



Chapter 5

HYDRAULIC LINE, VALVE, AND SWITCH SERVICE

UPON COMPLETION AND REVIEW OF THIS CHAPTER, YOU SHOULD BE ABLE TO:

- Bleed and flush the hydraulic system.
- Pressure test the brake hydraulic system.
- Reset a pressure differential valve (warning lamp switch).
- Inspect brake lines and fittings for leaks, dents, kinks, rust, cracks, or wear. Tighten loose fittings and supports.
- Inspect brake hose for leaks, kinks, cracks, bulging, or wear. Tighten or replace hoses as necessary.
- Remove and replace double flare and ISO brake lines, hoses, fittings, and supports.
- Fabricate replacement brake tubing, including the forming of double inverted flare or ISO flare ends and correct bends to fit the vehicle chassis.
- Diagnose poor stopping and brake pull or grab conditions caused by problems in the brake lines or brake hoses and perform needed repairs.
- Diagnose poor stopping and brake pull or grab conditions caused by problems in the hydraulic system valves and perform needed repairs.
- Inspect, test, and replace metering valves, proportioning valves, pressure differential valves, and combination valves.
- Inspect, test, adjust, and replace a height-sensing proportioning valve.
- Diagnose electrical problems in circuits for brake system switches and sensors.
- Test, adjust, repair, or replace the brake stoplamp switch and wiring.
- Inspect, test, and replace the brake warning lamp, switch, and wiring.
- Test and repair the parking brake indicator lamps, switches, and wiring.
- Inspect, test, and replace the master cylinder fluid level sensor or switch.
- Repair electrical wiring and connectors.

INTRODUCTION

All hydraulic systems need lines and hoses to contain the fluid. All hydraulic systems require valves to control and direct the fluid if work is to be done in an efficient manner. Take the dam across a river, for instance. The dam is, in fact, a valve that controls water flow, reducing flooding below the dam and directing flow through causeways to drive electric turbines. Releasing the water completely at one time would only destroy the electric plant and the surrounding areas. The hydraulic brake system shares some of the same concerns with regard to fluid containment and direction. Without the proper lines and hoses, the brake fluid would just “flood” and there would be no braking effect. If control valves were present, there would be uneven or no braking effect at all, which brings up the problems associated with the old mechanical brake system. Over the last 100 years, hydraulic brake systems have been improved to be almost fail-safe. But those lines, hoses,

and valves require some services during the life of the vehicle, even if the only reason is old age. This chapter outlines some of those common services. Some valves have been computerized, and, where appropriate, those valves are discussed in Chapter 10, Electronic Braking Systems.

RECENTERING A PRESSURE DIFFERENTIAL VALVE (FAILURE WARNING LAMP SWITCH)

Almost every technician refers to the pressure differential valve as a combination valve.

After bleeding or flushing and refilling some brake systems, the pressure differential valve (or warning lamp switch) may be actuated and the warning lamp may be lit. Opening a bleeder screw creates a pressure differential between the two halves of the hydraulic system. This pressure differential has the same effect as a leak, and the valve piston moves toward the low-pressure side to close the lamp circuit.

If the warning lamp stays lit after bleeding, the valve piston may need to be recentred. First, however, verify that the parking brake is not applied and that its linkage is properly adjusted. Also check the fluid level in the master cylinder reservoir. Both the parking brake warning circuit and the low-fluid warning circuit usually use the same warning lamp as the pressure differential valve. It is not uncommon to find the parking brake out of adjustment after relining the rear brakes or to find the fluid level low after bleeding the system.

Three different types of pressure differential valves have been used in domestic and imported vehicle brake systems. On older vehicles, the valve may be a separate part in the system. On newer vehicles, the valve is often part of the combination valve (Figure 5-1),

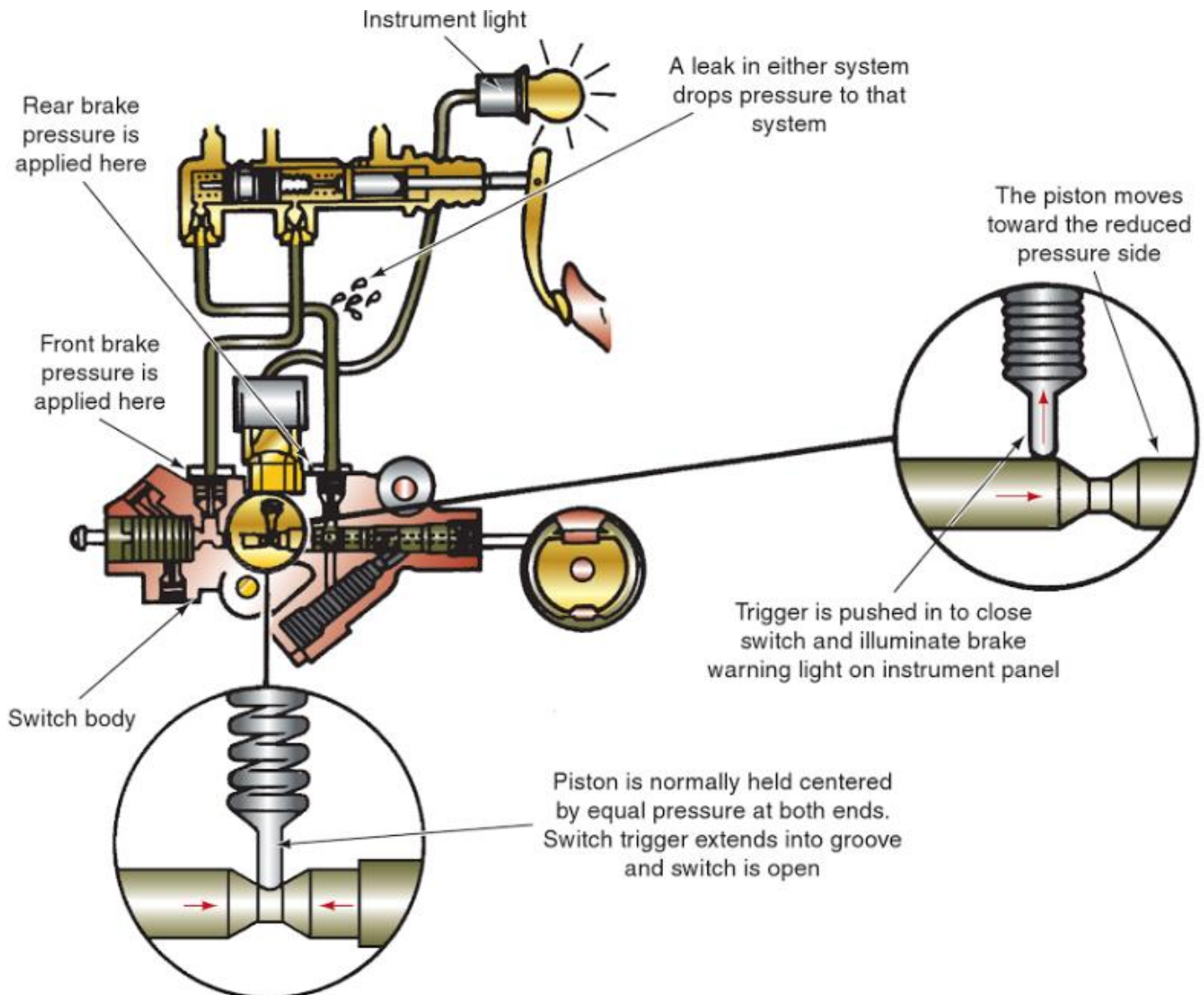


FIGURE 5-1 Many late-model pressure differential valves (warning lamp switches) are part of a combination valve.

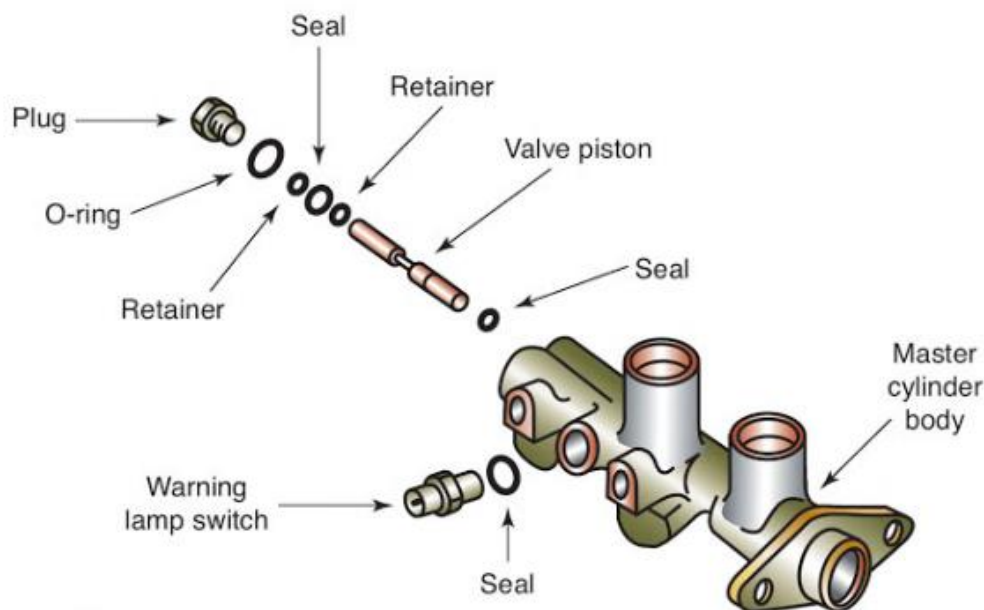


FIGURE 5-2 The pressure differential valve and the warning lamp switch are built into this master cylinder body.

or it may be built into the master cylinder (Figure 5-2). Whether a separate component or combined with other valve functions, a pressure differential valve of a given design operates in the same way. The following paragraphs explain how to recenter that valve piston when required.

Single-Piston Valve with Centering Springs

The most common pressure differential valve has a single piston and centering springs (Figure 5-3). The warning lamp lights only when the brakes are applied and a pressure difference exists between the two halves of the hydraulic system. When the brakes are released,

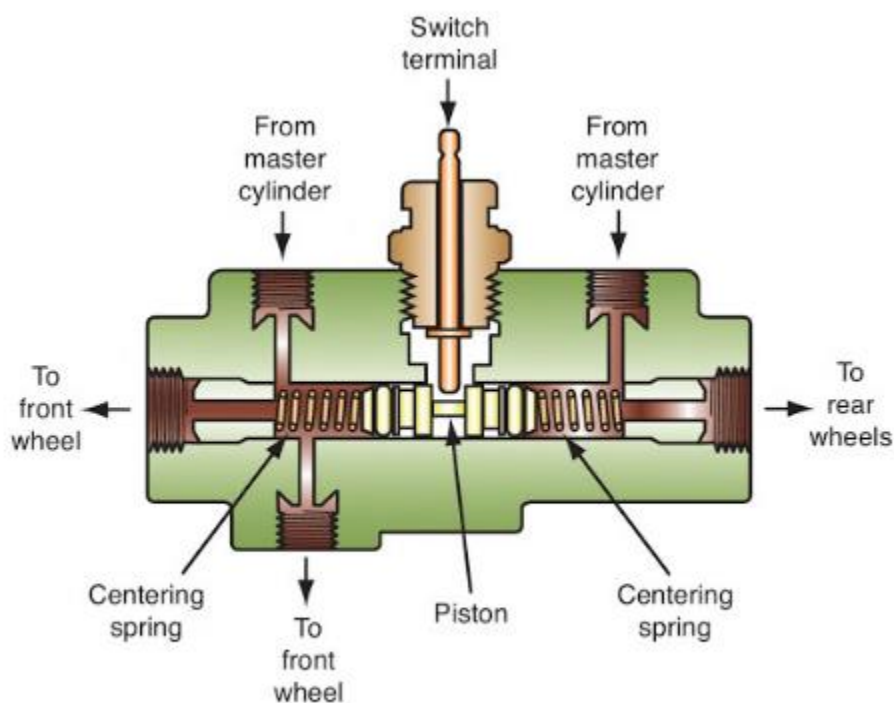


FIGURE 5-3 Pressure differential valve (warning lamp switch) with single piston and centering springs.

pressure is low in both halves of the system. The springs then recenter the valve piston, and the lamp should turn off.

The piston in this type of valve (or switch) should recenter automatically with no special action required. Occasionally, however, the piston may stick at one side of its bore or the other and leave the lamp lit. If the lamp is lit with the ignition on, apply the brakes rapidly with moderate to heavy force two or three times. Hydraulic pressure usually frees a stuck piston, and the springs will recenter it.

If the lamp stays lit and the parking brake or fluid level switch is not closed (lamp lit), try to recenter the piston, following the instructions in the next paragraph. If the lamp is still lit, test the circuit for an accidental ground. If the circuit is not otherwise grounded, replace the pressure differential valve.

Single-Piston Valve Without Centering Springs

Some other vehicles, particularly older Ford products and some imports, have a single-piston pressure differential valve without centering springs (Figure 5-4). This type of valve often leaves the warning lamp lit after system bleeding. Recentering the piston is a two-person job.

After ensuring that the parking brake is off and the fluid level is correct, turn on the ignition and verify that the lamp is lit. Open a bleeder screw on the side opposite from the side last bled. Have a coworker slowly press the brake pedal by hand until the warning lamp turns off. Tighten the bleeder screw.

When trying to recenter the piston in this type of valve, the piston often goes over center in the opposite direction. This causes the lamp to turn off momentarily and then relight. If this happens, open a bleeder screw on the opposite side of the hydraulic system and repeat the procedure. Two or three tries may be needed to get the piston properly centered. A solution to this problem is the use of a two-piston valve (Figure 5-5).



SPECIAL TOOLS

Cloths
Tubing with
transparent container

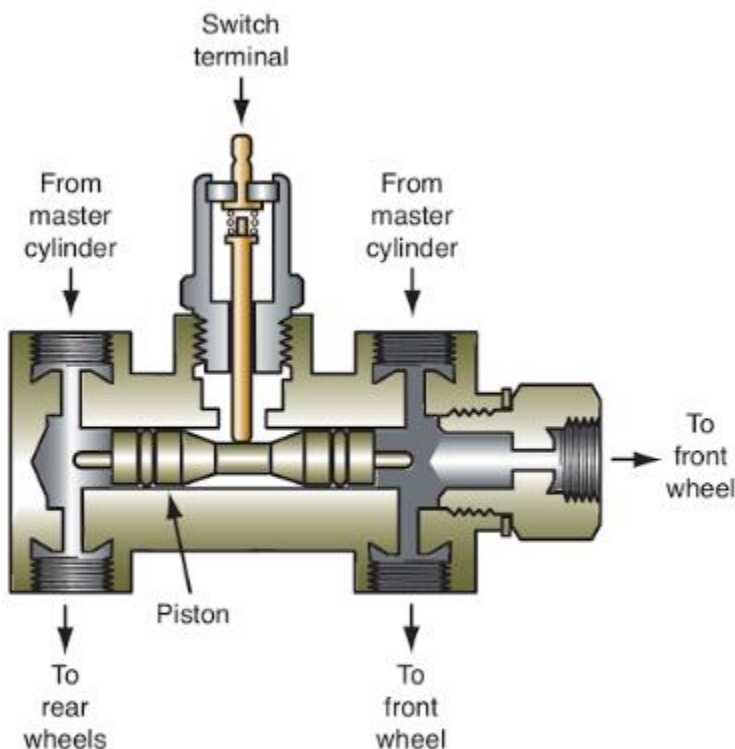


FIGURE 5-4 Pressure differential valve (warning lamp switch) with single piston and no centering springs.

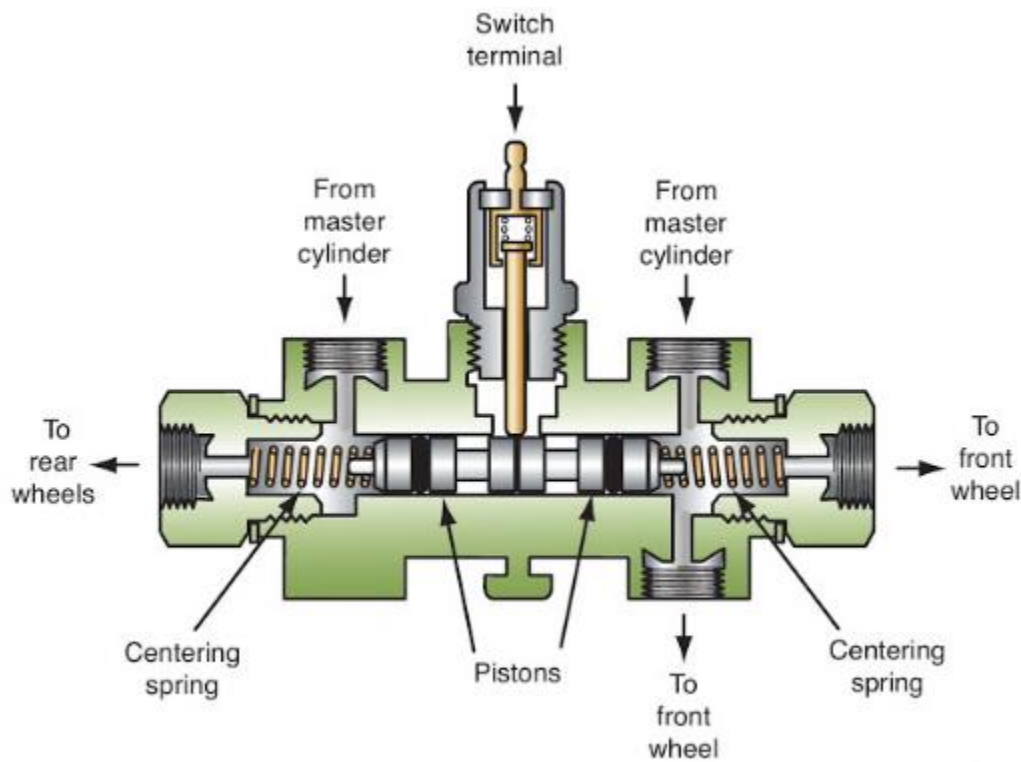


FIGURE 5-5 Pressure differential valve (warning lamp switch) with two pistons.

SERVICE TIP:

As mentioned in Chapter 5 of the *Classroom Manual*, there is a copper-nickel alloy brake tubing that meets SAE Standard J1047 and ISO 4038. It can be serviced in the same manner as the more common steel tubing.



SPECIAL TOOLS

Cloths
Brake pedal depressor



SERVICE TIP:

Very small leaks at brake line fittings that appear only under pressure can be hard to find. Often, pressure must be applied for a long time before seepage appears. Lift the vehicle and clean each valve and line connection. This will make it easier to spot a leak. To help pinpoint such a problem, apply the brakes with a brake

BRAKE LINE, FITTING, AND HOSE SERVICE

Hydraulic system lines are made of steel tubing and rubber hoses. Rigid hydraulic lines are made of double-wall, welded steel tubing that is coated to resist corrosion. Brake hoses must be free to flex and move as the wheel moves up and down or turns. Brake hoses also must be able to withstand the high pressures within the system. Exposure to the elements, road salts in winter, salt air, water, and contaminants in the system, all contribute to rusting and corrosion of brake fittings, lines, and hardware.

Brake Line Inspection

All carmakers include brake line inspection on their vehicle maintenance schedules. Most manufacturers recommend inspecting brake hoses twice a year, but it is good practice to check them whenever the vehicle is getting lubrication service. Steel brake lines and fittings should be checked for damage and leakage once a year or whenever the vehicle gets brake service.

Brake line inspection is more than a quick glance to see if all the parts are in place. Physical damage may be apparent from the outside, but wear and deterioration also can occur inside tubing and hoses. To inspect brake lines thoroughly, be sure to cover the points described in the following paragraphs.

Tubing Inspection. Steel tubing is more durable than rubber hoses, but it can suffer rust, corrosion, impact damage, and cracking. Water trapped around brake tubes, fittings, and mounting clips can rust and corrode steel tubing. Corrosion can be particularly severe in areas that use a lot of salt to melt ice on the roads during the winter. Mounting clips are necessary to hold brake lines to the body or frame, but they can trap salt water and hide severe corrosion. Therefore, inspect all mounting points closely.

Missing mounting clips can cause other problems. If brake tubing is not mounted securely, vibration can cause the tubing to fracture and leak. Brake tubing that hangs below the body or frame can be snagged and torn loose. Inspect all brake tubing for damage and looseness (Figure 5-6). Also look for empty screw holes or scuff marks on body and frame parts that indicate missing clips.



SERVICE TIP:

(Continued)
 pressure reading stays on the gauge after the pedal is released, loosen the fitting that connects the brake pipe to the hose. If the brake does not loosen and the gauge pressure does not drop to zero, the hose is retaining the pressure. Replace it.

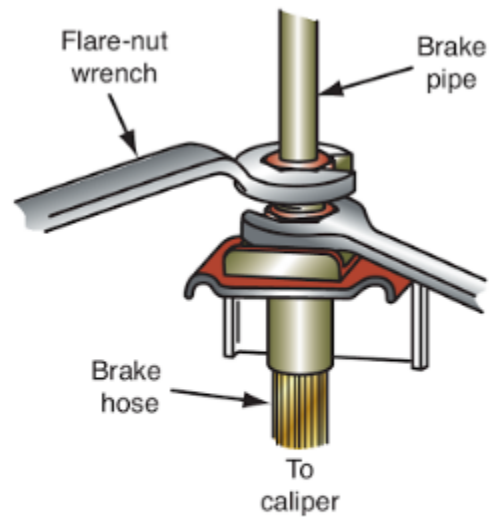


FIGURE 5-10 Use a flare-nut (line) wrench to disconnect the brake line (tubing) from the hose.



CAUTION:

Always clean around any lines or covers before removing or loosening them. Dirt and other contaminants will void the warranty and may damage system components.



SPECIAL TOOLS

Hand tools
 Cloths

end of the hose. Occasionally, some caliper fittings and hoses have left-hand threads. Sometimes the left-hand fasteners are noted with a slash through the flat surfaces of the nut or bolt.

Follow these guidelines to remove a brake hose:

1. Clean dirt away from the fittings at each end of the hose to keep it from entering the system.
2. Use a flare-nut wrench to disconnect the flare nut from the female end of the hose (Figure 5-10) or loosen and disconnect the swivel end of the hose. When loosening one fitting at the end of a hose, hold the mating half of the fitting with another flare-nut wrench, which will make fitting removal easier and prevent damage to mounting brackets and clips.
3. Remove the hose retaining clip from the mounting bracket with a pair of pliers.
4. Separate the hose from the mounting bracket and any other clips used to hold it in place.
5. Use a flare-nut wrench to disconnect the other end of the hose from the caliper or wheel cylinder.
6. If a replacement hose is not going to be installed immediately, cap or plug open fittings on the vehicle to keep dirt out of the system.

Hose Installation. When installing a brake hose, be sure the new hose is the correct length and determine whether or not the right-hand and left-hand hoses are the same or different. Route the new hose in the same location as the original and provide $\frac{3}{4}$ inch to 1 inch of clearance between the hose and suspension and wheel parts in all positions. If the original hose had special mounting clips or brackets, the replacement should have the same.



WARNING: Ensure that the fitting is not cross-threaded when reconnecting. This could damage the fitting or the component, or both.

Follow these guidelines to install a brake hose:

1. If the hose has a fixed male end, install it into the wheel cylinder or caliper first. If the connection requires a copper gasket, install a new one.
2. If one end of the hose has a banjo fitting for attachment to a caliper, install the banjo bolt and a new copper gasket on each side of the fitting shown earlier in Figure 5-9. Leave the

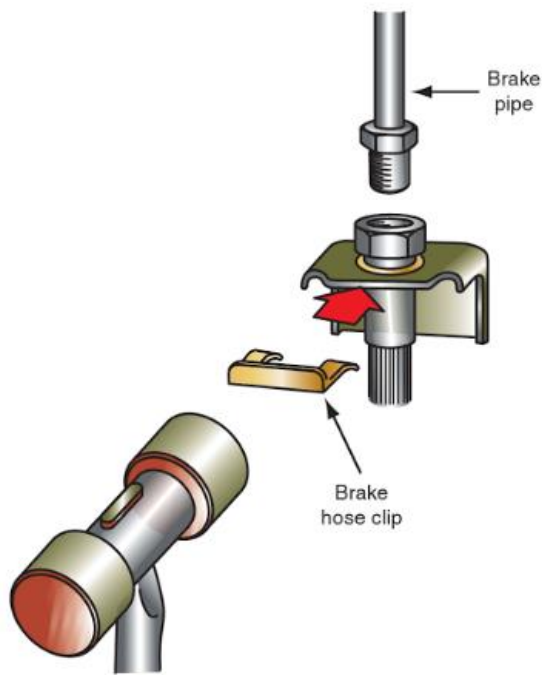


FIGURE 5-11 The locking clip is tapped into place with a small hammer.



CAUTION:

Always replace brake hoses in axle sets. This will eliminate brake mal-function(s) caused by bad hoses and help in diagnosing ongoing brake problems.



SERVICE TIP:

Some brake hoses are not DOT approved. Check with your supervisor or parts vendor as to the hose warranty or desirability of using nonapproved hose.

banjo bolt loose at this time; tighten it after connecting and securing the other end of the hose.

3. Route the hose through any support devices and install any required locating clips.
4. Insert the free end of the hose through the mounting bracket.
5. Depending on hose design, connect the flare nut on the steel brake line to the female end of the hose or connect the swivel end of the hose to the mating fitting.
6. Use a flare-nut wrench to tighten the fitting and hold the hose with another flare-nut wrench to keep it from twisting (see Figure 5-10). Check the colored stripe or the raised rib on the outside of the hose to verify that the hose has not twisted during installation.
7. Install the retaining clip to hold the hose to its mounting bracket (Figure 5-11). Install any other clips as required.
8. If the banjo bolt was left loose in step 2, position the banjo fitting to provide the best hose position and tighten the bolt.

After installing the new brake hose, check the hose and line connections for leaks and tighten if needed. Check for clearance during suspension rebound and while turning the wheels. If any contact occurs, reposition the hose, adjusting only the female end or the swivel end.

Brake Tubing Removal and Replacement

Removing and replacing a length of brake tubing looks like a straightforward job, but the following guidelines will make the task easier. Start by cleaning dirt away from the fittings at each end of the tubing. Do not remove the tubing mounting clamps yet. Leaving them in place will keep the tubing from moving around and make it easier to disconnect the fittings.

Use a flare-nut wrench to disconnect the fittings at each end of the tubing. If the tubing is attached to a hose, use another flare-nut wrench to hold the hose fitting. If the tubing is



CAUTION:

Never use low-pressure hydraulic hoses or oil hoses as replacements for brake hoses. These components cannot withstand the high pressure of the brake system. Fluid leakage, line rupture, and system failure can result.



CAUTION:

Always clean around any lines or covers before removing or loosening them. Dirt and other contaminants will void the warranty and may damage system components.

**SERVICE TIP:**

Install the fittings onto the tubing before flaring the ends. Many feet of tubing have been wasted over the years because the fitting will not fit over a finished flare.

attached to a rigidly mounted junction block or cylinder, a second wrench is not needed. If replacement tubing is not going to be installed immediately, cap or plug open fittings on the vehicle to keep dirt out of the system.

Remove the mounting clips from the chassis and remove the brake tubing. Inspect the clips and their screws to determine if they are reusable. If they are not, install new ones. If the brake tubing has any protective shields installed around it, save them also for installation with the new tubing. If you must fabricate a new section of tubing, save the old section for a bending guide.

To install a length of brake tubing, position it on the chassis and install the mounting clips loosely. Leaving the new tubing slightly loose will help to align the tube fittings. Next, use the appropriate flare-nut wrenches to connect the fittings at both ends of the tubing. Tighten the fittings securely and then tighten the mounting clips.