CHAPTER - 1

PETROL ENGINE & IT'S CONSTRUCTIONAL DETAILS :-

★. Working principle of two-stroke & four-stroke petrol engine →

→ TWO-STROKE PETROL ENGINE :-

* 1st Stroke (suction & compression) →

As the piston moves up from BDC, It closes the inlet port, the exhaust port & transfer port further upward movement of the piston results in compressing the mixture in the cylinder & the inlet port. the upward motion of the piston creats a partial vaccum inside the crank-case through the inlet port. the exhaust & transfer ports remain closed during the operation of the upward stroke. & the charge which reached above the piston during the previous stroke is compressed.

At the end of this stroke the mixture is ignited by an electracic spark.

* 2nd Stroke (power & exhaust) →

the piston is fired downward from the TDC during this stroke, the exhaust port opens & burnt gases escape into the atmosphere further downward movement of the piston opens the transfer port & allows the partially compressed mixture, received during the

previous stroke to each the combustion chamber from the crank-case.

→ FOUR-STROKE PETROL Engine →

To produce power in a four stroke engine the following operations take place in the sequence given →

SUCTION STROKE →

The piston moves from T.D.C to B.D.C. A vaccum is created inside the cylinder. The inlet valve opens while the exhaust valve remains closed. The charge (air & fuel mixture) enters the cylinder.

COMPRESSION STROKE →

The inlet valve closes. The exhaust valve remains closed. The piston moves from B.D.C to T.D.C. The charge (air & fuel) mixture is compressed. The pressure & temperature arise.

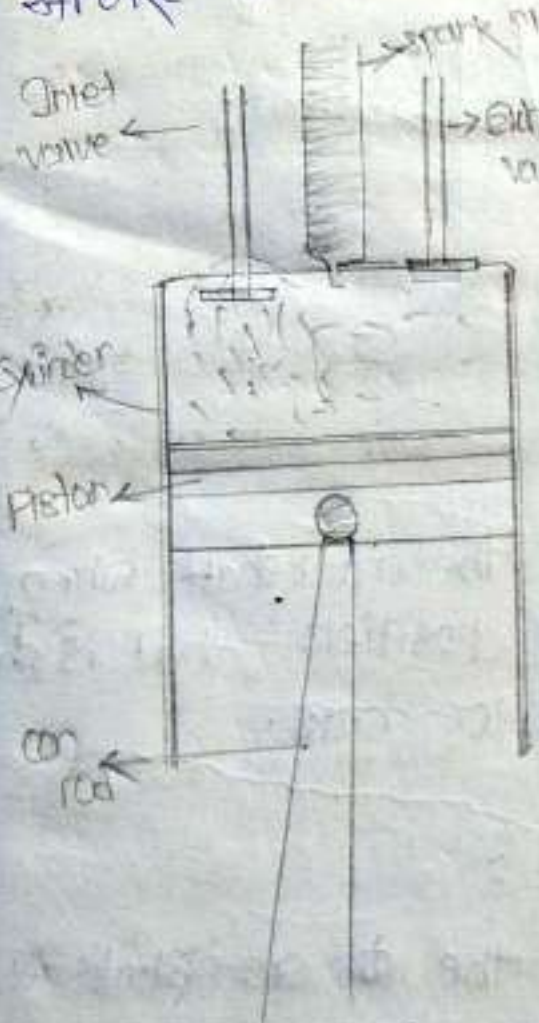
POWER STROKE →

The charge is ignited & pressure develops inside the cylinder. The gas expands & the piston is forced down T.D.C to B.D.C. Both valves remains closed. Power is supplied to the flywheel.

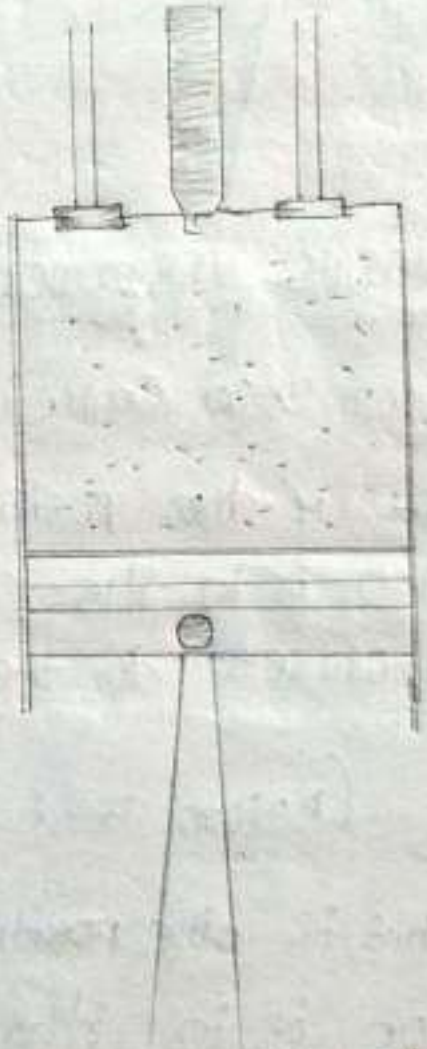
EXHAUST STROKE >

The inlet valve remains closed in position. The exhaust valves opens & the piston moves from B.D.C to T.D.C due to the energy stored in the flywheel. The burnt gas inside the cylinder go out through the exhaust valves. At the end of the stroke the exhaust valve closes.

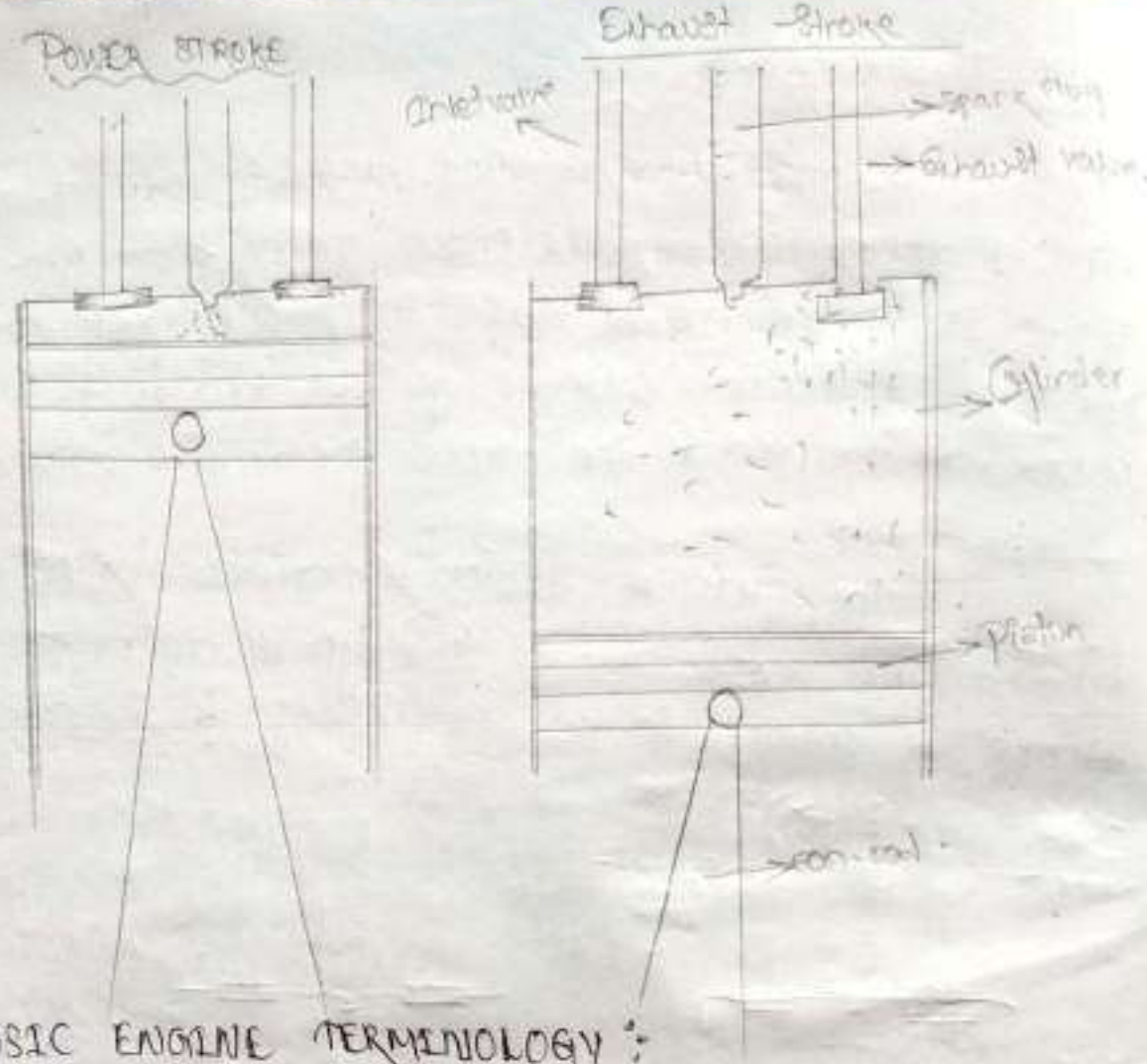
The cycle of suction & compression & power & exhaust are repeated. In this type of engines one power stroke is obtained in two revolutions of the crankshaft



Suction stroke



Compression stroke



BASIC ENGINE TERMINOLOGY :

1. T.D.C (Top Dead Centre) :-

This is the position of the crankshaft when the piston is in it's top most position that is the position closest to the cylinder head.

2. B.D.C (Bottom Dead Centre) :-

This is the position of the crankshaft when the piston is in it's lowest position. that is the position farthest from the cylinder head.

3. BORE :-

It is the internal diameter of the engine cylinder is also known as bore.

4. STROKE :

Distance travelled by the piston in moving from T.D.C to B.D.C.

5. CLEARANCE VOLUME : (V_c)

The volume of the cylinder (including the combustion chamber) above the piston when it is in the T.D.C position.

6. PISTON DISPLACEMENT :

It is the swept volume by the pistone inside the cylinders of a piston engine. It is also known as engine capacity

7. SWEPT VOLUME (V_s) :

> Swept volume is the displacement of one cylinder.

> It is the volume between T.D.C & B.D.C.

> This measurement can be listed in cubic inches or cubic centimeters.

$$V_s = A \times l = \frac{\pi}{4} d^2 l$$

$$= \left(\frac{\pi}{4}\right) d^2 \times l$$

8. ENGINE CAPACITY :

This is a total piston displacement or the swept volume of all the cylinder.

$$V_d = V_s \, n$$

9. COMPRESSION RATIO :- (r)

This indicates the extent to which the charge in the engine is compressed. This is calculated as the ratio of the volume above the piston at B.D.C to the volume above the piston at T.D.C.

Petrol engine - 8:10
Diesel engine - 15:24

$$r = \frac{V_s + V_c}{V_c}.$$

10. MEAN EFFECTIVE PRESSURE :-

Average effective pressure throughout the whole power stroke.

11. POWER :-

It is the workdone is a given period of time. doing the same amount of work in a lesser time would require more power.

12. INDICATED POWER :-

power developed within the engine cylinders is called indicated power's.

➢ It is calculate from area of the engine indicator diagram (expressed in K.W)

13. BRAKE POWER :-

(i) Actual power delivered to the crankshaft.
(ii) It is obtained by the deducating various power losses in the engine from the indicated power.

(iii) It is measured with a dynamometer & expressed in kW.

14. ENGINE TORQUE :- → Torque is also known as twisting or Turning force.

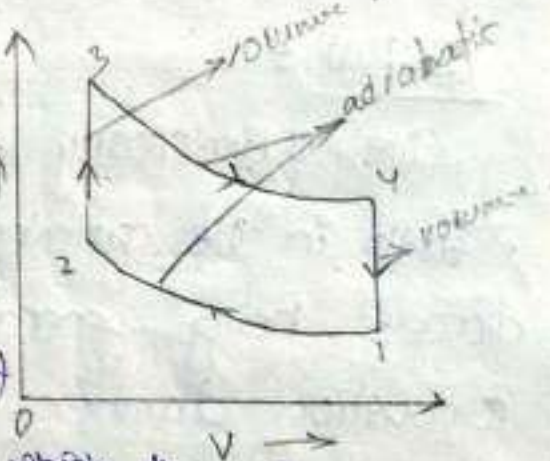
→ It is the force of rotation acting about the crankshaft axis at any given instant of time.

→ $T = F_\theta$. expressed in N/M.

ENGINE CYCLES →

1. OTTO CYCLE →

This cycle consists of two adiabatics & two constant volume lines at (1) cylinder is full of air process (1-2) represents adiabatic compression of the air. combustion take place at constant volume from (2) to (3) after which the air expands adiabatically from (3) to (4).

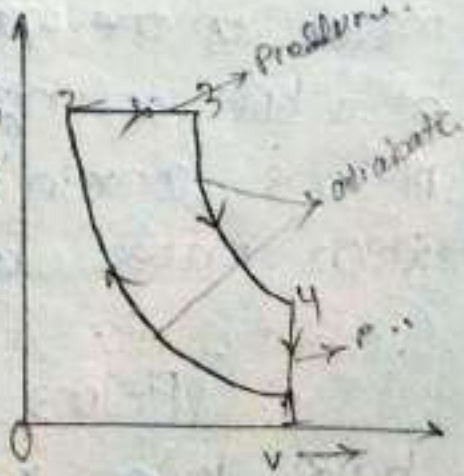


$$\eta = \left\{1 - \left(\frac{1}{r}\right)^{\gamma-1}\right.$$

r = comp. ratio
γ = ratio of specific heat

2. DIESEL ENGINE CYCLE :-

Popular diesel engine works on this cycle. here combustion takes place at constant pressure.



$$\eta = 1 - \frac{\beta^\gamma - \alpha^\gamma}{\gamma\,(\beta - 1)}$$

where β = volume ratio of cut off.

$$= \frac{\text{volume at (3)}}{\text{volume at (2)}}.$$

1.2 Constructional Details of petrol engine with materials ⇒

ENGINE COMPONENT :-

Every component has it's own significance in the smooth & desired functioning of an engine. The various components are constructed & manufactured with design & performance features of the engine.

PISTON :-

The cylindrically shaped mass that reciprocates back & forth in the cylinders, transmitting the pressure forces being generated by the fuel burnt in the combustion chamber for rotating the crankshaft is called piston.

The top of the piston is called crown & the sides are ~~the~~ called skirt. The face on the crown makes up one wall of the combustion chamber & may be a flat or highly contoured surface. Some pistons contain an indented bowl in the crown which makes a large percent of clearance volume

Pistons are made up alloy steel. pistons have lower thermal expansion which alloys for higher tolerance. Aluminium pistons are lighter

have less mass inertia. Some time synthetic or composite materials are used for the body of the piston, with only the crown made of metal. Some pistons have a ceramic coating on the face.

CYLINDER BLOCK :-

Body of engine containing the cylinders made of cast iron or alluminium. The engine block is machined with multiple tools (manually or CNC) to fit the other components. The block of water cooled engines includes a water jacket cast arround the cylinders. In air cooled engines the exterior surface of the block has cooling fins.

VALVE'S :-

These are used to allow flow of air & fuel or A/F mixture into & burnt/exhaust gases out of the cylinder at the proper time in the four stroke cycle engines. most engines used poppet valves which are spring loaded closed & pushed/open by camshaft action.

valves are mostly made of forged steel. Surface against which valves close are called valve's seats & are made of hardened steel or ceramic. Two stroke cycle engines have ports (slots) in the side of cylinder walls instead of mechanical valves.

CONNECTING ROD :-

Linkage used for connecting the piston with rotating crankshaft is called connecting rod. It is usually made of steel alloy forging or aluminium. connecting rod is fastened to crankshaft with the help of a bearing.

CRANKSHAFT :-

The rotating shaft through which engine work output is supplied to external systems is called crankshaft. The crankshaft is connected to the engine block with the main bearings. It is rotated by the reciprocating pistons through connecting rods connected to the crankshaft. offset from the axis of the rotation. This offset is sometimes called crankthrow or crank radius. most of crankshafts are made of forged steel, while some are made of cast iron.

CAMSHAFT :-

Rotating shaft used to operates the valves (intake & exhaust) at proper time in the engine cycle either directly or through mechanical or hydraulic linkage (push rods, rocker arms, & tappets) is know as camshaft.

one or mor camshafts mounted on the engine head. known as overhead cams. these are generally made of forged steel or cast iron & driven by means of a belt or chain (timing chain).

To reduce weight, some cams are made from a hollow shaft with the cam lobes press-fit on. In four stroke cycle engines the camshaft rotates at half engine speed.

Push RODS :-

It is the mechanical linkage between the camshaft & valves on over head valves engines used to operate the valve mechanism. push rods have oil passage through there length as part of a pressurized lubrication system.

PISTON PIN :-

It is fastened the connecting rod to the piston is called piston pin / wrist pin / gudgeon pin.

HEAD GASKET :-

It is the gasket that serves as a sealant between the engine block & the head where they bolt together to avoid any leakage & pressure loss. The gaskets are made in sandwich construction of metal & composite materials. Some engines use liquid head gaskets also.

CYLINDERS :-

The circular cylinders in the engine block in which pistons reciprocate back & forth. The walls of the cylinder ~~may be~~ have highly polished hard surfaces. Cylinders may be machined directly in the engine block or hard metal (drawn steel) sleeve may be pressed into the softer metal block also known as liners.

Sleeves may be dry sleeves, which do not contact the liquid in the water jacket or wet sleeves which form part of the water jacket.

PISTON RINGS :-

These are metal rings that fit into circumferential grooves around the piston & form sliding surface against the cylinder walls. Near the top of the piston are usually two or more compression rings made with highly polished surface. The purpose of the rings is to form a seal between the piston & cylinder walls & to restrict the high pressure gases in the combustion chamber from leaking pass the piston into the crank case.

Below the compression rings on the piston is at least one oil ring, which assists in lubricating the cylinder walls & scraps away excess oil to reduce oil consumption.

CYLINDER HEAD :-

The component that closes the end of cylinders, usually containing part of the clearance volume of the combustion chamber is called head. The head is usually made up of cast iron or alluminium & bolts to the engine block.

The head contains spark plug in the SI engines & the fuel injectors in CI engines & some SI engines. Most modern engines have the valves in the head & many have the camshafts also positioned there (overhead cam & overhead valves).

1.3

CYLINDER ARRANGEMENT :-

Engines are also classified according to the arrangement of the cylinders.

→ Multi cylinder engines are preferred over single cylinder engines due to reasons like (1) giving smooth torque out put

(I) Lighter fly wheel.
(II) Engine compactness
(III) Easy balancing etc...
(IV)

→ In multi cylinder engines the arrangement of cylinderes is very important.

→ Cylinder arrangements are →

1. In-line arrangement
2. V-engine.
3. opposed cylinders type.
4. Radial engine.

① IN-LINE ARRANGEMENT :-

- In-line engine or straight engine all the cylinders are arranged in a row.
- In-line four engine is the most common configuration.
- cylinders are arranged next to each other - in a straight line.
- cylinders sit on top of the crankshaft.
- Simple construction a single cylinder head, cylinder bank & valve train.
- contains relatively lesser moving parts than the other engine configuration.
- typically a single exhaust manifold.
- An even-firing inline engine is in primary balance of the pistons in pairs.
- The firing order is used for better engine balancing
- The most common firing order of four cylinder engine is 1-3-4-2 (or) 1-3-2-4. Six cylinder engine is 1-5-3-6-2-4 (or) 1-4-2-6-3-5.

② 'V'- configuration engine :-

- In a 'V' engine the cylinders & pistons are arranged in such way that it appears to be in a 'V'-shape.
- The first 'V' engine was built in 1889.
- 'V' configuration reduces the length, weight & height compared to equivalent inline configuration.
- Cylinders are located in a 'V' angle on either side of a common crankshaft.
- The angle of the 'V' varies between manufactures, although ones where the 'V' angle is 90° is preferred in some racing applications.
- Denoted by the numbers of cylinders a 'V'- configuration engine is a V_6 - V8, V10 or V12. used in motorcycles is called a 'V'-twin.
- ~~Note that the V16 engine is no longer used in automotive applications, since its smaller siblings. The V10 & V12 prev~~
- Two exhaust manifolds are used.
- 'V' engines are more compact compared to straight engines with same no. of cylinders.
- Contains more moving parts, resulting in higher cost/ complexity, weight. The same technicality above makes a 'V' engine heavy.

1.4 - VALVE ACTUATING MECHANISM :-

★. Actuating mechanism as use din this chapter, is that combination of parts that receives power from the drive mechanism & transmits the power to the engine valves.

★. A valve actuating mechanism may include the camshaft, cam followers, pushrods, rocker arms & valve springs.

★. There are two types of valve actuating mechanism these are → a) Side valve mechanism.
b) over head valve mechanism.

a) SIDE VALVE MECHANISM :-

In side valve mechanism both the inlet & exhaust valves are fitted in the cylinder block.

WORKING :-

When the camshaft rotates the camlobe lifts the valve directly through the tappet against the springs tension. When the camlobe reaches the maximum height the valve's are opens fully. further rotation of the cam causes the tappet to move down & the valve is closed by the tension of the valve spring the spring press the valve against it's seat which helps in preventing leakage of the gases through the valve.

b) over head valve mechanism :-

In this mechanism the valves are located in the cylinder head. push rods & rocker arms are used in addition to the side valve mechanism.

tappet - barrel → Ohead
Measure - S. head

WORKING →

When the camshaft rotates, the cambobe lifts the tapped upword. When the tappet moves up, it pushes the push rod & one end of the rocker arm upwards. the other end of the rocker arms tip, moves down word & the valve open against the spring tension.

When the cambobe reaches the maximum height the valve open fully. further rotation of the camshaft causes of tappet to move down & the valve is closed by the tension of the spring.

1.5 - VALVE ARRANGEMENT :- ITI NOTE

The valve operating mechanism is located directly below the valves & one camshaft activates both the intake & exhaust valves.

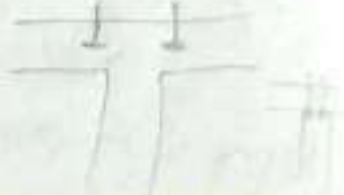
this arrangement requires a tappet, a pushrod, & a rocker arm above the cylinder to reverse the direction of valve movement.

- this are mainly four types of valve arrangement system these are → 'I' type.
→ 'F' type
→ 'T' type.
→ 'L' type.

a) 'I' TYPE :-

In this system the inlet & exhaust valves are located on the side of the cylinder head. The valves are operated by a single cam-shaft. Through the tappet push rod & rocker arm mechanism.

ex- Ambassador, Ashok Leyland.



b) 'F' TYPE :-

In this type the inlet valves are located on one side of the cylinder head & the exhaust valves are located on the other side of the cylinder. The valves are operated by a single camshaft.

The inlet valves are operated by the tappet, push rod & rocker arm mechanism. The exhaust valves are operated by the tappet directly.

ex- Mahindra & mahindra Jeep.

c) 'T' TYPE :-

In this system the inlet valves are located on one side of the cylinder blocks & the exhaust valve are located on the other side of the cylinder block. Two camshaft are used to operates the valves one for inlet & the other for exhaust. The valves are operated by the tappet directly.

ex- Ford.

VALVE CLEARANCE :-

Valve clearance are the small gaps between the tops of the valve stems & the part of the mechanism which presses on them to open the valves.

→ It is measured by feeler gauge.

TIMING GEAR :-

The gear train with a two to one reduction through which the crankshafts drives the camshaft & they controls valve timing in a four stroke cycle internal-combustion engine.

VIBRATION DAMPER :-

A device fitted to an engine crankshaft to reduce the stresses resulting from torsional vibration.

Chapter-II DIESEL ENGINE & IT'S CONSTRUCTIONAL DETAILS

4-STROKE DIESEL ENGINE :-

In the 1890's a German inventor, Rudolf Diesel has patented his invention of an efficient, slow burning, compression ignition, internal combustion engines.

The most important difference in this type engine is :-

* There is no fuel in the cylinder at the beginning of the compression stroke, therefore an autoignition does not occur in diesel engines.
* Diesel engine uses compression ignition instead of spark ignition.
* Because of the high temp. developed during the adiabatic compression, the fuel ignites spontaneously as it is injected.
* Therefore no spark plug is used.
* Before the beginning of the power-stroke, the injector starts to inject fuel directly into the combustion chamber.

WORKING :-

Intake stroke :- The piston moves from T.D.C to B.D.C & the cycle passes points 0 → 1. In this stroke the intake valve is open while the piston pulls air (without fuel) into the cylinder by producing vacuum pressure by producing vacuum pressure into the cylinder through its downward motion.

Compression stroke :-

The piston moves from bottom dead centre to T.D.C & the cycle passes points 1 → 2. In this stroke both the intake & exhaust valves are closed,

During this compression, the volume is reduced the pressure & temp. both rise. At the end of this stroke fuel is injected & burns in the compressed hot air. At the end of this stroke the crankshaft has completed a full 360° revolution.

POWER STROKE :-

The piston moves from T.D.C to B.D.C & the cycle passes points 2 → 3 → 4. In this stroke both the intake & exhaust valves are closed. At the beginning of the power stroke, a near isobaric combustion occur between 2 & 3. In this stroke interval the pressure remains constant since the piston descends & the volume increase. At 3 fuel injection & the cylinder contains gas at a higher temp than at 2. Between 3 & 4 this hot gas expands, again approximately adiabatically. In this stroke the piston is driven towards the crankshaft the volume is increased & the work is done by the gas on the piston.

EXHAUST STROKE :-

The piston moves from B.D.C to T.D.C & the cycle passes points 4 → 1 → 0. In this stroke the exhaust valve is open while the piston pulls out exhaust gases out of the chamber. At the end of this stroke the crankshaft has completed a second full 360° revolution.

a long time.

⊛ Advantage of diesel engine :-

- → High reliability
- → Low fuel cost.
- → High power/lb. of engine
- → Low fuel consumption.
- → Low Fire Hazard.
- → Greter heat efficiency - 30 %. (25 %. gas)
- → Longer service intervals.
- → Diesel engine gives great mileage.
- → The maintenance cost is less.

→ Lower fuel consumption :-

The diesel engine one of the most efficient divices known for producing power by burning fuel. At high loads, a diesel engine is 15% - 30% more efficient than a gasoline engine producing the same amount of power. Diesel engines have higher compression ratios. Diesel fuel has higher heat content than Petrol engine.

→ Diesel engines running at part load typically have 30 - 75% lower fuel consumption than a gasoline engine. At idle, a diesel engine uses only about 25% of the fuel required by a gasoline engine.

→ Longer engine life :-

Diesel truck engines are built to operate at moderate speeds with moderate bearing load. They are designed for long life.

→ Increased safety :-

Diesel fuel has a higher flash point than gasoline. This makes diesel fuel much safer where fuel spillage could occur in poorly ventilated spaces. Additionally, unlike gasoline, the exhaust of diesel has a very low amount of carbon monoxide (CO).

→ Diesel exhaust is much less harmful than gasoline exhaust, however it does have unpleasant odor.

★. COMBUSTION CHAMBER :-

A combustion chamber is the part of an internal combustion engine (ICE) or a reaction engine in which the fuel/air mix is burned.

→ It is an enclosed space inside of a combustion engine in which a fuel and air mixture is burned.

TYPES OF COMBUSTION CHAMBER OF D.ENGINE →

→ Open combustion chamber / Direct Combustion Chamber
→ Pre-combustion chamber
→ Swirl combustion chamber
→ Squish combustion chamber.
→ Air cell / energy-cell
→ Energy cell combustion chamber.

According shapes of type of combustion chamber →

Depending upon the location of the spark plug, valves & type of cylinder head, the combustion chambers are of following shapes →

→ Spherical-shape.
→ I-shape.
→ T-shape.
→ F-shape.
→ L-shape.

Direct injection type combustion :-

These also called open combustion chambers. The entire combustion space lies in the main cylinder & the fuel is injected into this volume.

Type's → these are 4 types of D.I combustion chamber's theese are →

(I) Shallow depth chamber →

this chamber, depth of the cavity provided in the piston is small due to this the squish is negligible.

It is usually adopted for large engines running at low speeds.

(II) Hemispherical chamber →

→ this design also gives small squish.

→ However its depth to diameter radius can be varied to obtain desired type of squish for better performance.

(III) cylindrical chamber →

this design is a modification of cylindrical chamber in the form of truncated cone.

Swirl is produced by masking valve up to 180° of circumference.

Squish produced is better than the previous two designs.

(IV) Toroidal chamber :-

This design produces a powerful squish along with air movement.

The masking needed on the valves is small & thus it makes better utilization of oxygen.

Advantages of D.I. combustion chamber :-

- Minimum heat loss during compression because of lower surface area to volume ratio & hence better efficiency.
- No cold start propiems.
- Fine atomization because of multihole nozzles

Disadvantage :-

- Complex design of fuel injection pump due to high fuel injection pressure requirements.
- Necessity of accurate metering of fuel by injection system particularly for small engines.

* PRE-COMBUSTION CHAMBER :-

It is an auxiliary space in which combustable gases are ignited & combustion started ahead of the main combustion chamber of a jet or gas engine.

The glow plug is an electrically operated device that protrudes into the pre-combustion chamber.

ADVANTAGE OF PRE-COMBUSTION CHAMBER :-

Disadvantage :-

→ The velocity of burning mixture is too high during the passage from pre-chamber, so the heat loss is very high.
→ This causes reduction in the thermal efficiency, which can be offset by increasing the compression ratio.
→ Cold starting will be difficult as the air losses heat to chamber walls during compression.

*. TURBULENCE CHAMBER :-

Turbulence is the way air fuel mixture moves inside ~~the cylinder~~ a combustion chamber. If the turbulence of charge is more then the air & fuel moves randomly inside the chamber.

ADVANTAGE OF TURBULENCE CHAMBER :-

→ Wide range of fuels can be used
→ Low Air & fuel ratio can be used as air is heavily swirled.
→ Engine can operated at high R.P.M.
→ Injection pressure & pattern are not very important

-So design & selection of nozzle is easy.

⇒ Low rate of pressure rise & smooth running of engine.

Disadvantage:-

- Starting of engine is difficult as heat losses are high.
- Mechanical efficiency is low.
- Because of high heat losses, bsfc is higher.

BSFC- Brake-specific fuel consumption

CHAPTER-03

PERFORMANCE OF I.C ENGINE

Characteristics of I.C Engines →

1) Brake thermal efficiency
2) Indicated thermal efficiency
3) Specific fuel consumption
4) Mechanical efficiency
5) Volumetric efficiency.
6) Air-fuel ratio
7) Mean effective pressure.

Brake Thermal Efficiency →

→ It is defined as break power of a heat engine as a function of thermal input from the fuel.

→ It is used to evaluate how well an engine converts the heat from a fuel to mechanical energy

Indicated Thermal Efficiency →

→ It is a dimensionless performance measure of a device that uses thermal energy, for example engine, a steam turbine, a steam engine, a boiler, a furnace, etc...

→ thermal efficiency indicates the extend to which the energy added by work is converted to net heat output.

Mechanical efficiency → (M·E)

→ Mechanical efficiency is the measure of effectiveness of a machine's energy & power that is input into the device, an output that makes force & movement into

→ Mechanical advantage by comparing the input & output force you can find the advantage of a machine.

Specific fuel Consumption → (S·F·C)

→ Thrust specific fuel consumption (TSFC) or sometimes simply specific fuel consumption (SFC), is an engg. term that is used to describe the fuel efficiency of an engine design with respect to thrust output.

Volumetric efficiency → (V·E)

→ volumetric efficiency in I·C engine is defined as the ratio of the mass density of the air-fuel mixture drawn into the cylinder at atmospheric pressure (during the intake stroke) to the mass density of the same actual volume of air in the intake manifold

Mean effective Pressure → (M·E·P)

→ Mean effective Pressure is a quantity relating to the operation of a reciprocating engine

is a valuabe measure of an engine's capacity to do work that is independent of engine displacement.

Air fuel Ratio → (A.F.R)

→ Air-fuel ratio (AFR) is the mass ratio of air to fuel present in a combustion process such as in an internal combustion engine.

calorific value of fuel →

→ The calorific value of a fuel is the quantity of heat produced by the combustion of 1 kg of a fuel is called C.V of fuel.

→ C.V of fuel is expressed in a unit called kilo-joule per k.g (KJ/k.g).

MORSE-TEST →

Morse test is a method of measuring Indicated power (I.P) of a multi cylinder Engine.

→ This method is used for both SI (petrol) & C.I (diesel) engine.

HEAT BALANCE SHEET →

A heat balance sheet is an account of heat supplied & heat utilized in various ways in the system.

→ Necessary information concerning the performance of the engine is obtained from the heat balance

CHAPTER - 4

FUEL FEED SYSTEM FOR PETROL & DIESEL ENGINE

Q1 → Internal combustion engine require fuel in order to run & motor vehicles are thus equipped with a fuel system that keeps the engine supplied with the correct amount of fuel, for all operating circumstances.

Q2 → The main components of fuel supply system include fuel tank, pump, filter, injector/carburator.

FUEL TANKS →

A fuel tank is a safe container for flammable fluids. Though any storage tank for fuel may be so called, the term is typically applied to part of an engine system in which the fuel is stored & propelled (fuel pump) or released (pressurized gas) into an engine.

FUEL LINE →

A fuel line is a hose used to bring fuel from one point in a vehicle to another or from a storage tank to a vehicle.

It is commonly made of reinforced rubber to prevent splitting & kinking.

FUEL FILTER →

It is fixed in both the ends of the fuel pumps to separate impurities from the fuel, thereby ensuring optimal engine performance.

FUEL INJECTOR →

It is an electronic valve that opens/closes at regulated intervals to deliver the right amount of fuel to the engine.

FUEL PUMP

It's primary function is to draw fuel from the fuel tank & pump it into the internal combustion engine.

There are two kinds of fuel pumps - mechanical & electrical, which are used in vehicles with carburators & electronic fuel injectors, respectively.

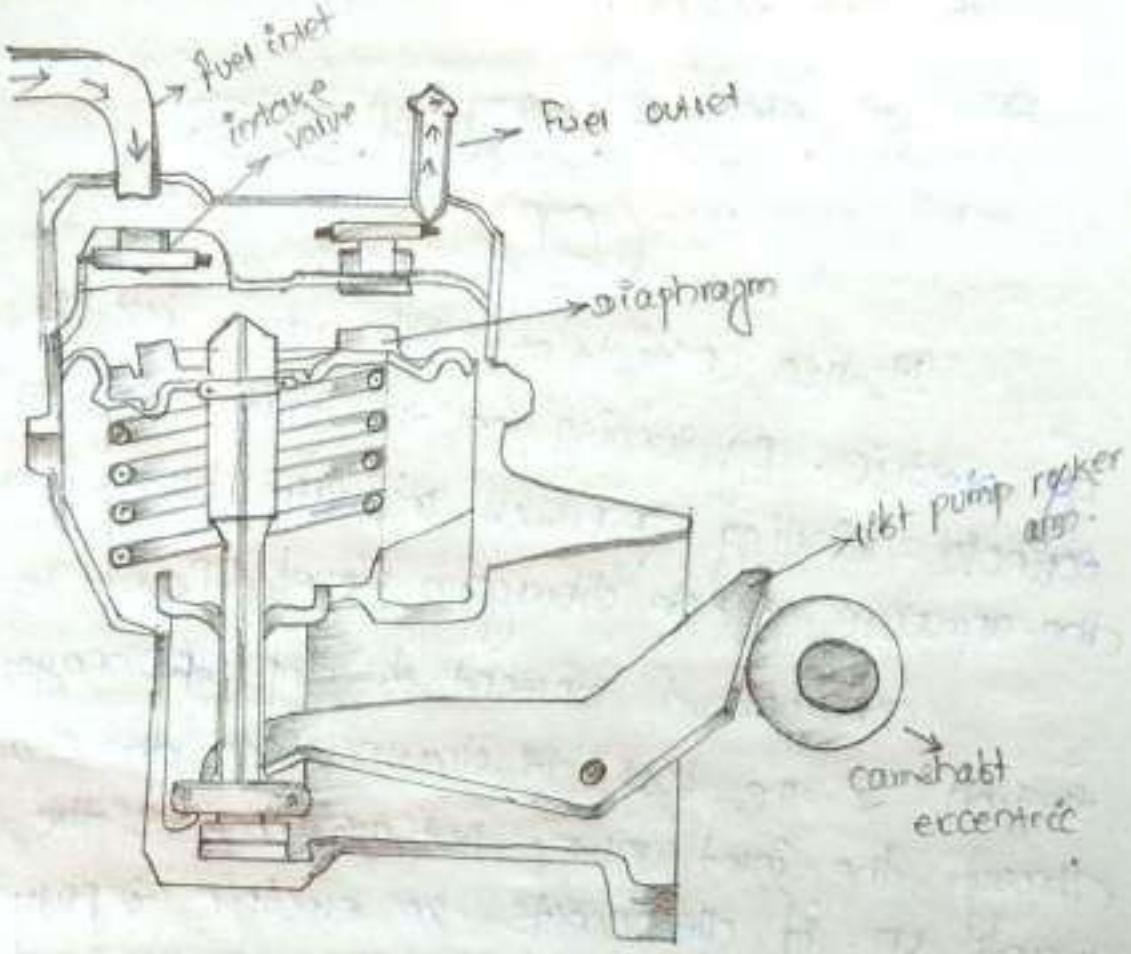
① Mechanical type fuel pumps →

A mechanical fuel pump is driven by the camshaft or by a special shaft driven by the crankshaft. As the shaft turns, a cam passes under a pivoted lever & forces it up at one end...

When the lever pulls the diaphragm down,

& creats suction that draws fuel along the fuel pipe into the pump through a one-way valve.

→ A mechanical fuel pump operates at a pressure about 4-6 PSI



→ (2) ELECTRICAL type fuel pump →

An electric fuel pump is a device used to power an automobile's engine by directing the fuel through electronic means. It is an alternative to manual fuel pump system & is considered to be a better use of technology with the function & operation of vehicles.

An electric pump is mounted inside the fuel tank & operated by the electrical systems of

> Electric fuel pump can deliver fuel at high pressure in order to meet the requirements of the engine.

~~How an electric fuel pump work?~~

(or)

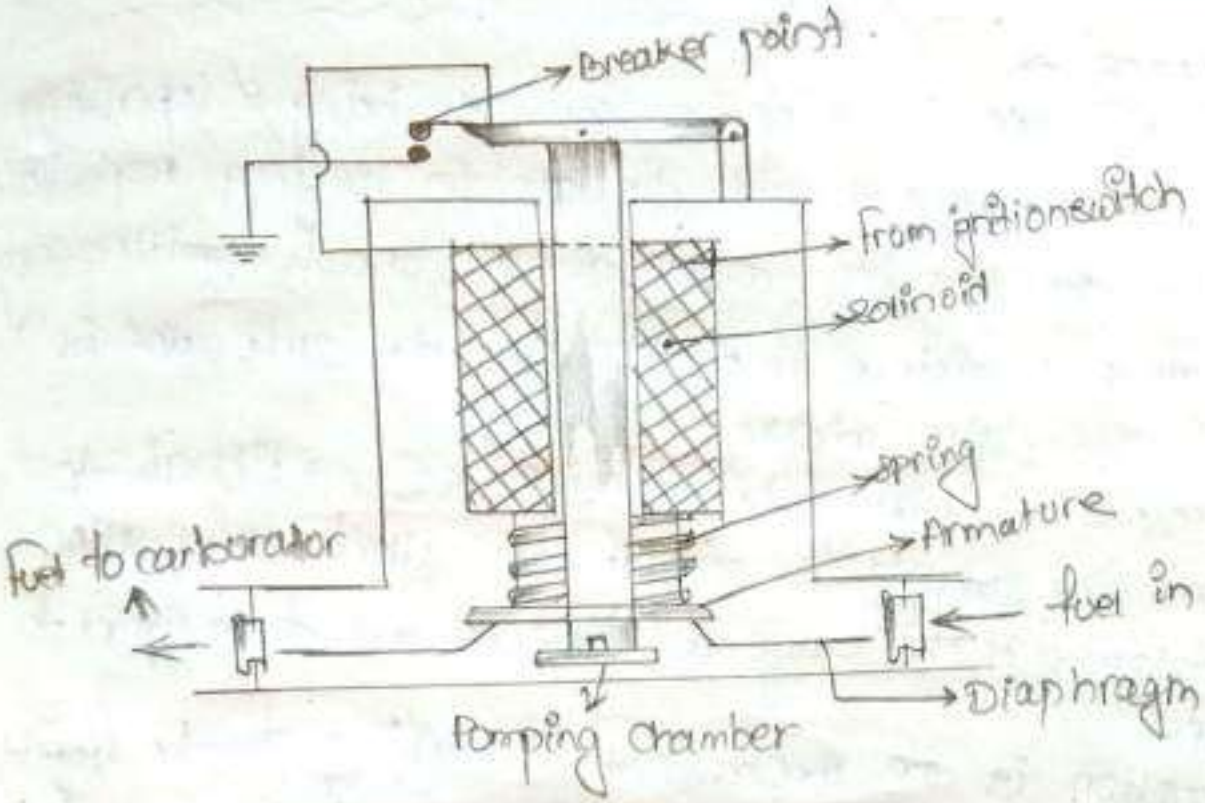
It also consists of diabragram but it is operated by electric. By turning on the ignition switch the solinoid winding generates magnatic flux, which pulls the armature & the diabragram moves up.

The upward moment of the diapphragm creats suction & the fuel is drawn into the chamber through the inlet valve. But as soon as the armature moves up, it disconnects the electric supply, the magnatic flux dies & the armature falls down, causing the diaphragm to move to create pressure in the pump chamber

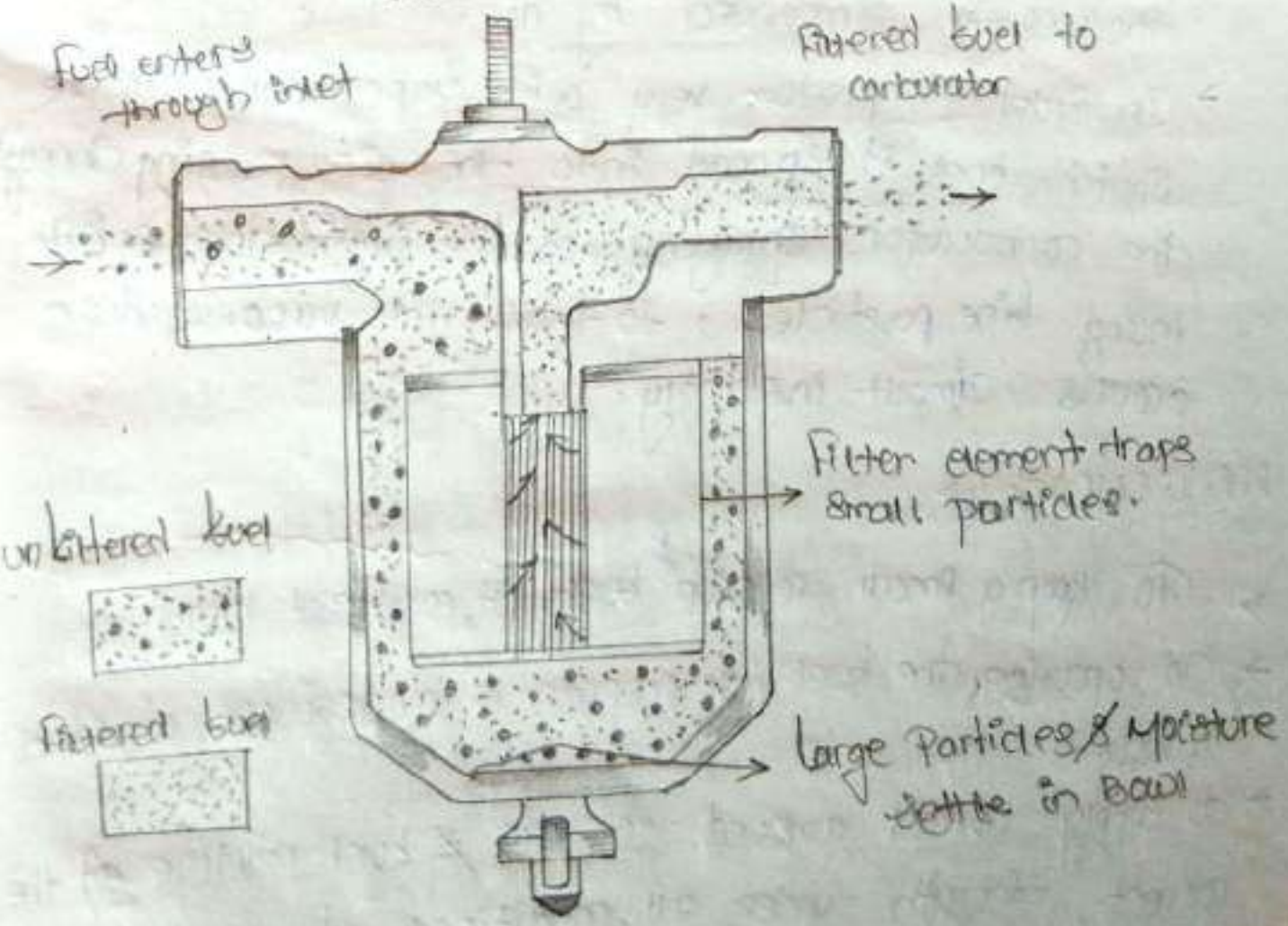
This causes the outlet valve to open & inlet valve to close.

The fuel goes out to the carburetor. The downward movement of the armature again sets electric supply to the solinoid & same process is repeated the pump continues operate until the ignition switch is turned off.

ELECTRIC FUEL PUMP



FUEL FILTER



Requirements & working principle of carburattor →

CARBURATOR →

→ The carborator is a device for atomizing & vaporizing the fuel & mixing it with the air in varying proportions to suit the charging conditions of spark ignition engine.

→ The air, fuel mixture so obtained from the carborator is called combustable mixture.

→ The process of mixing the gasoline fuel with air to obtained the combustable mixture is called carburation.

→ Vaporization is the change of state of fuel from liquid to vapour.

→ Atomization is the mechanical breaking of the liquid fuel into small particles so that every particle of the fuel is surrounded by air.

→ In order to produce very quick vaporization of the liquid fuel it spread into the air passing through the carborator, spraying of the liquid form is into many fine particles, so that the vaporization occurs almost instantly.

REQUIREMENTS / function

→ To keep a small reserve of fuel at constant head.

→ To vaporise the fuel to prepair a homogenious air & fuel mixture.

→ To supply correct amount of air & fuel mixture of the correct strength under all conditions of load & speed of the engine.

PRINCIPLE OF carburettor :-

→ The main parts are a float chamber, fuel jet, venturi, Nozzle & athrottle valve. The float in the float chamber is made up deep drawn brass sheet & its kept hollow for lightness.

→ Such floats have a tendency to leak along the joint seams. Due to this reason floats are now made up Nylon Plastic or expanded synthetic rubber.

→ The needle valve attach to the float lever serves to close or open to the fuel inlet to the float chamber depending upon the requirements.

→ The needle valve consists of a cylindrically stem with a conical tip made up steel or else a solid steel stem with a rubber set tip.

→ When the fuel level falls bellow a definite predetermine value the float also falls along with fuel level thus the opening the passage of the fuel supply.

→ The fuel starts flowing in & the float rises gradually till the fuel level reaches the desired value.

→ At this time the float needle closes the fuel inlet passage thus a constant head of fuel is maintain in float chamber this constant level of fuel is slightly bellow the nozzle outlet, so that the fuel may not drop all the time from the nozzle, even when the engine is not working. This provision also prevents the fuel from spilling out when the car is tilted on account of hill or highly cambered road.

→ A small vent in the float chamber keeps the pressure inside atmospheric.

CIRCUITS OF CARBURETOR

Most carburator's have five circuits or passages, for the fuel to flow the venturi or to other points in the carburator bore. These circuits are necessary because different engine operating contitions require different fuel-air mixtures.

The five carborador circuits are the float circuit, the low-speed circuit, the high-speed circuit, the accelerating pump circuit & the-choke circuit.

The fuel in the carburetor bowl must be kept at a certain level whenever the engine is running, if the level is too high, too much fuel will be discharged through the nozzle. The engine will use too much fuel & large deposits of carbon may from the cylinders. If the fuel level is too low, the mixture will be too 'lean' to operate the engine properly. The float circuits keeps the fuel at the correct level.

Air fuel ratio

> The carboration must supply the air fuel mixture at varying Proportions to suit the different operating requirements.

> The mixture must be rich for starting & must be relatively lean for idling & intermidiate speeds.

> for starting the air fuel ratio = 9:1 it is a rich mixture

> for ideaing the " " " = 12:1 it is a lean mixture

> for intermidiate speeds between 35-105 km/h the mixture is leane out 15:1.

> But at higher speeds 120 - 150 km/h with a wide open throttle the mixture again enreached 15:1.
> For acciliration at any speed the throttle is suddenly opened which causes a momentary enreachment of the mixture.
> ~~for this~~ the mixture most be reach for initial start because the engine & carburettors are cold, the fuel vapourises very poorly. Similarly for sudden opening of throttle for accilliration also ~~velocity~~ only. Hence extra fuel must come at the same time.

Carburettor's according to the direction of air :-

A down draught carburettor the air enters top of the carburettor & leaves at the bottom.

> In side draught carburettor the air enters top of the carburettor & leaves at the side.
> In up draught carburator the air enters at bottom or side of the carburettor & leaves at the top.
> In semi-down draught carburator the direction of the air flow is inclined top to bottom.

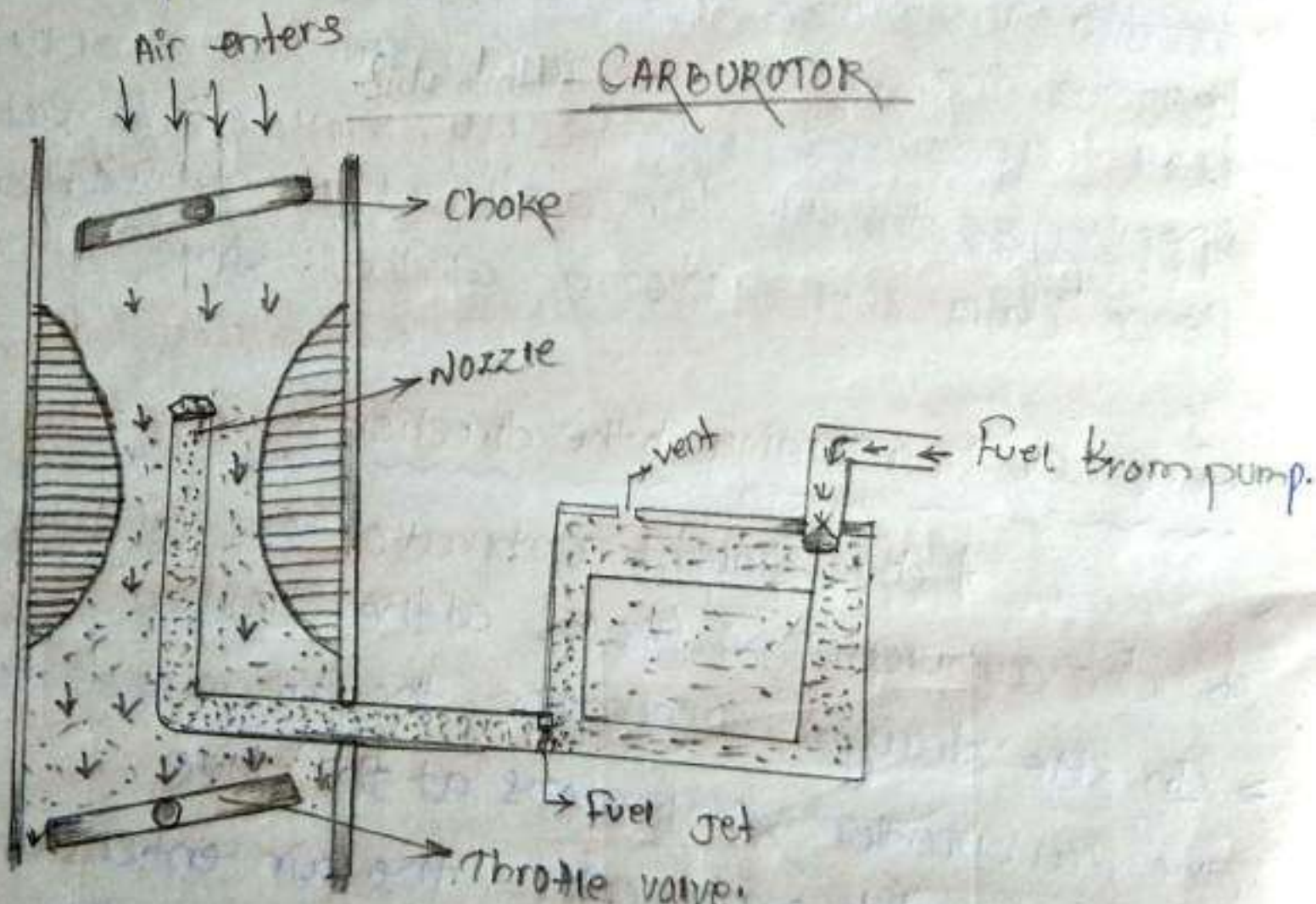
> In most passenger car's the down draught carburettor's are used because the gravity assist the flow of mixture.

> Therefore the engine works at better at lower speeds under load.

> Higher volumetric efficiency is achieved.

> The location of the carburator above the engine is more accessible for inspication, adjustment & for repair. & the air entering the carburator is pull up.

CARBUROTOR



S.U CARBURATOR →

It is an example of constant vaccum type carburator. It consist of a single jet in which a tappered needle operates. The area of the throat is varying by means of a Piston which slides up & down the tappered needle is connected to the accelirator. When the accelirator is operated, the piston moves up/down in the throad controling the supply of air, & the needle moves up & down to the jet controlling the supply of the fuel. When the piston moves up the throat area increases, more air passes through it. The needle also moves up increasing the angular area in the jet to pass more fuel.

When the piston moves down throat area decreases, less area passes through it & the needle also moves down decreasing the annular area in the jet to pass less fuel.

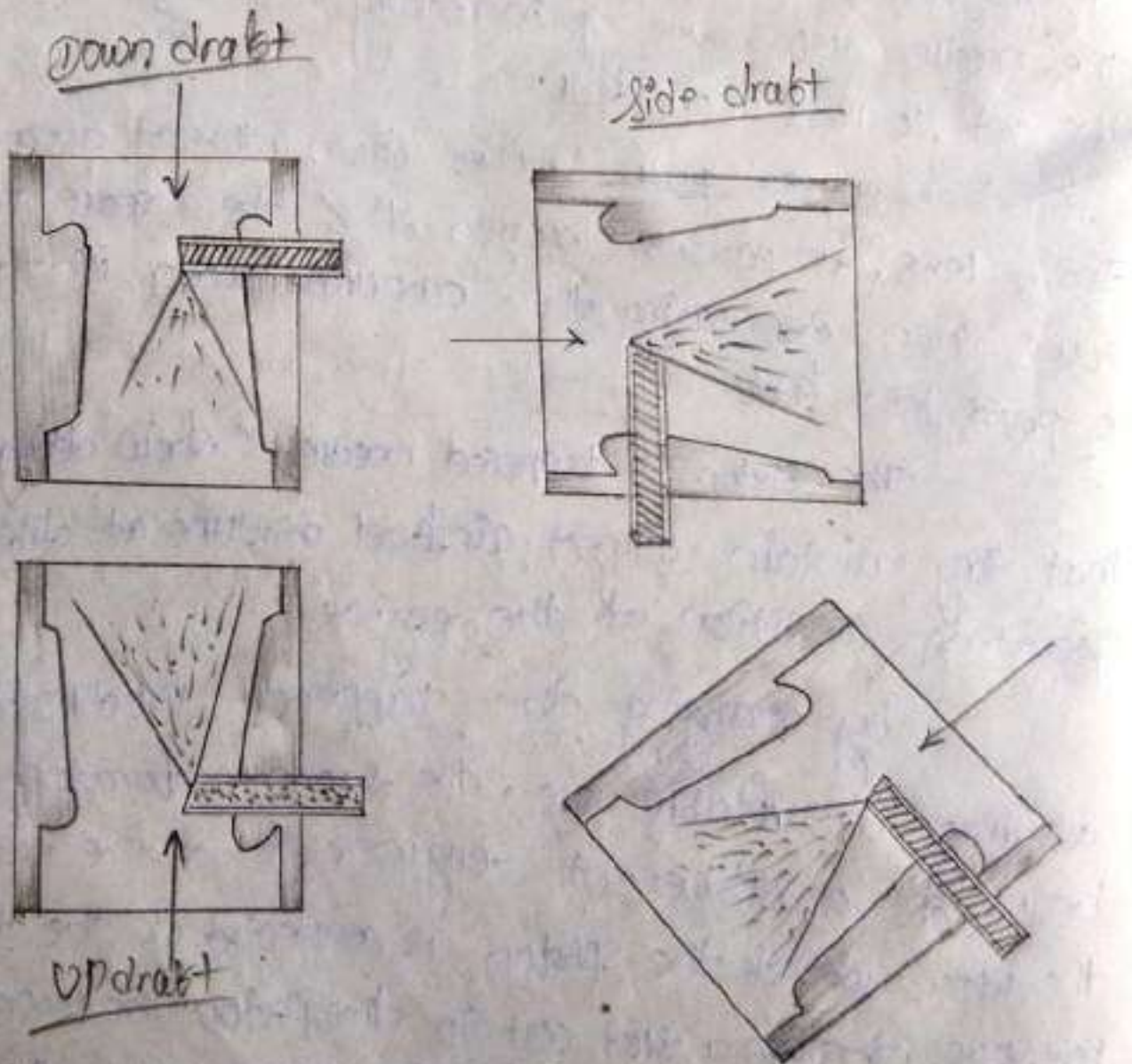
The piston & tappered needle are show designed that they maintain correct air, fuel mixture at diffferent operating condition of the engine.

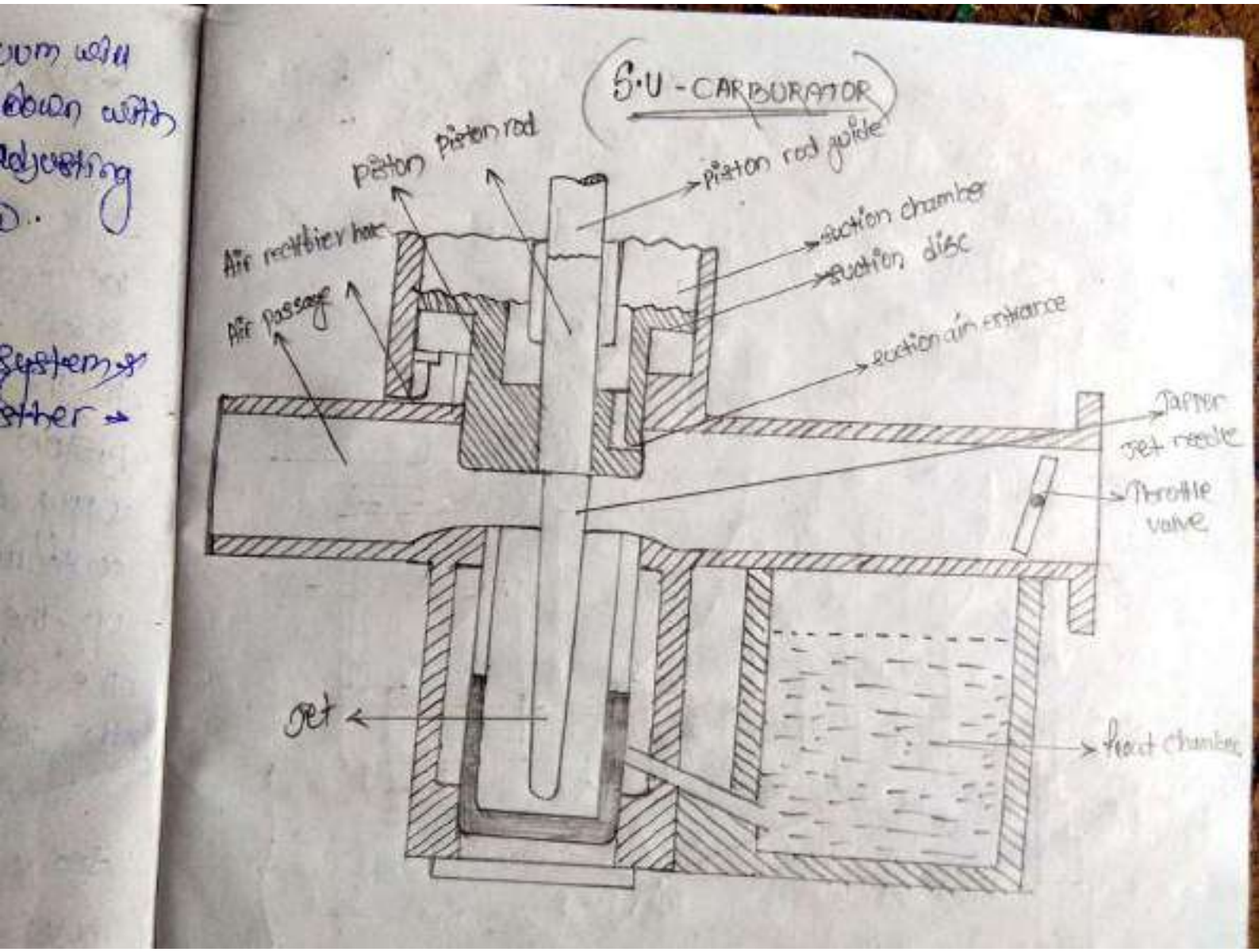
By changing the tappered needle & adopting a suitable one, the same carberetor can be used on diffferent engines to some extend. The upper side of the piston is connected to the throttle passage through a slot cut in the Piston. The lower side is exposed to the atmosperic Pressure, thus the position at any instant depends upon the balance upon its own weight against the vaccum force.

As the weight of the piston is constant vacuum will constant. The jet can be moved bodily up & down with respect to the tapered needle by at a adjusting screw located at the bottom of the screw.

This is done for the mixture strength.

There is no separate idealing or slow speed system & no accleration pump. The main advantage is better the rapid response during the acceleration.





FUEL INJECTION SYSTEM →

The function of a fuel injection system is to inject proper quantity of fuel into the engine cylinder at the correct time & at a predetermined rate.

Methods of fuel injection system →

There are two methods of fuel injection in compression ignition engines.

* Air blast injection
* Air less or solid injection →
  a) Individual Pump system.
  b) Common Rail system.

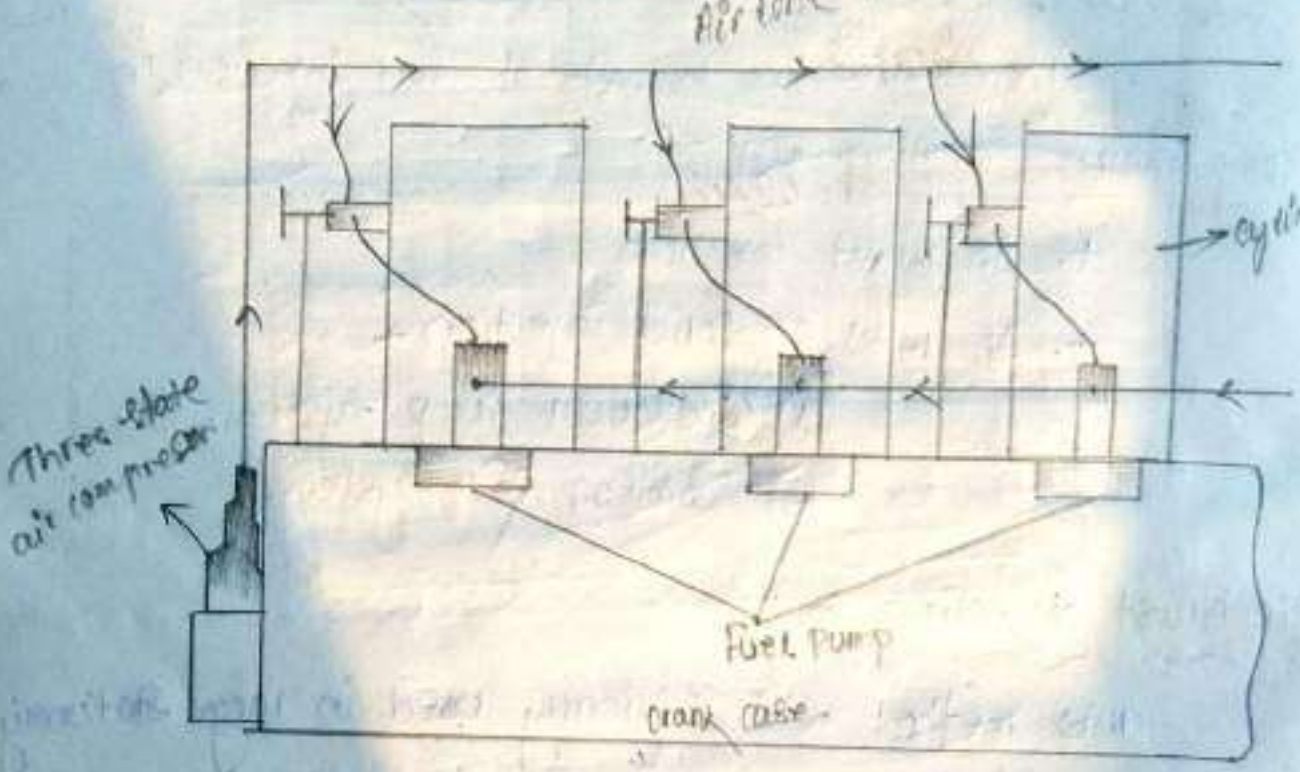
* Air blast injection →

This method was orginally used in large stationary & marine engines.

> But it is now obsolete, in this method the air compress to a very high pressure.
> A blast of this air is then injected carrying the fuel along with it into the cylinder.
> The rate of fuel injection is controlled by varying the Pressure of the air.
> The high Pressure air requires multistage compress so as to keep the air bottles charged.
> The fuel ignites by the high temperature of the air caused by the high compression.

- The compressor consumes about 10% of the power developed by the engine, decreasing the net output of the engine.
- This method of fuel injection is expensive & complicated.

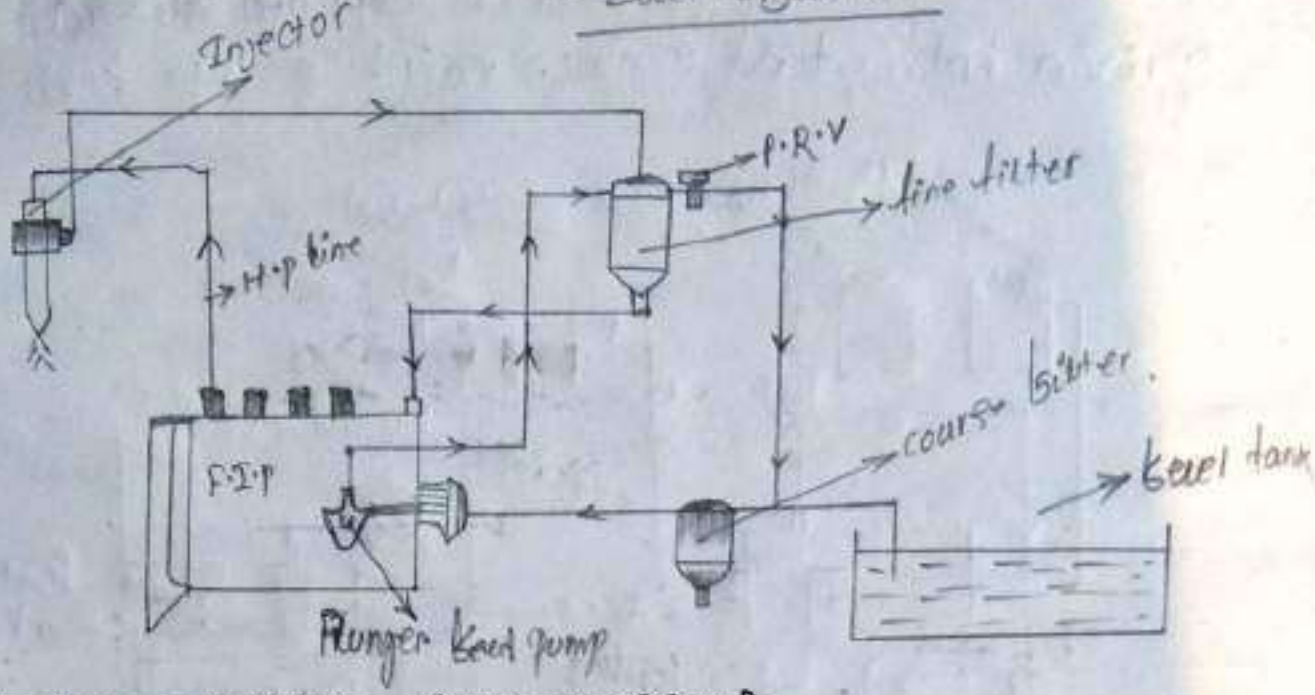
Air Blast injection



★. AIRLESS OR SOLID INJECTION :-

- In this method, the fuel under high pressure is directly injected into the combustion chamber.
- It burns due to the heat of compression of the air.
- This method requires a fuel pump to deliver the fuel at high pressure 3000 N/cm².
- This method is used for all types of small & big diesel engines.
- It can be devided into two systems.

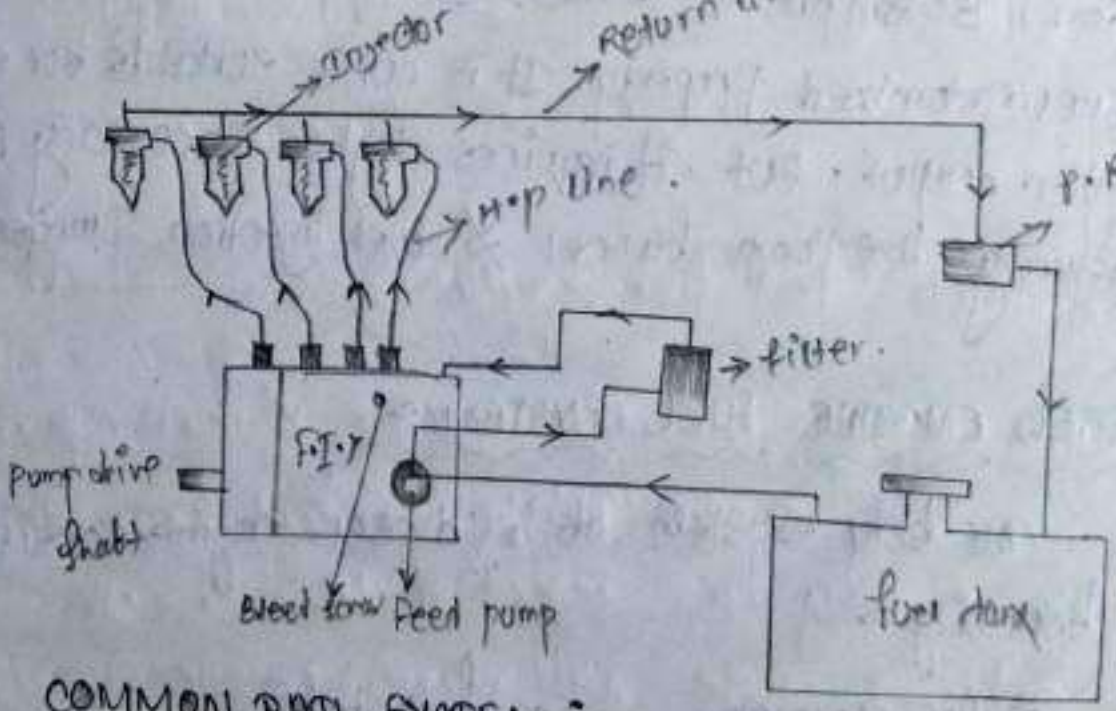
Solid Injection



a) INDIVIDUAL PUMP SYSTEM :-

In this system, each cylinder has its own individual high pressure pump & a metering unit.

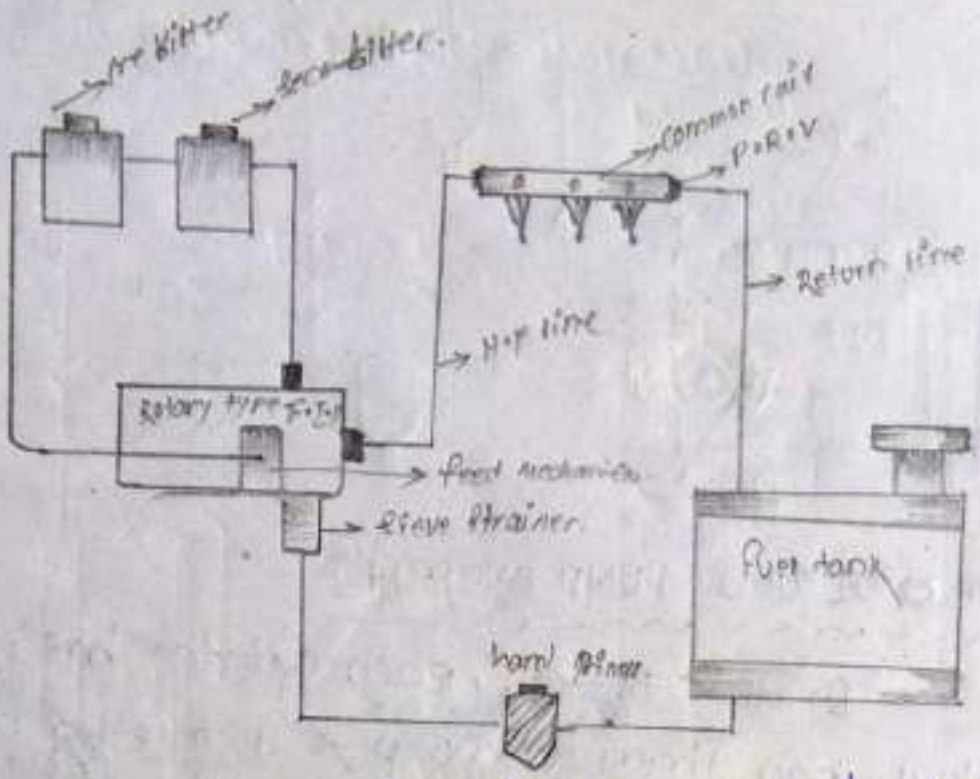
→ It is a quite compact & involves higher cost.



b) COMMON RAIL SYSTEM :-

→ In this system, the fuel is pumped by a multi-cylinder pump into a common rail, the pressure in this rail is controlled by relief valve.

→ A metered quantity of fuel is supplied to each cylinder from the common rail.



The air injection, in comparision to air blast injection, is simple in construction, light in weight & cheap. The fuel is atomized properly. It is quite suitable for engines of higher output. But, it requires higher accuracy in manufacturing the pump barrel & fuel injection plunger.

DIESEL ENGINE FUEL SYSTEM →

The fuel system of a diesel engine consists of the following →

- → Air cleaner.
- → fuel filter
- → Injector
- → fuel gauge
- → fuel tank
- → Injection pump.
- → fuel lines for necessary connections.

The main difference between the fuel system of a diesel engine & that of a petrol engine is that the fuel system of a diesel engine consists of an injector, instead of a carburetor, remaining items being the same.

In a Diesel engine, only the air is sucked & compressed inside the cylinder. At the end of compression stroke, the diesel oil is injected by an injector in the compressed air, which ignites due to the heat of compression & gives power impulse the Piston.

The fuel pump delivers fuel at a comparatively low pressure to the injector. Every cylinder is fitted with an injector. The quantity of the fuel to be injected is controlled by the injector. If less fuel is injected, less power will be developed & the engine will run slowly.

TBI SYSTEM (Throttle Body fuel injection):-

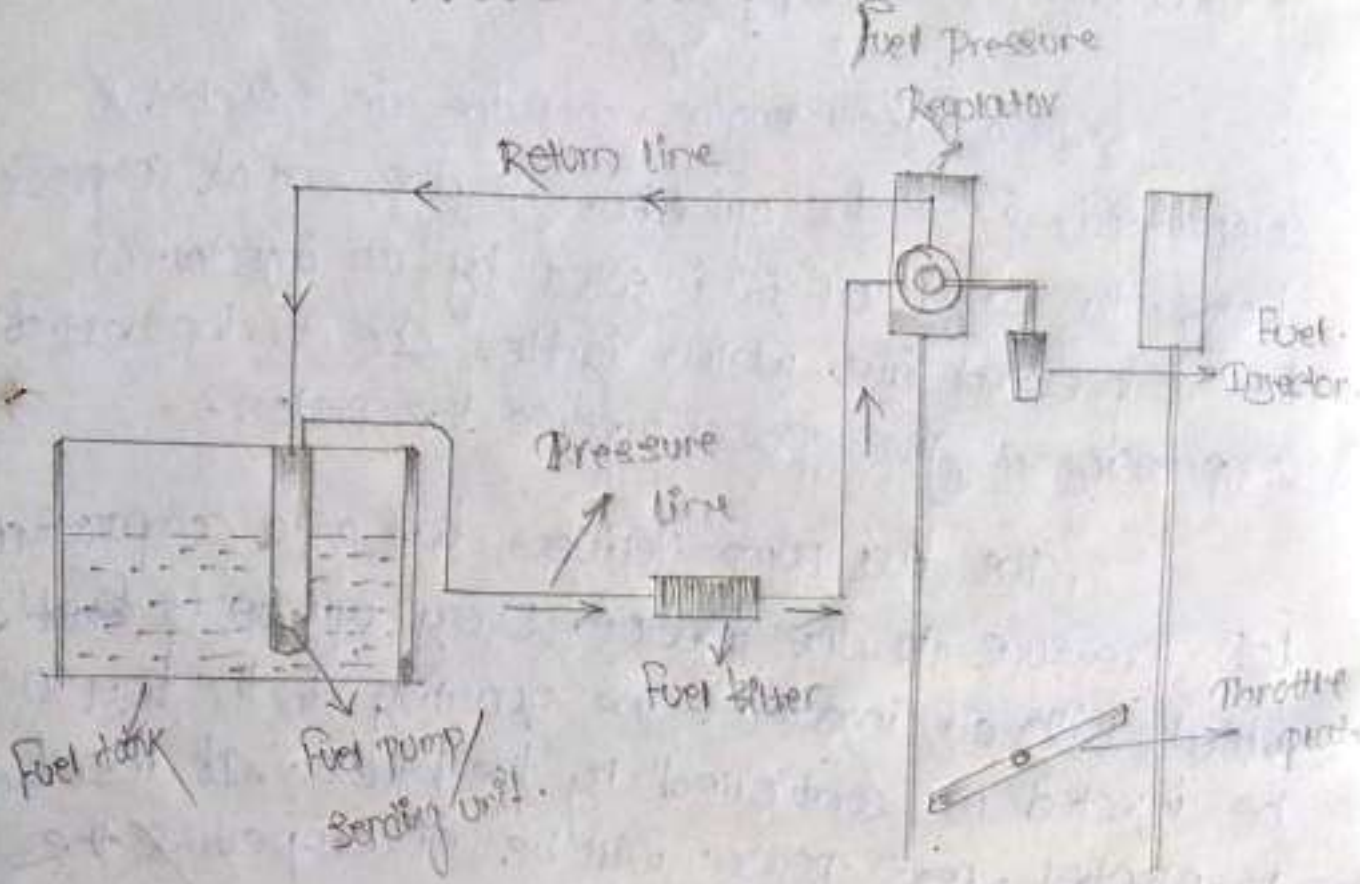
Fuel & air mixture within an EFI system depends on weather a throttle body or ported design is used. Therefore some fuel system components common to both the systems.

The throttle body unit is similar size & shape to a carburettor & like a carburator, mount on the intake manifold. fuel supplied & return line service one or sometimes two fuel injectors.

EFI -

the injector's spray fuel down into a throttle body chamber leading into the intake manifold.

THROTTLE BODY INJECTION

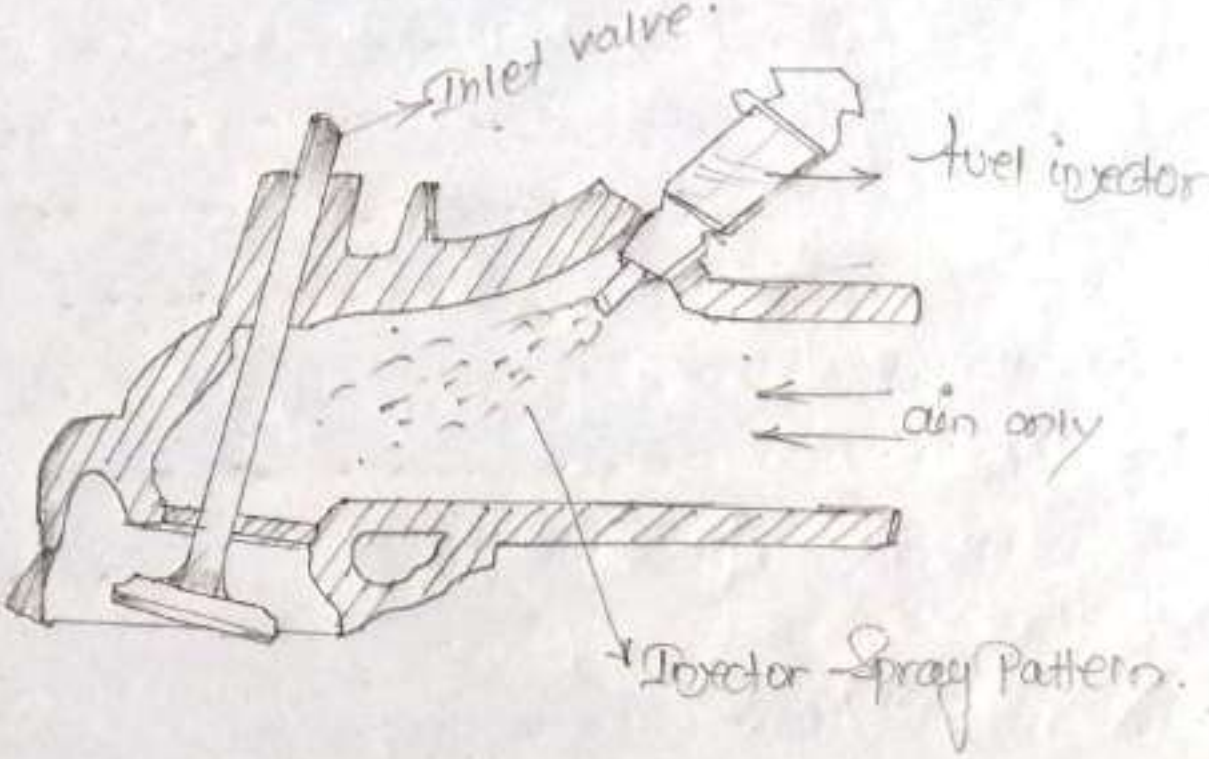


PFI Injection (port fuel injection):-

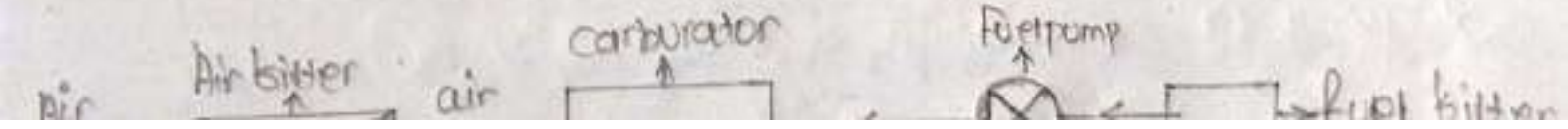
This system use one injector for each cylinder they are mounted in the intake manifold near the cylinder head where they can inject a fine, atomized fuel mixed as close as possible to the intake valve. Fuel lines run to each cylinder from a fuel manifold usually refered to as a fuel rail. the fuel rail assy on a PFI system of V-6 & V-8 engine usually consist of a left & right hand rail assy.

one two rails can be connected either by cross-over & return fuel tubes or by a mechanical bracket arrangement.

PORT FUEL INJECTION



LINE Diagram of Petrol engine fuel supply system →



ECM CONTROL & FUNCTIONS ➤

ENGINE ELECTRONIC CONTROL MODULE (ECM) ➤

➤ An engine control unit (ECU), also commonly called an engine ctrl module (ECM), is a type of electronic control unit that controls a series of actuators on an I.C engine to ensure optimal engine performance.

➤ The ECM regulates four main parts of your vehicle's operating systems – Airfuel ratio (A.F.R)
- Idle speed.
- variable valve Timing (VVT)
- Ignition Timing.

FUNCTION OF ECM ➤

➤ The Engine control module (ECM), also called the engine control unit (ECU), ensures that your vehicle operates at optimal performance.

➤ The ECM monitors most of the sensors in the engine bay in order to manage your vehicle air-fuel mixture & ~~order to~~ regulate the emission ctrl systems.

➤ The ECM regulates 4-main parts of vehicle operating system :- air fuel ratio, Idle speed, variable valve Timing, Ignition Timing.

➤ The ECM uses sensors to regulate the oxygen to fuel ratio detect in your car's exhaust to detect an engine rich/lean reading.

→ Some these sensors include the mass air flow sensor, the oxygen sensor, air-fuel sensor,.
→ For idle speed, the ECM relies on sensors located by the crankshaft & camshaft that track your vehicl RPM & engine load by monitoring the speed & rotatio & the engine.
→ (RPM) the VVT system ctrls when the valves are opened in the engine to either increase power or fuel economy.
→ Lastly, the ECM ctrls the Ignition Timing, this is the position at which the spark plug is fired within the combustion cycle.
→ The ECM also ctrls multiple other systems on top & these main tasks.
→ So, It is also called the brain & the vehicle

FUEL INJECTOR OR ATOMISER :-

The purpose of the fuel injector is to inject small volume of fuel in a fine spray & to assist in bringing is droplate into contact with sufficient oxygen to give quick & complete combustion.

- It consist of a niddle valve which is pressed on its seating in the nozzle by a plumber or spindle.
- A compression spring otrs the pressure upon the plunger by which the niddle valve opens.
- A nozzle is attached to the body of the injector by a cap nut.
- The fuel enters the nozzle through drillings in the injector body.
- The fuel may passed from a gallery down the sides of the lower parts of the niddle valve, or it may enter an angular groove in the nozzle & then pass through drillings to a point just above the nozzle seat.
- The body or the nozzle holder provides access for the fuel & outlet for the fuel that leaks onto the area occupied by the spring.
- When the niddle valve is raised from its seat by the pressure of the fuel acting on the conical or stepped face of the valve the injection of the fuel takes place.
- When the injection pressure falls below the spring pressure the valve closes.

⇒ This action tends to set up an oscillation of the valve during each injection & the consiquently breaks the fuel into small particles.

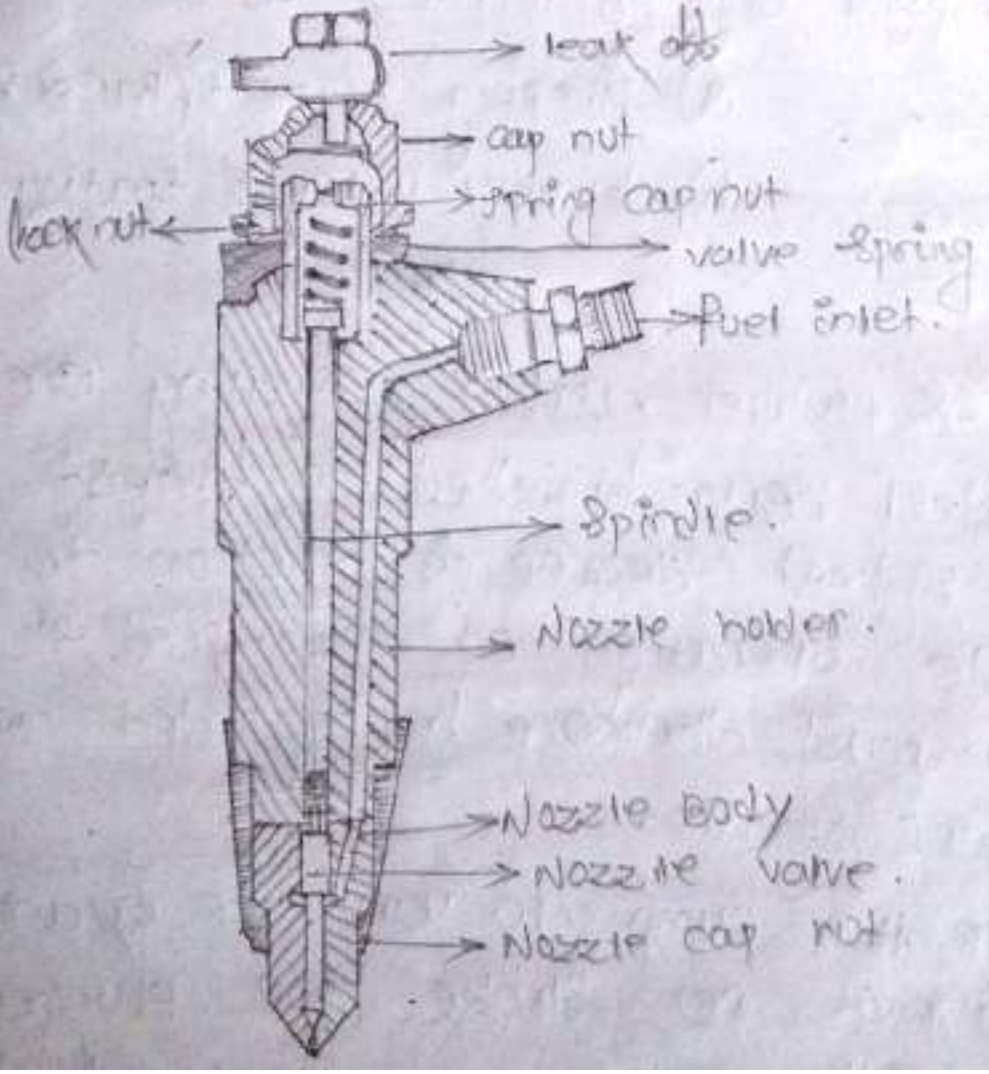
⇒ The fuel leakage passed the middle valve steam enter the upper part of the injector & is returned to the pump suction chamber or to the fuel tank.

(1) fuel leakage provides lubrication also ~~called~~ for the valve steam.

~~FUEL PUMP :~~

~~To deliver accurat~~

FUEL INJECTOR



Fuel Pump :-

- To deliver accurately measured amount of fuel at high pressure to the injectors.
- The amount of fuel delivered should be carried precisely with regard to the timing, rate & duration & must satisfy the work the engine is required to do.
- All our inline fuel injection Pumps are cam operated, spring return, Plunger type, using one pumping unit for each engine cylinder & incorporates it's own camshaft & tappet gear.
- Each pumping unit comprises of :-
  a) pumping element (Barrel & plunger)
  b) delivery valve & seating

- Barrel & plunger, valve & seating are highly ground steel being finished to finest limits & with highest degree of precision to permit of accurate operation at high speed & pressure, each pair must therefore be regarded as inseparable & not interchangeable.
- To enable the pump to vary the quantity of the fuel delivered per stroke the plunger is provided with vertical channel extending from its top edge to an angular groove, the upper edge of which is cut in the form of a

> External means are provided where by the plunger can be rotated in its barrel during operation.

Operation >

> The system of operation of the pump element which is comprised of the Plunger & barrel.
> When the plunger is at B.D.C oil can entered through the barrel ports either by gravity flow an overhead tank, or force feed from a fuel feed pump, the
> In a primed system the barrel & the pipes leading from the pump to the injectors, are full up oil. As the pump plunger rises a certain amount of fuel is pushed back through the barrel force, until the plunger reaches the position where the top land of the plunger has closed both ports.
> The fuel above the plunger is trapped, & it's only outlet is via the delivery valve which is mounted on top of the pump barrel.
> The pressure exerted by the rising plunger upon the oil causes this to lift the valve & to enter the pipe which connects the Pump to the injector.

GOVERNING SYSTEM OF FUEL :-

A Governor is a system that is used to maintain the mean speed of an engine, within certain limits, under fluctuating load conditions.

→ It does this by regulating & controlling the amount of fuel supplied to the engine...

→ Governors are also fitted in auxiliary diesel engines or generators, & Alternators on the ship.

TYPES OF GOVERNORS :-

following are the three different types of governors used in automobile vehicle -

a) Mechanical or Centrifugal Governor
b) Pneumatic Governor.
c) Hydraulic governor.

a) MECHANICAL / CENTRIFUGAL GOVERNOR :-

Mechanical Governor are fitted to large engines on an extension of the pump camshaft.

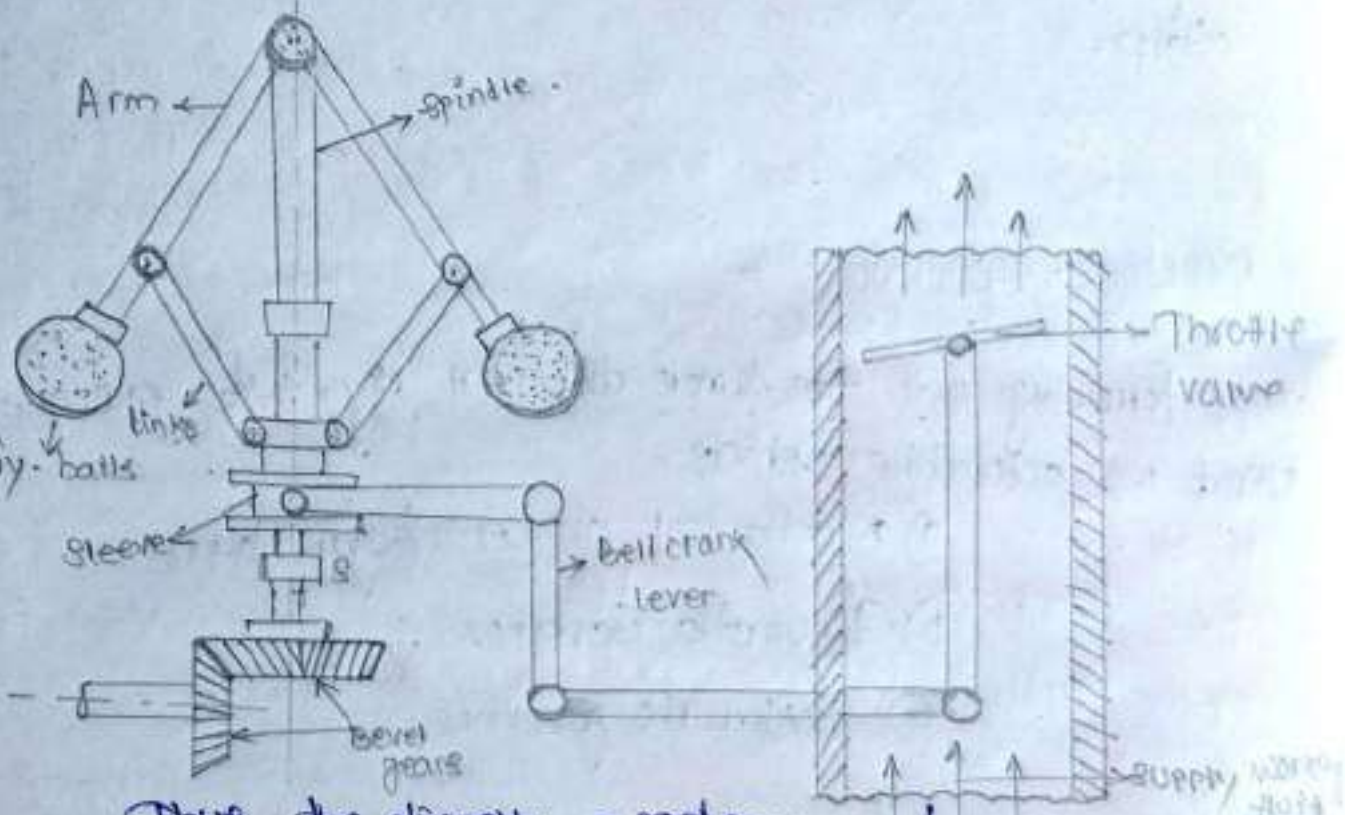
WORKING :-

When the engine starts, the weights take up a position to maintain a stable idling speed. As the accelerator pedal is depressed against the spring, the weight moves inwards, & since the weight are linked to the control rod, the fuel delivery is

increased & hence the engine speed also increases.

The increased engine speed causes the pump camshaft to rotate faster, which moves the weights outward against the action of ctrl springs, so reduced the fuel delivery until the correct balance is arrived at for a particular engine operating condition.

MECHANICAL GOVERNOR



Thus, the ~~directly~~ accelerator does not increase delivery directly but delays the action of the governor the relative position of governor-weight & ctrl-rod position when the engine is at idling & full-load position.

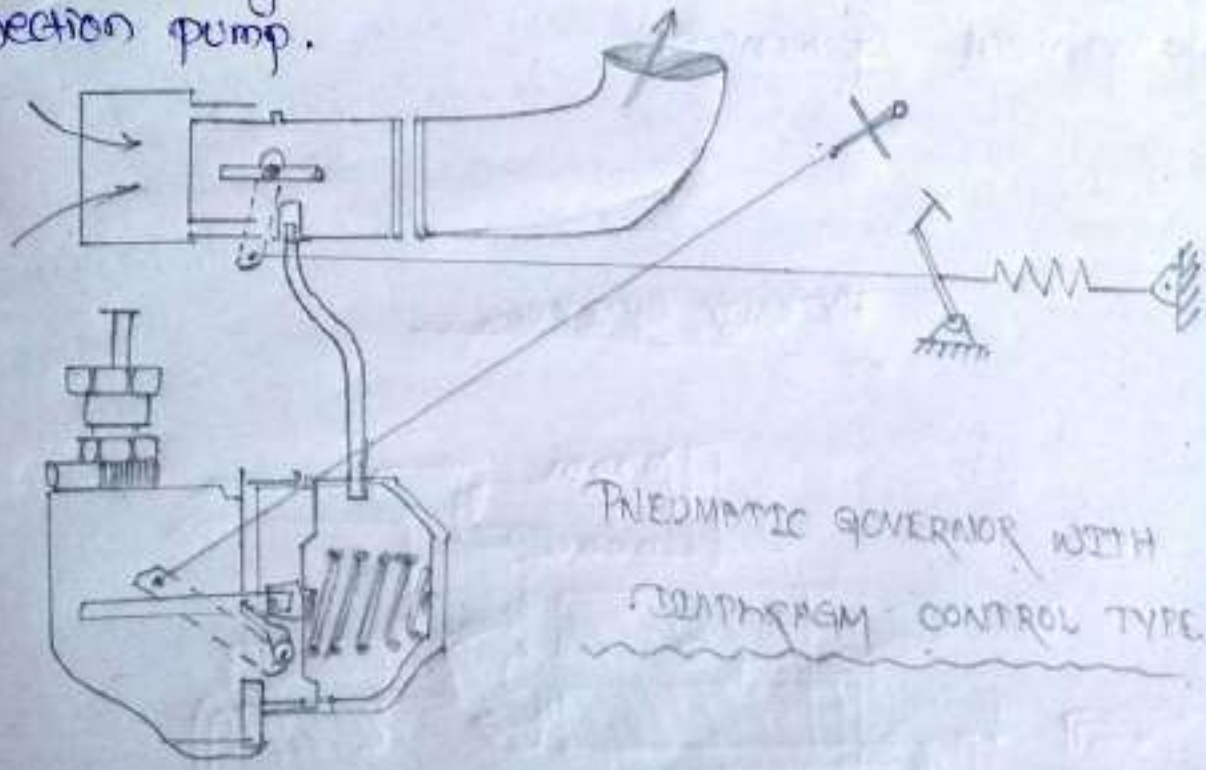
PNEUMATIC GOVERNOR :-

Pneumatic governor are most successfully used in small & medium size engines. They are sensitive to variations in torque loading & ensure stable

idling ctrl. As with Pneumatic induction Pipe ctrl, the air supply at light loads is throttle by a butterfly valve placed in a choke.

This valve is directly operated by the accelerator pedal. The throttle unit is placed between the air cleaner & the entry to the inlet manifold. which results in the reduced air pressure at the end of induction.

Injection then takes place into less dense air than with unrestricted induction, & the control thus becomes quantity rather than quality control. The fuel injection is controlled by the depression at the choke to a diaphragm chamber mounted on the end of the injection pump.



PNEUMATIC GOVERNOR WITH DIAPHRAGM CONTROL TYPE

The diaphragm plate is mounted on the end of the control rack of the pump. It is pushed to the full load position (to the right) by the main control

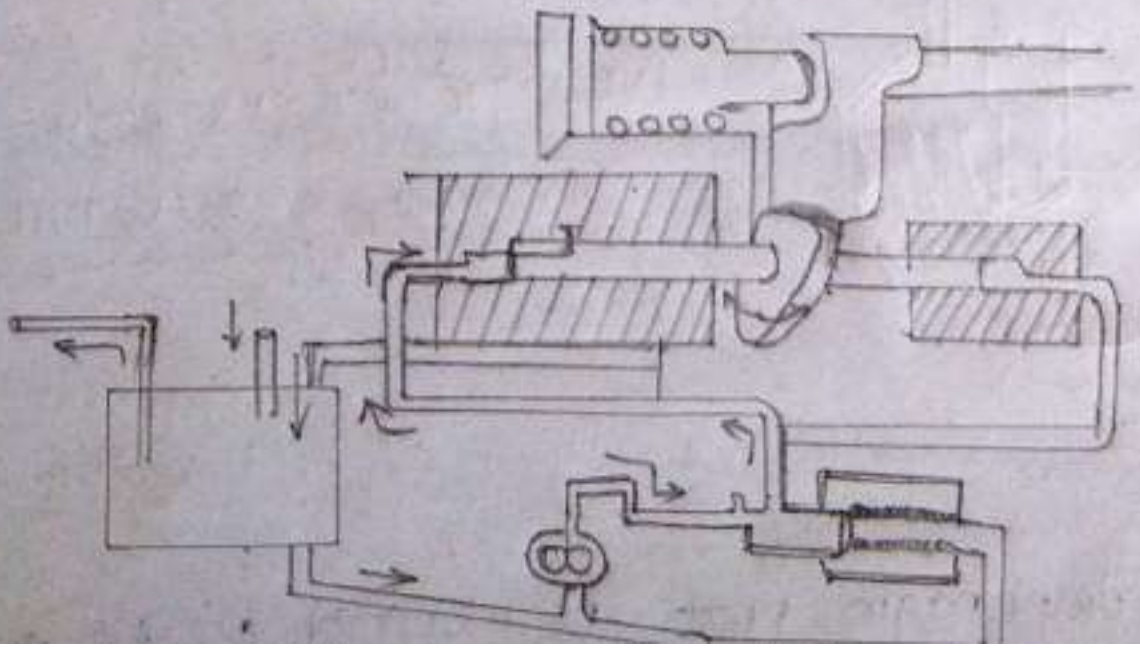
spring. Again the increased depression at the throttle, arising when the accelerator pedal is released. It will pull the diaphragm & control rod to the left. thus reducing the fuel supply.

An auxiliary spring is also used to balance the height depression at idling speed. It is brought into action progressively by the action of a cam.

HYDRAULIC GOVERNOR →

Hydraulic governors eliminate the high mechanical forces bearing loads & possible torsional vibrations in the drive. & hence they are preferred over mechanical Governors.

HYDRALIC GOVERNOR



In a mechanical governor, the operative agent is the centrifugal force which governs the speed. In a hydraulic goveror, it is the pressure difference across an orifice required to pass the oil flow from a positive oil pump driven by an engine.

The pressure difference varies as the square of the engine speed. It is determined at equilibrium by the pressure of the driver's foot on the accelerator pedal.

A hydraulic Governor, like a mechanical governor, is an all-speed governor i.e, the governor is in control throughout the whole rack is operated by the governor not directly by the accelerator to the supply to maintain the speed, no matter what the power requirements may be from moment to moment.

CHAPTER - 5

COOLING SYSTEM ⇒

⇒ I.C engine cooling uses either air or liquid to remove the waste heat from an I.C engine.

⇒ A system, which controls the engine temperature is known as a cooling system.

⇒ Combustion of fuel inside the cylinder develop a very high temperature at this temperature the engine parts will expand. Therefore it is necessary to keep the engine temperature to operating limits. This is done by the cooling system.

NECESSITY FOR ENGINE COOLING ⇒

⇒ To keep the engine at it's most efficient operating temperature.

⇒ Damage the materials of cylinder body & piston.

⇒ Reduce the strength of materials used for piston & piston rings.

⇒ Over heating reduces the efficiency of the engine.

⇒ Engine valves damage due to over heating.

⇒ Higher temp. also lower volumetric efficiency of the engine.

TYPES OF COOLING SYSTEM ⇒

There are two types of cooling system :-

a) Direct cooling ⇒ air cooling

b) Indirect cooling ⇒ Water cooling

① Air cooling system →

→ In this cooling system, which is conducted to the outer parts of the engine, is radiated & conducted away by the stream of air, which is obtained from the atmosphere.

→ In order to have efficient cooling by means of air, Providing fins around the cylinder & cylinder head increases the contact area.

→ The fins are metallic ridges, which are formed during the casting of the cylinder & cylinder head.

*. The amount of heat carried off by the air-cooling depends upon the following factors →

(i) The total area of the fin surfaces.
(ii) The velocity & amount of the cooling air &
(iii) The temp. of the fins & of the cooling air.

→ Air-cooling is mostly tractors of less-horsepower, motorcycles, scooters, small cars & small aircraft engines. where the forward motion of the machine gives good velocity to cool the engine.

→ Air-cooling is also provided in some small industrial engines.

→ In this system, individual cylinders are generally employed to provide ample cooling area by providing fins.

→ A blower is used to provide air.

Advantage of air cooled engine ⇒

- ⇒ The design of air-cooled engine is simple.
- ⇒ It is lighter in weight than water cooled engines due to the absence of water jackets, radiator, circulating pump & the weight of the cooling water.
- ⇒ It is cheaper to manufacture.
- ⇒ It needs less care & maintenance.
- ⇒ This system of cooling is particularly advantageous where there are extreme climatic conditions in the arctic or where there is scarcity of water as in deserts.
- ⇒ No risk of damage from frost, such as cracking of cylinder jackets or radiator water tubes.
- ⇒ No leakage problem.
- ⇒ coolant & antifreeze solution are not required.

Dis-advantage/limitations of air cooled engine ⇒

- ⇒ Engine is cooled uniformly.
- ⇒ The compression ratio of the engine is limited due to high wall temperature.
- ⇒ The volumetric efficiency of the engine is less than a water-cooled engine.
- ⇒ It produces aerodynamic noise.
- ⇒ It can be used for only small-sized engines due to its small capacity of heat dissipation.

(1) WATER COOLING SYSTEM :-

→ It serves two purpose in the working of an engine.

(i) It takes away the excessive heat generated in the engine & saves it from over heating.

(ii) It keeps the engine at working temperature for efficient & economical working.

A. This cooling system has four types of systems :-

→ Direct or non-return system.

→ Thermo-syphone system.

→ Hopper system.

→ Pump / forced circulation system.

Though the present tractor has a forced circulation system it is still worthwhile to get acquainted with the other three systems.

→(a) Direct or Non-return water cooling system →

These is suitable for large installations & where plenty of water is available. The water from a storage tank is directly supplied to the engine cylinder.

The hot water is not cooled for reuse but simply discharged. The low H.P engine, couple with the irrigation pump is an example.

(b) Thermo-syphone water cooling system

- This system works on the Principle that hot water being lighter rises up & the cold water being heavier goes down.
- In this system the radiator is placed at a higher level than the engine for the easy flow of water towards the engine.
- Heat is conducted to the water jackets from where it is taken away due to convection by the circulating water.
- As the water jackets becomes hot, It rises to the top of the radiator.
- cold water from the radiator takes the place of the rising hot water & in this way a circulation of water is set up the system.
- This keeping the engine at working temp.

(c) Hopper water cooling system

- This also works on the same principle as the thermo-syphon system.
- In this there is a hopper on a jacket containing of water, which surround the engine cylinder.
- In this system, as soon as water starts boiling, it is replaced by cold water.
- An engine fitted with this system cannot run for several hours without it being refilled with water.

⇒ (d) Forced / Pump circulation water cooling system ⇒

⇒ This system is similar in construction to the thermo-syphon system except that it makes use of a centrifugal pump to circulate the water throughout the water jackets & radiator.

⇒ The water flows from the lower portion of the radiator to the water jacket of the engine through the centrifugal pump.

⇒ After the circulation water comes back to the radiator, it loses it's heat by the process of radiation.

⇒ This system is employed in cars, trucks, tractors etc..

Parts of liquid/water cooling system ⇒

The main parts in the water-cooling system are ⇒

- ⇒ water pump
- ⇒ fan
- ⇒ Radiator & Pressure cap
- ⇒ fan belt.
- ⇒ water-jacket
- ⇒ thermostat-valve
- ⇒ Temperature gauge
- ⇒ Hose Pipe.

⇒ WATER PUMP ⇒

⇒ The centrifugal type water pump is used on engine. It is mounted on the front side of cylinder block & head.

⇒ The water pump is driven by the crankshaft pully through the fan belt. The impeller is mounted on the one end of the water pump shaft.

⇒ The shaft is fitted in the pump housing with bearings. A water seal is provided in the pump to prevent

leakage of water & to prevent water entering into the bearing.

> When the impeller rotate it draws water from the water tank of the radiator & comes water to the engine block by centrifugal force under pressure.

> The fan Mounted on the water pump pulley.

THERMOSTAT VALVE →

> It is a kind of check valve which opens & closes with the effect of temperature.

> It is fitted in the water outlet path of the engine.

> During the warm-up period, the thermostat is closed & the water pump circulates the water only throughout the cylinder block & cylinder head.

> When the Normal operating temperature is reached, the thermostat, the thermostat valve opens & allows hot water to flow towards the radiator.

> Thermostat valves are designed to start opening at ~~70-75~~ 75°C & they fully open at 82°C.

> There are mainly two types of thermostat valve used →

1. Bellows type.
2. Wax type.

RADIATOR →

> The purpose of the radiator is to cool down the water received from the engine.

> The radiator consists of three main parts →

1. upper tank
2. tubes
3. lower tank

→ Hot water from the upper tank, which comes from the engine, flows downwards through the tubes.

→ The heat contained in the hot water is conducted to the copper fins. Provided arround the tubes.

→ An overflow pipe is connected to the upper tank, permits excess water or stream to escape.

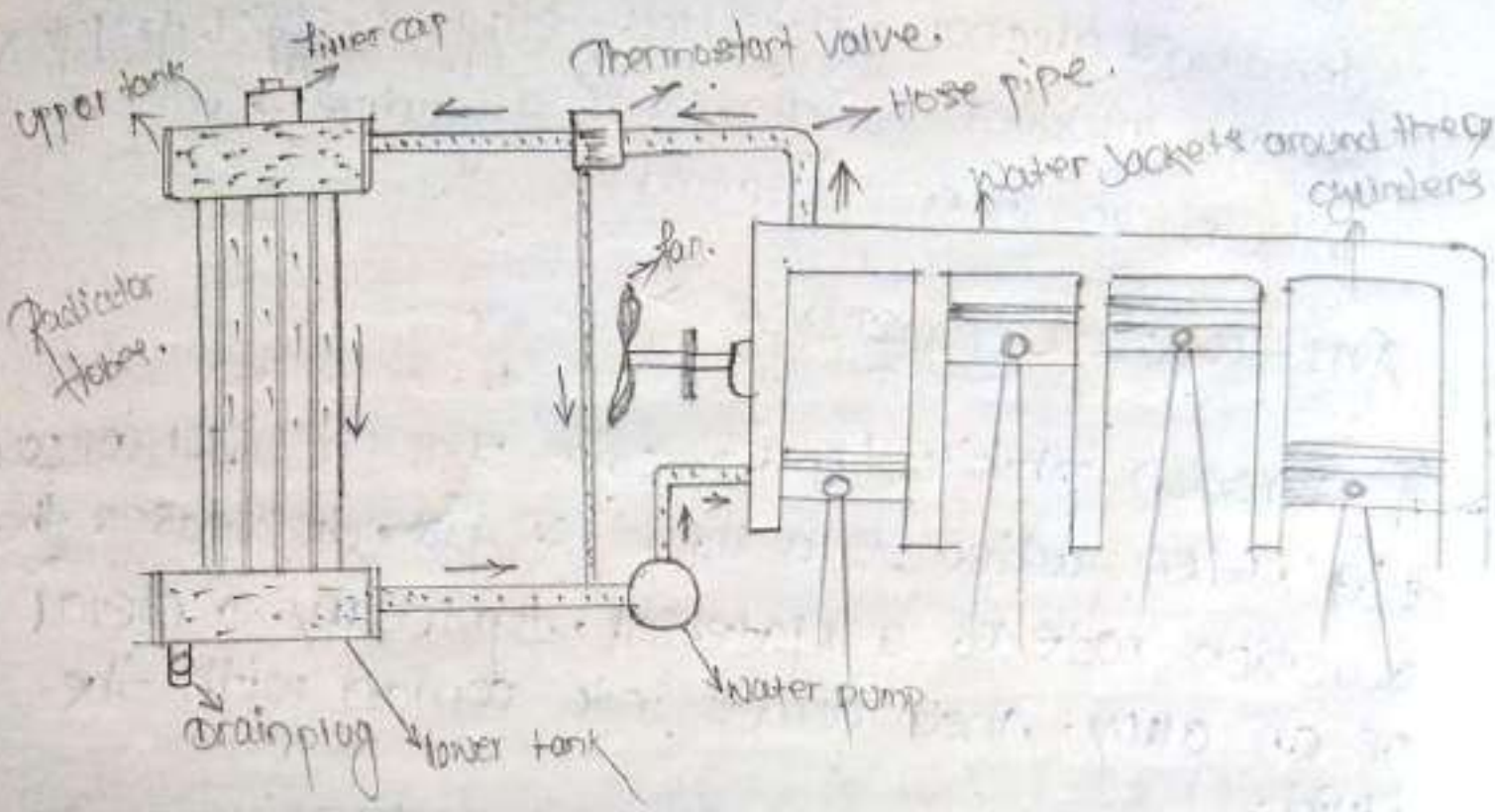
→ These are three type's they are →

(I) gilled tube radiator.

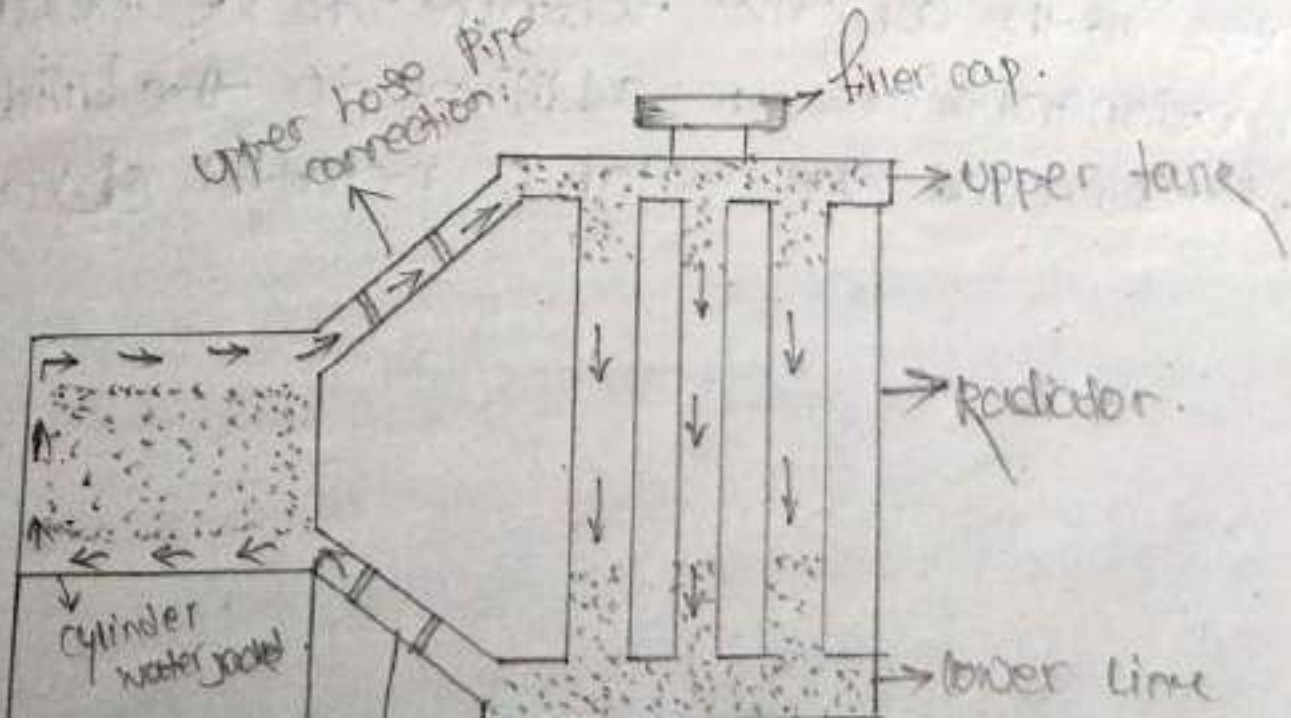
(II) Tubular radiator.

(III) Honey comb or cellular radiator.

PUMP / FORCED WATER COOLING SYSTEM



Thermo Syphone Water cooling System



ANTI-FREEZE SOLUTIONS →

→ In order to prevent the water in the cooling system from freezing, some chemical solutions which are known as anti-freeze solutions are mixed with water.

→ In cold areas, if the engine is kept without this solution for some time, the water may freeze & expand leading to fractures in the cylinder block, cylinder head, pipes or radiators.

→ The boiling point of the anti-freeze solution be as high as that of water.

→ An ideal mixture should easily dissolve in water, be reasonably cheap & should not deposit any foreign matter in the jacket pipes & radiator.

→ No single antifreeze solution satisfies all these requirements.

➢ The materials commonly used are wood, alcohol, denatured alcohol, glycerine, ethylene glycol, propylene glycol, mixtures of alcohol & glycerine & various mixtures of other chemical.

ANTI-CORROSIVE ADDITIVES ➢

➢ A corrosion inhibitor/Anticorrosive is a chemical compound that, when added to a liquid or gas, decreases the corrosion rate of a material, typically a metal or an alloy, that comes into contact with the fluid.

➢ The corrosion inhibitors depends on fluid composition, quantity of water, & flow regime.

➢ A common Anti-corrosive's involves formation of a coating, often a passivation layer, which prevents access of the corrosive substance to the metal.

➢ Corrosion inhibitors are additives to the fluid that surround the metal or related object.

LUBRICATION SYSTEM Chapter-6

LUBRICATION SYSTEM :-

→ Lubrication system is a process or technique of using a lubricant to reduce friction & wear & tear in a contact between two surfaces.

→ Lubrication is essentially required for Propes tractor Maintenance.

→ It is defined as supply of lubricating oil between the moving Parts.

Requirements of lubrication →

★ - To reduce the friction between the moving Parts.
★ - To reduce the wear of the moving Parts.
★ - To act as a cooling medium.
★ - To keep the engine parts clean.
★ - To absorb shocks between bearings & other engine Parts.
★ - To minimize the vibrations.
★ - To form good seal between Piston rings & cylinder walls.
★ - To increase efficiency.
★ - To prevent deposition of carbon & metalic components from corrosive attack.
★ - To resist oxidation.

Properties of lubricants →

→ Viscosity
→ Flash point
→ Fire Point

- Oiliness
- Corrosion
- pour point
- Colour
- Sulphur content
- Specific gravity (It varies between 0.85 to 0.96)
- Neutralization number.
- Adhesiveness.

Viscosity → A measure of a lubricant's resistant to flow.

FLASH POINT →

→ It is the temperature at which the vapour of the oil will flash when subjected to flame.

→ This weakens the oil film strength, sealing ability, & it may be caused by fuel system leaks, ignition problem etc...

FIRE POINT →

→ It is the temperature at which the the oil vapour will burn steadily for at least 5 seconds when lit by a flame.

CORROSION →

Moisture present in oil of condensing from atmosphere can lead to corrosion in engine.

Oiliness →

→ oiliness of a lubricant is a measure of its capacity to stick on the surface of machine parts, under conditions of heavy pressure or load.

> Mineral oils have got very poor oiliness, while vegetable oil have good oiliness.

POUR POINT >

> Temperature at which oil stops flowing. Dewaxing oil or using Pour point depressants are used to reduce the level.

TYPES OF LUBRICANT >

Three types →

* Solid → Graphite, Mica, Soap-stone.
* Semi-solid → grease.
* Liquid → Mineral, vegetable & animal oil.

Lubricating Parts of Engine →

→ Main crankshaft bearings
→ Big end bearings
→ Small end bearings

→ Camshaft bearings.
→ Piston rings & cylinder walls.
→ Valve mechanisms.

TYPES OF LUBRICATION SYSTEM →

① Mist lubrication – petrol & oil mixed.

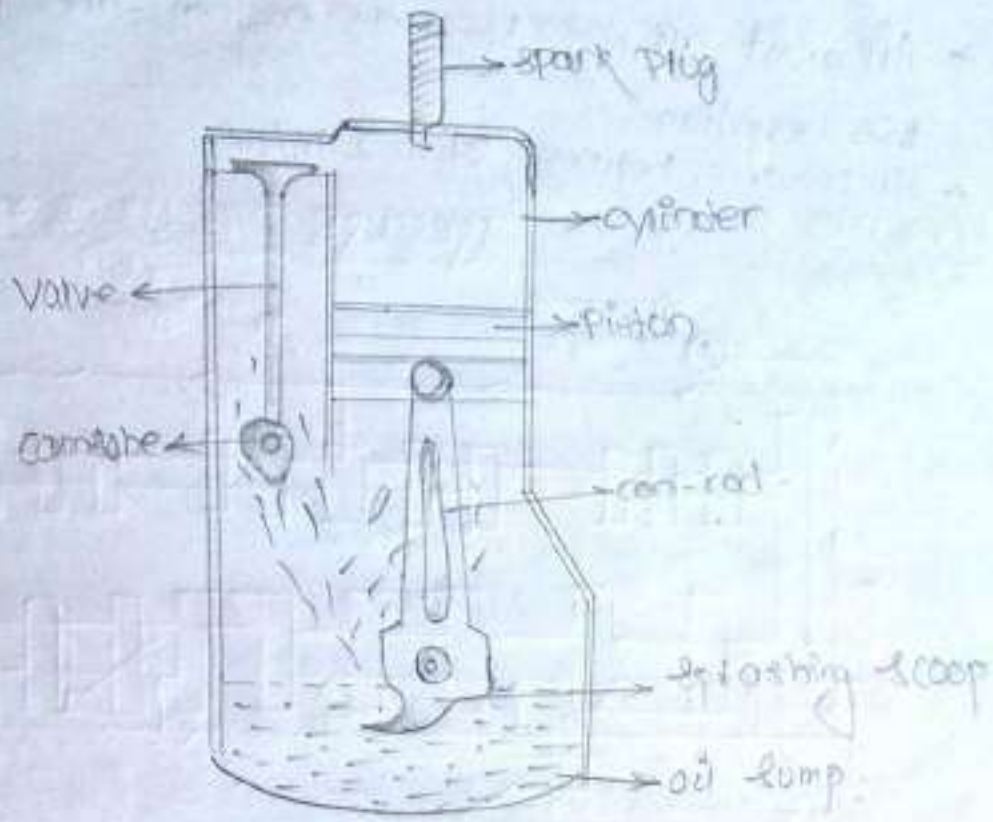
② Wet sump lubrication
- → Splash type
- → Pressure type
- → Semi-Pressure type
- → Gravity type.

③ → dry sump type.

→ SPLASH TYPE LUBRICATION SYSTEM →

→ In this system, the lubricating oil is stored in an oil trough or sump.
→ A scoop or dipper is made in the lowest part of the connecting rod.
→ When the engine runs, the dipper dips in the oil once in every revolution of the crankshaft & causes the oil to splash on the cylinder walls.
→ The main bearing, camshaft bearing, timing gear, piston, cylinder liners, etc... are lubricated by this system.

Sketch →



Pressure type lubrication system →

→ In this system, the engine parts are lubricated under pressure feed.

→ The lubricating oil is stored in a separate tank, from where an oil pump takes the oil through a strainer & delivers it through a filter to the main oil gallery at a pressure of 2-4 kg/cm².

SEMI-PRESSURE type lubrication system →

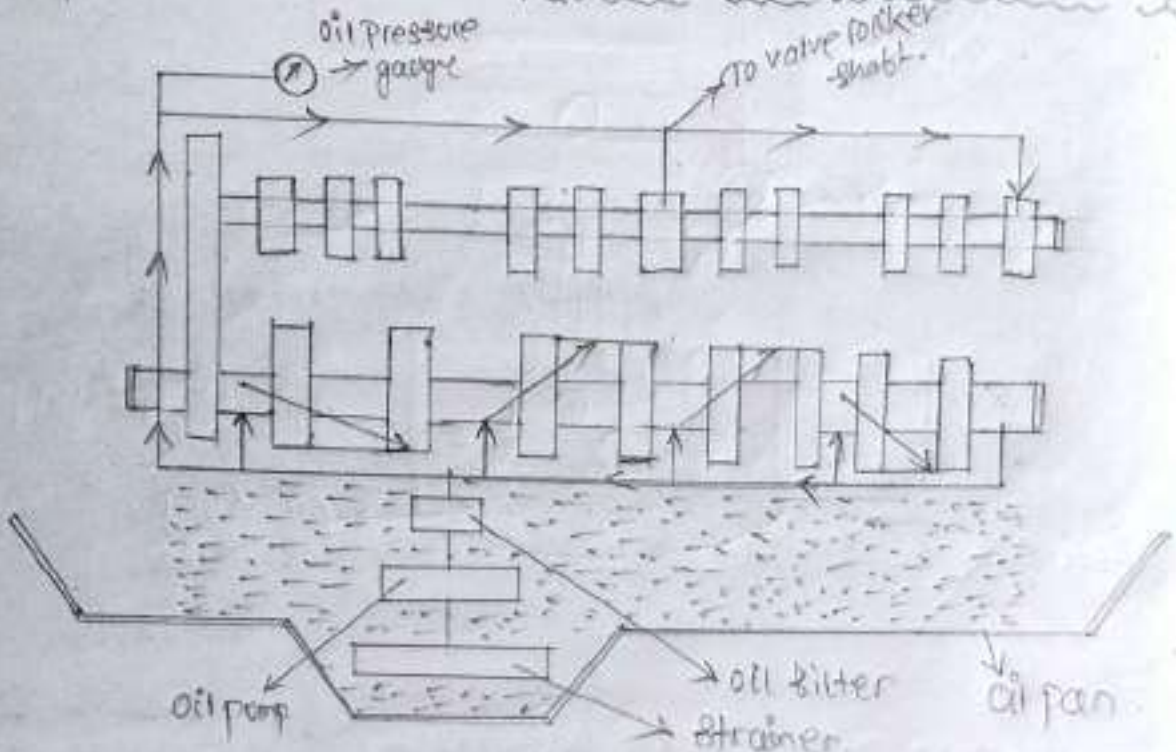
→ It is the combination of splash system & Pressure system.

→ Some parts are lubricated by splash system & some parts by pressure system.

> All most all the 4-stroke engines are lubricated by this system.
> oil pressure between 0.7 to 1 kg/cm².

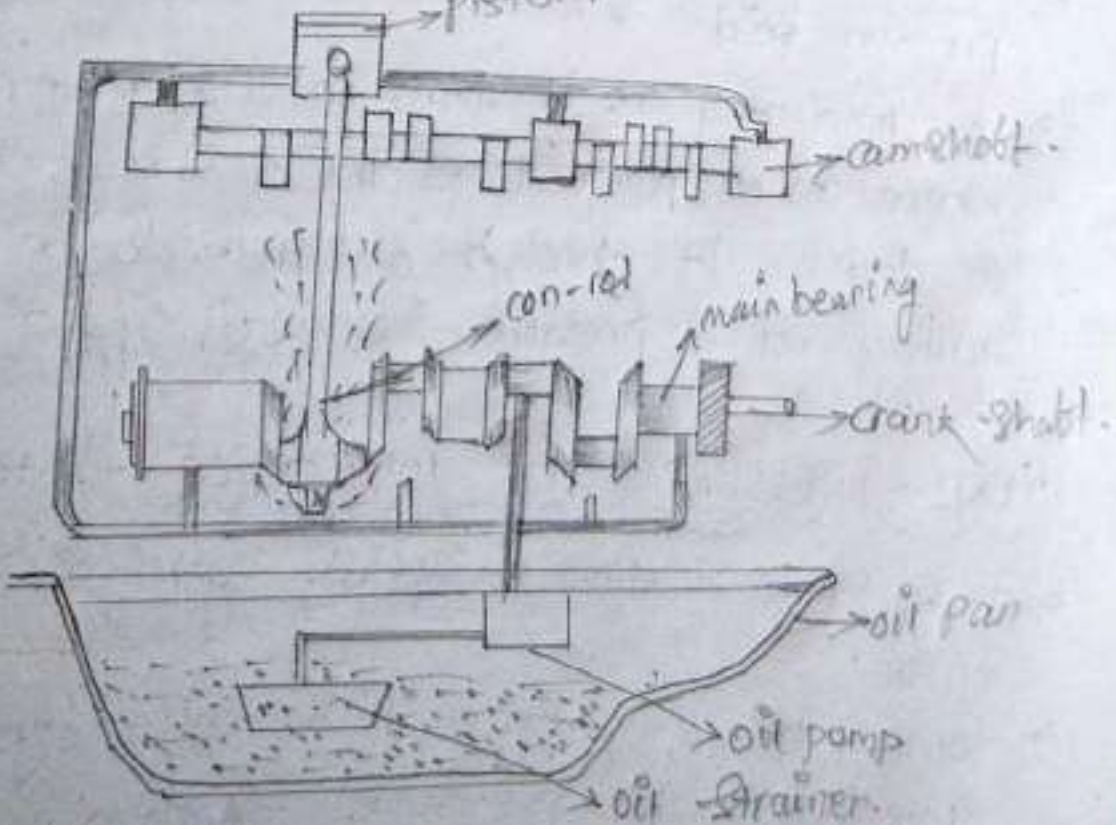
SKETCH =

PRESSURE TYPE LUBRICATION SYSTEM



SKETCH =

SEMI PRESSURE TYPE LUBRICATION SYSTEM



DRY SUMP LUBRICATION SYSTEM ⇒

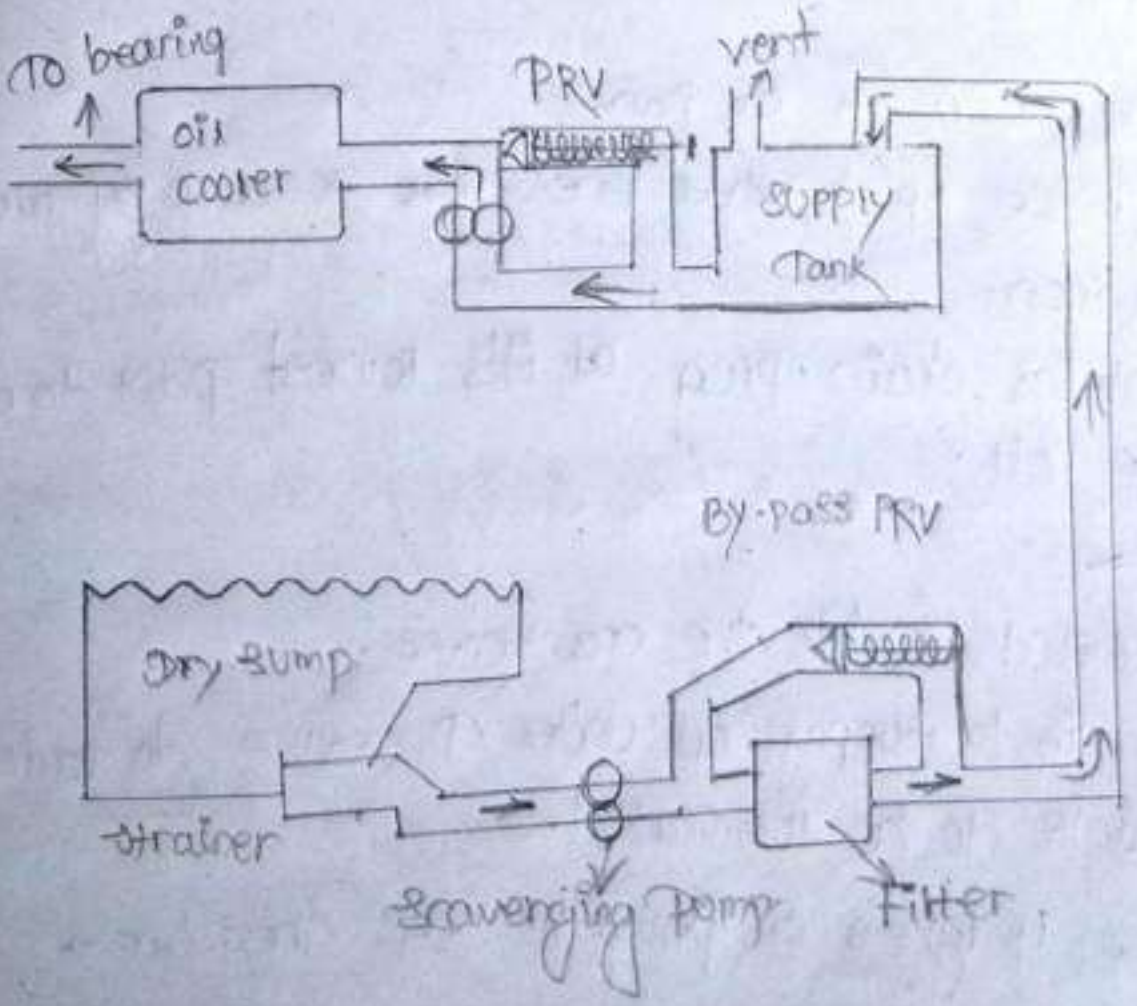
⇒ In dry sump, extra oil is stored in a tank outside the engine rather than oil pan.

⇒ In this system, the lubrication oil is passed through the pipes using scavenging pumps.

⇒ After, lubrication, the oil is again collected by special connecting sections & passed to heat exchanger for cooling.

⇒ Scavenging pump has greater capacity than oil feed pump & it is placed ~~outside~~ externally to sump.

Sketch



PART'S OF LUBRICATION SYSTEM :-

- Oil sump
- Oil Pump
- Oil cooler
- Oil filter & strainer
- Oil Pressure gauge
- Oil Pressure indicating light
- Oil level indicator.

Oil SUMP :-

- Lowest part of the crank chamber.
- Provided a covering for the crankshaft & contains oil in it.
- It also known as oil pan.
- It is made up of steel pressings & also by aluminium or cast iron.
- It contains drain plug at it's lowest part to drain out the oil.

Oil PUMP :-

- It is located inside the crankcase.
- Function is to supply oil under Pressure to various engine parts to be lubricated.
- Their are 4 type's oil pump is used they are :-
  - Gear type Pump
  - Rotor type "
  - Plunger " "
  - Vane type pump.

Oil cooler →

→ To cool the lubricating oil in heavy duty engines.
→ It is just like a simple heat exchanger.
→ Oil is cooled either by cold water from the radiator or by the air stream.
→ Water type oil cooler are most commonly used because they acts as reversible cooler.

Oil Filter →

→ It is used to filter out the dirt material from the oil.
→ Oil filter works out as two types of system →

* BY-PASS SYSTEM -

→ The By-pass valve is also known as a pressure relief valve (PRV). It is an integral part of the oil filter.
→ This valve opens when the oil filter becomes closed or when the oil is too thick.
→ This allows the oil to bypass the filter through a center tube.
→ A by-pass filter is usually a much finer filter to capture smaller particles than the full flow.

★. Full-Flow System →

→ Full flow means all of the oil is filtered.

→ Every drops of it passes through the engine oil filter before it is pumped throughout the engine.

→ The oil is pumped to all the crankshaft & rod bearing, camshaft bearing, valve, lifters, upper cylinder head, everywhere etc...

Oil Strainer →

→ It is simply a wire mesh screen

→ It is attached to the inlet of the oil pump & retains the dirt present in the oil.

→ Usually a floating strainer is installed.

Oil Pressure Gauge →

→ It is used to indicate the oil pressure in the engine.

Oil level Indicator → (Dip Stick).

→ The level of the oil in the crankcase is checked by dip-stick.

→ To check the oil level the long stick is dipped into the crankcase & taken out.

CRANK CASE VENTILATION ⇒

⇒ In an I.C engine, a crank case ventilation system removes unwanted gases from the crank case.

⇒ The system usually consists of a tube, a one-way valve, & a vaccum source.

⇒ The unwanted gases called "blow-by", are gases from the combustion chamber which have leaked past the piston rings.