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CUSTOM PERFORMANCE CALIBRATIONS

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2006-2009 Saab 93 2.8T Fuel System / Fuel Pump Guide

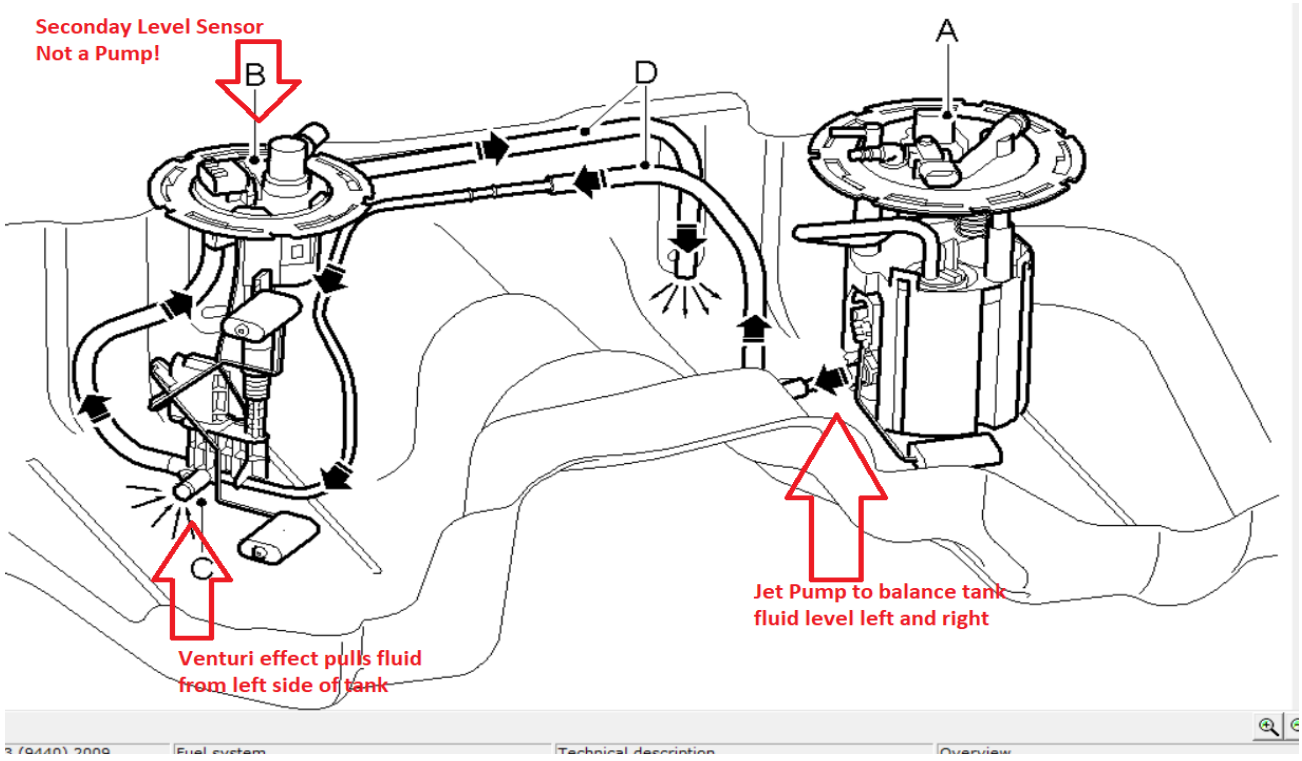
The Saab Aero FWD and XWD 2.8T has a non-return style fuel system with variable pressure utilizing a 255 liter per hour (lph) variable speed turbine fuel pump.

The factory injectors are located in the intake manifold and point / inject towards the center of the intake valves (two jets towards each valve). The injectors have a very specific split beam cone pattern with a bent angle orientation that targets both intake valves in each cylinder. Installing a non-factory injector without the exact properties will cause the fuel spray to accumulate mostly on the side walls of the intake manifold (causing undesirable wall wetting effects) rather than the back side of the intake valves.

Injectors are typically rated at a static injector (fully open for available window of time) at a specific operating fuel pressure. Because this engine runs an advanced programmable fuel pressure system, the actual injector flow depends on what fuel pressure we target, and the amount of pressure in the manifold. An injector flow ultimately depends on this, which is the pressure drop across the injector tip (Fuel pressure – manifold pressure). So at idle, if the manifold pressure is zero, the pressure drop across the tip is the rail pressure, however at wide open throttle and 7 psi of boost the programmed target pressure is 70 psi and the manifold pressure is 7 psi, so the pressure drop across the injector tip is 63 psi. Injector flow is approximately linear with pressure at larger injector pulse widths, so the flow at 63 psi is much higher than what an injector CC “rating” is at 38 psi. The factory original injector has a actual flow of ~300 CC at 40 psi, but that flow increases to ~380CC at 70 psi.

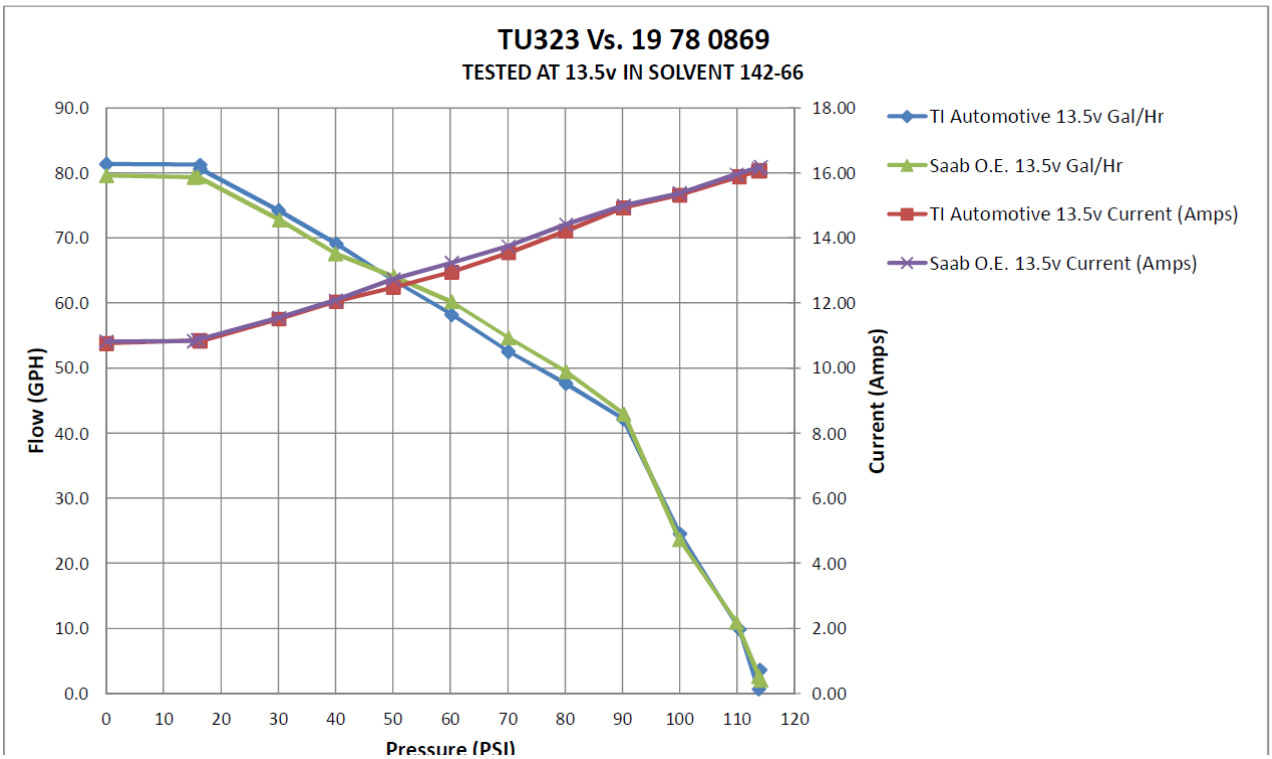
The desired fuel pressure is mapped out in the engine calibration based on the engine speed and absolute load (boost). The ECM calculates the requested fuel pressure and sends a signal to a power amplifier mounted under the passenger seat. The amplifier sends a PWM signal to the fuel pump to control the pump speed and can increase or decrease the PWM between 10-95% duty in order to adjust the actual fuel pressure to match the requested fuel pressure. Typical operating pressure varies between ~ 38 psi at idle and low load and engine speed up to approximately 70 psi under hard acceleration at higher engine speeds.

Walbro / TI-Automotive manufacture fuel modules for the 2.8T Saab in the USA/CA markets. The XWD and FWD use slightly different systems. The FWD model uses the TU-305 fuel module and the XWD uses the TU-323 fuel module. The main difference is that the XWD gas tank has a hump in the middle, called a "saddle" tank to provide clearance for the rear drive shaft. The XWD saddle tank therefore adds a secondary jet pump to continuously pull a small flow of fuel from the left (driver) side of the tank to the right side where the fuel pump housing is located.



The actual fuel flow for a turbine style pump is dependent on the absolute pressure and system voltage. Turbine fuel pumps have different pumping efficiencies at

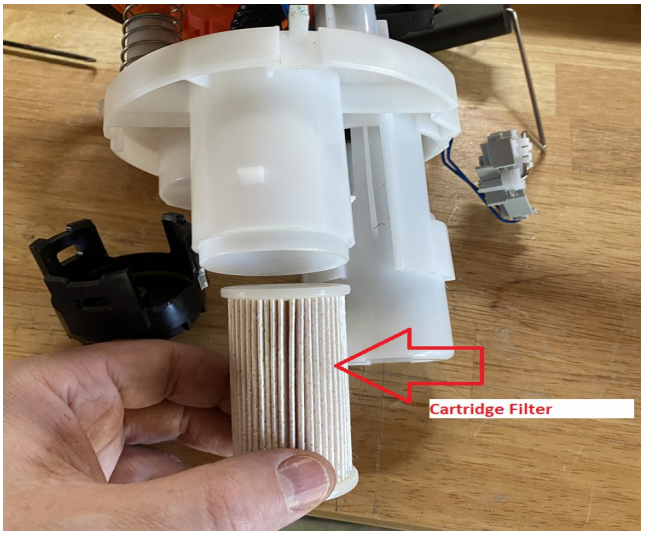
different pressures, and the overall flow is lower as we increase the operating pressure higher, as shown below:



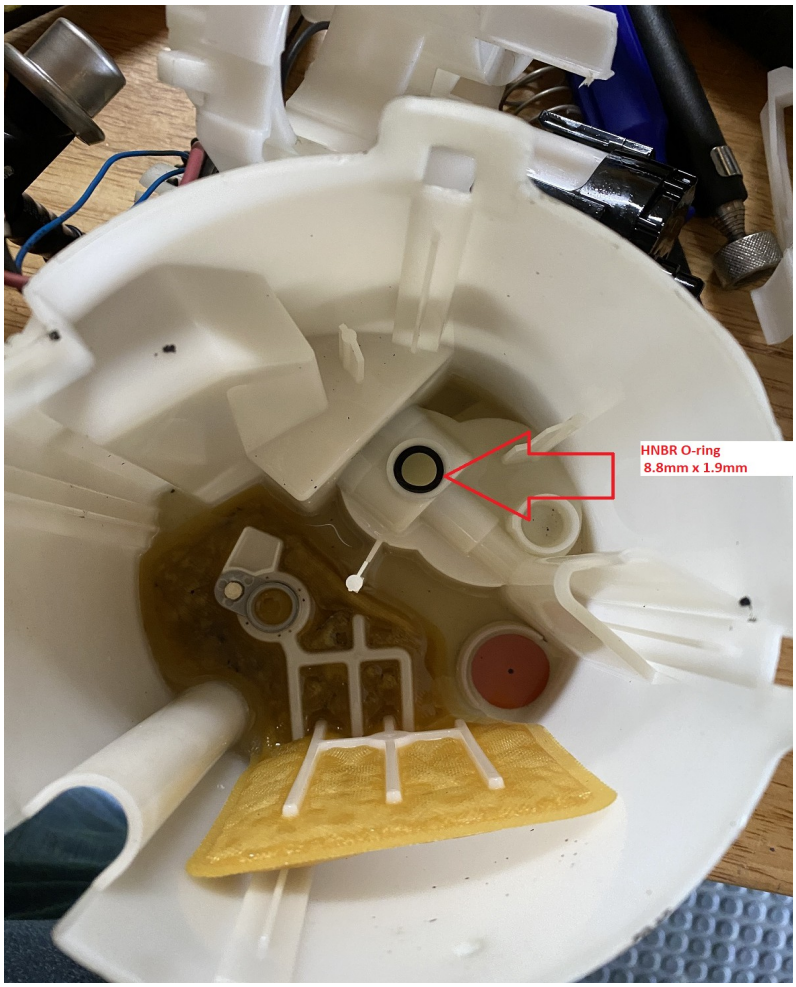
The fuel pump rating of ~ 255 lph (~68 gallons/hour) is only achieved at ~ 40 psi. As we increase pressure up to the sytem maximum of 70 psi the flow capability drops to ~ 55 gallons/hr or ~ 208 lph.

Because the fuel pressure is highest during peak fuel demand (when the car is at maximum acceleration and peak power output) it is not possible to accurately test this fuel pump in a service bay according to the instructions provided in the Saab workshop service manual which simply does a static pressure test with then engine off (no actual fuel flow demand). The only way to accurately assess the condition of the fuel pump is to monitor both the fuel rail pressure at the injectors while simultaneously monitoring the fuel pump PWM signal under wide open throttle acceleration up to maximum engine speed (redline). Once the commanded fuel pump PWM hits 95% the pump is operating at it's maximum speed – if the actual fuel pressure drops below 70 psi while the pump is at 95% duty then the pump is no longer capable of sustaining the target fuel pressure and should be replaced soon. The lower the actual pressure is under these conditions, the worse the condition of the pump. If the actual pressure drops below the target by more than a specific amount for a specified duration then the ECM will set a CEL with code the dreaded P0089. This is *almost* never due to the fuel pressure sensor being faulty and is usually a sign of a problem at the pump module.

The pump performance will deteriorate over time as the fuel pump ages – for a variety of reasons both physical / mechanical and electrical. The pump housing contains a cartridge style filter that is considered non-serviceable. As the filter does it's job it will gradually become more restricted due to filtered debris – the pump amplifier can adjust the PWM output to compensate for this as the pump ages. When a pump module is brand new the peak PWM may only be 65-70% at peak fuel demand.

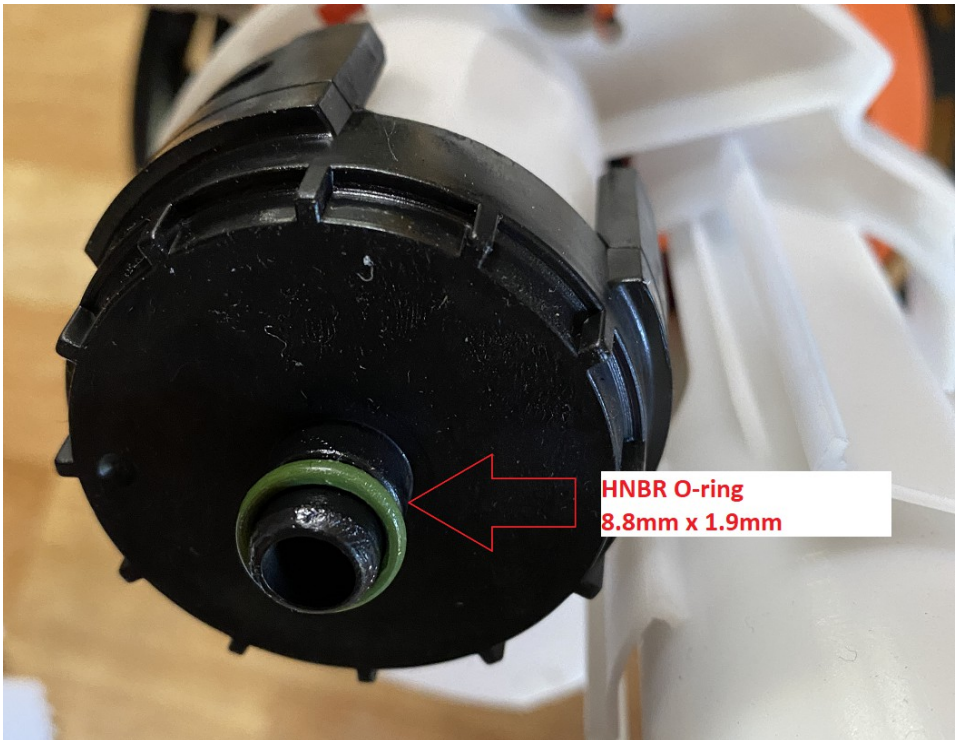


Another common source of low fuel pressure can occur when certain o-rings inside the pump module fail. By far the most common is the o-ring located at the base of fuel pick-up inside the fuel module assembly as shown here:



This o-ring may stay with the upper-housing when you separate the top and bottom sections as shown

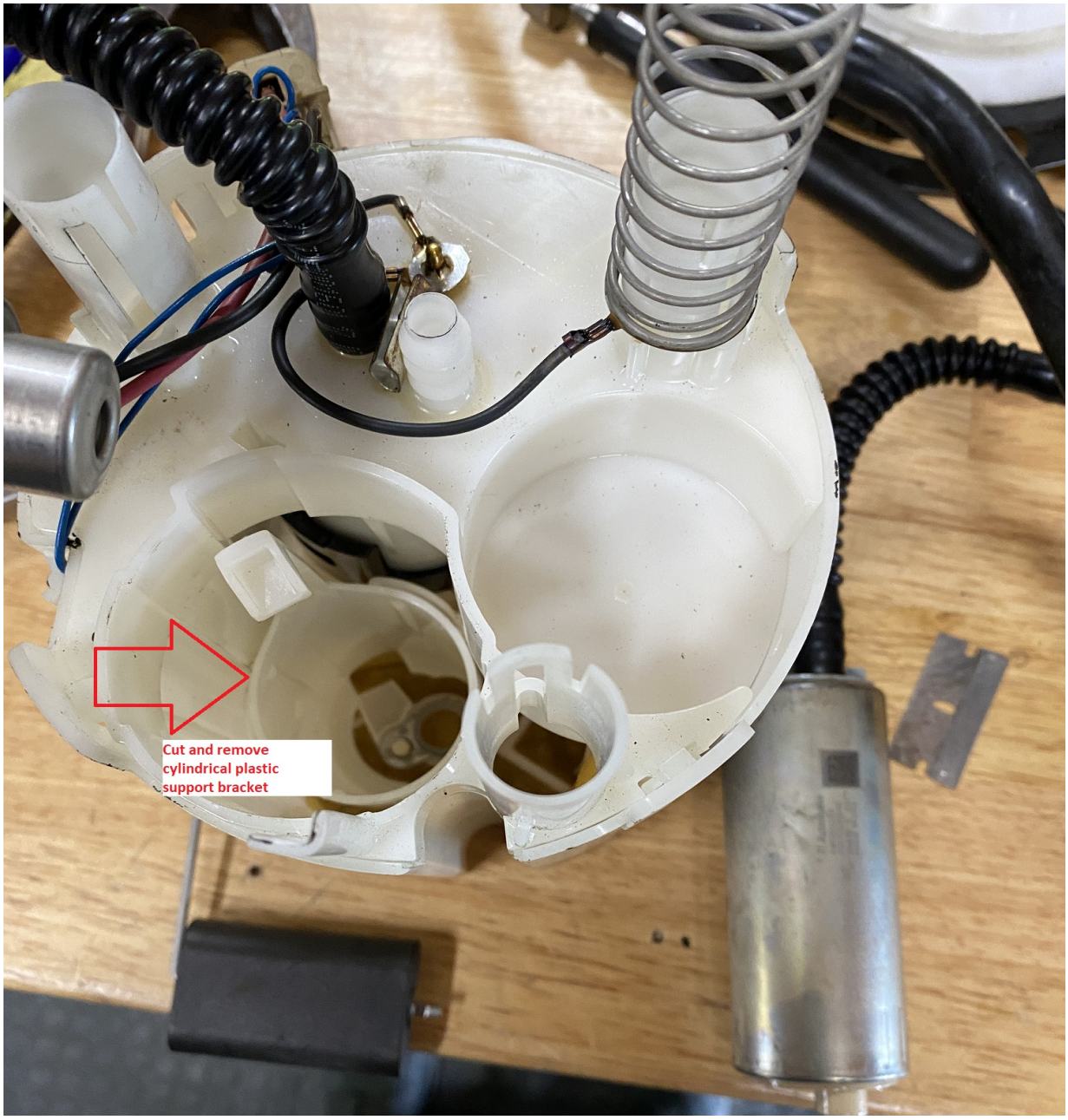
here:

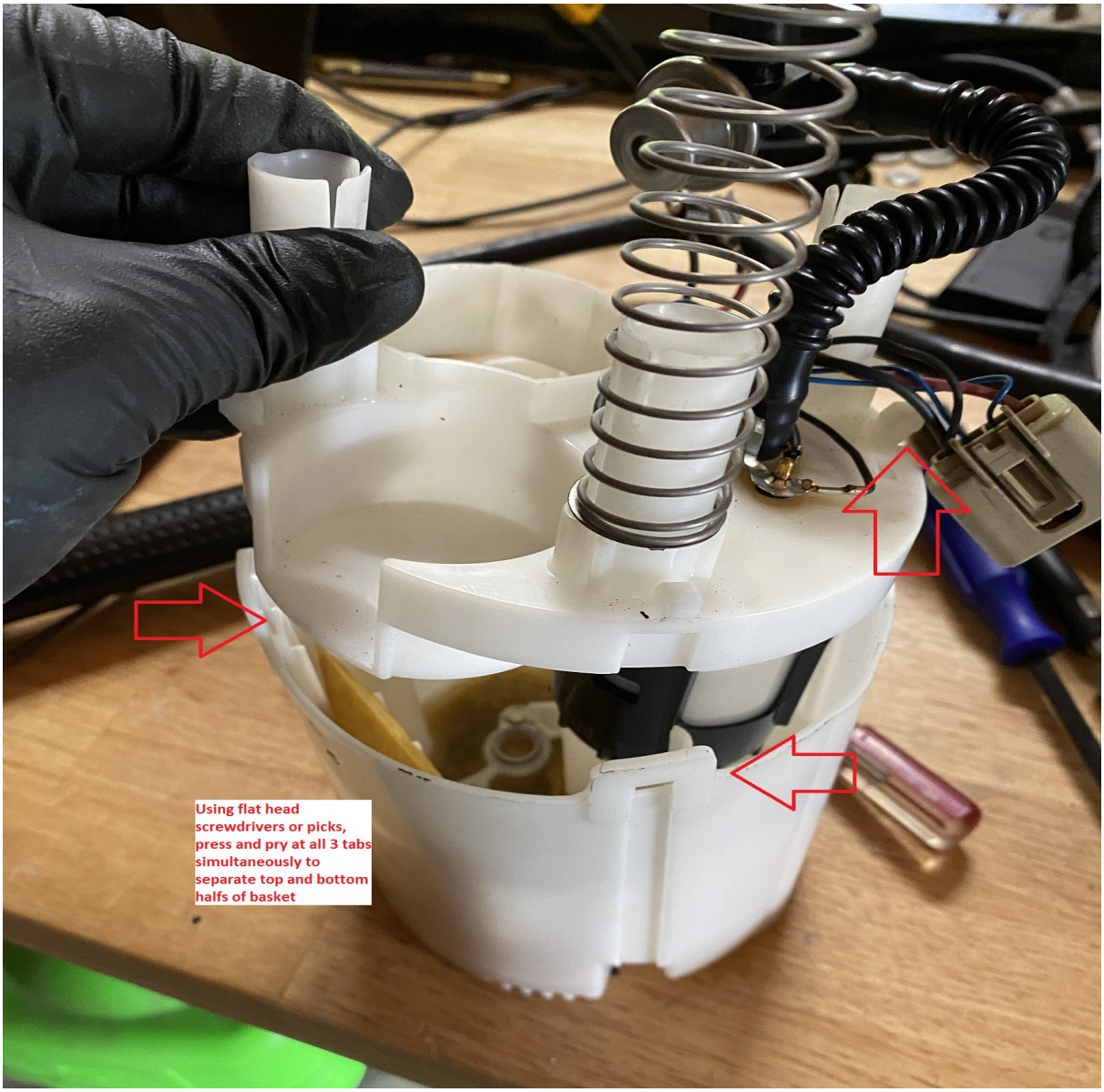


If this o-ring is missing or damaged the fuel pressure will be low, even if you install a new pump. This o-ring is absolutely critical!

Performance Upgrades

The factory 255lph pump in "new" condition is capable of supporting up to 450hp on gasoline (provided that you also install larger fuel injectors) or up to 360 hp on the original factory injectors. If you would like to install a performance pump capable of higher power on gasoline or E85 then I recommend installing a larger Walbro / TI-Automotive pump inside the factory pump assembly. The two pumps I typically use are the F90000274 450 LPH pump (good for up to ~650 hp on gasoline, ~460 hp on E85) or the F90000295 535 LPH pump (good for up to ~ 800 hp on gasoline or ~550 hp on E85). Installation of the pump is fairly straight forward, but you need to remove and disassemble the fuel pump basket and cut out some plastic supports in order to fit the larger pump inside the fuel basket:


Cut and remove
cylindrical plastic
support bracket


Using flat head screwdrivers or picks, press and pry at all 3 tabs simultaneously to separate top and bottom halfs of basket


WALBRO AUTOMOTIVE
FUEL PUMPS ARE NOW
TI AUTOMOTIVE
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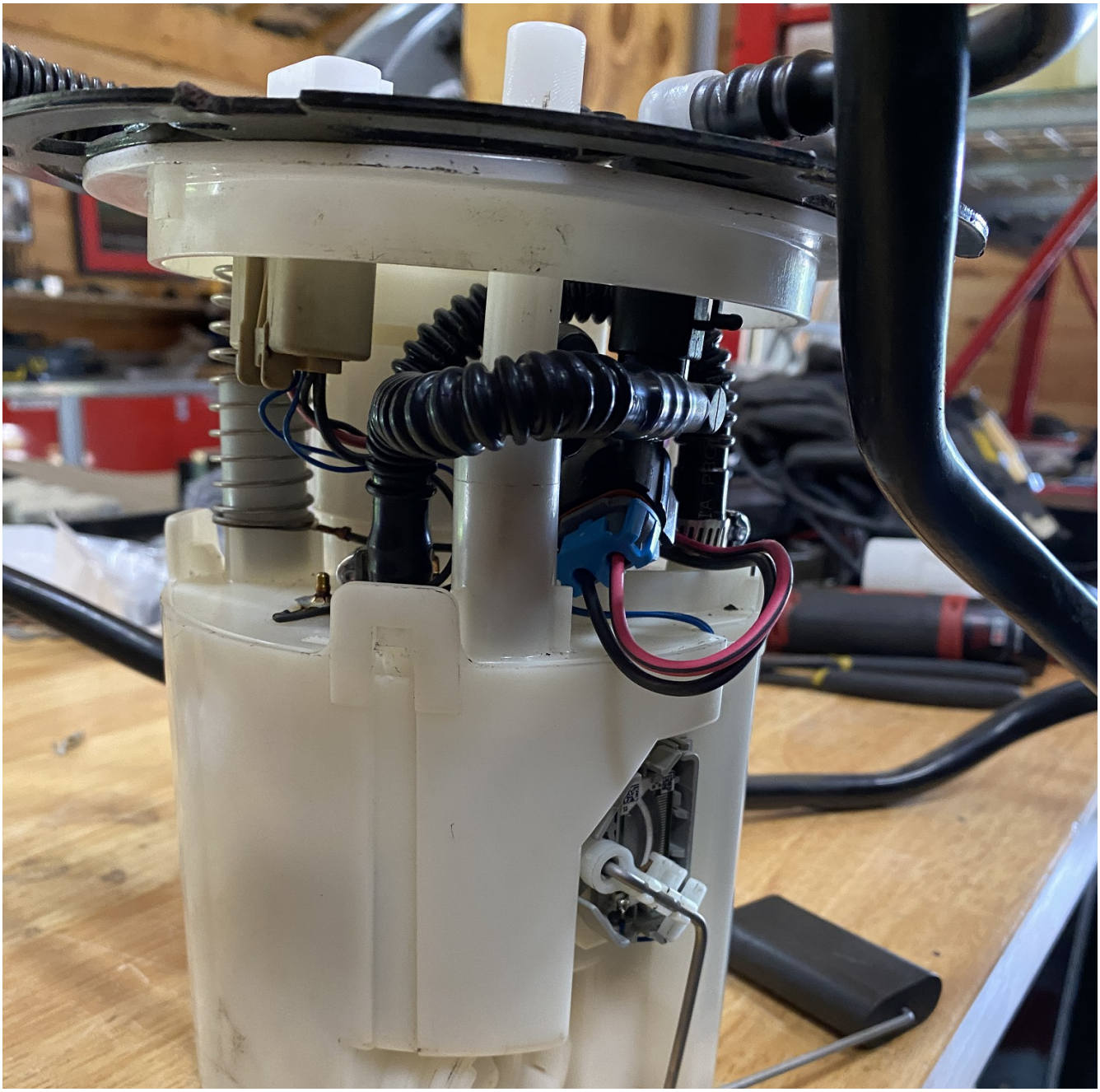
FUEL PUMP
BOMBA DE COMBUSTIBLE
POMPE À CARBURANT
TI Automotive
F90000295
NO CHECK VALVE



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