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TYPES OF BRAKING SYSTEM

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Winder Brakes & Braking System

- **Brake** is a safety device which inhibits motion.
- **Braking** is conversion of Kinetic Energy into other forms of energy.

Most commonly brakes use friction to convert Kinetic energy into Heat, although it may also be converts into other forms such as Electrical or Potential energy.

Purpose of using Brakes

1. Holding Function
2. Stopping Function
3. Emergency Stop Function
4. Controlled Slip Function

Classification of Braking System

1. **Electrical Braking System:** It is a device or system which converts Kinetic Energy of a moving or rotating body into Electrical Energy which can either be stored in batteries or lost as heat.

2. **Mechanical Braking System:** It dissipates all the Kinetic Energy of a system by means of frictional forces to the atmosphere in the form of heat.

Purpose of Mechanical Braking System

1. **Service Braking:** It is used to stop and hold the hoist at rest.

2. **Emergency Braking:** It automatically effects retardation and emergency stop of the hoist before the conveyances reach the limit of travel without assistance of any external source of energy.

NOTE: 'Service Braking' and 'Emergency Braking' have two operationally independent braking circuits so that service braking can be applied irrespective of the operation of emergency braking.

Classification of Mechanical Brakes

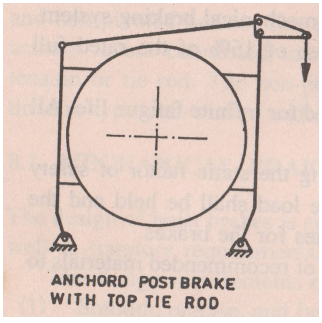
1. **Pivoted Brakes:** These are conventional brakes which actuate levers connected to the brake shoe frame through an adjustable tension or tie rod.

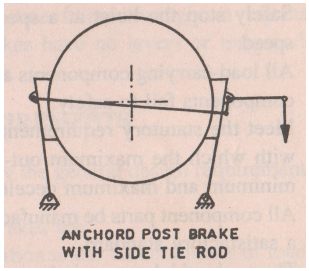
2. **Non-Pivoted Brakes:** These types of brakes have no levers or rods, such as *thruster-type unit brakes* and *disc brakes*.

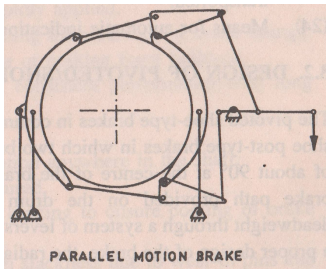
NOTE: The **Pivoted Brakes** commonly used for mine hoists are the **double shoe post** type brakes in which two brake blocks are pressed against the brake path by deadweight through levers or rods.

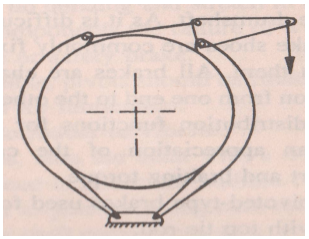
Different Designs for Pivoted Brakes

1. Anchored Post Brake with Top Tie Rod
2. Anchored Post Brake with Side Tie Rod
3. Suspended Post Brake
4. Parallel Motion Brake
5. Caliper Brake

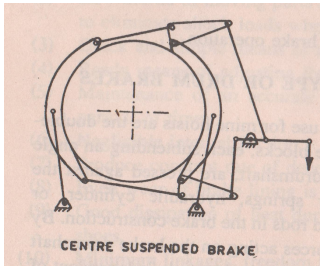






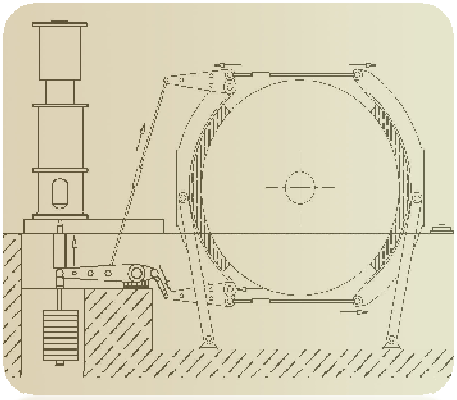


Caliper Brake

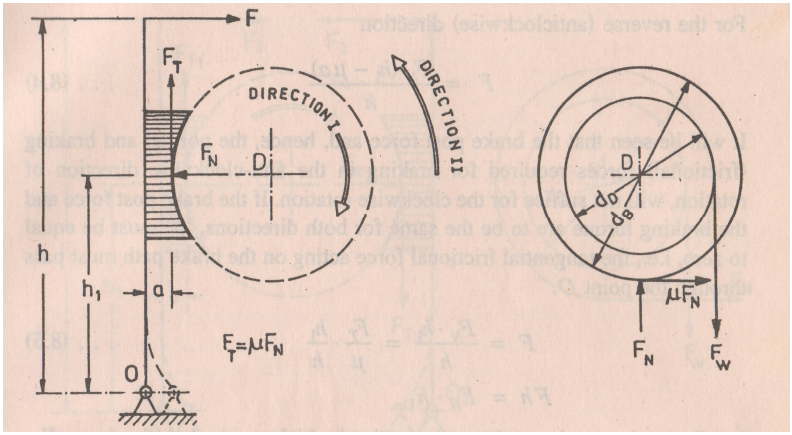


Working of Pivoted Brakes

- **Brake shoe** are connected to operating pedal of winding engineman by rod and levers.
- The wooden brake blocks are lined with bonded asbestos or fiber.
- **Dead weight** are suspended so the brake blocks grip the drum and hold it.
- An **adjuster** on the tie rods is used to adjust position of brake blocks relative to the drum.
- Centre Suspended brake is preferable to the Anchored Post brake.



Single-Shoe Post Brake



F → brake post force

f_T → Force acting tangential to the area of contact at point E

f_N → Force " normal

$$F_T = \mu f_N \quad \text{——— (1)}$$

$$F \cdot h = f_N \cdot h_1 + F_T \cdot a$$

$$\Rightarrow F = \frac{f_N (h_1 + \mu a)}{h} \quad \text{——— (2)}$$

Braking torque $= \mu f_N \cdot r_B$ ——— (3)

$$\text{Also } F = \frac{f_N (h_1 - \mu a)}{h} \quad \text{——— (4)}$$ Direction change.

If brake ~~torque~~ post force & braking torque are the same in both directions

$$\Rightarrow a = 0$$

$$\therefore F \cdot h = f_N \cdot h_1 \quad \text{——— (5)}$$

$$\Sigma M_D = 0$$

$$F_W \cdot \frac{d_D}{2} = \mu f_N \cdot \frac{d_B}{2} \rightarrow \text{Braking torque}$$

$$\Rightarrow F_N = F_W \cdot \frac{1}{\mu} \cdot \frac{d_D}{d_B}$$

$$\therefore F = f_N \cdot \frac{h_1}{h} = F_W \cdot \frac{h_1}{h} \cdot \frac{1}{\mu} \cdot \frac{d_B}{d_D}$$

$$\Rightarrow F_W = \mu \cdot F \cdot \frac{h}{h_1} \cdot \frac{d_B}{d_D}$$

∴ F is small ⇒ μ large, d_B & h are large, d_D & h_1 are small.

Brake Operating and Control System

1. It should assure a **Fast**, **Sensitive** and **Precise** control of braking effort.

2. The hoist operator should be able to perform braking operations **easily** by small movement of brake lever under **all conditions**.

Various Operating Systems

- **Compressed Air-operated Brakes:** Weight applies force on piston, leading to compression of **air** and in turn, the brake-pads are pushed against the drum.

- **Hydraulic Brakes:** Similar concept as Air-operated Brakes except, instead of **air** we have **oil** as the compressive fluid.

Compressed Air-operated Brakes

- In larger and modern mine hoists, two brake engines are used with separate adjustment of the service and emergency braking efforts .
- For small and medium capacity hoists, brakes with pair of cylinders mounted on single brake engine may be used.
- Diameter of cylinder may be same or different but they have to mount along a common center line .
- The braking effort with Service Braking is adjustable.
- It also protects the hoist and hoisting rope from severe stresses.

Advantages of Air-operated Brakes

- The supply of air is unlimited, so the brake system can never run out of its operating fluid, as hydraulic brakes can. Minor leaks do not result in brake failures.
- Air line couplings are easier to attach and detach than hydraulic lines; there is no danger of letting air into the hydraulic fluid. So air brake circuits of trailers can be attached and removed easily by operators with no training.
- Air not only serves as a fluid for transmission of force, but also stores potential energy. So it can serve to control the force applied. Air brake systems include an air tank that stores sufficient energy to stop the vehicle if the compressor fails.
- Air brakes are effective even with considerable leakage, so an air brake system can be designed with sufficient "fail-safe" capacity to stop the vehicle safely even when leaking.

Limitations of Air-operated Brakes

- Compressibility of air lead to slow brake operation.
- They are unable to ensure smooth, accurate and reliable braking.
- Initial cost is high.
- Deadweights are necessary.
- Power pack unit is quite large.

Hydraulic Brakes

- Depending on pressure of oil used, hydraulic brakes system are designed as:
  - low-pressure system (0.5-1.0 MPa)
  - medium-pressure system (10-21 MPa)
  - high-pressure system (24-27 MPa)
- The volume of fluid to be moved, the dead time, reaction time and size of hydraulic components decreases with increase in oil pressure.
- High pressure system have a high speed of operation with fast response and high accuracy of control.

Types of hydraulic brakes

1) **Shoe-type Hydraulic Brakes:** These are generally

a. ”Fluid pressure applied and fluid pressure released” type with weight application in case of power failure

b. “Spring pressure applied” type, sometimes reinforced by weight for emergency application

2) **Disc Brakes:** They consists of multiple brake unit arranged to work on a brake disc fitted on one or both sides of the hoist drum.

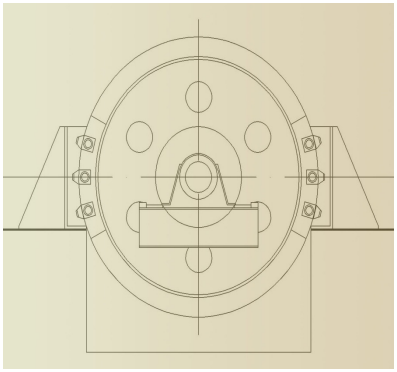
Shoe-type Hydraulic Brake

1) ***Fluid Pressure Applied and Released Brakes:***
   - Developed by G.E.C. in 1940 for Double-Drum Hoists
   - Used as low-pressure and high-pressure system
   - The braking torque can be varied from zero to maximum over complete range
   - In event of emergency de-energizing of solenoid results in braking, thus can be applied in about 0.2sec

2) ***Spring Power Brakes:***
   - Suitable for automatic mode of hoist operation
   - Braking torque can be adjusted instantaneously
   - High pressure braking system have gained wider acceptance
   - If carefully designed, the brake will act as good manual as well as emergency brakes

Disc Brakes

- Increasingly applied to drum hoists.
- Brake shoes are usually designed as circular segments.
- Consists of two similar halves mounted on a yoke
- Each half consists of a hydraulic brake cylinder with a piston and a powerful spring assembly.
- Hydraulically operated service brake and Bellevelle spring operated emergency brake.

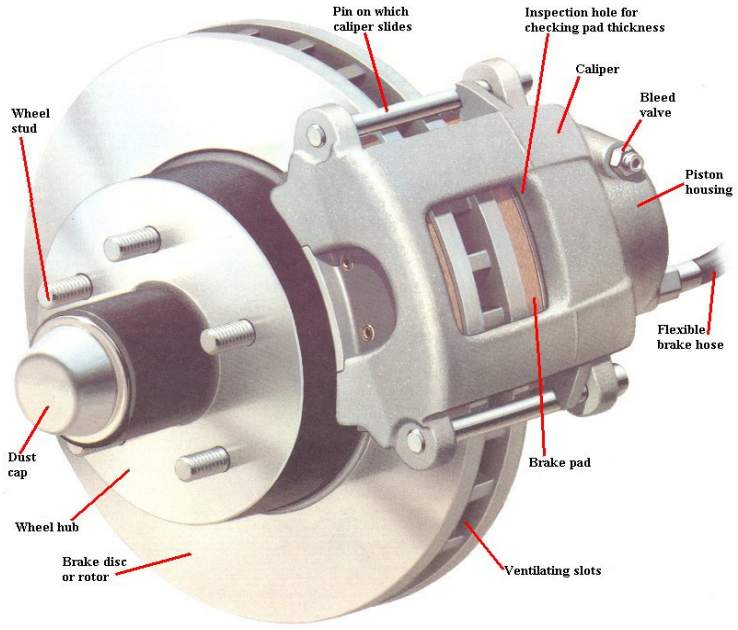


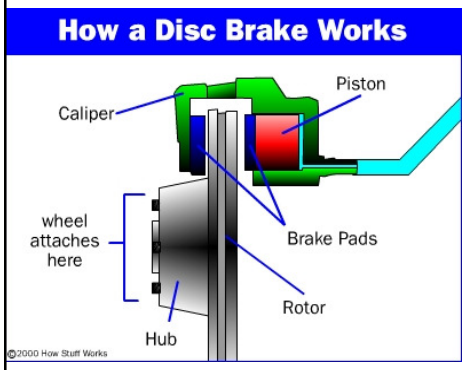
Disc Brakes (contd.)

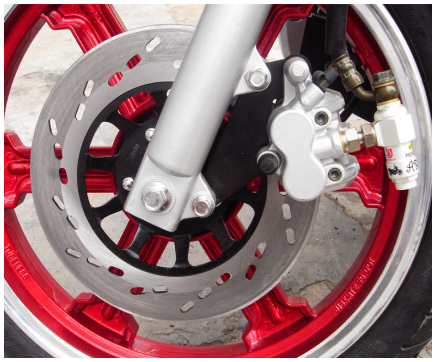
- **Though disc brakes rely on the same basic principles to slow a vehicle (friction and heat), their design is far superior to that of drum brakes.**
- **Instead of housing the major components within a metal drum, disc brakes use a slim rotor and small caliper to halt wheel movement. Within the caliper are two brake pads, one on each side of the rotor, that clamp together when the brake pedal is pressed.**
- **Once again, fluid is used to transfer the movement of the brake pedal into the movement of the brake pads.**
- **But unlike drum brakes, which allow heat to build up inside the drum during heavy braking, the rotor used in disc brakes is fully exposed to outside air. This exposure works to constantly cool the rotor, greatly reducing its tendency to overheat or cause fading.**

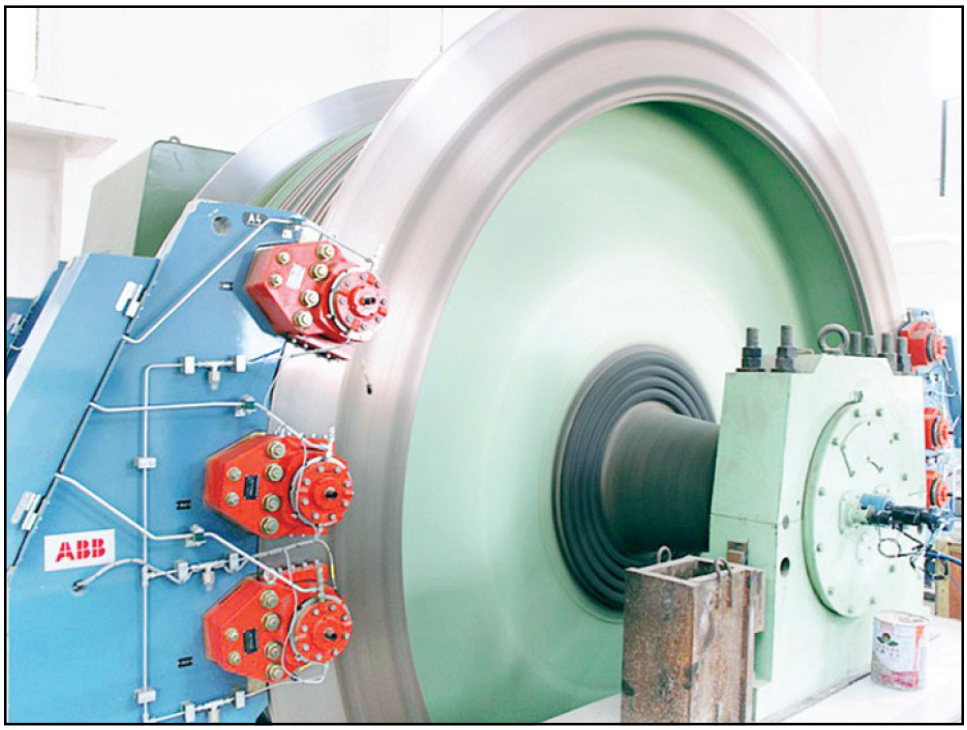
Disc Brakes (Contd.)

- The disc brake is designed to enable a large number of brake unit to be installed instead of fitting around the surface of the conventional drum brake ring, the new brakes grip on the either side of disc flanges mounted radically at the ends of the main drum right angle to it.
- The brake units are extremely compact and thus a relatively large number can be installed on each disk flange.
- The disc brake can be applied more rapidly than the conventional brakes and it is smoother in operation.




How a Disc Brake Works
Caliper
Piston
wheel attaches here
Brake Pads
Rotor
Hub
©2000 How Stuff Works





ABB

Advantages of Disc Brake over the conventional brakes

- Low inertia, fast response and extremely smooth and precise in operation.
- High braking capacity, 2-3 times that of double shoe suspended brake of same diameter.
- Easy to maintain and install with high reliability in service.
- Apply equal braking in both direction of rotation.
- Large cooling area since disc pad covering only small part of the disc.
- Being compact, since mounted on hoist bed plate itself requires, less space.
- Economical manufacture due to large number of units.

Coal Mines Regulations / Metaliferrous Mines Regulations

- According to **Coal Mine Regulation 2011:**

1) There shall be provided **one or more brakes** on the drum or the drum-shaft.

2) At least one of the brake shall be so designed that the **brake remains at the ON position** except when operated.

3) Where the brakes are Power-operated at least one of them shall be arranged to be **applied automatically** at all times, if the power supply fails.

4) The brake on the drum shall be used only for the purpose of keeping the drum stationary and **not for lowering the cage** or any other means of conveyance.