Pump YOU up!

The Ins and Outs of Fuel Pumps

Part 1

Bruce Smith

The principles of pumping fuel may seem at first pass a simple matter. But the need to deliver on-demand flow with a constant fuel line pressure (to prevent boiling and vapor lock) created some design challenges in the early days of the automobile. Solutions followed two basic approaches using either positive or non-positive pumping. Positive type pumps provide fuel continuously, requiring a separate bypass line to return fuel to the tank. Pumps of this type are less common with carburetors but were sometimes employed to deliver the higher pressures needed for fuel injection systems. For the Zenith or Solex carbs in our old Porsches, non-positive pumping is used – similar to most other cars of the time. Non-positive pumps deliver fuel to the carburetor only when it's needed but keep the fuel line pressurized at all times. This is accomplished using a pump chamber that's pressurized by a mechanically actuated diaphragm.

Mechanical Diaphragm Fuel Pumps

Non-positive diaphragm fuel pumps can be found in most car makes throughout the last century. The figures below show cross-sectional views of a few examples. The pump on the left is like those used in most vehicles in the 1940s but the concept dates back at least to the 1920s. It's fundamentally the same as the DVG pump used in Porsche 1600 356 A/B motors to the right of it. In both, rotation of an eccentric cam (on the distributor drive for the Porsche) actuates via a rod (13) a rocker (7) and link arm (6) to pull a diaphragm (3) against the pressure of a diaphragm spring (4). This reduces the pressure in the pump chamber, allowing fuel to enter through the inlet valve (2). The diaphragm moves back with the return stroke, forcing the fuel through the outlet valve (1). When the carburetor float bowl fills to close the float valve, back pressure is created in the chamber, regulated by the resistance of the diaphragm spring. This condition is maintained until the float valve re-opens to accept more fuel, allowing the diaphragm to re-actuate. When not pumping fuel, the rocker arm and link continue to move, but free within the link of the diaphragm shaft. This provides the so-called non-positive action of the pump. Fuel pumps on the earliest Porsches were the low volume design shared with VW motors of the day. In fact, the refinement of these pumps to produce the flow and pressure requirements of later Porsches resulted in no change to the base of the pump. Because of this, VW pumps for early 25-36 hp motors are a good source of spare parts for a 356 A/B fuel pump.

The Pierburg APG pump pictured at the far right is the design used in Porsche 1600s starting with the 356C and in all 912s. The pumping mechanism is simplified over the rocker arm type using a plunger rod and spring (4) coupled to the diaphragm assembly to allow for a non-positive return stroke. Regulation of fuel pressure is accomplished with a diaphragm and main spring. A mechanical APG pump with a dual chamber was also used in the earliest 911s with Solex carbs before being replaced with electric-only pumps for later Weber and Zenith motors.

Electric Fuel Pumps

Though the DVG and APG mechanical fuel pumps are most common for early Porsches, electric fuel pumps are worth mentioning as they were also employed. In particular, Autopulse pumps were used in tandem for Porsche four-cam motors in 356 Carreras and 550 Spyders. These pumps use a spring bellows expanded by an electrically actuated solenoid. The bellows basically acts as the diaphragm of the mechanical pump. At its extension limit, the bellows is released by the solenoid to close, sending fuel through the outlet valve. Once the carburetor float bowl is filled and the float valve closes, pressure against the bellows closes a contact to stop pumping. As the pressure lowers, pumping proceeds. A solid state or electronic fuel pump (Facet, for example) might also be found in an old Porsche as an aftermarket replacement or booster for an original mechanical pump. These use an electronically controlled coil and plunger combined with a foot valve to move fuel through the pump. Issues with these Facet type pumps are usually best handled by replacing them.

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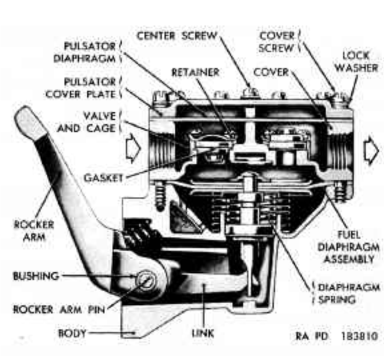

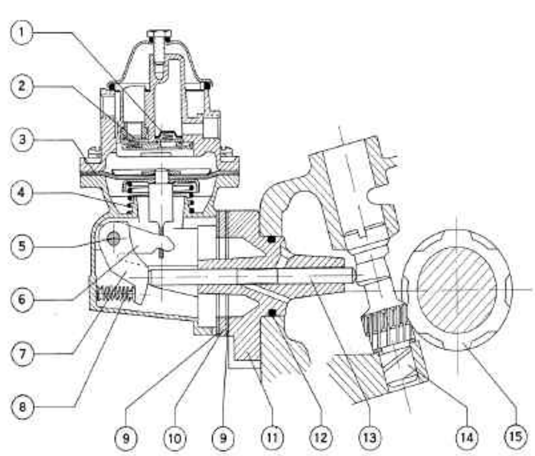

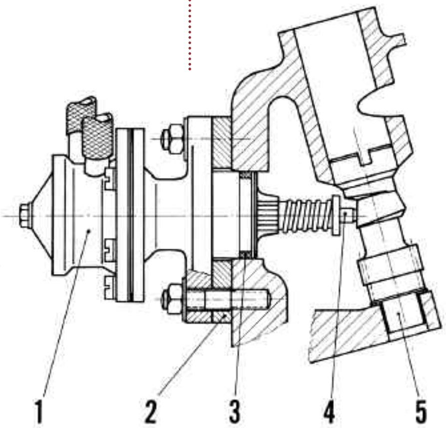

Restoring a Mechanical Fuel Pump

It becomes clear pretty quick if your car has a fuel pump problem. And it's often a good idea to carry out some maintenance if the pump's recent history isn't well known. Diaphragms harden, mating surfaces leak, valves wear, and years of neglect can leave the inside filled with residue of various sorts. Removing the pump and tearing it apart is pretty straight forward. Common sense usually dictates the order of disassembly and the Factory Manual or other sources will provide guidance. Screwdrivers, pliers, a pin punch, a light hammer and a rubber mallet are probably all you'll need. The challenges start once the pump is in pieces, which is where we will begin here. You can look things over once you remove the grease from the lower cavity (hopefully there is some), wipe down parts and clean the zinc alloy top and bottom. Look over the carburetor and fuel pump article in the March-April 2014 issue for some cleaning tips. Following are some of the problems you may find along the way.

The Bad and the Ugly

Pictured below are examples of the issues you might encounter once you've torn down your A/B or C/912 fuel pump. Realize that parts are probably 50+ years old so it's more likely than not that something will be less than ideal. In no order of likelihood or severity, here are some possible problem areas. Fixes for all but the worst of them will be discussed next time.

A1. There will probably be an amount of crud in the fuel cavities, some of which may be very difficult to remove. The problem isn't so much with organic residue, which can be attacked with carb cleaner or a suitable solvent, but with the inorganic stuff. In the March-April 2014 *Registry* article, I've also describe how the formation of zinc oxides will occur over time as fuel is left in carburetor bowls, tanks, lines and fuel pumps. In this example, the build-up in this APG pump is severe enough to be hopeless. Removal would leave the cavity too pitted to use.

A2. Though not explicitly shown, a common problem with C/912 APG pumps is the loosening of the brass fuel lines into the pump. This is more common with the output line and is easily found by wiggling the tube a bit. If it isn't firmly seated it will leak and may have been the source of the problems that led to its removal. We'll cover a fix for this next time as well.

B. The valves of the C/912 APG pump are generally not replaceable like those in the A/B DVG pump. Because of this, close inspection of both valves should be carried out. The output valve uses a phenolic chip and a light spring while the input valve is thin metal. The retaining ring for the output valve can be removed but spares are not available. Inlet valve replacements aren't made either. Parts from another pump would therefore be needed for replacement. But

valves aren't usually physically damaged. Instead they may be harmed by a heavy residue buildup. Once the pump top is clean, you can test the valve action by gently blowing/sucking the output fuel line or the input section at the top cavity. If you get a mouthful of something, I didn't tell you to do it.

C. Mating surfaces will usually be warped a bit, sometimes severely. You can see in this picture the extent of damage to the base of this C/912 pump by overtightening. It is no longer flat and wouldn't seal well against the base block. This is a good example of why overtightening can cause more problems than it will fix. There are two mating surfaces for each pump type. These should be flat enough that a gasket can be sealed, but most often are not.

D. Crushed dome tops are the most common problem with the A/B fuel pump. This is the main weakness of the design of these pumps. You should not expect that in the 50 year lifetime of a pump that no one has overtightened the top cover. And once it started leaking, tightening some more may have seemed the logical solution. The dome top pictured on the left has no hope to seal to the top bolt washer as the new cover on the right could. This top may have reached the point of no return. If not, it will take some work to get it back.

E. The valve seats on most A/B pumps is the soft ZAMAK alloy of the fuel pump body. DVG probably didn't plan for these pumps to last as long as we're asking them to but this is certainly another weakness in the design. Some later A/B and VW pumps used a harder insert, which can also be used to repair heavily worn soft seats. There is no chance that a valve would seal to this surface as it is.

F. There are several areas of the weak ZAMAK casting that are prone to cracking. If the actuator arm stroke isn't set right, failure can occur at the other end of the pump base. Overtightening of either style pump can crack the alloy near the interface. And here's an example of a crack in an A/B base that has seen an epoxy repair in the past. Once cleaned, cracks are pretty easy to spot. With the mechanical requirements of a fuel pump, this sort of damage can spell replacement. But there are a few decent ways to make a reliable repair.

G. Here's a crud-filled A/B pump top with an additional issue. The bolt threads for the top cover are completely stripped. Apparently, the top had been tightened so much that it ripped the threads. The problem is not as easy to spot when just a few threads are weakened. Again, a consequence of overtightening.

H. The general wear of parts needs to be closely inspected. Here is a rocker arm pin (right) that has been used for so long that the rocker arm has left circumferential grooves. It is probably still OK to use but it may be about time to replace it. The face of the rocker arm (left) that contacts the actuating rod will be worn on most all A/B pumps. If it's not, the pump probably hasn't been used much. Here's an example of wear that may interfere with rod motion. These parts came from a pump that hadn't seen grease in many years.

I. Finally here's a picture of two similar banjo bolts, both M12 X 23mm. But the one on the right is a finer thread pitch (1.25mm) that is used with Zenith carburetor fuel ports. The one on the left is a coarser thread pitch (1.5mm), correct for use with a DVG fuel pump. If you try to use one for the other, you will get some resistance. But not wanting to be told what to do, someone in the past may have forced the situation. What does it lead to? A headache and Helicoil for you. What fun.

These are some of the common trouble areas that might be encountered when rebuilding a mechanical fuel pump for your 356 or 912. So where to go from here? Well if you're in the middle of such a project, I haven't offered much help with respect to solutions. But if you can wait until the next installment, some fixes will be covered along with test methods for springs, leaks, pressures and flows. As time goes on, the condition of these fuel pumps is going to get progressively worse. And there aren't going to be any new ones made. Good replacements are getting harder to find so it is worth doing what is necessary to save the ones we've got.

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