LECTURE NOTES

ON

AUTOMOBILE ENGINEERING AND HYBRID VEHICLES

6TH SEMESTER

DIPLOMA IN MECHANICAL ENGINEERING

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Automobile

Automobile Engineering

It is the branch of engineering in which we study about the automobiles & have practice to propel them.

Automobile

An automobile is a self-propelled vehicle which is used for the transportation of passengers & goods upon the ground.

Vehicle

A vehicle is a machine which is used for the transportation of passengers & goods.

Automobile Exp:- Car, Bus, Truck, Jeep, Tractor, Scooter Motor cycle.

Automobile :→ Means → one which itself can move

→ 1st Automobile → 1769 - France

Nicholas - Joseph Cugnot

3-Wheeler - 4 seater Road vehicle

Speed - 2½ mph

Different names for Automobile

1. Auto
2. Automobile
3. Autocar
4. Car
5. Motor
6. Motor Car
7. Motor Vehicle
8. Motor Coach
9. Motor Wagon
10. Horseless Carriage

Types of Automobile

1. Purpose :→ (i) passenger vehicles - car, jeep, Bus
   (ii) Goods vehicles - Truck
   (iii) Special purpose - Ambulance, Fire vehicle, Army vehicle
2. Capacity :→
   (i) Light motor vehicles → Car, Motor cycle, Scooter
   (ii) Heavy motor vehicles → Bus, Tractor, Coaches
3. Fuel used :→
   (i) Petrol vehicles :→ Car, Jeep, Motor cycle, Scooter
   (ii) Diesel vehicles :→ Truck, Bus, Tractor, Bulldozer
   (iii) Steam Carriages :→ Steam Road rollers
   (iv) Gas vehicles :→ CNG vehicles
   (v) Electric Vehicle → Electric car, Electric bus

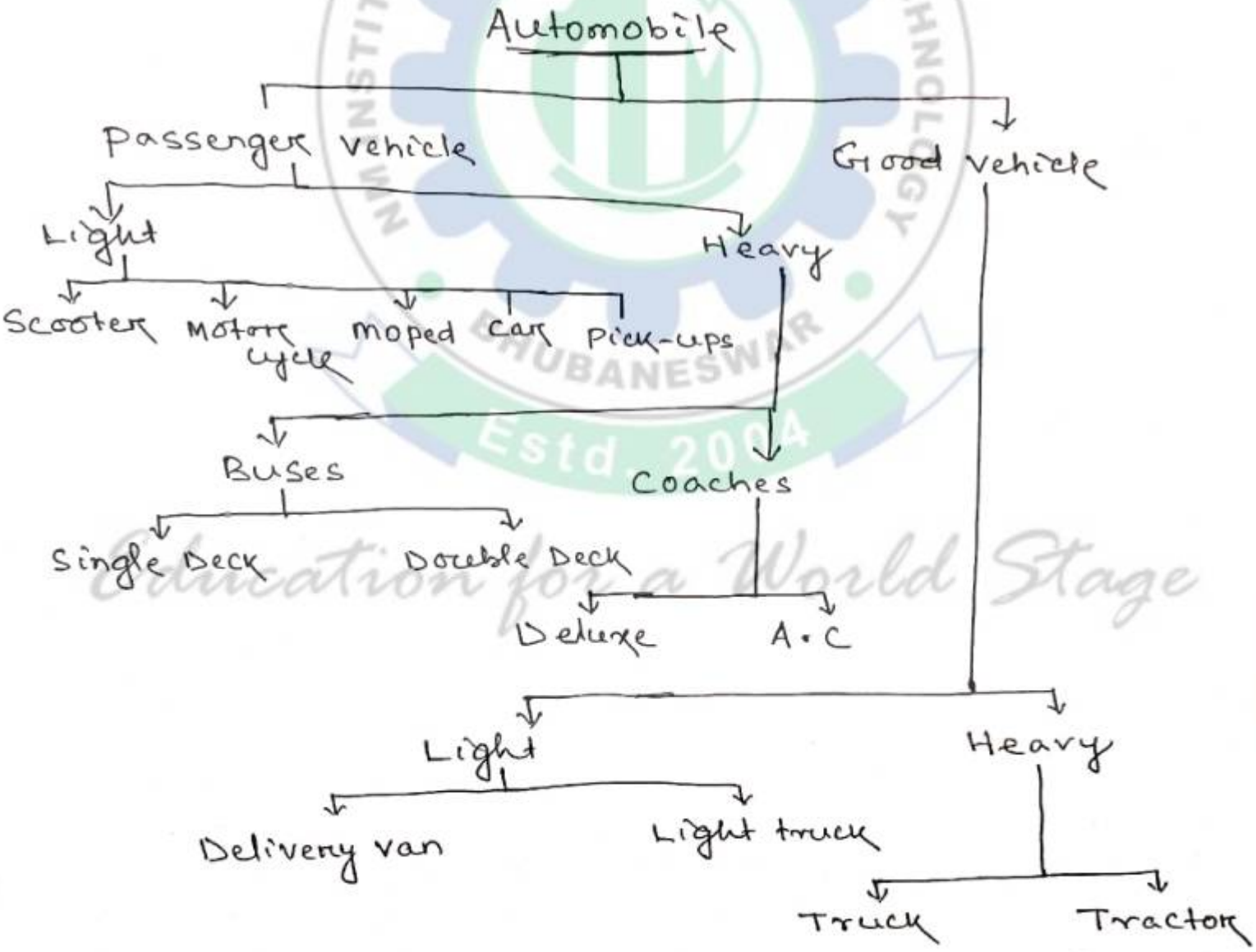
4. No. of Wheels

(i) Two wheeler :→ Mopeds, Scooter, Motor cycle
(ii) Three wheeler :→ Tempo, Road roller
(iii) Four wheeler :→ Car, Jeep, Bus, Tractor
(iv) Six wheeler :→ Truck, tanker,
(v) Eight or more wheeler :→ Car transporting vehicle
Rocket transporter.

5. Drive of the Vehicle

(i) single wheel drive
(ii) Two wheel drive
(iii) Four wheel drive
(iv) Six wheel drive

Classification of Automobile



Manufacturer's Specification

Motorcycle :→

1. Bajaj Auto - Bajaj M 50, Bajaj M 80
2. Enfield India - Bullet 350, Mini Bullet ~~[illegible]~~ 198
3. Escort - Rajdoot 350, Rajdoot 175,
4. Ideal Jawa - Yezdi 350, Yezdi 175
5. Ind Suzuki - AX 100
6. Karnataka Scooter - Falcon GT 50

Scooter :→

1. Andhra pradesh Scooter - Vespa PL 170
   Allwyn Pushpak 150
2. API - Lamby 150, MAC 175
3. Bajaj Auto - Bajaj 150 CBU, Bajaj 150 CKD
4. Girnar Scooter - Girnar 150
5. Lohia Machines - Vespa XE 100, Vespa XE 150
6. Maharashtra Scooter - Priya 150
7. Scooter India - Vijay Super 150, Lambretta Cento 100

Car :→

1. Hindustan Motors - Ambassador, Contessa
2. Maruti Udyog - Maruti 800 car, Maruti 800 Deluxe car
   Maruti 800 High roof Van
   Maruti 800 Flat roof van
3. Premier Automobiles - Premier Padmini
4. Sipani Automobiles - Dolphin
5. Standard Motors - Gazel

Bus

1. Ashok Leyland
2. Hindustan Motors
3. Premier Automobiles
4. Tata Engineering & Locomotives

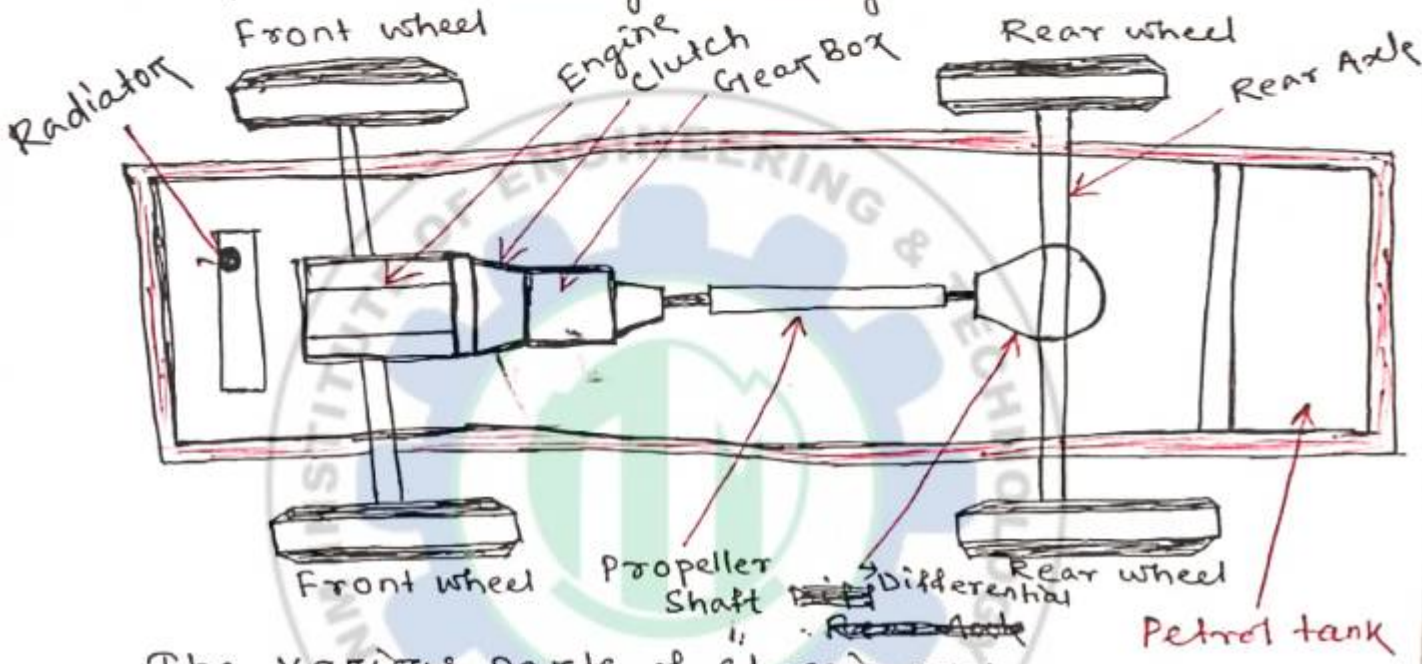
Body :→ Body is made of sheet metal or fibre glass, so that passengers can sit in it.

Chassis

(i) Vehicle without body is known as Chasis.

(ii) It is a French term. & also known as Carrying unit.

(iii) It contains all the major units necessary to propel the vehicle. It's the main mounting for all the components including the body.



The various parts of Chassis are:-

1. Frame
2. Front Suspension
3. Steering Mechanism
4. Radiator
5. Engine
6. Clutch
7. Gear Box
8. Propeller Shaft
9. Differential
10. Universal Joint
11. Brakes & Braking System
12. Storage Battery
13. Silencer
14. Shock Absorbers

(iv) The Chassis is devided into two types :→

* Running gear :→ it includes Frame, Steering System, Suspension System Brakes, Wheels & tyres.

* Power plant :→ it includes Engine assembly, power transmission

The Electrical system is the part of both Chassis & Body.

Classification of Engine

Gasoline → lightest & volatile liquid by refining petroleum

(a) Type of fuel used :-
- (i) Petrol engine or Gasoline engine
- (ii) Diesel Engine
- (iii) Gas engine

(b) Cycle of operation :-
- (i) Otto cycle
- (ii) Diesel cycle
- (c) Duel combustion cycle

(c) Number of stroke :→
- (i) Four - Stroke engine
- (ii) Two - Stroke engine

(d) Type of ignition :→
- (i) Spark ignition engine (S.I)
- (ii) Compression ignition engine (C.I)

(e) Position of cylinder :→
- (i) Single cylinder engine
- (ii) Two - cylinder
- (iii) Three - cylinder
- (iv) Four - cylinder
- (v) Six - cylinder
- (vi) Eight - cylinder
- (vii) Tweleve - cylinder
- (viii) Sixteen - cylinder

(f) Arrangement of cylinder :→
- (a) Vertical engine
- (b) Horizontal engine
- (c) Radial engine
- (d) V - engine
- (e) Opposed cylinder engine

(g) Type of cooling :→
- (a) Air cooled engine
- (b) Water cooled engine
- (c) Evaporation cooling engine.

Classification by Fuel used

(a) Petrol engine (b) Diesel engine (c) Gas engine

(a) Petrol Engine

- Fuel used, Petrol
- Based on otto cycle
- Air-fuel mixture is sucked into the cylinder during suction stroke. The correct air-fuel mixture obtained from Carburettor.
- The mixture is compressed during the compression stroke, ignited during power stroke, & the exhaust gases pushed out during the exhaust stroke.
- A spark plug is fitted at the top of the cylinder which gives spark to ignite the mixture.

(b) Diesel Engine

- Fuel used - diesel ~~engine~~
- Diesel oil is light, with a low viscosity & high cetane number.
- In diesel engine, only air is sucked into the cylinder during the suction stroke & compressed to a high pressure.
- The diesel oil is injected by an injector at the end of the compression stroke.
- NO Separate ignition system is required.
- The burnt gases expand pushing the piston down during the power stroke & finally the gases are pushed out during the exhaust stroke.

Difference bet^n Petrol & Diesel Engine

(i) In diesel engine, the fuel is fed into the cylinder by a fuel injector & is mixed with air inside the cylinder. In petrol engine, the air & fuel ~~mixture~~ mixed in Carburettor before they enter into the cylinder.

(ii) In diesel engine - fuel injector is used.
Petrol engine - Spark plug

(iii) The diesel engine produces more kilometers per litre in a motor vehicle than the petrol engine.

(iv) Diesel engine burns fuel of low volatility. Petrol engine burns fuel of high volatility.

↳ The property of gasoline, alcohol etc. to evaporate quickly (Gasoline is more volatile than Kerosene)

(V) Diesel engine works on constant pressure i.e diesel cycle, petrol engine works on constant volume i.e otto cycle.

(VI) Diesel engines are mostly used in heavy vehicles i.e Tractor, Truck, Bus. But petrol engines are mostly used in light vehicles like car, Jeep, motor cycle, scooter etc.

(VII) The fuel consumption of diesel engine is less as compared to petrol engine.

(VIII) The running cost of diesel engine is less as compared to petrol engine.

(IX) Diesel engine is heavier than petrol engine.

(C) Gas Engine / Gas turbine

↳ A gas engine is an internal combustion engine which runs on a gas fuel. such as coal gas, Biogas, natural gas.

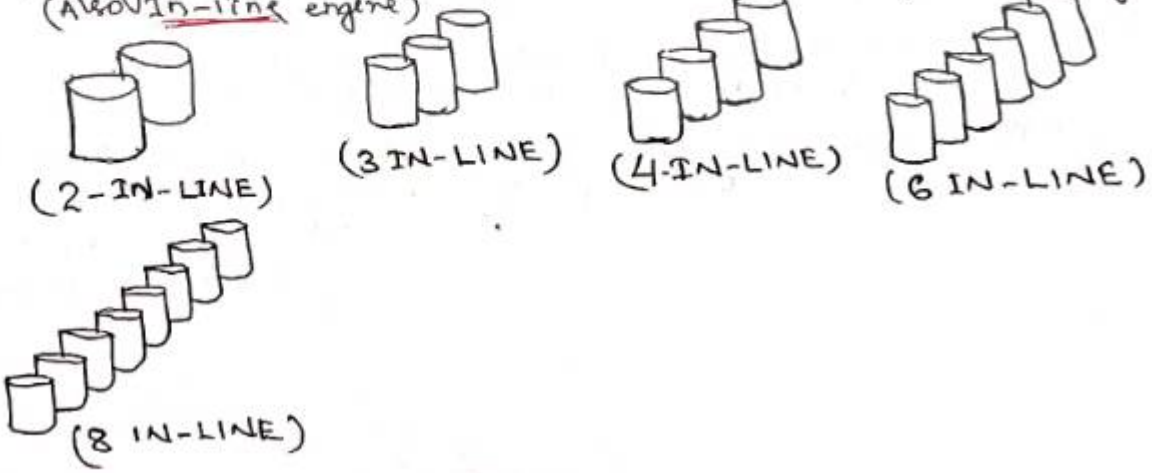
↳ Consist of two section → Gasifier section
→ Power section

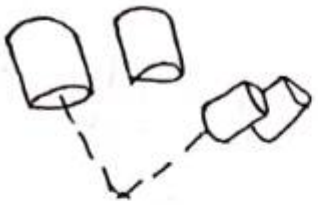
Classification of Engine by position (Numbers) & Arrangement of cylinder

↳ The automobile engine have
One-cylinder → Scooters, motorcycles,
Two-cylinder → Tractors
Four & Six-cylinder → Cars, Jeeps, Buses, Trucks,
Eight-cylinder → American passenger cars.
Twelve & Sixteen-cylinder → Also used in Cars, Buses, Trucks,
Three-cylinder → Foreign front drive automobile.

↳ The cylinder can arranged in several ways:- Vertical V-engine, Horizontal, Radial, opposed cylinder engine.

(Also In-line engine)

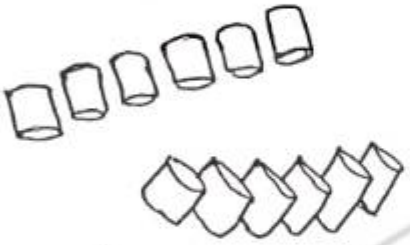




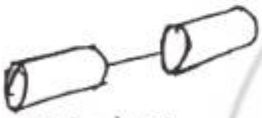
(V-4)

(V-6)

(V-8)



(V-12)



(Flat-2)

(Flat-4)

(Flat-6)

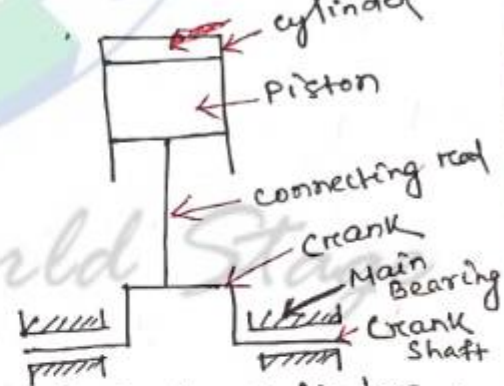
(Radial)

Single-cylinder Engine

↳ Used for light vehicles like Scooter, & Motor cycles.

↳ Minimum size - Restricted about 250-300 c.c

Jawa - 250 c.c engine
Rajdoot Motorcycle - 175 c.c engine
Lambretta - 150 c.c engine
Vespa - 150 c.c engine
Vijay Deluxe - 150 c.c engine



(single-cylinder engine)

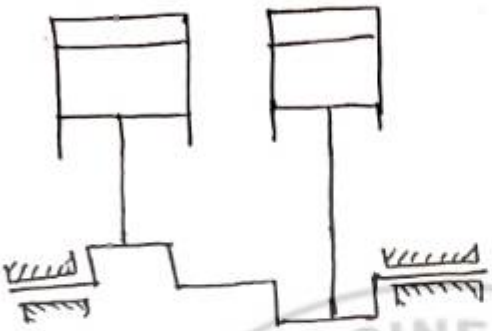
Two-cylinder Engine

↳ used in tractors

↳ It may be of 3 types:- (i) In-line vertical type
(ii) V-type
(iii) Opposed type

(i) In-line vertical type :→

↳ In this arrangement, the two cylinders are placed side by side vertically, so that their cranks are at 180° apart.



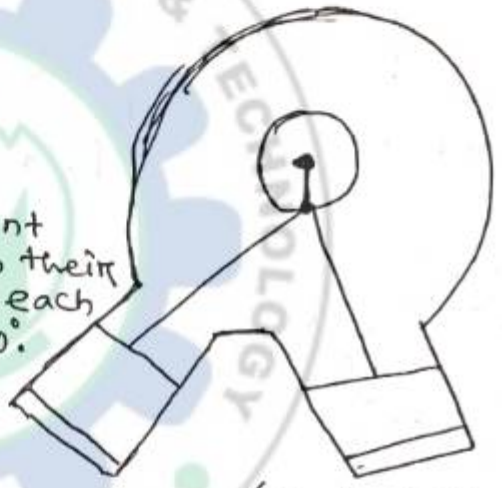
(In-line vertical type)

↳ This type of arrangement provides good balancing & more uniform torque.

(ii) V-type

↳ In this type of arrangement two cylinders are placed with their centre lines at some angle to each other. This angle is usually 60°.

↳ This arrangement is more economical.



(V-type)

(iii) Opposed type

↳ In this type of arrangement the two cylinders are arranged horizontally opposite to each other.

↳ Run smoothly at much higher speeds.

↳ Also gives higher outputs.

(Opposed type)

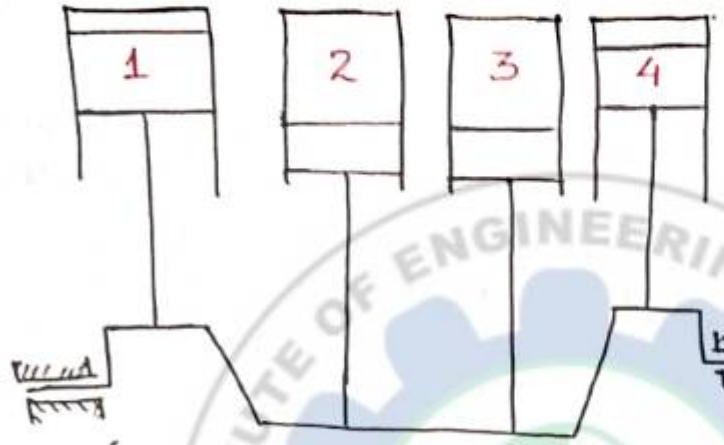
Three-cylinder Engine

↳ Used on front drive car.
↳ Differential is located betⁿ the engine & transmission.
↳ Here the three cylinders are placed in line.
↳ This is a two stroke cycle engine.
↳ Here the crankcase is devided into three separate compartments, one for each cylinder.

Four-cylinders Engine

↳ mostly used in ordinary cars.

↳ The torque obtain is more uniform as compared to the two-cylinder engine.



(In-line vertical type 4-cylinder Engine)

The four-cylinder engine arranged in three types:-

(i) In-line vertical type
(ii) V-type
(iii) opposed type

(i) In-line Vertical type :→

↳ In this type of arrangement, the 4-cylinders arranged in one row or line.

↳ The first & fourth cylinders are in phase while the second & third cylinders are also in phase but in opposite direction.

(ii) V-type :→

↳ Four-cylinders are in two rows of two cylinders each. & two rows are set at an angle to each other.

↳ The angle of V is kept small usually 15° to 20°, because with larger angle the balancing of the engine becomes more difficult.

(iii) Opposed type :→

↳ The cylinders are in two rows of two cylinder each. Set opposite to each other.

↳ The Volkswagen engine has this type of arrangement of 4-cylinder. It is air-cooled & mounted at the rear of the car.

Six & Eight-Cylinder Engine

↳ gives much more smoother torque & higher horse power.

↳ The cylinder of this engine also arranged in three ways :→ In-line . . .
V-type
& opposed type

↳ 6-cylinder engines & V-8 engines are mostly used. & the angle for V-8 engine kept 90°.

↳ V-6 engine has two, ~~three~~ 3-cylinder rows that are set at an angle to each other. Here the crank-shaft has three cranks.

↳ V-8 engine has two 4-cylinder rows that are set at an angle to each other. Here the crankshaft has four cranks.

Twelve & Sixteen-Cylinder Engine

3 types

(i) V-type has two rows of cylinder
(ii) W-type has three rows of cylinder
(iii) X-type has four rows of cylinder

↳ This type of engine is used in cars, buses, trucks, & industrial installations.

↳ The only ~~cars~~ passenger car now being made with a twelve-cylinder engine is → Ferrari

Classification of Engine basing on working principle

Four-Stroke Engine

↳ Completes a cycle of operation during the four strokes, Suction, Compression, Power & exhaust

↳ These four strokes require two revolutions of the crankshaft, Thus during every two revolutions of the crankshaft there is only one power stroke of piston.
Exp:- Car, truck, Bus

Two-stroke Engine :→ completes a cycle of operation during the two piston stroke.

↳ These two strokes requires one revolution of the crankshaft, Thus during every one revolution of the crankshaft ~~there~~ there is one power stroke of piston.
Exp:- Motor cyle, Scooter

The two-stroke engine produce more horse power as compared to 4-stroke engine of same size, running at same speed.

Transmission System

Transmission

Transmission is used for a device located betⁿ the clutch & propeller shaft. It is consist of gearbox, torque converter, overdrive, hydraulic drive.

Purpose of Transmission (~~Purpose of Gearbox~~)

The purpose of transmission is to provide high torque at the time of starting, Hill climbing, Pulling load.

Types of Transmission

(a) Manually operated transmission :-
- ↳ used in car, Bus & Truck
- ↳ Also known as Standard or Stickshift
- ↳ 3 - types :- Constant mesh
  Sliding mesh
  & Synchromesh

(b) Over drive :-
- ↳ A Semi-automatic type used in selective transmission. It is just a step closer to fully automatic.
- ↳ It is a device betⁿ transmission & propeller shaft to permit the propeller shaft turn faster.
- ↳ Combination of Manual & automatic transmission. Exp.- Ford } cars BMW

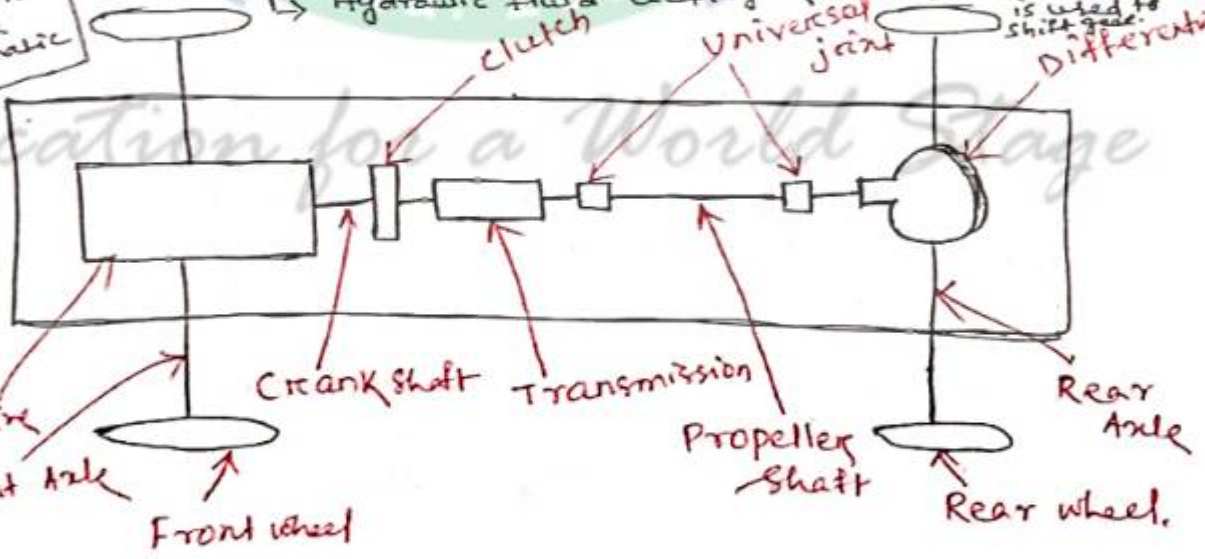
(C) Chrysler Semi-automatic :-
- ↳ Electric & Hydraulic controlled type used with a torque converter.

(d) Automatic transmission
- ↳ Driver does not need to shift gears.
- ↳ Requires torque converter & Mechanical, hydraulic or electrical control. (No clutch pedal)
  - ↳ Hydraulic fluid coupling or a torque converter is used to shift gear.

India Celerio (Maruti Suzuki)

World 1st Betta-1939 Cadillac & Hydramatic

Best cars
Tata Nexon
Toyota ~~corp~~ Yaris
Maruti Alto K10



(Automobile power Transmission)

(i) The motion of the crankshaft is transmitted to the gearbox (transmission) through clutch.

(ii) From the gearbox the motion is transmitted to the propeller shaft through universal joint & then to the differential through another universal joint.

(iii) Finally the power is transmitted to the rear wheel through rear axle.

Clutch

↳ Clutch is a device which engages & disengages power transmission from driving shaft to driven shaft.

↳ It is located betⁿ the engine & transmission.

↳ When the clutch is engaged,
the power flows from engine to rear wheels through the transmission system & the vehicle moves.
When the clutch is disengaged,
the power is not transmitted to the rear wheels & the vehicle stops while the engine is still running.

↳ ~~When~~ The clutch is disengaged, when
- ✓ Starting the engine
- ✓ Shifting the gears
- ✓ stopping the vehicle
- ✓ idling the engine (Engine is running but vehicle is not in motion)

The clutch is engaged, when
- ~~the~~ ✓ vehicle is to move

Needs of a clutch

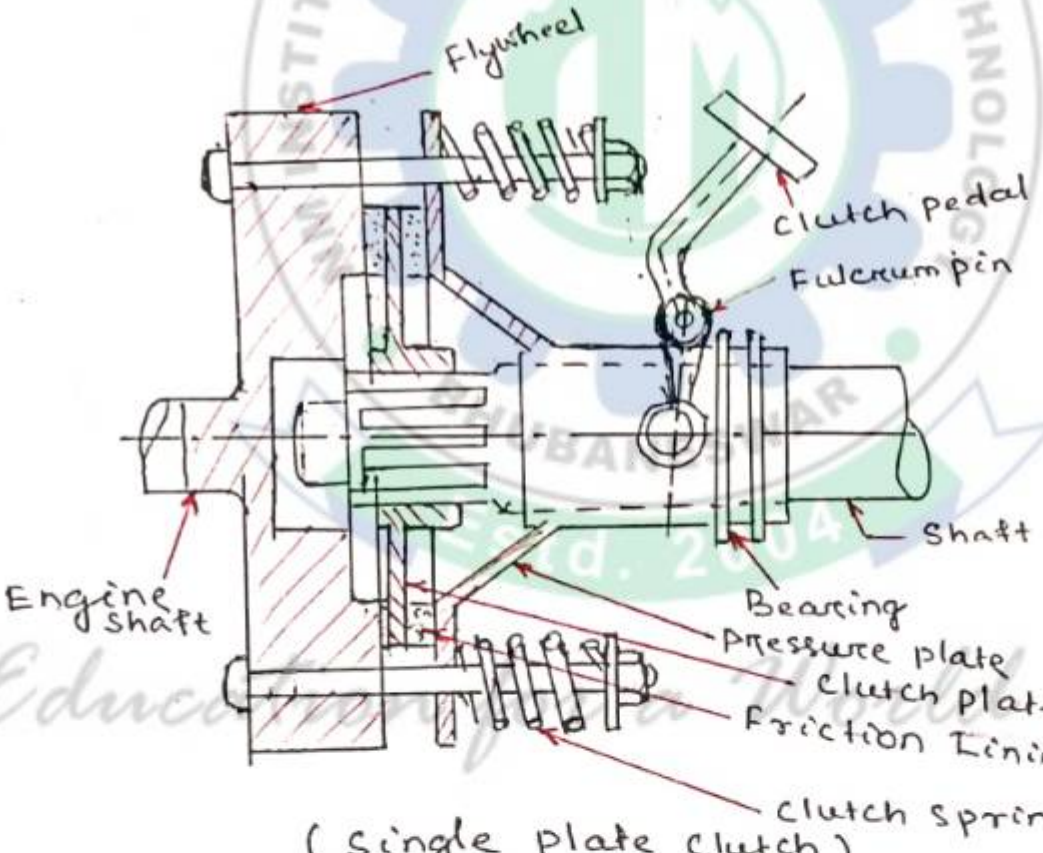
(i) It should be able to transmit maxᵐ torque of engine.
(ii) The clutch should engage to avoid sudden jerks.
(iii) It should be able to dissipate large amount of heat, which is generated during the operation of clutch.
(iv) The clutch should be dynamically balanced.
(v) It should eliminate noise produced during the power transmission.
(vi) It should be as small as possible in size, so that it will occupy minᵐ space.
(vii) It should be easy to operate.

Types of clutch

(1) Friction clutch :-
- (i) Single plate clutch
- (ii) Multiplate clutch → Wet, Dry
- (iii) Cone clutch → External, Internal

(2) Centrifugal clutch
(3) positive clutch
(4) Hydraulic clutch
(5) Electro-magnetic clutch
(6) Vacuum clutch

Single plate clutch / single Disc clutch



(Single plate clutch)

- It is most common type of clutch used in motor vehicles & it is consist of only one clutch plate which is mounted on the splines of the clutch shaft.
- A flywheel is mor on the crankshaft of the engine.
- A pressure plate onnected to the flywheel through the bolts & clutch springs.
- When the clutch is in engaged position, the clutch plate remains gripped betⁿ flywheel & pressure plate. Friction linings are provided on both sides of clutch plate.

↳ Due to friction on both sides, the clutch plate revolves with engine flywheel. Therefore clutch transmits engine power to clutch shaft. Clutch shaft is connected to the transmission (gearbox) of automobile. Clutch transmit power from engine to transmission.

↳ When clutch plate is disengaged, the clutch pedal is pressed. Because of this pressure plate moves back & clutch plate is disengaged from flywheel. In this case power doesn't reach the wheels & vehicle also stop running.

Multiple Disc / Multiplate clutch

↳ It is consist of number of clutch plates. As the no. of clutch plates increases obviously increases the capacity of the clutch to transmit torque.

↳ The plates are alternately fitted to the engine shaft & gearbox shaft. & Each alternate plate has inner & outer splines.

↳ It works same as single plate clutch by operating the clutch pedal.

↳ It is used in heavy commercial vehicles, racing cars, & motor cyles for transmitting high torque.

↳ It may be of two types :-
- Wet :- when operated in oil bath (Wet clutch)
- Dry :- when operated dry (Dry clutch)

↳ Generally used in automatic transmission

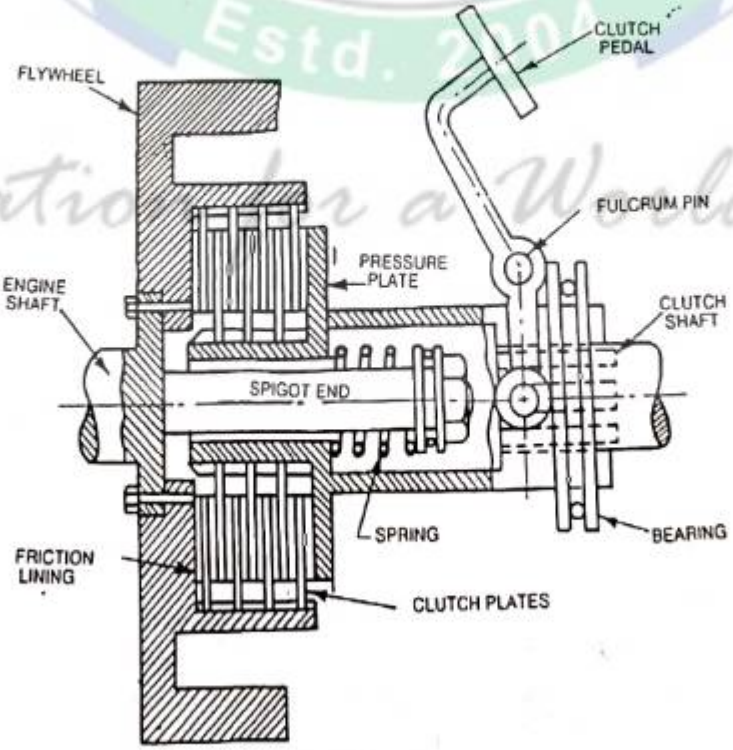


Fig. 22.8. Multiplate clutch.

Purpose of Gear Box

(i) TO provide high torque at the time of Starting, Vehicle acceleration, hill climbing.

(ii) TO provide more forward Speeds by providing more than one gear ratios.

(iii) TO provide a reverse gear for driving the Vehicle in reverse direction.

(iv) TO drive vehicle at low speeds.

(v) TO get high acceleration from rest.

Automatic Gear changing Mechanism

↳ It is also called auto, self-shifting transmission, n-Speed automatic, AT,

↳ It is a type of motor vehicle mechanism, that can automatically change gear ratio's as the vehicle moves, freeing the driver from having to shift gears manually.

↳ The most popular form found in automobiles is the hydraulic automatic transmission.

↳ This system used a fluid coupling inplace of friction clutch & gear changes hydraulically by the planetary gears.

↳ The advantages of automatic transmission to the driver is the lack of a clutch pedal & manual Shift Pattern in normal driving.

↳ It was invented in 1921 by Alfred Horner Munro of Regina, (Canada)

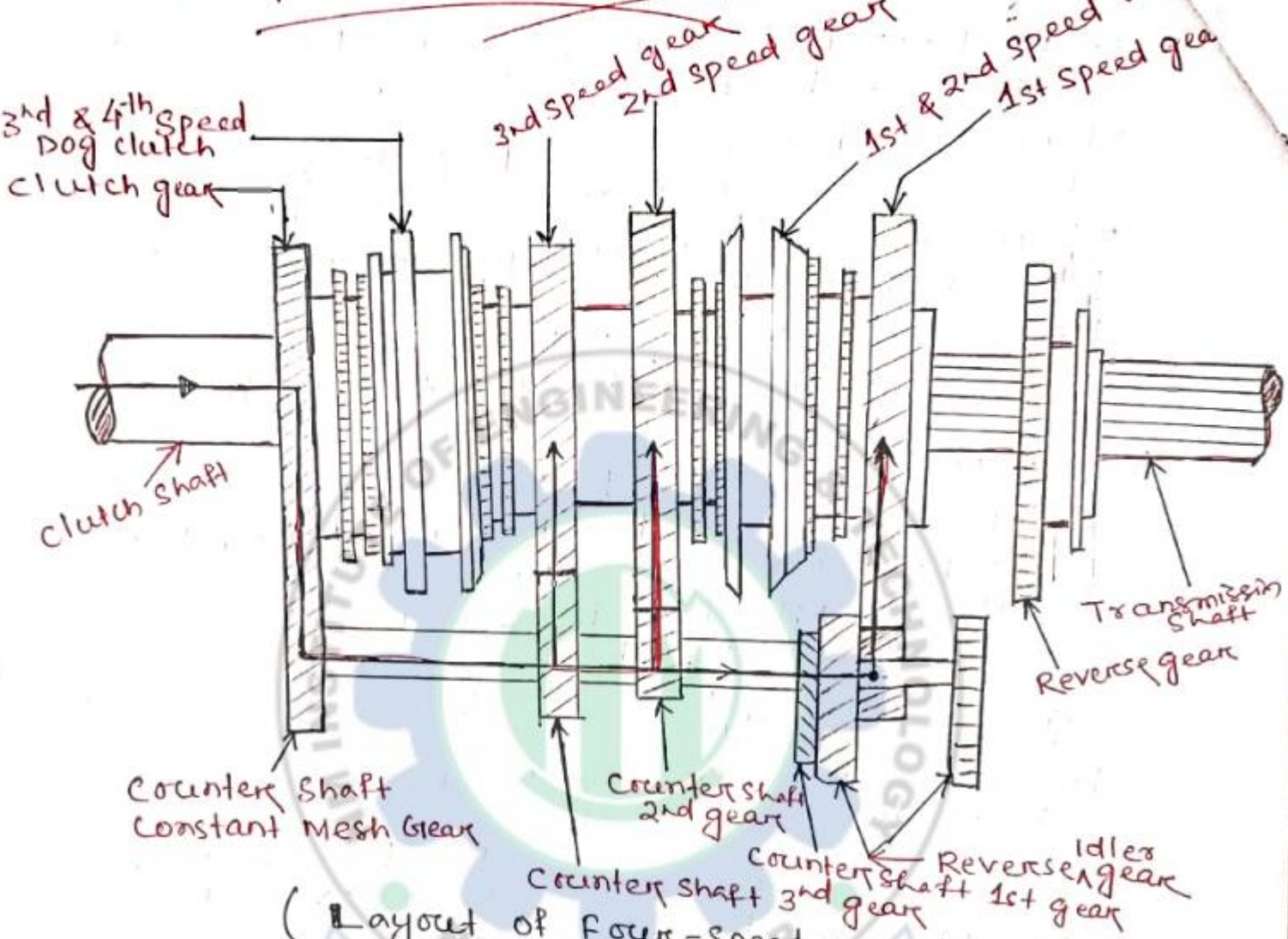
First hydraulically Automatic transmission :→

1932 → TWO Brazilian Engineers

↳ JOSE Braz Araripe

Fernando Lehly Lemos

4-Speed Gear Box



(Layout of Four-Speed gear box)

↳ The 4-speed gear box using synchromesh system in all the four forward speeds.

↳ The clutch shaft drives the counter shaft drive gear through main drive gear. The first, second & third speed gears on the main shafts are in constant mesh with their corresponding gears on the countershaft.

↳ The reverse idler gear & the reverse gear are not in mesh, in this position the gear box is in neutral so, no power is transmitted to the main shaft.

It is a device used to lock two components in relation to each other.

First gear :→

↳ This gear is obtained by shifting the dog clutch ~~by sliding~~ to the right. Thus engaging its internal teeth with the external dog teeth of the 1st speed gear.

Second Gear :→ To obtain second gear, first the 1-2 speed dog clutch is brought to neutral & then moved to the left thereby engaging its internal teeth with the external dog teeth of the second speed gear.

Third gear :→ To obtain this gear, first 1-2 speed dog clutch is shifted out of mesh from second gear & brought to neutral position. The 3-4 speed dog clutch is then moved to the right thus engaging its internal teeth with the external dog teeth of the third speed gear.

Fourth gear :→ To obtain this gear, the 3-4 dog clutch is first shifted to neutral position & then shifted to the left, thus engaging its internal teeth with the external dog teeth of main drive gear.

Reverse gear :→ This gear is obtained by first bringing the vehicle to rest position.

↳ The gear box is then brought to neutral position. After this, the reverse gear is moved to the left thus engaging it with the reverse idler rear gear.

Propeller shaft.

↳ propeller shaft is connected betⁿ the gear box & differential with universal joint at each end.

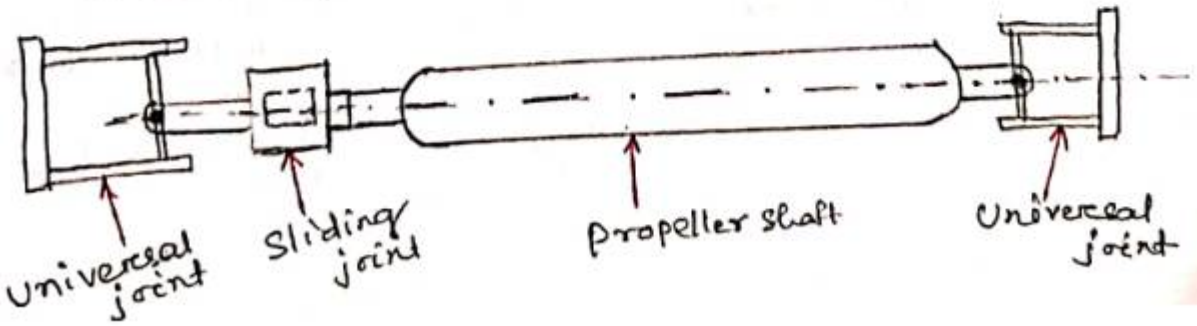
↳ The torque is transmitted from the gear box to the differential through propeller shaft.

↳ A sliding joint is used betⁿ the propeller shaft & universal joint near the gear box.

↳ The rotary motion of the ~~gear box~~ transmission main shaft is carried out through the propeller shaft to the differential, causing the rear wheels to rotate.

↳ It is made of a strong steel tube, solid propeller shafts are also used.

↳ The propeller shaft is in two sections, supported by a centre bearing & coupled together by universal joint



↳ A propeller shaft provided with one or more universal joints to permit variations in the angle of drive, & also it permit provided with a sliding joint that permits the effective length of the propeller shaft to change.

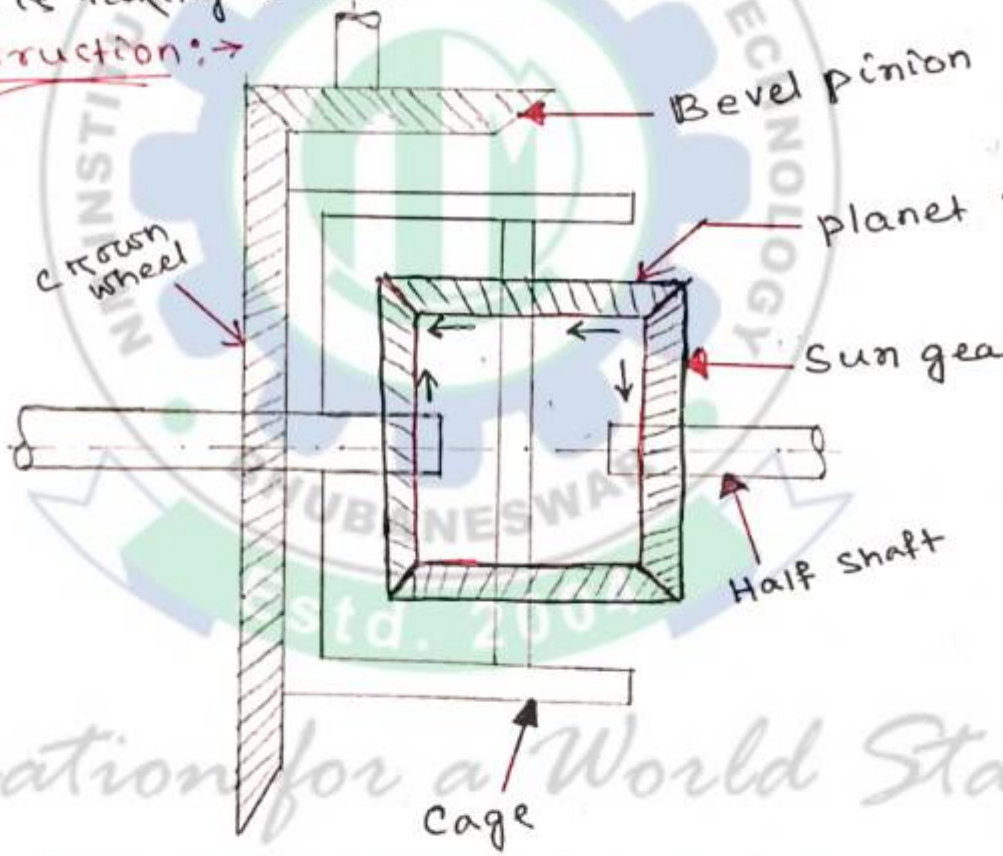
Differential

↳ It is a part of the inner axle housing assembly, which includes the differential, Rear axles, wheels, & bearings.

↳ It is consist of a system of gears arranged in such a way that connects the propeller shaft with rear axles.

Purpose:- The purpose of the differential is to provide the relative movement to the two rear wheels when the car is taking a turn.

Construction:→



↳ The sun gears are mounted on the inner end of each rear axle called half shaft. A differential cage is assembled on the left axle. A crown gear (Ring gear) is attached to the cage, so, that cage rotates with the crown gear.

↳ The crown gear is driven by the bevel pinion. The cage supports two planet pinions on a shaft which mesh with the two sun gears.

↳ When the differential cage is rotated, both the sun gears rotate & thus both wheels turn.

↳ When the car is running in a straight line, the crown wheel, cage, planet pinions & the sun gears, all turn as a unit without any relative motion.

↳ When the car takes a turn, the planet pinions rotate on their shaft to permit the outer rear wheel to turn more rapidly than the inner wheel.

Rear Axle

↳ Rear axle is the driving axle lies bet^n the driving wheels & the differential gear transmit power from the differential to the driving wheels.

↳ It is consist of two half shaft connected to the differential gear. Inner end of the half shaft is connected to the sun gear of differential & the outer end of the driving wheel.

Types

Depending upon the method of supporting, the rear axles are of 3 types:→

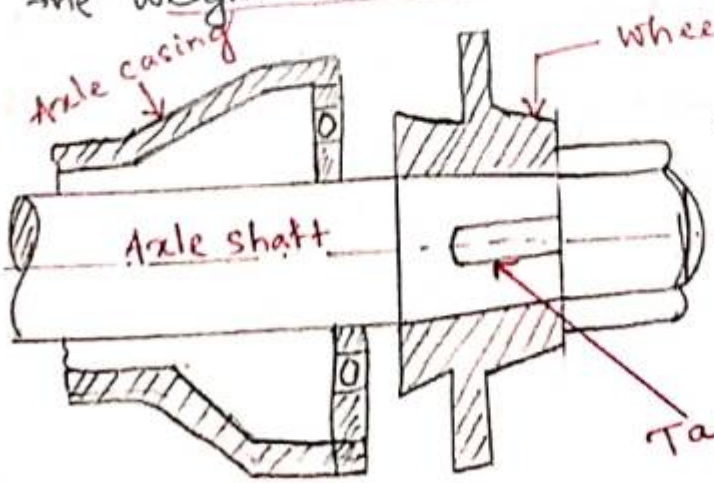
(a) Semi-floating axle
(b) Full-floating axle
(c) Three quarter floating axle

(a) Semi-floating axle :→

↳ It has a bearing located on the axle & inside the axle casing.

↳ It need to be a larger size for the same torque output, than any other type.

↳ The inner end of the axle is supported by the differential side gear & the outer end has to support the weight of the car.



↳ It is the simplest & cheapest axle & mostly used on cars.

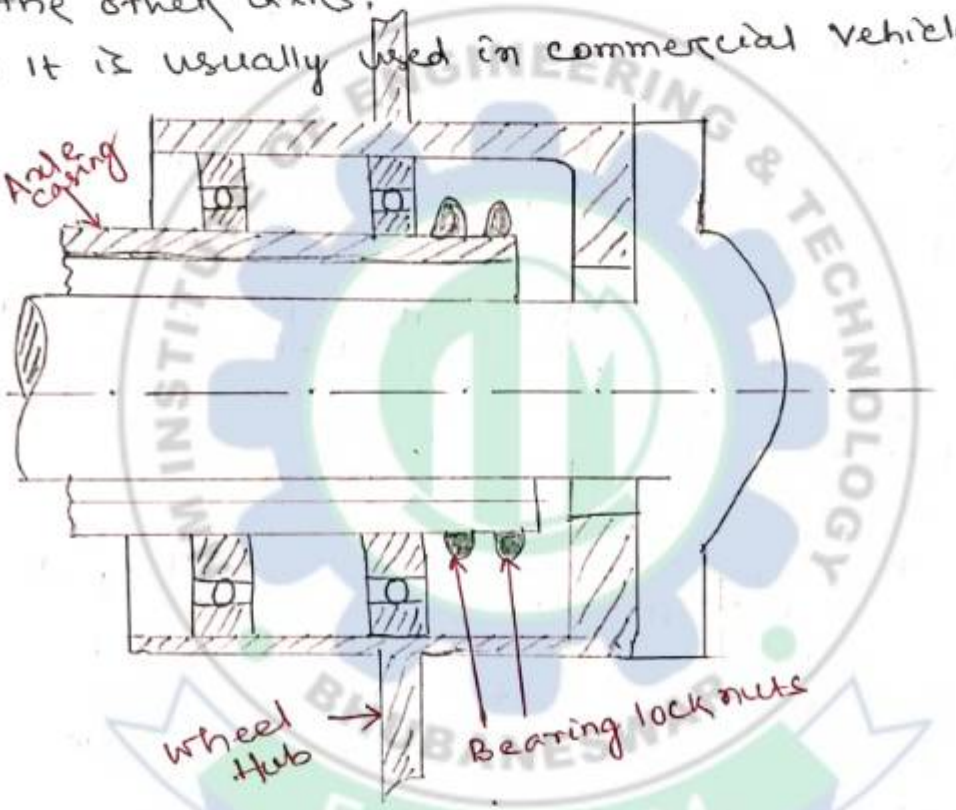
(b) Full-floating Axle

↳ It has two deep-groove ball or tapered roller bearings located betⁿ the axle casing & wheel hub.

↳ It transmits only the driving torque, for this reason, it is called full-floating.

↳ This type of axle is more expensive & heavier than the other axles.

↳ It is usually used in commercial vehicles.



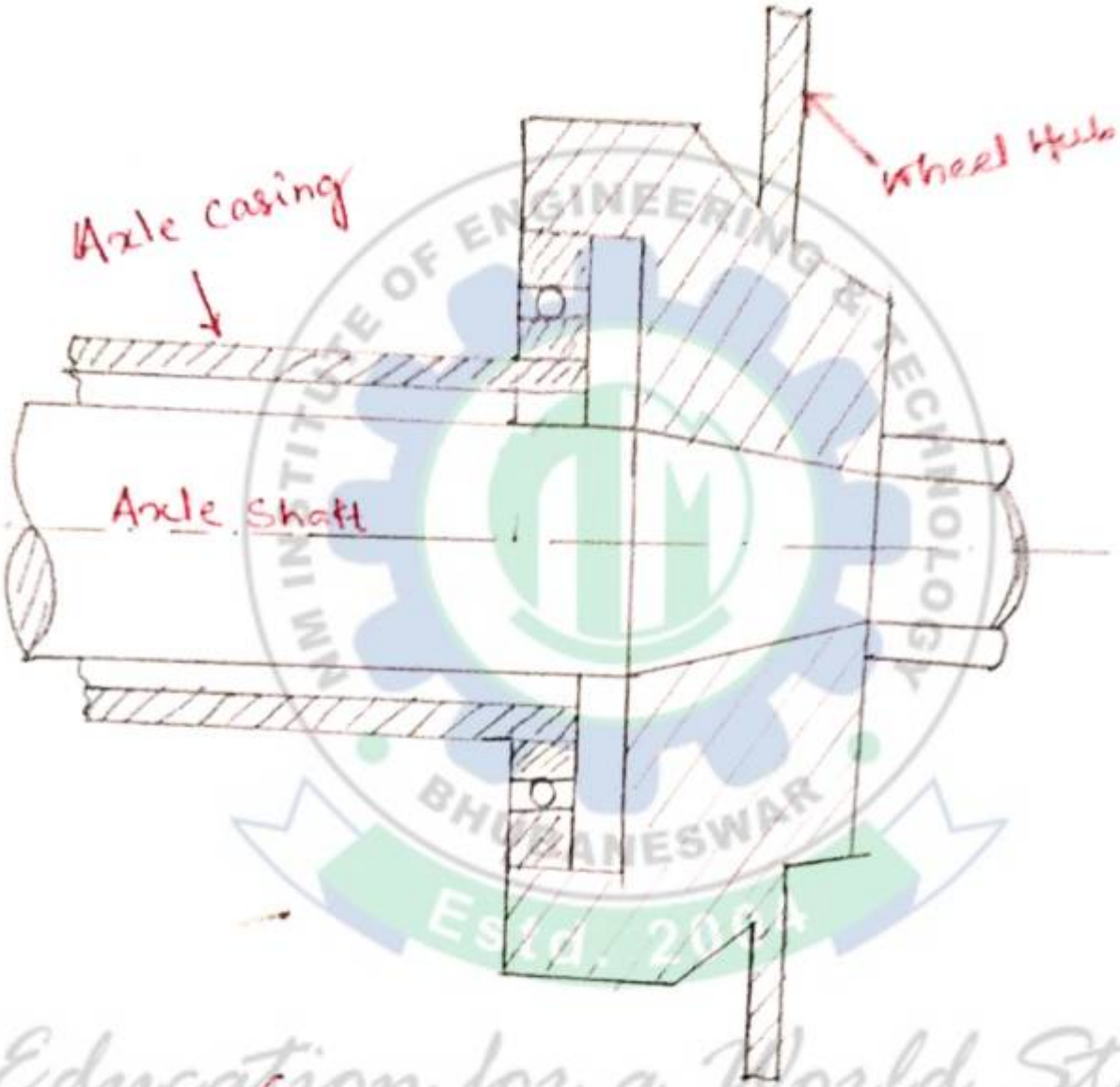
(c) Three quarter floating axle

↳ It has a bearing located betⁿ the hub & the axle casing.

↳ The axle is keyed rigidly to the hub, thus maintaining the alignement of the wheel.

↳ The inner end of this axle has the same construction as that of the Semi-floating axle.

↳ It is reliable, but not as simple as Semi-floating axle.



(Three Quarter floating Axle)

Braking System

Brake

↳ It is a mechanical device that controls motion by absorbing energy from a moving system.

↳ It is used for slowing or stopping a moving vehicle, wheel, axle or to prevent motion.

Need

↳ The braking system of a vehicle is the most important safety system.

↳ To stop at a moments notice will help to avoid an incident or accident.

Function of Brake

(i) To stop or slow down the vehicle in the shortest possible distance.

(ii) To control the vehicle when descending a hill.

Types of Brake

* with respect to application
  - → Foot brake
  - → Hand brake
* with respect to number of wheels
  - → Two-wheel brakes
  - → Four-wheel brakes
* with respect to method of braking contact
  - → Internal expanding brakes
  - → External contracting brakes
* with respect to method of applying braking force
  - → Single acting brakes
  - → Double acting brakes
* with respect to brake gear
  - → Mechanical brake
  - → Power brake
* with respect to nature of power employed
  - → Vacuum brakes
  - → Air brakes
  - → Hydraulic brakes
  - → Hydrostatic brakes
  - → Electric brakes

* with respect to power transmission
  - Direct acting brakes
  - Geared brakes

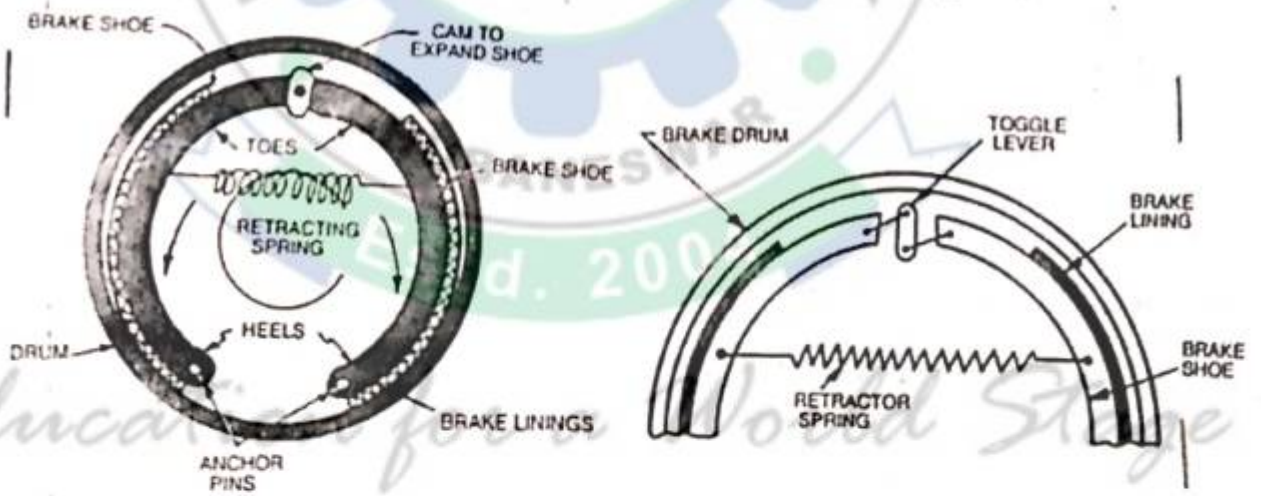
* with respect to power unit
  - ~~Eget~~ cylinder brakes
  - Diaphragm brakes

Mechanical Brake

↳ The mechanical brake consist of various mechanical elements i.e Drum, Brake shoes, Brake Linings, Cam to expand shoes, Retracting spring etc.

↳ The wheel is attached to a auxillary wheel called drum. & the brake shoes are made to contact these drum. The brake shoes have brake linings on their outer surfaces. & each shoes are hinged at one end by anchor pin.

↳ The retracting spring keeps the brake shoes into position when the brakes are not applied. The shoes are generally mounted to rub against the inside surface of the drum to form an internal expanding brake.



↳ When the brake pedal is pressed, the cam turns by means of linkage. When the cam turns, the shoes expands outword against the drum. The brake linings rub against the drum & thus stop its motion.

↳ The entire mechanical linkage betⁿ the brake pedal & shoes operates to transmit pedal force to the brake shoes & to produce breaking forces against the drum.

↳ The liquid used is known as brake fluid, & is a mixture of glycerine & alcohol or caster oil.

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

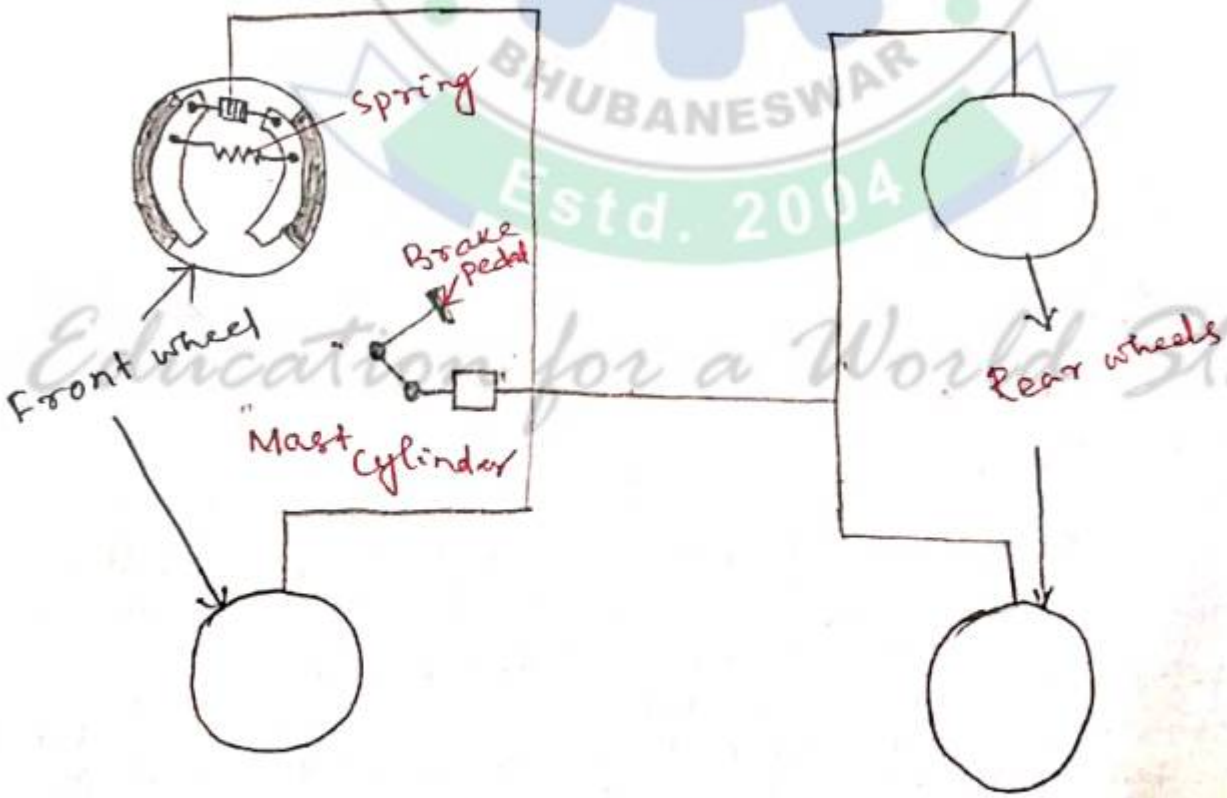
When brakes applied :-

The piston is forced into the master cylinder this increase the pressure of the fluid in the master cylinder.

This pressure forces the wheel cylinder pistons outwards. These piston in turns, force the brake shoes out against the brake drum. Thus the brakes are applied.

↳ When the driver releases the brake pedal, the master cylinder piston returns to its original position due to the return of spring pressure.

This spring pressure pull the brake shoes out of contact with the brake drums into their original position. This causes the wheel cylinder pistons also to come back to their original inward position. Thus the brakes are released.



(Hydraulic Braking System)

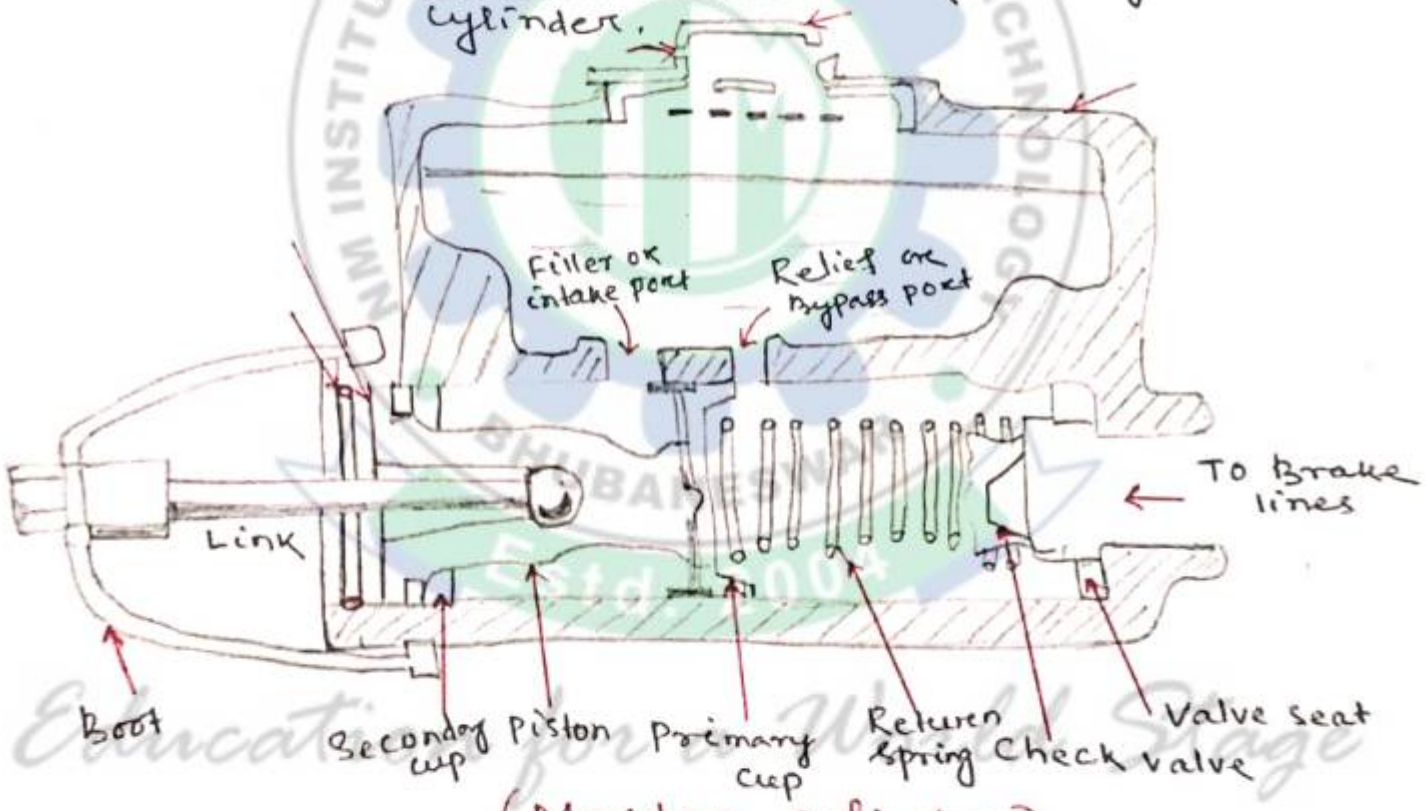
Master cylinder

↳ It is the heart of the hydraulic braking system.
It is consist of two main chamber :-

- The fluid Reservoir
  - contains fluid to supply to brake system.
- The compression chamber
  - In which the piston operates.

It supplies fluid to the brake system through two ports :-

- Filler or intake port (Larger port)
- Relief or Bypass port (smaller port)
  - connected to the hollow portion of the piston.
  - Connects the reservoire directly with the cylinder.

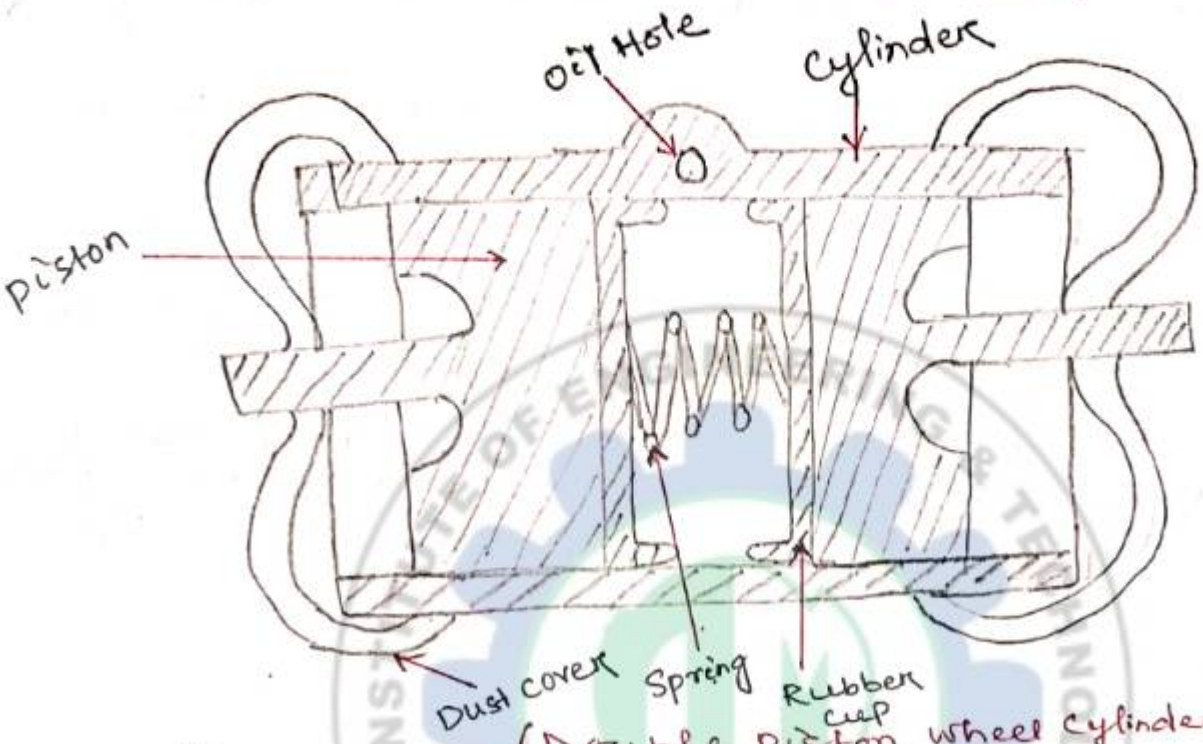


(Master cylinder)

↳ When the brake pedal is pressed, the master cylinder piston moves forward to force the liquid under pressure into the system. The liquid pressure is conducted to wheel cylinders, where it forces the wheel cylinder piston outwards. These piston force the brake shoes out against the brake drum.

↳ When brake pedal is released, the return spring quickly forces the master cylinder piston back against the piston stop.

Wheel cylinder or Slave cylinder



(Double piston wheel cylinder)

↳ It is the second important component of the hydraulic braking system.

↳ It is consist of two pistons which can move in opposite direction by the fluid pressure.

↳ When the brakes applied, the brake fluid enters the cylinder from inlet betⁿ the two pistons. It causes to forced out the pistons in opposite direction. This motion is transmitted to the brake shoes.

↳ The copper-coated, tin plated steel tubing & flexible tube are used to connect the master cylinder to the wheel cylinders.

↳ The tubes are used to connect the lines to the front wheel to be turned.

Advantages of Hydraulic Brakes

* Simple in construction.
* Equal braking effort to all the four wheels
* Increased braking effort.
* Low wear rate.
* High Mechanical advantage.
* Flexibility in braking lines.

Disadvantages

* The braking system fails if there is any leakage in brake lines.
* The brake shoes fails if the brake fluid leaks out.

Power Brakes

(i) Power brakes are a system of hydraulics used to slow down or stop most motor vehicles.

(ii) There is difficulty in case of larger cars to apply the brakes to the locking point by direct pedal pressure. So power braking became an absolute necessity on such type of vehicles.

The various power brakes are :→

(a) Air brakes
(b) Air hydraulic brakes
(c) Vacuum brakes
(d) Electric brakes

(a) Air Brake

(Layout of Air-Brake System)

(i) The various compressing & control units of air-brake system are :→ Air compressor, Governor, Pressure gauge, Safety valve & Reservoir. The air compressor also control the horn, wipers etc. of vehicle in aditional.

(ii) The compressor sends compressed air to the reservoir which is connected to the brake valve. The lines of tubing from the brake valve extend to the front & rear brake chambers.

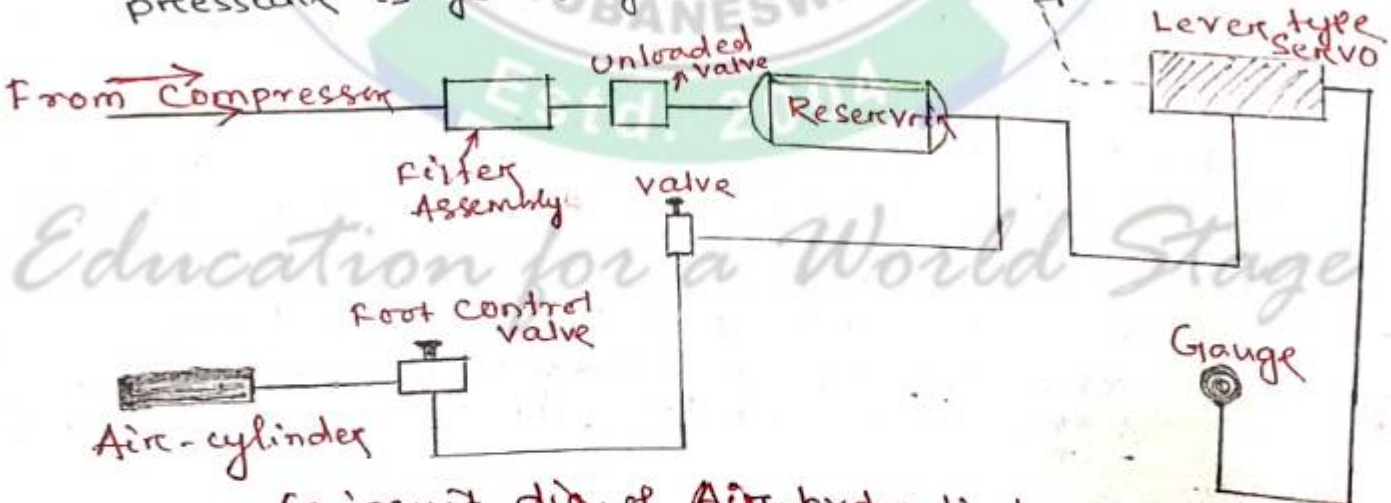
(iii) When the ~~Pedal~~ brake pedal is pressed, compressed air passes through the brake valve & the pressure is developed in the brake chambers to apply the brakes.

(iv) The brake valve is considered as the heart of the air-brake system. It's main purpose is to control the vehicle brakes in air pressure system.

(b) Air-Hydraulic Brake

(i) In air-hydraulic braking system, the air pressure is converted into hydraulic pressure. Here air power cylinder is combined with hydraulic master cylinder & reservoir.

(ii) The ratio bet^{n} the hydraulic pressure & the air pressure is generally maintained 15 : 1.



(Circuit dia. of Air-hydraulic brakes of Tata truck)

↳ Air-hydraulic braking system consist of various components i.e :-

* Air compressor
* Air pressure regulator
* Tyre inflating bottle
* Air container
* Truck brake valve
* Air pressure gauge

↳ The compressed air from the compressor flows to the tyre inflating bottle to the air pressure regulator to the air container & to the truck brake valves.

↳ When brake pedal is pressed :-

The air pressure forces the piston to move & this effort is transmitted to the master cylinder. The force acting on the master cylinder creates the hydraulic pressure required for the application of brakes.

(C) Vacuum Brake

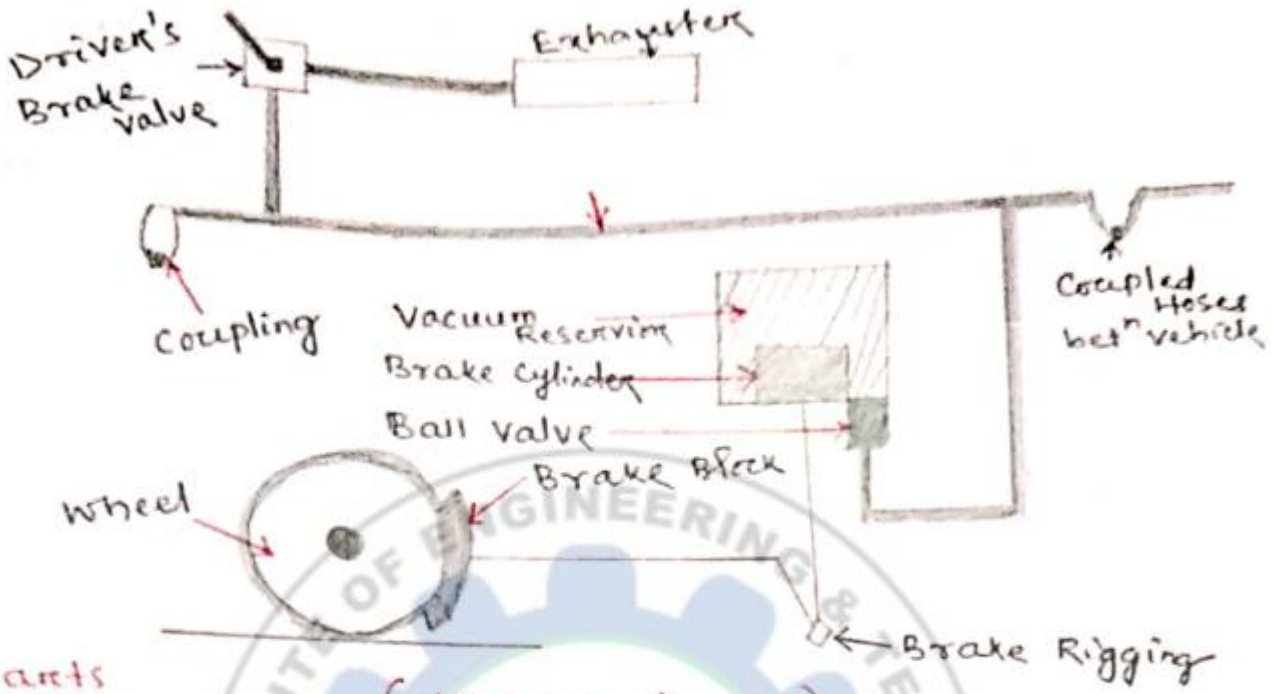
↳ It is a braking system employed on trains & introduced in 1860.

↳ The ejector removes atmospheric pressure from the brake pipe to create the vacuum using an exhauster.

↳ The vacuum in the brake pipe is created & maintained by a motor-driven exhauster. The exhauster has two speeds i.e High speed & Low speed.

The high speed is switched into to create a vacuum. & thus release the brake.

The low speed is used to keep the vacuum at the required level to maintain brake release.



Parts (Vacuum Brake)

(a) Driver's brake valve :→ The driver controls the brake by using brake valve. The various positions of brake valve are :-

Release :→ This raises the vacuum ~~pressure~~ in the brake pipe.

Running :→ Slowdown the speed of exhauster.

Lap :→ It is used to shut off the connection bet^n the exhauster & brake pipe.

(b) Exhauster :→ A two speed rotary machine is fitted to evacuate the atmospheric pressure from the brake pipe, Reservoir, Brake cylinder.

(c) Coupling :→ A coupling point is provided at the end to allow the end of brake pipe to be sealed.

(d) Coupled Hoses :→ The brake pipe is carried through flexible hoses.

(e) Vacuum Reservior :→ A vacuum reservior is provided on upper side to ensure there is always a source of vacuum available to operate the brake.

(f) Brake cylinder:-> ... piston operates, ~~...~~ ~~...~~
~~The cylinder~~ the brakes ... ...gh links called rigging
inside the cylinder.

(g) Brake Rigging :-> The brake cylinder piston transmits pressure to the brake block on each wheel through the system.

(h) Brake Block :-> It is the friction material which is pressed against the surface of the wheel.

(i) Ball Valve :-> It is used to ensure that the vacuum in the vacuum reservior is maintained at the required level.

Brake Lining

(i) ↳ are high friction material beings used rub against the rotating brake drum & to stop them.

(ii) It is made of asbestos, Rubber, Rèsin, minerals etc.

(d) Electric Brake

(i) It is a brake controlled by an electric current.
(ii) It is related to electromagnetic track brake used in railways, which is used electric current to directly control the brake force.

Working:-

↳ The magnet in the braking plate has two conductor wires which tap directly into the trailer wiring.

↳ when electricity is on, it magnetizes the brake magnet. The magnet is attached to the dreem face. When it contracts this area, the friction causes it to rotate, which pushes the shoes out against the drum.

↳ The brake shoes ~~press against~~ have a special brake pad material on them that resists the heat caused by the friction.

Auto Electric System

Lighting & Wiring

~~Purpose of lighting:~~

Lights are used in vehicles for various purposes. The main lights are:-

(a) Head lights
(b) Parking lights
(c) Direction-signal lights
(d) Blinker lights
(e) Stop lights
(f) Back-up lights
(g) Tail lights
(h) Interior lights

Head Light :→

↳ Head lights are auto lights that are found in front the vehicle.

↳ The purpose of head light to illuminate the road during low visibility conditions such as nights or fog condn.

Parking Light :→

↳ It is usually provided in front of the car.

↳ It is used while the car is parking.

↳ It provide a signal for other moving objects & thus avoid accident.

Direction-Signal light :→

↳ It is used to indicate the direction in which the vehicle is to turn.

↳ These light gives signal to the vehicles coming from the front or rear.

Back-up Light :→

↳ It come on when the driver shifts into reverse.

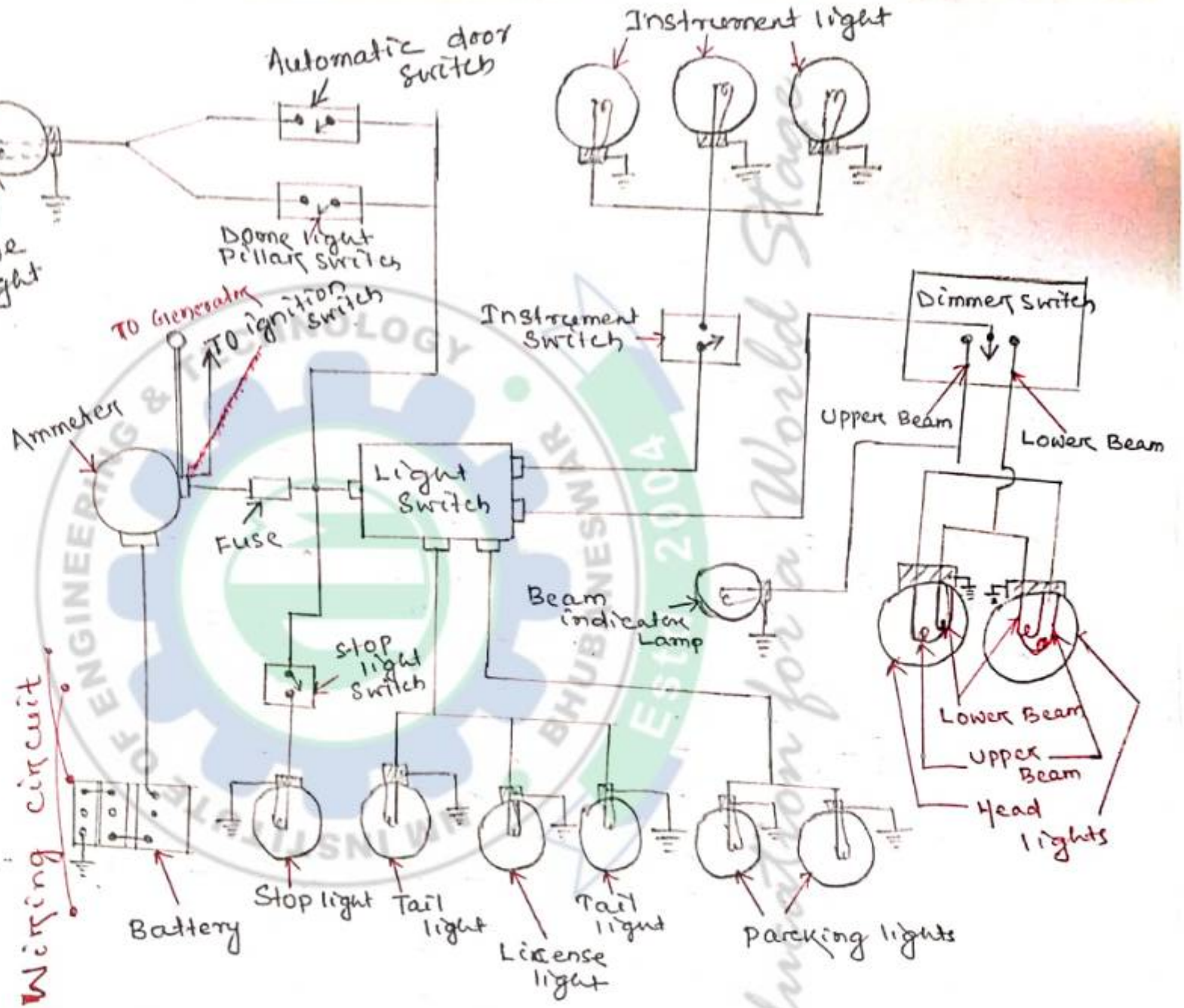
Blinker light :→ It provide a means of signalling when the car is stalled (suddenly stopped) on the highway.

Tail Light :→

↳ It ~~illuminate~~ found back of the car & used in night so that the other vehicles comming behind it are able to see it.

↳ It is kept on all the time when the car is running in the night.

Interior Light :- These light is located on the ceiling of the vehicle & illuminate when people enter or exit the car.
↳ It includes
- instrument panel light
- indicator light
- various warning lights
- map lights
- Radio dial lights
- clock lights



(Wiring circuit of a passenger car lighting system)

↳ The current is supplied to the system from the battery of 6 to 12 volts.

↳ The circuit begins at the battery & passes through the armature & a fuse before it reaches any switch

↳ The foot operated dimmer switch determines whether the current is going to the upper or lower filament.

↳ The dome light is controlled either by a hand operated pillar switch or by an automatic door switch that completes the circuit when a door is opened.

↳ The stop light is controlled by the stop light switch in the ~~break sys~~ brake system, so that when brakes are applied the switch is on.

↳ All other lights ~~are~~ are controlled by instrument panel. This switch has three positions for operating the different light like parking lights, tail lights, instrument lights etc.

↳ The wires for different circuits are also marked by means of special colours in the insulation, for example light green, dark green, blue, Red, Black etc. These colours permit identification of the various wires of different circuits.

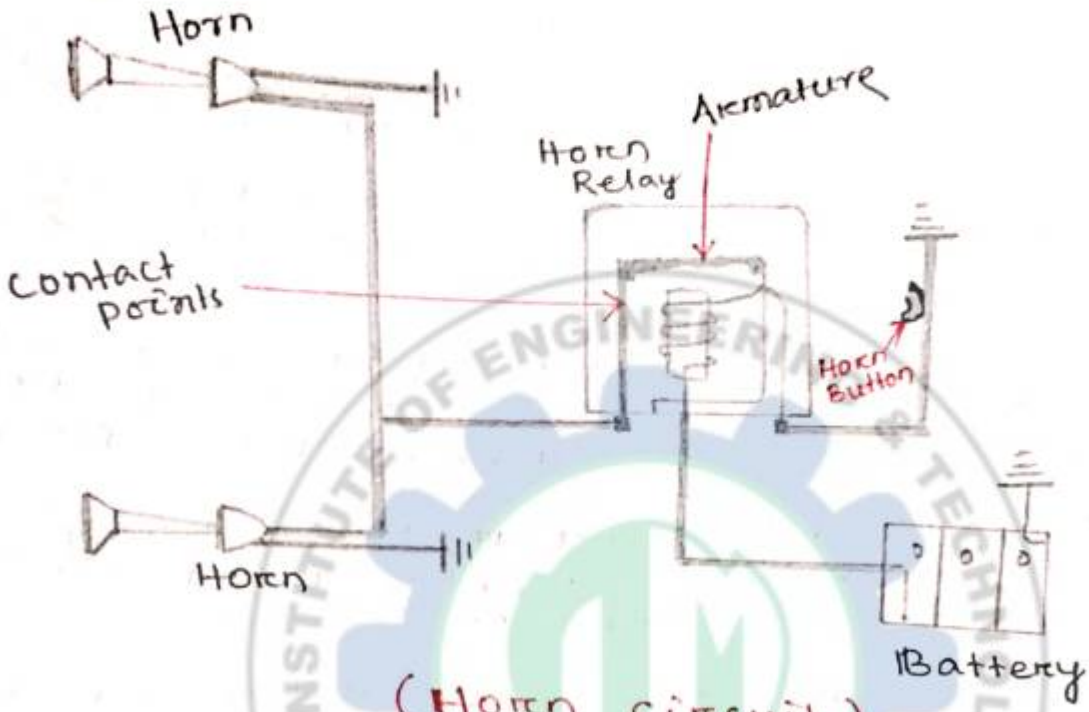
Horn circuit

↳ The Electrical horns are used in automobile vehicles.

↳ When the horn is operated it creates loud sound indicating that vehicle is comming so that other vehicle or ~~ped~~ people on road may clear off the path to pass it.

↳ Horn is also used to call the persons when the vehicle is ready to start.

Types
- Bulb horn → cycle, Auto
- Electric horn → car, trucks (most Automobiles)
- Air horn → Train, cars transporting truck



(Horn circuit)

↳ It is consist of a armature, a diaphragm, a winding & a pair of contact points connected in series. - determine the pitch of the sound

↳ When the horn button switch is pushed, it connects the horn winding to the battery. The current passing through the winding produces magnetic field, which pulls the armature down.

↳ The armature is attached to the diaphragm. The movement of diapharam opens the contact points, due to which the circuit is broken. This cycle is repeated rapidly. This rapid movement of the diaphragm produces noise.

Note

Speedometer :- Indicating vehicle speed.

odometers :- Indicating the distance travelled.

Tachometer :- Indicating engine speed in rpm.

Voltmeter :- Indicating battery voltage.

Oil pressure gauge :- Indicates the engine oil pressure

Fuel gauge :- Indicates the fuel level in the fuel tank.

Spark plug

↳ It is a device used to produce electric spark to ignite the compressed air-fuel mixture inside the cylinder.

↳ Spark plug is screwed in the top of the cylinder.

Construction :→ It is consist of 3 parts :-

(i) Insulated or centre electrode

(ii) outer or ground electrode

(iii) Insulation separating the two electrodes.

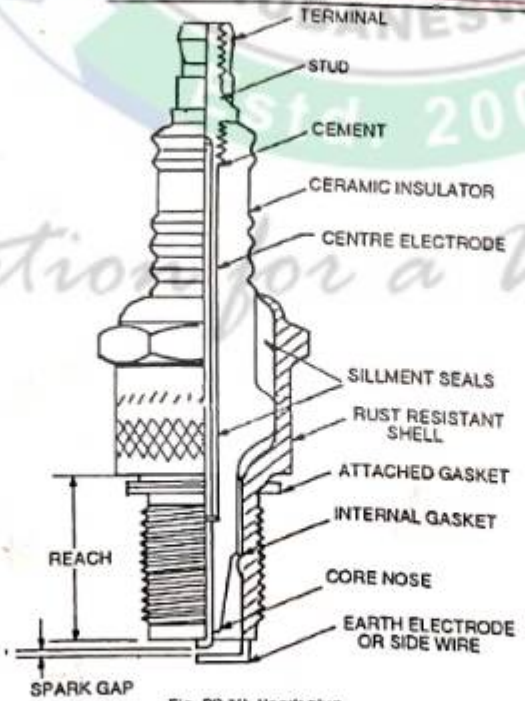


Fig. 20.12. Spark plug.

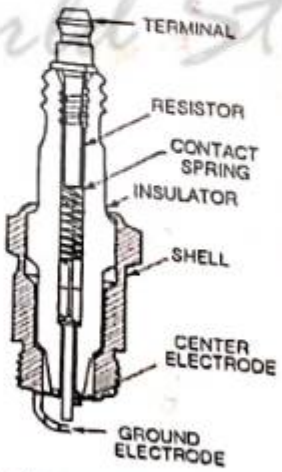


Fig. 20.13. Spark plug with a resistor.

↳ The upper end of the centre electrode is connected to the Spark plug terminal, where H.T (High Tension) Cable from the ignition coil is connected. It is surrounded by Porcelain insulator.
↳ made from clay, quartz (Rock crystal) & alumina

↳ The lower half portion of the insulator is fastened with a metal shell. The lower portion of the shell has a short electrode attached to one side & bent towards the centre electrode, so there is a gap bet^n two electrodes.

↳ The two electrodes are separated by the insulator. The lower part of the shell has screw thread & the upper part is made in hexagonal shape.

Materials used in the construction of different Parts of a Spark plug :→

Shell :→ Steel

Insulation → Porcelain, mica, Alumina,

Electrode :→ Nickel, Alloys of nickel & Manganese, Platinum alloy.

Requirements of Spark plug

(i) A good Spark plug must be able to function under all working conditions of temp. & Pressure.

(ii) It must maintain the proper gap bet^n two electrodes under all conditions.

(iii) The seals of the Spark plug must be able to withstand the high pressure & temp. created in the combustion chamber.

(iv) It must be perfectly gas tight.

(v) It must be corrosion resistant.

Working of Spark plug

↳ The fun^{n} of Spark plug is to produce an electric spark to ignite the compressed air-fuel mixture inside the cylinder.

↳ A proper gap is to be maintained bet^{n} the two electrodes of the spark plug so that sparking may takes place.

↳ When H.T (High tension) current passes through the circuit, it jumps the gap producing a spark, which ignites the compressed air-fuel mixture in the cylinder.

Spark plug gap

↳ The gap bet^{n} the centre electrode & the ground electrode is called spark plug gap.

↳ It varies from 0.4mm to 1.0mm. It is measured with a feeler gauge.

↳ The too large or too small gap reduces the efficiency of the entire ignition system, which causes losses in engine power & operating efficiency.

↳ The carbon deposited on the outside insulator bet^{n} the plug terminal & the shell, causing loss in combustion efficiency & decrease in engine power.

Types of Spark plug

According to the heat range, spark plug are of two types :→ (a) Hot spark plug
(b) Cold spark plug

* A hot spark plug has longer path of heat travel & runs hotter but a cold spark plug has shorter path of heat travel & runs cooler.
* Cold spark plugs are used in heavy duty or continuous running high speed engines to avoid overheating.
* A plug that runs hot will wear more rapidly, since the high temperatures causes the electrodes to burn away more quickly.

Common ignition Troubles & its Remedies

Component Sympton	Cause of Trouble	Remedy
(a) Ignition coil :→		
(i) Current in primary circuit less than the specified value.	* High Resistance in open circuit	* Test & Replace the defective coil
(ii) Primary current too high.	* primary short-circuited.	* Replace the coil
(iii) Engine misfire at high speed.	* Defective coil	* Replace
(iv) Hard starting	* Defective H.T. Cables	* Replace
(b) C.B points :- (contact Breaker Point (an electrical switch))		
(i) Burns rapidly & needs frequent Replacement	* Defective Condenser	* Replace
(ii) Burnt, dirty points	* High Resistance of primary circuit	* Clean the points & Replace the resistance.

(c) Distributor Assembly		
(i) Cam angle varies with speed.	* Less tension on breaker arm spring.	* Tighten to correct force.
(ii) Quick wear of rubbing blocks.	* Braker plate assembly damaged.	* change
(iii) Engine does'nt start in wet weather.	* Breaker arm spring too light.	* Loosen to correct tension
	* Cracked Cap	* Replace
(d) Condenser		
(i) Breaker points burn rapidly.	* Loose condenser lead	* Tighten
	* Ground condition poor.	* Clean
	* Connected to wrong terminal.	* Correct it
(ii) Engine misfire at high speed.	* Defective Condenser	* Replace
(iii) Difficult engine starting	* Low capacity condenser	* Replace it.
(e) Ignition switch :-		
(i) Low current in primary circuit	* switch resistance high	* Replace it
(ii) Engine does'nt start quickly	* open circuit in ballast resistor is by passed.	* Repair

(f) Advance mechanism :→		
(i) Engine runs Roughly.	* Mechanism operating incorrectly.	* check distributor
	* Late ignition timing.	* Advance it.
(ii) Engine overheats.		
(iii) Magneto noise	* Fan screw loose	* Tighten
	* Rotor/Stator plate loose	* Tighten
(g) Spark plug :→		
(i) Electrodes erosion occurs carbon, oil or lead deposits.	* corrosive combustion gases	* use proper fuel.
	* Alternative paths of current flow	* Remove carbon & clean the plug.
(ii) Overheating	* much advance ignition	* Adjust ignition advance.
	* plug used in unspecified	* use the correct plug.
	* weak mixture	* Adjust carburettor.
(iii) Misfiring	* Increase in spark plug gap.	* Adjust the gap or Replace the plug.

Suspension System

(i) It is the system of tires, tire air, springs, shock absorbers & linkages that connects a vehicle to its wheels & allows relative motion bet^n the two.

(ii) It protects the vehicle from damage & wear.

Function of Suspension system

(i) Support the weight.
(ii) Provides smooth ride.
(iii) Keeps tires in firm contact with the road.
(iv) Allow front wheels to turn side-to-side for steering.
(v) Isolate passenger from shock & vibration.

Requirements of a Suspension System :→

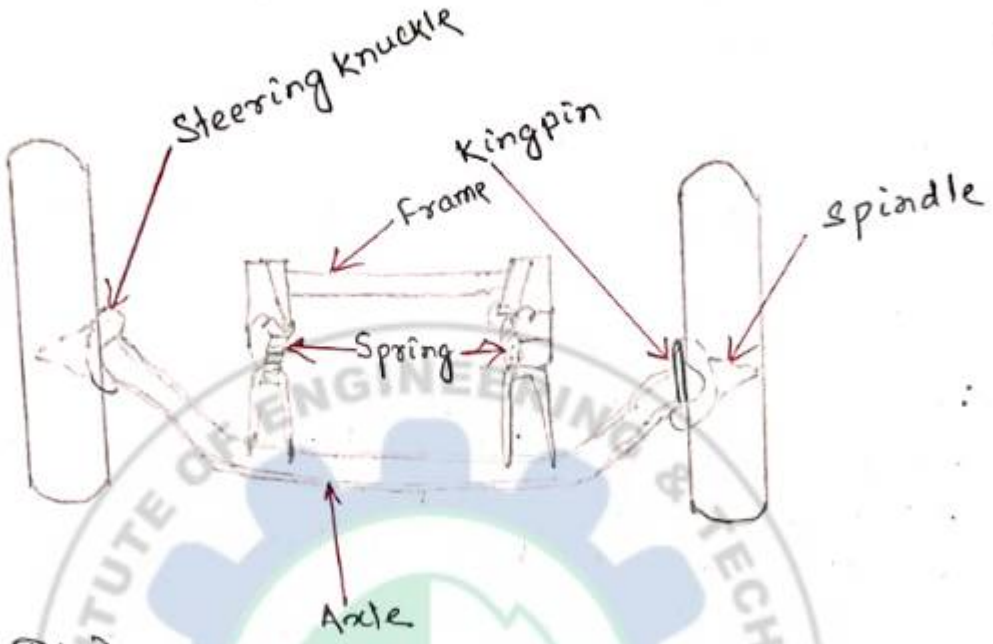
(i) Minimum wheel hop.
(ii) Low maintenance & operating cost.
(iii) Low initial cost.
(iv) Minimum weight.
(v) Minimum tyre wear.

Front End Suspension

The front end suspension swing at various angles to the car frame for steering & also move up & down with respect to car frame so front suspension is more ~~Completed~~ complicated than the rear end suspension.

The front end suspension may be of two type:-
(a) Rigid axle front suspension
(b) Independent front suspension

(a) Rigid axle front Suspension



(i) This type of suspension was used before the introduction of independent front wheel suspension.

(ii) It may be used either two longitudinal leaf spring or on transverse spring.

(iii) In this type of suspension, the front wheel hubs rotate on anti-friction bearings on steering spindles which are attached to the steering knuckles.

(iv) To permit the wheels to be turned by the steering gear, the steering spindle & steering knuckle assemblies are hinged on the axle ends.

(b) Independent Front Suspension

In independent front suspension system, each front wheel is independently supported by a coil, torsion bar or leaf spring.

The independent type front suspension is mostly used in ~~cars~~ passenger cars. in which the coil spring arrangement is the most common. These are 3 types :-

(a) 1st type (b) 2nd type (c) 3rd type

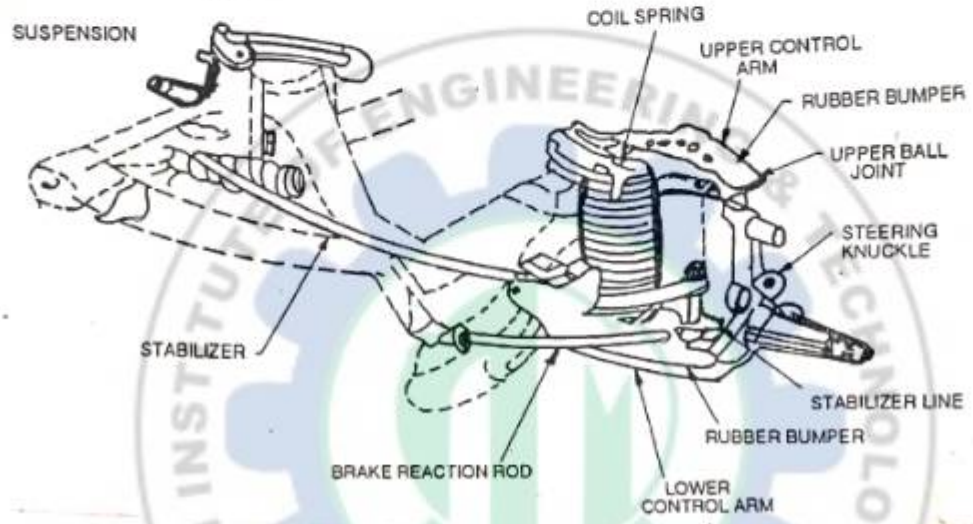
The other type of independent suspension systems are :-

* Twin I-beam construction type
* Single I-beam front suspension
* Independent front suspension using torsion bar

* Independent front suspension using coil, torsion bar & leaf spring.

(a) First type :→

In first type, the coil spring is located betⁿ the upper & Lower control arms. The lower control arm has one point attached to the car frame.



(b) Second type :→ In the second type, the coil spring is located betⁿ upper & lower control arms. The lower control arms has two point attached to the car frame.

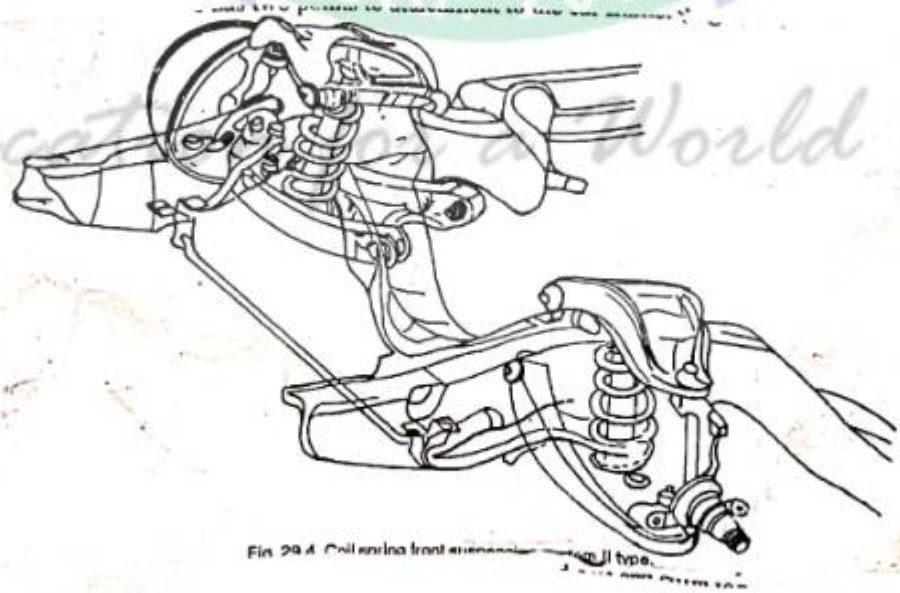
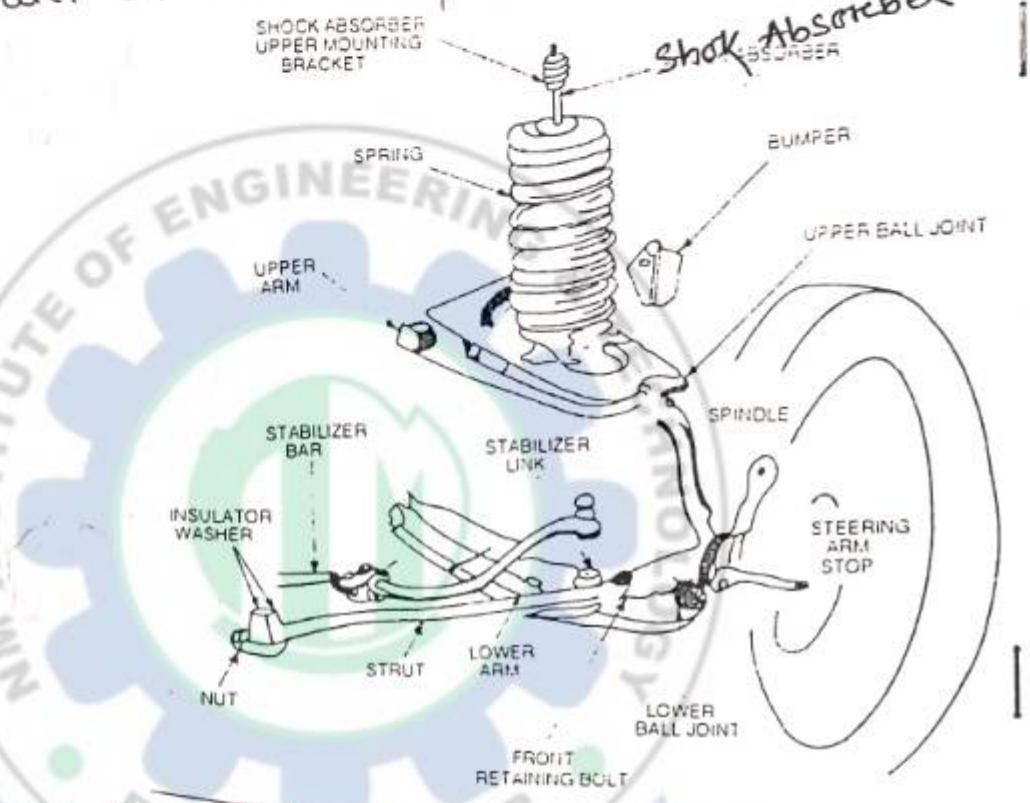


Fig. 29.4 Coil spring front suspension ... type.

(C) Third type :→ In the third type, the coil sp... is bet^n the upper control arm & spring tower i.e the part of the front-end-sheet-metal work



Twin I-beam Front Suspension

↳ The twin-I-beam construction is another type, used on some model of Ford trucks.

↳ Each front wheel is supported at the end by a separate I-beam. The ends of the I-beams are attached to the frame by pivots.

↳ The wheel ends of the two I-beams are attached to the frame by radius arms, which prevent backward or forward movement of the wheels

↳ This type of suspension provides more flexibility

Single I-beam front suspension

↳ It is used in larger trucks.

↳ The I-beam has a hole end through which a King pin is assembled to hold the steering knuckle in place.

↳ Each end of the I-beam is supported by a leaf spring.

Independent front suspension using Torsion bar

↳ In this type of suspension system, a steel rod, known as torsion bar, act as a spring to hold the upper & lower control arms parallel under load.

↳ The front end of the rod is of hexagonal shape & it fitted to an opening in the lower control arm. It's rear end is also of hexagonal shape opening in an anchor attached to the frame cross member.

↳ The torsion bar get twisted due to the forces on the wheel assembly outer end of the lower control arm.

↳ A strut rod is used to keep suspension in alignment.

↳ This type of suspension is able to avoid road shocks by causing the lower arm to twist the torsion bar.

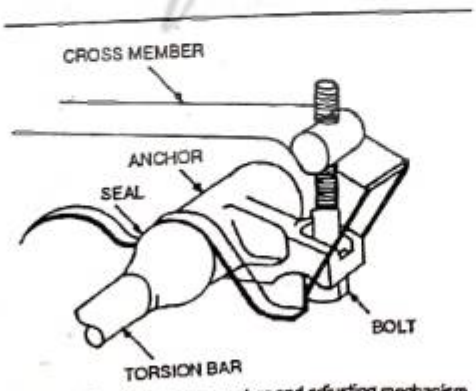


Fig. 29.9. Torsion bar, rear anchor and adjusting mechanism.

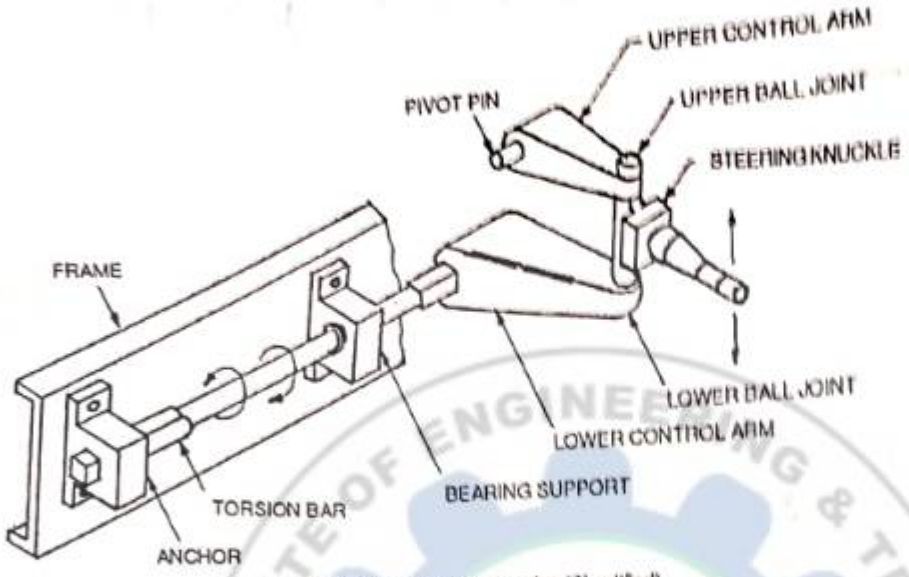


Fig. 29.10. Torsion Bar Suspension (Simplified).

Independent front Suspension using coil, torsion bar & Leaf spring :→

↳ This system is known as parallelogram type independent front suspension.

↳ It is consist of upper & lower link connected by the Stub axle carrier.

↳ The lower link is larger than the upper & they may not be flat.

↳ This system maintains the track width as the wheel rise & fall.

↳ It also minimize tyre wear.

Advantages of independent front Suspension

(i) It Provides more space for engine.
(ii) It may Provide softer Suspension
(iii) It reduces the tendency of rotating wheels to turn about the King pins.
(iv) It reduces the tendency of tilting the vehicle to one side when the wheel is lifted or drop due to the road variations.

Shock Absorber

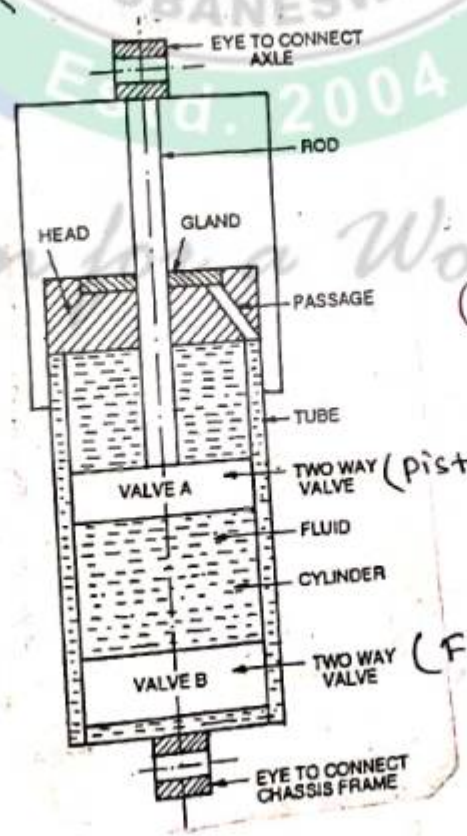
↳ It is a mechanical or hydraulic device design to absorb shock impulses.

↳ It does this by converting the kinetic energy of the shock into heat energy, which is then dissipated.

↳ Shock absorbers are of two types:-
(1) Mechanical
(2) Hydraulic

↓ Van type
↓ Telescopic type
↓ Piston type
→ single acting
→ Double acting

↳



(Telescopic Shock Absorber)

(piston valve)

(Foot valve)

Construction

(i) It is consist of an inner cylinder fitted with head at the open mouth

(ii) The head is also screwed into the outer reservoir which is fixed to the eye by means of which the reservoir is secured to the axle.

(iii) The piston slides inside the inner cylinder.

(iv) The piston is secured to the piston rod & which reservoir is connected to the other eye & this eye will be connected to the chassis frame.

(v) The outer portion of the piston rod & the reservoir are covered with a protecting cover which is fixed with the eye & the rod.

(vi) The gland provided at the head prevents the leakage of the fluid by scrapping around the piston rod & then passing it the reservoir through the drain hole.

(vii) The inner cylinder is provided with two valve systems. one foot valve is fixed at the bottom & the other with the sliding piston.

(viii) The piston valve & the foot valve assembly has outer ring of holes & inner ring of holes covered by the disc valve.

Working

(* The inner cylinder is completly filled with fluid & the reservoir is half filled.

* When the axle eye is moved upward then the fluid is displaced from the bottom side to the top side of the piston. under this condition the fluid must pass through the disc valve by opening the outer ring of holes.

* In this condition when the upper portion of the cylinder is fully filled or has less space, then the fluid will also be displaced through the inner rings of holes of the foot valve & the level of fluid will rise in the reservoir.

* Similarly when the axle eye will move downwards; then the fluid will be displaced from the top side to the bottom side of the piston.
* In this condition the fluid will pass through the disc valve by opening the inner ring of holes.
* The vacuum left by the piston rod inside the inner cylinder during this movement is filled by the fluid from the reservoir to the inner cylinder by opening outer ring of holes to the foot valve.
* This process will be repeated until the vibrations are damped out.

TYRE

* The tyre is mounted on the wheel rim.
* It must produce a minimum noise, while the wheel is turning on the road.
* It should have good grip while accelerating & braking the vehicle on both dry & wet roads.

TYPES Two types:- (a) Tube tyre
(b) Tubeless tyre

(a) Tube tyre

↳ It is a traditional tyre.
↳ It encloses a tube in which air is forced to a high pressure.
↳ The outer portion of the tyre is made of synthetic rubber called tread.
↳ At the inner edges, beads are formed by reinforcing with steel wires.

(b) Tubeless Tyre

↳ Tubeless tyre does not enclose the tube.
↳ The air under pressure is filled in the tyre itself.
↳ The inner construction of this tyre is same as that of the tube tyre.
↳ A non-return valve is fitted to the rim through which the air is forced inside the tyre.
↳ The tubeless tyres are lighter & run cooler than tube tyre.
↳ The main advantage of this tyre is that, it retains air for a long period even after being punctured. Also any hole in the tubeless tyre can be repaired simply by rubber plugging.

Tyre Specification

Every tyre is marked with its size.

If tyre is marking with **8.25 X 20 X 10 PR**

It means;→

(i) The width/thickness of tyre from shoulder to shoulder is 8.25"

(ii) Diameter of bead circle, which fits on the rim is 20".

(iii) PR means ply rating.
10PR means, the tyre consist of 10 plies

* The number of plies makes the tyre hard to resist heavy load. But hard tyre does not absorb road shock.

Exp:- Scooter tyre → 1 to 4 plies
Car tyre → 4 to 6 plies
Light truck tyre → 6 to 10 plies
Truck tyre → 10 to 22 plies

Causes & Remedies of tyre Wear :->

Causes

(i) Incorrect inflation (Air pressure)
(ii) Overloading
(iii) Bleeding of air in tyre (Expanding air)
↳ generating heat, thus increases the pressure.
(iv) Unequal tyres
(v) Defective brakes
(vi) Wrong loading
(vii) Misalignment
(viii) Careless driving

Remedies

(i) We should note that the tyre mileage lowers down if the tyre is either under-inflated or over-inflated.

~~(ii) Increase to are~~

(ii) Overloading :- Fit the tyre with adequate loading capacity limited to the axle & wheel strength.

(iii) The undue bleeding must be restricted.

(iv) ~~Maintain~~ Use the proper size tyre.

(v) Maintain the proper brake & replaced it if needed.

(vi) Regularly checked the proper wheel alignment.

(vii) Drive the vehicle properly & smoothly.

Engine Cooling

A System, which controls the engine temperature is known as cooling System.

Necessity of cooling System

(i) The temperature of the burning gases in the engine cylinder reaches upto 1500 to 2000°C, which is above the melting point of the material of the cylinder body & head of the engine. Therefore, if the heat is not dissipated, it would result in the failure of the cylinder material.

(ii) Due to very high temp., the films of the lubricating oil will oxidized, thus producing carbon deposite on the surface. This will result piston Seizure.

(iii) Due to over heating, large temp. differences may lead to a distortion of the engine components due to the ~~them~~ thermal stresses set up. This makes it necessary ~~for~~ the temp. variation to be kept to a minimum.

(iv) Higher temperatures also lower the volumetric efficiency of the engine.

Requirements of Efficient Cooling System :→

(i) It must be capable of removing only about 30% of the heat generated in the combustion chamber. Too much removable of heat lowers the thermal efficiency of the engine.

(ii) It removes heat at a fast rate when the engine is hot.

Types of Cooling System

(a) Air cooling System
(b) Water cooling System

(a) Air Cooling System

↳ In this type of cooling System, the heat, which is conducted to the outer parts of the engine, is radiated & conducted away by the steam of air, which is obtained from the atmosphere

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

↳ The fins are metallic ridges (An elongated region to withstanding high pre.) which are formed during the casting of the cylinder & cylinder head.

The amount of heat carried out by air-cooling depends upon:-

* Surface area of metal into contact with air
* Rate of air flow.
* Temp. difference betⁿ heated surface & the air.
* Conductivity of the metal.

↳ Air-cooling system is mostly used:-

Tractors
Motorcycles
Scooters
Small cars engine
Small aircraft engine
Small industrial engines:- where a blower is used to provide air.

Advantages

(i) Lighter in weight (Absence of radiator, cooling jacket, & coolant)
(ii) NO topping up the cooling system. (Raising the liquid level)
(iii) It needs less care & maintenance.
(iv) It is cheaper to manufacture.
(v) Engine warms-up faster than water-cooled system.
(vi) It can operated in cold climates where water may freez.
(vii) Design of air-cooled system is simple.

Disadvantages

(i) Less efficient cooling. (Bkz. co-efficient of heat transfer of air is less than that for water)

(ii) Not easy to maintain. Distortion of cylinder may take place.

(iii) More noisy operation.

(iv) Limited use in motor cycles & scooters where the cylinders are exposed to air stream.

(b) Water cooling System

↳ In this method of cooling, water is circulated through the water jackets to each of the combustion chambers, cylinders, valve seat & valve stems. This circulating air passes through the engine jackets takes heat of the combustion.

↳ When it passes through the radiator it cooled by air by the help of a fan. After passing through the radiator, the water again goes in the water jacket.

↳ It serves two purpose:-

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

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

Systems of water cooling

There are two systems of water cooling:-

(a) Thermosiphon System

(b) Pump circulation System

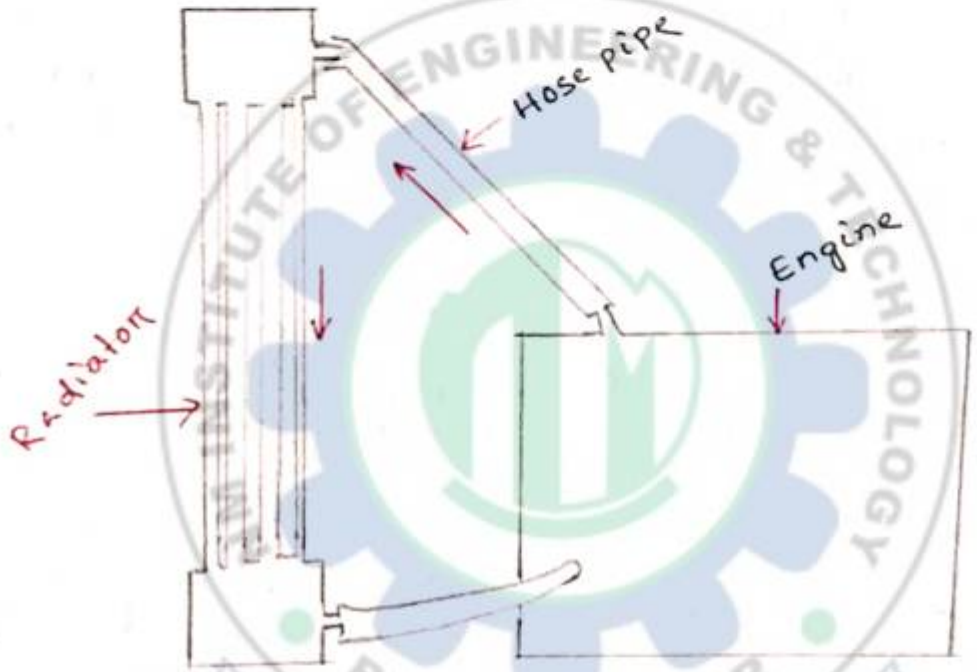
(a) Thermosiphon System

↳ The circulation of water is obtained due to the difference in densities of hot & cold regions of cooling water.

↳ The hot water from the engine jacket rises up in hose pipe & goes in the radiator from the top side

↳ It is cooled there & hence goes down at the bot
Side of the radiator, from where it goes again in
engine jacket.

↳ This system is simple & cheap. Here water must
be maintained upto certain minimum level. If water
level falls down, the cooling system will fail.



(Thermosiphon system of cooling)

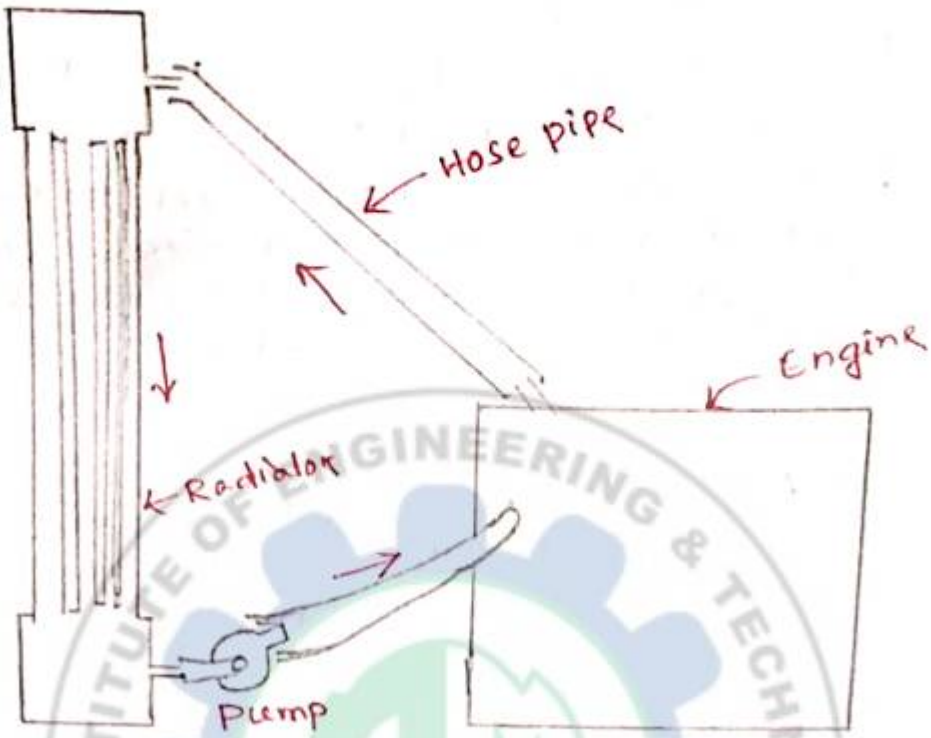
(b) Pump circulation System

↳ The circulation of water is obtained by a pump
The pump is driven by a V-Belt from a pulley
on the engine crank shaft.

↳ The circulation of water increases as the
engine speed increases.

↳ This system is more effective.

↳ There is no necessity of maintaining the
water upto correct level.



(Pump circulation System of Cooling)

Cooling Defects

The various problems or defects that occure in the cooling system are:→

* Loss of liquid coolant due to leaks
* overheating
* overcooling
* Incorrect temp. gauge reading
* Noises
* Frozen coolant

Loss of Liquid coolant due to leaks

* External leaks :- It is noted by inspection, as the coolant comes out from the system.
* Internal leaks :- It may allow some coolant to drain into the engine oil. Internal leaks may produce clouds of white vapour in the exhaust gases.
* If the leak is very great, it will rise the lubricating oil level in the oil pan.

Overheating

↳ It is caused by insufficient quantity of w in the cooling system.

↳ It is also caused by water passages, slipping of belt, Late ignition timing, incorrect valve timing, Pre-ignition, too tight bearings, too low engine oil level. etc.

Overcooling

↳ An engine is said to be overcooling if it is running below the normal operating range.

↳ It is caused by a thermostat that opens too soon or remains open at all times.

Incorrect temp. gauge reading

↳ If the gauge reading is incorrect, it should be either replaced or corrected.

Noises

↳ It is occure due to dry bearings, loose pulley on the pump shaft.

↳ Some pumps require Special water pump lubricant to the coolant by which the operation becomes noiseless.

Frozen coolant

↳ The water may freeze in the cooling system, when the car is parked where ~~to~~ the temp. is below the freezing point.

↳ This fails the cooling system completely & may cause serious breakage of any part of the system.

↳ If the coolant is frozen, the engine can be run at idling speed until it reaches a temp. of 200°c.

Defects ~~Defect~~	Causes
(1) External Leakage	* Loose hose clips * Defective rubber hose * Excessive wear in the water pump. * Damaged gasket
(2) Internal Leakage	* Defective cylinder head gasket * Cracked cylinder wall * Loose cylinder head bolt.
(3) Water Loss	* Boiling * External & internal leakage * Inoperative thermostat
(4) Poor circulation	* Insufficient coolant * Inoperative water pump * Loose fan belt * Inoperative thermostat
(5) Overheating	* Poor circulation * Dirty oil * Incorrect ignition & valve timing. * Low oil level
(6) Overcooling	* Defective thermostat * Inaccurate temp. gauge

Parts of water cooling System

Thermostat:→ used in water cooling system to regulate the circulation of water in system to maintain the normal working temp. of engine parts during the diff. operating conditions.

Radiator

It is a device which is having large amount Cooling surface & large amount of air, so that the water circulating through it is cooled efficie

Water pump

It is used in the water cooling system to increase the velocity of the circulating water.

Water Jacket

↳ It is cast into the cylinder block & heads.

↳ The jackets are the passages through which water circulates around the cylinders, valve ports & seats, combustion chambers.

Lubrication

To supply lubricating oil between the moving parts is known as lubrication.

It is essential in motor vehicle maintenance. Lubrication must be done properly & right type of lubricant should be used.

Function of Lubrication

(i) To reduce friction betⁿ the moving parts.
(ii) To reduce wear of the moving parts.
(iii) To act as a cooling medium for removing heat.
(iv) To keep the engine parts clean.
(v) To form a good seal betⁿ piston rings & cylinder walls.
(vi) To prevent deposition of carbon.
(vii) To absorb shocks betⁿ bearing & other parts thus reducing engine noises & extending engine life.

Function of Lubricating oil

(i) To minimize friction & wear.
(ii) To cool by carrying away heat.
(iii) To seal the piston.
(iv) To avoid vibration & impact.

Types of lubricants

3 types

(1) Solid → graphite, mica.
(2) Semi-solid → Grease
(3) Liquid → mineral oil, Vegetable oil Animal oil etc.

Graphite :→ (Solid)

↳ Used to lubricate → Automobile springs
Cylinders

↳ It has low co-efficient of friction & stable at high temperatures.

Mica :→ (Solid)

↳ Same properties as graphite.

Grease (semi-liquid)

↳ Used in → Chasis lubrication.
Axles lubrication

↳ It must be corrosive & should not be affected by water.

Types (Purpose)
- Water pump grease
- Chasis grease
- Multipurpose grease

Animal oil (Liquid)

↳ It is obtained from the animal fat like pig & fish, whale etc.

↳ These oil are not widely used in automobile industries, because they are oxidized easily & become gummy after some use.

↳ Caster oil is used in some applications because of its high viscosity & high strength.

Mineral oil (Liquid)

↳ It have good lubricating properties.

↳ Cheap & more available than other types.

↳ Mineral oil are obtained from petroleum & contain hydrocarbons.

↳ Light machine oil is a type of mineral oil which is used in generators, starters & distributors.

↳ Blended oil is a mixture of animal oil, vegitable oil & mineral oil

Properties of Lubricant

Viscosity :->

↳ Viscosity is a measure of resistance to flow or the internal friction of an oil.

↳ Viscosity means :- a heavy oil has high viscosity
a light oil has low viscosity
& medium oil has medium viscosity.

↳ It is used universally to grade lubricants. It increases when temp. increases & it decreases when temp. fall.

↳ Viscosity is measured by Viscosimeter. The unit of viscosity is Second Redwood

Flash point

↳ It is the lowest temp. at which the lubricating oil will flash when a small flame is passed across its surface.

↳ The flash point of oil should be sufficiently high so as to avoid flashing of oil vapours.

Fire point

↳ The lowest temp. at which the oil will burn continuously is called fire point.

↳ The fire point also high in a lubricating oil so that the oil does not burn in service.

Pour point

↳ It is the lowest temp. at which the lubricating oil will pour (Flow rapidly).

↳ This property must be considered because of its effect on starting an engine in cold weather.

Oiliness

↳ It is the property of an oil.

↳ This property is desirable in lubricating to the cylinder walls.

Colour

This property is used in case of checking the uniformity of brand of oil.

Emulsification

↳ When lubricating oil mixed with water, it is emulsified & losses its lubricating property.

↳ The emulsification number is an index of the tendency of an oil to emulsify with water.

Physical stability

↳ A lubricating oil must be stable physically at the lower & higher temp's. bet^n which oil is to be used.

Chemical Stability

A lubricating oil should be stable chemically. There should not be any tendency for oxide & carbon formation. The more oxide & carbon formation damages piston ring, spark plug & valves of the engine.

Specific gravity

↳ It is the measure of density of an oil. It is determined by a hydrometer, which floats in the oil.

↳ The scale used in hydrometer is recommended by the American Petroleum Institute. The result is called API gravity.

Neutralisation Number

↳ The neutralisation number test is a simple procedure to determine acidity or alkaline of an oil.

Adhesiveness

It is the property of lubricating oil due to which the oil particles stick with the metal surfaces.

Film Strength

It is the property of lubricating oil due to which the oil retains thin film bet^n the two surfaces even at high speed & load.

Cleanliness

↳ A lubricating oil must be clean. It should not contain dust & dirt particles.

↳ These impurities may be filtered out or removed with the change of oil at periodic intervals.

Lubrication System of I.C engine

The different lubricating system in automobile are:-

(a) Petroil system
(b) Splash System
(c) Pressure system
(d) Semi-pressure system
(e) Dry sump system.

(a) Petroil System :→

↳ It is generally adopted in two-stroke petrol engine like scooters & motor cycles.

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

↳ When the fuel goes into the crank chamber during the engine operation, the oil particles go deep into the bearing surfaces & lubricate them.

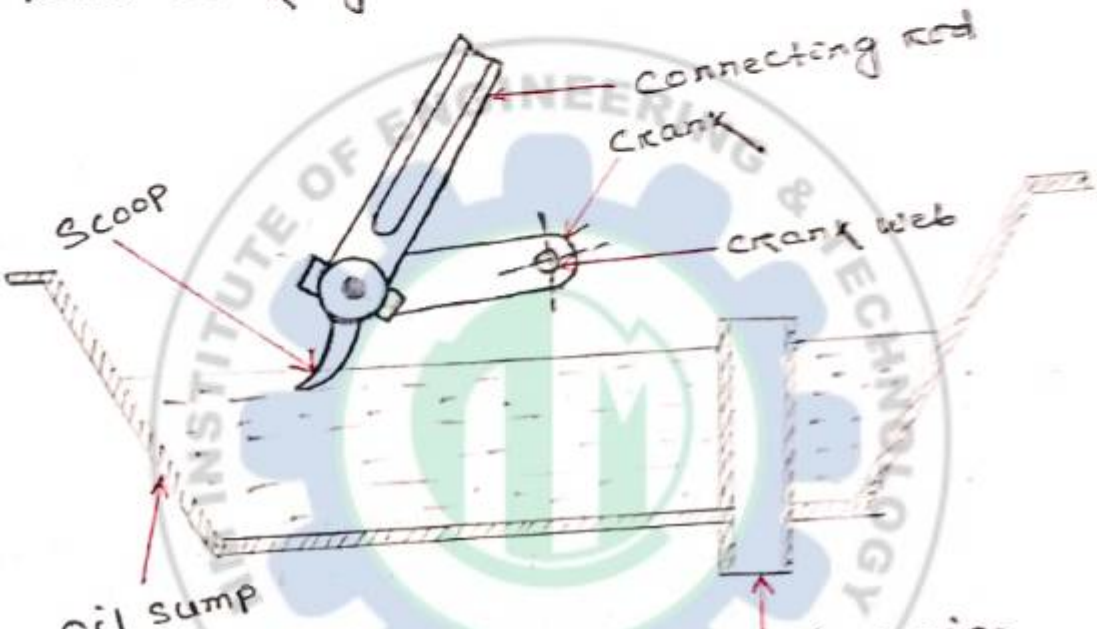
↳ The main disadvantage of this system is that, if the engine is remain unused for considerable time, the lubricating oil separate off from petrol & resulting in clogging of passages in the carburettor, hence starting trouble.

(b) Splash System

↳ The lubricating oil is stored in an oil sump. A dipper or scoop is made in the lowest part of the connecting rod.

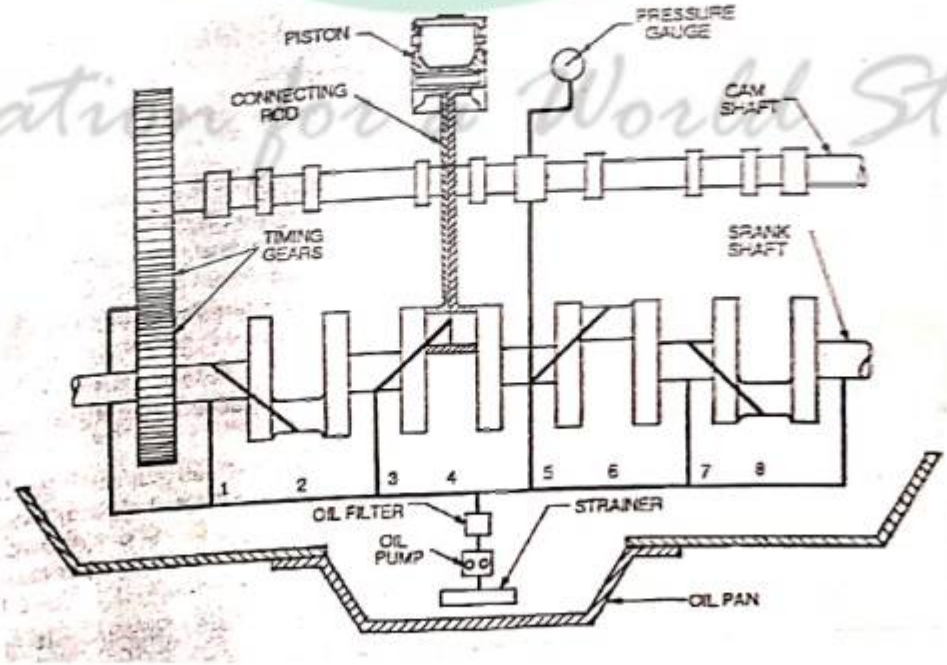
↳ When the engine runs, the scoop dips in the oil once in every revolution of the crankshaft & cause the oil to splash on the cylinder walls.

↳ This action affects the lubrication of the engine walls, piston ring, crankshaft bearings & big end bearings.



(Splash system of lubrication)

(b) Pressure system



↳ The lubricating oil is stored in a separate sump, from where an oil pump takes the oil through a strainer & delivers it to the main oil gallery through a filter.

↳ The oil from the main gallery goes to the main bearings, from where some of it after lubricating main bearing, falls back to the sump, some is splashed to lubricate the cylinder walls

↳ The remaining goes to the crankpin through a hole & then to the piston pin & then lubricates the piston rings.

(c) Semi-Pressure System

↳ It is the combination of Splash system & Pressure system.

↳ Some parts are lubricated by Splash system & Some parts by pressure system.

↳ Allmost all four-stroke engines are lubricated by this system.

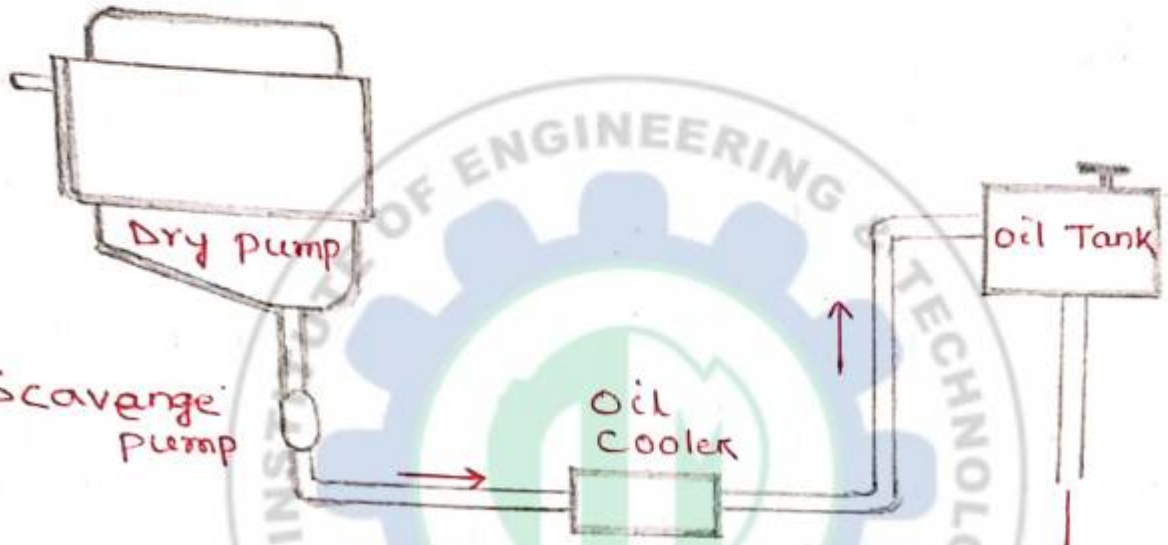
(d) Dry Sump System

↳ The system in which lubricating oil is not kept in the oil sump is known as dry sump system.

↳ In this system oil is carried in a separate tank from where it is feed to the engine.

↳ The system is consist of two pumps, one to feed oil & other to deliver it back to the oil tank.

↳ This system is used in a situation where the vehicle ~~is to~~ has to change its position continuously like in aircrafts.



(Dry Sum Lubrication)

Engine Lubricating Troubles

↳ Failure of oil pump.
↳ clogged oil lines & oil passage
↳ contaminated oil
↳ become unsuitable for its original purpose due to the presence of impurities or loss of original properties.

Engine Fuels

Petroleum

↳ Greek word

Petra → means ROCK

Oleum → Oil

↳ 1st drilled by an American → Kirosene
Edwin Drake (USA) - 1859

1st in India :→ * Assam Railway & Trading co.
* Assam Oil co. (AOC), Digboi Assam

Classification of Refinery Products

(1) Gas Fraction

* Natural gas :→ 95% - Methane, small amount of hydrocarbons.

* Liquified petroleum gas (LPG) :-
Butane & Propane
used → Domestic Fuel for cooking

(2) Light Fraction

* Petrol or Gasoline :→
Petrol octane number → 75 - 85 (India)
Gasoline octane number → 90 - 110 (USA)

* Naphtha & Kerosene :-
Naphtha is a product bet^{n} gasoline & Kirosene. ↳ used as a solvant in paint & chemical industries.
Kerosene is used for illumination purpose & also as fuel in jet.

(3) Distillates

* Diesel Fuel :→ The main characteristics of diesel fuels are:- cleanliness, ignition quality, volatility, & fluidity.

* Gas oils :→ These are used as absorbent for hydrocarbon gases.

(4) Lubricating oil

* Motor oil :→ Napthene base oils of low viscosity index may be used as diesel oil.
  Exp :- Diesel engine oil.

* Lubricants :→ These are used to prevent friction betⁿ the parts of any machine.
  Exp :- gear oil, Grease

* Cylinder oil :→ It is used as lubricant for steam engine cylinders.

(5) Grease & Waxes

↳ It includes paraffin wax, micro-crystalline wax.
  ↳ used for manufacturing wax paper, insulating material package sealing etc.
  ↳ it are the base materials of of grease, package Sealing.

(6) Residue

* Fuel oil & coke :→ used as industrial fuels
  ↳ coke is also used for manufacturing electrodes.

* Tar & asphalt :→ These are used as road oils, roofing material & protective coating.

Diesel Engine Fuel

↳ used diesel oil.
↳ only air is sucked inside the cylinder & compressed to a high pressure.
↳ The Compression ratio being 11 : 1 to 22 : 1.
↳ Diesel oil is light, with low viscosity & high Cetane number

Requirements of diesel oil

(i) Ignite readily & burn evenly
(ii) Must have lubricating qualities to operate the pump & valves

(iii) It must have low viscosity.

Liquid petroleum Gas (LPG)

↳ Two types:- Fuel propane
Fuel butane

↳ Mixture of both propane & butane are also used.

↳ mostly used in Bus lines, Truck fleets & industrial operations

Advantage

* Complete vaporization.
* closer control of air-fuel ratio.
* Complete air-fuel mixture at all temperatures.
* Combustion is lean & complete
* High antiknock value
* It's high octane value increases the thermal efficiency of the engine.

CARBURETTOR

↳ It is a device that mixes air & fuel for I.C engines in the proper ratio for combustion.

↳ The air-fuel mixture obtain from the carburetor is known as ~~Combustible~~ Combustible mixture.

The process of mixing the gasoline fuel with air to obtain the combustible mixture is called Carburetion.

Simple Carburettor

↳ A Simple carburettor consist of the round cylinder with a constricted section, a fuel nozzle, a throttle valve & a float chamber.

↳ The round cylinder is called air horn & the constricted section is called venturi. The venturi & float chamber are connected by the fuel nozzle. The throttle valve can be tilted to open & close the air horn.

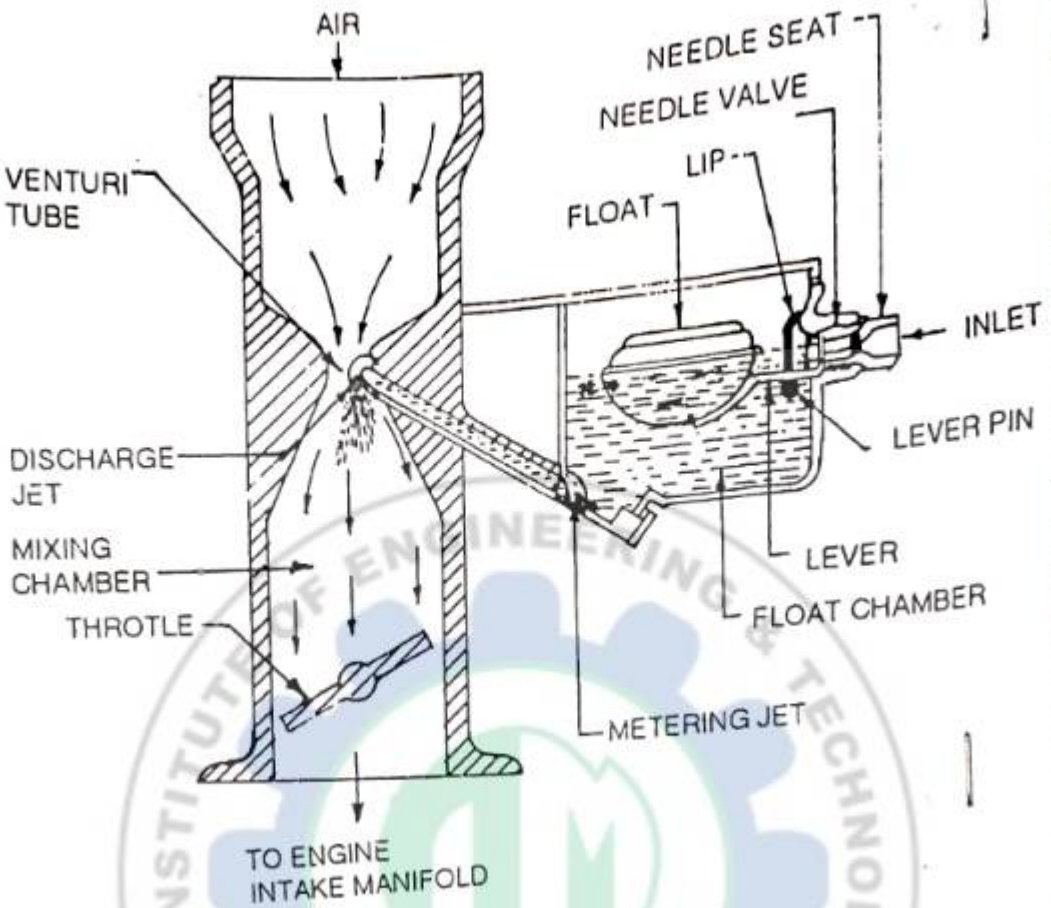


Fig. 10.8. Simple plain-tube carburettor.

Venturi :

(i) A venturi is a narrow space in the cylindrical air horn, through which the air is passes.

(ii) The spray of gasoline from the nozzle & the air entering through the venturi are mixed together in the mixing chamber.

(iii) The vaporization & atomization of the gasoline takes place in this chamber, & it mixes with air so that the combustible mixture is produced. This mixture passes through the intake into the cylinder.

Throttle Valve: →

(i) The throttle valve is a circular disc & located in the mixing chamber.

(ii) When the throttle valve is open, more air passes through the venturi & shocking more fuel, thus more amount of air-fuel mixture goes to the cylinder. The engine develops more power & runs faster.

(iii) When the throttle valve is close, less air passes the Venturi & Shocking less fuel, thus less amount of air fuel mixture goes to the cylinder. The engine develops less power & runs slowly.
(Throttle Valve connected to the driver pedal & it is controlled by the driver)

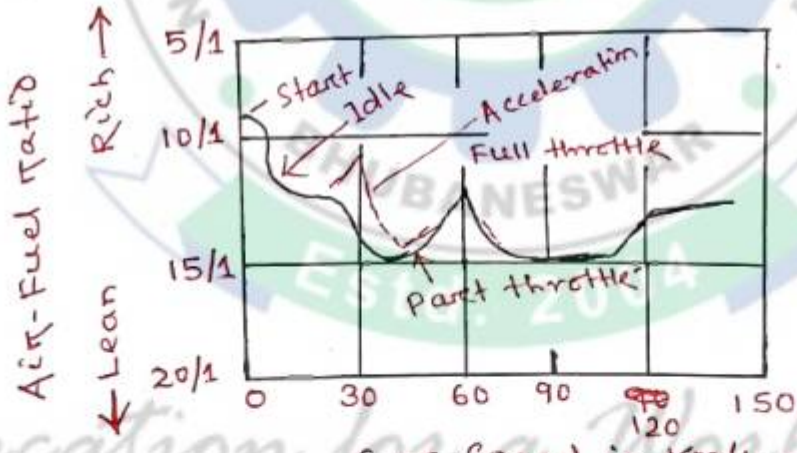
Metering System

(i) Metering System means, controll & measured fuel flow. i.e transfering proper amount of fuel to the air into the engine.

Air Fuel Ratio

(i) The carburettor must supply the air-fuel mixture of different properties to suit the different operating requirements.

(ii) The mixture must be rich for starting & must be relatively lean for idling & & intermediate speed.



(Air-Fuel ratio of a car)

(iii) For starting air fuel ratio is 9:1. It is a rich mixture.
For idling, the ratio is 12:1. It is lean mixture.
For intermediate, the ratio is 15:1. It is a lean mixture.
For high speed, the ratio is 13:1.

(iv) The air fuel ratio for different cars varies with speeds.

Classification of Carburettor

(1) According to arrangement of Float chamber :→
- (a) Eccentric
- (b) Concentric

(2) According to dirⁿ of air flow :→
- (a) Down draft
- (b) Side draft
- (c) Up draft
- (d) Semi-down draft

(3) According to the type of metering system :-
- (a) Air-bleed jet
- (b) Metering rod type

(4) According to the type of Venturi :→
- (a) plain venturi
- (b) Double venturi
- (c) Triple venturi
- (d) Vane venturi
- (e) Nozzle-bar venturi

(5) According to the type of power system :→
- (a) Manually operated
- (b) Vacuum operated

(6) According to the method of varrying the mixture strength :→
- (a) Constant choke Carburettor
- (b) Constant vacuum carburettor