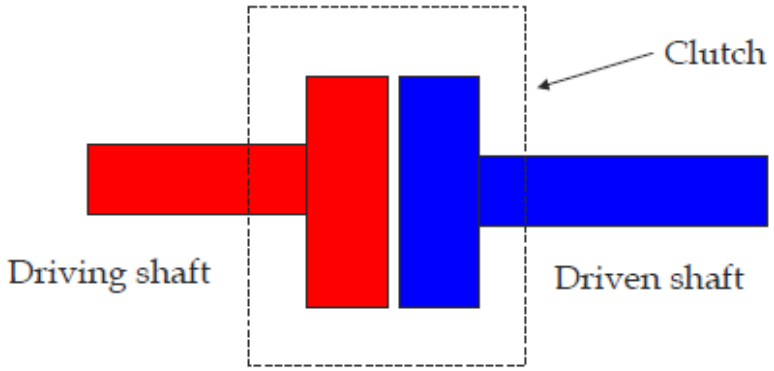
Unit II

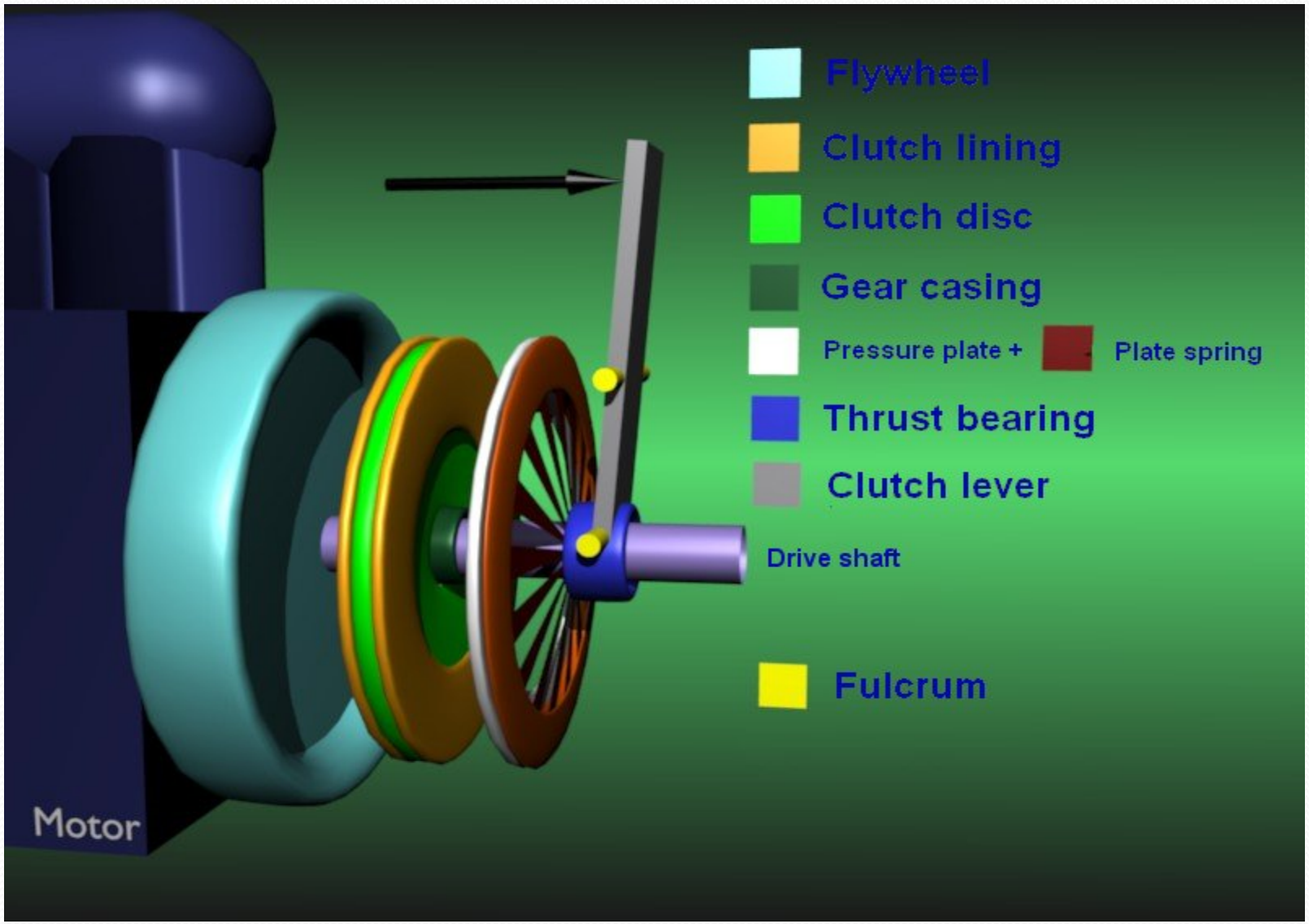
CLUTCHES



- Mechanism which enables rotary motion of shaft to be transmitted to the second shaft axis ,which is coincident with the first

OR

- Clutch is a device to connect driving and driven shafts of a machine, where the driven shaft can be disconnected almost instantaneously from the driving shaft as desired by the operator or driver


Flywheel
Clutch lining
Clutch disc
Gear casing
Pressure plate +
Plate spring
Thrust bearing
Clutch lever
Drive shaft
Fulcrum
Motor

Requirements of Clutch

1) Torque Transmission
2) Gradual Engagement
3) Heat Dissipation
4) Dynamic Balancing
5) Vibration Damping
6) Size
7) Inertia
8) Ease of operation

1)Torque Transmission

- The clutch should be able to transfer the maximum torque of engine under all conditions.
- Usually designed to transmit 125 to 150% of maximum engine torque.

2) **Gradual Engagement:**

Clutch should take the drive gradually without occurrence of sudden jerks

3)**Heat Dissipation:**

During clutch application large amount of heat is generated, the rubbing surfaces should have sufficient area and mass to absorb the heat generated. The design of clutch should ensure proper ventilation or cooling for adequate dissipation of heat.

4) Dynamic Balancing:

This is necessary particularly in high speed clutches.

5) **Vibration damping**:

Suitable mechanism should be incorporated within the clutch to eliminate the noise produced in transmission

6) **Size:**

The size of clutch must be smallest possible , so that it occupy minimum amount of space.

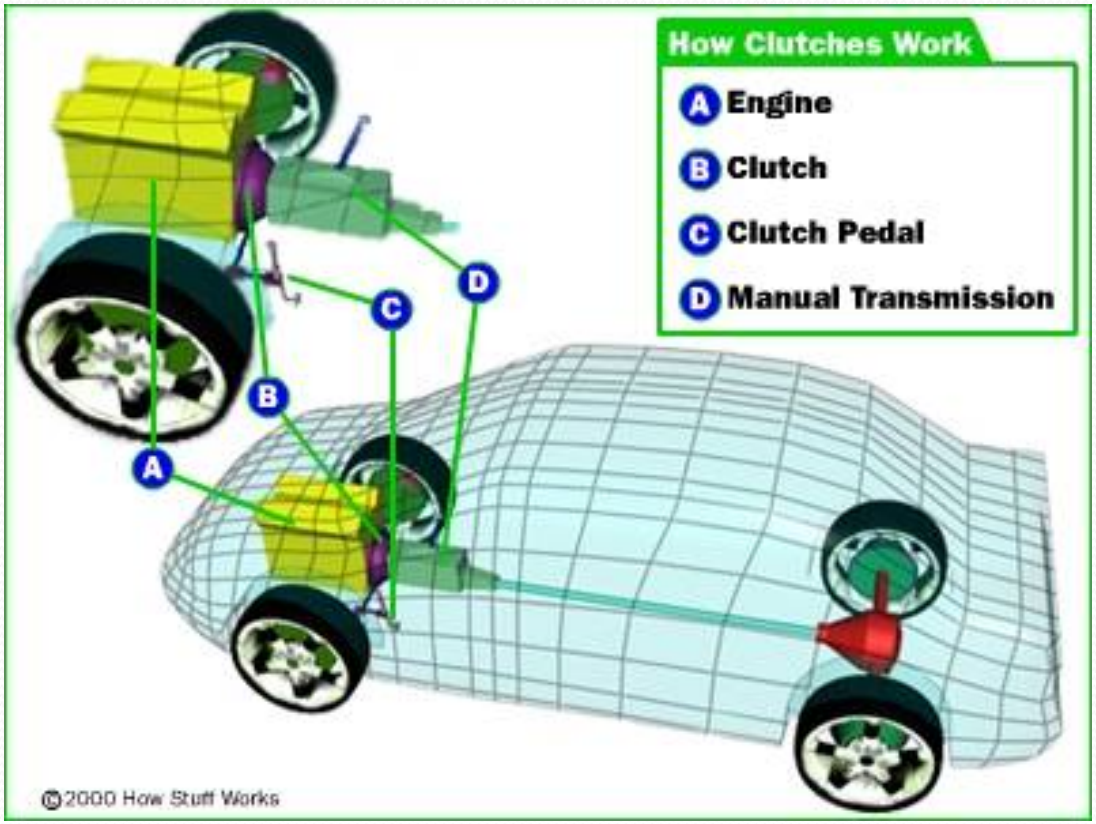
7) **Inertia:**

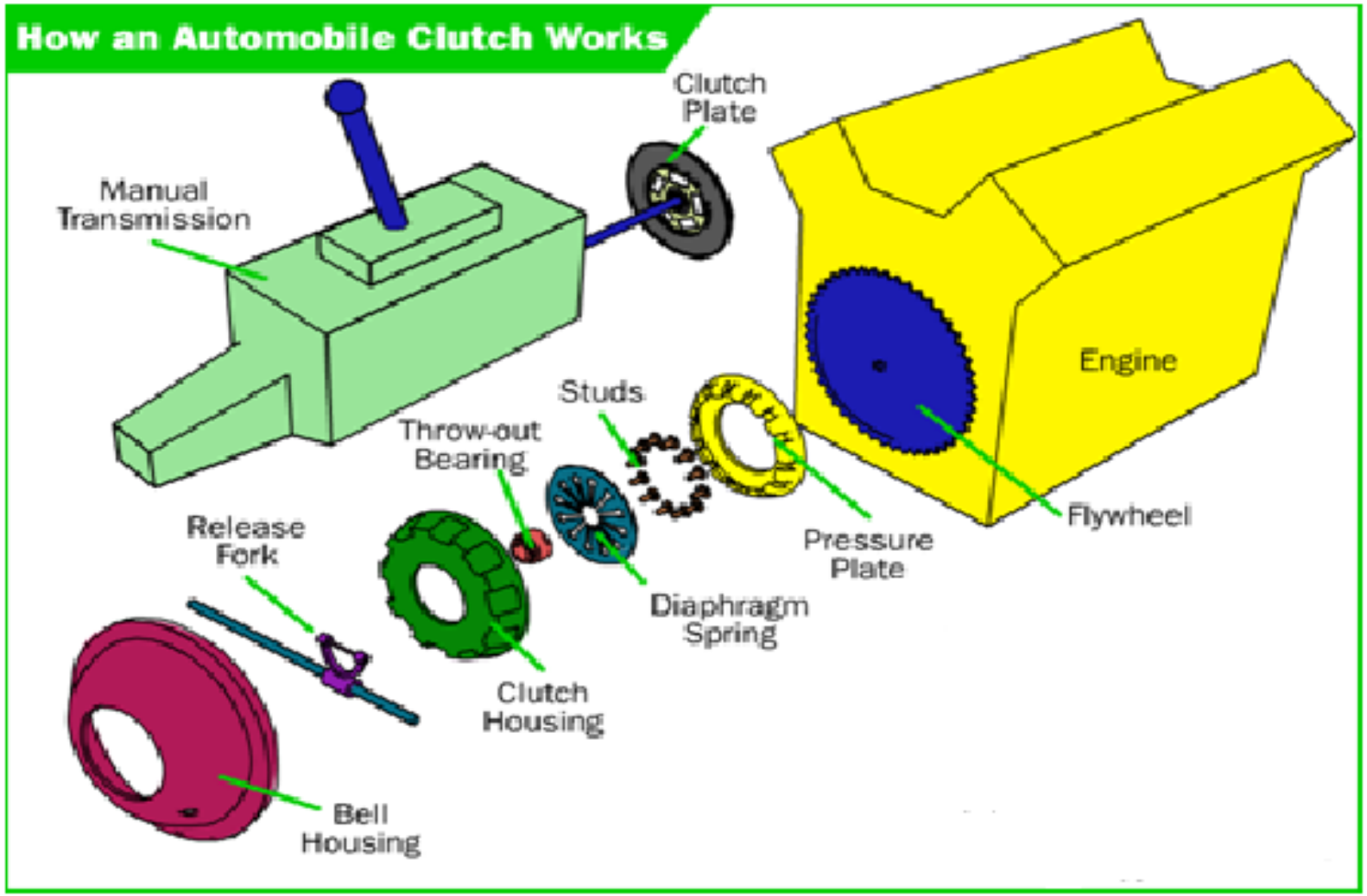
The clutch rotating parts should have minimum inertia.(Otherwise when clutch plate is released for gear changing, clutch plate will keep on spinning)

8) Ease of Operation:

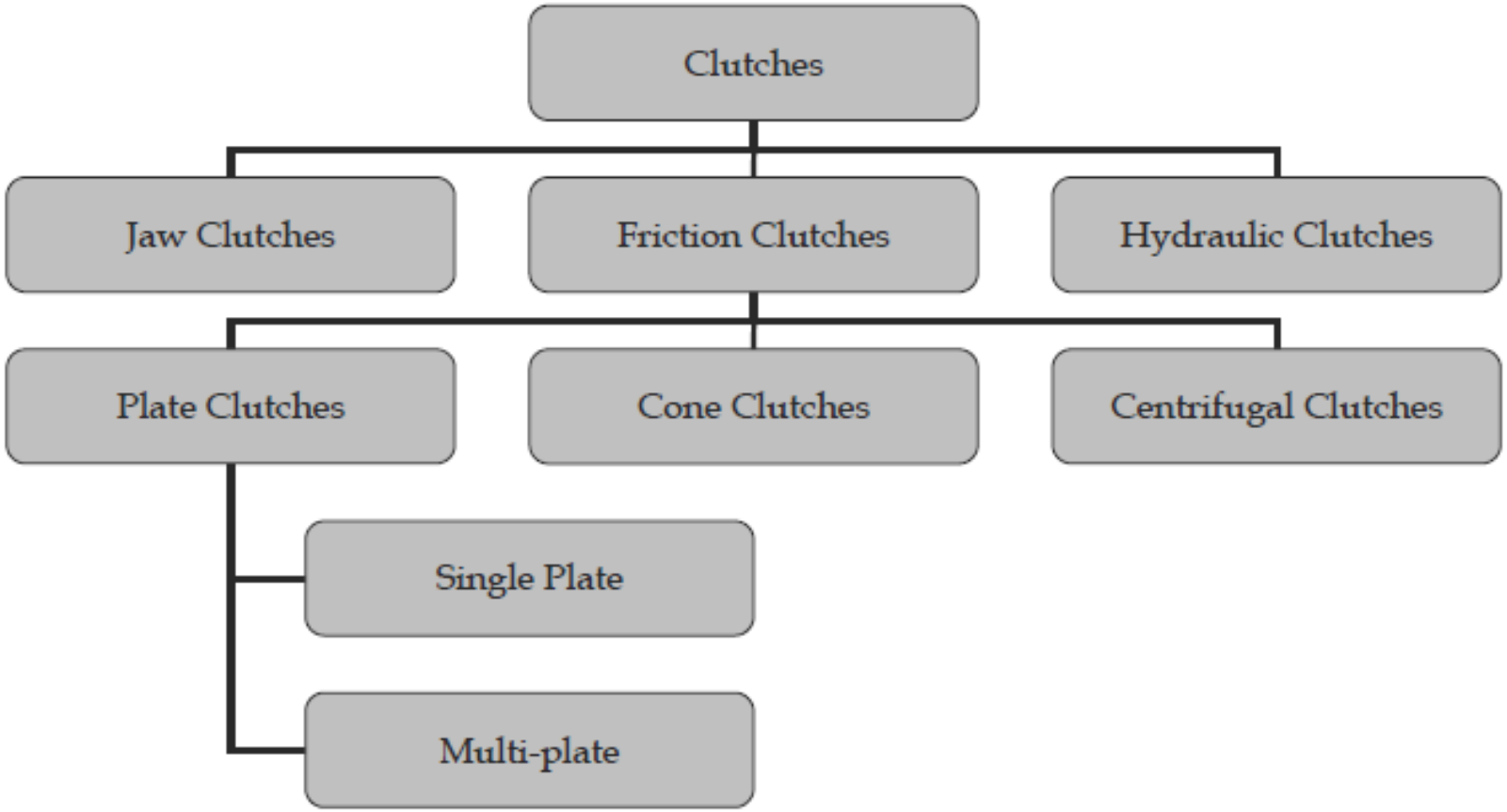
The operation of disengaging the clutch should be easy for driver.

- In a car, you need a clutch because the engine spins all the time, but the car's wheels do not. In order for- a car to stop without killing the engine, the wheels need to be disconnected from the engine somehow. The clutch allows us to smoothly engage a spinning engine to a non-spinning transmission by controlling the slippage between them.




How an Automobile Clutch Works
Clutch Plate
Manual Transmission
Engine
Studs
Throw-out Bearing
Release Fork
Pressure Plate
Flywheel
Diaphragm Spring
Clutch Housing
Bell Housing

Classification of clutches



Friction Clutches

- The friction clutches work on the fact that friction is caused when two rotating discs come into contact with each other

Principle of Friction Clutches

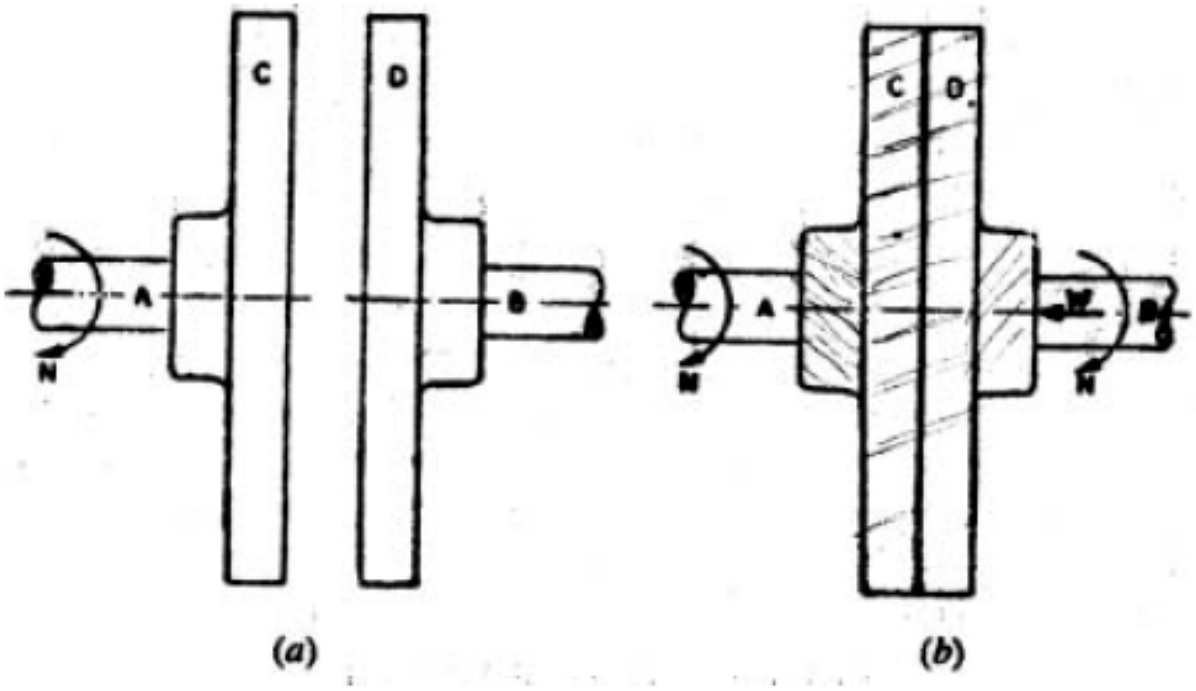


Figure 1: Principle of Friction Clutch

- Let the shaft A and Disc C be revolving at some speed say N rpm. Shaft B and disc D keyed to it are stationary, initially when the clutch is not engaged.
- Now apply some axial force W to disc D , so that it comes in contact with Disc C.
- As soon as the contact is made the force of friction between C and D will come into play and consequently the disc D will also start revolving
- The speed of D depends upon friction force present, which in 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 speed of D becomes equal to speed of C. Then clutch is said to be fully engaged.

- Let

W = axial load applied.

μ = coefficient of friction

R = effective mean radius of friction surface.

Then ,

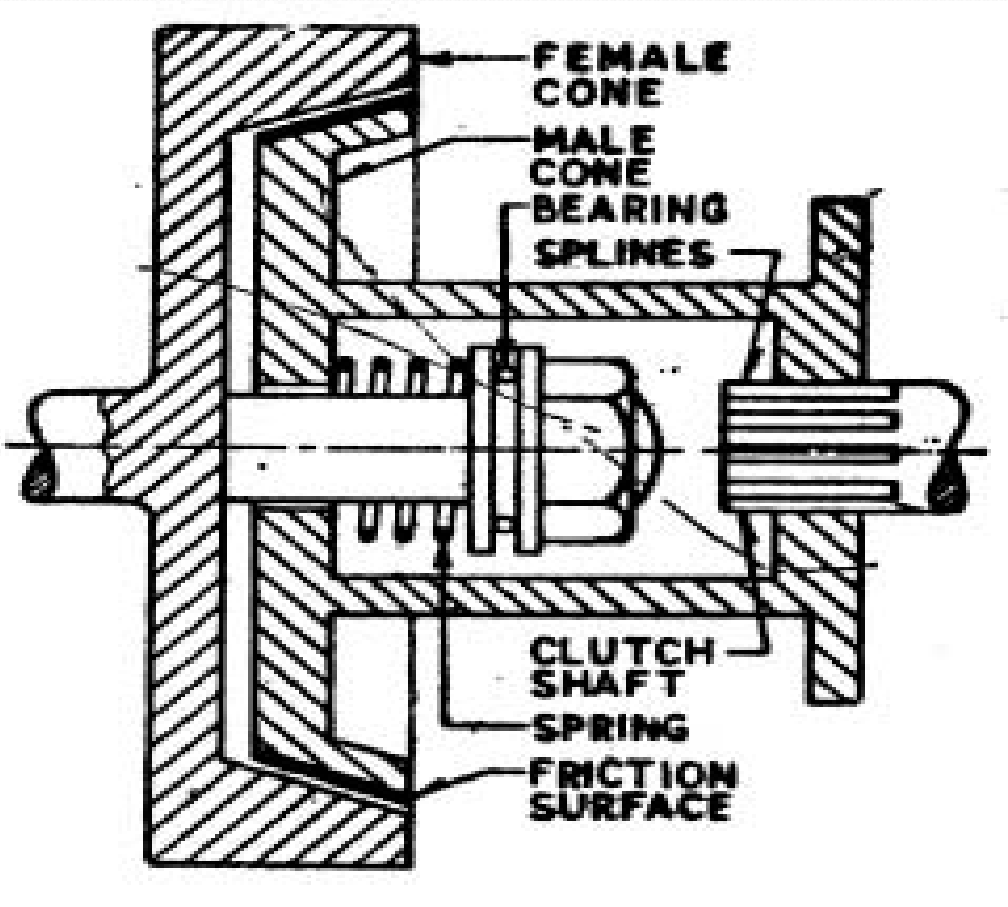
$$T = \mu W R$$

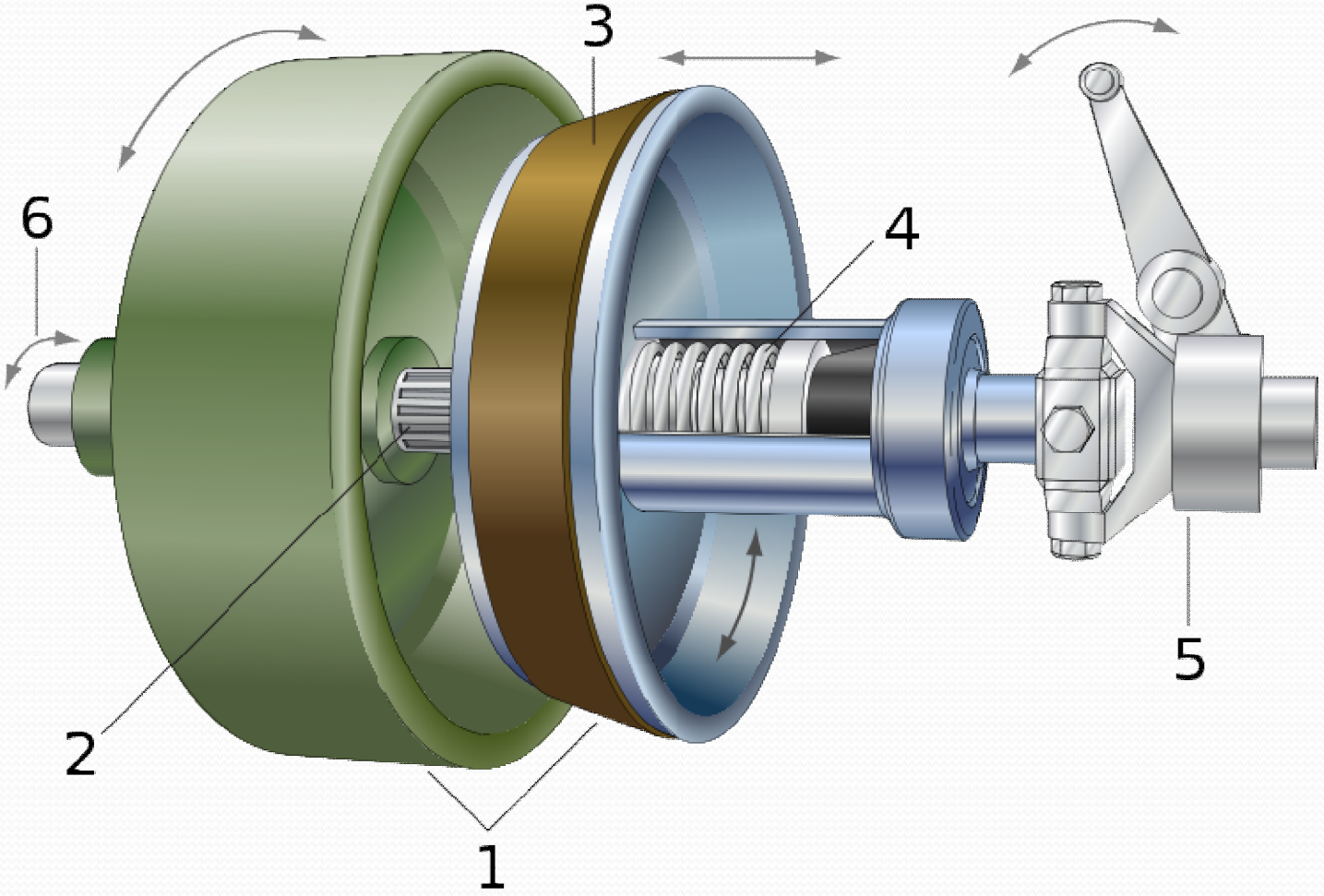
DRY FRICTION CLUTCHES

Types:

- Cone clutch
- Single Plate clutch
- Multiplate clutch
- Semi-centrifugal clutch
- Centrifugal clutch

Cone Clutch


FEMALE CONE
MALE CONE
BEARING
SPLINES
CLUTCH SHAFT
SPRING
FRICTION SURFACE


3
6
4
2
5
1

1. Cones: female= green, male= blue
2. Shaft: male cone is sliding on splines
3. Friction material
4. Spring: brings the male cone back after using the clutch control
5. Clutch control: separating both cones by pressing
6. Rotating direction: both direction of the axis are possible

- In the engaged position the friction surface are in complete contact. This is done by means of spring which keep the male cone pressed all the time.
- When the clutch is engaged the torque is transmitted from engine via the flywheel and the male cone to splined gear box shaft.
- For disengaging the clutch , the male cone is pulled out by means of lever system operated through clutch pedal thereby separating the contact surfaces.

Advantage

- The advantage of cone clutch is that the normal force acting on contact surface in this case is larger than axial force(as compared to single plate clutch in which the normal force acting on contact surfaces is equal to the axial force)

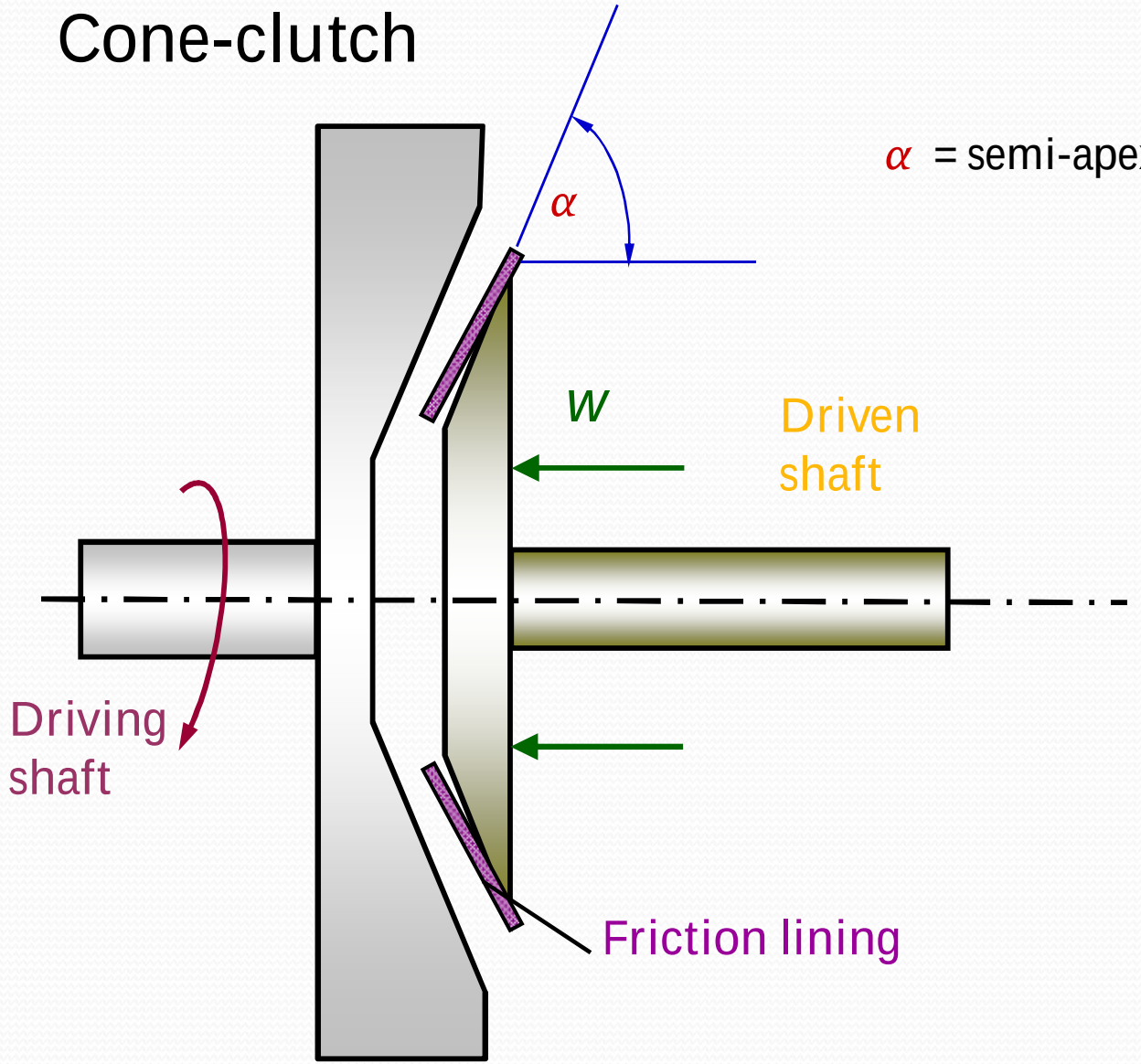
Disadvantages

This type of clutch is practically obsolete because of following reasons:

1) If the angle of cone is made less than about 20 degree, it will be difficult to disengage the clutch.

2) A small amount of wear on the cone surface results in considerable amount of axial movement of the male cone for which it will be difficult to allow.

Cone-clutch



α = semi-apex angle of the cone

The total frictional torque T :

$$T = \mu W R$$

R – mean radius

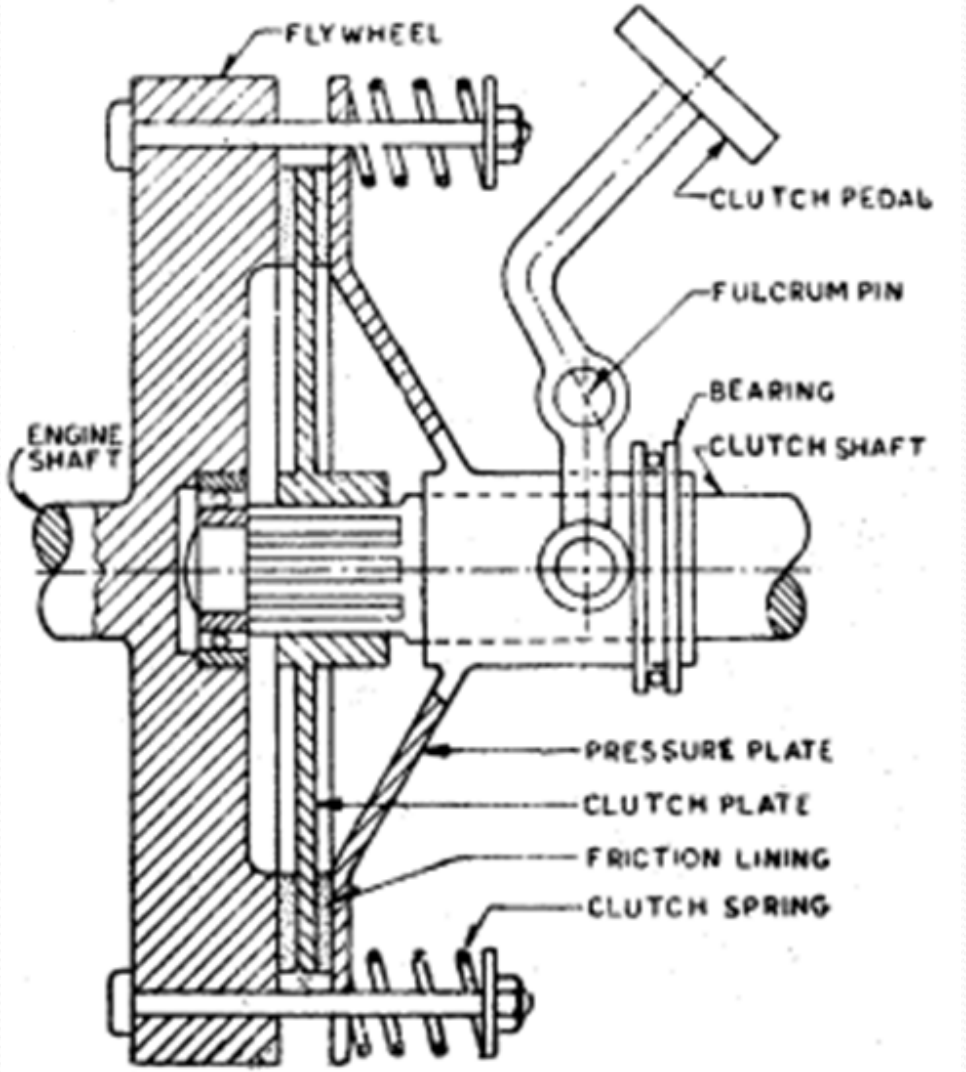
For uniform pressure (for new clutches)

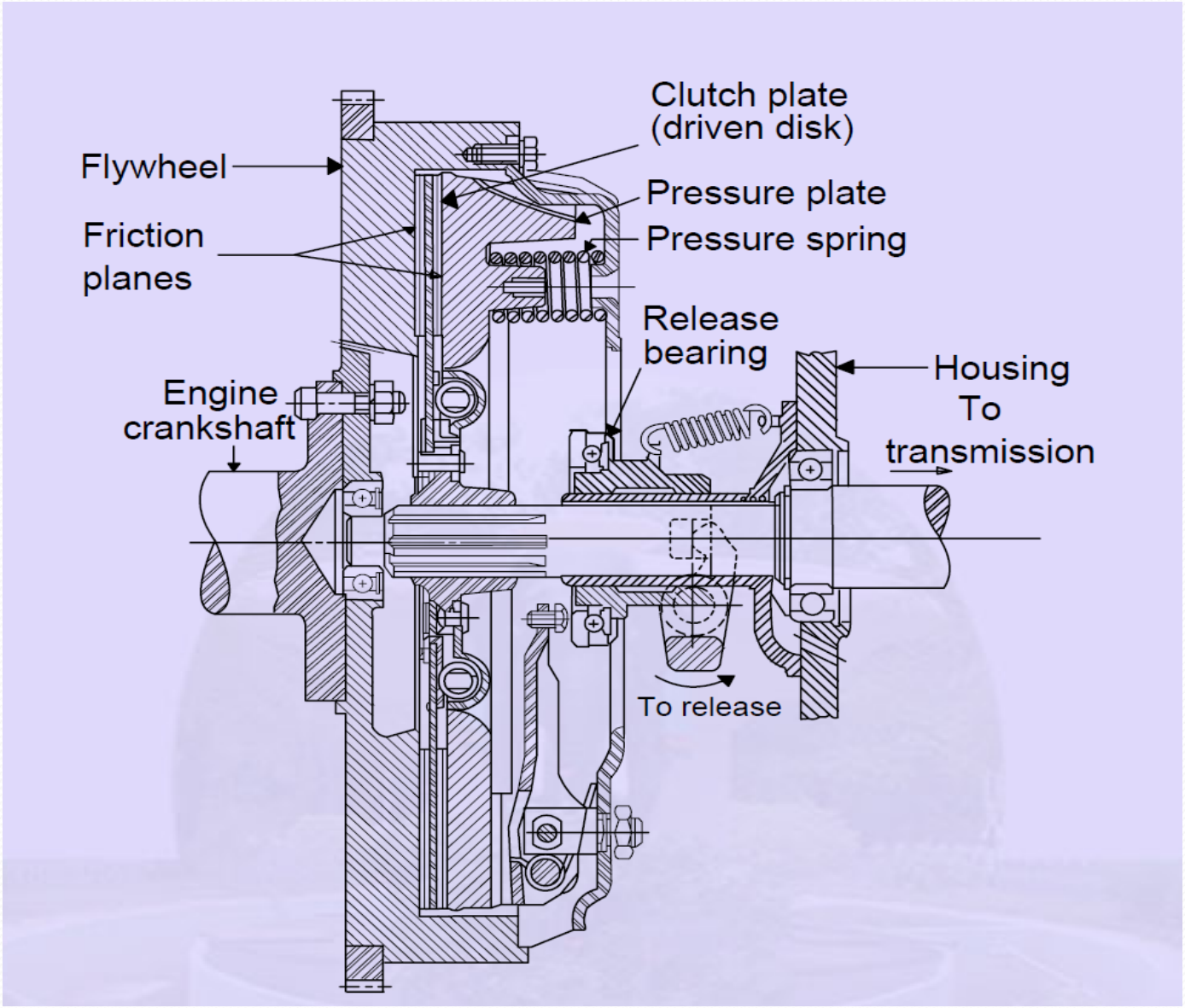
$$R = \frac{2}{3}\left[\frac{r_1^{\,3} - r_2^{\,3}}{r_1^{\,2} - r_2^{\,2}}\right]\cos ec\,\alpha$$

- For uniform wear (for old clutches)

$$R = \frac{[r_1 + r_2]}{2}\cos ec\,\alpha$$

SINGLE PLATE CLUTCH



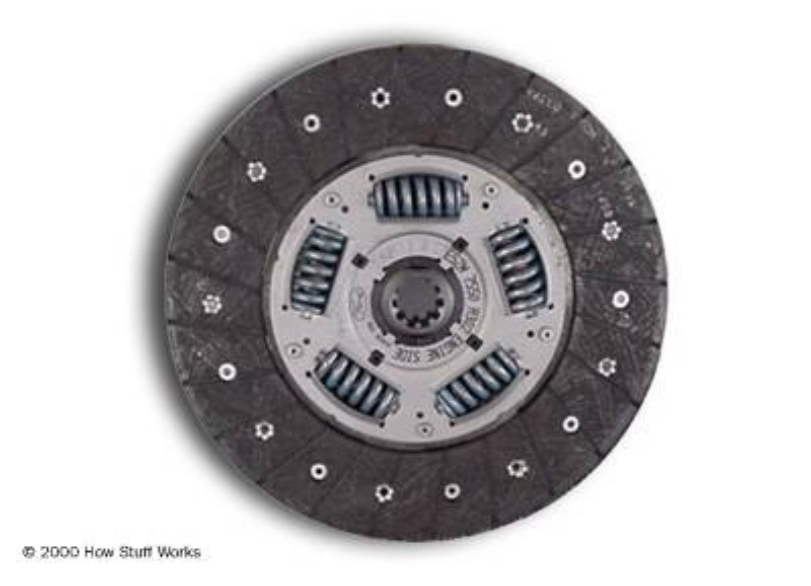

Clutch plate
(driven disk)
Flywheel
Pressure plate
Friction
planes
Pressure spring
Release
bearing
Housing
To
transmission
Engine
crankshaft
To release

Working of Single plate clutch

- Basically, the clutch needs three parts. These are the engine flywheel, a friction disc called the clutch plate and a pressure plate.
- There are springs which provide axial force to keep the clutch in engaged position.
- When the engine is running and the flywheel is rotating, the pressure plate also rotates as the pressure plate is attached to the flywheel. The friction disc is located between the two .
- When the driver has pushed down the clutch pedal the clutch is released. This action forces the pressure plate to move away from the friction disc against the force of springs.
- With this movement of pressure plate , the friction plate is released and the clutch is disengaged.

- When your foot is off the pedal, the springs push the pressure plate against the clutch disc, which in turn presses against the flywheel. This locks the engine to the transmission input shaft, causing them to spin at the same speed.
- The amount of force the clutch can hold depends on the friction between the clutch plate and the flywheel, and how much force the spring puts on the pressure plate

- When the clutch pedal is pressed, piston pushes on the release fork, which presses the throw-out bearing against the middle of the diaphragm spring. As the middle of the diaphragm spring is pushed in, a series of pins near the outside of the spring causes the spring to pull the pressure plate away from the clutch disc This releases the clutch from the spinning engine.



Advantages

- With single plate clutch , gear changing is easier than with the cone clutch , because the pedal movement is less in this case.
- More reliable (As it does not suffer from disadvantage of cone clutch , i.e. binding of cones)

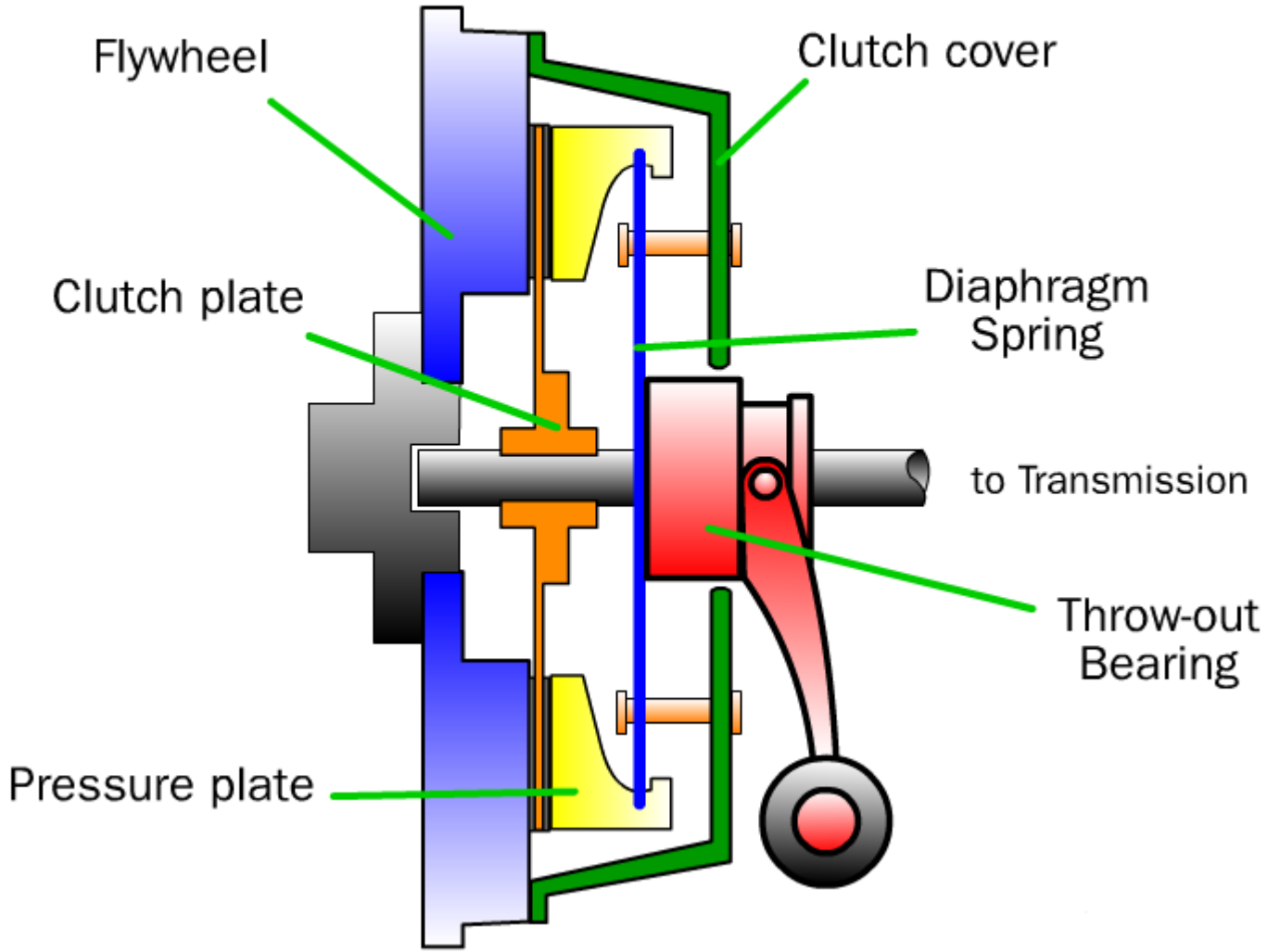
Disadvantages

- As compared to cone clutch , springs have to be more stiff and this means greater force required to be applied by driver while disengaging.

Diaphragm spring type Single plate clutch

- The construction of this type of clutch is similar to that of the single plate type of clutch except that here diaphragm springs(also called Belleville springs) are used instead of the ordinary coil springs.

Diaphragm Clutch



Advantages

- It is more compact means of storing energy. Thus compact design results in smaller clutch housing.
- The diaphragm spring is comparatively less affected by the centrifugal forces. It can withstand high rotational speeds.
- The diaphragm acts as both clamping spring and release levers , therefore many extra parts like struts , eyebolts, levers etc are eliminated in the diaphragm spring, because of which loss of efficiency because of friction wear of these parts also does not occur.

Design details of Single Plate Clutch

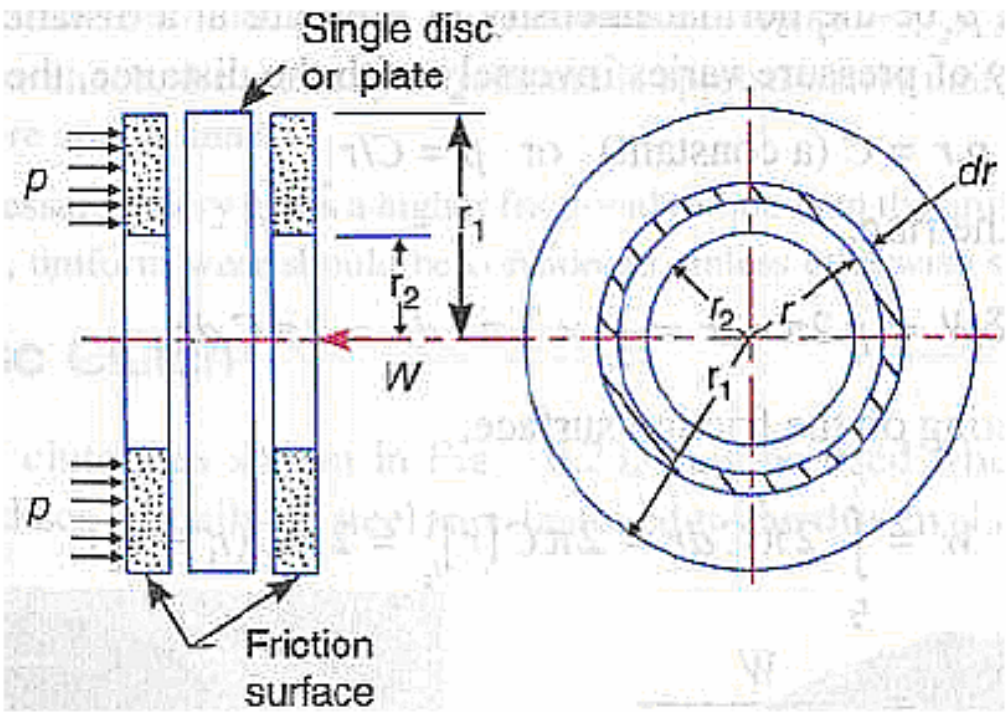


Plate clutch

The total frictional torque T :

- Considering uniform pressure (for new bearing)

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

- Considering uniform wear (for old bearing)

$$T = 2\frac{1}{2}\mu W\left[r_1 + r_2\right]$$

Cutch plate has two friction surfaces

Multiplate Clutch

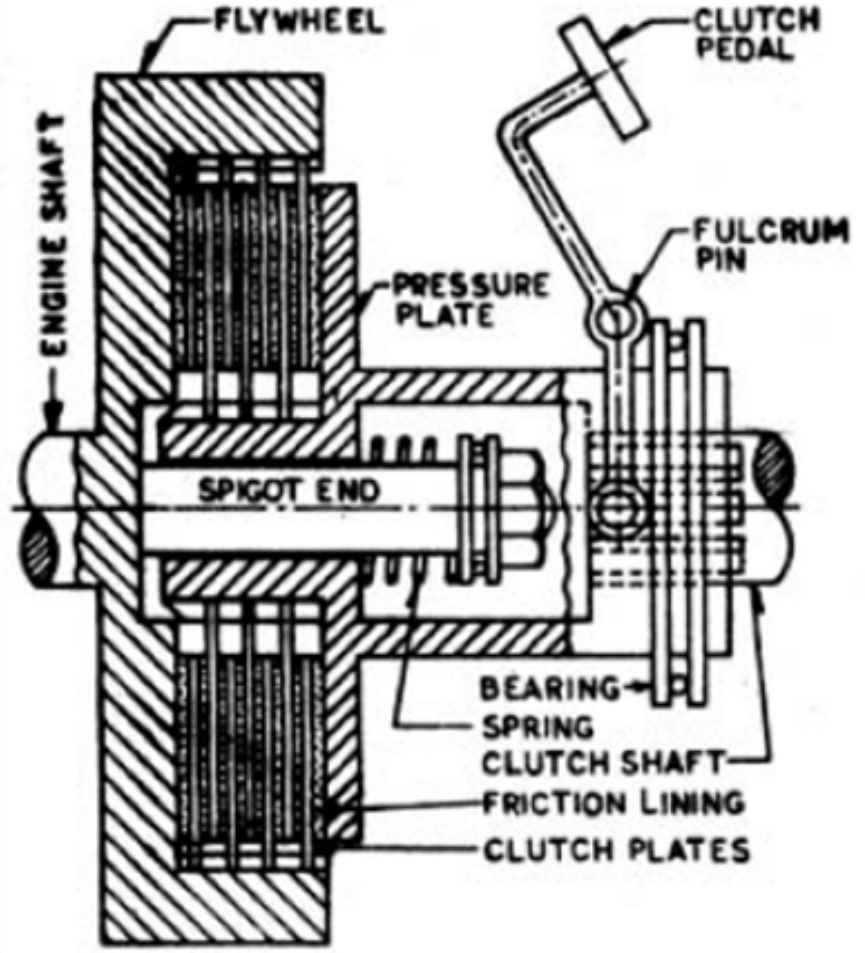
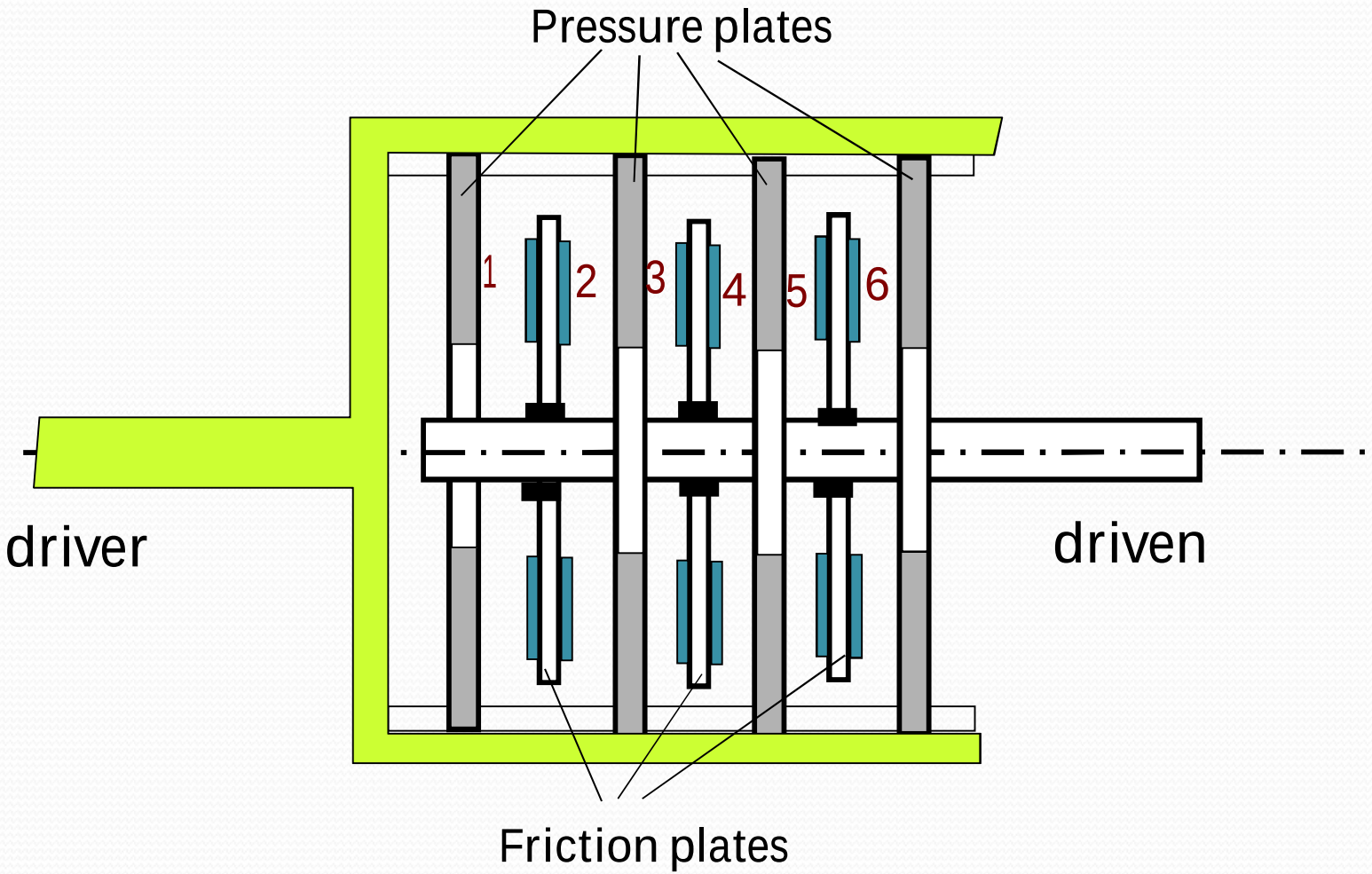


Figure : Multiplate Clutch

Multiple plate clutch



Multiplate Clutch

- The multiplate clutch is an extension of single plate type where the number of frictional and metal plates is increased.
- Increase in number of friction surfaces obviously increases capacity of the clutch to transmit torque.
- Alternatively, the overall diameter of the clutch is reduced for the same torque transmission as a single plate clutch
- This type of clutch is therefore used in some heavy transport vehicles and racing cars where high torque is to be transmitted.
- This finds application in case of scooters and motorcycles, where the space available is limited

Centrifugal clutch

- In fully centrifugal type clutches ,the springs are eliminated altogether and only centrifugal force is used to apply the required pressure for keeping the clutch in engaged position