# V CLUTCHES & BRAKES:-

## CLUTCHES:-

-> The clutch is a Mechanical device which is used to connect (or) disconnect the source of power at the operator's will. The use of clutches is Mostly found in automobile. In an automobile, clutch is a transmission device which is used to engage and disengage the power from the Engine to the rest of the system.

Functions of the clutch:-

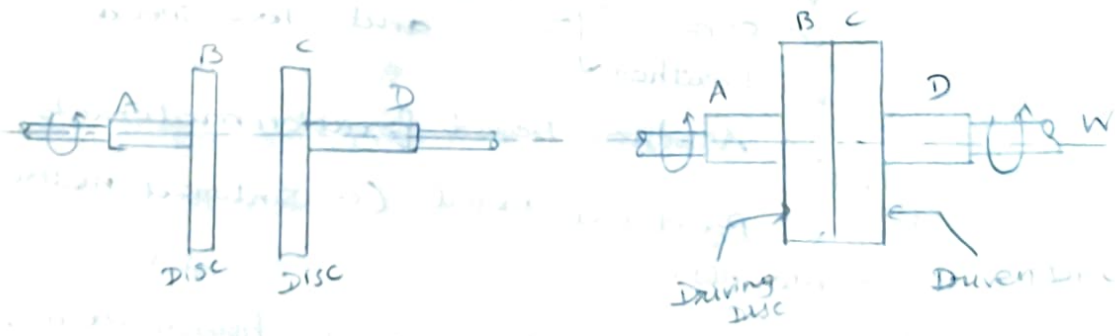
-> To connect and disconnect the shafts at will.

-> To start or stop a Machine (or a rotating Element) without starting and stopping the Prime Mover.

-> To Maintain Constant speed, torque and Power.

-> To reduce shocks transmitted between machine shafts.

-> For automatic disconnect, quick start and stop, gradual starts, and non-reversing and over running functions.




Before Engagement

b) After engagement

## Classification of clutches:-

The clutches are classified into two ways.

1) Based on the engagement (or) actuation method used:-

a) Mechanical
b) Pneumatic
c) Hydraulic
d) Electrical
e) Automatic

2) Based on the basic operating principle used:

a) Positive contact clutches
- ✓ Square jaw
- ✓ Spiral jaw
- ✓ Toothed.

b) Frictional clutches
- ✓ Axial
- ✓ Radial
- ✓ Cone.

c) over running clutches
- ✓ Roller
- ✓ Sprag
- ✓ Wrap-Spring.

d) Magnetic clutches:-
- ✓ Magnetic particles
- ✓ Hysteresis.
- ✓ Eddy current.

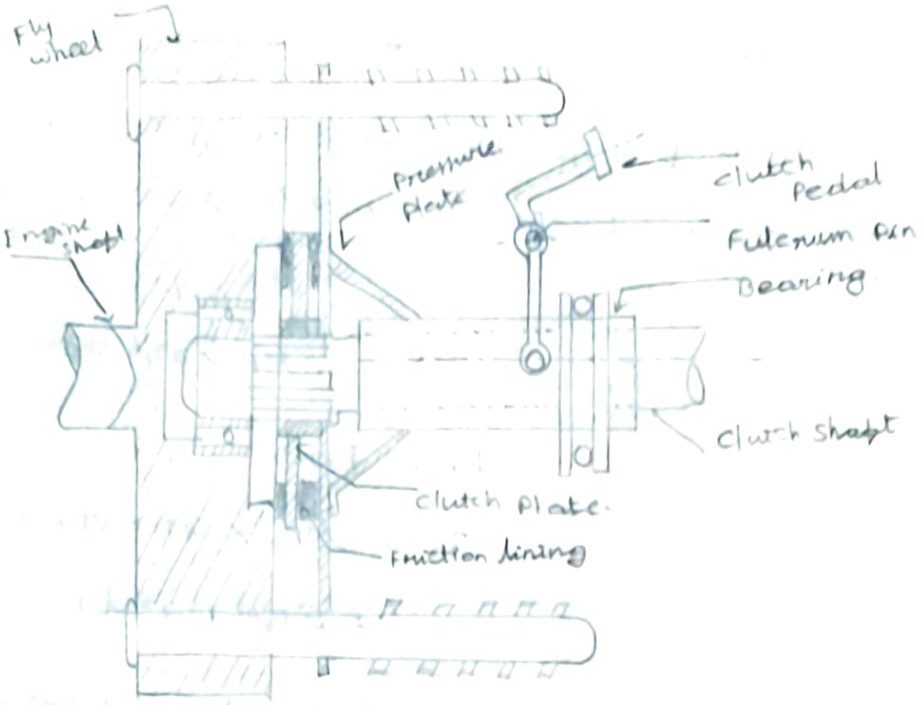
e) Fluid coupling.
- ✓ Dry fluid
- ✓ Hydraulic
- ✓

Commonly used Friction materials are.
- ✓ Wood
- ✓ Cork
- ✓ Leather

} → These are used only for light loads and low speeds.

- ✓ Asbestos based friction materials and
- ✓ Powdered metal (or Sintered metal) friction materials.

→ ✓ For High speeds and heavy loads.

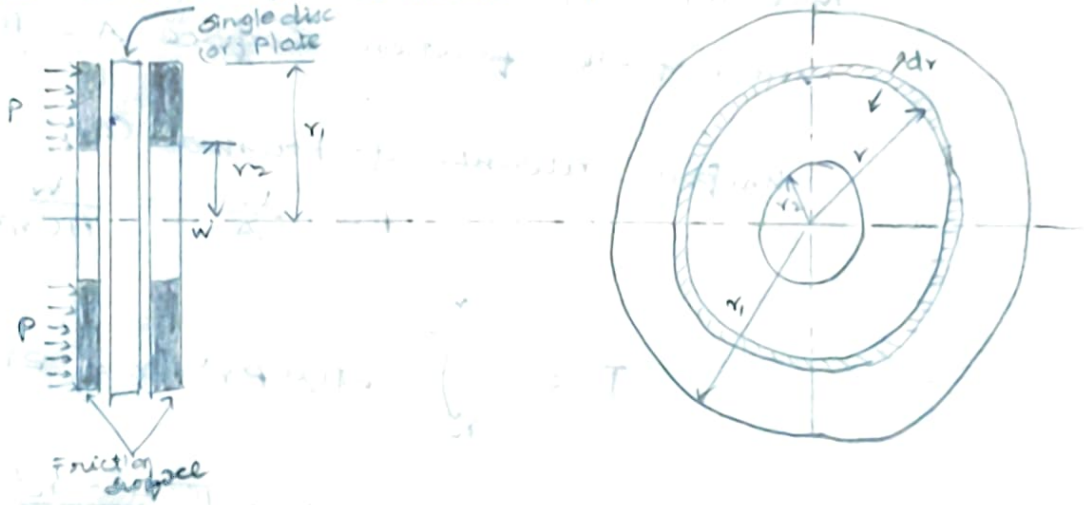



Single Plate clutch.

Design of a single Plate clutch :-

( Torque Transmitted by the single Plate clutch)

Consider two friction surfaces held together by an axial thrust W, as shown in fig.




Forces on a single disc (or) Plate clutch

T → Torque Transmitted by the clutch

P → intensity of axial Pressure acting on contact surfaces

$r_1$ → External radius of friction surface

$r_2$ → Internal " " "

$\mu$ → coefficient of friction.

Consider an Elementary ring of radius r and thickness dr, as shown in fig.

Area of the elemental ring $= 2\pi r \cdot dr$.

Normal (or) axial force on the ring $\delta W$ = Pressure x Area

$\Rightarrow p \times 2\pi r \times dr$.

$$F_r = \mu \cdot \delta W = \mu p \times 2\pi r \cdot dr$$

$$T_r = F_r \times r$$

$$T_r = \mu p \times 2\pi r \cdot dr \times r$$

$$= 2\pi \mu p r^2 dr.$$

The design of friction clutch is done based on any one of the following assumptions:

i) When there is a uniform pressure

ii) When there is a uniform wear.

Considering uniform Pressure:

Area of the friction surface $A = \pi(r_1^2 - r_2^2)$

Uniform intensity of Pressure (p)

$$p = \frac{W}{A} = \frac{W}{\pi(r_1^2 - r_2^2)}$$

$$T = \int_{r_2}^{r_1} 2\pi \mu p r^2 dr = 2\pi \mu p \left[\frac{r^3}{3}\right]_{r_2}^{r_1}$$

$$\Rightarrow 2\pi \mu p \left[\frac{r_1^3 - r_2^3}{3}\right]$$

$$T = 2\pi \mu \times \frac{W}{\pi(r_1^2 - r_2^2)} \left[\frac{r_1^3 - r_2^3}{3}\right]$$

$$T = \frac{2}{3} \times \mu W \left[\frac{r_1^3 - r_2^3}{r_1^2 - r_2^2}\right] = \mu W R$$

R -> mean radius of friction surface

$$R = \frac{2}{3}\left[\frac{r_1^3 - r_2^3}{r_1^2 - r_2^2}\right]$$

ii) considering uniform wear :-

For uniform wear, the intensity of Pressure varies inversely with the distance.

$$P.r = \text{constant} = C \quad (\text{or}) \quad P = \frac{C}{r}$$

$$P_1.r_1 = P_2.r_2 = C$$

Where $P_1$ and $P_2$ are intensities of Pressure at radii $r_1$ and $r_2$ Respectively ...,

$$\delta W = P 2\pi r\, dr = 2\pi (P.r)\, dr = 2\pi C\, dr$$

$$W = \int_{r_2}^{r_1} 2\pi C\, dr = 2\pi\, C [r]_{r_2}^{r_1} =$$

$$2\pi C (r_1 - r_2).$$

$$C = \frac{W}{2\pi (r_1 - r_2)}$$

$$T_r = 2\pi \mu P r^2\, dr = 2\pi\mu \times \frac{C}{r} \times r^2 . dr$$

$$\Rightarrow 2\pi\mu . C . r . dr$$

$$T = \int_{r_2}^{r_1} 2\pi \mu . C . dr = 2\pi \mu C \left[\frac{r_2}{2}\right]_{r_2}^{r_1}$$

$$2\pi\mu C \left[\frac{r_1^2 - r_2^2}{2}\right]$$

$$T = \pi\mu C \left[r_1^2 - r_2^2\right]$$

$$T = \pi\mu \times \frac{W}{2\pi (r_1 - r_2)} \times (r_1^2 - r_2^2)$$

$$T = \frac{1}{2} \times \mu . W (r_1 + r_2) = \mu . W . R.$$

$$\boxed{R = \frac{r_1 + r_2}{2}}$$

Design of a multiplate clutch:

(Torque Transmitted on multiplate clu

$n_1$ => Number of disc on driving shaft

$n_2$ => No of discs on the driven shaft

$$n = n_1 + n_2 - 1$$

$$T = n \cdot \mu \cdot W \cdot R$$

T: Total frictional Torque

$$R = \frac{2}{3}\left[\frac{r_1^3 - r_2^3}{r_1^2 - r_2^2}\right]$$ For uniform pressure

$$R = \frac{r_1 + r_2}{2}$$

Table 10.2

Driver dynamic characteristic factor $K_1$

(from databook, P.g No: 7.90)

Table 10.3 Driven dynamic characteristic factor $k_2$

(From databook P.g No: 7.91)

Table 10.4 wear factor, $k_3$ (from databook P g No 7.91)

Table 10.5 Frequency of operation factor, $K_4$

(from databook, P.g No: 7.91)