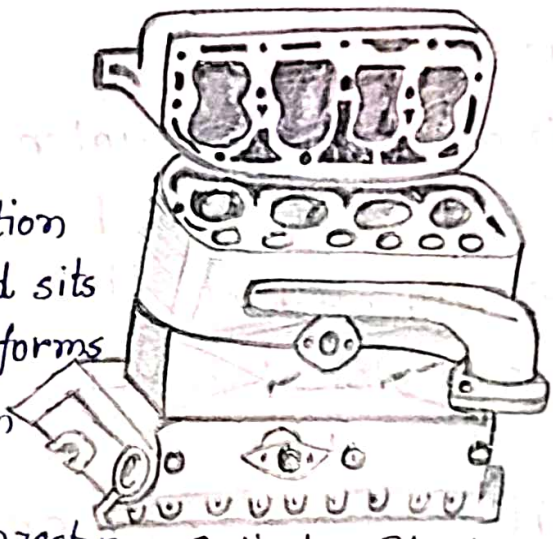
Automobile Engineering

UNIT-1 Introduction to basic structure of an automobile

Basic Engine Components

Cylinder block :

A cylinder block is the part of an engine containing the engine cylinders. Cylinder block is the structure which contains the cylinder, where any cylinder sleeves and coolant passages.



Cylinder Block

Cylinder head :

In an internal combustion engine, the cylinder head sits above the cylinders and forms the roof of the combustion chamber. The cylinder head also holds the injector and contains more moving parts than any other parts of engine.

Gaskets:

A gasket, also known as an O-ring or washer, seals the gap between two surfaces. These items are usually made of rubber and are available in different sizes and shapes depending on their purpose.

Cylinder Liner :

Cylinder liner or sleeve is a cylindrical component that is removable which is fitted in the engine block which provides the surface for the piston to reciprocate internally and carry out its compression. Cylinder liners can be easily replaced when it wears out.

Types of cylinder

Dry Liners :

Dry liner are made in the shape of a barrel having a flange at the top. The perfect contact of the liner with the cylinder block is necessary for the effective cooling of the liner. The dry liner are not in direct contact with cooling water.

Wet Liners :

In Wet liner cooling water comes in contact with the liner. The liner is provided with a flange at the top, which fits into the groove made in the cylinder block. The wet liner is better cooled than the dry liner. It is easily removable when it is worn-out or damaged.

Piston :

A piston is a moving disk enclosed in a cylinder which is made gas tight by piston rings. A piston can transform of heat energy into mechanical work and vice-versa

- In internal cumbustion engines, the gudgeon pin connects the piston to the connecting rod, and provides a bearing for the connecting rod to pivot, upon as the piston moves.

Piston Rings :

A piston ring is a metallic split ring that is attached to the outside/outer diameter of a piston in an internal combustion engine or steam engine.

The main function of piston rings in engines are :

Sealing the combustion chamber so that there is minimal loss of gases to the crank case.

There are two type of piston ring;

1. Compression ring.
2. Oil control ring.

Crankcase :

A crankcase is the part of an engine that contains and supports the crankshaft and main bearings. The main hood vent, located under the headlamp, channels fresh air to the crankcase.

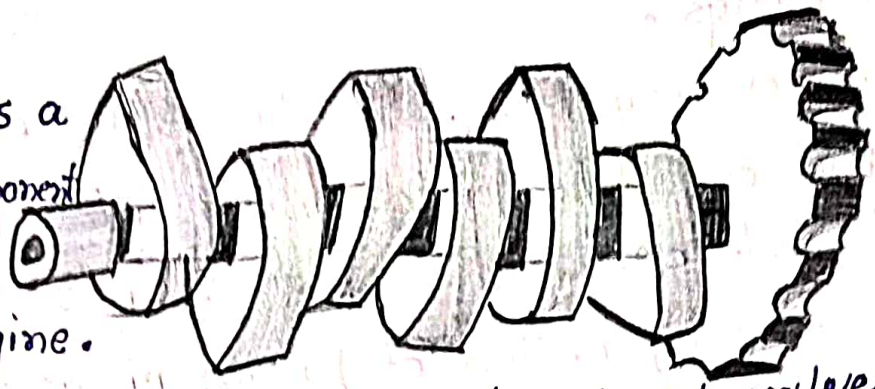
Crank shaft :

A crankshaft is a mechanical component used in a piston engine to convert the reciprocating motion into rotational motion. The crankshaft is a rotating shaft containing one or more crankpins, that are driven by the pistons via the connecting rods.

Connecting Rod :

A connecting rod is a shaft which connects a piston to a crankshaft in a reciprocating engine. It forms a simple mechanism that converts reciprocating motion into rotating motion.

Cam shaft:



The camshaft is a mechanical component of an internal combustion engine.

It opens and closes the inlet and exhaust valves of the engine at the right time, with the exhaust stroke and in a precisely defined sequence. The camshaft is driven by the crankshaft by way of gearwheels, a toothed belt or a timing chain.

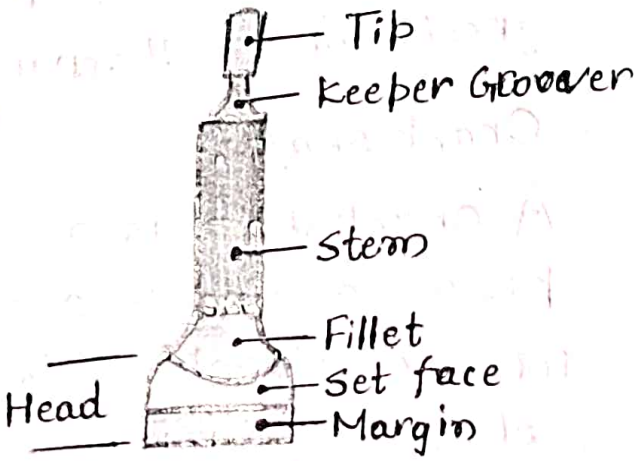
Engine Valve:

Engine valves are mechanically opened and closed, to admit air or expel exhaust gasses into the engine cylinder. These valves are located in the head casting of the engine.

There are two types of engine valves;

Intake / Inlet Valve

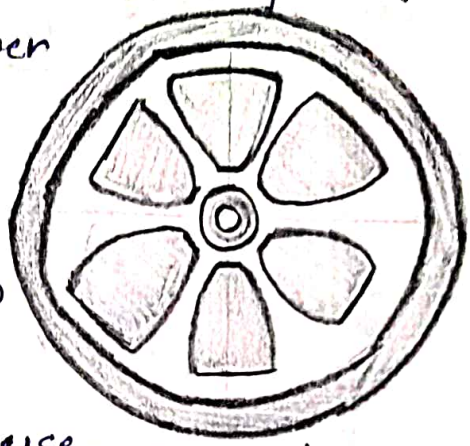
Exhaust valve.



Poppet Valve

Fly-wheel :

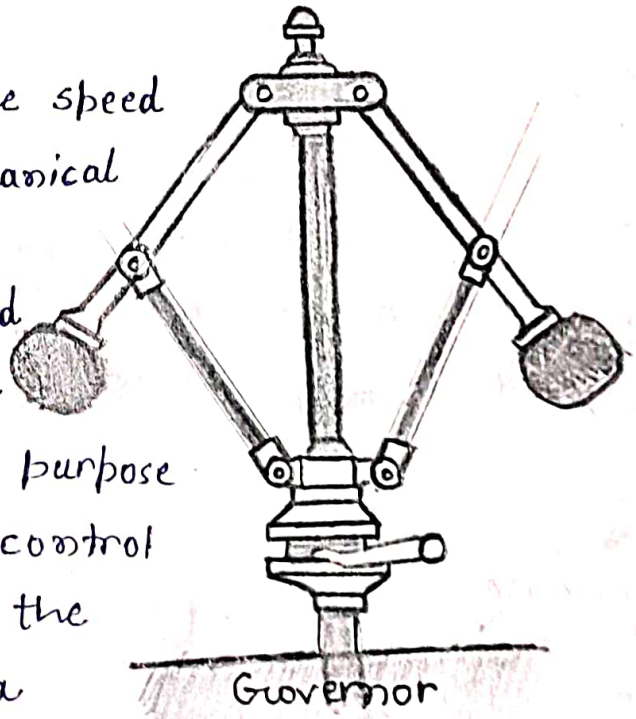
Flywheel, heavy wheel attached to a rotating shaft so as to smooth out delivery of power from a motor to a machine. The inertia of flywheel opposes and moderates fluctuations in the engine and stores the excess energy for intermittent use.



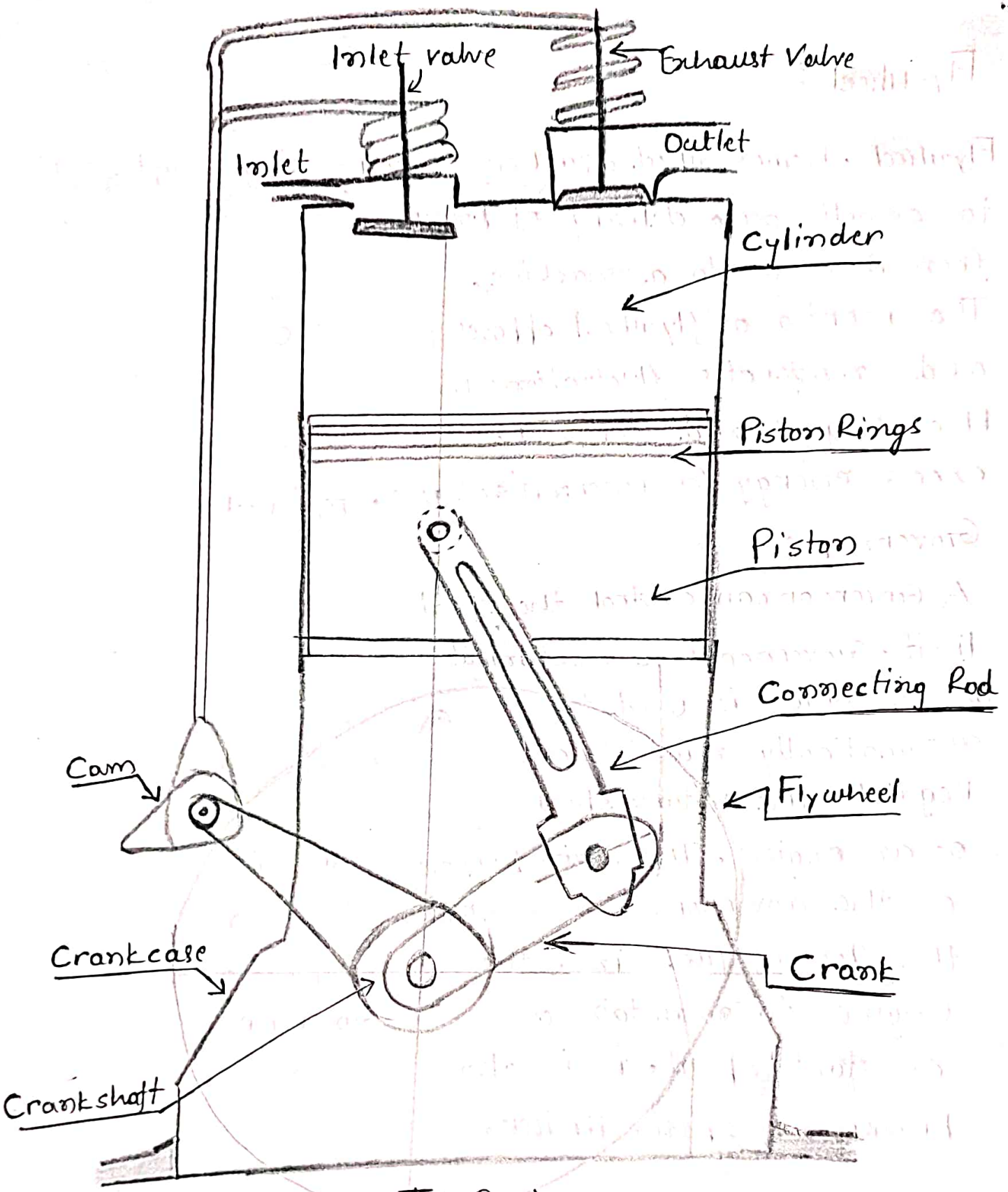
Fly-wheel

Governor :

A Governor can control the speed limit. Governor is a mechanical device which is used to automatically maintain and regulate the rotary speed of an engine. The main purpose of the governor is to control the flow of fuel into the engine to maintain a constant speed, it is also known as speed limiter.



Governor


Inlet valve
Exhaust Valve
Outlet
Inlet
Cylinder
Piston Rings
Piston
Connecting Rod
Cam
Flywheel
Crankcase
Crank
Crankshaft

IC Engine

UNIT-2 Cooling and Lubrication System

The engine component such as cylinder wall, cylinder head piston and valves when subjected to the higher temperature it gets overheated and due to over heating following damages takes place :-

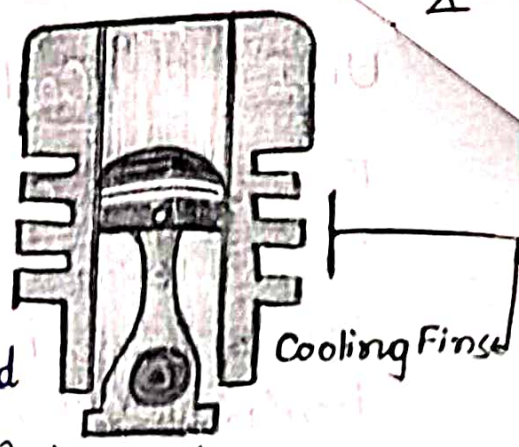
1. The value may wrap & the component may expand excessively leading to seizing of piston & piston rings.
2. The lubricating oil may decompose giving gummy and carbon deposit.
3. Due to large variation in the temperature of different engine parts thermal stresses are set up and these may cause distortion and cracking of parts.
4. In S.I. engines the overheating of spark plug may cause preignition which further leads to detonation.

Thus an efficient engine cooling system is required so that the temperature limit does not exceed beyond prescribed limit. The amount of heat removed is 20 to 30% of the heat released during combustion.

There are two types of engine cooling system used;

1. Air Cooling System
2. Water cooling System.

Air cooling system



IC Engine

In air cooling system heat of engine is dissipitated by the help of moving air.

In this system the cylinder wall and cylinder head is fitted with fins which provides increasing surface area.

Initially the heat from the engine is conducted to the fins now when the stream of flowing air passes over these fins it carries away this heat through itself by the process of convection.

The effectiveness this cooling system depends upon :-

- Surface area provided by fins:
  More will be no. of fins more will be the surface area and more will be heat transfer between air and fins hence increases the rate of cooling.
- Temperature difference between fins and air:
  More will be the temperature difference between fins and air more will be rate of heat transfer and thus increases rate of cooling.
- Thermal conductivity of fins:
  More will be the thermal conductivity of fin rate of heat transfer from engine to fin increases and engine cooling increases.
- Air Velocity: If rate of air flow is high it increases the rate of cooling.

Advantages of air cooled engine :-

1. The design of air-cooled engine is simple.
2. It lighter in weight than water cooled engines due to the absence of water jackets, radiator, circulating pump and the weight of the cooling water.
3. It is cheaper to manufacture.
4. It need less care and maintenance.
5. The system of cooling is particularly advantageous where there are extreme climate conditions in the arctic or where there is scarcity of water as in deserts.
6. No risk of damage from frost, such as cracking of cylinder jackets or radiator water tube.

Disadvantages of air cooling system

1. It can be applied only to small and medium engines, Cooling is not uniform.
2. It is suitable in places where ambient temperatures are lower.
3. Less effective as compare to water cooling.

Water Cooling System

Those engine cooling system in which the engine is cooled by abstracting the heat from the engine by the help of water are called as water cooling system.

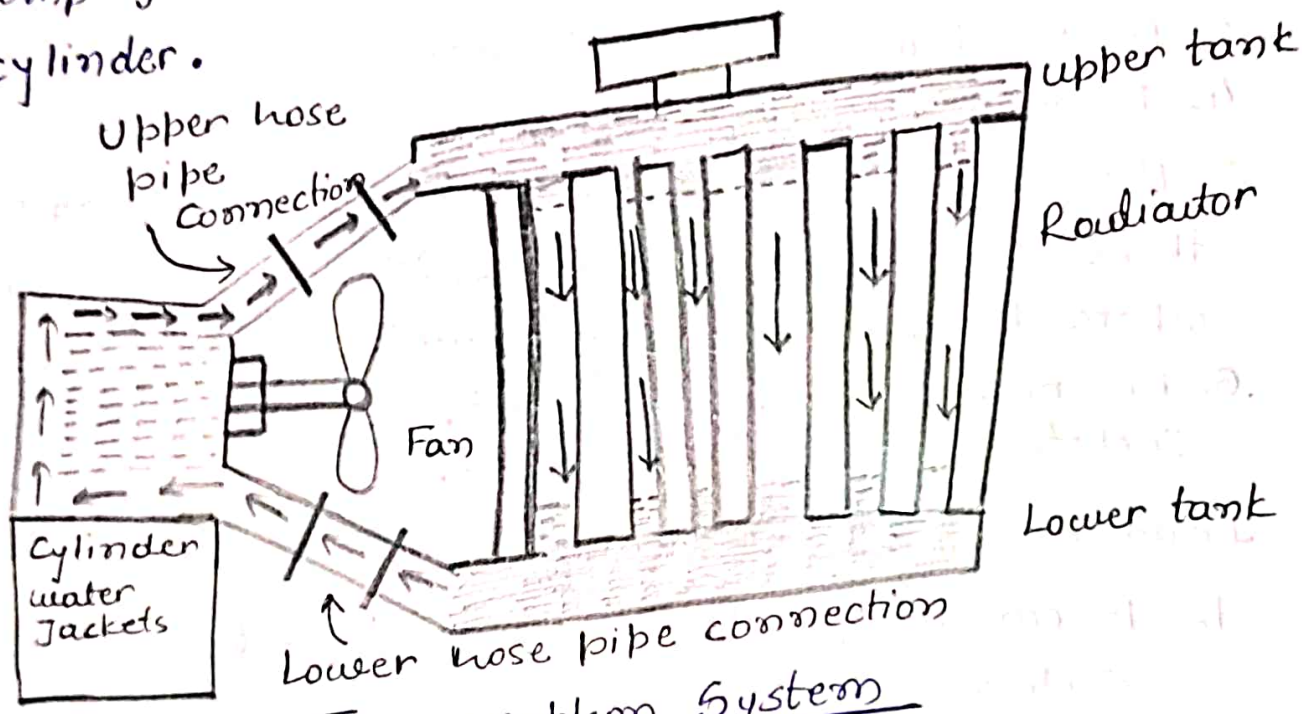
It is of two types :-

1. Thermosyphon water cooling system :-

It works on the principle of natural circulation is water required for cooling flows across the engine naturally on its own by density difference.

2. Pumped circulation water cooling system :

It works on the principle of forced circulation ie the water required for cooling flows across the engine by the help of external pump. The pump forced the water in across the engine cylinder.



Thermosyphon System

Construction :

It consist of a radiator have two tank the upper tank and lower tank both are connected to each other by series of verticle tubes.

The upper tank and lower tank are also connected to cylinder water jacket through hose pipe.

There is a fan ~~loss~~ also connected to engine behind the radiator which produces the draught required to flow the air steam across the tubes of radiator.

Working:

When the engine starts the water ~~Jacket~~ present in the water jacket of engine cylinder starts abstracting the engine heat due to which its temperature rises and its density reduces it becomes lighter which causes the heated water to move upward flows from the water Jacket to upper tank of radiator through hose pipe.

Now this heated water from upper tank flows to the lower tank through the verticle tubes.

Fan produces a draught which causes air to flow across tube, this air abstract heat from heated water in tube and thus water gets cooled down.

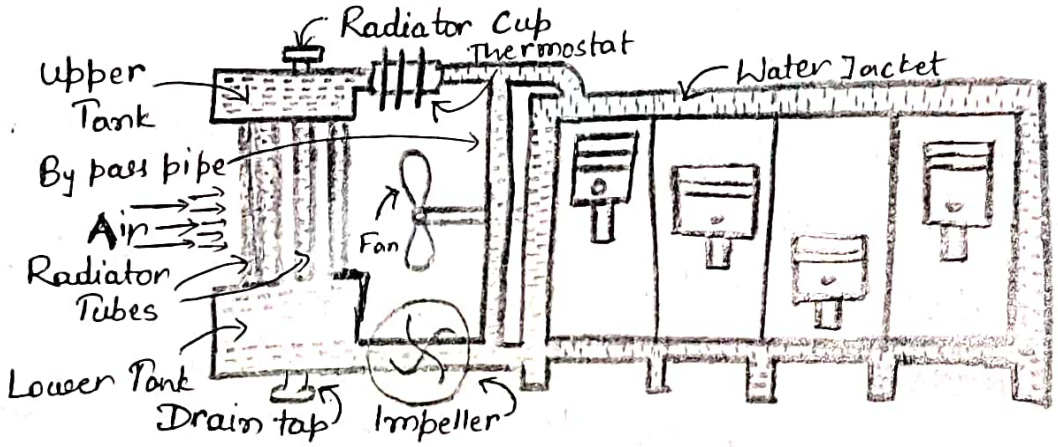
Now this cold water flows into engine water Jacket and again it abstract the engine heat and reject this heat to air in the radiator and makes the engine to get cool down.

Advantages;

- It is very simple in design.
- It is of very low cost.
- Requires very less maintenance.
- Less noisy in operation.

Disadvantages :-

1. Water circulation starts only when the engine becomes hot enough to cause the natural water circulation.
2. Radiator level should be kept at a higher level the engine for better water cirulation.
3. Level of water in radiator must not fall below the level of delievery pipe.
4. Rate of water circulation is low hence it is less efficient.
5. Used in old cars and small engine cars.



Pump Circulation Water Cooling System

Construction :

- It consist of a radiator have two tank the upper tank and lower tank both are connected to each other by series of verticle tubes.
- The upper tank and lower tank are also connected to ~~engine~~ ~~behind~~ ~~the~~ ~~radiator~~ cylinder water jacket through the hose pipe.
- There is a fan also connected to engine behind the radiator which produces the draught required to flow the air steam across the tubes of radiator.

- There is an impeller between lower tank and water jacket & a thermostat between upper tank and water jacket.

Working:

- In this cooling system when engine starts running the impeller forced the cooling water in water jacket of engine. cylinder.
- This water abstract the heat from the engine and when it reaches to a particular temperature the thermostat valve opens and water being heated is lighter moves to upper tank of radiator.
- Now this heated water flows to lower tank of radiator through series of tubes where it is cooled by the air steam moving across the tube.
- Since in this system water is pumped into water jacket hence it is called pumped circulation water cooling system.

Advantages:

1. It is very efficient cooling system as rate of water circulation is high.
2. Cooling is ensured in all working condition.

Disadvantages:

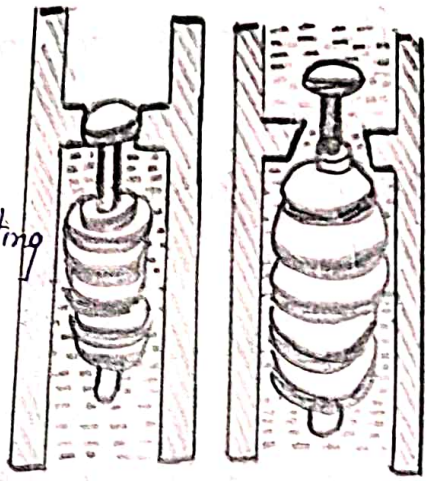
1. Engine may get over cooled.
2. Coolant circulation stops immediately when engine stops, however this undesirable as cooling must be continued till temperature reaches to its normal temperature.

Components of water cooling system

1. Radiator :

- It is the most important part of the water cooled system.
- It consist of two tanks are connected to each other through series of tubes. (both the upper and lower tank)
- These tubes are surrounded by fins over its entire length.
- The main function of radiator is to cool down the heated water which comes from the water jacket after abstracting the engine heat.

2. Thermostat valve :



- It is used in watercooled engine. It is fitted in the hose pipe connecting the upper tank and water jacted.
- Its operation is based on the liquid temperature. The valve open and closes by sensing the liquid temperature.
- When the liquid temperature rises to prescribed limt it opens and water from water jacket flows to radiator upper tank. While when temperature of liquid is under prescribed limit it get closed water return to water jacket through bypass passage line.

3. Water Pump :

- It is fitted in the hose pipe connecting the lower tank with water jacket of the engine.
- Its main function is to force the cold water from the lower tank to engine water jacket.

- It is driven by the crankshaft of the engine by connecting shaft of pump with the crankshaft with v-belt and pulley arrangement.
- In most of the water cooled engine system centrifugal pump is used as water pump.

4. Radiator Fan:

- It is installed behind the radiator.
- It is also driven by engine crankshaft by connecting it with pulley and belt.
- It produces draught due to which air steam flows across tubes of the radiator and cool down the water in the tubes.

5. Water Jacket:

- It is basically small packets present in the cylinder head and block of the engine.
- Through these pocket water circulate over the engine to abstract its heat.

6. Hose Pipe:

- It is made up of rubber.
- It connects the upper tank and lower tank through water jacket.
- Through these pipe heated water from water jacket flows to radiator upper tank and cold water from radiator lower tank to engine water jacket.

Difference between water cooling system and air cooling system:

Air Cooling System	Water Cooling System
• Cooling medium used is air.	• Cooling medium used is water.
• Less efficient as compared to water cooling system.	• More efficient as compared to air cooling system.
• Due to less component light in weight.	• Due to more component heavy in weight.
• No maintainance is required.	• More maintainance is required
• Engine design is simple.	• Engine design in complex.
• Used in small vehicles like two wheeler and three wheeler.	• Used in four wheeler.

Lubrication System

As we know that lubrication is a process of flowing and covering the mating surfaces which are in relative motion with each other.

- In an I.C. engine all most all engine parts have relative motion due to which the component gets rubbed against each other. This rubbing action will damage the parts of components after some time.
- Thus it become very much necessary to lubricate the components to increase there service life.

Objective of lubrication system

- It reduce the friction between mating parts and reduce there wear and tear. An oil film is formed between the mating parts which prevents them from comming in direct contact with each other.
- It reduce power consumption inorder to drive the component.
- It act as a cooling medium for removing the heat.
- It act as cleaning agent by preventing the carbon deposition over the surface of component and carry away harmful substance that result due to incomplete combustion.
- It act as a sealing agent and provides a good seal between piston ring and cylinder wall.

Petrol Lubrication System

- This is the simplest type of lubrication system. This method of lubrication is used in small engines like engine of scooters and ~~car~~ motorcycle.
- In this method of lubrication the lubricating oil is mixed with petrol and fed into the engine cylinder during suction stroke.
- About 3-6% of lubricating oil is added with petrol in petrol tank. When engine starts working the crank, compresses the fuel in crankcase due to which the gasoline evaporates and moves upward in combustion chamber while the lubricating oil left behind in form of mist (fog).
- The parts of engine such as piston, cylinder wall and connecting rod are lubricated by mist.

Advantages

1. It is simple in construction as no external system is required for lubrication.
2. Low Cost.
3. No maintainance cost is required for lubricating system.
4. Causes less engine weight.

Dis-advantages

1. If lubricating oil added is less, there will be suffecient lubricating and causes seizure of piston.
2. If lubricating oil is added more, it will produce large smoke.
3. It creates problem in engine starting.

Wet sump lubricating system

These system employs large capacity of oil sump at the base or bottom of crank chember and from the sump the lubricating oil is drawn by a low pressure pump and is forced to various engine parts.

The oil after circulating to different parts return back to sump.

In this type of lubrication system the sump is always filled with the lubricating oil hence it is called as wet sump lubrating system.

Wet sump lubricating system is of three type:-

1. Splash lubricating system
2. Semi pressurized lubricating system
3. Full pressurized lubricating system.

Splash Lubrication System

Construction:

- In this type of lubrication system there is a scoop attached with the cap of connecting rod.
- There is an oil through containing lubricating oil and during the operation the connecting rod rod having scoop get dipped in oil through and produces splash required for lubrication.
- Below oil through there is an oil reservoir called oil sump from which the oil is pumped to oil through by help of gear pump.

Working:

When the engine start working, the piston reciprocates & when piston moves from T.D.C. to B.D.C. the connecting rod cap having scoop gets dipped in the oil through, & when the piston moves from B.D.C. to T.D.C. connecting rod cap with scoop moves out of the oil through and produces a splash.

- The splash produced in the oil causes the lubricating oil to flow over the parts of the engine and lubricates them.
- After lubricating the oil return back by the action of gravity.
- Since the sump is always filled with water hence it is a type of wet sump lubricating system.

Pressurised Lubrication System

Construction :

- In this system, strainer present in the sump is connected with the gear pump. The gear pump is further connected with the air cooler and again with the filter.
- The filter is connected through the main oil gallery and with the turbo charger.
- There is hole drilled in the main shaft with two supply line one is towards compressor and fuel injector & other is towards internal passaige of rockers shaft.

Working :

When the engine start working the oil pump sucks the oil from the sump through strainer. In the oil pump the oil pressure is increased but its temperature also get increases. So this oil is passed through air cooler where it is cooled down while maintaining its pressure.

- Now this pressurized oil is passed through main oil gallery and excess of oil is return back to sump through turbo charger.
- Through main oil gallery this oil circulates to the holes and lubricates the crank shaft, crank web, main shaft, connecting rod, piston and piston rings.
- The oil also circulates to the rockershaft where it is injected downward to lubricate the camshaft.
- After lubrication the oil return back to the sump.

SAE Rating of lubricating oil

S.A.E. :- Society of automobile engineers gives rating to lubricating oil to classify them according to their viscosity.

Viscosity :- In lubricating oils, it is the property due to which one layer of lubricating oil offers frictional resistance to its adjecent layers.

- It depends on temperature, if temperature increases, viscosity of oil get decreases and temperature decreases viscosity increases.
- For a good lubricating oil its viscosity should be neither too high and nor too low.
- If the viscosity become very high it become very difficult for the oil to flow and circulates to various engine parts to lubricate them.
- If the viscosity becomes very low it becomes very difficut for oil to stick on the various engine parts surface.
- It becomes very necessary to give rating or grades to oil based on their viscosity in different climate condition.
- S.A.E. assign a number known as viscosity number to the lubricating oil by measuring the viscosity at a given temperature by viscometer.
- In order to assign the number two temperature are used as reference 0°F and 210°F.
- Oil defined in terms of viscosity number at 210°F such as SAE20, SAE30, SAE40, SAE 50 grades that work satisfactory in hot condition.
- Higher the lubrating number the oil will be better for lubrication in hot condition.
- Oil defined in term of viscosity number at 0°F such as SAE 5W, SAE 10W, SAE 20 W grades that works satisfactory in cold climate.

- Lower the viscosity number better will be oil, used in winter
- Some oil called multigrades oil which works satisfactory in both hot and cold climates. Example SAE20SAE50 has viscosity equals to SAE20 in winter and SAE50 in summer.

FUEL FEED SYSTEM

Conventional Fuels :

Those fuels which are in use from several years ago in our internal combustion engine are called conventional fuel.

- These fuels are also known as traditional fuel.
- These fuels are basically hydrocarbons, ie composed of hydrogen and carbon atoms.
- Examples Petrol & Deisel.

Hydrocarbons are basically of four types;

1. ALKENES

- They are also known as olefins.
- There chemical formula is C_nH_{2n}.
- They are open straight chain unsaturated hydrocarbon, ie having double bond.
- Example ethane, propene, butane etc.

2. ALKANES

- They are also known as paraffins.
- Its chemical formula is C_nH_{2n+2}.
  example mathane, ethane, propane etc.
- They are straight open chain saturated, ie single bonded hydrocarbons.
- Due to having single bond & open chain structure they are having very low cohesive force between the atoms which lowes their self ignition temperature.

3. NAPTHALENE :-

- They are cyclic saturated hydrocarbons.
- Their chemical formula is
- They are also saturated hydrocarbons but their structure is not open they are closed chain in their structure.

4. AROMATIC HYDROCARBONS :-

- They are cyclic unsaturated hydrocarbons.
- Their chemical formula is
- They are cyclic in structure and carbon atoms are double bonded.
- Due to this, they have strong cohesive force between carbon atoms.
- Due to this, they very high self ignition temperature.
- As we know that in spark ignition the self ignition temperature of fuel must be very high to reduce the chance of detonation and knocking.
- While in CI engine the self ignition temperature of fuel must be low to reduce the chance of detonation & knocking.
- Hense in SI engine we use gasoline, ie petrols as fuels as they are aromatic hydrocarbon.
- While in CI engines we use disel as fuels as they are paraffins.

Characterstics of good fuel for SI engines :-

- They should have high self ignition temperature.
- They should have anti-knocking resistance properties.
- They should have high calorific value.
- They should have clean burning.
- They should be non-corrosive in nature.

Characterstics of good fuel for CI engines :-

- They should have low self ignition temperature.
- They should have high volatile.
- They should have antiknoncking resistance properties.
- They should have high calorific value.
- They should have clean burning.
- They should be non corrosion in nature.

Alternative Fuel

Those fuels which are used in place of conventional fuels like petrol and diesel in our IC engines, ie the fuels which are alternative of conventional fuels are called alternative fuels.

Since these fuels are in use nowdays hence they are also known as non traditional fuel or unconventional fuel.

Examples; Alchohal fuel like methanol and ethanol
Compressed natural gasses CNG
Liquid petroleum gas LPG
Bio diesel
Solar power

Need of alternative fuels :-

- High cost of consrentional fuel.
- In some cases alternative fuels are more environmentaly friendly.
- Some alternative fuels are more eneregy efficient.

Methanol

- It is an alchohal fuel
- The primarily methonal fuel used is M85, which is made up of 85% methanol and 15% gasoline.
- It is produces from natural gas.

Ethanol :

- It is cheap non petroleum based fuel.
- It was first used by henry ford in 1980 who built a vehicle to run on ethanol.
- It is produced from the fermentation of plant and vegetable materials mainly sugar canes are used.
- It is clear and odourless liquid.

Compressed Natural Gas

- They are commonly known as CNG.
- They are basically natural gas which is a mixture of hydrocarbon mainly mathane and is produced from gas well during crude oil production.
- It has very low density so to store them inside the cylinder they are compressed to a pressure of 200 to 250 bar.

Liquified Petroleum Gas

- Liquified Petroleum Gas is also known as LPG.
- Liquified petroleum gas is a fuel gas which contains a flammable mixture of hydrocarbon gases, specifically propane, propylene, butylene, isobutane & n-butane.

Biodiesel

- It is a form of diesel fuel derived from plants or animals and consisting of long-chain fatty acid esters.
- It is typically made by chemically reacting lipids such as animal fat (tallow), soybean oil or some other vegetable oil with an alcohol, producing a mythyl, ethyl, or propyl ester by the process of transesterification.

Octane Number

- In petrol engine during suction stroke air and petrol, ie our fuel as a mixture enters into the engine cylinder and during the compression stroke this mixture is compressed.
- Due to compression the pressure & temperature of fuel mixture rises and at the end of compression stroke this mixture ignited by the help of spark plug which causes the combustion of fuel.
- Since we know that efficiency of petrol engine depends upon the compression ratio, ie when the compression ratio increases the engine efficiency increases.
- So we design our engine such that it has higher compression ratio in order to increase it efficiency.
- Now when the fuel is compressed in an engine with high C.R. then during compression stroke fuel gets compressed too much due to which its pressure & temperature rises very high & temperature become equal to its self ignition temperature.
- This makes the fuel to gets ignite self before it is to be ignited by spark plug.
- This phenomena of self ignition of fuel before the ignition by spark plug creates a pulsating noise in engine called detonation and the pulsating noise is called knocking.
- Now to eliminate this problem a chemical mixture of iso-octane with n-heptane is mixed with petrol to increase the self ignition temperature of fuel & increase the antiknocking properties in petrol.
- Based on the percentage of iso octane in a mixture of iso-octane & n-heptane the petrol is given a rating/grade known as octane number.
- Octane number is defined as a grade/rating given to petrol which indicates the percentage of iso-octane in a mixture of iso-octane and n-heptane the petrol.

- Example a petrol of octane no - 95 means in a mixture of iso-octane and n-heptane 95% is iso-octane & 5% n-heptane.
- Higher the octane no means higher will be the percentage of iso-octane in the mixture and higher will be the self ignition temperature and less will be chance of detonation.

Cetane Number

- In diesel engine only air is sucked during suction stroke & is compressed during compression stroke due to which its pressure and temperature rises.
- Now at the end of compression stroke the diesel fuel is injected from fuel injection nozzle and when this diesel comes in contact with compressed air since being volatile in nature gets mixed with it and when the temperature of mixture raises to self ignition temperature of diesel the fuel gets ignited.
- The time between the fuel is injected & ignited is called ignition delay or ignition lag.
- The ignition delay or ignition lag should be as small as possible otherwise accumalation of fuel in combustion chamber takes place which result in uncontrolled combustion and causes detonation / knocking.
- To eliminate this problem a chemical mixture of n-hexadecane also known as cetane & alpha methyl naphthalene is mixed in diesel.
- This lowers the self ignition temperature of diesel which means as the diesel is injected it quickly start burning ie. lower down the ignition delay.
- Thus ~~lower~~ based on the percentage of n-hexadecane (cetane) in alpha methylnepthalene diesel is given grade/rating known as cetane number.

- Cetane number is defined as the percentage of cetane in mixture of cetane and alpha methylnepthalene.
- Example if diesel having cetane number 55 means percentage of cetane in mixture of cetane and alpha methylnepthalene is 55%.
- Its Range is 30-60%.
- It should not be beyond its limit otherwise the self ignition temperature gets lower down so much that it gets ignited before get mixed with the compressed air.
- Thus higher the cetane number means lower will be the self ignition temperature of diesel and reduces the chance of detonation caused due to uncontrolled combustion.

Carburetor

Air Fuel Ratio

- As we know that in petrol engine, during suction stroke the suction of air fuel (petrol) mixture takes place.
- Now it is very much necessary that the air fuel (petrol) mixture is in correct proportion and in correct amount before entering into the engine cylinder inorder to make the engine performance better and economical.
- The correct proportion means the amount of both the air and fuel (Petrol) in the air ~~air~~ fuel mixture must be controlled.
- To supply correct amount of fuel in correct proportion we require a device fitted at the entry of intake manifold of petrol engine known as carburetor.

- Thus carburetor is a most important component of fuel feed system which is fitted at the entry of intake manifold to inorder to supply correct amount of fuel in correct proportion under required condition.

Air Fuel Mixture :—

- It is represented by A/F.
- It is defined as the ratio of amount of air to the amount of fuel in the air fuel mixture.
- It's range is from 7:1 to 22:1.
- Based on the amount of air in the air fuel mixture or amount of fuel in the air fuel mixture is devided into three categories :—
  1. Rich Mixture
  2. Stoichiometric mixture
  3. Lean Mixture

Rich Mixture (7:1 - 12:1) :—

- If the engine uses this mixture then it will develop ~~mixtur~~ minimum power.
- This mixture is required during starting, idling & accelerationg condition of the vehicle.
- Excess amount of black smoke is released.
- Fuel economy is poor.

Stoichiometric Mixture (14.7:1) :—

- It is also known as chemically correct mixture.
- If the engine uses this engine then it will develop optimu power.
- Controlled & colorless smoke is released.
- Our carburetor is designed for this mixture.
- Fuel economy is also optimum.

Lean Mixture (12:1 - 16:1):-

- If engine uses this fuel then it will develop less power.
- Engine runs by releasing lesser smoke.
- Better fuel economy is achieved.
- This fuel is required when engine runs at normal speed

Our vehicles have basically three running conditions:-

- Starting condition & idling condition, slow speed running condition :-

During this condition engine requires rich mixture but amount of fuel mixture needed is less.

- Normal running condition :-

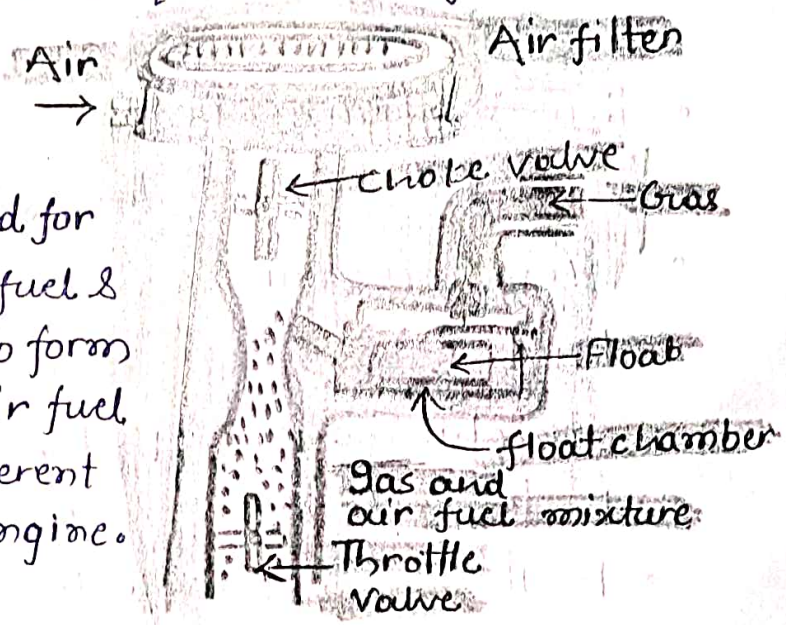
During this condition engine requires lean mixture with moderate amount of fuel mixture is required.

- Accelerating condition / high speed condition :-

During this condition rich mixture is required but the amount of fuel mixture required is high.

Construction & working of simple carburetor

- Carburetor is a device used for atomizing, vapourising the fuel & mixing the fuel with air to form a correct proportion of air fuel mixture to suit for different operating condition of engine.



Simple carburetor

- This process of atomizing, vapourising the fuel & mixing the fuel ~~which~~ with air to form required correct proportion of air fuel mixture is called carburator.
- Main components of the simple carburetor are as follow:-
  - Float chamber with flot
  - Fuel Nozzle
  - Venturi
  - Throttle valve
  - Choke valve
  - Metering jet
- In the float chamber, a constant level of petrol is maintained by float and needle valve.
- The float chamber is ventilated to atmosphere so that petrol is maintained at atmospheric pressure in float chamber.
- The float which is normally a hollow cylinder rises and needle valve closes the inlet part when fuel in the float chamber rises to certain level.
- There is a metering jet at the exit of float chamber.
- The mixting chamber which is also known as venturi tube contains venturi, fuel nozzle and throttle valve.
- The venturi tube is fitted with intake manifold. This tube has a narrow opening called venture.
- A nozzle is provided just below the centre of the venture While the tip of nozzle is slightly above the fuel level in the float chamber.
- The mixing chamber has two butterfly valve one is called throttle valve connected with accelerator pedal controls only the amount of air fuel mixture going into the engine cylinder and other is called choke valve which is

manually operated.

- The metering jet are designed that fuel air mixture entering into engine chamber is stoichiometric mixture.
- In simple carburator there is provision of only to control the amount of air fuel mixture but no provision to vary the A/F ratio at low, medium and high vehicle speed.
- However this problem is eliminated by making some modification in simple carburetor.

Working :-

- As we know that the intake manifold is at vaccum pressure and pressure outside the carburetor is atmospheric pressure, due to this there is pressure difference which cause the atmospheric air to flow through the venturi tube.
- The venturi increases the velocity of air increases causes drop in the pressure that is partial vaccum is created in the venturi, ie at the tip of nozzle.
- Since the fuel in the float chamber is at atmospheric pressure at ~~tip of nozzle due to this~~ there is vaccume pressure at tip of nozzle due to this pressure difference fuel starts flowing from float chamber to nozzle and gets discharged from the nozzle in form of atomized particle.
- In the venturi carburetion process take place which produce a homogeneous air fuel mixture which is further supplied to engine chamber from intake manifold.
- Now the amount of fuel entering to engine chamber is varied by opening and closing the throttle valve.
- When accelerator pedal is ~~pressed~~ released the throttle valve gets partially closes this reduces the amount of air fuel mixture gets entering into engine chamber.

- When accelerator pedal is pressed throttle valve get fully opened and maximum amount of air fuel mixture gets enter to engine chamber.
- During cold starting by the help of choke valve we reduce the amount of air entering in the venture reduces which causes the air fuel mixture to become rich mixture.
- In this carburator there is a drawback that it doesn't vary the A/F ratio at low, moderate and high vehicle speed.
- So this problem get eliminated by make some modification in simple carburetor by making arrangement of idling cir cuit system and accelerator pump system and such carburator is called mordern carbureton.

Multi Point Fuel Ignition System (MPFI) :—

Now a day, MPFI system is widely used in petrol engine in place of carburetor.

MPFI system is an electronic based fuel injection system which is used to supply proper amount of A/F fuel mixture in the multi cylinder engine at required time.

MPFI is fully controlled by electronic controlled module. ECM regulates the function of MPFI automatically with respect intake manifold air pressure, throttle position, crankshaft position, percentage of oxygen in exhaust gas.

Components

Sensor :-

1. Inlet manifold pressure sensor :- It is used to sense the pressure of air the intake manifold to adjust the A/F ratio as per the load on engine.

2. Crankshaft position sensor :- In multi cylinder engine different cylinder requires fuel mixture at different time according to there firing order, thus crankshaft position sensor sense that when which cylinder requires the A/F mixture.

3. Throttle position sensor :- It sense the throttle position and according to it adjust the A/F ratio.

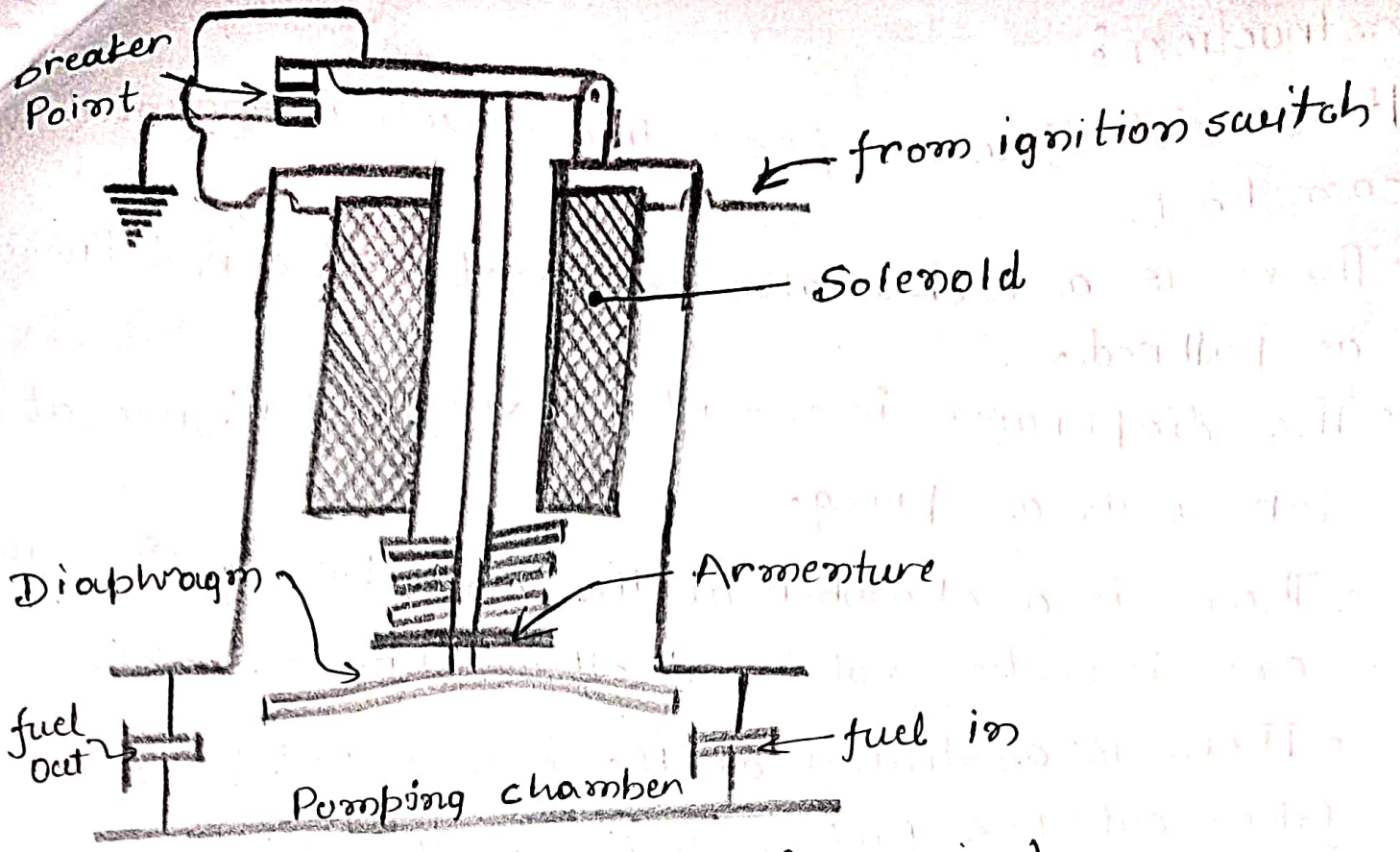
4. Exhaust gas sensor :- It sense the percentage of oxygen gas in the exhaust gas, if percentage of oxygen in exhaust gas is more it indicates improper combustion thus it decide what is the amount of A/F mixture required in the combustion chamber.

ECM :-

It stands for electronic controlled module.

It receive the information from the different sensor and based on the information generates signal to the and fuel pump fuel injectors when to inject and in what amount to inject the fuel mixture in the engine cylinder.

The fuel tank is connected to fuel pump and is connected with fuel filter which is further connected with a direct rail.



S.U. Electrical Fuel Pump (SI engine)

Constrction :-

- It consist of diaphragm which carries an armature within itself by means of the spring.
- The diaphragm and armature with spring are mounted over a rod which is hinged with the body frame at one end and is contact with contact breaker at anoter end.
- There is coil winding known as solenoid inside the body of fuel pump.

Working :

- Closing the ignition switch energizes the solenoid winding and the magnetic flux is created, which pul the armature to which the diaphragm is attached.
- Thus the diaphragm moves to cause suction in th pump chamber and the fuel is drawn into the chamber.

Construction :

- It consist of a cam/eccentric which is mounted over camshaft.
- There is a rocker arm connected with a rod know as pull rod.
- The diaphragm is mounted over the pull rod at its top with a spring.
- There is a chamber at the body having two valve one is suction valve and other is pressure valve.
- There is a strainer at the entry of fuel pump to filter out the fuel entering in the fuel pump.

Working :

- When the camshaft rotates it rotates the cam/eccentric mounted over it, since its rotation is eccentric there it makes contact with rocker arm.
- Due to this the rocker arm makes upward movement & forces the diaphragm to move downward against the spring.
- This creates potential energy in the spring & at the same time vaccum in the chamber due to this suction valve opens at the fuel from the fuel tank is sucked in the chamber.
- Now as the contact between cam & rocker arm eliminates then the spring releases its potential energy due to this pull rod moves downward.
- This movement of diaphragm compresses the fuel in the chamber due to this the pressure of fuel rises.
- Now the pressure valve opens & this pressure fuel gets discharged to the carburator.

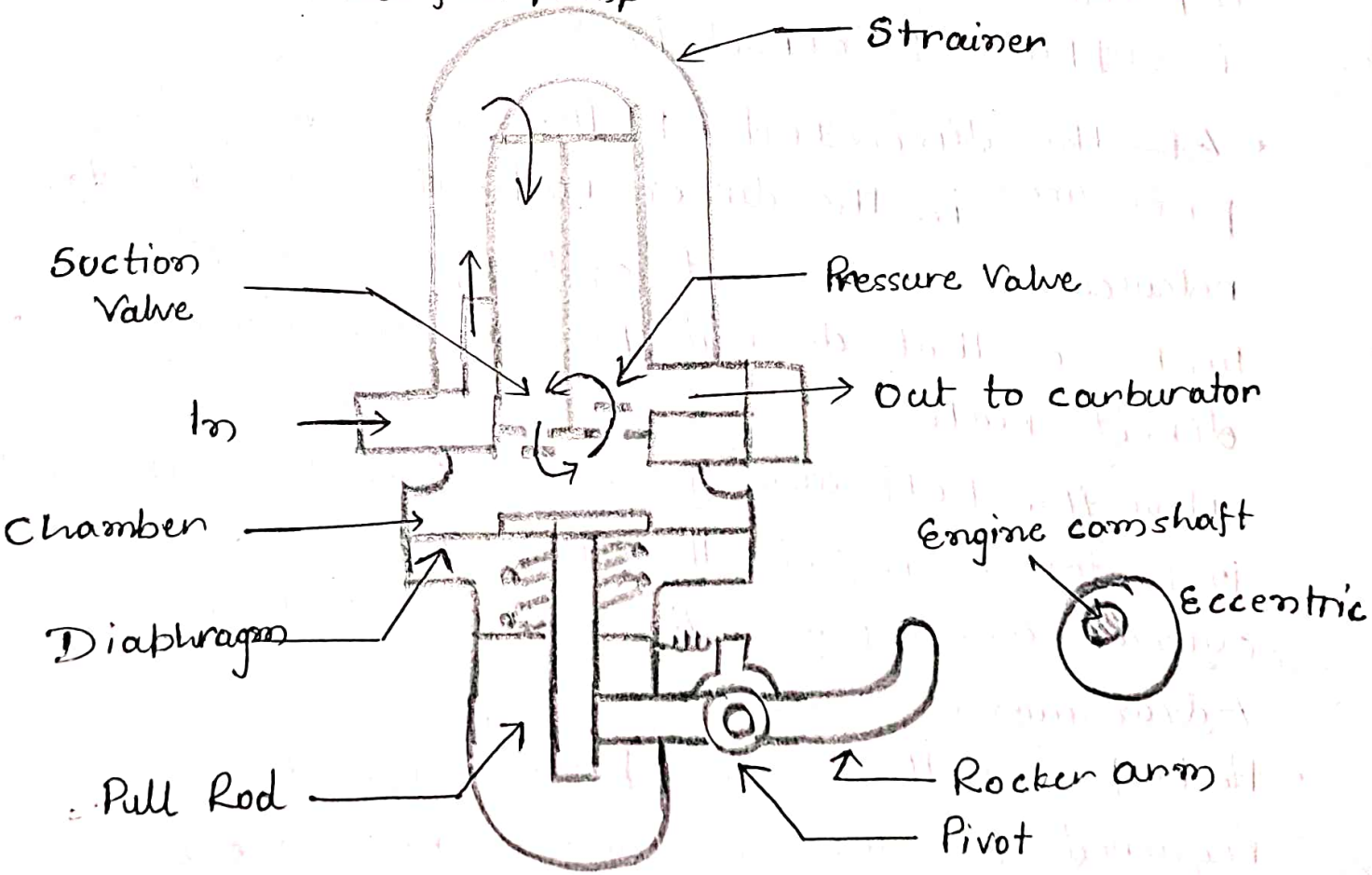
- It improve the engine response during sudden acceleration and retardation.

Fuel transfer pump :-

- Fuel transfer pump which is also known as fuel pump.
- Fuel pump is basically most important component of fuel feed system.
- Fuel pump is a device which is used to supply the fuel from fuel tank to carburetor under pressure.
- There are two types

1. A.C. Mechanical fuel pump
2. S.U. Electrical fuel pump.

AC Mechanical fuel pump



- At the direct rail a pressure control valve is p
to control the pressure of A/F mixture in the direct rail.
- The direct rail is connected to different fuel injectors of each cylinder.

Working :-

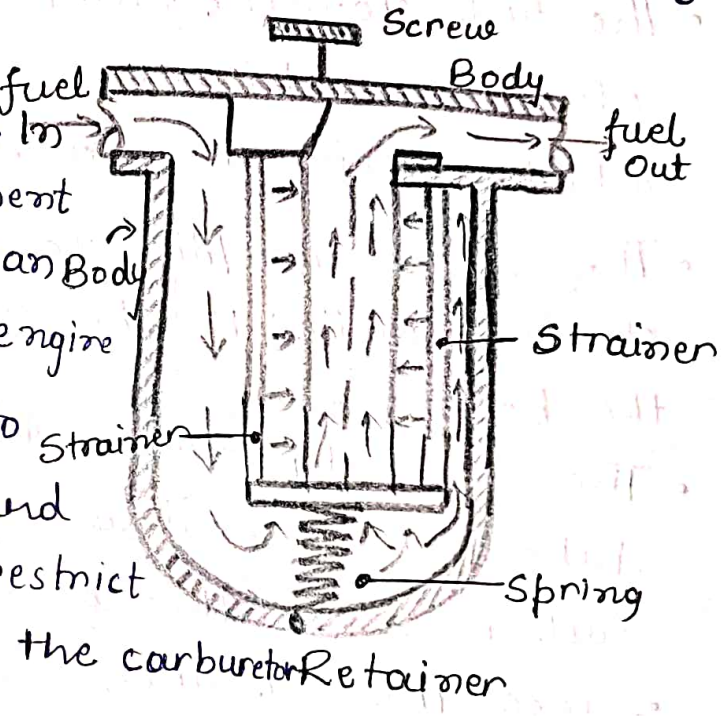
- Based on the information received from different sensors the ECM generates signal first to fuel pump to withdraw the required amount of fuel from fuel tank according to required A/F ratio.
- This fuel is now supplied fuel filter where impurities are filtered out and then the fuel mixture is supplied to direct rail.
- ~~At the direct rail~~ If the fuel is in excess pressure in the direct rail, then the P.C.V. releases some amount of fuel back to the fuel tank so that desired pressure is maintained in direct rail.
- Now the ECM also generates signal to the fuel injector to inject the fuel mixture to each cylinder according to there firing order.

Advantages :-

- It Improves the engine performance by supplying required amount of fuel in correct proportion at correct time to each of multi cylinder engine
- It reduces the fuel consumption and increases the fuel economy.

- But as soon as the armature moves, it interrupts the electric supply by disconnecting the breaker points the solenoid is de energized and the armature falls back.
- This causes the diaphragm to move so as to create the pressure in the pump chamber which opens the outlet valve and the fuel goes out to the carburetor.

Fuel Filter



- Fuel filter is one of the most important component of fuel feed system of an internal combustion engine
- Its main function is to filter out the dust and dirt particles and restrict their entering into the carburetor or fuel injector.
- Otherwise they would create the blockage in the passage of carburetor or fuel injector this would decrease the fuel efficiency and also damage the part of carburator and fuel injector.

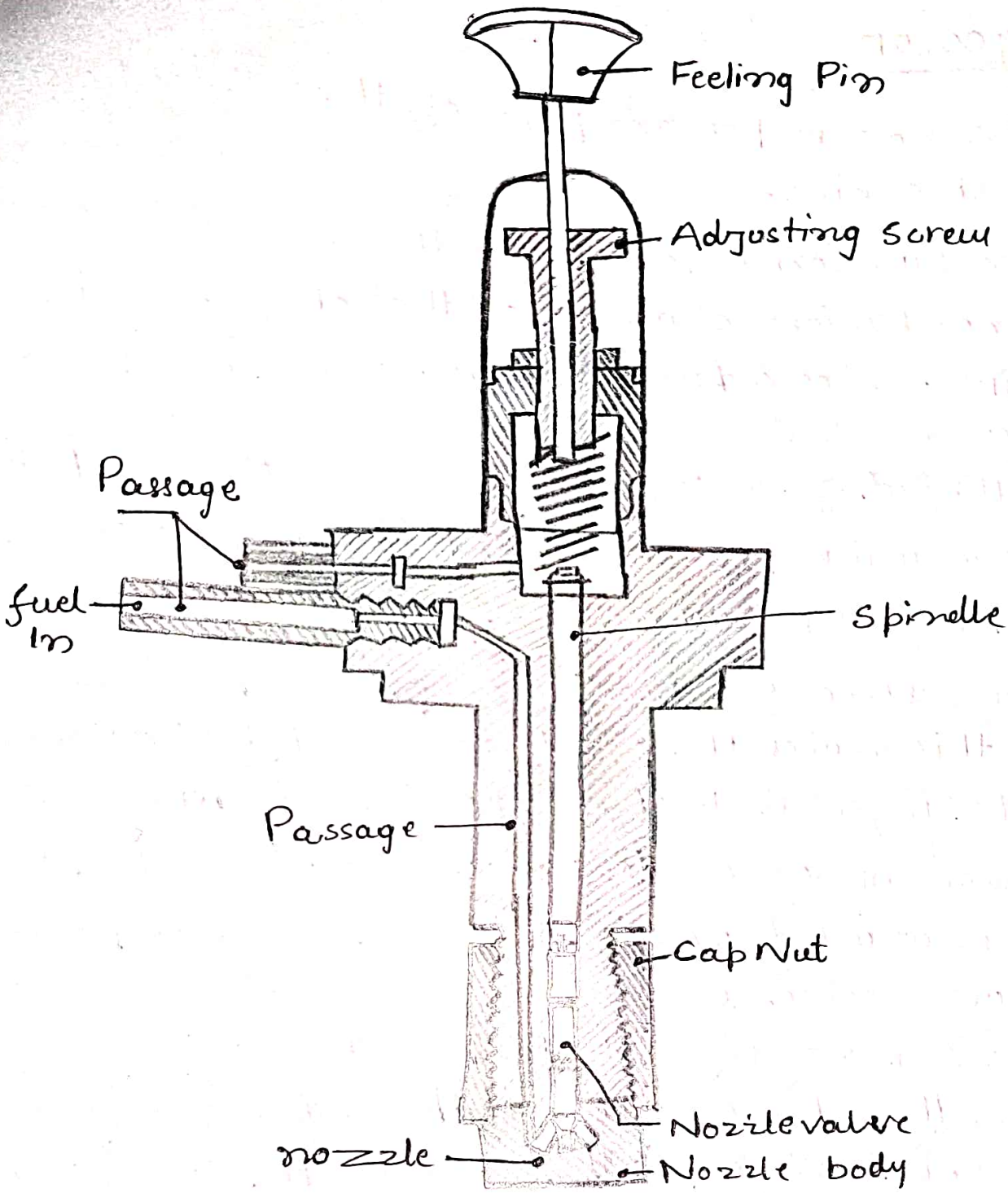
Construction

- It consist of a housing known as body with two opening one is for inlet of fuel from fuel pump & other is for discharge of filtered out fuel to carburetor/fuel injector.
- At the top of the housing there is a cover known as end cap which is clamped with the housing by means of screw.

- The central portion is basically a tube whose other circumference is our filter media known as strainer.
- This tube is mounted over the body by means of spring. This spring provides tension to tube to hold the component under varying pressure.

Working :

- The fuel from the fuel pump when enters to the fuel filter from inlet opening it passes from the strainer which carries the filter media within itself.
- The minute dust/dirt particles gets trapped in the strainer while the bigger size particle gets settled at the bottom.
- The fuel outer fuel now flow through the internal tube passes and gets discharge to the carburetor/ fuel injectors through outlet port opening.
- Since the fuel when enters is under pressure therefore the compression spring provides required tension to hold the component safely in the housing.



Fuel Injector

Fuel Injector

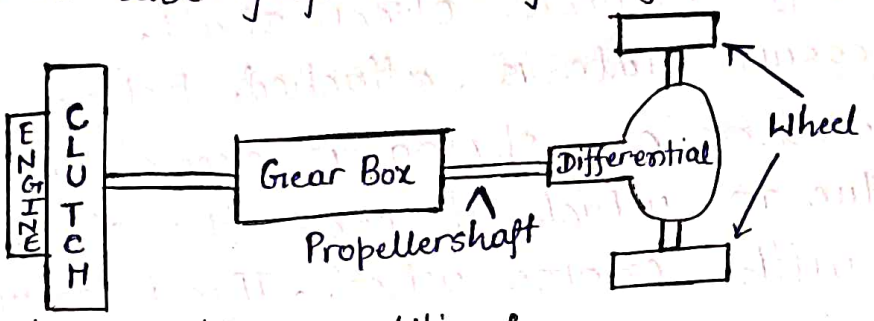
- It is the most important part of the fuel feed system of diesel engine.
- Its main function is to atomise the fuel and inject it in the combustion chamber so that atomise fuel particles and air makes a homogeneous mixture in the combustion chamber.
- When the fuel enters to the fuel injector through inline passage is under pressure and thus moves at the tip of fuel injectors where nozzle is present.
- This pressurized fuel now starts exerting pressure at nozzle this makes the nozzle valve to lift upward & fuel gets injected to the combustion chamber.
- The movement of nozzle valve also moves the plunger which is attached with a spring due to which potential energy gets stored in it.
- At the fuel gets injected the pressure at the nozzle reduces, the spring release it potential energy & nozzle valve falls down thus cut off the injection of fuel.

UNIT-3.

• Transmission System

Clutch

Clutch is the integram part of an engine. It is used to engage and disengage the engine from transmission system.



Clutch has two working condition :—

Engage Condition : When the clutch is in engage condition, the power from engine is transmitted to rear wheel via transmission system.

Disengage condition : When the clutch is in disengage condition, the power from the engine doesn't transmitted to the rear axle, because the connection between engine and transmition system is vanished.

Principle of operation of clutch :—

Clutch works on the principle of friction,

- When two member or surface are in contact with each other due to friction they are considered as a single unit.
- When one member rotates other one is also rotates.
- The member which rotates is called driving member & other member which is run by driving member is called driven member.
- The driving member is mounted on the flywheel of engine while driven member is mounted on pressure plate.
- When the clutch is in engage condition driving & driven member are in contact and power is transmitted from engine to transmission system.

clutch Working:

- In the working of clutch there are basically three parts involve, 1. Engine flywheel, 2. Clutch Plate, 3. Pressure Plate.
- The clutch plate is a friction plate that is having friction lining on the both its sides. The clutch plate is mounted over a shaft known as clutch shaft.
- The pressure plate is attached behind the clutch plate and by means of spring it exerts pressure on clutch plate due to which it forces the clutch plate to make contact with engine wheel. This is engaged condition.
- Now the clutch pedal is pressed, the fork attached with bearing pressure plate forces the release lever to move the pressure plate away from flywheel.
- This movement vanishes the required force due to which clutch plate in contact with flywheel and thus clutch plate looses its contact with flywheel this is our disengaged condition

Desirable Properties of clutch

1. Torque Transmission :— The clutch must be capable of transmitting high torque developed in engine to the transmission system without any shock.
2. Gradual Engagement :— The engagement between driving and driven member must be gradual, ie without any shock.
3. Heat dissipiation :- Due to friction heat energy is developed therefore there must be provision of small opening in friction plate (clutch plate) for proper heat dissipiation.

4. Size and weight of clutch :- The size of clutch must be small so that it can be accommodate very easily. The clutch must be light in weight, so that when clutch is in disengage condition it will stop automatically.

5. Free Pedal Mechanism :- A good clutch posses free pedal mechanism ie by applying small efforts clutch gets disengage and pedal is relased, then clutch gets engage automatically.

Types of clutch

Coil Spring Clutch :- Those clutch in which the engagement and disengagement are produce with the help of helical spring are called coil spring clutch. It is of two types,

i. Single plate clutch

ii. Multi-plate clutch.

Construction of coil spring clutch (Single Plate Clutch) :-

- It consist of a clutch plate, clutch shaft, pressure plate, hub, bolt with helical coil spring and clutch pedal.
- Clutch plate is mounted on clutch shaft and pressure plate is connected to flywheel with the help of bolt having spring.
- Pressure plate is attached with a hub. Hub is mounted freely on the clutch shaft.
- Clutch pedal is attached to hub with fulcrum.

Working :-

Clutch works on two working condition;-

a) Disengage Condition :- When the pedal is pressed the fulcrum forces the hub of clutch shaft to move away from engine flywheel. Due to this pressure plate also moves

against the spring which produces potential energy (PE) the spring.

- The movement vanish the pressure force on clutch plate due to which clutch plate losses its contact spring with friction lining on flywheel

b) Engage condition :— When the pedal is released the stored potential energy in coil also releases. This forces the pressure plate to force the clutch plate get engage with friction lining of flywheel. This is our engagement condition.

Construction of multiple plate coil spring clutch :—

Multiplate clutch consist of pressure plate, spigot with coil spring, multiple friction plate, clutch pedal having fulcrum, hub, clutch shaft.

- Pressure plate is mounted over spigot carrying spring.
- Multiplate clutch have two set of friction plate, one set of friction plate is mounted on engine flywheel & other is on pressure plate.
- Clutch pedal is attached on hub with fulcrum. the hub is mounted on clutch shaft with spline arrangment

Working :—

a). Disengage condition :— When the pedal is pressed hub mounted on clutch shaft moves away from flywheel.

This movement of pressure plate is assignst spring due to which potential energy is stored in spring.

Due to this contact between friction plate of pressure plate and flywheel gets vanished.

b) Engage condition :— When the pedal is released the potential energy stored in spring is releases. Due to which the pressure plate moves towards the flywheel. The movement causes the friction plate of both pressure plate and flywheel to get in contact. This is our engage condition.

Difference between Single Plate clutch & Multiplate clutch.

Single Plate Clutch	Multiplate clutch
1. It consist of single plate clutch having friction material present on both side of clutch plate.	1. It consist of more than one clutch plate friction material is coated only on one side of clutch plate.
2. Torque transmission capacity is low	2. Torque transmission capacity is high.
3. Heat generation is low.	3. Heat generation is high.
4. It doesn't require any cooling medium, so it is also known as dry clutch.	4. Cooling medium is required in form of coolant hence it is known as wet clutch.
5. It doesn't require spigot rod to hold pressure plate.	5. It required spigot rod to hold pressure plate.
6. Coefficient of friction must be high between friction plate	6. Coefficient of friction must be low.
7. Since spacing between friction lining of friction plate and engine flywheel is more which leads to sudden engagement.	7. Since spacing between friction plate is very less therefore engagement is gradual.

Centrtrifugal Clutch

Centrifugal clutch consist of two member one is driving member connected to engine shaft and other is driven member connected to transmission shaft.

- Four break shoe are held by spider brake shoe are connected to driving member through spring.
- Friction lining are present on break shoe outer periphery and driven member internal periphery.

Working:

Engagement :- When the engine shaft reaches to certain R.P.M. centrifugal force strart acting which pulls the break shoe radially onwards. Due to this the shoe friction lining meshes with the friction lining of driven member and now the driven member start rotating.

When shoe moves outward it is against the spring due to which potential energy stored in spring.

Disengagment :- When engine R.P.M. drops centrifugal force vanish. Spring release its P.E. and shoe return to its original position.

Friction lining of driven member and shoe losses its contact.

Advantages of centrifugal clutch :-

(i) Simple in construction.

(ii) Less no. of parts, so less maintenance is required.

(iii) Cheap and easy affordable.

(v) Automatic in operation and hence no operating mechanism is used.

Disadvantages :-

1. Slipping takes place.
2. Power loss.
3. Over heating.
4. Low capacity.

Gear Box

Gear box is basically a box having set of combination of gear arrangement known as gear train.

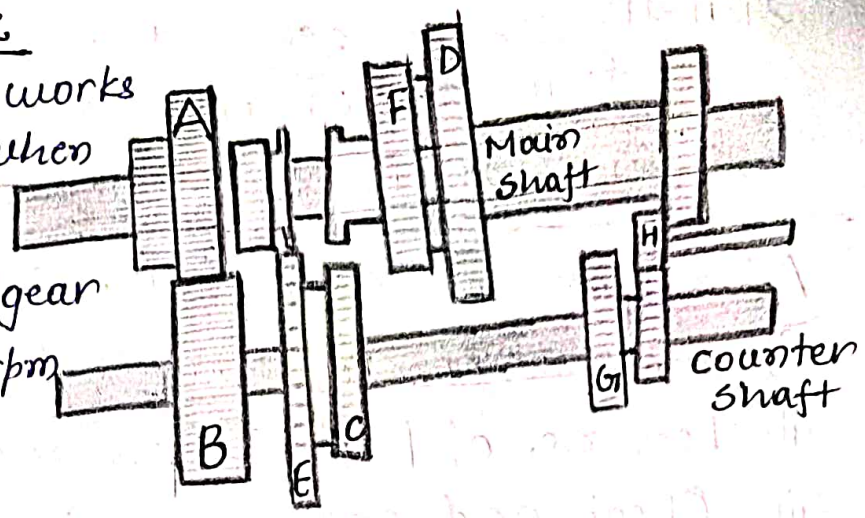
- It placed between clutch and propeller shaft.
- Its purpose is to vary the torque transmitted from clutch to propeller shaft by varying the rpm as required.

There are basically four types of gear box.

1. Sliding mesh gear box
2. Constant mesh gear box
3. Synchromesh gear box
4. Epicylic gear box.

Sliding Mesh Gear box

Sliding mesh gear box works on the principle that when the driving gear is transfered to driven gear and by varying the rpm torque is varied.



Sliding Mesh Gear Box

Construction :-

In this gear A is mounted on the engine shaft which is in mesh with gear B of the counter shaft. Gear F and D is mounted on the transmission shaft while gear E, C, G is mounted on Countershaft while an idler gear is in mesh with the gear G.

Working :-

- for first gear condition :- Connection between Gear A-B-C-D is done, since the number of teeth is more than gear C therefore RPM of gear D on transmission shaft is low and torque is high.
- for second gear condition :- Connection between gear A-B-E-F is done, since no of theet on gear F is less than gear E therefore RPM of gear F on transmission shaft is high and torque transmitted is low as compared to previous condition.
- for high speed condition :- This is our high speed condition known as top gear. In this the engine shaft is directly coupled with transmission system shaft and thus engine high RPM is transmitted to transmission shaft directly.

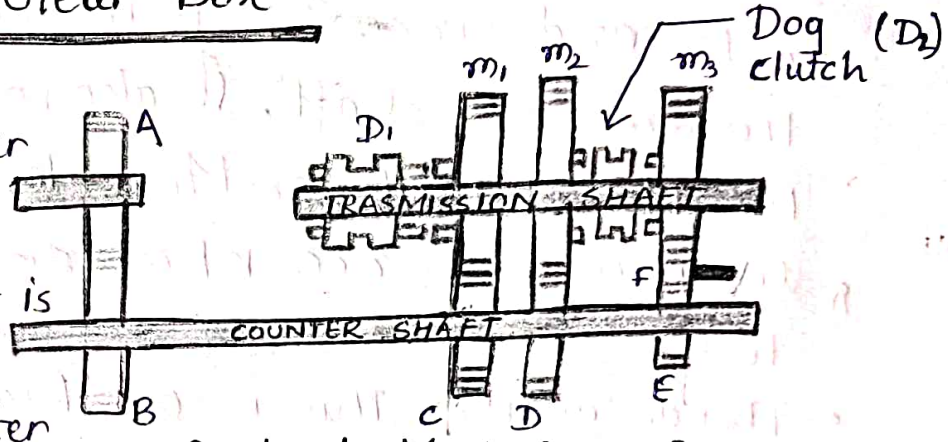
• for reverse gear condition :- Connection between ABGHD is done by the help of idler gear, by the help of idler gear we reverse the direction of rotation of transmission system shaft.

Since in this gear box the gears on T-S is meshed with the gears on C.S by sliding the T-S, hense it is known as sliding mesh gear box.

Constant Mesh Gear Box

Construction :-

• In this type of gear box all gears of transmission shaft is in constant mesh with gear of counter shaft.



Contant Mesh Gear Box

• The gear on counter is fixed while the gear on transmission shaft is free.

• The dog clutches are mounted on transmission shaft with the help of spline arrangement.

• The dog clutch D_1 lies between Gear A and m_1 while D_2 lies between M_1 and M_3.

• Dog clutch engages the gear of transmission shaft which is free to fixed condition. Since D_1 and D_2 are seperated from M_1, M_2 & M_3 mounted on transmission shaft due to which gear M_1, M_2, M_3 remains free on T.S.

Working :-

first gear position the D_2 moves towards M_2 due to which M_2 get engage with D_2. Now the rpm of D_2 equals to rpm of M_2 and so D_2 having spline

Contact with transmission shaft. Due to rotation of D_2, T.S also rotate with the same rpm of D_2.

Since no. of teeth on gear M_2 is more than no. of teeth on gear D, so rpm on gear M_2 is less and torque will be high.

- Second gear :- Dog D_2 moves towards M_1 and get interlocked wit it due to which rpm of D_1 equal to M_1 and since D_1 is in spline contact on transmission shaft, it also rotates with same RPM of M_1. No. of teeth on M_1 is less than no of teeth in gear c, hence rpm is more and torque is less.
- Third gear :- This is our high speed gear condition D_1 moves towards gear A and get interlocked with it. Due to which D_1 rotates with high rpm of Engine and makes the transmission shaft to rotate with this high rpm.
- Reverse Gear :- D_2 moves toward M_3 and interlocked with it. In this gear F is is idler gear with reverse the direction of M_3. Due to which D_2 also rotates in reverse direction and make the transmission shaft to rotate in reverse direction.

Propeller Shaft and Universal Joint

It connects between output shaft of gear box and bevel gear shaft of different at other end.
Since the power of engine is transmitted through this. Shaft to rear axle hence it known as drive shaft.

Function of propeller shaft :—

- It transmit motion from gear box to differential.
- It transfer motion of an angle which is varying frequently.
- It adjust change in length between gear box & differential.

Construction :—

- It is made up of steel tube i.e. Mild steel.
- It is a hollow shaft containing two types of joint.
  a. Universal joint
  b. Sliding Joint
- Diameter usually ranging from 50 mm from 1.5 - 7.5 mm. Tubular section makes it lighter in weight and will have high torque transmission capacity than solid shaft.

→ Function of universal joint

When the vehicle has to travel on uneven road the difference in level between gear box and differential changes frequently. Due to this the inclination between axis of shaft of gear box and axis of propeller shaft and differential shaf varies frequently. So to transform the torque / power between gear box and diffential is possible trough propeller shaft at varying inclination.

→ Function of Sliding Joint

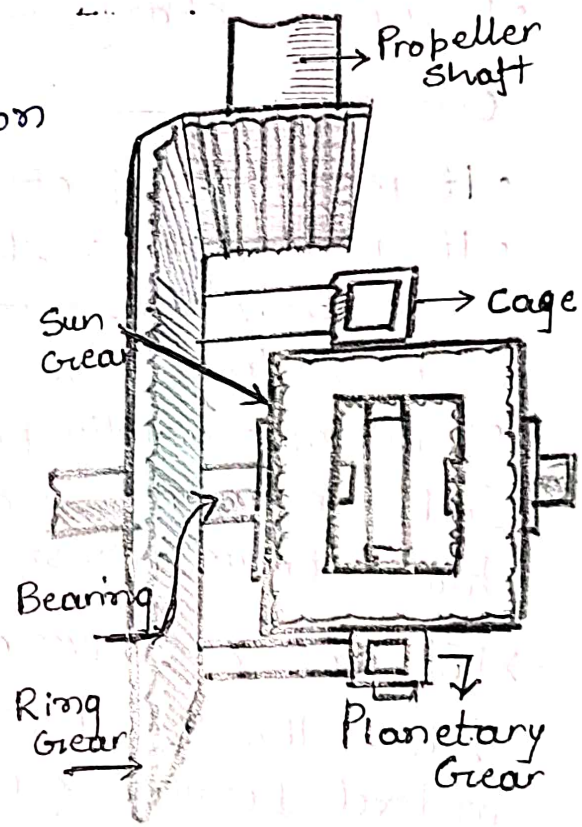
Due to variation in inclination the distance between gear box and differential varies thus propeller shaft has to adjust the length which is possibly by sliding joint.

Differential

Differential is a component having set of gears which connects the propeller shaft with axle. It has two basic function.

1. To transmit the power from engine to rear axle through propeller shaft in two mutual perpendicular direction.
2. When to turn the wheel require more RPM the inner wheel as the outer wheel has to travel more circumference distance so differential transfer more rpm to outer wheel the inner wheel.

Construction



- It consist of bevel gear mounted on propeller shaft, the bevel gear is in mesh with ring gear.
- Ring gear has a cage on which two planetary are mounted which are in mesh with sun gear of rear axle.
- Ring gear is mounted over are rear axle through bearing.

Working

It has two working cases

- When to turn the vehical straigh on road, In this case of differential has to transfer same rpm to both right and left side wheel.
- When propeller shaft rotates ring gear rotates which causes the cage to rotate about ring gear axis
- Due to this the whole arrangement of planetary & sun gear rotates as a unit about the axis of ring gear and not spin about on axis. Thus due to rotation of sun gear axle rotates with same rpm which is

equal to rpm of ring gear.

- When vehicle makes a turn the resistance offered on inner wheel axle increases as compared to outer wheel axle. Due to this planetary gear starts spinning about its axis, due to this tangential force increases on sun gear of outer wheel axle and decreases on sun gear of inner wheel axle. The causes the outer wheel axle to rotate at more rpm then inner axle.

Rear-Axle

In between rear wheel and differential the axle on which rear wheel is mounted is known as rear axle.

It is clear from construction of the differential that the rear axle is not single piece axle. It is two half axle wheel on the outer side of two half axle wheel is mounted and on inner side sun gear is mounted.

Since power from engine is transmitted continuosly for rear axle due to which it rotates continuously. Hence it is called live axle.

Load on Rear Axle

1. Weight of vehicle
2. Resisting torque
3. Driving thrust
4. Side thrust

Semi-Floating Rear Axle :—

- It is the most commonly used rear axle as it is cheap and easily available.
- In this bearing is mounted inside casing. ie between axle and casing.

- In this weight of vehicle transmit from axle casing → bearing → shaft → Wheel hub → Wheel → Road
- The driving thrust and side thrust are absorbed by bearing
- Axle have to bear the resisting torque.

Three - Quarter Floating Rear Axle

- Wheel hub may transmit very small load due to weight of vehicle to axle.
- Driving and side thrust absorb by bearing.
- Axle has to bear resisting torque.
- In this type the bearing is mounted outside axle casing i.e between wheel hub and axle casing.
- The load due to weight of vehicle is transmitted through axle casing - bearing - Wheel hub - wheel - to road.

Full Floating Rear Axle

- In this type of rear axle bearing is mounted between wheel hub and axle casing.
- Load of weight ~~of wheel~~ vehicle is transmitted from axle casing - bearing (taperd) - wheel hub - wheel - road. No load due to weight of vehicle of vehicle is transferred to axle.
- It has to bear only resisting torque, side thrust and driving thrust are absorbed by bearing.

Ignition System

Automobile Electrical System

- Electrical system plays very vital role in the working of any automobile vehicle.
- Electrical system used to operate the ignition system whose main function is to start the engine.
- Electrical system is used to supply electric current to difficult lightening circuit.

Ignition System:

Purpose :- Ignition system is used to ignite the fuel mixture at the end of compression.

→ It is used in petrol engine. To produce spark, spark plug requires a voltage of 30,000 to 40;000 volts, but the battery or magneto can supply max up to 12 volt.

→ In multicylinder engine the electric current is to be distributed to different spark plug of different cylinder. Thus to increase the voltage and distribute the current we require a system called Ignition system.

Battery Ignition System

Construction

It consist of two circuit;

a). Primary circuit :-

In this circuit battery is conducted to ignition switch ballast resistor (which protect the primary circuit from excessive current).

Ballast resistor is connected to primary coil winding which have 200-300 turn and primary winding is grounde through connected breaker.

A capacitor is connected with primary circuit in parallel

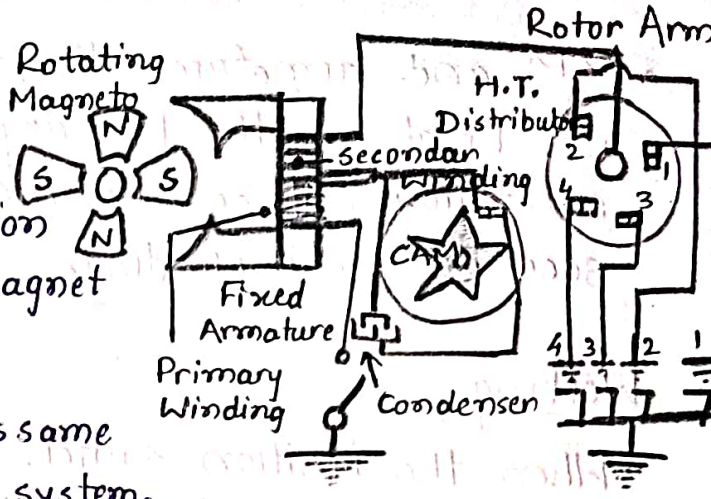
b). Secondary circuit :-

- It is known as high voltage circuit in this the secondary coil winding having (20000-30000) turns is connected to distributer arm.
- A soft iron core is placed in between primary and secondary winding coil.

Working-

- When the ignition switch is on to flow through primary winding having (200-300) turns. Now this current flows to ground through contact breaker.
- When the CAM rotates it break the circuit now all current starts flowing the capacitor. Due to which it get fully charged.
- Now the voltage in capacitor reaches to break down voltage. Due to which capacitor starts supplying current to battery.
- This reverse current is having high voltage which may damage the primary circuit so to protect primary circuit ballast resistor is used.
- This reverse current change the flux on secondary winding opposes this change in flux and induce an emf over itself.
- Since no of turns on secondary winding is (20000-30000) turns,
  Voltage in secondary winding set up to 30,000 to 40,000 volt.
- This high voltage current is supplied to different spark plug of distributer.

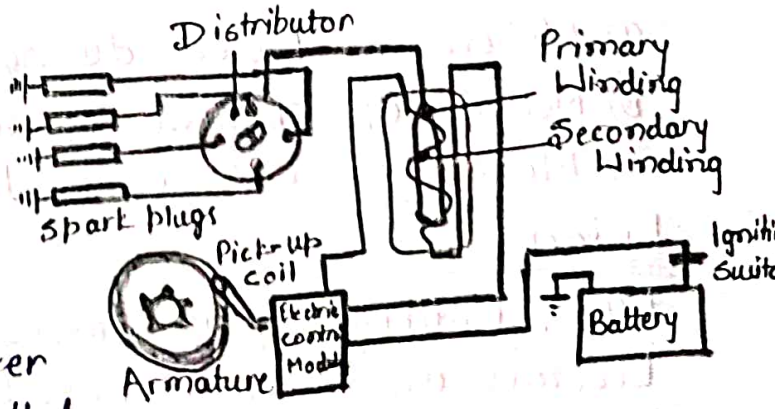
Magneto Ignition System



Construction And Working

- The battery shown in battery ignition system is replaced by a rotating magnet assembly known as "Magneto". While the remaining arrangement is same as that is used in battery ignition system.
- Due to rotating of magneto polarity changes the flux on primary winding. Primary winding appose the change in flux and induce an EMF through itself.
- Due to this EMF current starts flow through primary winding to ground. Due to this current primary winding produces magnetic field lines to secondary winding through iron core.
- When CAM rotates contact breaker breaks the circuit and current flows to condenser.
- Due to which a breakdown voltage reach in condenser which reverse the direction of current.
- This reverse current changes the flux on secondary winding. Secondary winding also opposes this change in flux and induce an emf over itself.
- Since no of turns on secondary winding is more ∴ voltage produced in secondary winding is very high up to 40,000 volt.
- Secondary winding supplies this high voltage current to different spark plug of different cylinder through distributor arm.

Electronic Ignition System



Construction:

- It is similar in construction to battery ignition system but the condenser and contact breaker is replaced by electronic controlled module (ECM) and an armature with pickup coil.

- ECM and armature with pick up coil is basically used to con and break up the primary circuit so that magnetic flux on secondary coil can be varied in order to induce the EMF on secondary coil winding.

Working –

- When the ignition switch is on curren from battery starts flowing through ECM in primary circuit.
- Due to flow of current through primary winding it produces magnetic field lines on secondary winding.
- When the teeth of armature coil comes in front of pick up coil a voltage signal is transfer to ECM due to which ECM breaks the primary circuit. When teeth goes away from pick up again ECM connect primary circuit.
- Due to this current becomes intermittent and magnetic flux on secondary coil get varied and emf is induced which is distributed to spark plug through distributor.

Starting Motor

All the desirable motion is provided by a device called Starting Motor.

Purpose :–

All the internal combustion engine are not self starting as because some motion in the engine are required before ignition such as

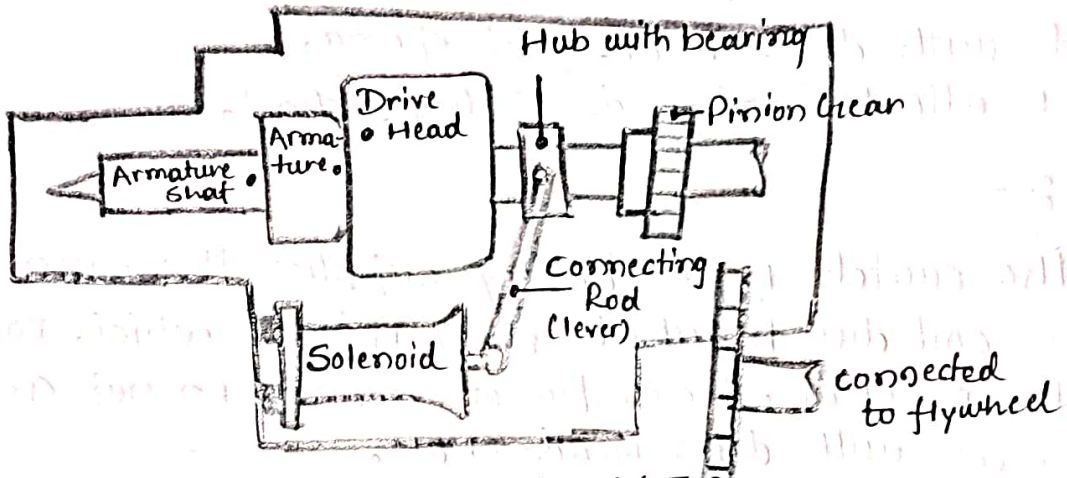
a) Motion in piston during suction and compression
b) Motion of opening of valve to maintain fuel supply
c) Motion in CAM of contract breaker.

Principle :–

When battery supplies current to series winding of pole it becomes an electromagnet and produces magnetic field which is experienced by conductor coil by right hand rule shaft over which conductor coil is mounted start rotating

Construction:-

- It is very simple in construction. It has two basic arrangement one is solenoid and other is a moving coil armature.
- Both armature and solenoid are in connection with battery.
- Armature shaft is connected with drive head shaft. Drive head shaft carries a pinion gear. The solenoid is attached with drive head shaft through lever and hub with bearing.



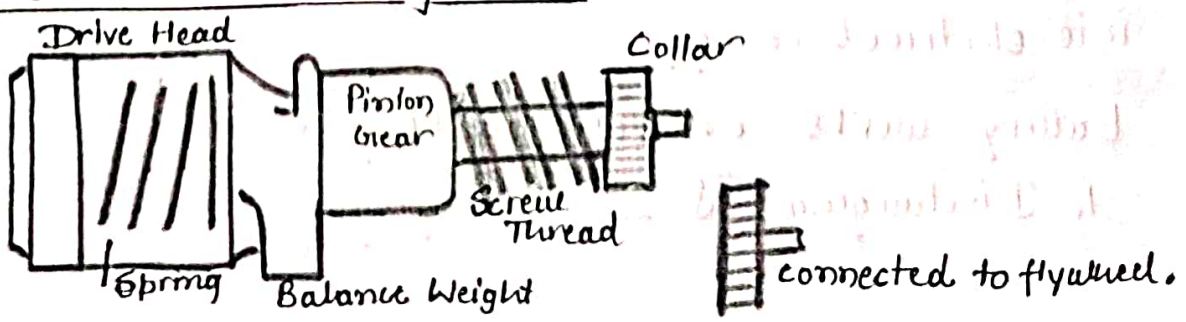
STARTING MOTOR

Working:

- When the switch is on the battery supplies the current to solenoid due to which the solenoid moves forward and forces the drive head shaft to also move forward this forces the pinion gear to get in mesh with flywheel gear.
- At the same time battery supplies current to armature & by motor principle armature shaft rotates which rotates drive head shaft and pinion gear.

∴ Pinion gear is in mesh with flywheel gear thus it also rotate and flywheel of cranck shaft start rotating in this way all the desirable motion is achieved.

Bendix Drive Starting Motor



Construction :-

- Bendix drive is an engagement mechanism used is starting motor.
- In bendix drive the head shaft has an external thread cut on it while the pinion gear mounted on it have internal thread cut on it.
- Pinion gear mounted over drive head shaft just like nut & bolt arrangement.
- A balance weight is attached with the pinion gear and is attached with drive head with spring.
- Collar is attached at end of drive shaft.

Working :-

When the switch is on battery supplies the current to armature coil due to which shaft rotates which rotate the drive head shaft. Since pinion gear is in nut and bolt arrangement with drive head shaft.

∴ It moves forward along the balance weight. However this movement is again the spring hence the potential energy is stored in it.

- Due to movement of pinion gear when it reaches to collar it get in mesh with fly wheel gear since pinion gear is in rotational motion. Hence fly wheel gear also rotates and motion is tranformed to crank shaft.

BATTERY

It is most important and essential component of our electrical system. In this, electrical energy can be stored in chemical energy and this chemical energy can be converted into electrical energy.

Battery works on two working condition;

1. Discharging & 2. Charging.

1. Discharging : During discharging chemical energy stored is converted into electrical energy. In this full charged battery which has stored chemical energy when connected any electrical load (bulb) it start lightening up by supplying electric current to it.

2. Charging : In this electrical energy is supplied to the battery which gets converted into chemical energy and stored in it. In this the fully discharged battery when connected to any electric supply the electrical energy supplied to battery gets converted into chemical energy.

"In automobile vehicle most commonly used battery is lead-Acid Battery.

LEAD - Acid BATTERY

It has two plate dipped in diluted sulphuric acid. One plate is hard made up of lead peroxide (PbO_2) and other plate is sponge lead (Pb).

Discharging

After charging H_2SO_4, contain some $2H^+$ and SO_4^{2-} ions while PbO_2 plate becomes positively charged and Pb plate become negatively charged.

The hydrogen ions moves towards PbO_2 and gains electric from it and become hydrogen gas. The hydrogen gas attack from ~~it~~ PbO_2 to form PbO and H_2O.

$$PbO_2 + H_2 \longrightarrow PbO + H_2O$$

→ This PbO react with H_2SO_4 to form $PbSO_4$ and water.

→ $PbSO_4$ deposite over plate and water makes weak electrolyte

$$PbO + H_2SO_4 \longrightarrow PbSO_4 + H_2O$$

SO_4^{2-} ions moves towards lead plate where they give their extra electrons and becomes radical (SO_4) which reacts with Pb to form $PbSO_4$, during discharging a layer of $PbSO_4$ deposited to both plate and electrolyte become weak.

Charging

When the battery gets fully discharged, the load is replaced by a DC source. One become cathode.

The H^+ ions moves cathode and becomes hydrogen gas and react with $PbSO_4$ of cathode to form Pb with H_2SO_4.

$$PbSO_4 + H_2 \rightarrow Pb + H_2SO_4.$$

The SO_4^{2-} moves towards anode and gives three extra free electrons and becomes radical (SO_4) which reacts with $PbSO_4$ on presence of hydrogen.

To form lead peroxide and H_2SO_4

$$PbSO_4 + SO_4 + 2H_2 \rightarrow PbO_2 + 2H_2SO_4.$$

During charging solution become strong, ie chemical example increases.

Wiring Circuit

Wiring circuit is one of the most important system used in automobile vehicle because through these circuit. Electricity is supplied from battery for various purpose.

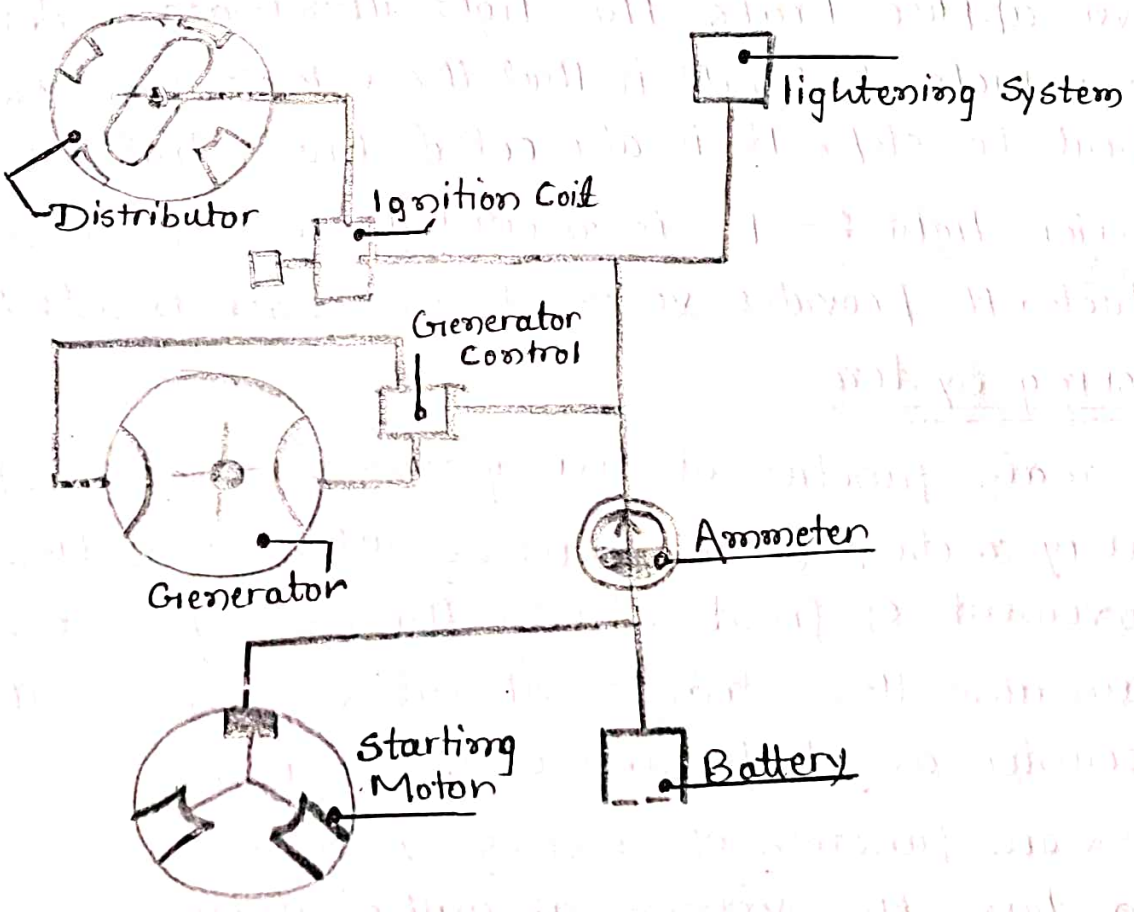
1. Starting and stopping the motor to run the engine or stop engine.
2. For production of spark in spark plug.
3. To charge the discharged battery
4. It is a system through which various electrical appliance are connected.

Starting Motor Circuit :- Starting motor circuit connect the starting motor to battery through wire so that current required to initiate the starting motor can be reached.

Generator circuit :- A DC source generator is connected to battery through the circuit, when battery starts discharging it gets charged. A DC source generator is connected to battery through wire the connection is called generator circuit.

Ignition Circuit :- This circuit is used to connect the ignition coil with battery. Through this circuit battery supplies current to ignition coil where its voltage is increased and its further supplied to distributon arm of spark plug.

Lightening Circuit :- Through these circuit lighting system is connected to battery. So that the current from battery is supplied to different lightening source.



Lightening Source and circuit

Headlight :- It is required to illuminate the path to permit safe night driving. They give high intensity light beam which is sufficient for vision of driver.

Direction Signal Indicator Light :- These are mounted on side of vehicle. These lights are used to indicate the direction in which the vehicle has to turn.

Parking Light :- In addition to head light, low intensity parking light are provided in front position of vehicle. They are just below the head light.

Tail Light :- It is the low intensity light mounted on rear portion of vehicle which gives signal to vehicle coming from rear side.

Stop light :- It is mounted on rear side of vehicle when driver applies brake this light illuminate and indicate the vehicle behind it that the vehicle front to it is about to stop. It is also called brake light.

Interior light :- It is mounted in the interior of vehicle. It provides vision to passenger inside the vehicle.

Steering System

The main function of steering system is to convert the rotatory motion of the steering wheel into the angular movement of front wheel. The steering system must also maintains the straight ahead motion of while it encounter any pot holes and bumbs.

The main function of steering system :-

1. To turn the vehicle at will of drive.
2. To control the direction of automobile vehicle.

3. To concert the rotary motion of steering wheel into angular displacement of front wheel.

4. To minimize the effort required to turn the steering wheel while making a turn.

Component of Steering System

Steering Wheel :- Steering wheel rotates to turn the wheel left and right. If to turn the wheel in left direction steering wheel rotates in anticlockwise direction and if to turn the wheel in right direction steering wheel rotate in clockwise direction.

Steering Column :- It is a hollow circular shaft which transfer the motion from steering wheel to steering gear box.

Steering Gear Box :- It is a speed reduction gear box as it reduces the rpm of output shaft of gear box due to which large torque is produced at output shaft of gear box which is transferred to wheel.

Steering Linkages :- It is a linkage mechanism system between the output shaft of gear box to the axle of the wheel it has following parts :-

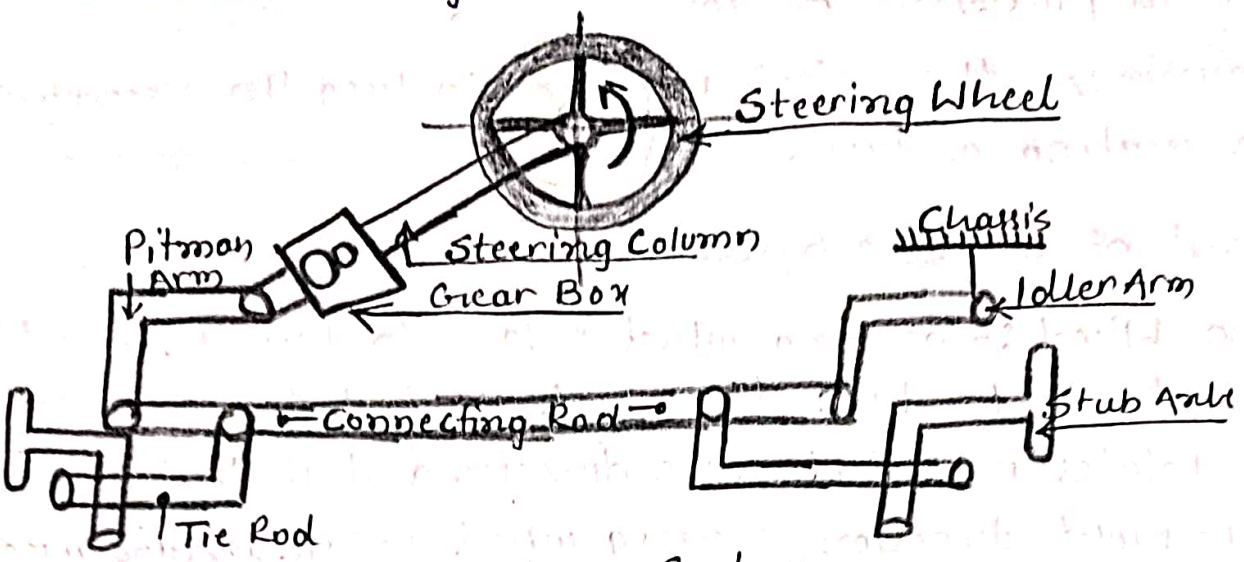
a). Pitman Arm :- It is also known as drop-arm it connects and transfer the motion from output shaft of gear box to connecting link.

b). Idler arm :- It is generally arranged opposite to pitman arm. It is rigidly mounted with chassis and it supports the steering system.

c) Connecting link :- It is a road which reciprocate due to rotation of pitman arm.

d) Tie Road :- It connect the transformation from connecting link to wheel.

e). Stub-Axle :- Swivelling motion of tie ~~rodd~~ rod is trans to wheel through stub axle.



Steering System

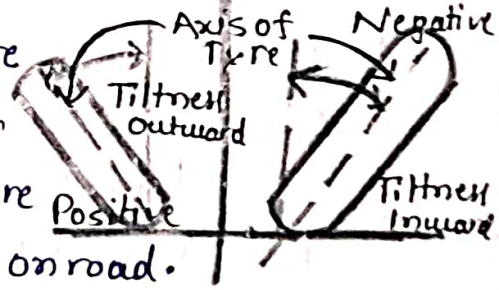
Wheel Alignment

To give better stability with uniform motion while running the vehicle on the road. A slight adjustment in wheel geometry has to be made. This adjustment in wheel geometry is called wheel Alignment.

The various alignment on wheel geometry are

Chamber Angle :- It is the angle between normal of road and axis of tyre it may be positive or negative as per requirement. The value of chamber angle is 2°-3°.

Positive chamber are given to those vehicle which are heavy loaded. Due to heavy load tyre tilt inward. Therefore positive chamber is given to compensate this so that tyre will become straight when vehicle run on road.



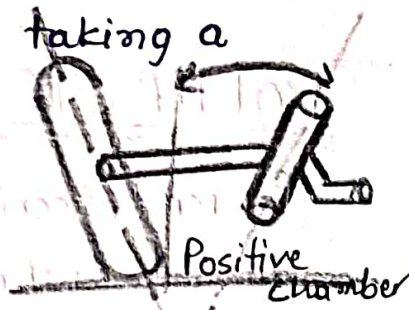
Negative chamber is given to those vehicle which runs at very high speed when vehicle runs at very high speed the centrifugal force becomes dominants which tends to tilt dominants which tends to till the tyre outward.

King Pin Inclination

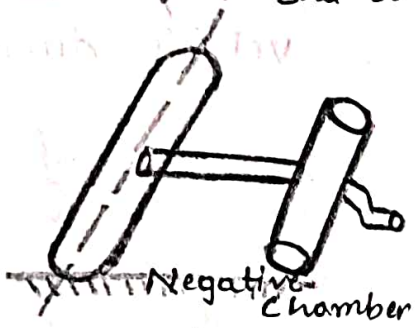
It is the angle between axis of kingpin and normal to the road surface when viewing the vehicle from front.

- Its value lies between 4°-8°.

Positive chamber - It provides stability while taking a turn because it helps in turning the wheel by giving it more space and thus reduces the restriction.



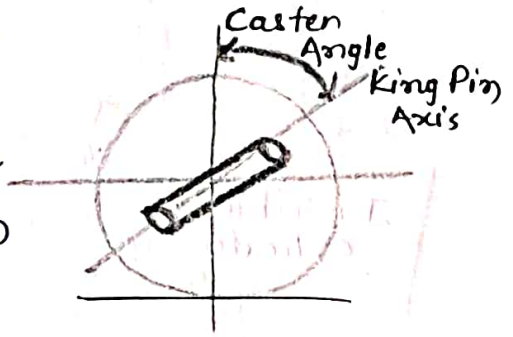
Negative chamber - It is the total angle between axis of tyre and king pin axis.



Caster Angle

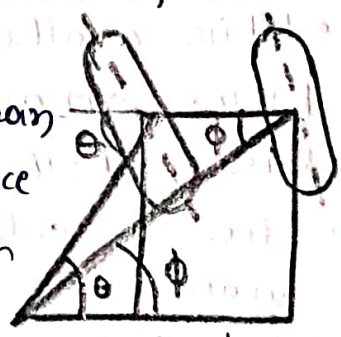
It is the total angle between kingpin axis with vertical when seen in side view. Its value lies between 2°-8°.

Caster angle is provided as it gives the steering column very less effort to turn the wheel taking a turn.



Toe - Out

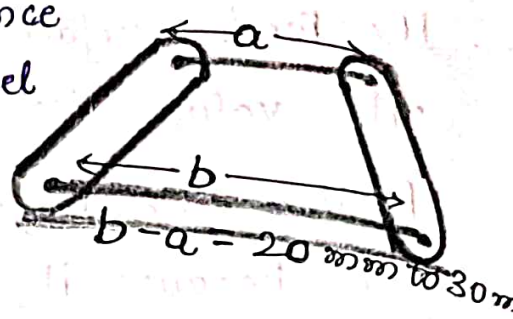
- When the vehicle takes a turn outer wheel has to cover large circumferential distance as compared to inner wheel and the instantaneous centre of rotation will be same for this the angle of inclination of outer wheel will be less than inner wheel.
- The difference is achieved by Ackerman steering linkage mechanism. The difference in inclination between outer and inner wheel called Toe - Out.



$\theta - \phi = (3° - 5°)$

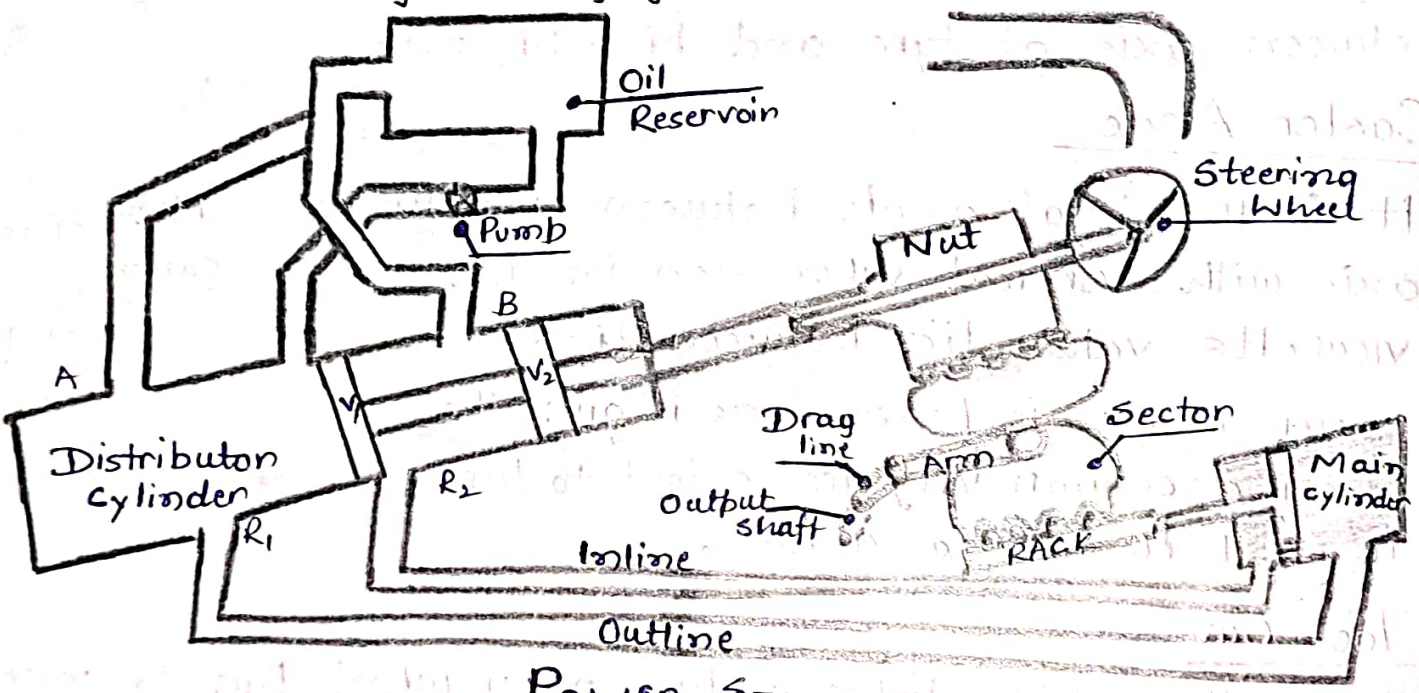
Toe-in

It is absorb that distance between fron position of two front wheel will be less than distance between rear portion of two front wheel this is known as toe-in.



POWER STEERING

Power steering gives induce power to the steering system due to which the effort made by the driver of the vehicle during turning get minimized gets negligible.



POWER STEERING

- It consist of two cylinders, one is distributor cylinder and other is main cylinder.
- Distributor cylinder contains spool valve V_1 & V_2.
- While another cylinder is our main cylinder contains piston arrangement with a gear rack attached with piston both cylinder is connected with pipeline.
- Steering column contains recirculating ball bearing arrangement having sector with teeth. It is in mesh with one side and with rack on other side. The nut is attached with the spool valve.
- The drag link is attached with output shaft of gear box.

Working of Power Steering

It has two working conditions, 1. Turning and 2. Returning.

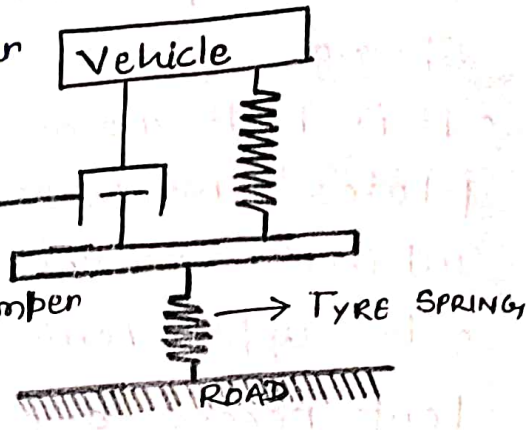
1. Turning :— When steering wheel rotates column also rotates which causes nut to reciprocate due to which valve change the position in which the high pressured oil from the reservoir goes to rod end side of main cylinder through inline pipe line. This support the motion of rack and the effort required to rotate wheel get minimized.

2. Returning :— When steering wheel rotate column rotates in opposite direction which causes the nut to reciprocate this change the valve position and now the H.P. oil enter to piston side of main cylinder through outline pipeline. This support motion of rack and the effort required to rotate wheel get minimized.

UNIT-4 SUSPENSION SYSTEM

Suspension System

It is most essential part of the automobile vehicles.



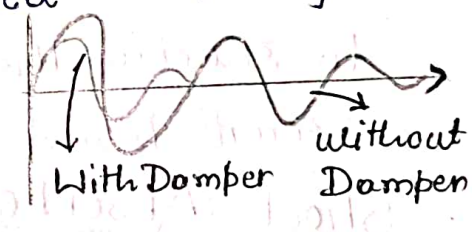
- When the vehicle runs on irregular surface, sudden shock commonly known as jerk is produced.
- If this produced jerk is transmitted inside the vehicle it would create discomfort to passenger seated inside the vehicle.
- Therefore to elimate this jerk before transferring inside the vehicle we require a system called suspension system.

Elements of suspension system :

It has two elements of suspension system.

a). Spring :- It is a device which absorb sudden shock and vibration and starts oscillating.

b). Damper :- The oscillating produced in spring is eliminated by damper. It is also known as shock absorber.



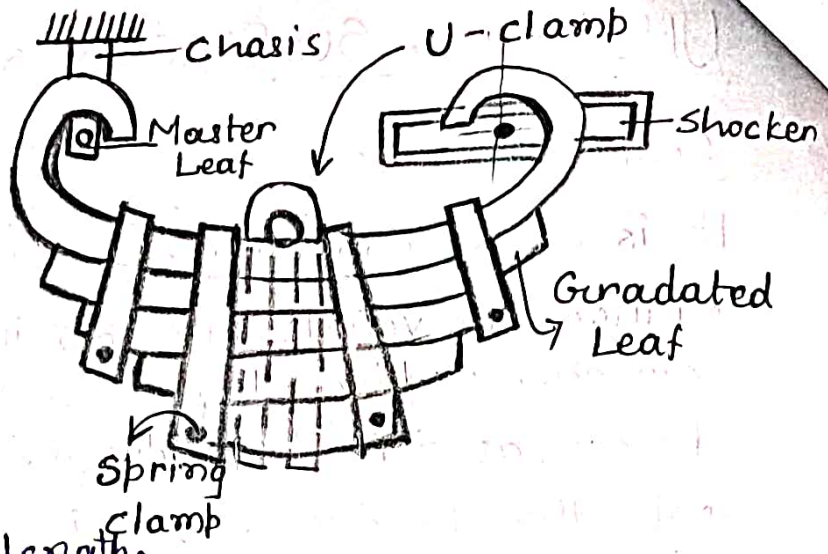
TYPES OF SPRING

a). Helical Coil b). Leaf Spring.

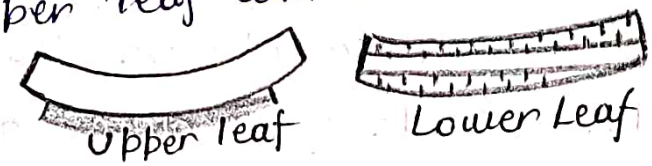
Helical coil spring :

- It is generally made up of ~~spring~~ steel. The best energy storing shape per unit weight is circular cross-section.
- The energy stored per unit volume is almost double as compared to leaf spring.
- For helical spring the spring coil is wounded round in form of helix. To increase the life of helical spring shot peening is done.

Leaf Spring



- Leaf spring used in automobiles is mainly semi-elliptical leaf spring.
- It is built up of no of plates known as leaf which is reducing in length.
- In upper leaf projections are made in lower leaf recess are made. The leaves are so assembled that projection of upper leaf will mesh in the recess of lower leaf.



- The leaf are botted centrally with U-bolt which prevent the longitudinal movement of leaves over each other.
- Spring clamp bind up the leaves together as a unit.
- One end of leaves are fixed chassis and other end to shackie. The end of spring at shackie is free to permit linear movement.

Shock Absorber

- If the shock absorb any load or any jerk potential energy gets stored in it.
- The spring quickly releases this potential energy and starts oscillating.
- This oscillation is not desirable therefore to eliminate this oscillation same arrangement is taken into addition with the spring known as shock absorption.

Types of shock absorber :

i. Hydraulic Shock Absorber
ii. Mechanical Shock Absorber

Hydraulic Shock Absorber :

The shock absorber which uses hydraulic liquid to eliminate the oscillation produced in spring is called hydraulic shock absrber.

Telescope Shock Absorber :

Construction :—

- The upper end of shock absorber is mounted on chassis while the lower end is mounted on axle casing.
- It has two cylinder one is inner cylinder which is completely fitted with hydraulic oil while other is outer cylinder known as reservoir cylinder which is half fitted a stopper placed in outer cylinder.
- Inner cylinder is divided into three chamber (A, B, C) with the two way piston valve and two way annulus valve.
- Piston rod is connected to two way piston valve.

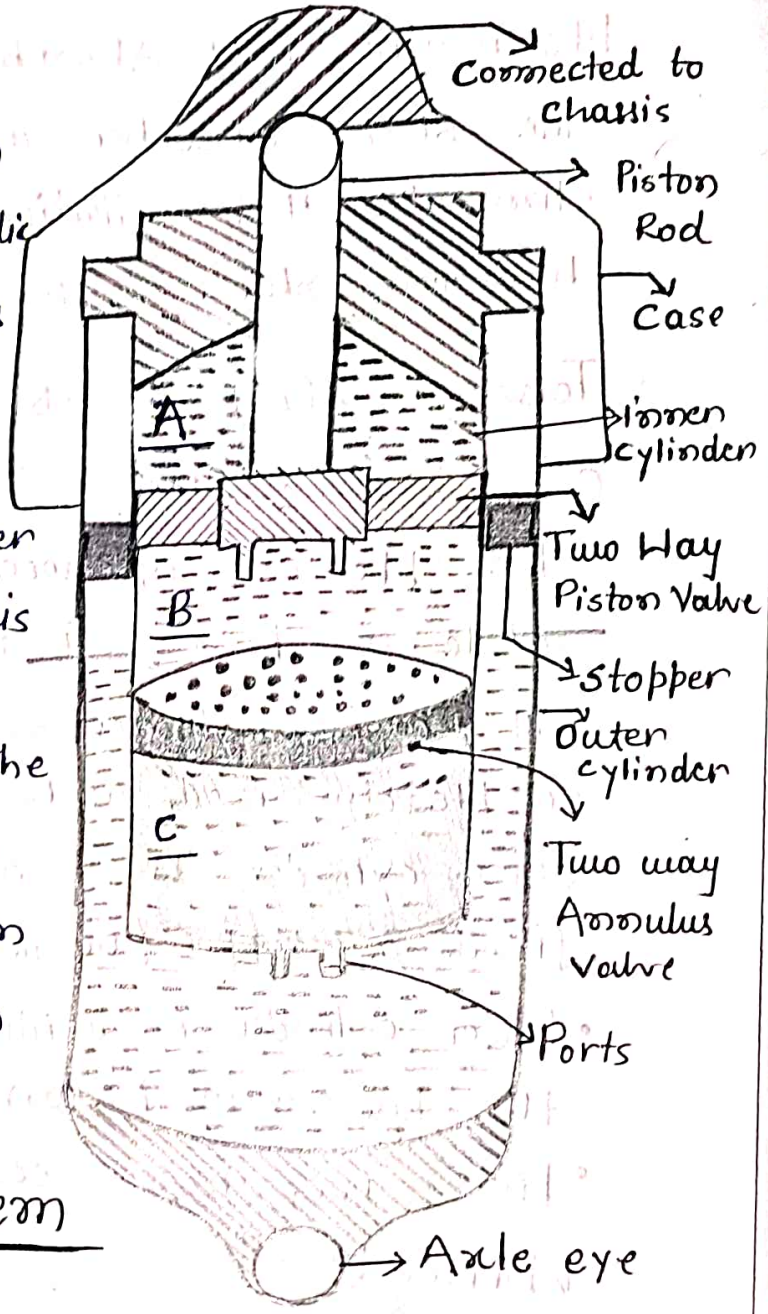
Working :—

It has two working condition, a) Loading, b) Unloading.

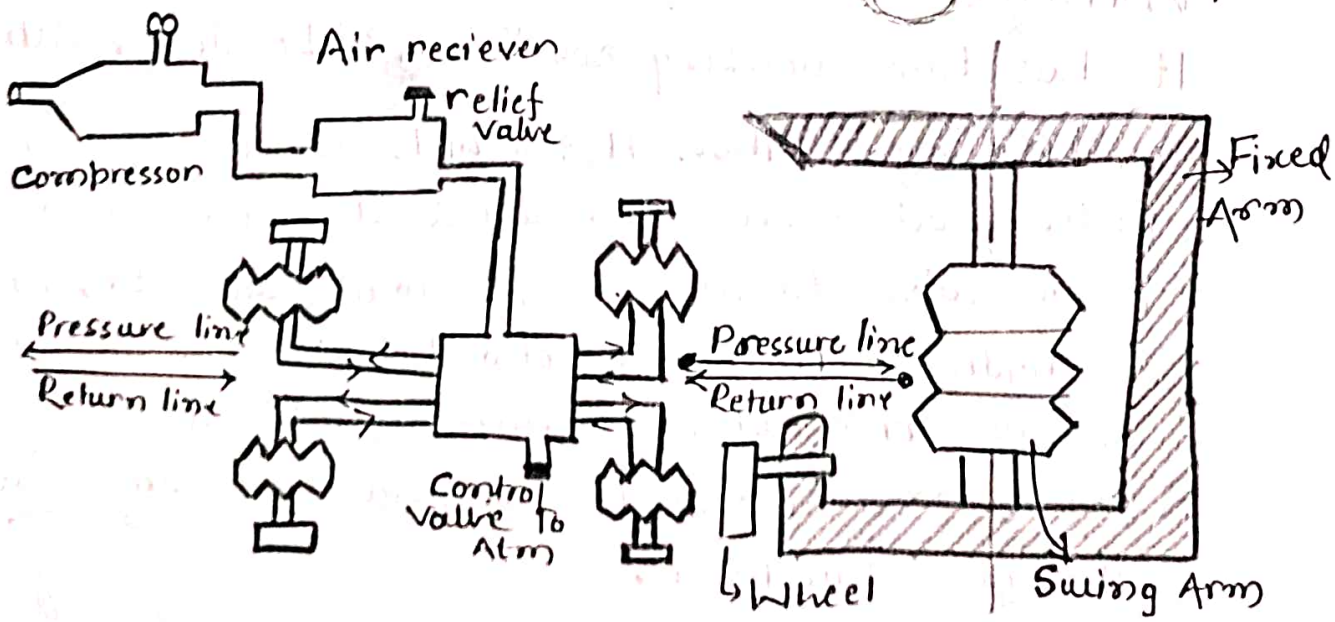
a). Loading :- When the vehicle encounters any shock piston rod moves downward this causes two way piston valve to also moves download this compresses the hydraulic liquid in chamber B due to which it pressure rises which causes the liquid of chamber B to rush into chamber A and reservoirs cylinder through chamber C.

• This causes the level of liquid in reservoir chamber to rise up which spotted by stopper but this causes the increment in pressure in reservoir cylinder and chamber A.

b). Unloading :- Now due to increment in pressure hydraulic liquid from chamber. A rushes into chamber B and from reservoir cylinder hydraulic oil also rushed into chamber B through chamber C. This rises the level of liquid in chamber B which moves the piston upward and shock absorber regains its position by damping the oscillation of spring.



Air Suspension System



Components of Air Suspension System

- Compressor

Compressor is attached to engine when engine runs compresses compresses the atmospheric air present in it.

- Air - Reservoir

It is a compressed air storage tank. The compressed air is from compressor is stored in this tank at a pressure of 20 kgf/cm². If the pressure of the air in the tank exceeds by this valve it is released by relief valve.

- Control Valve

Control valve controls the direction of air flow. It has two functions;

a). Supply the compressed air from reservoir to air bag through pressure line.

b). Rejects the excessive pressurised air in atmosphere through the return line.

- Air Bag

It is made of rubber whose one end is mounted on the fixed arm which is attached to the chassis and other end is attached to swing arm which is mounted on wheel axle.

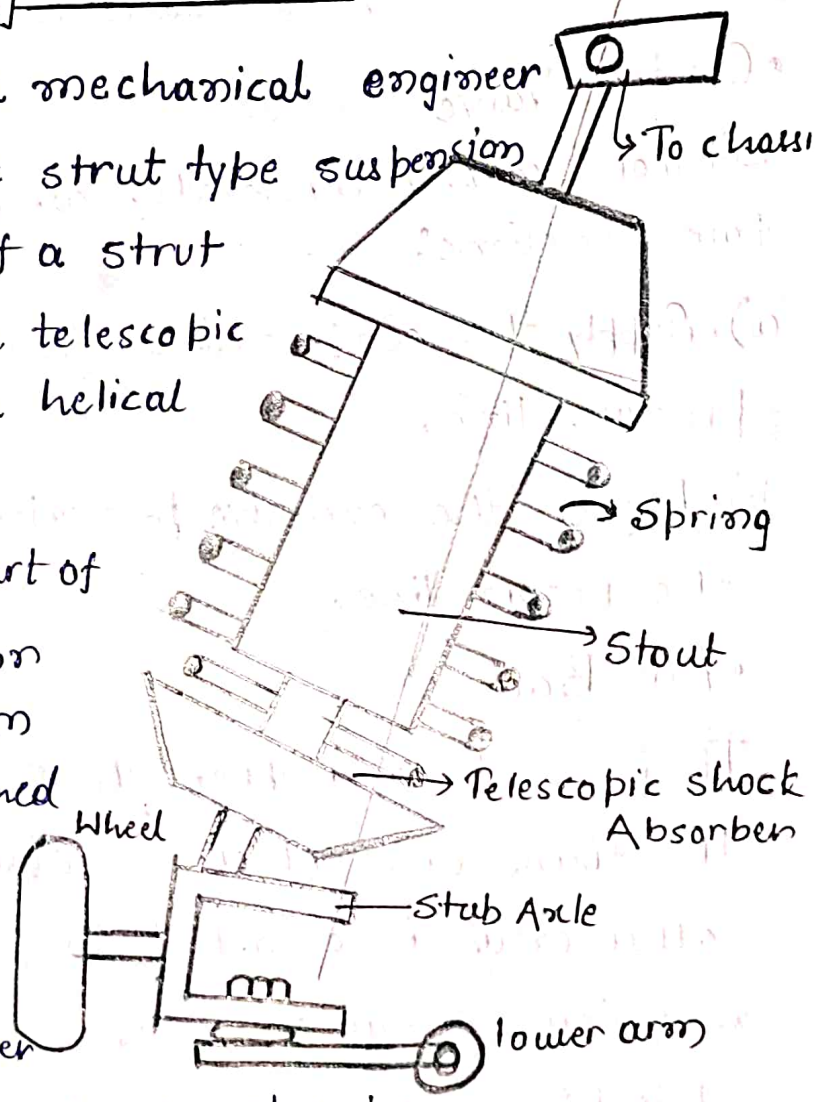
Working of Air Suspension System

- When vehicle encounters any jerk the wheel moves upward due to which swing arm deflects which compresses the air present in air bag due to which the pressure of air in bag exceeds beyond 20 kgf/cm².

- Due to this the return line valve opens and high pressured air is released from air bag to the atmosphere through return line till pressure reaches to 12 kgf/cm².
- Now the air from air storage tank rushes into air bag through pressure line due to which bag expands which swing the arm and wheel return to its original position.

Mac - Pherson System (Suspension system)

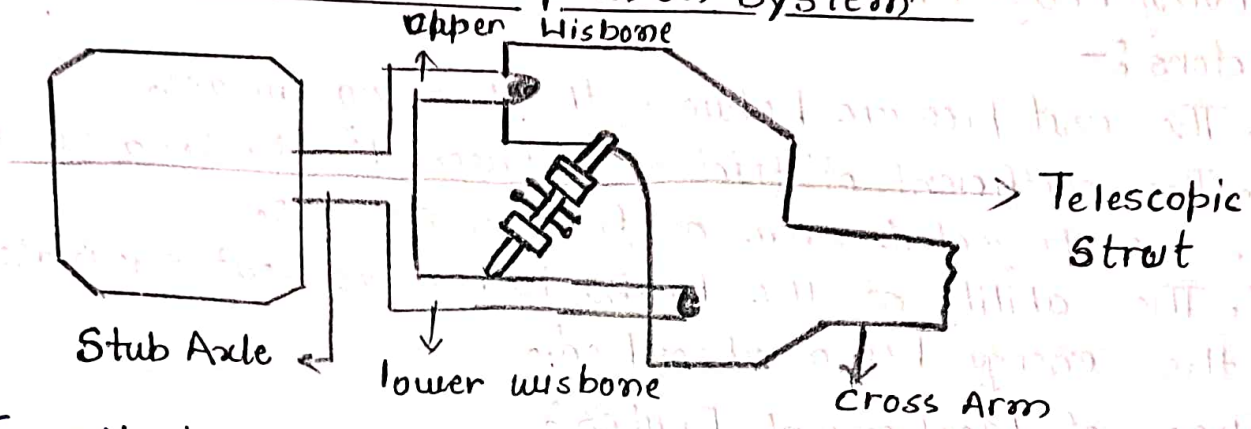
Mac-pherson is a mechanical engineer developed a telescopic strut type suspension system. It consist of a strut which is basically a telescopic shock absorber with helical coil spring.



- The top most part of strut is mounted on chassis while bottom most part is attached to stub-axle.
- Stub axle of wheel is mounted over lower arm which is hinged to the chassis.
- When vehicle encounters a jerks lower arm swings which cause the wheel to move upward and compress the spring, spring absorb the stock and starts oscillating which is damped by shock absorber.

• But it has a disadvantage that when lower are swings it disturb the camber angle of wheel which increases tyre wear and causes unstability in driving the vehicle.

Double Wisbone suspension System



To eliminate the problem of camber change in mac-pherson suspension system or to maintain constant camber angle slight modification is done in mac-pherson suspension system and the modified suspension System is called double wisbone suspension system.

• It consist of two arm called upper Wisbone and lower wisbone. Upper wisbone is shorter in length as compared to lower wisbone both wisbone is attached between stub axle and cross arm.

• At the cross arm wisbone is hinged and at the stub axle wisbone is fixed the spring with dampen is attached between cross arm and lower wisbone.

When vehicle encounter the jerk both arm swings and wheel moves upward. Spring absorb the jerk & starts oscillating which is damped by shock absorber. Due to swinging action of both arm the camber angle of wheel gets maintained. Cross arm is a rigid structure which also provide stability to vehicle when vehicle encounter jerk or shock.

Brake :

A brake is a device which is used to slow down or stop a moving body in the shortest posible time, by applying frictional resistance. The brake absorbs the kinetic energy of the moving body. The capacity of the brake depend upon many factors :-

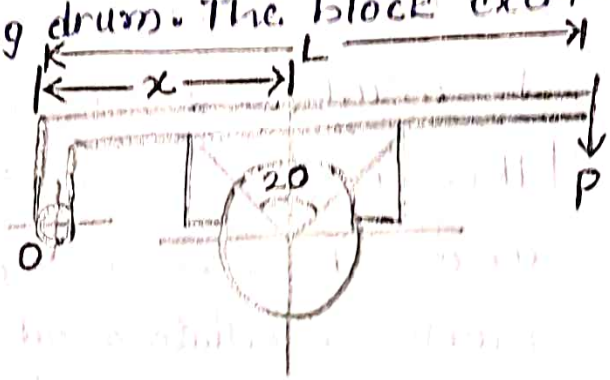
a). The unit pressure between the braking surface.
b). The coefficient of friction between the braking surface.
c). The projected area of friction surfaces.
d). The ability of the brake to remove heat equivalent to the energy being absorbed.

Types of Mechanical Brakes :

1. Block or Shoe Brake
2. Band Brake
3. Internal expanding shoe brake
4. Disc Brake.

Single Block or Shoe Brake

It consist of a block or shoe which is pressed against a rotating drum. The force on the drum is increased by using lever. The block is rigidly fixed to the lever. The force is applied at one end of the lever and the other end of the lever is pivoted on a fixed fulcrum O. When the force 'P' is applied at the lever end, the block is pressed the rotating drum. The block exert a radial force on the drum and the drum will act a normal reaction on the block or shoe. The block is made of a softer material than the rim of the wheel. This type of brake is commonly used on railway trains and tram cars.



Internal Expanding Shoe Brake

Construction:

Internal expanding shoe brake also known as drum brakes. An internal expanding brake consists of two shoes S1 & S2. The outer surface of the shoe is lined with some friction material to increase the coefficient of friction and to preven wearing away of the metal. Each shoe is pivoted at one end about a fixed fulcrum O_1 and O_2 and made to contact a cam at the other end.

Working:

When the brake is applied, the cam rotates, so that shoes are pushed outwards against the rim of the drum. The friction between the shoes and the drum produces the braking torque and hence reduces the speed of the drum. The shoes are normally held in off position by a spring. The drum encloses the entire mechanism to keep out dust and moisture. This types of brack commonly used in motor cars and trucks.

Disc Brake

The disc brake is a compact system and less effort is requires to stop the vehicle. A disc brake system works on Pascal's Law. It consists of master cylinder, disc, pistons, caliper, friction pad, break fluid, fluid reservoir. In disc brake a circular metal disc is used. The disc is attached to the wheel hub, hence wheel is rotating, the disc is rotated with the wheel. A number of holes is provided on the disc to remove the heat generating during braking.

Disc brake advantages :-

- Less braking time and braking distance.
- Heat generation is easily removed.
- Compact system.
- Less effort requires to stop vehicle.

Working

1. In running vehicle, when driver press the brake pedal, piston 1 presses the breaking fluid. Therefore pressure is generated into the system.
2. Hence fluid flows from master cylinder to cylinde 2 through the pipe line.
3. Due to break fluid pressure, piston 2 moves and presses the rotating disc from one side and caliper also presses the rotating disc from another side.
4. Hence due to the friction between the both friction pads and disc, the disc stops rotating, so the vehicle also stopped.
5. When the driver releases the breake padel, pressure on fluid is removed. Therefore piston and caliper come to their original position. Hence resulting breake getting released.

UNIT-5 SPECIAL PURPOSE VEHICLE

Those vehicles which are designed & manufactured to perform a specific or single particular task are called special purpose vehicles.

Advantages :-

- Increase the rate of work output as it performed the desired specific work in least possible time.
- Reduce the cost of operational work to be performed as compared with general purpose vehicle.
- By avoiding the human contact with operations we elimainate the hazardous effect.
- Complete the task in planned way thus increases the quality standard of work.

Classifications :-

- Earth moving vehicles :-

Those vehicles which are designed & manufactured for the purpose of excavating and moving the earthen materials like clay, sand, gravels etc.

Examples; Motor grader, Bulldozer, Dumpers.

- Constructional vehicles :-

Those vehicles which are used during constructional work are called constructional vehicles.

Example; Cement concrete mixture, Drill rig, Road Rollers.

- Material handling vehicles :-

Those vehicles which are used for lifting & transferring material from one location to another.

Example ; Crane, cargo etc.

• Agricultural vehicles :-
Those vehicles which are used during agricultural activity like ploughing, cropping, irrigation, harvesting.
Example ; Tractor, Harvestor, seed sawing vehicles.

TRACTOR

A tractor is an automobile vehicle specifically designed to deliver a high tractive effort (or torque) at slow speeds, for the purpose of hauling a trailer or machinery such as that used in agriculture, mining or construction.

- Most commonly, the term is used to describe a farm vehicle that provides the power and traction to machanize agricultural tasks, especially (and originally) tillage and now many more.
- Agricultural implements may be towed behind or mounted on the tractor.
- It is basically of two types :-

a). Track type tractors;
- In this type of tractors, instead of wheels; one track is fitted on either side. This track gets drive from the sprocket run by rear axie shaft.
- To steer the tractor, there is not steering gear fitted. The tractor, is steered by applying brakes to one side of the track with the other track moving. These are used for bulldozing or land clearing work.

b). Wheel type tractor;
These are most commonly used agricultural tractor, they can run fast & wheel types absorb a certain amount of field shocks also.

These can be further devided as:

1. Two wheel tractors :- These tractors are used for small farms, hilly area and gardening purposes and are called power tillers.
2. Three wheel tractor :- These tractors were very popular 15 years back but now its place has been taken by four wheel tractors. These tractors had single wheel fitted at the front end in the centre and were considered good for negotiable shorter turns.
3. Four wheel tractor :- These are most commonly used tractors in the contrary, These are also known as all purpose tractors. On the basis of available power, these have been classified as,

   i). Small Tractors - 15 to 25 hp.
   ii). Medium Tractors - 25 to 45 hp.
   iii). Large Tractors - more than 45 hp.

MOTOR GRADER

- Motor grader are motor vehicles equipped with a long front frame on which work equipment such as blade and scarifier are mounted.
- Motor graders are construction machines basically designed for construction and maintainance of road pavement.

Functions of Motor Grader :-

- Land Grading :- Land grading is the operation carried out to reshape the land by cutting, filling and smoothing to a designed continuous surface grade.

- Snow Removal :- In polar countries during winter season when climatic condition are extreme cold snow gets deposited over surface is removed.
- Scarifying :- The process of breaking the earthen materio is called scarifying. The scarifier is attached to break up ground surfaces. which is too hard to penetrate by blade.

Motor graders with a scarifier enable the removal of the top layer of previously wrecked pavements damaged by heavy traffic is then spreading / resurfacing it with a new layer of either gravel, aggregates or asphalt and polishing it up.

- Mixing :- The blade of the grader is available for mixing up road constrction materials by its rolling function.
- Spreading :- Motor grader with the help of its blade spreads out the deposited earthen material through out the pavent uniformly.
- Ditching :- Motor grader removed the earth heapee up under the chassis before it reaches the bottom of the machine.

Structural Features

The work equipment like blade and scarifier are provided forward the operator's seat. All power train components, including transmission, are arranged under or behind the operator's compartment.

- Blades :- The blade which is the main work equipment of motor grader is mounted under the frame at the middle of the wheel of the wheel base between front and rear axis.

Scarifying :- The scarifier is used for breaking hard ground prior to cutting of ground surface with the blade. The scarifier lifting cylinder is mounted on the front side of the frams.

Loader bucket :- It is used to carry/lift the earthen material & transfer it to desired location. It is mounted on the front portion by replacing the scarifier.

Main Frame :- It is used to support the loader bucket & scarifier.

Traction Frame :- It is used to support & cry the blade.

CAB :- It is the cabin where operator sits and all the driving / controlling arrangement are equipped.

Engine Assembly :- It is placed at rear portion of the vehicle, it is the power house of vehicle. It has two tank one is fuel tank and other is hydraulic tank.

Ripper Assembly :- Ripper is used to plough the land. It placed at rear side of vehicle just behind the engine.

EXCAVATOR

An excavator is an earth-moving equipment used for digging trenches and earth surface and lifting away soil and other materials.

Types of Excavator :-

- Crawler mounted excavator :- As the name suggests, crawlers provide mobility to the crawler-mounted excavators. The crawler mounted excavators are known for carrying out heavy works in terrain regions. Although the crawler mounted excavators have a low speed, they can work effectively on wet/soft soils, sharp rocks, or any adverse conditions, moreover, crawler-mounted excavators have a very small turning radius.

It is preferable to shift the crawler-mounted excavators from one site to the other on trailers only.

Truck-mounted Excavator:- This excavator is mounted on a truck chassis. A truck-mounted excavator can move with ease at high speed on the road. It has two separate engines and cabs for the excavator and truck chassis. This excavator requires more operating space & firm ground to function optimally.

Self-propelled Excavator:- These excavators have rubber tires and can move without external propulsion at a speed of 10-30 km per hour. The self-propelled evaporator has one engine and a cab.

Barge/Rail Excavator:- The excavators mounted on a barge or a rail are used for excavation works near the railway lines or in water.