

LEARNING MATERIAL OF
AUTOMOBILE ENGG & HYBRIDE VEHICLE
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CHAPTER – 1

Q. State types of Auto Vehicles(2007 (w) (1-a),2015 (1-a))

Ans: According to purpose [Passenger vehicles
Good vehicles

According to Capacity [Light vehicles
Heavy vehicles

According to no. of wheels [Two wheeler
Three wheeler
Four wheeler
Six wheeler

According to Fuel used [Petrol vehicle
Diesel vehicle
Electric vehicle
Steam carriage

Q. Write various systems of a vehicle.[2017(s)(2-a)]

Ans:-

- The Power generation system
- The Transmission system
- The Fuel System.
- The Ignition System
- The Electrical System
- The Exhaust System
- The Suspension and Steering Systems.
- The Braking System.

Q. State the manufacturers specification of Auto engines of a motor cycle. 2012(w) , 1(b), 2016 , 1(a)

Ans:BAJAJ PULSAR 220 F

Engine Type : 4 stroke, Petrol, Single Cylinder , DTS-i

Displacement : 220 cc

Max. Power : 21.05 PS @ 8500 rpm.

Max. Torque : 19.12 N-m @ 7000 rpm

Transmission : 5 speed, Constant mesh.

Cooling : Oil cooled.

Q. Define Automobile [2017(s) (1-a) 2010(s) (1-i)]

Ans:An Automobile is a self propelled vehicle used for the transportation of passengers and goods upon the ground.

Q. What is Automobile Chassis [2012 (s) 1-a]

Ans:The chassis consists of all the major units to propel the vehicle, direct its motion, stop and run it smoothly upon uneven surfaces.

Q. State the classification of engine on different basis [2017(s)(1-b)2012 (s) 2-a]

Ans:Based on Fuel:

- (i) Petrol Engine
- (ii) Diesel Engine
- (iii) Gas Engine

Based on cycle of operation :

- (i) Otto
- (ii) cycle
- (ii) Diesel cycle
- (iii) Dual cycle

Based on no. of strokes

- (i) 2 stroke engine
- (ii) 4 stroke engine

Based on type of ignition :

- (i) Spark ignition Engine
- (ii) Compression Ignition Engine

Based on No. of cylinder

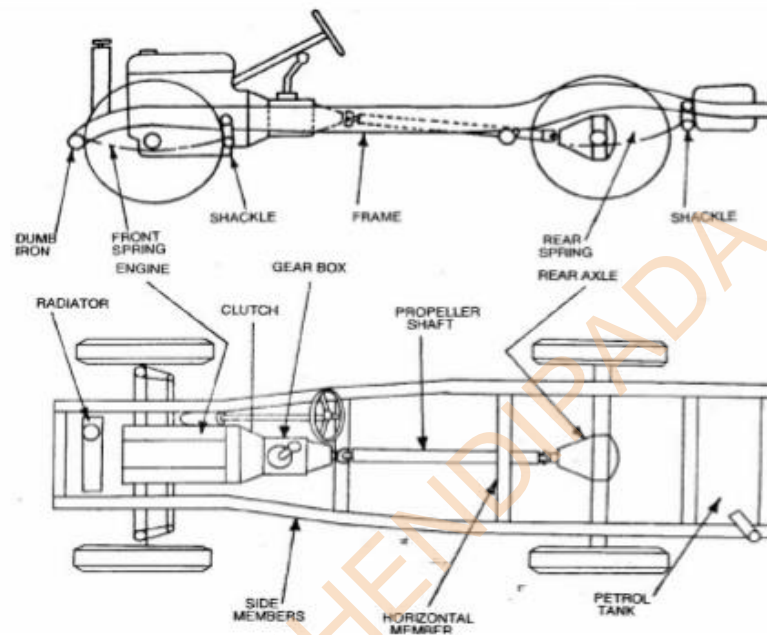
- (i) Single cylinder
- (ii) Double cylinder
- (iii) 3 cylinder
- (iv) 4 cylinder
- (v) 6 cylinder

Q. Explain the layout of Automobile Chassis with major components.

[2017(s) (1-c) 2013(w) 1-c]

Ans:-

Layout of Chassis and its main Components:



Q. What is I.C. Engine?

Ans:Internal combustion engines are those heat engines that burn their fuel inside the engine cylinder. On the other side, external combustion engines are those heat engines that burn their fuel outside the engine cylinder .

CHAPTER:2

Q. Write the function of clutch. [2017(s)(4-a)2008(s), 1-iv]

Ans:The function of clutch is to engage and disengage the engine shaft to the transmission (gear box).

Q. Differentiate between sliding Mesh and Synchromesh Gear box.

[2012(w) , 3(b)]

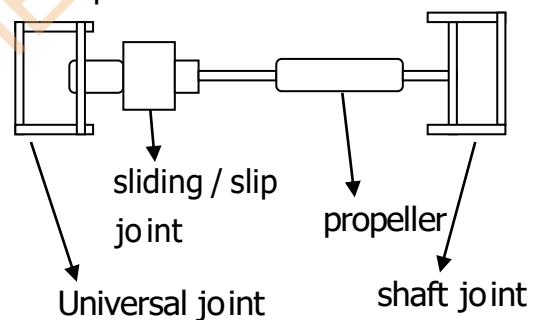
Ans:

Sliding Mesh Gear Box	Synchromesh Gear Box
→ Super gears are used	→ Helical gears are used
→ Produces more noise	→ Produces less noise
→ Synchronizers are not provided	→ Synchronizers are provided.
→ Lifespan is low.	→ Life span is high
→ Engagement of gears is not smooth	→ Gear engagement is smooth

Q. Describe the construction of propeller shaft. [2010(s), 2(e)]

Ans: Propeller shaft is a driving shaft which connects the transmission to the differential. It is made up of three main components.

- i. propeller shaft
- ii. Universal Joint
- iii. Slip/Sliding Joint



The shaft is generally made hollow. It has to withstand the torque and yet it must be light weight. When the length of the shafts is more, two sections of propeller shafts are used supported by a centre bearing and coupled together by a universal joint.

→ The transmission main shaft and differential pinion shaft are at some angle. So there must be some means to transmit the power at some angle. Universal Joint serves this purpose.

→ The transmission and differential are not in one level and this distance changes due to road irregularities. Slip joint compensates change in length.

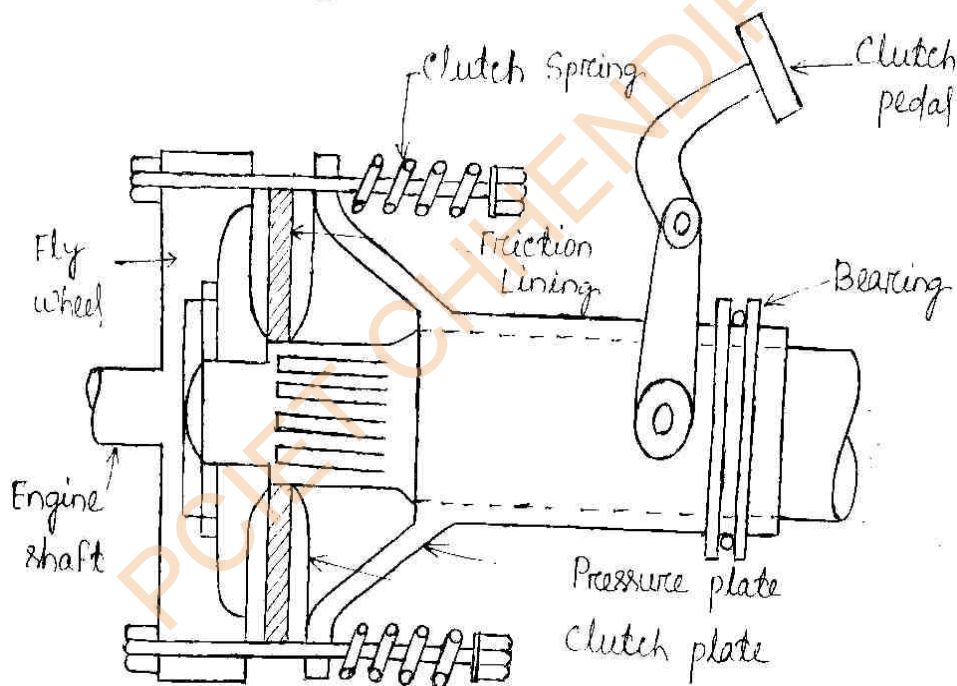
Q. State types of differential used. [2007(w), 1-e]

Ans: Various differentials used are :

- i. Conventional type
- ii. Non – slip type
- iii. Self – locking type

Q. With neat sketch describe the construction and working principle of single plate clutch. [2012(s) q.4]

Ans:



Construction:-

It is the most common type of clutch used in motor vehicles. Basically, it consists of only one clutch plate, mounted on the splines of the clutch shaft. 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.

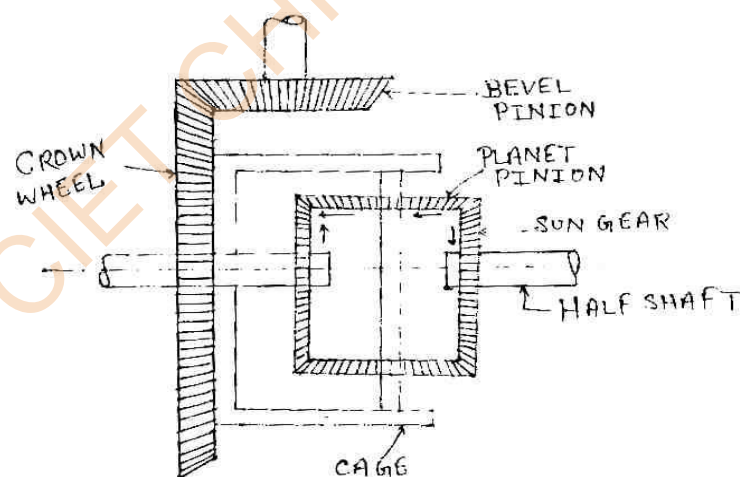
Working Principle:-

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. Due to the friction between the flywheel, clutch plate and pressure plate, the clutch plate revolves with the flywheel. As the clutch plate revolves the clutch shaft also revolves. Clutch shaft is connected to the transmission. Thus, the engine power is transmitted to the crankshaft to the clutch shaft.

When the clutch pedal is pressed, the pressure plate moves back against the force of the springs, 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 shaft speed reduces slowly and finally it stops rotating. As soon as the clutch pedal is pressed, the clutch is said to be disengaged, otherwise it remains engaged due to the spring forces.

Q. With neat sketch describe the construction and working of a conventional type differential with advantage & limitations. [2013(s)]

Ans: Differential is device which is provided at the rear wheel of the vehicle to provide the relative motion between the two rear wheel at the time of taking turn.



Construction :-

Differential is a part of rear axle housing assembly which consists of bevel pinion, crown gear, sun gear and planet gear. The sun gear are mounted on the inner end of each rear axle. A differential cage is assembled on the left axle. A crown gear is attached to the case, so that the cage rotates with the crown gear. The crown gear is driven by bevel pinion. But both the crown

wheel and cage are free on the left rear axle. The cage supports two planet pinions on a shaft which mesh with the two sum gears.

Working:-

When the vehicle moves in a straight line, the crown wheel, differential cage, planet pinion and sum gears all turn as a unit without any relative motion. When the vehicle takes a turn the planet pinions rotate on their axis to permit the outer wheel to rotate at a faster rate than the inner wheel.

Q. Classify Clutches [2014, 4-b]

Ans: Different types of clutches are as follows :

1. Friction clutch:
 - a. Single plate clutch
 - b. Multi plate clutch
 - i. Wet ii. Dry
 - c. Cone clutch
 - i. External ii. Internal
2. Centrifugal clutch
3. Semi-centrifugal clutch
4. Conical spring clutch or Diaphragm clutch:
 - a. Tapered finger type b. Crown spring type
5. Positive clutch – Dog and spline clutch
6. Hydraulic clutch
7. Electro-magnetic clutch
8. Vacuum clutch
9. Over running clutch or free-wheel unit.

Q. Explain working of multi plate clutch with neat sketch [2016, 2-b]

Ans: Multi plate Clutch:-

Multi plate clutch consists of a number of clutch plates, instead of only one clutch plate as in the case of single clutch. As the number of clutch plates are increased, the friction surface also increase. 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 splines 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.

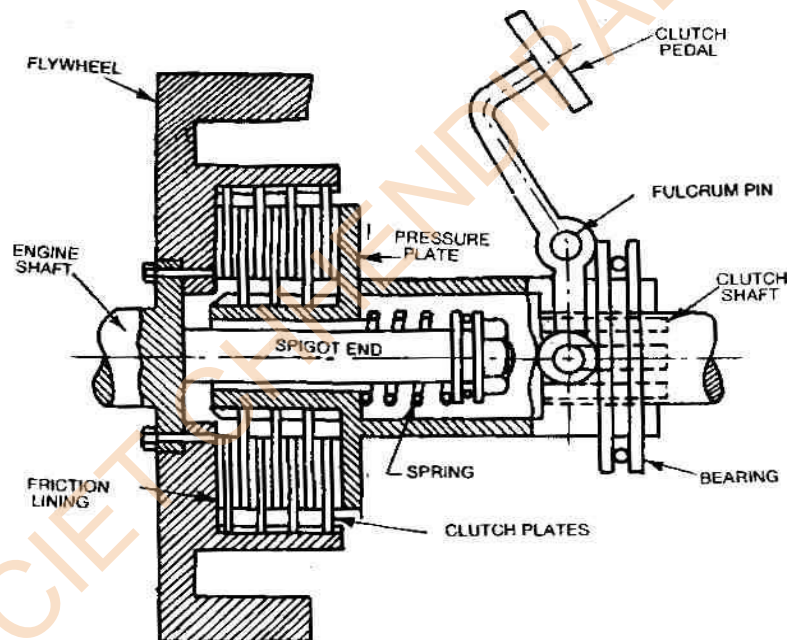
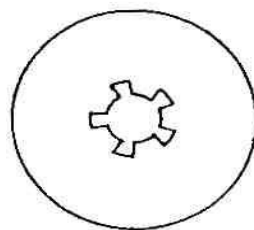
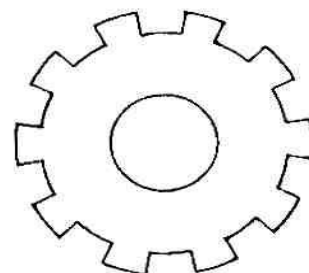


Fig. 22.8 Multiplate clutch



(a)



(b)

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

Q. Describe the working Universal Joint used in car [2014, 5-c]

Ans: An universal joint is used where two shafts are connected at an angle to transmit torque. In the transmission system of a motor vehicle, the transmission main shaft, propeller shaft and the differential pinion shaft are not in one line, and hence the connection between them are made by universal joint. One universal joint is used to connect the transmission main shaft and the propeller shaft, other universal joint is used to connect the other end of the propeller shaft and the differential pinion shaft, thus the connection between the three shafts are flexible and at an angle with each other. The universal joint permits the torque transmission not only at angle, but also while this angle is changing constantly.

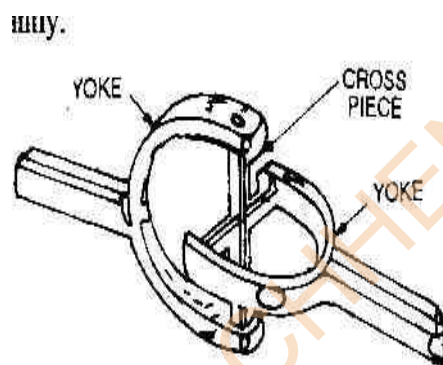


Fig. 25.2. A simple universal joint. (Cross type)

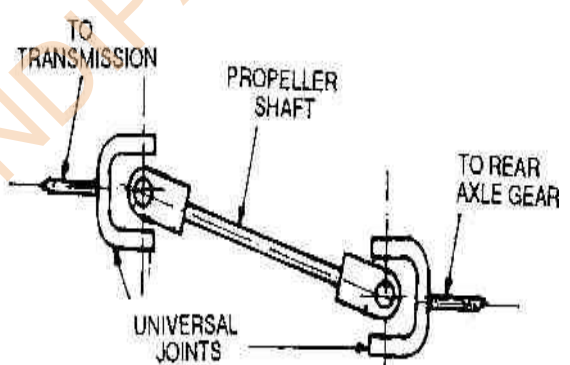


Fig. 25.3. Use of two universal joints.

driving shaft and other on the driven shaft, and a cross-piece called the spider. The four arms of spider, known as trunnions, are assembled into bearing in the ends of the two shaft yokes. The driving shaft and the driven shaft are at an angle to each other, the bearings in the yokes permits the yokes to swing around on the trunnions with each revolutions.

It is to be noted that simple universal joint does not transmit the motion uniformly when the shafts are operating at an angle, except in constant velocity type universal joint. Because the pivot pins do not revolve in the same plane, the driven shaft will increase to a maximum and decrease to a minimum twice in each revolution. Although the degree of variation is small, however, it may be minimized by the use of two universal joints. The two joints are

arranged so that the non-uniform rotation of each joint tends to neutralize that of the other, as shown in fig.

Q. Write different types of Universal Joints.

Ans: The universal joints may be of three types as follows :

1. Cross type or spider and two-yoke type.
2. Ball and turnnion type
3. Constant velocity type.

Q. What is the need of gear box in automobile. [2013, 4-b]

Ans: 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 (tractive 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.

CHAPTER:3

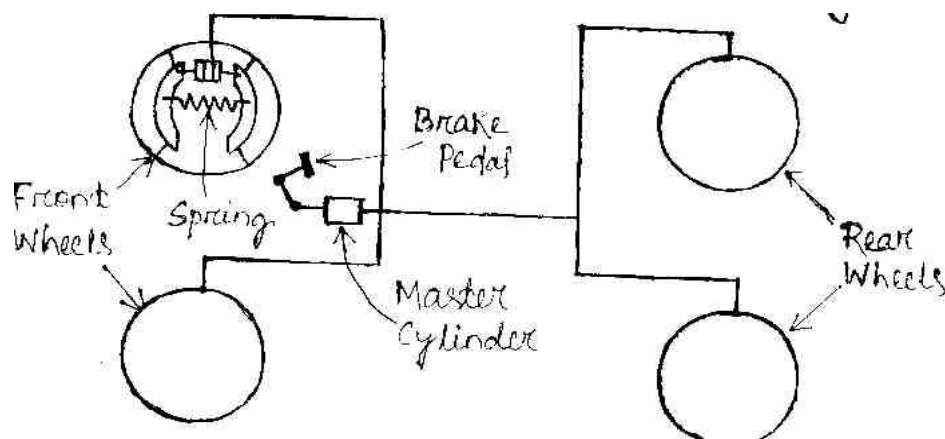
Q. With neat sketch explain the construction and working principle of

(i) Hydraulic braking system

(ii) Air – Assisted hydraulic braking system [2017(s)(3-c)2012

(s), 2009 (s)]

Ans:



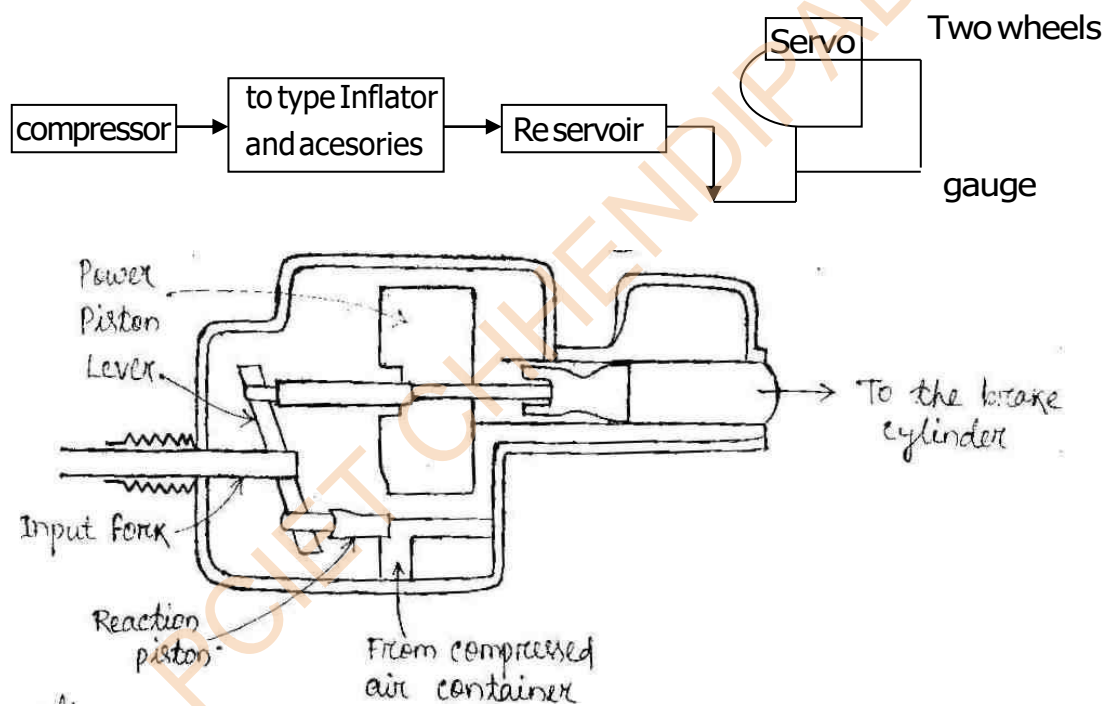
Construction:-

It is operated by hydraulic pressure. The system consists of a master cylinder, four wheel cylinder and brake lines. The system is filled with brake fluid.

Working Principle:-

When the brake pedal is pressed the brake fluid inside the master cylinder is pressurized and that pressure is transmitted to the wheel cylinder through brake lines. The wheel cylinder is connected with two pistons which expand outwards, thus expanding the brake shoe, so the brakes are applied.

Air assisted hydraulic braking system:



Construction :-

It consist of a piston of brake valve is held against the stop 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 behind the piston is connected to the atmosphere through the cross hole in the body.

Working Principle:-

When the brake pedal is depressed by the driver, the input rod moves the lever forward. In this condition the pin joint at the power piston guide acts

as a fulcrum the movement of the level moves the reaction piston and the exhaust passage is closed.

Further movement of the input rod opens the inlet valve 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.

Somewhere 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.

Q. Need of braking system in automobile. [2017(s)(3-a)2013, 6-a]

Ans: 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 vehicle to be retained when descending a hill.

The first function calls for the brakes which can apply large braking torques to the brake drums, while the second calls for brakes that can dissipate large quantities of heat without large temperature rises.

Q. State various types of braking system. [2017(s)(3-b)2014, 6-b]

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

1. With respect to application :
(a) Foot brake (b) Hand brake
2. With respect to the number of wheels :
(a) Two-wheel brakes (b) Four-wheel brakes
3. With respect to the method of braking contact :

- (a) Internal expanding brakes (b) External contracting brakes
4. With respect to the method of applying the braking force :
- (a) Single acting brakes (b) Double acting brakes
5. With respect to the brake gear :
- (a) Mechanical brakes (b) Power brakes
6. With respect to power transmission :
- (a) Vacuum brakes (b) Air brakes
- (c) Hydraulic brakes (d) Hydrostatic brakes
- (e) Electric brakes
7. With respect to power transmission :
- (a) Direct acting brakes (b) Geared brakes
8. With respect to power unit :
- (a) Cylinder brakes (b) Diaphragm brakes

Q. What is Vacuum brake [2016, 3-a]

Ans: In the air brakes the force of brake application is because of the difference of pressures on the opposite sides of the diaphragm. One side of the piston of diaphragm is exposed to the higher pressure while the other to the atmospheric pressure. In fact, it is the potential difference which is utilized to create the braking effect. Similar type of effect can be obtained if one side of the piston or diaphragm is exposed to the atmospheric pressure while the other side to a pressure below the atmospheric pressure. The pressure below atmospheric is obtained by exhausting air from it. This is the principle of vacuum brakes.

Q. What are the materials used in brake lining [2015, 7-a]

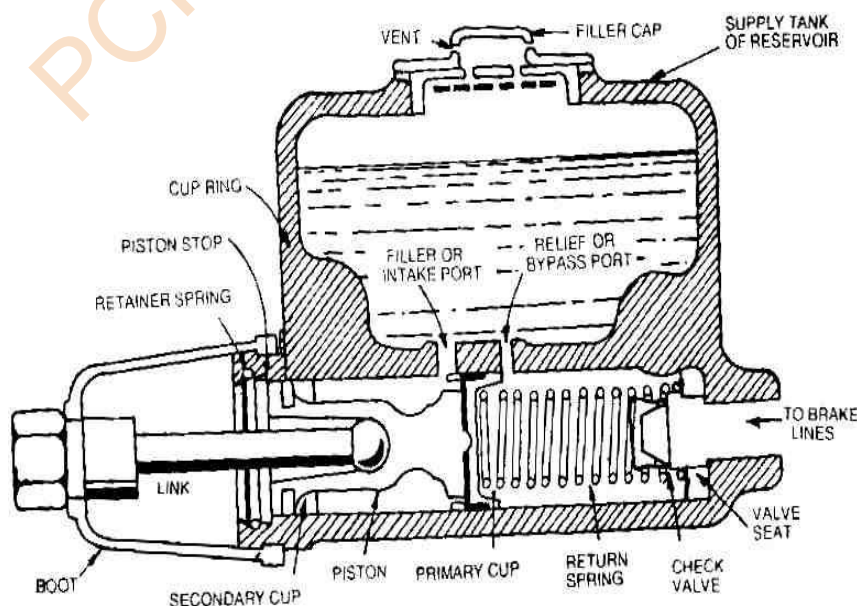
Ans: The brake linings are either of solid woven type of moulded type. The asbestos base non-metallic linings have an average co-efficient of friction of 0.4 upto about 260°C. Their maximum temperature resistance is about 350°C. Zinc wire lining have better resistance to wear than the non-metallic type. Also zinc services to conduct some heat away from the working surface. Moulded type linings are prepared directly from the mix which contains asbestos fibres,

together with resin powders and fillers. These linings have good wear resistance. Their maximum temperature resistance is about 450°C. The average co-efficient of friction is 0.4

Q. Explain of master cylinder with neat sketch. [2014, 5-c, 2015, 7-b]

Ans: The master cylinder is the heart of the hydraulic brake system. It consists of two main chambers – the fluid to supply to the brake system, and the compression chamber in which the piston operates. The reservoir supplies fluid to the brake system through two parts. The larger port is called the filler or intake part and is connected to the hollow portion of the piston between the primary and secondary cups which act as piston seals. The smaller port is called relief, bypass or compensating port which connects the reservoir directly with the cylinder and lines when the piston is in the released position. The reservoir is vented to the atmosphere so that the atmospheric pressure causes the flow through the filler port. The vent is placed in the filler cap. The boot covers the push rod and the end of the cylinder to keep it free from foreign matter.

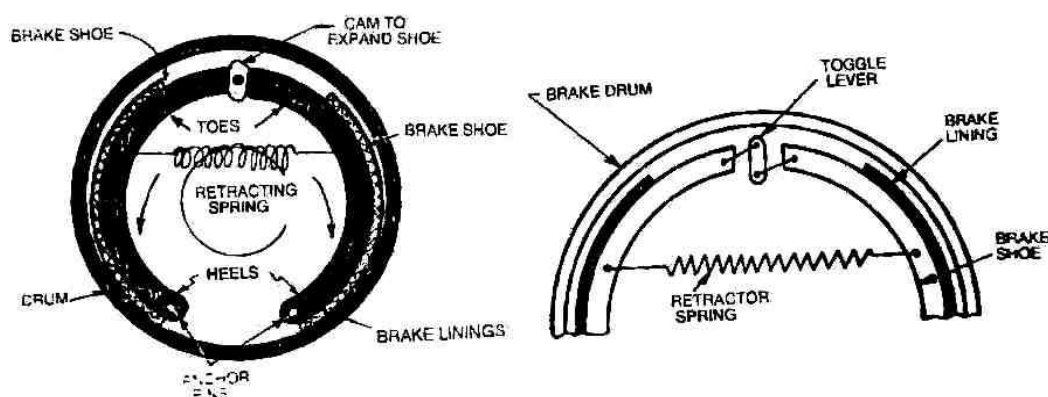
When the brake pedal is depressed, the master cylinder piston moves forward to force the liquid under pressure into the system. The relief port is sealed out of the system. The liquid pressure is conducted to the wheel cylinders, where it forces the wheel cylinder pistons outwards. These pistons force the brake shoes out against the brake drums.



When brake pedal is released, the return spring quickly forces the master cylinder piston back against the piston stop. Because the fluid in the lines returns rather slowly, a vacuum tends to form in the cylinder in front of the piston. This causes the primary cup to collapse to allow the liquid to flow from the reservoir through the filler port past the piston to fill the vacuum. When the pedal is in "off" position, the liquid may flow from the reservoir through the relief port in the master cylinder, supply lines, and wheel cylinders to make up for any fluid that may be lost or to compensate for shrinkage cooling of the liquid. In this way, a complete column of liquid is always maintained between the master cylinder piston and wheel cylinder pistons.

Q. Describe working of mechanical brake [2016, 3-b]

Ans: In a motor vehicle, the wheel is attached to an auxiliary wheel called drum. The brake shoes are made to contact this drum. In most designs, two shoes are used with each drum to form a complete brake mechanism at each 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 linings 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, then cam turns by means of brake linkage. When the cam turns, the shoes expands outwards against the drum. A toggle lever is also used for the same purpose, as shown in fig. The brake linings rub against the drum and thus stop its motion. The entire mechanical linkage between the brake pedal and the shoes operates to transmit pedal force to the brake shoes and to multiply that force through leverage to produce effective braking forces against the drum.

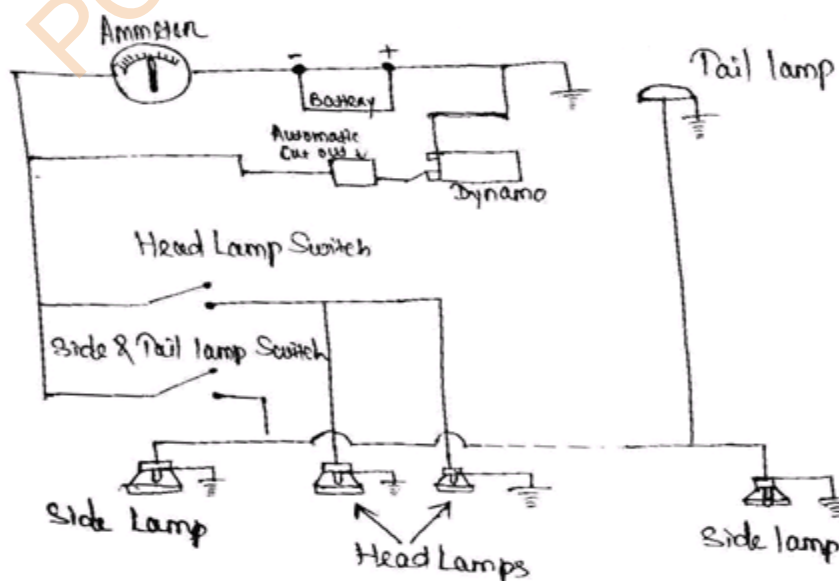
CHAPTER : 04

Q. Define hot and cold plug. [2012 (s), 2011 (s), 2009(s),]

Ans: According to the operating temperature the spark plugs are classified as hot and cold plugs. The hot plug has a longer path of heat dissipation thereby running at higher temperature than the cold plug. A hot plug is generally used in medium duty, low speed and cold operating conditions while the cold plug is used in heavy duty, high speed engines where high temperatures are encountered. It has experienced that a hotter plug gives better performance in burning of the depositors inside the chamber.

Q. Draw and explain the wiring diagram of lighting circuit of an automobile. [2017(s)(4-c)2012 (s), 2008 (s), 2016, 4-c, 2015, 6-c]

Ans:

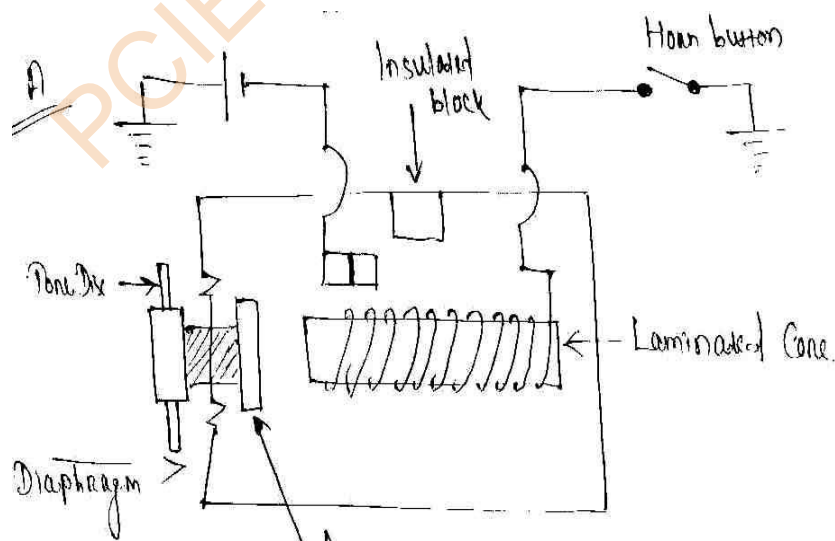


All the electrical components provided on the vehicle have supply from the battery as well as from the dynamo. Therefore each component needs two paths, one for supply and the other for returning the current to the battery. There are two methods of wiring, one is called double pole system, in which a pair of wires is led to every component and the other is earth return system in which the current is led to the component through a wire and returned through the chassis frame of the vehicle.

Referring to the figure in the earth returned single pole wiring system, the limited wire is needed for supplying the current and other terminal of the component is earthed nearby. Therefore second system is very cheaper and remains fairly complex and a colored cable system is used to assist in identification. In this system positive terminal of the battery is usually earthed instead of the negative one. In vehicle for warning lights a switch is provided which operates mechanically by means of brake pedal. Sometimes it is also incorporated in the hydraulic system and operated by hydraulic pressure, when the brake pedal is depressed.

Q. Draw the line diagram of a horn consist of an auto electric system with functional detail [2011 (s), 2008(s)]

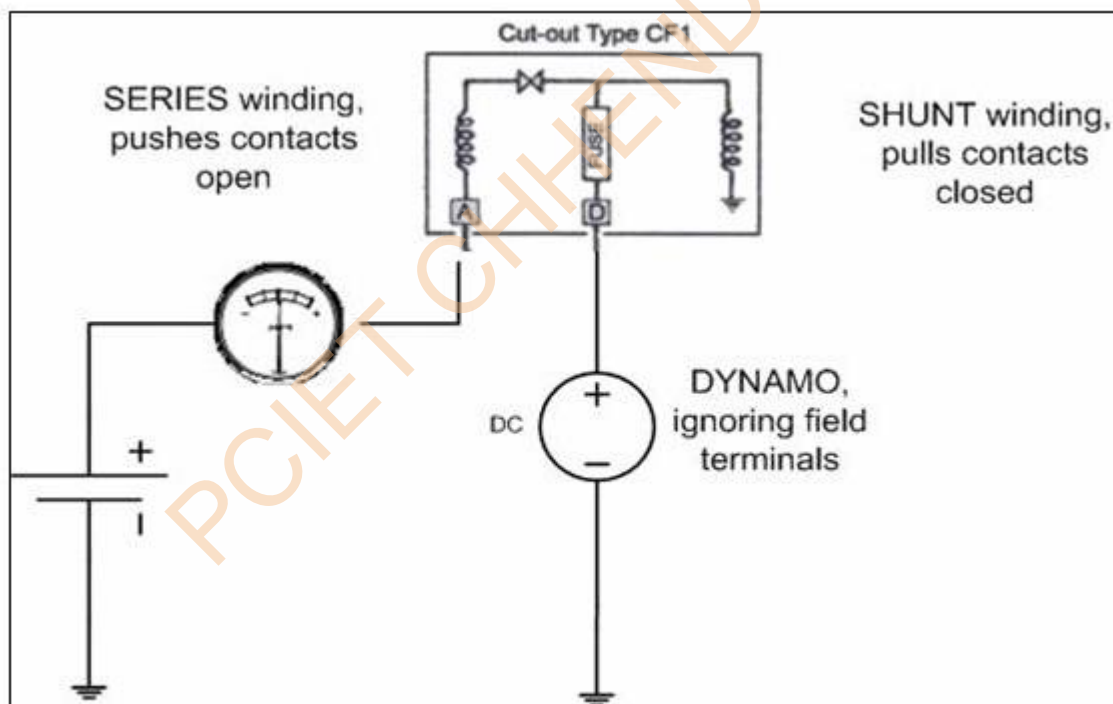
Ans:



An electric horn consists of an electro magnet, an armature connected with a flexible diaphragm and a tone disc. A strip is provided with the armature to disconnect the breaker points.

The working principle is that when the horn button is pressed, The battery high current passes around the solenoid, thereby magnetising the laminated cone . thus attracting the laminated core thus attracting the armature. This movement of the armature disconnects the points thereby collapsing the magnetic field and returning the armature to its original position under which re-contacting the points. This cycle remains continue thereby vibrating the diaphragm and producing required tone by means of the toned dsc.

Q. Briefly explain the cutout circuit with wiring diagram. [2010,2008 (s)]



Referring to figure the system consists of an electromagnet connected in the generator circuit by means of series and shunt windings as shown. When the generator develops sufficient pressure to charge the battery then the magnet attracts an armature against a spring and thereby closing the circuit between the

generator and the battery and which will so open the circuit when the battery pressure becomes greater than that developed in the generator.

Q. Specify a Spark Plug [2013, 4-a]

Ans: SPARK PLUG DATA

Type M12-13/225
 Thread (metric) M14 × 1.25
 Eletrode gap. 0.7 mm.

MICO SPARK PLUG RECOMMENDATION CHART

Vehicle	Recommended Plug	Gap mm
DODGE/FORGO 14 mm	W 95 T3	0.6
1960 onward 14 mm head	M 145 T3	0.6
18 mm head	M 145 Z1	0.6
HINDUSTAN Ten		
Landmaster	W 145 RI	0.6
Ambassador (side valve engine)		
Ambassador Mh II	W 160 Z2	0.6
Baby Hindustan	W 175 T2	0.6
HINDUSTAN BEDFORD		
500 cu. in	W 145 T3	0.6
230 cu. In (Chev)	W 169 Z2	0.6
JEEP	W 145 T3	0.7
NISHAN Jeep	W 175 T2	0.6
NISHAN Truck	W 175 T2	0.6
PREMIER Padmini	W 175 ZI	0.6
PREMIER		
Poineer		
14mm	W 145 T3	0.6
18 mm	W 145 TI	0.6
STANDARD		
Gazel and Herald	W 160 Z2	0.6

Q. State Function of Spark Plug [2016, 4-a]

Ans: 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 electrode.
2. Ground electrode or outer electrode.
3. Insulation separating the two electrodes.

Q. State the common ignition troubles and remedies [2017(s)(4-b)2016, 4-b]

Ans: Causes and remedies

1. Battery discharged – Change battery.
2. Battery defective – Test and replace if necessary.
3. Battery cable(s) defective or undersize for given duty – Replace cable(s).
4. Battery cable connection loose, corroded or poorly fitted – Repair as required.
5. Battery installed with reverse polarity – Switch battery cable hook up to terminals.
6. Starter motor not the right one – Install proper starter motor.
7. Starter motor defective – Repair or replace.
8. Starter motor solenoid or switch defective – Repair or replace solenoid or switch.
9. Starter motor improperly grounded – clean and or secure starter mounting.
10. Starter motor pinion binding against flywheel teeth – Repair as required.
11. Flywheel teeth flattened – Replace flywheel or flywheel ring gear.
12. Neutral safety switch improperly adjusted or defective – Adjust or replace safety switch.

13. Ignition switch defective (key start systems) – Replace switch.
14. Wiring between ignition switch and solenoid defective – Repair or replace wires.
15. Ignition timing advanced too far at cranking speed – Adjust ignition timing.
16. Motor oil or transmission oil (manual shift transmission) too thick – Replace oil, thin with lighter or allow to warm.

CHAPTER : 5

Q. Explain with neat sketch the working principle of telescopic shock Absorber.

Ans: Main parts

1. Chasis eye
2. Head
3. Piston rod grand
4. Inner cylinder
5. Piston cylinder
6. Procting cover
7. Reservoir
8. Axle eye
9. Foot valve
10. Inner ring of holes
11. Inner ring of holes
12. Outer ring of holes

Construction :-

It consist of an inner fitted with head at the open mouth. The head is also screwed into the outer reservoir. Which is fixed to the eye by means of which the reservoir is screw to the axle. The piston is screwed to the piston rod which is fixed to the another eye. By which it is secured to the frame. The outer part such as piston rod and reservoir are covered with the proactive cover which is fixed with the eye and the rod.

Working :-

- i. The inner cylinder is completely filled with fluid and the reservoir is half filled.
- ii. When the axle eye is moved upward the fluid must be displaced from the bottom side to the top side of the piston.
- iii. Under this condition the fluid will pass through the outer ring of the holes by opening the valve disc.
- iv. In this condition when the upper portion of the cylinder is filled fully or has less space then the fluid will also be displaced through the inner ring of holes of the foot valve and the level of the fluid in the reservoir will rise.
- v. Similarly when the axle eye is moved down ward then the fluid will be displaced from top side to the bottom side of the piston.
- vi. Under this condition the fluid will pass through the inner ring of the holes by opening the valve disc.
- vii. The vacuum of the inner cylinder is filled by the fluid displacement of reservoir.

Q. State Specification of a tyre [2017(s)(5-a)2016, 5-a, 2015, 3-a]**Ans: TYRE SIZE**

Every tyre is marked with its size. Let us see what is the meaning of this marking. If a tyre is marking with

$$8.25 \times 20 \times 10 \text{ PR.}$$

It means:

1. The width or thickness of tyre from shoulder to shoulder is 8.25"
2. Diameter of the bead circle, which fits on the rim, is 20"
3. PR means ply rating 10 PR means the tyre consists of 10 plies. Scooter tyres consists of 1 to 4 plies, car tyres 4 to 6 plies, light truck tyres 6 to 10 plies and truck tyres 10 to 22 plies. The number of plies makes the tyre hard to resist heavy load. But the hard tyre does not absorb road shocks.

Q. What are the common causes of tyre wear[2017(s)(5-b)]

Ans: Causes of Tyre wear

1. Incorrect inflation
2. Incorrect castor, camber, or to –in
3. excessive braking or violent acceleration
4. Worn steering mechanism.
5. Wrong king pins
6. Out of balance wheel.
7. Misalignment
8. Over-loading
9. Wrong loading.
10. Defective brakes
11. Toe out incorrect on turn.
12. Bleeding of air in tyre
13. Careless driving
14. Unequal tyres.
15. Incorrect rotation of tyres.

Causes of irregular tyre wear

Fault	Causes
1. Local rapid wear	Oval or eccentric brake drums, or a local increase in tyre stiffness
2. Wear on one shoulder more The other	Excessive wheel chamber misalignment
3. Heel and toe wear on individual Studs.	Road slip in one direction only.
4. One half of the tread circumference More worn than the other half	Unbalancing, in special causes, it may be due to maintaining a uniform and high speed

Q. Explain with neat sketch the constructional features of rear axle used in Indian car. [2013, 5 – c]

Ans: Depending upon the methods of supporting the rear axles and mounting the real wheel, the rear axles are of three types.

1. Semi-floating axle.
2. Full floating axle.
3. Three quarter floating axle.

Misalignment

1. Semi-floating axle.

A semi-floating axle has a bearing located on the axle and inside the axle casting. It has to support all the loads as listed above. Therefore, it needs to be a larger size for the same torque output, than any other type. The inner end of the axle is supported by the differential side gear. It is thus relieved of the job of supporting the weight of the car by the axle housing. The outer end has to support the weight of the car and take end thrust. The inner end of the axle is splined to the differential side gear. The outer end is flanged so that the wheel can be bolted directly to it. In some designs, the hub of the wheel is keyed to the outer end of the axle. The vehicle load is transmitted to the axle through the casing and the bearing, which causes the bending or shearing of the axle. The semi-floating axle is the simplest and cheapest of all other types and widely used on cars.

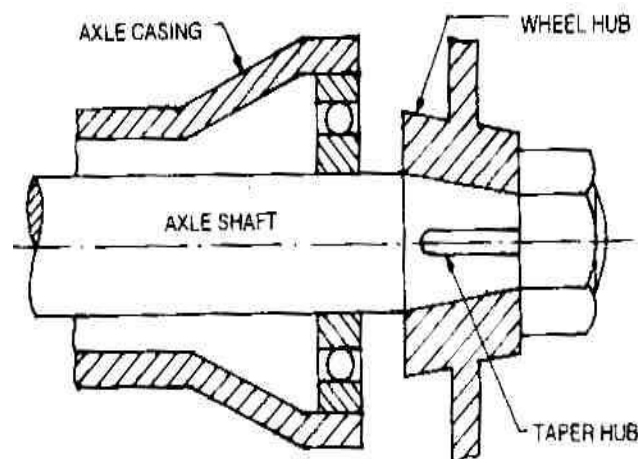


Fig. 26.6. Semi-floating axle.

2. Full floating axle

A full floating axle has two deep-groove ball or taper roller bearings, located between the axle casing and wheel hub. The outer of the axle is made flanged to which the wheel hub is bolted. The axle is not supported by bearings at either end, and its position is maintained by the way that it is supported at both ends. Thus the axle is relieved of all strain caused by the weight of the vehicle on end thrust. It transmits only the driving torque. For this reason, it is called full floating. The axle may be removed from the housing without disturbing the wheel by removing the nuts. An additional advantage of this design is the ability to the vehicle even if it has a broken axle. This type of axle is more expensive and heavier than the other axles. It is usually fitted on commercial vehicles.

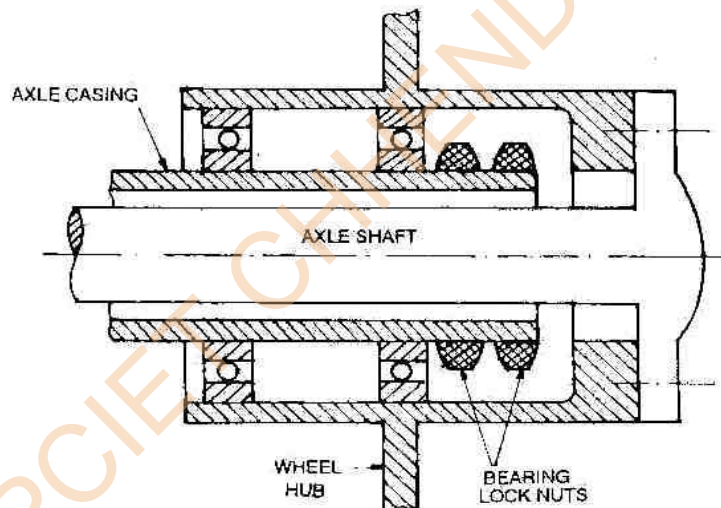


Fig. 26.7. Full floating axle.

3. Three quarter floating axle.

A three quarter floating axle has a bearing located between the hub and the axle casing. Thus the weight of the vehicle is transferred to the axle casing and only the side thrust and driving torque are taken by the axle. The axle is keyed rigidly to the hub, thus providing the driving connection and maintaining the alignment of the wheel. The inner end of this axle has the same construction as that of the semi-floating axle. Although the three quarter floating axle is more reliable but it is not as simple as the semi-floating axle.

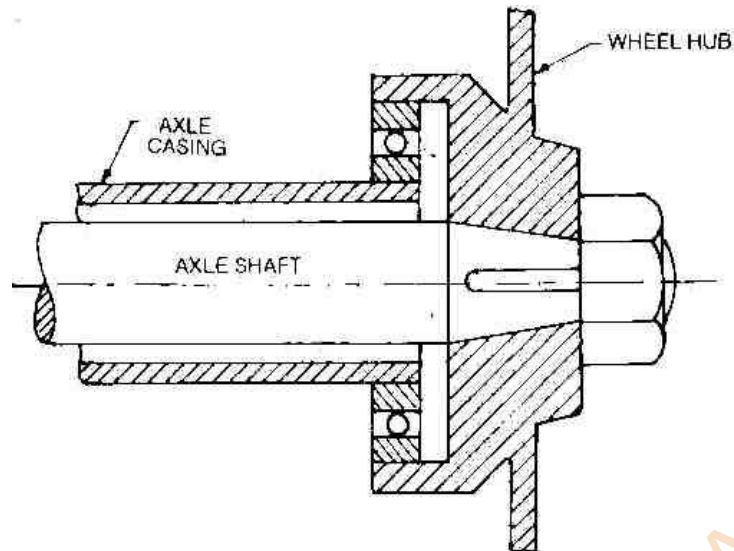
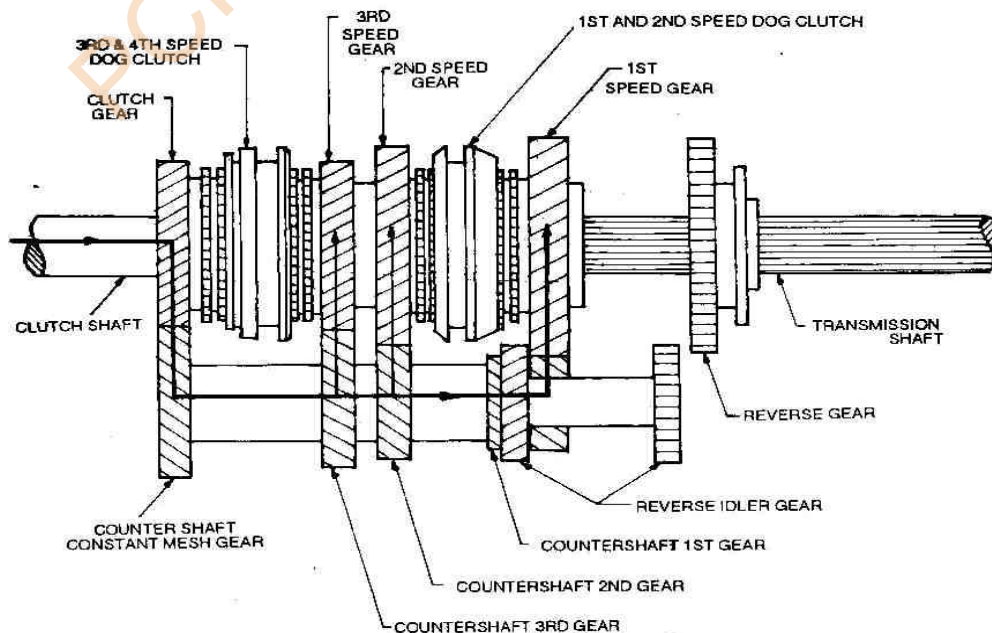


Fig. 26.B. Three quarter floating axle.

Q. Describe working of 4 speed gearbox with neat sketch [2017(s)(2-c)2013,4-c]

Ans: 4-Speed Gear Box

Figure shows the layout of a 4-speed gear box using synchromesh system in all the four forward speeds. Readers will note from the figure that the clutch shaft drives the countershaft drive gear through main drive gear. The first, second and third speed gears on the main shaft are in constant mesh with their corresponding gears on the countershaft. The reverse idler gear and the reverse sliding gear are not in mesh. In this position, the gear box is in neutral since no power is transmitting to the mainshaft.



First Gear : Figure shows the layout of gears transmitting power in first gear. This gear is obtained by shifting the dog clutch to the right thus engaging its internal teeth with the external dog teeth of the first speed gear.

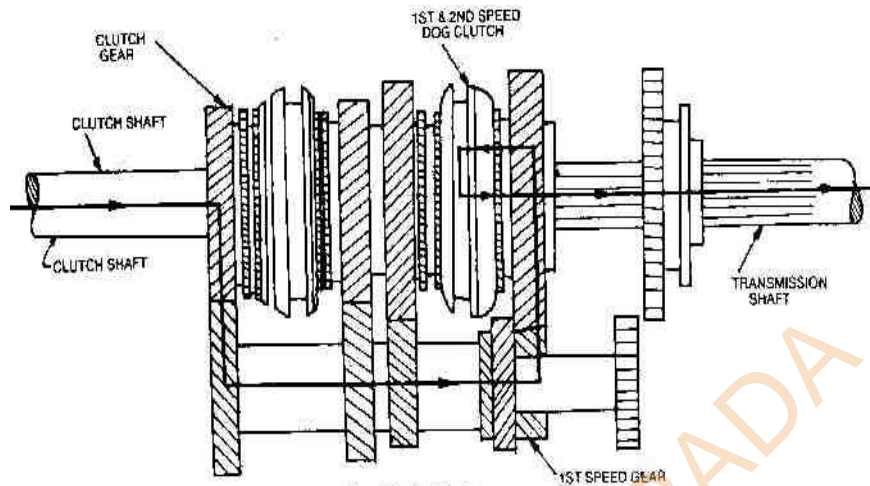


Fig. 23.20. First gear.

Second gear : Figure shows the layout of gears transmitting power in second gear. To obtain this gear, first the 1-2 speed dog clutch 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.

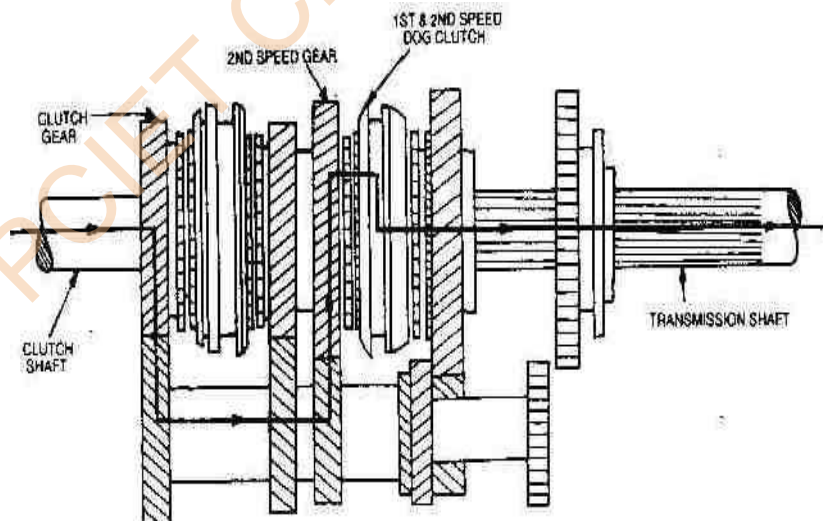


Fig. 23.21. Second gear.

Third gear : Figure shows the layout of gears transmitting power in 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

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

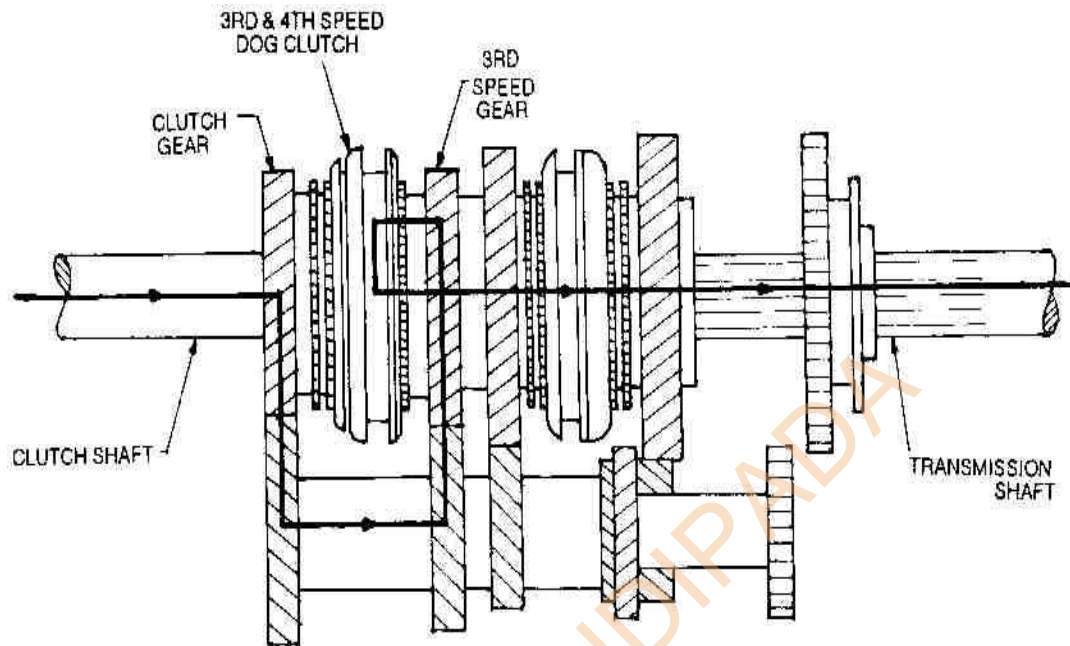
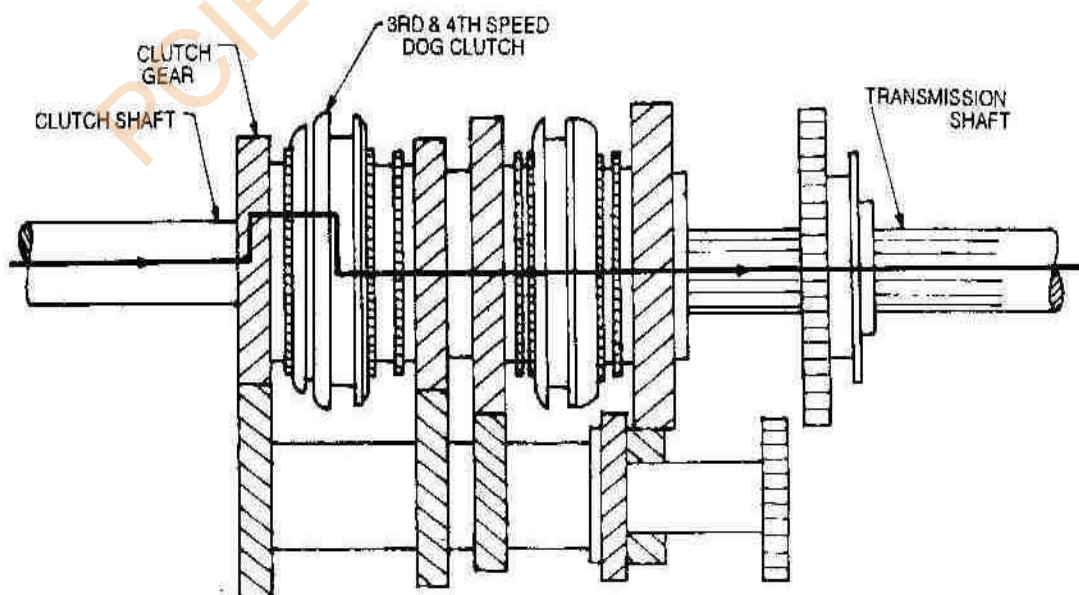
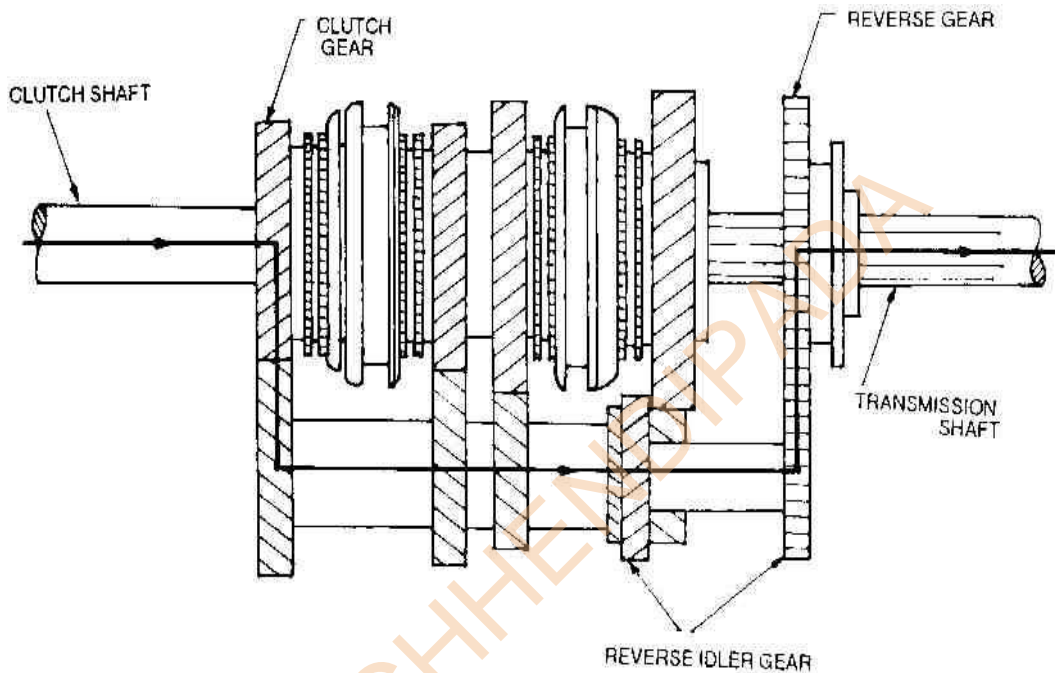


Fig. 23.22. Third gear

Fourth Gear : Figure shows the layout of gears transmitting power if 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



Reverse gear : Figure 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.



Q. Describe working of 3 speed constant mesh gear box with neat sketch. [2015 , 5-b]

Ans: Figure shows the layout of a three-speed gear box with a synchromesh system in its second and top gears. The housing, rotating parts with bearings and the shifting mechanism constitute the gear box. The housing is generally made of cast iron and bolted to the rear of the clutch housing. The housing acts as a container for the oil in which the gears operate. The case cover usually carries the shifting mechanism and it seals the gear box against water and dirt. The dog clutch synchronizer assemblies and bearings constitute the rotating parts. The flow of power during the various gear positions is discussed below.

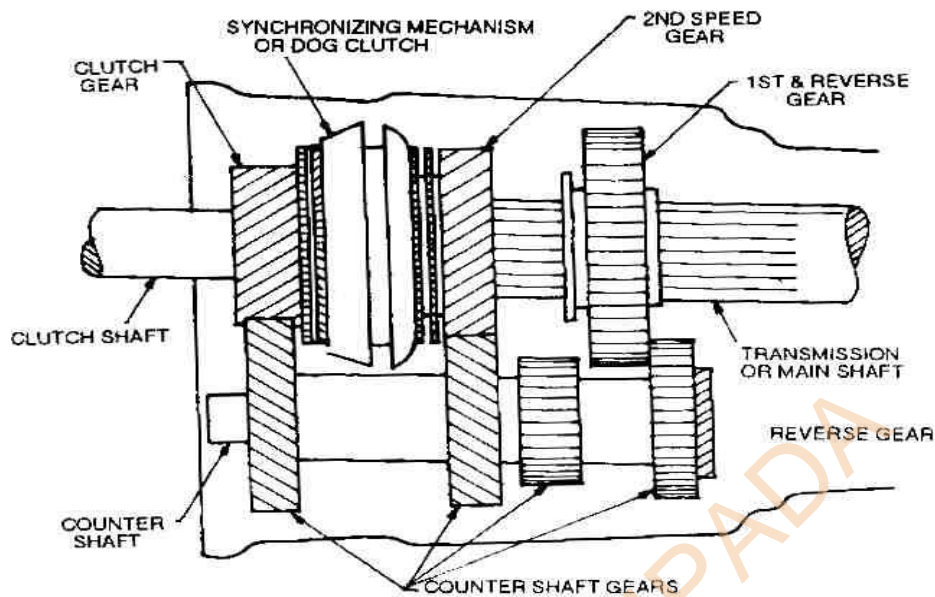
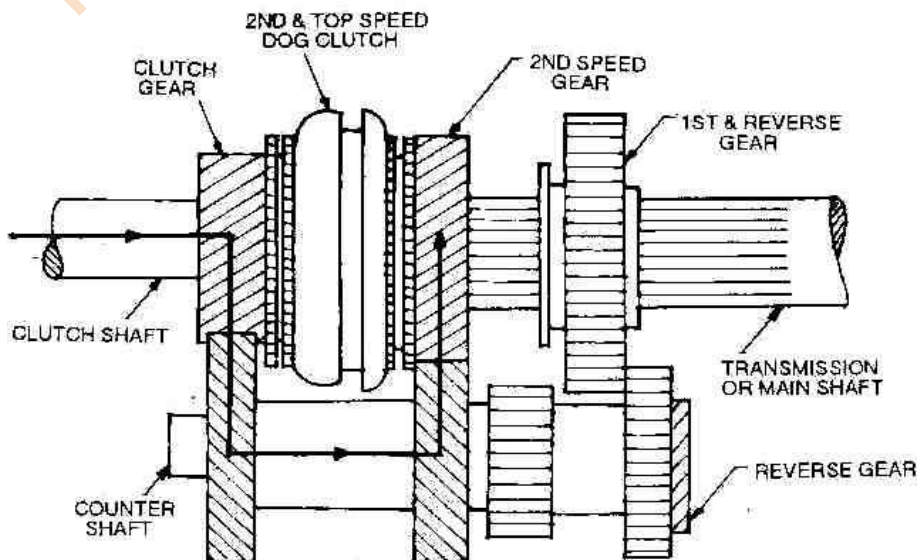


Fig. 23.12. Layout of three-speed gear box.

Neutral Position : figure shows the simplified diagram of a gear box depicting the flow of power in the neutral position. In this position, the gears inside the gear box simply rotate without effecting the main shaft of the gear box. The power transmitted by the clutch simply rotates the main drive gear and countershaft drive gear as well as the second speed gears on the main shaft and countershaft since they are constantly in mesh. The second speed gear on the main shaft is loosely fitted and hence, does not drive the main shaft. All the gears on the countershaft including the reverse gear, rotate, without effecting the main shaft. The bold line depicts the power flow.



First Gear : Figure shows the simplified diagram of a gear box showing flow of power in first gear. This position is obtained by sliding the first and reverse gear to the left unit its teeth mesh with that of the countershaft first gear. In this position, drive is given to the countershaft from the clutch and the main shaft is driven by the first gear, which is splined to it.

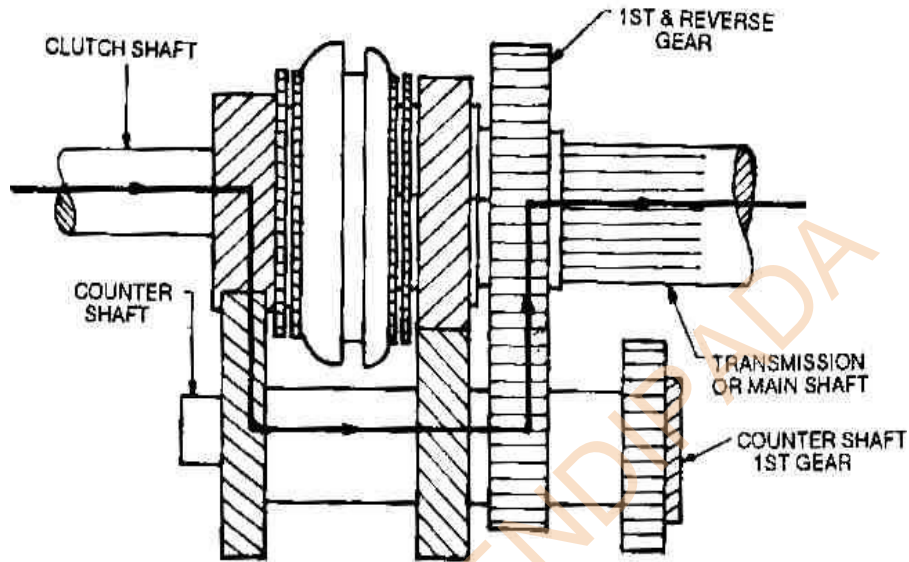


Fig. 23.14. First gear.

Second Gear : Figure shows the simplified diagram of a gear box showing flow of power in second gear. Before obtaining this position, the first gear is slide out of mesh bringing the gear box in the neutral position. After this, the dog clutch is moved to the right side making its internal teeth to mesh with the external teeth of second speed gear. The dog clutch is splined with the main shaft.

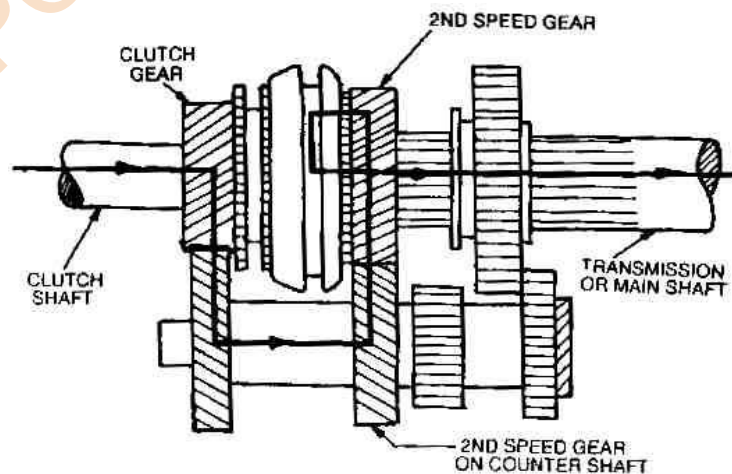


Fig. 23.15. Second gear.

Third or top Gear : Figure shows the simplified diagram of a gear box showing the flow of power in the third gear. This position is obtained by shifting the dog clutch to the left till its internal teeth mesh with the external teeth of the main drive gear. In this position, the main shaft is locked with the clutch shaft, thus making a direct drive.

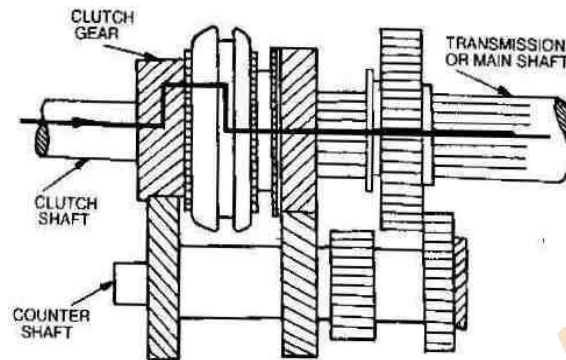
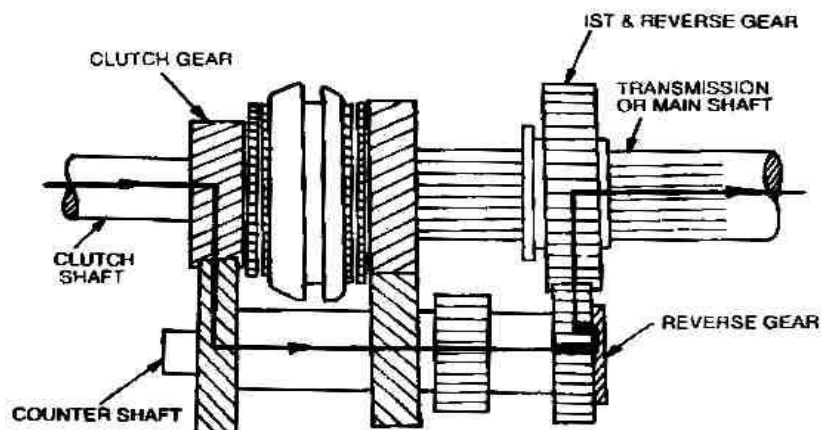


Fig. 23.16 Third gear.

Reverse Gear : Figure shows the simplified diagram of a gear box showing the flow of power in the reverse gear. Before obtaining this gear, the vehicle is brought to rest and the gear box to its neutral position. After this, the first and reverse gear is moved to the left till it meshes with the reverse idler. The second speed gears revolve but transmit no power. In this position, the power is transmitted through the reverse idler to the main shaft by the first reverse gear which is splined to the main shaft, gears on the main shaft are in constant mesh with the corresponding gears on the countershaft. The reverse idler gear and the reverse sliding gears are not in mesh. In this position, the gear box is in neutral since no power is transmitted to the main shaft.



Q. what are the components of transmission system? Explain in brief.[2017(s)(2-b)]

Ans: The power developed inside the engine cylinder is ultimately aimed to turn the wheels so that the motor vehicle can move on the road. The reciprocating motion of the piston turns a crankshaft rotating the fly wheel through the connecting rod. The circular motion of the crankshaft is now to be transmitted to the rear wheels. It is transmitted through the clutch, gearbox, universal joints, propeller shaft or drive shaft, differential and axles extending to the wheels. The application of engine power to the driving wheels through all these parts is called

power transmission. The power transmission system is usually the same on all modern passenger cars and trucks, but its arrangement may vary according to the method of drive and type of the transmission units.

Figure shows the power transmission system of an automobile. The motion of the crankshaft is transmitted through the clutch to the gear box or transmission, which consists of a set of gears to change the speed. From gear box, the motion is transmitted to the propeller shaft through the universal joint and then to the differential through another universal joint. Universal joint is used where the two rotating shafts are connected at an angle for power transmission. Finally, the power is transmitted to the rear wheels through the rear axles. The differential provides the relative motion to the two rear wheels while the vehicle is taking a turn. Thus, the power developed inside the cylinder is transmitted to the rear wheels through a system of transmission.

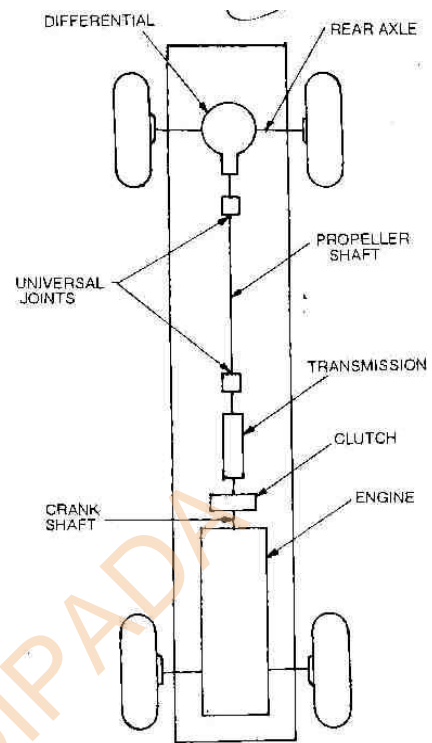


Fig. 22.1. Automobile power transmission system.

Q. Describe independent suspension system used in car. [2017(s)(5-c)2016, 5-c]

Ans: Independent type front suspension.

Practically all passenger cars now use the independent type front suspension system. In this system each front wheel can move up and down freely without affecting or altering the movement of the other front wheel. The front wheel is independently supported by a coil, torsion bar, or leaf spring. The coil spring arrangement is the most common.

There are three types of coil spring independent front suspension arrangements.

1. Coil spring is located between the upper and lower control arms and the lower control arm has one point of attachment to the car frame. In this arrangement, a strut or brake reaction rod, is used to prevent forward or backward movement of the lower control arm. It is attached between the outer end of the lower control arm, and the car frame.
2. Coil spring is located between the upper and lower control arms and the lower control arm has two points of attachment to the car frame. This can be seen in figure.
3. Coil spring is between the upper control arm and spring tower or housing that is part of the front end sheet metal work. This can be seen in fig.

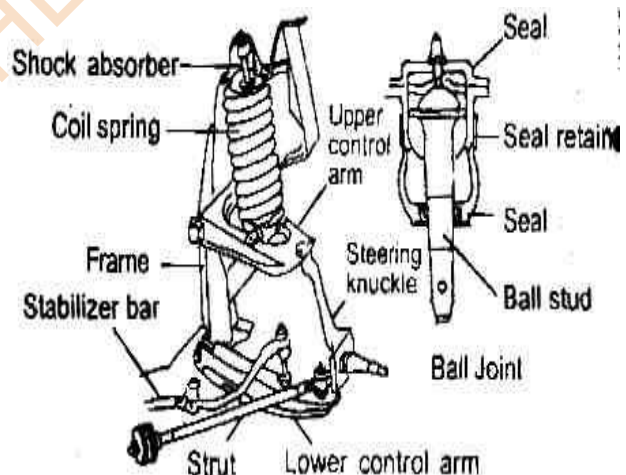
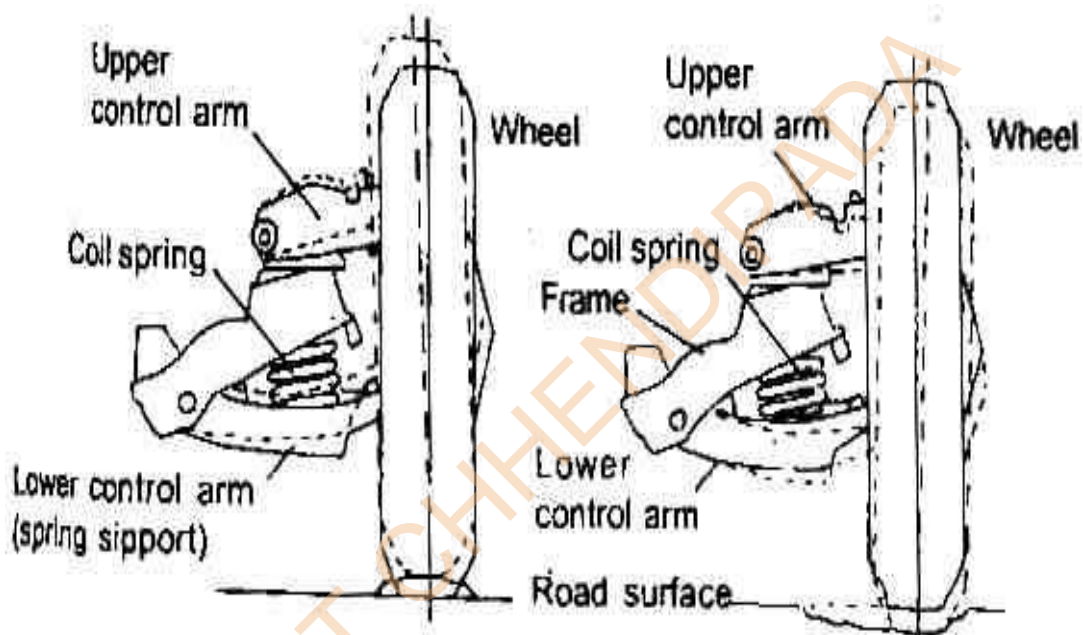


Fig 21.13 COIL SPRING MOUNTED ABOVE THE UPPER CONTROL ARM

In all these cases, a shock absorber is usually employed to control the reaction of each coil spring. The behavior of the front independent suspension as the wheel meets a bump in the road and as the wheel drops into a hole in the road can be seen in figure.

At the front most modern cars use coil springs with either double wishbones (also called A arms due to their shape) or Macpherson struts to locate the wheels and control the geometry of their movement, over bumps and in corners.

Unequal length wishbones or slightly inclined struts are preferred because they separate the effects of the springs and dampers more effectively and control wheel movements better. The upper wishbone is shorter than the lower one for superior corner control.



CHAPTER:6

Q. Describe the lubrication in case of 2-stroke petrol engine.[2017(s)(6-b)]

Ans:-

Petroil system of lubrication (mist lubrication):-

In two-stroke engines, the charge is compressed in the crankcase, and as such it is not suitable to have the lubricating oil in the sump. • Therefore, such engines are lubricated by adding 3 % to 6 % oil in the fuel tank itself. The oil and fuel mixture is inducted through the carburetor. • The fuel gets vaporized and the oil, in the form of mist, goes into the cylinder through the crankcase. • The oil that impinges the crankcase walls lubricates the main and connecting rod bearings, and the rest of the oil lubricates the piston, piston rings and

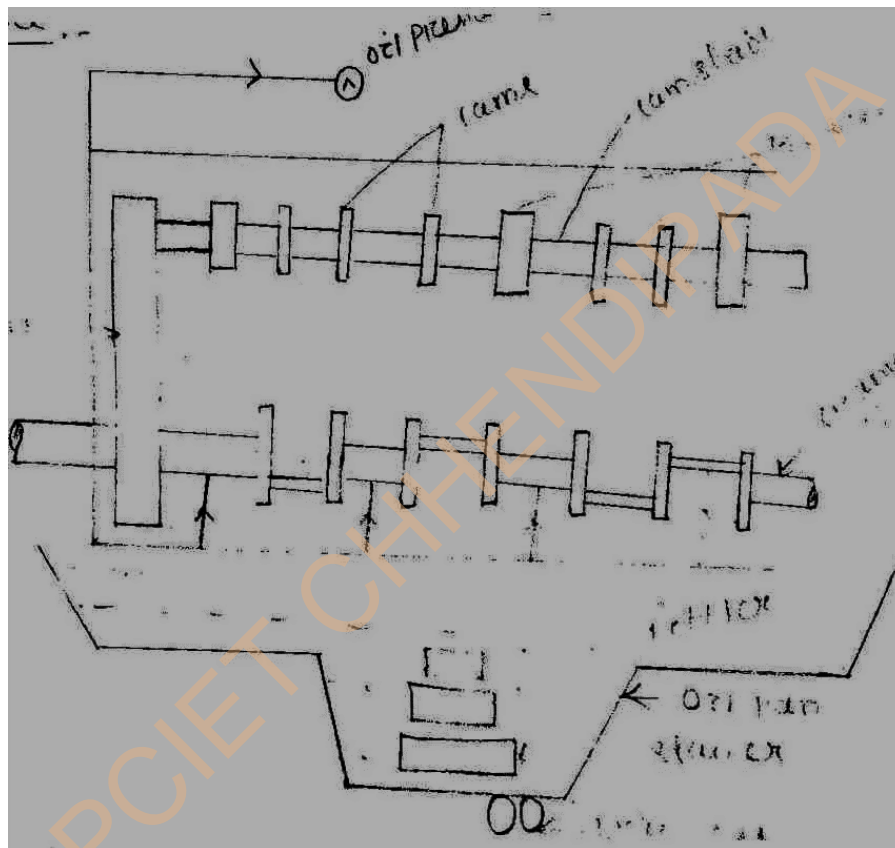
cylinder. • The main advantage with this system lies in the simplicity and low cost as the system does not require any oil pump, filter etc.

Q. Describe the various lubrication system for a IC Engine [2008(w)]

Ans: Mostly pressure lubrication system is used I.C. Engine

Pressure lubrication :

As a splash lubricating system is not sufficient to lubricate efficiently all part of the larger engines. There are a pressure lubricating system is provided.



Working:

- the system consist of an oil pump which takes the oil form the sump through the floating strainer and delivers it through a filter to oil gallery
- Here the pressure of the oil usually ranges between 2 to 4 kg cm².
- The oil form the main gallery is goes to the main bearing form where some of it after lubricating the main bearing falls back to sump.

- Some is splashed to lubricate the cylinder walls and the remaining goes through a hole to crank pin.
- From crank pin it goes to the connecting rod through a hole.
- For lubricating camshaft and timing gears, the oil is led through a separate oil line from one oil gallery
- An oil pressure gauges at the instrument panel indicates the oil pressure in the system.
- Oil filters and strain in the system colour off the oil from the dust, metal particles and other harmful particles.

Q. What are the type of cooling system and explain water cooling system in details [2017(s)(6-c)2015, 3-b]

Ans: Methods of cooling

There are following four methods of engine cooling.

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

Water cooling

In this method of cooling, water is circulated through water jackets around each of the combustion chambers, cylinders, valve seat and valve stems. The circulating water, when passes through the engine jackets in the block and cylinder heat, takes heat of the combustion. When it passes through the radiator, it is cooled by air drawn through the radiator by a fan and by air flow developed by the forward motion of the vehicle. After passing through the radiator, the water again goes in the engine jackets.

Systems of water cooling:

There are two systems of water cooling :

1. thermo siphon system : In this system of water cooling the circulation of water is obtained due to the difference in densities of hot and cold regions of the cooling water. There is no pump to circulate the water. The hot water from the engine jacket being lighter, rises up in the hose pipe and goes in the radiator from the top side. It is cooled there and hence goes

down at the bottom side of the radiator, from where it goes again in the engine jackets. The system is quite simple and cheap, but the cooling is rather slow. To maintain continuity of the water flow, the water must be maintained up to a certain minimum level. If the water level falls down, the circulation will discontinue and the cooling system will fail.

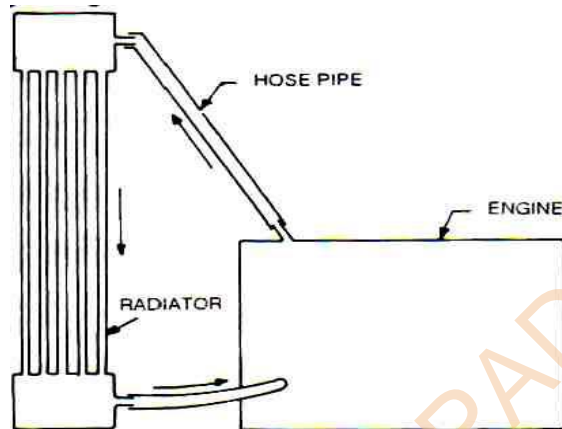


Fig. 14.2. Thermosiphon system of cooling

2. **pump circulation system:** In this system of water cooling, the circulation of water is obtained by a pump. The pump is driven by means of a V-belt from a pulley on the engine crankshaft. The system is more effective. The circulation of water becomes faster as the engine speed increases. There is no necessity of maintaining the water upto a correct level.

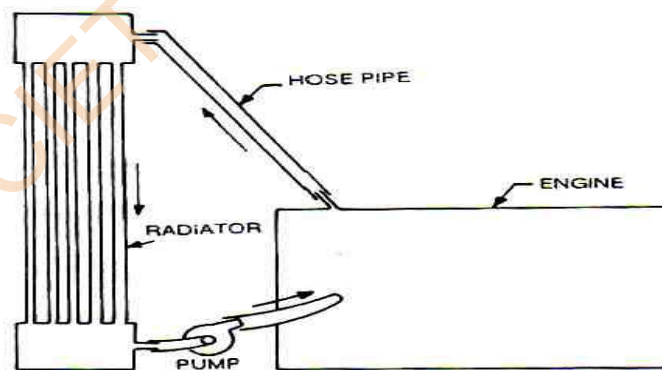


Fig. 14.3. (a) Pump circulation system of cooling.

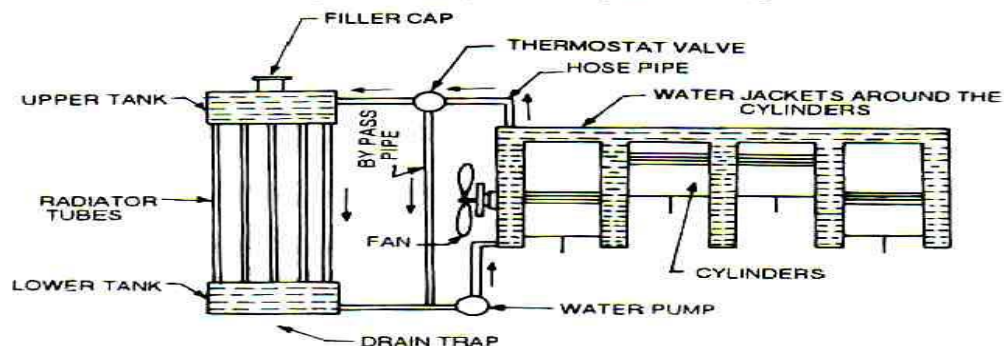


Fig. 14.3. (b) Water cooling system for a 4-cylinder engine.

Q.What is the function of radiator.[2017(s)(6-a)]

Ans:- The radiator is responsible for preventing the engine from overheating. When the engine is in use, it produces a lot of friction and heat, and the radiator uses coolants to keep the engine running at a healthy temperature.

Q. Describe defects of cooling and their causes and remedies [2016,6-b]

Ans:Summary of cooling system Troubles:

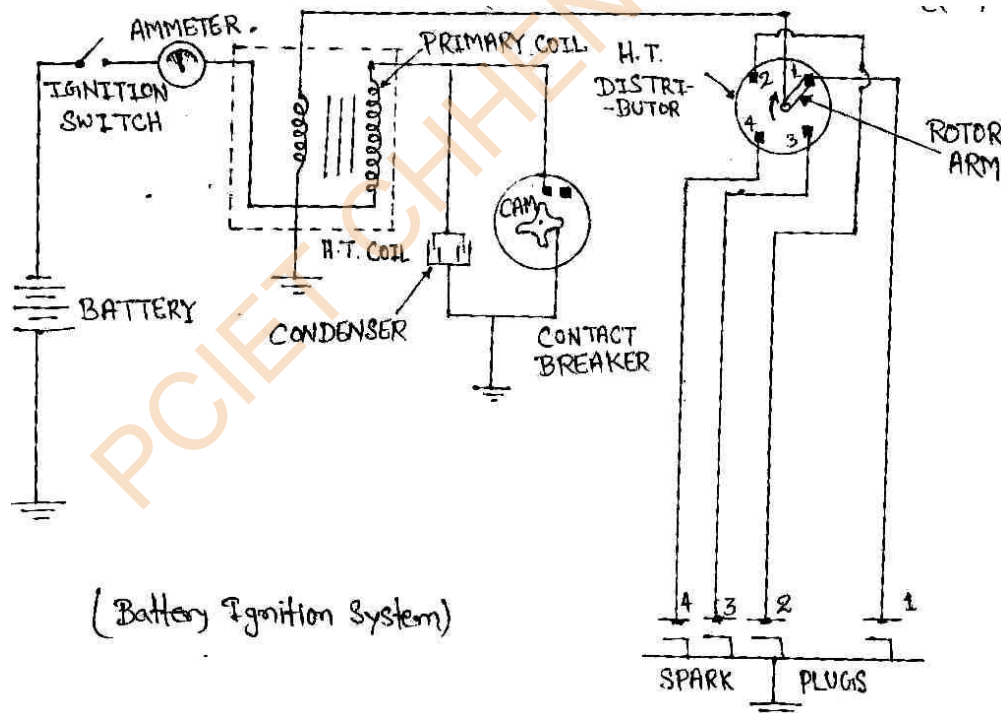
Troubles	Troubles
1. External leakage	<ol style="list-style-type: none"> 1. Loose hose clips 2. Defective rubber hose. 3. Damaged radiator seams 4. Excessive wear in the water pump. 5. Loose core plugs 6. Damaged gaskets 7. Leaks in the heater connections or plug. 8. Leak at the water temperature gauge plug.
2. Internal leakage	<ol style="list-style-type: none"> 1. Defective cylinder head gasket. 2. Cracked cylinder wall. 3. Loose cylinder head bolt.
3. Water loss	<ol style="list-style-type: none"> 1. Boiling 2. External or internal leakage 3. Restricted radiator or inoperative thermostat.
4. Poor circulation	<ol style="list-style-type: none"> 1. Restriction in system. 2. Insufficient coolant. 3. Inoperative water pump. 4. Loose fan belt. 5. Inoperative thermostat.
5. Corrosion	<ol style="list-style-type: none"> 1. Excessive impurity in the water. 2. Infrequent flushing and draining of the system. 3. Incorrect anti-freeze mixtures.
6. Overheating	<ol style="list-style-type: none"> 1. Poor circulation due to any reason. 2. Dirty oil and sludge in the engine. 3. Radiator fins choked. 4. Incorrect ignition timing. 5. Incorrect valve timing. 6. Low oil level. 7. Tight engine 8. Engine oil too thick.
7. Overcooling	<ol style="list-style-type: none"> 9. Clogged exhaust system. 10. Dragging brakes.

Q. State the need of engine cooling [2016, 6-a, 2013, 7-a]

Ans: 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 200°C – 250°C, at which the engine may work efficiency. Too much cooling would, however, lower thermal efficiency of the engine. Thus the purpose of the cooling system is to keep the engine at its most efficient operating temperature at all engine speeds and all driving conditions.

Q. Explain with neat sketch the Battery ignition system and magneto Ignition system. [2017(s)(7-b)2008 (w), 2-c, 2010(s) Q-5, 2012 (s) !-7]

Ans:



The figure shows battery ignition system for a four-cylinder engine. It consists of a battery, ammeter, switch, ignition coil, condenser, contact breaker, distributor and spark plug.

The primary ignition circuit starts at the battery and passes through the switch, ammeter, primary winding, 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 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.

The ignition coil steps up 6 or 12 volts from the battery to the high tension voltage of about 20,000 to 30,000 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.

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.

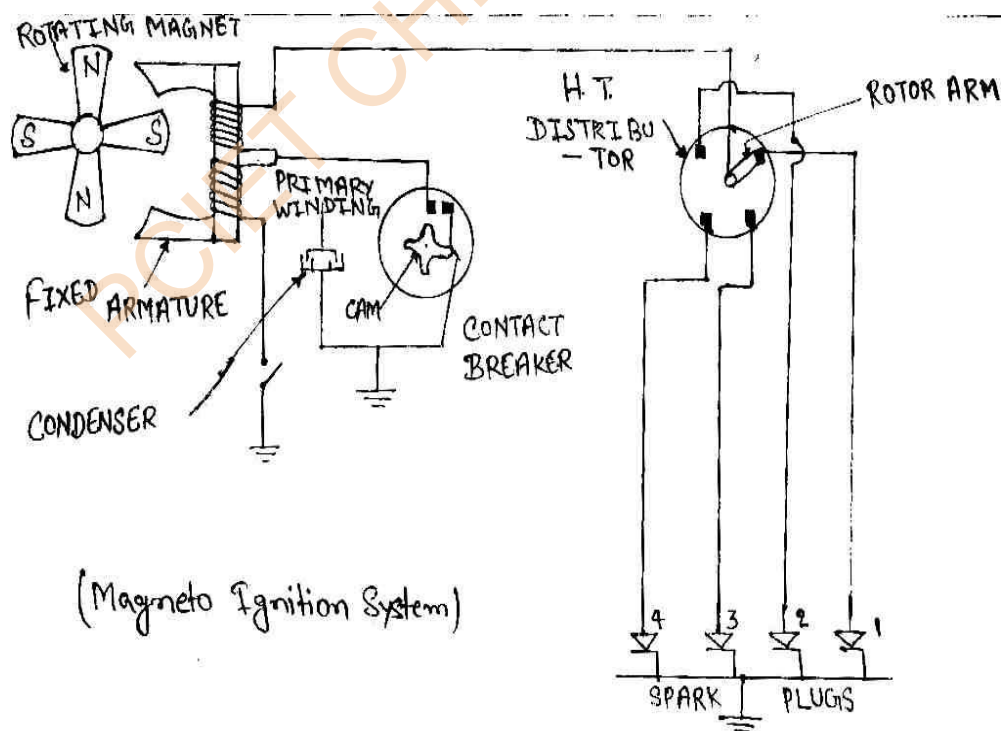


Figure shows magneto ignition system for a four cylinder engine. It consists of magneto instead of a battery. It produces and supplies current in the primary winding. The remaining arrangement in this system is the same as that in the battery ignition system. The magneto consists of a fixed armature 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 plug.

In a magneto, the magnetic field is produced by means of a permanent magnet whereas in conventional generator, the magnetic field is produced by passing some of the generated current through the field winding which produces magnetic field.

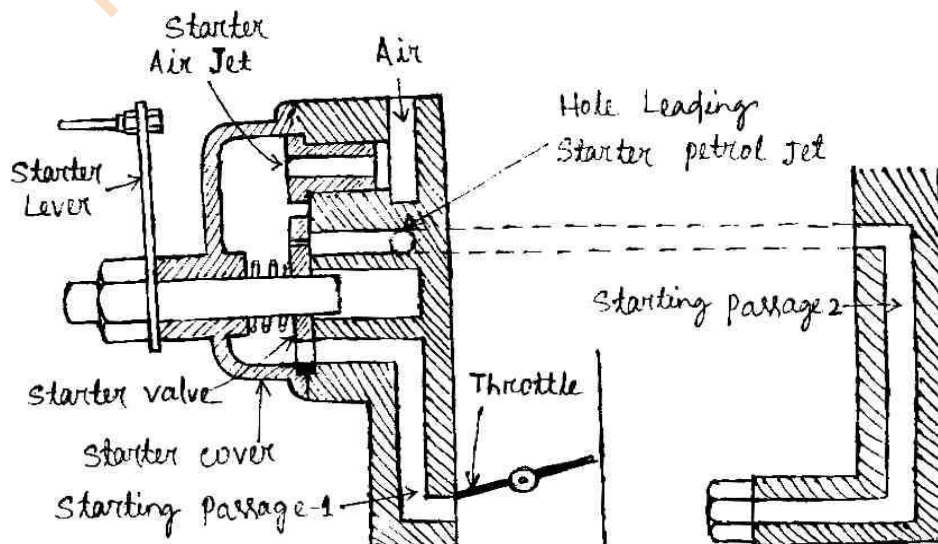
The magneto may be either rotating armature type or rotating magnet type. In rotating armature type magneto, the armature carrying the primary and secondary windings and the condenser, rotate between the poles of a stationary horse shoe magnet.

Q. Define carburettor. [2017(s)(7-a)]

Ans:- A carburettor is a device that mixes air and fuel for internal combustion engines in the proper ratio for combustion.

Q. Describe the construction and working principle of solex carburetor with neat sketch. [2008(s) Q-6, 2009 (s), Q-4, 2011(s) Q-3]

Ans:



Solex carburetor is a down draught type carburetor . It consists of the devices for starting, idling, normal running and acceleration.

Construction :

It consists of a starter valve in the form of a flat disc having holes of different sizes. These holes connect the petrol jet and starter jet sides to the passage which opens into the air horn just below the throttle valve. The starter lever is operated by the driver from the dash board, which adjusts the position of the starter valve so that either bigger or small holes come opposite the passage.

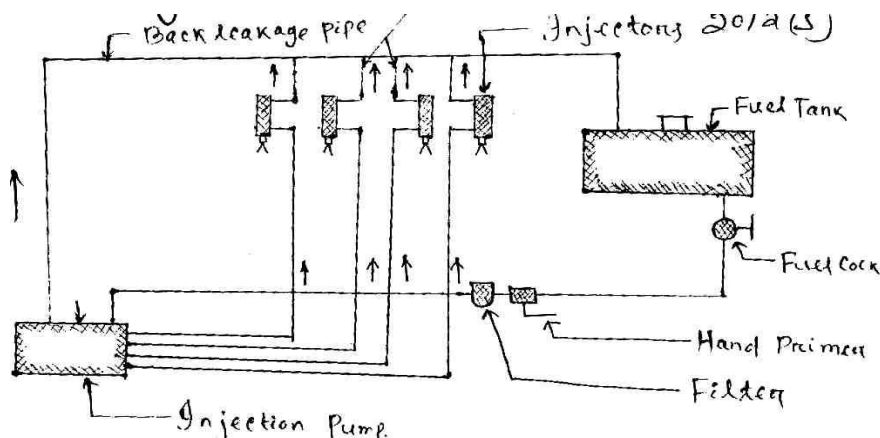
Working Principle:-

At the time of starting, bigger holes connect the passage so that more fuel may go to the engine. The throttle valve being closed, the whole of engine suction is applied to the starting passage 1, so that the petrol from the float chamber passage through the starter petrol jet and rises into passage 2, Some of it comes out and mixes with the air entering through the air jet. This air fuel mixtures is rich enough for starting for engine.

After the engine has started, the starter level is brought to the second position, so that smaller holes connect the passage reducing the amount of petrol. In this position the throttle valve is also partly open, so that the petrol is also coming from the main jet. The reduced mixture supply from the starter system, in this situation is, however, sufficient to keep the engine running. When the engine reaches the normal running temperature, the starter is brought to "off" position.

Q. Describe the working principle of fuel ignition system for multi cylinder engine. [2017(s)(7-c)2008 (w) Q-6, 2013(w) 7-c]

Ans:



The fuel system of a diesel engine consists of the following :

1. Air cleaner
2. Fuel Tank
3. Fuel Filter
4. Injection Pump
5. Injector
6. Fuel lines for necessary connection
7. Fuel gauge.

The complete layout of diesel fuel system is clear from fig. The diesel fuel is stored in a main fuel tank which consists of a fuel-level gauge and an air-vented filter cap. In most of the vehicles this fuel tank is installed lower than the engine level therefore a fuel-lift pump is necessary in the system. The fuel lift pump is generally of mechanical type which functions by means of vacuum of a diaphragm.

The usual system is omitted the lift pump and only it consists of a diaphragm type feed pump operated by the injection pumps camshaft. The feed pump draws fuel from the main tank through a preliminary filter thereby obtaining the lean fuel. The feed pump delivers the fuel to a main filter which is provided with a relief valve. The relief valve acts as a safeguard against excessive pressure of the fuel and discharge the excessive fuel back to the main tank.

In recent installations the preliminary filter is replaced by a plug filter and the system consists of two fuel filters which are provided between the deliver side of the feed pump and the inlet side of the injection pump. The primary filter takes out the greater part and the secondary filter takes out the finest particles of any dirt available in the fuel. Therefore, in this way the complete fuel system includes the main fuel tank, filters, fuel lift pump, fuel injection pump, injectors, low and high pressure pipe lines etc as shown in fig.

Q. How ignition takes place in petrol engine [2015, 4-a]

Ans: Petrol injection system is used in number of modern cars like Jaguar, Benz 250 S.E. Whereas single carburetor is used to deliver air-fuel mixture into multi-cylinder engine. It is likely that some of the cylinders may not get regular

supply of the mixture. The flow of mixture is restricted due to beds in its passage. Also, the power output of an engine mainly depends upon its air consumption, which cannot be increased beyond a certain limit with the use of a simple carburetor, and hence the maximum output is not obtained. The use of petrol injection system overcomes these difficulties. It ensures unrestricted fuel supply and controls it at all times of the engine operation.

In petrol injection, every cylinder is provided with an injection nozzle receiving the petrol from a pump. The petrol may be injected directly into the cylinder or into the inlet manifold. If the petrol is injected into cylinder, it should be timed as in the case of ordinary diesel engines. Petrol injection gives both higher power and low specific fuel consumption. But it has some disadvantages also like higher initial cost and maintenance cost, complicated design and difficult in operation. However, the modern carburetor is a simple, reliable and cheap device for normal operating condition.

Q. Explain multi point fuel injection system [2013, 7-c]

Ans: MULTI POINT FUEL INJECTION (MPFI)/ELECTRONIC FUEL INJECTION (EFI)

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 measure 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 ratio 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 the carburetor is relatively simple, it has been used almost exclusively on gasoline engines in the past. However, in response to recent demands for cleaner exhaust emission, more economical fuel consumption, improved drivability etc., the carburetor now must be equipped with various compensating devices, making it a 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 of 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.

Fuel injection system can be classified as follows :

Single Point : One fuel injector serves more than one cylinder. Throttle body fuel injection is an example. These systems are used only on homogeneous charge engines.

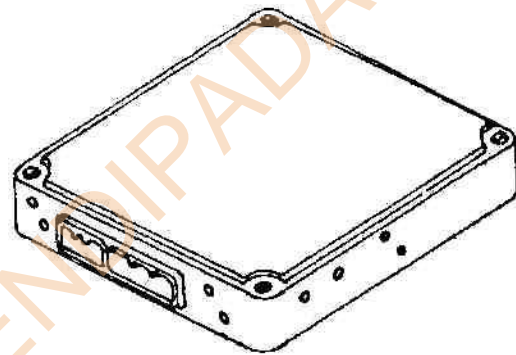


Fig. 11.66. MPFI.

Multiple Point:- One fuel injector per cylinder. These systems are always used on diesel engines and direct-injection stratified charge engines.

Electronic:- The metering of the fuel by solenoid actuation.

Mechanical. The metering of the fuel by cam actuation.

Port. The fuel injector sprays into the air stream at the inlet port.

In-cylinder The fuel injector spray is directly into the cylinder.

Low pressure. Fuel is injected into gas at a pressure level on the order of the intake pressure.

High pressure : Fuel is injected into the cylinder near the end of the compression stroke and therefore into gas at a pressure level on the order of the compression pressure.

Timed pulse : Each injection has a finite duration, controlling the duration's width is the dominant part of the metering scheme. The injection is then timed

to begin and end at specific times in the cycle. All in-cylinder injection systems and some port fuel injection systems are timed.

Continuous of steady: The fuel is flowing through the injector through all times in the engine cycle. In these systems the fuel is metered by controlling the pressure upstream of the fuel injectors

Q. Explain fuel system in diesel engine [2015, 3-c]

Ans: Diesel Engine Fuel System :

The fuel system of a diesel engine consists of the following

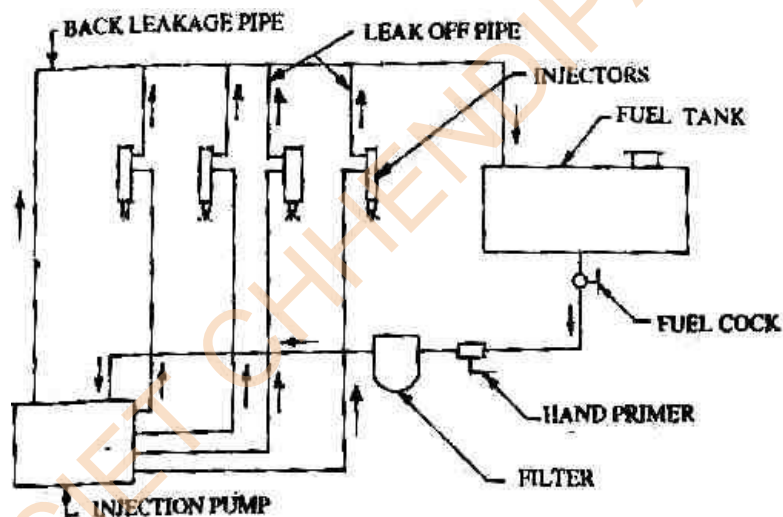
1. Air cleaner
2. Fuel tank.
3. Fuel filter
4. Injection pump
5. Injector
6. Fuel lines for necessary connections.
7. Fuel gauge.

The main difference between the fuel system of a diesel engine and that of a petrol engine is that the fuel system of a diesel engine consists of an injector, instead of a carburetor, remaining items being the same.

In a diesel engine, only the air is sucked and compressed inside the cylinder. At the end of compression stroke, the diesel oil is injected by an injector in the compressed air, which ignites due to the heat of compression and gives power impulse to the piston. The fuel pump delivers fuel at a comparatively low pressure to the injector. Every cylinder is fitted with a injector. The quantity of the fuel to be injected is controlled by the injector. If less fuel is injected, less power will be developed and the engine will run slowly.

With an effective compression ratio of 14 : 1, initial temperature of 60°C and assuming true adiabatic compression, the resulting temperature at T.D.C. would be 675°C. these conditions would be approximately attained at full load and full speed. This temperature of 575°C is more than sufficient to ignite Diesel fuels, which have self-ignition temperatures in air at atmospheric pressure ranging from 350°C to 450°C.

Fig. shows layout of fuel system for distributor type injection pump for a four cylinder diesel engine. It is using the gravity fuel tank. In this arrangement, the fuel tank must be at least one foot above the fuel filters and injection pump. When the fuel cock is opened, the fuel flow direct to a hand lever type of fuel priming pump, from which it then passes out to the inlet side of the main fuel filter. The fuel after being filtered proceeds to the inlet side of the fuel injection pump. From the injection pump, it flows under high pressure in the four fuel feed pipes leading to the fuel injectors. Each injector has a leak-off fuel pipe to carry off any back leakage fuel from the nozzle valve and guide members. This back-leakage fuel is returned to the fuel tank, together with any back-leakage from the distributor injection pump unit.



Where gravity tank feed is not used in the system, a fuel feed pump is used to supply the fuel to the filter and injection pump. The fuel feed pump is usually operated by a special cam on ignition pump's camshaft, so that both the feed and injection pumps form a single unit.

Q. What is ignition timing [2014, 3-a]

Ans: Ignition timing:

In the explosion or constant volume cycle, the maximum useful work can be realized with constant volume combustion and the maximum pressure occurring near the top dead center.

In a actual engine, certain time interval exists between the instant of ignition and the attainment of maximum pressure. This stipulates that the charge must be ignited before TDC. This ensures the combustion of most of the charge as the piston comes to TDC and begins to move towards BDC. The crank angle at which spark occurs relative to the top dead centre is called ignition timing.

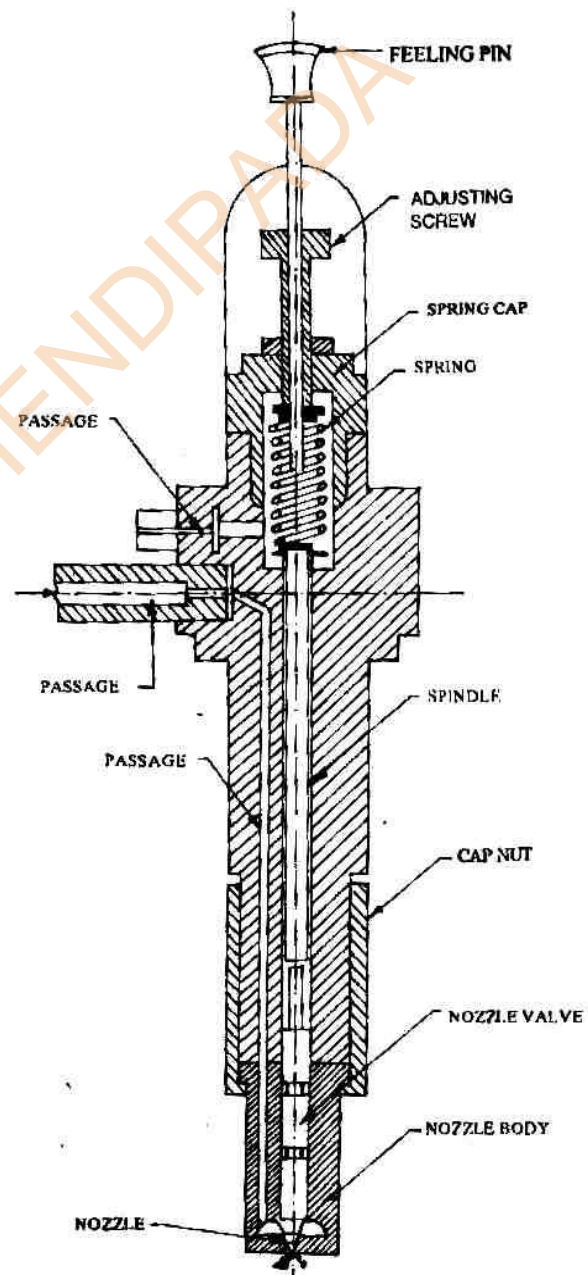
Q. Describe fuel injector in detail [2014 , 7-c]

Ans: FUEL INJECTOR (OR ATOMISER)

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.

Fig. shows C.A.V. fuel injector. It consists of a needle valve 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

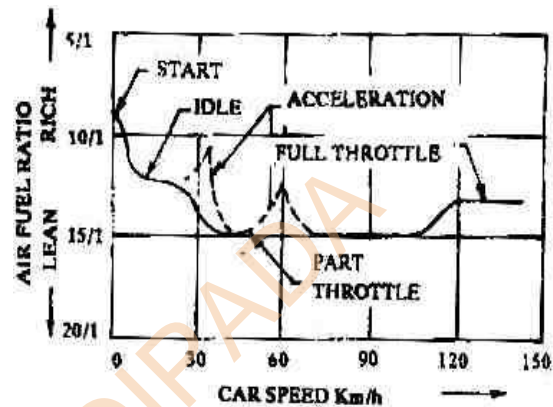


nozzle seat. The body or the nozzle holder provides access for the fuel and an outlet for the fuel that leaks into the area occupied by the spring.

Q. Define air fuel ratio and its importance [2015, 6-a, 2016, 7-a]

Ans: 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 and must be relatively lean for idling and intermediate speeds. Figure shows the air-fuel ratio for different speeds of a car. For starting the air fuel ratio is 9 : 1. It is a rich mixture. For idling the ratio is 12 : 1. It is a lean mixture. For intermediate speeds, between 35 to 105 km/h, the mixture further leans out 15 : 1. But at higher speeds 120 to 150 km/h, with a wide open throttle, the mixture is again enriched to about 13 : 1. For acceleration at any speed 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/hr.

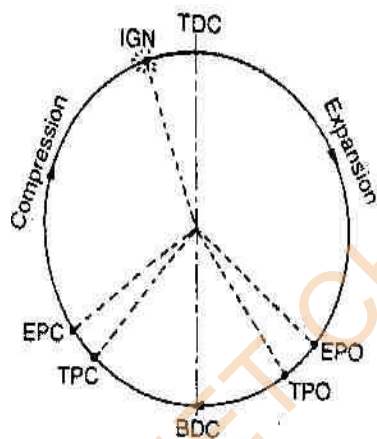


For different cars, the air fuel ratio also varies with speeds. The mixture must be rich for initial start, because the engine and the carburetor are cold, the fuel vaporizes very poorly. Thus extra amount of fuel is needed so that enough will vaporize for starting. Similarly, by sudden opening of the throttle for acceleration, air rushes suddenly. Hence extra fuel must come at the same time. The carburetor must be designed to supply correct air-fuel mixture for all the above operating conditions.

Q. Actual valve timing diagram for a two-stroke Cycle petrol engine.

Ans: In the valve timing diagram, as shown in fig. we see that the expansion of the champ (after ignition) starts as the piston moves from EDC towards BDC. First of all the exhaust port open before the piston reached BDC and the burnt gases start leaving the cylinder. After a small fraction of the

crank revolution, the transfer port also opens and the fresh fuel – air mixture enters into the engine cylinder. This is done as the fresh incoming charge helps in pushing out the burnt gases. Now the piston reaches BDC and then starts moving upwards. As the crank moves a little beyond BDC, first the transfer port closes and then the exhaust port also closes. This is done to suck fresh charge through the transfer port and to exhaust the burnt gases through the exhaust port simultaneously. Now the charge is compressed with both ports closed, and then ignited with the help of a spark plug before the end of compression stroke. This is done as the charge requires some time to ignite. By the time the piston reaches TDC, the burnt gases (under high pressure and temperature) push the piston downwards with full force and expansion of the burnt gases takes place. It may be noted that the exhaust and transfer ports open and close at equal angles on either side of the BDC position.



TDC : Top dead centre

BDC : Bottom dead centre

EPO : Exhaust port opens (35° – 50° before BDC)

TPO : Transfer port opens (30° – 40° before BDC)

TPC : Transfer port closes (30° – 40° after BDC)

EPC : Exhaust port opens (35° – 50° after BDC)

IGN : Ignition (15° – 20° before TDC)