BHADRAK ENGINEERING SCHOOL & TECHNOLOGY (BEST),
ASURALI, BHADRAK

Automobile Engg. & Hybrid Vehicles (Th- 02)

(As per the 2020-21 syllabus of the SCTE&VT, Bhubaneswar, Odisha)

Sixth Semester

Mechanical Engg.

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CHAPTER-WISE DISTRIBUTION OF PERIODS

Sl. No.	Name of the Chapter	Periods as per Syllabus	Required period	Expected Marks
01	**Introduction and Transmission system**	12	14	15
02	**Braking system**	05	09	15
03	**Ignition and Suspension system**	10	09	10
04	**Cooling and lubrication**	08	05	20
05	**Fuel and ignition system**	10	07	20
06	**Hybrid and Electric vehicles**	15	15	20
	TOTAL	**60**	**59**	100

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CHAPTER NO. -01
INTRODUCTION AND TRANSMISSION SYSTEM

Learning objectives:

1.1 Automobiles: Definition, need and classification: Layout of automobile chassis with major components (Line diagram)
1.2 Clutch System: Need, Types (Single & Multiple) and Working principle with sketch
1.3 Gear Box: Purpose of gear box, Construction and working of a 4-speed gear box
1.4 Concept of automatic gear changing mechanisms
1.5 Propeller shaft: Constructional features
1.6 Differential: Need, Types and Working principle

1.1 Automobiles: Definition, Need and Classification

Automobile is a branch of engineering in which we study all about the automobiles and have practice to propel them. the word automotive engineering is also used having the same meaning.
An automobile is a self-propelled vehicle which is used for the transportation of passengers and goods upon the ground. A vehicle is a machine which is used for the transportation of passengers and goods upon the ground. A self-propelled vehicle is that in which power required for the propulsion is produced from within

Classification Of Automobile

The automobiles are classified on the following basis
1. Purpose
(I.) Passenger vehicle- car, jeep, bus.
(II). Good vehicle -truck
2. Capacity
(I) light motor vehicles – car, motor cycle, and scooter.
(ii). heavy motor vehicles -bus, coach, tractor
3. Fuel used
(i). Petrol vehicle – car, jeep, motor cycle, scooter.
(ii)Diesel vehicle- truck, bus, tractor, bulldozer
(iii)Electric cab- battery truck, fork lift
(iv)Steam cartilages – steam road rollers
(v)Gas vehicles -CNG vehicles
4. No. of wheels:
(I). Two-wheeler- scooter, motor cycles
(ii)Three-wheeler – cars, jeeps, bus, tractors
(iii) Six-wheeler -truck, tanker, gun carriage vehicles
5. Drive of the vehicles: -
(I) Single wheel drive vehicle.
(ii)Two wheel drive vehicle.
(iii) Four-wheel drive vehicle.
(iv) Six-wheel vehicle.

Layout Of Automobile Chassis

A complete vehicle without body is called chassis. It consists of major unit to propel the vehicle, direct its motion, stop it and allow it to run smoothly over uneven surface.

The chassis include the following components

1. Frame

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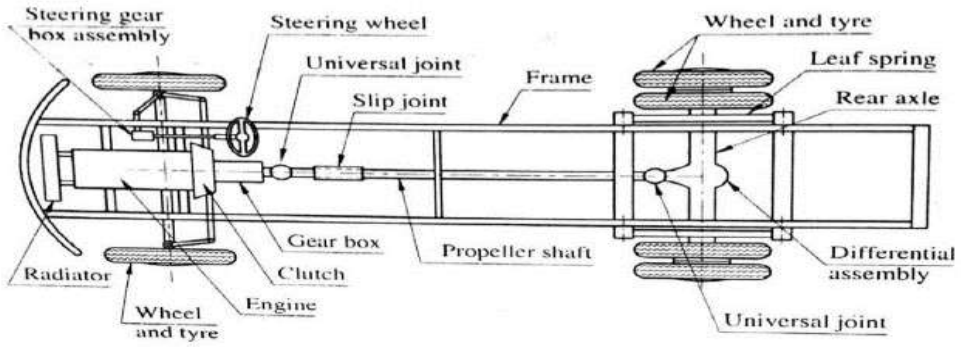
2. Front suspension
3. Steering mechanism
4. Radiator
5. Engine, clutch, gear box
6. Propeller shaft
7. Rear spring
8. Road wheels
9. Differential, half shaft, universal joint
10. Brakes and braking system
11. Storage battery
12. Silencer
13. Shock absorber, fuel tank, petrol and hydraulic pipe cables and some means of mounting these components



1.2 Clutch System

Clutch is a device used in the transmission system of a motor vehicle to engage and disengage the engine to the transmission. Thus, the clutch is located between the engine and the transmission. When the clutch is engaged, the power flows from the engine to the rear wheels through the transmission system and the vehicle moves. When the clutch is disengaged, the power is not transmitted to the rear wheels and the vehicle stops while the engine is still running. The clutch is disengaged when starting the engine, when shifting the gears, where stopping the vehicle and when idling the engine. The clutch is engaged only when the vehicle is to move and is kept engaged when the vehicle is moving. The clutch also permits the gradual taking up of the load. When properly operated, it prevents jerky motion of the vehicle and thus avoids putting undue strain on the remaining parts of the power transmission system.

The clutches used in motor vehicle are almost very similar in construction and operation. There are some differences in the details of the linkage as well as in the pressure plate assemblies. In addition, some clutches for heavy duty applications have two friction plates and an intermediate pressure plate. Some clutches are operated by hydraulic means. The dry single plate type of friction clutch is used almost exclusively in American passenger cars. Where the dry plate clutch operates dry--without using oil, the wet plate clutch operates in a batch of oil. Most designs of the clutches use number of coil springs but some use a diaphragm or conical type spring. The type of friction materials also varies in the clutches of different passenger cars.

Types Of Clutch System and working of clutch system

Different types of clutches are as follows:

1. Friction clutch:

(a) Single plate clutch.

(b) Multi-plate clutch: -

(1) Wet

(ii) Dry.

(c) Cone clutch. -
(1) External
(ii) Internal
2. Centrifugal clutch.

3. Semi-centrifugal clutch.

4. Conical spring clutch.

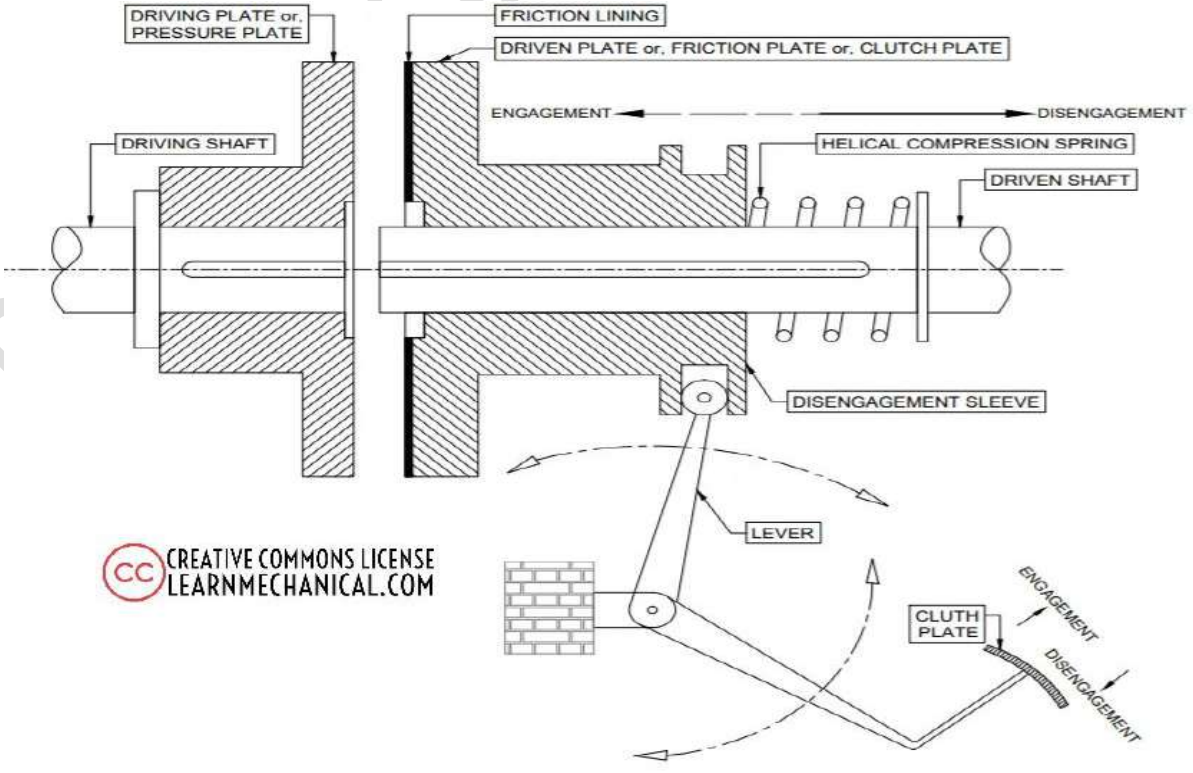
a. Tapered finger type.

b. Crown spring type.

5 Positive clutch - Dog and spine clutch
6. Hydraulic clutch.
7. Electro-magnetic clutch.
8. Vacuum clutch
9. over running clutch or free-wheel unit.

Single Clutch Plate

It is the most common type of clutch used in motor vehicles. Basically, it consists of only one clutch plate, mounted on the spines of the clutch shaft, as shown in fig.
The flywheel is mounted on the engine crankshaft and rotates with it. The pressure plate is bolted to the flywheel through clutch springs, and is free to slide on the clutch shaft when the clutch pedal is operated. When the clutch is engaged. The clutch plate is gripped between the flywheel and the pressure plate. The friction linings are on both the sides of the clutch plate revolves with the flywheel. As the clutch plate revolves, the clutch shaft also revolves with the flywheel. As the clutch plate revolves the clutch shaft also revolves, clutch shaft is connected to the transmitted to the crankshaft to the clutch shaft. When the clutch pedal is pressed plate moves back against the force of the spring and the clutch plate becomes free between the flywheel and the pressure plate. Thus, the flywheel remains rotating as long as the engine is running and the clutch pedal is pressed, the clutch is said to be disengaged otherwise it remains engaged due the spring forces



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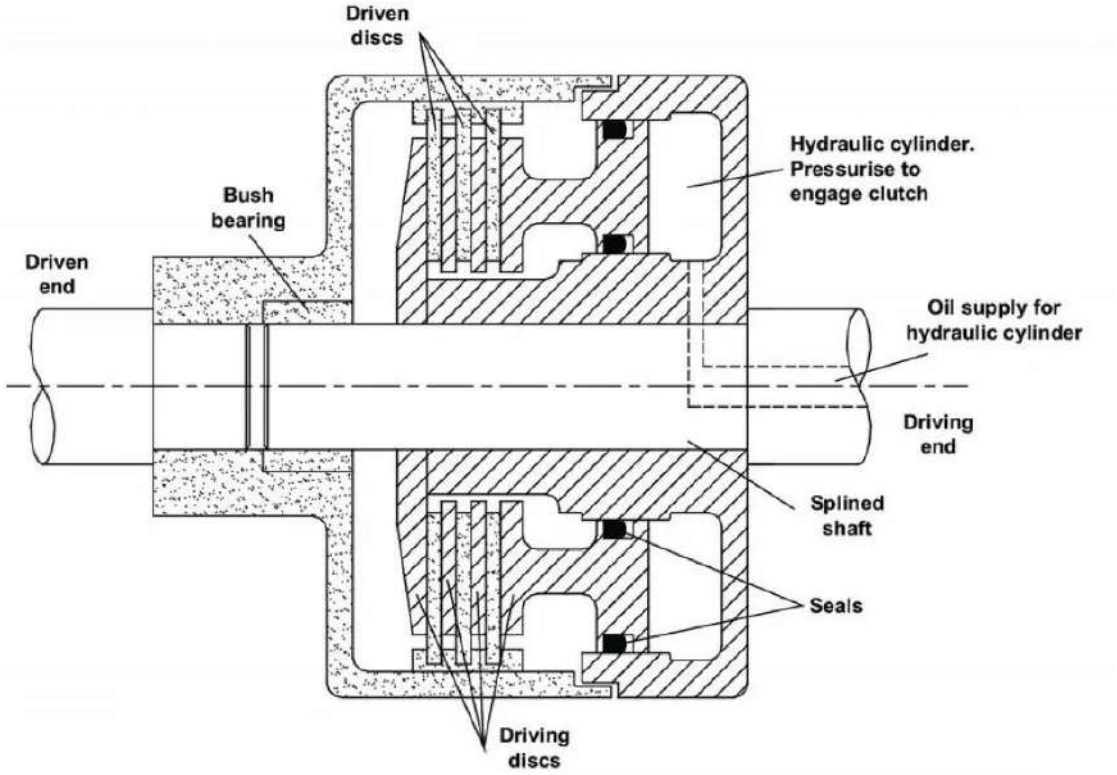
Multiplate Clutch

Multiplate clutch consists of a number of clutch plates, instead of only one clutch plate as in the case of single plate clutch. As the number of clutch plates is increased, the friction surface also increases. The increased number of friction surfaces obviously increases the capacity of the clutch to transmit torque. The plates are alternately fitted to the engine shaft and gear box shaft. They are firmly pressed by strong coil springs and assembled in a drum. Each of the alternate plate slides in grooves on the flywheel and the other slides on spines on the pressure plate. Thus, each alternate plate has inner and outer splines.

The multi plate clutch works in the same way as the single plate clutch, by operating the clutch pedal. The multi plate clutches are used in heavy commercial vehicles, racing cars and motor cycles for transmitting high torque.

The multi plate clutches may be dry or wet. When the clutch operates in an oil bath, it is called a wet clutch. When the clutch is operated dry it is called dry clutch. The wet clutch is generally used in conjunction with or as a part of the automatic transmission.



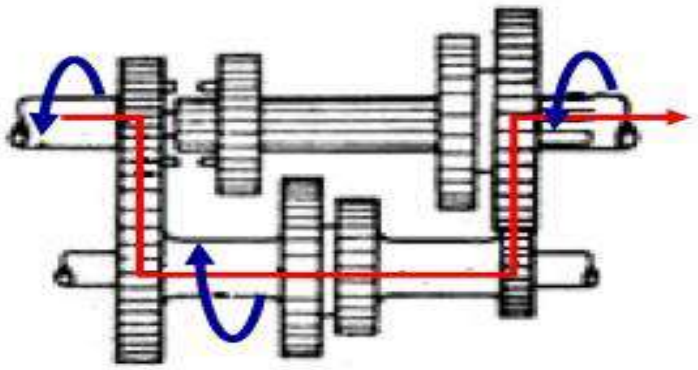
1.3 Gear Box: Purpose of Gear Box

Next to the clutch is the transmission in the transmission system of a motor vehicle. The word transmission" is used for a device that is located between the clutch and the propeller shaft. It may be a gear box, a torque convertor, overdrive, fluid drive or hydraulic drive. In this chapter we will describe box in details, the other devices will be described in the next chapter.

PURPOSE OF TRANSMISSION

The purpose of the transmission is to provide high torque at the time of starting, hill climbing, accelerating and pulling a load. When a vehicle is starting from rest, hill climbing, accelerating and meeting other resistances, high torque (traction effort) is required at the driving wheels. Hence a device must be provided to permit the engine crankshaft to revolve a relatively high speed, while the wheels turn at slower speeds. This is obtained by a set of gears called a transmission or gear set. The gear set is enclosed in a metal box called a gear box. The vehicle speed is also changed with the help of the transmission keeping the engine speed same with certain limit.

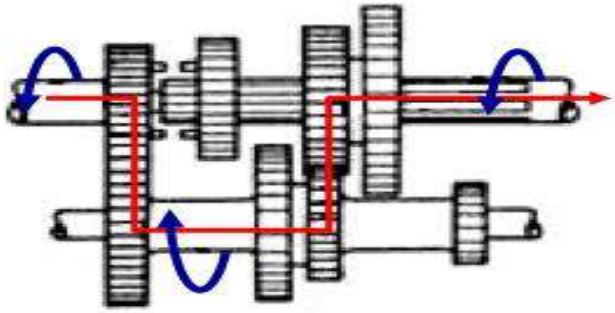
First gear



First gear

shows the layout of gears transmitting power in first gear, this gear is obtained by shifting thedog clutch to the right thus engaging its internal teeth with the external dog teeth of the first speed gear.

Second gear

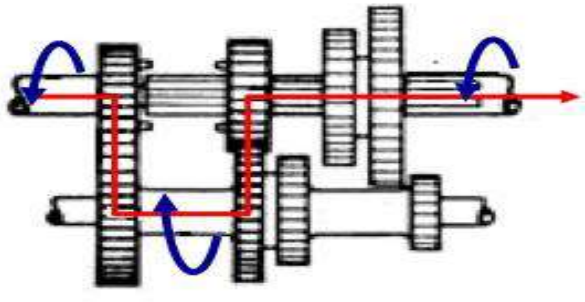


Second gear

Fig. shows the layout of gears transmitting power in second gear. To obtain this gear, first the 1-2 speed dog clutches is brought to neutral and then moved to the left thereby engaging its internal teeth with the external dog teeth of the second speed gear.

Third gear.

Fig.



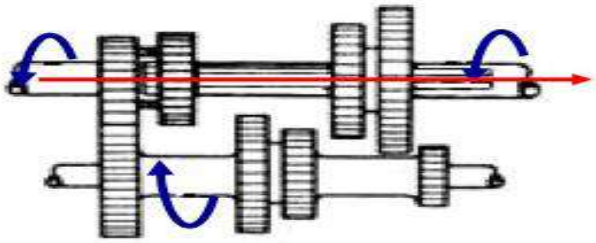
Third gear

Shows the layout of gears transmitting power third gear. In order to obtain this gear, first 1-2 speed dog clutch is shifted out of mesh from second gear and brought to neutral position. The 3-4 speed

dog clutches is then moved to the right thus engaging its internal teeth with the external dog teeth of the third speed gear.

Fourth gear

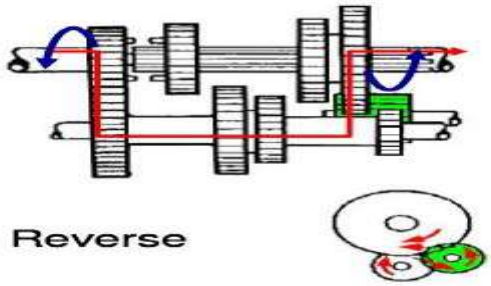
Shows the layout of gears transmitting power in fourth gear. In order to obtain this gear, the 3-4 dog clutch is first shifted to neutral position and then shifted to the left thus engaging its internal teeth with the external dog teeth of main drive gear.



Fourth gear (dogged, 1:1)

Reverse gear.

Fig



shows the layout of gears transmitting power in reverse gear. This gear is obtained by first bringing the vehicle to rest position. The gear box is then brought to neutral position. After this, the reverse sliding gear is moved to the left thus engaging it with the reverse idler rear gear.

1.4 Concept of Automatic Gear Changing Mechanisms

The transmission case is a two-piece construction, consisting of the upper case and lower case. The lower case has the three-fork shifting mechanism built in it. The upper-case house the reverse shaft.

Low speed drive. The low driven gear on the countershaft is free from this shaft and merely rotates around it, as driven from the low -drive gear of the input shaft. Shifting of the ever into 'low' causes the low -speed gear shifter fork to push the low -speed synchronizer towards the low driven gear and, through the dog teeth, mesh it with the gear, thus coupling the gear to the input shaft. In this condition, the drive is transmitted through the low drive gear on the input shaft and the low-driven gear on the countershaft to the gear of the final differential.

Second speed drive. Shifting the lever into 'second' causes the same low speed gear shifter fork to push the low-speed synchronizer to the other direction i.e., towards the second driven gear, and mesh it with this gear thereby coupling the gear to the input shaft.

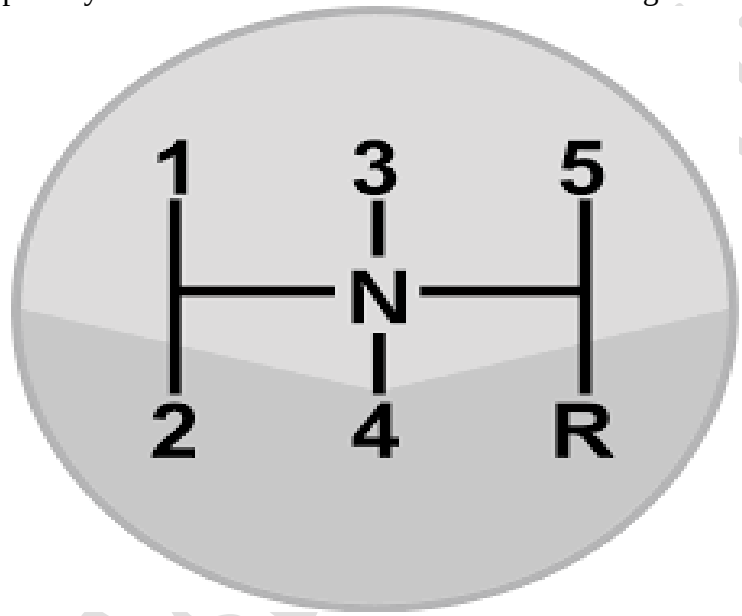
Third speed drive. Shifting the lever into 'third' actuates high speed shifter fork to engage the high-speed synchronizer with third driven gear on the countershaft. This gear, like the low and second driven gears, is free on the shaft and merely spins as driven by the third drive gear of input shaft when the gear shift lever is at any other position. In this condition, the drive is transmitted

through the third -drive gear on the input shaft and the third -drive gear on the countershaft to the final gear of the differential.

Top speed drive. Shifting the lever into 'top' causes the high-speed shifter fork, which is also used for the third speed, to mesh the top gear with the high-speed synchronizer on the countershaft. In this condition, the drive is transmitted through the top drive gear on the input shaft and top driven gear on the countershaft to the final gear of the differential.

Reverse drive. Shifting the lever into reverse causes the reverse gear shifter fork to mesh the reverse idler gear with the reverse gear on the input shaft and the low-speed synchronizer sleeve on the countershaft.

In this condition, the drive is transmitted through the reverse gear on the input shaft, reverse idler gear and low-speed synchronizer on the countershaft to the final gear of the differential.

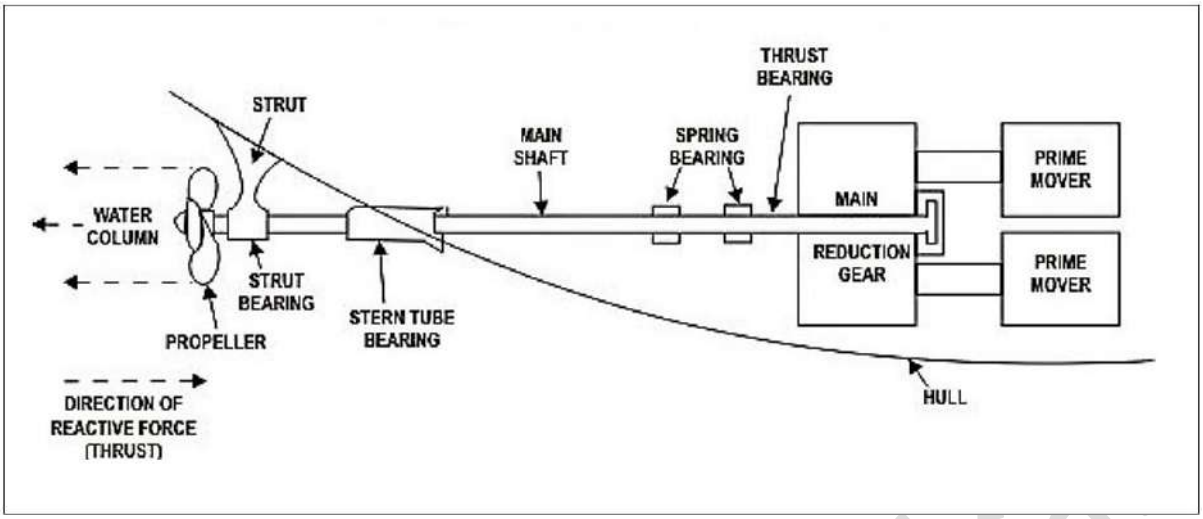


Gear shift lever position

1.5 Propeller Shaft

The propeller shaft is driving shaft that connects the transmission to the differential. The output shaft or main shaft from the transmission and pinion shaft extending from the differential unit are connected to the propeller shaft and the universal joints. A sliding joint is also used between the propeller shaft and the universal joint near the gear box. The rotary motion of the transmission main shaft is carried out through the propeller shaft to the differential, causing, the rear wheels to rotate. The propeller shaft has to withstand the tensional stresses of the transmitting torque, and yet it must be light and well balanced so that vibrations and whip will not occur at high speeds. For these reasons, it is made of a strong steel tube. Solid propeller shafts are also used. The propeller shaft may be exposed to the atmosphere or protected by an outer tune. Some applications include bearing at or near the propeller shaft centre to support the shaft. One some applications, the propeller shaft is in two sections, supported by a center bearing and coupled together by universal joint.

It is to be noted that the transmission main shaft and the differential pinion shaft are not in one horizontal level. The rear axle housing with differential is attached to the frame by springs, therefore, the distance between the gear box and the differential changes due to road irregularities. This also changes the angle of drive. In order that the propeller shaft must take curve of these two changes it is provided with one or more universal joints to permit variations in the angle of drive. Also, it must be provided with a sliding joint that permits the effective length of the propeller shaft to change.



1.6 Differential

If a car travels in a straight line, the two rear wheels turn on the road exactly the same speed. There is no relative movement between the two rear wheels. The propeller shaft may be geared rigidly, in this case, with the rear axle to rotate the rear wheels together. But when the car takes a turn, the outer wheel travels on a longer radius than the inner wheel. The outer wheel turns faster than the inner wheel, that is, there is a relative movement between the two rear wheels. If the two rear wheels are rigidly fixed toe rear axle the inner wheel will slip which will cause rapid tyre wear, steering difficulties and poor road holding. Therefore, there must be some devices to provide relative movement to the two rear wheels when the car is taking a turn. The differential serves this purpose.

Differential is a part of the inner axle housing assemble, which includes the differential, rear axles, wheels and bearings. the differential consists of a system of gears arranged in such a way that connects the propeller shaft with the rear axles. The purpose of the differential is to provide the relative movement to the two rear wheels when the car is taking a turn. The torque transmitted to each wheel is, however, always equal.

Construction.

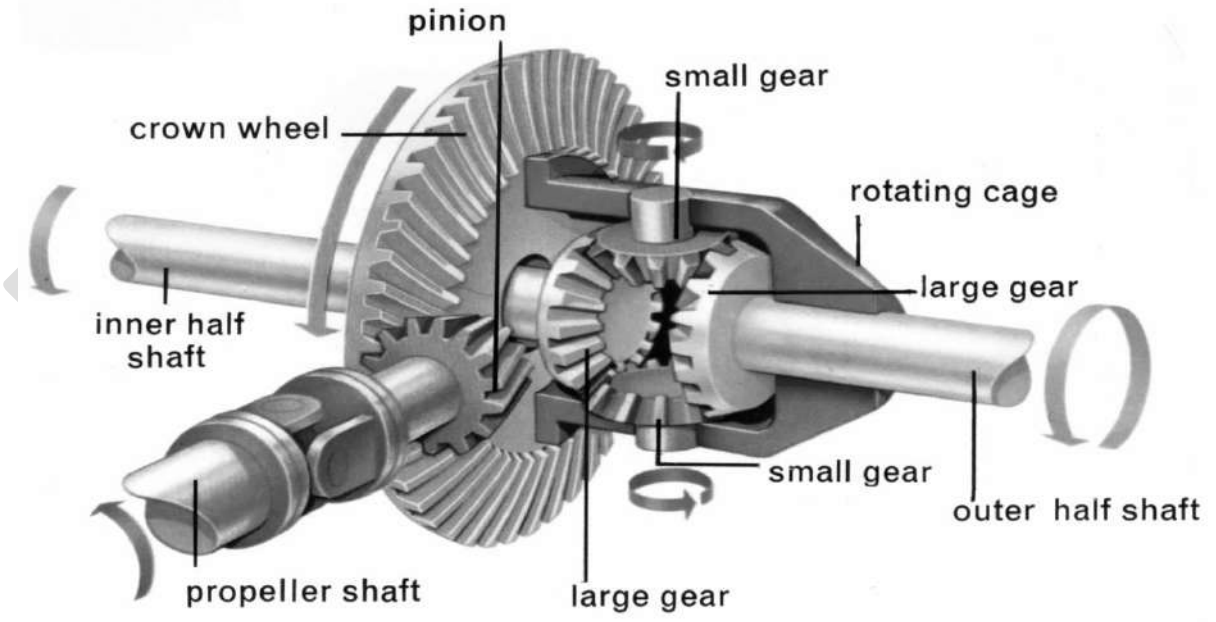


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Fig. Shows the construction of a simple differential. The sun gears are mounted on the inner end of each rear axle (called the half shaft). A differential cage is assembled on the left axle. A ring gear (called the crown gear) is attached to the case, so that the cage rotates with the crown gear. The

crown gear is driven by the bevel pinion both the crown wheel and cage are free on the left rear axle. The cage supports two planet pinions (called the differential pinion gears) on shafts which mesh with the two sun gears. Thus, when the differential cage is rotated, both the sun gears rotate and thus both wheels turn which are attached to the outer end of the rear axles, now let us suppose that one wheel is held stationary. Then when the differential cage is rotated, the planet gears will also rotate as they run around on the stationary axle sun gear. While rotating in this manner, the planet pinions carry rotary motion to the other axle sun gear, causing it, and the wheel too, to rotate. Therefore, when one rear wheel turns more rapidly than the other, while the car is taking a turn, the planet gears spin on its shaft transmitting more rotary motion to one rear wheel than to the other. When both the wheels turn at the same speed the planet pinions and the sun gears all turn as a unit without any relative motion. But when the car takes a turn, the planet pinions rotate on their shaft to permit the outer rear wheel to turn more rapidly than the inner wheel.

Generally differential two types
1. Conventional type
2. Self-locking type

POSSIBLE SHORT TYPE QUESTIONS WITH ANSWERS

1. What is chassis? 2012 (S)

Ans- automobile chassis is a French term initially used to denote the frame or main structure of a vehicles and it is the mounting for all the components including the body. It is also known as carrying unit**.**

2. Define automobile? 2011 (s), 2010 (s), 2018(s)

Ans- an automobile is a self-propelled vehicle in which power required for the propulsion is produced from within itself and is used for the transportation of passengers and goods upon the ground**.**

3. Define self-propelled vehicle? 2019(s)

Ans- self-propelled vehicle means auto and propelled move so the vehicle which runs on the ground by its own power to carry loads, goods and passenger is called self-propelled vehicle

4.why clutch is needed in an automobile system ? name the types os clutches ?2024 {s}

Ans –clutch is is needed to engage and disengage the power from engine o gear box asper requirement.there are two types of clutch that is single late clutch and multiplate clutch.

1. drive and model. 2018
2. Classify automobile engines based upon various aspects? 2018
3. What is the difference between diesel engine and petrol engine? 2018

LONG QUESTION

1- **Draw the layout of automobile chassis {Both plan and elevation }2024 [S]**
2- **Explain the construction of 4 speed gear box .2024 {s}**
3- **What is the necessity of gear box in an automobile ?Discuss about various parts of gear box .2024 {S}**

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CHAPTER NO. -02
BRAKING SYSTEM

Learning objectives:

2.1 Braking systems in automobiles: Need and types
2.2 Mechanical Brake
2.3 Hydraulic Brake
2.4 Air Brake
2.5 Air assisted Hydraulic Brake
2.6 Vacuum Brake

2.1 Braking systems in automobiles: Need and types

Brakes are applied on the wheels to stop the vehicle. Before applying the brakes, the acceleration is released to stop the fuel supply thus the engine develops no more power to run the vehicle, and then the brakes are applied which stop the rolling of the wheels on the road and hence the vehicle is stopped. Clutch is also disengaged which disconnects the engine from the transmission system. Thus, when the vehicle is standing, the engine is still running at idling.

Functions Of the Brakes

There are two distinct functions of the brakes

1. To stop or slow down the vehicle in the shortest possible distance in emergencies.
2. To control the vehicle to be retained when descending a hill.

Classifications Of Brakes

The automobile brakes are classified according to the different bases as follows

1. With respect to application

   Foot brake hand brake

2. With respect to the number of wheels

   Two wheels break four wheel brakes

3. With respect to the method of braking contact

   Internal expanding breaks external contraction brakes.

4. With respect to the method of applying the braking force.

   Single acting brakes double acting brakes

5. With respect to the brake gear

   Mechanical brakes power brakes

6. With respect to the nature of power employed

   Vacuum breaks air brakes

7. with respect to power transmission

   Direct acting brakes geared brakes

8. with respect to power unit

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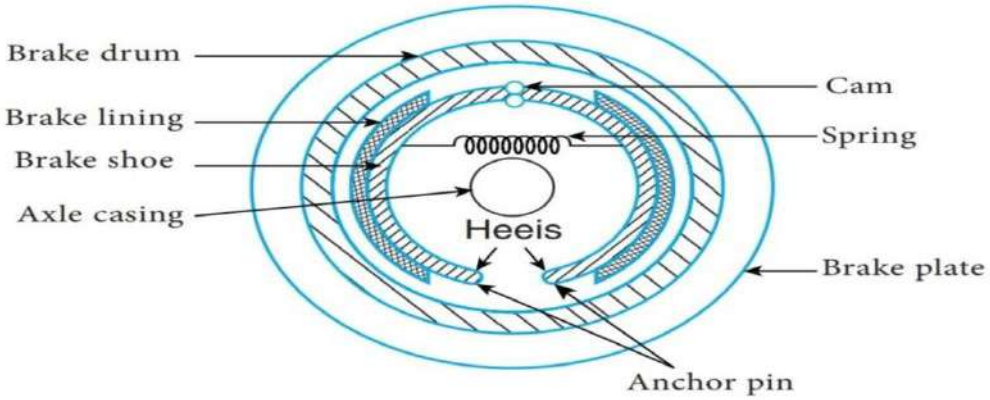
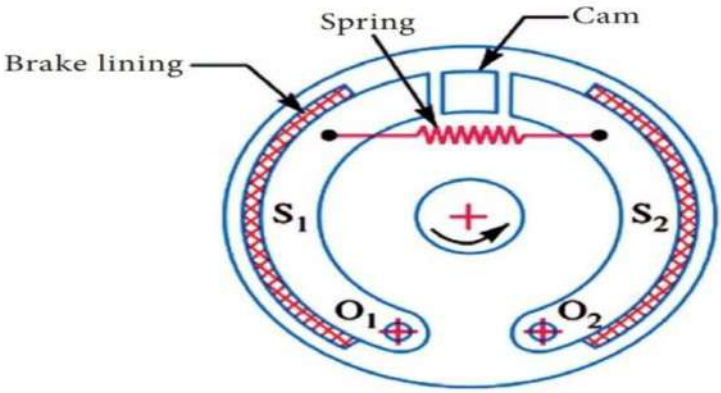
Cylinder breaks Diaphragm brakes.

2.2 Mechanical Brake





In a motor vehicle, the wheel is attached to an auxiliary wheel called drum. The br4ake shoes are made to contact this drum. In most designs, two shoes are used with each drum to form a complete brake mechanism a teach wheel. The brake shoes have brake linings on their outer surfaces. Each brake shoe is hinged at one end by an anchor pin; the other end is operated by some means so that the brake shoe expands outwards the brake lining come into contact with the drum. Retracting spring keeps the brakes shoes into position when the brakes are not applied. The drum encloses the entire mechanism to keep out dust and moisture. The wheel attaching bolts on the drum are used to contact wheel and drum. The braking plate completes the brake enclosure, holds the assembly to the car axle, and acts at the base for fastening the brake shoes and operating mechanisms. The shoes are generally mounted to rub against the inside surface of the drum to form an internal expanding brake.

When the brake pedal is pressed, the cam turns by means of brake linkage. When the cam turns, the shoes expand outwards against the drum. A toggle lever is also used for the same purpose, as shown in Fig.

The brake linings rub against be drum and thus strip its motion. The entire mechanical linkage between the brake pedal and the shoes operates to transmit pedal force to the brake shoes, and to multiple that force through leverage to produce effective braking forces against the drum.

2.3 Hydraulic Brakes

The hydraulic brakes are applied by the liquid pressure. The pedal force is transmitted to the brake shoe by means of a confined liquid through a system of force transmitted to all the brake shoes by a

force transmission system. This system is based upon Pascal's principle, which states that "the confined liquids transmit pressure without loss equally in all direction''.

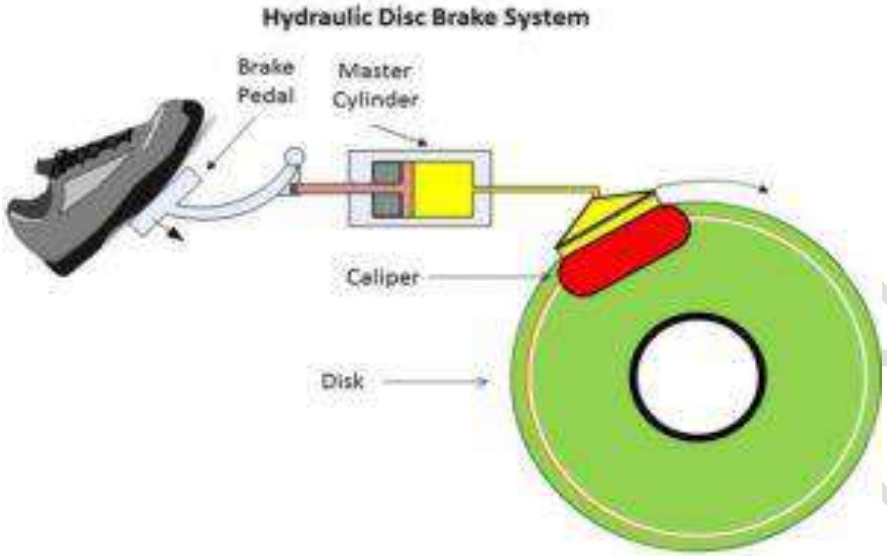


Fig. shows hydraulic consists of two main components master cylinder and wheel cylinder. The master cylinder is connected by tubing to the wheel cylinders at each of the four wheels. The system is filled with the liquid under light pressure when the brakes are not in operation. The liquid is known as brake fluid, and is usually a mixture of glycerin and alcohol or castor oil, denatured alcohol and some additives.

Each wheel brake consists of a cylinder brake drum which is mounted on the inner side of the wheel and revolves with it and two brake shoes which are mounted inside the brake drums and do not rotate. The shoes are fitted with a heat and wear resisting brake lining on their surfaces.

The brake pedal is connected to the master cylinder piston by means of a piston rod. When the brakes are to be applied, the driver depresses the pedal, the piston is force into the master cylinder, this increasing the pressure of the fluid in the master cylinder, this pressure is conducted instantaneously to the wheel cylinders on each of the four brakes, where it forces the wheel cylinder pistons outwards. These pistons, in turn, force the brake shoes out against the brake drums. Thus, the brakes are applied.

When the driver releases the brake pedal, the master cylinder piston returns to its original position to the return spring pressure, and thus the fluid pressure in the entire system drops to its original low value, which allows retraction spring on wheel brakes to pull the brake shoes out of contact with the brakes drums into their original positions. This causes the wheel cylinder pistons also to come back to their original inward position. Thus, the brakes are released.

2.4 Air Brake

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, unloaded 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 cambers when pedal is released, a limiting valve for limiting the maximum pressure in the front brake chamber and a relay valve to help in quick admission and release of air from rear brake chambers.

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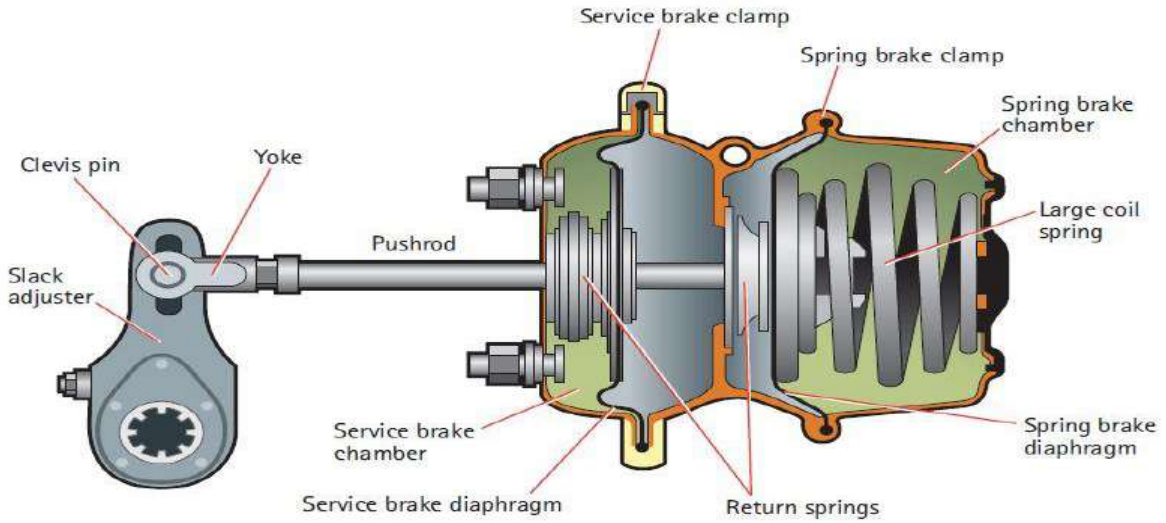


shows the layout of an air brake system for a bus or truck. The air compressor, governor, pressure gauge, safety valve and the reservoir constitute the compressing and the control units whereas the rest of them are termed as application units. The compressed air available on the vehicle is also used for the operation of additional assemblies of the vehicle such as horn, windshield wipers, etc.

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 operated the brake valve thus admitting compressed air to all the rake chambers. The compressed air operates the diaphragm of the brake chambers thereby applying the brakes.

2.5 Air Assisted Hydraulic Brakes

In this type of braking system, the air pressure is converted into hydraulic pressure here the air power cylinder is combined with the hydraulic master cylinder and the reservoir, the conventional type hydraulic brakes are actuated by the air power with the help of this unit. The bore of the power cylinder is generally kept four times that of the master cylinder. The ratio between the hydraulic pressure and the air pressure is generally maintained at 15:1 in India, the commercial vehicles manufactured by M/s. Tata Engg. And Locomotive co. has air hydraulic brakes. Shows the circuit diagram of compressed air of Tata Tuck braking system compressed air brake system consists of the following components:

1. Air compressor 2. Tyre inflating bottle. 3. Air pressure regulator 4.air container 5. Truck brake valve. 6. Air pressure gauge.

Compressed air delivered by the air compressor incorporated in engine is used to assist the hydraulic brake system to increase brake efficiency. Referring to it is observed that the compressed air from the compressor flows to the type inflating bottle to the air pressure regulator to air container and to the truck brake valves when desired.

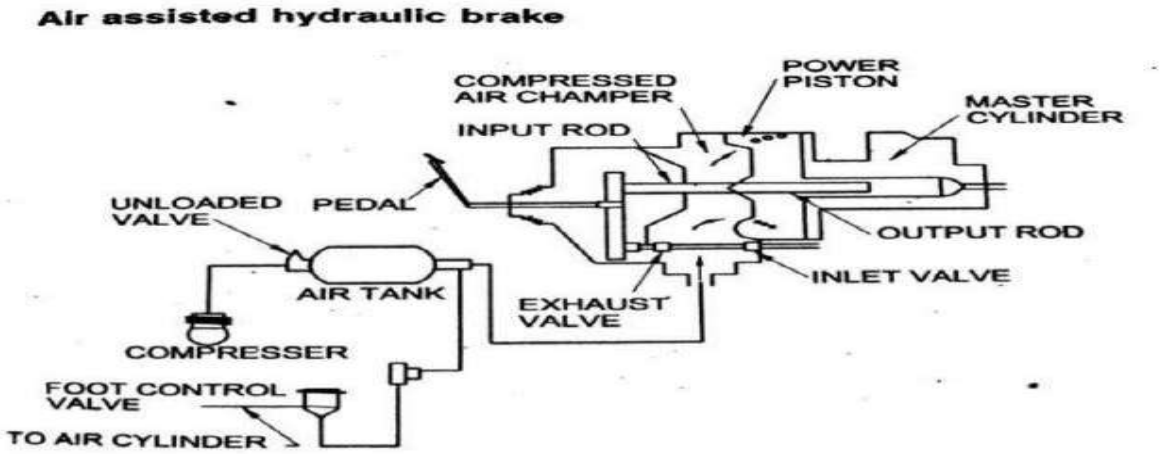
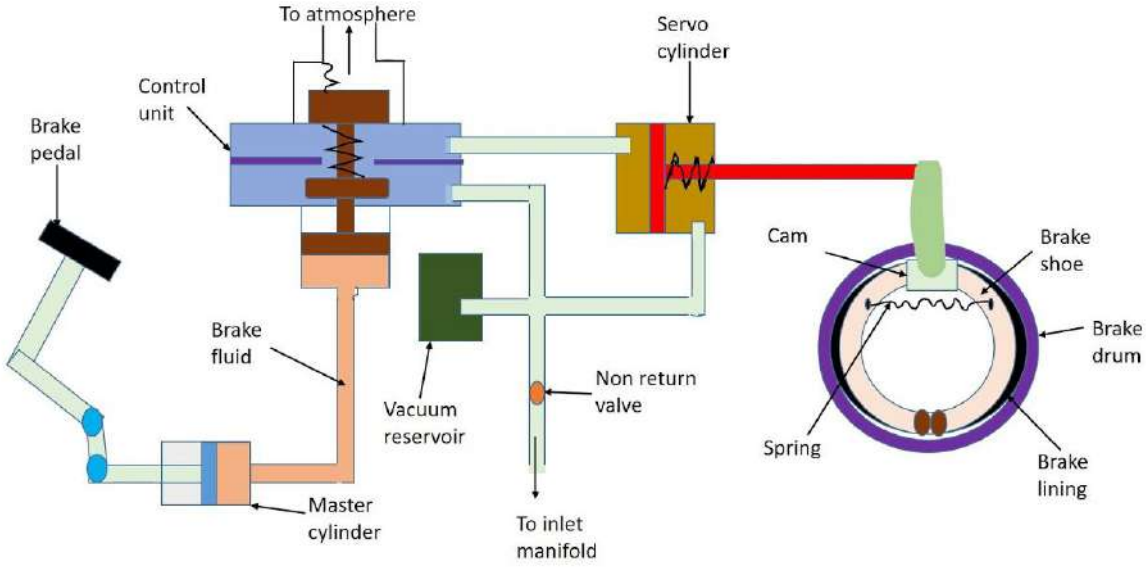


Fig. 31.44 shows the position of the servo and master cylinder when brakes are not applied. It will be seen that the piston of brake valve is held against the stip on the body by the return spring. The inlet valve is kept closed on its seat on the valve body and the exhaust valve remains open. The space exhausts passage on the reaction piston and the reaction fork.

When the brake pedal is depressed by the driver, the input rod moves the lever forward. In this reaction piston and the exhaust passage is close, further movement of the input rod opens the inlet value and air pressure is admitted into the space behind the piston through the cross hole on the body. This air pressure forces the power piston to move and this effort is transmitted to the master cylinder through the output rod. The force acting on the master cylinder thus creates the hydraulic pressure required for the application of brakes. Shows the position of the servo and master cylinder when brakes are applied.

2.6 Vacuum Brake

In the earliest day of railways trains were stopped or slowed by manually applied brakes. A major advanced was the adoption of a vacuum brake in which flexible pipe wire connected between all the vehicles of the train. The simple vacuum system had the major defect that in the event of one of the hoses connecting the vehicles becoming defect then the entire system was useless. The vacuum brake is the simplest form which consists of a continues pipes. The train pipe running throughout the length of the train. in the normal running a partial vacuum is maintain in the train pipe and the breaks are released. When air is admitted to the train pipe the air pressure act against the piston and cylinder in each vehicle. A vacuum is sustained on the other face of piston so that a net force is applied. A mechanical linkage transmits this force to the brake show which act on the thread of the wheel. the brake cylinder contains in a longer housing this gives a reserve of vacuum as the piston operation.



POSSIBLE SHORT TYPE QUESTIONS WITH ANSWERS

1**.what is detonation? 2007**

Ans – detonation is the name given to the sudden and violent knocking experienced inside the engine cylinder. Detonation is not pre-ignition. If the detonation is allowed to continue for a long period of time it may overheat the cylinder and spark plug so as to ignite the charge even before the sparking this will cause preignition.

2. classify the rear axle used in automobile? 2008

Ans- 1. Half floating rear axle

2. three quarter floating rear axle
3. fully floating rear axle

3. classify the engine according to the position of the cylinder? 2008

Ans- 1. Vertical engine 2. V engine 3. Horizontal engine 4. Opposed cylinder engine 5. Radial engine

4. Give example of 4 stroke vehicle? 2010

Modern Indian passenger car, ambassador car, Mahindra bolero, hero Honda motor cycle.

5. how ignition takes place in petrol engine? (2015)

Answer:

Petrol engine is S.I. engine in this engine a spark plug is used to ignite the fuel. When the air-fuel mixture is compressed into high ratio at that time a spark plug is created the fresh charge.

6.Name different types of braking system in automobiles .2024 {s}

The following types of braking systems are used in automobile 1- mechanical brake 2-hydraulic brake 3 –Air brake 4-Air assisted hydraulic brake 5-Vacuum brake.

7- What is air assisted hydraulic brake ?{ 2024 }{s}

This type of brake works by combining elements of air brake and a hydraulic brake .it has a special type of power cylinder that contains a hydraulic cylinder and anair cylinder in tandem .

POSSIBLE LONG TYPE QUESTIONS

1. Classify the auto engine based on different aspect? (2007)
2. State the classification of engines based on working principle, fuel used, position of cylinder and arrangement of cylinder? (2010, 2012)
3. State the constructional and placement features of various automobile engines? (2013)
4. How an air braking system works inan automobile ? explain it . 2024 {s}

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CHAPTER NO. -03
IGNITION AND SUSPENSION SYSTEM

Learning objectives:

3.1 Describe the Battery ignition and Magnet ignition system
3.2 Spark plugs: Purpose, construction and specifications
3.3 State the common ignition troubles and its remedies
3.4 Description of the conventional suspension system for Rear and Front axle
3.5 Description of independent suspension system used in cars (coil spring and tension bars)
3.6 Constructional features and working of a telescopic shock absorber

Introduction

The spark ignition engines require some device to ignite the compressed air fuel mixture inside the cylinder at the end of the compression stroke. Ignition system serves this purpose. It is a part of electrical system which carries the electrical current to spark plug which gives park to ignite the air fuel mixture at the correct time. The ignition system consists of a battery, switch, ignition distributor, ignition coil, spark plugs and necessary wiring. Some systems use transistors to reduce the load on the distributor contact points. Other systems use a combination of transistors and a magnetic pick up in the distributor.

Types Of Ignition System

There are two types of ignition systems used in petrol engines:

1. Battery ignition system
2. Magneto ignition system

Both the ignition systems are based on the principle of mutual electromagnetic induction. The battery ignition system is mostly used in passenger cars and light trucks. In the battery ignition system, the current in the primary winding is supplied by the battery whereas in magneto ignition system, the magneto produces and supplies the current in the primary winding.

3.1 Describe the Battery ignition and Magnet ignition system

Battery Ignition System

Battery ignition system for a four-cylinder engine. It consists of a battery, ammeter, switch, ignition coil, condenser, contact breaker, distributor and spart plug.

The primary ignition circuits start at the battery and pass through the switch, ammeter, primary winding, and contact breaker points to the ground. A condenser is also connected in parallel to the contact breaker points. One end of the condenser is connected to the contact breaker arm and the other end is grounded.

The secondary ignition circuit is not connected electrically to the primary ignition circuit. It starts from the ground and passes through the secondary winding, distributors, spark plug to the ground.

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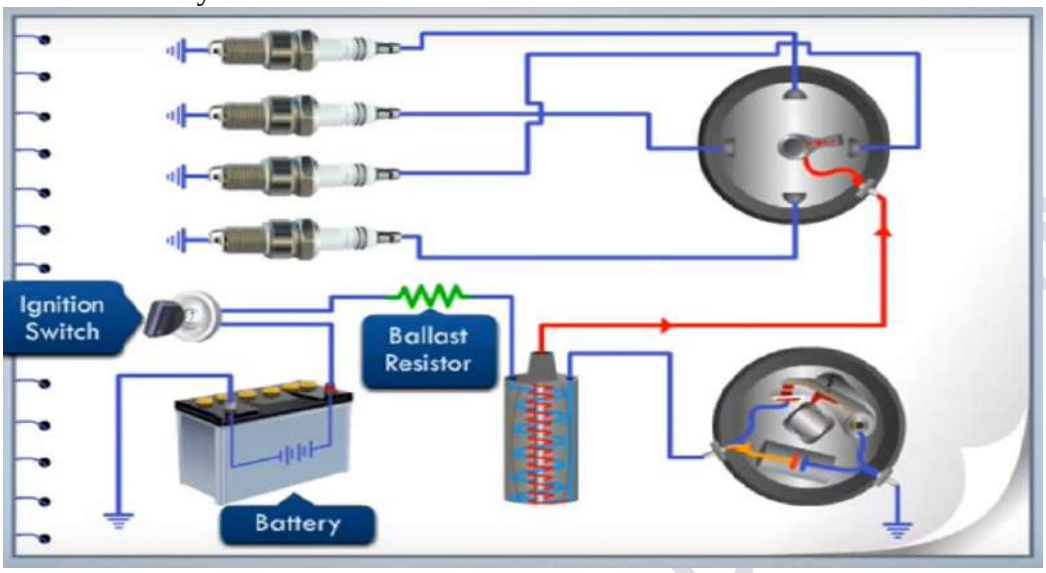
The ignition coil steps up 6 to 12 volts from the battery to the high tension voltage of about 20000 to 30000 volts required to jump the spark at the spark plug gap, which ignites to combustible charge in the cylinder. The rotor of the distributor revolves and distributes the current to the four segments which in turn. Send it to the spark plugs. The purpose of the condenser is to reduce arcing at the breaker points and thereby prolong their life. Because the ignition system is of four cylinder engine, the cam of the contact breaker has four lobes. It makes end breaks the contact of the primary circuit four times in every revolution of the cam.



When the ignition switch is on, the current will flow from the battery through the primary winding. It produces magnetic field in the coil. When the contact points open, the magnetic field collapses and the movement of the magnetic field induces current in the secondary winding coil.

Magneto Ignition System

Magneto ignition system for a four-cylinder engine. It consists of a magneto, instead of a battery, which produces and supplies current in the primary winding. The remaining arrangement in this system is the same as that in the battery ignition system. The magneto consists of a fixed armature having primary and secondary windings and a rotating magnetic assembly which is driven by the engine. When the magnets rotate, current flows in the primary winding. The secondary winding gives high voltage current to the distributor, which distributes it to the respective spark plugs.

The magneto may be either rotating armature type magneto, the armature carrying the primary and secondary windings and condenser, rotate between the poles of a stationary horse shoe magnet.

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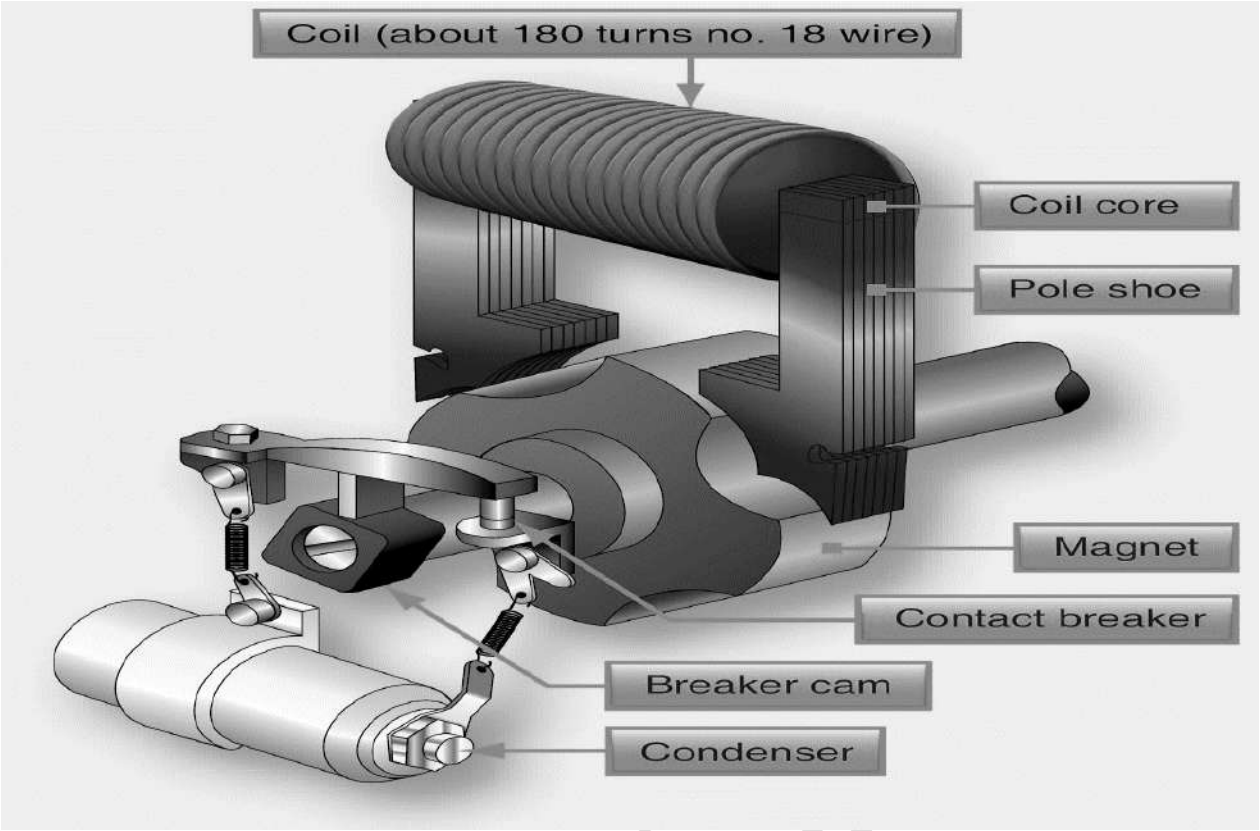
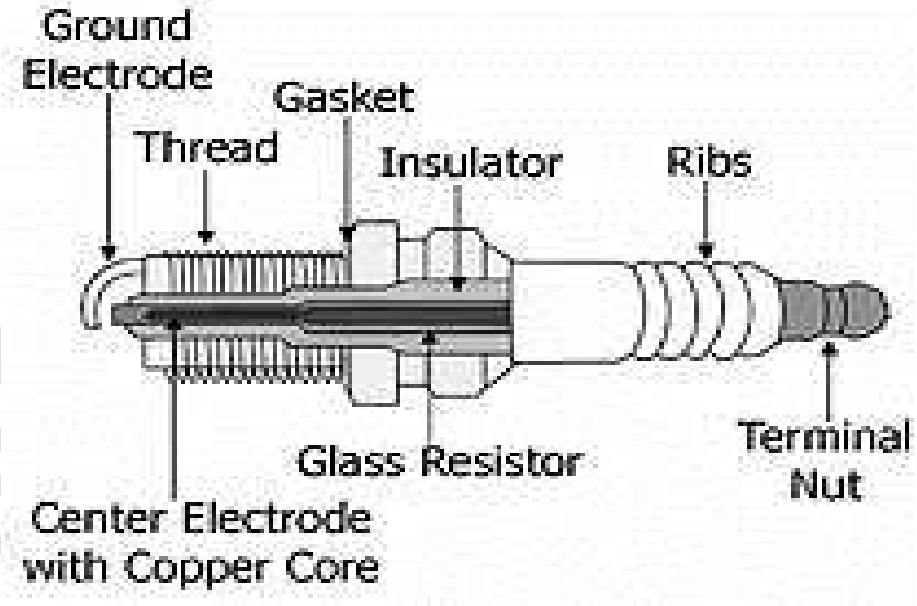


3.2 Spark Plug



Spark plug is a device to produce electric spark to ignite the compressed air fuel mixture inside the cylinder. The spark plug is screwed in the top of the cylinder so that its electrodes projects in the combustion chamber.

Construction. A spark plug consists of mainly three parts:

1. Centre electrode or insulated.
2. Ground electrode or outer electrode.
3. Insulation separating the two electrodes.

The upper end of the center electrode is connected to the spark plug terminal, where H.T. cable from the ignition coil is connected. It is surrounded by porcelain insulator. The lower half portion of the insulator is fastened is fastened with a metal shell. The lower portion of the shell has a short electrode attached top open side and bent in towards the center electrode, so that there is a gap between the two electrodes, the two electrodes are thus separated by the insulator. The sealing gaskets are provided between the insulator and the shell to prevent the escape of gases under various temperature and pressure conditions. The lower part of the shell has screw threads and the upper part is made in hexagonal shape like a unit, so that the spark plug may be screwed in or unscrewed from the cylinder head.

In some engines, a sealing gasket is also providing a seal between the two parts as well as aids in the conduction of heat. In other designs, a tapered fit is used. Some speak plugs are provided with a built in resistor, which forms part of the centre electrode. The resistor serves two purposes.

1. It reduces radio and television interference from the ignition system.
2. It reduces spark plug electrode erosion caused by excessively long sparking.

Materials. The materials used in the construction of different parts of a spark plug are as follows:

1. **Shell.** Sheet.
2. **Insulation.** Porcelain, mica, sintered alumina. The porcelain has disadvantages of brittleness and low resistance to thermal shocks. Mica is somewhat attacked by fuels. Sintered alumina is now almost extensively used for insulation.
3. **Electrode.** Nickel, alloy of nickel and manganese, alloy of nickel, Manganese and silicon. Platinum alloy, addition of manganese improves tensile strength and resistance to Sulphur attack at high temperatures. Platinum alloys are better for electrodes, but their high costs limit their use.

3.3 Common trouble and Remedy

TROUBELES	REMEDY
1.Heavy erosion of center electrode 2.incorrect gap between electrodes 3.center electrode melted 4.insulator tip breakage 5.deposite of piston materials	1.fit new spark plug 2.correct gap should be maintained between electrodes by the help of filler gauge 3.check the engine tune off and distributor 4. Check engine and fit new spark plug. 5.check the engine ignition timing setting and carburetor setting

3.4 Conventional Suspension System For Rear Axle

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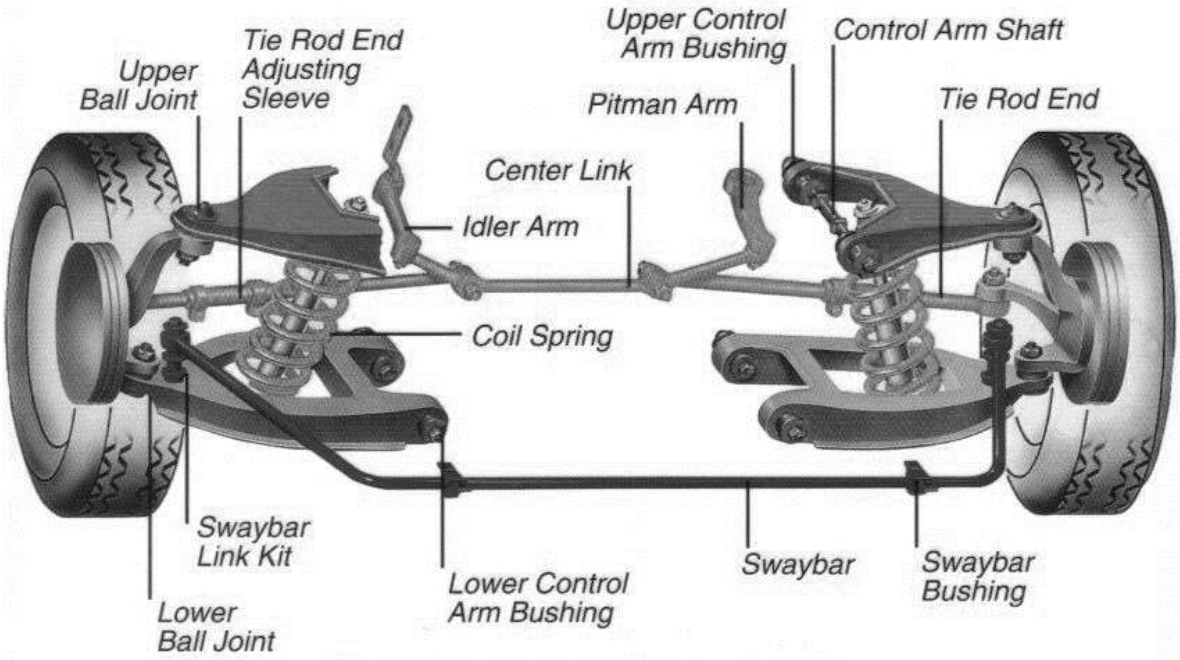

Conventional Suspension

Fig. shows conventional suspension system. This type of suspension is always used in conjunction with torque tube, torque reaction link, or torque rod drive. Therefore, the coil springs are not subjected to driving thrust or twist. Stabilizers and radius rods are also used which relieve the coil springs of all stresses except those acting in a vertical direction. The stabilizer prevents excessive roll or sideway when the car is cornering. The radius rod keeps the rear axle and frame in lateral alignment. The coil springs are seated in pan shaped brackets – spring seats attached to the rear axle.

3.4 Conventional Suspension for Front Axle

Fig. shows conventional suspension for front wheel suspension. This type of suspension was universally used before the introduction of independent front wheel suspension. It may use either two longitudinal leaf springs, as shown in the figure, or on transverse spring, usually in conjunction with shock absorbers these assemblies are mounted similarly to rear leaf spring suspensions.

In this type of suspension, the front wheel hubs rotate on antifriction bearings of steering spindles which are attached to the steering knuckles. To permit the wheels to be turned by the steering gear, the steering spindle and steering knuckle assemblies are hinged on the axle ends. The pin that forms the pivot of this hinge is usually referred to as the king pin or steering knuckle pin.

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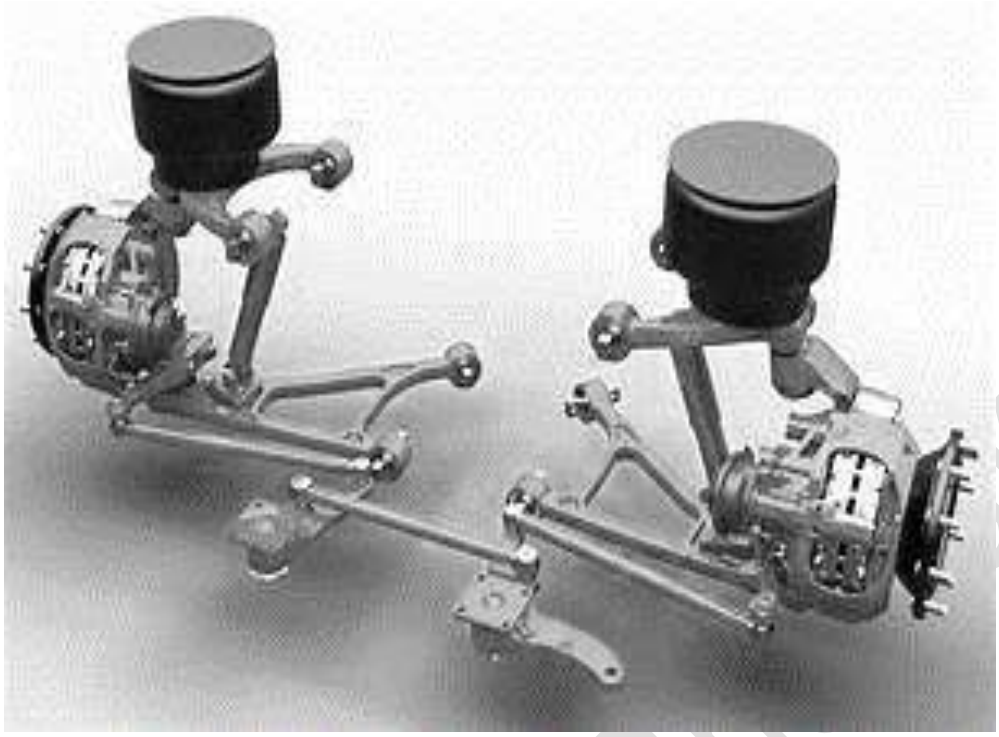


. Where the forked portion is integral with the steering knuckle and fits over the end of the axle, the construction is forked portion is integral with the steering knuckle and fits over the end of the axle, the construction is known as reverse Elliot. In Elliot type construction, the ends of the axle are forked to hold the steering knuckle extension between the ends.

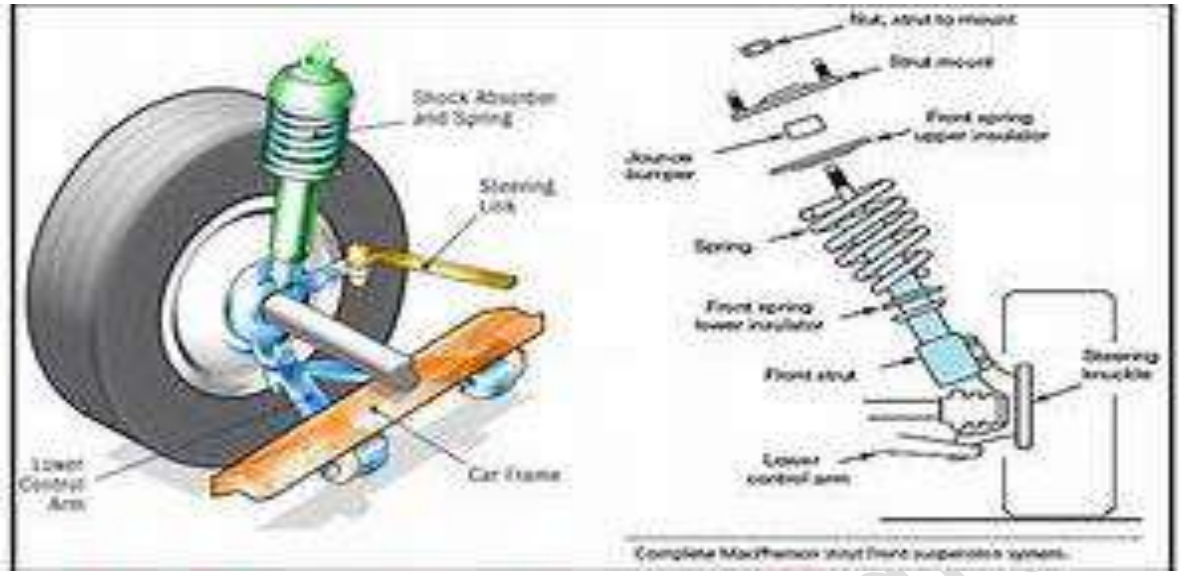
3.5 Independent Suspension System

In the independent type of front suspension, each front wheel is independently supported by a coil, torsion bar or leaf spring. Almost all the passenger cars now use the independent front suspension, in which the coil spring arrangement is the most common.
There are three types of coil spring front suspension:

1. In the first type, the coil spring is located between the upper and lower control arms. The lower control arm has one point attachment to the car frame.
2. In the second type, the coil, spring is located between the upper and lower control arms. The lower control arms have two points to attachment to the car frame.

3. In the third type, the coil spring is between the upper control arm and spring tower or housing that is part of the front-end sheet-metal work

. Other types of front suspension, besides coil spring type, are also in use. The twin I-beam construction is another type, used on some models of Ford trucks. Each front wheel is supported at the end by a separate I -beam. The ends of the I -beams are attached to the frame by pivots, the wheel ends of the two I-beam are attached to the fr4a e by radius arms, which prevent backward or forward movement of the wheels. This type of suspension provides more flexibility.

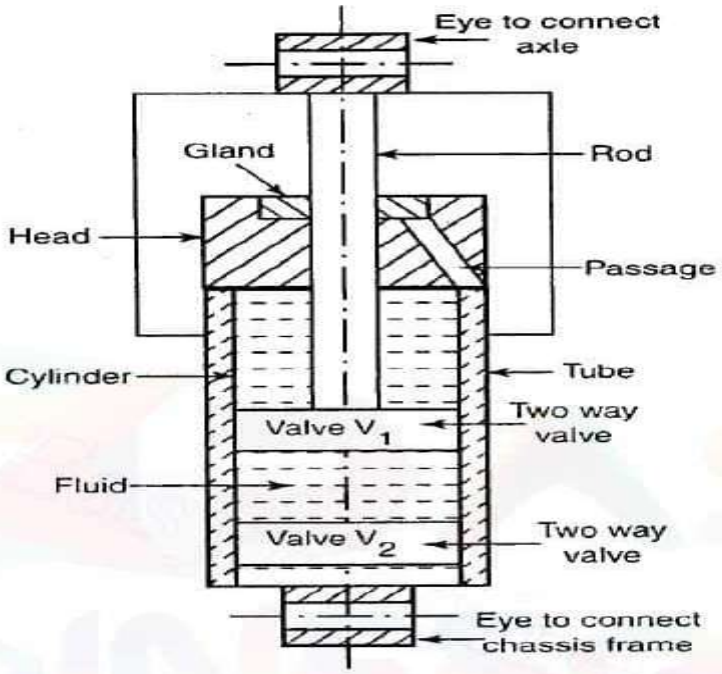


3.6 Telescopic Shock Absorber

A simple diagram of the telescopic shock absorber is shown in fig. Its upper eye is connected to the axle and the lower eye to the chassis frame. A two-way valve A is attached to a rod G. another two way valve B is attached to the lower end of cylinder C. the fluid is in the space above and below the valve A, and also in the annular space between the cylinder C and tube D, which is connected to the space below the valve B. The head J has a gland H. any fluid scrapped off by the rod G is brought down into the annular space through the inclined passage.

The shock absorber works as follows: when the vehicle comes across a bump the lower eye E moves up. Therefore, the fluid passed from the lower side of the valve A to its upper side. But since the volume of the space above valve A is less than the volume of the rod G, the fluid exerts pressure on the valve 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 side of the valve B to its upper side.

The shock absorber must be filled with shock absorber fluid at regular intervals as recommended by the manufacturer or when required by its condition. The modern telescopic shock absorbers are no longer serviced. If they leak or do not offer proper resistance to push and pull, they should be replaced.



POSSIBLE SHORT TYPE QUESTIONS WITH ANSWERS

1. **State the use of suspension system? (2012)**

Ans- To eliminate road shocks from transmission to vehicle components.
2. To obtain good road holding while driving, cornering and braking.
3. To keep the proper steering geometry.
4. To obtain a particular height to body structure.

2. **Write down two function of suspension system?2018**

   Ans- To eliminate road shocks from transmission to vehicle components.
   2. To obtain good road holding while driving, cornering and braking.
   3. To keep the proper steering geometry.
   4. To obtain a particular height to body structure.
   5. To resist the torque and braking reactions.
   8. To maintain the stability of the vehicle while traveling over rough round or when turning in order to minimize the rolling, pitching or vertical movement tendency.
   9. To safeguard the occupants against road shocks and provide a riding comfort.

3. **What do you mean by independent suspension? 2018 ,2024 {s}**

   Ans- the suspension system by which each of the wheel of the vehicle react independently to a bump on the road is called independent**.**

4. **Name the common ignition problems ?2024 {s}**

Ans

1.Heavy erosion of center electrode
2.incorrect gap between electrodes
3.center electrode melted
4.insulator tip breakage
5.deposite of piston materials.

POSSIBLE LONG TYPE QUESTIONS

1. what is conventional suspension system? (2011)
2. what do you mean by telescopic shock absorber? Explain its working with neat sketch? (2013, 2015, 2018)
3. describe the conventional suspension system for rear axle and front axle? (2018)
4. write down the construction and working of leaf spring? (2018)
5. What do you mean by ignition in an automobile ? Describe battery ignition system .2024 {s}

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CHAPTER NO. -04

COOLING AND LUBRICATION

Learning objectives:

4.1 Engine cooling: Need and classification

4.2 Describe defects of cooling and their remedial measures

4.3 Describe the Function of lubrication

4.4 Describe the lubrication System of I.C. engine

4.1 Engine cooling: Need and classification

During the combustion of air fuel mixture enormous amount of heat is produced inside the engine cylinder and the temperature as high as 2500 c may be reached by the burning gases. The temperature is so high that it will break the lubricating film between the moving parts, weld the moving parts or may cause any mechanical breakage of the engine parts. Hence this temperature must be reduced by some means to such a value, about 200c 250 c, at which the engine may work at the cooling system is to keep the engine at its most efficient operating temperature at all engine speeds and all driving conditions. About 15% of the total heat produced is utilised for useful work at the crankshaft. Remaining amount of heat is absorbed in friction, removed by exhaust gases and taken by cooling system. The cooling system. The cooling system is designed to remove above 30 to 35% of heat produced in the engine cylinder. When the combustion takes place, the cylinder walls, cylinder head, piston and valves are heated. Their temperature should not reach excessive values. They must be cooled by some means to a desirable temperature. It is also to be noted that the engine is quite inefficient when cold. The cooling system is so designed that it prevents cooling until the engine reaches to its normal operating cooling system is so designed that it prevents cooling system begins to function. It coos rapidly when the engine is too hot, and it cools slowly or not at all when the engine is cooled or is warming up. Most engines are designed to operate in a definite temperature range which will ensure correct clearances between parts, promote vaporization of the fuel, keep the oil at its best viscosity and prevent the condensation of harmful vapour. Thus the duty of the cooling system is to keep the engine from getting too hot not to keep it cool.

There are following types of cooling system are generally used in automobile sector.

1. Air cooling
2. Water cooling
3. Liquid cooling
4. Steam cooling

4.2 Defect of cooling and their remedial measures

DEFECTS	REMEDIES
1- Water pump failure	1-Water pump should be repaired and replaced.
2- Noise	2-Noise should be minimized by proper maintenance.
3- Over heating	3-Over heating causes such as circulation of water, improper valve timing and ignition timing should be found out and rectified.
4- Radiator leak	4. Radiator leak should be repaired or it should be changed.
5- Over cooling	5- Over cooling caused should be finding out such as thermostat valve working should be properly maintained.
6- Loss of liquid coolant due to leaks	6- Leaks should be repaired as per the requirement.

4.3 Function of Lubrication

1. To minimize friction and wear.
2. To cool by carrying away heat.
3. To seal the piston and thus preventing escape of gases in the cylinders with consequent loss of power.
4. To cushion the parts against vibration and impact.
5. To clean the parts as it lubricates them, carrying away impurities.

4.4 Lubrication system of I.C Engine

The different systems for lubricating the automobile engine are as follows:

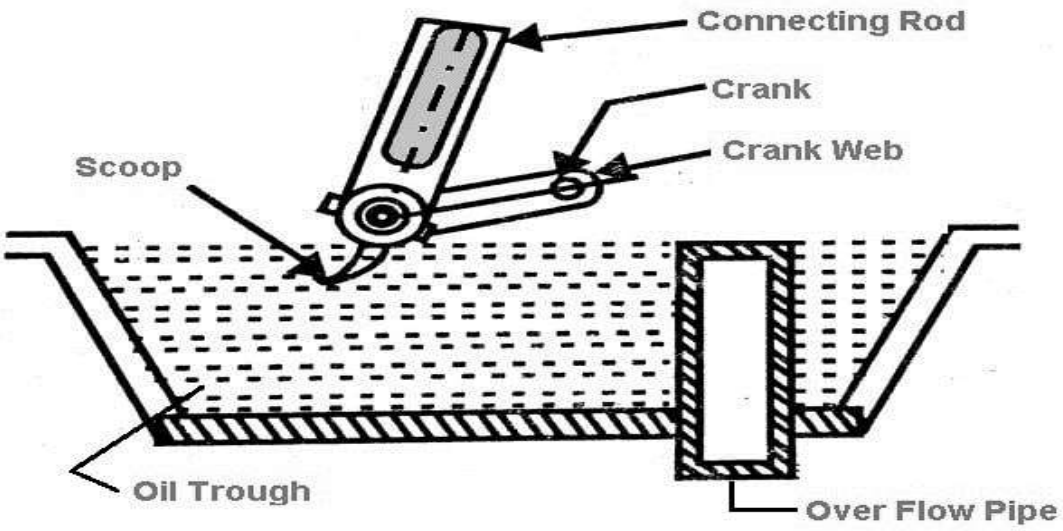
1. Petrol system.
2. Splash system.
3. Pressure system.
4. Semi pressure system.
5. Dry sump system.

Petrol system

- This system of lubrication is generally adopted in two stroke petrol engine like scooters and motor cycles. It is simplest form of lubricating system. It does not consist of any separate part, like oil pump, for the purpose of lubrication. But the lubricating oil is mixed into the petrol itself while filling in the petrol tank of the vehicle, in a specified ratio. When the fuel goes into the crank chamber during the engine operation, the oil particles go deep into the bearing surfaces and lubricate them. The piston rings, cylinder walls, piston pin, etc. are lubricated in the same way.
- If the engine is allowed to remain unused for a considerable time, the lubricating oil separates off form petrol and leads to clogging of passages in the carburettor, resulting in the engine starting trouble. This is the main disadvantage of this system.

Splash system

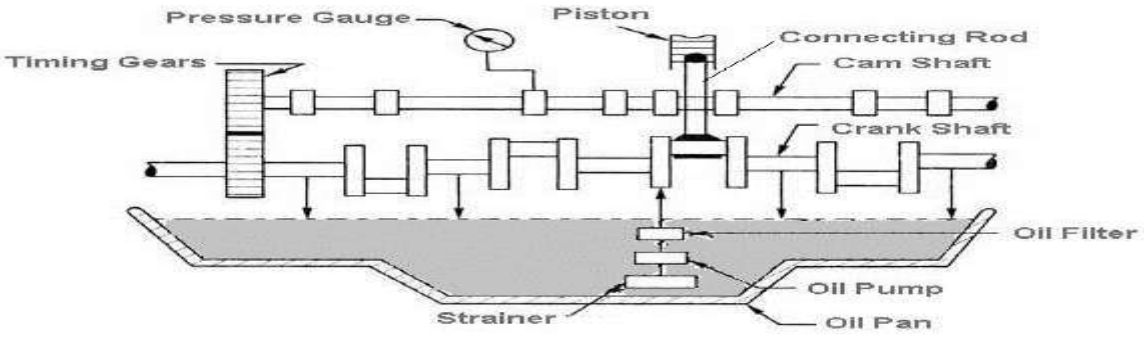
- In this system of lubrication, the lubricating oil is stored in an oil trough or sump. A scoop or dipper is made in the lowest part of the connecting rod. When the engine runs, the dipper dips in the oil once in every revolution of the crankshaft and causes the oil to splash on the cylinder walls. This action affects the lubrication of the engine walls, piston ring, crankshaft bearings and big end bearings.
- Splash system mostly works in connection with pressure system in an engine, some parts being lubricated by splash system and the other by pressure system.



Splash System Lubrication

Pressure system

In this system of lubrication, the engine parts are lubricated under pressure feed. The lubricating oil is stored in a separate tank or the sump, from where an oil pump takes the oil through a strainer and delivers it through a filter to the main oil gallery at pressure of 2-4 kg/cm. The oil from the main gallery goes to the min bearings, from where some of it after lubrication the main bearing, falls back to the sump, some is splashed to lubricate the cylinder walls and the remaining goes through a hole to the crankpin. From the crank pin it goes to the piston pin through a hole in the connecting rod web, where it lubricates the piston rings.



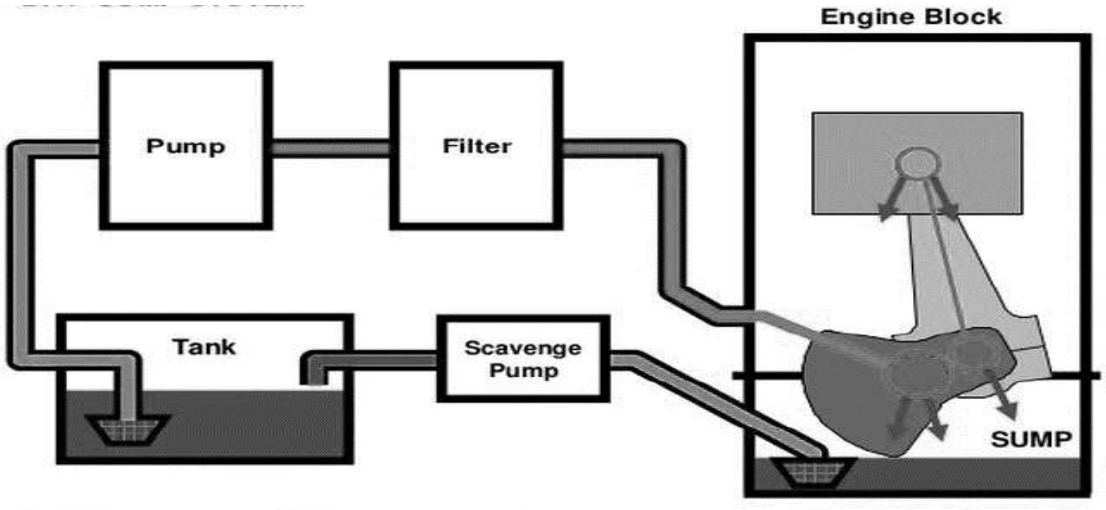
Pressure System of Lubrication

For lubricating camshaft and timing gears, the oil is led through a separate oil line from the oil gallery. The valve tappets are lubricated by connecting the main oil gallery to the tappet guide surfaces through drilled holes.

An oil pressure gauge at the instrument panel indicates the oil pressure in the system. Oil filters and strainers in the system clear off the oil filters and strainers in the system clear off the oil from dust, metal particles and other harmful particles.

Dry sump system

The system in which the lubricating oil is stored in the oil sump is called wet sump system, like the pressure system. But the system in which the lubricating oil is not kept in the oil sump is known as dry sump system. In this system, the oil is carried in a separate tank from where it is fed to the engine. The oil which falls into the oil sump after lubrication is sent back to the oil tank by a separate delivery pump. Thus, the system consists of two pumps, one to feed the oil and the other to deliver it back to the oil tank. This system is used in situations where the vehicle has to change its position continuously, like in aircraft. The main advantage of this system is that there is no chance of breakdown the oil supply during up and down movement of the vehicle.



POSSIBLE SHORT TYPE QUESTIONS WITH ANSWERS

1. **What do you mean by thermostat?** (2007)
2. Ans- a thermostat is a valve which is used in the water-cooling system to regulate the circulation of water in system to maintain the normal working temperature of the engine parts during the different operating condition, which automatically keeps the cooling water temperature at a predetermined value.
3. **Explain the necessity of engine cooling?** (2008)
   Ans- engine cooling is required to keep the temperature of the engine low to avoid engine seizure to avoid danger of engine failure to avoid loss of volumetric efficiency and power.
4. **What is the use of pressure relief valve in engine cooling system?** (2011)
   Ans- this is a component of the gear pump used in lubricating system of an engine. This is provided to relieve excessive pressure due to high engine speed on clogged oil lines.
5. **What is the necessity of lubrication system?** (2012)
   Ans- it is used to reduce the dry or solid friction produced inside, by adding a film of some lubricating oil is interposed between two sections so that the two are not in actual physical contact with each other, the only resistance to motion remains the resistance of the oil itself.
6. **What is oil filter?** (2013)
   Ans- oil filter is used in the engine lubricating system of most of the motor vehicles to filter out the dirt or grit particles from the oil.
   7- State the function of lubrication ? 2024 {s}
   1. To minimize friction and wear.
   2. To cool by carrying away heat.
   3. To seal the piston and thus preventing escape of gases in the cylinders with consequent loss of power.
   4. To cushion the parts against vibration and impact.
   5. To clean the parts as it lubricates them, carrying away impurities.

POSSIBLE LONG TYPE QUESTIONS

1. The name radiator is ill defined. Justify? (2007)
2. Describe with the help of a neat sketch pump circulating water cooling system? (2007)
3. With neat sketch explain any lubricating system used in IC engine. (2008, 2013)
4. Why cooling of engine is very much necessary? Write down the different types of cooling process, its defect and remedial measures? (2011)
5. Describe the pressure lubrication system used in automobile with neat sketch? (2012, 2013)
6. Short note on engine cooling? (2013)
7. What are the types of cooling system and explain the water-cooling system in details? (2015)
8. Mention seven primary objectives of lubrication and seven required properties of a good lubricant? (2018)
9. Explain about cooling defects and their remedial measures? (2019) 2024 {s}
10. Why cooling system is provided in IC engine? (2019)
11. Explain dry sump lubrication system? (2019)
12. State the advantage and disadvantage of air cooling system? 2024 {s}
13. What is the purpose of lubrication in an automobile .2024{s]

ECE Asurali, Bhadrak

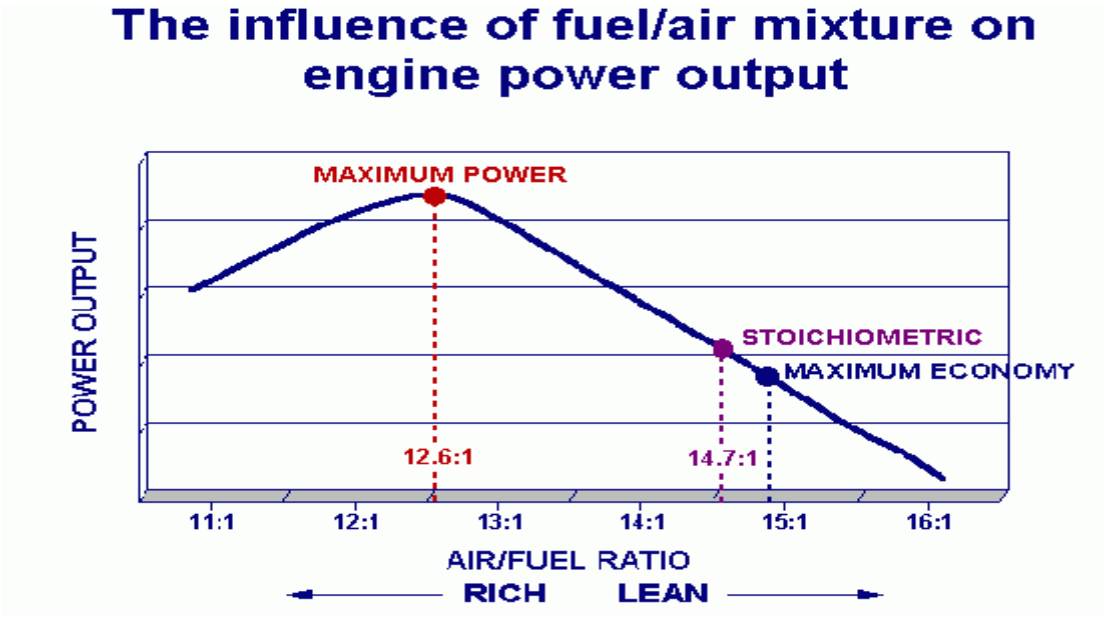
CHAPTER NO. -04
FUEL SYSTEM

Learning objectives:

5.1 Describe Air fuel ratio
5.2 Describe Carburetion process for Petrol Engine
5.3 Describe Multipoint fuel injection system for Petrol Engine
5.4Describe the working principle of fuel injection system for multi cylinder Engine
5.5 Filter for Diesel engine
5.6 Describe the working principle of Fuel feed pump and Fuel Injector for Diesel engine

5.1 Air Fuel Ratio

The carburetor must supply the air fuel mixture of varying proportions to suit the different operating requirements. The mixture must be rich for starting, a and must be relatively lean for idling and intermediate speeds. Fig. shows the air fuel ratio foe different speeds of a car. Foe starting, the air fuel ratio is 9:1. It is as rich mixture. Foe idling, the ratio is 12:1. It is a lean mixture. For intermediate speeds, between 35 to 105 km/hr, the mixture further leans at 15:1. But at higher speeds mixture further leans out 120 to 150 km/h, with a wide-open throttle, the mixture is again enriched to about 13:1. For acceleration at any seed the throttle is suddenly opened which causes a momentary enrichment of the mixture. Two examples of acceleration are shown by dotted lines, on at 25 km\h and the other at 45 km\h.



5.2 Carburetion Process for Petrol Engine

The carburetor is a device for atomizing and vaporing the fuel and mixing it with the air in varying proportions to suit the changing conditions of spark ignition engines. The air fuel mixture so obtained from the carburetor is called the combustible mixture. The process of mixture the petrol fuel with air to obtain the combustible mixture is called carburetion.

Hence the terms vaporization and atomization should be understood clearly. Vaporization is the hence of state of the fuel from liquid to vapor. Atomization is the mechanical breaking up of the liquid fuel into small particles so that every particle of the fuel is surrounded by air. In order to produce very quick vaporization of the liquid fuel, it is sprayed into the air passing through the carburetor. Spraying of the liquid turns it into many fine particles, so that the vaporization occurs almost instantly.

5.3 Multi Point Fuel Injection Systems

Automobiles use one of two devices for supplying the air fuel mixture in correct ratio to the cylinders in all rpm ranges; a carburetor or an Multi Point Fuel Injection Electronic Fuel Injection system. Both of these measures the intake air volume, which varies depending on the opening angle of the throttle valve and the engine rpm, and they both supply a proper ration of fuel and air to the cylinders in accordance with the volume of intake air. The MPFI and EFI is the same reference of the system. Because the construction of h carburetor is relatively simple, it has been used almost exclusively on petrol engines in the past. However, in response to recent demands for cleaner exhaust emissions, more economical fuel consumption, improved drivability, etc., the carburetor now must be equipped with various compensating devices, making it more complex system.

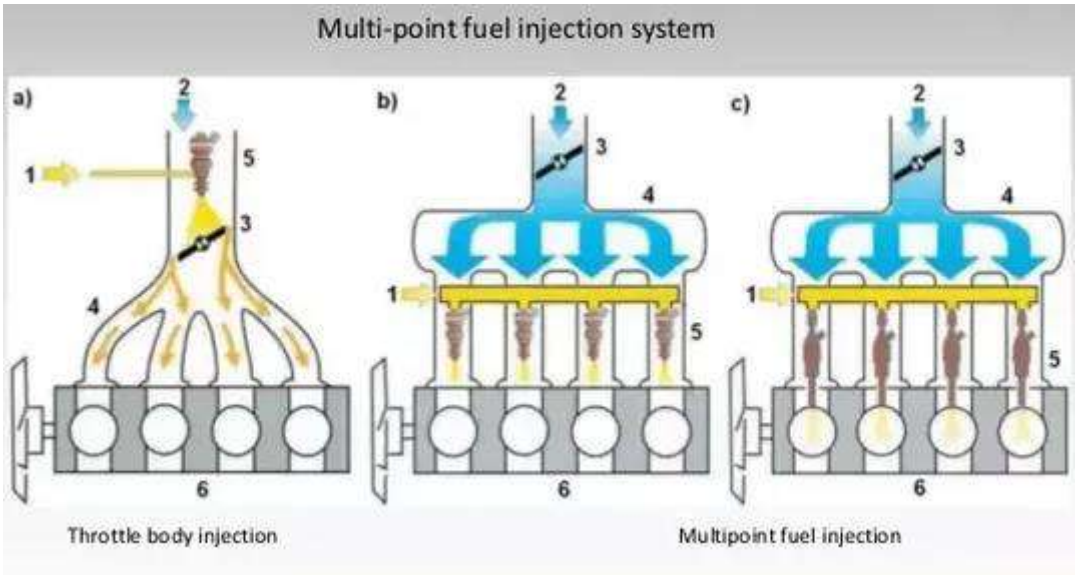
In place of the carburetor therefore the MPFI system is used, assuring the proper air fuel ratio to the engine by electrically injecting fuel in accordance with various driving conditions. The MPFI, however, calibrates the fuel at optimum requirement fuel as desired by engine. The fuel is controlled not only by manual but so many other sensors. Carburetors atomize the fuel by processes relying on the air speed being greater than the fuel speed at the fuel nozzle. They also meter the fuel using the air flow as the independent variable. Fuel injection differs in both respects. The fuel speed at the point of delivery is greater than the air speed to atomize the fuel and the fuel is metered proportionally to air flow but not by the air flow itself; rather a pump is used to generate the pressure difference necessary to flow the fuel.

5.4 Working Principle of Fuel Injection System for Multi Cylinder Engine

There are two methods of fuel injection in compression ignition engines:

1- Air blast injection.
2- Airless or solid injection.
   (a) Individual pump system
   (b) Common rail system.

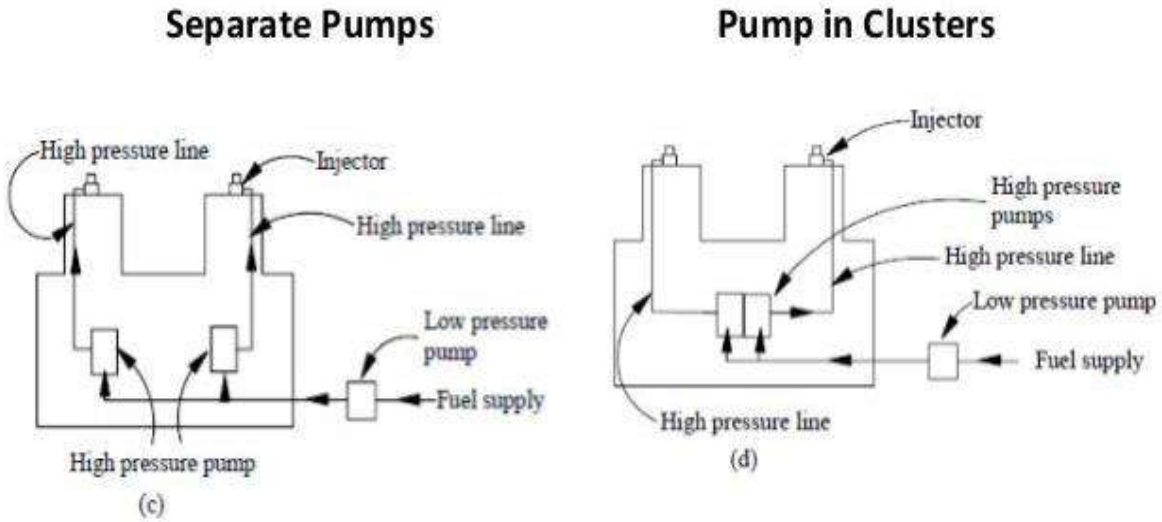
Air blast injection. This method was originally used in large stationary and marine engines. But it is now obsolete. In this method, the air is first compressed to very high pressure. A blast of this air is then injected carrying the fuel along with it into the cylinder. The rate of fuel injection is controlled by varying the pressure of the air. The high-pressure air requires multistage compressor so as to keep the air bottles charged. The fuel ignites by the high temperature of the air caused by the high compression. The compressor consumes about 10% of the power developed by the engine, decreasing the net output of the engine. This method of fuel inject is expensive and complicated.



Airless or Solid injection. In this method, the fuel under high pressure is directly injected into the combustion chamber. It burns due to the heat of compression of the air. This method requires a fuel pump to deliver the fuel at thigh pressure. This method is used for all types of small and big diesel engines. It can be divided into two systems.

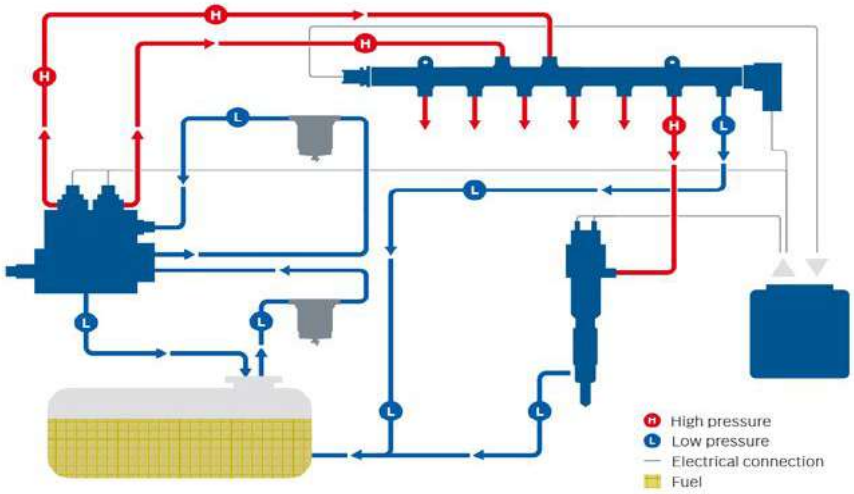
(a) **Individual pump system.**

In this system each cylinder has its own individual high-pressure pump and a metering unit.



(b) **Common rail system.** In this system, the fuel is pumped by a multi cylinder pump into a common rail; the pressure in this rail is controlled by valve. A metered quantity of fuel is supplied to each cylinder from the common rail.

Fig.

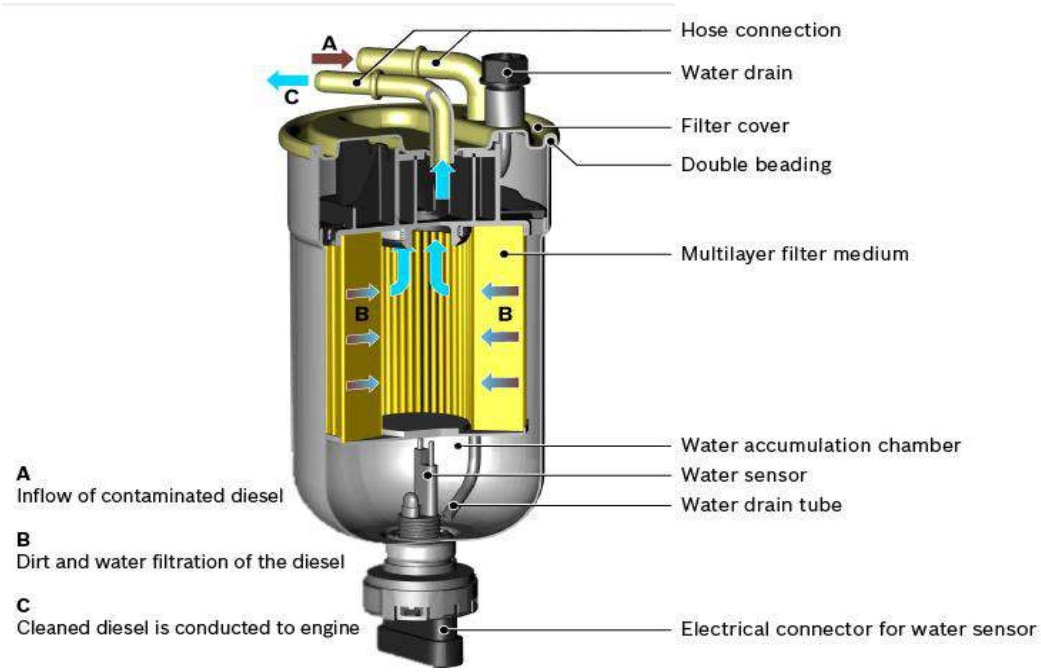


The airless injection in comparison to air blast injection is simple in construction, light in weight and cheap. The fuel is atomized properly. It is quite suitable for engine of higher output, but it requires higher accuracy in manufacturing the pump barrel and fuel injection plunger.

5.5 Fuel Filter for Diesel Engine

Dirt carried in the fuel is recognized as a prime sourced of trouble and inefficiency in diesel engine operation, as it is the cause of wear in the fuel injection pump and nozzles. The fuel injection pump is a sturdy, well designed piece of equipment that will give double free service for many thousands of hours running provided the fuel is clean, but if dirt, and especially fine dust, is allowed to pass into the system in the fuel, then wear fallows, and with it irregular running and loss of power: maintenance costs will become heavy and engines will need frequent attention. Where sedimentation in fuel. Under working conditions, however, it is absolutely essential that the fuel be properly filtered before centering the injection pump.

Fig.



Prior to putting into operation or after cleaning and changing of the filter element the filter must be filled with fuel oil through the filter plug orifice on the filter cove. After filling, the filler plug should be replaced immediately and the filter air vented. Filter, cannot be over emphasized, as many complaints of fuel pump element wear can be traced to lack of care in the servicing of filters when choking takes place, this is usually found to be due o a waxy sludge which is deposited from the fuel. If filters are found to choke in an

unreasonably short time this will probably point to a satisfactory fuel supply or storage tank installation, and should be taken to find out how, and at what point an undue number of impurities can enter the system.

Paper elements are not intended to be cleaned and must be discarded when choked. The cost of replacement elements has been kept down to the lowest possible figure compatible with meticulous care in manufacture and compares more than favorably with other less efficient filtering elements. The number of filters used for any engine installation will obviously depend upon the capacity of the particular engine and the conditions of operation. In all cases, the main object is to provide the highest possible degree of filtration consistent with long filter element life.

5.6 Fuel Injector

The purpose of the fuel injector is to inject a small volume of fuel in a fine spray and to assist in bringing each droplet into contact with sufficient oxygen to give quick and complete combustion. Shows C.A.V. fuel injector. It consists of a needle vale which is pressed on its seating in the nozzle by a plunger or spindle. A compression spring controls the pressure upon the plunger by which the needle valve opens. A nozzle is attached to the body of the injector by a cap nut. The fuel enters the nozzle through drillings in the injector body. The fuel may pass from a gallery down the sides of the lower parts of the needle valve, or it may enter an annular groove in the nozzle and then pass-through drillings to a point just above the nozzle seat. The body or a nozzle holder provides access for the fuel and an outlet for the fuel that leaks into the area occupied by the spring.

Ehen the needle valve is raised from its seat by the pressure of the fuel acting on the conical or stepped face of the valve, his injection of the fuel takes place. When the injection pressure falls each injection and consequently breaks the fuel into small particles. Fuel leakage past the needle valve stem enters the upper part of the injector and is returned to the pump suction chamber or to the fuel tank. Fuel leakage provides lubrication also for the valve stem.

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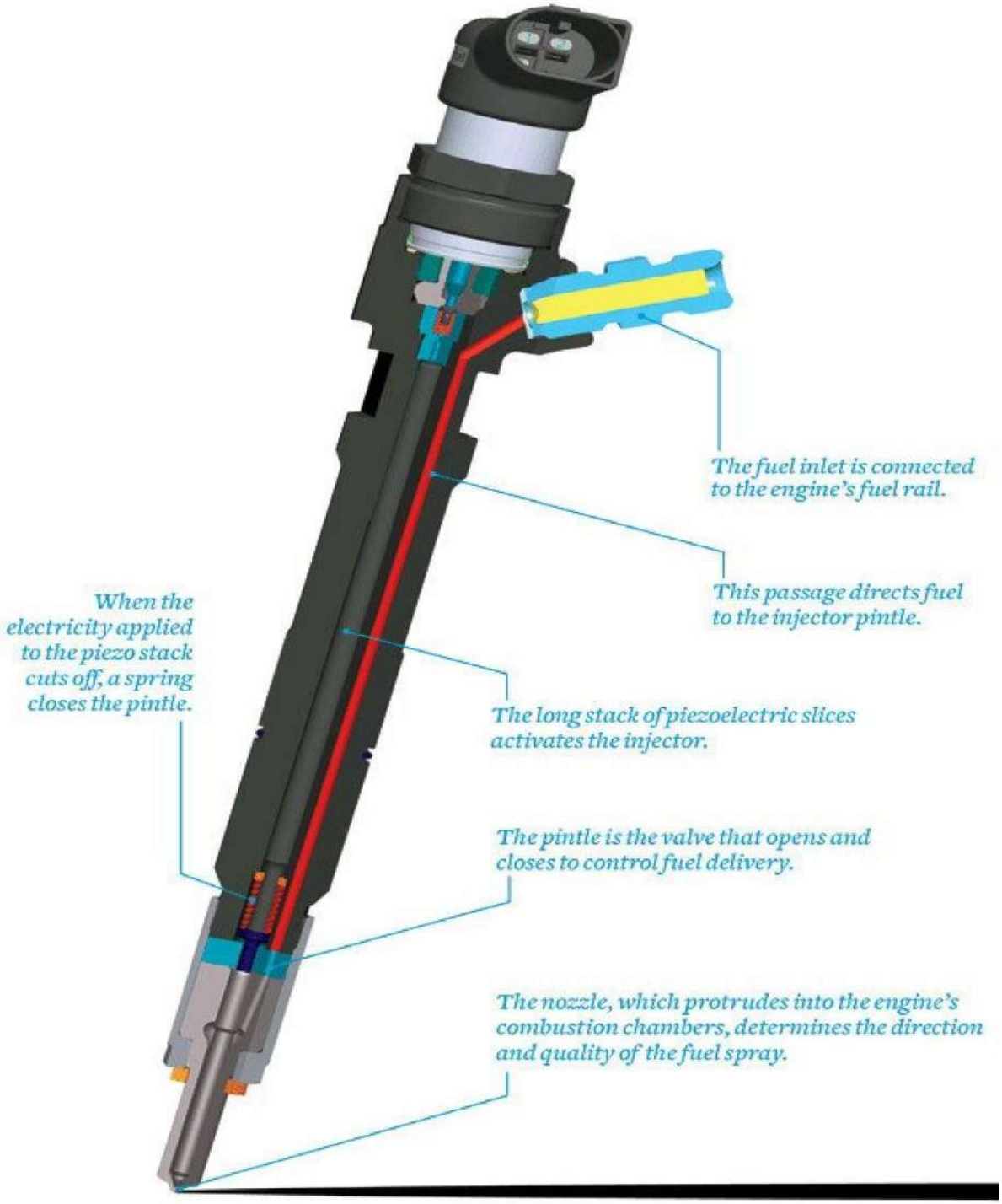

5.7 Fuel Feed Pumps

The fuel feed pump used for the diesel engine is similar to that of a fuel lift pump for the petrol engine. It delivers the fuel from the tank to the injection pump continuously and at a reasonable pressure. It is necessary because there is possibility of formation of vapor bubbles and subsequently cavitations in the pump due to suction of the rapidly moving plungers of the injection pump. This would lead to uncontrolled variations in the rate of delivery of fuel to the cylinders, causing rough running and possibly even cavitations could cause mechanical damage in the injection pump. Generally, delivery pressures of between about 29 and 98kpa adequate for preventing vapor formation on the suction side of in line type injection pumps. This pressure also ensures adequate supply of fuel for filling the plunger elements at high speeds in a rotary distribution pump.

POSSIBLE SHORT TYPE QUESTIONS WITH ANSWERS

1. **Define air fuel ratio? (2012, 2013, 2015 ,2024 {s})**

Ans- it is defined as the amount of fuel by mass present in a definite mass of air.

A.F ratio = mass of fuel/mass of air

2. **What is the use of fuel feed pump? (2012)**

Ans- fuel feed pump is used to feed the fuel at a suitable pressure into the engine cylinder which is basically needed in diesel engine**.**

3.Why the carburetor is very much essential for ignition system of an automobile? (2011,2010, 2009,2008)

Ans- the main function of carburetor are as follows-

1It preserves fuel at a constant lead.

2It provides easy starting while the engine is col.

3It ensures the engine to run slowly without missing and without undue wastage of fuel.

4.What is an injector? (2010)

Ans- The function of fuel injector is to convey the measured amount of fuel under the higher pressure from the injection pump to combustion chamber in spray form. This unit consists of injection nozzle, its holder and pipe connections and is located in the head or side of the combustion chamber.

1. **What is firing order? (2009, 2007, 2018)**

Ans- firing order is the order in which various cylinder of a multi-cylinder engine fire. The firing order is arranged to have power impulses equally spaced and form the point of view of balancing. For a four-cylinder engine the firing order is of following order. -

   a. **1-3-4-2**
   b. **1-2-4-3**

2. **What is supercharger? (2007)**

Ans- A supercharger is a device which increases the pressure of the air-fuel mixture from the carburetor before it enters the engine. It is connected between the carburetor and the cylinder in the way of intake manifold. It is usually driven by the engine through suitable gears and shafts.

3. **What is meant by atomization of fuel? (2007)**

Ans- In a carburetor, the fuel leaves the fuel jet or nozzle more or less in the form of stream. This liquid stream is turn apart into ligaments. These ligaments break up and contract to-form drops for various sizes.

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4. How could you define octane number? (2007,2013)

Ans- octane number of an unknown fuel is defined as the percentage of isooctane in the primary reference fuel that gives the same knock intensity. The antiknock value of fuel is measured in octane number rating. The fuel iso-octane is highly resistant to knock. It was a octane rating of 100.

5. What is the function of spark plug? (2013,2018,2019)

Ans- the function of spark plug is to produce electric spark to ignite the compressed air-fuel mixture inside the cylinder.

6. How are ignition systems are classified according to the supply of electric energy to the spark plug.

Ans- Ignition systems are classified according to the supply of electric energy to the spark plug. They are mainly 2 types- 1. Battery ignition system

2. Magnet ignition system

11. Define flash and fire point? (2019)

Ans- The temperature at which a particular organic compound gives off sufficient vapor to ignite in the air is called flash point. The lowest temperature at which the vapor if that fuel will continue to burn after ignition by an open flame is called fire point.

12.Name of the factors influencing the process of carburetion? (2019)

Ans – 1. Engine speed

7. Temperature of the incoming air
8. Design of carburetor
9. Vaporization characteristics of fuel.

13-Define carburetion prcess ?2024 {s}

Ans .Carburetion is a process of mixing fuel with air to creat combustible mixture in carburetor .carburator is a device in which carburetionproces is done .

POSSIBLE LONG TYPE QUESTIONS

1. Describe the fuel injection system of multi cylinder engine? (2012,2010,2009,2008,2013)
2. Explain battery and magnet ignition system with diagram? (2012, 2008, 2015)
3. What do you mean by air fuel ratio? Why it is very much essential for efficiency of automobile? (2012)
4. Describe the battery ignition system of an automobile? (2010, 2007, 2013, 2015)
5. Write short notes no any two- (2008, 2010,2013)
   1. fuel feed pump
   2. solex carburetor
   3. magnet ignition
6. Describe the working principle of an injector with the help of a neat sketch? (2010)
7. Describe the construction and working of solex carburetor with neat sketch? (2009, 2008)
8. Write short notes (any two) (2007)
   1. anti-freeze solution
   2. carburetor
   3. knocking
   4. T-C- transmission
9. Explain ignition timing of petrol engine. Also state the common ignition troubles and its remedies? (2013)
10. Describe the working principle of spark plug? (2013)
11. What do you mean by carburetion? Describe in details with respect to air fuel ratio? (2013)
12. Draw line and block diagrams and describe the fuel injection system (distributor type) for a 4-cylinder diesel engine? (2013)
13. What the difference between battery and magnet ignition system? (2019)
14. Write down the function of fuel injection system? (2019)
15. Explain about diesel fuel filter? (2019)

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16. What is valve timing and explain actual valve timing diagram? (2015)
17. Explain fuel system in diesel engine? (2015)
18. Describe multipoint fuel injection system for petrol engine ?2024 {s}
19. Discuss briefly the working principle of fuel injection system for disel engine with sketch .2024 {s}

CHAPTER NO.- 06
HYBRID AND ELECTRIC VEHICLE

Learning objectives:

6.1 Introduction, Social and Envv. Importance Of Hybrid and Electric Vehicles
6.2 Description of Electric Vehicles Operational Advantages, Present Performance and Applications of Electric Vehicle.
6.3 Battery for Electric Vehicle (BEV), Battery Types and Fuel Cells
6.4 Hybrid Vehicles, Types of Hybrids and Electric Vehicles: Parallel, Series, Parallel and Series Configuration
6.5 Drive Train
6.6 Solar Powered Vehicle

6.1 Introduction, Social and Envv. Importance Of Hybrid and Electric Vehicles

Introduction: -

- Electric vehicles are defined as vehicles which use an electric motor for propulsion. Electric vehicle is propelled by one or more electric motors, receiving power from an onboard source of electricity such as batteries, fuel cells, ultracapacitor, flywheel, etc. Pure electric vehicles run only on batteries and need charger to replenish the battery's power from an electrical outlet. A hybrid is a vehicle that has two or more power sources propel it. An example that is often seen is a moped. The petrol engine is one power source and the rider provided the second power source by "pedal power". Other vehicle that are classed as hybrid include some trains (diesel and electric) and submarines (nuclear and electric).

Social and Envv. Importance Of hybrid and Electric Vehicles

- The main reasons for the need of electric vehicles are:
- Depletion of oil reserves
- Stringent emission standards
- Noise pollution

There would be no exhaust emission emitted from electric drives. These zero emission vehicles are almost noiseless and can be charged at home or work place. EVs are easier to service and maintain due to the absence of spark plugs, clutch and gears. They are ideals for 'stop-start' city driving conditions. EVs are extremely reliable and ease to drive.

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It is knowing that almost any fuel can be used to generate electricity. There for our dependence upon petroleum can be reduced by switching to electric vehicles.

6.2 Description of Electric Vehicles Operational Advantages, Present Performance and Applications of Electric Vehicle.

- An electric vehicle consists of a battery that provided energy, an electric motor that drives the wheels, and a controller that regulates the energy flow to the motor. There are no gearbox and clutch in these vehicles.
- **Motor: -** The prime mover in electric vehicle is the high-torque electric motor. The motor converts the energy stored in the power pack into mechanical motion. The high torque electric motor ensures a quick acceleration. The power from the motor is delivered to the wheels directly or through the transaxle that propels the vehicle. While breaking, the motor acts like a generator and recharges the batteries.
- There is several choices of the type of drive motor. The basic choice is between an AC and a DC motor The AC motor offers many control advantages but requires the DC produced by the batteries to be converted using an inverter. A DC shunts wound motor rated at about 50 to become the most popular. Reva has a 13 kW separately excited DC motor with a high torque of 70Nm at zero speed.
- **Power pack: -** Automobile manufacturers use these types of rechargeable battery for electric car use. Those types are lead-acid batteries, nickel metal hydride (NiMH) batteries, and lithium-ion (Li-ion) batteries. The space occupied by these heavy batteries is large. Operational problems include the limited range of the vehicle and its comparatively low maximum speed. Currently the main advantage of lead-acid batteries is the existing mature technology, which is accepted by the motor industry.
- REVA's Power pack consists of eight 6-volts EV tubular type lead acid batteries that attain 80 percent state of charge in under 2.5 hours. A complete charge is achieved in less than seven hours and gives a range of 80km. The power pack is housed beneath the front seats, which lowers the centre of gravity, thus increasing the safety of passengers. Charging REVA is a safe and easy process – just plug into a 220 Volt, 15 Ampere socket at home or at work. A full charge consumes just about 9 units of electricity.
- **Charger: - EVs** have an on-board charge, which converts AC into DC power to charge the power pack. The charge is computer controlled with an in – built stabilizer and auto shut-off mechanism. The smart charger output is connected to the power pack and ensures that optimum current and voltage is maintained at all times.

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- **Controller: -** EVs also have a computerized motor controller. This regulates the flow of energy from the power pack to the motor in direct relation to pressure applied on the accelerator. It ensures perfect speed control and optimum use of energy in both forward and reverse direction. Speed controllers are rated according to the voltage and amperage ranges.
- **DC/DC converter: -** A 12V auxiliary battery is normally used in an electric car to power all 12 V accessories such as lights, horn and so on. There is no alternator in EVs to keep this battery charged. EVs use a DC/DC converter which taps the full battery pack voltage and cut it down to a regulated 13.5 V output, similar to an alternator. It is not advisable to eliminate the auxiliary battery completely, for safety reasons. If the DC/DC converter fails at night or the battery pack falls below the low voltage shut-off of the converter, the auxiliary battery will have enough charge to bring the car home.
- **Energy Management System (EMS): -** The brain of EVs the Energy Management System (EMS) that monitors and controls all required functions. The EMS is a computer-based system that optimizes charging and energy output of batteries to maximum operating range and improve performance. The EMS increases the electric vehicle range by 10-15% and battery life 25-30%. The system also predicts available range for a given state of battery charge. The EMS also maintains an electronics log of the vehicle performance, enables personnel to run diagnostic checks on the car to give service information about the car.
- Compared with internal Combustion Engine Vehicle (ICEVs), EVs offer a relatively shorts driving range. Thus, in order to maximize the utilization of on-board stored energy, an intelligent energy management system needs to be adopted. Making use of sensory inputs from various EV subsystems, including sensors for temperatures of outside and inside air, current and voltage of the electric motor, vehicle speed and acceleration as well as external climate and environment, the EMS can realize the following functions:
- To optimize the system energy flow.
- To predict the remaining available energy and hence the residual driving range.
- To suggest more efficient driving behaviours.
- To direct regenerative energy from braking to receptive energy sources such as batteries.
- To modulate temperature control in response to external climate.
- To adjust lighting brightness in response to external environment.
- To propose a suitable battery charger algorithm.

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- To analyse the operation history of the energy source, especially the battery.
- To diagnose any incorrect operation or defective components of the energy source.
- When the EMS is coupled with a navigation system, it can plan energy efficient routes, locate charging facilities for extended trips, and modify range predictions on the basis of traffic conditions. In summary the EMS has the distinct features of integrated multi-functions, flexibility and adaptability such that the limited on-board energy can use wisely.

Advantages Of Electric Vehicle: -

1. Mechanically simpler.
2. Running cost is 40 paisa per kilometre.
3. Zero emission vehicles, also reducing greenhouse emission.
4. They are very quiet in operation. While running, it does not produce noise and vibrations.
5. As there are no gears and clutch in these vehicles, they are extremely reliable, safe and easy to drive and man oeuvre in the congested cities.
6. Minimum maintenance and service as EVs have fewer moving parts.
7. Idles foe stop –stars conditions.
8. More durable than gasoline-powered cars.
9. More energy efficient then gasoline engines.
10. Reduce dependency on imported energy sources.
11. Power regeneration.

6.3 Battery for Electric Vehicle (BEV), Battery Types and Fuel Cells

- A Battery Electric vehicle (BEV) runs entirely using an electric motor and battery, without the support of a traditional internal combustion engine, and must be plugged into an external source of electricity to recharge its battery. Like all electric vehicle, BEV s can also recharge their batteries through a process known as regenerative breaking, which uses the vehicle's electric motor to assist in slowing the vehicle, and to recover some of the energy normally converted to heat by the breaks.
- BEVs have to rely solely on the energy stored in their battery packs; therefore, the range of such vehicle depends directly on the battery capacity.
- Typically, they can cover 100km-250km on one charge, whereas the top-tier models can go a lot further, from 300km to 500km.these ranges depend on driving condition, climate, battery type and age. Once depleted, charging the battery pack takes quite a lot of time compared to refuelling a conventional internal combustion engine vehicle.
- It can take as long as 36 hours completely replenish the batteries there are far less time-consuming ones as well, but none is comparable to the little time required to refill fuel tank. Charging time depends on the charger configuration, its infrastructure and operating power level.

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Vehicle model	Range	Charge time
Tesla Model S	335-426 km	5 hours
Nissan Leaf	120km	3 hours
BMWi3	160 km	6 hours
Mitsubishi iMi	100km	7 hours
Smart	109km	6 hours
Ford Focus	110km	4 hours

Advantages: -

- No emission while running.
- Silent
- No gas or oil changes
- Ability to conveniently charge at home
- Fast and smooth acceleration
- Low cost of operation
- Instant and high torques, even at low speed

Disadvantages: -

- Shorter range than gasoline vehicle although most people drive well within the range of today's BEV and could rent a hybrid for the rare long trips.
- Slightly more expensive than their gasoline equivalent although the gasoline saving payoff the difference in typically 2-3 years.

Application: -

- Nissan leaf and Tesla's are some high selling BEVs these days, along with some Chinese vehicles.

6.4 Hybrid Vehicles, Types of Hybrids and Electric Vehicles: Parallel, Series, Parallel and Series Configuration

Batteries for Hybrid and Plug-In Electric Vehicles

Energy storage systems, usually batteries, are essential for hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and all-electric vehicles (EVs).

Types of Energy Storage Systems

The following energy storage systems are used in HEVs, PHEVs, and EVs.

Lithium-Ion Batteries

Lithium-ion batteries are currently used in most portable consumer electronics such as cell phones and laptops because of their high energy per unit mass relative to other electrical energy storage systems. They also have a high power-to-weight ratio, high energy efficiency, good high-temperature performance, and low self-discharge. Most components of lithium-ion batteries can be recycled, but the cost of material recovery remains a challenge for the industry. The U.S. Department of Energy is also supporting the Lithium-Ion Battery Recycling Prize to identify

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solutions for collecting, sorting, storing, and transporting spent and discarded lithium-ion batteries for eventual recycling and materials recovery. Most of today's PHEVs and EVs use lithium-ion batteries, though the exact chemistry often varies from that of consumer electronics batteries. Research and development are ongoing to reduce their relatively high cost, extend their useful life, and address safety concerns in regard to overheating.

Nickel-Metal Hydride Batteries

Nickel-metal hydride batteries, used routinely in computer and medical equipment, offer reasonable specific energy and specific power capabilities. Nickel-metal hydride batteries have a much longer life cycle than lead-acid batteries and are safe and abuse tolerant. These batteries have been widely used in HEVs. The main challenges with nickel-metal hydride batteries are their high cost, high self-discharge and heat generation at high temperatures, and the need to control hydrogen loss.

Lead-Acid Batteries

Lead-acid batteries can be designed to be high power and are inexpensive, safe, and reliable. However, low specific energy, poor cold-temperature performance, and short calendar and cycle life impede their use. Advanced high-power lead-acid batteries are being developed, but these batteries are only used in commercially available electric-drive vehicles for ancillary loads.

Ultracapacitors

Ultracapacitors store energy in a polarized liquid between an electrode and an electrolyte. Energy storage capacity increases as the liquid's surface area increases. Ultracapacitors can provide vehicles additional power during acceleration and hill climbing and help recover braking energy. They may also be useful as secondary energy-storage devices in electric-drive vehicles because they help electrochemical batteries level load power.

6.5 Drive Train:

Hybrid vehicle drive trains transmit power to the driving wheels for hybrid vehicles. A hybrid vehicle has multiple forms of motive power. Hybrids come in many configurations. For example, a hybrid may receive its energy by burning gasoline, but switch between an electric motor and a combustion engine.

Different Types of Hybrid Drive Trains

- A **hybrid vehicle** uses two or more distinct types of power, such as:

- an internal combustion engine and batteries or ultracapacitors in diesel hybrid vehicles.
- a fuel cell and batteries in fuel cell hybrid vehicles.
- an overhead electric line and batteries in Trolley hybrid buses.

- There are two different types of hybrid systems:

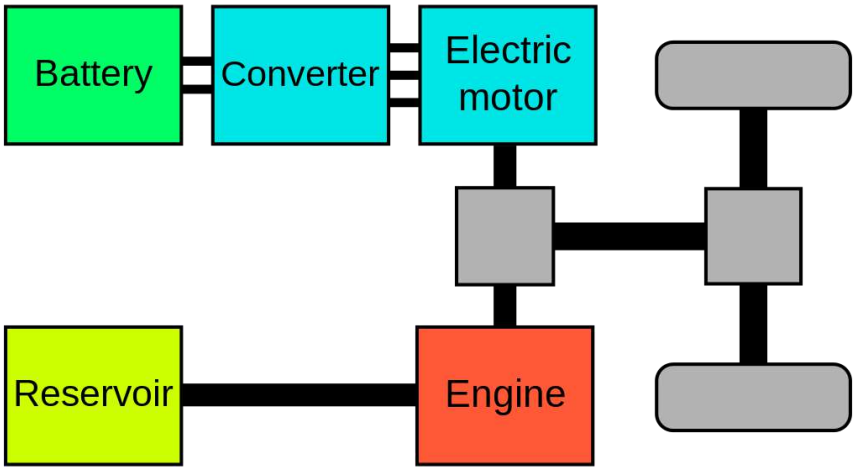
- parallel and series hybrids

Parallel hybrid

Parallel hybrid systems have both an internal combustion engine and an electric motor that can both individually drive the car or both coupled up jointly giving drive. This is the most common hybrid system as of 2016. If they are joined at an axis (in parallel), the speeds at this axis must be identical and the supplied torques will add together (most electric bicycles are of this type). When only one of the two sources is in use, the other must be connected via a one-way clutch or freewheel so it can rotate freely.

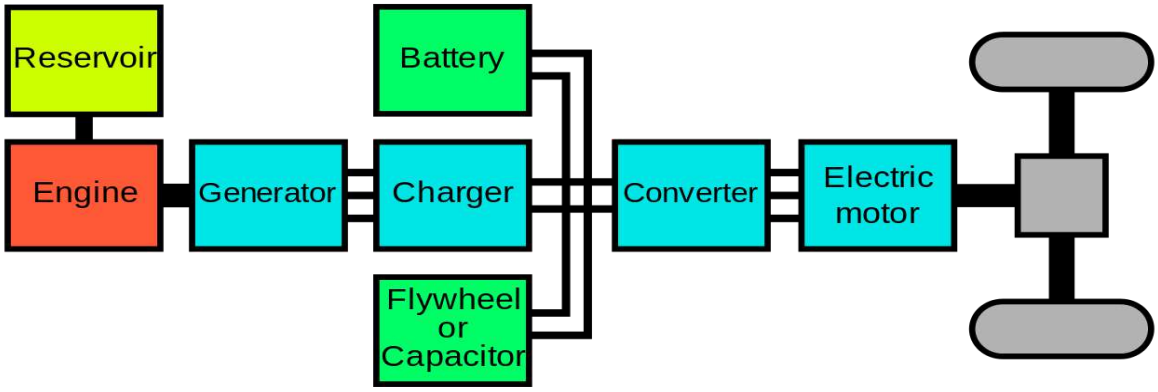
- In a **parallel hybrid bus,** the combustion engine and the electric motor are connected to the transmission independently. The electric motor is designed to provide power during stop-

and-go traffic while at highway speeds the vehicle is powered solely by the internal combustion engine. During acceleration, both the electric motor and the combustion engine power the transmission.

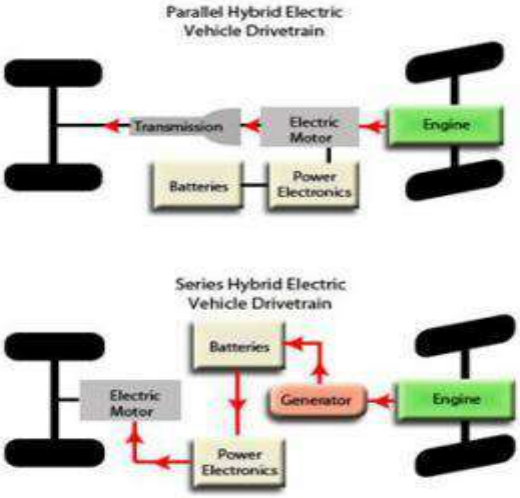


Series hybrid

Structure of a series-hybrid vehicle. The grey square represents a differential gear. An alternative arrangement (not shown) is to have electric motors at two or four wheels. Series hybrids are also referred to as extended-range electric vehicles (EREV)[5] or range-extended electric vehicles (REEV), or electric vehicle with extended range (EVER). (Series hybrids with particular characteristics are classified as range-extended battery-electric vehicle (BEVx) by the California Air Resources Board. Electric transmission has been available as an alternative to conventional mechanical transmissions since 1903. Typically, mechanical transmissions impose many penalties, including weight, bulk, noise, cost, complexity and a drain on engine power with every gear-change, whether accomplished manually or automatically. Unlike ICEs, electric motors do not require a transmission.



- **A series hybrid bus** is exclusively propelled by the electric motor. In a series hybrid bus, the internal combustion engine (ICE) is connected to an electric generator which converts the energy produced by the ICE into electric power. This electricity powers a motor which turns the wheels of the vehicle. The generator also recharges a battery pack which provides supplemental power to the motor. Since the ICE is not connected to the wheels, it can operate at an optimum rate and can even be switched off for short periods of time for a temporary all-electric operation of the bus.



6.6 Solar Powered Vehicle

A solar car is a solar vehicle used for land transport. Solar cars usually run on only power from the sun, although some models will supplement that power using a battery, or use solar panels to recharge batteries or run auxiliary systems for a car that mainly uses battery power.

Solar cars combine technology typically used in the aerospace, bicycle, alternative energy and automotive industries. The design of a solar vehicle is severely limited by the amount of energy input into the car. Most solar cars have been built for the purpose of solar car races. Some prototypes have been designed for public use, and the Lightyear One solar charged battery electric vehicle is expected to be available starting in 2021; currently, no cars primarily powered by the sun are available commercially

Solar cars depend on a solar array that uses photovoltaic cells (PV cells) to convert sunlight into electricity. PV cells directly convert sunlight into electricity. When sunlight (photons) strike PV cells, they excite electrons and allow them to flow, creating an electric current. PV cells are made of semiconductor materials such as silicon and alloys of indium, gallium and nitrogen. Crystalline silicon is the most common material used and has an efficiency rate of 15-20%.

Solar array:

The solar array consists of hundreds of solar cells converting sunlight into electricity. In order to construct an array, PV cells are placed together to form modules which are placed together to form an array. The larger arrays in use can produce over 2 kilowatts (2.6 hp).

Batteries
The battery pack in a typical solar car is sufficient to allow the car to go 250 miles (400 km) without sun, and allow the car to continuously travel at speeds of 60 mph (97 km/h).
Motors
The motors used in solar cars typically generate about 2 or 3 horsepower, yet experimental light solar cars may attain the same speed as a typical family car (100 mph (160 km/h)).
Telemetry
To keep the car running smoothly, the driver must monitor multiple gauges to spot possible problems. Cars without gauges almost always feature wireless telemetry, which allows the driver's team to monitor the car's energy consumption, solar energy capture and other parameters and thereby freeing the driver to concentrate on driving.

Cars for public use
The first solar family car was built in 2013. Researchers at Case Western Reserve University, have also developed a better solar car which can recharge more quickly, due to better materials used in the solar panels.
Chinese solar panel manufacturer Hanergy plans to build and sell solar cars equipped with lithium-ion batteries to consumers in China. Hanergy says that five to six hours of sunlight should allow the cars' thin-film solar cells to generate between 8-10 kWh of power a day, allowing the car to travel about 80 km (50 mi) on solar power alone. Maximum range is about 350 km (217 mi).

POSSIBLE SHORT TYPE QUESTIONS WITH ANSWERS

1. What Are the Social and Envv. Importance Of Hybrid and Electric Vehicles?
   - Ans- The main reasons for the need of electric vehicles are:
   - Depletion of oil reserves
   - Stringent emission standards
   - Noise pollution
2. What are the advantages of using electric vehicle?

Ans- **Advantages: -**

- No emission while running.
- Silent
- No gas or oil changes

- Ability to conveniently charge at home
- Fast and smooth acceleration
- Low cost of operation
- Instant and high torques, even at low speed

3- what are the operational advantage of electric vehicle ? 2024 {s}

- Ans –
- No emission while running.
- Silent
- No gas or oil changes
- Ability to conveniently charge at home
- Fast and smooth acceleration
- Low cost of operation
- Instant and high torques, even at low speed

4-What do you understand by Hybrid vehicle ? 2024 {s}

The vehicle which uses more than energy sources to move is called hybrid vehicle .such as electric motor and an internal combustion engine.

POSSIBLE LONG TYPE QUESTIONS

1. What is electric vehicle. state its applications and advantages?
2. Explain solar powered vehicle?2024 {s}
3. What is hybrid vehicle and explain its types?
4. Describe the operational advantages ,present performance and application of electric vehicle .2024 {s}

Surajit Sinha