Gasoline and Diesel Fuel Systems

Gasoline Fuel System

The function of the fuel system is to supply a combustible mixture of air and fuel to the engine.

Gasoline

Gasoline is a highly volatile, flammable liquid hydrocarbon mixture used as a fuel for internal combustion engines. A comparatively economical fuel, gasoline is the primary fuel for automobiles worldwide. Chemicals called additives such as lead, detergents, and anti-oxidants, are mixed into gasoline to improve its operating characteristics.

Properties of Gasoline

1- Volatility

The ease with which gasoline vaporizes is called volatility. A high volatility gasoline vaporizes very quickly. A low volatility gasoline vaporizes slowly.

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2- Antiknock Quality

In modern high compression gasoline engines, the air-fuel mixture tends to ignite spontaneously or to explode instead of burning rather slowly and uniformly. The result is a knock, a ping, or a detonation. For this reason, gasoline refiners have various ways to make gasoline that does not detonate easily.

3- Octane Rating

The octane rating of a gasoline is a measurement of the ability of the fuel to resist knock or ping. high octane rating indicates the fuel will NOT knock or ping easily. It should be used in a high compression or turbocharged engine. A low octane gasoline is suitable for a low compression engine.

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Air-Fuel Ratio

For proper combustion and engine performance, the right amounts of air and fuel must be mixed together. If too much fuel or too little fuel is used, engine power, fuel economy, and efficiency are reduced. For a gasoline engine, the perfect air-fuel ratio is 14.7:1 (14.7 parts air to 1 part fuel by weight).

Lean Air-Fuel Mixture

A lean air-fuel mixture contains a large amount of air. For example, 20:1 would be a very lean mixture. A slightly lean mixture is desirable for high gas mileage and low exhaust emissions. Extra air in the cylinder ensures that all the fuel will be burned; however, too lean of a mixture can cause poor engine performance (lack of power, missing) and even engine damage.

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Rich Air-Fuel Mixture

A rich air-fuel mixture contains a little more fuel mixed with the air. For gasoline, 8:1(8 parts air to 1 part fuel) is a very rich mixture. A slightly rich mixture tends to increase power; however, it also increases fuel consumption and exhaust emissions

Gasoline Fuel System Components

- Fuel tank (stores gasoline)
- Fuel pump (draws fuel from the tank and forces it to the fuel-metering device)
- Fuel filters (remove contaminants in the fuel)
- Carburetor or gasoline injectors
- Fuel lines (carry fuel between the tank, the pump, and other parts)

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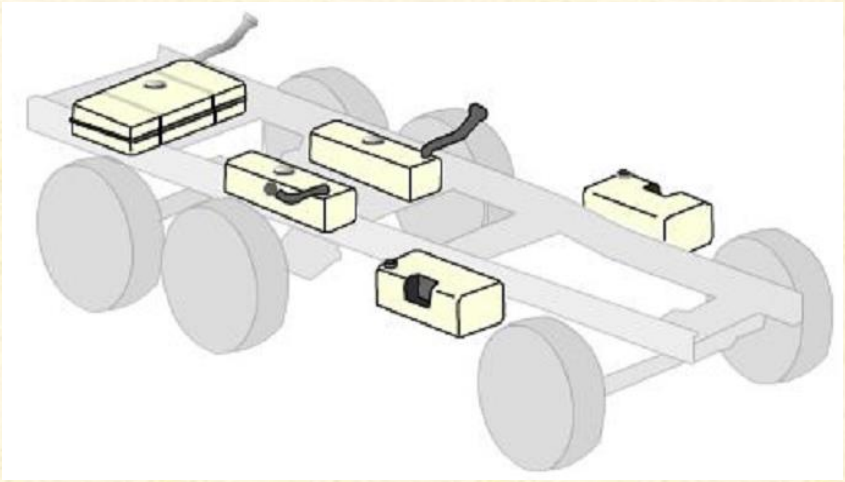
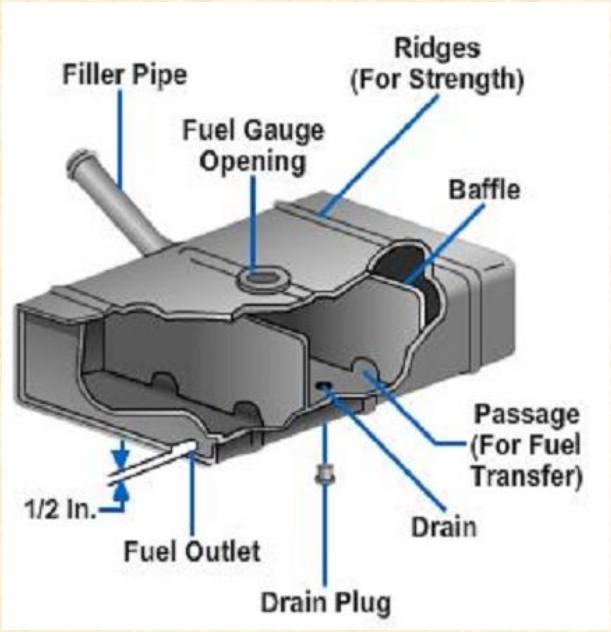
Fuel Tank

An automotive fuel tank must safely hold an adequate supply of fuel for prolonged engine operation. The location of the fuel tank should be in an area that is protected from flying debris, shielded from collision damage, and not subjected to bottoming . A fuel tank can be located just about anywhere in the vehicle that meets these requirements.





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Fuel Gauges

The fuel gauge indicates the fuel level in the fuel tank. It is a magnetic indicating system that can be found on either an analog or digital instrument panel.

The fuel sending unit is combined with the fuel pump assembly and consists of a variable resistor controlled by the level of an attached float mechanism in the tank. When the fuel is low, resistance in the sender is low; therefore movement of lift of the gauge is low. When the resistance is high, such as with a full tank, the indicator is high, showing the gauge higher up the scale on the instrument panel.

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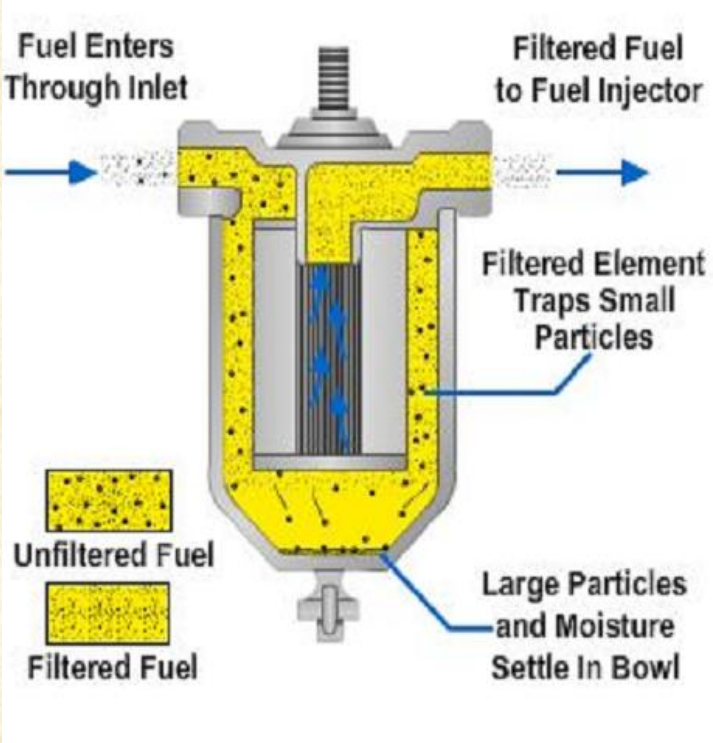
Fuel Filters

The fuel injection system is highly sensitive to foreign particles. Fuel filters prevent water, dirt, and rust particles from entering the system.



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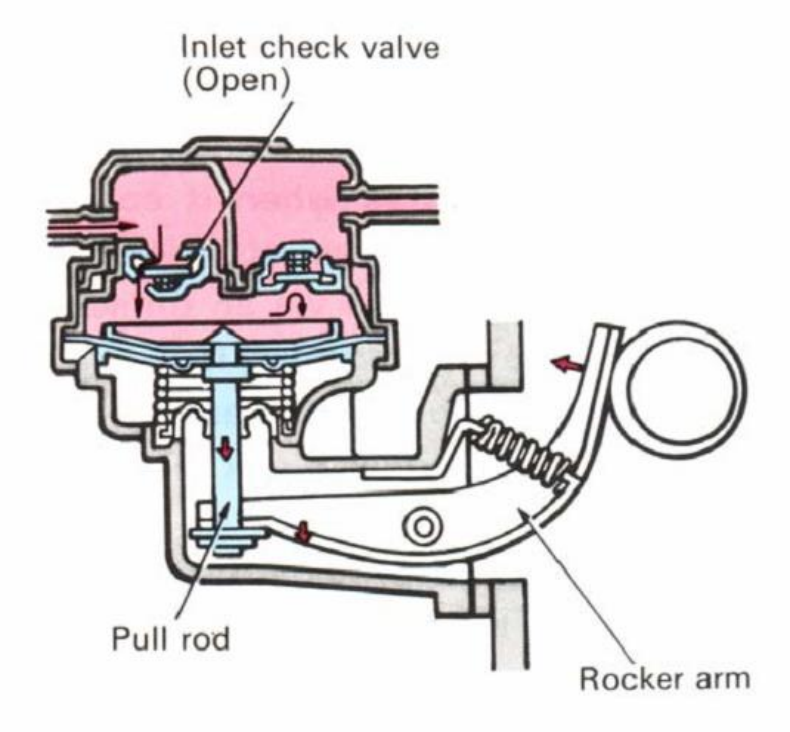
Fuel Pump

A fuel pump is the device that draws the fuel from the tank to the engine's carburetor or injection system. All late model vehicles use an electric fuel pump. The fuel pump can be located either inside the tank or in the fuel system after the tank.

There are four types of fuel pumps:

1- the diaphragm pump
2- plunger pump
3- bellows pump
4- impeller or rotary pump.



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Fuel Lines and Hoses

Fuel lines and hoses carry fuel from the tank to the filter and carburetor or fuel injection assembly. They can be made from either metal tubing or flexible nylon or synthetic rubber hoses. The latter must be able to resist gasoline.

The hoses must be non-permeable so gas and gas vapors cannot evaporate through the hose.

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Carburetor

Spark-ignition engines normally use volatile liquid fuels. Preparation of fuel-air mixture is done outside the engine cylinder and formation of a homogeneous mixture is normally not completed in the inlet manifold.

Definition of Carburetion

The process of formation of a combustible fuel-air mixture by mixing the proper amount of fuel with air before admission to engine cylinder is called carburetion and the device which does this job is called a carburetor.

Factors Affecting Carburetion

i. The engine speed
ii. The vaporization characteristics of the fuel
iii. The temperature of the incoming air and
iv. The design of the carburetor

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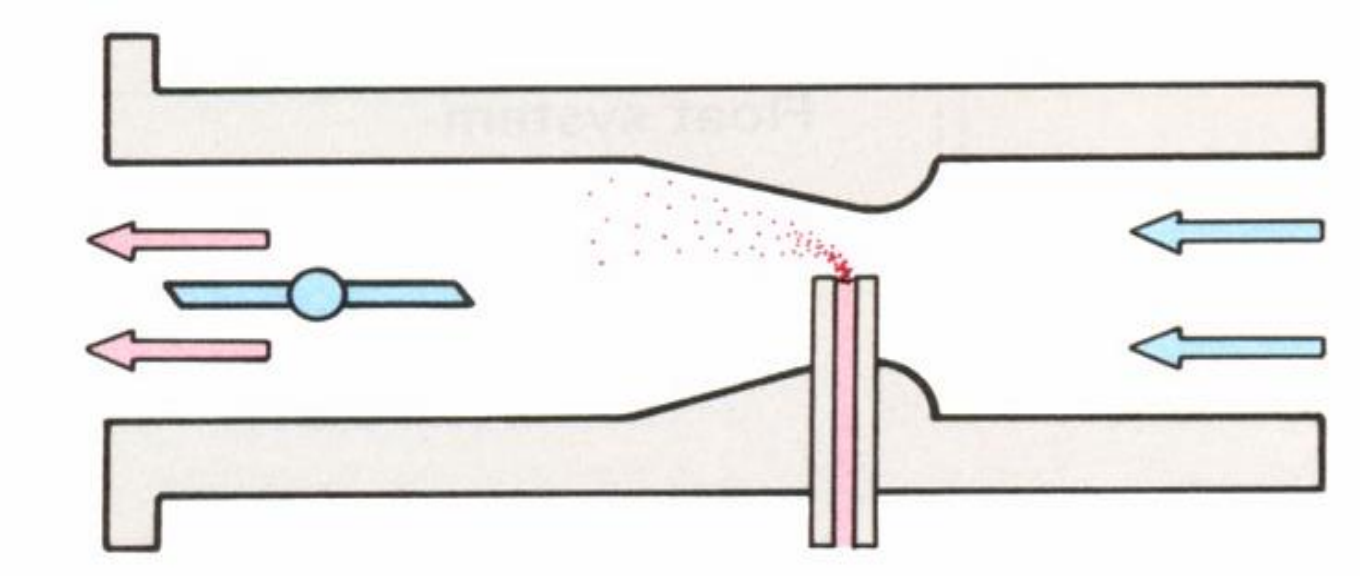
Principle of Carburetion

Both air and gasoline are drawn through the carburetor and into the engine cylinders by the suction created by the downward movement of the piston. This suction is due to an increase in the volume of the cylinder and a consequent decrease in the gas pressure in this chamber.



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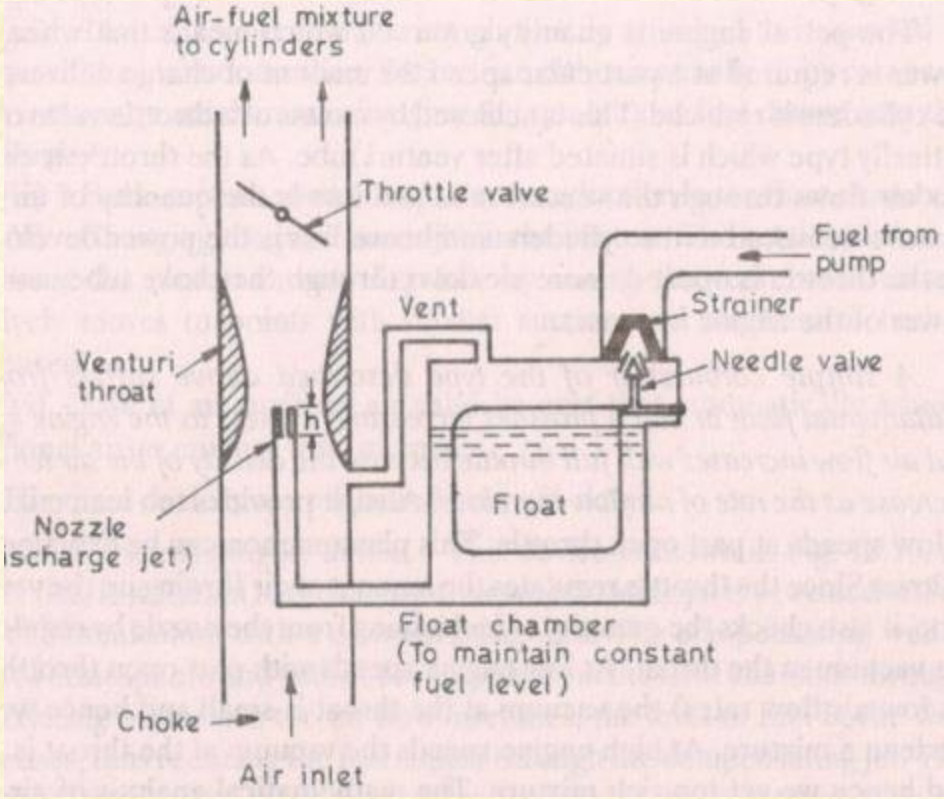
The Simple Carburetor

The simple carburetor mainly consists of a float chamber, fuel discharge nozzle and a metering orifice, a venturi, a throttle valve and a choke. The float and a needle valve system maintain a constant level of gasoline in the float chamber.



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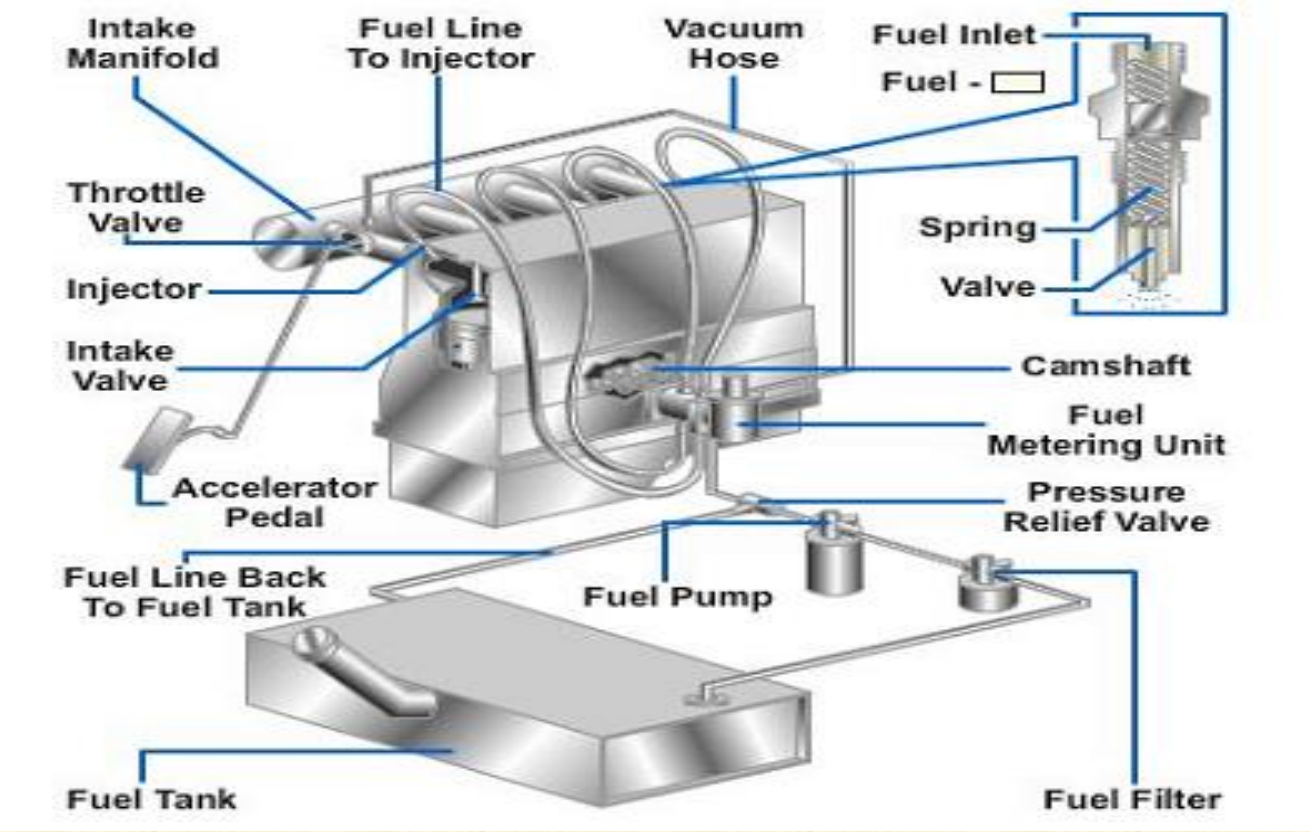
Fuel injection.

A modern gasoline injection system uses pressure from an electric fuel pump to spray fuel into the engine intake manifold. Like a carburetor, it must provide the engine with the correct air-fuel mixture for specific operating conditions.



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Advantages of gasoline injection system:

1- Improved atomization. Fuel is forced into the intake manifold under pressure that helps break fuel droplets into a fine mist.

2- Better fuel distribution. Each cylinder receives an equal flow of fuel vapors.

3- Smoother idle. Lean fuel mixture can be used without rough idle because of better fuel distribution and low-speed atomization.

4- Lower emissions. Lean, efficient air-fuel mixture reduces exhaust pollution.

5- Better cold weather drivability. Injection provides better control of mixture enrichment than a carburetor.

6- Increased engine power. Precise metering of fuel to each cylinder and increased air flow can result in more horsepower output.

7- Fewer parts. Simpler, late model, electronic fuel injection systems have fewer parts than modern computer-controlled carburetors.

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Diesel Fuel Systems

Compression ratios in the diesel engine range between 6:1 for a stationary engine and 24:1 for passenger vehicles. This high ratio causes increased compression pressures of 400 to 600 psi and cylinder temperatures reaching 800°F to 1200°F. At the proper time, the diesel fuel is injected into the cylinder by a fuel-injection system, which usually consists of a pump, fuel line, and injector or nozzle. When the fuel oil enters the cylinder, it will ignite because of the high temperatures. The diesel engine is known as a compression-ignition engine, while the gasoline engine is a spark-ignition engine.

Diesel Fuel

Diesel fuel is heavier than gasoline because it is obtained from the residue of the crude oil after the more volatile fuels have been removed.

Using a poor or improper grade of fuel can cause hard starting, incomplete combustion, a smoky exhaust, and engine knocks.

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Properties of Diesel Fuel

Cetane Number

Cetane number is a measure of the fuel oil's volatility; the higher the rating, the easier the engine will start and the smoother the combustion process will be within the ratings specified by the engine manufacturer.
the higher the cetane rating, the easier the fuel will ignite once injected into the diesel combustion chamber. If the cetane number is too low, you will have difficulty in starting. This can be accompanied by engine knock and puffs of white smoke during warm-up in cold weather.

Volatility

Fuel volatility requirements depend on the same factors as cetane number. The more volatile fuels are best for engines where rapidly changing loads and speeds are encountered. Low volatile fuels tend to give better fuel economy where their characteristics are needed for complete combustion, and will produce less smoke, odor, deposits, crankcase dilution, and engine wear.

Gasoline and Diesel Fuel Systems

Viscosity

The viscosity is a measure of the resistance to flow of the fuel, and it will decrease as the fuel oil temperature increases. What this means is that a fluid with a high viscosity is heavier than a fluid with low viscosity. A high viscosity fuel may cause extreme pressures in the injection systems and will cause reduced atomization and vaporization of the fuel spray.

Sulfur Content

Sulfur has a definite effect on the wear of the internal components of the engine, such as the piston ring, pistons, valves, and cylinder liners. In addition, a high sulfur content fuel requires that the engine oil and filter be changed more often because the corrosive effects of hydrogen sulfide in the fuel and the sulfur dioxide or sulfur trioxide that is formed during the combustion process combine with water vapor to form acids. High additive lubricating oils are desired when high sulfur fuels are used.

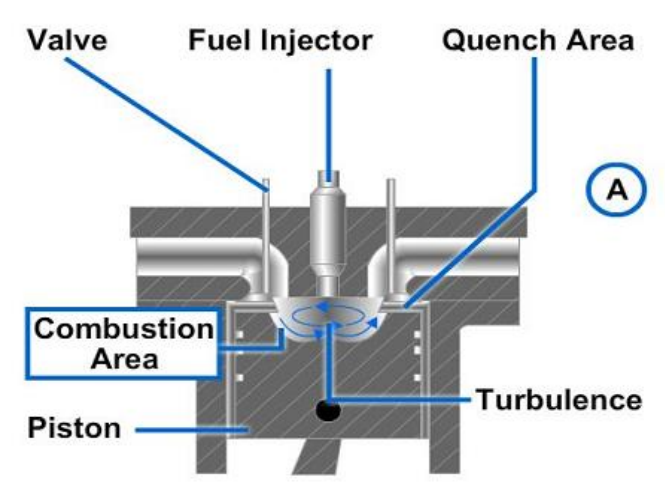
Gasoline and Diesel Fuel Systems

Combustion Chamber Design

The fuel injected into the combustion chamber must be mixed thoroughly with the compressed air and distributed as evenly as possible throughout the chamber if the engine is to function at maximum efficiency and exhibit maximum drivability.

Direct Injection Combustion Chamber

Direct injection is the most common combustion chamber and is found in nearly all engines. The fuel is injected directly into an open combustion chamber formed by the piston and cylinder head. The main advantage of this type of injection is that it is simple and has high fuel efficiency.



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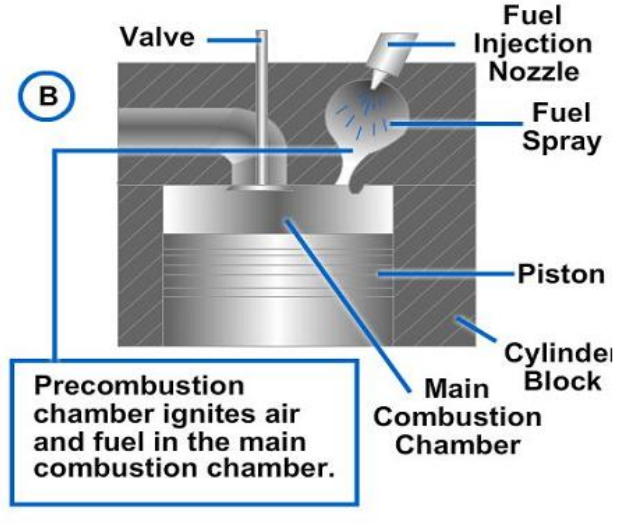
Indirect Injection Combustion Chamber

Indirect injection chambers were previously used mostly in passenger cars and light truck applications because of lower exhaust emissions and quietness. In today's technology with electronic timing, direct injection systems are superior. Therefore, you will not see many indirect injections system on new engines; they are still on many older engines.

Pre-combustion Chamber

Precombustion chamber design involves a separate combustion chamber located in either the cylinder head or wall.



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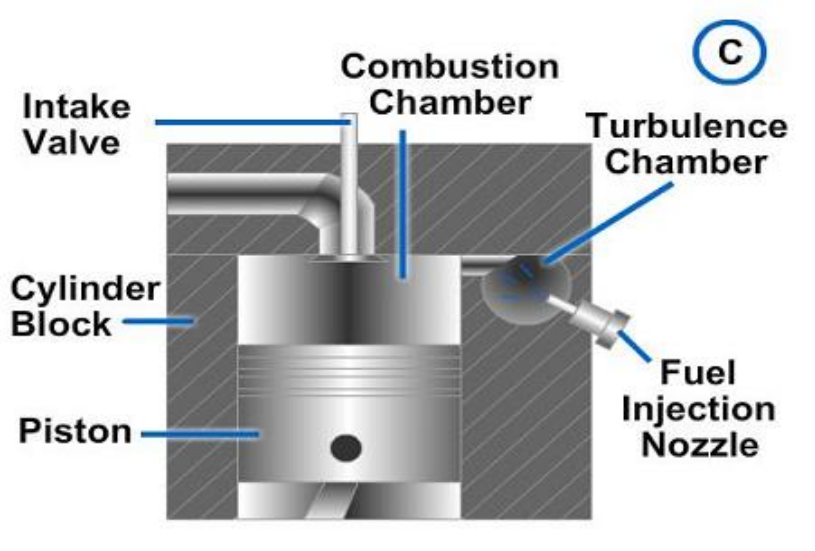
Swirl Combustion Chamber

Swirl chamber systems use the auxiliary combustion chamber that is ball-shaped and opens at an angle to the main combustion chamber. The swirl chamber contains 50% - 70% of the TDC cylinder volume and is connected at a right angle to the main combustion chamber. A strong vortex (mass of swirling air) is created during the compression stroke. The injector nozzle is positioned so the injected fuel penetrates the vortex and strikes the hot wall, and combustion begins. As combustion begins, the flow travels into the main combustion chamber for complete combustion.



Gasoline and Diesel Fuel Systems

Engine Governors

A governor is a device that senses engine speed and load, and changes fuel delivery accordingly.

A governor is needed to regulate the amount of fuel delivered at idle to prevent it from stalling. It is also required so it can cut off the fuel supply when the engine reaches its maximum rated speed. Without a governor, a diesel engine could reach maximum RPM and destroy itself quickly. The governor is often included in the design of the fuel injection system. The main reason that a diesel requires a governor is that a diesel engine operates with excess air under all loads and speeds.

Types of Governors

1- Mechanical governor
2- Servo-mechanical governor
3- Hydraulic governor
4- Pneumatic or electronic governor

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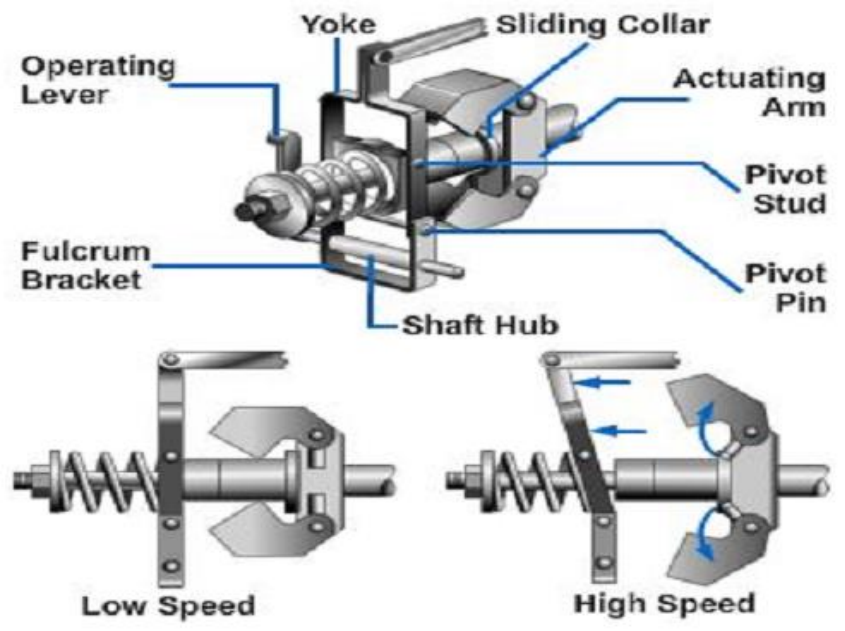
Mechanical Governors

In most governors installed on diesel engines used by the Navy, the centrifugal force of rotating weights (flyballs) and the tensions of a helical coil spring (or springs) are used in governor operation.

In mechanical centrifugal flyweight governors, two forces oppose each other. One of these forces is tension spring (or springs) which may be varied either by an adjusting device or by movement of the manual throttle.



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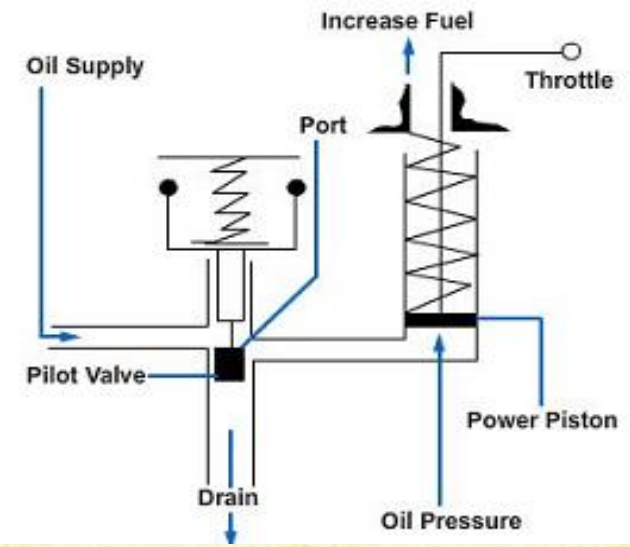
Hydraulic Governors

In hydraulic governors, the power which moves the engine throttle does NOT come from the speed-measuring device, but instead comes from a hydraulic power piston, or servomotor.

The basic principle of a hydraulic governor is very simple. When the governor is operating at control speed or state of balance, the pilot valve closes the port and there is no oil flow.

When the governor speed falls due to an increase in engine load, the flyweights move inward and the pilot valve moves down.



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Electronic Governors

The recent introduction of an electronically controlled diesel fuel injection system on several heavy-duty high-speed truck engines has allowed the speed of the diesel engine to be controlled electronically rather than mechanically. The same type of balance condition in a mechanical governor occurs in an electronic governor. The major difference is that in the electronic governor, electric currents (amperes) and voltages (pressure) are used together instead of mechanical weight and spring forces.

Gasoline and Diesel Fuel Systems

Diesel Fuel System Components

The basic fuel system consists of the fuel tank(s) and a fuel transfer pump (supply) that can be a separate engine-driven pump or can be mounted on or inside the injection pump. In addition, the system uses two fuel filters—a primary and secondary filter—to remove impurities from the fuel. In some systems you will have a fuel filter/water separator that contains an internal filter and water trap.