

Unit no.4 Vehicle systems notes

Syllabus :- Introduction of chassis layouts, steering system, suspension system, braking system, cooling system and fuel injection system and fuel supply system. Study of Electric and Hybrid Vehicle systems. Study of power transmission system, clutch, gear box (Simple Numerical), propeller shaft, universal joint, differential gearbox and axles. Vehicle active and passive safety arrangements: seat, seat belts, airbags and antilock brake system.

CHASSIS LAYOUTS:-

A vehicle with out body is called Chassis. The components of the vehicle like Power plant, Transmission System, Axles, Wheels and Tyres, Suspension, Controlling Systems like Braking, Steering etc., and also electrical system parts are mounted on the Chassis frame.

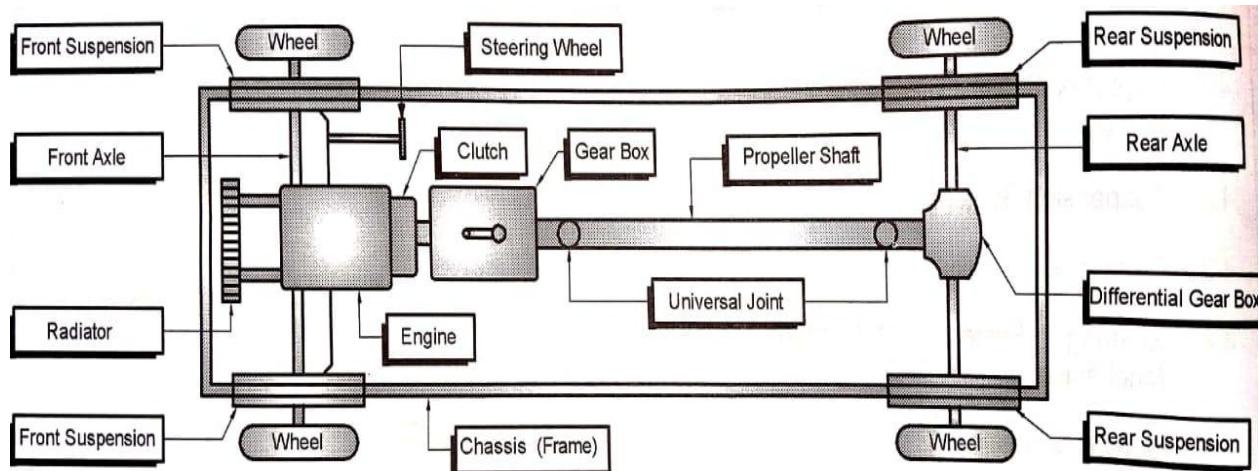


Fig. 4.1.2 : Layout of Chassis

The following main components of the Chassis are

- 1. Frame:** chassis is a skeleton frame of a vehicle on which various components or system of vehicle (radiator, engine, gearbox, suspension system, steering system, fuel tank, etc.).
- 2. Engine or Power plant:** It provides the source of power. An engine is a device that converts thermal energy into mechanical work. The thermal energy is produced by the combustion of air fuel mixture inside the cylinder by means of a spark produced by the spark plug. Since it uses thermal energy it is called as thermal engines.

3. **Clutch:** A clutch is a mechanical device which engages and disengages power transmission especially from driving shaft to driven shaft. In the simplest application, clutches connect and disconnect two rotating shafts (drive shafts or line shafts). In these devices, one shaft is typically attached to an engine or other power unit (the driving member) while the other shaft (the driven member) provides output power for work.
4. **Gear Box:** Torque ratio between the engine and wheels to be varied for rapid acceleration and for climbing gradients. It provides means of reversal of vehicle motion. Transmission can be disconnected from engine by neutral position of gear box.
5. **Propeller Shaft & Universal Joint:** The propeller shaft is a driving shaft which connects the transmission main shaft to the differential of the rear axle. It transmits the power from gear box to rear axle with the help of universal joints. The propeller shaft is also known as drive shaft. Universal joints (also called Hooke's joints) are used to allow torque (rotational power) to be transmitted through a varying angle. A typical use is in the propeller shaft of a car or truck, where the torque from the engine is fed to the rear axle.
6. **Differential gear box:** Differentials are used to transmit the power at right angles to the shaft. The power from the gear box comes through the propeller shaft and is given to the differential. From differential the power is distributed to the wheels.

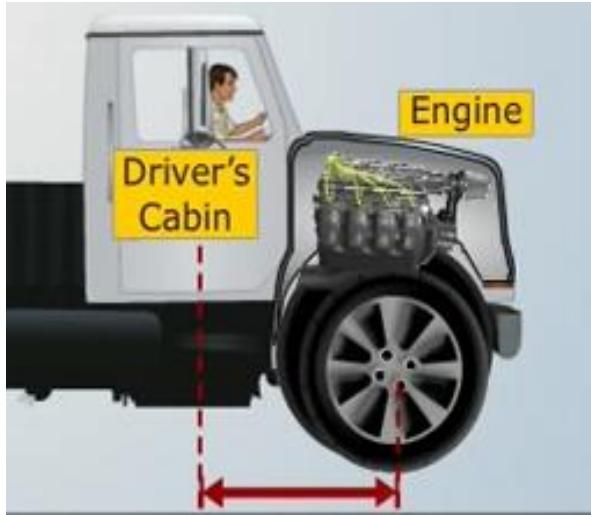
➤ **TYPES OF CHASSIS FRAMES:**

There are three types of frames

- **Backward control (conventional chassis)**
- **Forward control**
- **Semi – forward control**

A. Backward control (conventional chassis)

1. Here engine is usually mounted in front of driver's seat. This offers advantage as safety of driver in case of head collision.
2. Driver's front view is reduced as well as space utilization for pay load is also reduced.



B. Forward control

1. The engine is mounted completely inside driver's cabin.
2. Full utilization of space.
3. Driver's safety is reduced to large extent in case of head on collision with other vehicle



C. Semi – forward control

1. Half engine fitted inside driver's cabin.
2. This chassis layout gives advantage good drivers safety and more space utilization.

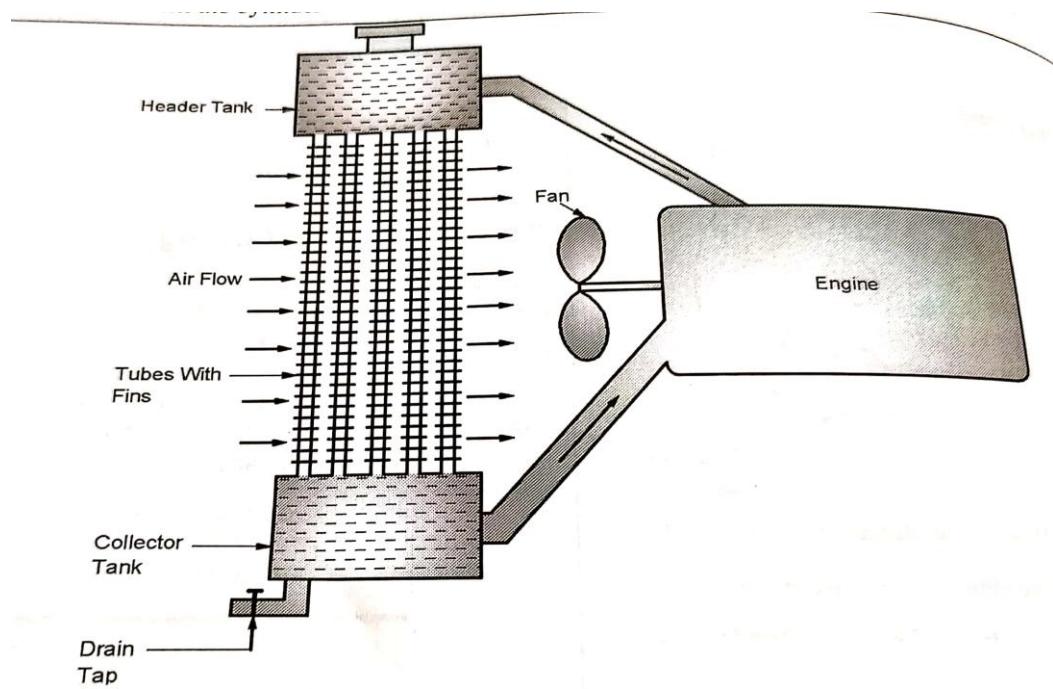


➤ **Cooling system :-**

- Types of cooling system
 - 1. Air cooling system
 - 2. Water cooling system

1. Water cooling system

In this method, cooling water jackets are provided around the cylinder, cylinder head, valve seats etc. The water when circulated through the jackets, it absorbs heat of combustion. This hot water will then be cooling in the radiator partially by a fan and partially by the flow developed by the forward motion of the vehicle. The cooled water is again recirculated through the water jackets.



Water cooling system mainly consists of :

- (a) Radiator,
- (b) Thermostat valve,
- (c) Water pump,
- (d) Fan,
- (e) Water Jackets

Radiator:-

It mainly consists of an upper tank and lower tank and between them is a core. The upper tank is connected to the water outlets from the engines jackets by a hose pipe and the lower tank is connect to the jacket inlet through water pump by means of hose pipes.

Thermostat Valve:-

Thermostat Valve It is a valve which prevents flow of water from the engine to radiator, so that engine readily reaches to its maximum efficient operating temperature. After attaining maximum efficient operating temperature, it automatically begins functioning.

Water Pump:-

It is said to be the heart of engine cooling system. Water pump has a radial impeller inside its casing which is driven by engine itself. Serpentine belt is used to deliver rotational motion of engine main pulley to the water pump pulley.

Fan :-

It is driven by the engine output shaft through same belt that drives the pump. It is provided behind the radiator and it blows air over the radiator for cooling purpose.

Water Jackets :-

Cooling water jackets are provided around the cylinder, cylinder head, valve seats and any hot parts which are to be cooled. Heat generated in the engine cylinder, conducted through the cylinder walls to the jackets. The water flowing through the jackets absorbs this heat and gets hot.

➤ Advantages

- a) Uniform cooling of cylinder, cylinder head and valves.
- b) Specific fuel consumption of engine improves by using water cooling system.
- c) If we employ water cooling system, then engine need not be provided at the front end of moving vehicle.
- d) Engine is less noisy as compared with air cooled engines

➤ Disadvantages

- a) It depends upon the supply of water.
- b) The water pump which circulates water absorbs considerable power.
- c) If the water cooling system fails then it will result in severe damage of engine.
- d) The water cooling system is costlier as it has more number of parts. Also it requires more maintenance and care for its parts.

➤ Fuel injection system and fuel supply system

1. Fuel injection system and fuel supply system FOR SI ENGINE
2. Fuel injection system and fuel supply system FOR CI ENGINE

1. Fuel injection system and fuel supply system FOR SI ENGINE

Traditionally carburetor is essential element of fuel supply system in petrol engine. It is now being replaced in petrol four wheelers by **multi-point fuel injection system (MPFI) system**.

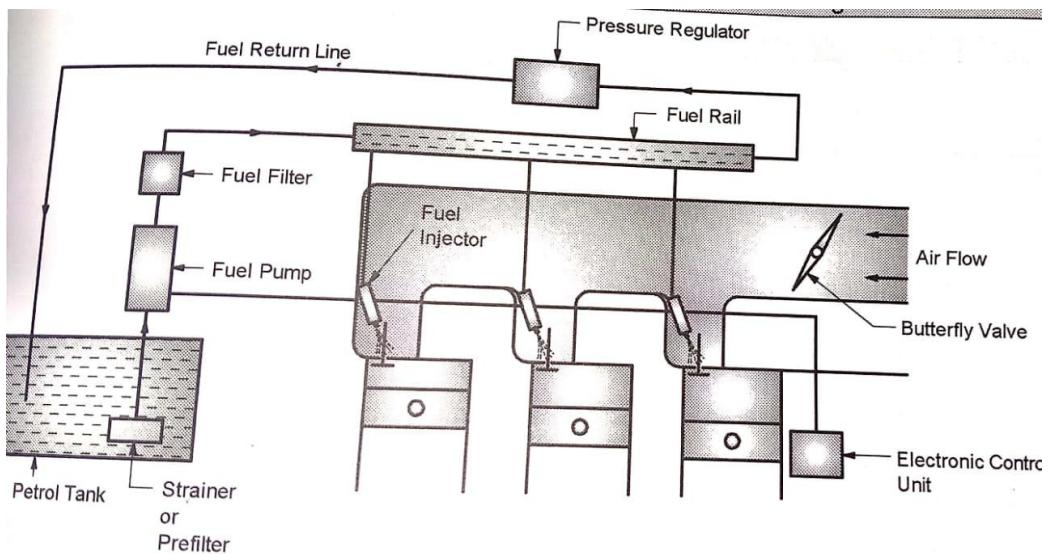


Fig. 4.7.1 : Fuel Supply and Fuel Injection System in Petrol Engine (MPFI)

1. **Fuel Pump:** Fuel pump increase the pressure the pressure of the petrol before feeding it to the fuel rail. The fuel pump is driven by engine camshaft or electric motor.
2. **Fuel filter:** A fuel filter cleans the fuel of any impurities like dust particles or any form of debris present in the fuel tank small enough to travel into the fuel filter. The purpose of the fuel filter is to clean the fuel of such impurities before it reaches the pump.
3. **Fuel rail:** A fuel rail is high pressure tubing which takes fuel to the injectors in an internal combustion engine
4. **Fuel injector:** a fuel injector is placed in intake manifold of each cylinder. The pressure petrol enters the fuel injector and fuel injector injects the petrol into intake manifold at high velocity. The air is flowing through the intake manifold. The homogenous air & petrol mixture then enter the engine cylinder through the intake valve.
5. **Pressure regulator:** A pressure regulator is a device which controls the pressure of petrol on fuel rail.
6. **Electronic control unit:** The ECU controls the fuel injection system. ECU decides the quantity of fuel to be injected & controls ignition timings.

2. Fuel injection system and fuel supply system FOR CI ENGINE

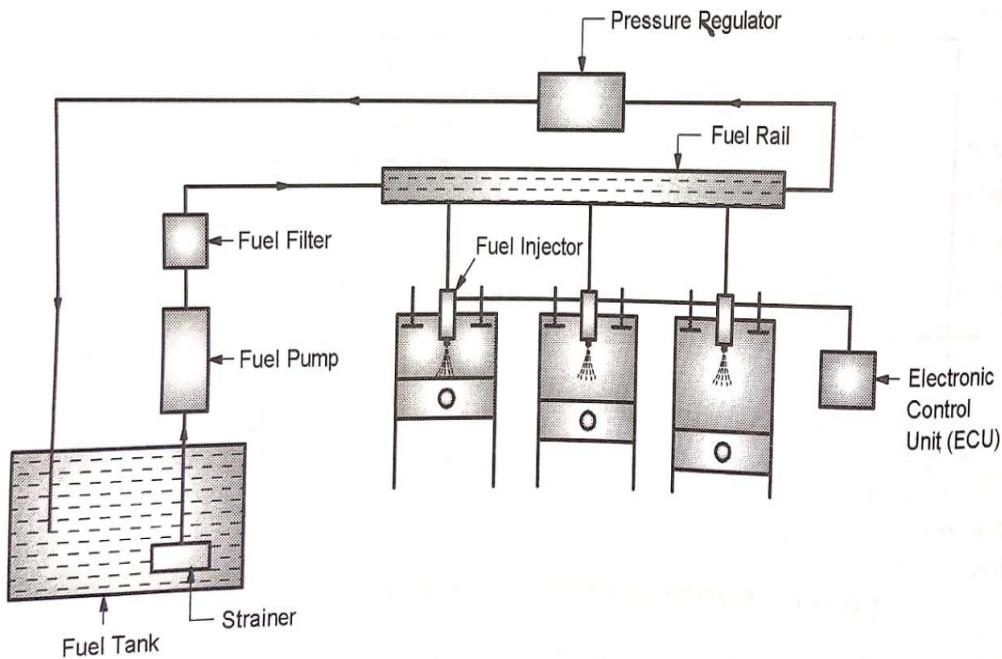


Fig. 4.8.1 : Fuel Supply and Fuel Injection System of Diesel Engine

- 1. Fuel Pump:** Fuel pump increase the pressure the pressure of the diesel before feeding it to the fuel rail. The fuel pump is driven by engine camshaft or electric motor.
- 2. Fuel filter:** A fuel filter cleans the fuel of any impurities like dust particles or any form of debris present in the fuel tank small enough to travel into the fuel filter. The purpose of the fuel filter is to clean the fuel of such impurities before it reaches the pump.
- 3. Fuel rail:** A fuel rail is high pressure tubing which takes fuel to the injectors in an internal combustion engine.
- 4. Fuel injector:** a fuel injector is placed in cylinder head of each cylinder. The high pressure diesel enters the fuel injector and fuel injector injects the diesel into cylinder at the end of compression stroke.
- 5. Pressure regulator:** A pressure regulator is a device which controls the pressure of diesel on fuel rail.
- 6. Electronic control unit:** The ECU controls the fuel injection system. ECU decides the quantity of fuel to be injected & controls ignition timings.

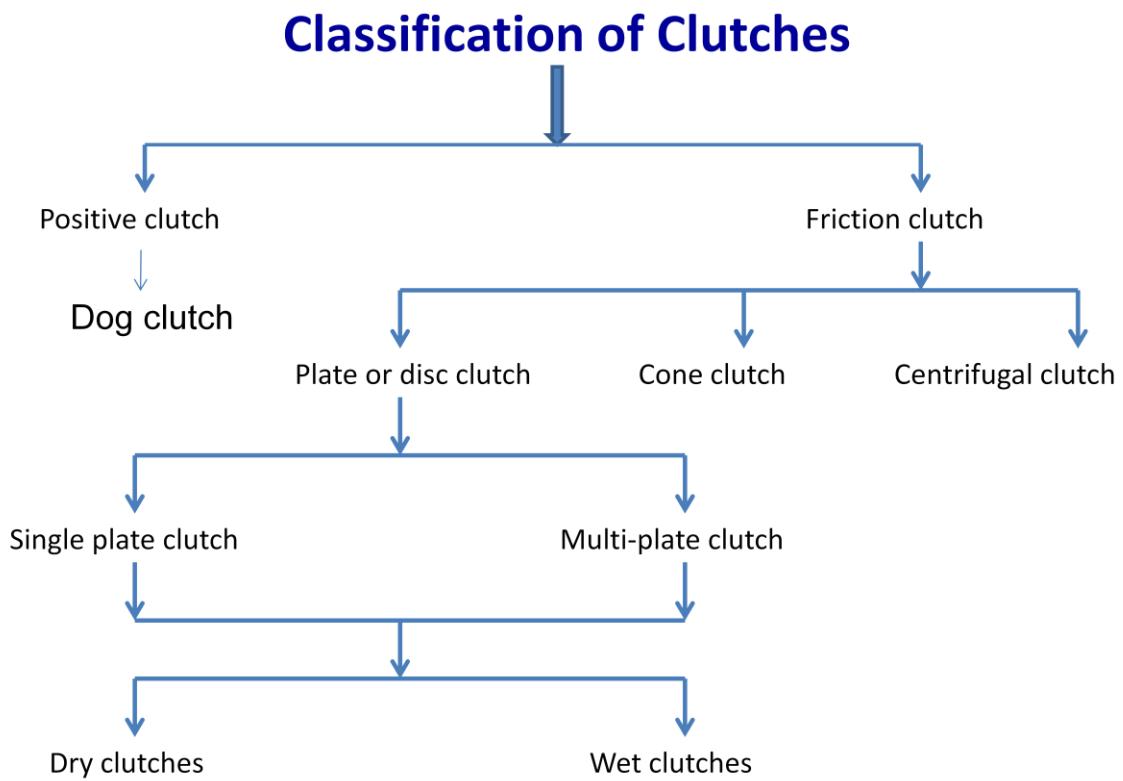
➤ Advantages of injection system for SI & CI

1. Meter correct quantity of fuel as per load & speed
2. Correct timing of fuel injection
3. Equal distribution of fuel to all cylinders
4. Injection of fuel to start and terminate instantaneously. No dribbling

➤ Clutches

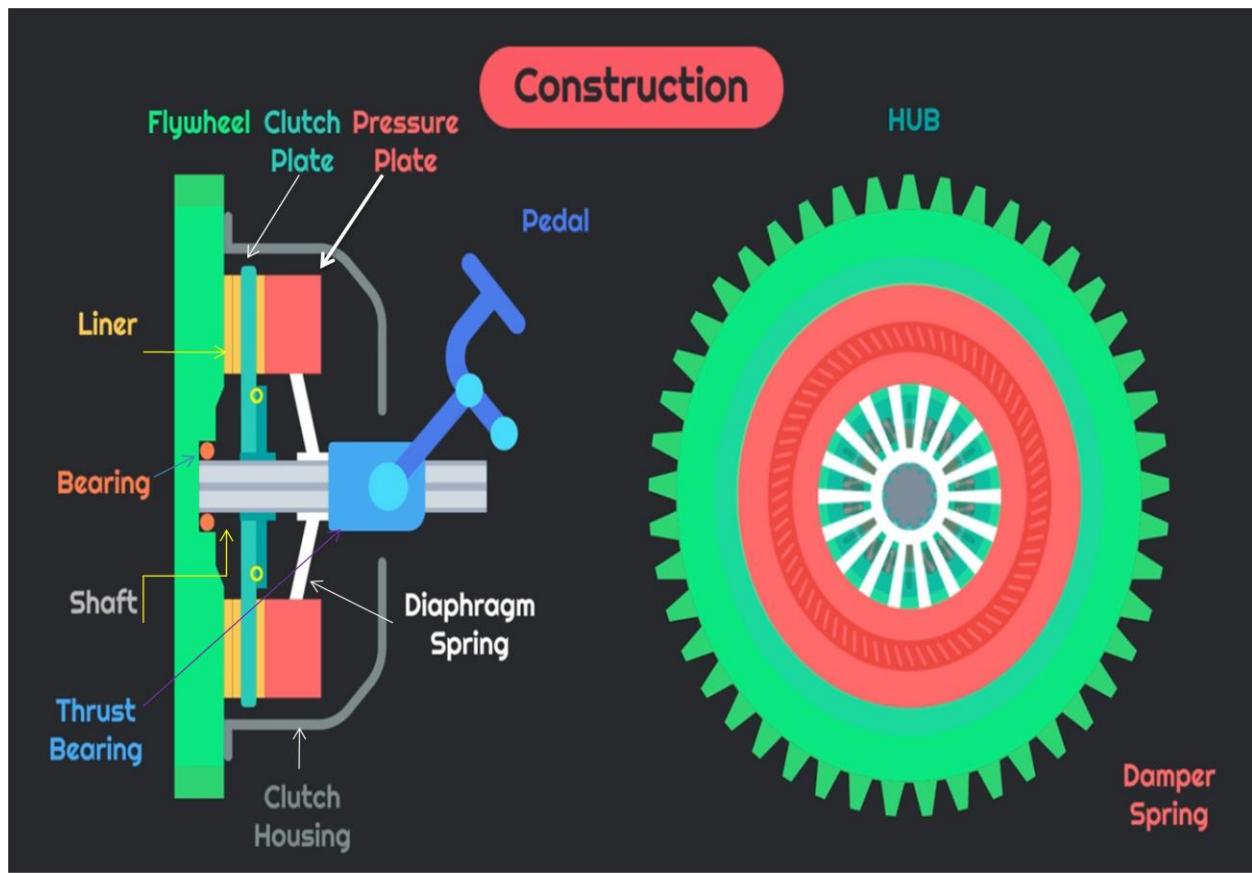
- Clutch is defined as the mechanism to transmit rotary motion from driving shaft to driven shaft as and when required, without stopping the drive shaft.
- Clutch is a device used to engage and disengage two co-axial shafts while at rest or in relative motion gradually. The gradual engagement of driven shaft limits torque demanded from the driving shaft.

➤ Types of clutches:



1. Single Plate Clutch

It consists of two flanges with friction lining on one flange (mounted on driven shaft). In this system, one flange is rigidly keyed to the driving shaft and other is free to move along the splines provided on the driven shaft.



Flywheel:

Flywheel is attached to engine output and its other side comes in contact with clutch plate when pressure is applied by the pressure plate.

Clutch plate:

In single plate clutch only one clutch plate is used. Clutch plate is main component of clutches. It is thin disc type metallic plate having both side frictional surfaces. Frictional surfaces on plate must be of such material to provide friction for transmitting torque without slipping. The coefficient of friction of contact surfaces should be high for proper connection without slipping. Clutch plate is assembled in between flywheel and pressure plate.

Pressure plate:

The pressure plate which is generally made up of cast iron. It helps in applying pressure on clutch plates to maintain the proper contact between the surfaces of flywheel and clutch plate by means of spring which are attached to it.

Springs:

Springs are used to maintain the pressure on pressure plate for proper connection between clutch plate and flywheel and prevent the slipping of contact surfaces.

Operating mechanism:

This includes foot pedal, linkage, bearing and lever etc. All these components are connected in a sequence. Foot pedal is located inside the automobiles; a lever mechanism is attached with foot pedal which transmit the motion from pedal to spring by means of thrust bearings.

Working:

Working of single plate clutch is very simple. A mechanism is responsible for the engagement and disengagement of clutch. We easily engage and disengage the torque transmitting shafts just by apply some force on the paddle of automobile. A lever is attached to the paddle which is responsible for the force transmission from the paddle. When pedal is pressed spring is compressed and engine is free to move without any load. Lever is attached in such a manner when we press the clutch paddle thrust bearing moves forward and pressure plate moves backward or it moves away from the flywheel; due to this the connection between the clutch plate and flywheel released and shafts are disengaged. This time we can easily change gears in case of automobiles. Again if we want to engage the shafts just release the clutch paddle; then springs attached to the pressure plate push the pressure plate forward. Clutch plate is mounted between the pressure plate and flywheel on the hub. Clutch plate has both side friction lining that's why it mounted in between pressure plate and flywheel and helps in torque transmission.

Advantages:

- The working of the single plate clutch is smooth i.e. the engagement and disengagement is very smooth in operation
- Less slip occurs in it; slip is occurs only at the time of engagement after engagement no slip occurs and the functioning becomes very smooth.
- Power losses are very less.
- Less heat generates because only single plate is used. Heat generation creates problem in power transmission and can damage the working parts.
- No requirement of coolant because less is generated therefore they are called dry clutches.

Disadvantages:

- It has less torque transmitting capacity
- It has bigger in size even for transmitting less torque.
- It requires high maintenance because they are dry clutches and it is necessary to prevent them from moisture or any leakage of lubricant/oil in machinery.
- Single plate clutches have high wear and tear rate and have less smooth engagement.

➤ GEAR BOX

Torque ratio between the engine and wheels to be varied for rapid acceleration and for climbing gradients. It provides means of reversal of vehicle motion. Transmission can be disconnected from engine by neutral position of gear box.

➤ **Necessity Of Gear Box In An Automobile**

- The gear box is necessary in the transmission system to maintain engine speed at the most economical value under all conditions of vehicle movement.
 - An ideal gear box would provide an infinite range of gear ratios, so that the engine speed should be kept at or near that the maximum power is developed whatever the speed of the vehicle.

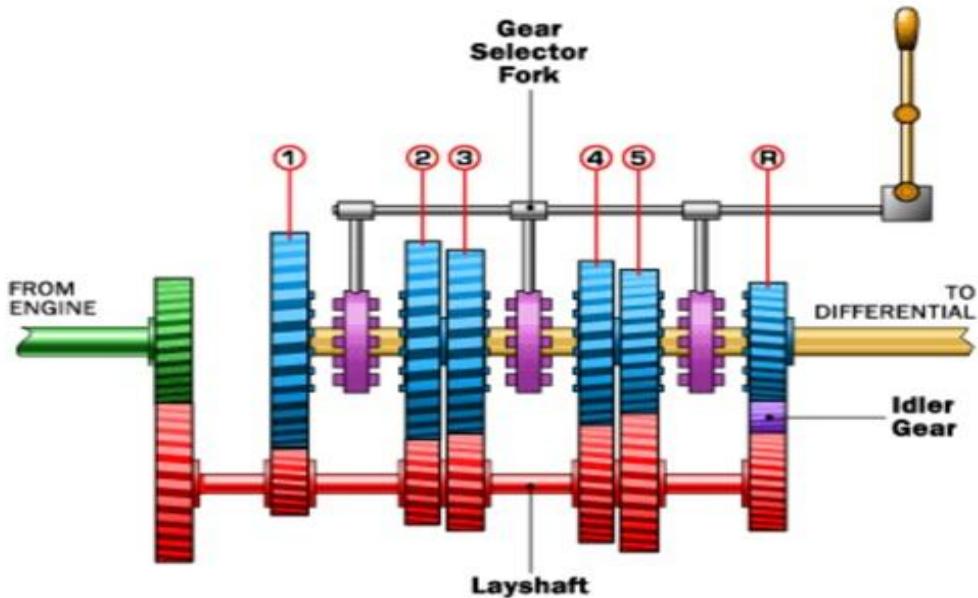
➤ Selective Type Gear Box

- It is the transmission in which any speed may be selected from the neutral position reverse gear.

Some selective type gear boxes are,

1. Constant mesh gear box with positive dog clutch.
 2. Constant mesh gear box with synchromesh device.
 3. Sliding mesh gear box

1. Constant mesh gear box with positive dog clutch



➤ Construction

Counter shaft or Lay Shaft:

This shaft is in direct contact with the **clutch** and the main shaft. Keeping in mind according to the gear ratio, the speed of the counter shaft may be less than the speed of the engine. The gear ratio can be defined as the ratio of the teeth of driven gear to the teeth of the driver gear.

Main shaft:

This shaft operates the speed of the vehicle. The power is made available to the main shaft through the gears from the counter shaft. This is done in accordance with the gear ratio.

Dog clutch:

Dog clutch is special feature of constant mesh gearbox. It is used for the coupling of any two shafts. This is done by interference. Using a dog clutch, various gears can be locked to the output and input shafts.

Gears:

The main work of the **gears** is the transmission of power between the shafts. If the gear ratio is more than one, the main shaft will work at a speed that is slower than the counter shaft, and vice versa. The arrangement of both reverse, as well as forward gears is present.

➤ Working:

Forward gear selection:

From the input shaft, the power starts flowing and is divided into six parts. Each part goes to one of the output gears, namely first, second, third, fourth, fifth and sixth. Gear ratios can be obtained for each of them. This can be done by the proper sliding of dog clutch over the teeth of the selected gearwheel. After this the path of the energy flow completes. This happens due to the locking movement of the output shaft.

Reverse gear selection:

The power will flow from the input shaft to the reverse gears. The power is then transmitted from the reverse gear to the reverse idler. The idler wheel will change the direction of the rotation. In the case of forward direction gear selection, the output gears will rotate in a direction opposite to the input gears. But in the case of reverse gear selection, the rotation is in the same direction as the input shaft.

The steps are taken to change any gear in the constant mesh gearbox system:

1. The first step when one wants to modify the gear would be the pressing of the clutch. After this comes the neutral state of the vehicle to be achieved. Proper optimization of the engine's speed is required.
2. After the neutral gear, one moves forward to the first gear. The power is thus transmitted from gear box input shaft to layshaft 1st gear and from there 1st gear on the main shaft and finally to the gear output shaft.
3. Since the diameter of 1st gear comparatively bigger, speed of engine reduces but torque is increased.
4. In Second gear, the dog clutch shifts to right, engaging with the second gear on the main shaft, and thus another gear ratio is obtained with increased in speed and reduction in torque.
5. To achieve third gear, the second dog clutch is shifted to its left in order to mesh with 3rd gear on main shaft. In this condition, the speed increases further, while torque reduces.
6. When dog clutch is shifted to its right in order to mesh with 4th gear on main shaft. In this condition, the speed increases than 3rd gear and torque is reduces.
7. The top or 5th gear is achieve the third dog clutch is shifted to its left in order to mesh with 5th gear on main shaft. In this condition, highest speed achieved i.e speed of the clutch shaft almost equal to the speed of main shaft.
8. In reverse position, the third dog clutch shifted towards its right to engage with the reverse gear that rotates in reverse direction using idler gear, and thus reverse motion is transferred to the gear box out put shaft.
9. The motion obtained at the gear box output shaft through different gearing arrangement is then transferred to the differential gear box.

Advantages:

- The first and foremost benefit of the constant gear mesh is the utilization of helical gears. The double helical gears and the helical gears are extremely beneficial owing to their quieter operating capabilities
- There are various conditions which might cause harm. In the case of constant mesh gearbox, any harm is suffered entirely by the dog clutch teeth. The teeth belonging to the gear wheels remain intact. This is not the case for sliding mesh gear box.
- The other gear boxes are noisy and create an unwanted din.

Disadvantages:

- It is less efficient than the others due to higher mesh teeth. Skill is required for it.
- The double clutch mesh is required. This is required to have the spinning movements of the shaft

Application:

Some of the vehicles which use this type of gearboxes are farm trucks, motorcycles, and heavy machinery

➤ Gear ratio or Speed ratio:

- The Gear Ratio is defined as the ratio of speed of input shaft (engine shaft) to the speed of output shaft (propeller shaft).

OR

- The ratio of the number of teeth on the output shaft (gear) to the number of teeth on input shaft (pinion).

$$i = N_1/N_2 = d_2/d_1 = Z_2/Z_1$$

Where,

i = Gear ratio or Speed ratio

N₁ = speed of input shaft of gear box in r.p.m

N₂ = speed of output shaft of gear box in r.p.m

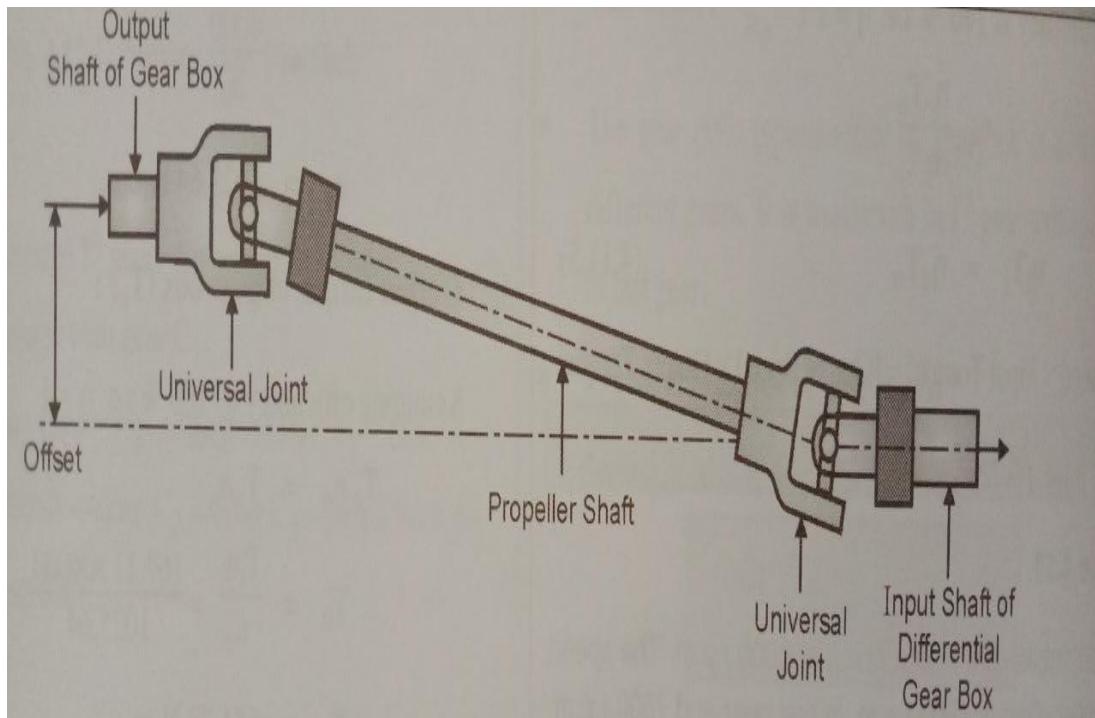
Z₂ = number of teeth on the output shaft (gear)

Z₁ = number of teeth on input shaft (pinion)

d₂ = pitch circle diameter of gear, mm

d₁ = pitch circle diameter of pinion, mm

➤ Propeller Shaft & universal joint



Propeller Shaft:

It is the shaft which connects the transmission output shaft to the differential mechanism at the rear wheels. In other words the shaft which transmits the engine power from slip joint (sliding joint) to wheels through differential, this power used for to move the vehicle from one place to another.

- **Functions:**

- It transmits rotary motion of the gearbox output shaft to the differential.
- It transmits motion at some angle which varies frequently.

- **Construction:**

- It is made up of a steel hollow tube, which are connected with slip joint and two universal joints.
- Having diameter 50 to 70 mm and thickness from 1.5 to 7.5 mm.
- The slip joint are made on the propeller shaft with external splines on shaft and internal splines on the sleeve.

➤ Universal joint

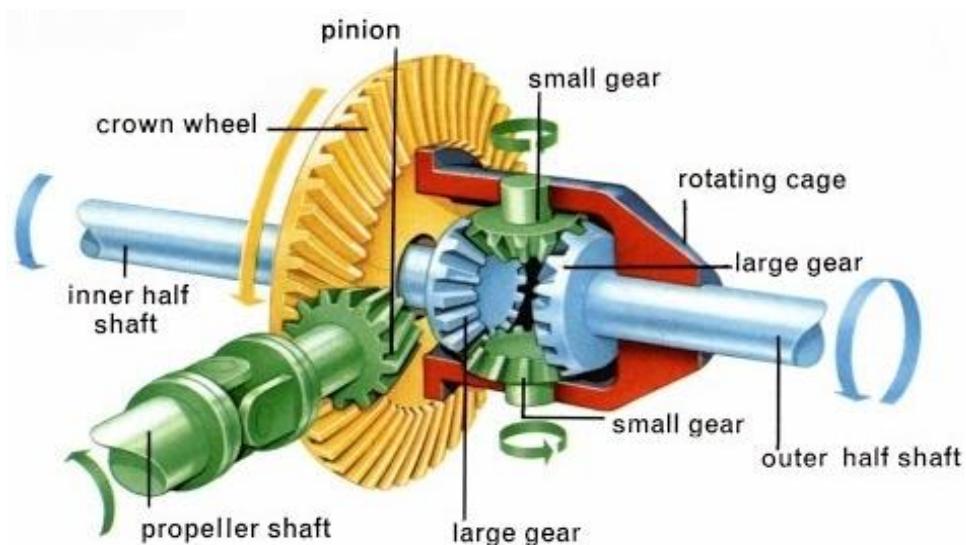
- A joint is a particular type of connection between two shafts, whose axes are inclined to each other. The Hooke's joint is simple type of universal joint which is widely used in vehicles. The construction is of this joint is very simple. This type of joint efficient for small angles of propeller shaft movement up & down, upto the 18° .
- The angular movements between the two shafts are possible due universal joint (Hook's Joint), The Hooke's joint uses needle roller bearing to support the cross in the yokes. This results in increase of joint efficiency.

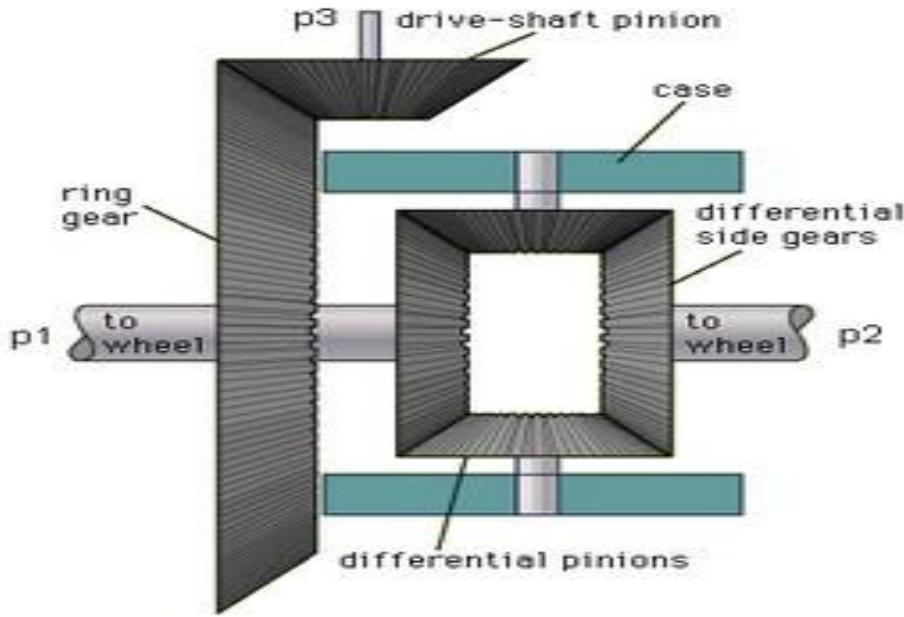
➤ Differential gear box

- When the car is taking a turn, the outer wheels will have to travel greater distance as compared to inner wheels in this case differential works. The less rotation of a inner wheel and more rotation to outer wheel it is possible by only using different gears in differential. Or inner wheel steady and outer wheel in running condition. Due to every vehicle required differential.

Function

- Reduce speed and increase torque
- Change the direction of torque as gearbox output shaft is longitudinal
- i.e. it turns the drive of propeller shaft to that of the wheels.





Construction:

- The driving gear wheel with less no. of teeth called bevel pinion
- The driving conical gear called as crown wheel.

Working:

- The propeller shaft has a small bevel pinion which is in mesh with the crown wheel at right angle this crown wheel rotates the rear axles. The axles are two half shafts.
- The rotation of propeller shaft converted at right angles to the rear axles.
- The crown wheel size is larger than the size of the pinion bevel gear hence the speed of crown wheel is lower than bevel pinion

➤ Braking System

- The brake is used to slow-down or stops the motion of the moving member whenever required. In other words brakes are one of the very important control components of vehicle.
- The main function of brake is to stop the vehicle within the smallest possible distance. This is done by converting the kinetic energy of the vehicle into heat energy & this heat dissipated in environment. In braking action, the kinetic energy is converted into heat by friction and the generated heat is ultimately dissipated to the atmosphere.

➤ Classification of Braking System

1. On the Basis of Power Source

1. Mechanical braking system
2. Hydraulic braking system
3. Air or pneumatic braking system
4. Vacuum braking system
5. Magnetic braking system
6. Electric braking system

2. On the Basis of Frictional Braking Contact

- (i) Internal expanding brakes (e.g.- drum brakes)
- (ii) External contracting brakes(e.g. disc brakes)

3. On the Basis of Brake Force Distribution

- (i) Single acting brakes
- (ii) Dual acting brakes

1. Disc Brake

1. Wheel Hub: The disc rotor is attached to the wheel hub and it rotates with it. The wheel of the vehicle is bolted to the wheel hub.

2. Caliper Assembly: The caliper assembly consists of

(i) Brake pad: It makes contact with the rotor disc and due to the friction between the brake pad and rotor disc the vehicle speed reduces and it stops.

(ii) Caliper bracket

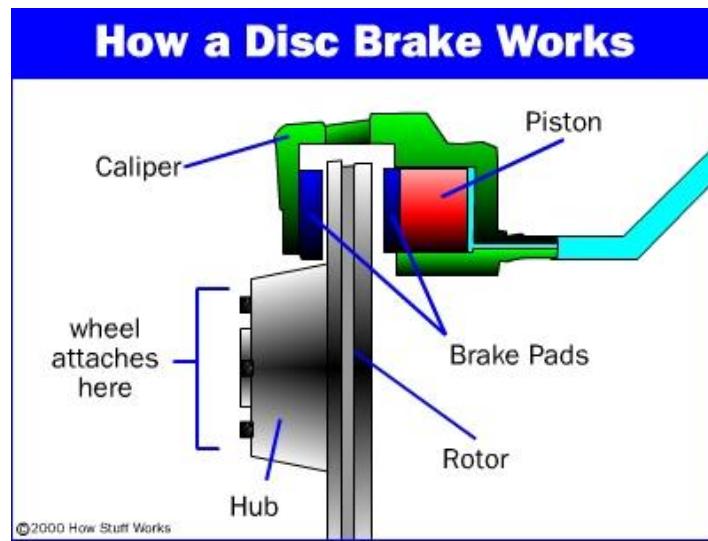
(iii) Caliper frame

(iv) Piston: It applies the brake force on the brake pads when brake lever is pressed.

(v) Slider pin: It is the sliding pin which slides in the hole when brake is applied.

(vi) Dust boots: It prevents the entry of dust into the caliper pin or slider pin hole.

3. Disc Rotor: It is the rotating part of disc brake. When brakes are applied, a lot of heat is generated which can decrease the braking efficiency, so the rotor has drilled vent holes on it which dissipates the heat.

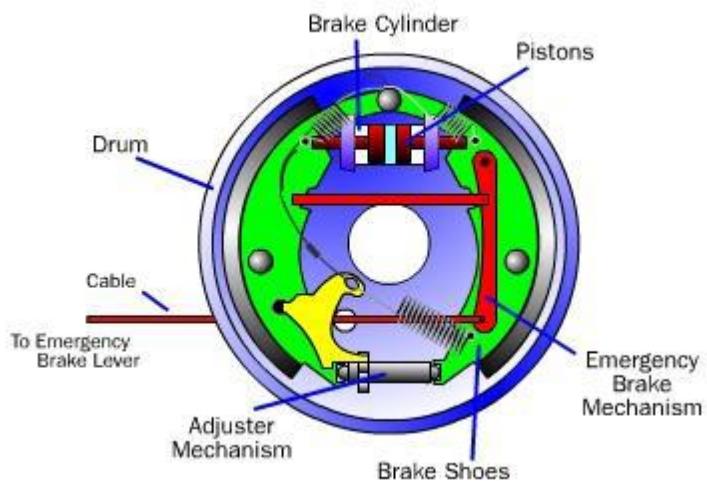


➤ WORKING PRINCIPLE

When brake pedal is pressed, the high pressure fluid from the master cylinder pushes the piston outward. The piston pushes the brake pad against the rotating disc. As the inner brake pad touches rotor, the fluid pressure exerts further force and the caliper moves inward and pulls the outward brake pad towards the rotating disc and it touches the disc.

2. Now both the brake pads are pushes the rotating disc, a large amount of friction is generated in between the pads and rotating disc and slows down the vehicle and finally let it stop.
3. When brake pad is released, the piston moves inward, the brake pad away from the rotating disc. And the vehicle again starts to move.

2. Drum Brake



The whole assembly of the drum brake is fitted to the back plate of the wheel. The back plate remains stationary and it does not rotate with the wheel.

1. Brake Drum:

It is a round cast iron housing which is used to stop the vehicle with the help of brake shoe. The drum brake is bolted to the hub of the wheel. It rotates with the hub.

2. Brake Shoe:

It is the frictional part of the drum brake, without it the working of the brake is not possible. The brake shoe has brake lining at its outer curve. It is the brake lining which makes contact with brake drum during the stopping of the vehicle. It is of two types

- (i) Primary Brake Shoe:** The shoe having large lining material is called as primary shoe.
- (ii) Secondary brake shoe:** The shoe with small lining material is called secondary shoe.

3. Wheel Cylinder:

It is used to force the brake shoe outward to apply the brake. The wheel cylinder is connected to the master cylinder. It contains piston which moves outward when brake is applied and forces the brake shoe towards inner surface of the drum.

4. Return or Retracting Spring:

It is used to retract the brake shoe after brake is applied. Two return springs are there in drum brake, one for the primary shoe and other one is for secondary shoe.

5. Self Adjuster:

It maintains the minimum gap between the brake shoe and drum so that they do not contact each other when pedal is not pressed. In the case if the brake lining wear out, and gap increases in between the shoe and drum, It can be adjusted again to maintain the gap between shoe and drum inner surface. once it is adjusted it maintains the same gap during the brake working by itself.

➤ WORKING PRINCIPLE

1. As the brake pedal is pressed, it compresses the fluid in the master cylinder and allows the piston of the wheel cylinder to expand outward.
2. The outward motion of the piston of wheel cylinder forces the brake shoe outward against the brake drum.
3. As the brake shoe lining touches the inner surface of the drum, and due to the friction generated in between the brake shoe and drum, the motion of the wheel reduces and vehicle stops.

4. As the force is removed from the brake pedal, the retracting springs draws the brake shoe inward and the contact between the friction lining and drum ended. Now again the brake is ready to apply.

5. A self adjusting screw is present at the bottom, which is used to maintain a minimum gap between the drum and brake shoe. When the lining of the brake shoe is wear out than the gap between the drum and brake shoe increases, at that time the adjuster is adjusted again to maintain the minimum gap.

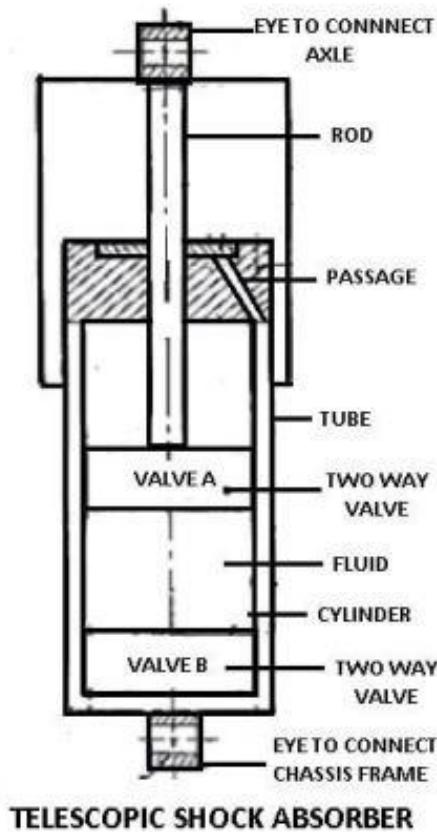
➤ **Suspension system**

- The automobile frame and body are mounted on the front and rear axle not directly but through the springs and shock absorbers. The assembly of parts, which perform the isolation of parts from the road shocks, may be in the forms of bounce, pitch and roll is called suspension system.

➤ **Functions of suspension system:**

1. It prevents the vehicle body and frame from road shocks.
2. It gives stability of the vehicle.
3. It safeguards the passengers and goods from road shocks.
4. It gives the good road holding while driving, cornering and braking.
5. It gives cushioning effect.
6. It provides comfort.

The telescopic shock absorber consists of a cylinder to which a head is welded to screwed to the outer tube. The space between outer and inner tube is called reservoir. A pressed steel cap and axle eye by means of which cylinder is screwed to the axle are welded to the outer tube. A piston slides inside the cylinder and screwed to the piston rod at which its upper end of chassis eye, it is attached to the frame of the vehicle. The part of the piston rod that is outside of the cylinder is protected by a cover which is welded to the chassis eye. A piston rod gland packing prevent the leakage, when the piston passes through the head and any fluid is trapped by it is supplied to the reservoir through drain hole.



➤ Working Principle

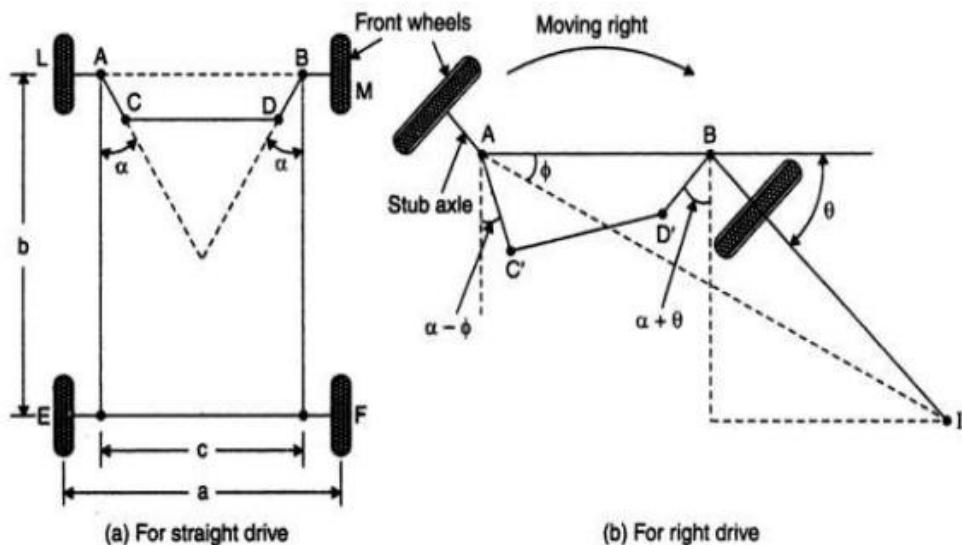
If the axle eye moves upwards then the fluid must be displaced from the bottom. Top side of the bottom side fluid through the outer ring of the piston by lifting the non return valve. But since the increase in the volume of upper end of the cylinder is less than the volume of the lower end. Fluid will also displaced through the inner ring of holes of non return valve of foot valve, and the level at the fluid will raise in the reservoir. The pressure setup will depend on the size of hole in the piston and Foot valve and the square of the speed of which the cylinder is moved. For downward motion of the cylinder the fluid will be displaced from the upper end of the piston. In the lower end through the inner ring of hole of non return valve in the piston. The fluid will also be drawn in the lower end of the cylinder from the reservoir to the outer ring of hole of non return valve of the foot valve.

➤ Steering System

- The purpose of steering system is to allow the driver to control the direction of vehicle by turning the front wheels. This is achieved by means of steering wheel and a steering column. A steering column transmits the rotation of the steering wheel to the steering gears.

- The steering gears increase the rotational force of the steering wheel in order to transmit greater torque to steering linkage.
- The steering linkage transmits the steering gear movement to the front wheels of the vehicle.

Ackerman steering mechanism



Condition for perfect steering

Let

a = Wheel track,

b = Wheel base, and

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

Now from triangle IBP ,

$$\cot \theta = \frac{BP}{IP}$$

and from triangle IAP ,

$$\cot \phi = \frac{AP}{IP}$$

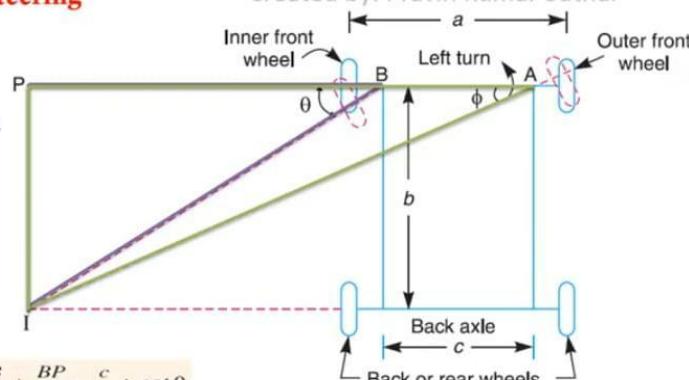
$$\cot \phi = \frac{AP}{IP} = \frac{AB + BP}{IP} = \frac{AB}{IP} + \frac{BP}{IP} = \frac{c}{b} + \cot \theta$$

$$\therefore \cot \phi - \cot \theta = c/b$$

This is the fundamental equation for correct steering.

If this condition is satisfied, there will be no skidding of the wheels, when the vehicle takes a turn.

Created by: Pravin Kumar Suthar



➤ **Vehicle Active Safety**

It is related design of vehicle safety the active safety is important . At a time of vehicle design to consider all conditions of active safety is consider

Following factor under Active Safety,

- There should be more glass area with minimum blind spots. This will increase the efficiency of driver for parking and driving in heavy traffic.
- Good mirrors will enable the driver to see potential hazards when reversing parking or changing lines. Mirrors are to be adjusted from inside of car. Heated mirrors should be preferred to avoid fogging in bad weather.
- Headlights should be designed in such a way that there is adequate intensity of lights. They should give a good view of road ahead to the driver. In some cars wipers or water jets are employed to help cleaning the headlights.
- The suspension system and steering system should be properly designed to get better holding of roads and improved characteristics while cornering.
- Now a day's ABS (Antilock braking system) is applied for better steering and controlling of ~~vehicle~~.

➤ **Passive Safety**

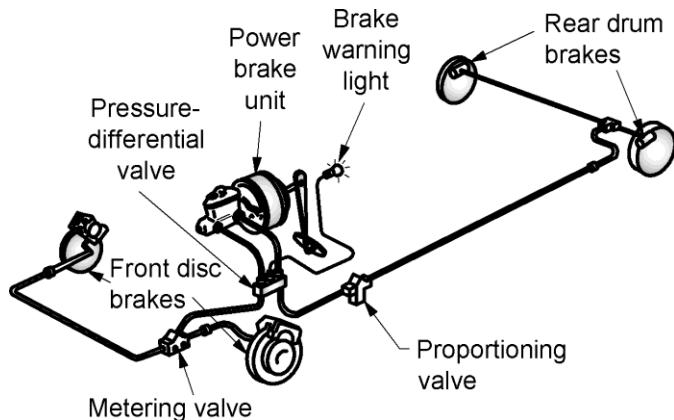
Some of passive safety features help to absorb crash forces collision of vehicle. The following points come under passive safety features.

- To reduce the risk of spilled fuel and consequent fire in case of near end collision fuel tank should be located at suitable positions.
- In case of accident it is very important to consider the doors closing after car comes to rest otherwise there are channels of person to be thrown out and being killed are increased so the doors should be fitted with safety lock.
- Various switches controls etc. should be so shaped that they are not protruding excessively so as to cause injury to the occupants at the front at the time of front side collision.
- To minimize the leg injuries to occupants of front seats, a knee bolster must be provided knee bolster is an energy absorbing crushable barrier under the dashboard that stops occupant knees from striking hard components and surfaces below and behind the dash.
- Seat belts should be worn both by passengers as well as drivers.
-

➤ Antilock Brake System (ABS)

These types of a brakes are called as Anti-skid Brake system because of these brake reduces the risk of tyres skidding under heavy load condition and allows driver to maintain steering control of the vehicle. Antilock brake system operates under heavy load braking or on slipping surface conditions.

- ABS calculates the required slip rate of the wheels accurately based on the vehicle speed and the speed of the wheels and then controls the brake fluid pressure to achieve the target slip rate.
- Although Antilock brake system prevents complete locking of the wheels in practice it allows some wheel slip in order to attain the best possible braking. At the time of applying brake on brake pedal by driver in conventional braking system is different than ABS.
- Modern ABS consists of an Electronic Control Unit (ECU). An individual sensor is connected to each wheel of car
- ECU controls and monitors the antilock function and when required.
- In some ABS, a lateral accelerator sensor is also provided to monitor the lateral (side) movement of the vehicle while taking a turn. This also ensures proper braking out the time of turning.
- Electrically driven hydraulic pump is called as Hydraulic Booster. It has four outlet brake lines connecting to each wheel.



➤ Working of ABS

The sensor of each wheel provides the varying voltage signal to the E.C.U. of brake system E.C.U. Computes the voltage signal and compares it with programmable information and determines whether a wheel is about to lock or skid.