

Braking Systems



Brake

- ❖ The device used to stop any vehicle by applying frictional forces.
- ❖ One of most important control components of vehicle.
- ❖ They are required to stop vehicle within smallest possible distance.
- ❖ This is done by converting kinetic energy of vehicle into heat energy which is dissipated into atmosphere.



Braking Requirements

1. Brakes must be strong enough to stop vehicle with in a minimum distance in an emergency.
2. Brakes must have good anti-fade characteristics i.e. their effectiveness should not decrease with prolonged application. This requirement demands cooling of brakes should be very efficient.



Types

- The brakes of an automobile are classified according to as :-
 1. Purpose
 2. Location
 3. Construction
 4. Method of actuation
 5. Extra braking effort



- **Purpose:-** From this point of view Brakes are classified as service or primary and parking or secondary brakes.
- **Location:-** From this point of view brakes are located at wheels or at transmission.
- **Construction:-** From this point of view brakes are drum brakes and disc brakes.



- **Method of actuation:-** This criterion gives following brake type :
 - a) Mechanical Brakes
 - b) Hydraulic Brakes
 - c) Electric Brakes
 - d) Vacuum Brakes
 - e) Air Brakes
 - f) By-wire Brakes

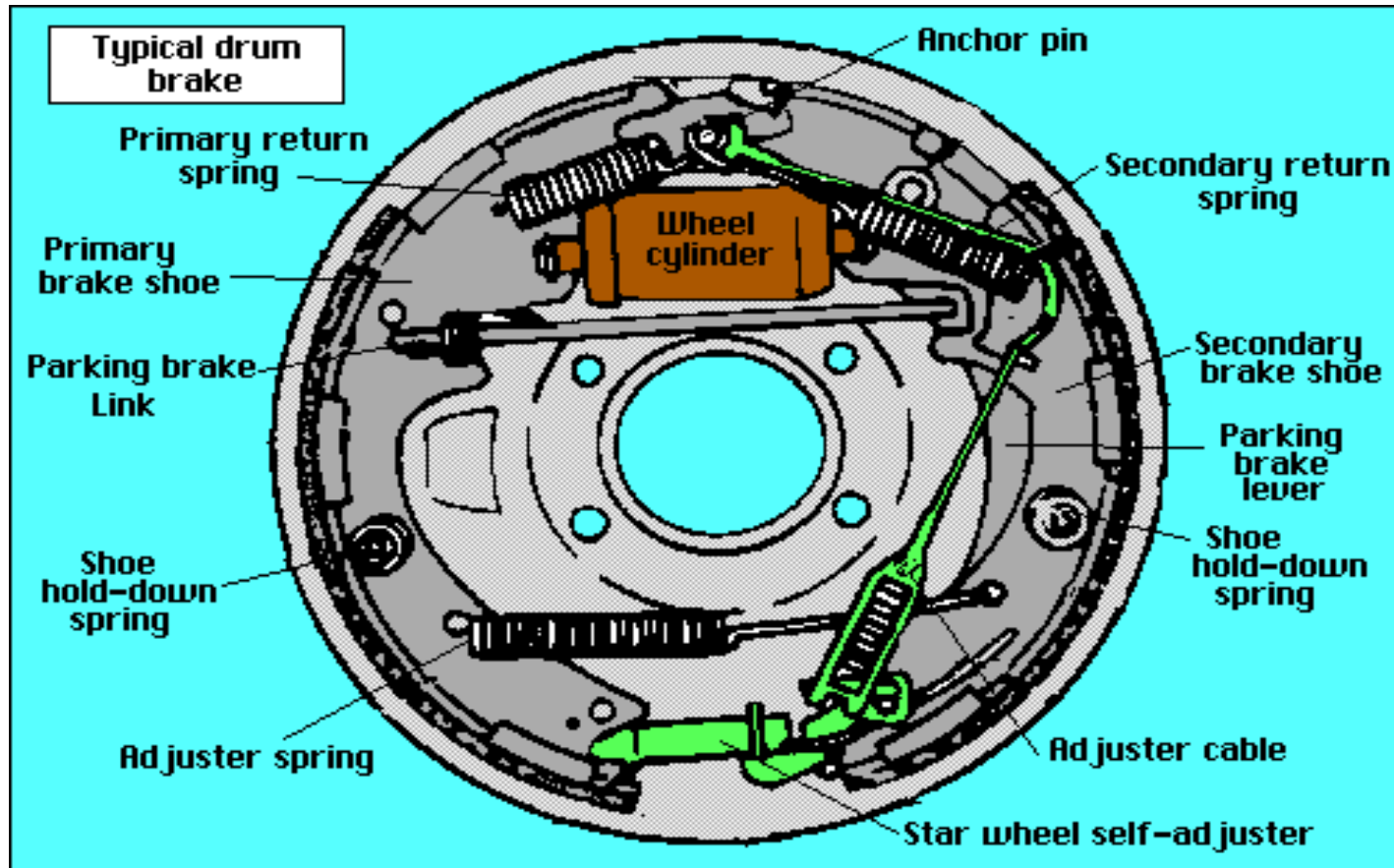


Drum Brakes

- Shoes press against a spinning surface. In this system, that surface is called a drum.
- Drum brakes have more parts than disc brakes and are harder to service, but they are less expensive to manufacture.



Drum Brakes

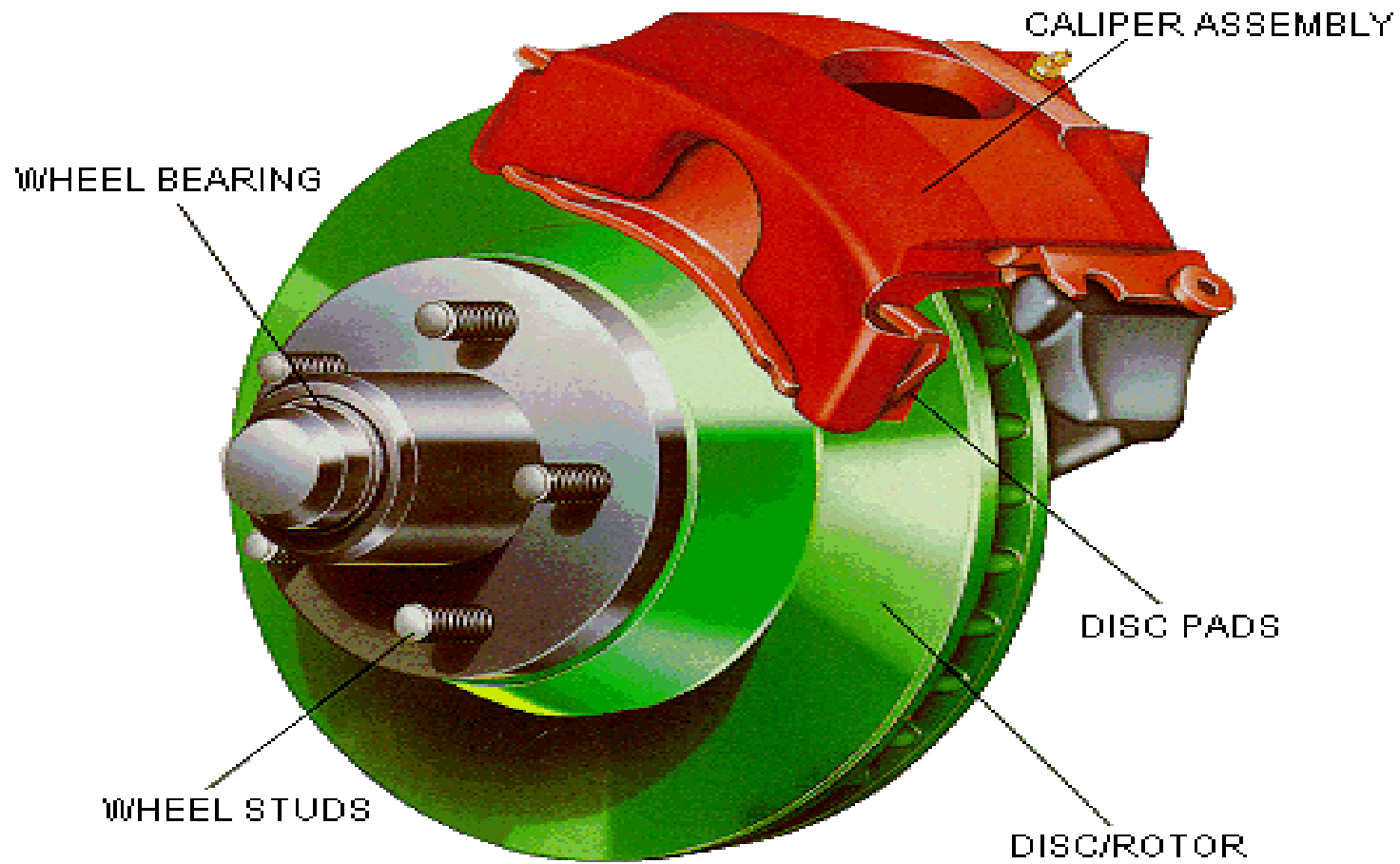


Disc Brakes

- A disc brake consists of a cast iron disc bolted to wheel hub and stationary housing called caliper. Caliper is connected to some stationary part of vehicle like axle.
- When brakes are applied, piston move friction pads into contact with disc, applying equal and opposite force on disc. On releasing brakes, the rubber sealing rings act as return springs and retract piston and friction pads away from disc.



Disc Brakes



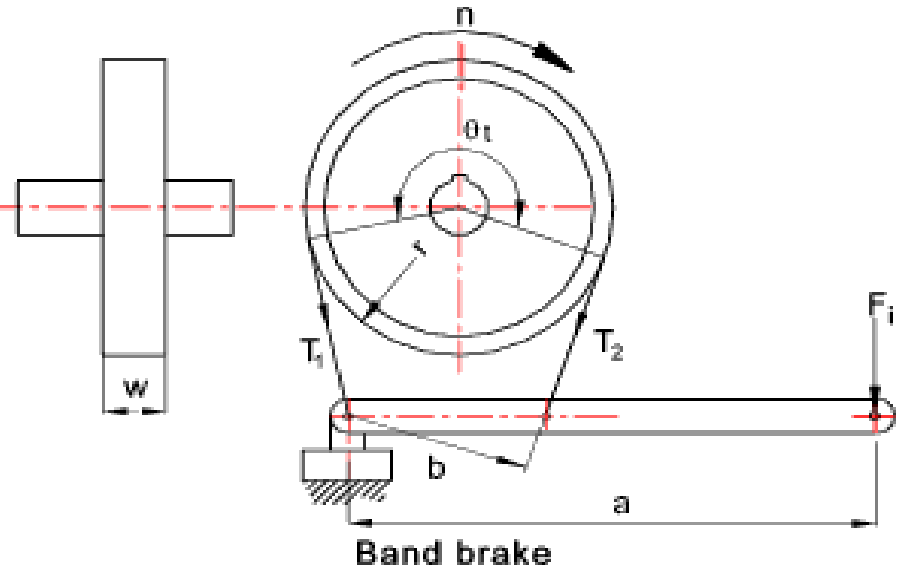
Mechanical Brakes

- Mechanical brakes are assemblies consisting of mechanical elements for the slowing or stopping of vehicle. They use levers or linkages to transmit force from one point to another.
- There are several types of mechanical brakes. Band brakes, the simplest brake configuration, have a metal band lined with heat and wear resistant friction material. Drum brakes, which are commonly used on automobile rear wheels work when shoes press against a spinning surface called a drum. Disc breaks are constructed of brake pads, a caliper, and a rotor. During operation, the brake pads are squeezed against the rotor. Cone brakes are made with a cup and a cone, which is lined with heat and wear resistant material. During actuation, the cone is pressed against the mating cup surface.



Band Brakes

- The principle is that a band is wrapped part round a rotating drum. Tension can be applied to the band using a lever. The restraining torque results from the difference in tension between the two ends of the belt.

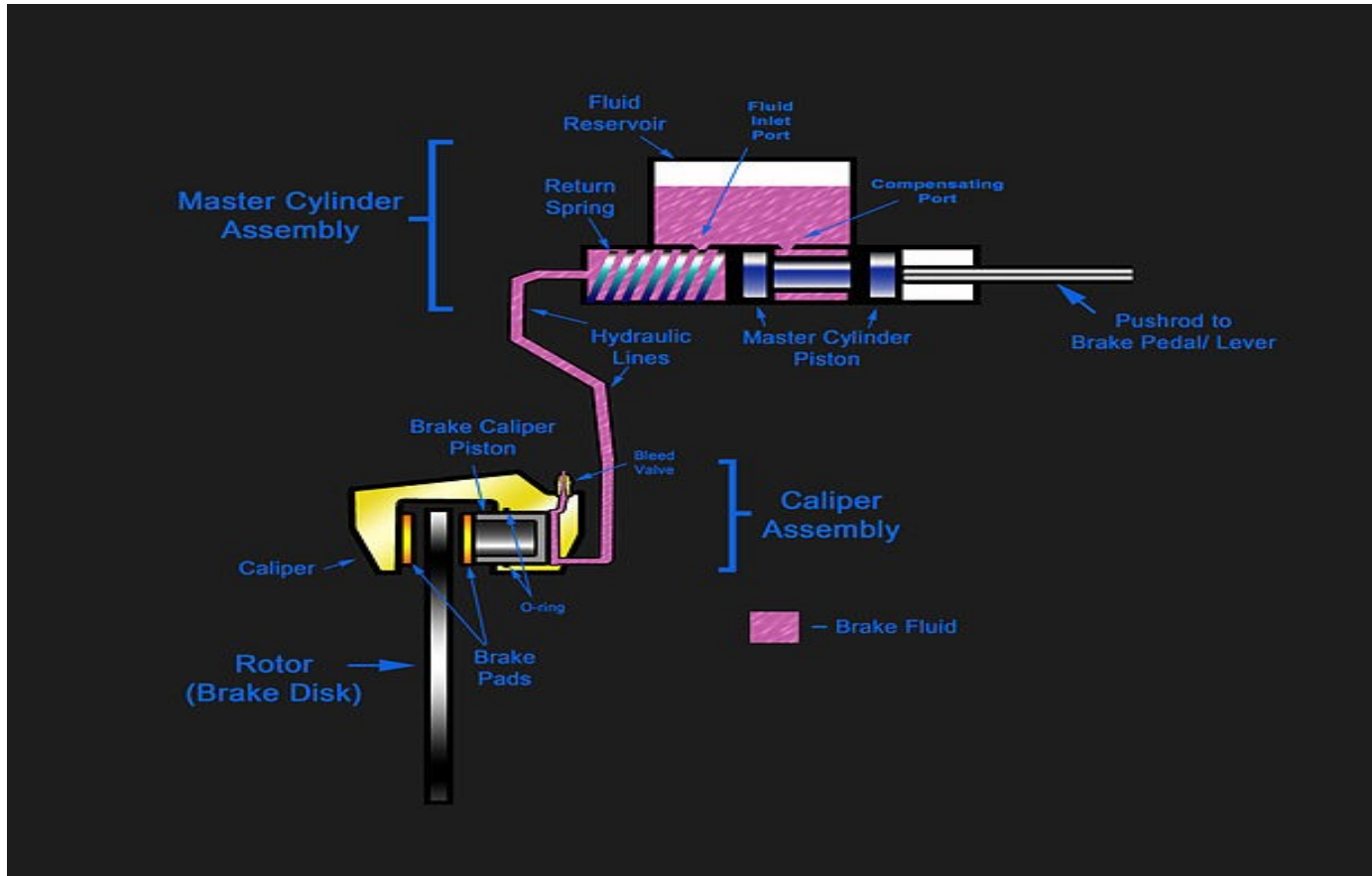


Hydraulic Brakes

- The hydraulic brake is an arrangement of braking mechanism which uses brake fluid specially ethylene glycol to transfer pressure from the controlling unit to the actual brake mechanism of the vehicle.
- Parts of hydraulic brakes:-
 1. Brake Pedal
 2. Push rod
 3. Master cylinder assembly
 4. Brake caliper assembly



Cont....



System Operation

- as the brake pedal is pressed, a pushrod exerts force on the piston(s) in the master cylinder.
- This forces fluid through the hydraulic lines toward calipers.
- The brake caliper piston(s) then apply force to the brake pads. This causes them to be pushed against the spinning rotor, and the friction between the pads and the rotor causes a braking [torque](#) to be generated, slowing the vehicle.



Electrical Brakes

- Electric brakes are actuator devices that use an electrical current or magnetic actuating force to slow or stop the motion of a rotating vehicle.
- There are two main types of electric brakes: magnetic and [friction](#).
- Magnetic brakes are non-contact brakes that use magnetic fields to actuate the braking components
- **Permanent magnetic brake**
- **Electromagnetic brake**
- **Eddy current brakes**
- **Hysteresis powered brakes**



Permanent Magnetic Brake

1. Applications:- electric motors, Robotics
2. Advantages:- High and accurate Torque, long life, unaffected by power supply, safe and easy to use
3. Disadvantages:- Require a constant current control to offset the permanent magnetic field.



Electromagnetic brake

1. Applications:- Copy machines, conveyor drives, packaging machinery, printing machinery, food processing machinery and factory automation.
2. Advantages:- Fast response time, smooth, reliable, and backlash free operation, produce high torque, automatic air gap available.
3. Disadvantages:- Braking force diminishes as speed diminishes, load cannot be held at a standstill causing safety concern.



Eddy current brakes

1. Applications:- Train and roller coaster brakes.
2. Advantages:- Noncontact, Frictionless, resettable, light weight, few moving parts.
3. Disadvantages:- Unusable at low speeds, generates heat.



Hysteresis powered brakes

1. Applications:- Food and drug packaging operations, clean rooms, environmental test chambers, load simulation for life testing on rotating devices, capping, bolting and other screwing applications.
2. Advantages:- Long, maintenance-free life, cost effective, operational, smoothness, torque repeatability, broad speed range, environmental stability, high-dissipation capability. The torque remains constant and smooth and responds with increases and decreases in current.
3. Disadvantages:- Experience a salient-pole phenomenon called "cogging", an undesirable, pulsating output torque which prevents smooth and efficient operation of these systems



Servo Brake System

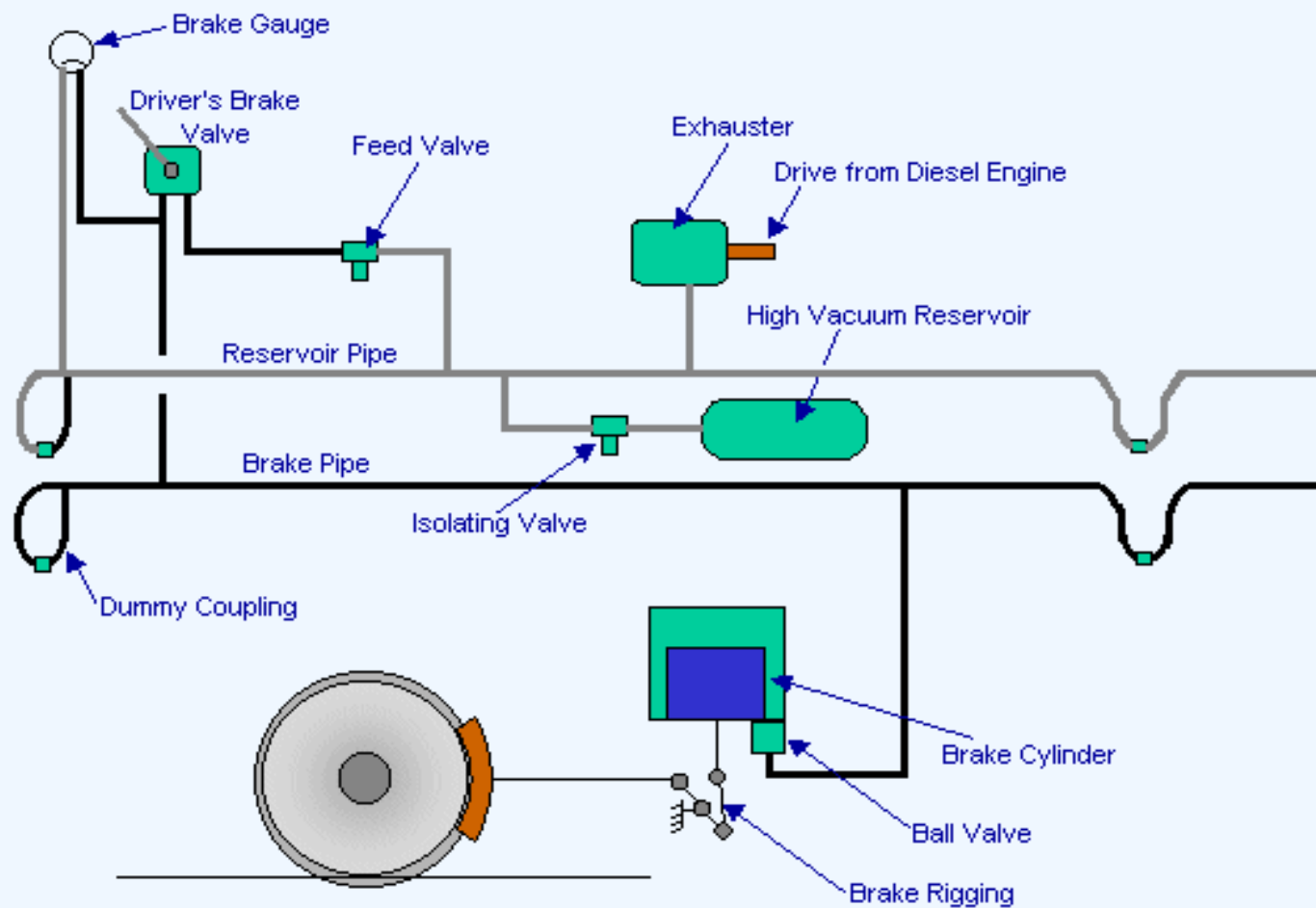
1. Servo Mechanism:- A **servomechanism**, or **servo**, is an automatic device that uses error-sensing [negative feedback](#) to correct the performance of a mechanism. It applies only to systems where the [feedback](#) or error-correction signals help control mechanical position, speed or other parameters. It is an electronically controlled mechanical or hydraulic device permitting a large action or strong forces to be controlled by a small electrical signal.



Power Brakes

- These are the brakes in which power of engine or battery is used to enhance the braking effort.
 - These are of four types:- Vacuum Brakes, Air Brakes, Hydraulic Booster Brake and Electro-Hydraulic Booster brake.
1. **Vaccum Brakes**:- Vacuum brake system is controlled through a brake pipe connecting a brake valve in the driver's cab with braking equipment on every vehicle. The operation of the brake equipment on each vehicle depends on the condition of a vacuum created in the pipe by an ejector or exhauster.





Schematic of Two Pipe Vacuum Brake System Used on BR Diesel Cars



2. **Air Brakes:-** The operation of air brakes is similar to hydraulic brake except that compressed air is used to apply brakes instead of hydraulic pressure. Air brakes are commonly used on heavy vehicles like trucks, buses etc.



3. **Antilock Brake System (ABS)**:- Due to excessive braking brakes are locked which causes skidding. Skidding is avoided by releasing braking pressure just before wheels are lock up and then reapplying same. This process is called pressure modulation. A modern ABS consists of an electronic control unit (ECU)., one sensor on each wheel, an electrically driven hydraulic pump and pressure accumulator. Accumulator is used to store hydraulic fluid to maintain high pressure in braking system. It is charged with nitrogen gas. ECU monitors and controls the antilock function when required.

