I CHAPTER
CLUTCH

Power transmission:

The power developed by the engine in automobiles should be transmitted to the road wheel efficiently. The power transmission system basically needs a clutch to transmit the power from the engine to the remaining parts of the transmission. The power transmission system is different for different types of vehicles.

In the case of two wheelers with gears the power is transmitted from the clutch to the gearbox and then transmitted to the wheels by means of chain drive or gear drive. In the case of non-geared two wheelers the power is transmitted from the clutch directly to the wheels through the chain drive / gear drive or sometimes through the variator mechanism.

In the case of LMVs (Light Motor Vehicle) and HTVs (Heavy Transport Vehicle) the power transmission consists of clutch and gearbox as the common features. In the conventional transmission system, (front engine rear wheel drive) the power is transmitted from gearbox to road wheels by means of universal joint, propeller shaft, sliding joint, differential and half shaft. In the case of front engine front wheel drive, transaxle is commonly used. In this case, the gear box is arranged transversely and power transmission may not be provided with propeller shaft and bevel gear arrangement. This type of arrangement is compact and also contains less number of moving parts. In the case of four wheel drive, the arrangement is similar to conventional power transmission with transfer gear box or transfer case as the additional features. The transfer gear box transmits the power to both the axles uniformly.

Functions of a Clutch:

The torque developed by the engine at starting speed is very low. Therefore, it is not possible to start the engine under load. This requires that the transmission system should provide a means of connecting and disconnecting the engine from rest of the transmission system. Such an operation must be smooth and without shock to the occupants of the vehicle.

Thus the two main functions of a clutch are:

1. To engage and disengage the transmission from engine to the remaining parts of transmission. (To allow the engine to be separated from rest of the transmission system) This is required when:

(a) Starting and running the engine at a sufficiently high speed to generate sufficient power necessary for moving the vehicle from rest.

(b) Shifting the gears so that damage to gear teeth can be avoided.

(c) Stopping the vehicle after applying the brakes.

2. The second function of the clutch is to allow the engine to take up the driving load of the vehicle gradually and without any shock.

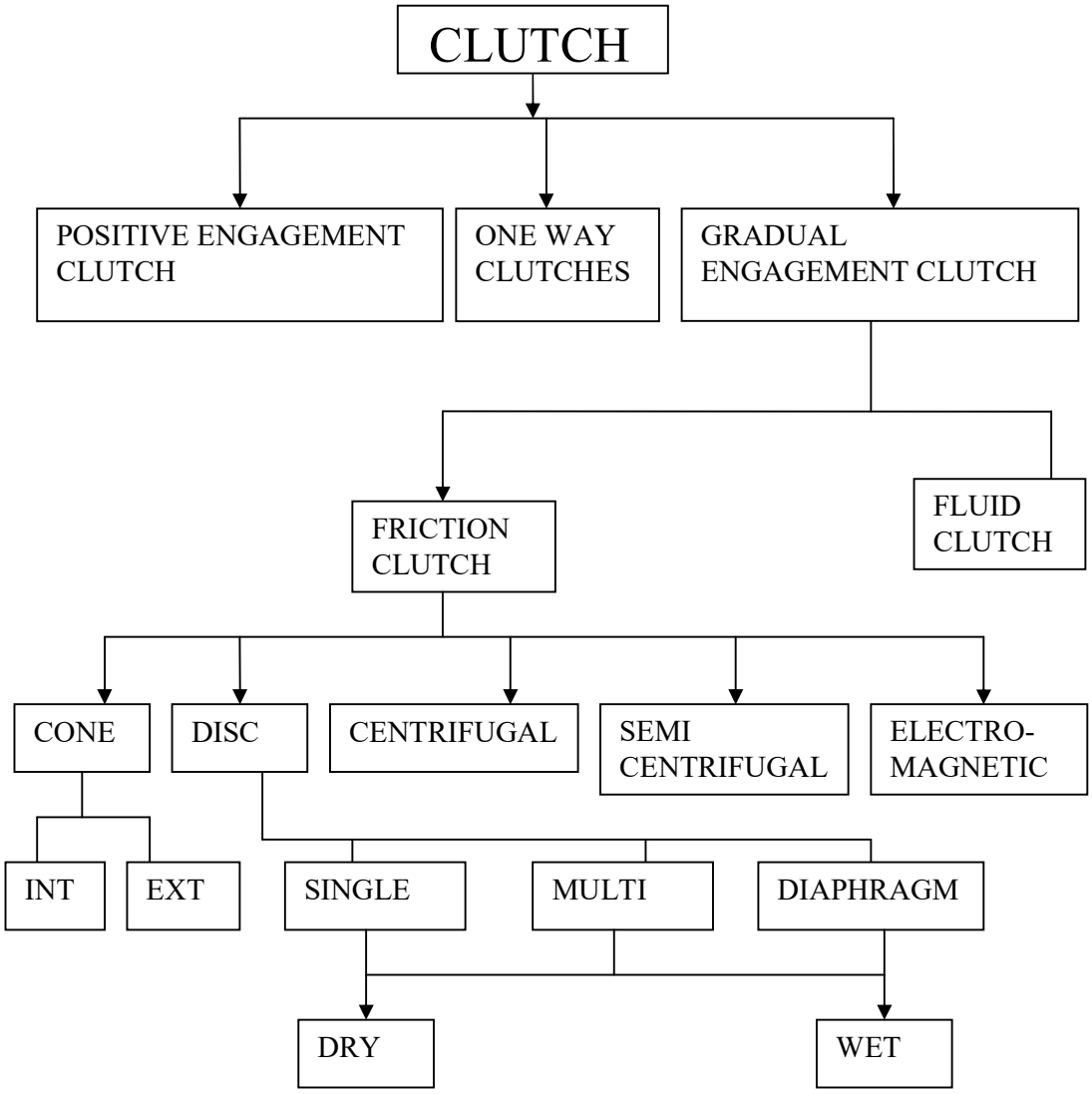
Requirements of clutch:

The main requirements of a clutch are as follows:

1. It should be able to transmit maximum torque of the engine.
2. It should engage gradually to avoid sudden jerks.
3. It should be able to dissipate large amount of heat generated during clutch operation.
4. It should be dynamically balanced, particularly in the case of high speed engine clutches.
5. It should have suitable mechanism to damp vibrations and to eliminate noise produced during power transmission.
6. It should be as small as possible so that it will occupy minimum space.
7. It should be easy to operate requiring as little effort as possible on the part of the driver.

8. It should be made as light as possible so that it will continue to rotate for any length of time after the clutch has been disengaged.
9. It must be trouble free and have longer life.
10. It must be easy to inspect, adjust and repair.

Classification of clutches:



Principle of operation of clutches:

Clutch works on the principle of friction. When two friction surfaces are brought in contact with each other and pressed with certain force, they are united due to the friction between them. If one is rotated, other will also rotate due to this condition. It can be separated or brought into contact whenever required. One surface is referred to as driving member and other as driven member. The friction between two surfaces depends upon

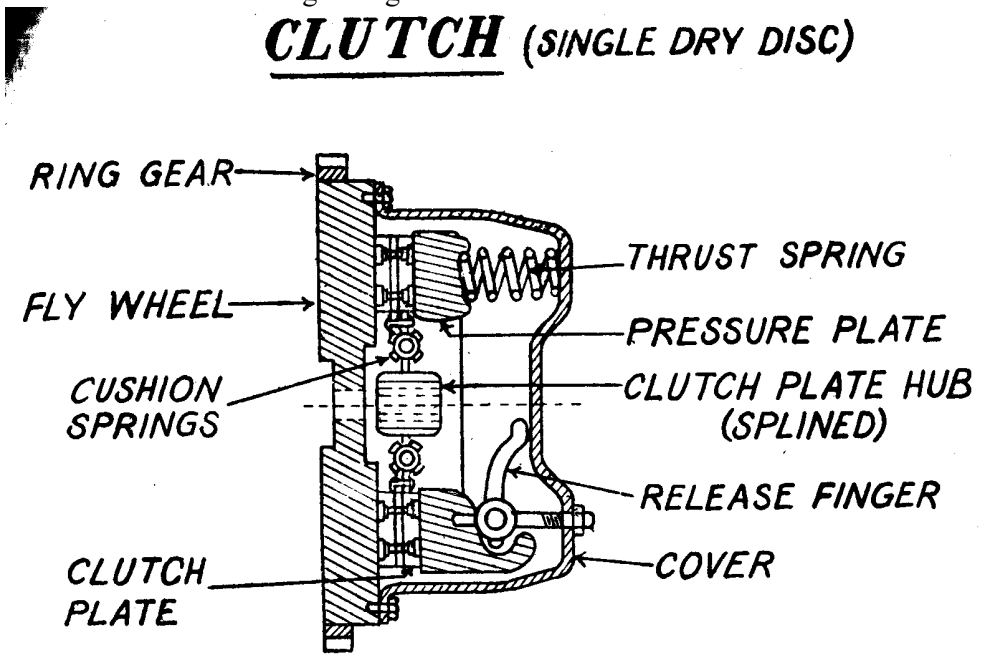
1. Area of contact surface.
2. Force applied on them.
3. Coefficient of friction of surface material.

When the driven member is brought in contact with driver, the clutch slips initially. As the pressure increases, the driven member is brought to the speed of the driving member. When the speed of both members becomes equal, then the two members are in frictional contact without any slip and clutch is said to be fully engaged. The driving torque can be increased by increasing

the effective radius of contact, coefficient of friction, clamping force, or the number of contact surfaces.

SINGLE PLATE CLUTCH

Construction: The main components of a single plate clutch are driving member, driven member and the actuating linkages.



Driving Members

Driving members of a single plate clutch are input shaft (crank shaft) fixed to the flywheel, pressure plate, and the clutch cover which is bolted to the flywheel. These three components rotate along with the crank shaft in both engaged and disengaged condition. Flywheel is attached to the crank shaft and has threaded bolts or holes or grooves for bolting the clutch covers. Machined surface of the flywheel contacts the clutch facing. The pressure plate applies the required force on the clutch plate which contacts with fly wheel. To apply the required force, pressure springs are attached between the pressure plate and clutch cover. Pressure plate can be withdrawn by releasing the spring with the help of release lever. Lugs are provided on the pressure plate for providing the release fingers. Pressure plate springs are provided inside, release finger, and anti-ratting springs are provided inside the clutch cover and the entire assembly is bolted to fly wheel.

Driven members

It is the clutch plate which is splined to the driven shaft. (clutch shaft or input shaft of gear box) Clutch plate is used with friction material on both the surfaces. It consists of a centre hub with internal splines which moves along the splined shaft during the transmission. The power is transmitted from the clutch to the shaft through these splines. It consists of torsional and cushioning springs which transmit the force applied to the facing to the central hub. The spring also reduces torsional vibrations and provides smooth engagement or disengagement of the clutch. The friction material is normally riveted to the projected portions of the clutch disc in CMVs (Commercial Motor Vehicles) and HMVs (Heavy Motor Vehicles).

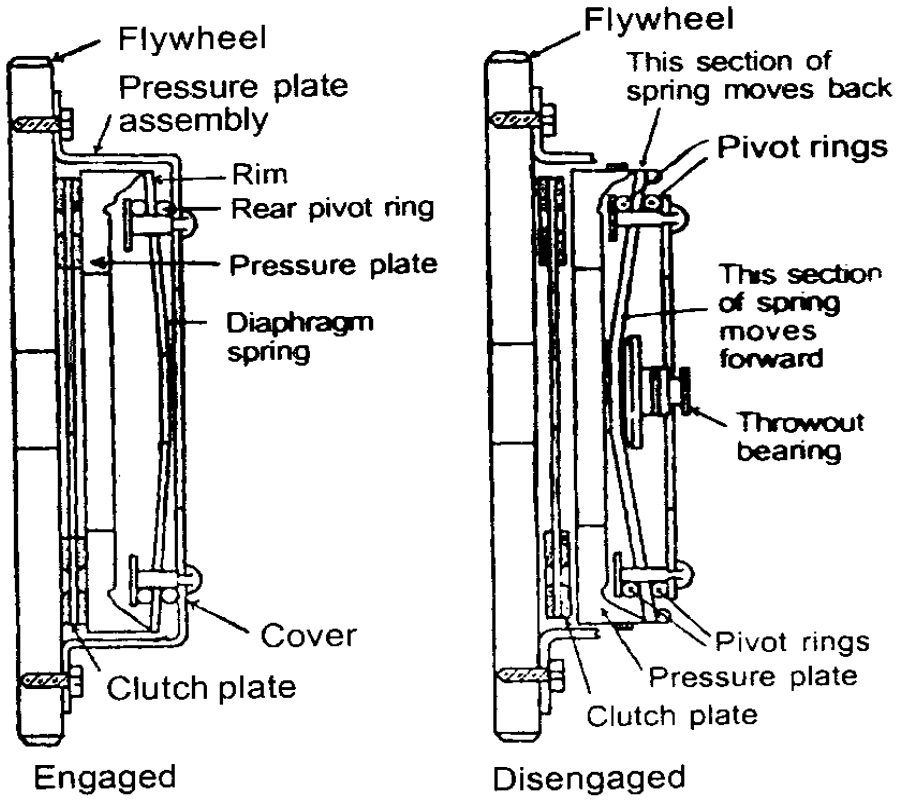
Actuating members

It consists of release fingers, withdrawal fork and release bearing. The outer end of the release finger is located on the pressure plate and inner end is projected towards the clutch shaft and are positioned with the help of anti-rattling springs. Withdrawal fork carrying the release bearing is pivoted in the clutch outer casing. The release bearing actuates the inner end of the release fingers.

Working / operation

In fully engaged condition the driven plate is firmly clamped between the flywheel and pressure plate due to the force applied by springs. This forms a non-slip connection between the driving and driven plates. Hence when the flywheel rotates, the clutch plate also rotates and this causes the transmission of power to the input shaft of gear box through splines. When clutch pedal is pressed, the pressure on the driven plate is released by compressing the pressure springs through the release fingers. In this condition there is no force acting on the clutch plate and is free between the flywheel and pressure plate. This disengaged condition ensures easier shifting of gears.

DIAPHRAGM CLUTCH



In this type of clutches, diaphragm type springs are used instead of coil / helical springs. This type of clutch does not require any release levers as the spring itself acts as a series of levers. This type of springs do not have constant rate characteristics as in the case of coil springs and the pressure on the diaphragm springs increases until it is in flat position, thereafter decreases after passing this position. Hence the driver does not have to exert heavy pedal pressure to hold the clutch out of engagement compared to coil spring type. In coil spring type, the spring pressure increases when the pedal is depressed to disengage the clutch and high pressure is required to keep the clutch in disengaged position.

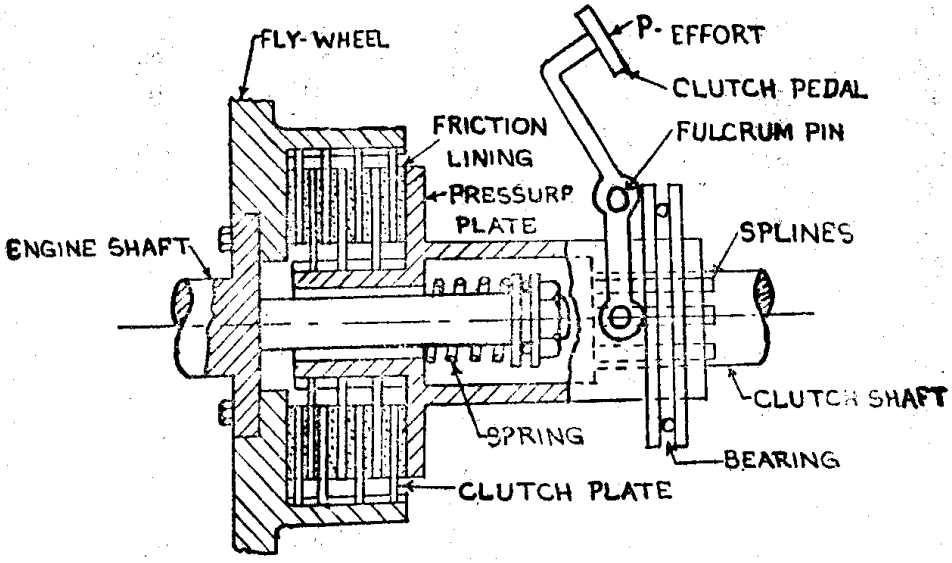
This clutch consists of conventional friction clutch plate, pressure plate, diaphragm type spring and release sleeve. The diaphragm spring is held between the inner end of the main bearing and its outer circumference fits into the counter bore of the pressure plate. The central position of the diaphragm spring is divided into several segments by radial slots terminating into holes. These segments act like a spring providing the required thrust on the pressure plate. This simple arrangement eliminates the necessity of providing separate release levers.

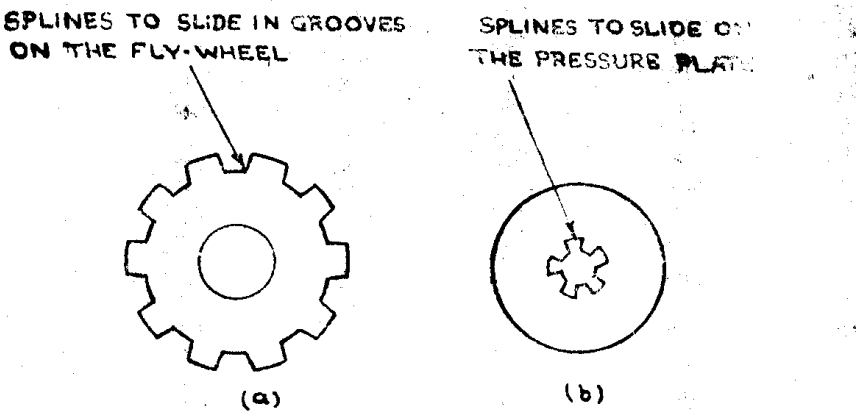
Working:

In the engaged position the spring pivots on the inner pivot rings as it is held on the clutch cover so that its outer rings contacts with the pressure plate. Again in this conical position the spring exerts through pressure to keep the pressure plate in firm contact with the clutch plate and

flywheel. When the pedal is pressed the linkage moves release bearing towards the flywheel to disengage the clutch. As the bearing contacts with inner position of the conical springs it moves that position forward which cause the link to move backward. This removes the pressure on the pressure plate and release the clutch plate from contact with other driving members.

MULTI PLATE CLUTCHES





(*a*) Plate with outer splines (*b*) Plate with inner splines

The clutch having more than three discs is referred to as multi disc clutch or multi plate clutch. It is similar to a single plate clutch but has more number of frictional and metallic plates. Due to the increase in the numbers of plates (friction), the frictional surface in contact is also increased which increases the capacity of the clutch to transmit the same torque with lesser diameter of the plate clutch. Hence the clutches are most commonly used in two wheelers and three wheelers due to compact size. It is used in heavy duty transmission system for transmitting higher torque. (For example torque transmission in heavy earth moving equipments) and power take off (P. T. O.) transmission in tractors.

Construction

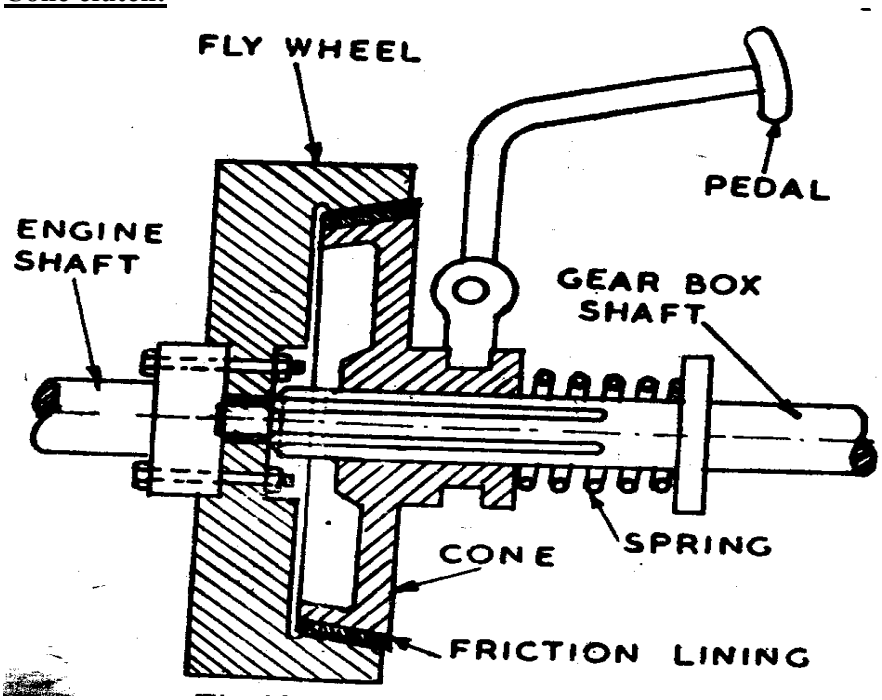
Construction of multi plate clutches is similar to single plate clutches except in the arrangement of number of friction plates and metal plates. It consists of inner drum which is referred to clutch shaft and has a number of plates splined to the outer surface. Another drum is coupled to fly wheel and carries a number of plates splined to its inner surface. The plates are arranged in alternate manners. The plates can revolve with the drum as well as it can slide axially. A spring keeps the outer and inner plates pressed together, so that the driving members

transmit the power to the driven member. The clutches can be disengaged by pulling the inner drum against the spring force.

Multi plate clutch can be dry type or wet type. The clutch is partially filled with oil. The coefficient of friction in oil varies from 0.07 to 0.17 of asbestos based fabrics.

1. The oil acts as cushioning medium to provide smooth engagement and disengagement
2. The oil also carries the heat dissipated by the clutch due to friction. This reduces operational temperature and increases the life of the clutch plates.
3. The oil acts as lubricant and reduces axial thrust lost due to bending of splines.
4. The major disadvantage is the reduction in coefficient of friction when immersed in oil. It can be compensated by using high operating pressure of different friction material. Generally cork inserted multi plate clutches are used in wet clutches. In wet clutches the fluid under pressure is fed along the shaft.

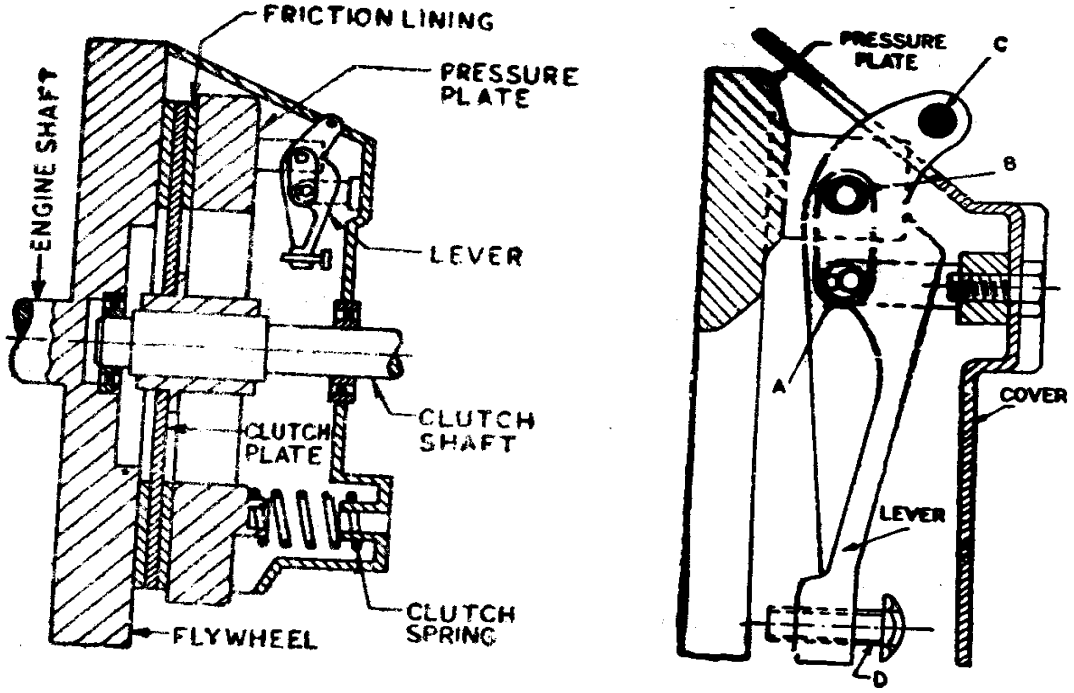
Cone clutch:



This type of clutches provides a positive drive when the external face of the male cone member engages with the internal face of the recessed conical female member. The facing is usually fitted to the female or recessed member in order to improve heat dissipation and durability. Normally cone clutches are used with epicyclic gear trains for a higher torque transmission. The energy which a cone clutch can absorb during engagement is less compared to the energy absorbed by a multiple clutch. But it is compact, cheaper and requires low clamping load due to the wedging action. The cone clutches are loaded by spring or hydraulic cylinders. Wedge angle and accurate axial alignment are the two important factors for good cone clutch performance. If the wedge angle is very less, it results in excessive wedge action and fierce engagement. This in turn results in difficult operation for disengagement. If the wedge angle is too large, it reduces torque transmission capacity of the clutch and makes the clutch to skid. Semi-cone angle of 12-16 are commonly used for effective torque transmission.

During the engagement of clutch the driven member is forced towards the driving cone by the spring force. Hence the power is transmitted from the engine to the driving cone, driving cone to driven cone and driven to the gear box. When the clutch is to be disengaged, the driven cone is to be pulled off by means of actuating linkages and contact surfaces are separated. Hence no power is transmitted to the clutch shaft.

SEMI-CENTRIFUGAL CLUTCHES:

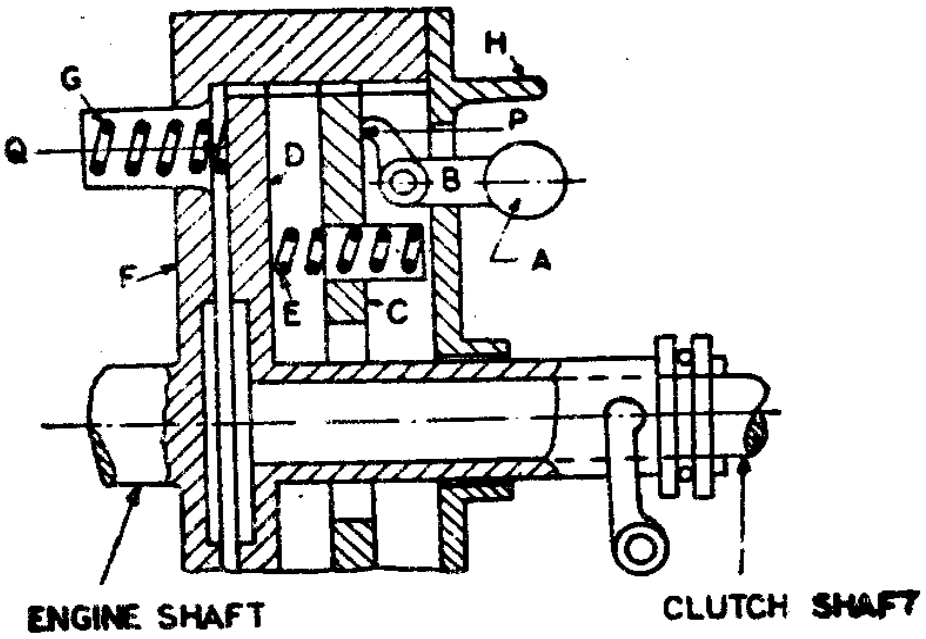


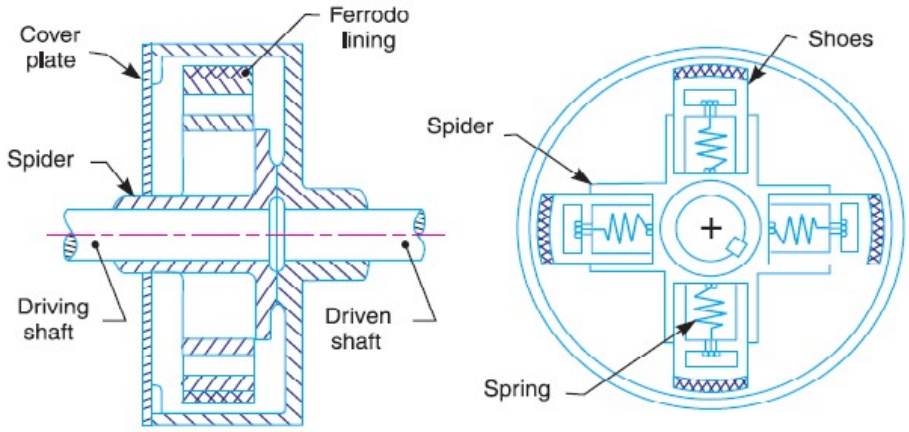
This type of clutch makes use of centrifugal force to assist the spring force at high speed. To reduce the effort of the driver to operate the clutch, the assistance is taken from the centrifugal force. To transmit small torque, spring with minimum stiffness is used which is sufficient for applying the required amount of force and also not so stiff to minimize the strain of the driver during disengagement. When high power is transmitted through the clutch, then pressure of the springs is a considerable factor. In semi-centrifugal clutches, help is taken from centrifugal force by keeping certain weights in eccentric position. The springs are designed to transmit the power at normal speeds and at high speed the assistance is taken from the weights, the weighted lever is hanged at three points at regular intervals. The lever is provided with fulcrum connected to the clutch cover at one end and hinged to the pressure plate at the center and the weight is connected at the outer end. The tail of the lever is provided with the adjusting screw by means of which centrifugal force on the pressure plate can be adjusted. During the increase in speed the weight moves about fulcrum due to the centrifugal force of the weight and hence the pressure plate moves towards the flywheel, thereby increasing the torque transmitting capacity.

Centrifugal Clutch:

This type of clutches operates automatically depending on the engine speed. This type of clutch makes use of centrifugal force to apply the force on the clutch plate as well as on the pressure plate for keeping the clutch in engaged position. In this type, transmission of the power is controlled by the operation of the accelerator. It makes the driving operation very easy and convenient. Hence it is used in automatic transmission in two wheelers with variator mechanisms or two-wheeler without gear mechanism.

This system consists of flywheel as driving member and clutch plate as the driven member. The clutch plate is provided with friction lining on its outer surface. The clutch plate is actuated by means of floating spring which exerts pressure on the pressure plate. The spring on the fly wheel keeps the clutch is disengaged position at low speeds. When the speed increases the weight flees off thereby operating bell crank lever and pressing the pressure plate. The force acting on the pressure plate is transmitted to the clutch plate through the helical spring placed between clutch plate and pressure plate. Due to this force the clutch plate is pressed on to flywheel providing the transmission through the friction lining and thereby resulting in engagement of clutch. The stop provided above the weight limits the amount of centrifugal force. If the speed is increased over this limit, the pressure on the plate will be constant.





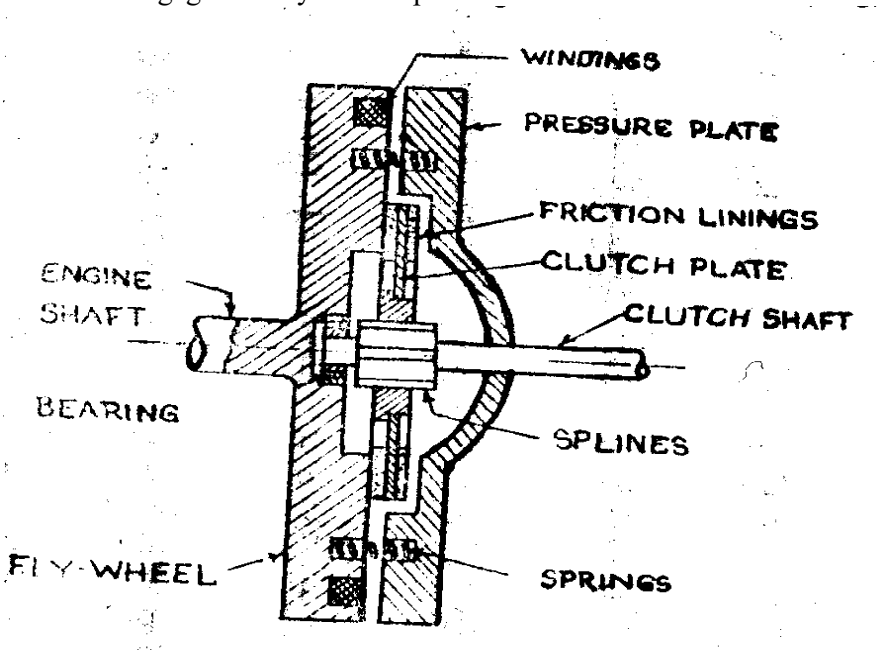
Other type of centrifugal clutches used in automobiles (generally in mopeds) consists of spider as the driving member. The spider has four shoes having the frictional surfaces. These are kept in contact with the cylindrical clutch case by means of springs. As the speed increases, the shoes extend outwards due to centrifugal force and make contact with the cylindrical clutch to transmit the power. The transmission starts as soon as the centrifugal force exceeds the spring force and shoes extends outwards. Hence the power transmission starts as soon as the engine starts rotating at a speed enough to develop the required centrifugal force. The transmission stops as soon as the engine speed drops below the desired value. Hence no power is transmitted to the road wheels when the engine is idle or running at lesser speed than the desired value.

Electromagnetic Clutch:

In this system, the clutch is controlled by means electric current supplied to the field windings in the flywheel. The fly wheel is attached with the field winding, which is given electric current by means of battery, dynamo or alternator. The construction feature of main components is almost similar to the single plate clutch. When electric current is supplied to the windings the flywheel will attract the pressure plate and clutch plate is forced between pressure plate and flywheel resulting in engagement. When the supply to the winding is cut off the clutch is disengaged by releasing the pressure plate due to the force exerted by the helical springs or tension springs. Electromagnetic clutch consists of a clutch release switch. When then driver

holds the gear lever to change the gear, the switch is operated cutting off the current to the winding which causes the clutch disengaged.

When the vehicle is stalling, the engine speed is lower & the dynamo output is low, the clutch is not firmly engaged. Therefore, three springs are also provided on the pressure plate which helps the clutch engaged firmly at low speed also.



The forces of the electromagnet can be regulated by means of an electrical resistance provided with acceleration system and controlled by the accelerator pedal. When the speed is increased, the accelerator pedal is pressed and the resistance is gradually cut off and thus in this way, force of electromagnet is increased and clutch transmission becomes more rigid.