Automotive Transmission
REQUIREMENTS OF TRANSMISSION SYSTEM

• To provide for disconnecting the engine from the driving wheels.
• When the engine is running, to enable the connection to the driving wheels to be made smoothly and without shock.
• To enable the leverage between the engine and driving wheels varied.
• Speed reduction between engine and the drive wheels in the ratio of about 5:1.
• To enable power transmission at varied angles and varied lengths.
• To drive the driving wheel at different speeds when required.
• To enable diversion of power flow at right angle.
Types of transmission system

- Electrical & Electromagnetic transmission
  - a) Fluid coupling
  - b) Torque converter
  - c) Automotive transmission

- Hydraulic transmission
  - a) Fluid coupling
  - b) Torque converter
  - c) Automotive transmission

- Mechanical transmission
  - a) Clutch, gear box, and line axle transmission
  - b) Clutch, gear box, and dead axle transmission
  - c) Clutch, gear box, axeless transmission
A clutch is a mechanism which enables the rotary motion of one shaft to be transmitted to second shaft, whose axis is coincident with that of first.

The clutch is located b/w the engine and gear box.

When the clutch is engaged, the power flows from the engine to the rear wheels through the transmission system and the vehicle moves.

When the clutch is disengaged, the power is not transmitted to the rear wheels and the vehicle stops while the engine is still running.

The clutch is disengaged when:

1) Starting the engine
2) Shifting the gears
3) Stopping the vehicle
4) Idling the engine

The clutch is engaged only when the vehicle is to move and is kept engaged when the vehicle is moving.
Function of a clutch

- To permit engagement or disengagement of a gear when the vehicle is stationary and the engine is running.
- To transmit the engine power to the road wheels smoothly without shock to the transmission system while setting the wheel in motion.
- To permit the engaging of gears when the vehicle is in motion without damaging the gear wheels.
The clutch disengages and engages the engine to the transmission.

- Only one disc is turning.
- Both discs are turning.
Requirements of a clutch

- It should be **engage gradually** to avoid sudden jerks.
- It should be **easily operated** (i.e., it should consume minimum physical effort at the time of engagement and disengagement).
- It should be **dynamically balanced** (particularly required in case of high-speed engine clutches).
- It should be **free from slip** when engaged.
- It should be as possible so that it will **occupy minimum space**.
- It should be **easily accessible** and have simple means of adjustment.
- It should be suitable mechanism to **damp vibrations** and to eliminate noise produced during the power transmission.
- It should be able to **dissipate large amount of heat** which is generated during the clutch operation due to friction.
- The **wearing surfaces** should have long life.
Types of clutches

Positive engaged clutch
- Dog clutch
  - Cone clutch
  - Disc clutch
  - Single disc clutch

Gradually engaged clutch
- Friction clutch
  - Semi centrifugal clutch
  - Multi disc clutch
- Centrifugal clutch
  - Fluid coupling
Positive clutches

- The positive clutches are used when a positive drive is required.
- The simplest type of a positive clutch is a jaw or claw clutch.
- The jaw clutch permits one shaft to drive another through a direct contact of interlocking jaws.
- A square jaw type of clutch will transmit power in either direction of rotation.
- The spiral jaws may be left-hand or right-hand, because power transmitted by them in one direction only.
Basic Principle of friction clutch

Only one disc is turning

Both discs are turning

Fig : A

Fig : B
Principle of friction clutch explanation

- Let shaft “A” and disc “C” be revolved at same speed, say N r.p.m
- Shaft “B” and the disc “D” keyed to it are stationary, initially when the clutch is not engaged.
- Now apply some axial force “W” to the disc “D” so that it comes in contact with disc “C”.
- As soon as the contact is made, the force of friction b/w “C” and “D” will come in to play and consequently the disc “D” will also start revolving.
- The force of “D” depends upon the friction force present, which is turn, is proportional to the force “W” applied.
- If “W” is increased gradually, the speed of “D” will be increased correspondingly till the stage comes when the speed of “D” becomes equal to the speed of “C”
- Then the clutch is said to be fully engaged
The clutch disc is squeezed against the flywheel by spring pressure when the pedal is up.
Pushing on the pedal moves the pivot lever to pull the pressure plate away from the disc.
Exploded view of single plate coil spring clutch
CONSTRUCTION OF MULTI COIL SPRING SINGLE PLATE CLUTCH

• A typical clutch actuated by a number of coil springs on a pitch circle nears the periphery as shown.
• The driven shaft which normally is a forward extension of gearbox primary shaft is supported at its front end in ball bearing in a hole in the centre of flywheel web, which is spigot and bolted onto a flange at the rear end of the crankshaft.
• In this clutch, the coil springs force the pressure plate forwards to clamp the driven plate between it and the rear face of the flywheel.
• Three lugs extend rearwards from periphery of pressure plate both to rotate the pressure plate and to cause it to rotate with the rest of the assembly.
• The driven plate of course is splined onto the shaft
• There are three release levers pressing the coil springs at the outer end.
• The inner ends of the levers can be forced forward by means of thrust bearing made of graphite and slide along the clutch shaft when clutch pedal is depressed.
• The driven plate mounted between flywheel and pressure plate makes the clutch shaft to rotate to transmit power.
• It has the clutch facing made of friction materials around the periphery of disc.
WORKING OF MULTI COIL SPRING SINGLE PLATE CLUTCH

• When the clutch is engaged, the clutch plate is gripped between the flywheel and pressure plate.
• The friction linings are on both sides of clutch plate.
• Due to friction between flywheel, clutch plate and pressure plate, the clutch plate revolves with the flywheel.
• As clutch plate revolves the clutch shaft also revolves.
• Thus, engine power is transmitted to the clutch shaft.
• When the clutch pedal is pressed the pressure plate moves back against the spring force and clutch plate becomes free between flywheel and pressure plate.
• Thus flywheel remains rotating as long as the clutch pedal is pressed, the clutch is said to be disengaged and clutch shaft speed reduces slowly and finally it stops rotating.
Advantages to a coil spring.

- It is better for heavy-duty uses because more coil springs can be installed to make a clutch apply with more force.
- Putting a weight at the end of the release lever results in centrifugal force applying the clutch more tightly at higher speeds.

Coil spring disadvantages include:

- More pedal pressure is required from the driver to disengage it.
- It does not apply the clutch as heavily as the disc wears.
- Coil spring clutch covers must be precisely balanced after assembly.
Multi-plate Clutch

Outer drum

Inner drum
Explanation about the Multi-plate clutch

• The multi-plate clutch is an extension of single plate type where the number of frictional and the metal plates are increased. The increase in the number of friction surfaces obviously increase capacity of the clutch to transmit torque, the size remaining fixed.

• Alternatively, the overall diameter of the clutch is reduced for the same torque transmission as a single plate clutch.

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

• Besides, this finds applications in case of scooters and motorcycles, where space available is limited.

• Extension of flywheel is a drum; which on its inner circumference is splined to carry a number of thin metal plates. These must consequently revolve with drum but are able to slide axially.

• Interleaved with these outer plates are a number of inner plates that are splined to an inner drum which is coupled rotationally to the gearbox shaft.
• This drum is supported on a spigot extension of the crankshaft with a bush bearing. Between the web of inner drum and a sleeve screwed in to the cover plate of the outer drum is a strong coil spring.
• Thus inner drum is pressed to left, squeezing both outer and inner plates.
• Thus driving torque is transmitted due to friction between the plates.
• The clutch is disengaged by pulling inner drum right against spring force.
• The plates of multi-plate clutch were made of steel and phosphor bronze alternately but now are all of steel or one set may be lined with a friction material.
• With metal to metal contact lubrication is essential. So clutch is made oil-tight and partly filled with oil. The oil tends to make the Plates drag when clutch is disengaged so a clutch stop (or) brake is fitted to avoid this drag.
Diaphragm Clutch
Exploded view of diaphragm spring clutch

The coil-spring clutch is rapidly being superseded by the diaphragm clutch, which needs less pedal effort. It contains a conical spring, with slugs radiating from the centre, and is almost flattened, so that in trying to regain its conical shape it exerts an even pressure round its outer edge. This presses against the pressure plate. The thrust pad, acting against the diaphragm, flexes it the other way and frees the pressure plate.

Engaged: The flattened diaphragm spring pushes against the pressure plate.

Disengaged: Thrust pad flexes the spring and so frees the pressure plate.

Parts of a Diaphragm Clutch:
- Pressure plate
- Locating studs fix diaphragm, sandwiched between fulcrum rings, to cover.
- Fulcrum rings
- Diaphragm spring pushes pressure plate against driven plate.
- Clutch thrust fork
- Friction pads on driven plate
- Crankshaft
- Diaphragm
- Pressure plate
Load Vs Deflection

- **Multispring**
  - Load vs Deflection graph
  - Points A, B, C, D

- **Diaphragm**
  - Load vs Deflection graph
  - Points A, B, C, D

Legend:
- A - When dismantled
- B - When assembled
- C - When clutch pressed
Explanation about the diaphragm spring clutch

- Diaphragm spring pressure plate assemblies are widely used in most modern cars.
- The diaphragm spring is a single thin sheet of metal which yields when pressure is applied to it.
- When pressure is removed the metal springs back to its original shape.
- The centre portion of the diaphragm spring is slit into numerous fingers that act as release levers.
- During disengagement of the clutch the fingers are moved forward by the release bearing.
- The spring pivots over the fulcrum ring and its outer rim moves away from the flywheel.
- The retracting spring pulls the pressure plate away from the clutch plate thus disengaging the clutch.
• When engaged the release bearing and the fingers of the diaphragm spring move towards the transmission.
• As the diaphragm pivots over the pivot ring its outer rim forces the pressure plate against the clutch disc so that the clutch plate is engaged to the flywheel.
Advantages of the diaphragm clutch

- It is more compact than other designs.
- It is easier to balance rotationally and is less subjected to unwanted effects due to centrifugal force at high rotational speeds.
- It gives uniformly distributed pressure on pressure plate.
- No needs release levers.
- Minimum effort is sufficient to disengage the clutch.
- It provides minimum number of moving components and hence minimum internal friction is experienced.
- This is very commonly used in cars, light Lorries and mini trucks but is not much used in heavy vehicles.
Centrifugal Clutch
Explanation about the centrifugal clutch

- In this type of clutches, the springs are eliminated altogether and only the centrifugal force is used to apply the required pressure for keeping the clutch in engagement position.
- The advantage of the centrifugal clutch is that no separate clutch pedal is required.
- The clutch is operated automatically depending upon the engine speed.
- This means that car can be stopped in gear without stalling the engine.
- Similarly while starting, the driver can first select the gear, put the car into the gear and simply press the accelerator pedal. This makes the driving operation very easy.
- Figure shows a schematic diagram of a centrifugal clutch. As the speed increases, the weight A flying, thereby operating the bell crank lever B that presses the plate C.
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- This force is transmitted to the plate D by means of springs E. The plate D containing friction lining is thus pressed against the flywheel F thereby engages the clutch.
- Spring G serves to keep the clutch disengaged at low speed say 500 rpm.
- The stop H limits the amount of centrifugal force.
- The operating characteristics of this type of clutch will be then as shown in figure.
- Force P is proportional to the centrifugal force at a particular speed, while force Q exerted by spring G is constant at all speeds.
- The firm line in the figure shows that net force on the plate D for various engine speeds. At the upper end the curve is made flat by means of stop H.
Semi Centrifugal Clutch
Explanation about the semi-centrifugal clutch

- It uses both centrifugal and spring force for keeping it in an engaged position of the clutch.
- The springs are designed to transmit torque at normal speed, while centrifugal force assists in torque transmission at high speed.
- This clutch consists of three hinged and weighted levers and three clutch springs alternately arranged at equal spaces on the pressure plate.
- At low speeds the springs keep the clutch engaged and the weighted levers do not have any pressure on pressure plate.
- At high speeds when power transmission is high, weights fly off and the levers also exert pressure on plate, keeping the clutch firmly engaged.
- When the speed decreases the weights do not exert any pressure on the pressure plate.
- Only spring pressure is exerted on pressure plate which keeps the clutch engaged.
• An adjusting screw is provided at the end of the lever by means of which the centrifugal force on pressure plate can be adjusted.
• At low speeds pressure on the spring is sufficient to transmit the torque required.
• However at high speeds, the centrifugal force due to weight moves about the fulcrum thereby pressing the pressure plate.
• The centrifugal force is proportional to the square of speed so that adequate pressure level is attained.
Graph shows the variation of force on the pressure plate as speed increases. At low speeds spring along applies the force on the pressure plate. But when speed of the engine raises the centrifugal force also applied by the weights.
Electromagnetic clutch

Fig. 3.30. Electromagnetic clutch.
Explanation about the Electromagnetic clutch

- This type of clutch has been employed on some Renault cars.
- The construction and working of this clutch may be understood by means of simplified fig.
- A is the engine flywheel incorporating the winding B.
- Clutch plate C is lined with friction surfaces and is free to slide on splines on the clutch shaft.
- D is the pressure plate.
- The winding B is supplied with current from battery dynamo.
- When the winding B is energized, it attracts the pressure plate D, thereby engaging the clutch.
- When supply to winding B is cut off, the clutch is disengaged.
- There is a clutch release switch in the gear lever.
- This switch is operated as soon as the driver holds the gear lever change the gear, cutting off current to the winding and thus causing clutch disengagement.
• Ordinarily the winding is connected to engine dynamo. At lower engine speeds, dynamo output is also low which makes the force in winding very small.

• Three springs are also provided in the clutch (not shown) to balance this reduced electromagnetic force at low speeds, thus disengaging the clutch.

• During normal operation, the electromagnetic force of the winding is regulated by means of an electrical resistance, which itself is controlled by means of accelerator pedal.

• As the acceleration pedal is pressed the resistance is gradually cut, thus increasing the electromagnetic force.

• The electromagnetic type of clutch is best suited remote operation is desired since no linkages are required to control its engagement.

• A major limitation of this type is that of heat capacity since the clutch-operating temperature is limited by the temperature rating of the insulation of the magnetic coil.

• Another disadvantage is its higher initial cost.