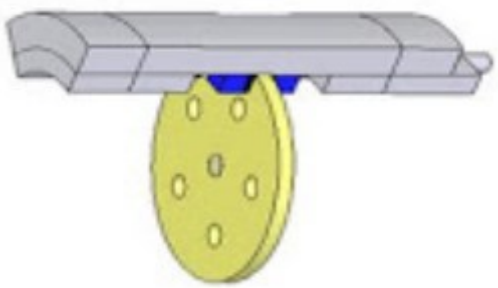
I. Brakes

I.1 Definition

A brake is a device that converts mechanical energy into thermal energy, intended to reduce, regulate, or eliminate the speed of a solid object.



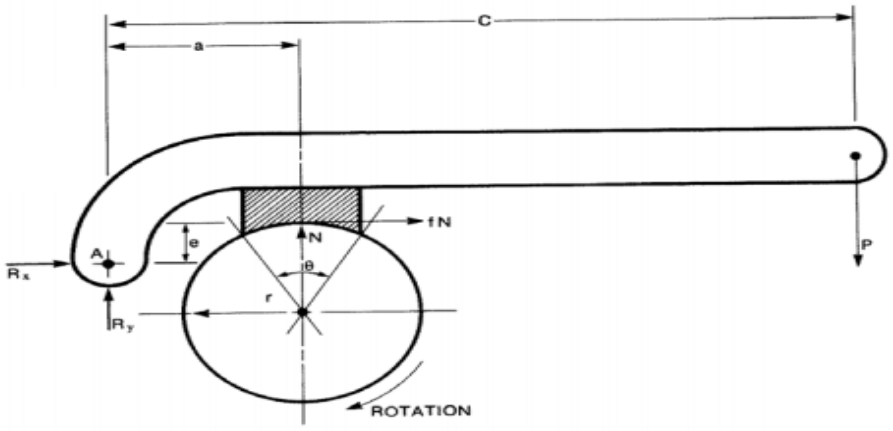
The properties of a brake are characterised by the following parameters:

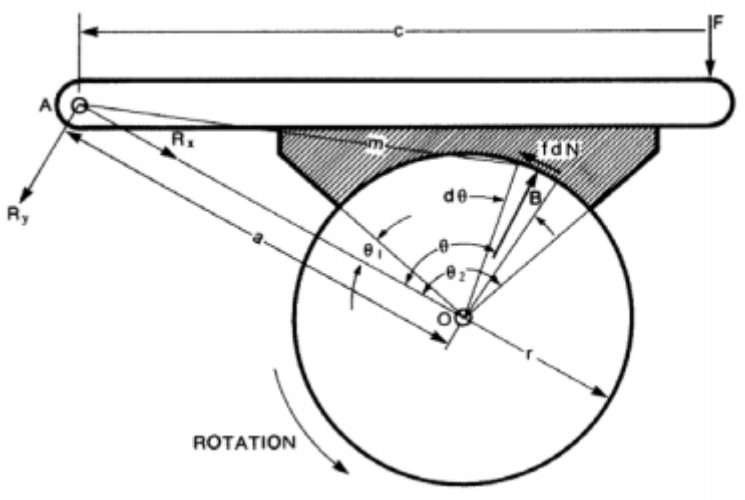
— The control force is the maximum constant force exerted by the operator on the brake control during braking.
— The control stroke is the movement of the brake control from the rest position to the braking position.
— The control index of a braking system is the product of the force and the control stroke.
— The efficiency of a brake (often referred to as the power of a brake) is the ratio of the braking torque to the control index.
— The regularity of a brake is characterised by its regularity index, which is the ratio of the relative variation in braking torque to the relative variation in the coefficient of friction.

I.2 Types of Brakes

1- Shoe Brakes

These consist primarily of a block made of wood or asbestos, a lever, and a drum. The block can be either short or long, and it may be rigidly fixed or articulated.

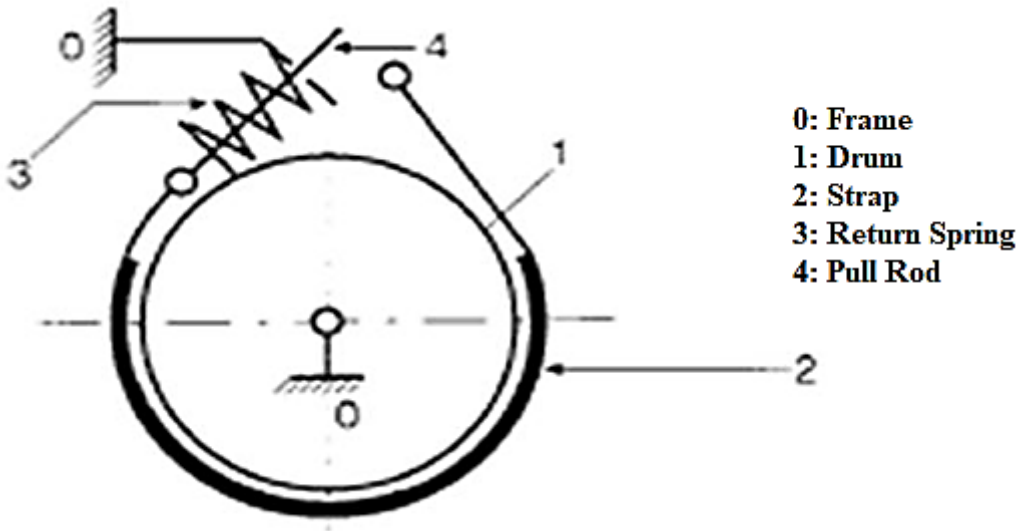




The cylindrical surfaces of the drum and the block that are in contact are usually smooth; sometimes, a V-groove is made in the drum to increase the normal force.

2- Strap Brake

This is the simplest of all brake types. It consists of a cylinder (drum) around which a belt, strap, or band made of fabric, leather, or steel with a lining is wrapped.



3. Disc Brakes

The friction surfaces are flat and perpendicular to the axis. The disk is a thin cylinder with a large diameter. The ratio between D and d is a maximum of 0.7. For the calculation of the linings, it is accepted that under normal operating conditions, wear of 1 mm occurs for a torque of 15×10^6 daNm/cm^2 of lining.

The linings are available in the following forms:

- Complete or partial pads.

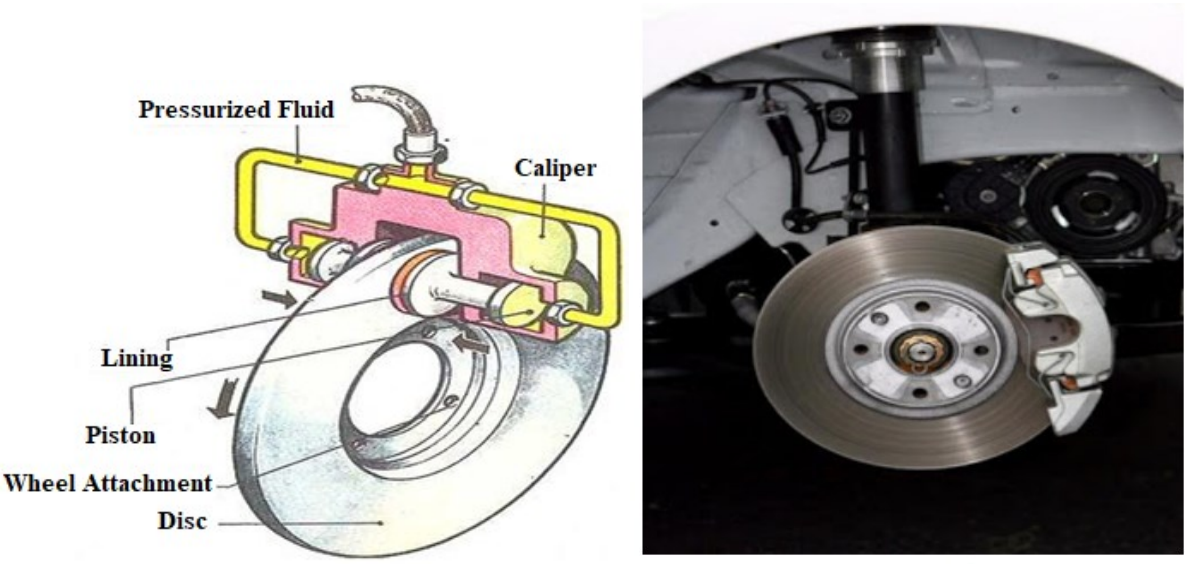


Figure - Schematic Description of a Disc Brake System

Controls:

- **Strap Brake**: Mechanical Control

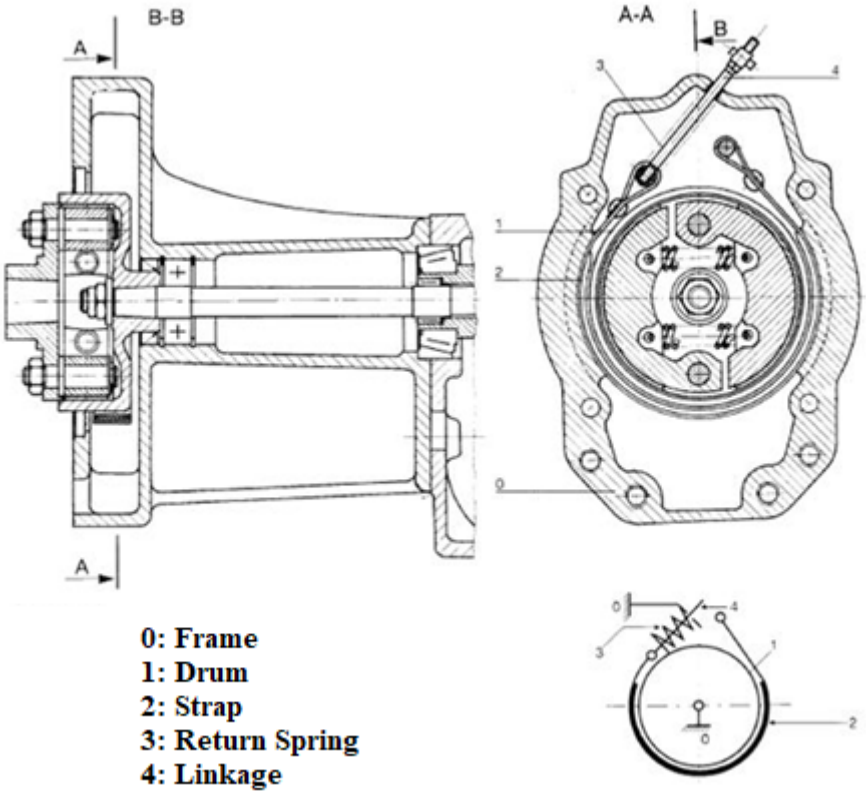


Figure -Mono Disc Brake - Pneumatic Control

II. Clutches (Couplings)

II.1 Definition:

A clutch is a temporary coupling that enables the engagement or disengagement of two rotating shafts at will.

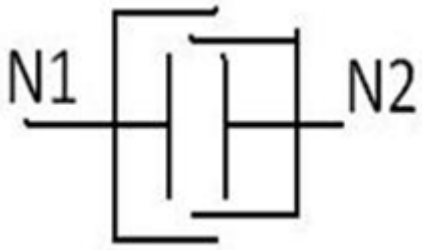


Figure - General Symbol

II.2 Role

The couplings is designed to temporarily transmit rotational motion and torque from a driving component to a driven component. It must allow for:

- A gradual or rapid start-up of the machine to reach its operating speed.
- Complete and slip-free transmission of the total motor torque to the driven machine during operation.
- Instantaneous cessation of torque transmission through a simple and easy maneuver requiring minimal effort.

II.3 Classification of Clutches (Couplings)

Clutches can be classified based on either their drive mechanism or their method of control.

II.3.1 Classification by Drive Mechanism

II.3.1.1 Instantaneous Clutches (Couplings)

These are clutches that engage through an obstacle (toothed clutches: square, trapezoidal, triangular). Their design is simple and economical, and engagement must occur when the system is at rest.

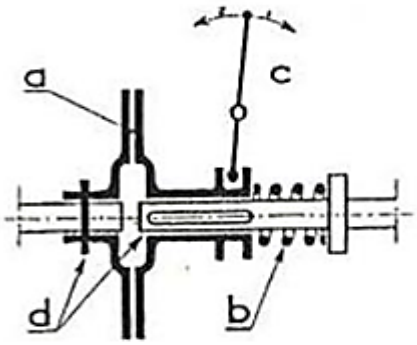
II.3.1.2 Progressive Clutches (Couplings)

These are clutches where the engagement mechanism can be based on friction, powder, or hydraulic systems. Engagement can be performed while the system is in operation.

A – Friction Clutches (Couplings)

1. **Construction**

Friction clutches consist of multiple components that work together to create frictional force for engagement.



A Progressive Clutch is Generally Composed of:

a. Contact Surfaces

b. Pressure System

c. Control Device

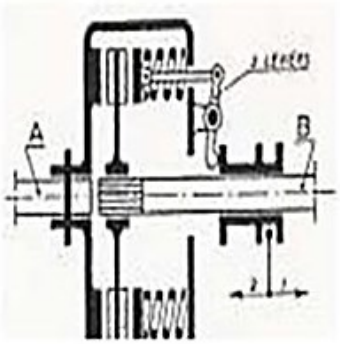
d. Sleeve-shaft Connections

Figure- The components of a progressive clutch

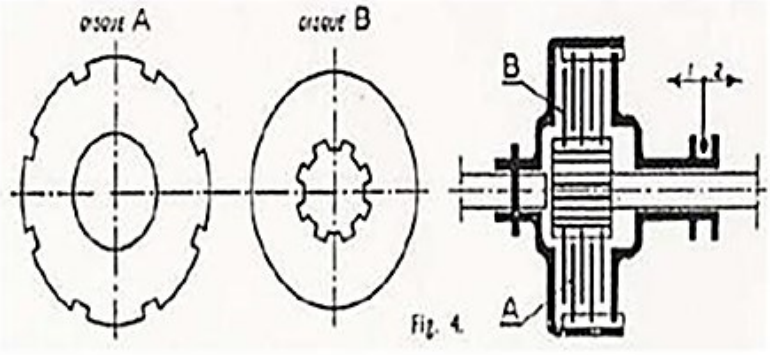
2. Surface Shapes

The contact surfaces can be flat, cylindrical, or conical.

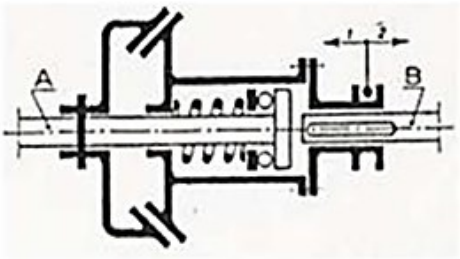
- Single Disc Plane Friction Clutch



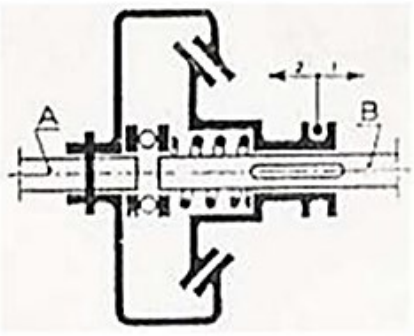
- Multi-Disc Plane Friction Clutch



- Conical Friction Clutch - Direct Cone



- Conical Friction Clutch - Inverse Cone



- Cylindrical Friction Clutch

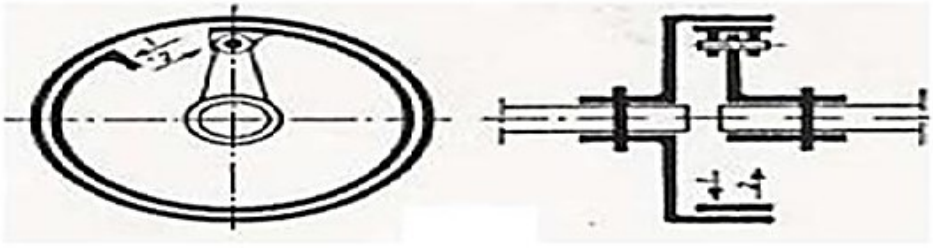


Figure. Types of friction clutches

3. Friction Linings

Friction linings must meet the following conditions:

- High coefficient of friction.
- Excellent wear resistance and thermal stability.

Materials:

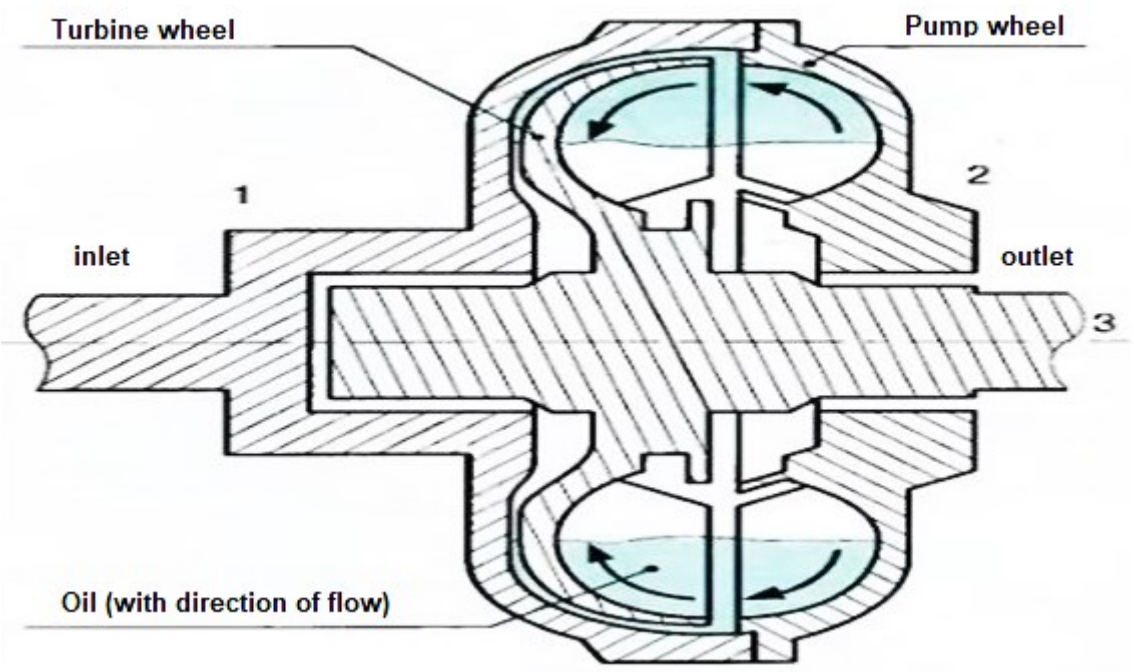
The most commonly used material is Ferrodo, which consists of asbestos fabric reinforced with copper, brass, or lead wire, secured to the clutch elements by riveting or adhesive bonding. Metallic linings (cast iron, steel, bronze) are also available, working in either oil or dry conditions.

4. The Pressure System

The pressure system generally consists of a hardened carbon steel coil spring; it can be a single unit arranged concentrically around the axis of the two shafts. Some clutches feature multiple identical springs distributed evenly around the mean radius of the contact surface. This configuration ensures more uniform pressure distribution.

B – Hydraulic Clutches

The operation is based on the movement of a certain mass of fluid via a driving turbine (flywheel). The energy of this fluid mass is transferred to a driven turbine (receiver flywheel). As the driving flywheel rotates, it propels the oil, which, due to centrifugal force, is ejected against the vanes of the receiver flywheel, causing it to rotate.



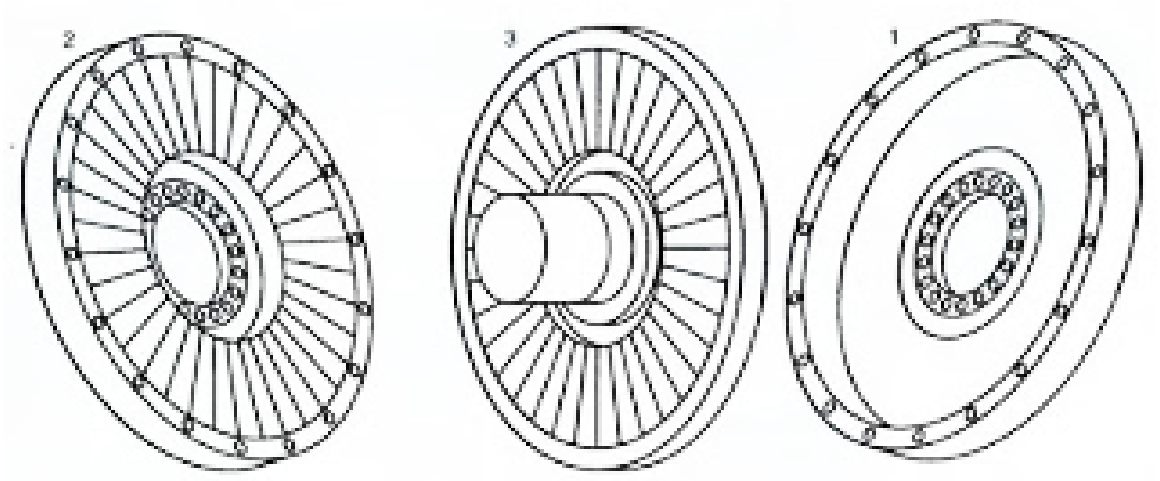


Figure - Hydraulic Clutches

II.3.2 Classification by Control Method

The role of a clutch control system is to transmit the force applied to the clutch pedal to the plates, multiplying it in the process.

1. Mechanical Control Clutches

These are generally used when no power source is available. Levers, forks, cams, etc., are employed.

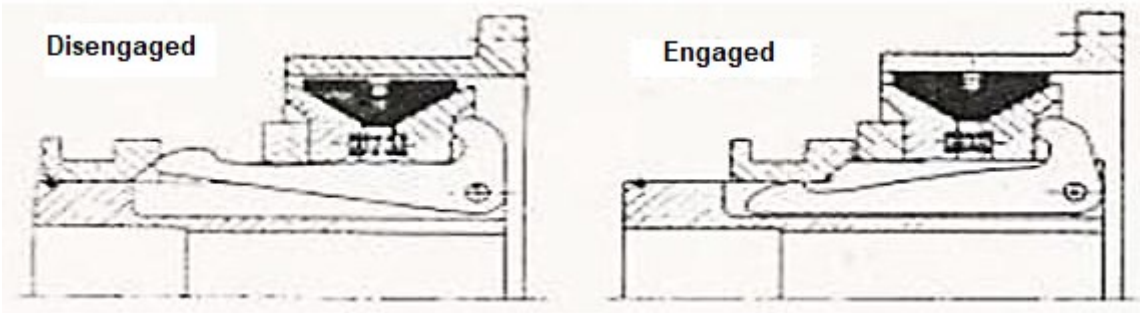


Figure - Mechanical Control Clutches

2. Hydraulic Control Clutches

The compressive force F is generated when the fluid is under pressure. This system allows for very good clutch progression, with easily adjustable pressure. However, achieving effective sealing can be challenging.

3. Pneumatic Control Clutches

The compressive force is generated by pressurized gas. Both hydraulic and pneumatic control systems transmit torque based on the pressure applied. It is imperative to maintain this pressure throughout the entire operation duration.

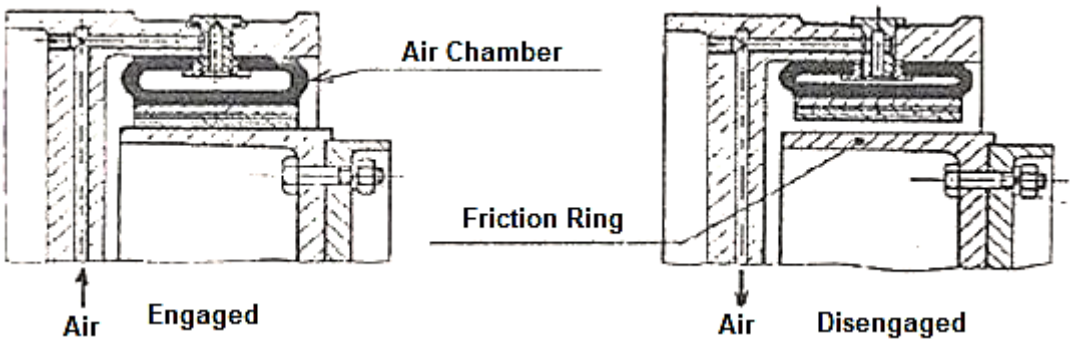


Figure - Pneumatic Control Clutches

4. Electromagnetic Clutches

A direct current passes through a coil, and the clutch plates are drawn in by an electromagnet. Progressivity is achieved by varying the intensity using a rheostat.
Advantage: Remote control capability.

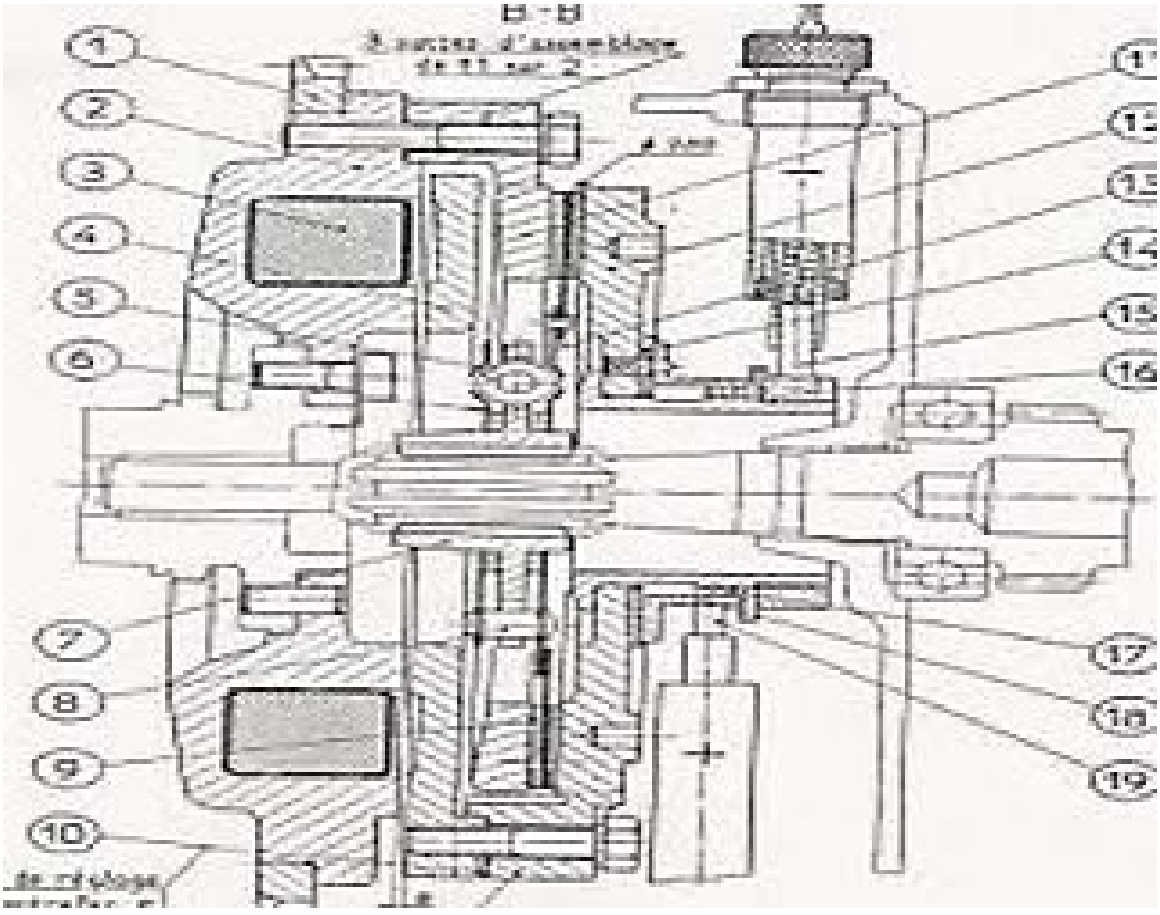
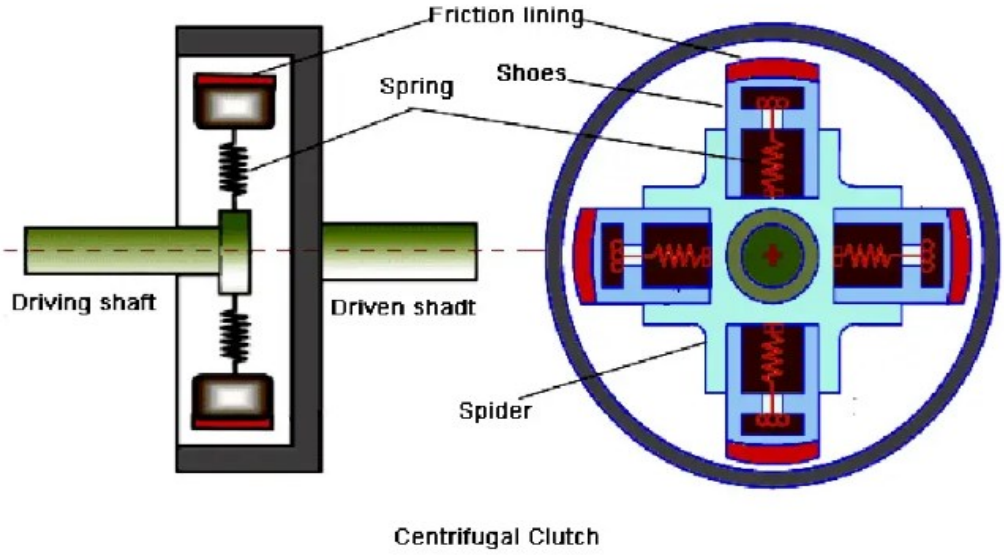


Figure - Electromagnetic Clutches

5. Centrifugal Clutches

Clutches that gradually connect the engine and the receiver as the engine speed approaches the nominal speed. The principle of controlling these clutches uses centrifugal force as the pressing force. It enables a programmed coupling function based on the driving component.



F igure - Centrifugal Clutches