

Definition:-

Automobile is a self propelled vehicle.

Components of Automobile:-

- * Basic Structure.
- * Power Plant.
- * Transmission System.
- * Auxiliaries
- * Controls.
- * Superstructure.

Basic Structure:-

↳ This is the unit in which remaining units are build to turn it into a power operated vehicle.

- Frame
- Suspension System
- Axles
- Wheels
- Tyres.

Frame:-

→ Conventional Pressed steel frame to which all the Mechanical units are attached and on which the body is superimposed.

→ The Integral or frameless construction the body structure is so designed as to combine the functions of body and frame.

Advantages of Frontal Construction over Conventional Frame.



- * Lower Manufacturing Cost.
- * During Collision the body crumbles, thereby absorbing the shock due to impact and thus providing safety to passengers.
- * Compared to the boxed construction lower body position may be obtained thus resulting in increased stability.

Disadvantages:

- * Reduction of strength and stability
- * Only for Mass production.
- * Increased Cost of repairs in case of damage
- * Topless cars are difficult to design.

Suspension Systems

Objectives of Suspension.

- To prevent the road shocks from being transmitted to the vehicle components.
- To safeguard the passengers from road shocks
- To preserve the stability of vehicle.

Types

- * Conventional system in which the road springs are attached to the rigid beam axle.
- * Independent system,

Axles

The Weight Carrying Portion

Types:

Front Axle.

Rear Axle.

Types of Rear Axles.

- * Fully floating type
- * Three Quarter Floating type
- * Semi-floating type.

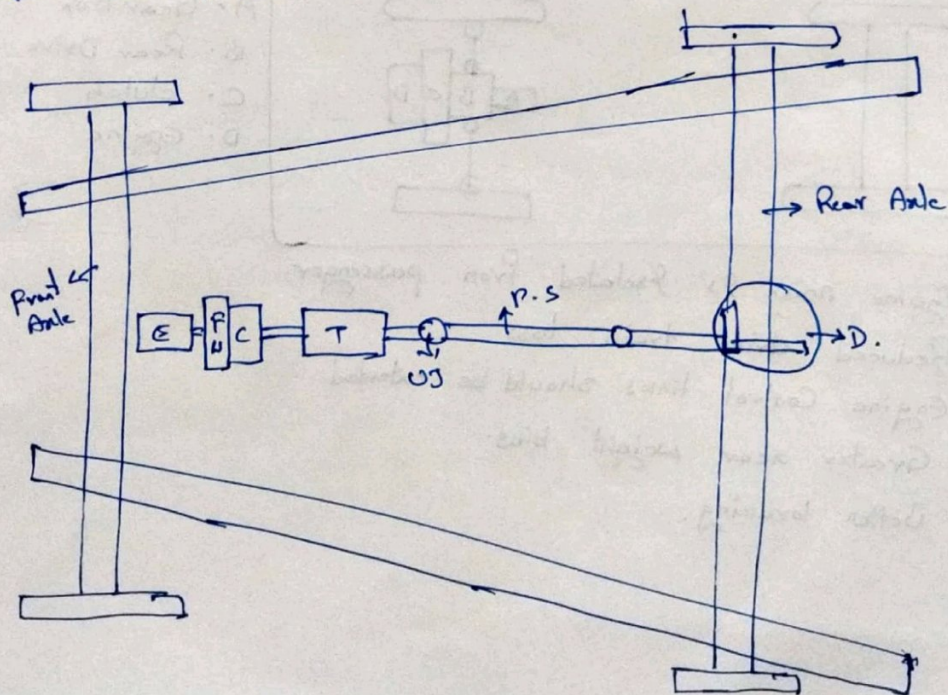
Wheels.

Wire Spoked wheels are used.

Transmission System:-

The transmission system consist. of a clutch, Gearbox.

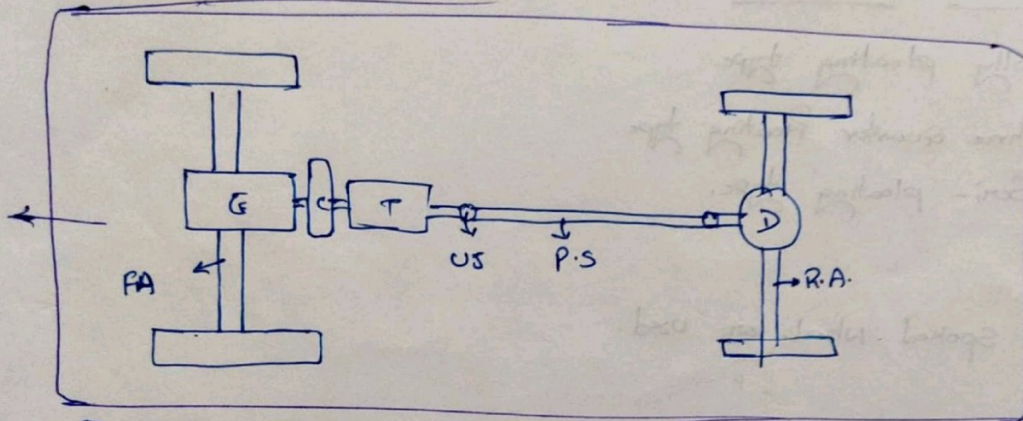
Layout of Complete Transmission of Automobile.



Functions of Transmission

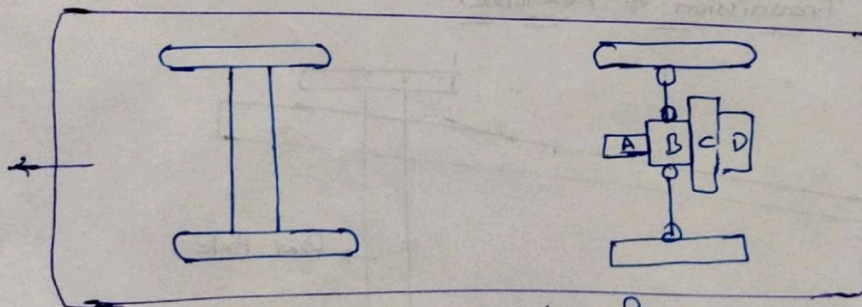
- * To disconnect the engine from road wheels when desired.
- * To Connect the engine to the driving wheels without shock.
- * To reduce the engine speed Completely
- * To turn the drive through a right angle.

Rear Wheel Drive (Front Engine Rear wheel Drive).



Rear Engine Rear Wheel Drive

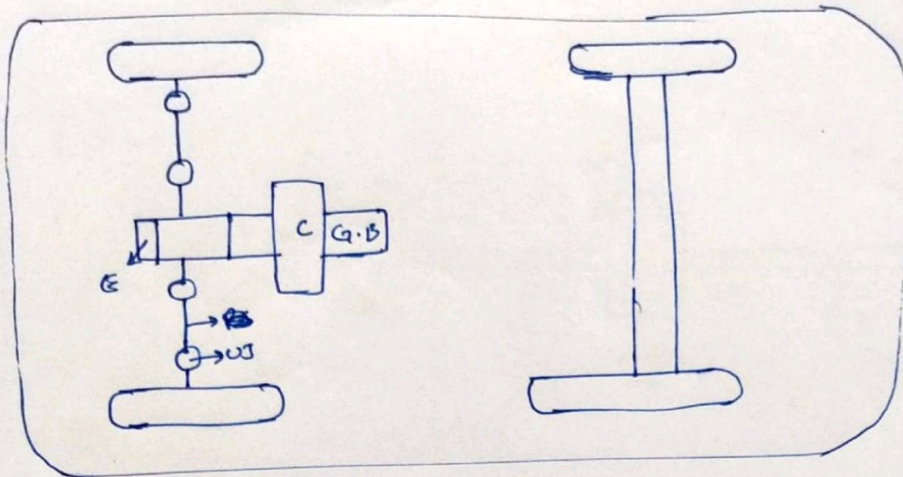
Rear Engine Rear Wheel Drive.



- A. Gear Box
- B. Rear Drive
- C. clutch
- D. Engine

- * Engine noise is isolated from passenger.
- * Reduced drive train loss.
- * Engine Control links should be extended.
- * Greater rear weight bias.
- * Better braking.

Front Engine Front Wheel Drive.



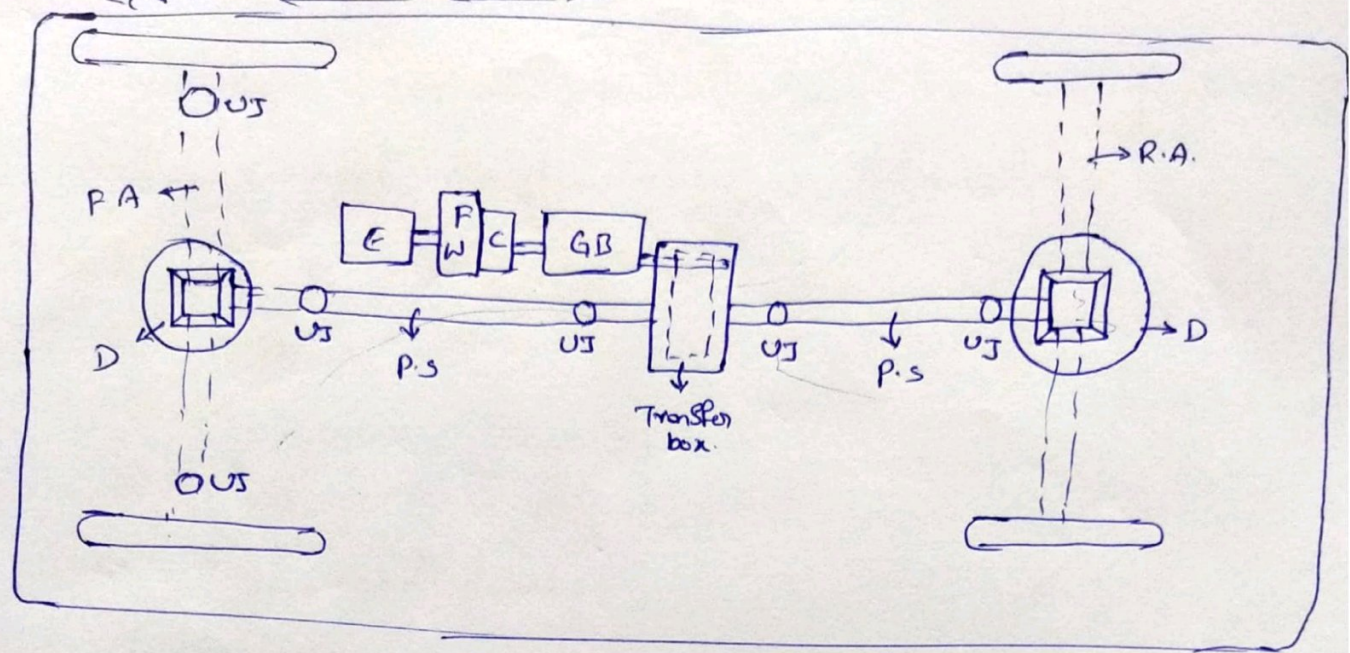
Advantages:-

- * Economic
- * Better road holding even on curves
- * Vehicle has good adhesion on road as more weight is placed on front wheel.

Disadvantages

- * Not used in powerful cars.
- * Difficult to feed more power

Layout of Four Wheel Drive



General classification of automobiles:-

Automobiles can be classified from the point of view of various general considerations as follows:

1. Use:

- i, Mopeds
- ii, Motor cycles, Scooters
- iii, Cars, jeeps
- iv, Buses and trucks

2. Capacity:

→ Heavy transport Vehicles (H.T.V.)

Example: trucks (i.e. lorries) and buses.

→ Light transport Vehicles (L.T.V). like cars, jeeps etc.

3. Make and model:

→ Bajaj 'pulsar', Royal Enfield 'Bullet', Honda 'external'

→ Premier 'padmini', Hindustan 'Ambassador', Maruti 800 etc.

→ Tata 'Indica', Izyland 'cheetah', Ford 'Ikon', General Motors 'corse' etc.

4. Fuel used:

→ Petrol Vehicles, eg:- Scooters, motor cycles, cars (petrol models)

→ Diesel Vehicles eg:- Buses, trucks, cars (special diesel models)

5. Body style:

→ closed cars such as Saloon, Coupe etc.

→ open cars like Sports car, convertible car etc.

→ Special styles such as estate car, station wagon etc.

6. Wheels:-

- two wheelers ; eg:- Scooters, motor cycles, mopeds
- Three wheelers like autosickshaws, tempos.
- Four wheelers eg:- cars, jeeps.
- Six wheelers eg:- ~~cars~~, trucks, buses.

7. Drive:-

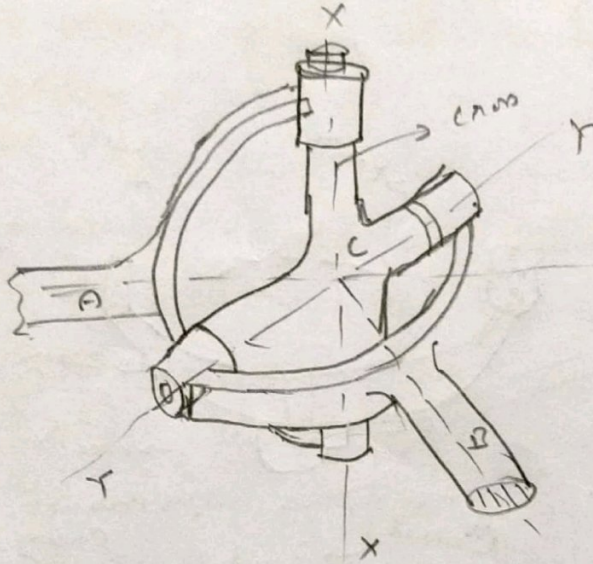
- whether the vehicles can be driven sitting towards right (or) left side.
 - a) left hand drive eg:- American vehicles for use in USA
 - b) Right hand drive eg:- Indian vehicles
- Whether the front axle, rear axle or both axles are driving axles.
 - a) front wheel drive, eg:- volkswagen car, Maruthi car
 - b) Rear wheel drive: premier, Ambassador cars.
 - c) All wheel drive: jeeps.

8. Transmission:-

- 1) Manual in which ordinary crash type gear box used. The examples are most of the Indian cars.
- 2) Semi-automatic
- 3) Fully-automatic
- 4) continuously variable
- 5) Automatic manual

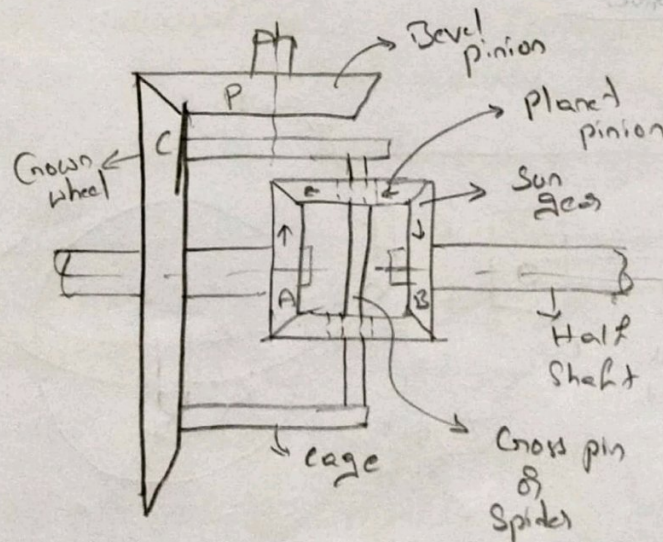
Universal Joint:

A universal joint is a particular type of connection b/w two shafts, whose axes are inclined to each other. The most simple type is Hook's joint.



Differential

A device which uses to overcome the skidding is called a Differential.

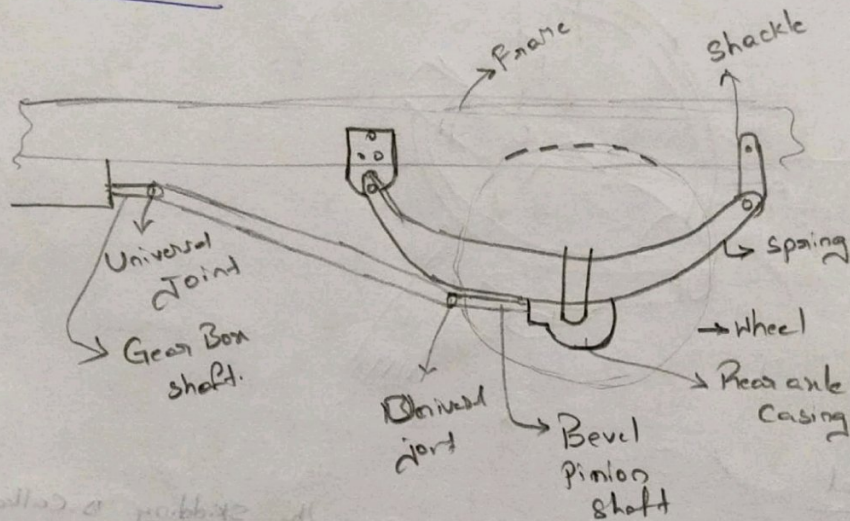


Rear Axle Drives:

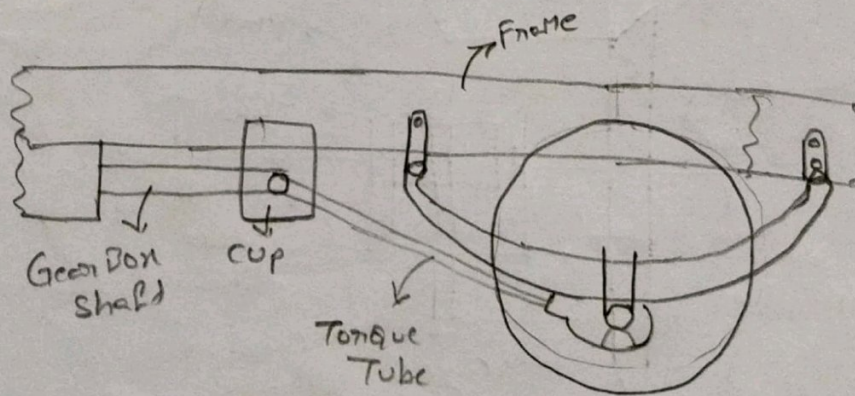
In all the drives employed for the rear axle the springs take the weight of the body.

- * Hotchkiss Drive
- * Torque tube Drive

Hotchkiss Drive



Torque Tube Drive



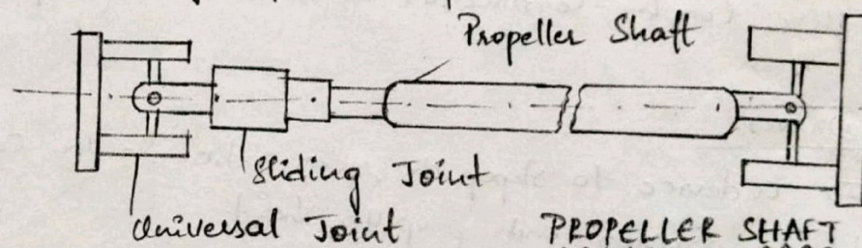
5. What is the function of Propeller Shaft

DRIVE LINE:

It is the group of parts connecting the transmission with the driving wheels. It consists of the drive shaft (is called propeller shaft), universal joints, constant velocity joints and the half shafts.

PROPELLER SHAFT:

This is the shaft which transmits the drive from the transmission to the bevel pinion or worm of final drive in front engine, rear drive w/ vehicles and from the transfer box to the front and rear axles in all-wheel drive vehicle. It is also called drive shaft. It consists mainly of three parts:



(a) SHAFT:

As this has to withstand mainly torsional loads, it is usually made of tubular cross-section. It also has to be well balanced to avoid whirling at high speeds. Shafts are made of steel, aluminium or composite materials.

(b) One or two universal joints, depending upon the type of rear axle drive used. The universal joints account for the up and down movements of the rear axle when the vehicle is running.

Slip joint Depending on the type of drive one slip joint may be there in ^{shaft} ~~joint~~. This serves to adjust the length of the propeller shaft when demanded by rear end movements.

Comparison of Automatic & Manual Transmission

Advantages:

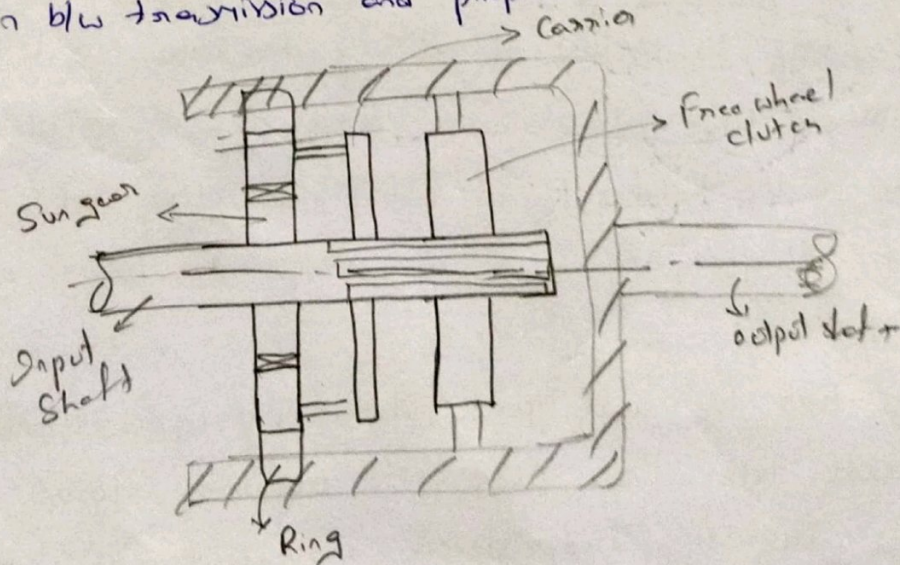
- * More precise control of shifting results in better driveability
- * No skill required for operating.

Disadvantages:

- * Higher fuel consumption due to lower mechanical efficiency.
- * Higher initial cost
- * More complex construction which results in expensive repairs

Over Drives:

Is a device to step up the gear ratio in the car. It is fitted in b/w transmission and propeller shaft.



UNIT-I INTRODUCTION

① with the help of a neat sketch. Explain Lubrication System also discuss its advantages & disadvantages?

② The various Systems adopted for the Lubrication of automobile Engine are:-

- ① petroil System
- ② Splash System
- ③ pressure System and
- ④ Dry-sump System.

① petroil System:-

This is used generally for Small two-Stroke Engines. Example in majority of scooter and motor cycle Engines

→ It is the simplest of all types of Engine Lubrication Systems
→ Certain amount of the lubricating oil is mixed with the petrol itself, the usual ratio being 2% to 3% of oil. If it is less, there is danger of oil starvation (a) insufficient lubrication causing damage to the Engine.

→ If however it is more, there will be excessive carbon deposit in the cylinder Head and the Engine will also give Dark Smoke.

→ When the petrol mixture enters the crankcase, due to high temperatures there, the petrol component vaporizes leaving a thin film of lubricating oil on the crank case, cylinder walls, crankshaft and bearings.

→ The main requirements of lubricating oil for two-stroke Engine are that it should readily mix with petrol and burn without leaving much residue.

② Splash System:-

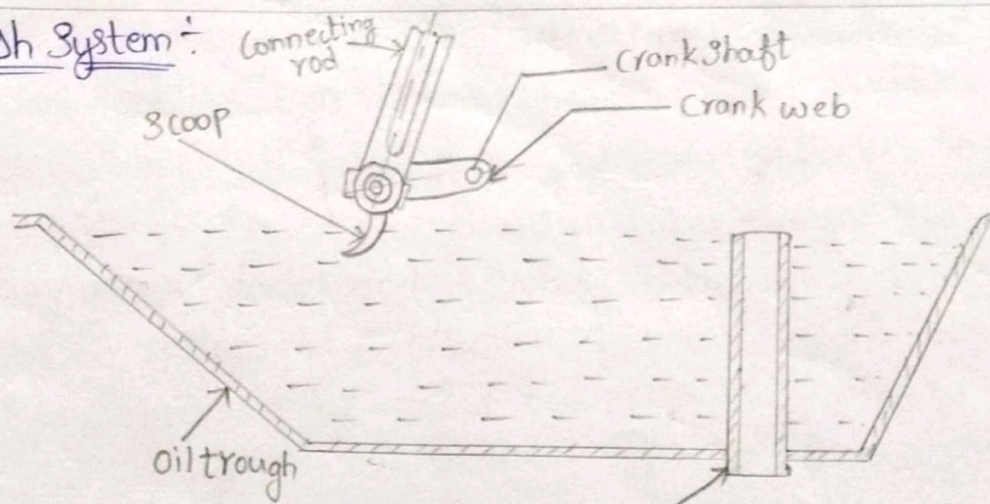


Figure of Splash lubrication

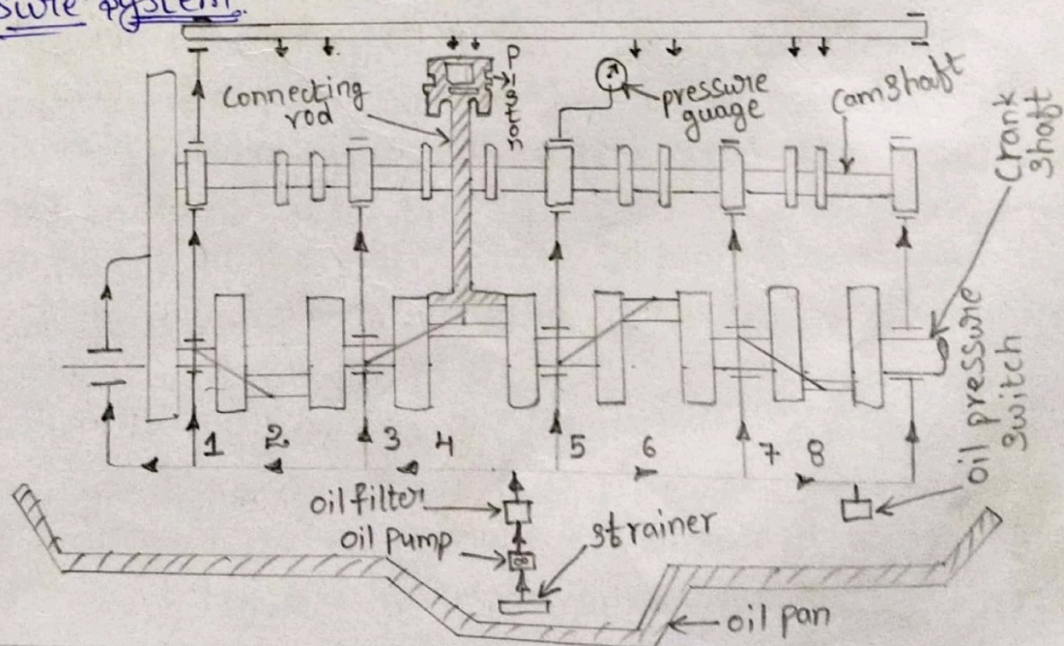
→ This was employed for the engines of early motor cycles. It is one of the cheapest methods of engine lubrication.

→ A scoop is made in the lowest part of the connecting rod and the oil is stored in the oil trough, it being pumped there from the crankcase oil pump.

→ When the engine runs, the scoop causes the oil to splash on the cylinder walls each time it passes through its B.D.C. position.

→ It affects the lubrication of engine walls, gudgeon pin, main crankshaft bearings, big end bearings etc.

③ Pressure System:-



→ This system is used almost universally in modern car Engines. The splash system though cheaper, is not suitable for automobile Engines because of the absence of positive lubrication.

→ In the pressure system an oil pump takes the oil from wet sump through a strainer and delivers it through a filter to the main oil gallery at a pressure of 200 to 400 kPa. The oil pressure is controlled by means of a pressure-relief valve, situated in the filter unit (8) the pump housing.

④ Dry Sump System:

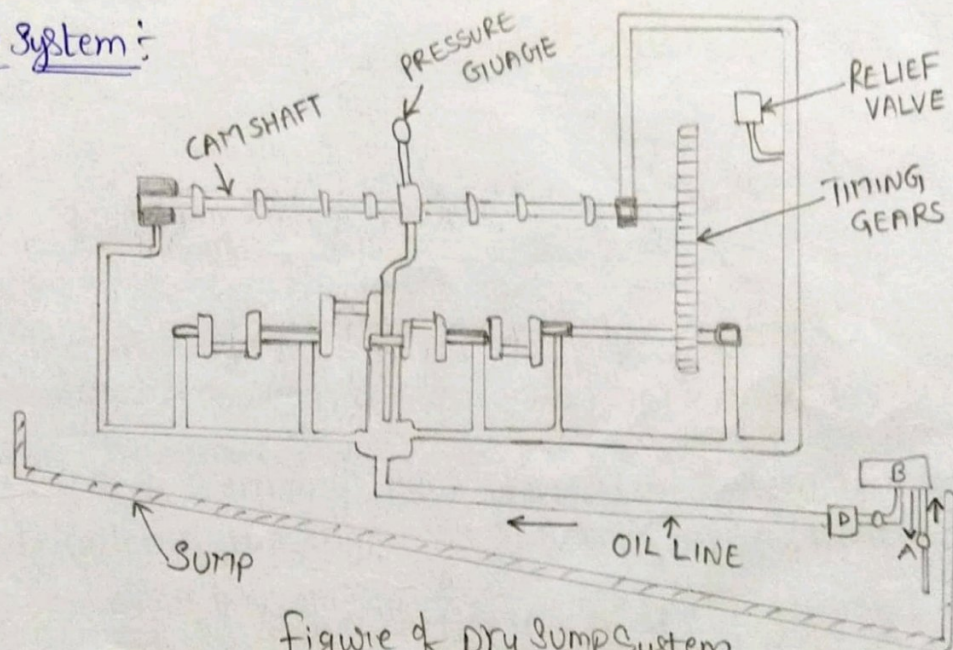


Figure of Dry Sump System

→ This system is employed in some racing car Engines and for situations where the vehicle has to be operated at very steep angles. If ordinary wet sump pressure system of lubrication is used in such cases, the situations may arise when there is no oil at the place where oil pump is installed.

→ To avoid such pump 'A' is installed in the crankcase portion which is the lowest. It pumps oil to a separate reservoir 'B' from where the pressure pump 'C' pumps the oil through filter 'D', to the cylinder bearings; a full pressure system of lubrication is employed. The oil pressure is maintained at 400-500 kPa for the main and big end bearings while about 50-100 kPa pressure

- is used for timing gears and cam-shaft bearings etc.
- obviously, in this system, the pump can be smaller in size and can be placed anywhere in the vehicle.
- This system is thus more reliable, but is more complex and costlier due to additional pump and high pressure oil lines, due to which it is not used in common vehicles.

(ii) PRE - LUBRICATION SYSTEM:-

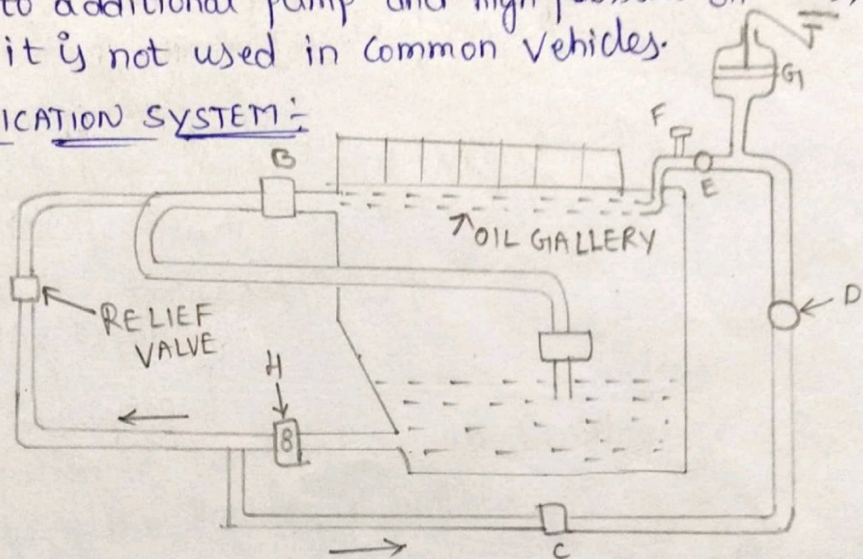


Figure of PRE - LUBRICATION SYSTEM

- Daimler-Benz of Germany have devised a system by means of which lubrication of the engine is ensured before it actually starts.
- The Arrangement as shown in figure. "A" is the main oil pump which is operated by the engine and it delivers oil to the oil gallery through filter "B".
- A secondary lubricating pump "H" is provided which is operated by an electric motor. The oil from "H" is divided into two branches. one branch goes through filter "C" and non-return valve "D" to the fuel control device "G1".
- The main oil gallery is further connected through pressure switch "F" and valve "E" to the fuel control device "G1".
- When the pump "H" is started, in the pre-lubrication stage the oil flows through filter B to oil gallery.

Advantages & disadvantages of Lubrication system

Advantages:

- Allows High running speeds.
- Hydrodynamic lubrication is possible.
- Rapid removal of wear particles and dirt from bearing.
- Allows high loads.
- Reduces heavy noise and vibrations.
- Replacement of Bearing is quite simple.
- It removes the temperature of Bearings and it extends the life of the Engine.

Disadvantages:

- poor dissipation of temperature in Bearing.
- Service life of the Engine is limited.
- Carbon formation occurs normally on the combustion chamber walls, pistons, valve stems and piston rings.
- It results due to incomplete combustion of fuel, particularly so at the time of starting and idling when richer fuel is supplied.
- The unfiltered lubricating oil is splashed again and again. It reduces the life of the bearings.

Write a short notes on turbocharging and supercharging?

Supercharging:

Supercharging is the process of supplying to the engine, air-fuel mixture at a pressure above the atmospheric i.c.

→ On an ordinary engine without a supercharger, the downward piston movement during the intake stroke creates a vacuum in the inlet manifold, which is used to draw in the air-fuel mixture through the carburettor into the cylinders.

→ With supercharging, however, due to higher pressure, the density of charge increases and, therefore, its weight per stroke is increased for the same swept volume.

→ It is seen that the power output of an engine is almost directly proportional to the weight of charge per minute, therefore, the supercharge engine gives more output.

→ Up to 40% increase in power and torque may be obtained by supercharging.

Superchargers:

A supercharger, also called a blower, is a gas compressor used to pump air into the cylinders of an I.C engine. In petrol engines, the charge is petrol/air mixture.

→ Generally, four types of superchargers are in use:

① Centrifugal type

② Root's type

③ Vane type and

④ Screw type.

① Centrifugal type:

This is the common type of supercharging on the automotive engines. It is run from the engine pulley by means of a V-belt. The air/fuel mixture enters

(7)

the impeller at the centre and after passing through the impeller and the diffuser vanes, it enters the volute casing, where a part of its kinetic energy is recovered and the mixture at supercharged pressure goes out of the casing to the engine.

→ Generally due to the high pressure, about 30% more air-fuel mixture is forced into the combustion chamber.

→ The impeller of this supercharger is required to run at very high speeds, say up to 80,000 r.p.m., these impellers are made of Duralumin, (8) alloy steels.

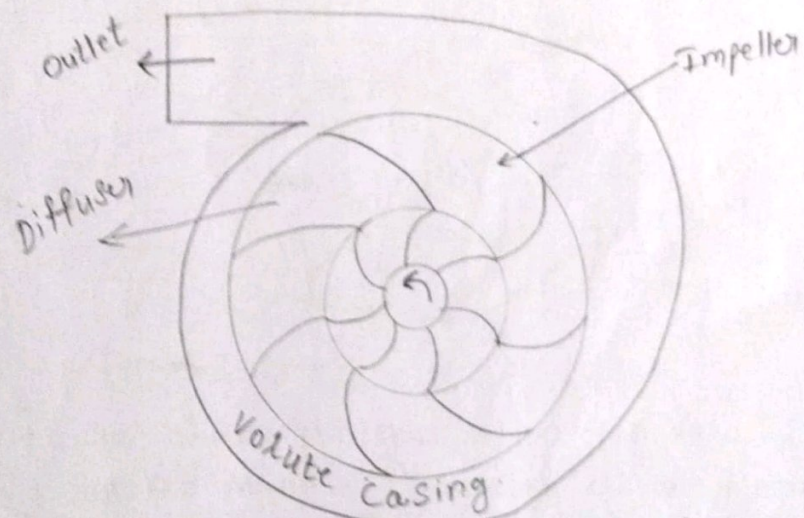


Figure of Centrifugal type of Supercharger

② Root's Supercharger

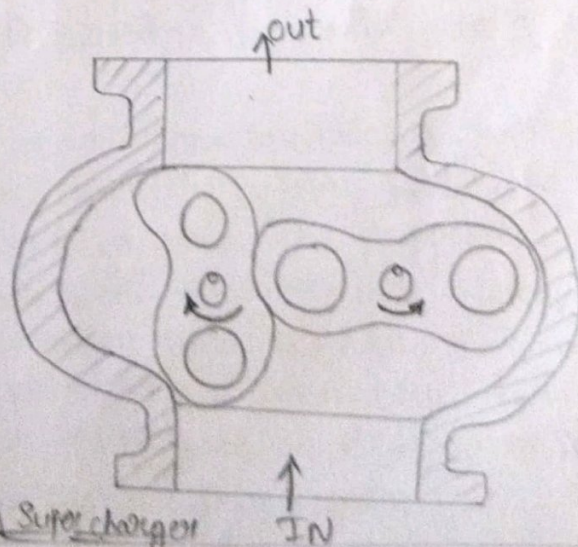


Figure of Root's Supercharger

→ It consists of Epicycloid shape as shown in above figure. An Epicycloid is the locus of a point on the circumference of a circle which rolls on another circle. Each rotor is keyed to its shaft.

→ Which are connected together by means of gears of equal size, so that the two rotors revolve at the same speeds. The working action of this supercharger is just like a gear pump, so that we get the mixture at the outlet at a high pressure.

③ Vane type Supercharger's

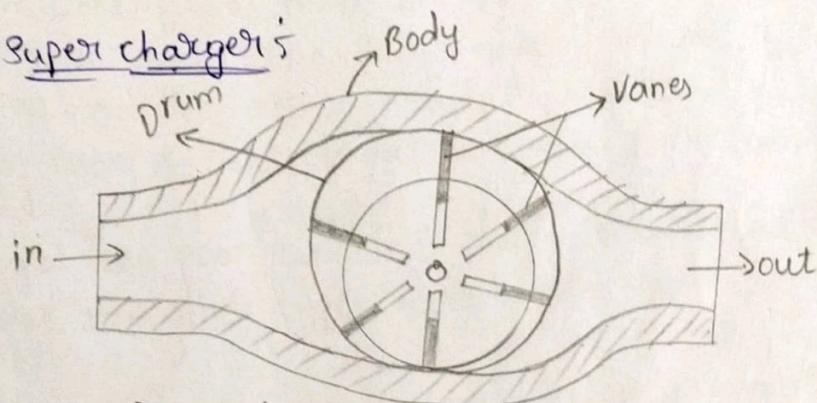


Figure of Vane type Supercharger

→ In the above figure, shows the construction of a vane type supercharger, in a simplified manner. A number of vanes are mounted on the drum in such a manner that they can slide in (&) out against some spring force, so that all the time they are in contact with the inner surface of the supercharger body.

→ The vanes are usually made from laminates of linen impregnated with phenolic resin. However, Tufnol, because of its similar qualities, has also been used. The properties required for a vane material are, quiet running, low friction, low coefficient of thermal expansion and resistance to continuous exposure of oil and petrol. It is seen that space between the body and the drum goes on decreasing from the inlet to the outlet side as the drum rotates.

→ Thus the mixture entrapped between any two vanes at the inlet will experience decrease of volume and hence increase of pressure as it reaches the outlet.

④ Screw type Supercharger :

→ These compress the air between two intermeshing screws, taking it at one end and compressing the air as it travels along the screw axis.

→ Out of the various types of superchargers described above, all except the centrifugal one, are the positive displacement types, i.e., they have about the same output volume of air for each rotation. On the other hand, the volume output rate in case of centrifugal compressors increases with increase of speed.

→ The centrifugal has poor working characteristics at lower speeds, whereas the other types work well even at lower speed ranges.

→ Further, Roots type is simple in construction; requires least maintenance and has comparatively longer life.

→ In vane type the problem of wear of vane tips is always there.

→ The centrifugal type supercharger has been used mainly on aircraft engines, whereas the roots type on automobile engines.

Turbo Charging : Def?

To be understand the technique of turbo charging it is useful to be familiar with the internal combustion engine's principle of operation. Today, most of passenger car and commercial diesel engines are four-stroke piston engines controlled by intake and exhaust valves. One operating cycle consists of four strokes

during one complete revolutions of crankshaft.

① Suction (Charge Exchange Stroke) :

→ When the piston moves down, air [Diesel Engine (d)] direct injection petrol engine (d) a fuel/air mixture (Petrol Engine) is drawn through the intake valve.

② Compression (Power Stroke) :

The cylinder volume is compressed.

③ Expansion (Power Stroke) :

→ In the petrol engine, the fuel/air mixture is ignited by a spark plug, whereas in the diesel engine fuel is injected under high pressure and the mixture ignites spontaneously.

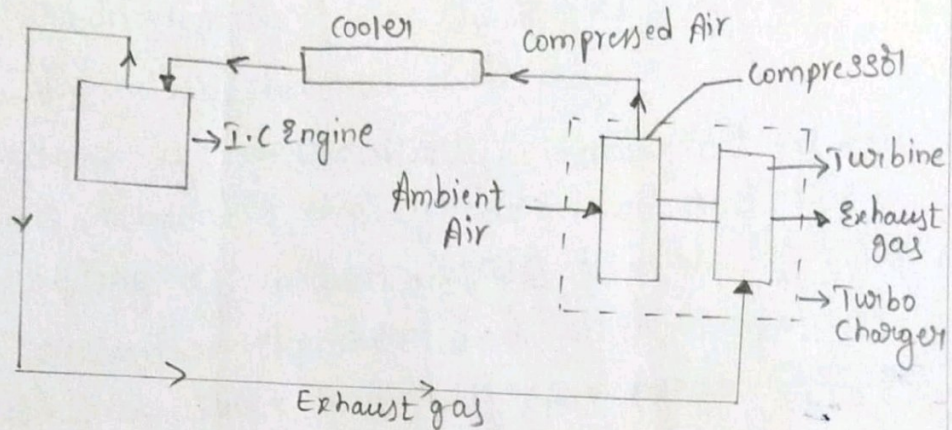
④ Exhaust (Charge Exchange Stroke) :

→ The exhaust gas is expelled when the piston moves up.

In the above-described procedure, the engine operates as a naturally aspirated engine. The combustion air is drawn directly into the cylinder during the intake stroke. In turbocharged engines, the combustion air is already precompressed before being supplied to the engine. The engine aspirates the same volume of air, but due to the higher pressure, more air mass is supplied into the combustion chamber. Consequently more fuel can be burnt, so that the engine's power output increases related to the same speed and swept volume.

Turbocharger

In a petrol engine, about 35-40% of the energy contained in the fuel goes waste in the outgoing exhaust gases.



- The turbocharger includes a turbine and a centrifugal compressor coupled together in above figure. The exhaust gases from the engine enter the turbocharger and run the turbine, which further drives the compressor.
- The atmospheric air enters the compressor which raises its pressure by about 0.5 bar [50 kPa] increase the power by 50% from the same engine.
- The advantages of using turbochargers in automotive engines are:
 - ① power output of a given displacement engine is increased.
 - ② Torque characteristic of the turbocharged engine is better.
 - ③ reduced fuel consumption.
 - ④ reduced noxious exhaust gas emissions.
 - ⑤ turbocharged engines have more B.P./weight ratio, compared to naturally aspirated engines.
 - ⑥ power loss due to decrease in air density at higher altitudes is reduced by using turbocharger.

write a short notes on Decarbonisation and reboring &

Decarbonisation:

"The decarbonisation of an engine involves removal of carbon deposits from the engine, using either mechanical (physical) (a) chemical methods."

→ The procedure of mechanically cleaning out carbon deposits entails removal of the cylinder head and then, physically scraping off carbon deposits from the top of the piston, the combustion chamber and other components example valves. Two stroke engines of yore needed frequent decarbonising as the lubricating oil [2-T oil, in common parlance] burnt in the combustion chamber, leaving behind carbon residue.

→ The procedure of chemical by adding certain chemicals like alcohols and Terpenes into the conventional fuel supply [petrol/diesel] appears to dissolve and remove at least a part of the carbon deposit formed in various parts of the engine, such as fuel injection systems, valves, exhaust manifolds; combustion chambers etc.

Reboring:

The cylinder block comprises the main body of the engine. Due to a constant, ~~ref~~ reciprocating action of the pistons working rapidly and under load, the cylinders are subject to wear at certain time.

→ When wear and tear on the pistons and rings are added to this, the resultant excessive clearance will cause a loss of compression in the engine.

→ for these causes, the engine will be made a new (or) wider bored by replacing of new parts, which are in good condition to do the work.

4. Explain different types of oil pumps with neat sketches.
OIL PUMPS :-

Next to oil strainer in the lubrication system sequence, comes the oil pumps. Its function is to supply oil under pressure to the various engine parts. The oil pump is generally located inside the crank case below the oil level.

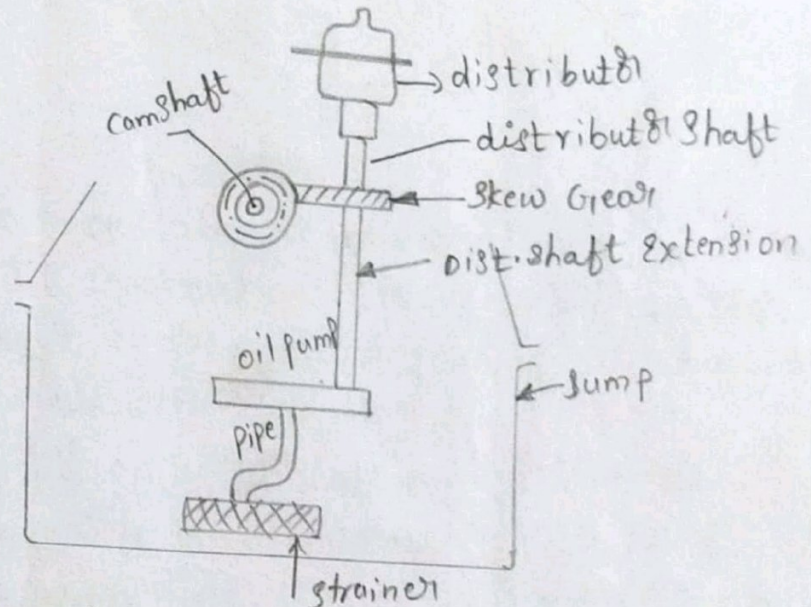
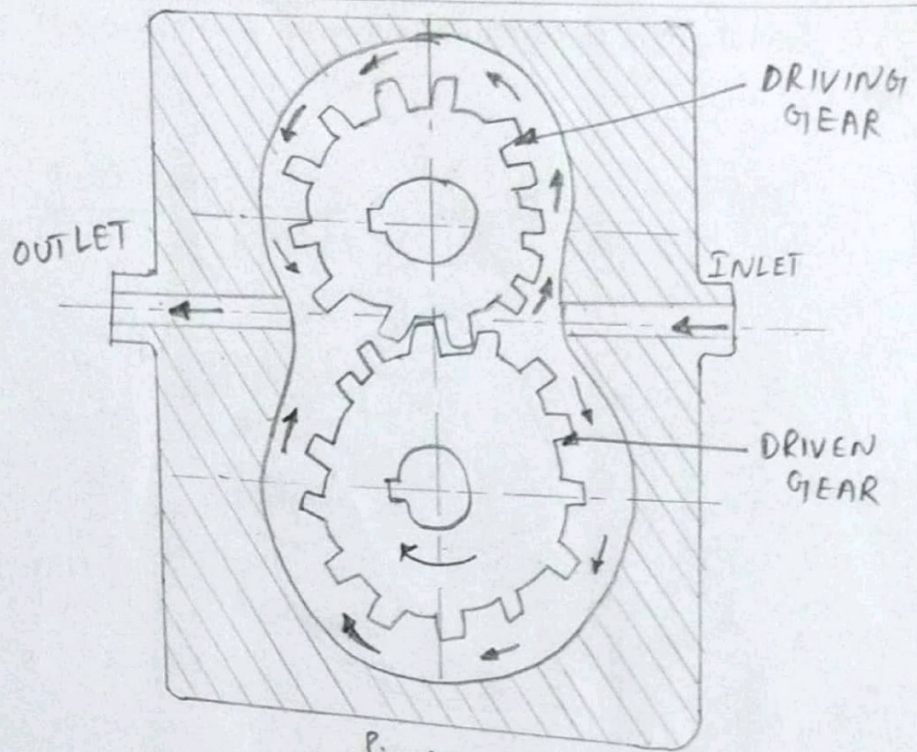


Figure of Drive for oil pump

→ Further, with wear of bearings and other engine parts, more oil will start leaking which may result in loss of engine pressure. The size of the pump should be sufficient to maintain the desired pressure with reasonable amount of wear. There are different types of pumps are used for engine lubrication are :-

- ① Gear pump
- ② Crescent type gear pump
- ③ Rotor pump
- ④ Plunger pump and
- ⑤ Vane pump.

① Gear pump:



Figure

- This is the type once almost universally used in the automotive Engines. Its construction is very simple. In that it consists of two gears, & for quieter running, helical gears only which are in mesh with each other.
- One gear is mounted on a ~~sub~~ shaft and is driven only whereas the other gear is the driving gear, itself being driven directly by the cam shaft through the same gear which drives the distributor shaft.
- The oil is transported from the inlet to the outlet side in gear spaces between the gear teeth as shown in figure and is discharged through the outlet port. Continuous delivery of the oil is from the outlet port exceeds the volume of the lubrication system passages, with the result that excess discharged oil then causes the oil pressure in the system and rate of circulation of oil to be increased.
- The pump is always submerged in oil in the crankcase and therefore no

no-priming is necessary. The pump delivers oil at about 300-400 kPa.

② Crescent type gear pump

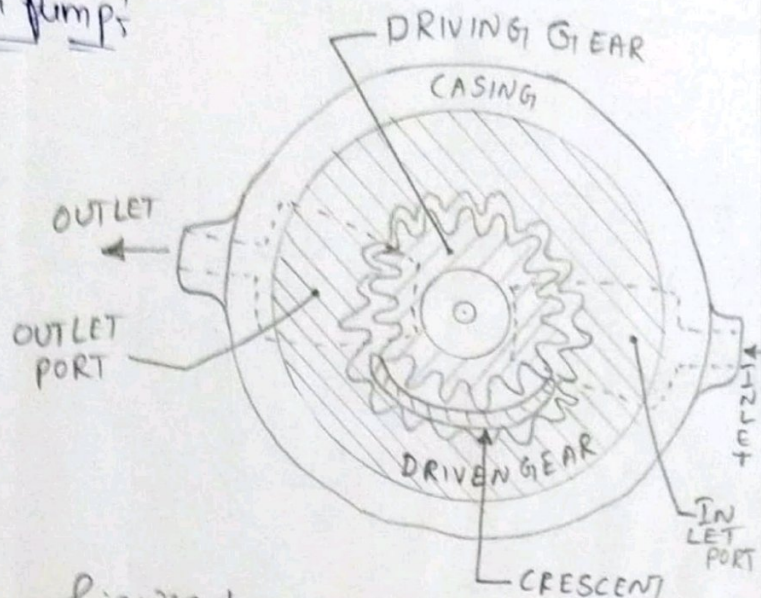


Figure of crescent type gear pump

- In this an internal ring gear is in mesh with a driving external gear which is mounted eccentrically with respect to the ring gear. Due to this eccentricity, there is a space in between the two gears where a crescent shape spacer is placed as shown in above figure.
- Due to rotation of the gears, a suction is produced at the inlet end of the crescent, which draws in oil. The oil is then trapped in tooth spaces between the crescent and the driving gear and the crescent and the tooth spaces of the internal driven gear and is thus carried towards to outlet side of the crescent where it is discharged into the outlet port.
- With continuous running the spaces between the gear tooth will be filled with oil after which the extra oil will cause the oil pressure to increase.

→ This type of pump is very suitable for small compact engines where camshaft is mounted high. This occupies a very small space and is driven directly by means of a gear or internal gear of the pump.

③ Rotary pump

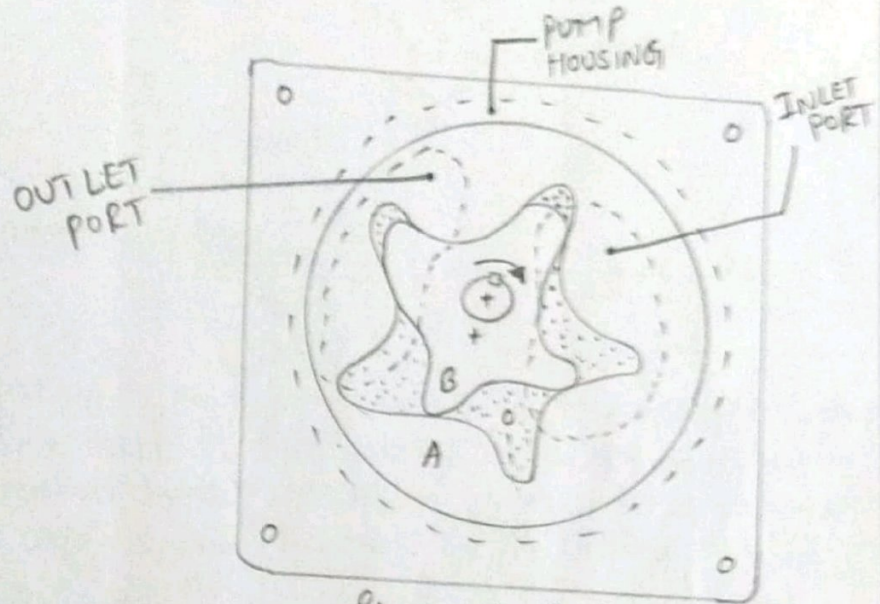


Figure of Rotary pump

→ This type of oil pump is now widely used in automobiles. It is similar to the gear pump except that in this two gears mesh internally. "A" is the external rotor having the number of lobes one more than on the internal rotor "B".

→ The axes of rotation of the two rotors are different which causes the size of the spaces between them to vary. The rotor "B" gets its drive from the engine and causes rotor "A" to rotate along with it.

→ The oil enters the pump through inlet port, as the rotor lobes are moving out of mesh. The oil is transported from inlet to the outlet of the pump in the spaces between rotor lobes. The rotation reduces the clearance between the lobes and oil is discharged ~~under~~ under pressure as the lobes of the rotors move into mesh at the outlet port.

→ This is also quieter running since there are comparatively,

100 teeth in mesh for each revolution. Because of these advantages, its use is ~~is~~ increase in the automobile engines.

④ Plunger pump :

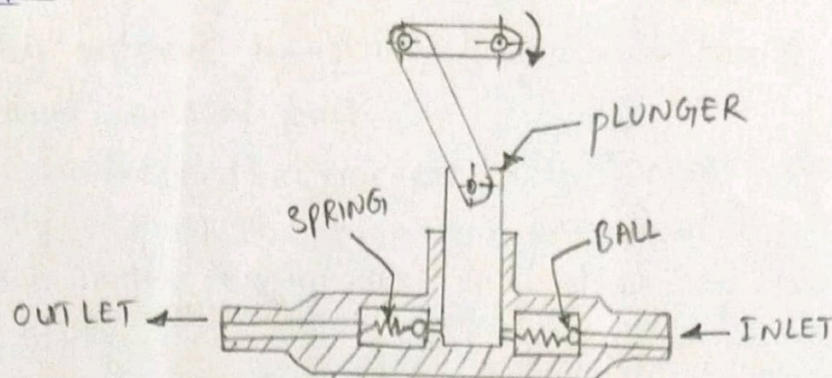


figure of plunger pump

→ This is reciprocating type of pump in which the oil gets communicated from the inlet to the outlet by alternate suction and pressure created by a reciprocating plunger. This was once used in engines using splash lubrication for filling the oil troughs, but is obsolete now.

⑤ Vane pump :

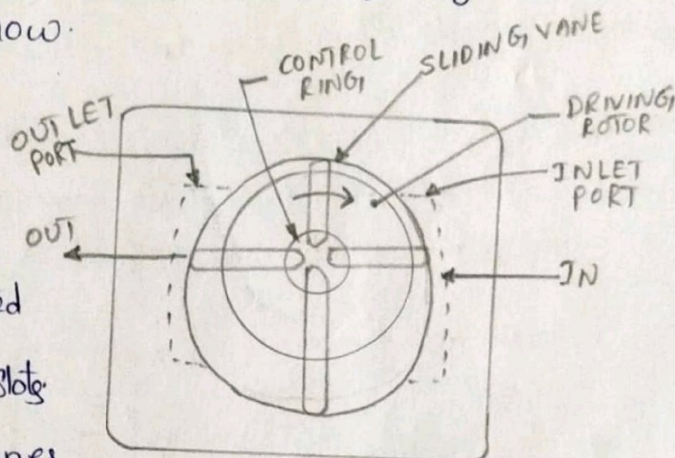


figure of vane pump

→ The movement of sliding vanes is guided by means of a control ring as shown in figure.

→ When the pump is operating, the vanes are pressed outward against the housing by their centrifugal force. The oil enters the inlet port and is swept by the vanes to the outlet port. This type of pump has an advantage of a continuous oil flow compared to the pulsating oil flow in case of gear pump.

Explain different types of oil filters with neat sketch?

The lubricating oil with use, is deteriorated resulting in the formation of Sludge, Lacquer and carbon. Further, it is contaminated by various by-products of combustion of fuel, water, acids and unburnt fuel.

→ In addition to these the fine particles of metal due to wear, Especially during the running-in period and particles of rust formed in the engine are the other impurities present in the oil.

→ It is necessary to remove these impurities to avoid permanent damage to any (or) more running parts of the engine.

→ It has been found from experience that impurity particles of 5 to 15 microns diameter are most damaging, because the oil size is bigger than this due to which small particles never come into contact with the mating surfaces separated by oil.

→ There are two different types of oil filter systems are there. (a) By-pass system and (b) Full flow system.

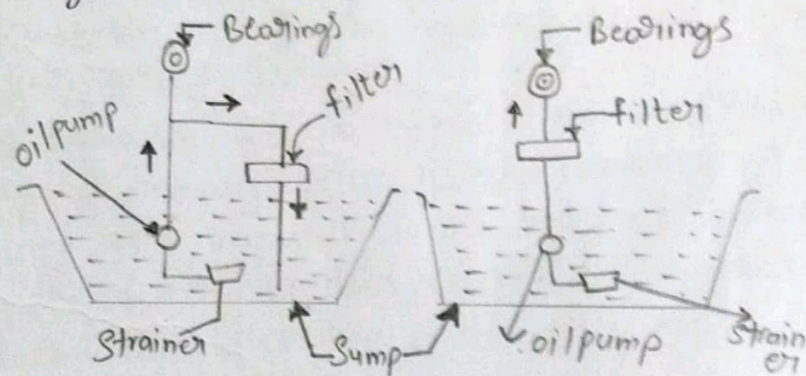


Figure of oil filtering systems

(a) By-pass system (b) Full flow system

→ In the by-pass system the whole of the oil does not pass through the filter at the same time. Most of the oil without

being filtered goes to the bearings not pass through the filter at the same time. Most of the oil without being filtered goes to the bearings whereas the rest (about 10%) passing through the filter is cleaned out and is returned to the sump.

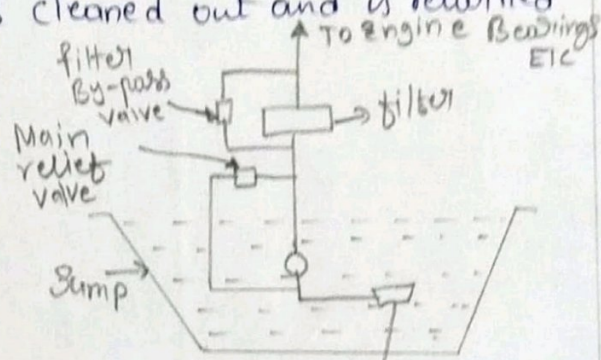


Diagram of full-flow filtration system

→ In the full-flow system, however, all the oil which goes to the bearings must pass through the filter first.

→ Thus, if any time the filter is blocked in the full flow system the oil flow would be stopped and the bearings would be starved.

→ An oil filter must have the following characteristics:
 ① High filtration efficiency ② Less pressure loss. Excessive pressure loss occurs due to high resistance in the filter element, preventing oil from reaching all the engine parts requiring lubricating ③ Long life.

→ oil filters are basically of two types these are primary and the secondary. A primary filter is also known as surface filter; since the impurities are retained on the outer surface of the filter. It uses coarse filter material and is installed on the inlet side of the oil pump.

→ The secondary filter is installed on the outlet side of the oil pump. and since the impurities in this are retained progressively along the depth of the filter material, it is also called "depth filter".

→ Primary filter is more commonly known as strainer. and is formed from wire gauze of 40-60 μ m. The secondary filters

Used in the automobile engines are of various kinds, the important ones out of them being:

- ① Cartridge type ② Edge type ③ centrifugal type and

① Cartridge type oil filter

This type is used on most automobile engines and it consists of a filtering element placed in the metallic casing.

→ The impure lubricating oil is made to pass through the filtering element, which takes up all the impurities. The element is given a pleated form to maximize the surface area of the filter for a given size of a element.

→ Currently filter elements with fine pores have been employed which has made it practicable to arrest particles of size down to within the region of 5 microns.

→ The filtering elements of two types are available, the ones which can be cleaned and those which have to be replaced after certain intervals, say, 10,000 km.

→ Commonly used materials for filtering are wire gauze, cotton, felt, paper, plastic-impregnated paper etc.

→ The filtering element must let the oil pass through without much resistance, but should prevent the undesirable particles from entering the oil galleries. The resistance to flow offered by a new filter element is about 0.3 to 0.5 bar. However, with use the resistance increases due

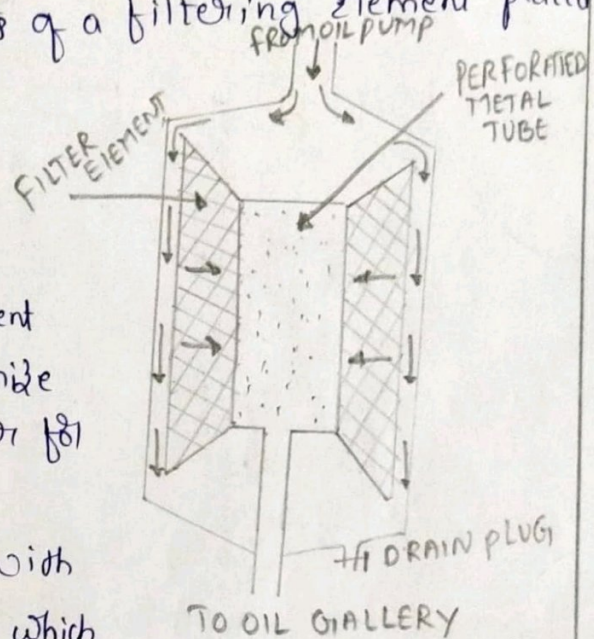
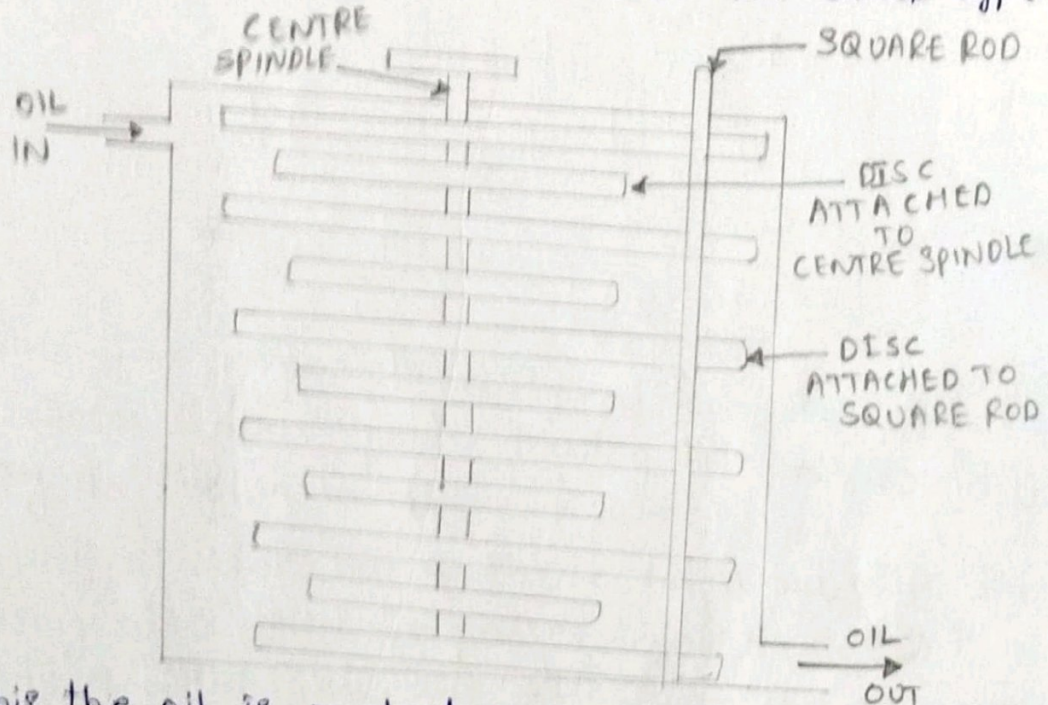


Figure of cartridge type oil filter

due to clogging of the filter Element. The maximum permissible resistance is about 2 bars.

② Edge type oil filter

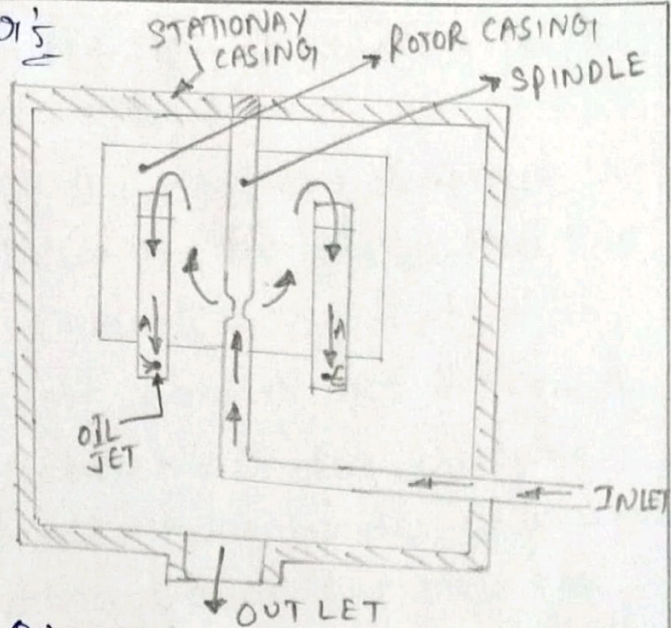
It is also called the Stack type.



→ In this the oil is made to pass through a number of closely spaced discs. The alternate discs are mounted over a central spindle, while the discs in between these are attached to a separate fixed spindle as shown in above figure.

→ The clearance between two successive discs is a few microns. The oil is made to flow through the spaces between these discs and because of the very small spaces involved the impurities are left on the disc peripheries from where these are periodically removed by simply operating the central knob. This may be done ~~either~~ either manually (B) the knob may be connected to the clutch system and operated periodically by means of clutch action.

③ Centrifugal type oil filter's



→ In this the impure (a) dirty oil from the Engine enters the hollow central Spindle having holes around its periphery as shown in above figure.

→ The dirty oil comes out of these holes and fills the rotor casing after which it passes down the tubes "A" out the ends of which jets are attached. The oil under pressure passes through these jets, the reaction of which gives the motion to the rotor casing in the opposite direction so that it starts rotating. The oil impinges on the outer stationary casing under heavy pressures, where the impurities are retained and clean oil falls below from where it is taken out.

→ The working Speed of the rotor is usually between 2000 and 7000 rpm; depending upon the oil pressure circulating the oil.

→ Force of upto 2000 times the gravity are produced which are quite effective in throwing the impurities, including very fine ones, out of the oil system. The filter walls have to be cleaned at intervals of about 70,000 km.

⑥ what is crankcase ventilation & explain how it is achieved in automobile engine?

⑦ Although, the piston and the rings are designed to form a gas-tight seal between the piston and the cylinder walls, yet the products of combustion do leak from the combustion chamber into the crankcase.

→ These contain mainly unburnt air-fuel mixture, partially burnt hydrocarbons, nitrogen oxides, water vapor, carbon monoxide and carbon dioxide, but may also consist of traces of acid due to sulphur present in the fuel.

→ The piston blow-by increases with engine speed and with wear of cylinder bore, pistons and rings. The effects of piston blow-by are:

① The air-fuel mixture, partially burnt and fully burnt vapour fumes will

condense and contaminate the lubricating oil in the crankcase which may result in the deterioration of performance of the engine lubricating oil and also in the production of sludge by the oxidation of the oil.

② High concentration of combustible air-fuel mixture in the crankcase, which may cause an explosion there.

③ corrosion of engine parts in case of fuels containing sulphur.

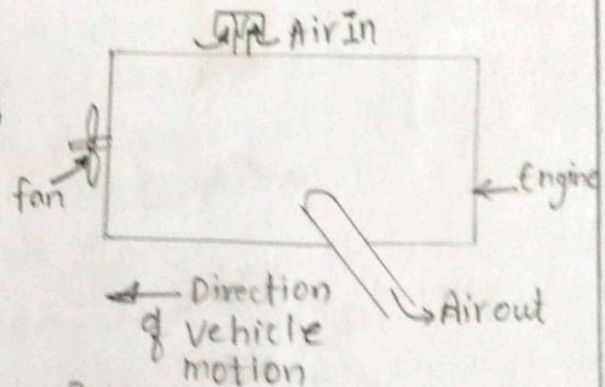


Figure of Road draft System of crankcase ventilation.

→ Crank case Ventilation was developed as a remedial measure against this. A steady flow of air is carried through the Engine Crankcase which carries away the products of combustion along with it in the form of vapour & mist.

→ The methods of crankcase ventilation that have been developed so far are: (1) Road draft System.
(2) Manifold Suction System.

→ In the above figure, shows a road draft System in which use is made of the air stream due to motion of the vehicle, and supplemented by the cooling fan. The air enters the Engine at the ~~Eng~~ top and is then circulated in the crankcase where it carries the mist, vapours, etc. after which it comes out through the outlet and goes into the atmosphere.

→ In the manifold Suction System, which is also called "positive Crankcase Ventilation System", filtered air from the Engine air intake is drawn through the Crankcase where it gathers water vapours, unburnt fuel vapours and exhaust gases after which it is directed to the inlet manifold and from there to the Engine Cylinder where any unburnt fuel is burnt.

→ The main advantage of the manifold Suction System is that being a closed type of system this does not cause pollution to atmosphere, which occurs in the road draft System. Moreover, it prevents pressure build-up in the Crankcase due to combustion-pressure blow-by and also prevents back fire gases from entering the Crank Case.

Briefly explain the components of four wheel automobile?

Components of four wheel Automobiles

* Basic Structure

- frame, suspension, axles, wheels, tyres.

* Powerplant

* Transmission System

- Clutch, gear box.

* Auxiliaries.

* Controls

- steering, brakes.

* Super Structures.

Frame:

- ① Types:-
- ① conventional pressed steel frame.
 - ② Integral (B) frameless construction.

Advantages of frame:

- Reduce the weight and consequent saving in the fuel consumption.
- lower manufacturing cost.
- During collision of the body compresses there by absorbing the shocks due to the impact and thus providing safety to the passenger.
- compared to the frame construction, lower body position may obtain thus increase stability of the automobile.

Dis-advantages:-

- Reduction of strength durability.
- Economical only if frameless construction is considered in mass production.

- Increase cost of repair in case of damage to the body.
- The top less vehicles are difficult to design with the frameless construction.

SUSPENSION SYSTEM

The main objectives of Suspension System are (i) To prevent road shocks from being transmitted to vehicle components.

- (ii) To safeguard the passenger from road shock.
- (iii) To preserve the stability of the vehicle.

Types of Suspension Systems

- (1) Conventional System in which the load springs are attached to a rigid beam axle.
- (2) Independent Suspension system in which there is no result action and each beam is free to move vertically without any reaction.

AXLES

The weight carrying portions of the axle whether it may be front (or) rear axle is considered as a beam supported at the ends.

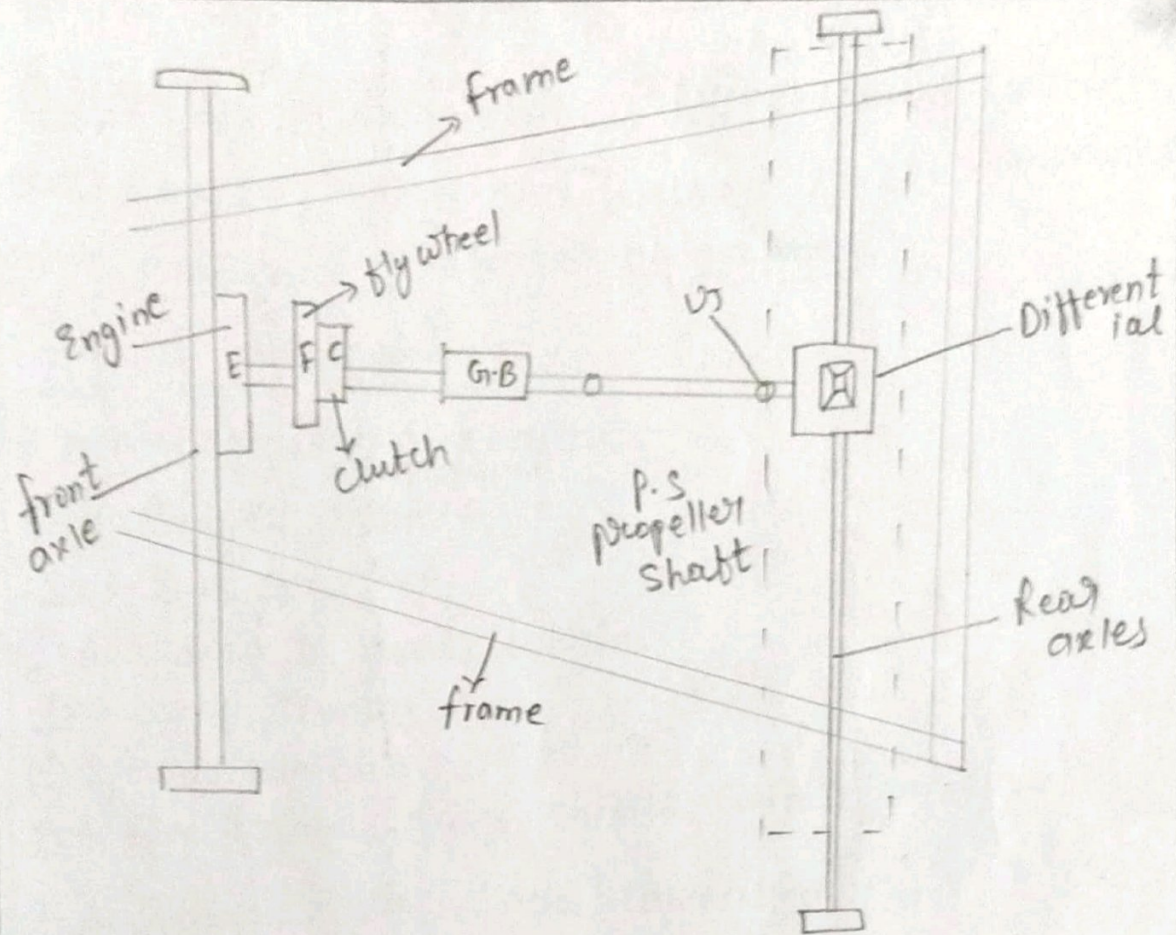
TYPES OF REAR AXLES

- (1) Fully floating type
- (2) Three quarter floating type.
- (3) Semi floating type.

TRANSMISSION SYSTEM

FUNCTIONS OF TRANSMISSION SYSTEM

- To disconnect the engine from the rear wheels when desired.
- To connect the engine to drive wheel without shaft.
- To reduce the engine speed permanently in a fixed ratio.



Clutch ; Gear box } refer 2nd, IIIrd, IVth unit material.

- Auxiliaries
- Controls.
 - steering, brakes
- Super Structures

Explain different types of Automobiles? ✓

Automobile: An Automobile is self propelled vehicle driven by I.C Engine and is used for the transportation of goods and passenger on ground.

Types of Automobiles:

* According to the purpose:

① Passenger vehicle

Ex: Bus, Car, Jeep.

② According to goods vehicle.

Ex: Lorry, Trucks.

③ Special vehicles

Ex: Fire Engines, Army vehicles, concrete mixture.

* According to the Load capacity:

① Light duty vehicles. Ex: Motor cycles, Scooter.

② Heavy duty vehicles.

Ex: Bus, Trucks, Tractor.

* According to No. of wheels and Axles:

① Two wheelers like motor cycles, bikes.

② Three wheelers - Auto, Rickshaw, Tempo.

③ Four wheelers - Car, Jeep.

④ 8 in wheelers - Bus, Trucks, Lorry.

⑤ 8 in axles wheelers (8) Ten tyres.

NOTE: Bus and Trucks have 6 types. out of which 4 types are carried on their rear wheels for additional factors.

* According to fuel used +

① petrol vehicles (or) gasoline.

Ex: Bus, Motorcycle, Trucks.

② Diesel vehicles

Ex: Lorries, Buses

③ Steam vehicles

Ex: Ships, Steam road rollers.

④ Electrical vehicles.

Ex: Battery trucks.

* According to the Suspension System +

① conventional Leaf Spring.

② Independent coil Spring

③ Torsion bar Spring.

④ Pneumatic Suspension System.

* According to the type of Automatic Body System +

① Two door Sedan type vehicle.

② Hard top vehicle type

③ four door Sedan type vehicles

④ Van.

* According to the drive of wheel +

① Right hand drive ② Left hand drive .

③ Rear wheel drive ④ front wheel drive

⑤ Single wheel drive ⑥ Two wheel drive

⑦ four wheel drive (or) All wheel drive

⑧ Six wheel drive.

Q Briefly Explain the Nitriding of crankshaft?

(A) Nitriding is a Heat treating process that diffuses nitrogen into the surface of a metal to create a case-hardened surface.

→ These processes are most commonly used on low-carbon, low alloy steels. They are also used on medium and high-carbon steels, titanium, aluminium and molybdenum.

→ Nitriding on alloy steels has many advantages. In order to best apply the many forms of nitriding; Ion plasma, gas deep case.

→ For example, deep case nitriding is widely used to provide a deep, hard bed for roller bearing races. Gas deep case nitriding is required in order to survive the very high unit loading of the harder small diameter rollers. This application also needs the added compressive strength of deep case to this bed to minimize the Brinell effect.

→ By this process of Nitriding on crankshaft is used to harden the surface of the material of crankshaft.

UNIT - 2

TRANSMISSION SYSTEM

1. Describe the requirements of Automobile wheel and Explain different types of wheels.

A: REQUIREMENTS OF AUTOMOBILE WHEELS

The Various requirements of an Automobile wheel are:

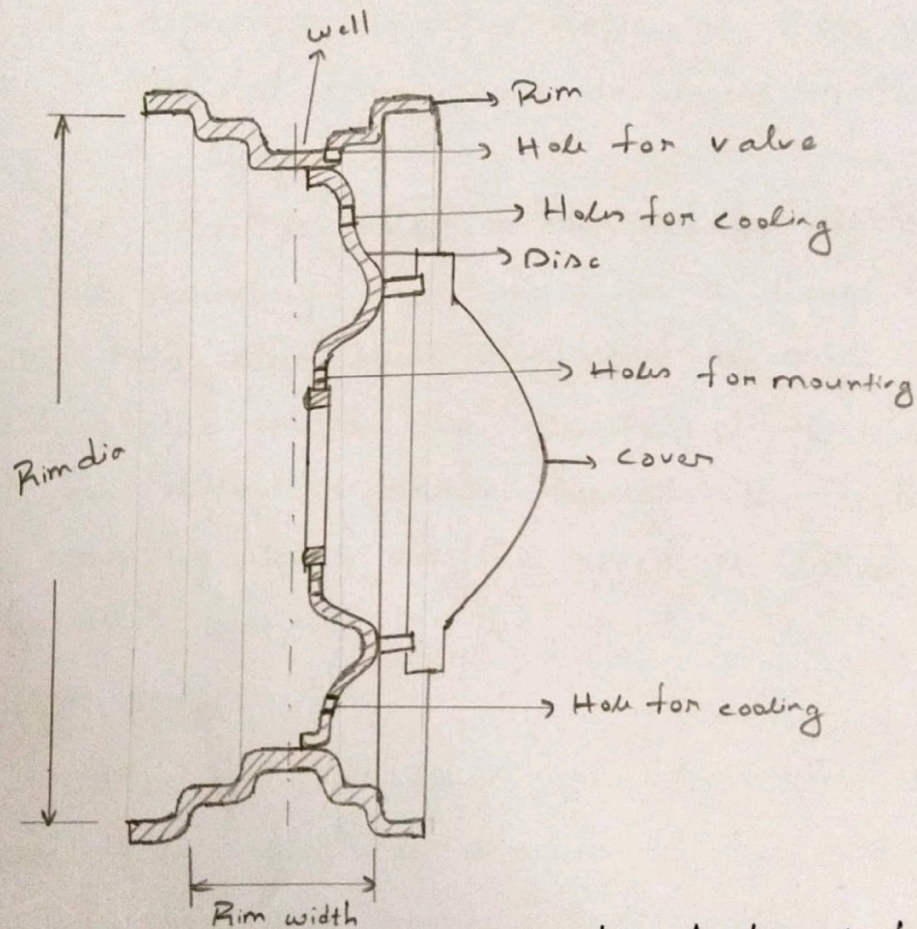
- (i). It must be strong enough to perform the above functions.
- (ii) It should be balanced both statically as well as dynamically
- (iii) It should be lightest possible so that the unsprung weight is least.
- (iv) It should be possible to remove or mount the wheel easily.
- (v). Its material should not deteriorate with weathering and age. In Case, the material is susceptible to corrosion, it must be given suitable protective treatment.

TYPES OF WHEELS:

There are three types of wheels. They are as follows:

- (i). The pressed steel disc wheel.
- (ii). The wire wheel
- (iii). The light alloy wheel.

(i). DISC WHEELS:



This type of wheel consists of two parts, a steel rim which is generally well-based to receive the tyre and a pressed steel disc. The rim and the disc may be integral, permanently attached or attachable, depending upon design. A typical steel disc, in which the pressed

steel disc is welded to the rim. The rim profile, indicated by letters J, K, JJ, JK or B in the specification

When the bead of the tyre is resting in the well, it is possible to pass the tyre over the opposite edge of the rim. Without the ~~rim~~ well it would not be possible to mount or remove the tyre from the wheel. The seat of the rim where the tyre rests usually has a 5 degree or 15 degree taper so that as the tyre is inflated, the beads are forced up the taper to give a wedge fit.

The wheel is fitted on the axle by tightening nuts onto the mounting studs fixed on a flange attached to the later. These studs also serve as guide for mounting the wheel. The diameter of the imaginary circle, in millimeters, drawn through the centre of the mounting holes on the wheel is called the pitch circle diameter of the wheel.

(ii). WIRE WHEEL:

Unlike the disc wheel, the wire wheel has a separate hub, which is attached to the rim through a number of wire spokes. Each spoke is individually hooked at one end of the hub while its other end is pushed through a hole in the wheel rim. The spokes carry the weight, transmit the driving and braking torques and withstand the side forces

while cornering, in tension. Spokes in fig. (c) is sustained by these spokes in tension. Similarly, the driving and the braking torques are taken up by the tension in the spokes in the desired direction as shown below in fig. (a) and (b) respectively. The side forces on cornering are taken up by the spoke forming triangular arrangement as shown in fig. (d). Thus it seen that the spokes have to be mounted on the wheel in a complicated manner.

The advantages of this type of wheel are light weight and high strength, and above all it provides much better cooling of the brake drum.

* It is also very cheap easy to change the wheel when required, because only one nut has to be opened.

However, it is expensive due to their intricate construction.

(iii) LIGHT ALLOY CAST (OR) FORGED WHEELS:

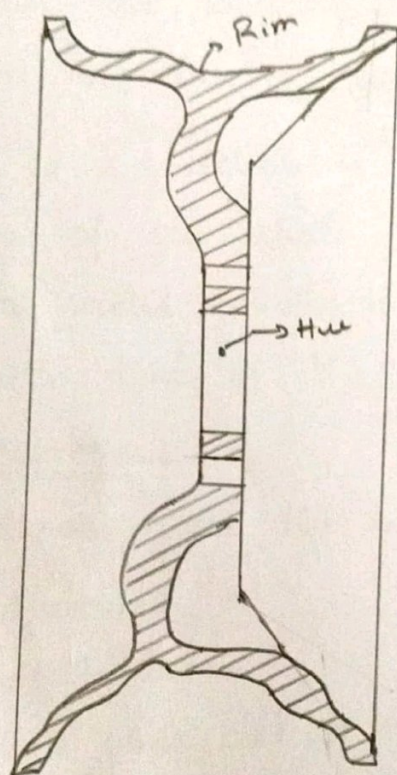


Fig 1- Light alloy cast wheel

The late trend in case of automobile wheels is the use of wheels made from aluminium or magnesium alloys. Cast wheels are generally used for cars while forged wheels are preferred for wheels of heavier vehicles. The main advantage of light-alloy wheel

weighs about 50% of a steel wheel and about 40% of an aluminium alloy wheel for similar strength. Moreover light alloys are better conductors of heat which helps the wheels dissipate any heat generated by the tyres or brakes and thereby run cooler. Further, wider rims are possible in their case, improves stability on cornering. * Higher cost is perhaps the only disadvantage of light alloy wheels.

2. Briefly explain the working principle of Clutch and different types of clutches with neat sketch.

3. Clutch is a mechanism which enables the rotary motion of one shaft to be transmitted, when desired, to a second shaft the axis of which is coincident with that of the first.

TYPES OF CLUTCHES:

The following are the main types of Clutches:

1. Friction Clutches.

(i) Cone clutch

(ii) Single plate clutch

(iii) Multi plate clutch

(iv) Centrifugal clutch

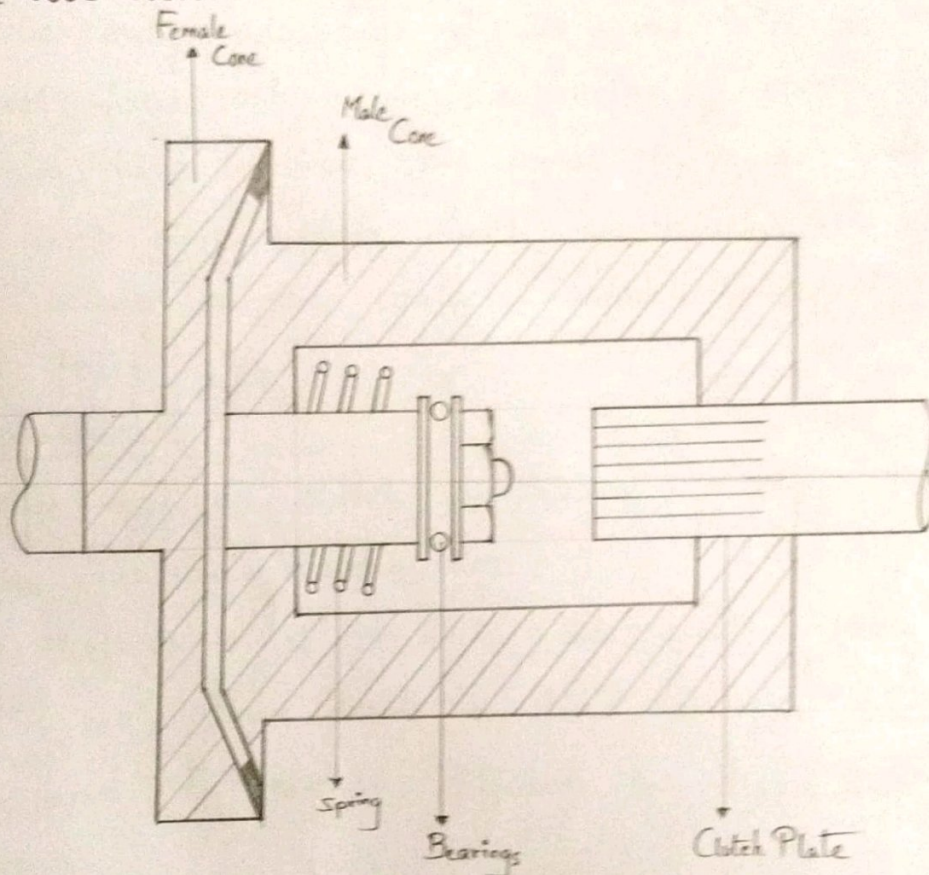
(v) Semi-Centrifugal clutch.

2. Fluid fly wheel.

1. FRICTION CLUTCHES:

The friction clutches work on the fact that friction is caused when two rotating when two rotating discs come into contact with each other. On the other hand, the fluid flywheel works on the transfer of energy from one rotor to the other by means of some fluid.

(a) CONE CLUTCH:



In this type the contact surfaces are in the form of cones. In the engaged position, the male cone is fully inside the female cone so that the friction surfaces are in complete contact. This is done by means of springs which keep the male cone pressed all the time.

When the clutch is engaged, the torque is transmitted from the engine via the flywheel and the male cone to the splined gear box shaft. For disengaging the clutch the male cone is pulled out by means of the lever system operated through the clutch pedal thereby separating the contact surfaces.

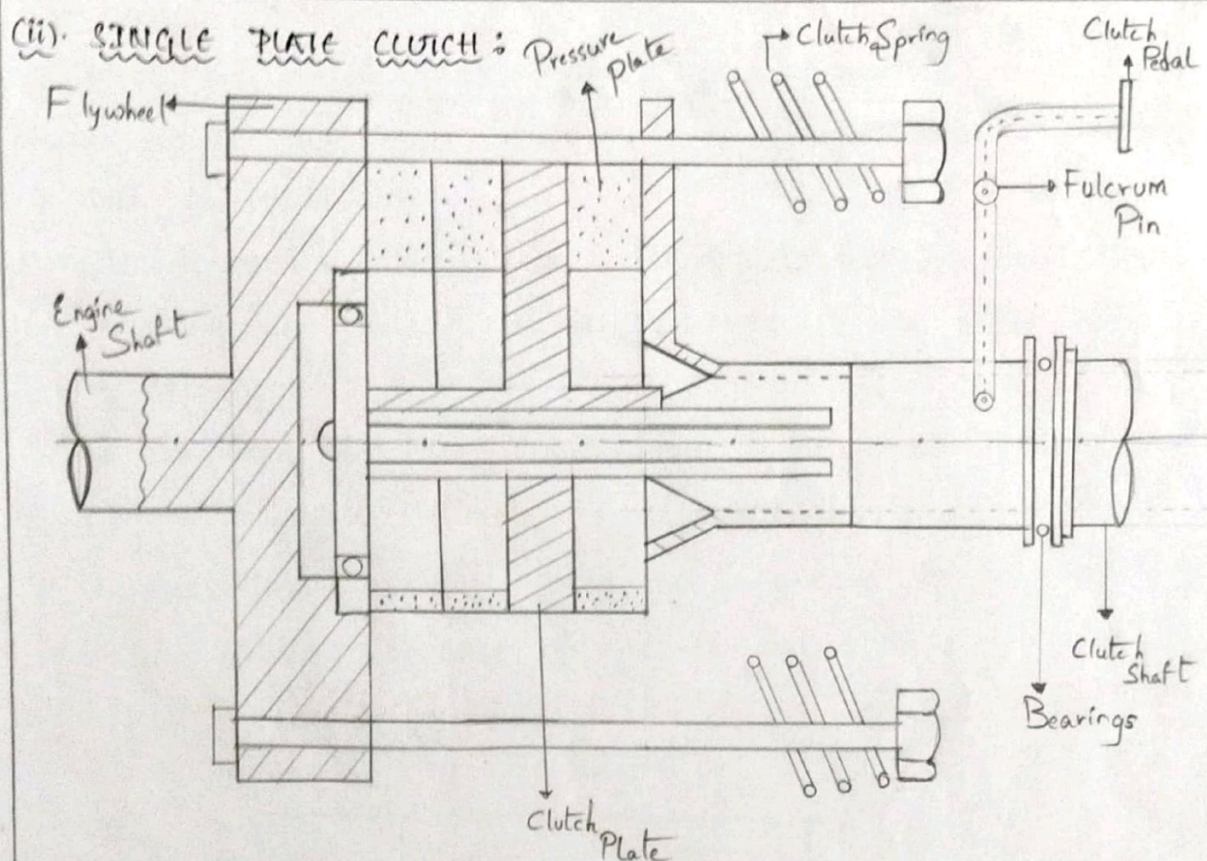
ADVANTAGES:

The only advantage of the Cone clutch is that the normal force acting on the contact surfaces in this case is larger than the axial force, as compared to the simple single plate clutch in which the normal force acting on the contact surfaces is equal to the axial force.

DIS-ADVANTAGES:

This type of clutch is practically obsolete because of certain inherent disadvantages:

1. If the angle of cone is made smaller than about 20° the male cone tends to bind or join the female cone and it becomes difficult to disengage the clutch.
2. A small amount of wear on the cone surface results in a considerable amount of the axial movement of the male cone for which it will be difficult to allow.



In single plate clutch, friction plate is held b/w the flywheel and the pressure plate. There are springs arranged circumferentially, which provide axial force to keep the clutch in engaged position. The friction plate is mounted on a hub which is splined from inside and is thus free to slide over the gear box shaft. Friction facing is attached to the friction plate on both sides to provide two annular friction surfaces for the transmission of power. A pedal is provided to pull the pressure plate against the spring force whenever it is required to be disengaged.

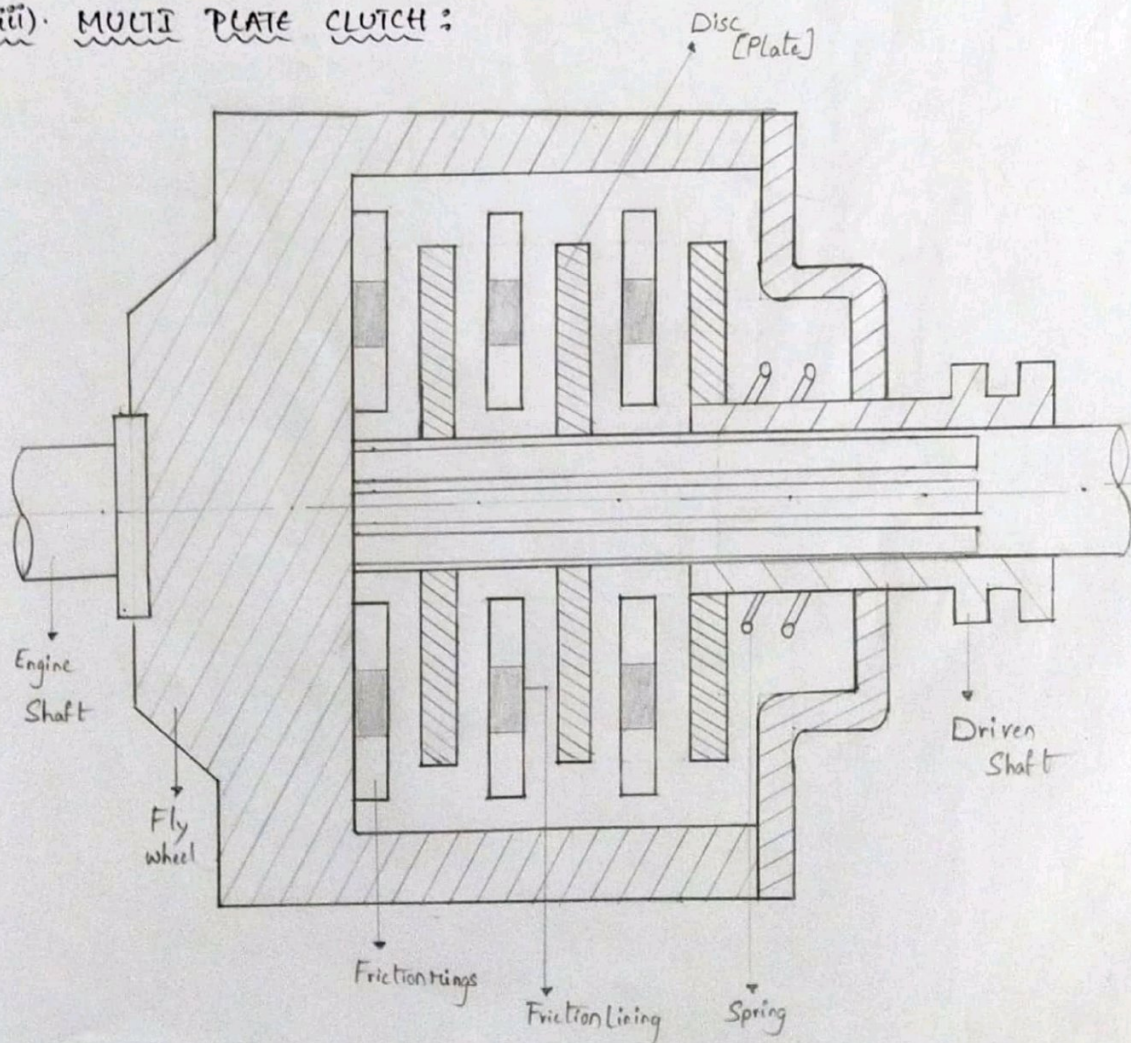
ADVANTAGES:

(i) With the single plate clutch, gear changing is easier than with the cone clutch, because the pedal movement is less in this case.

(ii) It does not suffer from disadvantages of cone clutch i.e. binding of cones etc. and hence it is more reliable.

DIS-ADVANTAGES:

As compared to the Cone clutch, single plate clutch will have a spring thereby most stiffness is required. It means that greater force is required to be applied by the driver in case of dis-engaging.

(iii) MULTI PLATE CLUTCH:

The multiplate clutch is an extension of single plate type where the number of frictional and the metal plates is increased. The increase in the number of friction surfaces obviously increases capacity of the clutch to transmit torque, the size remaining fixed. Alternatively, the overall diameter of the clutch is reduced for the same torque transmission as a single plate clutch. * This type of clutch is therefore, used in some heavy transport vehicles and racing cars where high torque is to be transmitted.

(iv). CENTRIFUGAL CLUTCH:

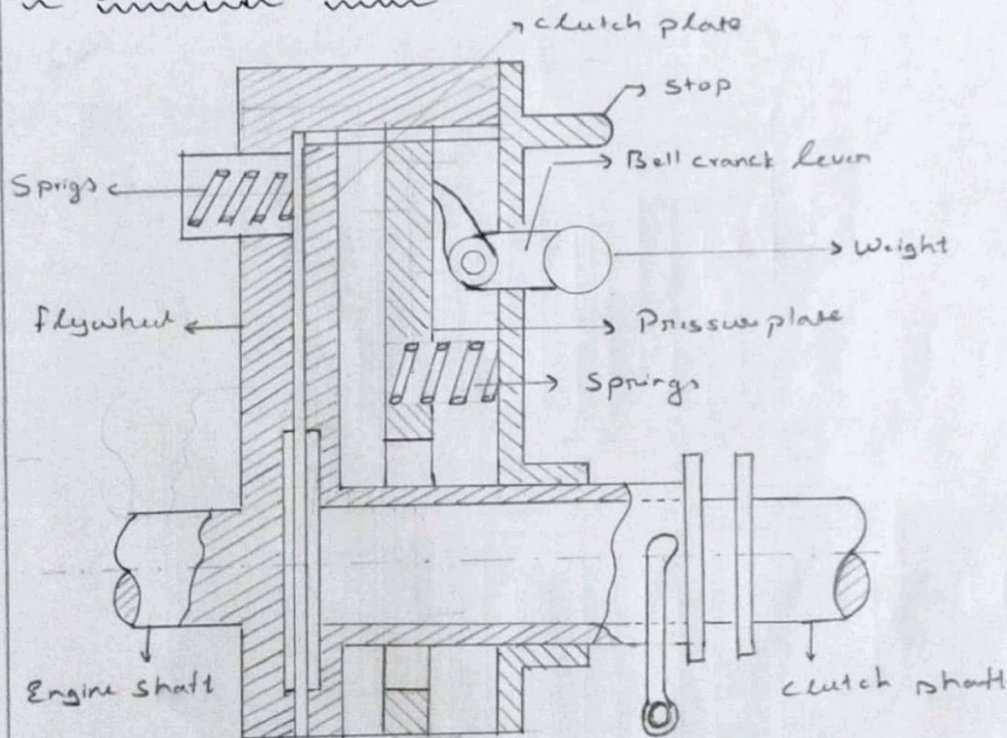


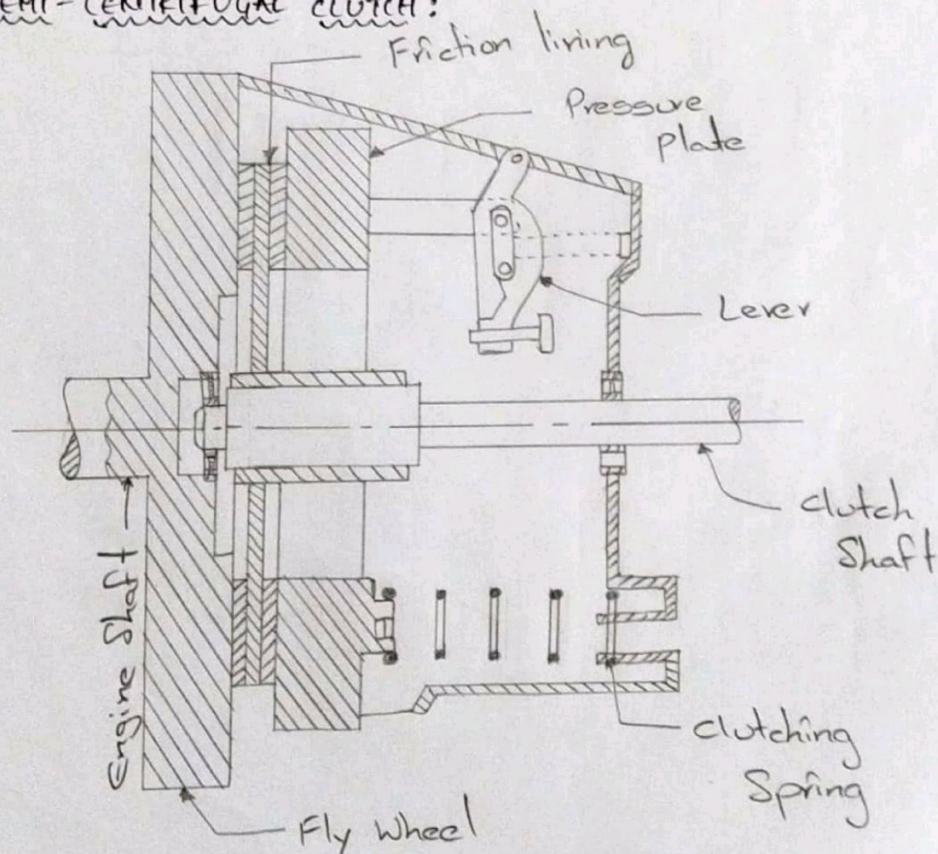
Fig 1. Centrifugal Clutch

In this type of clutch, the springs are eliminated altogether and only the Centrifugal force is used to apply the required pressure for keeping the clutch in engaged position.

The clutch is operated automatically depending upon the engine speed. This means that car can be stopped in gear without starting the engine.

As the speed increases, the weight flies, thereby operating the bell crank lever which presses the plate. This force is transmitted to the plate by means of springs. The plate containing friction lining is thus pressed against the flywheel thereby engaging the clutch.

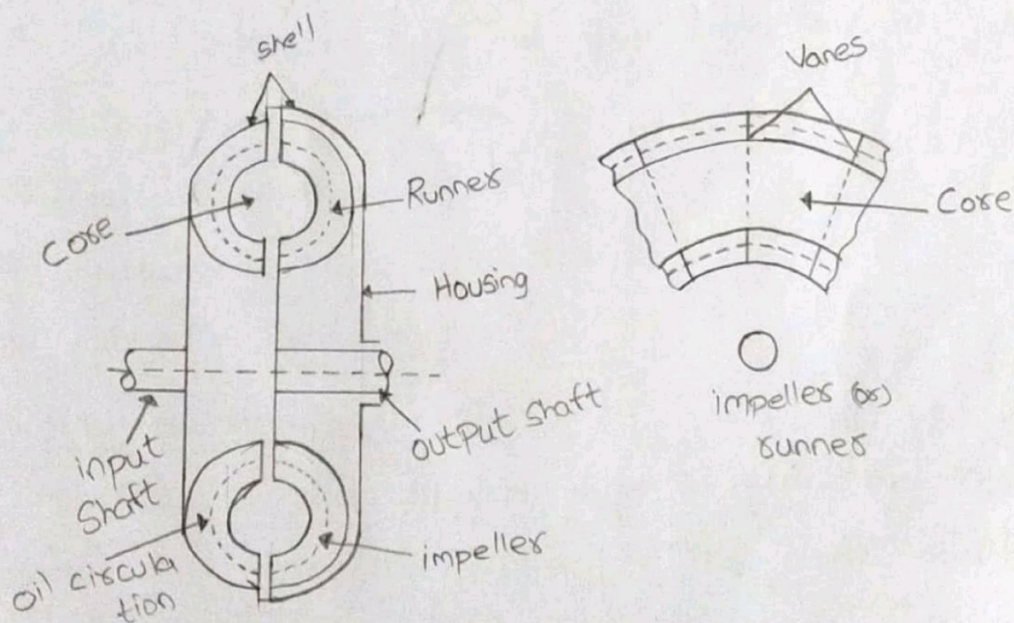
(v). SEMI-CENTRIFUGAL CLUTCH:



In Semi-Centrifugal clutch, three linged and weighted levers are arranged at equal intervals. One of these is on enlarged scale. This lever is having fulcrum and is linged to pressure plate. To reduce friction, the levers are mounted on needle roller bearings on the pressure plate. At moderate speeds the pressure of the springs is sufficient to transmit the required torque.

However at higher speeds, the weight due to the centrifugal force moves about as fulcrum thereby pressing the pressure plate. The Centrifugal force is proportional to the square of the speed so that adequate pressure level is attained.

2. FLUID FLY WHEEL:



It consists of two members, the driving and the driven. The driving member is attached to the engine flywheel and the driven member, to the transmission shaft. The two members do not have any direct contact with each other. The driven member is free to slide on splines on the transmission shaft. The two rotors are always filled with fluid of suitable viscosity. These are provided with radial ribs to form a number of passages, which avoid formation of eddies and also guide the fluid to flow in the desired direction.

3. With a neat sketch, explain different types of Gear boxes & their working principles.

A: TYPES OF GEAR BOXES:

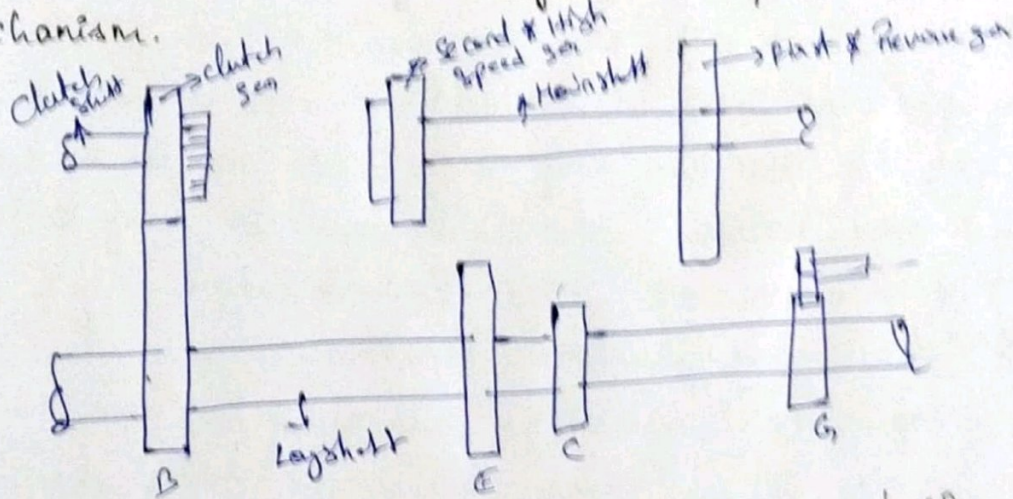
The different types of Gear boxes are as follows:

- (i) Sliding mesh gear box
- (ii) Constant mesh gear box
- (iii) Synchronous mesh gear box
- (iv) Epicyclic gear box.

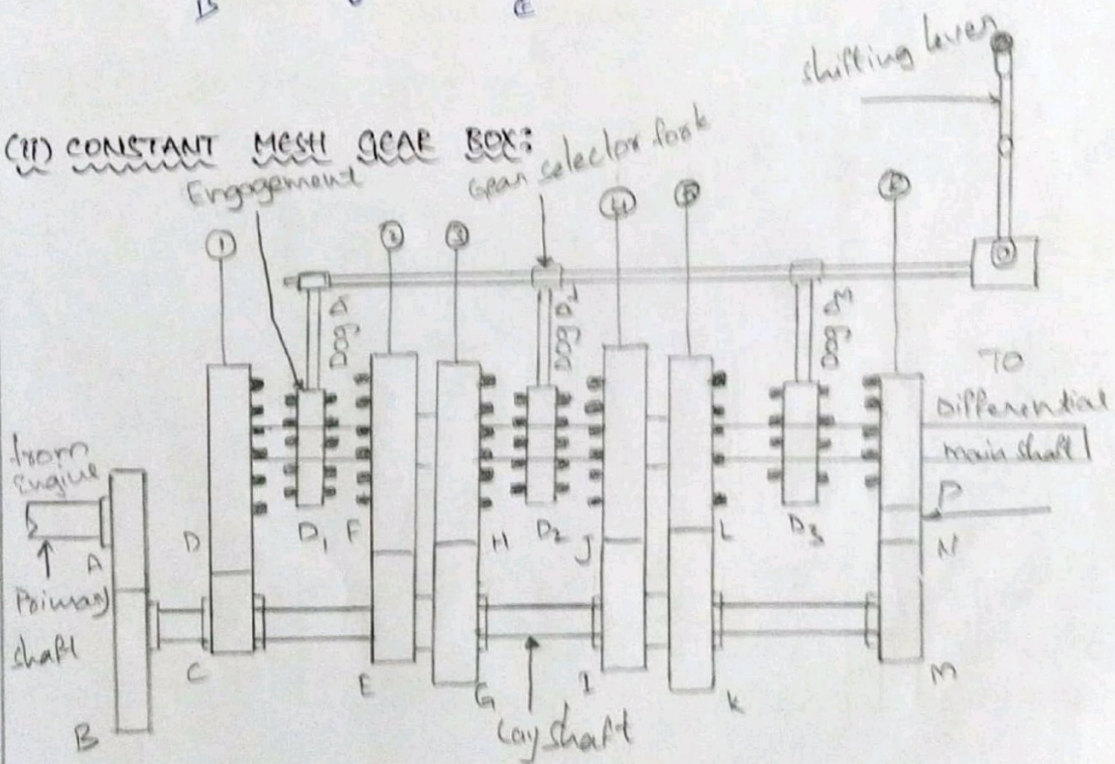
(i) SLIDING MESH GEAR BOX:

This is the simplest type of gear box. The power comes from the engine to the clutch shaft and hence to the clutch gear which is always in mesh with a gear on the layshaft. All the gears on the layshaft are fixed to it and as such they are all the time rotating when the engine is

running and the clutch is engaged. Three direct and one reverse speeds are attained on suitably moving the gear on the main shaft by means of selector mechanism.



(ii) CONSTANT MESH GEAR BOX:

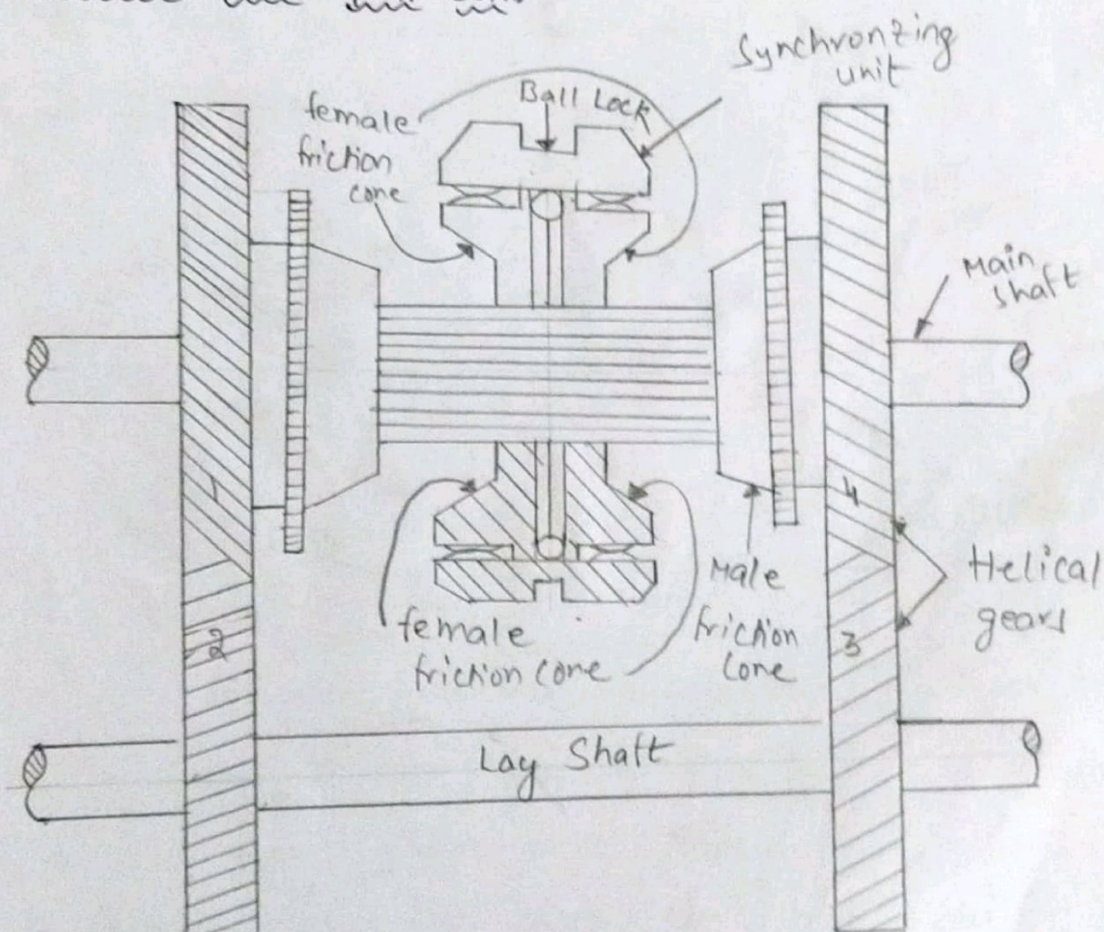


In this type of Gear box, all the gears are in constant mesh with the corresponding gears on the layshaft. The gears on the main shaft which is splined

are free. The dog clutches are provided which are free to slide on the main shaft. The gears on the layshaft are however fixed.

When the left dog clutch is slide to the left by means of selector mechanism, its teeth are engaged with those on the clutch gear and we get the direct gear. The same dog clutch, however, when slide to right makes contact with the second gear and second gear is obtained. Similarly movement of the right dog clutch to the left results in low gear and towards right in reverse gear.

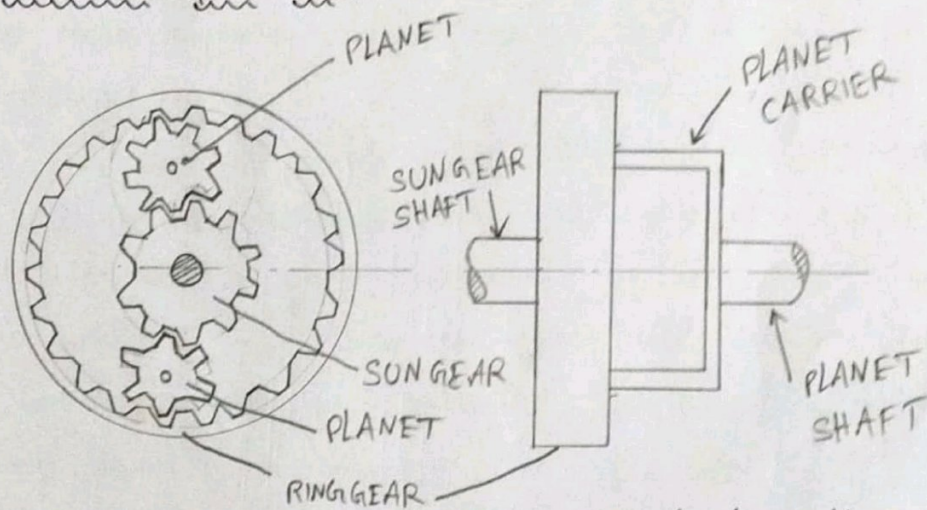
(iii) SYNCHRO MESH GEAR BOX:



This type of gear box is similar to the constant mesh type. In that all the gears on the mainshaft are in constant mesh with the corresponding gears on the layshaft. The gears on the layshaft are fixed to it while those on the mainshaft are free to rotate on the same. The parts which ultimately are to be engaged, are first brought into frictional contact which equalizes their speed, after which these may be engaged smoothly.

In most of the earlier cars, however, the synchromesh devices were not fitted to all the gears. They were fitted only on the high gears and on the low and reverse gears ordinary dog clutches are only provided. This was done to reduce the cost.

(iv). EPICYCLIC GEAR BOX:



An Epicyclic gear box consists of two, three or even four epicyclic or planetary gear sets. A simple gear has a sun gear, about which planets turn round. These planet gears are carried by a carrier and

a shaft and are also in mesh internally with a ring gear, which is also called annulus or internal gear sometimes.

Different torque ratios i.e. speed ratios 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.

4. What are the Advantages of Tube less tyres?

A: The tubeless tyres possess following advantages over the conventional tubed tyres:

1. LESSER UNSPRUNG WEIGHT:

Being lighter, unsprung weight is reduced, reducing wheel bounce, which also means fuel saving.

2. BETTER COOLING:

In case of tubed tyres, heat in the compressed air has to pass through the tube material i.e. rubber, which is not a good conductor of heat. Since there is no tube in the tubeless tyres, heat can be passed on to the atmosphere directly, resulting in better cooling thereby increasing the tyre life.

3. LESSER ROLLING RESISTANCE:

Even the rolling resistance in a tubeless tyre is lower compared to the tubed type. This is due to the fact that tubeless tyre sidewall is more supple as there is no internal tube to generate

(17)
friction. This also helps the tyre to run cooler by eliminating heat generation caused by the internal shuffling of the tube.

4. COMFORTABLE RIDE:

In case of tubeless tyre, shocks and vibrations are absorbed at the ~~type~~ of tyre level, thus making the ride softer, quieter and more comfortable.

5. SLOWER LEAKAGE OF AIR:

Since the inner liner in the tubeless tyres is not stretched like the tube, it retains the air better resulting in its slower leakage.

6. SIMPLER ASSEMBLY:

Only the tyre has to be fitted over the rim. There is no danger of the tube being punctured during assembly.

7. IMPROVED SAFETY:

In case of any hole being caused in the tyre, the same can be repaired simply by plugging, whereas in case of the conventional tyres, it takes quite sometime to remove the tube for repair. Apart from this, a tubeless tyre retains the air pressure for long periods even when punctured by nail provided the same is held in the place. Thus the chances of sudden tyre puncture leading to accident are reduced, thus leading to improved safety.

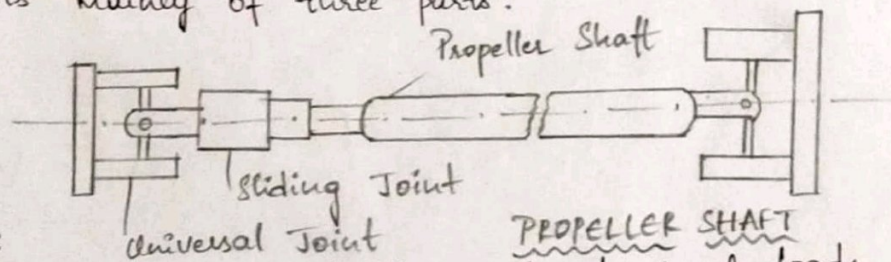
5. What is the function of Propeller Shaft

A: DRIVE LINE:

It is the group of parts connecting the transmission with the driving wheels. It consists of the drive shaft (is called propeller shaft), universal joints, constant velocity joints and the half shafts.

PROPELLER SHAFT:

This is the shaft which transmits the drive from the transmission to the bevel pinion or worm of final drive in front engine, rear drive w. vehicles and from the transfer box to the front and rear axles in all-wheel drive vehicle. It is also called drive shaft. It consists mainly of three parts:



(a) SHAFT:

As this has to withstand mainly torsional loads, it is usually made of tubular cross-section. It also has to be well balanced to avoid whirling at high speeds. Shafts are made of steel, aluminium or composite materials.

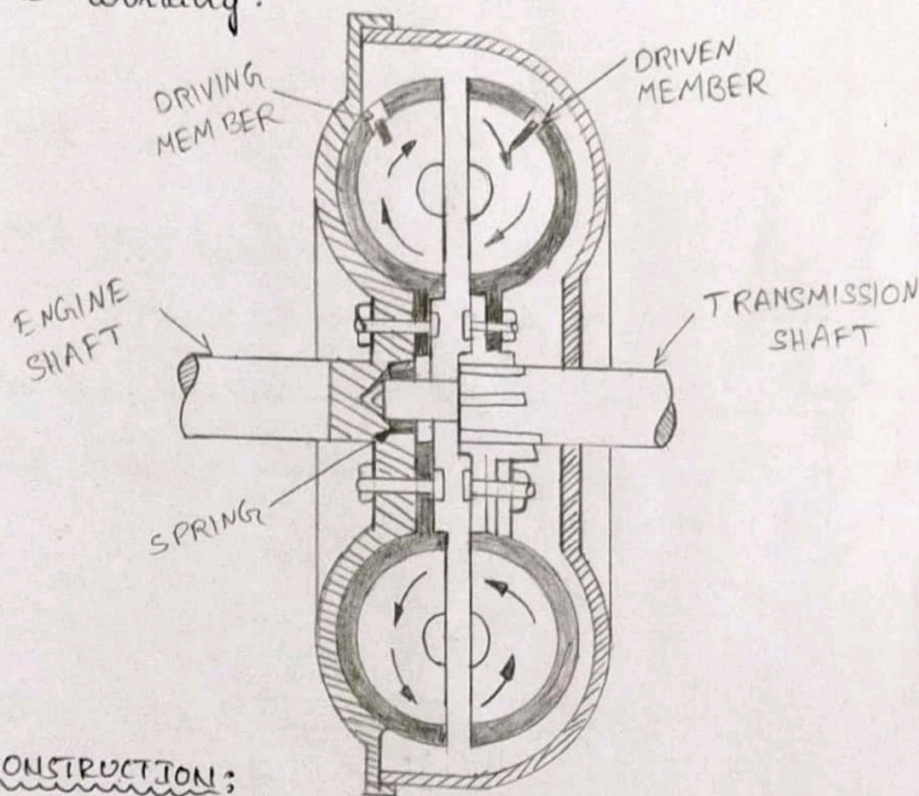
(b) One or two universal joints, depending upon the type of rear axle drive used. The universal joints account for the up and down movements of the rear axle when the vehicle is running.

(c) SLIP JOINT

Depending upon the type of drive, one slip joint may be there in shaft. This serves to adjust the length of the propeller shaft when demanded by the rear axle movements.

Slip joint is formed by the internal splines on the sleeve attached to the left universal joint and external splines on the propeller shaft.

6. What is Fluid Fly wheel ? Explain its Construction and working.



CONSTRUCTION:

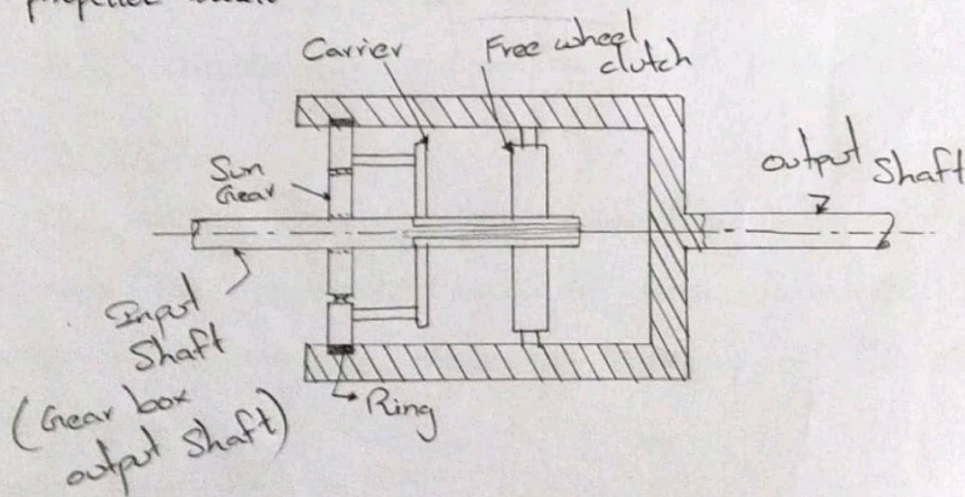
The fluid flywheel or the hydraulic coupling as it is frequently called, has been used in cars employing automatic transmissions.

It consists of two members, the driving and the driven. The driving member is attached to the engine flywheel and the driven member, to the transmission shaft. The two members do not have any direct contact with each other. The driven member is free to slide on splines on the transmission shaft. The two rotors are always filled with fluid of suitable viscosity. These are provided with radial ribs to form a number of passages, which avoid formation of eddies and also guide the fluid to flow in the desired direction.

Q. What is an Over drive and explain its Construction with neat sketch.

A: OVER DRIVE:

Overdrive is a device to step up the gear ratio in the car. It is fitted in between transmission and the propeller shaft.



It consists of an Epicyclic gear train in which the sun gear is free to rotate on the input shaft splines. The output shaft is connected to the ring.

When the sun gear is locked with the casing, i.e. it becomes stationary, the speed of the output shaft is increased i.e. overdrive is engaged. When, however, the sun gear is locked to the carrier or to the ring, solid drive through the gear train is obtained. Thus depending on the locking of the sun gear with casing or with carrier the overdrive or the normal direct drive is obtained.

8. Define Tyre. Explain different types of tyres with neat sketch.

A: TYRE:

A tyre is a cushion provided with an Automobile wheel. It consists of mainly the outer cover i.e. the tyre proper and the tube inside. The tyre-tube assembly is mounted over the wheel rim. It is the air inside the tube that carries the entire load and provides the Cushion.

TYPES OF TYRES:

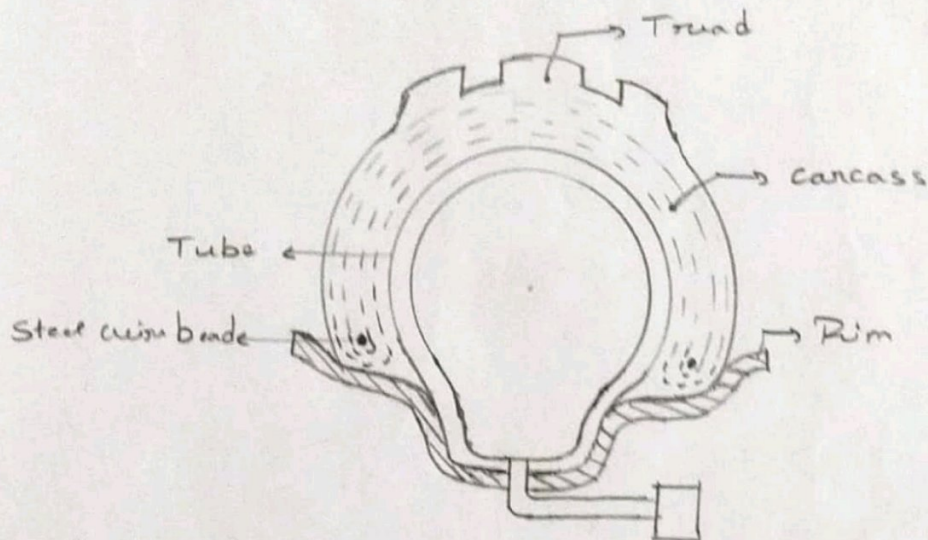
The use of solid tyres on automobiles is now obsolete and only the pneumatic tyres are used universally. These pneumatic tyres may be classified according of following considerations:

1. Basic Construction
2. Use
3. Ability to run flat.

1. BASIC CONSTRUCTION:

According to this Criterion, the tyres may be the conventional tyre with tube and the tubeless tyre.

(i) CONVENTIONAL TUBED TYRE:



It consists of two main parts, the carcass and the tread. The carcass is the basic structure taking mainly the various loads and consists of a number of plies wound in a particular fashion from the cords of rayon or any other suitable material. Each cord in each ply is covered with resilient rubber compounds and all the plies are insulated against each other. The term 'ply rating' which is often used in tyre industry does not indicate exact number of plies in the tyre. It is only a relative index of tyre strength and load-carrying capacity. A four-ply rating tyre, for example, may actually have only two plies. The sidewall is a protective rubber coating on the outside of the tyre carcass and is designed to resist cutting, scuffing and cracking.

(ii) ALL-SEASON TYRES:

These are the tyres that one commonly finds on almost all production cars. Obviously, they are designed by compromising on performance, grip, noise and life. For instance, they are made of harder rubber for longer life, which decreases the grip and cornering power.

(iii) WET-WEATHER TYRES:

Such tyres have many more sipes for dispersing water from the contact patch. Sipes are small, slit-like grooves in the tread blocks that allow the blocks to flex. This increased flexibility increases the traction by creating an additional biting edge.

(iv) SNOW/ICE TYRES:

These have larger tread block patterns, which makes them noisier. For extreme climates, snow tyres have small metal stud inserts which bite into the snow and ice. However, such tyres have a much shorter life and are extremely noisy if run over dry roads.

5. ALL-TERRAIN TYRES:

These are commonly used on SUV's and pick-ups. These are larger in size and have stiffer sidewalls and bigger tread-block patterns. This increases their grip on loose sand and dirt when running off-road but are more noisy on normal roads.

3. ABILITY TO RUN FLAT:

Flat running tyres are designed to resist the effects of deflation and to enable the vehicle to be drive continuously after the puncture, at reasonable reduced speeds, say, 80km/h for limited distances of about 80km.

A. DEVELOPMENT HISTORY:

→ First generation (1970's)

These were based on special wheel with sealant gel.

1970 - DENOVO in the market

1972 - DENOVO 2 (DENLOC)

1974 - Denovo fitted on Mini Cooper

1979 - Denovo 2 fitted on Fairlady Z

→ Second generation (1980's)

These had a special wheel with tyre-side walls reinforced.

1983 - TDT tyre launched

1984 - TDT fitted on Fairlady Z

1987 - Denloc fitted on Porsche 959

→ Third generation (1990's)

These had normal wheel with tyre-side walls reinforced.

1995 - BOST launched.

→ Fourth generation (2000's)

These also have reinforced side walls with normal wheel.

2000 - CTT Run-flat tyre launched

2003 - CTT Run-flat tyre with low heat generation materials

2002 - CTT Run-flat tyre fitted on Lexus GS

2004 - CTT Run-flat tyre fitted on Nissan GTR.

B. TECHNOLOGY:

Basically there are three types of technologies available for run flat. They are:

(I) SELF-SEALING TYRES:

This type of tyre has just the standard construction except that there is an extra lining inside the tyre under the tread area and is coated with a puncture sealant which can seal permanently punctures upto about about 4mm in diameter. Such tyres, due to their conventional construction and loss of air symptom in case of excessive damage, do not require any low pressure air warning system.

An example of these is "Continental Contiseal" type.

(II) SELF-SUPPORTING TYRES:

Such tyres are specially specifically constructed so that the side walls are more stiff and can support the vehicle weight by themselves in case of a puncture. In a typical construction, rubber is sandwiched between layers of heat-resistant cord in the side walls, which prevents the same from folding over on the themselves in case of loss of air pressure. Such tyres also have special beads which retain their grip over the wheel rim in the event of air loss.

(III) AUXILIARY-SUPPORTED TYRES:

In such types, the tread of the flat tyre rests on a support ring attached to the wheel in case of loss of pressure due to puncture.

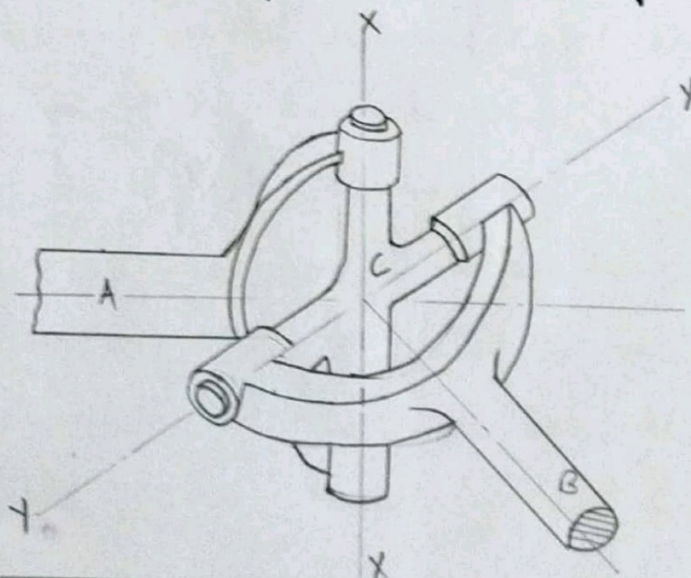
The Advantages of this type of system are:

- * The main responsibility to provide run flat capability is on the wheel and not on the tyre
- * Auxiliary support systems may provide better ride quality since their sidewall stiffness can be equivalent to that in case of standard tyres.

However, the disadvantage is that in such systems, standard tyres would not be accepted. Consequently, due to lower volumes, they are costlier.

9. Briefly, Explain the working principle of Universal Joint.

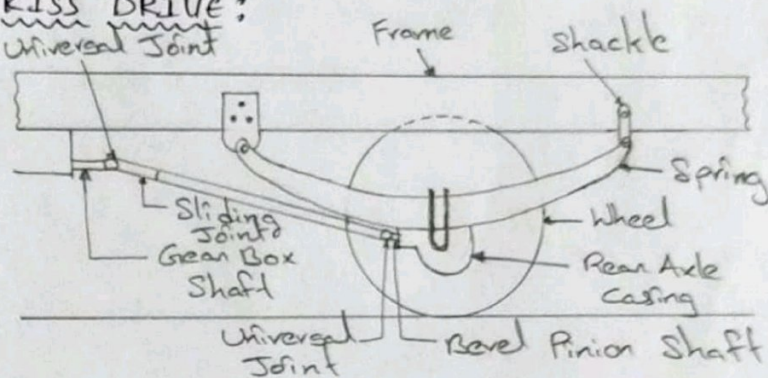
A: A universal joint is a particular type of connection between two shafts, whose axes are inclined to each other. The most simple type of Universal joint is the Hooke's joint, which is most widely used because of the fact that it is simple and compact in construction and reasonably efficient at small angles of propeller shaft movement up and down, say upto 18° .



The axes of shafts A and B are intersecting. Each of these shafts contains a yoke. The cross C has four arms. The two opposite arms of the cross are supported in bushes in the yoke of shaft A, while the other two arms of the cross are supported in the yoke of shaft B. Thus shaft A can have angular rotation about axis xx and the shaft B, about the axis yy. It will be possible with the Hooke's joint for the shafts A and B to have positive drive while allowing angular movement between them.

10. Write short notes on Hotch-kiss Drive.

A: HOTCH KISS DRIVE:



This is the simplest and most widely used type of rear axle drive. In this case the springs besides taking weight of the body, also take the torque reaction, driving thrust and the side thrust. The propeller shaft is provided with two universal joints and also a sliding joint. The spring is fixed rigidly in the middle, to the rear axle. The driving thrust is transmitted to the frame by the front half of the springs.

Due to the Torque reaction, the spring deflects as thus torque reaction is taken up and bending of spring under torque reaction. Similarly, to take up the braking torque the springs would deflect in opposite direction.

When the rear axle moves up and down, it has to move in a circle with the front spring support at the frame as centre. But for the propeller shaft motion, the centre is at the front universal joint. This means that during this movement of the rear axle, the length of the propeller shaft has to vary. This is provided for by means of a sliding joint in the propeller shaft.

UNIT - III

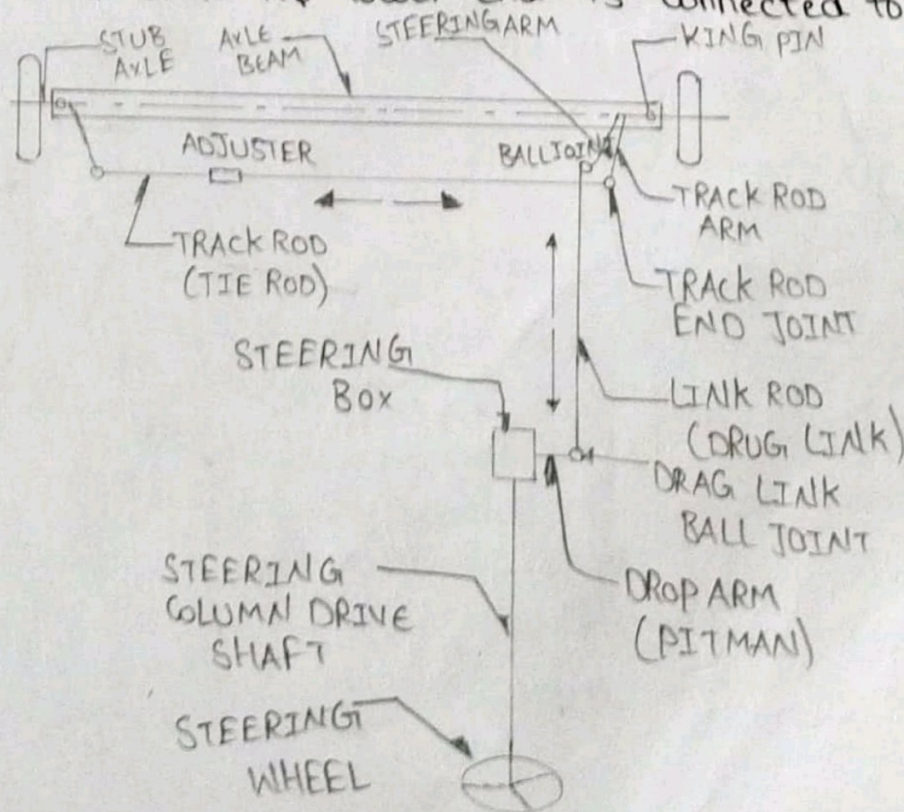
STEERING SYSTEM

1) Explain in detail steering linkage with independent Suspension System.

A. Steering linkage depends upon the type of the Vehicle, Whether it is a car which has independent front Suspension or a Commercial Vehicle having generally a rigid axle type front Suspension. Each of these linkage will now be described.

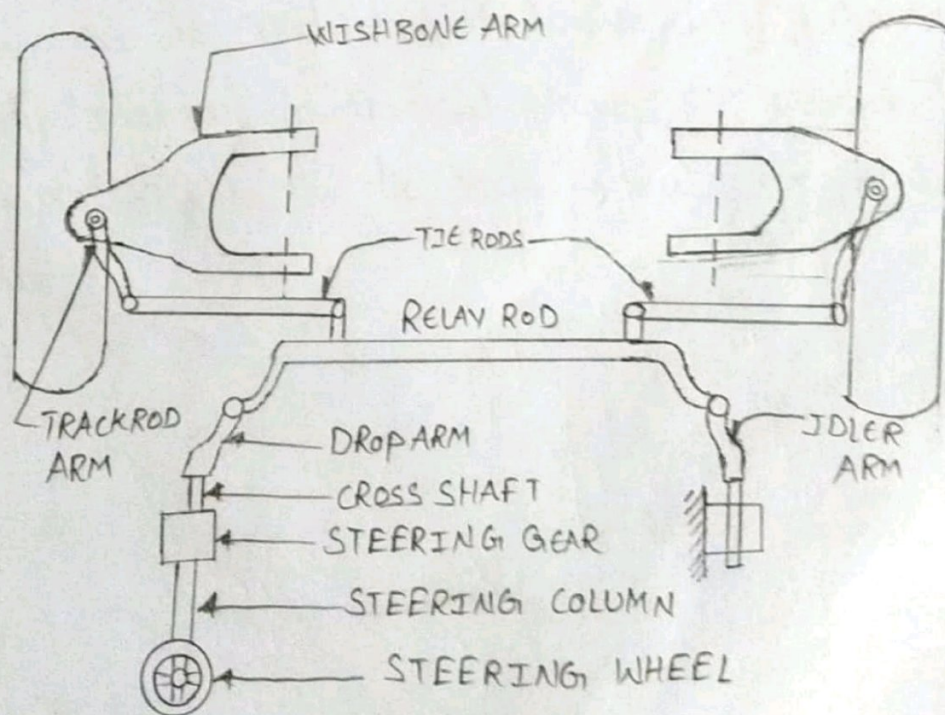
Steering linkage for vehicle with rigid axle front Suspension:

The drop arm (also called pitman arm) is rigidly connected to the cross-shaft to the steering gear at its lower end, while its lower end is connected to the



link rod through a ball joint. To the other end of the link rod is connected the link rod arm through a ball joint. Attached rigidly to the other end of the link rod arm is the sub axle on which the road wheel is mounted. Each stub axle has a forged track rod arm rigidly bolted to the wheel axle. The other ends of the track rod arms are connected to the track rod by means of ball joints. The design of these ball joints is such that the expanding spring compensates for wear or mis-adjustments. An adjuster is also provided in the track rod to change its length for adjusting wheel alignment.

Steering linkage for vehicle with independent front suspension:
In case of conventional rigid axle suspension, the main axle beam ensures the movement of stub axle



②

in the horizontal plane only. In this therefore, there is no vertical deflection of the suspension and hence there is no change in effective track-rod length. However, in the case of independent suspension, the two stub axles can move up or down independent of each other due to which distance between ball-joints ends of the two track arms is continuously varying. On account of this a single track rod as in conventional system described above, cannot be used.

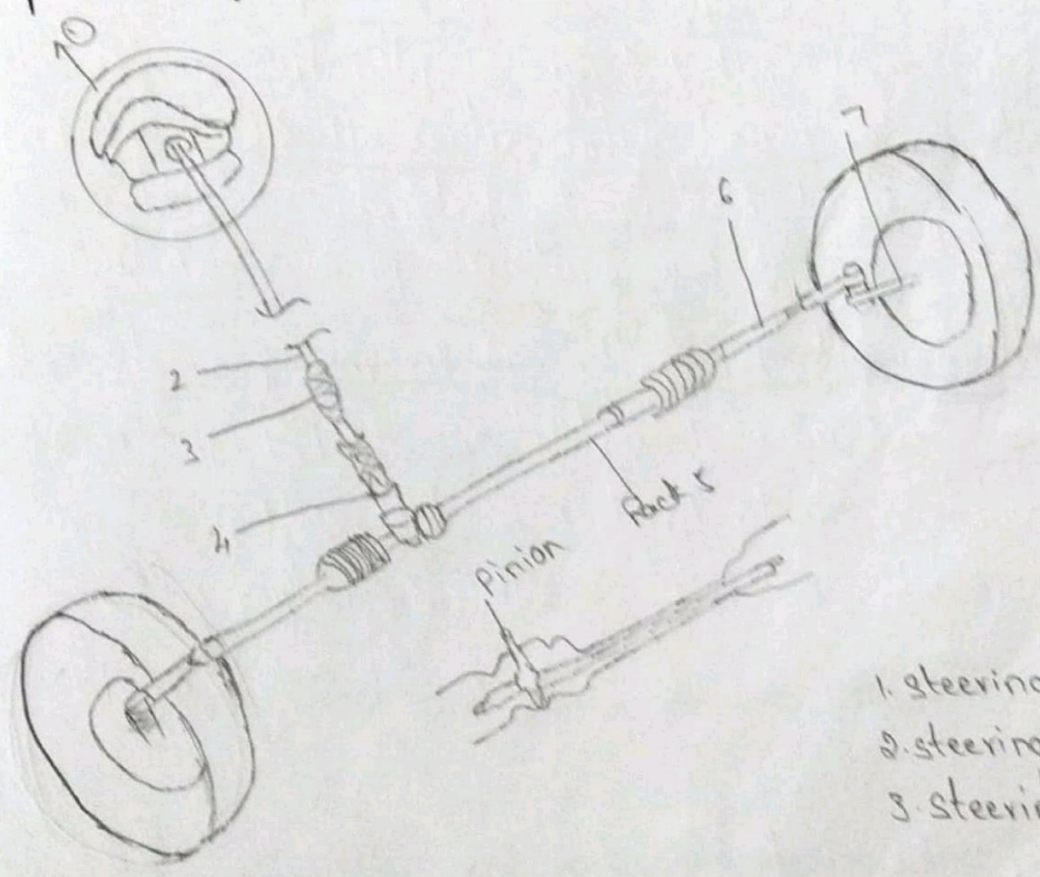
Depicts one linkage for independent suspension where the above difficulty is avoided. Here three-piece track rod is used, the centre portion being called the relay rod, which is connected at one end to an idler arm supported on body structure and to the drop arm of the steering gear at the other end through ball joints.

The relay rod is restricted to move in horizontal plane only. Movement in vertical plane is provided by the outer portion, viz, the tie rods about the end ball joints.

Q2.) With the help of neat sketch Explain the working of rack and pinion steering gear.

A) This Rack and pinion steering gear

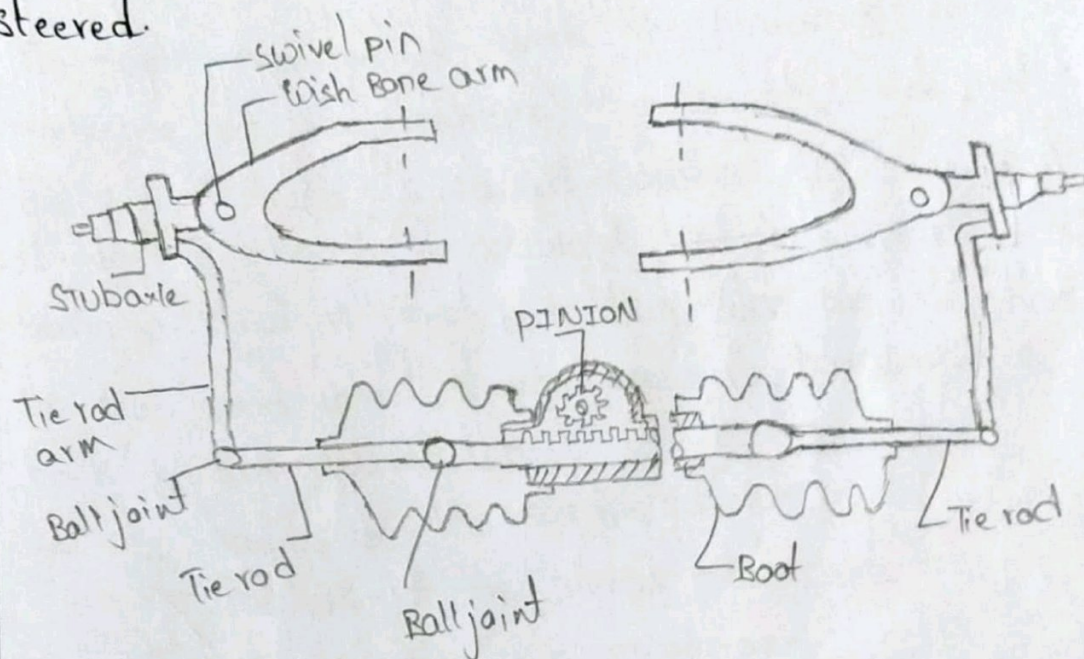
This type is steering gear is used on light vehicle like cars and in power steering. Maruti 800 cars employ this steering gear (Fig 8.44). It is simple, light and responsive. It occupies very small space and uses lesser number of linkage components compared to the worm and wheel type of gear.



Rack and pinion steering system

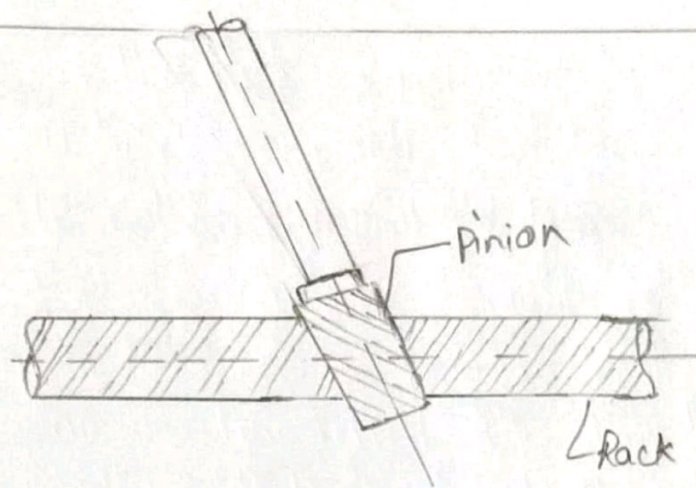
- 1. steering wheel
- 2. steering shaft
- 3. steering shaft joint
- 4. steering pinion
- 5. steering gear case
- 6. Tie rod
- 7. steering knuckle.

fig 8.45 shows the rack and pinion type of steering gear (end take off type) along with its linkage. The rotary motion of the steering wheel is transmitted to the pinion of the steering gear through universal joints. The pinion is in mesh with a rack. The circular motion of the pinion is transferred into the linear rack movement, which is further relayed through the ball joints and tie rods to the stub axles for the wheels to be steered.



Rack and pinion steering gear.

Compared with the end take off design, this is also affected less by bump steer. When the toe of wheels changes as they go over a bump or through a depression on the end, the vehicle is said to have bump steer.



Tilting the pinion axis.

The tooth profiles of both the pinion as well as the rack are of the involute form so that side profile of the pinion teeth is curved. However, the side profile of the rack teeth is straight line, its pitch circle being a straight line. But this also provides damping so that road wheel shocks are not transmitted back to the steering wheel.

Let r_s = radius of the steering wheel

r_p = radius of the pinion pitch-circle

T = number of teeth on pinion

P = circular pitch of the pinion
= linear pitch of the rack.

Then for one revolution of steering wheel, the input movement at the steering wheel, $x_i = 2\pi r_s$

and the output movement at the rack, $x_o = 2\pi r_p = T \times P$

$$\therefore \text{movement ratio, } MR = \frac{x_i}{x_o} = \frac{2\pi r_s}{2\pi r_p} = \frac{r_s}{r_p}$$

Also,

$$MR = \frac{2\pi r_s}{T_p}$$

If there is no friction in the gears

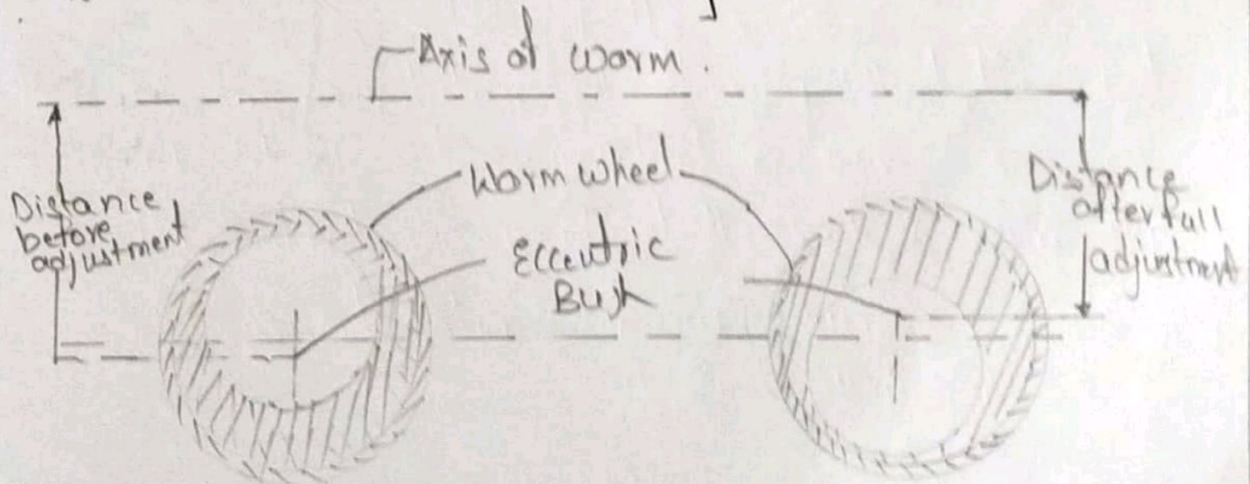
$$\text{Movement ratio} = \frac{\text{output load at the rack}}{\text{Input effort at the steering wheel.}}$$

i.e. $MR = \frac{W}{E}$

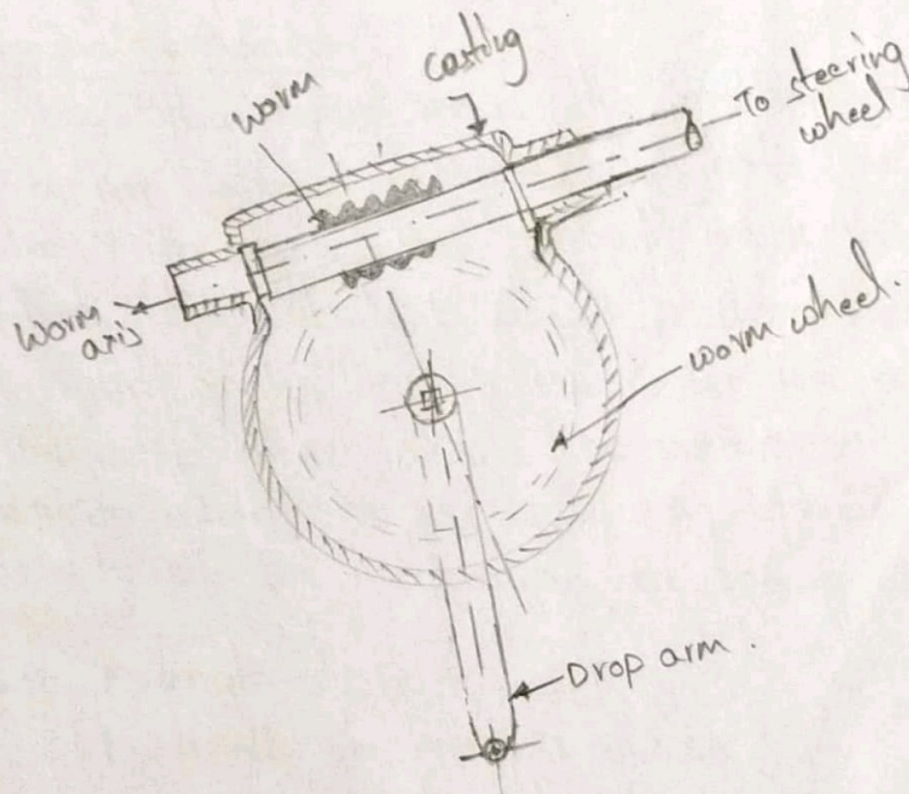
With the help of neat sketch Explain the working of worm and wheel steering gear.

Worm and wheel steering gear

from the figure gives a simplified diagram of the worm and wheel gear. The movement of the steering wheel turns the worm, which in turn drives the worm wheel. Attached to the wheel spindle rigidly is drop arm, so that a rotation of the steering wheel corresponds to a linear motion of the drop arm end, which is connected to the link rod as has already been discussed.



In place of Worm wheel, only a sector is also Sometimes used, but the Complete wheel has an advantage over the later in that in this Case back lash due to Wearing out of the teeth of the worm and worm Wheel can be easily adjusted. For this purpose the Worm wheel is mounted over an eccentric bush. When the teeth have worn out, the problem is how to bring the worm and the wheel together to take up the wear. This is done by rotating the bush together through a certain angle.



Worm and wheel steering gear.

(9)

4.) With the help of neat sketch Explain working of Ackerman steering mechanism?

A STEERING MECHANISM:

We have already seen that for perfect steering we must always have an instantaneous center about which all the wheels must rotate. for this purpose inner wheel has to turn more than the outer wheel. To achieve this condition, two types of mechanism, have been devised, viz, the Davis and the Ackerman steering ~~condition~~ ~~condition~~, two mechanisms. out of these Ackermann mechanism is almost universally used because of its simplicity.

Ackermann mechanism:

from the below figure shows this mechanism. Links RA and SB are integral with the stub axles. These links are connected with each other through track rod AB. when the vehicle is in straight ahead position these links make equal angles α with the center line of the car. The dotted lines indicate the position of the mechanism when the car is turning left. In fig 8.21(b) the details of the mechanism are shown on enlarged scale.

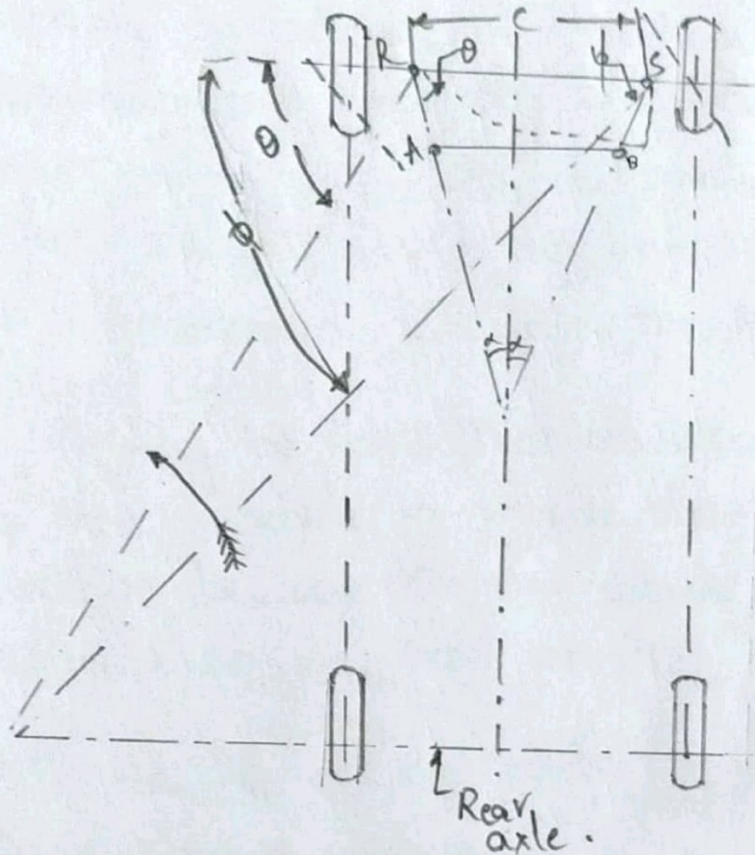
Let l = length of track rod

and r = length of links RA and SB

Then referring fig 8.21 (b) and neglecting the obliquity of the track rod in the turned position, the movements of A and B in the horizontal direction may be taken to be same (each equal to 'x').

Then

$$\sin(\alpha + \theta) = \frac{Y + X}{r}$$



and $\sin(\alpha - \phi) = \frac{Y - X}{r}$

Adding $\sin(\alpha + \theta) + \sin(\alpha - \phi) = \frac{2Y}{r} = 2 \sin \alpha$

The mechanism gives only 3 positions for correct steering; one when $\theta = 0$ and the other two each corresponding to the turn to right or left (at a fixed turning angle). However, for other angles also it gives a close approximation to the ideal condition. Further this has the advantage that it employs pivots and not sliding constraints, due to which reason its

maintenance is easier. That is why it is universally employed. However, lately the automobile designers do not care to follow the Ackermann mechanism very strictly on account of the improvement in the suspension and tyres. Any small deviation from the true rolling angles can be readily corrected by the tyres sidewall flexibility and tread distortion. Rather it is endeavored to obtain the smallest value of the turning circle.

(It may be noted that while parking, it is easier to steer a vehicle in reverse than in the forward direction because the rear wheels turn on smaller radius than the front wheels.)

(5) With the help of neat sketch explain working of Davis steering mechanism.

(A) Davis steering Gear Mechanism:

The Davis steering gear is shown in fig 9.16. It is an exact steering gear mechanism. The slotted links AM and BH are attached to the front wheel axle, which turn on pivots A and B respectively. The rod CD is constrained to move in the direction of its length, by the sliding members at P and Q. These constraints are connected to the slotted link AM and BH by a sliding and a turning pair at each end. The steering is affected by moving

(12)

CO to the right or left of its normal position. C'D' shows the position of CO for turning to the left.

Let a = vertical distance between AB and CO

b = wheel base

d = Horizontal distance between AC and BO,

c = Distance between the pivots A and B of the front axle.

x = Distance moved by AC to AC' = CC' = DD'

α = Angle of inclination of the links AC and BD, to the Vertical.

from triangle AA'C.

$$\tan(\alpha + \phi) = \frac{A'C'}{AA'} = \frac{d+x}{a} \rightarrow (i)$$

from triangle AA'C.

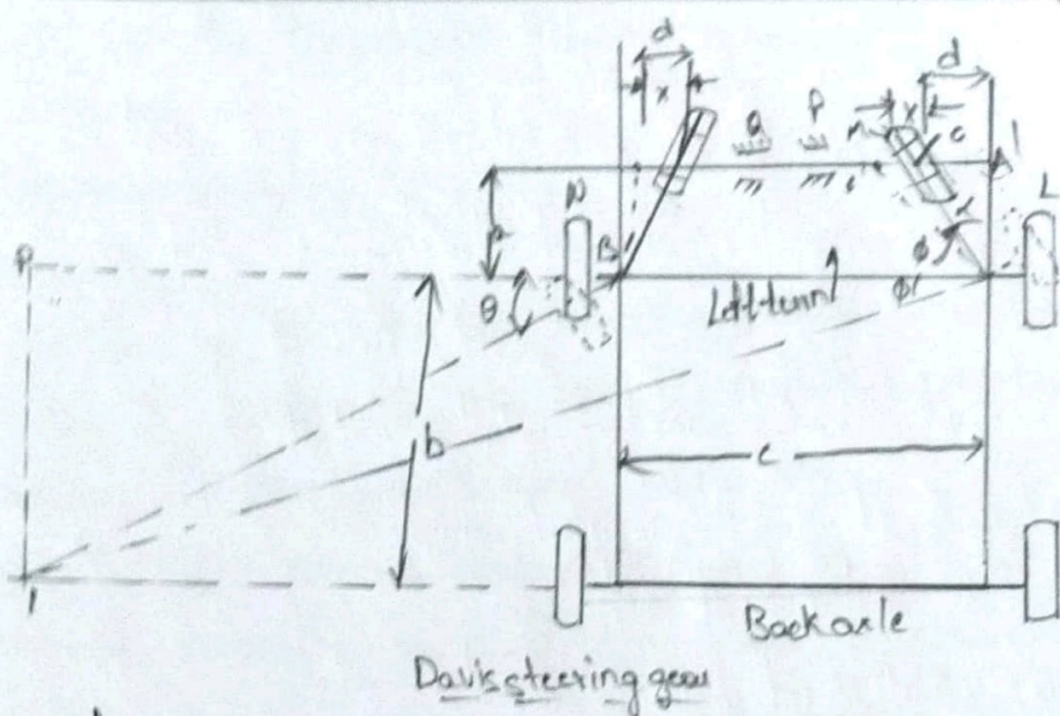
$$\tan \alpha = \frac{A'C}{AA'} = \frac{d}{a} \rightarrow (ii)$$

from triangle BB'D.

$$\tan(\alpha - \theta) = \frac{B'D'}{BB'} = \frac{d-x}{a} \rightarrow (iii)$$

We know that $\tan(\alpha + \phi) = \frac{\tan \alpha + \tan \phi}{1 - \tan \alpha \cdot \tan \phi}$

$$\frac{d+x}{a} = \frac{\frac{d}{a} + \tan \phi}{1 - \frac{d}{a} \times \tan \phi} = \frac{d + a \tan \phi}{a - d \tan \phi}$$



∴ from equation (i) and (ii)

$$(d+x)(a-d \tan \phi) = a(d + a \tan \phi)$$

$$a \cdot d - d^2 \tan \phi + a \cdot x - d \cdot x \tan \phi = a \cdot d + a^2 \tan \phi$$

$$\tan \phi (a^2 + d^2 + d \cdot y) = ax \text{ or } \tan \phi = \frac{ax}{a^2 + d^2 + d \cdot y} \rightarrow iv$$

similarly, from $\tan(\alpha - \theta) = \frac{d-x}{a}$, we get

$$\tan \theta = \frac{ax}{a^2 + d^2 - d \cdot x}$$

We know that for correct steering

$$\cot \phi - \cot \theta = c/b \text{ or } 1/\tan \phi - 1/\tan \theta = c/b$$

$$\frac{a^2 + d^2 + d \cdot x}{a \cdot x} - \frac{a^2 + d^2 - d \cdot x}{a \cdot x} = c/b$$

[from equations $\underline{IV}$ & $\underline{V}$]

$$\frac{2d \cdot x}{a \cdot x} = c/b \text{ (or)} \frac{2d}{a} = c/b$$

$$2 \tan \alpha = c/b \text{ or } \tan \alpha = \frac{c}{2b}$$

$$\therefore (d/a = \tan \alpha).$$

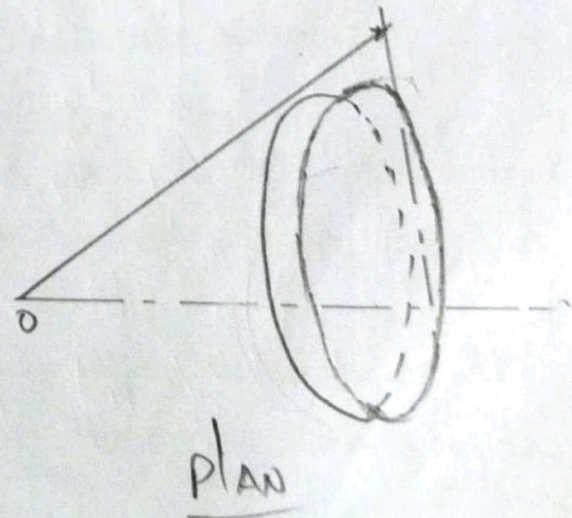
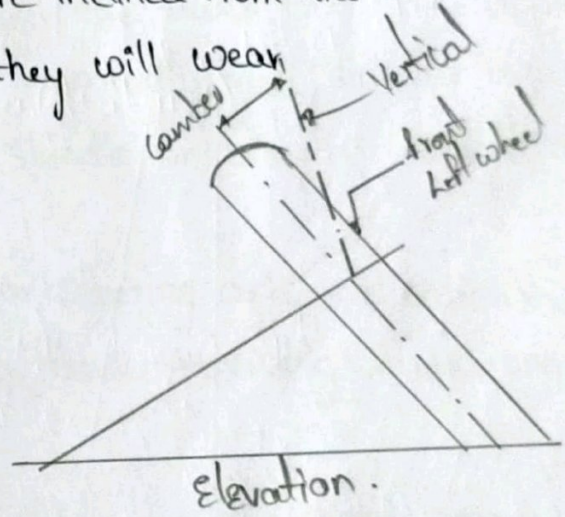
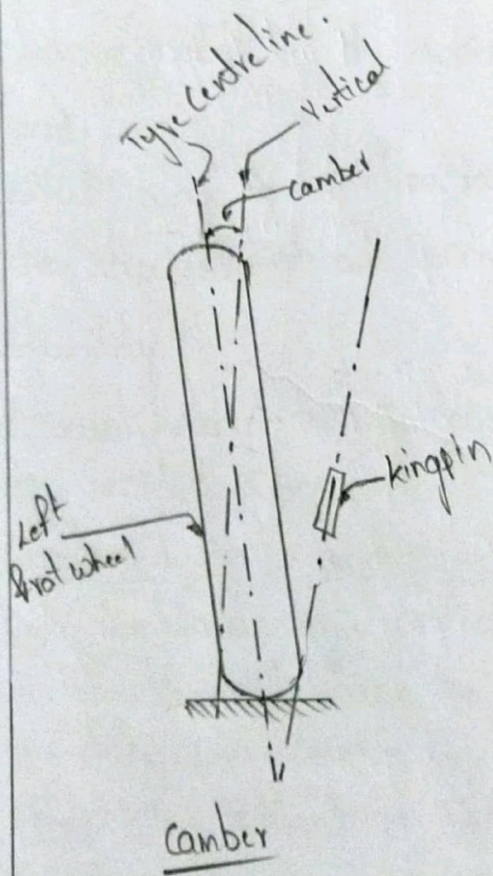
6.) What are the Components steering geometry Explain their functions.

A) Steering geometry:

1. Camber:

Camber is the tilt of the car wheels from the vertical. Camber is positive if the tilt is outward at the top. Camber is also called 'wheel rake'.

Effect: It is always desirable tyres should roll on the ground vertically so that the wear is uniform. If while running, the tyres are inclined from the vertical either inward or outward, they will wear



(15)

move on one side than the other. In case of positive camber, as the vehicle turns, the outside suspension tends to rise on the wheel.

Amount: Camber should not generally exceed 2° . However, the exact amount of camber is specified taking into account the king pin inclination.

King pin inclination (steering axis inclination)

Def: Inclination of the king pin from vertical is called the king pin inclination or king pin rake. Steering axis is an imaginary line drawn through the lower and the upper steering pivot points. SAI is non-adjustable, since it would change only if the wheel spindle or steering knuckle are bent.

effect: king pin inclination (or steering axis inclination) helps the straight ahead recovery, thus providing directional stability.

Amount: About 7 to 8 degrees. However, the exact amount is decided considering the wheel rake value.

Combined Angle and scrub Radius:

Def: Combined angle or included angle is the angle formed in the vertical plane between the wheel center line and the king pin centre line.

effect: The effect of combined angle variation on the scrub radius and hence on the forces acting on the

(16)

turn the wheel in case of a rear-wheel drive vehicle.

Amount! Combined angle may be 9-10 degrees and the scrub radius should be upto about 12mm. Front wheel drive vehicle usually have negative scrub radius. However, scrub radius is set at the factory and is not adjustable.

Castor

Def! The angle between the king pin centre line and the vertical, in the plane of the wheel is called the castor angle.

Effect! In rear-wheel drive vehicles, steering axis pulls the front tyres, whereas the tyre drag on account of the vehicle weight is on the vertical line at the center of the footprint.

Amount! About 3° of castor gives good results.

Toe-in or Toe-out

Def! Toe-in is the amount by which the front wheels are set closer together at the front than at the rear when the vehicle is stationary i.e. $\text{toe in} = B - A$.

Effect! In a rear-wheel drive vehicle, the rear axle pushes the front axle tyres as they roll along the road.

Amount! Toe-in initially provided generally does not exceed 3mm.

Toe-change or Bump-steer

It occurs when the length of the tie rod is not correct or it is installed at an incorrect angle. The outer tie rod end moves up and down whenever the suspension compresses and extends.

What are the different types of steering gears and explain.

The steering gear converts the turning motion of the steering wheel into the to and fro motion of the link rod of the steering linkage. Moreover, it also provides the necessary leverage so that the driver is able to steer the vehicle without fatigue.

There are many types and makes of steering gears in use for automobiles. However, only a few important ones out of them are discussed here. The working of the other types is also similar.

Worm and wheel steering gear

It gives a simplified diagram of the worm and wheel gear. The movement of the steering wheel turns the worm which in turn drives the worm wheel. Attached to the wheel spindle rigidly is drop arm, so that a rotation of the steering wheel corresponds to a linear motion of the drop arm end, which is connected to the link rod as has already been discussed.

Cam and double roller steering gear:

This type of steering gear is employed in Ashok Leyland Vehicles in India, its working is similar to the worm wheel type described above. The steering ratio as used in these Vehicles.

Worm and nut steering gear:

The construction of a worm and nut type of steering gear is shown simplified in again the steering wheel rotation rotates the worm which in turn moves the nut along its length. This causes the drop arm end to move linearly, further moving the link rod and thus steering the wheels.

Recirculating Ball type steering gear

This type of gear was perhaps the most widely used steering gear at one time. In India, it has been used in the Tata, Dodge/Fargo, standard 20 Vehicles. It consists of a worm at the end of steering rod.

Rack and pinion steering gear:

This type of steering gear is used on light Vehicles like cars and in power steering. Maruti 800 cars employ this steering gear. It is simple, light and responsive. It occupies very small space and uses lesser number of linkage components compared to the worm and wheel type of gear.

Explain the terms Camber Caster, king pin, Combined angle.
Camber!

Def! Camber is the tilt of the car wheels from the Vertical, Camber is positive if the tilt is outward at the top. Camber is also called 'wheel rake'.

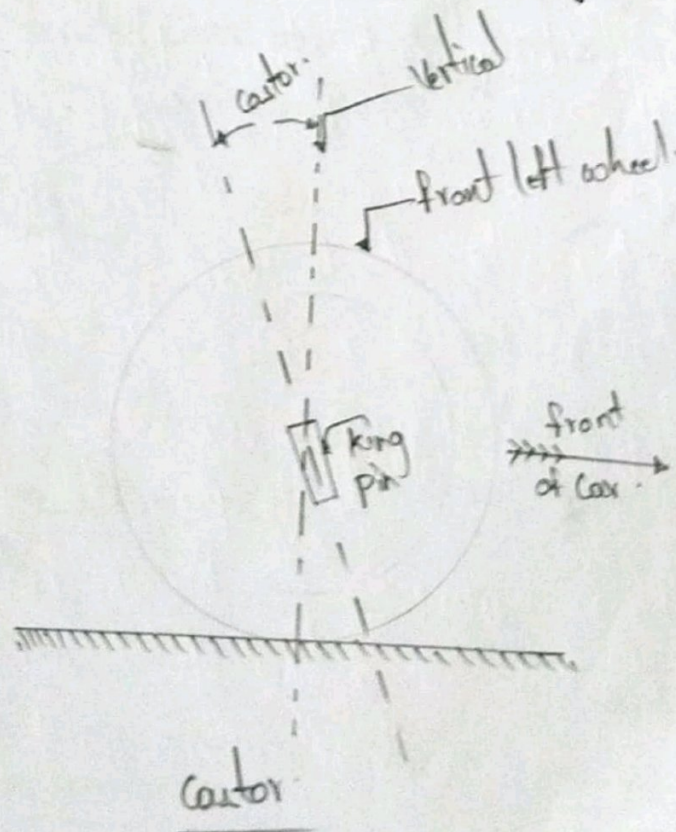
Effect! It is always desirable that tyres should roll on the ground vertically so that the wear is uniform. If while running, the tyres are inclined from the vertical either inward or outward, they will wear more on one side than the other. In case of positive camber, as the vehicle turns, the outside suspension tends to rise on the wheel, when the wheel returns to straight ahead position, the weight of the vehicle presses down on the steering axis and this helps straighten the wheel. Thus positive camber aids steering wheel return after completing the turn i.e., it increases straight-ahead stability. However, this also means increases of turning effort required at the steering wheel. Negative camber on the other hand, resists the tendency of the wheel to slip sideways during cornering, but also increases the steering effort.

Amount! Camber should not generally exceed 2° . However, the exact amount of camber is specified taking into account the king pin inclination.

Castor:

Def: The angle between the king pin centre line and the vertical, in the plane of the wheel is called the castor angle. If the king pin centre line meets the ground at a point ahead of the vertical wheel centre line, as is shown it is called positive castor while if it is behind the vertical wheel centre line, it is called negative castor.

Effect: In rear-wheel drive vehicles, the steering axis pulls the front tyres, whereas the tyre drag on account of the vehicle weight is on the vertical line at the centre of the footprint. Since in positive castor steering axis would meet the ground ahead of the centre of tyre print, the latter would always follow the former.



As the change of Castor angle result in the change of the other angles of the steering geometry, i.e, camber, king pin inclination and toe-in or toe-out, it is very important that this angle is adjusted first of all, while doing the adjustment job.

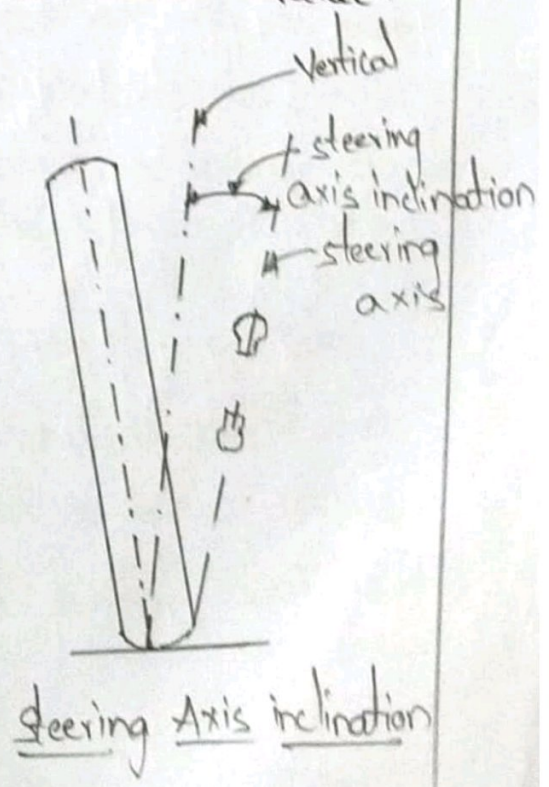
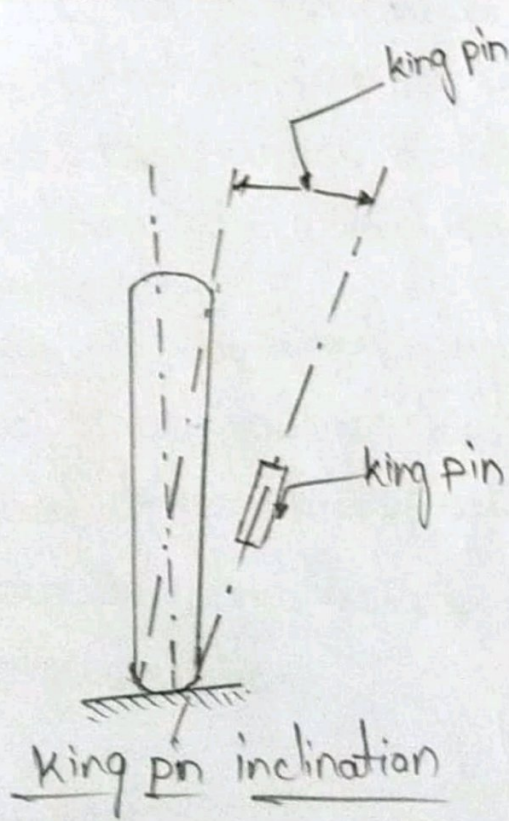
Amount: About 8° of Castor gives good result.

King pin inclination:

Def: inclination of the king pin from vertical is called the king pin inclination or king pin rake. In modern cars where the king pin has been replaced by the ball joints.

Effect: king pin inclination helps the straight ahead recovery, thus providing directional stability.

Amount: About 7 to 8 degrees. However, the exact amount is decided considering the wheel rake value.

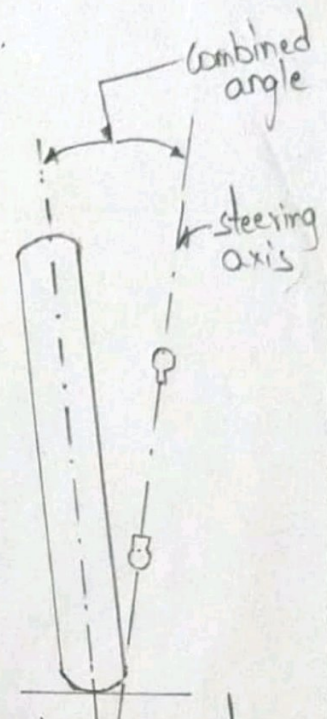


Combined Angle and Scrub radius:

Def: Combined angle or included angle is the angle formed in the vertical plane between the wheel centre line and the king pin centre line (or steering axis).

Combined angle is equal to camber plus king pin inclination.

Thus the forward tractive force acts at the point on the road where the steering axis or the king pin meets when projected. The road resistance acts at the wheel contact point on the road. The distance between these two points is called scrub radius.

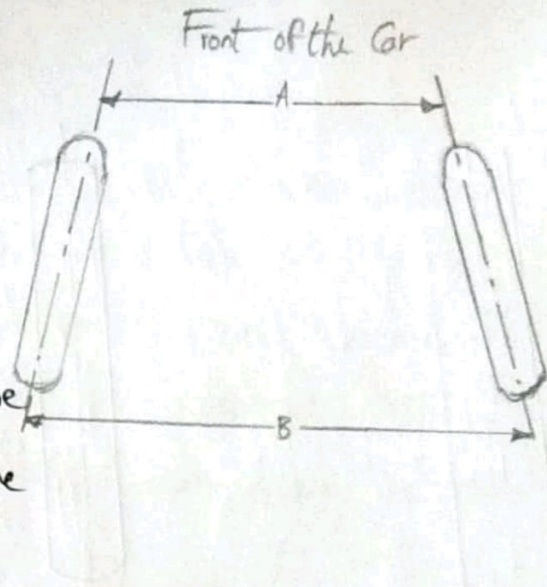


Effect: The effect of Combined angle variation on the scrub radius and hence on the forces acting to turn the wheel in case of a rear-wheel drive vehicle. It is seen that unless scrub radius is zero, a torque acts to turn the wheel away from the straight ahead position.

Amount: Combined angle may be 9-10 degrees and the scrub radius should be upto about 12 mm. Front wheel drive vehicles usually have negative scrub radius. However, scrub radius is set at the factory and is not adjustable.

9) Toe-in or Toe-out

Def: Toe-in is the amount by which the front wheels are set closer together at the front than at the rear when the vehicle is stationary. i.e., toe in = $B - A$, on the other hand, the wheel may be set closer at the rear than at the front in which case the difference of the distance b/w the front wheels at the rear is called toe-out.

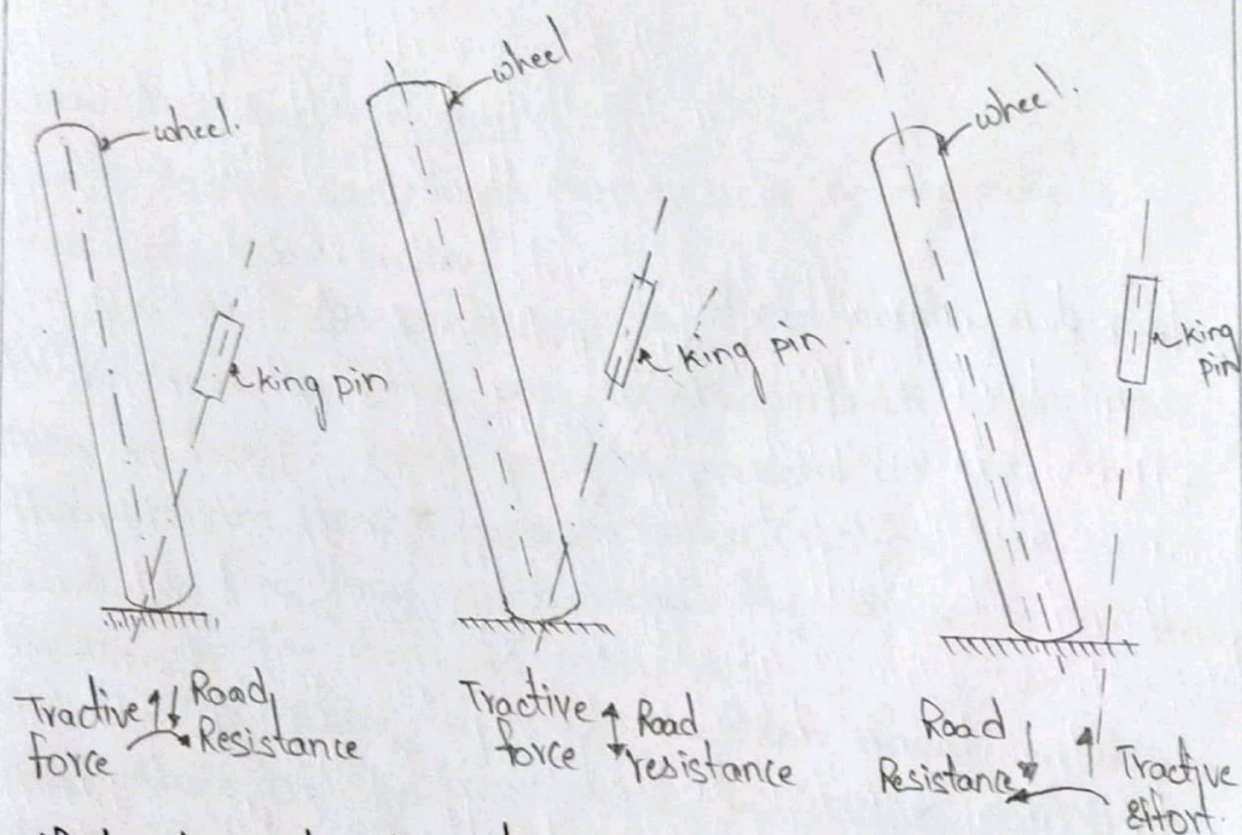


effect: In a rear-wheel drive vehicle, the rear axle pushes the front axle tyres as they roll along the road. Tyre rolling resistance produces some drag which results in rearward movement of the suspension arms against their bushings. Toe amount also effects the handling characteristics. Increase in toe-in would result in decreased oversteer and increased directional stability at high speeds, whereas increase in toe-out would result in reduced understeer and greater ease in steering during cornering.

Amount: Toe-in initially provided generally does not exceed 3mm.

Centre point steering:

Centre point steering was considered ideal to achieve, but now it has been proved by experience that best results are obtained in practice if the point of intersection of the wheel and the king pin centre line is slightly below the ground. In case the centre point steering is adopted, any small change in the combined angle under variable running conditions will cause the point of intersection to over.



Effect of Combined angle variation in rear wheel drive vehicle. The point of intersection of the wheel and king pin centre lines (a) above the ground (negative scrub radius) - tendency to toe in. (b) just at the ground (zero scrub radius) - no effect and (c) below the ground (positive

Scrub radius) - tendency to toe-out.

As the driving and handling sensations come from the road and the tyre, the scrub radius is the parameter to provide necessary road feel to the driver.

Amount:-

Combined angle may be 9-10 degrees and the scrub radius should be up to about 12mm. front wheel drive vehicles usually have negative scrub radius. However, scrub radius is set at the factory and is not adjustable.

10. understeer and oversteer

During turns, centrifugal force acts on the wheels.

Two cases can arise.

(i) when the slip angles of the front wheel are greater than those for the rear wheels, (a) which for instance, may be due to lower inflation pressure at the front than at the rear wheels or when cross-ply tyres are used at the front with radial ply tyres at the rear), radius of the turn is increased.

(ii) when the slip angles of the front wheels are less than those of the rear wheels, as radius of the turn is decreased.

The above explanation of the understeer and oversteer conditions is equally valid even when the vehicle is going straight and is subjected to side force due to road camber or some cross-wind.

Factors affecting oversteer and understeer

1. Passive factor

(i) weight distribution. If the vehicle weight is biased toward the front axle, it would cause oversteer, while understeer would result due to weight bias towards to rear axle.

(ii) Type of drive and engine placement.

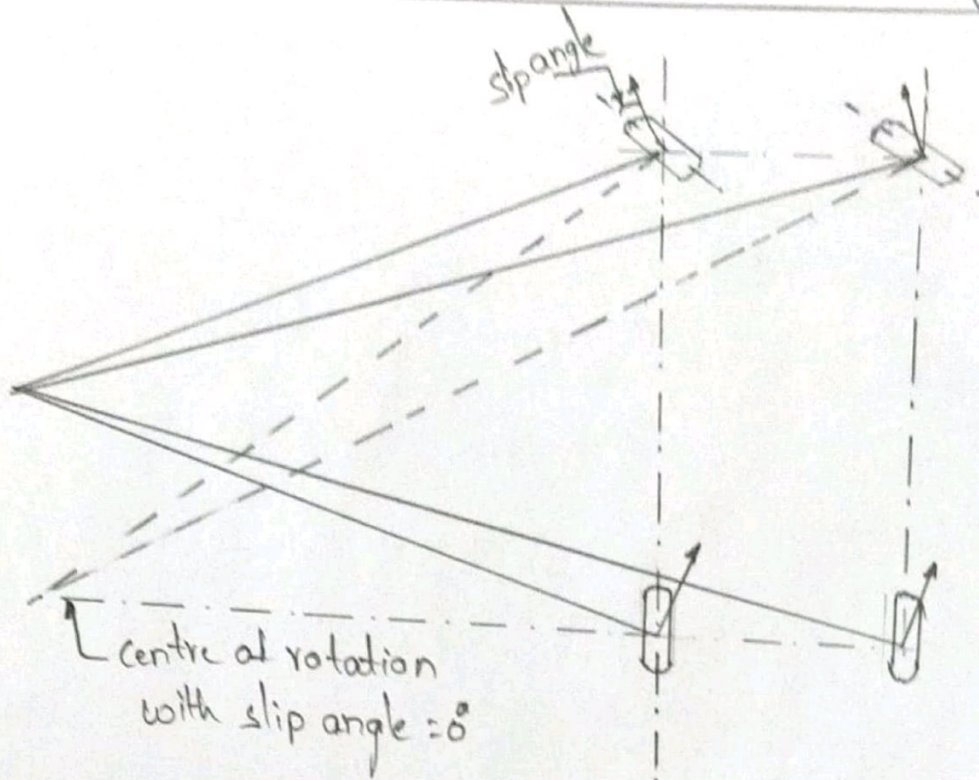
(a) Rear wheel drive, engine at the front. Engine placement at the front results in greater grip at the front viz., relatively lower grip level at the rear which would result in oversteer, especially while accelerating while cornering.

(b) Rear wheel drive, engine also at the rear. Such a vehicle e.g., Porsche 911 also has a tendency to oversteer due to a different reason.

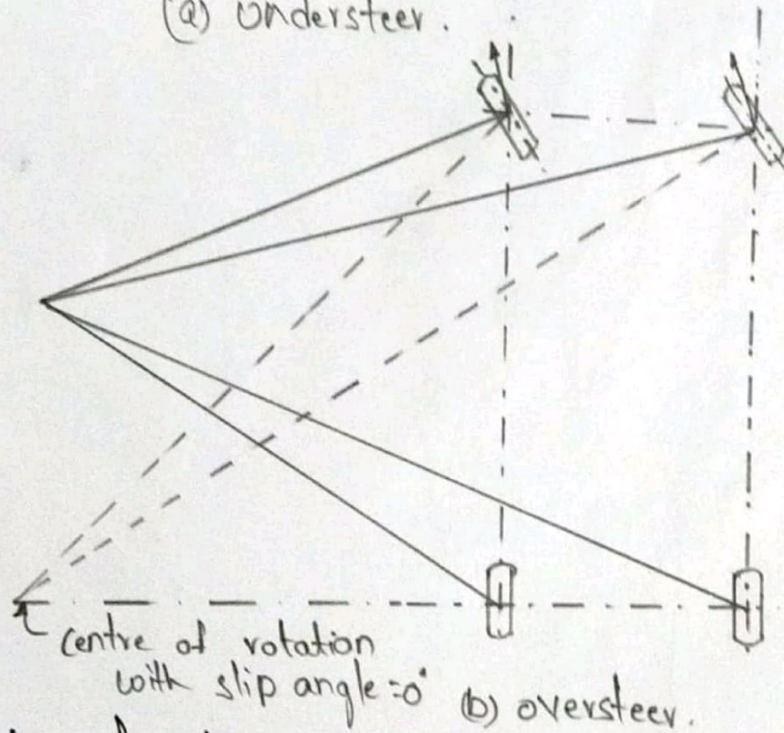
2. Active factor

(i) Cornering speed. Entering the corner too fast increases the tendency to oversteer.

(ii) Throttle position. If the engine is powerful and you press the pedal too hard, you could oversteer. Similarly lifting the foot from the pedal in the midst of the turn, there would be forward weight transfer due to which rear wheels would lose traction resulting in oversteer. In front wheel drive vehicles, pressing the accelerator pedal again can help to reduce oversteer.



(a) understeer.



(b) oversteer.

oversteering is preferred in racing cars, which enables the driver to accelerate early as the car passes the apex of a corner, thus gaining extra speed on the following straight.

Objectives

- * To prevent the road shocks from being transmitted to the vehicle components
- * To defuse the occupants from road shocks
- * To preserve the stability of the vehicle in pitch & rolling while in action

Types

- 1) Steel Springs
 - a) leaf springs,
 - b) tapered leaf
 - c) coil springs,
 - d) torsion bar
- 2) Rubber springs
 - a) Compression springs,
 - b) e. flex springs
 - c) steel reinforced
 - d) progressive
 - e, force flex
 - f, torsion flex
- 3) plate springs
- 4) Air springs
- 5) Hydraulic

SUSPENSION SYSTEMS

UNIT - IV

(1) Briefly explain construction and working of telescopic type shock absorbers.

A 'Telescopic' shock absorber derives its name from the tubular shape of early telescopes used in ancient times. There are of two types, viz., the mono tube type and twin-tube type. Where in a twin tube shock absorber is shown.

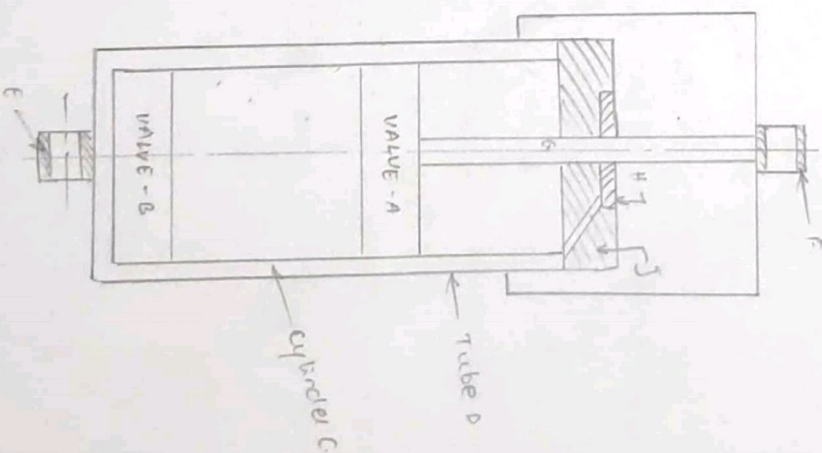


Fig: Telescopic type shock absorber.

There is a fluid in space below valve assembly A, below B and also in annular space b/w cylinder C and tube D, which is connected to space below the valve assembly B as shown. The fluid is generally used in shock absorbers is a mixture of 60% transformer oil and 40% turbine oil.

To understand the action of shock absorber, consider that the vehicle has come across a bump. Then eye E would move up and thereby the fluid will pass from the lower side valve assembly A to its upper side. But since the volume of space above A is less by the volume of the rod E, the fluid will also exit its pressure valve assembly B and go to the underside of valve B. The passing of fluid through valve openings provides the damping. Similarly for downward motion of the eye E during rebound, the fluid will pass from the upper side of the valve assembly A to the lower side and also from the lower side of valve assembly B to its upper side.

(2) Briefly explain diff types of front wheel Independent suspension system.

Sol:- Front wheel Independent Suspension:-

Independent Suspension has become almost universal in case of front axle, due to simplicity of the construction of such a suspension system.

Five types of Independent Suspension are in use for front axle:-

(a) Wish bone type (or) Parallel link type

(b) Mac Pherson strut type.

(c) Vertical Guide type.

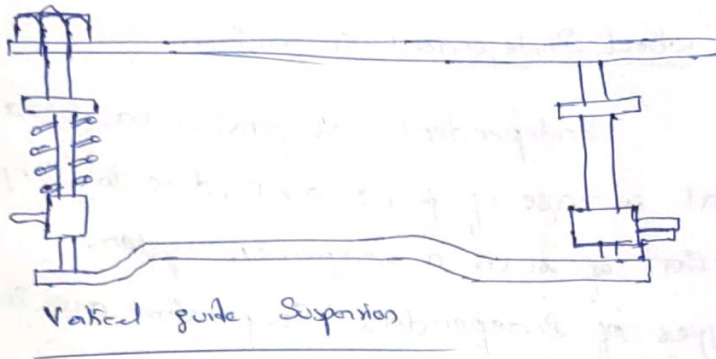
(d) Trailing link type

(e) Swinging half-axle type.

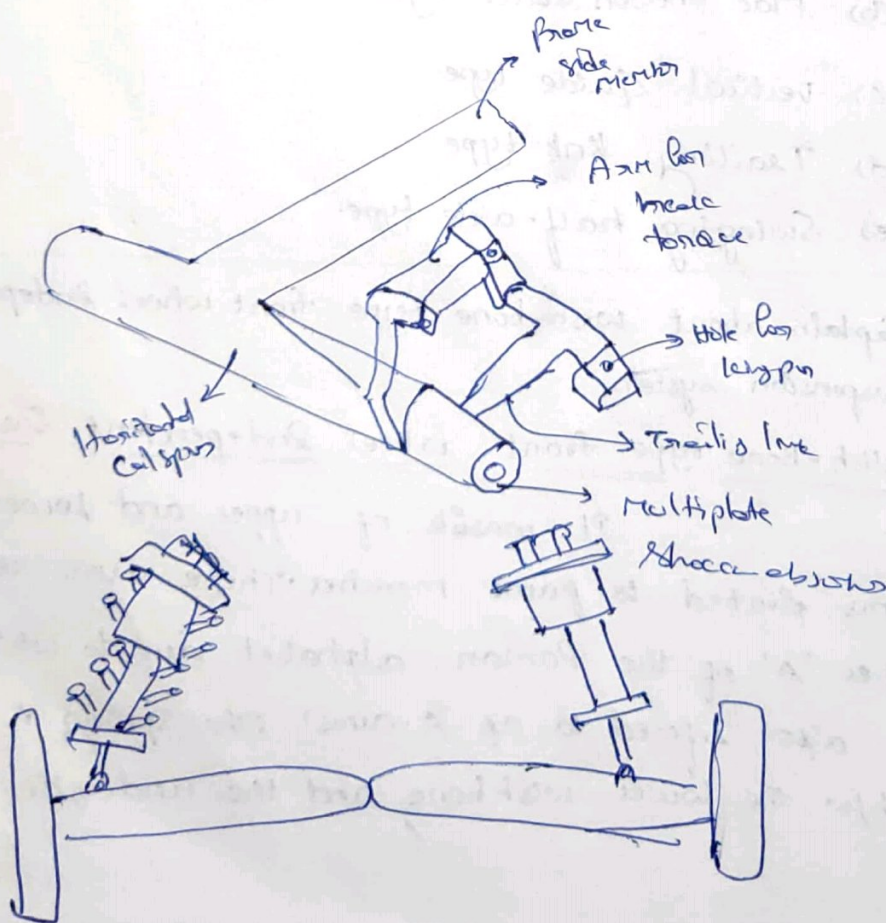
(3) Explain about wish-bone type front wheel Independent suspension system.

Sol:- Wish-Bone type front wheel Independent Suspn System

It consists of upper and lower wishbone arms pivoted to frame member. These arms resemble letter 'A' of the Roman alphabet due to which there are also referred to as 'A-arms'. The spring is placed in b/w the lower wishbone and the underside of the



Trailing Link Suspension



cross-member
and the c
the lower

inside t
and to
like t
which

(4) Explain
50/1. Trailing

steer
also
th

(4)
cross-member. The vehicle wt, is transmitted from the body and the cross-member to coil spring then which it goes to the lower wishbone member. A shock absorber is placed

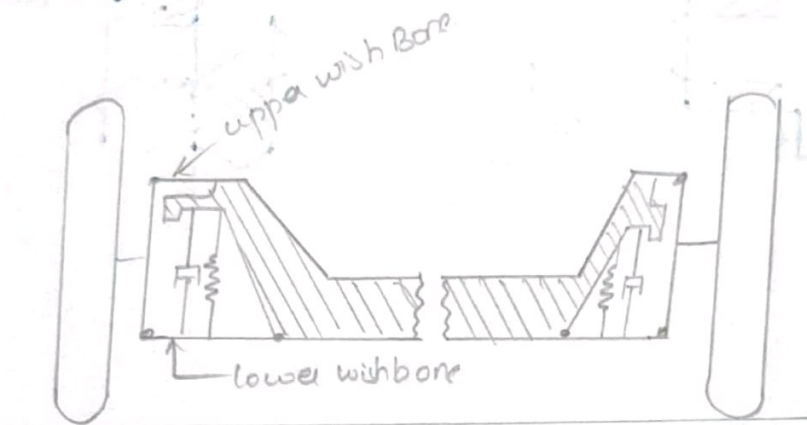


fig. Wishbone type Independent Suspension.

inside the coil spring and is attached to the cross-member and to lower wishbone member. The wishbone arms are like the chicken wishbone or letter - V in shape, b/c of which the system is so called.

(4) Explain about Mac Pherson strut type of Suspension.

Sol: Mac Pherson strut type of Suspension:-

In this only lower wishbones are used. A strut containing shock absorber and the spring carries also the stub axle on which the wheel is mounted. This type of suspension gives the max room in Engine

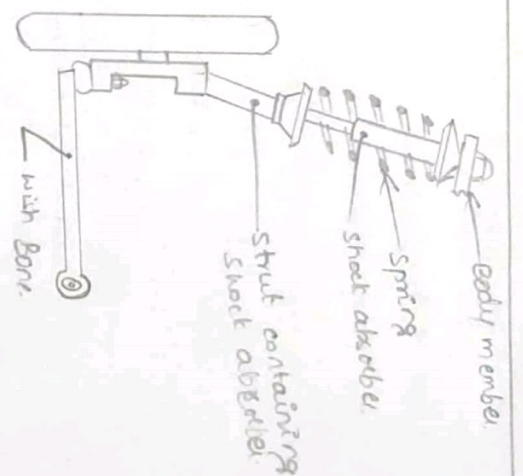
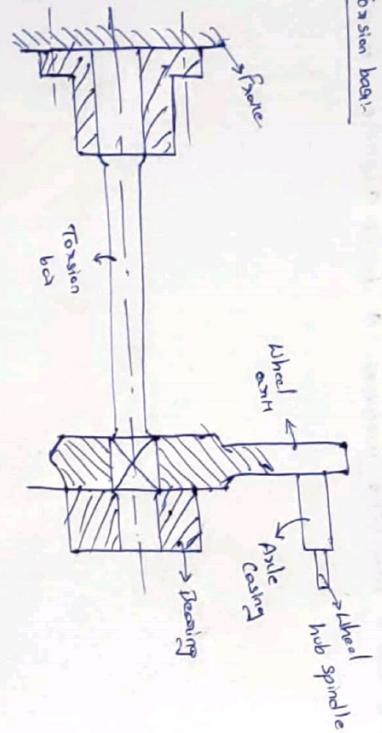


Fig: Mac Pherson Strut Suspension.

compartment and this is, therefore, commonly used on front wheel drive. In India, the system was first used in Maruti 800 car. This type of suspension with anti-roll bar is employed in Volkswagen Jetta & Passat cars. This is claimed to provide increased road safety, improve ride comfort and light and self-stabilizing steering.

(5) Briefly explain the layout of Air Suspension system.

Sol:-

Two generally used types of air springs are (a) shows a bellow type spring (b) indicates a piston type Spring. Both have been shown employed in a wishbone type independent suspension system. Internal volume of the bellows is reduced during jounce, which means that the air pressure inside the spring is increased as it is compressed. i.e., the spring becomes stiffer. Due to this the optimally comfortable ride is provided under all conditions.

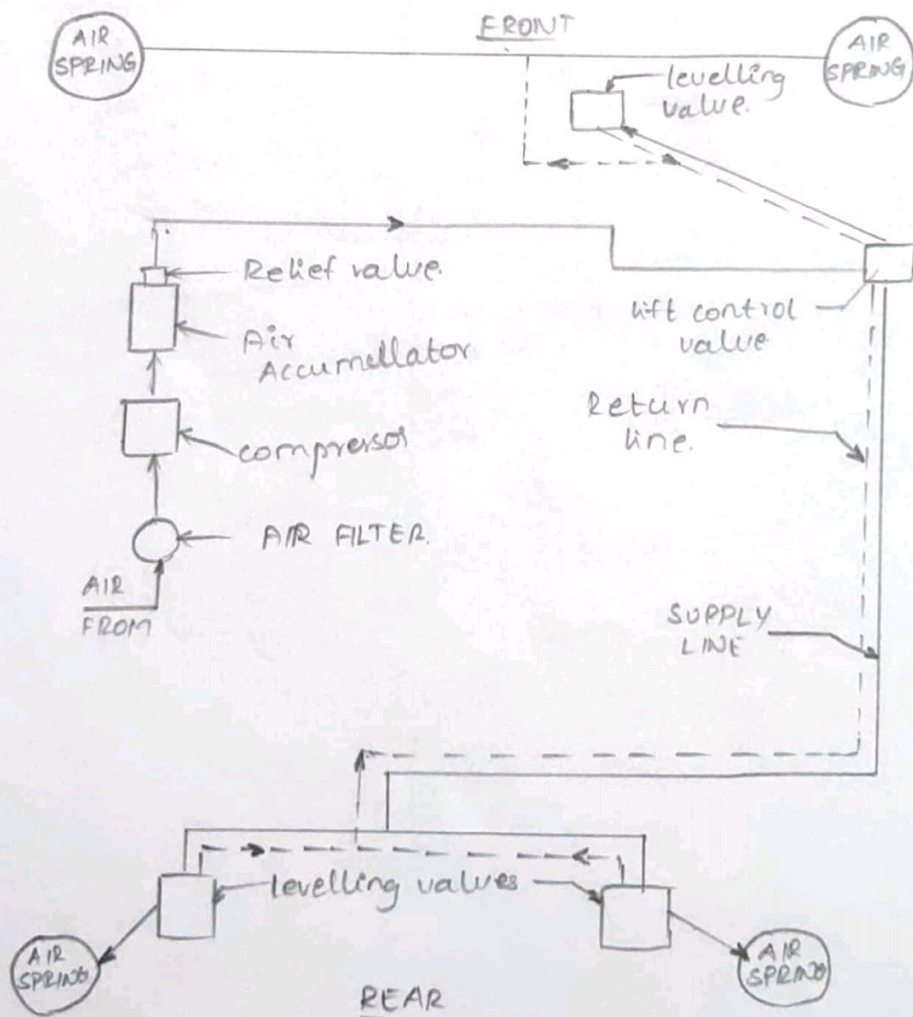


Fig. Schematic diag showing the layout of an Air Suspension System.

(6) Explain about Hydraulic suspension system.

Sol:-

In this system a displacer unit is fitted at each of 4 wheels. The displacer units are all interconnected by means of fluid. In displacer unit, is used as a spring where as fluid under pressure acts as damping system. The stem is connected to wheel through suitable linkage so that its movement is proportional to up and down movement of the wheel. The two valves are assembled at rt. 180° to each other.

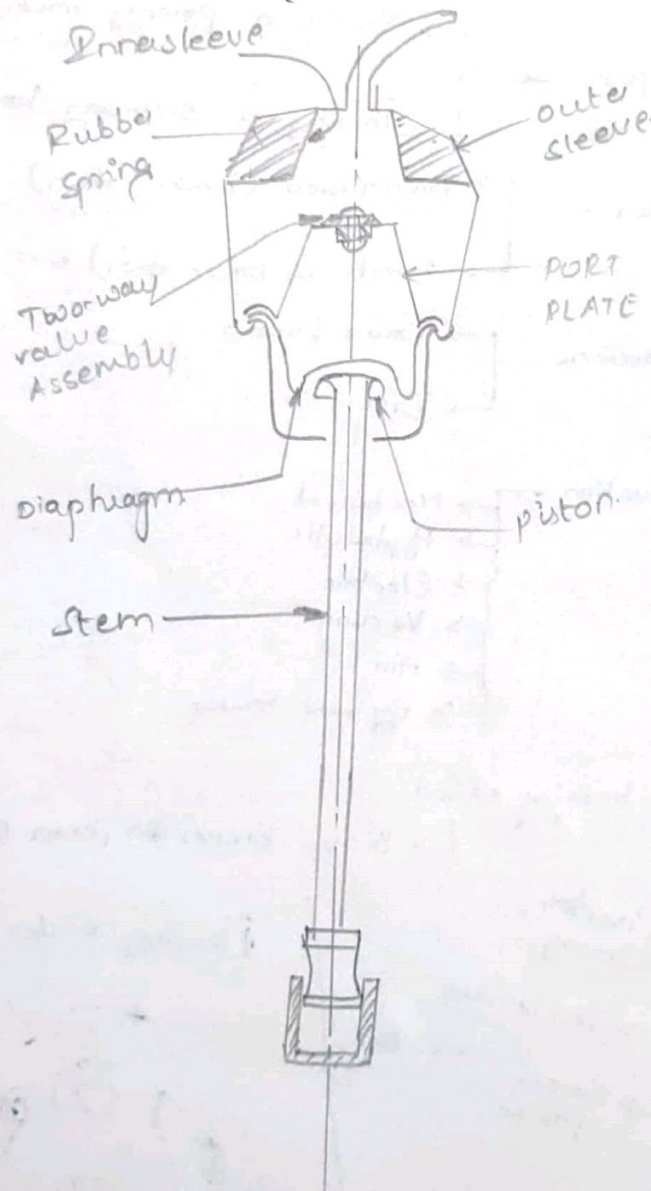


fig: Hydroelastic Suspension Displacer unit.

Cracks: Are measured to stop the vehicle within the smallest possible distance and this is done by converting the KE of the vehicle into heat energy which is dissipated into atmosphere.

Requirements:

1. The brakes must be strong enough to stop the vehicle with in a minimum distance in an emergency.
2. The brakes must have good anti-lock characteristics.

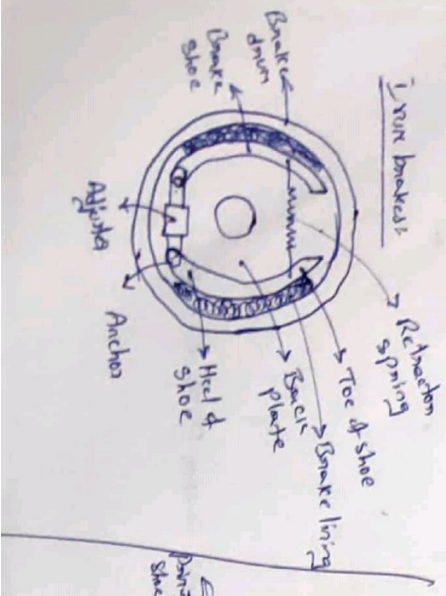
Types

- * According to purpose
 - Service & primary brakes
 - Parking & secondary brakes
- * According to location
 - Transmission (brake drum)
 - wheels (4 brake drum) ✓
- * According to construction
 - Drum brakes
 - Disc - " -
- * According to Activation
 - Mechanical
 - Hydraulic
 - Electric
 - Vacuum
 - Air
 - Regenerative brakes.

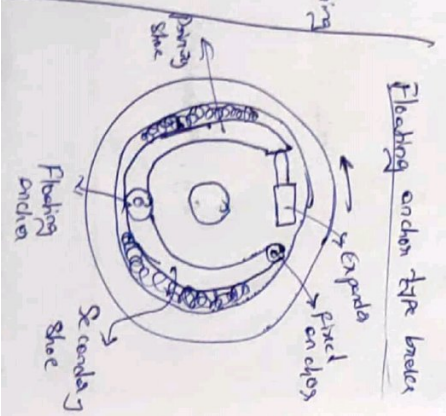
* According to Exhne. braking effort.

→ Servo brakes (or) Power operated brakes

Drum brakes



Floating caliper type brakes



BRAKING SYSTEM

(a) write short note on Tandem Master Cylinder.

Tandem master cylinder ensures reliability with not much extra cost. In this, sep. line goes to diff. sections of the brake system, say, the rear and front brakes and if it is so arranged that if front brake lines are damaged, the rear brake will be still effective. If rear brake line is defective at least front brake will be applied. A simplified diag. of tandem master cylinder is shown.

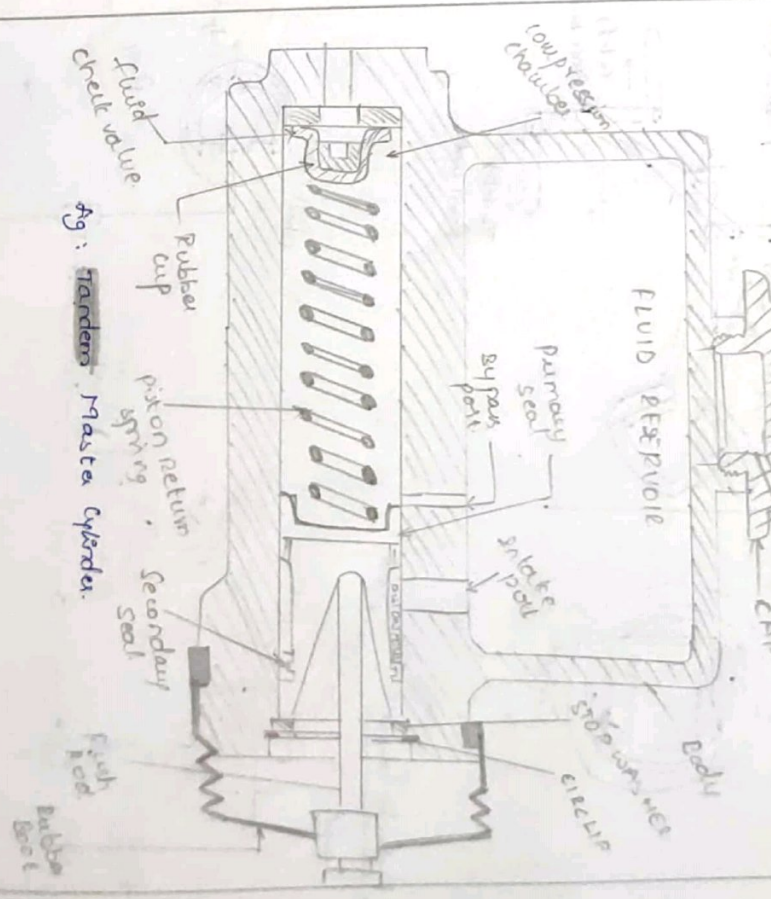
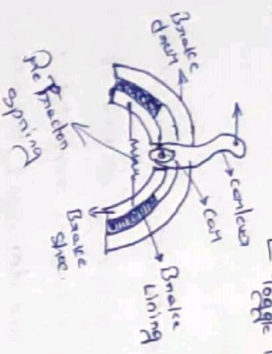


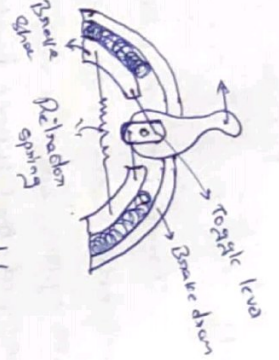
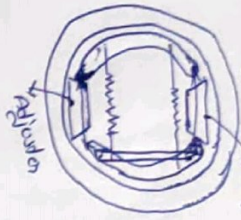
Fig: Tandem Master Cylinder.

Mechanical Brakes — Can Toggle lever



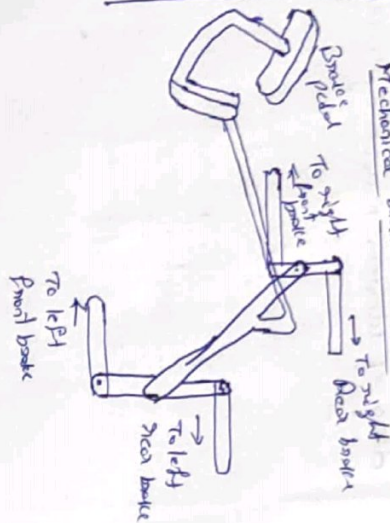
Can opened

Two leading shoe brake

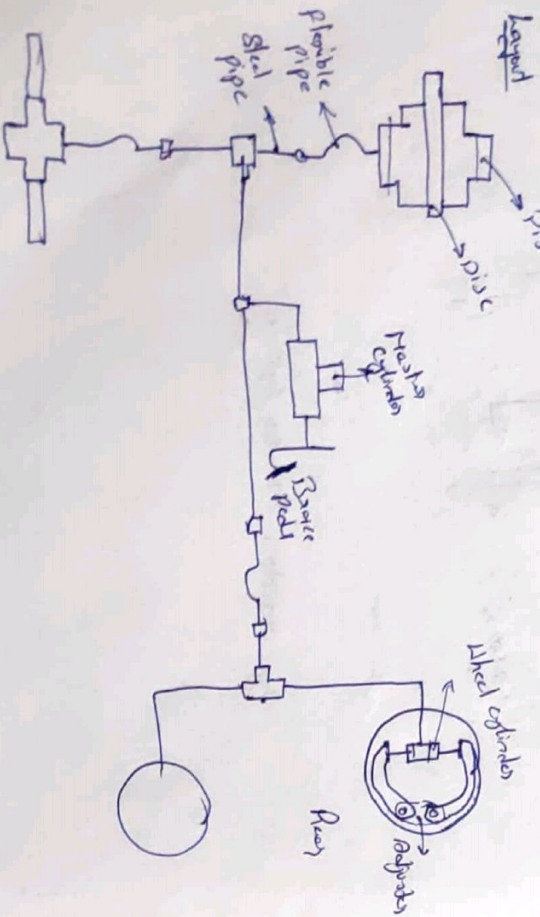


Toggle opened

Mechanical brake linkage

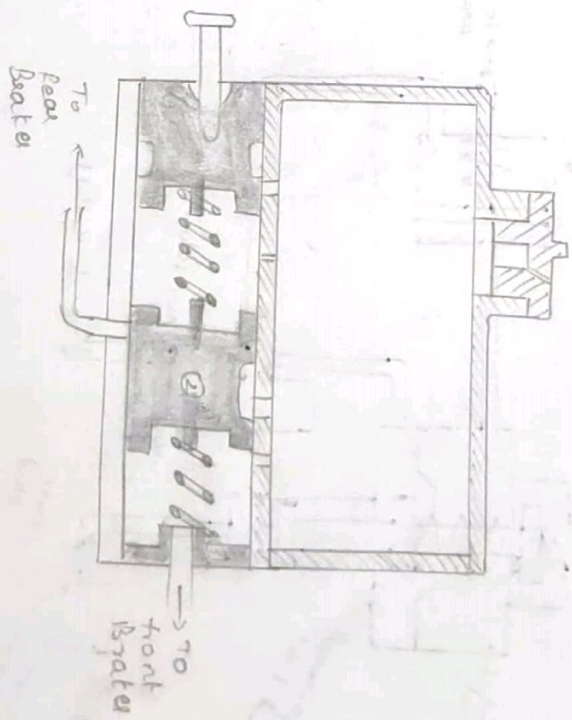


Hydraulic brakes layout



(8) Spl.

Explain about the master cylinder. This can be slightly named as heart of hydraulic braking system. There are 2 main chambers viz, fluid reservoir and compression chamber in which the piston operates the fluid in the reservoir compensates for any change in the fluid volume in the pipelines due to temp vibrations and to some extent due to leakage. To prevent leakage there are seals on both ends of piston in compression chamber. The reduced dia region of piston is always surrounded by the fluid.



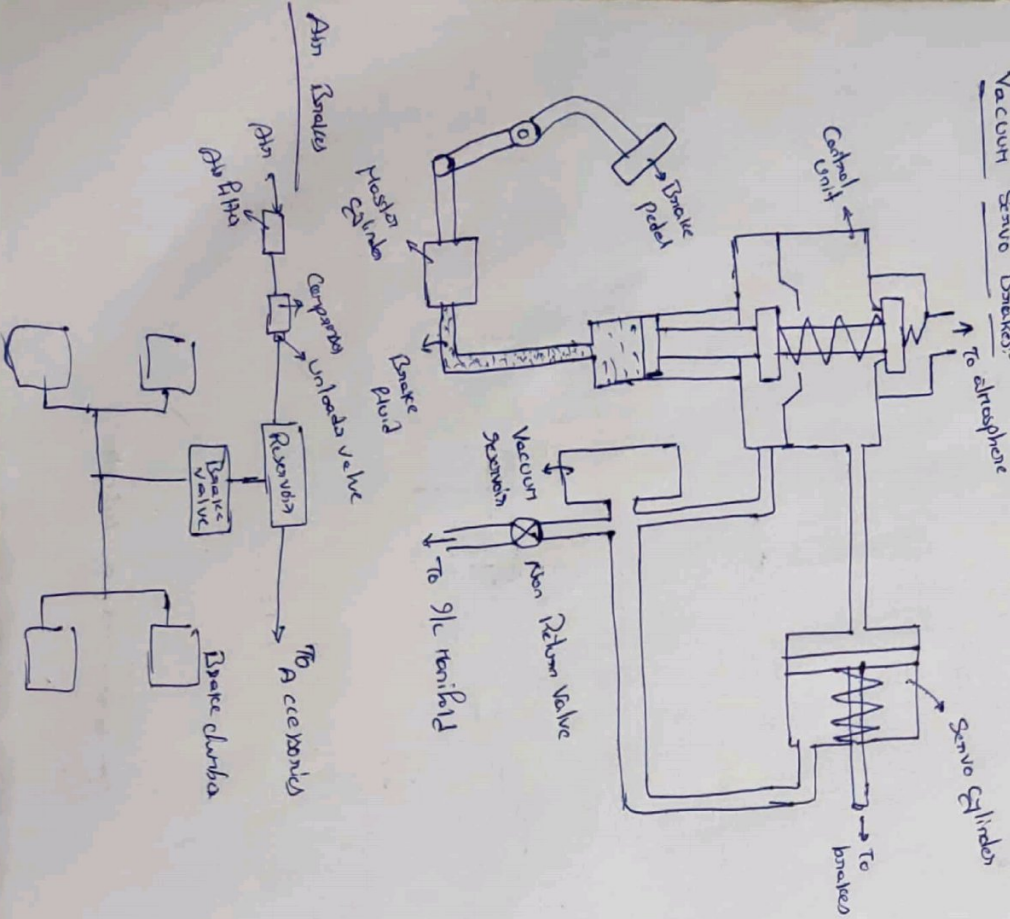
Tandem master cylinder. fig: Tandem master cylinder.

Brake Fluid Requirements

- * Boiling point $\rightarrow$ High boiling point 250-300°C
- * Viscosity $\rightarrow$ Viscosity of the brake fluid should vary very little with temp.
- * Lubrication properties $\rightarrow$ Good lubrication.
- * Effect on Rubber $\rightarrow$ Hydraulic rubber seals should not get effect.
- * Corrosive action $\rightarrow$ Should not corrode the metal components.
- * Storage stability $\rightarrow$ ethyl alcohol + castor oil. (Low temp).

40-50% Castor oil + 50-60% butyl alcohol.
65% Racthid ethyl alcohol + 35% Glycerine

Vacuum Servo Brakes



(Q) Explain briefly about the charging system.

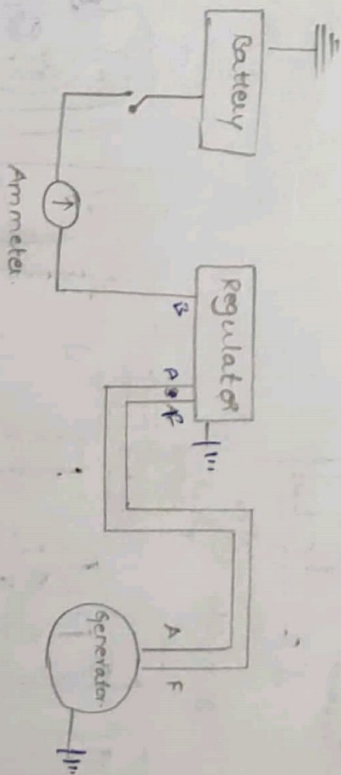
charging system:

The function of charging system in an automobile is to generate, regulate and supply the electrical energy for charging the battery.

Requirements of charging system when the vehicle is in running

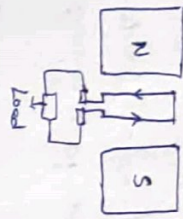
1. To supply the current demand of all loads.
2. To supply the current required for charging the battery under all conditions.
3. To supply constant voltage under all conditions.
4. Should include a provision to indicate proper working.
5. Should have highest power to weight ratio.
6. Should be reliable and quiet.
7. Should require less maintenance.

charging circuit:-



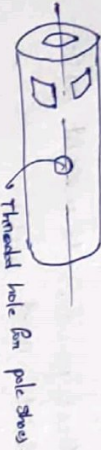
Generation:-

Generation in an Automobile supplies the electrical energy for charging the battery in the vehicle. The generation is driven from the engine by belt drive.

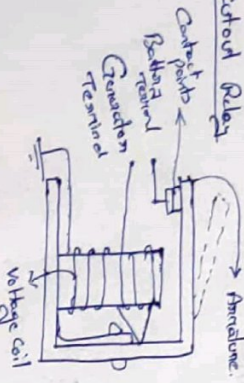


Construction

Components Frame, Armature, Pictails

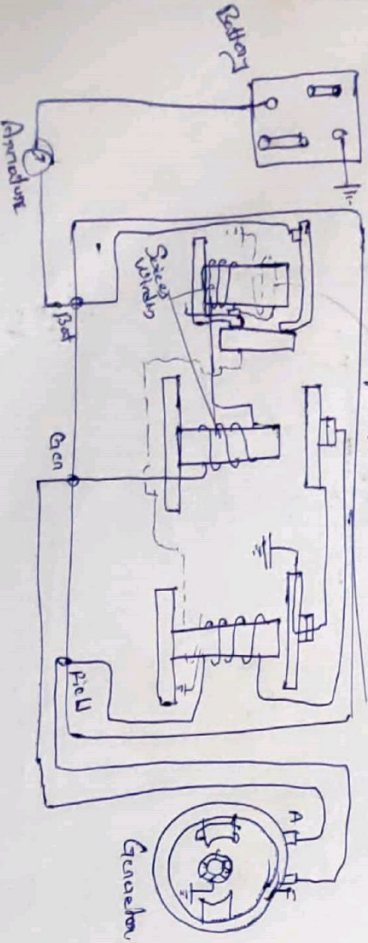


Circuit Rules



Constant Voltage Regulation:-

→ Shift winding



(10) Write a note on type of starting device.
Sol:- Types of starting device:-

(a) Bendix type drive

(i) standard Bendix drive

(ii) foliothru Bendix drive

(iii) Compress spring type

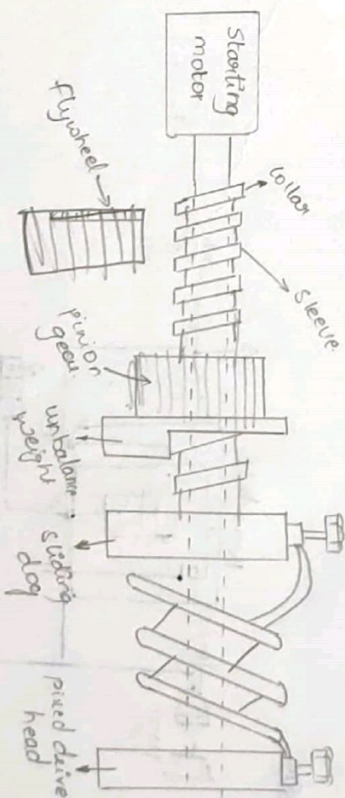
(iv) Rubber spring type

(b) Over Running clutch called the pre-engaged type

(c) Dyer drive.

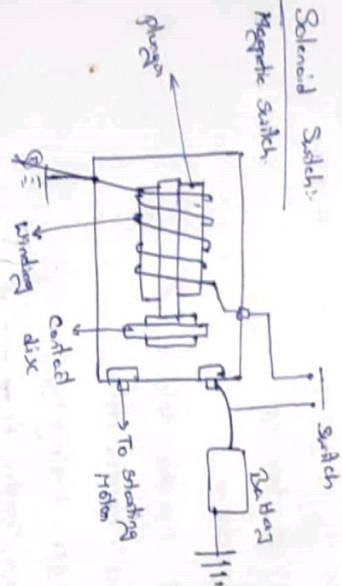
(a) Bendix drive:- Bendix drives are the Geneva device in which the starter motor pinion is made to engage and disengage with the toothed ring on the periphery of engine flywheel.

(i) standard Bendix Drive:-



Soleneid Switch:-

Magnetic Switch



Lighting system:-

Head Light

Types of head lights:-

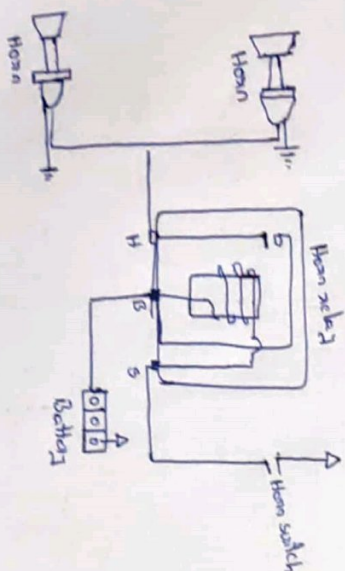
* In candle scarf lamps.

* HID Lamps

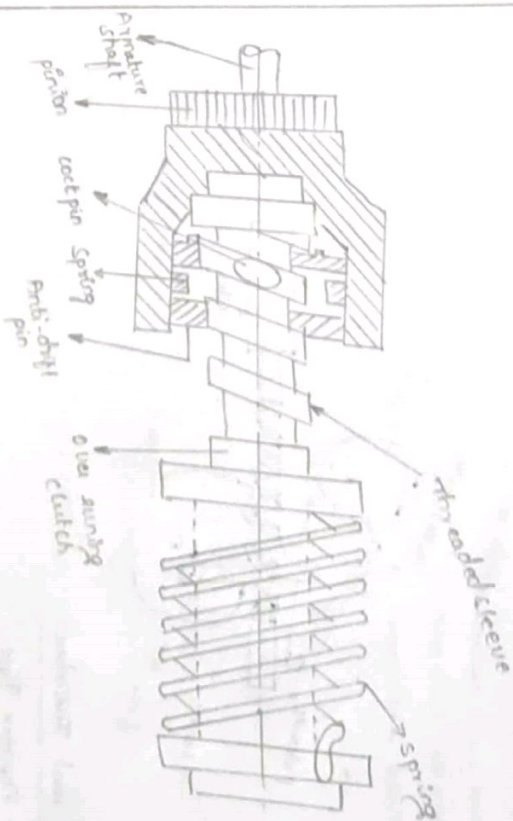
(High quality discharge),

Such as

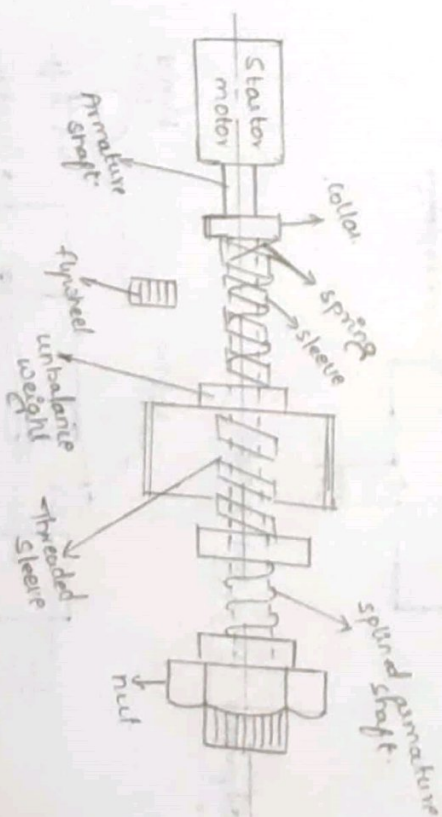
- * LED lamps → Light emitting diodes



(ii) folle thru berindare :-

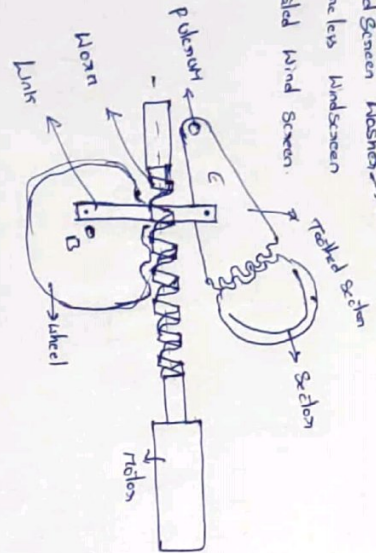


(iii) Compression spring type berda drive



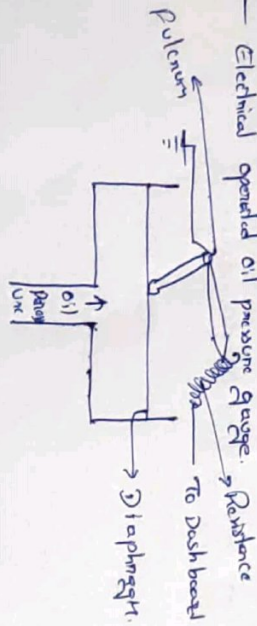
Wind Screen Wiper:

- Wind Screen Washer → Motor, wiper, blades, motor pump, electric motor
- Wiperless Windscreen
- Heated Wind Screen

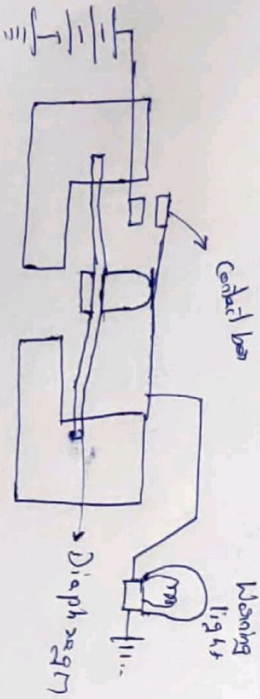


Oil level Indications:

- Dipstick Type.
- Electrical operated oil pressure gauge.



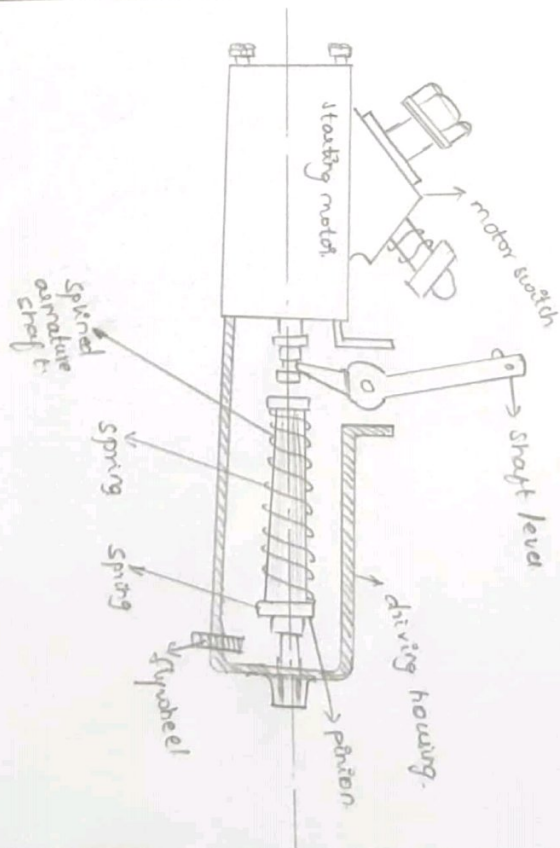
Oil pressure Warning light & Switch



(iv) Rubber spring type bendix drive:

Same as that of above i.e., compression spring

(v) Over running clutch type starting drive:



ENGINE SPECIFICATION AND SAFETY SYSTEMS

1. Explain any 5 safety systems that are used in automobile?

Safety has always been of prime importance in automobile design for engineers. With the successive advances in design over the years features and safety.

The safety systems are

1. The seatbelt system
2. The Airbag system
3. The Anti-Lock Braking System
4. ~~Power windows~~
5. ACTIVE Suspension

ANTI-LACERATIVE
WINDSHIELD

① The Seatbelt Systems :

Seat belt and shoulder belts of various types have been used in passenger cars for many years. The lap belt and shoulder belt are fixed to a connector. The lap belt usually has an automatic locking retractor, while the shoulder belt and lap/shoulder have an inertial locking retractor. A mechanical initial locking retractor used extensively in U.S. cars has a pendulum weight, which locks the belt during rapid deceleration of the vehicle.

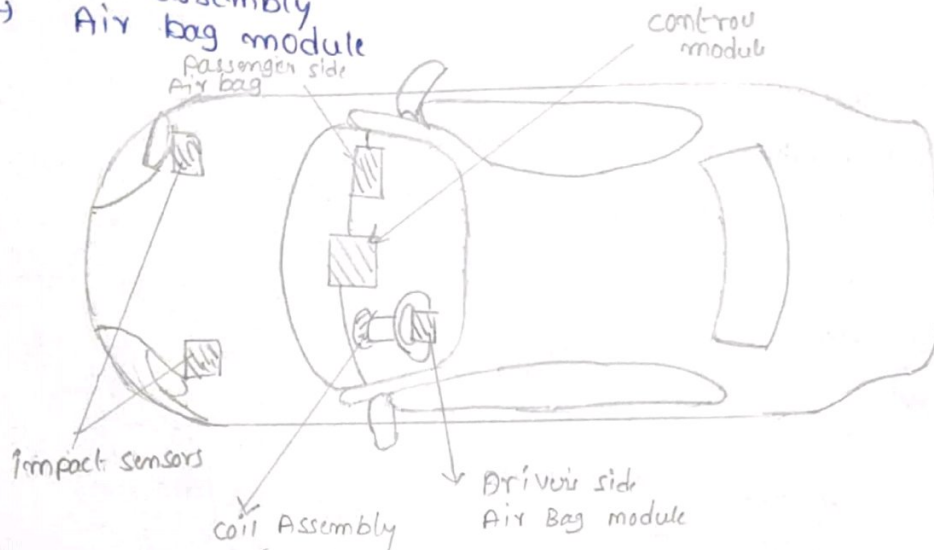
The seat belts are Automatic seat belt, power seat's

② The Airbag systems

Air bags are standard equipment on most late-model passenger vehicles. Air bag systems are designed to deploy when a vehicle is involved in a head on collision of adequate force. The method becoming most popular for an air bag system is to build most of the required components into one unit.

Most air bag systems consist of many common components that include

- Driver and passenger air bags
- Passenger seat switches
- Impact sensors
- Control module
- Coil assembly
- Air bag module



③ Anti-Lock Brake system.

The reason for the development of anti lock is in essence quite simple. on brake application if one or more of a vehicle's wheels lock i.e begin to skid then this has a number of consequences.

- Braking distance increases
- steering control is lost
- Tyre wear will be excessive and abnormal
- An accident is far more likely to occur.

④ ANTI-LACERATIVE WINDSHIELD

Some passenger cars feature an anti lacerative windshield designed to virtually avoid any facial cuts from broken windshields in case of vehicle accidents. This windshield has superior abrasion resistance and chemical resistance properties.

The anti lacerative windshield usually has a two-part plastic layer applied to its inside surface.

The HPR windshields comprise of a layer of laminated plastic between two sheets of glass.

The anti-lacerative windshield needs no special care. However abrasive cleaning agents or metal scrapers should not be used on the inner surface.

⑤ ACTIVE SUSPENSION

Active suspension was born in the grand prix world. It is slowly becoming more popular in production vehicles. Conventional suspension systems are always a compromise between soft springs for comfort and harder springs for better cornering ability. Any suspension system has to perform the following four main functions.

- To absorb bumps
- To manage nose dive when braking
- To prevent roll over when cornering
- To control vehicle body movement

Important benefits of active suspension are

1. Improvements in ride comfort, vehicle handling and safety.

2. Predictable control of the vehicle under various operating conditions

3. No change in handling when the vehicle is loaded or not loaded.

2. Due the engine specification of any one available Transport vehicle?

Ans

In a Automobile the engine specifications are in Transport vehicle are

ENGINE

Model - TATA Cummins BS.9

Maximum power - 179 HP @ 2500 rpm

Maximum Torque - 675 NM @ 1400-1600 rpm

CLUTCH

TYPE

Diameter

GEAR BOX

Model

No of Gears

FRONT AXILE

TYPE

REAR AXILE

TYPE

SUSPENSION

FRONT

CABIN

TYPE

BRAKES

TYPE

STEERING

TYPE

CHASSIS

TYPE

PERFORMANCE

Gradeability

maximum speed

TCD

FUEL TANK

Capacity

TYRE

TYPE

Number of Tyres

WEIGHTS

G.V.W

Kerb weight

- single plate dry friction, push type
- 380mm

- TATA GT50
- 6 Forward 1 Reverse, FGR 9.19

- Extra Heavy Duty Forged / Beam,
Reverse Elliot TYPE

- RA 109RR, Ratio 6.83

- semi elliptical multi-leaf spring with
anti-roll bars

- sleeper cabin

- Full Air S cam Brakes with ABS

- Power Steering

- Ladder type heavy duty riveted
and bolted

- 174.

- 70 km/h

- 12.3M

- 400L

- 10R 20-16PR

- Front - 2 Rear - 4 Spare - 1

- 40200 kg coupled with 3axles
Semi - Trailer

- CAB - 5970 kg

DIMENSIONS

- | | |
|------------------|--|
| Overall Length | - 5593 mm (only tractor) |
| wheel Base | - 3200 mm |
| Load Body Length | - Trailer type - Skeletal / side wall
Flat Bed / well bed / semi low bed
Trailer length 7m to 12.5m
Body types - Tanker, Half deck
High deck, Trailers |

③

Explain about anti lock brake system (ABS),
central locking system ?

Ans

ANTI-LOCK BRAKE SYSTEM:-

Many vehicles now are equipped with anti-lock brake systems. These systems are electronic and hydraulic components to help prevent wheel lockup during periods of hard braking. Anti lock brake systems improve passenger safety by maintaining directional control while providing maximum braking efficiency.

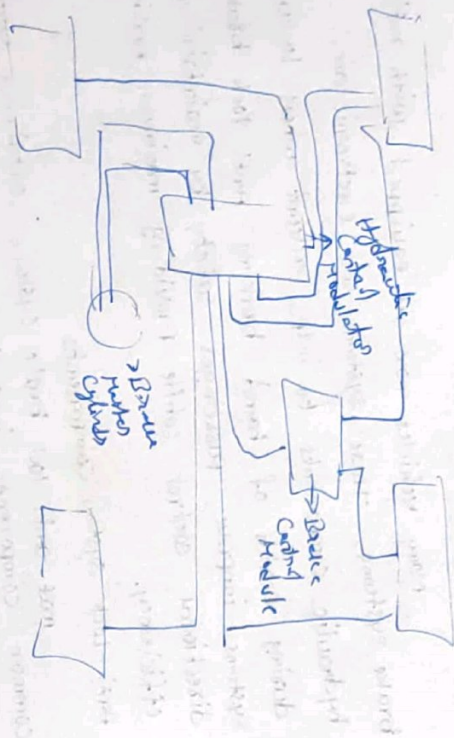
Anti-Lock system components

most anti lock brake systems containing several common components including.

- wheel speed sensors
- Toothed rotors
- Hydraulic actuators.
- control module.

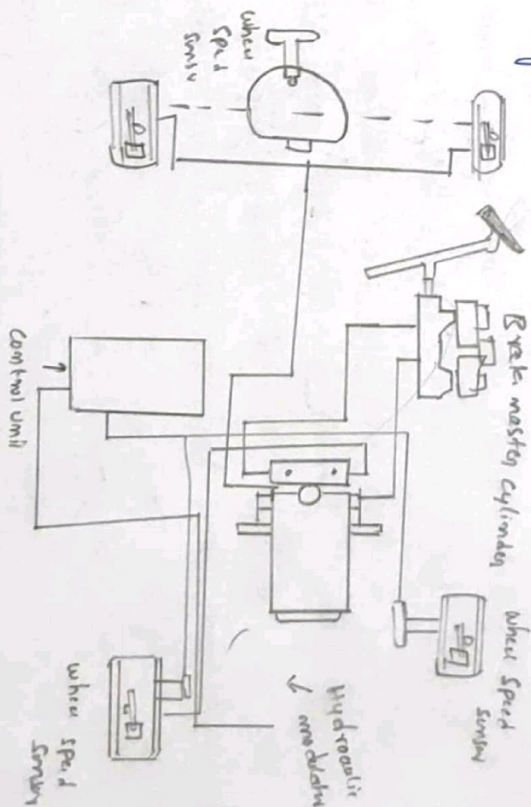
ANTI lock Brake system operation.

During normal braking the anti-lock portion of the brake system does not come into play.



Even though, the sensors continuously monitor the speed of wheel rotation and send signals to the control module. When the brake pedal is pressed, brake fluid flows from the master cylinder, through the hydraulic actuator, and into the brake calipers.

When the control module detects that a wheel is approaching lockup, it signals a solenoid valve in the hydraulic actuator to block the fluid passage



CENTRAL LOCKING SYSTEM :-

Power Door Locks :- Electric Most late model automobile power door locks are powered by a solenoid, which operates the locking mechanism. A master switch on driver's door or on the centre console operates a relay that in turn sends

current to each of the solenoids, locking all four doors. The locks can also be operated manually.

Vacuum: Another type of power door lock is vacuum operated. Vacuum comes from the intake manifold or a vacuum pump. The vacuum is brought to the doors in a vacuum hose. Vacuum operates a vacuum motor installed in the door. A vacuum motor uses a spring-loaded diaphragm enclosed in a housing. A rod is attached at the diaphragm at one end and the lock mechanism at the other end. When the driver's door is locked,

Functional Requirements of Central Locking:-

When the vehicle's door key is turned in the driver's door lock, all the other doors on the vehicle should also lock. This is achieved through motors or solenoids installed in each door. In case the system can be only operated from the driver's door key then an actuator is not needed in this door. If the system can be operated from either front door or by remote control then all vehicle doors need an actuator. Also, vehicles with sophisticated alarm systems normally lock all the doors, as the alarm is set.

4

due the specification for engine of any one of the available cars ?

Sol

Specification of Maruti Alto 800 STD (Petrol)

Fuel Type	— Petrol
Engine Displacement	— 796 cc
BHP	— 47.3 bhp @ 6000 rpm
Torque	— 69 Nm @ 3500 rpm

Technical specs of Maruti Alto 800 STD (Petrol)

Top speed	— 140 kmph
Acceleration (0-100)	— 19 seconds
Engine Displacement (cc)	— 796
Maximum Power	— 47.3 bhp @ 6000 rpm
Maximum Torque	— 69 Nm @ 3500 rpm
Engine Description	— 0.8 litre 47.3 bhp 12V F80
Turning radius	— 4.6 metres
No of cylinders	— 3
Drive Type	— FWD
Turbo charger	— NO
Valves Per cylinder	— <u>4</u>
Fuel supply system	— MPFI
Gear box	— 5 speed
Steering Gear Type	— Rack & pinion
length , width Height	— 3480 mm , 1515 mm , 1475

5. What is object of using air bags in automobiles. what are different types of Air bags?

Air bags are standard equipment on most late-model passenger vehicles. Air bags systems are designed to deploy when a vehicle is involved in a head on collision of adequate force. The method becoming most popular for an air bag system is to build most of the required components into one unit. This reduces the amount of wiring and connection, thus improving reliability. It is important that some form of system monitoring is built in, as the operation of an air bag cannot be tested - it only ever works once. Most air bags systems consist of many common components that include:

- ⇒ Driver and passenger air bags
- ⇒ A warning light
- ⇒ Passenger seat switches
- ⇒ Impact sensors
- ⇒ Control module
- ⇒ coil assembly
- ⇒ Air bag module

The types of Air bags:-

Trouble-Shooting Air Bag System:-

Always consult the manufacturer's service manual this is applicable, before attempting to troubleshoot an air bag system.

This is necessary, because using incorrect equipment or test procedure can activate the system.

Servicing a Deployed Air Bag System:-

Generally, manufacturers recommend replacement of all

related parts after an air bag has been deployed. However, some applications only require the replacement of the inflator module and the igniter. Always follow the recommendations in the applicable service manual.

6. Define the construction and working of safety belt system?

Seat belts have various types in passenger cars for many years working:

A mechanical inertia locking retractor used extensively in U.S. cars, has a pendulum weight which locks the belt during rapid deceleration of the vehicle.

A seat belt retractor allows the belts to move in or out as the passenger needs until then, the retractor automatically locks occurs to restrain the forward motion of the person. Front seat belts generally incorporate a timed reminder lamp and sound buzzer signal. These warnings are designed to remind the driver and passengers to fasten lap and shoulder belt when passenger to ignition key is turned to the on position. If the driver's seat belt is buckled the buzzer will not operate but fasten seat belt reminder sign will stay on for four (or) 8 seconds.

What is speed control and advantages of automobile engineering of speed.

Speed control with a centrifugal governor was used in automobiles as early as 1906 in the Wilson-Pilcher and also in the 1960's by Peerless.

The driver must bring the vehicle up to speed manually and used a button to set the cruise control to the current speed.

Advantages of speed control and its advantages.

- its usefulness for long drives across
- some drivers use it to avoid subconsciously violating speed limits. A driver who otherwise tends to subconsciously increase speed over the course of highway journey may avoid speeding.
- speeding around curves that require slowing down
- rough or loose terrain that could negatively affect the cruise control controls.
- rainy or wet weather could lose traction.

Define briefly Energy Absorbing Bumper Systems.

National and international law requires auto manufacturers to install bumper systems that will protect vehicle safety systems in a barrier impact of 8 km/hr. The manufacturers have devised many different systems to absorb the energy of a low-speed impact but are one of three main types.

Fluid / gas energy absorbing unit :

it is an energy absorber that is similar to a hydraulic shock absorber but with a nitrogen gas preload that acts as a piston return after impact

Fluid / spring energy absorbing unit :

It is an energy absorber that is similar to a shock absorber, but has a spring inside the hydraulic unit that returns the unit that returns the unit and bumper to the original position.

Plastic Pad / impact bar energy absorbing units :

It has a plastic honeycomb pad backed by an impact bar. This pad-type energy absorber, or isolator, uses no fluids or gases, but compresses on impact; then the bumper, pad, and impact bar return to original position.

Briefly explain the high Adhesion Control cycle and low adhesion control cycle?

High Adhesion Control cycle:

1. This is the initial braking stage, with ABS not yet activated.

2. Wheel speed exceeds the threshold as calculated from the vehicle reference speed and brake pressure is held at a constant value.

3. Wheel deceleration falls below a threshold (ϵ) and brake pressure is reduced.

4. The brake pressure is being held and wheel speed will increase.

5. Wheel ~~pressure~~ ~~is~~ being acceleration exceeds the upper limit ($+\Delta$) So brake pressure is now allowed to increase.

Low Adhesion Control cycle:

1. The first stage is initial braking with ABS not yet activated.

2. Wheel speed exceeds the threshold as calculated from the vehicle reference speed and brake pressure is held at a constant value.

3. A brake pressure holding phase allows the wheel speed to increase.

4. There is a gradual introduction of increased brake pressure and holding pressure in small steps until the wheel slips again.

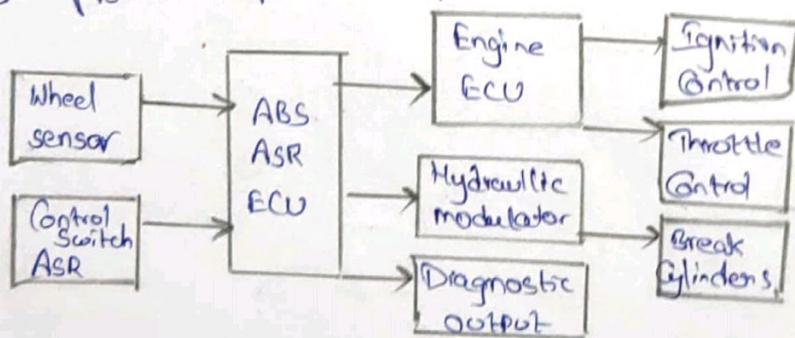
5. Brake pressure is decreased, allowing wheel speed to increase.

Explain Traction Control:

The steerability of a vehicle is lost not only when the wheels lock up on braking. A similar effect arises as the wheels spin when the vehicle is driven off under severe acceleration. Electronic traction control has been developed as a supplement to ABS. This control system prevents the wheels from spinning when moving off or when accelerating sharply when moving. In this way an individual wheel, which is spinning, is braked in a controlled manner. If both or all of the wheels are spinning, the drive torque is reduced by means of an engine control function. Traction Control is known as ASR or TCR.

Traction Control will achieve the following objectives:

1. Maintain vehicle stability
2. Reduce vehicle's yawing moment reactions.
3. Provide optimum propulsion at all speeds.



Following advantages are claimed by a good traction control system:

1. Improved tractive force
2. Improved safety and stability on poor surfaces
3. Lesser driver stress
4. Enhanced tyre life
5. No wheel spin on turning and cornering.

UNIT-VI

ENGINE EMISSION & SERVICE.

1. Explain Different Methods of treating Automobile exhaust gases to reduce pollutants? in Diesel engines?

Ans:- As the diesel engine operates with excess air, problem of incomplete combustion resulting in emission of hydrocarbon is not there. However in these engines, apart from NO_x , Particulate matter (PM) also has to be removed from exhaust.

Various technologies used are:

a) For controlling PM.

- Diesel oxidation catalysts (DOC's)
- Diesel Particulate filters (DPF)
- closed crankcase ventilation (CCV)

b) For controlling NO_x .

- Exhaust gas reflection (EGR)
- Selective catalyst reduction (SCR)
- Lean NO_x catalysts (LNCs)
- Lean NO_x traps (LNTs).

Oxidation Catalysts:-

→ These have been found to reduce 20 to 50% PM on mass basis.

→ The oxidation catalyst converter used in diesel engine is a "two-way converter". which operates in a different manner than the three-way catalyst converter.

- The diesel engine catalytic converter is a pure oxidation catalyst converter, which oxidises hydrocarbons and carbon monoxide into water and carbon dioxide.
- It cannot reduce nitrogen oxides. such a catalyst converter as used on an old model Mercedes-Benz car.
- Modern diesel engines do have a lambda closed-loop control, where in signals from lambda sensor can be used for precise adaptation of EGR.
- The boost pressure and start-of-injection according to various operating modes of the engine, leading to reduction of emissions by about 20%.

Particulate filters (traps) :-

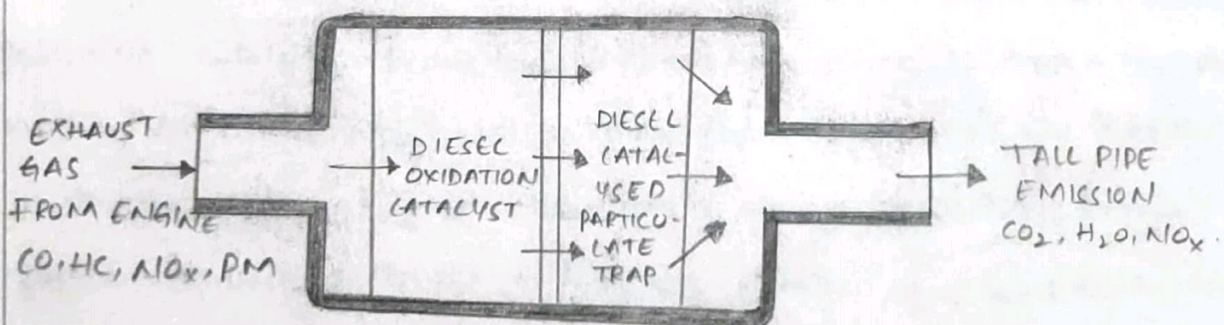


fig: Diesel catalytic convert -cum- Particulate trap.

- The particular matter can be removed by passing the exhaust gas through a filter. Where in the particulates are retained on the filter element.
- which are periodically removed by their oxidation by means of hot exhaust gases, either at elevated temperature or in the presence of catalyst.

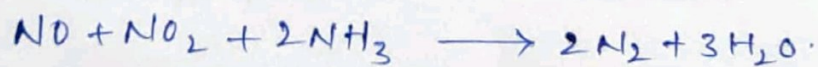
→ It must be noted that diesel particulate matter ignites at 500°C to 600°C . where as the normal operating temperature ranges of exhaust gases is from 200°C to 500°C from idling to full load.

→ Particulate filters may be of flow-through or wall flow designs. While the former type are capable of achieving 50-75 percent PM reduction, the later design can remove over 90 percent.

Selective Catalytic reduction:-

SCR uses urea as a reducing agent. It has been found to reduce 75-90 percent NO_x , while simultaneously reducing HC emissions up to 80 percent and PM emission by 20-30 percent.

Bosch of Germany have also developed "Denoxtronic", which is a Selective Catalytic Reduction (SCR) technique. The SCR operates with the "Ad Blue" which is a reduction agent and is injected into the exhaust gases. The toxic NO_x is ~~reduced~~ the exhaust gas is converted into a harmless Nitrogen gas and water drops.



(from Ad Blue)

SCR technology has already worked well in stationary engines. For automotive applications, the following additional monitoring systems have been designed.

1. Gas sensors, particularly NO_x sensors are used downstream of the catalytic converter system the use of a NO_x sensor

gives closed loop control of the complete system since any failure or tempering would result in sensor detecting a sudden change in NO_x levels.

2. Urea sensors have been employed to detect the presence, concentration and level of Ad Blue in the tank.

Lean NO_x Catalyst:-

Lean NO_x catalysts often include a porous material made of zeolite having a microporous, open framework structure. However such systems are not much in use due to relatively low NO_x conversion (20 to 30%) and also corresponding fuel economy penalties due to the injection of small amount of diesel fuel into the exhaust upstream of the catalyst, to serve as a reductant.

Lean NO_x traps:-

LNTs are also called as NO_x absorber catalysts are another method to reduce NO_x in an oxygen-rich exhaust. This technology removes NO_x in a lean, oxygen rich exhaust for diesel and even petrol lean-burn DI engines. This is done in following steps.

1. oxidising NO to NO_2 over a precious metal catalyst which is platinum.
2. storing NO_2 in an adjacent alkaline earth oxide trapping site as nitrate.
3. The stored NO_x is then periodically removed by two-step regeneration which includes temporarily introducing a rich exhaust condition followed by reduction to Nitrogen by an ordinary three-way catalytic converter.

===== X =====

2. What is Catalytic Converter? Explain about Three way Catalytic Converter?

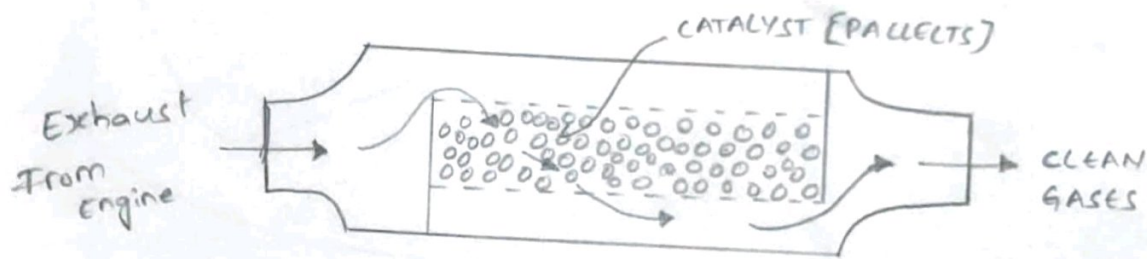
Ans:- A catalytic converter is a cylindrical unit about the size of a small silencer and is installed on the exhaust system of a vehicle such as car, scooter, moped, motor cycle or auto-rickshaw.

Three way catalytic Converter:-

which is used almost in all petrol cars. It controls CO and HC by oxidation.

Three way converters are now commonly being used for petrol engines and operate in two stages. The first converter stage uses rhodium to reduce the NO_x in the exhaust nitrogen and oxygen. In the second convert stage platinum or Palladium acts as oxidation catalyst to change HC and CO into harmless water and CO_2 . For supplying the oxygen required in the second stage, air is fed into the exhaust after the first stage.

The catalyst allows the oxidation of the exhaust gases at a much lower temperature than in the combustion chamber. With temperatures exceeding 300°C , the steady-state conversion efficiencies of a new converter are about 98% for carbon monoxide and about 95% for hydrocarbons. The outgoing exhaust gases in a petrol engine are at a temperature of $300^{\circ}\text{--}400^{\circ}\text{C}$ during idling and may reach 700°C under full load conditions. Converters should be best operated between 400°C and 800°C . The temperature at which a catalyst is 50% effective, is known as the light-off temperature.



Flow of gas Through Catalytic Converter.

3. Explain the Controlling of Emissions from SI engine?

Ans:- Two types of techniques are used for treating the exhaust gases from the petrol engine to reduce the percentage pollutants in them.

1. Oxidation Methods.

By this method Nitrogen oxides in the exhaust cannot be removed. A few such systems are described here.

i. Air injection system:-

In this system compressed air is injected into each exhaust port slightly downstream of the exhaust valves.

The injected air mixes with very hot, fully and partially burnt exhaust gases and causes oxidation of the CO and hydrocarbons. The effectiveness of this system, however depends upon the following:

1. Strength of the air-fuel mixture.
2. Temperature and pressure of exhaust gas and mixture reaction.
3. Time available for exhaust gas-air mixture.
4. Heat losses from the exhaust-reaction zone.

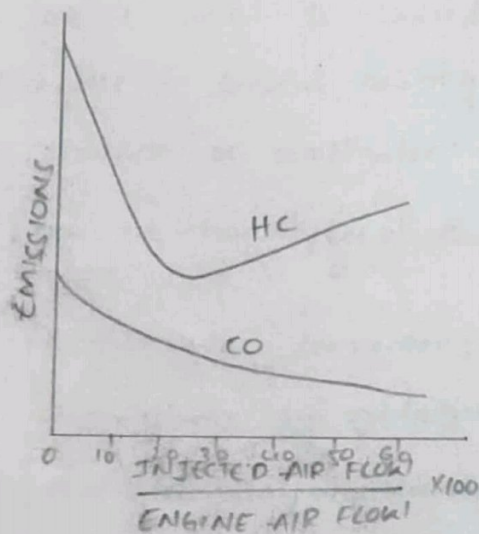


fig. Effect of Injected Air-flow on the emission.

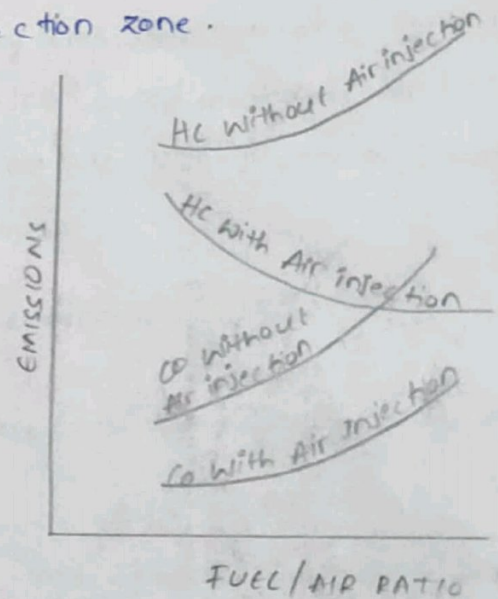


fig: Effect of idle fuel-ratio on CO and HC emissions.

ii) Pulse Air-Injection Reactor (PAIR) System:-

Some engines do not require all the air supplied by the pump in the air injection system. Such engines may be provided with pulse air system. The system employs the pressure pulses of the exhaust to pull air into the exhaust system. When exhaust valve opens exhaust gases rushes out at high speed due to their inertia, more exhaust is pulled from the cylinders as the exhaust valve closes causing thereby a momentary partial vacuum in the exhaust ports. Negative pressure in the exhaust manifold moves air from air cleaner through the Check Valves and pipes into the exhaust ports.

2. Catalytic Converters:-

The exhaust gases from the engine are passed through catalytic converters. A catalytic converter is a cylindrical unit about the size of a small silencer and is installed into the exhaust system of a vehicle such as a car, scooter, moped, motor cycle or auto-rickshaw. It is placed between the exhaust manifold and the silencer. Inside the converter there is a honey comb structure of a ceramic or metal, which is coated with alumina based materials and thereafter a second coating of precious metals like platinum, Palladium or Rhodium or combinations of the same.

There are two types of catalytic converters:-

1. A two-way converter: which is used to control only CO and HC emissions by oxidation.
2. A Three way converter: which is used almost in all petrol cars. It controls CO and HC by oxidation, as well as NOx reduction.

= X =

4. What are the Advantages & Disadvantages of ~~using~~ using CNG as alternative fuel?

Ans:-

The Advantages of CNG as Alternative fuel are:-

1. Reduced pollution with CNG. CO emissions are reduced by 70-90%, HC emissions by 40-60%, NOx emissions by 30-40%, and CO₂ emissions by about 10%. Compared with the petrol. Moreover, being lighter than air, CNG dissipates quickly in the air & moves up.
2. Economical. In terms of calorific value, the cost CNG is almost a third of the cost of petrol.

3. Reduced maintenance since CNG burns cleanly, vehicle maintenance is reduced.
4. Easy availability. Natural gas is available in India in large quantities. Moreover, it does not require refining as in case of petrol and diesel.
5. Better anti-knock property. CNG can be safely used in engines with compression ratio as high as 12:1. Its octane number is higher than that of petrol.

However, there are accompanying disadvantages also:-

1. Safe compression ratio of CNG engines are lower compared with diesel engines.
2. CNG cylinder takes a considerable portion of the luggage space.
3. Special safe fuel storage cylinders are expensive to design and build, which increases the overall cost of a CNG vehicle.
4. The range is only half that of a petrol car with same size of fuel tank.

===== X =====

5. Discuss the general precautions to be observed during the servicing of an engine?

Ans:- Before the engine is disassembled for service, it is desirable to ascertain whether the overhauling is really necessary or not. Generally the ~~overhauling~~ ^{overhauling} is required in the following events:-

1. Power loss due to poor engine compression.

2. Excessive consumption of lubricating oil which should be determined accurately
3. Lubricating oil pressure too low, provided the same is not due to external leakage, less oil in the sump, defective oil pump or faulty oil pressure gauge.
4. Mechanical failures such as excessive clearance in main or big end bearings or in the valve tappets, piston slap or some broken component indicate that the overhauling is required.

The servicing procedure for the following parts has been given in this Chapter.

1. cylinder head.

4. cylinder.

2. Valves and Valve mechanism.

5. Crankshaft and main bearings.

3. piston-connecting rod Assembly

Precautions:-

1. Hot engine parts should be handled with care.
2. Taking out lubricating oil from the hot engine must be done with care. The same may be hot enough to cause burns.
3. Be careful while removing radiator cap of hot engine.
4. There are many heavy engine parts. Use proper equipment and methods to handle such parts.
5. Engine mating surfaces are precision machined. Such surfaces must be handled with utmost care to avoid damage.
6. Wrong connections may cause damage to electrical system.

7. What is the reboring of the engine cylinder. Describe the reboring procedure.

Ans:-

Reboring is done on a special reboring machines. The top surface of the cylinder block is thoroughly cleaned and the boring bar set on one of the cylinder bores. The bar is set on the centred and clamped properly. The cutter is then set to the desired depth of cut and the machine started. The cutter will bore progressively to the other end, and the machine stops when the boring is complete. cylinder is bored 0.0125 mm to 0.05 mm less than the required size. After reboring the cylinder size and wall finish are completed by means of honing.

Before starting the reboring operation it is very important that suitable steps are taken so as to prevent the entry of metal or abrasive particles in the oil galleries. It is a good practice to wrap insulation tapes on crankpins and to cover other parts as is possible. After the job is complete, again the cylinder must be thoroughly and wiped with clean to remove all abrasive particles.

After reboring has been done on a cylinder block a number of times it is found that it is no longer possible to bore any further. In such cases dry or wet liners may be fitted, after which the cylinder dimensions are reduced to the original standard values. Some liners have to be remachined

after tilting while others do not need such a process.

== X ==

Q. How do you check the Alignment of the Camshaft.

Ans:-

Failure of Camshaft is indicated by excessive wear of cam lobes, although camshaft in modern engines should normally run for the engine life of the engine and need not be replaced. The same may however be checked for straightness when the engine is dismantled, by placing it on V-blocks or holding it between centres and using a dial bore indicator. In many cases a bent camshaft may be straightened in hydraulic press.

The wear of the cams

Should be measured. If the height H of each cam is less than the prescribed limit, replace the cam shaft. The thrust clearance may also be measured and if found excessive thrust plate or the cam shaft has to be replaced.

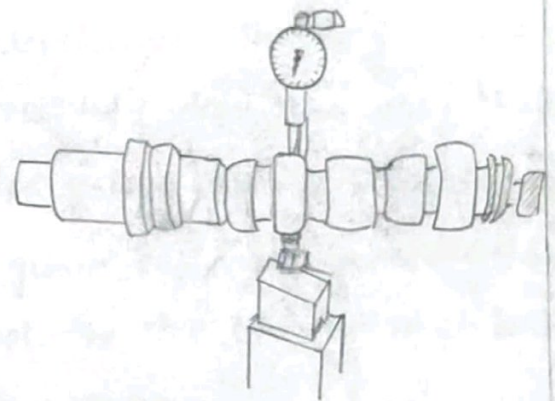


fig: Checking Camshaft for Straightness.

Camshaft runs at half the crankshaft speed, due to which reason its bearings have a longer life. The bearing clearance may be found out from the difference in the diameter of the bearing. The camshaft bearing clearance generally allowed is upto 0.15mm. If the measured clearance exceeds this, the bearing will need replacement. The worn out bearings can be removed from the cylinder blocks by means of a special puller and the new installed using a replacing tool.

7. Explain the checks to be made before fitting new piston rings.

Ans:-

The piston rings should be examined for uneven wear, loss of tension, scratches etc. However as a rule, new rings are always fitted once rings are removed from the piston. In case the engine has to be dismantled at low mileage while fitting new rings, select the proper ring for the piston to be used i.e. "Standard size rings should be used for a standard size piston" and oversize rings for the oversize piston.

Before fitting the new rings the following checks to be made:

1. Side clearance:

Place the new ring with its outer side in the piston ring groove and roll it throughout the circumference. The ring should not stick, neither should it be excessively free. The side clearance may be checked by using a feeler gauge placed between the new ring groove side. The ring groove sides are generally from 0.025 to 0.100 mm for all grooves except the top one for which both the limits are higher, i.e. from 0.040 to 0.150 mm.

2. End clearance:

The clearance or the gap between the ring ends when fitted in the cylinder should be more than the minimum specified which is generally taken as 0.001 mm per mm of circumference. If the gap is less than this amount the rings ends will come together but against each other and will ultimately break at higher temperatures.

10. Briefly explain the emission Norms of Euro and Bharath Stage Norms.

Ans:- Emission norms for the European countries are given below.

EURO NORMS FOR PETROL (INCLUDING CNG/LPG)/DIESEL PASSENGER VEHICLES.

Standard	CO gm/km	HC/NOx gm/km	PM gm/km
EURO I (1992/93)			
Petrol	2.72	0.97	N.A.
Diesel	2.72	0.97	0.14
TO 1994 Diesel DI	2.72	1.36	0.19.
EURO II (1995/97)			
Petrol	2.2	0.5	N.A.
Diesel	1.0	0.7	0.08
TO 1999 diesel DI	1.0	0.9	0.10
EURO III (1999/2000/2001)			
Petrol	2.3	0.2/0.15	N.A.
Diesel	0.64	0.56/0.5	0.05
EURO IV (2005)			
Petrol	1.0	0.1/0.08	N.A.
Diesel	0.5	0.3/0.25	0.025

EURO NORMS FOR PETROL (INCLUDING CNG/LPG)/DIESEL PASSENGER VEHICLES.

Standard	CO (mg/km)	THC+NOx (mg/km)	THC (mg/km)	NMHC (mg/km)	NOx (mg/km)	PM (mg/km)	PN (x/km)
EURO 5 (2009)							
Petrol	1000	—	100	68	60	*50/μg	—
Diesel	500	280	—	—	180	50/μg	60x10 ¹¹
EURO 6 (2011)							
Petrol	1000	—	100	68	60	*50/μg	—
Diesel	500	170	—	—	80	50/μg	69x10 ¹¹

* For DI engines only.

@ 4.8mg/km Standard w.e.f. Sept 2011.

3. State the safe level of pollutants for cars according to the INDIA 2000 Norms.

Ans:-

In comparison to USA, emission norms in India are not as stringent. Although Indian norms are equivalent to Euro norms, yet their implementation in India is lagging behind European implementation.

Bharat stage II norms for cars and commercial vehicles were enforced in the entire country w.e.f April 1, 2005, whereas Bharat stage III were made mandatory for cars and commercial vehicles in 11 metros, viz, Delhi, Mumbai, Chennai, Kolkata, Bangalore, Hyderabad, Ahmedabad, Pune, Surat, Kanpur and Agra. Bharat stage II norms for cars and commercial vehicles in the entire country and Bharat stage IV norms in the 13 metros have been enforced with effect April 1, 2010 after which the implementation of BS-IV norms has further been extended to a total of 20 cities w.e.f March 1, 2012. The latest additions being Gujarat, Hissar (Haryana) and Bhaatpur (Rajasthan). It is proposed to enforce BS-IV norms in 50 cities by 2015.

For two wheelers & three wheelers, Euro II norms have been enforced from April 1, 2005 and Euro III norms have come into force with effect from April 1, 2010.

In India also, new corporate Average fuel economy (CAF) standards are being introduced with effect from 2015. The new standards will rise the fuel efficiency of petrol cars from the current average of 14.1 km/lit to 17.3 km/lit and diesel cars from 15.5 km/lit to 19.9 km/lit. CO₂ emission standard would also improve from 165 g/km to 135 g/km.