

## INTRODUCTION

Brakes are an energy-absorbing mechanism that converts vehicle movement into heat while stopping the rotation of the wheels. All braking systems are designed to reduce the speed and stop a moving vehicle and to keep it from moving if the vehicle is stationary. Service brakes are the main driver-operated brakes of the vehicle. Service brakes are also called base brakes or foundation brakes. Figure 1.

Drum brakes are used on the rear of many rear-wheel-drive, front-wheel-drive, and four-wheel-drive vehicles. When drum brakes are applied, brake shoes are moved outward against a rotating brake drum.

Disc brakes are used on the front of most vehicles built since the early 1970s, and on the rear wheels of many vehicles. A disc brake operates by squeezing brake pads on both sides of a rotor or disc that is attached to the wheel.

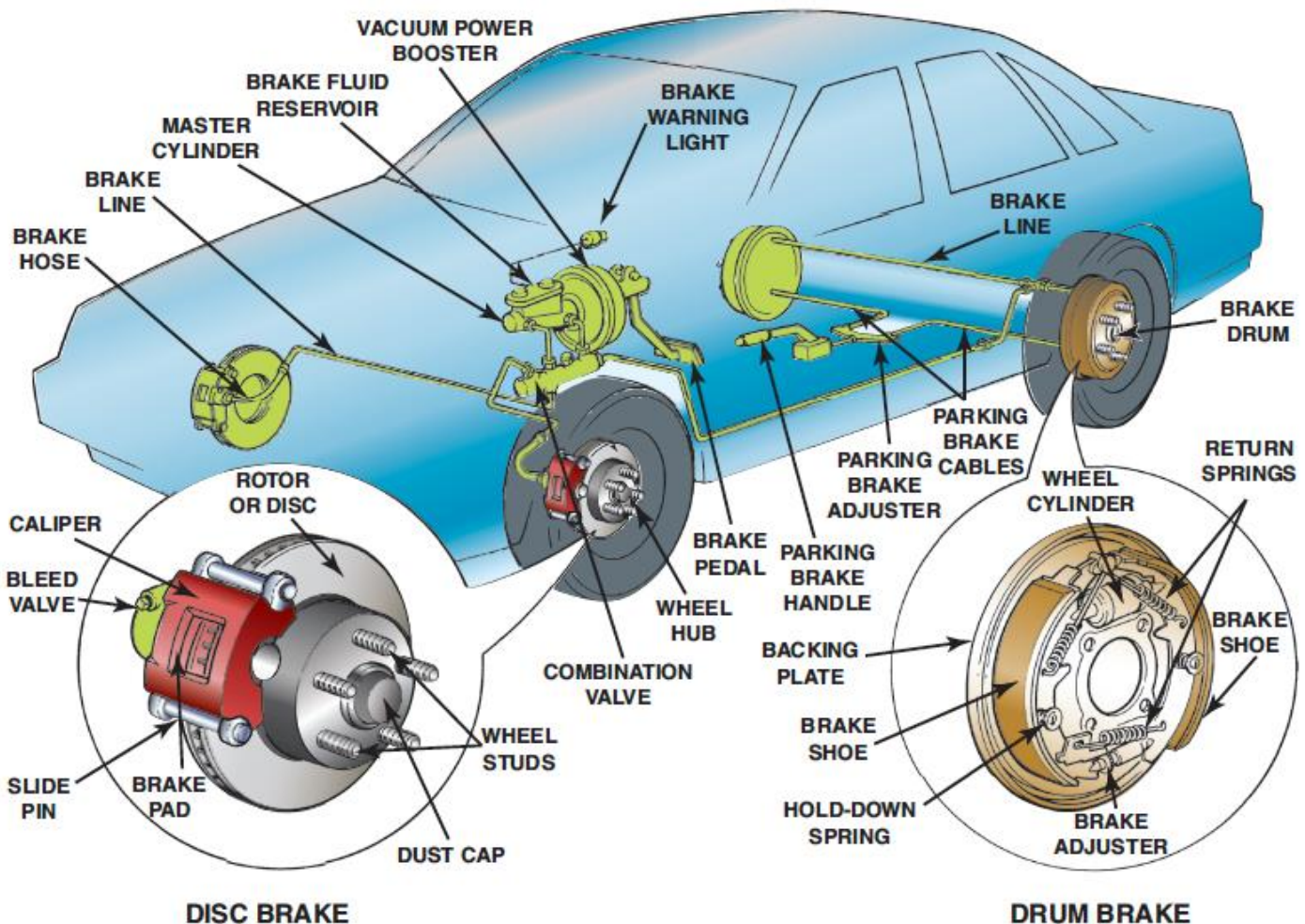


Figure 1. Vehicle brake system.

Brake system components can be classified and placed into six subsystem categories, depending on their function. Figure 2.

1. *Apply system.* The driver starts the operation of the braking system by pressing on the brake pedal or applying the parking brake. The apply system includes all the levers, pedals, or linkage needed to activate a braking force.

2. *Boost system.* The boost (power brake) system is used on most vehicles to reduce the force that the driver must exert on the brake pedal.

3. *Hydraulic system.* The brake pedal force is transferred to the hydraulic system, where the force is directed through pipes and hoses to the wheel brakes.

4. *Wheel brakes.* Hydraulic pressure from the hydraulic system moves a piston, in either a disc or drum brake system, which uses friction to press material against a rotating drum or rotor. The resulting friction slows the rotation of the wheels.

5. *Brake balance control system.* Mechanical, electrical, and hydraulic components are used to ensure that brakes are applied quickly and with balanced pressure for safe operation. Components in this category include proportioning valves, and antilock brake system components.

6. *Brake warning lights.* There are two brake system–related warning lights, figure 3:

- The red brake warning lamp (RBWL) lights whenever a hydraulic system failure occurs or low brake fluid level has been detected.
- The amber ABS warning lamp or dim red brake light indicates an ABS self-test and/or a possible problem in the ABS.

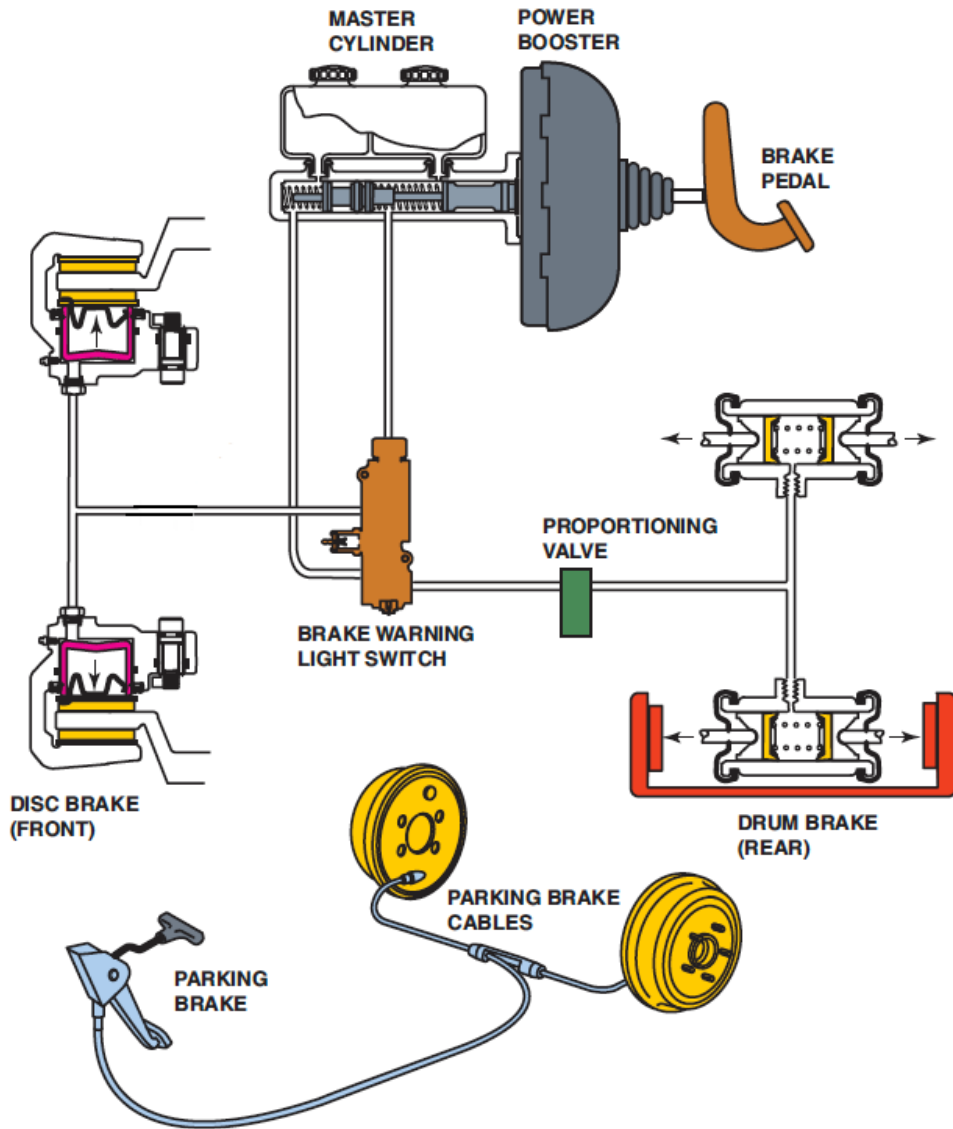


Figure 2. Brake system categories.

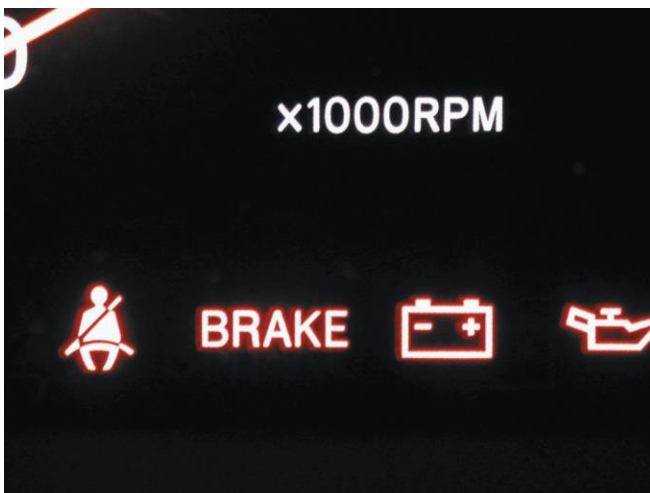


Figure 3. Brake system warning lights.

The purpose of an antilock brake system (ABS) is to prevent the wheels from locking during braking, especially on low-friction surfaces, such as wet, icy, or snowy roads. ABS uses sensors at the wheels to measure the wheel speed. If a wheel is rotating slower than the others, indicating possible lockup (e.g., on an icy spot), the ABS computer controls the brake fluid pressure to that wheel for a fraction of a second. Figure 4.

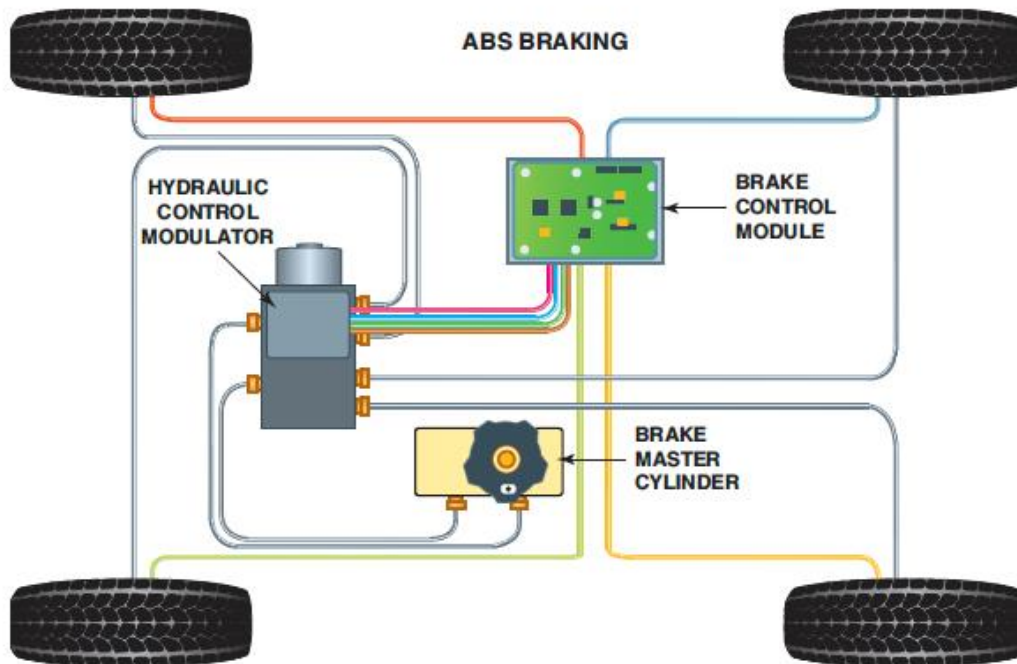


Figure 4. Typical components of an antilock brake system (ABS) used on a rear-wheel-drive vehicle.

## ASE TEST TOPICS

### ► Master Cylinder

**1. Diagnose poor stopping, dragging, high or low pedal, and hard or spongy pedal caused by the master cylinder; determine needed repairs.**

The master cylinder is a major component of the braking system. No braking occurs until the driver depresses the brake pedal. Brake pedal movement and force are transferred to the brake fluid and directed to wheel cylinders or calipers. Figure 5.

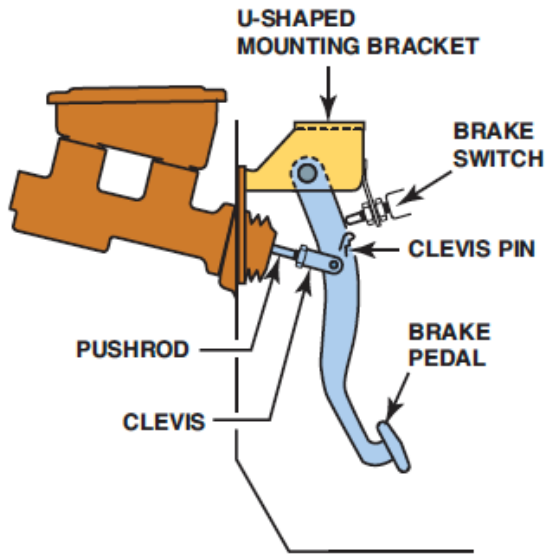


Figure 5. Brake pedal and master cylinder.

The master cylinder is separated into two pressure-building chambers (or circuits) to provide braking force to one-half of the brake system in the event of a leak or damage to one circuit. Figure 6.

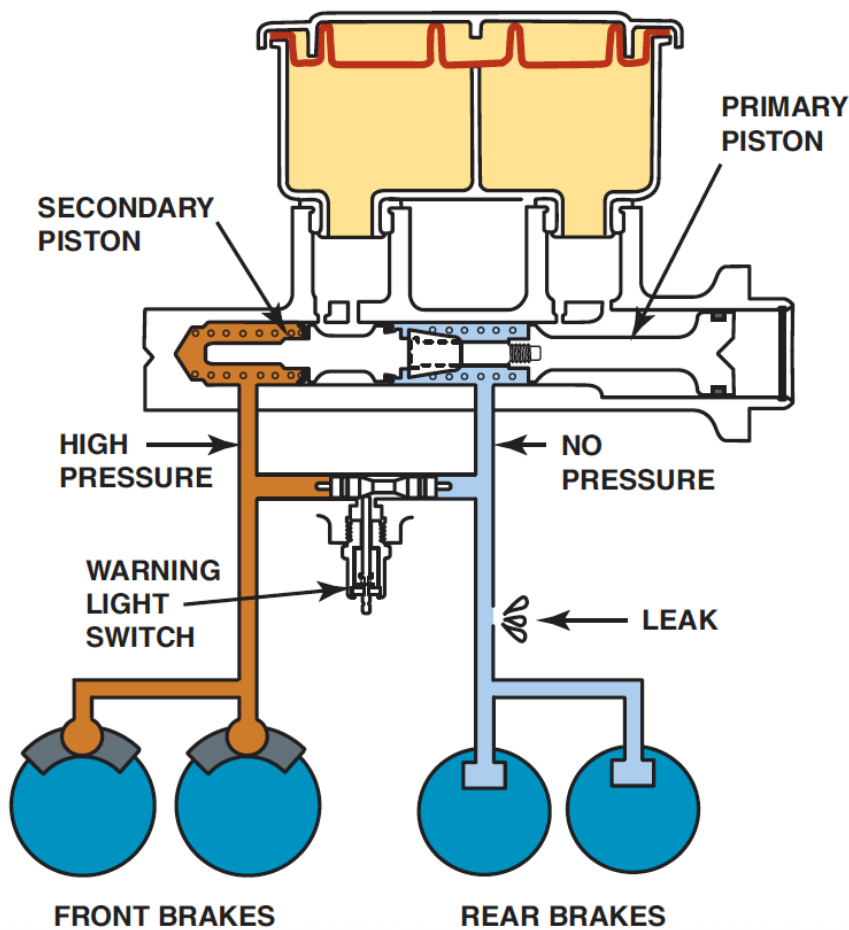


Figure 6. Master cylinder and brakes, operation with a leak in the rear brake circuit.

Some common master cylinder fault symptoms include:

- **Spongy brake pedal.** A spongy pedal with a larger-than-normal travel indicates air in the lines. Check for leaks and bleed the air from the system.
- **Lower-than-normal brake pedal.** A brake pedal that travels downward more than normal and then gets firm is an indication that one circuit of the dual-circuit hydraulic system is probably not working. Check for leaks in the system and repair as necessary.
- **Sinking brake pedal.** If the brake pedal sinks all the way to the floor especially when the vehicle is not moving, suspect a defective master cylinder that is leaking internally. This internal leakage is often called bypassing because the brake fluid is leaking past the sealing cups, allowing pressure from one chamber to leak into the other chamber.

## 2. Measure and adjust master cylinder pushrod length.

Whenever the vacuum brake booster or the master cylinder is replaced, the pushrod length should be checked. The length of the pushrod must match correctly with the master cylinder. Figure 7.

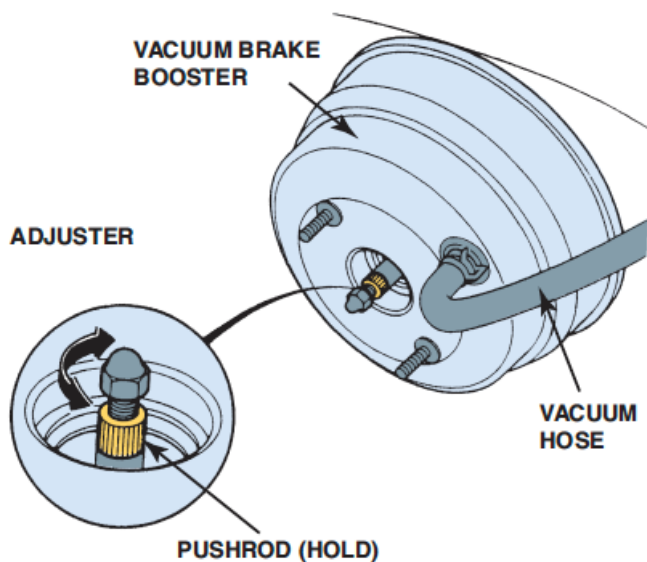


Figure 7. To adjust, hold the pushrod body and turn the friction-fit bolt.

A gauge is often used to measure the position of the master cylinder piston, and then the other end of the gauge is used to determine the proper pushrod clearance. Figure 8.

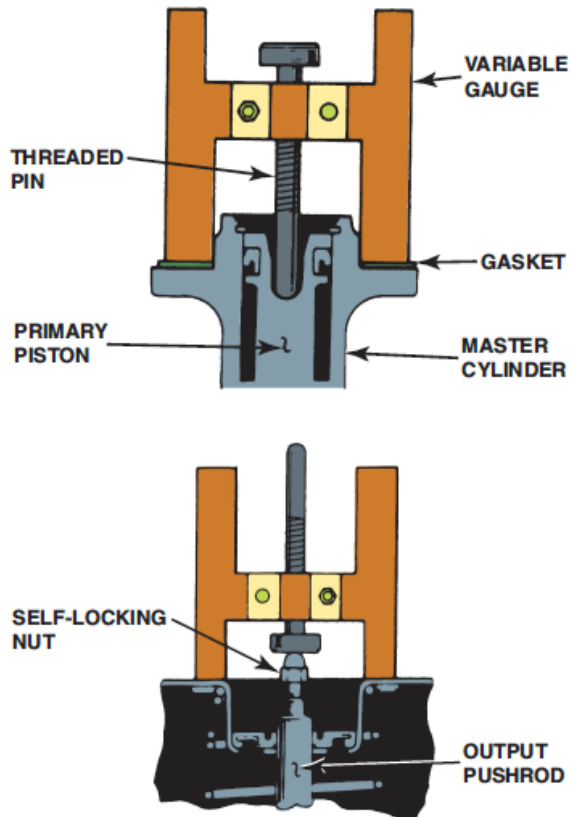


Figure 8. Booster pushrod gauge tool.

Some vacuum brake boosters do not use adjustable pushrods. If found to be the incorrect length, a replacement pushrod of the correct length should be installed.

### 3. Check master cylinder for failures by pressing brake pedal; determine needed repairs.

To test if the hydraulic system is leaking, depress and release the brake pedal several times. This should deplete any residual power assist from the vacuum booster. After depleting the power-assist unit, depress and then hold the brake pedal depressed with medium force (20 to 35 lb or 88 to 154 N). The brake pedal should not fall away.

If the pedal falls, the brake hydraulic system is leaking. If there is no external leak, there is an internal leak inside the master cylinder. Replace the master cylinder.

### 4. Diagnose the cause of master cylinder external fluid leakage.

A visual inspection of the master cylinder should include:

- Check the brake fluid for proper level and condition. Brake fluid should not be rusty, thick, or contaminated.
- Check for any external leaks at the lines or at the pushrod area. Figure 9.

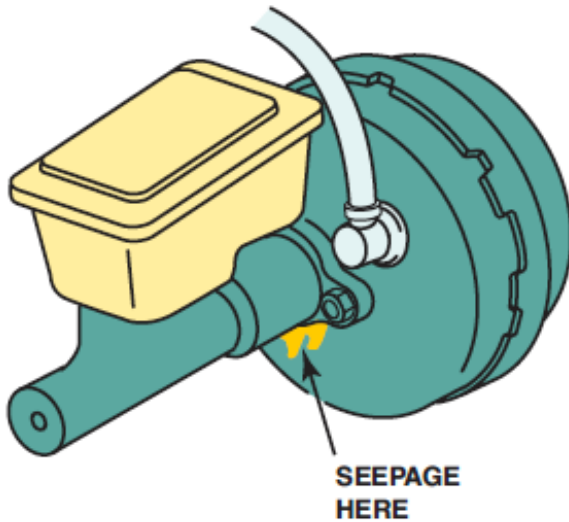


Figure 9. Fluid in this area indicates a leaking primary piston seal.

**5. Remove and replace master cylinder; bench bleed and install master cylinder; verify master cylinder function.**

To remove the master cylinder:

- Empty the reservoir, if possible
- Disconnect the brake lines using a flare nut wrench. Figure 10.
- Remove the nuts securing the master cylinder to the booster.
- Remove the master cylinder.



Figure 10. Whenever disconnecting or tightening a brake line, always use the correct size flare-nut wrench.

Bench bleeding means to bleed air from the master cylinder before installing it on the vehicle. The master cylinder is clamped into a bench vise while using a rounded end of a dowel rod to push on the pushrod end with bleeder tubes down into the brake fluid. Stroke the pistons until no air comes out of the bleeder tubes. Figure 11.

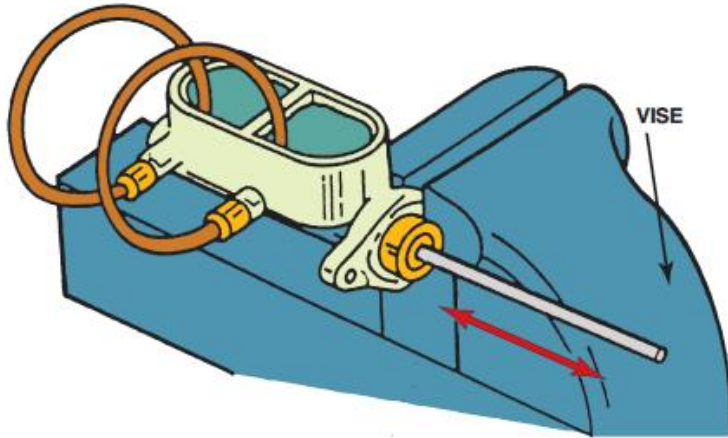


Figure 11. Bench bleeding the master cylinder before installation.

After the master cylinder has been bench bled, it can be installed in the vehicle.

- Install the master cylinder onto the booster but do not tighten the fasteners.
- Thread the brake lines into the master cylinder ports. Having the cylinder loose at this point makes this easier.
- Tighten the fasteners at the booster to factory specifications.
- Tighten the brake lines using the line wrench.
- Bleed the system as needed.

### ► Lines and Hoses

#### **6. Diagnose poor stopping, pulling or dragging caused by problems in the lines and hoses; determine needed repairs.**

High-pressure double-walled steel brake lines or high-strength flexible lines are used to connect the master cylinder to each wheel.

For maximum strength and durability, all brake systems use double-walled brake tubing made from plated steel sheet. Figure 12.

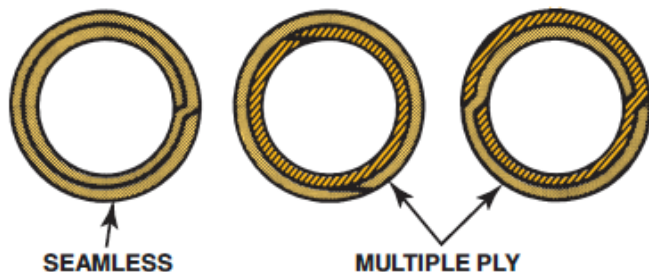


Figure 12. Steel brake line cross sectional view.

Flexible brake hoses are used on each front wheel to allow for steering and suspension movement and at the rear to allow for rear suspension travel. Figure 13.



Figure 13. A brake hose is made from several layers of braided and molded material.

A constricted brake hose can cause an individual brake to remain applied, thereby causing excessive brake pad wear and unequal braking. A constricted flexible brake line can also cause the vehicle to pull to one side. Figure 14.

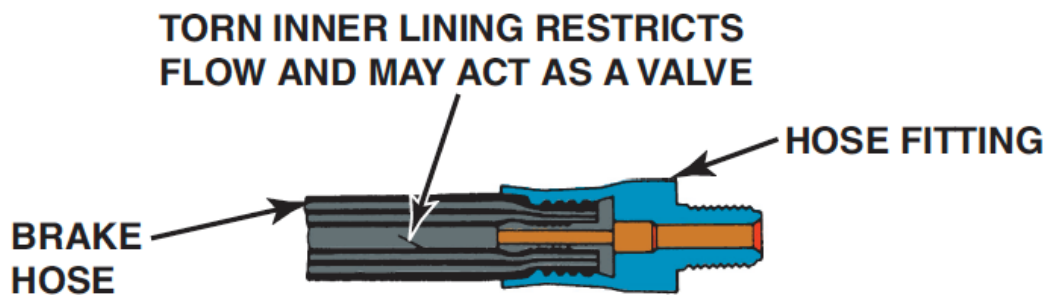


Figure 14. A torn inner liner can cause the caliper to remain partially applied, causing a pull or excessive pad wear.

**7. Inspect brake lines and fittings for leaks, dents, kinks, rust, cracks or wear; inspect for loose fittings and supports; determine needed repairs.**

All double-walled brake tubing is plated with tin, zinc, or other similar substances for protection against rust and corrosion. While these coatings have been effective, the liquid sodium chloride and rock salt used to de-ice winter roads break down and will eventually destroy steel tubing lines. Even armored brake line can leak, and a visual inspection is an important part of any brake service. Figure 15.



Figure 15. Leaking brake line found during a visual inspection. Fluid level was low in the reservoir.

**8. Inspect flexible brake hoses for leaks, kinks, cracks, bulging, wear or corrosion; inspect for loose fittings and supports; determine needed repairs.**

Flexible brake hose should be carefully inspected for cuts or other damage, especially near sections where the brake hose is attached to the vehicle. Figure 16.



Figure 16. This brake hose should be replaced.

**9. Replace brake lines, hoses, fittings and supports; fabricate brake lines using proper material and flaring procedures (double flare and ISO types).**

If replacing a brake line, there are two options:

OPTION 1 Purchase pre-made lines in the diameter and length needed. Brake line can also be purchased in selected lengths already correctly flared.

OPTION 2 Cut and flare lines to match what is needed. When replacing steel brake lines, new steel tubing should be used, and a double lap flare or an ISO flare needs to be completed at each end using a special flaring tool. Figures 17, 19, and 19.

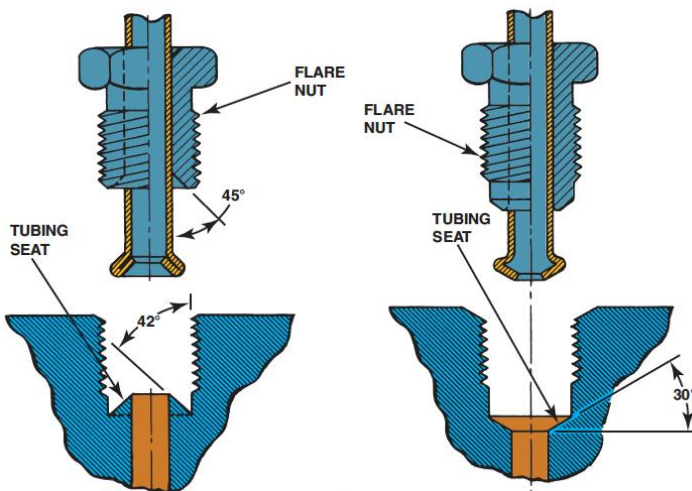


Figure 17. Double flare (left) and ISO flare (right).



Figure 18. Double flare using the flaring tool.

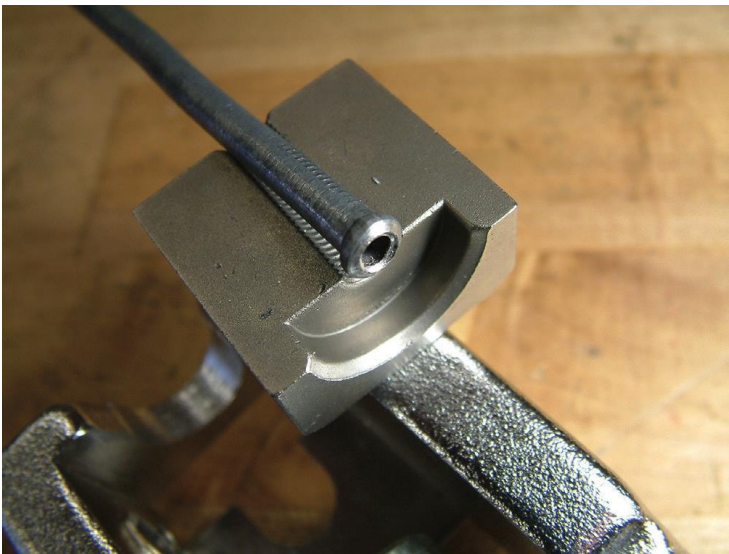


Figure 19. Making an ISO flare requires a special tool and the proper size forming mandrel.

### **10. Inspect brake lines and hoses for proper routing and support.**

The outside covering a brake hose is ribbed or has a stripe as part of the manufacturing process. These ribs make it easy for the technician to see if the hose is twisted. It is not unusual for flexible brake lines to become turned around and twisted when the disc brake caliper is removed and then replaced during a brake pad change. Figure 20.

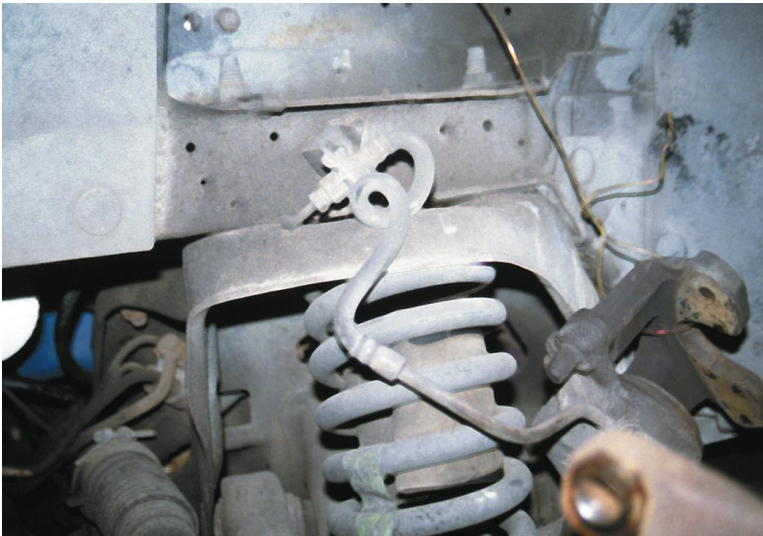


Figure 20. The twisted brake line can cause brake hose failure if not corrected.

► **Valves and Switches**

**11. Diagnose poor stopping, pulling or dragging caused by problems in the hydraulic system valve(s); determine needed repairs.**

Whenever rear brakes tend to lock during braking, the proportioning valve should be checked for proper operation. A defective proportioning valve usually allows rear brake pressure to increase too rapidly, causing the rear wheels to lock up during hard braking.

A defective metering valve (older vehicles) can cause the front brakes to apply before the rear brakes. This is most commonly noticed on slippery surfaces such as on snow or ice or on rain-slick roads.

**12. Inspect, test and replace metering, proportioning, pressure differential and combination valves.**

A metering valve is used on many front-disc, rear-drum-brake-equipped vehicles. The metering valve prevents the full operation of (holds off) the disc brakes until between 75 to 125 PSI is sent to the rear drum brakes. Figure 21.



Figure 21. A metering valve is used on some older vehicles.

A proportioning valve improves brake balance during hard stops by limiting hydraulic pressure to the rear brakes. Unless application pressure to the rear wheels is limited, the brakes will lock, making the vehicle unstable and likely to skid. Figure 22.

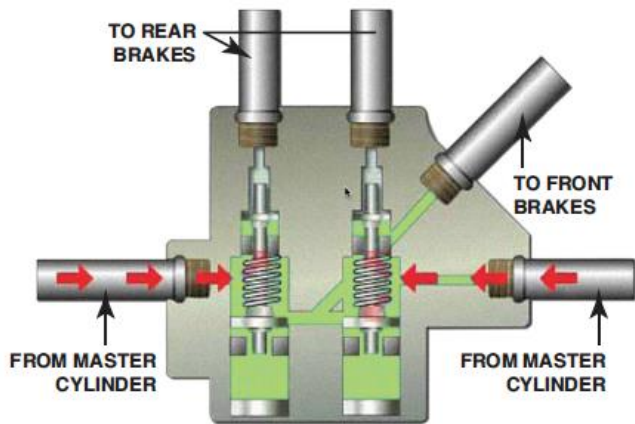


Figure 22. A proportioning valve controls pressure to the rear brakes.

A pressure-differential switch is used on vehicles built after 1967 with dual master cylinders to warn the driver of a loss of pressure in one of the two separate systems by lighting the dashboard red brake warning indicator lamp. This system was used until it was replaced with a brake fluid level sensor, used on newer vehicles. Figure 23.

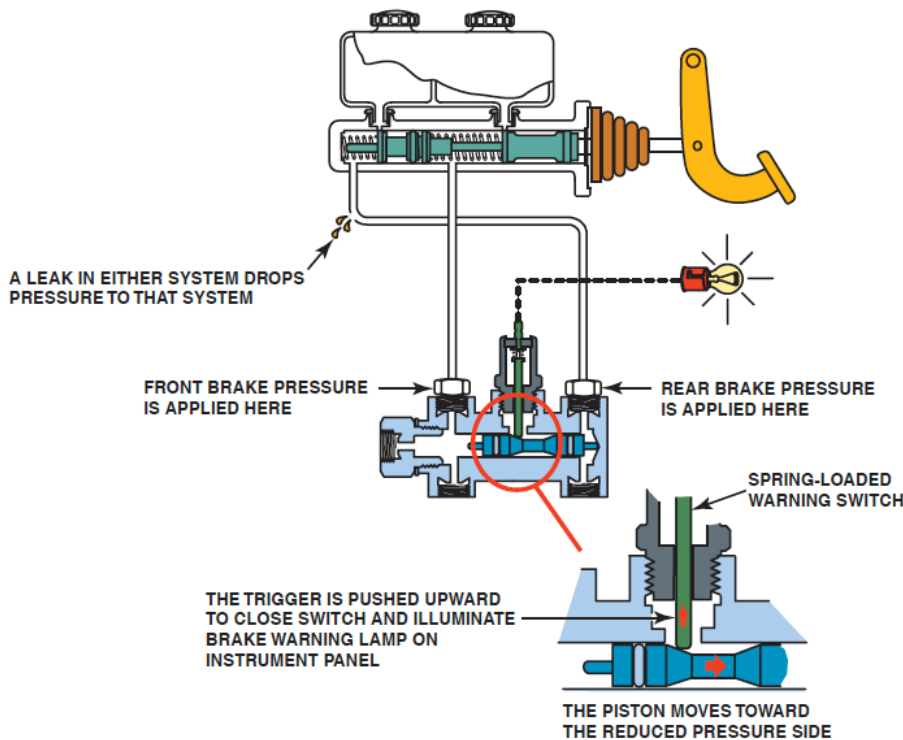


Figure 23. Pressure differential valve warns of a leak in the hydraulic system.

Most vehicle manufacturers combine the function of a proportioning valve with one or more other valves into one unit called a combination valve. Figure 24.

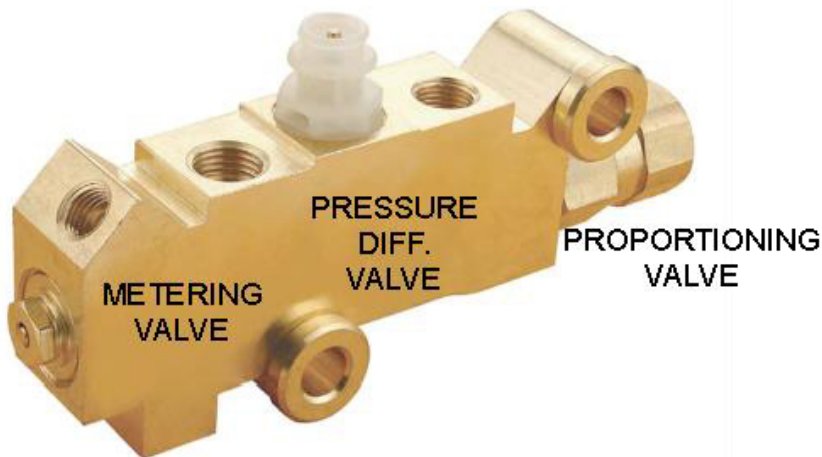


Figure 24. Combination valve.

**13. Inspect, test, replace and adjust load or height sensing-type proportioning valve(s).**

Many vehicles use a proportioning valve that varies the amount of pressure that can be sent to the rear brakes depending on the height of the rear suspension. A height-sensing proportioning valve provides the vehicle with variable brake balance. The valve allows higher pressure to be applied to the rear brakes when the vehicle is heavily loaded and less pressure when the vehicle is lightly loaded. Figure 24.

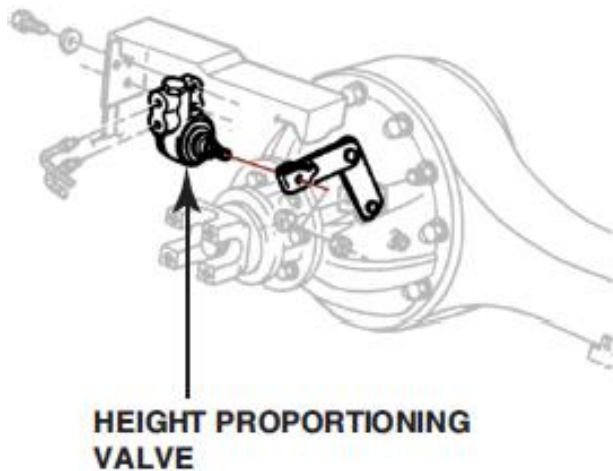


Figure 24. The height sensing valve is mounted to the frame, and an arm connects to the rear axle.

Height sensing proportioning valves should be adjusted when replaced. Procedures vary from one vehicle to another. Always consult the factory service information for the exact procedure. Some trucks require the use of special plastic gauges available from the dealer.

**14. Inspect, test and replace brake system warning lights, indicators, switches, sensors and circuits; test, adjust and repair or replace brake stop light/brake pedal position switch sensor, lamps and related circuits.**



- Electronic stability control (ESC) system input signal

The brake light switch or sensor is most easily checked with the use of a scan tool. Both the powertrain data list and the ABS data list will show the brake switch as an “ON/OFF” status when the pedal is pressed.

### ► Bleeding, Flushing and Leak Testing

#### **15. Diagnose poor stopping, pulling, dragging or incorrect pedal travel caused by problems in the brake fluid; determined needed repairs.**

Brake fluid should be inspected regularly by performing the following tests:

- Color/condition. New brake fluid is clear or amber in color. If the brake fluid is black or discolored like black coffee or coffee with cream, the fluid should be changed.
- Tested using a tester or test strips. Often, brake fluid does not look as if it is bad but has absorbed moisture enough to reduce its effectiveness.
- Boiling point tester. An electronic tester can be used to measure the actual boiling temperature of the brake fluid. Figure 26.

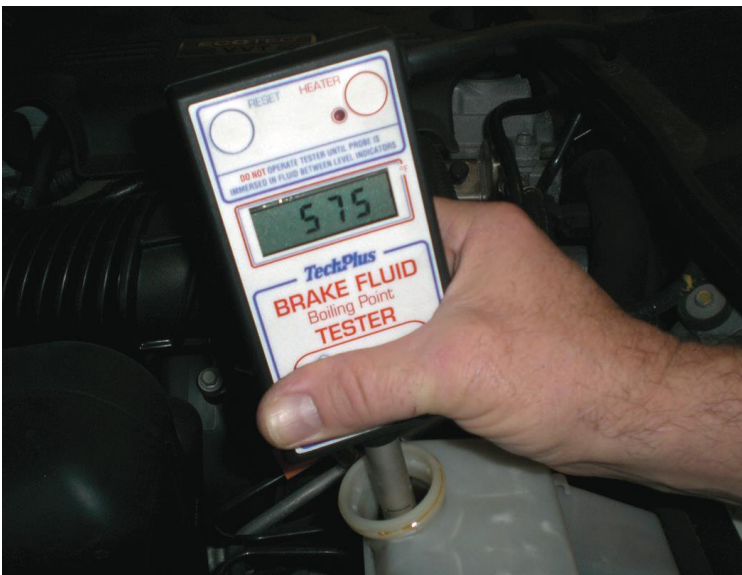


Figure 26. An electronic tester that measures the boiling temperature of the brake fluid is useful to help determine if the brake fluid needs to be replaced.

#### **16. Bleed and/or flush hydraulic system using manual, pressure, vacuum or gravity method(s).**

Brake bleeding is removing any trapped air from the hydraulic system. If air is in the brake hydraulic system, the brake pedal will often feel “spongy.” The brake pedal will also travel farther (lower-than-normal brake pedal) before the brakes start to apply. For most vehicles equipped with start the bleeding with the wheel farthest from the master cylinder and work toward the closest.

*Manual bleeding* is the most commonly used method and uses hydraulic pressure created by the master cylinder to pump fresh fluid through the brake system.

- Loosen the bleeder screw approximately one-half turn, and have an assistant slowly depress the brake pedal.
- Tighten the bleeder screw, then have your assistant slowly release the brake pedal.
- Wait at least 15 seconds to allow time for any small bubbles to form into larger bubbles.
- Repeat until no more air bubbles emerge from the bleeder.

*Vacuum bleeding* uses a special suction pump that attaches to the bleeder screw. The pump creates a low-pressure area at the bleeder screw, which allows atmospheric pressure to force brake fluid through the system when the bleeder screw is opened. Figure 27.

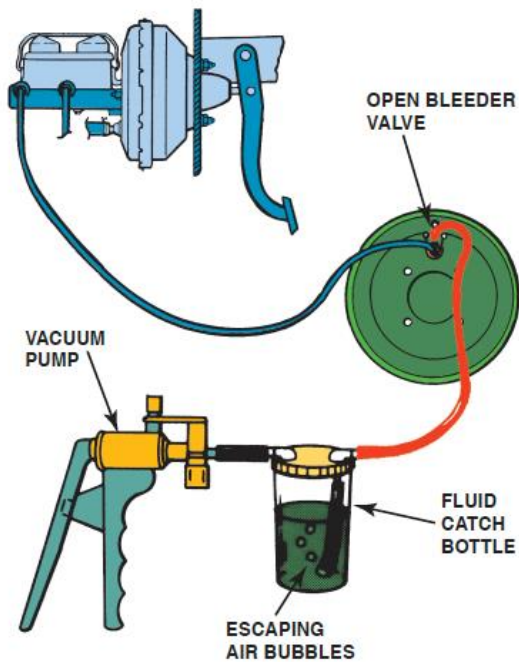


Figure 27. Vacuum bleeding.

*Gravity bleeding* is a slow, but effective, method that will work on many vehicles to rid the hydraulic system of air. The procedure involves simply opening the bleeder valve and waiting until brake fluid flows from the open valve. Figure 28.



Figure 28. Gravity bleeding is simply opening the bleeder valve and allowing gravity to force the brake fluid out of the bleeder valve.

*Pressure bleeding* is a common method used to bleed the brake hydraulic system. In this process, a pressure bleeder attached to the master cylinder forces brake fluid through the system under pressure to purge any trapped air.

The tools required for pressure bleeding include a plastic hose and fluid catch jar as used in manual bleeding, as well as a pressure bleeder, a source of air pressure to charge the bleeder, and an adapter to attach the pressure bleeder to the master cylinder fluid reservoir. Figure 29.

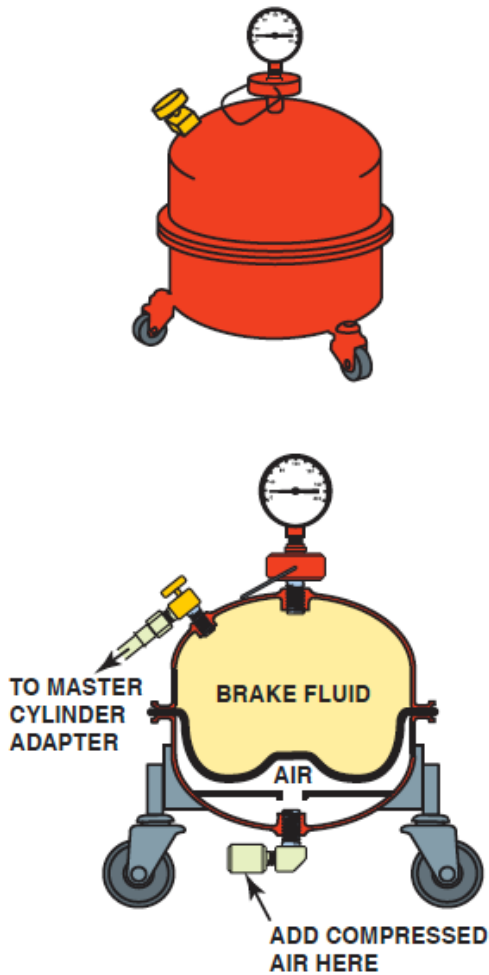


Figure 29. Pressure bleeder tank.

Brake fluid under pressure from the pressure bleeder is applied to the top of the master cylinder. It is very important that the proper adapter be used for the master cylinder. Figure 30.



Figure 30. Master cylinder adapter for pressure bleeding.

Brake fluid flushing is a procedure where the old brake fluid is removed, and new brake fluid is added to the hydraulic system. A turkey baster is used to remove the old brake fluid from the master cylinder reservoir, then fill the master cylinder reservoir with new brake fluid from a sealed container. Figure 31.



Figure 31. Remove the old fluid then fill with new fluid.

Using any of the bleeding methods, bleed at each wheel until the fluid that emerges from the bleeder screw is free of any discoloration and contamination.

### **17. Pressure test brake hydraulic system.**

The brake hydraulic system should be put under pressure and then inspected for leaks.

- With the engine off, have an assistant pump the brake pedal several times to deplete the power booster.
- Hold the pedal down with moderate pressure (25 to 50 lbs.)
- Raise the vehicle on a lift and inspect for leaks at all brake line fittings (calipers, wheel cylinders, brake line-to-hose connections). Figure 32.



Figure 32. Check for leaks at hydraulic system fittings.

To measure the actual pressure in a brake system, a brake pressure gauge and adapter is installed at a bleeder valve location. Apply brake pressure and compare the reading to the manufacturer's specifications. A pressure drop or pressure outside the acceptable range indicates a problem.

**18. Select, handle, store and install proper brake fluids (including silicone fluids). Fill master cylinder to proper level.**

Brake fluid is designed to function in the hydraulic brake system under all operating conditions. Brake fluid is a polyalkylene-glycol-ether mixture called polyglycol for short. All polyglycol brake fluid is clear to amber in color. Brake fluid has to have the following characteristics:

- A high boiling point
- A low freezing point
- No ability to damage rubber parts in the brake system

DOT 3 brake fluid is the type most often used. There are, however, certain important characteristics. DOT 3 absorbs moisture (hygroscopic) and must be used from a sealed (capped) container. If the container is allowed to remain open for any length of time, DOT 3 will absorb moisture from the surrounding air. Always check the brake fluid recommendations on the top of the master cylinders of imported vehicles before adding DOT 3.

DOT 4 brake fluid is the specified brake fluid for use in many European vehicles. Most vehicle manufacturers recommend that DOT 3 and DOT 4 not be mixed. Figure 33.



Figure 33. This vehicle requires DOT 4 brake fluid.

DOT 5.1 brake fluid is a non-silicone-based polyglycol fluid and is clear to amber in color. This severe duty fluid has a boiling point of over 500°F.

DOT 5 brake fluid is commonly called silicone brake fluid and is purple (violet) in color to distinguish it from DOT 3 or DOT 4 brake fluid. This fluid is not normally used and is not compatible with any vehicle with an antilock brake system.

Most vehicles built since the early 1980s are equipped with see-through master cylinder reservoirs, which permit owners and service technicians to check the brake fluid level without having to remove the top of the reservoir. Figure 34.



Figure 34. The reservoir makes it easy to check fluid level.

If the brake fluid is down to the “minimum” mark, before refilling the reservoir some inspections should be made.

- If the master cylinder reservoir is low, there may be a leak that should be repaired.

- As the disc brake pads wear, disc brake piston moves outward. The brake fluid level goes down as the piston moves outward.

Therefore, if the brake fluid is low, the vehicle should be serviced—either for new brakes or to repair a leak.

► **Power Assist Units**

**19. Inspect and test brake pedal linkage for binding, looseness and adjustment; determine needed repairs.**

The pedal linkage and pins should be checked for missing cotter pins or a loose adjusting nut. Verify the return spring is connected and inspect the stop light switch nuts and wiring. Figure 35.

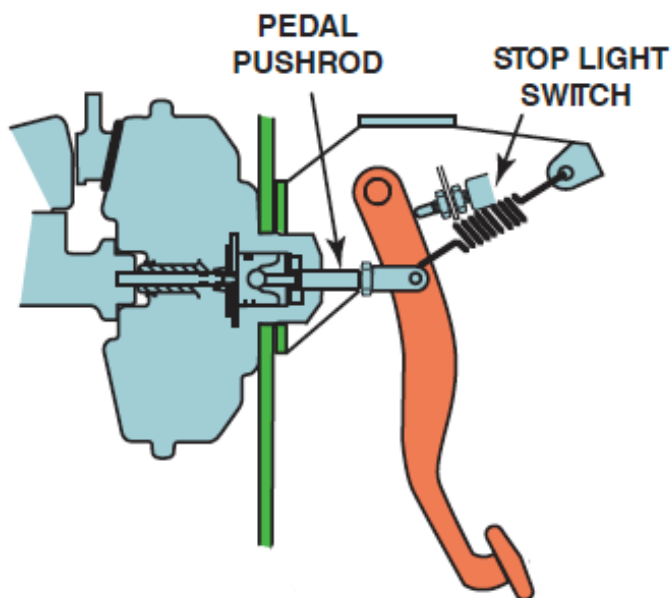


Figure 35. Pedal linkage and booster pushrod.

**20. Test pedal free travel with and without engine running to check power booster operation.**

Vacuum Booster Operation Test

- With the engine “off,” apply the brakes several times to deplete the vacuum.
- The pedal should have a small amount of freeplay. Figure 36.
- With a foot on the brake pedal, start the engine. The brake pedal should drop.
- If the brake pedal does not drop, check for proper vacuum source to the booster.

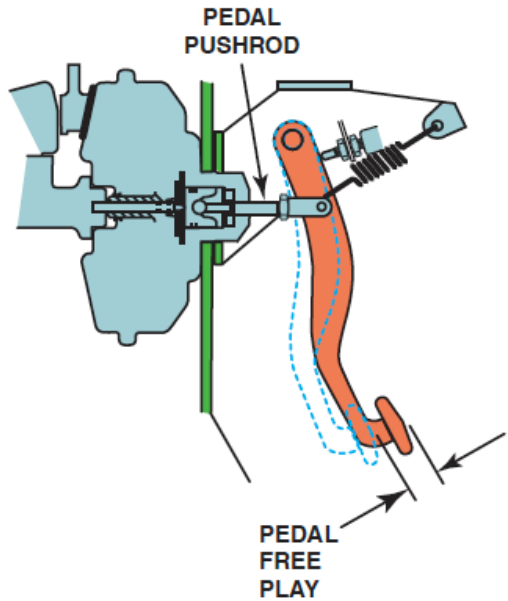


Figure 36. Brake pedal free play is the distance between the brake pedal fully released and the position of the brake pedal when braking resistance is felt.

### 21. Check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster.

Vacuum boosters get their vacuum supply from the engine intake manifold. Diesel engines, however, run unthrottled (engine speed is controlled strictly by the amount of fuel injected) and have little or no intake manifold vacuum. If a vehicle with a diesel engine is equipped with a vacuum-powered brake booster, it must also be fitted with an auxiliary vacuum pump. Figure 37.

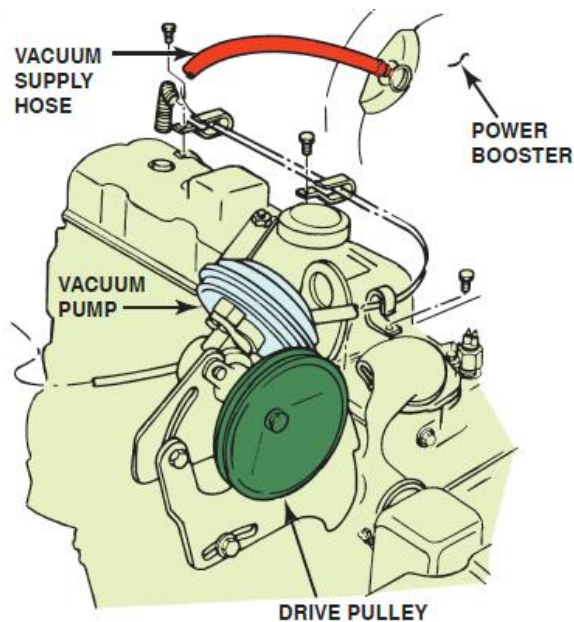


Figure 37. Auxiliary vacuum pump.

Manifold vacuum at idle typically falls between 15 and 20 in. Hg (381 and 508 mm Hg), and most vacuum brake boosters are designed to operate with vacuum levels in this range.

**22. Diagnose vacuum-type power booster unit for vacuum leaks and proper operation; inspect the check valve for proper operation; repair, adjust or replace parts as necessary.**

To test if the vacuum booster can hold a vacuum, perform the following steps:

Step 1 Operate the engine to build up a vacuum in the booster, then turn the engine off.

Step 2 Wait one minute.

Step 3 Depress the brake pedal several times. There should be two or more power-assisted brake applications.

If applications are not power assisted, either the vacuum check valve or the booster is leaking. To test the check valve, remove the valve from the booster and blow through the check valve. If air passes through, the valve is defective and must be replaced. Figure 38,

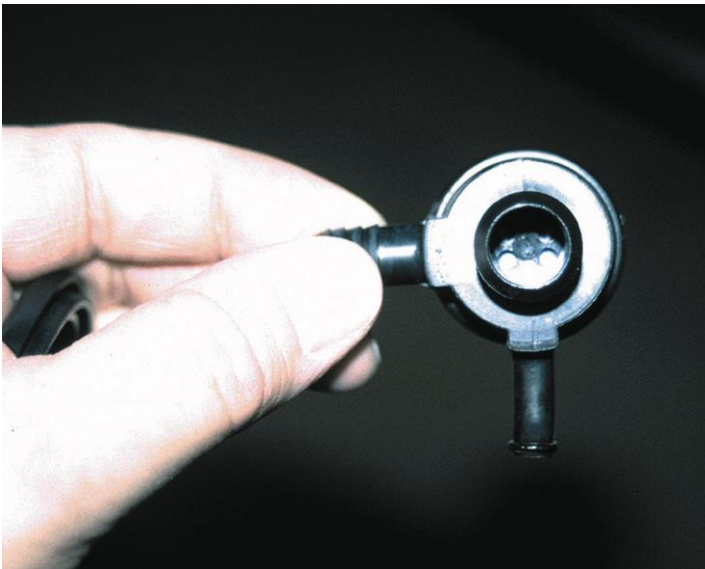


Figure 38. This valve allows air to flow in only one direction—from the booster toward the engine. This valve prevents loss of vacuum when the engine stops.

If the check valve is okay, the vacuum booster is leaking and should be repaired or replaced based on the manufacturer's recommendations.

**23. Diagnose hydro-boost system for leaks and proper operation; repair or replace parts as necessary; refill and bleed system following manufacturers' specifications.**

Hydro-Boost is a hydraulically operated power assist unit. The Hydro-Boost system uses the pressurized hydraulic fluid from the vehicle's power steering pump as a power source rather than using engine vacuum. Figure 39.

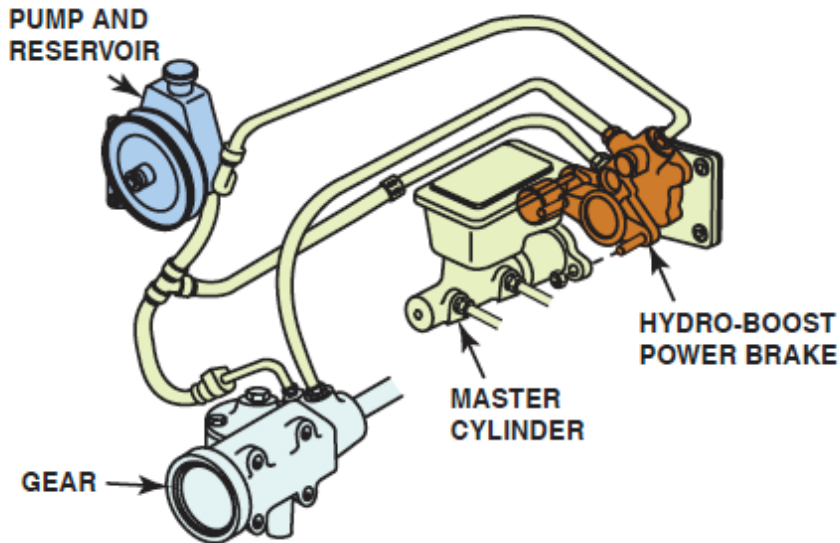


Figure 39. Hydro-Boost system.

The first step of troubleshooting is to perform a thorough visual inspection, including the following:

1. Checking for proper power steering fluid level
2. Checking for leaks from the unit or power steering pump
3. Checking the condition and tightness of the power steering drive belt
4. Checking for proper operation of the base brake system

Hydro-Boost Function Test. With the engine off, apply the brake pedal several times until the accumulator is depleted completely. Depress the service brake pedal and start the engine. The pedal should fall and then push back against the driver's foot.

**24. Diagnose electronic brake servo/brake simulator system for proper operation; determine needed repairs.**

An electromechanical brake booster replaces the vacuum booster, including its vacuum supply. The electric brake booster unit takes the driver applied brake demand and transforms this into an amplified brake pressure. The ABS modulator and booster work together to provide friction braking, regenerative braking (HEVs and EVs), and automatic emergency braking. For diagnosis a scan tool and factory service information is needed. Figure 40.



Figure 40. Electric power brake unit on an electric vehicle.

► **Parking Brake**

**25. Diagnose parking brake system operation (including electronic parking brakes); inspect cables and parts for wear, rust and corrosion; clean or replace parts as necessary; lubricate assembly.**

Parking brakes are applied by a pedal, a lever, or a handle from inside the vehicle. Foot pedals and floor-mounted levers are the most common means of applying parking brakes. Figure 41.

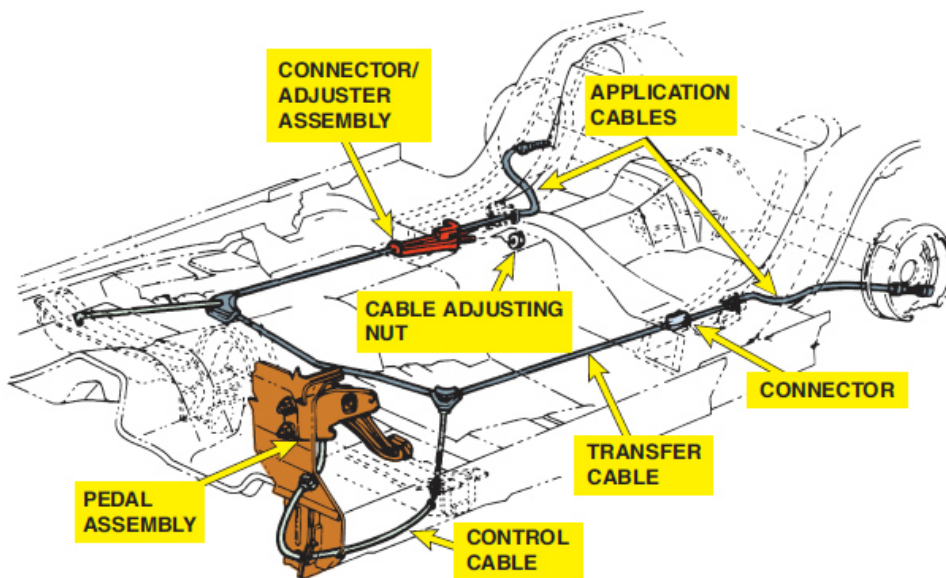


Figure 41. Typical parking brake cable system showing the foot-operated parking brake lever and cable routing.

The parking brake must hold a fully loaded (laden) vehicle stationary on a slope of 20% up or down grade. Any parking brake system, including electric parking brakes, that cannot pass this test should be serviced.

Parking brake cables should be inspected for proper operation, including cable operated electric parking brakes. Figure 42.



Figure 42. Electric parking brake with cables.

A cable that is larger in diameter in one section indicates that it is rusting inside and has swollen. A rusting parking brake cable can keep the rear brake applied even though the parking brake lever has been released. Figure 43.



Figure 43. A parking brake cable with internal rust, seizing the cable.

Most parking brake cables do not require lubrication because they are lined with nylon or Teflon, and any cable housing ends located under the vehicle are protected by rubber or nylon seals. Cables on some older vehicles may have grease fittings for lubrication.

## **26. Adjust parking brake assembly; check operation.**

Most manufacturers specify a minimum of three or four and a maximum of eight to ten clicks when applying the parking brake. Rear drum brakes should be inspected and adjusted correctly before attempting to adjust the parking brake cable. Figure 44.

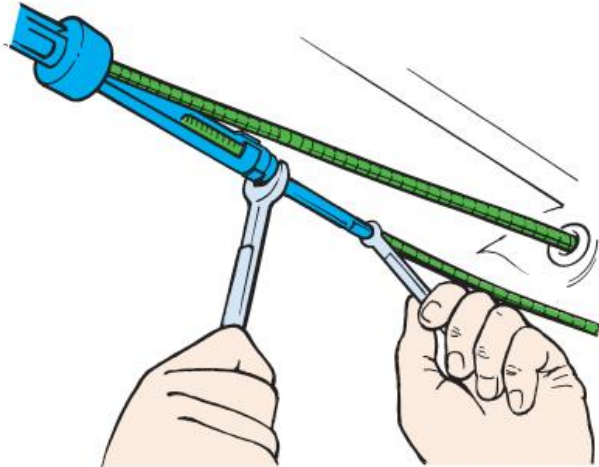


Figure 44. Parking brake cable adjustment.

Rear disc service brakes with fixed calipers commonly have a parking brake drum formed into the hub of the brake rotor. Rear disc auxiliary drum parking brakes are adjusted manually using a starwheel adjuster, which is reached through an opening in the outside of the drum. Figure 45.

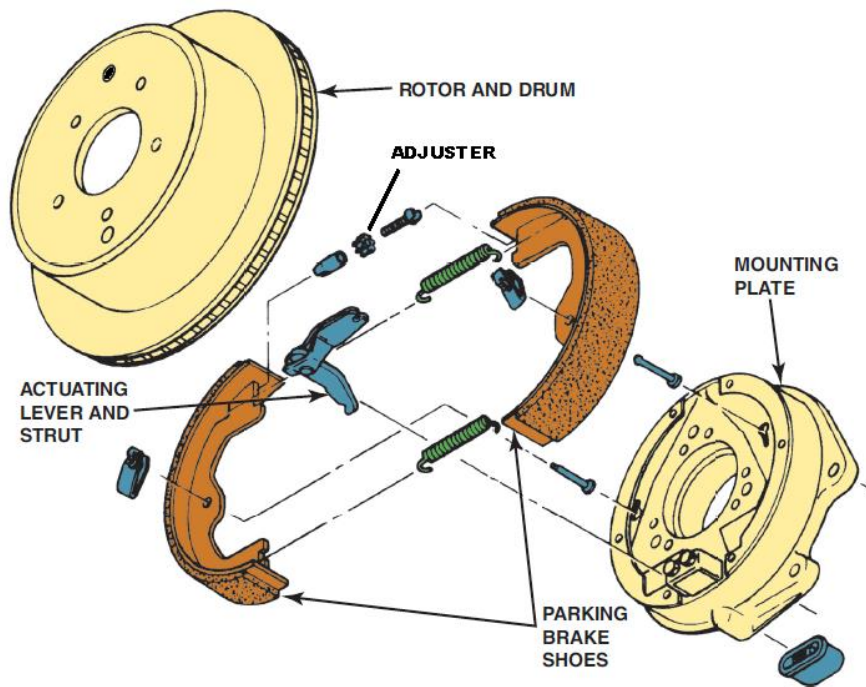


Figure 45. Rear disc parking brake and adjuster.

**27. Test the parking brake indicator light, switch and wiring.**

The warning lamp for the parking brake warns the driver that the parking brake is applied or partially applied. Older vehicles control the red brake warning lamp using straight wiring and switches. It is becoming more common for this function to be controlled by onboard computers and data systems instead. Figure 46.

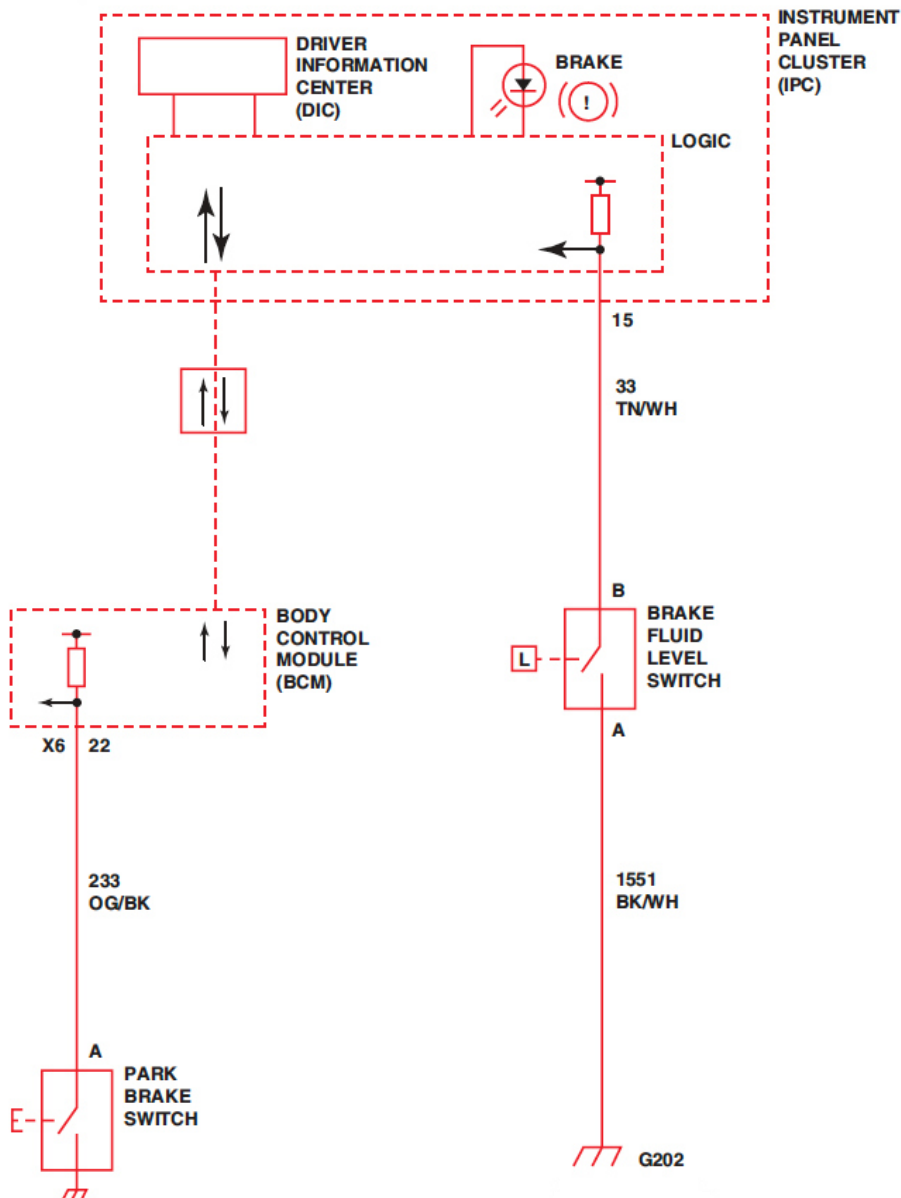


Figure 46. The parking brake switch is an input to the BCM.

**28. Retract integral and/or electronic parking brake caliper piston(s) according to manufacturers' specifications.**

Caliper-actuated disc parking brakes are used on vehicles whose rear disc brakes are equipped with floating or sliding brake calipers. In this design, a special mechanism in the caliper applies the caliper piston mechanically. The mechanism is operated by a parking brake cable attached to a lever that protrudes from the inboard side of the caliper. Figure 47.

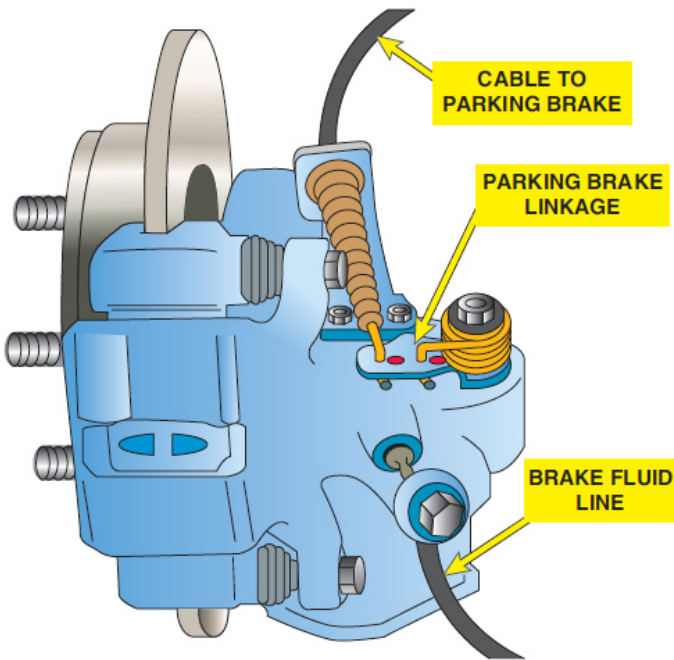


Figure 47. Rear caliper with integral parking brake actuator.

When changing brake pads on this type of caliper the caliper piston must be rotated with a special tool to retract the piston. Attempting to force the piston with a C-clamp will damage the caliper. Figure 48.

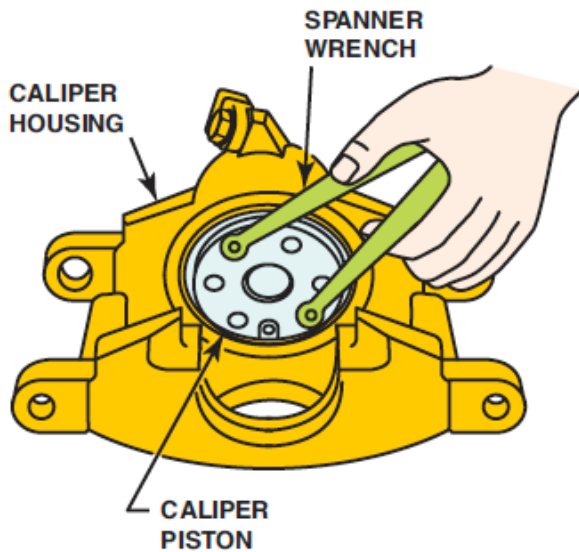


Figure 48. Rotate the piston to allow it to screw into the caliper bore.

On vehicles with electric parking brakes a scan tool may be required when servicing the rear caliper or brake pads. Figure 49.



Figure 49. Scan tool functions for parking brake service.

**29. Adjust calipers with integrated parking brakes according to manufacturers' recommendations.**

Some vehicles using calipers with integral parking brake have special procedures that should be followed to set the proper clearance between the pad and rotor after a brake pad change. Figure 50.

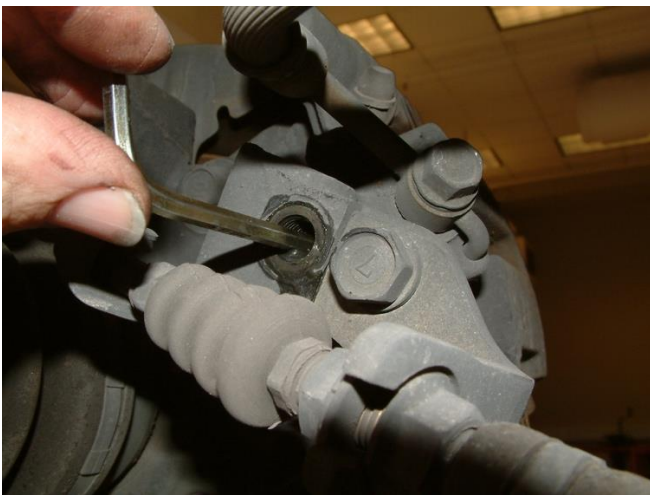


Figure 50. The pads are adjusted to lightly contact the rotor on this vehicle.