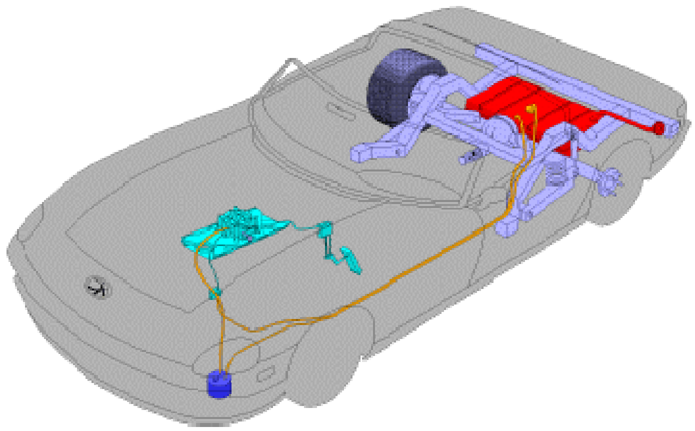
# Fuel System Overview



Below is an overview of fuel system operation

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## The Fuel System (Overview)

The purpose of the fuel system is to provide a mixture of fuel and air to the engine of the car. The air-fuel mixture must be in proportion to the speed and load placed on the engine. Major parts of the system include: fuel tank and cap, emission controls, fuel line, fuel pump, fuel filter, carburetor, and intake manifold as well as the fuel gauge, which indicates the amount of fuel in the tank.

### Engine Fuel

Engine fuel is mainly made up of hydrogen and carbon, mixed so that it will burn with oxygen present, and will free its heat energy into mechanical energy. Liquid fuels are ideal for internal combustion engines, because they can be economically produced, have a high heat value per pound, an ideal rate of burning, and can be easily handled and stored. The most common engine fuels are gasoline, kerosene and Diesel fuel oil.

Gasoline has many advantages and is used to a greater extent than any other fuel in internal combustion engines having spark ignition. It has a better burning rate than other fuels, and, because it vaporizes easily, it gives quick starting in cold weather, smooth acceleration and maximum power.

Diesel fuel oil ranks next to gasoline in quantity used. It can be produced as cheaply as gasoline, but its use is limited to Diesel type engines. The use of kerosene as a fuel is usually limited to farm tractors, marine and stationary engines, all which operate at a fairly constant speed. Its traits are such that it cannot be properly mixed with air and controlled in variable speed engines.

### Octane Rating

A gasoline's ability to resist detonation is called its "octane" or anti-knock rating. Gasoline from asphaltic base crude oil produces less knock than one from paraffinic base crude. Cracked gas has less tendency to knock than straight run gas. All marketed gasolines are a blend of straight run and cracked gasolines, so unless their blending is controlled, the anti-knock qualities will vary.

A mixture of iso-octane, which has a very high anti-knock rating, and heptane, which makes a pronounced knock, is used as a reference fuel to establish an anti-knock standard. The anti-knock value or octane number is represented by the percentage of volume of iso-octane that must be mixed with normal heptane in order to duplicate the knocking of the gasoline which is being tested. These ratings range from 50 in third grade gasolines to 110 in aviational fuels. The rating of 100 means a fuel having an anti-knock value equal to that of iso-octane. If the octane rating of a gasoline is naturally low, the fuel will detonate as it burns and power will be applied to the pistons in hammer-like blows. The ideal power is that which pushes steadily on the pistons, rather than hammer against them. The octane rating of a gasoline can be raised by treating it with a chemical which is not a fuel. The best chemical known is tetra-ethyl lead compound, which is added to the gasoline.

Tetra-ethyl lead is a liquid which mixes thoroughly with gasoline and vaporizes completely. Ethylene dibromide prevents the tetra-ethyl lead from forming lead oxide deposits on spark plugs and on valve seats and stems. Red dye is added to identify an ethyl treated gasoline and to warn against its being used as anything but an engine fuel. In 1975, it became illegal to use a leaded gasoline except in cars built prior to this time. With the addition of the catalytic converter, it is undesirable to burn leaded fuel, because leaded fuel will clog the converter and increase the back-pressure of the exhaust.

## Fuel Tank

All modern fuel systems are fed through a pump, so the fuel tank is usually at the rear of the chassis under the trunk compartment. Some vehicles have a rear engine with the tank in the forward compartment. The fuel tank stores the excess fuel until it is needed for operation of the vehicle. The fuel tank has an inlet pipe and an outlet pipe. The outlet pipe has a fitting for fuel line connection and may be located in the top or in the side of the tank. The lower end is about one-half inch above the bottom of the tank so that collected sediment will not be flushed out into the carburetor. The bottom of the tank contains a drain plug so that tank may be drained and cleaned.

The gas tank of the early cars was placed higher than the engine. The idea was that the gas would flow down to the engine. This arrangement caused a problem when the car went uphill -- the gas flowed away from the engine.

Solution: drive up the hill backwards!

## Fuel Filter

Clean fuel is important, because of the many small jets and passages in the carburetor and openings in a fuel injector. To ensure this cleanliness, fuel filters are installed in the fuel line. Fuel filters can be located at any point between the fuel tank and the carburetor. One may be in the tank itself, in the fuel pump or in the carburetor. The most common placement is between the fuel tank and a mechanical fuel pump. In this case, the fuel enters a glass bowl and passes up through the filter screen and out through an outlet. Any water or solid material which is trapped by the filter will fall to the bottom of the glass bowl where it can be easily seen and removed. Dirt particles usually come from scales of rust in the tank cars, storage tanks or drums. Water comes from condensed moisture in the fuel tanks.

## Fuel Pump

The fuel pump has three functions: to deliver enough fuel to supply the requirements of an engine under all operating conditions, to maintain enough pressure in the line between the carburetor and the pump to keep the fuel from boiling, and to prevent vapor lock. Excessive pressure can hold the carburetor float needle off its seat, causing high gasoline level in the float chamber. This will result in high gasoline consumption. The pump generally delivers a minimum of ten gallons of gasoline per hour at top engine speeds, under an operating pressure of from about 2 1/2 to 7 pounds. Highest pressure occurs at idling speed and the lowest at top speed. Although fuel pumps all work to produce the same effect, there are various types that may operate somewhat differently.

## Mechanical Fuel Pump

The mechanical fuel pump differs in that it has a vacuum booster section. The vacuum section is operated by the fuel pump arm; otherwise, it has nothing to do with the fuel system. During the suction (or first) stroke, the rotation of the eccentric on the camshaft puts the pump operating arm into motion, pulling the lever and diaphragm down against the pressure of the diaphragm spring and producing suction (vacuum) in the pump chamber. The suction will hold the outlet valve closed and pull the inlet valve open, causing fuel to flow through the filter screen and down through the inlet valve of the pump chamber.

During the return stroke, the diaphragm is forced up by the diaphragm spring, the inlet valve closes and the outlet valve opens to allow fuel to flow through the outlet to the carburetor. The operating lever is hinged to the pump arm, so that it can move down but cannot be raised by the pump arm. The pump arm spring forces the arm to follow the cam without moving the lever. The lever can only be moved upward by the diaphragm spring. This process causes fuel to be delivered to the carburetor only when the fuel pressure in the outlet is less than the pressure maintained by the diaphragm spring. This happens when the passage of fuel from the pump into the carburetor float chamber is open and the float needle is not seated.

## Electric Fuel Pump

Electric fuel pumps have been used for many years on trucks, buses and heavy equipment, and they have also been used as replacements for mechanically operated fuel pumps on automobiles, but only recently have they become part of a car's original equipment. The replacement types usually use a diaphragm arrangement like the mechanical pumps, except that it is actuated by an electrical solenoid.

The electrically driven turbine type of pump, first used on the Buick Riviera, was a great departure from the usual fuel pump design. It uses a small turbine wheel driven by a constant speed electric motor. The entire unit is located in the fuel tank and submerged in the fuel itself. This pump operates continuously when the engine is running. It keeps up a constant pressure which is capable of supplying the maximum fuel demands of the engine. When less fuel is required, the pump does not deliver at full potential, because the turbine is not a positive displacement type like the mechanical pump. Consequently, the turbine will run without pumping fuel and so, needs no means of varying fuel delivery rate like its mechanical counterpart. Since the fuel can flow past the spinning turbine blades, there is no need for pump inlet and outlet valves nor is there any need to vary its speed.

A relay for the electric fuel pump is used to complete the circuit to the fuel pump. This cuts off current to the fuel pump in the event of an accident.

## Vacuum Pump

Several fuel pumps have a vacuum booster section that operates the windshield wipers at an almost constant speed. The fuel section then functions in the same way as ordinary fuel pumps. One difference is that the rotation of the camshaft eccentric in the vacuum pump also operates the vacuum booster section by actuating the pump arm, which pushes a link and the bellows diaphragm assembly upward, expelling air in the upper chamber through its exhaust valve out into the intake manifold. On the return stroke of the pump arm, the diaphragm spring moves the bellows diaphragm down, producing a suction in the vacuum chamber. The suction opens the intake valve of the vacuum section and draws air through the inlet pipe from the windshield wipers.

When the wipers are not operating, the intake manifold suction (vacuum) holds the diaphragm up against the diaphragm spring pressure so that the diaphragm does not function with every stroke of the pump arm. When the vacuum is greater than the suction produced by the pump, the air flows from the windshield wiper through the inlet valve and vacuum chamber of the pump and out the exhaust valve outlet to the manifold, leaving the vacuum section inoperative. With high suction in the intake manifold, the operation of the wiper will be the same as if the pump were not installed. When the suction is low, as when the engine is accelerated or operating at high speed, the suction of the pump is greater than that in the manifold and the vacuum section operates the wipers at a constant speed. Some pumps have the vacuum section located in the bottom of the pump instead of in the top, but the operation is basically the same.

## Air Cleaners

Air cleaners are made to separate dust and other particles in the incoming air before it enters the carburetor. Thousands of cubic feet of air are drawn from within the car hood and passed through the engine cylinders, so it is important that the air is clean.

When driving on dirt or other dusty roads, dust particles are drawn through the radiator and find their way into the engine if it is not filtered and cleaned. Dust and other foreign materials in the engine will cause excessive wear and operating problems.

## Fuel Gauges

Cars are equipped with fuel gauges which are operated along with the vehicle's electrical system. There are two types: the thermostatic type and the balancing coil type. The thermostatic type is made of a standing unit, located in the fuel tank, and the gauge itself (registering unit), which is located on the instrument panel. The fuel gauge used in some cars and trucks is of the electrically operated balanced coil type. These have a dash unit and a tank unit. The dash unit has two coils, spaced about 90 degrees apart, with an armature and integral pointer at the intersections of the coil axis. The dial has a scale in fractions between "Empty" and "Full". The tank unit has a housing, which encloses a rheostat, and a sliding brush which contacts the rheostat. The brush is actuated by the float arm. The movement of the float arm is controlled by the height of the fuel in the supply tank. The height of the fuel (called variations in resistance) changes the value of the dash unit coil so that the pointer indicates the amount of fuel available. A calibrated friction brake is included in the tank unit to prevent the wave motions of the fuel from fluctuating the pointer on the dash unit. Current from the battery passes through the limiting coil to the common connection between the two coils, which is the lower terminal on the dash unit. The current is then offered two paths, one through the operating coil of the dash unit and the other over the wire to the tank unit. When the tank is low or empty, the sliding brush cuts out all resistance in the tank unit. Most of the current will pass through the tank unit circuit because of the low resistance and only a small portion through the operating coil to the dash unit. As a result, this coil is not magnetized enough to move the dash unit pointer, which is then held at the "Empty" position by the limiting coil.

If the tank is partly full or full, the float rises on the surface of the fuel and moves the sliding brush over the rheostat, putting resistance in the tank unit circuit. More current will then pass through the operating coil to give a magnetic pull on the pointer, which overcomes some of the pull of the limiting coil. When the tank is full, the tank unit circuit contains the maximum resistance to the flow of the current. The operating coil will then receive its maximum current and exert pull of the pointer to give a "Full" reading. As the tank empties, the operating coil loses some of its magnetic pull and the limiting coil will still have about the same pull so that the pointer is pulled toward the lower reading. Variations in battery voltage will not cause an error in the gauge reading because its operation only depends on the difference in magnetic effect between the two coils.

## Fuel Lines

Fuel lines, which connect all the units of the fuel system, are usually made of rolled steel or, sometimes, of drawn copper. Steel tubing, when used for fuel lines, is generally rust proofed by being copper or zinc plated.

Fuel lines are placed as far away from exhaust pipes, mufflers, and manifolds as possible, so that excessive heat will not cause vapor lock. They are attached to the frame, the engine, and other units in such a way that the effect of vibration is minimal, and so that they are free of contact with sharp edges which might cause wear. In areas where there is a lot of movement, as between the car`s frame and rubber-mounted engine, short lengths of gasoline resistant flexible tubing are used.