

# Automobile engineering

⇒ Automobile - An Automobile is a self propelled vehicle which is used for transportation of passengers and goods upon the ground.

## Example

(i) Bullock cart / mikksha → Not an automobile

because power is supply externally track

(ii) Train → Not an automobile its run on rails

(iii) Sheep → Not an automobile travel in sea.

(iv) Air craft → Not " " flying in air.

(v) bus / car / Motor / Auto / Jeep / Truck → An Automobile

The automobile are classified according to

## 1. Purpose

(i) Passenger Vehicles - Car, jeep, bus, Auto

(ii) Goods Vehicles - Truck, Tractor

## 2. Capacity

(i) Light Motor Vehicles - Car, Motor cycle, scooter

(ii) Heavy Motor Vehicles - Bus, Truck, Tractor

## 3. Fuel used

(i) Petrol Vehicles - Car, Jeep, Scooter, Motor cycle

(ii) Diesel Vehicles - Truck, bus, tractor, bulldozer

## 4. Number of wheels

(i) Two wheeler - Scooter, Motor cycle

(ii) Three wheeler - Tampos, road rollers

(iii) four wheeler - Car, jeep, bus, Tractors

(iv) Six wheeler - Trucks, Tankers

(v) Eight wheeler - Car transporting vehicle

## 5. Drive of the Vehicles

(i) Single wheel drive vehicle - scooter, motor cycle

(ii) Two " " " " - Car, jeep, auto

(iii) four wheel drive vehicle - work shop jeep

6 Make an Model

(i) Ashok Leyland - Truck

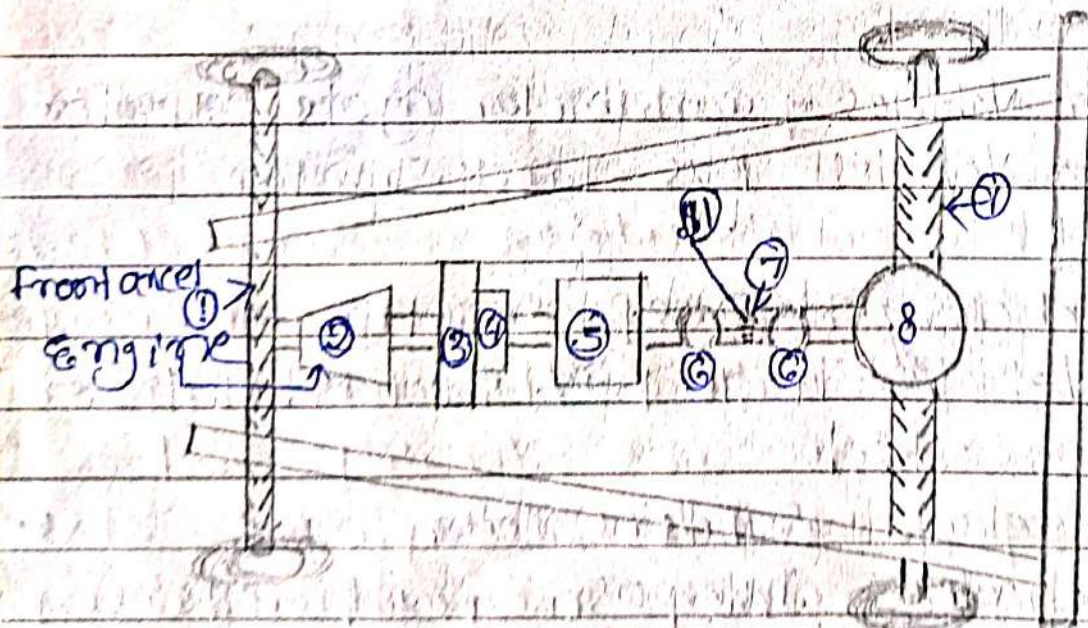
(ii) Tata - Car

## Classification of Automobile

Chassis

Body

Engine	Driving system	Control system	Electrical system	Other system
Mechanical part	1) Clutch	1) Steering	1) Charging	1) Suspension
Rolling "	2) Transmission	2) Braking	2) Ignition	
Lubricating "	3) Differential		3) Light	
Fuel "	4) Heat axle		4) WORN	
Exhaust "				



## Transmission System of Automobile

- |                   |                   |
|-------------------|-------------------|
| ① Front axle      | ⑦ Propeller shaft |
| ② Engine          | ⑧ Differential    |
| ③ Fly wheel       | ⑨ Rear axle       |
| ④ Clutch          | ⑩ Rear wheel      |
| ⑤ Gear box        | ⑪ Slip joint      |
| ⑥ Universal joint |                   |

## Chassis and body

An automobile consists of two main parts

- (1) Chassis
- (2) Body or Super structure.

(1) Chassis → A chassis is a complete combination of various system and components that enable it to run on the road.

⇒ The chassis comprises a basic structure, Transmission system, auxiliary, control system and the wheels.

(2) BODY → The purpose of body is to provide a comfort and protection to passenger beside giving good look.

⇒ The body include passenger compartment, bumpers, Radiate Grille, hood, <sup>(Cover of auto)</sup> Interior trim etc.

## The essential parts of the engine.

- (1) Cylinder block
- (2) piston rings
- (3) Cylinder head
- (4) piston pins
- (5) Cylinder liner
- (6) Connecting rods
- (7) Crank case
- (8) Crankshaft
- (9) Piston
- (10) Bearing (To support crank shaft)

(1) Cylinder block  
It give a support and enclose the moving part. The cylinder block consists of three main parts.

1. The cylinder which piston slide up and down

2. The port or opening of the valve.

3. The passage for the flow of cooling water.

It is the basic structure of an engine.

It is generally a single piece casting having completely design and made up gray cast Iron or nickel and chromium.

⇒ The cylinder head is mounted on the top of the block.

⇒ The cylinder block is attached to some parts with sealing gaskets which provide good seal to prevent leakage of water.

### ⇒ (ii) Cylinder head

It is a single piece casting mounted on the cylinder block and provide protection to the valve and piston by enclosing them.

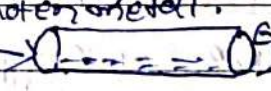
⇒ cylinder head contain cooling water jacket, spark plug, combustion chamber and some time valve is present.

⇒ cylinder head is usually made of gray iron or aluminium alloy. Dt 21.7.14.

(iii) Cylinder liner: - It is a cylindrical component that fixed inside the bore. The piston ring press upon these liner and allow remain contact with them or rub with them during reciprocating motion of the piston.

⇒ Cylinder liner provide a suitable wear resistant surface for cylinder bore.

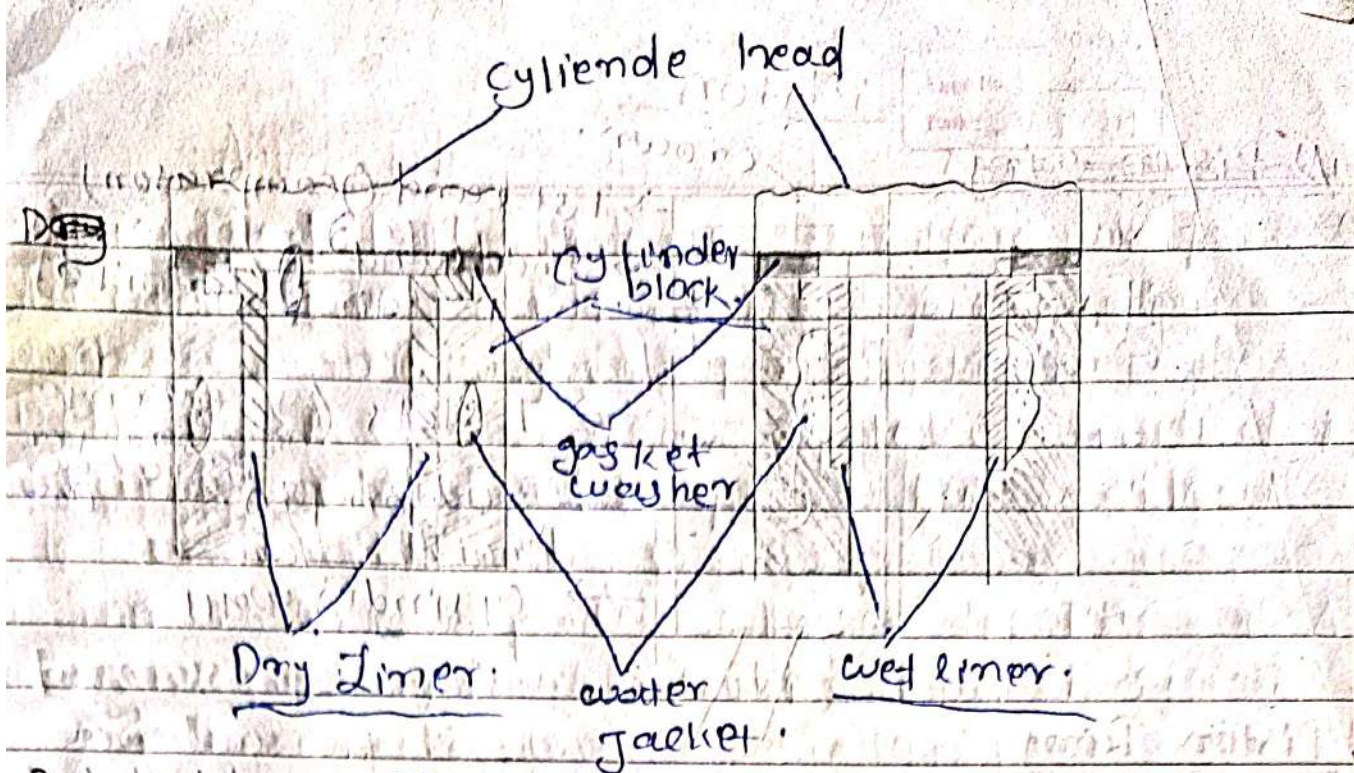
⇒ Liner are made up of ~~iron~~ <sup>alloy</sup> iron containing silicon, manganese, and chromium <sup>metals</sup>.

⇒ They are cast centrifugally  (means when the molten metal is given to a inside the cylinder and the cylinder is moving circularly on its axis, then a layer is form inside the surface of cylinder it is called centrifugal casting)

⇒ Liner are easily change/replace.

⇒ The cylinder liner are two type

- (i) dry liners
- (ii) wet liners.



Dry Liner : (Range 1.5 mm to 3mm)  
direct

It is not in a contact with the cooling water so the liner is called dry liner.

⇒ A dry liner can not be finished accurately before fitting because of shrinkage stress produced.

Wet Liners : (Range 1.5

⇒ If outer water is in directly contact with the cooling water circulating within jacket.

⇒ A wet liner finished accurately before fitting.

Piston

⇒ Piston is a cylindrical member which is placed inside the cylinder.

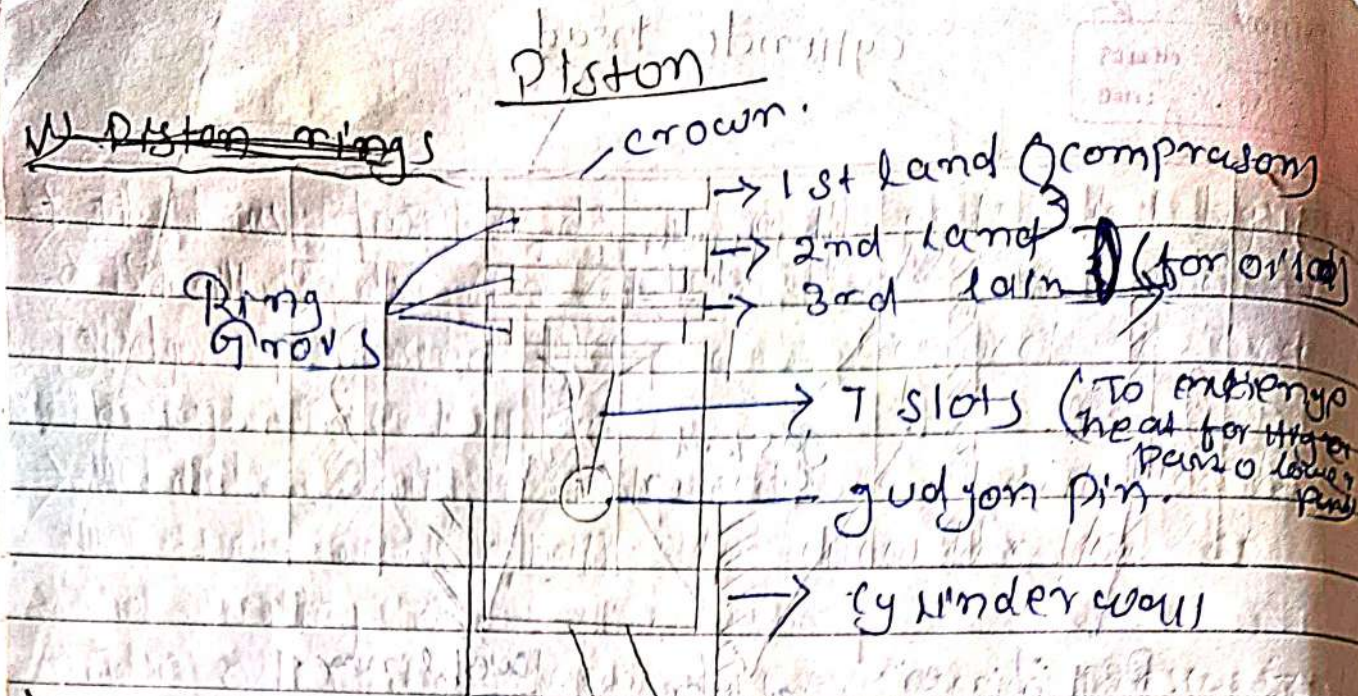
⇒ Piston moves linearly under the influence of gas pressure and transmit this motion to the connecting rod and convert the rotary motion of crank shaft by help of crank.

⇒ Piston is connect with connecting rod by the help of gudgeon pin.

⇒ Piston houses piston rings

⇒ The top of piston is called head or crown.

It is made up cast aluminium alloy or cast iron.



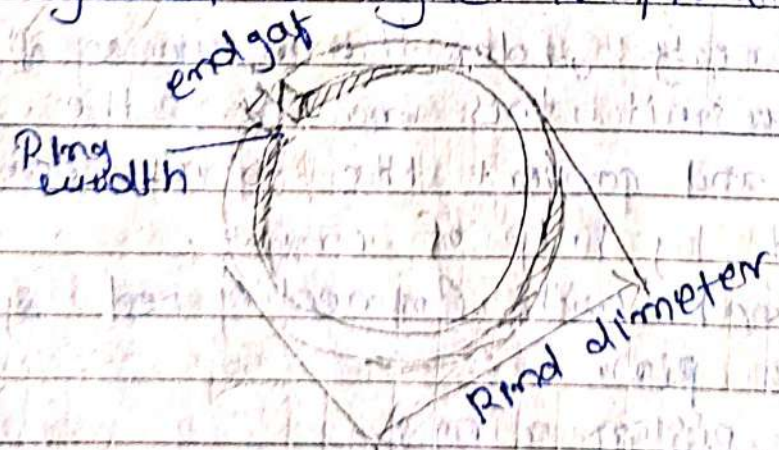
Piston Ring

In IC Engine piston rings are provided to serve

- (i) Seal to prevent leakage of combustion gas.
- (ii) Lubricating oil control on cylinder wall so as to minimise wears and tears.

Types (i) Compression or gas rings  
 (ii) oil ring or oil shaper ring

It is made up of cast Iron, connecting Silicon and manganese with a very fine finish. also Chromium plated rings are used at the top compression ring which is subjected to higher temperature.



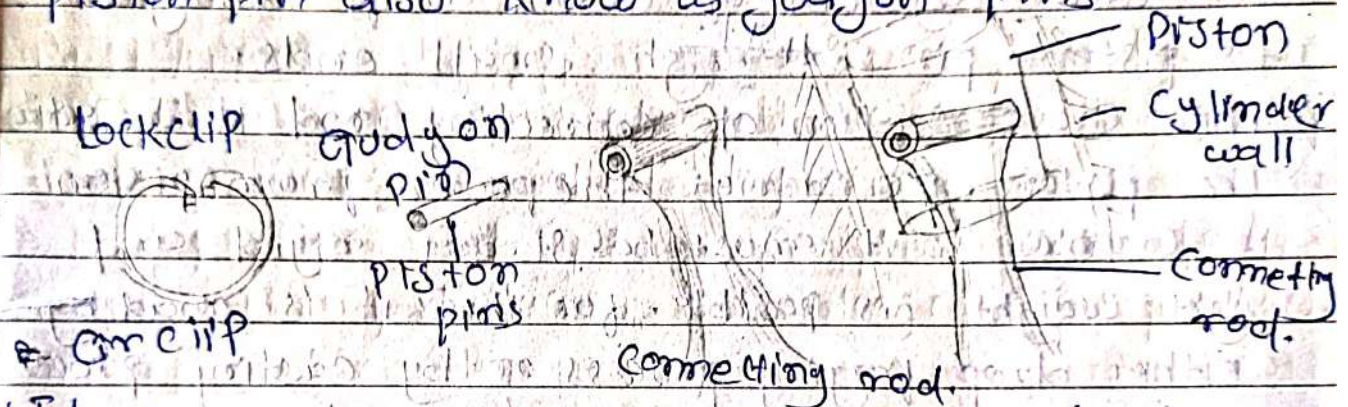
⇒ The top compression ring near combustion chamber has to do hard work of gas sealing and transfer heat for piston crown to cylinder wall.

⇒ The contraction of oil ring is different from compression ring. Here oil vent passages are provided all around the section a certain spacing in the channel.

After scraping the lubricating oil from the cylinder interior they allow oil to flow back through the oil vent.

### VI) Piston pin

piston pin also known as gudgeon pins.



It connects the piston and small end of connecting rods.

⇒ piston pin is hollow cylindrical made up of hardened ~~steel~~ steel having 1.5% Carbon, 3% Silicon, 0.5% Mg.

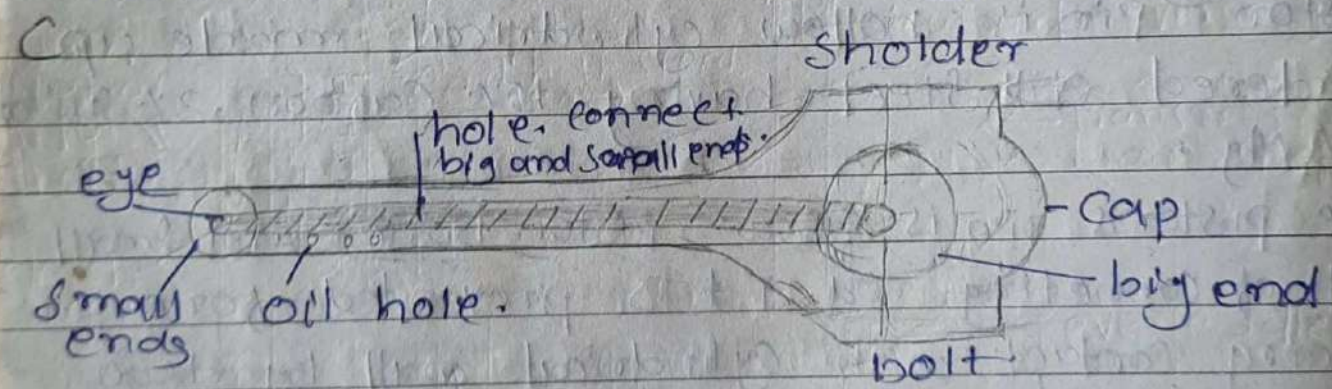
⇒ The piston pin is fixed to piston bosses and small end of connecting rod. It is prevented from coming in contact with cylindrical wall by two lock clips or lock rings also called air clips.

### VII) Connecting rods

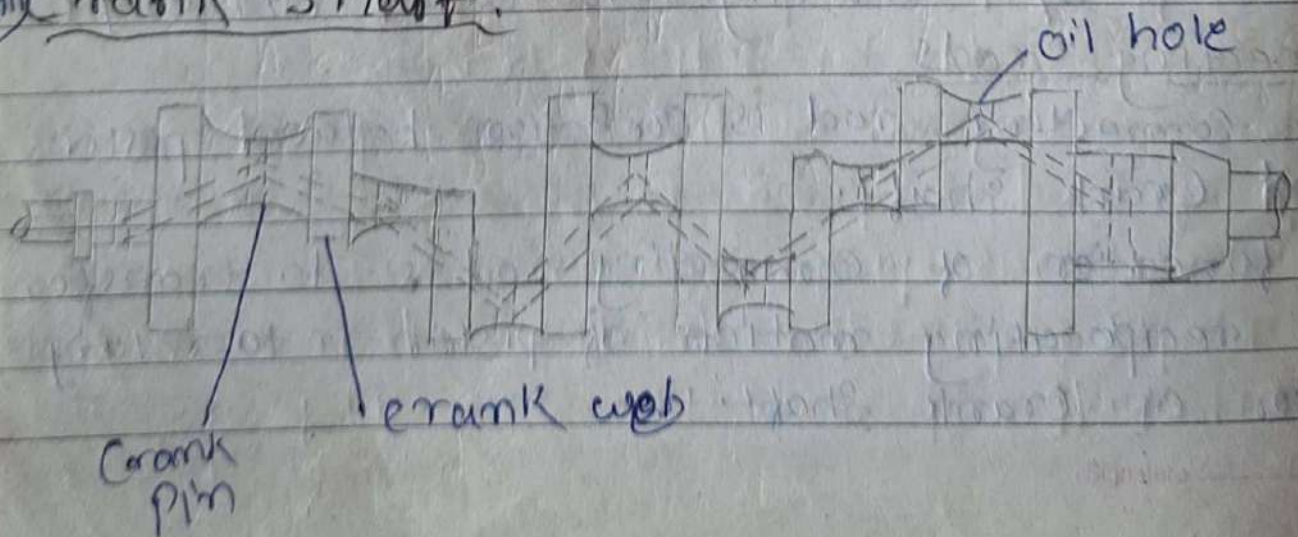
⇒ The connecting rod is connection between piston and crank shaft.

⇒ The function of connecting rod is to transfer the reciprocating motion of piston into rotating motion of crank shaft.

- It has two ends small ends and big ends.
- Small ends connect to the piston pin or gudgeon pin and big end is connect to crank through crank pin.
- A hole is drill in between small ends and big end in the crank shaft for allow the flow of lubricating oil.
- The oil comes from big end from pressurized lubrication system of crank shaft and goes to piston pin ~~through~~ small ends.
- The cross section of connecting rod is I section.
- The piston pin carries the power from piston to crank. So it must be strong, rigid and light weight as possible. for this it is made by either drop forging process or by casting process.
- The material generally used to make connecting rod is Aluminium alloy and alloy steel.



with Crank Shaft!





- ⇒ It is a rotating component connected the crank.
  - ⇒ Crank shaft first part is power transmission system on to which the ~~recipro~~ reciprocating motion of piston is converted to rotating motion with help of a connecting rod. So crank shaft received power from connecting rod then transfer to clause and subsequently to wheel.
  - ⇒ A crank shaft is consist of crank pins, webs, balancing weight and main journal, fly wheels
  - ⇒ Crank shaft has drill oil passage. through oil can flow from bearing to the connecting rods.
  - ⇒ Front end of crank shaft carry (i) Gear (ii) vibration damper to control vibration (iii) Fan belt pulley to generate engine fan, water pump and generator with a V belt.
  - ⇒ The rear end of crank shaft carry fly wheel
  - ix) Crank Case :- (Crank case) or (Crank Box)
  - ⇒ Crank case is attached to bottom face of cylinder block. and it act as the base of engine.
  - ⇒ It support the crank shaft and cam shaft.
  - ⇒ The oil pan and cylinder block tighter are called the <sup>crank case</sup> crank case.
  - ⇒ The cylindrical block and upper half of crank case are act as the single integral unit. and it made up of Aluminium alloy for light weight, good thermal conductivity and good cooling.
  - x) CAMSHAFT → A camshaft is responsible for opening of valve. and two cam for each cylinder one to operate inlet valve and the other the exhaust valve. ⇒ A cam is a device change rotary motion of camshaft into linear motion of the follower. ⇒ It also operate fuel pump or oil pump.
  - ⇒ The camshaft turns at half speed of crank shaft thus every two revolution of crank shaft produce a one revolution of camshaft. and opening and closing of each valve.
- Crank shaft → Chain → Crank Shaft  
 Crank shaft → Timing mark → Crank Shaft

Gear box - The gear set is enclosed in a metal box is called as gear box.

Types of gear box: Gear boxes are classified into  
 1. Selective Gear box

- (a) Sliding mesh gear box
- (b) Constant mesh gear box
- (c) Synchromesh gear box

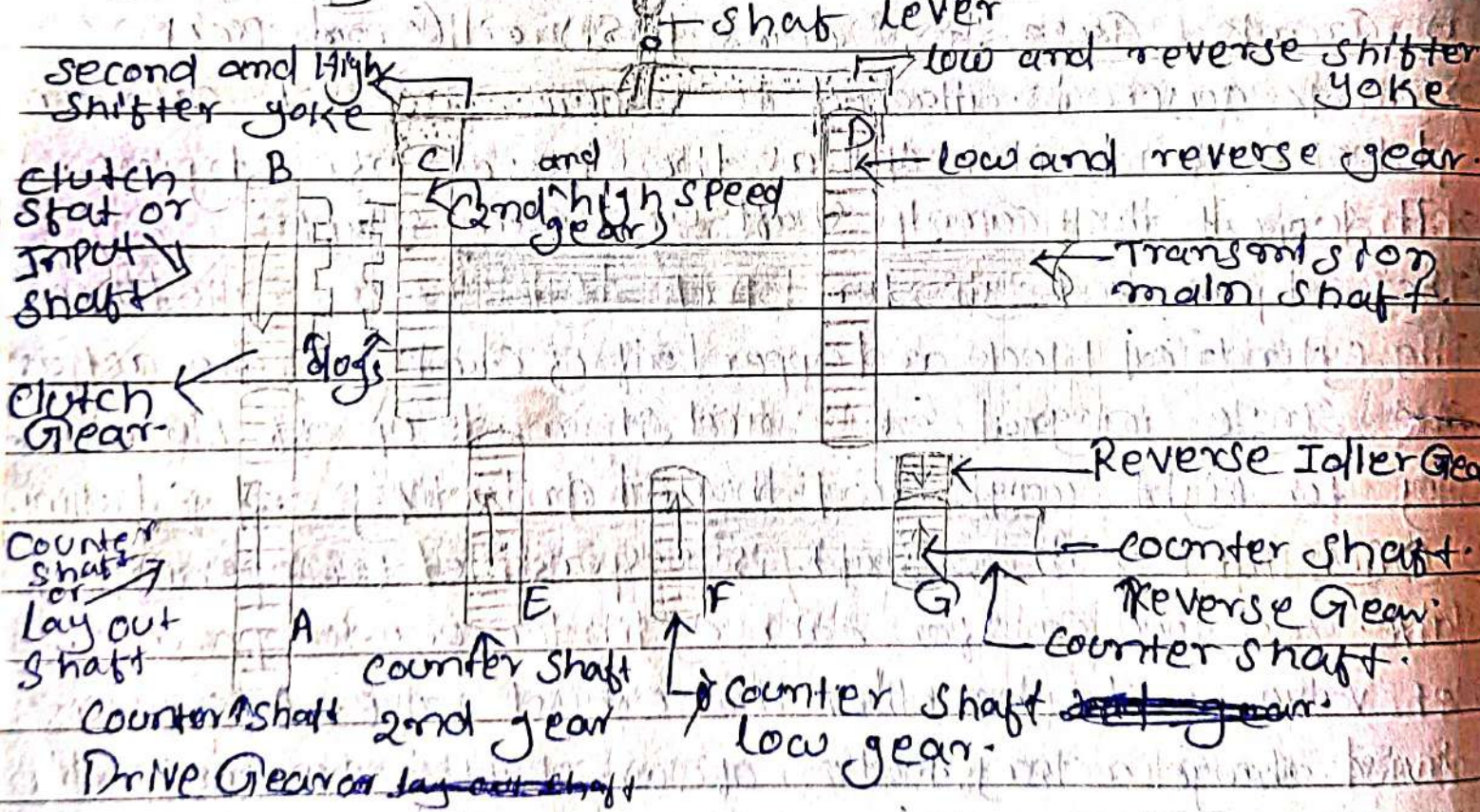
2. Automatic Gear box

- (a) fluid type (b) Electric type (iii) planetary

1. Selective Gear box

- In a selective gear box gear are shifted by hands.
- The selective gear box are very simple in construction and relatively free from trouble.
- This type of gear box are used in vehicle like cars, buses, trucks.

(a) Sliding Mesh Gear box

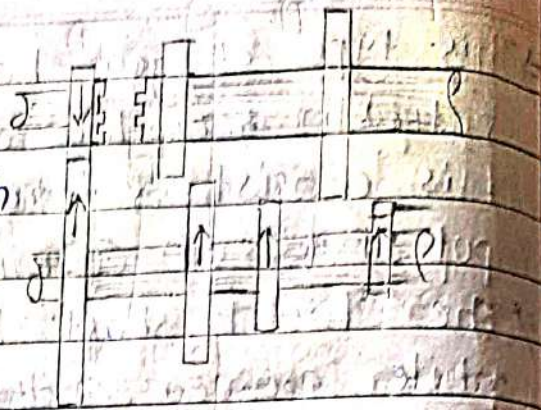


→ It is the gear box in which main shafts are moved right or left for meshing with appropriate gears on the lay shafts for obtaining different speeds.

- ⇒ This type of gear has various diameter and number of teeth mounted on the main shaft.
- It consists of three shaft: (i) Clutch shaft or input shaft, (ii) Counter shaft, (iii) Main shaft or output shaft.
- ⇒ The clutch shaft and main shaft are in a line while counter shaft is parallel to them.
- ⇒ The input shaft <sup>drives</sup> transmits powers from the engine through clutch and transfer to main shaft by gear mounted on the counter shaft.
- ⇒ The main shaft transmits power to the propeller shaft and then to the road wheels.
- ⇒ The clutch shaft contains gear is called clutch gear which remains mesh with counter shaft of drive gear.
- ⇒ Number of teeth on clutch gear and counter shaft drive gear generally fixed that is counter shaft drive gear has more teeth than clutch gear.
- ⇒ Two gears are mounted on the main shaft which can be slid by the shifter yoke when the shaft lever is operated.
- ⇒ These gears are attached with the gear of counter shaft and 1st, 2nd, ~~3rd~~ and reverse gear are operated.
- ⇒ The dogs of input are directly coupled with the main shaft when the 3rd gear or top most gear is obtained.
- ⇒ A reverse idler gear is mounted on another shaft and always remains connected to the reverse gear of the counter shaft and does not affect the gear ratio in back word motion.

## Gear in neutral

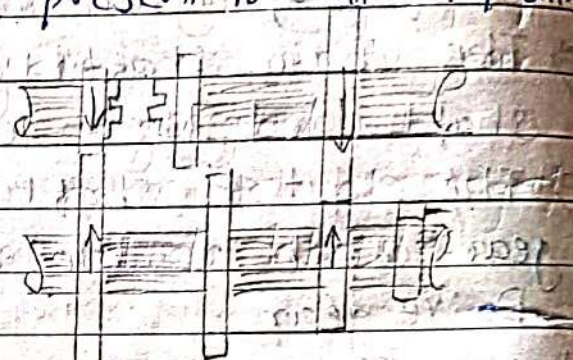
when the Engine is running and clutch is engaged. the clutch gear drives the counter shaft gear. The counter shaft rotate opposite direction with clutch shaft.



Shaft  $\rightarrow$  only the clutch shaft gear is connected to counter shaft gear other gear are free so the vehicle is not running and it present in natural position.

## First or low Speed gear

The larger gear of main shaft mean low and reverse gear is attached to the first or low gear of counter shaft.

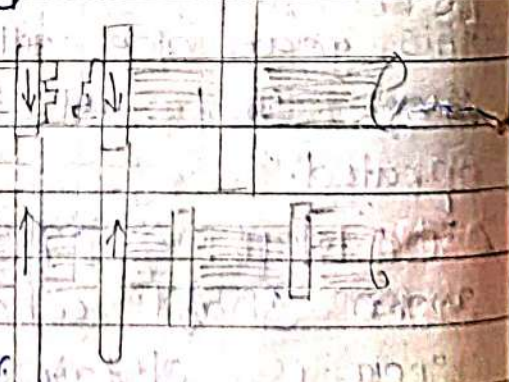


or low gear. If the clutch gear is rotate 4000 Rpm speed then counter shaft drive gear rotate. It rotate low speed gear of counter shaft and low speed gear rotate the larger gear in main shaft and larger gear rotate 1142.8 Rpm almost 3:1 ratio.

## Second Speed gear

$\rightarrow$  Smaller gear of main shaft is attached with the 2nd gear of counter shaft.

$\rightarrow$  If the clutch shaft rotated 4000 Rpm then counter shaft driver gear rotate.



It rotates 2nd gear of counter shaft and it rotate <sup>smaller</sup> gear of main shaft and we found output 2000 Rpm almost 2:1 ratio. means clutch shaft moves 2 time then small gear move one time.

Third top or higher gear.

⇒ The clutch shaft gear is attached to the main shaft by the help of dogs in this gear.

⇒ then clutch shaft rotate

@ 4000 Rpm, the output or main

shaft rotate 4000 Rpm, here there is no link in the counter shaft. gear ratio is 1:1.

Reverse gear

⇒ The larger gear of main shaft is attached to the reverse gear of counter shaft through the Idler gear.

⇒ The clutch shaft rotate 4000

Rpm it rotate. driver gear of counter shaft.

then the reverse gear of counter shaft rotate.

and it rotate Idler gear. the Idler gear rotate opposite direction of reverse gear.

⇒ The Idler gear rotate the larger gear of main shaft in 940 RPM. very slow speed.

⇒ Due to this reverse rotation of wheel take place so that vehicle move to back word.

In this type of gear box all the gear of main shaft are in constant mesh with the corresponding gear of counter shaft (lay shaft)

→ The two dog ~~to~~ clutches are provide on the main shaft one between clutch gear and second gear and other is between first gear and reverse gear.

→ when the left hand dog clutch is ~~made~~ <sup>slide</sup> to the left by means of the gear shift lever it mesh with clutch gear and top speed gear is obtained.

→ When the left hand dog clutch is mesh with the second gear the second gear is obtain

→ Similarly by sliding right hand dog clutch left and right the first speed (low gear) <sup>gear</sup> and reverse gear is obtained.

⇒ In this type of gear box all the gear are constant mesh, so they are safe from being damaged and unpleasant grinding sound does not occur when engaging and disengaging them.

### Synchromesh Gear box

→ The synchromesh type of gear box is similar to constant mesh gear box. but the synchromesh gear box is provide with a synchromesh device by which to gear to be engaged are first brought into frictional contact which equalizer their speed after they are ~~are~~ engaged smoothly.

⇒ A = Engine shaft ⇒ B, C, D, E - on the main shaft are always in mesh with corresponding gear to counter shaft.

→ If 'A' is rotating then all gear of main shaft (B, C, D, E) rotation are equal <sup>are called synchromesh device which is</sup>

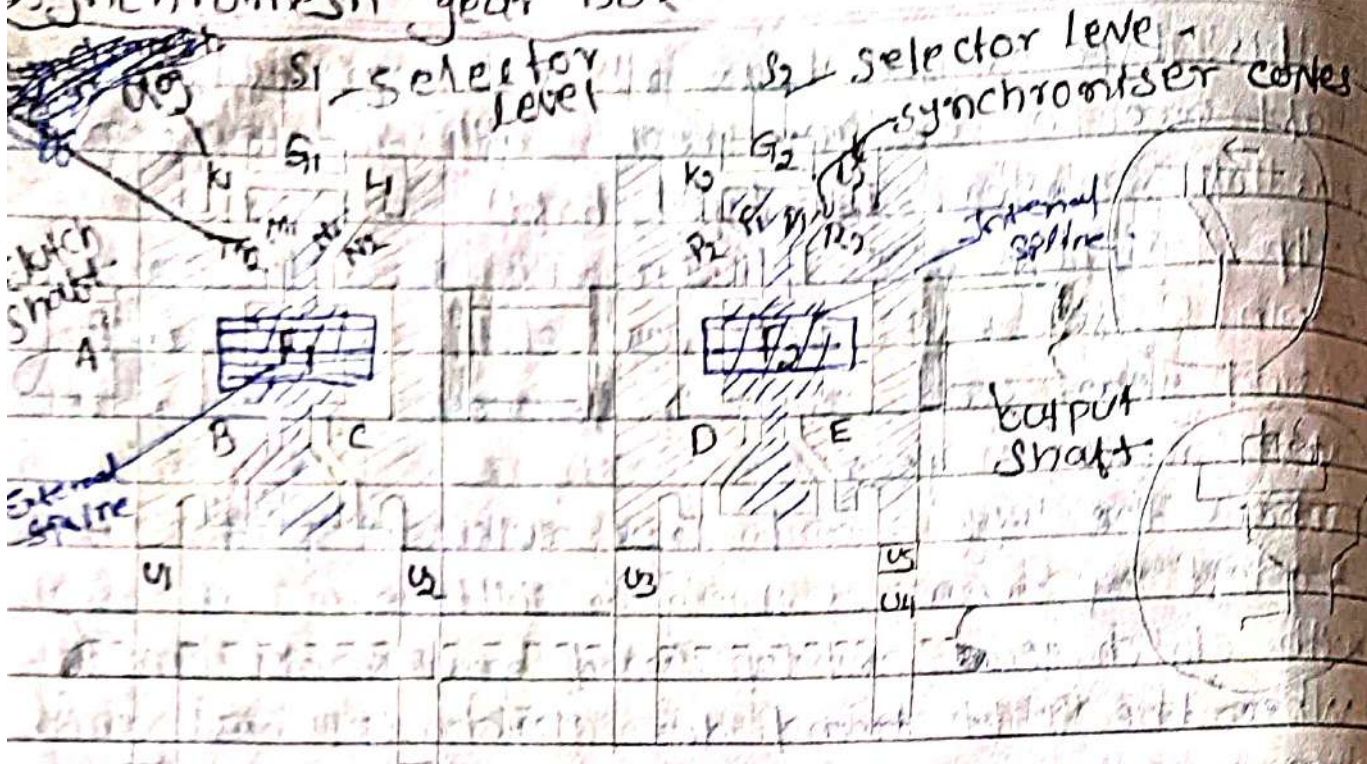
→ F<sub>1</sub> and F<sub>2</sub> are free to slide on main shaft

→ K<sub>1</sub>, L<sub>1</sub>, K<sub>2</sub>, L<sub>2</sub> are the dog <sup>or gear tooth</sup> fit on the teeth of G<sub>1</sub> & G<sub>2</sub>.

→ The force apply on G<sub>1</sub> and G<sub>2</sub> through fork S<sub>1</sub> and S<sub>2</sub>

→ There are 8 friction surface M<sub>1</sub>, M<sub>2</sub>, N<sub>1</sub>, N<sub>2</sub>, P<sub>1</sub>, P<sub>2</sub>, R<sub>1</sub>, R<sub>2</sub>

# Synchromesh gear box



## For top or direct gear

⇒ The selector  $G_1$  and  $F_1$  slide towards left till it ~~is~~ the synchroniser cone  $m_2$  and  $m_1$  connect.

⇒ Then  $m_1$  and  $m_2$  rub and friction made there speed equal <sup>to</sup> each other.

⇒ After that  $G_1$  again moves towards dog  $K_1$  and attach or engage with  $K_1$ .

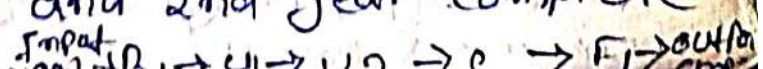
⇒ Now top gear is started.

## 2nd gear

⇒ Then for 2nd gear  $G_1$  and  $F_1$  moves towards right till the synchroniser cone  $N_2$  and  $N_1$  get connect.

⇒ Then  $N_1$  and  $N_2$  ~~meet~~ rub and friction made there speed equal.

⇒ After that  $G_1$  again moves toward dog  $L_1$  and engage with  $L_1$  and 2nd gear complete.



# 1st gear

- $G_2$  and  $F_2$  moves towards left till the synchroniser cone  $R_2$  and  $P_1$  connected.
- Then  $R_2$  and  $P_1$  rub and friction made there. Speed equal.
- Then again  $G_2$  moves towards dog  $K_2$  and get engaged with  $K_2$  and 1st gear complete.
- The power transfer through  $A \rightarrow B \rightarrow U_1 \rightarrow U_3 \rightarrow D$
- $F_2 \rightarrow$  Output shaft.

# Reverse gear

- $G_2$  and  $F_2$  moves towards right till the synchroniser cone  $R_2$  and  $R_1$  get engaged.
- ~~The~~ The  $R_1$  and  $R_2$  rub and friction made there. Speed equal.
- Then again  $G_2$  moves towards  $L_2$  and get engaged with  $L_2$  and reverse gear complete.
- The power transfer through  $A \rightarrow B \rightarrow U_1 \rightarrow U_4$  (Idle gear)  $\rightarrow E \rightarrow F_2 \rightarrow$  Output shaft.

→ Now synchromesh type of gear box is used in most of the automobile and it improved to sliding mesh and constant mesh type of gear box.

→ In synchromesh type of gear box it allows smooth and quick shifting of gear without damaging teeth.

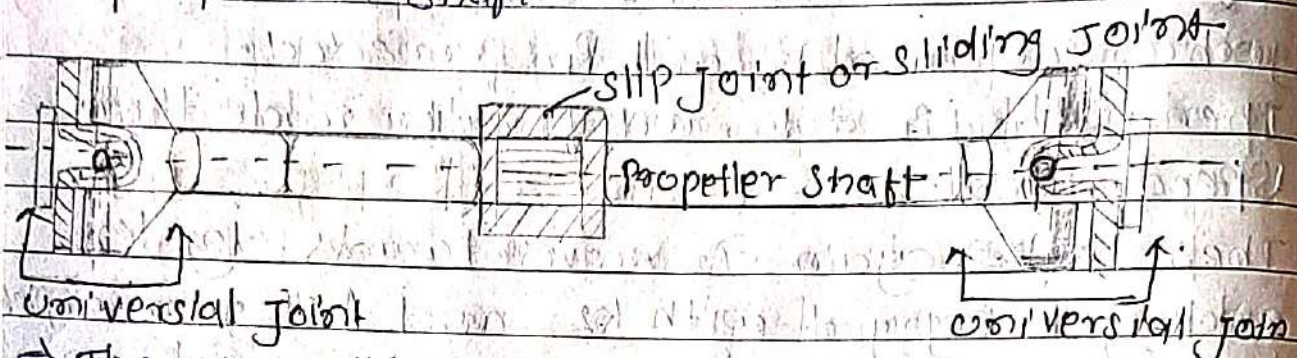
→ Synchromesh devices are not fitted in all gear they are fitted only Top, reverse and first gear.

→ It is very costly.



# PROPELLER SHAFT

⇒ Next to the gear box after transmission system is the propeller shaft.



⇒ The propeller shaft is a driving shaft that connects transmission system or gear box output to the differential of rear axle.

⇒ The rotary motion of the transmission main shaft is carried out through propeller shaft to differential causing the rear wheels to rotate.

⇒ The power or torque is transmit from gear box to differential with the help of universal joint which is fitted both end of propeller shaft.

Function of Propeller Shaft:

⇒ It has to operate at different length and different <sup>angle</sup> ~~direction~~.

⇒ The rear axle housing with differential to the frame by spring there fore distance between gear box and differential changes due to road irregularities and change the angle of drive.

⇒ As the vehicle moves on the roads there are some jolts due to which the spring expand and contract.

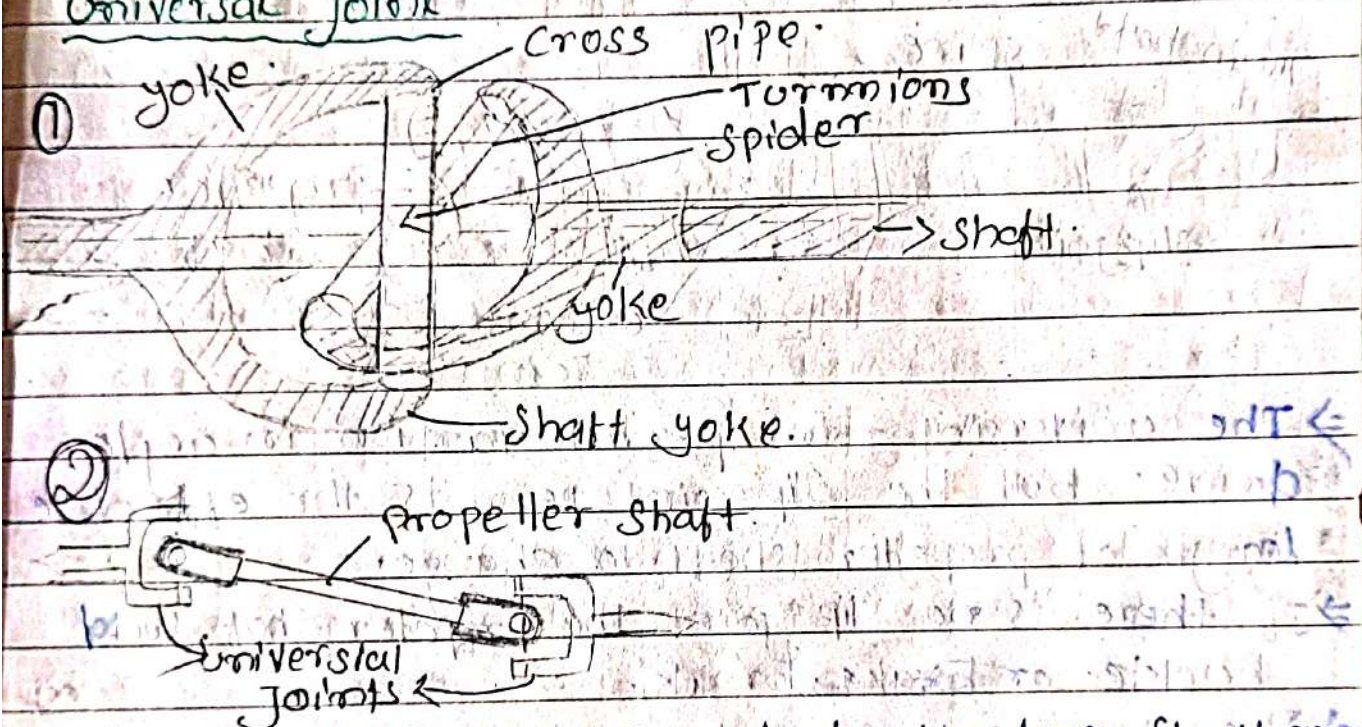
⇒ The propeller shaft has to face both changes angular changes and longitudinal or length change.

⇒ The propeller shaft is also is not too same time as the gear box because the level of rear axle is lower than the gear box.

⇒ To adjust the angular motion universal joint is provide. and to adjust the change in length slip joint or sliding joint is provide.

⇒ The propeller shaft has to withstand the torsional stress of the transmitting torque so it must be light weight and well balanced so it is made up high quality alloy steel.

### Universal joint



⇒ A universal joint is used when two shaft are connected at an angle to transmit the torque.

⇒ It is also know as hook joint.

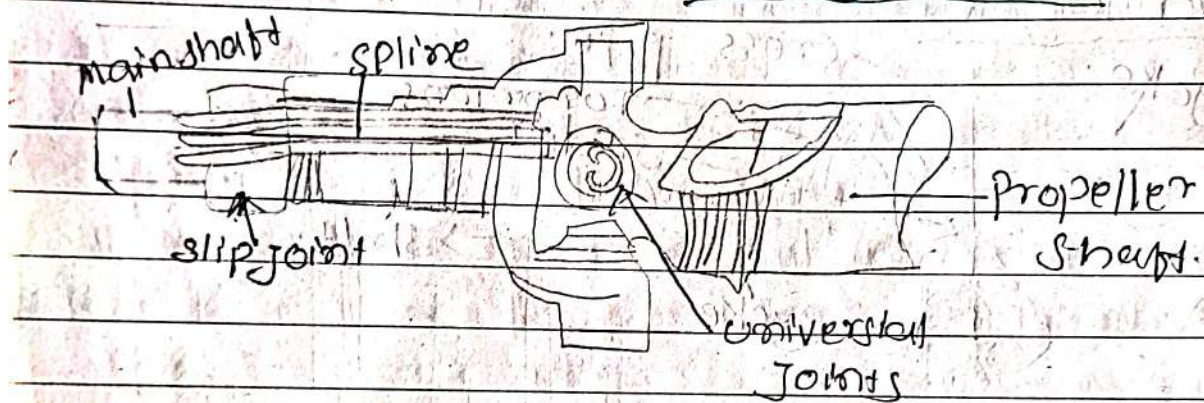
⇒ In transmission system the propeller shaft constly rising and falling due to rough roads and spg

⇒ one universal joint is used to connect the main shaft, gear box and propeller shaft. another universal joint is used to connect other end of propeller shaft and differential pinion shaft.

⇒ This joint not only makes connection between two rigid shaft but also permit to ~~anti~~ transmission of power when the angle continuously change.

⇒ It is double hinged (conoid) joint. Consisting two Y shaped yokes  
 ⇒ One yoke is provide at driving shaft and other on the driven shaft. and ~~A~~ cross ~~shaped~~ shaped member know as spider connect two yoke.

⇒ The four arms of spider is know as terminal slip joint or sliding joint



⇒ The universal joint permit variation in angle drive. but the slip joint permits the effective length of propeller shaft to change.

⇒ If there is no slip joint the propeller shaft would buckle or ~~break~~ break.

⇒ The slip joint consist of two shaft having splines. outside splines on one shaft and matching internal splines on another shaft or hollow shaft.

⇒ The splines causes two shaft to rotate together as well as same time. one shaft can slide over another shaft.

⇒ when rear spring compress due to jaris on the road the differential rise up and the propeller shaft is shortened. when spring against expand, the differential return its original position and propeller shaft get its original

this action of shaft know as telescopic action.

### Requirement of Propeller Shaft:

Must have high torsional strength.

Dynamically balanced.

Low Stress Concentration.

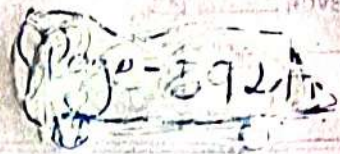
Reduce thrust load under high torque.

High fatigue life.

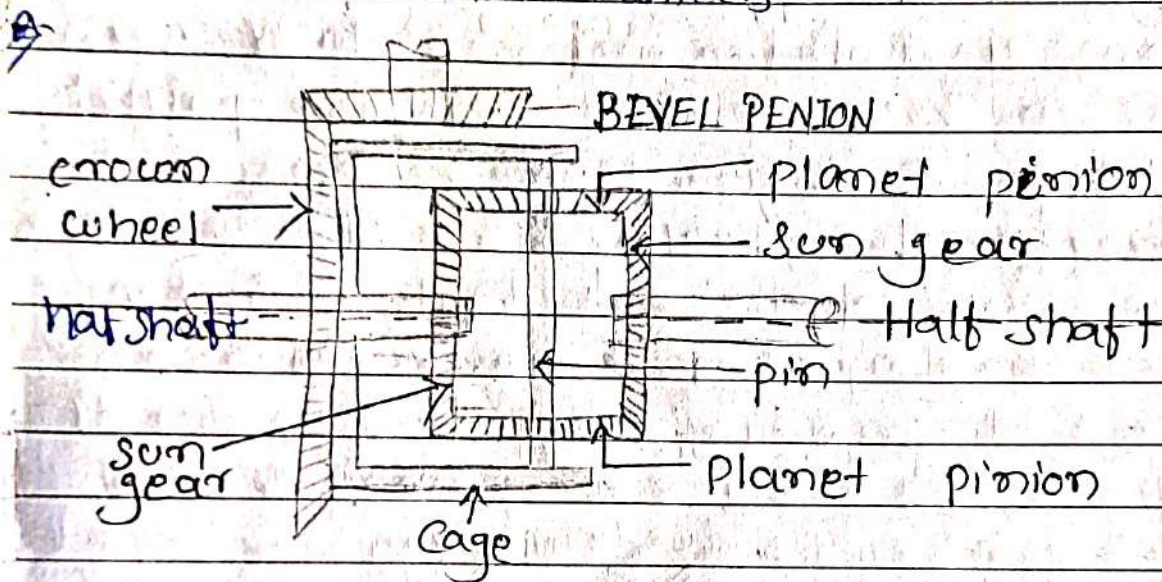
Types of Propeller Shaft  $\rightarrow$  Bendix tector

swiss joint, Rzeppa joint, Tripoid, Tulipet.

# DIFFERENTIAL AND REAR AXLE



- ⇒ It is most essential part of an automobile.
- ⇒ when the car takes a turn the outer wheel travel on a longer radius than inner wheels. The outer wheels turns faster than inner wheels. So the inner wheel slip which will cause rapide tyre ~~are~~ wear, steering difficulties.
- ⇒ To overcome these skidding a differential mechanism allows the outer wheel to rotate more than inner wheels.



- ⇒ The sun gears are fitted or mounted inner end of each rear axle called half shaft.
- ⇒ A differential cage is attached on the left half shaft.
- ⇒ A ring gear (called crown gear) is attached with the cage. So that cage rotate with the crown gear.
- ⇒ The crown gear or ring gear ~~are~~ is driven by Bevel pinion.
- ⇒ Both crown wheel and cage are free on the left rear axle.
- ⇒ The cage supports two planet pinion (called differential pinion gears) fitted by pin <sup>and</sup> mesh with the sun gears.

→ Planet pinion are free to rotate on the pin.

→ So when differential cage is rotated both the Sun gear rotate and both wheels turn which are attach to outer rear axle or outer shaft.

→ ~~Let us~~ <sup>Now</sup> Suppose that one wheel held Stationary (constant)

→ So when differential cage rotated, the planet gear also rotate as they are run across on stationary axle sun gear.

→ while rotating in this manner the planet pinions carry rotary motion to the other axle sun gear. causing it, and the wheel too, to rotate.

→ Therefore when one rear wheels turns more rapidly than other when car taking turns.

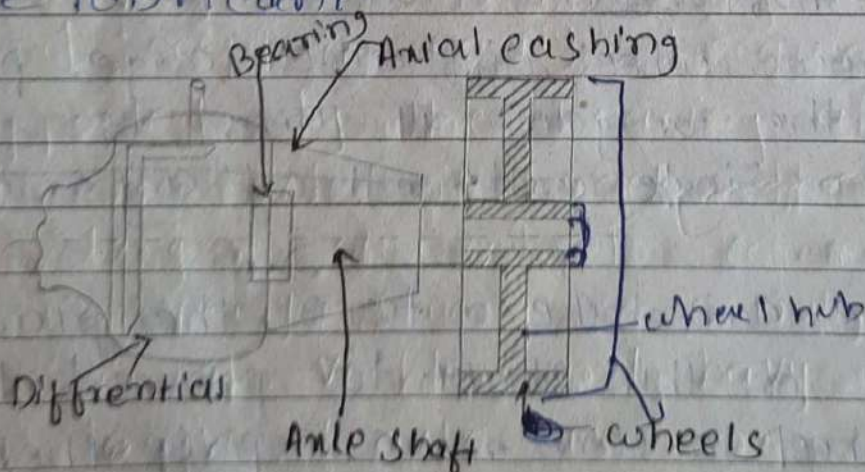
→ Also the planet gear spin on its shaft transmit more rotary motion to one rear wheel than another when both wheel <sup>not</sup> turns at ~~same speed~~ <sup>on road</sup> or vehicle ~~drive~~ going to straight planet pinion do not rotate on shaft, ~~or~~ crown gear.

→ And the crown wheel, differential cage, planet pinions and the sun gear all turns as a unit rotating as a single unit without any relative motion.

→ But when the car take a turn, the planet pinion rotate on their shaft to permit the outer rear wheel to turn more rapidly than inner wheel.

## REAR AXLE Page 595

- ⇒ In between the differential and driving wheels the rear axle is present to transmit power from differential to the driving wheels.
- ⇒ The rear axle is not a single piece but it is in two halves connected by the differential and one part is known as half shaft.
- ⇒ Inner end of half shaft is connected to sun gear of differential and outer end of half shaft is connected to the driving wheels.
- ⇒ In rear wheel or back wheels are drive wheels so rear ~~axle~~ wheels are the driving wheels.
- ⇒ A housing (or casing) is completely encloses the rear axles and differential protecting them from water, dust and injury in addition to mounting their inner bearing and providing a container for the lubricant.



### Various load and torque at the rear axle

- (i) Shearing force due to vehicle weight.
- (ii) The weight ~~is~~ causes bending moment to the axial shaft (Through spring, seat and road wheels.)
- (iii) Driving torque.
- (iv) Thrust forces caused by side force. by

## causes of axle failure:

- Lubricant is not menten at require level.
- Lubricant is incorrect grade (low quality)
- The replace part are not of the correct tight.
- Dust or abrasive particale enter the axle.

## Types of rear axles

Depending upon the Method of Supporting the rear axle are three type.

- (i) Semi floating axle.
- (ii) Full floating axle.
- (iii) Three quarter floating axle.

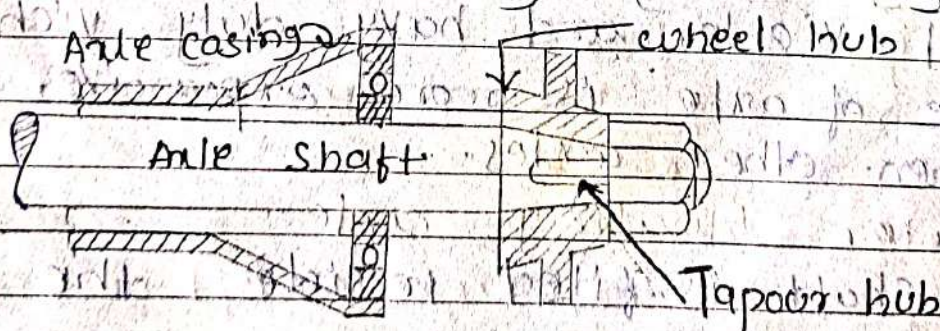
### Semi floating axle

A Semi floating axle has a bearing located on the axle and inside the axle casing.

- It has to supports all the loads so it is larger in size.

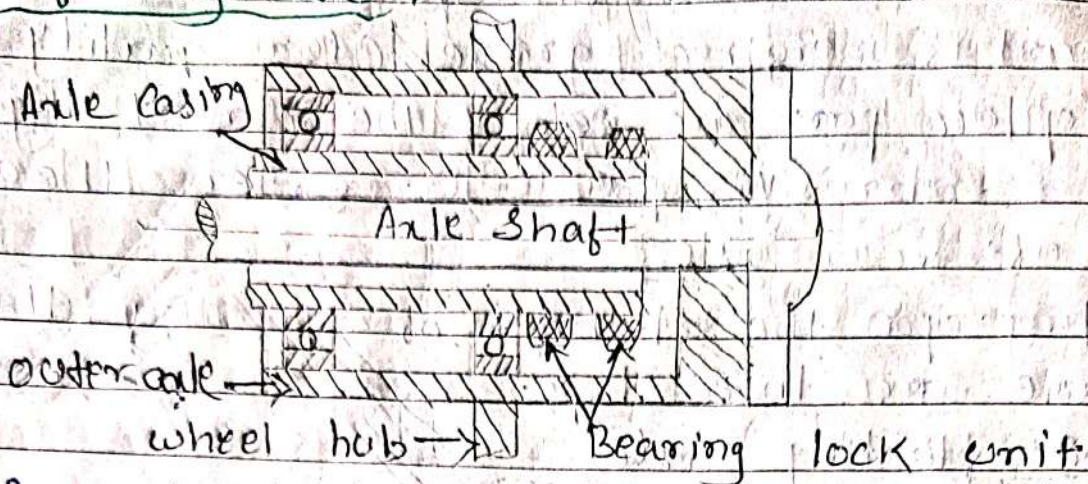
- The inner end of axle is supported by differential side gear.
- The outer end of axle support weight of the car and take end thrust.
- The vehicle load is transmitted to the axle through the <sup>suspension spring</sup> casing and bearing.

⇒ They are the simplest and cheapest of all other types and widely use in car.





## full floating axle



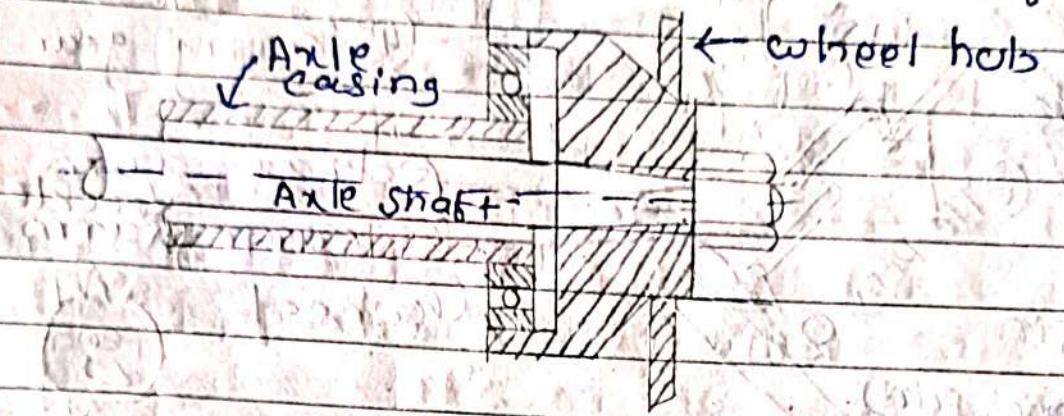
- A full floating axle has two deep groove roller bearing located between axle casing and wheel hub.
- in the outer axle the wheel hub is fitted
- The axle is taken all the weight of vehicle and thrust or jerk of wheel. So it is called full floating axle.
- The axle may be removed from the housing without disturbing the wheel by removing the nuts or bearing lock nuts and replace easily because it is not supported by the bearing at either end.
- If an axle is broken there would be no danger of wheel coming off.
- It is very strong so usually fitted in commercial vehicle and heavy duty vehicles.
- This type of axle is more expensive and heavier than other axles.

## Three quarter floating axle

- The axle shaft is fitted inside the axle casing.
- Bearing are located outer side between wheel hub and axle casing.
- The weight of vehicle is transferred to axle casing only the side thrust and driving torque are

taken by the shaft axle. so ~~axle on~~  
 the major part of load is taken by axial  
 casing and shaft axle only take care off  
 rotation and transmission of power.

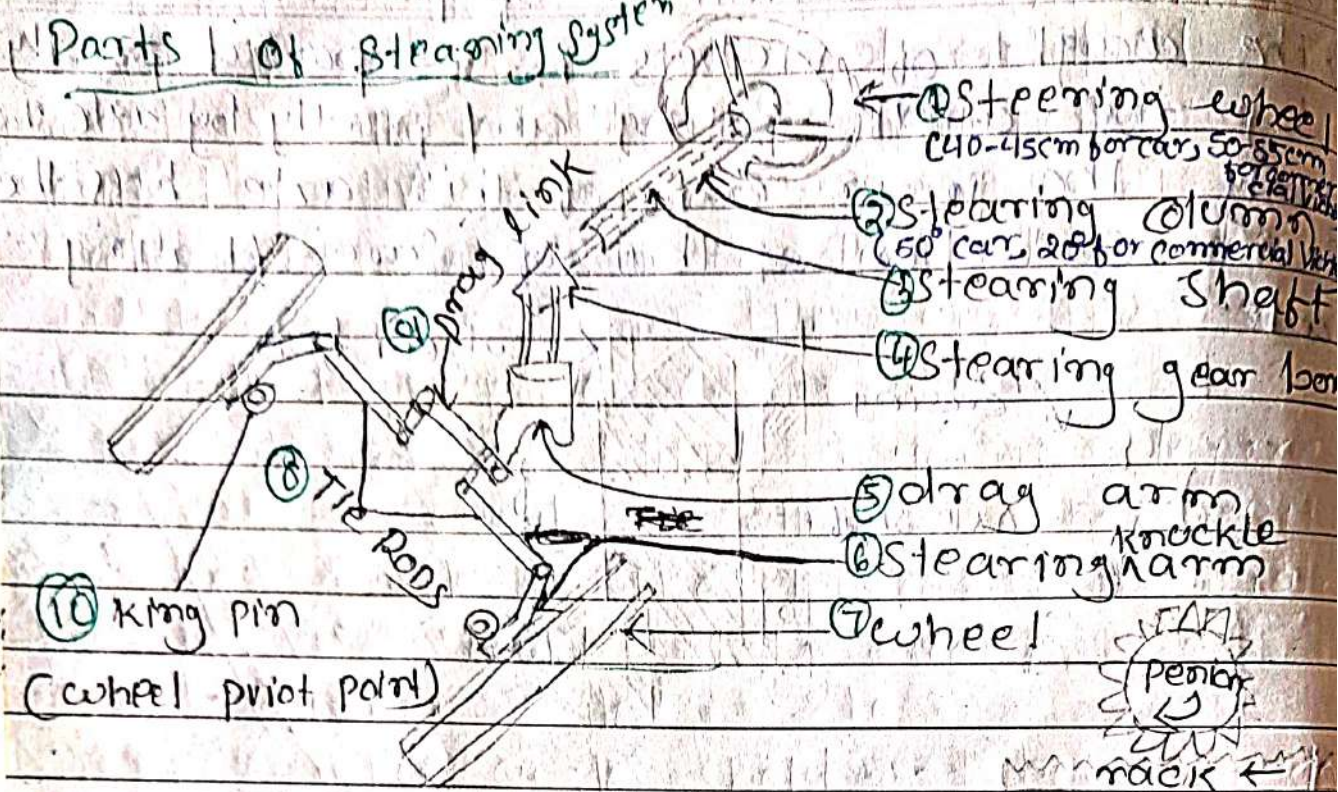
→ The weight of vehicle is supported partly  
 by the axial casing and partly by axle shaft  
~~same~~ the inner end of this axle has the  
 same construction as that of same floating  
 axle.



# STEERING AND FRONT AXLE

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## Parts of Steering System



→ It is the main controlling system of an automobile.

→ The purpose of the steering system is to allow the driver to control the direction of the vehicle.

→ by turning the front wheel.

→ This is done by means of the steering wheel.

→ The steering column, which transmits the rotation of the steering wheel to the steering gear, and the steering gear which increases the rotation force of the steering wheel in order to generate torque to the steering linkage and then to the front wheel.

→ The <sup>main</sup> function of the steering system is to convert the rotary motion of the steering wheel into an angular turn of the front wheel.

## Steering System Function

1) It helps in swinging the wheels to the left or right.

2) It helps in turning the vehicle.

3) It provides directional stability.

4) It helps in controlling wear and tear of the tires.

5) It helps in achieving the self-righting effect.

The steering system essentially consists of two elements a steering gear at the lower end of steering knuckles and steering linkage.

6. It absorbs major part of the road shocks there by preventing them to get transmitted to the hand of driver.

Requirements of good steering system

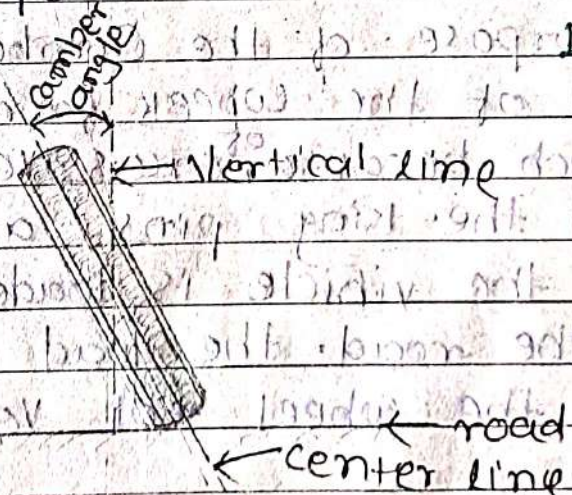
- (1) For easy to handle
- (2) Provide directional stability
- (3) Very accurate

Type of steering gear

- (1) worm and sector steering gear
  - (2) worm and roller
  - (3) cam and double flange
  - (4) Worm and ball bearing nut
  - (5) cam and rod and peg
  - (6) Cam and roller
- (7) Rectangular ball
- (8) Rack and pinion

Dr. 10.9.14

CAMBER



Camber is the tilting in or out of the front wheel from the vertical when viewed from the front of the vehicle.

For the camber is the angle

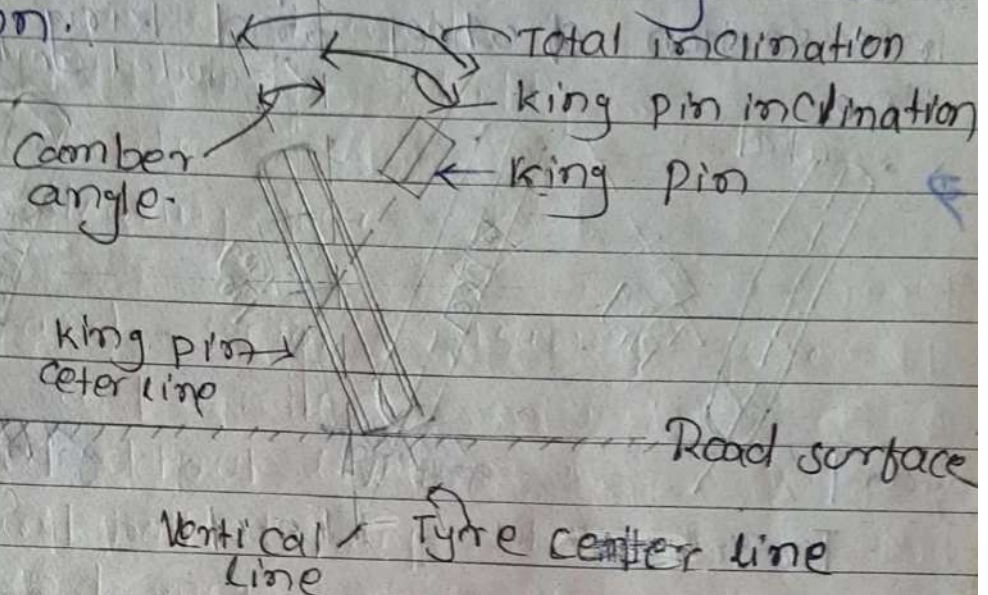
The angle between the center line of the tyre and the vertical line when viewed from the front of vehicle is known as camber.

the wheel

- ⇒ when the angle is out word on tilted out word is ~~edge~~ at the top then bottom is called positive camber.
- ⇒ when the angle is in word on the wheel tilted in word at the top then bottom is called negative camber.
- ⇒ The amount of tilted major in degree from the vertical is called camber angle.
- ⇒ Camber angle is also known as "wheel rake".
- ⇒ Camber should not be exceed  $2^{\circ}$  to  $3^{\circ}$ .
- ⇒ The camber angle is  $2^{\circ}$  to  $3^{\circ}$ .
- ⇒ The "Camber" angle should not be exceed  $3^{\circ}$ . If this angle is more then one side of tyre wear more then other side.
- ⇒ The front wheel are not parallel to each other but slightly out word at the top and in word at the bottom.
- ⇒ The purpose of the camber is to prevent the top of the wheels from tilting in word too much because of excessive loads or play in the king pins and wheel bearing.
- ⇒ when the vehicle is loaded and rolling along on the road, the load will just about bring the wheel ~~at~~ <sup>net</sup> vertical position.
- ⇒

## KING PIN INCLINATION OR STEERING AXLE INCLINATION

It is the angle between the vertical line and center of the king pin when viewed from the front of vehicle. It is known as king pin inclination or steering axle inclination.



→ Now a days king pin has been replaced by ball joint and that is renamed steering axle's inclination.

→ Generally king pin inclination is  $7^{\circ}$  to  $8^{\circ}$ .

→ King pin is used to provide directional stability in modern cars. by tending to turn the wheel to the straight ahead position after any ~~turn~~ turn.

→ It makes operation of steering quite easy when the vehicle is stationary.

→ It reduces the tyre wear also.

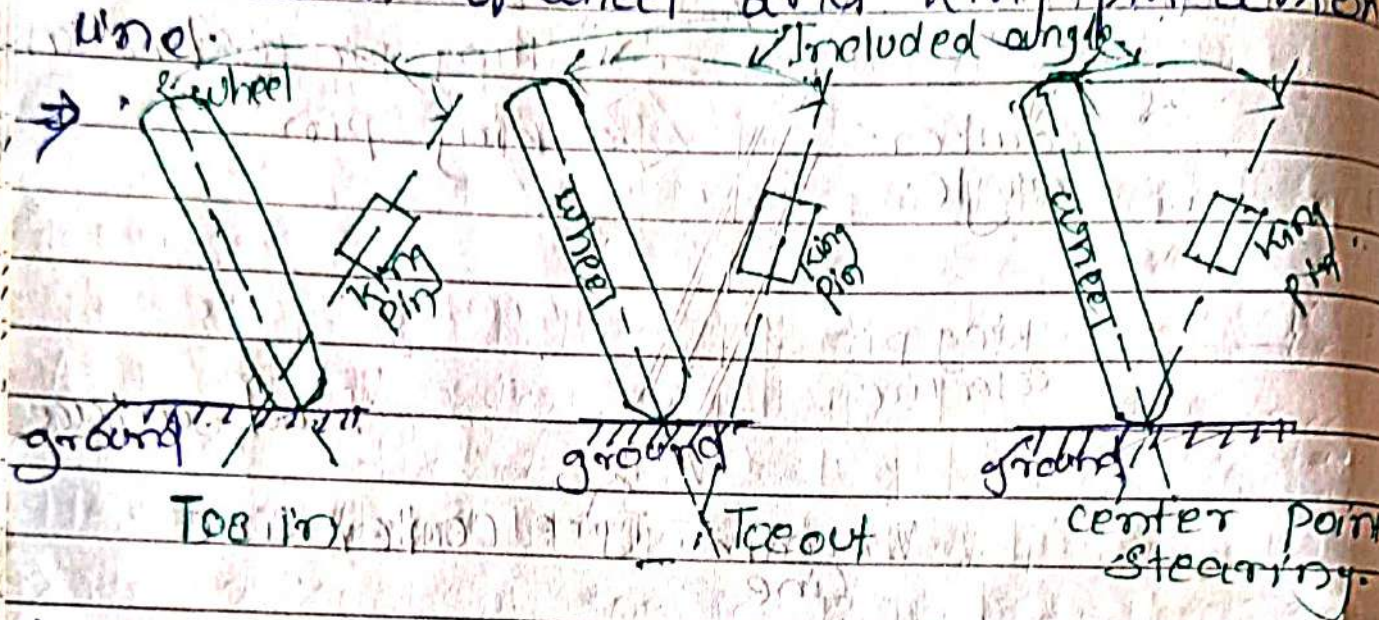
→ It must be equal on both sides. if greater on one side than the other the vehicle will tend to pull to the side having greater angle.

→ The king pin inclination is made adjustable only by bending.

Included angle (See diagram of king pin

The combined of camber angle and king pin inclination is called included angle or Total inclination angle.

→ It is determine the point of intersection of wheel and king pin center line.



→ If the point of intersection of king pin and wheel center line and wheel is above the ground the wheel tends to toe in

→ If the point of intersection of king pin center line and wheel below the ground the wheel tends to toe out

→ If it is at ground the wheel keep its straight position with out any tendency to toe in or toe out. In this position the steering is called Center point steering.

Grade-film festival

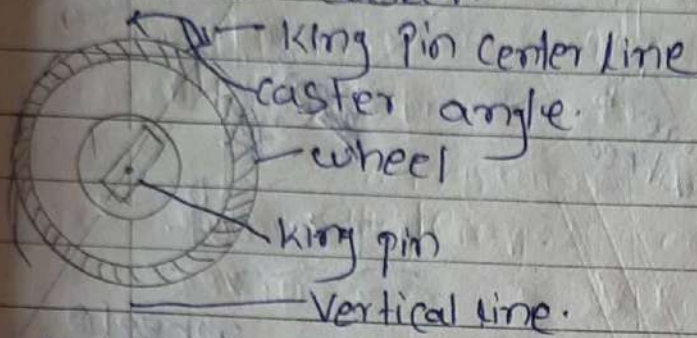
Child great: Obama

RK - Raj Kumar Prami

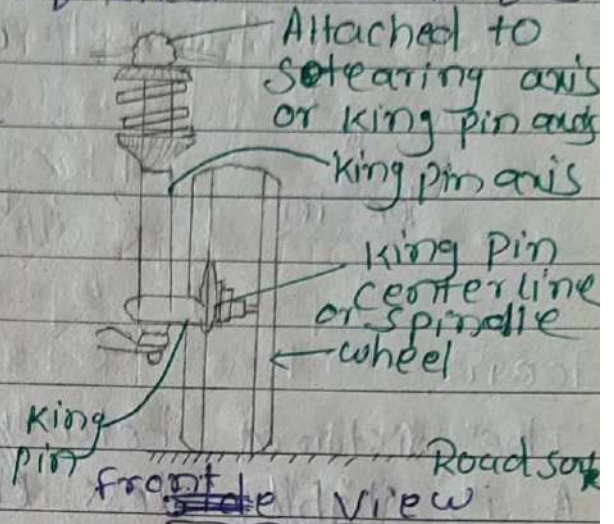
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# CASTER

⇒ The king pin axis ~~may~~ also (or steering axis) may also be tilted forward or backward from the vertical line of wheel. this tilt is known as caster.



~~Front View~~  
Side View

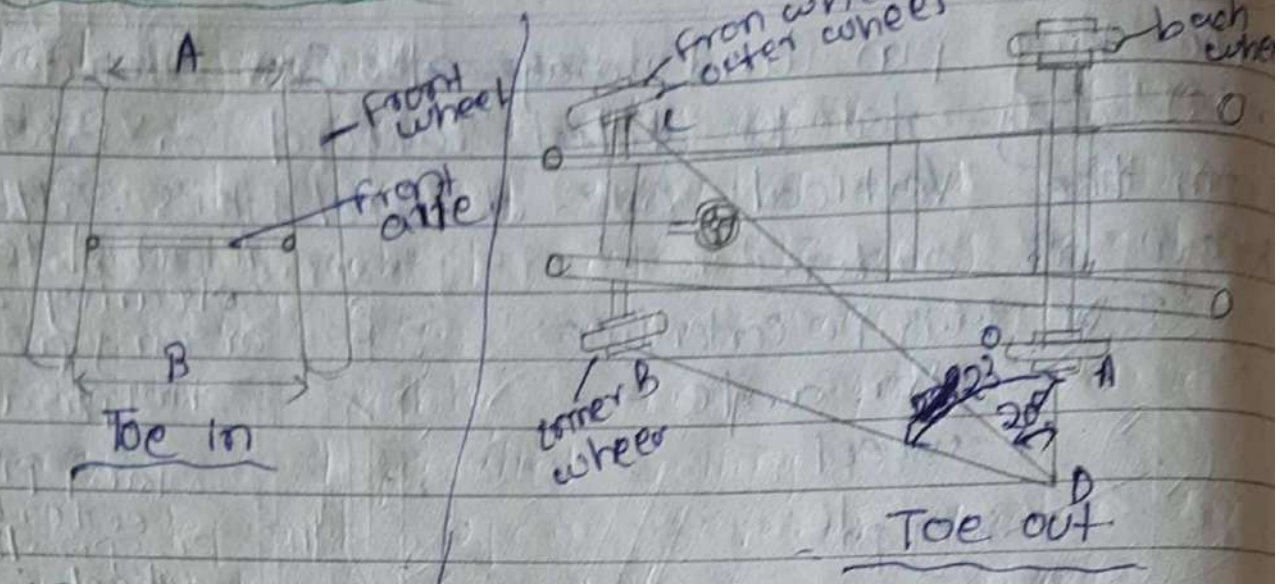


Caster angle - The angle between the vertical line and the king pin center line in the plane of wheel (when viewed from side) is called caster angle.

- ⇒ The caster angle is  $2^{\circ}$  to  $8^{\circ}$
- ⇒ ~~The~~ When the top of the king pin is backward the caster angle is positive
- ⇒ When the top of king pin is forward the caster angle is negative.
- ⇒ When both the front wheel have positive caster the vehicle tends to roll out on turns
- ⇒ But if front wheel have negative caster. the vehicle tends to roll in turns or tends to back.
- ⇒ The caster produce directional stability by causing the wheel lead or flow in the same direction as the vehicle travels.



# Toe (in/out)



## Toe-in

The distance between the front ~~wheel~~ <sup>wheel</sup> ends A is slightly less than the distance between the another ends B <sup>in stationary state</sup>. The difference between these distance is called toe-in.

- ⇒ The amount of toe in or ~~the dist~~ (B-A) is 3 to 5 mm
- ⇒ Toe-in is provided to ensure parallel rolling of front wheel
- ⇒ To stabilize steering
- ⇒ Prevent side slipping
- ⇒ Excessive tyre wear.
- ⇒ The wheel are set to toe-in when the ~~car~~ car is standing. Still they tend to roll parallel on the road when the car is moving <sup>forward</sup>.

## Toe out

- ⇒ It is the difference <sup>in angle</sup> between the two front wheel during turns
- ⇒ The steering system is designed to turn inner wheel through a larger angle than the outside when making turn.
- ⇒ Excessive toe-out causes toe-out on turns.

→ Let take a reference point D from straight of back wheel then → The inner wheel turn to an angle  $23^\circ$  while outer wheel turns  $20^\circ$  So the the difference between the two angle is  $3^\circ$ .

→ The toe out is secured providing the proper relation ship between knuckle arm, tie rods and pitman arms.

→ The wheels are said to toe out when the car taking turns the outer wheels make a ~~longer~~ travel on a larger radius than inner wheel therefore the inner wheel must make a larger angle than the outer wheel.

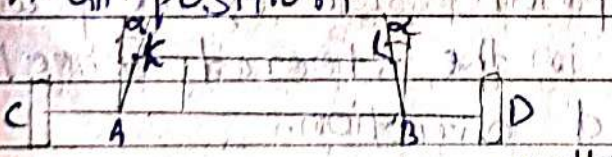
STEERING MECHANISMS

There are two types of steering gear mechanism

- (1) Davis steering gear
- (2) Ackermann steering gear.

DAVIS steering gear

→ It has sliding pair  
 • So more friction  
 → wear out earlier  
 • Not mathematically accurate in all position

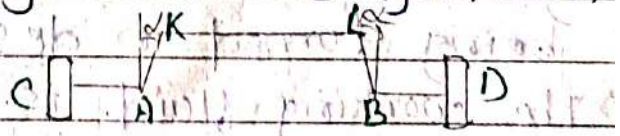


→ cross link KL is parallel to <sup>another</sup> link AB  
 • The KL slide in bearing when steering wheel is operated  
 → AK and BL = short arm are inclined so that there is a stubble axle AC and BD  

$$\tan \delta = \frac{2 AB}{l \text{ (wheel base)}}$$

Ackermann steering gear

→ steering gear has only turning pair  
 • So less friction  
 → wears out less than Davis's steering gear  
 • Not mathematically accurate except in three position  
 (i) right (ii) left (iii) straight position



→ Cross link KL is connected to the short axle AC and BD of the front wheel through short arm AK & BL  
 → It is preferred in all vehicle now a days

## Wheel Alignment

- ⇒ The front wheel alignment is influenced by correct steering geometry and setting of front wheel axle, steering mechanism.
- ⇒ It provides an easier directional control stability to vehicle when negotiating curve or torque and parallel rolling.
- ⇒ It depends upon several factors like
  - (i) Camber (Positive & Negative)
  - (ii) King pin inclination
  - (iii) Caster angle
  - (iv) Toe (in/out)

## POWER STEERING

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- ⇒ The increased use of large pressure balloons tyre has the steering problem due to <sup>greater</sup> contact area between tyre and ground.
- ⇒ The driver requires greater force to be exerted on the steering wheel when vehicle has to take a sharp turn.
- ⇒ Power steering makes it easier to ~~turn~~ sharp turn.
- ⇒ It is operative when the steering wheel exceeds pre-determined value.
- ⇒ When this effort is excluded, a valve directs the working fluid to the appropriate side of the power cylinder, and this results in the steered wheel being turned in desired direction.
- ⇒ The working fluid is high quality lubricating oil having:
  - There are two types of power steering systems
  - 1. Integral power steering (for steering gear)
  - 2. Linkage power steering (for part of linkage)

- Brakes are one most important control component of the vehicle.
- Once the vehicle is started, it must be stopped some where. So Brakes are applied on the wheels to stop the vehicle or slow up the vehicle.
  - Before applying the brakes the acceleration is released to stop fuel supply, thus the engine develops no more power to run the vehicle. and then the brakes are applied.

### Functions of BRAKES

- 1) To stop or slow down the moving vehicle in shortest possible distance and time.
- 2) To hold the vehicle in his <sup>(constant)</sup> stationary position.

### Requirement of good braking system

- It should stop the vehicle at reasonable distance.
- It should be promotes higher degree of safety on the road.
- It should be dissipating heat very quickly.
- It should work equally good in all weather.
- All component of ~~braking~~<sup>braking</sup> system should be strong enough to take mechanical stress and strength.