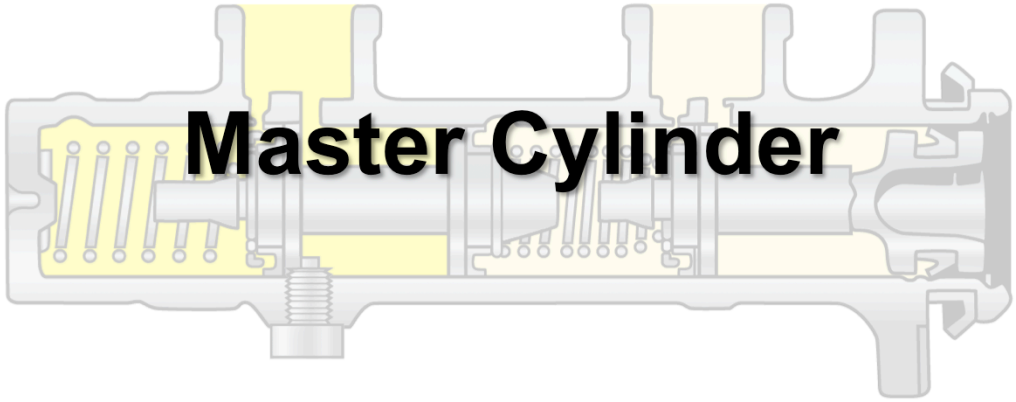
Section 2

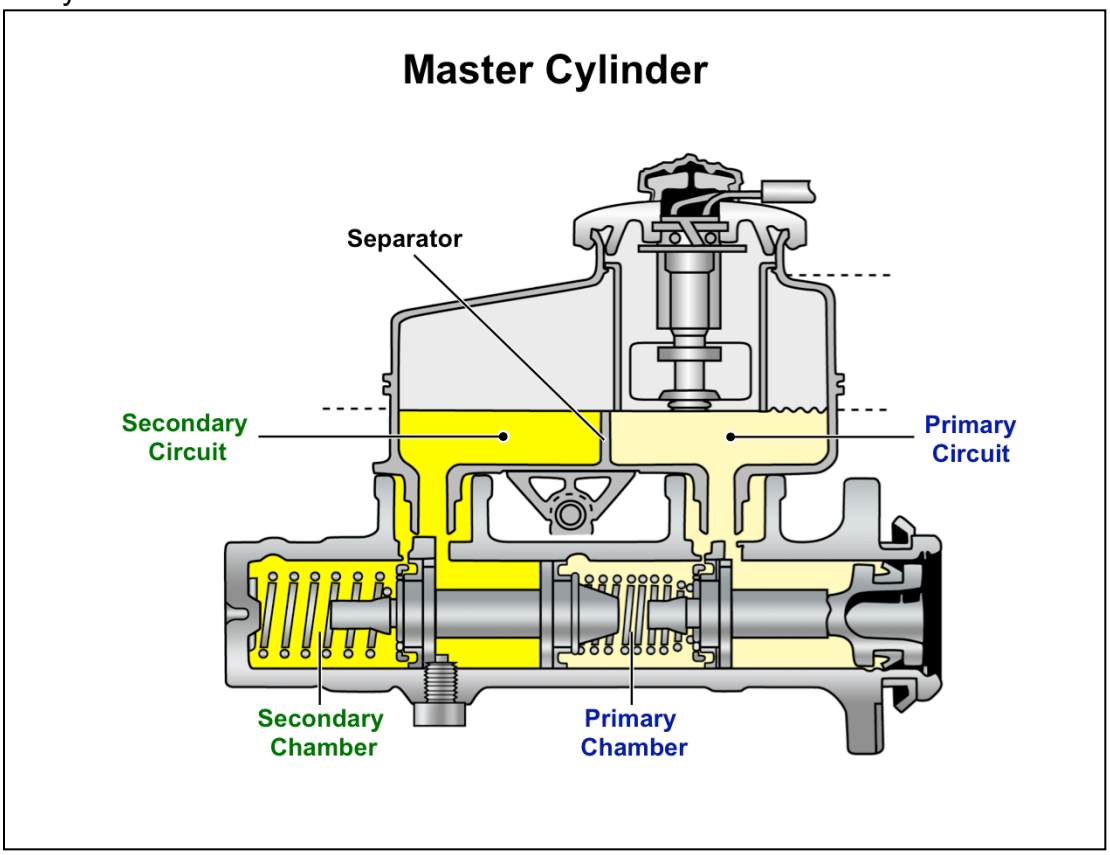


Master Cylinder

Section 2 Topics

This section covers:

1. Master cylinder components
2. Master cylinder operation
3. Master cylinder diagnosis
4. Brake tubing
5. Brake bleeding



Master Cylinder

The master cylinder converts the motion of the brake pedal into hydraulic pressure. A tandem master cylinder consists of:

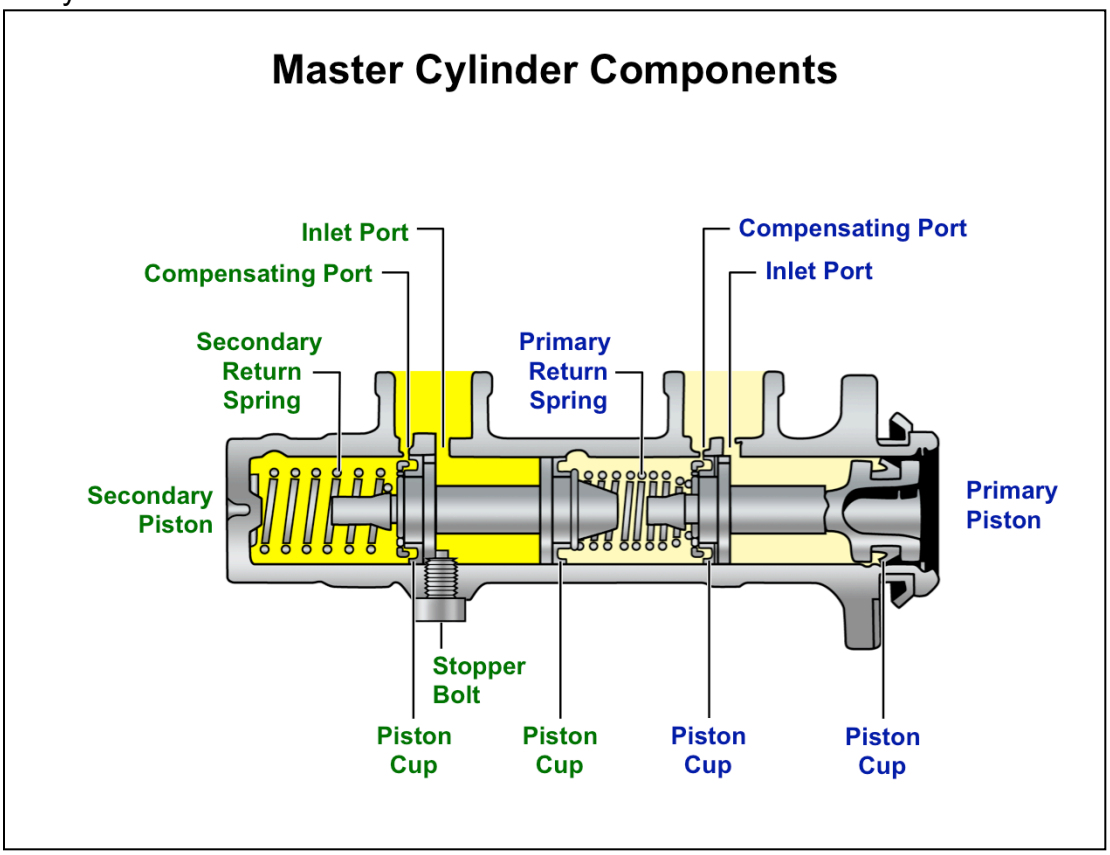
- Reservoir tank
- Piston(s)
- Cylinder

Most vehicles use a tandem master cylinder, where the cylinder is separated into two chambers:

- The primary chamber at the rear of the master cylinder feeds the rear wheels.
- The secondary chamber at the front of the master cylinder feeds the front wheels.

Dividing the cylinder into two chambers provides a safety factor. If one circuit looses pressure, the other remains functional.

The reservoir tank stores brake fluid. A separator in the reservoir ensures sufficient fluid for at least one circuit (in case of a leak in the other circuit). The cap contains a small vent hole that allows the fluid to expand and contract. A diaphragm separates the fluid from contact with the air.



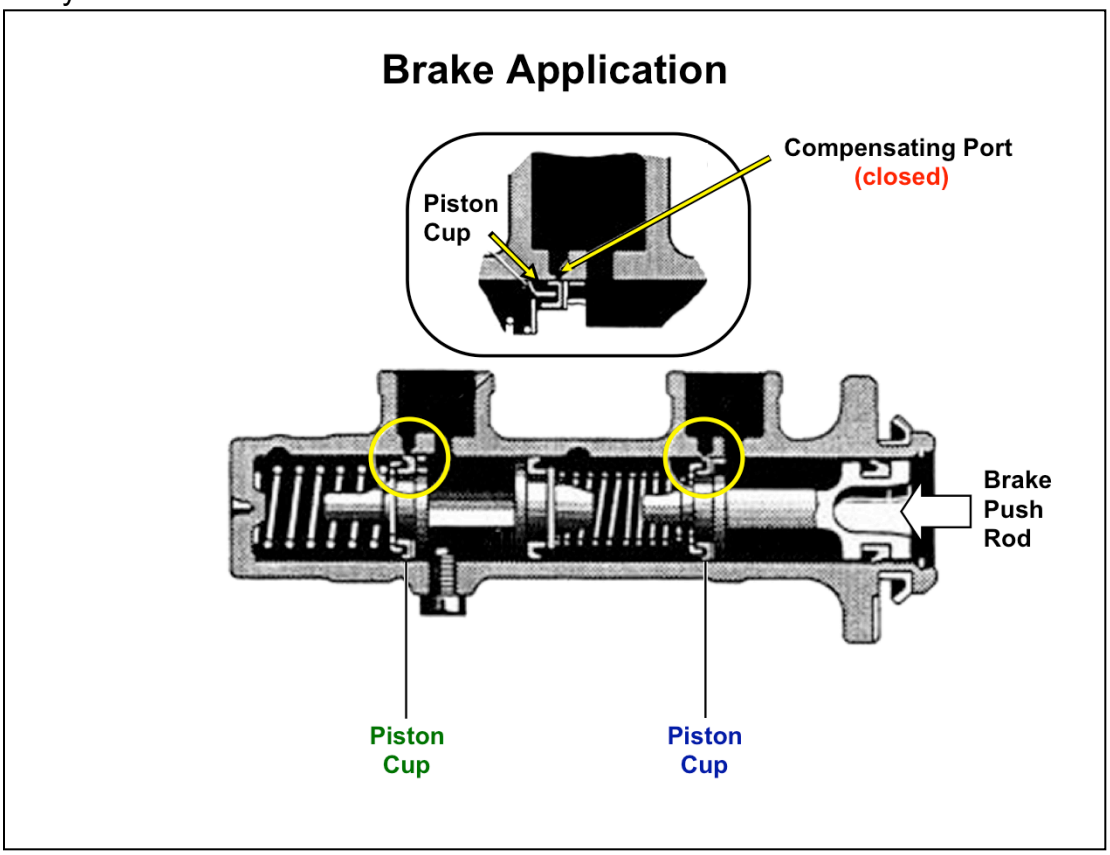
Master Cylinder Components

The master cylinder body houses the following components:

- Compensating port: A narrow passage between the fluid reservoir and the brake cylinder that equalizes pressure between the reservoir and cylinder chamber when the brakes are released.
- Inlet port: An unrestricted passage that prevents air from being drawn into the system as the brake is released.
- Piston cups: Seals that block the flow of fluid between chambers.
- Return springs: Heavy springs that keep the moving components in place when the brakes are not applied.
- Stopper bolt: A stopper that limits secondary piston travel.

When the system is at rest and the brakes are not applied:

- The piston cups attached to the face of the primary and secondary pistons are positioned between compensating port and inlet port.
- Fluid moves freely between the reservoir and cylinder via the compensating port.



Brake Application

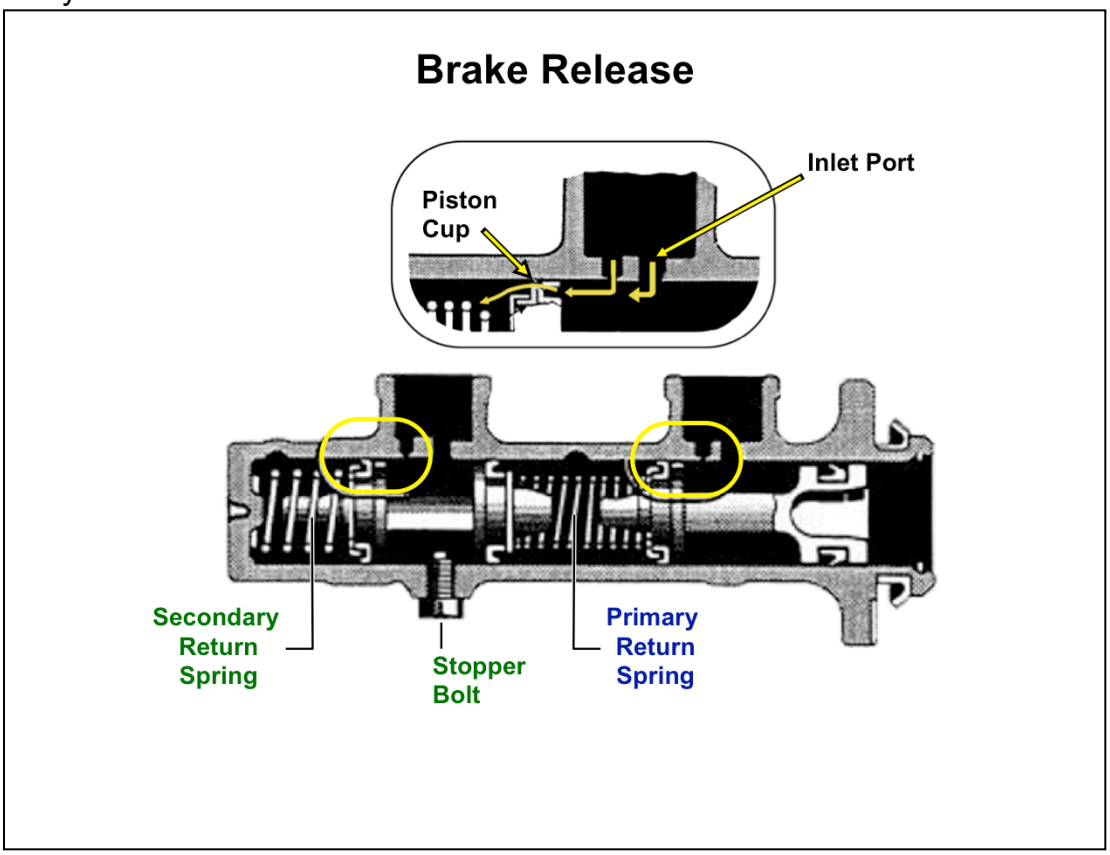
When the brakes are applied:

- The brake pushrod moves the primary piston to the left.
- The piston cup passes the compensating port, sealing the primary chamber.

As the piston continues to move to the left pressure builds in the primary chamber and is transmitted to:

- Two wheel cylinders
- The secondary piston

The secondary piston moves to the left, transmitting pressure to the other two wheel cylinders.



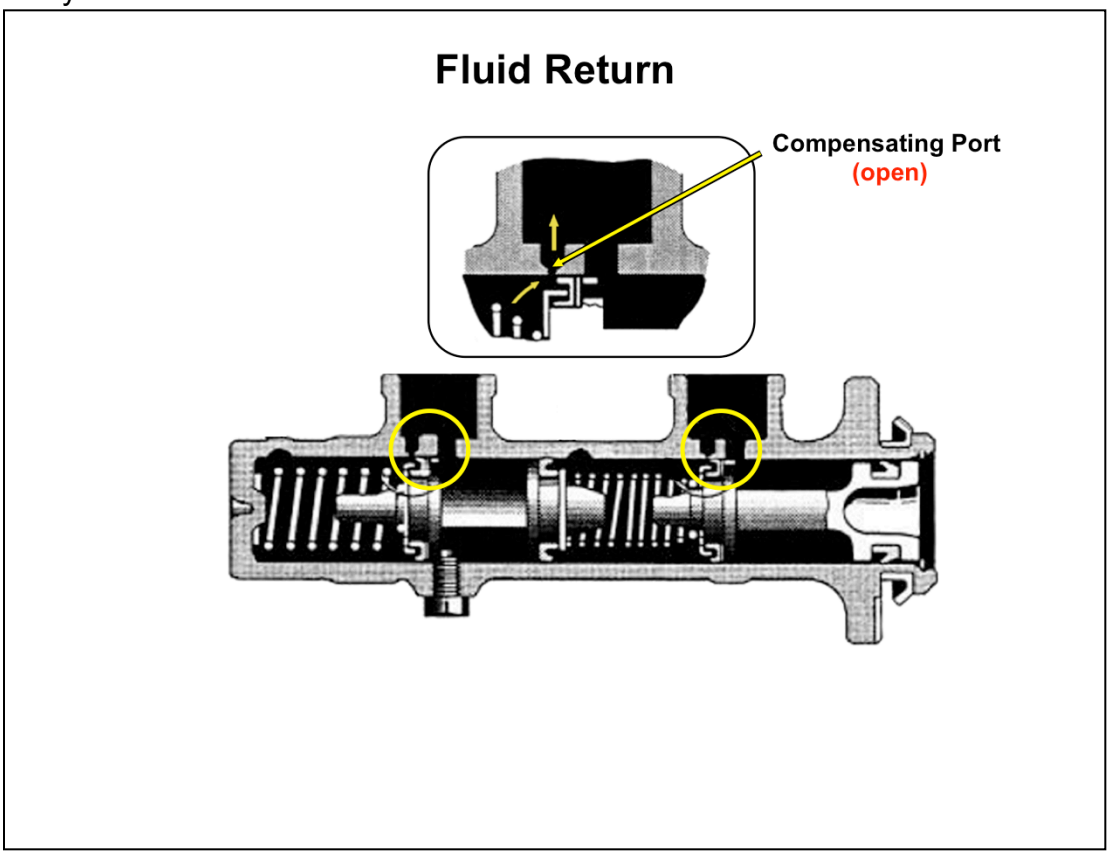
Brake Release

When the brakes are released:

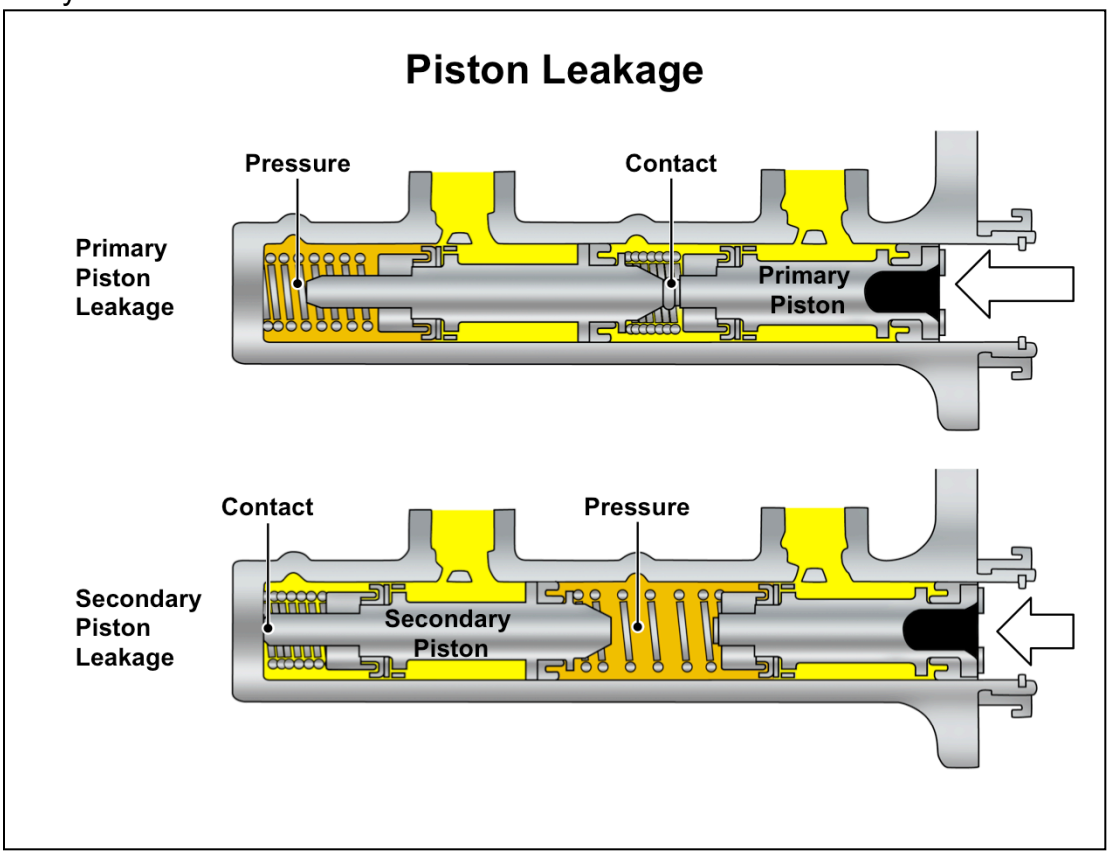
- The primary and secondary return springs return both pistons to their at rest positions.
- The stopper bolt keeps the secondary piston from moving too far to the right.

The pistons return to their original positions more quickly than the fluid returns from the system, so:

- System pressure briefly drops below normal
- Fluid from the inlet port flows through small orifices in the pistons and past the piston cup, preventing air from entering the system.



Fluid Return Fluid returns to the reservoir through the compensating port to equalize pressure.



Piston Leakage

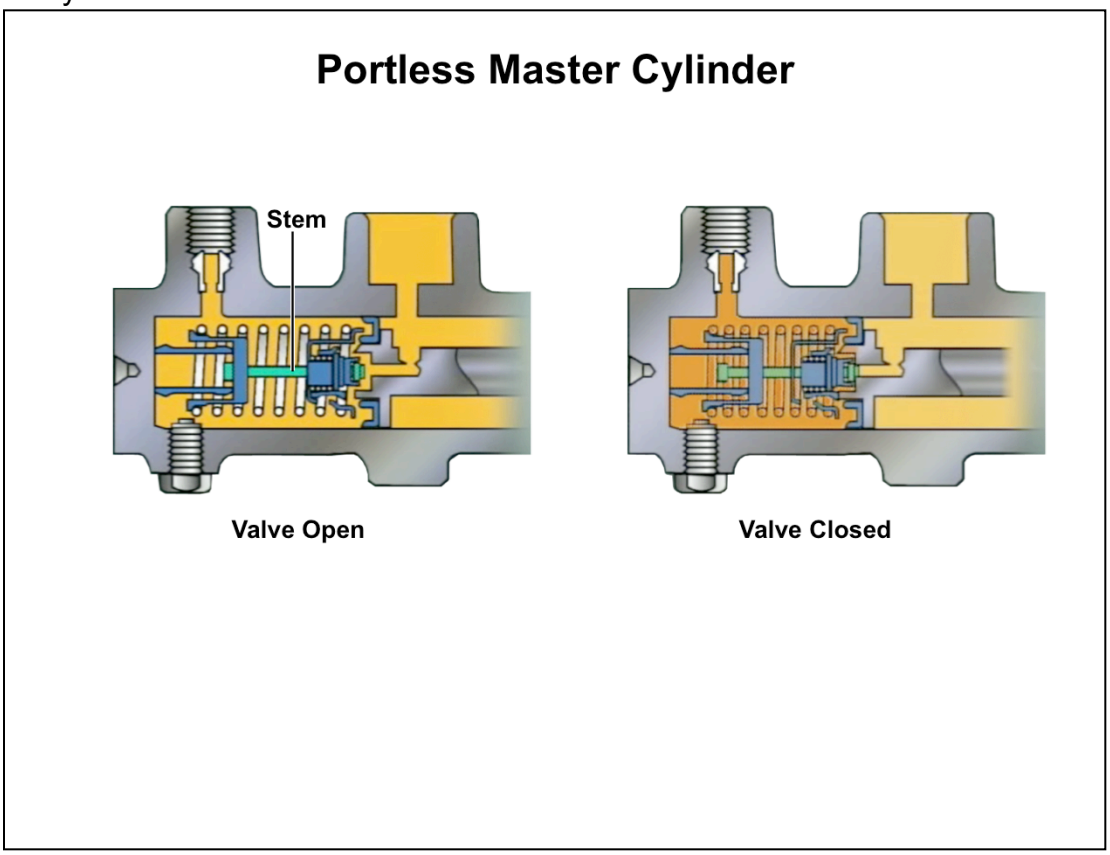
If the primary circuit looses pressure:

- The brake pedal moves with little resistance until the primary piston contacts the secondary piston.
- The primary piston physically moves the secondary piston to the left.
- Pressure builds in the secondary chamber and activates the secondary circuit.

If the secondary circuit looses pressure:

- Initially, the brake pedal moves with little resistance.
- Hydraulic pressure in the primary chamber moves the secondary piston to the left until it contacts the cylinder wall.
- Once the secondary piston contacts the wall, pressure builds in the primary chamber and activates the primary circuit.

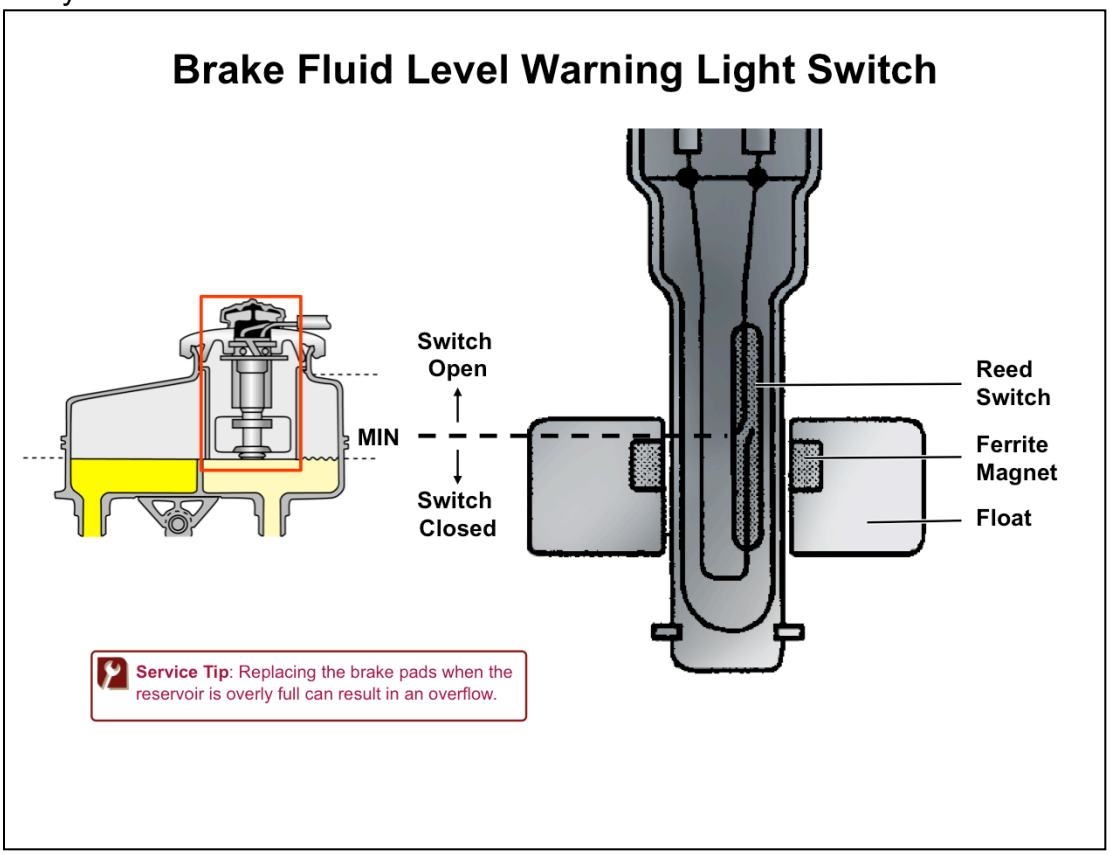
In both cases the pedal travels much further than during normal braking and the overall brake force is half the normal amount.



Portless Master Cylinder

Portless master cylinders use a slightly different approach to compensation that allows them to send more pressure to the wheel cylinders. Instead of using separate inlet and compensating ports, there is a single non-restrictive passage from the reservoir to the piston. A machined passage in the piston handles compensation.

- When the brakes are at rest the valve is open, allowing fluid to move freely between the reservoir and chamber.
- When the brakes are applied the spring loaded valve closes, sealing the passage and allowing pressure to build in the circuit.



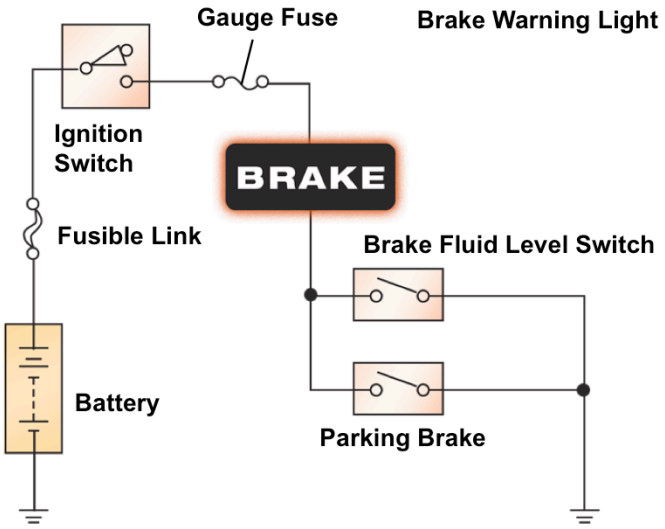
Brake Fluid Level Warning Light Switch

This switch is located in the reservoir cap or reservoir body. It is normally OFF when fluid level is within specifications. If the fluid level drops, the switch float contains a magnet that closes the reed switch.

The under-hood section of the repair manual specifies to "*Check that the brake fluid levels are near the upper level lines on the see-through reservoirs".*

SERVICE TIP Replacing the brake pads when the reservoir is overly full can result in an overflow.

Brake Warning Light Circuit



Note: When the Brake warning light is illuminated, ABS and cruise control are inoperative.

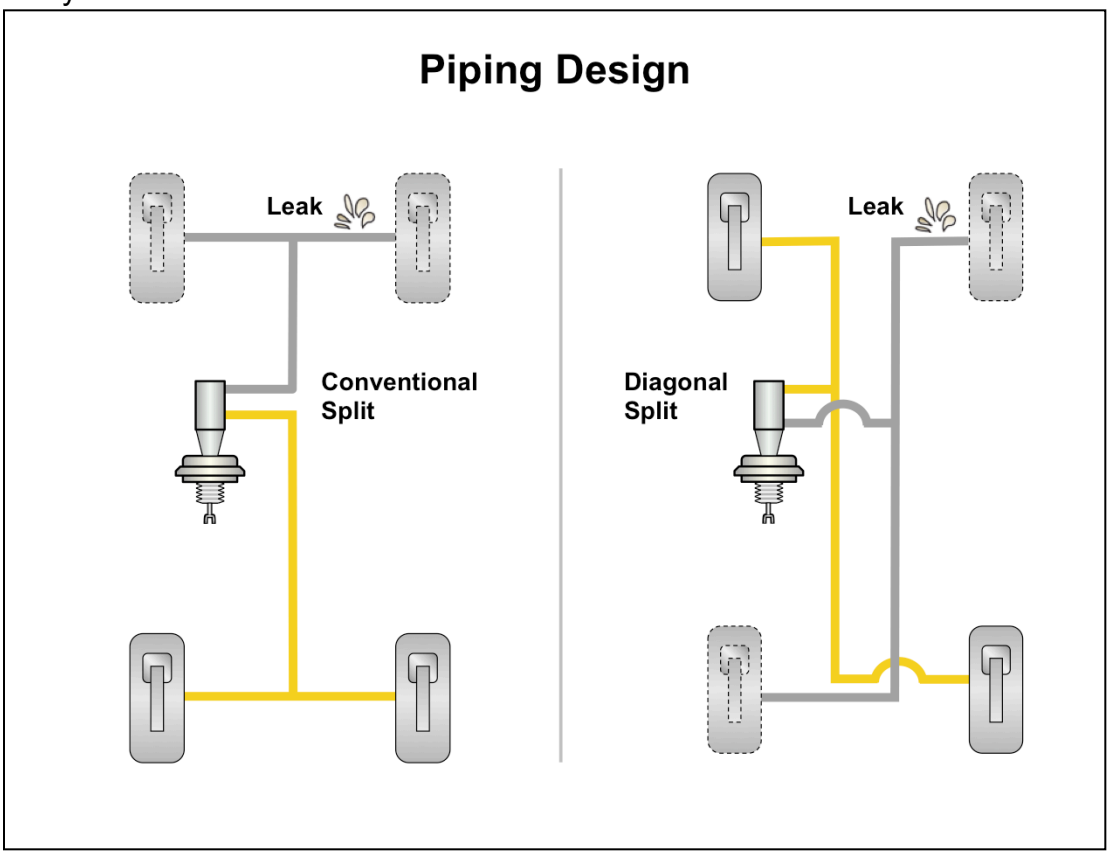
Brake Warning Light Circuit

If the fluid level switch closes, the combination meter BRAKE warning light is turned on.

NOTE

This warning light is also turned on when the parking brake is set.

When the Brake warning light is illuminated, ABS and cruise control are inoperative.



Piping Design

Tandem master cylinders split the hydraulic pressure into two separate circuits. There are two common configurations:

Conventional Split

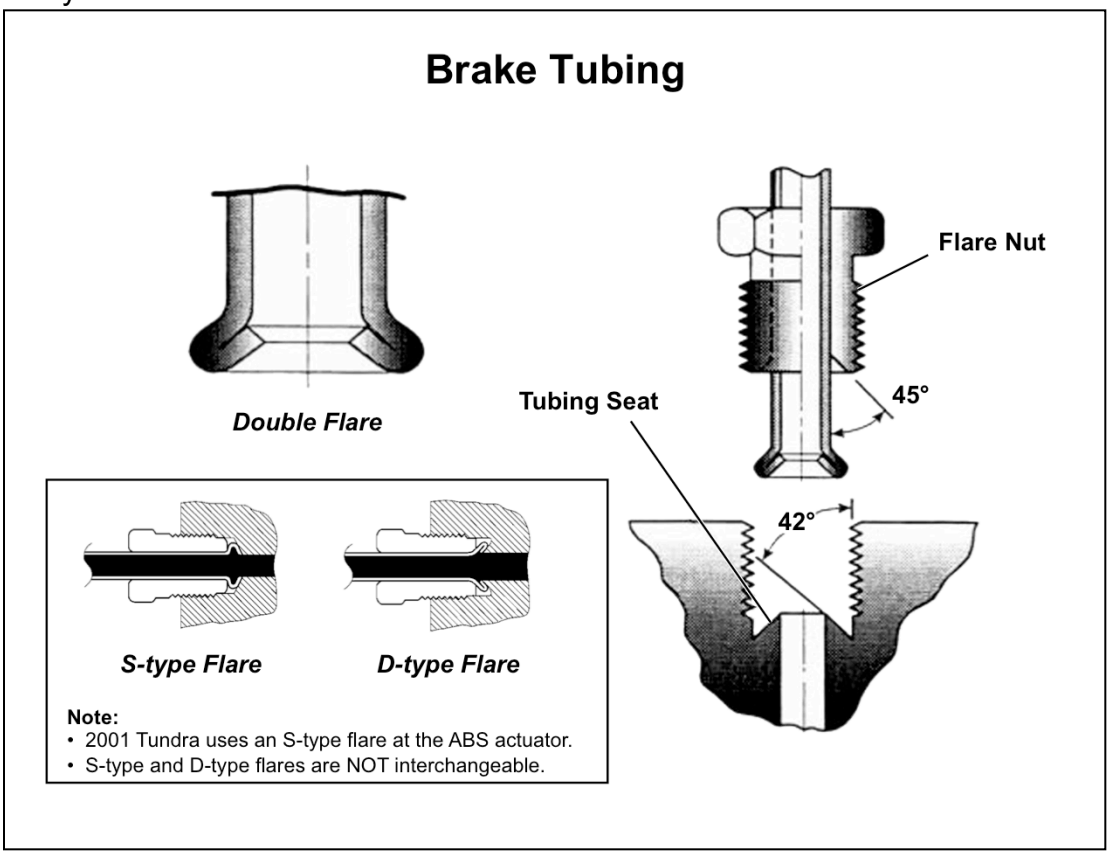
Front-engine, rear-drive vehicles have the front wheels on one half of the system and the rear wheels on the other half. Depending on where a failure occurs, braking efficiency can be severely affected.

Diagonal Split

A diagonal split system provides more stable braking should one half of the system fail:

- Left front and right rear
- Right front and left rear

In the event of a failure, the effect on a vehicle's braking efficiency will be the same, regardless of which half of the system malfunctions.



Brake Tubing

Brake tubing is made of seamless steel. The copper-plated steel sheets are typically plated with tin and zinc for corrosion protection.

The tubing connects the brake system network of hydraulic components. Each end has a custom double-flared fitting and is fitted with a flare nut. The flare nut and tubing seat provide an interference fit that ensures proper seating of the double flare.

NOTE Flare nuts require a flare nut wrench for removal and installation.

Master Cylinder Bleeding



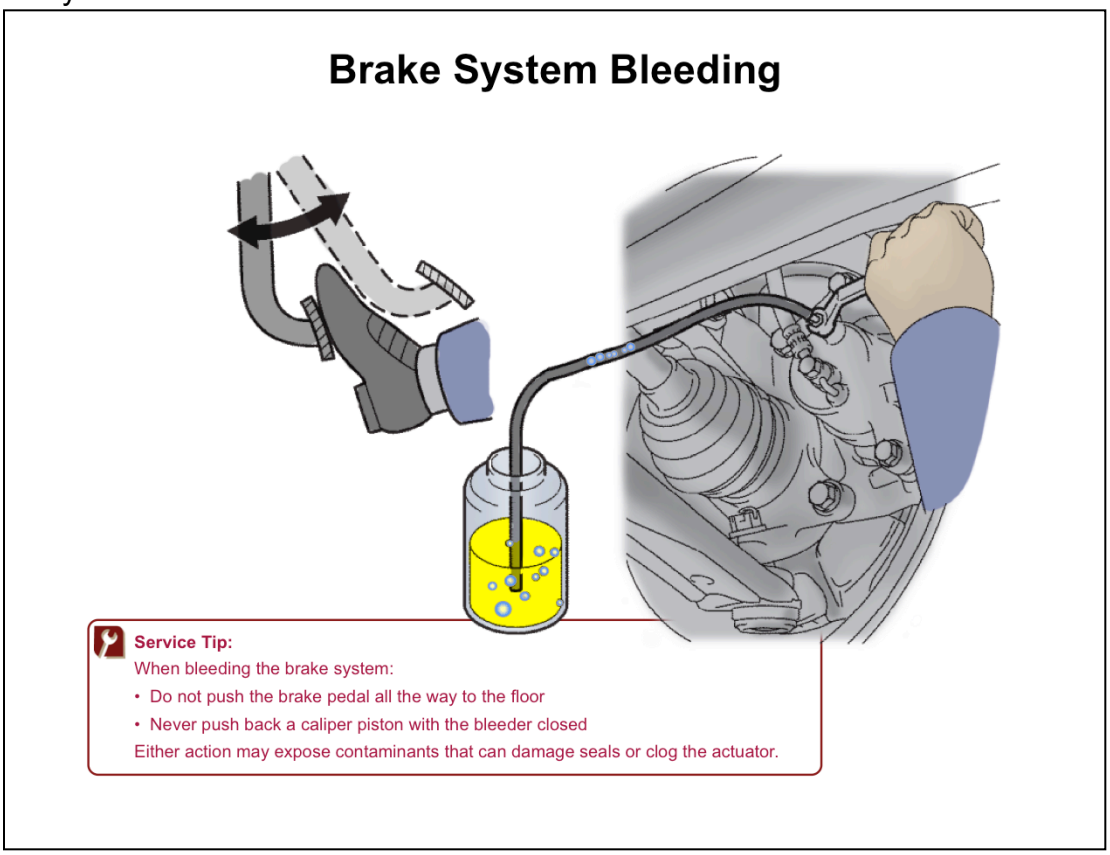
Master Cylinder Bleeding

Master Cylinder Bench Bleed Procedure

A new master cylinder should be filled with brake fluid before it is installed on the vehicle. This process is call “bench bleeding.”

1. Clamp the mounting flange in the soft jaws of a vise.
2. Fill the reservoir with clean brake fluid. Replenish the fluid as needed during bleeding.
3. Use a wooden dowel to slowly push the master cylinder piston approximately one inch into the cylinder bore and hold it there.
   - Do not push the piston all the way in as this can damage the seal.
   - Do not use a metal tool against piston as this can scratch the cup.
4. Cover each outlet port to prevent air from re-entering.
5. Slowly release the piston. The return spring will return the piston to the rest position and purge air to the reservoir.
6. Continue to stroke the piston until there is no air in the brake fluid. This may take three or more piston strokes.
7. Plug the ports, install the master cylinder and connect the hydraulic lines one line at a time.
8. To bleed any remaining air from the cylinder:
   a. Depress the brake pedal slowly and hold it down.
   b. Open the hydraulic line flare nut at the master cylinder just enough to allow any air to escape.
   c. Tighten the flare nut and release the brake pedal.
   d. Repeat the process until all air is removed.

CAUTION Wash brake fluid any painted surfaces immediately to avoid paint damage.



Brake System Bleeding

Bleed the entire brake system after performing any brake work or if diagnosis indicates air in the system. The process requires two people: one to depress and hold the brake pedal creating pressure in the master cylinder and brake lines, and another to loosen the brake bleeder plug at each wheel, allowing the contaminated fluid/air mixture to escape.

1. Top off the fluid in the master cylinder reservoir and monitor the fluid level throughout this procedure. If the fluid level falls too low and exposes the inlet ports the master cylinder and brake system will have to be re-bled.
2. Connect a clear vinyl tube to the bleeder plug on the wheel cylinder or caliper farthest from the master cylinder. Submerge the open end of the tube in a small container fresh brake fluid.
3. Depress the brake pedal several times, then hold it down. (Do not force the brake pedal all the way to the floor as debris may damage the seals.)
4. Loosen the bleeder plug and look for bubbles in the fluid flowing through the vinyl tubing. When fluid flow slows tighten the bleeder plug, then release the brake pedal.
5. Repeat steps 3 & 4 until the fluid leaving the wheel cylinder or caliper is clean and completely free of air bubbles, then tighten the bleeder plug to specification.
6. Repeat for each wheel in sequence, moving from the farthest to the closest. (Typically RR, LR, RF, LF.)

When the brake bleeding procedure is complete, top off the master cylinder fluid and clean any excess brake fluid from painted surfaces.

NOTE Vehicles equipped with ABS may require additional actuator bleeding using Techstream. Check the Repair Manual for specific procedures.