LECTURE NOTES

ON

AUTOMOBILE ENGINEERING

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UNIT-01 INTRODUCTION AND TRANSMISSION SYSTEM

Introduction

→ Automobile is a vehicle that is capable of propelling itself.

→ An automobile is a self propell vehicle which is used for transportation of passengers and goods on the ground.

Automobile Engineering

It is a branch of engineering in which we study all about the automobiles and have practice to propell them.

Note:-

→ The other names of automobiles are auto, autocar, car, motor, motor car, motor vehicle and motor coach, motor wagons etc.

Needs of automobiles

→ Automobiles are needed for every one in this world. People use this for transportation purpose and several other reasons like treading of goods, service from one place to another place.

→ But most common reason for massive use of vehicle is the transportation of passengers from one place to another place.

Classification of Automobiles

Automobile can be classified into several types based on several criteria.

① Based on the purpose

ⓐ Passengers Vehicles

ex- bus, cars, passenger trains etc.

ⓑ Goods vehicles

ex- Trucks, Tractors etc.

② According to the capacity
   ⓐ Light vehicles or Light motor vehicle (LMV)
      ex - car, motor cycle, scooter
   ⓑ Heavy motor vehicle (HMV)
      ex - Bus, tractors, cars etc.

③ According to the fuel used
   ⓐ petrol vehicle
      ex - motorcycle, cars, scooter
   ⓑ Diesel vehicle
      ex - Truck, Bus, cars etc
   ⓒ Electric Cab
      ex - electric vehicle, Battery vehicle, fork lift etc.
   ⓓ steam carriages
      ex - steam road roller, steam wagon
   ⓔ Gas vehicle
      ex - CNG vehicle

④ According to the number of wheels
   ⓐ 2-wheeler vehicles
      ex - Motor cycle
           scooter
   ⓑ 3-wheeler vehicles
      ex - Tempo, road roller etc
   ⓒ 4-wheeler vehicles
      ex - Car, Jeeps
   ⓓ 6-wheel vehicles
      ex - trucks, tankers
   ⓔ 8-wheeler vehicles
      ex - Rocket transport vehicle
           car transport vehicle

⑤ According to the drive of vehicle

ⓐ single wheel drive vehicle
ex- scooty, Bike etc.

ⓑ Two wheel drive vehicle
ex. - cars

ⓒ four wheel drive vehicle
ex- Bolero

ⓓ six wheel drive vehicle
ex- military transport service

Specification of Automobiles

① Type - cars
trucks
Buses
motor cycle

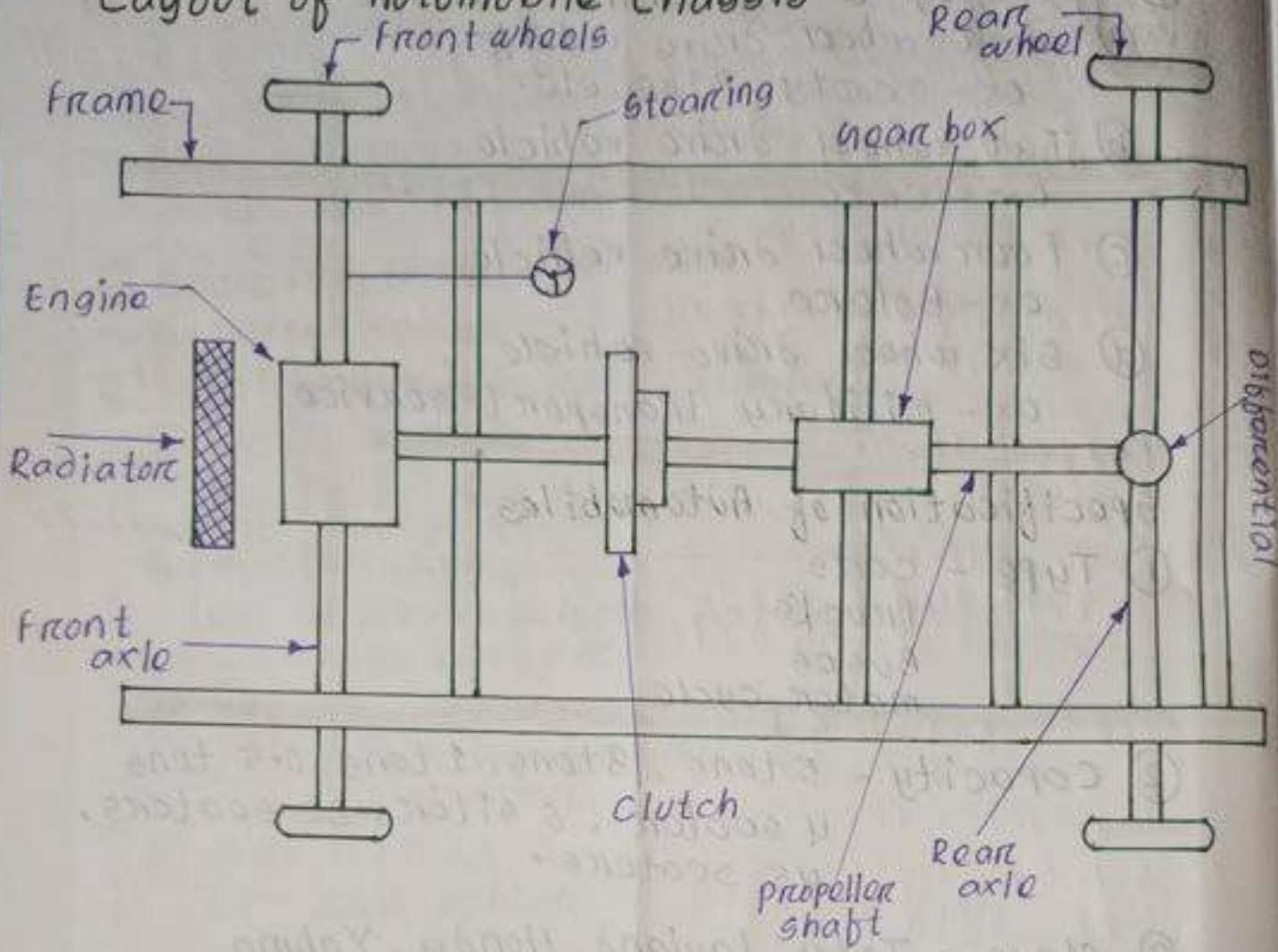
② Capacity - 5 tons, 3 tons, 1 tons, 0.5 tons
4 seater, 6 siter, 30 seaters,
45 seaters.

③ Make - Tata, Layland, Honda, Yahma

④ Drive - Left hand drive
right hand drive
single wheel drive
two wheel drive
four wheel drive
six wheel drive

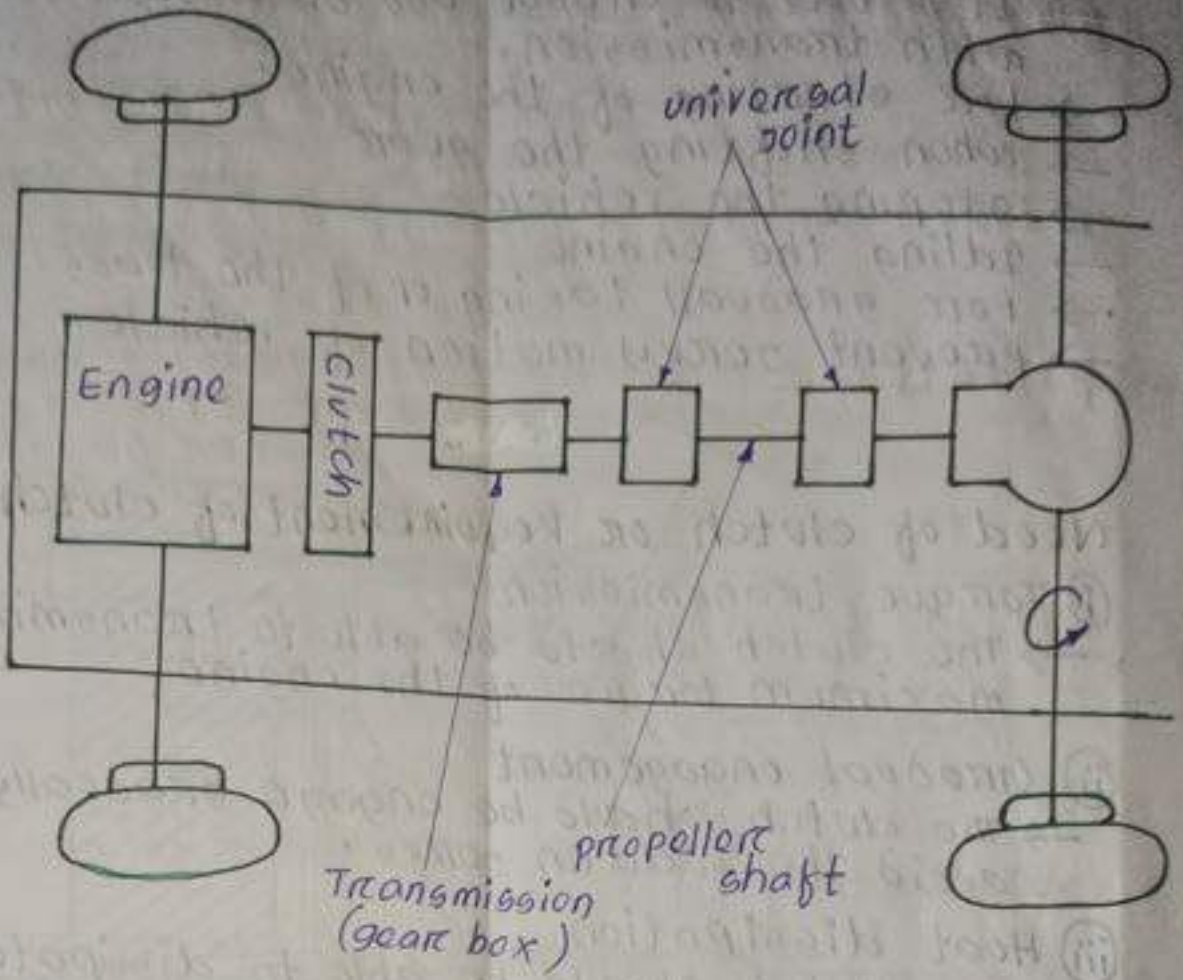
⑤ Model - Nisan Altima
Mazda MX-5
Toyota

Layout of Automobile Chassis



1. Frame
2. Radiator
3. Front axle
4. Front wheel
5. Engine
6. steering
7. Clutch
8. Gear Box
9. Driving shaft
10. propeller shaft
11. Differential
12. Rear axle
13. wheel

Clutch System



→ Clutch is a device used in the transmission system of motor vehicle to engage and disengage the engine to the transmission (gear box).

→ The clutch is located in between the engine and the transmission.

→ When the clutch is engaged the power flows from the engine to the rear wheels through the transmission system and the vehicle moves.

→ when the clutch is disengaged the power is not transmitted to the rear wheels and the vehicle stops, but the engine is still running.

→ The clutch is disengaged when starting the engine, when shifting the gears, when steping the vehicles and when idling the engine.

→ The clutch is engaged only when the vehicle is to move and is get engaged when the vehicle is moving.

Function of clutch

→ It is used to engage and disengage the engine with transmission.
→ For starting of the engine.
→ When shifting the gears
→ Stoping the vehicle.
→ Idling the engine
→ For gradual taking up of the loads.
→ Prevent jerky motion of vehicle.

Need of clutch or Requirement of clutch

(i) Torque transmission
→ The clutch should be able to transmit maximum torque of the engine.

(ii) Gradual engagement
→ The clutch should be engage gradually to avoid the sudden jerks.

(iii) Heat dissipation
→ The clutch should be able to dissipate large amount of heat which is generated during the clutch operation due to friction.

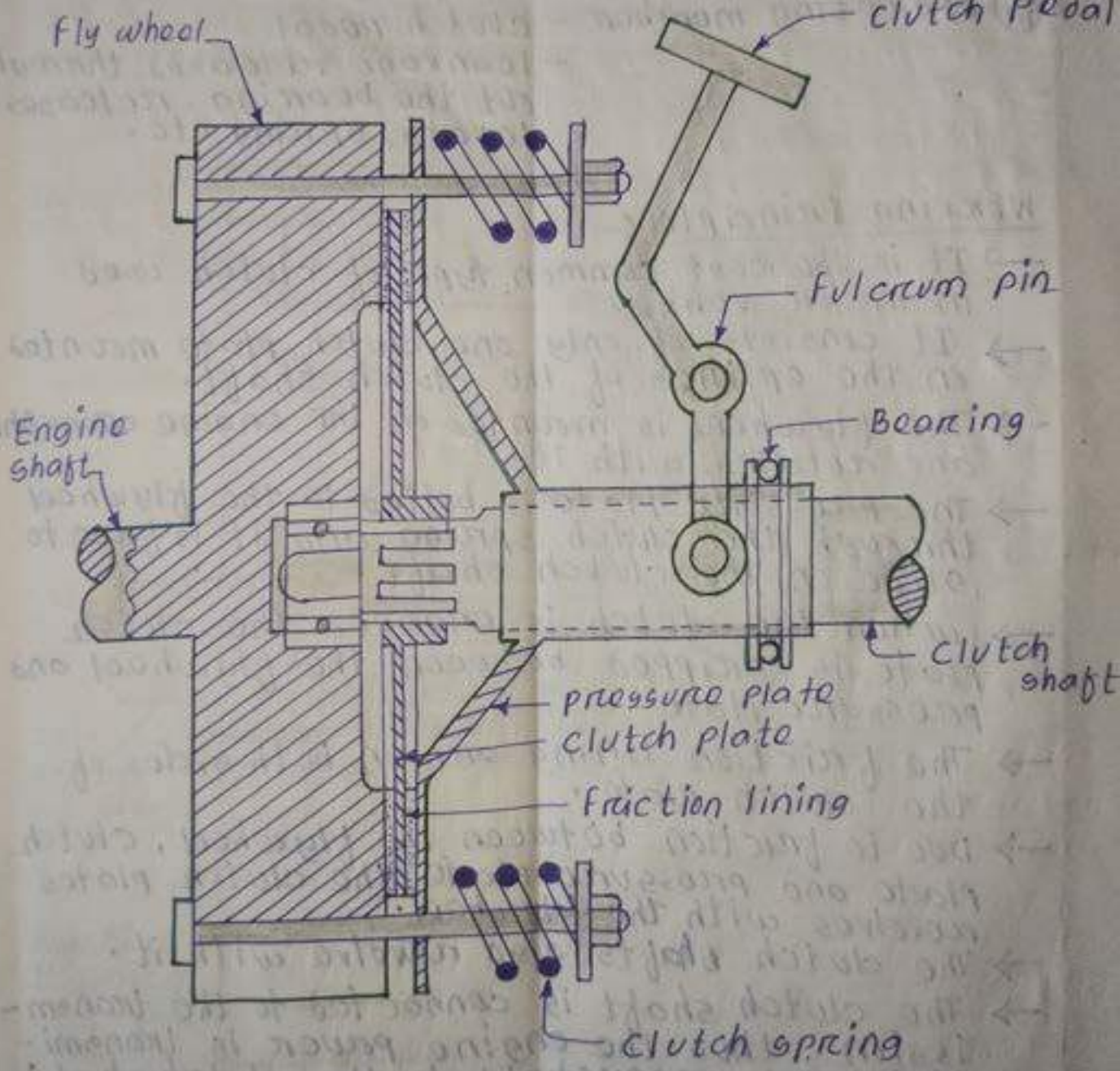
Types of clutch

Different types of clutches are there as follows

1. Friction clutch
   - (a) single plate clutch
   - (b) multiplate clutch
2. Centrifugal clutch
3. Semi-centrifugal clutch
4. Conical spring clutch or Diaphragm clutch
5. Positive clutch
6. Hydraulic clutch
7. Electromagnetic clutch

⑧ Vaccume clutch
⑨ Over running clutch or free wheel unit clutch.

- Single Plate clutch



Parts :-

(i) Driving member - flywheel. pressure plate / driving disc
- connecting to crankshaft of engine

(ii) Driven member - clutchplate
- free to slide on spindle clutch shaft.

(iii) operating member - clutch pedal
- leankage released through out the bearing. releases levers, spring etc.

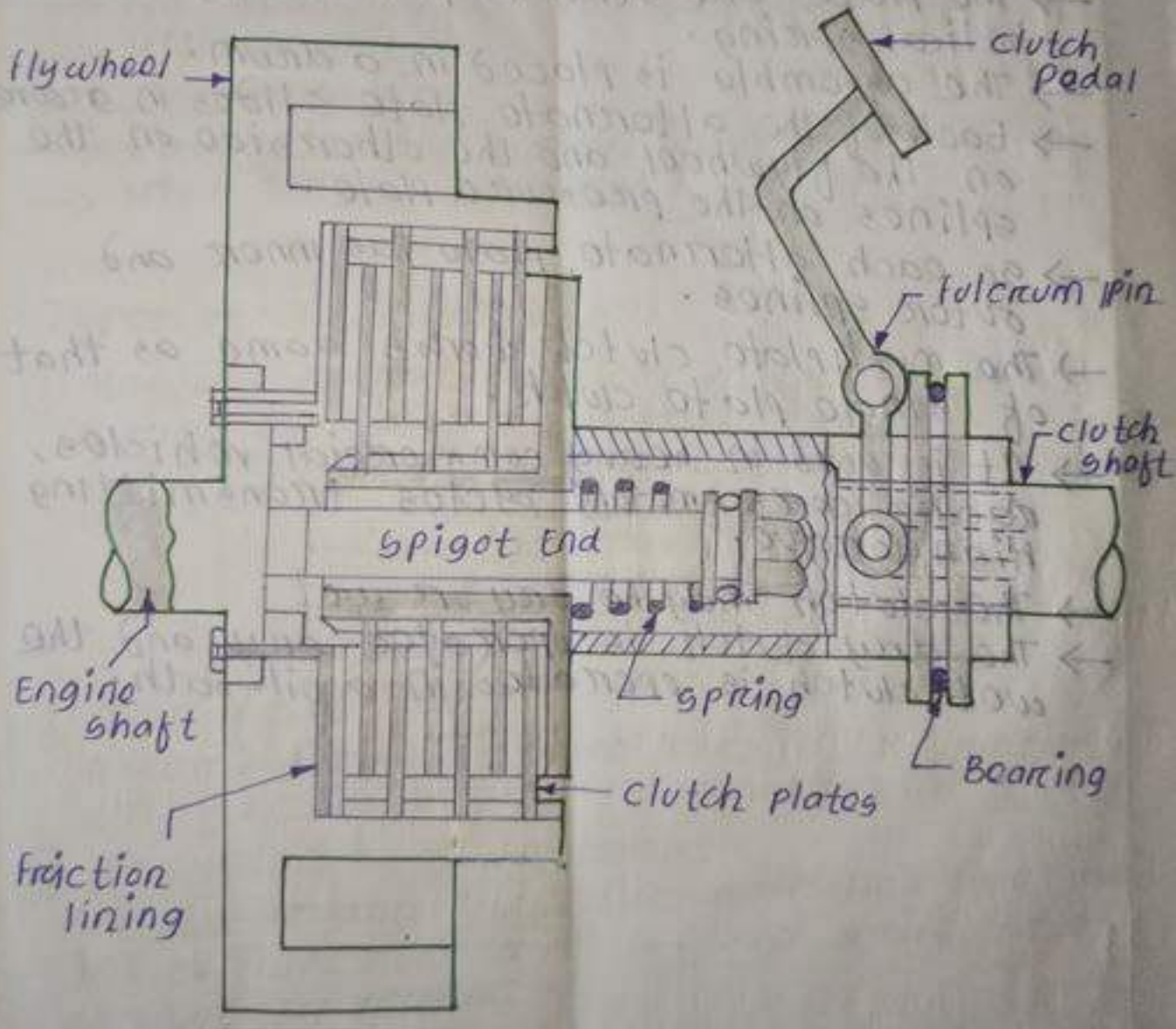
Working Principle :-

→ It is the most common type of clutch used in motor vehicle.
→ It consists of only one clutch plate mounted on the splines of the clutch shaft.
→ The flywheel is mounted on the engine crankshaft and rotates with it.
→ The pressure plate is bolted to the flywheel through the clutch spring and it is free to slide on the clutch shaft.
→ when the clutch is engaged the clutch plate is gripped between the flywheel and pressure plate.
→ The friction lining are on both sides of the clutch plate.
→ Due to friction between the flywheel, clutch plate and pressure plate the clutch plates revolves with the flywheel.
→ The clutch shafts also revolve with it.
→ The clutch shaft is connected to the transmission. thus the engine power is transmitted from crankshaft to the clutch shaft.
→ when the clutch pedal is pressed, the pressure plate moves back against the force of spring. this makes the clutch plate free between the flywheel and pressure plate.

→ So the flywheel rotates as the crankshaft rotates, but clutch shaft speed reduces slowly and finally it stop rotating

→ when the clutch paddle is pressed, the clutch is said to be disengaged, otherwise it remain engaged due to spring force.

- Multiplate clutch



Working principle :-

→ Multiplate clutch uses no of clutch plate as friction element.
→ As the number of clutch plates are increased the friction surface also increases
→ The increased number of surface of friction increases the capacity of the clutch to transmit torque.
→ The plates are alternately fitted to the engine shaft and gear box shaft.
→ The plates are strongly pressed by strong helical spring.
→ The assembly is placed in a drum.
→ Each of the alternate plate slides in grooves on the flywheel and the otherside on the splines on the pressure plate.
→ So each alternate plate has inner and outer splines.
→ The multiplate clutch works same as that of single plate clutch.
→ It is used in heavy commercial vehicles, racing cars, motor cycles transmitting high torque.
→ The clutch may be dry or wet.
→ The dry clutch is operated dry and the wet clutch is operated in a oil-bath.

Gear Box

→ It is a set of gears arranged in such a manner to transmit the torque
→ The set is placed in a box, so it is called the gear box.
→ It is located in between the clutch and the propellor shaft.

Needs of gear box (Purpose of gear box)

→ For starting the vehicle from rest.
→ Hill climbing.
→ Accelerating
→ Retrading the motion of vehicle.
→ High torque required.

Types of Transmission

① Manually operated selective transmission
A type used in cars, buses and trucks. It is also known as standard and stickshift. It is of three types.
→ constant mesh
→ sliding mesh
→ synchromesh

② over drive
A semi-automatic type used in conjuction with of selective transmission.

③ chrysler semi-automatic
An electic and hydraulic controlled type used in conjunction with a fluid drive or a torque converter.

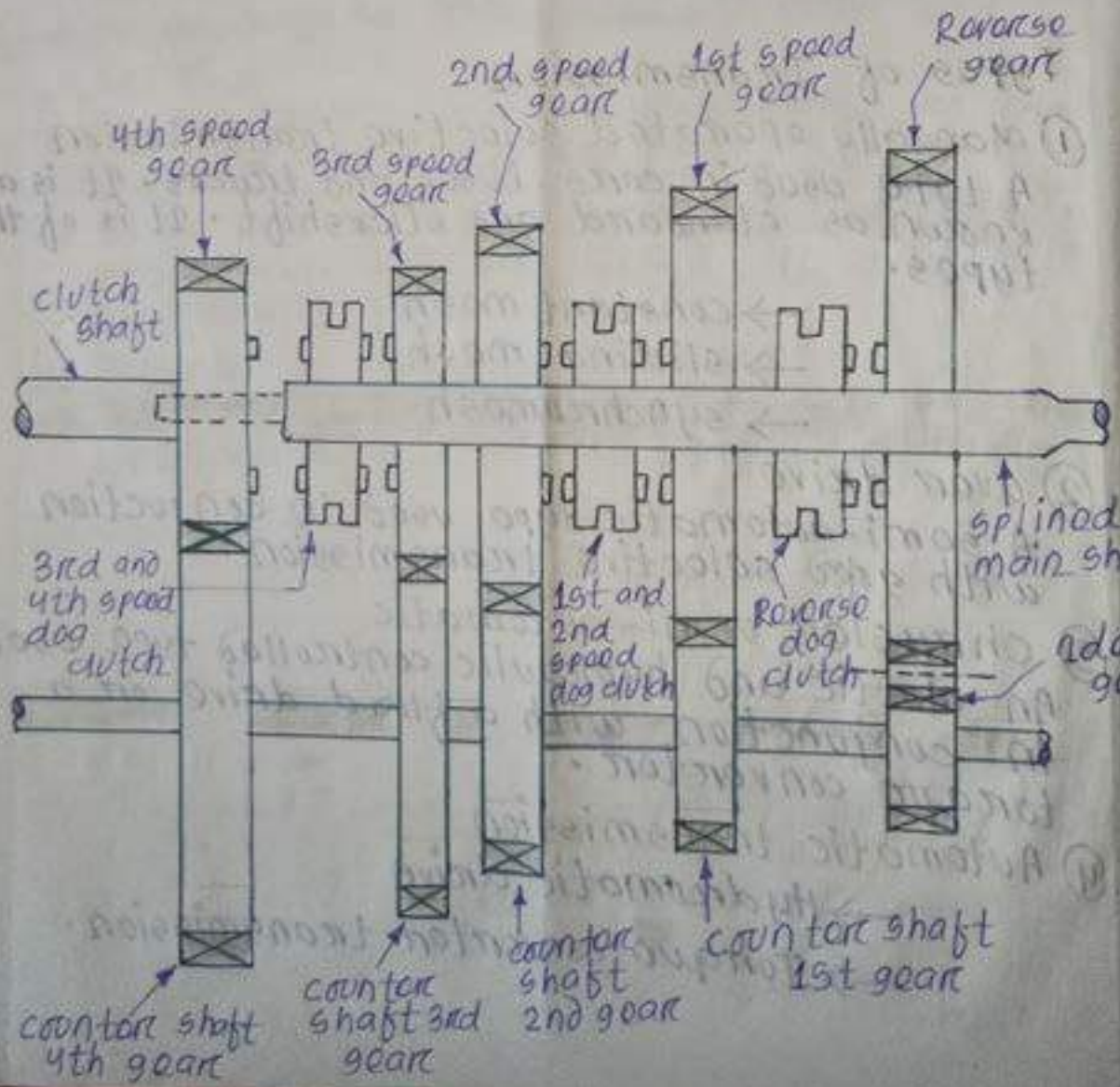
④ Automatic transmission
→ Hydromatic drive
→ Torque converter transmission.

⑤ According to speed
→ 2 speed
→ 3 speed
→ 4 speed
→ 5 speed
→ 6 speed

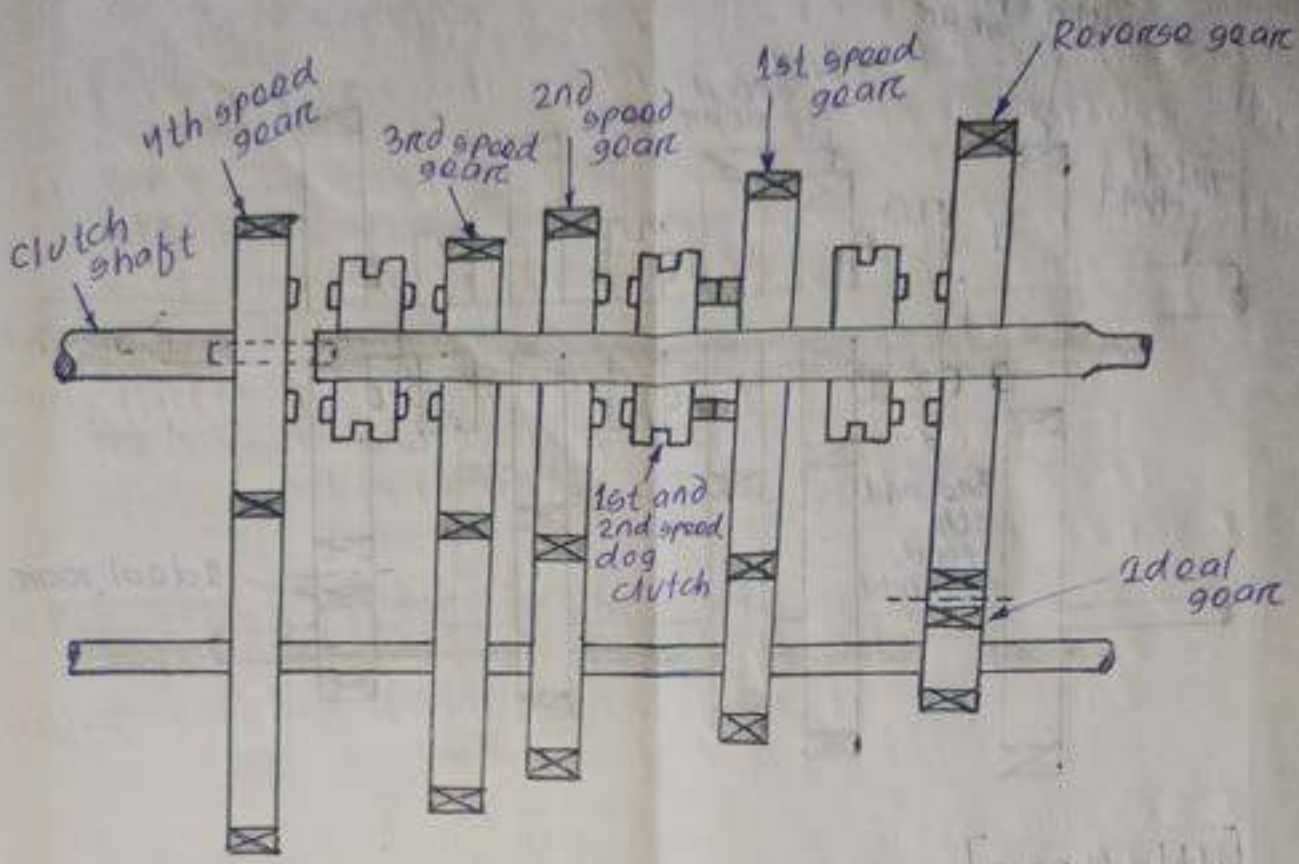
4-Speed Gear Box

• Diagram

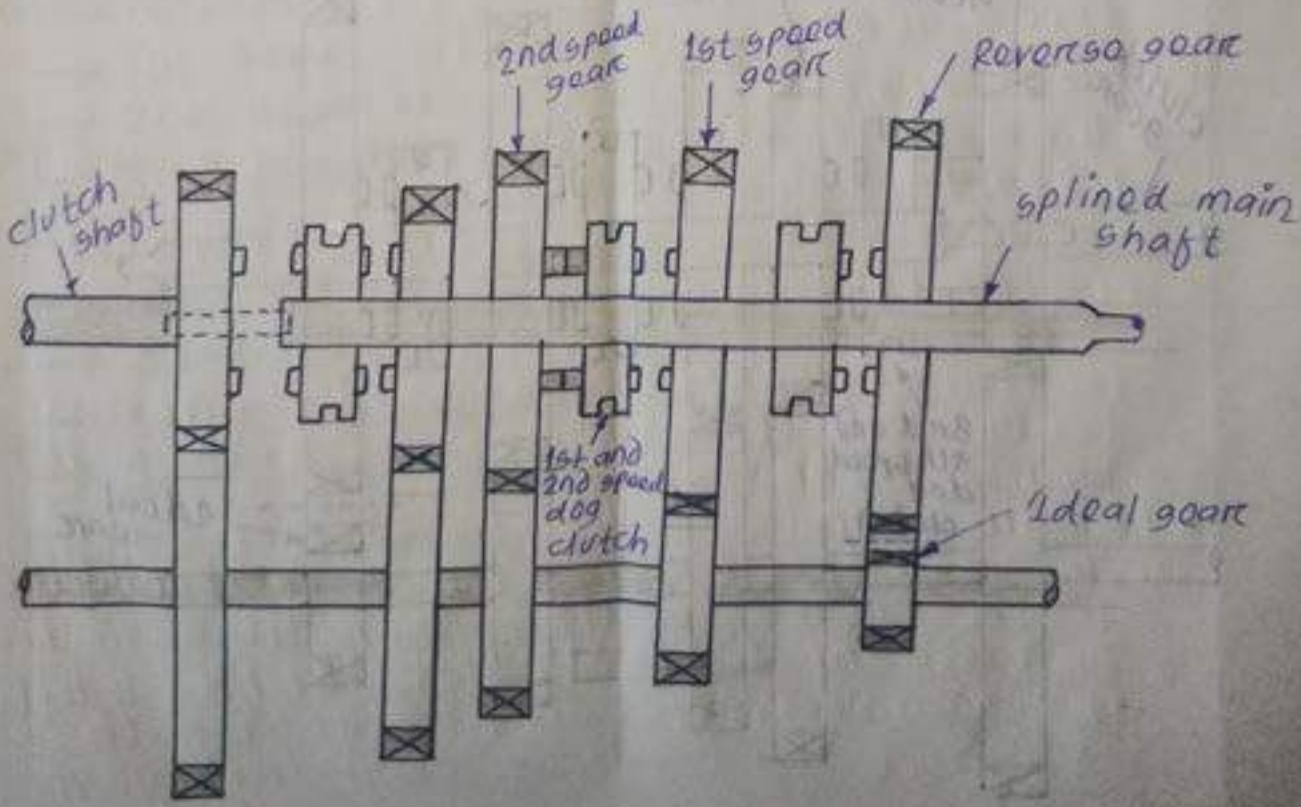
[Neutral Position]



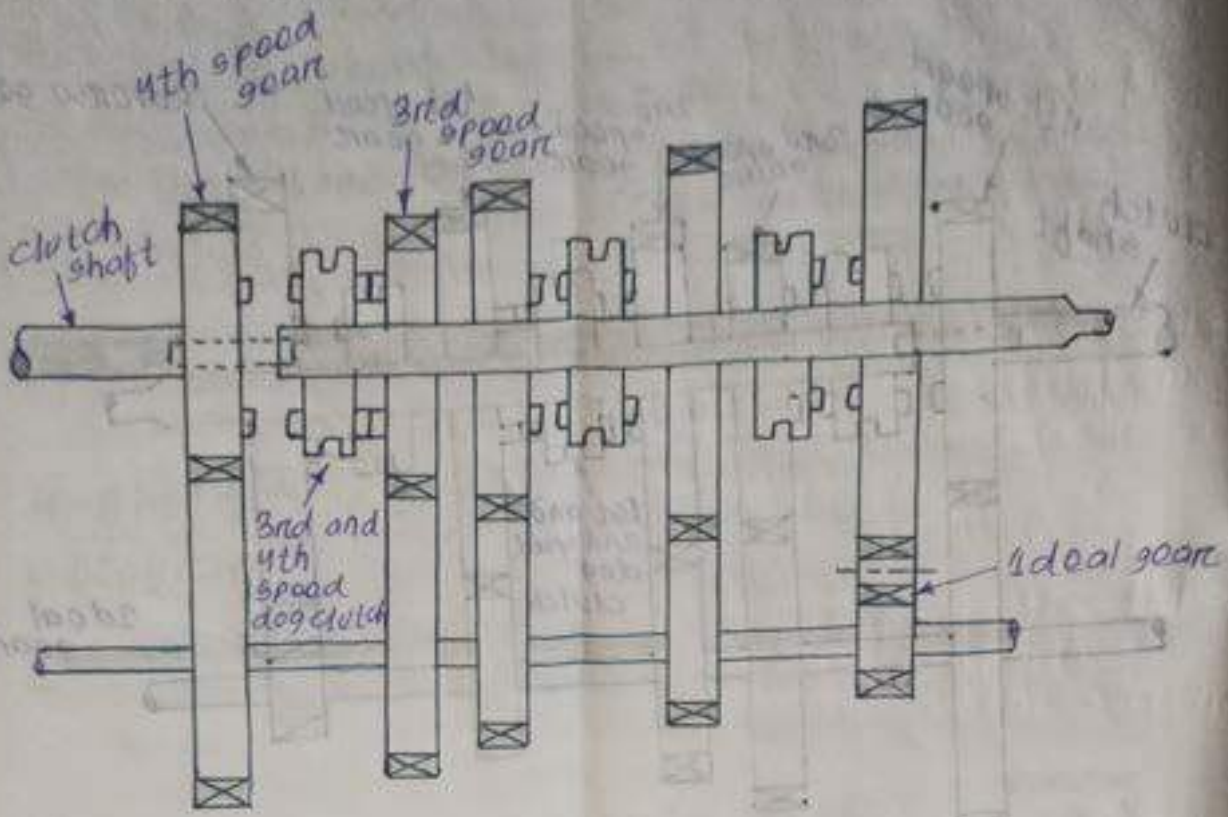
[First Gear]



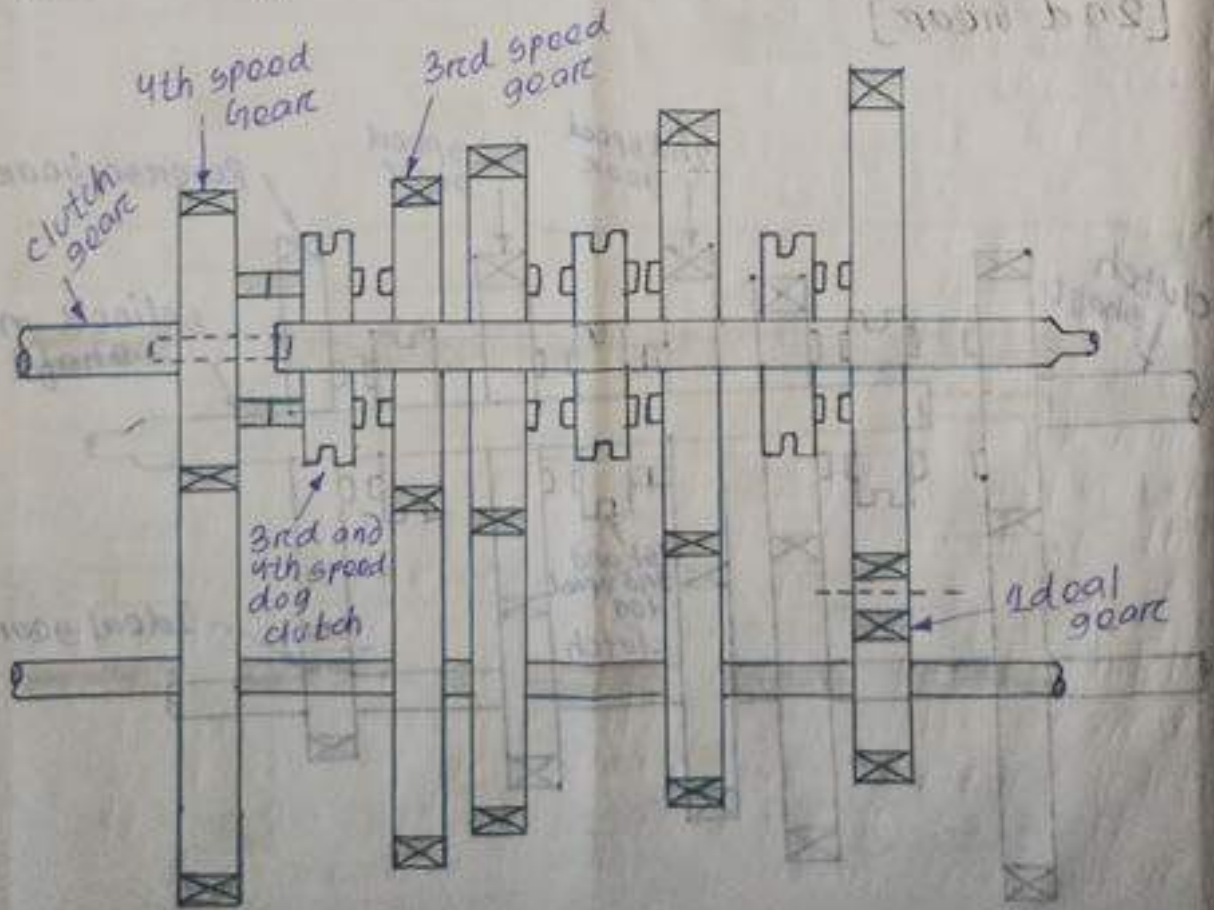
[2nd Gear]



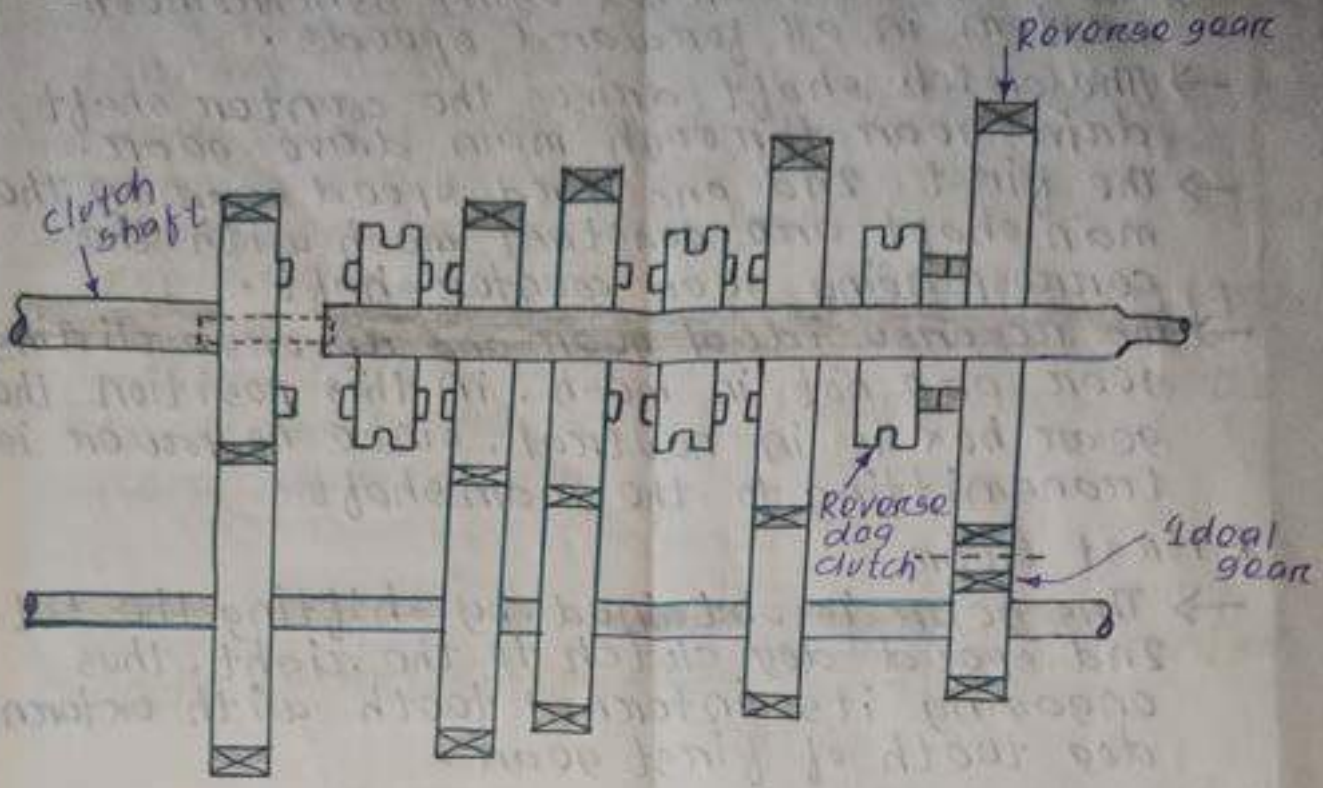
[3rd Gear]



[4th Gear]



[Reverse Gear]



Ports :-

→ Neutral
→ 1st Gear
→ 2nd Gear
→ 3rd Gear
→ 4th Gear
→ Ideal Gear
→ Clutch shaft
→ Splined main shaft
→ Counter shaft
→ Dog clutches

Working :-

* Neutral position

→ In 4-speed gear box using synchromesh system in all forward speeds.

→ The clutch shaft drives the counter shaft drive gear through main drive gear.

→ The first, 2nd and third speed gear on the main shaft are constant mesh with the corresponding gear counter shaft.

→ The reverse ideal gear and reverse sliding gear are not in mesh. in this position the gear box is in neutral, since no power is transmitting to the mainshaft.

* First Gear

→ This gear is obtained by shifting the 1st and 2nd speed dog clutch to the right, thus engaging its internal tooth with external dog tooth of first gear.

* Second Gear

→ To obtain this gear, at first 1st and 2nd speed dog clutch brought to neutral and then moved to left, thus engage its internal tooth with external dog tooth of the second speed gear.

* Third Gear

→ In order to obtain this gear, at first the 1-2 speed dog clutch is first shifted out of mesh from second gear and brought to neutral position.

→ Then the 3-4 speed dog clutch is then moved to the right, thus engaging its internal tooth with the external dog tooth of the third speed gear.

* Fourth gear

→ The 3-4 speed dog clutch is first shifted to the neutral position.

→ Then the 3-4 speed dog clutch shifted to left thus engaging its internal tooth with external dog teeth of main drive gear.

* Reverse gear

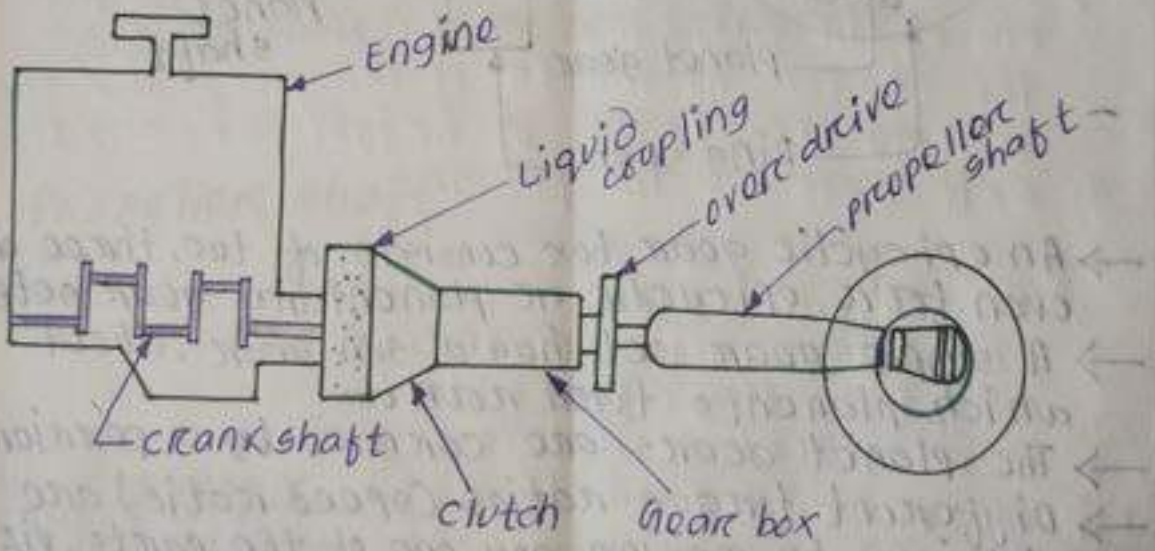
→ The above figure shows that layout of gears transmitting power in reverse gear.

→ This gear is obtained at first bringing the vehicle to the rest position.

→ The gear box is then brought to the neutral position.

→ After this reverse dog clutch moved to the right, thus engaging its internal gear teeth with the external dog teeth of the reverse gear.

Concept of Automatic Gear changing mechanism



→ Automatic transmission operate basically by controling vehicle speed and engine load.

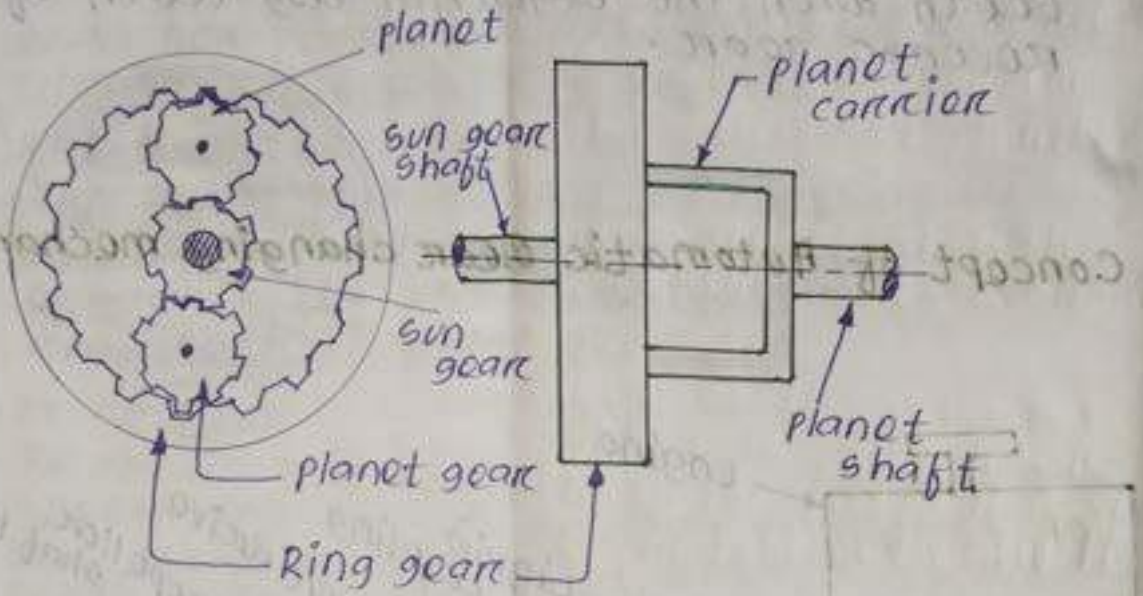
→ Increasing vehicle speed needs changing gears upwards, whereas increasing engine load necessitate change from higher to lower gears.

→ For the speed factor a sensitive control unit (mechanical, electrical, hydraulic) is driven off a suitable point beyond transmission and thus its control action becomes sensitive to vehicle speed.

→ The engine load factor is introduced by the position of the accelerator pedal. Thus the engine load sensitive control unit is operated by the depression of accelerator pedal.

→ The most commonly type of automatic transmission uses hydraulic power to shift gears.

Epicyclic Gear Box



→ An epicyclic gear box consists of two, three or even four epicyclic or planentary gear sets.

→ A simple gear set has a sun gear, about which planents turn round.

→ The planet gears are carried by a carrier

→ Different torque ratios (speed ratio) are obtained by making any one of the parts, viz. the sun gear, the planets and the annulus stationary.

→ Similarly by locking two parts with each other, a solid drive i.e direct gear is obtained.

There may be six possible speeds, four of which are forward and two reverse.

(i) forward, fast output speed - This is obtained when planet carrier is driving, ring is driven and the sun gear held stationary.

(ii) forward, very fast output - This is obtained when planet is driving, sun gear is driven and the ring gear is held stationary.

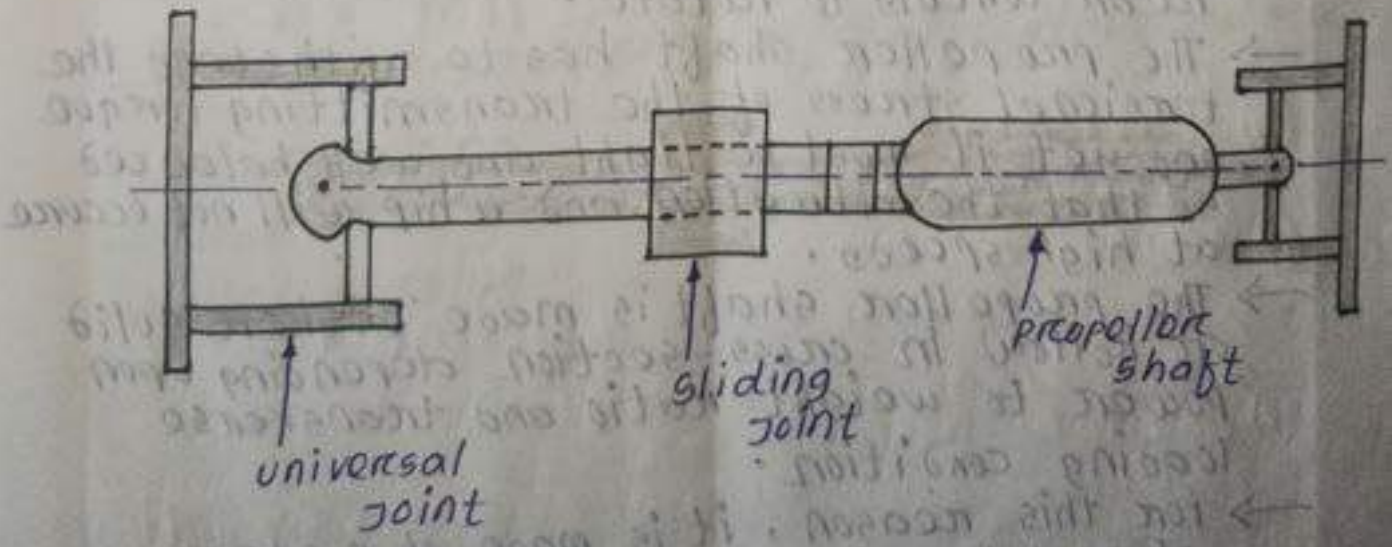
(iii) forward, slow output speed - with ring gear driving, planet carries driven and the sun gear stationary, this comes about.

(iv) forward, very slow output speed - This results when the sun gear is driving, planet carrier driven and the ring gear is stationary.

(v) Reverse, slow output speed - This is obtained when the sun gear is driving, the ring gear is driven and the planet carriers stationary.

(vi) Reverse, fast output speed - This condition is obtained with the ring gear driving, sun gear driven and the planet carrier stationary.

Propeller shaft



Function of propellor shaft

→ The propellor shaft is a driving shaft that connects the transmission to the differential.
→ It transmits power from the gear box to the wheel through differential.
→ It is generally located along axis of the vehicle.
→ The output shaft or main shaft from the transmission and pinion shaft extending from the differential unit are connected to the propellor shaft and the universal joint.
→ A sliding joint is also used between the propellor shaft and the universal joint near the gear box.
→ There are two universal joints at both ends of the propellor shaft and to transmit power at an angle.
→ A slip joint is provided at the gear box end of the propellor shaft to compensate the change in length of the propellor shaft during the change in height between the axle axis and the frame.

→ The rotary motion of the transmission main shaft is carried out through the propellor shaft to the differential, causing the rear wheels to rotate.
→ The propellor shaft has to withstand the torsional stress of the transmitting torque and yet it must be light and well balanced so that the vibration and whip will not occure at high speeds.
→ The propellor shaft is made either solid or hollow in cross-section depending upon power to weight ratio and transverse loading condition.
→ for this reason, it is made of a strong steel tube.
→ Solid propellor shafts are also used.

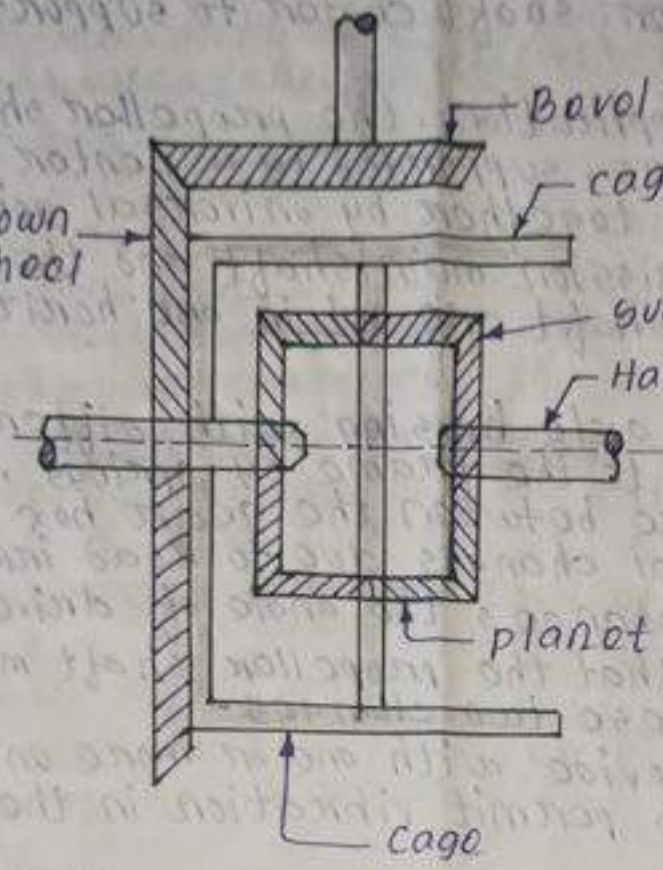
→ The propellor shaft may be exposed to the atmosphere or protected by an outer tube.
→ some application including bearings at or near the propellor shaft center to support the shaft.
→ on some application, the propellor shaft is in two sections, supported by a center bearing and coupled together by universal joint.
→ The transmission main shaft and the differential pinion shaft are not in one horizontal level.
→ The rear axle housing with differential is attached to the frame by springs, therefore the distance between the gear box and the differential changes due to road irregularities
→ This also changes the angle of drive.
→ In order that the propellor shaft must take curve of these two changes -:
  (i) It is provide with one or more universal joint to permit vibration in the angle of drive.
  (ii) It must be provide with a sliding joint that permits the effective length of the propellor shaft to change.

Materials for propellor shaft
→ Low carbon steel with 10-18 % of Cr and 5-8 % Ni
→ Aqua alloy - chromium nickel stainless steel.

Manufacturing
→ Hot rolling.
→ Hot forging.

Differential

Construction :-



(i) Sun gear
→ It is mounted on inner end of rear axle.

(ii) Ring gear
→ It is also called crown gear and it is attached to the cage so that cage rotates with crown gear.

(iii) Bevel pinion
→ It drives the crown gear.

(iv) Planet pinion
→ They are also called differential pinion.
→ They rotates in a shaft and in mesh with two sun gear.

(v) Cage
→ It houses differential assembly consisting of sun and planet gear.

→ It is free to rotate on the left rear axle.

Power Transmission steps

Propellor shaft

↓

Bevel pinion

↓

crown gear or ring gear

↓

cage

↓

planet gear

↓

Sun gear

↓

Half shaft (Left and right)

↓

Rear wheels

Working Principle

→ when bevel pinion rotates through the power of propellor shaft, it drives the crown gear.

→ As cage attached with the crown gear so it rotates with sun gear.

→ When the differential cage is rotated with the planet gears were also rotate and run arround the sun gear.

→ In this manner a planet pinion provide rotary motion to sun gear causing wheels to rotate.

→ Therefore one rear wheel turns more rapidly than other, while car is taking a turn.

→ The planet gears spin on its shaft transmitting more rotary motion to one rear wheel than to the other.

→ when the vehicle is running in a straight line the crown wheel differential cage, planet gears and sun gears, all turns as a unit.
→ In this case the planet pinion do not rotate on its shaft.

Types of Differential

There are following types of differential

(i) open Differential (OD)
(ii) Limited slip Differential (LSD)
(iii) Locking Differential (Locker) is able to lock the two drive wheels on an axle together.
(iv) spool is an open differential in which the axles have been mechanically fastened together.

UNIT-02 BRAKING SYSTEM

Function of Brake

There are two main functions of the brooking system are

→ To stop or slow down the vehicle in shortest possible distance in emergencies.

→ To control the vehicle to be retained when descending a hill.

Definition :-

A brake is one of the most important controls of the vehicle. This is a combination of some interactive parts. It absorbs energy from the moving parts and slow down the vehicle with the help of friction.

Classification of Brakes

The automobile brakes are classified according to the different bases as follows:

① With respect to the application
   - ⓐ Hand operated
   - ⓑ foot operated

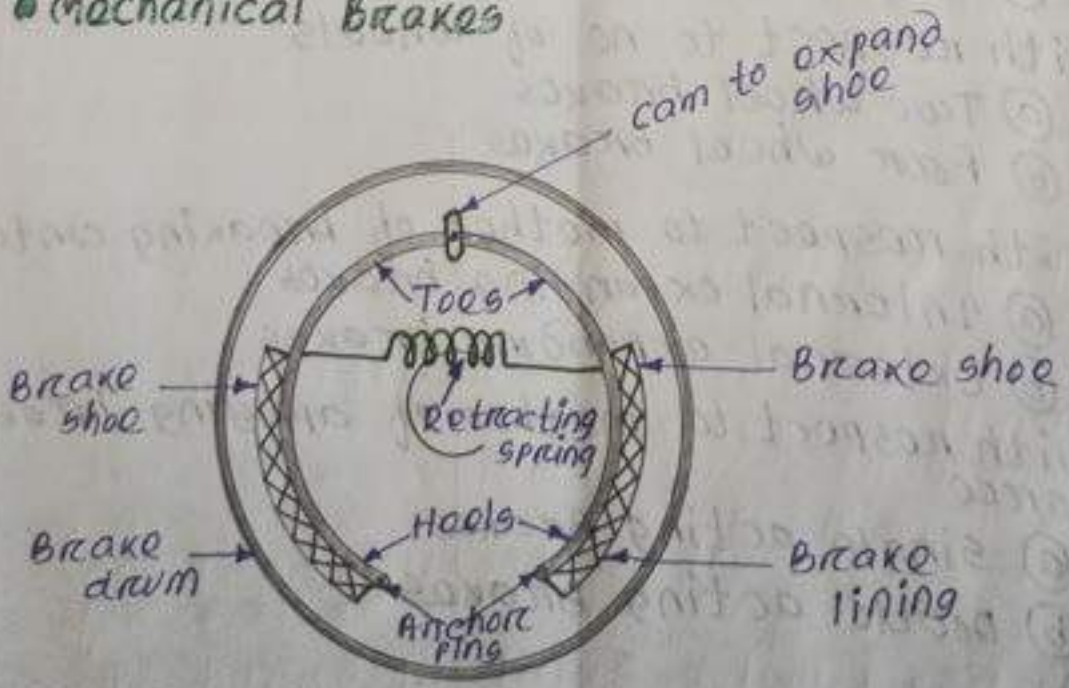
② With respect to no. of wheels
   - ⓐ Two wheel brakes
   - ⓑ Four wheel brakes

③ With respect to method of breaking contact
   - ⓐ Internal expanding brakes
   - ⓑ External expanding brakes

④ with respect to method of applying brake force
   - ⓐ single acting Brakes
   - ⓑ Double acting Brakes

⑤ with respect to Brake gear
   ⓐ Mechanical Brakes
   ⓑ Power Brakes
⑥ with respect to nature of power employed
   ⓐ Vacuum Brakes
   ⓑ Air Brakes
   ⓒ Hydraulic Brakes
   ⓓ Hydrostatic Brakes
   ⓔ Electric Brakes
⑦ with respect to power transmission
   ⓐ Direct acting brakes
   ⓑ Geared Brakes
⑧ with respect to power unit
   ⓐ cylinder Brakes
   ⓑ Diaphragm Brakes

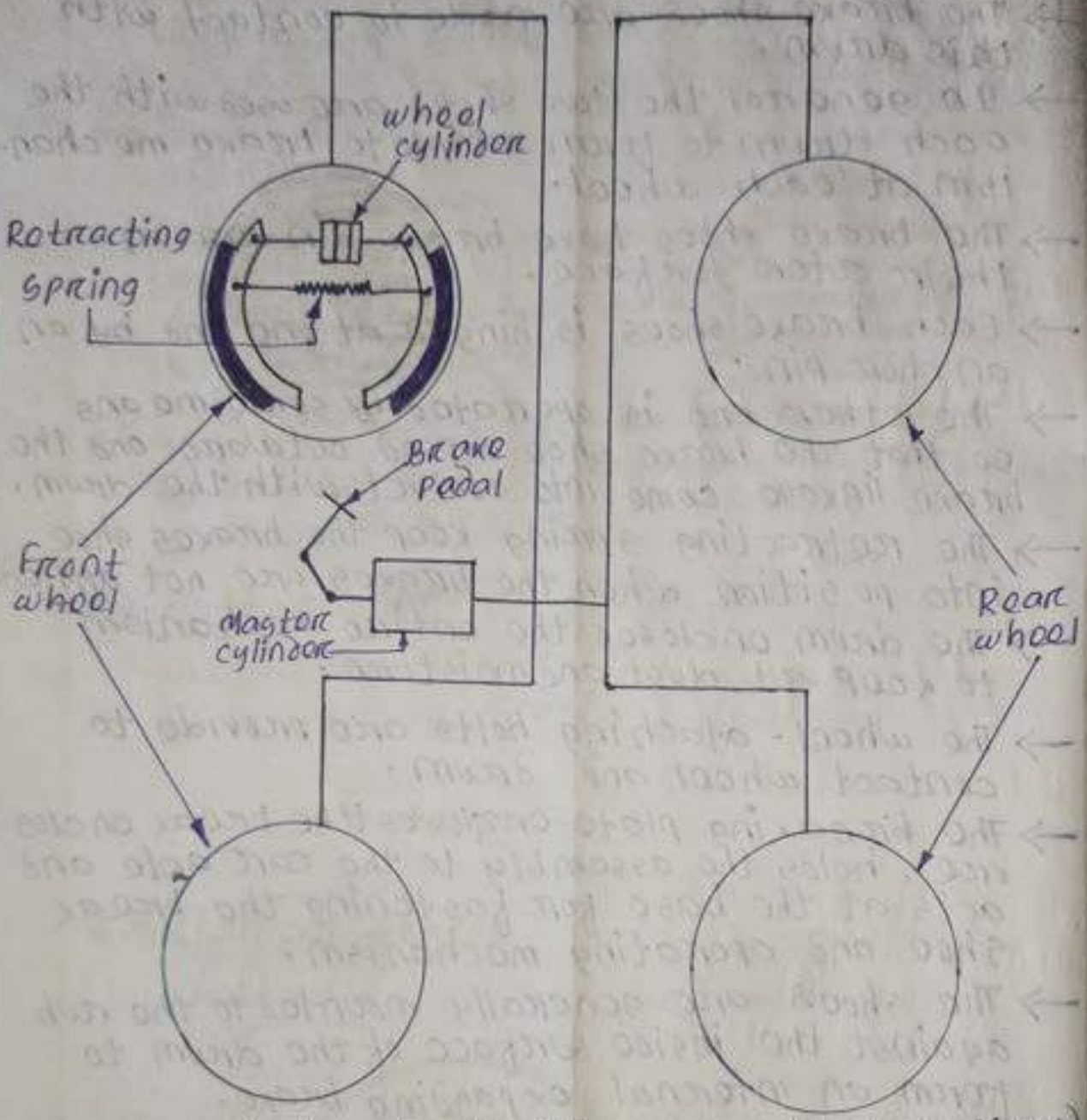
• Mechanical Brakes



→ In a motor vehicle the wheel is attached to an auxilary wheel called drum.
→ The brake shoes are made to contact with this drum.
→ In general the two shoes are used with the each drum to form complete to brake mechanism at each wheel.
→ The brake shoes have brake linkage on their outer surface.
→ Each brake shoes is hinged at one end by an anchor pin.
→ The other end is operated by some means so that the brake shoe expand outward and the brake linkage come into contact with the drum.
→ The retracting spring keep the brakes shoe into position when the brakes are not applied
→ The drum encloses the entire mechanism to keep out dust and moisture.
→ The wheel-atached bolts are provide to contact wheel and drum.
→ The breaking plate complete the break enclosure, holds the assembly to the cart axle and acts at the base for fastening the break shoe and operating mechanism.
→ The shoes are generally mounted to the rub against the inside surface of the drum to form an internal expanding brake.

→ when the padle is pressed, the cam turns by means of the break linkage.
→ when the cam turns, the shoe expands outward against the drum.
→ The brake lining rub against the drum and thus stop the motion.
→ The entire mechanical linkage between the brake padle and the shoes operates to transmit the padle force to the brake shoes.

Hydraulic Brake



→ The hydraulic Brakes are applied by liquid pressure.

→ The pedal force is transmitted to the brake shoe by means of the confined liquid through a system of force transmission.

→ The force applied to the pedal is multiplied and transmitted to all the brakes by a force of transmission system.

→ The hydraulic brake system based on the pascle principle.

Construction :-

→ It consists of two main components.
- master cylinder
- wheel cylinder

→ The master cylinder is connected by tubing to the wheel cylinder at each of four wheels.

→ The system is filled with the liquid under light pressure, when the brakes are not in operation.

→ The liquid is known as brake fluid.

→ It is a mixture of glycerone and alcohol or castor oil and some additives.

→ Each wheel brake consists of a cylinder brake drum which is mounted on the inner side of the wheel and revolves with it.

→ The brake shoes which are mounted inside the brake drum do not rotate.

→ The brake shoes are fitted with a heat and wear resisting brake lining on their surface.

→ The brake pedal is connected to the master cylinder by means of a piston rod.

Working :-

→ when the driver presses the pedal, the piston is forced into the master cylinder, this increasing the pressure of fluid in the master cylinder and in the entire system.

→ The pressure is conducted instantaneously to the wheel cylinders on which the four brakes where it forces the wheel cylinder piston outwards.

→ The piston force the brake shoes act against the brake drum so the brakes are applied.

→ when the driver release the brakes pedal the master cylinder piston returns to its original position due to return of spring pressure, which causes drop in fluid pressure in the entire system to its original value.

→ This allow retracting spring on wheel brakes to pull the brake shoes out of contact with the brake drums in to their original position.

→ This causes the wheel cylinder piston to come back to their original inward position so the brakes are released.

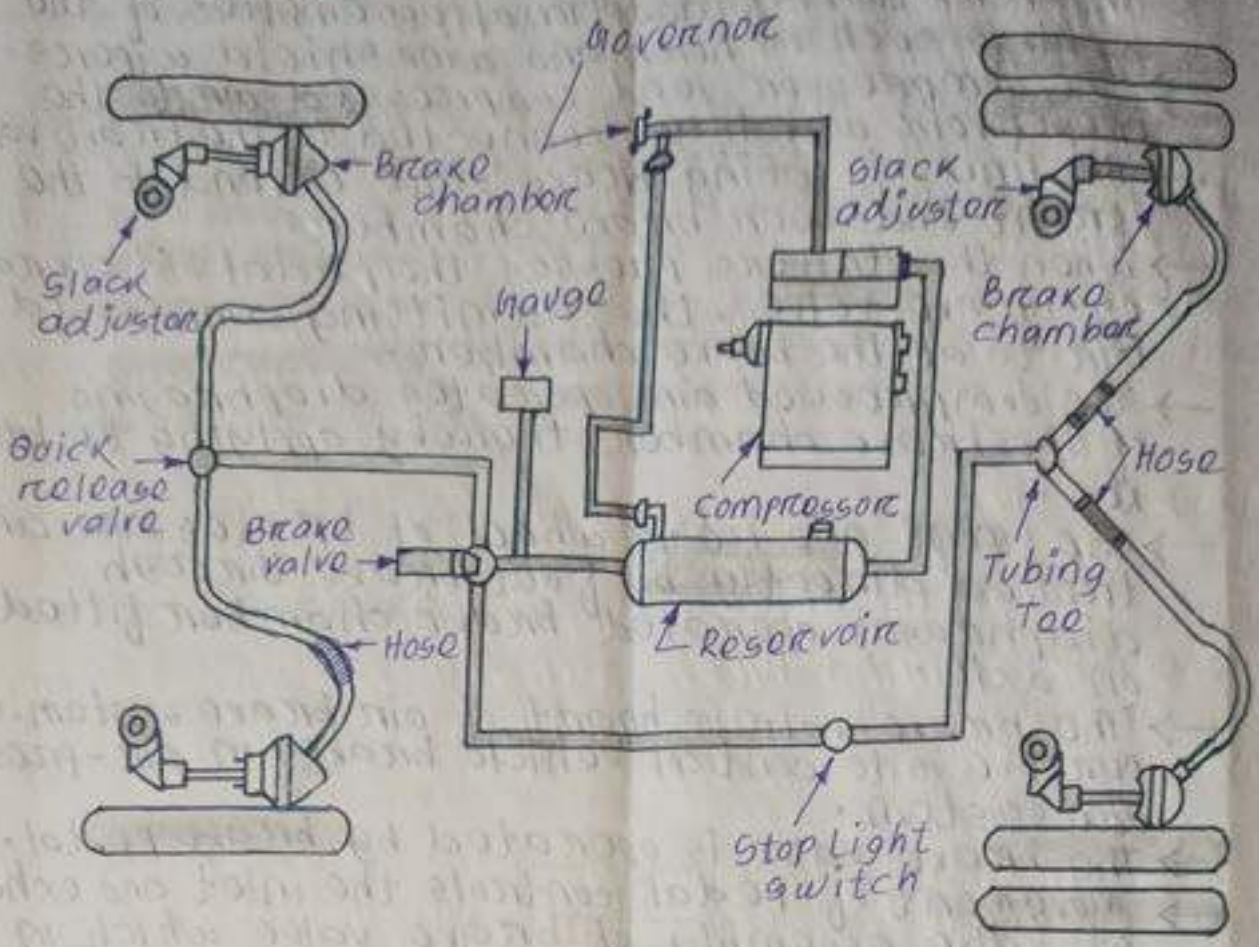
Advantages :-

→ Simple in construction.
→ Equal Breaking effect for all four wheels.
→ Increased breaking effort.
→ Self compensating system.
→ Low wear rates.
→ Flexibility braking lines.
→ High mechanical advantage.

Disadvantages :-

→ The braking system fails, if there is any leakage in brake lines
→ The brake shoes are liable to get ruined if the brake fluid leaks out.

Air Brakes



Construction :-

→ Air brakes consists of an air compressor, a brake valve, series of brake chamber, un-load valve, a pressure gauge and a safety valve. Those are all connected by line of tubing.

→ The other breaking system may have additional components such as stop-light switch, a low pressure indicator, an air supply valve to supply air for tyre inflation, a quick release valve to release air quickly from the front brake chamber when the pedal is released a limiting valve for limiting the maximum pressure in the front brake chamber and a relay valve to help in quick admission and released of air from rear brake chamber.

→ The compressor, governor, pressure gauge, safety valve and reservoir constitute the compressing and control units and other of them are application unit.

→ The compressed air available in vehicle is used in operation of additional assemblies of the vehicle such as horn and wind shield wipers.
→ The compressor send compressed air to the reservoir which are connected to the brake valve
→ The lines of tubing brake valve extend to the front and rear brake chamber.
→ when the drivers presses the pedal, it operates brake valve, thus admitting compressed air to all the brake chamber.
→ The compressed air operates diaphragms of the brake chamber thereby applying the brakes.
→ The front and rear wheel of brakes are controlled directly by foot brake through diaphragm operated brake chamber fitted on axle.
→ The brake valve is heart of air brake system. Its purpose is to control vehicle brakes in air-pressure system.
→ The brake valve is operated by brake pedal.
→ Movement of pedal controls the inlet and exhaust valve assembly of brake valve which in turn regulates air pressure in brake chamber vehicle.

Working :-
→ when the pedal is pressed, compressed air passes through the valve and pressure developed in brake chamber applied brakes.
→ The valve is automatically adjust the pressure in proportion to degree of pedal movement so that further pedal is depressed the greater breaking force in chamber until the point is reached where full reservoir pressure is developed to apply the brakes.
→ In addition to provide precise control of breaking pressure during application and release, the valve imparts a relative reaction to movement of the pedal so that driver can sense the degree of brake application.

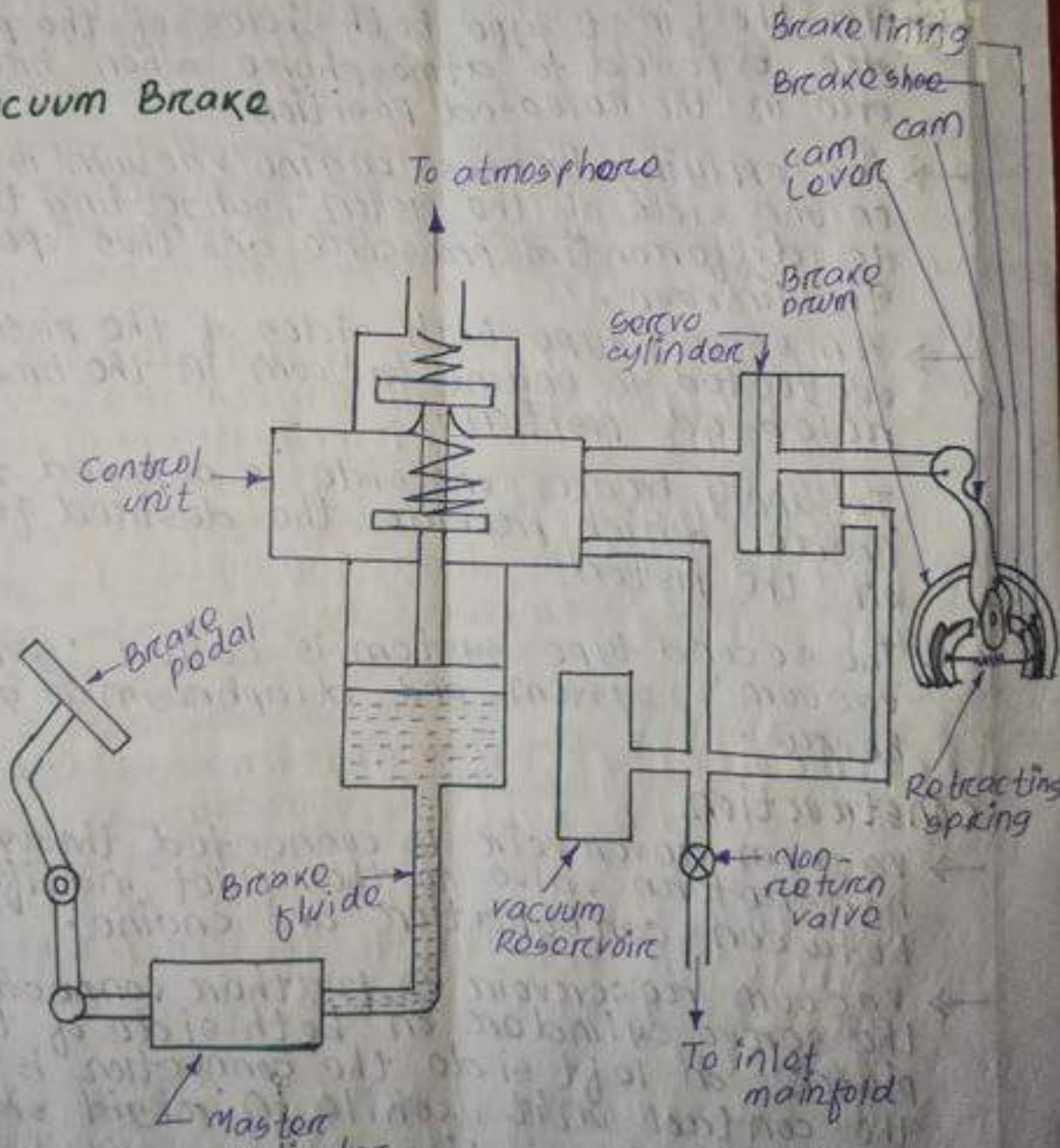
Advantages :-

→ More power than ordinary mechanical and hydraulic brakes and so that used in heavy vehicle.

→ Air brake simplify chasis design. It does not matter where component of system located on chasis so that they inter connect with pipe lines.

→ Apart from braking compressed air used for tyre inflation, wind screen wiper, horns and other accessories.

● Vacuum Brake



→ In vacuum brake Brake, the suction from engine inlet manifold is utilized for brake application.

→ There are two types of vacuum servo brakes, both incorporating a piston for a diaphragm operating in a cylinder and provided with suitable linkage for brake application.

→ A small vacuum reservoir is also there to provide enough vacuum for several brake applications even after the engine has stopped.

→ In the first type both sides of the piston are exposed to atmosphere when brakes are in the released position.

For applying brakes, engine vacuum is applied on one side of the piston, subjecting the same to differential pressure and thus operating the linkage.

→ In second type both sides of the piston are subjected to engine vacuum in the brake released position.

To apply brakes one side is exposed to atmosphere. which provide the desired force on the piston.

→ The second type system is called 'suspended vacuum' system and diaphragm is given below.

Construction

→ vacuum reservoir is connected through a non-return valve to the inlet manifold between carburettor and engine.

→ vacuum reservoir is further connected to the servo cylinder on both side of the piston on left side the connection is through the control unit, while on right side is direct connection.

→ Control units also contains a piston to which two valves are attached.
→ The upper valves controls the connection between the atmosphere and left side of the piston in the servo cylinder.
→ The lower valves controls the connection between the vacuum reservoir and left side of the piston in the servo cylinder.
→ The piston in the control unit itself is actuated by the brake pedal through the master cylinder as shown in the figure.

Working :-
→ when the brake pedal is free, upper valve in the control unit is closed and the lower one is open. Thus both side of the piston in the servo cylinder are exposed to the engine vacuum.
→ when the brake pedal is passed to apply the brakes the pressure of the brake fluid pushes the piston in the control unit up, thereby closing the lower valve there and opening the upper valve.
→ Thus left side of the servo piston is exposed to atmospheric pressure, where as vacuum acts on the right side.
→ This causes the servo piston to move to right. This movement is utilised to apply the brakes in the wheels through some linkage which may be mechanical or hydraulic.

UNIT-03 IGNITION AND SUSPENSION SYSTEM

Ignition

→ An ignition system generates a spark or heats an electrode to a high temperature to ignite a fuel-air mixture in spark ignition internal combustion engine, oil-fired and gas-fired boilers, rocket engines etc.

→ The spark ignition engine requires some device to ignite the compressed air fuel mixture inside the engine cylinder at the end of compression stroke, for this ignition system are required.

→ It is a part of electrical system which carries electrical current to the spark plug which gives spark to ignite the air fuel mixture at the correct time.

→ compression ignition engine do not have such ignition system. In compression ignition engine only air is compressed in the cylinder and at the end of compression stroke the fuel is injected which catch fire due to the high temperature and pressure of compress air.

Requirement of an Ignition system

→ The ignition system supply high voltage (30000V) to the spark plug. This produce the electric spark at the spark plug gap that ignite or set fire to the compressed air fuel mixture inside the combustion chamber.

→ The sparking must be take place at the correct time at the end of compression stroke in every cycle operation

Types of ignition system

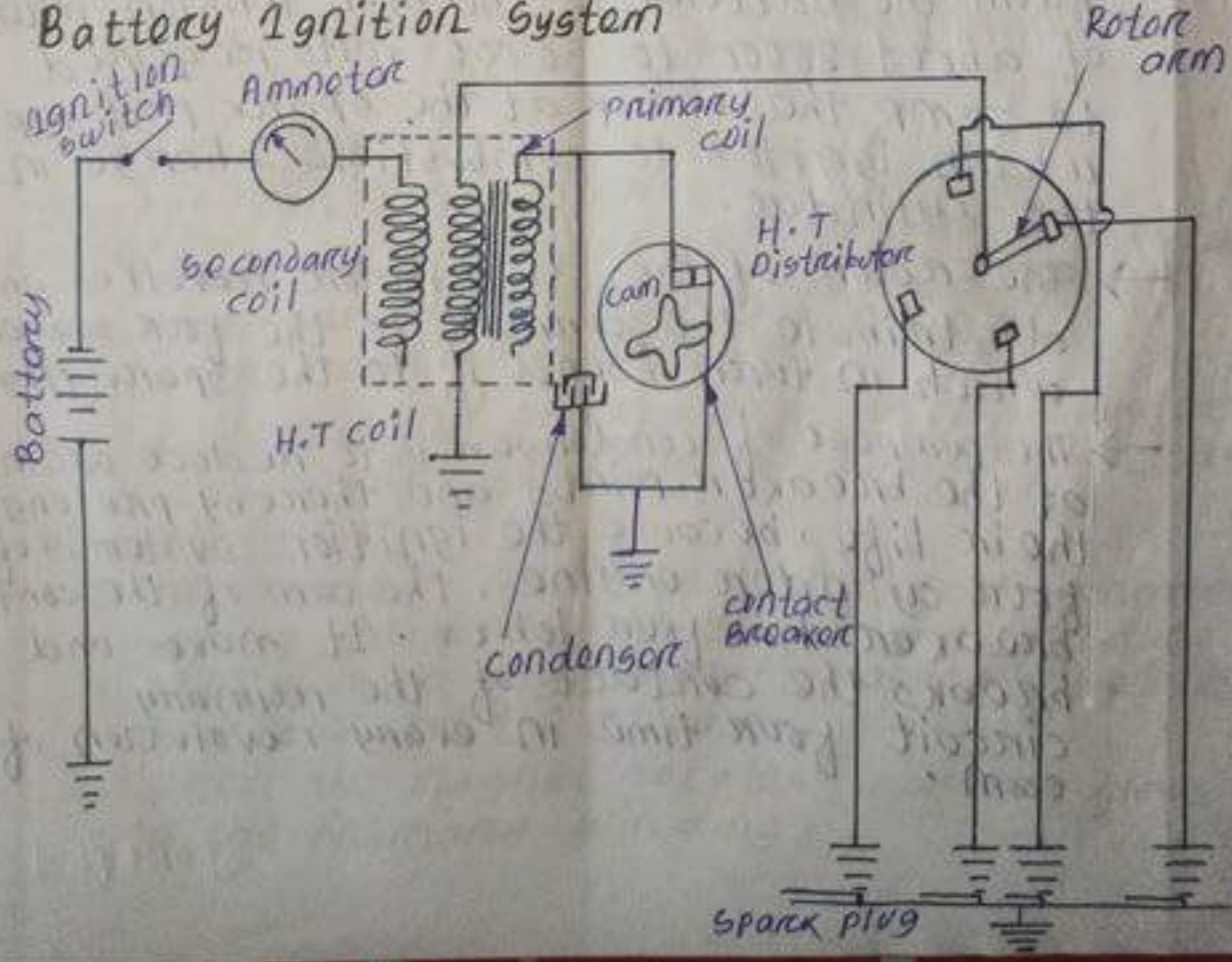
There are two types of ignition system used in petrol engine.

1. Battery ignition system or coil ignition system
2. Magneto ignition system.

→ Both ignition system based on the principle of mutual electro magnetic induction. The battery ignition system is mostly used in passenger cars and light truck.

→ In the battery ignition system the current in the primary winding is supplied by the battery where in magneto ignition system, the magent produces and supply in the primary winding.

Battery Ignition System



Construction

→ It consists of battery, ammeter, switch, ignition coil, condenser, contact breaker distributor and sparking.

→ The primary ignition circuits starts at the battery and passes through the switch ammeter, primary winding, contact breaker points to ground.

→ A condenser is also connected in parallel to the contact breaker points one end of the condenser is connected to the contact breaker arm and the other end is grounded.

→ The secondary ignition circuit is not connected electrically to the primary ignition circuit. It starts from the ground and passes through the secondary winding, distributers, spark plug to the ground.

→ The ignition coil steps up 6 volts or 12 volts from the battery to the high tension voltage of about 20000 to 30000 volts required to jump the spark at the spark plug gap which ignites to combustible charge in the cylinder.

→ The rotor of the distributor revolves and distribute the current to the four segments which in turn, send it to the spark plug.

→ The purpose of condenser is to reduce arcing at the breaker points and thereby prolong their life, because the ignition system is of four cylinder engine, the cam of the contact breaker has four lobes. It makes and breaks the contact of the primary circuit four time in every revolution of cam.

Working

→ when the ignition switch is on, the current will flow from the battery through the primary winding. It produces magnetic field in the coil.

→ when the contact points open, the magnetic field collapse and the movement of the magnetic field induces current in the secondary winding coil.

→ Because the secondary winding has many more turns (about 21000 turns) of fine wire (40 SWG), the voltage increases upto 30000 volts.

→ The primary winding consists of 200-300 turns of thick wire (20 SWG).

→ About 1500 volts are necessary to make the spark jump at 1mm gap.

→ The distributor then directs this high voltage to the proper spark plug when it jumps the gap, producing a spark which ignites the combustible mixture in the cylinder.

Magnet Ignition system

construction

→ It consists of a magneto, instead of a battery which produces and supplies current in the primary winding.

→ The remaining arrangement in this system is the same as that in the battery ignition system.

→ The magneto consists of a fixed armature having primary and secondary winding and a rotating magnetic assembly which is driven by the engine.

→ when the magnet rotates, current flows in the primary winding.

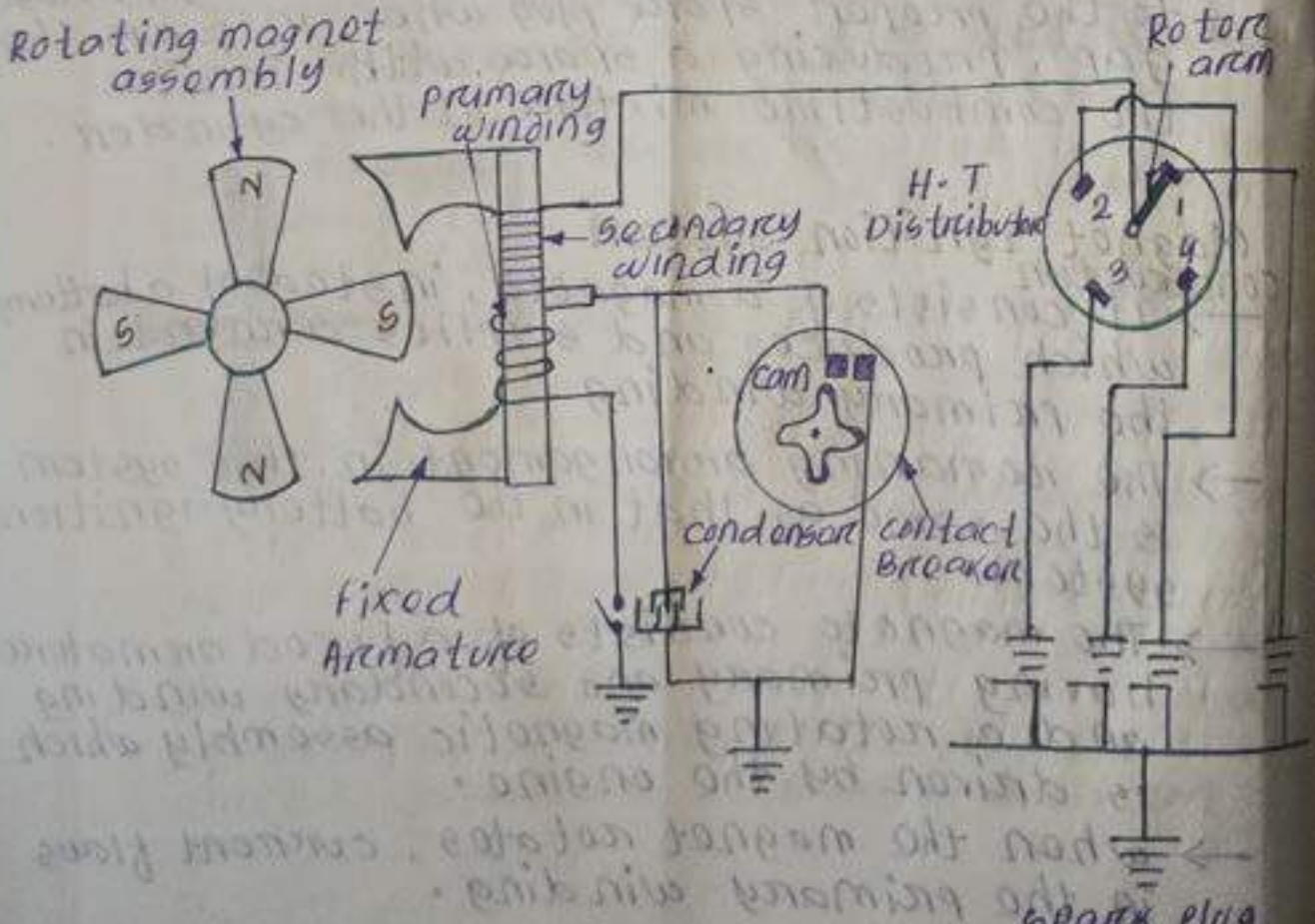
→ The secondary winding gives high voltage current to the distributor, which distributes it to the respective spark plugs.

→ In a magneto, the magnetic field is produced by means of parmanent magnet.

→ whereas in convetional generator, the magnetic field is produced by passing some of generated current through the field winding which produce the magnetic field.

→ The magneto may be either rotating armature type or rotating magnet type.

→ In rotating armature type magneto, the armature carrying the primary and secondary windings and the condenser rotates between the pole of a stationary horse shoe magnet.



Working

→ The magneto ignition system, magneto is used.
→ when the engine of the system starts, it helps the magneto to rotate and thus it's producing the energy in the form of high voltage then one end of the magneto is grounded through a contact breaker and the ignition capacitor is connected to its parallel.

→ The contact breaker is regulated by the cam and when the breaker is open, current flows through the capacitor and charges it.

→ Now the capacitor is acting as a charger now, the primary current flows is reduced thus reducing the overall magnetic field, generated in the system.

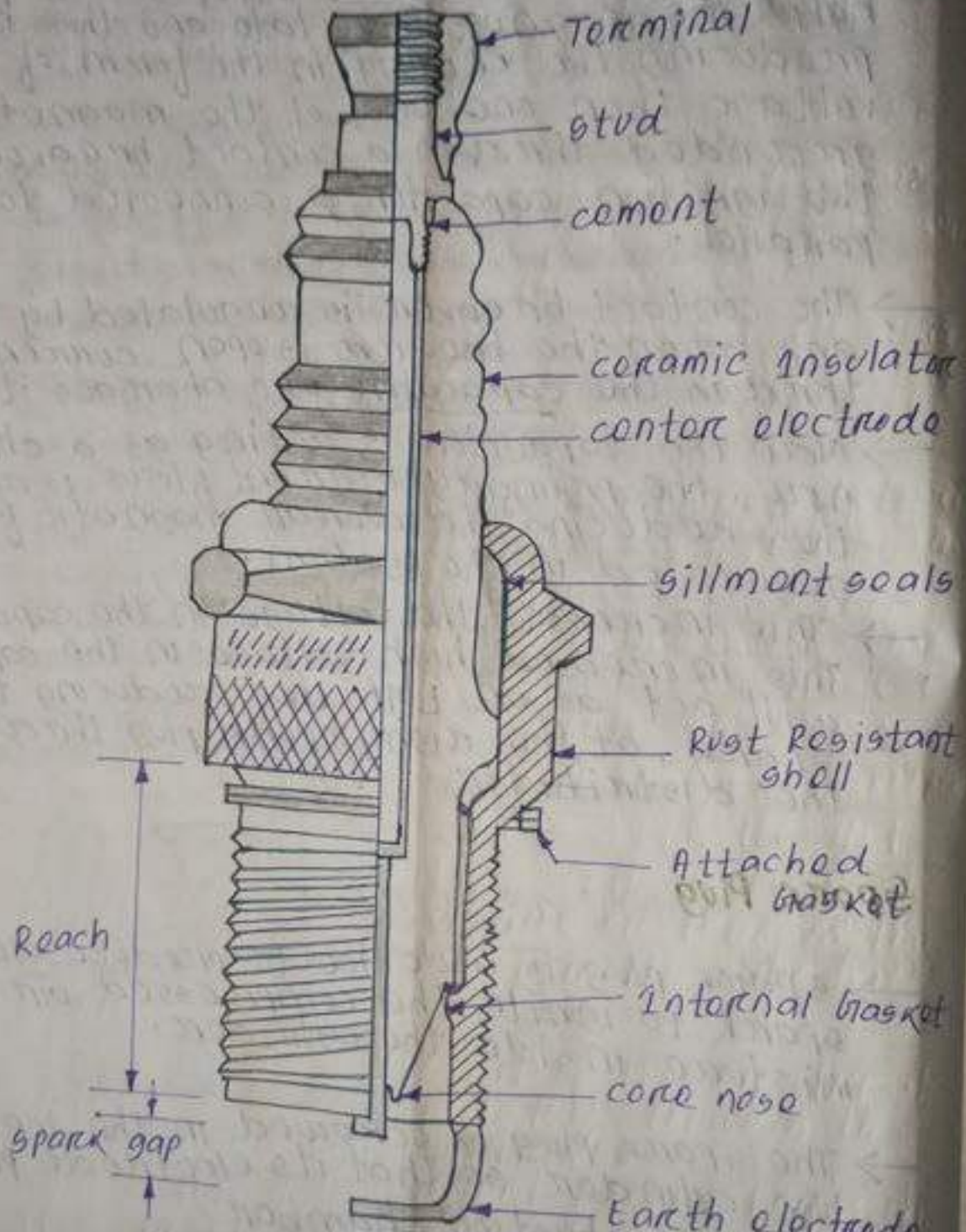
→ This increases the voltage in the capacitor. This increased high voltage in the capacitor will act as an EMF thus producing the spark, at the right spark plug through the distributor.

Spark Plug

→ spark plug is a device to produce electric spark to ignite the compressed air-fuel mixture inside the cylinder.

→ The spark plug is screwed in the top of the cylinder so that its electrode projects in the combustion chamber.

Diagram


Terminal
stud
cement
ceramic Insulator
center electrode
gillmont seals
Rust Resistant shell
Attached Gasket
Internal Gasket
core nose
Earth electrode
Reach
spark gap

Construction

→ A spark plug consists of mainly three parts.

① center electrode or insulated electrode
② Ground electrode or outer electrode
③ Insulation separating the two electrode

→ The upper end of the center electrode is connected to the spark plug terminal, where H.T cable from ignition coil is connected.

Note :-

* H.T Cable → High tension cable

→ It is surrounded by porcelain insulator.
→ The lower half portion of the insulator is fastend with a metal shell.
→ The lower portion of the shell has short electrode attached to one side and bent in towards the center electrode, so that there is a gap between the two electrode.
→ The two electrodes are thus separated by the insulator.
→ The sealing gaskets are provided between the insulator and the shell to prevent the escape of gases under various temperature and pressure conditions.
→ The lower part of the shell has screw threads and the upper part is made in hexagonal shape like a nut, so that the spark plug may be screwed in or unscrewed from the cylinder head.
→ The gap between the center electrode and the ground electrode is called the spark plug gap.

→ The gap is adjusted to recommended specification by bending the ground electrode.
→ The gap varies from 0.4 mm to 1.0 mm.
→ It is measured with filler gauge.

Working

→ The function of spark plug is to produce an electric spark to ignite the compressed air-fuel mixture inside the cylinder.
→ It must produce the spark at the correct movement at the end of the compression stroke.
→ A proper gap is to be maintained between the two electrode of the spark plug so that the sparking may take place.
→ When the spark plug is screwed in the cylinder head, the ground electrode is said to be connected with ground.
→ The terminal of the center electrode is directly connected with the H.T lead of the ignition coil in case of single cylinder engine or through the distributor in case of multi-cylinder engine.
→ The secondary circuit of the electrical system is to be completed through the gap between the electrodes.
→ When the H.T current passes through the circuit, it jumps the gap producing a spark, which ignites the compressed air-fuel mixture in the cylinder.

- Comparision of Battery Ignition and Magneto Ignition system

Battery Ignition system	Magneto Ignition system
① current is obtained from the battery.	① current is generated by magneto.
② sparking is good even at low speed.	② poor sparking at low speed.
③ starting of engine is easier.	③ starting engine is difficult.
④ If the battery is discharged, the engine can not be started.	④ Battery is not needed in magneto ignition system.
⑤ It occupies more space.	⑤ It occupies less space.
⑥ complicated wiring.	⑥ simple wiring.
⑦ Less costly.	⑦ More costly.
⑧ spark intensity falls as the engine speed rise.	⑧ spark intensity improves as the engine speed rise.
⑨ used in cars, buses, trucks.	⑨ used in motor cycles, scooters, racing cars

- Common Ignition troubles and its Remedies

Components	Symptom	Cause	Remedies
Ignition coil	→ Engine misfires	- Defective coil	- Replace
	→ Hard starting	- Defective high tension cable.	- Replace

Condensor	→ Breaker points burns rapidly.	- Loose condenser lead.	- Tighten
	→ engine misfire at high speed.	- Defective condensor.	- Replace.
Ignition switch	→ Low current in primary circuit.	- switch resistance high	- Replace
Magneto	→ Noise	- Magneto cover bent inward.	- Replace it
		- Fan screw loose.	- Tighten it
Spark plug	→ electrode erosion occurs.	- corrosive combustion gases.	- Used proper fuel.
	→ Misfiring	- Increase in spark plug gap.	- Adjust the gap or replace the plug.

• Suspensions System

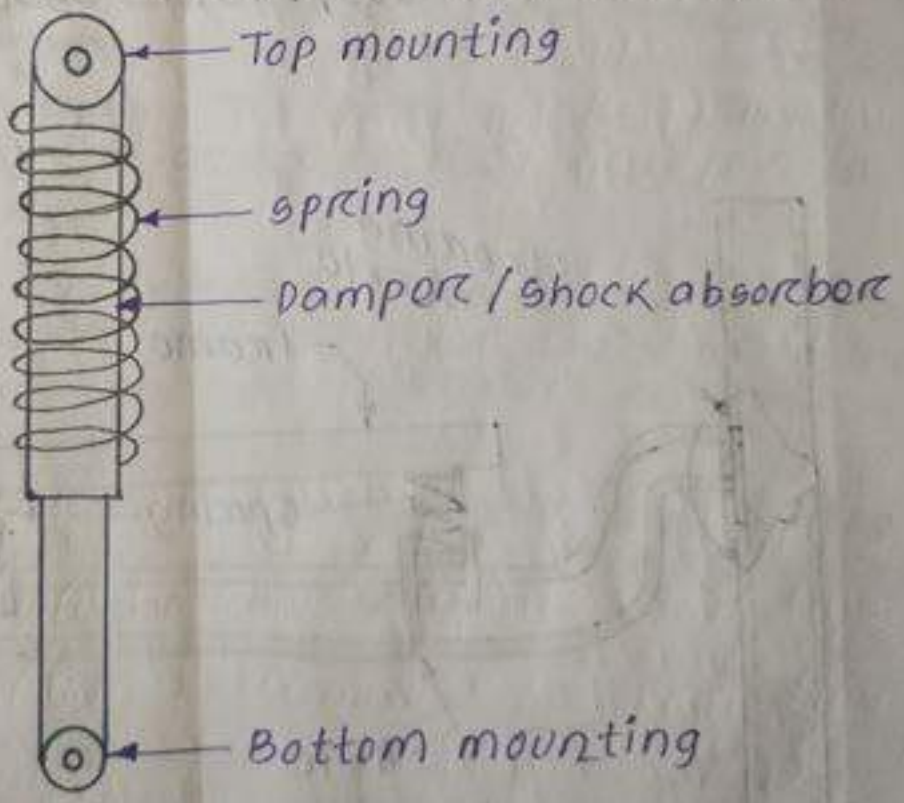
→ The automobile frame and body are mounted on the front and rear axle not directly but through some form of springs.

→ This is done to damp or absorb to road shocks transmitted to the frame by the wheels as they rolls over the roads.

→ All this parts which perform its function are collectively called a suspension system.

→ Thus the suspension system includes spring, shock absorbers and their mountings.

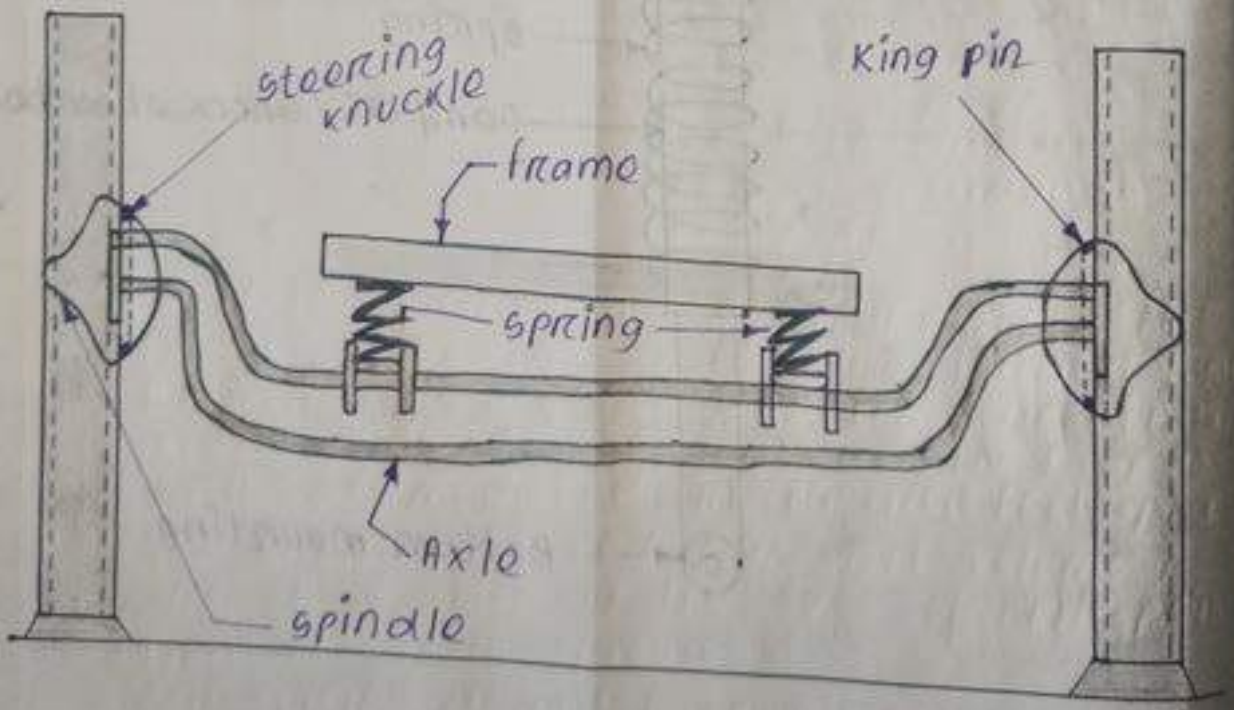
→ The suspension system of a motor vehicle is devided into the rear end suspension and front end suspension.



Function of Suspension System

1. To prevent the road shocks from being transmitted to the vehicle components / frame.
2. To preserve the stability of vehicle in pitching or rolling while in motion.
3. To safeguard the occupants from road shocks.
4. To provide good road holding while driving and cornering and breaking.
5. To maintain proper steering Geometry.

Conventional Suspension System



→ The above figure shows a typical conventional suspension system of front wheel.

→ This type of suspension system was universally used before the introduction of independent front wheel suspension.

→ It may be used either to longitudinal leaf spring, such as shown in the figure or transverse spring, usually in conjuction with shock absorber.

→ Those assemblies are mounted similarly to rear leaf spring suspension system.

→ In this type of suspension system the front wheel hubs rotate on antifriction bearing on steering spindles. which are attached to the steering knuckle.

→ To permits the wheels to be turned by steering gear, the steering spindle and steering knuckle assembly are hinged on the axle end

→ The pin that forms the pivot of this hinge is successfully referred to the king pin or steering knuckle pin.

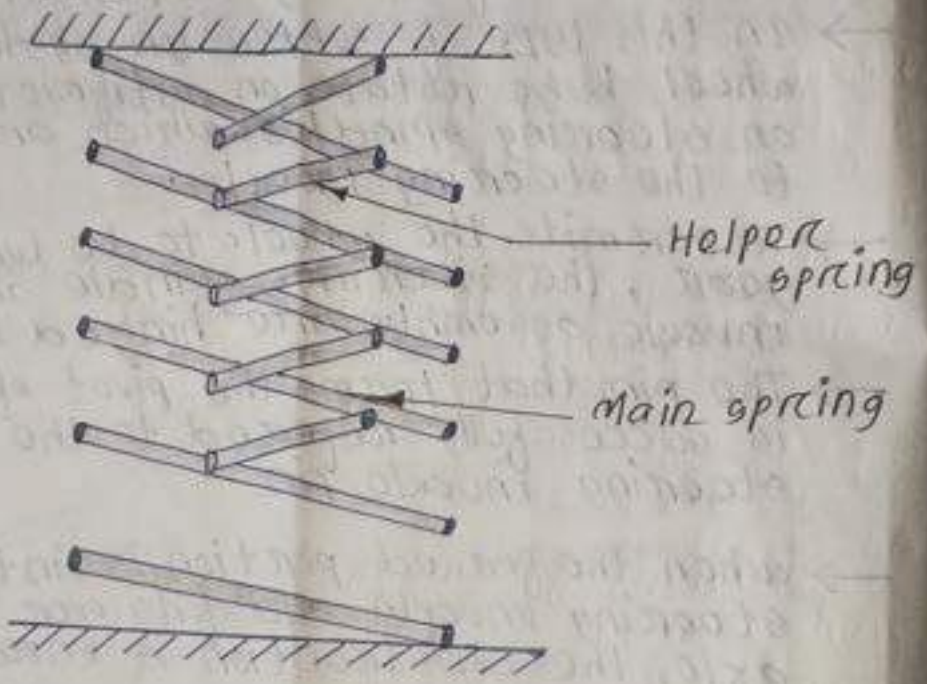
→ when the forked portion is integral with the steering knuckle and fits over the end of the axle, the construction is known as Reverse elliot.

→ In elliot type construction the end of the axle are forked to hold the steering knuckle extension between the ends.

• Independent suspension system

In the independent suspension type system each wheel is independently supported by a coil spring, torsion bar or leaf spring. Almost all the passengar cars now use the independent suspension system, in which the coil spring arrangement is the most common.

Coil spring



→ The coil springs are used mainly with the independent suspension through they have also being used in the conventional rigid axle suspensions as they can be well accomodated in restricted spaces.

→ The energy stored per unit volume is almost double in the case of coil springs than the leaf springs.

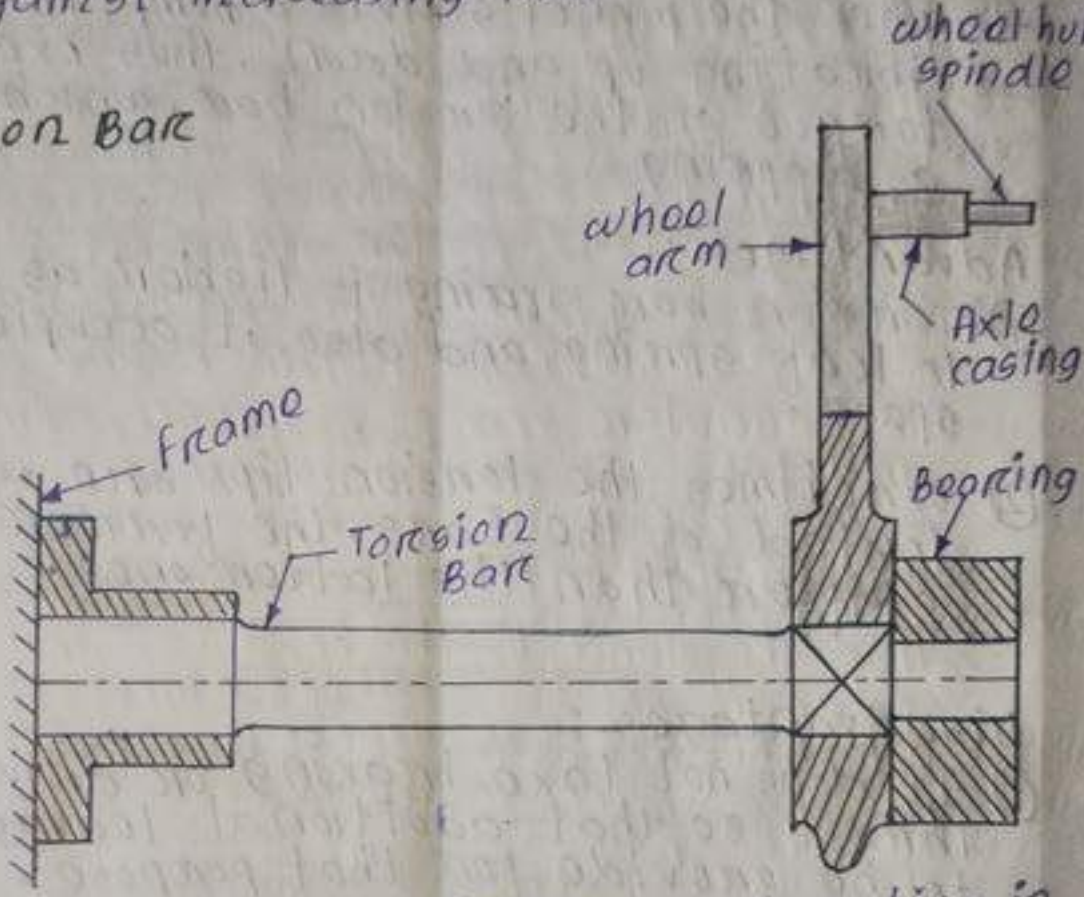
→ Coil spring do not have noise problems, nor do they have static friction causing harshness of ride as in case of leaf spring.

→ The spring takes place shear as well as bending stress.

→ The coil springs, however can not take torque reaction and side thrust for which alternative arrangement have to be provided.

→ A helper coil spring is also sometimes used to provide progressive stiffness against increasing load.

Torsion Bar



→ Torsion bar is simply a rod acting in torsion and taking shear stresses only.

→ These are made of heat treated alloying spring steel.

→ The amount of energy stored per unit weight of material is nearly the same as for coil springs. Torsion bars is often used with the independent suspensions.

Construction :-

→ The above figure shown that the bar is fix at one end to the frame, while the other end is fixed to the end of the wheel arm and supported in the bearing.

→ The other end of the wheel arm is connected to the wheel hub

Working :-

→ when the wheel strikes a bump, it start vibrating up and down, thus exerting torque on the torsion bar, which acts as a spring.

Advantages :-

① Torsion bar spring is lighter as compared to leaf spring and also it occupies less space.

② sometimes the torsion tips are used instead of the bars, the formers being stiffer than the latter ones.

Disadvantages :-

① It does not take breaking or driving thrust so that additional leakage have to be provide for that purpose.

② The absence of friction force, and hence of damping is a necessity to control the vibration produced due to the road shocks.

• Shock Absorber or Damper

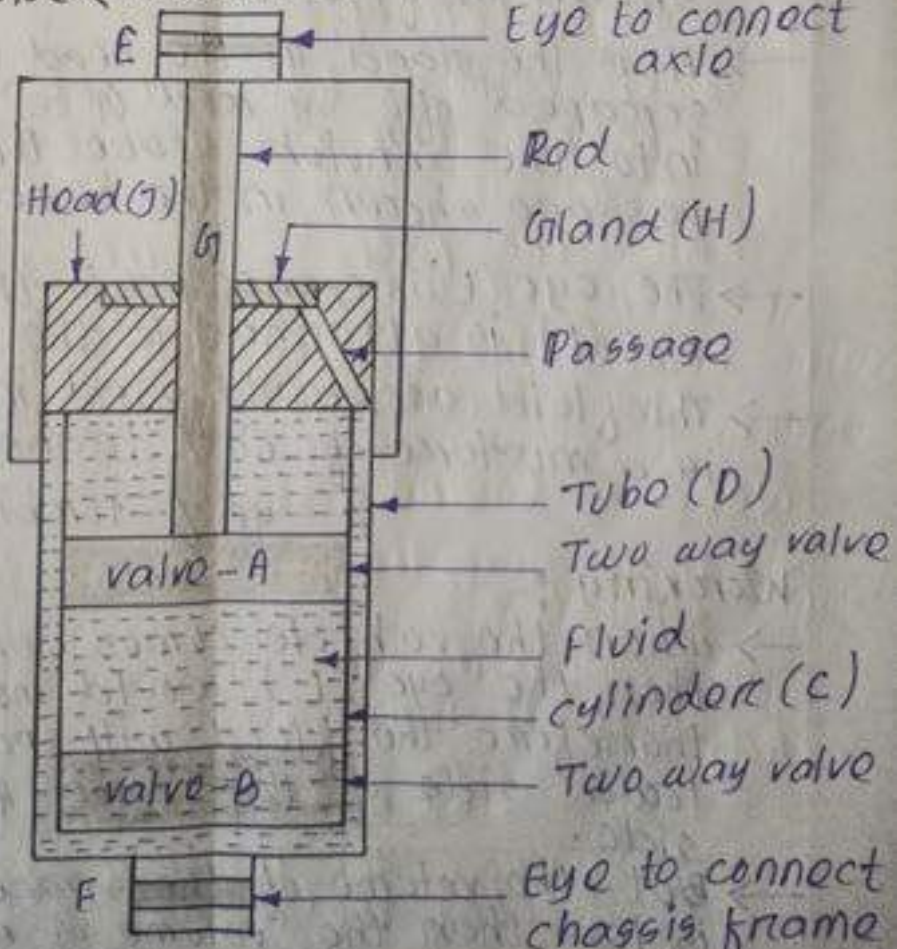
→ When a vehicle wheels strikes a bump, the spring is compressed enough and only a little vertical upward motion is transferred to the frame.

→ When the wheel comes down from the bump, the spring expands very rapidly. If this rebound is not controlled, the spring starts to vibrate heavily.

→ To control this vibration, the shock absorber is used in the suspension system

→ Similarly when the wheels falls over a hole, the spring expands and is enable to take the full vehicle load. The shock absorber takes the part of this load.

Telescopic Shock Absorber



A telescopic shock absorber derives its name from the tubular shape of early telescopes used in ancient time.

→ These are two types
- mono tube type
- twin tube type

Twin tube type

→ The above figure, the rod 'G' is attached to the two way valve-A while another similar two way valve-B is attached at the lower end of the cylinder 'C'.

→ There is a fluid in the space below the valve assembly (A), below (B) and also in the annular space between cylinder (C) and tube (D), which is connected to the space below the valve assembly (B) as shown in figure.

→ H is the gland in the head (J) and any fluid scraped off by rod G is brought down into the annular space through the inclined passage shown in the head.

→ The eye (E) is connected to the axle while eye (F) is attached to the chasis frame.

→ The fluid generally used in shock absorber is a mixture of 60 % transformer oil.
40 % turbine oil

Working :-

→ When the vehicle comes across the bump, then the eye (E) would move up and therefore the fluid will passes from the lower side of the valve-A to its upper side.

→ But the volume of the space above the valve is less than the volume of rod (G).

→ The fluid applies pressure on valve-B and go to the under side of the valve-B.

→ This pressure of fluid through the valve opening provides a damping force.

→ similarly when the eye connected to the chassis frame, moving downward, the fluid passage from upper side of the valve-A to the lower side and also from lower side of valve-B to upper side.

UNIT-04 COOLING AND LUBRICATION

→ During the combustion of air-fuel mixture, a large amount of heat is produced inside the engine cylinder and temperature as high as 25000°C may be reached by the burning gases.

→ The temperature is so high that it will break the lubricating film between the moving parts, weld the moving parts, or cause any mechanical breakage of the engine parts.

→ Hence the temperature must be reduced by some means to such a value about 200°C to - 250°C at which the engine the engine may work effectively.

→ cooling beyond permissible limit is not desirable because it decreases the overall efficiency due to the following reason.

① Thermal efficiency is decreased due to more loss of heat to the cylinder wall.

② The vaporization of fuel is less, it decreases combustion efficiency.

③ Viscosity of lubricant increases at low temperature, it increases frictions.

→ Thus the purpose of the cooling system is to keep the engine at its most efficient operating temperature at all engine speed and all driving conditions.

Need of Engine Cooling

→ To remove the heat generated from the engine cylinder.

→ To maintain the engine cylinder at the constant temperature requiem.

→ To prevent the distortion of engine parts due to uneven heating and cooling.

→ To improve the thermal efficiency of the engine

→ To prevent the burning of lubricating oil.

Classification of Engine Cooling

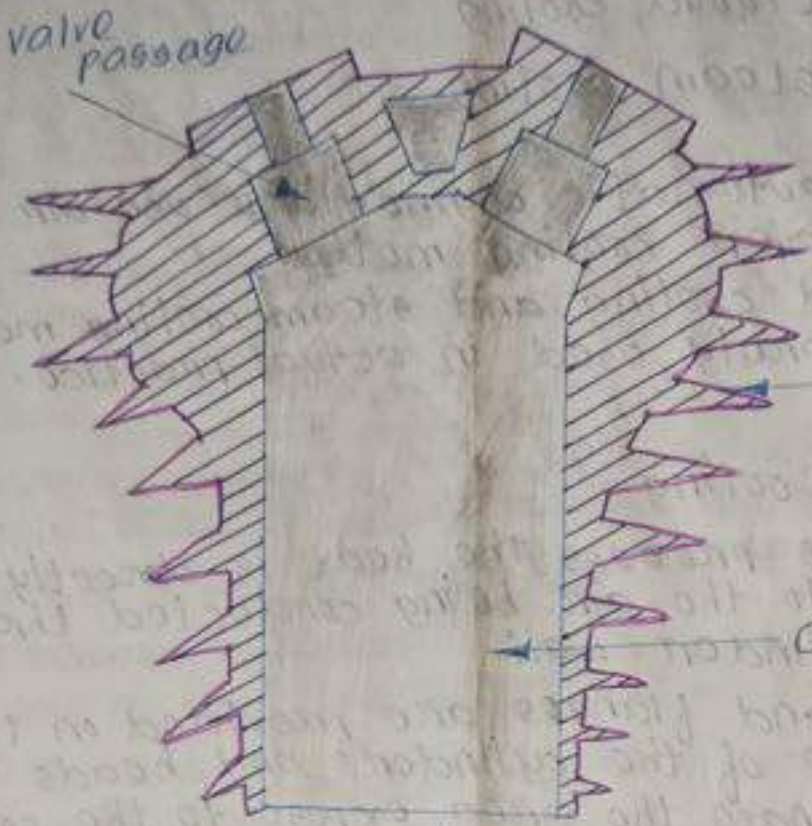
1. Air Cooling
2. Water cooling
3. Liquid cooling
4. Steam cooling

→ Most automatic engines are use air cooling and water cooling method.
→ Liquid cooling and steam cooling methods are rarely used in actual practice.

➡ Air Cooling

→ In this process the heat is directly dissipated to the air being conducted through the cylinder wall.
→ Fins and flanges are provided on the outer surface of the cylinders and heads serve to increase the area expose to the cooling air: and increase the rate of cooling.
→ When the current of air flowing continously over the heated surface of the engine heat is removed.
→ The amount of heat dissipated depends upon the following factors.

- Surface area of metal in contact with air
- Rate of air flow
- Temperature difference between the heated surface and the air.
- conductivity of the metal.



→ For effective air cooling, the surface area of metal which comes in contact with air is increased by providing fins over the cylinder barrels.
→ More the surface area in contact with the air, more the heat transferred.
→ Higher the rate of flow, higher the heat is dissipated.
→ Higher the temperature difference between the heated surface and the air, higher will be the heat dissipation.

Advantages :-
→ Lighter in weight as compared to water cooling.
→ No topping up the cooling system.
→ No leaks to guard against.

→ Antifreeze not required.
→ Engine warms up faster than with water cooled design.
→ can be operated in cold climate where water may freeze.
→ can be used in area where there is scarcity of cooling water.

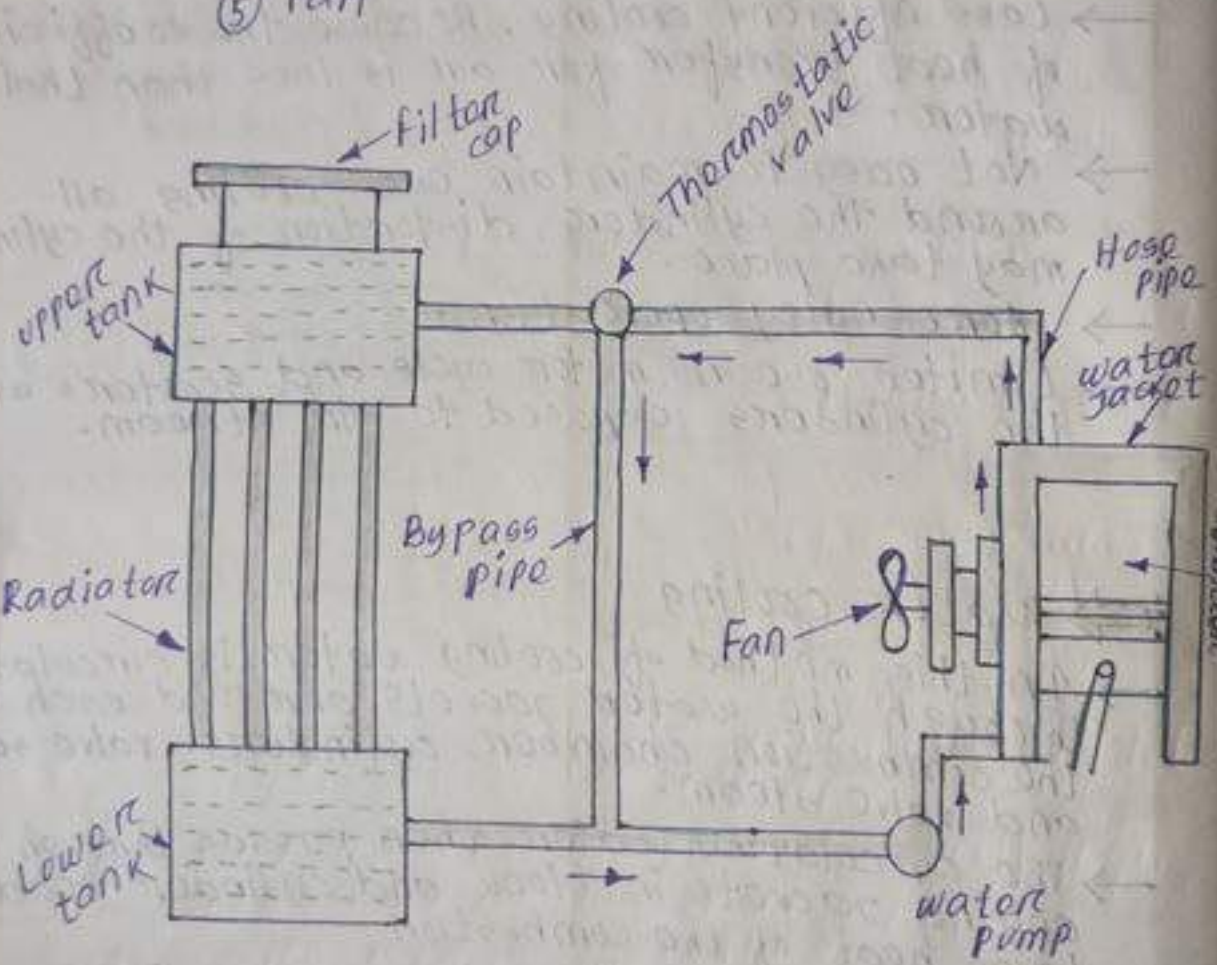
Disadvantages
→ Less efficient cooling, because the coefficient of heat transfer for air is less than that of water.
→ Not easy to maintain even cooling all around the cylinder, distortion of the cylinder may take place.
→ More noisy operation.
→ Limited use in motor cycle and scooters where the cylinders exposed to air stream.

⇨ Water cooling

→ In this method of cooling water is circulated through the water jackets around each of the combustion chamber, cylinders, valve seat and valve steam.
→ The circulating water when passes through the engine jackets in block and cylinder head takes heat of the combustion.
→ when it passes through radiator, it is cooled by air drawn through radiator by a fan and by air flow develop by the forward motion of vehicle.
→ After passing through - radiator, the water again goes in the engine jackets.

→ The several components of water cooling system are

① Radiator
② Pump
③ Water Jackets
④ Thermostant
⑤ Fan



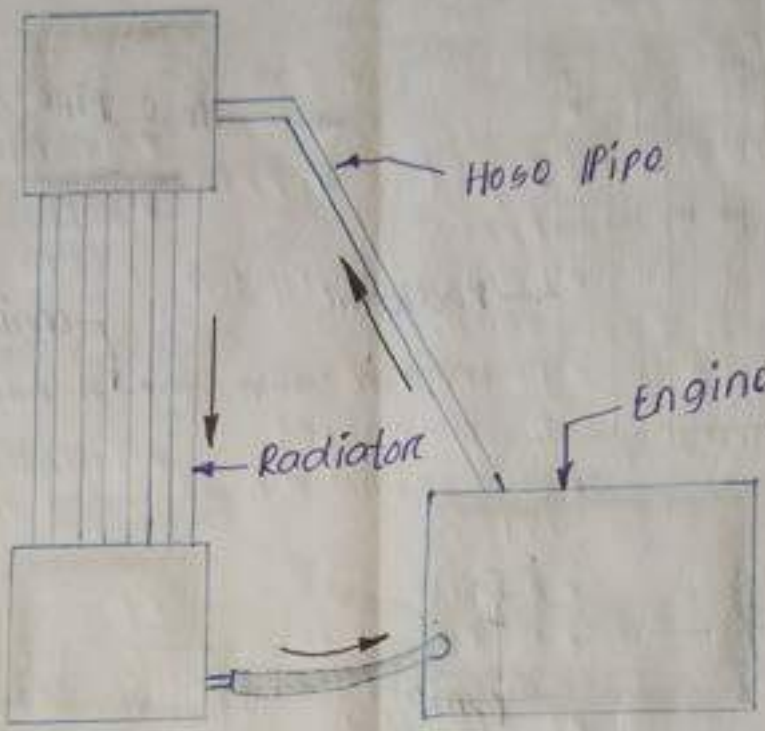
Advantages :-
→ High cooling rate.
→ can be fitted large engines.

Disadvantages :-
→ can be overheated in cold area.
→ Any defect in the system causes overheating.

There are two systems of water cooling:

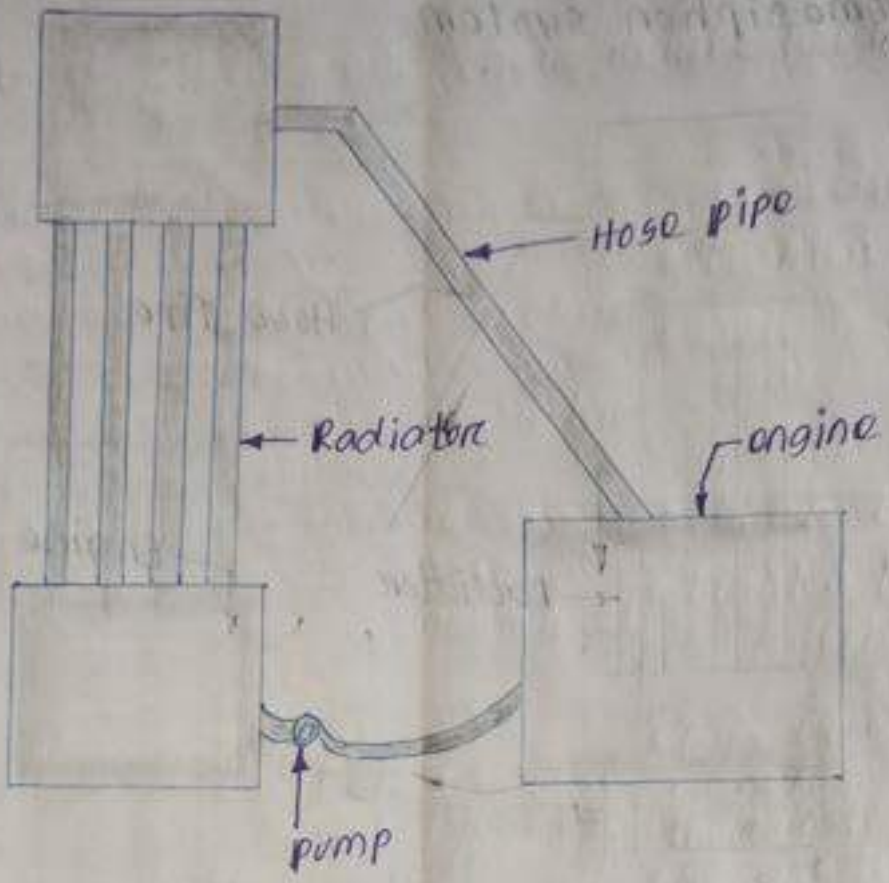
① Thermosiphon system
② pump circulating system

① Thermosiphon system



→ In this system of water cooling the circulation of water is obtained due to the difference in densities of hot and cold regions of the cooling water.
→ There is no pump to circulate the water.
→ The hot water from the engine jacket being lighter, rises up in the hose pipe and goes in the radiator from the top side.
→ It is cooled there and hence goes down at the bottom side of the radiator. from where it goes down again in the engine jackets.
→ The system is quite simple and cheap, but the cooling is rather slow.
→ To maintain continuity of water flow, the water must be maintained upto certain minimum level.

② Pump circulation system



→ In this system of water cooling, the circulation of water is obtained by a pump.
→ The pump is driven by means of a belt from a pulley on the engine crankshaft.
→ The system is more effective.
→ The circulation of water becomes faster as the engine speed increases.
→ There is no necessity of maintaining the water upto a correct level.

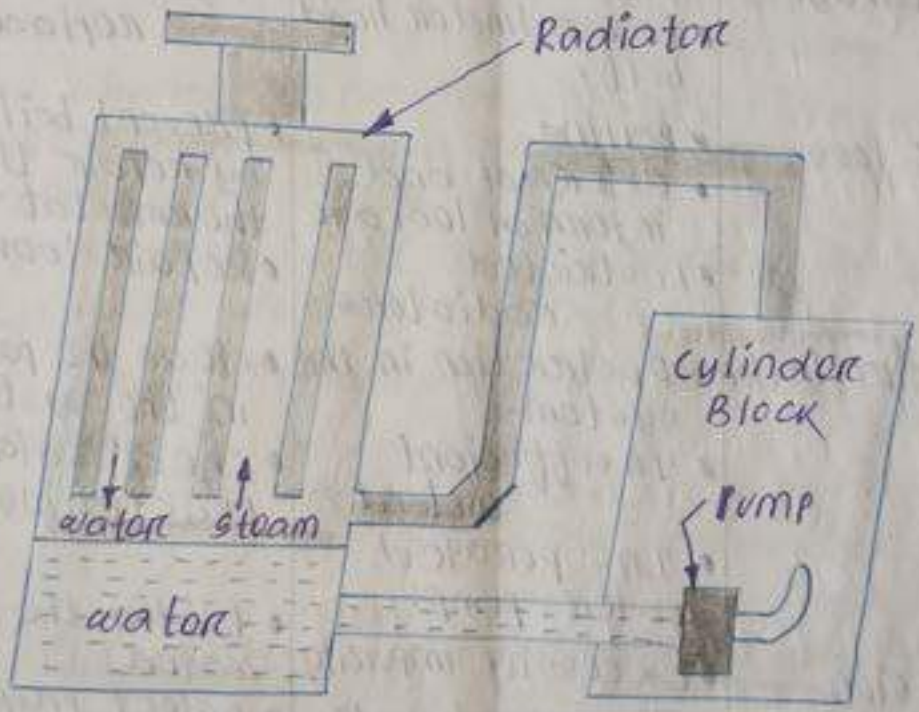
➡ Liquid cooling

→ In this method of cooling, instead of water, other liquid having higher boiling points are used for cooling.

→ Examples of those type of liquids are
Glycerine (Boiling point - 290°C)
Ethylene glycol (Boiling point - 195°C)

→ Due to their high boiling point, these liquid have increased capacity to carry heat and hence the weight of coolant and radiator is decreased.

➡ Steam cooling



→ In this method of cooling, steam is used for cooling.

→ The cooling system consists of the same components as those of water cooling, except the radiator.

→ The radiator is in the form of condenser in this system.

→ The circulation of water is made by a pump.

→ The water in the cylinder jackets is converted into steam, which flows out at the top of the engine

block and goes to the bottom of radiator.
→ The steam is condensed in the radiator and the water thus formed is again circulated by the pump.

Defects of Cooling and their remedial measures

Defects	Cause	Remedies
① External leakage	• Defective rubber hose • Damage radiator seam	• Tighten clips • Replace the hose seam
② Internal leakage	• Defective cylinder head gasket • Lose cylinder head bolt.	• change the gasket • Tighten the bolt/ replace.
③ Water loss	• Boiling • external and internal leakage • Restricted radiators	• prevent boiling by repair the thermostat. • Repair leakage
④ Poor circulation	• Restriction in the system. • Insufficient coolant. • In-operated water pump.	• clean the passage in the system. • check water pump functioning
⑤ Corrosion	• Excessive impurity • Incorrect anti-freeze mixture	• Filter the incoming water • select proper anti-freeze mixture
⑥ overheating	• poor circulation • Low oil level. • Too thick engine oil. • In correct timing	• check the circulation system • select proper engine oil, correct valve and ignition timing

• Lubrication

→ Lubrication is the method of supplying lubricating oil between the moving parts.

→ Lubrication is essentially required in motion vehicle maintainance, to supply lubricating oil between the moving parts is simply termed as lubrication.

→ Lubrication of all moving parts is essential to reduce friction, wear and to prevent siezure.

➡ Function of lubrication

→ To reduce friction between the moving parts.

→ To reduce wear of moving parts.

→ To act as a cooling medium for removing heat.

→ To keep the engine parts clean, specially piston ring, ring grooves, oil way and filters.

→ To absorb shocks between bearing and other engine parts, thus reducing engine noise and extending engine life.

→ To form a good seal between piston ring and cylinder walls.

→ To prevent deposition of carbon, soot and lacquer.

→ To absorb and carry away harmful substance resulting from incomplete combustion.

→ To prevent metalic components from corrosive attack by the acid formed during the combustion process.

→ To resists oxidation which causes sludge and lackqgers.

Lubricating system in IC engine

The different system for lubricating the automo engine are as follows.

1. Petroil system or mixed lubrication system
2. splash system
3. pressure system
4. semi-pressure system
5. Dry-sump system

Note :-

Types of lubricants are

1. solid lubricants
   - ex- graphite
   - mica
   - soap stone
2. semi solid lubricants
   - ex - grease
3. Liquid lubricants
   - ex- mineral oils
   - vegetable oils
   - animals oils

1. Petroil Lubrication system

→ This system of lubrication is generally applied in 2S petrol engines, like scooter and motor cycles.

→ It is simplest type of lubrication system.

→ It does not contain any moving parts.

→ The lubricating oil is mixed into the petrol while filling in petrol tank of vehicle in a specific ratio.

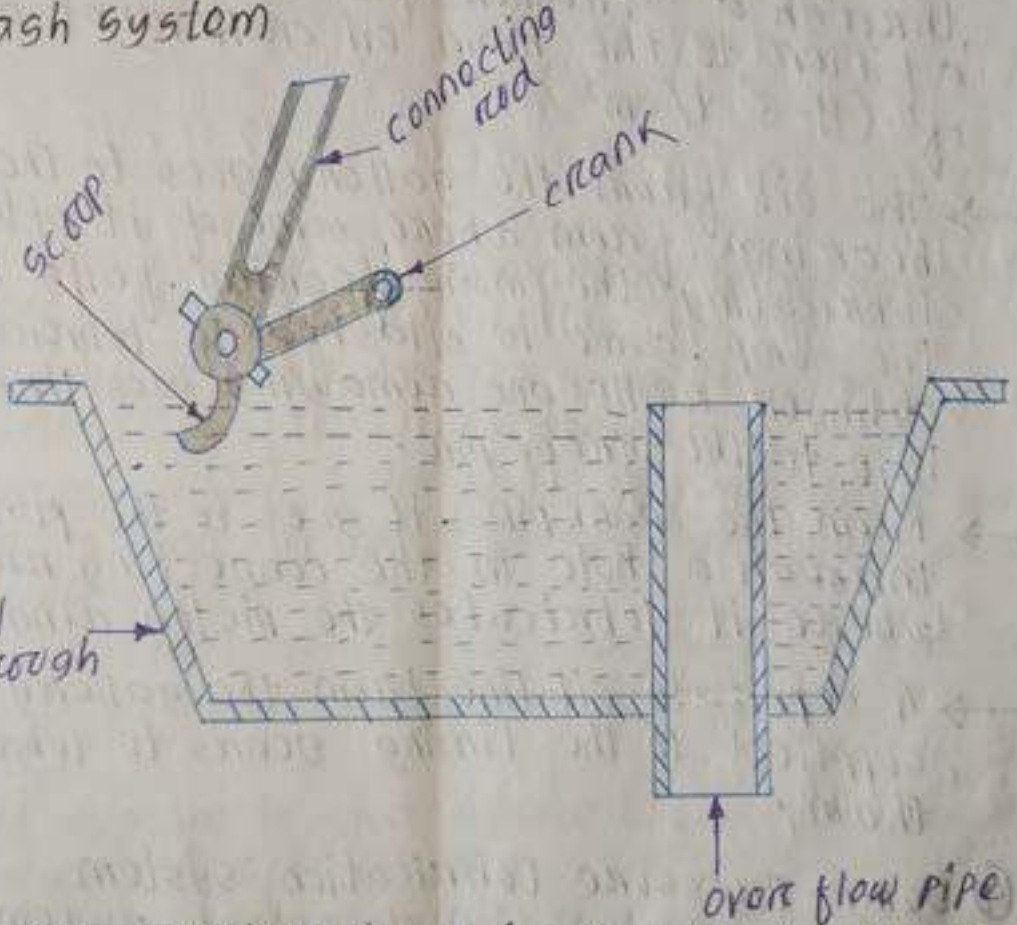
→ when the fuel goes into the crank chamber during the engine operation, the oil particles go deep into the bearing surface and lubricate them.

→ The piston rings, cylinder walls, piston pins etc. are lubricated in the same ways.

→ If the engine is allowed to remain unused for a considerable time, the lubricating oil separates off from the petrol and leads to clogging the passage in the carburettor, resulting in the engine starting troubles.

↳ This is the main disadvantages of petroil lubricating system.

② Splash system



→ In this system of lubrication, the lubricating oil is stored in an oil trough or sump.

→ A scoop or dipper is made in the lowest part of the connecting rod.

→ when the engine runs the deeper dips in the oil once in every revolution of crankshaft and causes the oil to splash on the cylinder walls.

→ This action affects the lubrication of the engine walls, piston rings, crankshaft bearings and big end bearings.

→ Splash system mostly works in connection with pressure system in an engine, some parts being lubricated by splash system and the other by pressure system.

③ Pressure Lubrication System

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

→ The lubricating oil is stored in a separate tank from where an oil pump takes the oil through a strainer and delivers it through a filter to the main oil gallery at a pressure of (4-8 N/cm²)

→ The oil from the gallery goes to the main bearings. From where some of it after lubricating the main bearing, falls back to the sump, same is splashed to lubricate the cylinder walls and remaining goes through a hole to the crank pin.

→ From the crank pin, it goes to the piston pin through a hole in the connecting rod web, where it lubricates the piston rings.

→ A separate oil line from the gallery is supplied to the timing gears to lubricate them.

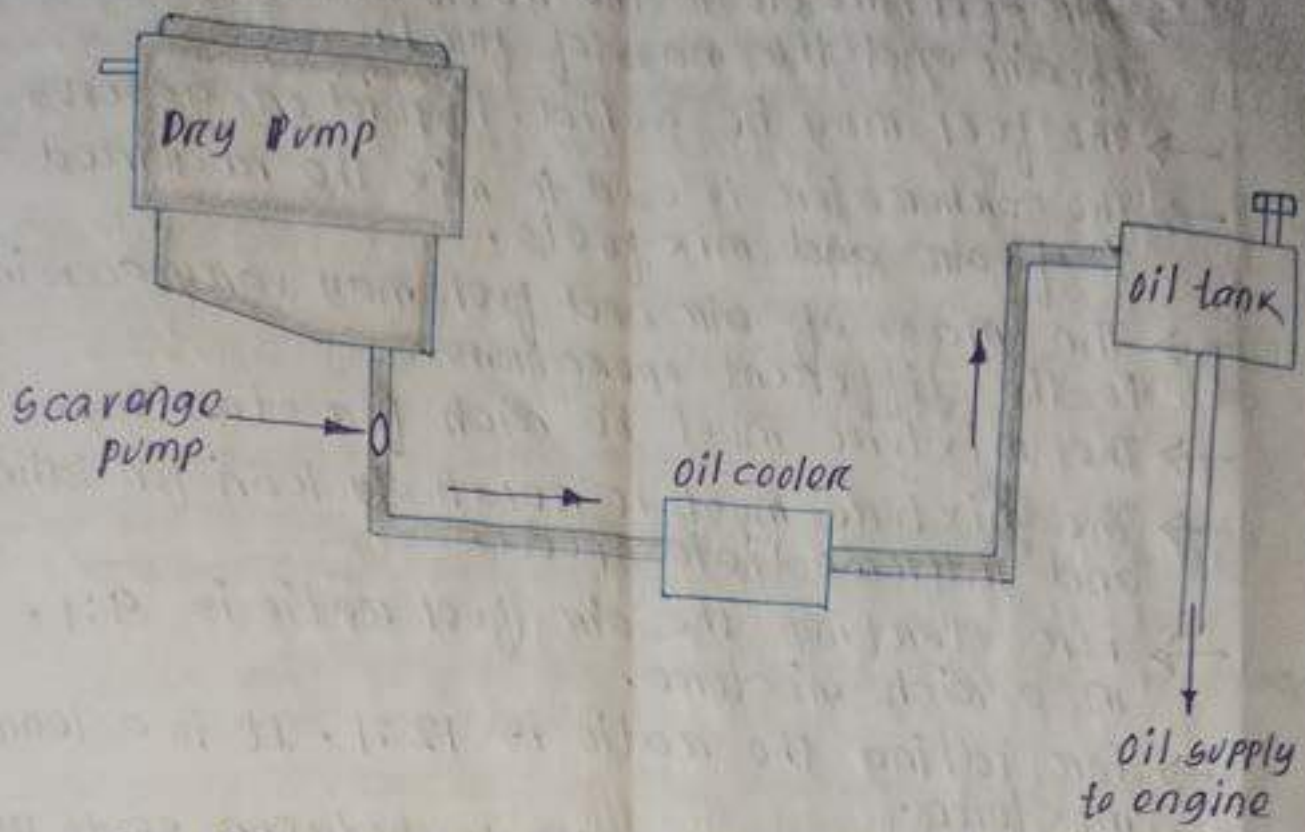
④ Semi-Pressure Lubrication System

→ It is a combination of splash system and pressure system.

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

→ Almost all the 4-s engine are lubricated by this system.

⑤ Dry-sump lubrication system



→ In this system of lubrication, lubricating oil is not stored in oil sump.

→ The oil is carried in a separate tank from where it is fed to the engine.

→ The oil which falls into oil sump after lubrication is send back to the oil tank by a separate delivery pump.

→ This system consists of two pumps to feed the oil and other to deliver it back to the oil tank.

→ This system is used where the vehicle has to change its' position continously.

→ The main advantages of this system is that there is no chance of breakdown of oil supply during up and down movement of vehicle.

UNIT--05 FUEL SYSTEM

• AIR-FUEL RATIO

→ Air-fuel ratio is the ratio between the mass of air and the mass of fuel.

→ The fuel may be solid, liquid or gaseous.

→ The carburetor is used to mix the required % of air and ... fuels.

→ The mass of air and fuel may vary according to the different operations.

→ The mixture must be rich for starting.

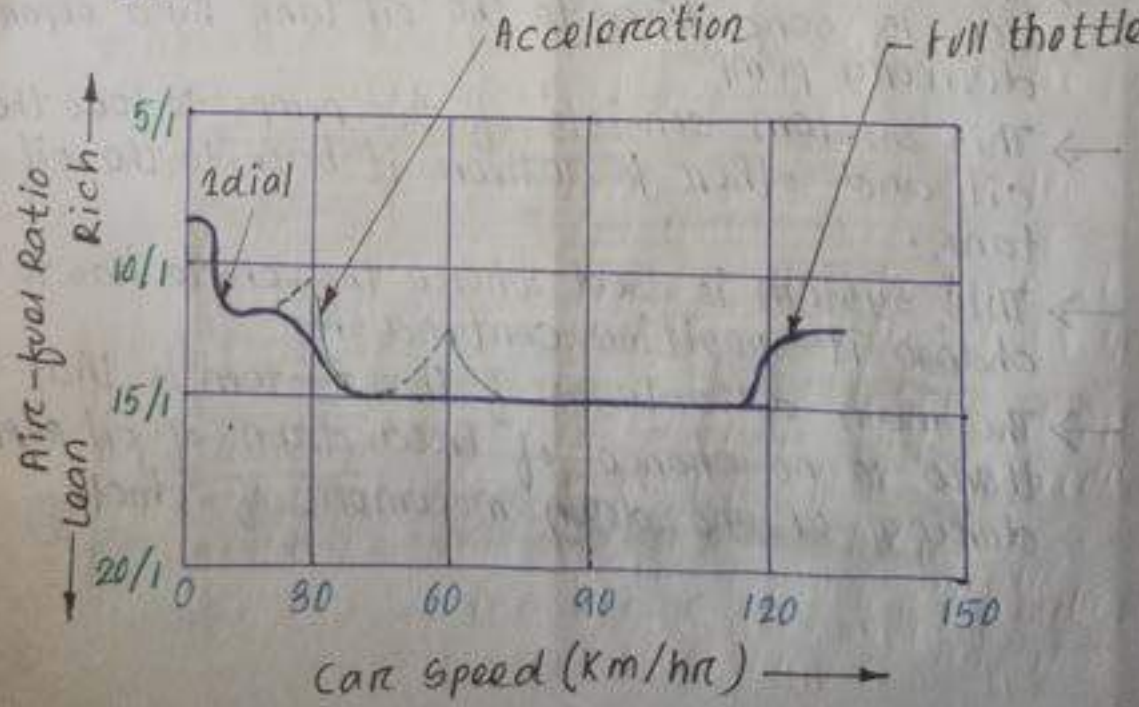
→ The mixture must be relatively lean for idling and intermediate speed.

→ For starting, the air-fuel ratio is 9:1, in a rich mixture.

→ For idling the ratio is 12:1. It is a lean mixture.

→ For intermediate speeds between 35 to 105 km/hr, the mixture ratio is 15:1.

→ But at higher speeds (120 to 150 km/hr) with a wide open throttle, the mixture is again enhanced to 13:1.



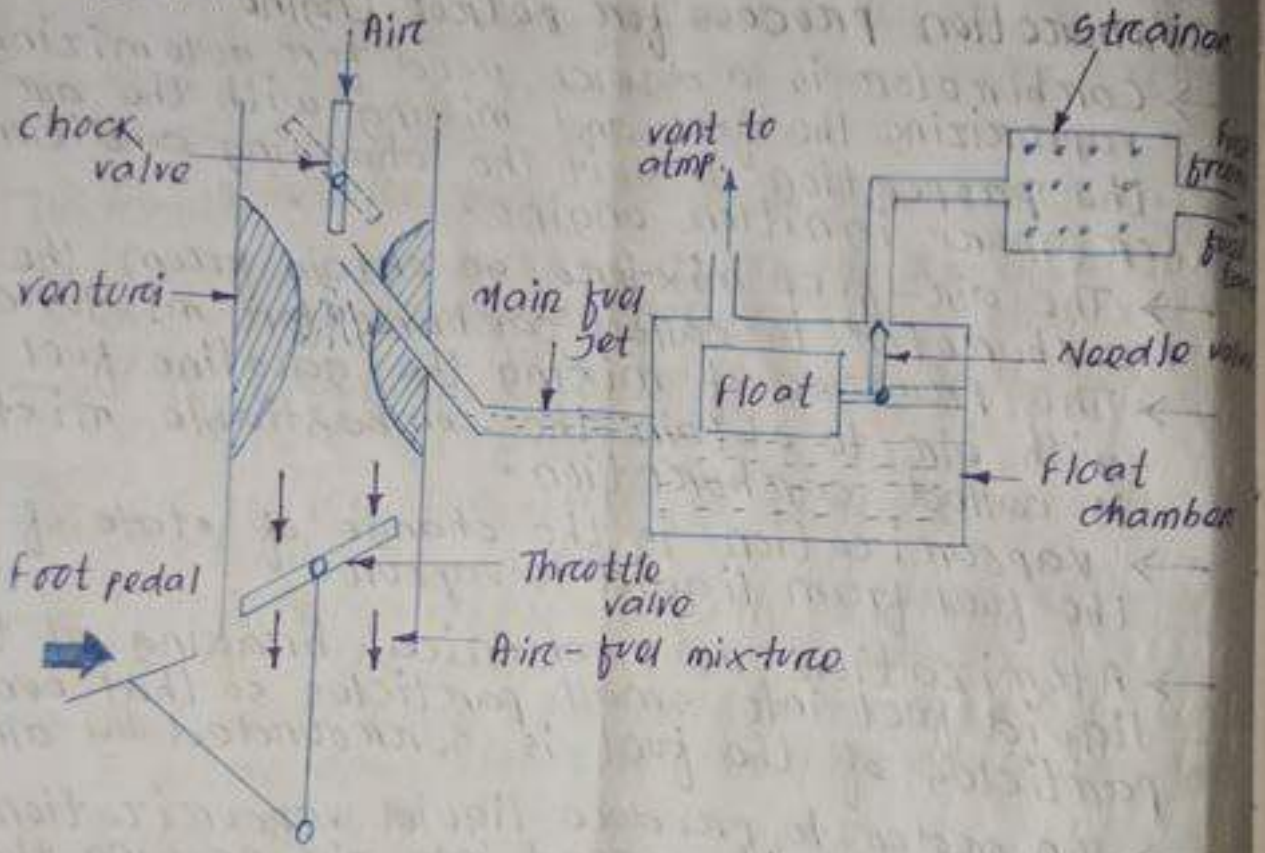
→ For different cars, the air-fuel mixture also varies with speed.
→ The mixture must be rich for intial start, because the engine and the carburator are cold, the fuel vapourizes very poorly.

Carburetion process for petrol Engine

→ Carburetor is a device used for automizing vapourizing the fuel and mixing with the air, the proportion to suit the changing condition of spark ignition engine.
→ The air-fuel mixture so obtain from the carburetor is called carburettor mixture.
→ The process of mixing the gasoline fuel with air to obtain the combustiable mixture is called carburetion.
→ vapourization is the change of state of the fuel from liquid to vapour.
→ Atomization is mechanical braking of the liquid fuel into small particles so that every particles of the fuel is surrounded by air.
→ In order to produce liquid vapourization of liquid fuel, it spread into air passing through carburetor.
→ The carburator supply the air-fuel mixture of varying proportion to suit the changing condition of the engine
→ The mixture must be rich (have a higher % of fuel) for starting, accelaration and high speed operation.
→ The mixture should be lean for (lower % of fuel) operation at intermodiate speed with a worm engine.
→ The theoritical perfect mixture of an air and gas contains (15 part of air and one part of gasoline)

Simple Carburator

→ The carburator is a device for atomizing and vaporizing fuel and mixing it with air in varying proportions to suit the changing operating condition such as varying engine speed load and operating temperature of the motor vehicle engine.



→ During the suction stroke air is drawn through the air cleaner and it passes through the air horn.

→ A discharge tube is connected between the air horn and the fuel blow.

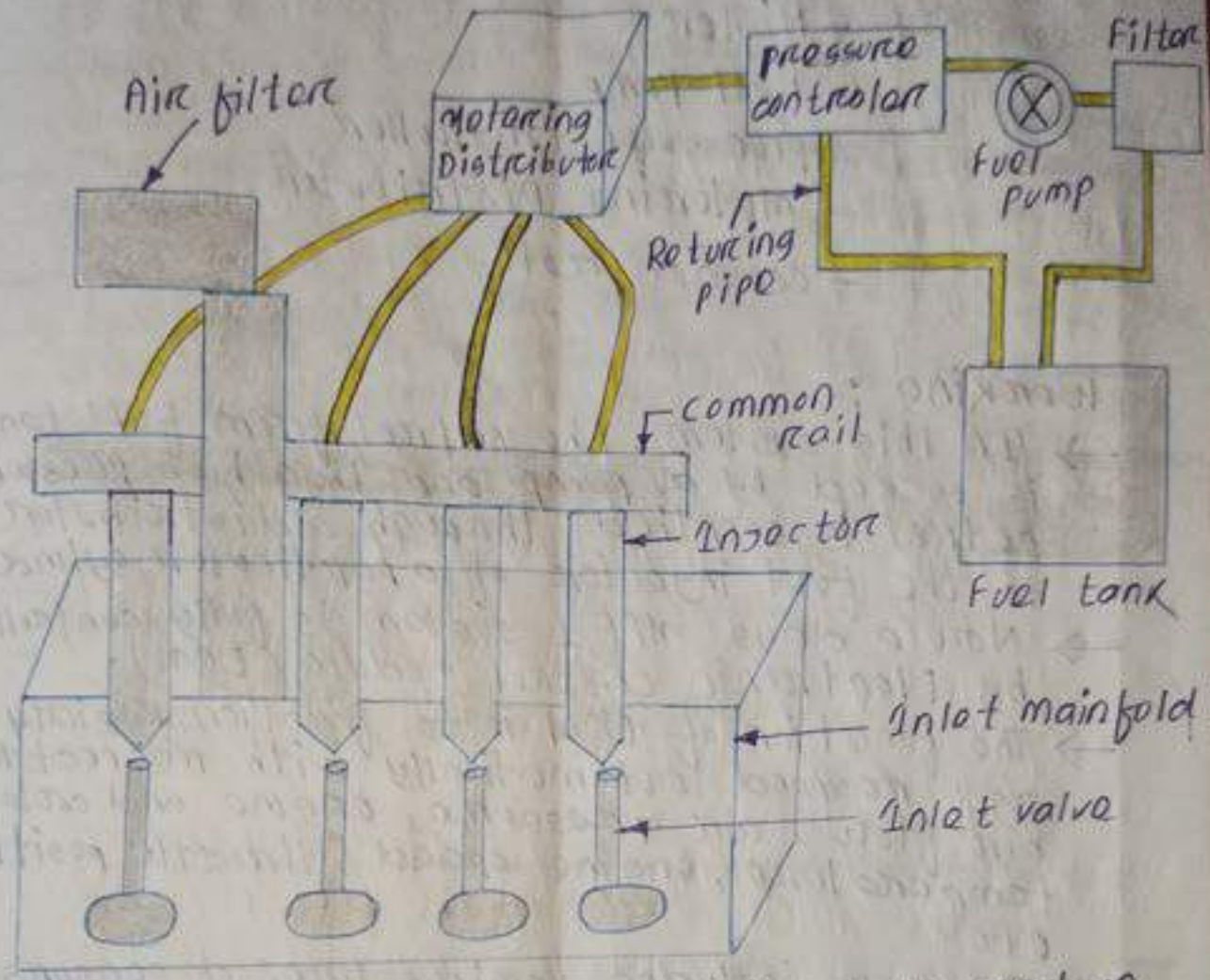
→ when the air passes through the air horn it creates a vaccum at the tip of the discharge tube and suck fuel from the fuel bowl.

→ An air blood is provided on the jet tube which helps in breaking the fuel particle into very fine particles. This is known as atomizing.

→ The fuel and air mixture sucked into the cylinder

→ This process of breaking up fuel and mixing it with air is called carburation.

Multipoint fuel injection system for petrol Engine



→ Now a days MPFI system is widely used in petrol engine in place of carburator.

→ The purpose of MPFI system is to supply proper air-fuel ratio to each cylinder of the engine.

→ The injection type are
- port injection type
- throttle body injection type

→ MPFI system requires one injector per cylinder and in some cases one or more injector are also used to supplement the fuel flow during starting and warm up period.

→ The MPFI system consists of following parts

- Fuel tank
- Filter
- Fuel pump
- pressure controller
- Metering Distributor
- common rail.

Working :-

→ In this system, the petrol from fuel tank is sucked by a pump and then high pressure petrol is supplied through a distributor to the fuel injector of a particular cylinder.

→ Now a days MPFI system is fully controlled by Electronic control module (ECM).

→ The function of ECM is to function rapidly and respond automatically with respect to air flow, air pressure, engine and coolant temperature, engine speed, throttle position etc.

→ The ECM includes various types of sensors. like

- air flow sensor
- air pressure sensor
- coolant temp. sensors.
- engine speed sensors
- throttle position sensors etc.

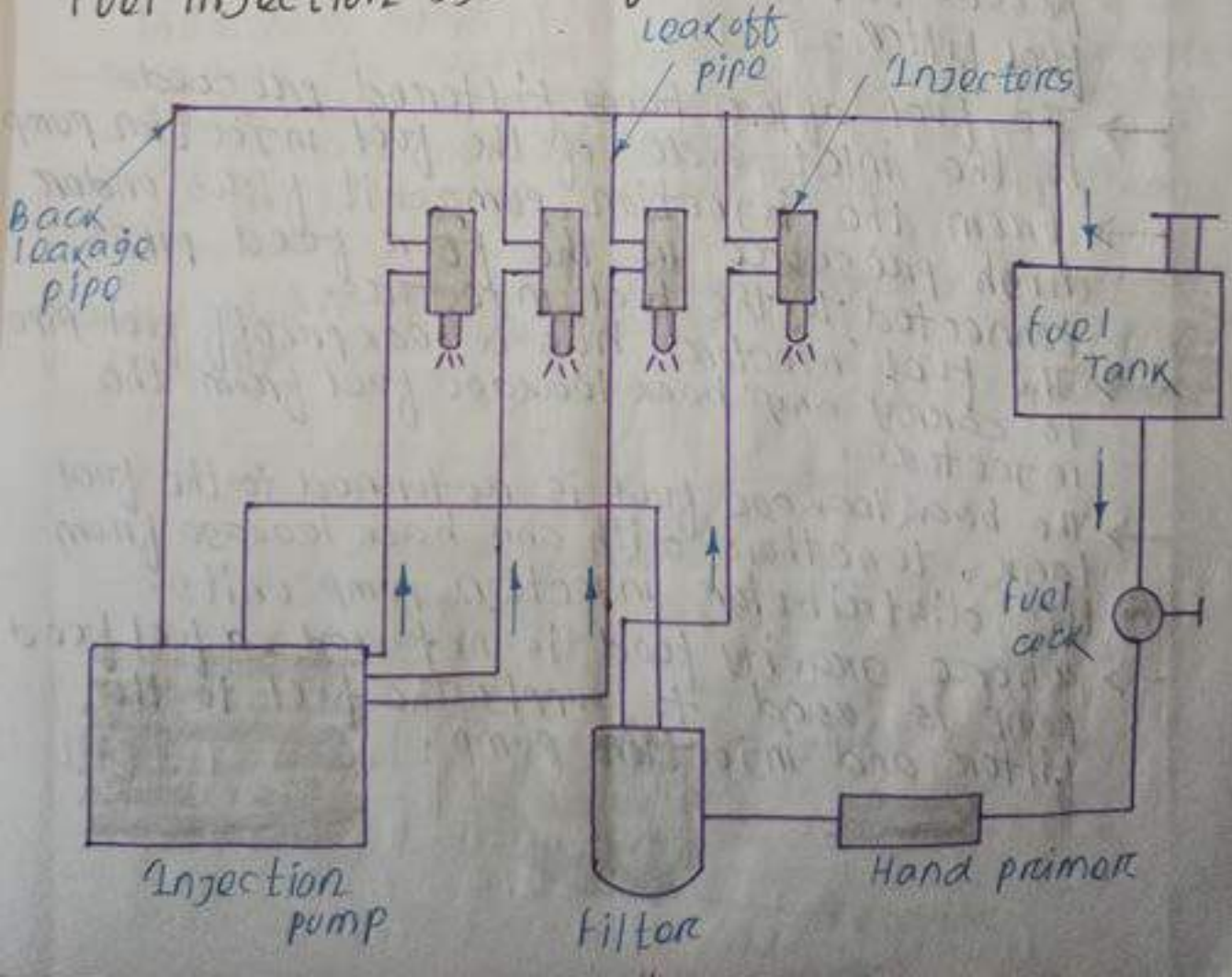
→ The fuel is stored in the fuel tank. It is also known as fuel reservoir.

→ Then the fuel is passes to the filter, where dust particles, bad contaminants are removed by the filter.

→ The fuel is sucked from the reservoir by the help of fuel pump.

→ The fuel then flow to the pressure controllere where the pressure of the fuel is controlled and excess of fuel returns to the fuel reservoir by the returning pipe.
→ Then the controlled oil passes to the metering distributor.
→ The metering distributor distribute the fuel to each injector according to the requirement.
→ Then the system have air supply system.
→ For example if the metering distributor distribute oil to the first injector, then the air is automatically supply to the first cylinder head.
→ The air is coming from atmosphere with proper filtration and in this way the MPFI system works.

Fuel injection system for Diesel. engine



→ The fuel supply system of a diesel engine consists of following components.

(i) Air cleaner
(ii) Fuel tank
(iii) Fuel filter
(iv) Injection pump
(v) injector
(vi) Fuel
(vii) Fuel Gauge

→ The fuel tank of the fuel supply system should be at least one foot above the fuel filters and injection pump.

→ when the fuel cock is open, the fuel flows directly to the hand primer which then passes out to inlet side of the main fuel filter.

→ The fuel after being filtered proceeds to the inlet side of the fuel injection pump

→ From the injection pump, it flows under high pressure in the four feed pipes connected to the fuel injectors.

→ The fuel injector has a leak off fuel pipe to carry any back leakage fuel from the injectors.

→ The back leakage fuel is returned to the fuel tank, together with any back leakage from the distributor injection pump units.

→ where gravity feed is not used, a fuel feed pump is used to supply the fuel to the filter and injection pump.

Filter for Diesel Engine

→ The purpose of fuel filter is to remove the impurities from the fuel and provide trouble free service of other components of the system.

→ The components of fuel filter are :-

(i) Coarse filter element
(ii) micro filter element
(iii) Rubber gasket
(iv) Bowl
(v) center bolt
(vi) Air venting screw

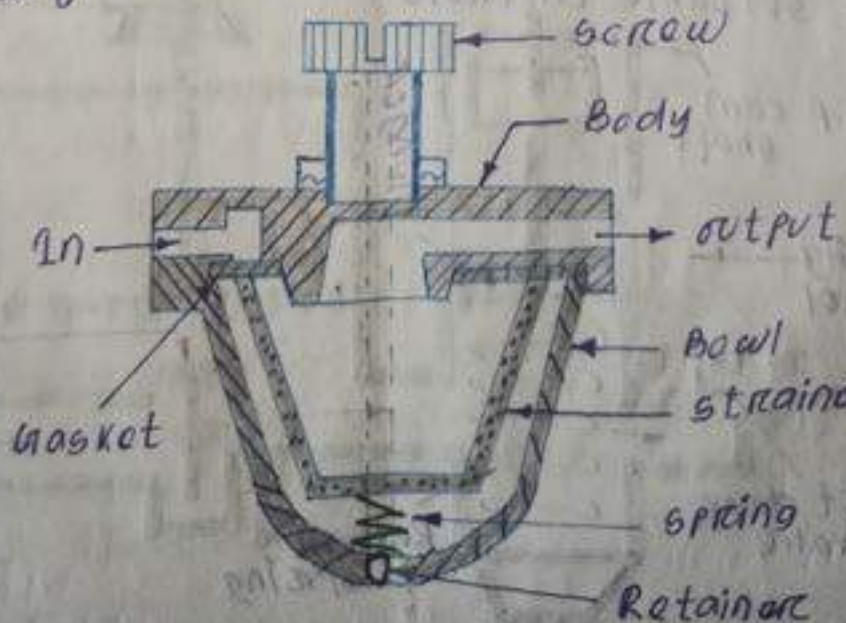
→ The fuel enters the filter bowl in the inlet, then passes through the filter element and leaves the filter to outlet orifice completely clean.

→ In multistage filter the fuel oil close fast through primary filter and then through secondary microfilter before entering fuel injection pump.

→ During the passage through filtering elements. Large and micro impurities in the form of dirt, duct get trapped.

→ so the filtering element need to be clean regularly.

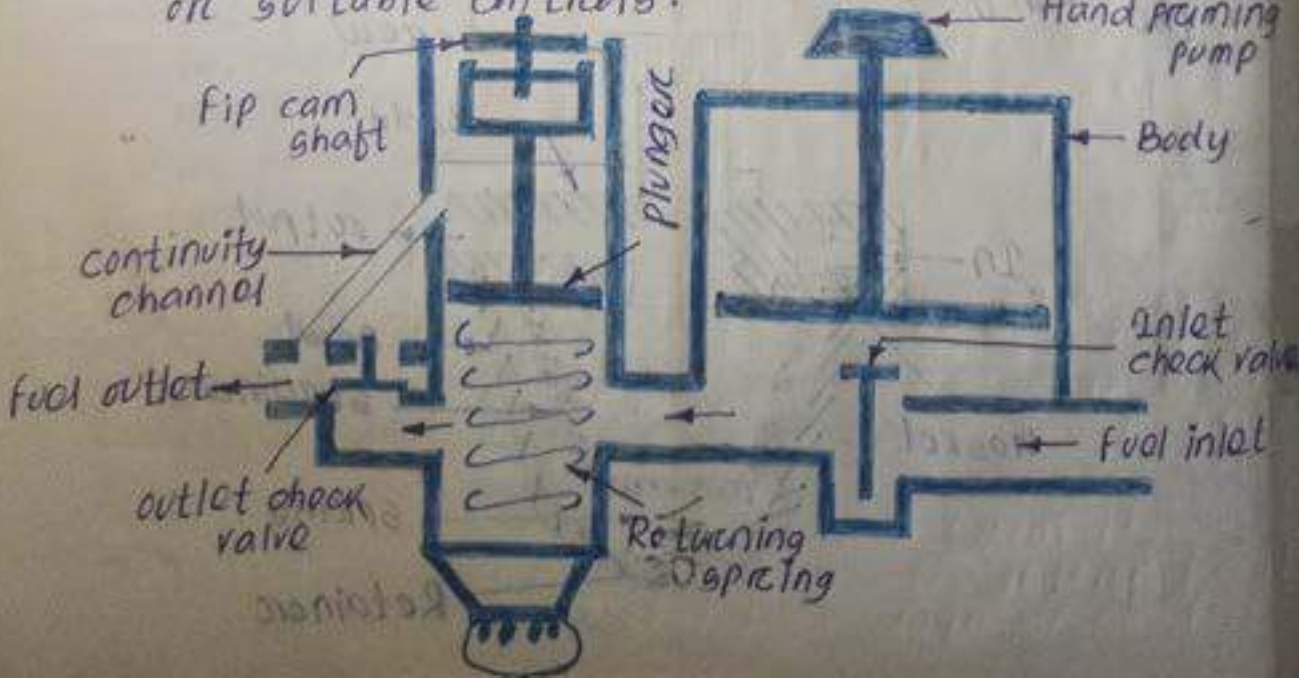
→ The filter should be clean properly according to the perfect time interval.



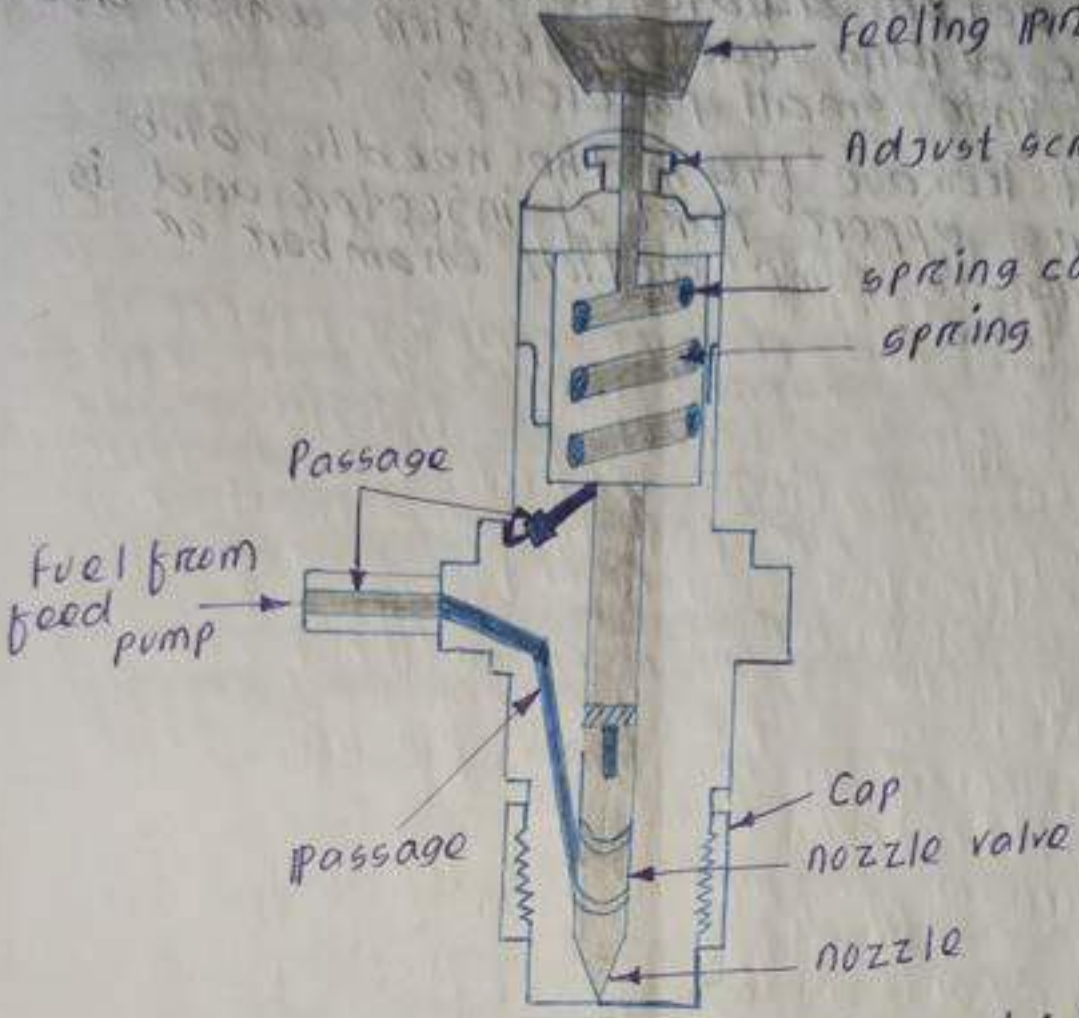
Fuel Feed Pump

Working principle

→ The fuel feed pump delivers the accurately measured amount of fuel at high pressure to injector.
→ The amount of fuel delivered should be control with regard to timing, rate and duration of engine requirements.
→ It consists of pumping element, delivery valve camshaft and trapped gear.
→ The pump has a plunger and barrel arrangement.
→ When the plunger is at BDC, oil enters through the barrel either by gravity or force feed.
→ As the plunger rises, a shorter amount of fuel is pushed through barrel parts.
→ The pressure extracted by the plunger on the oil lifts that valve and enters the delivery pipe.
→ There is a toothed quadrant which meshes with a rack provided on the control rod. which actuates all the pump elements in the unit.
→ It is externally connected to the governor or suitable controls.



Fuel Injector for Diesel Engine



→ It consists of a needle valve which is pressed on its seating the nozzle by a plunger.
→ A compression spring controls the pressure on the plunger, by which needle valve
→ A nozzle is attached to body of injector by a cap nut.
→ The fuel enters the nozzle nozzle through the drilling in the injector body.
→ The fuel may pass from a gallary downwards to the needle valve.
→ Then it passes through the nozzle seat.
→ The body provides passage of fuel.
→ when the needle valve is lifted from its seat by the pressure of fuel, the injection of fuel takes place.

→ when the injection pressure becomes less than spring force the valve closes.
→ This action creates an oxidation of the valve during each injection which breaks fuel into small particles.
→ Fuel leakage from the needle valve enters upper part of injector and is return to pump suction chamber or fuel tank.

UNIT-06 ELECTRIC AND HYBRID VEHICLE

Introduction

→ An electric vehicle (EV) is an automotive vehicle that uses one or more electric motors for propulsion.

→ Electric vehicle have low running costs as they have less moving parts for maintaining and also very environmentally friendly as they use little or no fossil fuels (petrol or diesel)

→ while some EVs used lead acid or nickel metal hybride the standard for modern battery electric vehicle is now considered to be lithium ion batteries, as they have a greater longevity and are excellent at retaining energy.

→ A hybrid vehicle combines any two power (energy) sources, possible combinations include.

- Diesel / Electric
- Gasoline / Fly wheel
- Fuel cell (FC) battery

→ Typically, one energy source is storage and the other is conversion of a fuel to energy.

→ The combination of two power sources may support two separate propulsion systems.

→ Thus to be a true hybrid, the vehicle must have at least two modes of propulsion. For example a truck that uses a diesel to drive a generator, which in turn drives several electrical motors for all-wheel drive is not a hybrid.

→ But if the truck has electrical energy storage to provide a second mode, which is electrical assists, than it is hybrid vehicle.

→ These two power sources may be paired in series meaning that the gas engine charges the batteries of an electric motor that powers the car or in parallel, with both mechanical driving the car directly.

→ An electric car is an automobile that is propelled by one or more electric motors, using only energy stored in batteries.
→ Compared to internal combustion engine vehicles, electric cars are quieter, have no exhaust emmisions and lower emmision overall.

Social and Environmental importance of Electric and Hybrid vehicle

→ The social and environmental importance of electric and hybrid vehicles includes effect on mobility and travel, electricity, supply system operations, petroleum and other fuels consumption, air pollution and traffic noise.
→ An estimated 80 percent of average annual vehicle kilometers can be electrified.
→ Electricity supply system will not need expand capacity and will benifit from load levelling if overnight recharging of electric vehicles is encouraged.
→ petroleum consumption for transportation purpose will define, but the banifits are dependent on the type of fuel used to generate recharge electricity.
→ The fuel mix used by power stations also determines air pollution impacts, since decreases in vehicle emmision accompanied by increases in power plant emmision.
→ Improvements in traffic noise are modest, with 100 percentage electrification of light vehicle producing a 13 percentage decrease in traffic noise impacts.

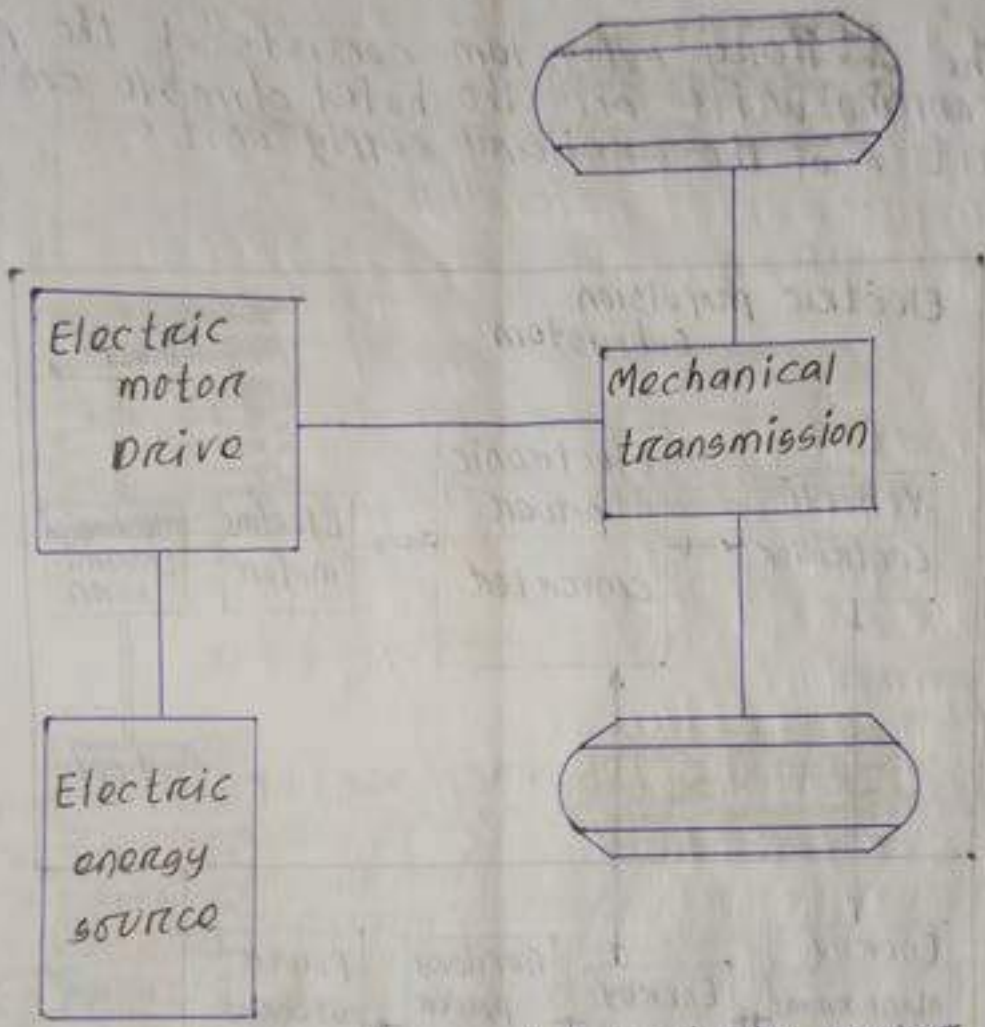
Electric vehicles

→ Electric vehicles (EVs) use an electric motor for traction.
→ chemical batteries, fuel cells, ultra capacitors and flywheel for their corresponding energy sources.
→ The EV was mainly converted from the existing ICEV by replacing the internal combustion engine and fuel tank with an electric

motor drive and battery pack while relating all the other components.

→ In its place, the modern EV is built based on original body and frame design.

→ The structure provides a greater and unique shape to the EVs.



Primary electric vehicle power train

Configuration of Electric vehicle

→ The drive train of electric vehicle consists of three major subsystems.

- electric motor propulsion
- Energy sources
- Auxilary

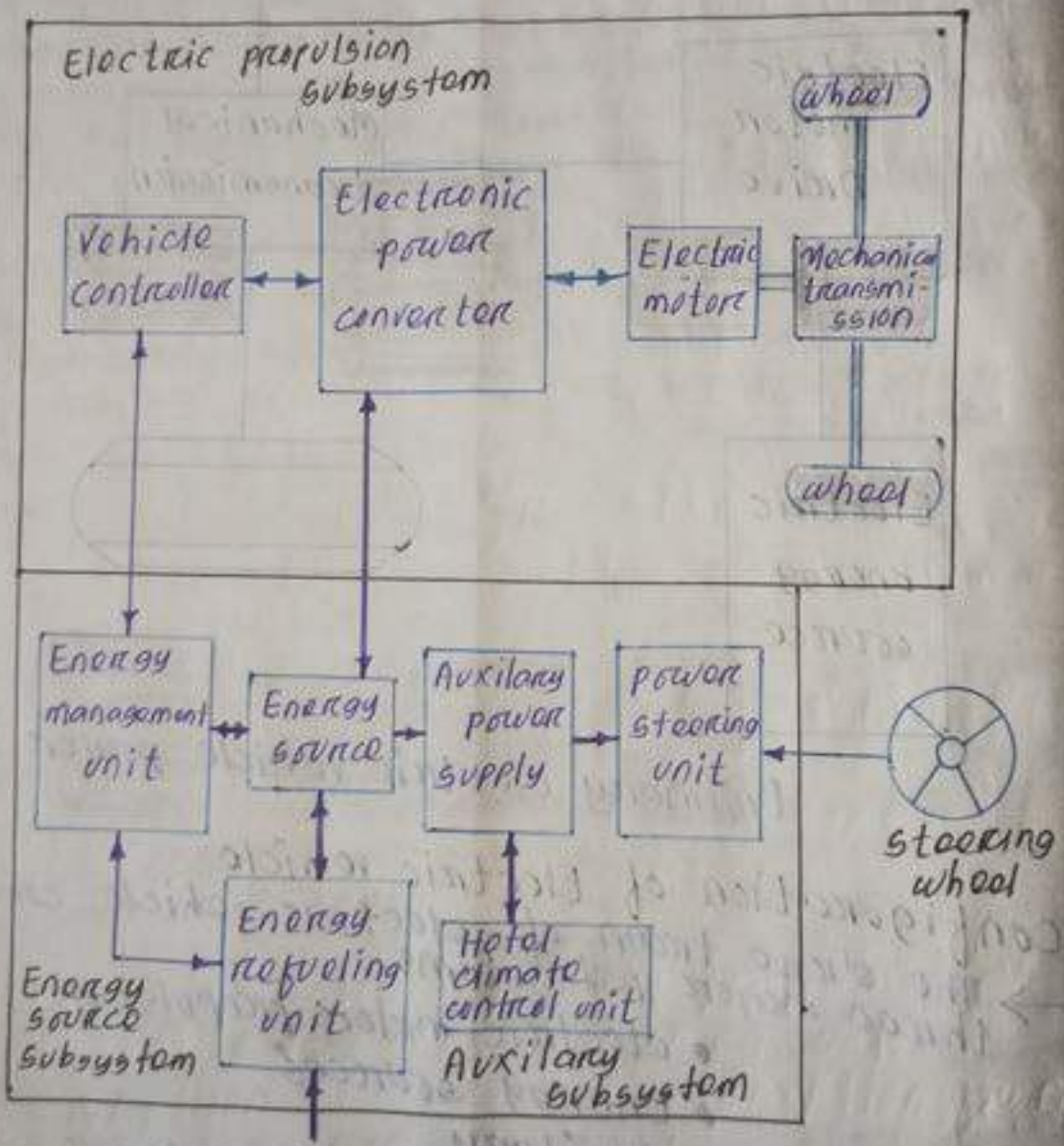
→ The electric propulsion subsystem is comparised with following units

- a vehicle controllor
- power electronic convertor.
- electric motor.

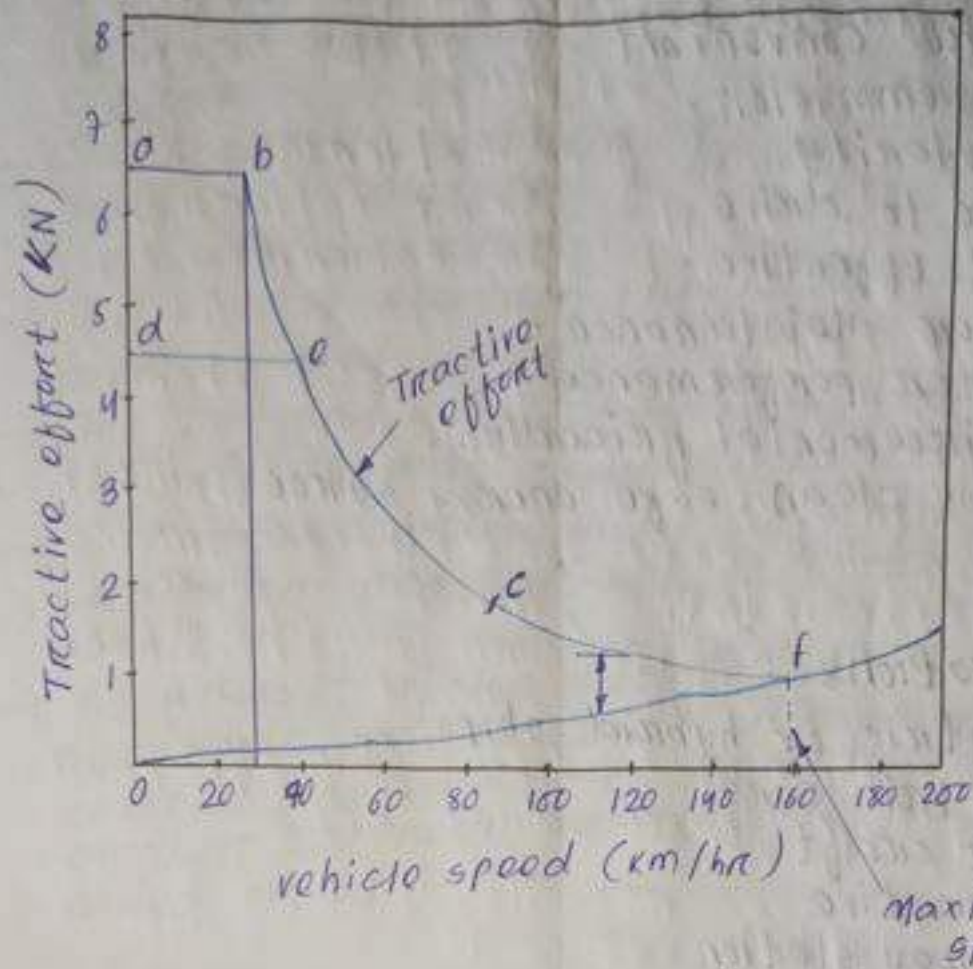
- mechanical transmission
- Driving wheels.

→ The energy sources subsystem involves in
- energy source
- the energy management unit
- Auxilary supply unit.

→ The auxilary subsystem consists of the power steering units and the hotel climate control unit and the auxilary supply unit.



Electric vehicle performance



→ Basic vehicle performance includes maximum cruising speed, grade ability and acceleration

→ The maximum speed of a vehicle can be easily found by the intersection point of the tractive effort curve with the resistance curve in the tractive effort vs vehicle speed diagram shown in the figure.

→ It should be noted that such an intersection point does not exist in some designs which usually use a large traction motor or large gear ratio.

→ In case the maximum vehicle speed is determined by the maximum speed of the traction motor as

$$V_{max} = \frac{\pi N_{m\,max} r_d}{30 i_{g\,min} i_0} \quad (m/s)$$

Advantages of an Electric vehicle

→ No gas required.
→ More convenient.
→ No ammision.
→ popularity.
→ safe to drive.
→ cost effective.
→ Lower maintainance.
→ Better performance.
→ Environmental friendly.
→ It is clean, safe energy source.

Applications

→ Electric or hybrid ships
→ Electric cars.
→ Air craft
→ Locomotive
→ Railway station
→ Industrial utility application.
  - Industrial fork lift
  - Airport tugs.
  - Golf cart

→ Refuse trucks
→ mining vehicle
→ Excavators

operational advantages

→ potentially lower fuel running costs.
→ Exemption from vehicle exemption from vehicle excise duty.
→ Reduced administration.
→ Reduction in delivery point ammision.
→ It reduced emmisions.

Battary for electric vehicle.

→ A battary cell is a device that stores the chemical energy and converts it to electrical energy.

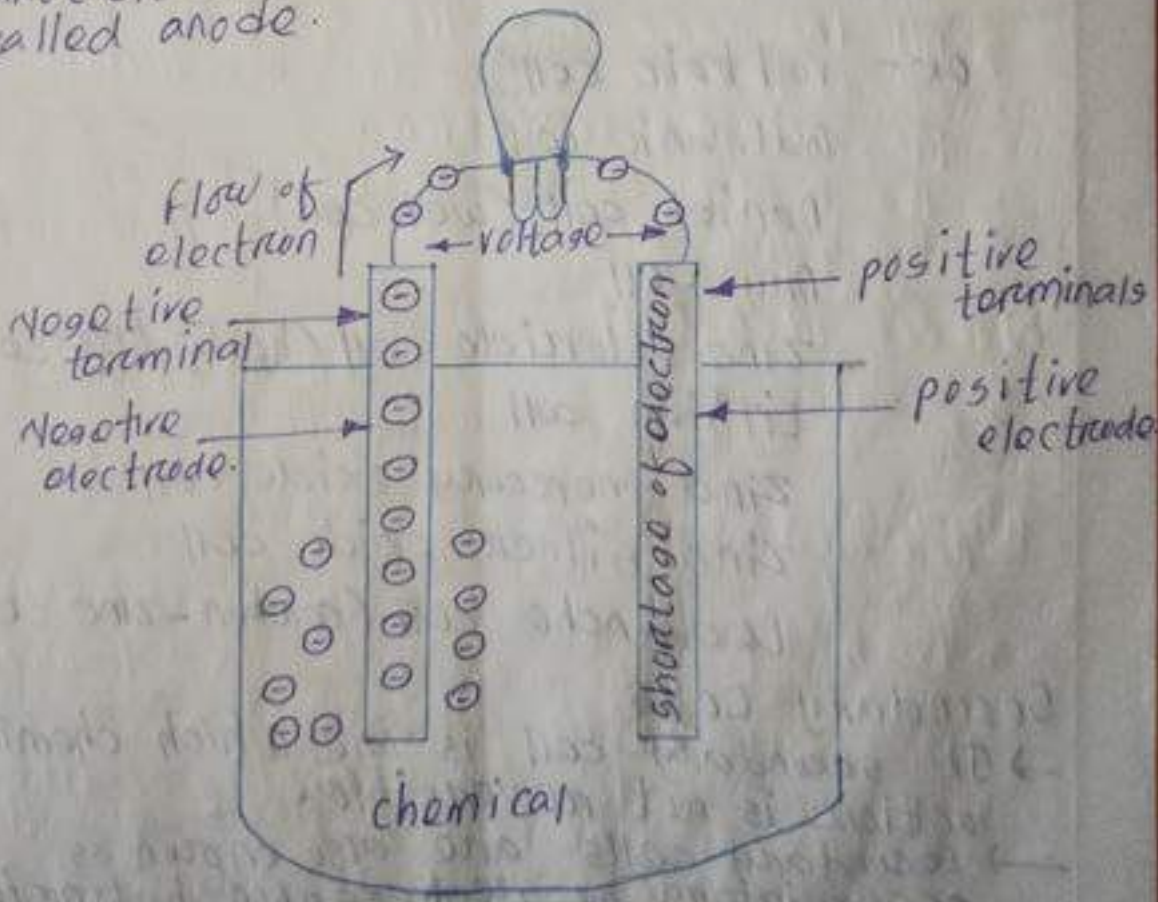
→ The chemical reactions in a battary involve the flow of electrons from one material to the another material.

→ The flow of electron provide an electric current that can be used to do work.

→ The battary manufacturer usually specify the battary with coulometric capacity (amp-hrs)

→ A battary works on the oxidation and reduction reaction of an electrolyte with metal.

→ As a result of the oxidation reaction, one electrode gets negetively charged and called cathode and due to the reduction reaction another electrode gets positively charged called anode.



Types of Battery

- Primary Batteries
- secondary Batteries
  - Lead-Acid Batteries
  - Nickel-cadmium Batteries
  - Nickel-iron Batteries

Primary Cells

→ Primary cell is a cell in which chemical action is not reversible.

→ A primary cell is one which the chemical action eats away one of the electrodes usually negative electrode.

→ many types of primary cells have been developed.

→ primary cells are also called "Disposible cells." or "throw away" cells

ex- voltaic cell
Galvanic cell
Daniel cell (wet cell)
Dry cell
zinc chloride cell (heavy duty cell)
Lithium cell
zinc-mercury oxide cell
zinc-silver oxide cell
Leclanche cell (carbon-zinc cell)

Secondary Cells

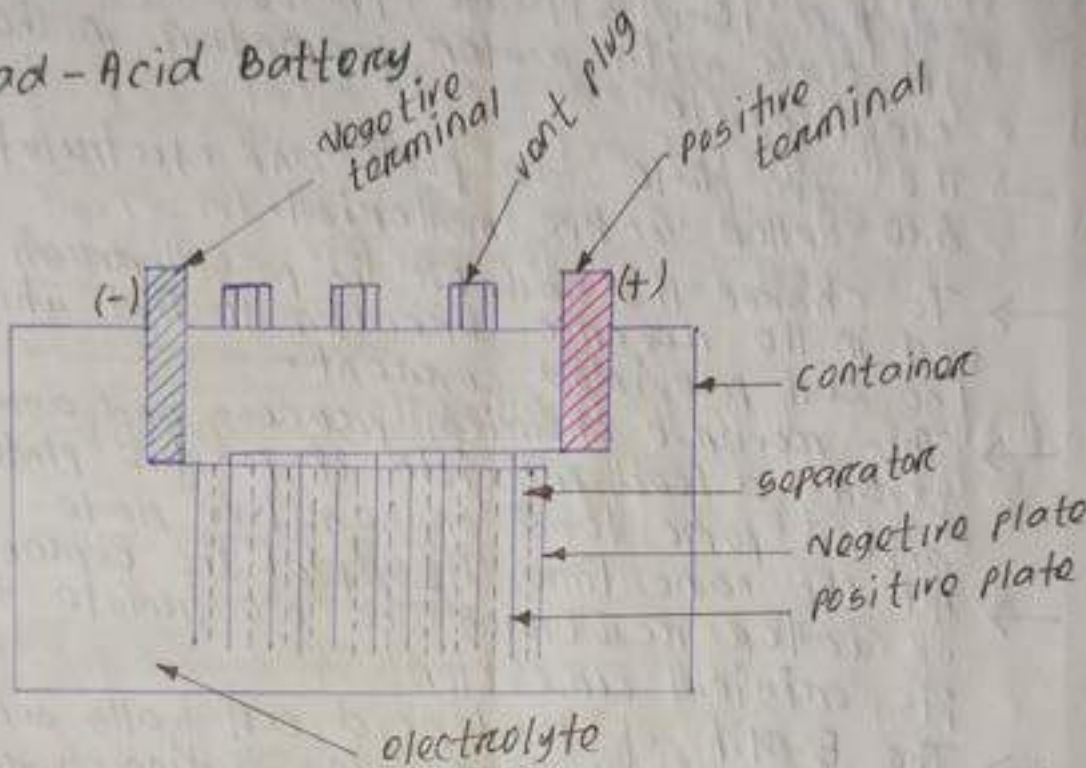
→ In secondary cell is one which chemical action is not reversible.

→ secondary cells are also known as accumulators or rechargeable batteries sometimes storage batteries.

→ secondary cell was first invented by French scintist Gaston Planet in 1859.

ex- Lead acid battery
- Nickel-iron alkaline battery.
- Nickel - cadmium alkaline battery
- silver - zinc battery

Lead - Acid Battery



A battery consists of number of cells and each cell of the battery consists of following components.

- container
- positive terminal
- Negative terminal
- separator
- Electrolyte
- cell cover and vent plug
- cell connector
- Battery terminal

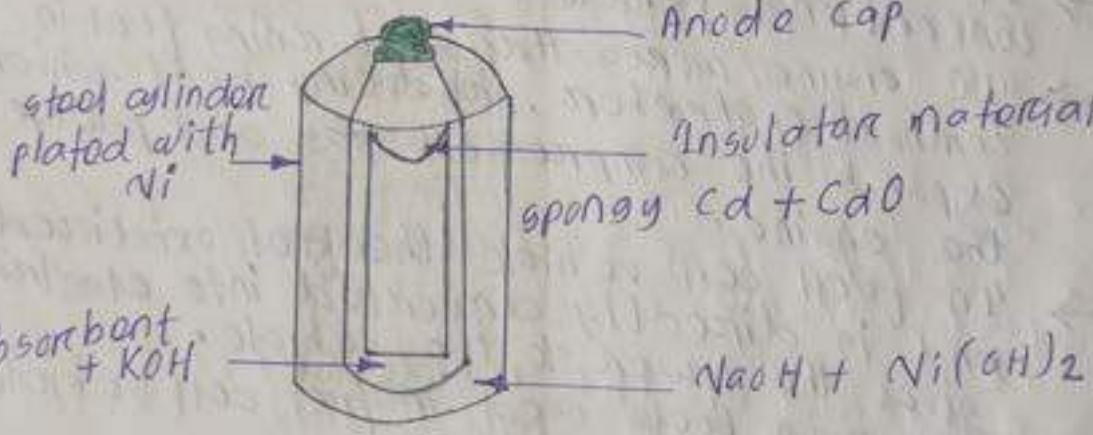
→ The most inexpensive secondary cell and is widely used for commercial purpose.
→ The positive plates is PbO_2,
The negative plates is Pb,
are immersed in a dilute sulphuric acid.
→ when the cell supplies current to the solution the chemical action takes place forms lead sulphate ($PbSO_4$) on the both the plate with water formation in the electrolyte.
→ The two plate, -ve plate and electrolyte are called active material.
→ To charge the cell D.C is pass through the cell in the reverse direction to that which the cell provided current.
→ This reverse chemical process and again forms a lead peroxide on positive plate and a pure lead on negative plate.
→ At the same time H_2SO_4 at the expense of water restoring the electrolyte to its original condition
→ The E.M.f of lead acid cell falls during discharge and increasing during charging.

Nickel-iron cell

→ similar to lead acid cell nickel iron cell also has a multi plate construction.
→ The positive plate consists of a number of perforated steel tubes mounted on a nickel plate steel grid.
→ Each tube is filled with nickel hydroxide.
→ About 19% of graphite is added to increase the conductivity of plates.
→ It also contains an activating additive barium hydroxide which is about 2% of active material to increase the service of the plates.

→ The negative plates are constructed of many small perforated steel pockets each filled with powdered iron.
→ Small quantities of nickel sulphate and ferrous sulphide are added to improve the performance of the cell.
→ The alternative positive and negative plate of the cell are sandwiched together with separator.
→ The negative plates are connected together like positive plates.
→ The outside plate being negative.
→ The number of negative plates is always on more than the number of positive plates.

Nickel-Cadmium Battery



Ni-Cd cell

→ Nickel-cadmium rechargeable cell is another secondary storage alkaline battery.
→ Ni-Cd cell is rechargeable.
→ The cell can be represented as
- Cd / CdO / KOH (6M) / Ni(OH) / Ni
- Anode sponge Cd / CdO
- Cathode nickel oxyhydroxide / Ni
- electrolyte KOH (6M)

→ Rechargeable Ni-Cd battery comprise a +ve electrode plate which use nickel oxy hydroxide as it main active material.
→ A -ve plate which uses cadmium as its main active material, a separator made of a thin non-woven fabric.
→ An alkaline electrolyte and metal case sealing plate provided with a self-sealing safety valve.
→ A cell cup made up of steel coated with nickel acts as cathode.
→ A cell cap in contact with the anode of the cell is at the center and anodic.

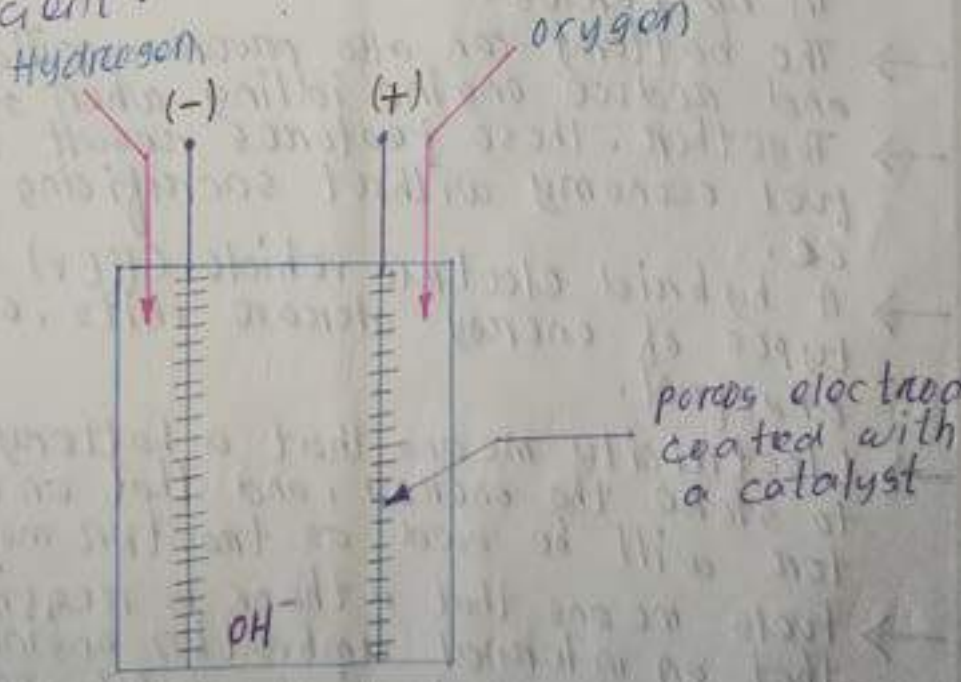
Introduction to fuell cells

→ It acts like an reactor on automobile conventional vehicle.
→ IC engine works through burning fuel in combustion chamber, producing heat which expands the compressed gas and power the engine.
→ In fuell cell vehicle the fuel oxidized and is directly converted into electricity gives the power to the vehicle.
→ The main fuels used in fuel cell vehicle is hydrogen.

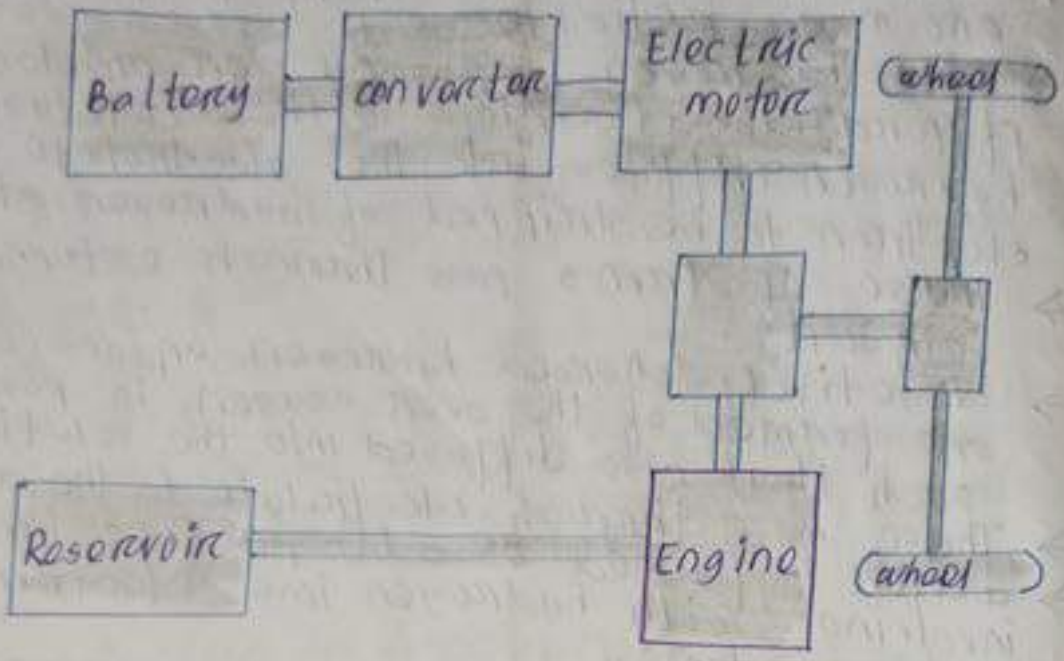
Working Principle

→ It involves the oxidation process and transfer the electron between fuel and oxidant.
→ Energy of fuel cell directly converted the fuel to electricity.
→ Battery cell involves an oxide reduction at positive pole an oxidation in negative pole, during some part of their chemical process.

→ An electrolyte, anode, cathode are used to separates the reactions in fuel cells.
→ fuel cells are more silent in operation and more reliable.
→ when hydrogen is passed over an electrode of porous nickel coated with a catalyst, hydrogen diffuses into the electrolyte causing electron to be stripped of hydrogen atoms.
→ These electrons pass through external circuits.
→ Negetively charged hydrogen anions (OH^-) are formed of the over oxygen is passed such they also diffused into the solutions.
→ These move through electrolyte to the anode.
→ water is formed as a by-product by reaction involving with hydrogen ions, electrons and oxygen atoms.
→ working temp. of fuel cell is about 373K
→ Hydrogen is the main fuel used with oxygen
→ when compares to battery cons it is more efficient.



Hybrid Vehicle



→ Hybrid electric vehicle are powered by an internal combustion engine and an electric motor. which uses energy stored in batteries.

→ The battery can also power auxillary loads and reduce engine idling - when stopped.

→ Together. these features result in better fuel economy without sacrificing performance.

→ A hybrid electric vehicle (HEV) has two types of energy storage units, electricity and fuel.

→ Electricity means that a battery is used to store the energy, and that an electromotor will be used as traction motor.

→ fuels means that a thank is required. and that on internal combustion engine is used to generate mechanical power, or that a fuel cell will be used to convert fuel to electrical energy.

→ in the latter case, traction will be performed by electromotor only.

→ In the first case, the vehicle will have both an engine and a motor.

Main components of Hybrid vehicle

- Motor
- The battery pack
- Accessories