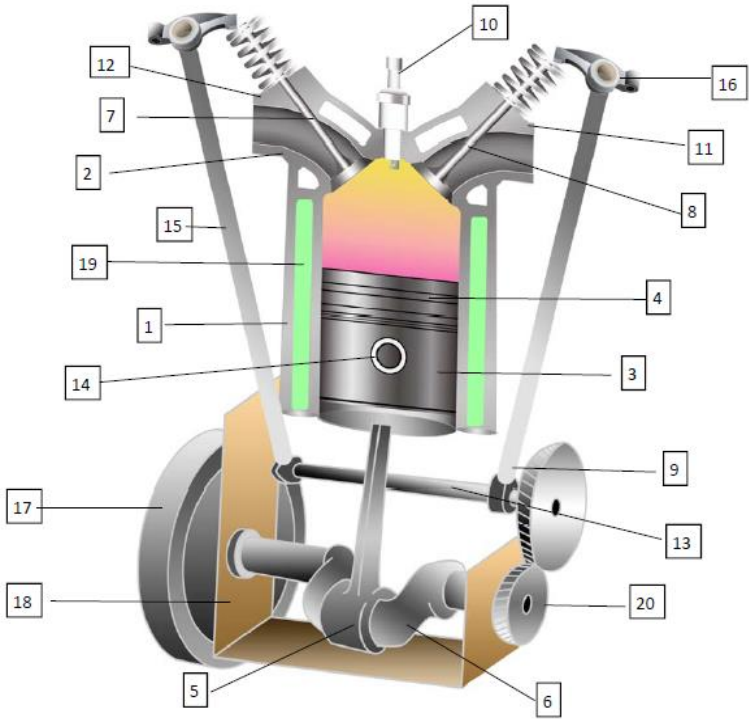
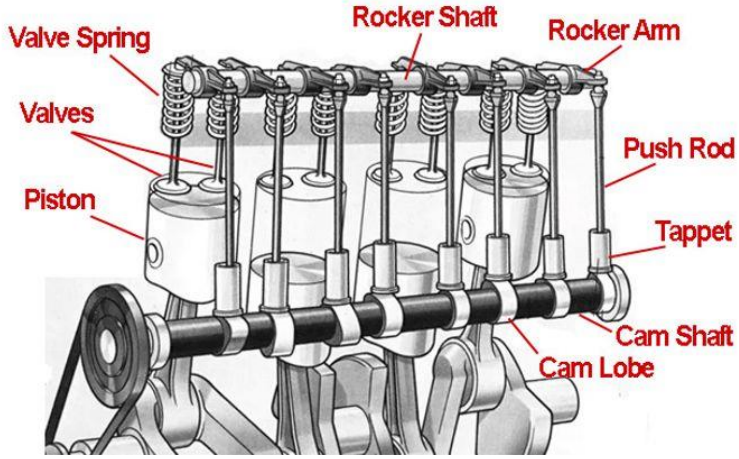
MODULE I

ENGINE PARTS



1. Cylinder Block
2. Cylinder Head
3. Piston
4. Piston Rings
5. Connecting Rod
6. Crankshaft
7. Intake Valve
8. Exhaust Valve
9. Tappet
10. Spark Plug or Injector
11. Exhaust Manifold
12. Intake Manifold
13. Camshaft
14. Piston Pin
15. Pushrod
16. Rocker arm
17. Flywheel
18. Oil Sump
19. Coolant
20. Timing Gears



1.Engine block

In an internal combustion engine, the engine block is the structure which contains the cylinders and other components

The cylinders are made of Cast iron and Cast steel by the process of casting to handle all the temperature and pressure which is generated after the combustion of fuel.

2.Cylinder head

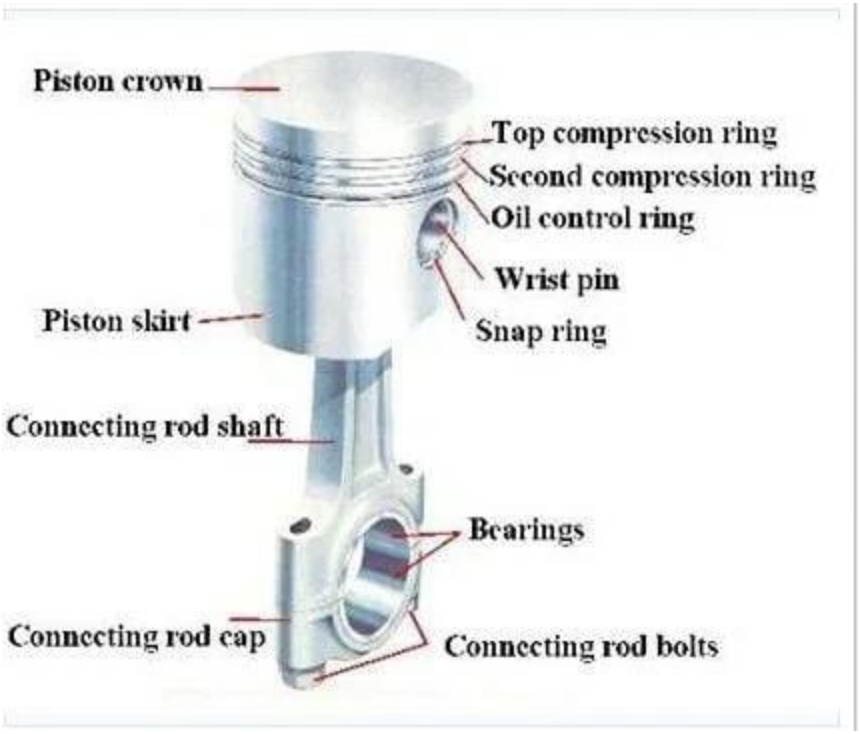
The cylinder head is the top cover of the engine cylinder which covers the cylinder from the topside to seal the cylinder and does not give a permit to air and gas to enter and exit from the system.

Made up of cast iron or aluminium alloy

3.Piston

A Piston slides inside the cylinder in reciprocating motion and transfers mechanical energy to the crankshaft with the help of connecting rod.

The piston is made up of cast iron or sometimes made of aluminum alloy.



4.Piston rings

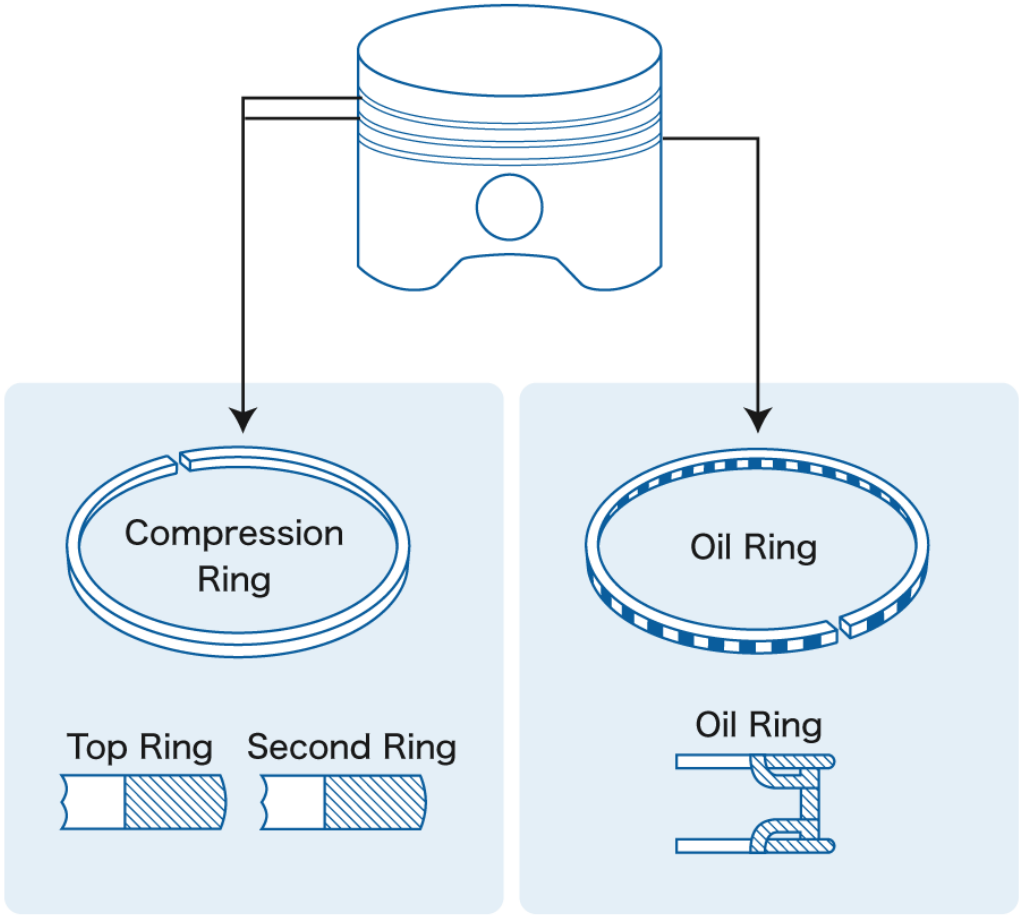
The piston rings are used to provide the sealing effect between the cylinder and the piston.

It prevents the leakage of the engine's combustion gas from bypassing the piston and also helps to overcome the friction around the piston.

Two types

1. Compression ring (prevents leakage and transfers heat from piston to the liner)
2. Oil control ring maintains the proper lubrication between the cylinder and the piston and is placed under the pressure ring

Piston rings



5.Connecting rod

A connecting rod is used to connect the piston to the crank.

made up of Low carbon steel or cast aluminum alloy

6.Crank shaft

In an engine, the crankshaft receives the power or efforts or thrust by the piston through the connecting rod and transmits this power of reciprocating motion of the piston into rotary motion of the crankshaft which is further connected to the flywheel and transmission shaft which is used to move the vehicle

made by casting and forging process using the material of alloy steel or cast iron

7.Flywheel

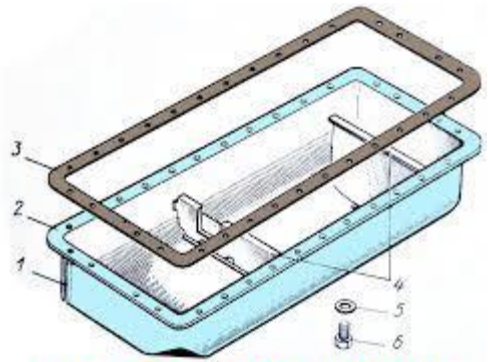
A Flywheel is an inertial (force) energy storage device.

The flywheel absorbs mechanical energy and serves as a reservoir during the period when the supply of energy is more than the requirement and releases it during the period when energy is less than required.

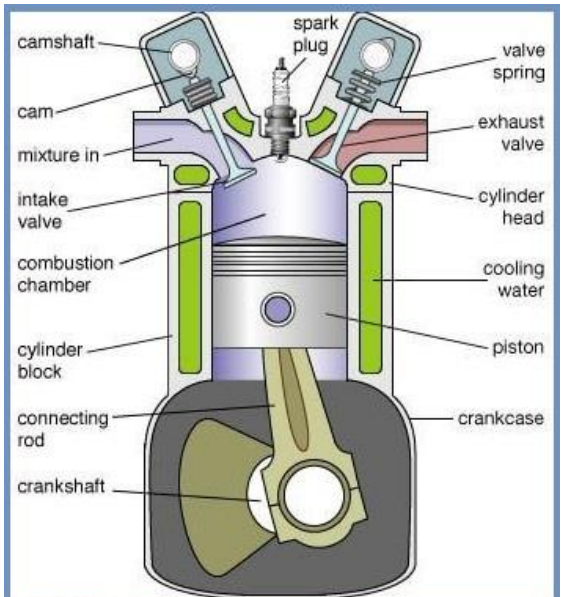
8.Crankcase

The crankcase is the housing that surrounds the crankshaft

Four-stroke engines typically have an oil sump at the bottom of the crankcase and the majority of the engine's oil is held within the crankcase.



CRANKCASE CONSTRUCTION



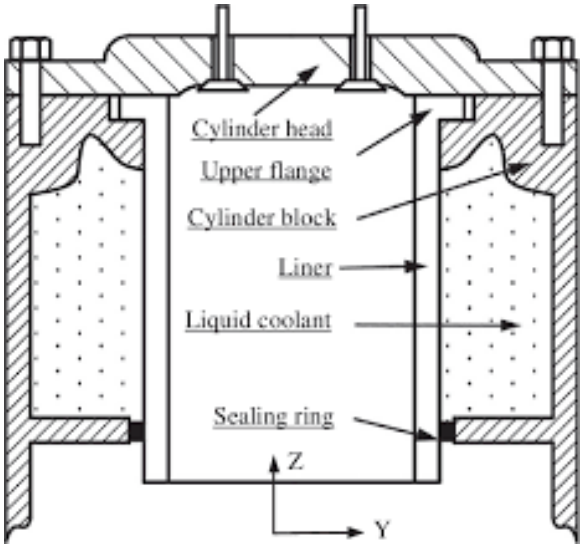
9.Cylinder liners

The cylinder liner is a sleeve in which the piston of an engine reciprocates

The use of separate barrels or sleeves, which are known as cylinder liners, provides a long life to the cylinder.

They can be removed and replaced

Made of special alloy cast iron



IC Engine Systems

- Fuel systems
- Cooling system
- Lubricating system
- Governing system
- Ignition system

Fuel system

- The system by means of which fuel is supplied to the engine according to its requirement.
- The fuel is carried in tank located at suitable Place in the vehicle. From the tank, it is fed to the carburetor or injection pump by different ways.

Fuel feed systems

1. Gravity feed system

- the fuel tank is placed at a higher level than the engine
- fuel from the tank flows through the fuel line towards the carburetor or injection pump by its own weight (gravity).

2. Vacuum feed system

- the system uses in engine manifold, vacuum to draw fuel from main fuel tank to an auxiliary tank.
- From auxiliary tank fuel is fed to carburetor float chamber by gravity.

3. Pressure feed system

- A pressure sealed fuel tank is used
- An air pump is used to maintain pressure in side the fuel tank and thus fuel flows from tank to carburetor

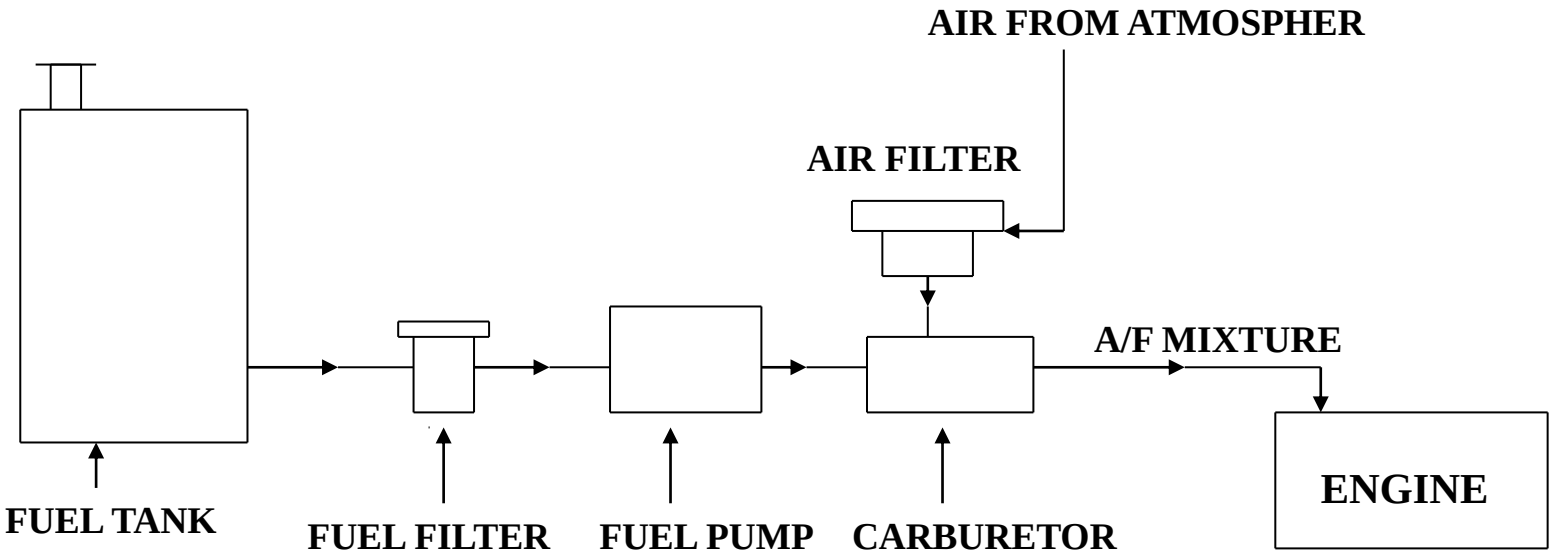
Pump system

- A fuel pump which pumps the petrol to the carburetor through a flexible pipe
- Pump is mechanical or electrically operated.

Fuel injection system

- Fuel is atomised by means of an injector nozzle and then delivered into an air stream.
- Separate injectors are used for each cylinders.

FUEL SYSTEM OF PETROL ENGINE



Main components of this system.

1. Fuel tank
2. Fuel filter
3. Fuel pump
4. Carburetor
5. Air cleaner
6. Fuel gauge.

Simple carburetor

- Main parts – float chamber, fuel jet, venturi, nozzle and a throttle valve.
- Float in the float chamber keeps the fuel level in desired level.
- The level of fuel is slightly below the out let of nozzle to prevents the fuel from spilling out when the engine is not working.
- A small vent in the float chamber keeps pressure inside as atmospheric pressure.

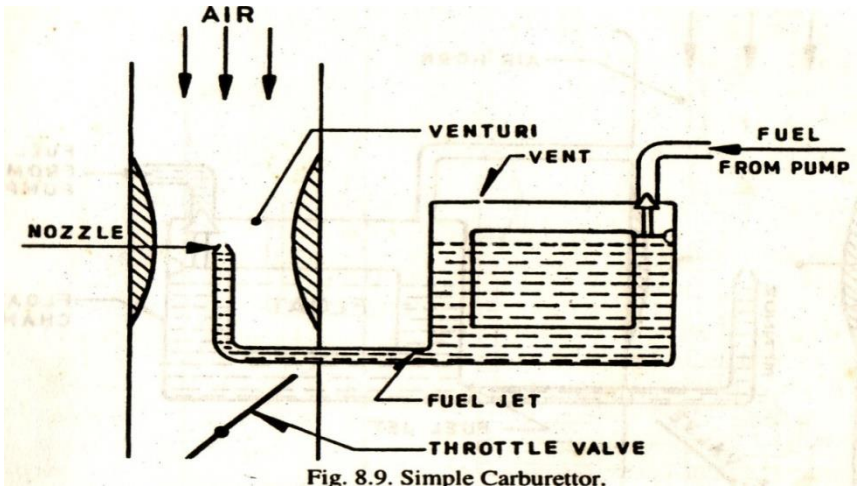


Fig. 8.9. Simple Carburettor.

Working

- flow of fuel is metered by fuel jet and fuel flows to the venturi through the discharge nozzle.
- venturi is simply a restriction in air passage.
- at less area of venturi the air velocity increases and pressure decreases where the nozzle is located.
- this depression being applied at the nozzle, the fuel comes out and vaporized by the coming air stream.
- The mixture then goes through inlet manifold to the engine cylinder.

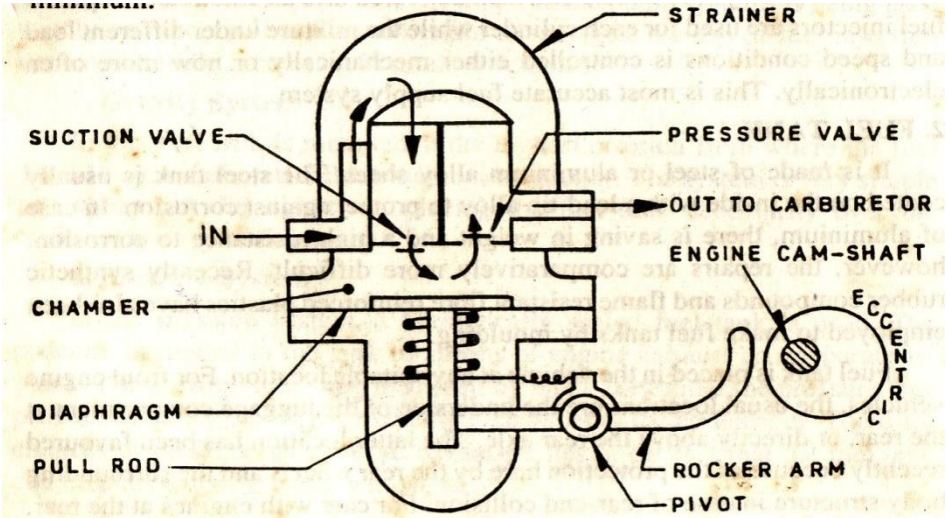


Fig. 8.2. A.C. Mechanical pump.

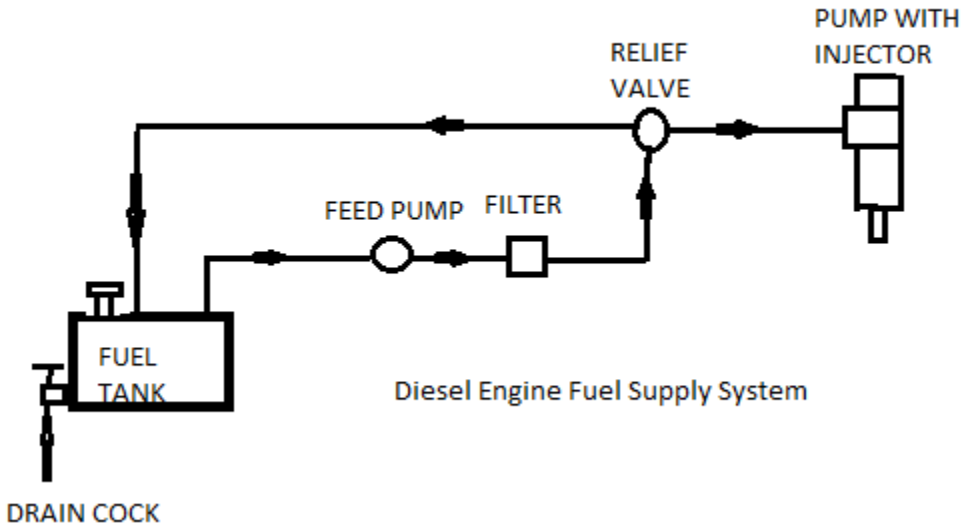
A C Mechanical pump (fuel pump)

- a diaphragm type of pump
- diaphragm is made up of high-grade cotton impregnated with synthetic rubber.
- valves are made of bakelite, to reduce weight and inertia stresses.
- pump is driven by cam shaft by means of an eccentric or cam.
- eccentric operates rocker arm which pushes the diaphragm up and down.
- downward movement of diaphragm opens the inlet valve and allow the fuel to go in chamber through strainer.
- upward movement of diaphragm closes the inlet valve and opens the out let valve allow the fuel goes to carburettor.

Mixture strength requirements

- it depends on different speed, temperature, load conditions on engine.
- at start condition rich mixture is required, because the engine is cold so the fuel does not vapourize properly. (air fuel ratio is 9:1)
- at idling condition rich mixture (air fuel ratio is 12:1) is required but not as rich as starting. It is due to over come the frictional power and reaching the normal temperature.
- 14.6 : 1 air fuel ratio which would give chemically complete combustion of petrol under ideal condition the mixture is known as **stoichiometric mixture.**
- For intermediate speeds, between 35 to 105km/hr the mixture further leans out 15:1.
- At higher speeds 120 to 150km/hr, with a wide open throttle, the mixture is again enriched to about 13:1
- For normal part throttle operation at cruising speed a comparatively lean mixture is required (15:1 air fuel ratio)
- For full throttle, rich mixture is required (air fuel ratio is 12:1)

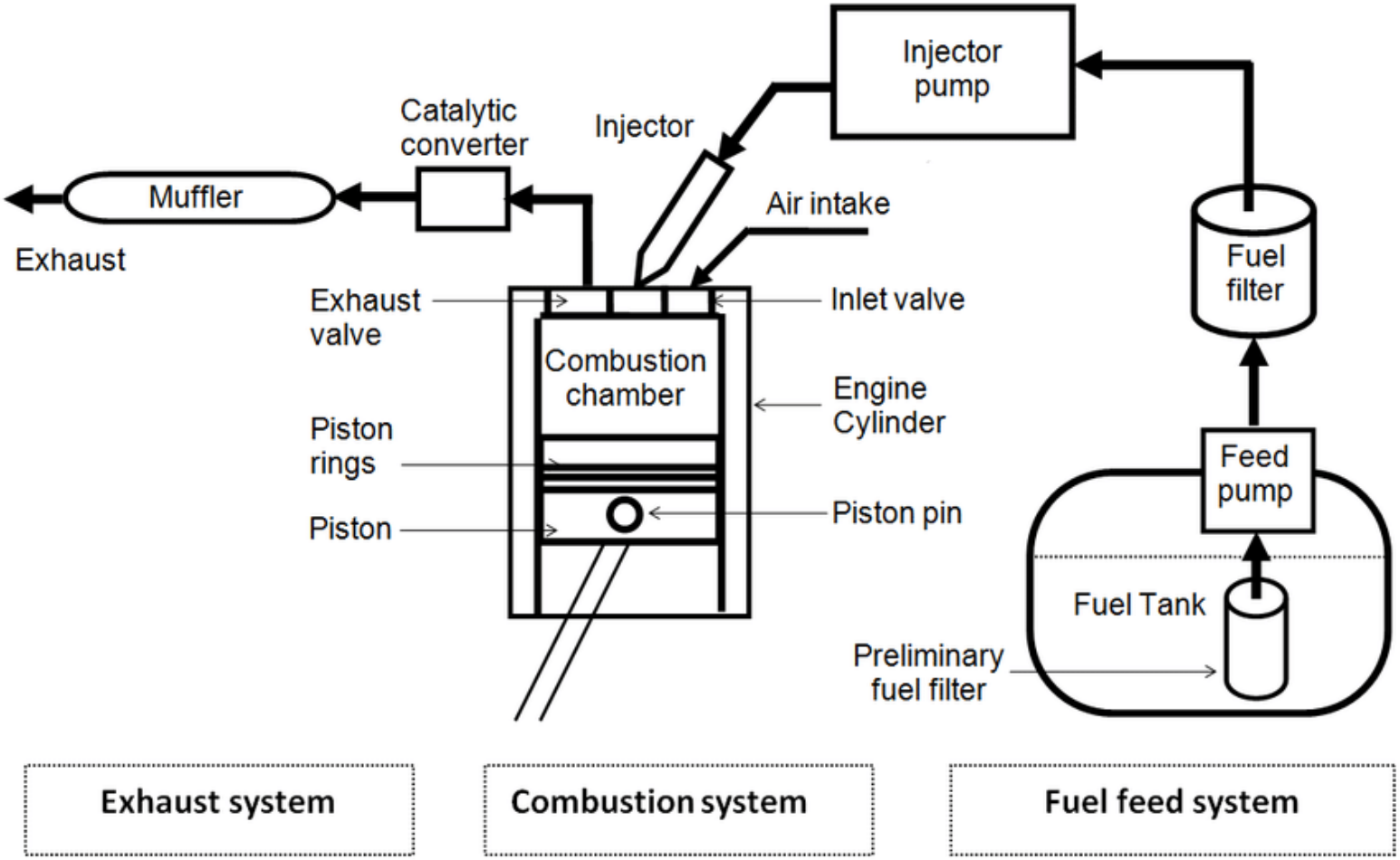
FUEL SYSTEM OF DIESEL ENGINE



Diesel Engine Fuel Supply System

Main components of fuel system in CI Engines

- Fuel tank
- Fuel feed pump
- Filter
- Injection pump
- Injector


Injector pump
Catalytic converter
Injector
Muffler
Air intake
Exhaust
Fuel filter
Exhaust valve
Inlet valve
Combustion chamber
Engine Cylinder
Piston rings
Feed pump
Piston pin
Piston
Fuel Tank
Preliminary fuel filter
Exhaust system
Combustion system
Fuel feed system

Fuel tank

Made of steel metal. Usually of rectangular or barrel shaped. It is reinforced by means of baffle plates to avoid splashing and surging of fuel. It consist of a neck for pouring fuel, a drain hole to remove fuel, an out let connection for the fuel line.

Fuel filter

It filters fuel before it goes to the injector. it consist of filtering element which removes dirt and contaminations in fuel.

Feed pump

It is used to draw the fuel from the tank and feed to the injector.

Fuel injection pump

The fuel injection pump serves the supply of metered quantity of fuel into engine cylinder.

Fuel injector

The function of fuel injector is to spray the high pressure fuel into the engine cylinder

FUEL FEED PUMP

When cam rotates, plunger moves upwards.

Inlet valve closes and fuel forced through outlet valve

Then the plunger moves downwards.

Creates lower pressure, fuel enters into the chamber through inlet valve.

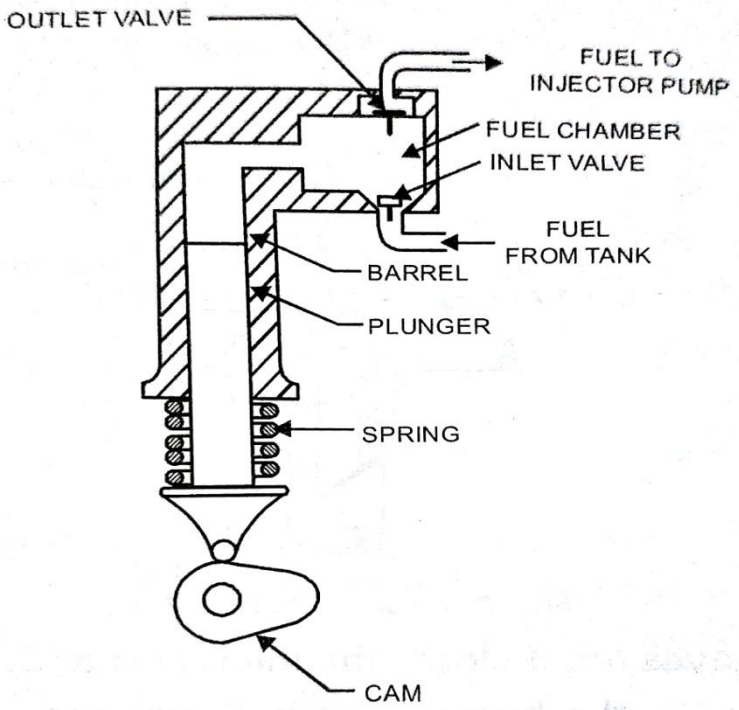
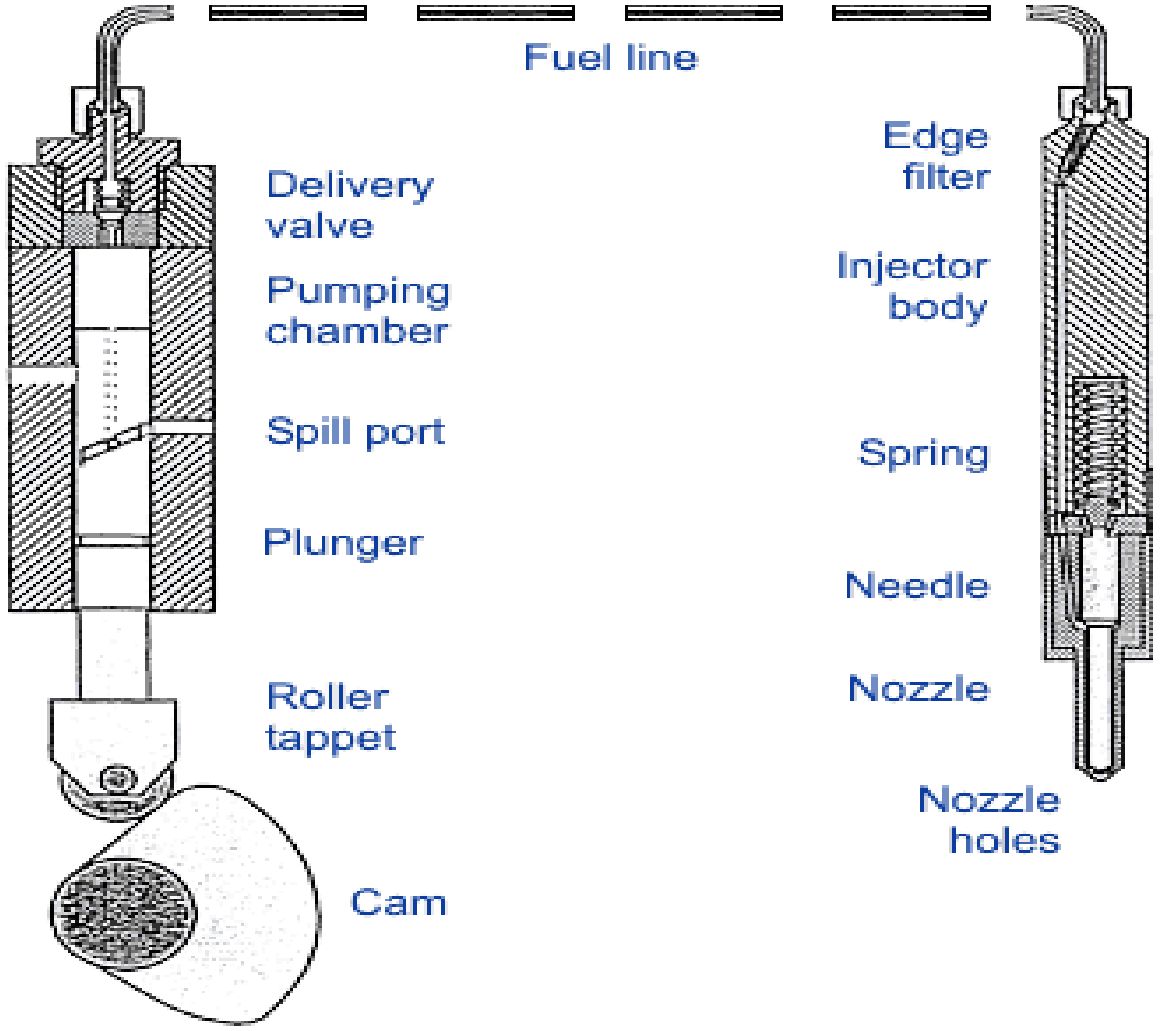
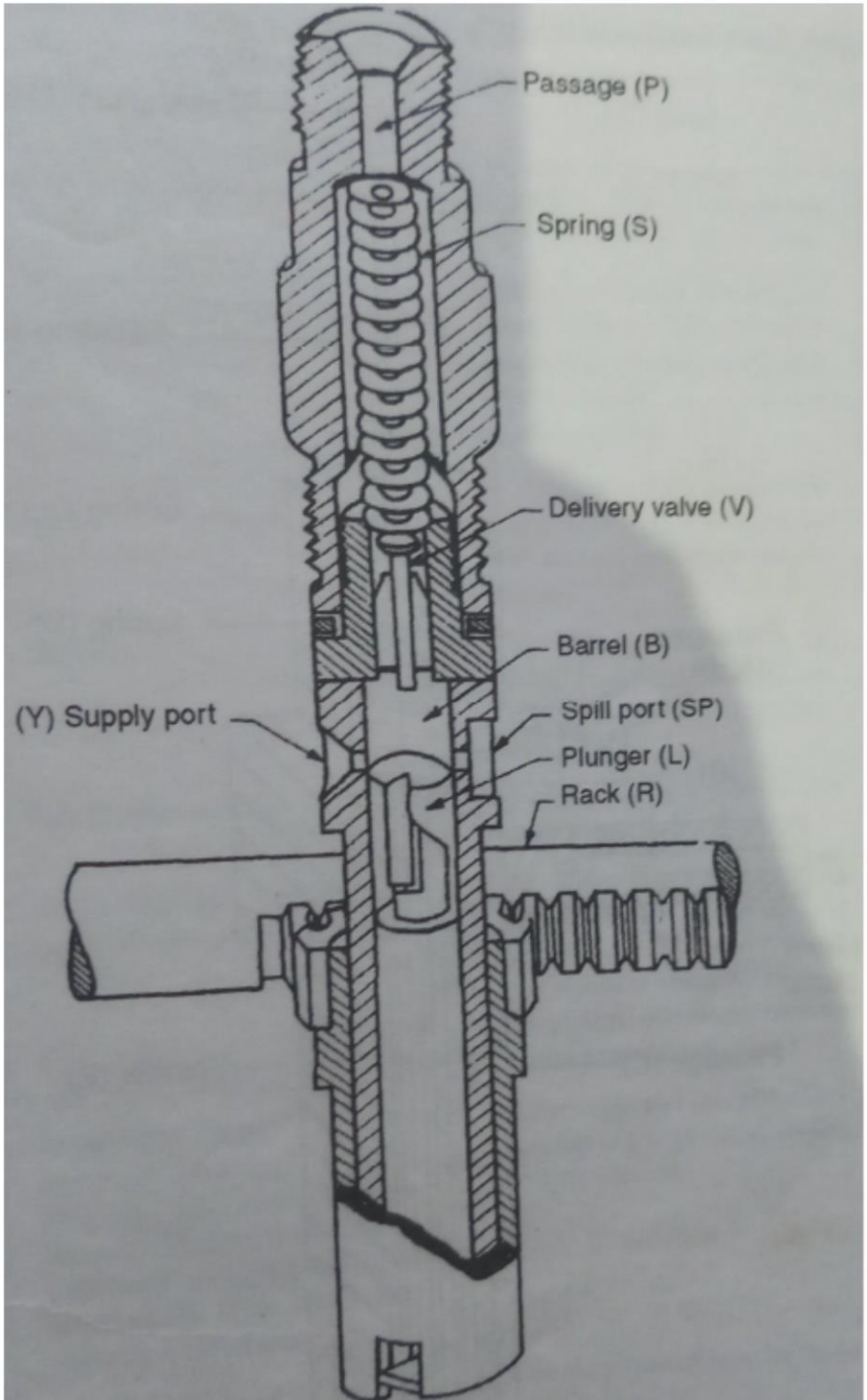


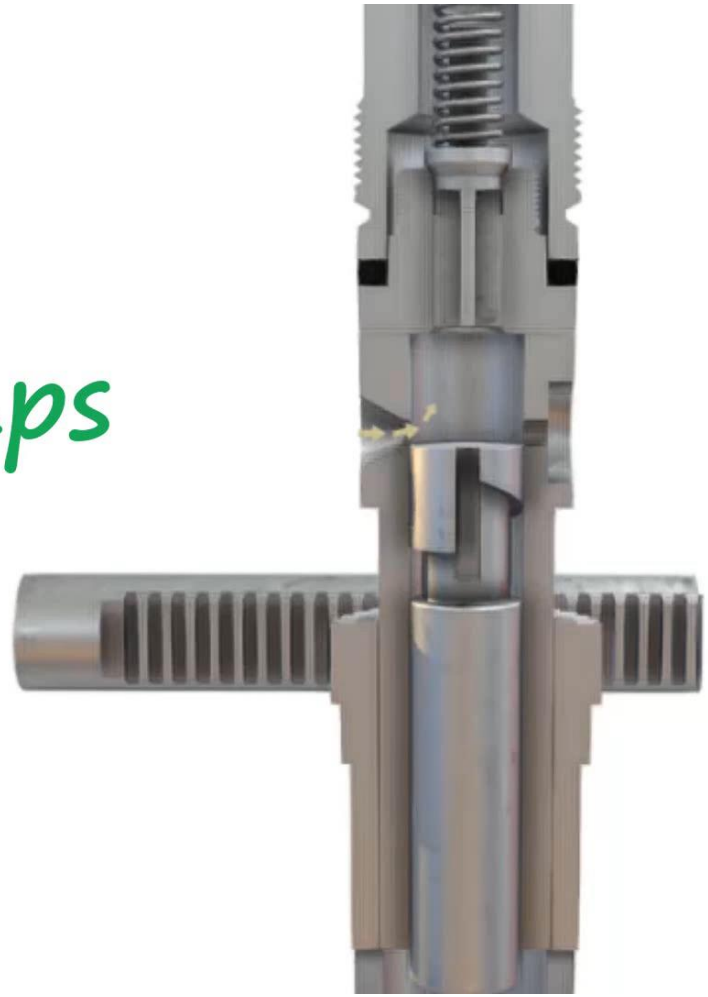
Fig. 2.2 Fuel Feed Pump

Fuel injection pump




Passage (P)
Spring (S)
Delivery valve (V)
Barrel (B)
(Y) Supply port
Spill port (SP)
Plunger (L)
Rack (R)

How Helix Fuel Pumps Work!



- Comprises of a plunger reciprocating in a barrel.
- Cylindrical barrel with 2 diametrically opposite ports (inlet and spill).
- Upper portion of plunger is provided with vertical groove.
- Plunger is turned by rack and teethed segment.
- As the plunger moves upwards, both valves closes and allow fuel to enter into fuel injector at high pressure.
- As soon as the spill port uncovers, the fuel passes through the vertical grove to the spill port.
- Thus quantity of fuel delivered is controlled.

Fuel Injector

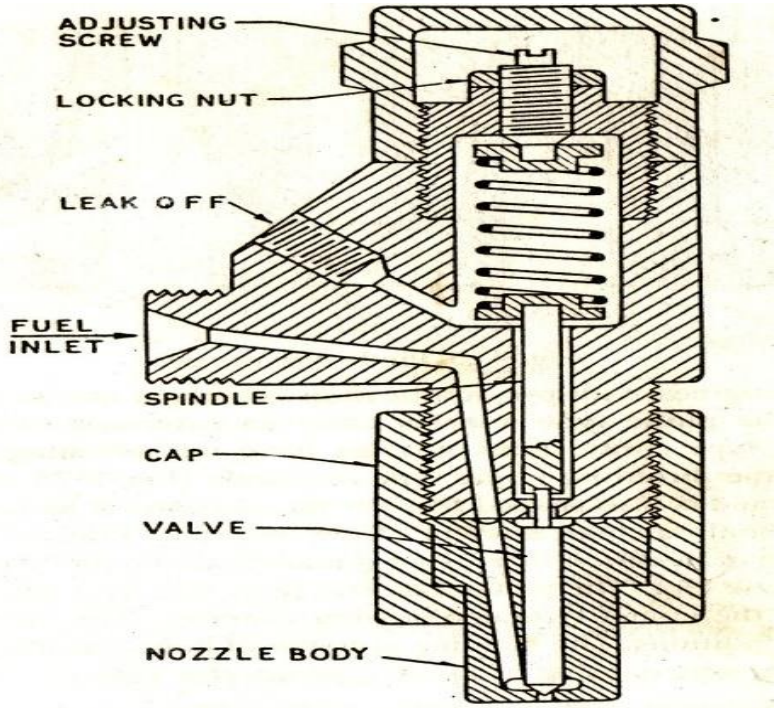


Fig. 9.23. Fuel injector (Bosch type).

Nozzle and nozzle holder are the main parts. A spring loaded spindle press the nozzle valve against its seat. This provides sufficient pressure for fuel injection and spray of atomised fuel is fed into combustion chamber. The fuel from injector pump enters through fuel inlet, and is directed down to a space below the nozzle valve. Due to high pressure of fuel, the valve is lifted against the spring pressure which can be adjusted by means of adjusting screw. The fuel is then sprayed through nozzle to the combustion chamber. Any leakage of excess fuel is taken off through the leak of pipe.

Fuel filters

1.Primary filter

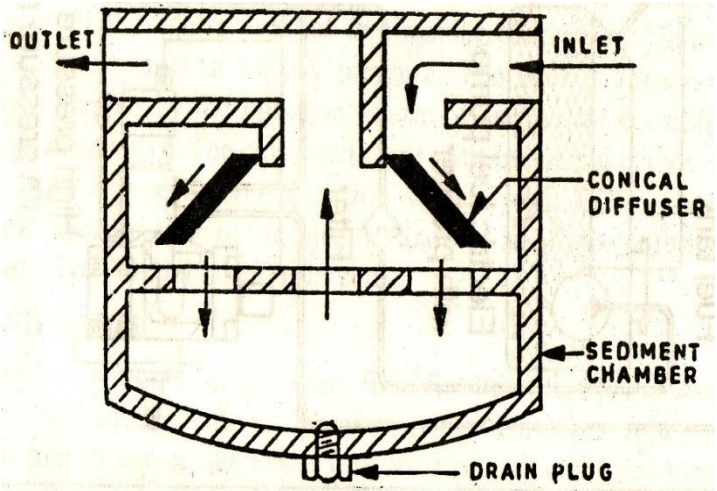
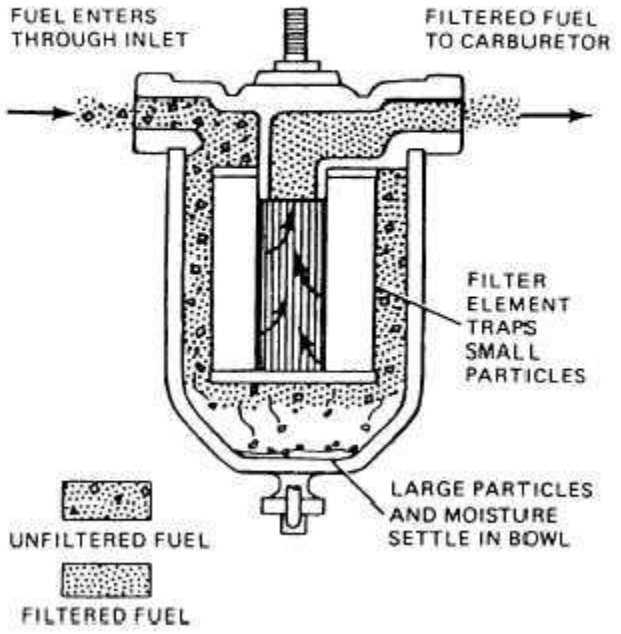


Fig. 9.7. Sedimentation type primary filter.

Fuel from the fuel tank enters the filter and flows around the conical diffuser and accelerated to sediments chamber. Impurities settled down at bottom of the chamber. Impurities settled down can be drained off periodically. Clean oil passes to the outlet of the filter.

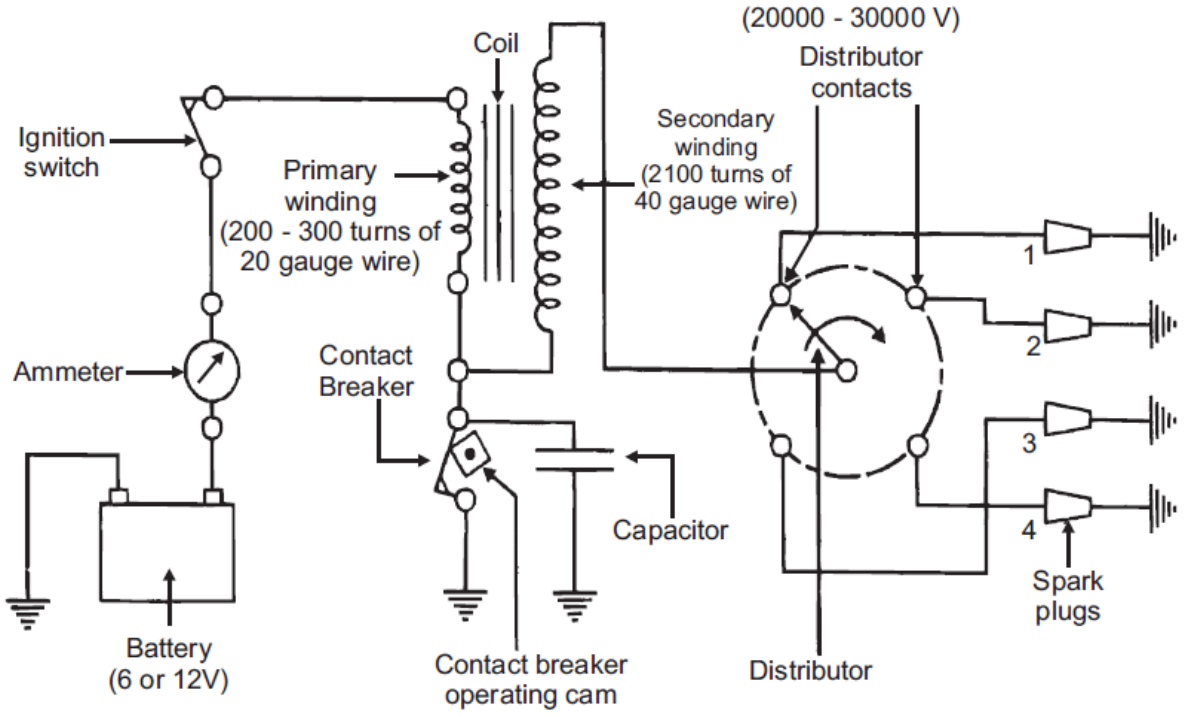
Secondary filter



Ignition system of SI engine

- An ignition system must provide a source of electrical energy, a means of boosting the low voltage from the source and a means for timing and distributing high voltage to each spark plug. Generally 2 types…
- Battery ignition
- Magneto ignition

1.Battery ignition system (Coil Ignition system)



Firing 1-3-4-2 or
1 -2 -4 -3

- The system has a primary circuit and secondary circuit.
- Primary circuit consists of battery, ammeter, ignition switch, primary coil, condenser and breaker points.
- Secondary circuit consists of secondary coil, distributer and spark plug.
- One end of the primary winding is connected to the positive terminal of battery and other end to the contact breaker.
- Contact breaker points are operated by cam.
- Condenser is connected parallel to the contact breaker points.

Working

When the ignition switch is closed and engine in cranked, as soon as the contact breaker closes, a low voltage current will flow through the primary winding. It is also to be noted that the contact beaker cam opens and closes the circuit 4-times (for 4 cylinders) in one revolution. When the contact breaker opens the contact, the magnetic field begins to collapse. Because of this collapsing magnetic field, current will be induced in the secondary winding. And because of more turns (@ 21000 turns) of secondary, voltage goes unto 28000-30000 volts.

Adavantages

- Low initial cost
- Provides better sparks at low speeds
- Simple design
- Maintenance cost is low

Limitations

- Engine cannot be started if the battery is weak
- Not suitable for aero engines
- Breaker points are subjected to wear

COOLING SYSTEM

Functions of cooling system:

- To keep the temperature of cylinder below certain limit.
- To dissipate the excess heat from the cylinder wall.
- To resist the burning of lubricant, thereby avoid piston and cylinder damage.

Methods of cooling

- Air cooling
- Water cooling

Air cooling

In air cooling method current of air flowing continuously over the heated metal surface, in this way the heat is removed and it is by conduction convection heat transfer method.

Rate of heat dissipation is depends on following factors :

- Surface area of metal into contact with air.
- Mass flow rate of air.
- Temperature difference between the heated surface and air.
- Conductivity of metal.

For effective cooling, air contact area on metal surface should be increased by using fins on the cylinder barrels.

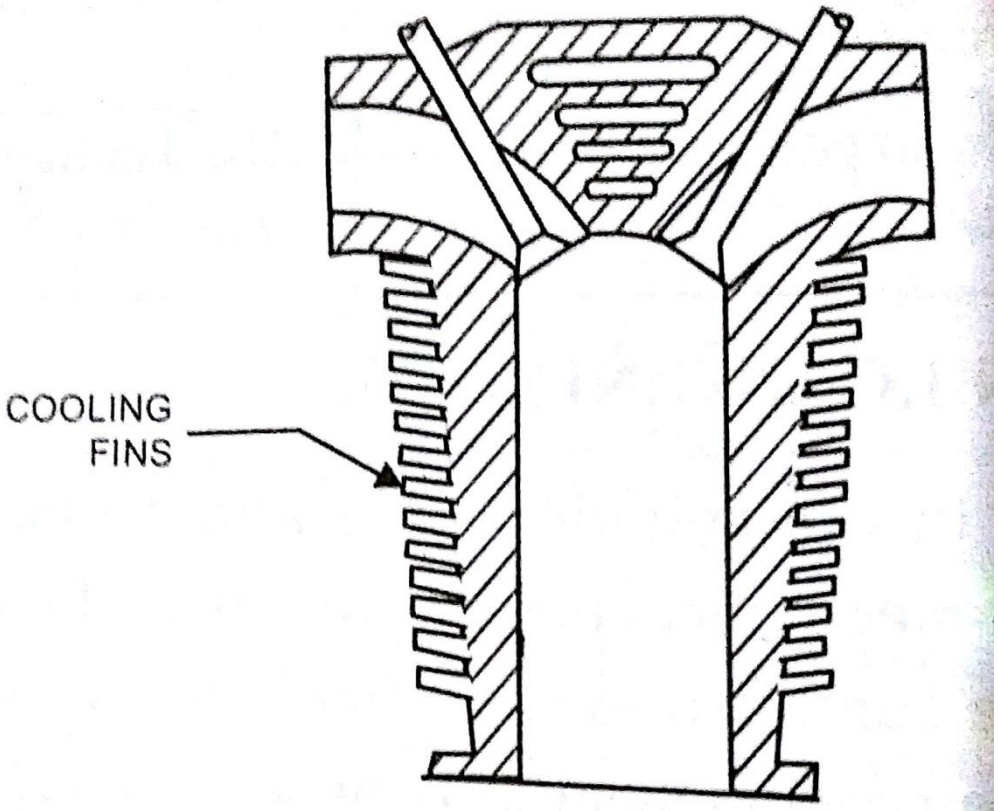
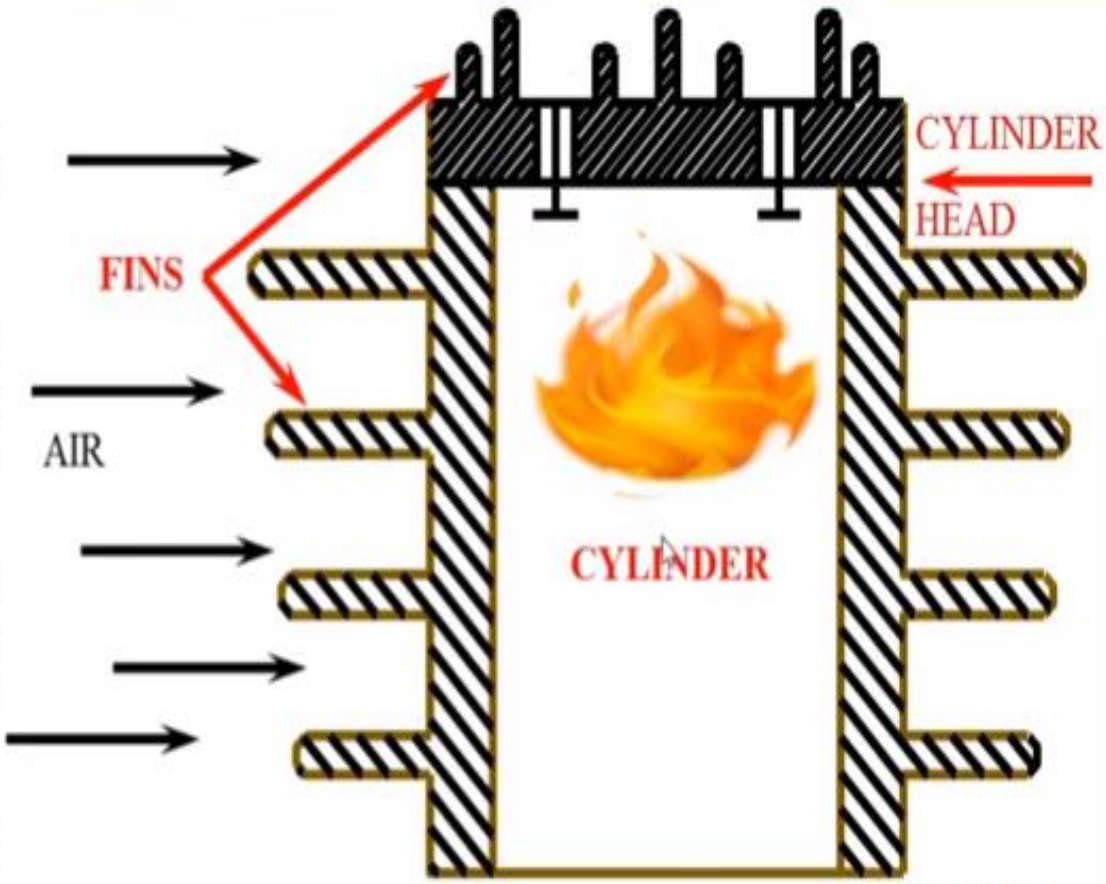


Fig. 2.15 Air Cooling

Air Cooling System

AIR COOLING

- In this method , heat is carried away by the air flowing over and around the engine cylinder.
- It is used in motorcycles, scooters, etc.
- In order to have efficient cooling by means of air, providing fins around the cylinder and cylinder head increases the contact area.
- The fins are metallic ridges, which are formed during the casting of the cylinder and cylinder head as shown in fig.
- Heat generated due to combustion in the engine cylinder will be conducted to the fins and when the air flows over the fins , heat will be dissipated to air.
- The fins are arranged in such a way that they are at right angles to the cylinder axis.



BEST
MECHANICAL ENGINEERING

Advantages:

- Lighter in weight – absents of radiator, cooling jackets and the coolant.
- Can operated in extreme climates – where the water may freeze.
- The system is advantage – where the scarcity of cooling water.
- Maintenance is easy – because there is no leakage problem.
- Engine warming up is easier than water cooled engines.

Disadvantages ;

- Even cooling all around the cylinder is not easy
- Efficiency of cooling is lesser, because of lower coefficient of heat transfer of air.
- Use of fan may cause power lose in engine.
- Air cooled engines are more noisy
- Under certain conditions fins around the cylinder may vibrate that may cause of increased noise level.

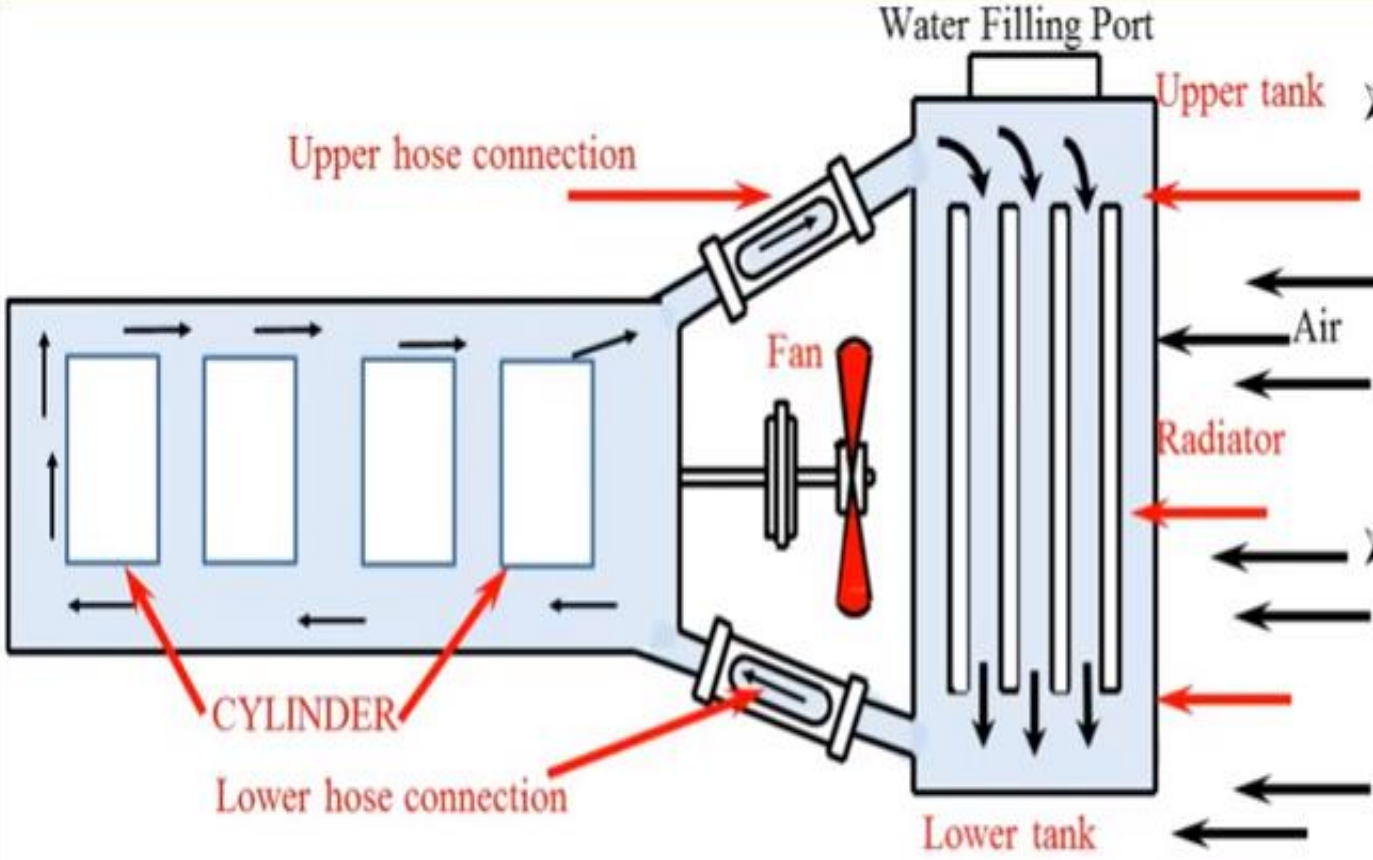
Water cooling

A cooling medium is used – engine cylinders are surrounded by water jacket – heat flows from the cylinder wall to water - hot water goes to radiator from it loses its heat to the air. Antifreeze element added water is known as coolant.

Types of water cooling system :

1. **Thermosyphon (Gravity circulation) system**
2. **Forced circulation system**

Thermo Syphon Cooling

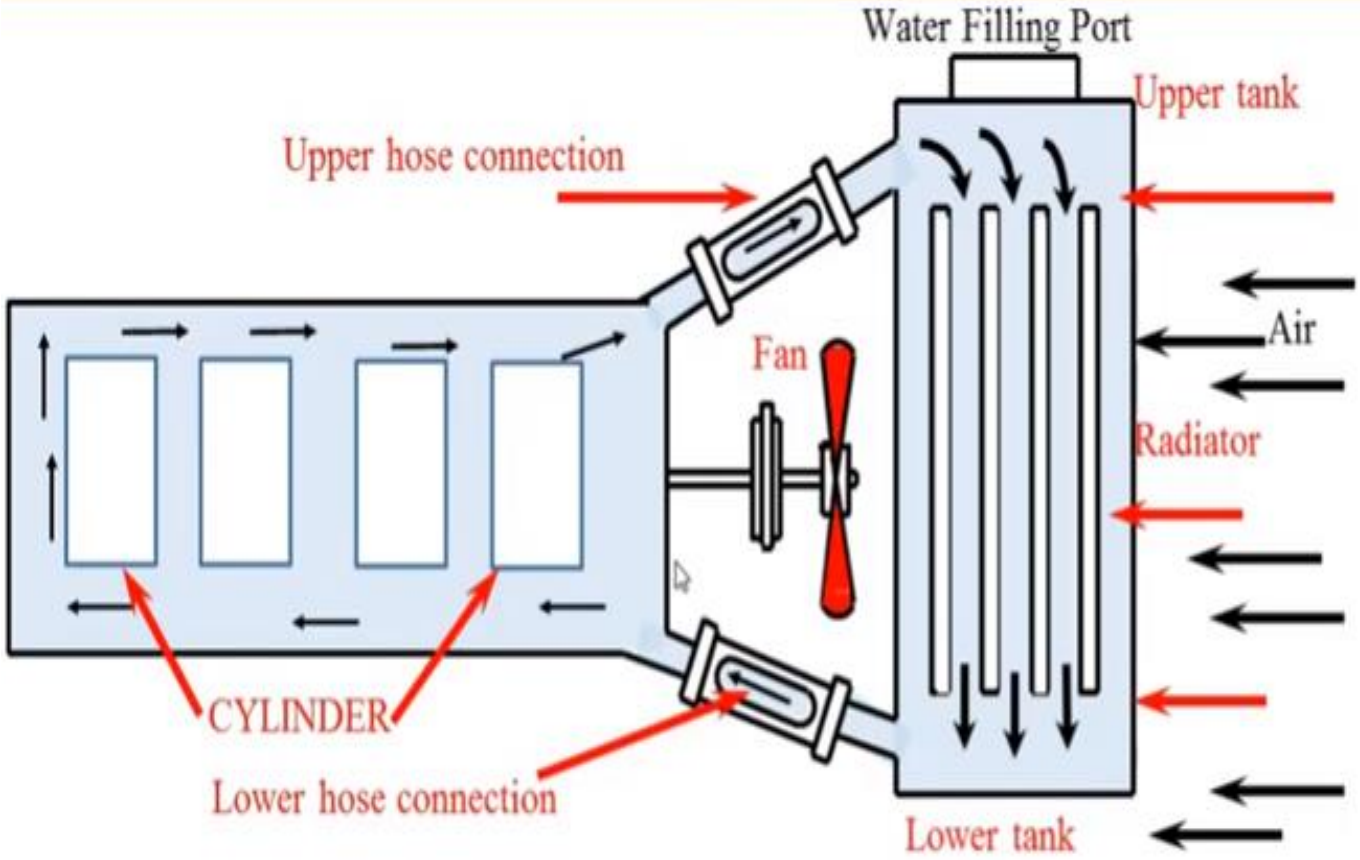


- The system is so designed that the water may **circulate naturally** because of the density difference of hot water and cold water.
- Fig. shows the schematic arrangement of an engine cooled on thermo-syphon principle.

- The system consists of a radiator having upper and lower tanks connected to upper and lower water jackets of the cylinder respectively through pipes.
- The hot water in the jacket rises and flows into the upper tank due to lower density compared to cold water and the cold water from radiator flows to lower water jacket to replace the hot water.

BEST
MECHANICAL ENGINEERING

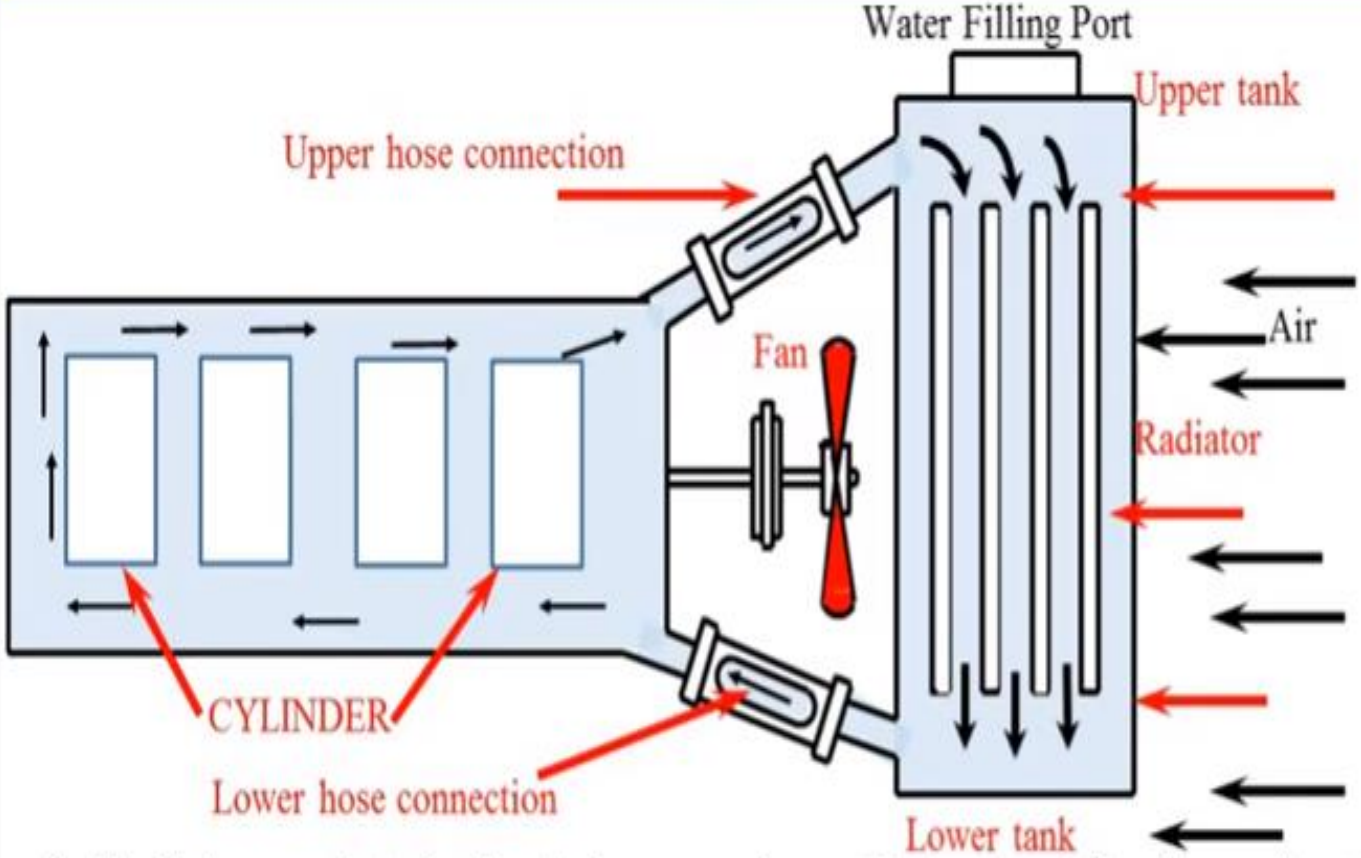
Thermo Syphon Cooling



- From upper tank the water travels down the radiator tubes across which the cool air passes drawn by the fan driven by the engine crankshaft.
- In order to increase the rate of heat transfer, the surface area of the radiator exposed to the air blast is provided with fins.
- System is suitable for low capacity engines only *limitation of system.*

BEST
MECHANICAL ENGINEERING

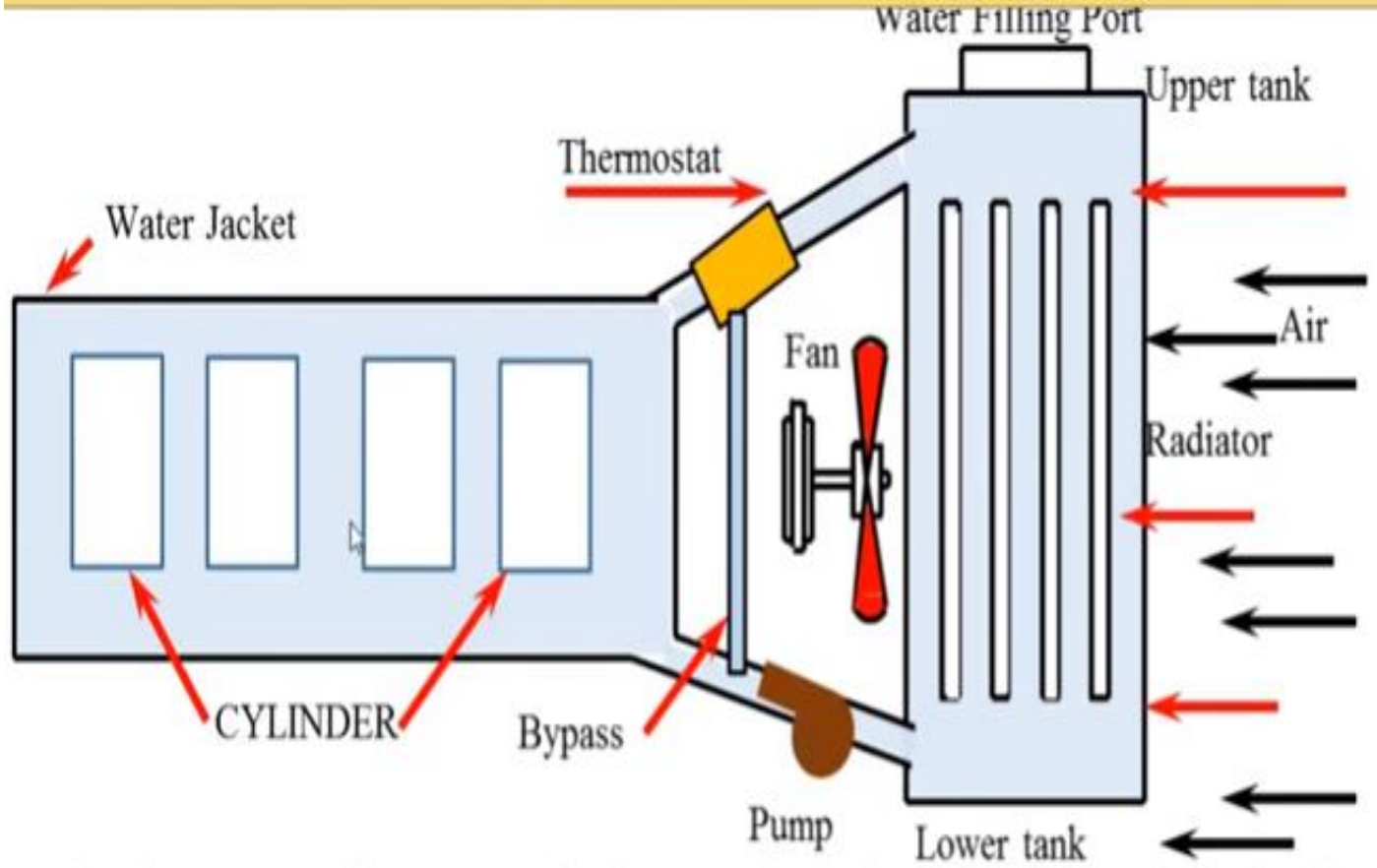
Thermo Syphon Cooling



- Radiator needs to be kept above engine cylinder level for flow of water to the engine under gravity for its efficient functioning.
- Circulation of water is established only when engine becomes hot.
- Not suitable for heavy duty engines where very high heat transfer rates are required.

BEST
MECHANICAL ENGINEERING

Forced Circulation Thermo stat Cooling System

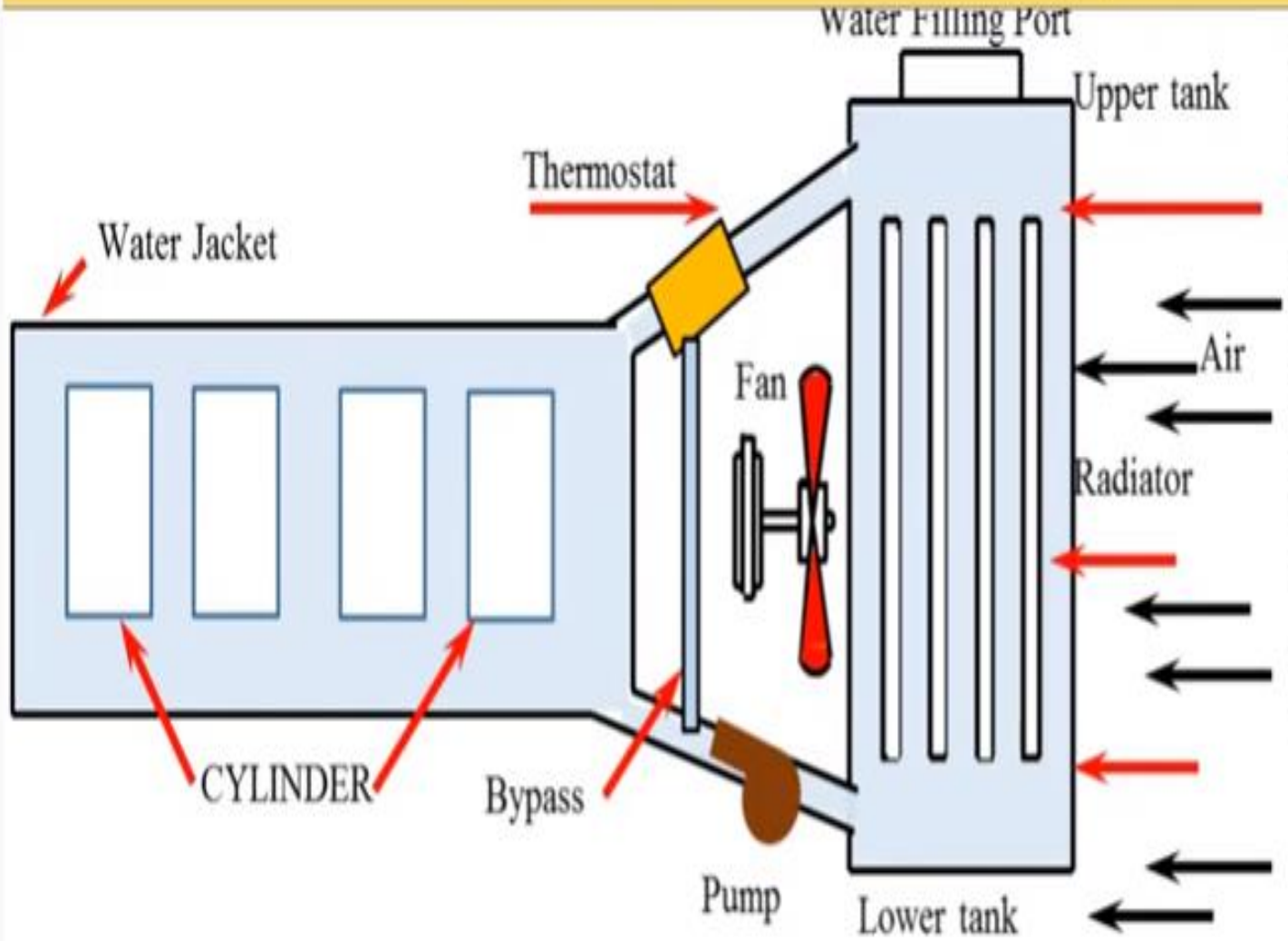


In the thermostat cooling system, the thermostat is used to maintain a predefined minimum water temperature around the engine cylinder, therefore no cold starting problem during the cold weather.

The thermostat cooling system consist of pump, radiator, thermostat, and fan as shown in fig.

The function of pump is to circulate the water through the water jacket to remove the heat from the engine and through the radiator where is cooled by the flow of air over radiator.

Forced Circulation Thermo stat Cooling System



The thermostat is temperature operated valve and fitted in the upper hose connection,
It prevents the circulation of water below a certain temperature (usually upto 85^0C) through the radiator so that water in the jacket gets heated up quickly.

Thermostat

It automatically keeps the cooling water temperature at a predetermined value.

Types of thermostats

1. Bellows type or aneroid type
2. Wax thermostat

1.Bellows type thermostat

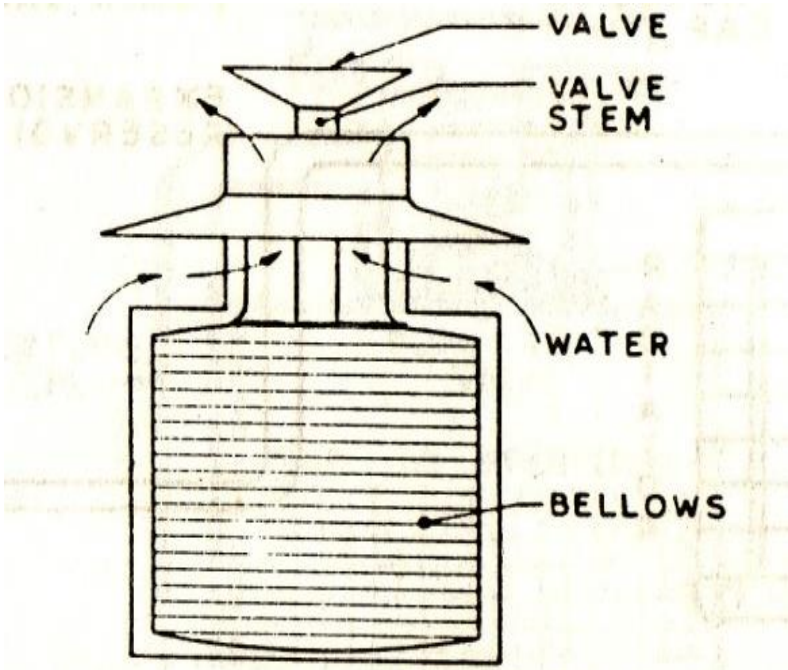
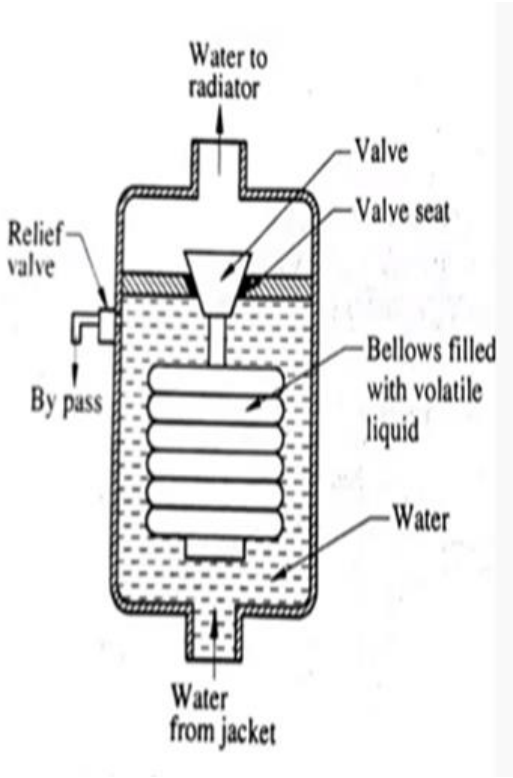


Fig. 5.12. Bellows type Thermostat.

- Thermostat valve consists of thin copper tubes bellows partially filled with a volatile Liquid (ether or methyl alchohol)
- This volatile liquid evaporates at a particular temperature
- During warm up period (Starting of engine) ,the valve remains closed
- As the engine runs the water is pumped which raises the pressure of water
- This causes the pressure relief valve to open
- So the pump circulates water through water jackets only
- The water does not pass through radiator,hence cooling will not take place



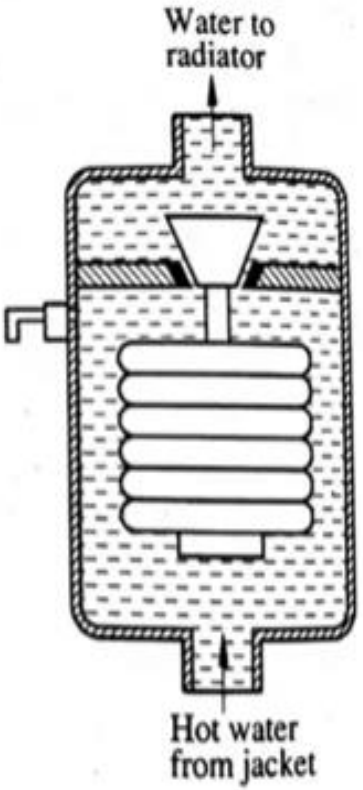
When engine is reached at normal operating temperature (say 85^0C),

The volatile liquid in the thermostat valve is vaporised , thus creating enough pressure inside the bellows to expand and lift the valve as shown in fig.

Hence thermostat valve is opened and water pressure falls, relief valve closes, hence the water circulated through radiator, engine cooling comes in action.

This type of cooling system is used for automobiles as well as standby diesel power plant upto 200 KVA.

In case of larger diesel power plant, this system is used with cooling tower instead of radiator.



2.Wax thermostat

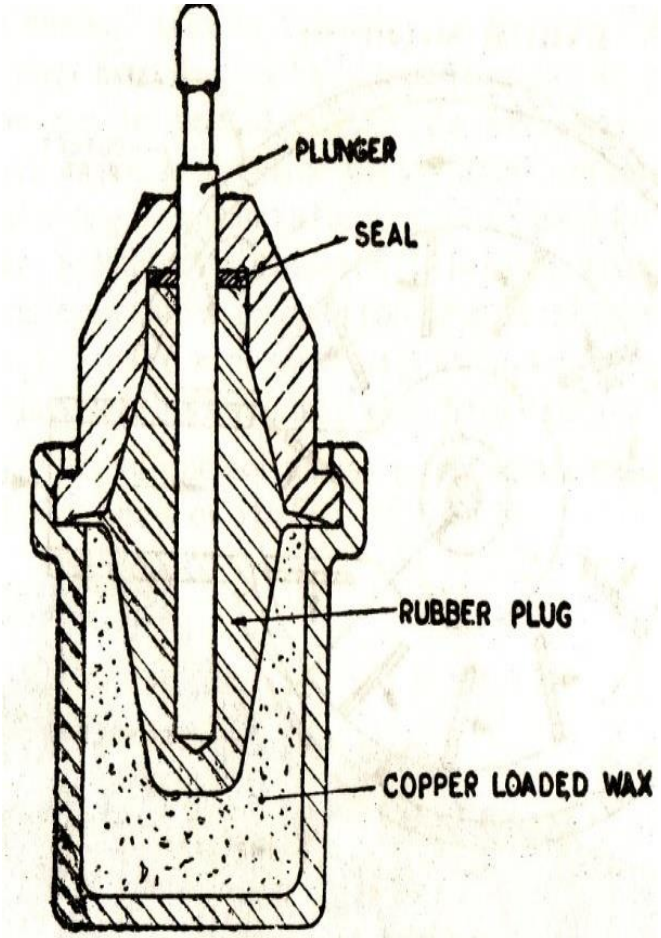
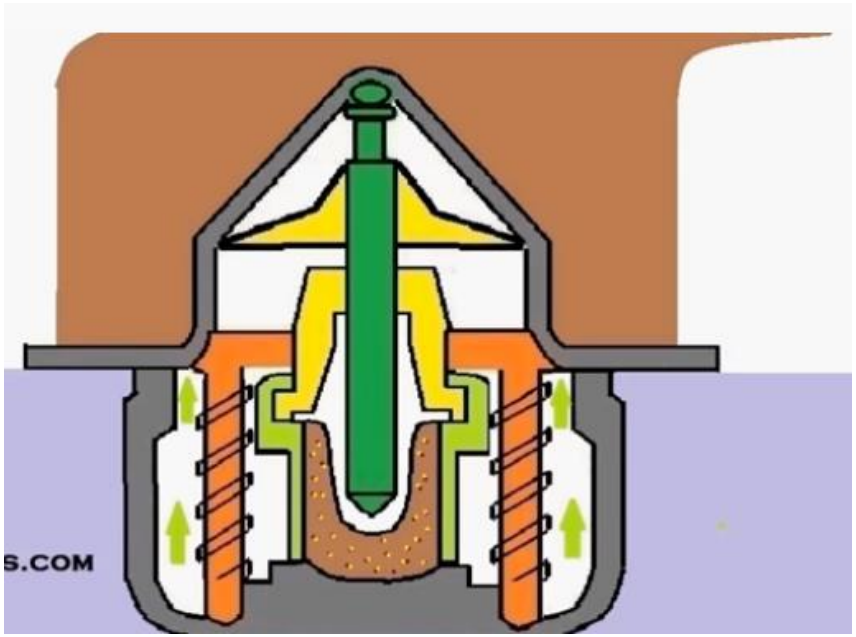
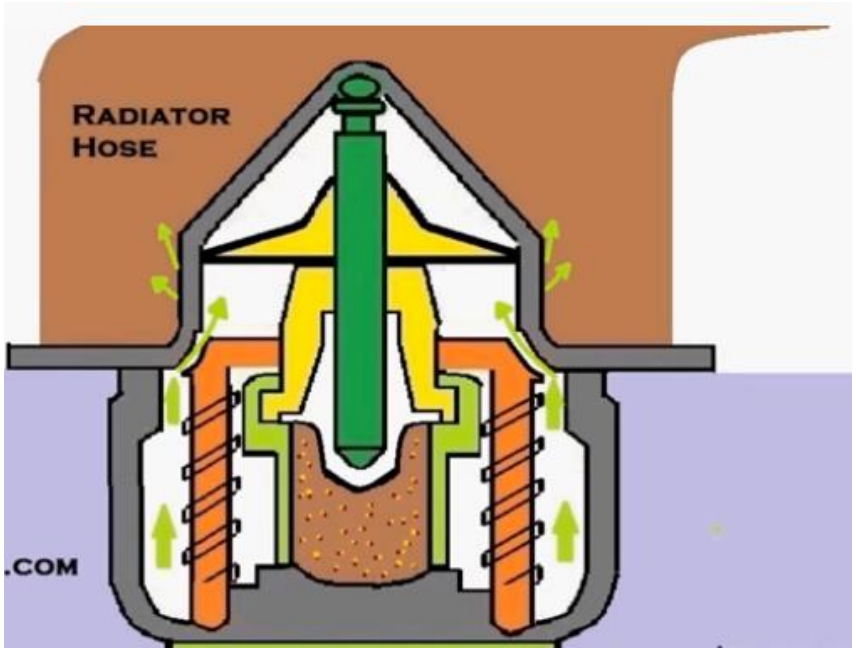


Fig. 5.14. Dole Thermostat.

- Heat of the coolant transmitted to the copper – loaded wax having high coefficient of thermal expansion which expands so that the rubber plug exerts a force on plunger which moves upwards. This movement of the plunger opens the thermostat valve to allow coolant to flow through the radiator.




RADIATOR
HOSE

Radiators

Function :

- To ensure close contact of the hot coolant with outside air
- To ensure high rate of heat transfer.

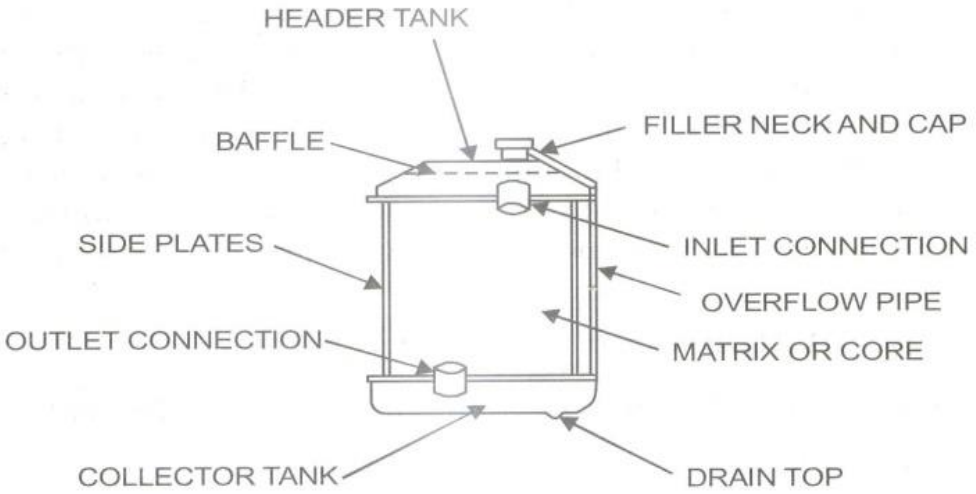


Fig. 2.36 Radiator

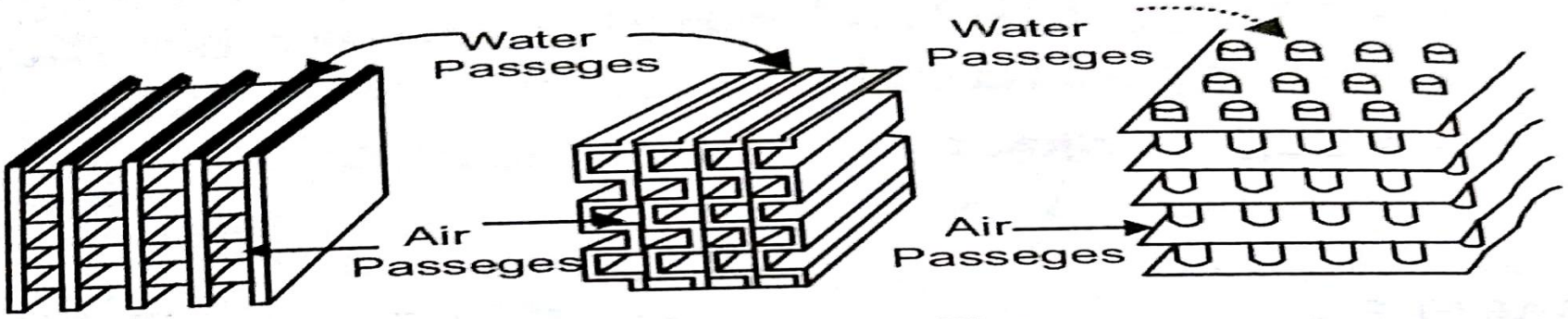
Parts: upper tank (header), core, lower tank (collector), over flow pipe in the header tank, drain pipe in the lower tank.

Working: Hot coolant from engine enters the radiator at the top – flowing down through the radiator- coolant cooled down by cross-flow of air – coolant collects at collector tank – then pumped to the engine for cooling.

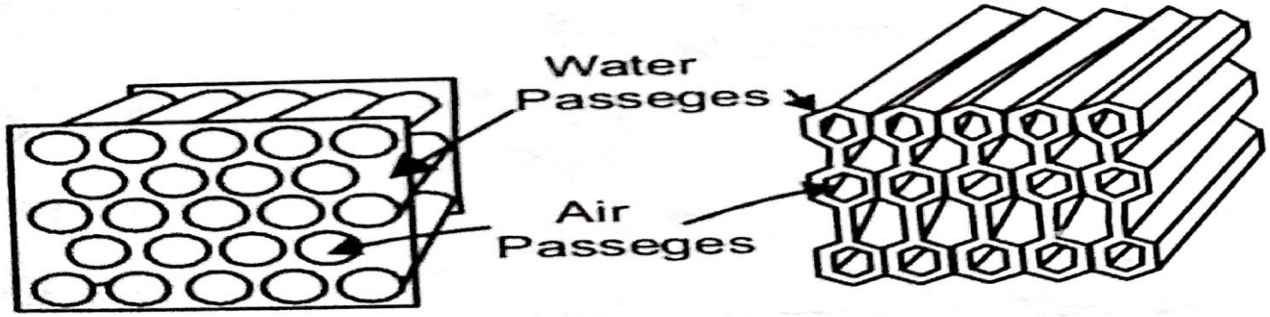
Types :

1.Tubular type : coolant flows through tubes and air passes around them.

2.Celluar type : air passes through the tubes and coolant flows in the space between them.



(a) Tubular Type



(b) Cellular Type

Fig. 2.35 Types of Radiators

It consist of metallic bellows particularly filled with some volatile liquid like acetone, alcohol or either which boils between 70-85^{o}C. A valve is attached to one end of the bellows, other end is attached to a frame. The thermostat is fitted in the coolant hose pipe at the engine outlet. When the temperature of water is low, pressure of the acetone is less, keeping the valve on its seat. In this case the thermostat is in closed position. So the water flows through the bye-pass to the pump. When the engine is started and the temperature reaches the design temperature the acetone liquid is vaporised and exerts pressure on the valve. The valve then opens for water circulation.

Compare Air Cooling And Water Cooling Systems

Sl.no	Air Cooling System	Water Cooling System
1	The design of this system is simple and less costly.	The design of this system is complicated and more costly.
2	The weight of the cooling system (per B.H.P. of the engine) is very less.	The weight of the cooling system (per B.H.P. the engine) in much more.
3	The fuel consumption is more.	The fuel consumption is less.
4	Its installation and maintenance are very easy and less costly.	Its installation and maintenance in difficult and more costly.
5	There is no danger of leakage or freezing of the coolant.	There is a danger of leakage or freezing of the coolant.
6	It works smoothly and continuously. Moreover, it does not depend on any coolant.	If the system fails, it may cause serious damage to the engine within a short time.
7	Air cooling system is not suitable for multi cylinder engines	This system can be employed in multi cylinder engines satisfactorily

COOLANT IN IC ENGINES

- Since water is easily obtained, cheap, and able to transfer heat readily, it has served as a basic coolant for many years. Some properties of water, such as its boiling point, freezing point, and natural corrosive action on metals, limit its usefulness as a coolant. To counteract this, use antifreeze.

Antifreeze Mixture

- In western countries if the water used in the radiator freezes because of cold climates, then ice formed has more volume and produces cracks in the cylinder blocks, pipes, and radiator. So, to prevent freezing antifreeze mixtures or solutions are added in the cooling water.

The ideal antifreeze solutions should have the following properties :

(a) It should dissolve in water easily.

(b) It should not evaporate.

(c) It should not deposit any foreign matter in cooling system.

(d) It should not have any harmful effect on any part of cooling system.

(e) It should be cheap and easily available.

(f) It should not corrode the system.

Normally following are used as antifreeze solutions :

(a) Methyl, ethyl and isopropyl alcohols.

(b) A solution of alcohol and water.

(c) Ethylene Glycol.

(d) A solution of water and Ethylene Glycol.

(e) Glycerin along with water, etc.

There are three main types of coolant that car companies use: Inorganic Additive Technology (IAT), Organic Acid Technology (OAT), and Hybrid Organic Acid Technology (HOAT).

Temperature Indicators

Temperature indicator is used to know the temperature of water in the cooling system in the engine jackets which shown on panel instrument.

Types of temperature indicators:

1. Mechanically operated temperature indicators
2. Electrically operated temperature indicators

1.Mechanically operated temperature indicator

It is bourdon tube type – a sealed bulb fitted in the cylinder head water jacket – it is connected to a capillary tube containing volatile liquid – the arrangement is shown in fig. Resulting from the heat of the water in the cylinder head vaporize the liquid in the capillary tube, increases the gas pressure in it – this moves a panel gauge needle over a calibrated dial.

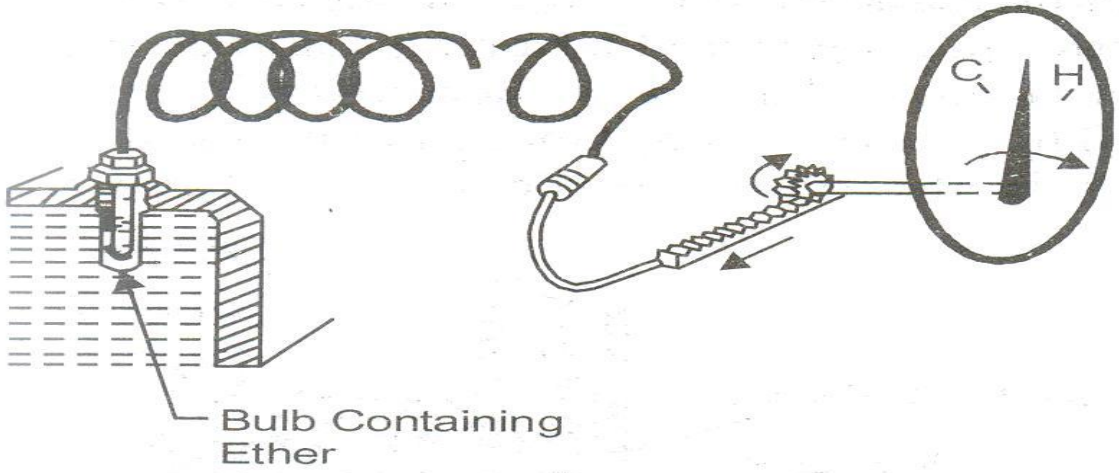


Fig. 2.39 (a) Mechanical Type Temperature Indicator

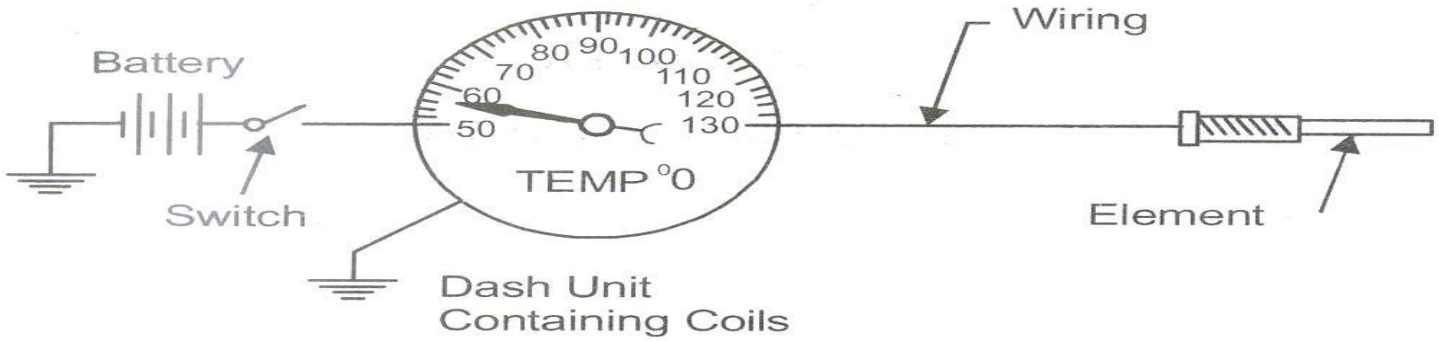


Fig. 2.39 (b) Electrical Type Temperature Indicator

2. Electrically operated temperature indicator

The principle used here is the increase in temperature decreases the electrical resistance – an element connected to the coil is inserted into the cooling water jacket shown in fig. With the increase of temperature of cooling water, the resistance of the element decrease resulting in more flow of current in the coil and increase of built up e.m.f. The pull of the coil in the armature carrying the indicator gets increased. Therefore the movement of the pointer will indicate the increase in temperature on the gauge directly.

IC Engine lubrication

Functions

- To decrease the power required to overcome the friction, there by increasing the power output.
- To reduce the wear between rubbing and bearing surfaces so that the engine service life is increased.
- To clean the surface by washing away carbon and metal particles caused by wear.
- To prevent the flow of gases through a space between piston rings and cylinder walls.
- To reduce the noise.

Methods of lubrication

1. Splash lubrication
2. Pressure lubrication
3. Petroil /Mist lubrication

1. Splash lubrication

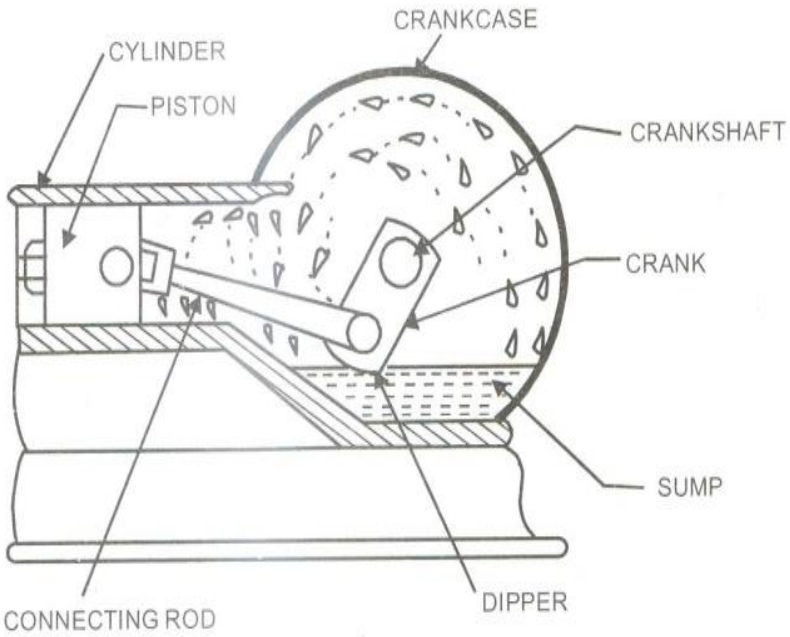
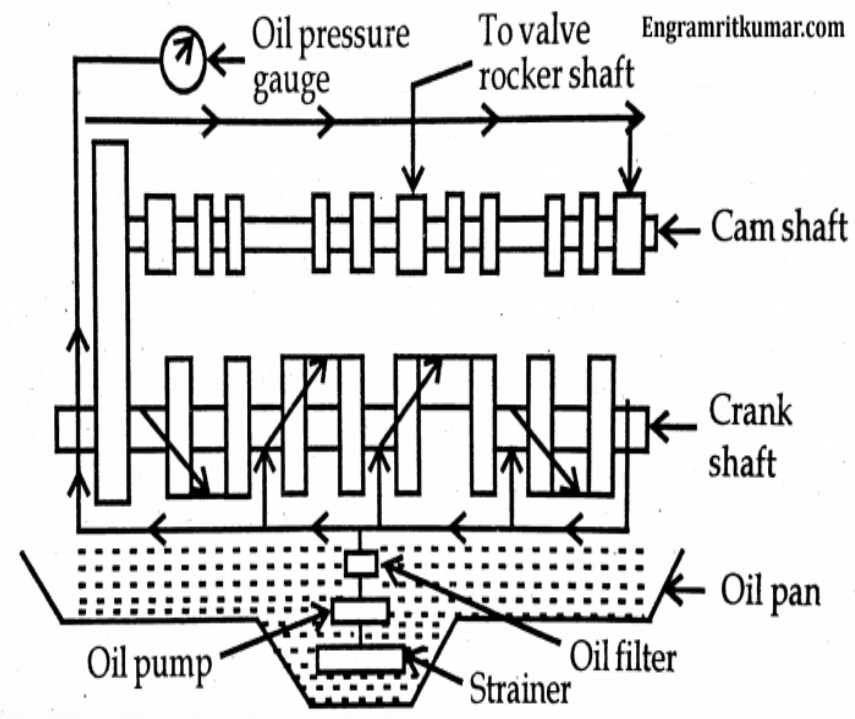


Fig. 2.19 SPLASH LUBRICATION

Splash lubrication is employed for small engines. In this case parts are lubricated by oil thrown by a small projection (dipper) at the big end of the connecting rod. The oil is kept in the crank case and a certain level is maintained. The dipper provided at the end of a connecting rod drops in the oil, and oil is splashed into the piston and other parts of engine which needs lubrication. Oil pockets are provided to catch the splashing oil, and from the pockets the oil will flow to the bearing surfaces through drilled holes

2. Pressure lubrication



Pressure lubrication is a process where an oil pump precisely distributes oil to key areas of the pump. Typically, the oil is pumped through an oil filter and into the pump where it is then recycled and reused; using a replaceable oil filter can further improve the life of the oil. The oil is transported to the key area by use of an oil pump. Therefore, the viscosity of the oil is not as critical as with a splash tube system.

3. Petroil Lubrication System:

Used in the two-stroke petrol engines likes scooters, motorcycles, extra.

In this type of system, a certain amount of oil is mixed with petrol itself and the mixture is induced through carburettor

The petrol is vapourised and the oil in the form of mist goes to crank case and cylinder

Oil impinges on crank case walls lubricates the main and connecting rod bearings

Rest of the oil which passes on the cylinder during charging and scavenging periods lubricates piston ,piston rings and the cylinder

Governing of I C Engines

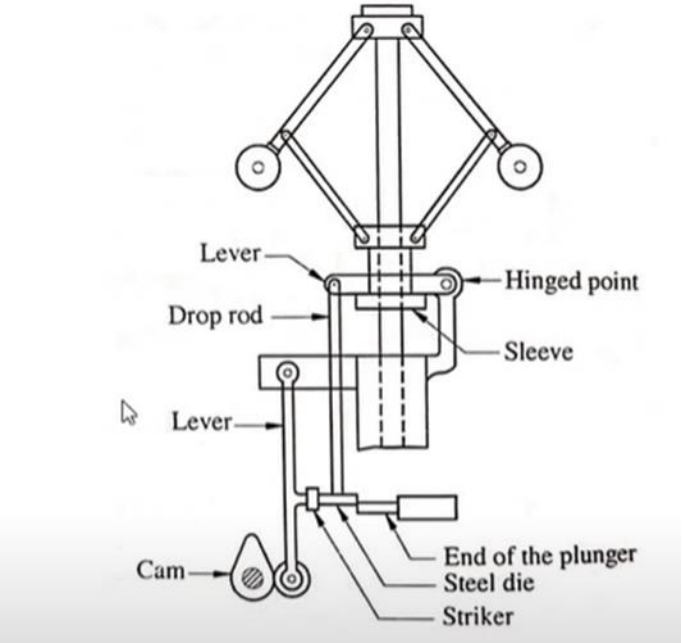
If the engine runs at a constant flow rate of fuel, engine will speed up when the load decreases and will slow down when the load increases. To run the engine at a steady speed, the flow of fuel must vary in such a way that the power developed is just equal to that needed at the desired speed. The process of controlling the speed of the engine by adjusting the fuel supply is called governing.

Methods of Governing

1. Hit and miss governing
2. Quality governing
3. Quantity governing
4. Combined method of governing

1.Hit and miss governing

In this method, the supply of fuel is stopped for one or more cycles when the speed of the engine increases. Once the supply is cut off, engine performs idle cycles which will reduce the engine speed



When the engine speed increases the sleeve gets lifted up due to the increase in the radius of rotation of balls

The lever attached to the sleeve thus lifts the striker (which engages the plunger) away from plunger which operates the fuel pump.

Thus fuel supply will be cut off

2.Quality governing

In this method the quality of fuel supplied is varied by altering the air fuel ratio.

For quality governing the amount of air drawn into cylinder is constant, but the supply of fuel varies.

This method is employed for high speed diesel engines.

3.Quantity governing

In this method the quantity of mixture supplied to the engine varied by regulating the throttle valve.

This method is employed in spark ignition engines

FUEL INJECTION SYSTEMS

- Fuel injection is a system for admitting fuel into an internal combustion engine.
- This replaced carburetors during the 1980s and 1990s
- Fuel injection atomizes the fuel by forcibly pumping it through a small nozzle under high pressure

TYPES

1.Direct Injection

2. Manifold injection and port injection

Direct injection

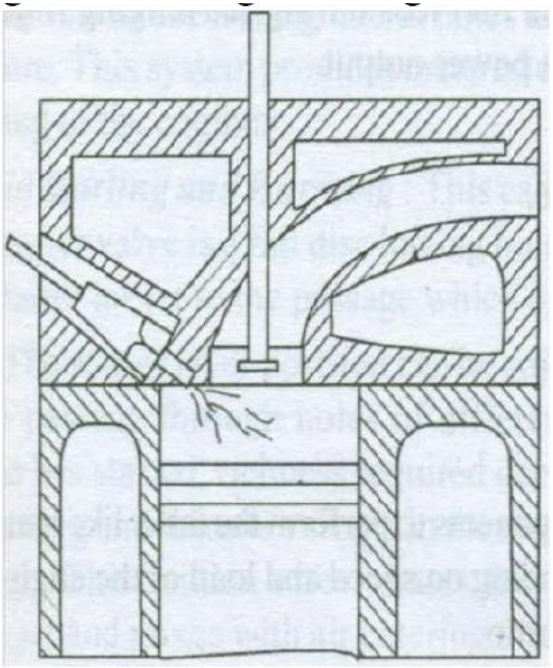


Fig. (a) Direct injection system

Fuel is sprayed directly to the combustion chamber

2.Manifold and port injection systems

Fuel is atomized into manifold or inlet ports

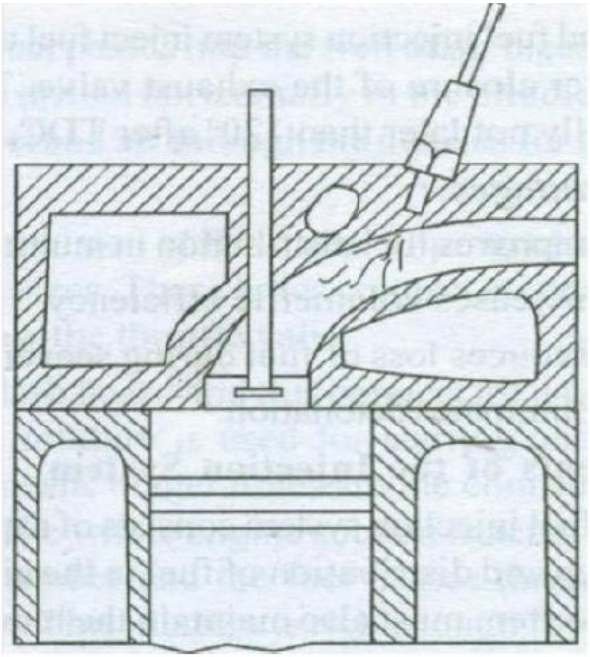


Fig. (b) Port injection system

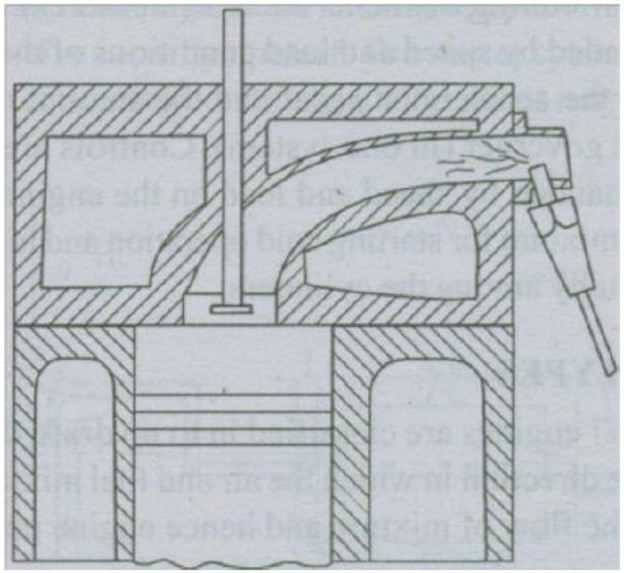
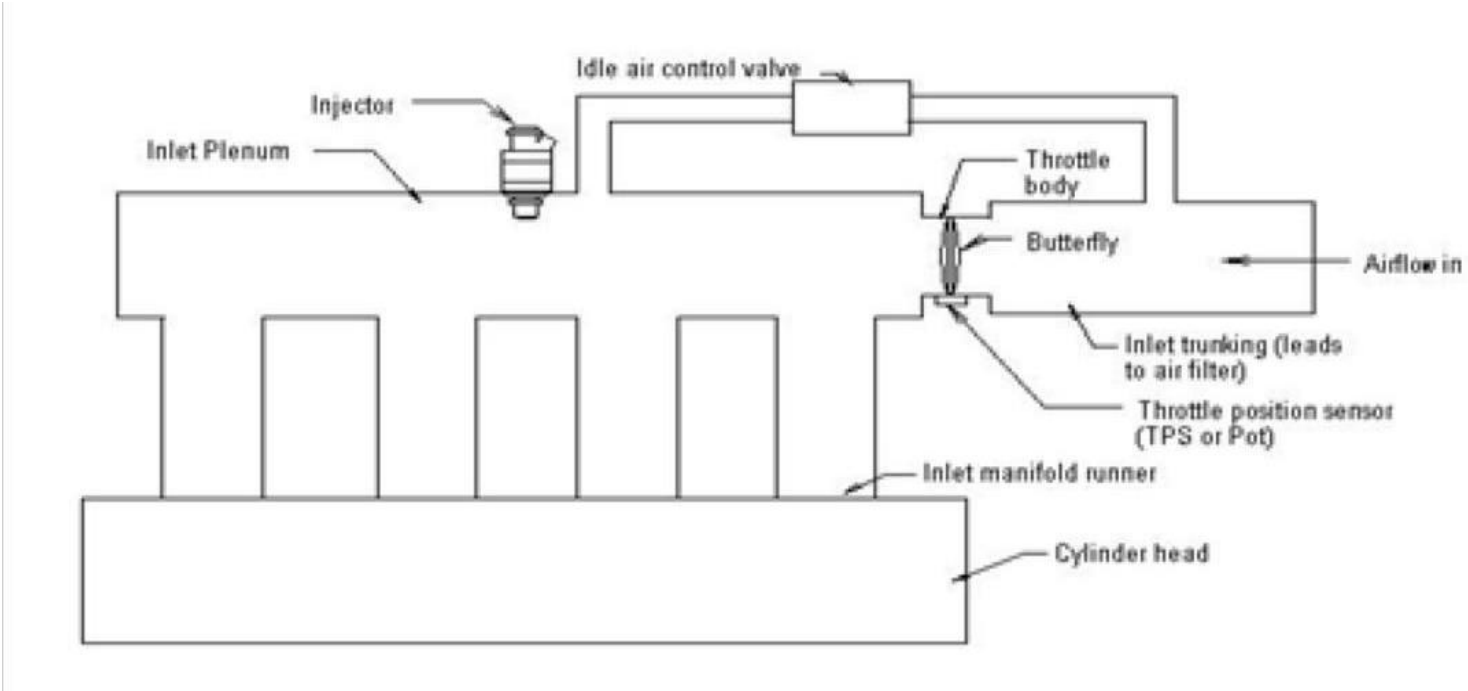


Fig. (c) Throttle body injection

Sigle point or throttle body injection

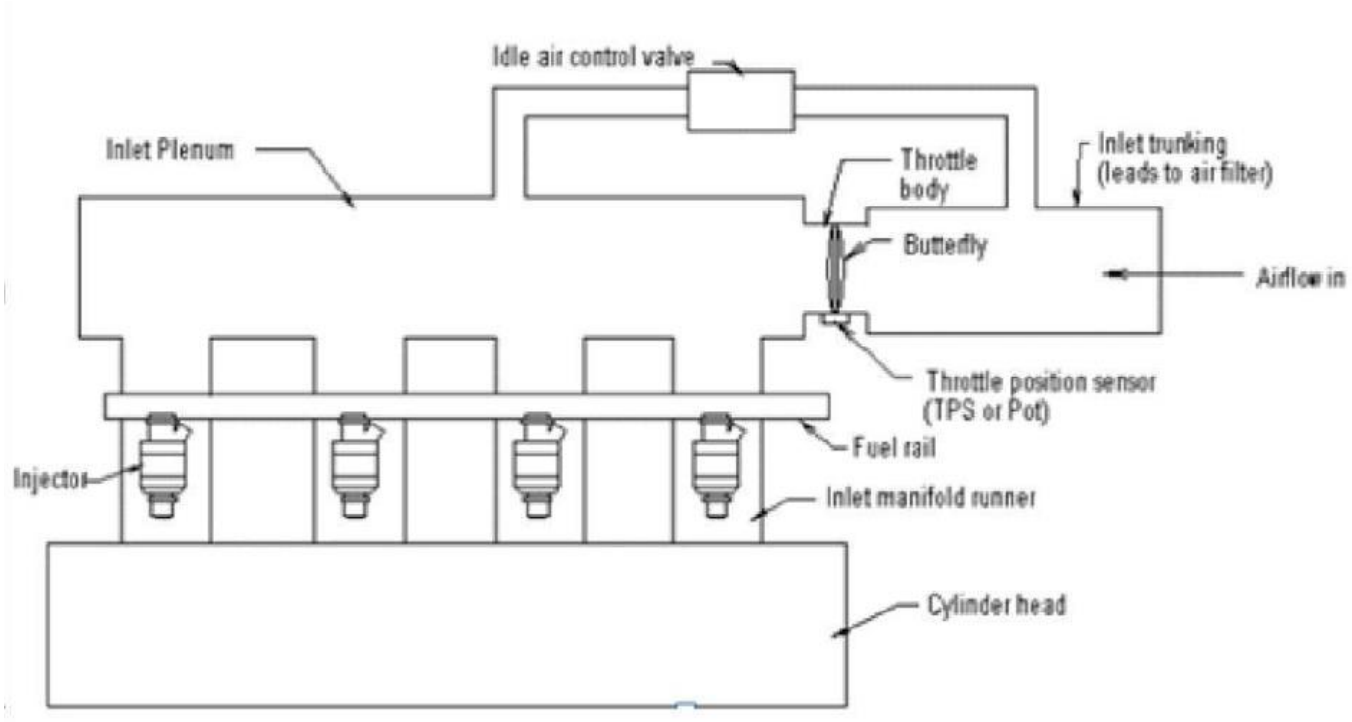
single-point injection system replaces the carburetor with one or two fuel-injector nozzles in the throttle body which is the throat of the engine's air intake manifold



Port or Multipoint fuel injection system

It has separate injector nozzle to each cylinder, right outside its intake port, which is why the system is sometimes called port injection

This system meters fuel more precisely than TBI systems



Common rail direct injection

Common-Rail Direct Injection (CRDI) System

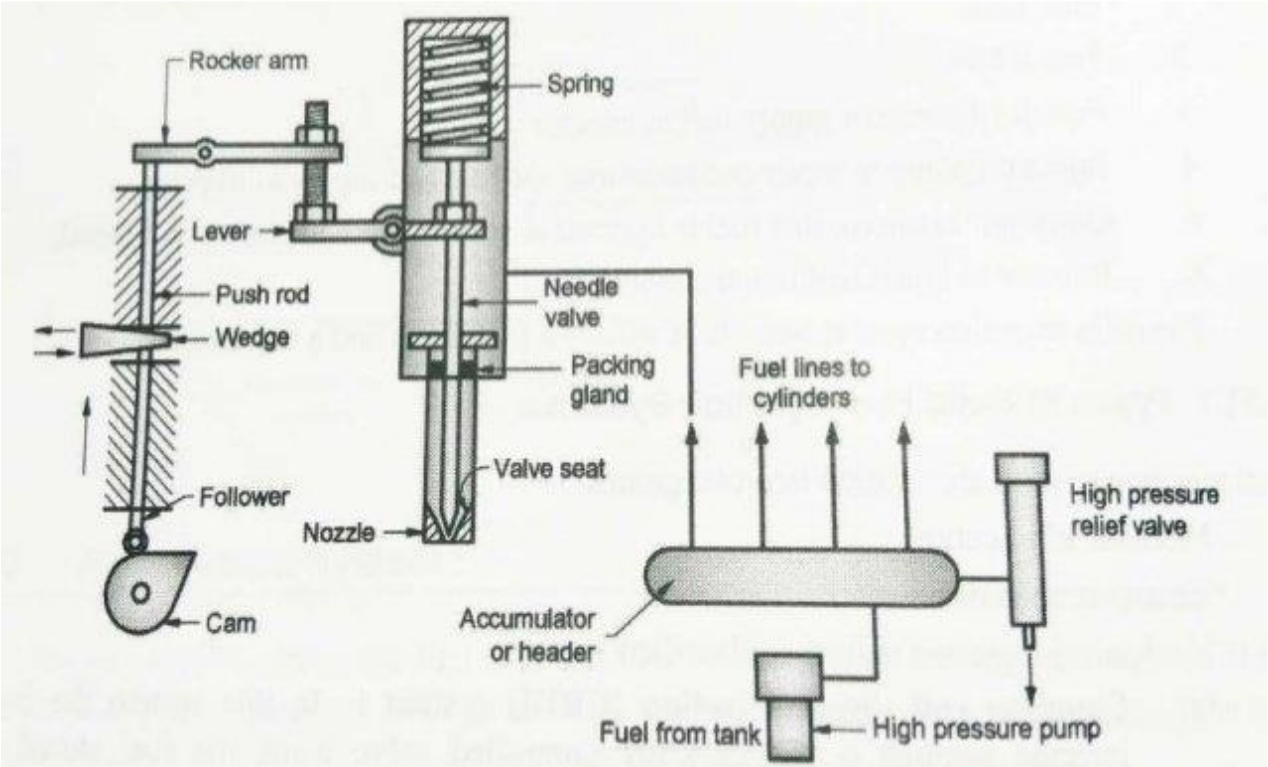


Fig. 4.31.1 : Common rail system

The high-pressure pump is used to supply fuel to the accumulator or the header from the fuel tank. In case pressure in the accumulator increases beyond the limit, the high-pressure relief valve which is connected to the accumulator helps to reduce the pressure.

This fuel from the accumulator is supplied to engine cylinders using fuel lines with the help of injectors.

Needle valve is used to control the opening and closing of the nozzle while it sprays the fuel into the cylinders.

Cam is connected to the spring with the help of a rocker arm and lever.

The wedge plays the main role in this system. It controls the amount of fuel to be injected into the cylinder in accordance with the power required for the engine.