

**B. E.**

**Seventh Semester Examination Dec., 2009  
AUTOMOBILE ENGINEERING**

**Note :** Attempt all questions.

**Q. 1. (a)** Explain briefly various requirements of the automobile body.

**(b)** Discuss advantages & disadvantages of four wheel driver over those with drive axle.

**(c)** Discuss future trends in automobiles.

**Ans. Requirement of automobile :**

The chassis of an automobile consists of following suitably mounted :

1. Engine & Radiator
2. Transmission system, consisting of the clutch, gear box, Propeller shaft & the rear axle.
3. Suspension system.
4. Road wheels.
5. Steering system.
6. Brakes
7. Fuel tank.

The commercial vehicle have to carry large loads, framed construction is invariably used for these.

The engine clutch & the transmission are all bolted together to form one rigid assembly which is mounted usually on the front end of the frame. It is supported on the frame at three places by mean of rubber blocks.

A double frame increases the resistance to bending, ensures an even distribution of the load on the chassis frame.

**Q. 2. What is the function of a clutch in an automobile? Why do we use multiple clutches? Explain the constructed features and working of multiplate wet type clutch using neat diagrams.**

**Ans. Clutch :**

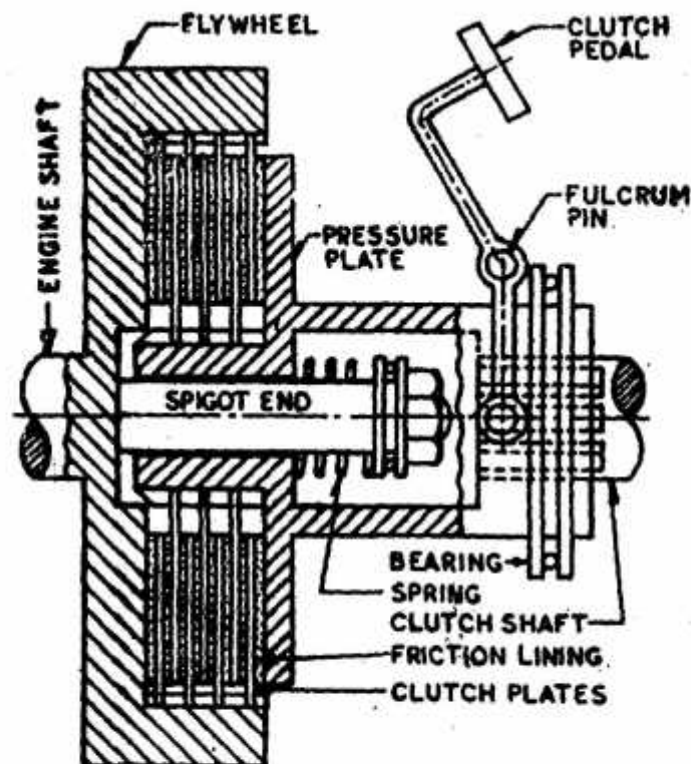
It is a mechanism which enables the rotary motion of one shaft to be transmitted, when desired to a second shaft the axis of which is coincident with that of the first.

**Multiple clutch :**

It is an extension of single plate type where the no. of frictional and the metal plates is increased. The increase in the number of friction surfaces obviously increases capacity of clutch to transmit torque. The size remaining fixed. Alternatively, the overall dia. of the clutch is reduced for the same torque transmission as a single plate clutch.

This type of clutch is, therefore, used in some heavy transport vehicles and racing cars where high torque is to be transmitted.

Besides, this finds application in case of scooters & motor cycles, where space available is limited.



**Fig. Multiple clutch**

A simplified diagram of multiple clutch is given above. This clutch is provided with more than one friction

plate. The construction is similar to that of single plate type except that all the friction plates in this case are in two sets, i.e., one set of plates slides in grooves on the fly wheel & the other one slides on splines on the pressure plate hub.

**Design Detail :**

If  $n$  = Total no. of friction plates in the multiple clutch, the no. of pairs of contact surface =  $(n-1)$

The torque  $= T = (n-1)\mu WR$

Accordingly,

(i) For uniform pressure intensity

$$T = (n-1)\mu W \frac{2}{3} \left( \frac{r_o^2 - r_i^2}{r_o^2 - r_i^2} \right)$$

(ii) For uniform wear

$$T = (n-1)\mu W \left( \frac{r_i + r_o}{2} \right).$$

**Q. 3. What is the necessity of a gearbox in a vehicle? Describe in detail function, construction and working of a synchronous gear box.**

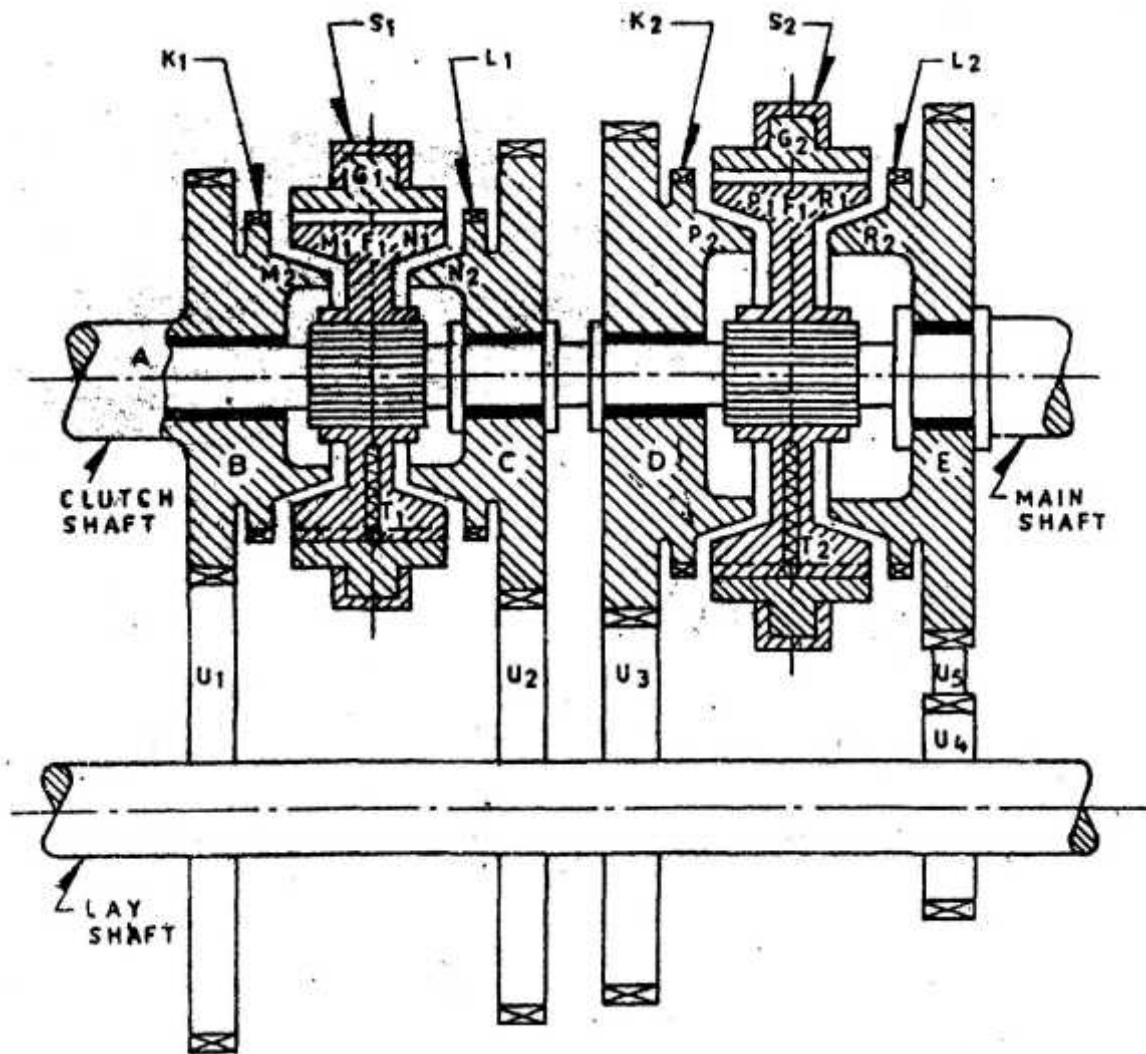
**Ans.** The gearbox is an important part in automobiles. It transmits power from the engine crankshaft to the rear wheel.

**Synchronous gear box :**

This type of gear box is similar to the constant mesh type in that all the gears. On the main shaft are in constant mesh with the corresponding gear on the lay shaft.

In this are have the provision of synchromesh device which avoids the necessity of double deducing. The part, which ultimately are to be engaged, are first brought into frictional contact which equalizes their speed, after which these maybe engaged smoothly.

The fig., given below show the construction & working of synchromesh gear box.



**Synchromesh Gear Box**

**Construction :**

In above fig. A is the engineer shaft, gear B, C, D, E are free on the main shaft & are always in mesh with the corresponding gear on the lay shafts.



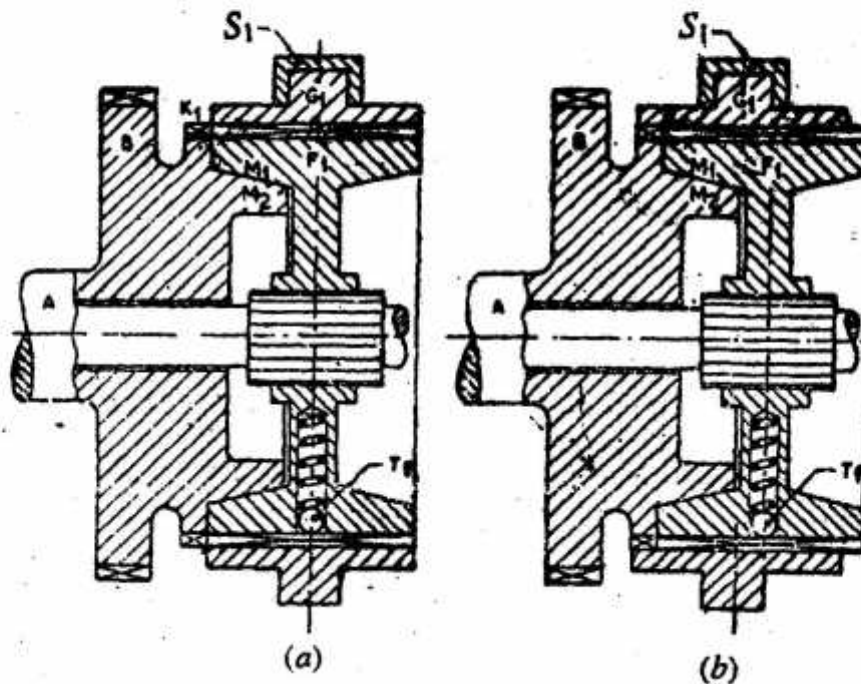
Thus, all the gears on main shaft as well as on lay shaft continue to rotate so long as shaft A is rotating. Member  $f_1$  &  $f_2$  are free to slide on splines on the main shaft.  $G_1$  &  $G_2$  are ring shaped members having internal teeth fit onto the external teeth members  $f_1$  &  $f_2$  respectively,  $K_1$  &  $K_3$  are dog teeth on B & D respectively & these also fit onto the teeth of  $G_1$  &  $G_2$ .

$S_1$  &  $S_2$  are the forks.  $T_1$  &  $T_2$  are the balls supported by springs. These tends to prevent the sliding of member  $G_1(G_2)$  on  $F_1(F_2)$ .

However, when the force applied on  $G_1(G_2)$  through fork  $S_1(S_2)$  exceeds a certain value, the balls are overcome & member  $G_1(G_2)$  slides over  $F_1(F_2)$ . There are usually six of these balls symmetrically placed circumferentially in one synchromesh device.

$M_1$ ,  $M_2$ ,  $N_1$ ,  $N_2$ ,  $P_1$ ,  $P_2$ ,  $R_1$ ,  $R_2$  are the friction at surface.

The working is clearly understood from the fig., given below :

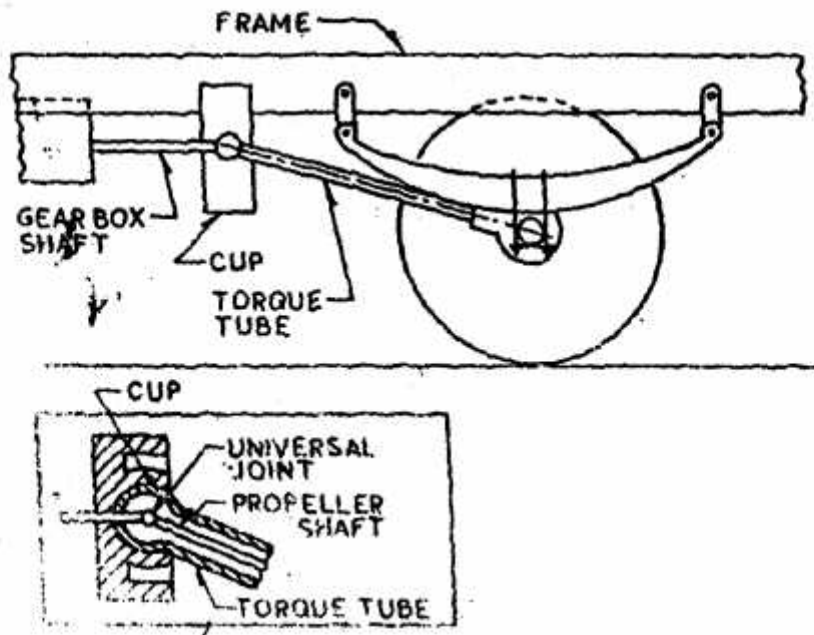


**Q. 4. (a) Explain torque tube drive with the help of a neat sketch.**

**Ans. Torque tube driver :**

In this type of drive, the spring takes only the side thrust besides, supporting the body weight.

The torque reaction, braking torque & the driving thrust are taken by another member which is called the torque tube. One end of torque tube is attached to the axle casing, while the other end which is spherical in shape fits in the cup fixed to the frame as shown below in fig.



**Fig Torque tube drive**

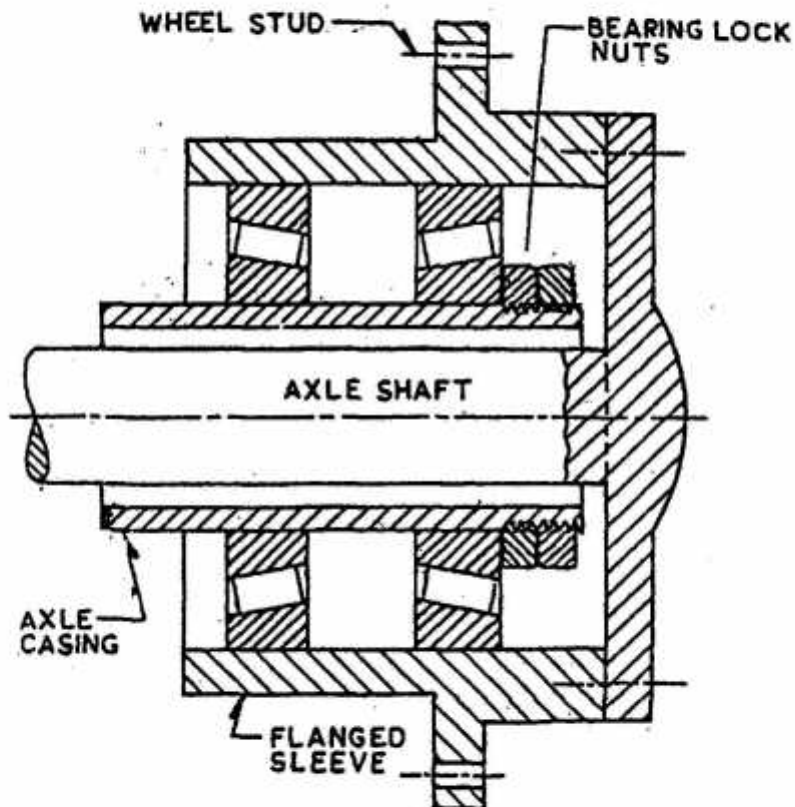
As is seen the torque tube encloses the propeller shaft. Since in this case the torque tube takes the torque reaction, the centre line of the bevel pinion shaft will not shift & further it will always pass through the centre of the spherical cup, if the propeller shaft is connected to the gear box shaft by mean of a universal joint situated exactly at the centre of spherical cup.

In such a situation, no universal joint is needed at the rear end of the propeller shaft. Also no sliding joint is provided because both the pinion shaft & the propeller shaft in this case will move about the same centre, i.e., about the centre of the spherical cup. Clearly torque reaction & the driving thrust are taken by the torque tube.

**Q. 4. (b) Discuss the constructional details of a fully floating axle with the help of a sketch.**

**Ans. Fully floating axle :**

This type is very robust and is used for heavy vehicles as shown in fig. given below, the axle shaft have flanges at the outer ends, which are connected to the flanged sleeve by means of bolts.



**Full-floating axle.**

There are two taper roller bearings supporting the axle casing in the hub, which take up any side load. Thus in this the axle shaft carry only the driving torque.



The weight of the vehicle & the end thrust are not carried by them, the weight being completely supported by the wheels & the axle casing. As the axle shafts carry only the driving torque, their failure or removal does not affect the wheels.

Thus, the axle shafts can be taken out or replaced without jacking up the vehicle.

For the same reason the vehicle can be tuned even with a broken half-shaft. However, it is the costliest type.

**Q. 5. What is independent suspension. Explain any three methods, to achieve the same in front axle of automobiles. Compare the same with rigid suspension.**

**Ans. Independent suspension :**

When a vehicle with rigid axle suspension encounters road irregularities, the axle tilts and the wheel no longer remains vertical. This causes the whole of the vehicle to tilt on one side. Such a state of affairs is not desirable. Apart from causing rough ride, it causes 'Wheel Wobble'. The road adhesion is also decreased.

To avoid this wheels are sprung independent of each other. This is known as independent suspension.

Compared to the rigid axle type, softer springs can be used without increasing rolling effect.

With independent suspension, steering geometry is not altered with spring deflection as in case of rigid axle suspension where effect is especially noticeable during braking & acceleration.

**Front wheel independent suspension :** Independent suspension has become almost universal in the case of front axle, due to the simplicity of construction of such a suspension system.

Three main types :

1. Wishbone type suspension.
2. Mac pherson strut type.
3. Vertical guide suspension.

**1. Wishbone type suspension :**

The fig. shows a diagrammatic sketch of wishbone type suspension with coil springs. The use of coil springs in the front axle suspension of cars is now almost universal.

It consists of upper & the lower wishbone arms pivoted to the frame member. These arms resemble letter 'A' of the Roman alphabet due to which these are also referred to as 'A-arms.'

The spring is placed in between the lower wishbone & the underside of the cross-member. The vehicle weight is transmitted from the body & the cross-member to the coil spring through which it goes to the lower wishbone members. A shock absorber is placed inside the coil spring & is attached to the cross-member & to lower wishbone member.



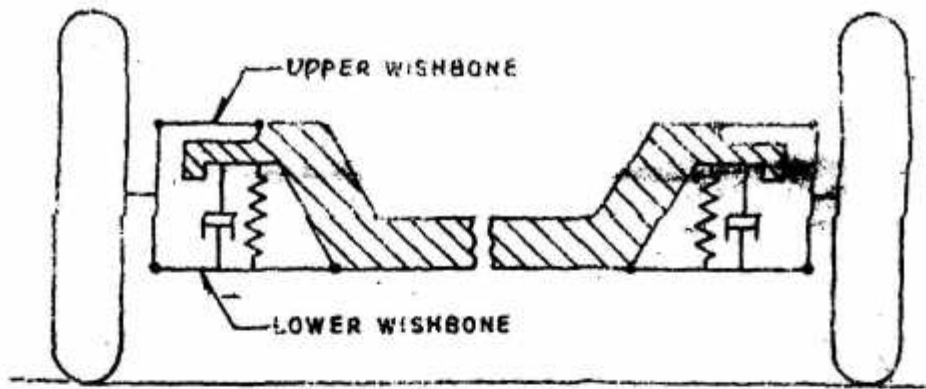


Fig. Wishbone type independent suspension with coil springs

2. Mac pherson strut type of suspension :

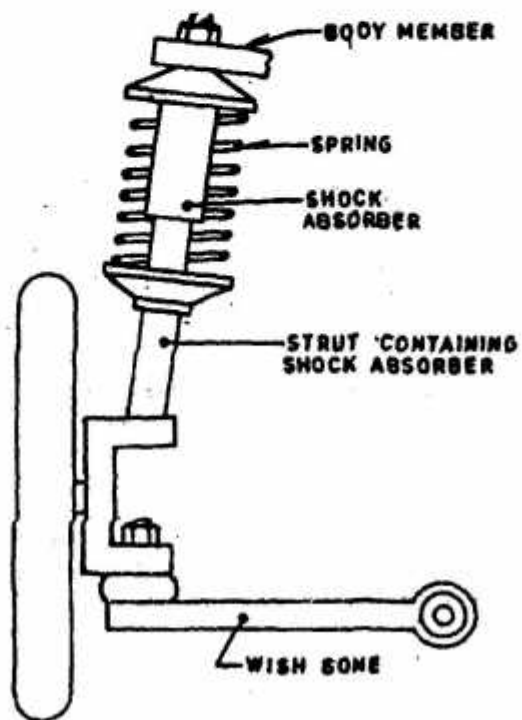


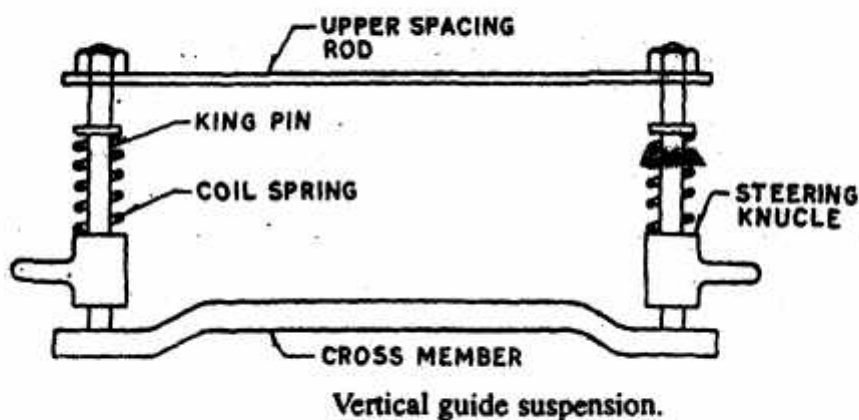
Fig. Mac pherson strut suspension.

In this layout, only lower wishbone are used. A strut containing shock absorber and the spring carries also the stubble on which the wheel is mounted. The wishbone is hinged to the cross-member & positions the wheel as well as resists, accelerating, braking & side forces.

This type of suspension gives the maximum room in the engine compartment & is therefore, commonly used on front wheel drive cars.

### 3. Vertical guide suspension :

In this the king pin is attached directly to the cross-member of the frame. It can slide up & down as shown in fig., corresponding to up & down motion of the wheel, thus compressing or elongating the springs. In this the track, wheel-base & wheel attitude remain unchanged, but the system is having disadvantage of decreased stability.



Q. 6.(a) What do you understand from the term 'backlash' in steering gears? Sketch any one steering gear and explain the constructional features provided to adjust black lash.

Ans. Back Lash :

This is checked with the wheels touching the ground in straight ahead position. If excessive back lash is present, the same can be adjusted either by bush (worm & worm wheel type steering gear) or by tapered teeth (recirculating ball type steering gear) or by means of shims.

Worm & worm wheel steering gear. In worm & worm wheel-steering gear the backlash due to wearing out of the teeth of the worm & worm wheel can be easily adjusted. For this purpose the worm wheel is moved over the 'eccentric bush'. When the teeth have worn out, the problem is how to bring the worm & wheel together to take up the wear. This is done by rotating the bush through a certain angle, as shown below.

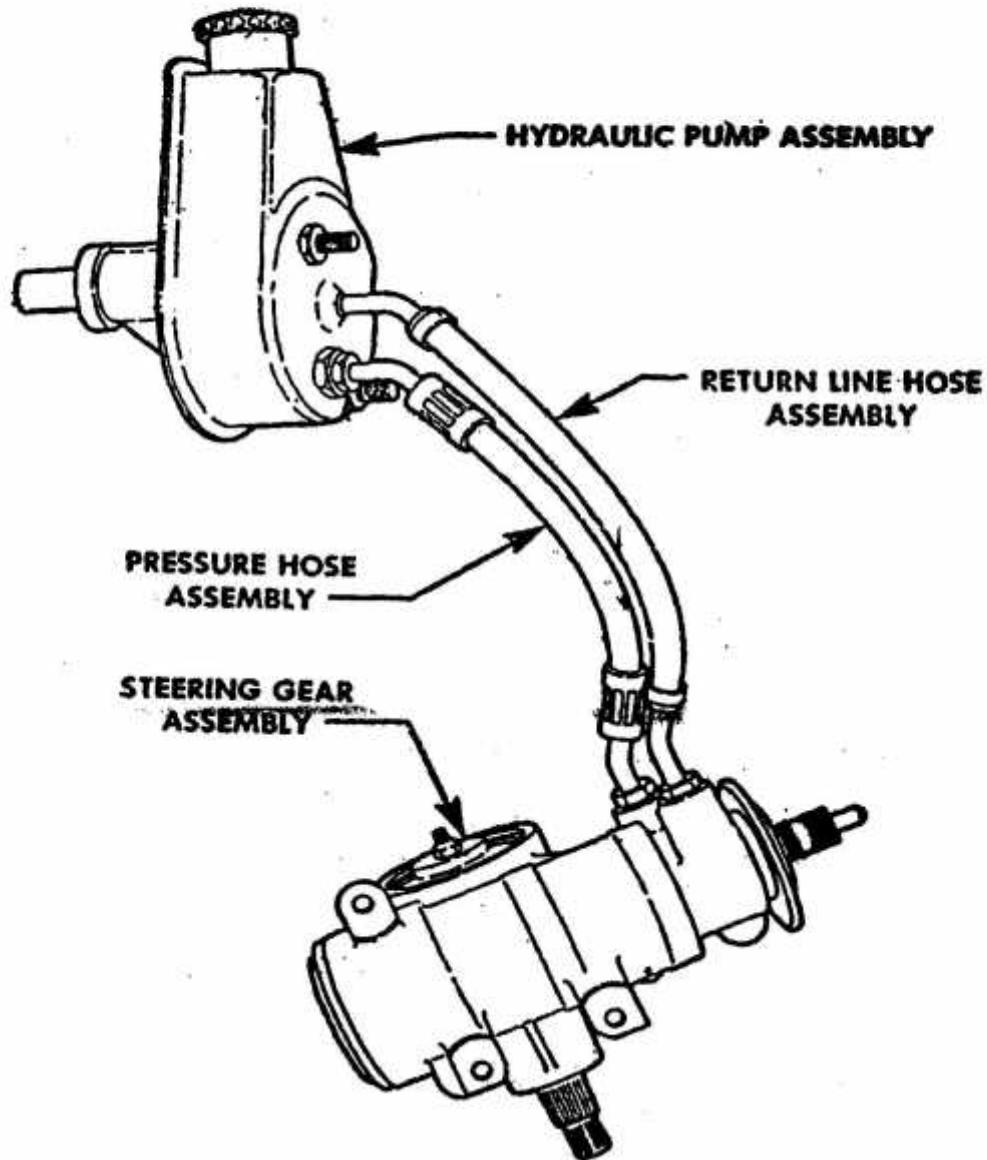
**Q. 6. (b) Describe the construction and working of power steering gear with a neat sketch.**

**Ans. Power steering :**

These are operated by fluid under pressure.

In the integral type power steering the power steering assembly is an integral part of the steering gear.

**Construction & operation :**



It is shown below. The main component is a hydraulic pump assembly connected by hoses.

The slight movement of the steering wheel actuates a valve so that the fluid under pressure from the reservoir enters on the appropriate side of a cylinder thereby applying pressure on one side of a piston to operate the steering linkage. Which steers the wheel in the appropriate direction.

**Q-7. (a) What is the principle of operation of hydraulic brakes? Discuss main parts of hydraulic brakes compare hydraulic and pneumatic brakes.**

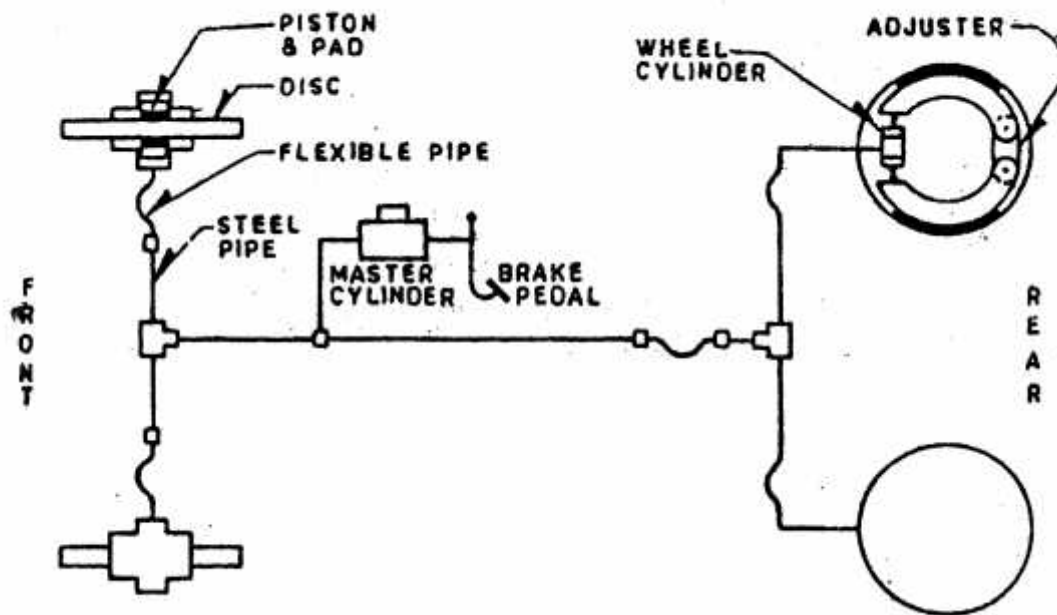
**(b) Discuss wheel balancing and rotation of tyres in automobiles.**

**Ans. Hydraulic breaks :**

The working principle of the hydraulic brake system is shown below. It consists of one master cylinder & four wheel cylinders filled with a liquid. The cross-section of each cylinder is  $1\text{ cm}^2$ . A certain force, say  $10\text{ kg}$  is applied at the certain master cylinder. The same force of  $10\text{ kg}$  is applied on the other four cylinders. This shows that the pressure at the master cylinder is the same as that on the other four cylinders. This is the principle of the hydraulic brake system.

**Construction & output of hydraulic system :**

Every wheel cylinder contains two pistons which moves outwards. The hydraulic fluid flows from the master cylinder to the four wheel cylinders through suitable pipes.



**Hydraulic brake system**



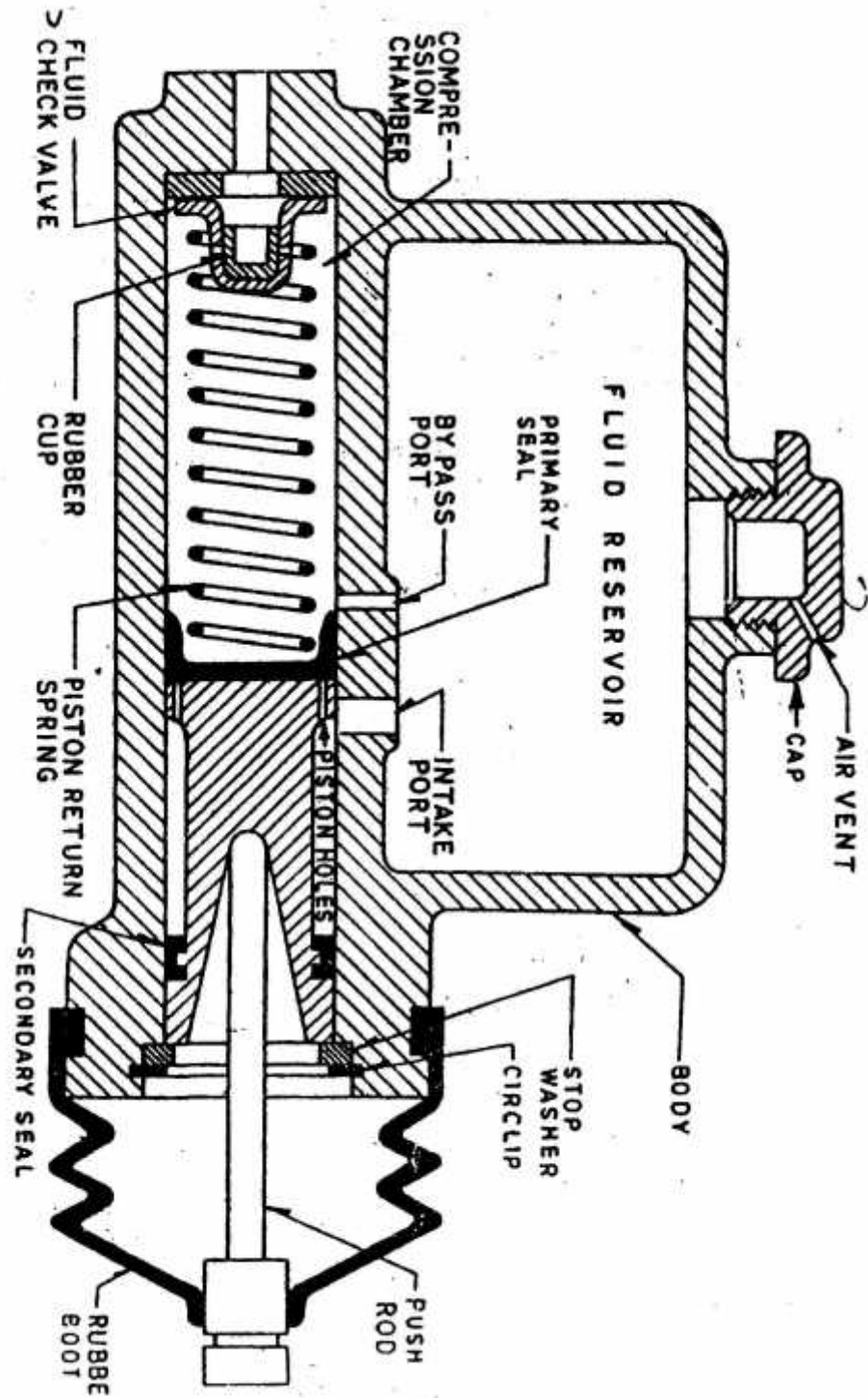


Fig. 10.26 Master Cylinder.

Main components of hydraulic brake system :

1. Master cylinder
2. Wheel cylinder.

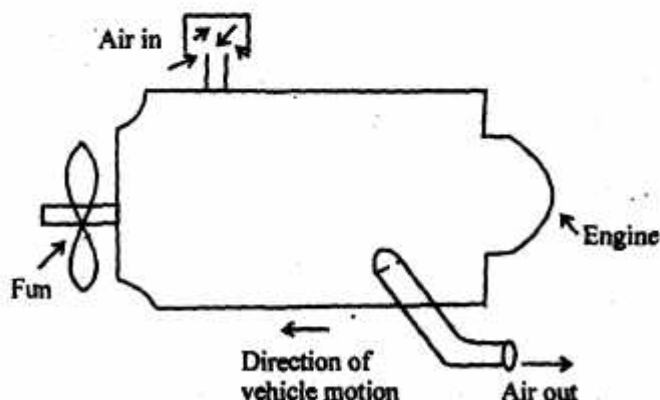
The fig. given below shows the cross-section of master cylinder. It consist of a reservoir, feed hole, by-pass post, piston, primary cup, secondary cup. Spring & check valve spring. The liquid in the reservoir flow through the by-pass-port to the master cylinder when the pedal is pressed, the master piston is moved to the right. When it crosses the by-pass port the liquid is forced along the pipe lines to the wheel cylinders. But when the pedal is released, the master piston is moved backward by the spring.

**Q. 8. (a) What are the sources of atmospheric pollution from the automobile? Explain various pollution control techniques used in practice.**

**(b) Explain construction and operation of positive crank case ventilation system used in automobiles.**

**Ans. Positive crank case ventilation :**

In this type of ventilation, the vapour in the crank case are returned to the engine through the inlet main fold, and not sent out directly to the atmosphere.



**Fig. Road draft system of cranks case ventilation**

The outlet tube of crankcase is connected to the intake manifold below the carburettor. The vapours from the crankcase are drawn into the intake manifold after which they go to the engine. During the operation of the engine, unburnt fuel, if any, will be burnt.