



# **SNS COLLEGE OF TECHNOLOGY**

**Coimbatore-35**  
**An Autonomous Institution**

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## **DEPARTMENT OF MECHANICAL ENGINEERING**

### **DESIGN OF Transmission System**

III YEAR VISEM

UNIT 5– Brakes



# Contents

What are the Functions of Brakes?

Internal Expanding Brake

External Contracting Type Brake

Disc Brake

Internal Expanding Rim Clutches

Internal And External Shoe Brakes.

Design Of Brakes

Problem Discussion



# Automotive Brakes

- Provide a means of using friction to either slow, stop, or hold the wheels of a vehicle
- When a car is moving, it has energy stored in the form of inertia (kinetic energy)
- To stop the vehicle, the brakes convert kinetic (moving) energy into heat



# BRAKES

**Friction** is the resistance to motion between two objects in contact with each other.

- Dry friction (*Brakes*)
- Greasy Friction (*Wheel bearings*)
- Viscous (*Crank main bearings*)



Friction varies with the roughness of the surfaces.

**Kinetic (*Motion*) Friction**

**Static (*Rest*) Friction**



# BRAKES

Friction between *Drums & Shoes* or *Pads & Rotors* slows the car.



Friction between TIRES and ROAD stops the car.

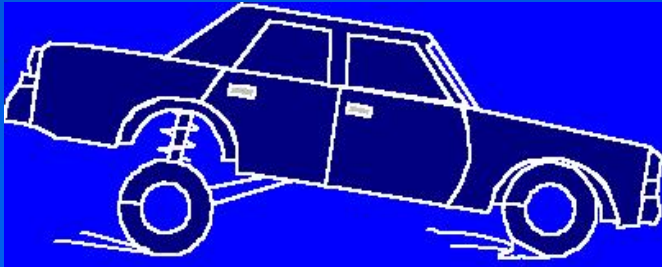


# How it Works

- *Friction develops heat which absorbs kinetic energy of the car*

# BRAKE SYSTEMS 101

## *How it Works - Energy Conversion*



The brake system converts the kinetic energy of vehicle motion into **heat**

# PURPOSE OF BRAKING SYSTEM

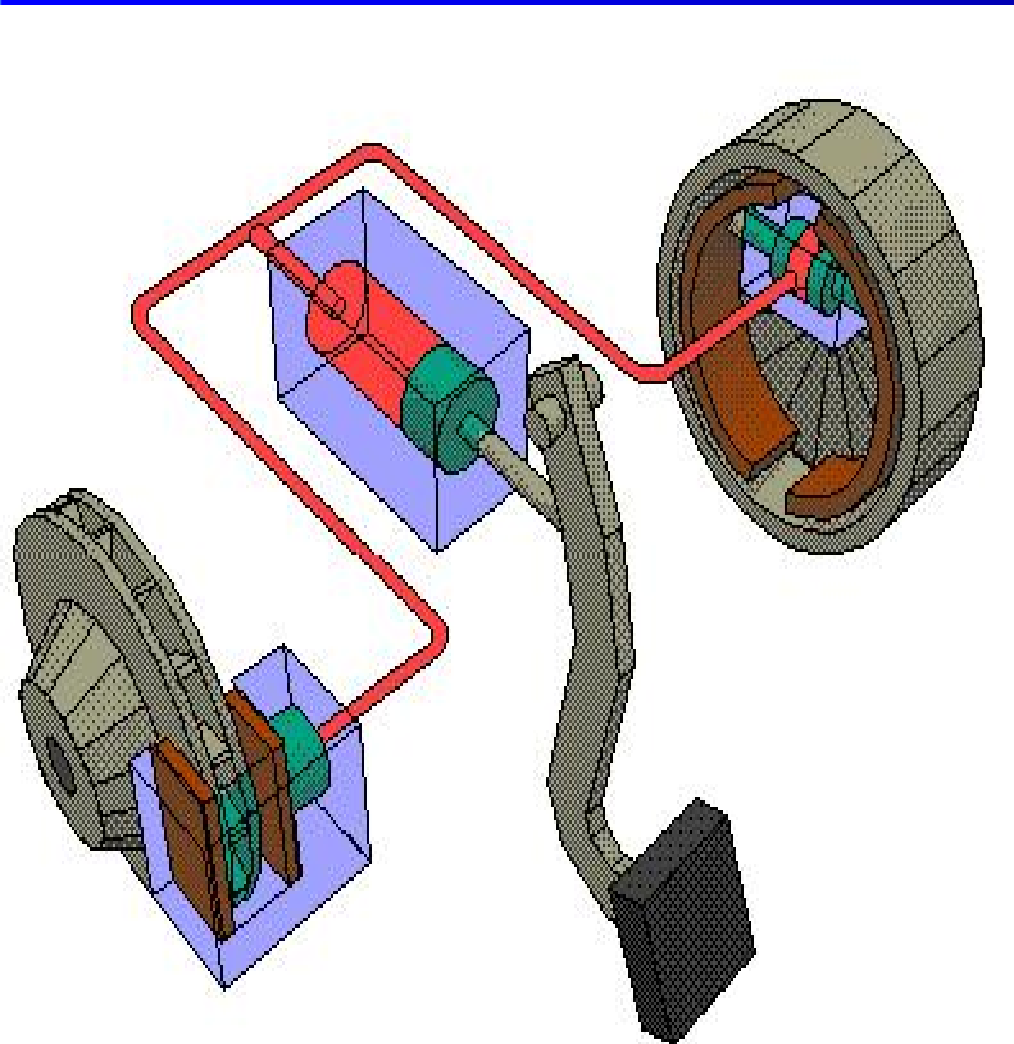
- Stop the vehicle by converting the kinetic energy of the vehicle to heat energy.
- Heat energy is created in the brakes by friction.
- Friction is created between a moving and a non-moving surface at each wheel to generate the heat.
- Disc and drum brakes are the most common type of braking systems used.



# *Factors Effecting Braking\**

- Number of wheels braking.
- Weight of vehicle.
- Type of friction material.
- Surface area of friction material.
- Size or discs or drums
- Tire traction.
- Road surface.
- Load transfer.
- Incline or decline of road. (gravity)
- Engine braking.
- Pressure applied

# Types of Braking Systems



- *Service brakes*. It's the primary braking system using a the pedal connected to a hydraulic system causing it to operate.
- *Parking brakes*. It's mechanically applied by a lever or pedal.

# TYPES OF BRAKES

## MECHANICAL BRAKES

### (a) RADIAL BRAKES

(i) Internal & External

(ii) Block

(iii) Band

### (b) AXIAL BRAKES

(i) disc brakes

(ii) cone brakes

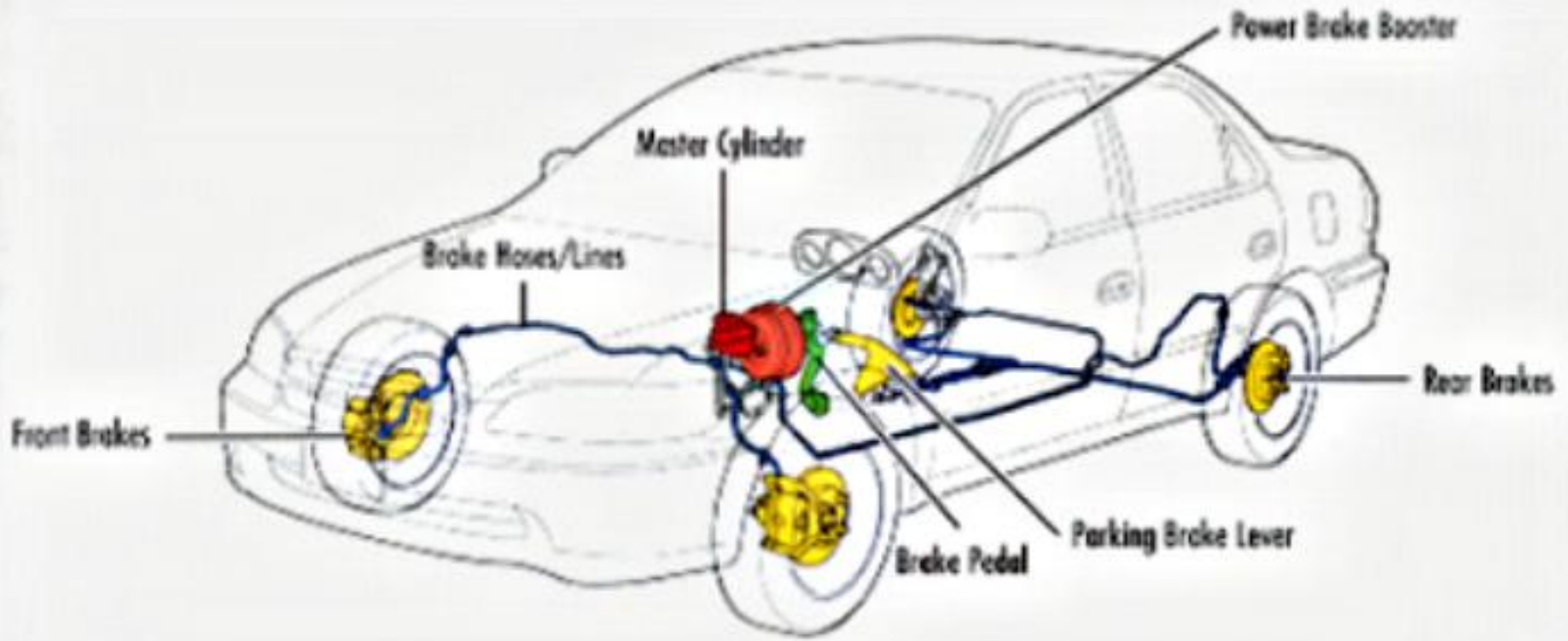
## HYDRAULIC BRAKES

## VACUUM-ASSISTED BRAKES

## AIR PRESSURE ASSISTED BRAKES

## AIR PRESSURE BRAKES

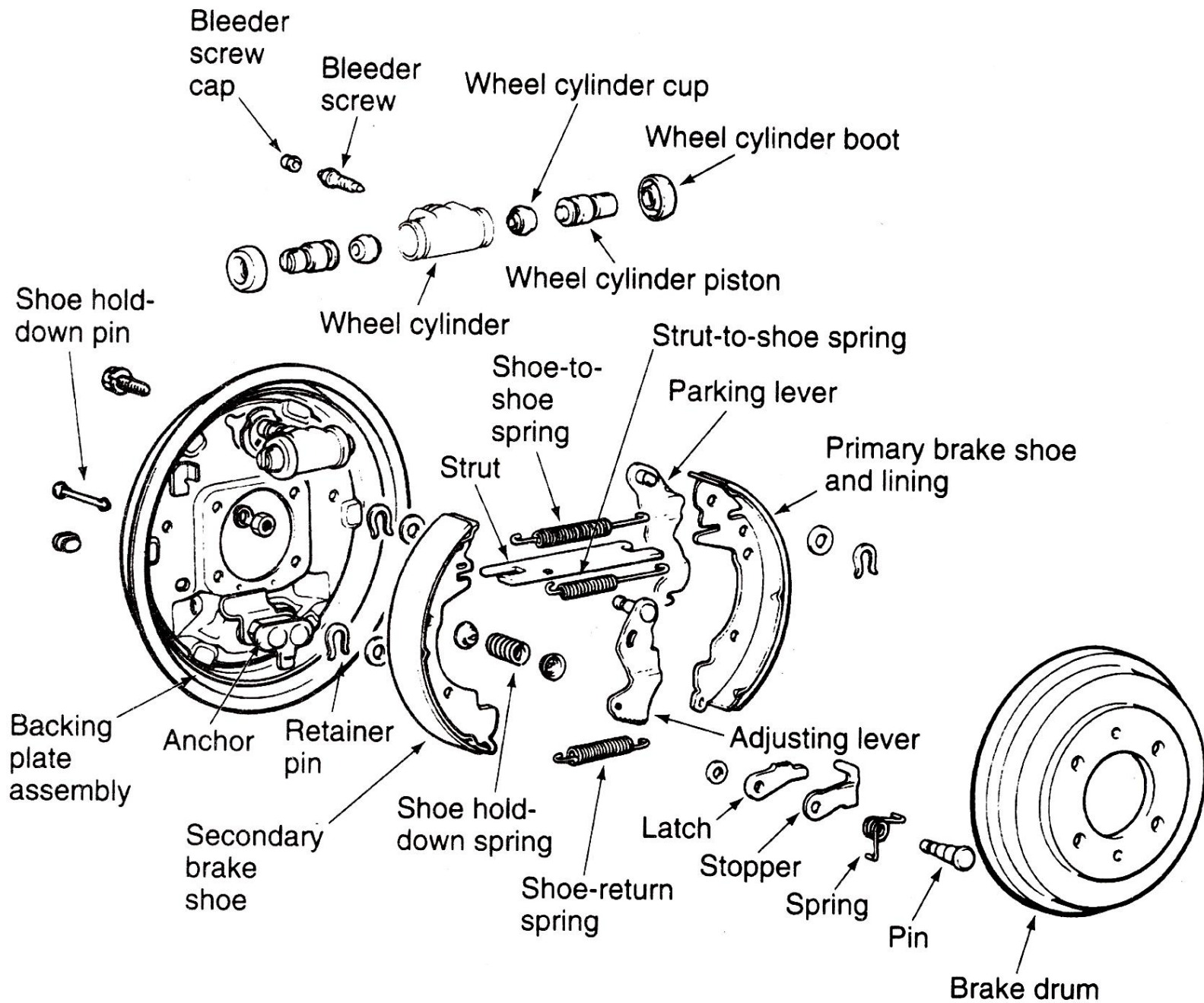
## ELECTRICAL BRAKES



## BASIC PARTS

- Pedal assembly
- Hydraulic system
- Power booster
- Disc brake assembly
- Drum brake assembly
- Parking brake

# Drum Brakes





# BRAKES

## Brake Action

- Brake **Pedal** is connected to the **Master Cylinder**.



- Each wheel has a **Wheel cylinder**

(Rear)



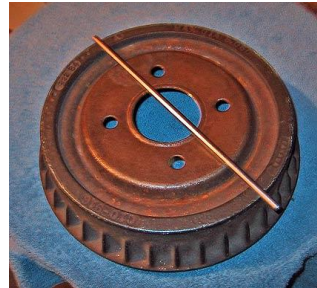
Or **Caliper**

(Front)



- Each wheel has a brake **Drum**

(Rear)



Or **Disk**

(Front)

- Each wheel has **Shoes**

(Rear)



Or **Pads**

(Front)





# BRAKES

When the vehicle comes to a stop, most of the weight is shifted to the front



70% - 80% of the work is done by the front brakes

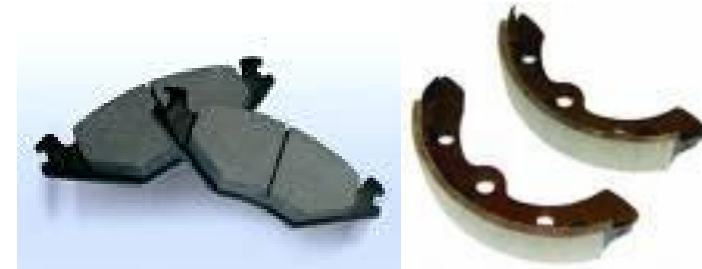


# BRAKES

## Brake Lining

Brake lining is made of various materials (Asbestos)

Some are bonded or glued to a metal plate.



Some are riveted to a metal plate.



Brake lining must be strong enough to absorb the heat and last a long time, yet save the drums and rotors from wearing too quickly.





# BRAKES

**Disk brakes** found on front of most vehicles as well as at rear of four wheel Disk brakes vehicles.

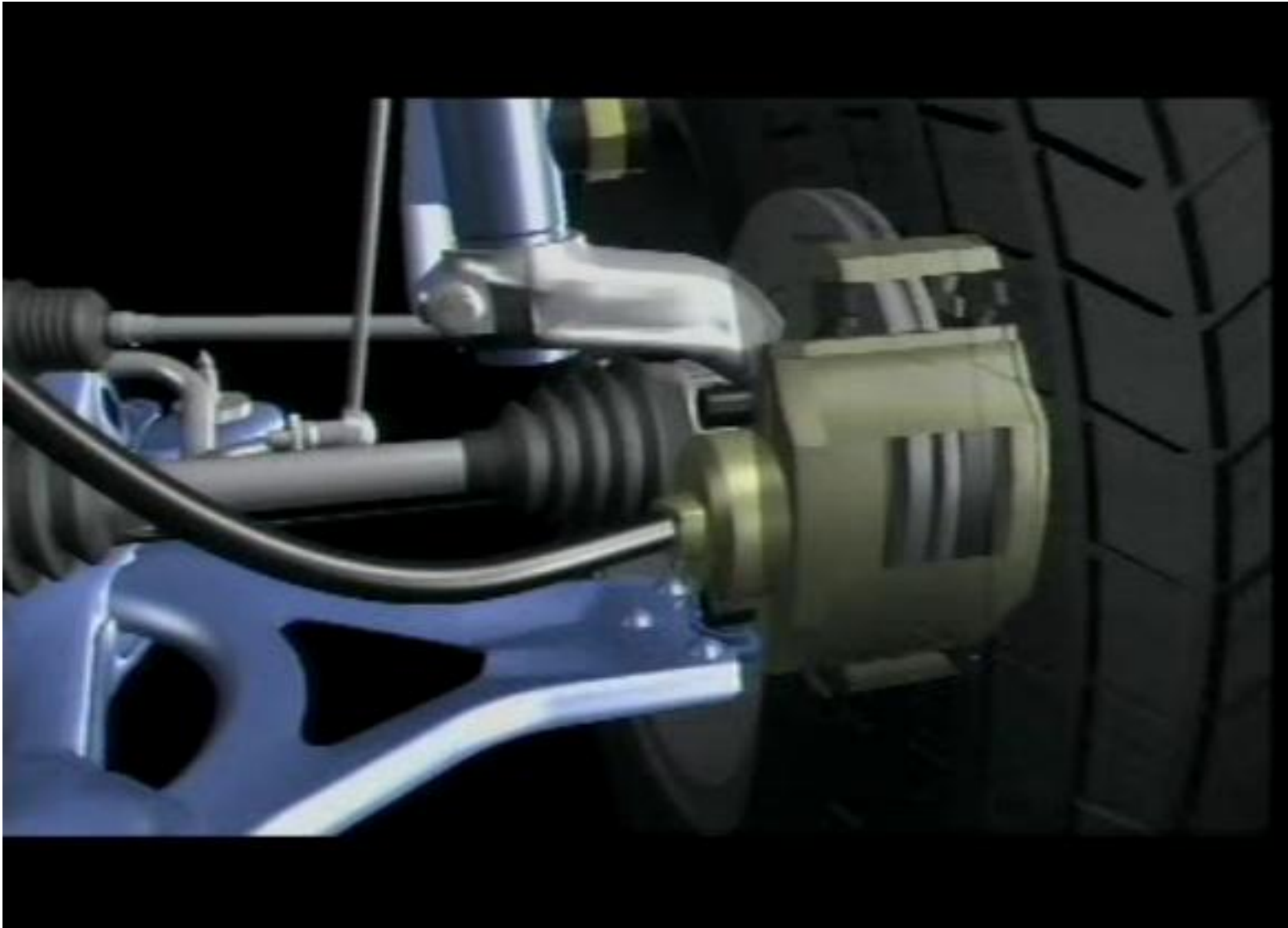
- Has a rotor/disk between two pads
- Caliper squeezes the pads against the disk when the brakes are applied
- Disk brakes work much better than the drum brakes, as they cool better and apply more pressure.

## **CHOICES**

- Metallic (last longer, but bad for rotor)
- Semi-metallic
- Ceramic



# Disc Brakes





Cross-Drilled Rotors

# Disc Parts



Bearings



Caliper

Rubber Hoses



Backing Plate and Spindle



Pads

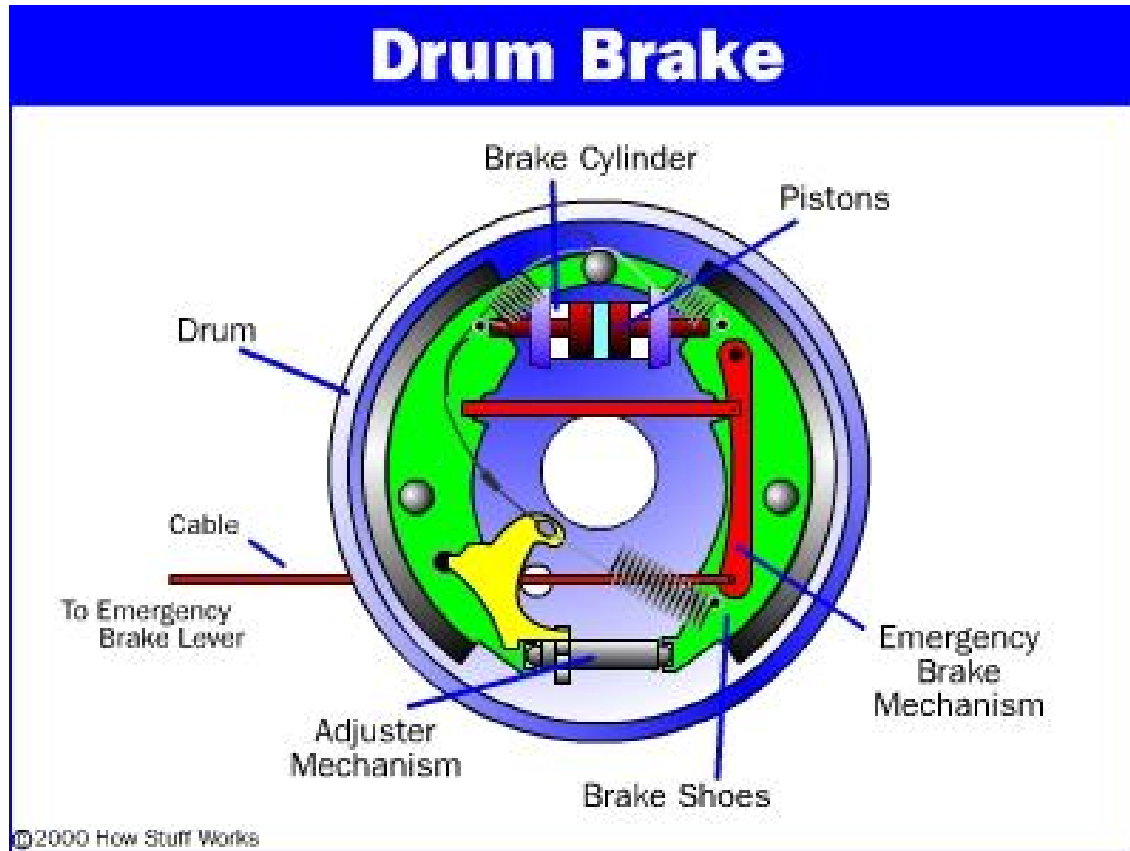




# BRAKES

Drum Brakes on the rear wheels of the vehicle.

- When brakes are applied, the wheel cylinder pushes the brake shoes against the rotating drum.



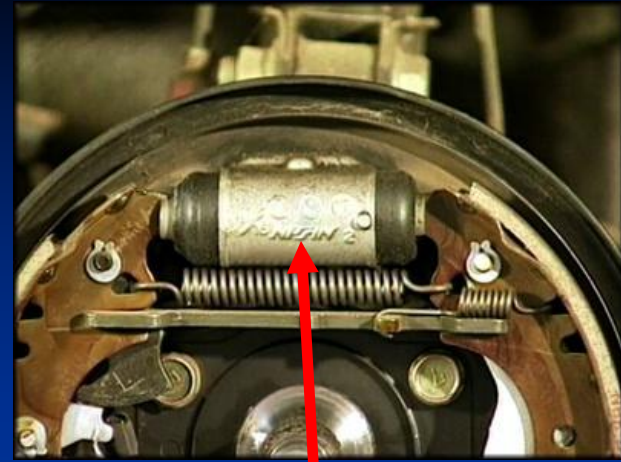
# Drum Parts



Adjusting Screw



Wheel  
Cylinder



Hardware



Backing plate



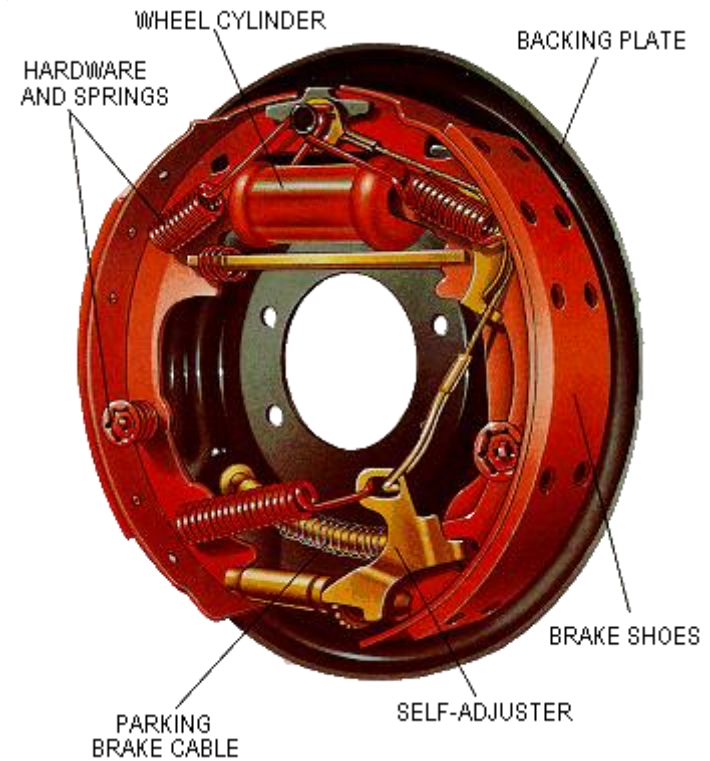
Drum





# BRAKES

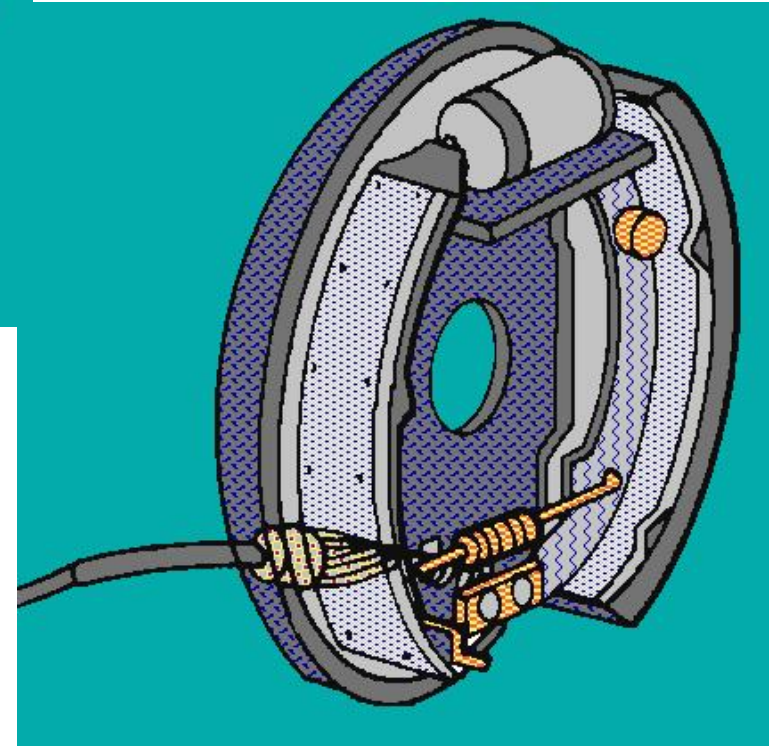
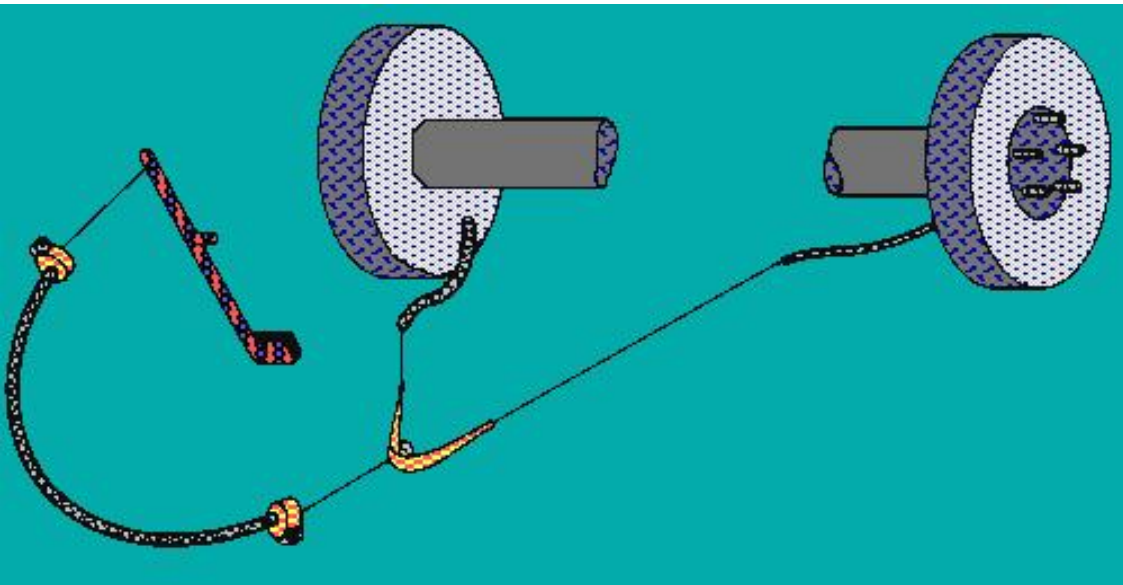
- Rear brakes are self adjusting.
- They adjust when the vehicle is reversed and brakes are applied.
  
- Can be manually adjusted by turning the star-wheel.
  
- Primary shoe sits at the front (smaller/thinner), and secondary shoe sits towards the rear (bigger/thicker).
  
- Replace shoes when they are down to 1/16” at any point.





# BRAKES

**Parking brakes** are part of the rear brakes and are operated mechanically with the help of a lever and cables.









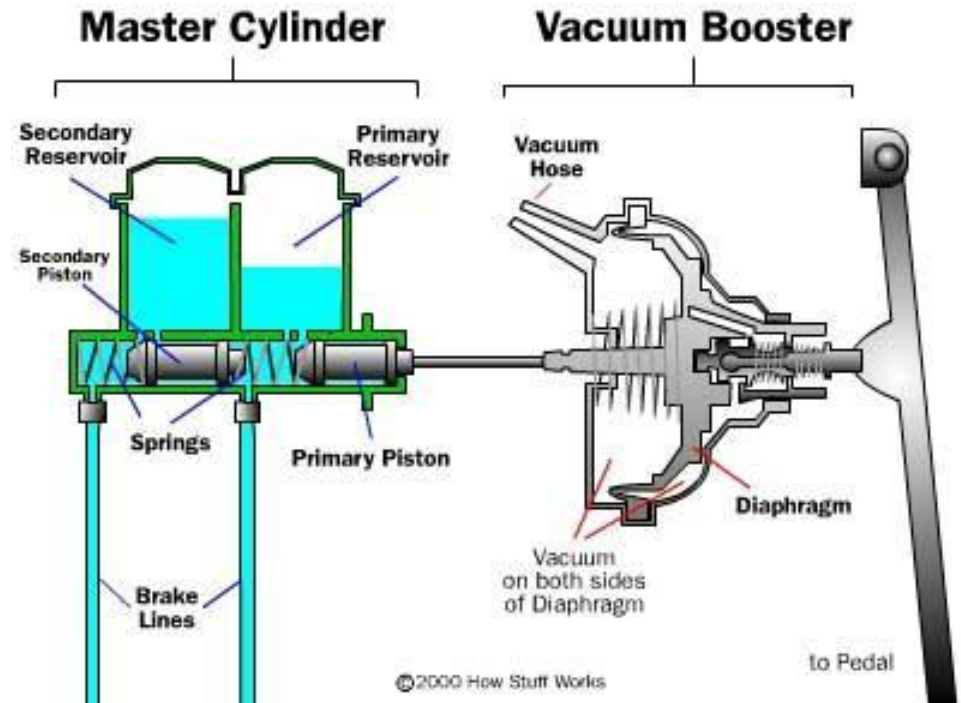
# BRAKES

- **Power Brakes** assists in braking when the pedal is pressed.

Hydraulic booster hydraulic pressure is applied by power-steering pump

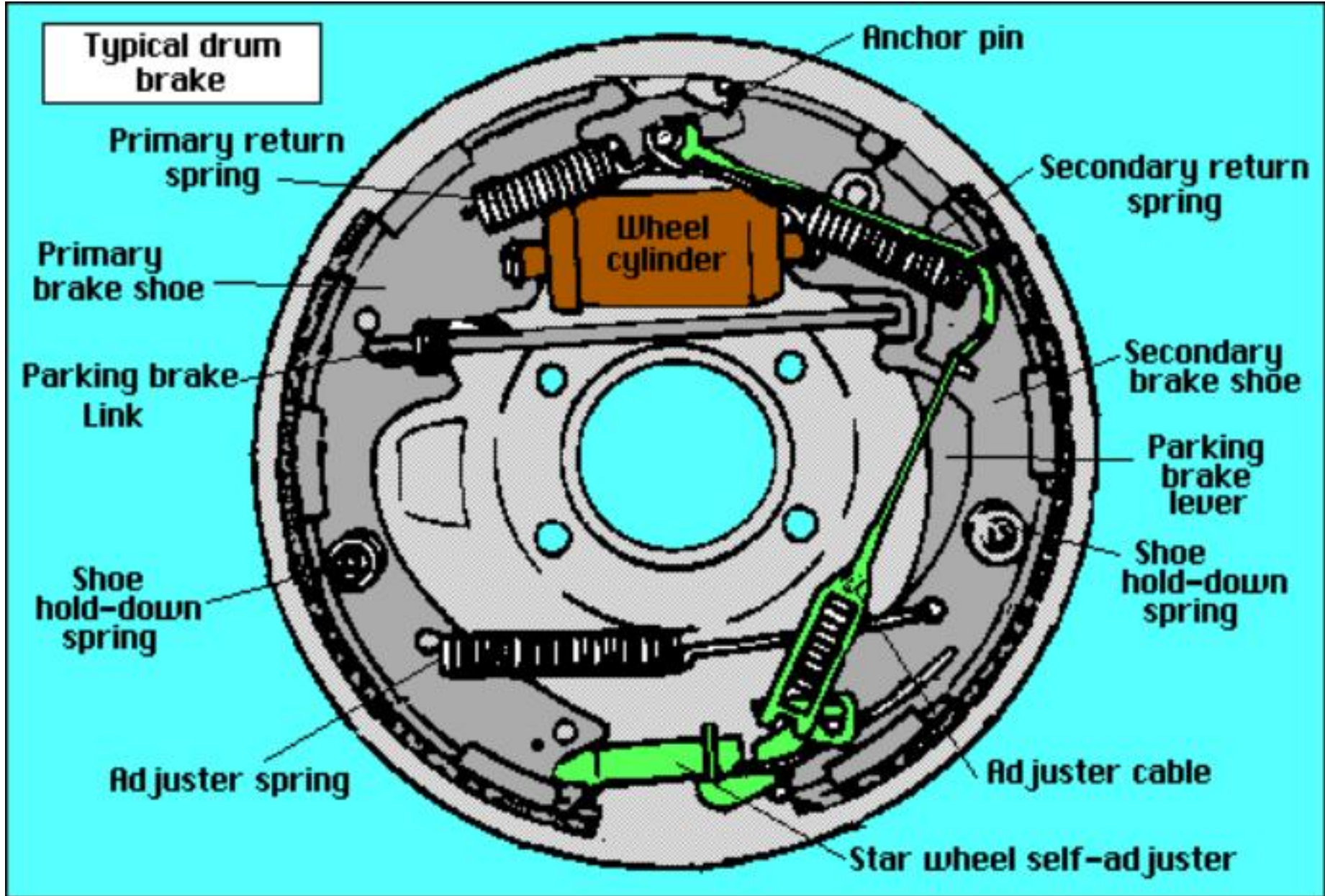
Vacuum Booster works with the vacuum from the vehicle's manifold.

To Check press on the brake pedal and start the vehicle, if working properly the pedal should go down.





# INTERNAL EXPANDING BRAKE

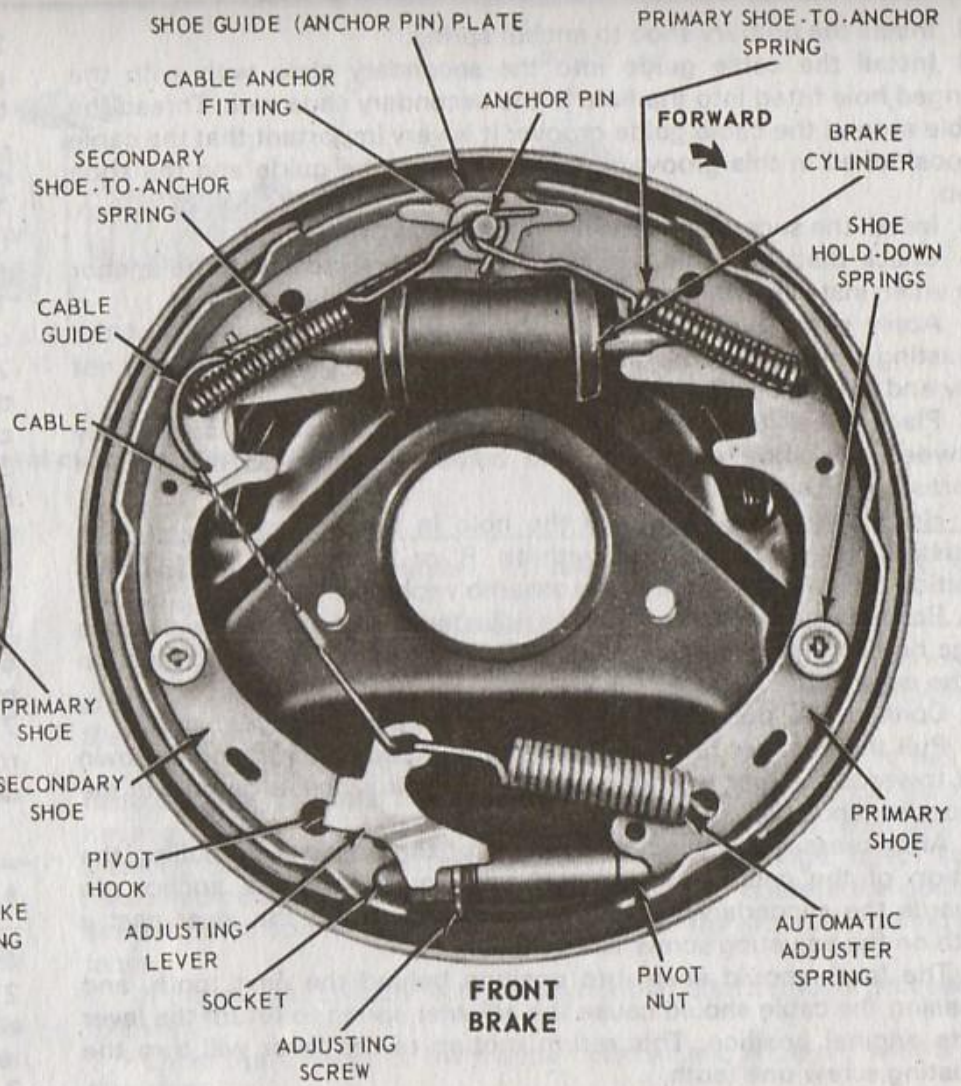
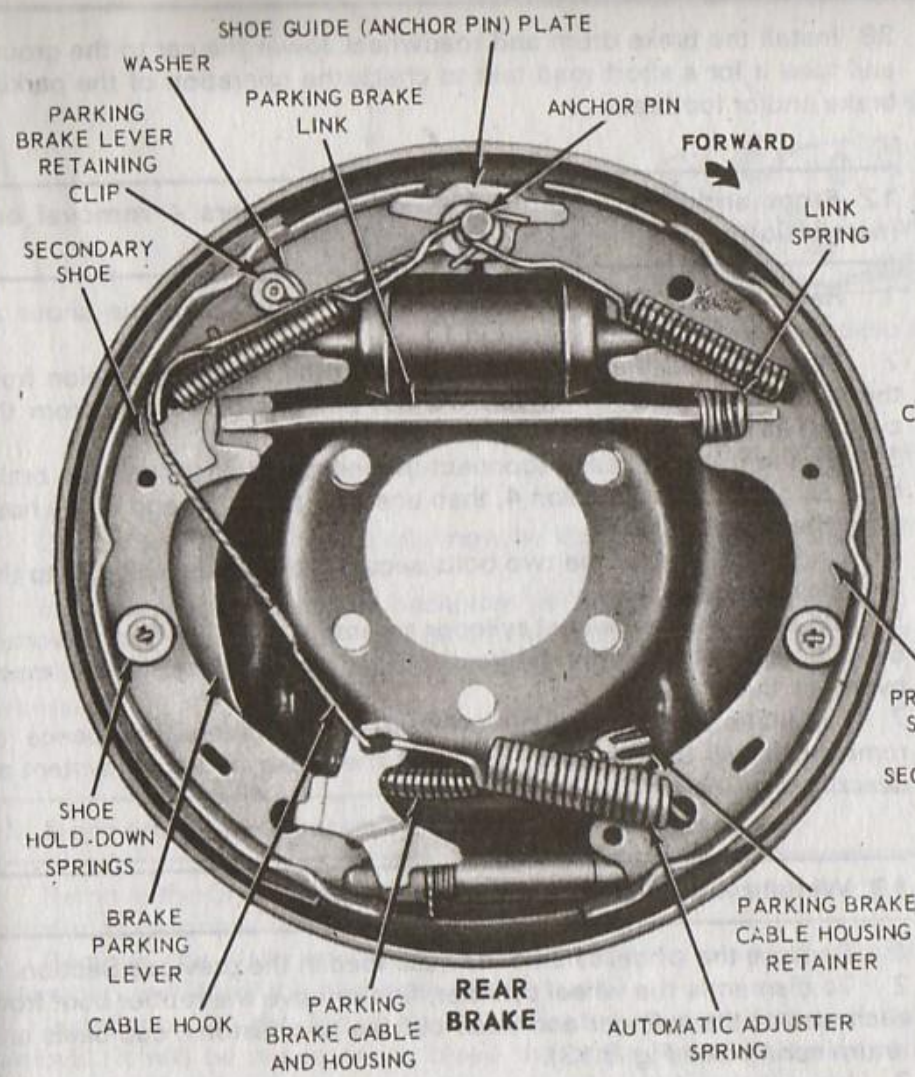






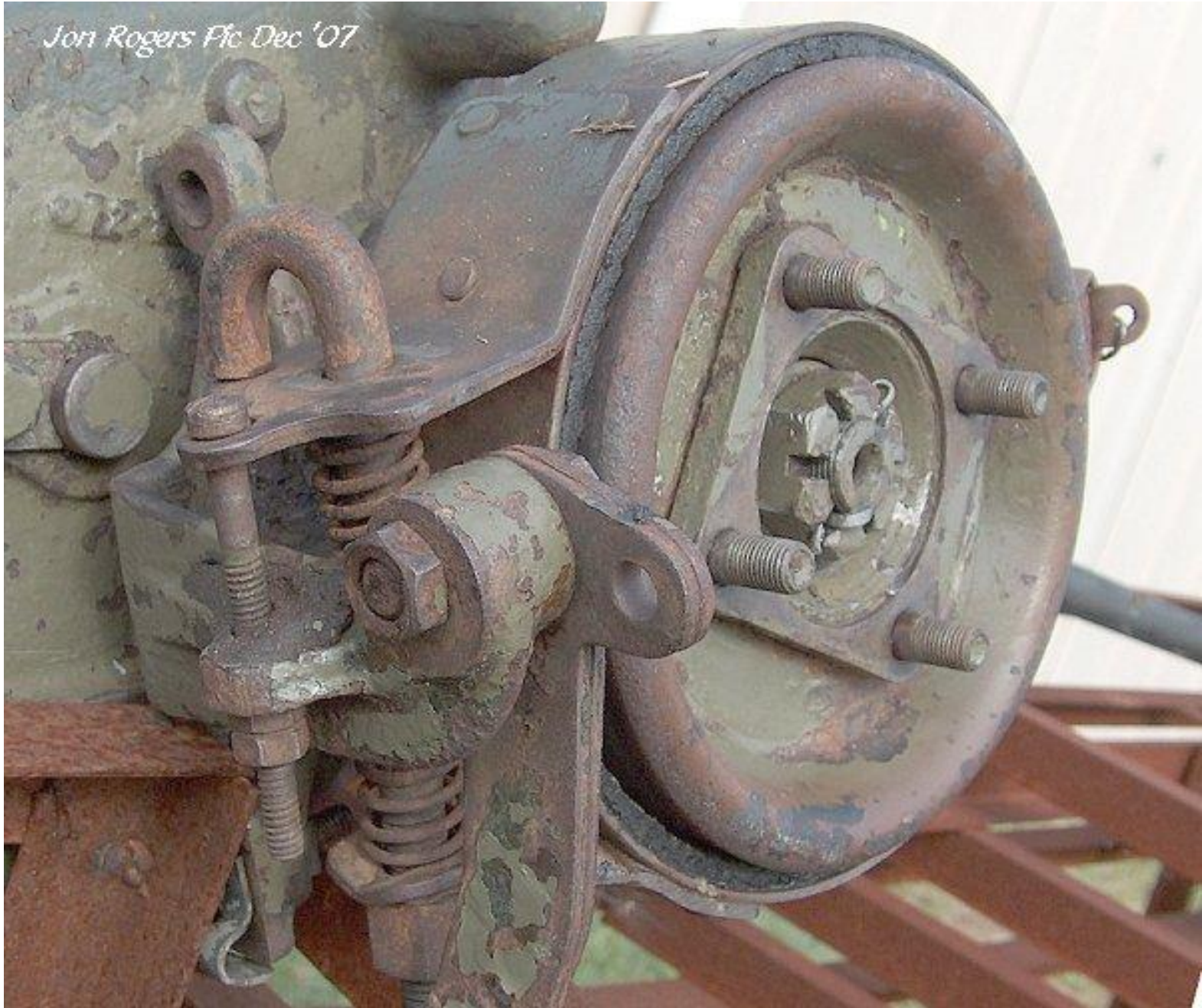


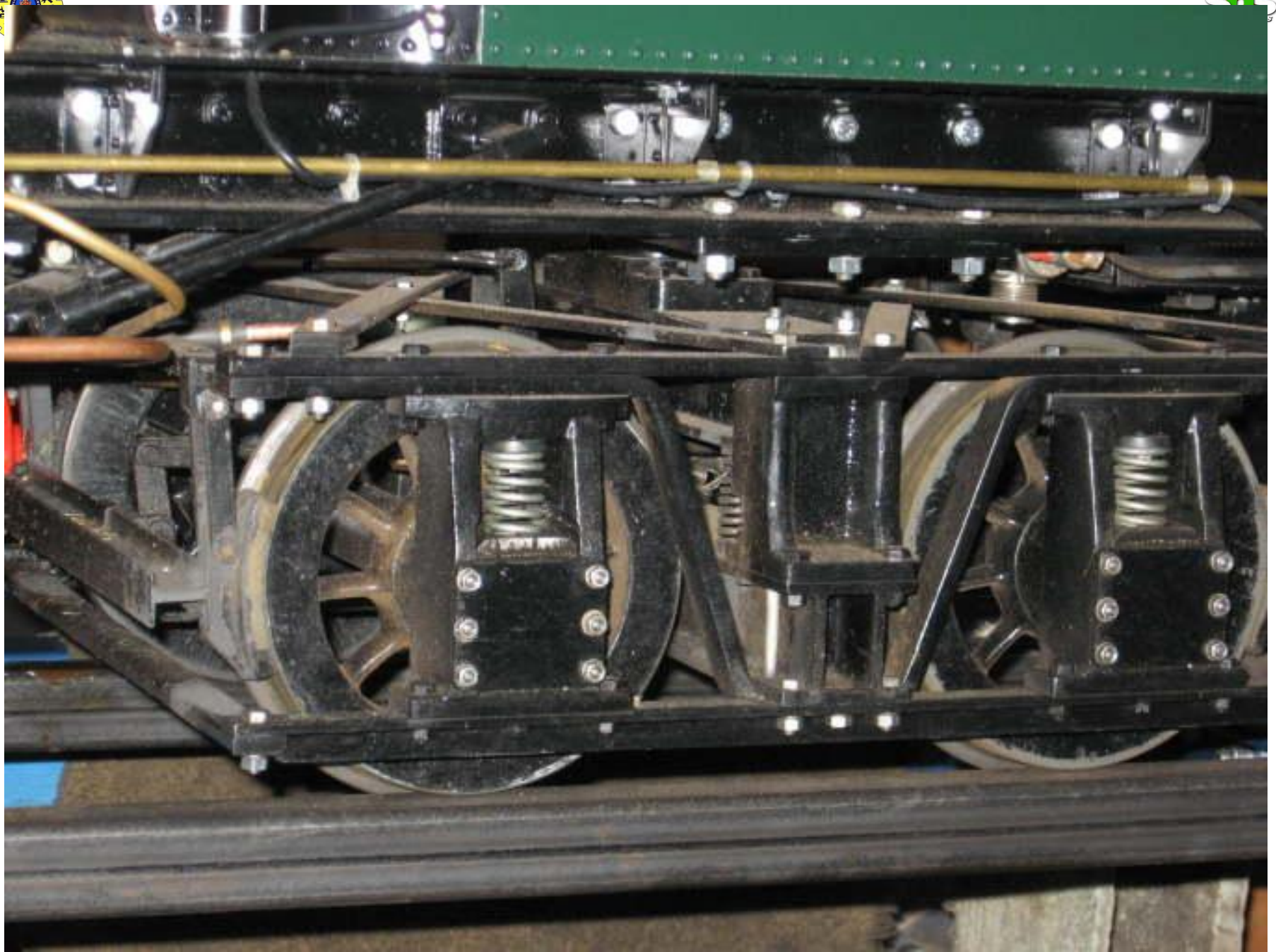
1995 Chrysler rear brake shoes -  
all wet due to blown wheel cylinder



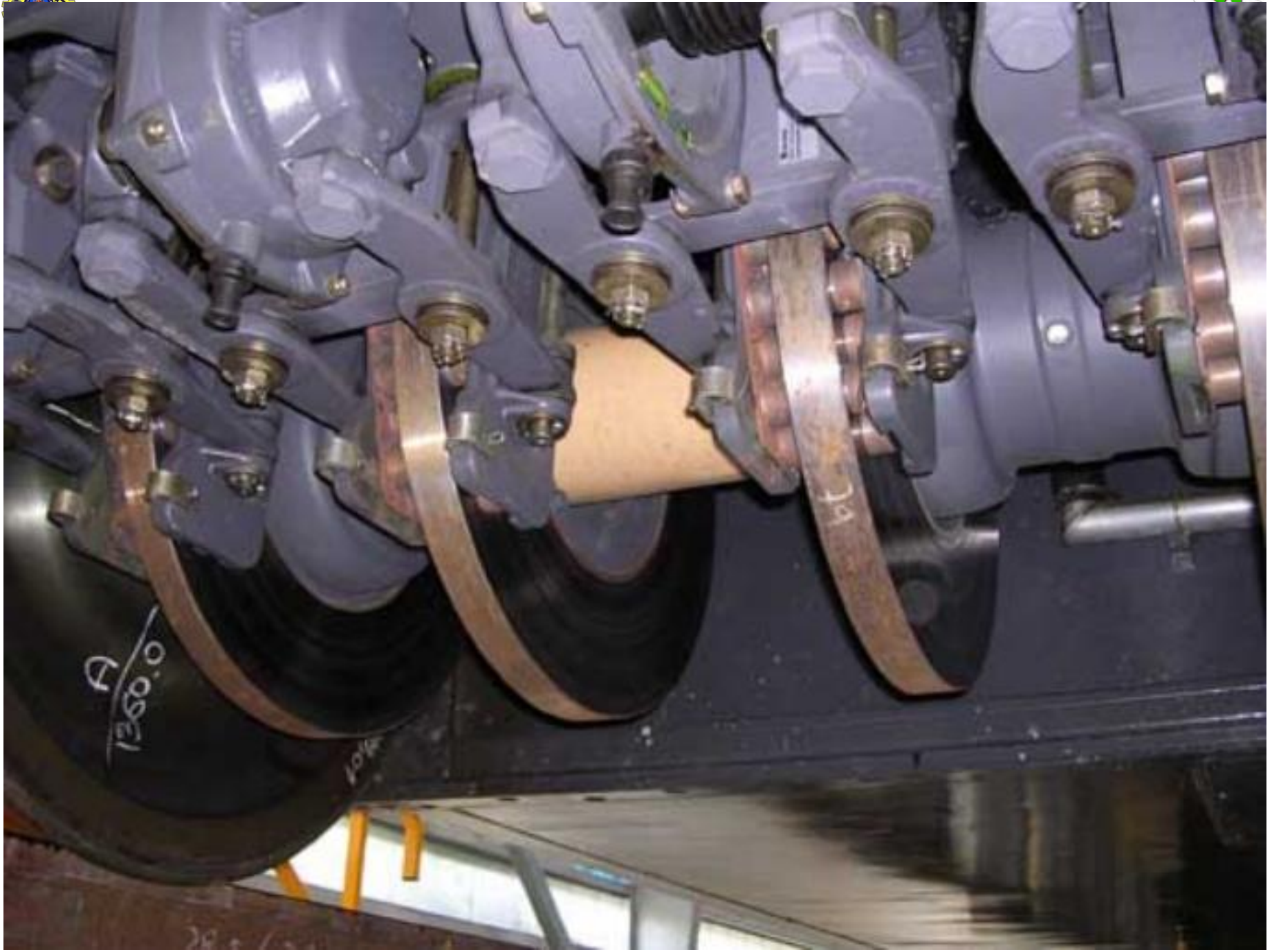


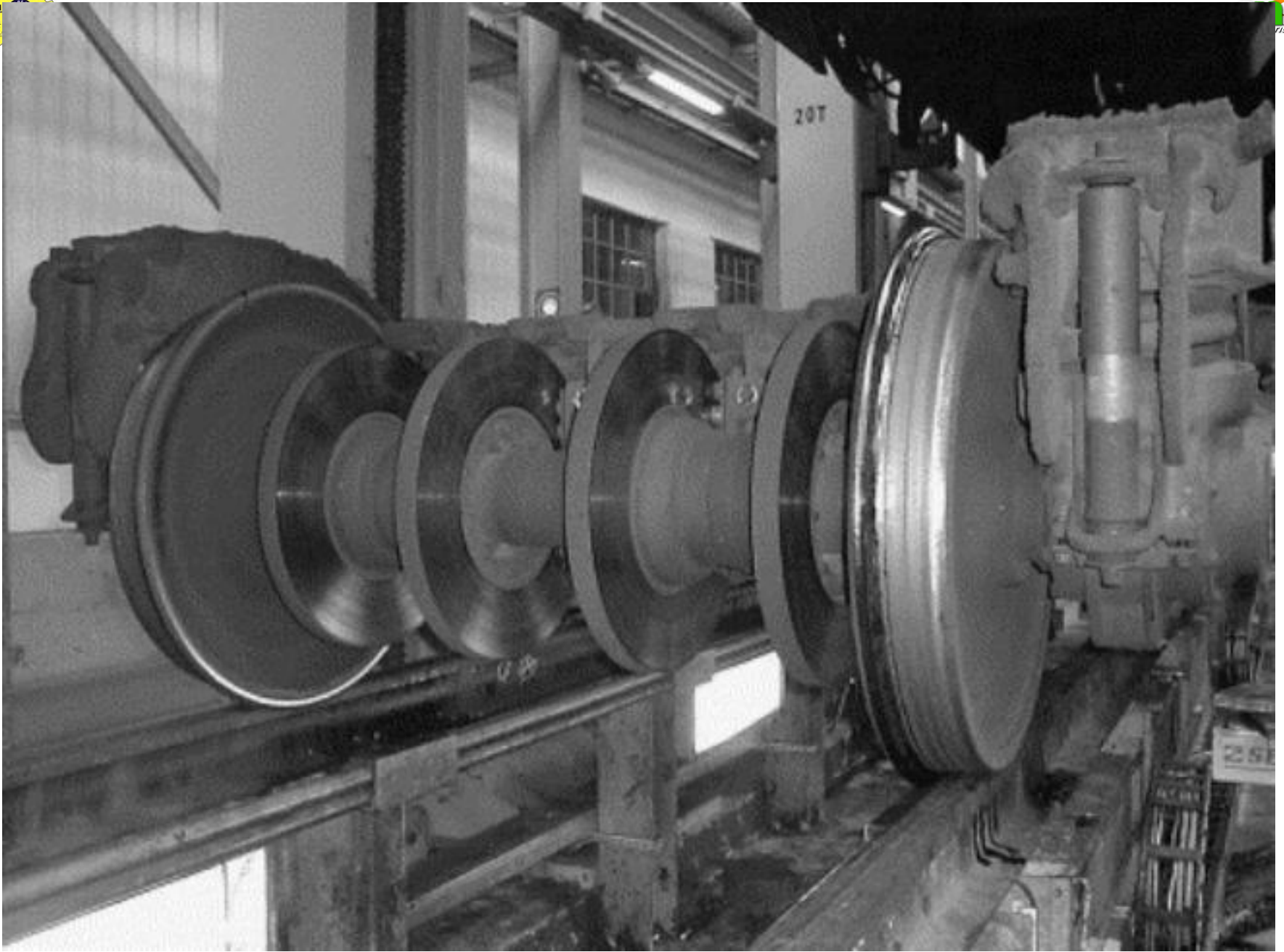
# External contracting type brake







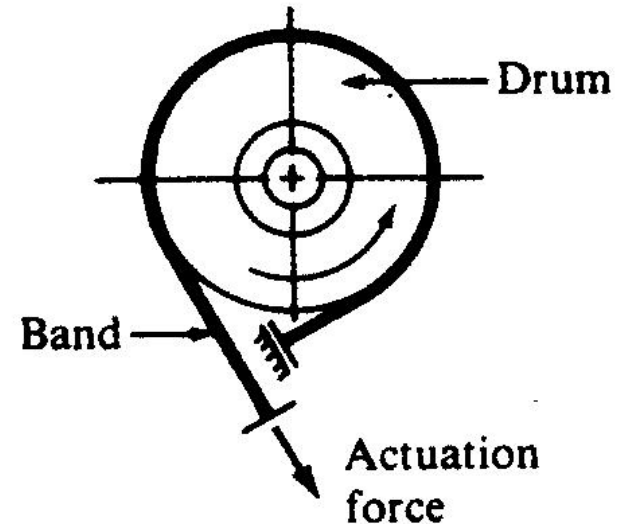






# TYPES OF FRICTION CLUTCHES AND BRAKES

- Band brake
  - Used only as a brake, the friction material is on a flexible band that nearly surrounds a cylindrical drum attached to the machine to be controlled.
  - When braking is desired, the band is tightened on the drum, exerting a tangential force to stop the load.



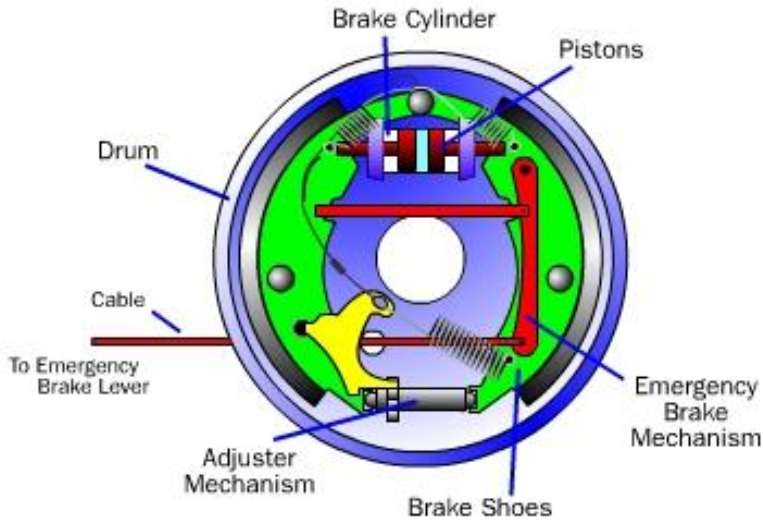


# TYPES OF FRICTION CLUTCHES AND BRAKES

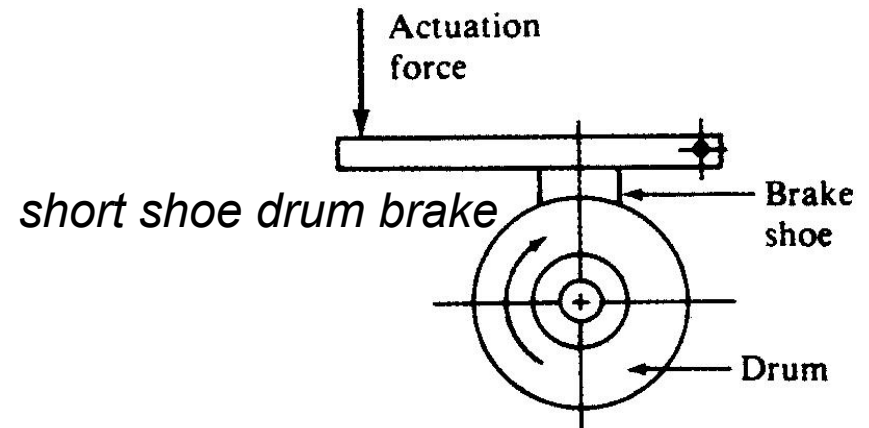
- Block or shoe drum brake
  - Curved, rigid pads faced with the friction material are forced against the surface of a drum, from either the outside or the inside, exerting a tangential force to stop the load.



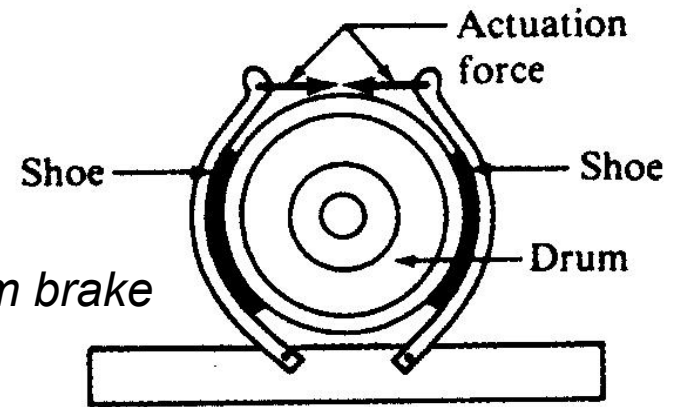
# TYPES OF FRICTION CLUTCHES AND BRAKES



*internal long shoe drum brake*

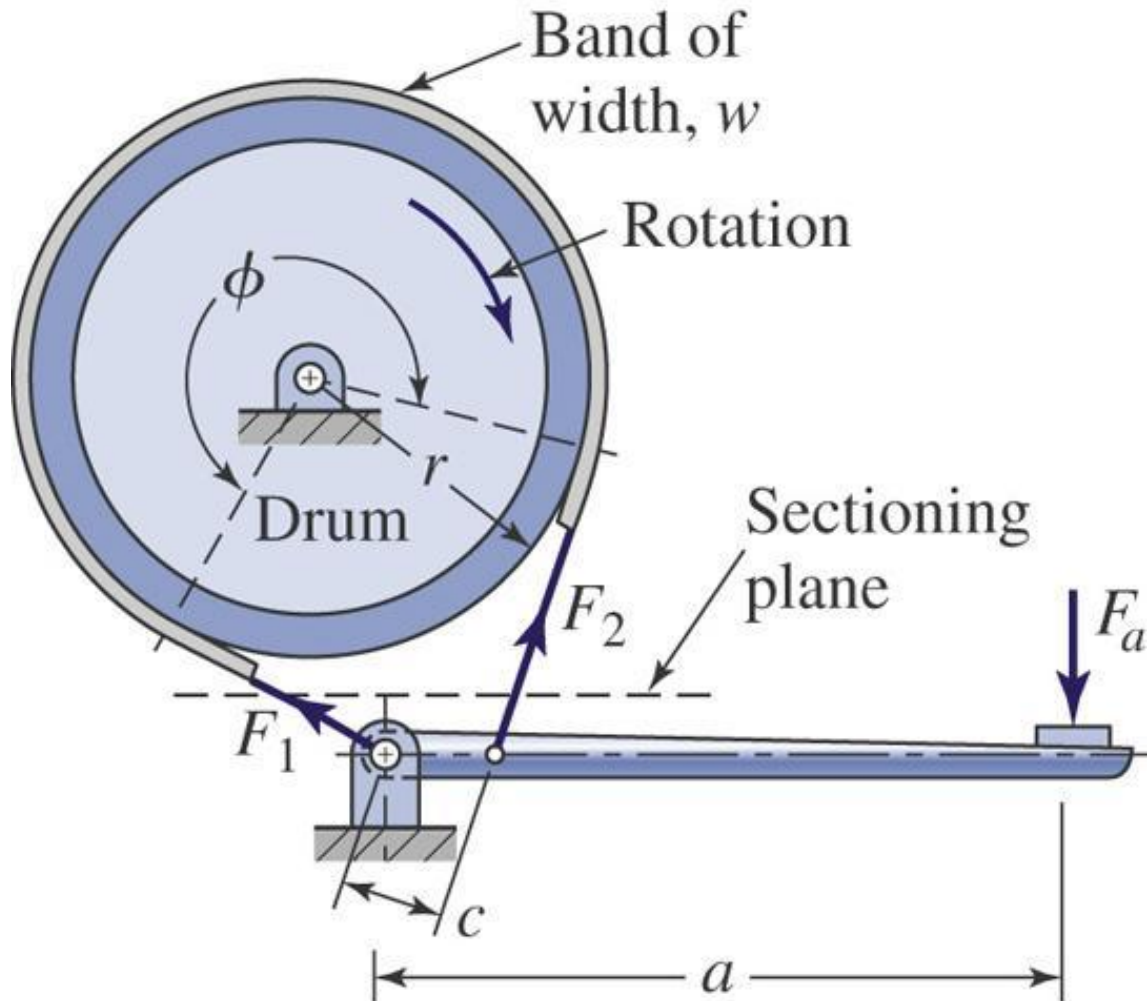


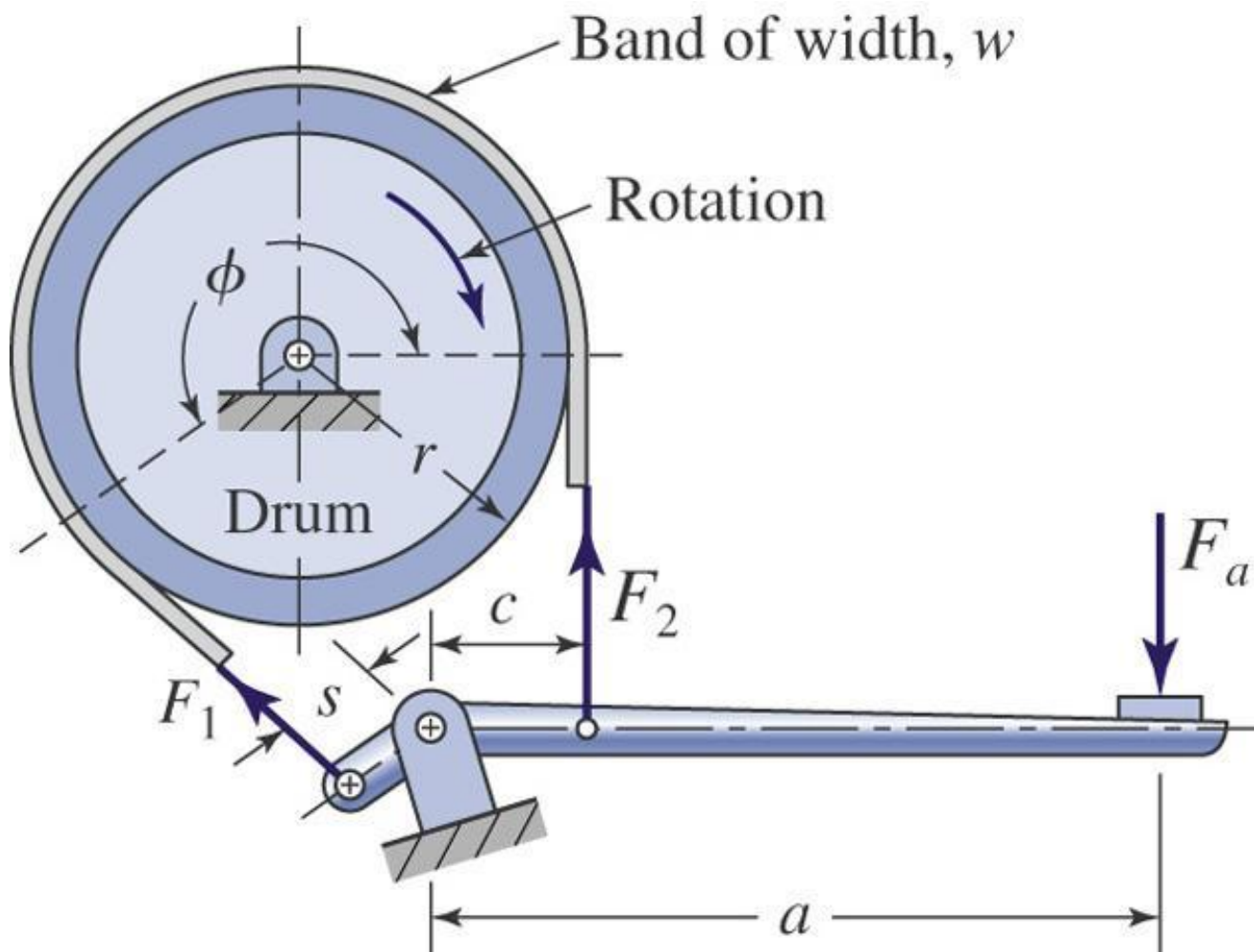
*short shoe drum brake*

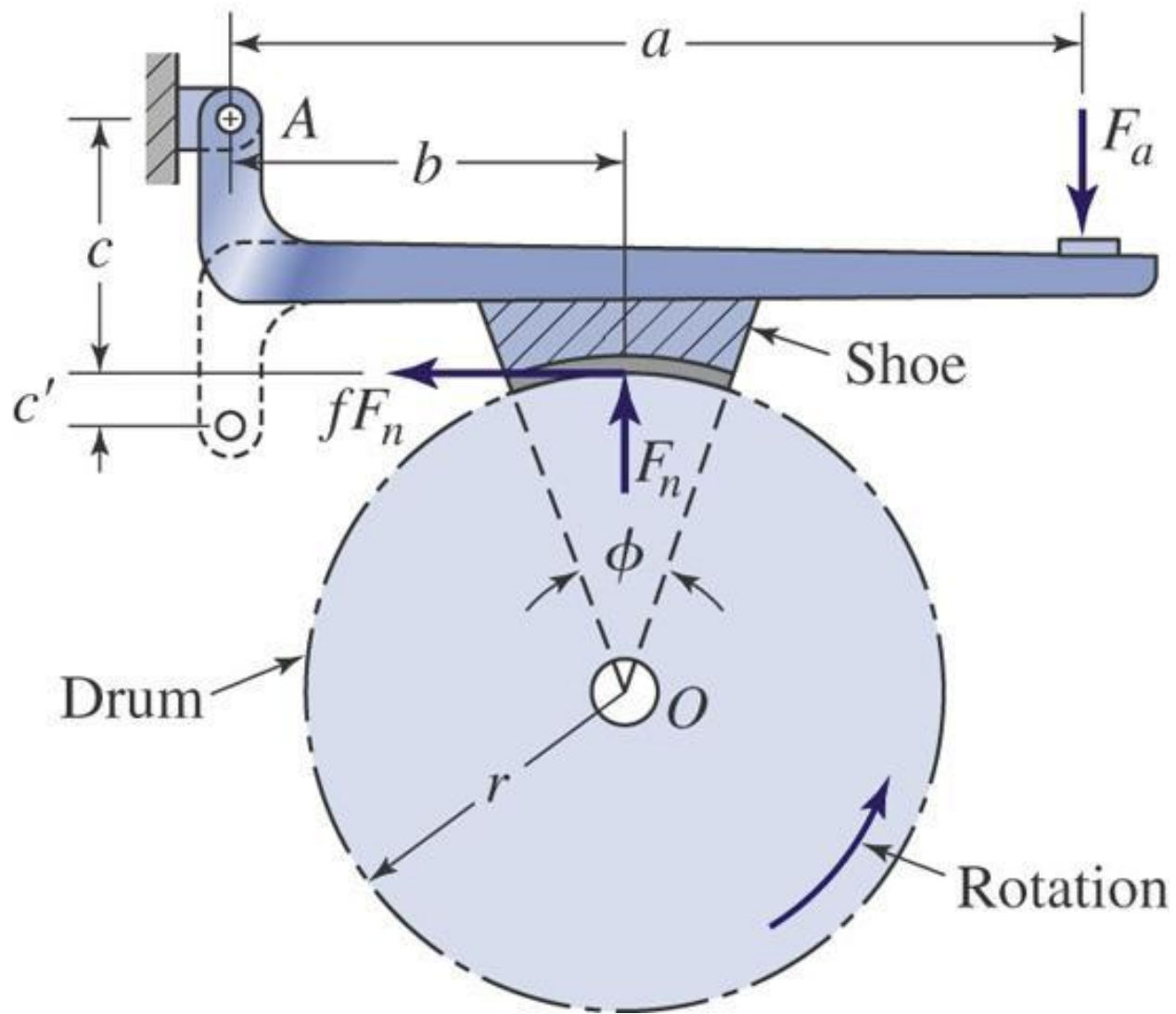


*external long shoe drum brake*

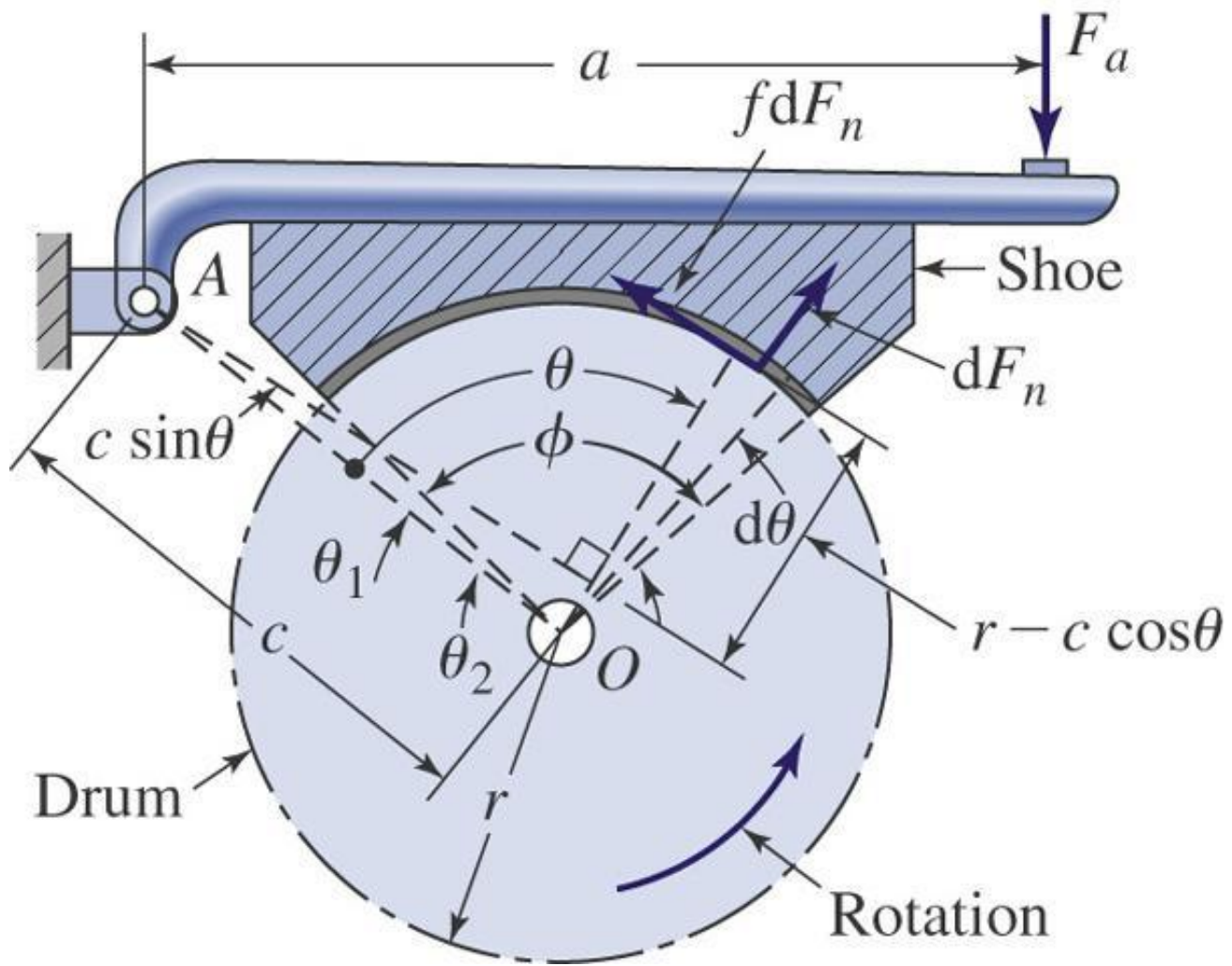
# How much force is needed to stop the Drum

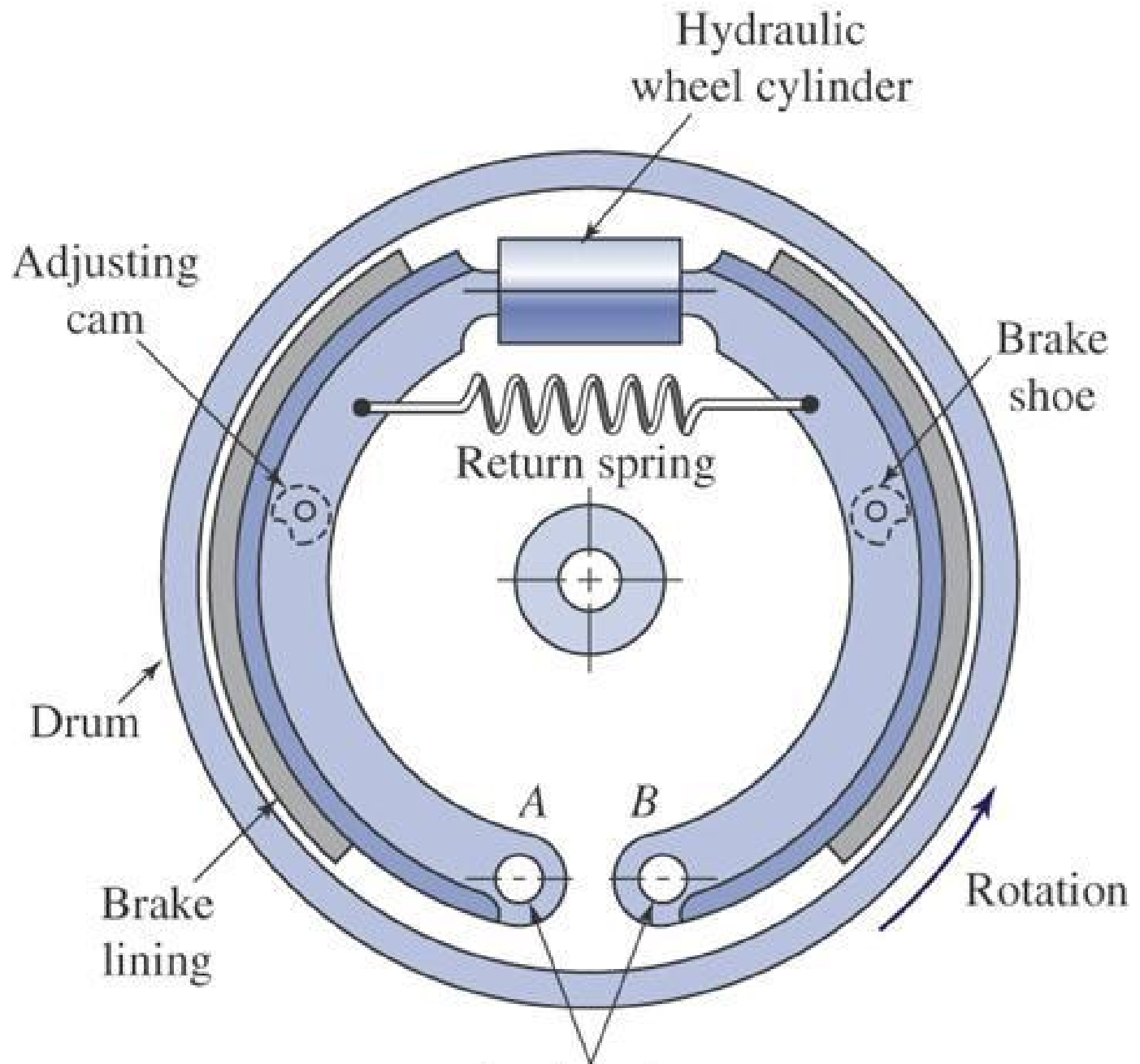






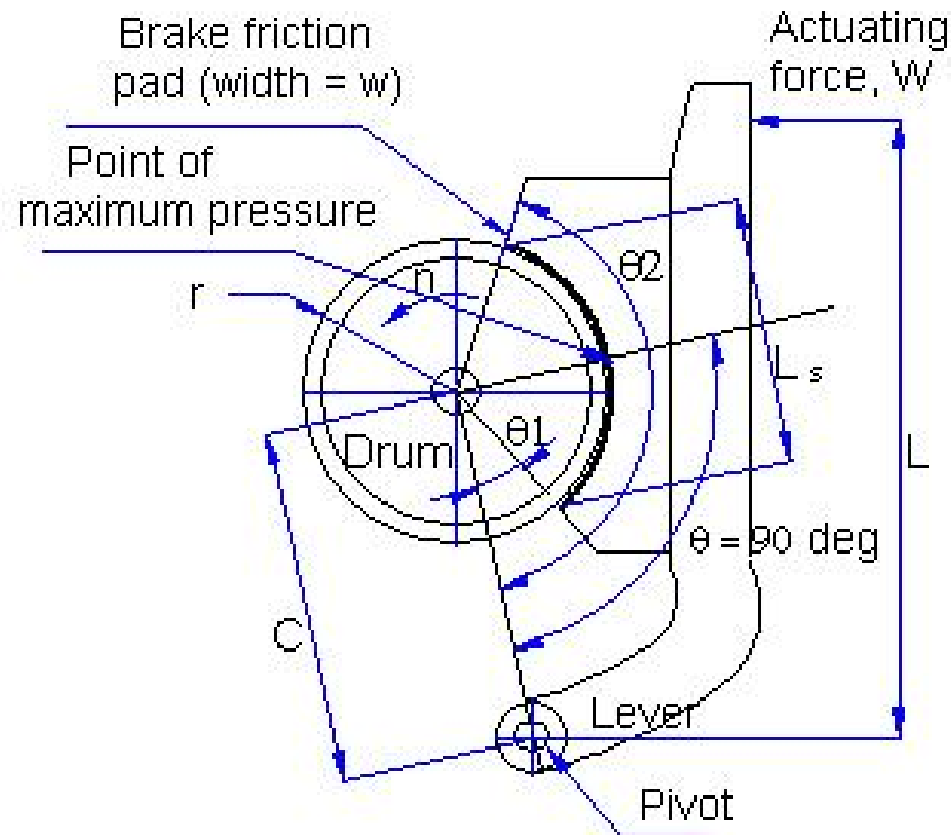






# DRUM BRAKES

- External long shoe drum brakes



# DRUM BRAKES

- External long shoe drum brakes

- Friction torque:  $T_f = wr^2 fP_{\max} (\cos \theta_1 - \cos \theta_2)$

- Moment of normal force:

$$M_N = 0.25P_{\max} wrC [2(\theta_2 - \theta_1) - \sin 2\theta_2 + \sin 2\theta_1]$$

- Moment of friction force :

$$M_f = fP_{\max} wr [r(\cos \theta_1 - \cos \theta_2) + 0.25C(\cos 2\theta_2 - \cos 2\theta_1)]$$

*$M_f$  is negative if the drum surface is moving away from the pivot and positive if it is moving toward the pivot.*

# DRUM BRAKES

- External long shoe drum brakes
  - Friction power:  $P_f = T_f W \omega$
  - Brake shoe area:  $A = L_s w = 2wr \sin[(\theta_2 - \theta_1)/2]$
  - Wear Ratio :  $WR = P_f / A$

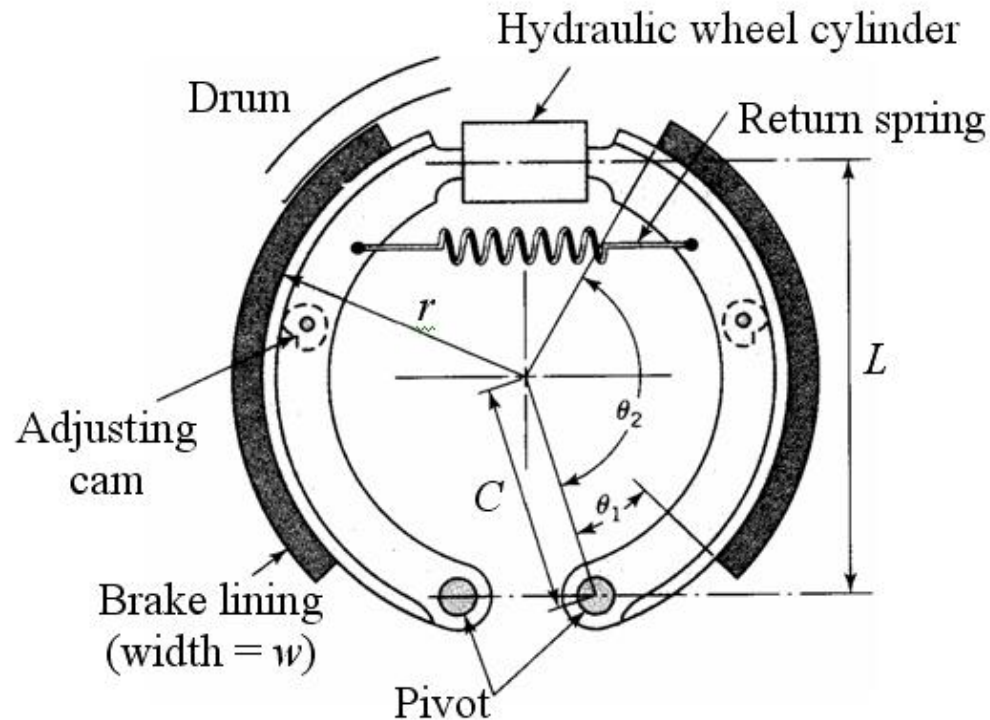
*Where:*

$\omega =$  rotational speed in rad/s

$(\theta_2 - \theta_1)$  in radian

# DRUM BRAKES

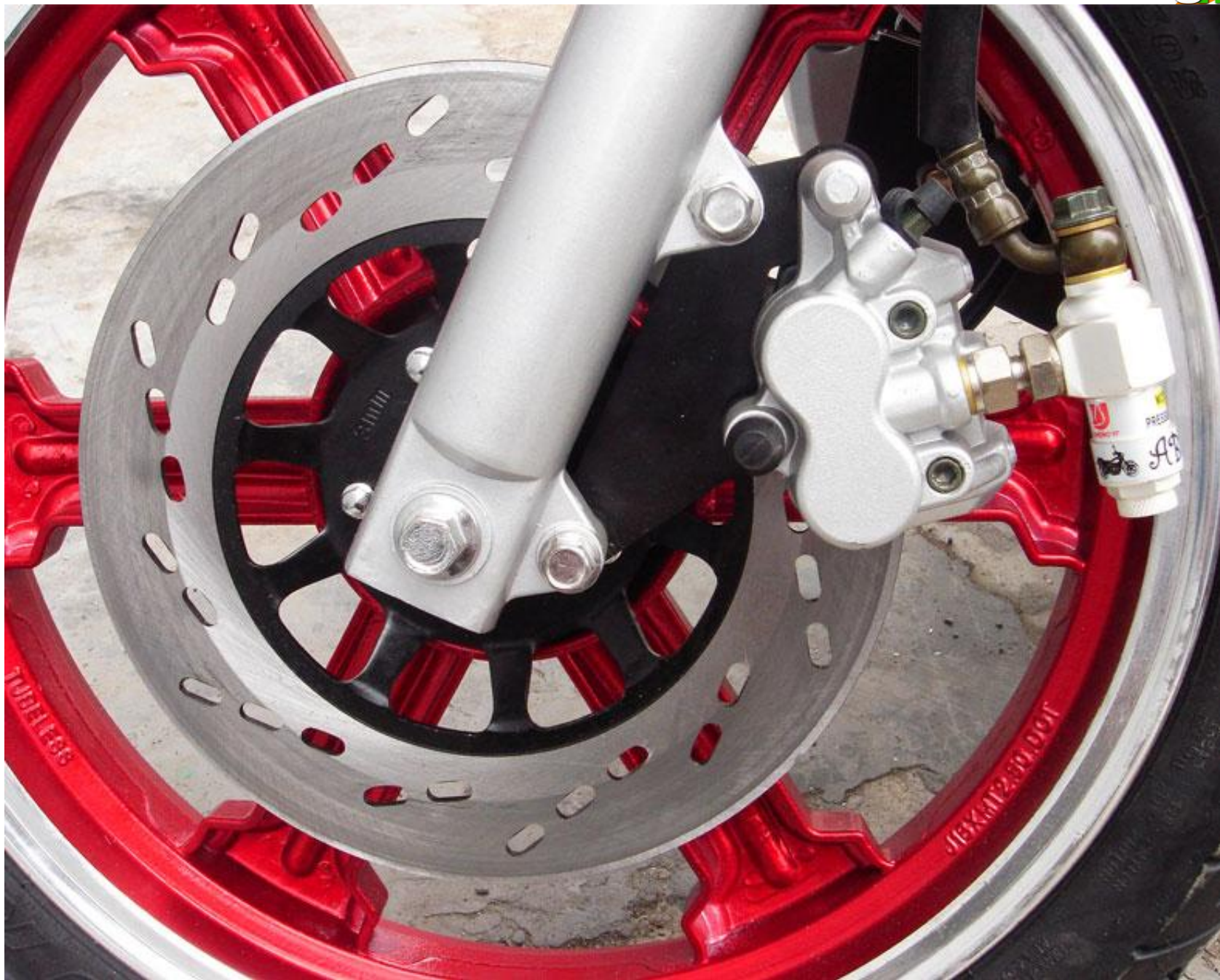
- Internal long shoe drum brakes
  - Same as External long shoe drum brakes with the following geometry features:





# DISC BRAKE





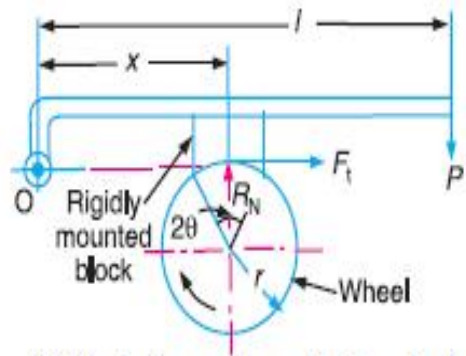




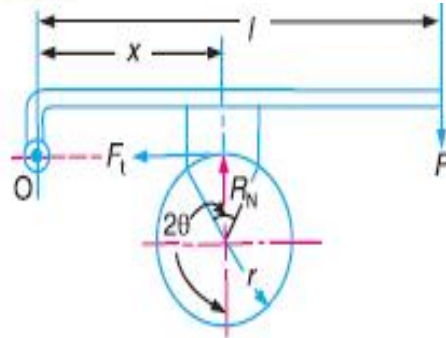
# DOUBLE BLOCK OR SHOE BRAKE



# Single Block or Shoe Brake



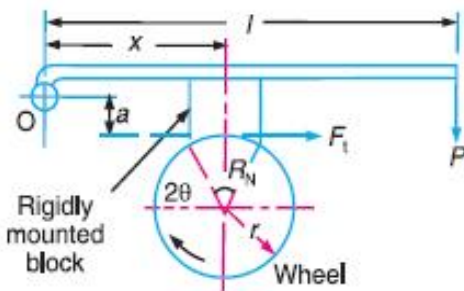
(a) Clockwise rotation of brake wheel



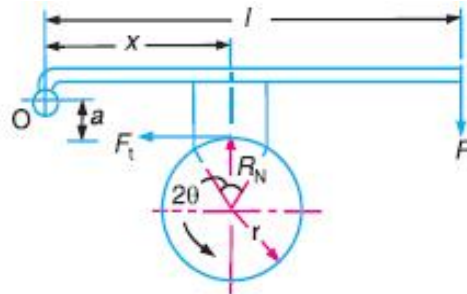
(b) Anticlockwise rotation of brake wheel.

Single block or shoe brake consists of a block or shoe which is pressed against the rim of a revolving brake wheel drum.

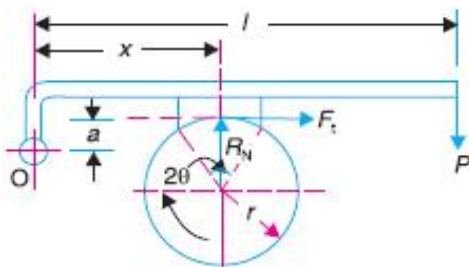
Used on railway trains and tram cars



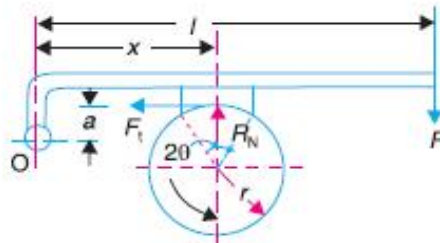
(a) Clockwise rotation of brake wheel.



(b) Anticlockwise rotation of brake wheel.



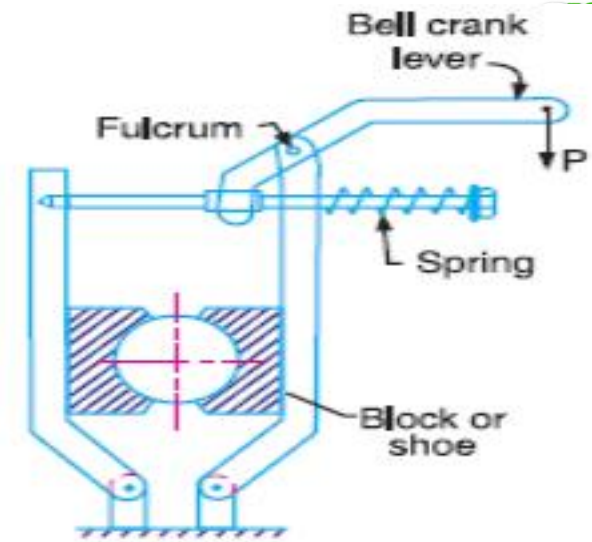
(a) Clockwise rotation of brake wheel.



(b) Anticlockwise rotation of brake wheel.

## Double Block or Shoe Brake

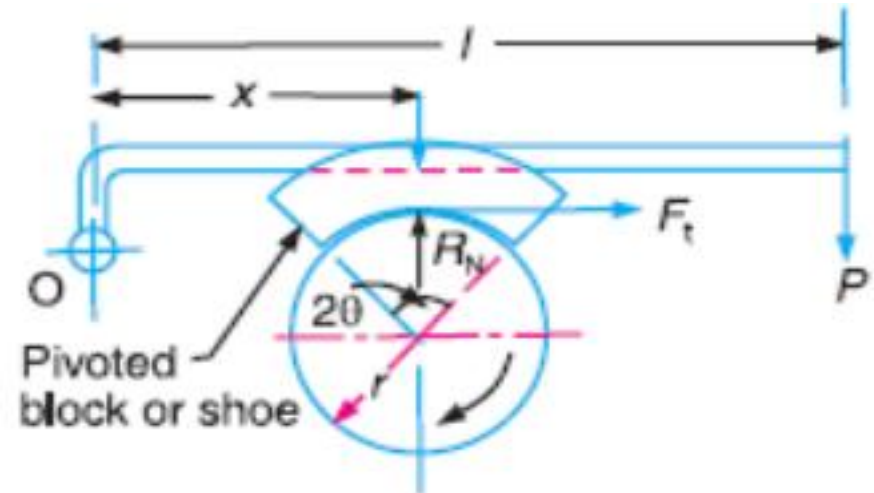
When a single block brake is applied to a rolling wheel, and additional load is thrown on the shaft bearings due to the normal force. This produces **bending of the shaft**. In order to overcome this drawback, a double block or shoe brake is used.



**Fig. 19.9.** Double block or shoe brake.

## Pivoted Block or Shoe Brake

when the angle of contact is less than  $60^\circ$ , then it may be assumed that the normal pressure between the block and the wheel is uniform. But when the angle of contact is greater than  $60^\circ$ , then the unit pressure normal to the surface of contact is less at the ends than at the centre.



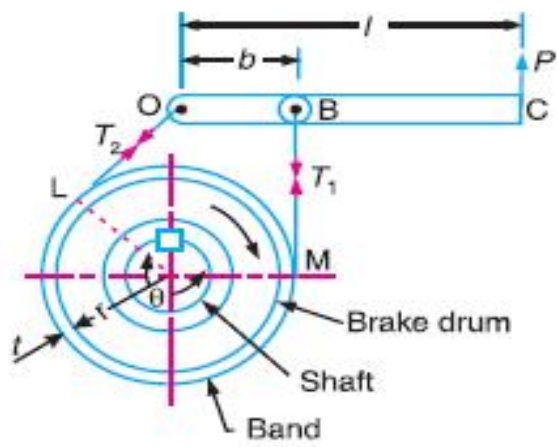
**Fig. 19.4.** Pivoted block or shoe brake.

# Simple Band Brake

A band brake is called a simple band brake in which one end of the band is attached to a fixed pin or fulcrum of the lever while the other end is attached to the lever at a distance  $b$  from the fulcrum.

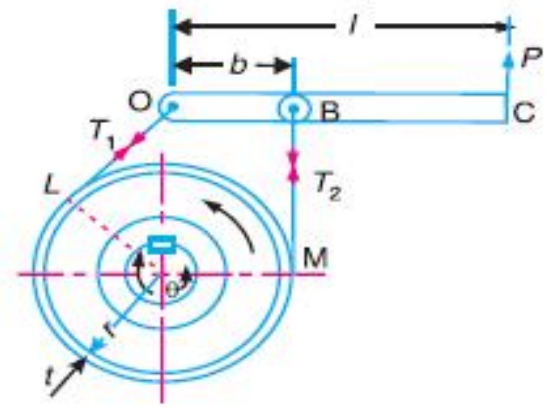


Band brake



(a) Clockwise rotation of drum.

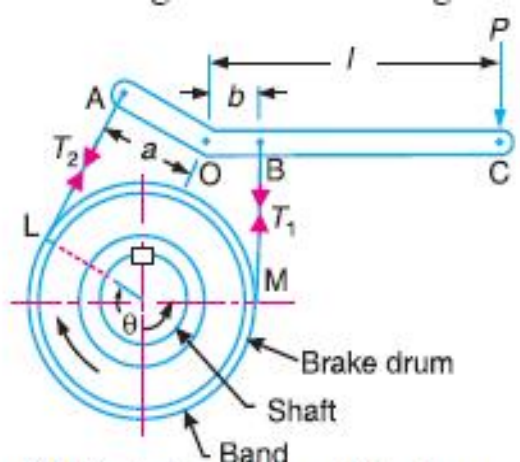
Bands of a brake shown separately



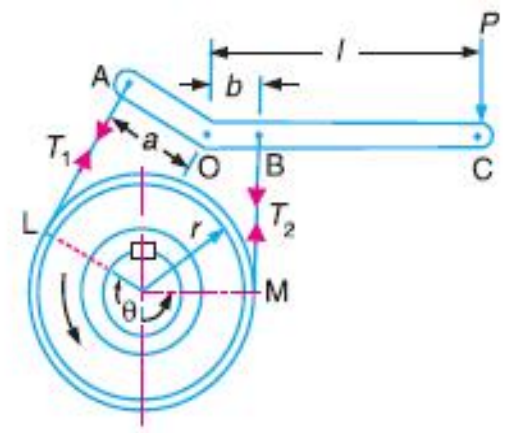
(b) Anticlockwise rotation of drum.

# Differential Band Brake

In a differential band brake, the ends of the band are joined at A and B to a lever AOC pivoted on a fixed pin or fulcrum O.



(a) Clockwise rotation of the drum.



(a) Anticlockwise rotation of the drum.