

UNIT

1

Chassis Frame and Body

Structure

- 1.1 Introduction of chassis frame
- 1.2 Layout of chassis and its main components
- 1.3 Functions of the chassis frame
- 1.4 Types of chassis frame
- 1.5 Various loads acting on the chassis frame
- 1.6 Different bodies used in Automobiles
- 1.7 Requirement of bodies for various types of vehicles.

Learning Objectives

After studying this unit the student will be able to learn about

- Requirement of chassis frame
- Types of Chassis frame
- Loads acting on chassis frame
- Layout of chassis and its parts
- Different types of automobile bodies

1.1 Introduction of Chassis Frame

Chassis frame is the basic frame work of the automobile. It supports all the parts of the automobile attached to it. It is made of drop forged steel. All the parts related to automobiles are attached to it only. All the systems related to automobile like powerplant, transmission, steering, suspension, braking system etc are attached to and supported by it only.

1.2 Layout of Chassis and its main components

“Chassis” a French term which means the complete Automobiles without Body and it includes all the systems like power plant, transmission, steering, suspension, wheels tyres, auto electric system etc. without body. If Body is also attached to it then it is known as the particular vehicle as per the shape and design of the body.

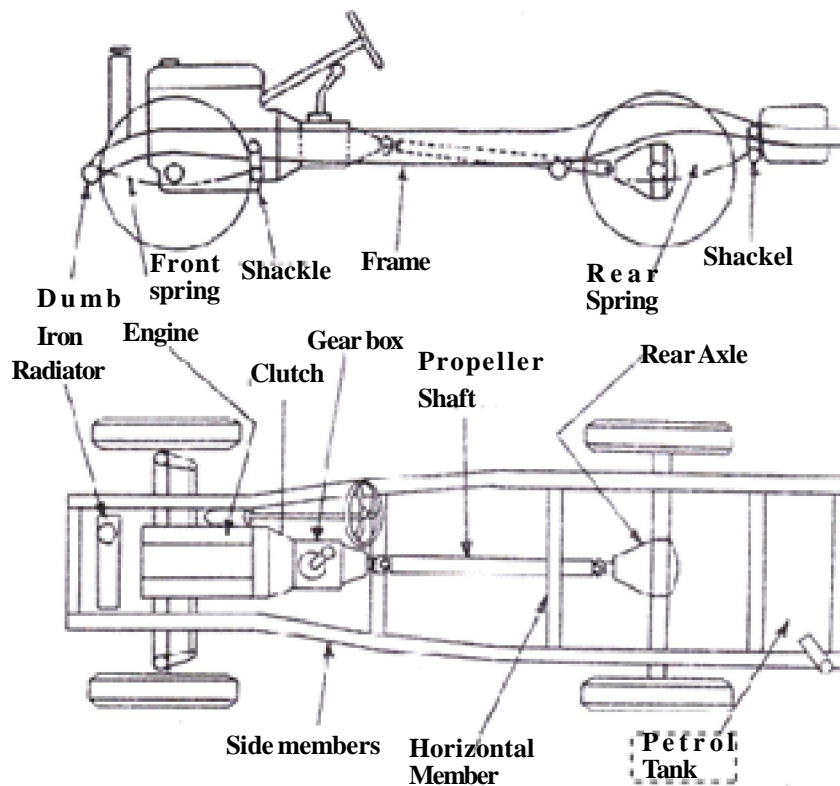


Fig 1.1 Chassis

1.3 The Functions of the Chassis frame

1. To carry all the stationary loads attached to it and loads of passenger and cargo carried in it .
2. To withstand torsional vibration caused by the movement of the vehicle
3. To withstand the centrifugal force caused by cornering of the vehicle
4. To control the vibration caused by the running of the vehicle
5. To withstand bending stresses due to rise and fall of the front and rear axles.

1.4 Types of Chassis frame

There are different types of chassis frame sections

1. Channel section



2. Box section



3. Tubular section



The conventional frame is also known as Non-load carrying frame. In this type of frame, the loads on the vehicle are transferred to the suspension by the frame which is the main skeleton of the vehicle.

The channel section is used in long members and box section in short members. Tubular section is used now-a-days in three wheelers, scooters, matadors and pickup vans.

The frames should be strong enough to bear load while sudden brakes and accidents.

1.5 Various loads acting on the Chassis frame

The loads acting on the chassis frame are as follow

1. Stationary loads namely the loads of permanent attachment like all the parts of the chassis, body etc.
2. Short duration loads while turning, braking etc.
3. Momentary loads while quick acceleration, sudden braking etc.
4. Loads applied while crossing roads of irregular and uneven surfaces
5. Loads caused by sudden accidents, head on collisions etc.
6. Loads caused by irregular and overloading of vehicle.

1.6 Different Bodies used in Automobiles

The automobiles bodies are designed according to the requirement of the vehicle. According to design and requirement of the vehicle , there are different types of Automobiles bodies. Some of them are listed as below :

- (i) Car
- (ii) Straight truck or Punjab truck body
- (iii) Truck with half body
- (iv) Platform type truck
- (v) Tractor
- (vi) Tractor with articulated trailer
- (vii) Tanker
- (viii) Bus
- (ix) Dumper truck
- (x) Delivery van
- (x) Station wagon
- (xi) Pick up van
- (xii) Jeep
- (xiv) Long wheel base truck etc

1.7 Requirement of Bodies for various types of vehicle

According to requirement , automobile bodies are classified mainly into different types namely private vehicle, commercial vehicle, fleet transport vehicle, passenger transport vehicle, Ambulances vehicle used for transport of Army personal, Ammunition etc., different types of tanker vehicle etc. If it is a private vehicle, the vehicle is used for luxury personal travelling , private cargo transport etc, namely car , mini van , Omni bus, matador etc.

If it is commercial vehicle the vehicle is used for transportation of goods some other vehicles, freezer boxes etc. If it is tanker, it is used to transport milk , water, edible oils, petroleum products , gases , acids etc. The tanker bodies are designed according to the relevant requirement .

If it is an army vehicles, the vehicle are separately designed namely Arm truck, heavy long wheel base cargo trucks , long platform trucks etc. These are exclusively used to carry the army personal, arms and ammunitions etc.

Some automobiles manufacturing companies are using long wheel base trucks with closed body structure for transporting of the vehicle produced in their factories to different market outlets.

The private vehicles used in different fields namely Buses of different types, air conditioned Buses, station Wagons etc, Usually Road Transport organization of a state is a fleet organized jointly by the state Government an exclusive body which is to operate buses for travelling of passenger to various places within the state as well as Inter-State travelling also the Road transport corporation organization is having differently designed buses namely ordinary body buses, Deluxe buses , semi luxury buses, Air conditioned buses and also buses with sleeper coach etc.

Summary

- Chassis is the basic framework of the automobile. It supports all the parts of the automobile.
- It has to withstand centrifugal force while cornering and bending stresses due to rise and fall of front and rear axles.
- Different types of chassis frames are i. Channel section ii. Box section iii. Tubular section.
- The loads acting on chassis frame are
 - i. Stationary loads of permanent attachments.
 - ii. Short duration loads while turning, braking etc.
 - iii. Loads applied while crossing irregular and uneven surfaces.
 - iv. Loads caused by irregular and overloading of the vehicle.
 - v. Loads caused by sudden accidents.
 - vi. Momentary loads while quick acceleration, sudden braking etc.

Short Answer Type Questions

1. Define chassis.
2. Mention the types of chassis frame.

3. What is the purpose of chassis frame?
4. Mention any eight types of automobile bodies.

Long Answer Type Questions

1. List out the functions of chassis frame.
2. Mention various loads acting on chassis frame.
3. Discuss about the requirements of different automobile bodies.

UNIT

2

Steering System**Structure**

- 2.1 Requirement of vehicle steering system
- 2.2 Types of steering Gear boxes
- 2.3 Types of Steering systems and power steering.
- 2.4 Steering linkages
- 2.5 Under Steering, Over steering and Turning Radius.
- 2.6 Steering gear mechanisms.
- 2.7 Steering geometry - Caster, Camber, Kingpin inclination, toe-in and toe-out.
- 2.8 Steering defects - wheel wobble and shimmy.
- 2.9 List out the types of steering systems used in various vehicles.

Learning Objectives

After studying this unit ,the student should be able to learn the

- (i) Requirement of vehicle steering
- (ii) Types of steering system
- (iii) Types of steering gears and their application in various vehicles

- (iv) Different measurement and angles in steering gears measurement and angles in steering geometry namely castor angle, camber angle, king inclination Toe-etc.
- (v) Different defects in steering namely wheel wobble , hard steering etc.

2.1 Requirements of Vehicle Steering System

The steering system of a vehicle is having the following requirements

- (1) It should be able to turn the vehicle with more mechanical advantage and less efforts.
- (2) It should turn the wheel within shortest possible time
- (3) There should be self-centering action in the steering geometry
- (4) It should be certain degree irreversible so that the shocks of the roads surface are not transmitted to the hands of the driver.

2.2 Types of Steering Gear Xoxes

- 1. Worm and wheel steering gear
- 2. Worm and roller steering gear
- 3. Worm and sector steering gear
- 4. Can and lever steering gear
- 5. Rack and pinion steering gear
- 6. Re circulating ball steering gear

2.2.1 Worm and wheel steering gear

In this type of steering gear box there will be worm at the bottom end of steering inner column. This worm meshes with a wheel in steering gear box housing. When steering wheel turned, the steering column revolves and the wheel is rotated along with it . This causes the drop arm to move and thereby move drag link and other steering linkages like Tie-rod king pin etc.

2.2.2 Worm and Roller

In this steering gear, there will be a worm at the bottom end of inner column and a roller is there in the steering gear box. When the worm rotates, the roller which is attached to it also rotates causing the Roller to rotate and there by moving drop arm.

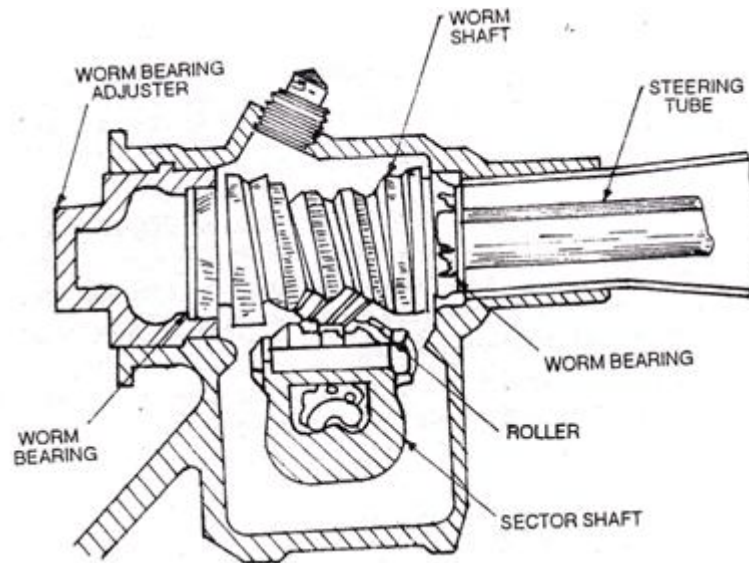


Fig 2.1 Worm and Roller steering Gear

2.2.3 Worm and Sector Steering Gear

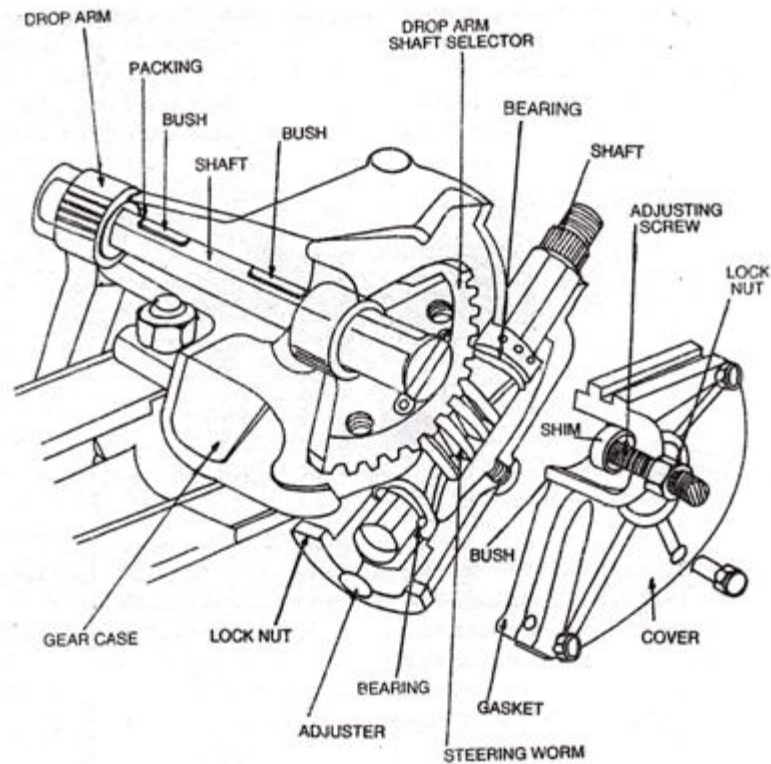


Fig 2.2 Worm and Sector steering Gear

In this type of steering gear, there will be a worm at the bottom end of steering inner column and a part of sector shape is there in the steering gear housing. The worm meshes with sector and it moves by the rotation of worm and there by moving drop arm which is attached to it.

Cam and Lever steering gear

In this type of steering gear, a special worm called cam is located at the end of inner column which it attached to column in the steering gear. When the worm is rotated, the lever is also moved in the groove provided in the worm. This causes the lever to swing through an arc.

2.2.4 Recirculating Ball Steering Gear

In this steering gear there will be some steel balls in the grooves of steering inner column which move along with the steering worm. This enables to control the friction among them and there by reducing noise. It increases the mechanical advantage of the operator for easy and smooth operation of steering.

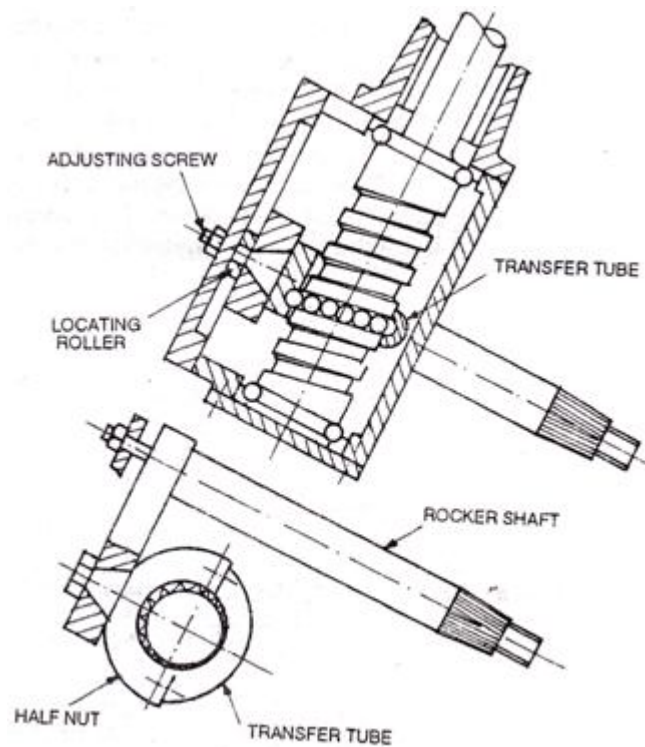


Fig. 28.16. Recirculating ball steering gear.

Fig 2.3 Recirculating Ball steering Gear

2.2.5 Rack and pinion Steering gear

In this steering gear, a pinion is mounted at the end of the steering inner column. It engages the rack which has ball joints at each end to allow the raise and fall of the wheels, the rods are connected with ball joints to the sub axles. The rotary movement of steering wheel turn the pinion which moves the rack sideways parallel to tie rod.

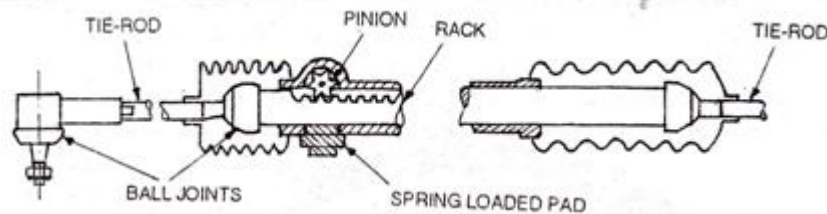


Fig 2.4 Rack and Pinion steering gear

2.3 Types of Steering system

The steering system is said to be of different types according to its position along with the vibration of front wheels.

When deflection of the steered wheels due to road surface is transmitted through the steering linkage and steering gear box to the steering wheel, the system is said to be “Reversible steering”

If every small imperfection of the road surface cause the steering to rotate it is known as Reversible steering . But it is not advisable. Some degree of reversibility is needed so that the wheels will find to strength up after negotiating a bending. This effect is called semi reversible . When steered wheels do not cause any deflects due to road irregularities it is known as irreversible steering. The semi reversible steering is always desired.

Power Steering

The power steering system provides additional assistance to the turning effort applied to the manual steering system.

The power steering is of two types – Hydraulic and electric/ electronic . A hydraulic –electric hybrid system is also possible.

A hydraulic power steering (HPS) used hydraulic pressure applied by on engine driven pump to assist the motion of turning the steering wheel.

Electric power steering (EPS) is more effects than the hydraulic power steering since the electric power steering motor only needs to provide assistance when the steering wheels turned where as the hydraulic pump must run constantly. The main components of an integral power steering system consist of a hydraulic pump assembly connected with hoses. A rotary valve power steering gear for the integral system using recirculating ball type worm and wheel steering gear is most commonly used one.

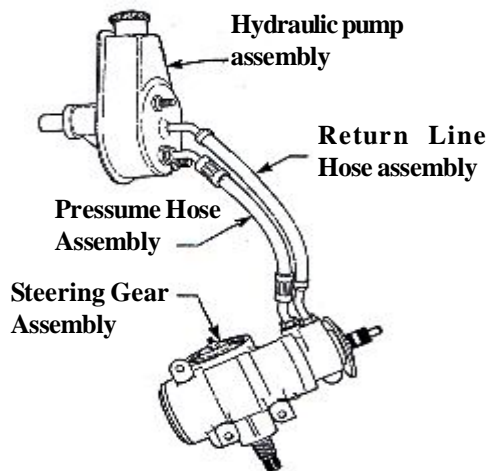


Fig 2.5 Power steering Gear

2.4 Steering linkages

The steering linkage is a connection of various links between the steering gear box and the front wheels. The motion of pitman arm of steering gearbox is transferred to the steering knuckles of the front wheels through the steering linkage.

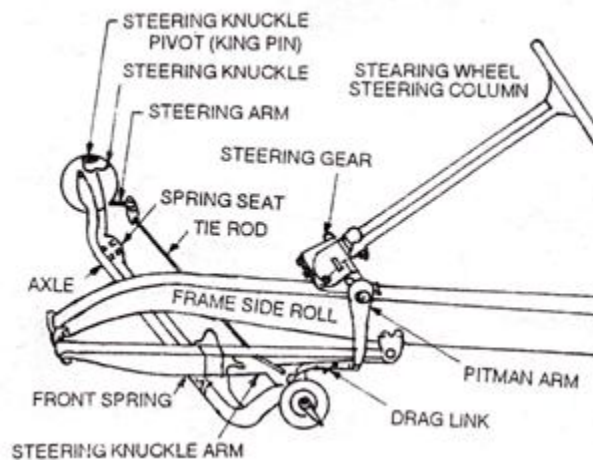


Fig 2.6 Power steering Gear

When the steering wheel is turned to the left or right, the pitman arm swings from one side to the other. This movement of the pitman arm gives angular movement to the front wheels through the steering linkage.

The most commonly use steering linkage is conventional steering linkage. The pitman Arm (drop arm) is connected directly by a connecting link namely drag link to a steering knuckle arm attached to the left hand steering knuckle. The motion is carried across from this arm to a steering arm on the right side steering knuckle by means of the rod. The drag link and drop arm (Pitman Arm) are mounted on the left side of the frame.

In some designs the drag link is connected between the drop arm and right steering knuckle arm by locating drop arm beneath the steering gear.

In direct cross type steering linkage, the pitman arm (Drop Arm) is connected directly to one end of the rod which its turn is connected to another. The other ends of the rods are connected to the steering arms.

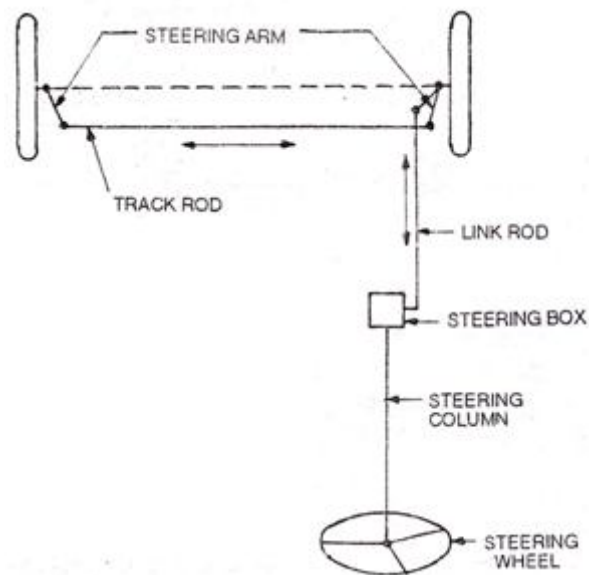


Fig 2.7 Conventioaal steering linkage

2.5 Under Steering, Over steering and Turning Radius

While taking a turn, the wheels are not always pointing in direction in which the vehicle is moving, due to distortion of tyre tread. The angle between the wheel inclination and the path taken by the wheel is known as “Slip angle”. When the slip angle is greater at the rear than of the front, the vehicle tends to “over steer” the vehicle is to turn into the curve more than the driver intended.

When the slip angle is smaller at the rear than at the front, the vehicle tends to “under steer”.

The under steer is most commonly preferred because correction by the driver involves rotating the steering wheel a little more in the direction of the turn.

It can be noted that the slip angle is affected by the road camber side winds, tyre inflation and variations in the load on either the front or rear axle.

Turning Radius : Turning radius is the radius of the circle on which the outside front wheel moves when the front wheels are turned to their extreme outer position.

This radius is 5 to 7m for buses and trucks. The turning radius is usually proportioned to the wheel base of the vehicle, because the maximum rotation of the steering knuckle is seldom more than 35 degrees.

2.6 Steering Gear Mechanism

There are two types of steering gear mechanism.

1. Davis steering gear
2. Ackerman steering gear

The Davis steering gear has sliding pairs, whereas the Ackerman steering gear has only turning pairs. The sliding pair has more friction than the turning pair. Therefore the Davis steering gear will wear out earlier and become inaccurate after certain time.

Although, the Ackerman steering gear is not mathematically accurate except in their position, contrary to the Davis steering gear which is mathematically correct in a position

However, Ackerman steering gear is preferred to Davis steering gear

Davis steering Gear : The Davis steering gear mechanism consist of a cross link “KL” sliding parallel to another link “AB” and its connecting to the stub axles of the two front wheels by means of two similar bell crane levers “ACK” and “DBL” pivoted at “A” on the “B” respectively. The cords link “KL” slides on the bearing and carries pins at its ends “K” and “L”. The slide blocks are pivoted on these pins and move with the turning of bell crane levers as the steering wheel is operated. When the vehicle is running straight, the gear is said to be in mid position. The short Arms “AK” and “BL” are inclined at an angle of “ $90 + 0C$ ” to their stub axles “AC” and “BD” respectively

$$\tan \alpha = \frac{b}{2l}$$

Where $b = AB$ = distance between the points of front axles.

l = wheel base

The range of b/l is 0.4 to 0.5

Hence the angle “ θ ” lies between 11.3° and 14.1°

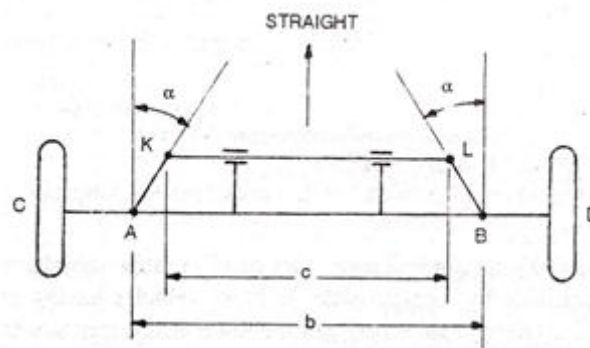


Fig 2.8 Davis steering gear mechanism

Ackerman steering gear : The Ackerman steering gear mechanism consist of cross link “KL” connected to the short axels “AC” and “BD” of the two front wheel through the sort arms “AK” and “BL” forming bell crane levers CAKL and BDKL respectively .

When the vehicle is taking a turn, the inside wheel must follow a tight curve than the outside wheel .

When the vehicle is running straight the cross link “KL” is parallel to “AB” the short arms “AK” and “BL” both make angle θ to the horizontal axis of chassis.

The angles θ and θ are shown in figure. The value of b/L is between 0.4 to 0.5.

For correct steering

$$\cot \phi - \cot \theta = b/l.$$

In Ackerman steering gear, there are three positions to be observed infact. The value of θ will be different as the vehicle is running straight, vehicle is taking a left turn and vehicle is taking a right turn.

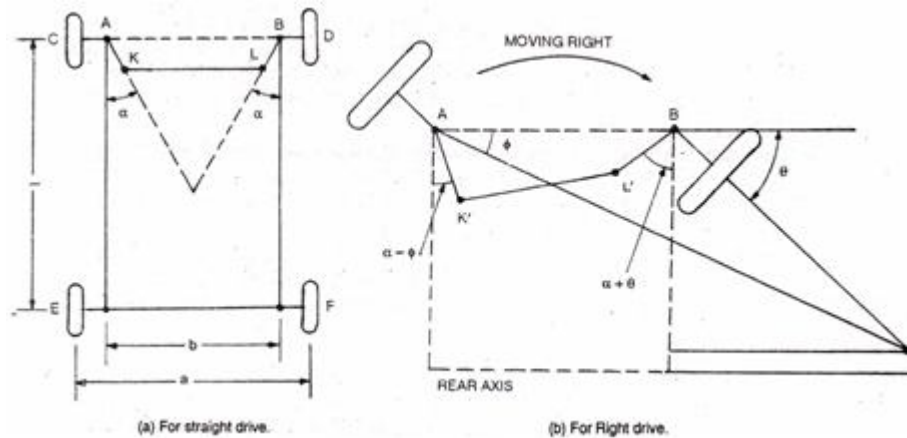


Fig 2.9 Ackerman steering gear

2.7 Steering geometry - Caster, Camber, Kingpin inclination, toe-in and toe-out.

Steering Geometry : It refers to the positioning of the front wheels and steering mechanism that gives the vehicle directional stability , promotes ease of steering and reduces tyre wear to a minimum. It also refers to the angular relationship between the front wheels and parts attached to the front wheel, frame of the vehicle. It depends upon the following terms. Caster angle, camber angle, King Pin inclination , Toe-in Toe-Out on turn.

Caster angle: It is the angle of tilting the king pin axis either forward or backward from the vertical line. This tilting is known as Caster. The angle between the vertical line and the king pin centre line in the plane of the wheel (When viewed from the side) is called the Caster angle.

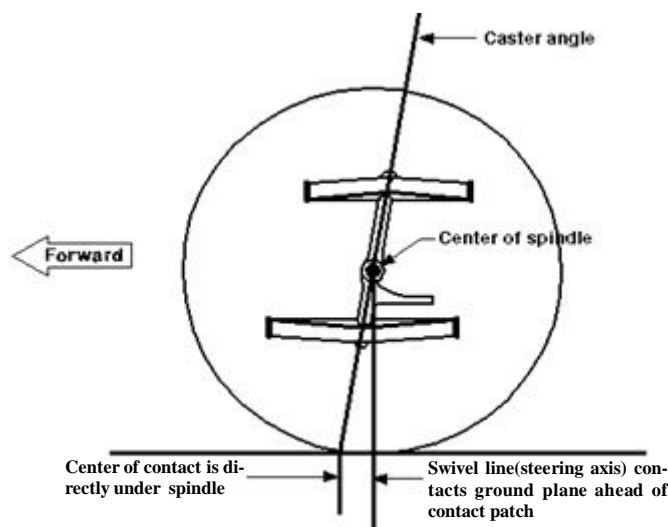


Fig 2.10 Caster angle

When the top of the king pin is backward, the caster angle is positive, and when it is forward, the caster angle is negative. Usually the caster angle in modern vehicles ranges from 2 to 8 degrees.

The main purpose of caster angle is to create self centering effect in the steering. It provides the directional stability. It positive caster increase the efforts required to steer and tries to keep the wheels straight ahead. In heavy duty trucks negative caster is preferred. This makes the steering easier.

Camber Angle : It is the angle between the centre line of the tyre and the vertical. When viewed from the front of the vehicle when the angle is outward, so that the wheels are farther apart at the top the camber is “Positive” when the angle is inward, so that the wheels are closer together at the top, the camber is “Negative”. The usual value of camber angle should not exceed 2°.

When the camber angle is positive, it causes slip out prevention lightens the perpendicular load and lessen the required steering effort. If it is a Zero camber, it prevents uneven wear of tyres. When the camber angle is negative, the camber thrust increase with increase in tyre inclination relative to the road surface.

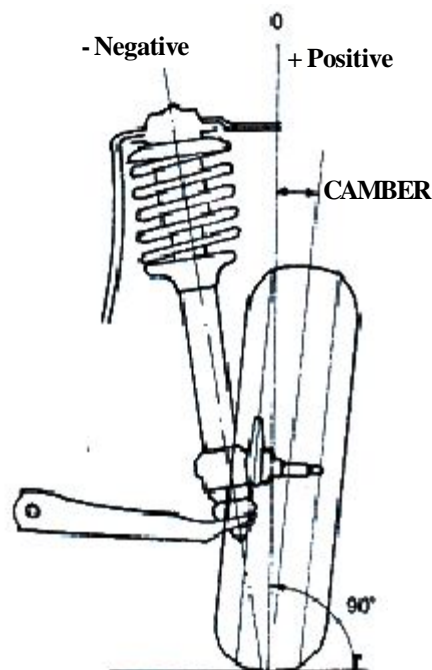


Fig 2.11 Camber angle

King Pin Inclination or steering Axis Inclination

It is the angle between the vertical line and the center of the King pin the steering axis when viewed from the front. The Kingpin inclination, in combination with caster angle, is used to provide directional stability. It also reduces steering effort particularly when the vehicle is stationary. It reduces tyre wear also. The kingpin inclination in modern vehicle ranges from 4° to 8° . It is also known as steering Axis inclination.

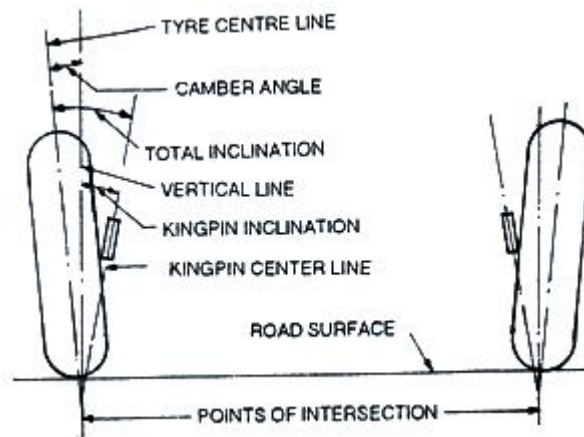


Fig 2.12 King pin inclination

Toe-In : It is the inward tilting of front wheels at the front so that the distance between the front wheels at the front is less than the distance between at the front wheels at the rear when viewed from the top. The Amount of the Toe-in is usually 3 to 5 mm .

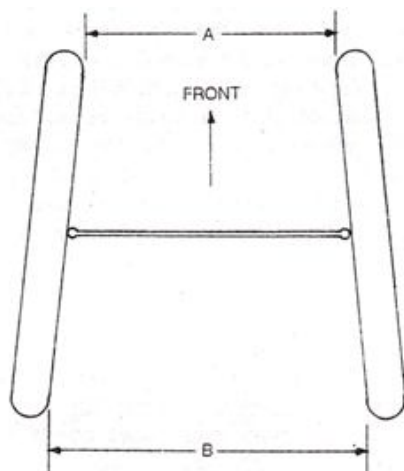


Fig 2.13 Toe-in

The toe-in is provided to ensure parallel rolling of the front wheels to stabilize steering and prevent side slipping of front wheels and thereby prevent excessive tyre wear.

Toe-Out : Toe-out is the difference in angles between the two front wheels and the car frame during turns. The steering system is designed to turn the inside wheel through a larger angle than the outside wheel when making a turn. The toe-out is secured by providing the proper relationship between steering knuckle arms, tie rods and pitman arm (drop arm).

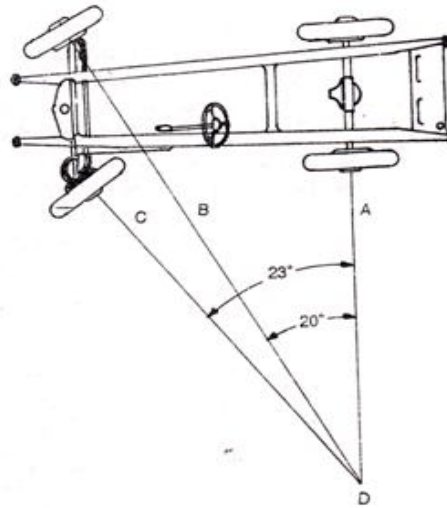


Fig 2.14 Toe-out

2.8 Steering defects - Wheel Wobble and Shimmy

(i) **Wheel wobble and shimmy :** when the vehicle go through an uneven or rough road, the front wheel will get shaken for a while. This problem can also be seen when the vehicle is slowing down. This problem may caused by the following reason.

Reason	Remedy
1. Unbalanced wheels	1. The wheels should be balanced at wheel balance
2. Unevenly worn out tyres	2. Rotate the tyres or Replace with new ones if necessary
3. Inoperative shock absorbers	3. Replace them
4. Incorrect Toe-in	4. Adjust the Toe-in
5. Loose spring U-Bolts	5. Tighten
6. Loose steering linkages	6. Tighten
7. Worn out kingpin steering , linkages	7. Tighten or Replace as per the necessity wheel bearings, steering gear
8. Inoperative stabilizer	8. Replace

2.9 List out the types of steering systems used in various vehicles

S. No.	Vehicle make	Type of Steering	Camber	Castor	King pin inclination	Toe-in (mm)	Steering Ratio	Turning circle (Metres)
1.	Maruti (Suzuki) 800	Rack & Pinion	$1^{\circ}21'$	$3^{\circ}15'$	$12^{\circ}50'$	2 - 4	17.5 : 1	8.8
2.	Hindustan Ambassador Mark II	Rack & Pinion	$\frac{1^{\circ}}{2}$ to 1°	$2 \frac{1^{\circ}}{2}$ to $3 \frac{1^{\circ}}{2}$	$7^{\circ} - 42'$ to $8^{\circ}42'$	1.6 - 4.0	14 : 1	10.83 (Right) 10.74 (Left)
3.	Fiat 1100	Worm & Roller	$(^{\circ} - 30') \pm 20'$	$(20^{\circ} - 10') + (10' - 30')$	7°	7 - 9 Unladen 1 - 3 Laden	16.4 : 1	
4.	Jeep CJ Series	Worm & Roller	$1 \frac{1^{\circ}}{2}$	3°	$7 \frac{1^{\circ}}{2}$	1.2 - 2.4	20 : 1	11.72
5.	Ashok Layland Comet Passenger	Cam & Double Roller	$1 \frac{1^{\circ}}{2}$	1°	3°	Nil	24.7 : 1	20.7
6.	Tata 1210 vehicles	Recirculating Ball	1°	$30^{\circ} - (1^{\circ} - 30')$	$9^{\circ} - 30'$	1 - 3	34.2 : 1	
7.	Dodge/Fargo Model 89 M 4	Recirculating Ball	$1 \frac{1^{\circ}}{2}$	$1 \frac{1^{\circ}}{2}$	8°	0 - 3.165	24 : 1	
8.	Standard 20	Worm & Roller or Recirculation Ball	$1^{\circ} - 36'$	Nil	$5^{\circ} - 58'$	1.5		10.36
9.	Swaraj Mazda	Ball nut type with Tilt & Telescopic Steering Wheel	$1^{\circ} - 30'$	$2^{\circ}30'$	7°	0 - 6	24 - 30 : 1	

Summary

- The steering system of a vehicle should be able to turn the vehicle with less effort and more mechanical advantage.
- Types of steering gears
 - i. Worm and Wheel
 - ii. Worm and Roller
 - iii. Worm and sector
 - iv. Cam and lever
 - v. Rack and pinion
 - vi. Recirculating Ball
- When deflection of steered wheels due to road surface is transmitted through steering linkage and steering gear to the steering wheel, the system is reversible steering.
- The steering linkages are the connections of various links between steering gear box and the front wheels.
- The angle between the 'wheel inclination' and the 'path taken' by the wheel is known as 'Slip angle'.
- When the slip angle is greater at rear than at front, it is known as 'Over steer'.
- When the slip angle is smaller at rear than at front, it is known as 'Under steer'.
- Turning radius: It is the radius of the circle on which the outside front wheel moves when the front wheels are turned to their extreme outer position.
- Caster angle is the angle of tilting of king pin axis either forward or backward from the vertical line. When the top of the king pin is backward, the caster angle is 'positive' and when it is forward, the caster angle is 'negative'. Usually caster angle varies from 2 to 8 degrees.
- Camber angle is the angle between the centre line of the tyre and the vertical line when viewed from the front of the vehicle. when the angle

is outward it is known as 'positive' and when the angle is inward it is known as 'negative'. The usual value of camber should not exceed 2° .

- King pin inclination is the angle between the vertical line and the centre line of the king pin when viewed from the front. It's usual value ranges from 4 to 8 degrees.
- Toe-in : It is the inward tilting of front wheels at the top. It's amount is usually 3 to 5mm.
- Toe-out: It is the difference in angles between the two front wheels and the car frame during turning.

Short Answer Type Questions

1. What is the purpose of steering system?
2. Mention the types steering gears.
3. What is ship angle?
4. Define 'Under steer' and 'Over steer'.
5. What is meant by Turning Radius?
6. Define castor angle. What is its usual value?
7. Define camber angle. Mention its usual value
8. What is king pin inclination?
9. Define Toe-in and write its usual value.

Long Answer Type Questions

1. Briefly explain recirculating ball steering gear with neat sketch?
2. Briefly explain Rack and Pinion steering gear with neat sketch.
3. Briefly explain power steering with diagram.
4. Briefly explain Ackerman steering principle with neat sketch.
5. Discuss about the steering defect - 'Wheel Wobble'.

UNIT

3

Braking System**Structure**

- 3.0 Introduction
- 3.1 Functions of Brakes
- 3.2 Requirement of automobile Brakes
- 3.3 Stopping time and stopping distance
- 3.4 Types of Braking system - Disc and Drum Braking system
- 3.5 Construction and working of Mechanical, Hydraulic and Air brakes.
- 3.6 Bleeding of brakes in Hydraulic brakes.
- 3.7 List out types of Brakes used in various vehicles.

Learning Objectives

After learning this unit, the student should be able to learn about .

- Purpose of brake, fundamental types of brakes in different vehicles
- Stopping time and stopping distance.
- Application of different types of brakes in various types of vehicle
- Commonly occurred troubles in brakes with their rectification

3.0 Introduction

In Automobiles brakes play important role in slowing down and stopping of the vehicle as and when required by the driver. Fundamentally the brakes are of two types (i) **Internal expanding** (ii) **External contracting type**. Different types of brakes are used in different vehicles as per the requirement. According to application, the brakes are of different types-**mechanical, hydraulic air, vacuum, Air assisted Hydraulic**.

3.1 Functions of Brakes

- (i) To slow down or to stop the vehicle as and when required.
- (ii) To control the vehicle when the vehicle is rolling down on a slope road down ward.
- (iii) To travel smoothly and safely even in heavy flow of traffic by controlling the movement of the vehicle.

3.2 Requirement of Automobile Brakes

- (i) The brakes must stop the vehicle within shortest possible distance.
- (ii) These must be released suddenly after releasing them
- (iii) Total control of the vehicle should be there

3.3 Stopping time and Stopping Distance

The stopping time and stopping distance shows the efficiency of brakes.

The maximum retarding force applied by the brake at the wheels, F , depends upon the coefficient of friction between the road and tyre surface μ and the component of the weight of the vehicle on the wheel, w .

$$F = \mu w$$

In actual practice 100% of brakes efficiency is not used. The stopping time and distance depend upon

- (i) Vehicle speed
- (ii) Condition of road surface
- (iii) Condition of tyre tread.
- (iv) Coefficient of friction between the tyre tread and road surface.
- (v) Coefficient of friction between brake drum and brake lining (in case of Drum brakes).

- (vi) Coefficient of friction between the disc and the friction pad (in case of Disc brakes).
- (vii) Brake force applied by the driver.

However, during emergency braking, the reaction of the driver and response time of the brakes also play an important role. The total stopping distance in case of emergency braking may be divided into three parts :

- (i) Distance travelled during the reaction time of the driver.
- (ii) Distance travelled between the time elapsed between driver pressing the brake pedal and actual application of brakes at wheels.
- (iii) Net stopping distance, depending upon the deceleration.

Keeping all the factors in view, the assumed brake efficiencies for some of the vehicle may be like the values given in the table approximately.

Efficiency %	Approximate stopping distance (in metres) for the speeds			
	30 Km/H	50 Km/H	80 Km/H	100 Km/H
100	3.5	9.8	25.2	39.3
80	4.4	12.2	31.5	49.1
60	6.0	16.3	42.0	65.5
30	12.0	32.6	84.0	131.0

These values depend upon the distance travelled during the reaction time of the driver and distance travelled between applying pedal and actual application of brakes at wheels.

3.4 Types of Braking system - Disc and Drum Braking system

Disc Brakes

The disc brake consists a cast iron disc bolted to the wheel hub and a stationary housing called calliper. The Calliper is connected to some stationary part of vehicle, like axle casing or the stab axle and is cast in two parts, each part containing a piston. In between each piston and the disc, there is a friction pad held in position by retaining pins, spring plates etc.

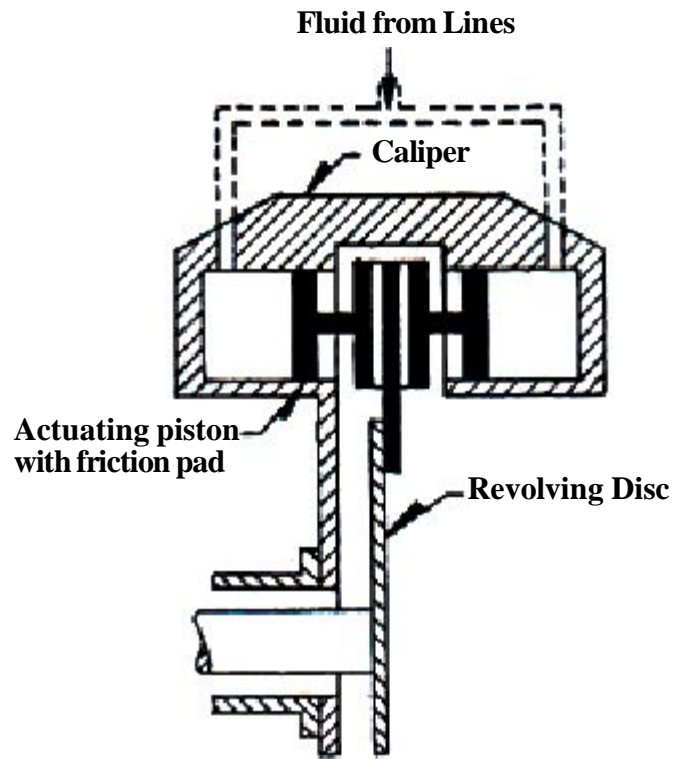


Fig 3.1 Disc Brake

When the brakes are applied, hydraulically actuated piston move the friction pads into contact with the disc, applying equal and opposite forces on the later. On releasing brakes, the rubber sealing rings act as return springs and retract the pistons and the friction pads away from the disc.

Drum Brakes

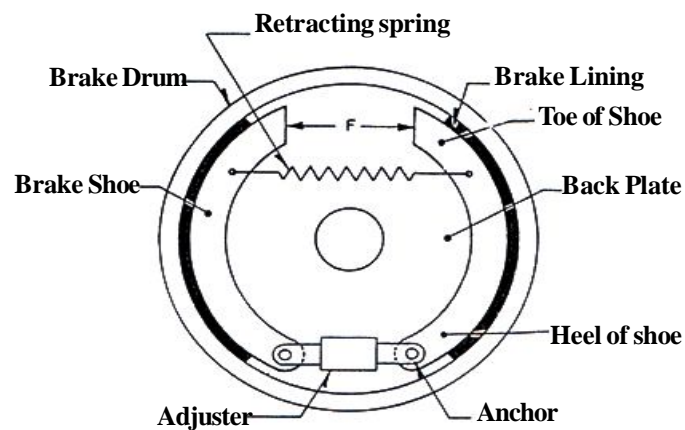


Fig 3.2 Drum Brake

In this type of brakes, a brake drum is attached concentric to the axle hub whereas on the axle casing is mounted a back plate. In case of front axle, the brake plates are bolted to the steering knuckle. The back plate is made of pressed steel and is ribbed to increase rigidity and to provide support for the expanding brake shoes. These brakes are also known as internal expanding brakes.

3.5 Construction and working of Mechanical, Hydraulic and Air brakes.

3.5.1 Construction and working of Mechanical Brakes

These brakes are operated completely through mechanical links and lever. These are applied in two wheelers and these wheeler. These are also applied in four wheeler as parking or Emergency brakes. In the wheel drum there are two brake shoes which are linked closely by a retracting spring. There will be a can between the two shoes. When brake pedal is applied, the can will rotate causing the brake shoes expand against the force of the returning spring. This causes the shoes to rub against rotating wheel drum and thereby stopping it. When brake pedal is released, the can inside wheel drum will come back to its position causing the brake shoes to come back with the presence of returning position and thus releasing brakes.

3.5.2 Construction and working of hydraulic brakes

The hydraulic brakes are being operated in the Pascal's law which states that "The pressure applied on any liquid is equally transmitted to all the direction at the same time". In the same manner the pressure of brake pedal which is applied on the brake fluid in the master cylinder is transmitted to all the four wheel cylinder with equal pressure and at the same time. In this way the brake shoes which are attached to the wheel cylinder (s) are expanded and thus the brakes are applied.

The parts of hydraulic braking system are (i) Brake pedal (ii) Pull and push rod (iii)- Master cylinder (iv) Brake pipe lines (v) wheel cylinder (vi) brake shoes.

When the brake pedal is applied the piston inside the master cylinder is pushed forward and it caused the pressurized brake fluid moves forward to all the four wheel cylinder at the same time with same pressure. There at the wheel cylinder the brake shoes will be expanded with the developed pressure in the wheel cylinder. All the wheel cylinder will be operated at the same time according to Pascal's law. This is how the brakes are applied. While releasing brakes with contracting of brake shoes with spring force the brake fluid in the

wheel cylinder will try to go back to the master cylinder. As there is no pressure on the position of the master cylinder, the brake fluid push the check valve of master cylinder and the enter into the reservoir through barrel and by pass valve of master cylinder.

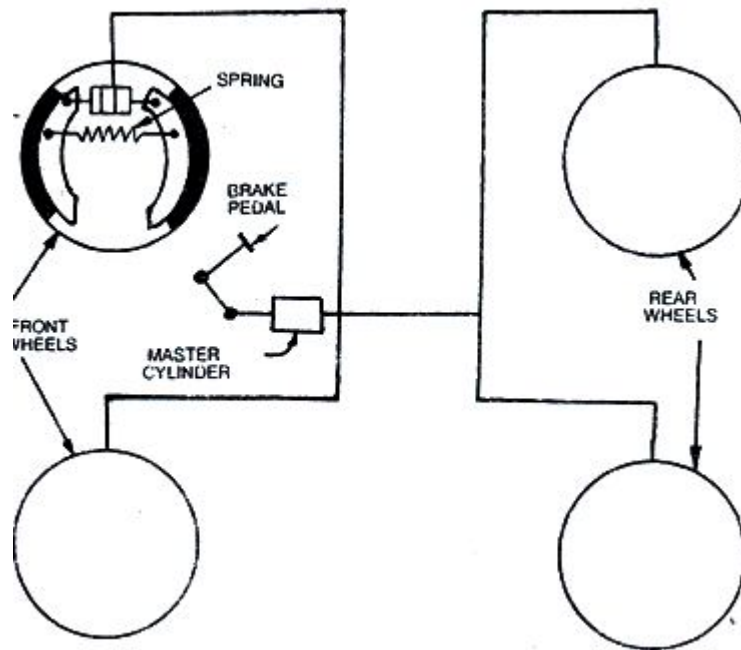


Fig 3.3 Hydraulic Brake System

Master cylinder

It is the most important part of hydraulic braking system . It contains two main chambers .

- (i) Fluid reservoir – which stores the brake fluid in it
- (ii) Barrel-which is compressor and develops pressure in brake fluid

(i) Reservoir : The reservoir also contains two parts . The larger part is called filler or intake port and the smaller port is called by pas through which the returned fluid from the system will enter into reservoir from barrel.

(ii) Barrel : In the barrel of master cylinder the parts are – (a) Primary cup (b) Position (c) Secondary cup (d) Return spring (d) Return spring (e) Check value .

When the brake pedal is applied the push rod will push the piston of master cylinder and there by the pressure is applied on the Hydraulic Brake fluid. The pressurized brake fluid will enter into system through check valve

which does not allow the fluid to return back. This causes the pressure on the system and applying brakes at the wheel cylinder.

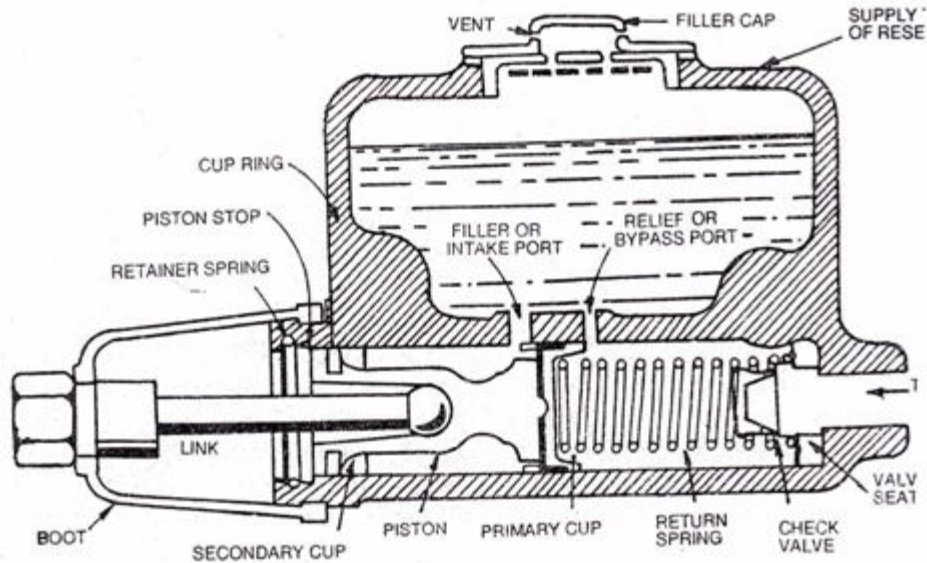


Fig 3.4 Master Cylinder

Wheel cylinder

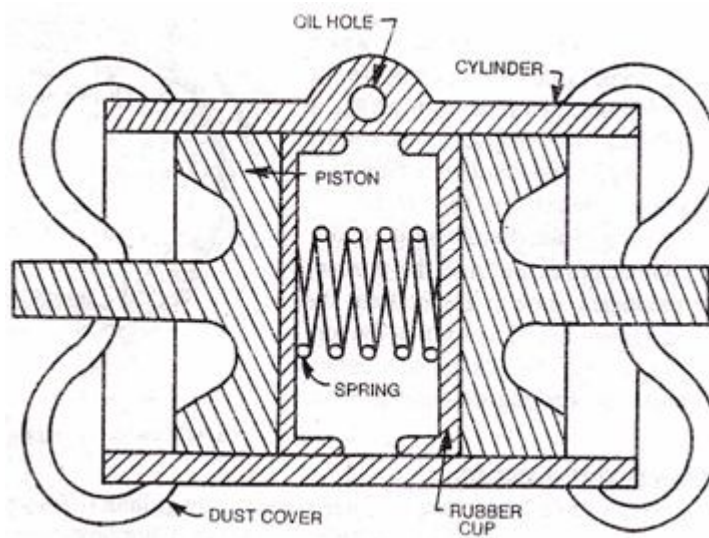


Fig 3.5 Wheel Cylinder

Wheel cylinder or slave cylinder assist the main master cylinder in covering the pressure to the piston inside it and push the brake shoes attached to it. Some of the wheel cylinder having one piston and some having two pistons. The wheel cylinder having one piston will operate only one brake shoe and the two wheel cylinder are require to operate two brake shoes. In some wheel cylinder, both brake shoes are operated as they are having two piston in them.

When brakes are applied the brake fluid enter into the cylinder through a brake pipe line. It cause to force out the piston. This motion is transmitted to brake shoes causing them to expand against the running wheel drum to hold it tightly and stop it. .

3.6 Bleeding of brakes in Hydraulic brakes.

In Hydraulic Brakes, the removal of air from the entire Hydraulic system starting from master cylinder to different wheel cylinders is known as Brake Bleeding

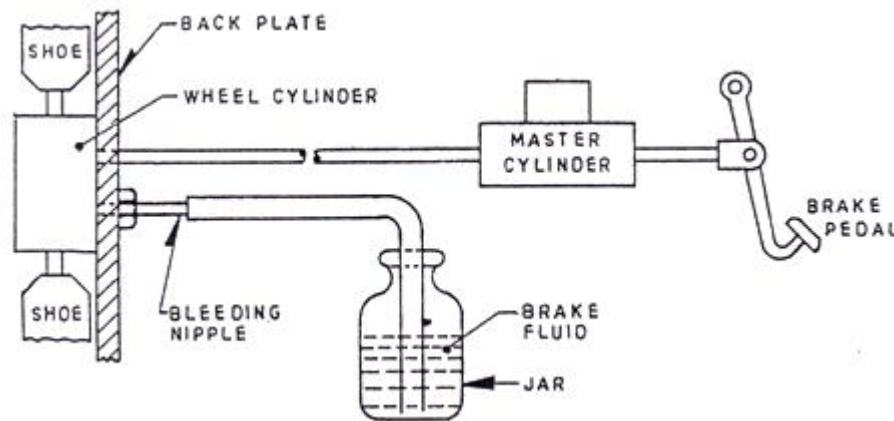


Fig 3.6 Wheel Cylinder

It includes the following process :

- (i) At first check all the pipe lines and junction boxes from master cylinder to wheel cylinder. Whether there is any leak among them.
- (ii) Ask one person to pump the brake pedal and keep it in pressing position
- (iii) The second person should loosen the bleeding nipple at the back plate of the wheel cylinder position.

- (iv) Keep the bleeding nipple in open until the air bubbles disappear and the brake fluid comes out with a force . Collect the brake fluid in a glass tumbler.
- (v) Then tighten the bleeding nipple
- (vi) Repeat this process in all the wheel cylinders starting from the farthest wheel to the master cylinder and ending with the nearest wheel.
- (vii) Make sure that the level of brake fluid in master cylinder is $\frac{1}{4}$ less than the top covers while filling it.

Air Brakes

The manufacturers of braking systems offer a variety of air brake equipment. However, the simplest system consists of an air compressor, a brake valve, series of brake chambers, unloader valve, a pressure gauge and a safety valve. These are all connected by lines of tubing. The other braking systems may have additional components such as stop-light switch, a low pressure indicator, an air supply valve to supply air for tyre inflation, a quick release valve to release air quickly from the front brake chambers when pedal is released, a limiting valve for limiting the maximum pressure in the front brake chambers and a relay valve to help in quick admission and release of air from rear brake chambers.

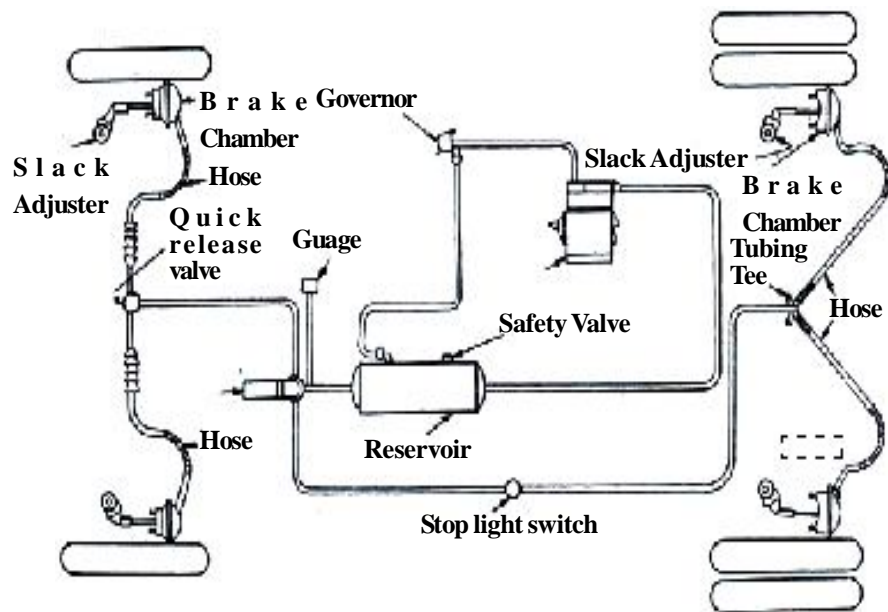


Fig 3.7 Air Brake

The compressor sends compressed air to the-reservoirs which are connected to the brake. valve. The lines of tubing from the brake valve extend to the front and rear brake chambers. When the drive depresses the pedal, it operates the brake valve thus admitting compressed air to all the brake chambers. The compressed air operates the diaphragm of the brake chambers thereby applying the brakes.

3.7 List out types of Brakes used in various vehicles.

S.No	Vehicle Make	Type of Brake	Dia of drum. (mm)	Linings
1	Maruti (Suzuki) 800	Hydraulic Front-Disc Type Rear-Drum Type	Pad thickness = 15.5 mm Disc thickness = 11 mm Drum dia = 180 mm	Ferodo MR41 or DM85
2	Hindustan Ambassador Mark II	Hydraulic	203.2	
3	Fiat 1000 (Premier Padmini)	Hydraulic	250.0	Ferodo
4	Jeep CJ Series	Hydraulic	221.6	Ferodo
5	Ashok Leyland Comet Passenger, Viking	Air Pressure Diaphragm-operated	393.7	Ferodo F3H
6	Dodge/Fargo Model 89 M4	Hydraulic, with com- pressed air booster	Front 406.4 Rear 431.8	Ferodo
7	Tata 1210 E	Hydraulic air pressure booster	Front 412.0 Rear 412.0	Ferodo
8	Standard 20	Hydraulic	319.4	Ferodo
9	Swarni Mazda	Hydraulic with vacuum booster	Front 300.0 Rear 228.6	

Summary

- Brakes are used to slow down or to stop the vehicle as and when required by the driver.
- Brakes are of two types
 - i. Internal Expanding brakes.
 - ii. External contracting brakes.
- According to usage, the brakes are classified as
 - i. Mechanical brakes
 - ii. Hydraulic brakes
 - iii. Air brakes
 - iv. Vacuum brakes
 - v. Air assisted hydraulic brakes
 - vi. Hydrovac brakes etc.
- Requirements of Brakes
 - i. The brakes must stop the vehicle within shortest possible distance.
 - ii. These must be released suddenly immediately after releasing them.
 - iii. Total control of the vehicle should be ther.
- Mechanical brakes are operated through mechanical links and levers.
- These are used in two wheelers and in case of 4 wheeler. These are used as 'Parking Brakes' or 'Emergency Brakes'.
- Hydraulic brakes are operated according to pascal's law which states that "the pressure applied on any liquid is equally transmitted to all the directions at the same time."
- Main parts of hydraulic brakes system are
 - i. Brake pedal
 - ii. Master cylinder
 - iii. Brake pipe line

iv. Wheel cylinder

v. Brake drum

- Air brakes are operated with the assistance of compressed air.

Short Answer Type Questions

1. What is the purpose of Brakes?
2. Define stopping distance?
3. Mention the main parts of hydraulic brakes.
4. On which law the hydraulic brakes work?
5. What is meant by 'Brake bleeding'?

Long Answer Type Questions

1. Briefly explain the construction and working of mechanical brakes.
2. Explain the hydraulic brakes with neat sketch.
3. Explain the master cylinder with neat diagram.
4. Explain the brake bleeding process with sketch.
5. Explain the air braking system with sketch.

UNIT

4

Suspension System**Structure**

- 4.1 Requirements of Automobiles Suspension system
- 4.2 Types of suspension system - conventional and Independent
- 4.3 Types of Springs - Laminated Spring, coil spring, helical spring.
- 4.4 Need of Shock absorber
- 4.5 Stabilizers bar and torsion bar.
- 4.6 List out the type of suspension system used in various vehicles.

Learning Objectives

After studying this unit the student should be able to learn the

- Requirement of suspension system in automobiles
- Types of suspension system, types of springs
- Need of shock absorber, stabilizer bar, torsion bar.
- Types of suspension system used in different vehicles.

4.1 Requirement of automobiles suspension system

The automobile suspension system is having the following requirement

- (i) To have minimum deflection to the vehicles with required stability

- (ii) To have minimum wheel hop.
- (iii) To safe guard the occupants and cargo against road shocks
- (iv) To minimize the effects of stresses due to road shocks on the mechanism of the vehicle.
- (v) To keep the body perfect in level while travelling over rough and uneven roads.
- (vi) To keep the body of the vehicle safe from road shocks.

4.2 Types of suspension system - conventional and Independent

There are different types of suspension system provided in different vehicles. Those are

- (i) Conventional suspension system
- (ii) Independent suspension system

4.2.1 Conventional suspension system

In this suspension system. The wheels are fitted on beam type which are attached to the chassis frame through road springs. In this type of suspension, the effect on one wheel is directly transmitted to the other side wheel through the axle.

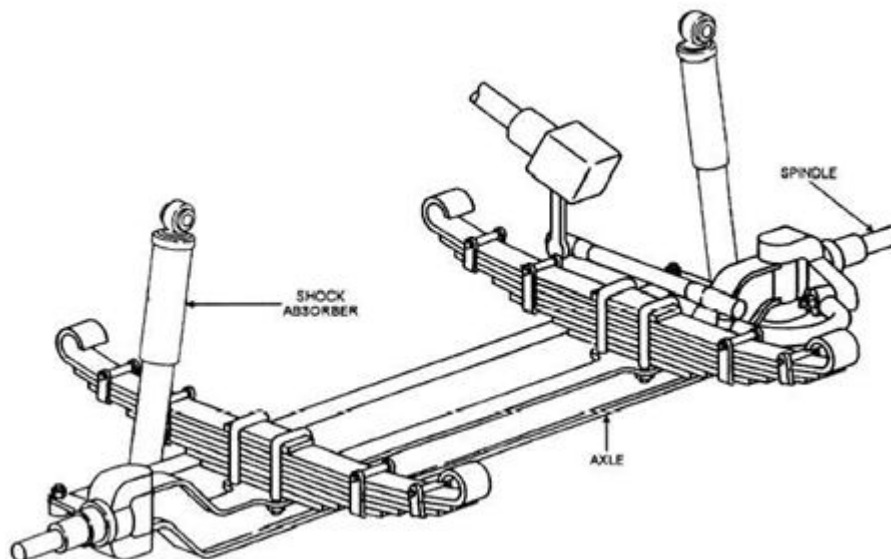


Fig 4.1 Conventional Suspension System

4.2.2 Independent suspension system

In this system the suspension for each wheel is in an independent unit and is free from the effect of one another. There will be no effect of road shocks on the vehicle directly.

4.2.3 Types of independent suspension system

- (i) Wishbone arm system
- (ii) Trailing link system
- (iii) Sliding pillar system

Wishbone arm system

Wishbone arm type independent suspension system is most popular type of all independent suspension system. In this system transverse springs along with coil springs are mostly used. In European cars, torsion bars instead of coil springs are used. In this system there are two suspension or control arms are used in each side of the vehicle. These arms are like two legs of a chicken wishbone or better 'V'. These wishbone arms are connected with chassis frame on the open end. The closed end spreads out of the chassis frame. One arm is below whereas the other is above the frame. The closed ends of both upper and lower suspension arms are connected with steering knuckle support to which the steering knuckle is attached by means of kingpin. A coil spring is placed between the frame and the lower wishbone arm. Mostly the open end of upper control arm is connected with the shock absorber shaft which is fitted at the frame. When there is a bump, the wheel tends to go up, the control since the shock absorber is fitted with the upper control arm, it damps the vibrations set up in the coil spring due to road irregularities.

Trailing link system

The trailing link independent suspension uses parallelogram linkages lying beside the frame side members. Usually a horizontal coil spring is used in this type of suspension system. During compression and rebound, the spring winds and unwinds. In some vehicles the torsion bar may also be fitted instead of horizontal coil spring.

Sliding pillar system

In this system the pillar or elongated king pin is attached to the wheel and slides up and down in the axle type beam fixed rigidly to the vehicle frame.

4.3 Types of Springs - Laminated Spring, coil spring, helical spring

The springs support the chassis frame. The entire weight of the vehicle live engine, power train, body, passengers, cargo etc, falls on the chassis frame. The spring damp the road shocks transmitted to the wheels as they travel over the road thereby protecting the units supported directly by the frame. The springs are placed between the chassis frame and the axle.

Types of springs

- (i) Leaf springs
- (ii) Coil springs
- (iii) Helical Springs

(i) Leaf springs : The leaf springs are of different types namely-full elliptic three quarter elliptic, semi elliptic, quarter elliptic transverse. In almost all automobiles which are having conventional suspension system the semi elliptic leaf springs are most commonly used.

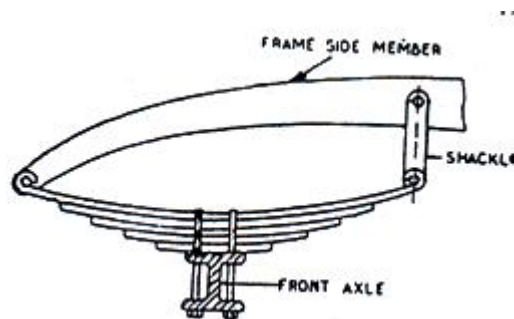


Fig 4.2 Leaf Springs

The leaf springs are made of long flat strip steel. Several strips are placed one on the other and held together by means of centre bolt and chaps. Each strip is called is leaf. There is one main leaf which is extended to full length.

Each succeeding leaf is shorter than the preceeding one. The main leaf contains eyes are both ends for making connections with the frame. The entire set is fitted from the chassis frame by hanging with a shackle at one side and the other side is fixed to frame. During jerks, the leaf spring bounces and each strip flexes and rebounds again and again.

(ii) Coil springs : Coil spring is made of a length of special spring steel, usually round in section which is wound in the shape of coil. The ends of coil spring are kept flat so that could seat properly. They can store twice energy per unit volume in comparison to leaf spring. To seat the coil springs pan shaped brackets or spring seats are attached to the axles. This suspension is also used in combination with torque tube or torque rod.

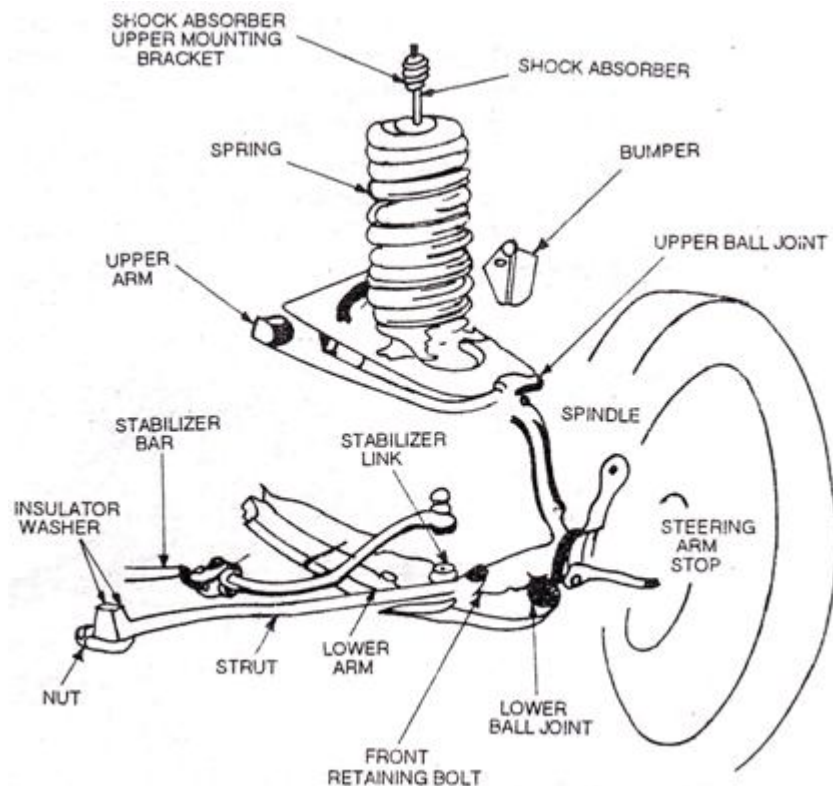


Fig 4.3 Coil Springs

(iii) Helical Springs : The helical springs are preferably used in combination with independent suspension system. The length and diameter of the spring wire greatly affect the stiffness of the spring. But the length is controlled by the diameter of the coil and the number of active coils.

4.4 Need of Shock absorber

Shock absorber compresses with the road shock and rebalances while travelling on uneven roads due to usage of this, the effect of road shock is required by the shock absorber suddenly and releases slowly while travelling on uneven roads.

There shock absorber are of two types

- (i) Mechanical type
- (ii) Hydraulic type

Hydraulic Shock Absorber

The shock absorber develop resistance to the spring by forcing a fluid through check valves and small holes. 'Double' acting shock absorber offer resistance both during compression and rebound of the spring. The 'Double acting Hydraulic telescopic shock absorber' are the commonly used shock absorber which are described as shown in the figure below

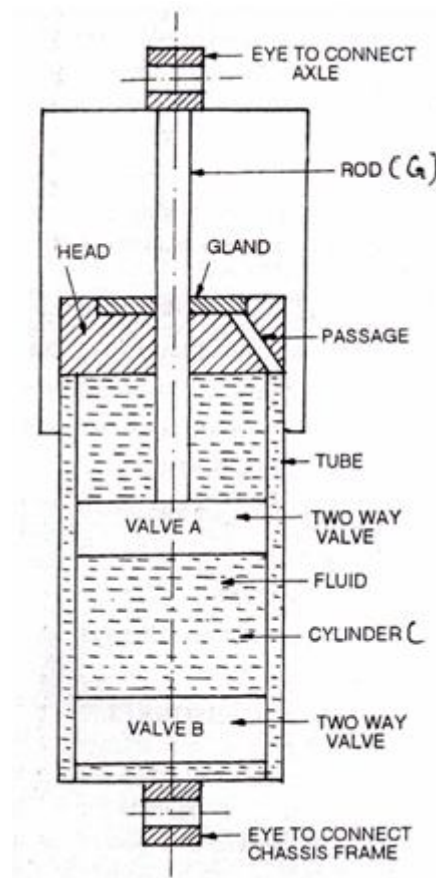


Fig 4.4 Hydraulic shock absorber

Its upper eye is connected to the axle and the lower eye to the chassis frame. A two way valve 'A' is attached to as rod 'G'. Another two way valve B is attached to the lower and of the cylinder C. The fluid is in the space above

and below the cylinder C and tube D, which is connected to the space below the valve B. The J has glad H. Any fluid scrapped off the rod G is brought down into the annular space through the inclined passage.

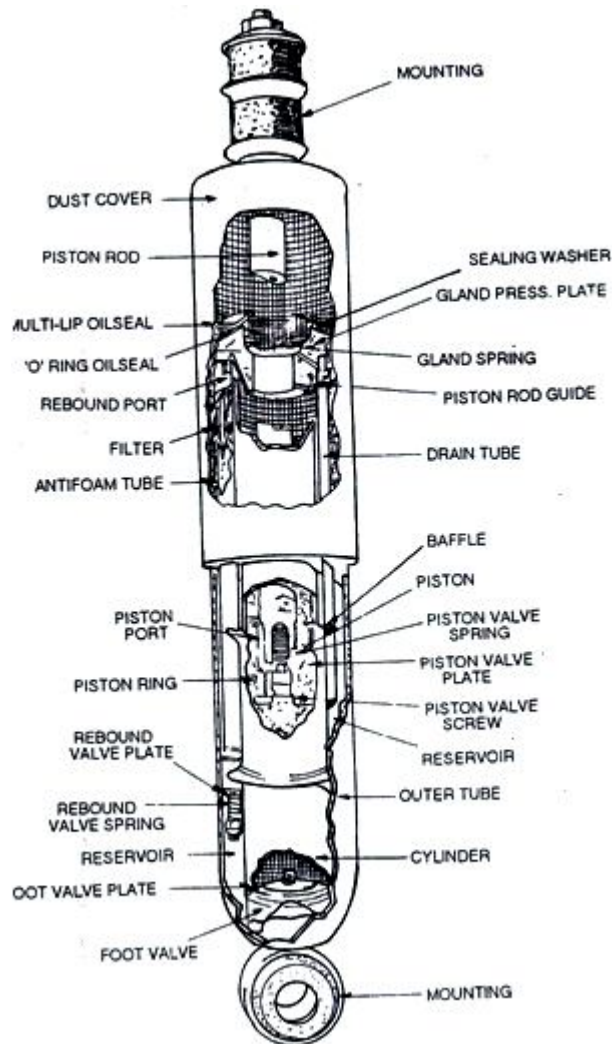


Fig 4.5 Hydraulic shock absorber(detailed construction)

When the vehicle comes across a bump the lower eye E moves up. Therefore the fluid passes from the lower side of the vehicle A to its types side .But since the volume of the space above valve A is less than the volume B. This pressure of the fluid through the valve opening provides the damping force. Similarly when the lower eye E moves down., the fluid passes from the upper side of the valve A to the lower side and also from the lower of the valve B to the upper side.

4.5 Stabilizers bar and torsion bar

4.5.1 Stabilizer

A stabilizer or a sway bar, is necessarily used in all independent front suspension units. It reduces the tendency of the vehicle to roll or tip on either side when taking a turn. This tendency has been increased due to the use of softer springs and independent front end suspension.

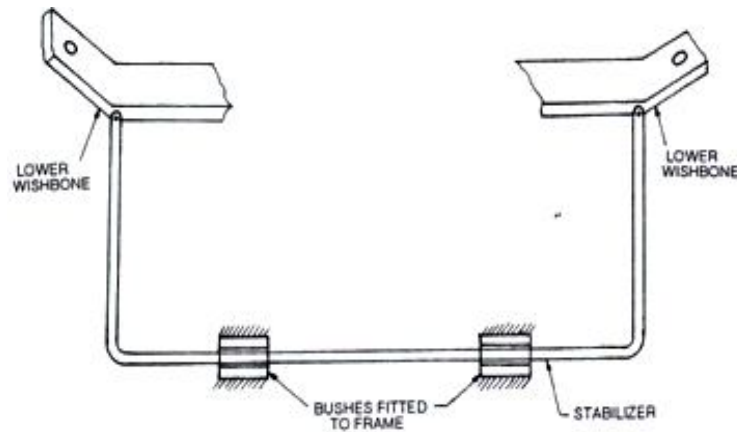


Fig 4.6 Stabilizer

A stabilizer is simply a bar of as long steel with arms at each end connected to the lower wishbone arm of independent suspension or to the axle. It is supported by bush bearing fixed to the frame and is parallel to the cross member. When both the wheels deflect up or down by the same amount the stabilizer bar simply turns in the bearings. When only one wheel deflects then only one end of stabilizer moves, thus twisting the stabilizer which acts as a spring between two sides of independent suspension system. In this way, the stabilizer reduces heeling or tipping of the vehicle on curves.

4.5.2 Torsion bar

In independent suspension system, the torsion bar is attached to the axle with the king pin of the front axle. The torsion bar absorbs the shock by moving in a certain angle with the axle. It is almost always used along with any kind of independent suspension system. It is used along with rubber torsion units.

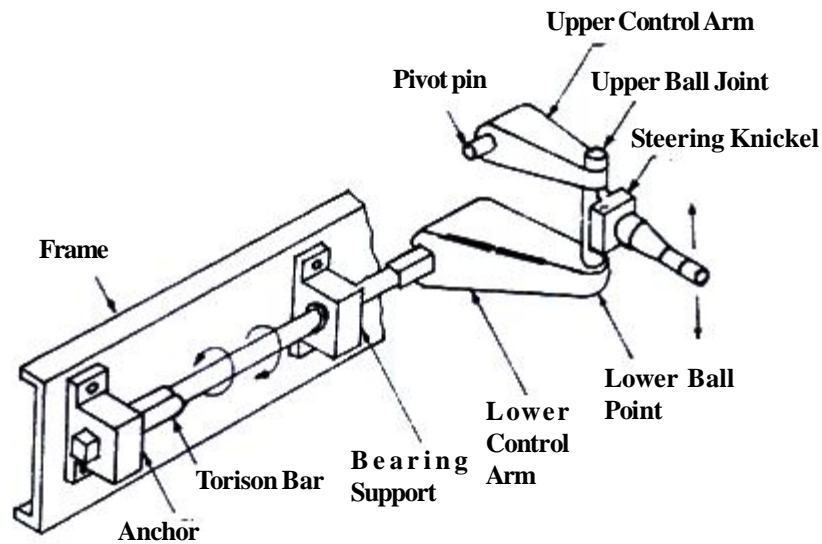


Fig. 4.7

4.6 List out the type of suspension system used in various vehicles

Sl. No.	Front Suspension		Rear Suspension	
	Make	Type	Type	Shock Absorbers
1	Hindustan Ambassador Mark II	Independent torsion bar	Semi-ellipse leaf	Hydraulic telescopic double acting
2	Fiat 1100	Independent coil springs	Semi-elliptic leaf	Hydraulic telescopic double acting
3	Jeep (J-3B)	Semi-ellipse leaf	Semi-ellipse leaf	Hydraulic telescopic double acting
4	Ashok Leyland Comet passenger	Semi-elliptic leaf	Semi-elliptic leaf	Hydraulic telescopic double acting
5	Dodge / Fargo model 89 M4	Semi-elliptic leaf	Semi-elliptic leaf	Hydraulic telescopic double acting

Summary

- Suspension system is provided to safeguard the occupants and cargo in the vehicle against road shocks and to give a smooth and comfortable drive.
- Types of Suspension drive
 - i. Conventional suspension system.
 - ii. Independent suspension system.
- Types of Springs
 - i. Leaf springs
 - ii. Coil springs
 - iii. Helical springs
- Types of Independent suspension system
 - i. Wishbone arm system.
 - ii. Trailing link system
 - iii. Sliding pillar system.
- Shock absorber compresses with the road shock and rebounds while travelling on uneven roads
- A stabilizer is used in independent front suspension units. It reduces the tendency of the vehicle to roll or tip on either side while taking a turn.
- In independent suspension system, the torsion bar is attached to the axle with king pin.
- The torsion bar absorbs shock by moving in certain angle with the axle.

Short Answer Type Questions

1. What is the purpose of suspension system?
2. Mention the types of suspension system.
3. What is the purpose of stabilizer?
4. What is meant by independent suspension system?

5. What is the purpose of shock absorber?

6. What is the purpose of Torsion bar?

Long Answer Type Questions

1. Briefly explain leaf spring with neat sketch?
2. Explain about a hydraulic shock absorber with neat sketch.
3. Explain the wishbone arm independent suspension system with a neat sketch.

UNIT

5

Seat, Door and Window mechanism

Structure

- 5.1 Construction and working of door lock mechanism
- 5.2 Construction and working of Manual window regulating mechanism
- 5.3 Construction and working of Power window regulating mechanism
- 5.4 Construction and working of Seat Adjustment mechanism.

Learning Objectives

After studying this unit the student will be able to understand

- Construction or working, door, door locking mechanism
- Construction of working on window regulating mechanism (manual and power)
- Construction and working of seat adjustment

5.1 Construction and working of door lock mechanism

In automobiles the doors play an important role of closing of the vehicle for protecting of passengers and cargo as the case may be. In cargo transport vehicles, the doors are closed as plain doors by using simple plain tower locking mechanism.

In cars and luxury vehicles, the door locking provision is almost all vehicles separately. In some door locking mechanism locks are provided outwards and in some other vehicles inward direction. In some recent models they are operated with remote control.

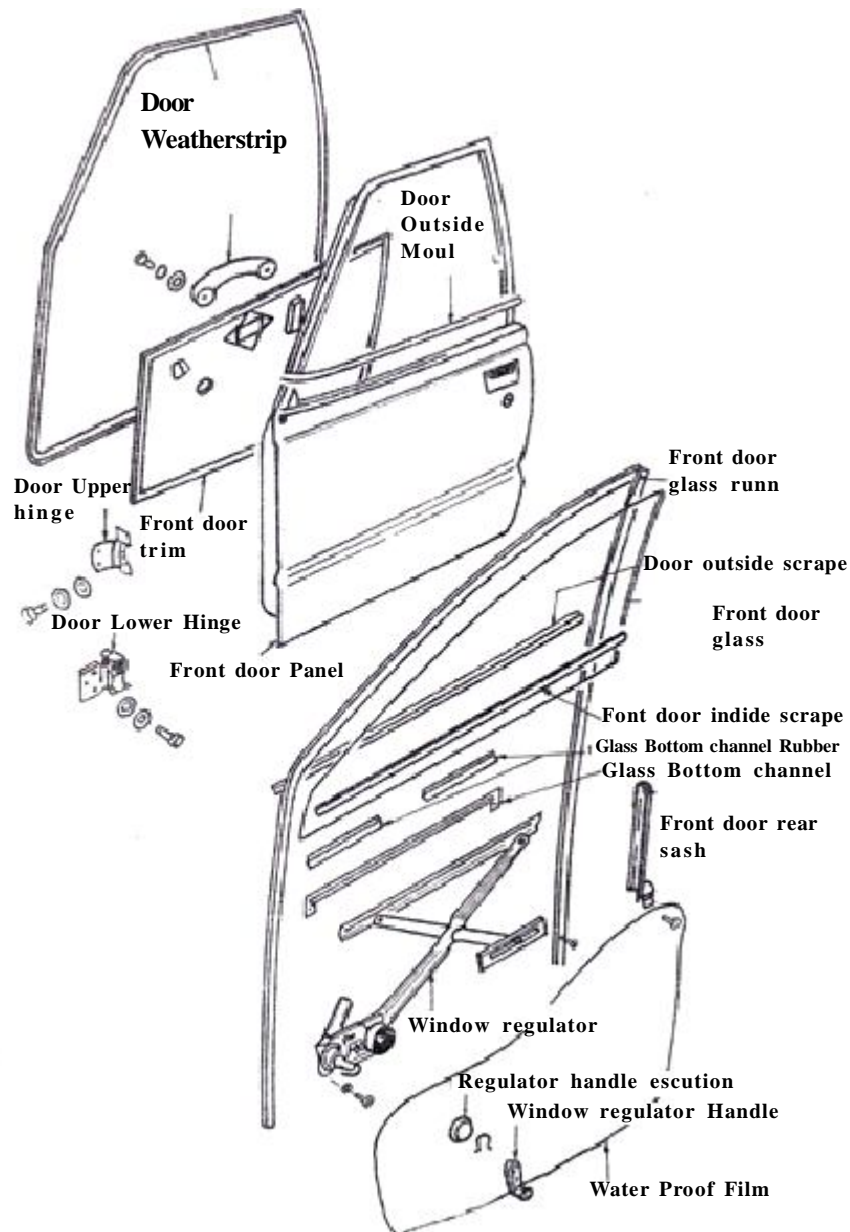


Fig 5.1 Doorregulating mechanism

Method of door locking mechanism

Almost in all kinds of automobiles, the door locking mechanism is just closing the door and the lock will be automatically operated. For unlocking any of the following methods may be applied.

- (a) With a key
- (b) By pressing the unlock button inside the vehicle
- (c) By using a combination lock outside the door
- (d) By pulling up the knob inside the door panel
- (e) With a keyless entry remote control
- (f) By a signal from control centre

Some of the vehicles, are having different methods of self check for door locking. It will warn you if it is not properly locked by lighting the body light or beeping a horn etc. In power lock mechanism, body controller monitors are the possible sources of locking and unlocking signals. There will be an actuator in the door and a latch will be connected to the locking handle. When the actuator moves, it connects the handle to lock the door. To unlock it the body controller supplies power to the door lock actuated for a timed interval.

A keyless remote entry device consists of a fob in the key ring and a radio receiver controller inside the car, which opens and closes the car doors on the receipt of a signal from the fob.

5.2 Construction and working of Manual window regulating mechanism

In cars and in some luxury vehicles, the window glasses can be operated for opening and closing to some extent as per the necessity. This can be done manually or by using a single button at each window or by using a panel of buttons at the control of the driver.

In olden days only manually operated window regulating mechanisms were being used. There will be a handle inside the door to regulate it. This can be operated manually by rotating the handle to the extent required. There will be a wheel inside of door panel which is connected to this handle.

5.3 Construction and working of Power window regulating mechanism

In modern days the window regulating mechanisms are being operated with power. By using the switches the height of closing and opening of window

glasses can be regulated. It is operated with electricity from the battery. In some cars, these can be operated with remote control.

5.4 Construction and working of Seat Adjustment mechanism

In automobiles the seat adjustment plays an important role in almost all kinds of vehicles. The seat should be in proper manner for comfort sitting as per the requirement of the operator. The space between the seat and operation pedals like accelerator, clutch, brake etc. Should be in a proper manner that the operator can reach them and it should be as long as possible if the operator is tall. The seat can be moved to and from the front dash board. Its height also can be increased or decreased as the case may be .

In buses of high comfort, the passenger seats can be adjusted according to the requirements . These can be adjusted like an easy chair for a comfort sitting or even for sleeping.

The seats used in cars are of various types such as rigid, folding back and bucket type . The front seats may be single type or full bench type with seat cushion and back rest . In case of two doors cars, the seat back rest in folding type, so that it swings forwards to allow access into back seat. Front seats are provided with adjustment that allows the seat to move back and forth or up and down as per the requirements. These adjustment are done manually or by using electric motor also.

Summary

- There are two types of Door locking mechanism.
 - i. Manual
 - ii. Automatic
- Sophisticated sensor operated door and window locking system are there.
- Window regulating mechanism is also either manually or battery operated can also be used. These are operated with remote control.
- The seat also can be adjusted according to the height of the person and also giving sufficient space for legs.

Short Answer Type Questions

1. What is the purpose of window regulating?
2. How many types of door locking mechanism are there.
3. What is the necessity of seat adjustment?

Long Answer Type Questions

1. Briefly explain manual and power of operated window regulating mechanism.

UNIT

6

Air Conditioning of Motor Vehicles**Structure**

- 6.1 Necessity of automobiles air conditioning
- 6.2 Construction and working of passenger car air conditioning.

Learning Objectives

After studying this unit, the student will be able to understand

- The necessity of automobile air conditioning
- Constructional details and working of it

6.1 Necessity of Automobiles Air Conditioning

The air conditioning of automobiles is very essential to maintain human comfort and improve internal atmosphere of an automobile in an enclosed space. It is required for proper control of freshness, temperature, humidity and cleanliness of air which is done by automobile air conditioning.

Working Principle

In an automobile air conditioning system, three main processes of heating, cooling and dehumidification are involved.

The heat required to warm the automobile is derived from the engine coolant or circulating warm water after passing through a heating coil. For

producing cooling effect an evaporator coil is placed inside the chamber of automobile. The air to be circulated inside the passenger compartment is cooled by the evaporator coil. The dust particles are entrapped by the wet surfaces of the evaporator core and are drained off with the condensed moisture. This provides clean and pure air for breathing.

6.2 Construction and working of passenger car air conditioning

The automobile air conditioning system includes compressor magnetic clutch condenser, receiver-drier-strainer, expansion valve, evaporator, blower and the air distributor system.

Compressor : It is driven by a belt from the crankshaft pulley. A magnetic clutch engages the compressor shaft. The applied voltage to compressor clutch coil, the clutch plate is locked by the magnetic force and the compressor shaft is turned with the pulley. When the voltage is interrupted the springs in the clutch plate and hub assembly automatically moves the plate away from the pulley which causes the compressor to stop. The compressor compresses the refrigerant to a maximum of about 20 kgf/cm² at 100°C.

Magnetic clutch : It is essentially controlled and is housed in pulley assembly. Its controlling switch is provided in the controlling panel. In the off or vent position the compressor and its clutch are off. In other four positions of the selector switch, the clutch is engaged or disengaged depending upon the temperature of air.

Condenser : Condenser is basically a fin and tube radiator. It is usually placed in front of radiator. It receives heated and compressed refrigerant vapour from the compressor and is cooled by the air passing across the condensers.

Receiver - driver (or Dehydrator)

The refrigerant is stored under pressure in the receiver-driver. The pressure in the receiver lies in between 5 kg/cm² to 20 kg f/cm² depending upon the compressor speed and surrounding air temperature. The drier removes any traces of moisture present in the system to avoid freezing of moisture at low temperature. Drier is usually a silica gel filter that absorbs any water.

Expansion valve : The refrigerant goes from dehydrator to expansion valve where a sudden expansion to a much lower pressure occurs. The refrigerant changes back to vapour state and this causes cooling effect. It is operated by opposing pressures on either side of the diaphragm.

Evaporator : It is located inside the passenger compartment. It gives cooling effect . A high capacity blower circulates the air in the interior part of the vehicle across the evaporator coils and this drops the temperature. The heat picked up by the refrigerant goes back to the compressor in the form of vapour where the refrigerant is again compressed to a high pressure.

Suction throttling valve : It ensures that the refrigerant in the evaporator stays at such a pressure that the evaporator core surface temperature does not fall below the freezing point of water (0°C), thus preventing ice formation in the evaporator.

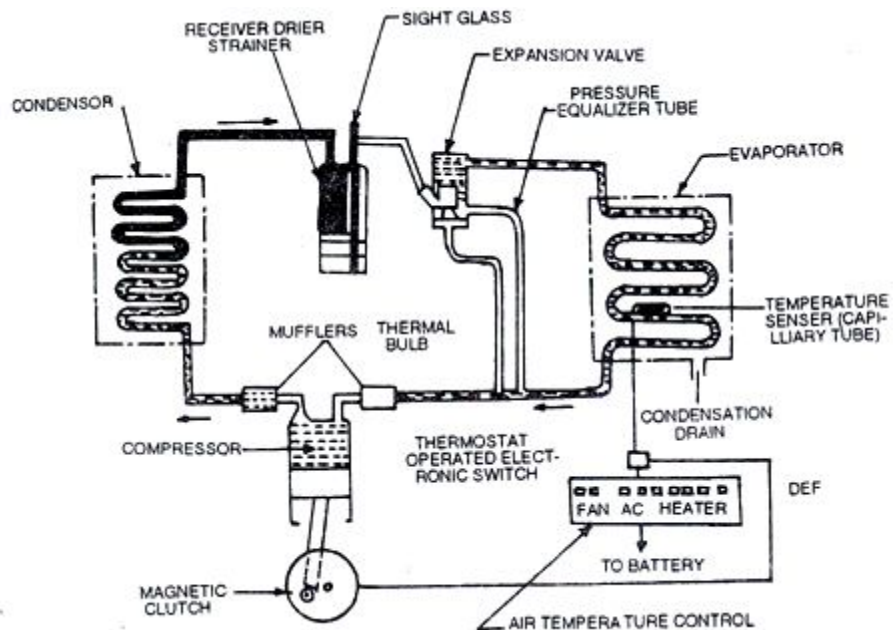


Fig 6.1 Automobile air-conditioning system

Summary

The air conditioning of automobiles is very essential to maintain comfort and improve internal atmosphere of an automobile in an enclosed space.

In automobile air conditioning, there main processes of heating, cooling and dehumidification are involved.

Main parts of Automobile air conditioning are compressor, magnetic clutch, condensor, receiver - drier, strainer, expansion valves, evaporation, blower and air distributor system.

Short Answer Type Questions

1. What is the necessity of Automobile air conditioning?
2. What is the working principle of automobile air conditioning?

Long Answer Type Questions

1. Briefly explain the construction and working of Automobile air conditioning with neat sketch.

UNIT

7

Painting of Automobiles**Structure**

- 7.1 Constituents of paints
- 7.2 Methods of painting
- 7.3 Painting Procedure
- 7.4 Reasons for failure of paint.

Learning Objectives

After studying this unit the student will be able to understand the

- Constituents of automobile paint
- Painting methods and processes
- Reasons for failure of paints in automobiles.

7.1 Constituents of Paints

Usually a paint consists of the following ingredients

1. Vehicle
2. Pigment
3. Enamel
4. Drier
5. Thinner

Vehicle

It is the main constituent of paint in solid form. It is the actual colour ingredient of the paint which forms the film. It is also known as binder. The most commonly used binders are synthetic or natural resins such as acrylics vinyl-acrylics, Vinyl-acetate/ethylenes; polyurethanes polyester, melamine resins, epoxy or oils.

Pigment

Pigments are granular solids incorporated in the paint to contribute colour. The pigments impart toughness, texture to give the paint special properties. It does not allow the main vehicle to loosen the paint particles. Titanium dioxide is used as pigment in most paints. Silica, Alumina, Zirconium are also used as pigments. These materials give better exterior durability or better hiding performance.

Enamel

The enamel portion of paint is mixed with vehicle and pigment to give it glazing appearance.

Drier

The drier in the paint allows the paint to dry as fast as possible so that the paint may not slip down from the body of the automobile to give it a uniform appearance at all parts of the body. Driers are oxygen carrying catalysts. They accelerate the drying of the oil film by oxidation, polymerization and condensation. Most effective driers used are resins, linoleates, tungstates and naphthalenes of copper, manganese, lead and zinc.

Thinners

The thinner in the paint is used to make it thin while mixing the vehicle, pigments and drier. It enables the paint to spread easily and also to be sprayed as the case may be. It is a volatile substance. Therefore evaporates after the paint has been applied. Popularly used thinners are turpentine, mineral spirits, benzene, dipentene, naphthalene, xylol, kerosene, methylated naphthalene etc.

7.2 Methods of Painting

Different types of painting methods are being applied for painting of automobiles

- (i) Brushing
- (ii) Dipping

(iii) Roller coating

(iv) Spraying

(v) Tumbling

Brushing

In automobiles some of the inner parts which can not be in reach of spray gun, can be painted by brushing with automobiles paints using paint brush.

Dipping

The parts of irregular shape and small in size can either be sprayed nor brushed. Such parts can be removed from the vehicle and dipped in a drum filled with paint.

Roller Coating

In automobiles the parts which are in sheet shaped can be painted by roller coating . The sheet shaped articles are passed through the rollers which are dipped in paint. By rotating the rollers on the sheets, the paint will be applied uniformly.

Spraying

The entire outer surface of the vehicle body is painted by means by spraying the paint with spray gun. In this method the paint is atomized by the force of compressed air or by the action of high pressure compression of paint and turning of paint into small particles which travel to the article to be painted.

Tumbling

Small sized articles are painted by this method. They are put in a rotating barrel containing properly mixed paint . The barrel is closed and rotated for a suitable amount of time. Articles get coated with paint and after taking out, they will be finally dried.

7.3 Painting Procedure

As anyone who's ever detailed by hand can tell you, painting a car is anything but simple. However, automotive manufacturers have developed several different techniques for body painting that yield effective, reliable results. The process is completely automated and works mainly through sealed chambers built onto the assembly line.

Step 1: Electrocoating

To keep the paint from peeling off or forming unsightly “bubbles” of rust underneath, the entire exterior must be protected from corrosion. Getting into each and every crevice with aerosol-sprayed paint can be difficult and expensive, even with a completely automated system. Instead, chains are attached to the chassis and the body is lowered by machine into a solution of ionically charged paint particles. The chain is electrically conductive and linked to a larger circuit. Meanwhile, the vat containing the paint solution is equipped with electrodes linked to the same circuit. When the body gets submerged, the circuit is completed, causing the current to flow from the vat electrodes, into the metal exterior and up the chain. In the process, this electrical field pulls the ionic paint particles toward the metal exterior, completely coating it.

After about 15 minutes of electrocoating, the body is hoisted out of the vat and carried (via a ceiling-mounted track) to a “drying chamber” where heat lamps dry the excess paint.

Step 2: Primer

Once the anti-corrosive layer has been electroplated on, primer is applied to add smoothness and allow a top paint layer to stick to the body. First, the body is lowered off the chains to rest on a floor apparatus attached to a track. To apply the primer, the body moves down the track into a special sealed room called a “flow chamber” (Figure 1). The flow chamber features a constant flow of air that takes vaporized primer particles from openings in the ceiling where they gently deposit on the exterior for a uniform thickness. Meanwhile, the bottom of the chamber has several outlet openings attached to a vacuum, removing excess primer to be collected and reused. After about 10 minutes, the body is moved down the track to another drying room.

Step 3: Base Coat

Once the primer has dried, the body moves into another flow chamber for the application of the base coat. The base coat constitutes the actual “color” of the car, including textural details like aluminum flakes for a sparkle effect. Like the primer, the base coat’s application involves the continual flow of vaporized paint across the body for about 10 minutes, followed by a trip to a drying room.

Step 4: Clear Coat

Just as the electrocoating protects metal from corrosion, the clear coat protects the base coat against light scratches, organic solvents, water and UV sun damage. As the name suggests, it is transparent, showcasing the base coat like glass does a picture. Typically, a flow chamber applies the clear coat as well.

7.4 Reasons for Failure of Paint**Chalking**

It is the progressive powdering of paint film on the painted surface. This occurs because of improper dispersion of pigment and vehicle.

Flaking

Peeling out of paint film from the painted surface is known as flaking. This is due to the presence of dust or greasy matter in the paint. Improper surface preparation may also cause this.

Cracking

Cracking of paint occurs because of

- (i) Unequal expansion and contraction of coats
- (ii) Variation of temperature of exposed film.

This can be prevented by applying a primary hard coat.

Colour Change

This happens because of chemical effects of atmospheric gases in the environment.

Summary

- A paint consists of the following ingredients :
 - i. Vehicle
 - ii. Pigment
 - iii. Enamel
 - iv. Drier
 - v. Thinner
- A vehicle is the actual color ingredient and is also known as binder.

- Pigments are granular solids to contribute colour.
- Enamel is used in painting for glazing appearance.
- Drier allows the paint to dry as fast as possible.
- Methods of painting - Brushing, Dipping, Roller coating, Spraying, Tumbling.
- Reason for failure of paint - Chalking, Flaking, Cracking, Colour change.

Short Answer Type Questions

1. What are the constituents of Paint?
2. Mention the methods of vehicle painting.
3. What is chalking in painting of automobile?
4. What is flaking of Automobile painting?

Long Answer Type Questions

1. Explain the ingredients of painting.
2. Briefly explain the painting methods.
3. Explain step by step process of Automobile painting.

UNIT

8

Automobile Pollution**Structure**

- 8.1 Effects of automobile pollution on environment and human beings
- 8.2 Types of automobile emissions
- 8.3 Treatment of exhaust gases by using catalytic convertors
- 8.4 Exhaust gas Analyzer

Learning Objectives

After studying this unit the student will be able to understand the

- The effects of automobile pollution on environment and human beings.
- Types of automobiles emissions
- Treatment of exhaust gases by using catalytic convertors
- Measuring of percentage of pollutants from petrol and Diesel vehicles by using 'Exhaust gas analyzers'

8.1 Effects of automobile pollution on environment and human beings

The major sources of automobile air pollution are the exhaust gases of the automobiles. The exhaust gases of automobiles contain severe pollutants in the form of nitrogen oxides which are toxic. The oxides of nitrogen together

with Hydrocarbons react in the presence of sunlight and form petrochemical smog. Its bad effects include crop damage.

8.2 Types of automobile emissions

- (i) Exhaust emissions
- (ii) Evaporative emissions
- (iii) Crank case blowy

Exhaust emissions

The exhaust emissions contain the specific substances- Hydrocarbons (HC) Carbon Monoxide (CO) and Oxides of nitrogen (NO). Hydrocarbons are the unburned fuel vapours coming out with the exhaust due to incomplete combustion. Hydrocarbons also occur in crank case blowy and fuel evaporation. Carbon monoxide occurs only in engine exhaust. It is the exhaust of incomplete combustion due to insufficient amount of air fuel mixture or insufficient time for complete combustion. 'Oxides of nitrogen' are the combination of nitric oxide (NO) and nitrogen dioxide (NO²) which occurs only in exhaust. At high temperatures nitrogen and oxygen heat with each other causing creation of NO.

Evaporative emissions

These emissions take place from the fuel supply system. About 30% of the total Hydrocarbon emission occur from fuel tank, pipe lines, carburettor etc.

Crank case Blow by

Crank case blow by means the leakage of fresh charge past the piston and piston rings from the cylinder to crank case. It is almost 20% of the total HC emissions from the engine and about 30 % if piston rings are worn. In these gases about 85% raw hydrocarbons and 15% of burnt gases will be leaked. These gases can be controlled by crank case ventilation.

From the above process, the major pollutants are released. Those are

- (i) Carbon monoxide
- (ii) Unburnt Hydrocarbons
- (iii) Oxides of nitrogen
- (iv) Lead oxides
- (v) Sulphur dioxide
- (vi) Smoke

Of the above pollutants, carbon monoxide (CO) is most undesirable. The effect of CO inhalation are headaches, sickness or loss of mental alertness. Carbon monoxide reacts with haemoglobin (HB) in the blood to give carboxyhaemoglobin (COHB) and this causes decrease of HB for oxygen transport.

A combination of strong sunshine and stagnant air allows unburnt hydrocarbons and oxides of nitrogen to combine chemically to produce 'Photochemical smog'. This causes damage to rubber, clothing, paint, and exposed surfaces.

Lead present in lead oxides in exhaust gases can be harmful particularly for children in the age group of 1 to 5 years.

Sulphur dioxide causes visibility attenuation, bronchitis and even lung cancer also.

8.3 Treatment of exhaust gases by using catalytic converters

The exhaust gases from the engine are passed through 'Catalytic convertor' which is a cylindrical unit about the size of a small silencer and is installed into the exhaust system of a vehicle between exhaust manifold and silencer. Inside the converter there is a honeycomb structure of a ceramic or metal, which is coated with alumina base materials and thereafter a second coating of precious metal like platinum, palladium or rhodium. This second coating serves as catalyst. A catalyst is a substance which causes a chemical reaction. As a result of this reaction when the exhaust gases pass over the convertor substance, toxic gases such as CO, HC and NO are converted into harmless CO₂, H₂ and N₂.

8.4 Exhaust gas Analyzer

The analysis of exhaust gases can be done with the help of infrared analyzer. The analyzer is capable of measuring the hydrocarbons and carbon monoxide. The probe is inserted into the tail pipe of vehicle and the analyzer is switched on. The exhaust sample is moved by an internal pump, through the sample line and filter. Then it is vented to atmosphere. In the sample cell, a beam of infrared light is made to pass through the exhaust sample. The analyzer then determines the quantities of Hydrocarbons and carbon monoxide with the help of processing electronics and indicates the same by moving the respective indicators. The quantities indicated are in parts per million (PPM).

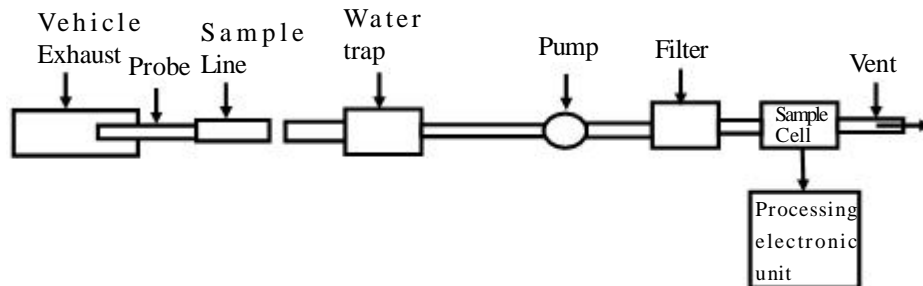


Fig 8.1 Operation of Exhaust gas Analyzer

Specifications of a typical modern gas analyzers

CO	Ranges :	0-9.9%
	Accuracy :	$\pm 0.21\%$
	Repeatability	$\pm 2\%$ fs.
HC	Ranges	0-5000 ppm
	Accuracy	± 40 ppm at 0-2000 RPM
	Repeatability	± 150 ppm at 2000-5000 RPM
O ₂	Ranges	0-20.9%
	Accuracy	$\pm 0.4\%$ at 0-5%
		$\pm 1.0\%$ at 5 - 20.9%
	Repeatability	$\pm 2\%$ fs.
CO ₂	Ranges	0-20.0%
	Accuracy	$\pm 0.9\%$ at 0-0%
		$\pm 0.48\%$ at 10-16%
		$\pm 1.44\%$ at 16-20 %
	Repeatability	$\pm 2\%$ fs

Warm up time : 10 minutes at 20°C

Response time : 14 seconds for 90% for final reading (10 m pipe)

Operating temperature : 2°C to 43°C

Dimension	: 315 mm (w) x 282 mm (H) x 270 mm (D)
Weight	: 14.3 kg.
Power	: 200-24, v, 50-60 HZ, 100W.
Options	: (i) Printer (ii) RPM/ Oil temperature display

For Diesel engines it is also required to measure the smoke capacity and K-value for which a smoke meter is used. Main specification of a typical smoke meter (Manatec - DSM 2000) are as follows

Measurement parameters	Range	Resolution
Opacity	0-99.9%	0.10%
K- Value	0.99.9%	0.10%
Other specification		\pm
Linearity		\pm 0.1 m ⁻¹
Repeatability		0.1 m ⁻¹
Response time physical		< 0.4 sec
Response time - electrical		< 1 ms
Warm up time		< 3 minutes
Smoke measuring call length		430 mm.

Summary

- The major sources of automobile air pollution are the exhaust gases of automobiles.
- The exhaust gases of automobile contain severe pollutants in the form of nitrogen oxides.
- Types of Automobile emission.
 - i. Exhaust emission
 - ii. Evaporative emissions
 - iii. Crank case blow by

Short Answer Type Questions

1. Mention the types of automobile emission.
2. Mention the pollutant released while crank case blow by.
3. What is the purpose of exhaust gas analyzer.

Long Answer Type Questions

1. Briefly explain the working of catalytic converter.
2. Explain the operation of Exhaust gas analyzer.
3. Explain the effects of automobile pollution on environment and human beings.

UNIT

9

Legal aspects of Motor Vehicles**Structure**

- 9.1 Traffic signs and signals
- 9.2 Requirements regarding registration of vehicle
- 9.3 Necessity of permits for commercial vehicles.
- 9.4 Insurance coverage
- 9.5 Procedure for obtaining Driving license

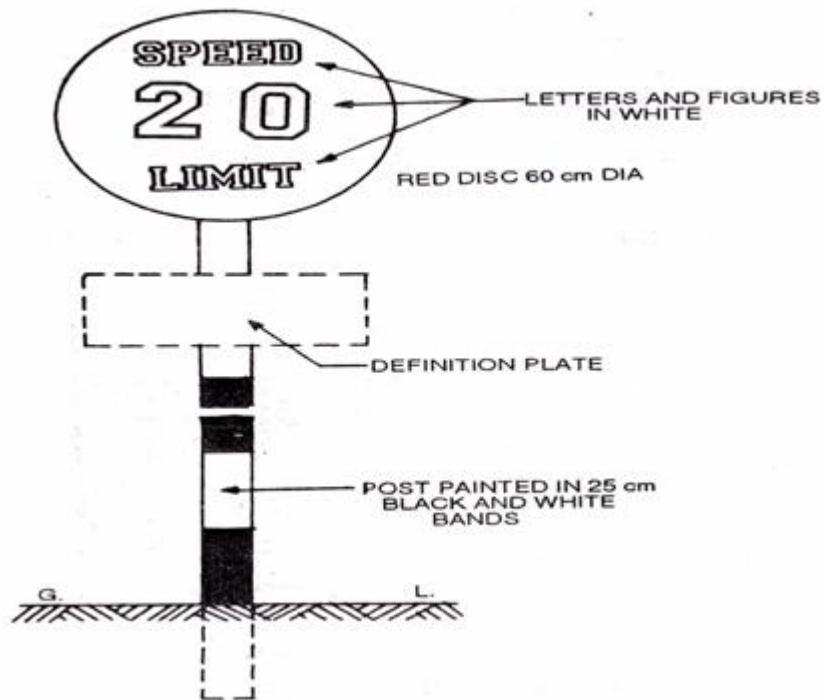
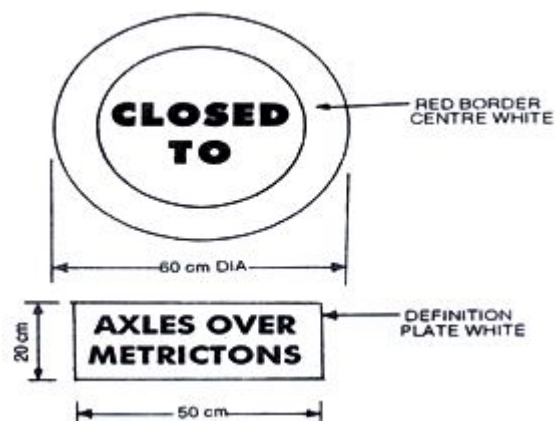
Learning Objectives

After studying this unit, the student can be able to understand

- Traffic signs and signals
- Requirements regarding registration
- Necessity of permits for commercial vehicles with insurance coverage
- Procedure for obtaining driving license.

9.1 Traffic signs and signals**9.1.1 Traffic signs**

- (a) Mandatory
- (b) Cautionary
- (c) Informatory

a. Mandatory Signs**Fig 9.1 Mandatory speed limit****Fig 9.2 Weight limit**

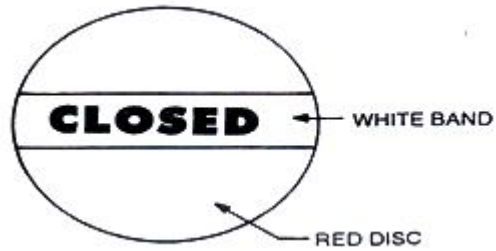


Fig 9.3 Total prohibition

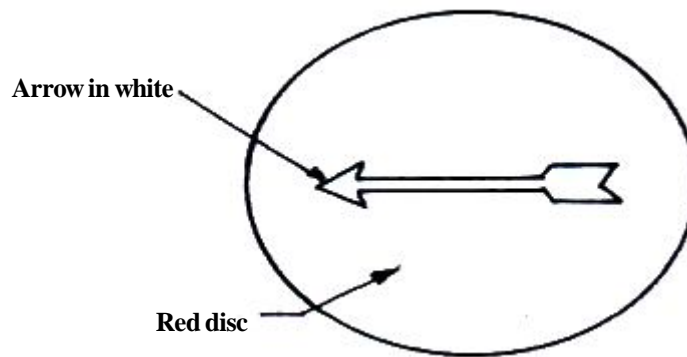


Fig 9.4 Direction sign

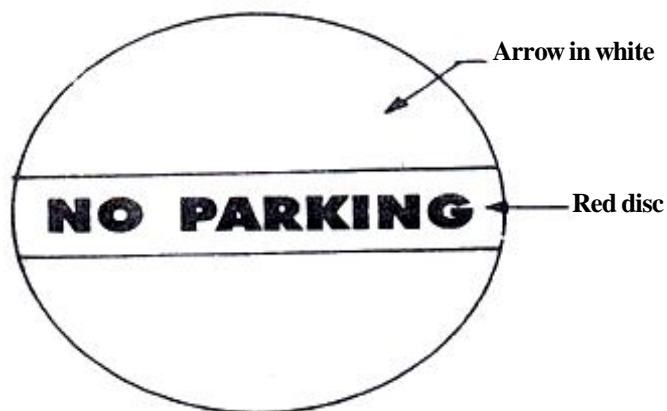


Fig 9.5 No Parking

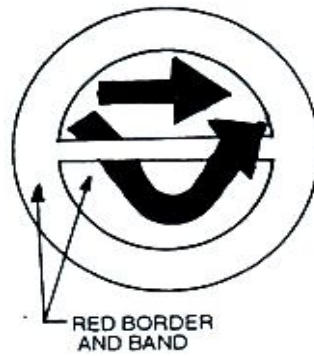


Fig 9.6 Overtaking Prohibited



Fig 9.7 Use of sound signals prohibited

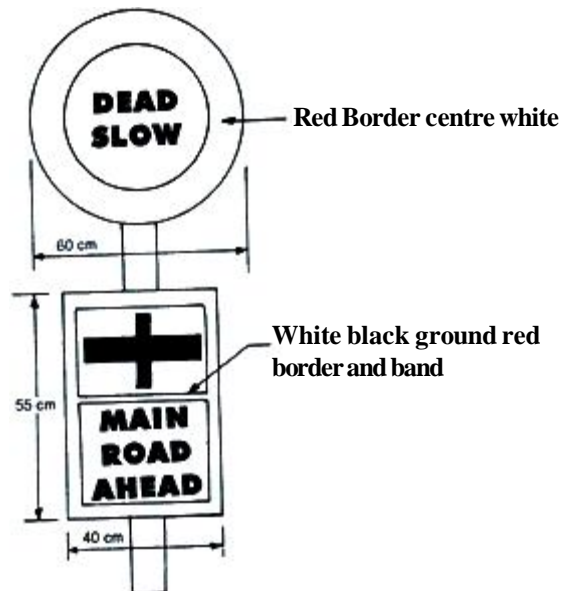


Fig 9.8 Main road ahead

b. Cautionary Signs

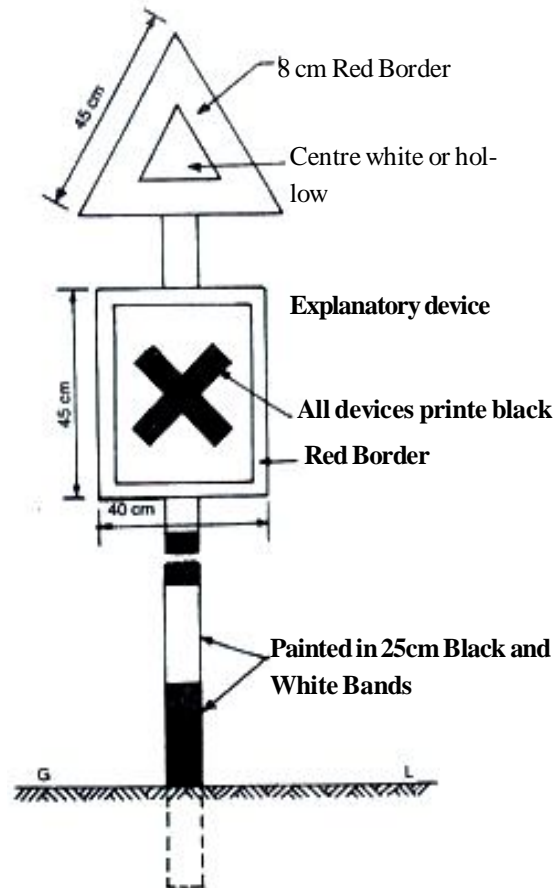


Fig 9.9 General Design

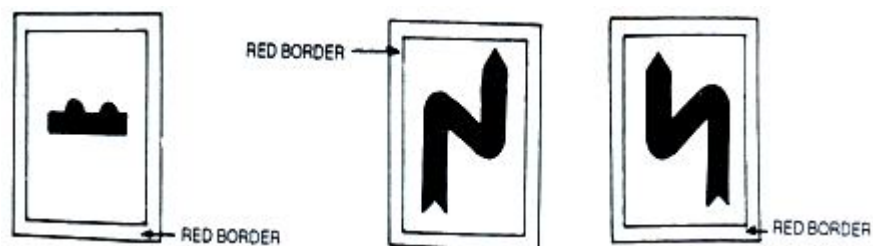


Fig 9.10 Rough road, Zig-zag(right) and Zig - zag (left)

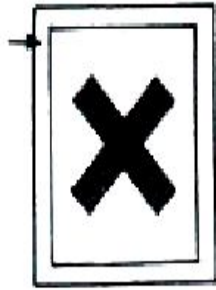


Fig 9.11 Cross Roads

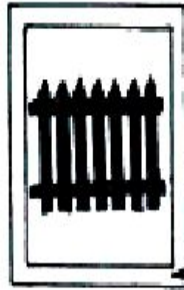


Fig 9.12 Level Crossing (Guarded)

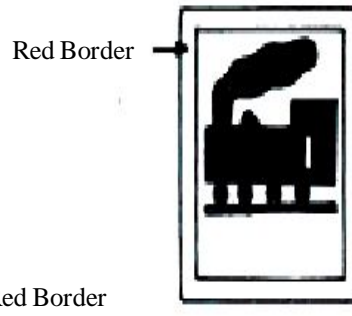


Fig 9.13 Level Crossing (Unguarded)



Fig 9.14 Right turn

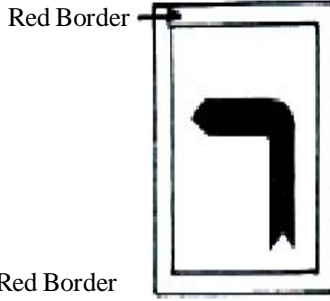


Fig 9.15 Left turn



Fig 9.16 School

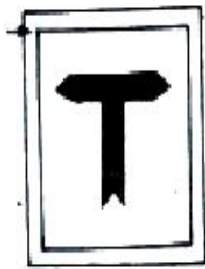


Fig 9.17 Dead end cross road



Fig 9.18 Side road (right)

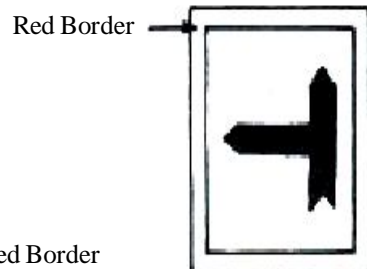


Fig 9.19 Side Road (left)



Fig 9.20 Steep Hill

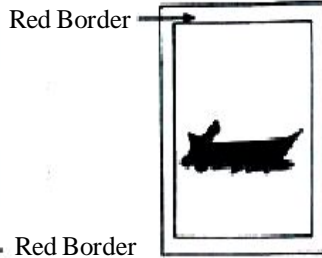


Fig 9.21 Perry

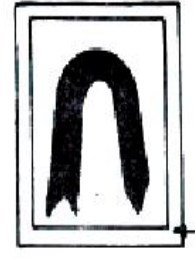


Fig 9.22 Hair Pin Bend (right)



Red Border

Fig 9.23 Hair Pind Bend (Left)



Red Border

Fig 9.24 Narrow bridge red borders

c. Informatory signs

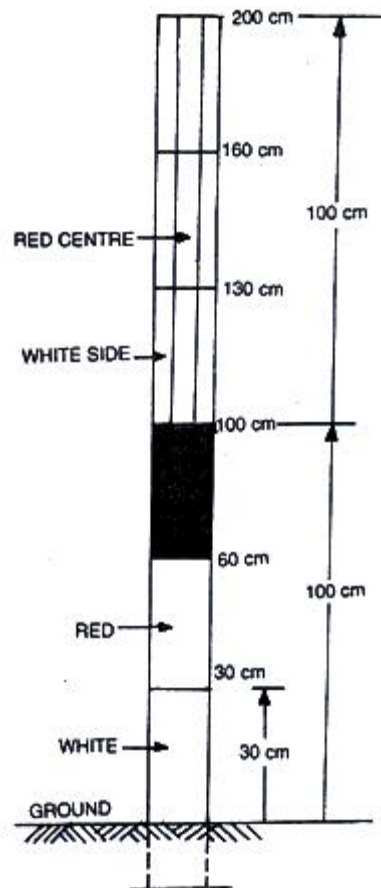


Fig 9.25 Flood Gauge Side elevation

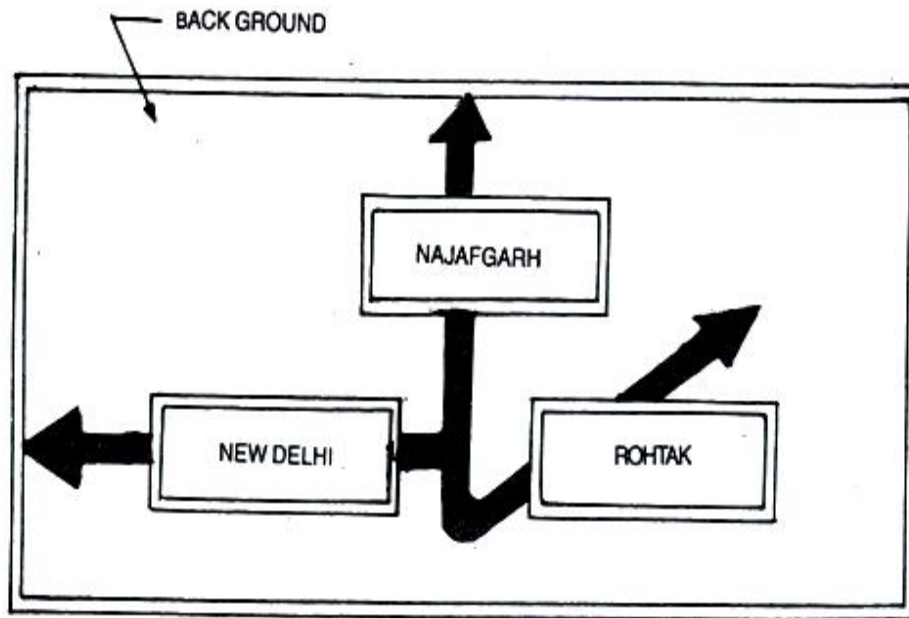


Fig 9.26 Road junction approach

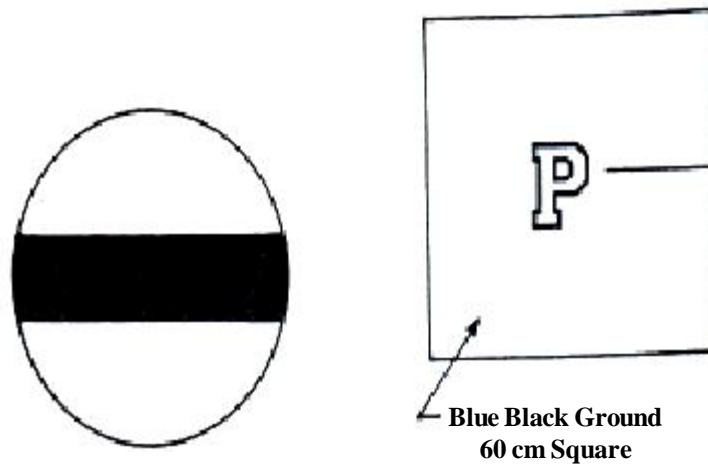


Fig 9.27 Road junction approach

9.1.2 Traffic Light Signals

1. Red means stop. Wait behind the stop line on the carriages way.
2. Red and Amber also means stop. Do not pass through or start until Green shows.

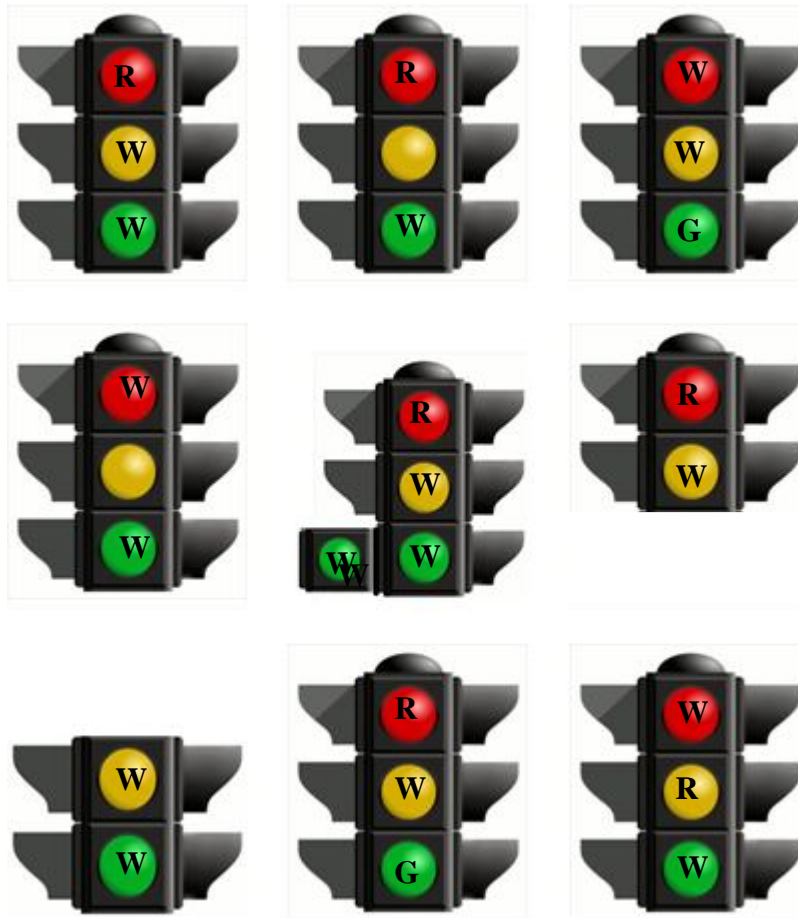


Fig 9.28 Light Signals

9.1.3 Police Signals

1. To stop a vehicle approaching from behind
2. To stop a vehicle coming from front
3. To stop vehicles approaching simultaneously from front and behind
4. To stop traffic approaching from left and wanting to turn right.
5. To stop traffic approaching from the right to allow traffic from the left to turn right.
6. To allow traffic coming from the right and turning right by stopping traffic approaching from the left.
7. Warning signal closing all traffic

8. Beckoning on vehicles approaching from left
9. Beckoning on vehicles approaching from left
10. Beckoning on vehicles from front.



Fig 9.29 Police Signals

9.2 Requirements regarding registration of vehicle

Necessity for registration

According to Rule 22 in chapter III of motor vehicles Act 'No person shall drive any motor vehicle and no owner of a motor vehicle shall cause or permit the vehicle to be driven in any public place or in any other place for the purpose of carrying passengers or goods unless the vehicle is registered in accordance with this unit and the certificates of registration of the vehicle has not been suspended or cancelled and the vehicle carries registration make displayed in the prescribed manner.

Registration where to be made

According to section '23' of M.Y Act is Every Owner of a motor vehicle shall cause the vehicle to be registered by a registering authority in the state in which he is residing or the place of business where the vehicle is normally kept.

9.3 Necessity of permits for commercial vehicles

According to ‘ Section 42’ in chapter IV of M.V. Act

1. No owner to a transport vehicle shall use or permit the use of the vehicle in any public place, whether or not such vehicle is actually carrying any passenger of a permit granted or counter signed by a Regional or State Transport Authority or Commission authorizing the use of the vehicle in that place in the manner in which the vehicle is being used. Provided that stage carriage permit shall subject to any conditions that may be specified in the permit, authorize the use of the vehicle as a contract carriage of goods for or in connection with a trade or business carried on by him.

2. In determining for the purpose this chapter whether a transport vehicle is or is not used for the carriages of goods for hire or reward.

(a) The delivery or collection by or on behalf of the owner of goods sold, used or left or hire or give purchase the course of any trade or business carried on by him other than the trade of business or providing transport.

(b) The delivery or collection by or on behalf of the owner of the goods, which have been or which are to be subjected to a process treatment in the course of trade or business or providing transport.

(c) The carriages of goods in a transport vehicle by a manufacturer of or agent or order in such goods whilst the vehicle is being used for demonstration purpose.

Shall not be deemed to constitute a carrying of the goods for hire or rewards, but the carriage in a transport vehicle of goods by a person not being a dealer in such good who had acquired temporary ownership of good for the purpose of transporting ownership shall be deemed to constitute a carrying of the goods for hire or rewards.

3. Sub section (1) Shall not apply

(a) To any transport vehicle owned by the central government and used for Government purpose unconnected with any commercial enterprise.

(b) To any transport vehicle owned by a local authority or by a person acting under contract with a local authority and used solely for road cleansing road watering conservancy purposes.

(c) To any transport vehicle used solely police, fire brigade or ambulance purposes.

(d) To any transport vehicle used solely for conveyance purposes.

(e) To any transport vehicle used for towing a disabled vehicle or for removing goods from a disabled vehicle to a place of safety.

(f) To any transport vehicle used for any other public purpose prescribed in this behalf.

(g) To any transport vehicle used by a person who manufacture or deals in manufacturer or in motor vehicles or builds body for attachment to chassis.

(h) To any transport vehicle owned by or solely for the purpose or nay educational institution which is recognized by the State Government or whose managing committee is a society registered under the societies registration act, 1860 (XXI of 1860).

(i) To any goods vehicle which is light motor vehicle and does not ply for reward to any two wheeled, trailer which a registered weight not exceeding 800 kilogram and down by a motor car.

(j) Subjected to such condition as the control government may notification in the official gazette specify, to any transport vehicle, purchased in one state and proceeding to a place situated in other state, without carrying any gods or passengers.

(k) To any transport vehicle has been temporarily registered under section 25, while proceeding empty of any place for the purpose of registration to the vehicle under section 24.

(l) To any transport vehicle used for such purposes other than plying for hire or rewards as the central Government may, by notification in the official Gazette, specify.

(m) To any transport vehicle, which, wing, to flood earthquake or any other natural calamity is required within or outside, with a view to enabling it to reach is destination or

4. Subjected to provisions of subsection (3) sub section (1) shall of the state Government by rule made under section 68 to prescribes apply to any motor vehicle adopted to carry more than nine person excluding the diver.

9.4 Insurance coverage

(Chapter (viii) of M.V. Act 1939)

(i) Authorized insurer means an insurer in whose case the requirements of the insurance Act 1938 (IV of 1938) the complied with

(ii) Certificate of insurance : Issued by an authorized insurer in persuade of sub section (4) section 95, and includes a cover note complying with such requirements as may be prescribed and where more than one certificate has been issued in connected with policy or where a copy of certificate has been issues.

(iii) Property includes road, bridges, culverts, cause ways, trees, pots and milestones.

(iv) Third party includes the government.

(v) Necessity for insurance against third party risk (1) No person shall use except as a passenger or cause or allow any other person to use a motor vehicle in public place unless there is in force in relation to the use of vehicle by that person or that other person as the case may be policy of insurance complying with the requirements to this unit.

(2) Subsection (1) shall not apply to any vehicle owned by the central Government purpose unconnected with any commercial enterprise.

(3) The appropriate government may be order exempt form the operation Government sub section (1) any vehicle owned by any of the following authorities namely .

(a) The Central government or state government if the vehicle is used for government purposes connected with any commercial enterprise.

(b) Any local authority.

(c) Any state transport undertaking with in the meaning of section 68A, provided that no such order shall be made in relation to any such authority unless a final has been established and is maintained by that authority in accordance with the rules made in that behalf under this act for meeting any liability arising out of the of any vehicle of that authority which that authority or nay person in its employment may occur to third parties.

9.5 Procedure for obtaining driving license

Driving license is must for driving a motor vehicle. The driving license authorities the person to drive the vehicle.

For obtaining a driving license of a two wheeler / three wheeler/ light motor vehicle of 4 wheelers ,a person should complete the age of eighteen years and for a transport vehicle the person should complete the age of twenty years.

The person should apply for a learning license before applying for any type of license. It will be valued for a period of six months. The person should apply for a permanent license before the expiry of a learning license.

For learning a person should carry the learning license and the vehicle on which he is being trained to drive should be posted with L boards at front and rear sides of the vehicles.

After being inspected under the regional transport authority, the person will be issued a permanent driving license (According to third schedule or M.C. Act)

A medical certificate issued in form C is the first schedule of M.V. Act is also should be produced by the applicant for obtaining driving license.

A driving license shall specify whether the holder is entitled to drive as a paid employee and whether he is entitled to drive a transport vehicle and shall further be expressed as entitling the holder to drive a motor vehicle of one or more of the following classes namely.

- (a) Motor cycle
- (b) Invalid carriage
- (c) Light motor vehicle
- (d) Medium motor vehicle
- (e) Heavy motor vehicle
- (f) Road Roller
- (g) Motor vehicle of a specified description.

Summary

The vehicle should be registered at the Regional Transport Authority of that Particular area.

Traffic signals are of three types a) Mandatory signals b) Cautionary Signals c) Informatory Signals

For transportation, the vehicle should be permitted properly according to section 42 of M.V. Act.

Before applying for driving license, one must apply for Learning License for a particular vehicle.

Short Answer Type Questions

1. Write any two mandatory traffic signals.
2. Write any four cautionary traffic signals.
3. Write any two informatory traffic signals.

Long Answer Type Questions

1. Explain the procedure for obtaining a driving license.