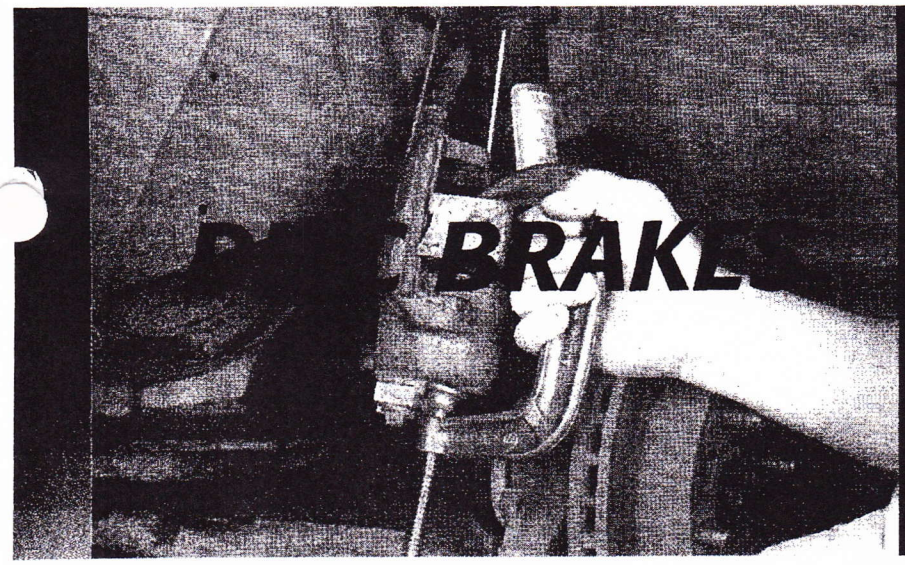
Disc Brakes



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OBJECTIVES

◆ List the advantages of disc brakes. ◆ List disc brake components and describe their functions. ◆ Explain the difference between the three types of calipers commonly used on disc brakes. ◆ Describe the two types of parking brake systems used with disc brakes. ◆ Explain what precautions should be taken when servicing disc brake systems. ◆ Describe the general procedure involved in a complete caliper service or overhaul. ◆ List and describe five typical disc brake rotor problems.

Disc brakes resemble the brakes on a bicycle. The friction elements are in the form of pads, which are squeezed or clamped about the edge of a rotating wheel. With automotive disc brakes, this wheel is a separate unit, called a **rotor**, inboard of the wheel (Figure 40–1). The rotor is typically made of cast iron. However, there is much research being done with composite materials in the design of rotors. Since the pads clamp against both sides of a rotor, both sides are machined smooth. Usually the two surfaces are separated by a finned center section for better cooling. Such rotors are called ventilated rotors. The pads are attached to metal shoes, which are actuated by pistons, the same as with drum brakes. The pistons are contained within a **caliper** assembly, a housing that wraps around the edge of the rotor. The caliper is kept from rotating by way of bolts holding it to the steering knuckle.

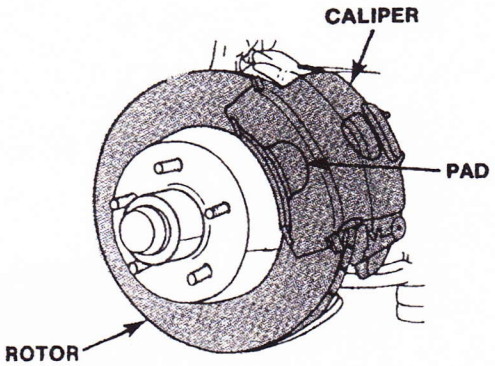


FIGURE 40–1 Typical disc brake assembly.

The caliper is a housing containing the pistons and related seals, springs, and boots as well as the cylinder(s) and fluid passages necessary to force the friction linings or pads against the rotor. The caliper resembles a hand in the way it wraps around the edge of the rotor. It is attached to the steering knuckle. Some models employ light spring pressure to keep the pads close against the rotor. In other caliper designs, this is achieved by a unique seal that allows the piston to be pushed out the necessary amount, then retracts it just enough to pull the pad off the rotor.

Unlike shoes in a drum brake, the pads act perpendicular to the rotation of the disc when the brakes are applied. This effect is different from that produced in a brake drum, where frictional drag actually pulls the shoe into the drum. Disc brakes are said to be nonenergized. They require more force to achieve the same braking effort. For this reason, they are ordinarily used in conjunction with a power brake unit.

Disc brake calipers fall into two categories: fixed and moving designs. The latter includes both sliding and floating calipers.

Disc brakes offer four major advantages over conventional drum brakes. They are resistant to heat fade. Disc brakes are generally more resistant to heat fade during high-speed brake stops or repeated stops. The design of the disc brake rotor exposes more surface to the air and thus dissipates heat more efficiently. They are also resistant to water fade because the rotation of the rotor tends to throw off moisture. The squeeze of the sharp edges of the pads clears the surface of water. Disc brakes perform more straight-line

stops. Due to their clamping action, disc brakes are less apt to pull. Finally, disc brakes automatically adjust as pads wear.

DISC BRAKE COMPONENTS AND THEIR FUNCTIONS

The disc brakes used on American cars are typically of two basic designs: **fixed** or floating **caliper**. There is also a sliding caliper, but its design is very similar to the **floating caliper**. The only difference is that **sliding calipers** slide on surfaces that have been machined smooth for this purpose, and floating calipers slide on special pins or bolts. The disc brake, regardless of its design, consists of a hub and rotor assembly, a caliper assembly, and a brake pad assembly.

Hub and Rotor Assembly

Many of the advantages of disc brakes can be attributed to the disc, or rotor, as it is more commonly called. The typical rotor is made of cast iron. Iron has a high coefficient of friction and withstands wear exceptionally well. The rotor is attached to and rotates with the hub assembly (Figure 40–2). Solid rotors are used on lightweight vehicles, and trucks generally have ventilated rotors (Figure 40–3).

The ventilated rotor is cast with a weblike construction between two friction surfaces. The webs radiate out from the center of the rotor, much like vanes or fins in a fan. As the rotor turns, air is drawn into the rotor at its center, flows between the friction surfaces, and is discharged along the outer edge. This cools the rotor vent effectively, drastically reducing the incidence of brake fade, even during multiple hard stops.

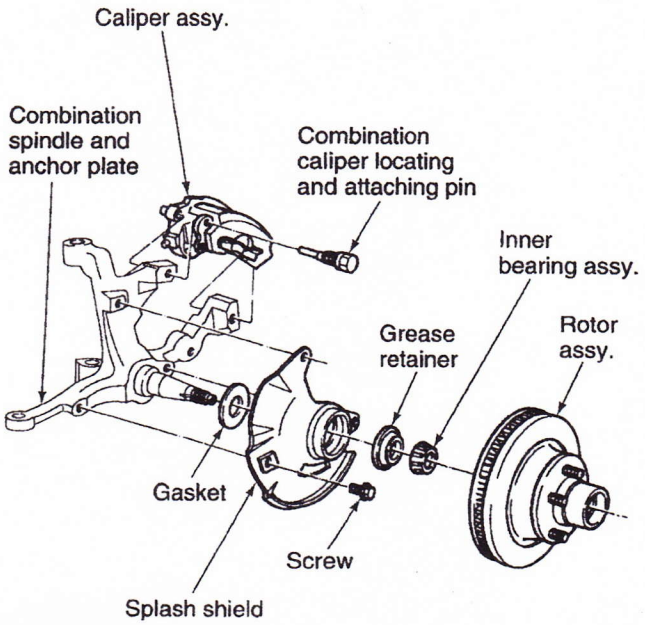
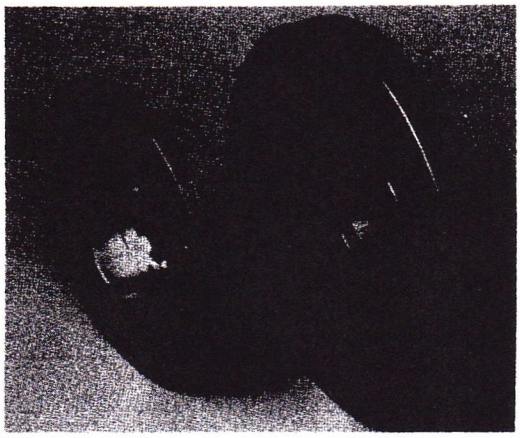


FIGURE 40–2 A wheel hub and disc brake assembly. *Courtesy of Ford Motor Company*



A B

FIGURE 40–3 (A) Downsized solid rotor; (B) full-size ventilated rotor.

Rotors are cooled by splash shields or plates. The **splash shield** protects the rotor and pads from road splashes and dirt. It is also shaped to channel the flow of air over the exposed rotor surfaces. As long as the car is moving, this flow of air helps to cool the rotor. The splash shield cannot be removed unless the rotor and caliper are first removed. Replacement of the splash shield is necessary only when it has been damaged or when the spindle is replaced.

Caliper Assembly

Caliper action converts hydraulic pressure into mechanical force. The caliper assembly (Figure 40–4) is composed of the following components.

Caliper Housing

The caliper housing is usually a one-piece construction of cast iron or aluminum and has an inspection hole in the top to allow for lining wear inspection. A cylinder bore is located in that portion of the casting nearest the engine. In the cylinder bore is a groove that seats a square-cut seal. This groove is tapered toward the bottom of the bore to increase the compression on the edge of the seal that is nearest hydraulic pressure. The top of the cylinder bore is also grooved as a seat for the dust boot. A fluid inlet hole is machined into the bottom of the cylinder bore and a bleeder valve outlet hole is located near the top of the casting. The caliper has inner ears with holes for mounting on the anchor plate.

Caliper Pistons

A caliper can contain one, two, or four cylinder bores and pistons that provide uniform pressure distribu-

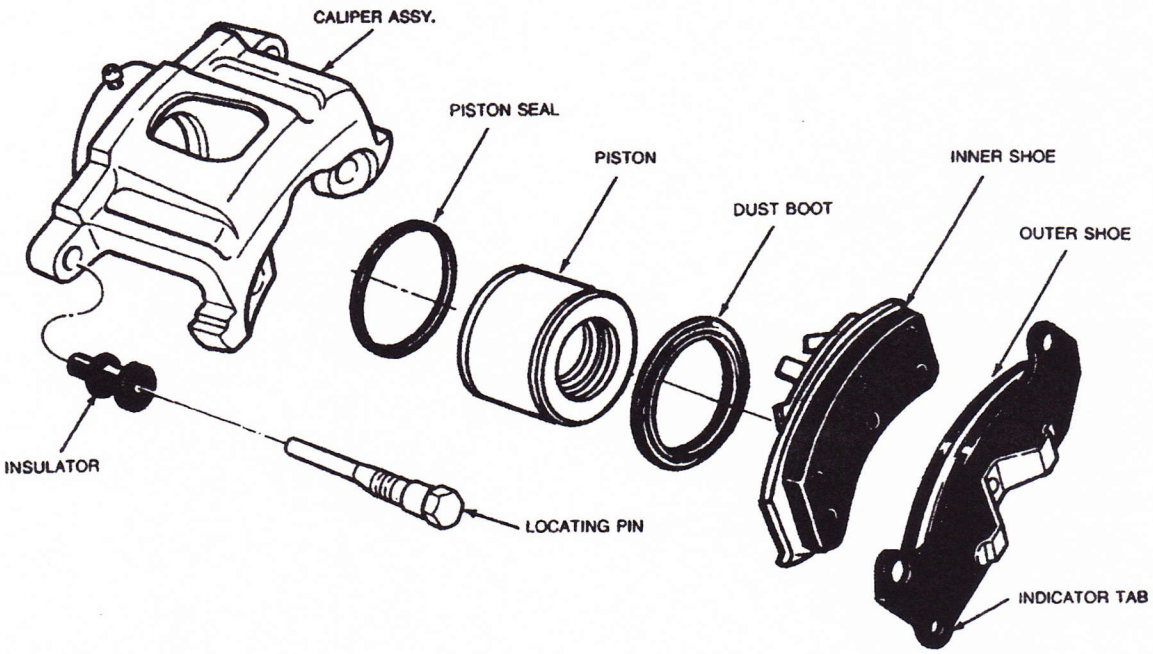


FIGURE 40–4 Parts of a typical sliding caliper. *Courtesy of Ford Motor Company*

tion against the brake's friction pads. Because there is no self-energizing action with disc brakes, the pistons are relatively large in diameter and short in stroke to provide high pressure on the friction pad assemblies with a minimum of fluid displacement.

Basically, the hydraulics of disc brakes are the same as for drum brakes, where the master cylinder piston forces the brake fluid into the wheel cylinders and against the wheel pistons.

The disc brake piston is made of either steel, aluminum, or fiberglass-reinforced **phenolic piston** resin. The steel pistons are usually nickel-chrome plated for improved durability and smoothness. The pistons usually have a larger diameter to provide the necessary braking force with little fluid movement. The top of the pistons is grooved to accept the **dust boot.**

Dust Boot

The dust boot seats in a groove at the top of the cylinder bore and also in a groove in the piston. The dust boot prevents moisture and road contamination from entering the bore.

Piston Hydraulic Seal

The piston hydraulic seal prevents fluid leakage between the cylinder bore wall and the piston. This rubber sealing ring also acts as a retracting mechanism for the piston when hydraulic pressure is released, causing the piston to return in its bore (Figure 40–5). When hydraulic pressure is diminished, the seal functions as a return spring to retract the piston.

In addition, as the disc brake pads wear, the seal allows the piston to move further out to adjust automatically for the wear and to maintain the lining in proper relationship with the rotor. Additional brake fluid in the caliper bore compensates for lining wear. In this manner, the caliper assembly maintains the inboard and outboard shoe and lining in the proper relationship with the rotor surface throughout the full life of the lining.

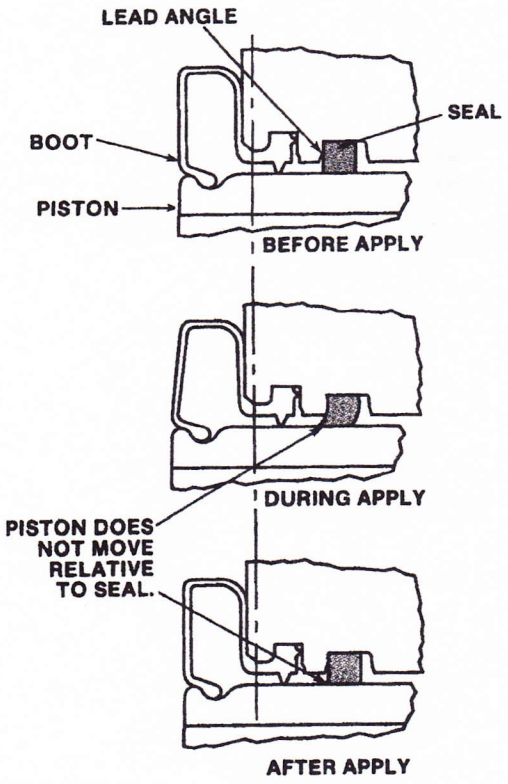


FIGURE 40–5 Function of a low-drag caliper seal.

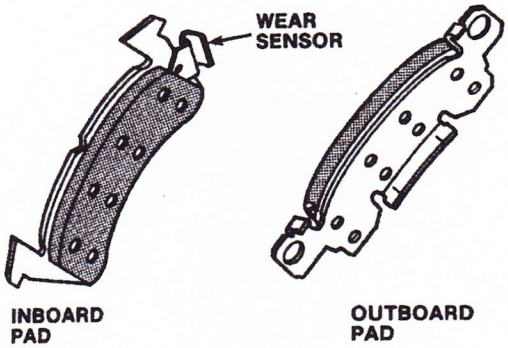


FIGURE 40–6 Typical pad linings.

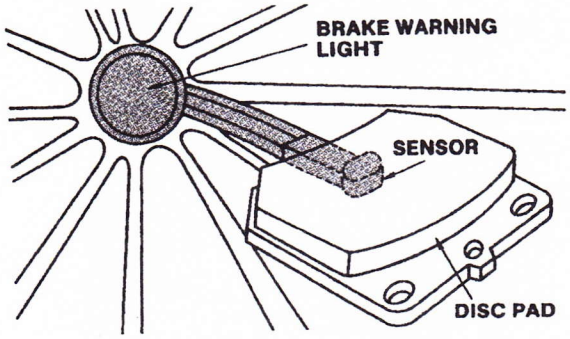


FIGURE 40–8 Visual disc brake pad wear sensor.

Brake Pad Assembly

Brake shoe pads with disc brakes are metal plates with the linings either riveted or bonded to them. Pads are placed one in each side of the caliper and together straddle the rotor. The inner brake pad, which is positioned against the piston, is not interchangeable with the outer brake pad (Figure 40–6). The linings are made of semimetallic or other nonasbestos material.

Disc Pad Wear Sensors

Some brake shoe pads have wear-sensing indicators. The three most common design wear sensors are audible, visual, and tactile.

Audible sensors are thin, spring steel tabs that are riveted to the edge of the pad backing plate and are bent to contact the rotor when the lining wears down to a point that replacement is necessary. At that point, the sensor causes a high-pitched squeal at all times the wheel is turning, except when the brakes are applied; then the noise goes away. The noise gives a warning to the driver that brake service is needed and perhaps saves the rotor from destruction (Figure 40–7). The tab is generally installed toward the rear of the wheel.

Visual sensors inform the driver of the need for new linings. This method employs electrical contacts recessed in the pads that touch the rotor when the linings are worn out. This completes a circuit and turns on a dashboard warning light (Figure 40–8). This system is found mostly on imports.

Tactile sensors create pedal pulsation as the sensor on the rotor face contacts the sensor attached to the lower portion of the disc pad (Figure 40–9).

WARNING!

As disc brake pad linings wear thin, more brake fluid is needed in the system. ■

CUSTOMER CARE

Excessive heat liquefies the resin binder that holds the brake pad material together. Once liquefied, the binder rises to the surface of the pad to form a glaze. A glazed pad surface may cause squealing because more heat must be created to achieve an amount of friction equal to a pad in good condition. One common cause of pad glazing is the improper break-in of the pads. Remember to inform customers that unnecessary hard braking during the first 200 miles of a pad's life can generate enough heat to glaze the pads and ruin the quality of the work just performed. ■

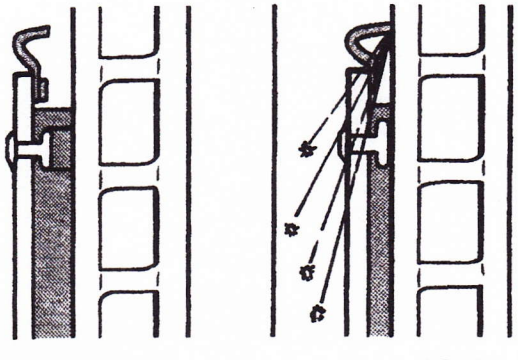


FIGURE 40–7 Audible disc brake pad wear indicator.

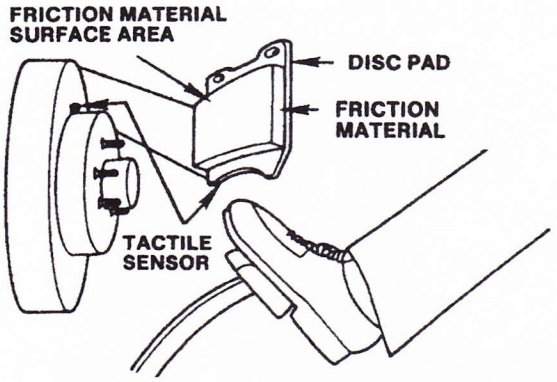


FIGURE 40–9 Location of the tactile sensor, which causes the brake pedal to pulsate when the brake pads are worn.

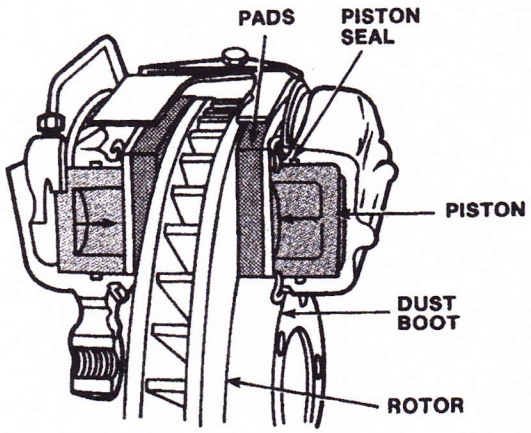


FIGURE 40–10 Cross section of a fixed caliper.

Fixed Caliper Disc Brakes

Fixed caliper disc brakes include a caliper assembly that is bolted in a fixed position and does not move when the brakes are applied. The pistons in both sides come inward to force the pads against the rotor (Figure 40–10). Import cars use the fixed caliper more widely than domestics.

Floating Caliper Disc Brakes

The Ford floating caliper disc brake shown in Figure 40–11 is a typical example of a floating caliper. The caliper on this brake is a one-piece casting that has one hydraulic cylinder and a single piston.

The caliper is attached to the **spindle anchor plate** with two threaded locating pins. A Teflon® sleeve separates the caliper housing from each pin. The caliper slides back and forth on the pins as the brakes are actuated. Upon brake application, hydraulic pressure builds in the caliper cavity behind the piston and seal. Because hydraulic pressure exerts equal force in all directions, pressure against the piston is equal to that exerted against the caliper housing. The piston seal offers the point of least resistance. Initial movement is of the piston outward in the bore.

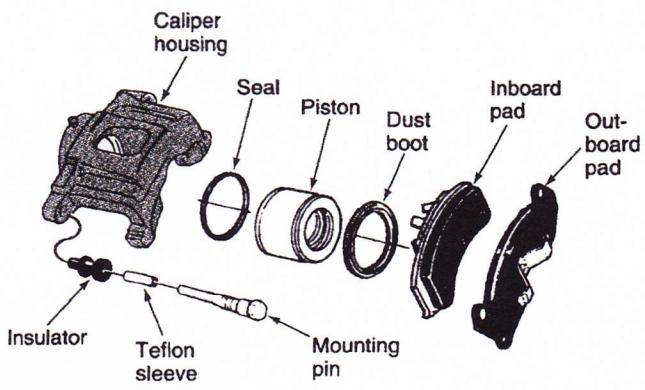


FIGURE 40–11 Ford/Kelsey floating caliper disc brake.

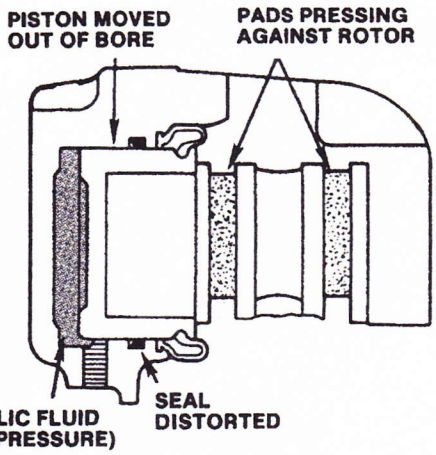


FIGURE 40–12 Cross section of a caliper in the applied position.

The piston presses the inboard pad against the rotor. As the pad contacts the revolving rotor, greater resistance to outward movement is increased, forcing pressure to push the caliper away from the piston. This action forces the outboard pad against the rotor (Figure 40–12). However, both pads are applied with equal pressure.

Sliding Caliper Disc Brakes

Sliding caliper disc brakes get their name from the fact that the caliper slides or moves sideways when the brakes are applied. As mentioned previously, in operation these brakes are almost identical to the floating type.

But unlike the floating caliper, the sliding caliper does not float on pins or bolts attached to the anchor plate. The sliding caliper has angular machined surfaces at each end that slide in mating machined surfaces on the anchor plate.

Figure 40–13 is an example of a typical sliding caliper disc brake. The caliper on this brake is a one-piece casting that has one hydraulic cylinder and a single piston. Machined surfaces on the caliper are

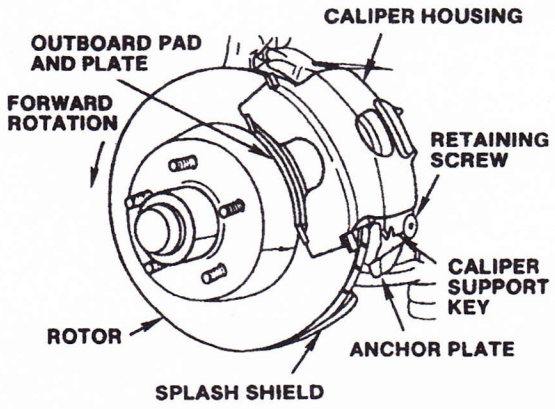


FIGURE 40–13 Sliding caliper disc brake.

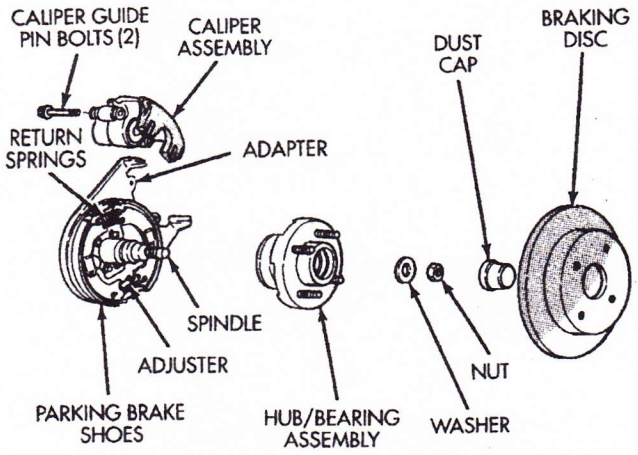


FIGURE 40–14 Typical parking brake that uses a drum built into the center of a rotor. *Courtesy of Chrysler Corporation*

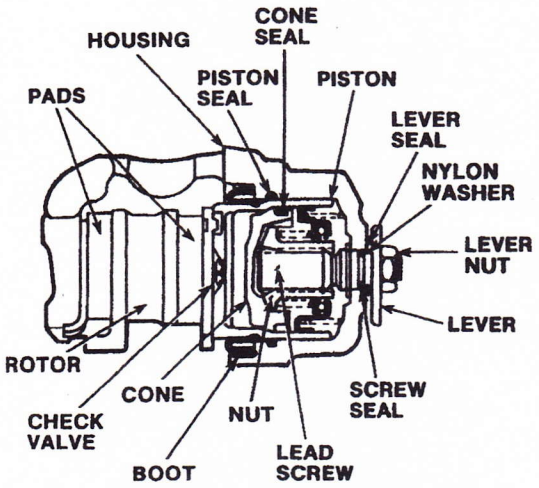


FIGURE 40–15 Delco-Moraine disc parking brake.

positioned against mating machined surfaces on the anchor, which is where the caliper then slides back and forth.

REAR DISC/DRUM (AUXILIARY DRUM) PARKING BRAKE

The rear disc/drum or auxiliary drum parking brake arrangement is found on some General Motors' and Chrysler vehicles that use discs on the rear wheels. On these brakes, the inside of each rear wheel hub and rotor assembly is used as the parking brake drum. Figure 40–14 shows a typical rear disc/drum parking brake.

REAR DISC PARKING BRAKES

Instead of using an auxiliary drum and shoes to hold the vehicle when parked, these brakes have a mechanism that forces the pads against the rotor mechanically. One method for doing this is the ball-and-ramp arrangement. Another method used in the General Motors' rear calipers for E-body cars, uses a high lead thrust screw to hold the piston out and maintain contact with the pads and rotors (Figure 40–15). Other types of actuating systems for rear disc brakes include the use of a variety of cams.

SERVICE PRECAUTIONS

The following general service precautions apply to all disc brake systems and should be reviewed before studying the specific servicing techniques in this chapter.

1. Road test the vehicle to determine the condition of the brakes.
2. Be sure the vehicle is properly centered and secured on stands or a hoist.
3. Disconnect the battery ground cable.
4. Before any service is performed, inspect the wheel and brake assembly for obvious damage that could affect braking. Check the following.
   - Tires for excessive wear or improper inflation
   - Wheels for bent or warped rims
   - Wheel bearings for looseness or wear
   - Suspension components to see if they are worn or broken
   - Brake fluid level
   - Master cylinder, brake lines or hoses, and each wheel for leaks
5. During servicing, grease, oil, brake fluid, or any other foreign material must be kept off the brake linings, caliper, surfaces of the disc, and external surfaces of the hub. Handle the brake disc and caliper in such a way to avoid deformation of the disc and nicking or scratching brake linings.
6. Work on one wheel at a time to avoid popping pistons out of the other caliper and allow the other caliper assembly to be used as a guide.
7. When removing wheels, be sure to avoid damage to the rotor, external lines, bleeder screws, and splash shield.
8. When a hydraulic hose is disconnected, plug it to prevent any foreign material from entering.
9. Do not attempt to remove the hub with the wheel and tire still mounted. The wheel and tire must be dismounted and the caliper removed before the hub and rotor can be dismounted.
10. Never permit the caliper assembly to hang with the weight on the brake hose. Support it on the suspension or hang it by a piece of wire.
11. Inspect the caliper for leaks. If leakage is present, the caliper must be overhauled.
12. Use crocus cloth to remove rust, corrosion, pitting, and scratches from the piston bore. If the

bore cannot be cleaned with crocus cloth, light honing is permitted. Do not hone a plated bore.

13. When using compressed air to remove caliper pistons, avoid high pressures. A safe pressure to use is 30 psi.
14. Clean the brake components in either denatured alcohol or clean brake fluid. Do not use mineral-based cleaning solvent such as gasoline, kerosene, carbon tetrachloride, acetone, or paint thinner to clean the caliper. It causes rubber parts to become soft and swollen in an extremely short time.
15. Lubricate any moving member such as the caliper housing or mounting bracket to ensure a free-moving action. Use only recommended lubricant.
16. Before the brake pads are installed, apply a disc brake noise suppressor to the back of the pads to prevent brake squeal. For best results, follow the directions on the container.
17. The front-wheel bearing should be adjusted to the manufacturer's specifications.
18. Check the master cylinder fluid level and be sure the reservoirs are filled when the brake job is completed.
19. Obtain a firm brake pedal after servicing the brakes and before moving the vehicle. Be sure to road test the vehicle.
20. Always torque the lug nuts when installing a wheel on a vehicle with disc brakes. Never use an impact gun to tighten the lug nuts. Warpage of the rotor could result if an impact gun is used.

Before beginning brake work, remove about two-thirds of the brake fluid from the front or disc brake reservoir on a front/rear split system (Figure 40–16). On a diagonally split system, remove fluid from both reservoirs. If this is not done, the fluid could overflow and spill when the pistons are forced back into the caliper bore, possibly damaging the painted surfaces. Replace the cover. Discard old brake fluid.

Another common procedure (and perhaps a better way) is to open the caliper bleeder screw and run a hose down to a container to catch the fluid that is expelled when the piston is forced back into its bore. This also makes it easier to move the piston.

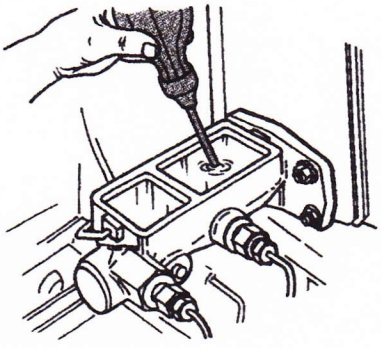


FIGURE 40–16 Removing brake fluid from master cylinder reservoir.

If the bleeder screws are frozen tight with corrosion, it is sometimes possible to free them using a propane torch and penetrating oil. Of course, the caliper has to be removed from the car, taken to a bench, and worked on there. If the bleeder screws cannot be loosened, they can be drilled out and the caliper retapped for an insert, or the caliper can be replaced with a new or rebuilt unit. The bleeder screw should be removed when doing an overhaul.

CAUTION

When using the propane torch to loosen a bleeder screw, use it with extreme care. ■

GENERAL CALIPER INSPECTING AND SERVICING

The general procedures involved in a complete caliper service or overhaul include tasks such as:

- Caliper removal
- Brake pad removal
- Caliper disassembly
- Caliper assembly
- Brake pad installation
- Caliper installation

Not all caliper work includes every one of these tasks. Frequently, caliper service involves only the removal and installation of the brake pads. However, since the new pads are thicker than the worn-out set they replace, they locate the piston farther back in the bore where dirt and corrosion might cause the seals to leak. For this reason, it is often good practice to rebuild the calipers whenever installing new pads. Of course, it is also good practice to true up or replace the rotors when replacing brake pads.

When bench working a caliper assembly, use a vise that is equipped with protector jaws. Excessive vise pressure causes bore and piston distortion.

SHOP TALK

Some shops do not rebuild calipers. They contract them out to specialty shops. However, the brake technician must at least know how to rebuild calipers. ■

Caliper Removal

The first step in proper caliper service is to remove the caliper assembly from the vehicle. Depending on the caliper design, this operation is accomplished in various ways. Specific caliper removal procedures are given in service manuals. General details of the task follow.

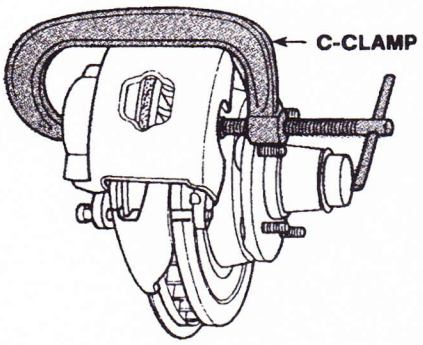


FIGURE 40–17 Bottoming piston in the bore.

PROCEDURES

Removing Calipers

1. Remove the brake fluid from the master cylinder.
2. Raise the vehicle and remove the wheel and tire assembly. Use care to avoid damage to or interference with bleeder screw fitting during removal.
3. Mark the right-hand and left-hand caliper assemblies with chalk prior to removing from the vehicle, so they can be positioned correctly during installation.
4. On a sliding or floating caliper, install a C-clamp on the caliper with the solid end of the clamp on the caliper housing and the screw end on the metal portion of the outboard brake pad. Tighten the clamp until the piston bottoms in the caliper bore (Figure 40–17), then remove the clamp. Bottoming the piston allows room for the brake pad to slide over the ridge of rust that accumulates on the edge of the rotor.
5. Disconnect the brake hose from the caliper and remove the copper gasket or washer and the cap end of the brake end. If only the brake pads are to be replaced, do not disconnect the brake hose.
6. Remove the two mounting brackets to the steering knuckle bolts. Support the caliper when removing the second bolt to prevent the caliper from falling.
7. On a sliding caliper, remove the top bolts, retainer clip, and **antirattle springs** (Figure 40–18). On a floating caliper, remove the two special pins that hold the caliper to the anchor plate (Figure 40–19). On an older type fixed caliper, remove the bolts holding it to the steering knuckle. On all three types, get the caliper off by prying it straight up and lifting it clear of the rotor.

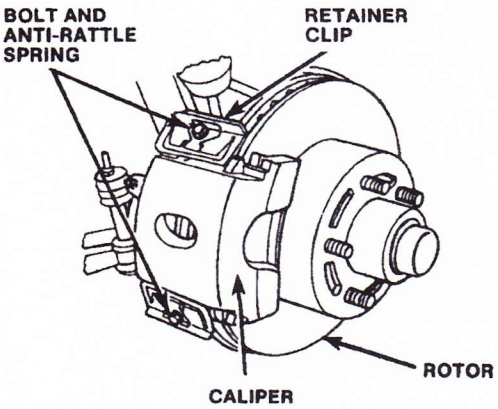


FIGURE 40–18 Sliding caliper removal.

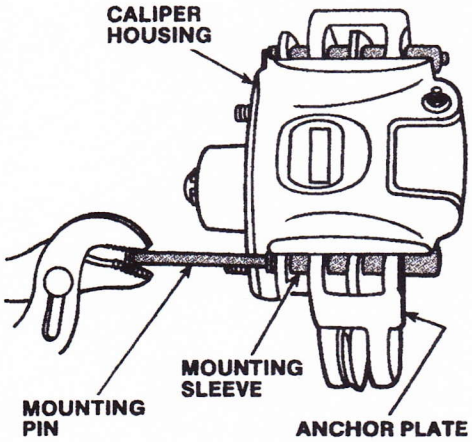


FIGURE 40–19 Floating caliper removal.

Brake Pad Removal

Disc brake linings should be checked periodically or whenever the wheels are removed. Some calipers have inspection holes in the caliper body. If they do not, the brake pads can be visually inspected from the outer ends of the caliper.

If the friction pads appear worn and in need of replacement, measure them at the thinnest part of the pad. Compare this measurement to the minimum brake pad lining thickness listed in the vehicle's service manual, and replace the pads if needed.

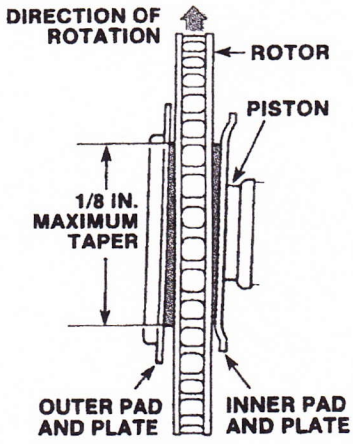


FIGURE 40–20 Normal pad wear pattern.

Uneven pad wear on a sliding caliper often means the caliper is sticking and not giving equal pressure to both pads. On a sliding caliper, the problem could be that the caliper ways are not allowing a smooth sliding movement. Check these machined ways for proper clearance. A slightly tapered wear pattern on the pads of certain models is caused by caliper twist during braking. It is normal if it does not exceed 1/8-inch taper from one end of the pad to the other (Figure 40–20).

Sliding or floating calipers must always be lifted off the rotor for pad replacement. Fixed calipers might have pads that can be replaced by removing the retaining pins or clips instead of having to lift off the entire caliper. They can be held in position by retaining pins (Figure 40–21), guide pins (Figure 27–22), or a support key (Figure 40–23). Note the position of the shims, antirattle clips, keys, bushings, or pins during disassembly. A typical procedure for replacing brake pads is outlined in Photo Sequence 29.

If only the pads have to be replaced, lift the caliper off the rotor and hang it up by a wire. Remove the outer pad and inner pad. Remove the old sleeves and bushings and install new ones. Replace rusty pins on a floating caliper to provide for free movement. Transfer shoe retainers, which can be clips or springs, onto the new pads.

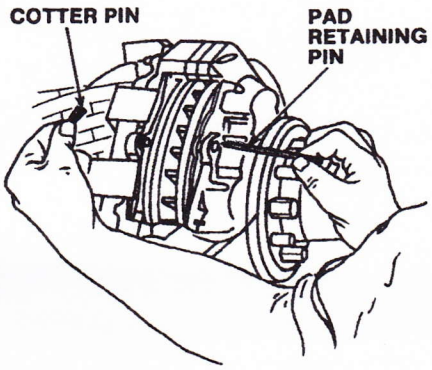


FIGURE 40–21 Removing brake pad retaining pins.

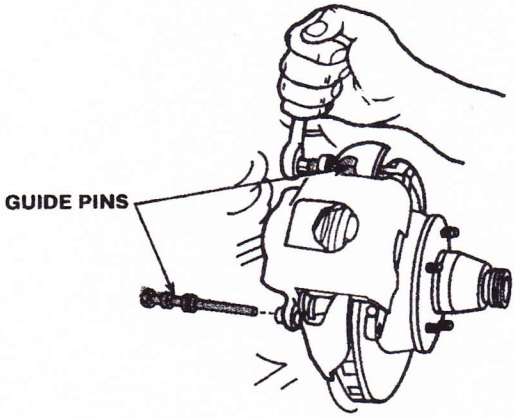


FIGURE 40–22 Removing guide pins.

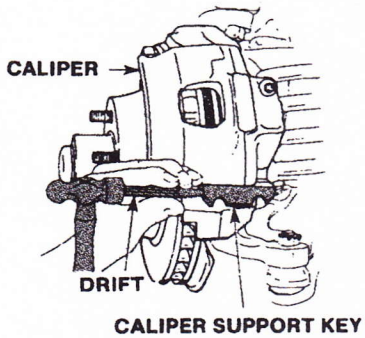


FIGURE 40–23 Removing caliper support key.

SHOP TALK

If new pads and plates are not to be installed immediately, insert several thicknesses of clean cardboard or plastic in the caliper. This keeps the pistons from coming out of caliper cylinders. ■

Caliper Disassembly

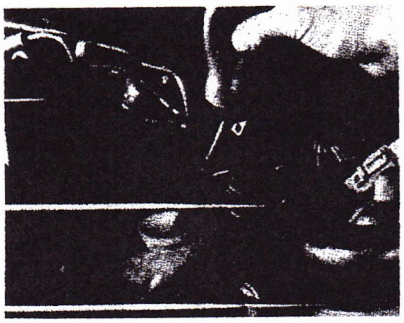
If the caliper must be rebuilt, it should be taken to the workbench for servicing. Drain any brake fluid from the caliper by way of bleeder screws. Remove the bleeder valve protector, if so equipped.

On a floating caliper, examine the mounting pins for rust that could limit travel. Most manufacturers recommend that these pins and their bushings be replaced each time the caliper is removed. This is a good idea because the pins are inexpensive and a good insurance against costly comebacks. On a fixed caliper, check the pistons for sticking and rebuild the caliper if this problem is found.

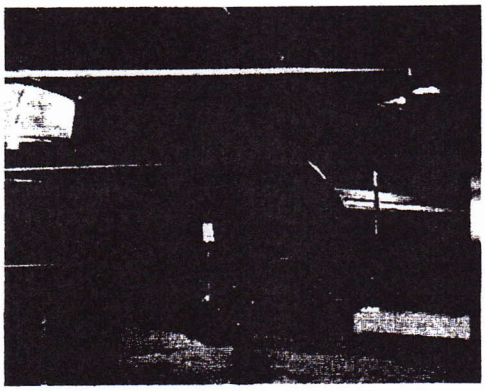
To disassemble the caliper, the piston and dust boot must first be removed. Use compressed air to pop the piston out of the bore.

PHOTO SEQUENCE 29

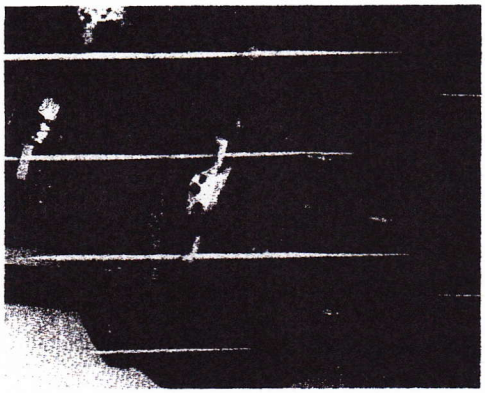
REMOVING AND REPLACING BRAKE PADS



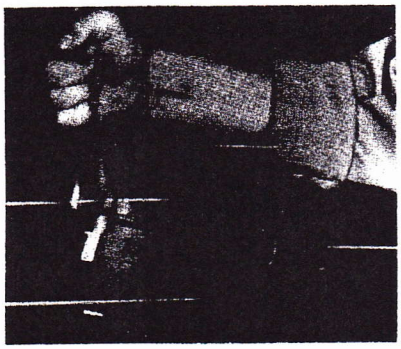
P29–1 Front brake pad replacement begins with removing brake fluid from the master cylinder reservoir. Using a siphon, remove enough fluid to cause the reservoir to be half-full.



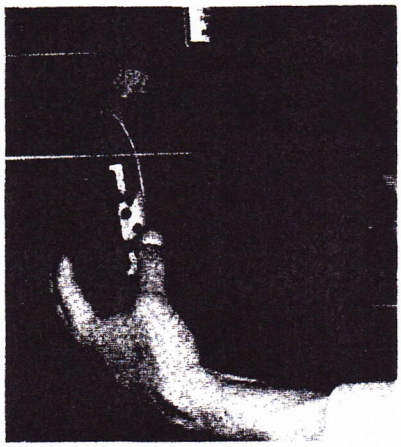
P29–2 Raise the car. Make sure it is safely positioned on the lift. Remove its wheel assemblies.



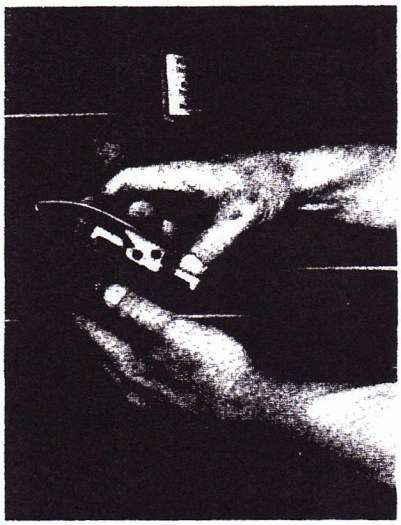
P29–3 Inspect the brake assembly. Look for signs of fluid leaks, broken or cracked lines, or a damaged brake rotor. If any problem is found, correct it when installing the new brake pads.



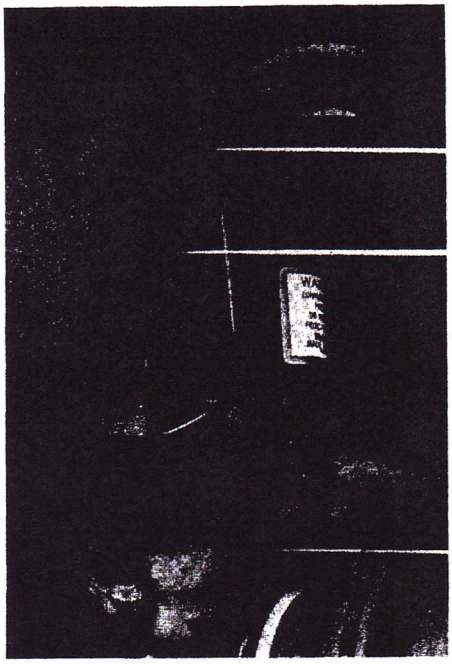
P29–4 Loosen the bolts and remove the pad locator pins.



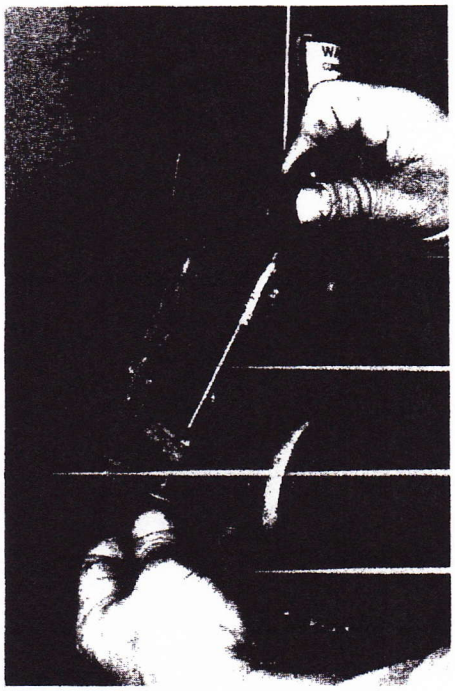
P29–5 Lift and rotate the caliper assembly from the rotor.



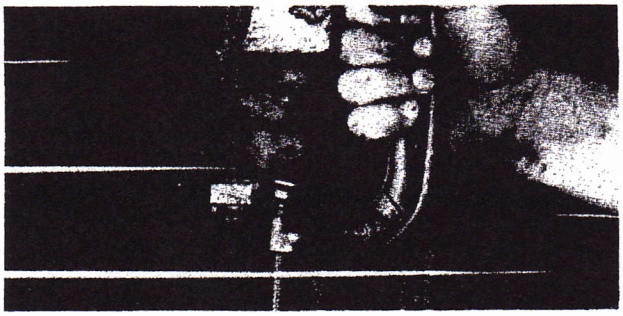
P29–6 Remove the brake pads from the caliper assembly.



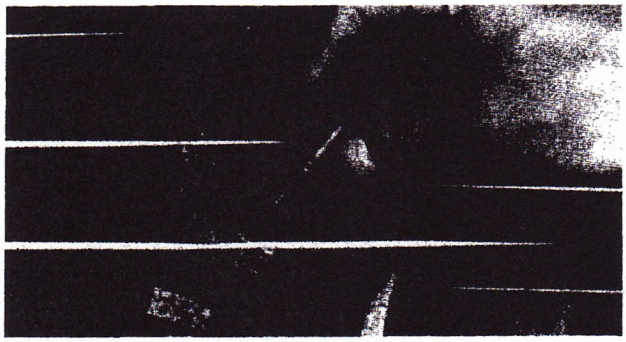
P29–7 Fasten a piece of wire to the car's frame and support the caliper with the wire.



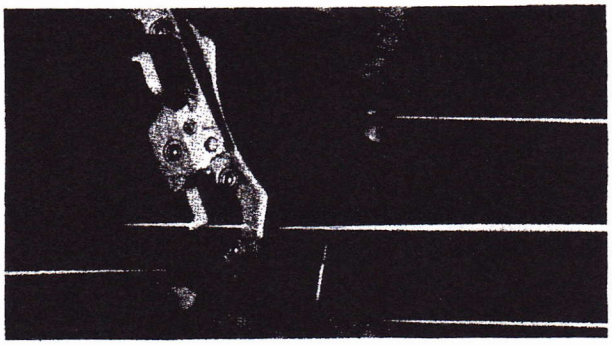
P29–8 Check the condition of the locating pin insulators and sleeves.



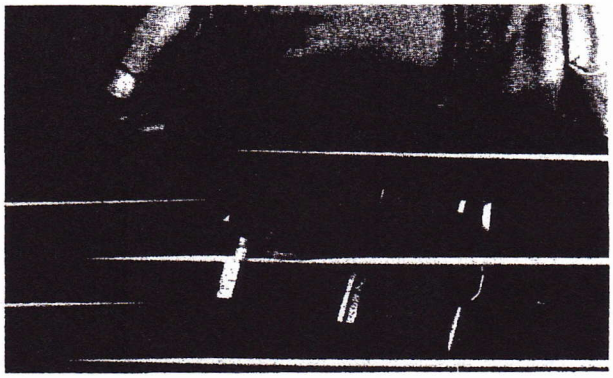
P29–9 Place a piece of wood over the caliper's piston and install a C-clamp over the wood and caliper. Tighten the clamp to force the piston back into its bore.



P29–10 Remove the clamp and install new locating pin insulators and sleeves, if necessary.



P29–11 Install the new pads into the caliper.



P29–12 Set caliper with pads over the rotor and install the locating pins. After the assembly is in the proper position, torque the pins according to specifications

PROCEDURES

Disassembling a Caliper

1. Position the caliper face down on a bench.
2. Insert the used outer pad into the caliper. Place a folded shop towel on the face of the lining to cushion the piston.
3. Apply low air pressure (never more than 30 psi) to the fluid inlet port of the caliper to force the piston from the caliper housing (Figure 40–24).

CAUTION:

Be careful to apply air pressure very gradually. Be sure there are enough cloths to catch the piston when it comes out of the bore. Never place your fingers in front of the piston for any reason when applying compressed air. Personal injury could occur if the piston is popped out of the bore. ■

4. If a piston is frozen, release air pressure and tap the piston into its bore with a soft-headed hammer or mallet. Reapply air pressure.
5. Frozen phenolic (plastic) pistons can be broken into pieces with a chisel and hammer.

CAUTION:

Protect the eyes with safety glasses. Avoid damaging the caliper bore and seal groove with the chisel. ■

6. Internal expanding pliers are sometimes used to remove pistons from caliper bores.

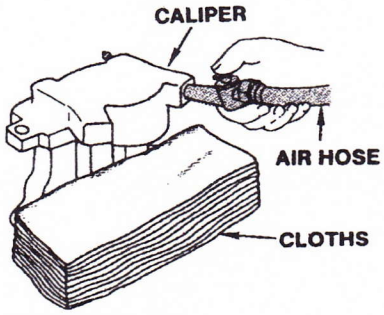


FIGURE 40–24 Using air to remove a piston.

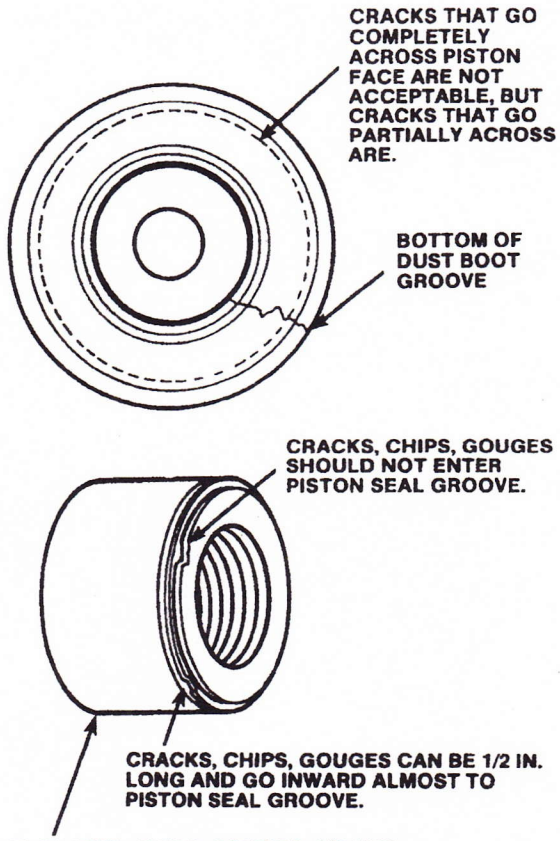


FIGURE 40–25 Inspect phenolic piston for surface irregularities.

Inspect phenolic pistons for cracks, chips, or gouges (Figure 40–25). Replace the piston if any of these conditions are evident. If the plated surface of a steel piston is worn, pitted, scored, or corroded, it also should be replaced.

Dust boots vary in design depending on the type of piston and seal, but they all fit into one groove in the piston and another groove in the cylinder. One type comes out with the piston and peels off. Another type stays in place and the piston comes out through the boot, and is then removed from the cylinder (Figure 40–26). In either case, peel the boot from its

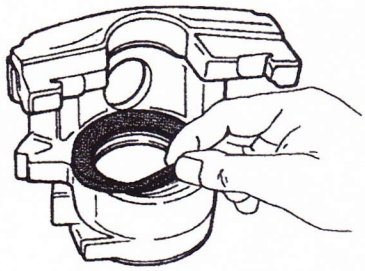


FIGURE 40–26 Peeling off dust boot.

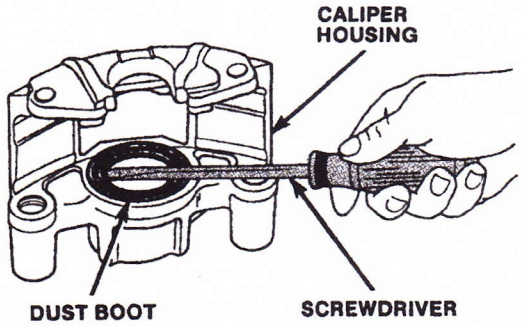


FIGURE 40–27 Prying out dust boot with a screwdriver.

groove. In some cases it might be necessary to pry the dust boot out with a screwdriver (Figure 40–27). The old boot can be discarded since it must be replaced along with the seal.

WARNING!

Be careful not to scratch the cylinder bore while prying out the dust boot. ■

Remove a stroking seal by prying it out of the piston with a wooden or plastic tool. Pry a fixed seal out of the cylinder with the same type of tool (Figure 40–28). Do not use a screwdriver or other metal tool. Any of these could nick the metal in the caliper bore and cause a leak. Inspect the bore for pitting or scoring. A bore that shows light scratches or corrosion can usually be cleaned with crocus cloth. However, a

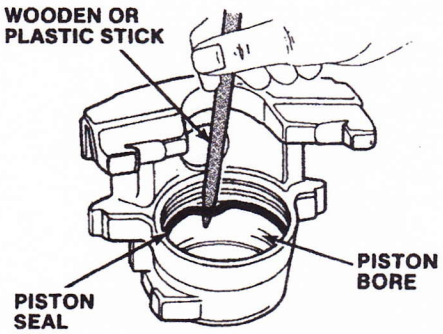


FIGURE 40–28 Removing piston seal with a wooden or plastic stick.

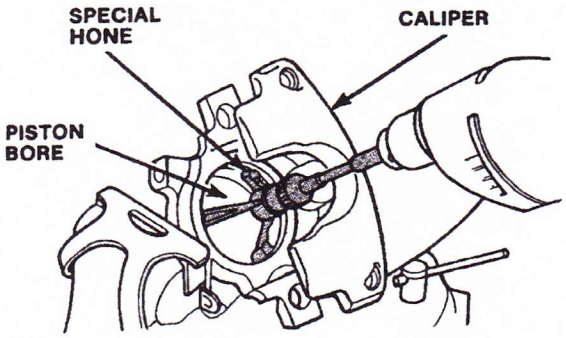


FIGURE 40–29 Honing caliper bore.

bore that has deep scratches or scoring must be honed, provided the diameter of the bore is not increased more than 0.002 inch. If the bore does not clean up within this specification, a new caliper housing should be installed. Black stains on the bore walls are caused by piston seals. They do no harm.

When using a hone (Figure 40–29), be sure to install the hone baffle before honing the bore. The baffle protects the hone stones from damage. Use extreme care in cleaning the caliper after honing. Remove all dust and grit by flushing the caliper with alcohol. Wipe it dry with a clean lint-free cloth and then clean the caliper a second time in the same manner.

Loaded Calipers

There is now a trend toward installing loaded calipers, rather than overhauling calipers in the shop. Loaded calipers are completely assembled with friction pads and mounting hardware included. Besides the convenience and the savings of installation time, preassembled calipers also reduce the odds of errors in installation.

Mistakes that are frequently made when replacing calipers include forgetting to bend pad locating tabs that prevent pad vibration and noise, leaving off antirattle clips and pad insulators, and reusing corroded caliper-mounting hardware that can cause a floating caliper to bind up and wear the pads unevenly.

One of the major causes of premature brake wear is rust. It causes improper slider and piston operation that leads to uneven pad wear. Tests have shown that when only the pads are replaced, the new pads can wear out in half the mileage as the originals when rust affects caliper operation. Installing a loaded caliper ensures that all parts requiring replacement are replaced.

SHOP TALK

Make sure the supplier tells you what type of friction material is used on their loaded caliper assemblies. Some suppliers use lower grade friction material to keep cost down. Also, avoid mismatching friction materials from side to side. When one caliper is bad, both calipers should be replaced using the same friction material on both sides. ■

Caliper Assembly

Before assembling the caliper, clean all metal parts to be reused and the phenolic piston (if so equipped) in clean denatured alcohol or brake fluid. Then, clean out and dry the grooves and passageways with compressed air. Make sure that the caliper bore and component parts are thoroughly clean.

Some designs of disc brakes require that the piston-to-bore clearance be checked with a feeler gauge (Figure 40–30). If clearances exceed the limits listed in the service manual, the piston must be replaced.

To replace a typical piston seal, dust boot, and piston, first lubricate the new piston seal with clean brake fluid or assembly lubricant (usually supplied with the caliper rebuild kit). Make sure the seal is not distorted. Insert it into the groove in the cylinder bore so it does not become twisted or rolled. Install a new dust boot by setting the flange squarely in the outer groove of the caliper bore. Next, coat the piston with brake fluid or assembly lubricant and install it in the cylinder bore (Figure 40–31). Be sure to use a wood block or other flat stock when installing the piston back into the pis-

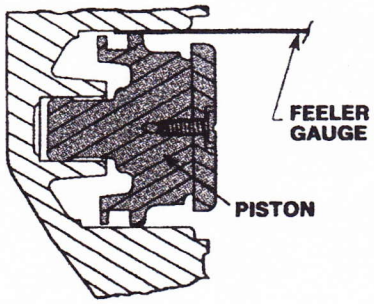


FIGURE 40–30 Checking piston clearance with feeler gauge.

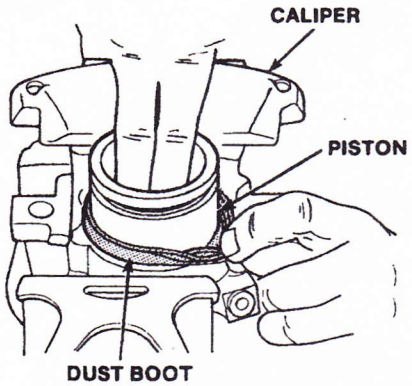


FIGURE 40–31 When installing a piston in a caliper bore, make sure the piston is lubricated.

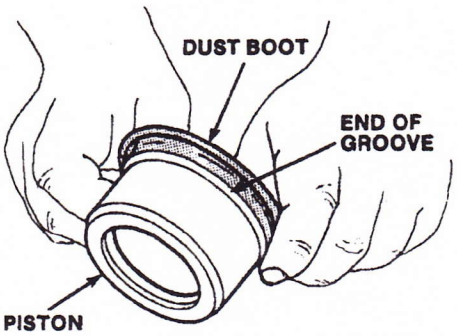


FIGURE 40–32 Some installation procedures require the dust boot to be pulled over the end of the piston.

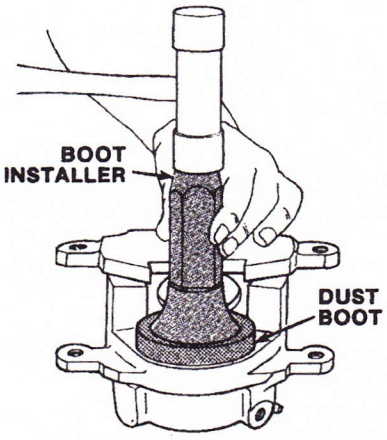


FIGURE 40–33 Seating a dust boot with a boot installer.

ton bore. Never apply a C-clamp directly to a phenolic piston, and be sure the pistons are not cocked. Spread the dust boot over the piston as it is installed. Seat the dust boot in the piston groove.

With some types of boot/piston arrangements, the procedure of installation is slightly different from that already described. That is, the new dust boot is pulled over the end of the piston (Figure 40–32). Lubricate the piston with brake fluid before installing it in the caliper. Then, by hand, slip the piston carefully into the cylinder bore, pushing it straight, so the piston seal is not damaged during installation. Use an installation tool or wooden block to seat the new dust boot (Figure 40–33).

The installation of some dust boots requires that its groove be filled with a bead of silicone sealer (Figure 40–34). After lubricating the dust boot, insert the piston. Bottom the piston in the cylinder bore and seat the dust boot in the recess next to the bore. Seal the area between the dust boot ring and caliper housing with a bead of silicone sealer (Figure 40–35).

WARNING!

Be sure no sealant gets between the piston and cylinder since it retards its action. ■

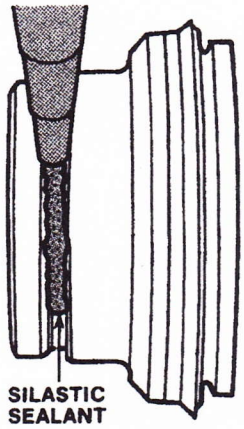


FIGURE 40–34 Applying sealer to dust boot groove.

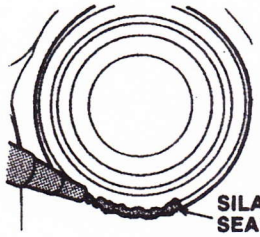


FIGURE 40–35 Applying sealer between dust boot ring and caliper housing.

Another point to keep in mind is that some caliper designs have a slot cut in the face of the pistons that must align with an **antisqueal shim**. Make sure the piston and shim align. It might be necessary to turn the piston to achieve proper alignment.

To complete the caliper assembly job, install the bleeder screw.

WARNING!

On fixed calipers, bridge bolts are used to hold the two caliper halves together. These are high-tensile bolts are ordered only by specific part number. They require accurate torque tightness to prevent leakage. Do not attempt to use standard bolts in place of bridge bolts. ■

Brake Pad Installation

It is a good practice to replace disc brake hardware when replacing disc brake pads. Hardware life is drastically affected by intense heat, weather conditions, abrasive particles, and normal wear. Replacement of the disc brake hardware ensures proper caliper movement and brake pad retention. Hardware replacement aids in preventing brake noise and uneven brake pad wear.

Fixed Caliper Brake Pads

The designs of fixed caliper disc brakes vary slightly. Generally, to replace the pads insert new pads and

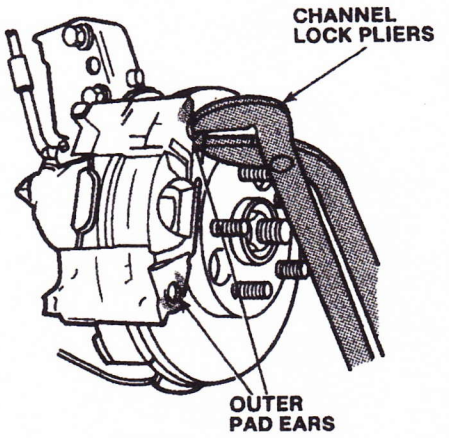


FIGURE 40–36 Clinching down pad ears with channel lock pliers.

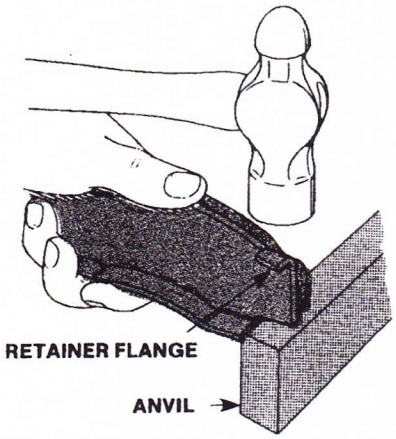


FIGURE 40–38 Bend the retaining flange if there is excessive free play.

plates in the caliper with the metal plates against the end of the pistons. Be sure the plates are properly seated in the caliper. Spread the pads apart and slide the caliper into position on the rotor. With some pads, mounting bolts are used to hold them in place. These bolts are usually tightened 80 to 90 foot-pounds. On some fixed disc brakes, the pads are held in place by retaining clips or, as with some Delco-Moraine designs, both retaining pins and clips are used. Figure 40–36 shows channel lock pliers being used to clinch down the ear clips of the outer pads. Reinstall the antirattle spring/clips and other hardware (if so equipped).

Sliding Caliper Brake Pads

Push the piston carefully back into the bore until it bottoms. Slide a new outer pad and lining assembly into the recess of the caliper (Figure 40–37). No free play between the brake pad flanges and caliper fingers should exist. If free play is found, remove the pad from the caliper and bend the flanges to eliminate all vertical free play (Figure 40–38). Install the pad.

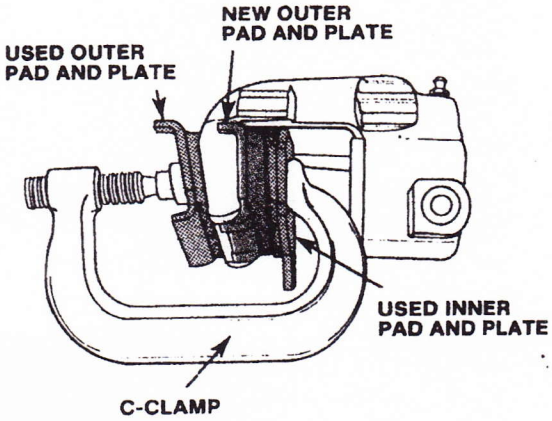


FIGURE 40–37 Installing an outboard pad on the caliper.

Place the inner pad into position on the adapter with the pad flange in the adapter's machined ways. Slide the adapter assembly into position in the adapter and over the disc. Align the caliper on the adapter's ways. Do not pull the dust boot from its groove when the piston and boot slide over the inboard pad. Install the antirattle springs (if so equipped) on top of the retainer plate and tighten the retaining screws to specification.

Floating Caliper Brake Pads

For floating or pin caliper disc brakes, compress the flanges of the outer bushing in the caliper fingers and work them into position in the hole from the outer side of the caliper. Compress the flanges of the inner guide pin bushings and install them.

Slide the new pad and lining assemblies into position in the adapter and caliper. Be sure the metal portion of the pad is fully recessed in the caliper and adapter and the proper pad is on the outer side of the caliper.

Hold the outer pad and carefully slide the caliper into position in the adapter and over the disc. Align the guide pin holes of the adapter with those of the inner and outer pads. Install the guide pins through the bushings, caliper, adapter, and inner and outer pads into the outer bushings in the caliper and antirattle spring.

Caliper Installation

To reinstall the caliper on the vehicle, first install the caliper assembly over the rotor with the outer brake pad against the rotor's braking surface. This prevents pinching the piston boot between the inner brake pad and the piston. Make sure the correct caliper is installed on the correct anchor plate according to the way they were marked during disassembly. Next, lubricate the rubber insulators (if so equipped) with

silicone dielectric compound. Install the caliper assembly back on its mounting brackets. Connect the brake hose to the caliper. If copper washers or gaskets are used, be sure to use new ones. The old ones might have taken a set and might not form a tight seal if reused. Fill the master cylinder reservoirs and bleed the hydraulic system. Check for fluid leaks under maximum pedal pressure. Lower the vehicle and road test it.

ROTOR INSPECTING AND SERVICING

The cause for braking complaints on cars equipped with drum brakes can usually be found by visually examining the brake drum. In cases where the same complaints involve disc brakes, visual inspection of the rotor does not give the answer. Tolerances on rotor thickness, parallelism, runout, flatness, and depth of scoring are very critical and must be measured with exacting gauges and micrometers. To perform a proper servicing job on rotors, accurate measuring tools and up-to-date rotor resurfacing equipment are required.

WARNING!

Never turn the rotor on one side of the vehicle and not the other. ■

The rotors should be inspected whenever brake pads are required and when the wheels are removed for other types of service. The following are typical disc brake rotor conditions that need careful inspection.

Lateral Runout

Excessive **lateral runout** is a wobbling of the rotor from side to side when it rotates. The excessive wobble knocks the pads farther back than normal, causing the pedal to pulse and vibrate during braking. Chatter can also result. It also causes excessive pedal travel because the pistons have farther to travel to reach the rotor. If runout exceeds specifications, the rotor must be turned or replaced.

Lack of Parallelism

Parallelism refers to variations in thickness of the rotor. If the rotor is out of parallel, it can cause excessive pedal travel, front end vibration, pedal pulsation, chatter, and on occasion, grabbing of the brakes. It must be resurfaced or replaced.

Scoring

Rotor wear or scoring can be caused by linings that are worn through to the rivets or backing plate or by friction material that is harsh or unkind to the mating surface. Rust, road dirt, and other contamination could also cause rotor scoring.

Light scoring (less than a depth of 0.015 inch) of the disc braking surface can occur during normal brake use. This does not affect brake operation. However, this can result in a higher-than-average brake shoe lining wear rate. But, any rotor having score marks more than 0.15 inch should be refinished or replaced.

Bluing or Heat Checking

If the lining surface is charred, blued, or hard-ended with a heavy glaze, or if the rotor is severely heat checked, machine the rotor or replace it.

Hard or chill spots of steel in a rotor cast-iron surface usually result from a change in the metallurgy caused by braking heat. Pulling, rapid wear, hard pedal, and noise occur. These spots can be removed by grinding. However, only the raised surfaces are removed, and they could reappear when heat is again encountered. The rotor must be replaced.

Rusty Rotor

If the vehicle has not been driven for a period of time, the discs rust in the area not covered by the lining and cause noise and chatter. Excessive wear and scoring of the discs and lining result. Wear ridges on the discs can cause temporary improper pad lining contact if ridges are not removed before installation of new lining. Lining deposits on the disc can cause erratic friction characteristics if a new lining is installed without resurfacing or cleaning the disc.

SHOP TALK

Specific inspection and repair procedures can be found in the service manuals. Always refer to them when performing a brake job. ■

CASE STUDY

An obviously embarrassed customer explains his problem to the brake shop technician. He just finished installing new disc pads on his light truck, but the disc brakes are dragging.

The young man insists he performed the work correctly and the rest of the braking system is in fine working order.

The technician inspects the front brakes and finds the owner cleaned all components well and installed the pads correctly. The technician checks the action of the caliper. Its piston shows no signs of sticking, but the caliper appears to be binding. Removal and inspection of the caliper locates the problem. Although the owner had carefully cleaned the slides of the caliper, he had failed to apply any lubricant to the surface. This was causing the calipers to bind and the brakes to drag.

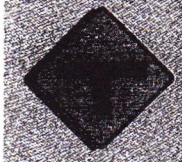
Omitting the simplest of tasks when performing repairs can often lead to failure and wasted time.

KEY TERMS

Antirattle spring
Antisqueal shim
Audible sensor
Caliper
Dust boot
Fixed caliper
Floating caliper
Lateral runout
Parallelism
Phenolic piston
Rotor
Sliding caliper
Spindle anchor plate
Splash shield

SUMMARY

- Disc brakes offer four major advantages over drum brakes: resistance to heat fade, resistance to water fade, increased straight-line stopping ability, and automatic adjustment.
- The typical rotor is attached to and rotates with the wheel hub assembly. Heavier vehicles generally use ventilated rotors. Splash shields protect the rotors and pads from road moisture and dirt.
- The caliper assembly includes cylinder bores and pistons, dust boots, and piston hydraulic seals.
- Brake pads are placed in each side of the caliper and together straddle the rotor. Some brake pads have wear sensors.
- Fixed caliper disc brakes do not move when the brakes are applied. Floating caliper disc brakes slide back and forth on pins or bolts. Sliding calipers slide on surfaces that have been machined smooth for this purpose.
- The rear disc/drum parking brake in a rear disc brake in which the inside of each rear wheel hub and rotor assembly is used as the parking brake drum.
- Rear disc parking brakes have a mechanism that forces the pads against the rotor mechanically.
- The general procedures involved in a complete caliper overhaul include tasks such as caliper removal, brake pad removal, caliper disassembly, caliper assembly, brake pad installation, and caliper installation.
- The first step in proper caliper service is to remove the caliper assembly from the vehicle.
- Disc brake pads should be checked periodically or whenever the wheels are removed. They should be replaced if they fail to exceed minimum lining thickness as listed in the service manual.
- To disassemble the caliper, the piston and dust boot must first be removed. Compressed air is used to pop the piston out of the bore.
- Before assembling the caliper, all metal parts and the phenolic piston are cleaned in denatured alcohol or brake fluid. The grooves and passageways of the caliper are cleaned out and dried with compressed air.
- It is a good practice to replace disc brake hardware when replacing disc brake pads.
- The caliper assembly is installed over the rotor with the outer brake pad against the rotor's braking surface.
- Disc brake rotor conditions that must be corrected include lateral runout, lack of parallelism, scoring, blueing or heat checking, and rusty rotors.



TECH MANUAL

The following procedures are included in Chapter 40 of the *Tech Manual* that accompanies this book:

1. *Inspect brake hardware and pads.*
2. *Remove and replace a front rotor from a FWD vehicle.*
3. *Inspect and measure brake rotors.*