Clutches: Working and its Applications

TABLE OF CONTENT

INTRODUCTION TO CLUTCHES

PURPOSE OF A CLUTCH

The Clutch serves the two purpose:

- ✓ Allows engine to be *disengaged* from transmission for shifting gears and coming to a stop
- ✓ Allows smooth *engagement* of engine to transmission

REQUIREMENTS OF A CLUTCH

The Clutch serves the two purpose:

- ✓ Allows engine to be *disengaged* from transmission for shifting gears and coming to a stop
- ✓ Allows smooth *engagement* of engine to transmission

LOCATION OF A CLUTCH

Depending on the type of drive, the clutch changes its location:

- Rear wheel drive
  - Front engine
  - Rear engine
  - Mid engine
- Front wheel drive

COMPONENTS IN A CLUTCHES

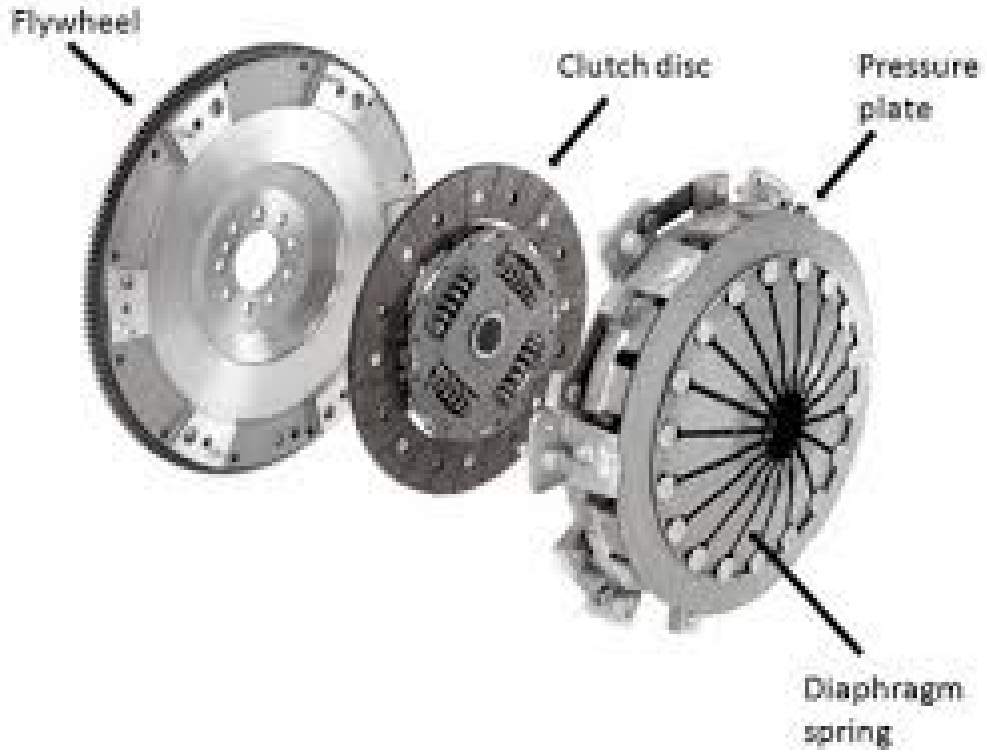
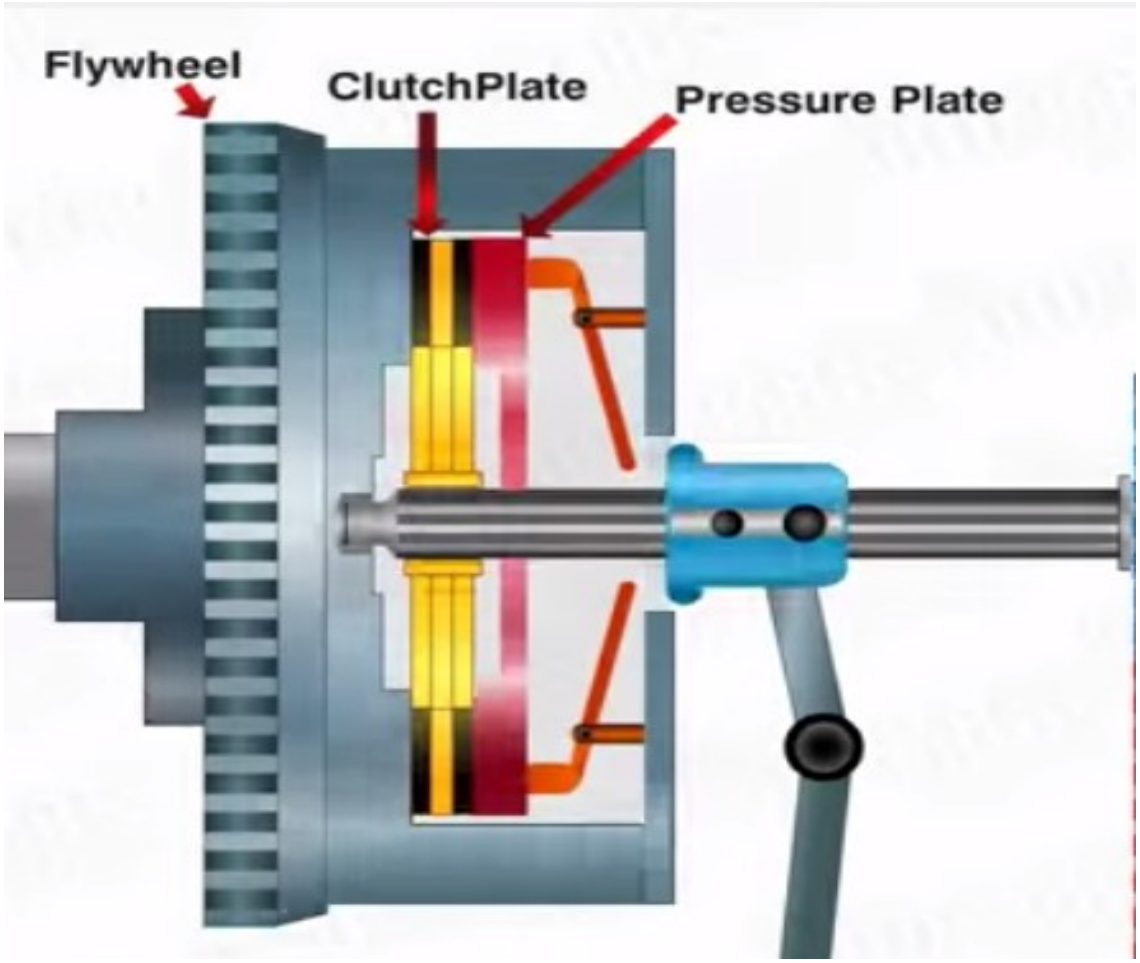
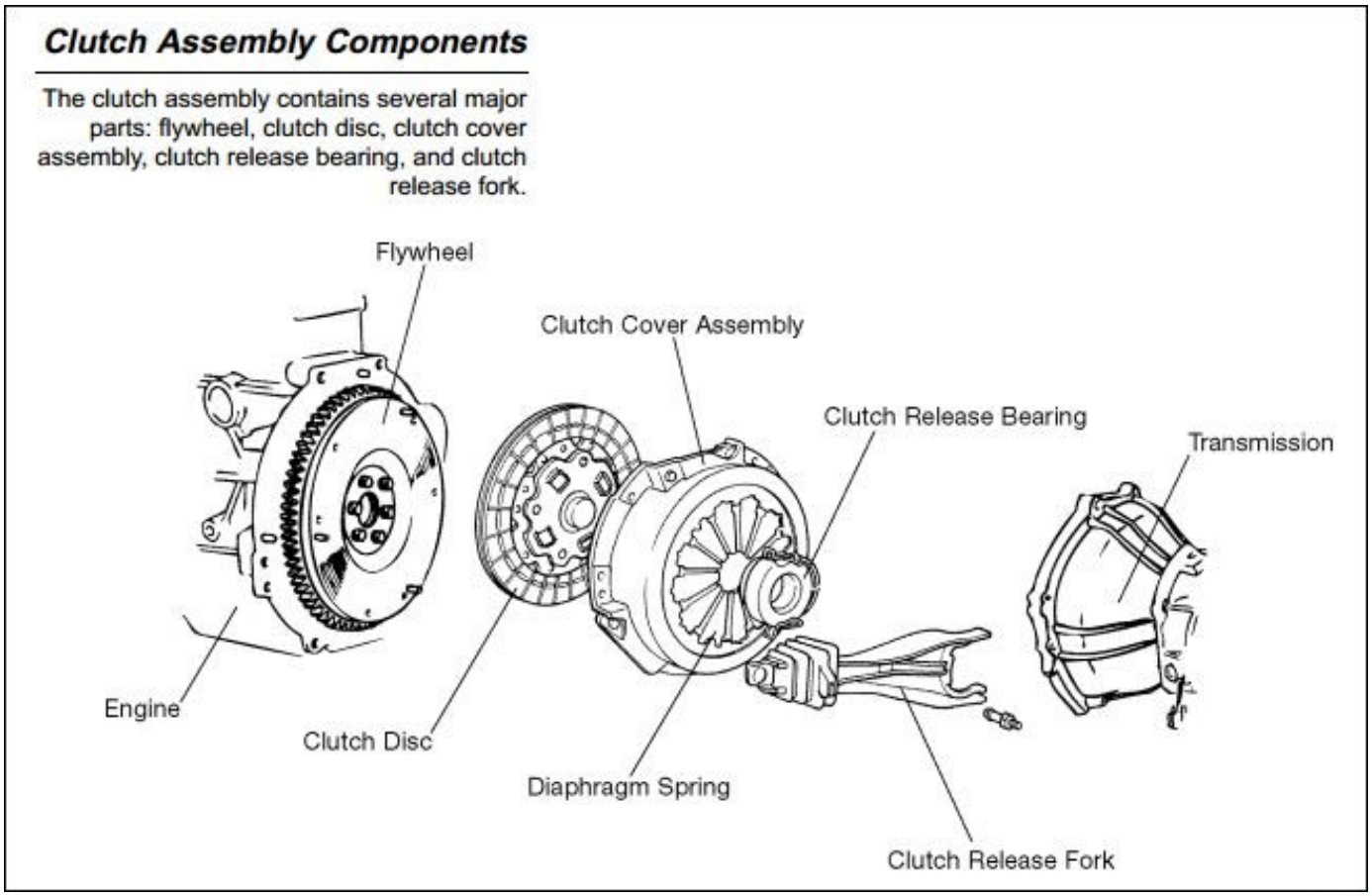


DIAGRAM OF CLUTCH PARTS



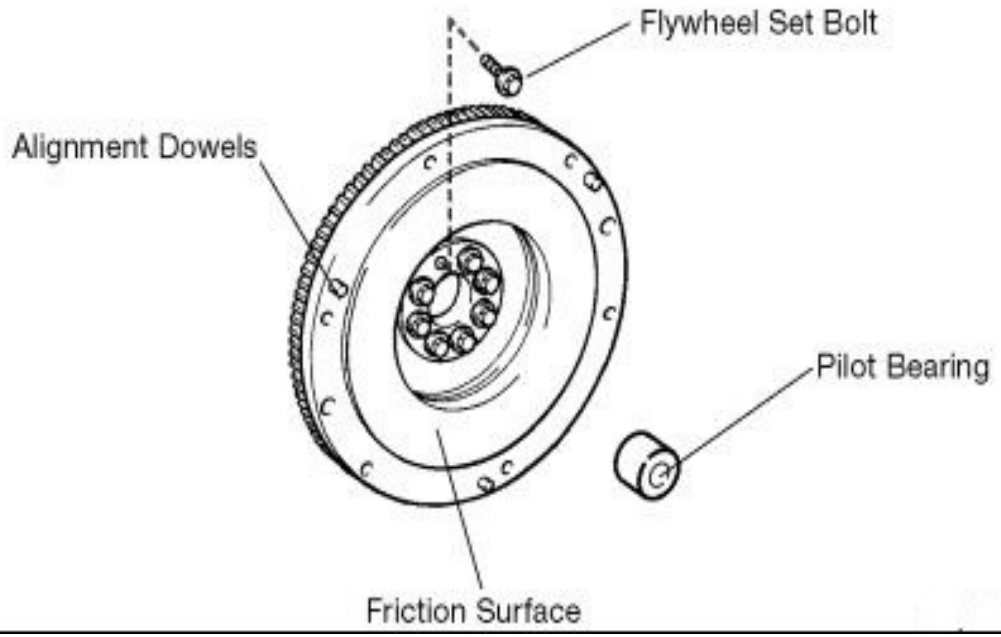
CLUTCH ASSEMBLY COMPONENTS



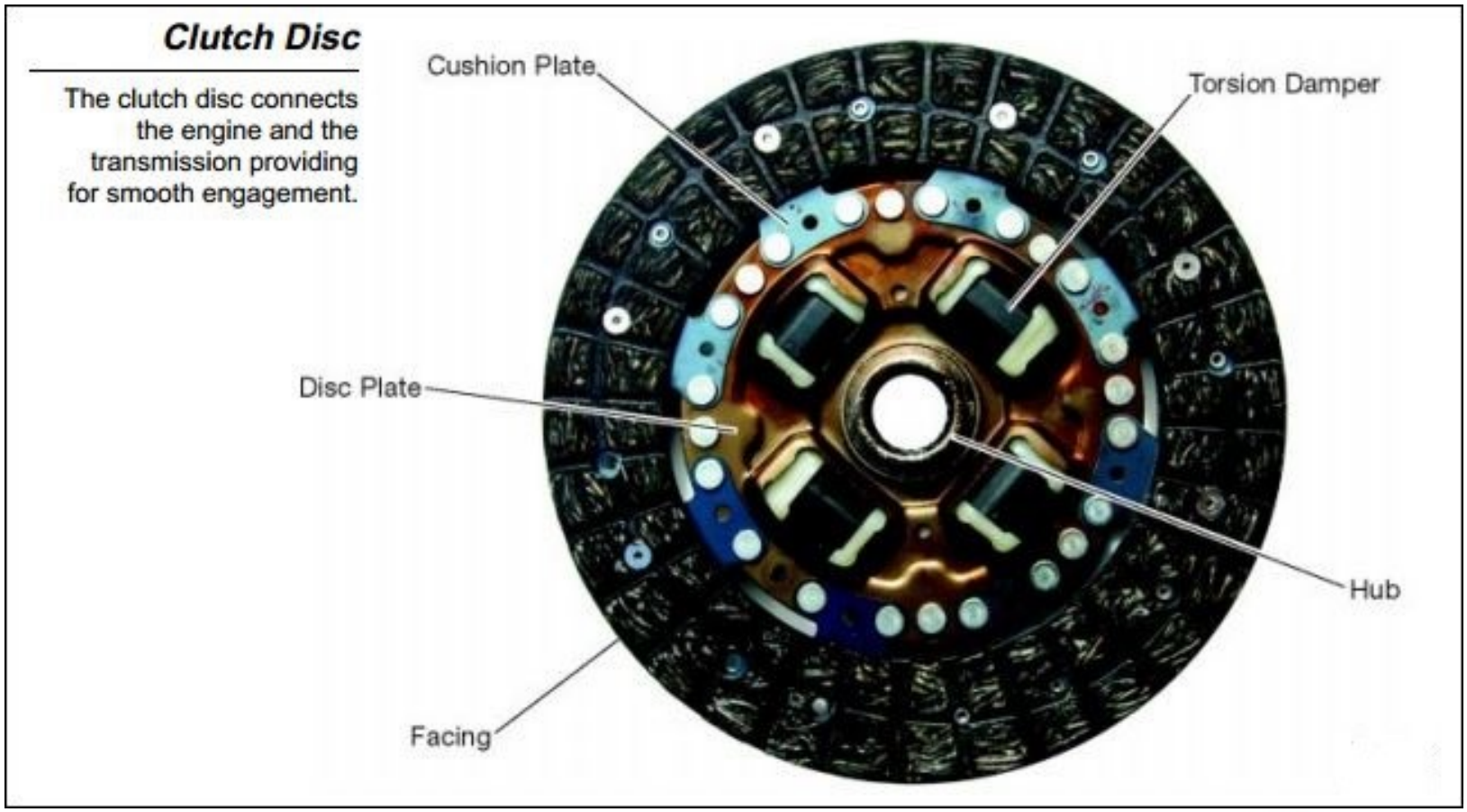
1. FLYWHEEL

Flywheel

A flywheel is very similar to a brake rotor in appearance. It is a large metal disc that stores and releases energy pulses from the crankshaft.



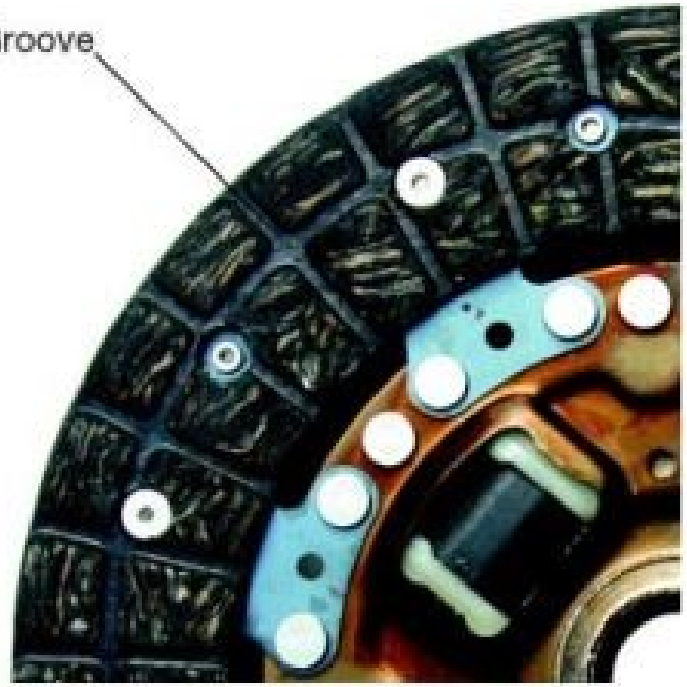
2. CLUTCH DISK



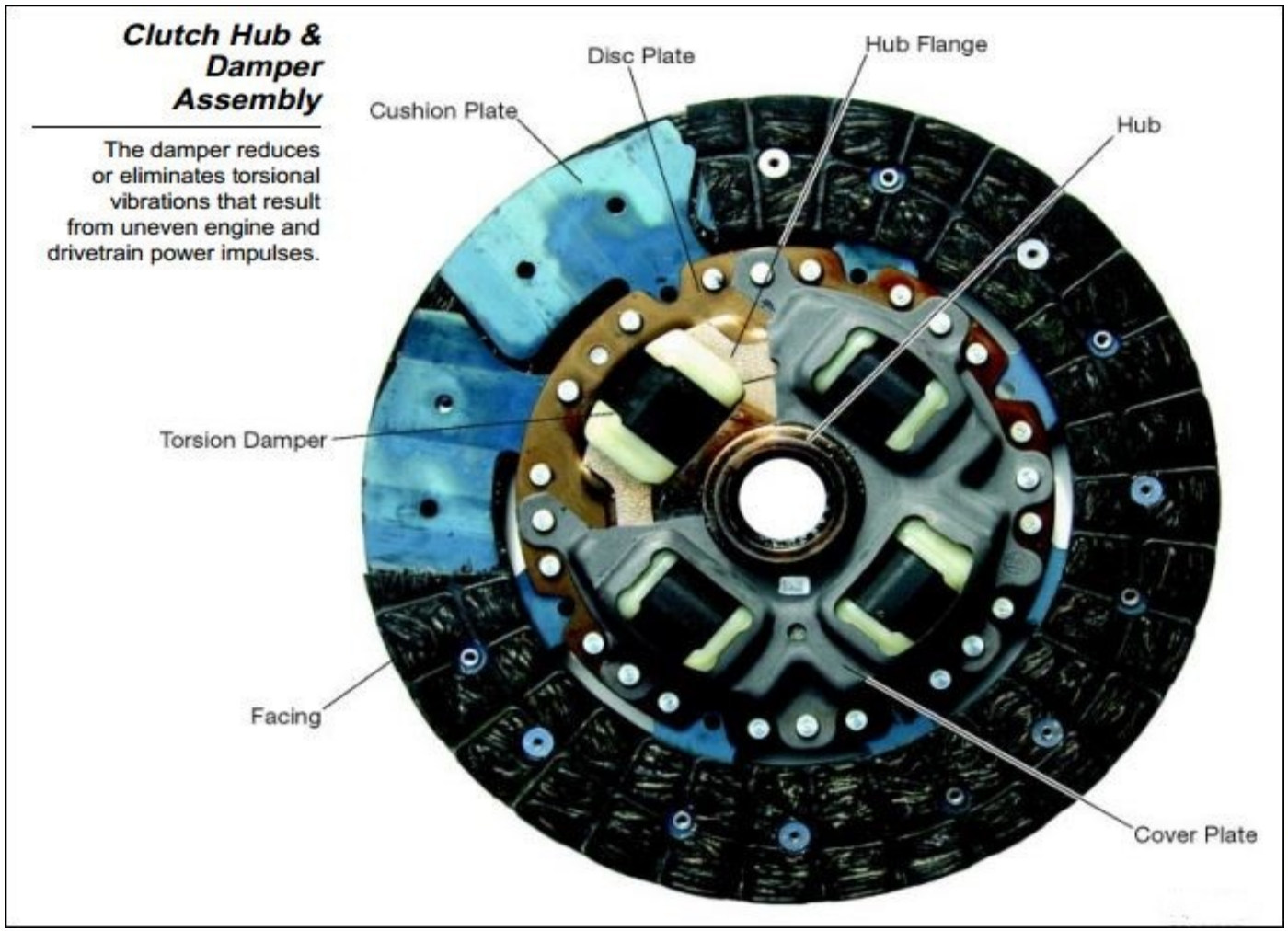
3. CIRCULAR GROOVE

Circular Groove

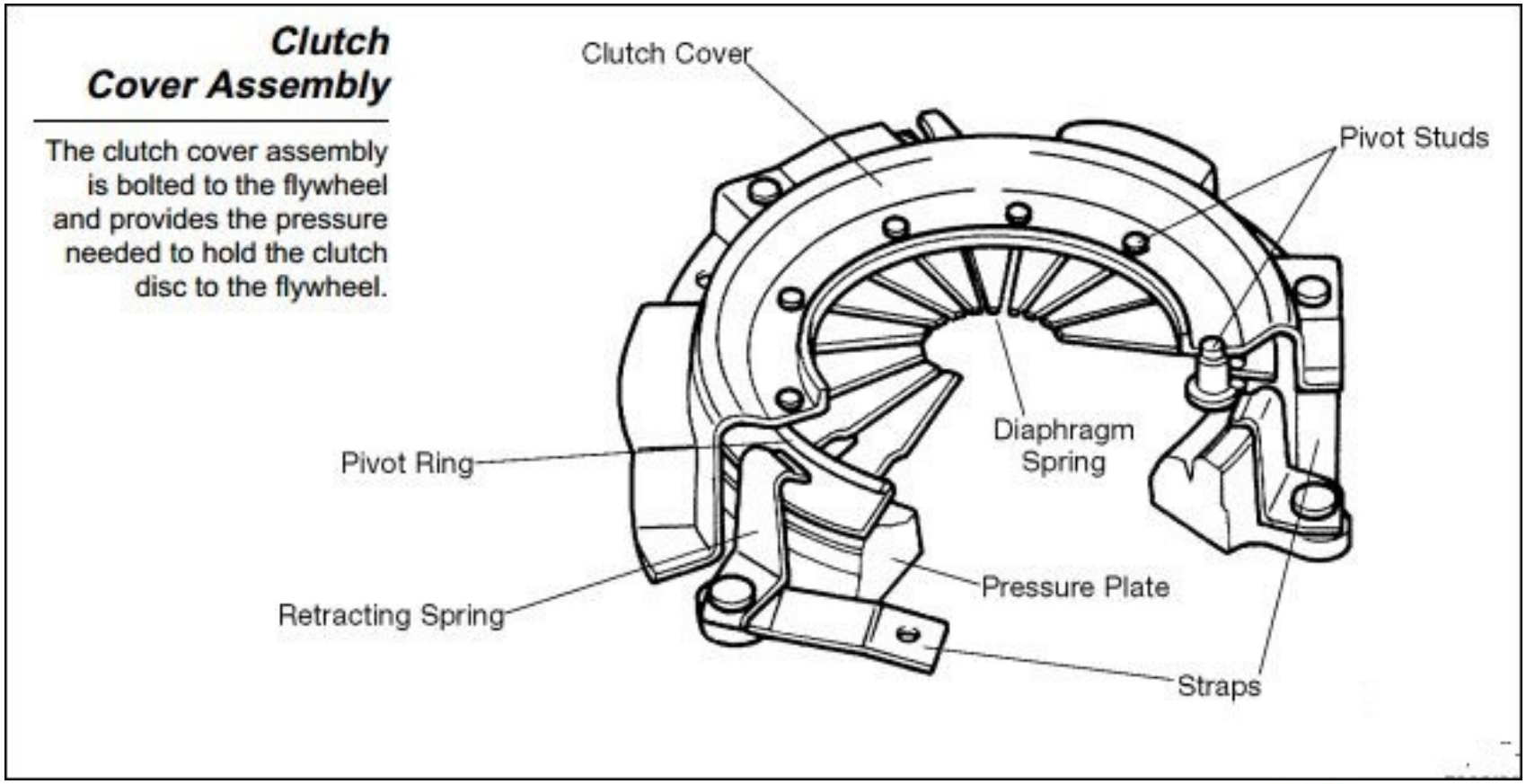
To eliminate the problem of the clutch disc adhering to the flywheel and pressure plate, grooves are provided in the clutch disc facing.



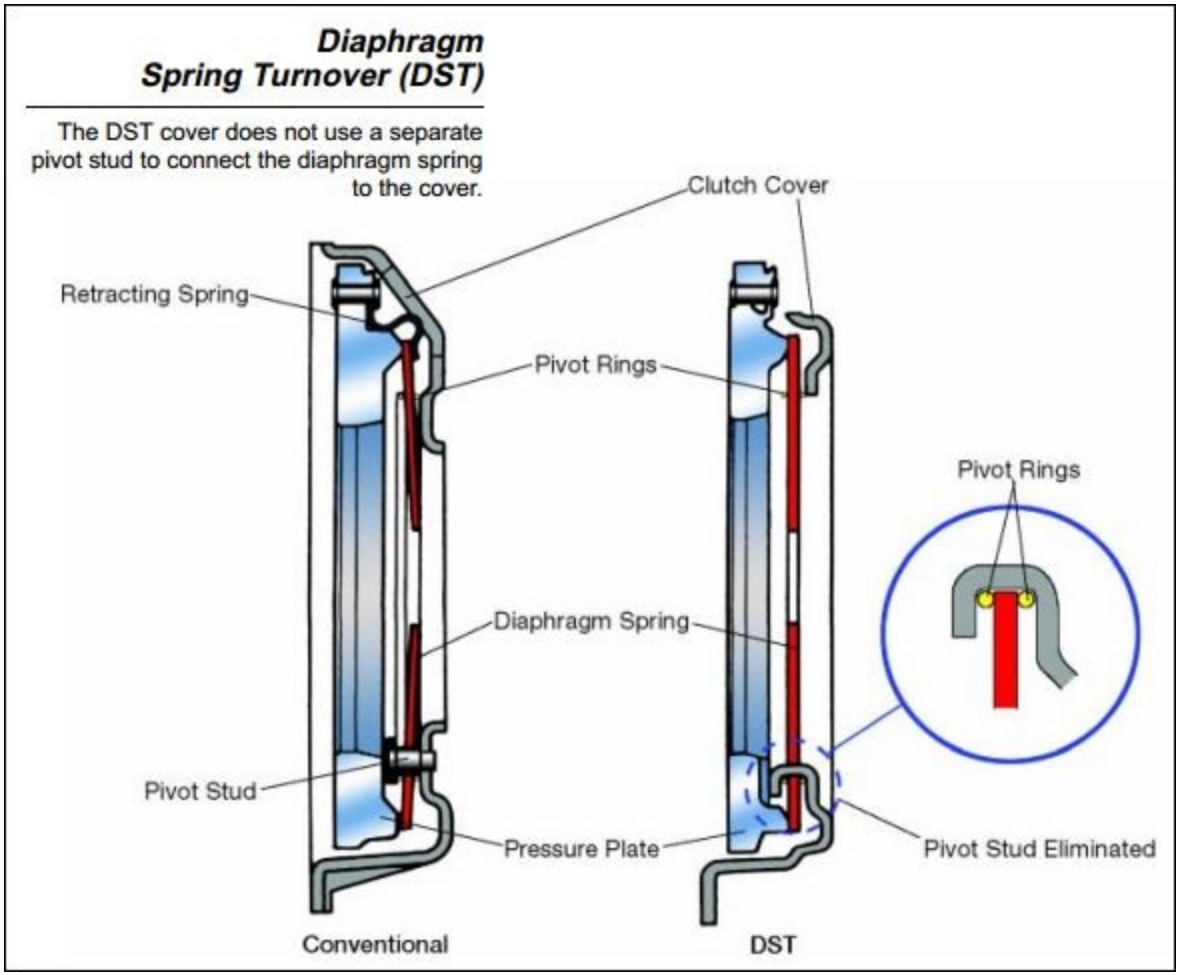
4. CLUTCH HUB AND DAMPER ASSEMBLY



5. CLUTCH COVER ASSEMBLY



6. DIAPHRAGM SPRING TURNOVER



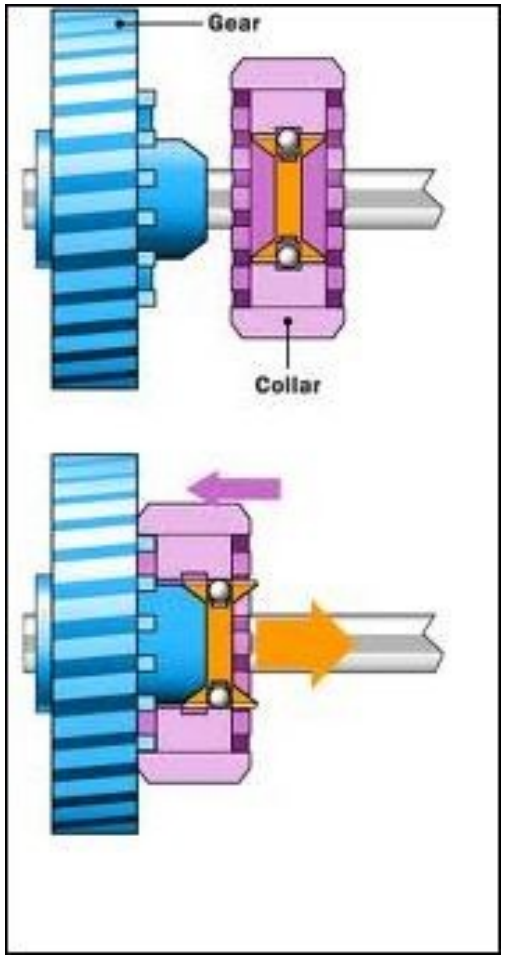
TYPES OF CLUTCHES

DIFFERENT TYPES OF CLUTCH

In this presentation, basically three types of clutch has been explained:

- ✓ Dog Clutch
- ✓ Belt Clutch
- ✓ Centrifugal Clutch

DOG CLUTCH



✓ A dog clutch is a type of clutch that couples two rotating shafts or other rotating components not by friction but by interference.

✓ The two parts of the clutch are designed such that one will push the other, causing both to rotate at the same speed and will never slip.

✓ Utilized in automobile manual transmissions.

BELT CLUTCH

✓ Engine power is transmitted via a set of belts that are slack when the engine is idling, but an idler pulley can tighten the belts to increase friction between the belts and the pulleys.

✓ Used on agricultural equipment, lawn mowers, tillers, and snow blowers.

CENTRIFUGAL CLUTCH

✓ This clutch system employs centrifugal force to automatically engage the clutch when the engine rpm rises above a threshold and to automatically disengage the clutch when the engine rpm falls low enough.

✓ A centrifugal clutch is used in some vehicles (e.g., mopeds) and also in other applications where the speed of the engine defines the state of the clutch, for example, in a chainsaw.

WORKING OF A CLUTCH

STEP-WISE WORKING OF A CLUTCH

1 | When the clutch pedal is depressed, the "Throw-out bearing" pushes the pressure plate's release fingers.

2 | The pressure plate pulls away from the clutch disc, disengaging the clutch, thus interrupting power flow

3 | When the clutch pedal is released and the clutch is fully engaged, the release bearing is normally stationary and does not rotate with the pressure plate.

STEP-WISE WORKING OF A CLUTCH -2

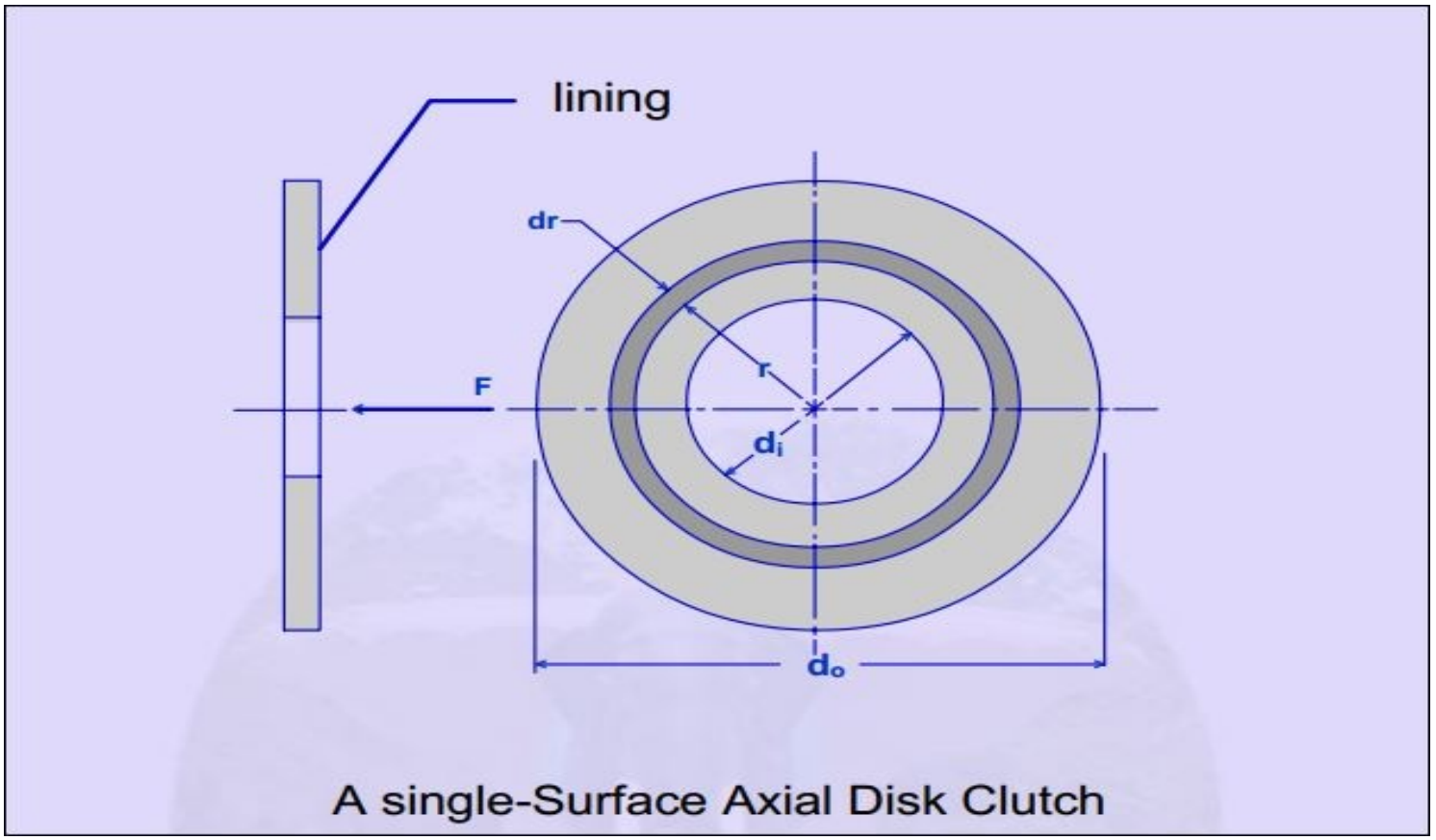
4 | Clutch operation is accomplished either mechanically or with a hydraulic pressure system.

If a vehicle has a mechanically operated linkage, it will incorporate either a shaft-and-lever linkage arrangement or a cable. 5 |

6 | Systems that are made up of linkages, levers and pivot points are found primarily on older vehicles.

PRESSURE EQUATIONS - CLUTCH

SCHEMATIC DIAGRAM OF A CLUTCH PLATE



A single-Surface Axial Disk Clutch

EQUATION FOR TOTAL TORQUE

Now the torque that can be transmitted by this elemental are is equal to the frictional force times the moment arm about the axis that is the radius 'r'

i.e. $T = dF.\ r = f.dN.\ r = f.p.A.r$

$= f.p.2.\pi.r.\ dr\ .r$

The total torque that could be transmitted is obtained by integrating this equation between the limits of inner radius ri to the outer radius ro

$$T = \int_{r_i}^{r_o} 2\pi pfr^2 dr = \frac{2}{3}\pi pf(r_o^3 - r_i^3)$$

Integrating the normal force between the same limits we get the actuating force that need to be applied to transmit this torque.

EQUATION FOR TOTAL TORQUE - 2

$$F_a = \int_{r_i}^{r_o} 2\pi p r dr$$

$$F_a = \pi\left(r_o^2 - r_i^2\right).p$$

Equation 1 and 2 can be combined together to give equation for the torque

$$T = fF_a \cdot \frac{2}{3}\frac{(r_o^3 - r_i^3)}{(r_o^2 - r_i^2)}$$

UNIFORM WEAR CONDITION

Uniform Wear Condition

According to some established theories the wear in a mechanical system is proportional to the 'PV' factor where P refers the contact pressure and V the sliding velocity. Based on this for the case of a plate clutch we can state

The constant-wear rate R_w is assumed to be proportional to the product of pressure p and velocity V.

$$R_w = pV = \text{constant}$$

UNIFORM WEAR CONDITION – 2

And the velocity at any point on the face of the clutch is $V = r.\omega$

Combining these equation, assuming a constant angular velocity ω

$$pr = \text{constant} = K$$

The largest pressure p_{max} must then occur at the smallest radius r_i,

$$K = p_{max} r_i$$

Hence pressure at any point in the contact region

$$p = p_{max} \frac{r_i}{r}$$

FINDING THE AXIAL FORCE

In the previous equations substituting this value for the pressure term p and integrating between the limits as done earlier we get the equation for the torque transmitted and the actuating force to be applied.

I.e The axial force F_a is found by substituting $p = p_{max}\frac{r_i}{r}$ for p.

and integrating equation $dN = 2\pi prdr$

$$F = \int_{r_i}^{r_o} 2\pi prdr = \int_{r_i}^{r_o} 2\pi\left(p_{max}\frac{r_i}{r}\right)rdr = 2\pi p_{max} r_i (r_o - r_i)$$

TORQUE – UNIFORM WEAR

Similarly the Torque

$$T = \int_{r_i}^{r_o} f 2\pi p_{max} r_i r dr = f\pi p_{max} r_i (r_o^2 - r_i^2)$$

Substituting the values of actuating force Fa

The equation can be given as

$$T = fF_a \cdot \frac{(r_o + r_i)}{2}$$

MATERIALS USED - CLUTCH

SOME MATERIALS USED TO MAKE CLUTCH

- ✓ Organic Materials
- ✓ Kevlar Materials
- ✓ Semi-Metallic Materials
- ✓ Sintered Metal
- ✓ Carbon Materials

DETAILED DESCRIPTION OF THE MATERIALS

Name of Material .	Dynamic friction coeficient	Tº Fading	Type
G95	0.45 ±0.05 µ	260ºC	Woven yarn friction material
G98	0.45 ±0.05 µ	270ºC	Woven yarn friction material
G 13	0.4 ±0.05 µ	260ºC	Woven yarn friction material
HCC	0.4 ±0.05 µ	330ºC	Woven yarn friction material
HDS57	0.42 ±0.05 µ	280ºC	Woven yarn friction material
V2000R	0.45 ±0.05 µ	320ºC	Woven yarn friction material
VH-03	0.4 ±0.05 µ	320ºC	Woven yarn friction material

DETAILED DESCRIPTION OF THE MATERIALS -2

SF-001	0.5 ±0.05 µ	400ºC	Kevlar friction paper
SF-BU	0.45 ±0.05 µ	390ºC	Kevlar friction paper
SF-MC2	0.5 ±0.05 µ	390ºC	Kevlar friction paper
AFV	0.45 ±0.05 µ	320ºC	Ridgid moulded friction material
CR-2M	0.38 ±0.05 µ	360ºC	Ridgid moulded friction material
DD01	0.45 ±0.05 µ	300ºC	Ridgid moulded friction material
FAG/M	0.4 ±0.05 µ	310ºC	Ridgid moulded friction material
FAG/TW	0.45 ±0.05 µ	330ºC	Ridgid moulded friction material
LO31	0.18 ±0.05 µ	200ºC	Rigid moulded friction material