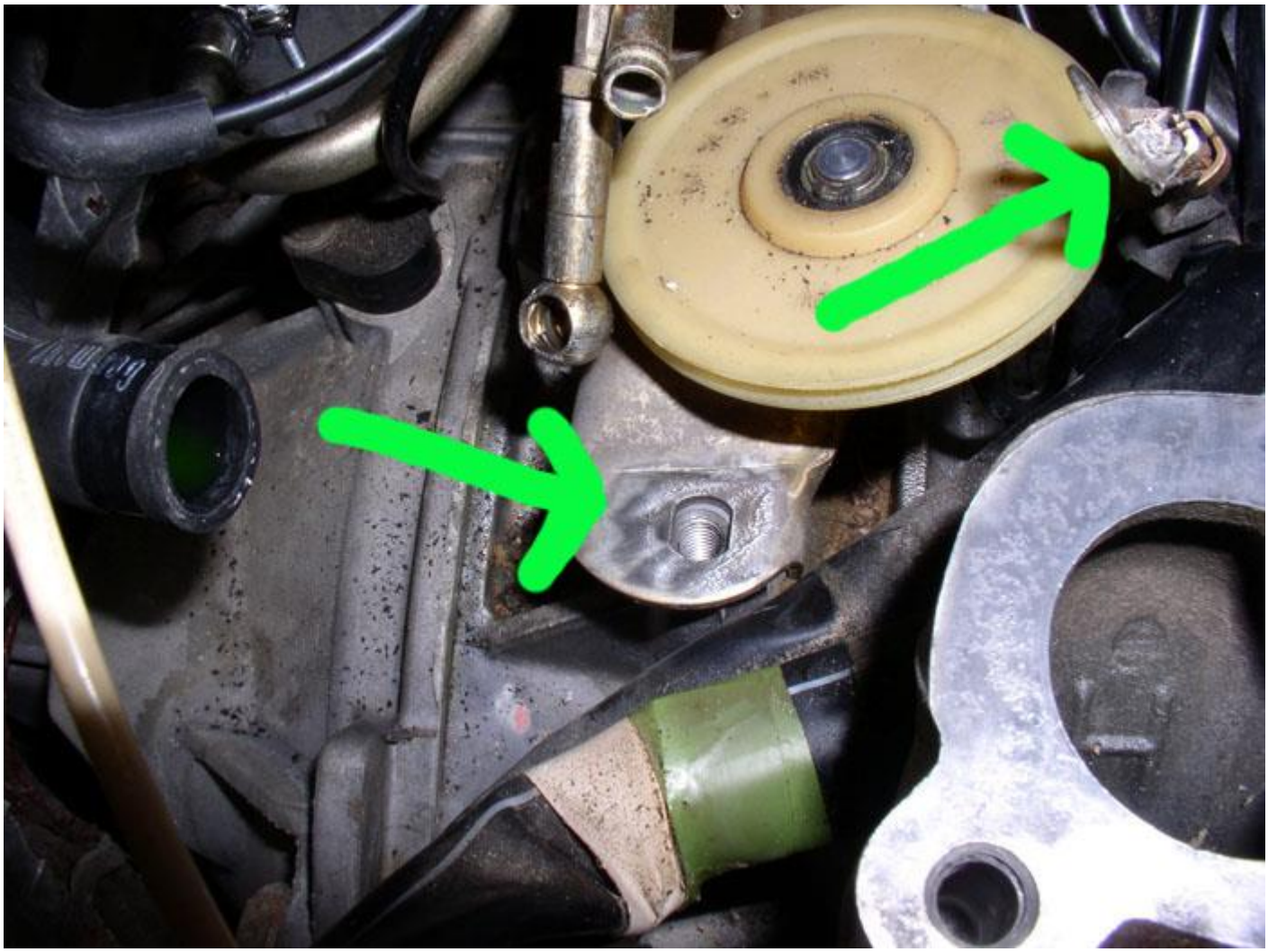
After you've removed the harness clamping bolt (13mm), spread the clamp apart wide enough to manuever the main harness out of the clamp. I had to do this because the knock sensor cable was underneath the harness in the clamp and I couldn't manuever the cable out. The vacuum line from the throttle body to the air diverter valve is also bundled with the harness in this clamp. Also note there is a ground connection under the harness clamp (see the green arrow). We'll clean this shortly. After the harness is out of the clamp....



....you can easily extract the rear knock sensor and sensor cable.



Next, inspect the gound connection under the harness clamp for loose wires or corrosion. Mine seemed snug and the contact surfaces were good but I cleaned it anyway. I used a wire brush on the block side (see left arrow) as well as the ground wire side (right arrow).



Before connecting the new knock sensors, I inspected the area around the threads in the block and noticed some caked dirt. I found a pick to be useful in cleaning this area out before connecting the sensors.



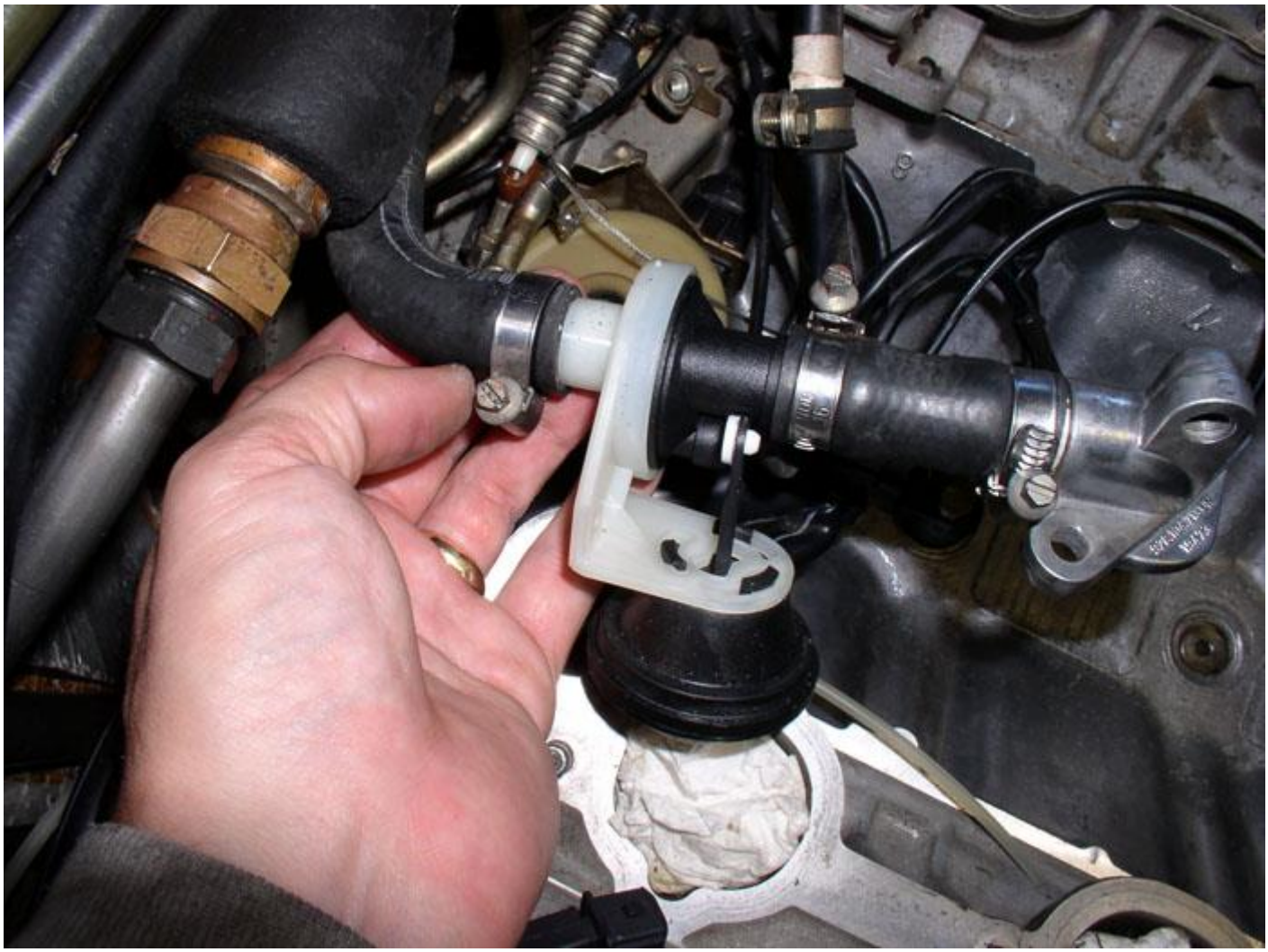
Since I noticed threadlocker on the bolts when removed, I applied a new coat of threadlocker blue to the threads before installation. I assume the threadlocker was used to minimize the chance of loose mounting bolts causing false readings.



Next, position the knock sensor and install the 13mm mounting bolt. For the rear, first lay the knock sensor cable in the harness clamp and take up all the slack between the block connection and the harness clamp (as shown in the picture), giving you maximum cable to work with between the harness clamp and where the cable will plug into the fuel injector harness at the fuel rail. For the front knock sensor, orient the cable so that it points rearward then loop it up and over the block valley wall where it will be connected with the harness later (see picture). Then torque the 13mm bolts to 15 ftlbs or 20 Nm. Finally, insert the wiring harness back into the rear harness clamp ensuring the knock sensor cable and vacuum line are included in the clamp. Ensure the ground wire we cleaned earlier is positioned under the harness clamp as before, then tighten the 13mm clamp bolt down.



Now we can install the new heater water valve. You will remove the water port adapter plate from the old heater valve assembly then assemble the adapter plate, new short hose if you purchased one, and heater valve as shown (black end toward the block, white end toward the firewall) - but do not tighten any of the hose clamps yet.



Next, attach the vacuum elbow to the heater valve diaphram. I replaced all the elbows with new ones.



Place the gasket on the head mating surface.



Next, we need to orient the heater valve assembly so that it is not rubbing against other components and is not in a bind. To do this, position the adapter plate on the head and install one of the 13mm bolt to hold it in place. Then with the clamps still loose, rotate the assembly so that it does not touch or rub other components - particularly the vacuum elbow. When you are satisfied with the orientation, remove the 13mm bolt, pull the assembly forward and tighten the rear hose clamp. Then re-install the adapter plate to the head, install the 13mm bolt ( but don't torque it down yet).....



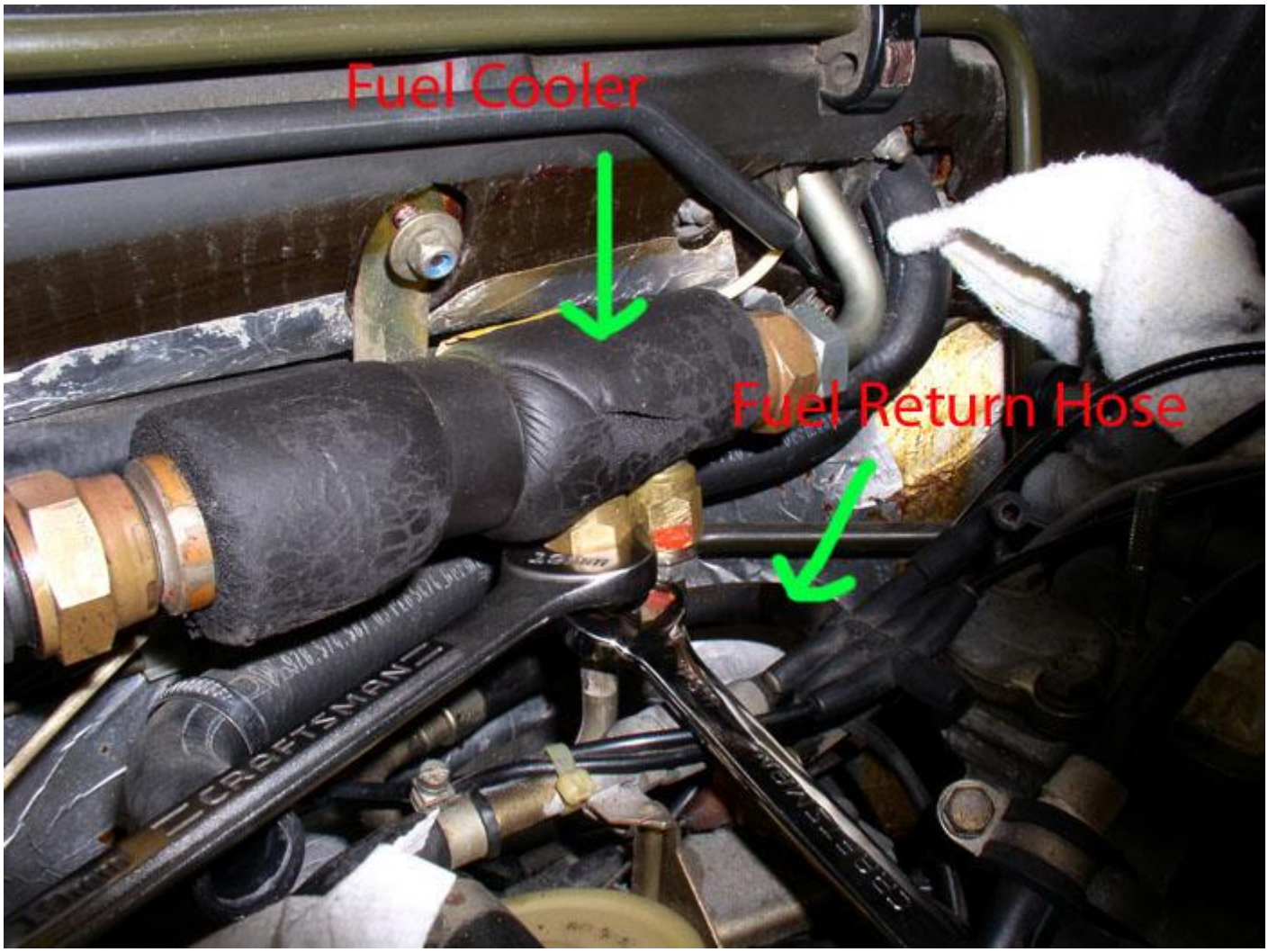
....and tighten the remaining two hose clamps on the short hose.



I had ordered the moulded hose replacement for the Fuel Pressure Regulator (FPR) and installed it next. I wasn't sure if I was supposed to use the bulk hose in Roger's kit for this hose because of the tight radius so I ordered the replacement. I used Roger's kit for all other fuel hose replacements. You can orient the hose as shown in the picture. However, ensure the top of the fuel hose section pointed at by the green arrow is level with the mating surface of the heater water port on the head adjacent to it. When you re-install the FPR bracket, it has a hose guide that will fit around the FPR return hose and the hose should be oriented this way to fit properly in the guide. Tighten the hose clamp (used clamps from Roger's kit)



Next, you can replace the fuel return hose that feeds into the fuel cooler. The return hose from the FPR feeds the inlet side of the cooler (shown in the picture) and is the left connection. The right connection from the cooler returns the cooled fuel to the fuel tank. Use a 19mm wrench to counterhold the nut attached to the cooler and a 17mm wrench to loosen the fuel return hose nut. Then, use a 19mm wrench to remove the nut at the other end of the return hose where it connects to the throttle cable and fuel hose engine bracket that's attached to the block. Remove the return hose.




The hose should look like this (see below) along with the bulk hose from Roger's kit. You will wan to save the metal end pieces from the original hose and install them on the bulk hose. I've had real good experiences using the dremel tool with metal cutting wheel attachment as shown.



First, carefully cut the metal hose crimping using the dremel. Do not cut too deeply because you don't want to damage the hose barbs on the fitting below the hose. Cut as as close to the nut as you can without cutting touching the nut.



Make two cuts to ease the removal of the hose crimp.



After the incisions are made, use a screwdriver to pry up the metal crimp as shown here.



Then use a pair of pliers to remove a portion of the hose crimp.



You can then cut through the rubber hose with a utility knife - being careful not to score the barbs on the fitting underneath the hose. Then pull the hose fitting out from the hose. Perform the same operation on the other end of the the hose.



With the old hose removed. Use it to measure out and cut a matching length of the bulk hose from Roger's hose kit. I used a utility knife to cut the hose.



Next, fit the barb with nut on the hose. It was a nice fit - snug and not too tight that it required any special procedures to install.



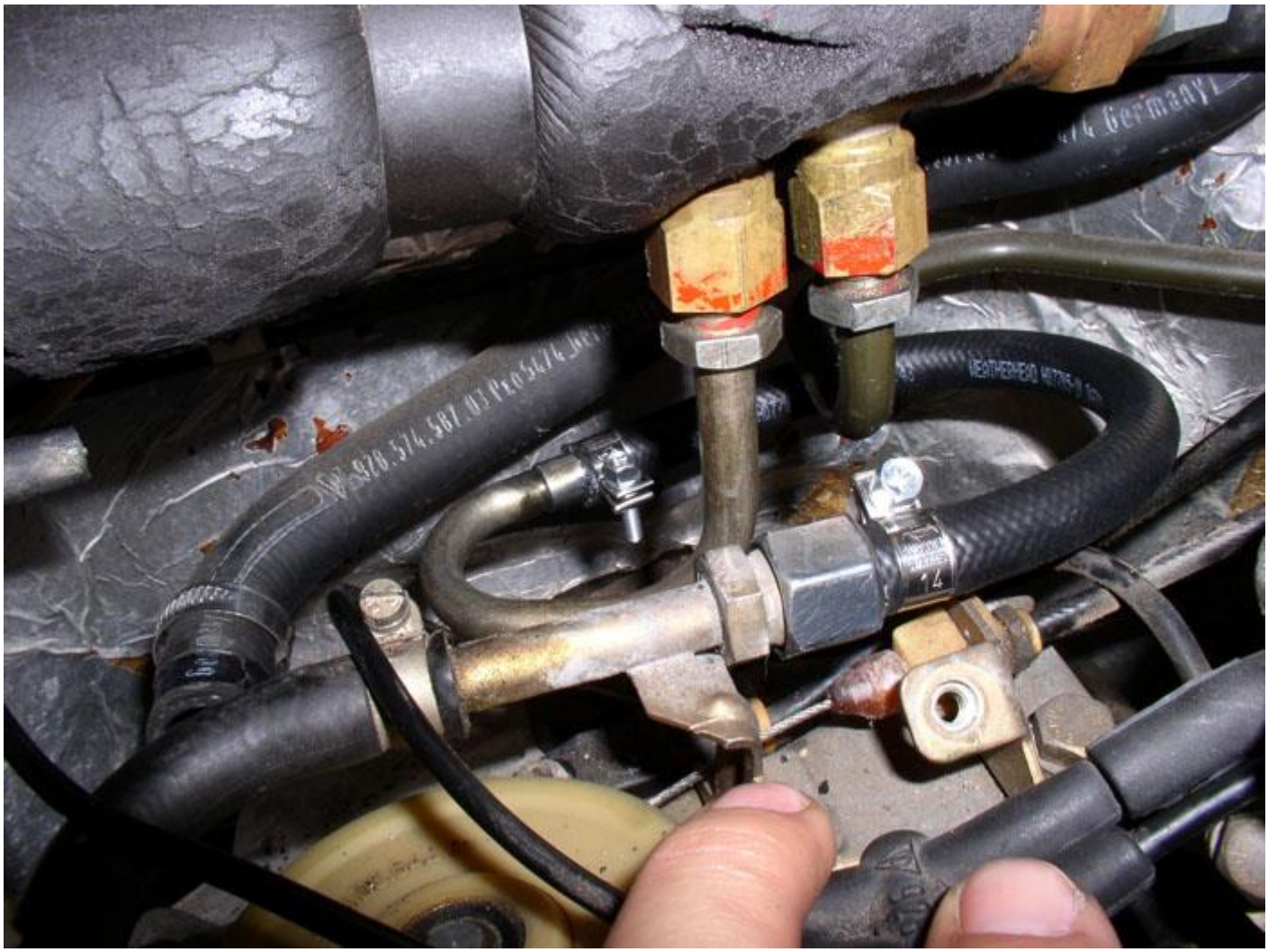
Now install the two hose clamps oriented so they face inward with the phillips head is facing up as shown. Then attach the tube end of the return hose as shown.




Check the orientation of the clamps so they can be accessed when the hose is installed. Then tighten the clamps.



Re-install the hose at the cooler and the throttle cable/fuel hose engine bracket using the 17mm and 19mm wrenches.

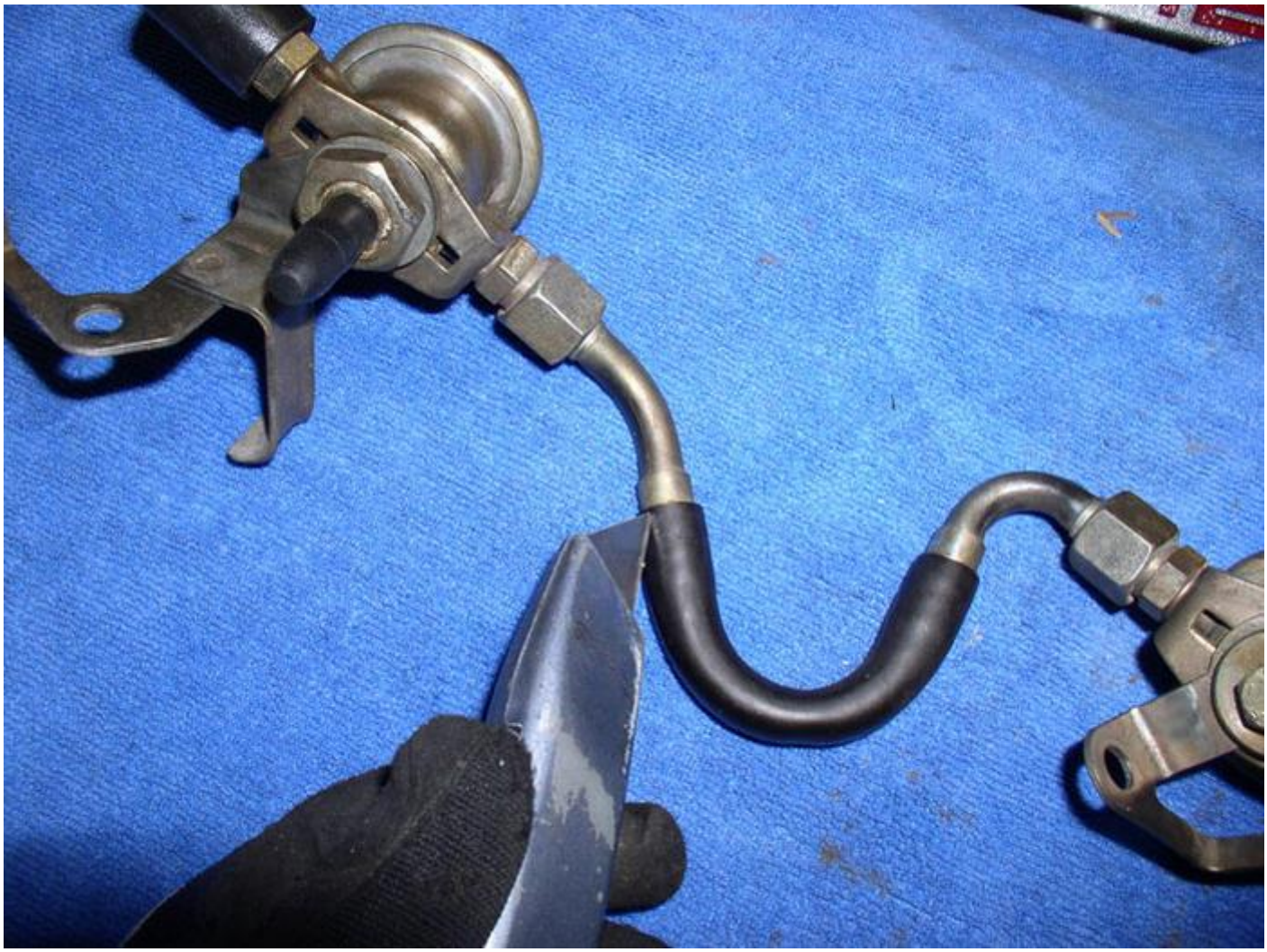


Next, replace the small "U" shaped fuel hose that runs between the rear FPD and FPR. This is a moulded hose that comes with its own clamps with Roger's kit.



Use a utility knife to carefully cut lengthwise incisions in the rubber hose being careful not to cut too deeply and

score the metal barbs underneath the hose.



After the incisions are made, use a screwdriver to pry the hose apart enough to allow you to pull the hose off the barbs.



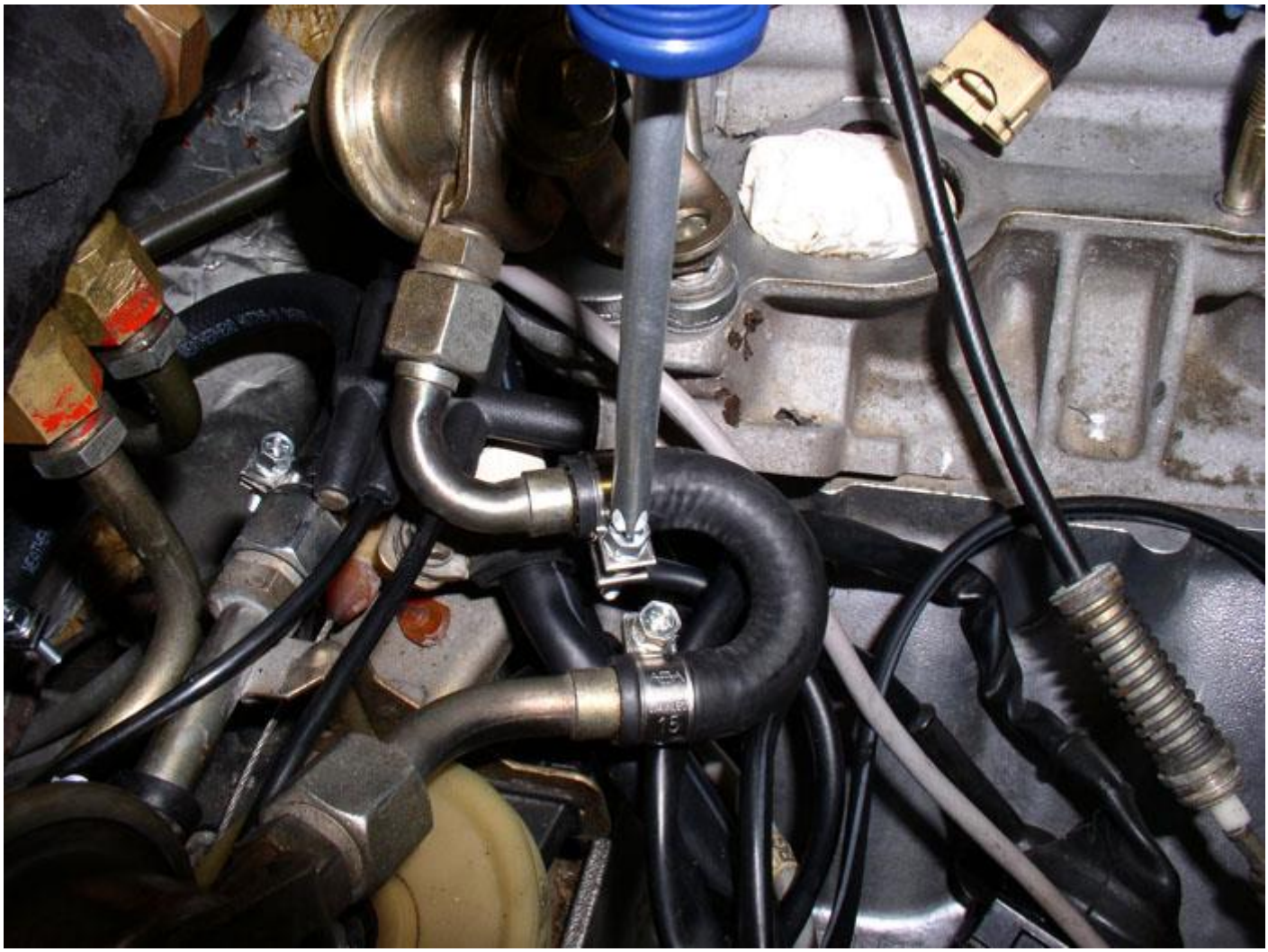
Next, fit one end of the hose to the Fuel Pressure Regulator (FPR) in approximately the same orientation as the old hose.



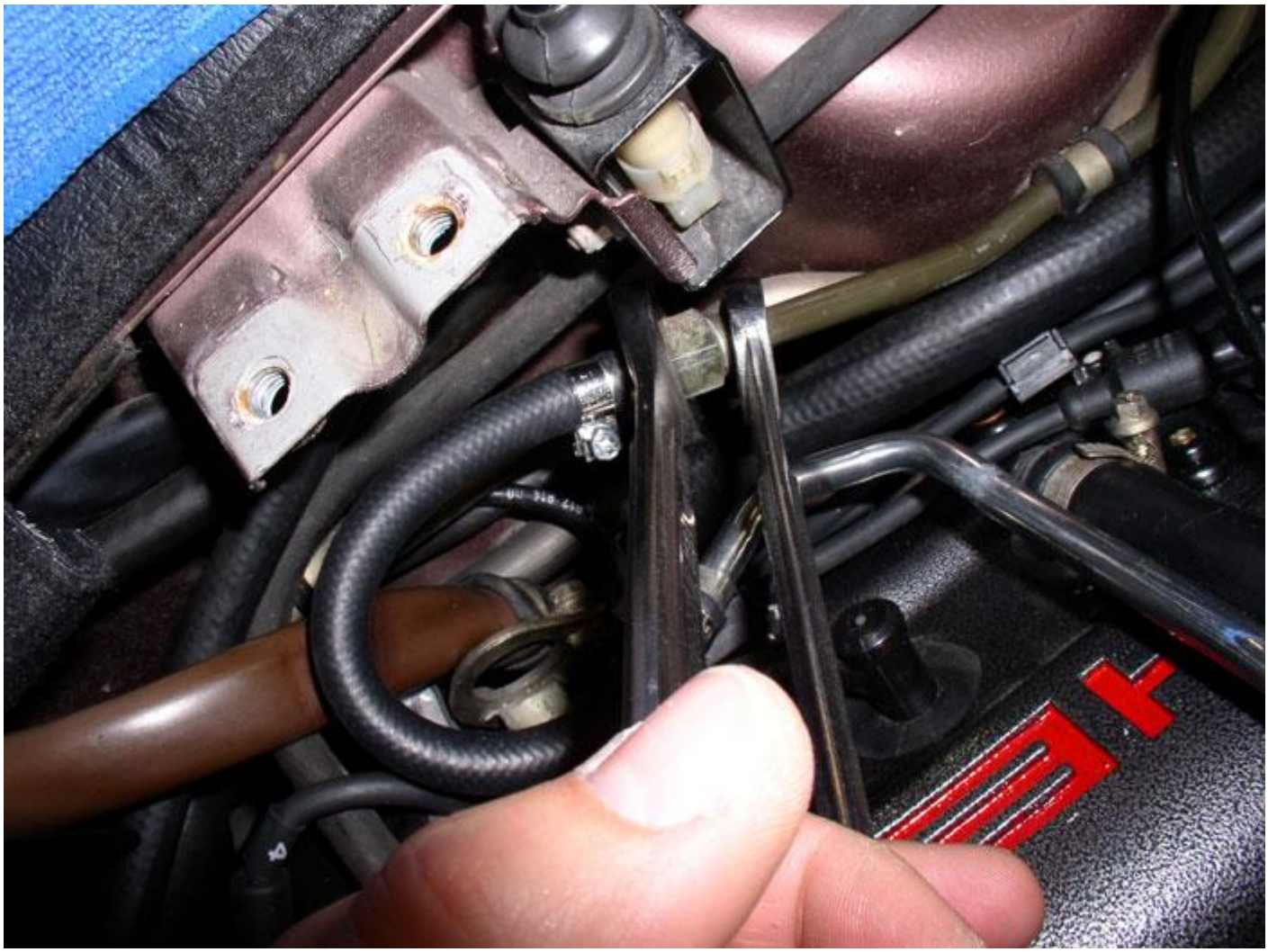
Slide the two hose clamps onto the hose oriented so that the phillips head is facing up and inward when installed. Then attach the Fuel Pressure Damper (FPD) to the other end of the hose but don't tighten the clamps yet.



Finally, take the assembly to the engine and place the FPR and FPD brackets over the rear intake mounting studs as they would be installed for a fit check. Rotate the hose and FPR/FPD so that the hose is not in a bind. Then tighten the hose clamps as shown. Remove the assembly afterwards for re-install later.



The last bulk hose repair to make is the fuel supply line that runs over the passenger cam cover (pictured below with the new bulk hose intalled). This hose will be installed later. The procedure for replacing this hose is identical as the procedure for the fuel return hose at the fuel cooler we just completed.



One more hose comes with Roger's kit and it is the front hose that runs from passenger fuel rail to front FPD. It already has fittings on the ends and simply needs to be bolted on. This will be installed when the fuel rails are re-installed.

**Throttle Body Vacuum Leak Repair**

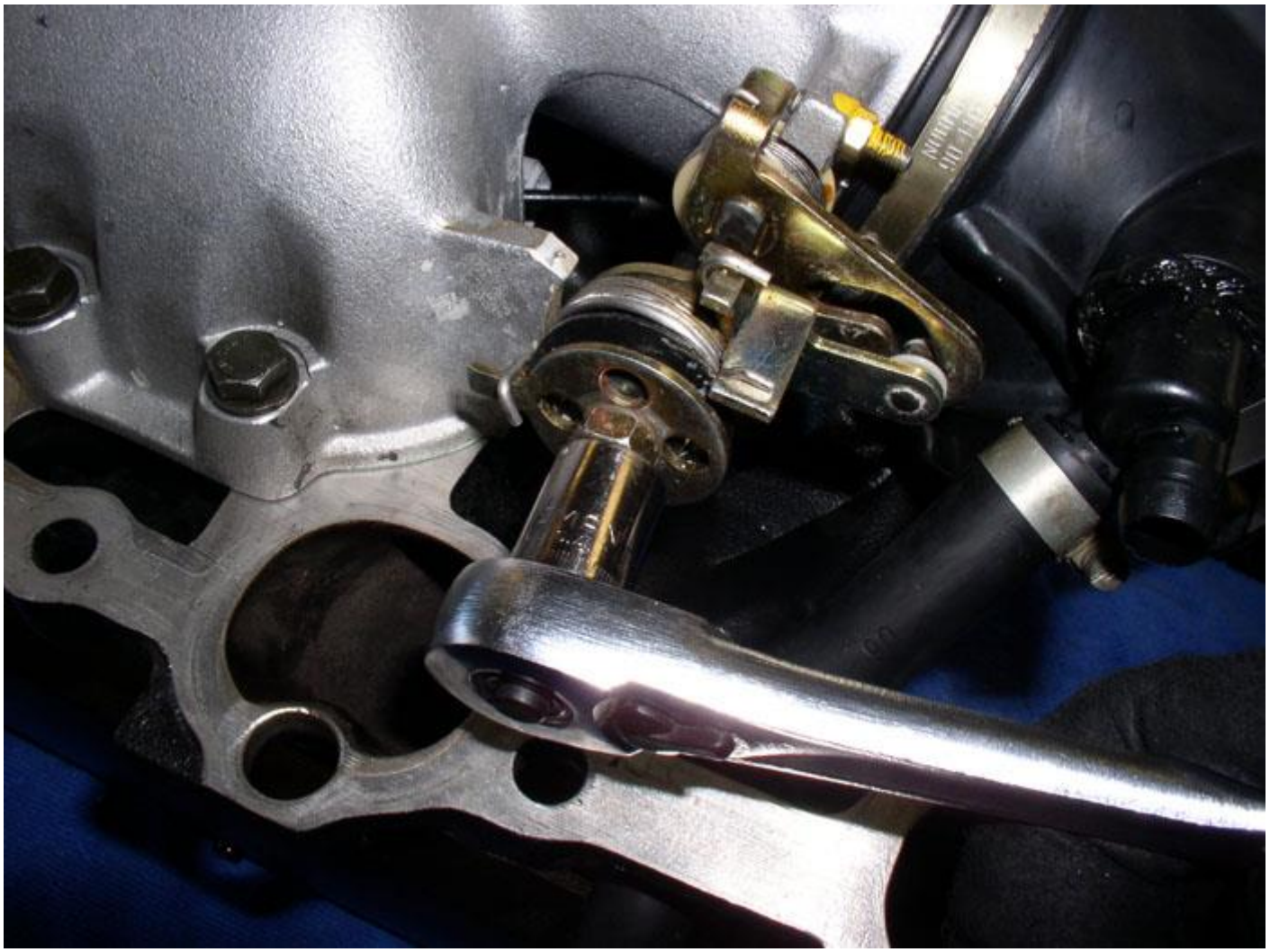
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If you tested the intake system for vacuum leaks before disassembly and found a leak at the throttle body, now is a good time to repair the leak while you're waiting for the intake and cam covers to come back from the powder coaters.

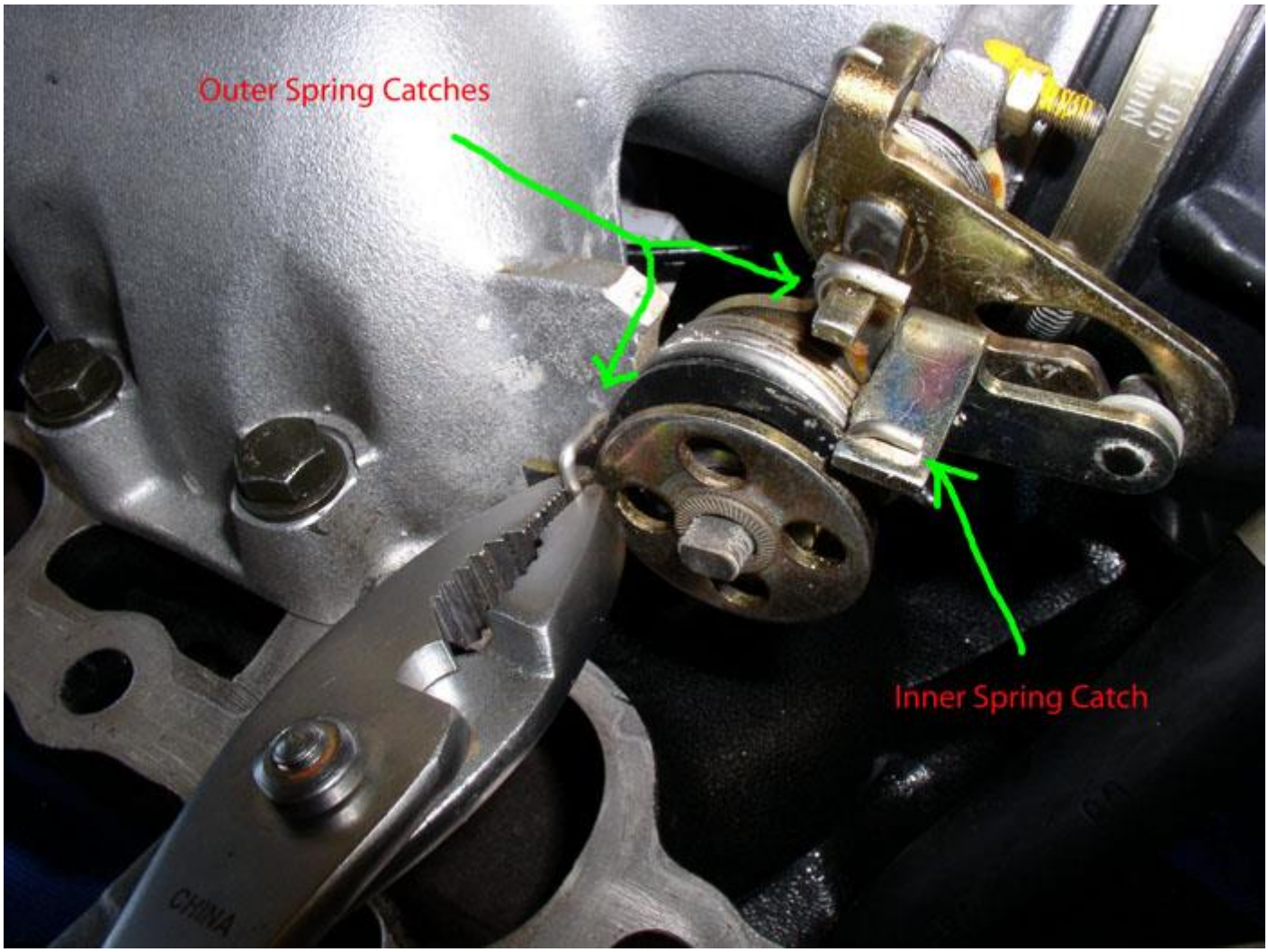
Unfortunately, I did not test mine before disassembing the intake so I discovered the throttle body leak AFTER I had reassembled everything and installed it back on the car. After pressurizing the intake to 2.5 PSI, I could hear the leak coming from the throttle body but couldn't pinpoint it. Then I used a long wooden match and waived it in the vicinity of the leak and quickly pinpointed the leak at the throttle plate bearings - the leak practically blew the match out!

So everything came off again and here's the steps I used to repair the leak. I made one interesting discovery: Roger's flappy bearings with seals are the same size as the bearings in the throttle plate body. Has anyone else tried to replace the throttle plate bearings with Roger's Flappy bearings?? The results of the repair were EXCELLENT - cured the leak! From now on, I have 4 of Roger's sealed bearings on hand for an intake job (2 for the flappy and 2 for the throttle plate).

First, remove the 13mm nut and small ribbed washer underneath the nut on the end of the throttle cable spring assembly. As you disassemble these assemblies, keep the parts ordered in the sequence you removed them to ease re-assembly.



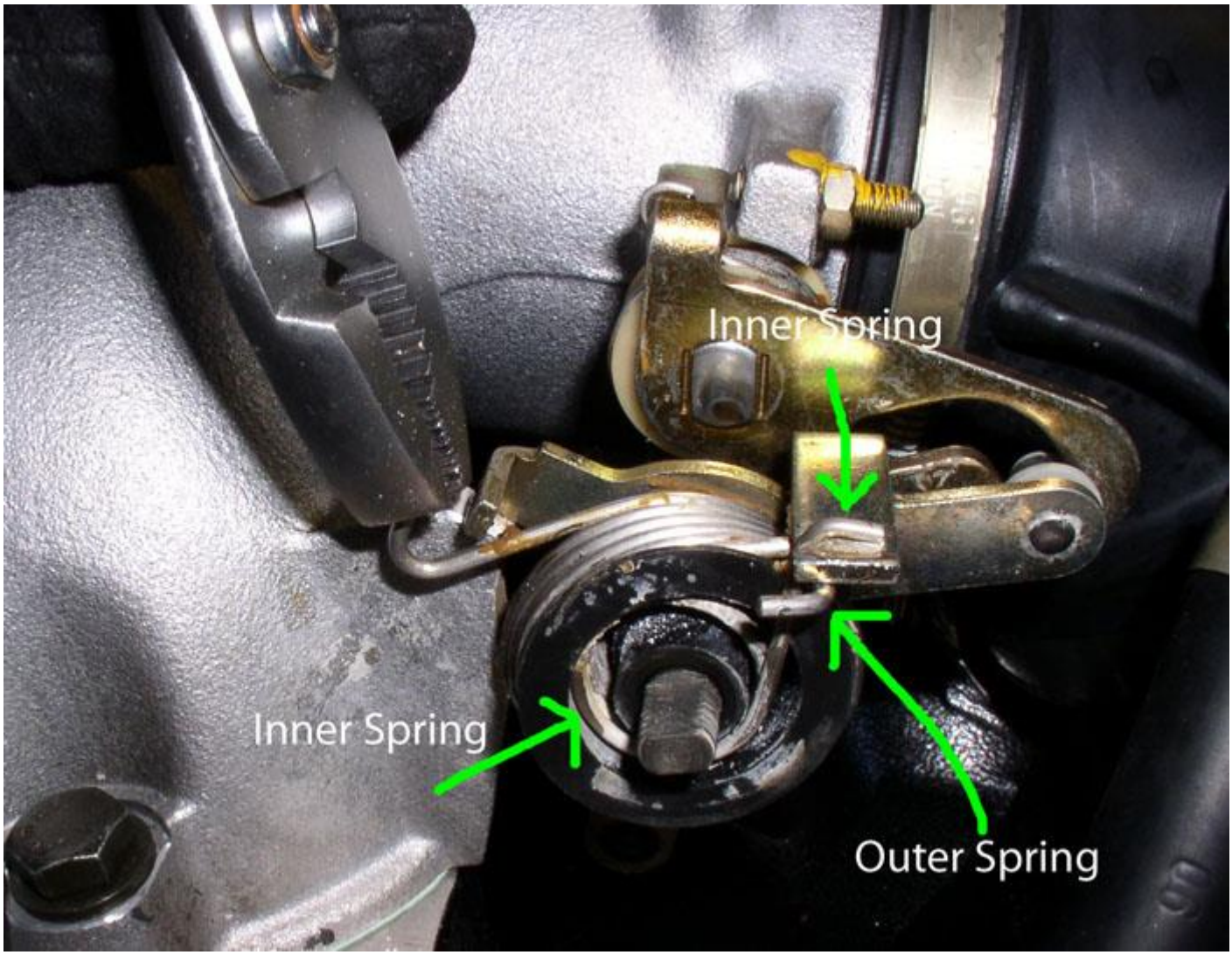
There are 2 springs on this assembly. An outer spring (heavier spring) and an inner spring (lighter, smaller spring - not fully visible). The outer spring catches are identified below as well as one of the inner spring catches. In order to remove the outer metal plate, use pliers to grasp and "unhook" the outer spring from the catch as shown and remove the metal plate.



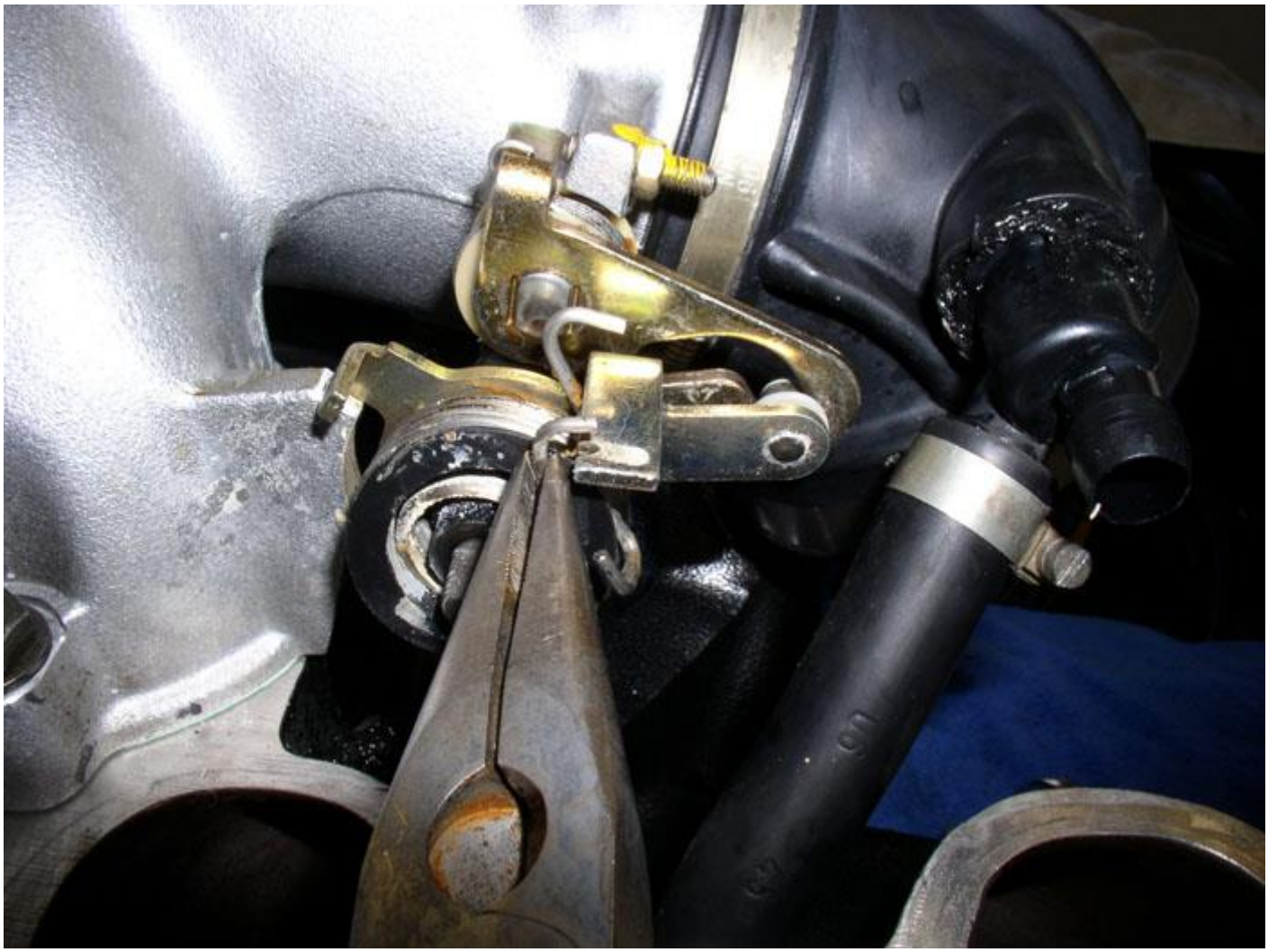

Under the metal plate, you will find a small plastic retainer - remove it. Note the inner spring now visible.



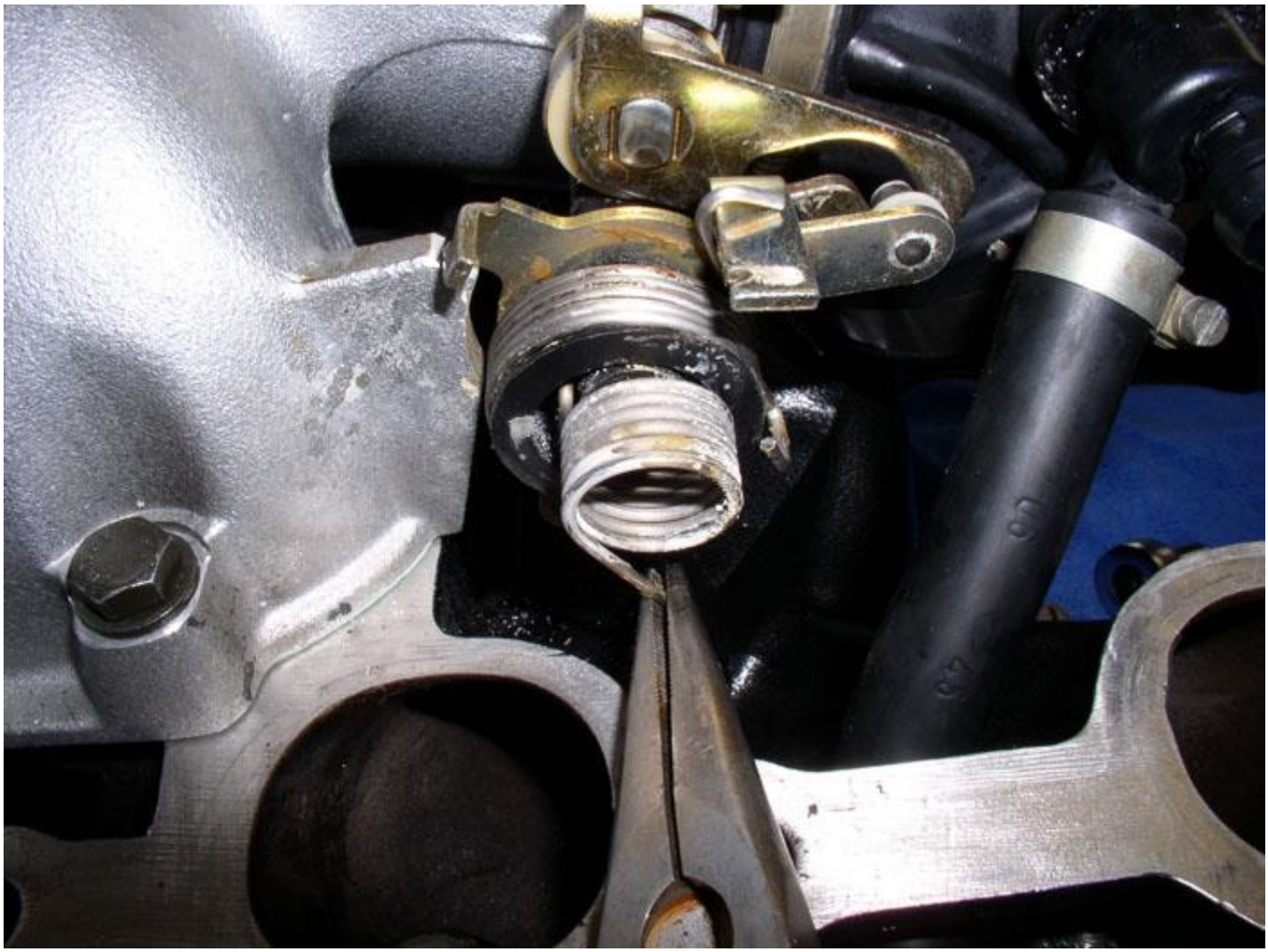
Next, remove the other outer spring catch with pliers as shown.



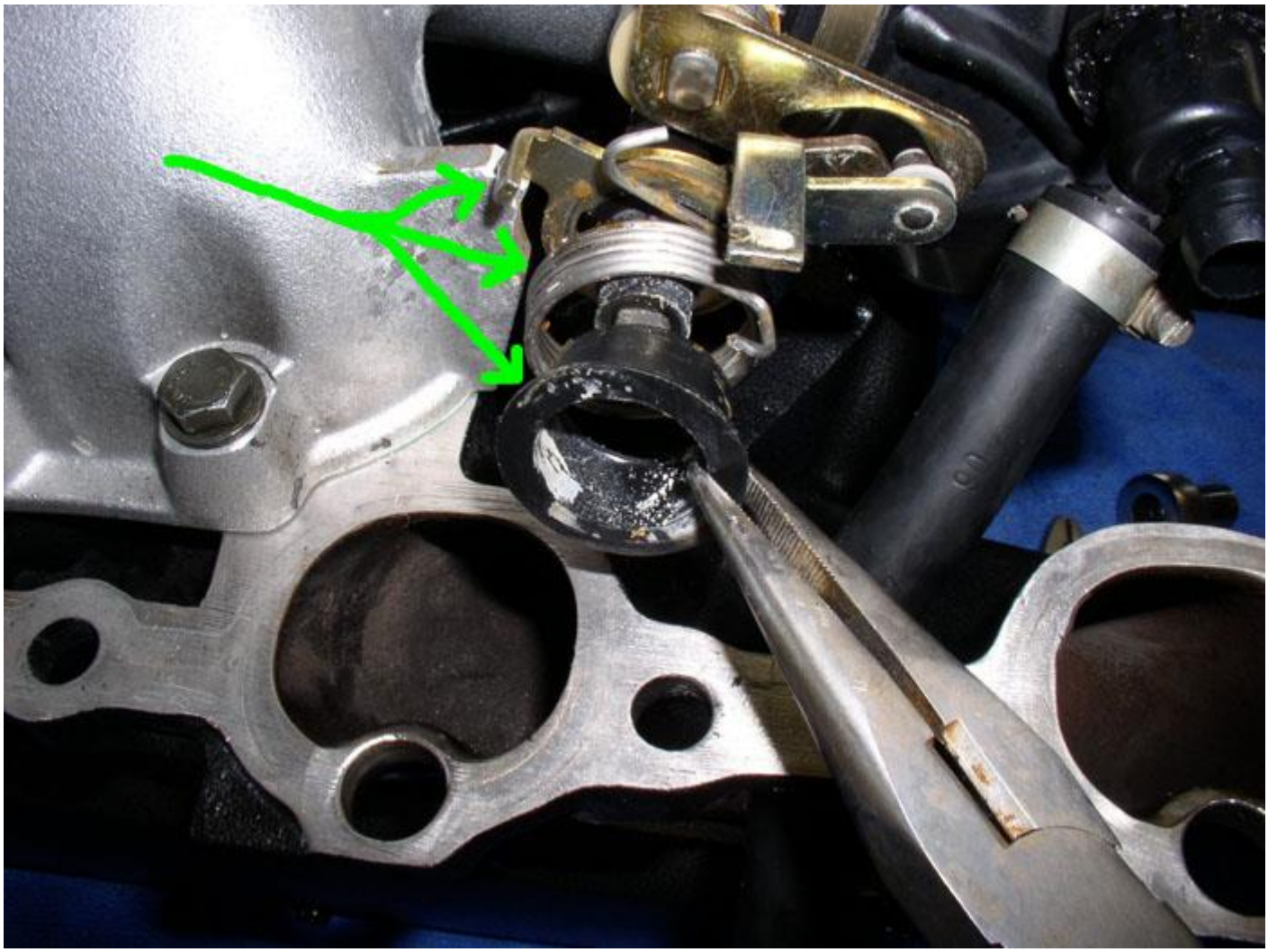

Then remove the inner spring catch using pliers as shown.



Grab the inner spring with pliers and rotate slightly clockwise to release the catch at the other end and pull out the spring.



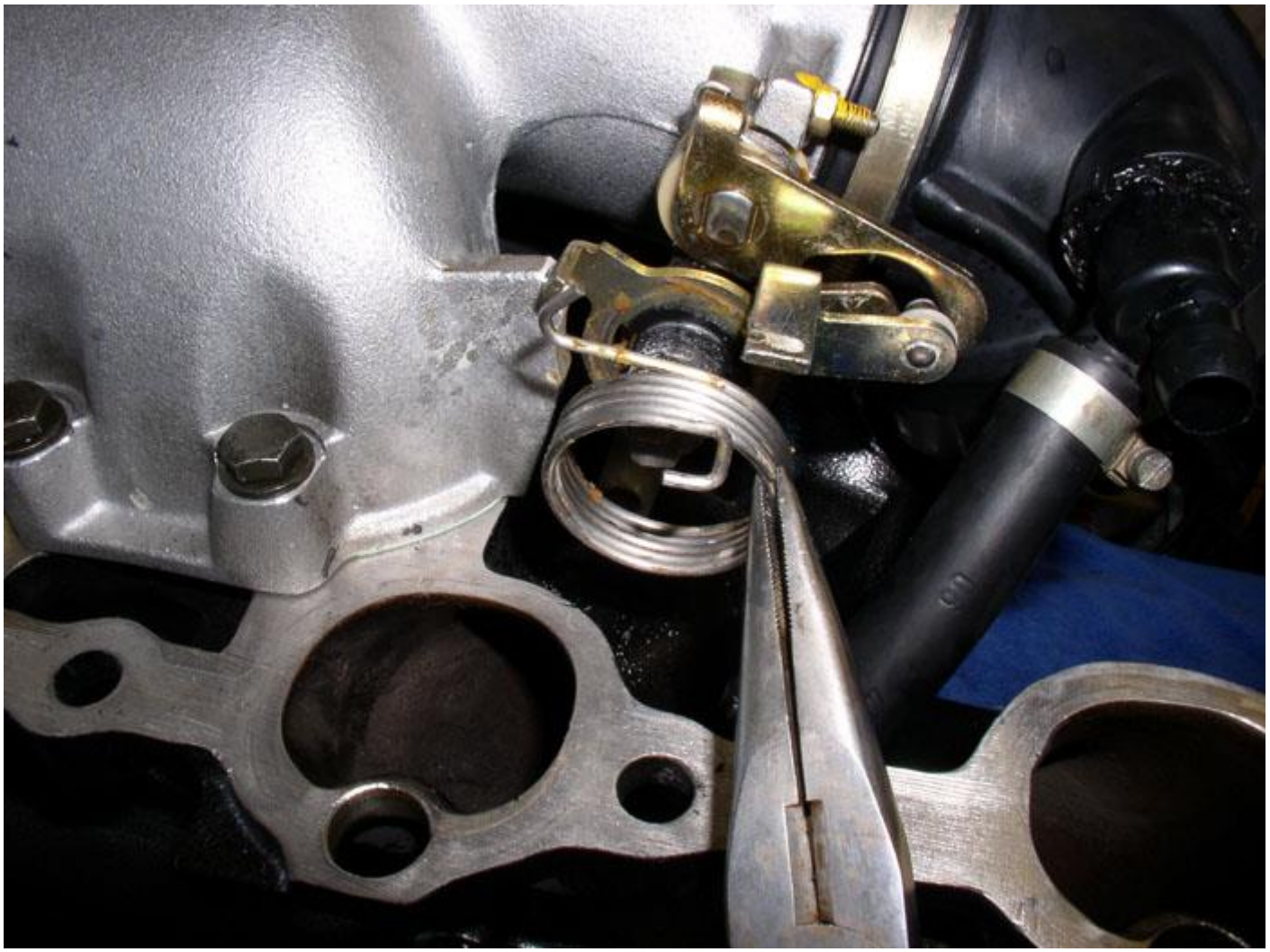
The next assembly should be one piece indicated by the arrows - metal plate, outer spring, and plastic spring carrier. My plastic spring carrier was broke and separated from the metal plate. If yours is still intact, all three of these pieces may come off as a unit. If it's broke like mine, remove them individually starting with the plastic spring carrier as shown.



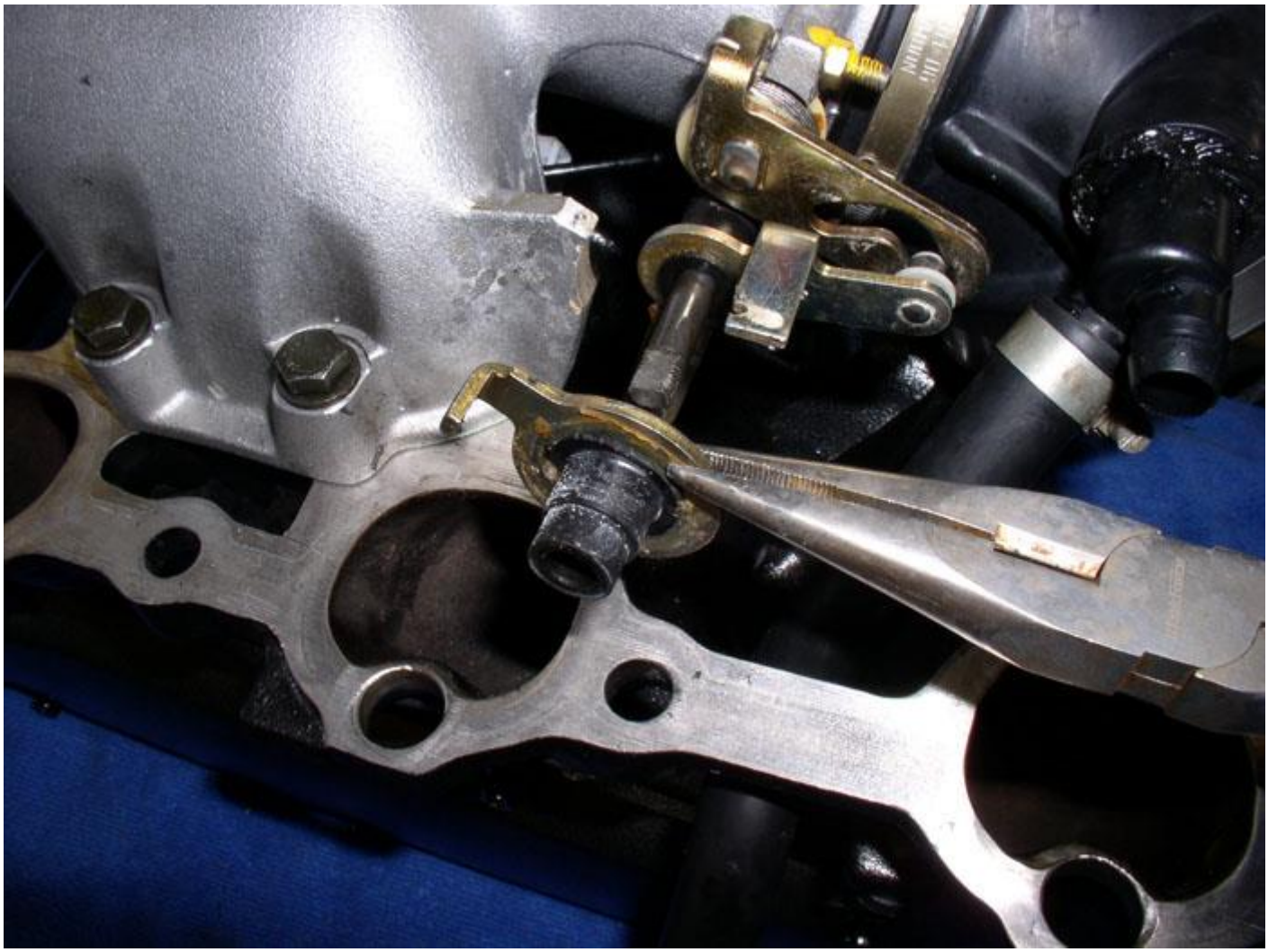
This is what the correctly functioning (i.e., not broke) unit should look like (minus the outer spring).



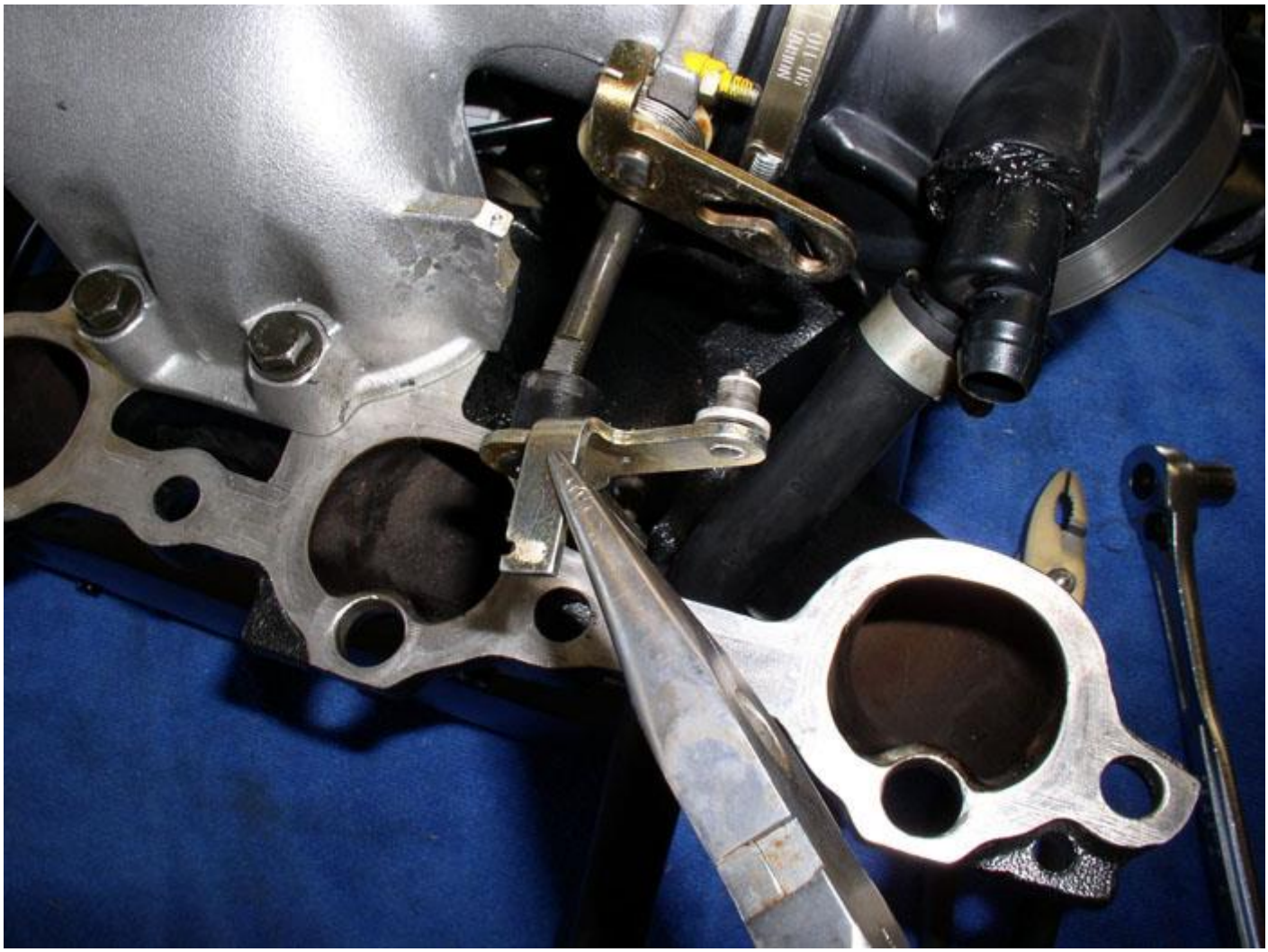
Remove the outer spring....



...And the metal plate.



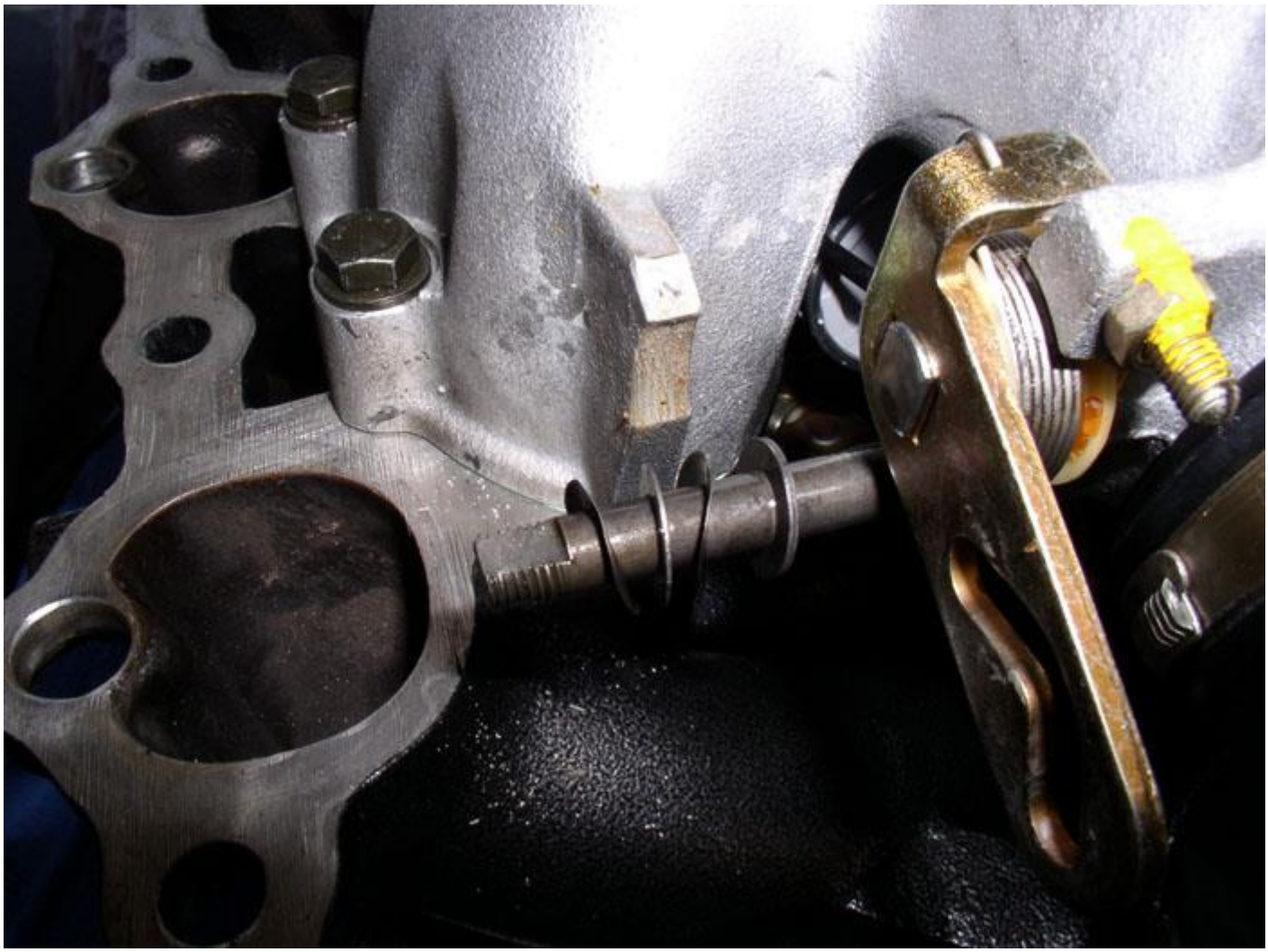
Remove the throttle cable lever arm.



Note the lever arm has a small plastic bushing that rides inside the throttle plate arm. Keep track of this piece and be carefull not to loose it. I kept it on the lever arm the whole time.



Remove the 4 washers on the spring shaft. Note the order as shown. There are two spring washers and two flat washers.

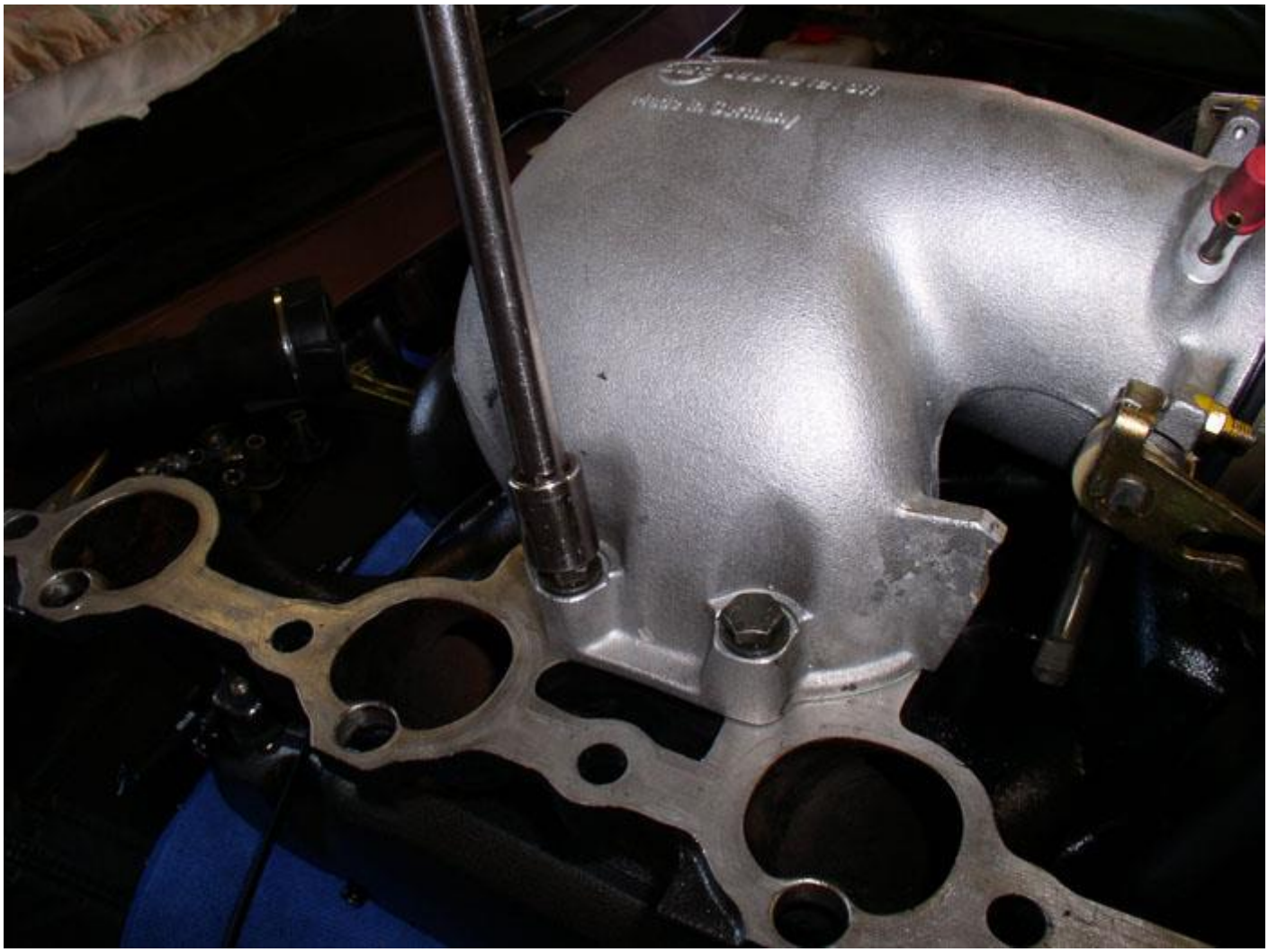


Here's the order of the parts that were taken off. Also note that item 5 and 7 were originally one piece with the spring (item 6) mounted on the plastic carrier. Also note the arrows on 5 and 7. The plastic spring carrier (#5) has a small notch in it that mates up to the small opening on the metal plate it's supposed to be attached to (#7). The notch and the opening are for the inner spring (item #4) to hook to. We

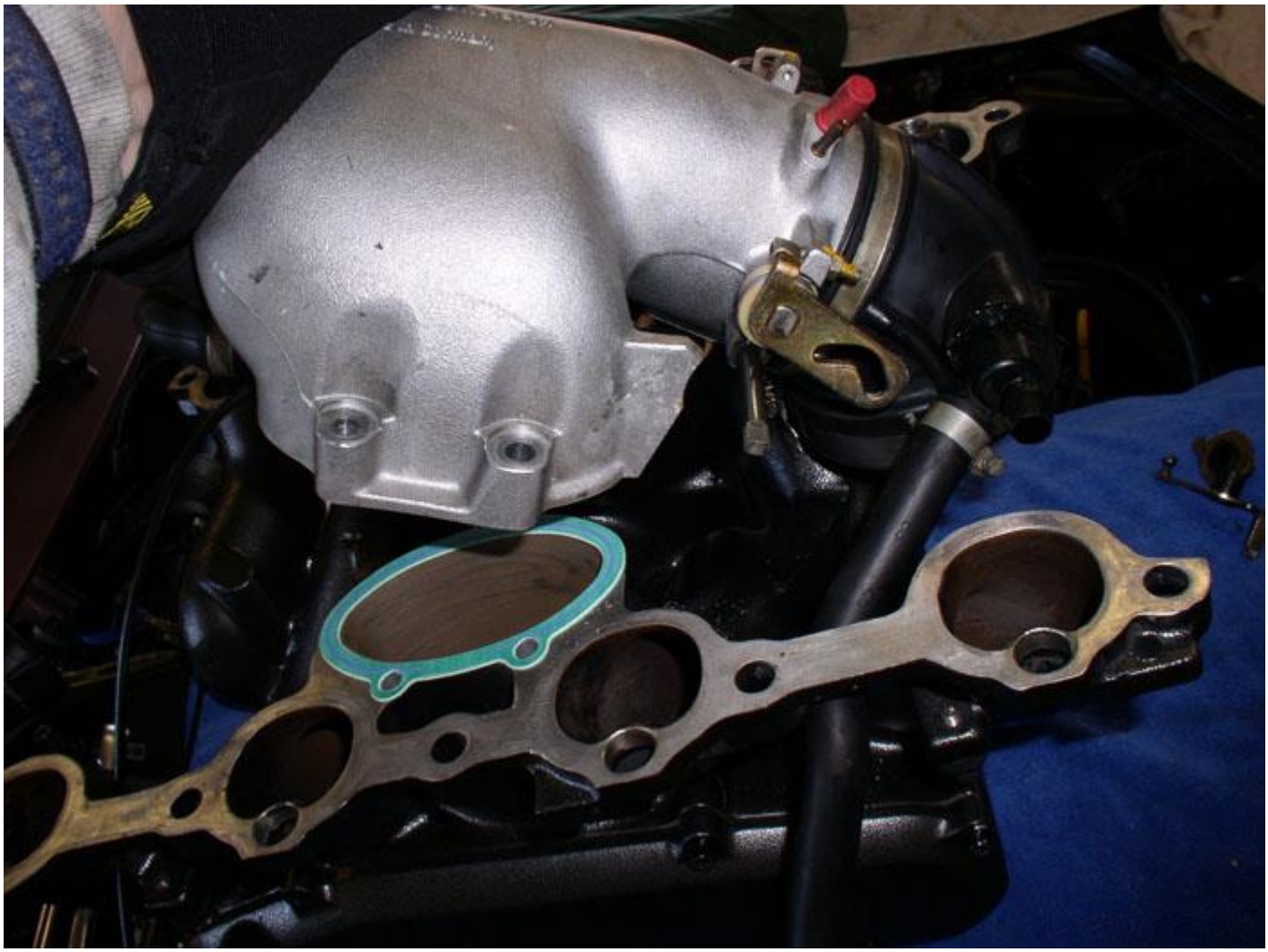


'll look at this more closely upon re-assembly.

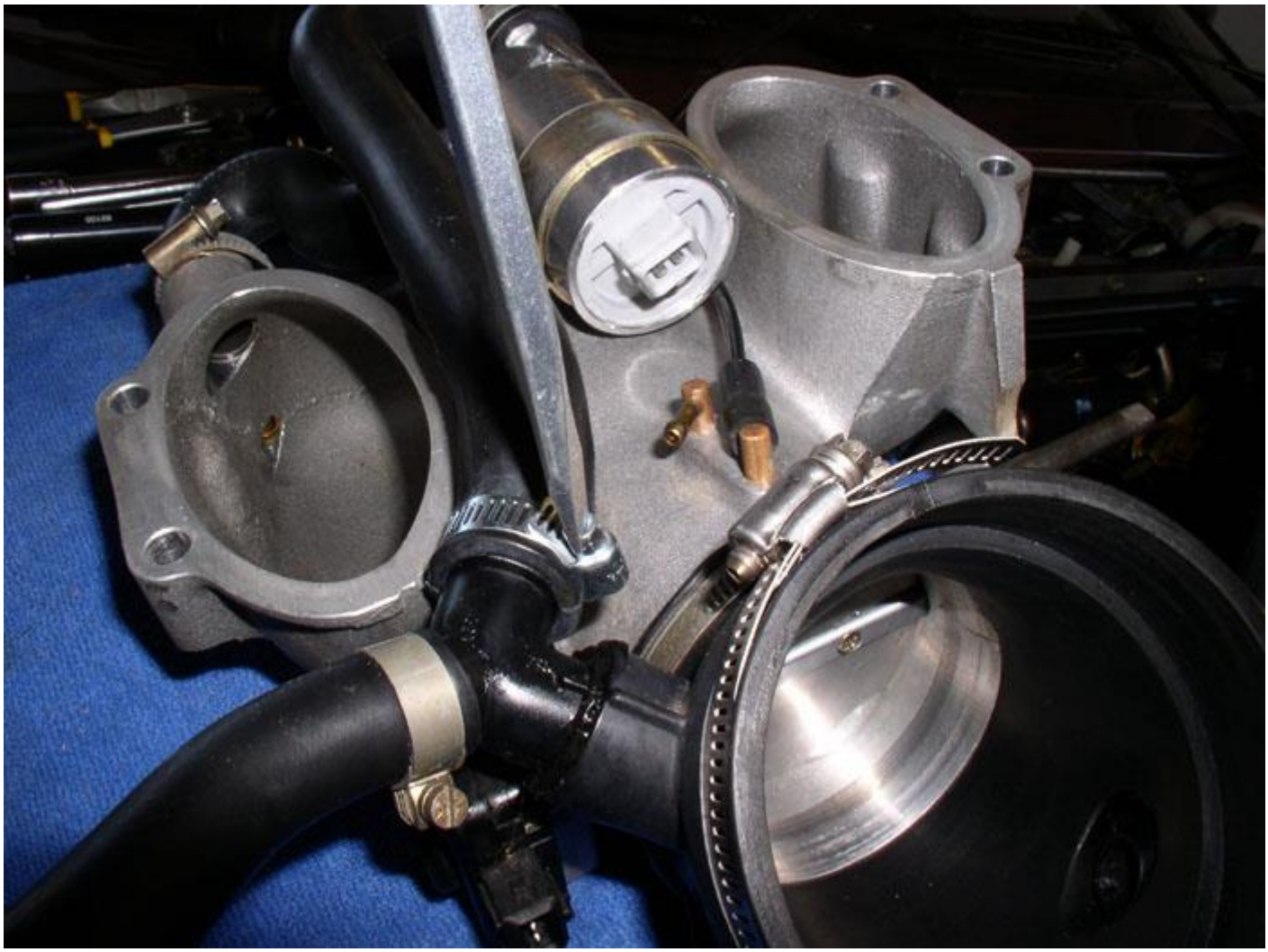
If you haven't already separated the Throttle Body from the intake, now's the time to do it. Remove the four 13mm bolts that hold the Throttle Body to the Intake (2 on each side)



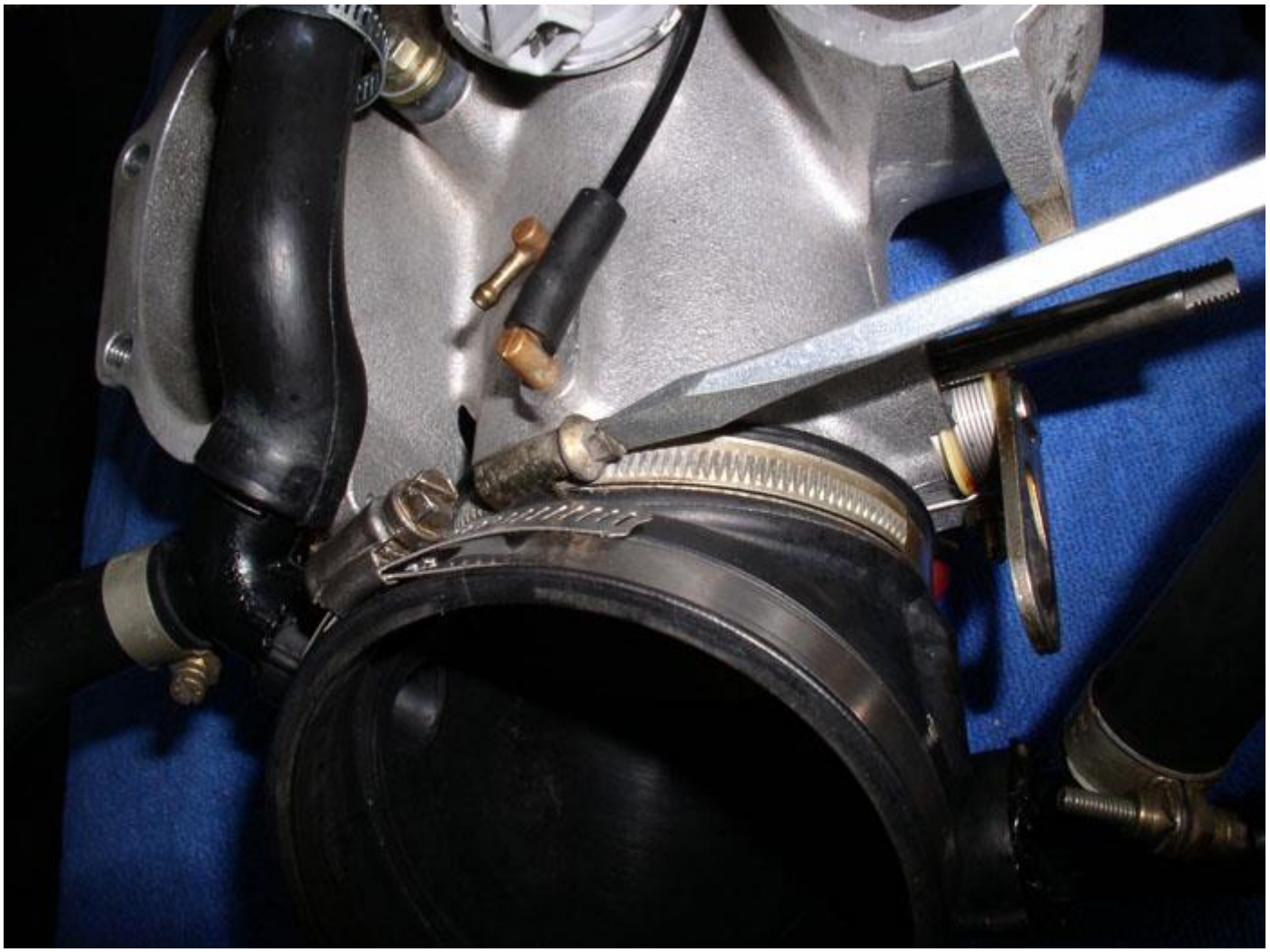
Remove the intake, guiding any hoses still attached through the intake runners.



Loosen the clamp on the ISV intake hose at the Air Guide Cowl. Disconnect the hose.



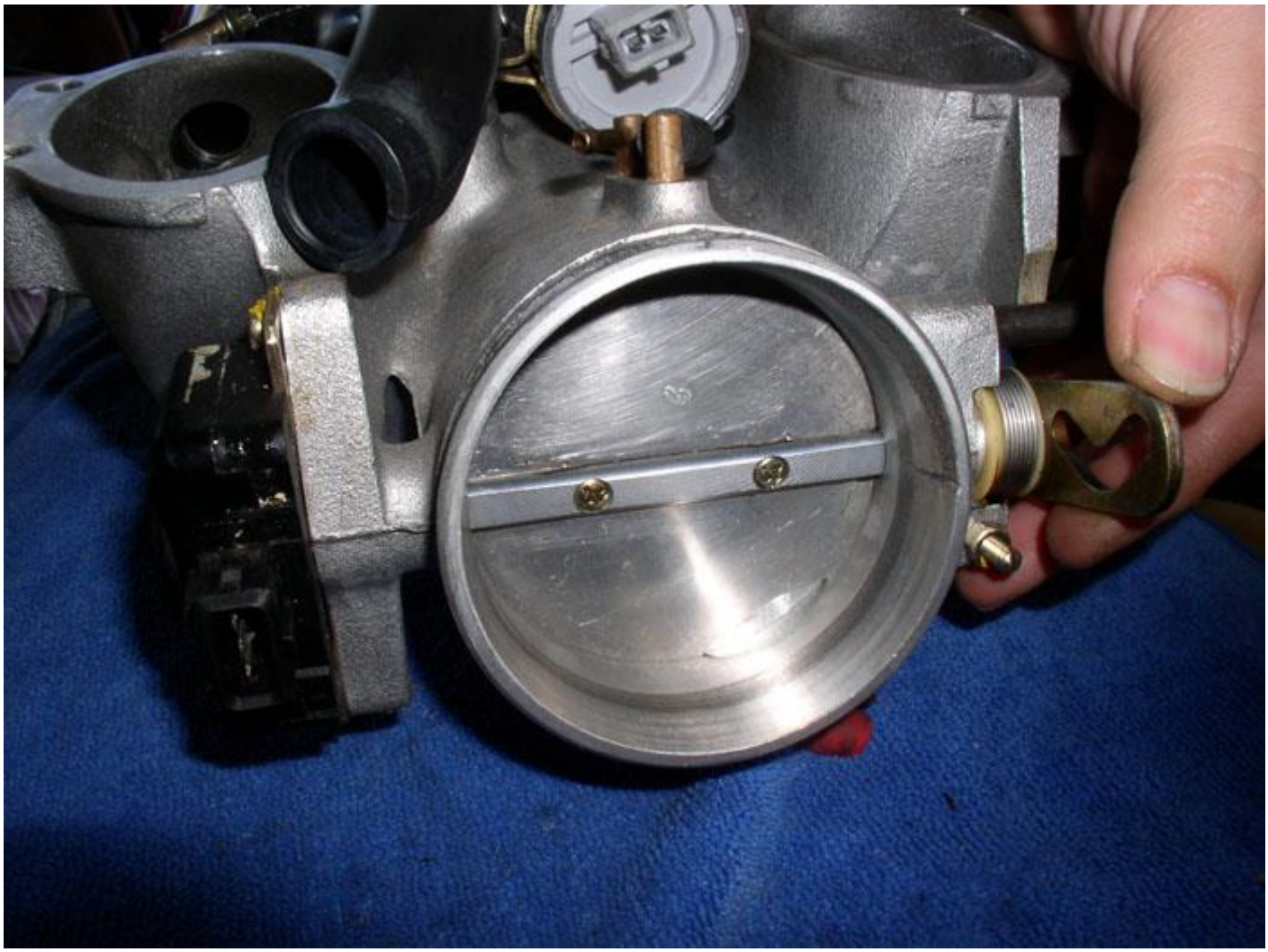
Loosen the Air Guide Cowl clamp at the Throttle Body.



Remove the Air Guide Cowl from the Throttle Body.



Check the operation of the throttle plate and Throttle Position Sensor. Note any sticking or scraping - it should operate smoothly. Listen for the "click" of the Throttle Position Sensor as you begin opening the throttle plate. Make note of when the "click" occurs. It should click at about 1 degree of movement of the throttle plate. The "click" is the Idle contact functioning in the TPS - letting the EZK and LH know when the car is no longer idling and to use a different fuel/injector map. If everything checks out ok, you'll have a baseline of how it should operate when you put it back together. Many times I have taken something apart without noting how it operated before and when I put it back together, I wasn't sure if it was operating better or worse than before the repair. So, now I baseline.



Remove the throttle plate by first removing the 2 phillips screws that attach it to the throttle plate shaft.



Rotate the throttle plate shaft 90 degrees and pull the throttle plate out. Notice the edges of the plate are camfered. You will want to make note of the orientation of the plate as you pull it out in order to get the camfers correct when you re-install the plate later. The easy way to do this is to note that there is a recessed arc cut into the front of the plate (look at the bottom half of the front of the plate). Simply ensure this arc is facing forward and at the bottom when you re-install the plate.



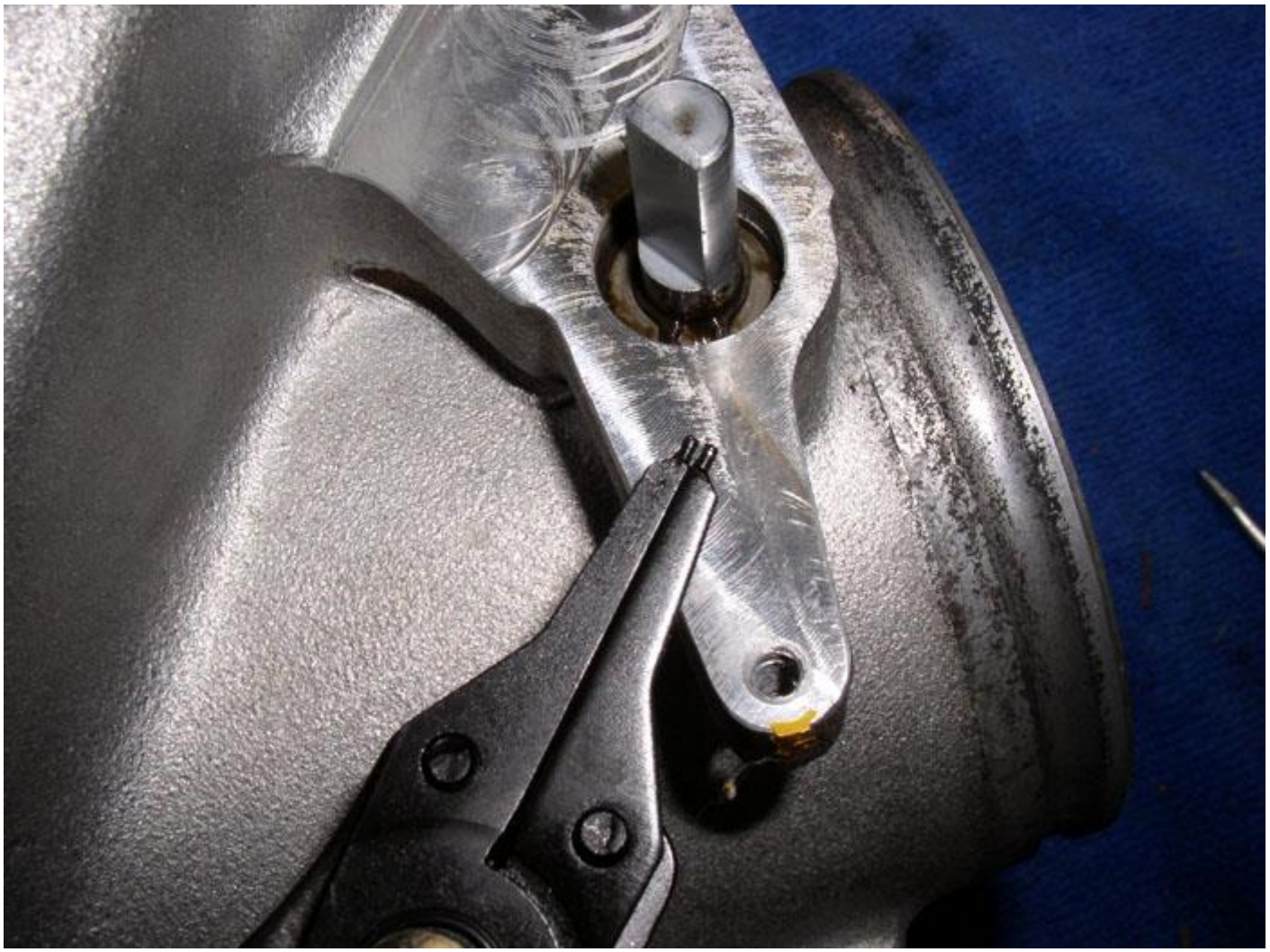
Next, remove the TPS by first removing the 2 phillips screws that secure it to the throttle body. Before you remove the screws, note the general orientation of the TPS on the throttle body. The mounting tab on the TPS is slotted so it can be adjusted to get the 1 degree of deflection on on the throttle plate before breaking idle contact just right. By noting the general orientation, on removal, you can get the TPS "close" to it's original location on re-install and simply fine tune the orientation from there. We'll discuss this when it's re-installed.



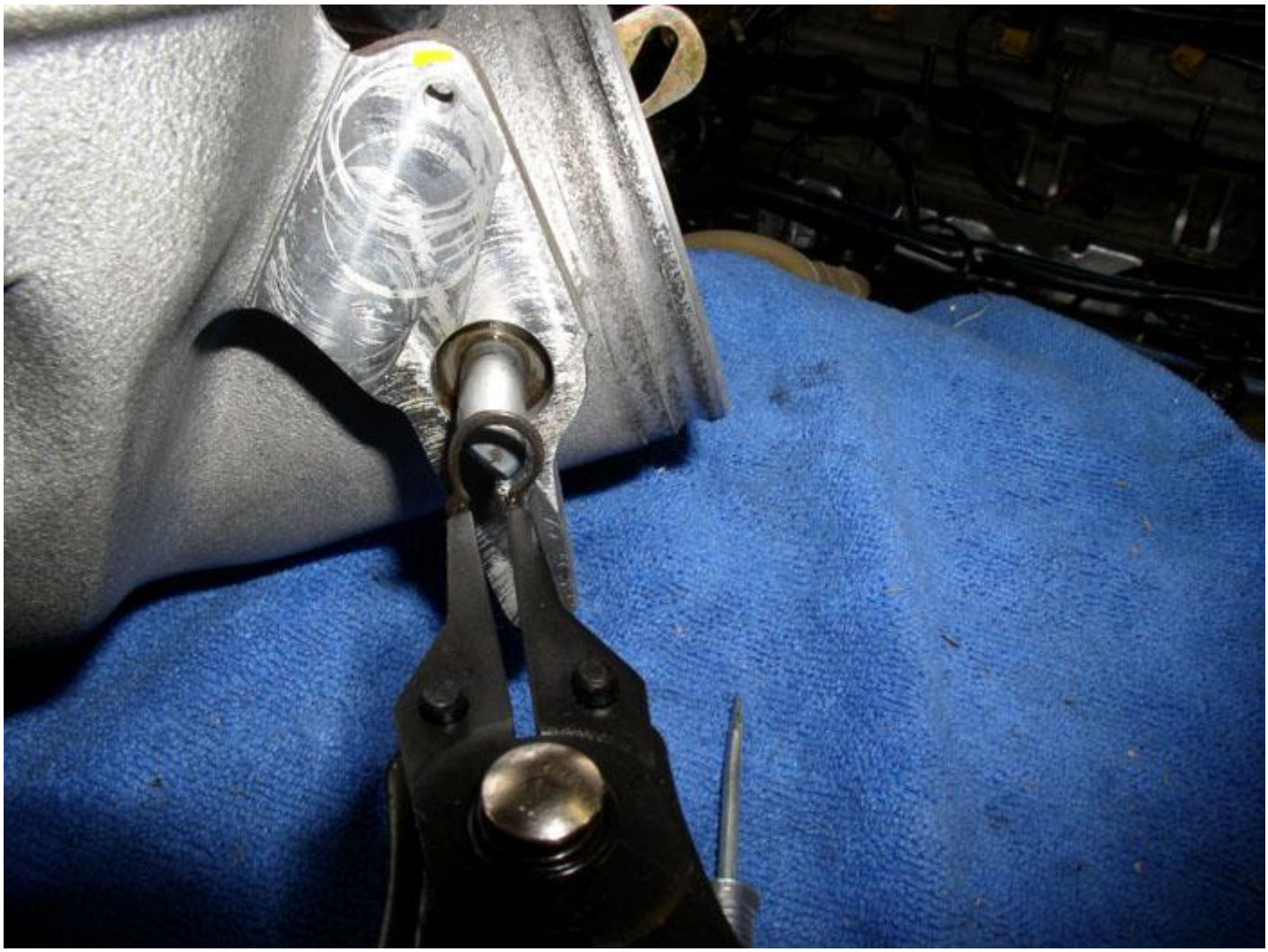
Remove the TPS by pulling out away from the throttle body.



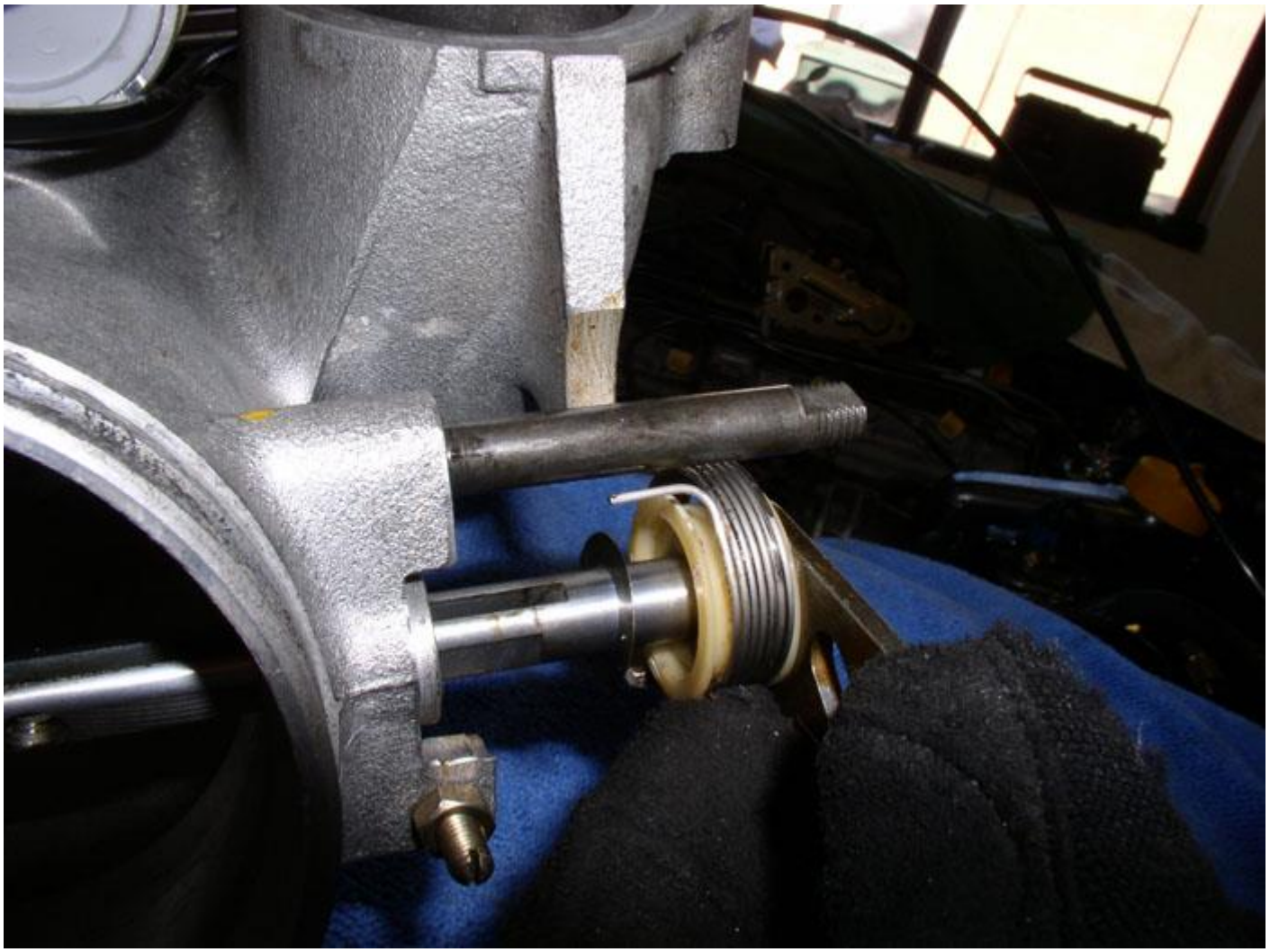
Next, remove the small circlip that holds the throttle plate shaft in place. Use an appropriately sized circlip pliers.
I had to use my smallest set.



The circlip is thin and can be damaged if stretched too much so be careful on removal. It doesn't seem to be the same kind of spring metal I find on other circlips - (maybe because it's so small). I found that it was slightly distorted/stretched upon removal but when I re-installed it, I could bend it back into shape with no problem.



Now you can remove the throttle plate shaft by simply pulling it out as shown.



After you have the shaft out, note the order of the plastic washers, metal washers and spring as shown (in case you want to disassemble and clean). Here's the order....



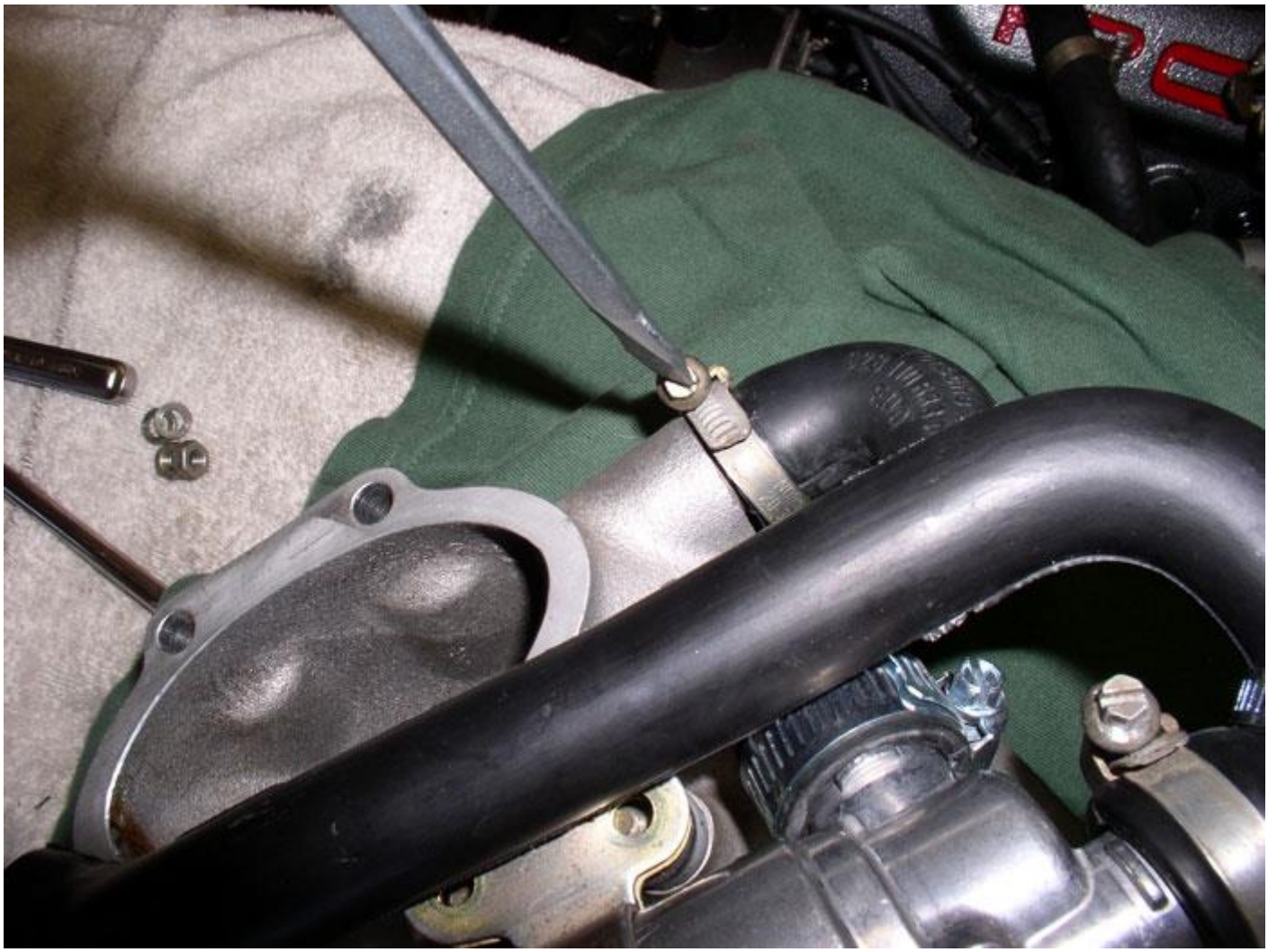
Under the circlip (on the TPS side), remove the flat washer that sits on top of the bearing.



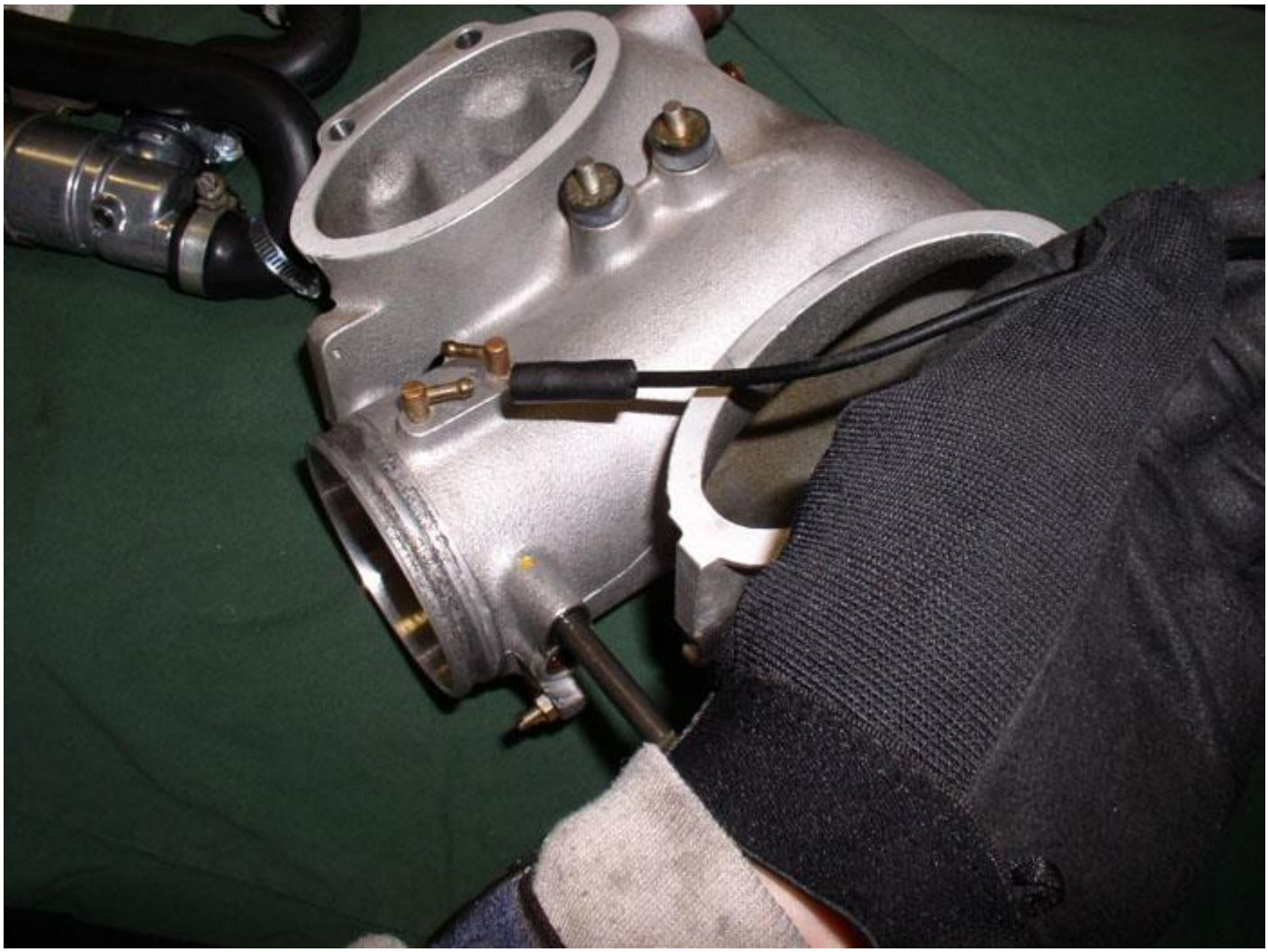
Next, remove the ISV from the throttle body. Begin by removing the two 10mm nuts that secure the ISV bracket to the throttle body.



Then, loosen the clamp at the ISV supply hose at the throttle body. Disconnect the hose and remove the ISV and hoses attached.



Now, remove the two vacuum hoses. The short vacuum line goes to the 7-port vacuum manifold at the rear of the engine. The long line goes to the fuel vent diaphram on the passenger fender wall by the coolant reservior. Short line goes on the rear port, long line on the front port.



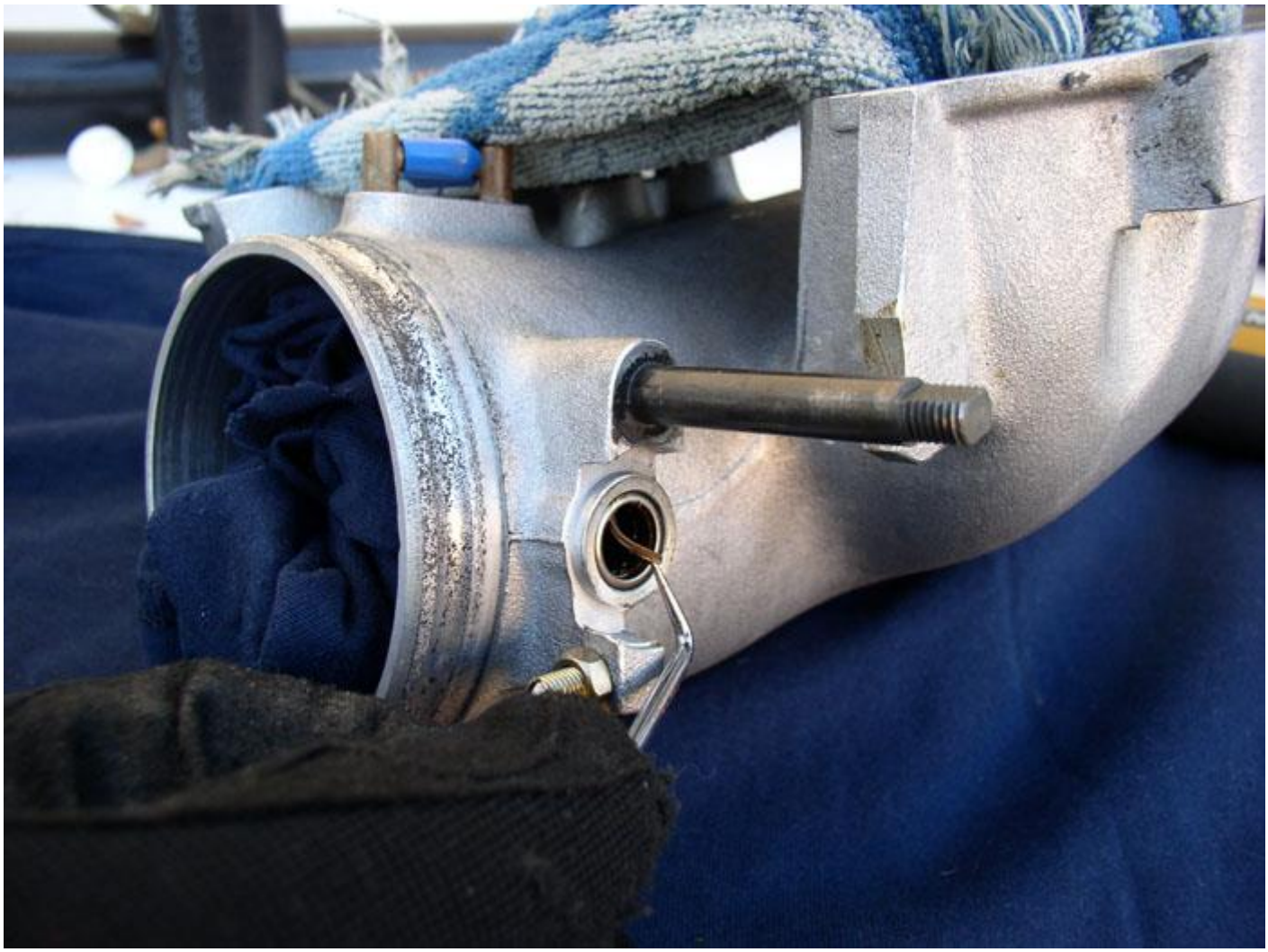
Stuff the throttle plate opening with a clean rag to minimize metal filings from getting into the throttle body.



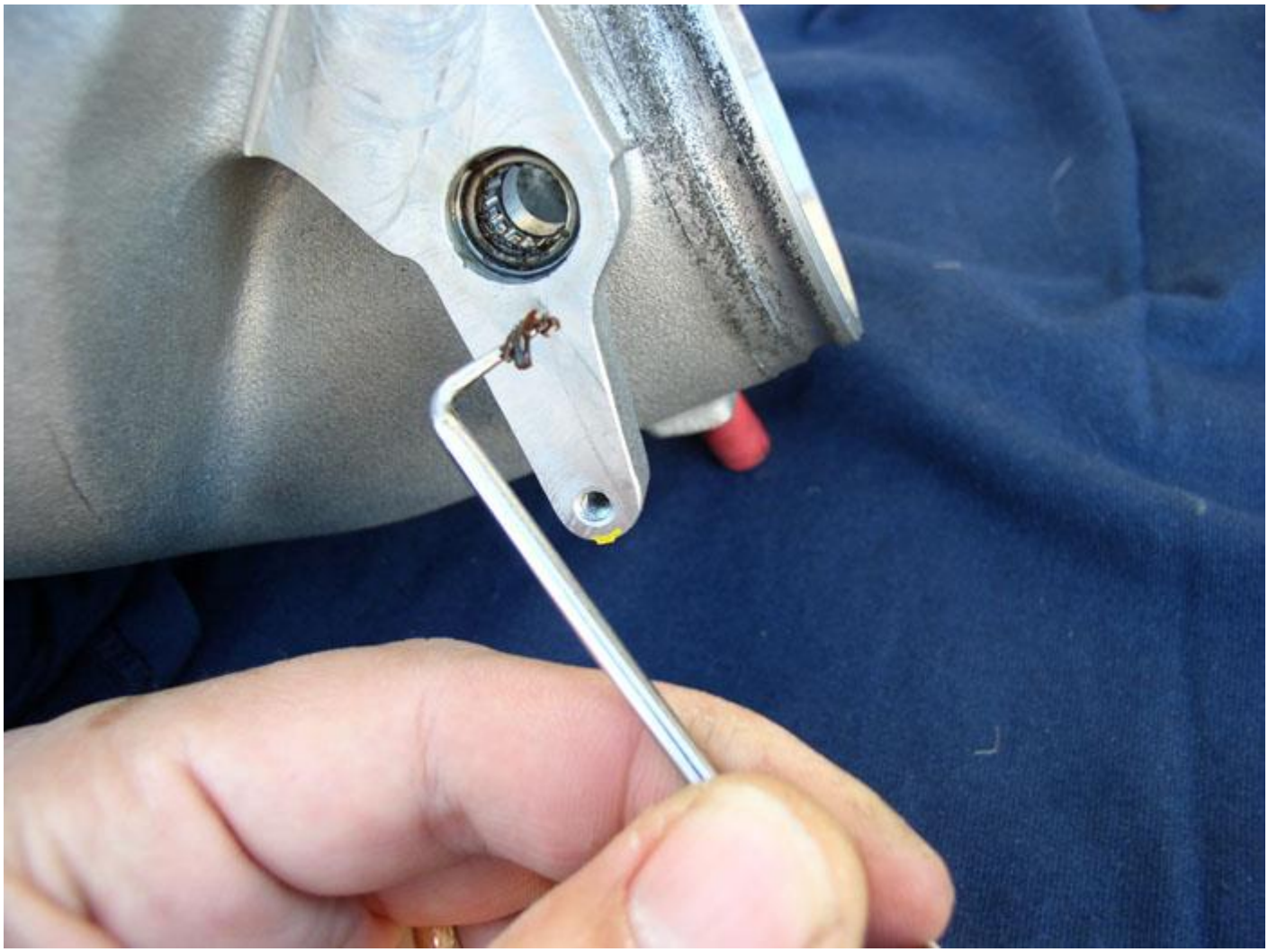
Stuff the intake ports on the throttle body with a clean towel for the same reasons. Cap the vacuum ports with vacuum plugs.



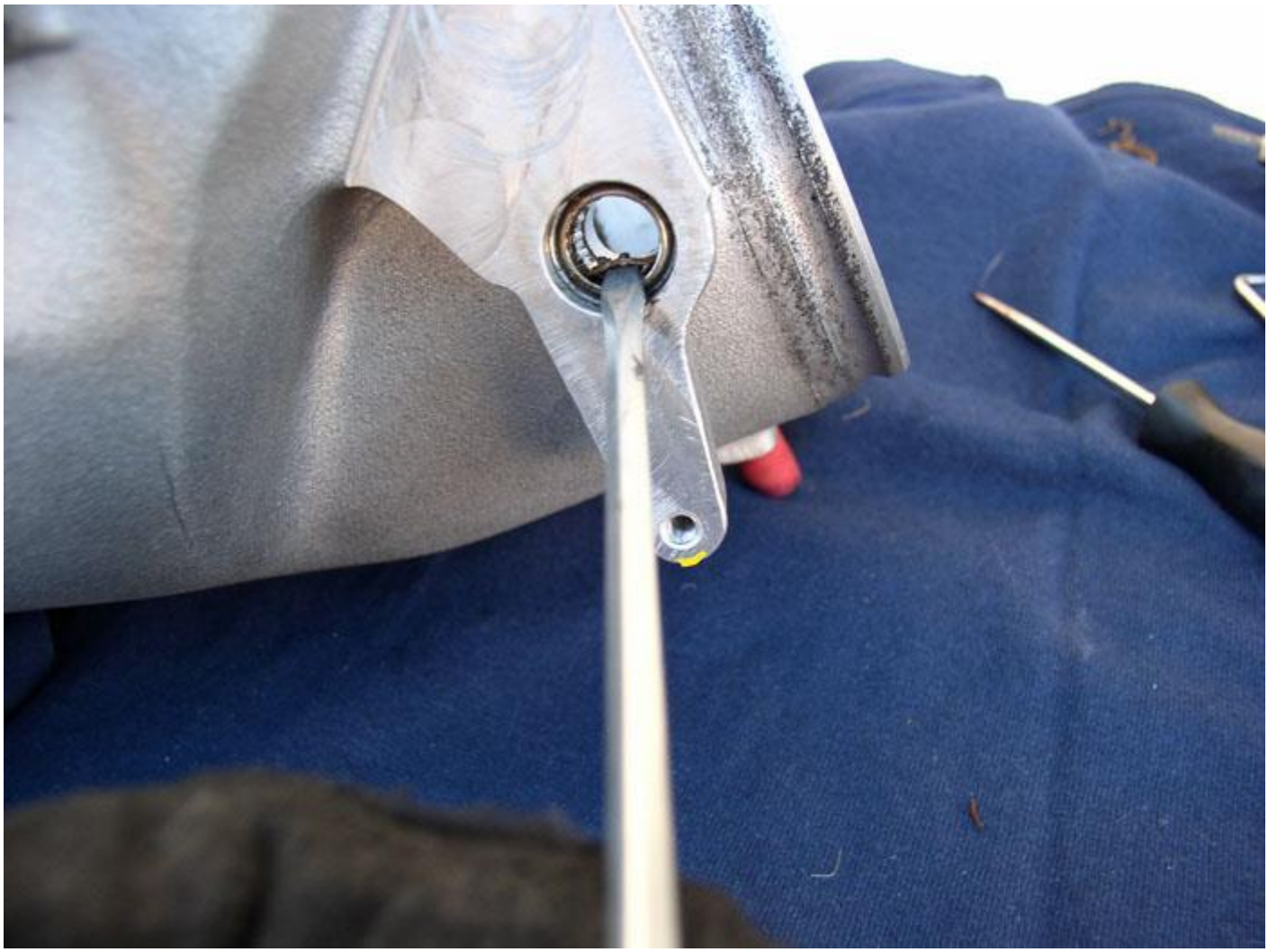
You can use a small pick tool to pick out the old shaft seal from the bearing housings. The linkage side seal was so thin, it didn't seem to be doing much good.



The TPS side shaft seal had disintegrated into small bits.



Use a flat blade screwdriver (thin blade) to pry up the needle bearing cage.



Then extract the needle bearing cage with a pair of needle nose pliers - how appropriate!



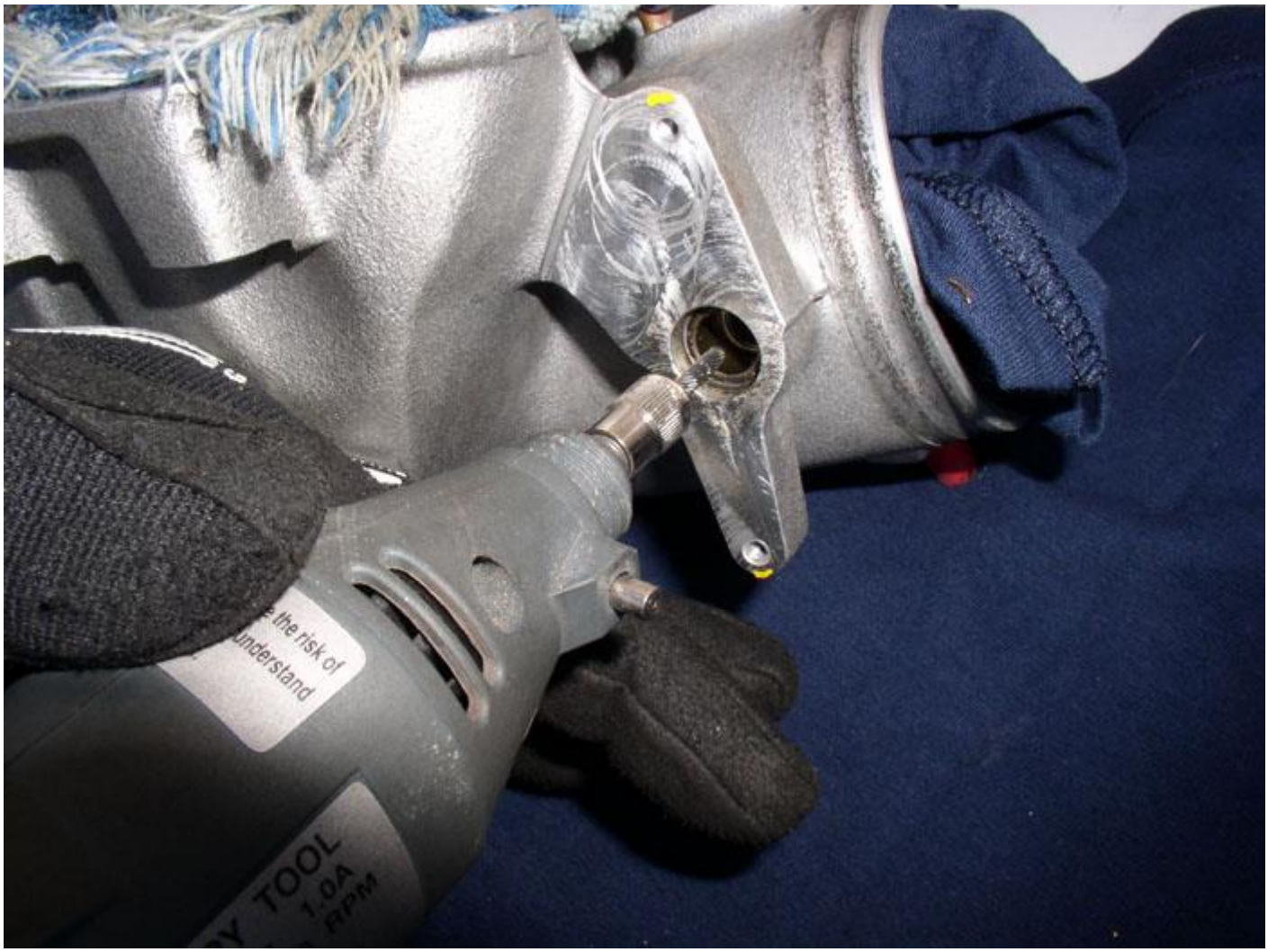
Now it's time to take a break and have some fun - you deserve it! Collect your needle bearings, grab your magnetic pick up tool and see how many needle bearings you can stack end to end. My record is 6!




Now, back to work! We'll be using Schocki's favorite tool of choice for bearing cutting - the Dremel 9901 Tungsten Carbide Cutter! Also pictured are the double sealed bearings available from Roger - same bearings that fit the flappy valve shaft.




At this point, the bearing shell is all that is left to remove. Use the dremel with 9901 bit to cut through the bearing shell. It took me a little practice but after a few bearing removals, it's pretty easy. Insert the bit so that it hits the bottom (i.e., inside end) of the bearing casing and cut the full length of the bearing casing at the same time. Hold the bit level/parallel with the bearing casing so that you cut uniformly across the shell. It doesn't take long before you cut through the casing. If you're a newbie like me, use light pressure and remove the bit often while cutting to check your progress.




You will know you are close or done when you see the color of the metal casing change to a bright silver, that's the throttle body aluminum. Use light pressure on the dremel when you're getting close so as to minimize cutting into the aluminum of the bearing seat. On my latest bearing removals using this technique, the nick in the bearing seat is barely noticeable. Make sure you have a uniform strip of aluminum color down the length of the bearing casing. Then you can easily pry at the edges (near the cut) of the bearing casing with flat blade screwdriver to break the casing loose.



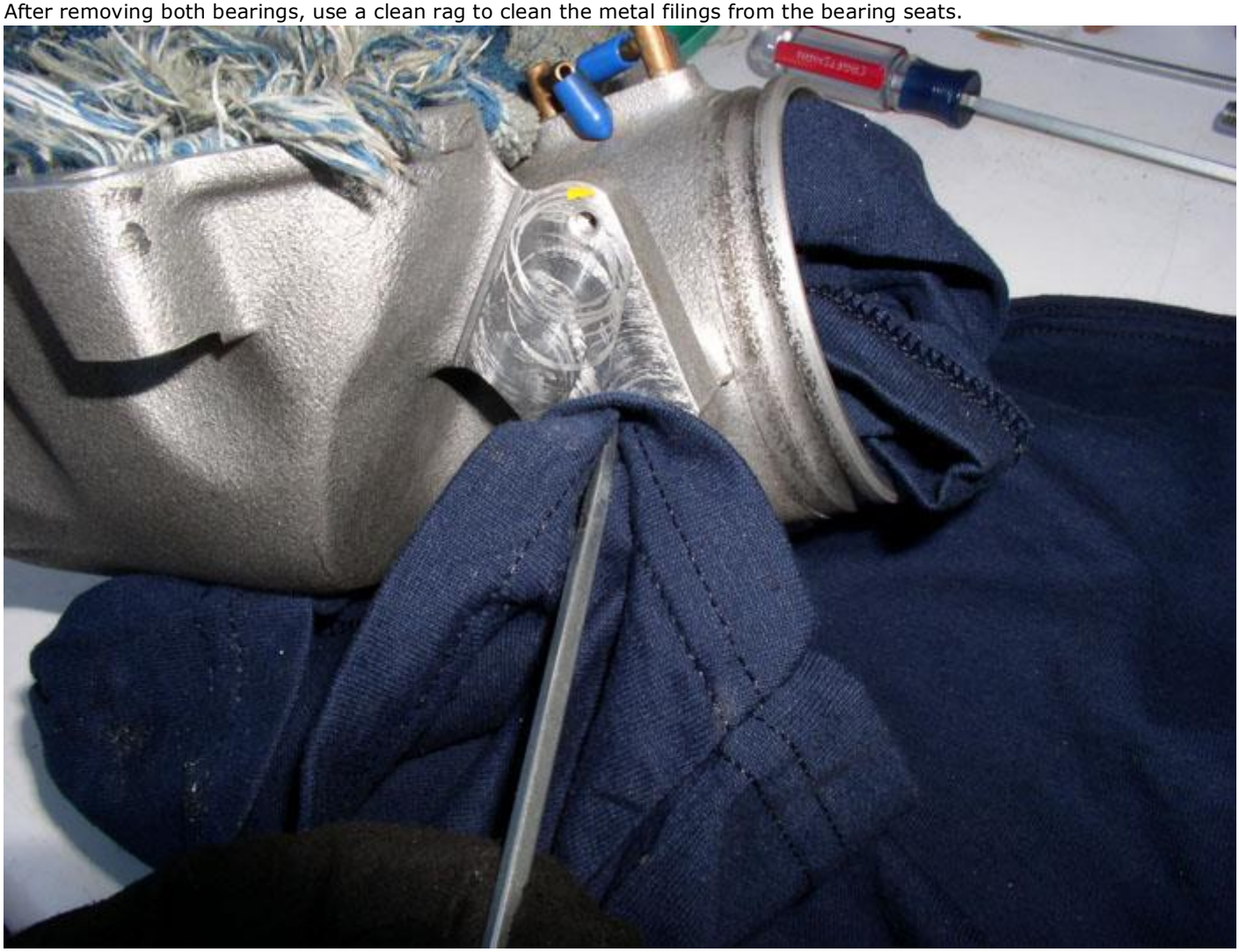
Then extract the cut casing with a pair of pliers.


WorkForce

Here's the old bearing casing next to the new bearing from Roger.



After removing both bearings, use a clean rag to clean the metal filings from the bearing seats.



A screwdriver can help to stuff the rag through and sea-saw the rag in the seat to clean the filings out.



Here's a nice easy way to install the bearings. Got to Home Depot or your favorite hardware store and pick up a 3/8" threaded rod in a 12" length. Disregard the silicone sealant in the picture, you won't be using it here.




Also pick up two 3/8" nuts and 2 washers. I think I paid about $3 for all this. BTW, you will be able to use the exact same hardware to install the flappy valve bearings in the intake.




Then, use some WD-40 to lubricate the bearing seat.




Place one nut and one washer on the threaded rod and then gently load one of the new bearings. Place the bearing on the rod so that the flat edge (bottom edge) of the bearing is facing the throttle body. The curved top edge of the bearing should be facing outward from the throttle body when fully seated. Be careful not to force the bearing on the threaded rod too hard as you may displace one of the seals.



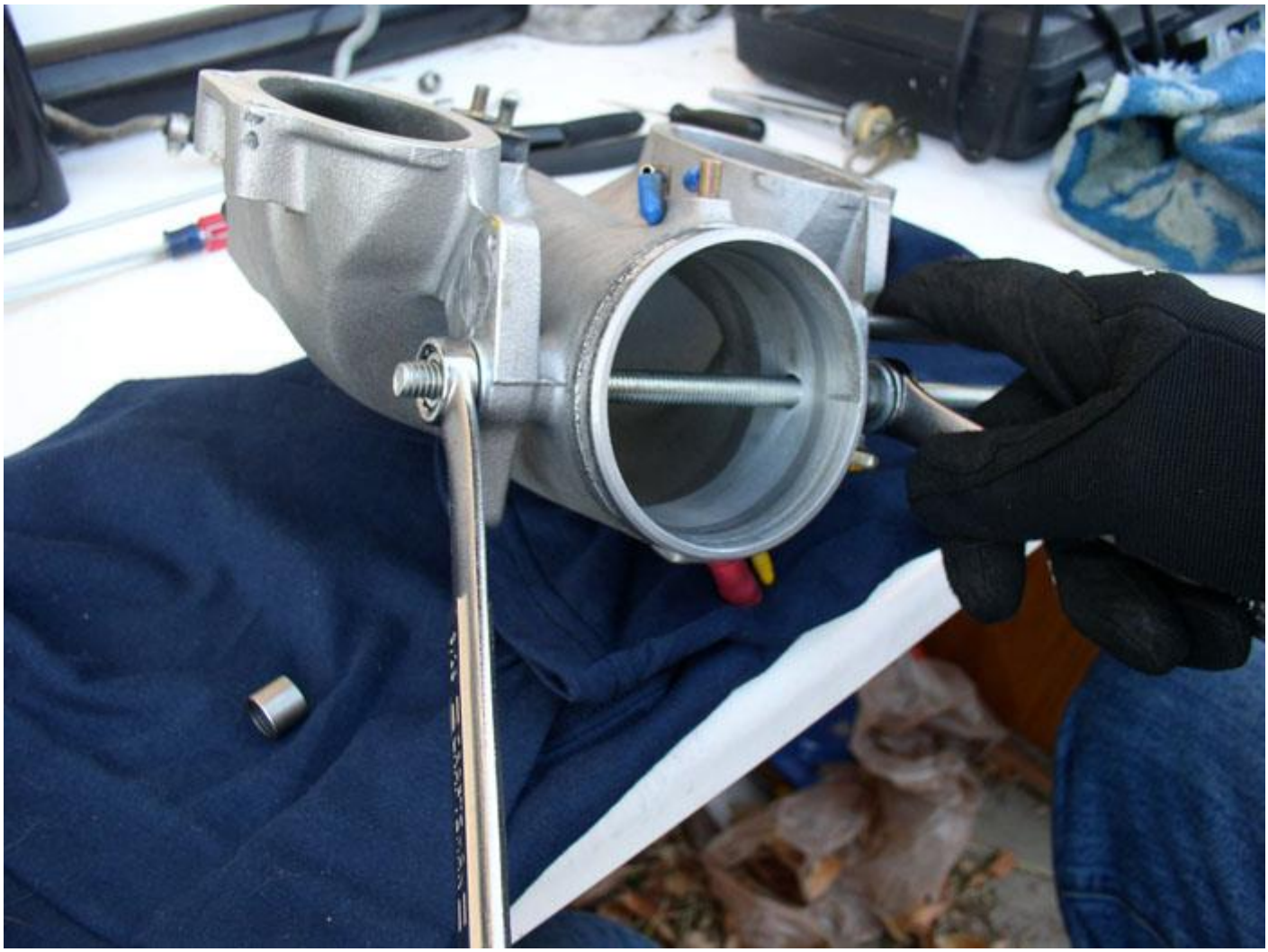
Next, slide the threaded rod throught the throttle body in the same manner as the plate shaft as shown below.



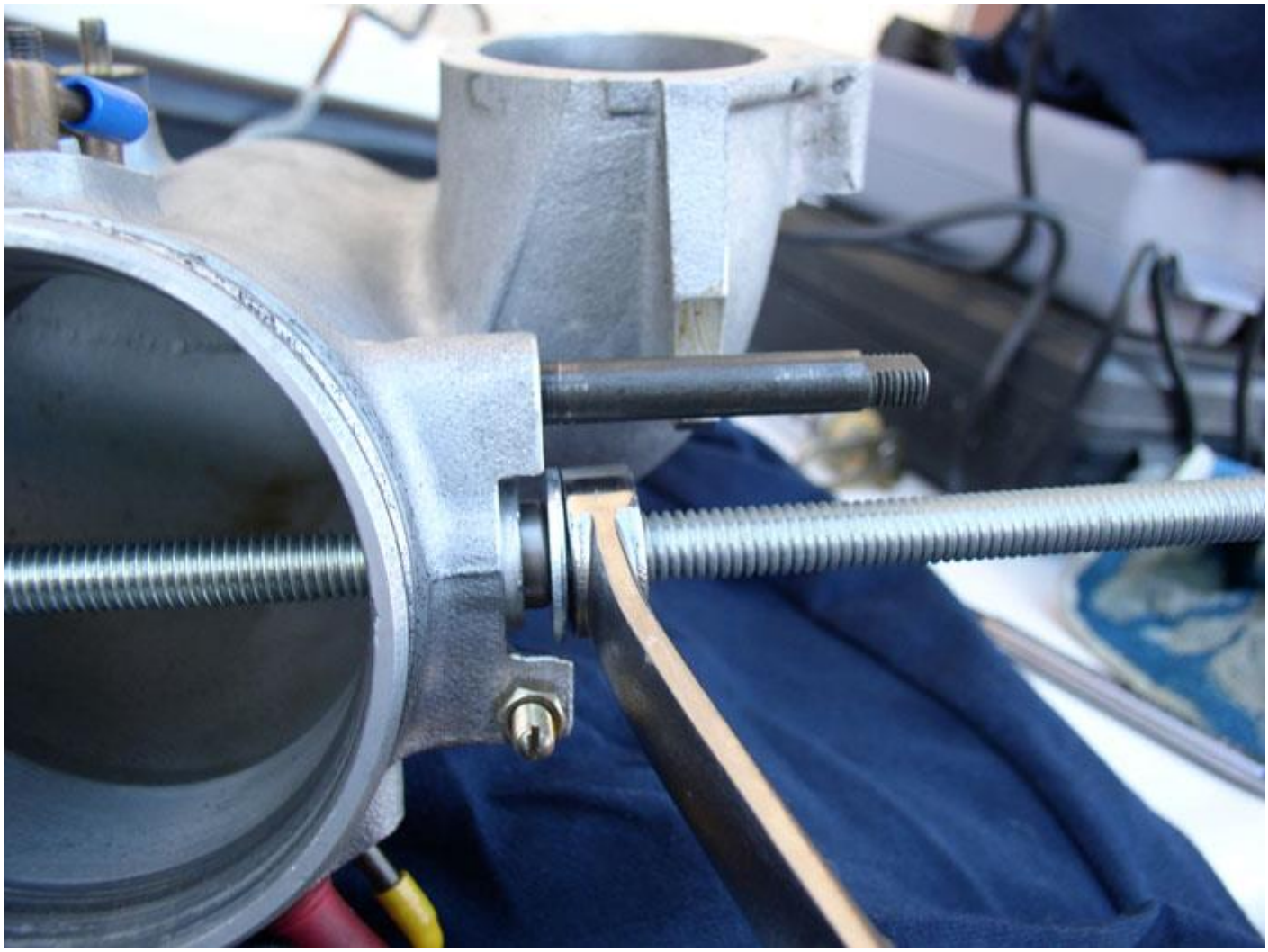
Attach the other washer and other nut to the threads on the other side of the threaded rod.



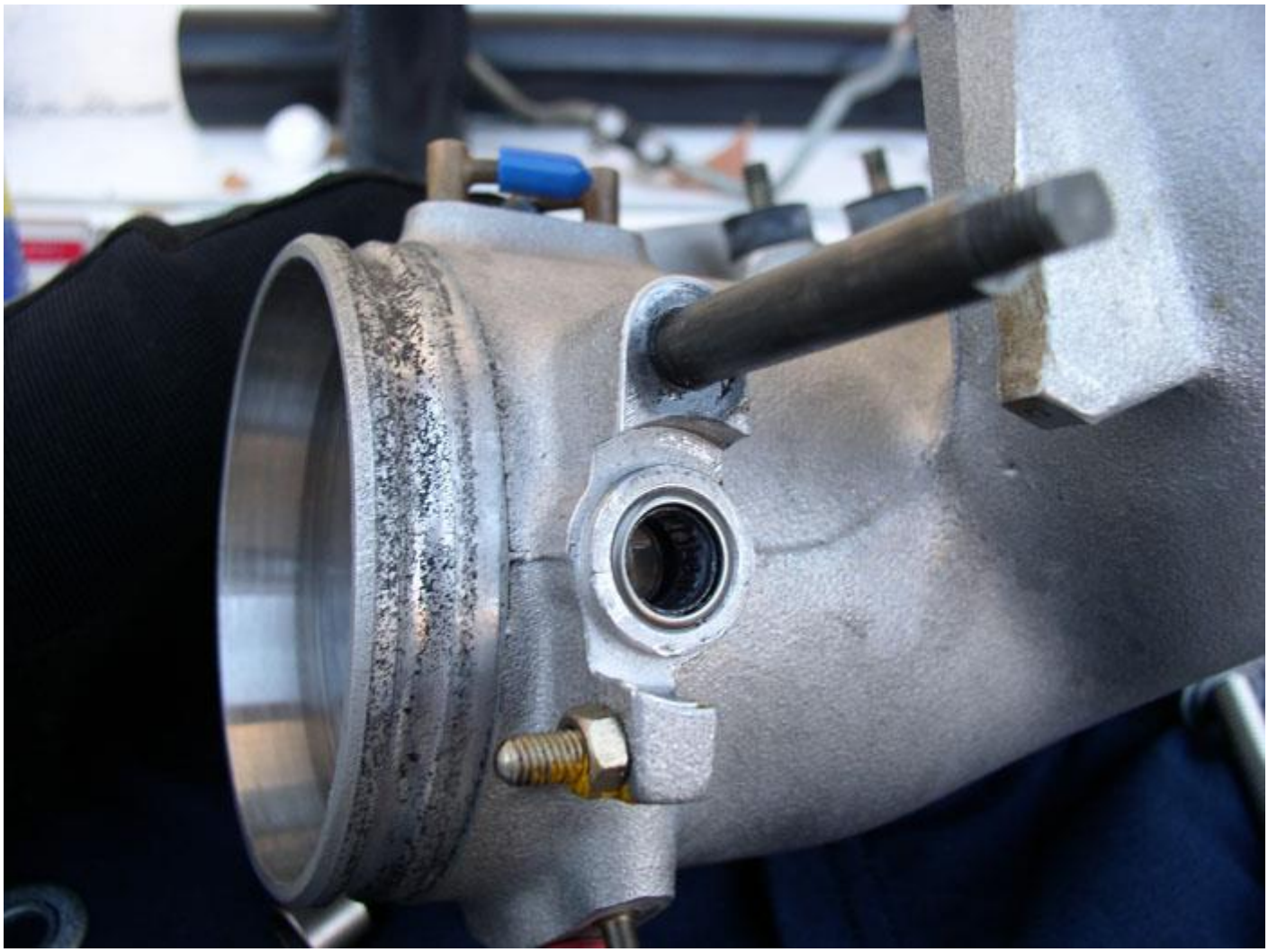
Use your choice of combination wrench or gear wrenchs on each nut to tighten down the bearing into the seat. The 3/8" rod fits well through the bearing and the bearing seats so that there is little opportunity for the bearing to get crosswise in the seat while tightening.



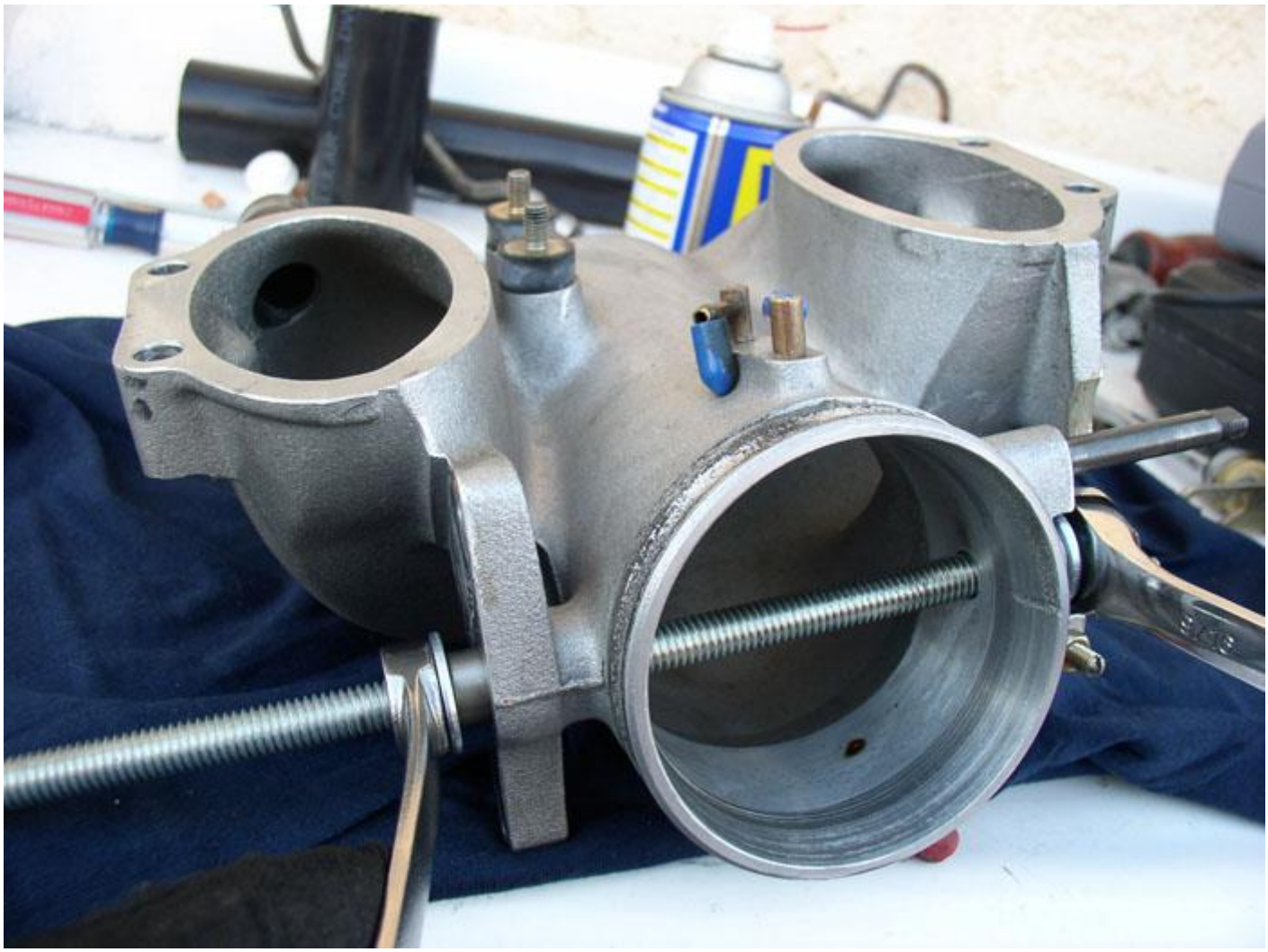
You should encounter little resistance while tightening the bearing into place.



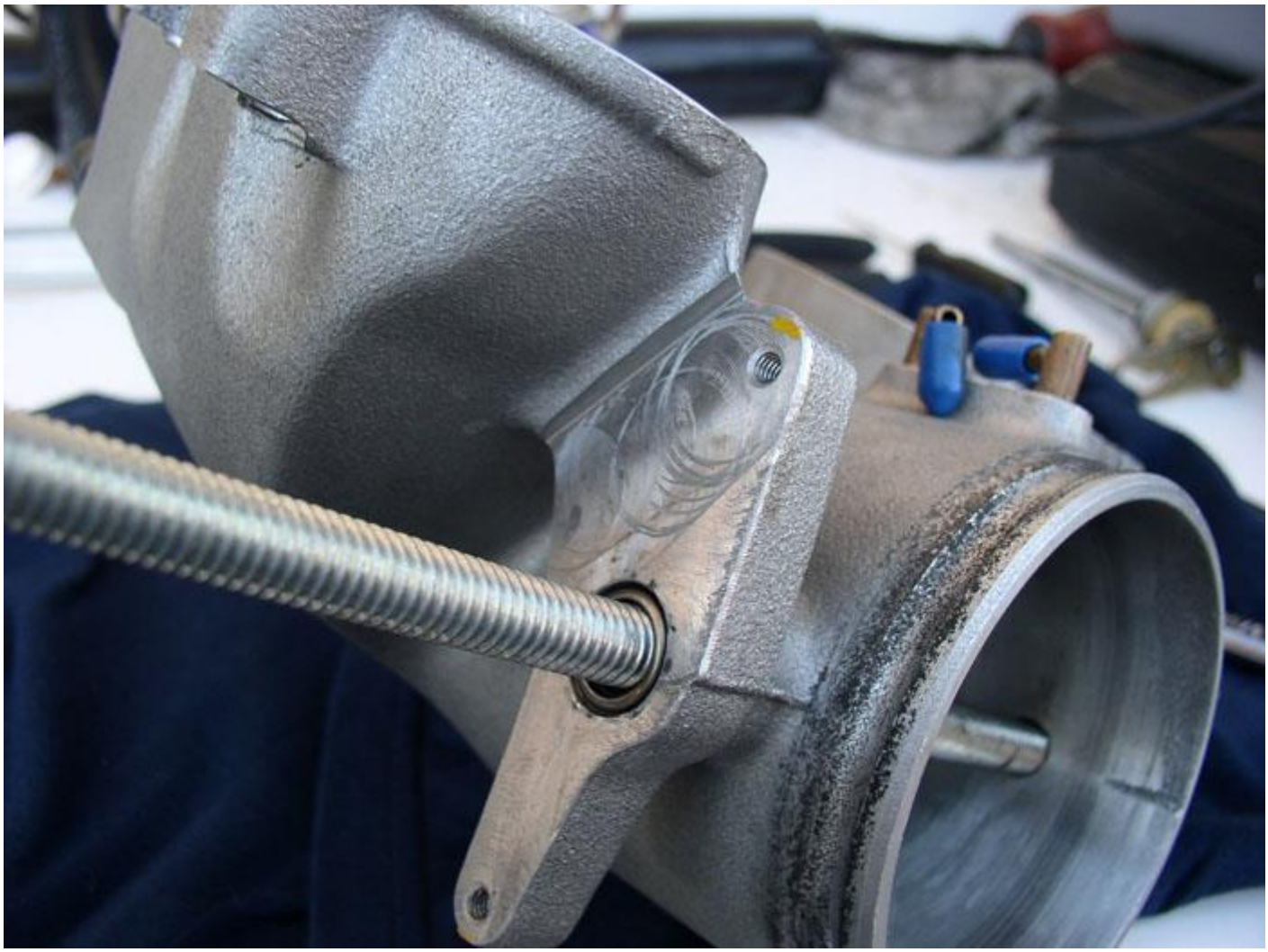
When you do encounter resistance, you have probably hit the bottom or seated the bearing flush against the throttle body. Stop tightening and take the nut and washer off. Then gently remove the threaded rod.



Next, set up the rod and bearing in the same manner for the TPS side of the throttle body. Tighten down the bearing...



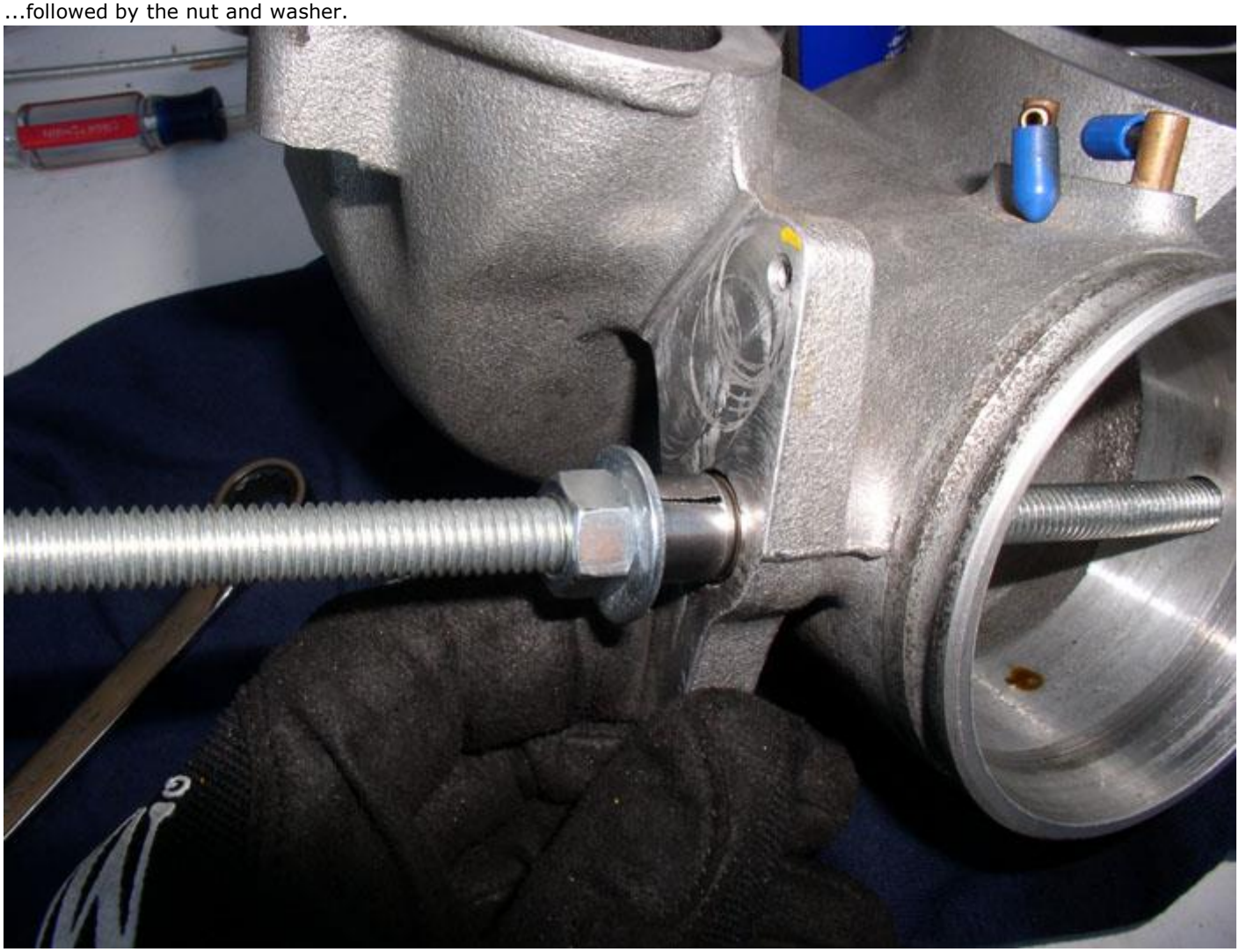
...until it is flush with the throttle body. Remove the nut and washer but keep the threaded rod in place. As you recall, the TPS side bearing is recessed.



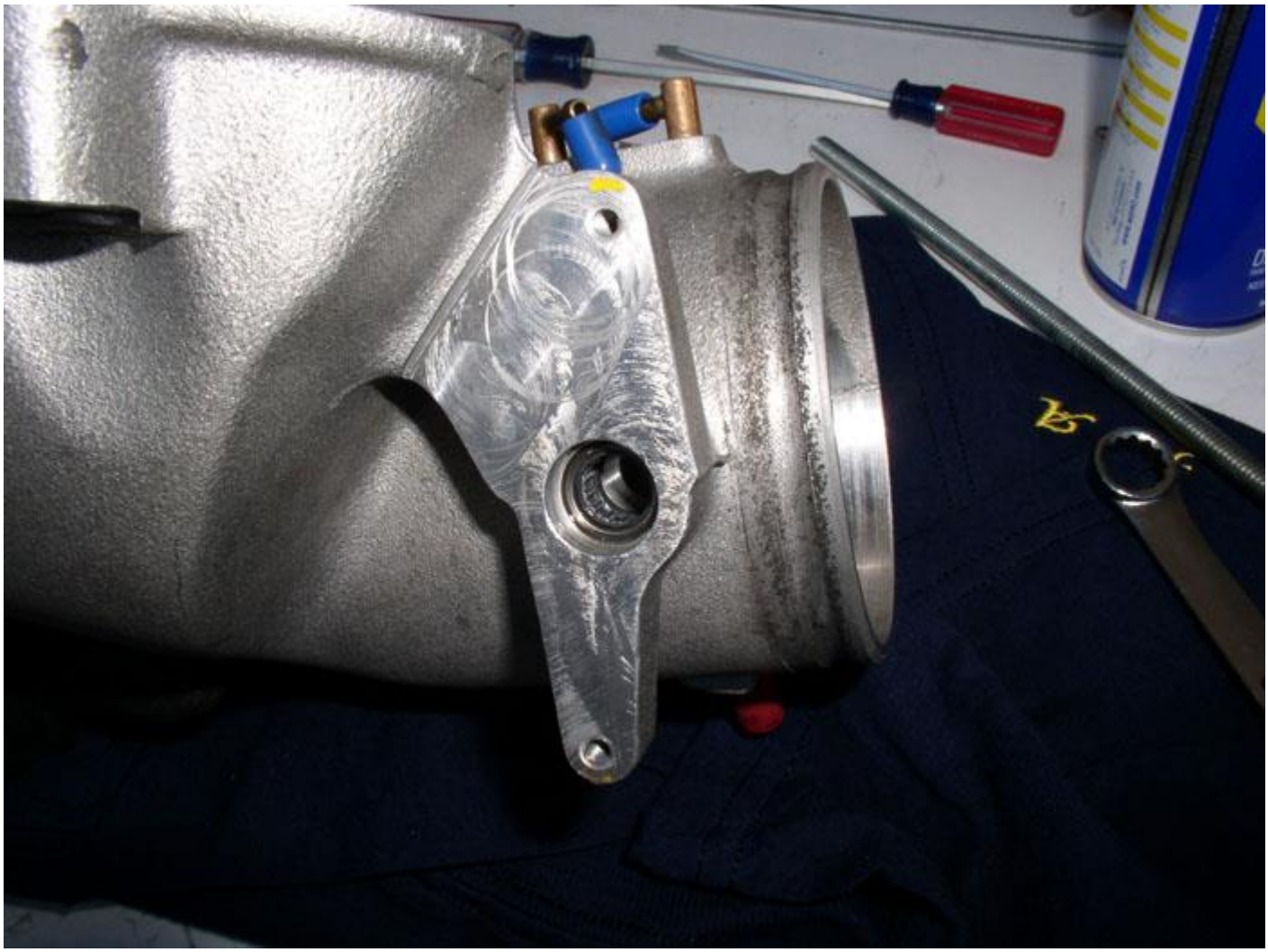
If you're old bearing casing you removed earlier is in good shape, load it onto the threaded rod....



...followed by the nut and washer.



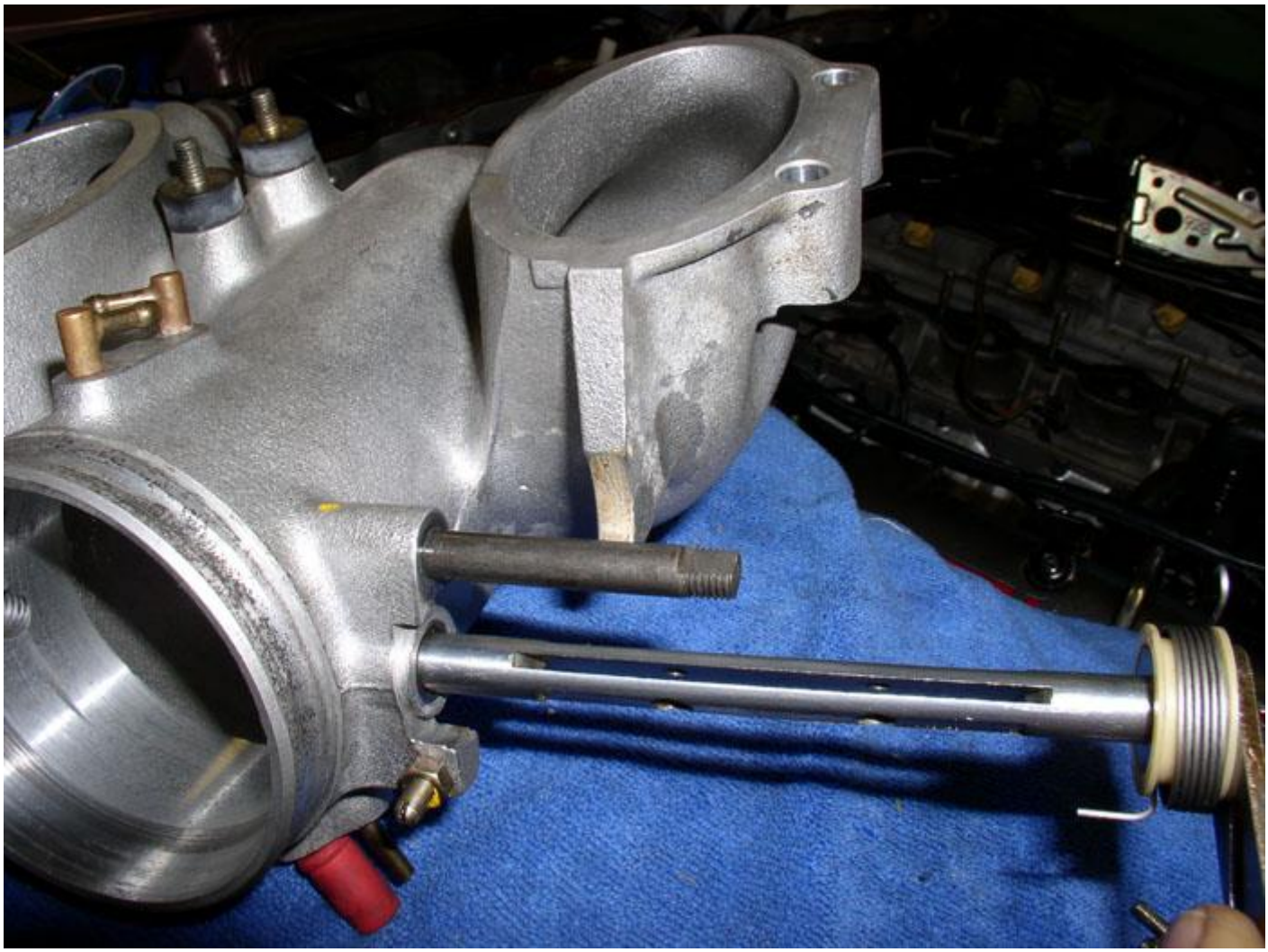
Tighten the nut down until you encounter resistance. Then remove the nut, washer and carefully remove the threaded rod. The bearing should be fully seated in the recessed cavity as shown.



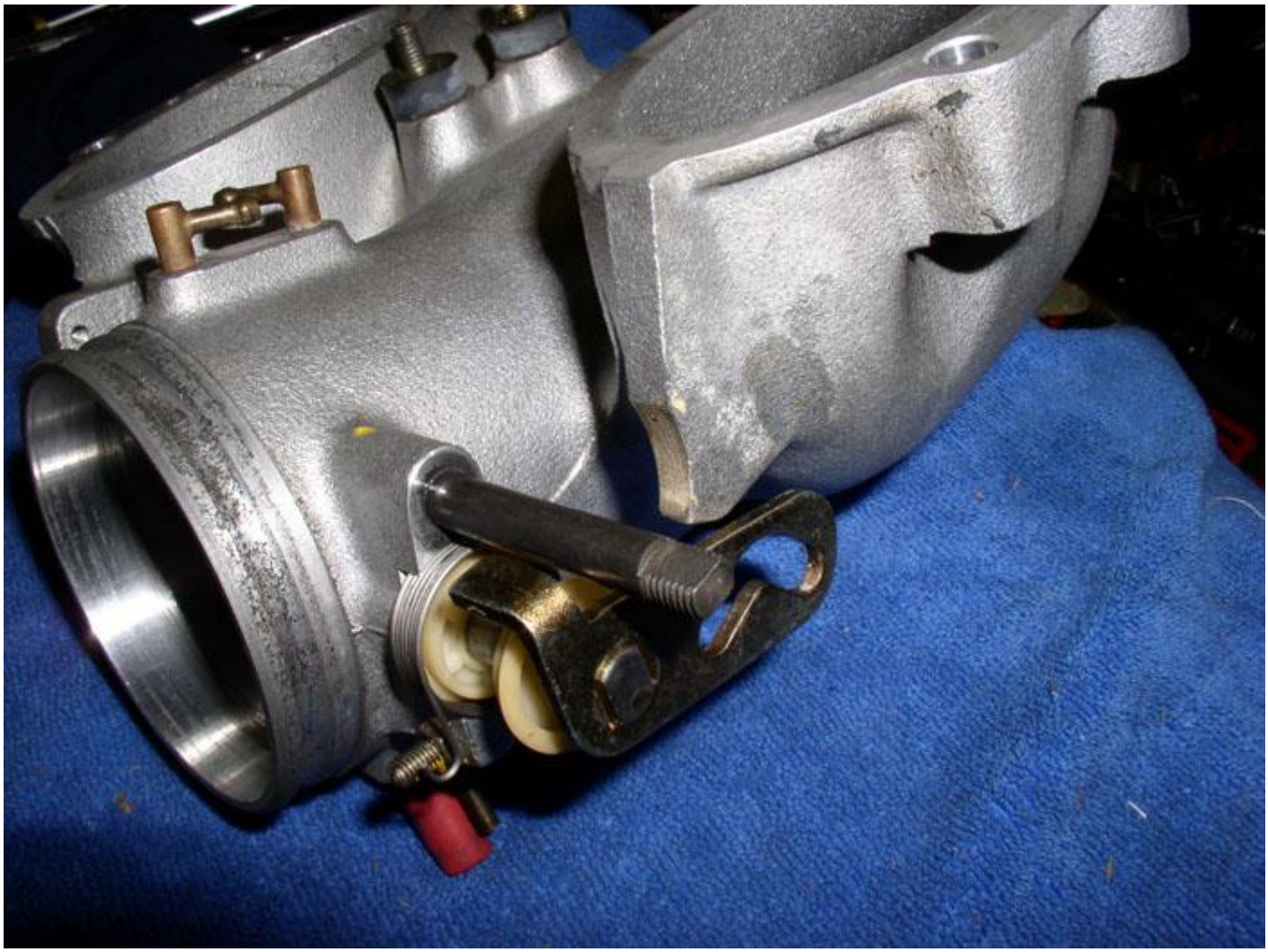
Next, you install the throttle plate shaft. The bearing seals are already pre-lubricated but I used a small amount of silicone lubricant on the shaft itself to ease installation and not deform the bearing seals.



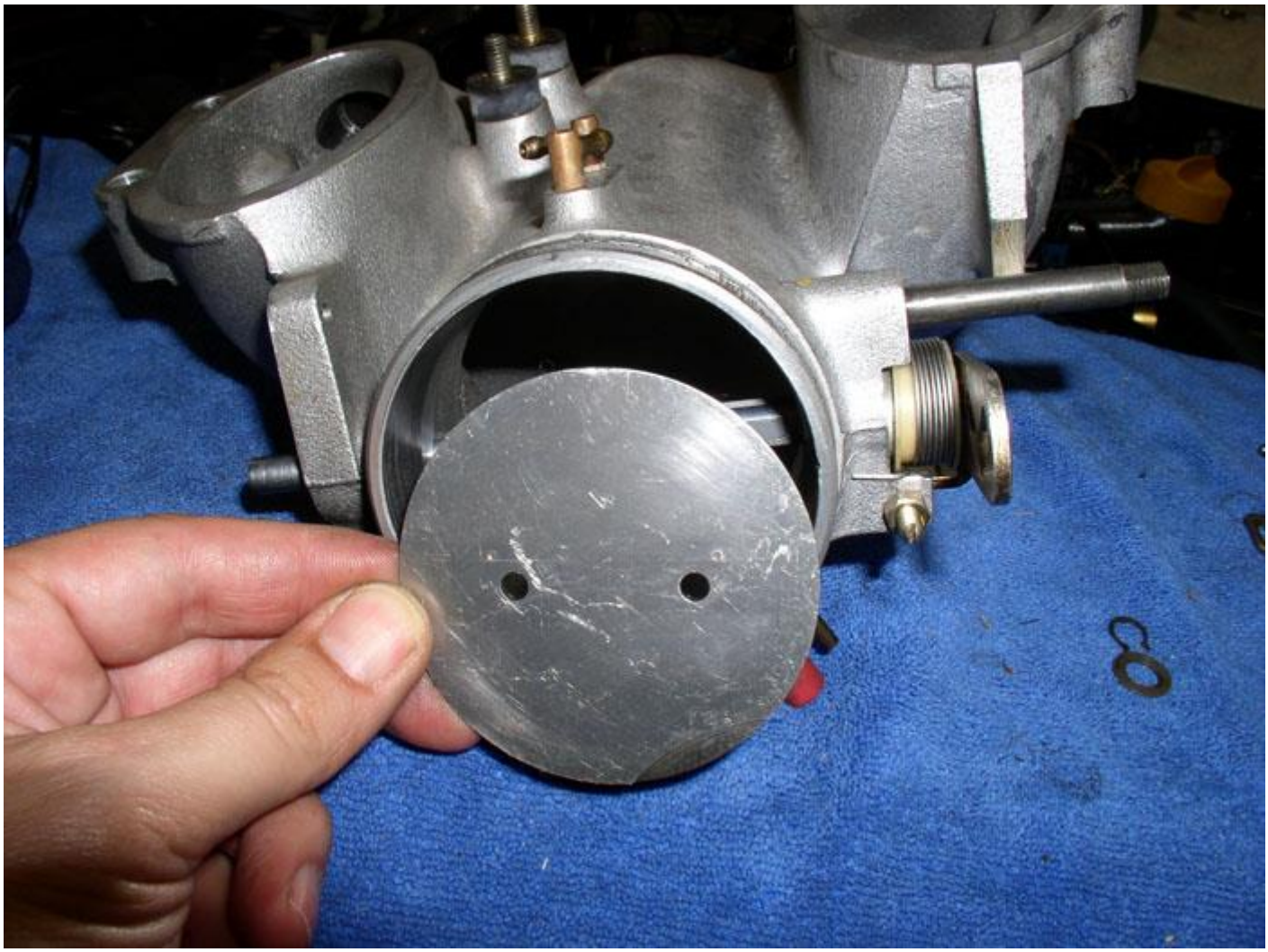

Insert the shaft on the spring linkage side as shown, being careful to keep an eye on the bearing seals - ensuring they do not bind or deform during installation of the shaft. Twisting the shaft on installation can help. I did have one seal bind on me while installing the shaft but by backing the shaft up and re-inserting with a twisting motion, the seal righted itself.



Install the throttle plate shaft until it is fully seated against the throttle body as shown.



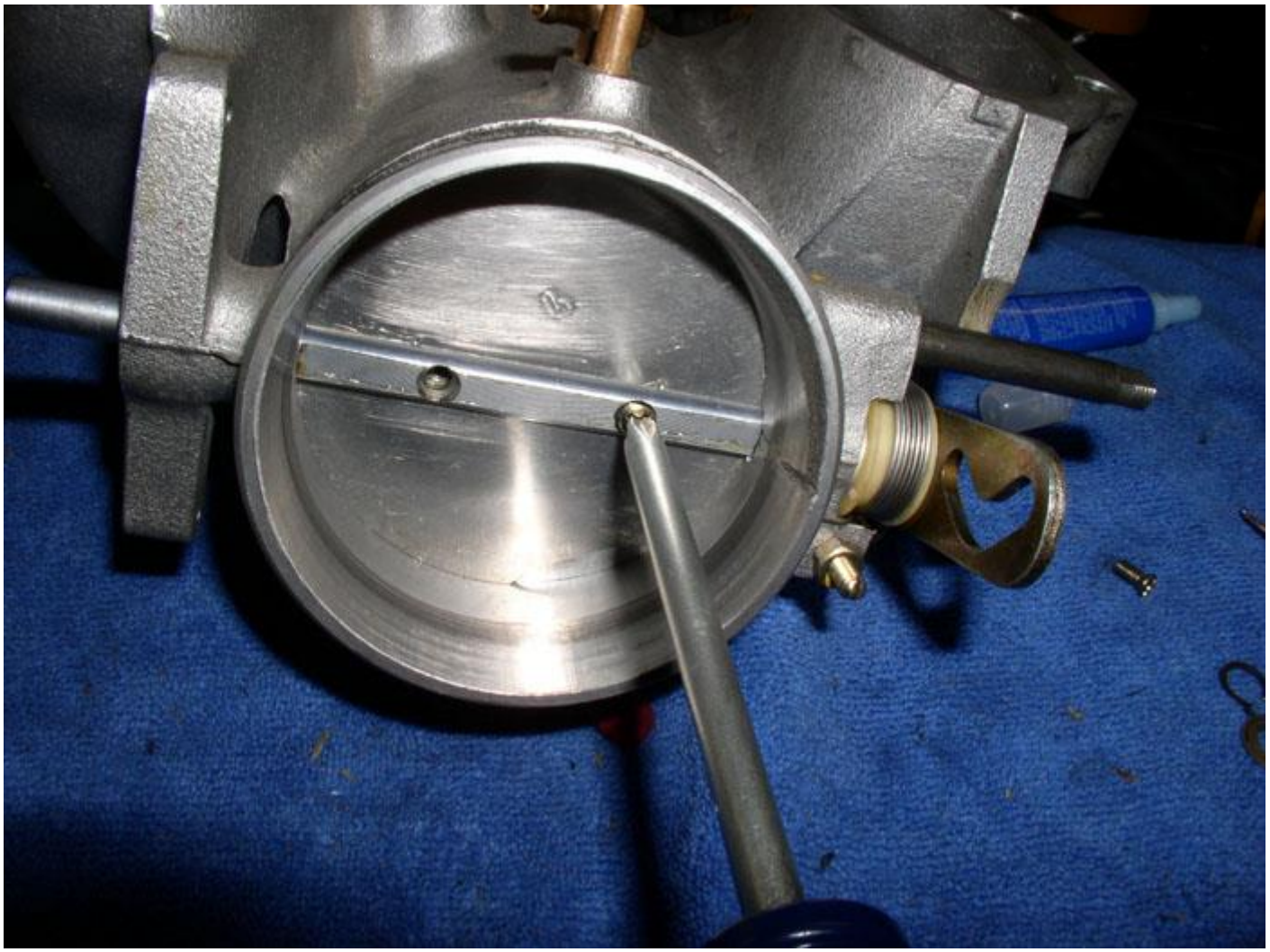
Next, install the throttle plate. You will notice a curved arc cut into the front surface of the throttle plate. This faces forward and on the bottom half of the shaft as shown.



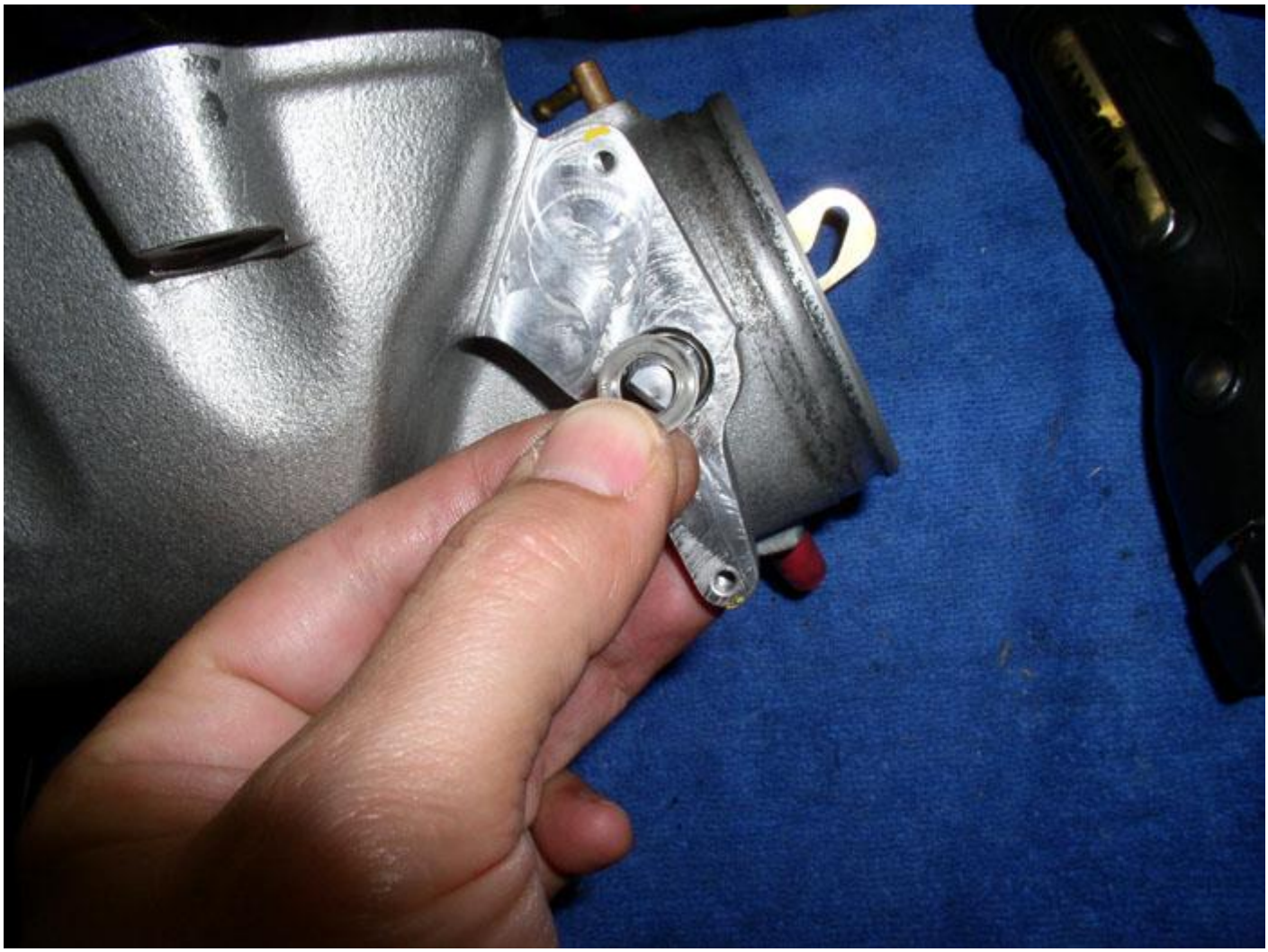
To ensure the throttle plate screws stayed put, I used threadlocker blue on the small phillips screw threads.



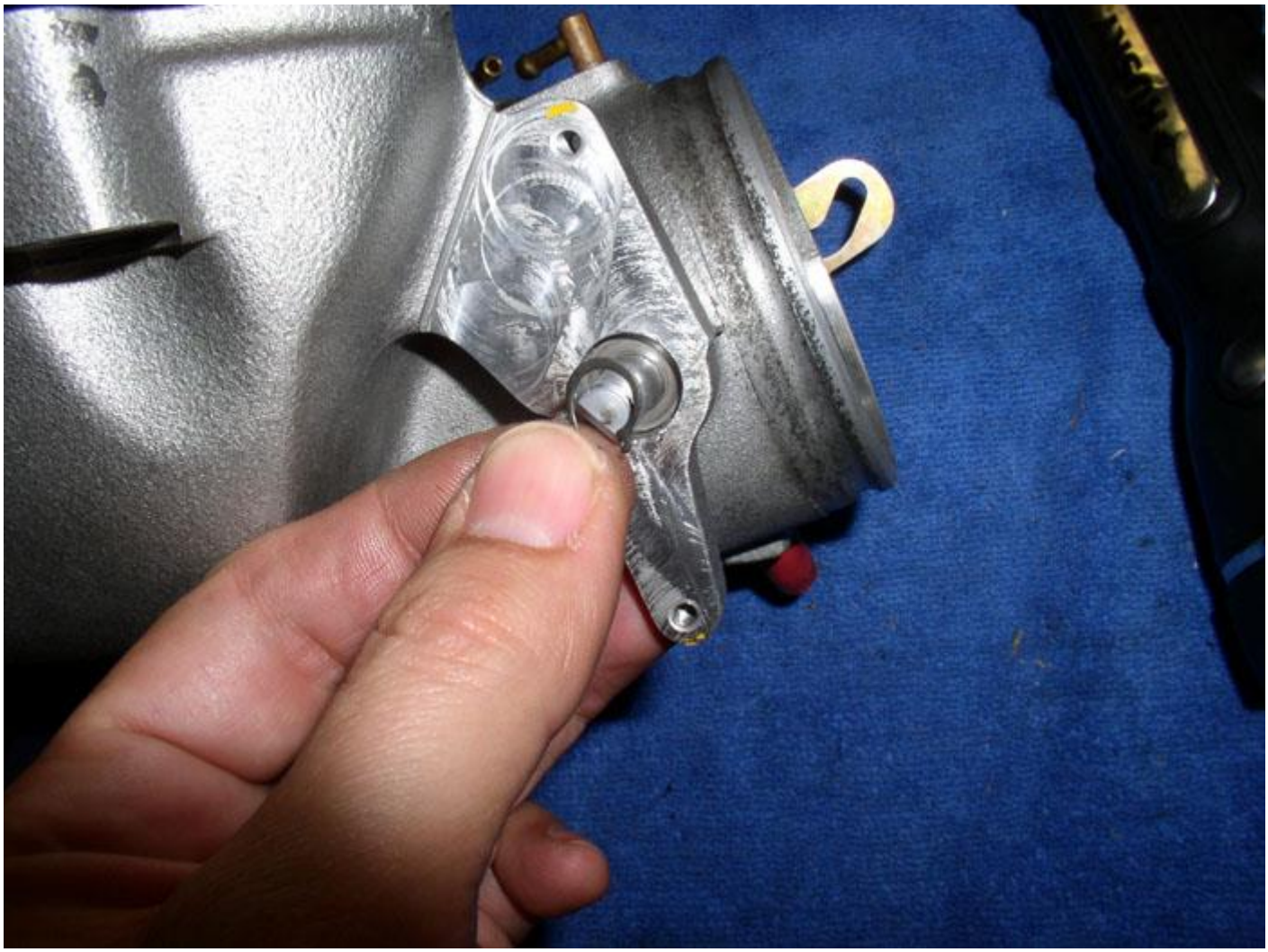

Install the plate by turning the throttle shaft 90 degrees and inserting the plate into the shaft. You will need to work the throttle shaft open and close until the throttle plate is positioned perfectly on the shaft so as not to scrape or rub on the sides of the throttle body walls. Once it's moving freely, tighten the plate down with the screws. Then operate the plate after the screws are tightened to ensure the plate still moves freely.



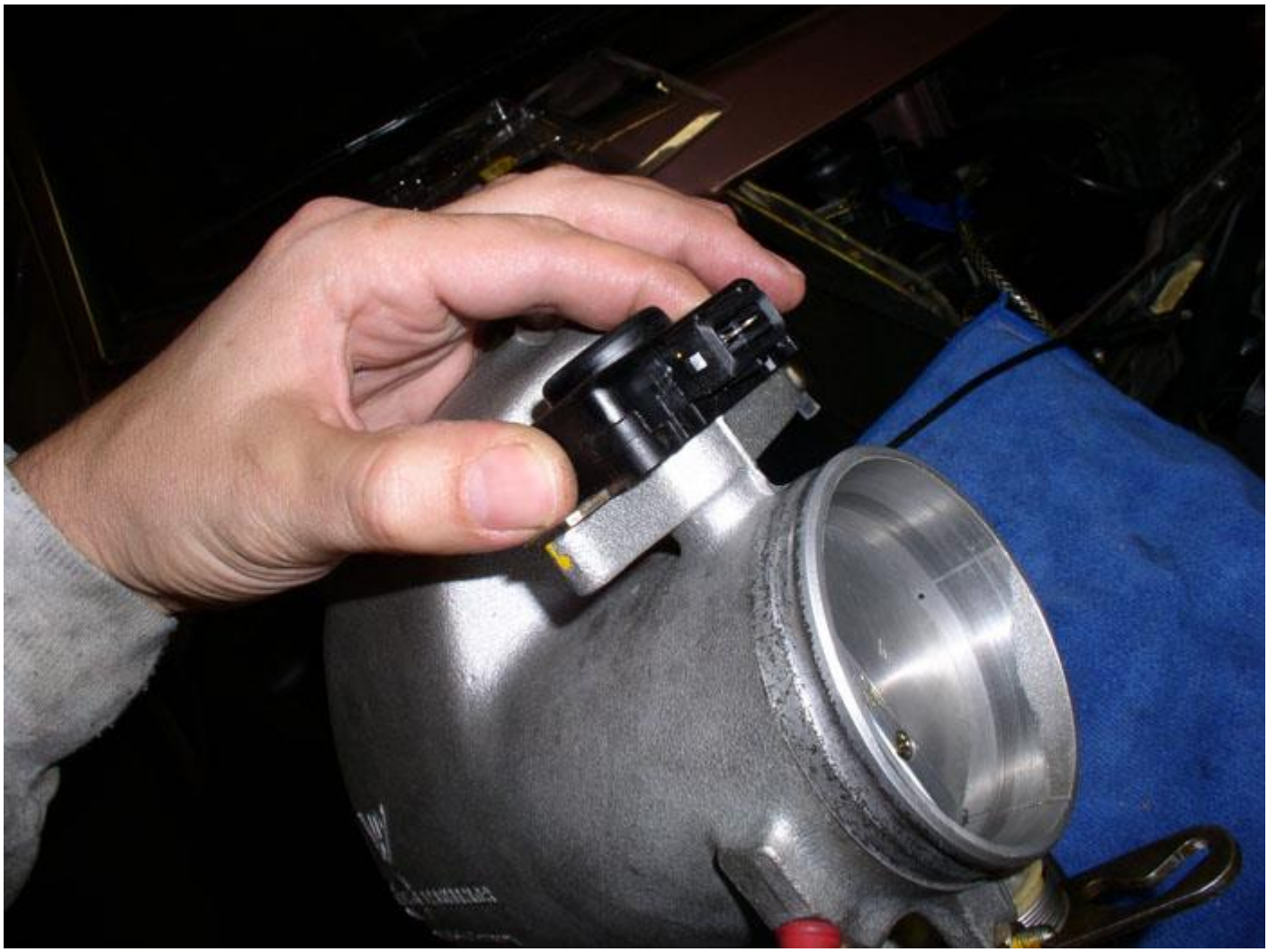
Then install the washer at the TPS side of the throttle plate shaft.



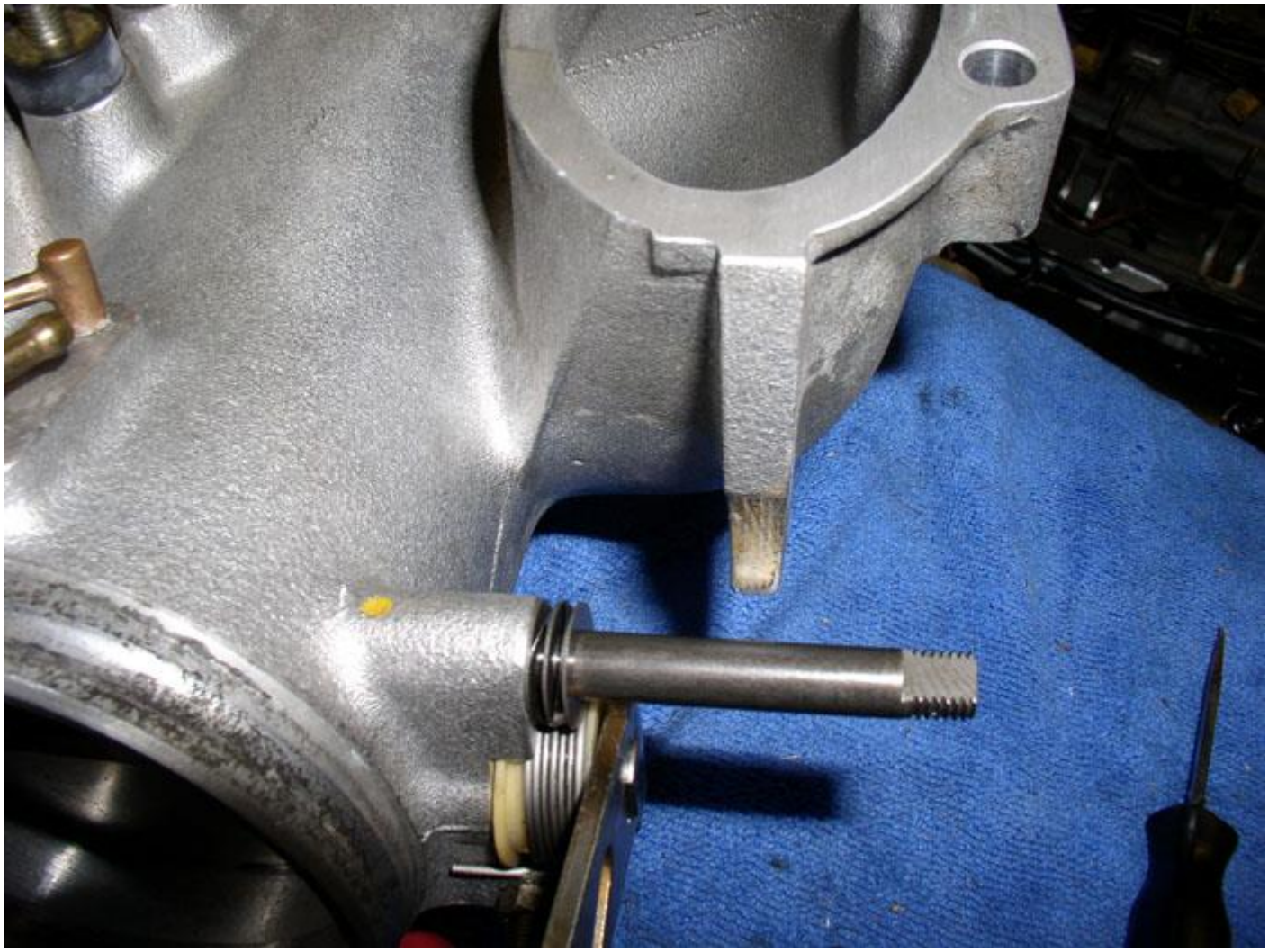
Followed by the small circlip. Use the circlip pliers once again to install the clip. If your clip was slightly stretched by the removal process, like mine. You can "clamp" it back into shape with some needle nose pliers after it's seated in the retaining groove of the throttle plate shaft.



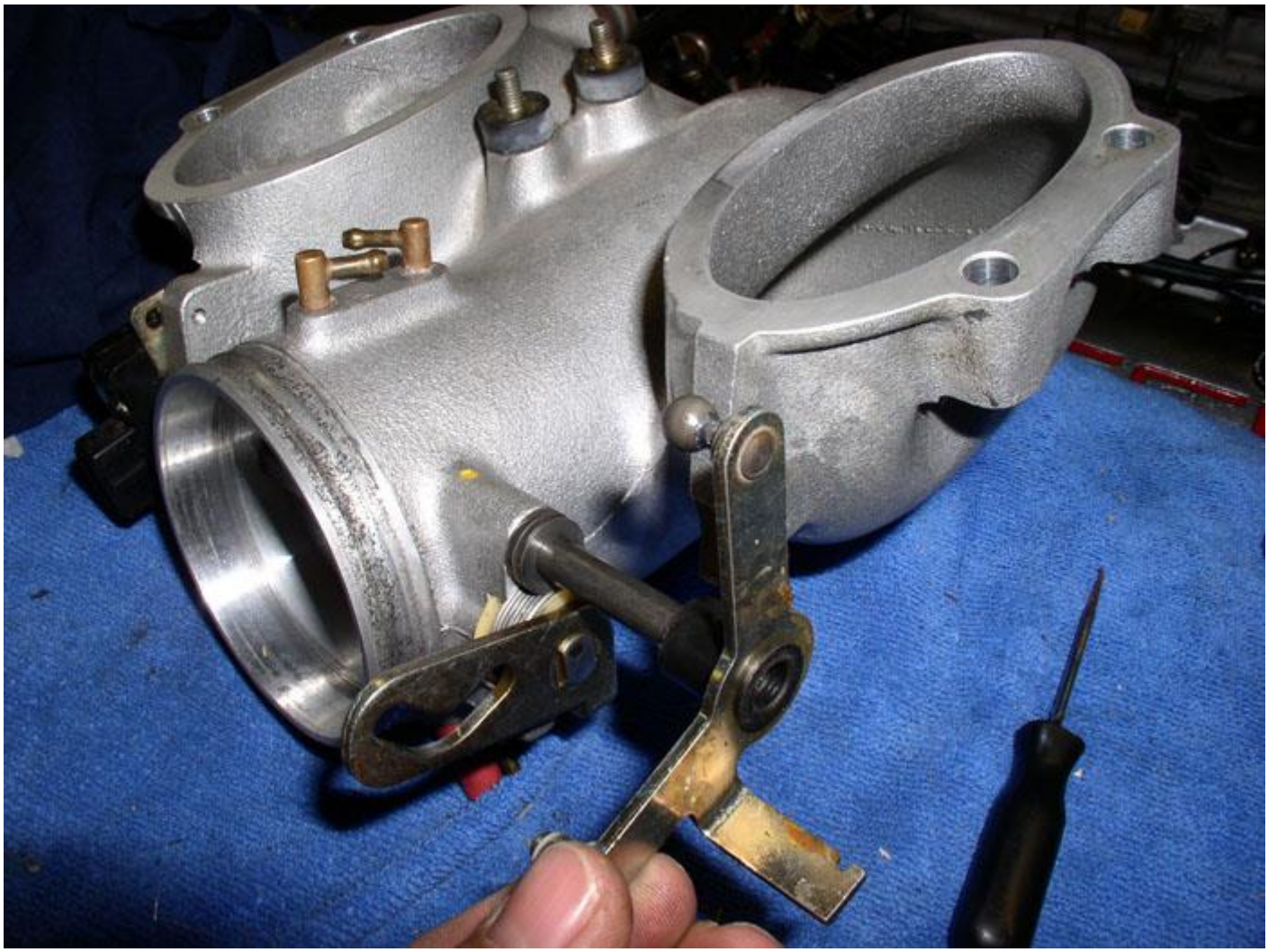
Next, install the TPS. Position it approximately at the same orientation as you removed it. Lightly snug down the mounting screws. Then operate the throttle shaft and listen for the "click" of the idle contacts of the TPS as you move the shaft. Adjust the position of the TPS so that you hear the "click" when the throttle plate is open just about 1 degree. Then tighten down the mounting screws on the TPS. Test the operation again to ensure it's working as it did before the disassembly.



Now, install the 4 washers in the same order they come off the throttle cable linkage shaft (spring-flat-spring-flat).



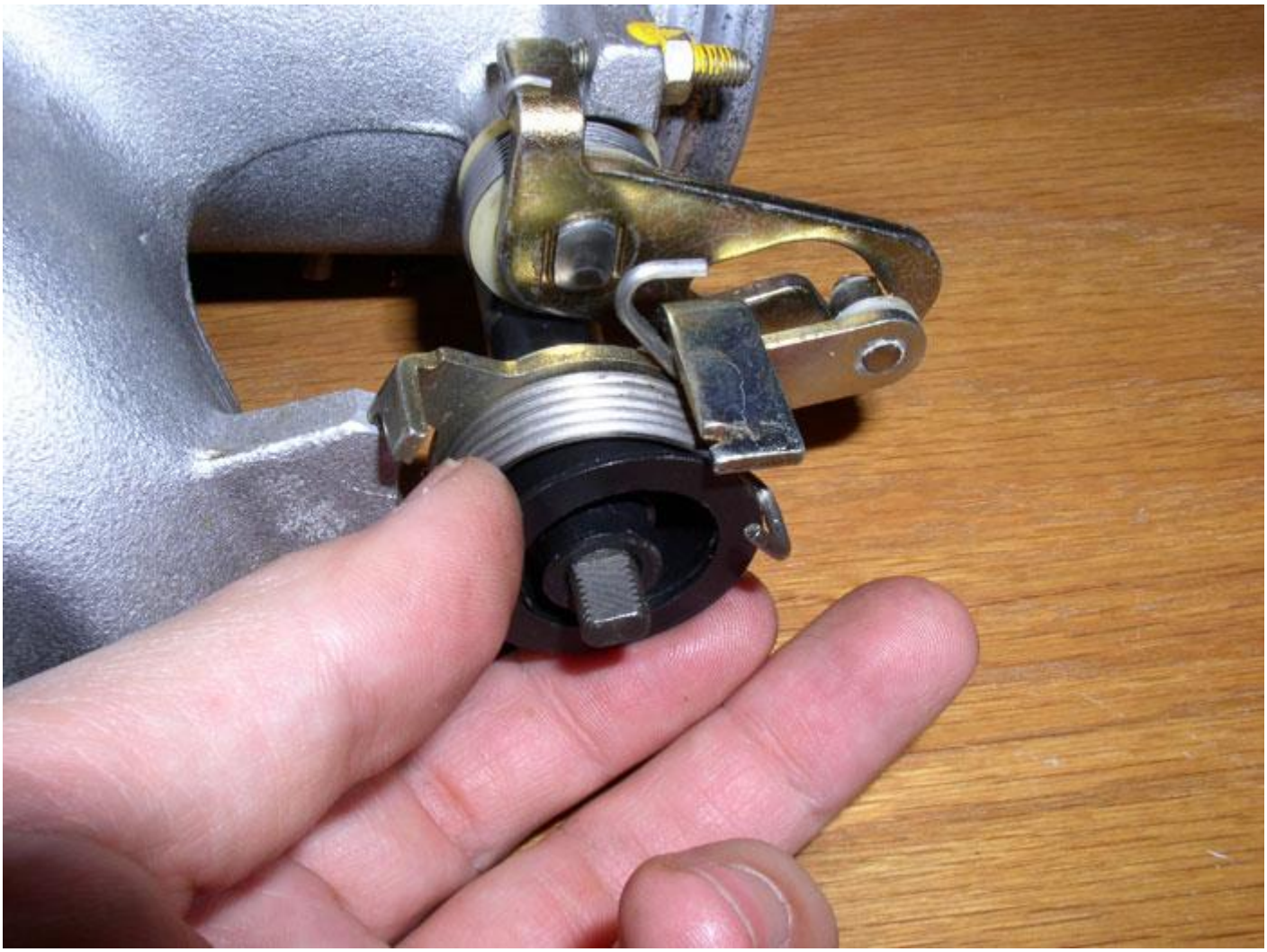
I lightly lubricated the throttle cable linkage shaft with WD-40 during the intallation of the linkage. Next came the throttle cable lever arm.



Next comes the outer and inner spring carrier. If your's is still intact, it will look like this below. The outer spring carrier (see green arrow), was broke on mine.



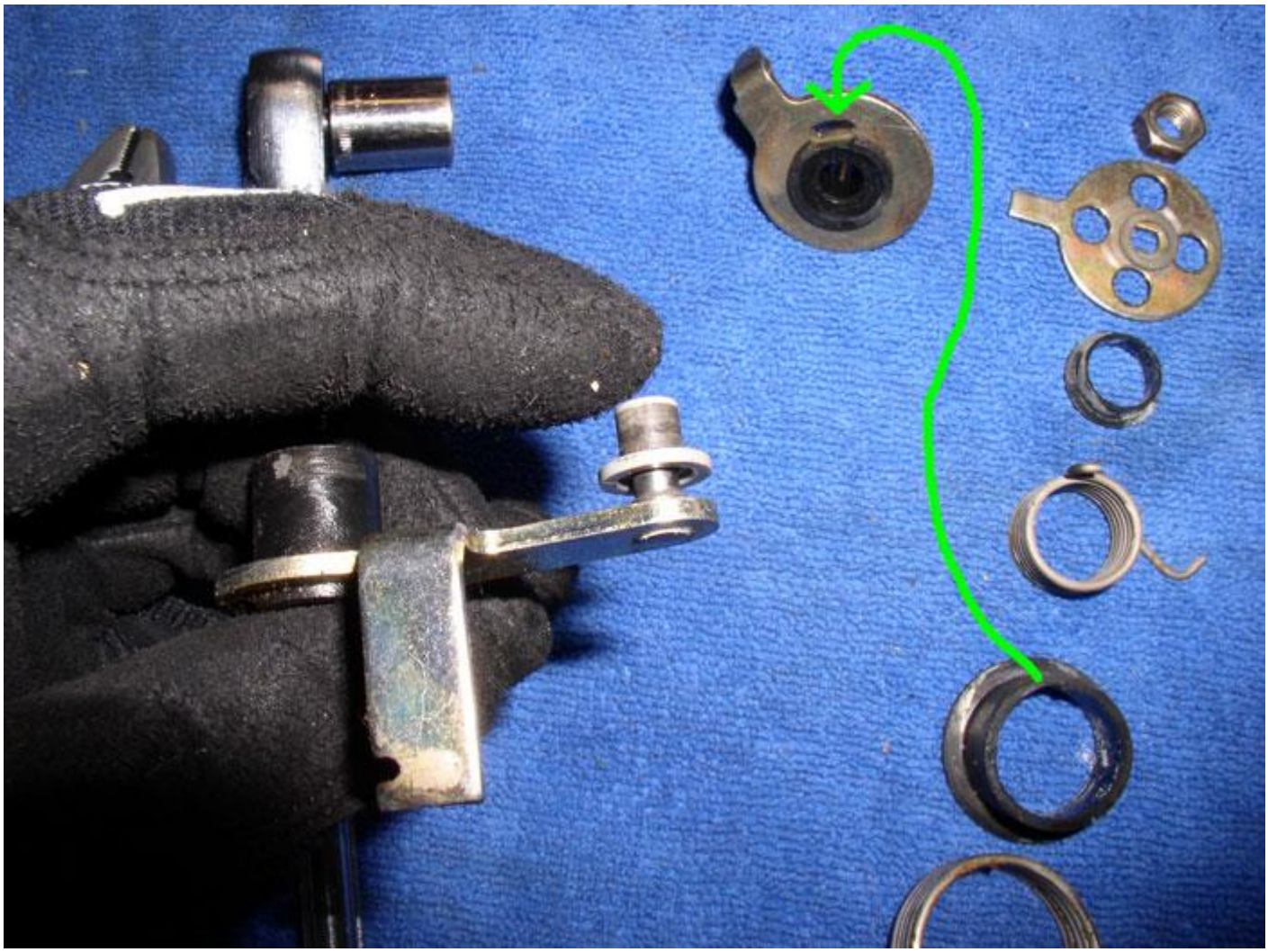
If yours is together, you can install the outer spring and position the unit back onto the shaft together as a unit as shown below.



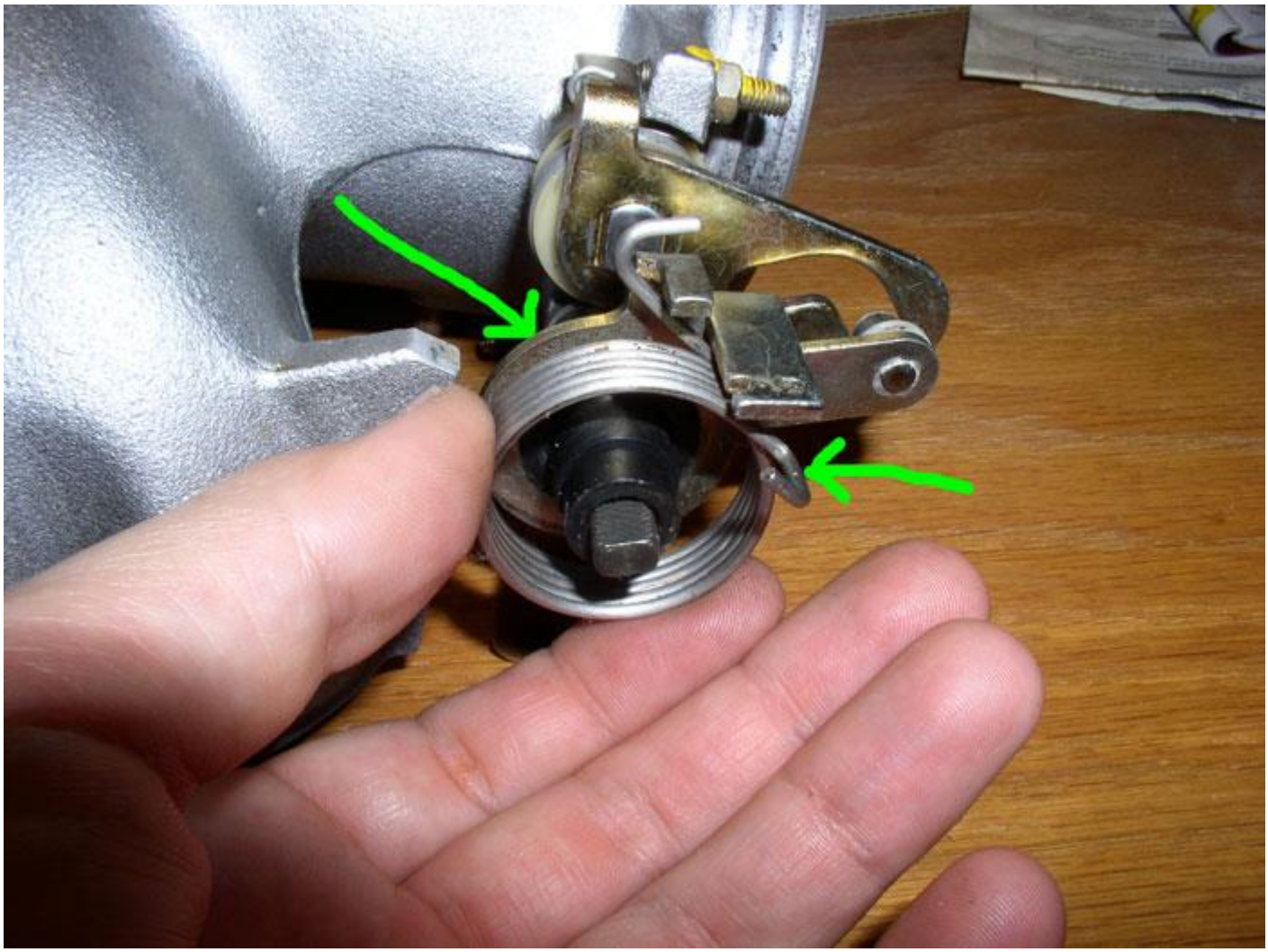
Otherwise, locate the small notch on the outer spring carrier as indicated by the green arrow below.




You will be aligning the notch in the plastic spring carrier with the oval slot in the spring carrier plate as shown with the green line. The notch in the plastic and oval in the plate are there to allow the inner spring to catch on the spring carrier plate (shown shortly). You could try to glue the plastic spring carrier back together with the plate using super glue or equivalent but I didn't think that would stand up to the pressure of the springs so I left them apart for the installation.



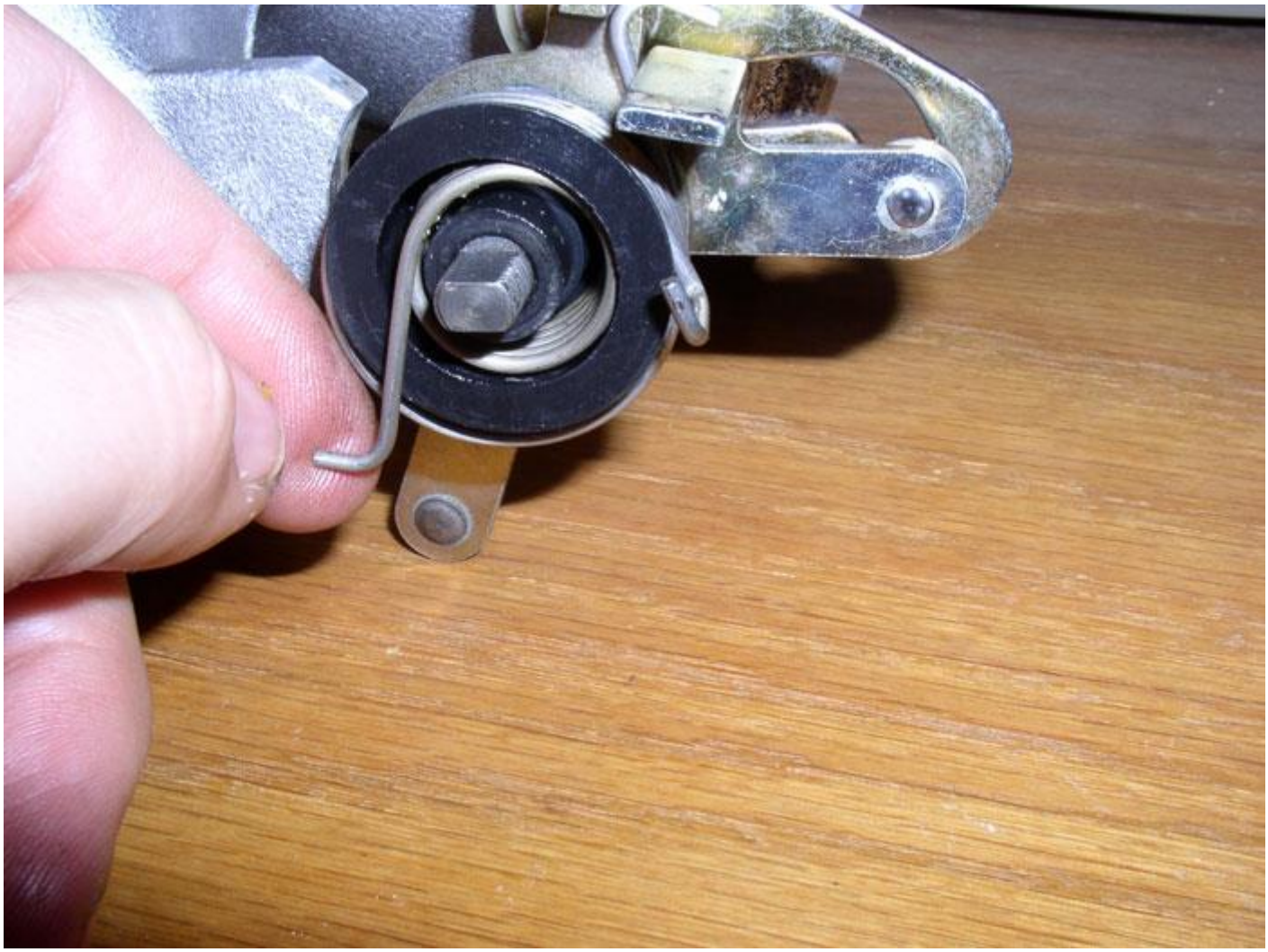
First, install the spring carrier plate followed by the outer spring as shown.



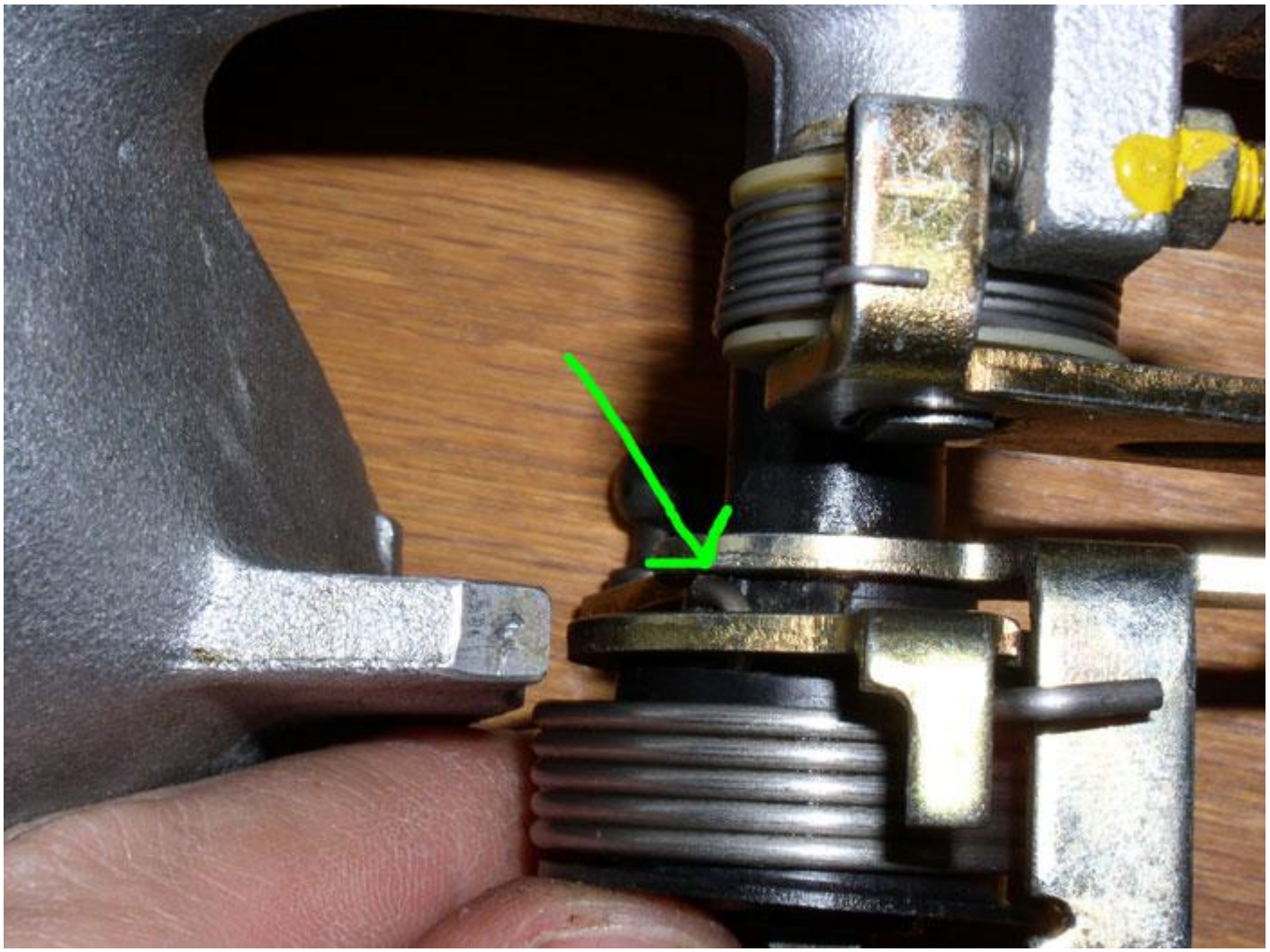
Then, install the spring carrier lining up the notch with the oval slot on the plate as described two pictures ago.



Next, install the inner spring as shown.....



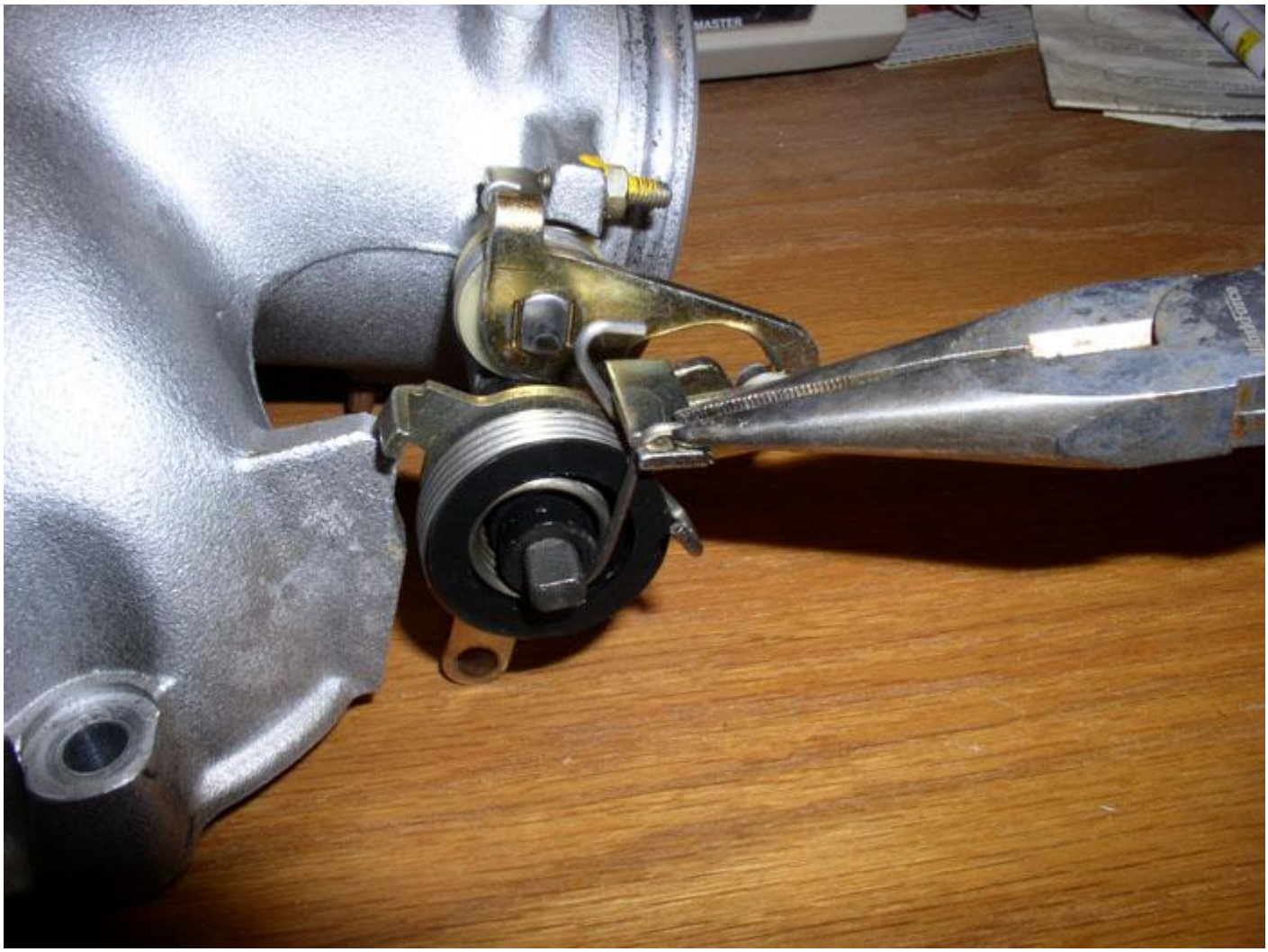
and hook the other end of the inner spring on the carrier plate as shown below.



Then grasp the other end of the inner spring with pliers.....



....and secure it in the notch on the catch as pictured below.



Grasp the outer spring with pliers and secure the end on the catch as shown below.



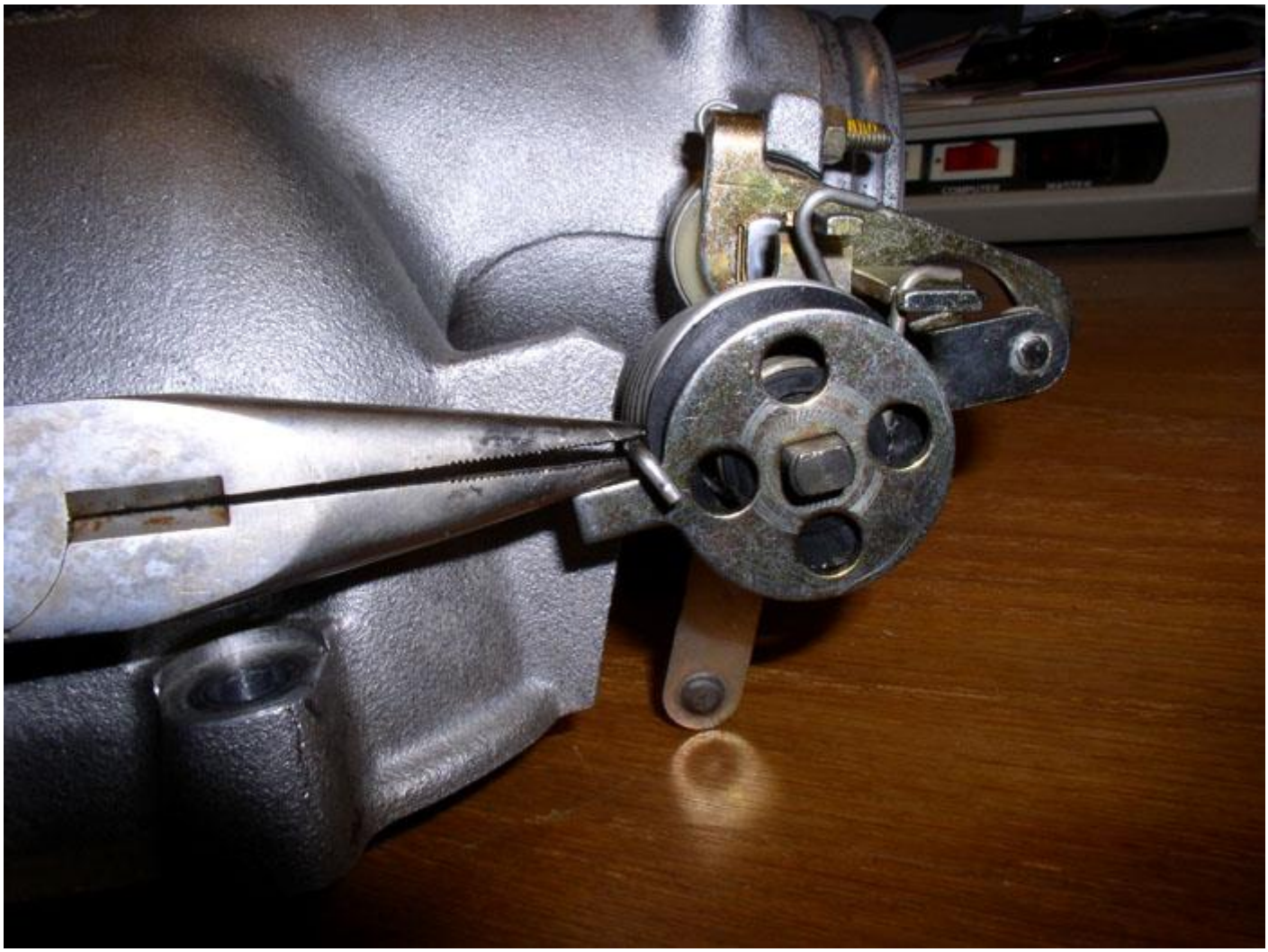
Place the small plastic retaining washer on the shaft next.



Install the outer catch plate as shown and grasp the other end of the outer spring with pliers and .....



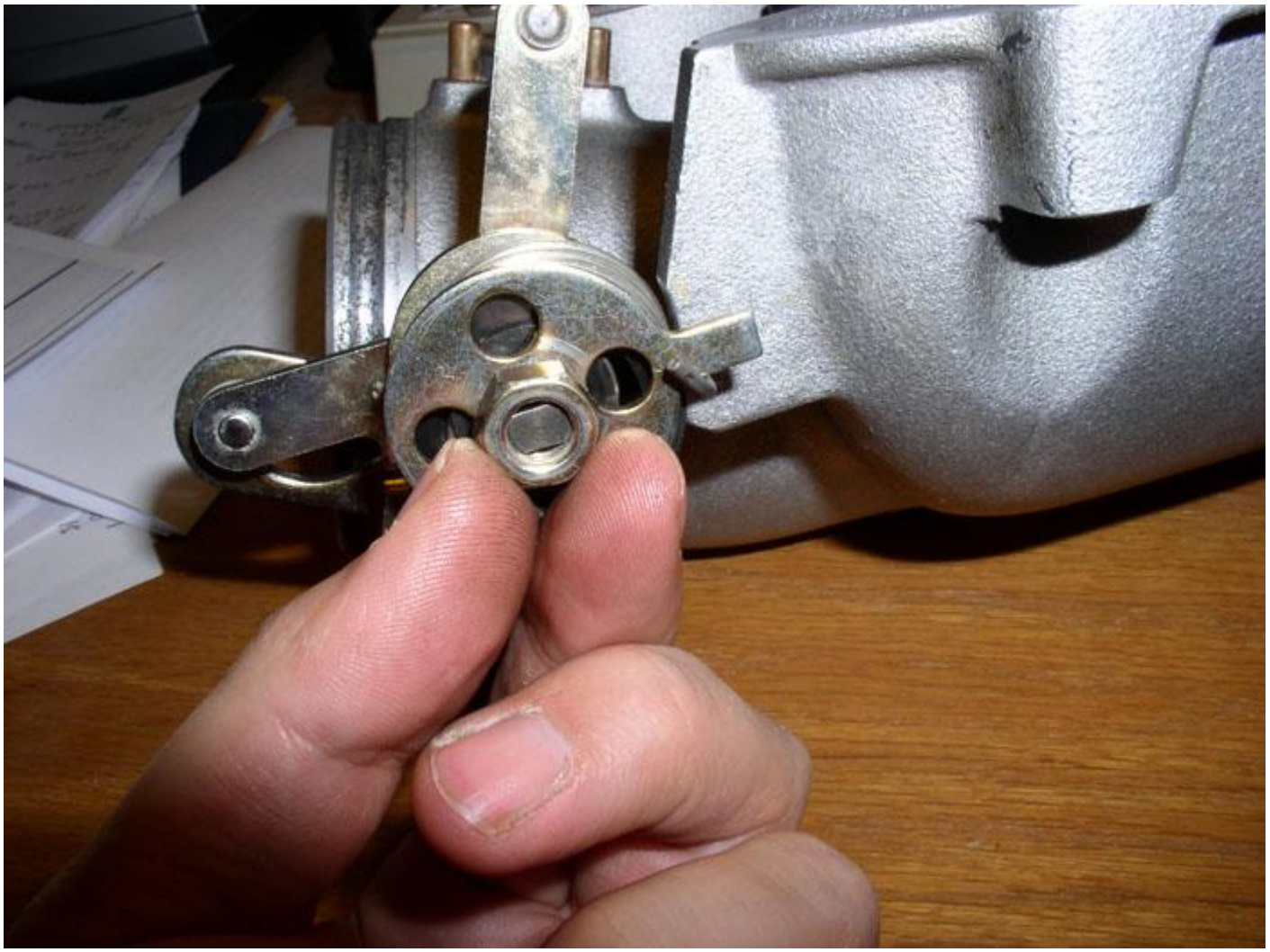
attach the spring to the catch on the outer plate as shown.



Install the ribbed washer.



Followed by the 13mm nut. Tighten down the 13mm nut to secure the assembly. Operate the throttle linkage and plate. It should be smooth and have about the same resistance as before you disassembled it.



Next, install the ISV by secruring the mounting bracket to the throttle body with the two 10mm nuts.



Reattach the ISV hose to throttle body intake and tighten the clamp.



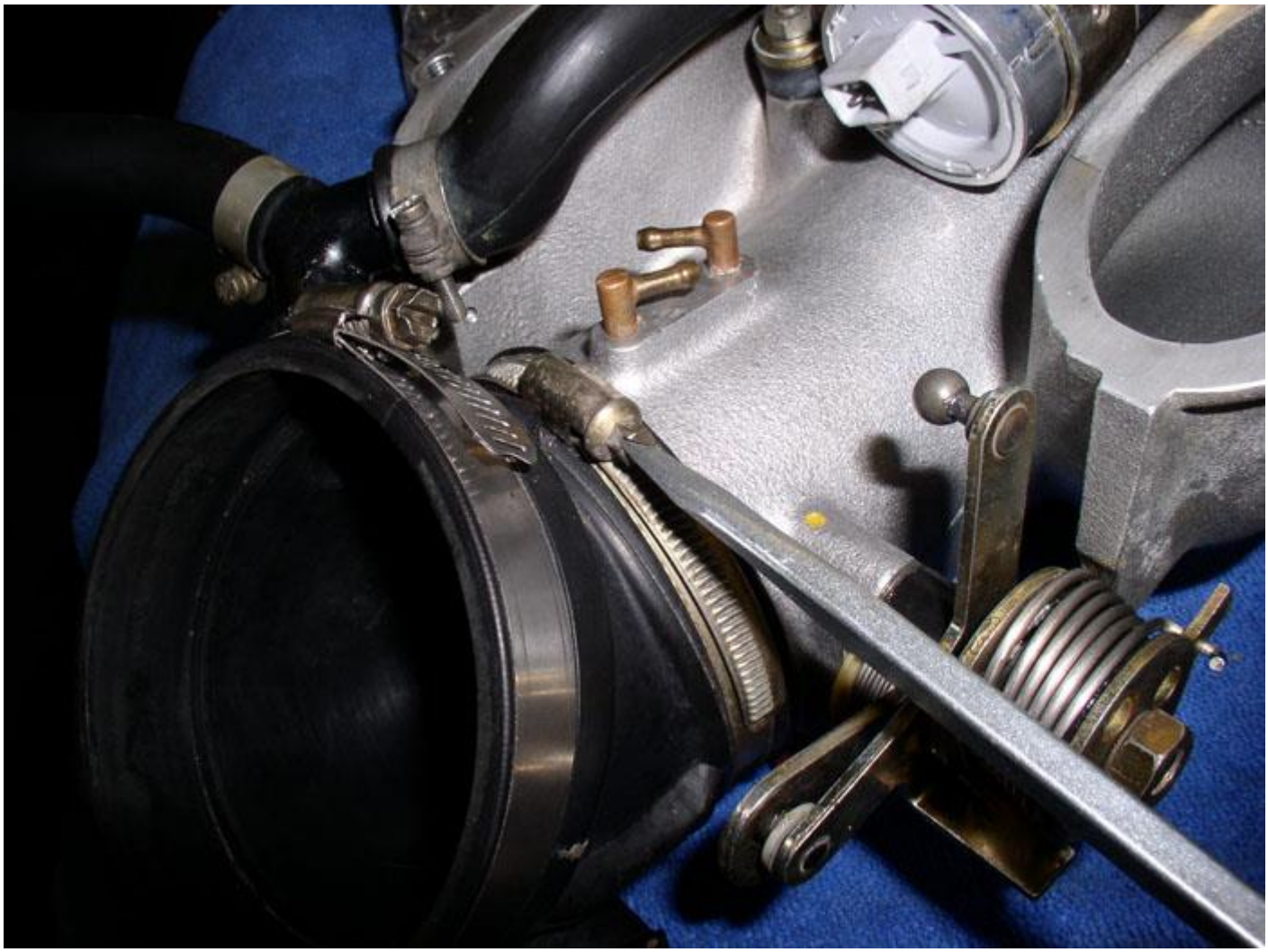
Install the Air Guide Cowl but don't tighten the clamp yet.



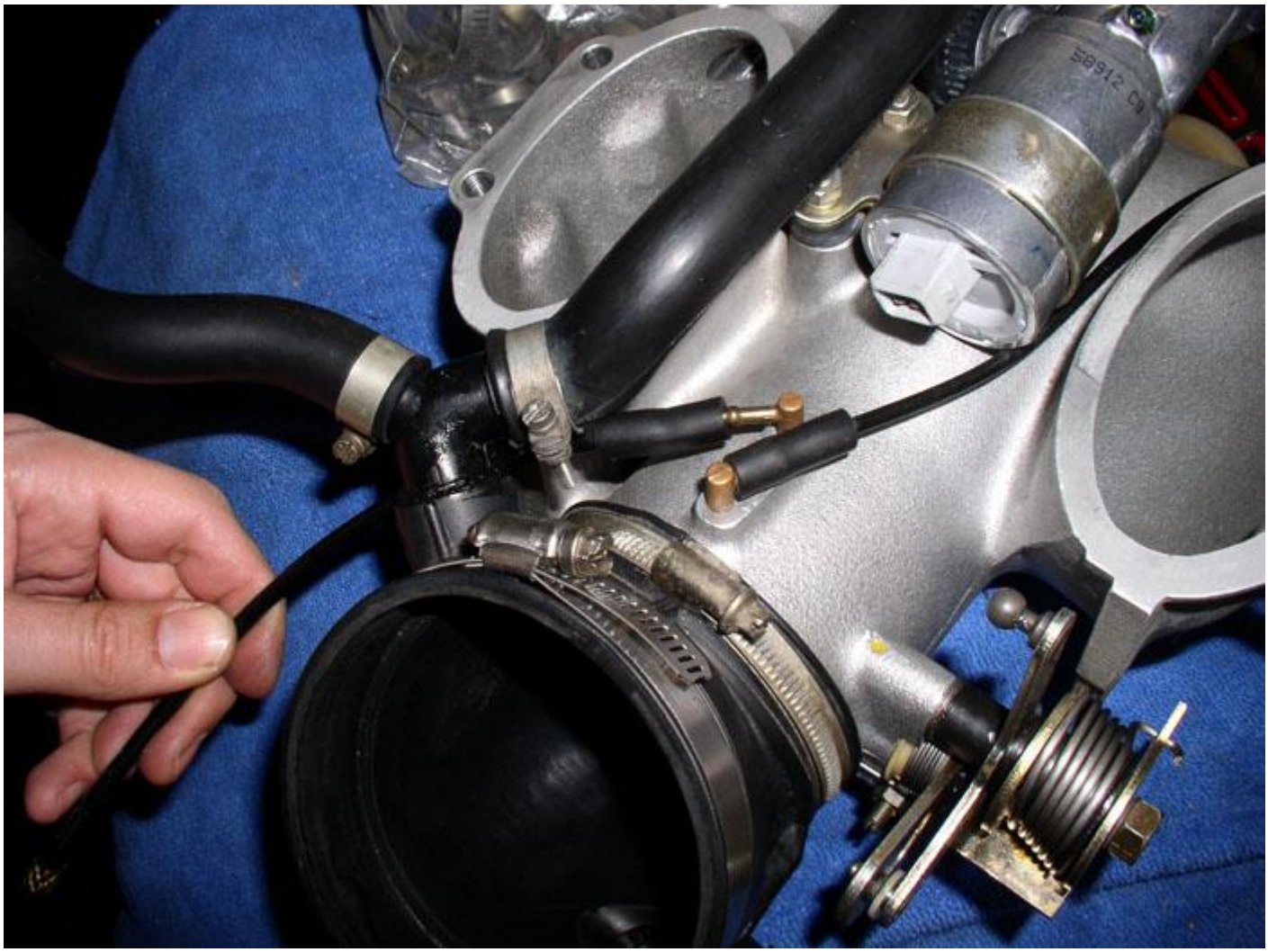
Attach the ISV supply hose to the Air Guide Cowl as shown and tighten the clamp.



Now, tighten the clamp on the Air Guide Cowl ensuring it is lined up properly. I lined up the center ridge on top of the cowl with the two vacuum ports.



Attach the vacuum lines to the vacuum ports. Short line to the rear port and long line to the front port as shown.



Re-attach the throttle body to the intake using the four 13mm bolts. Torque to 15 ftlbs.



Congratulations! Your vacuum leak at the throttle body linkage should be cured!

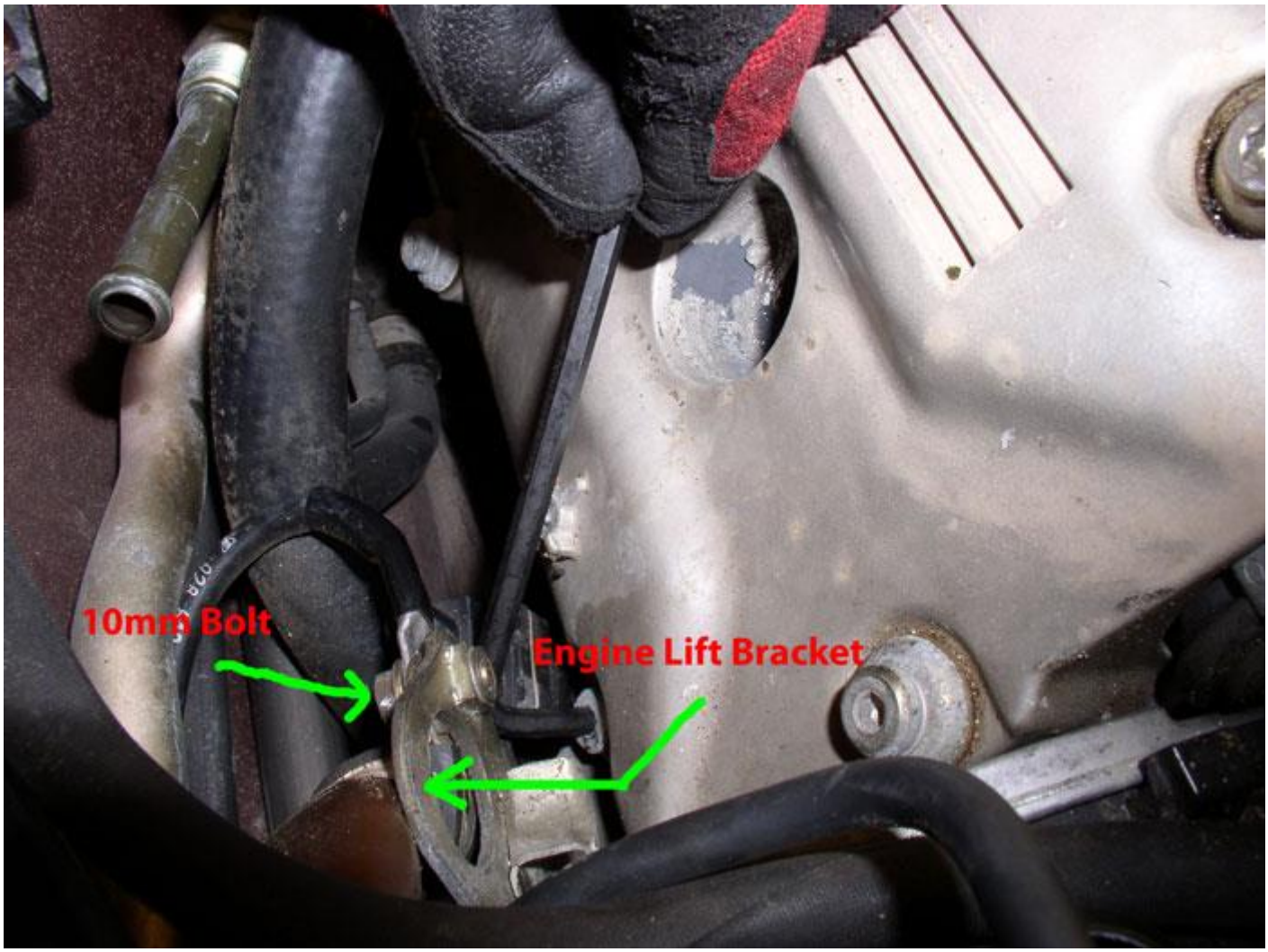
As mentioned before, I fixed this leak AFTER I had assembed the intake and had to take it off again. I should have tested the throttle body for leaks before taking the intake off the car and then I would be fixing the leak while the intake was at the powder coaters. So, now we'll resume the intake installation procedure.

**Hall Sensor Inspection**

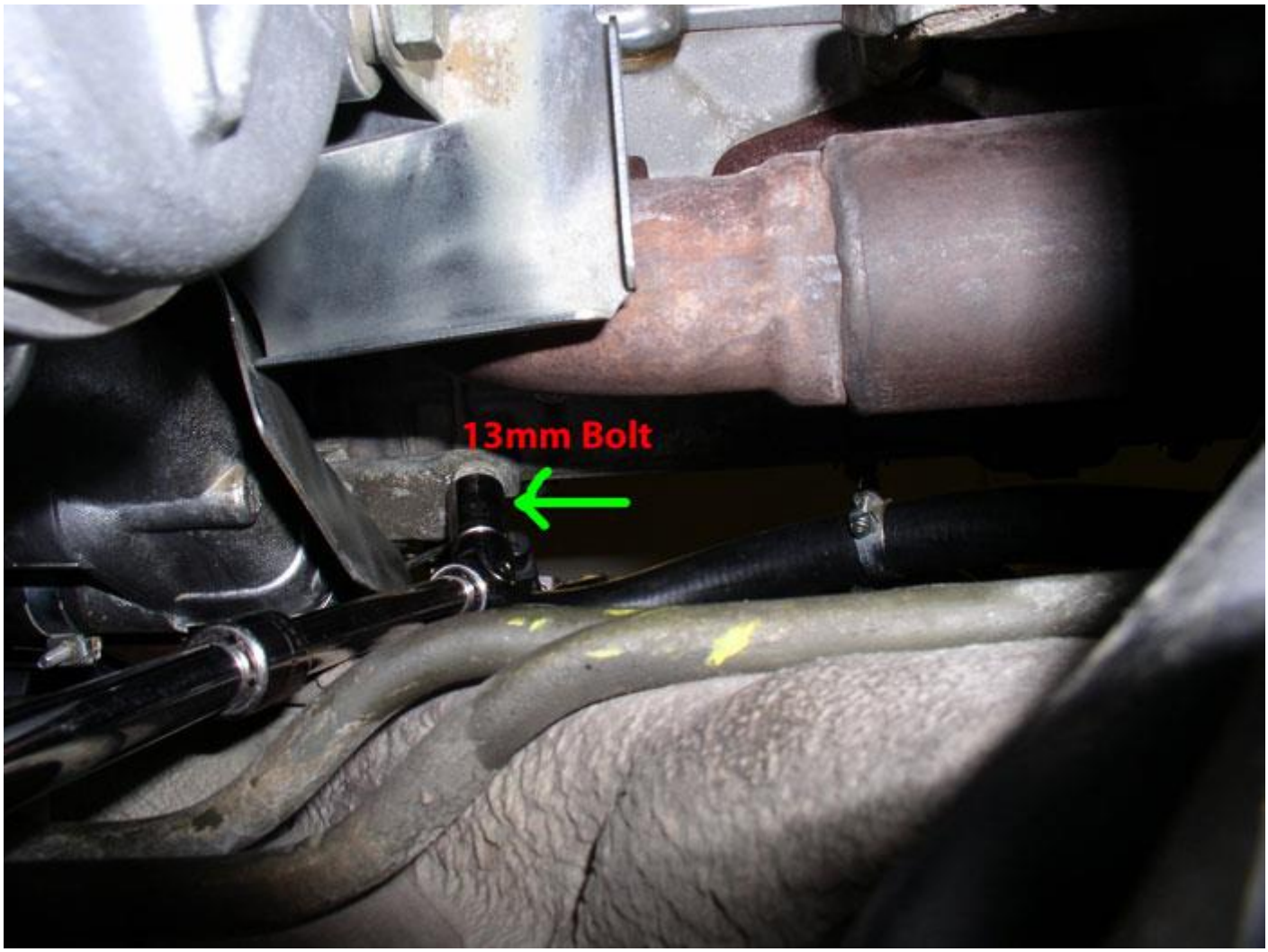
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OK....one last thing to check before beginning the intake and cam cover preparation for installation - the Hall Sensor. The Hall Sensor is used by the EZK to retard the timing of a specific cylinder when combustion knock is detected. By knowing the position of the cam (through the Hall Sensor) at the time of the combustion knock (through the knock sensors), the EZK identifies the offending cylinder and retards the timing of that cylinder by 3 degrees. If knocks continue, it will retard in steps of 3 degrees to a maximum of 9 degress for that cylinder. The timing of all cylinders will be retarded 6 degrees if the knock sensors or Hall Sensor fail. The Hall Sensor is located on the passenger front side of the engine and is attached to the back side of the metal cam gear plate. You recall I did not remove the engine lift bracket when removing the cam cover because it was not necessary. However, I wanted to get a good look at the sensor and the plug connection to the wiring harness so the engine lift bracket needed to be removed. In addition, removing the lift bracket would also provide a little extra room for re-installing the cam covers which will take place shortly.

You will first need to remove the 10mm bolt that holds the wiring harness clamp to the lift bracket. There is also a ground strap wire connected to the lift bracket that runs to the passenger side coil mounting bracket. After removing the harness clamp, I reinstalled the 10mm bolt with the ground strap attached to keep them together.



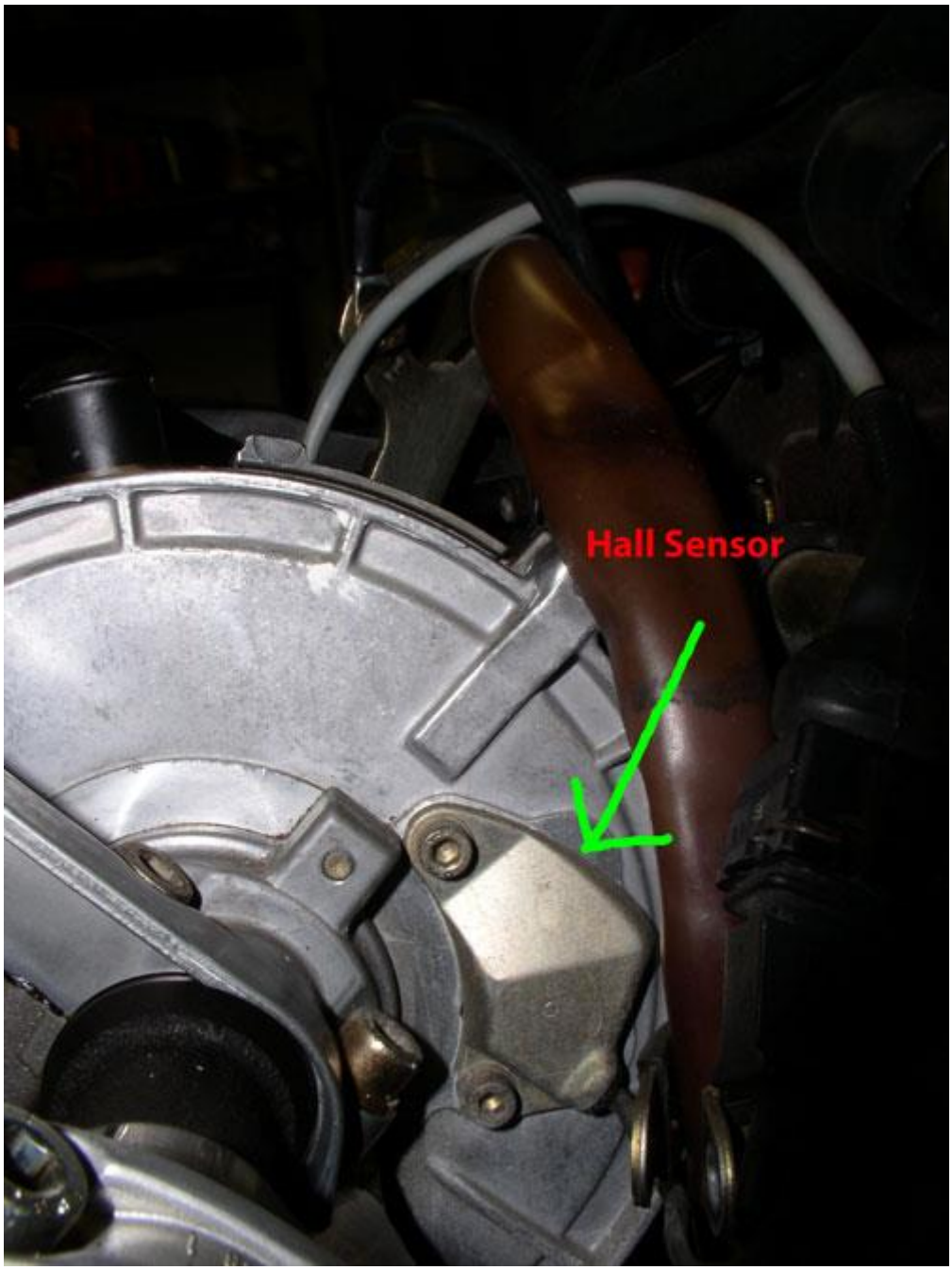

Next, you'll need to remove the 13mm bolt that secures the lift bracket to the engine head. I found it easier to access this bolt from undeneath the car using a 12" + 6" extension with universal elbow. Although the lift bracket has two mounting holes, only one bolt is used to secure it. The other mounting hole slips over a mounting pin that extrudes from the side of the head.



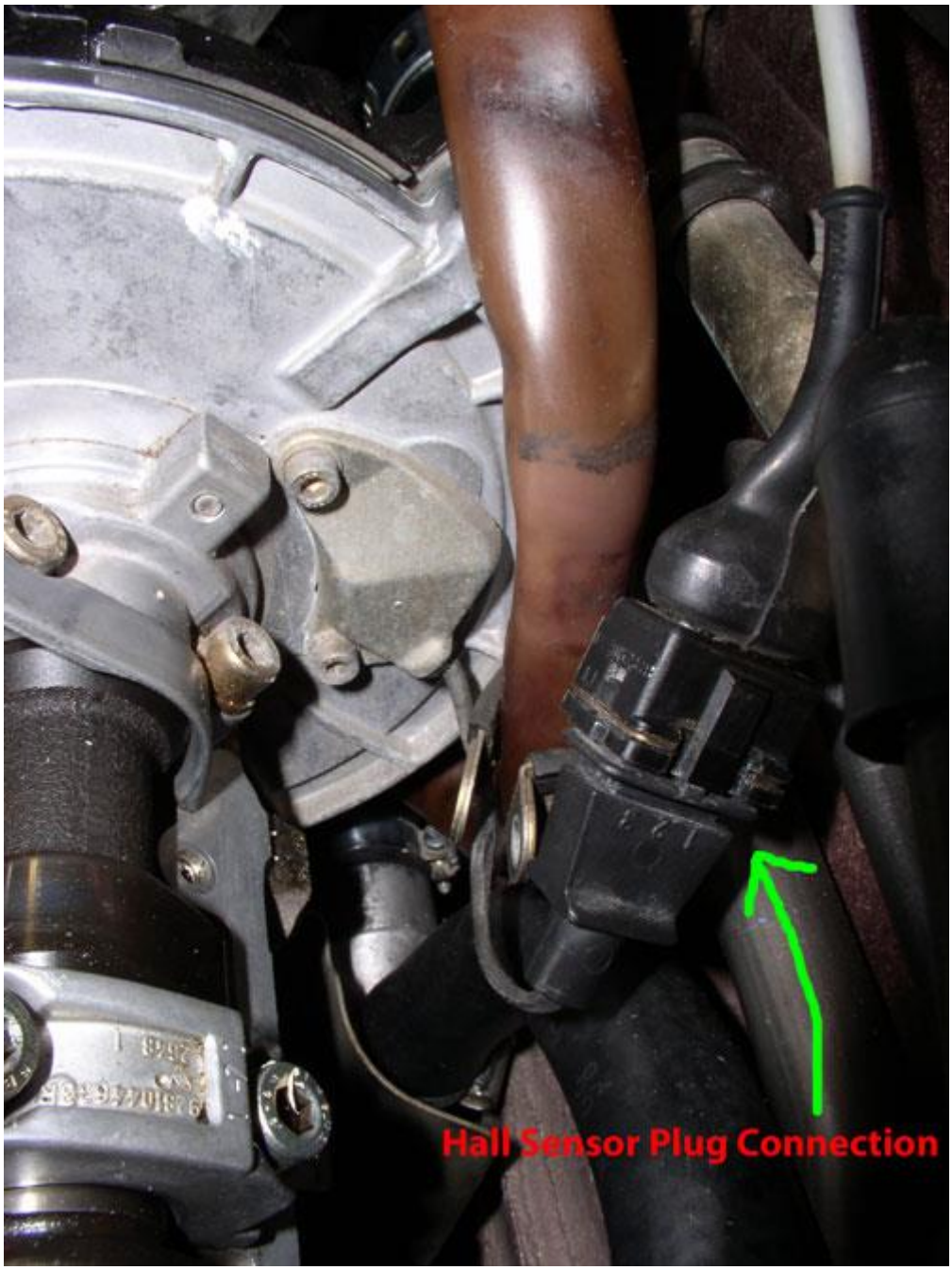

After the 13mm bolt is removed, you can take out the lift bracket and set it aside.



Here's a shot of the Hall Sensor. It's mounted with two 5mm allen head bolts. If your sensor is known to be bad, now's the time to replace it while it's easy to access. I don't believe mine was causing any problems so I decided not to replace it until I had evidence it was broke. If you replace yours, the tightening torque for the mounting bolts is 6 ftlbs or 72 inch pounds.

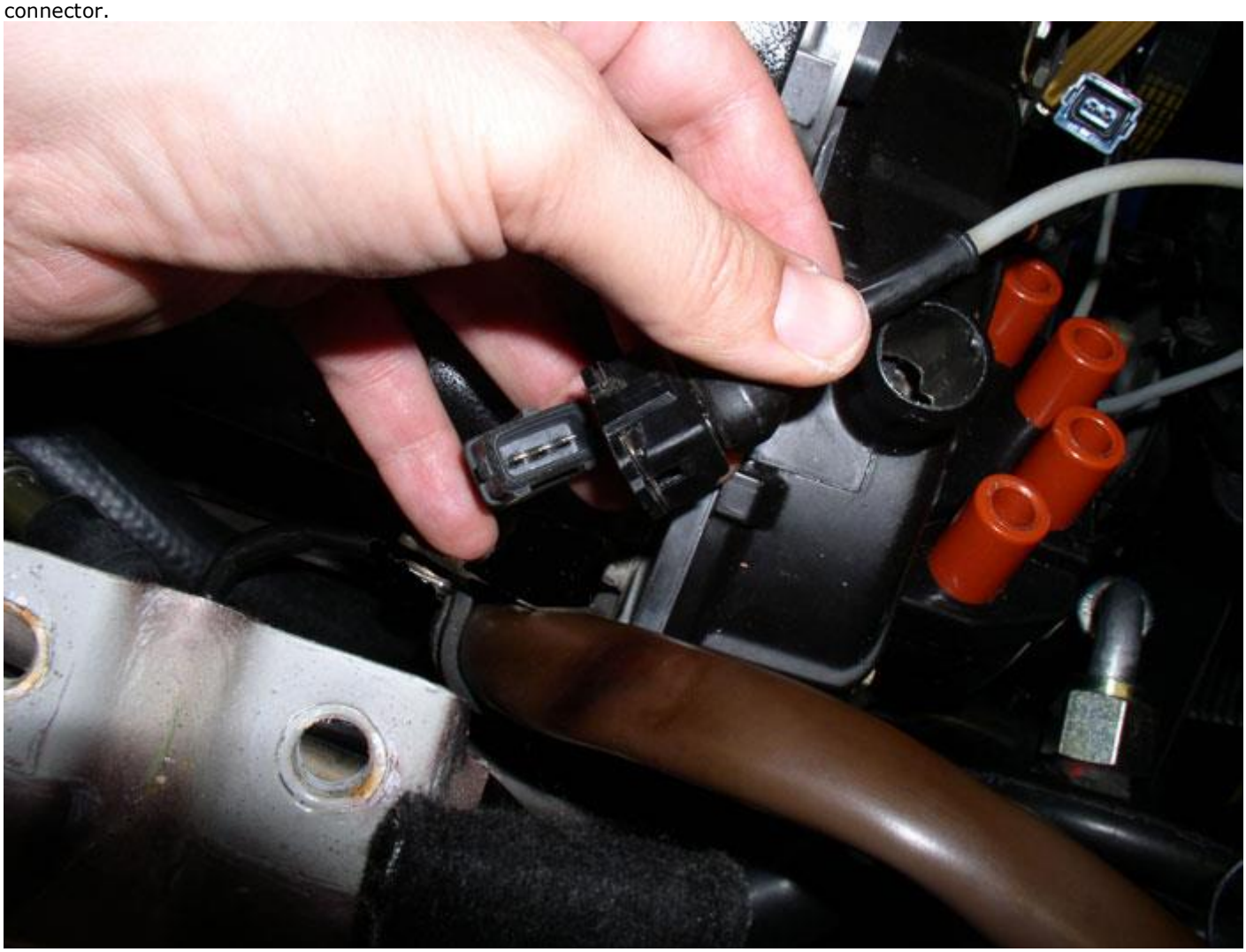



Here's the Hall Sensor plug connection to the wiring harness. This connection is typically the failure point. The sensor side of the connection becomes brittle and cracks and no longer secures a good connection with the wiring harness.




Unplug the Hall Sensor from the wiring harness and inspect the plugs condition. Mine actually looked just fine, no discolorations or cracks visible. The electrical connections themselves also looked clean and free of dirt and corrosion. If you find no problems with the Hall Sensor plug connection, re-connect the plug to the harness. Leave the lift bracket off until the cam cover is installed. If your Sensor plug is cracked or shows signs of discoloration or brittleness, I would recommend replacing the Hall Sensor - it will come with a new plug

connector.



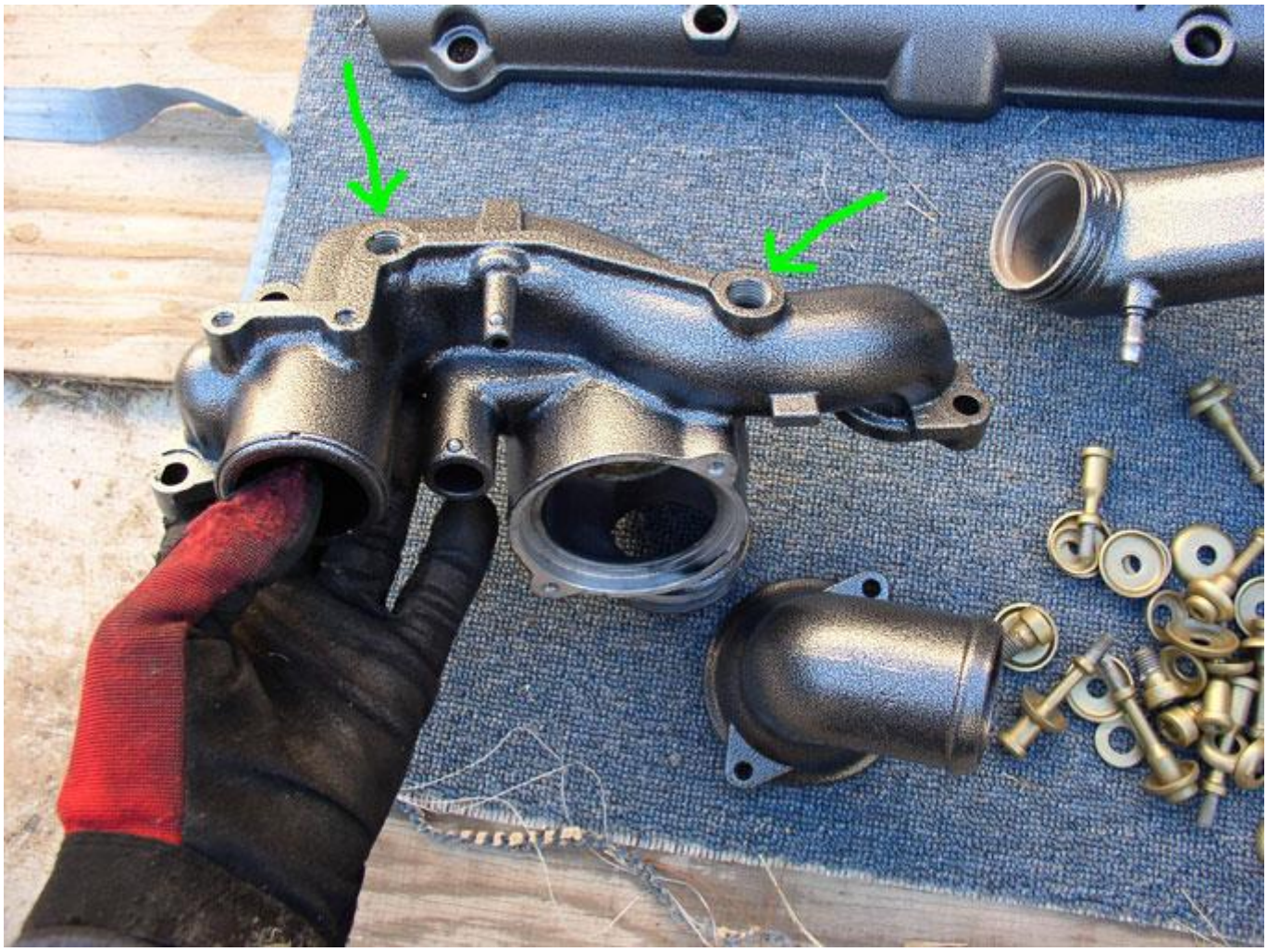
**Flappy Bearing Replacement**

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So I received my parts back from the Powder Coaters. I used Olympic Coatings in Escondido, CA. I went with a textured finish to hide the casting imperfections and a darker color to hide dirt/dust better. This finish is called silver vein. For all of these parts, it cost about $250 and took about 3.5 weeks.




If you had parts powder coated like mine, there may be some cleanup work required before reassembly. For example, depending on how good the powder coater masked off threads and ports, you may have to sand or file powder coating residue from some of those surfaces. On my water bridge, since I went with a textured finish, I needed to file smooth the mating surface for both the Temp II sensor and the Temp guage sending unit as shown below oOtherwise, I had leaks. I used a file to maintain a level surface vs using sandpaper. No need to file all the powdercoating off, just enough to smooth out the textured finish so the sealing ring gets good contact on the water bridge surface.



The mating surface on the intake runners also had residue. I used a wire brush wheel on a bench buffer to clean these surfaces. A coarse wheel with light pressure worked well for me (being careful not to introduce heavy scratches in the intake mating surface.



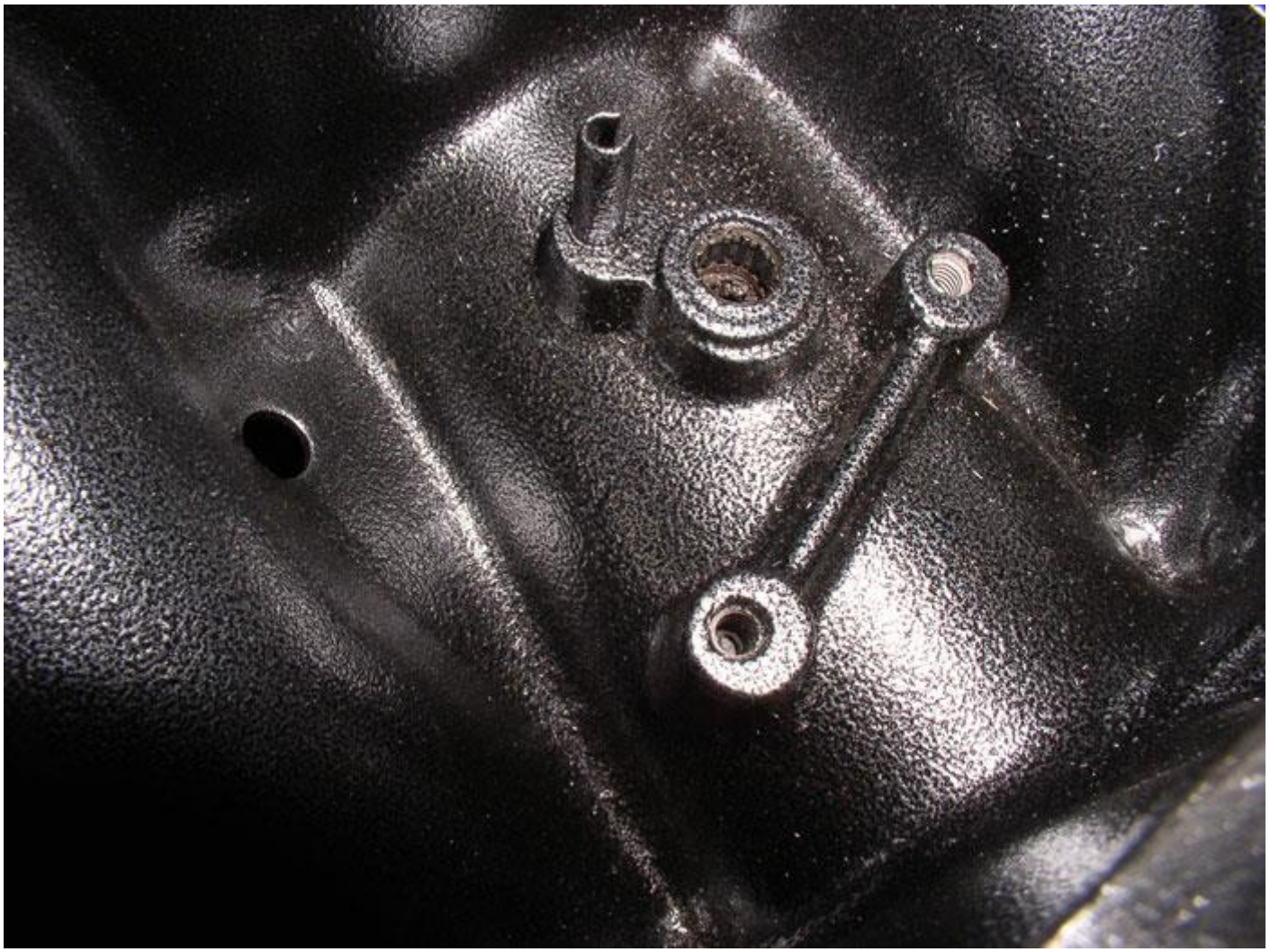

Here's the difference after cleaning one side.



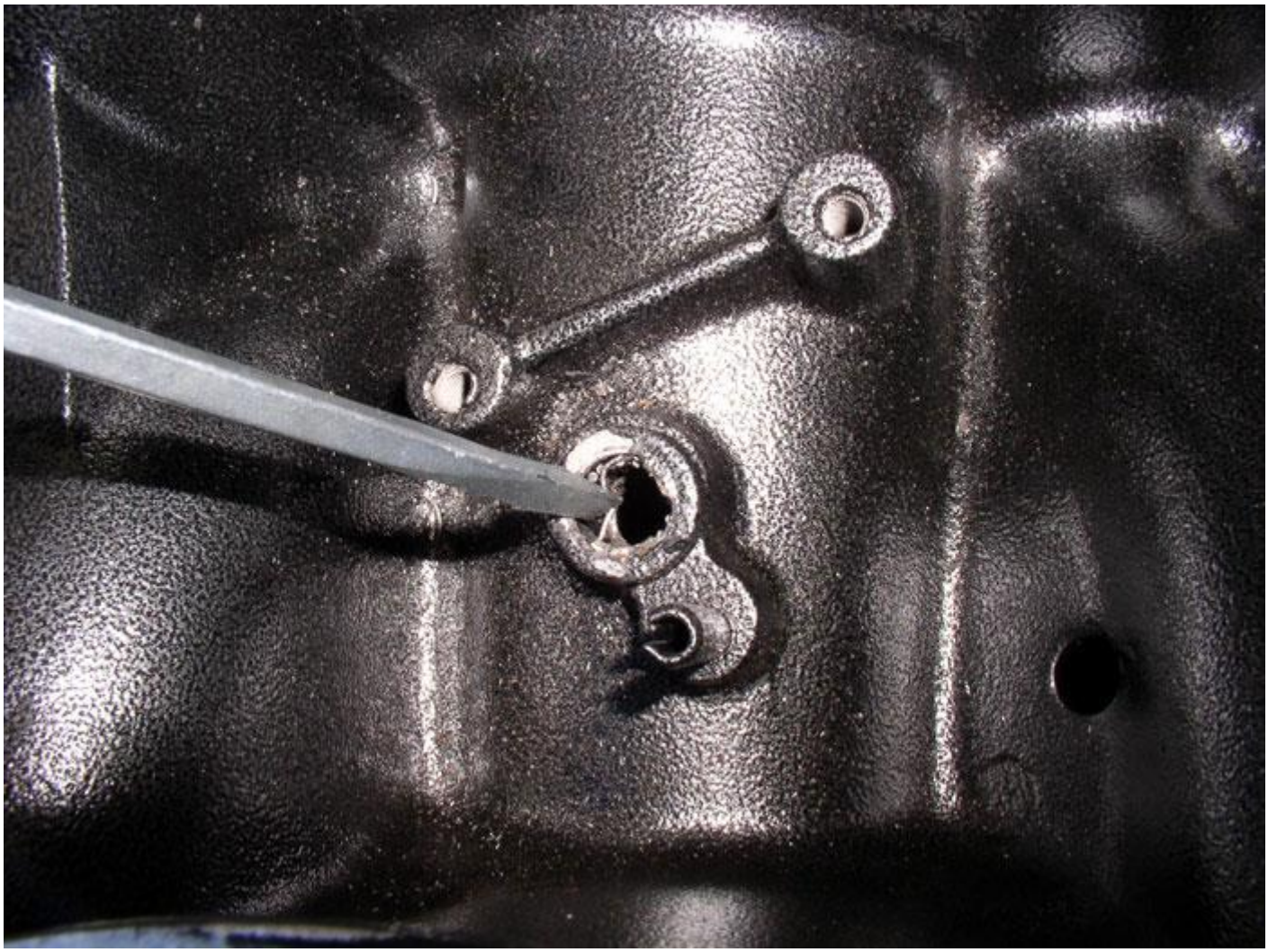
I had the cam cover bolts and intake umbrella washers also powder coated a brass finish - hoping it would look similar to the orginial finish but was disappointed in the color. Therefore, I repainted the visible areas of this hardware with engine enamel, gloss black and liked it much better.



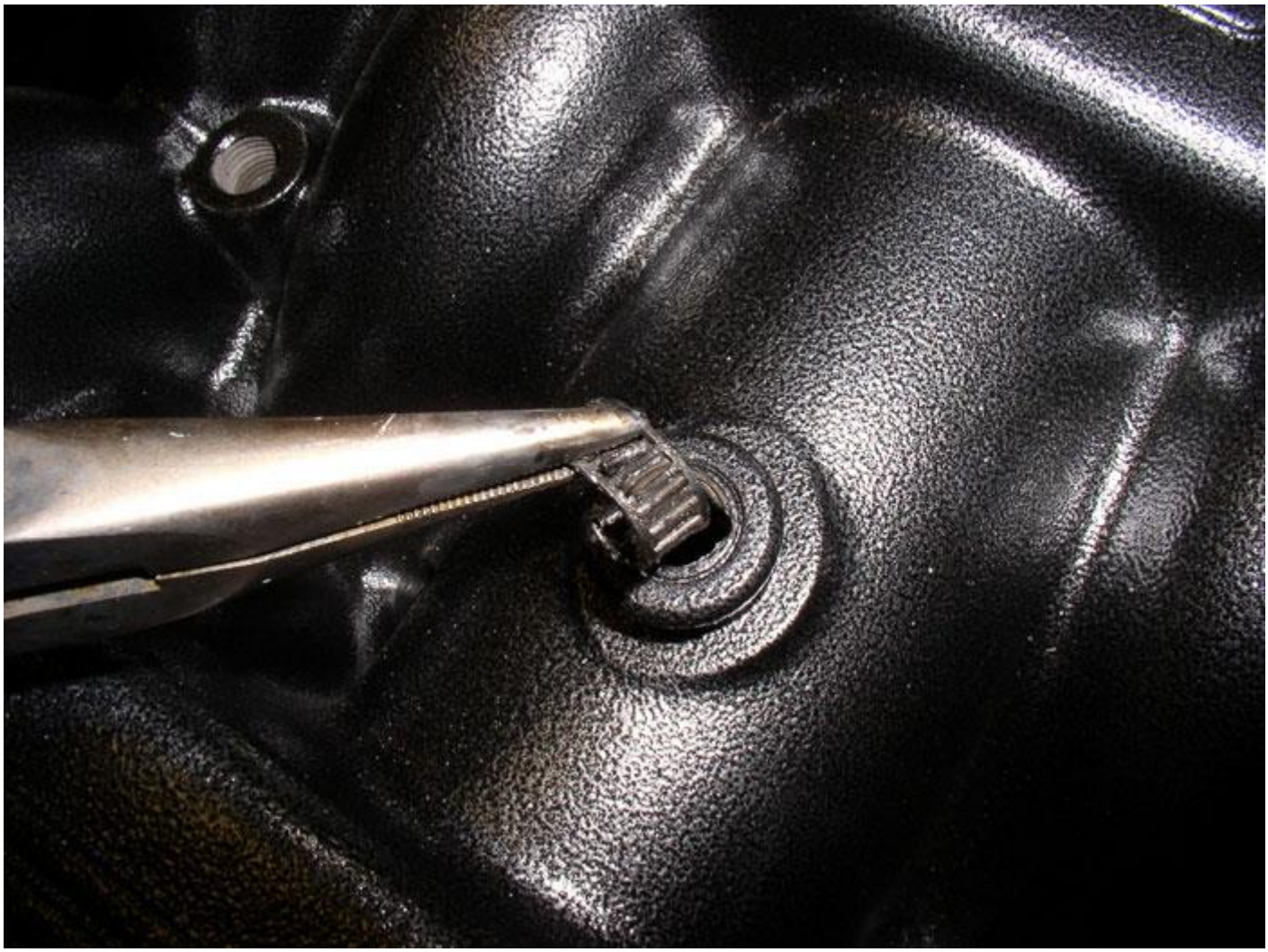
If you sent your intake to the powder coaters, it's likely you will need to replace your flappy bearings. Although, I understand some have been able to simply clean the bearings in place and re-use them. If you have a vacuum leak at the flappy bearings, you will need to replace the seals or the bearings themselves that come with new seals, if you want to cure the leak. Roger sells the correct replacement bearings and they come with double seals.



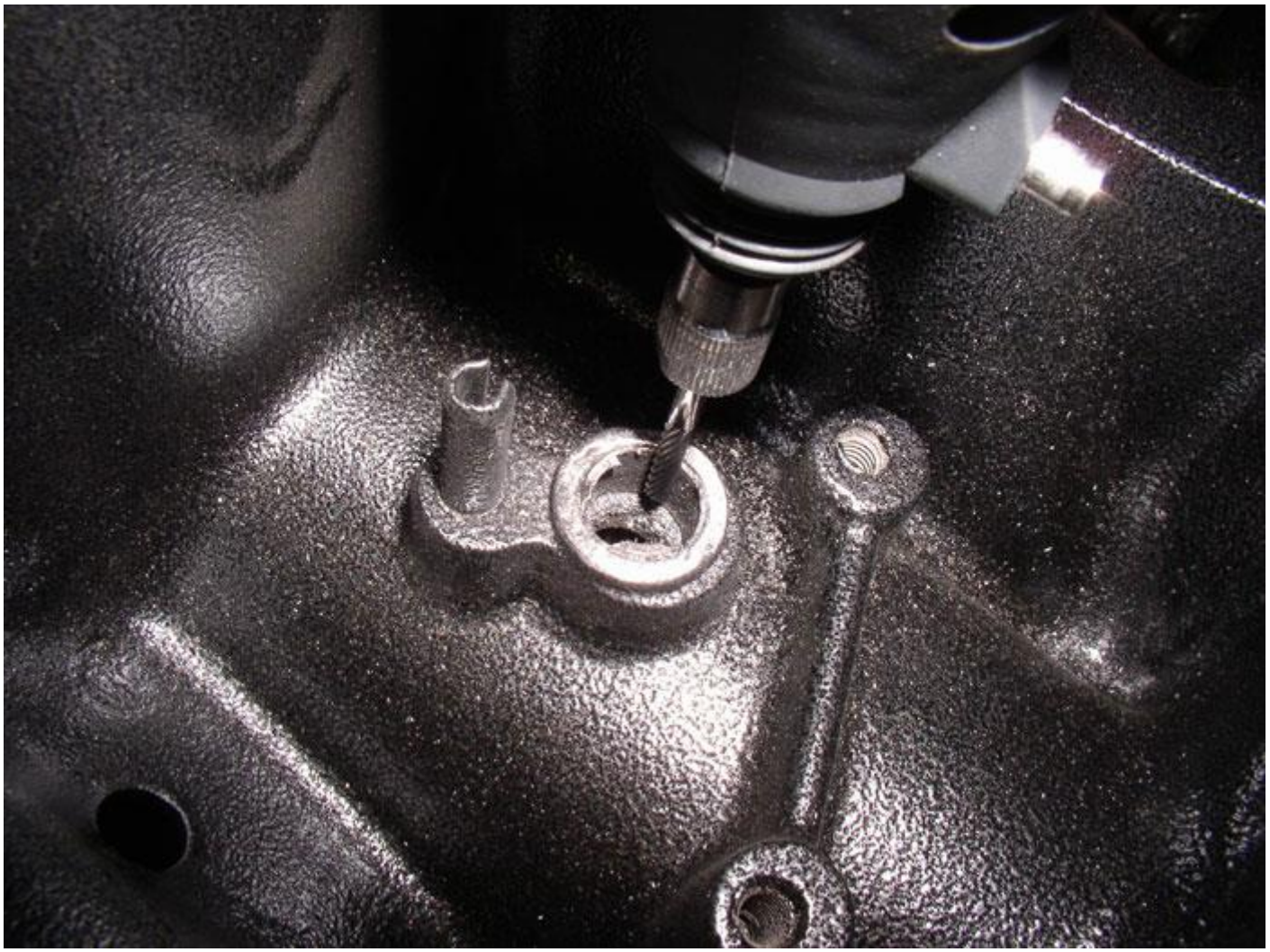
To replace the bearings with seals, first pry up the needle bearing cage with a small flat blade screwdriver.



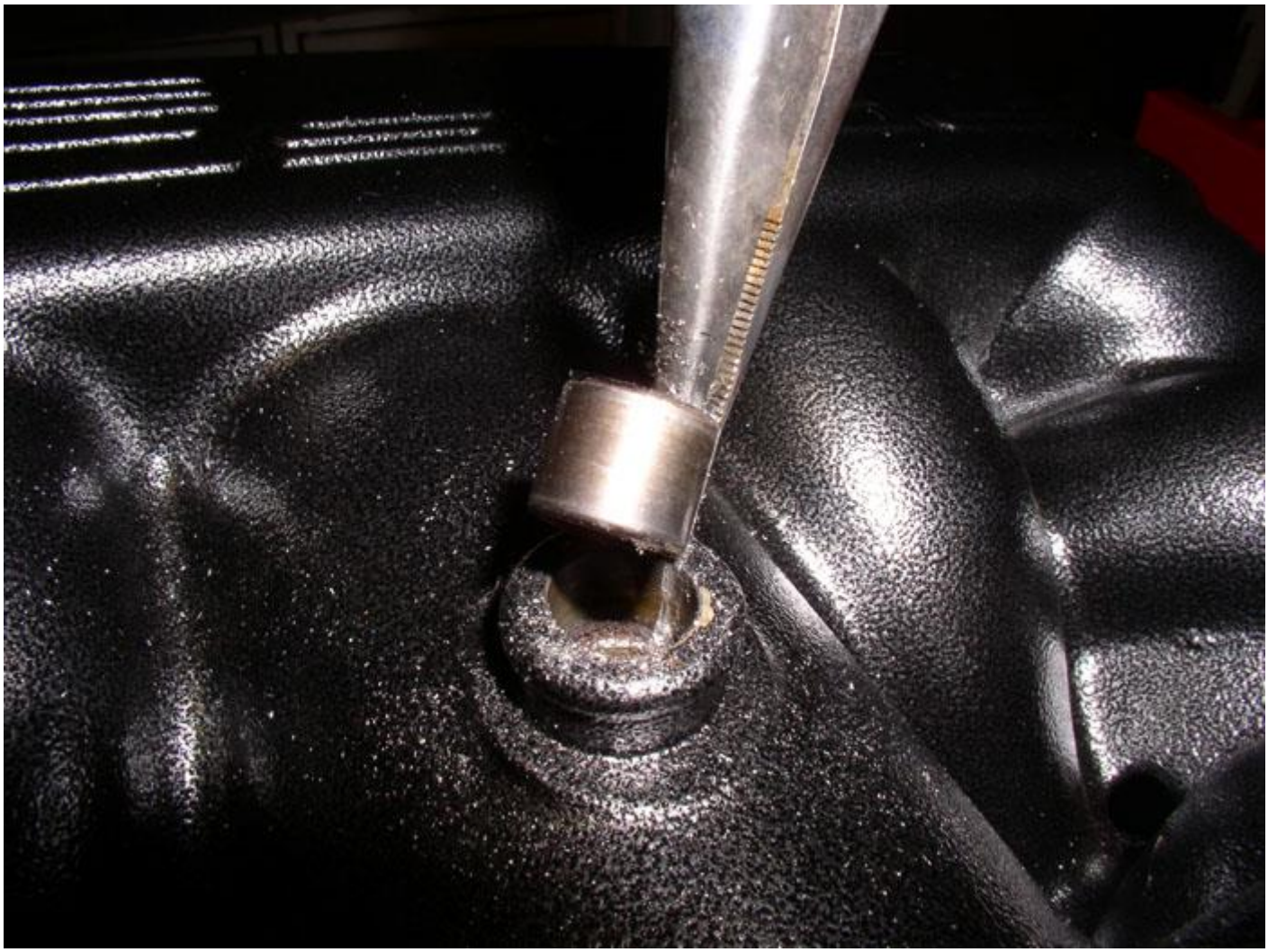
Then, use a pair of needle nose pliers to extract the needle bearing cage.



After removing all the left over needle bearings, I cut the bearing casing using a dremel Tungsten Carbide Cutter No. 9901. I learned this technique by reading one of Schocki's posts. THANKS, Schocki! Keep the cutting bit level and parallel with the bearing casing to cut a consistent penetrating groove in the casing. Apply light pressure and take your time - especially if it's your first time. I stopped frequently and checked the depth of cut. You will know when you cut through when you see the metal underneath the cutter change to a bright silver ( this is the aluminum seat - the intake). Cut lightly and make sure you have a steady line all the way down the length of the bearing casing. At that point, you should be able to pry under the lip of the bearing casing with a screwdriver to break it loose.



Once the bearing is broke loose, extract it with a pair of needle nose pliers.



Here's a pic of the cut bearing casing.



The objective is to cut through the casing with minimal scoring to the bearing seat. Perform the same operation on the bearing on the other side of the intake



Next, clean the bearing seats with a clean rag - a flat blade screwdriver helps.

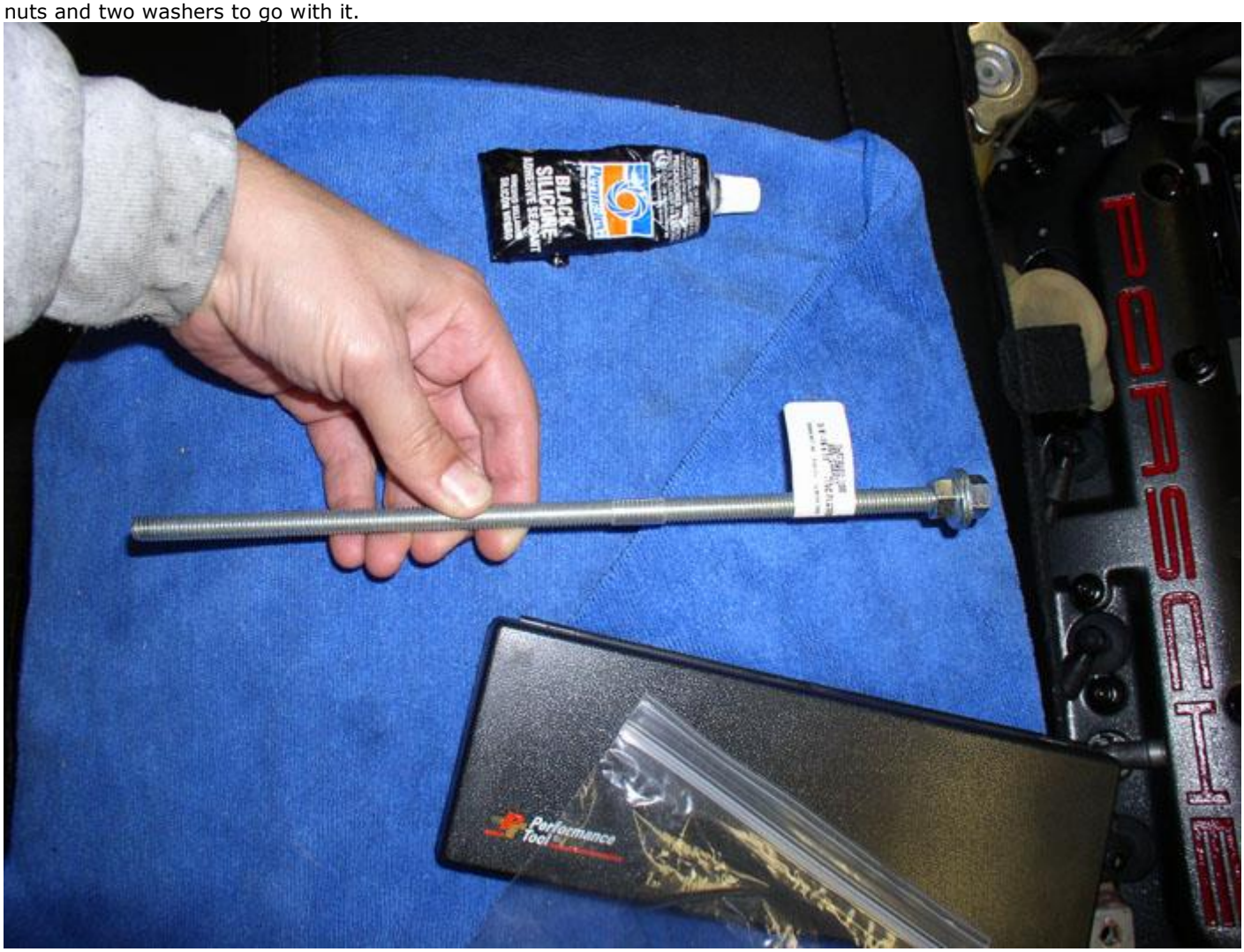


Lubricate the bearing seats with WD-40 or similar product. I used a q-tip to apply the lubricant.



To install the new bearings, I used a 12" length of 3/8" threaded rod (from Home Depot) and also bought two

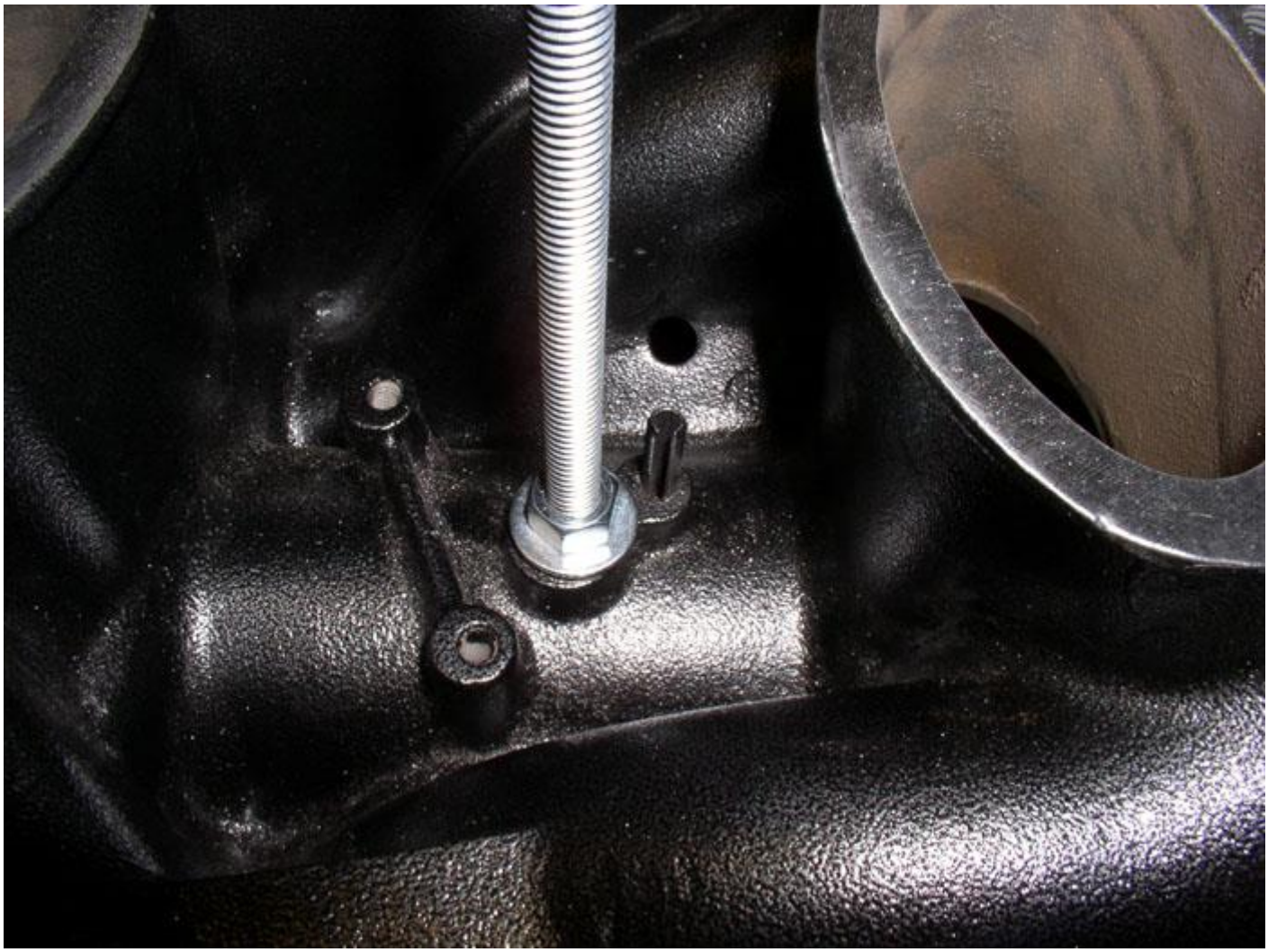
nuts and two washers to go with it.




Here's a close up of the threaded rod I purchased from HD. I found the 3/8" thread to fit perfectly inside the bearings.




Put one nut and one washer on the threaded rod and insert the rod through the bearing seat (it doesn't matter if you start with the top or bottom bearing)....



....and out the other side with enough thread to place a bearing and nut with washer.



Place a bearing on the rod with the flat edge facing down toward the intake seat. The rounded edge of the bearing should be facing up away from the intake as shown. When placing the bearing on the threaded rod, be careful not to force the bearing on so as to distort or displace the small seals inside the bearing.



Place a washer and a nut on the rod and finger tighten down.



Use a 9/16" wrench to turn the nut while counterholding the other nut on the other end of the rod.



Tighten down the nut. You should not encounter much resistance at all.



Tighten down until the washer is flush with the intake.



Then remove the nut and washer. Carefully extract the rod being carefull not to displace the bearing seals.



Perform the same operation on the other bearing on the opposite end of the intake.



Congratulations.....you just completed the flappy bearing replacement!

**Flappy Valve and Diaphram Installation**

---

After the bearings are installed, you can install the flappy valve (plate and shaft) and vacuum diaphram next. The flappy shaft has plastic washers, a spring, spring washer and flat washers. Here's the oder these parts were on my flappy.



Here's all the parts that need to be re-installed that are part of the flappy system.

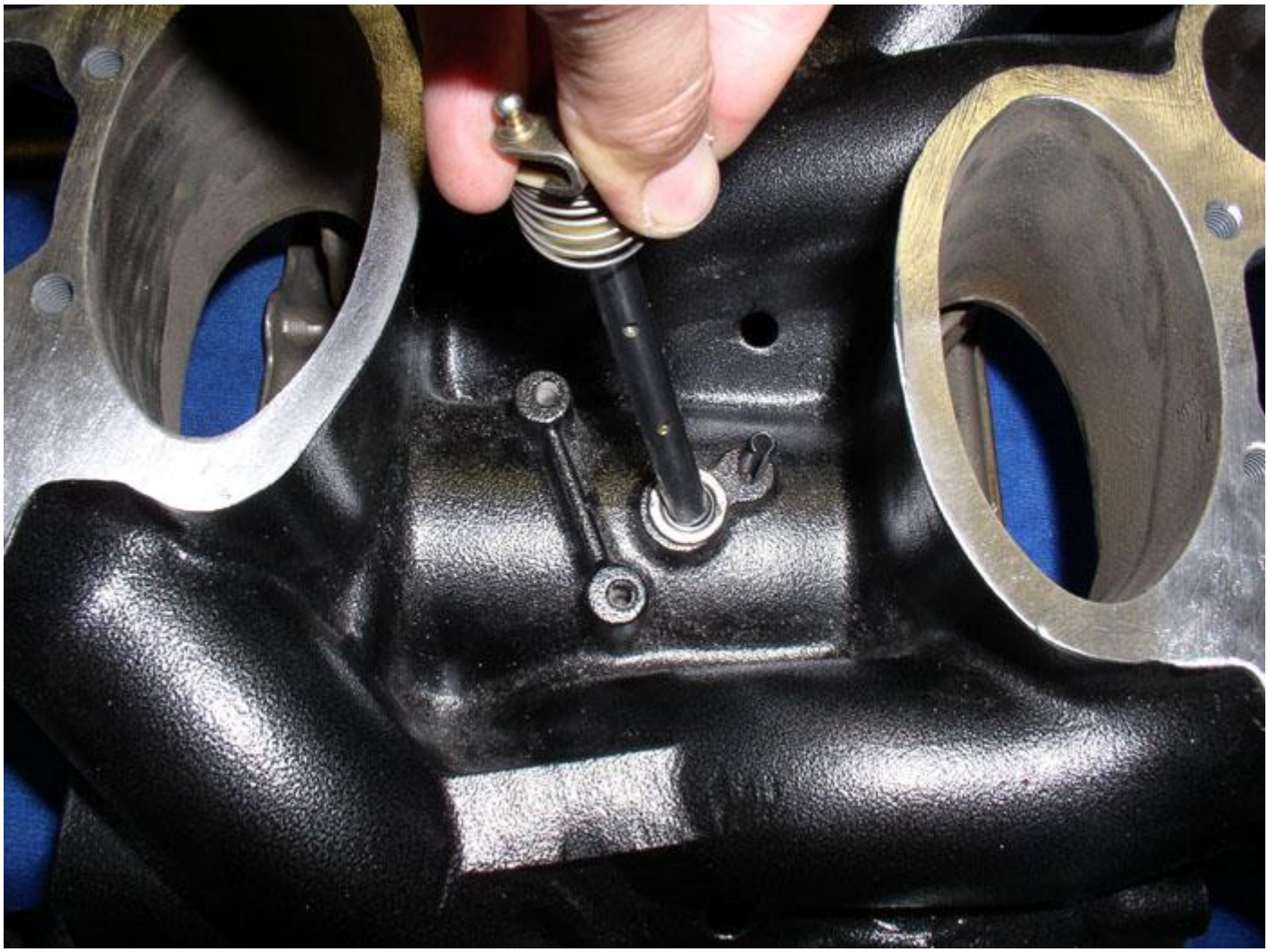


Start by applying a light coat of silicone lubricant on the flappy plate shaft before installation.




Insert the flappy shaft with hardware in the correct order (as shown above) through the bottom bearing. Be careful while inserting the shaft to ensure the seals in the bearing do not distort. I used a twisting motion on the install. When you insert the shaft all the way to the bottom of the bearing seat, you can position the spring onto the spring catch (the spindle protruding up from the bottom of the intake just to the right of the flappy plate shaft - see pic). IIRC, to get the proper tension on the spring and plate action, I wound the spring about twice around the shaft in a tightening direction. UPDATE: After checking the spring tension on a virgin intake (Idaho), I discovered the spring tension was less than one turn around the shaft on that car and flappy movement would begin at vacuum of 2 inches Hg and be fully open at 4 inches Hg. I believe the lighter tension is more appropriate and I'll be correcting the tension on Virgina next time I have teh intake off. (See post 166 for pictures and additional information about my testing of spring tension on Idaho).

UPDATE 2: you will notice there is no flappy stopper nut attached to the top of the small spindle that the spring catches on. There should be one there but it was missing on Virginia and I didn't know it was missing until I had disassembled the intake on Idaho. See post 167 for pictures of how the nut should be installed and how it actually prevents the flappy plate from completely closing. I understand that if yours is missing, you can manufacture another one by taking a 19mm bolt and cutting the head off and drilling a hole (off center) to place on top of the spindle. See pics in post 167.



On the topside of the intake, install the retaining washer....



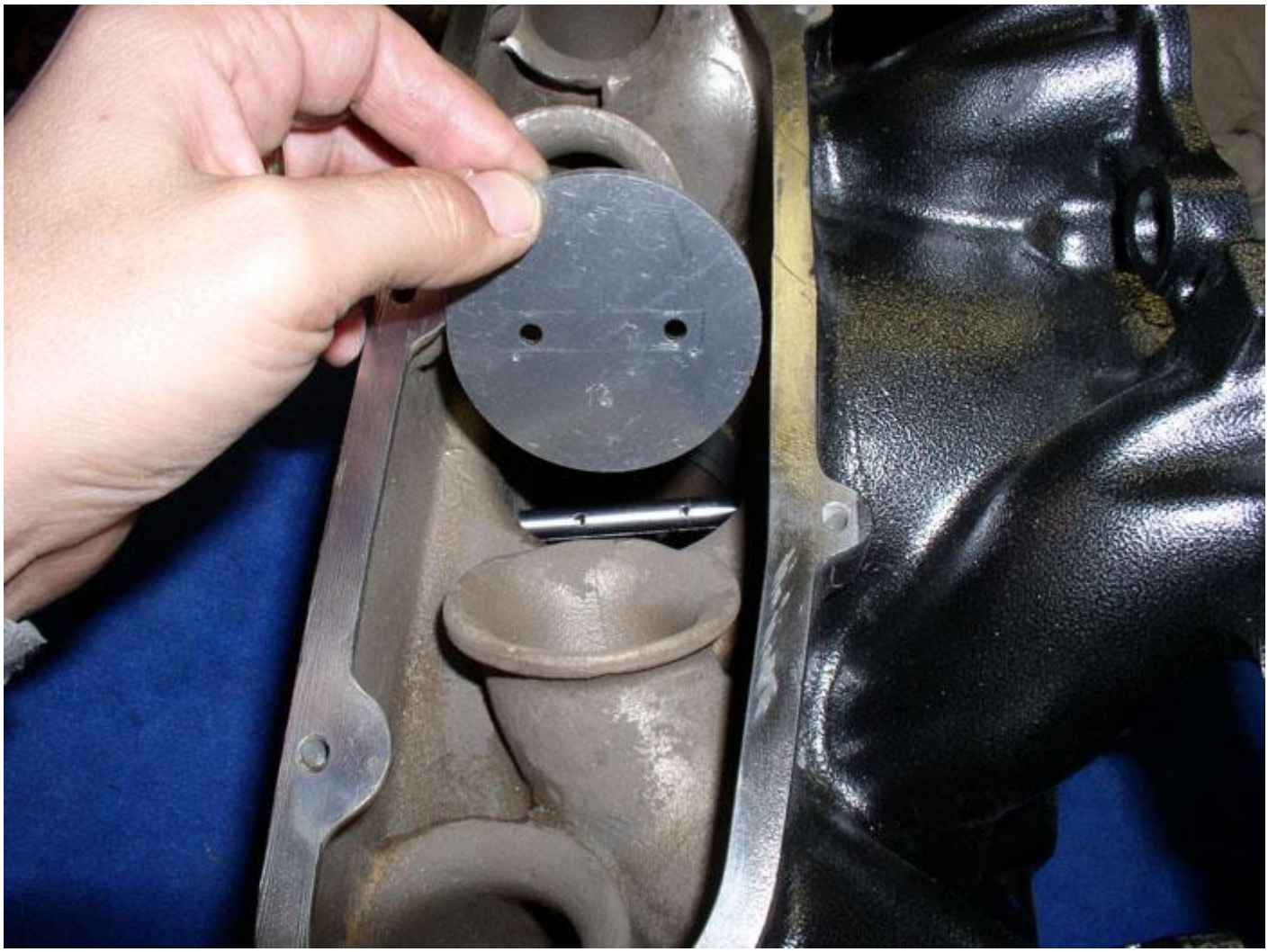
...followed by the spring circlip.



Ensure the circlip is fully seated in the groove in the flappy shaft.



Next, rotate the flappy shaft 90 degrees and insert the flappy plate into the slot in the shaft. Orient the plate in the same manner as before the disassembly. If you marked the plate, follow the indications on your markings. If you didn't mark the orientation, you'll need to examine the camfers on the plate and make sure they are positioned to mate smoothly against the wall of the intake.



After you've inserted the plate, operate the shaft/plate without the screws inserted to ensure smooth operation of the valve. UPDATE: with the flappy plate stopper nut attached, the flappy plate should not fully close. A slight gap should exist between the plate edges and the walls (about 1/16"). See post 167 for pictures of the correctly installed stopper nut and gap between the plate and walls. The next time I have the intake off of Virginia, I will be installing the stopper nut. There should be no sticking or rubbing. After fine adjustments to ensure smooth operation....



....install the mounting screws. I used threadlocker blue on the threads of the screws before installation. Tighten down the screws. Re-check operation of the plate and ensure smooth operation.



Install the rubber cap on top of the intake.



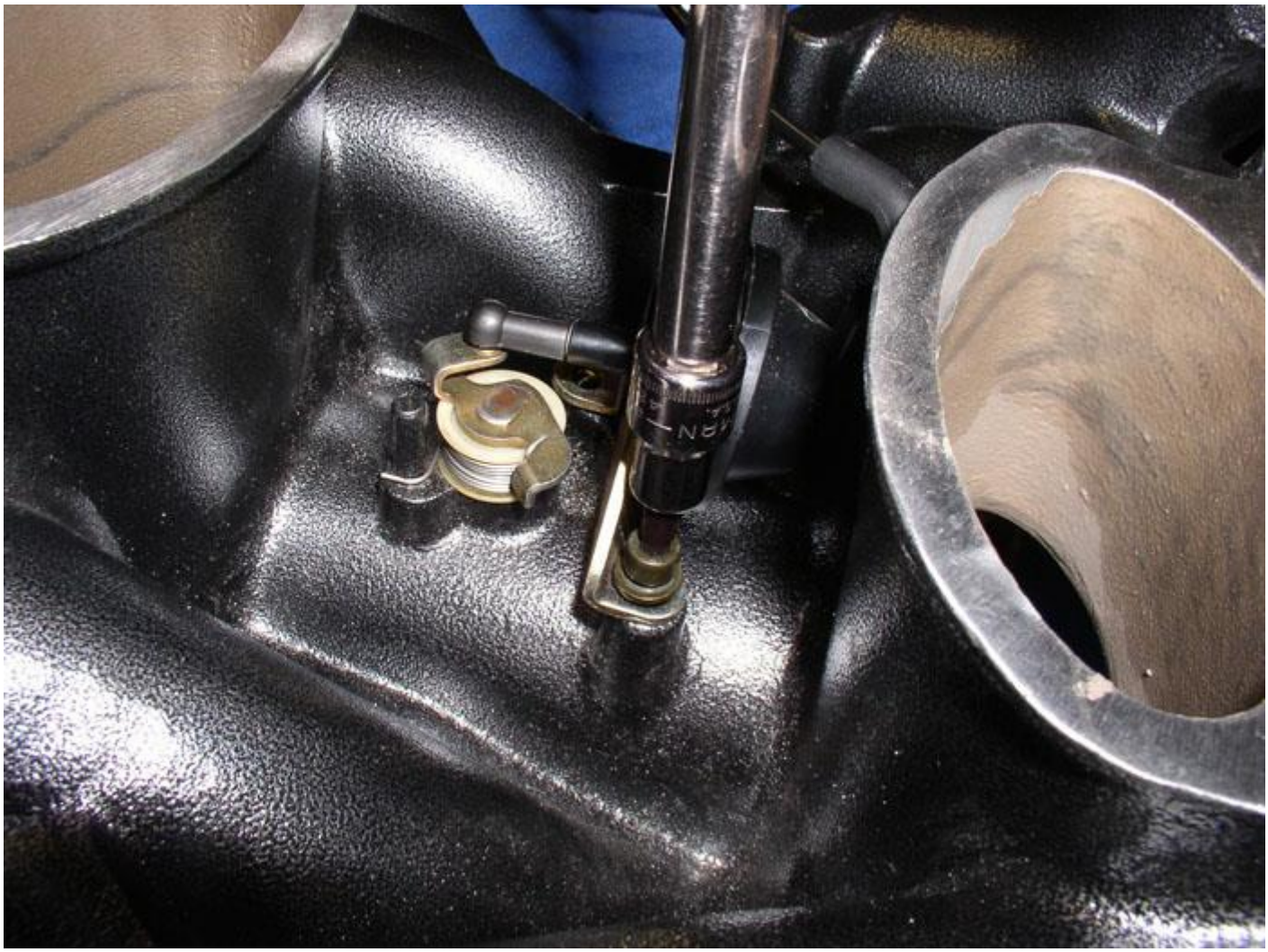
Position the diaphram unit over the mounting holes as shown and line up the diaphram ball connector with the ball on the flappy shaft lever arm.



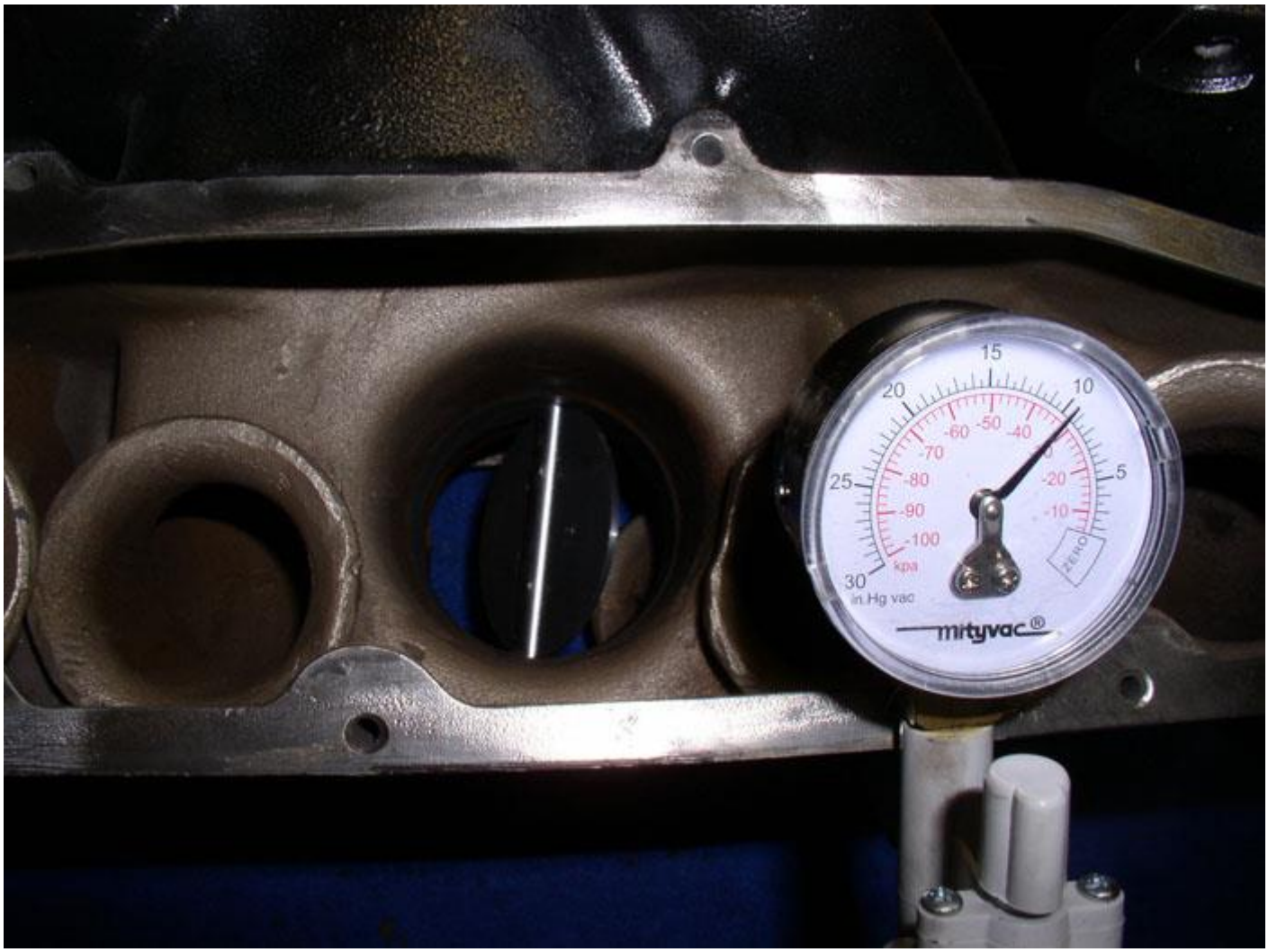
Note how the spring catches are attached. One on the intake spindle and the other end of the spring on the shaft lever arm. Press the diaphram ball connector onto the ball of the lever arm as shown.



Install the mounting bolts. Two 5mm allen head bolts. I used about 6-7 fllbs torque or about 75 inch lbs.



Finally, connect a hand vacuum pump up to the diaphram vacuum elbow and test operation of the diaphram and flappy valve under vacuum. It should operate smoothly. Mine would begin to move at about 5 inHG vacuum and would be fully open about 12-13 inHG vacuum. This was about the same as before the disassembly.




Flappy Valve and Diaphram Installation complete!

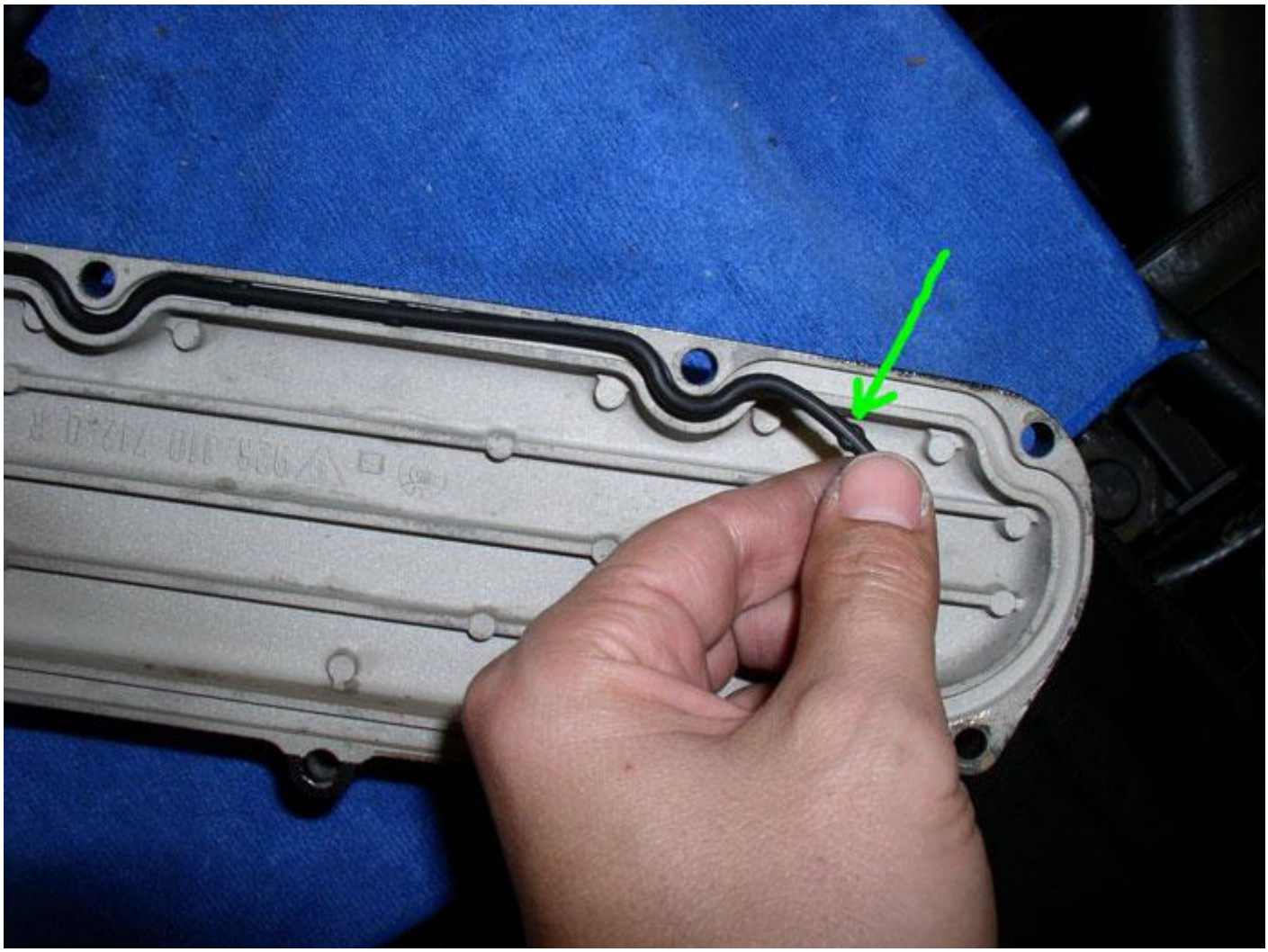
**Detail Painting Intake and Cam Covers**

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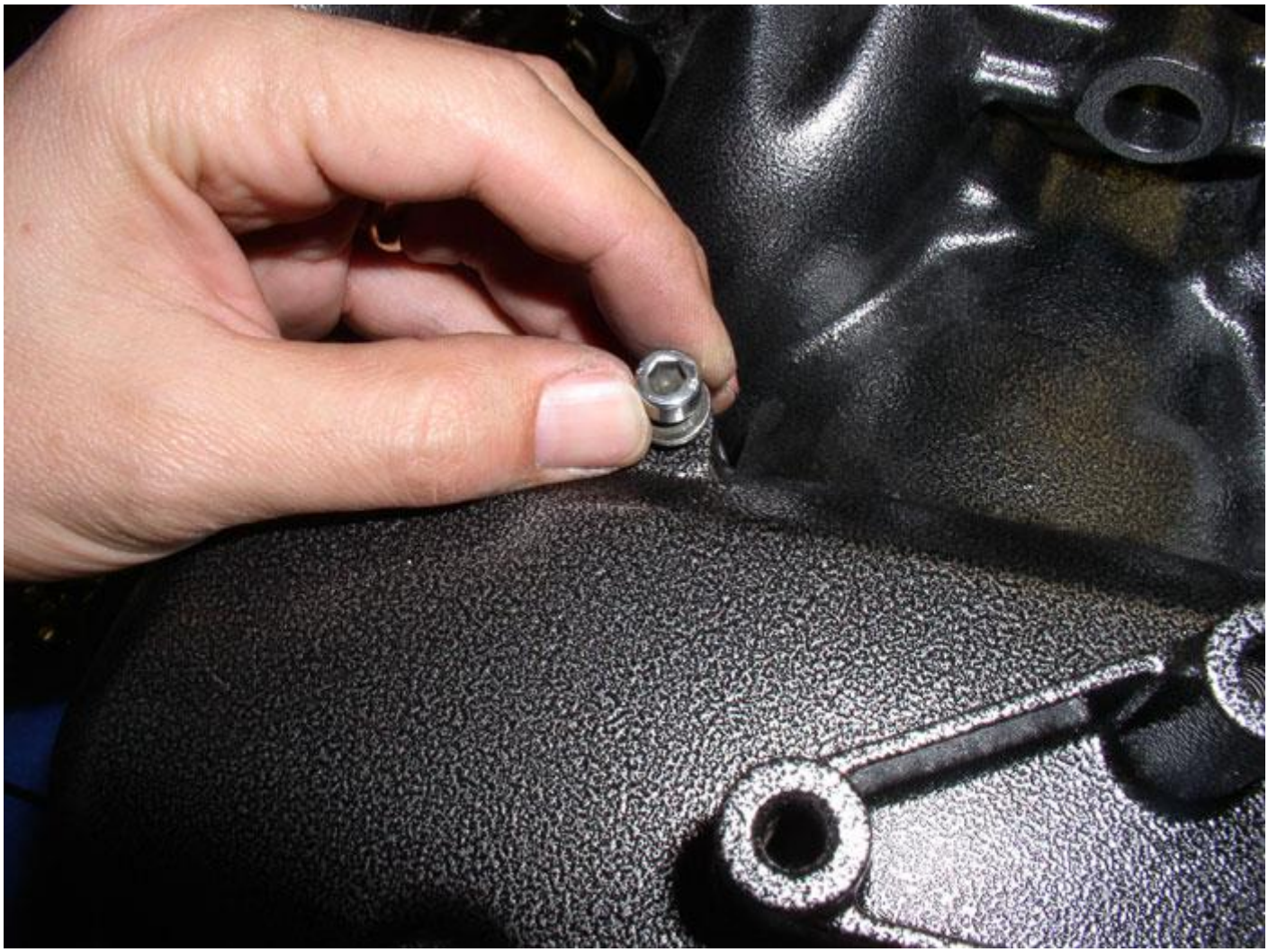
Next, install the intake side covers with gaskets. Each side cover is different so the gaskets are fitted for their respective cover.



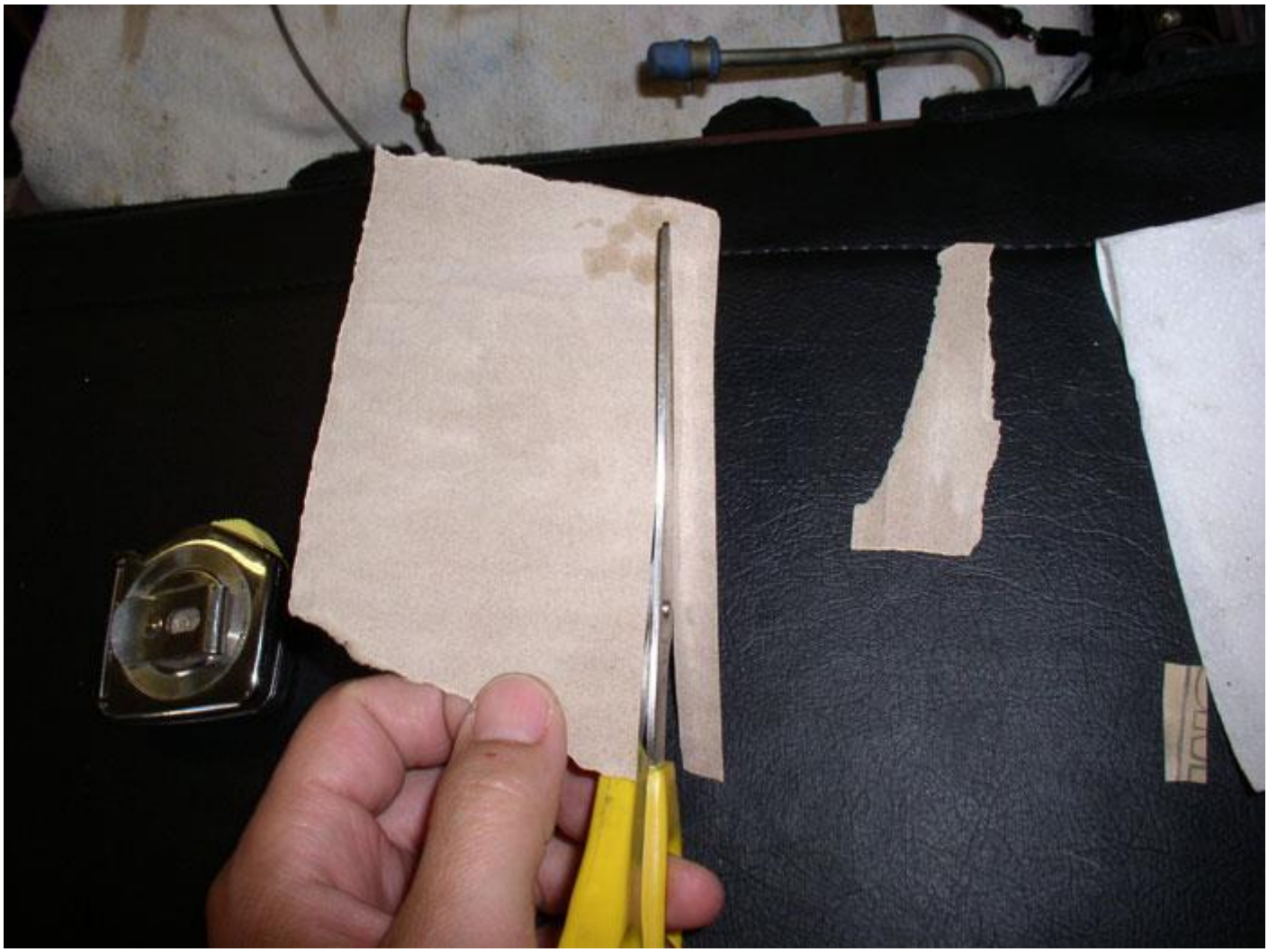

As you lay in the gasket into the side cover channel, notice the rubber tabs on the gasket - designed to hold the gasket in place. Therefore, no adheasive/sealant is required on these gaskets.



Next, position the cover with gasket installed onto the intake and install the 5mm allen head bolts. Torque the bolts to 8 ftlbs or 96 inch lbs.



If you decide to paint the lettering on the intake and cam covers and you will be painting over the powder coat surface, you will need to prepare the cam cover and intake surfaces for the paint. I used 150 grit sandpaper. Cut a strip approximately 1/4" wide and about 6" long.



Fold the sandpaper in half lengthwise so it's about 1/8" wide.



Select a small, narrow blade screwdriver ensuring the blade fits between the recessed lettering grooves.



Bend the sandpaper strip over the tip of the screwdriver as pictured and lightly sand the "flat" of the letters on the cam covers. No need to try to remove the existing powder coat or painted surface. The objective is to simply roughen up the surface so the paint will bond better.



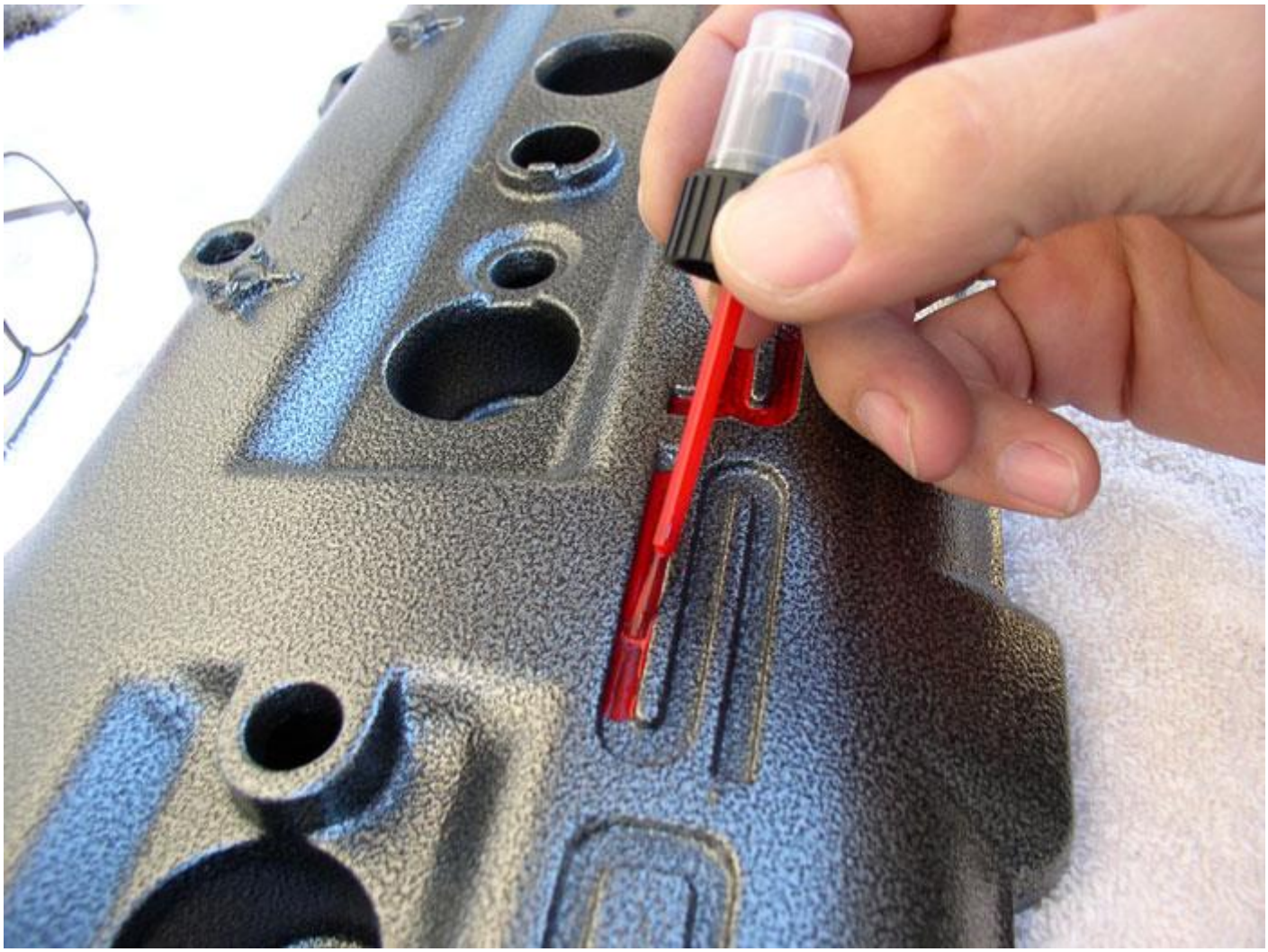
After the light sanding, use a damp (not wet) terry cloth rag to wipe the freshly sanded letters clean of dust.



I used automotive touch up paint you buy at an automotive parts store or Wal-Mart in this case. For the red letters, I used a GM color #519 "Victory Red". I also bought a variety of paint brushes thinking I would certainly have the perfect brush to apply paint. However,.....




I found the applicator brush that came with the touch-up paint to work very nicely. So I used it. I applied 3 coats of the touch-up paint. Let the paint dry 30-60 minutes between coats ensuring paint is dry to the touch (not tacky) before applying next coat. I focused on painting the "flat" of the recessed lettering and didn't paint the "walls" of the recessed letters.



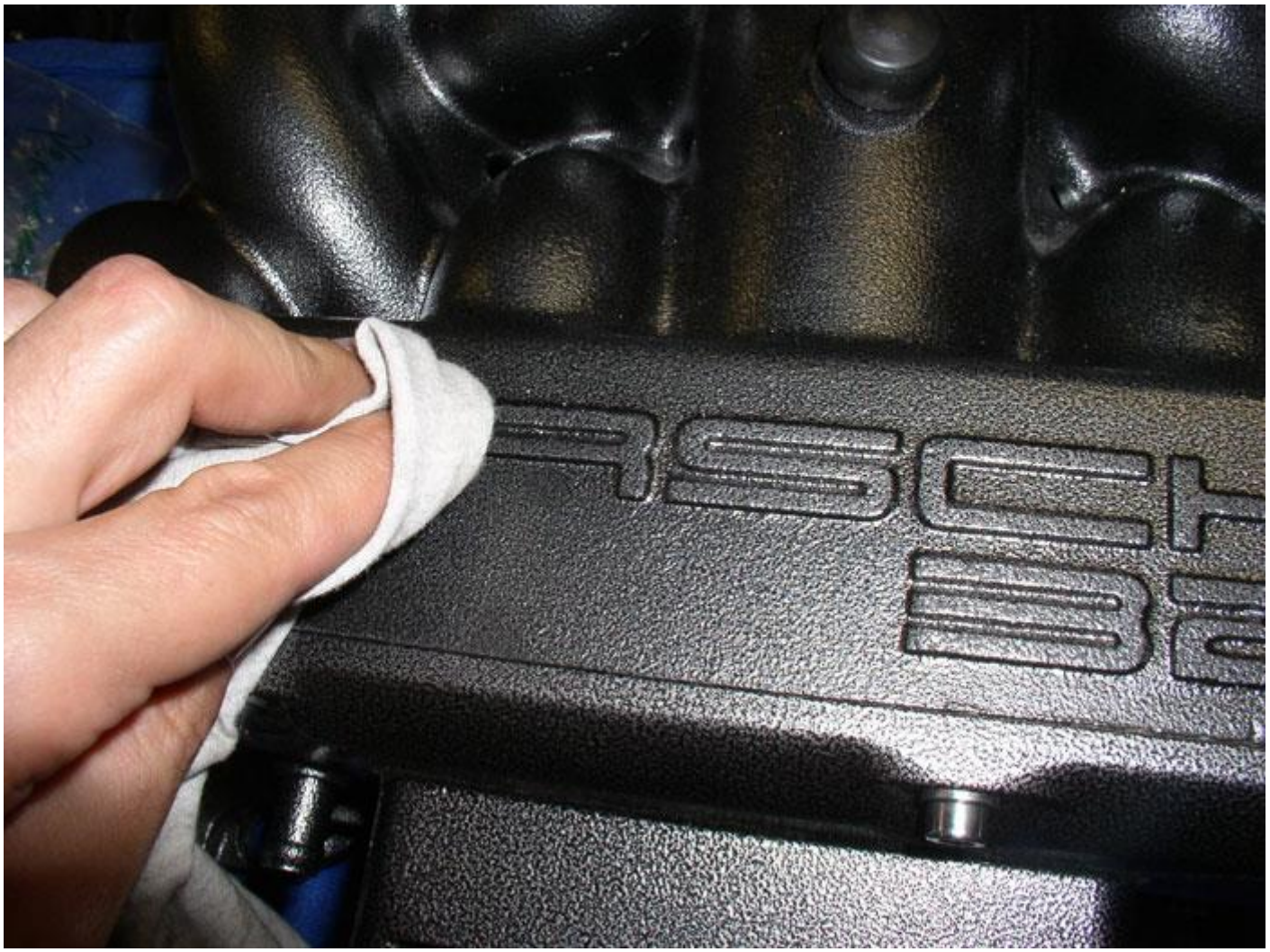
When done, it should look something like this.



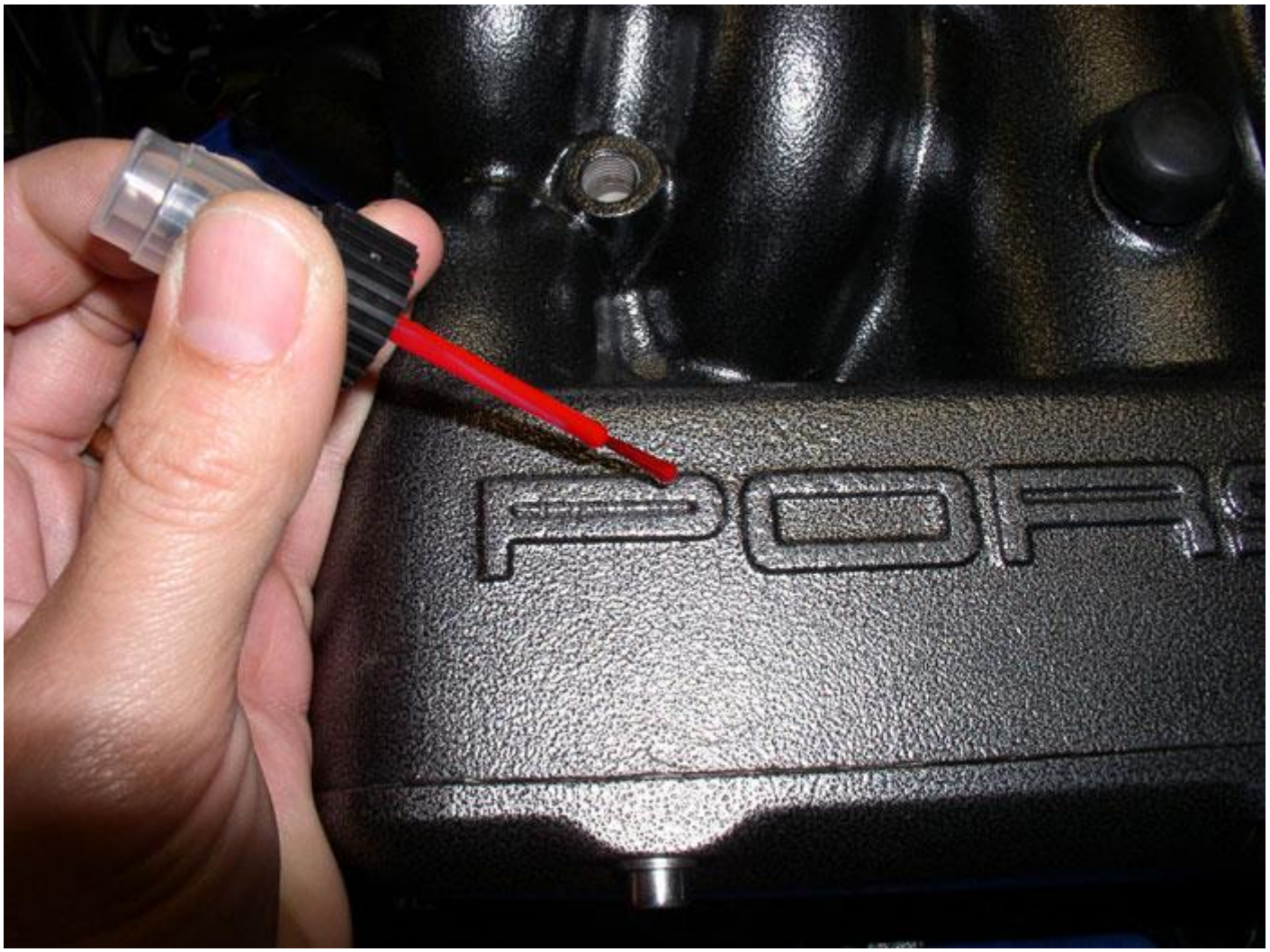

Next, the intake lettering. Start by rouging the surface of the letters with 150 grit sandpaper as with the cam cover letters.



Wipe the dust off the letter surfaces.



Then apply the paint as on the cam covers. Again, I used 3 coats of paint and tried to stay on the flat of the letter only.



When done, it should look something like this. I used "Ford Chrome Yellow" on the "32V" letters. I thought the

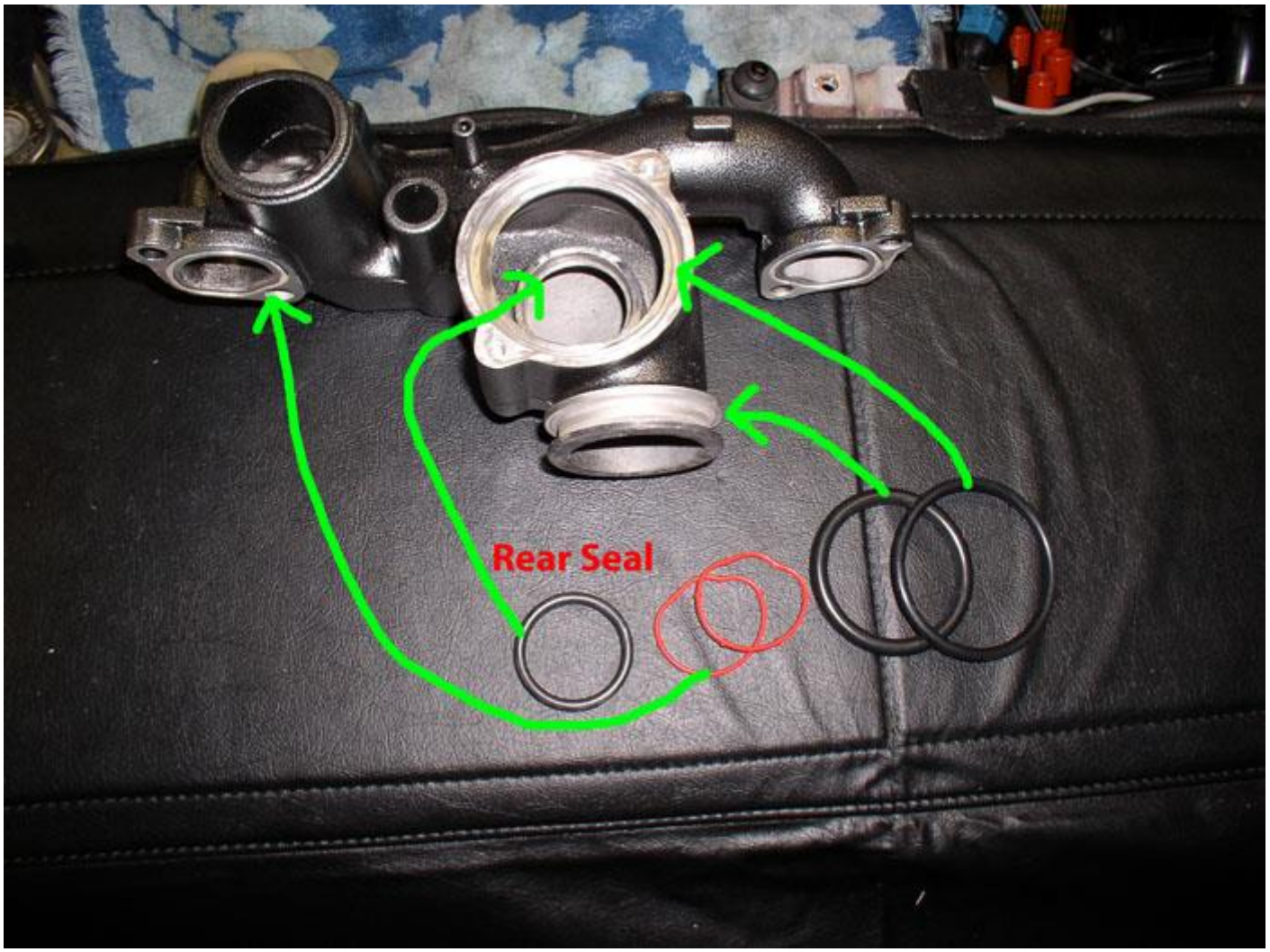
yellow would match the other yellow highlights under the hood (e.g., oil filler cap, oil dipstick, yellow decals).



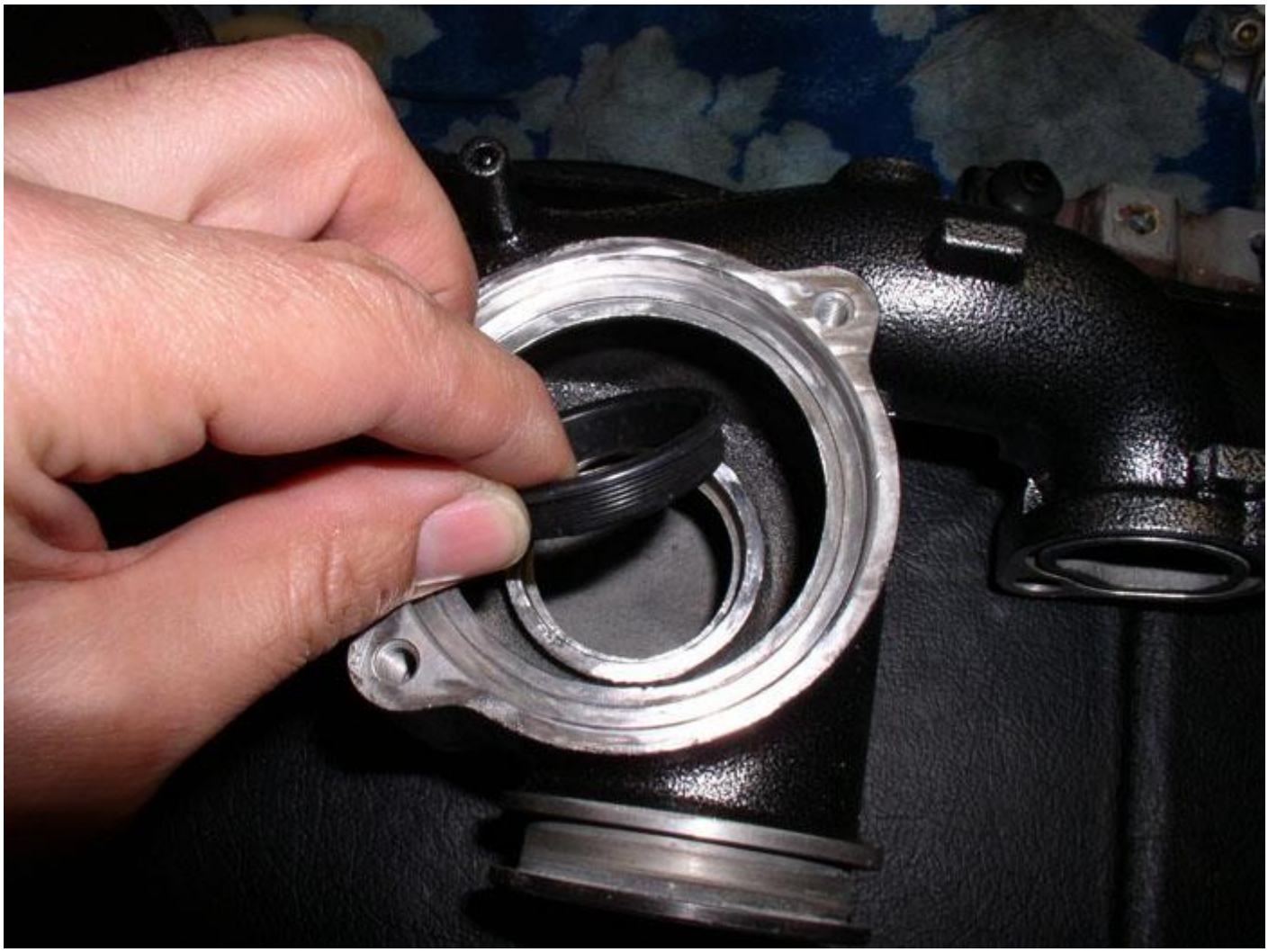

**Water Bridge and Oil Filler Neck Installation**

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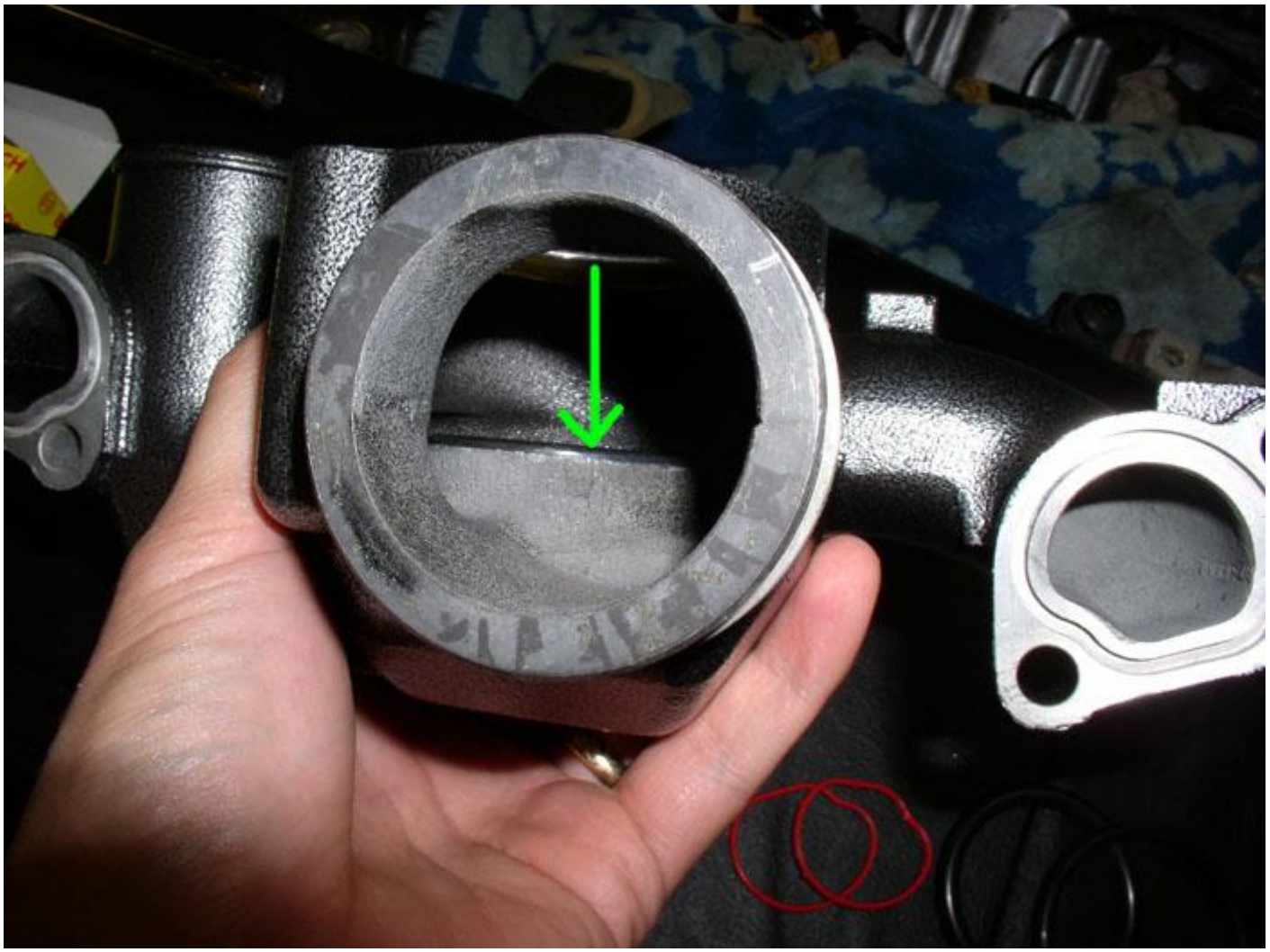
OK....back to the installation. Next, I prepared the water bridge and oil filler neck for re-installation. First the water bridge. It's a good idea to replace all the o-rings and seals. Here's a pic of the bridge and the seals that need to be installed. There are two red seals for the bridge to cylinder heads. A thermostat rear seal that mounts to the rear of the bridge. A thick o-ring that is installed at the base of the bridge for the bridge to block connection. And finally, the thermostat o-ring for the 90 degree elbow pipe.




First, install the rear seal. Simply press it into place as shown.



Ensure it is fully seated. The lip should lay flat on the thermostat housing as shown.



Next, the bridge to block o-ring. I applied a thin coat of silicone lubricant to the o-ring to help get the ring on the bridge but also to help install the bridge into the block.




The mounted o-ring should look like this.



Next came the bridge-to-cylinder heads seals. There are two of these and they are moulded to the contour of the bridge port. Insert the seal into the grooves matching the moulding to the grooves in the port.



You will notice small knobs that protrude from the seal that help hold the seal in place during installation.
Installed seal should look like this.



Now it's time to fill the block with coolant. I usually simply install the bridge with the block empy of coolant. Being adventurous, I decided to fill the block first to aid in bleeding air in the system when re-filling the coolant. I found this method to work much better at getting air out of the system than my previous method. Remove the rag protecting the thermostat bridge port to the block and instert a funnel. Also, remove the stuffing from the cylinder heads coolant ports and ensure the mating surfaces are clean if you haven't already cleaned them.



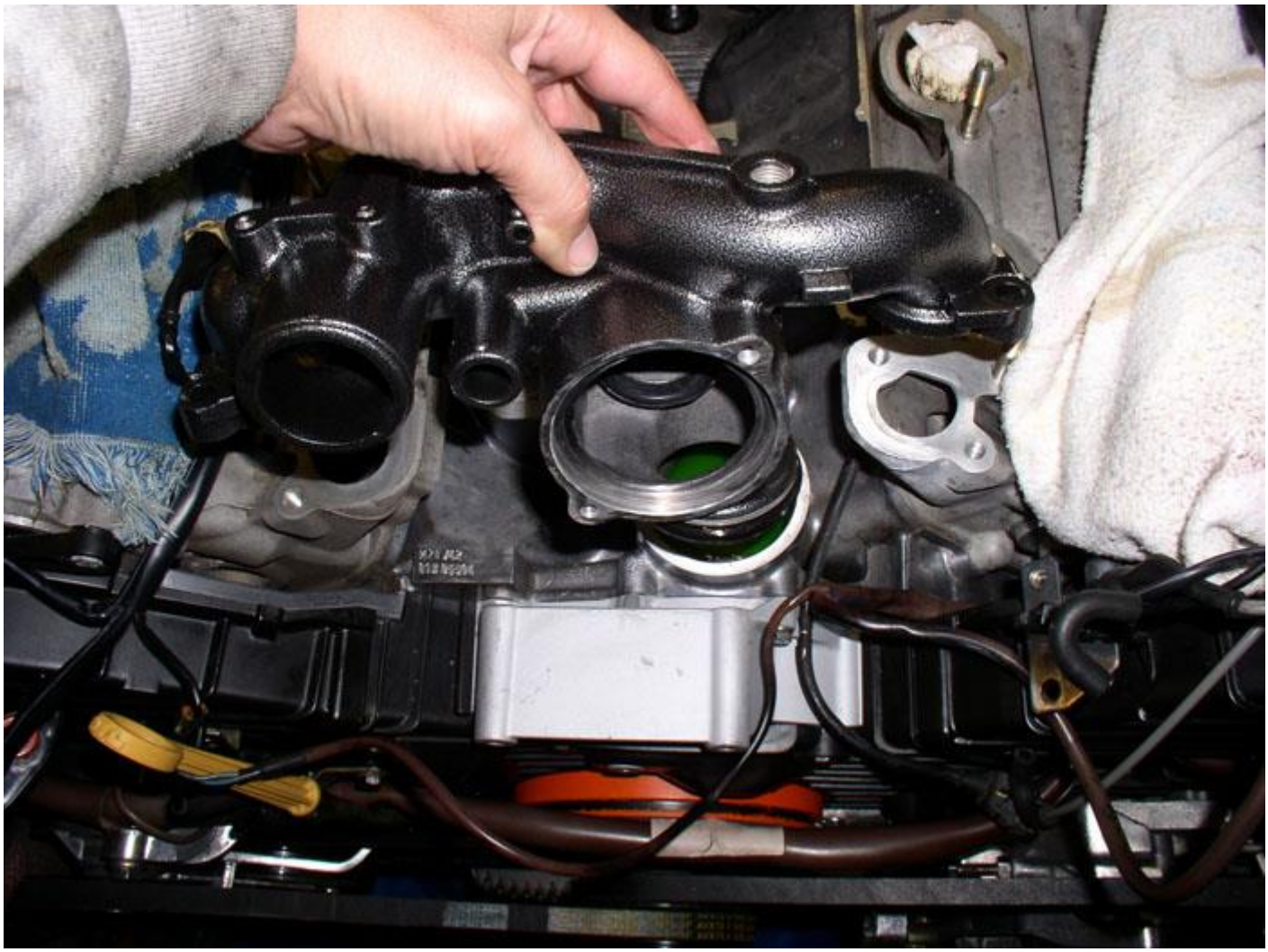
It's best to use distilled water mixed with your coolant. Continuing to feel adventurous, I used a 70% water and 30% coolant mixture this time. Previous times I always used 50/50 mix.




Add coolant until you see it pool at the base of the thermostat bridge port in the block.




Next, Position the bridge and line up the bridge-to-block o-ring.



Press the bridge down from on top until it is fully seated. The cylinder head ports on each side will seat first.



Install the 6mm allen head bolts. There are four of them. The long one goes on the passenger side to the rear. Make sure you also install the fuel line clamp bracket on the forward passenger side 6mm allen head bolt. Before installing the driver's side front bolt, you will need to install the Fuel Pressure Damper (FPD).



The FPD has an "L" bracket attached that holds the front knock sensor connector to the wiring harness. See below.


ATTENTION HAUTE TENSION

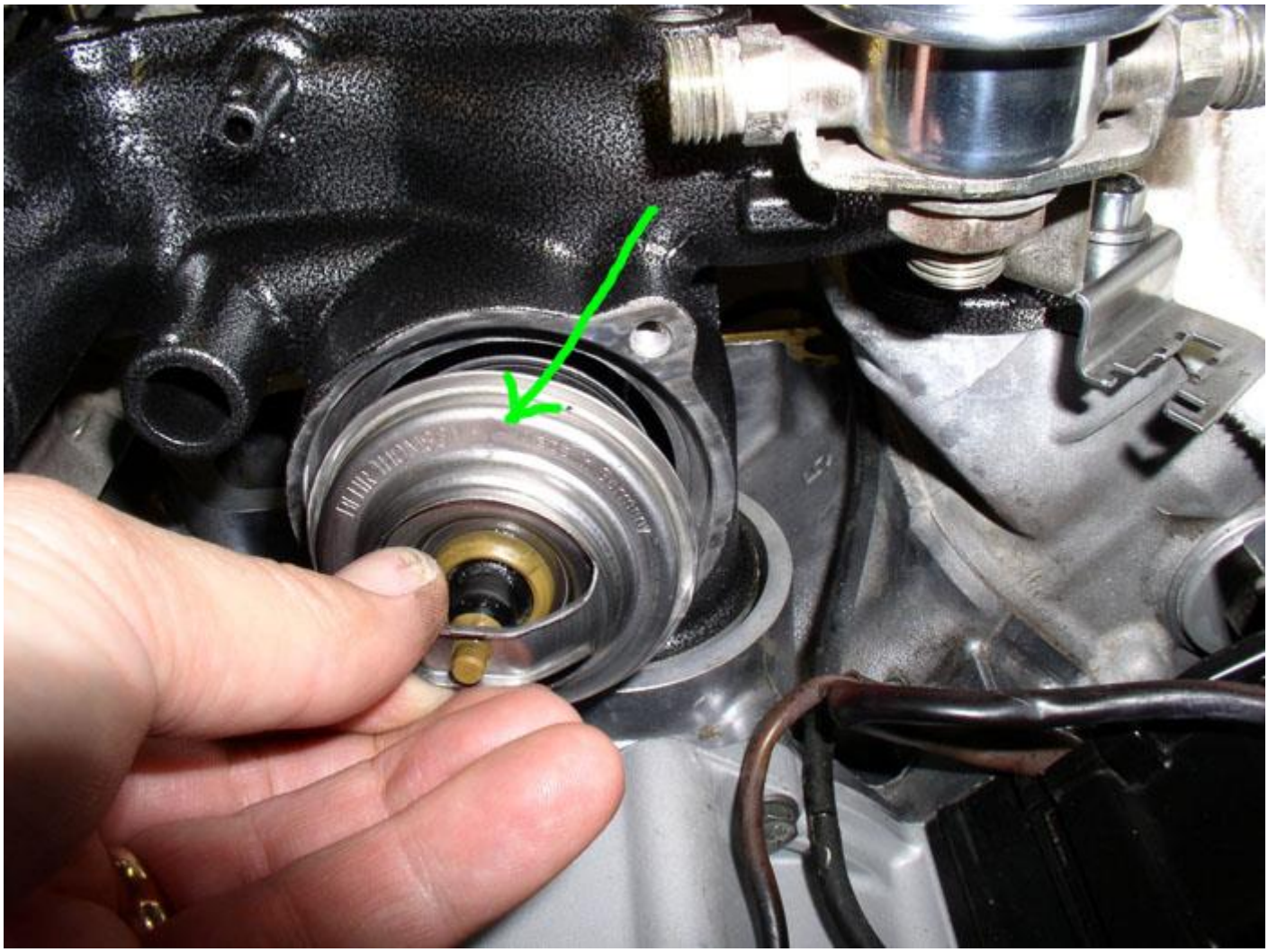
Install the knock sensor bracket on top of the "L" of the FPD as shown.




Install the Fuel Pressure Damper (FPD) on top of the driver's side front mounting hole and install the allen head bolt. Also install the fuel line clamp bracket on the passenger side front of the bridge and install the allen head bolt as shown. I simply finger tightened the bolts down for now.



Next, install the thermostat. You will notice an arrow stamped on the front of the thermostat flange. Position this arrow so that it is facing up and mount the thermostat into its groove in the thermostat housing. You will notice a shallow inner groove in the housing - use this for the thermostat.



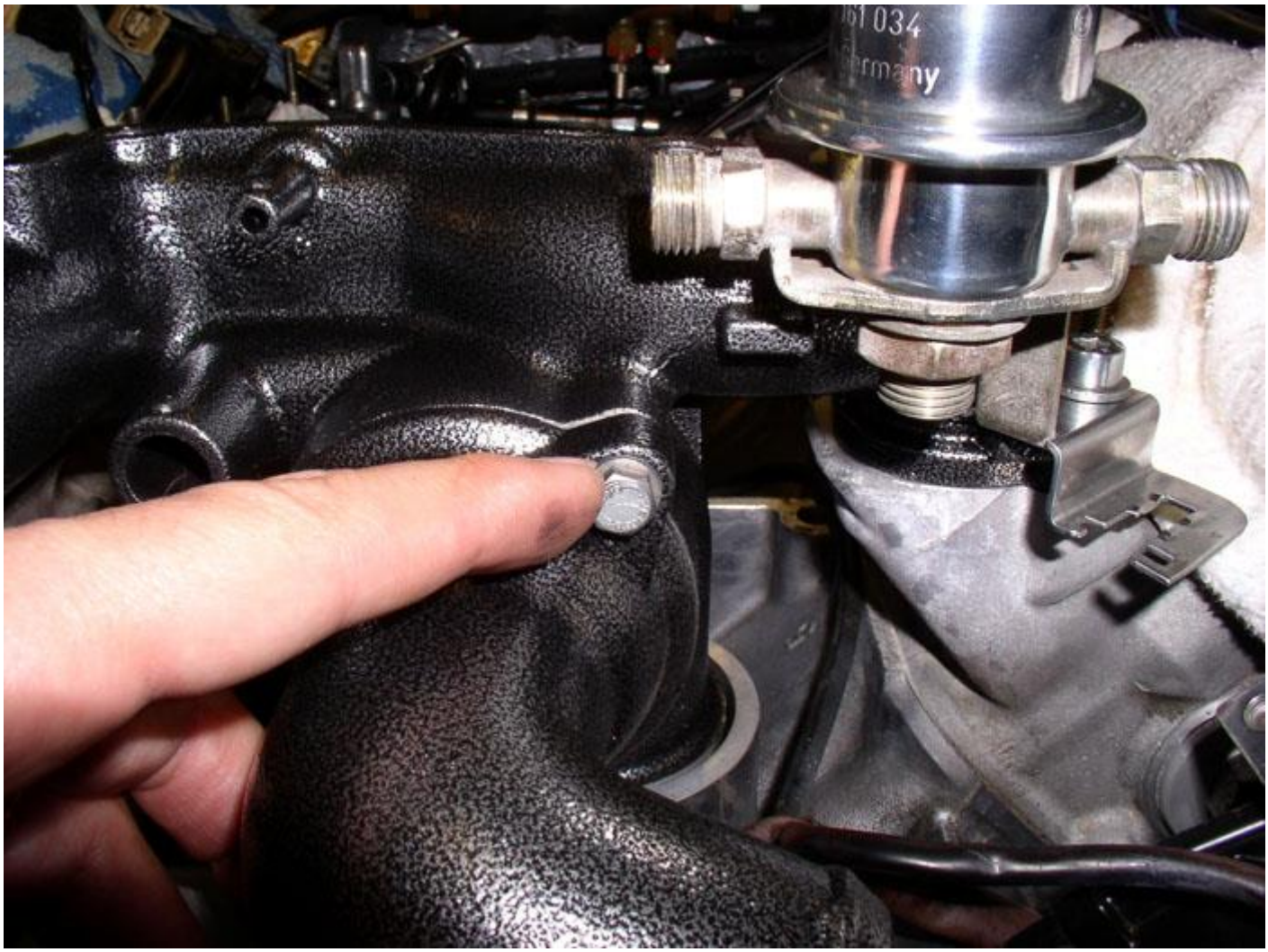
Place the o-ring over the thermostat as shown. It should fit inside the outer groove as shown.



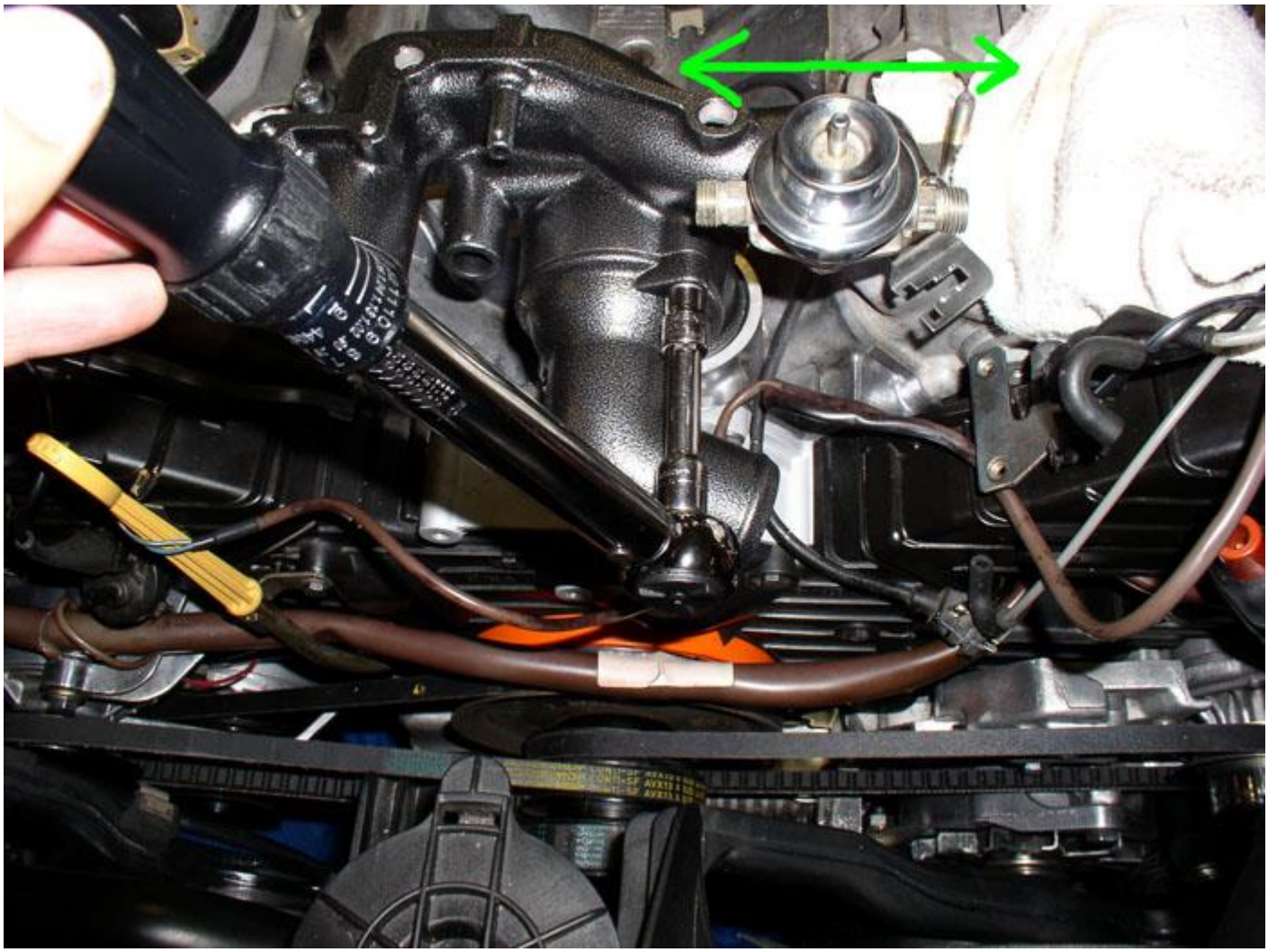
Place the 90 degree elbow into position lining up the bolt mounting holes.



Install the two 10mm housing bolts and finger tighten.




Now, you can torque everything down. First, ensure the FPD is aligned so that it runs parallel with the engine brace (approximately) as shown in the pic below. The WSM recommends a two pass torque method on the Bridge-to-cylinder heads 6mm allen head bolts. First pass, torque the allen head bolts to 7 ftlbs or 84 inch lbs. Second pass, tighten the allen head bolts to 16 flt lbs or 192 inch lbs. Then torque the 90 degree elbow into place with the two 10mm bolts. Torque to 8 ftlbs or 96 inch lbs.



Next came the oil filler neck. My filler neck is metal and has the metal baffle with integrated rubber seal. The seal had hardened and was no longer providing a good seal. I understand this part is no longer available. So I decided to improvise and use gasket maker/sealer on the existing seal. If you have the plastic baffle, seals are separate and still available. You can install the new seal at this time.



Otherwise, if you're in the same boat as I am, picking a sealant suited for the job is next. This seems like appropriate sealant to use. From the package, it advertises it's very resistant to oil and is sensor safe.



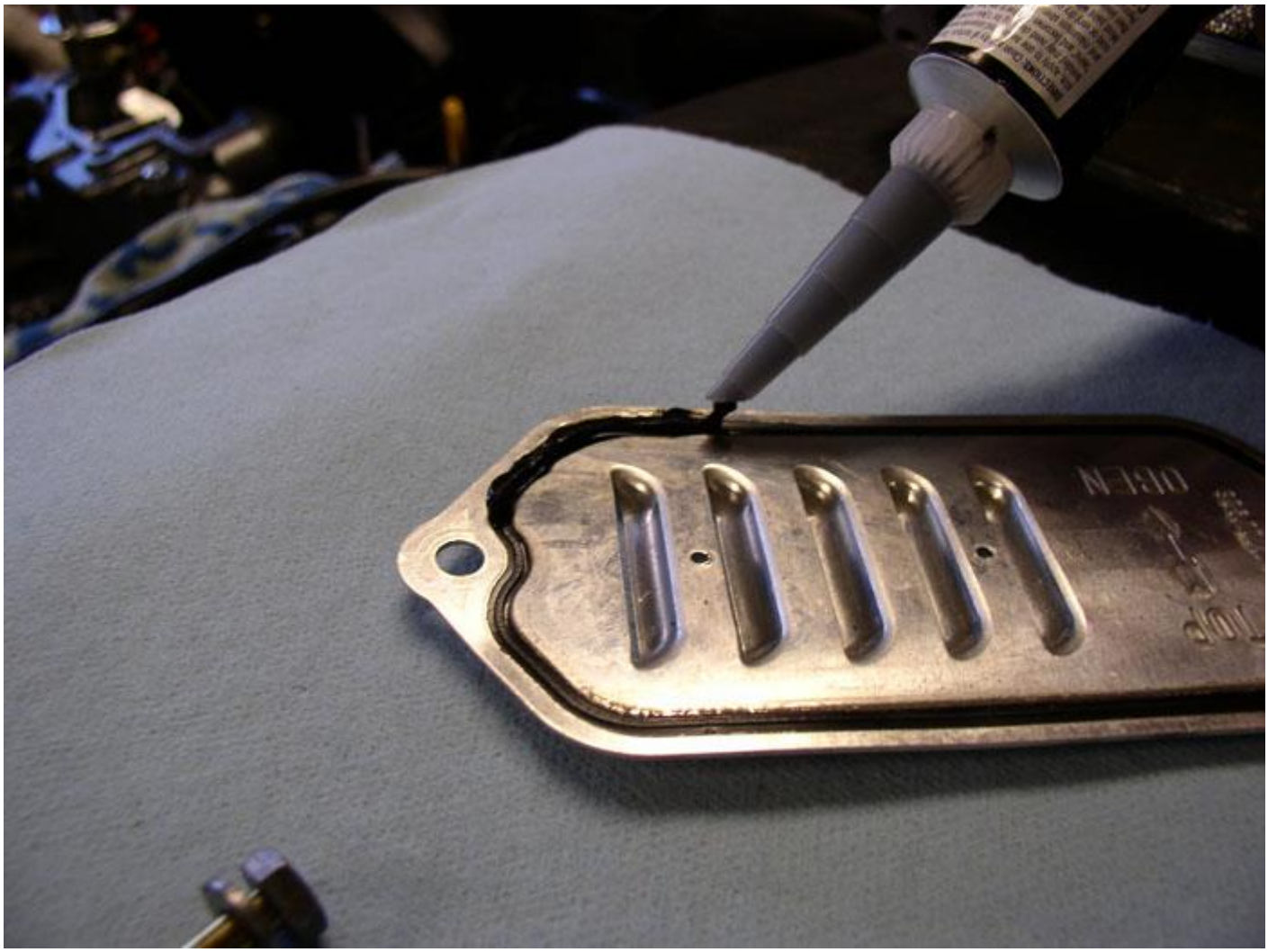

First, you will need to clean the mating surface for the sealant. I used brake cleaner sprayed on a cloth.....




....then wipe the cloth on the block surface and the oil filler neck mating surface to remove any dirt or oily residue.



Apply a small bead of sealant/gasket maker to the existing seal. Apply to both sides.



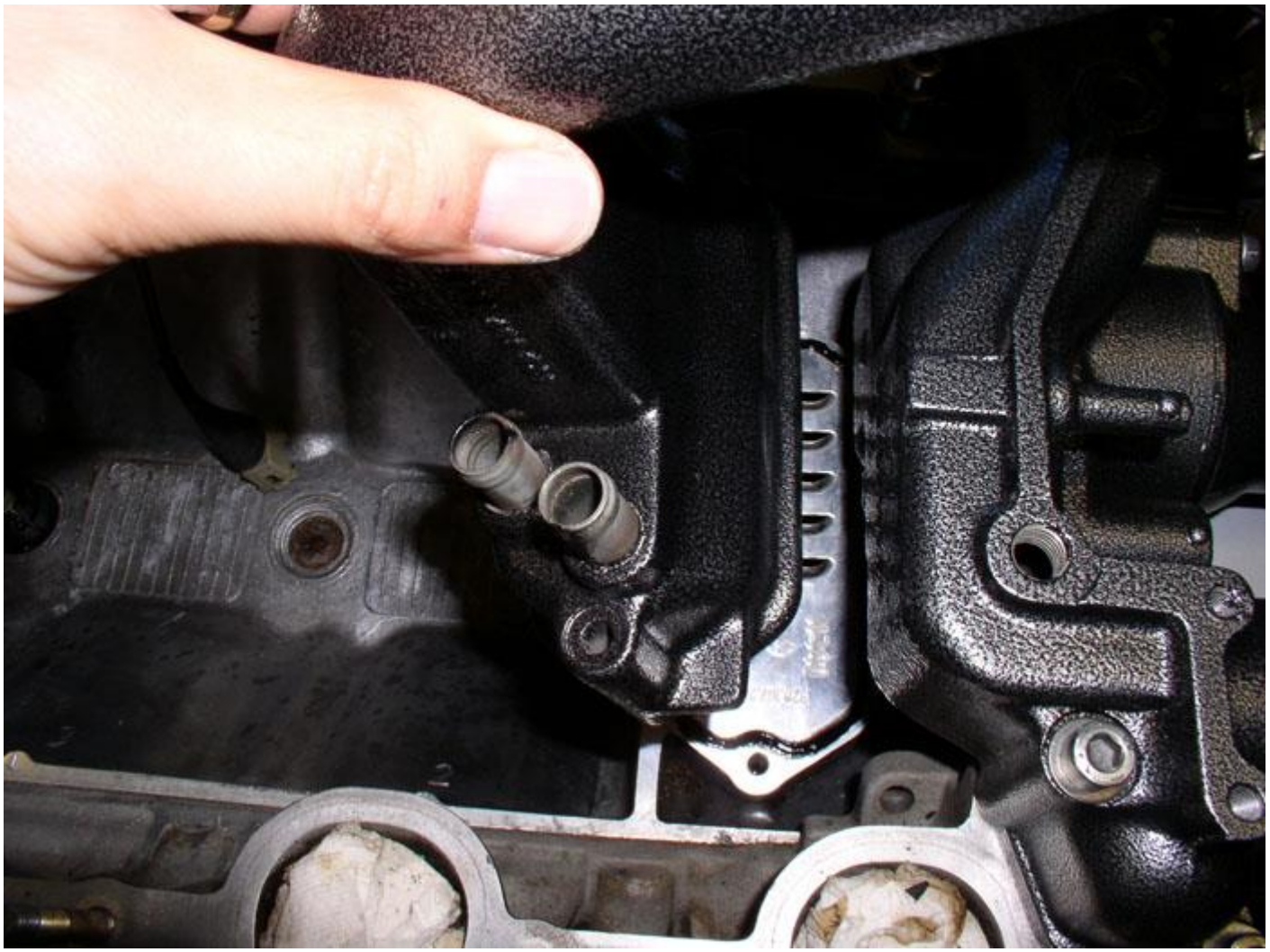
Position the baffle with sealant into position making sure it is oriented properly.



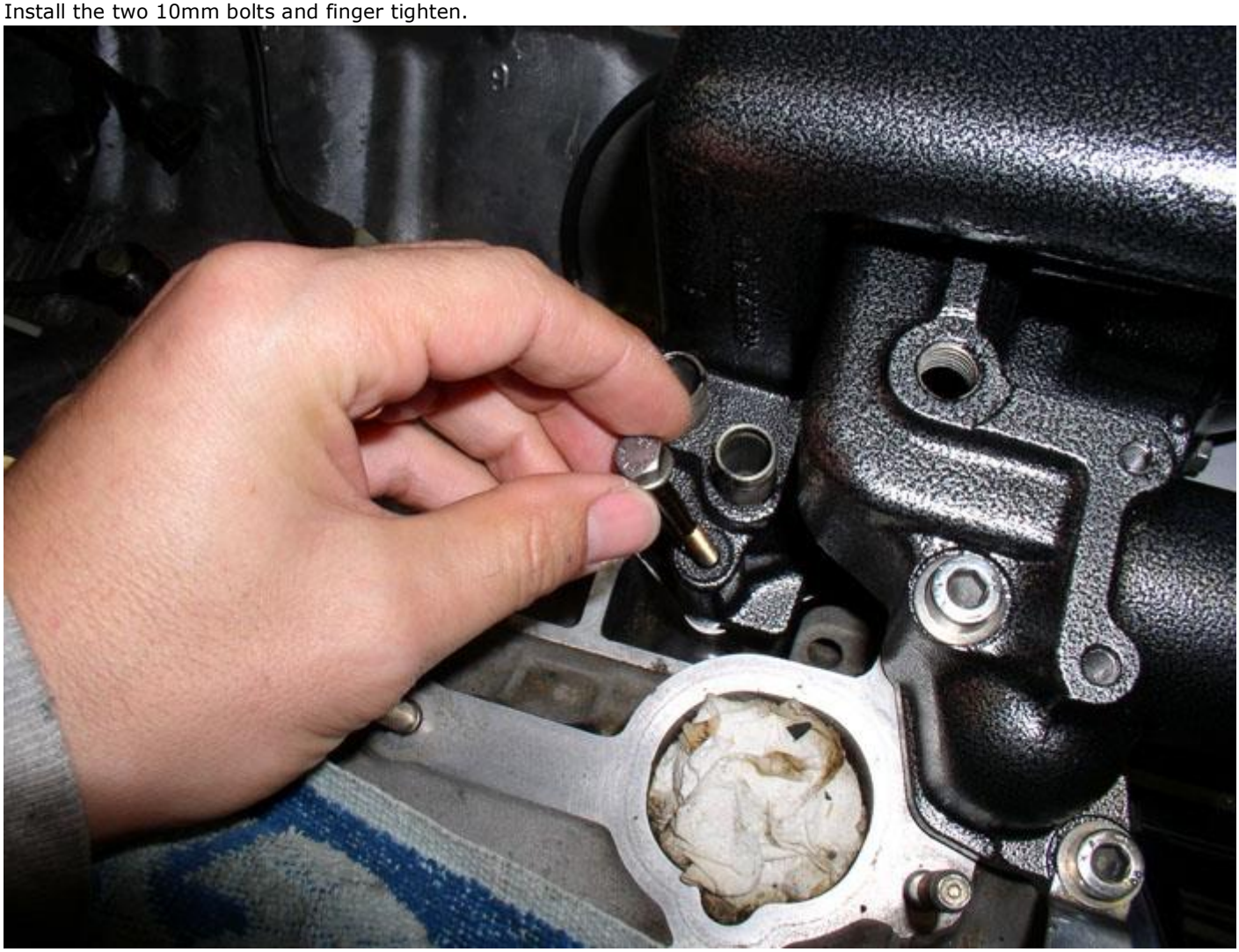
Note the markings on the baffle. There is the word "TOP", "OBEN" and an arrow stamped into the surface. I oriented my baffle so "TOP" is facing up and the arrow is pointing forward out the front of the car as shown.



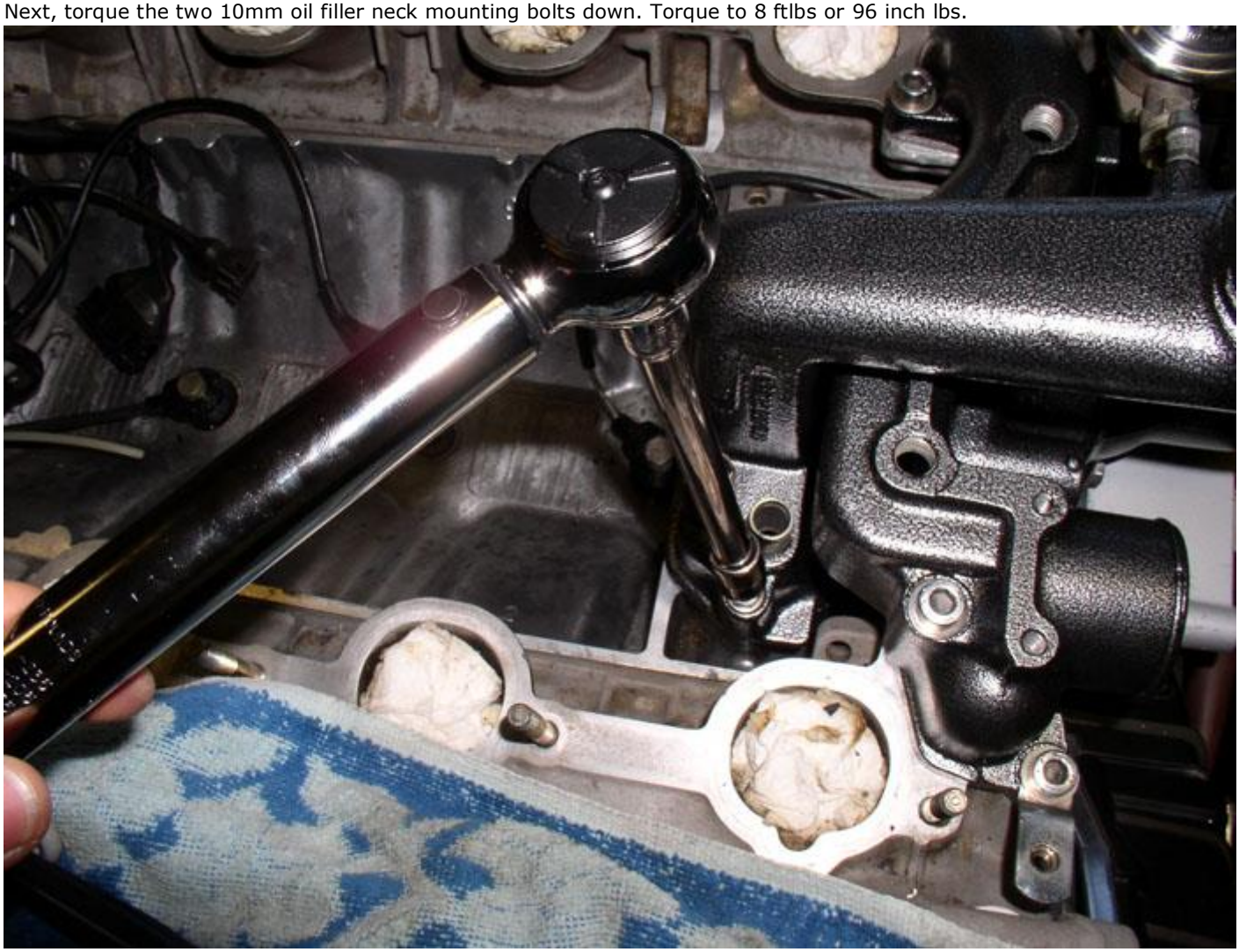

Next, position the oil filler neck over the top of the baffle, line up the mounting holes and set it into place.



Install the two 10mm bolts and finger tighten.



Next, torque the two 10mm oil filler neck mounting bolts down. Torque to 8 ftlbs or 96 inch lbs.



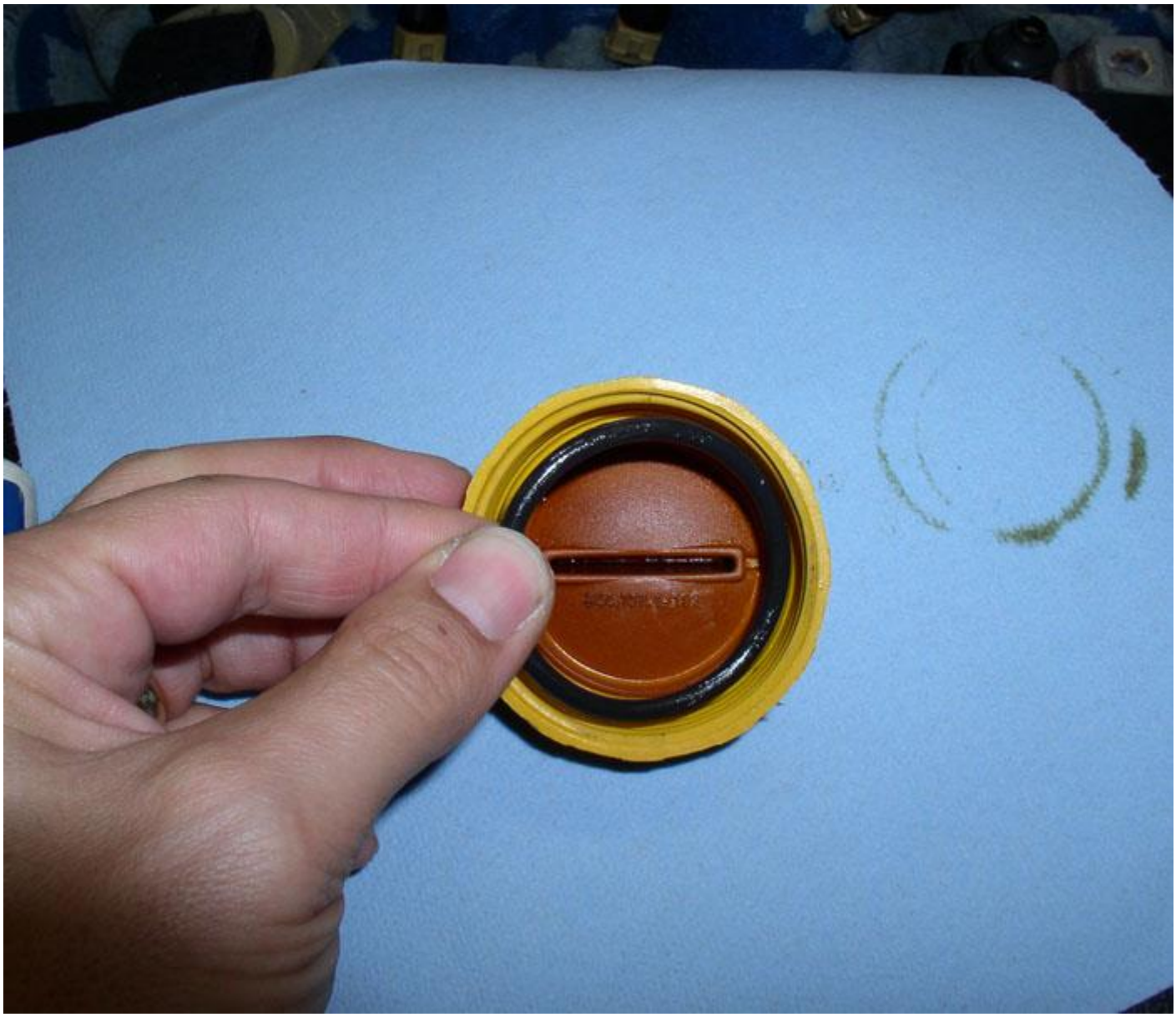
Ideally, you want a consistent showing of sealant as evidence of a good seal with sufficient sealant all around but you don't want an excessive amount showing - just enough to be barely visible.



Next, the finishing touch on the oil filler neck - Replacing the o-ring in the filler cap. Remove the old o-ring with a pick tool. You can clean the cap (especially the outside of it) with your favorite cleaner (Orange Blast citrus cleaner in my case). I've also heard that comet cleanser works but have not tried that yet.



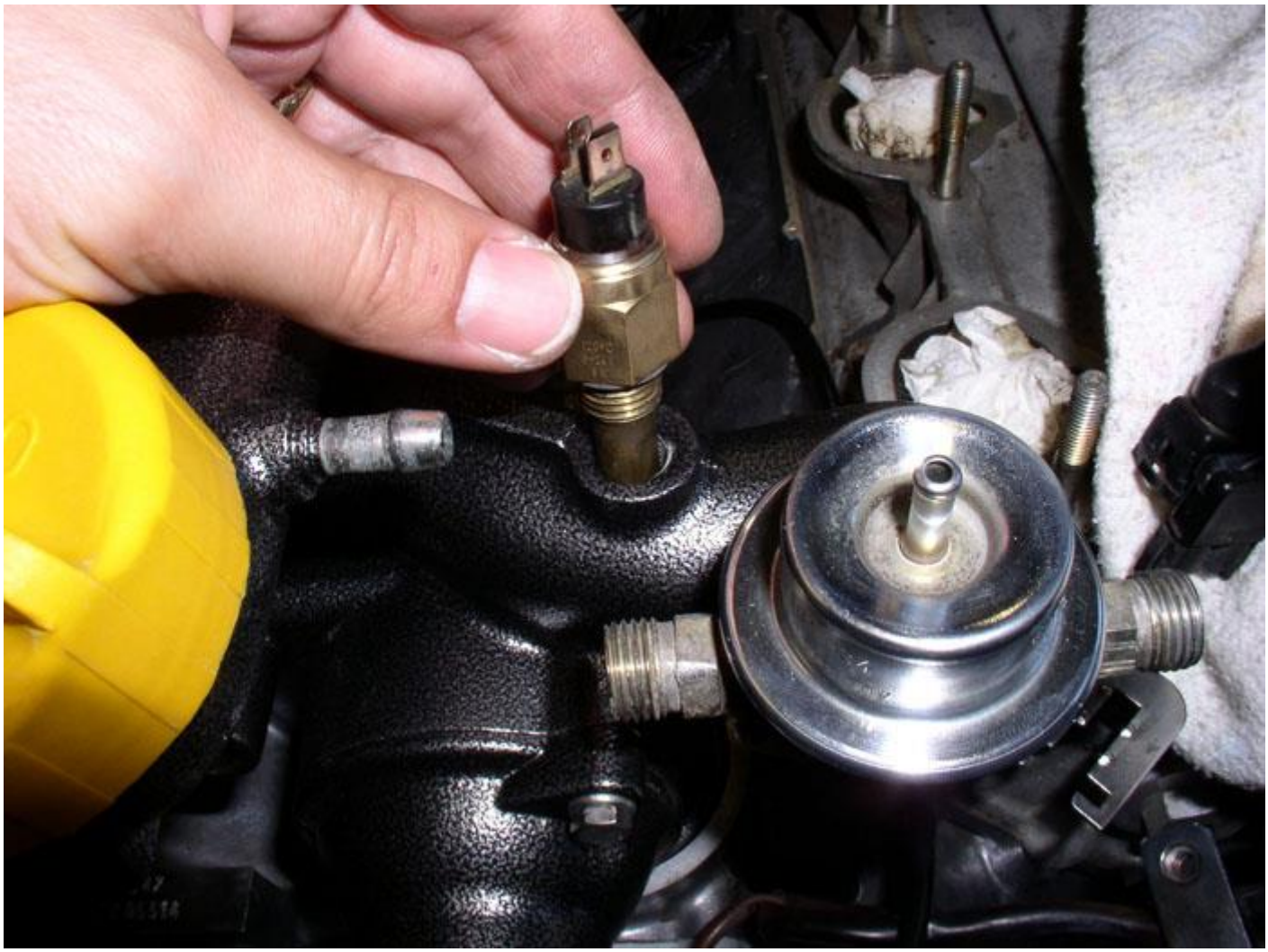

Install the new o-ring with some motor oil on it to ease installation of the o-ring but also to provide a lubricated surface to mate with the filler neck.



Install the cap on the filler neck.



Finally, finish off the water bridge. Install the Temperature Gauge sending unit with sealing ring. It is mounted on top of the bridge on the driver's side. It's best to use a new sealing ring but the old one can be re-used if not worn out. Finger tighten down.



Install the Temp II sensor in the same manner on the other side of the bridge..



Torque the Temp II sensor to 9 ftlbs or 108 inch lbs. Torque the temperature gauge sending unit to 20 ftlbs.



Temp II sensor installed with seal.



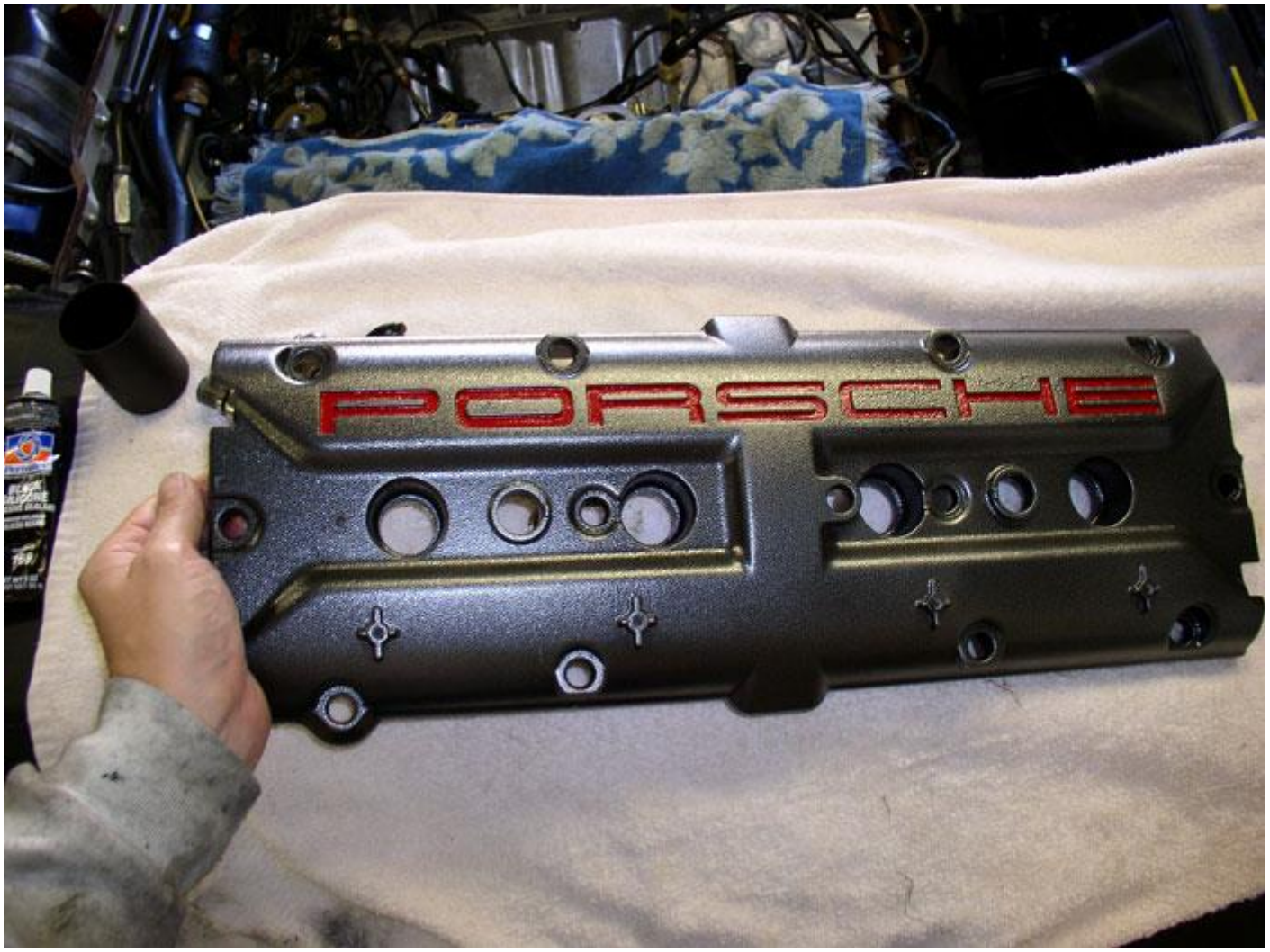
Temp gauge sending unit installed with seal.




**Cam Cover Prep & Installation**

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Next, you can prepare the cam covers for installation now that the detail paint has dried. The cam cover should look like this - no "accessories" installed yet.




First, remove the old o-rings from the driver's side cam cover plugs.



Also remove the old o-rings from the passenger side PCV elbows.



Clean the parts. Here's a shot of the hardware parts that will be installed.



Next, I lubricated the four new o-rings with a light coat silicone lubricant. This will aid installation of the o-rings onto the elbows and plugs and will also aid installation of the plugs and elbows into the cam cover. If you use a silicone lubricant, make sure it is O2 sensor safe. Even small amounts of silicone in the combustion system can cause O2 sensor failure. This particular brand of lubricant doesn't state anything about being O2 sensor safe so I'll have to live with my newbie lesson learned here - but you don't have to. Motor oil is a safe and easy alternative to use on the o-rings since they will come in contact with motor oil anyway during the course of performing their job.




Slide the o-ring onto the threads of the elbow and position it in the groove as shown. Wipe off excess lubricant. Repeat for the other elbow.




Slide the o-ring over the plug....



....until it rests in the upper goove as shown. Repeat for the other plug.



Insert the PCV elbows into the passenger cam cover. If you're not sure which cam cover is the passenger side, look at the 4 small threaded holes at the bottom half of the cam cover (two are pictured below). The passenger cam cover will have two threaded holes toward the right-hand end of the cam cover (near the end of the word "Porsche"). The other two holes do not have threads. The Driver's side cam cover has the two threaded holes near the front of the cam cover (near the beginning of the word "Porsche"). These threaded holes are for the spark plug harness clamps to mount to the cam covers. Also note the elbows are keyed to a notch on the cam cover.



Install both elbows at this time.




Flip the passenger cam cover over. First, install the locking tab washer on the front PCV elbow. The washer is keyed - ensure the key tab is lined up with the slot in the threads as shown.



Next, install the notched lock nut and....



....tighten down using a pair of pliers. I used needle nose pliers to grip the notches in the lock nut. Tighten the nut until one of the notches lines up with the locking tab that was used previously to lock the nut down. You can spot the previous locked tab by the bent shape from prying it loose from before.



Use a screwdriver to bend the tab back into the notch in the lock nut.



Here's a shot of the front PCV elbow locked down.



Now for the rear PCV elbow. The rear elbow has a metal cylinder that fits over the top of it. Install the cylinder as shown.



Place the locking tab washer over the elbow threads in the same manner as the forward elbow just completed - ensuring the downward metal tab is lined up with the slot in the side of the PCV elbow threads.



Next, install the notched lock nut.



Use the needle nose pliers to tighten the notched nut down.



As before, line up the notch with the previously bent washer tab and bend the washer tab over into the notch in the lock nut.



Now for the driver's side cam cover plugs. Both plugs also have a keyed notch that lines up with the tab on the cam cover. Install as shown.



Press the plug down until it is fully seated. Install the other plug as well.




Flip the cam cover over and install the circlip that secures the plug. Use an appropriate sized circlip pliers as shown.



Ensure the circlip is fully seated in the bottom groove in the plug as shown.



Next, clean the cam cover gasket groove. Mine had remnants of what looked like silicone sealant all along the bottom of the groove. I assumed this was to aid in holding the gasket in place during installation. Also, clean the gasket seat for the spark plug gaskets on the underside of the cam cover. After cleaning these areas, wipe down the underside of the cam cover to remove any loose chips or dust. Compressed air or a damp cloth works well.



Then clean the mating surface on the cylinder head. I found remnants of the white silicone-like sealant in the 4 corners of the cam cover mating surfaces. These four corners are identified in the service bulletin as areas that need a shot of sealant when installing the new gasket and cam cover.



Once I removed the old sealant, I wanted to remove any oily residue from the head mating surface. The best way to do this is spray brake cleaner on a clean rag/towel as shown.




Then wipe the section of towel with cleaner on it over the mating surfaces. Repeat this procedure for the other cylinder head.

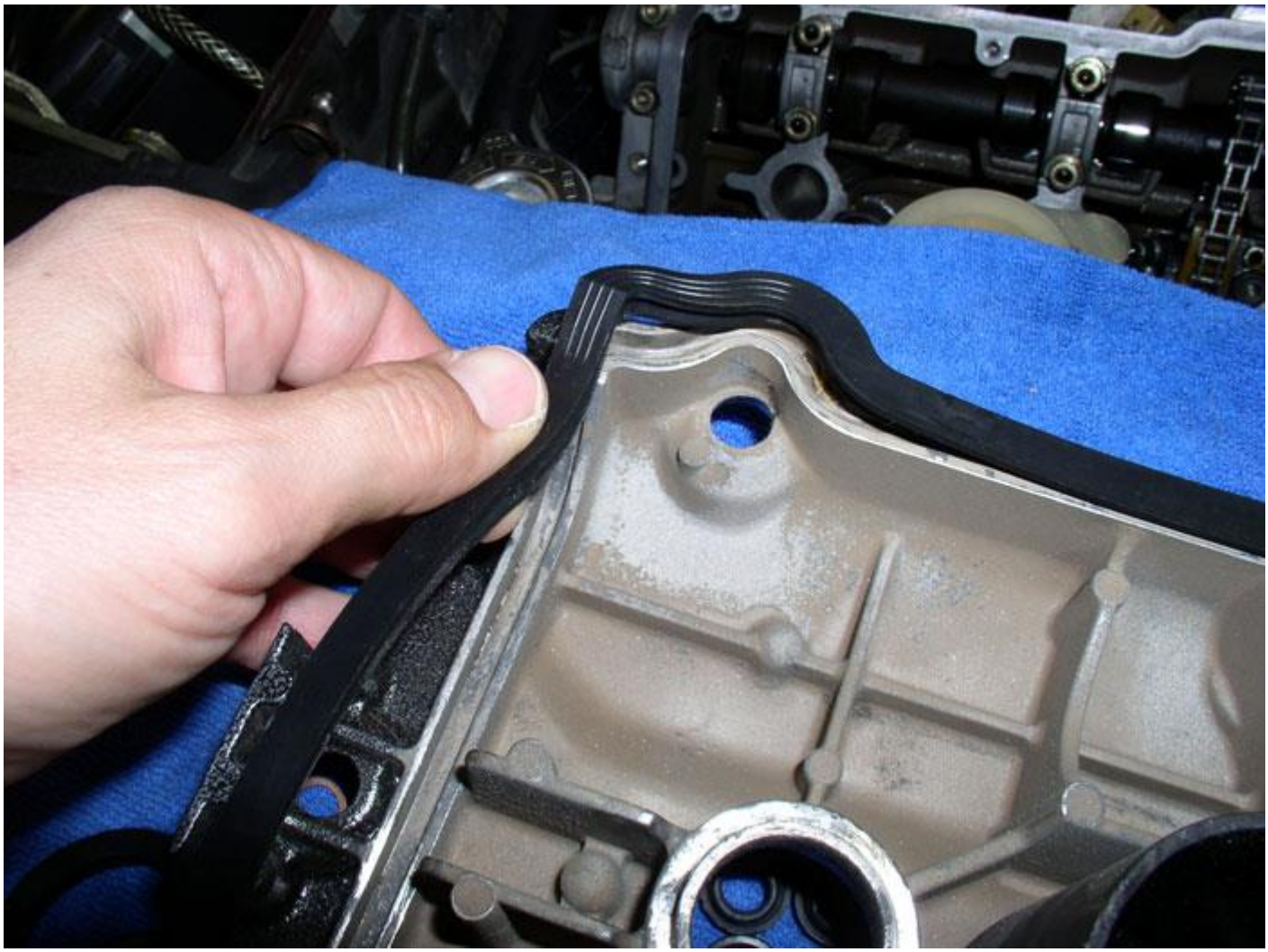


Next, sort out the cam cover bolts and umbrella washers for each cam cover. There are 13 bolts for each cover -

4 small ones and 9 longer ones.



At this point, you're ready to install the cam covers. I started with the passenger side. Since this was my first experience re-installing the cam cover, I decided to do a dry fit first - like a dress rehearsal - just to make sure I could manuever the cover with gaskets in place. I would recommend the same if this is your first experience. Start by dry-fitting the cam cover gasket into the channel as shown.



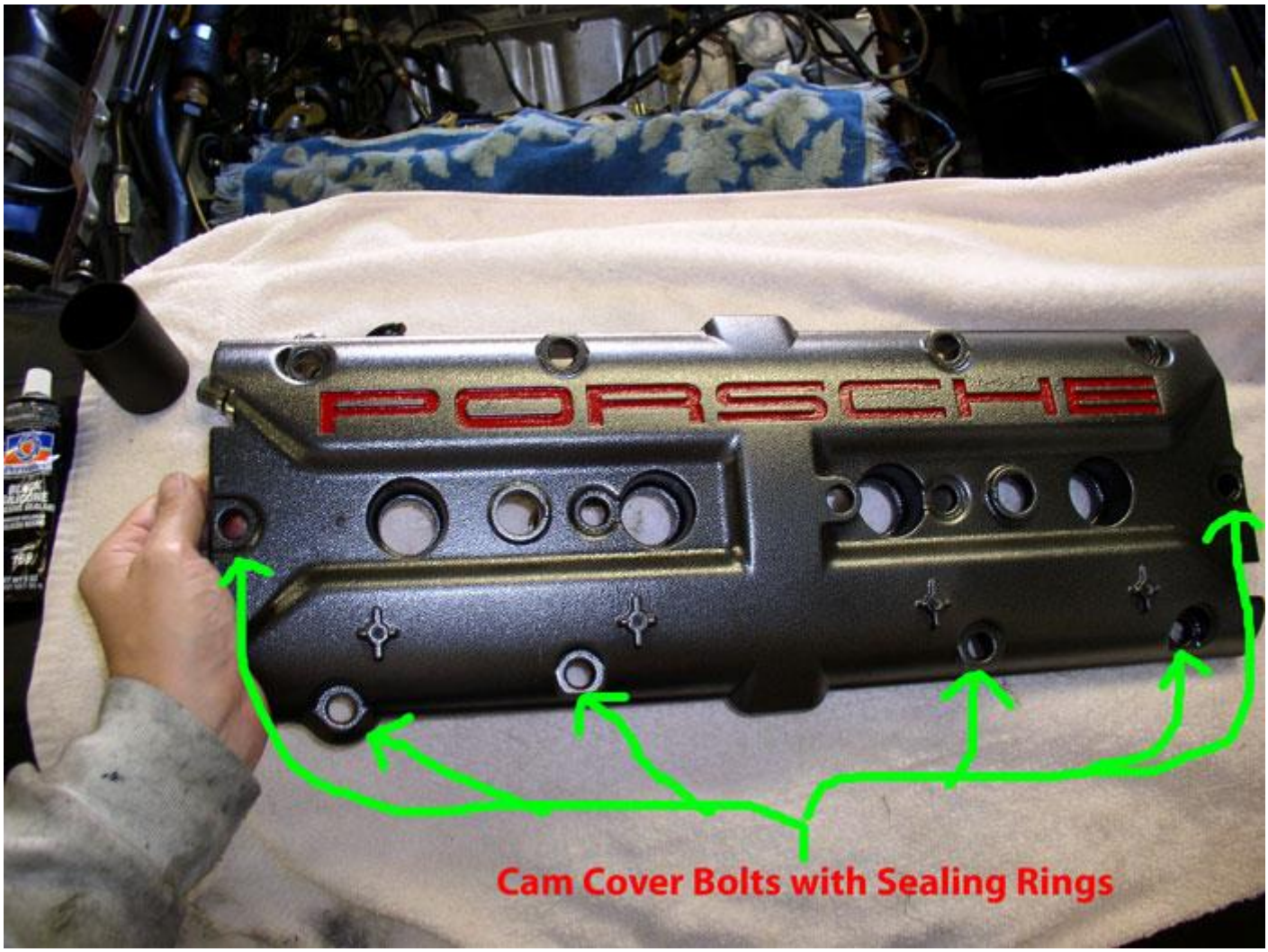
Then set the spark plug gaskets in place as well.



Manuever the cam cover into place noting the angle that works best. Once you're satisfied, remove the cam cover from the cylinder head and remove the gaskets from the cam cover.




The gasket set for the cam covers should come with 12 sealing rings for the cam cover bolts - six seals for each cover. The sealing rings are to be installed on the bolts at the locations depicted on the picture below. All bolts on the bottom row get the seals (which includes 2 short bolts and 2 long bolts) and the 2 end bolts on the middle row (both are long bolts). According to the service bulletin, these seals help provide additional clamping pressure on the cam cover to the cylinder head. Based on their location, these 6 bolts would appear to have the most contact with oil and therefore would benefit from the extra clamping pressure. Thanks to an insightful observation from Dave C. and Bill Ball, Porsche seems to have been inconsistent with the use of the sealing rings especially in later year S4s. Most '87s have the sealing rings and even '88s but after that, the sealing rings are not commonly found on '89s and non-existent on 90+. Therefore, if your cam cover has never been taken off since the factory installation, it's best to note which bolts had the sealing rings (if any) and ensure the seals go back on the same bolts. If your cam covers have been taken off by previous owners/mechanics and the seals don't show up in the following recommended pattern, I would recommend placing the seals in the pattern as instructed by the service bulletin - especially if its an '87.




Pre-assemble the 6 bolts with the sealing rings as shown. Two short bolts and 4 long bolts get the seal.



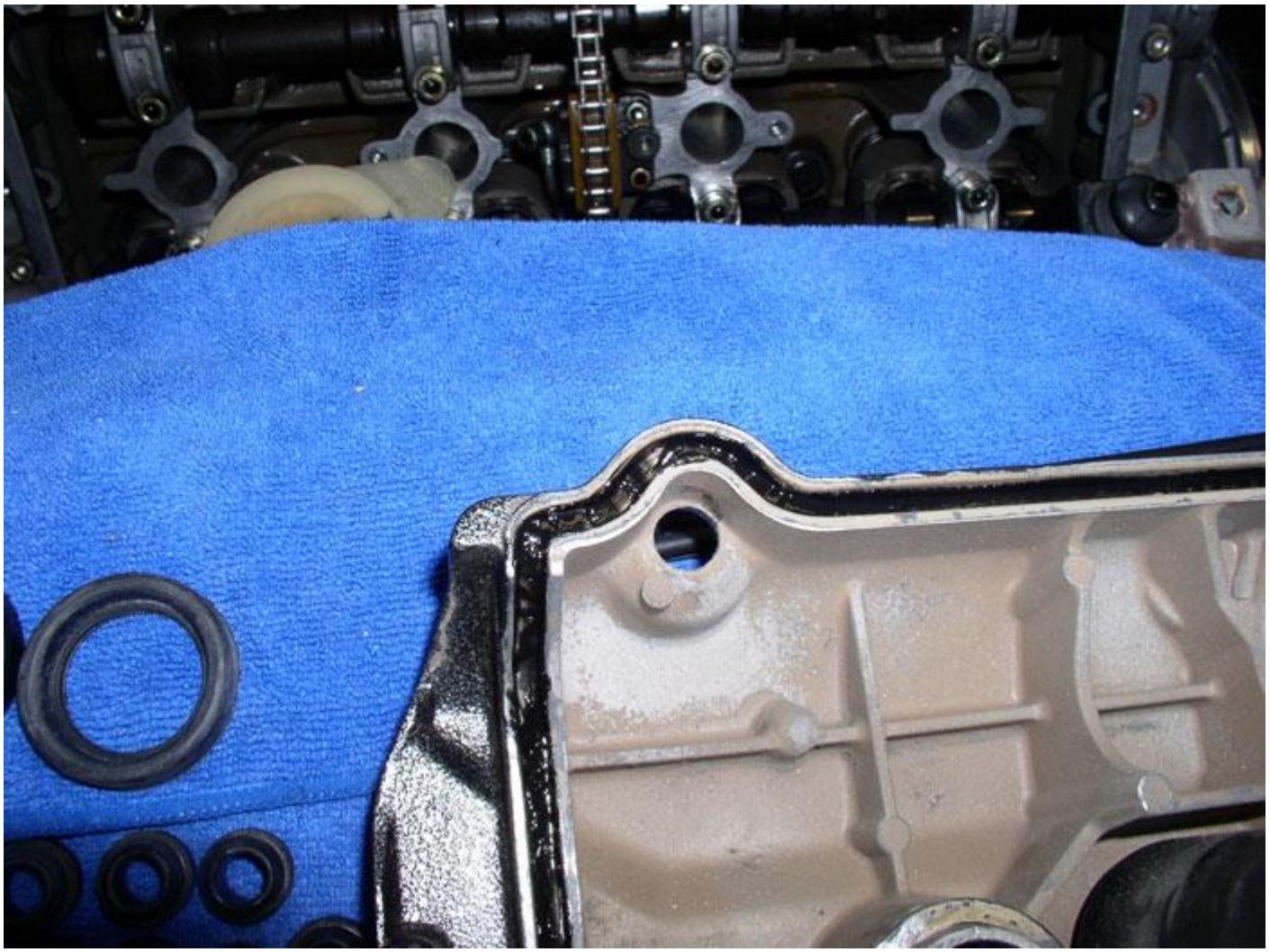
Next, you can lubricate the thrust washer (rubber cam bolt bushings). Thanks to some great tips from forum members, you have several options on what kind of lubricant to use. Some available choices are PBR Rubber Grease (thanks, Hilton), Super Lube Synthetic Grease or Vasaline (thanks, Bill), silicone lube that is sensor safe, or plain old motor oil. What ever you use, apply it sparingly and ensure it's sensor safe (for silicone based lubricants).




The prepared bolts should look like this when ready to install (for the 6 with seals). Pre-assemble all 13 bolts for the passenger cam cover.



Next, prepare the cam cover with gasket. Since my cam cover and old gasket showed signs of a rubber-like sealant/adheasive used in the channel, I followed the example and applied a light coat of sensor safe gasket maker (Permatex, Ultra Black) in the channel as shown.



Then carefully lay in the gasket ensuring the moulded parts of the gasket match with their counterparts on the cam cover.



My spark plug seals that came out also had the same type of sealant/adheasive on them so I followed the example again on these gaskets. Apply a small amount of the same sensor safe gasket maker on the cam cover seat for the spark plug gasket.



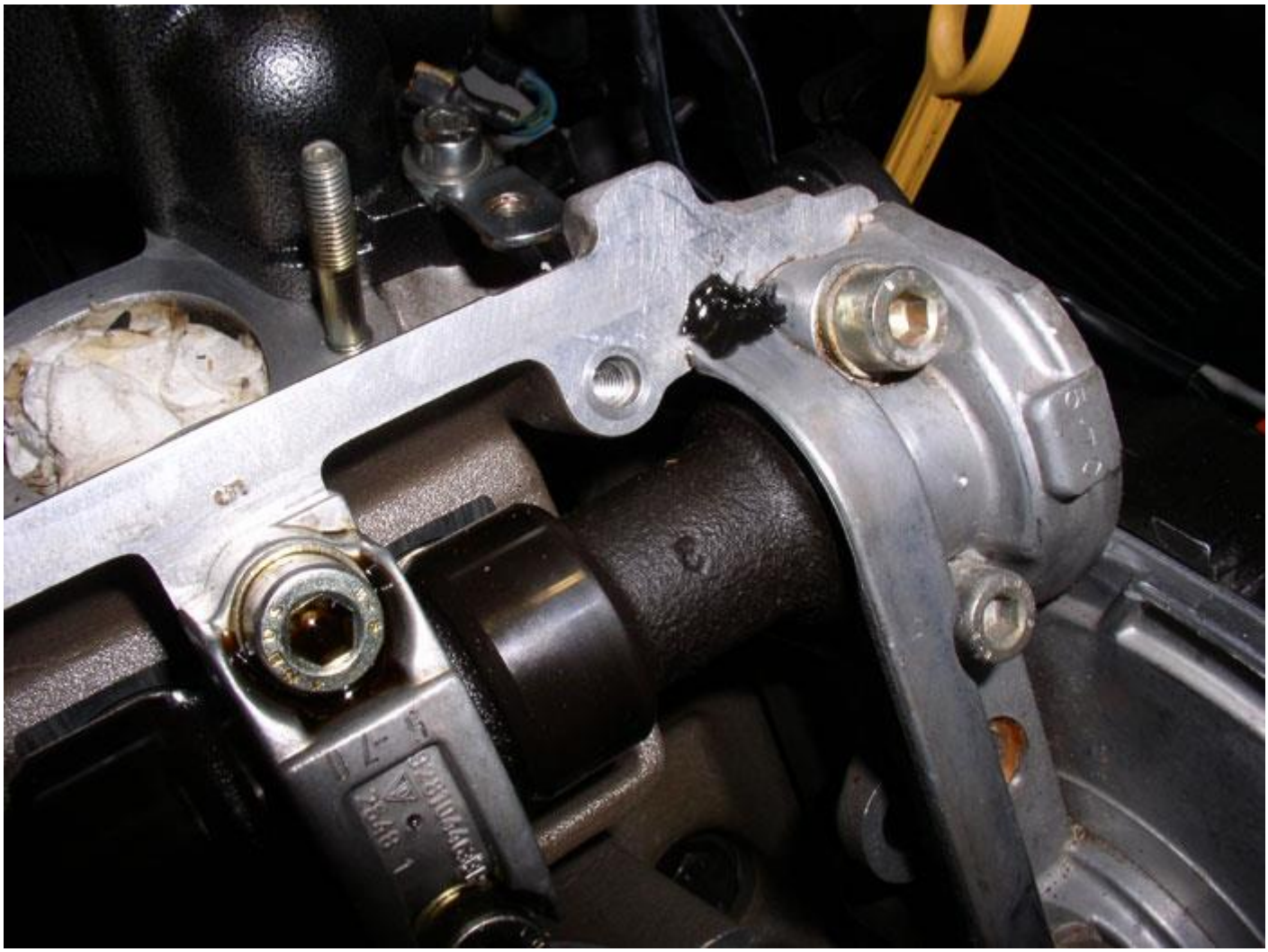
Install the spark plug gasket. Repeat for the other 3 spark plug gaskets.



My old spark plug gaskets also had adheasive/sealant applied to the top surface of the gasket. So I followed suit. I could not find anything in the WSM that gives this instruction (or instruction on using the adheasive/sealant on any of the cam cover gaskets - only on the 4 corners of the cylinder head mating surface). Therefore, I would put it in the category of personal preference but not required. I liked the idea of having the adheasive/sealant on the cam cover side to help retain the gaskets on installation. I'm not sure if having the adheasive/sealant on top of the spark plug gaskets provides benefit.



Next, apply a dab of the sensor safe gasket maker in the four corners of the cylinder head mating surface as shown. The bottom two corners are a little tricky due to the angle and limited space to see.

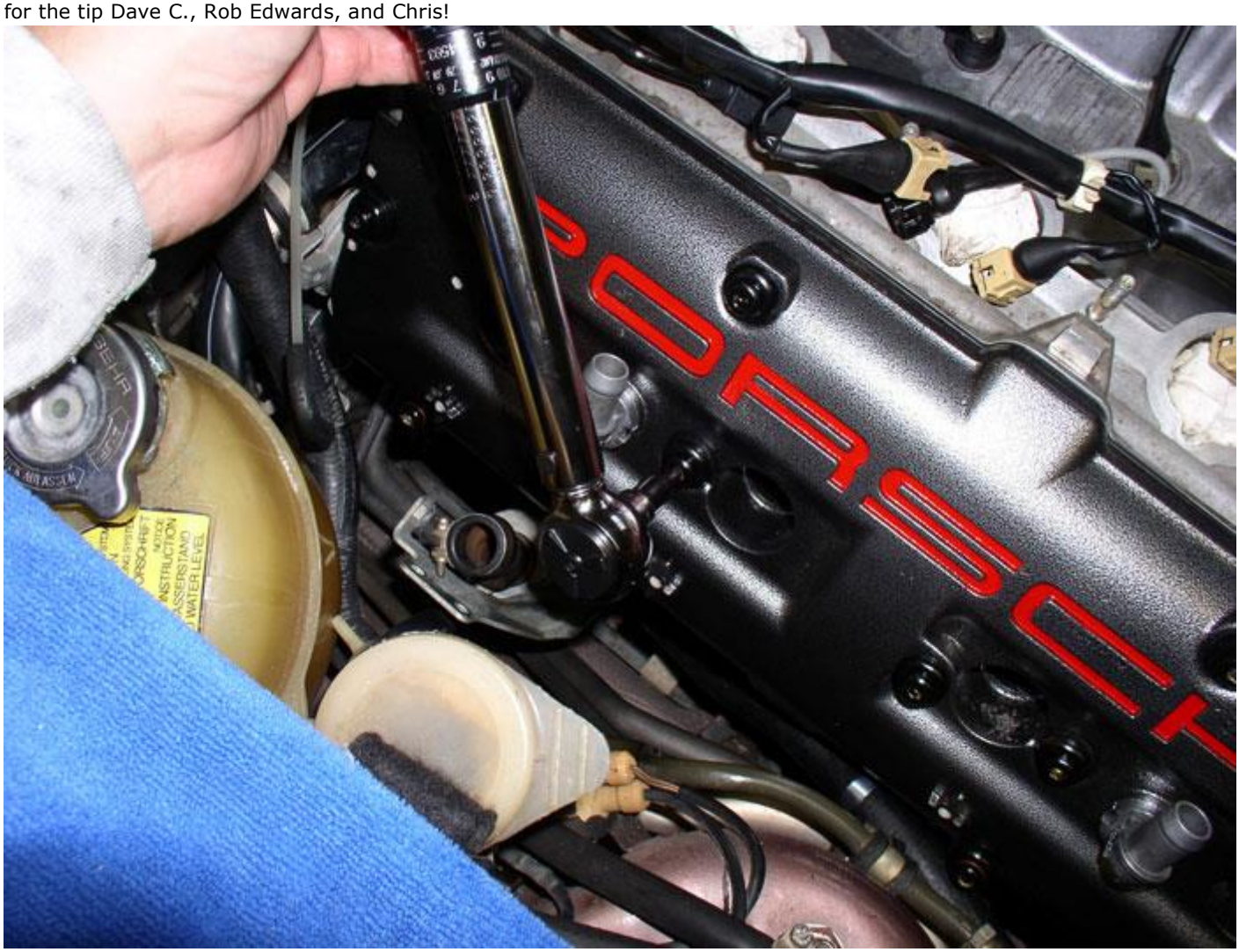


Now, manuever the cam cover into place as you did in the dry run. Make sure the gaskets all mate up to their mating surfaces on the cylinder head. On this passenger installation, I didn't catch the fact that I had somehow dislodged the gasked from the left side (rear of the engine end) of the cam cover. I had put everything put back together and when I started the engine, it ran like crap. Traced the vacuum leak to the cam cover gasket - huge leak. Had to take the cam over off and reseat the gasket and re-install. All better after that.




Begin installing the cam cover bolts you pre-assembled. Install the 6 with sealing rings as previously discussed. The 4 smaller bolts go in the 4 corners of the cam cover. Finger tighten all the bolts first. Then, follow up with the torque wrench. I started with the torque wrench in the middle row and worked outward. Torque the bolts to 7 ftlbs or 84 inch pounds - I had to use the inch pound torque wrench for these. After the middle row, I did the top row and finally tightened the bottom row. On the passenger side bottom row, I could use the torque wrench on the rear 2 bolts. I had to use the allen key wrench on the front 2 bolts and had to guess at the torque value. Next time, I'm going to buy and use a flex head gear wrench with 5mm allen bit - should go a lot easier - thanks

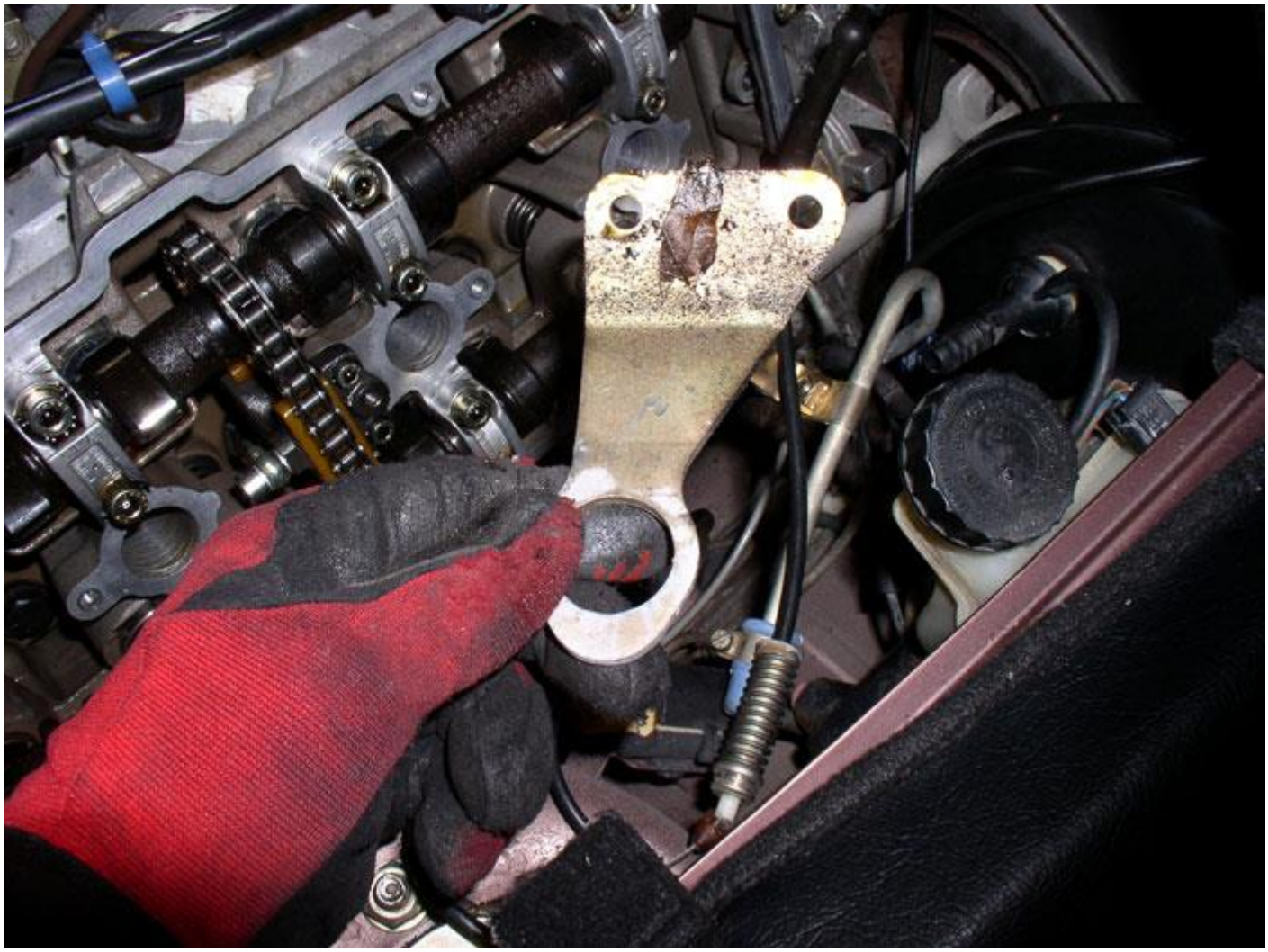
for the tip Dave C., Rob Edwards, and Chris!




Now for the driver's side cam covers. To ease installation, I removed the engine lift hook. As I recall, the engine lift hook did not pose a problem on removal of the cam cover but I could use the extra space on installation. The bracket is held on to the head by a single 13mm bolt. Remove the bolt. You can access this one from above the engine.



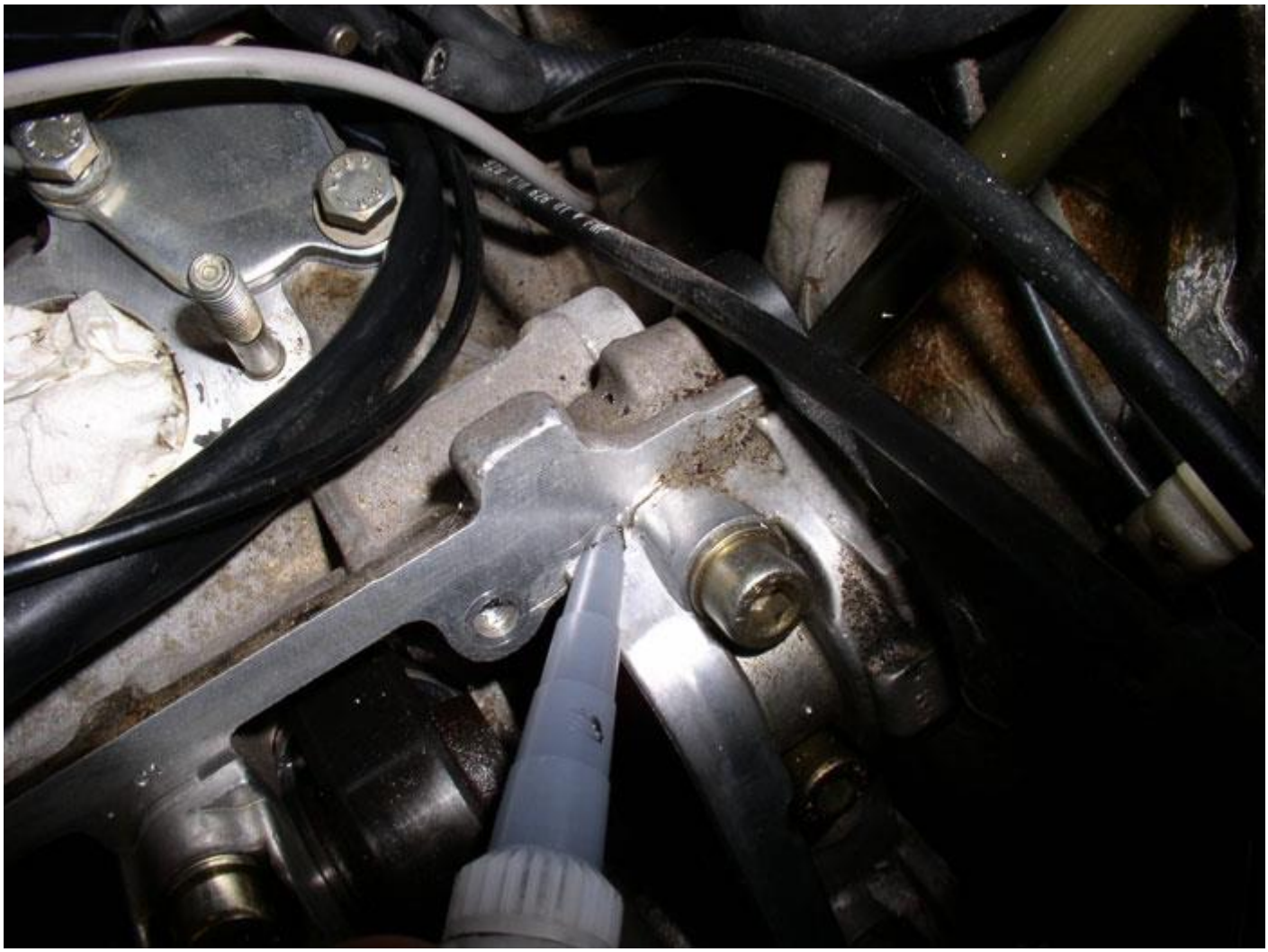
After the bolt is removed, take out the bracket. It has two mounting holes but one of the holes is for a locator pin protruding from the side of the head.



Prepare the cam cover in the same manner as the passenger side described previously using the sensor safe gasket sealer/adheasive to secure the gaskets before installation.



Don't forget to dab the 4 corners of the head with the gasket sealer/adheasive.



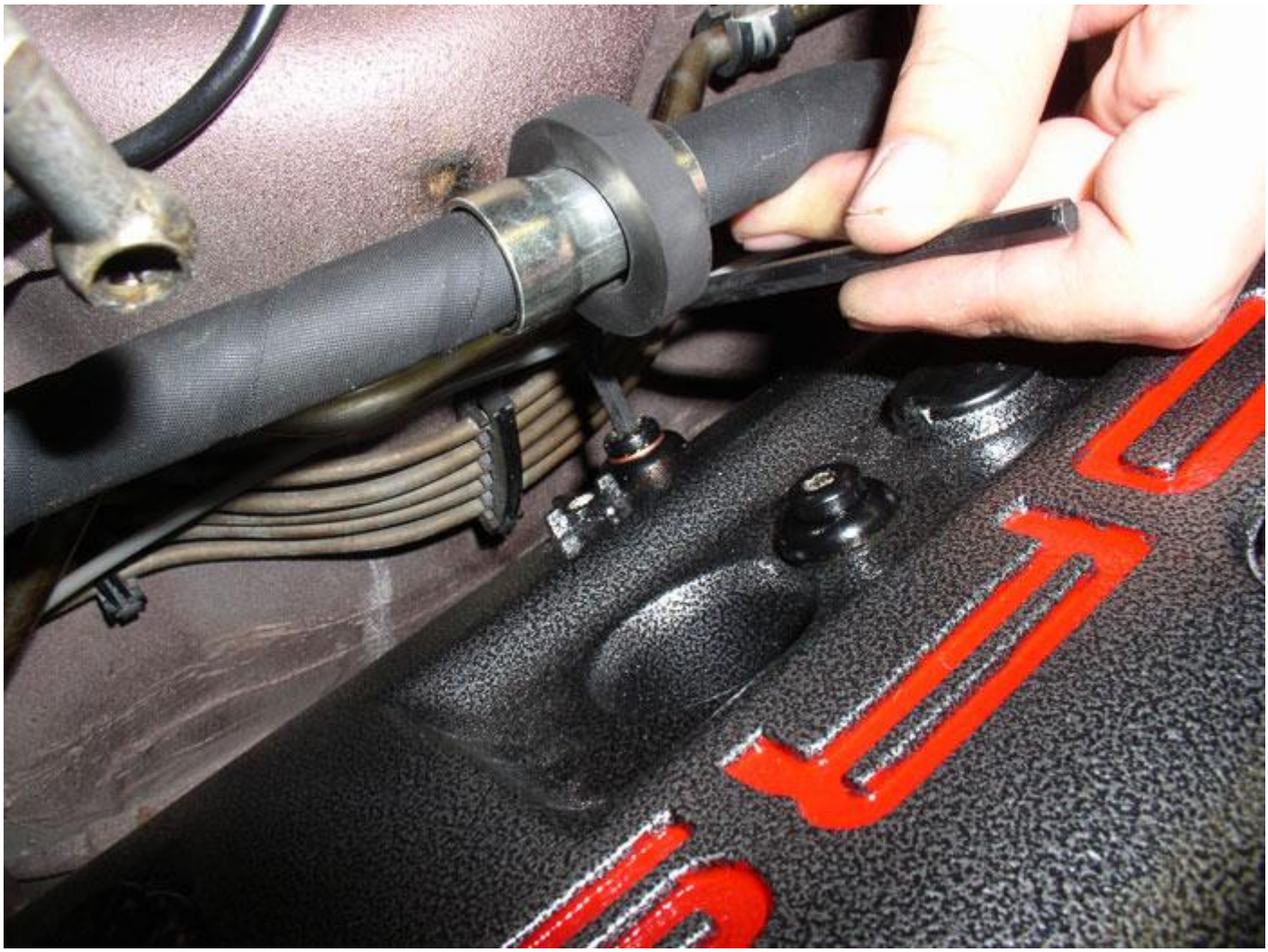
Next, maneuver the cam cover into place.



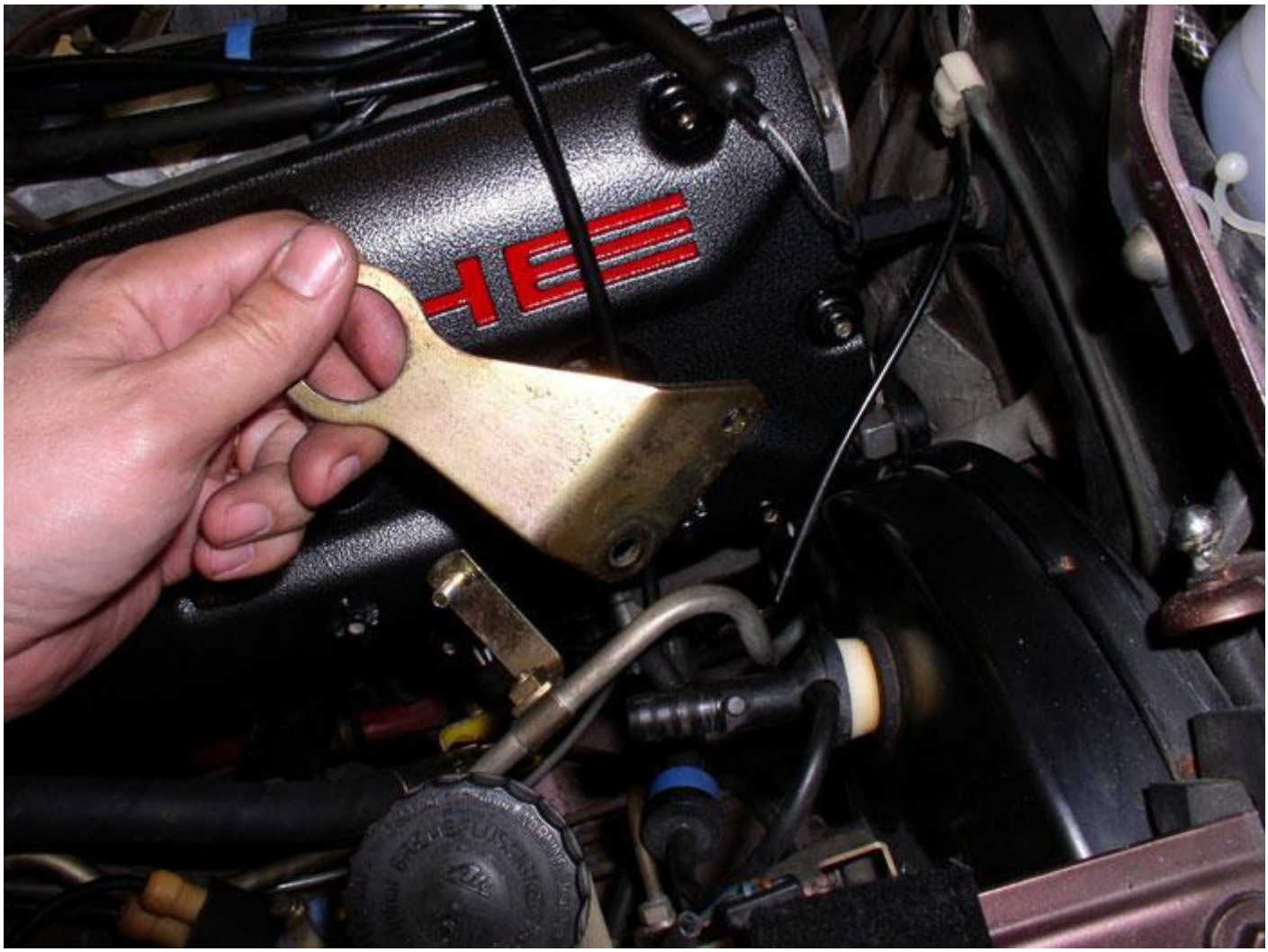

Then start placing the cam cover bolts. Like the passenger side, I started torquing the middle row first, then the top row then the bottom row using the 5mm allen socket. In order to get enough room to access the front lower bolt, I removed the driver's side coil. I could then get the torque wrench in to tighten the bolt down. I was also able to use the torque wrench to get at the last bolt and 2nd to the last bolt(toward rear of engine) on the bottom row of the cam cover.



The other bolt on the bottom row I had to use the 5mm allen key wrench and guess at the torque value. It also required holding the power steering hose out of the way with one hand while tightening with the other.



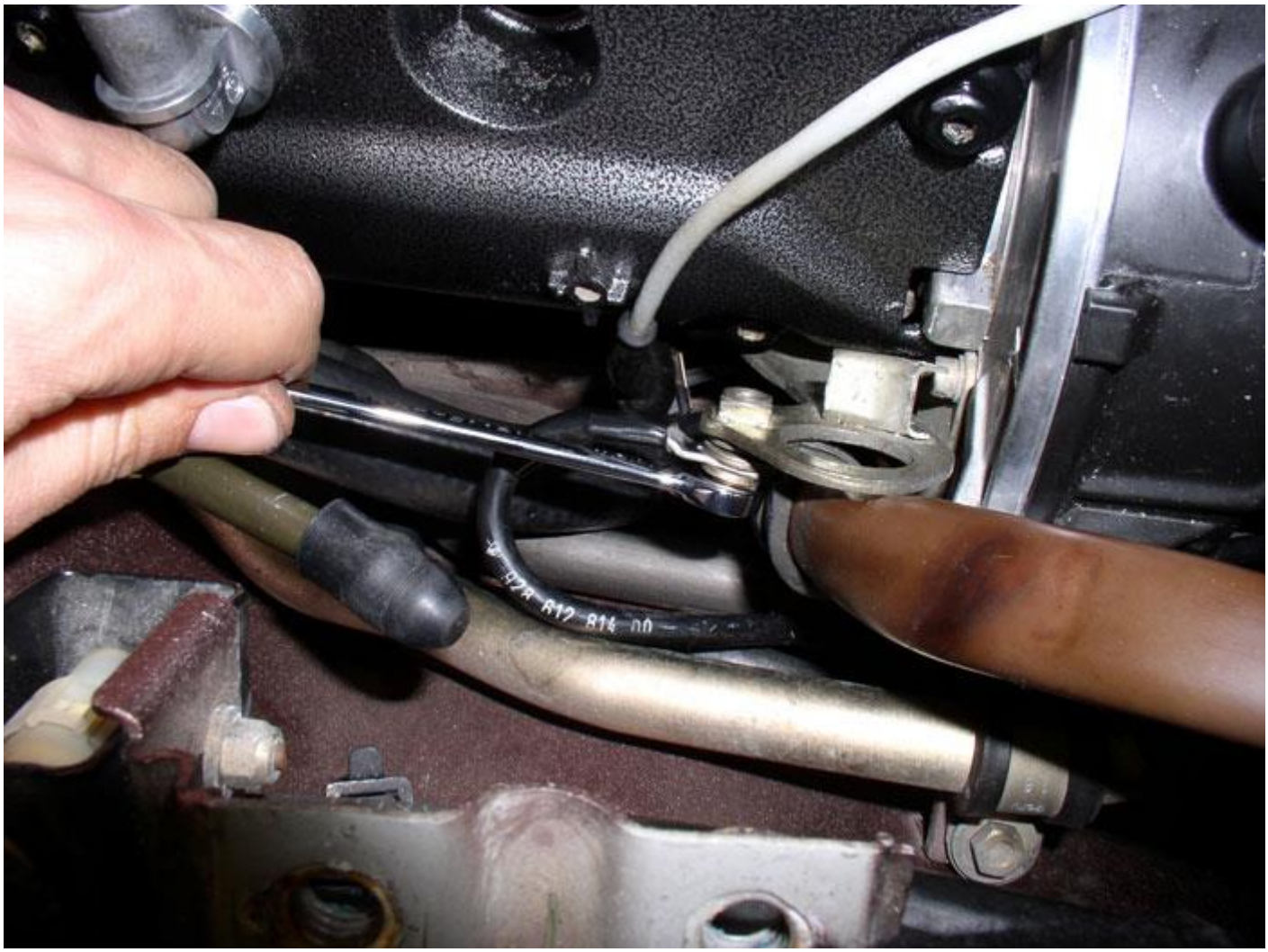
Next, re-install the driver's side engine lift hook. Locate the lift hook on the locator pin protruding from the side of the head first then install the 13mm bolt and tighten down.



On the passenger side, re-install the engine lift hook as well. Same process as on the driver's side but you will need to tighten the 13mm bolt from underneath the car using extensions and a universal elbow as shown. I worked above to get the bolt started with my fingers then went underneath to tighten.



Once the lift bracket is installed, re-attach the wiring harness clamp to the engine lift bracket. The ground lead should be underneath the harness clamp. Tighten the 10mm bolt.



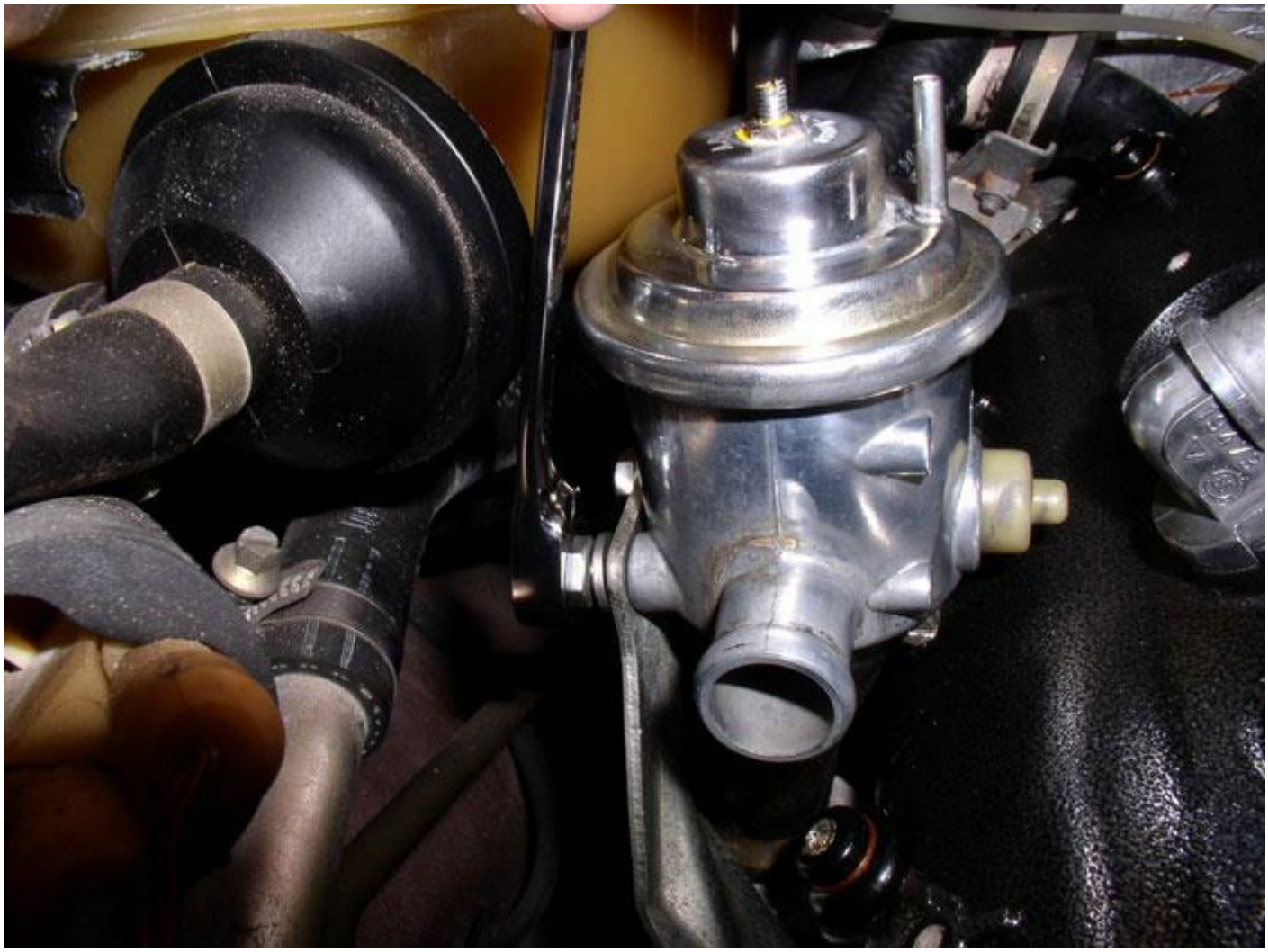
Next, install the bolts that secure the air diverter bracket to the cylinder head on the passenger side. You may be able to reach the bolts by hand from underneath to get them started. Otherwise, you can place the bolt in the socket and use the extensions to get the bolts started. Then tighten them both down.



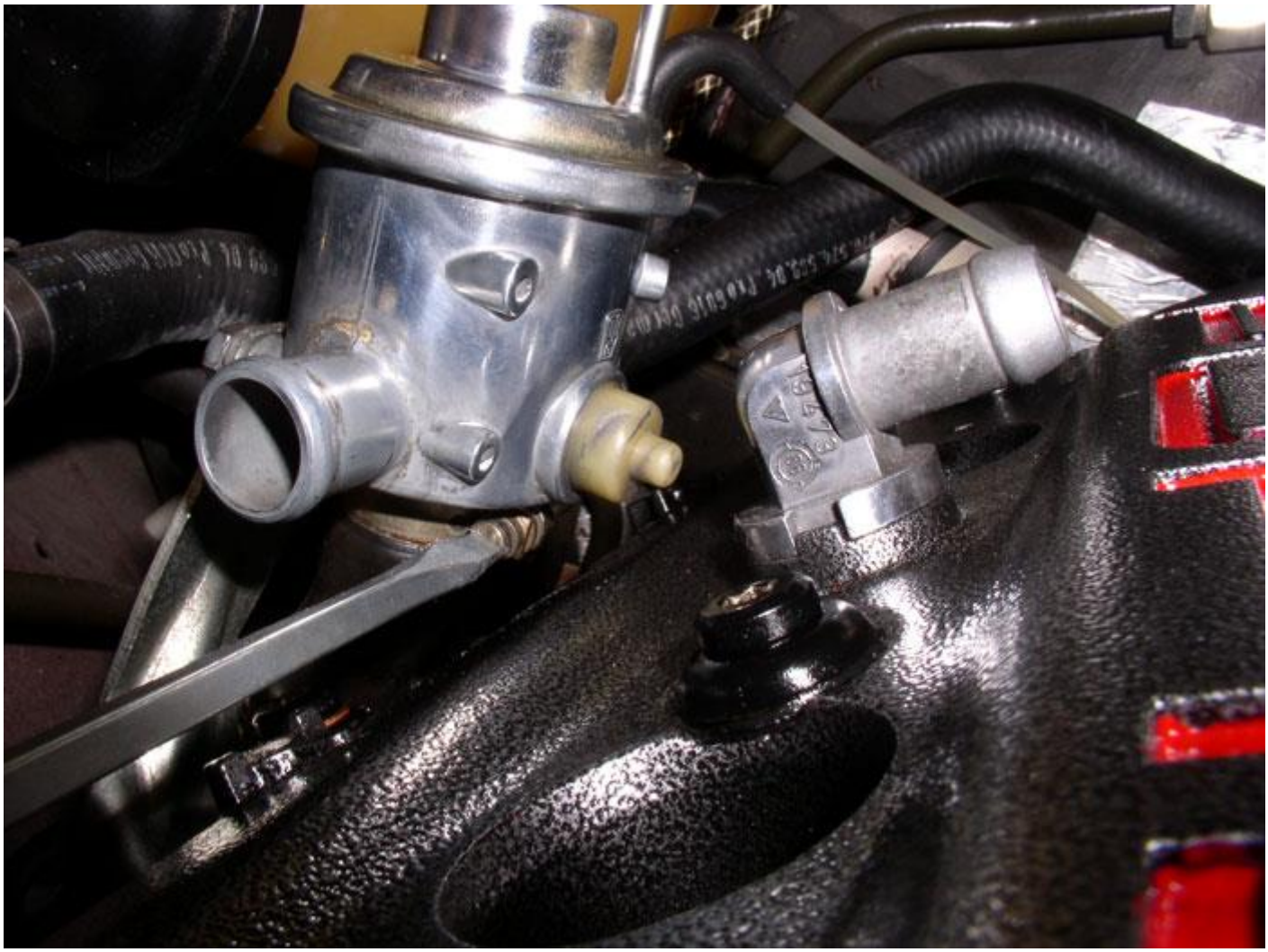
Install the diverter valve onto the rubber hose beneath the valve. The rubber hose connects to a metal pipe that runs into the catalytic converter. Orient the valve as shown. Don't tighten the hose clamp yet.



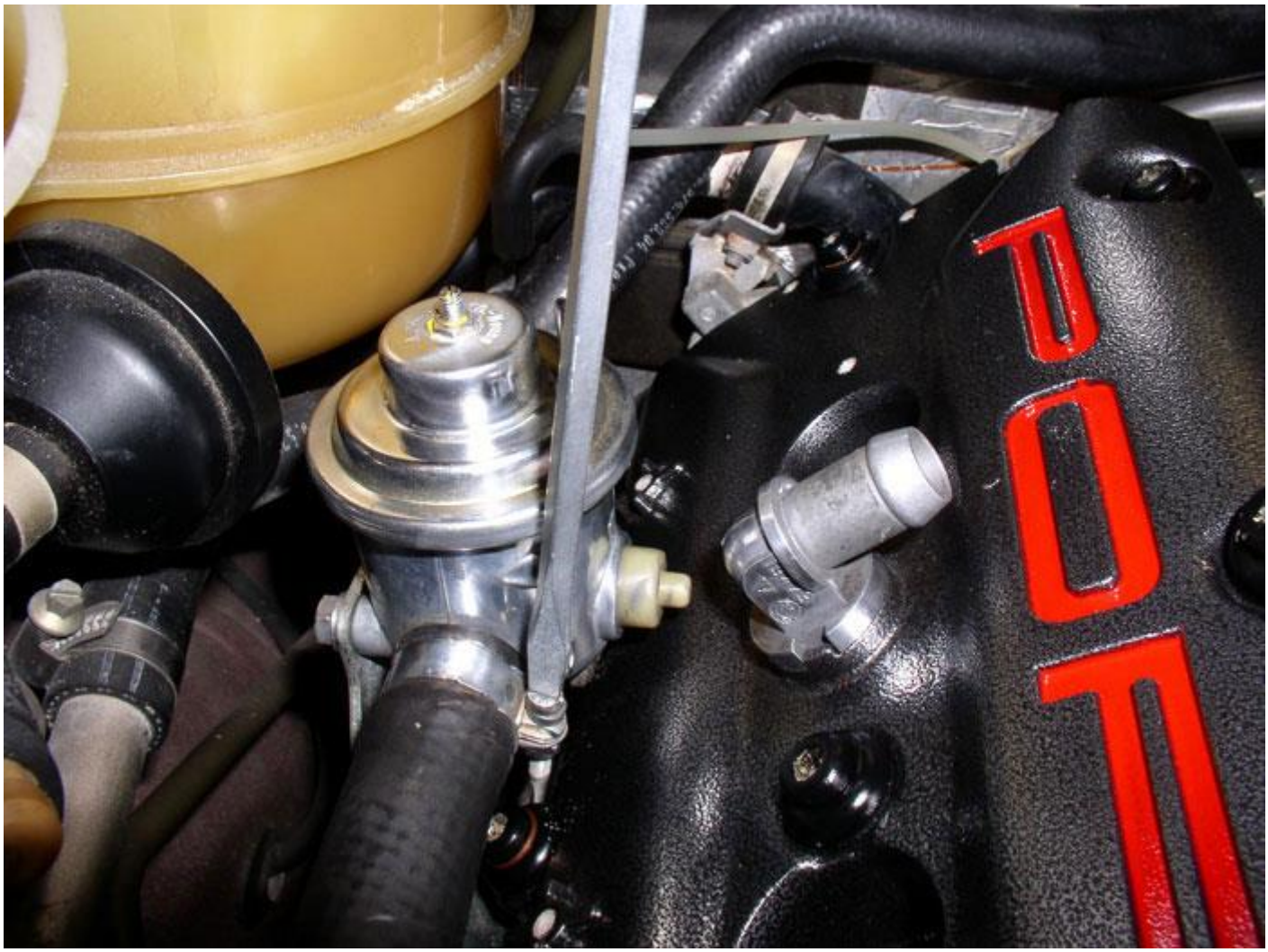
Next, install the two 10mm bolts that secure the diverter valve to the bracket.



Then tighten the hose clamp on the bottom of the diverter valve.



Finally, attach the inlet hose to the diverter valve and tighten the hose clamp.



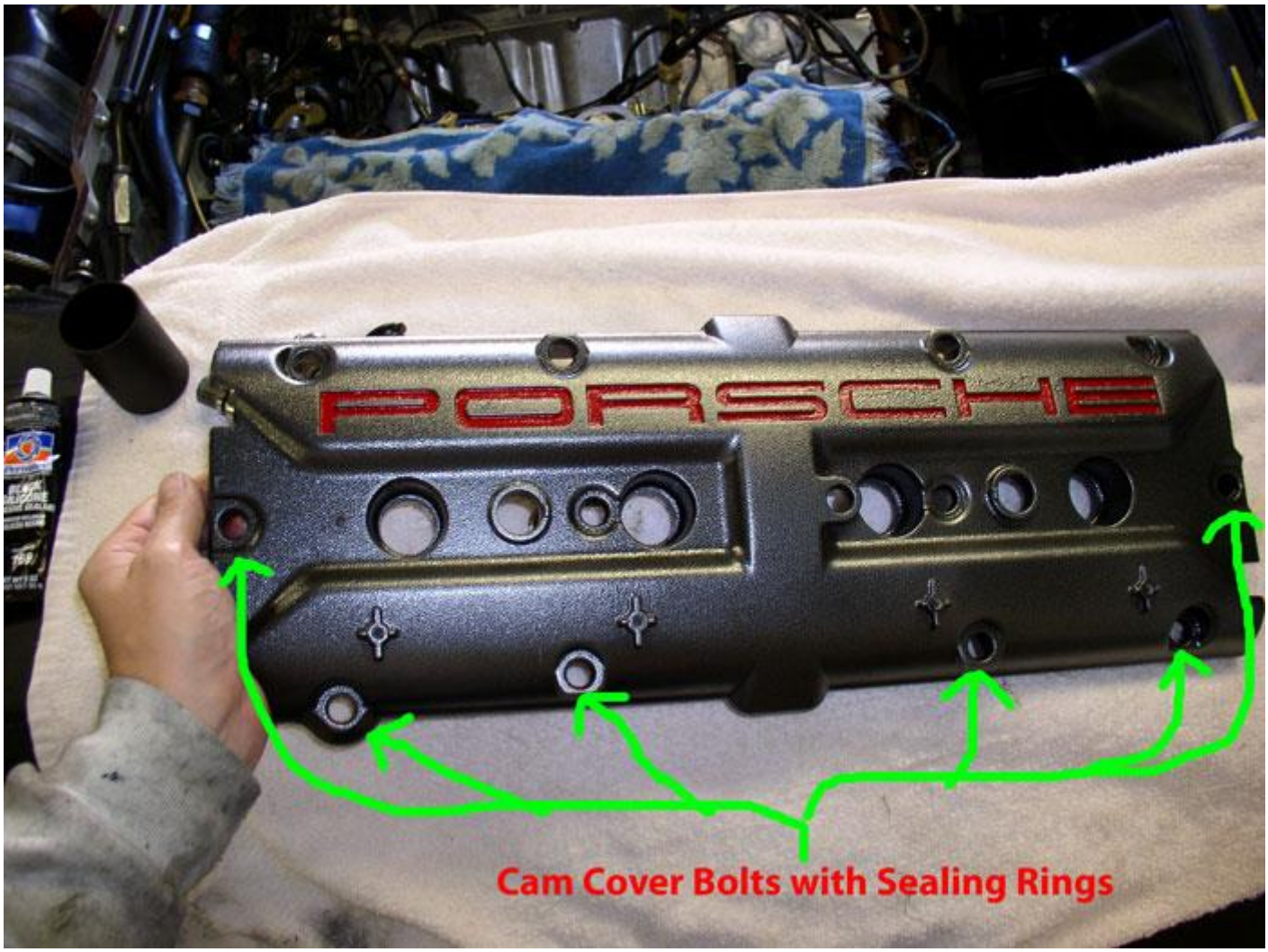
Now you're ready for the final phase - installing the intake.

the sealing rings don't actually seal, just spacers to increase force.

The bolts are designed to "bottom out" on the bolt shoulder at the top of the threads (see below). Hence the low torque values required (7 ftlbs).



By introducing additional space between the head of the bolt and the umbrella washer (using the sealing ring pictured above) the distance to "bottom out" the shoulder against the cylinder head is effectively lengthened - giving you a turn or two more of force that is applied to the rubber thrust washer that is not available on the bolts without the sealing ring. The additional force exerted on the rubber thrust washer is transferred and distributed across the bottom edge of the cam cover (where the sealing rings are used) - see below.




Since more oil pools at the bottom edge of the cam cover than at the top edge of the cam cover (due to gravity) additional clamping force helps seal the cam cover gasket and prevent premature leaking across the bottom of the cam cover. Since the heads and cam covers are tilted, it creates an assymetric oil pooling condition under the cam cover. The use of the sealing rings across the bottom as pictured above provides an assymetric clamping solution to effectively deal with the condition without designing special bolts or using twice the number of sealing rings that aren't needed on the other bolts on the cam cover. Thinking about it - pretty nifty, low cost solution.

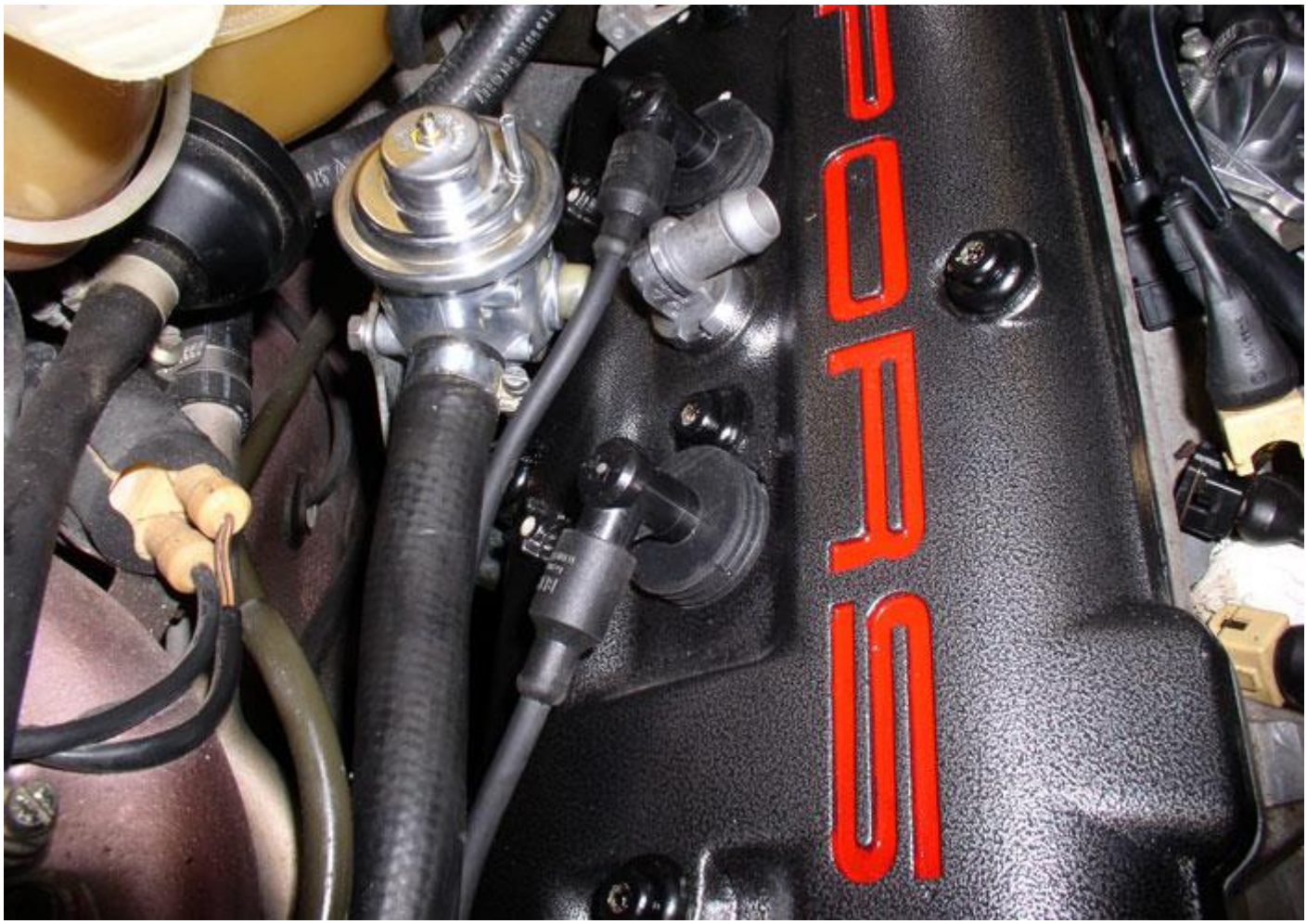
**Intake Installation**

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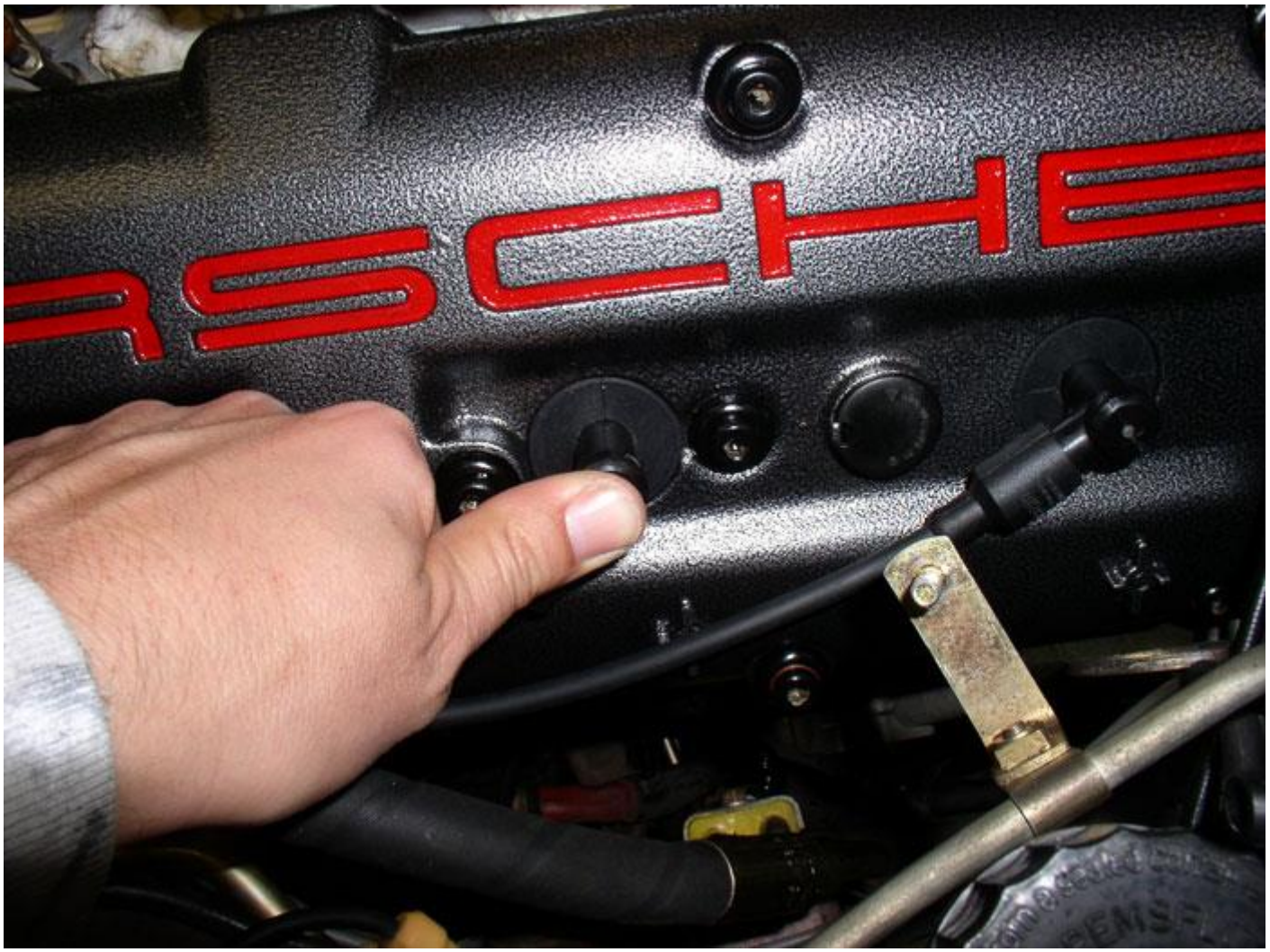
First, some prep work is needed before installing the intake. Position the spark plug wires over the cam covers. The number 4 plug wire is fed under the plug wire guide on the passenger side engine lift hook at the front of the engine. See below.



Since we did not disconnect the plug wires from the distributor, matching up the plug wires to their respective cylinders is straight forward (my plug wires were also numbered). The length of the wires will help determine which plug they go to. You can confirm the wire matches the correct spark plug by looking at distributor spark plug map typically located on a decal on top of the radiator. Position the plug end of the wires into the spark plug holes in the cam cover.



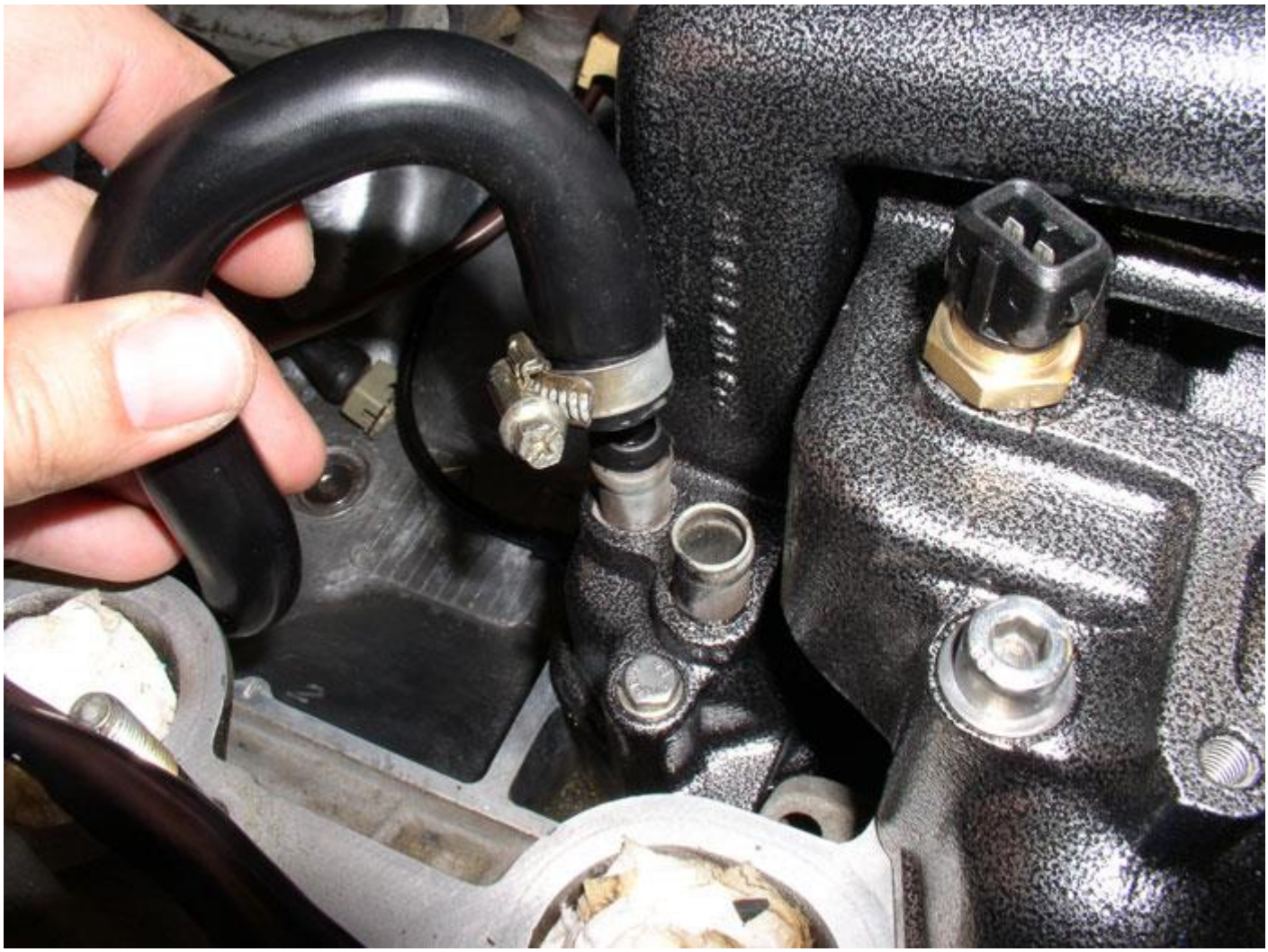
Once you've matched all the wires up to their respective spark plugs and confirmed the matching, press them into place until you hear/feel a solid "click". The plug gasket should be flush with the top of the cam cover as shown. At this time, you can attach the spark plug wiring harness to the harness bracket on the cam covers. However, I have left mine off for now since it makes it a lot easier to move the spark plug wires around if additional tweaking is needed before wrapping up this job. I plan to install the harness brackets on the cam covers and attache the spark plug harness later on (when I'm done goofing around under the hood).



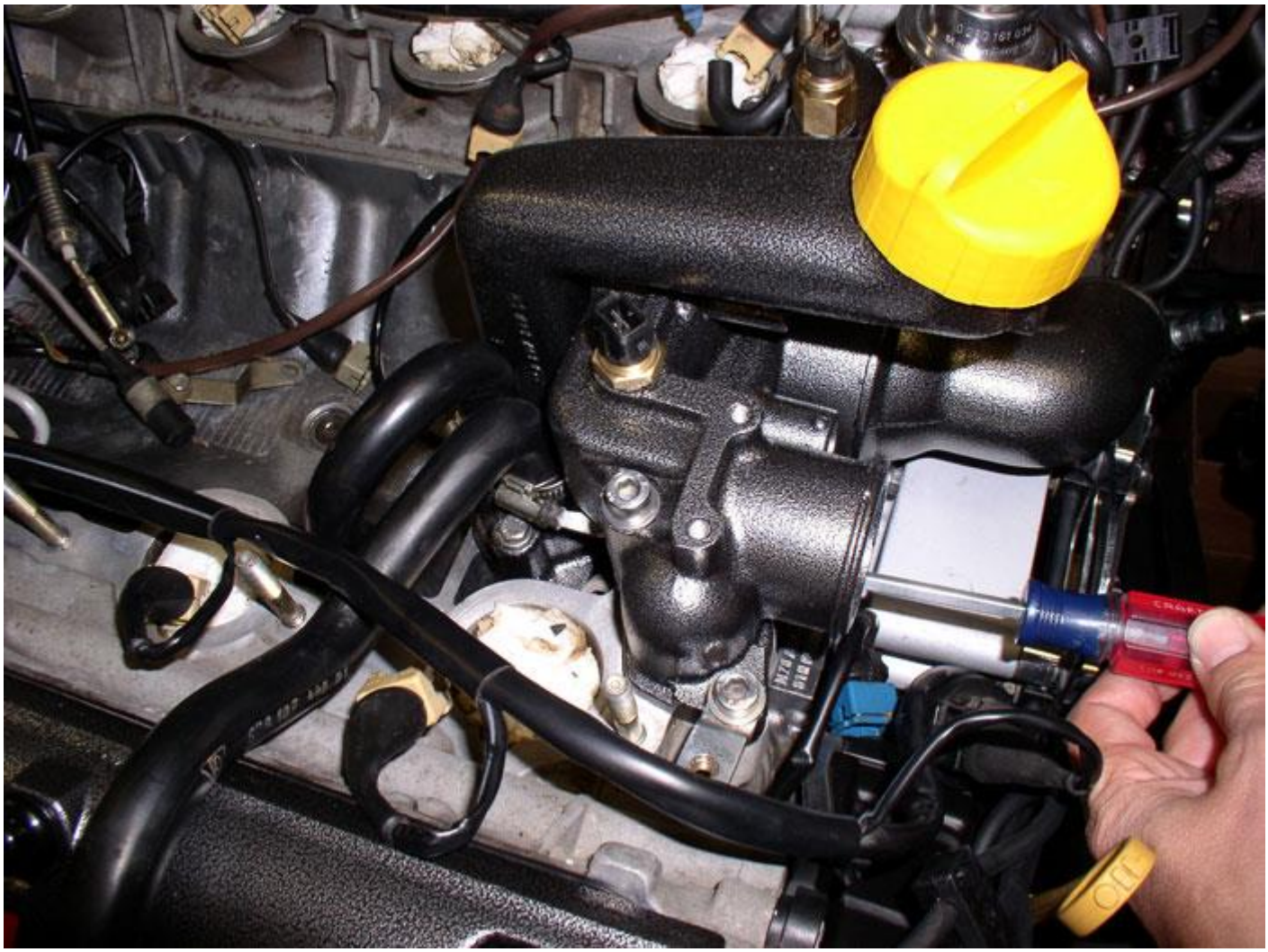
Next, install the one-way PCV valve in the rear port of the oil filler neck. I checked the operation of the valve by simply blowing on each end. Air should flow in one direction through the valve but not in the other direction. Oh yea, good idea to clean the valve before putting it in your mouth.



Install the long PCV hose onto the rear oil filler neck port. The other end of this hose connects to the Air Cowl Guide which will be connected shortly. Position the hose as shown, it should be oriented so that runs parallel to and follows the inside edge of the cylinder head. Tighten the clamp.



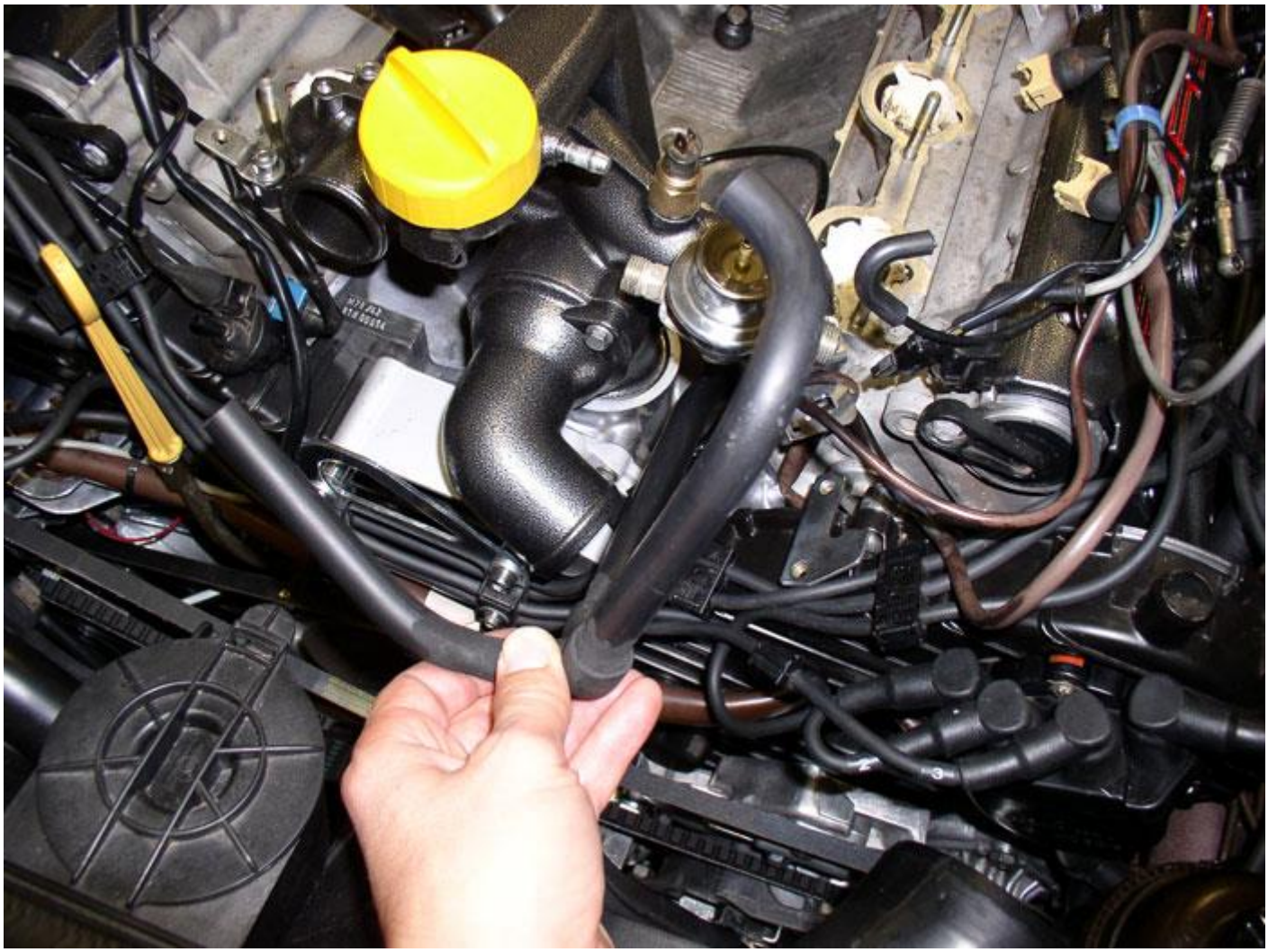
Next, attach the cam cover breather hose to the front oil filler neck port as shown. Position this hose so that the other end connects to the front breather elbow on the cam cover without binding the hose at the oil filler neck. Don't connect/clamp the end at the cam cover elbow yet. You can tighten the clamp on the breather hose at the filler neck by using a long screw driver or socket extension as shown.



Since my fuel rail mounting studs on the intake were toast, I ordered new ones. I installed these next. The longer stud is threaded into the intake while the shorter end of the stud should be facing upward to mount the fuel rail. You will not be able to install the fuel rail mounting nuts if the long end of the stud is pointing upward. I also learned from a post on this thread (although I can't find it now) that if these rubber parts harden and fail and break like mine did, there is a possibility that a fuel leak may occur at the injectors which may also lead to an engine fire. I understand that solid metal mounts may be available and could be an alternative mount to use. A matter of personal preference.



Position the 3-way fuel vapor/oil filler neck/throttle body hose as shown but don't connect just yet.



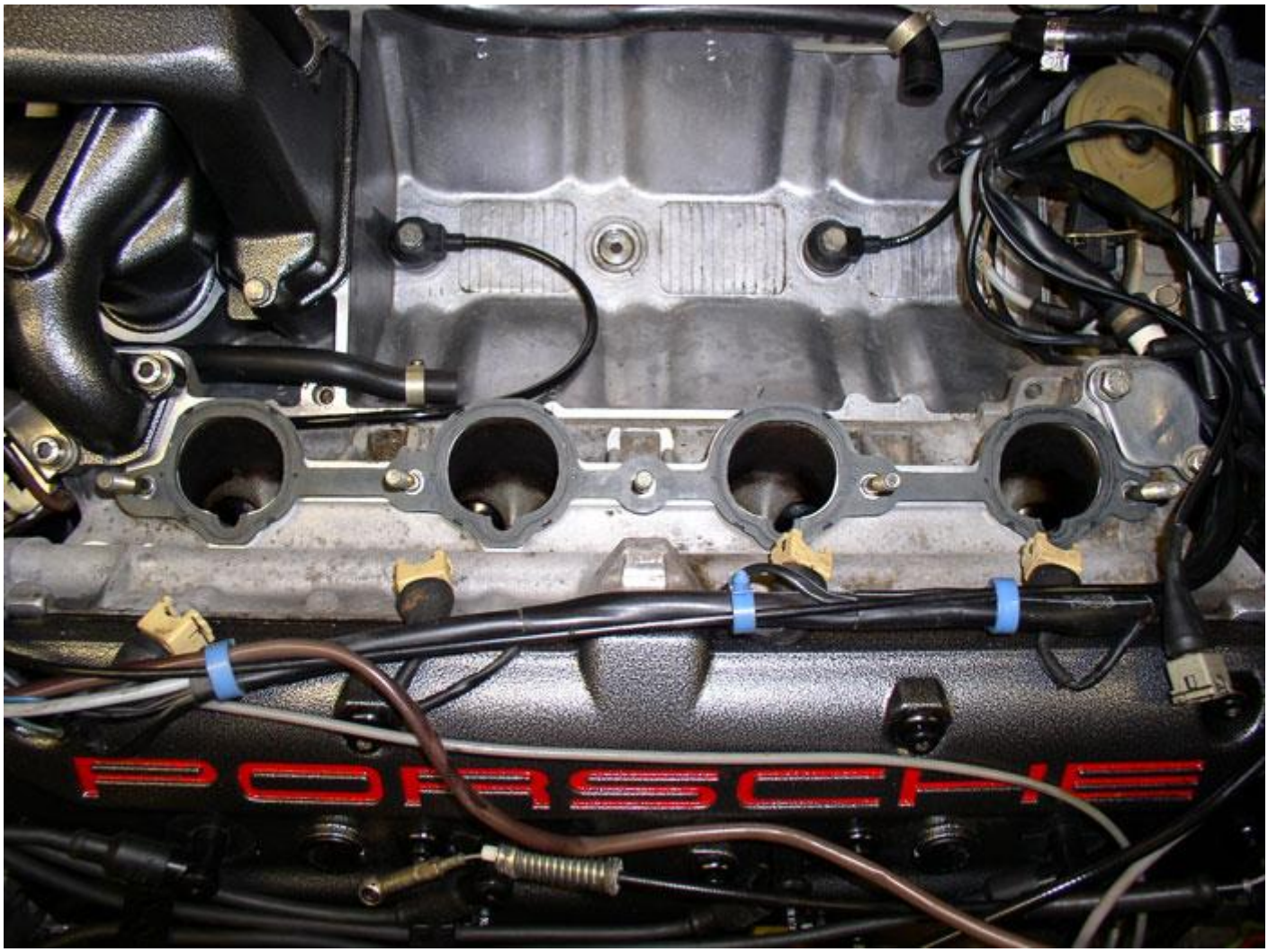
Next, prepare the cylinder head mating surface for the intake by wiping it down and removing any residual debris.



After wiping down the mating surface, remove the rags/plugs in the intake ports. I double checked to ensure nothing foreign made it's way into the cylinder head.



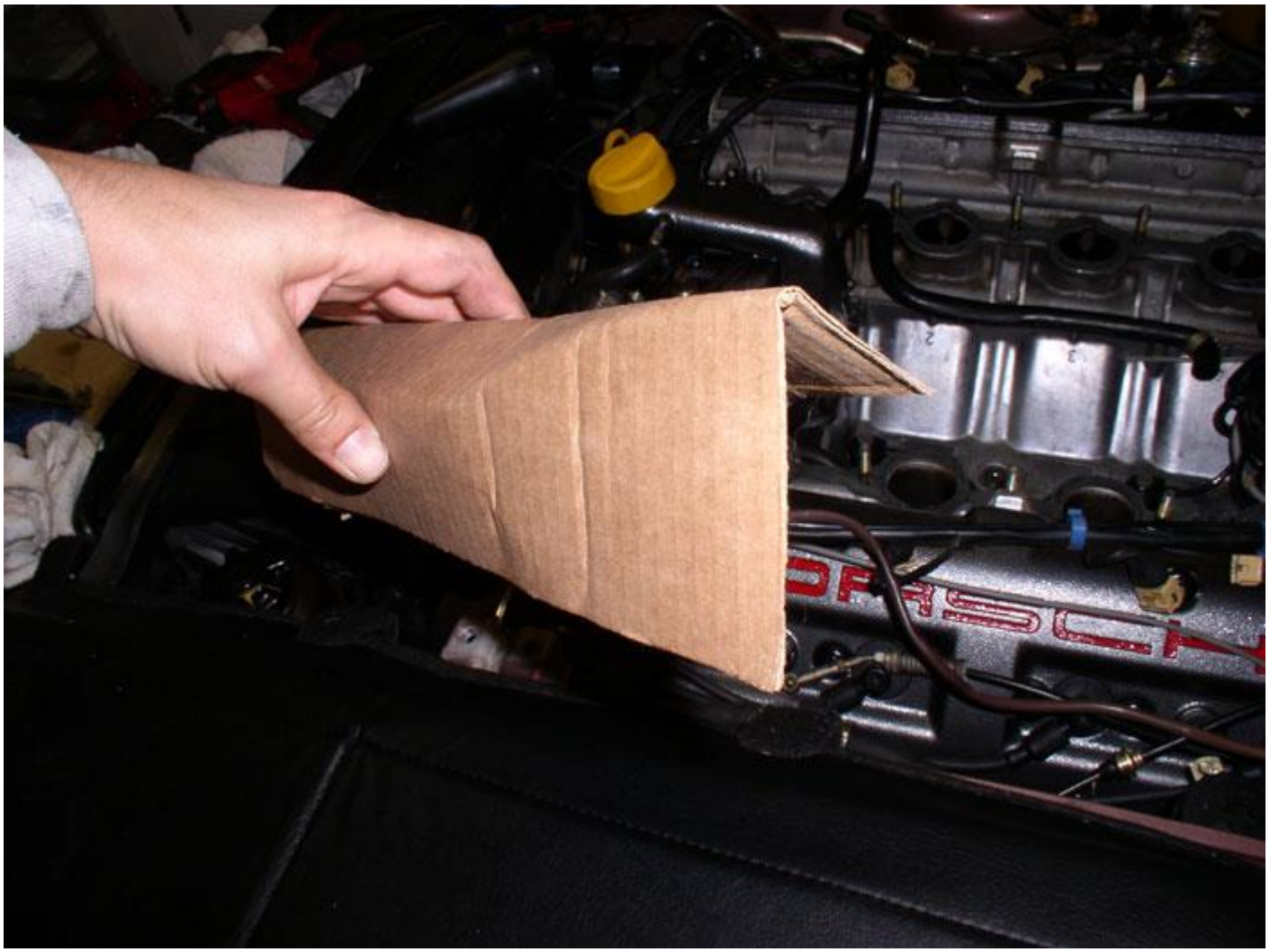
Install the intake rubber gaskets. Ensure they are facing up - there is stamped lettering on the top side (e.g., "TOP"). Also ensure the curved recess for the injector is matched to the same recess in the mating surface of the cylinder head as shown.




Install the other gasket. Now, it's ready to bring the intake/throttle body assembly over and should look something like this.



To help with keeping the intake elevated while making some underneath connections, I used cardboard strips (about 8" wide and 12-18" long). Bend the cardboard strips lenthwise as shown creating appoximately a 3X2X3 "U" shape.



Place the cardboard "U" shaped stands inverted over the intake mounting studs as shown.

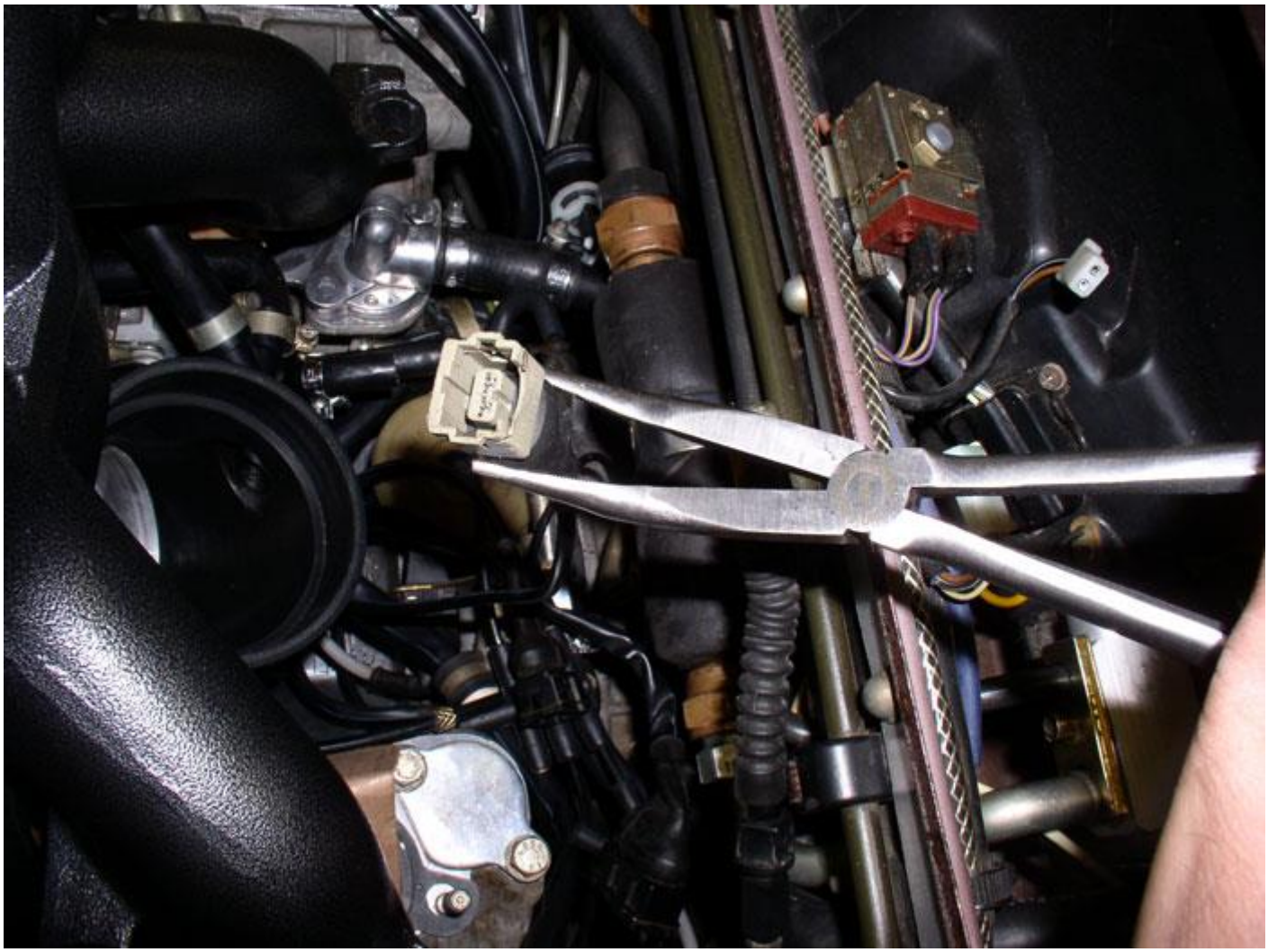


Then bring the intake/throttle body assembly over and set it on the cardboard "stands". Next, lift up the passenger side of the intake and route the front cam cover breather hose through the gap between the first two intake runner legs as shown. Then grasp the fuel vapor diaphram vacuum line (see arrow) and route it through

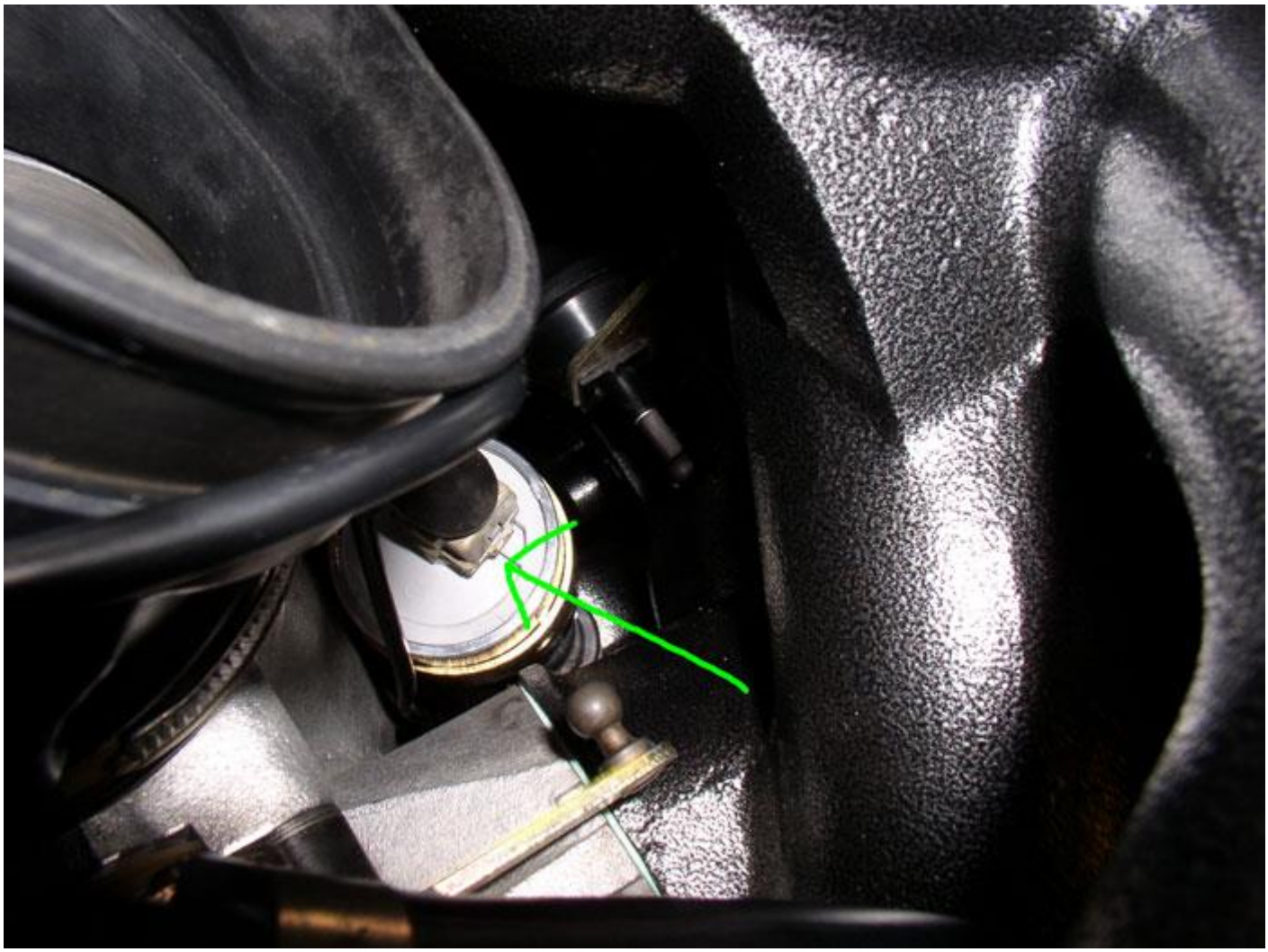
the first two intake runner legs as well.



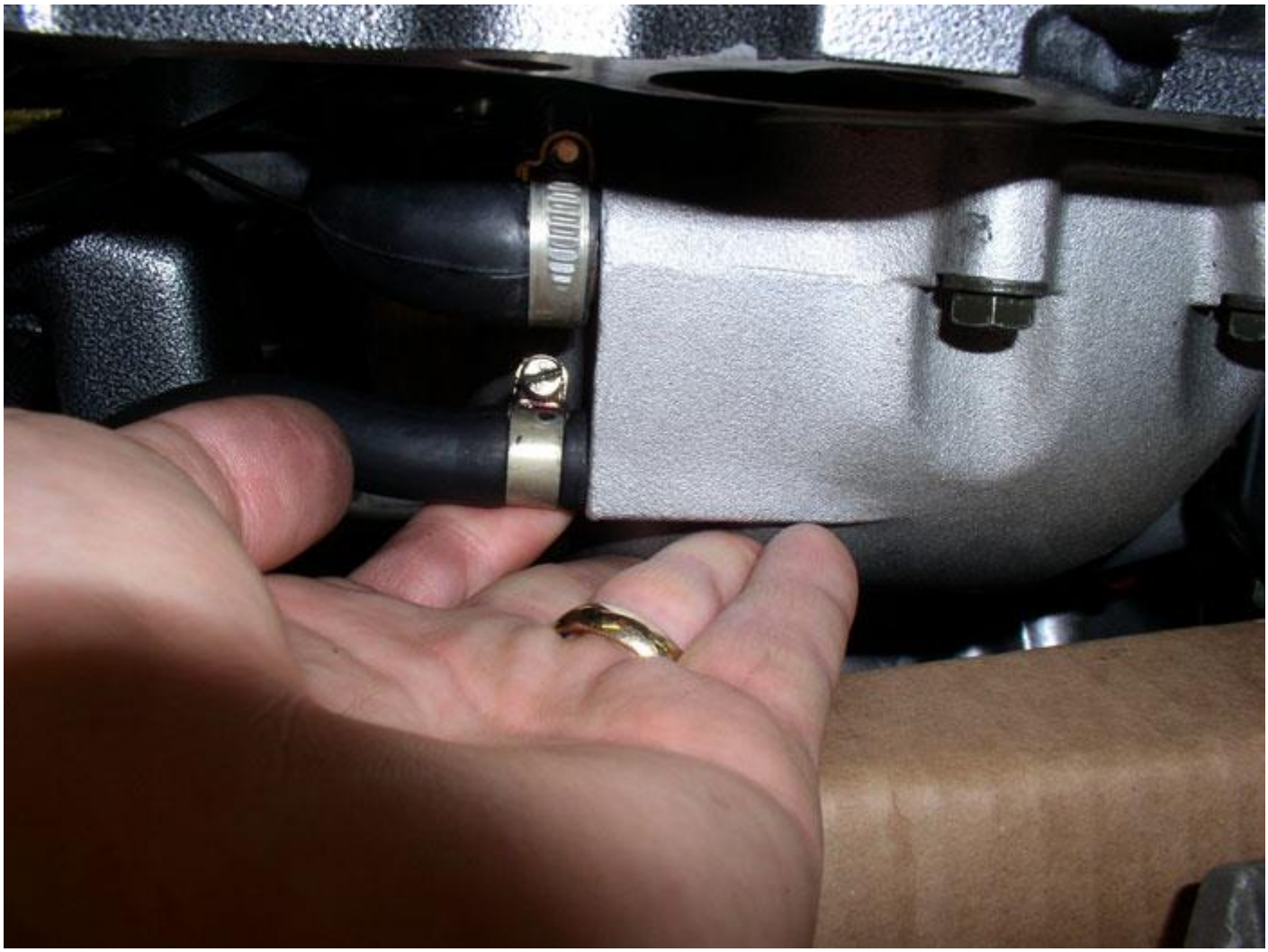

Next, connect the Idle Stabilization Valve (ISV) electrical plug. I used an extra long pair of 90 degree needle nose pliers to grip the plug end. Then rotate the intake so you can gain visual access to the ISV end of the connection. I rotated the intake toward the driver's side of the car since I'm right handed. The plug connection is keyed so you will need to position the plug end in the pliers to match the keyed receptacle at the ISV. Then, manuever the needle nose pliers under the intake and carefully line up the keyed plug and press into place. Be careful not to squeeze the connector with the pliers too hard as it may be brittle and break. I actually broke a corner off the plug (I think it was the 3rd time I removed the intake on this job when I chipped the connector! It still holds just fine).



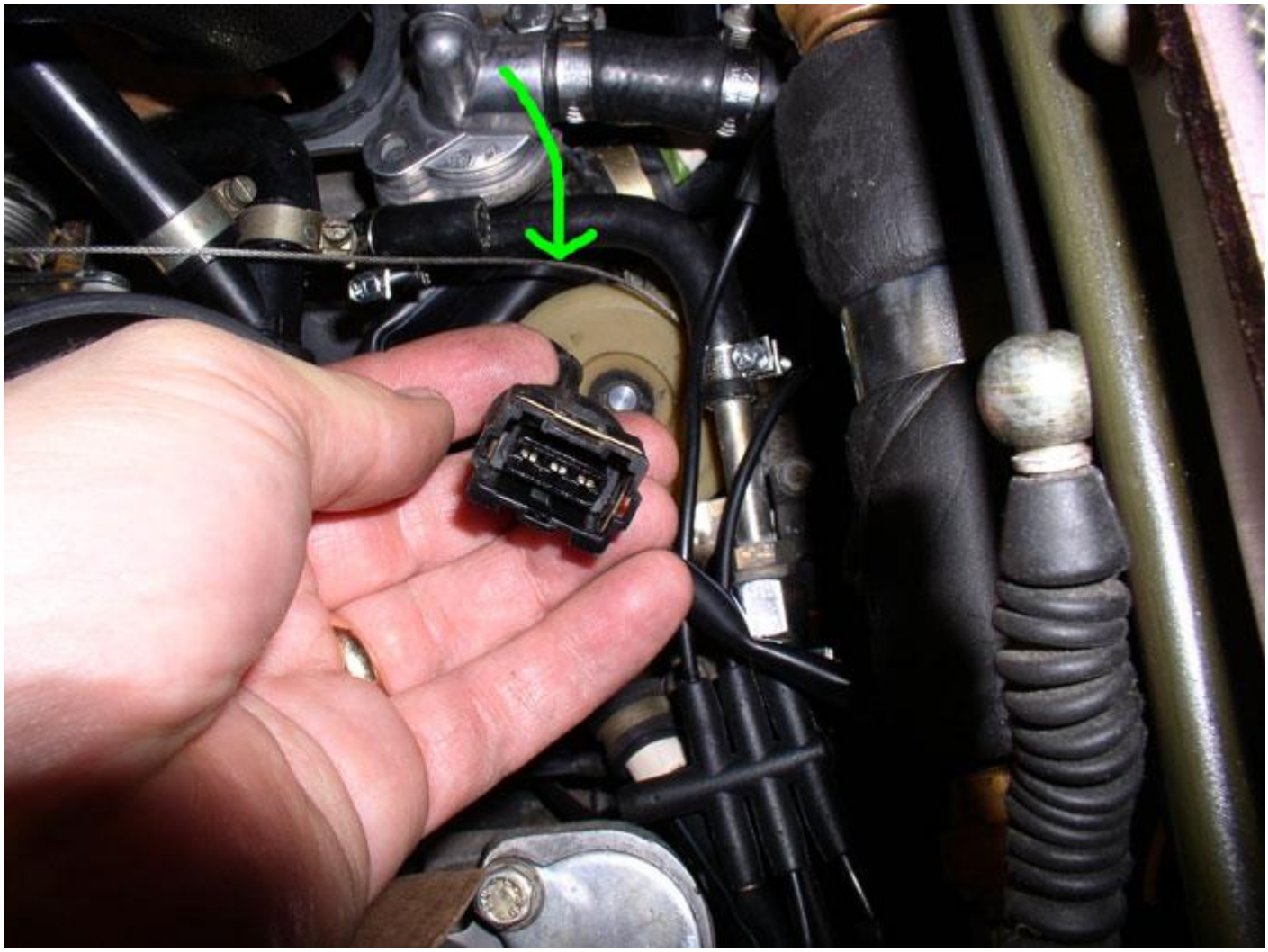
The wire connection should look like this when connected.



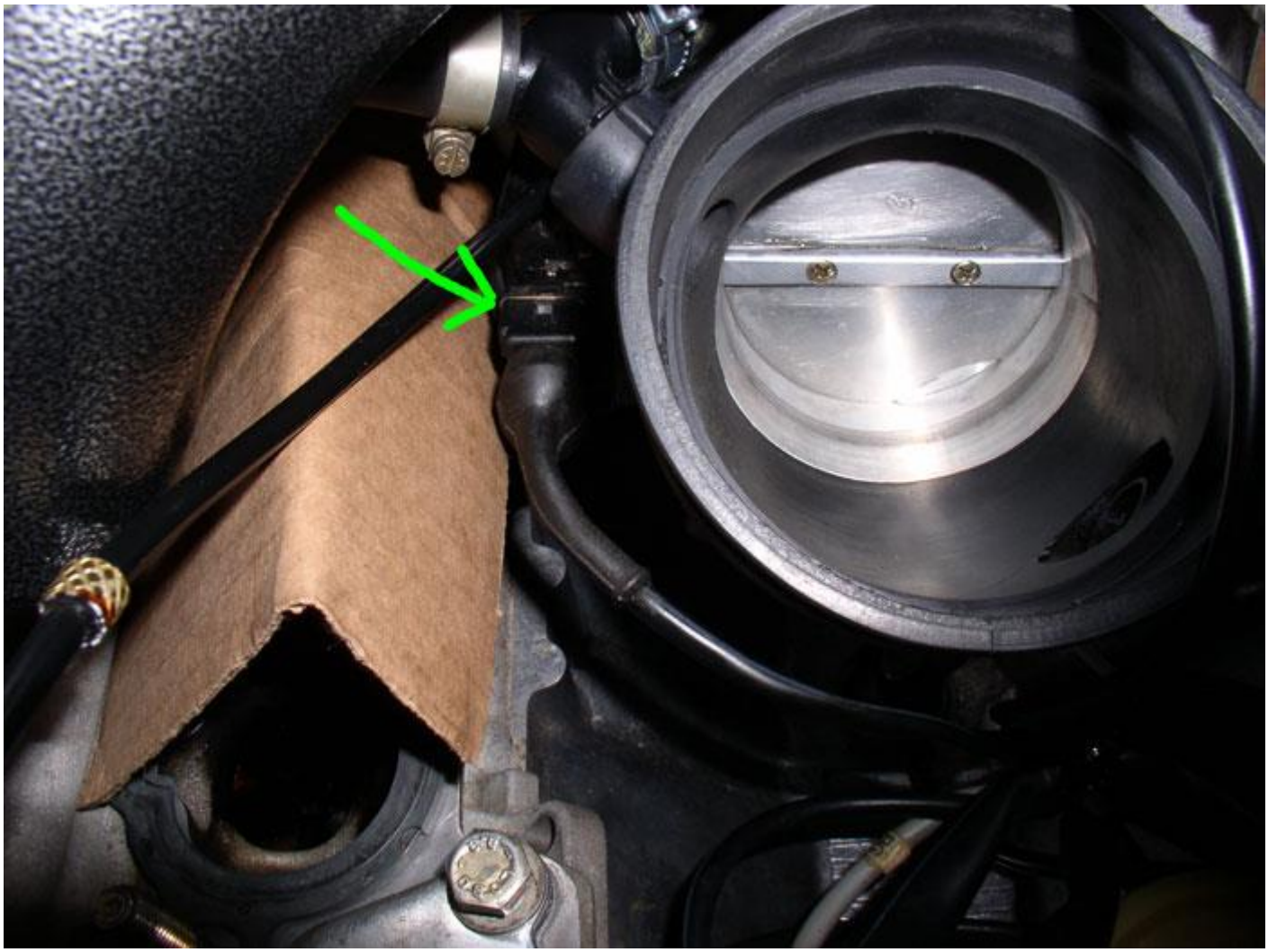
Next, rotate the intake back to normal and lift up the driver's side to gain access to the throttle body. Connect the 3-way fuel vapor/oil filler neck/throttle body hose to the port on the bottom of the throttle body as shown. Position the clamp as shown and tighen down.



While you're on the driver's side, locate the Throttle Postion Sensor (TPS) harness connector as shown. Also note the throttle plate cable at the wheel shown by the arrow in the picture. It most certainly has come off the wheel during this repair. Don't worry about threading the cable on the wheel just yet, we'll get to that. But make sure the cable is accessible.



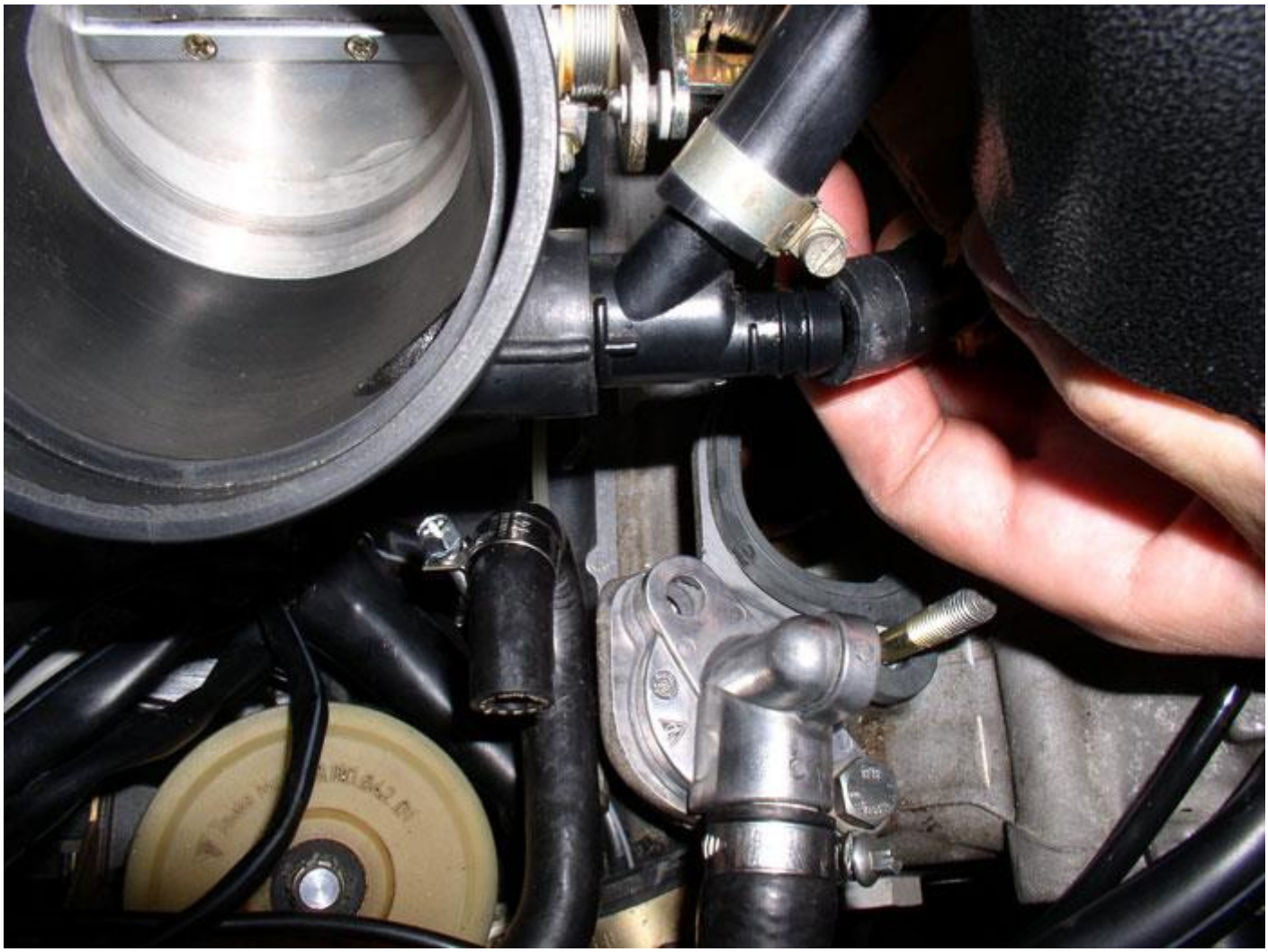
Connect the TPS harness plug to the TPS on the side of the throttle body.



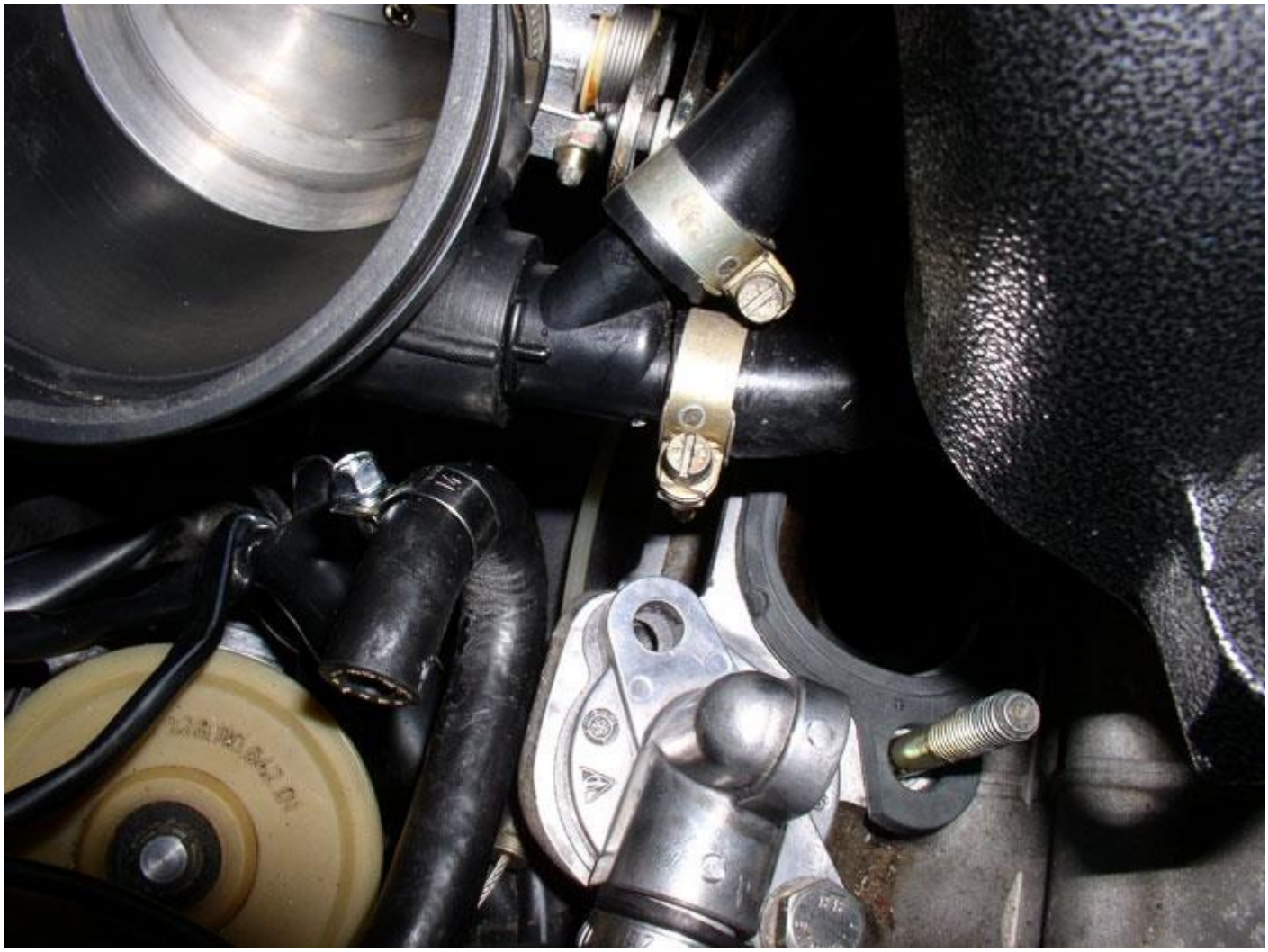
Move to the front of the intake, driver's side and manuever the flappy valve vacuum line through the opening under the water bridge



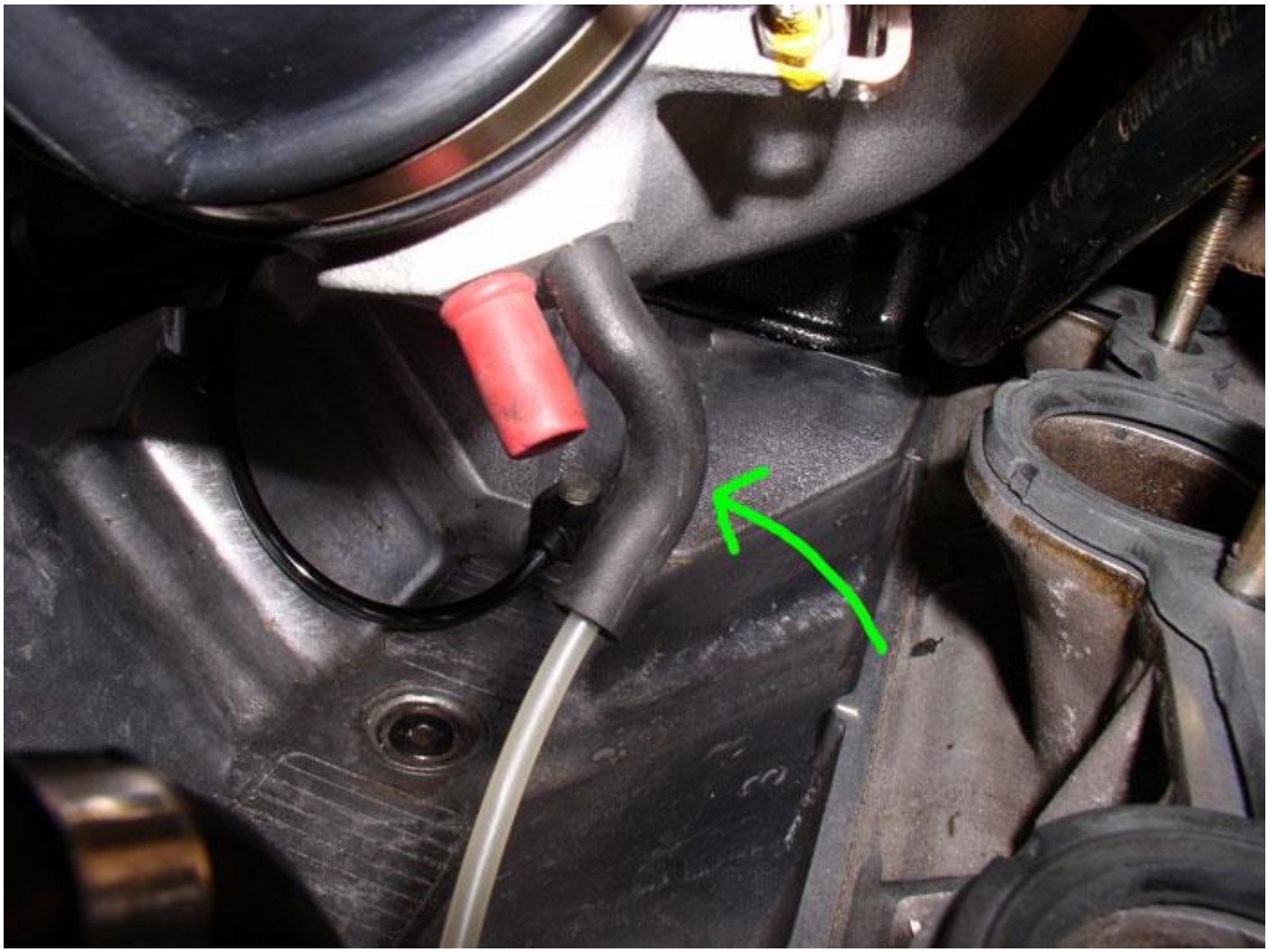
Next, move over to the passenger side and lift up the intake. Connect the long PCV hose that runs to the rear port of the oil filler neck, to the "Y" connector attached to the Air Guide Cowl.



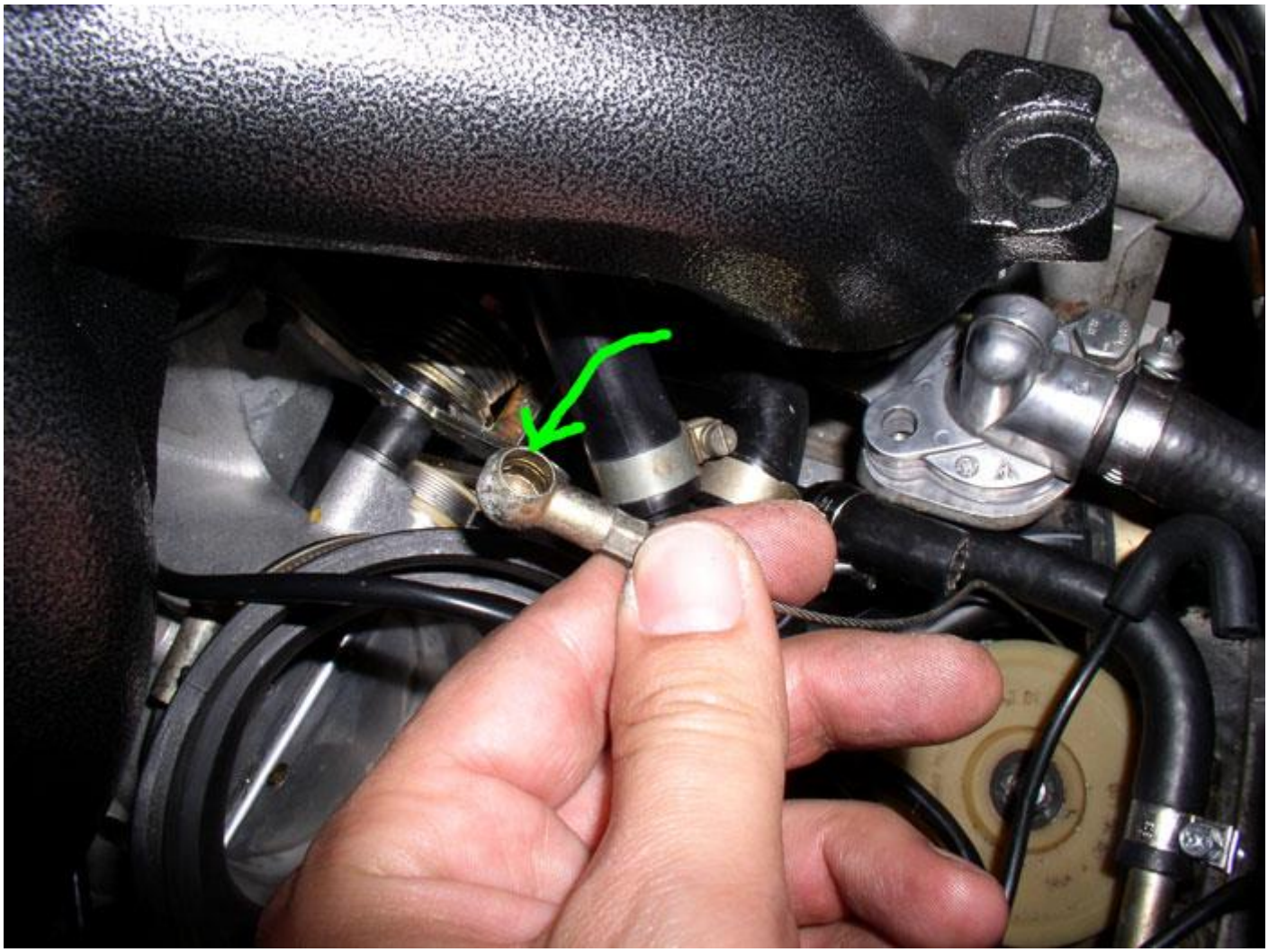
Position the clamp as shown and tighten down.



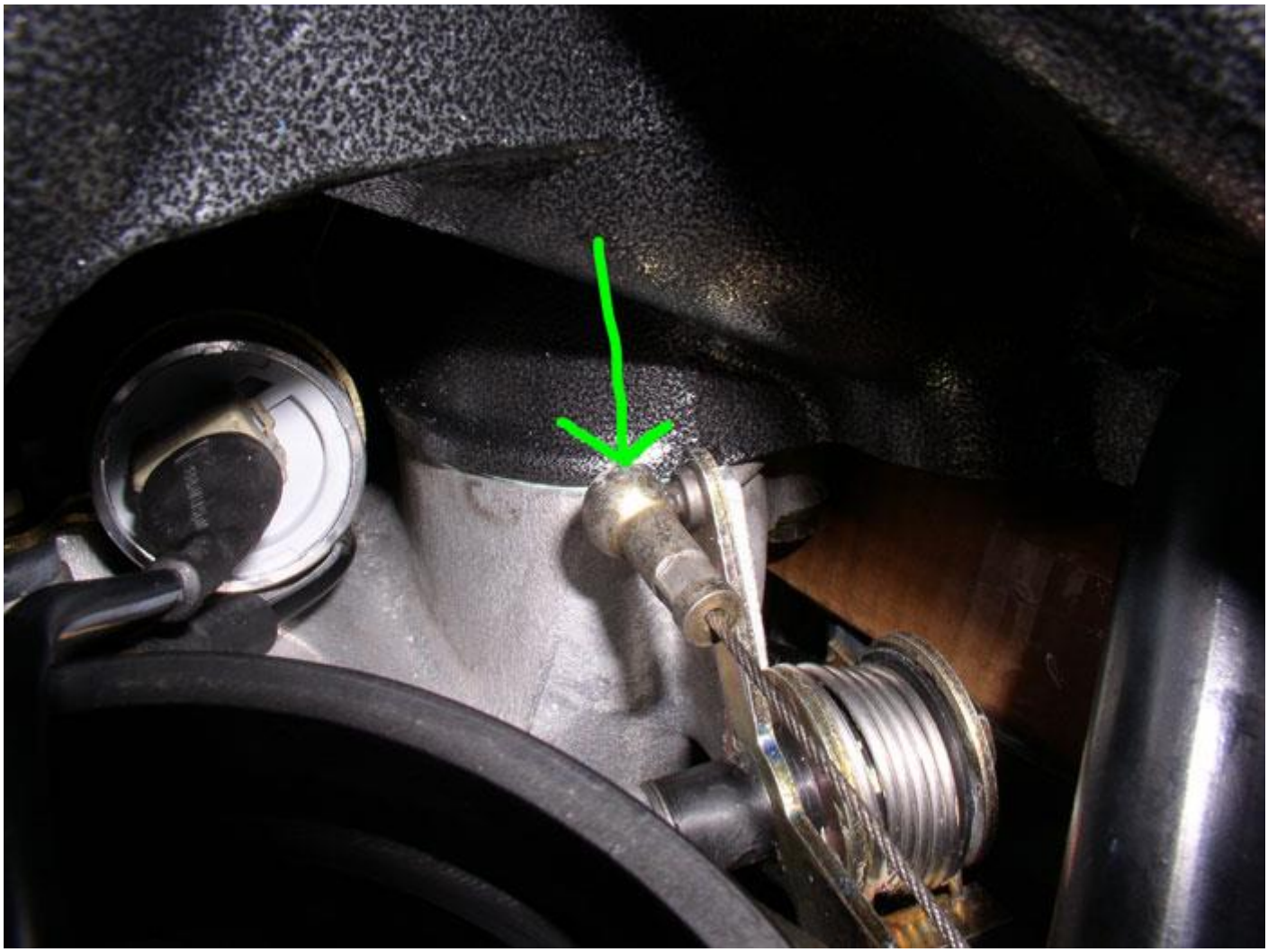
Then, connect the air diverter valve vacuum line elbow to the open port on the bottom of the throttle body as shown.



Next, locate the end of the throttle plate cable and ensure it is not obstructed or wrapped around any hoses/wires. I placed a moderate amount of black grease in the the ball cap before installation.



Press the ball cap end of the cable onto the ball at the throttle plate lever arm as shown.



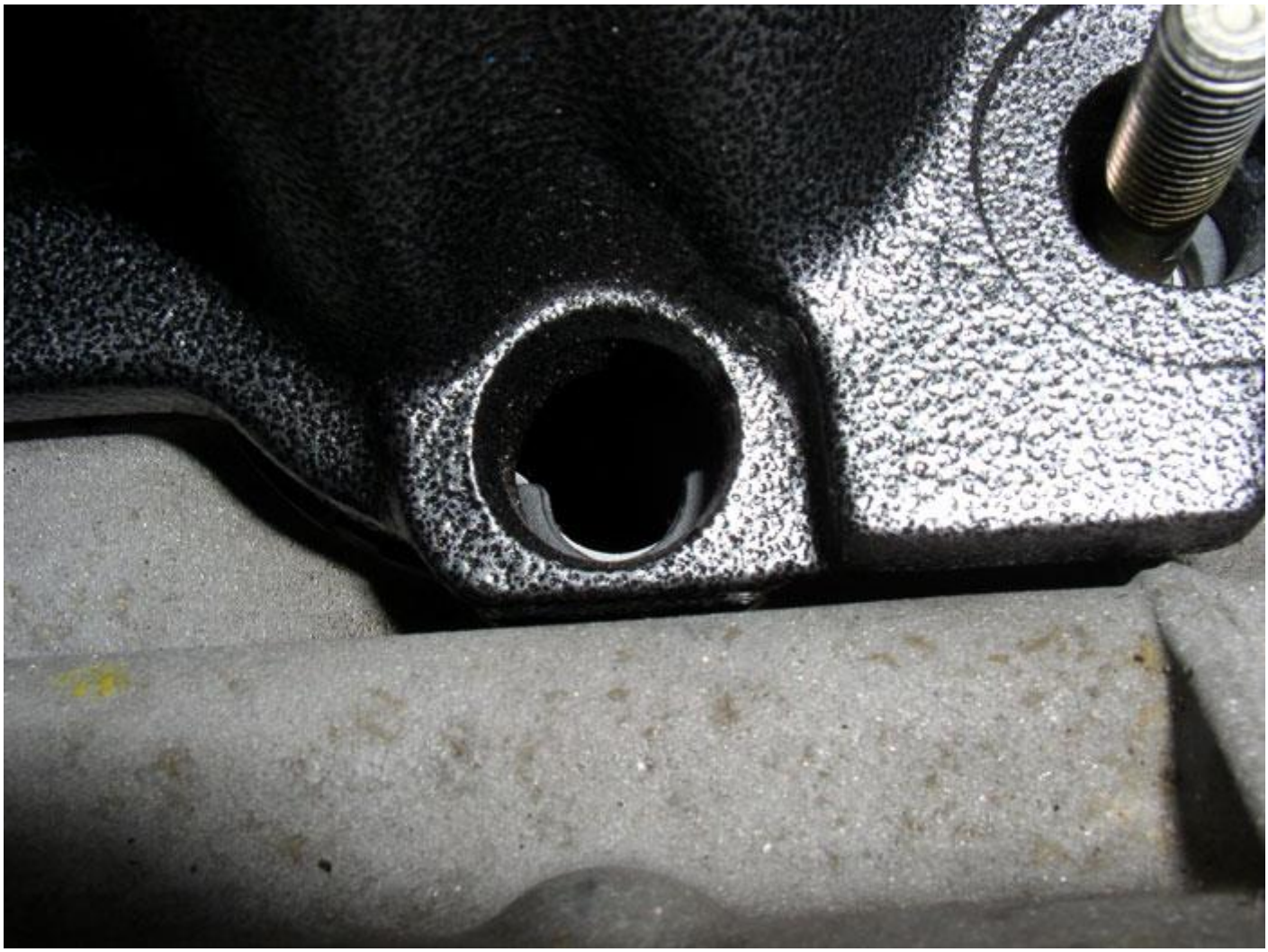
Next, remove the cardboard and lower the intake over the mounting studs.



Thread the throttle plate cable around the cable wheel as shown. Pull the other end of the cable to ensure the throttle plate and cable operate smoothly througout its range.

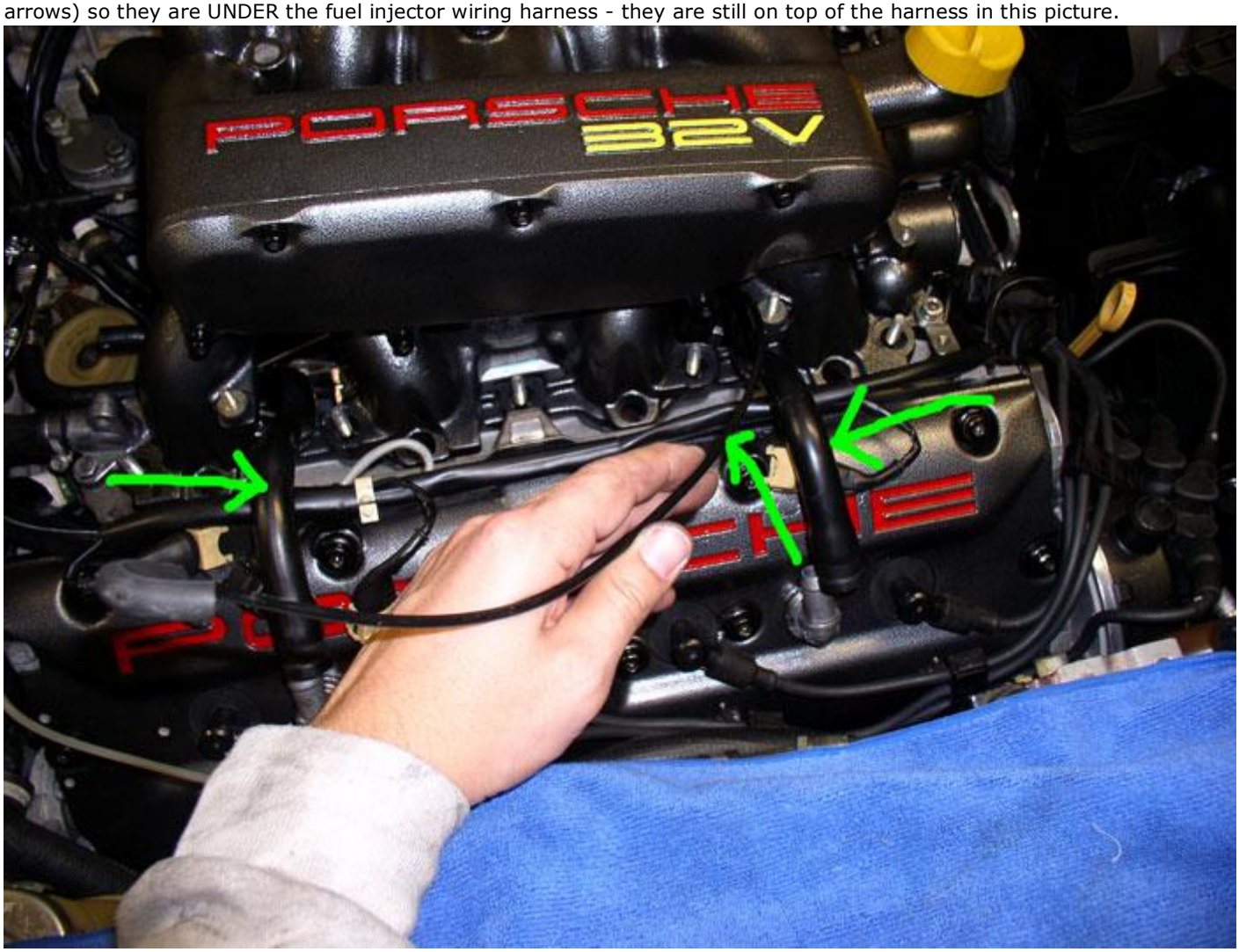


Ensure the recessed cutout in the intake gasket for the fuel injectors lines up with the recessed cutout in the cylinder head and is centered in the fuel injector hole.



On the passenger side, route the two cam cover breather hoses and fuel vapor diaphram vacuum line (see

arrows) so they are UNDER the fuel injector wiring harness - they are still on top of the harness in this picture.

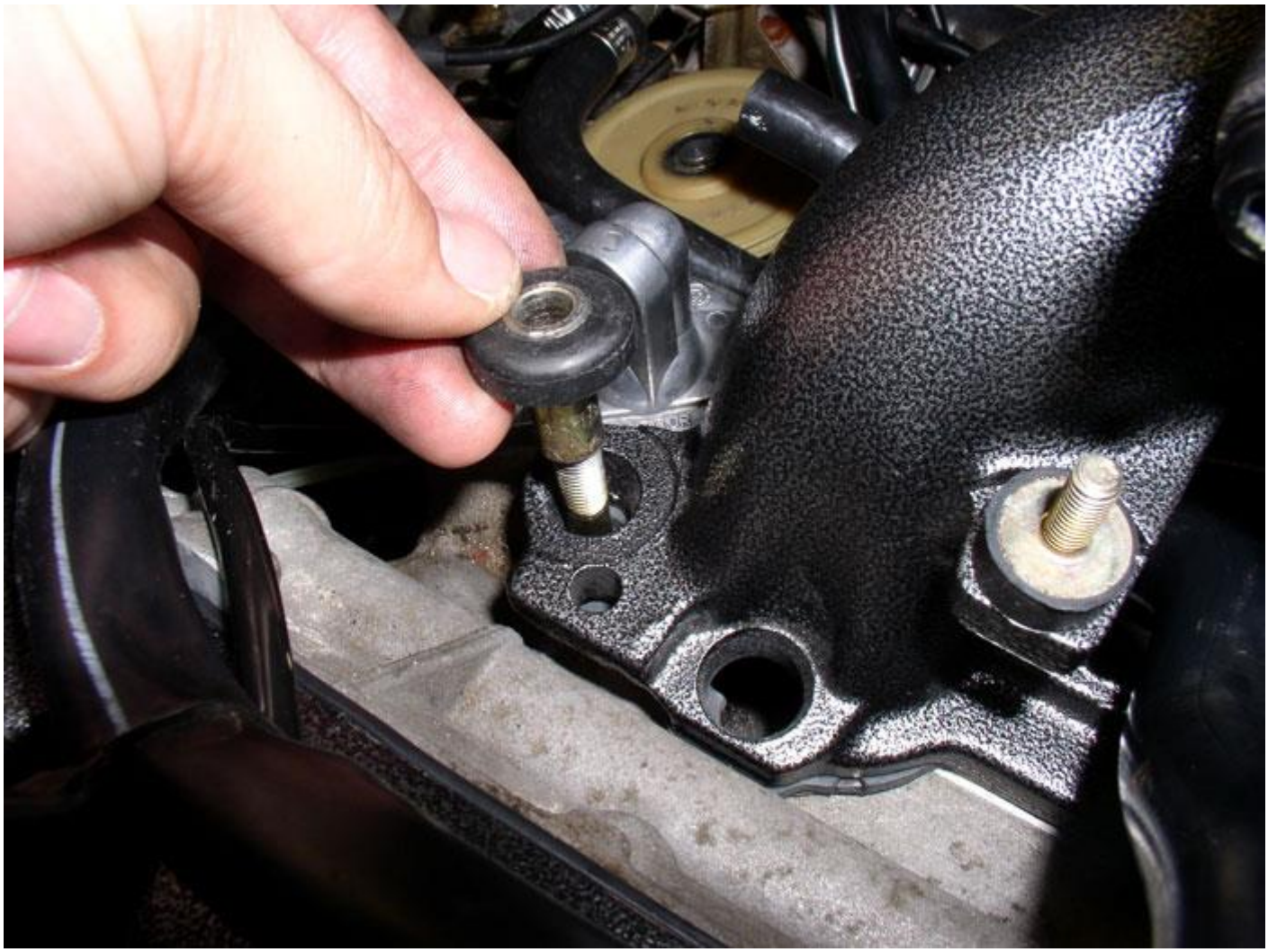



Next, prepare the mounting hardward for the intake. You should have 10 each of the following: metal sleeves, new rubber thrust washers, metal umbrella washers and locking 13mm nuts. There are a couple of ways to install the metal sleeve - flange up or flange down. If yours was installed with flange down when you removed it (like mine was), you may decide you want to install the metal sleeve in the same orientation on this install. You will need to install the metal sleeve from underneath the intake with flange oriented down. Then install the rubber thrust washer on the top of the metal sleeve to hold it in place in the intake. Now you can lower the intake over the studs.

However, when I looked in the PET and tech bulletin #8701 from the 1984-1993 tech bulletins on CD, the diagrams seemed to indicate the order of the sleeve and thrust washer installation - thrust washer first then sleeve then umbrella washer then lock nut. See post 160 of this thread for more details. Based on this observation, I decided to install the sleeve with flange oriented up. If you decide to go this route as well, you can follow the next pictures and steps for installation (I believe the sleeve will function the same regardless if the flange is oriented up or down so it may be more a matter of preference). Insert the sleeve into the rubber thrust washer with the flange oriented on top of the washer as shown. There was a recessed groove in the top of the thrust washers I received to accomodate the flange on the sleeve.



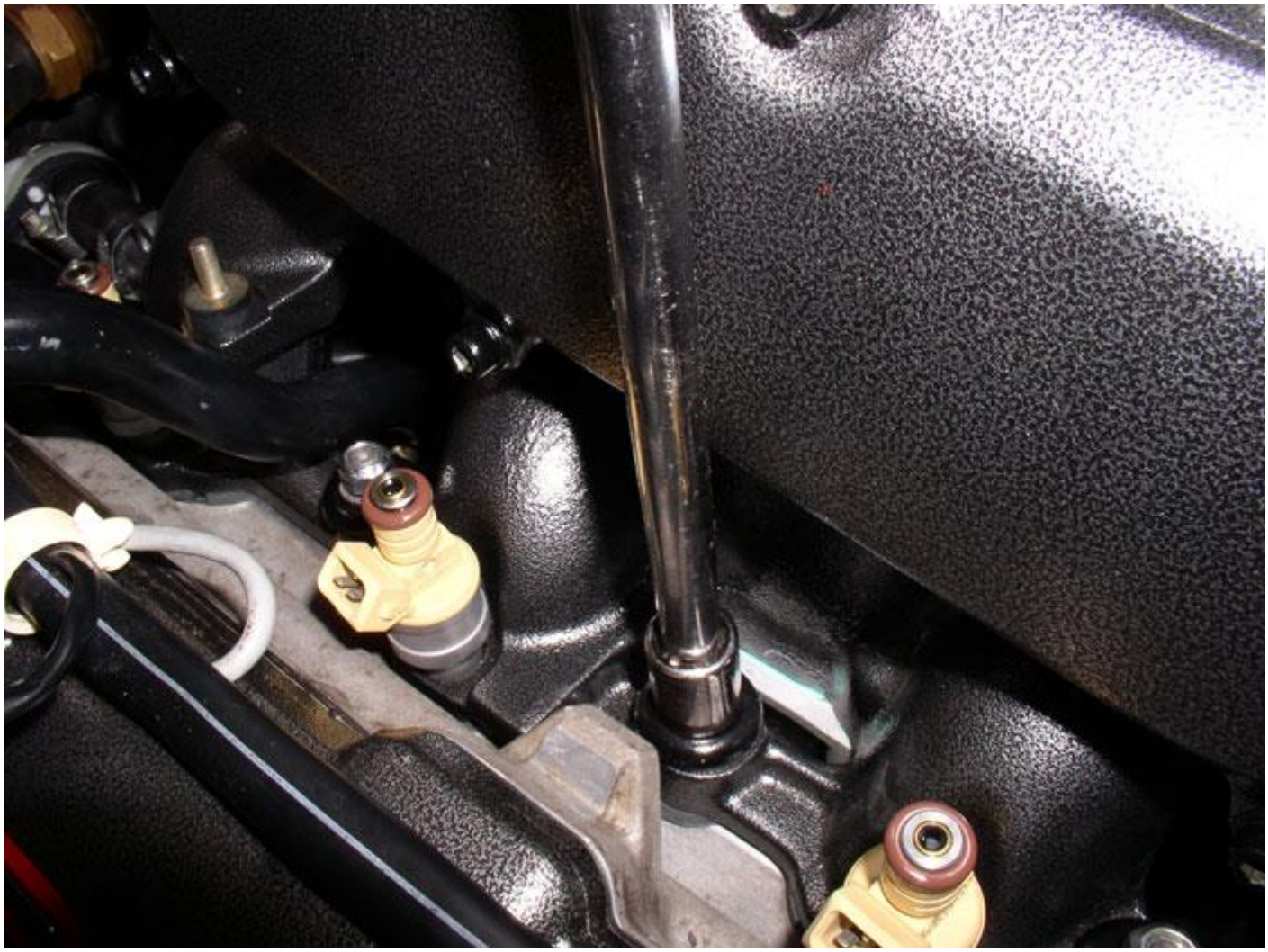
Install the rubber thrust washer and sleeve onto the intake mounting studs.



Place the umbrella washer on next.



Since my injectors were sent out for cleaning and were separated from the fuel rail, I test fit them in the injector holes before installing and torquing down the intake nuts. This served two side benefits, it plugged the injector hole to prevent debris from falling into the cylinder head and second, it helped me ensure the injectors would fit properly and line up with the gasket underneath before torquing the intake down. Install the 13mm locknut on the studs and begin torquing them down. Torque to 11 ftlbs. I started in the middle of the intake and worked outward and side to side (driver's vs passenger side). HOWEVER, do not install and torque down the rear (toward the firewall) nut on each side of the intake - you will need to install the fuel pressure damper/regulator assembly on this stud before installing the nut and torquing down.



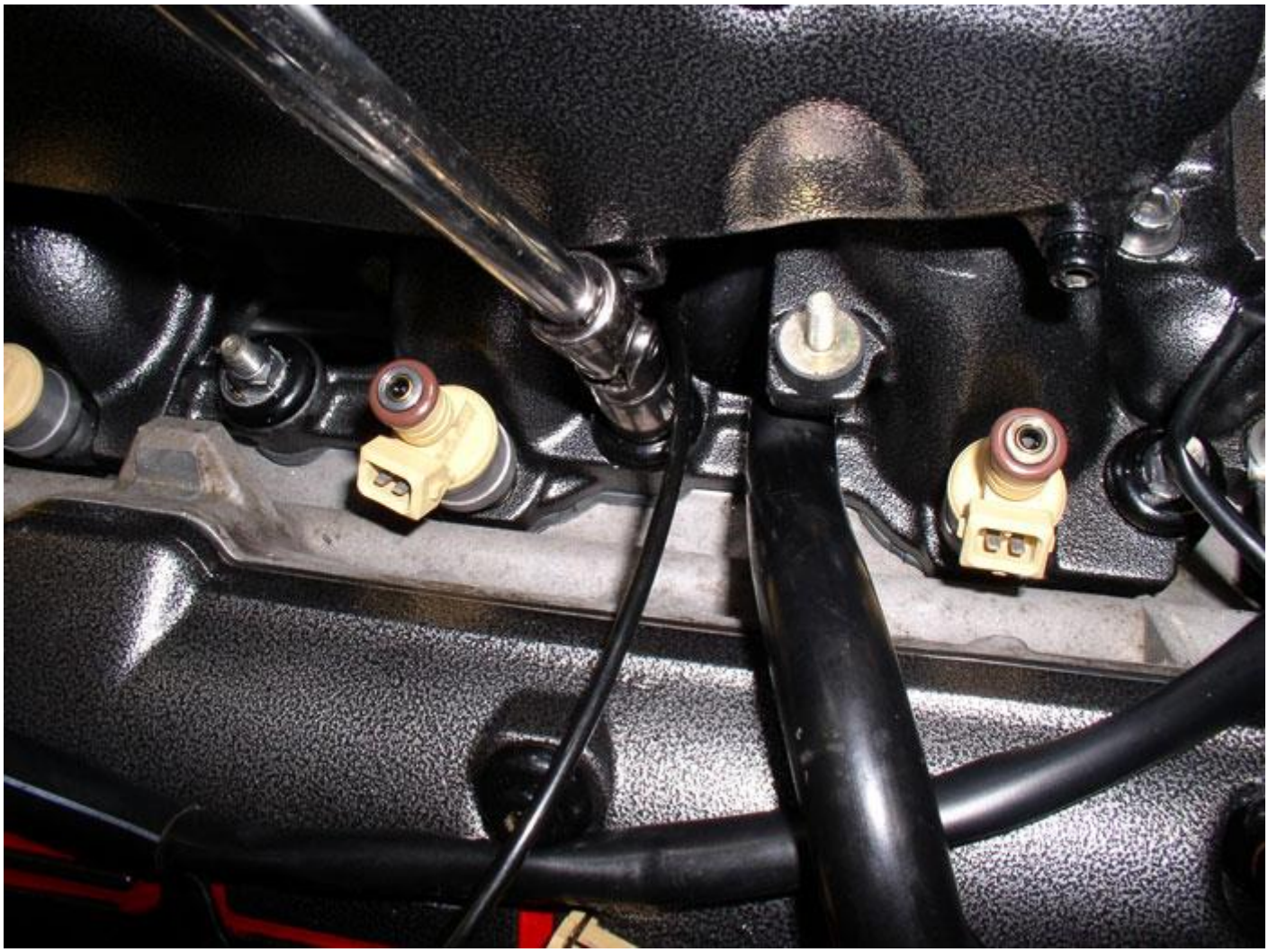
For the harder to reach nuts, you will need to use a universal elbow joint with your torque wrench.



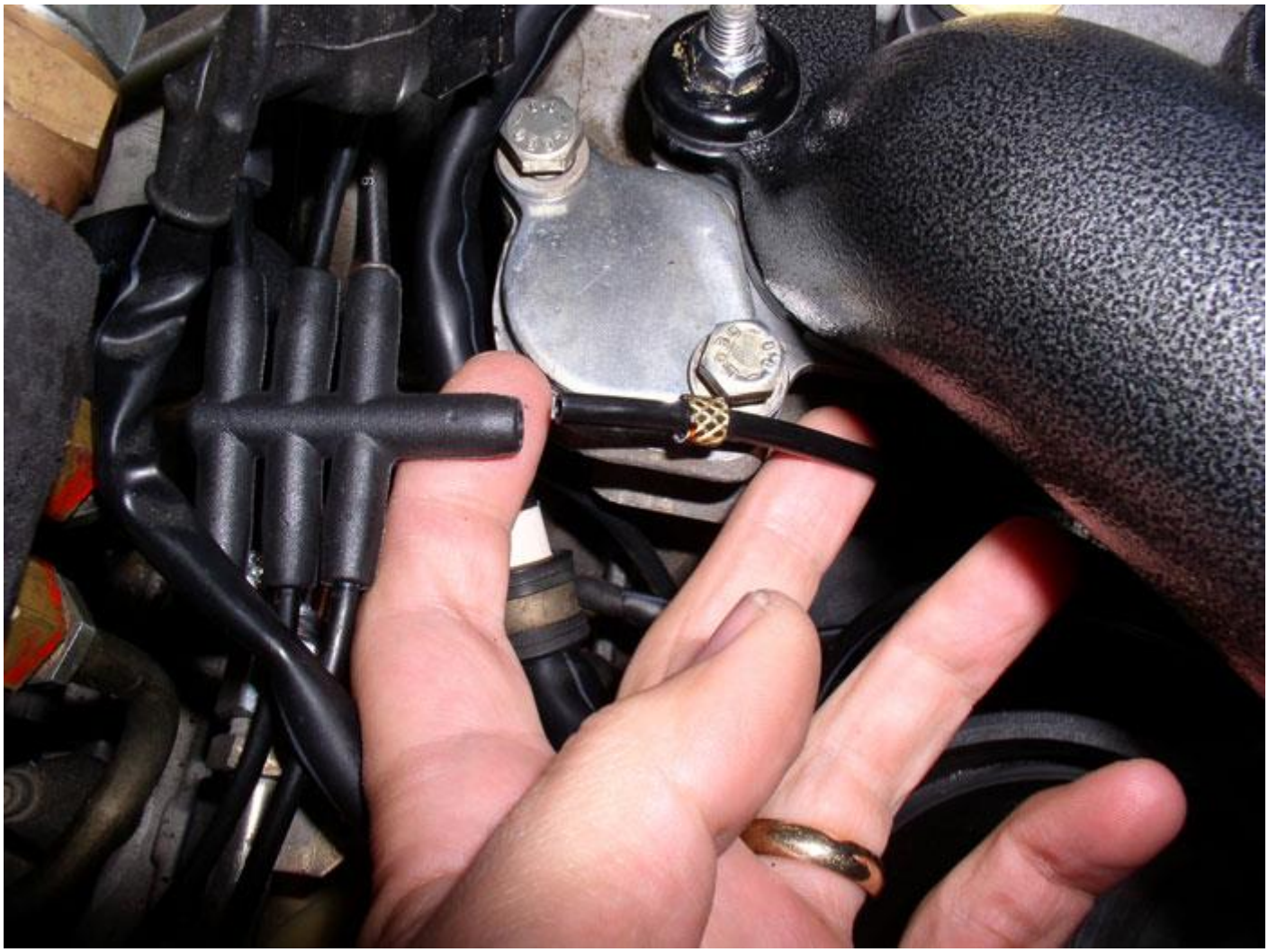
On the passenger side, I needed to remove the intake side cover plate allen head bolt just above the intake mounting stud in order to get the socket on the 13mm nut. The allen head bolt is 5mm.



Torque the 13mm nut under the allen head bolt down and re-install the 5mm allen head bolt into the side cover plate.



I replaced my 7-port vacuum manifold at the back of the engine with a new one. If you do the same, simply transfer the vacuum lines from the old manifold one at a time to the new manifold. I also had two metal plugs to transfer since two ports are not used. Then connect the vacuum line from the throttle body to the inlet port of the vacuum manifold as shown.



Next, I placed the passenger side fuel rail on top of the injectors (without pressure) to do a fit check on the rear knock sensor. Ensure the knock sensor connector will reach the plug bracket on top of the fuel rail. It was at this time I noticed the new plug on the new knock sensor would not fit into the bracket on the fuel rail. After some time trying to make it fit with no success, I decided not to use the fuel rail bracket but did ensure there was enough slack in the knock sensor wire to connect to the wiring harness receptacle and would tuck the connection between the fuel rail and intake runners.



Next, I worked on the insulation on the fuel rails. My original insulation was completely missing. I came across a post here on this great 928 forum about someone that used pipe insulation as an alternative to the fuel rail insulation as I understand the fuel rail insulation is no longer available. I wish I could remember who it was because they deserve the credit for this idea. I went to Home Depot and bought 3/4" inside diameter pipe insulation and cut it down to the length required to cover the fuel rail.



Wrap the insulation around the fuel rail so the ends meet on the underside.



Use a utility knife to carefully cut around the injector openings and the mounting tabs on the fuel rail. Flip the fuel rail over and cut out the openings in the top of the rail for the fuel rail plastic covers mounting holes.



Use zip ties for securing the insulation to the fuel rail.



Do the same procedure on the other fuel rail. When complete, it should look something like this. I found that the fuel rail plastic covers will fit snuggly on the fuel rails with this insulation, at first. After a time, the insulation conforms to the square pattern of the rail and the cover and fits nicely. I can't say that I've noticed significant noise reduction on the injector clicking, though. Too bad I don't have an instrument to measure the sound before

and after the insulation installation.



Next, make some fuel line connections before installing the fuel rails. If you haven't already repaired/replaced the fuel hose on the front fuel supply line and you purchased one of Roger's fuel line kits, now's the time to make the repair. You can cut the existing hose off the end connectors using a utility knife. Be carefull to not cut too hard/deeply that you score the metal barbs underneath.



Peel back the rubber hose with a screwdriver after cutting and you should be able to pull the hose off the barbed connectors. Both ends of the fuel line connectors should look like this when the hose is removed.



Measure out and cut the same length of new hose from Roger's kit.



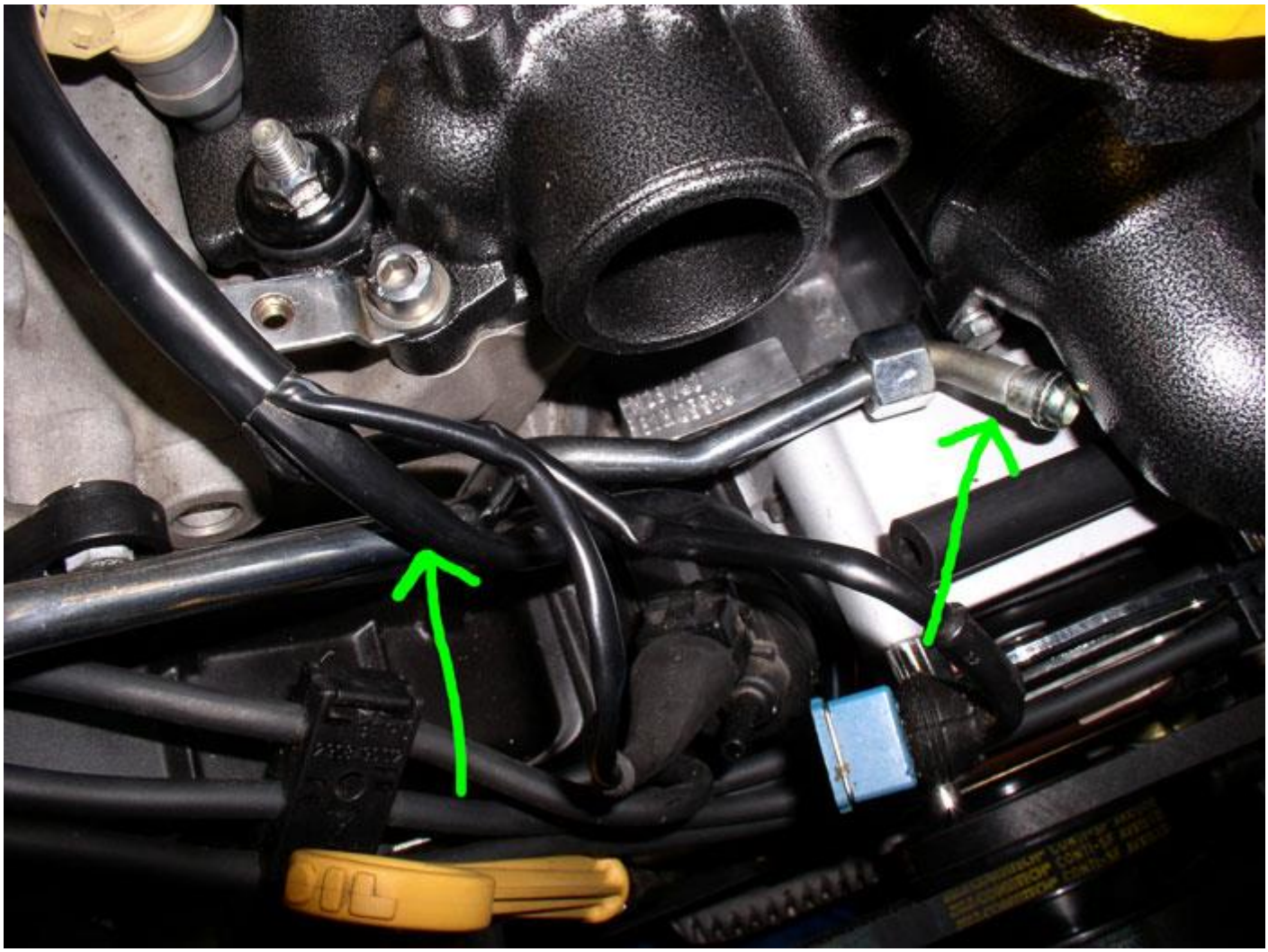
Attach the fuel line nut to one end of the new hose but don't tighten the clamp yet.



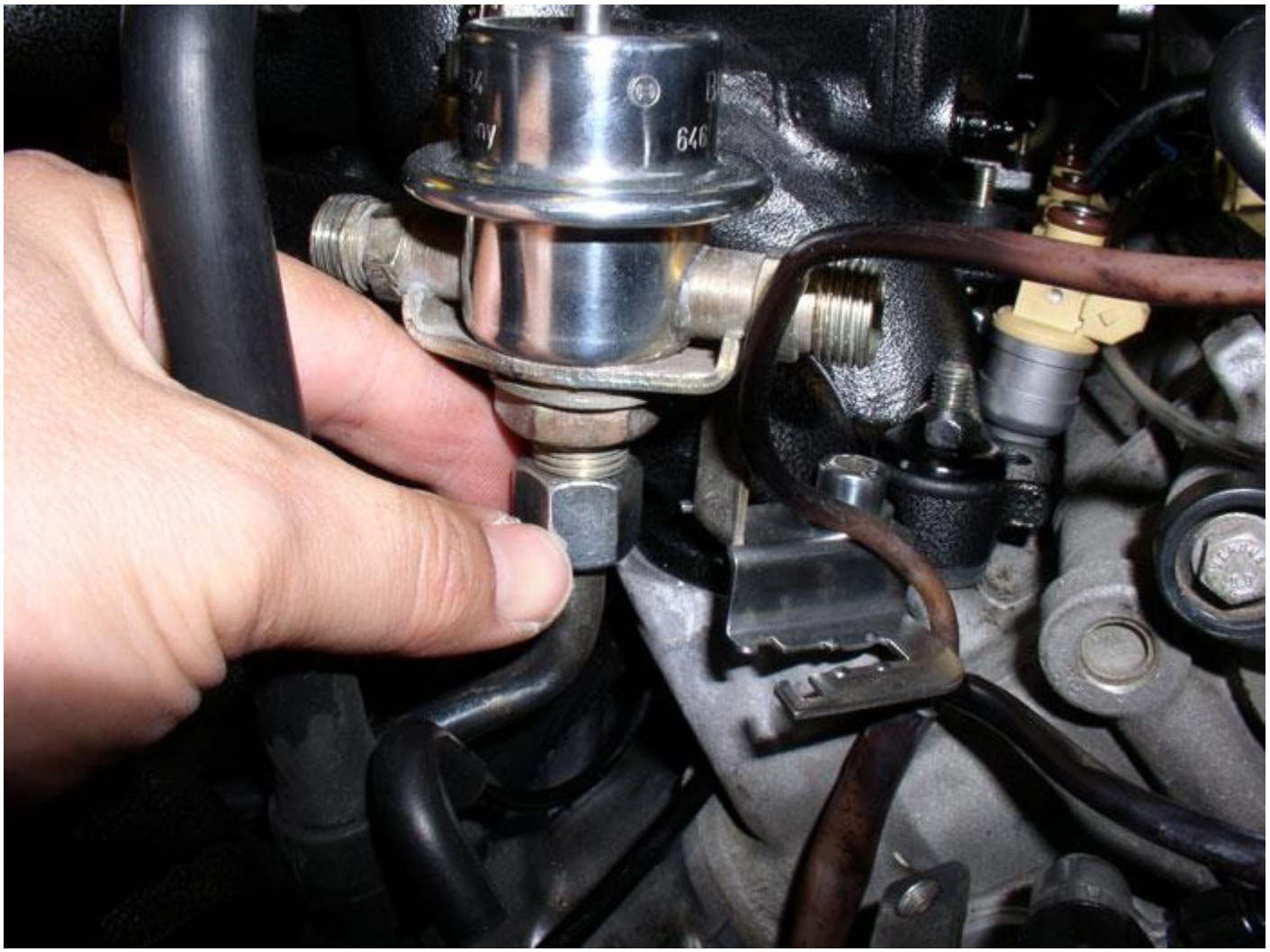
Attach the other end of the hose (dont' forget the 2nd clamp) to the metal fuel line. The new fuel hose had a natural bend to it so it worked best to orient the fuel hose so that it bends in the same direction when installed. You can get the orientation correct by test fitting the assembly to make sure the hose orientation and clamps are positioned correctly. I positioned the clamps so they face inward on the inner radius of the bend as shown. Then tighten down the hose clamps.



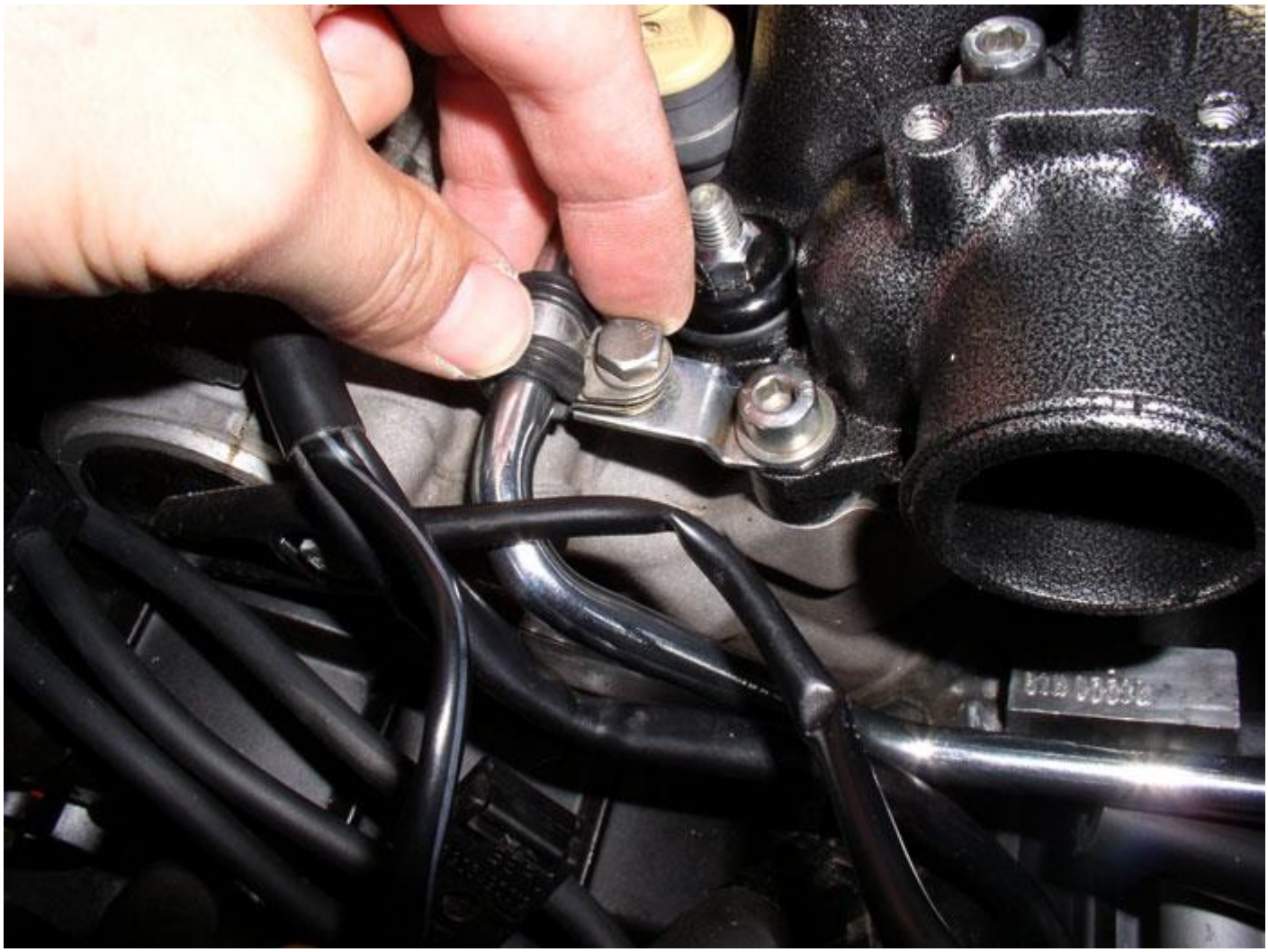
Manuever the Fuel Pressure Damper (FPD) end of the fuel line under the radiator hose elbow attached to the water bridge as shown. Ensure the fuel line is under the wiring harness as shown by the left arrow.



Position the fuel line so you can connect the nut on the fuel line to the bottom of the FPD. Don't tighten the nut yet. I waited until the other lines were connected to the FPD before tightening them all down.



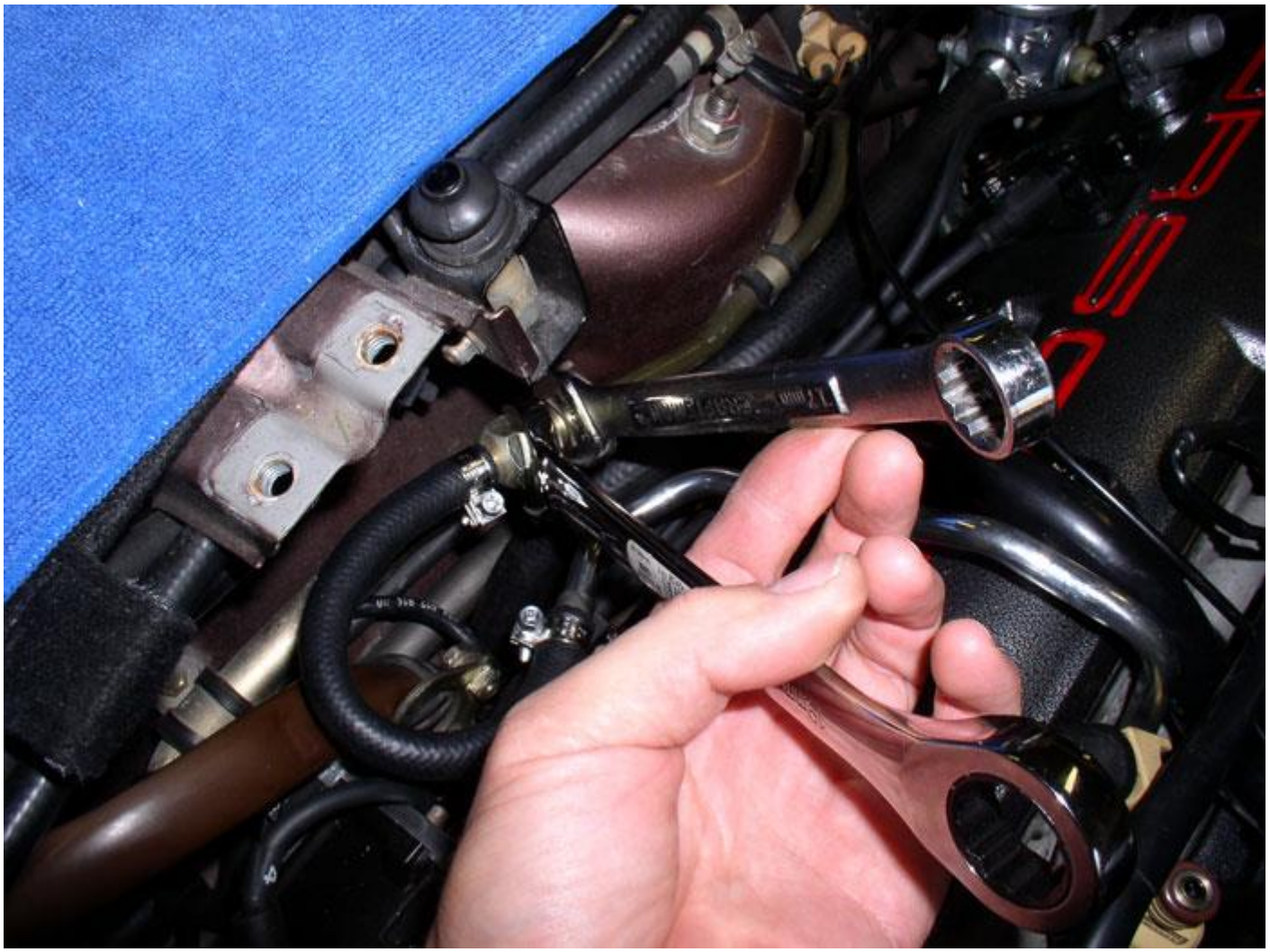
Attach the fuel line clamp to the bracket that is located at the front passenger side of the water bridge. It's a 10mm bolt - tighten the bolt down.



Connect the fuel hose to the fuel supply line at the passenger fender well.



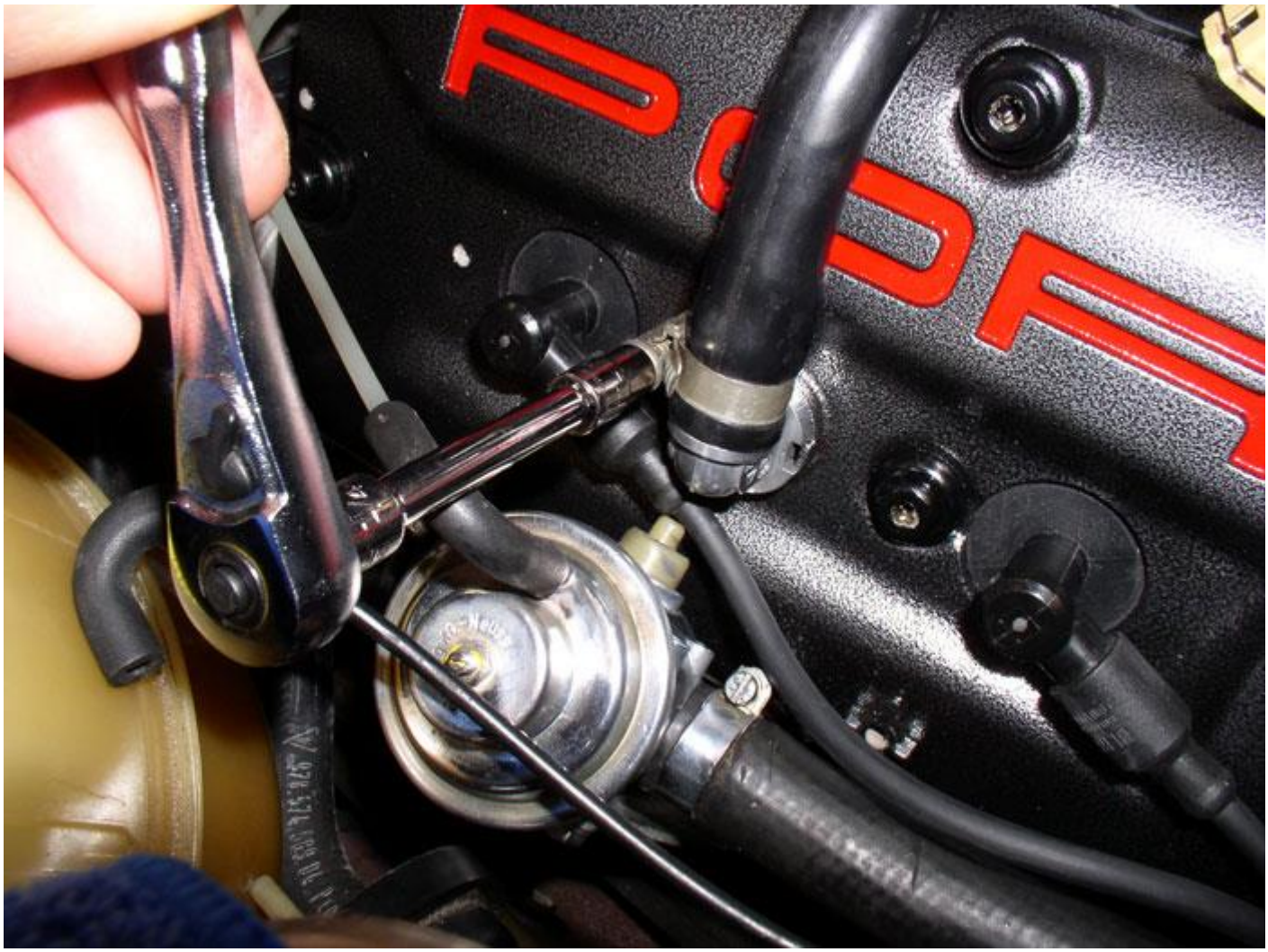
Tighten the connection down using a 17mm wrench and a 19mm wrench to counterhold.



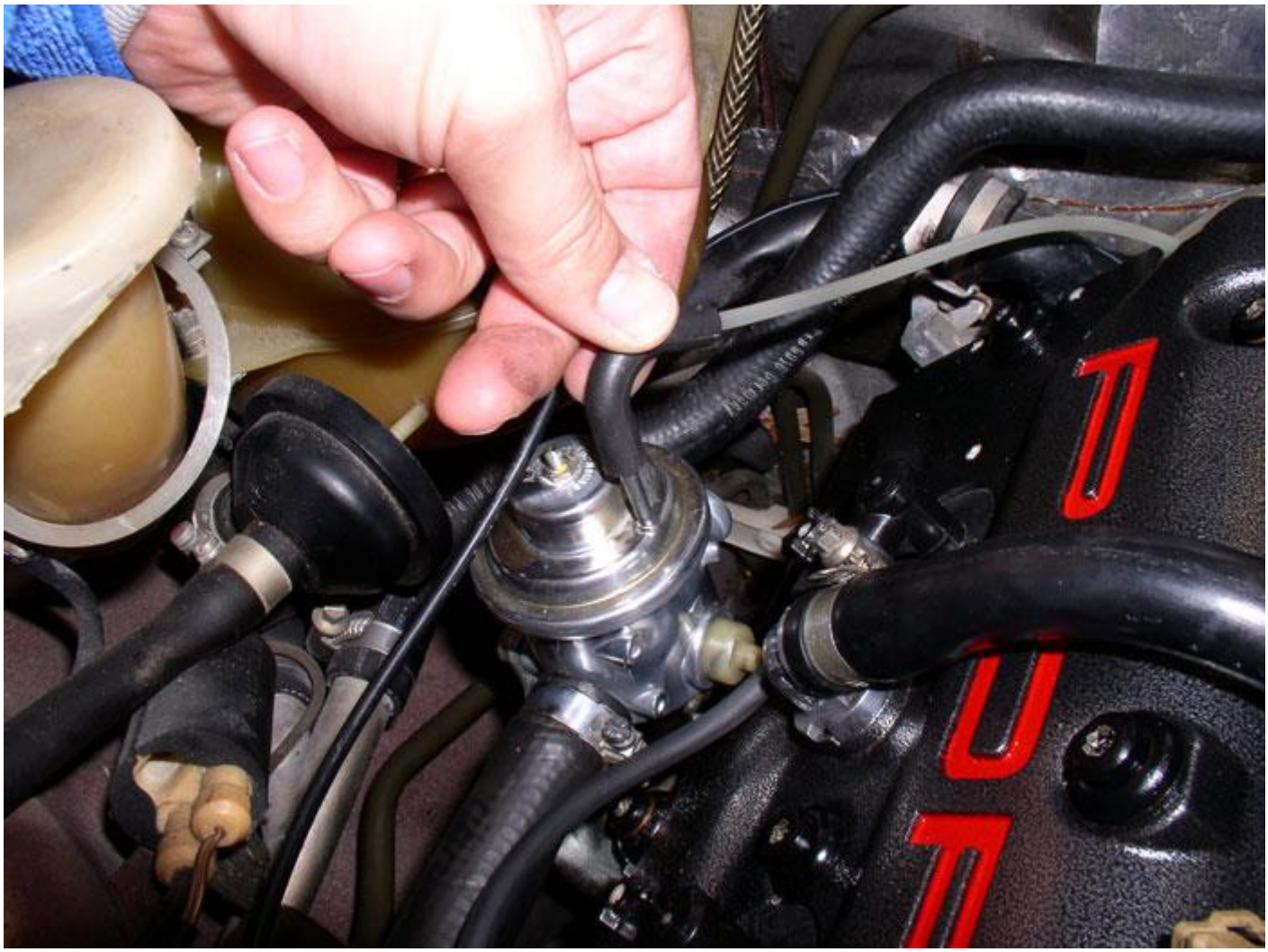
Next, attach the front cam cover breather hose to the elbow at the cam cover and tighten the hose clamp.



Do the same for the rear cam cover breather hose and cam cover elbow.



Attach the diverter valve vacuum line elbow to the port on the diverter valve.

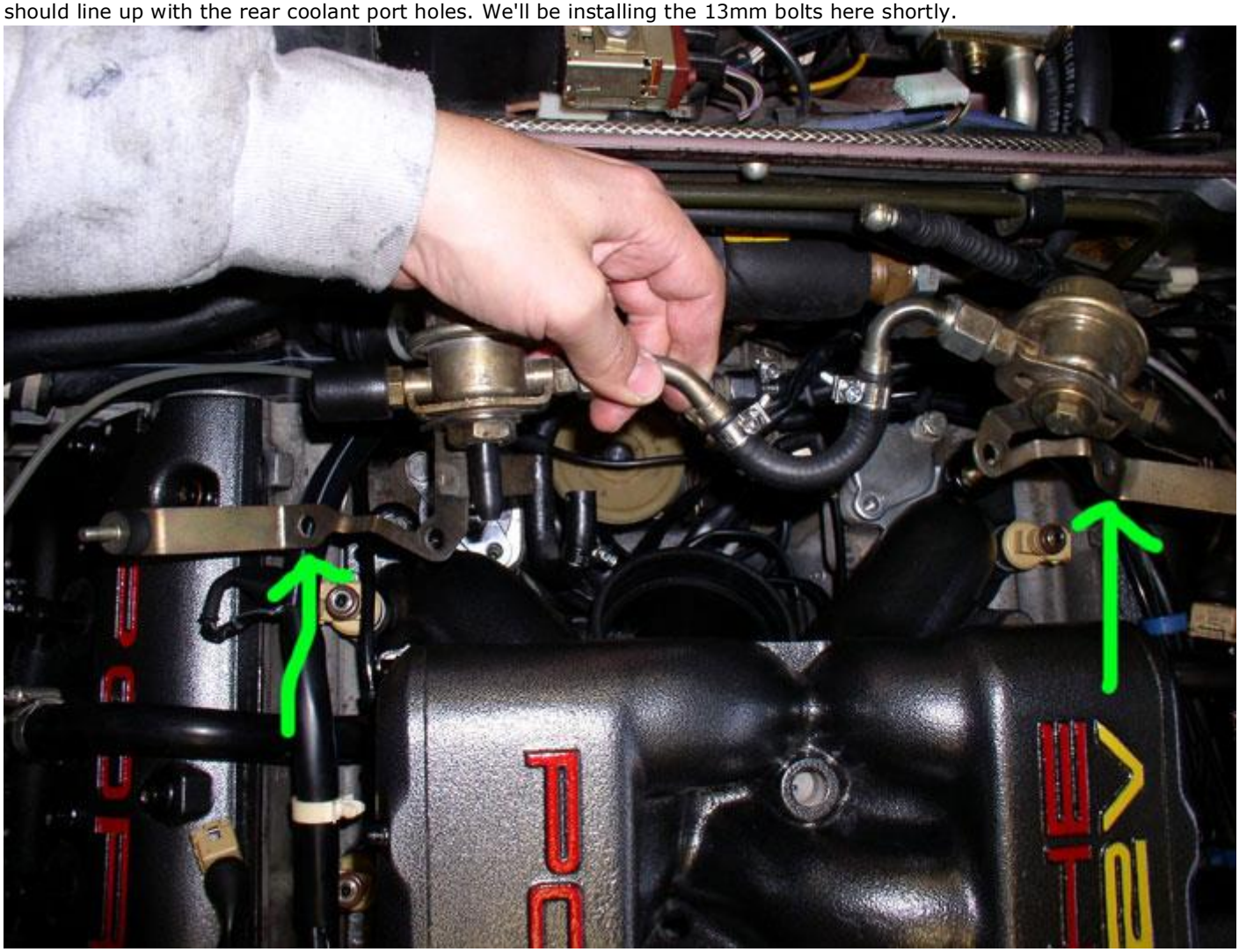


Attach the fuel vapor diaphram vacuum elbow to the port on the diaphram.

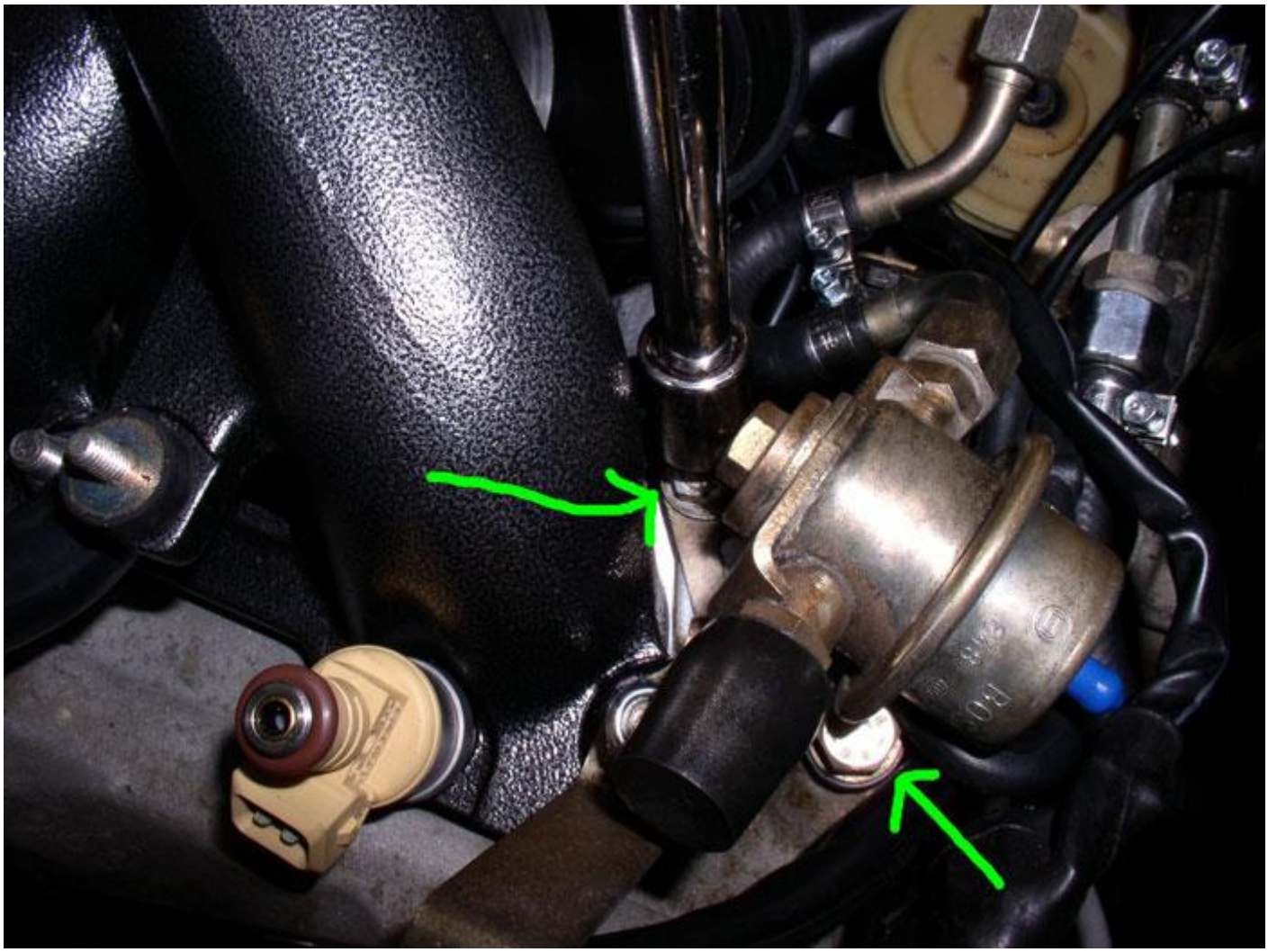


Position the rear FPD/FPR assembly into place at the rear of the engine. Place the mounting bracket holes indicated by the green arrows onto the rear intake mounting studs. The 13mm intake nuts can now be threaded onto the intake mounting studs but don't torque down yet. The other holes in the FPD/FPR assembly brackets

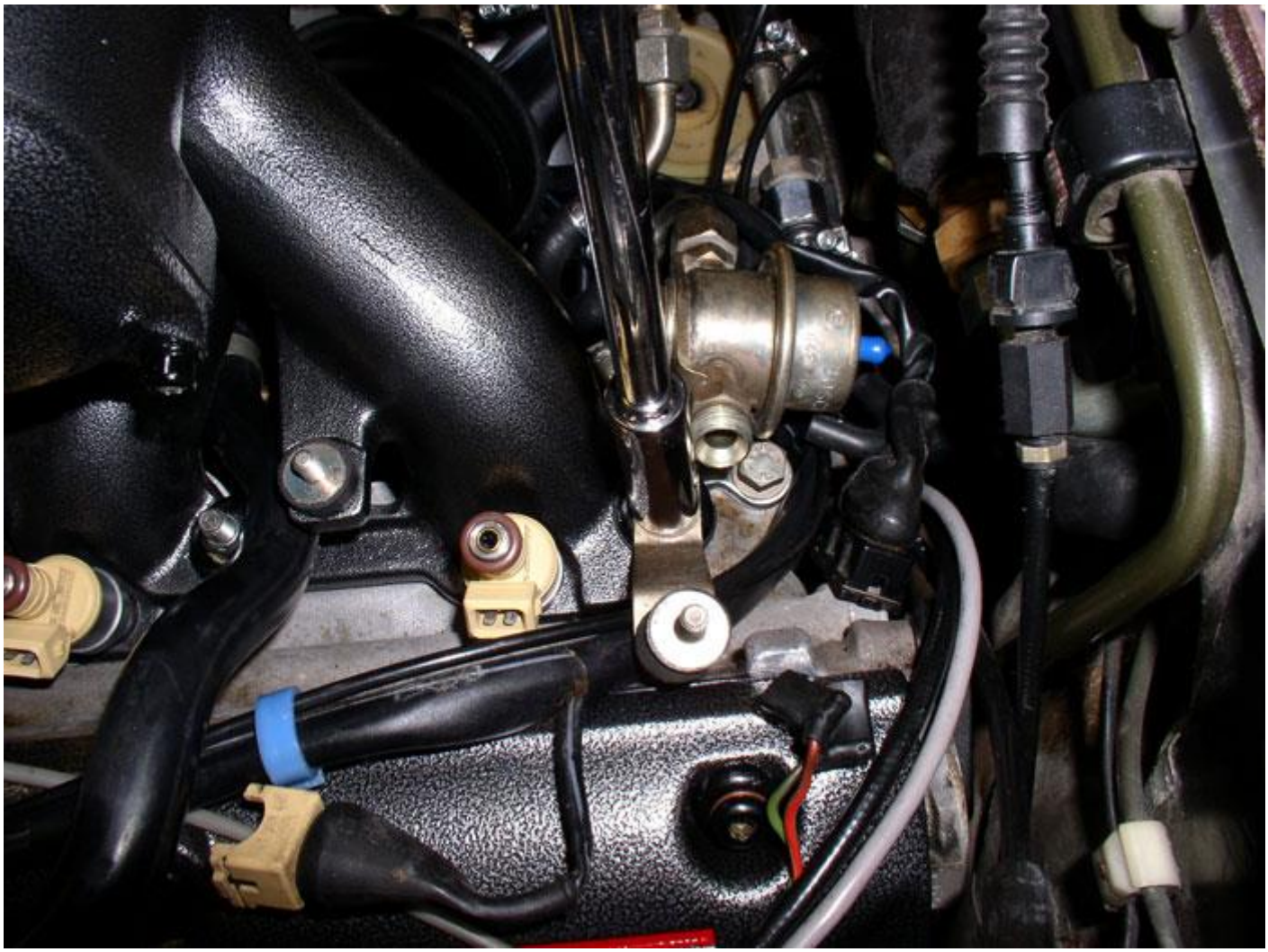
should line up with the rear coolant port holes. We'll be installing the 13mm bolts here shortly.



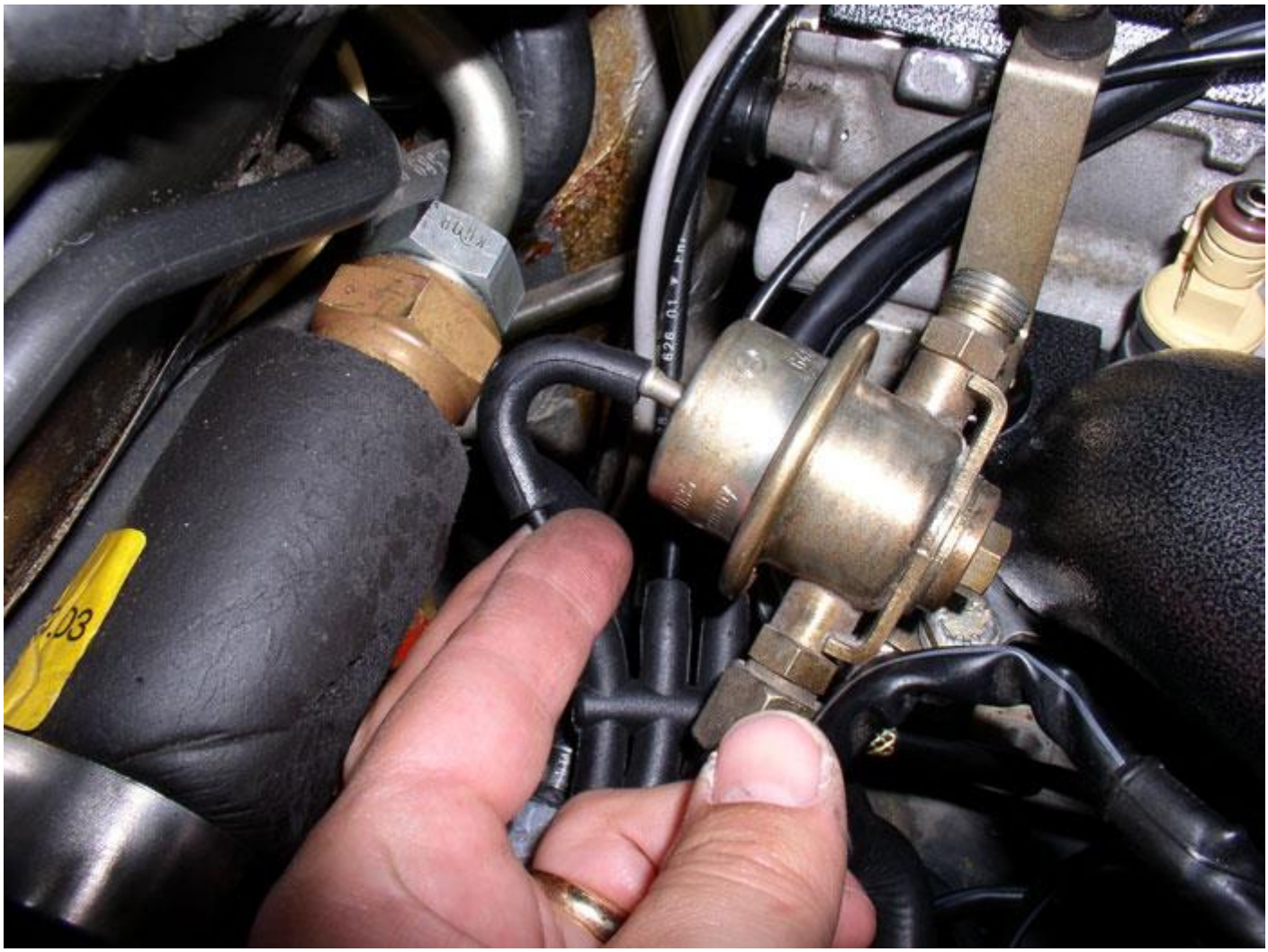
Next, install the 13mm bolt into the rear FPD bracket and into the coolant port threads (see left arrow). Torque down to 16 ftlbs. Then torque down the other 13mm bolt to the coolant port to 16 ftlbs. If the FPD is in the way, you can push it out of the way (push it forward toward the front of the car) because the bracket is fairly flexible. Just push it enough to get the socket on the bolt and torque down. Perform the same operation on the passenger side on the Fuel Pressure Regulator.



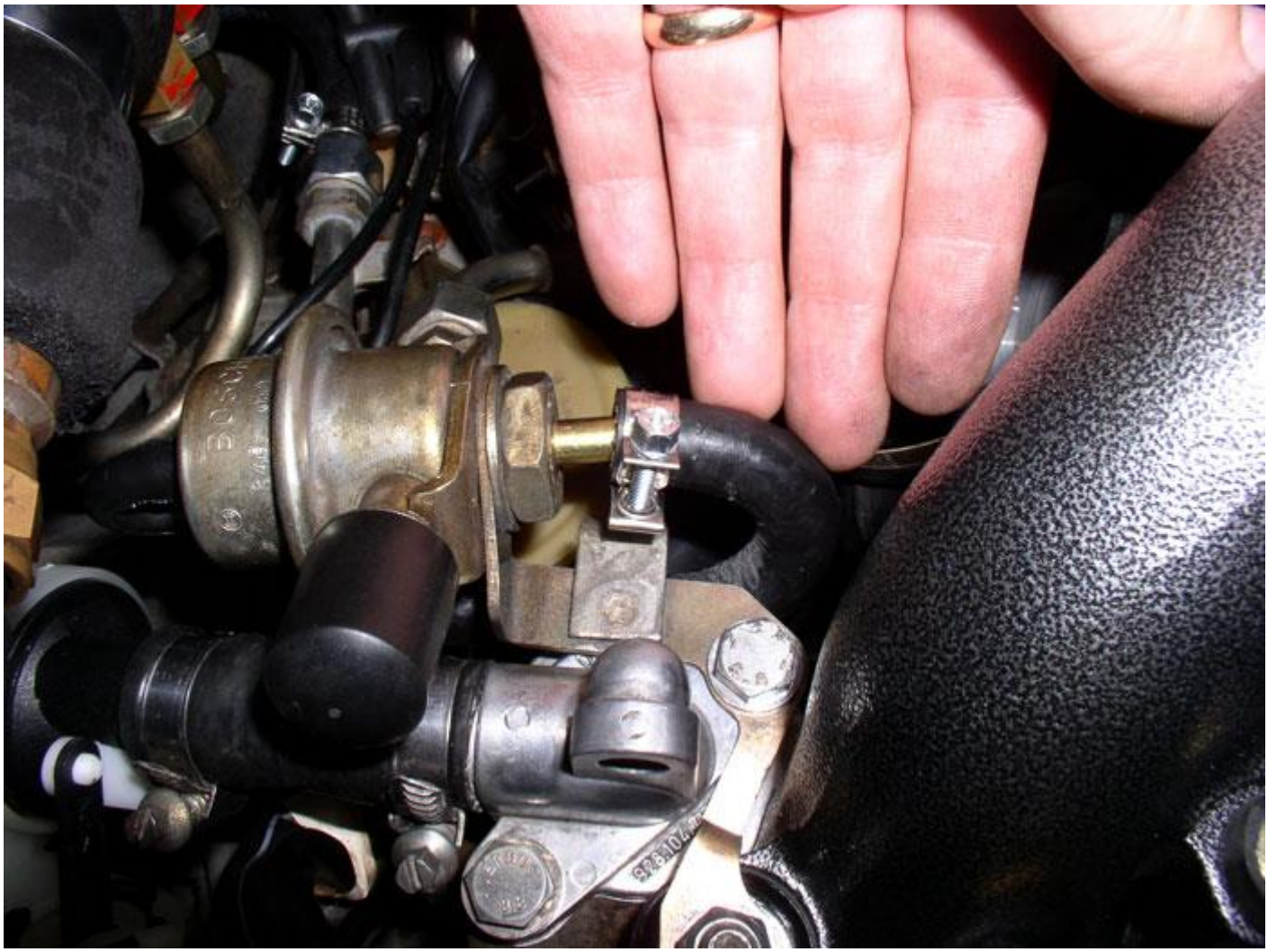
Next, Torque down the 13mm nut on the FPD bracket on the last intake runner stud. Torque to 11 ftlbs. Do the same on the the other side for the FPR.



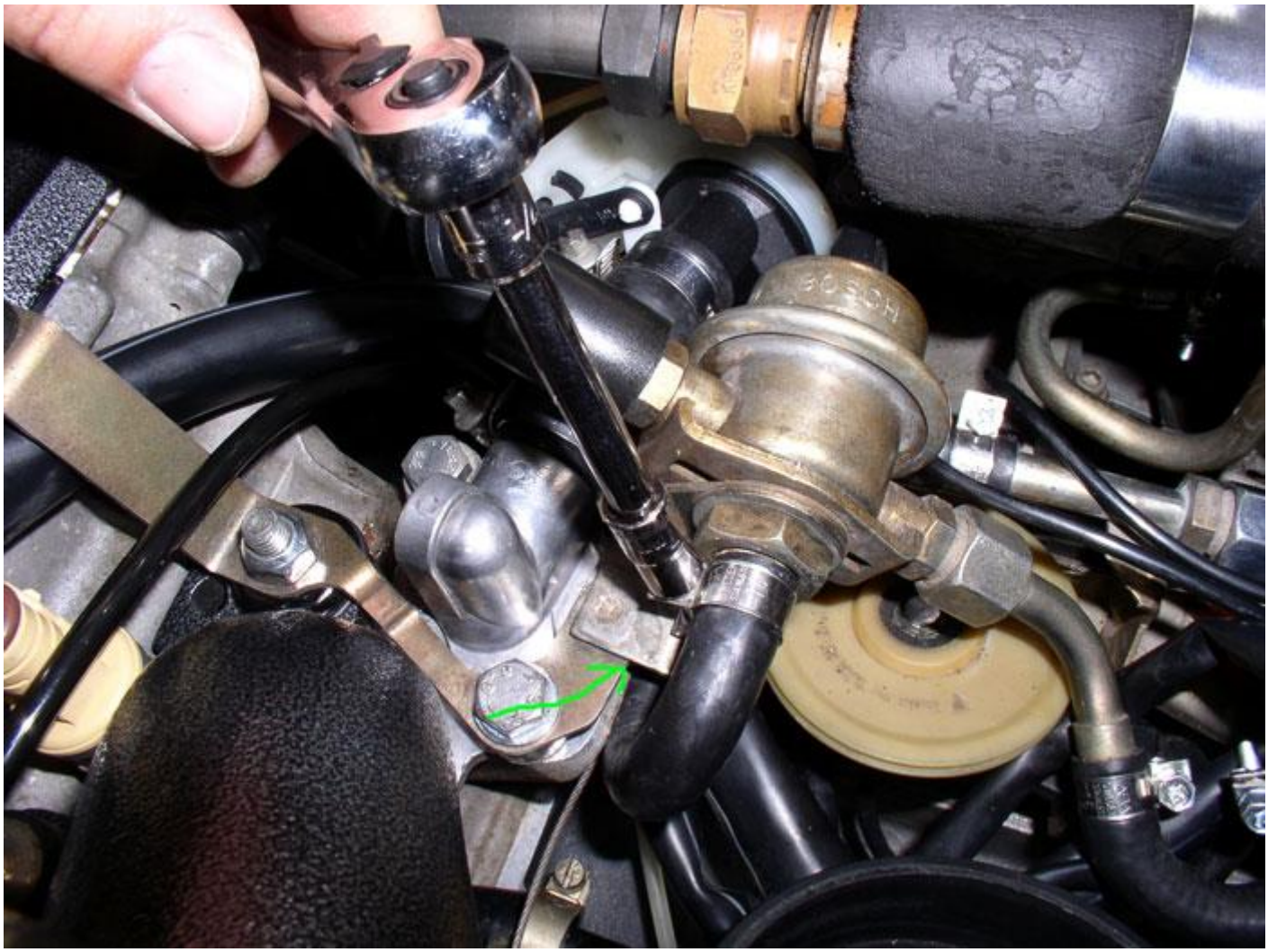
Attach the vacuum elbows and lines to the FPD and FPR.



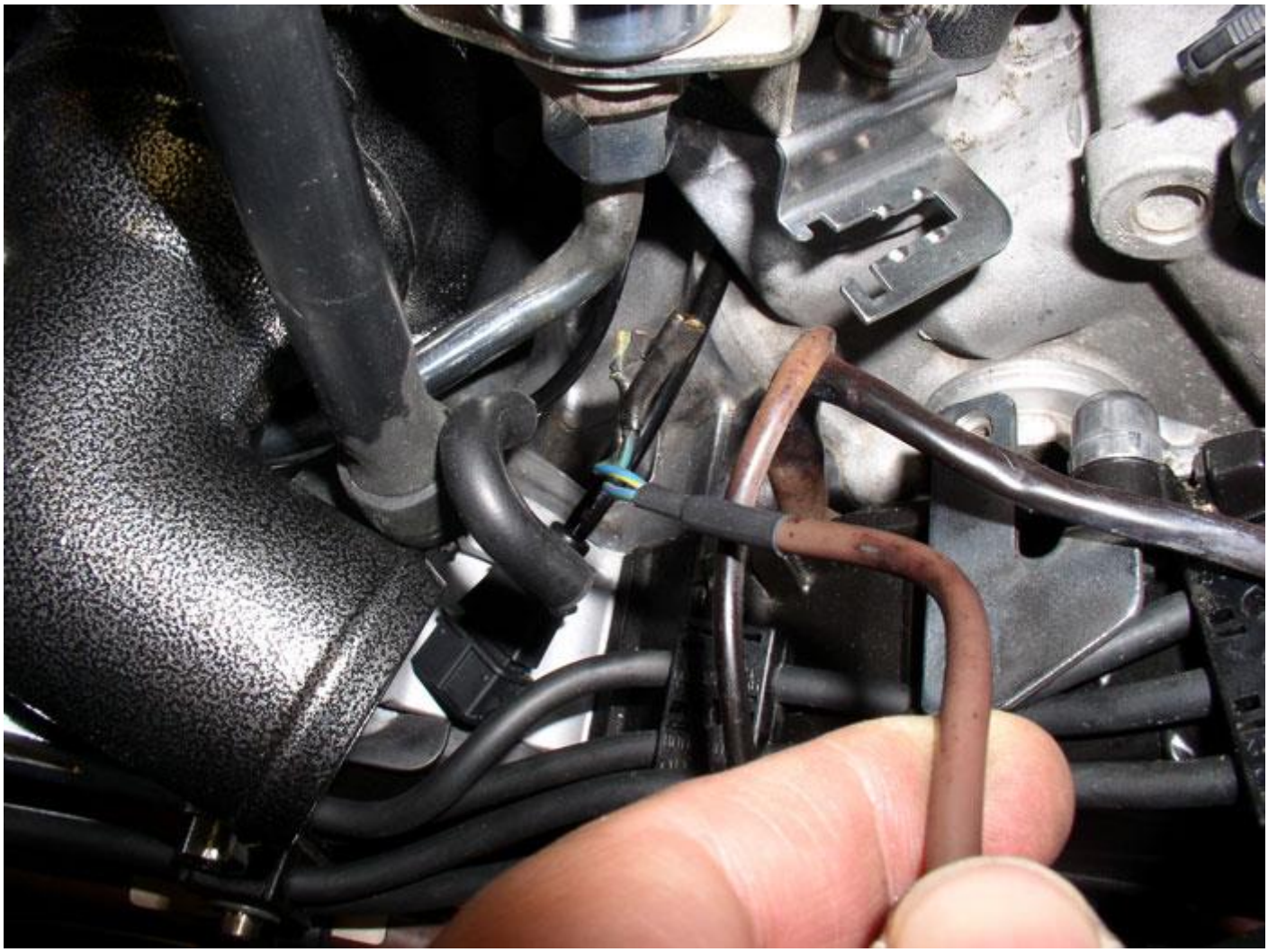
Connect the fuel return line to the port on the FPR.



Before tighting the hose clamp, ensure the return hose is inside the fuel hose guide that is attached to the mounting bracket (see green arrow). Ensure the hose is not pinched or in a bind. Then tighten the hose clamp.



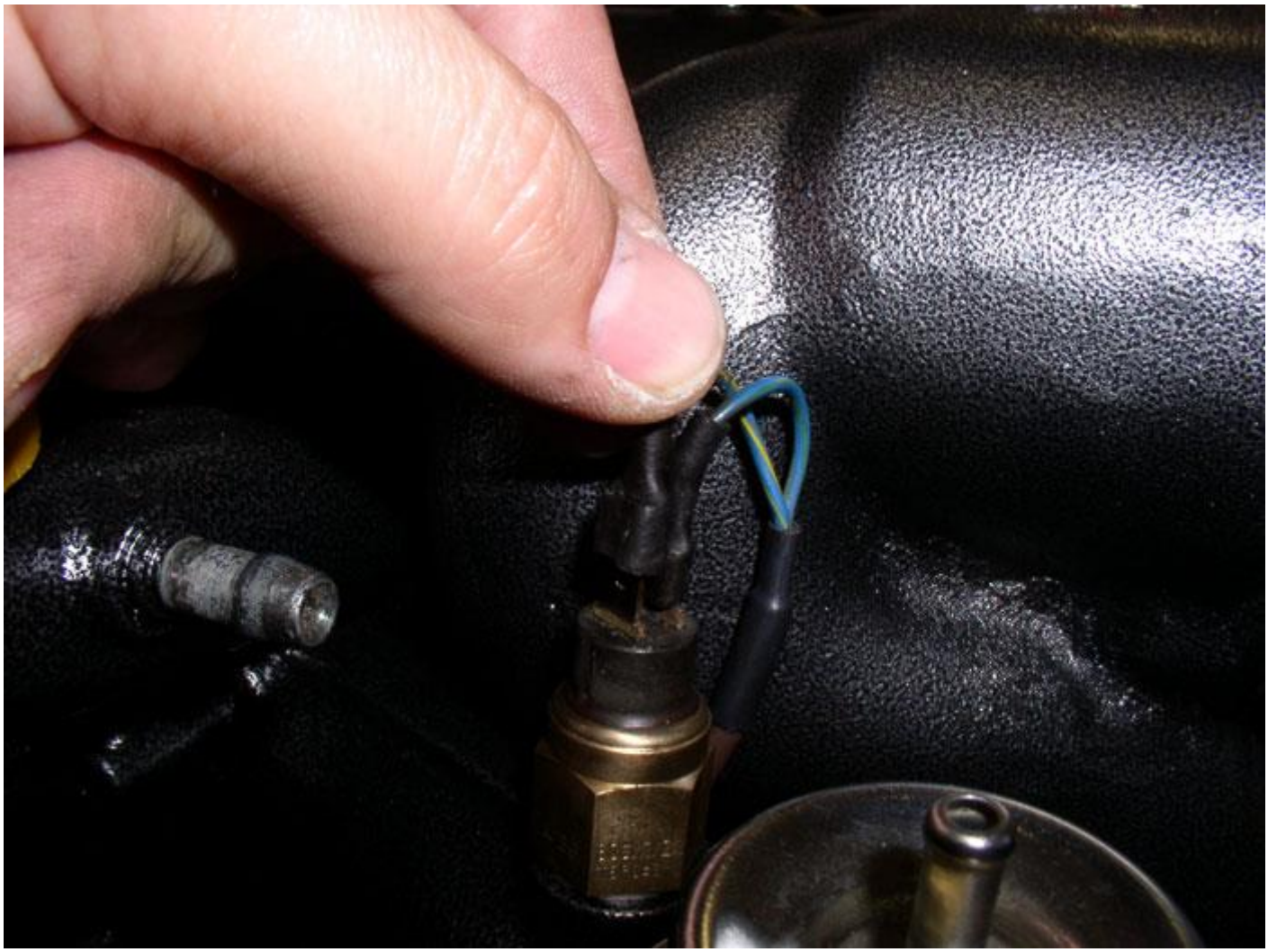

Next, feed the temperature gauge wires under the front FPD and under the water bridge....



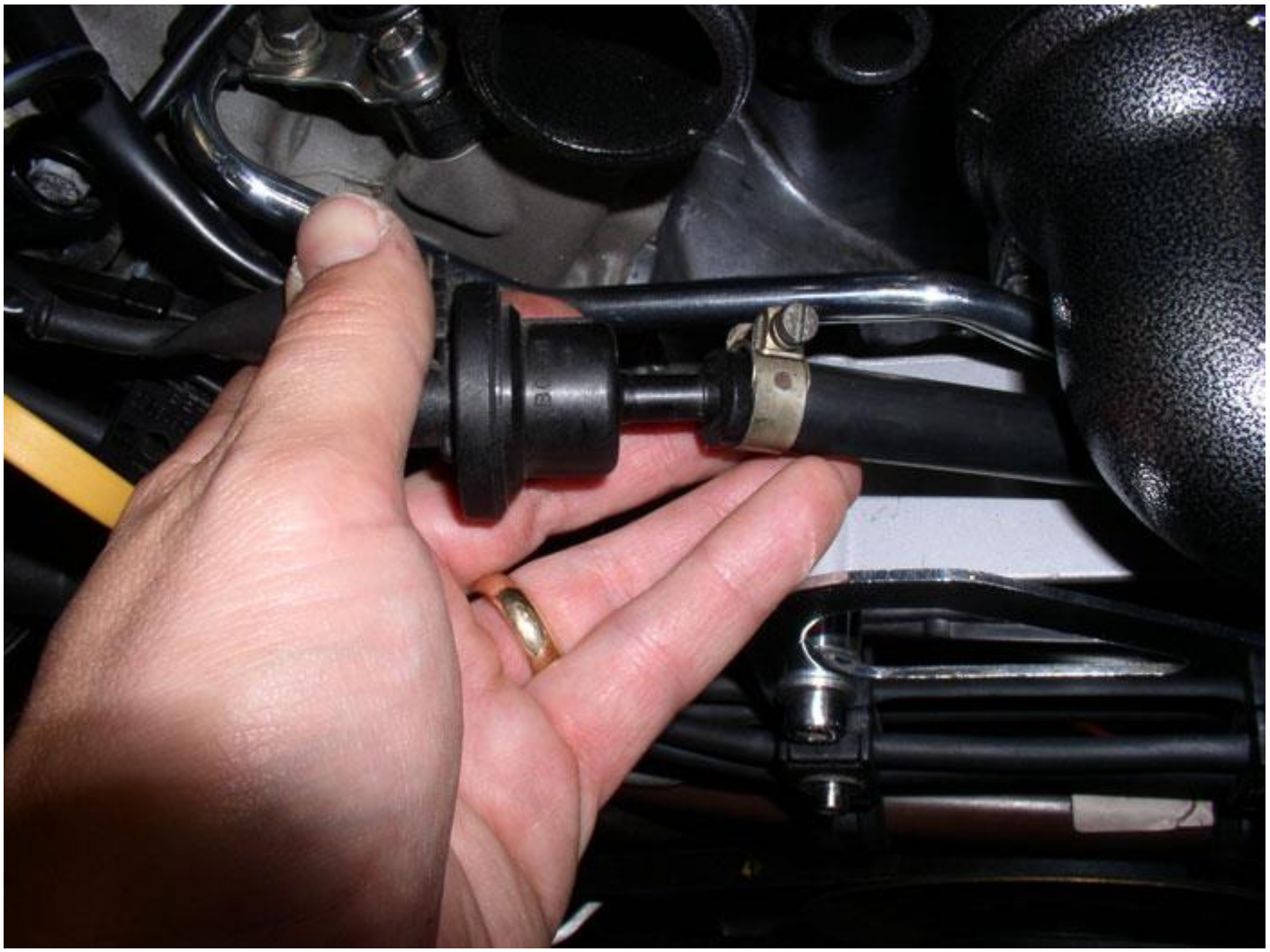
...and up between the water bridge and front of the intake.



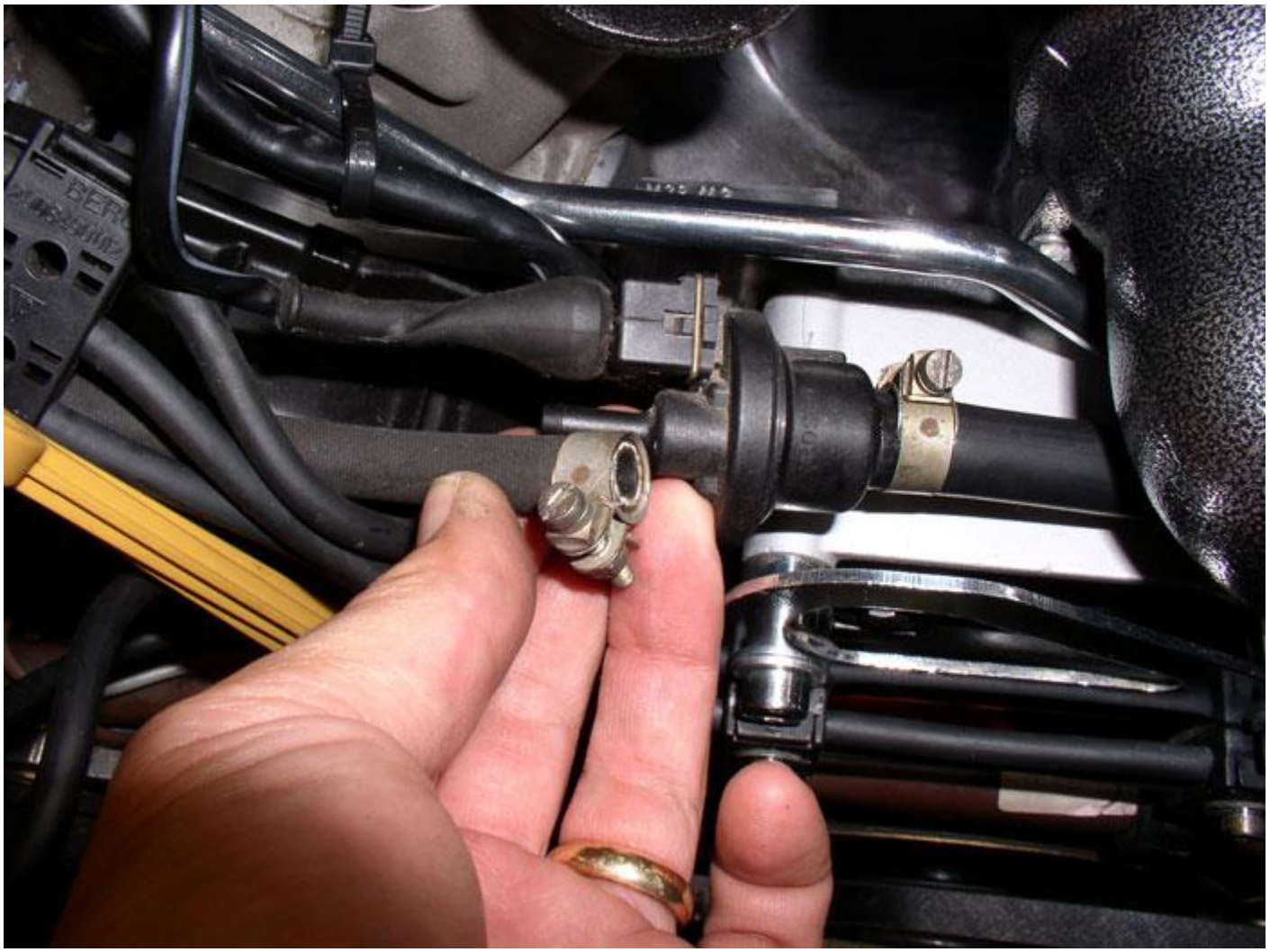
Connect the wires to the sending unit. The connecting blades are of different sizes so simply match up the sizes on the sending unit to the wire connector.



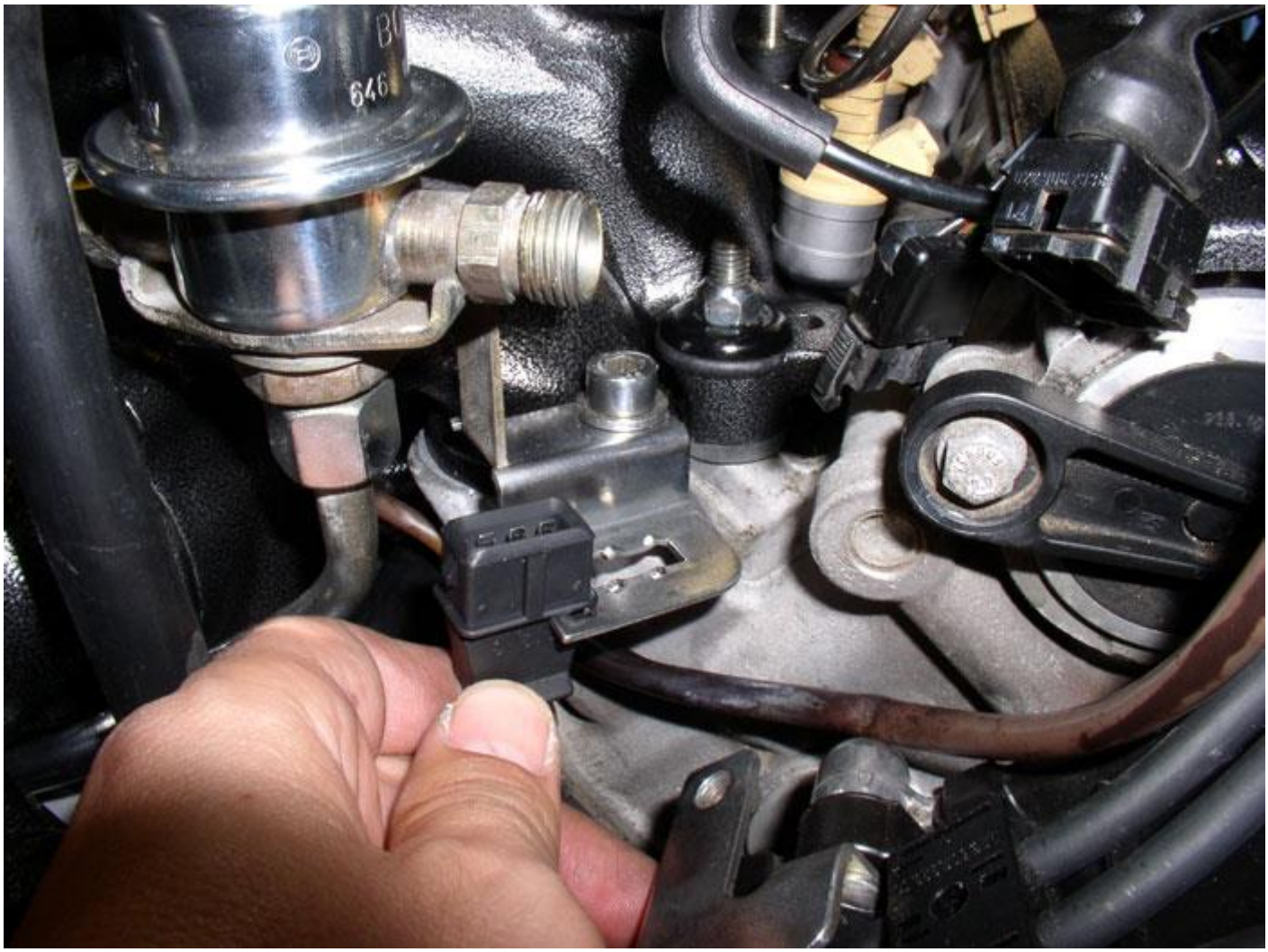
Next, attach the 3-way fuel vapor vent hose to the solenoid at the front of the engine (as shown) and tighten the hose clamp.



Connect the supply hose from the fuel vapor vent diaphram to the solenoid as shown and tighten the hose clamp.



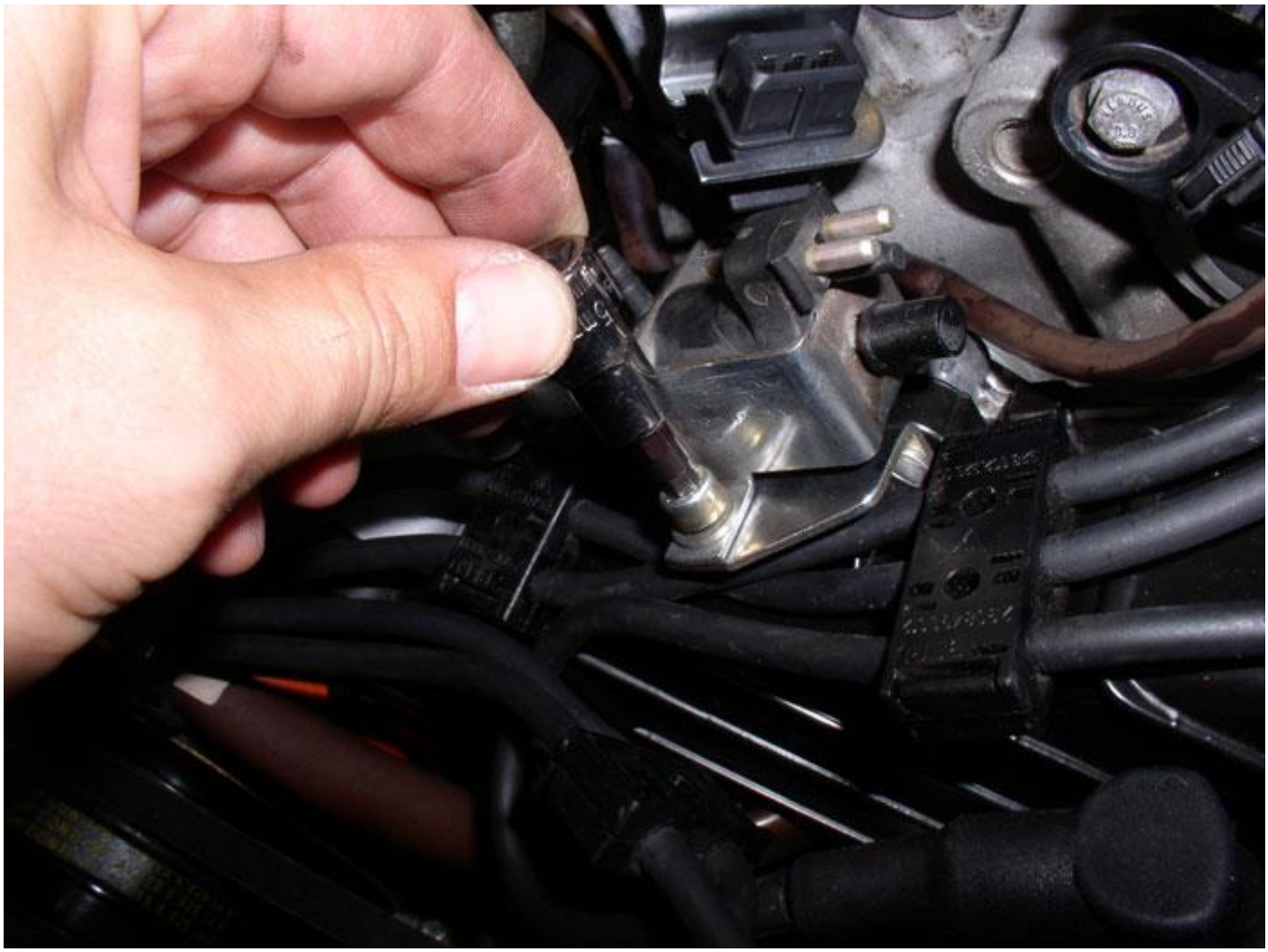
Insert the front knock sensor plug into the plug bracket. It is keyed to go in one way.



Position the flappy valve vacuum solenoid onto its mounting bracket as shown.

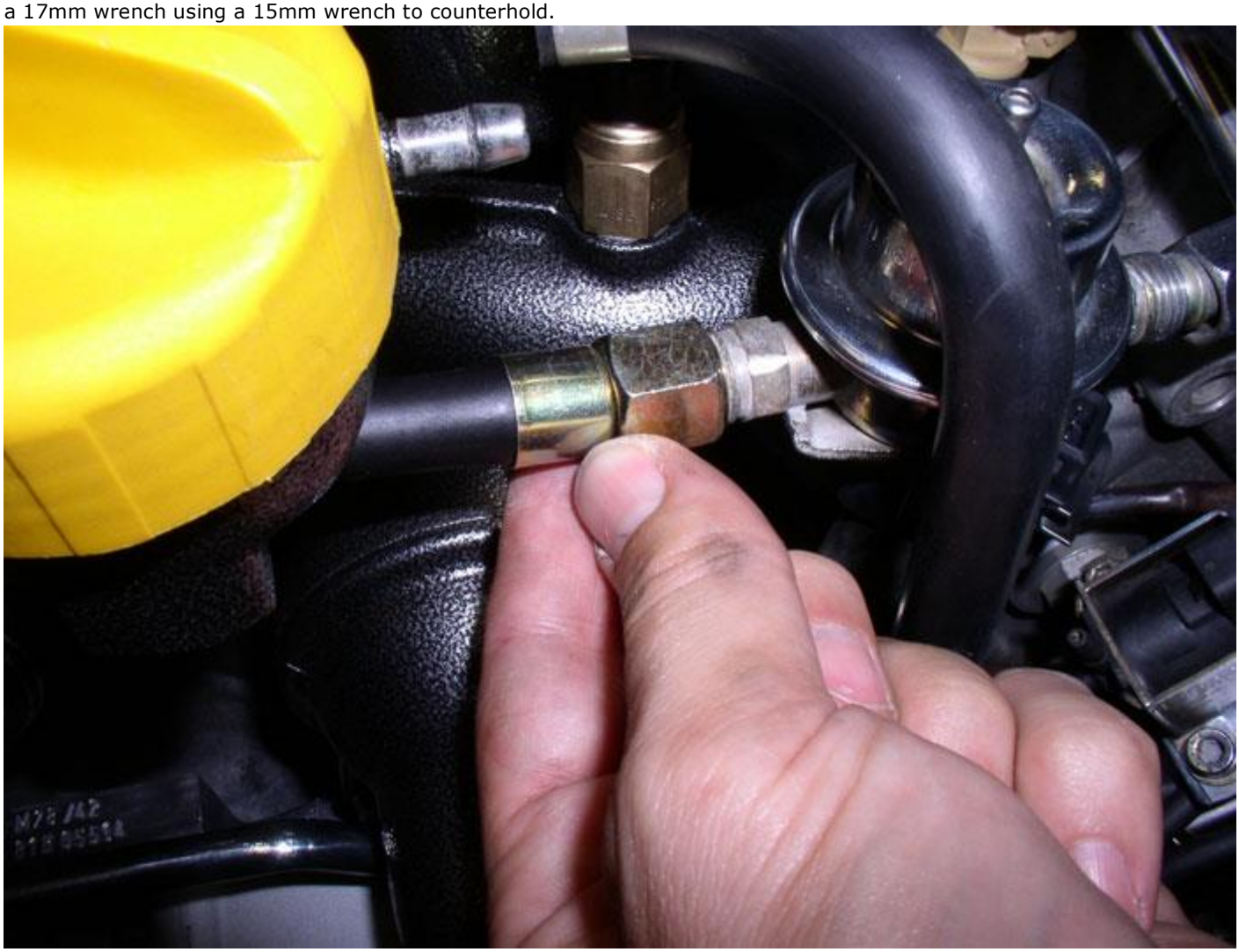


Secure the solenoid to the bracket with the two 5mm allen head bolts.



Attach the front fuel hose that runs between the FPD and passenger fuel rail to the front FPD. Tighten down with

a 17mm wrench using a 15mm wrench to counterhold.



**Fuel Rail Installation**

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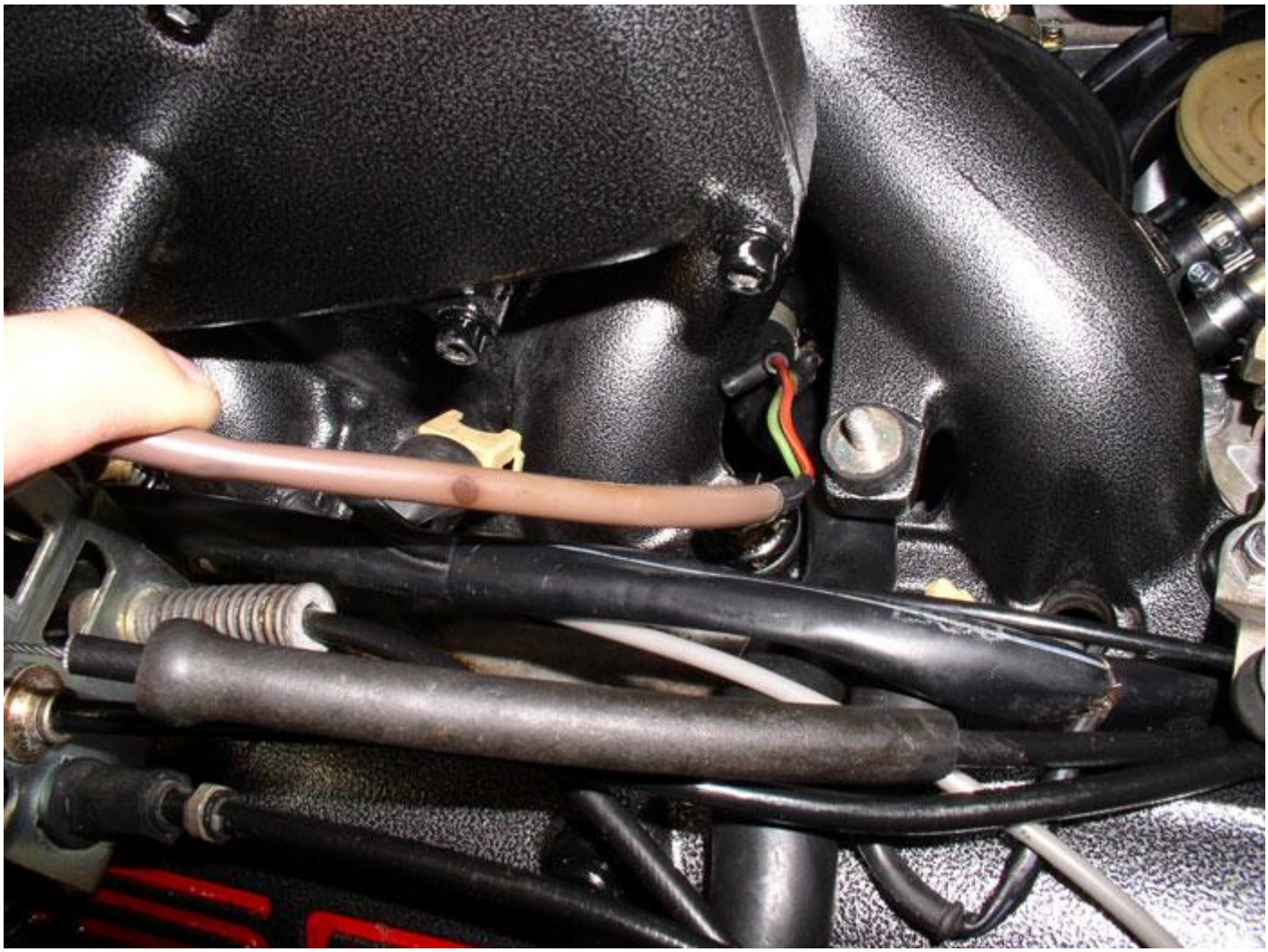
Before getting to work on the fuel rails, I installed the air temperature switch in the top of the plenum. This temperature switch is used (along with inputs from other sensors) to control the front radiator flaps being open/closed and radiator fans.



Use a 22mm deep socket to re-install and snug down. I couldn't find a torque value in the manuals but given the ease with which the switch came out, 15 ftlbs seemed sufficient.



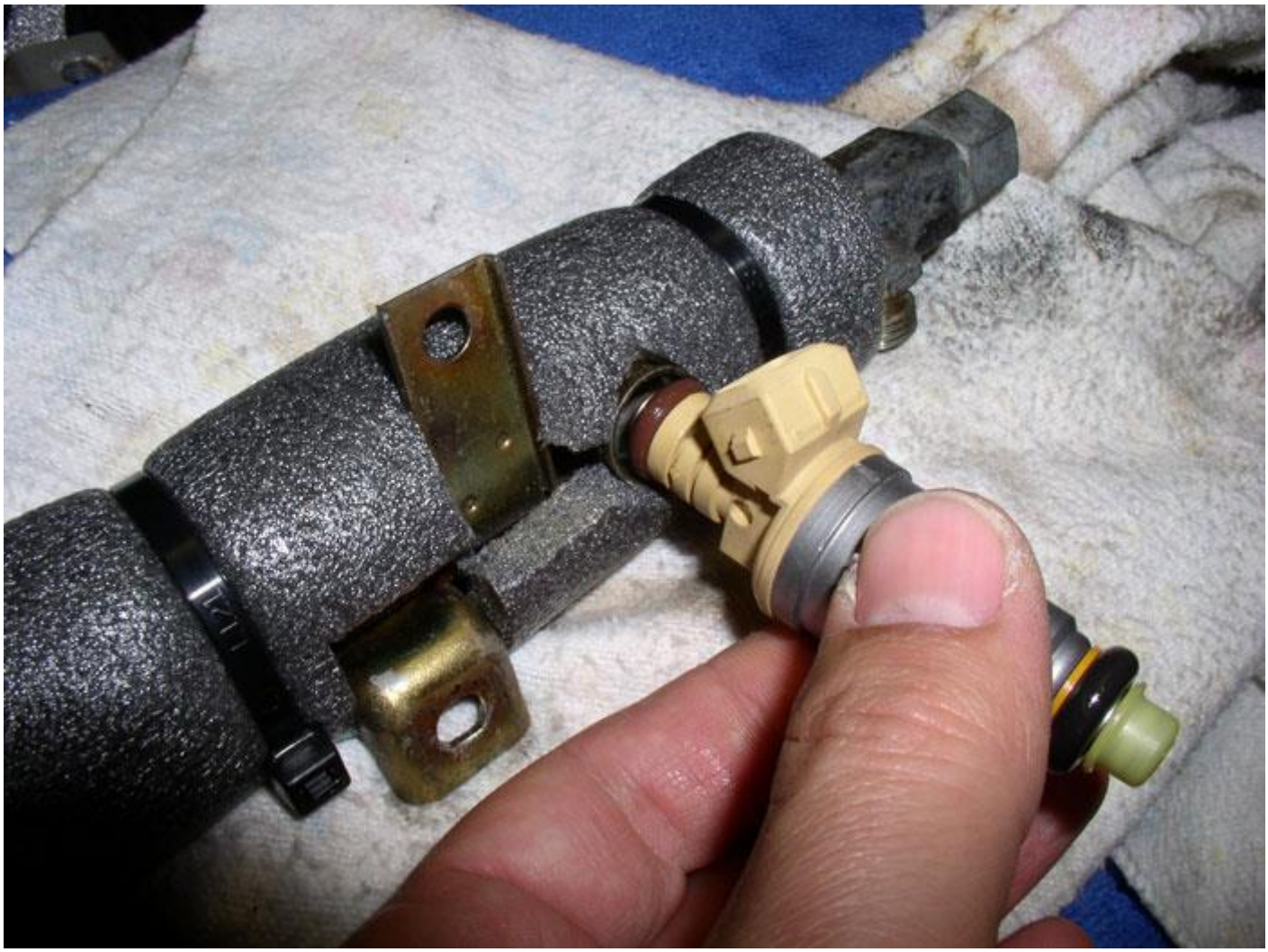
Next, route the harness connection to the temperature switch. Route the wire as shown below between the last two intake runner legs....



....and up behind the intake. Make sure enough wire is present to connect to the terminals. I did not connect mine to the switch just yet.




Now for the fuel injectors. If you sent your injectors off or removed them from the fuel rail, now's the time to install the injectors back into the fuel rail. I had my injectors temporarily installed into the intake to prevent debris from entering the head. If you did the same, remove them and install into the fuel rails. It's a good idea to use a lubricant on the upper and lower o-ring seals of the fuel injector. I've used a light coat of motor oil - you can also use another lubricant but ensure it is sensor-safe. Push the top of the fuel injector into the rail until it is fully seated. Orient the fuel injector so that the plug to the harness is facing away from the intake when the fuel rail is mounted (see below).



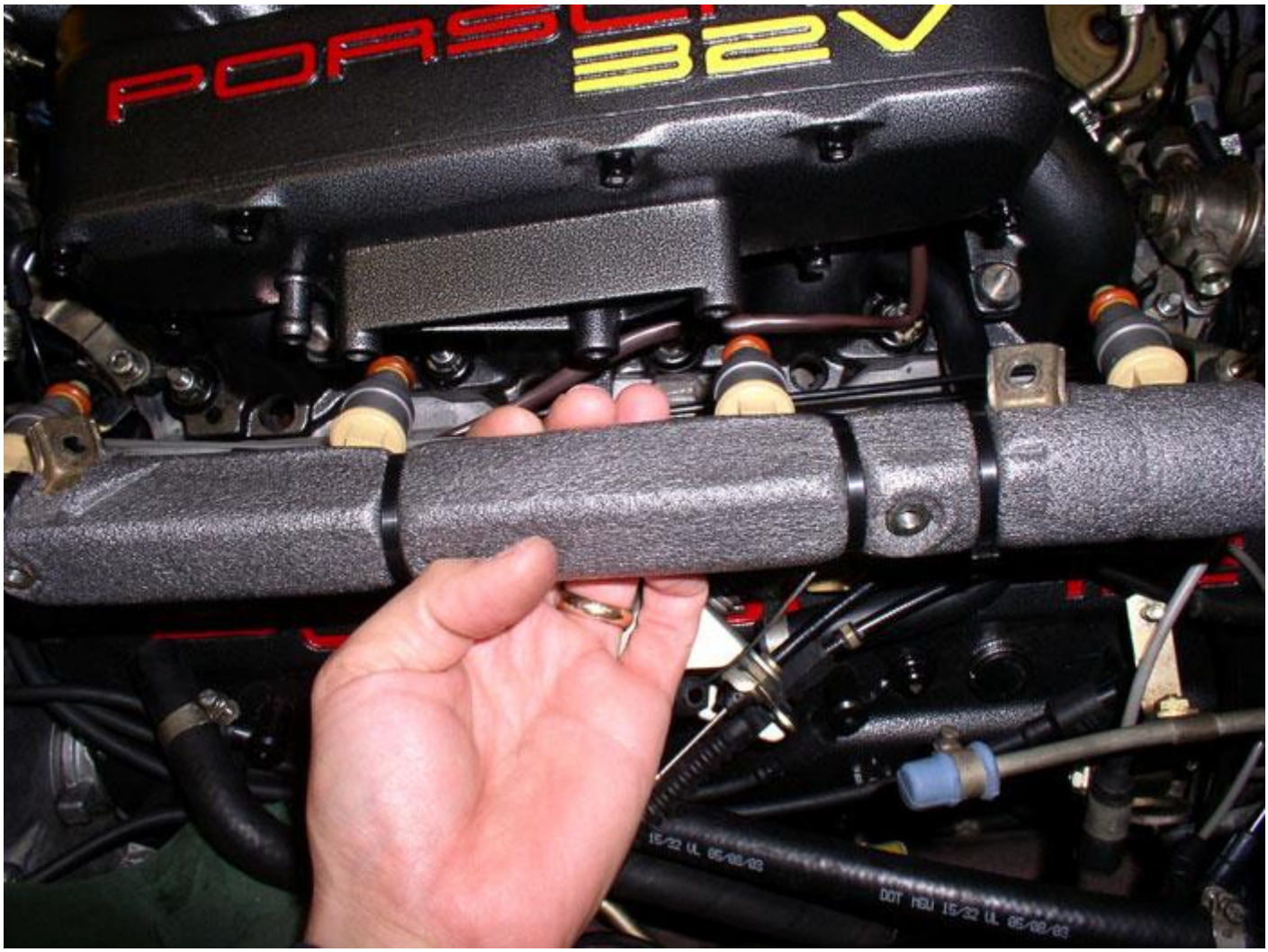
After the fuel injector is in, attach the retaining clip as shown. I oriented the retaining clip in the same manner as they were attached when I took them out.



Attach all four injectors to the fuel rail and then do the same for the other fuel rail.



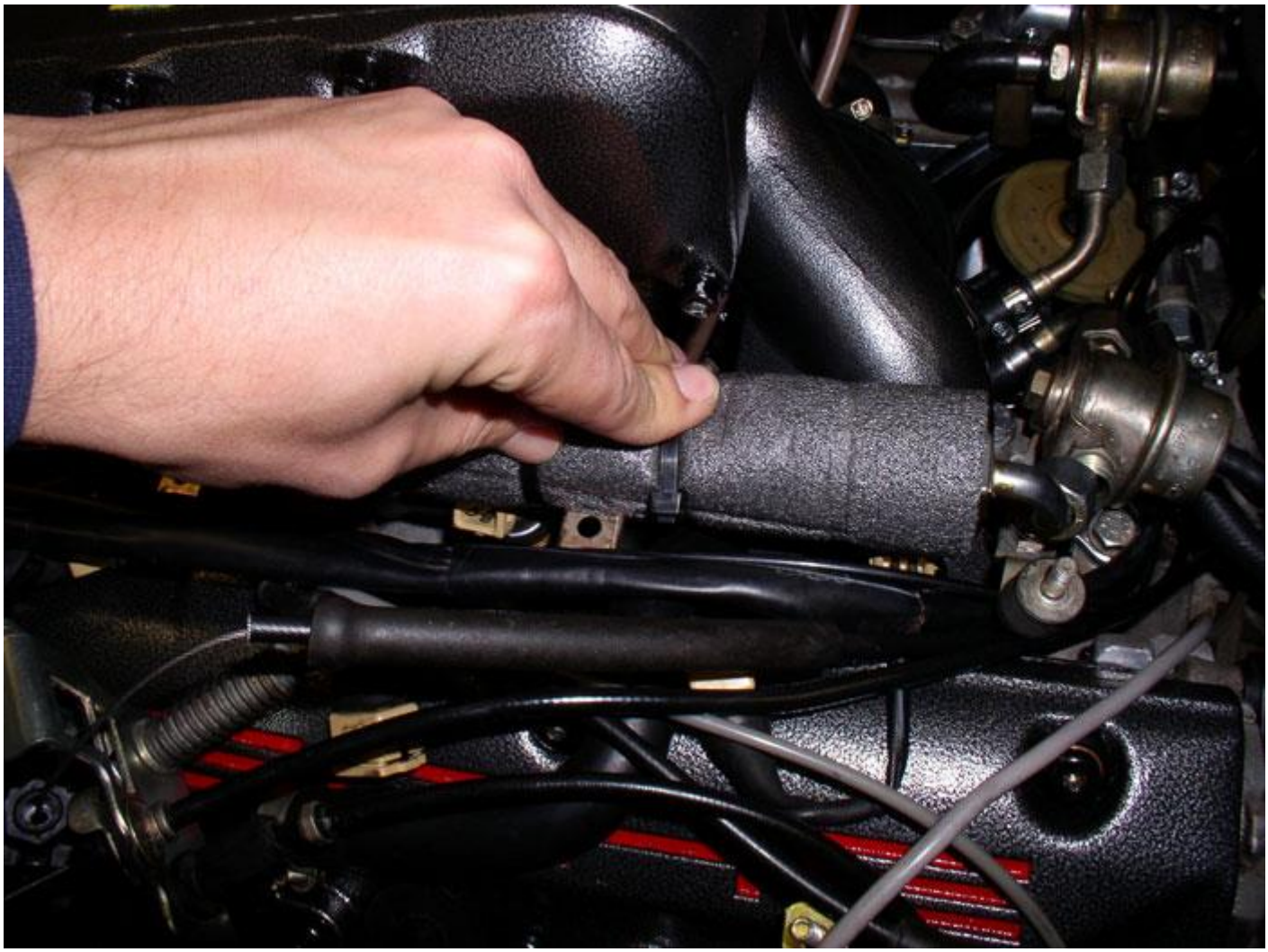
Starting with the driver's side, position the fuel rail with injectors into place. Ensure the ends of the fuel rail line up with the fuel pressure dampers at each end. Also ensure the two mounting brackets on the fuel rail are lined up to fit over the M6 mounting studs on the intake. .



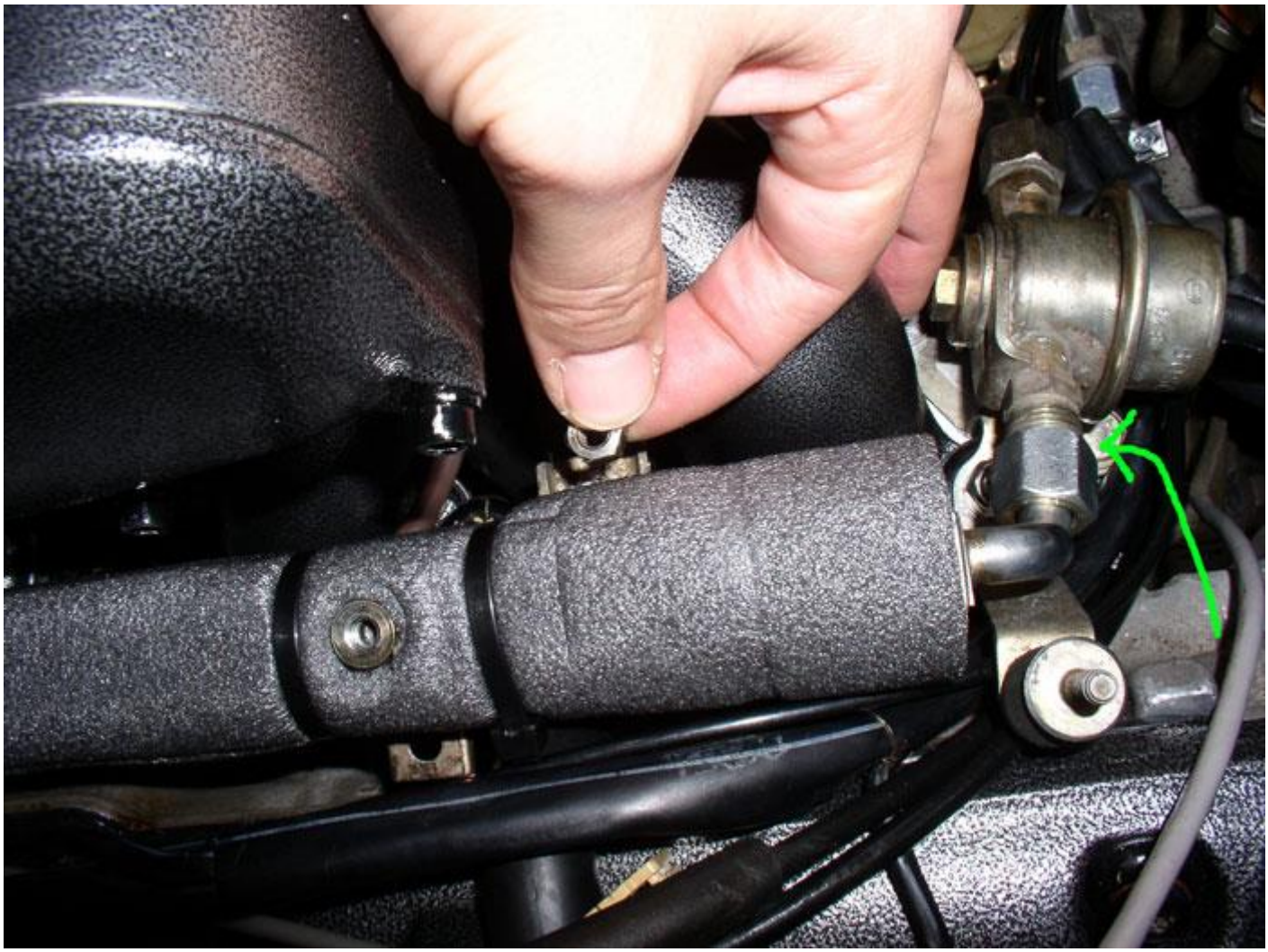

When you lower the fuel rail down into position, ensure the air temperature switch wires harness is routed between cylinders 6 and 7 fuel injectors as shown. Also, it is very important that you ensure each injector is lined up to go into is respective injector hole in the intake. Otherwise, a misaligned injector can result in a cracked pintle cap while pressing the fuel rail down into place.



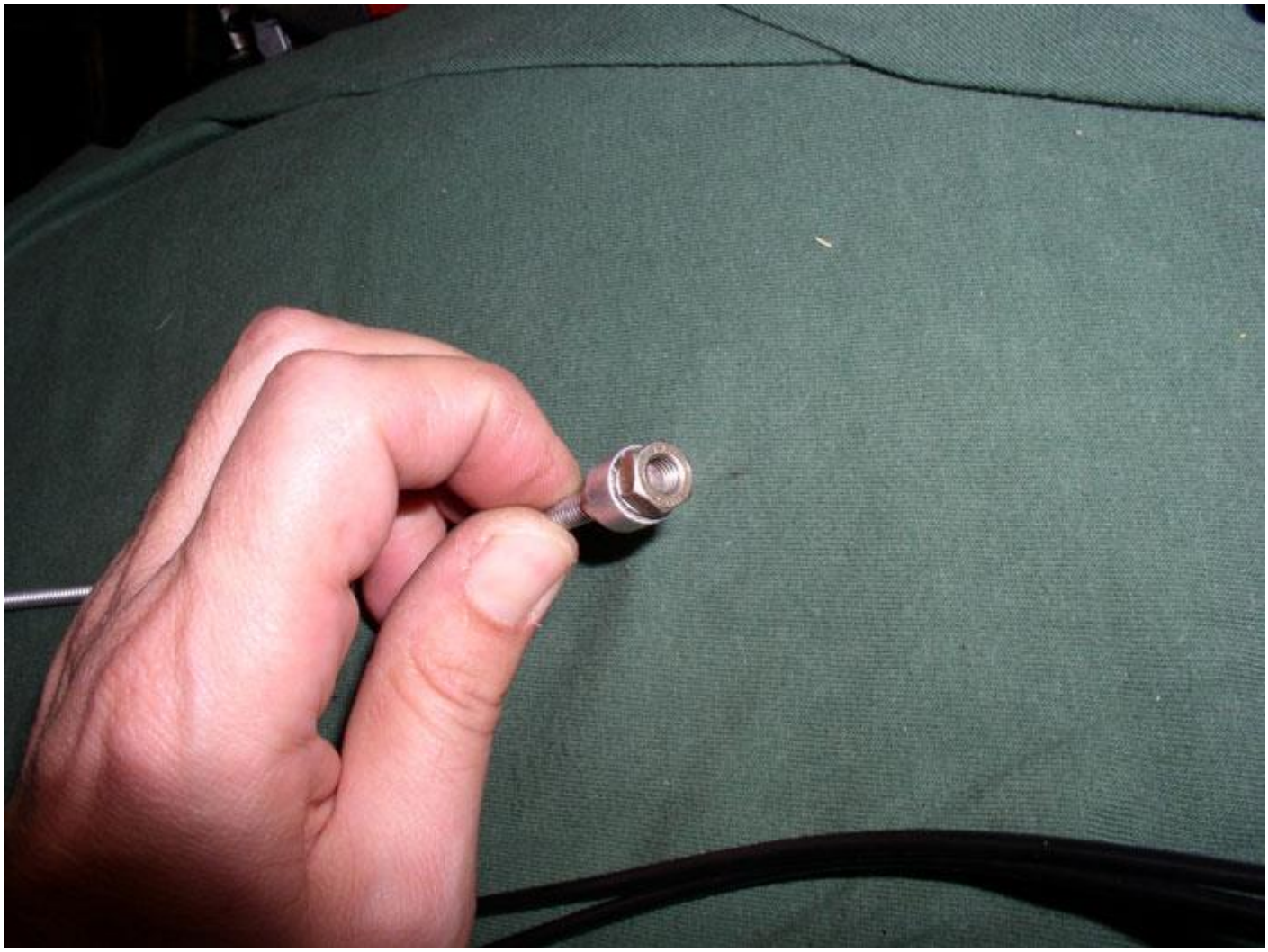
Then press down on the fuel rail until all four injectors are fully seated. The fuel rail mounting brackets will only allow you to push down so far until the brackets are seated on their M6 studs.



Before installing and tightening down the 10mm nut on the fuel rail mounting brackets, ensure the end of the fuel rail is perfectly aligned with the Fuel Pressure Damper (FPD) receiving end (see green arrow). It is important that the fuel rail is not in a bind as a result of misalignment of the fuel rail connection at the FPDs - otherwise it may lead to leaking seals (vacuum leak) at the fuel injectors. Install the 10mm nut on the fuel rail mounting stud at the rear of the fuel rail.



To reach the mounting stud on the front of the fuel rail, I used a magnetic pick-up tool to hold the nut....



....then placed the nut on the stud and turned the magnetic tool until the nut was started on the threads.



Next, use a 10mm socket wrench with extension to tighten the 2 fuel rail mounting nuts. Tighten to 7 ftlbs.

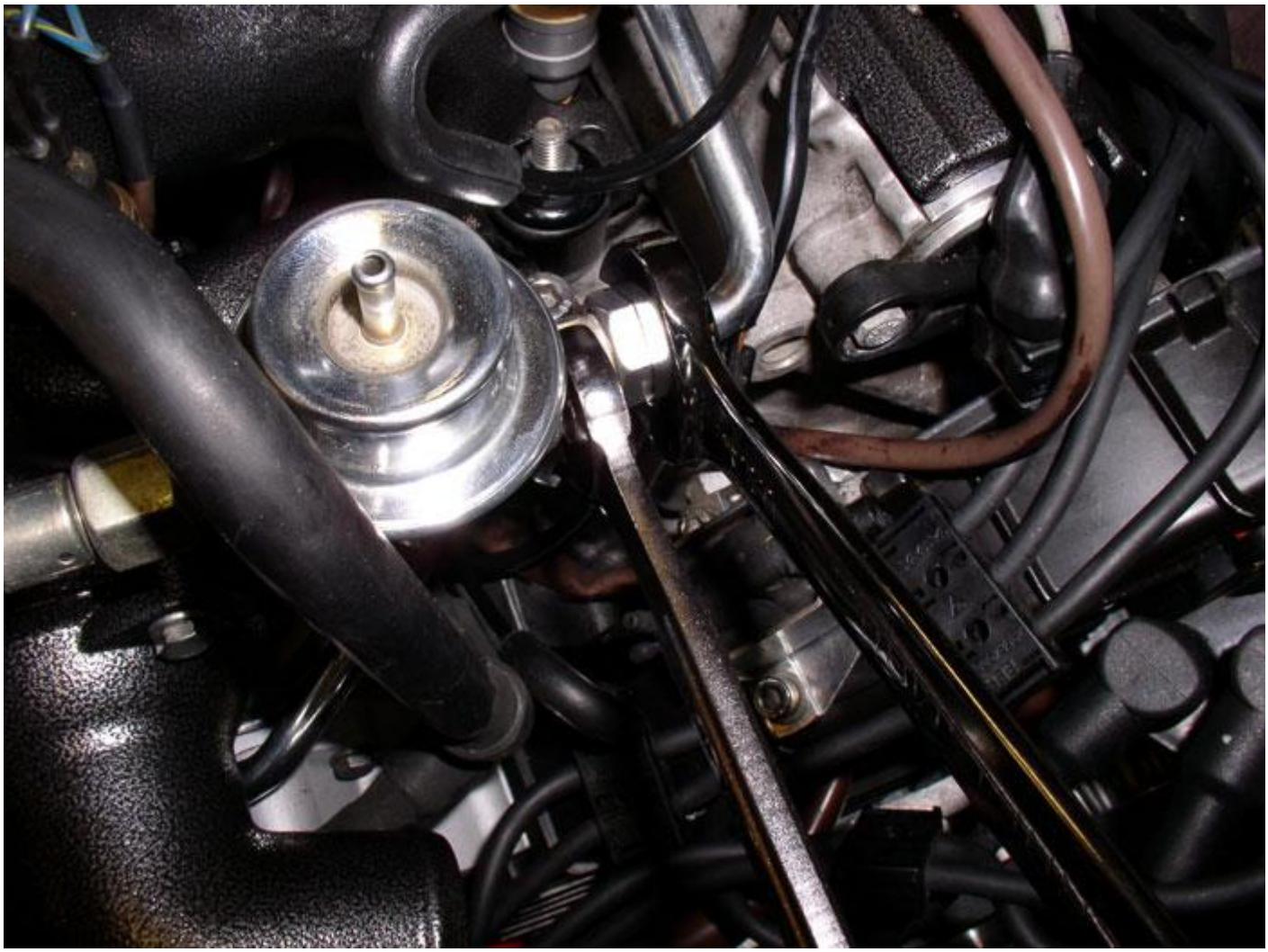


Thread the fuel rail rear connecting nut onto the rear FPD. Use a 19mm wrench to tighten the fuel rail nut and use a 15mm wrench to counterhold the FPD as shown. Snug firmly but don't overtighten as this can damage the

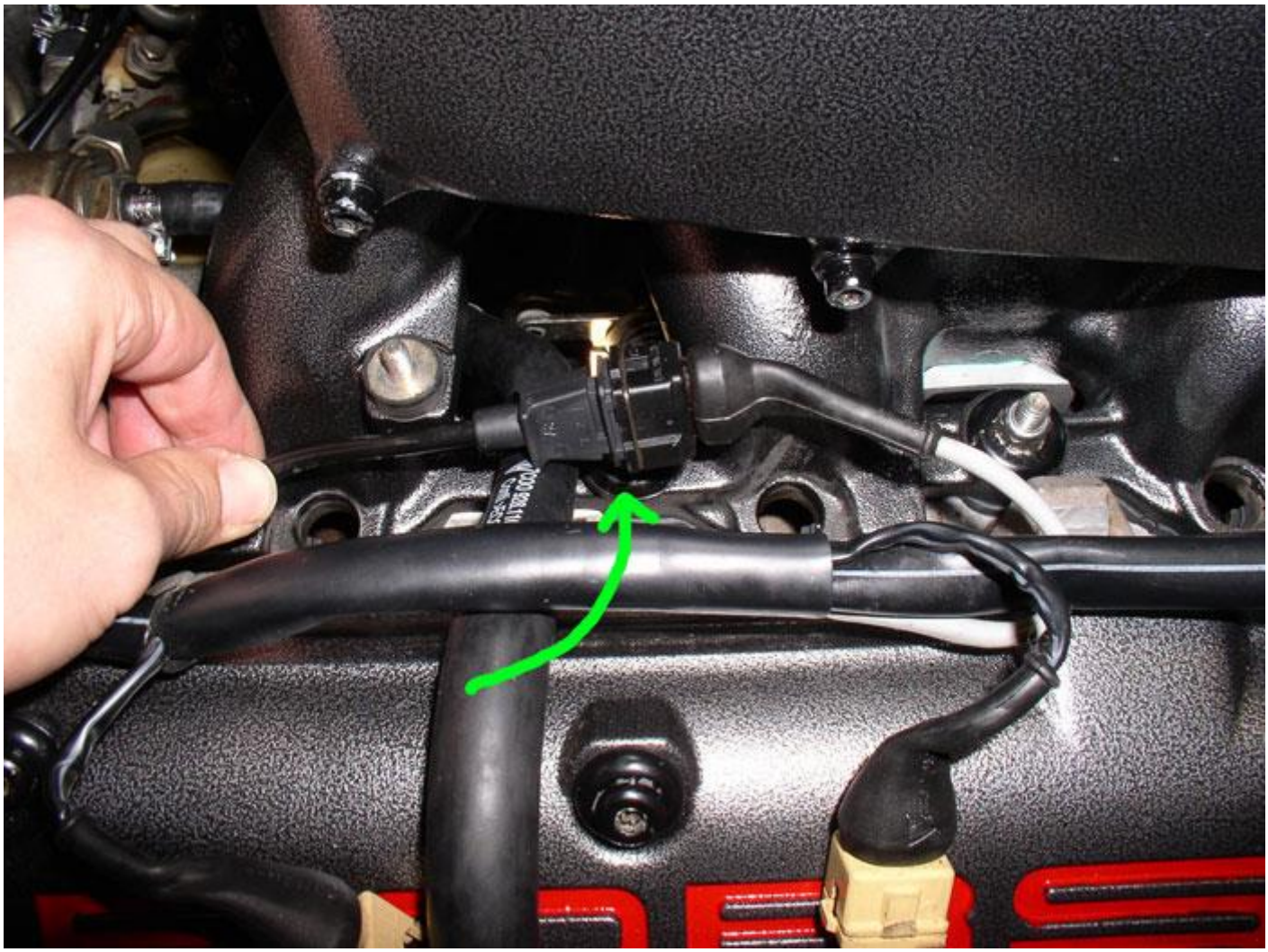
sealing surfaces of the compression type fitting.




Now, thread the front fuel rail connecting nut to the front FPD. Ensure the fuel rail is perfectly aligned with the FPD and is not in a bind. If it does not line up, check the installation of the fuel rail to make sure nothing is causing the connection to misalign. You may need to slightly loosen the FPD from the water bridge to adjust the connection. Then, use a 19mm wrench to tighten down the 19mm nut while using a 15mm wrench to counterhold the FPD. Tighten in the same manner as the rear FPD.



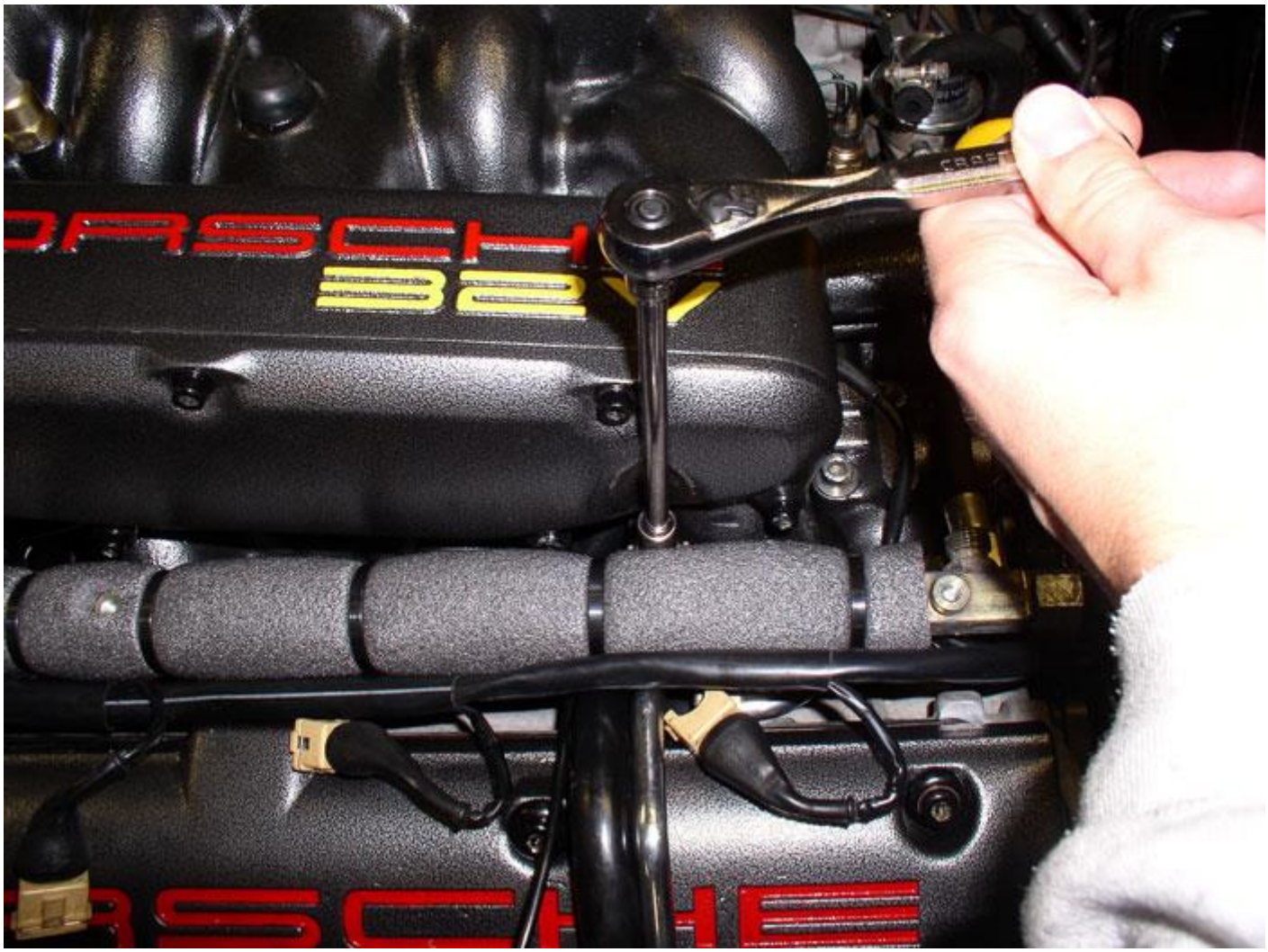
Next, move over to the passenger side of the intake. I positioned the rear knock sensor connection so that it would be tucked between the fuel rail and the intake runners out of sight.



Position the fuel rail into place. Line up the fuel rail to rear FPR connection and ensure all fuel injectors are lined up with their respective holes in the intake. Also, make sure the fuel rail mounting tabs are lined up with the two M6 studs on the intake (same procedure as just completed on the driver's side). Then push down on the fuel rail until it is seated.




Install the 10mm nuts that secure the fuel rail to the intake and tighten with 10mm socket down to 7 ftlbs.



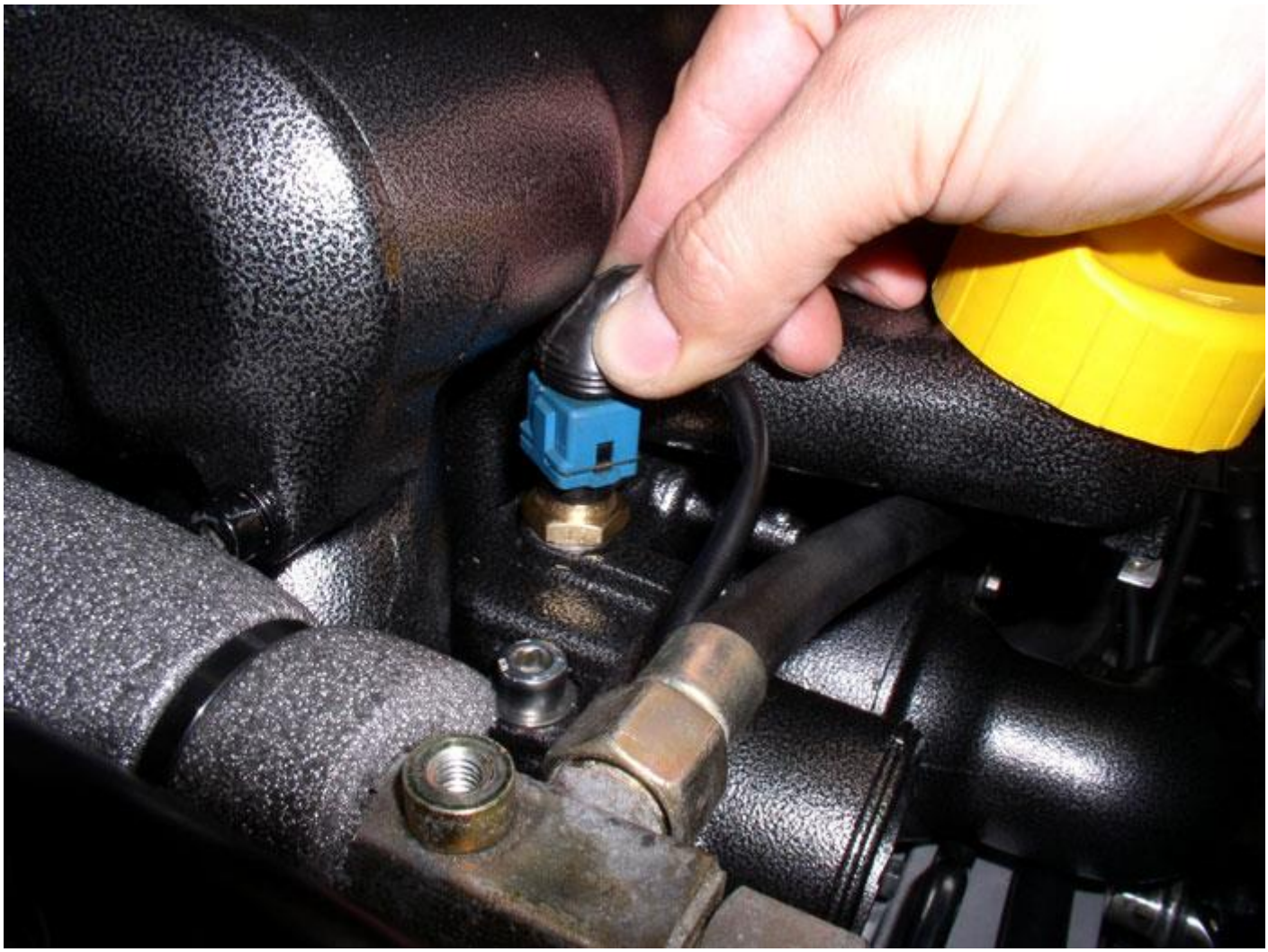
Ensure the rear FPR and fuel rail connection are perfectly aligned and thread the 19mm nut onto the FPR. Then tighten nut with a 19mm wrench and counterhold the FPR with a 15mm wrench. Tighten in the same manner as the driver's side connections.



Attach the front fuel hose to the front of the fuel rail and tighten down with a 19mm wrench. You can counterhold the fuel rail with another 19mm wrench.



Go ahead and attach the Temp II sensor plug onto the sensor.

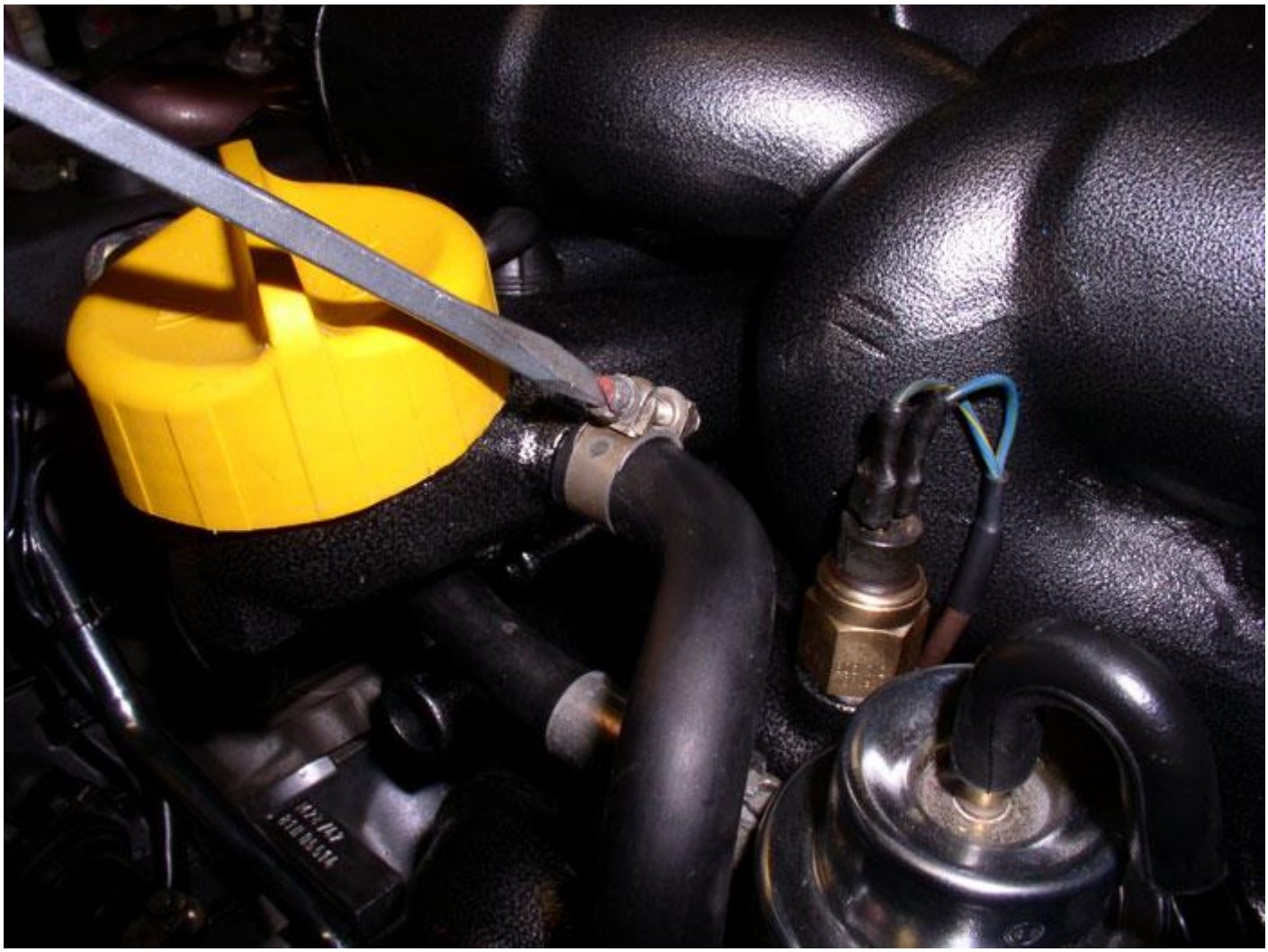


Before connecting the fuel injectors to the wiring harness and installing the fuel rail covers, I found it best to perform a vacuum leak test at this stage before making final connections so that I didn't have as much re-work to take things off to repair the leaks. I learned this the hard way by connecting EVERYTHING back together and starting the car - hoping it would run perfectly. It didn't - I had leaks and had to take things apart again to fix them.

So first, connect the vacuum elbow to the front FPD.



Then connect the 3-way hose to the oil filler neck and tighten down the hose clamp.



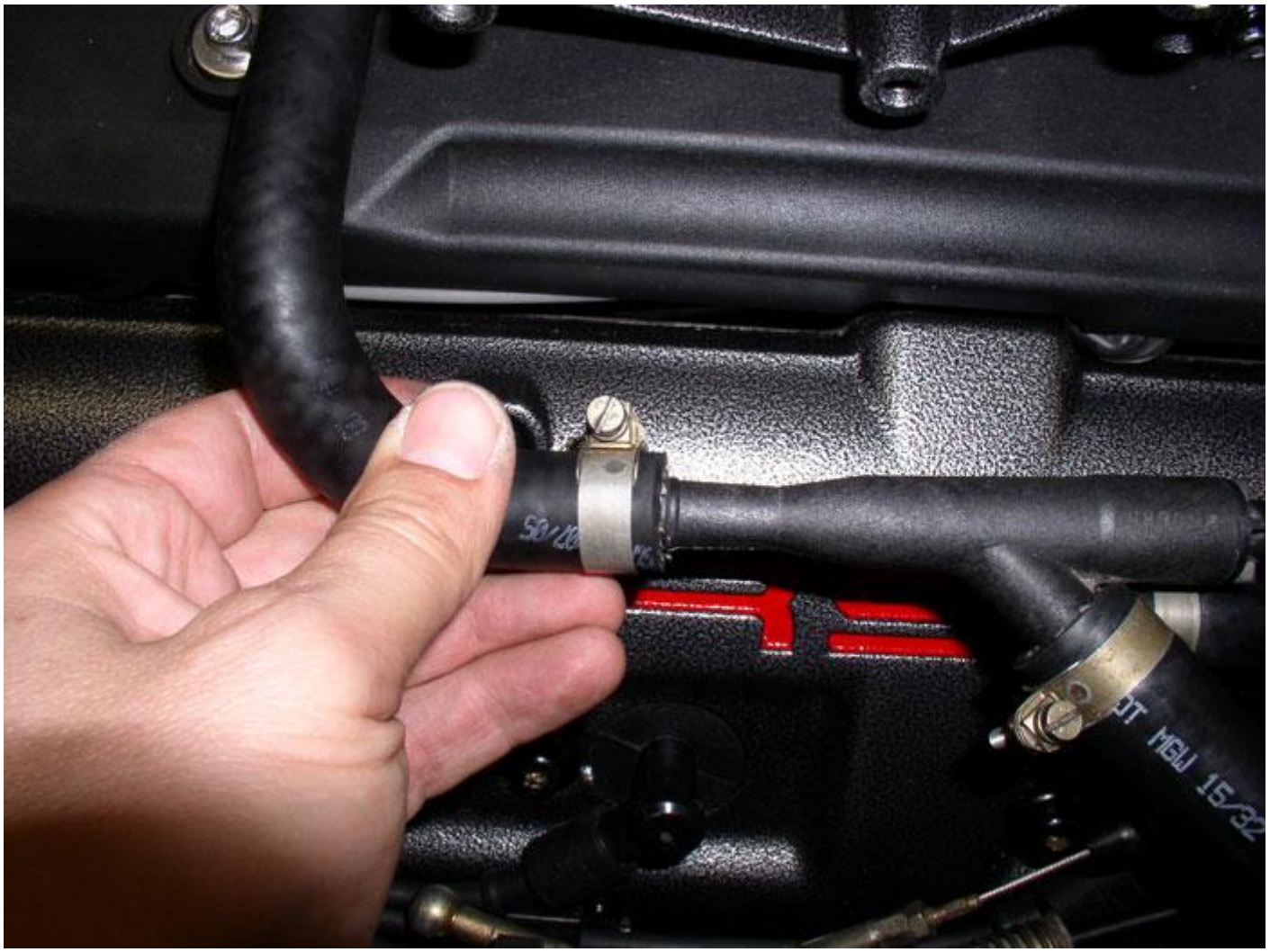
Next, connect the plenum-to-venturi hose to the port on the side cover of the plenum. Don't tighten the hose clamp yet. Ignore the fuel rail cover already in place - unfortunately, I did not have a picture of this without the fuel rail cover in place.



If you replaced all your hoses at the venturi like I did, connect the venturi-to-brake booster hose at the venturi next and tighten the hose clamp.




Then, connect the venturi assembly to the plenum hose you just attached to the plenum. Don't tighten the hose clamp yet.



Connect the hose coming from the Air Guide Cowl to the venturi assembly.

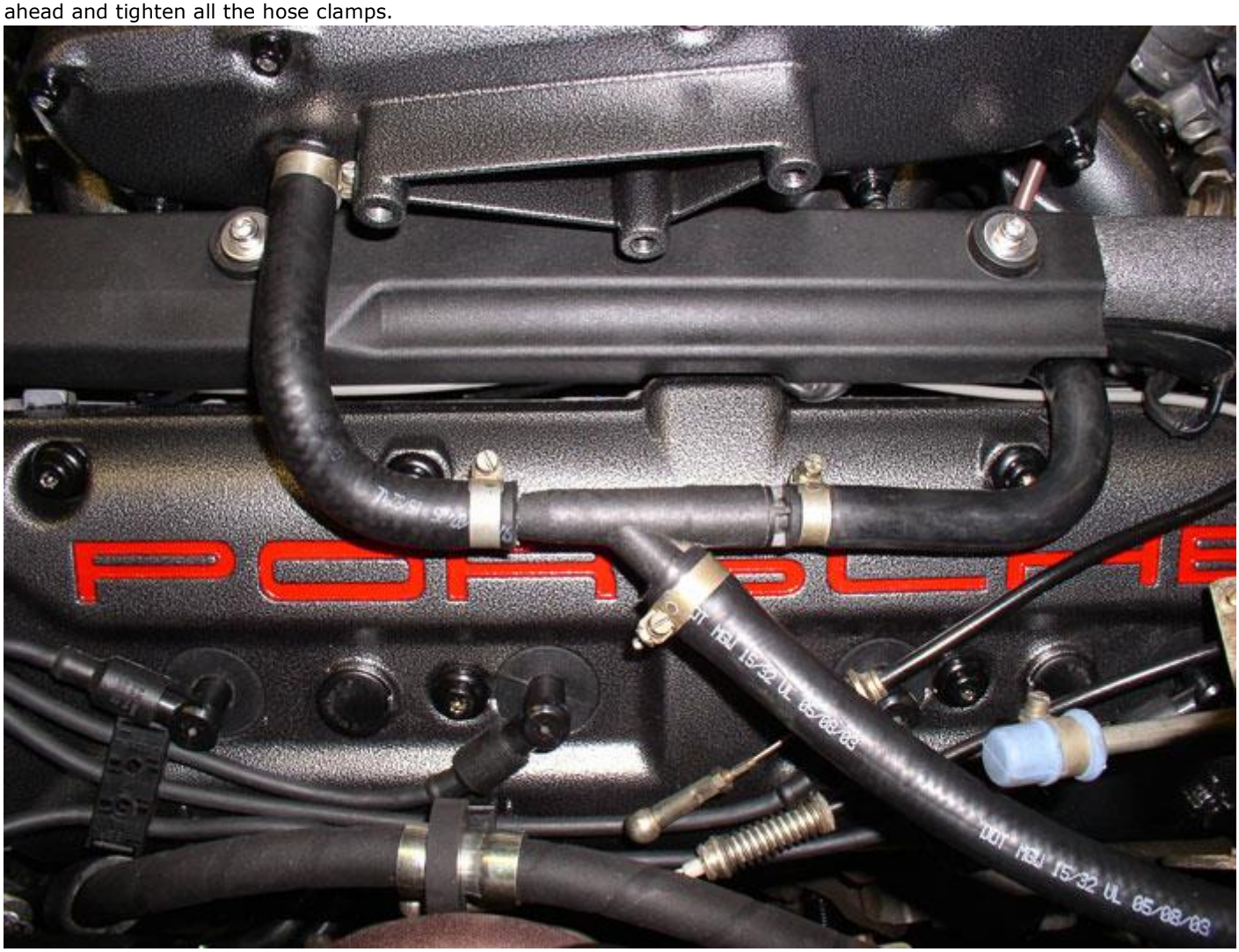



Connect the brake booster hose to the brake booster port. Tighten the hose clamp.

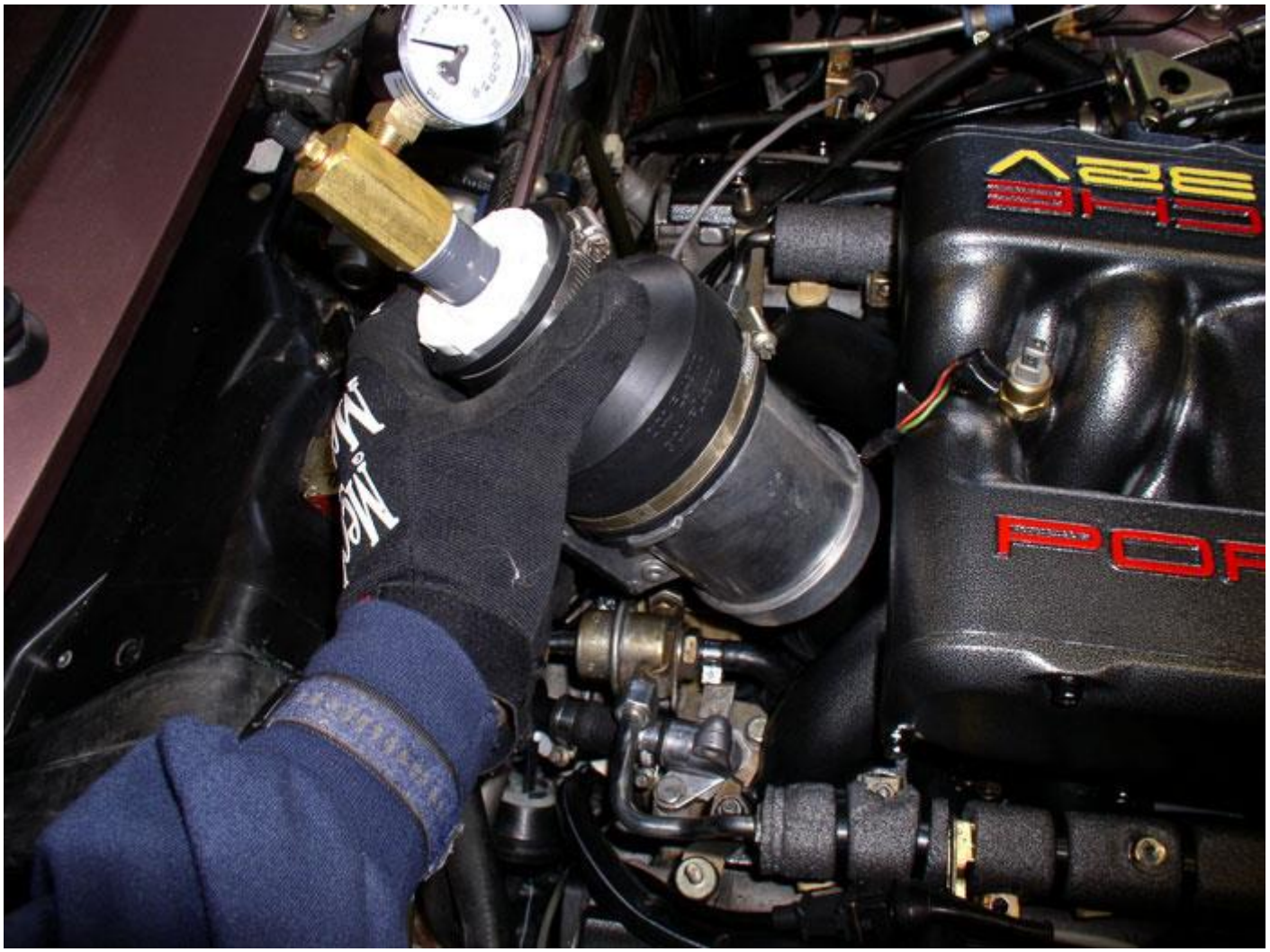



The hose connections should look like this (minus the fuel rail cover - sorry). With the hose assembly in place, go

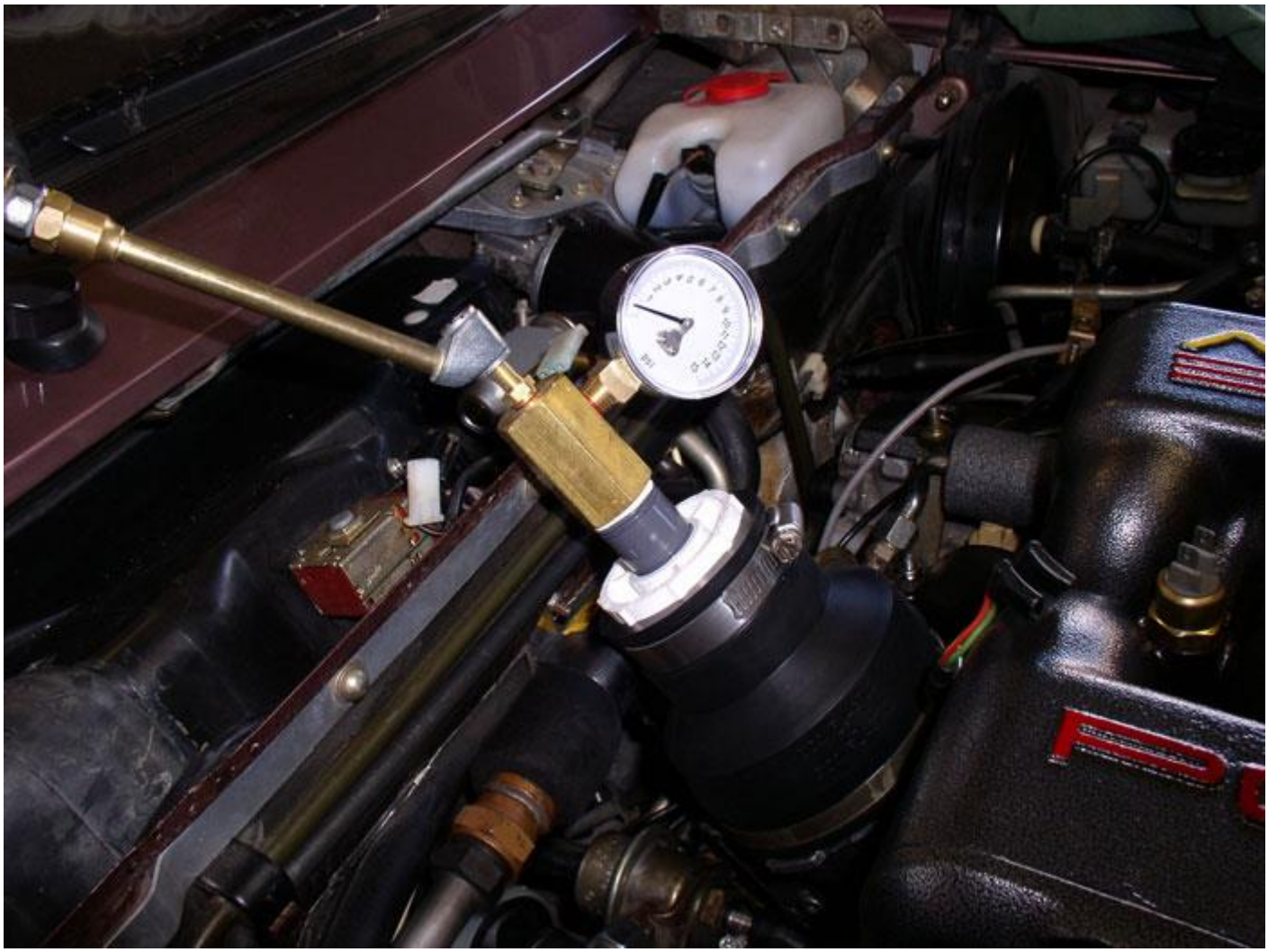
ahead and tighten all the hose clamps.



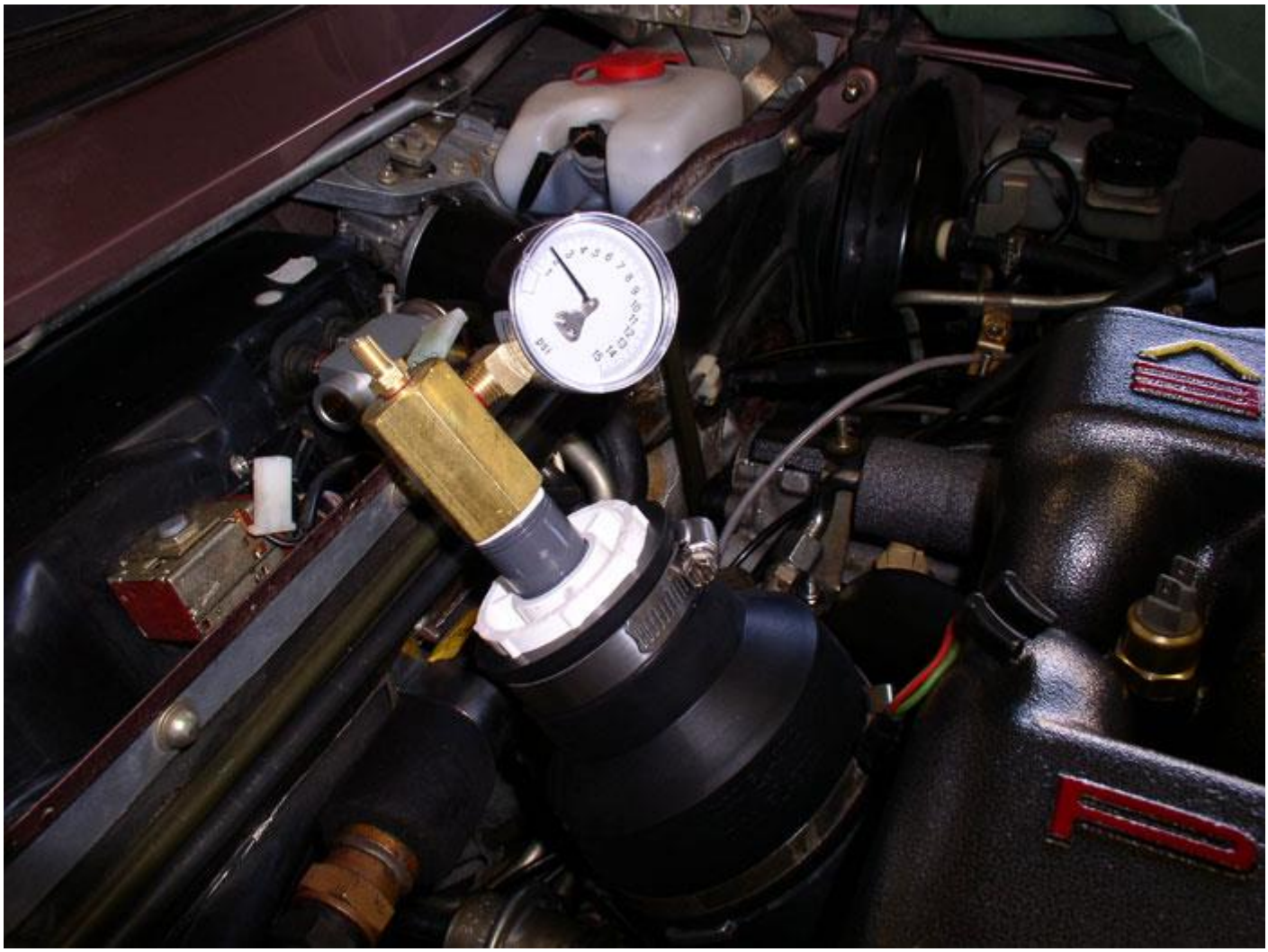
This is a great point to do a vacuum leak test before completing the rest of the intake installation. You may remember earlier in this thread that I described how to build the vacuum leak testing device. I use it here to test for leaks. After you've clamped the rubber adapter to the MAF, install the unit by inserting the MAF end into the Air Guid Cowl and tightenting the clamp nice and snug.



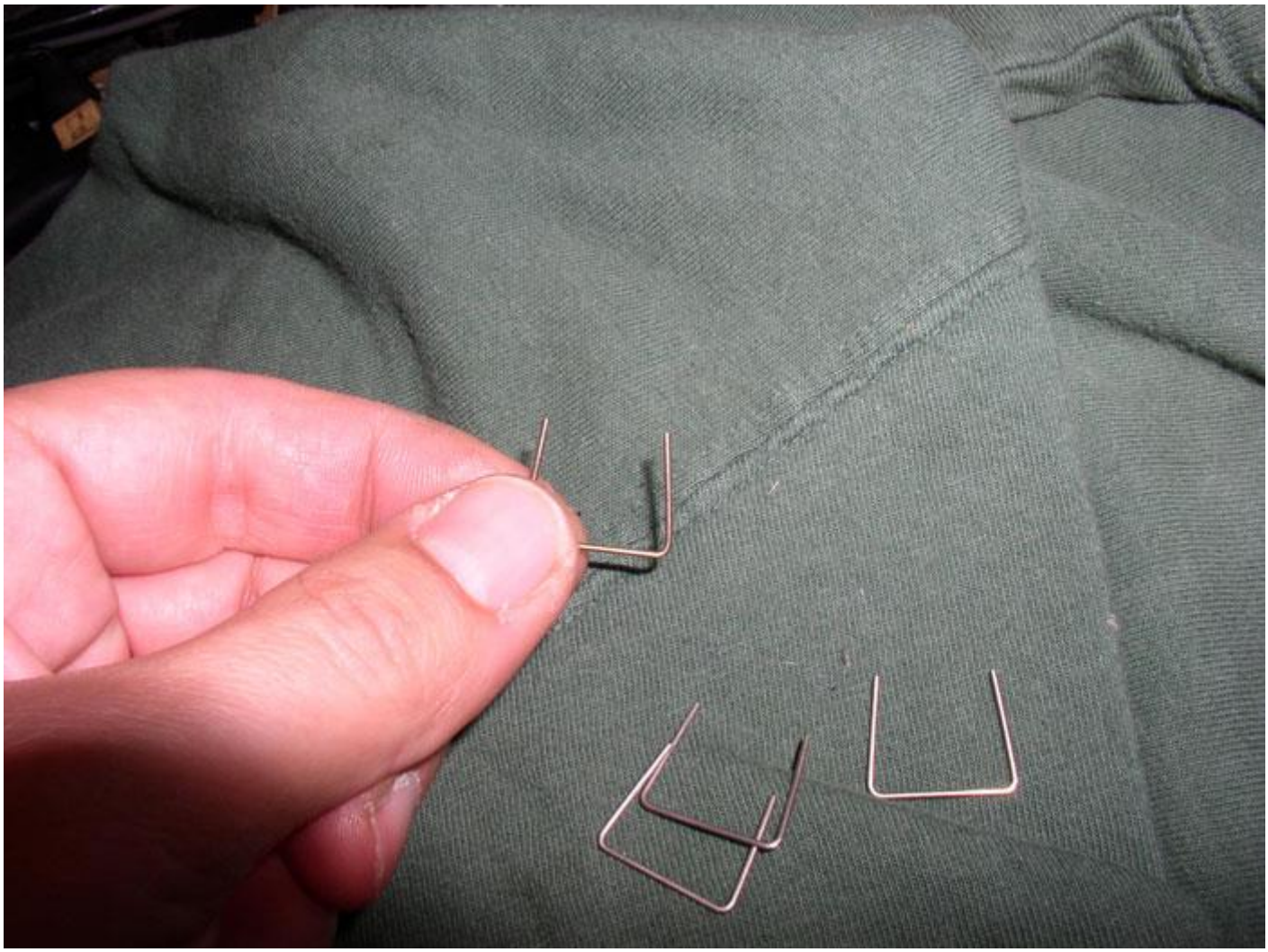
I pressurized the system to about 1-2 PSI and watch the pressure gauge to see how quickly it falls.



If you have a leak, it will be obvious by the steady drop in pressure on the gauge. If it's a large leak, you will be able to hear it. Next you will need to pinpoint the leak. I used a spray bottle filled with a very small amount of dishwashing soap and water and sprayed at locations where the sound was coming from. At places I couldn't get the spray (e.g., throttle body linkage), I used a long wooden match and could see the air nearly blowing out the match near the leak. The leaks I had were the following: A huge leak was caused by a misaligned cam cover gasket on the passenger side. After fixing that and pressurizing again, I found I had a large leak at the fuel injectors lower O-ring caused by the fuel rail being in a bind because the fuel rail was not perfectly aligned with the FPDs on the driver's side (hence, my comments about alignment of the fuel rail and FPD/FPR). After repairing these and pressurizing again, I found I had a large leak at the throttle body linkage using the long wooden match to pinpoint. After removing the intake again and repairing the throttle body leak with Roger's flappy bearings - I pressurized again and achieved a very good seal (IMHO). After these repairs, I was able to pressurize to 2.5 PSI and monitored the drop. It took about 4 minutes to drop to zero. Which seemed good enough to me.



Once your happy with the sealing qualities of the intake system, you can remove the testing device and finish the fuel rail assembly. First, I connected the fuel injector harness plugs to the fuel injectors. If you collected the retaining clip for the plugs, now's the time to install the clips back into the plugs. When I originally removed my injector plugs from the injectors, about half of the injector clips simply fell off. None of the clips were secured to the plug housing. I removed all of them from the plugs as they would easily come off and fall into the engine during the intake repair. The following procedure illustrates how I put them back in. However, thanks to some valuable insight from Bill Ball (THANKS, Bill!), there are other, highly recommended ways to secure the clips to the plugs more permanently. First, you can buy the clips that have the 90 degree bend at the ends that secure the clip to the plug. I understand these may be available still if you buy the pigtail plug kit and simply remove the clip from the new pigtail and use it on your existing plug. Another way is to simply using a soldering iron to melt some of the surrounding plastic on the front side of the plug over the wire clip to hold it in place. Unfortunately, I did not know about either of these alternatives at the time of this repair so I would strongly recommend the more permanant solution when you re-install the fuel injector plugs. I'm going to try to order some of the 90 degree clips as soon as possible and re-install the plugs. THANKS again, Bill for this valuable tip!



It can be a little tricky to get the clips back into the plugs but here's the procedure I used. Begin by inserting the clip about 3/4 the way into its slot in the plug as shown.



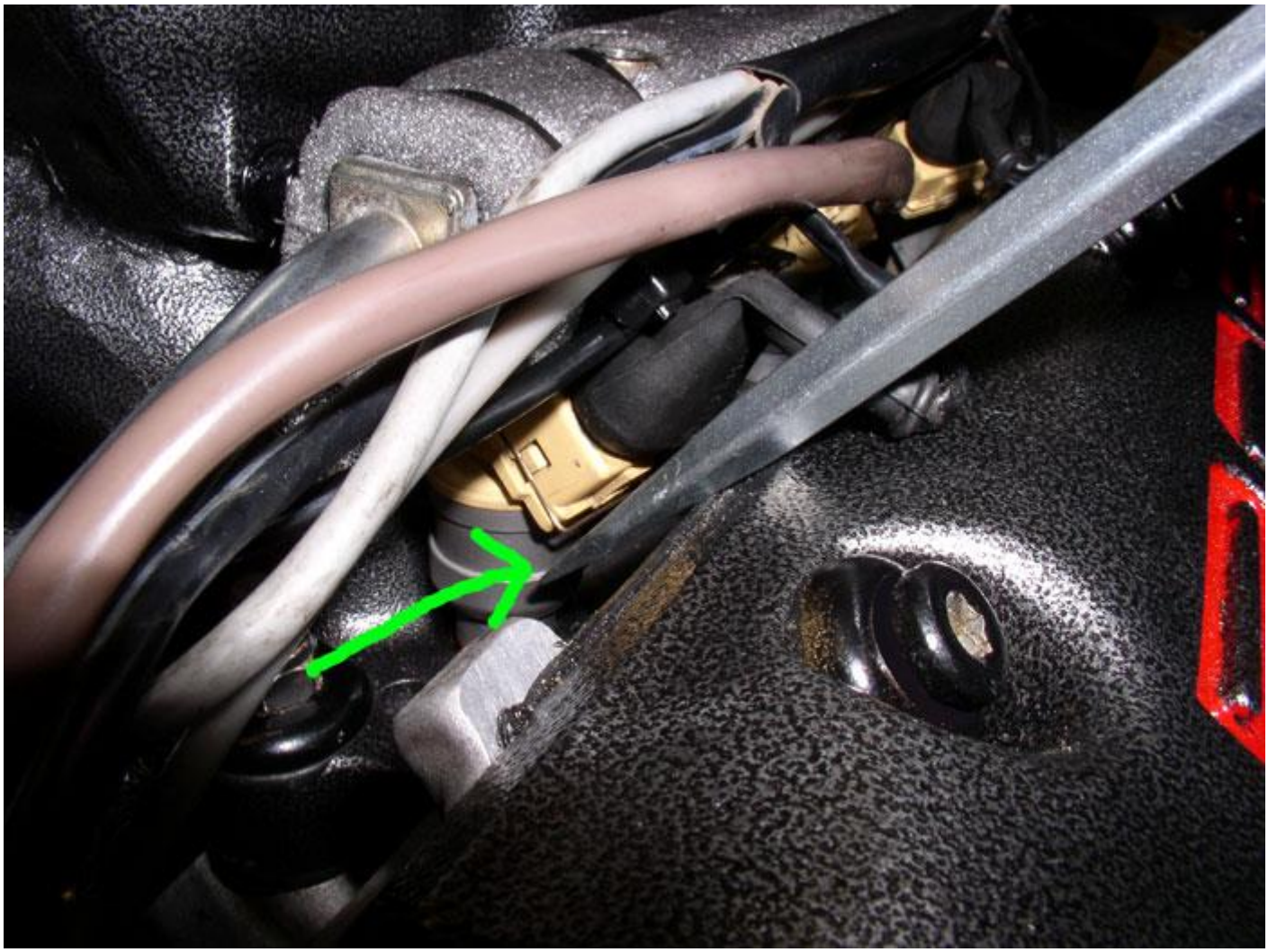
Then, use a pair of circlip pliers to pry the clip open enough to press the clip in all the way until it's fully seated. I found it handy to simply position the pliers into the recessed openings in the plug and apply pressure to the pliers until they were fully seated against the walls of the plug - then press the clip into place with your finger (see below).



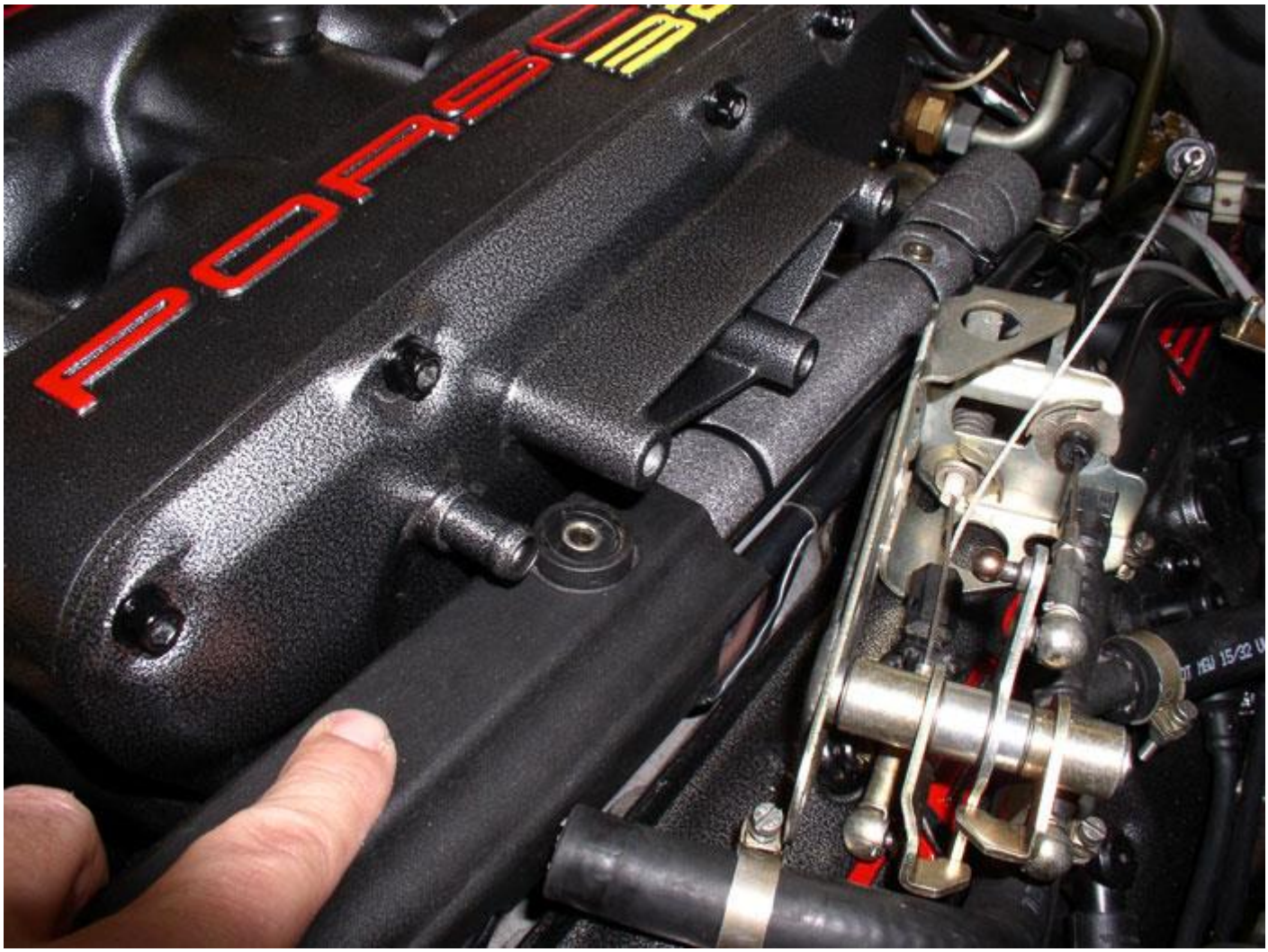
Next, install the fuel injector plug onto the associated fuel injector until you feel/hear it click into place.



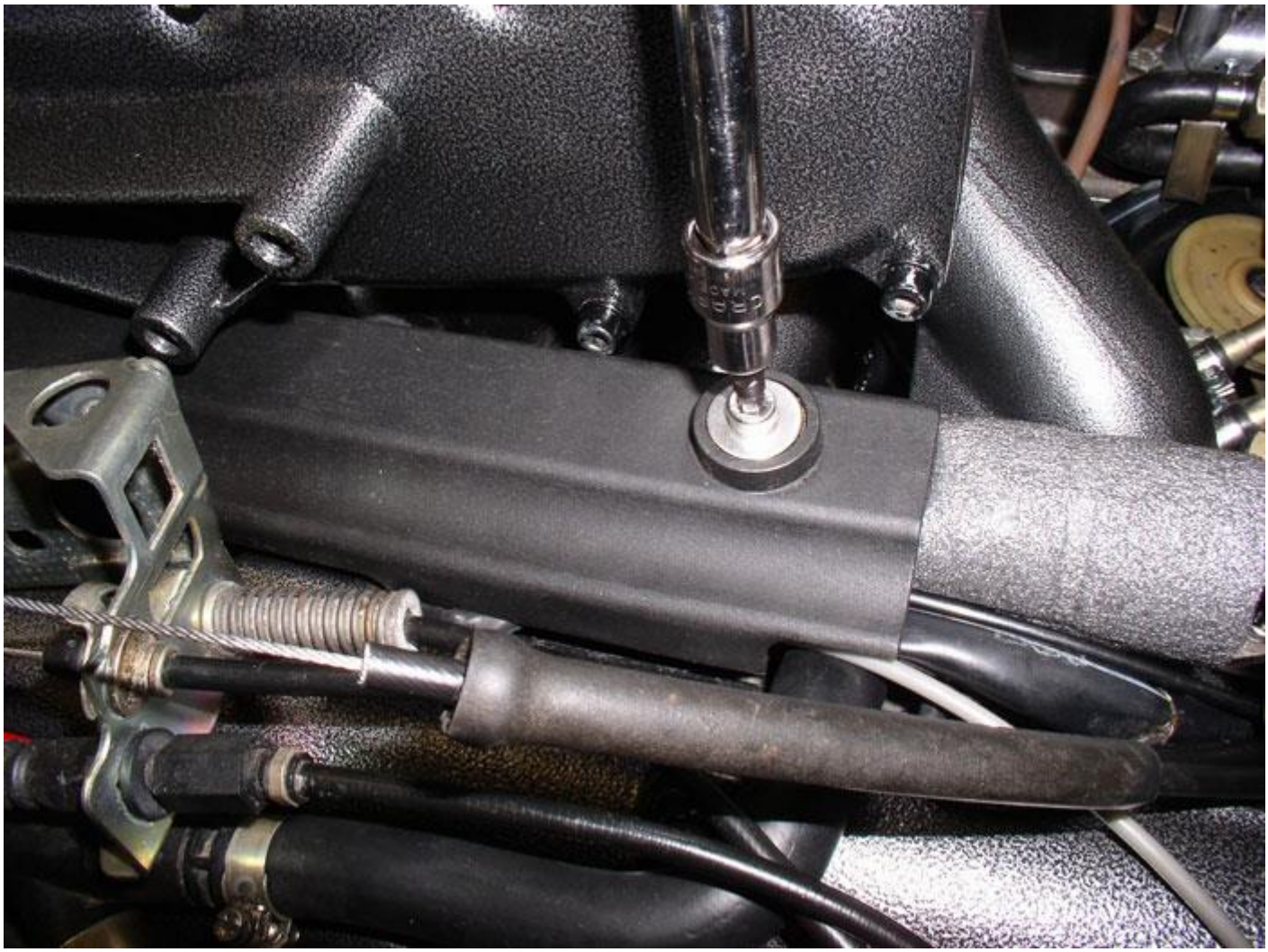
With these clips, I noticed that after it "clicked" into place, the clip would "back out" from the plug about 1/8 inch. Therefore, use a screwdriver as shown to simply push the clip back into its fully seated position. I had to do this on all eight injectors. Next time, I'll locate some of the clips with the 90 degree locking bend on the ends (as Bill Ball suggests) and install those.



Next, install the fuel rail covers. I started with the driver's side. You can remove the plenum-to-venturi hose from the side cover plate of the plenum to make room for installation. Slide the fuel rail in from the front as shown.



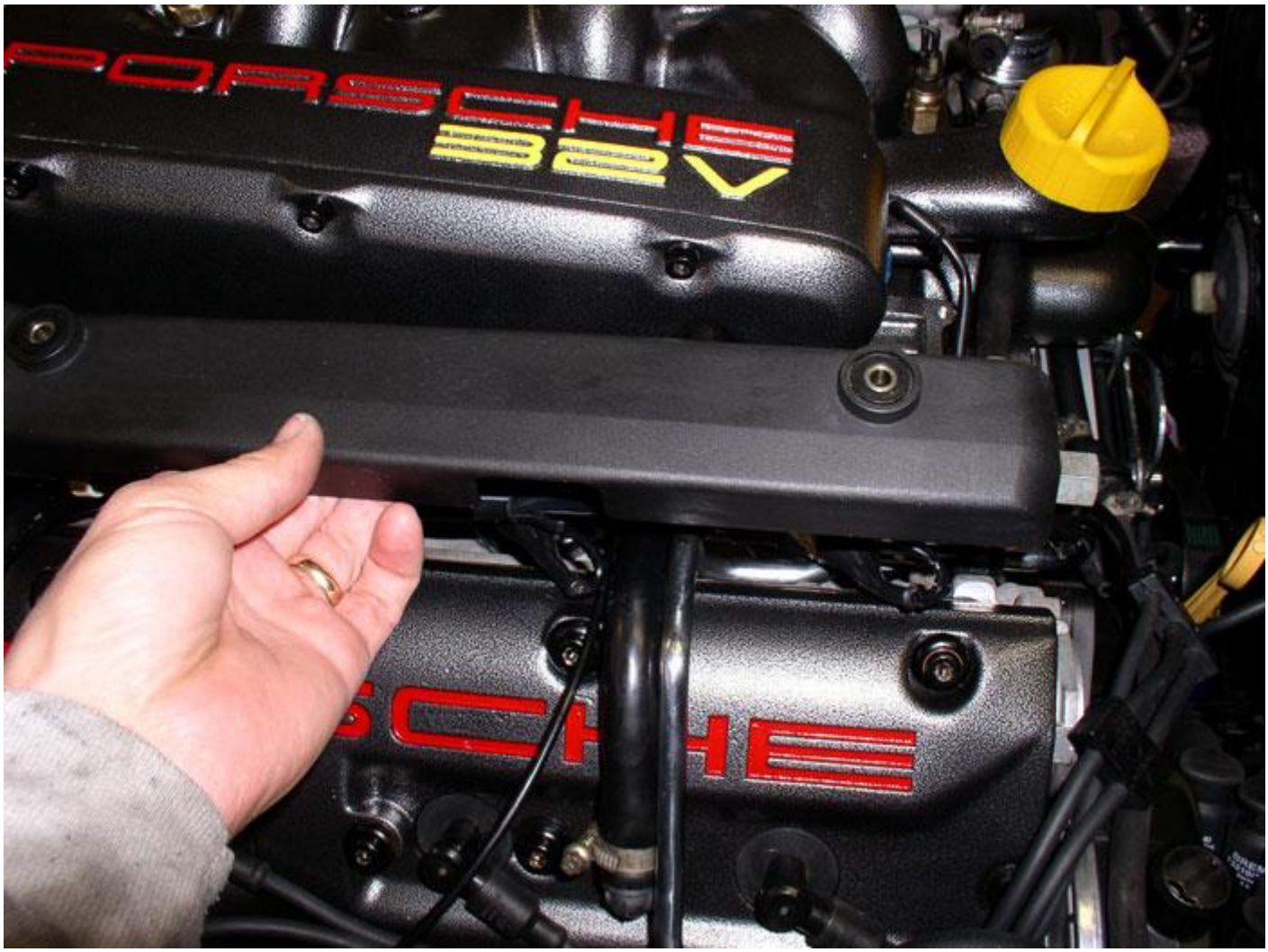
Line up the mounting holes of the cover with the mounts on the rail and install the M6 bolts using a 5mm allen head socket. My previous bolts were too corroded and small to clean appropriately so I replaced them with the same sized stainless steel equivalent. These do not require a lot of torque, I just simply "snugged" them down.



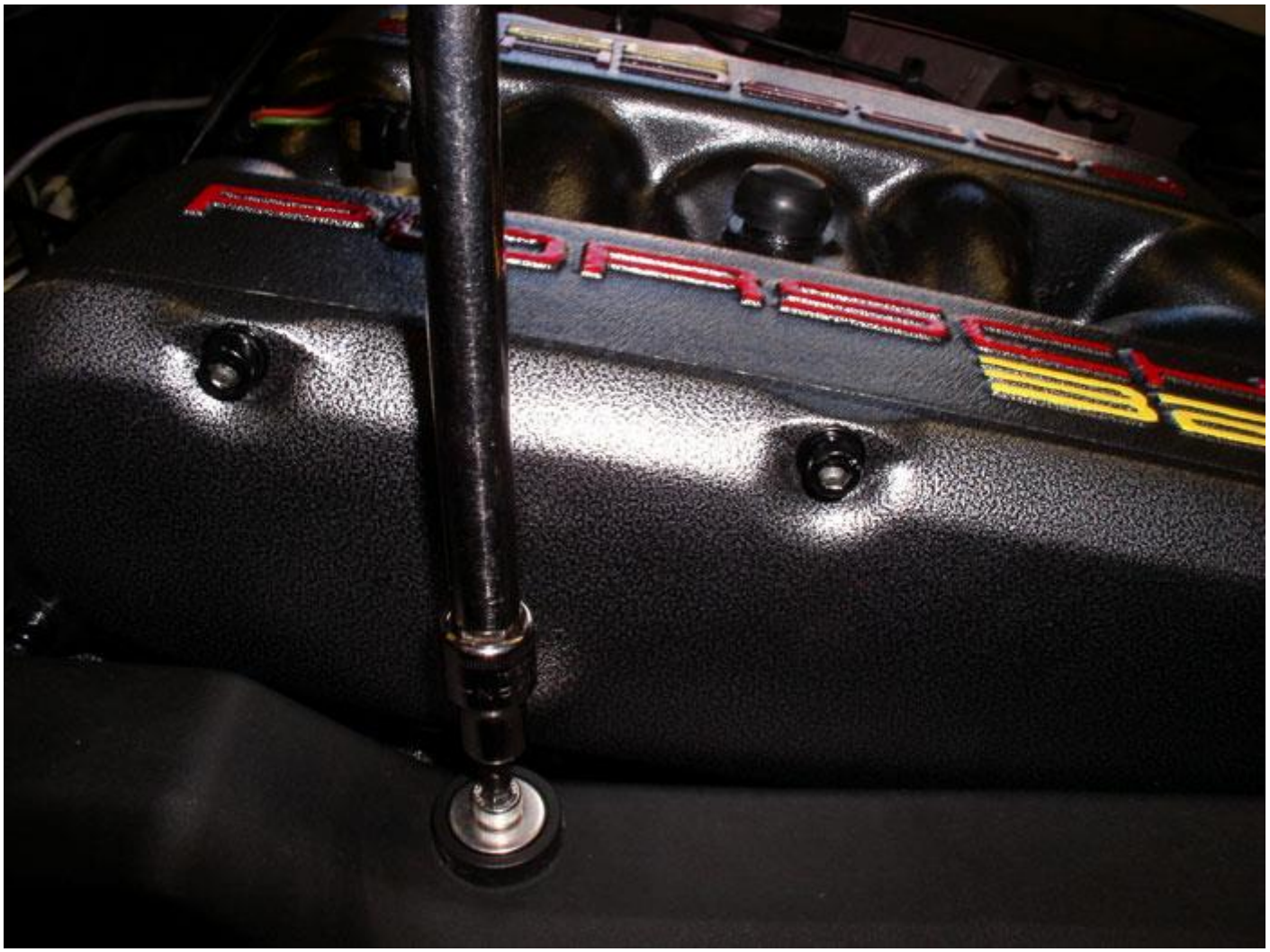
While you're on the driver's side, you can connect the intake air temp sensor wires to the sensor as shown. It does not matter which post the wires are connected to.



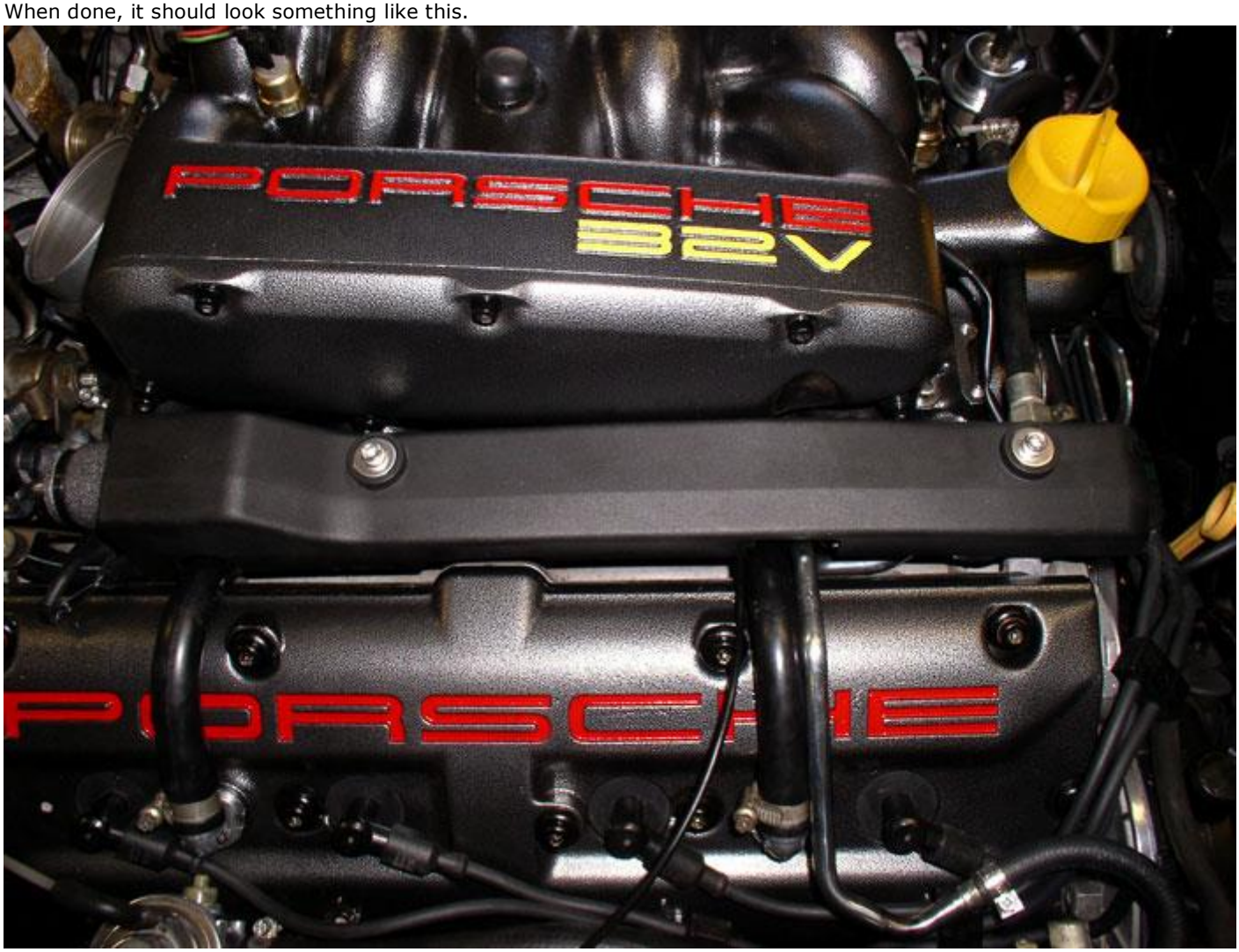
Next, comes the passenger side fuel rail cover. Simply position this cover over the rail from above and line up the mounting holes with the fuel rail....




....and snug down the two 5mm allen head bolts.



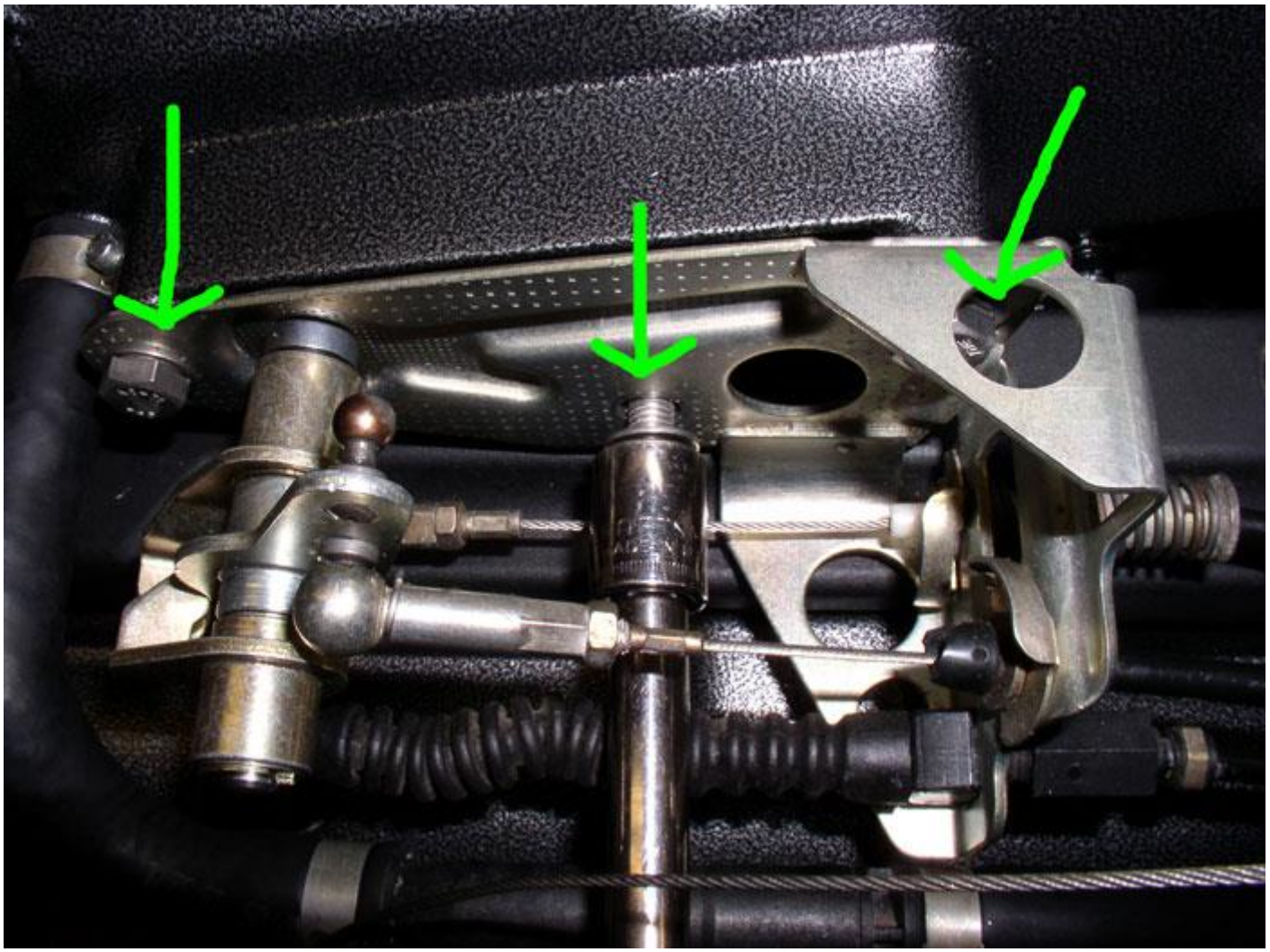
When done, it should look something like this.




Coming down the home stretch now. Re-connect the plenum-to-venturi hose to the side cover plate of the plenum and tighten the clamp.



Attach the cable linkage bracket to the mounting holes on the side of the plenum. Attach with three 13mm bolts as shown. Torque to 15 ftlbs.



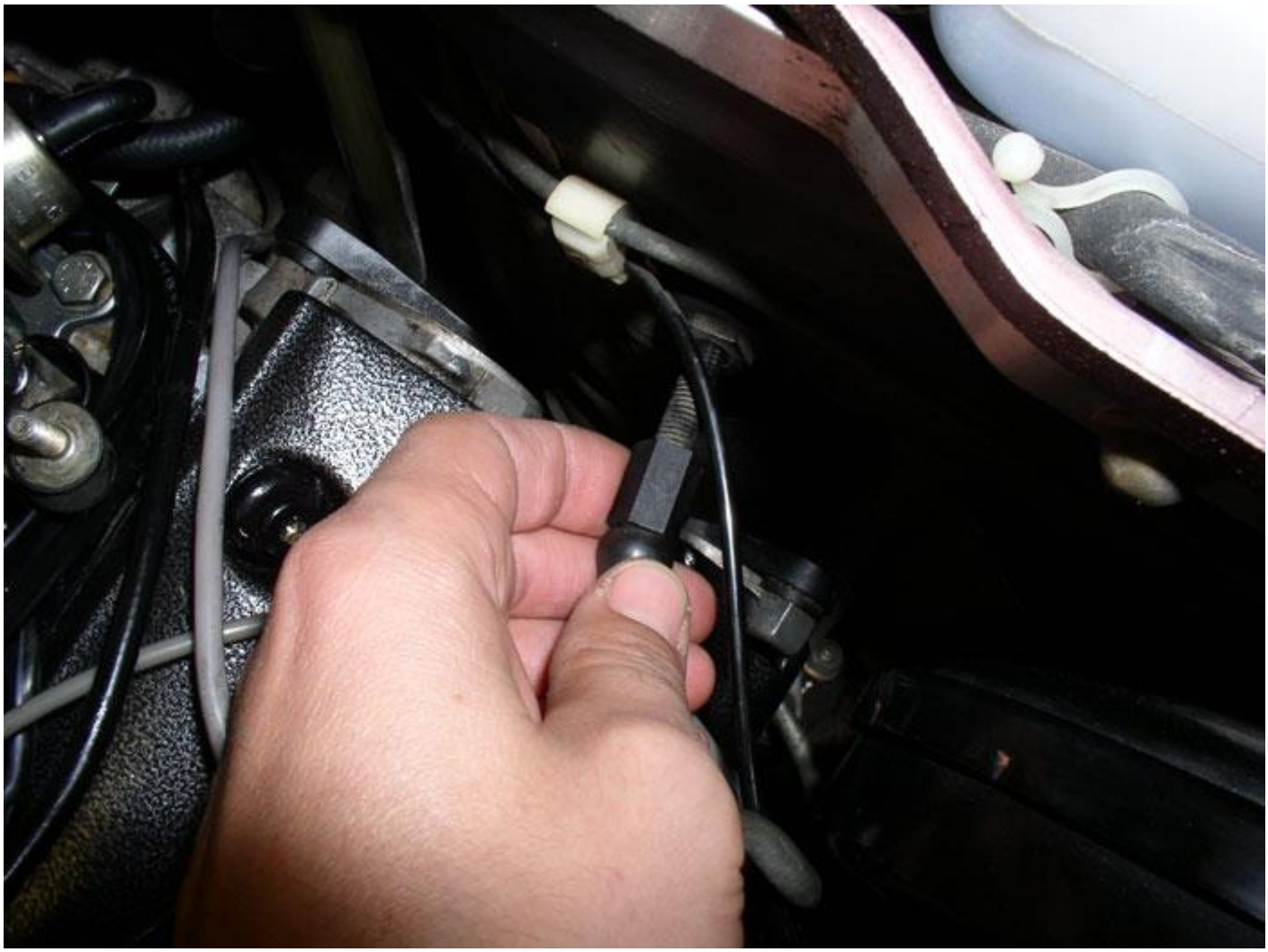
I put black grease on the acclerator cable ball connector at the lever arm as shown.



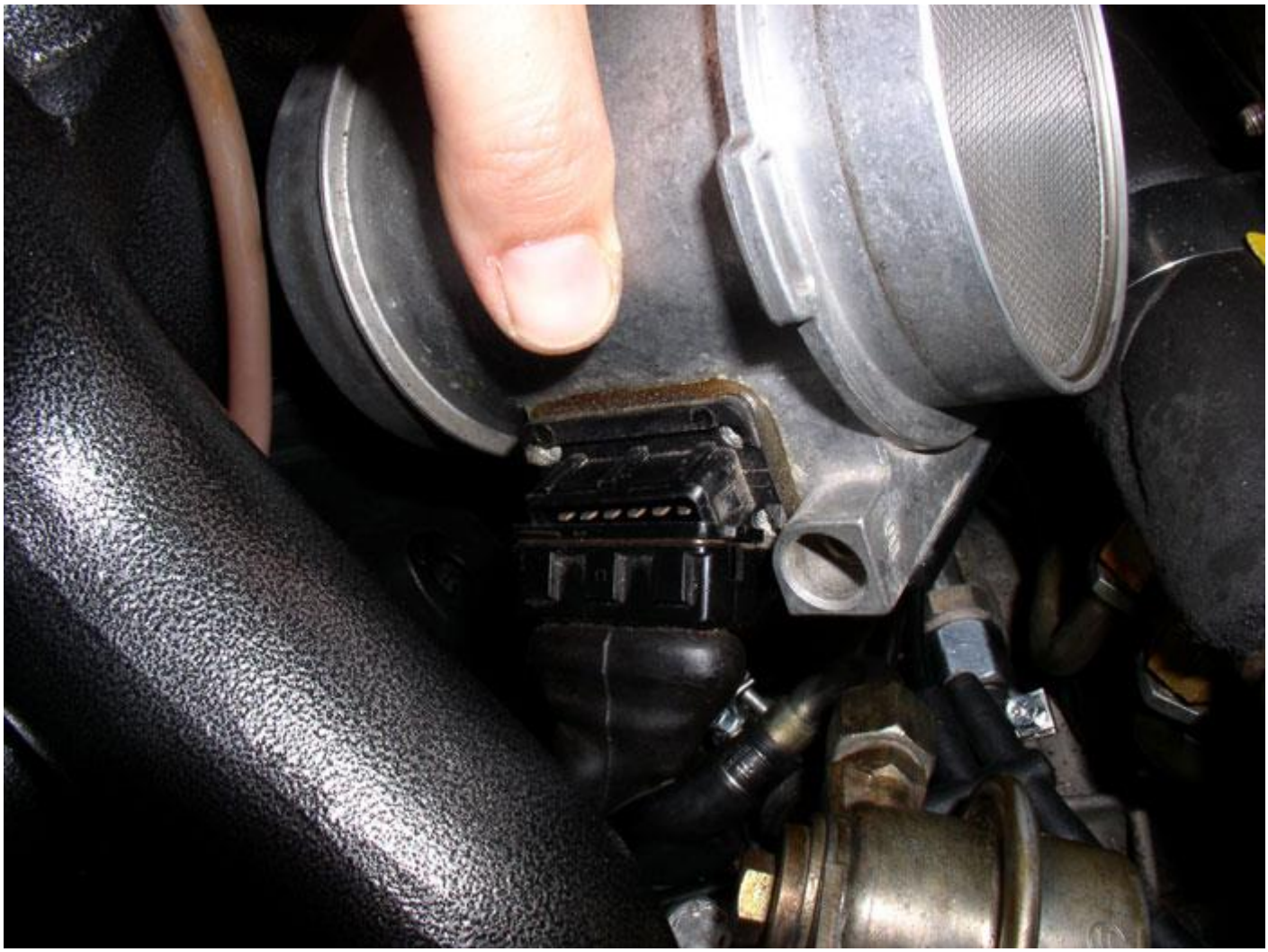
Thread the accelerator cable through the square hole in the cable linkage bracket and push the plastic connector in until it "clicks" into place. Pull on the end of the accelerator cable to make sure it is operating smoothly and the cable has not come off the cable wheel near the throttle body. If it works smoothly, attach the ball connector at the end of the cable to the ball at the lever arm and press into place until it "snaps" on.



Work the cable linkage with your hand to see if the TPS idle contact switch is working correctly. When you open the throttle plate (rotating cable linkage clockwise as if accelerating) and release slowly, you should hear the click of the idle contact of the TPS. It should click when you slightly move the cable linkage off idle position and it should click again when you release the linkage slowly. If the cable linkage will not return to idle position on its own, you may need to adjust the accelerator cable tension. I had to make a minor adjustment to mine to get it operate perfectly. Accelerator cable tension can be adjusted by the threaded cable connection at the firewall as shown. Increasing the number of threads visible (turning counter-clockwise) increases the tension accordingly. Reducing the number of threads visible (turning clockwise) creates more slack.



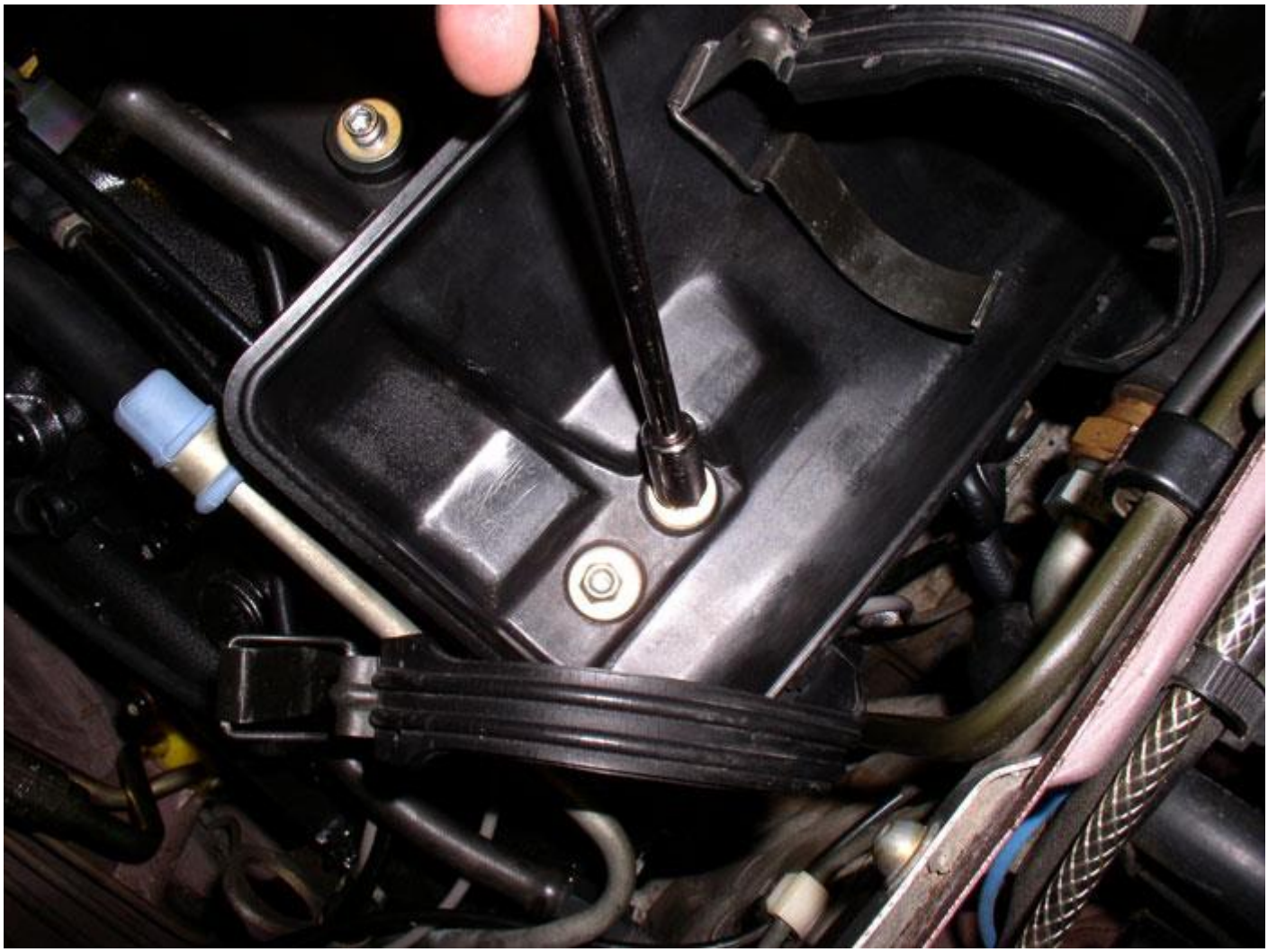
Next, install the Mass Air Flow (MAF) sensor. After you've removed it from the vacuum testing device, position it near the cowl and connect the harness plug. Then, fit the MAF into the Air Guide Cowl making sure it is fully seated. Tighten the clamp on the cowl.



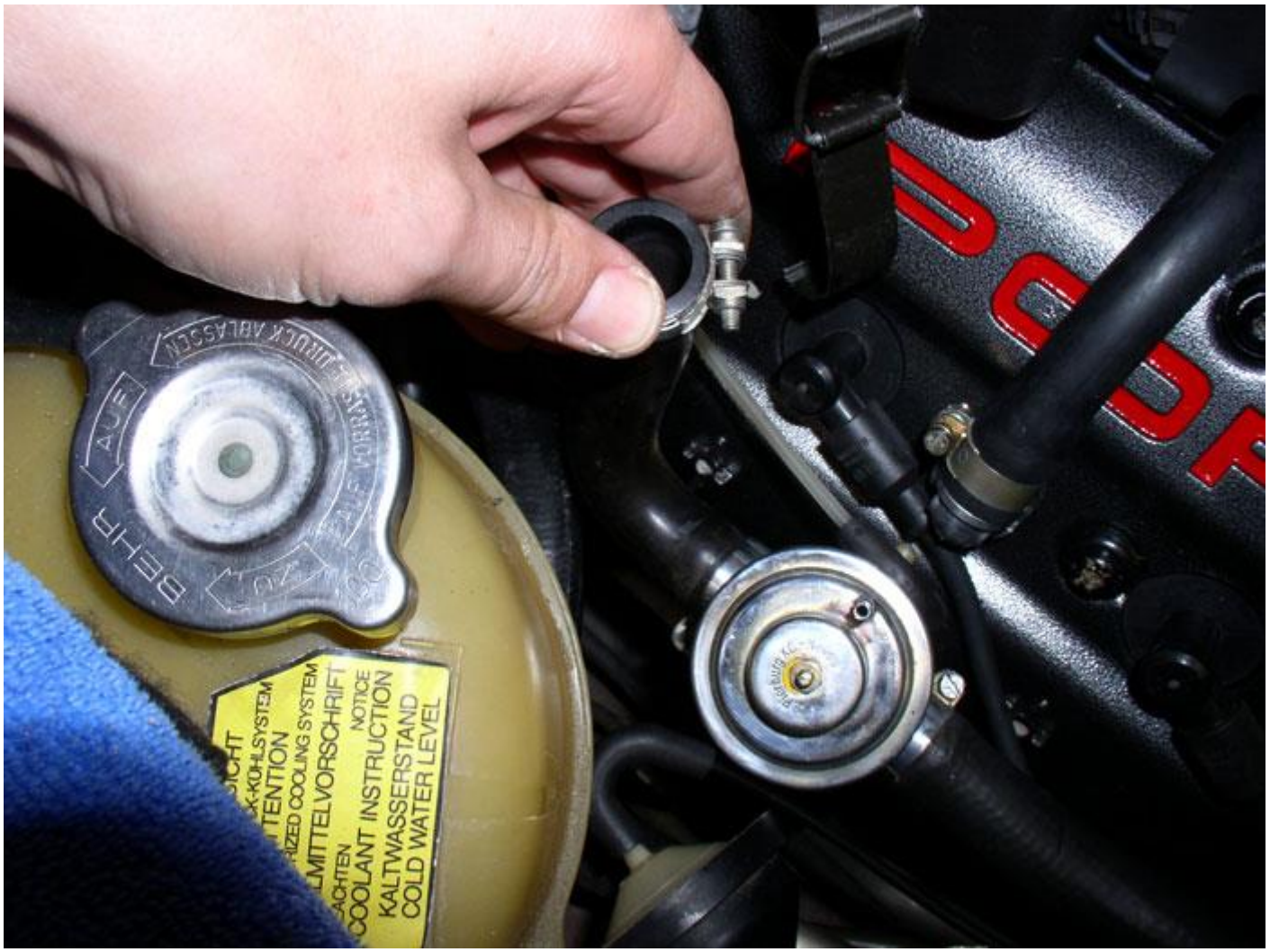
Install the lower half of the air filter box. Position it into place over the MAF and press the MAF sealing ring onto the MAF. At the same time, ensure the mounting studs (two on each end of the box) are lined up with their respective holes in the box.



Tighten down the air box using the 10mm nuts and washers as shown.



Next, install the air diverter valve hose that connects to the top half of the air filter box. You can install the hose, leave the clamp loose and dry fit the top of the filter box in place to line up the hose with its port on the air box lid. Then remove the lid and tighten the hose clamp at the diverter valve.



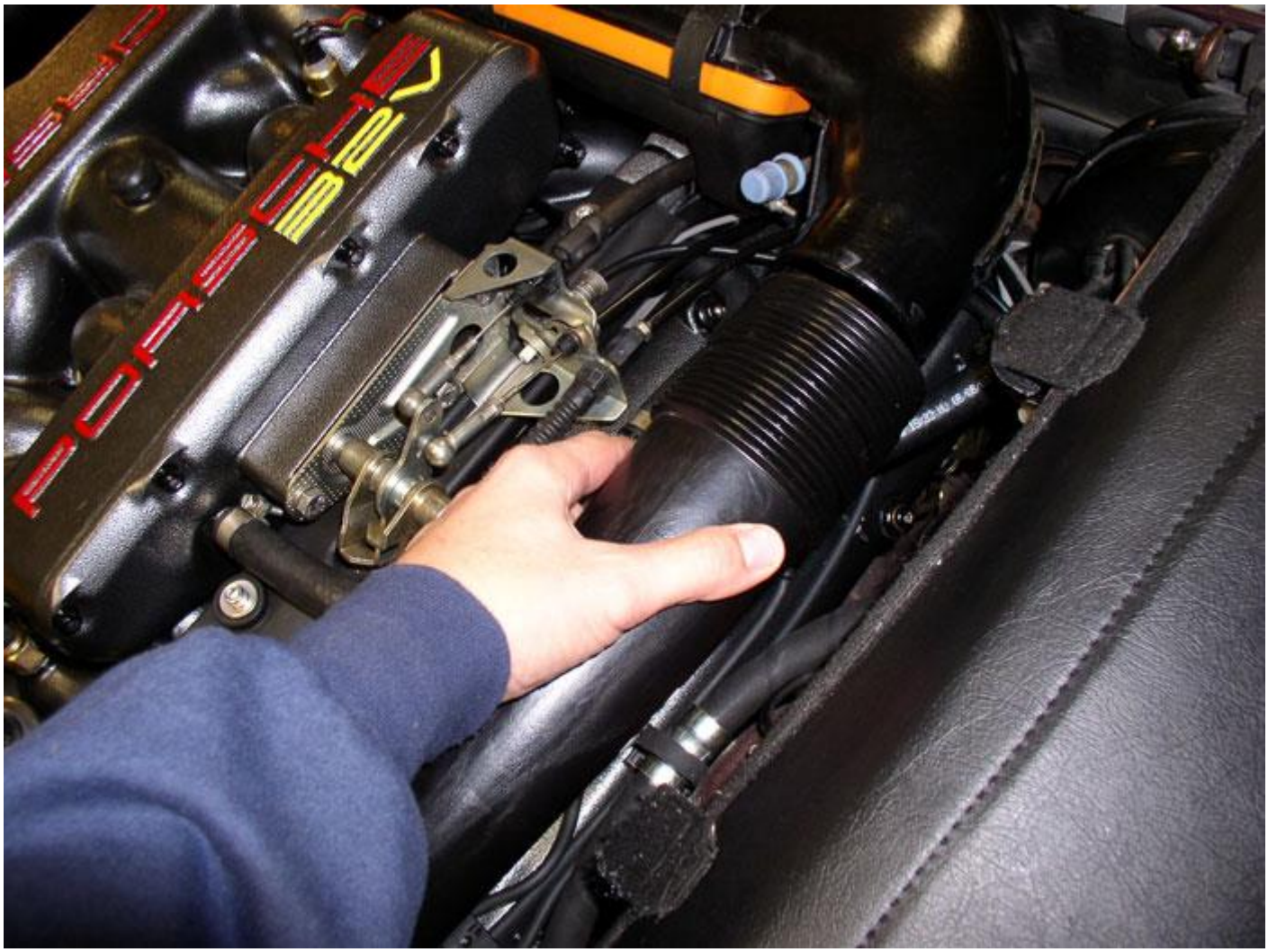

Install the air filter. You will notice arrows imprinted on the end of the air filter. Make sure these arrows are pointed upwards. Then install the top of the air filter box, lining up the air diverter valve hose with the port underneath the lid.



Secure the air box lid clamps and tighten the air diverter valve hose clamp underneath.



Install the air tubes next.




Then, re-install the belly pans in the order they were removed and lower the car. Install the cross brace next. Tighten the 8mm allen head bolts to 30 ftlbs. Then, after the suspension settles, I came back and loosened them

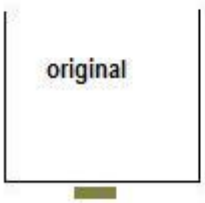
and watched the fenders move in slightly and re-tightened the bolts back down.

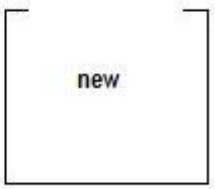


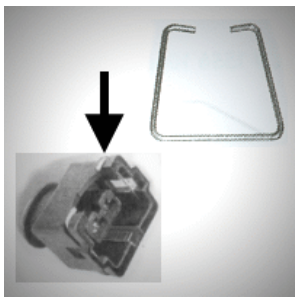
Dwayne:

Sorry to interrupt your workflow again. You noted that those wire clips on the injector electrical plug are a problem. As you have them now, they can easily fall off and allow the plug to come free and the injector to stop firing. If you don't install the updated style wires, then you should try to re-fix the clips to the injector plug. They were originally held inplace by a bit of plastic melted over the channel at the base of the clip (see illustration below). That plastic can chip off and lead to what you have. I've successfuly used a soldering iron to work some of the adjacent plastic over the wire in the channel, recreating the original. Wish I had taken some pictures! I thought about just putting a dab of epoxy over the wire there. I thought it probably wouldn't hold, but that might be another alternative. The wires are only supposed to be able to spring at the sides and otherwise should be anchored to the plug so they won't fall off.

I'm repeating myself, but you can get the newer styler wire clips that cannot fall off by buying new pigtails (all over eBay for a little over $2 each - er, they used to be. I see they are getting harder to find. They are obsolete.) and just moving the new style wire clip over to your current plugs. No need to replace the entire pigtail. You can save the rest of the pigtail until needed later.
Attached Images



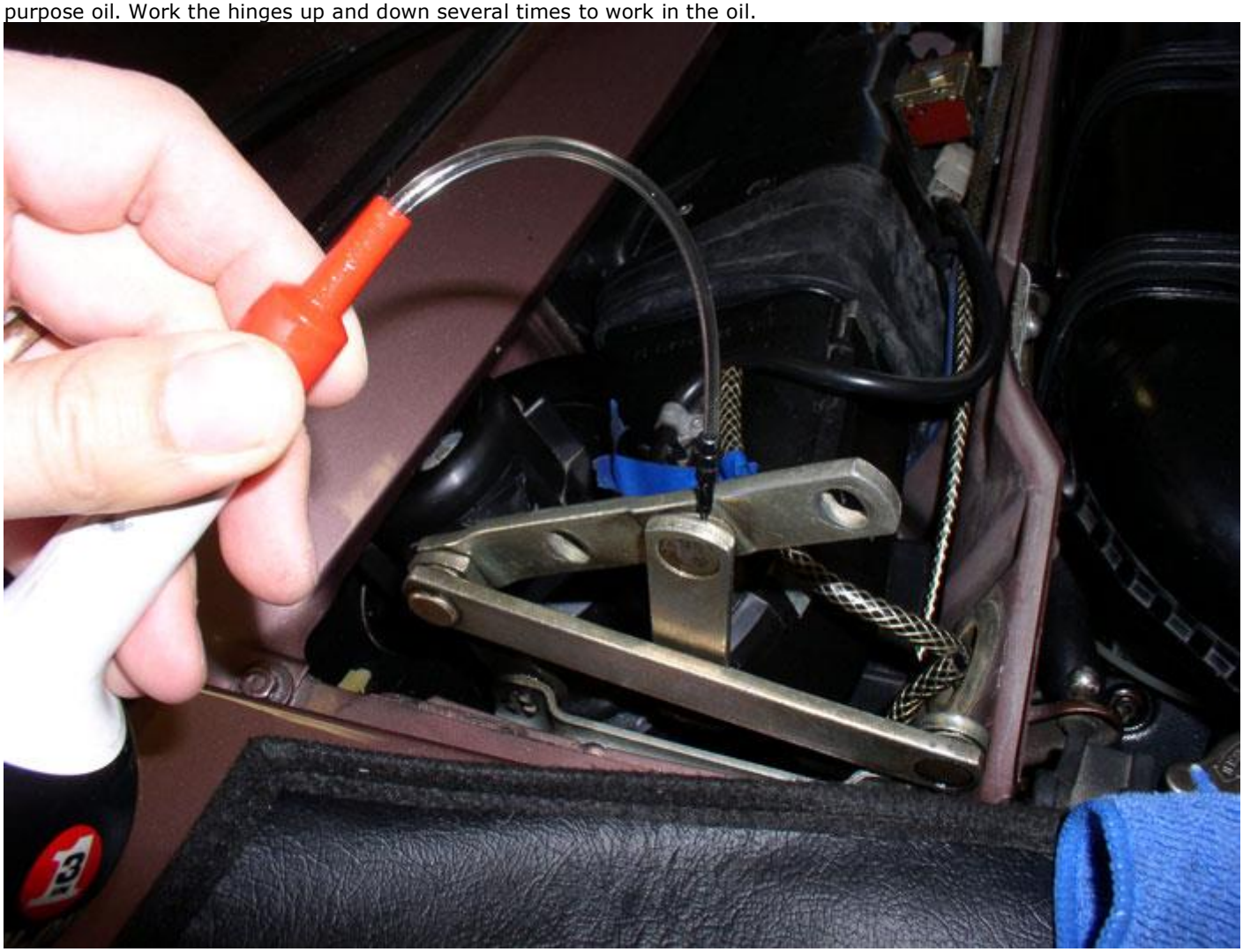



http://www.eagleday.com/amp2fejutiho.html

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Bill
**Wrap up! Hood Installation**

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If you removed the hood, now's the time to re-install it. First, lubricate the hinge joints. I used a light general purpose oil. Work the hinges up and down several times to work in the oil.



If you're working alone, like me, lay out your bolts and shims and wrenches so they are easily accessable near the hinges. I had two shims for each side.



Place a towel under the hood near the hinge and cowl to protect it from scratches. I also left the service covers on for fender protection. Bring the hood over and gently lay it into position as shown.



Next, lift up one side of the hood at the hinge and insert the shims. Line up the holes for the front bolt and install the 13mm bolt - I used the 13mm socket and 3" extension bar. Do the same for the other side of the hood.



I then lifted the hood with one hand and used the other to start the rear bolt using the extension again. The objective is to simply get the bolt well started in the hole. Do the same for the other side of the hood.



Next, support the hood with a wooden or rubber tipped rod. I used a clothes hangar dowel you find in your closet. Remove the service covers at this time so you can check for proper alignment.



Now you can fine tune the adjustment. First position the hinge so that it is approximately where it was when you removed it. I was carefull not to wash or wax the area at the hinge since the original 'dirt' left a marker where the hinge should go.



When it's lined up as close as you can get it to it original position, snug all four of the bolts down LIGHTLY - just enough to hold them in place as you make final adjustments.



Move to the front of the hood and check the alignment of the hood pin to the receiver latch. It should be perfectly centered in the hole. Mine was very close on first try but I had to fine tune it. Do not try to latch the hood (i.e., press it all the way down into the receiver) unless it looks perfectly centered - otherwise it can get wedged in there and be difficult to "unlatch". If it's not lined up perfectly, raise and support the hood enough to gain access to the bolts at the hinges and loosen enough to adjust the hood slightly. For example, when looking at the hood from the front of the car, my hood pin was a little to the left of the center of the receiver hole. I loosened the passenger side bolts at the hinge and moved the hood forward about 1/16 of an inch then snugged the bolts down again. Then go to the pin and receiver at the front and check alignment again. It took me two adjustments to get it centered. It's trial and error mixed with a little patience and you can get it perfect. When it's aligned in the center of the receiver, close the hood all the way and try opening it from the hood release lever in the car to check for normal operation. I have found this method also ensures the gaps between the hood and fender consistenly come out even as well. The final adjustment check to make is hood height. It should be flush with the fenders. If it's too high or low, you will need to make an adjustment at the hinge again. This time, when you loosen the bolts, simply raise or lower the hood a the hinge to get the right height - trick is to keep the bolts snug enough that you can move the hood at the hinge without allowing it to slip forward or back. After the height adjustment, check for normal operation again.



When the hood operation checks out, torque the 13mm hood bolts to 15 ftlbs.



Next, make the electrical connections. There should be a 2 pin connector and a 3 pin connector to the hood.
These are for the heated windshield washer nozzles and hood light. Make both of these connections as shown.



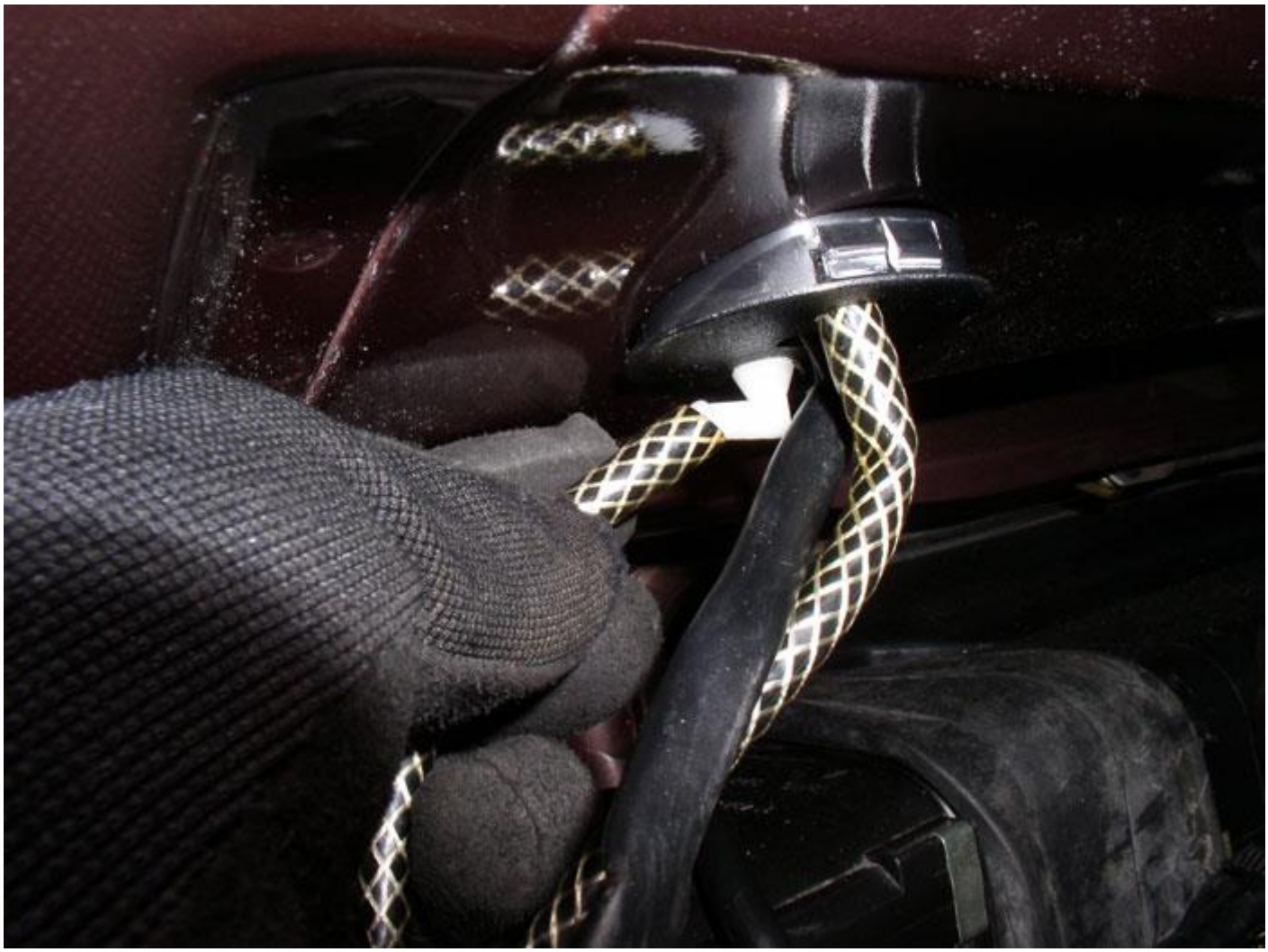
Next comes the windshield washer fluid hose connections. When I removed the hoses, you may remember that I marked (taped) one of the hoses with "external" because one of the hoses was connected external to the hood and the other hose was connected internally. First, connect the internal hose fitting. On mine, it was located up inside the hood. After locating it.....



....push it down through the hole in the plastic cover plate and connect the "internal" hose.



Then, connect the "external" hose to the other external fitting.

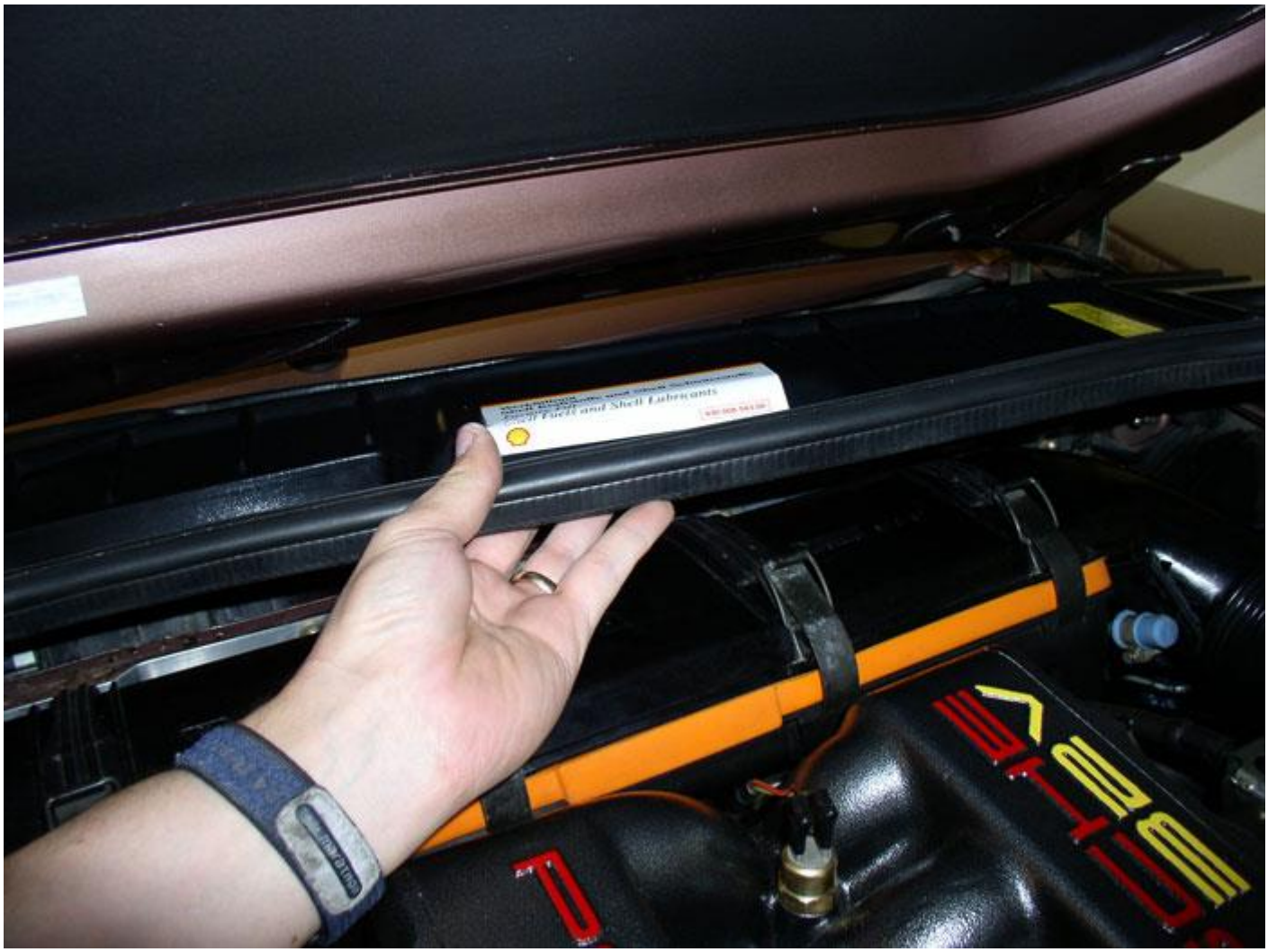


Fit the plastic cover over the hole in the hood and push it in until it snaps into place. Bundle the wire and hoses

together with a plastic bungee or zip tie.



Now you can install the wiper motor and fan blower motor cover. Place the cover into position, guiding the hood wires at each end into their recessed openings.



There are two tabs that hold the rear edge of the cover in place. They are located just under the cowl. Ensure the rear edge of the plastic cover fits on top of these tabs and slides under the cowl. See pic below where tab is at the end of my finger. I needed to pry one of my tabs open slightly as it looked like it was too tight to allow the cover to slip in.



Next, press the front of the cover down over the firewall top edge.




Attach the bottom of the hood shock to the ball connector as shown. These connections simply "snap" on without the use of a tool.




Attach the top of the hood shock to the ball connector on the hood as shown.



And FINALLY, you're DONE! It should look something like this.



For those of you following along at home, CONGRATULATIONS on your intake removal, repair and installation!

My wife and I are very happy with the end result, it cleaned up the engine and now it runs fantastic. This was also a TREMENDOUS learning experience for me (being my first S4 intake job). Many forum members have offered valuable and insightful advice and tips along this thread and it has been of great help to me and has improved the overall quality of the thread - I would like to say THANK YOU! I also extend the offer to all to continue to provide comments or additional tips that will contribute to the quality of this thread - I'm always looking for better ways of performing this work.

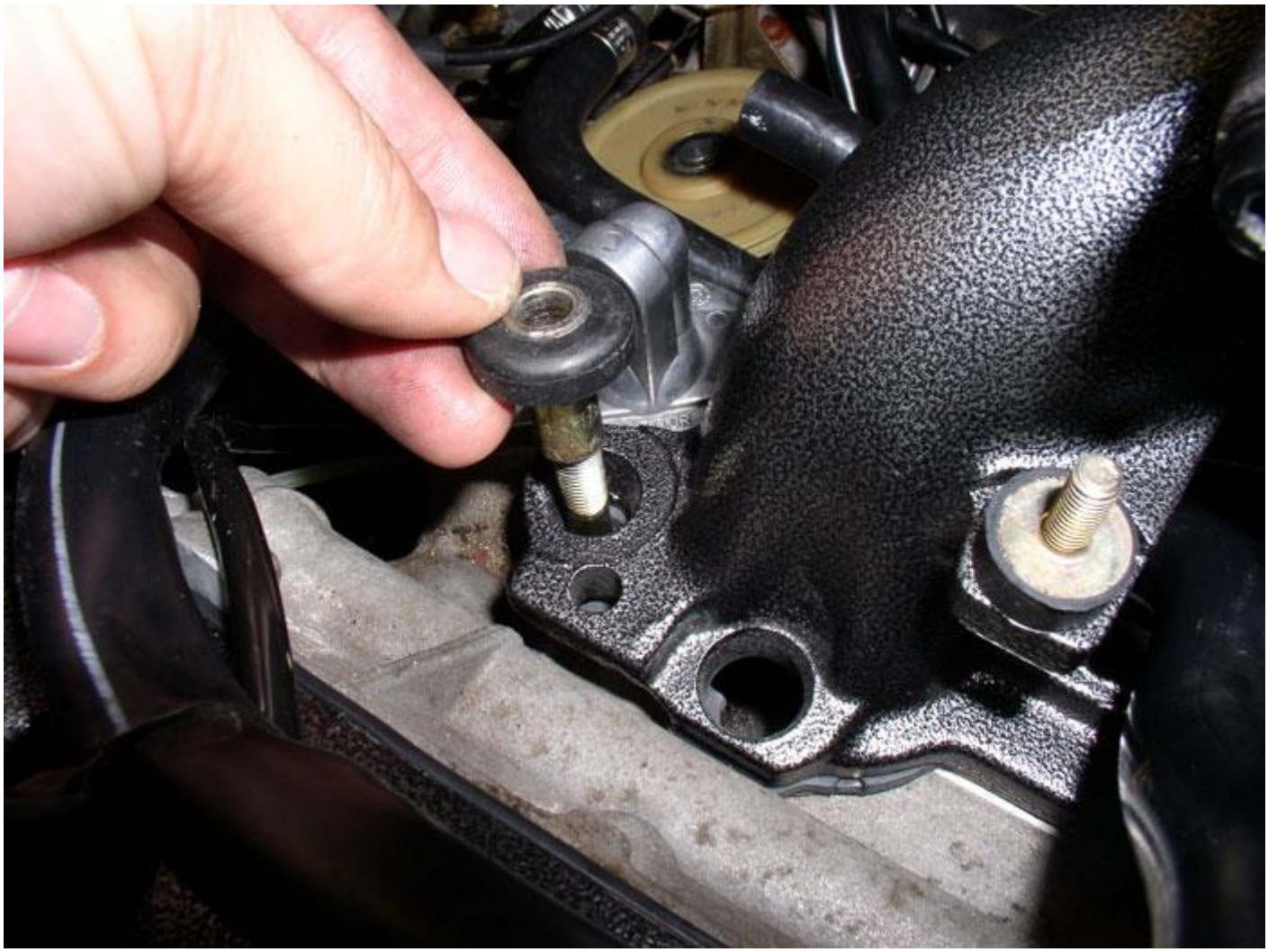
I trust this thread is helpful for other newbie first timers like myself - that was my goal - even it was a few more pictures than I had planned (more than 630 in total).

Next, I'm going through the thread and perform some clean up and try to address all the comments and input. Then, if Randy's offer is still open, I believe it will be copied to the DIY section for 928. THANKS again and ENJOY!

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Dwayne
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I've received some great comments on this post about the orientation of the intake thrust washer sleeve. You may recall (a few pictures back) that I installed the sleeve with the flange oriented up as seen in the pictures below.

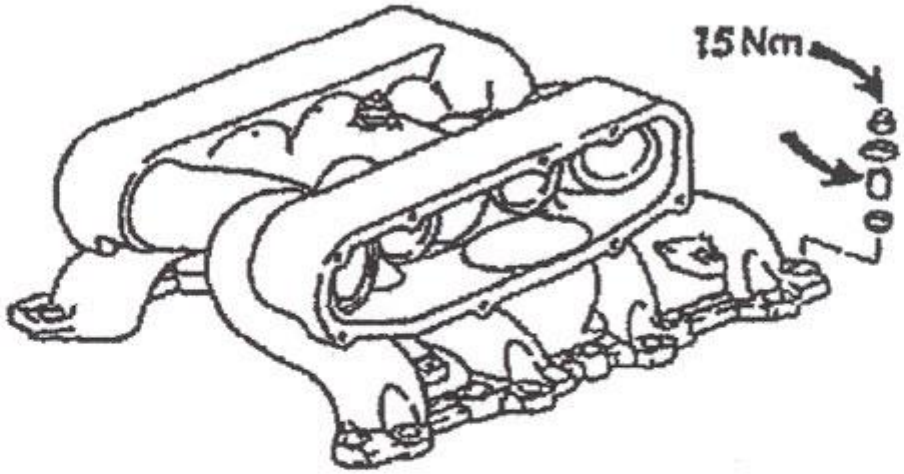




However, when I was removing the old thrust washers from the intake, I noticed they were installed with flange down and the sleeve had to be removed out the bottom of the intake as pictured below. I"m not sure why this orientation is found on the factory intallation. Perhaps this orientation aided installation of the intake at the factory. Or perhaps it aided centering of the intake over the studs.




I've been doing some research in order to determine what is the correct orientation of the intake thrust washer sleeve - flange up or flange down. I did not find any reference or help in the WSM. When I found the picture of the parts exploded view of the intake washer assembly (at the time I performed the re-install), it appeared to indicate the flange of the sleeve should be oriented up. The picture below is from the Tech bulletins 1984-1993 bulletin #8701 "Engine Performance Intake Manifold Leaks". It's the same diagram found in the PET as well.




2

1

**Picture 2**

## portant Notice

The order seems to be rubber thrust washer on the bottom (first) then the metal sleeve, then the large umbrella washer, then the nut (last). The only way I could find to install in this order is with the flange oriented up. However, based on some of the comments received, some virgin disassemblies of factory installed intakes have the flange oriented down. Unfortunately, I can't explain the difference between what may be the factory installation vs. the apparent recommended installation from the PET and Tech Bulletin. Therefore, I can only offer the following recommendation:

The length of the sleeve is the important factor here. It should function the same whether it is installed with flange down or flange up. If it is installed with flange down, it can be installed on the intake studs first (with flange down) before setting the intake down on the intake studs. Or, it can be installed on the intake from underneath (as shown in the third picture above) and secure the sleeve in place by installing the rubber thrust washer from the top to hold the sleve in place. Then install the intake over the studs and finish by installing the umbrella washer and lock nut.

If it is installed with flange up, as the pictures from the PET and tech bulletin would seem to suggest, the sleeve and thrust washer can be installed from on top as is documented in this thread. I believe this may be more of a matter of personal preference and the end result in performance should be the same.

I have edited the respective part of the post to include some of this discussion. Again, thanks for the great comments and the help in improving the quality of this post and procedure!

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Dwayne

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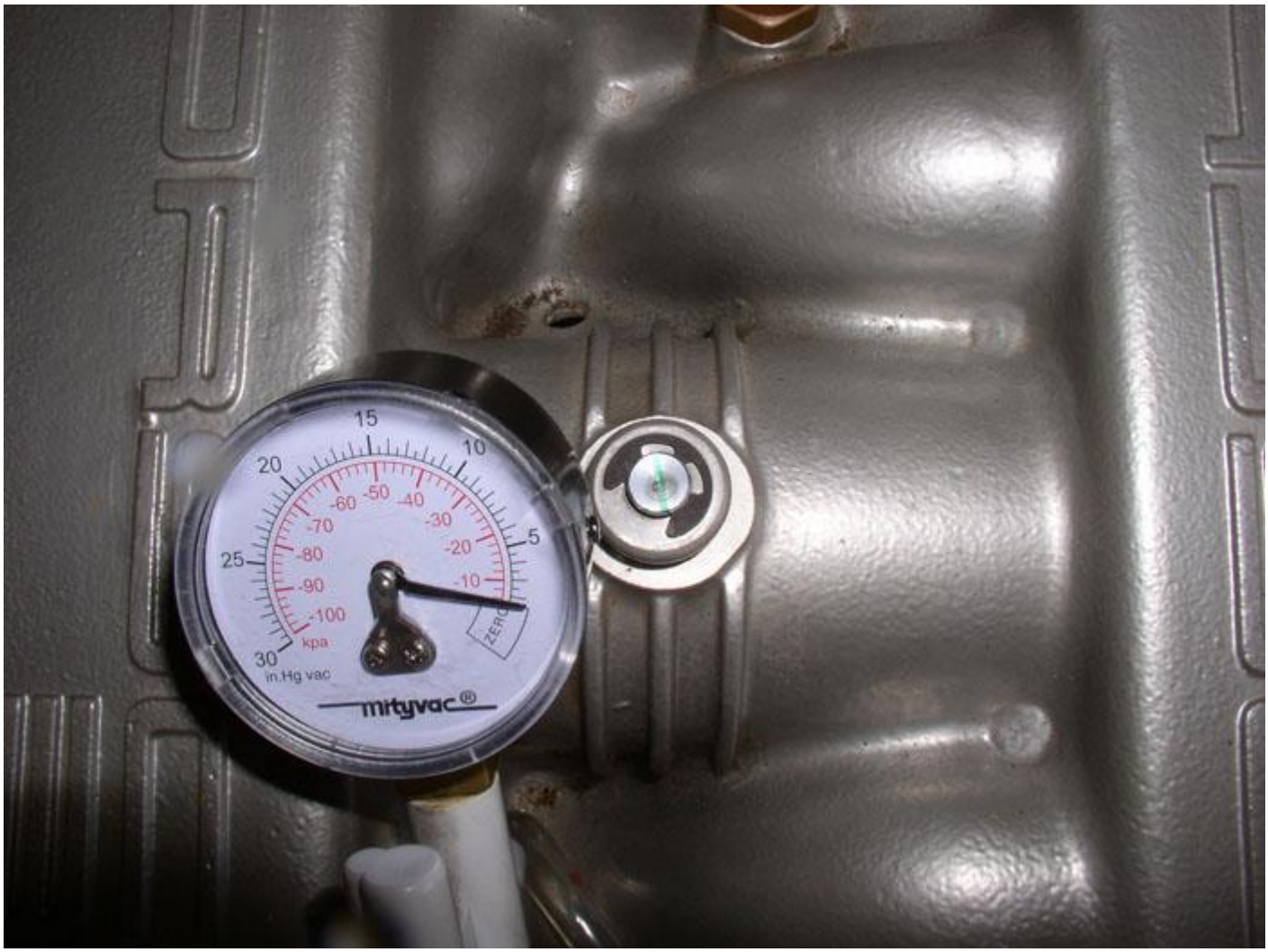
**A couple of updates**

Hello again,
Well, I took the intake off of Idaho ('88) recently and found a couple of interesting things worth noting for this thread. First, the spring tension on the flappy. In my original writeup on post #85, I wrapped the spring around the post a couple of times. This seems to be too tight and results in more vacuum in order to move the flappy plate - although I believed it was that tight when I took it off. I know Virginia ('87), the car that I documented this thread with, did have the intake taken off previously, so perhaps it was not installed with the correct tension by the PO.

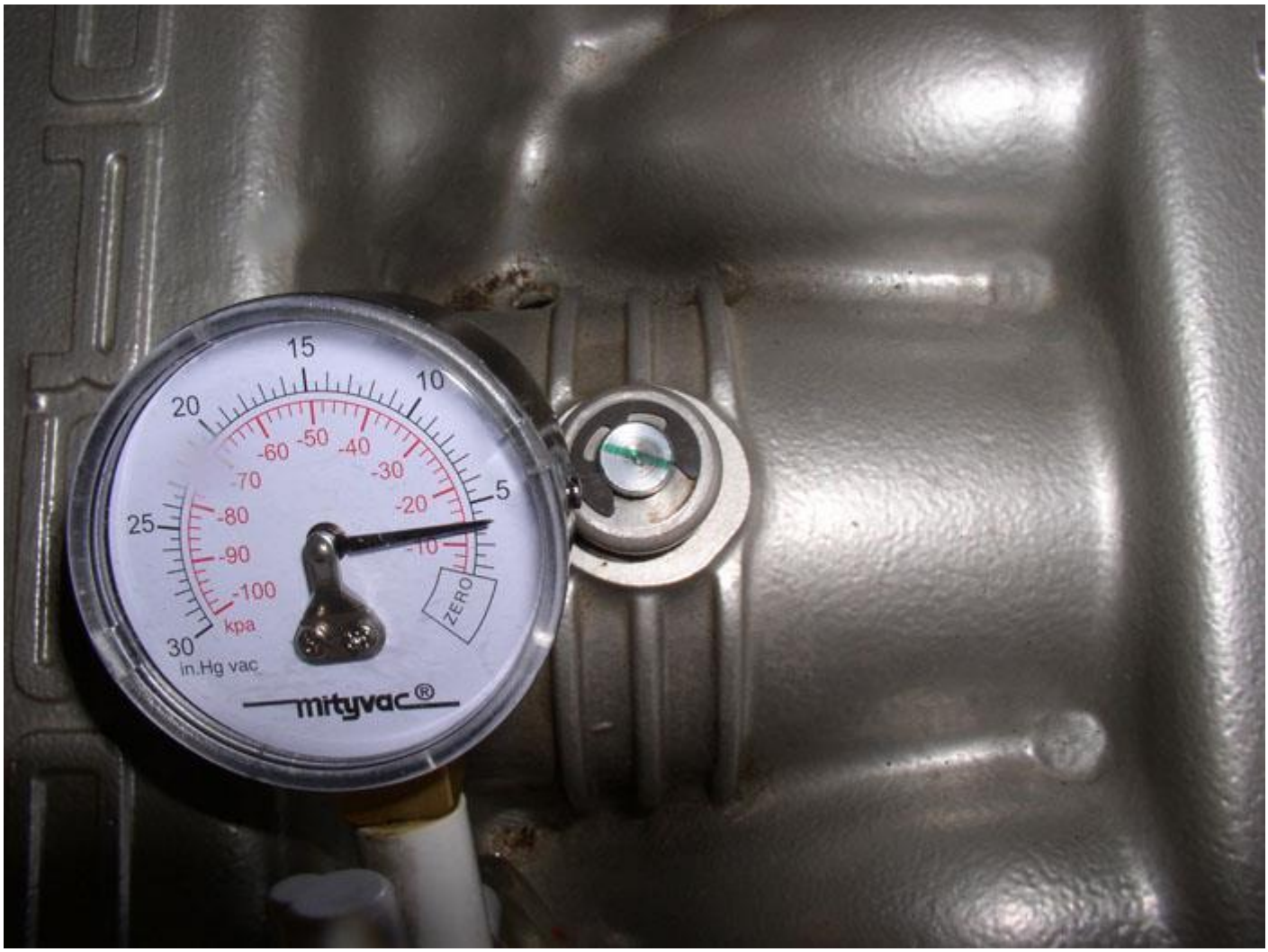
Anyway, I tested Idaho (a virgin intake) before disassembly to see what vacuum was required to move the flappy plate. This can easily be done by pulling the rubber cap off the top of the intake and marking the flappy spindle with a sharpie marker. In this case, I marked a vertical line so I could tell when the flappy was moving under vacuum. Next, disconnect the vacuum elbow to the flappy at the vacuum solenoid at the front of the engine and attach a vacuum pump to the elbow. Here's the flappy at rest with no vacuum.




I slowly applied vacuum and noticed the flappy began movement at about 2 Inches Hg.




And the flappy was fully open when vacuum was at about 4 Inches Hg. This was significantly less vacuum than what was applied to my original post with Virginia.



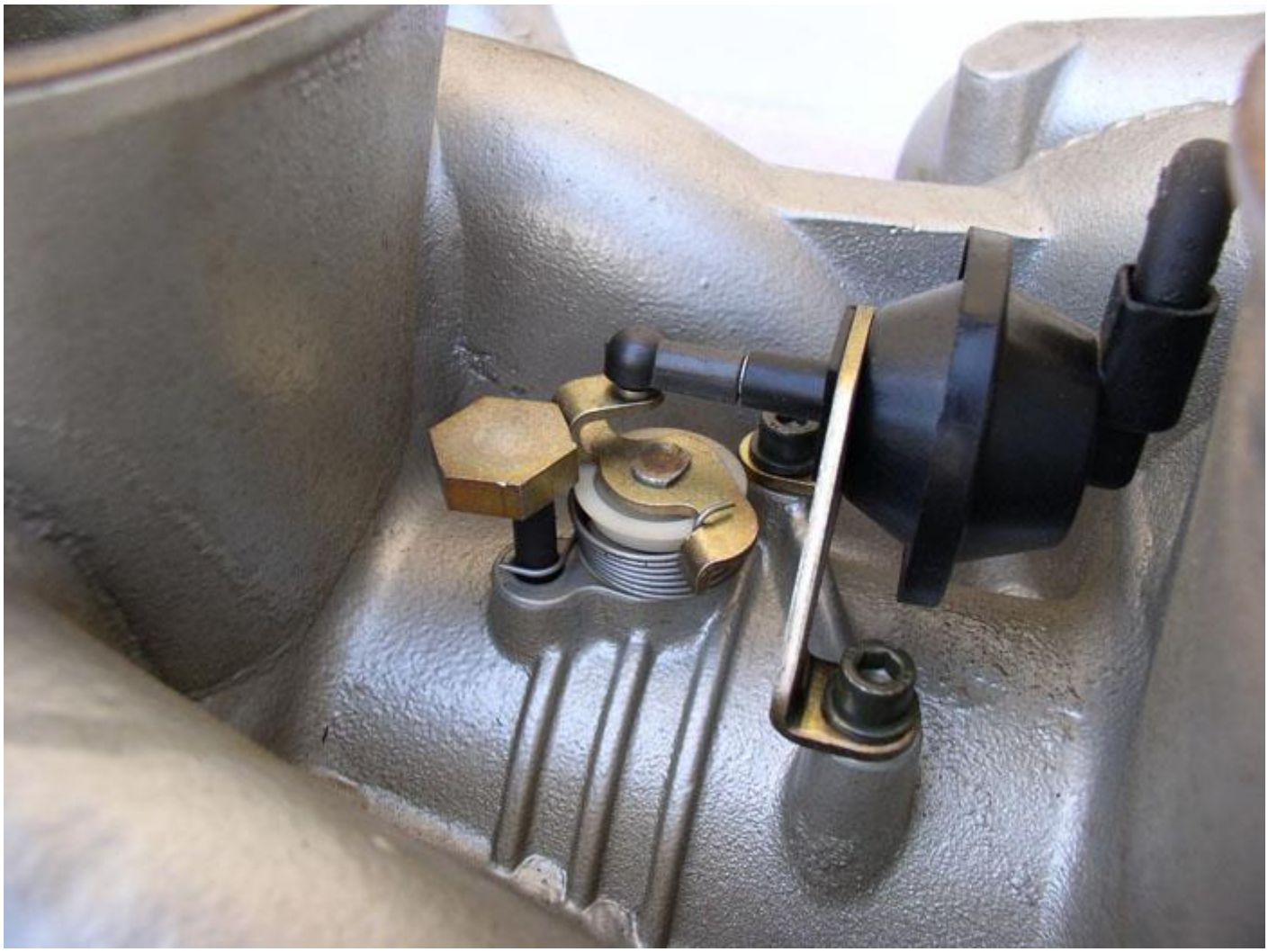

When I disassembled Idaho's intake, I discovered the spring tension was less than one wrap! Therefore, I reassembled the intake under the same conditions and verified Idaho's flappy still operated as before the refresh. Next time I have Virginia's intake off, I'll be taking the tension out of the flappy spring to set it so that it begins moving at 2 Inches Hg and fully open at 4 Inches Hg. I've updated post number 85 with this information as well.

Sorry if this has caused any confusion but I believe the lighter tension is more appropriate. THANKS!

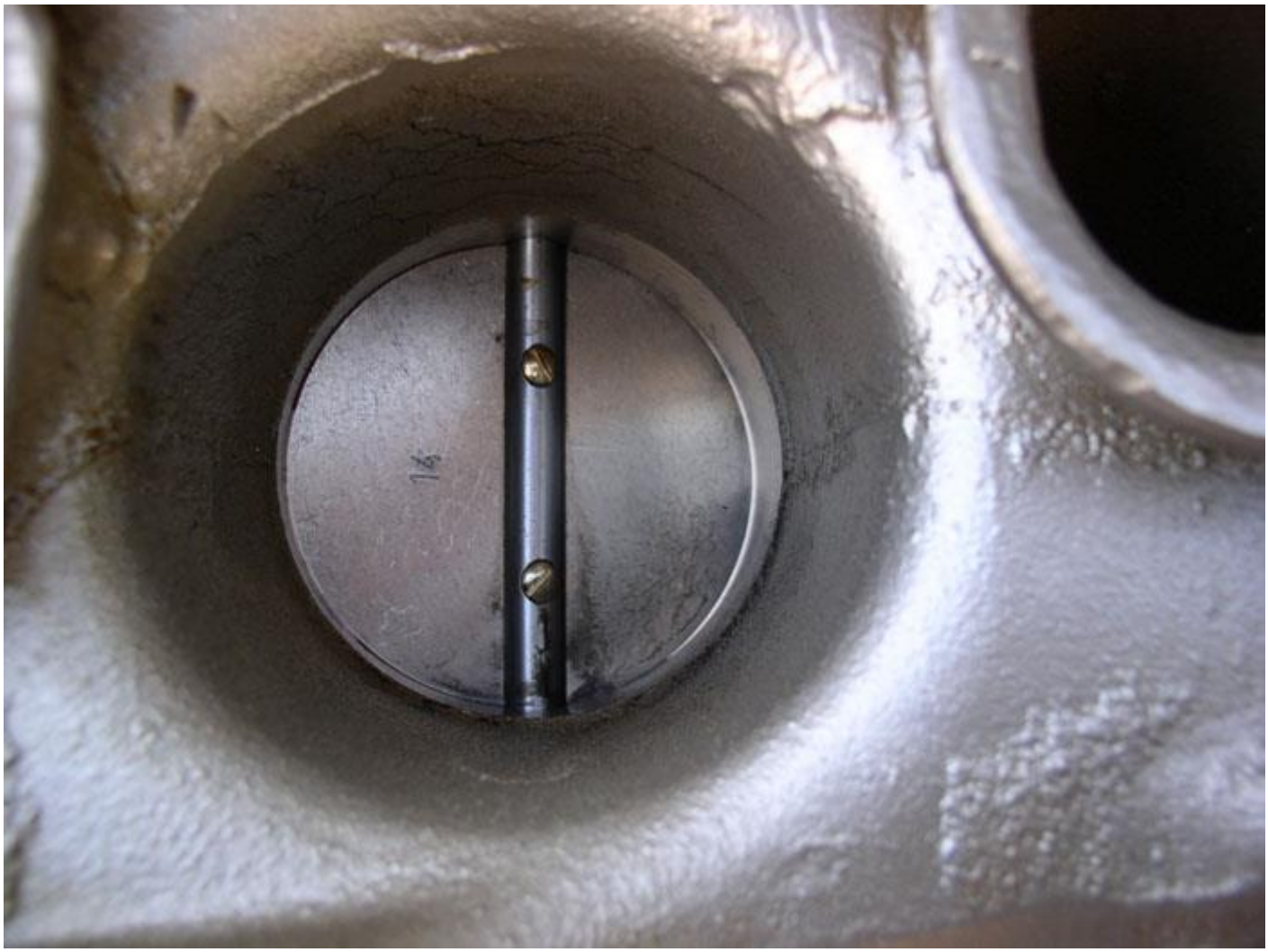
**Flappy Stopper Nut**

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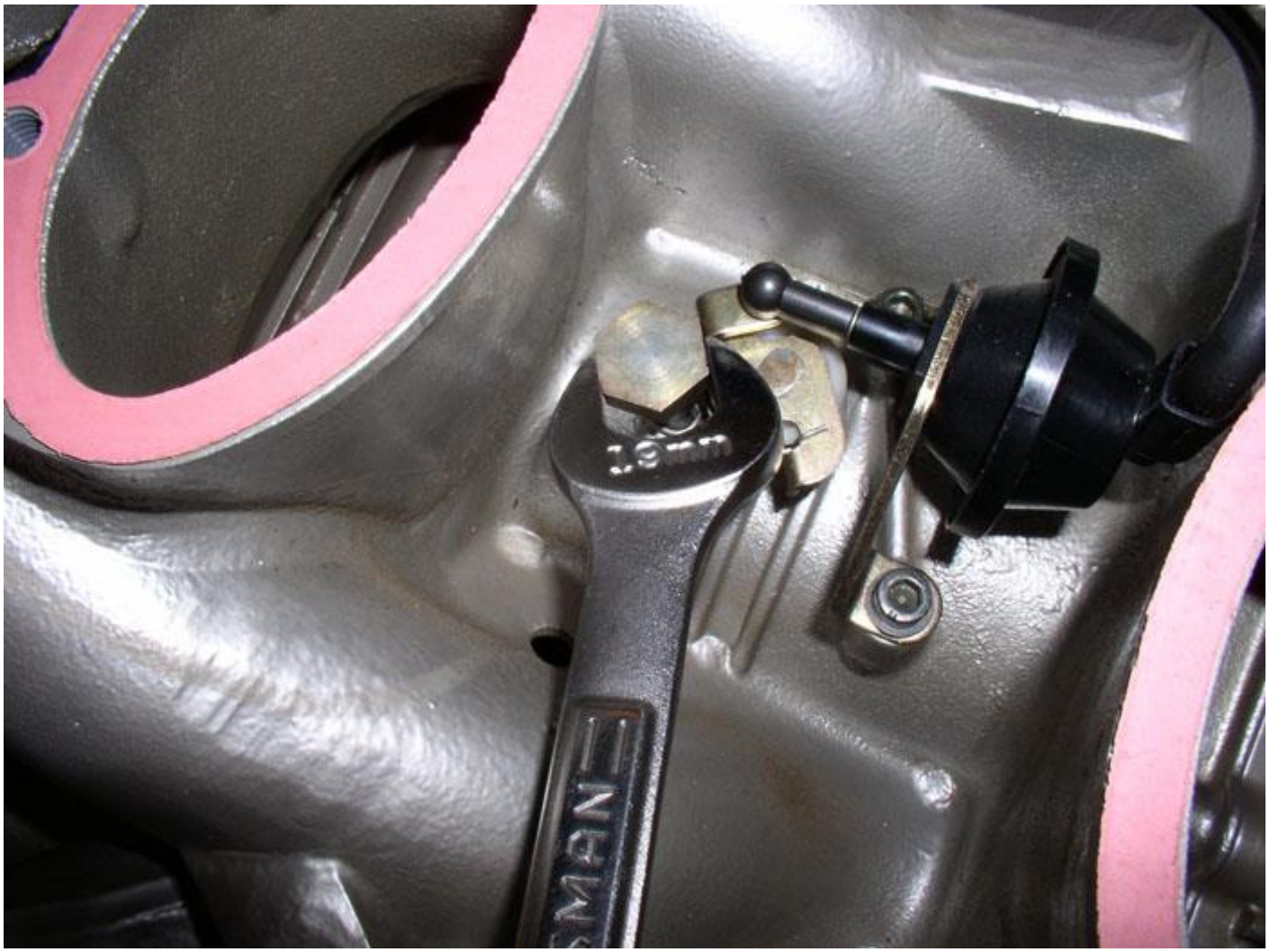
While I was working on Virginia's intake in the original post, I did not notice I was missing the flappy stopper nut located underneath the intake (see post #85). Apparently, mine had fallen off or come off when the PO had removed the intake. After a couple of comments on this thread that the nut was missing, I confirmed what the nut looks like, how it is installed and its proper setting when I disassembled Idaho's intake recently. Here's a pic of the nut properly installed from Idaho's intake job:



The nut is positioned so that it just prevents the flappy plate from completely closing against the walls of the intake. Here's a shot at the flappy at rest and you can see a small gap between the edge of the plate and the walls of the intake (perhaps a 16th of an inch).



The nut seemed firmly attached when I examined it on Idaho. However, if your nut is missing , you can replace it with a 19mm bolt head (cut away from the threads of the bolt) with a drilled hole (off center) that allows you to fit the replacement nut on the spindle - then twist the nut to adjust the flappy plate stop position.



When I take Virginia's intake off again in the future, I'll be installing the flappy stopper nut according to spec but wanted to get this udpate to those that may have been using this post and found this discrepancy. I've also updated the text on post #85 where this missing nut is obvious. Sorry again for the confusion. THANKS!

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Dwayne
84 928 S, 'California', AT, Black/Tan, 168K miles, retired DD
85 928 S, 'Iris', AT, IrisBlue/Tan, 15K miles, Wife's Baby Shark
86.5 928 S, 'Colorado', 5-Speed, Black/Tan, 137K miles, Belt Failure
87 928 S4, 'Oregon', AT, Black/Linen, 65K miles, No Sunroof!, My DD
87 928 S4, 'Virginia', AT, Cassisrot/Burgundy, 65K miles, No Sunroof!, Wife's DD
88 928 S4, 'Idaho', AT, White/Burgundy, 30K miles, Wife's Pampered Shark
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Thats the stopper nut I was telling you about, i would suggest that you refit the nut with some loctite so it wont fall off later.
It would be better to fit the nut in the correct position instead of trying to spin it on the roll pin, twisting this could cause the roll pin to shatter.
Fit the nut then tap into place

MrMerlin

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