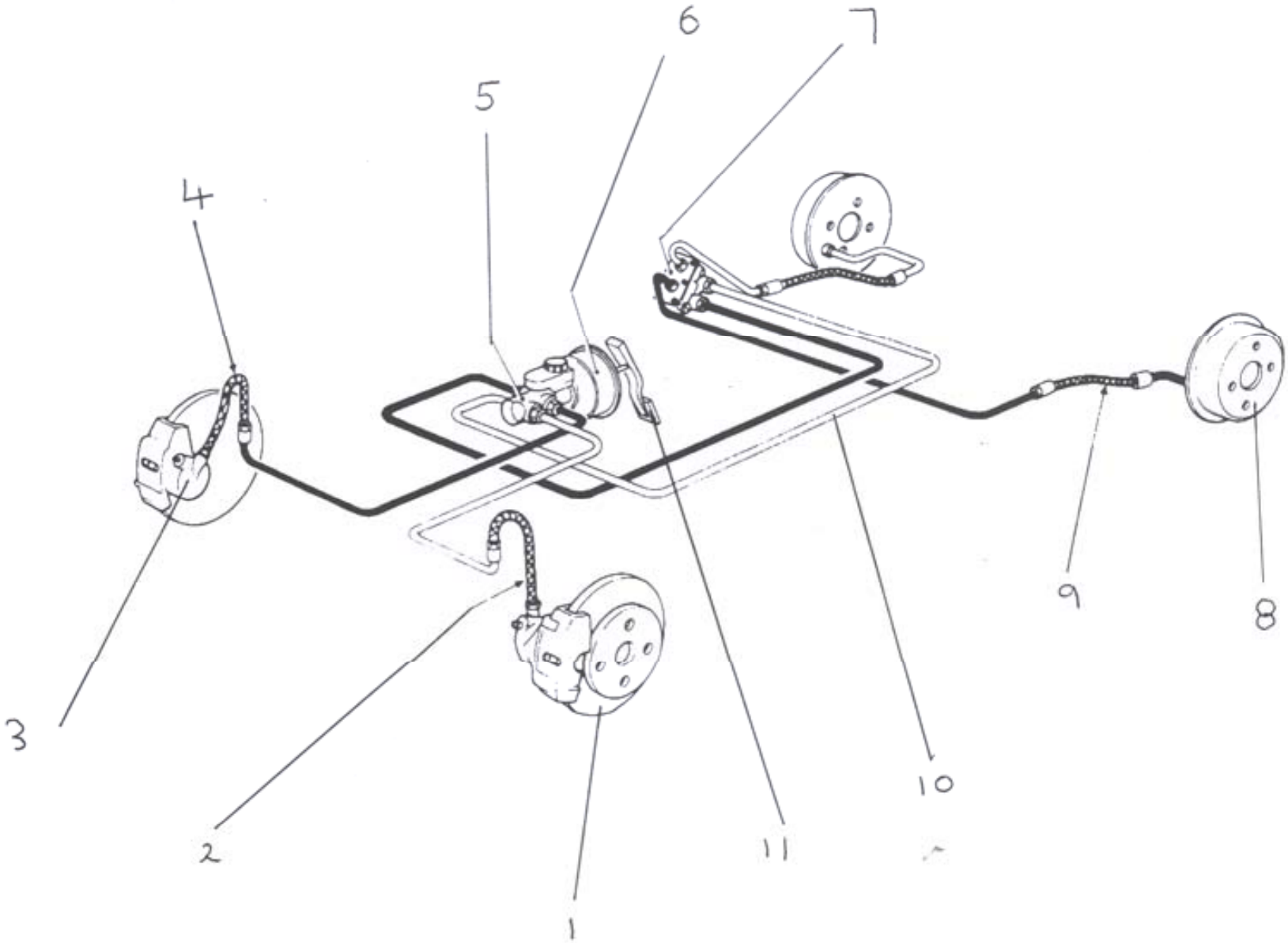
The Braking System

- The energy used to accelerate or move a vehicle from rest to a certain speed is called "Kinetic" (moving) energy.
- To slow the vehicle down, this kinetic energy must be converted or changed, **energy cannot be simply lost.** The kinetic energy is converted to heat energy through the use of friction, how quickly the energy is changed, governs how quickly the vehicle slows down.
- The system responsible for this energy conversion and stopping or slowing the vehicle down is called the "**Braking System"**
- Maximum braking is achieved when –
- All the wheels are about to skid (stop rotating)
- Adhesion (the amount of grip) between the tyre and the road is at its best.
- Tyre adhesion depends upon, the condition of the tyre and the state of the road e.g. wet, dry, greasy etc
- When the brakes are applied, pieces of stationary friction material are forced against drums or discs which are rotating with the road wheels. The friction created slows the vehicle down, the heat produced is carried away by the surrounding air.

The Braking System

- All cars have two braking systems; one which works on all four wheels and is operated by the foot (brake) pedal, through a hydraulic system which ensures the braking force is applied evenly to each wheel; and one which normally operates on the rear wheels only, through a mechanical linkage, and is operated by a separate pedal or lever; this is the parking/handbrake/emergency brake. Both systems work independently of each other.
- **Drum Brakes –** these have two brake shoes which are attached to a stationary back-plate, the brake shoes are internally expanded or pushed out by the wheel cylinder into contact with the brake drum which rotates with the road wheel. Depending on how the brake shoes are attached to the back-plate effects, the “self- servo action”, this is were the rotating drum tries to pull the brake shoes into contact with itself when the brakes are applied. This action produces a powerful braking action. One disadvantage with drum brakes is that severe or prolonged braking can cause excessive heat build up resulting in “brake fade”, this is were the braking performance falls off and can result in complete brake failure.
- **Disc Brakes** – these have a brake disc which rotates with the road wheel, when the brakes are applied a stationary brake caliper forces the brake pads into contact with the brake disc slowing it down. The heat generated by the disc brake is more easily dissipated because the rubbing surfaces are exposed to the air and are not enclosed in a drum.

Braking System Layout



The Braking System (Terminology)

- Foot brake – The brake control pedal which operates the main braking system.
- Handbrake (Park brake, emergency brake) – A lever which operates a mechanical linkage to lock normally the rear wheels for parking.
- Brake pads – Steel backed blocks of friction material which are pressed onto both sides of the brake disc to slow the vehicle.
- Brake shoes – Steel crescent shaped shoes with a friction material lining, these are pressed onto the drum to slow the vehicle down.
- Brake disc – A circular steel disc which rotates with the wheel, some are solid, but some have ventilation holes.
- Brake drum – Steel drum shape which rotates with the wheel, inside the drum are the brake shoes.
- Brake fluid – A special fluid used in the hydraulic system which is used to operate the systems hydraulic components.
- Master cylinder – the master cylinder piston is moved by the brake pedal, it is basically a syringe which forces the brake fluid through the pipes to the hydraulic components.
- Wheel cylinders – forces the brake shoes onto the brake drum.
- Brake callipers – forces the brake pads onto the brake disc.
- Brake servo/booster – increases the force applied to the master cylinder to make the brakes more effective.
- Brake pipes – connect the various hydraulic components to the master cylinder.
- Flexible brake pipes – connect the hydraulic components, but allow for movement of the steering and suspension

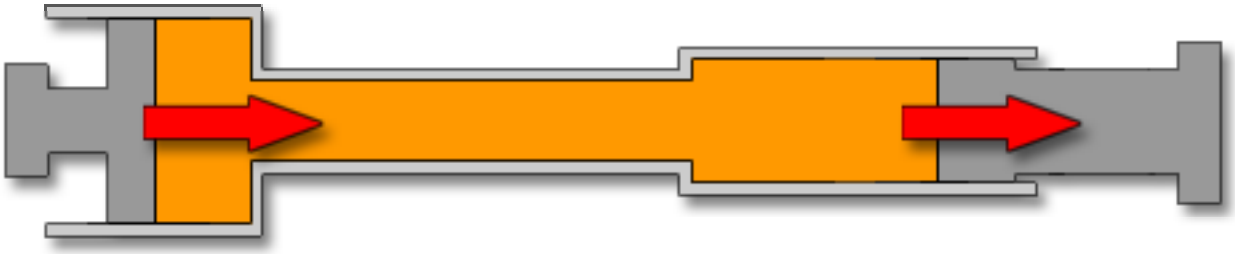
Hydraulic Action

Please note air is compressible, air must not be present in the Hydraulic System, this will result in brake failure

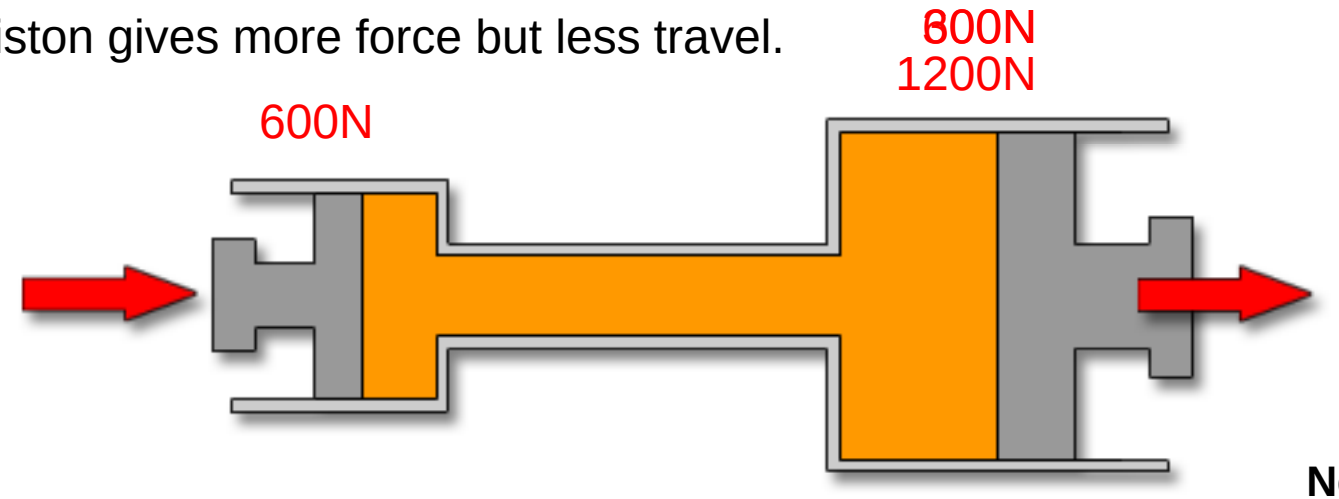
Hydraulic fluid does not compress.

Same size pistons give same force.

Smaller output piston gives smaller force, but more travel.



Larger piston gives more force but less travel.



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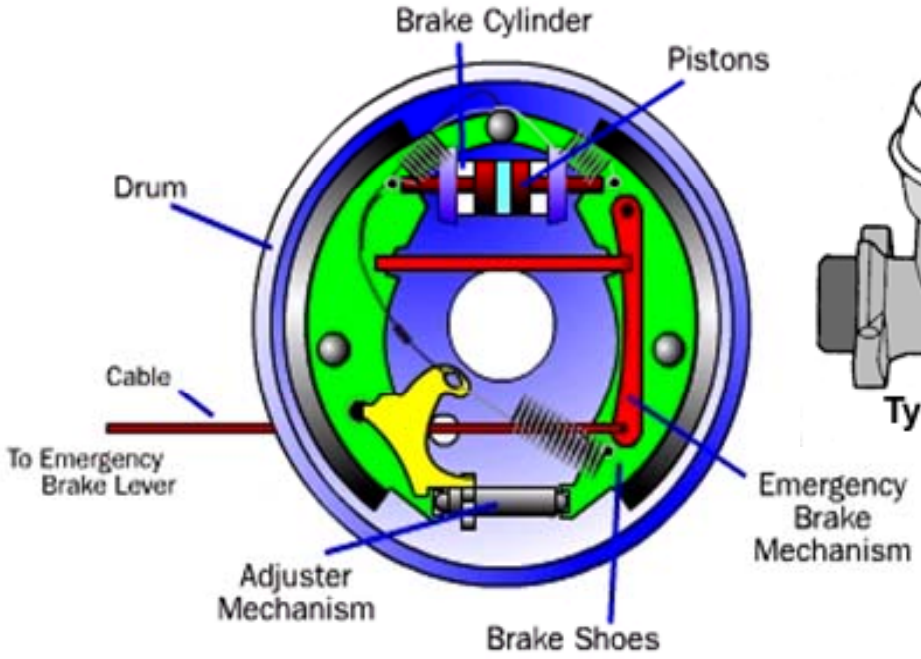
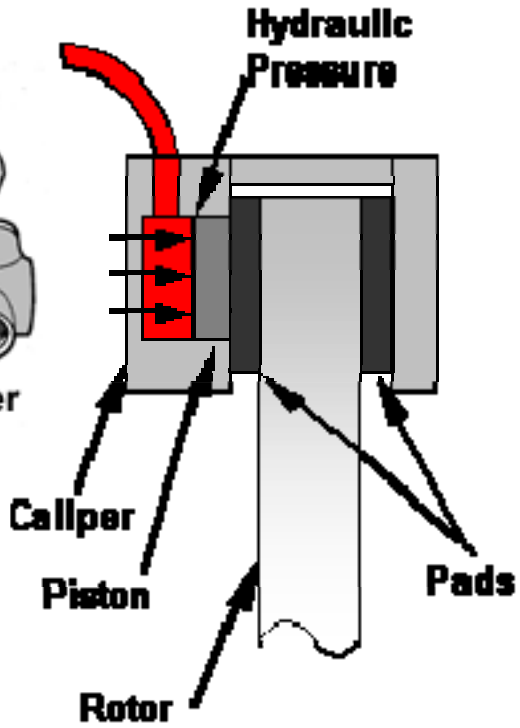
The Braking System



Typical Master Cylinder



- **Drum Brakes** - When you press the brake pedal, fluid is pumped along the *brake pipes* from the *master cylinder* into the *wheel cylinders*. The wheel cylinders *pistons* force the *brake shoes* against the *drum.*

- **Disc Brakes** – with *disc brakes* the hydraulic action is the same as with the *drum brakes*, but the hydraulic pistons clamp the *brake pads* on to the *disc*

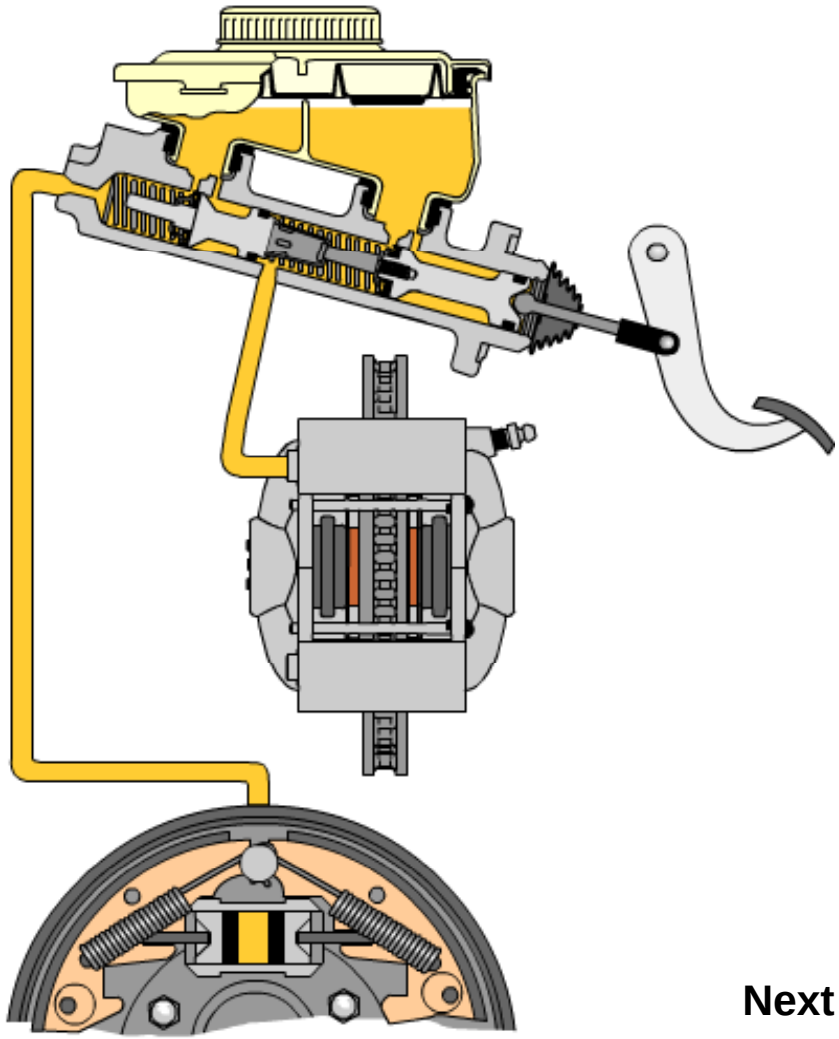
Brake Callipers and Cylinders

The master cylinder fluid pressure pushes the brake calliper pistons together and the brake cylinder pistons apart.

The brake linings are forced against the surfaces of the disc or drum.

When the brake pedal is released, springs pull the linings away from drum. The tension in the main seals push the calliper piston away from the disc.

Excess fluid is pushed back into the master cylinder reservoir.



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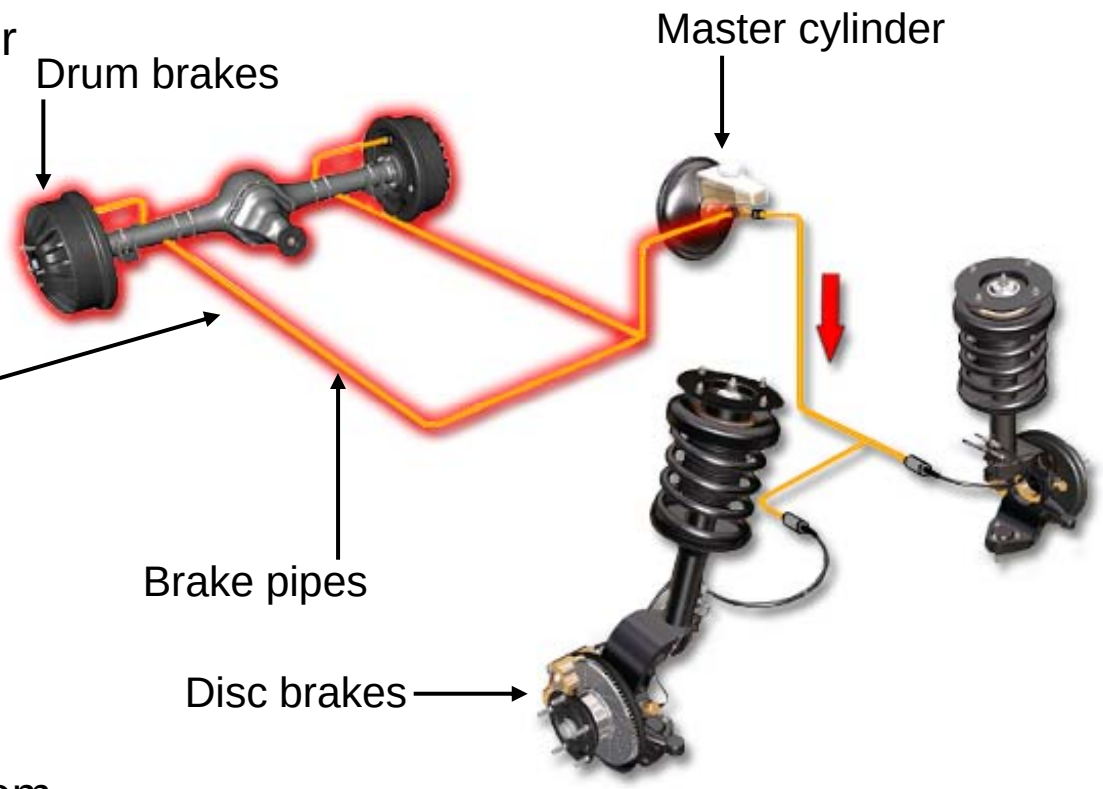
Dual Circuit Braking System

A dual circuit braking system has a dual master cylinder and two separate braking circuits.

A fluid leak in one circuit still leaves two wheels with working brakes.

This is a much safer system.



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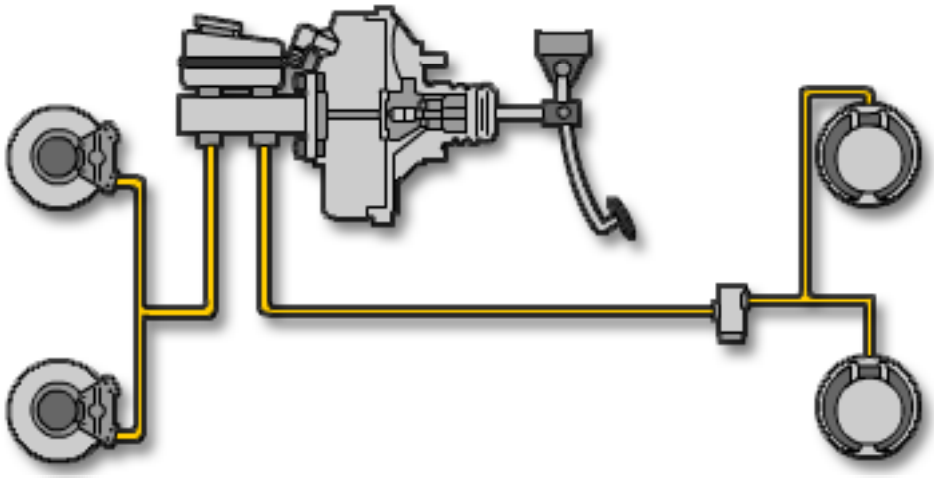
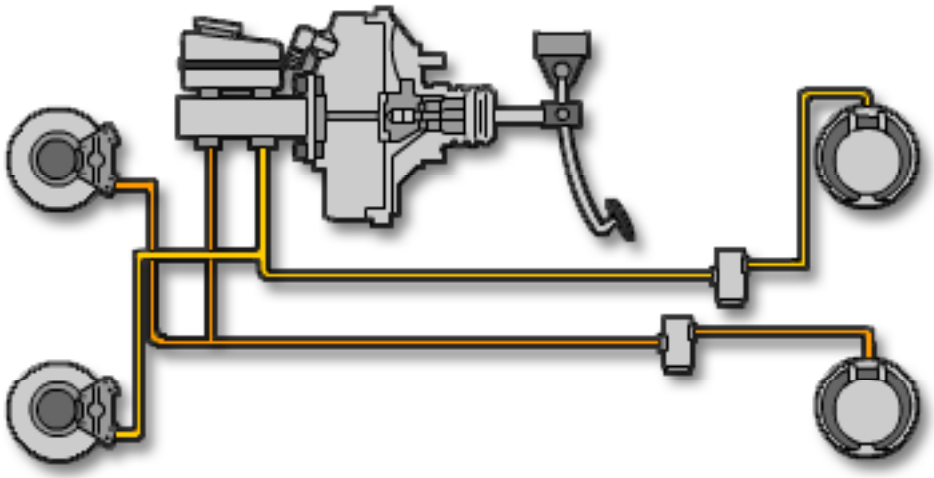
Split Systems

For dual-circuit brakes, the system may be split longitudinally (vertically).



Alternatively, it may be split diagonally.



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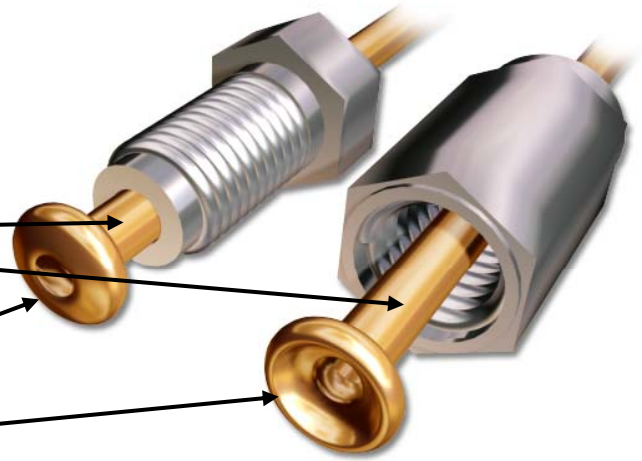
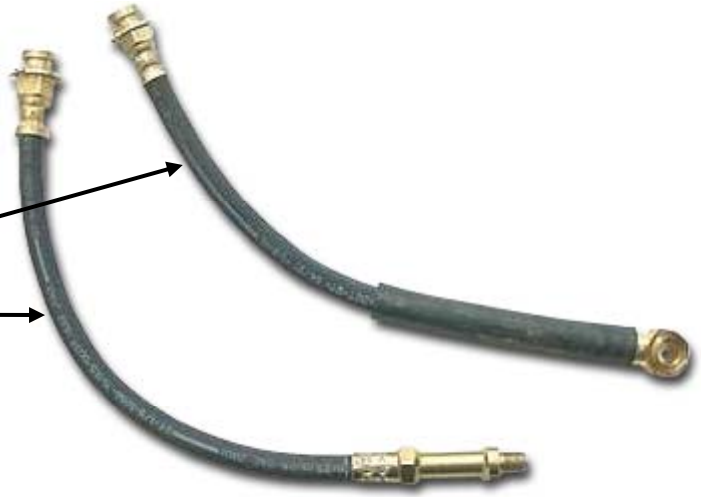
Brake Pipes and Hoses

Brake pipes may be of steel or copper double wall alloy tubing, where clamped to rigid bodywork.



They are dressed to shape and the ends are flared.

Where movement or vibration is found, flexible hoses must be used instead.



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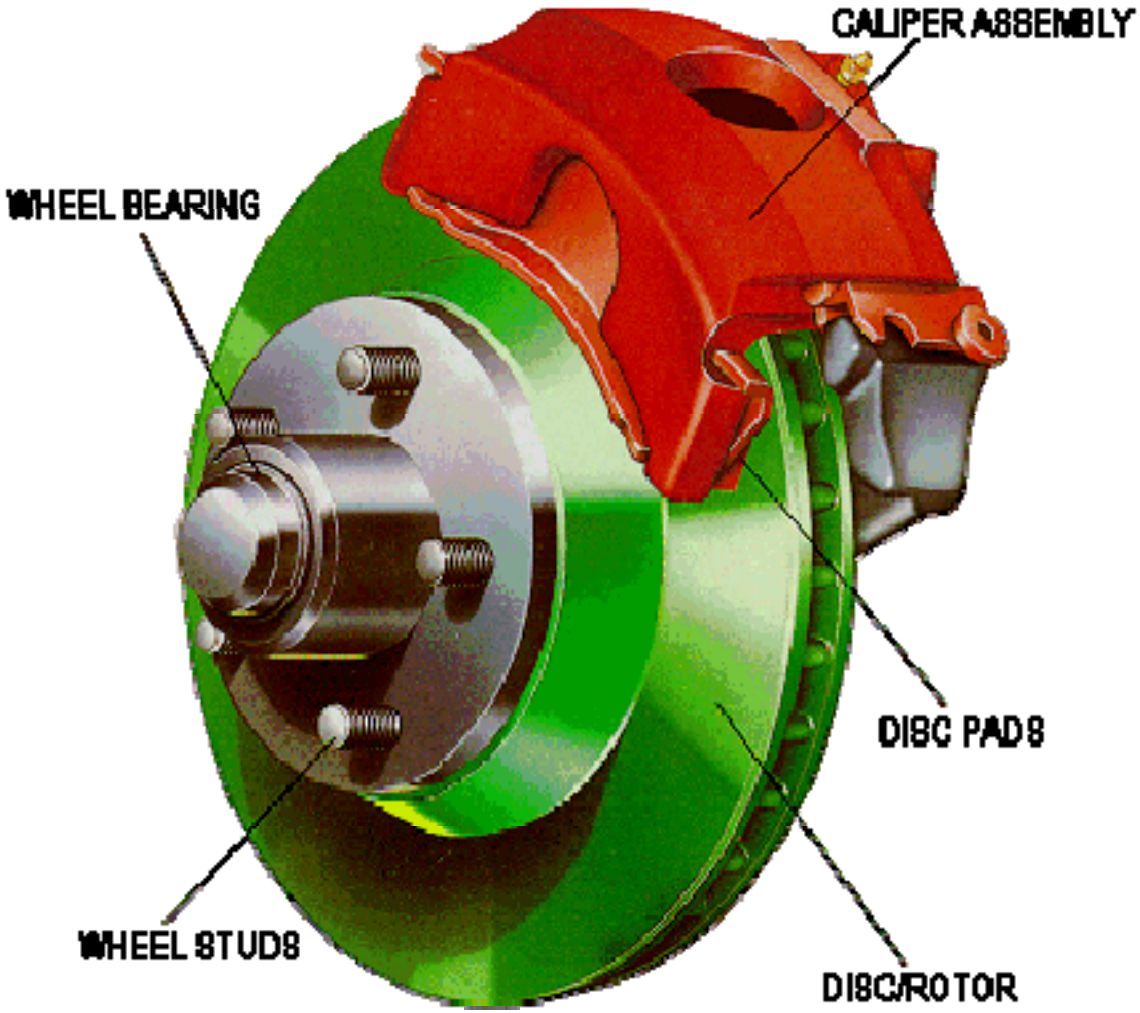
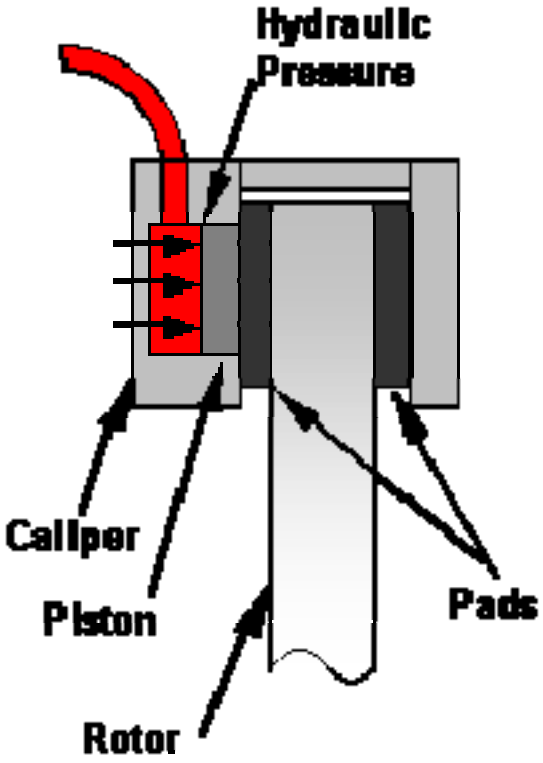
Brake Disc Assembly



Disc Brakes are self adjusting



Please note, Disc Brakes do not have any **self servo effect**, a Servo/Booster unit is fitted to increase the force applied by the driver when the brake pedal is operated.

Disc Calliper Components

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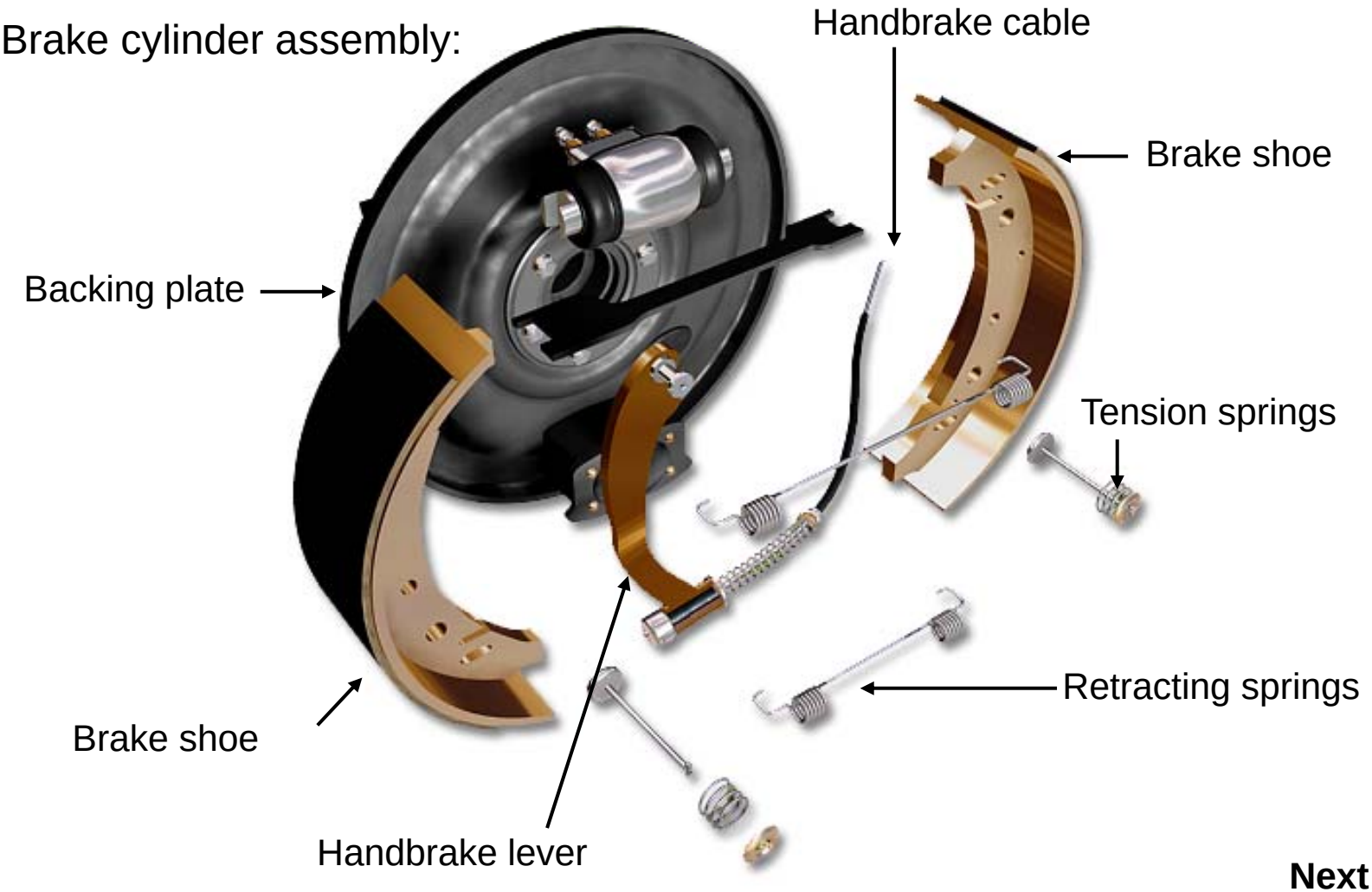
Drum Brake Assembly

Brake cylinder assembly:



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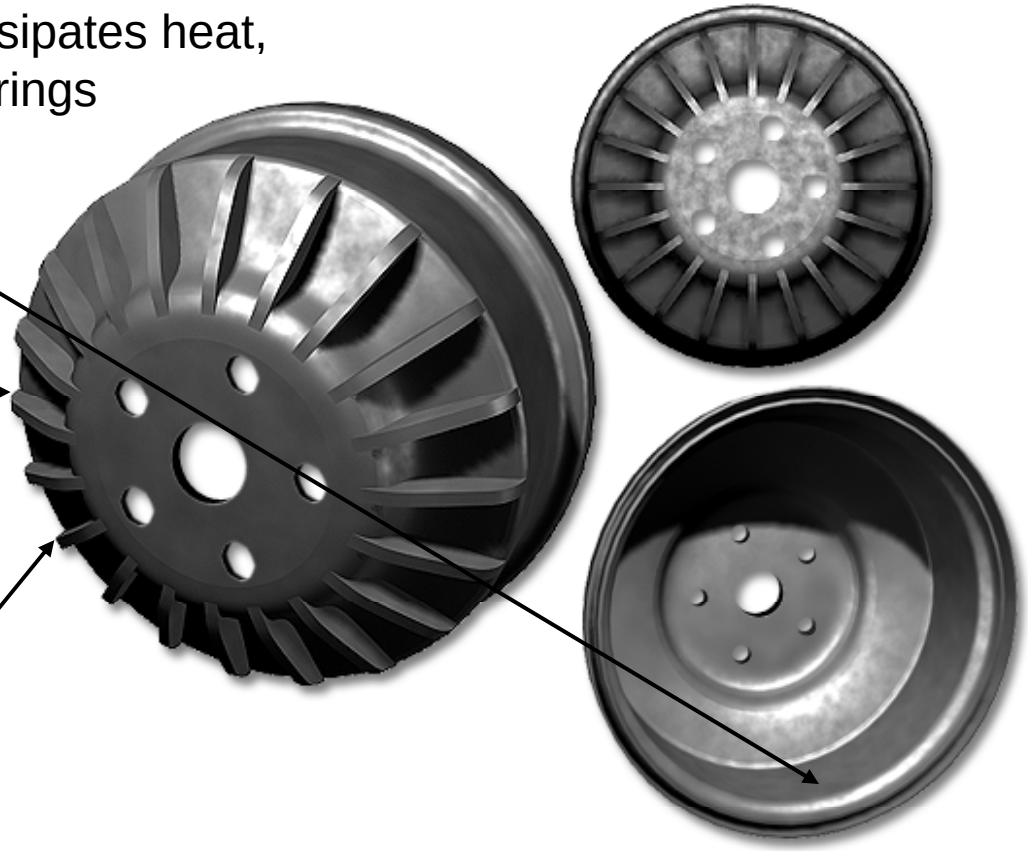
Brake Drum

The drum provides a friction surface for the brake linings. It also dissipates heat, and can support wheel bearings or road wheel.

Drum fits over wheel hub or drive flange.

Drums sometimes have fins to aid cooling.



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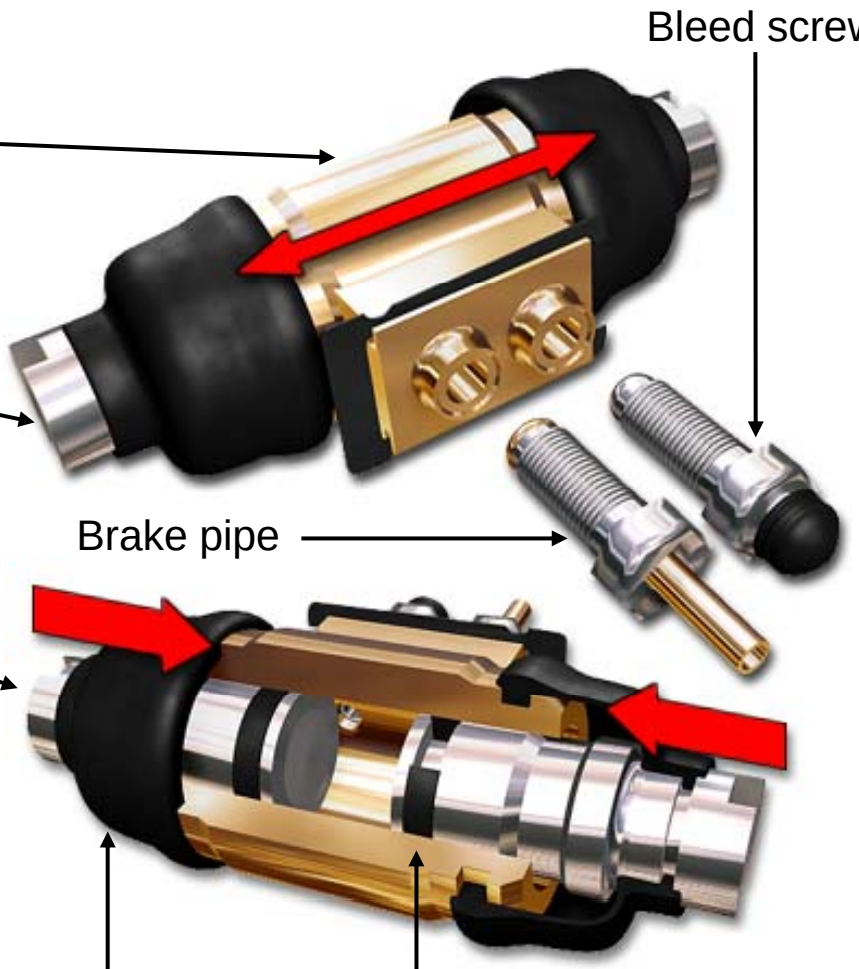
Wheel Cylinder

Most have two pistons in one cylinder.

Brake pressure is applied.

Brake pressure is released.

Bleed screw allows unwanted air to be removed from the brake pipes and cylinder.



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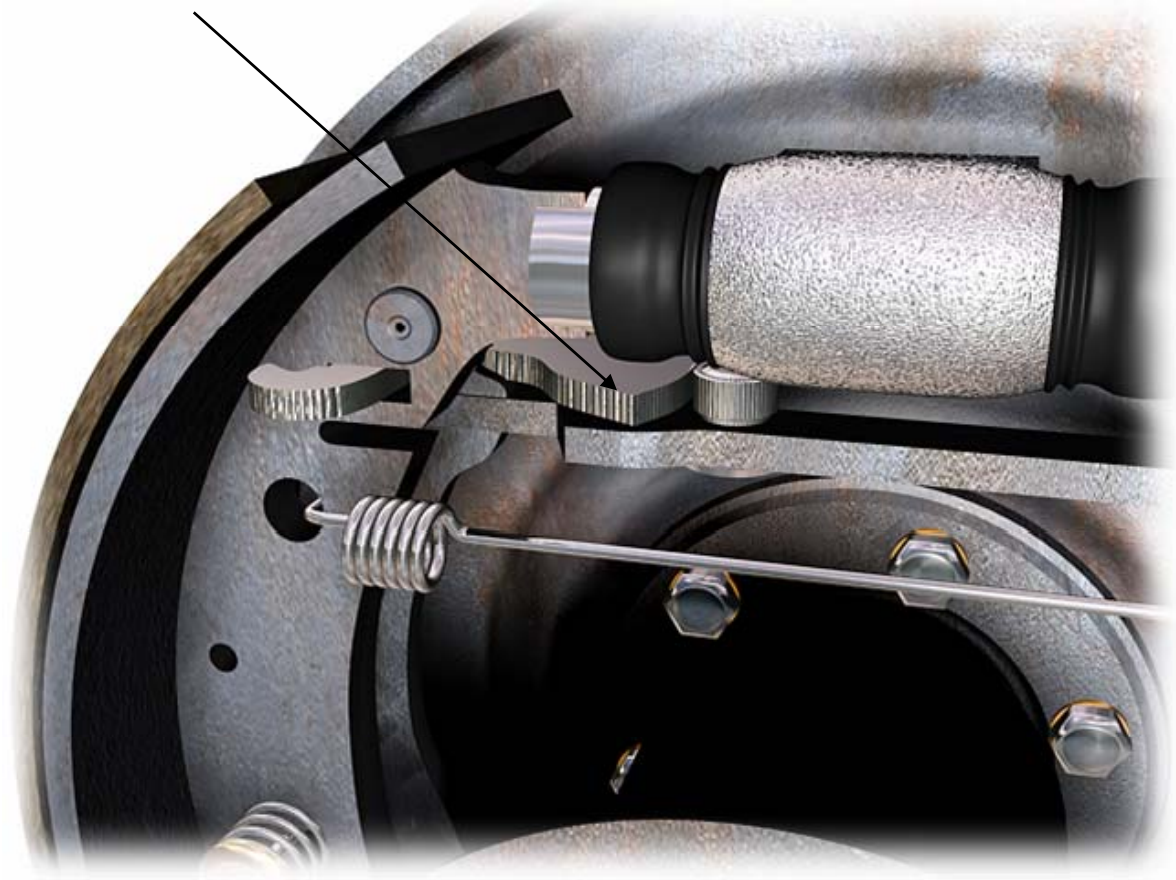
Brake Shoe Adjuster

Adjustment of the Brake Shoes is required to maintain the correct lining to Drum clearance



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Hydraulic Fluid Specification

Brake fluid must meet SAE and DOT specifications for:

- **Viscosity** - Flow at all temperatures.
- **Lubrication** - Reduce wear on moving parts.
- **Non-corrosive** - No reaction to metal and rubber.
- **Low freezing point** - Does not solidify in cold weather.
- **Water tolerant** – Always use new and the correct type of fluid recommended for the Braking system. Brake fluid is **Hygroscopic** which means that over a period of time it absorbs water which lowers its boiling point. Should the fluid boil, air would form in the hydraulic system, resulting in brake failure.
- **High boiling point** - Remains liquid at high temperatures.

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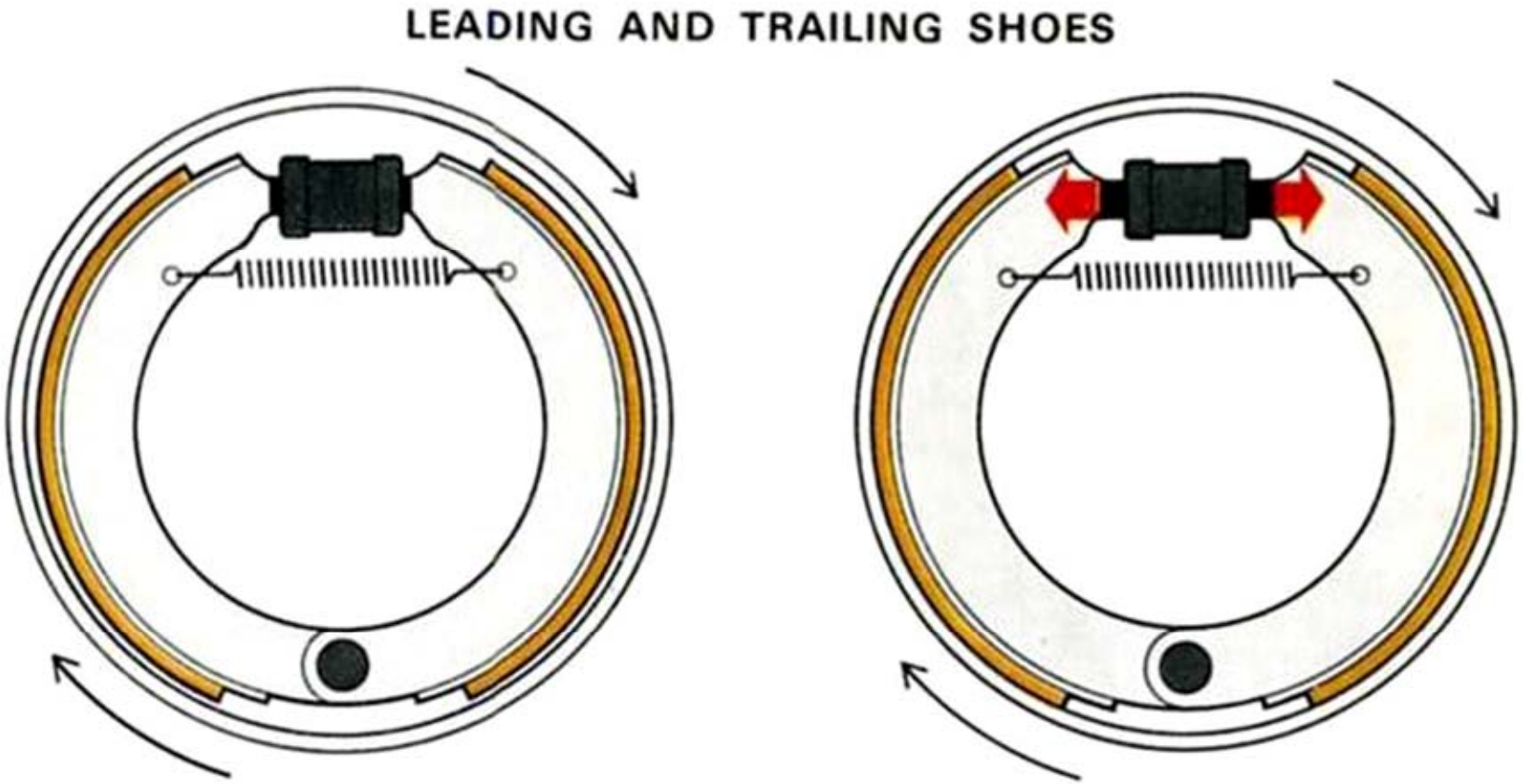
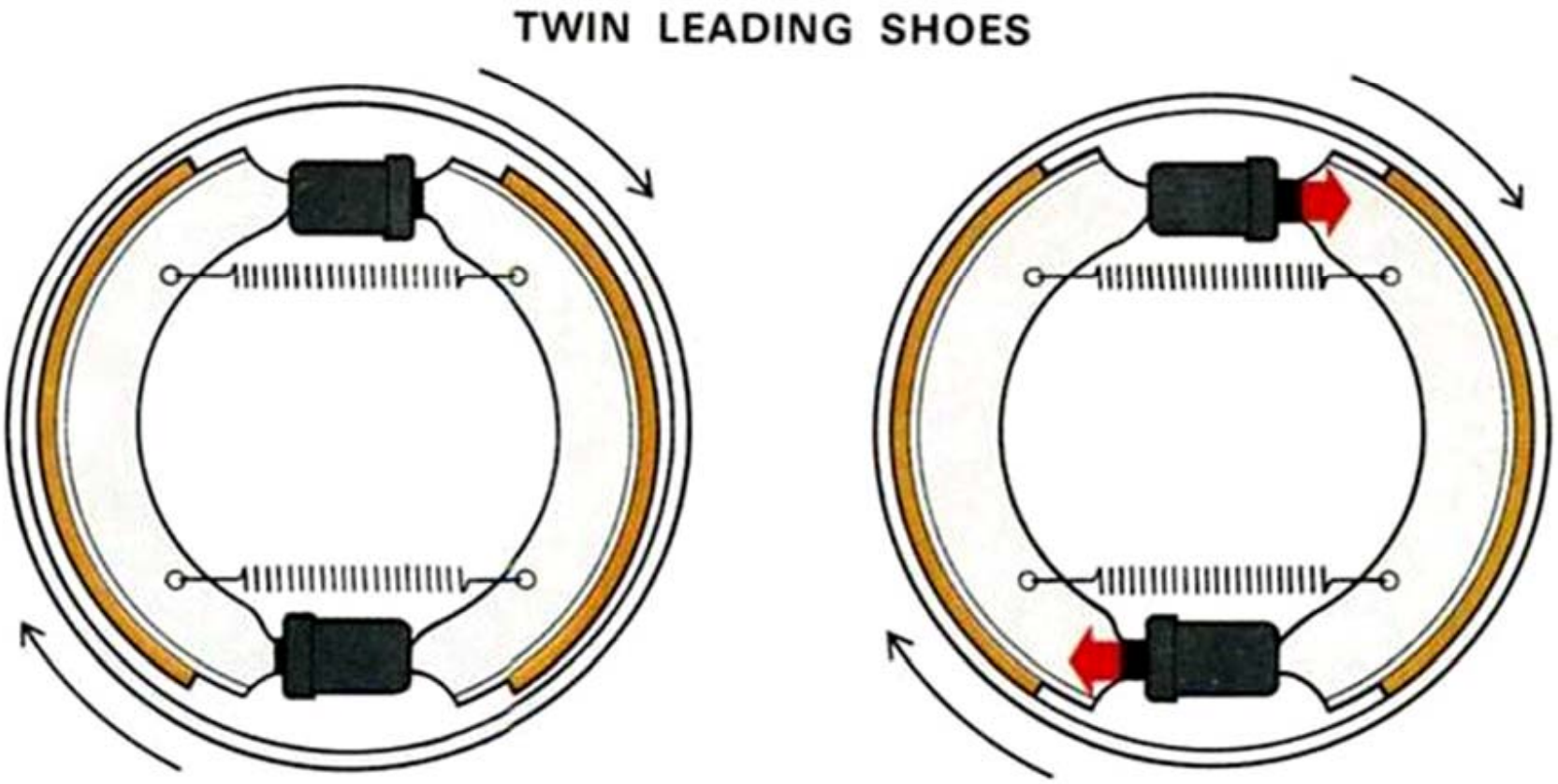
Leading and Trailing Shoes are best suited for use on the rear of the vehicle where less braking force is required, however this arrangement does allow for the effective use of the handbrake mechanism, as the direction of rotation of the drum changes, **the trailing shoe** becomes the **leading** due to the **self servo effect**



Twin Leading Shoes are used on the front brakes due to the increased braking force required, this is provided by the **self servo** effect of both **shoes**, however, should the direction of rotation of the drum change, they both become **Trailing Shoes**



Handbrake

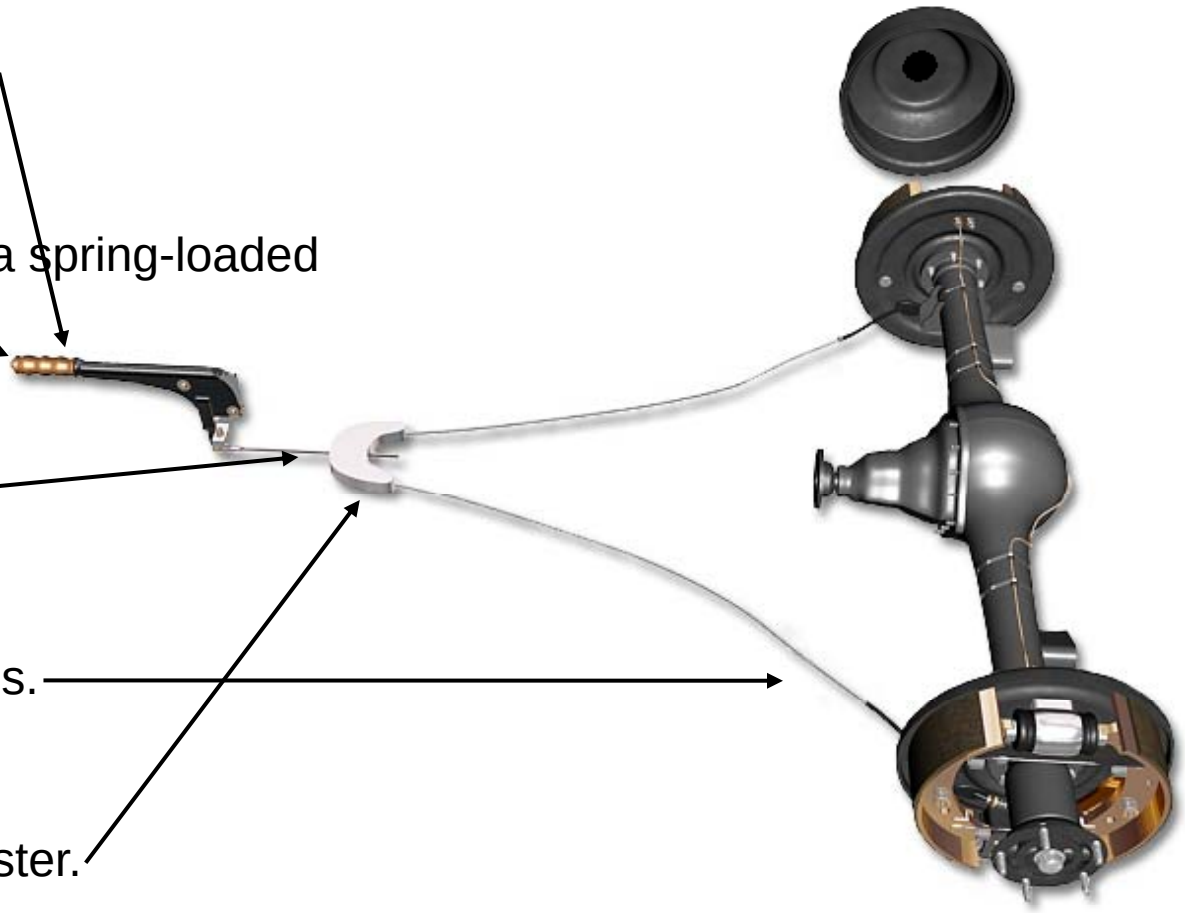
Manually operated.

Ratchet lever with a spring-loaded release button.

Cable/rod linkage.

Left and right cables.

Equalizer and adjuster.



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