

Fuel pump

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A **fuel pump** is a frequently (but not always) essential component on a car or other internal combustion engine. Many engines (older motorcycle engines in particular) do not require any fuel pump at all, requiring only gravity to feed fuel from the fuel tank or under high pressure to the fuel injection system. Often, carbureted engines use low pressure mechanical pumps that are mounted outside the fuel tank, whereas fuel injected engines often use electric fuel pumps that are mounted inside the fuel tank (and some fuel injected engines have two fuel pumps: one low pressure/high volume supply pump in the tank and one high pressure/low volume pump on or near the engine).^[1]

Contents

- 1 Mechanical pump
 - 1.1 Decline of mechanical pumps
- 2 Electric pump
- 3 Turbopumps
- 4 References



A high-pressure fuel pump on a Yanmar 2GM20 marine diesel engine.

Mechanical pump

Prior to the widespread adoption of electronic fuel injection, most carbureted automobile engines used mechanical fuel pumps to transfer fuel from the fuel tank into the fuel bowls of the carburetor. Most mechanical fuel pumps are diaphragm pumps, which are a type of positive displacement pump. Diaphragm pumps contain a pump chamber whose volume is increased or decreased by the flexing of a flexible diaphragm, similar to the action of a piston pump. A check valve is located at both the inlet and outlet ports of the pump chamber to force the fuel to flow in one direction only. Specific designs vary, but in the most common configuration, these pumps are typically bolted onto the engine block or head, and the engine's camshaft has an extra eccentric lobe that operates a lever on the pump, either directly or via a pushrod, by pulling the diaphragm to bottom dead center. In doing so, the volume inside the pump chamber increased, causing pressure to decrease. This allows fuel to be pushed into the pump from the tank (caused by atmospheric pressure acting on the fuel in the tank). The return motion of the diaphragm to top dead center is accomplished by a diaphragm spring, during which the fuel in the pump chamber is squeezed through the outlet port and into the carburetor. The pressure at which the fuel is expelled from the pump is thus limited (and therefore regulated) by the force applied by the diaphragm spring.

The carburetor typically contains a float bowl into which the expelled fuel is pumped. When the fuel level in the float bowl exceeds a certain level, the inlet valve to the carburetor will close, preventing the fuel pump from pumping more fuel into the carburetor. At this point, any remaining fuel inside the pump chamber is trapped, unable to exit through the inlet port or outlet port. The diaphragm will continue to allow pressure to the diaphragm, and during the subsequent rotation, the eccentric will pull the diaphragm back to bottom dead center, where it will remain until the inlet valve to the carburetor reopens.

Because one side of the pump diaphragm contains fuel under pressure and the other side is connected to the crankcase of the engine, if the diaphragm splits (a common failure), it can leak fuel into the crankcase.

The pump creates negative pressure to draw the fuel through the lines. However, the low pressure between the pump and the fuel tank, in combination with heat from the engine and/or hot weather, can cause the fuel to vaporize in the supply line. This results in fuel starvation as the fuel pump, designed to pump liquid, not vapor, is unable to suck more fuel to the engine, causing the engine to stall. This condition is different from vapor lock, where high engine heat on the pressured side of the pump (between the pump and the carburetor) boils the fuel in the lines, also starving the engine of enough fuel to run. Mechanical automotive fuel pumps generally do not generate much more than 10-15 psi, which is more than enough for most carburetors.



Mechanical fuel pump, fitted to cylinder head

Decline of mechanical pumps

As engines moved away from carburetors and towards fuel injection, mechanical fuel pumps were replaced with electric fuel pumps, because fuel injection systems operate more efficiently at higher fuel pressures (40-60 psi) than mechanical diaphragm pumps can generate. Electric fuel pumps are generally located in the fuel tank, in order to use the fuel in the tank to cool the pump and to ensure a steady supply of fuel.

Another benefit of an in-tank mounted fuel pump is that a suction pump at the engine could suck in air through a (difficult to diagnose) faulty hose connection, while a leaking connection in a pressure line will show itself immediately. A potential hazard of a tank-mounted fuel pump is that all of the fuel lines are under (high) pressure, from the tank to the engine. Any leak will be easily detected, but is also hazardous.

Electric pump

Electric fuel pump^[2] has its own electric motor and is operated by vehicle's ECU. Electric motor pushes fuel from fuel tank to the engine through fuel lines. Standard electric fuel pumps operate in 50-200 p.s.i. pressure rate. There are in-tank and external electric fuel pumps. In-tank fuel pumps are located in the bottom of the fuel tank. It is the most common type of setup. Electric external fuel pumps are usually mounted on a frame rail outside the fuel tank.

In many modern cars the fuel pump is usually electric and located inside the fuel tank. The pump creates positive pressure in the fuel lines, pushing the gasoline to the engine. The higher gasoline pressure raises the boiling point. Placing the pump in the tank puts the component least likely to handle gasoline vapor well (the pump itself) farthest from the engine, submersed in cool liquid. Another benefit to placing the pump inside the tank is that it is less likely to start a fire. Though electrical components (such as a fuel pump) can spark and ignite fuel vapors, liquid fuel will not explode (see flammability limit) and therefore submerging the pump in the tank is one of the safest places to put it. In most cars, the fuel pump delivers a constant flow of gasoline to the engine; fuel not used is returned to the tank. This further reduces the chance of the fuel boiling, since it is never kept close to the hot engine for too long.

The ignition switch does not carry the power to the fuel pump; instead, it activates a relay which will handle the higher current load. It is common for the fuel pump relay to become oxidized and cease functioning; this is much more common than the actual fuel pump failing. Modern engines utilize solid-state control which allows the fuel pressure to be controlled via pulse-width modulation of the pump voltage. This increases the life of the pump, allows a smaller and lighter device to be used, and reduces electrical load.

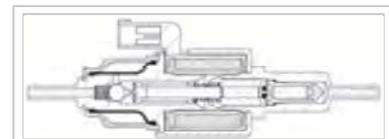
Cars with electronic fuel injection have an electronic control unit (ECU) and this may be programmed with safety logic that will shut the electric fuel pump off, even if the engine is running. In the event of a collision this will prevent fuel leaking from any ruptured fuel line. Additionally, cars may have an inertia switch (usually located underneath the front passenger seat) that is "tripped" in the event of an impact, or a *roll-over valve* that will shut off the fuel pump in case the car rolls over.

Some ECUs may also be programmed to shut off the fuel pump if they detect low or zero oil pressure, for instance if the engine has suffered a terminal failure (with the subsequent risk of fire in the engine compartment).

The fuel sending unit assembly may be a combination of the electric fuel pump, the filter, the strainer, and the electronic device used to measure the amount of fuel in the tank via a float attached to a sensor which sends data to the dash-mounted fuel gauge. The fuel pump by itself is a relatively inexpensive part. But a mechanic at a garage might have a preference to install the entire unit assembly.



Electric fuel pump



A piston metering pump f.e. gasoline- or additive metering pump

Turbopumps

Many jet engines, including rocket engines use a turbopump which is a centrifugal pump usually propelled by a gas turbine or in some cases a ram-air device (particularly in ramjet engines which lack a shaft).

References

1. Hollebeak, Barry (2005). *Classroom Manual for Automotive Fuels and Emissions*. Cengage Learning. p. 154. Retrieved June 12, 2012.
2. "Mechanical or Electric Fuel Pump?".

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Categories: Pumps | Engine fuel system technology | Engine components

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