Basic Brakes

Basic Brakes Notes

Four Hydraulic Principles

a) Air is compressible. Its volume is reduced if placed under pressure in a closed container.

b) Liquids are not compressible. Pascal's Law states that a pressure exerted upon a mass of liquid in a closed container is transmitted without loss equally and in all directions.

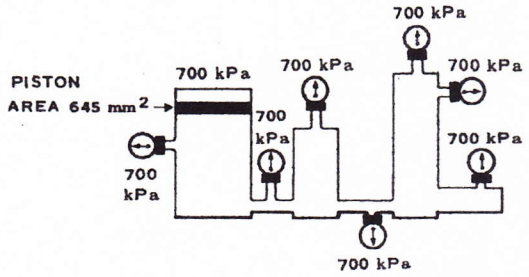
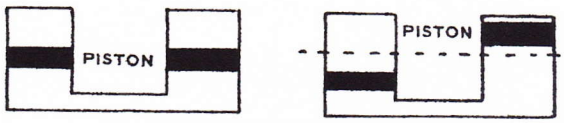


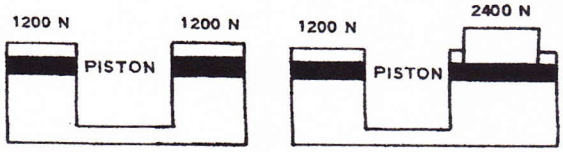
Fig. 10-3 Pascal's Law

c) Liquids transfer motion. If two pistons are connected to one another, compression of one of the pistons results in movement of the other.



(C) LIQUIDS TRANSFER MOTION

d) Liquids transfer force. If two equal size pistons are connected to one another, and a compression force is placed on one of the pistons, an equal force will be felt at the other piston.



(D) LIQUIDS TRANSMIT FORCE

Friction

Static friction is the force required to start a resting object moving.

Kinetic friction is the force required to keep an object moving at a constant rate.

It requires more force to start an object moving (static) than it does to keep it moving (kinetic).

Frictional force varies with the amount of weight being applied to the sliding surfaces. A container with 10 kilograms grams of material in it requires less force to be pulled across the floor than a container with 50 kilograms in it.

Frictional force varies with the smoothness of the sliding surfaces. Less force is required to pull a container across a smooth floor than a rough floor.

Frictional force varies with the materials of the sliding surfaces. Less force is required to pull a wooden block across the floor than to pull a soft rubber block across the floor.

A Vehicle's Braking Ability

Weight is one of the factors that determines the stopping ability of a vehicle. If the weight is doubled, the energy of motion which must be converted into heat energy is also doubled. The brake system must be able to absorb and dissipate the heat energy produced by stopping the weight of vehicle it was designed for.

Vehicle speed determines braking ability. When the brakes are applied, the energy of motion is converted to heat energy, and the vehicle slows down. The effect of higher speed is greater than the effect of greater weight. If vehicle speed is doubled, four times as much energy of motion is produced, and four times as much heat must be absorbed and dissipated to stop the vehicle.

Tires and road conditions determine braking ability. The contact between the tires and road is the rolling friction which must stop the vehicle. If the brake friction overcomes the rolling friction, the tire will lock up, and the heat will be absorbed and dissipated by the tire skidding on the road.

The overall braking ability of a vehicle at a given weight and speed depends on the following:

a.) Amount of brake lining surface area.
b.) Radius of brake rotor, or drum.
c.) Rolling radius of the tire.
d.) Brake lining coefficient of friction.
e.) Coefficient of friction between the tire and road.
f.) Proper brake adjustment.
g.) The efficiency of the brake system design.

Mechanical Advantage

Mechanical advantage is gained in a brake system by using different sized pistons throughout the system.

If a piston drives a larger piston there is a gain in force, but a loss in travel distance.

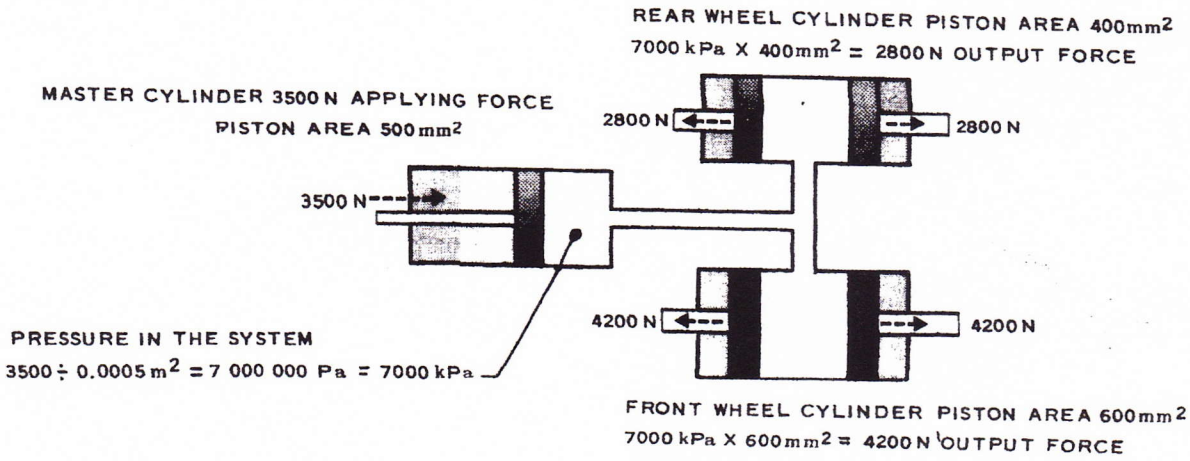
If a piston drives a smaller piston there is a loss in force, but a gain in travel distance.

The formula for figuring out the amount of pressure which the driving piston is applying is:

$$\frac{\text{force}}{\text{piston area}} = \text{pressure}$$

The formula for figuring out the amount of force which the driven piston is applying is:

$$\text{pressure} \times \text{piston area} = \text{force}$$



Basic Brake System

A basic brake system consists of the following components:

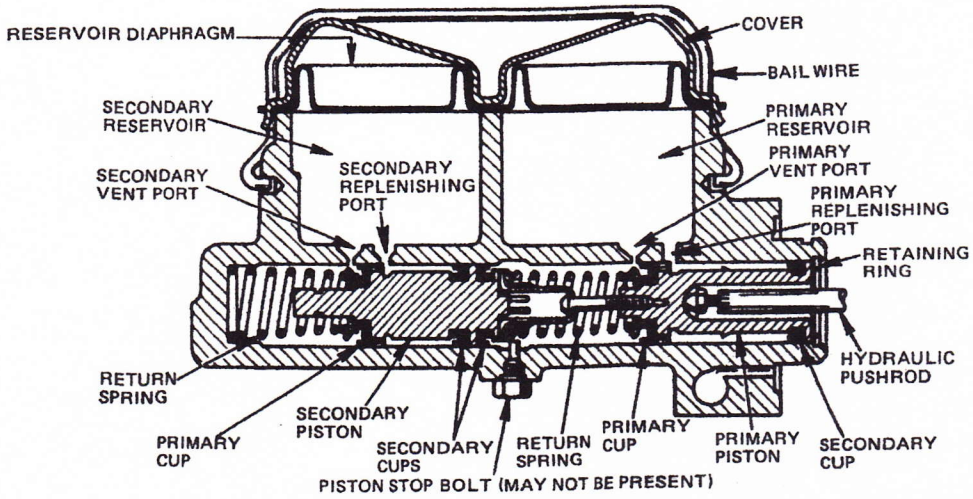
a) Master Cylinder
b) Brake Hydraulic Control Valves
c) Brake Lines & Fluid
d) Drum Brake System Including Wheel Cylinders
e) Disc Brake System Including Calipers

a). Master Cylinder

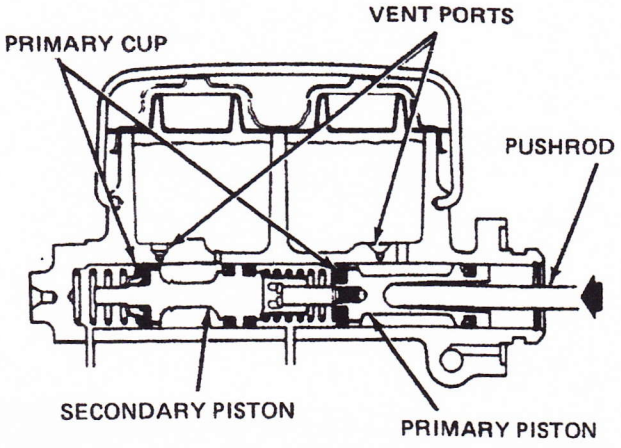
The master cylinder is a hydraulic pump that is operated by a pushrod attached to the brake pedal or by a power brake booster. The cylinder converts mechanical force into hydraulic pressure. The most common type in use is the dual system tandem master cylinder.

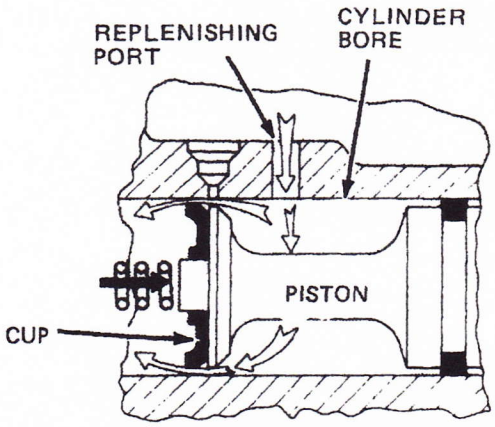
In this type, there are two separate hydraulic pressure systems. One of the hydraulic systems may be connected to the front brakes, and the other to the rear brakes. If one system fails, the other system still works, providing greater protection against a total loss of stopping power. There are two distinct fluid reservoirs and each has a vent and a replenishing port that leads into the cylinder bore. An airtight seal for the reservoir is provided by a rubber diaphragm, which is held in place by a metal cover. The cylinder bore contains the return springs, two pistons, and the seals. A retaining ring fits into a groove near the end of the bore and holds the piston assemblies in the cylinder.

Master Cylinder Components.



When the brake pedal is depressed, the pushrod moves the primary piston forward in the cylinder bore. The primary vent port is sealed off by the lip of the primary cup. As a result, a solid column of fluid is created between the primary and secondary pistons. With the help of the primary piston return spring, this column moves the secondary piston forward in the cylinder bore. This closes the secondary vent port. When both ports are closed, any further movement of the pushrod and pistons serves to increase the hydraulic pressure in the area ahead of each piston. This pressure is then transmitted through two hydraulic brake systems to the wheels.





When the brake pedal is released, the piston return springs move both pistons to their normal released position. The piston may move faster than the fluid can return from the calipers and/or wheel cylinders, creating a low pressure ahead of the piston. To allow rapid pedal return, this low pressure must be relieved. Fluid flows from the reservoir through the replenishing port, then around the outside of the piston and cup to the area ahead of the piston. Due to this replenishing action, the area in front of each piston is kept full of brake fluid at all times. Any excess fluid is returned to the master cylinder reservoirs through the vent ports after the pistons reach their fully released positions.

b.) Brake Hydraulic Control Valves

1.) Brake Warning Switch

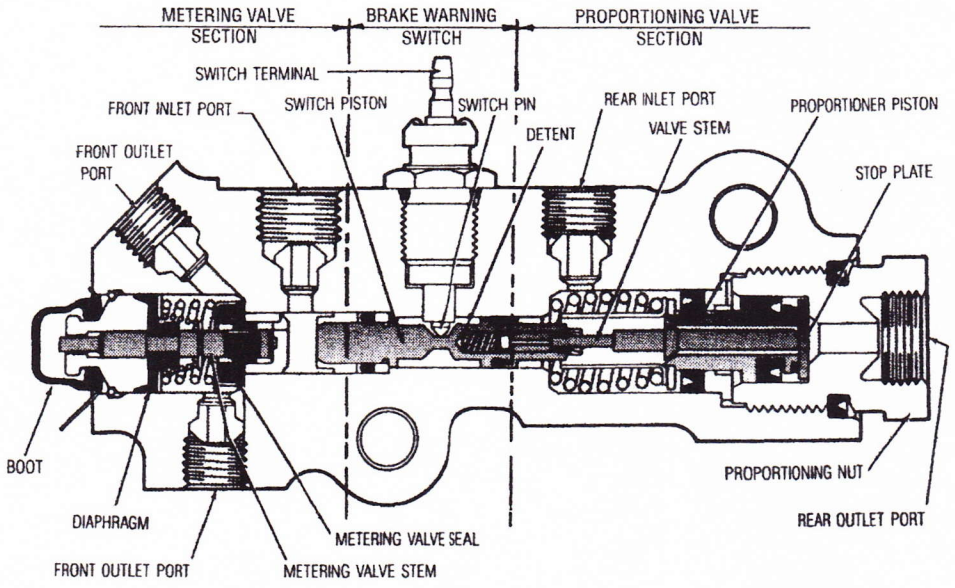
The brake warning switch is used to warn the driver of a loss of hydraulic pressure in the brake system. If a pressure loss occurs in the system, the pressure differential valve will move to the side of the switch with the least amount of pressure, and activate the dash warning light. The switch and light stay activated until the system is repaired.

2.) Proportioning Valve

The proportioning valve is used to control the rear brakes. During heavy brake application, the vehicle will tend to "dive" forward. This lifts the rear end of the vehicle, and makes it easy for the rear wheels to lock up. The proportioning valve delivers full input pressure to the rear brakes up to the "split point". Beyond the split point it reduces pressure to the rear brakes. If there is a front brake system pressure loss, the brake warning switch opens a by-pass in the proportioning valve to allow full pressure to flow.

3. Metering Valve

The metering valve is used to delay the pressure to front disc brakes so the rear drum brakes have time to overcome the return springs and contact the brake drums. The valve limits pressure to the front brakes to about 100 kPa until the pressure at the valve reaches about 1000 kPa. As this pressure is reached, the valve opens completely to give full pressure to the front brakes. This valve helps to prevent the front brakes from locking on icy surfaces under light braking conditions.



Typical Brake Hydraulic Combination Control Valves

c.) Brake Lines & Fluid

Brake fluid is transmitted throughout the vehicle with steel tubing, and is galvanized to prevent corrosion. High pressure neoprene cloth hoses are used wherever a flexible connection is needed. Flexible brake hoses can crack on the outside, and eventually break open. They should be checked regularly for damage.

Brake fluid is the only type of fluid that can be used in a brake hydraulic system.

Brake fluid must have the following properties:

a) flows easily at all temperatures
b) chemically stable over long periods of time
c) lubricates
d) non corrosive to metal parts
e) will not break down rubber
f) will not expand or contract with temperature changes

Engine oil, transmission fluid, solvents, or other carbon based fluids destroy rubber parts in a brake hydraulic system, and should never be used as brake fluid or cleaners.

Bleeding Brakes

Air in the brake hydraulic system causes the brake pedal to feel "soft", and reduces braking efficiency. Air needs to be bled from the system using the following basic technique:

a) Fill the master cylinder fluid reservoir with brake fluid.
b) Check if any bleed screws are seized - repair as necessary.
c) Start from the wheel farthest from the master cylinder, and move closer as the air is completely bled out of each wheel.
d) For each wheel have a partner SLOWLY pump the brake pedal 3 - 4 times, and HOLD it down (drums must be on).
e) Open the bleed screw and let as much fluid out as possible, watching to see if any air bubbles are present in the fluid. Do not lift the brake pedal at all while the bleed screw is open.
f) Close the bleed screw.
g) Repeat steps d, e, and f, at each wheel until no air is seen in the fluid leaving the system – regularly check the fluid level in the reservoir.