Unit No.02

Drive Train

Prepared by,

Prof. Santosh Kailas Chandole

ME (Design Engineering)

BE (Automobile Engineering)
Clutches

The clutch is an intermediate mechanism which is placed in between the flywheel and the gearbox for the purpose of allowing or discounting the power flow from engine to the transmission system. the clutch remain engaged position and allow flow of power from engine to the gearbox.

Requirements of a good clutch:-
1. Gradual engagement
2. Effortless operation
3. Size
4. Inertia and mass

Different type of clutches can be classified:-
1. Friction clutches
2. Fluid Flywheel
3. Electromagnetic clutches
4. Power clutches
5. Electro-rheological clutches
WHAT IS CLUTCHES?

- A **clutch** is a mechanical device that engages and disengages the power transmission, especially from driving shaft to driven shaft.

- In the simplest application, clutches connect and disconnect two rotating shafts (drive shafts or line shafts). In these devices, one shaft is typically attached to an engine or other power unit (the driving member) while the other shaft (the driven member) provides output power for work.
PRINCIPLE OF CLUTCH

• It operates on the principle of friction. When two surfaces are brought in contact and are held against each other due to friction between them, they can be used to transmit power. If one is rotated, then the other also rotates. One surface is connected to the engine and the other to the transmission system of the automobile. Thus, clutch is nothing but a combination of two friction surfaces.
MAIN PARTS OF A CLUTCH

• It consists of
  (a) a driving member,
  (b) a driven member, and
  (c) an operating member.

• Driving member has a flywheel which is mounted on the engine crankshaft. A disc is bolted to flywheel which is known as pressure plate or driving disc.

• The driven member is a disc called clutch plate. This plate can slide freely to and fro on the clutch shaft.

• The operating member consists of a pedal or lever which can be pressed to disengaged the driving and driven plate.
TYPES OF CLUTCHES

1) Mechanical clutches
2) Pneumatic clutches
3) Hydraulic clutches
4) Electromagnetic clutches

- **Mechanical clutches**
  1) Positive contact clutches
     i. jaw clutches
     ii. toothed clutches
  2) Friction clutches
     i. Disc clutches
     ii. Cone clutches
     iii. centrifugal clutches
A single plate is commonly used in cars and light vehicles. It has only one clutch plate which is mounted on the splines of the clutch shaft.

A flywheel is mounted on the crankshaft of the engine. A pressure plate is connected to the flywheel through the bolts and clutch springs. It is free to slide on the clutch shaft with the movement of clutch pedal.

When clutch is in engaged position, the clutch plate remains gripped between flywheel and pressure plate. Friction linings are provided on both the sides of clutch plate.
On one side clutch plate is in touch with flywheel and on other side with pressure plate. Due to friction on both sides, the clutch plate revolves with engine flywheel. Therefore, clutch transmits engine power to clutch shaft. Clutch shaft is connected to transmission (or gear box) of automobile. Thus, clutch transmits power from engine to transmission system which in turn rotates wheels of engine.

When the clutch plate is to be disengaged, the clutch pedal is pressed. Because of this pressure plate moves back and clutch plate is disengaged from flywheel. Thus, clutch shaft stops rotating even if engine flywheel is rotating. In this position, power does not reach the wheels and vehicle also stops running. Single plate clutch is shown in fig.
MULTIPLATE CLUTCH

 ✓ Multi-plate clutch consists of more than one clutch plates contrary to single plate clutch which consists of only one plate. Friction surfaces are made in case of multi-plate clutch. Due to increased number of friction surfaces, a multi-plate clutch can transmit large torque.

 ✓ Therefore, it is used in racing cars and heavy motor vehicles which have high engine power. The clutch plates are alternatively fitted with engine shaft and the shaft of gearbox. The plates are firmly held by the force of coil springs and they assembled in a drum.
✓ One plate slides in the grooves on the flywheel and the next plate slides on spines provided on pressure plate. Thus, each alternate plate slides in grooves on the flywheel and the other on splines of pressure plate. If we take two consecutive plates, then one has inner and other has outer splines.

✓ When the clutch pedal is pressed, the pressure plate moves back against the force of coil spring, hence the clutch plates are disengaged and engine flywheel and gear box are decoupled. However, when clutch pedal is not pressed the clutch remain in engaged position and the power can be transmitted from engine flywheel to the gear box. This type of clutch has been shown in Figure.
Cone clutch

\[ \alpha = \text{semi-apex angle of the cone} \]

Only one pair of driving surfaces is possible, \( n = 1 \)

The maximum torque transmitted = \( T = \mu W r_m \csc \alpha \)
Centrifugal clutch

Total friction torque, \( T = \eta \mu R (F - P) \)
Gear box

Necessity of Gear box: Necessity for gear ratios in transmission, Synchronous gear boxes, 3, 4 and 5 speed gear boxes, Free Wheeling mechanism, Planetary gears systems, over drives, fluid coupling and torque converters, Epicyclic gear box, principle of automatic transmission, calculation of gear ratios

Functions of Transmission:

• To provide the high torque at the time of starting, hill climbing, accelerating and pulling a load since high tractive effort is needed
• It permits engine crankshaft to revolve at high speed, while the wheels turn at slower speeds
• Variable torque by set of gears
• Vehicle speed can be changed keeping engine speed same with certain limit
• The transmission also provides a neutral position so that the engine and the road wheels are disconnected even with the clutch in the engaged position
• A means to back the car by reversing the direction of rotation of the drive is also provided by the transmission
1. Constant mesh gear box
Explanation of Constant mesh gear box

In this type of gearbox, all the gears of the main shaft are in constant mesh with corresponding gears of the countershaft.

• The gears on the main shaft which are bushed are free to rotate.
• The dog clutches are provided on main shaft.
• The gears on the lay shaft are, however, fixed.
• When the left Dog clutch is slide to the left by means of the selector mechanism, its teeth are engaged with those on the clutch gear and we get the direct gear
  • The same dog clutch, however, when slide to right makes contact with the second gear and second gear is obtained.
• Similarly movement of the right dog clutch to the left results in low gear and towards right in reverse gear. Usually the helical gears are used in constant mesh gearbox for smooth and noiseless operation
2. SYNCHROMESH GEAR BOX
Explanation of SYNCHROMESH GEAR BOX

This type of gearbox is similar to the constant mesh type gearbox.

- Instead of using dog clutches here synchronizers are used.
- The modern cars use helical gears and synchromesh devices in gearboxes, that synchronize the rotation of gears that are about to be meshed SYNCHRONIZERS.
- This type of gearbox is similar to the constant mesh type in that all the gears on the main shaft are in constant mesh with the corresponding gears on the lay shaft.
- The gears on the lay shaft are fixed to it while those on the main shaft are free to rotate on the same.

Its working is also similar to the constant mesh type, but in the former there is one definite improvement over the latter.

- This is the provision of synchromesh device which avoids the necessity of double-declutching.
- The parts that ultimately are to be engaged are first brought into frictional contact, which equalizes their speed, after which these may be engaged smoothly.
- Figure shows the construction and working of a synchromesh gearbox. In most of the cars, however, the synchromesh devices are not fitted to all the gears as is shown in this figure.
- They are fitted only on the high gears and on the low and reverse gears ordinary dog clutches are only provided.
- This is done to reduce the cost.
3. Sliding mesh type of gear box
Explanation of Sliding mesh Gear Box

**FIRST GEAR** • By operating gearshift lever, the larger gear on main shaft is made to slide and mesh with first gear of countershaft. • The main shaft turns in the same direction as clutch shaft in the ratio of 3:1.

**SECOND GEAR** • By operating gear shaft lever, the smaller gear on the main shaft is made to slide and mesh with second gear of counter shaft. • A gear reduction of approximately 2:1 is obtained.

**TOP GEAR** • By operating gearshift lever, the combined second speed gear and top speed gear is forced axially against clutch shaft gear. • External teeth on clutch gear mesh with internal teeth on top gear and the gear ratio is 1:1.

**REVERSE GEAR** • By operating gearshift lever, the larger gear of main shaft is meshed with reverse idler gear. • The reverse idler gear is always on the mesh with counter shaft reverse gear. Interposing the idler gear, between reverse and main shaft gear, the main shaft turns in a direction opposite to clutch shaft.

**NEUTRAL GEAR** • When engine is running and the clutch is engaged, clutch shaft gear drives the drive gear of the lay shaft and thus lay shaft also rotates. • But the main shaft remains stationary as no gears in main shaft are engaged with lay shaft gears.
An **automatic transmission**, also called auto, self-shifting **transmission**, n-speed **automatic** (where n is its number of forward gear ratios), or AT, is a type of motor vehicle **transmission** that can automatically change gear ratios as the vehicle moves, freeing the driver from having to shift gears manually.
DIFFERENTIAL
Explanation of DIFFERENTIAL

To the crown wheel of the final drive is attached a cage which carries a spider. The sun gears mesh with two or four planet pinions. Each of the half shafts is splined to the sun gears. The crown wheel is free to rotate on the half shaft.

When the vehicle is going in straight ahead position both the cage and inner gears rotate as a single unit and there is no relative movement between the various differential gears.

To understand when vehicle is taking a turn, let us assume the cage to be stationary. Thus by rotating one of the sun gear (say left) at a speed of ‘n’ RPM causes the right sun gear to rotate at the same speed but in opposite direction. If ‘N’ RPM is the vehicle’s speed then the speed of inner wheels will be (N - n) RPM and the speed of outer wheels will be (N + n) RPM. This speed is superimposed to the normal speed wheel when vehicle is taking a turn. The torque from final drive is divided equally between the two half shafts. As the planet pinions are attached to the spider they cannot apply different torque to the teeth of one side from the one on the other side. They divide the torque equally between the two half shafts even when the speed is different.
Due to this reason, when one of the wheels gets trapped on a slippery surface where it can simply skid and that the torque given to it will just rotate idly, then no tractive force can be obtained from the other wheel. In this case the wheel speed will rotate twice the crown wheel speed, while the other will remain stationary. This equality of torque will be possible if there is no friction in the differential. However in actual practice, this is not possible as there will also be inequality of torques. The larger the amount of friction, the larger is the inequality of torques. For example, if one of the wheel with friction in the differential gets stuck into the mud, when it get lifted from the mud while turning with high speed, the larger amount of torque is transmitted to the other wheel which has a good drip then the slippery wheel. Then the grip of the wheel is utilized, this would not be possible in the absence of friction. It is for this reason, that clutch friction plates are introduced in differential in between cage and sun gear. These plates are loaded with the help of dished springs, which are so mounted that loading decreases or increases as torque are varied. The frictional differential, thus provided is not to stop the normal differential action and are called Nom-slip differential.
The propeller shaft is a shaft that transmits power from gear box to the differential.
• On one end, propeller shaft in connected to main transmission shaft by universal joint.
• On the other hand, it is connected to differential pinion shaft by another universal joint.
• Propeller shaft transmits the rotary motion of main transmission shaft (coming from gear box) to the differential so that rear wheels can be rotated.
• A sliding (slip) joint, is also fitted between universal joint and propeller shaft on transmission side which takes care of axial motion of propeller shaft.
• Propeller shaft is made of a steel tube which can withstand torsional stresses and vibrations at high speeds.
Universal (Hooks) Joint

• Universal joints are used to connect to pinion flange yoke and sleeve yoke
• May have balance weights attached

Advantages of Universal joints:
• High torque capacity
• Long bearing life
• High operating angle capability
• Heat treated alloy steel components
• Ideal loading across entire bearing length due to balanced deflection between yokes and cross
• High shock and overload capacity
• Long life