INTRODUCTION

Disc brakes use a piston(s) to squeeze friction material (pads) on both sides of a rotating disc (rotor). The rotor is attached to and stops the wheel. Disc brakes are used on the front wheels of late-model vehicles, and on the rear wheels of an increasing number of automobiles. Figure 1.

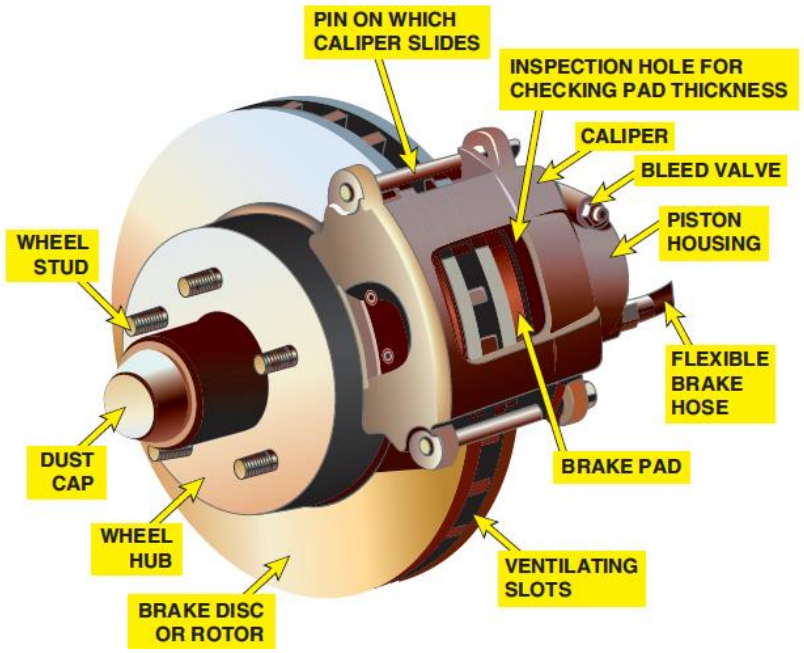

Figure 1. Disc brake assembly.

The major disc brake friction assembly components include the following:

- The brake caliper uses hydraulic pressure to create the mechanical force required to move the brake pads into contact with the brake rotor. Figure 2.

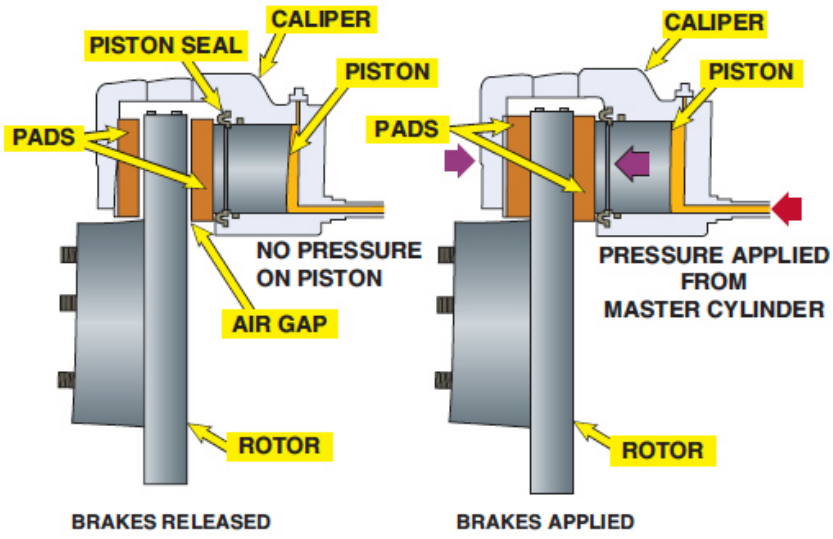

Figure 2. Brake caliper and rotor operation.

- The lining of a disc brake is part of an assembly called the brake pad. A brake pad is a relatively simple part that consists of a block of friction material attached to a stamped steel backing plate. Figure 3.

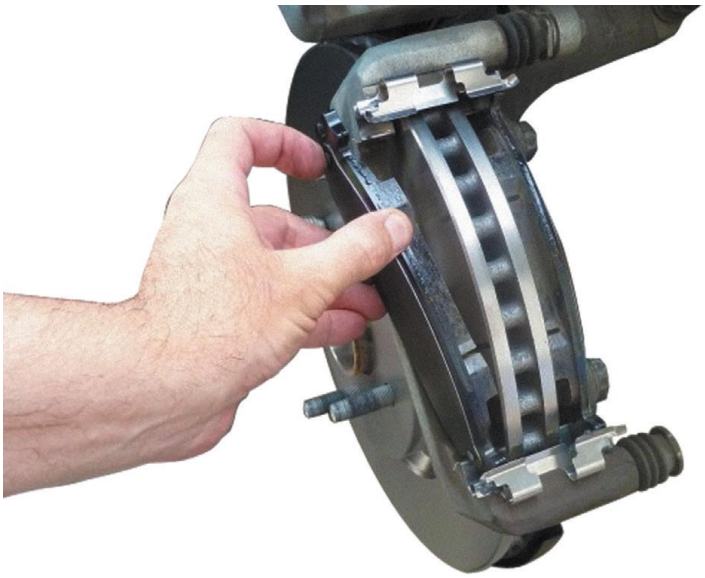

Figure 3. Typical brake pads.

- The brake rotor provides the friction surfaces for the brake pads to rub against. The rotor, the largest and heaviest part of a disc brake, is usually made of cast iron because that metal has excellent friction and wear properties. There are two basic types of rotors, figure 4:
    - Solid—Solid rotors are most often used on the rear of vehicles equipped with four-wheel disc brakes.
    - Vented—Vented rotors have radial cooling passages cast between the friction surfaces.

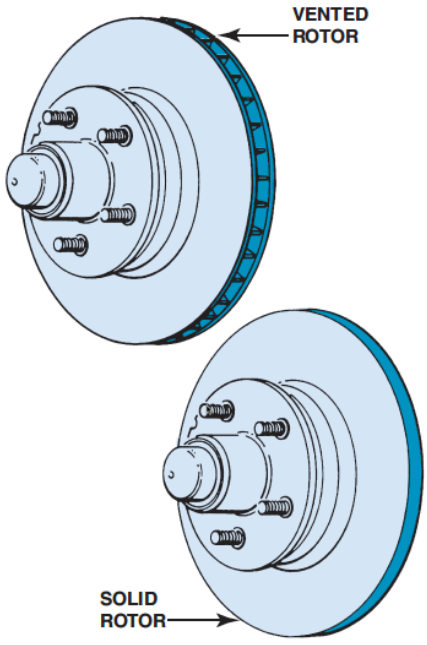

Figure 4. Types of brake rotors.

CALIPERS

FIXED CALIPER DESIGN. The fixed caliper has a body manufactured in two halves, and uses two, four, or six pistons to apply the brake pads. The fixed caliper gets its name from the fact that the caliper is rigidly mounted to the suspension. Figure 5.

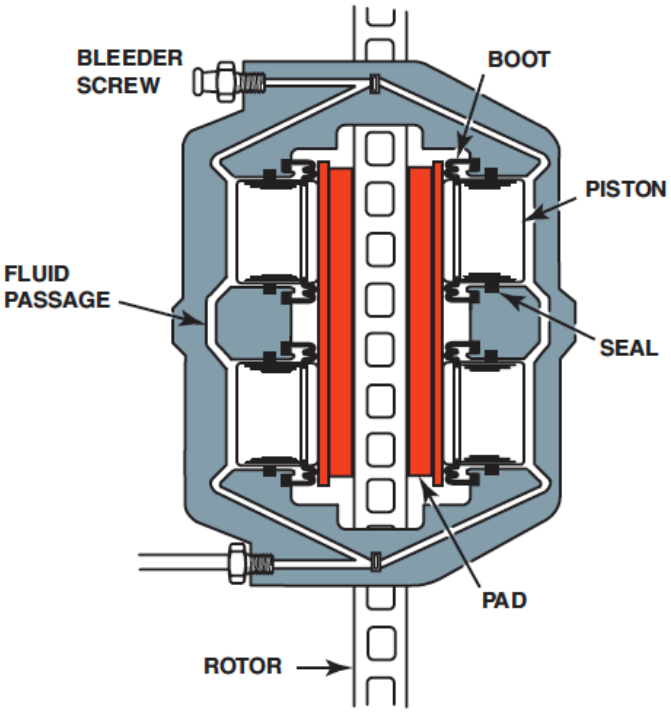

Figure 5. A four piston fixed caliper.

FLOATING AND SLIDING CALIPER DESIGN. The front brakes of most vehicles are fitted with either floating or sliding calipers, which are not rigidly mounted. The caliper is free to move within a limited range on an anchor plate that is solidly mounted to the vehicle suspension. Figure 6.

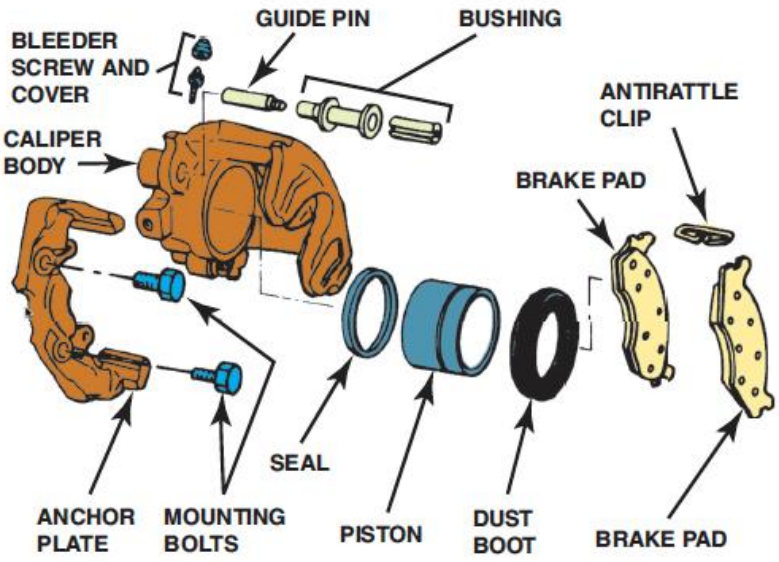

Figure 6. A single piston floating caliper.

REAR DISC BRAKE CALIPERS. In recent years, four-wheel disc brake systems have become more common. Adapting the disc brake to also function as the parking brake is done by installing a series of cables, levers, and internal parts to mechanically actuate the brake caliper. Figure 7.

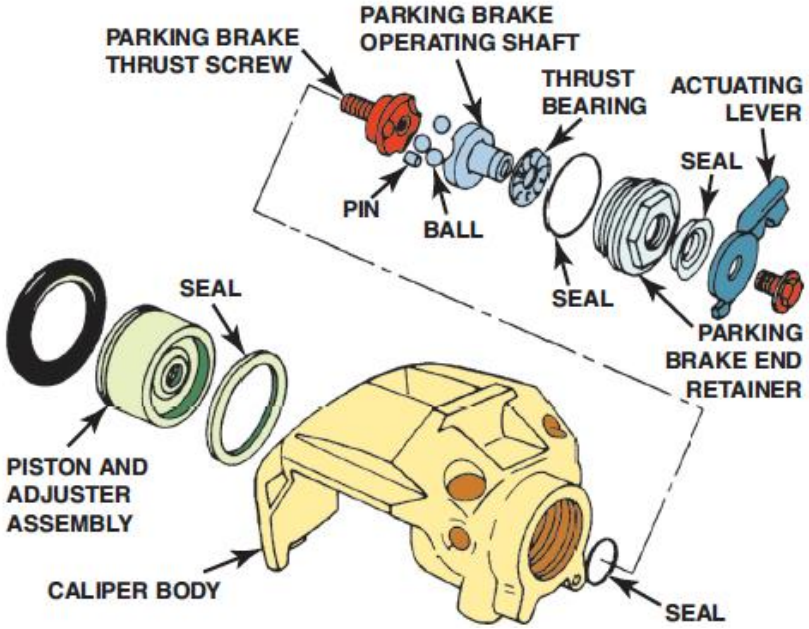

Figure 7. A rear brake caliper often includes a parking brake mechanism.

SELF-ADJUSTING AND WEAR COMPENSATION. Disc brakes are self-adjusting because any wear of the linings is automatically compensated for by the action of the brake caliper. As pad wear occurs and the piston moves, additional brake fluid is needed behind the piston. This additional brake fluid comes from the master cylinder and the brake fluid level drops as the disc brake pads wear. Figure 8.

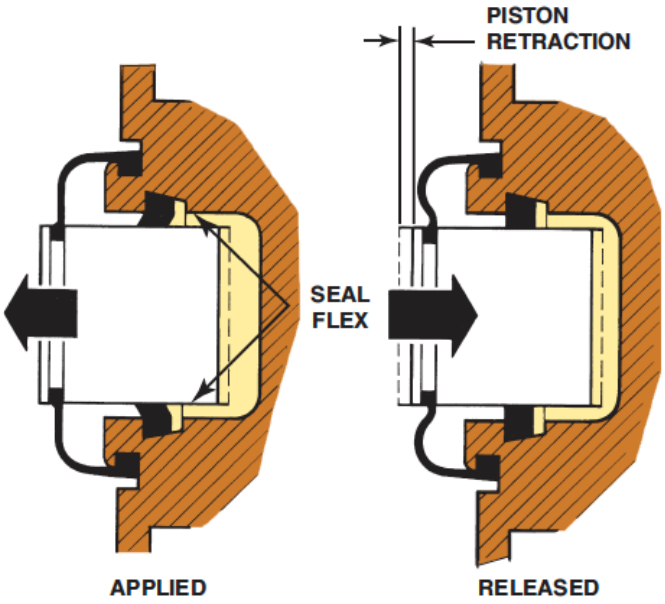

Figure 8. The square-cut O-ring not only seals hydraulic brake fluid but also retracts the caliper piston when the brake pedal is released.

ASE TEST TOPICS

1. Diagnose poor stopping, pulling, dragging or incorrect pedal travel caused by disc brake hydraulic problems; determine needed repairs.

Possible symptoms and causes of disc brake hydraulic problems include:

PULLS TO ONE SIDE DURING BRAKING. Restricted brake lines or hoses; stuck or seized caliper or caliper piston

EXCESSIVE PEDAL TRAVEL. Insufficient fluid in the master cylinder; air trapped in the system

DRAGGING BRAKES. Pressure trapped in the brake lines (to diagnose, momentarily open the caliper bleeder valve to relieve the pressure); restricted brake tubes or hoses

2. Diagnose poor stopping, noise, pulling, grabbing, dragging, pedal pulsation or incorrect pedal travel caused by disc brake mechanical problems; determine needed repairs.

Possible symptoms and causes of disc brake mechanical problems include:

PULLS TO ONE SIDE DURING BRAKING. Incorrect or unequal tire pressures; front end out of alignment; unmatched tires on the same axle; loose calipers

BRAKE ROUGHNESS OR CHATTER (PEDAL PULSATES). Excessive lateral runout of rotor; parallelism of the rotor not within specifications; brake pads worn to metal backing plate

EXCESSIVE PEDAL EFFORT. Binding or seized caliper mounting; improper rotor surface finish; excessively worn pad or lining; piston in the caliper stuck or sluggish

EXCESSIVE PEDAL TRAVEL. Excessive rotor lateral runout

DRAGGING BRAKES. Improperly lubricated caliper mounting system; improper clearance between the caliper and torque abutment surfaces

FRONT DISC BRAKES VERY SENSITIVE TO LIGHT BRAKE APPLICATIONS. Incorrect lining material; improper rotor surface finish

3. Retract brake caliper piston(s) according to manufacturers' recommendations.

The caliper piston can be retracted before or after removing the caliper. This is a necessary procedure when replacing brake pads. Many manufacturers recommend that the bleeder valve be opened, and the brake fluid forced into a container rather than back into the hydraulic system. This helps prevent contaminated brake fluid from being forced into the ABS hydraulic unit, where the contamination could cause problems. Figure 9.

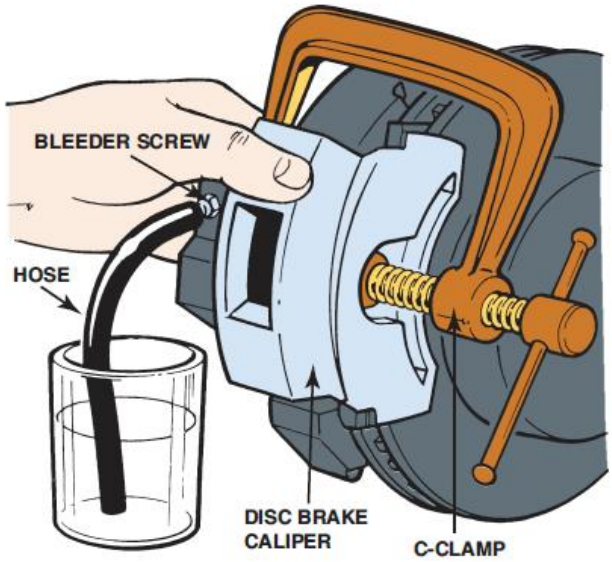

Figure 9. Push the piston into its bore while letting the fluid bleed into a container.

4. Remove caliper assembly from mountings; inspect for leaks and damage to caliper housing.

To remove a caliper assembly, remove the mounting bolts and then pull the caliper away from the brake rotor. Figures 10 and 11.

Figure 10. Loosen and remove the mounting bolts.

Figure 11. Slide the caliper off of the rotor.

If the caliper is not being removed, it must be supported properly so that the weight of the caliper is not pulling on the flexible rubber brake line. A suitable piece of wire, such as a coat hanger, may be used. Figure 12.

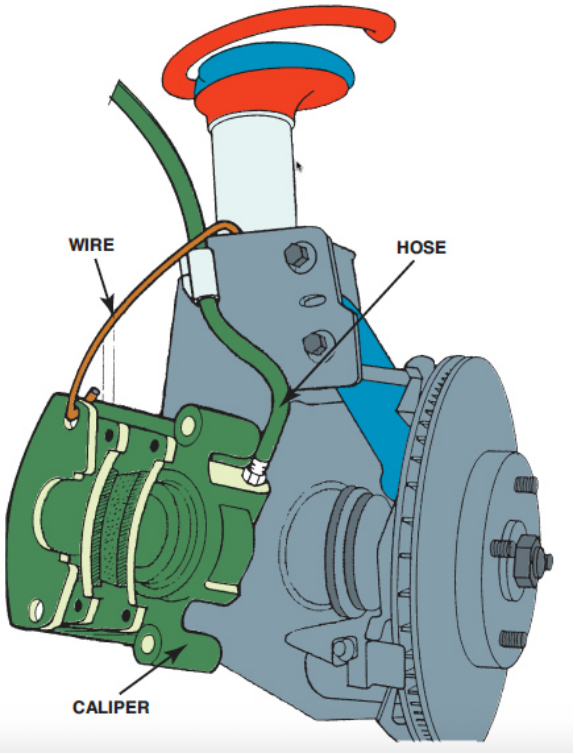

Figure 12. Support the caliper with a wire hook.

Check for brake fluid in and around the piston boot area. If the boot is damaged or a fluid leak is visible, then a caliper assembly repair or replacement is required.

5. Clean and inspect caliper mountings, slides/pins and threads for wear and damage.

Mounting bolts, guide pins, and sleeves should be cleaned and lubricated. Figure 13.

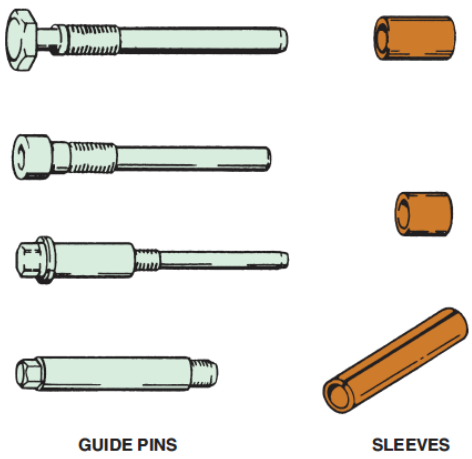

Figure 13. Metal guide pins and sleeves are used to retain and locate floating calipers.

Some vehicles use sliding caliper mounts that are called abutments, reaction pads, or ways. The sliding surfaces of the caliper and support should be cleaned and coated with a synthetic grease. Figure 14.

Figure 14. Cleaning the caliper mounting surface.

6. Remove, clean and inspect pads and retaining hardware; determine needed repairs, adjustments and replacements.

A thorough visual inspection of the brake pads can only be accomplished by removing the friction pads. After removing the pads measure the thickness of the lining. Figure 15.

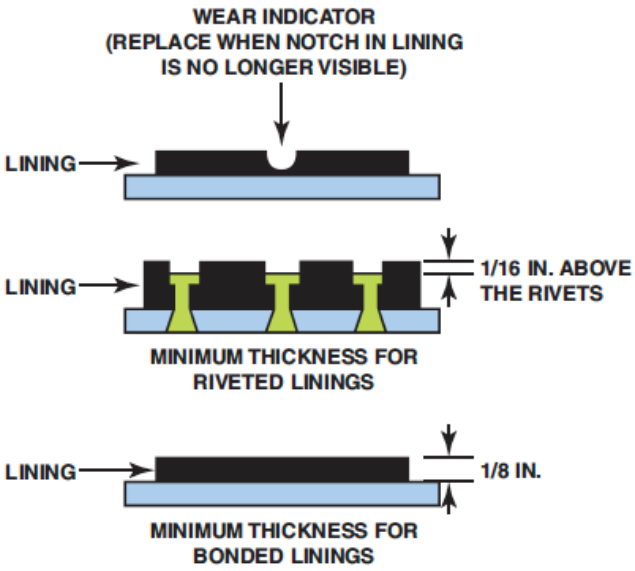

Figure 15. Brake pad inspection.

7. Clean caliper assembly; inspect external parts for wear, rust, scoring and damage; replace any damaged or worn parts; determine the need to repair or replace caliper assembly.

If the caliper boot is torn or cracked moisture intrusion is possible. Phenolic caliper pistons are made from a phenol-formaldehyde resin combined with various reinforcing fibers. These should be inspected for cracks. Any of these faults usually means the caliper should be replaced. Figure 16.

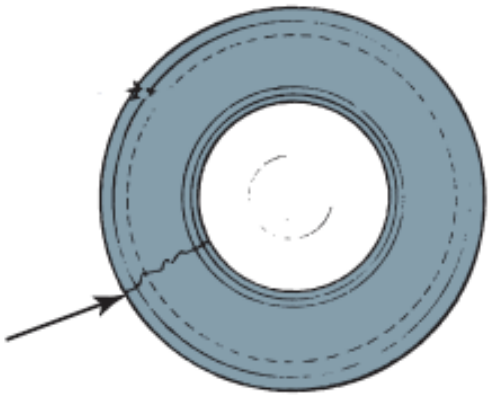

Figure 16. A cracked piston requires that the caliper be replaced.

8. Clean, inspect and measure rotor with a dial indicator and a micrometer; follow manufacturers' recommendations in determining the need to index, machine or replace the rotor.

Lateral runout, often abbreviated LRO, is side-to-side wobble of the rotor as it rotates on the spindle. Overtightened or unevenly tightened lug nuts or bolts are a common source of runout. Most maximum values range between 0.003 and 0.008 inch (0.05 and 0.20 mm). Figure 17.

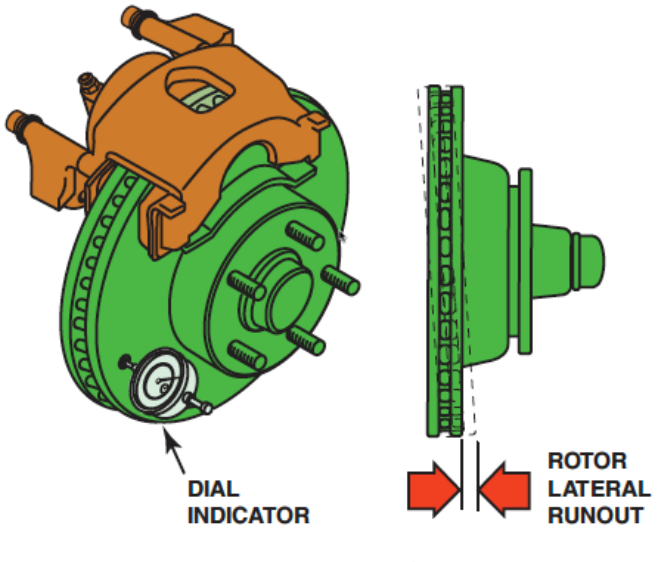

Figure 17. Lateral runout is measured with a dial indicator.

Lack of parallelism, also called thickness variation (TV), is a variation in the thickness of the rotor when it is measured at several places around its circumference. A rotor with friction surfaces that are not parallel is the most common disc brake cause of a pulsating brake pedal. Most manufacturers specify that the two friction surfaces of a rotor must be parallel within half a thousandth of an inch, 0.0005 inch (0.013 mm), or less. Figure 18.

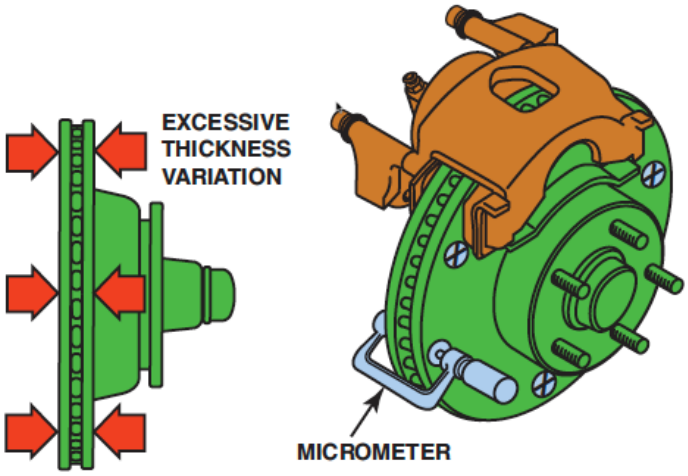

Figure 18. Thickness variation is measured with a micrometer.

Most rotors have a minimum thickness cast or stamped into the rotor. This thickness is minimum wear thickness. At least 0.015 inch (0.4 mm) must remain after machining to allow for wear. Rotor thickness is measured at the same time as checking for parallelism.

A rotor that has grooves deeper than 0.060 inch (1.5 mm) or is heavily rusted is normally replaced. Thickness variation exceeding specifications with a brake pedal pulsation complaint may be fixed by machining, as long as the rotor has adequate thickness. Figure 19.

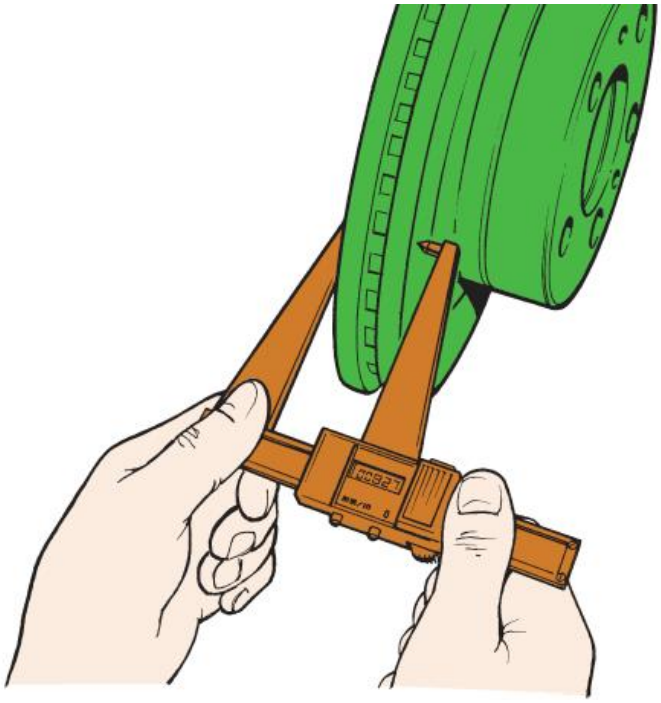

Figure 19. This special micrometer has pointed measuring tips to measure any deep grooves.

9. Remove and replace rotor.

After removing the brake caliper the rotor can be removed. Some vehicles have a rotor that is cast as part of the front wheel hub. These may be called “hubbed” rotors. This type requires removal of the wheel bearing, then cleaning and repacking the bearing when reinstalling the rotor. Figure 20.

Figure 20. One piece hub and rotor.

Another design has the rotor mounted on the wheel flange. This type may be called a “hubless” rotor. After removing the brake caliper the rotor just slides off of the hub. When reinstalling a hubless rotor both the rotor and the hub should be cleaned of all rust and debris. Figure 21 and 22.

Figure 21. Cleaning the inside of the rotor.

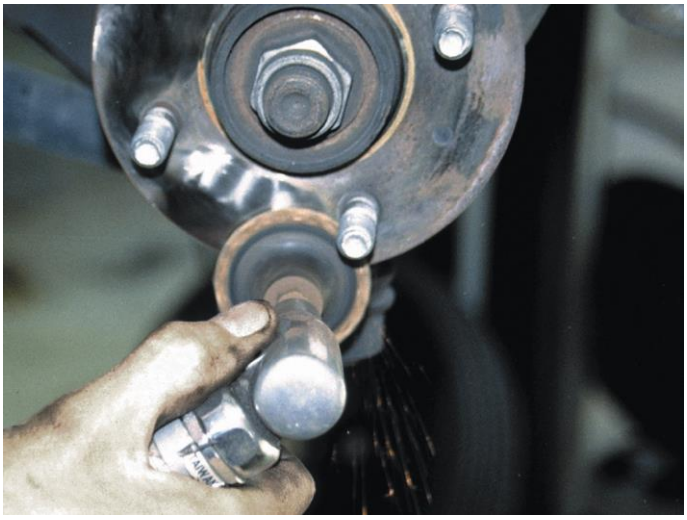

Figure 22. Cleaning the hub flange.

10 . Machine rotor, using on-car or off-car method, according to manufacturers' procedures and specifications.

1. Mount the disc brake rotor to the spindle of the lathe using the cones and adapters recommended. Figure 23.

Figure 23. Use the correct cone and adapters to mount the rotor.

2. Install a rotor damper and position the cutting tools close to the rotor surface.

3. Make a scratch cut on the rotor face.

4. Loosen the retaining nut, turn the rotor one-half turn (180°), and retighten the nut. Make another scratch cut.

a. The second scratch cut should be side-by-side with the first scratch cut if the rotor is properly installed. Figure 24.

b. If the second scratch cut is on the opposite side (180°) from the first scratch cut, the rotor may not be installed on the lathe correctly.

5. After proper installation of the disc brake rotor on the brake lathe, proceed with machining the rotor.

Figure 24. Scratch cuts are side-by-side. OK to proceed with machining.

Many vehicle manufacturers recommend on-the-vehicle machining for rotors if the disc brake rotor must be machined due to deep scoring or pulsating brake pedal complaint. Hub-mount, on-the-vehicle lathes attach to the hub using the lug nuts of the vehicle. Figure 25.

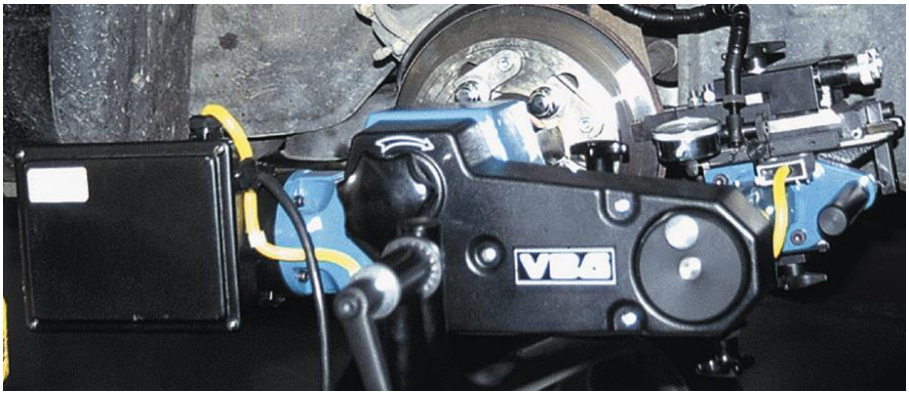

Figure 25. An on-car lathe uses an electric motor to rotate the hub while machining the rotor.

11. Install pads, calipers and related attaching hardware; lubricate components following manufacturers' procedures and specifications; bleed system and inspect for leaks.

Always lubricate caliper bushings, shims, and other brake hardware as instructed by the manufacturer. Install the pads into the anchor plate and then install the caliper. Figures 26, 27, and 28.

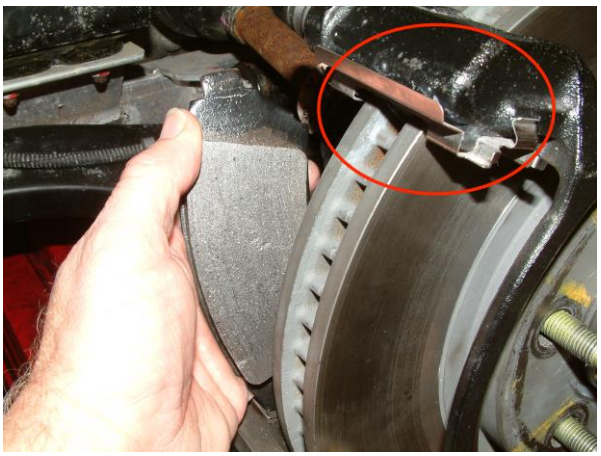

Figure 26. Install the new brake pads and related hardware (circle).

Figure 27. Install the caliper.

Figure 28. Tighten the mounting bolts to the proper torque.

12. Reinstall wheel, torque lug nuts, and make final checks and adjustments.

For wheel mounting torque, make certain that the wheel studs are clean and dry, and torqued to the manufacturer's specifications. Most manufacturers warn that the wheel studs should not be oiled or lubricated with grease.

All vehicle manufacturers recommend that the lug nuts be tightened to factory specifications using a torque wrench. Check service information for the specified torque for the lug nuts on the vehicle being serviced. For most passenger vehicles, this torque is usually 80 to 100 lb-ft. Torque the lug nuts in a star pattern. This method helps insure that the wheel is installed straight onto the hub. Figure 29.

Figure 29. A torque wrench being used to tighten lug nuts on a pickup truck.

13. Road test vehicle and burnish/break-in pads according to manufacturer's recommendations.

After installing replacement disc brake pads, depress the brake pedal several times before driving the vehicle. The brake pedal must be depressed ("pumped") several times before enough brake fluid can be moved from the master cylinder into the calipers to move the piston tight against the pads and the pads against the rotors.

Some manufacturers recommend that their replacement brake pads be bedded-in or burnished before returning the vehicle to the owner. This break-in procedure helps the replacement pads to conform to the rotor and helps cure the resins used in the manufacture of the pads.

After installing new pads, perform the following steps:

> STEP 1 Make 6 to 10 brake applications from approximately 35 mph (56 km/h) with moderate brake pedal force.
>
> STEP 2 Make an additional two to three hard brake applications from approximately 45 mph (72 km/h).

14. Diagnose wheel bearing noises and vibration problems; determine needed repairs.

Symptoms of defective wheel bearings include the following:

- A hum, rumbling, or growling noise that increases with vehicle speed
- Roughness felt in the steering wheel that changes with the vehicle speed or cornering
- Looseness or excessive play in the steering wheel, especially while driving over rough road surfaces
- A loud grinding noise in severe cases, indicating a defective front wheel bearing

15. Remove, clean, inspect, repack wheel bearings or replace wheel bearings and races; replace seals; replace hub and bearing assemblies; adjust wheel/hub bearings according to manufacturers' specifications.

A two-piece wheel bearing (inner and outer) is serviced by removing the bearings, washing out the old grease, cleaning the bearings, and then repacking with new grease. Figure 30.

Figure 30. Cleaning the wheel bearing.

During installation, the bearings require careful adjustment. When the wheel bearing is properly adjusted, the wheel will have about 0.001 to 0.005 inch (0.03 to 0.13 mm) end play. Figure 31.

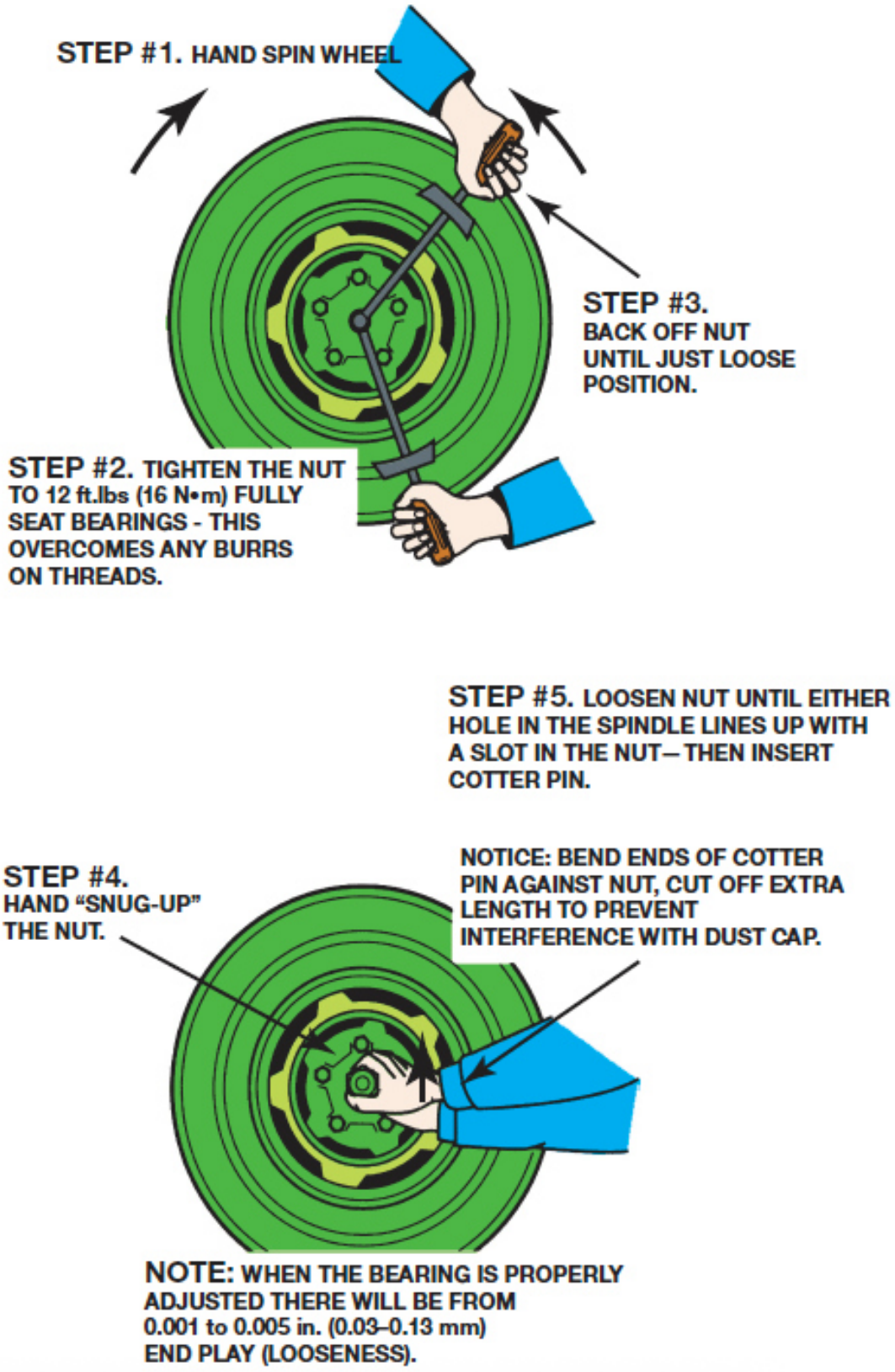

Figure 31. Wheel bearing adjustment.

Most front-wheel-drive vehicles use a sealed bearing assembly that is bolted to the steering knuckle. A sealed bearing/hub assembly may also be used on the rear wheels or a FWD vehicle. The bearing/hub assembly is replaced as a unit after removing the caliper, rotor, and mounting bolts. Figure 32.

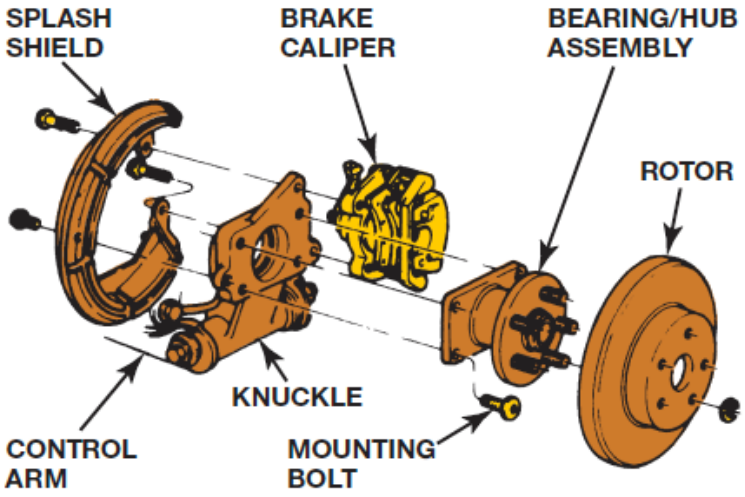

Figure 32. Rear wheel sealed bearing/hub assembly replacement.

16. Distinguish between brake component vibration and tire/wheel vibration; determine needed repairs.

Though there are many possible sources of a vibration, some simple observations may help to locate the problem quickly:

1. If the vibration is felt or seen in the steering wheel, dash, or hood of the vehicle, the problem is most likely to be caused by defective or out-of-balance front wheels or tires.

2. If the vibration is felt in the seat of the pants or seems to be all over the vehicle, the problem is most likely to be caused by defective or out-of-balance rear wheels or tires.

3. A vibration during braking only usually indicates out-of-round brake drums, brake rotor thickness variation, or other braking system problems.

- The front rotors are the cause of the vibration if the steering wheel is also vibrating (moving) during braking.
- The rear drums or rotors are the cause of the vibration if the vibration is felt throughout the vehicle and brake pedal, but not the steering wheel.