Drum & Disc Brake Service

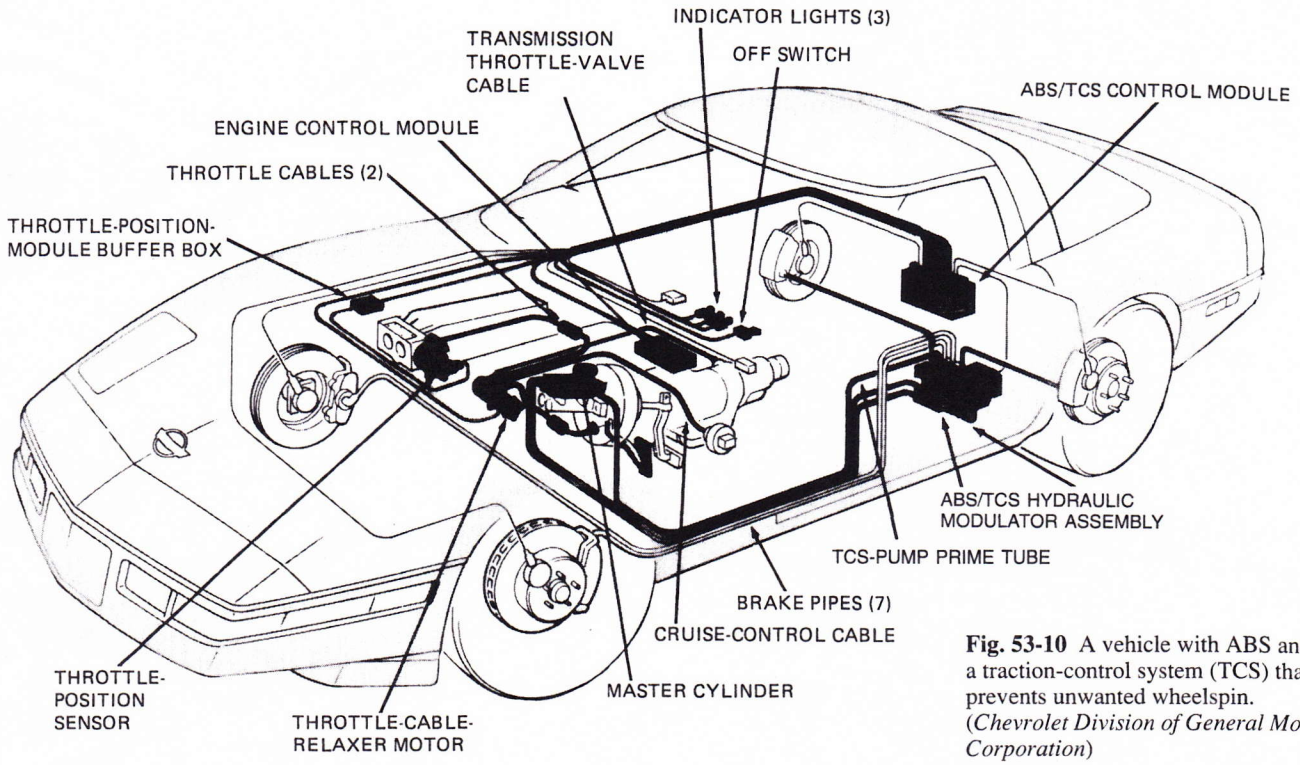


Fig. 53-10 A vehicle with ABS and a traction-control system (TCS) that prevents unwanted wheelspin. (*Chevrolet Division of General Motors Corporation*)

occurs during acceleration (➢17-11). To prevent unwanted wheelspin, some vehicles with ABS also have a *traction-control system* (TCS). When a wheel is about to spin, the traction-control system (Fig. 53-10) applies the brake at that wheel. This slows the wheel until the chance of wheel spin has passed.

➢ 53-10 OPERATION OF TRACTION-CONTROL SYSTEM

The antilock-braking system and traction-control system share many parts. The wheel-speed sensors report wheel speed to the *ABS/TCS control module* (Fig. 53-10). When a wheel slows so quickly that it is about to skid, the ABS holds or releases the brake pressure at that wheel (➢53-1). If wheel speed increases so quickly that the wheel is about to spin, the TCS applies the brake at that wheel. This slows the wheel and prevents wheel spin.

The TCS can also reduce engine speed and torque if braking alone does not prevent wheelspin. When this is necessary, the ABS/TCS control module signals the engine control module. It then retards the spark and reduces the amount of fuel delivered by the fuel injectors.

DRUM-BRAKE TROUBLE DIAGNOSIS

➢ 53-11 CAUTION FOR WORKING AROUND BRAKE DUST

Some brake linings in drum and disc brakes are made of asbestos. Ingesting asbestos fibers, either by breathing or swallowing, can cause serious bodily harm. Never use an air nozzle to blow dust off the brakes. Never sand or grind brake linings or clean brake parts with a dry cloth or compressed air.

Instead, clean the parts with an EPA-approved vacuum (Fig. 4-6) that has a *High Efficiency Particulate Air* (HEPA) filter. Another method is to wipe parts with a cloth dampened with water. Dispose of the cloths safely in a special container for hazardous materials (➢4-13). Using dampened cloths or a vacuum with a HEPA filter prevents asbestos fibers from becoming airborne. Always wash your hands after handling dusty brake parts and brake linings.

➢ 53-12 DIAGNOSING DRUM-BRAKE TROUBLES

When the driver depresses the brake pedal, hydraulic pressure forces the brake lining against the drum or discs. The resulting friction and heat cause brake parts to wear. Warning lights and fluid-level and wear indicators help alert the driver to the need for brake service. Improper operation and other driver complaints indicate the need for brake inspection and testing. Correcting a brake problem early helps prevent damage to other parts and possible brake failure.

A complaint of faulty braking should be immediately diagnosed to determine its cause. Figure 53-11 is a drum-brake trouble-diagnosis chart. It also covers brake hydraulic systems. Following sections describe the various complaints, possible causes, and checks or corrections. Later sections describe disc-brake and power-brake trouble diagnosis.

Complaint	Possible Cause	Check or Correction
1. Pedal goes to floor, loss of pedal reserve (➢53-13)	a. Self-adjuster not working	Repair
	b. Bent master-cylinder pushrod	Replace
	c. Linkage or shoes out of adjustment	Adjust
	d. Brake linings worn	Replace
	e. Lack of brake fluid	Add fluid, bleed system
	f. Air in hydraulic system	Add fluid, bleed system
	g. Defective master cylinder	Repair or replace
2. One brake drags (➢53-14)	a. Shoes out of adjustment	Adjust
	b. Clogged brake line	Clear or replace
	c. Wheel cylinder defective	Repair or replace
	d. Weak or broken return spring	Replace
	e. Loose wheel bearing	Adjust or replace
3. All brakes drag (➢53-15)	a. Incorrect linkage adjustment	Adjust
	b. Defective master cylinder	Repair or replace
	c. Mineral oil in system	Replace damaged rubber parts; flush, fill, and bleed system
4. Pulls to one side when braking (➢53-16)	a. Oil on brake linings	Replace linings and oil seals; avoid overlubrication
	b. Brake fluid on brake linings	Replace linings; repair or replace wheel cylinder
	c. Brake shoes out of adjustment	Adjust
	d. Tires not uniformly inflated	Adjust tire pressure
	e. Brake line clogged	Clear or replace line
	f. Defective wheel cylinder	Repair or replace
	g. Brake backing plate loose	Tighten
	h. Mismatched linings	Install matched linings
5. Soft or spongy pedal (➢53-17)	a. Air in hydraulic system	Add fluid, bleed system
	b. Brake shoes out of adjustment	Adjust
	c. Defective master cylinder	Repair or replace
	d. Loose connections or damaged brake line	Tighten connection, replace line
	e. Loss of brake fluid	See item 9, below
6. Poor braking requiring excessive pedal force (➢53-18)	a. Brake linings wet with water	Allow to dry
	b. Shoes out of adjustment	Adjust
	c. Brake linings hot	Allow to cool
	d. Brake linings burned	Replace
	e. Brake drum glazed	Refinish or replace
	f. Power brake inoperative	Repair or replace
	g. Wheel-cylinder pistons stuck	Repair or replace
7. Brakes grab (➢53-19)	a. Shoes out of adjustment	Adjust
	b. Wrong linings	Install correct linings
	c. Grease on brake lining	Replace lining; check seals; avoid overlubrication
	d. Oil on brake lining	Replace linings; check seals, avoid overlubrication
	e. Brake fluid on brake lining	Replace linings; repair or replace wheel cylinders
	f. Drums scored	Refinish or replace drums
	g. Backing plate loose	Tighten
	h. Power-brake booster defective	Repair or replace
8. Noisy brakes (➢53-20)	a. Linings worn	Replace
	b. Shoes warped	Replace
	c. Shoe rivets loose	Replace shoe and lining
	d. Drums worn or rough	Refinish or replace
	e. Loose parts	Tighten
9. Loss of brake fluid (➢53-21)	a. Master cylinder leaks	Repair or replace
	b. Wheel cylinder leaks	Repair or replace
	c. Loose connections, damaged brake line	Tighten connections, replace line
NOTE: After repair, add brake fluid and bleed system.		
10. Brakes do not self-adjust (➢53-22)	a. Adjusting screw stuck	Free and clean
	b. Adjusting lever does not engage adjusting wheel	Repair; free or replace adjuster
	c. Adjuster incorrectly installed	Install correctly
11. Brake warning light comes on while braking (➢53-23)	a. One section of hydraulic system has failed	Inspect and repair
	b. Pressure-differential valve defective	Replace

Fig. 53-11 Drum-brake trouble-diagnosis chart.

CAUTION!

Always wear eye protection (safety goggles or safety glasses) when working on vehicles with an antilock-braking system (ABS). Follow the procedures in the vehicle service manual to open or service the hydraulic system. Some systems have high hydraulic pressure even when the ignition key is OFF. Loosening a fitting or bleeder valve (Fig. 45-23) may cause a high-pressure stream of brake fluid to spray out that will penetrate your skin. This stream of brake fluid can also damage the vehicle paint and the brake system.

➢ 53-13 BRAKE PEDAL GOES TO THE FLOOR

When the brake pedal goes to the floor, there is no *pedal reserve* (Fig. 53-12). This is the distance from the brake pedal to the floor after the brakes are applied. If full pedal travel does not produce adequate braking, a loss of brake fluid may have occurred. One section of the hydraulic system may have failed (both seldom fail at the same time). If only one section is working, greater pedal force is required and the brakes apply only when the pedal is almost to the floor.

Also, the driver may have ignored the brake-warning light, or the light bulb or pressure-differential valve has failed. Other causes of loss of pedal reserve include a bent master-cylinder pushrod, improperly adjusted linkage or brake shoes, worn brake linings, air in the hydraulic system, and a defective master cylinder.

➢ 53-14 ONE BRAKE DRAGS

A brake *drags* when a brake shoe does not move away from the drum as the brakes are released. This could be caused by a piston in the wheel cylinder sticking in its applied position. Other causes include incorrect shoe adjustment, a clogged brake line that does not release pressure from the wheel cylinder, and weak or broken brake-shoe return springs. Also, a loose wheel bearing could permit the wheel to wobble. This could allow the brake drum to contact the brake shoes. When the parking brake is applied overnight, sometimes the brake lining will absorb moisture and stick or freeze to the drum.

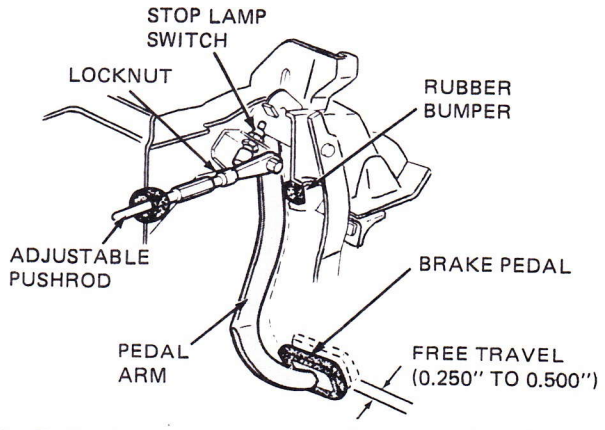


Fig. 53-12 Measuring free travel, or free play, in the brake pedal.

➢ 53-15 ALL BRAKES DRAG

All the brakes can drag if the brake pedal does not have enough *free travel* (Fig. 53-12). This is the distance the brake pedal moves before the primary seals on the master-cylinder pistons close the vent ports (➢52-24). Dragging results if the master-cylinder pistons do not fully retract. The vent ports are not opened to relieve the pressure by allowing fluid-flow back into the reservoir. Unless this happens, the hydraulic pressure is trapped in the lines to the wheel cylinders. The shoes cannot retract.

Dragging brakes can also be caused by swollen seals or cups in the master cylinder. This results if oil is added to the system. Oil causes the piston cups to swell. Then they cannot clear the ports and release the pressure. Clogged ports cause the same condition.

Careful! Never put any type of oil in the brake system. It causes rubber parts to swell and break. This could result in complete brake failure.

➢ 53-16 PULLS TO ONE SIDE WHEN BRAKING

If the vehicle pulls to one side when the brakes are applied, there is more braking force on that side. This results from brake lining contaminated with oil or brake fluid, unevenly adjusted shoes, defective wheel cylinders, or clogged brake lines. Any of these can prevent uniform braking at all wheels. A loose brake backing plate and mixing types of brake linings can also cause the vehicle to pull to one side when braking. Other possible causes are improper wheel alignment, a broken spring, and worn control-arm bushings.

In a vehicle with front engine and rear-wheel drive, rear linings can become oil-soaked if the lubricant level in the rear axle is high. The lubricant leaks past the oil seal. In front drum brakes, grease can get on the linings if the wheel bearings are over-lubricated or if the grease seals leak. Wheel cylinders will leak if the cups are defective or if an actuating pin is improperly installed (Fig. 52-15).

Contaminated linings may cause a pull to one side or the other. For example, if oil or brake fluid gets on linings at a left wheel, the linings may tend to grab and cause the vehicle to pull to the left (➢51-7). However, water on the linings at a left wheel may prevent normal friction. Then the vehicle pulls to the right. The direction of pull often depends on the type of lining material and the contaminant.

➢ 53-17 SOFT OR SPONGY PEDAL

Air in the hydraulic system causes a soft or spongy pedal. The air may get in because of a low fluid level in the

master cylinder. This permits air to be forced into the system as the pistons move forward during braking. Air is removed by adding brake fluid and bleeding the system (➢53-48).

Plugged air vents in the master-cylinder cap or cover also may cause a vacuum during the return stroke of the pistons. Air then bypasses the primary-piston cup (Fig. 52-29) and enters the system. In addition, some master cylinders have a residual check valve (➢52-25) in the lines to the drum brakes. If the valve leaks and does not maintain a slight pressure in the system, air could leak in around the cups in the wheel cylinder.

➢ 53-18 POOR BRAKING REQUIRING EXCESSIVE PEDAL FORCE

A need for excessive pedal force can be caused by improper brake-shoe adjustment or the wrong brake lining. Another possible cause is *brake fade*. This is a temporary reduction or fading out of braking effectiveness. It occurs when the brake lining overheats from excessively long and hard brake application, as when coming down a hill. Normal braking usually returns after the brakes cool. Fading may also occur after driving through water and getting the linings wet. The water reduces the friction between the lining and the drum. Normal braking usually returns after the linings have dried.

Excessively long braking creates high temperatures that may burn or *char* the braking linings. Then the linings must be replaced. Overheating can also *glaze* the brake drums so they become too smooth for good braking action. Glazed drums must be refinished to remove the glaze. Sometimes normal wear causes drums to glaze, even without excessive overheating.

Failure of the power-brake booster (➢53-35) increases the pedal force needed to produce braking. The power-brake booster must be rebuilt or replaced.

➢ 53-19 BRAKES GRAB

Linings contaminated with grease, oil, or brake fluid tend to grab with light pedal force. These linings must be replaced. Grabbing can also result if the shoes are out of adjustment, if the wrong linings are being used, or if drums are *scored* or rough (Fig. 53-13). A loose brake backing plate can shift as the linings contact the drum and cause grabbing. A defective power-brake booster can also cause grabbing.

➢ 53-20 NOISY BRAKES

Brake noise can result if linings are so worn that the rivets contact the drum, and if the shoes are warped so that contact with the drum is not uniform. Other causes include rivets so loose that they rub on the drum, and a worn or rough drum (Fig. 53-13). Any of these conditions can cause a squeak or squeal when brakes are applied. Also, loose parts, such as the brake backing plate, may rattle.

➢ 53-21 LOSS OF BRAKE FLUID

Leaks result in loss of brake fluid. They can occur from the master cylinder, wheel cylinders (or calipers), lines, and connections (Fig. 53-14). Check the brake lines for secure attachment and check the master-cylinder mounting. The brake lines and attaching nuts must be tight. Brake-line fittings must not show any signs of leakage. After correcting the cause of the leak, add brake fluid and bleed the system (➢53-48).

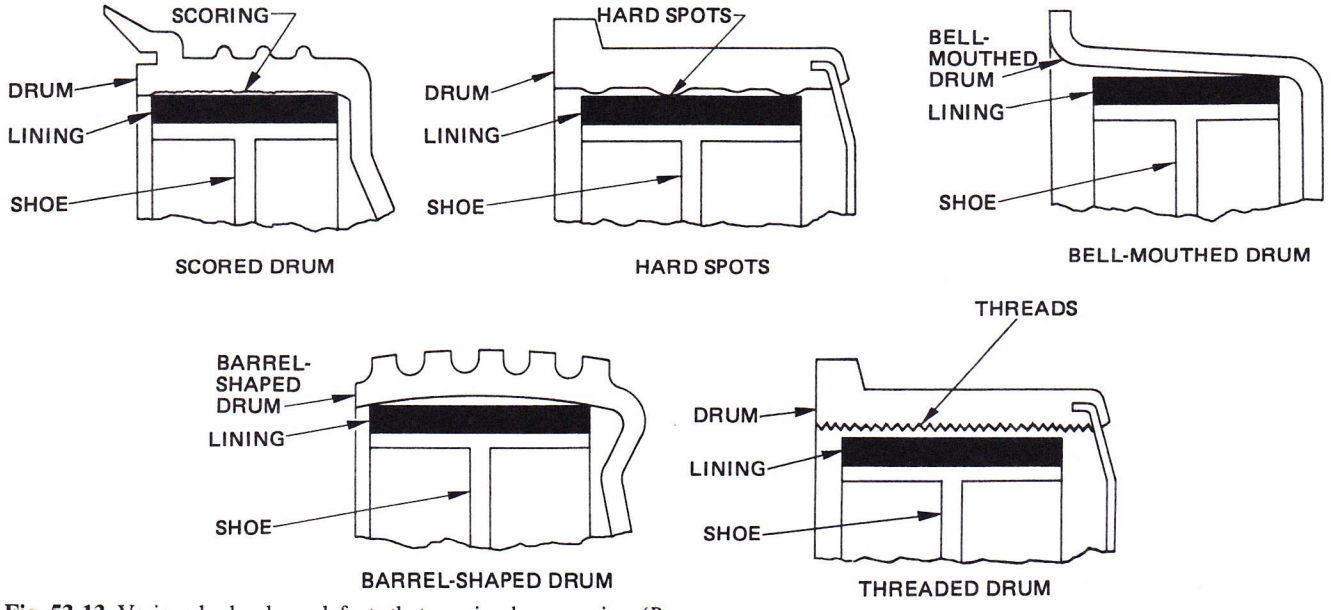


Fig. 53-13 Various brake-drum defects that require drum service. (*Bear Manufacturing Company*)

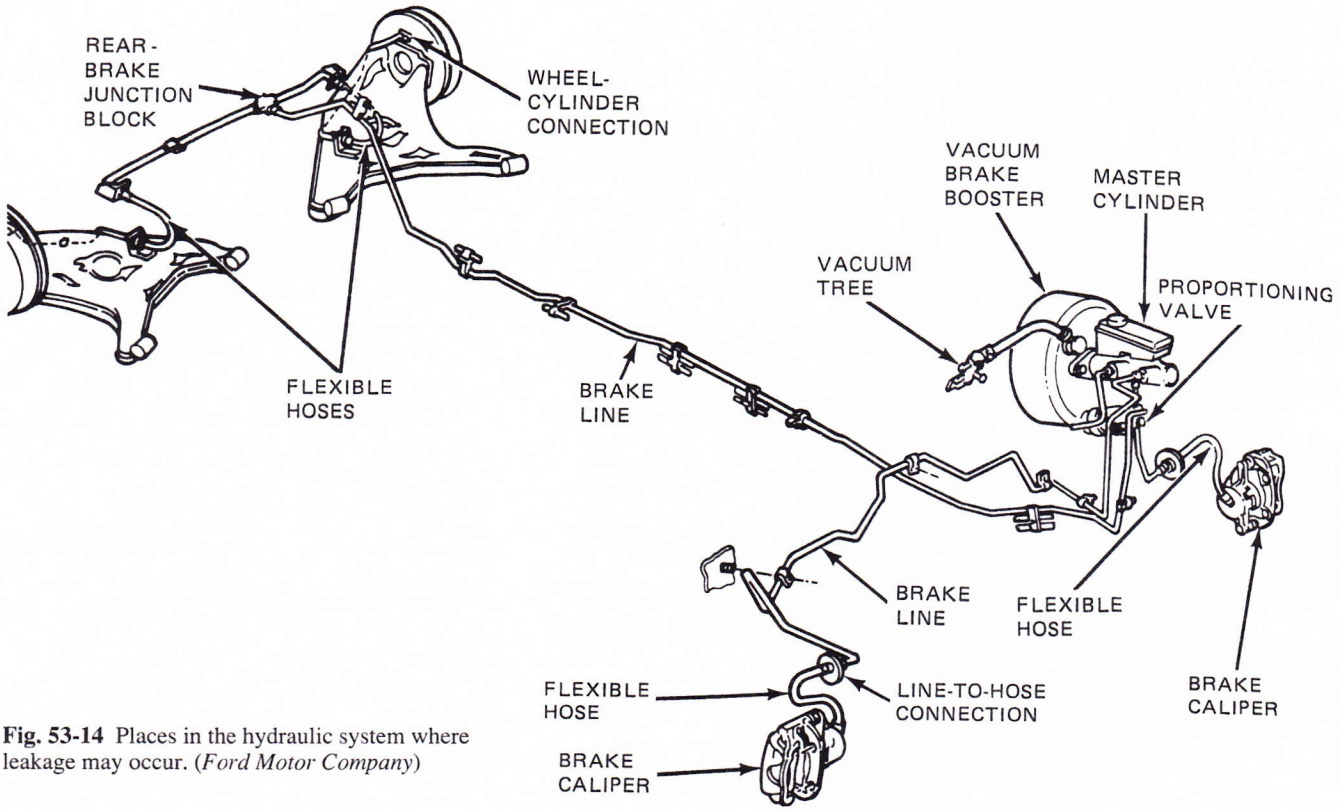


Fig. 53-14 Places in the hydraulic system where leakage may occur. (*Ford Motor Company*)

➢ 53-22 BRAKES DO NOT SELF-ADJUST

If the self-adjuster mechanism is incorrectly installed, the adjusting screw is stuck, or the adjusting lever is not engaging the adjusting wheel (➢52-14), the brakes will not self-adjust. Remove the drum and inspect the brake to find and correct the trouble.

➢ 53-23 BRAKE WARNING LIGHT COMES ON WHILE BRAKING

Illumination of the brake warning light (Fig. 53-10) while braking usually indicates that one section of the hydraulic system has failed. Both sections should be checked so the trouble can be found and corrected. The light may also illuminate because of a defective pressure-differential valve. It may be dangerous to continue to drive the vehicle if the brake warning light comes on while braking. Although the vehicle can be braked, only half the wheel brakes may be working.

DISC-BRAKE TROUBLE DIAGNOSIS

➢ 53-24 DIAGNOSING DISC-BRAKE TROUBLES

Sometimes troubles in disc brakes are similar to troubles in drum brakes. Both braking systems use a brake pedal and linkage, power-brake booster, master cylinder and hydraulic system, and connecting lines and hoses. The diagnosis and service of these common components are basically the same regardless of the type of brake at the wheel. However, the disc brake has fewer parts and is simpler in construction and operation. This makes disc-brake diagnosis and service different from a drum brake.

Vehicles with disc brakes at all four wheels can have some troubles that are not found in four-wheel drum brakes (Fig. 53-11) or front-disc/rear-drum systems. One reason is that many rear disc brakes have an integral parking brake (➢52-18) built into the caliper. Figure 53-15 is a trouble diagnosis chart for front disc and four-wheel disc brake systems. Following sections describe typical complaints, their possible causes, and the checks or corrections to make. Section 53-35 describes power-brake diagnosis.

➢ 53-25 EXCESSIVE PEDAL TRAVEL

Anything that requires excessive movement of the caliper pistons causes excessive pedal travel. For example, a disc brake with excessive runout forces the pistons farther back into their bores when the brakes are released. Then additional pedal travel is required the next time the brakes are applied. Air in the brake lines, low brake fluid, or incorrect brake fluid (with low boiling point) can cause a spongy pedal and excessive pedal travel.

➢ 53-26 PEDAL PULSATIONS

Pulsations felt in the brake pedal are often due to a disc with excessive runout (wobble) or a disc that is out of

Complaint	Possible Cause	Check or Correction
1. Excessive pedal travel (➢53-25)	a. Excessive disc runout	Refinish or replace disc
	b. Air in hydraulic system	Bleed brakes
	c. Low brake fluid	Fill, inspect, repair, and bleed system
	d. Bent shoe and lining or loose insulators	Inspect; replace
	e. Loose wheel bearing	Adjust or replace
	f. Damaged piston seal in caliper	Replace
	g. Power brake inoperative	Repair or replace
	h. Failure of one section of hydraulic system	Inspect and repair. Check brake warning light, if not on.
	i. Caliper parking brake not adjusting	Inspect rear calipers; repair
2. Pedal pulsations (➢53-26)	a. Excessive disc runout (wobble)	Refinish or replace disc
	b. Disc out of parallel (uneven disc thickness)	Refinish or replace disc
	c. Loose wheel bearings	Adjust or replace
	d. Tight caliper slides	Free, repair
	e. Wheel-and-tire vibration	Diagnose vibration
3. Excessive pedal force, grabbing, uneven braking (➢53-27)	a. Power-brake defective	Repair or replace
	b. Brake fluid, oil, grease on lining	Replace
	c. Lining worn	Replace
	d. Wrong lining	Install correct lining
	e. Piston stuck in caliper	Service or replace caliper
	f. Failure of one section of hydraulic system	Inspect and repair. Check brake warning light, if not on.
4. Pulls to one side while braking (➢53-28)	a. Brake fluid, oil, or grease on linings	Replace
	b. Seized caliper	Service
	c. Piston stuck in caliper	Service or replace caliper
	d. Incorrect tire pressure	Adjust
	e. Bent shoe	Replace
	f. Incorrect wheel alignment	Align
	g. Broken rear spring	Replace
	h. Restricted line or hose	Repair or replace
	i. Unmatched linings	Replace
	j. Loose caliper	Tighten
	k. Loose suspension parts	Tighten
5. Brake noise (➢53-29)		
A. Groan when slowly releasing brakes (creep groan)	a. Typical of some disc brakes	Not detrimental, no action required. Often eliminated when driver increases or decreases brake-pedal force slightly
B. Rattle at low speed	a. Shoe loose on caliper	Clinch shoe tabs to caliper; install new shoes
C. Scraping	a. Mounting bolts too long	Install correct bolts
	b. Disc rubbing caliper	Remove rust or mud from caliper; tighten caliper bolts
	c. Loose wheel bearing	Adjust or replace
	d. Worn lining; wear sensor scraping on disc	Inspect disc; replace lining
	e. Improper assembly	Correct
D. Occasional squeal	a. Typical of many disc brakes	Not detrimental, no action required. Explain to driver that occasional squeal cannot always be eliminated.
E. Frequent or continuous squeal	a. Shoe loose on caliper	Clinch shoe tabs to caliper
	b. Worn or missing parts	Check for damaged or missing antirattle springs, antisqueal shims or insulators, or worn caliper guide pins and bushings
	c. Improper clearance on rear disc brakes	Check clearance between disc and lining
	d. Disc scored or improperly machined	Refinish or replace disc
	e. Antisqueal compound not applied to shoes	Remove and apply antisqueal compound to back of shoes
	f. Glazed linings	Sand linings; inspect disc
	g. Rivets loose in shoe and lining	Replace shoes
6. Brakes fail to release (➢53-30)	a. Power-brake defective	Repair or replace
	b. Brake pedal binding	Free, repair
	c. Master-cylinder pushrod improperly adjusted	Adjust

Fig. 53-15 Disc-brake trouble-diagnosis chart.

Complaint	Possible Cause	Check or Correction
	d. Driver rides pedal	Notify driver
	e. Incorrect stoplight-switch adjustment	Adjust
	f. Caliper piston not retracting	Service or replace
	g. Speed-control switch improperly adjusted	Adjust
	h. Incorrect parking-brake adjustment	Adjust
	i. Restricted pipes, hoses, or banjo bolts	Repair or replace
7. Fluid leaking from caliper (➢53-31)	a. Damaged or worn piston seal	Replace
	b. Scores or corrosion on piston or in caliper bore	Service caliper
8. Front disc brakes grab (rear drum brakes OK) (➢53-32)	a. Defective metering valve	Replace
	b. Incorrect lining	Replace
	c. Improper surface finish on disc	Refinish disc
9. No braking with pedal fully depressed (➢53-33)	a. Piston pushed back in caliper	Pump brake pedal; check shoe position
	b. Leak in hydraulic system	Repair
	c. Damaged piston seal	Replace
	d. Air in hydraulic system	Add fluid, bleed system
	e. Leak past primary cup in master cylinder	Service or replace master cylinder
10. Fluid level low in master cylinder (➢53-34)	a. Leaks	Repair; add fluid, bleed system
	b. Worn linings	Replace
11. Warning light comes on while braking (➢53-23)	a. One section of hydraulic system has failed	Check both sections; replace
	b. Pressure-differential valve defective	Replace
12. Caliper parking brake will not hold vehicle (➢52-18)	a. Improper parking-brake cable adjustment	Adjust
	b. Defective rear actuators	Adjust, repair
	c. Ineffective rear lining	Inspect, replace
	d. Defective parking-brake pedal assembly	Repair
13. Caliper parking brake will not release (➢52-19)	a. Improper cable adjustment	Adjust
	b. Vacuum-release system inoperative	Repair

parallel (uneven thickness). Rotation of the disc pushes the pistons back in their bores. This movement is carried back through the master cylinder to the brake pedal. A loose wheel bearing and tight caliper slides also cause pedal pulsation. In some antilock-braking systems, a pulsating pedal is a normal condition during ABS operation (➢53-4).

➢ 53-27 EXCESSIVE PEDAL FORCE, GRABBING, UNEVEN BRAKING

If excessive pedal force is required for braking, the power brake may be defective. Also, worn, hot, or wet linings need extra force to produce braking. An excessively hard push on the brake pedal may be needed before a caliper with a stuck piston can provide braking.

➢ 53-28 PULLS TO ONE SIDE WHILE BRAKING

Pulling to one side while braking is usually due to uneven braking. Possible causes include a *seized* or non-moving floating-caliper, sliding-caliper, or caliper piston. Other possible causes are brake fluid on the linings, unmatched linings, warped brake shoes, and a restriction in a brake line or hose. Improper wheel alignment, worn control-arm bushings, uneven tire pressures, and a broken or weak suspension spring will also cause the vehicle to pull to one side during braking.

➢ 53-29 BRAKE NOISE

Noise is a common complaint about disc brakes. Some noise such as occasional squealing cannot always be totally eliminated. Inspect the brakes if the driver complains of frequent and continuous noise. A cause of rattle and squeal during braking is a loose brake pad on the caliper. Tightening the shoe tabs against the caliper may eliminate the noise. Sometimes an *antisqueak shim* or *insulator* is installed on the back of the shoe (Fig. 53-16). This prevents vibration between the shoe and the caliper.

Many sets of new brake pads have a container of *anti-squeal compound* packaged with the pads. When applied to

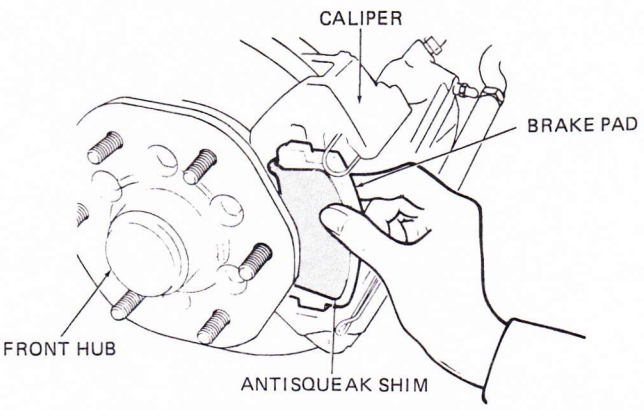


Fig. 53-16 Placing an antisqueak shim, or insulator, between the back of the shoe and the caliper to help reduce noise. (*Chrysler Corporation*)

the back of the shoes, the compound helps dampen the vibrations that are heard as brake squeal. However, a scraping noise when the brakes are applied may be the lining wear sensor (➢52-17) scraping the disc.

➢ 53-30 BRAKES FAIL TO RELEASE

This could result from sticking pedal linkage, a defective power brake, a stuck caliper piston, or the master cylinder not releasing pressure. These conditions cause the linings to ride the disc and get very hot. Even with the brake pedal released, the resulting heat may cause or further increase pressure in the hydraulic system.

To check for pressure in the hydraulic system, open a bleeder valve while the brake pedal is released. If fluid squirts out, this indicates pressure in that section of the hydraulic system. Check the adjustment of the master-cylinder pushrod and the stoplight switch (Fig. 53-12).

Careful! Follow the procedure in the vehicle service manual and ➢53-37 before loosening a bleeder valve on a vehicle with ABS. Then tighten and bleed the hydraulic system (➢53-47 to 53-49) to remove any air that entered through the loosened bleeder valve.

➢ 53-31 FLUID LEAKING FROM CALIPER

A caliper may leak brake fluid because of a damaged or worn piston seal. Leaking is also caused by a rough surface on the piston or in the caliper bore. This may result from scratches, scores, and rust or corrosion.

➢ 53-32 FRONT-DISC BRAKES GRAB

In a vehicle with front-disc and rear-drum brakes, the metering valve (➢52-21) should prevent or hold off front brake application until after the rear-drum brakes apply. Failure of the metering valve may cause the front-disc brakes to grab with light pedal force. Improper lining or disc refinishing will also cause this condition.

➢ 53-33 NO BRAKING WITH PEDAL FULLY DEPRESSED

If the brakes have been serviced, the caliper pistons may have been pushed far back in their bores. A single pedal stroke will not produce braking. After any disc-brake service, pump the brake pedal several times. This moves the pistons into proper position for normal braking.

➢ 53-34 FLUID LEVEL LOW IN MASTER CYLINDER

This can result from leaks or worn linings. As the linings wear, the fluid level goes down in the master-cylinder reservoir. More fluid remains in the calipers (Fig. 53-17).

POWER-BRAKE TROUBLE DIAGNOSIS

➢ 53-35 DIAGNOSING POWER-BRAKE TROUBLES

A quick check of power-brake operation can be made with the booster on the vehicle. With the engine off, pump the brake pedal several times. This uses up any stored vacuum or hydraulic pressure. Then depress the brake pedal and start the engine. If the booster is operating properly, the pedal will fall away or drop slightly. This is a normal condition of power-brake operation.

If the booster is not operating properly, refer to the power-brake trouble-diagnosis chart in the vehicle service manual. Figure 53-18 is a typical chart showing various power-brake troubles and their possible causes and corrections. The vehicle service manual also covers how to repair and replace power-brake boosters.

➢ 53-36 ANTILOCK-BRAKING-SYSTEM TROUBLE DIAGNOSIS

The antilock-braking system is a dual brake system with antilock components added (➢53-2). These include a

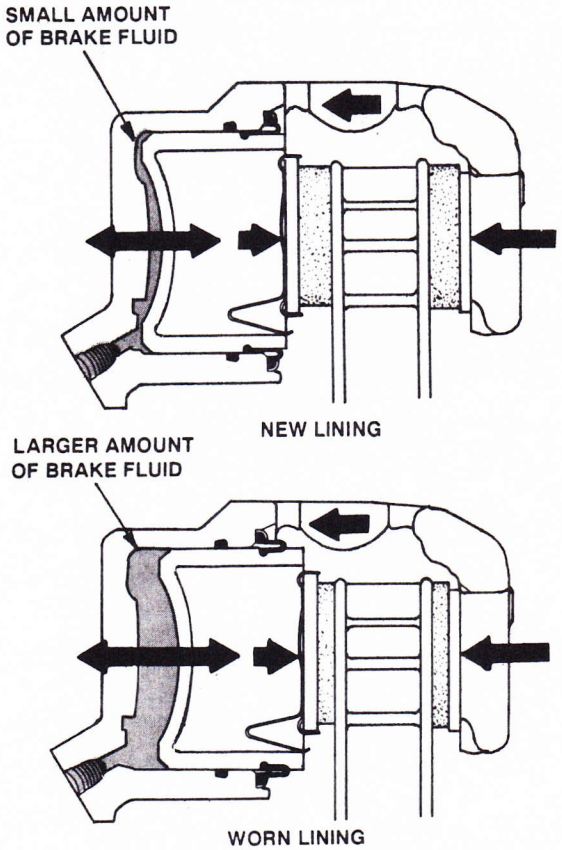


Fig. 53-17 As disc-brake linings wear, fluid level lowers in the master cylinder. More fluid remains in the calipers. (*Delco Moraine Division of General Motors Corporation*)

Complaint	Possible Cause	Check or Correction
1. Excessive pedal force required (vacuum booster)	a. Defective vacuum check valve	Free or replace
	b. Hose collapsed	Replace
	c. Vacuum fitting plugged	Clear, replace
	d. Pedal linkage binding	Free
	e. Air inlet clogged	Clear
	f. Faulty piston seal	Replace
	g. Stuck piston	Clear, replace damaged parts
	h. Faulty diaphragm	Replace
	i. Causes listed under item 6 in Fig. 53-11 and item 3 in Fig. 53-15	
2. Brakes grab	a. Reaction or "brake feel" mechanism damaged	Replace damaged parts
	b. Air-vacuum valve sticking	Free, replace
	c. Causes listed under item 7 in Fig. 53-11 or item 3 in Fig. 53-15	
3. Pedal goes to floor	a. Hydraulic-plunger seal leaking	Replace
	b. Compensating valve sticking	Replace valve
	c. Causes listed under item 1 in Fig. 53-11 or item 8 in Fig. 53-15	
4. Brakes fail to release	a. Pedal linkage binding	Free
	b. Faulty check valve	Free, replace
	c. Compensator port plugged	Clean port
	d. Hydraulic plunger seal sticking	Replace seal
	e. Piston sticking	Lubricate, replace damaged parts
	f. Broken return spring	Replace
	g. Causes listed under item 3 in Fig. 53-11 or item 6 in Fig. 53-15	
5. Loss of brake fluid	a. Worn or damaged seals in hydraulic section	Replace, fill, bleed
	b. Loose line connections	Tighten, replace seals
	c. Causes listed under item 9 in Fig. 53-11 or items 7 and 9 in Fig. 53-15	

Fig. 53-18 Power-brake trouble-diagnosis chart.

hydraulic or vacuum booster, ABS control module, wheel-speed sensors, and a deceleration sensor (with 4WD or AWD).

A vehicle with ABS can have the same brake-system troubles described above. These are listed in the trouble-diagnosis charts for drum and disc brake systems (Figs. 53-11 and 53-15). An ABS trouble is the failure to prevent wheel lockup. Also, oversize tires on a vehicle can prevent normal ABS operation.

Many vehicles with ABS have two instrument-panel indicator lights, ANTILOCK (amber) and BRAKE (red). A typical starting procedure is that when the ignition key is turned on, the ANTILOCK light should illuminate for three to five seconds. It may stay on for up to 30 seconds while pressure builds in the accumulator.

During cranking, both the BRAKE and the ANTILOCK lights illuminate. After the engine starts, the BRAKE light goes out. The ANTILOCK light remains on for three to five seconds. Both lights should be off at all other times. Any other sequence of light actions may indicate trouble. Refer to the diagnostic procedure in the vehicle service manual.

Some ABS diagnostic procedures require the use of a *breakout box* (➢33-18) and a pressure gauge. The breakout box connects to the ABS wiring-harness connector. The pressure gauge (Fig. 53-19) checks the pressure developed in the hydraulic unit. Other procedures require a scan tool to retrieve trouble codes (➢53-37).

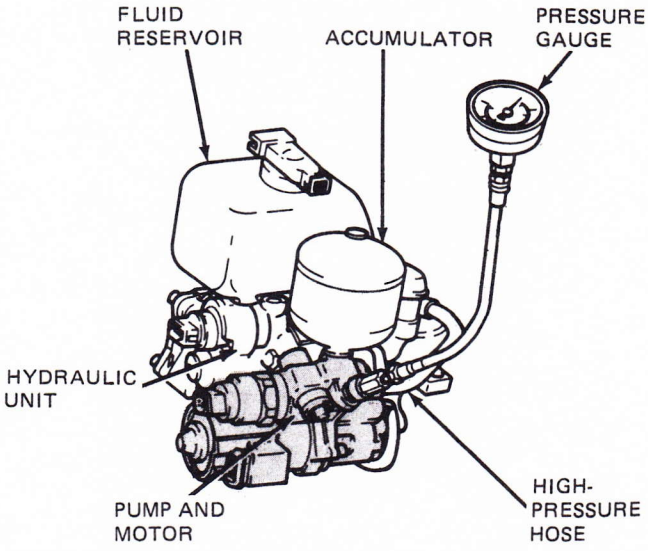


Fig. 53-19 Installing pressure gauge to make pressure tests of the ABS. (*Buick Division of General Motors Corporation*)

➢ 53-37 CHECKING ABS OPERATION

As a first step in ABS diagnosis, perform a visual inspection. Inspect the system for loose connections, faulty master-cylinder operation, abnormal braking action, and leaks. To use the lamp-sequence procedure, turn the

ignition OFF for 15 seconds. Then turn the ignition ON and watch the actions of the BRAKE and ANTILOCK lights.

Many ABS control modules store faults or trouble codes in memory (➢10-18). These may be retrieved using a scan tool. The meaning of each trouble code is in the vehicle service manual. Codes can be set for failures of the wheel-speed sensors, vehicle-speed sensor, deceleration sensor, stoplight switch, solenoid valves, relays, and ABS control module.

Sometimes trouble codes result from *driver-induced faults*. These can occur if the vehicle is driven with the parking brake applied or if there is excessive wheelspin. A code indicating a defective control module can be set by improperly connecting and disconnecting the scan tool (➢20-13). This must be done with the ignition key OFF. Any time a fault code appears for the ABS control module, erase the code. Then test the system operation before determining the ABS control module should be replaced.

Careful! Some vehicles have a hydraulic accumulator as part of the antilock-braking system. A very high pressure may exist in the brake lines and hydraulic system. Before performing tests or other brake work on a vehicle with a hydraulic accumulator, first depressurize the accumulator. Follow the procedure in the vehicle service manual. A typical procedure is to turn the ignition key OFF and disconnect the negative cable from the battery. Apply and release the brake pedal with a force of about 50 pounds [222 N] at least 20 times. When the accumulator is depressurized, the brake pedal will have a different feel.

DRUM-BRAKE SERVICE

➢ 53-38 SERVICING DRUM BRAKES

Complaints of faulty braking action should be analyzed to determine the cause. Sometimes all that is necessary is to adjust drum-brake shoes. Other services include:

- Adding brake fluid.
- Flushing the hydraulic system.
- Bleeding the hydraulic system to remove air.
- Repairing or replacing the master cylinder or wheel cylinders.
- Replacing brake linings.
- Refinishing the drums.
- Repairing or replacing the power-brake unit.
- Replacing wheel-speed sensors.

In addition, brake hoses and lines are replaced along with other sensors, switches, and valves. Tube cutting, bending, and flaring are described in ➢7-24.

➢ 53-39 ADJUSTING DRUM BRAKES

Drum brakes without adjusters require periodic adjustment to compensate for lining wear. Self-adjusting drum brakes should require adjustment only after the brakes have been disassembled for service. These services include replacing brake shoes, and refinishing or replacing the brake drums.

Procedures for adjusting the various types of drum brakes are in the vehicle service manual. Most duo-servo brakes (➢52-11) can be adjusted through a slot or hole in the backing plate (Fig. 53-20). A *brake-shoe adjusting gauge* (Fig. 53-21) can be used to make a preliminary adjustment if the drums are removed. Complete the adjustment by making several alternating reverse and forward stops. If adequate pedal reserve does not build up, the self-adjusters are not working.

➢ 53-40 REPLACING DRUM-BRAKE SHOES

When linings wear, shoes must be replaced. This requires removal of the wheel and brake drum. Then remove the

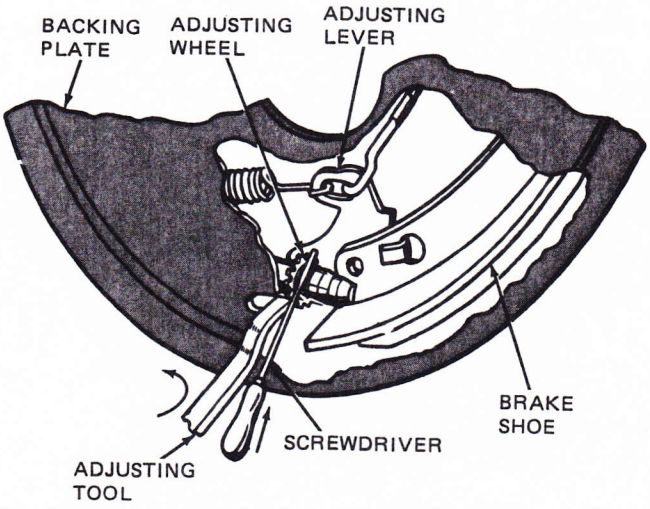


Fig. 53-20 Using a screwdriver to hold the adjusting lever off the adjusting screw so it can be turned with the adjusting tool. (*Bendix Corporation*)

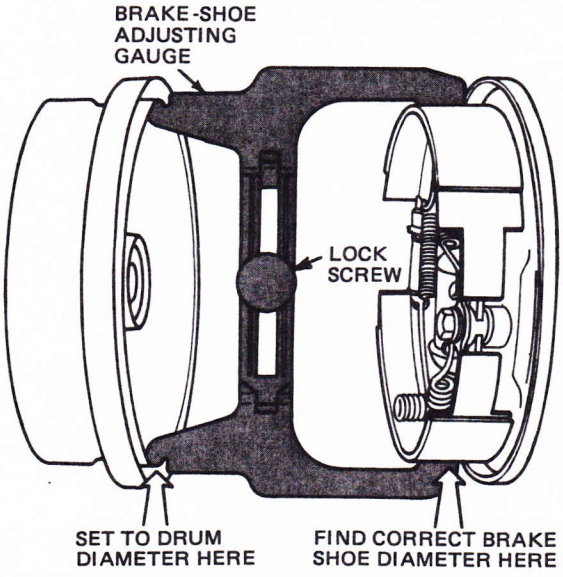


Fig. 53-21 Using the brake-shoe adjusting gauge to set the preliminary clearance between the linings and the drum. (*Ford Motor Company*)

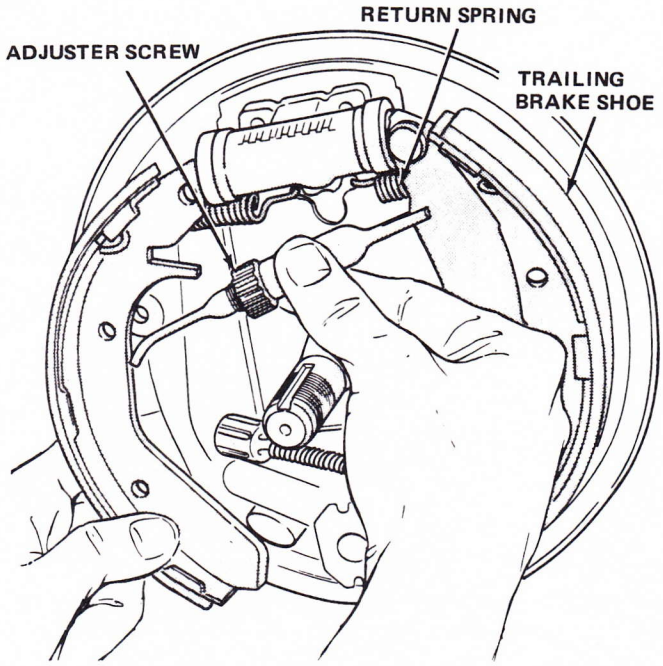


Fig. 53-22 Replacing brake shoes on a rear drum brake. (*Chrysler Corporation*)

adjuster screw and worn shoes (Fig. 53-22). Install new shoes.

➢ 53-41 SERVICING BRAKE DRUMS

Service or replace brake drums if they are distorted, cracked, scored, rough, or excessively glazed (Fig. 53-13). Light score marks can be removed with fine emery cloth. Remove all traces of emery. Deeper scores, roughness, or glaze can be removed by turning or grinding the drum on a *brake-drum lathe*. After refinishing, the diameters of the left and right drums on the same axle should be within 0.010 inch [0.24 mm] of each other. If the diameters vary more than this, replace both drums.

Brake drums have a *discard diameter* cast into them. This dimension is the maximum allowable diameter. If the drum must be refinished to a larger diameter, replace it. The drum would be too thin for safe use.

➢ 53-42 WHEEL-CYLINDER SERVICE

Most wheel cylinders can be disassembled and rebuilt on the vehicle. However, many manufacturers recommend removing the wheel cylinder. This makes it easier to properly clean, inspect, and reassemble the wheel cylinder. To remove a wheel cylinder, first remove the wheel and brake drum. Disconnect the brake hose from the wheel cylinder. Take out the attaching bolts or retainer (Fig. 53-23). Plug or tape closed the end of the hose to prevent dirt from entering.

Disassemble the wheel cylinder by pulling off the boots. Push out the pistons, cups, and spring. Clean parts in clean

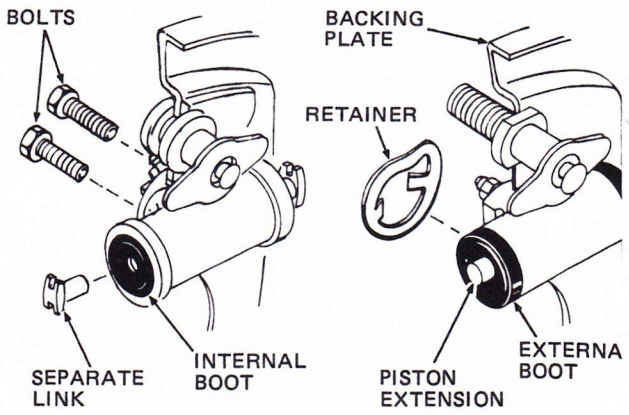


Fig. 53-23 Two methods of attaching the wheel cylinder to the backing plate. (*Delco Moraine Division of General Motors Corporation*)

brake fluid. Dry the parts with the compressed air. Put them on a clean lint-free towel. Blow out the passages in the wheel cylinder with compressed air to make sure they are clear.

Inspect the wheel-cylinder bore for scoring and corrosion. Use crocus cloth to remove light corrosion and stains. Replace the wheel cylinder if this does not clean the bore or if it is pitted or scored. Some wheel cylinders can be honed (Fig. 53-24). However, the bore must not be honed more than 0.003 inch [0.08 mm] larger than its original diameter. If scores do not clean up, replace the wheel cylinder. Also, replace the wheel cylinder if the clearance between the bore and pistons is excessive.

When reassembling the wheel cylinder, lubricate all parts with clean brake fluid. Install all the new parts in the wheel-cylinder repair or rebuild kit when reassembling the wheel cylinder.

Careful! Do not allow any grease or oil to touch the rubber parts or other internal parts in the hydraulic system. Oil or grease will cause the rubber parts to swell. This can lead to brake failure.

➢ 53-43 MASTER-CYLINDER SERVICE

Some master cylinders can be rebuilt. Others should be replaced. The service procedures for cast-iron and composite master cylinders (➢52-24) are similar. However, some master-cylinders have coated bores that should not be honed.

To service the master cylinder, first clean the outside. Then remove the master cylinder from the vehicle. Remove the cover and seal, and pour out any remaining brake fluid. Mount the master cylinder in a vise.

Follow the disassembly instructions in the vehicle service manual. Figure 52-29 shows a disassembled master cylinder. A typical disassembly procedure is to force the primary piston inward and remove the snap ring from the

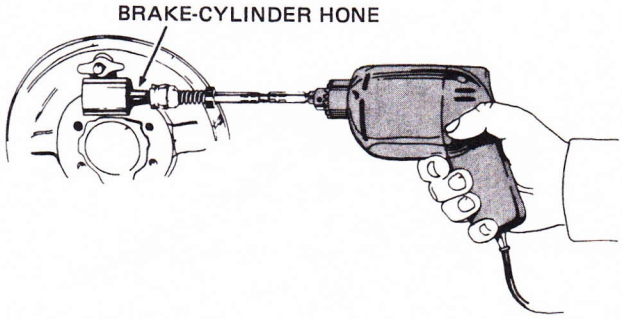


Fig. 53-24 Honing the bore in a wheel cylinder. (*ATW*)

groove in the piston bore. Then remove the primary-piston assembly. Using an air nozzle, apply slight air pressure through the vent port in the secondary reservoir. This will force out the secondary-piston assembly.

Clean all parts in brake fluid or brake-cleaning solvent. Blow dry with compressed air. Replace the master cylinder if the bore is scored, corroded, pitted, or cracked. In master-cylinder bores that can be honed, replace the master cylinder if pits or scores remain after light honing. Assemble the master cylinder following the assembly instructions in the vehicle service manual. Install all the new parts in the master-cylinder repair or rebuild kit.

Bench-bleed the master cylinder before installing it on the vehicle. To do this, install *bleeder tubes* in the outlets (Fig. 53-25). Fill the reservoirs with brake fluid. Then move the pistons back and forth to remove any trapped air. Stop when no more bubbles are visible in the brake fluid.

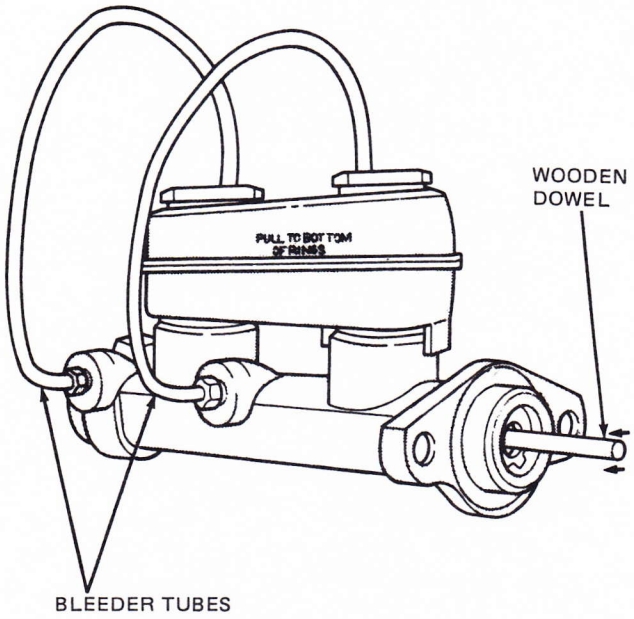


Fig. 53-25 Install bleeder tubes and operate the pistons with a wooden dowel to bench-bleed the master cylinder. (*Chrysler Corporation*)

CAUTION!

Always wear eye protection (safety glasses or safety goggles) when bench-bleeding a master cylinder. Some brake fluid may spray out. Do not hold your face directly above the reservoirs when operating the pistons.

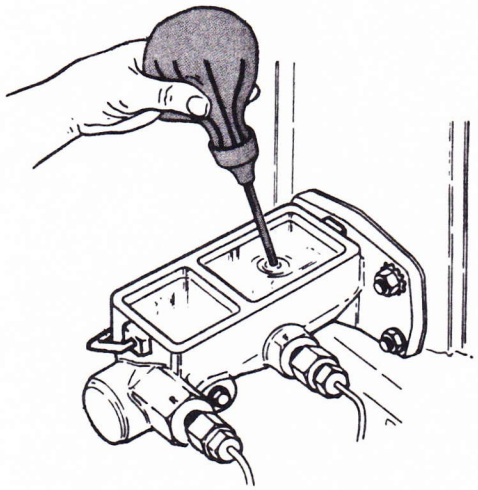


Fig. 53-26 Before performing any disc-brake service, remove about 1/2 to 2/3 of the fluid from the master cylinder. (*ATW*)

DISC-BRAKE SERVICE

➢ 53-44 SERVICING DISC BRAKES

The brake shoes in fixed calipers usually can be replaced without removing the caliper. With the vehicle on a lift or safety stands, remove the wheel. Remove some fluid from the master-cylinder reservoir (Fig. 53-26). Discard this fluid. Then use slip-joint pliers to push the pistons in. Use two pairs of pliers to pull the shoes out. Removing fluid from the reservoir prevents it from overflowing when the pistons are pushed in.

On the floating and sliding caliper, the wheel and caliper must be removed to replace the shoes. First, remove two-thirds of the fluid from the reservoir (Fig. 53-26). Discard the fluid. Raise the vehicle and remove the wheel. Use a C clamp (Fig. 53-27) and tighten it to force the piston back into its cylinder. Remove the mounting hardware and lift off the caliper. Support it with a wire hook so the caliper does not hang from the brake hose. Remove the old shoes. Remove the sleeves and bushings from the caliper. Figure 53-28 shows a disassembled floating caliper.

To install the caliper, first install new sleeves and bushings and the shoes. Make sure the piston is pushed back in its cylinder. Position the caliper over the disc and install the mounting bolts. If necessary, clinch the upper ears of the outboard shoe to hold it in place. The ear should be flat against the caliper.

Add fresh brake fluid to the reservoir. Pump the brake pedal several times to seat the linings against the disc and get a firm pedal. Check and fill the master cylinder if necessary.

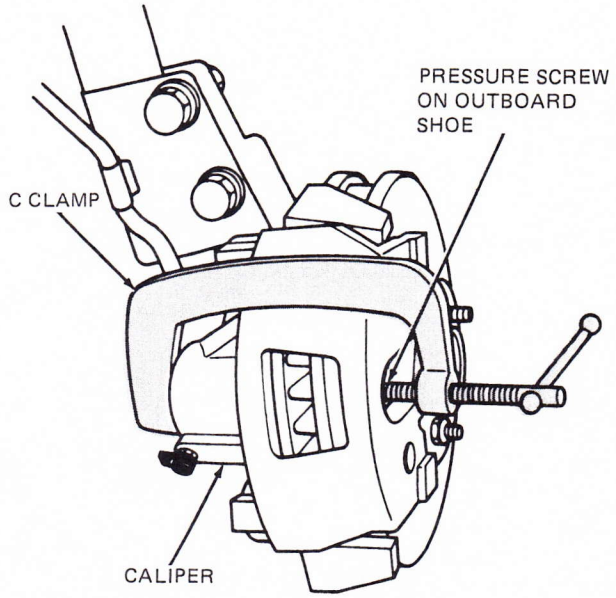


Fig. 53-27 Use a C clamp to force the piston back into the caliper bore. (*Buick Division of General Motors Corporation*)

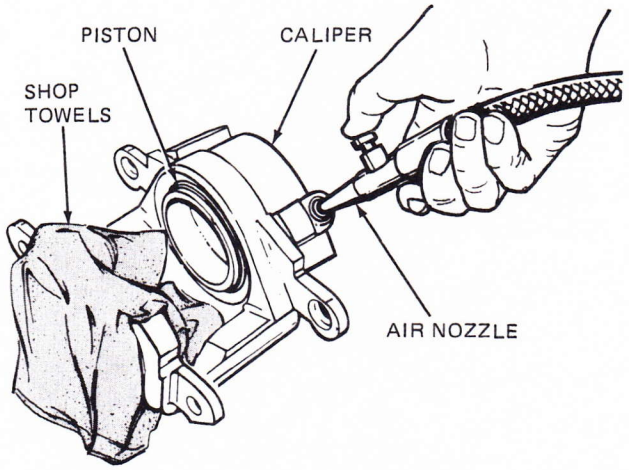


Fig. 53-29 Using air pressure to remove the piston from the caliper. (*Buick Division of General Motors Corporation*)

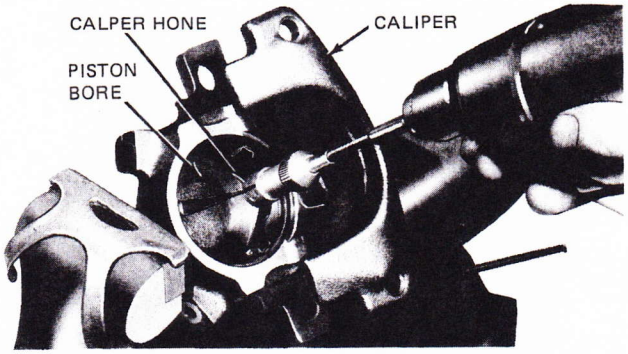


Fig. 53-30 Honing the caliper bore. (*Chrysler Corporation*)

CAUTION!

Do not try to remove the vehicle until you feel a firm brake pedal.

➢ 53-45 CALIPER SERVICE

If caliper pistons or seals require replacement, remove the caliper from the vehicle. Use a *caliper-piston remover* or compressed air (Fig. 53-29) to remove the piston from the caliper. Clean all parts using alcohol or clean brake fluid and wipe them dry. Clean out all drilled passages and bores.

Inspect the caliper bore for scratches or scoring. Light scratches or corrosion can usually be cleaned out with crocus cloth. Bore with light roughness or corrosion can be cleaned with a hone (Fig. 53-30). However, if honing increases the bore diameter more than 0.001 inch [0.025 mm], install a new caliper. Replace any caliper piston that is pitted or scored. Also, replace a metal piston if any of its chrome plating has worn off.

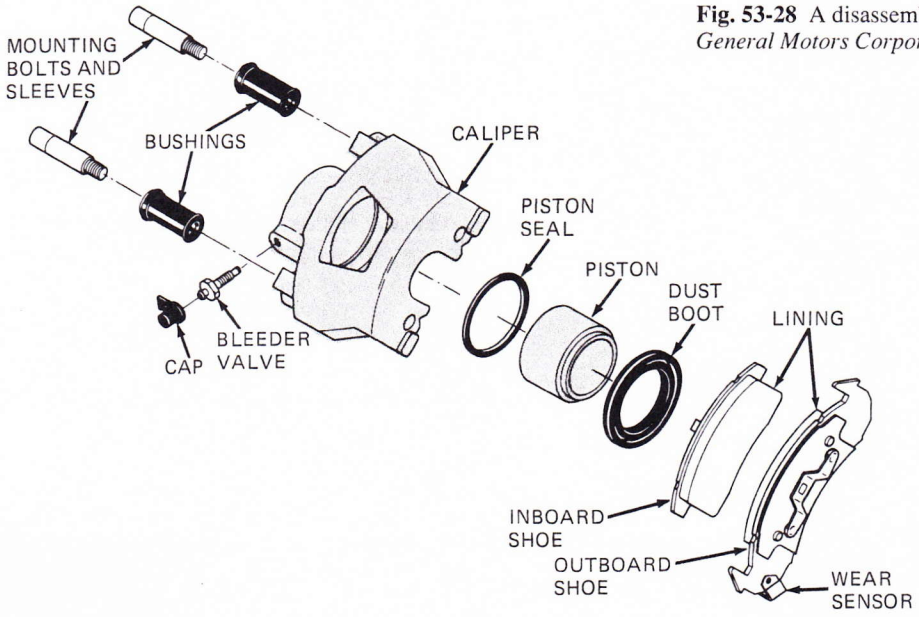


Fig. 53-28 A disassembled floating caliper. (*Buick Division of General Motors Corporation*)

Assemble the caliper by first dipping the new piston seal in clean brake fluid (Fig. 53-28). Install the seal in the groove in the caliper bore. Lubricate the piston with clean brake fluid and install a new dust boot on the piston. Then install the piston in the caliper. Do not unseat or twist the seal. Install the caliper on the vehicle. Check and, if necessary, adjust the wheel bearings.

➢ 53-46 SERVICING BRAKE DISCS

Brake discs require replacement if they become deeply scored or warped. Light scores and grooving are normal and will not affect braking. Heavier scores require refinishing or replacing the disc. Install a new disc if wear is beyond acceptable limits.

Each brake disc is marked with a *discard thickness* (Fig. 53-31). This is the minimum thickness to which the disc can be refinished. If refinishing would cause the disc thickness to be less than the discard thickness, replace the disc. It would be too thin for safe use.

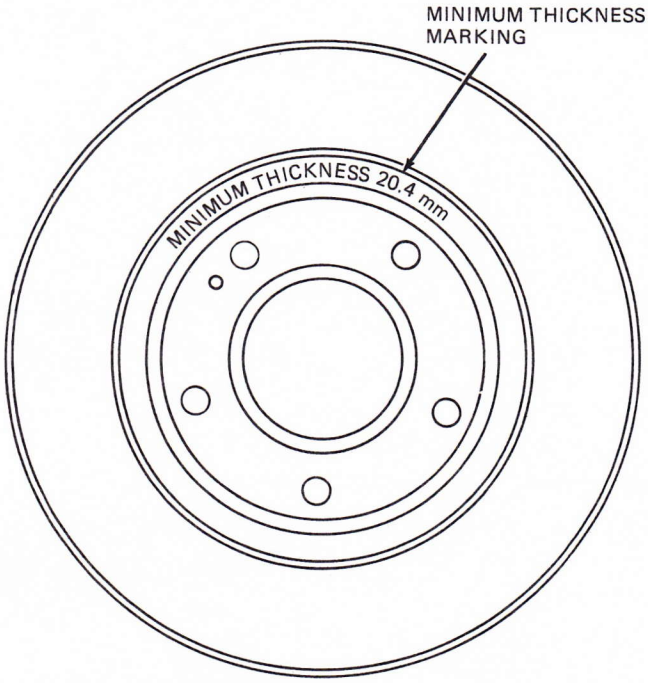


Fig. 53-31 Minimum thickness, or discard thickness, marking on a disc-brake rotor. (*Chrysler Corporation*)

HYDRAULIC-SYSTEM SERVICE

➢ 53-47 FLUSHING THE NON-ABS HYDRAULIC SYSTEM

Flushing requires removing all of the old brake fluid from the hydraulic system. Some vehicle manufacturers recommend flushing when new parts are installed. The system *must* be flushed if it has been contaminated. Signs of contamination include corroded metal parts and soft or swollen rubber parts. If contamination has occurred, replace all rubber parts before flushing the system.

To flush the system, install a pressure bleeder on the master cylinder (Fig. 53-32). If the system has a metering valve (➢52-21), it must be held in the open position. Bleed the caliper or wheel cylinder farthest from the master cylinder first. Connect a bleeder hose on the bleeder valve. Put the other end of the hose in a transparent container partly filled with clean brake fluid.

A typical bleeding sequence is right rear, left rear, right front, and left front. Open the right-rear bleeder valve about 1 1/2 turns and let fluid drain into the container. Close the valve when the fluid appears clean and clear. Repeat the procedure at each wheel. When flushing is completed, fill the master-cylinder reservoir and bleed the hydraulic system (➢53-48).

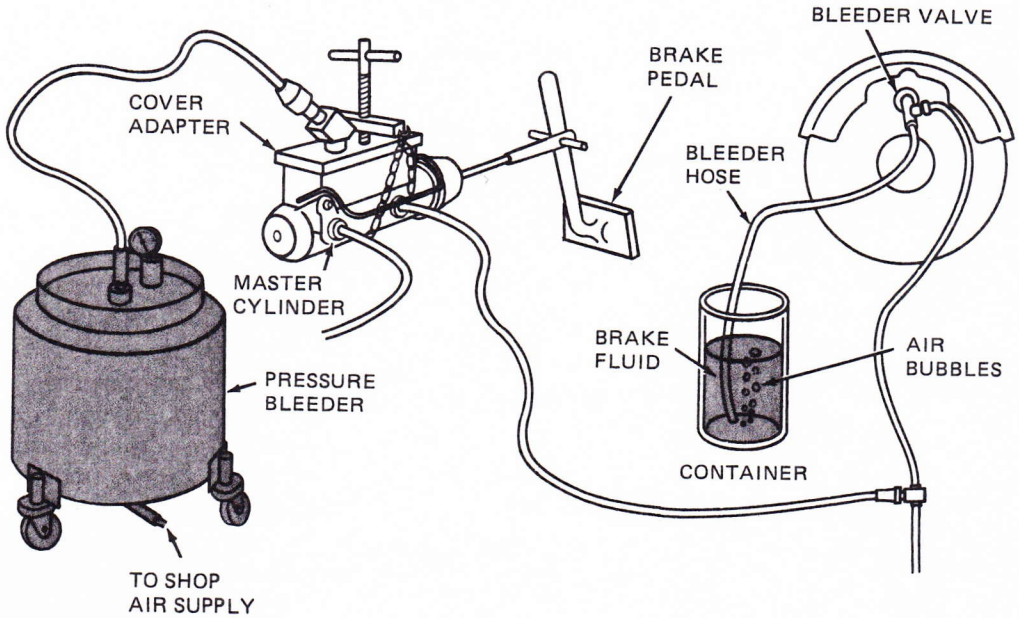


Fig. 53-32 Bleeding the hydraulic system with a pressure bleeder. (*Pontiac Division of General Motors Corporation*)

At least one quart [0.946 L] of brake fluid or *flushing fluid* may be needed to flush the hydraulic system.

➢ 53-48 FILLING AND BLEEDING THE NON-ABS HYDRAULIC SYSTEM

A soft or spongy brake pedal (➢53-17) usually indicates air trapped in the hydraulic system. The system must be bled to remove the air. Bleeding is also required if connections have been loosened or opened during service work. This can allow air to enter the hydraulic system.

Bleeding is similar to flushing (➢53-47). However, watch for air bubbles in the fluid during bleeding. If the master cylinder has a bleeder valve, bleed the master-cylinder first. Continue bleeding at each bleeder valve until the fluid runs out with no air bubbles (Fig. 53-32). During bleeding, make sure the master-cylinder reservoir stays filled. Add fluid as necessary.

➢ 53-49 BLEEDING THE ABS HYDRAULIC SYSTEM

Follow the procedure in the vehicle service manual to bleed the brakes on a vehicle with an antilock-braking system. On some vehicles, the two sections of the hydraulic system are bled in different ways. The front wheels are bled the same way as described in ➢53-48. However, some vehicles with ABS have a hydraulic unit that maintains pressure after the engine and ignition key are OFF. This allows bleeding the rear wheels without using a pressure bleeder.

After connecting the bleeder hose to one rear-wheel bleeder valve, put the lower end of the hose in a container partly filled with clean brake fluid. Then turn the ignition key ON to assure pressure in the hydraulic unit. Slightly depress the brake pedal for at least 10 seconds. When the fluid runs out clear and without bubbles, close the bleeder valve. Then bleed the brake at the other wheel.

MULTIPLE-CHOICE TEST

Select the **one** *correct, best, or most probable answer to each question.*
You can find the answers in the section indicated at the end of each question.

1. The brake pedal goes to the floor. All the following could be the cause EXCEPT (➢53-13)
   a. lack of brake fluid
   b. loose wheel bearing
   c. self-adjusters not working
   d. brake linings worn
2. In a car with front-disc and rear-drum brakes, the brake pedal sinks slowly to the floor while the pedal is depressed at a traffic light. This condition could be caused by (➢53-13)
   a. a leaking cup in the master cylinder
   b. a leaking power-brake booster
   c. a leaking residual check valve
   d. an internal leak in the combination valve
3. A possible cause of all brakes dragging is (➢53-15)
   a. a loose wheel bearing
   b. a piston stuck in a wheel cylinder or caliper
   c. insufficient brake-pedal free travel
   d. insufficient pedal reserve
4. The vehicle pulls to one side when braking. All the following could be the cause EXCEPT (➢53-16)
   a. air in the hydraulic system
   b. oil or brake fluid on linings
   c. shoes out of adjustment
   d. defective wheel cylinder
5. Air can enter the hydraulic system because of (➢53-17)
   a. self-adjusters not working
   b. failure of one section of the hydraulic system
   c. linings contaminated with oil or brake fluid
   d. low fluid level in master cylinder
6. Technician A says brake fade may be caused by brake lining that is overheated or wet. Technician B says failure of the power-brake booster increases the force required on the brake pedal. Who is right? (➢53-18)
   a. A only
   b. B only
   c. both A and B
   d. neither A nor B
7. Excessive pedal travel in a disc-brake system may be caused by all the following EXCEPT (➢53-25)
   a. uneven tire pressure
   b. fluid low in master cylinder
   c. excessive disc runout
   d. loose wheel bearing

Brakes should be road tested on a dry, clean, reasonably smooth, and level roadway. A true test of brake performance cannot be made if the roadway is wet, greasy, or covered with loose dirt. All tires do not grip the road equally. Testing is also adversely affected if the roadway is crowned so as to throw the weight of the vehicle toward the wheels on one side, or if the roadway is so rough that wheels tend to bounce.

Test brakes at different speeds with both light and heavy pedal pressure. Avoid locking the wheels and sliding the tires on the roadway. There are external conditions that affect brake road-test performance. Tires having unequal contact and grip on the road cause unequal braking. Tires must be equally inflated and the tread pattern of right and left tires must be approximately equal. When the vehicle has unequal loading, the most heavily loaded wheels require more braking power than others and a heavily loaded vehicle requires more braking effort. A loose front-wheel bearing permits the drum and wheel to tilt and have spotty contact with the brake linings, causing erratic brake action. Misalignment of the front end causes the brakes to pull to one side. Also, a loose front-wheel bearing could permit the disc to tilt and have spotty contact with brake shoe linings, causing pulsations when the brakes are applied. Faulty shock absorbers that do not prevent the car from bouncing on quick stops can give the erroneous impression that the brakes are too severe.

DRUM BRAKE INSPECTION

Before inspecting drum brakes, place the vehicle in neutral, release the parking brake, and raise the vehicle on the hoist. Once the vehicle is raised, mark the wheel-to-drum and drum-to-axle positions so the components can be accurately reassembled. Relieve all tension from the parking brake cable by loosening or removing the adjusting nut at the equalizer. To access the drum brake assembly, remove the lug nuts and pull the wheel off the hub.

CAUTION!

When servicing wheel brake parts, do not create dust by cleaning with a dry brush or with compressed air. Asbestos fibers can become airborne if dust is created during servicing. Breathing dust containing asbestos fibers can cause serious bodily harm. To clean away asbestos from brake surfaces, use an OSHA-approved washer. Follow manufacturer's instructions when using the washer.

Shoe and Lining Removal

Several different methods are used to mount the drum to the wheel hub flange. It can be fastened with rivets or by swaging the piloting shoulders of the wheel studs, or wi speed nut fasteners installed over the threads of the whe studs.

The most common mounting method is to use the ti rim and lug nuts. The drum is a slip fit over the axle flan and studs. Speed nuts are installed at the vehicle man facturing plant for temporary retention of the drum the assembly line until the wheel is installed.

A **floating drum** can be retained by a nut and cott pin. The drum can also be secured to the axle flange l one or two bolts. Some import applications have tv additional holes threaded into the drum face so bolts c be used to press the drum from the hub or flange.

After removing the retaining devices that hold tl drum to the axle flange or hub, the drum can be remov for servicing. If the brake drum is rusted or corroded the axle flange and cannot be removed, lightly tap the ax flange to the drum mounting surface with a plastic m let. Remember that if the drum is worn, the brake sh adjustment has to be backed off for the drums to cle the brake shoes. Do not force the drum or distort it. D not allow the drum to drop.

If the brake shoes have expanded too tightly again the drum or have cut into the friction surface of the dru brake, the drums might be too tight for removal. In su a case, the shoes must be adjusted inward before tl brake drum is removed. On most cars with self-adjusti mechanisms, reach through the adjusting slot with a th screwdriver (or similar tool) and carefully push the se adjusting lever away from the star wheel a maximum 1/16 inch (1.5 mm) **(Figure 45–15)**. While holding tl lever back, insert a brake adjusting tool into the slot ar turn the star wheel in the proper direction until the bral drum can be removed.

Be sure to inspect the rear wheel axle gaskets and whe seals for leaks. Replace worn components as needed.

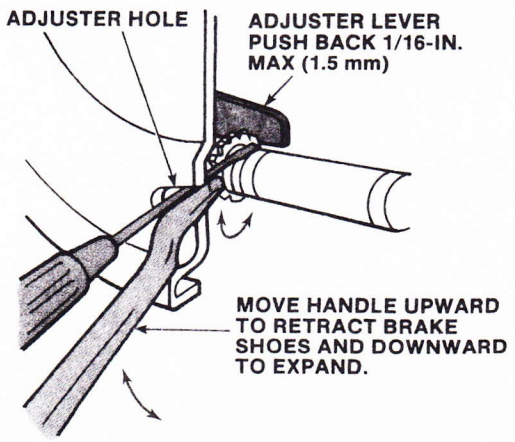


Figure 45–15 Backing off the self-adjusters in order t remove the brake drum.

Figure 45–16 Carefully check the inside surface of the brake drum.

Drum Inspection

One of the most important safety inspections to be made is that of the brake drum **(Figure 45–16)**. First, visually inspect the brake shoes, as installed on the car. Their condition can many times reveal defects in the drums. If the linings on one wheel are worn more than the others, it might indicate a rough drum. Uneven wear from side to side on any one set of shoes can be caused by a tapered drum. If some linings are worn badly at the toe or heel, it might indicate an out-of-round drum.

Thoroughly clean the drums with a water-dampened cloth or a water-based solution. Equipment for washing brake parts is commercially available. Wet cleaning methods must be used to prevent asbestos fibers from becoming airborne. If the drums have been exposed to leaking oil or grease, thoroughly clean them with a non-oil-based solvent after washing to remove dust and dirt. It is important to determine the source of the oil or grease leak and correct the problem before reinstalling the drums.

Brake drums act as a heat sink. They absorb heat and dissipate it into the air. As drums wear from normal use or are machined, their cooling surface area is reduced and their operating temperatures increase. Structural strength also reduces. This leads to overdistortion, which causes some of the drum conditions covered here.

SCORED DRUM SURFACE **Figure 45–17** shows a scored drum surface. The most common cause of this condition is buildup of brake dust and dirt between the brake lining and drum. A glazed brake lining, hardened by high heat or in some cases by very hard inferior grade brake lining, can also groove the drum surface. Excessive lining wear that exposes the rivet head or shoe steel will score the drum surface. If the grooves are not too deep, the drum can be turned.

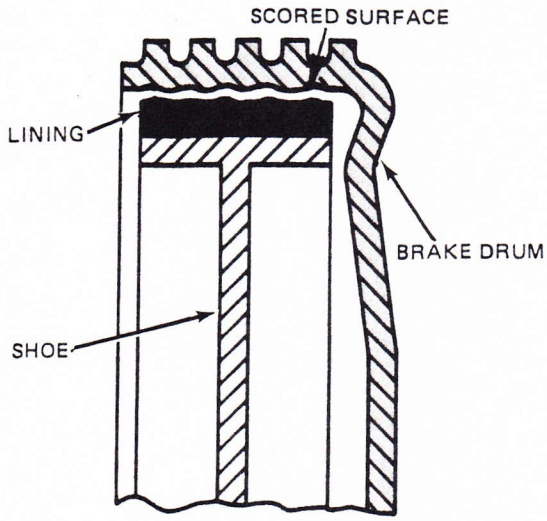


Figure 45–17 Example of a scored brake drum.
Courtesy of Wagner Brake Products

BELL-MOUTHED DRUM **Figure 45–18** shows a distortion due to extreme heat and braking pressure. It occurs mostly on wide drums and is caused by poor support at the outside of the drum. Full drum-to-lining contact cannot be achieved and fading can be expected. Drums must be turned.

CONCAVE DRUM **Figure 45–19A** shows an excessive wear pattern in the center area of the drum brake surface. Extreme braking pressure can distort the shoe platform so braking pressure is concentrated at the center of the drum.

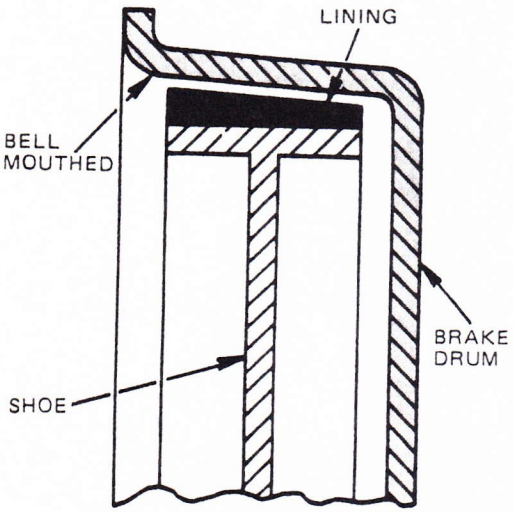


Figure 45–18 Example of a bell-mouthed brake drum.
Courtesy of Wagner Brake Products

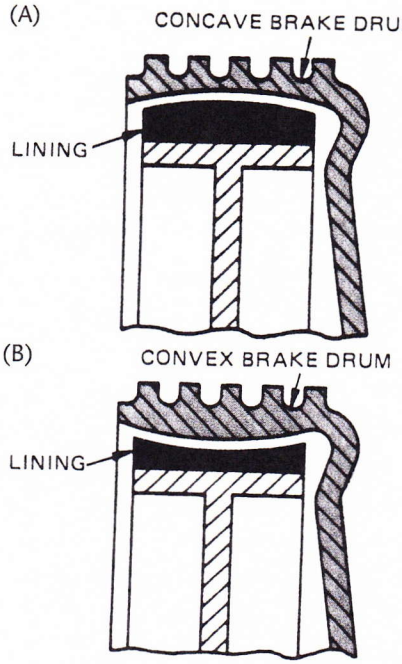


Figure 45-19 Examples of concave and convex brake drums. *Courtesy of Wagner Brake Products*

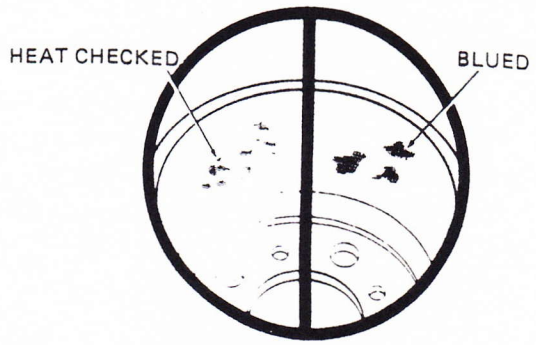


Figure 45-20 Example of a heat checked and ov heated brake drum. *Courtesy of Wagner Brake Products*

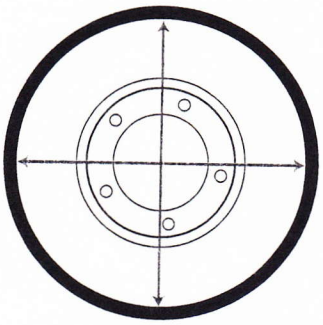


Figure 45-21 Measure the inside diameter of the drum in several spots to determine out-of-roundness.

CONVEX DRUM This wear pattern is greater at the closed end of the drum **(Figure 45–19B)**. It is the result of excessive heat or an oversized drum, which allows the open end of the drum to distort.

HARD SPOTS ON THE DRUM This condition in the cast-iron surface, sometimes called chisel spots or islands of steel, results from a change in metallurgy caused by braking heat. Chatter, pulling, rapid wear, hard pedal, and noise occur. These spots can be removed by grinding. However, only the raised surfaces are removed, and they can reappear when heat is applied. The drum must be replaced.

THREADED DRUM SURFACE An extremely sharp or chipped tool bit or a lathe that turns too fast can result in a threaded drum surface. This condition can cause a snapping sound during brake application as the shoes ride outward on the thread, then snap back. To avoid this, recondition drums using a rounded tool and proper lathe speed. Check the edge of the drum surface around the mounting flange side for tool marks indicating a previous rebore. If the drum has been rebored, it might have worn too thin for use. Check the diameter.

HEAT CHECKS **Heat checks** are visible, unlike hard spots that do not appear until the machining of the drum **(Figure 45–20)**. Extreme operating temperatures are the major cause. The drum might also show a bluish/gold tint, which is a sign of high temperatures. Hardened carbide lathe bits or special grinding attachments are available through lathe manufacturers to service these conditions. Excessive damage by heat checks or spots requires drum replacement.

CRACKED DRUM Cracks in the cast-iron drum caused by excessive stress. They can be anywhere but ally are in the vicinity of the bolt circle or at the ou of the flange. Fine cracks in the drums are often ha see and, unfortunately, often do not show up until machining. Nevertheless, should any cracks appea matter how small, the drum must be replaced.

OUT-OF-ROUND DRUMS Drums with eccentric tortion might appear fine to the eye but can cause pul grabbing, and pedal vibration or pulsation. An ou round or egg-shaped condition **(Figure 45–21)** is caused by heating and cooling during normal brake ation. Out-of-round drums can be detected before drum is removed by adjusting the brake to a light and feeling the rotation of the drum by hand. Afte moving the drum, gauge it to determine the amou eccentric distortion. Drums with this defect shoul machined or replaced.

Drum Measurements

Measure every drum with a drum micrometer **(Figure 22)**, even if the drum passed a visual inspection, to n sure that it is within the safe oversize limits. If the d is within safe limits, even though the surface app smooth, it should be turned to assure a true drum sur

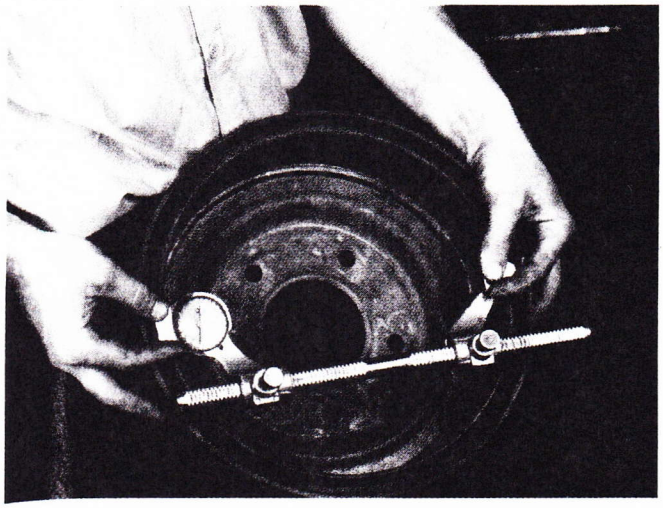


Figure 45-22 Measuring the inside diameter with a drum micrometer.

and to remove any possible contamination in the surface from previous brake linings, road dust, and so forth. Remember that if too much metal is removed from a drum, unsafe conditions can result.

Take measurements at the open and closed edges of the friction surface and at right angles to each other. Drums with taper or out-of-roundness exceeding 0.006 inch (.152 mm) are unfit for service and should be turned or replaced. If the maximum diameter reading (measured from the bottom of any grooves that might be present) exceeds the new drum diameter by more than 0.060 inch (1.5 mm), the drum cannot be reworked. If the drums are smooth and true but exceed the new diameter by 0.090 inch (2.2 mm) or more, they must be replaced.

If the drums are true, smooth up any slight scores by polishing with fine emery cloth. If deep scores or grooves are present that cannot be removed by this method, the drum must be turned or replaced.

Drum Refinishing

Brake drums can be refinished by either turning or grinding on a **brake lathe (Figure 45–23)**.

Only enough metal should be removed to obtain a true, smooth friction surface. When one drum must be machined to remove defects, the other drum on the same axle set must also be machined in the same manner and to the same diameter so braking is equal.

Brake drums are stamped with a discard dimension **(Figure 45–24)**. This is the allowable wear dimension and not the allowable machining dimension. There must be 0.030 inch (.762 mm) left for wear after turning the drums. Some states have laws about measuring the limits of a brake drum.

Machining or grinding brake drums increases the inside diameter of the drum and changes the lining-to-drum fit. When remachining a drum, follow the equipment instructions for the specific tool you are using.

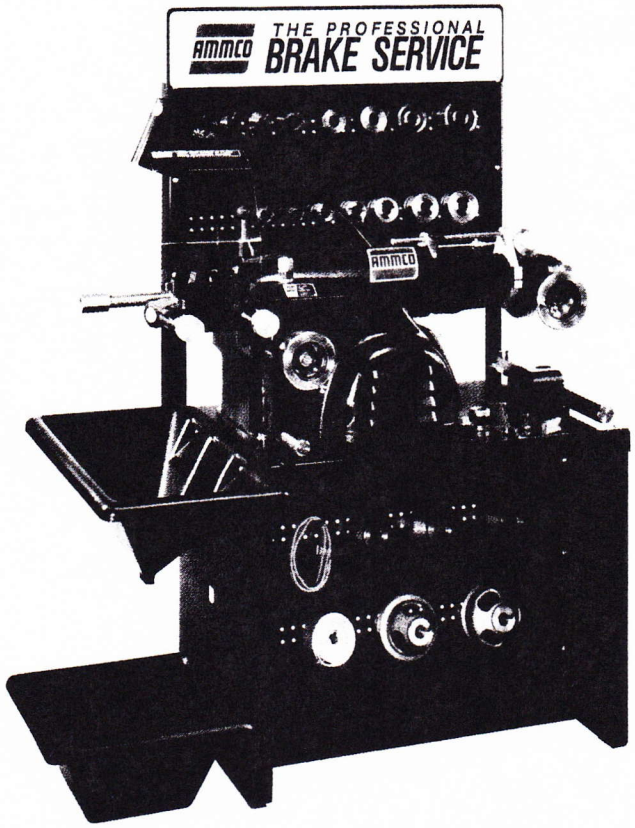


Figure 45-23 Brake drums can be resurfaced by grinding or turning them on a brake lathe. *Courtesy of Hennessy Industries, Inc.*

Figure 45-24 The drum's discard diameter is stamped on the drum.

Cleaning Newly Refaced Drums

The friction surface of a newly refaced drum contains millions of tiny metal particles. These particles not only remain free on the surface, they always lodge themselves in the open pores of the newly machined surface. If the metal particles are allowed to remain in the drum, they become imbedded in the brake lining. Once the brake lining gets contaminated in this manner, it acts as a fine grinding stone and scores the drum.

These metal particles must be removed by washing or cleaning the drum. Do not blow out the drum with air pressure. Either of the following methods is recommended to clean a newly refaced brake drum. The first method involves washing the brake drum thoroughly with hot water and wiping with a lint-free rag. Then, use

the air pressure to thoroughly dry it. If the front hub and drums are being cleaned, be very careful to avoid contaminating the wheel bearing grease. Or, completely remove all the old grease, then regrease and repack the

Figure 45–25 A brake spring tool.

PROCEDURE

Mechanical Component Service of Duo-Servo Drum Brakes

STEP 1 *Disconnect the cable from the parking brake lever.*

STEP 2 *If required, install wheel cylinder clamps on the wheel cylinders to prevent fluid leakage or air from getting into the system while the shoes are removed. Some brakes have wheel cylinder stops; therefore, wheel cylinder clamps are not required. Regardless of whether or not the clamps are needed, do not press down on the brake pedal after shoe return springs have been removed. To prevent this, block up the brake pedal so it cannot be depressed.*

STEP 3 *Remove the brake shoe return springs. Use a brake spring removal and installation tool to unhook the springs from the anchor pin or anchor plate* **(Figure 45–25)**.

STEP 4 *Remove the shoe retaining or hold-down cups and springs. Special tools are available, but the hold-down springs can be removed by using pliers to compress the spring and rotating the cup with relation to the pin.*

STEP 5 *Self-adjuster parts can now be removed. Lift off the actuating link, lever and pivot assembly, sleeve (through lever), and return spring. No advantage is gained by disassembling the lever and pivot assembly unless one of the parts is damaged.*

STEP 6 *Spread the shoes slightly to free the parking brake strut and remove the strut with its spring. Disconnect the parking brake lever from the secondary shoe. It can be attached with a retaining clip, bolt, or simply hooked into the shoe.*

STEP 7 *Slip the anchor plate off the pin. No advantage is gained by removing the plate if it is bolted on or riveted. Spread the anchor ends of the shoes and disengage them from the wheel cylinder links, if used. Remove the shoes connected at the bottom by the adjusting screw and spring, as an assembly.*

STEP 8 *Overlap the anchor end of the shoes to relieve spring tension. Unhook the adjusting screw spring, and remove the adjusting screw assembly.*

SHOP TALK

Keep the adjusting screws and automatic adjus parts for left and right brakes separate. These p usually are different. For example, on some automatic adjusters, the adjusting screws on the right brakes have left-hand threads and th adjusting screws on the left brakes have right-h threads. ■

PROCEDURE

Disassembling Nonservo or Leadin Trailing Brakes

STEP 1 *Install the wheel cylinder clamp. Tl unhook the adjuster spring from the pa ing brake strut and reverse shoe.*

STEP 2 *Unhook the upper shoe-to-shoe spring fr the shoes and unhook the antinoise spr from the spring bracket.*

STEP 3 *Remove the parking brake strut and dis gage the shoe webs from the flat, cla shoe hold-down clips.*

STEP 4 *Unhook the lower shoe-to-shoe spring a remove the forward shoe. Disconnect parking brake cable, then remove the serve shoe.*

STEP 5 *Remove the shoe hold-down clips from backing plate.*

STEP 6 *Press off the C-shaped retainers from pins and remove the parking brake lev automatic adjuster lever, and adjus latch.*

STEP 7 *Remove the parking brake lever.*

SHOP TALK

Mark the shoe positions if shoes and linings are be reused. When disassembling an unfamiliar bra assembly, work on one wheel at a time and use the other wheel as a reference. ■

PROCEDURE

Cleaning and Inspecting Brake Parts

STEP 1 *Clean the backing plates, struts, levers, and other metal parts to be reused using a water-dampened cloth or a water-based solution. Equipment is commercially available to perform washing functions of brake parts. Wet cleaning methods must be used to prevent asbestos fibers from becoming airborne.*

STEP 2 *Carefully examine the raised shoe pads on the backing plate to make sure they are free from corrosion or other surface defects that might prevent the shoes from sliding freely. Use fine emery cloth to remove surface defects, if necessary. Clean them thoroughly.*

STEP 3 *Check to make sure that the backing plates are not cracked or bent. If so, they must be replaced. Make sure backing plate bolts and bolted-on anchor pins are torqued to specifications.*

STEP 4 *If replacement of the wheel cylinder is needed, it should be done at this time. To determine wheel cylinder condition, carefully inspect the boots. If they are cut, torn, heat-cracked, or show evidence of excessive leakage, the wheel cylinders should be replaced. If more than a drop of fluid spills out, leakage is excessive and indicates that replacement is necessary.*

STEP 5 *Disassemble the adjusting screw assembly* ***(Figure 45–26)*** *and clean the parts in a suitable solvent. Make sure the adjusting screw threads into the pivot nut over its complete length without sticking or binding. Check that none of the adjusting screw teeth are damaged. Lubricate the adjusting screw threads with brake lubricant.*

STEP 6 *Examine the shoe anchor, support plate, and small parts for signs of looseness, wear, or damage that could cause faulty shoe alignment. Check springs for spread or collapsed coils, twisted or nicked shanks, and severe discoloration. Operate star wheel automatic adjusters by prying the shoe lightly away from its anchor or by pulling the cable to make sure the adjuster advances easily, one notch at a time. Adjuster cables tend to stretch, and star wheels and pawls become blunted after a long period of use. For rear-axle parking brakes, pull on the cable and shoe linkage to make sure no binding condition is present that could cause the shoes to drag when the parking brake is released.*

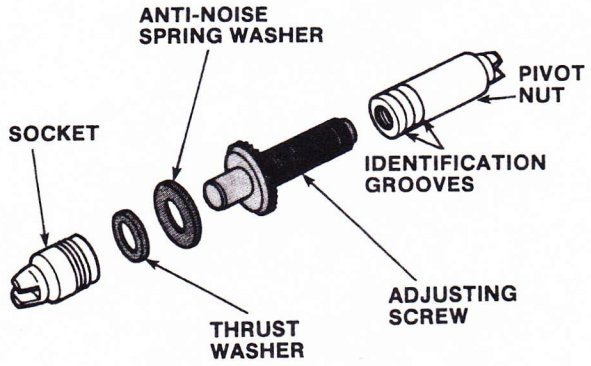


Figure 45–26 Exploded view of a brake adjuster assembly.

WARNING!

Do not use ordinary grease to lubricate drum brake parts. It does not hold up under high temperatures.

wheel bearing after the drum has been cleaned and dried. The wheel bearings and the grease seals must be removed from the drum before cleaning. The second method involves wiping the inside of the brake drum (especially the newly machined surface) with a lint-free white cloth dipped in one of the many available brake cleaning solvents that do not leave a residue. This operation should be repeated until dirt is no longer apparent on the wiping cloth. Allow the drum to dry before reinstalling it on the vehicle.

Both of these procedures are also good for cleaning disc brake rotors.

Cleaning, Inspecting, and Lubricating Brake Parts

CAUTION!

When servicing wheel brake parts, do not create dust by cleaning with a dry brush or compressed air.

SHOP TALK

Some brake technicians check brake spring tension by the drop method. This method is not overly scientific and the results are not always correct. Drop the brake spring on a clean concrete floor. If it bounces with a chunky sound, it is good. If the bounced spring gives off a tinny sound, it is tired and should be replaced. ■

To complete the drum brake inspection, examine wheel bearings and hub grease seals for signs of damage. Service or replace, if necessary.

BRAKE SHOES AND LININGS

Lining materials influence braking operation. The use of a lining with a friction value that is too high can result in a severe grabbing condition. A friction value that is too low can make stopping difficult because of a hard pedal.

Overheating a lining accelerates wear and can result in dangerous lining heat fade—a friction-reducing condition that hardens the pedal and lengthens the stopping distance. Continual overheating eventually pushes the lining beyond the point of recovery into a permanent fade condition. In addition to fade, overheating can cause squeal.

Overheating is indicated by a lining that is charred or has a glass-hard glazed surface, or if severe, random cracking of the surface is present.

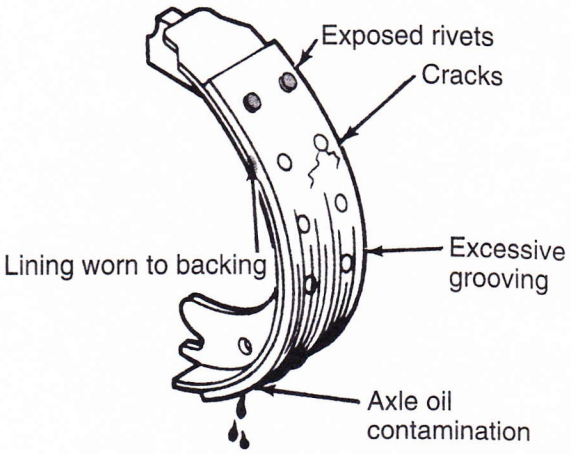


Figure 45-27 Potential brake shoe problems. *Courtesy of Wagner Brake Products*

CAUTION!

Automotive friction materials often contain substantial amounts of asbestos. Studies indicate that exposure to excessive amounts of asbestos dust can be a potential health hazard. It is important that anyone handling brake linings understands this and takes the necessary precautions to avoid injury.

Inspect the linings for uneven wear, imbedded foreign material, loose rivets, and to see if they are oil soaked. If linings are oil soaked, replace them.

If linings are otherwise serviceable, tighten or replace loose rivets, remove imbedded foreign material, and clean the rivet counterbores.

If linings at any wheel show a spotty wear pattern or an uneven contact with the brake drum, it is an indication that the linings are not centered in the drums. Linings should be circle ground to provide better contact with the drum.

Brake Relining

Brake linings that are worn to within 1/32 inch (.79 mm) of a rivet head or that have been contaminated with brake fluid, grease, or oil must be replaced **(Figure 45–27)**. Failure to replace worn linings results in a scored drum. When it is necessary to replace brake shoes, they must also be replaced on the wheel on the opposite side of the vehicle. Inspect brake shoes for distortion, cracks, or looseness. If these conditions exist, the shoe must be discarded.

Do not let brake fluid, oil, or grease touch the brake lining. If a brake lining kit is used to replace the linings, follow the instructions in the kit and install all the parts provided.

The two general methods of attaching the linings to the brake shoes are bonding and riveting. The **bonded linings** are fastened with a special adhesive to the shoe, clamped in place, then cured in an oven. Instead of using an adhesive, some linings are riveted to the shoe. Riveted linings allow for better heat transfer than bonded linings.

Sizing New Linings

Modern brake shoes are usually supplied with what is known as cam, offset, contour, or eccentric shape, which is ground in at the factory. That is, the full thickness of the lining is present at the middle of the shoe, but is ground down slightly at the heel and toe. The diameter of the circle the shoes make is slightly smaller than that of the drum. This compensates for the minor tolerance variations of drums and brake mountings and promotes proper wearing-in of the linings to match the drum.

SHOP TALK

On duo-servo shoe designs, the forward shoe is the primary and the rear, the secondary. The secondary shoe lining is longer. ■

Lining Adjustment

New **eccentric-ground** linings tolerate a closer new lining clearance adjustment than concentric ground linings. With manual adjusters, the shoes should be expanded into the drums until the linings are at the point of drag but not dragging heavily against the drum. With star wheel automatic adjusters, a drum/shoe gauge **(Figure 45–28)** provides a convenient means of making the preliminary adjustment. This type of gauge, when set at actual drum diameter, automatically provides the working clearance of the shoes **(Figure 45–29)**. If new linings have been concentrically ground, the initial clearance adjustment must be backed off an amount that provides sufficient working clearance.

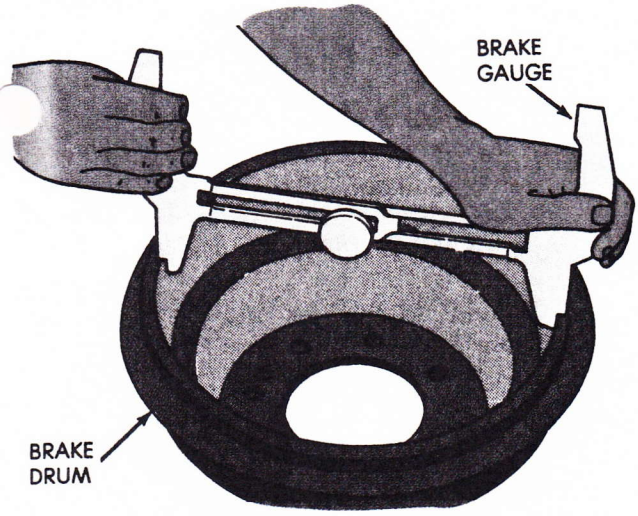


Figure 45-28 Using a brake gauge to measure the diameter of a brake drum. *Courtesy of DaimlerChrysler Corporation*

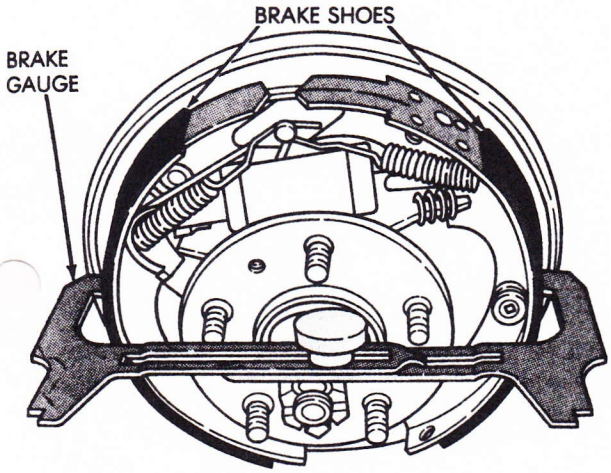


Figure 45-29 Using the other side of the brake gauge to set the brake shoes. *Courtesy of DaimlerChrysler Corporation*

Many technicians take pride in showing the customer a high pedal, but it should be remembered that with new linings an extremely high pedal indicates tight clearances and can cause seating problems.

Drum Shoe and Brake Installation

Before installing the shoes, be sure to sand or stone the inner edge of the shoe to dress down any slight lining or metal nicks and burrs that could interfere with the sliding upon the support pads.

A support (backing) plate must be tight on its mount and not bent. Stone the shoe support pads brightly and dress down any burrs or grooves that could cause the shoes to bind or hang up.

Using an approved lubricant, lightly coat the support pads **(Figure 45–30)** and the threads of servo star wheel adjusters. On rear axle parking brakes, lubricate any point

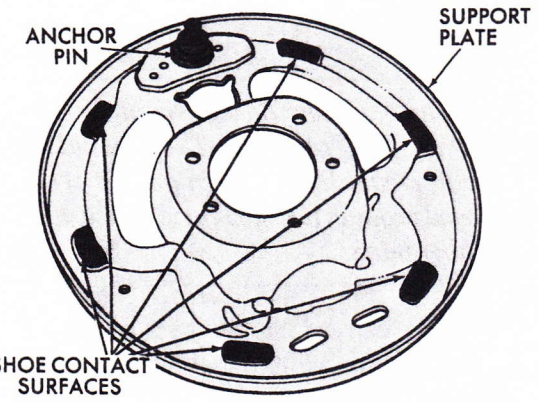


Figure 45-30 The areas or pads where the brake shoe will rub or contact the backing plate. *Courtesy of Daimler Chrysler Corporation*

of potential binding in the linkage and the cable. Do not lubricate nonservo brake adjusters other than to free a frozen adjuster with penetrating oil.

Reassemble the brakes in the reverse order of disassembly. Make sure all parts are in their proper locations and that both brake shoes are properly positioned in either end of the adjuster. Also, both brake shoes should correctly engage the wheel cylinder pushrods and parking brake links. They should be centered on the backing plate. Parking brake links and levers should be in place on the rear brakes. With all of the parts in place, try the fit of the brake drum over the new shoes. If not slightly snug, pull it off and turn the star wheel until a slight drag is felt when sliding on the drum. A brake preset gauge makes this job easy and final brake adjustment simple. Then install the brake drum, wheel bearings, spindle nuts, cotter pins, dust caps, and wheel/tire assemblies, and make the final brake adjustments as specified in individual instructions in the vehicle's service manual. Torque the spindle and lug nuts to specifications.

WHEEL CYLINDER INSPECTION AND SERVICING

Wheel cylinders might need replacement when the brake shoes are replaced or when they begin to leak.

Inspecting and Cleaning Wheel Cylinders

Wheel cylinder leaks reveal themselves in several ways: (1) fluid can be found when the dust boot is peeled back; (2) the cylinder, linings, and backing plate, or the inside of a tire might be wet; or (3) there might be a drop in the level of fluid in the master cylinder reservoir.

Such leaks can cause the brakes to grab or fail and should be immediately corrected. Note the amount of fluid present when the dust boot is pulled back. A small amount of fluid seepage dampening the interior of the boot is normal. A dripping boot is not.

WARNING!

Hydraulic system parts should not be allowed to come in contact with oil or grease. They should not be handled with greasy hands. Even a trace of any petroleum-based product is sufficient to cause damage to the rubber parts.

Cylinder binding can be caused by rust deposits, swollen cups due to fluid contamination, or by a cup wedged into an excessive piston clearance. If the clearance between the pistons and the bore wall exceeds allowable values, a condition called heel drag might exist. It can result in rapid cup wear and can cause the piston to retract very slowly when the brakes are released.

Evidence of a scored, pitted, or corroded cylinder bore is a ring of hard, crystal-like substance. This substance is sometimes noticed in the cylinder bore in which the piston rests after the brakes are released.

Light roughness or deposits can be removed with crocus cloth or an approved cylinder hone. While honing lightly, brake fluid can be used as a lubricant. If the bore cannot be cleaned up readily, the cylinder must be replaced.

Care must be taken when installing new or reconditioned wheel cylinders on cars equipped with wheel cylinder piston stops. The rubber dust boots and the pistons must be squeezed into the cylinder before it is tightened to the backing plate. If this is not done, the pistons jam against the stops causing hydraulic fluid leaks and erratic brake performance.

PROCEDURE

Replacing a Wheel Cylinder

STEP 1 *Since brake hoses are an important link in the hydraulic system, it is recommended they be replaced when a new cylinder is to be installed or when the old cylinder is to be reconditioned. Remove the brake shoe assemblies from the backing plate before proceeding. The smallest amount of brake fluid contaminates the friction surface of the brake lining.*

STEP 2 *Using two appropriate wrenches, disconnect the hydraulic hose from the steel line located on the chassis. On solid rear axles, use the appropriate tubing wrench and disconnect the hydraulic line where it enters the wheel cylinder. Care must be exercised in removing this steel line. It might be bent at this point and be difficult to install once new wheel cylinders are mounted to the backing plate.*

STEP 3 *Remove the plates, shims, and bolts that hold the wheel cylinder to the backing plate. Some later designed wheel cylinders are held to the backing plate with a retaining ring that can be removed with two small picks.*

STEP 4 *Remove the wheel cylinder from the backing plate and clean the area with a proper cleaning solvent.*

DRUM PARKING BRAKES

The parking brake keeps a vehicle from rolling while it is parked. It is important to remember that the parking brake is not part of the vehicle's hydraulic braking system. It works mechanically, using a lever assembly connected through a cable system to the rear drum service brakes.

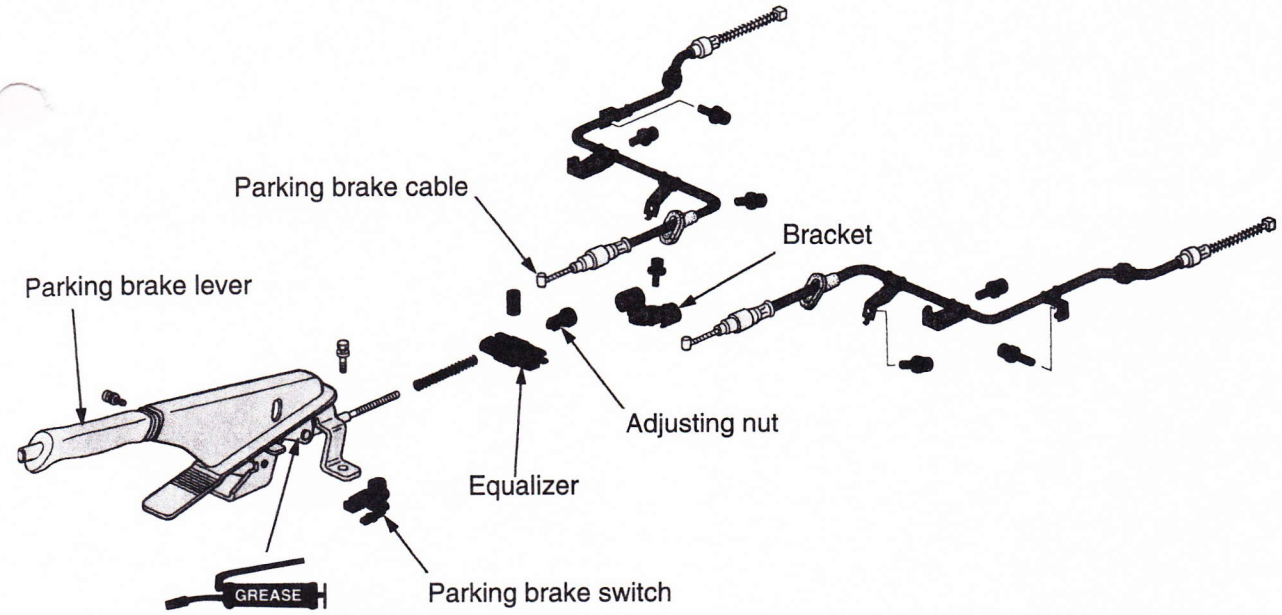
Types of Parking Brake Systems

Parking brakes can be either hand or foot operated. In general, downsized cars and light trucks use hand-operated self-adjusting lever systems **(Figure 45–31)**. Full-size vehicles normally use a foot-operated parking brake pedal **(Figure 45–32A)**. The pedal or lever assembly is designed to latch into an applied position and is released by pulling a brake release handle or pushing a release button.

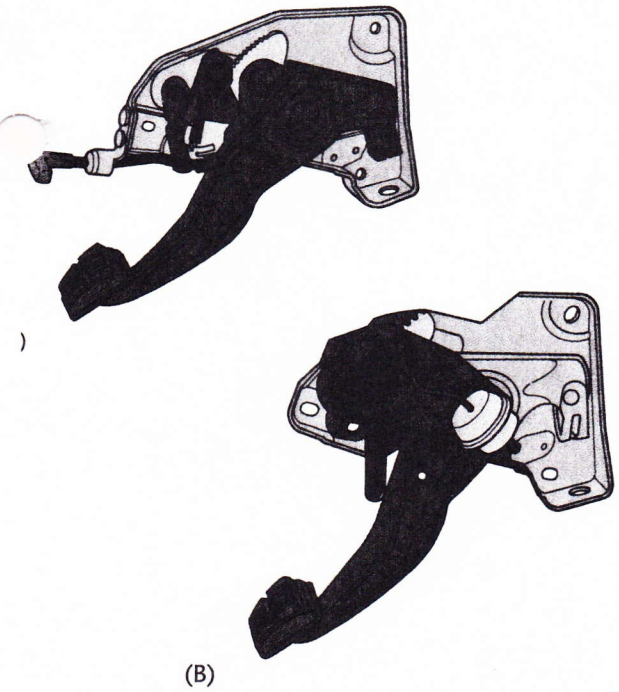
On some vehicles, a vacuum power unit **(Figure 45–32B)** is connected by a rod to the upper end of the release lever. The vacuum motor is actuated to release the parking brake whenever the engine is running and the transmission is in forward driving gear. The lower end of the release lever extends down for alternate manual release in the event of vacuum power failure or for optional manual release at any time. Hoses connect the power unit and the engine manifold to a vacuum release valve on the steering column.

The starting point of a typical parking brake cable and lever system is the foot pedal or hand lever. This assembly is a variable ratio lever mechanism that converts input effort of the operator and pedal/lever travel into output force with less travel. Tensile force from the front cable is transmitted through the car's brake cable system to the rear brakes. This tension pulls the flexible steel cables attached to each of the rear brakes. It serves to operate the internal lever and strut mechanism of each rear brake, expanding the brake shoes against the drum. Springs return the shoes to the unapplied position when the parking brake pedal is released and tensile forces in the cable system are relaxed.

An electronic switch, triggered when the brake pedal is applied, lights the brake indicator in the instrument panel when the ignition is turned on. The light goes out



igure 45–31 Typical setup for a center-mounted hand-operated parking brake. *Courtesy of American Honda Motor Co., Inc.*



(B)

gure 45–32 Typical pedal-operated parking brakes: mechanical release and (B) vacuum release.

ıen either the pedal or control is released or the igni- n is turned off.

The cable/lever routing system in a typical parking e arrangement **(Figure 45–33)** employs a three lever ıp to multiply the physical effort of the operator. First he pedal assembly or hand grip. When moved, it mul- lies the operator's effect and pulls the front cable. The nt cable, in turn, pulls the equalizer lever.

The **equalizer lever** multiplies the effort of the pedal assembly, or hand grip, and pulls the rear cables. This pulling effort passes through an equalizer, which ensures equal pull on both rear cables. The equalizer functions by allowing the rear brake cables to slip slightly to balance out small differences in cable length or adjustment.

USING SERVICE MANUALS

Service manuals list the standard brake drum inside diameter along with the discard dimension. They also state the standard and minimum lining thickness. Manual illustrations should be used to accurately identify all components plus the disassemble/reassembly procedure. Tightening torques for backing plate nuts and other components should always be followed. ■

INTEGRAL PARKING BRAKES

Integral parking brakes are for vehicles with rear wheel drum brakes. **Figure 45–34** shows a typical integral parking brake. When the parking brake pedal is applied, the cables and equalizer exert a balanced pull on the parking brake levers of both rear brakes. The levers and the parking brake struts move the shoes outward against the brake drums. The shoes are held in this position until the parking brake pedal is released.

The rear cable enters each rear brake through a conduit **(Figure 45–35)**. The cable end engages the lower end of the parking brake lever. This lever is hinged to the web of the secondary shoe and linked with the primary

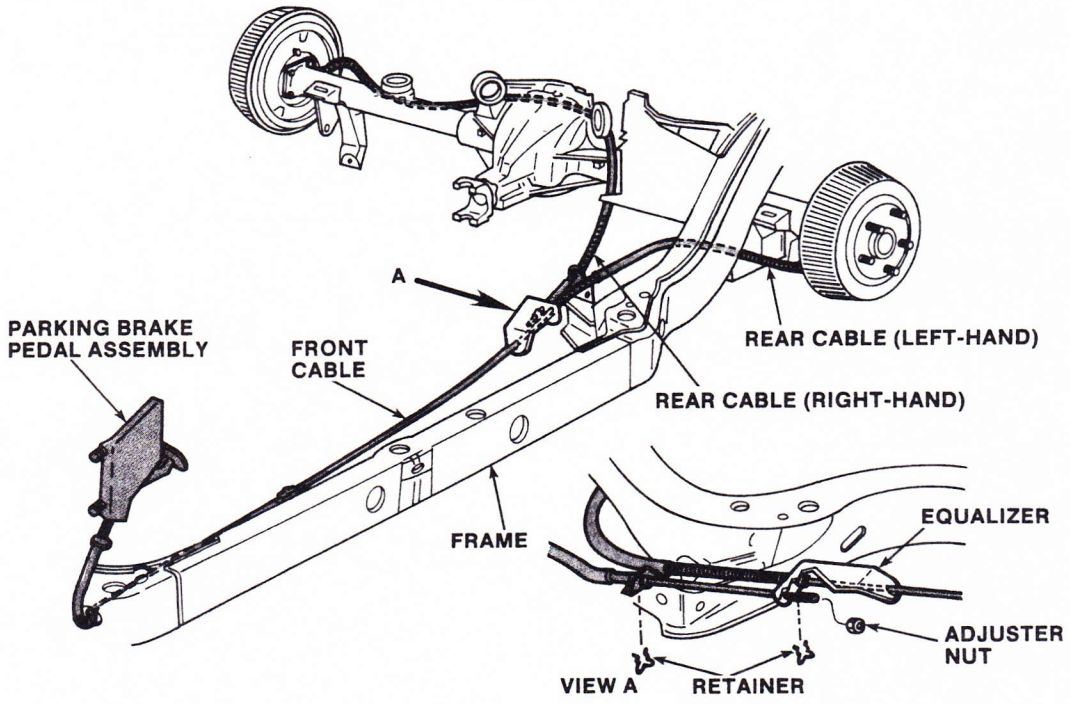


Figure 45-33 Typical parking brake routing to a cable equalizer and the rear drum brakes.

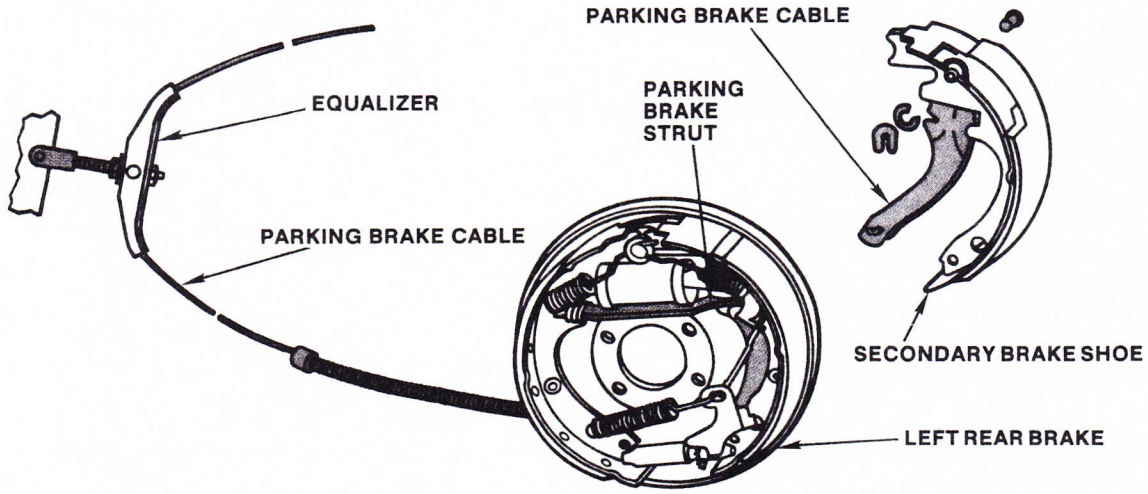


Figure 45-34 Integral parking brake components.

shoe by means of a strut. The lever and strut expand both shoes away from the anchor and wheel cylinder and into contact with the drum as the cable and lever are drawn forward. The shoe return springs reposition the shoes when the cable is slacked.

To remove and replace the rear brake shoes, it might be necessary to relieve the parking brake cable tension by backing off the adjusting check nuts at the equalizer. Count the turns backed off in order to restore the nuts to their original position.

Adjusting and Replacing Parking Brakes

Regular wheel brake service should be completed before adjusting the parking brake. Then check the parking brake for free movement of the parking brake cables i the conduits. If necessary, apply a lubricant to free th cables. Check for worn equalizer and linkage parts. Re place any defective parts. Finally, check for broken strand in the cables. Replace any cable that has broken strands c shows signs of wear.

TESTING Test the parking brake by parking the vehi cle facing up on an incline of 30 degrees or less. Set th parking brake fully and place the transmission in neutra The vehicle should hold steady. Reverse the vehicle posi tion so it is facing down the incline and repeat the test. I the vehicle creeps or rolls in either case, the parking brak requires adjustment.

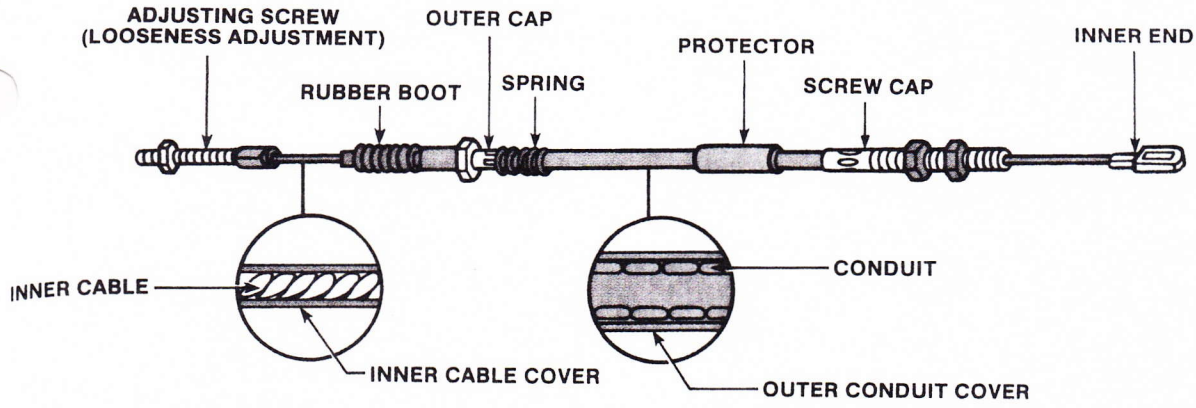


Figure 45-35 Rear cable and conduit details

CASE STUDY

Shortly after new brake shoes and hardware were installed on a vehicle, it is returned to the shop on the rear of a tow truck. An extremely irate and distressed customer is heard throughout the entire service bay area. It seems when the customer applied the brakes while traveling at a high speed, there was a sudden loss of braking power and a fine metallic grinding noise was heard. Luckily, the customer was able to control the vehicle and avoid an accident, but the situation was potentially disastrous.

The vehicle is immediately placed on a hoist and the drum brakes are disassembled. Although all the parts are new, they had failed. The shoes are pulled away from the backing plate and the hold-down pins and retainers are broken.

The technician replaces all broken components with new parts from the shop's parts department. Everything appears to be installed correctly and in good working order.

The technician is reluctant to release the vehicle to the owner without uncovering the cause of the first failure. Inspecting the assembly, the technician compares the new shoes with the failed shoes. He notices the hold-down pin bores on the defective shoes do not line up perfectly with the pins. More comparisons between the new and failed parts uncover slight differences. The shoes and hardware that had failed were the wrong parts for the vehicle. Although similar in many ways, these slight differences were enough to cause a major failure. The technician who had performed the original replacement should have visually compared the new parts with the old parts.

KEY TERMS

Anchor pin
Backing plate
Bonded linings
Brake lathe
Duo-servo drum brake
Eccentric-ground
Equalizer lever
Floating drum
Heat checks
Hold-down spring
Nonservo drum brake
Overtravel spring
Primary shoe
Return spring
Secondary shoe
Self-energizing force
Shoe anchor
Web

SUMMARY

- Drum brakes are still used on the rear wheels of many cars and light trucks.
- The drum is mounted to the wheel hub. When the brakes are applied, a wheel cylinder uses hydraulic power to press two brake shoes against the inside surface of the drum. The resulting friction between the shoe's lining and drum slows the drum and wheel.
- The brake's anchor pin acts as a brake shoe stop, keeping the shoes from following the rotating drum. This creates a wedging action that multiplies braking force.
- The shoes and wheel cylinder are mounted on a backing plate. Hardware, such as shoe return springs, hold-down parts, and linkages are also mounted on the backing plate.
- The primary or leading shoe is toward the front of the vehicle while the secondary or trailing shoe is toward the rear of the vehicle.
- Brake lining can be attached to the shoes by riveting or a special adhesive bonding process.
- Brake drums act as a heat sink to dissipate the heat of braking friction. Drums can be refinished on a brake

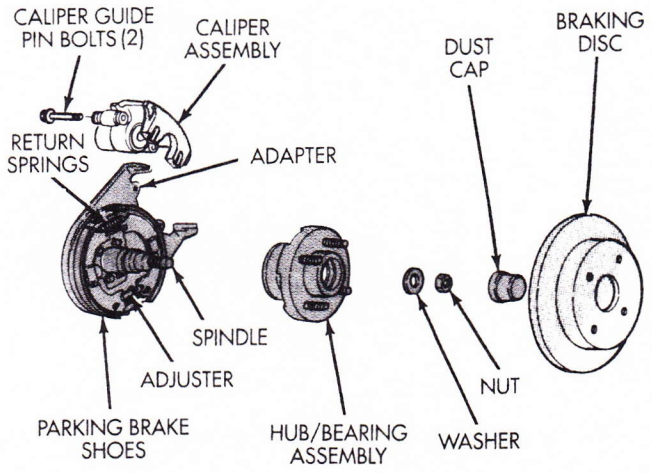


Figure 46-9 A typical parking brake that uses a drum built into the center of a rotor. *Courtesy of DaimlerChrysler Corporation*

the inside of each rear wheel hub and rotor assembly is used as the parking brake drum **(Figure 46–9)**. The auxiliary drum brake is a smaller version of a drum brake and is serviced like any other drum 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 that is found on many vehicles has a threaded, spring-loaded pushrod **(Figure 46–10)**. As the parking brakes are applied, a mechanism rotates or unscrews the pushrod, which in turn pushes the piston out. Other types of actuating systems for rear disc brakes include the use of a variety of cams.

DISC BRAKE DIAGNOSIS

Many problems that are experienced on vehicles with disc brakes are the same ones that are evident with drum brake systems. There are some problems that occur only with disc brakes. Before covering the typical complaints, it is important to remind you to get as much information as possible about the complaint from the customer. Then road test the vehicle to verify the complaint. A complete inspection of the rotor, caliper, and pads **(Figure 46–11)** should be done anytime you are working on the brakes.

What follows is a brief discussion of common complaints and their typical causes.

Warning Lights

Today's vehicles are normally equipped with more than one brake warning light on the instrument panel. Regardless of what warning light is lit, it is an indication of warning to the driver. You need to understand what would cause the different lights to illuminate in order to take care of the problem. Keep in mind, a vehicle may have one, two, or all of these lights.

The red warning light indicates there is a problem i the regular brake system, such as low brake fluid leve or that the parking brake is on. A low fluid light may b present in addition to the red brake warning light. Whe ever the fluid is low, you should suspect a leak or ve worn brake pads.

The yellow or amber brake warning light is tied int the antilock brake system. This light turns on for two re sons: the ABS system is performing a self-test or there a fault in the ABS system.

A blue warning light lets the driver know the whee are slipping because of poor road conditions. More di cussion on the amber and blue lights is given in the ne chapter of this book.

Pulsating Pedal

Customers will feel a vibration or pulsation in the brak pedal when the brakes are applied if a brake rotor warped. If this symptom exists, check the rotors fc runout and parallelism. A warped rotor should b replaced and is often caused by improper tightening c the wheel lug nuts. In fact, uneven lug nut torque ca cause a pulsating brake pedal. You should be aware tha pedal pulsation is normal on vehicles with ABS when th antilock brake system is working.

Spongy Pedal

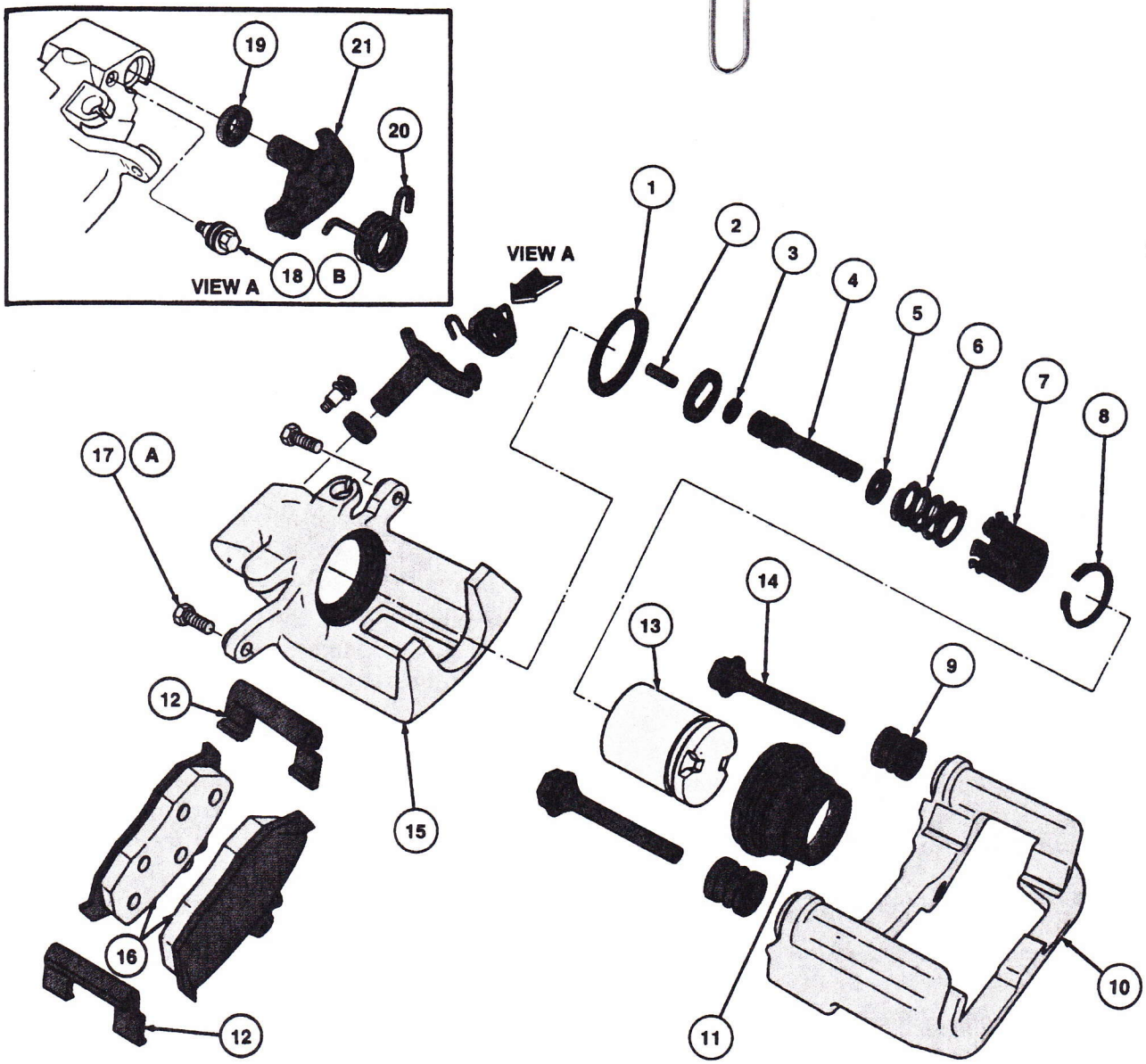
With a spongy pedal, the customer will probably feel th need to pump the brake pedal to get good stopping abi ity. The complaint may also be described as a soft peda This problem is caused by air in the hydraulic systen Although bleeding the system may remove the air, yo should always question how the air got in there. Chec for leaks and for proper master cylinder operation.

Hard Pedal

The driver's complaint of a hard pedal normally indicate a problem with the power brake booster. However it ca also be caused by a restricted brake line or hose. Car fully check the lines and hoses for damage. Feel the brak hoses. If they seem to have lost their rigidity, the hose ma have collapsed on the inside and this is causing the restri tion. Restrictions can also be caused by frozen caliper c wheel cylinder pistons.

Dragging Brakes

Dragging brakes make the vehicle feel as if it has lost c is losing power as it drives down the road. The proble also wastes a lot of fuel and generates destructive amoun of heat that can cause serious brake damage and brak failure. While trying to find the cause of this problen check the parking brake first. Make sure it is off. Chec the rear wheels to make sure the parking brakes ar released when they should be. If the problem is not in th parking brakes, check for sticky or seized pistons at th calipers and wheel cylinders.



1. Piston seal
2. Pin
3. O-ring
4. Pushrod
5. Flat washer
6. Spring
7. Spring cage
8. Snapring
9. Slider pin boot seal
10. Rear support
11. Piston dust boot
12. Antirattle clip
13. Piston
14. Locating pin
15. Caliper
16. Brake pads
17. Pin retainer
18. Limiting bolt
19. Parking brake shaft seal
20. Parking brake lever return spring
21. Parking brake lever

Figure 46-10 A rear caliper with a threaded drive for the piston. *Courtesy of Ford Motor Company*

Grabbing Brakes

When the brakes seem to be overly sensitive to pedal pressure, they are grabbing. Normally this problem is caused by contaminated brake linings. If the linings are covered or saturated with oil, find the source of the oil and repair it. Then replace the pads and refinish or replace the rotor.

Noise

If the customer's complaint is noisy brakes, verify during the road test that the problem is in the brakes. If the noise is caused by the brakes, pay attention to the type of noise and let that lead to the source of the problem. Remember, some brake pads have wear sensors that are

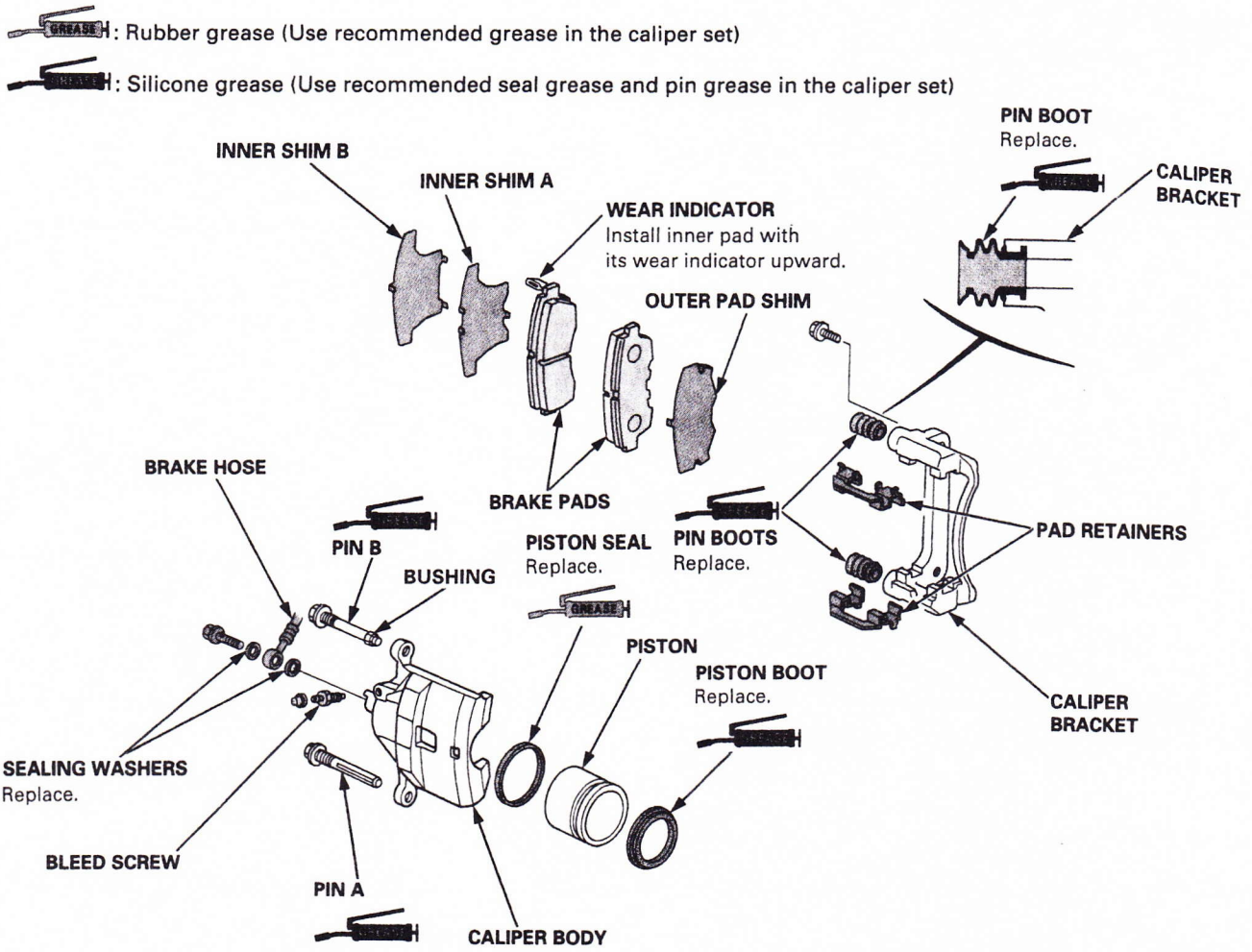


Figure 46-11 Whenever you are doing brake work, thoroughly inspect the entire brake assembly. *Courtesy of American Honda Motor Co., Inc.*

designed to make a high-pitched squeal when the pads are worn. Other causes could be the rotor rubbing against the splash shield or that something has become wedged between the rotor and another part of the vehicle. Noise may also be caused by failure to install all of the hardware when placing a caliper or brake pads in service.

Pulling

When a vehicle drifts or pulls to one side while cruising or when braking, the cause could be in the brake system or in the steering and suspension system. Check the inflation of the tires, the tires' tread condition, and verify that the tires on each axle are the same size. Check the operation of the brakes. If only one front wheel is actually doing the braking, the vehicle will seem to stumble or pivot on that one wheel. If no problems are found in the brake system, suspect an alignment or suspension problem.

SERVICE PRECAUTIONS

The following general service precautions apply to all disc brake systems and should always be followed:

1. Be sure the vehicle is properly centered a secured on stands or a hoist.
2. If the vehicle has antilock brakes, depressurize system according to the procedures given the service manual.
3. Disconnect the battery ground cable.
4. Before any service is performed, carefully ch the following:
   - Tires for excessive wear or improper inflatio
   - Wheels for bent or warped rims
   - Wheel bearings for looseness or wear
   - Suspension components to see if they are w or broken
   - Brake fluid level
   - Master cylinder, brake lines or hoses, and e wheel for leaks
5. During servicing, grease, oil, brake fluid, or a other foreign material must be kept off the br linings, caliper, surfaces of the disc, and exter

surfaces of the hub. Handle the brake disc and caliper in such a way as to avoid deformation of the disc and nicking or scratching of the brake linings.

6. When a hydraulic hose is disconnected, plug it to prevent any foreign material from entering.
7. Never permit the caliper assembly to hang with its weight on the brake hose. Support it on the suspension or hang it by a piece of wire.
8. Inspect the caliper for leaks. If leakage is present, the caliper must be overhauled.
9. When using compressed air to remove caliper pistons, avoid high pressures. A safe pressure to use is 30 psi (207 kPa).
10. 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.
11. Lubricate any moving member such as the caliper housing or mounting bracket to assure a free-moving action. Use only recommended lubricant.
12. 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.
13. Obtain a firm brake pedal after servicing the brakes and before moving the vehicle. Be sure to road test the vehicle.
14. 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 master cylinder's reservoir. 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.

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.

WARNING!

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

GENERAL CALIPER INSPECTING AND SERVICING

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 carefully inspect 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.

Caliper Removal

To be able to replace brake pads, service the rotor, or to replace the caliper, the caliper must be removed. The procedure for doing this will vary according to caliper design. Always follow the specific procedures given in a service manual. Use the following as an example of these procedures:

1. Remove the brake fluid from the master cylinder.
2. Raise the vehicle and remove the wheel and tire assembly.
3. On a sliding or floating caliper, install a C-clamp 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 46–12)**,

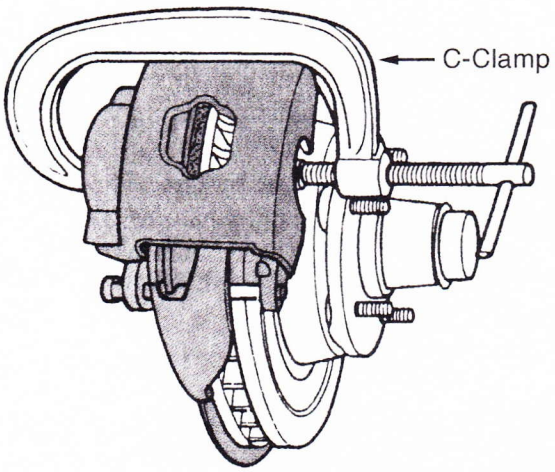
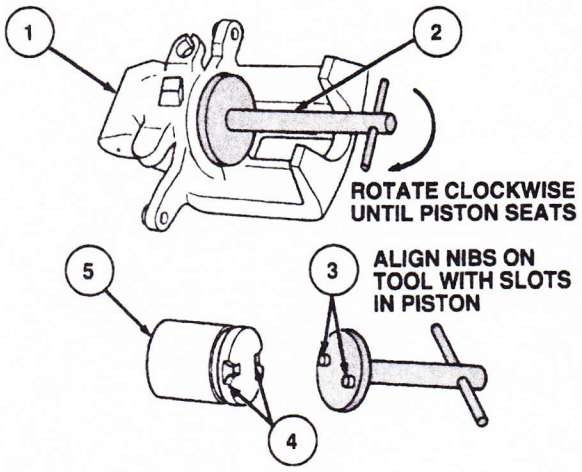


Figure 46-12 Bottoming the piston in the caliper's bore.



Item	Description
1	Caliper Housing
2	Rear Caliper Piston Adjuster Tool
3	Nibs
4	Slots
5	Rear Disc Brake Piston and Adjuster

Figure 46-13 A special tool is required to move a threaded piston into its bore. *Courtesy of Ford Motor Company*

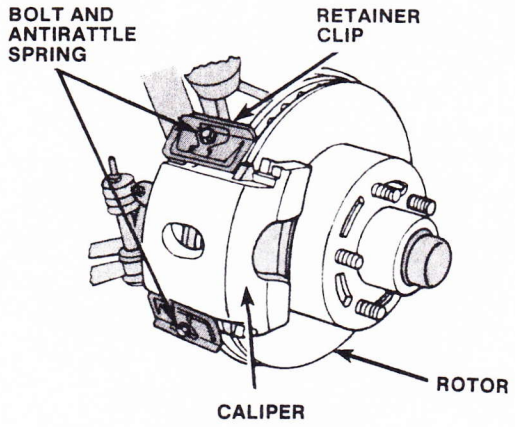


Figure 46-14 Sliding caliper removal.

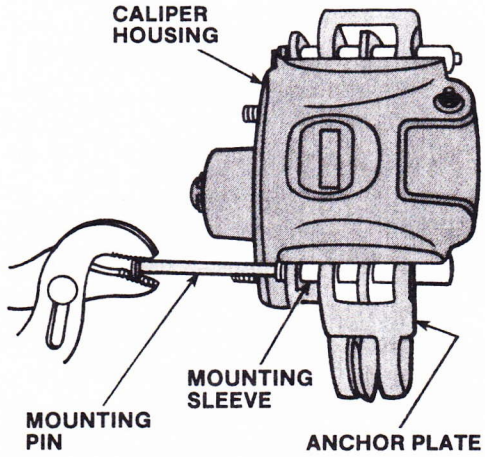


Figure 46-15 Floating caliper removal.

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.

4. On threaded-type rear calipers, the piston must be rotated to depress it. This requires a special tool **(Figure 46–13)**.
5. Disconnect the brake hose from the caliper and remove the copper gasket or washer and cap the end of the brake hose. 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 46–14)**. On a floating caliper, remove the two special pins that hold the caliper to the anchor plate **(Figure 46–15)**. On a 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.

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 e of the caliper.

If you are not sure the pads are worn enough to v rant replacement, measure them at the thinnest par the pad. Compare this measurement to the minim brake pad lining thickness listed in the vehicle's ser manual, and replace the pads if needed.

When a pad on one side of the rotor has worn m than on the other side, the condition is called une wear. Uneven pad wear often means the caliper is st ing and not giving equal pressure to both pads. C sliding caliper, the problem could be caused by poor lu cation of or deformation of the machined sliding area the caliper and/or anchor plate. A slightly tapered w pattern on the pads of certain models is caused by cal twist during braking. It is normal if it does not exceed inch (3-mm) taper from one end of the pad to the o **(Figure 46–16)**.

Sliding or floating calipers must always be lifted the rotor for pad replacement. Fixed calipers might h pads that can be replaced by removing the retaining l or clips instead of having to lift off the entire caliper. Br pads may be held in position by retaining pins, guide p or a support key. Note the position of the shims, a

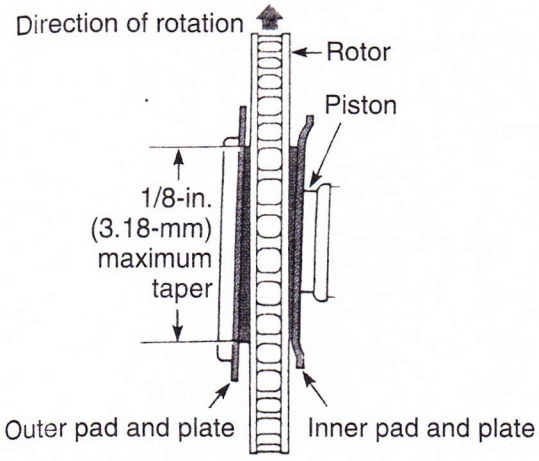


Figure 46-16 Normal pad wear pattern.

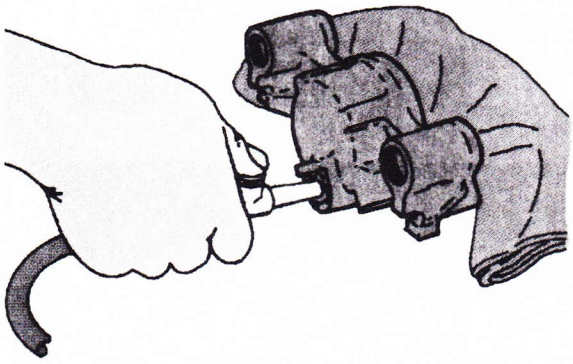


Figure 46-17 Using air to remove a piston. *Courtesy of General Motors Corporation—Service Operations*

rattle clips, keys, bushings, or pins during disassembly. A typical procedure for replacing brake pads is outlined in Photo Sequence 50, included in this chapter.

If only the pads are going 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.

SHOP TALK

Most often, calipers are replaced rather than rebuilt. The old caliper is sent back to the manufacturer as a core. The following overview for rebuilding is intended only to give you an understanding of what may be done. Always refer to the appropriate service manual when rebuilding a caliper. ■

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. Place the caliper face down on a workbench **(Figure 46–17)**. Insert the used outer pad or a block of wood into the caliper. Place a folded shop towel on the face of the lining to cushion the piston. 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.

CAUTION!

Wear safety glasses while doing this to protect your eyes from spraying brake fluid.

WARNING!

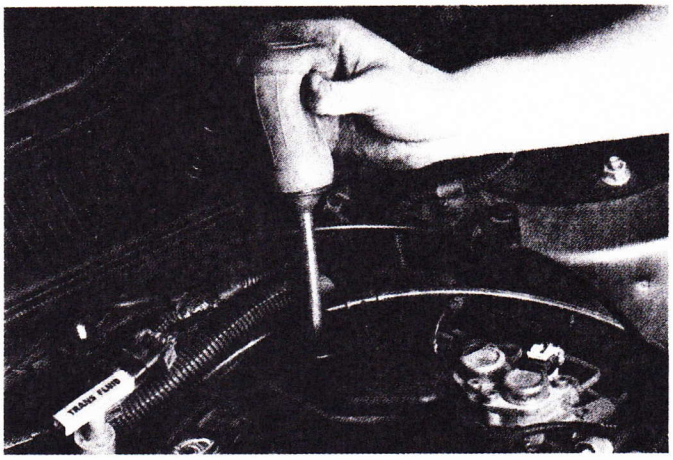
Be careful to apply air pressure very gradually. Be sure there are enough cloths to catch the piston when it comes out of the bore. Never place your fingers in front of the piston for any reason when applying compressed air. Personal injury could occur if the piston is popped out of the bore.

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. Frozen phenolic (plastic) pistons can be broken into pieces with a chisel and hammer. Be careful not to damage the cylinder bore while doing this. Internal expanding pliers are sometimes used to remove pistons from caliper bores.

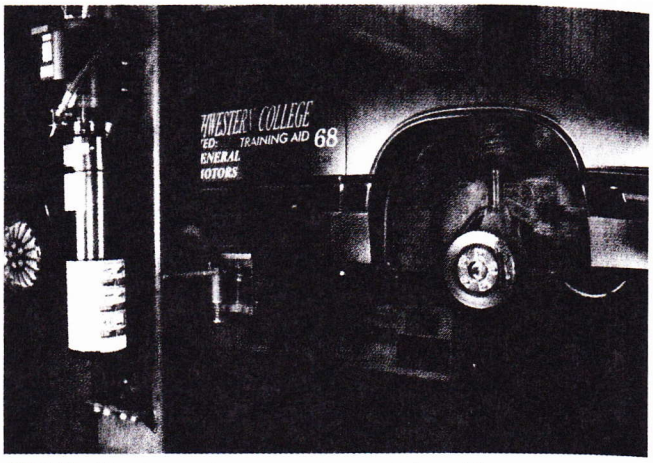
Inspect phenolic pistons for cracks, chips, or gouges. Replace the piston if any of these conditions are evident. If the plated surface of a steel piston is worn, pitted, scored, or corroded, it also should be replaced.

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 then is removed from the cylinder **(Figure 46–18)**. In either case, peel the boot from its groove. In some cases it might be necessary to pry it out, but be careful not to scratch

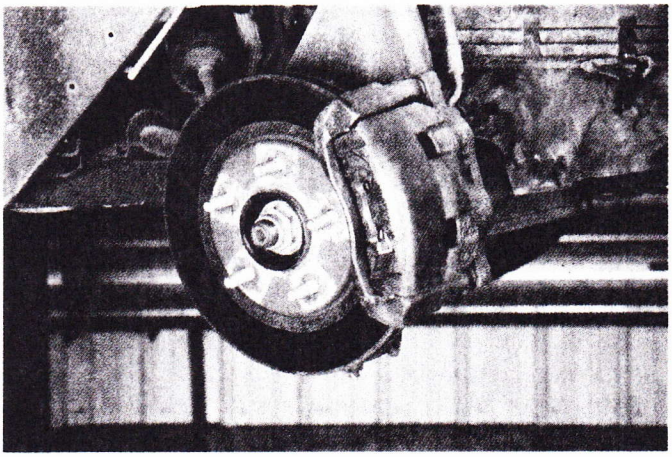
Photo Sequence 50
Removing and Replacing Brake Pads



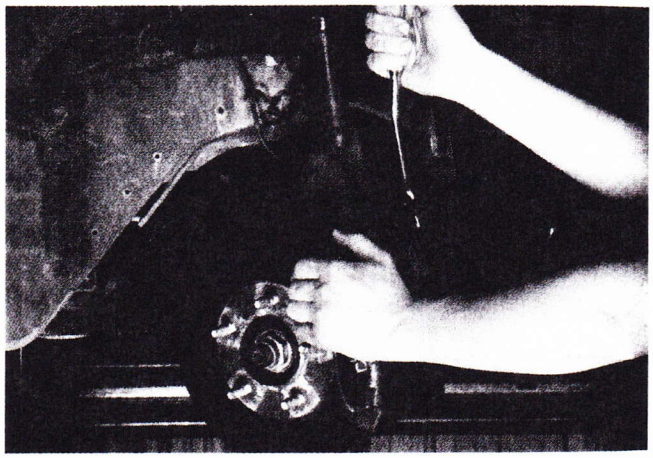
P50-1 *Front brake pad replacement begins with removing brake fluid from the master cylinder reservoir.*



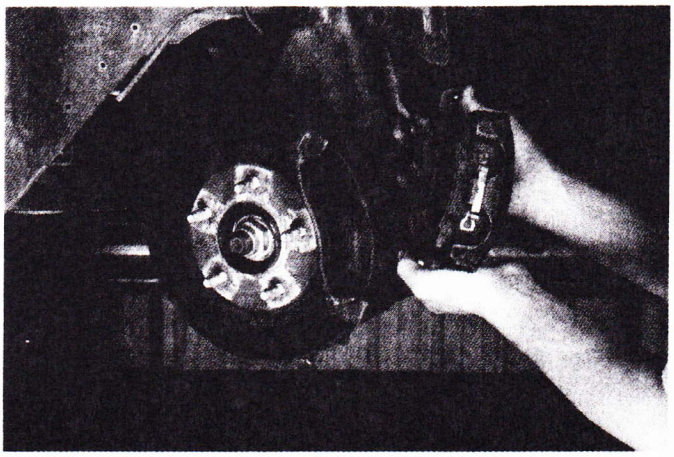
P50-2 *Raise the car. Make sure it is safely positioned on the lift. Remove its wheel assemblies.*



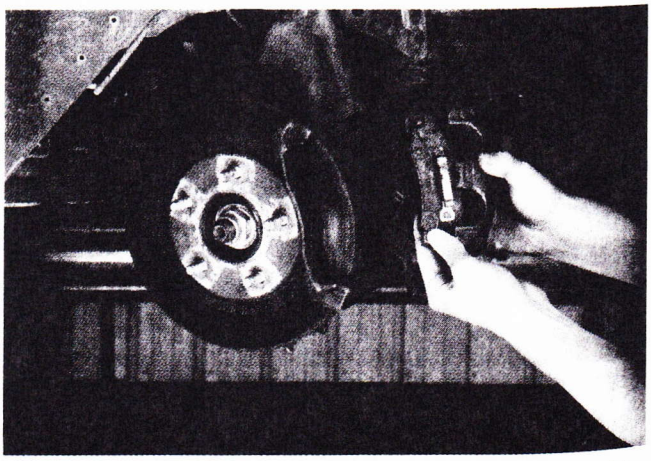
P50-3 *Inspect the brake assembly. Look for signs of fluid leaks, broken or cracked lines, or a damaged brake rotor. If any problem is found, correct it before installing the new brake pads.*



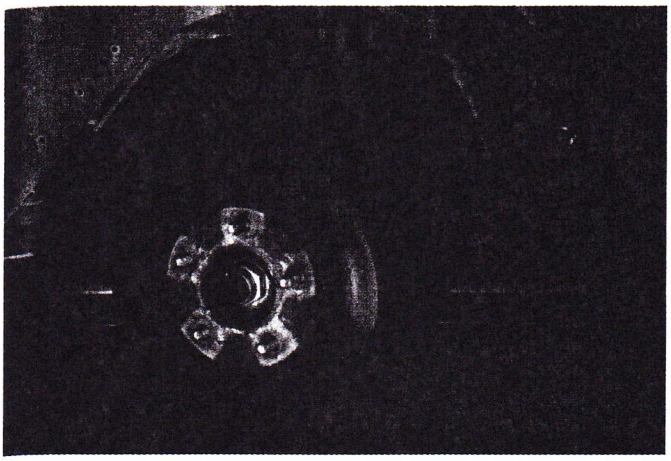
P50-4 *Loosen the bolts and remove the pad locator pins.*



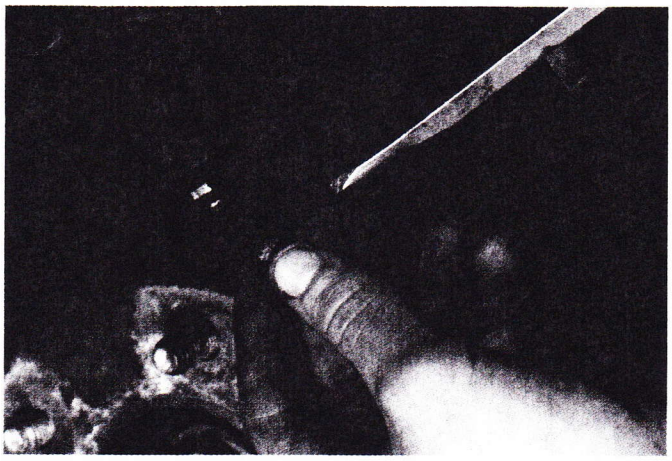
P50-5 *Lift and rotate the caliper assembly from the rotor.*



P50-6 *Remove the brake pads from the caliper assembly.*

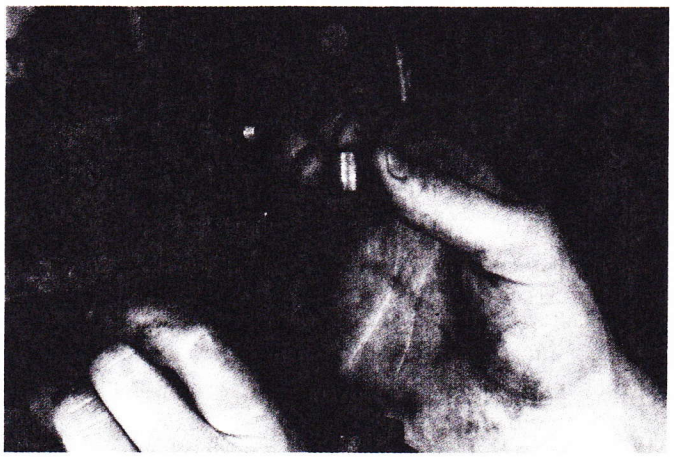


P50-7 *Fasten a piece of wire to the car's frame and support the caliper with the wire.*



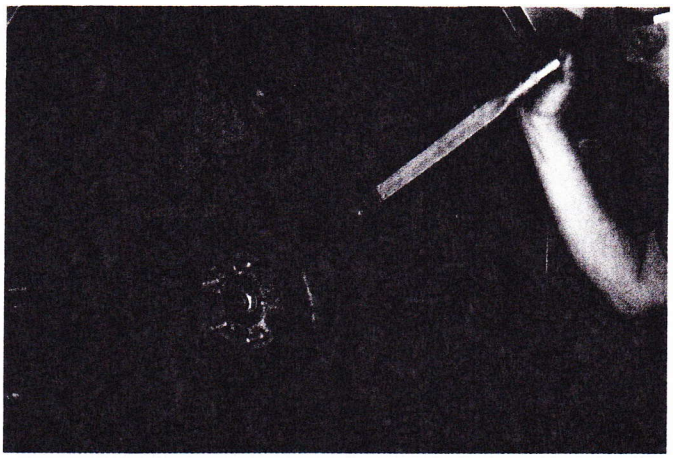
P50-8 *Check the condition of the locating pin insulators and sleeves.*

P50-9 *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.*



P50-10 *Remove the clamp and install new locating pin insulators and sleeves, if necessary.*

P50-11 *Install the new pads into the caliper.*



P50-12 *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.*

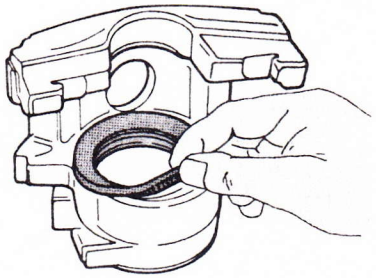


Figure 46-18 Peeling off the dust boot.

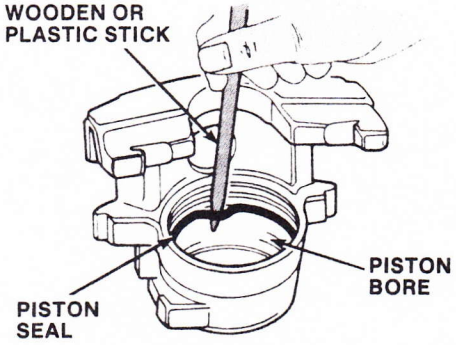


Figure 46-19 Removing a piston seal with a wooden or plastic stick.

the cylinder bore while doing so. The old boot can be discarded since it must be replaced along with the seal.

Remove the piston's and the cylinder's seal by prying them out with a wooden or plastic tool **(Figure 46–19)**. 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 bore that has deep scratches or scoring normally indicates that the caliper should be replaced. In some cases, the cylinder can be honed. Check the service manual before doing this. If there is no mention of honing the bore, the manufacturer probably does not recommend it. Black stains on the bore walls are caused by piston seals. They do no harm.

When using a hone, 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 **(Figure 46–20)** 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 during caliper overhaul.

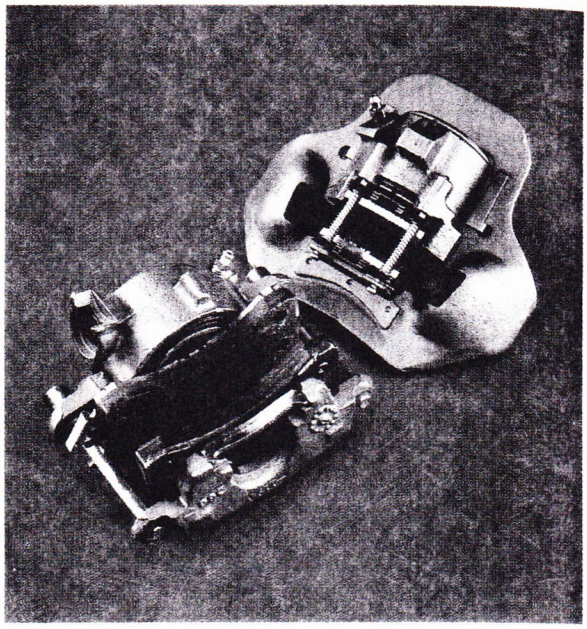


Figure 46-20 A pair of loaded brake calipers. *Courtesy of Bendix Brakes by AlliedSignal*

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

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 Reassembly

Before assembling the caliper, clean the phenolic piston (if so equipped) and all metal parts to be reused 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.

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

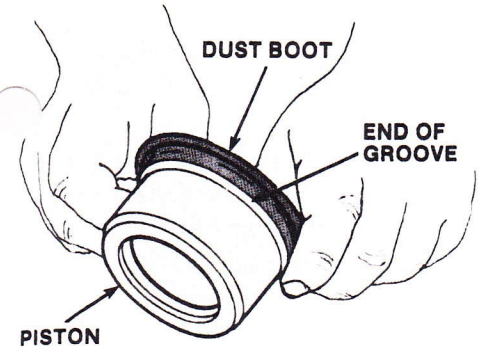


Figure 46-21 Some installation procedures require the dust boot to be pulled over the end of the piston.

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. Be sure to use a wood block or other flat stock when installing the piston back into the piston 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 46–21)**. 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 46–22)**.

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 that 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.

CAUTION!

On fixed calipers, bridge bolts are used to hold the two caliper halves together. These are high-tensile bolts 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 **(Figure 46–23)** when replacing disc brake pads. Replacement of the hardware ensures proper caliper movement and brake pad retention. It also aids in preventing brake noise and uneven brake pad wear.

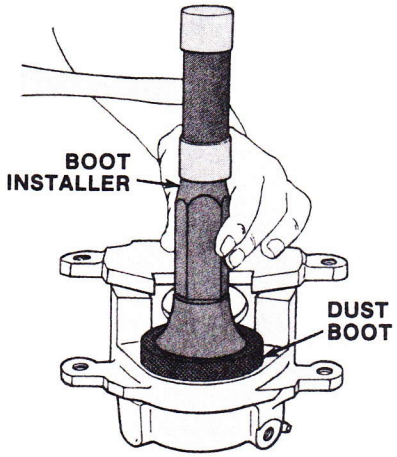


Figure 46-22 Seating a dust boot with a boot installer.

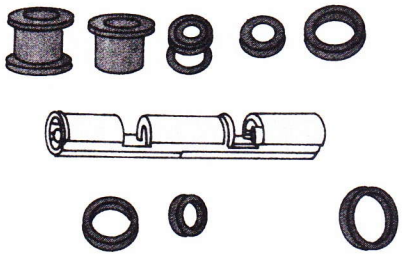


Figure 46-23 An assortment of caliper guide pin bushings and insulators. *Courtesy of Wagner Brake Products*

FIXED CALIPER BRAKE PADS The designs of fixed caliper disc brakes vary slightly. Generally, to replace the pads, insert new pads and plates in the caliper with the metal plates against the end of the pistons. Be sure that 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 (108 to 122 newton-meters). On some fixed disc brakes, the pads are held in place by retaining clips and/or retaining pins. 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. Lightly lubricate the sliding surfaces of the caliper and the caliper anchor. Slide a new outer pad into the recess of the caliper. 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 46–24)**. Install the pad.

Place the inner pad into position on the caliper anchor with the pad's flange on the machined sliding area. Fit the caliper over the rotor. Align the caliper to the anchor and slide it into position. Be careful not to pull the dust boot from its groove when the piston and boot slide over the inboard pad. Install the antirattle springs (if so equipped)

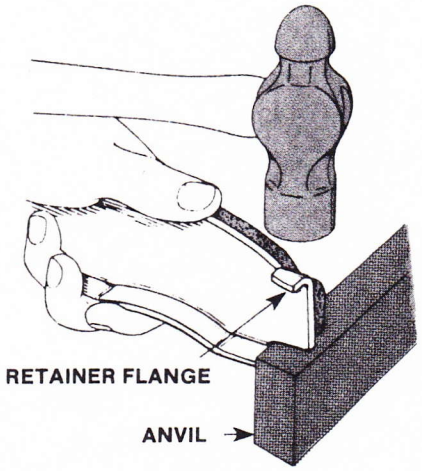


Figure 46-24 Bend the retaining flange if there is excessive free play.

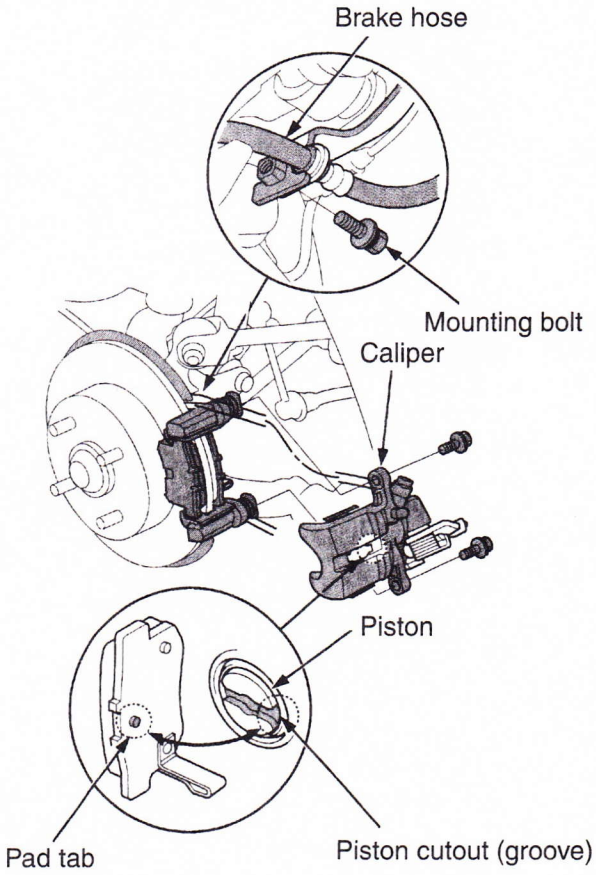


Figure 46-25 On some rear brake assemblies there is a tab on the back of the pad that must line up with the groove in the piston. *Courtesy of American Honda Motor Co., Inc.*

on top of the retainer plate and tighten the retaining screws to specification.

On some calipers, especially those used as rear brakes, there is a notch or groove in the piston and a tab on the rear of the inner pad. During installation of the pad, the tab must fit into the groove in the piston **(Figure 46–25)**.

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 that the metal portion of the pad is fully recessed in the caliper and adapter and that the proper pad is on the outer side of the caliper.

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

When installing any type of caliper, follow these guidelines:

- Make sure the correct caliper is installed on the correct anchor plate.
- Lubricate the rubber insulators (if so equipped) with silicone dielectric compound.
- After the caliper assembly is in 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

Tolerances on rotor thickness, parallelism, runout, flatness, and depth of scoring are very critical and must be measured with exacting gauges and micrometers. Accurate measuring tools and up-to-date rotor resurfacing equipment are required for brake rotor service. 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.

CAUTION!

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

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

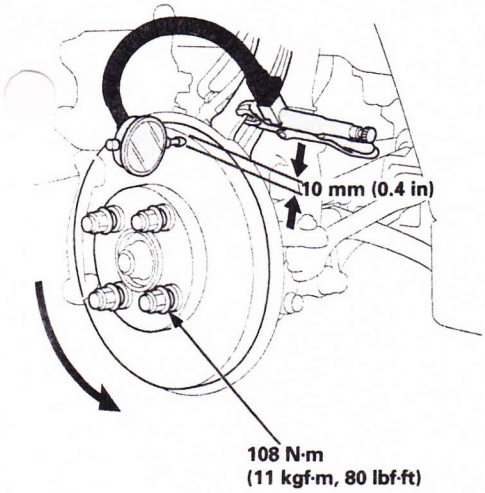


Figure 46-26 Checking the lateral runout of a brake rotor. *Courtesy of American Honda Motor Co., Inc.*

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 **(Figure 46–26)**, the rotor must be turned or replaced.

Lack of Parallelism

Parallelism refers to variations in thickness of the rotor **(Figure 46–27)**. 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 [.381 mm]) of the disc braking surface can occur during normal brake use. This does not affect brake operation; however, it can result in a higher-than-average brake shoe lining wear rate. But, any rotor having score marks more than 0.15 inch (3.8 mm) 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.

Rotor Service

If the thickness of the rotor is below the minimal allowable thickness or is badly distorted, it must be replaced. If it has imperfections and has a thickness that is close to the minimum allowable thickness, it should also be replaced. If the thickness is well beyond minimum specifications, it can be trued and smoothed with a brake lathe. When replacing a rotor, make sure to tighten or secure it according to the manufacturer's recommendations.

On some vehicles the rotors are directional. These ventilated discs have curved cooling fins **(Figure 46–28)**. For maximum cooling, these fins must point rearward at the top of the rotor. This allows centrifugal force to spin air outward from inside the rotor.

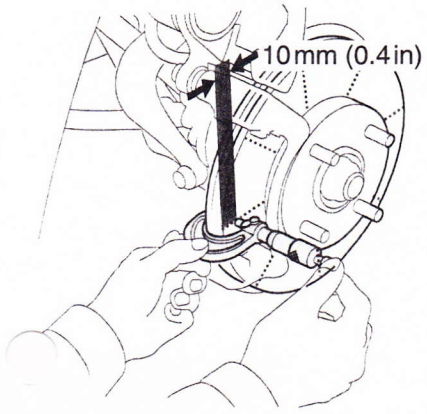


Figure 46-27 To check a rotor's parallelism, measure the thickness of the rotor at eight different spots. *Courtesy of American Honda Motor Co., Inc.*

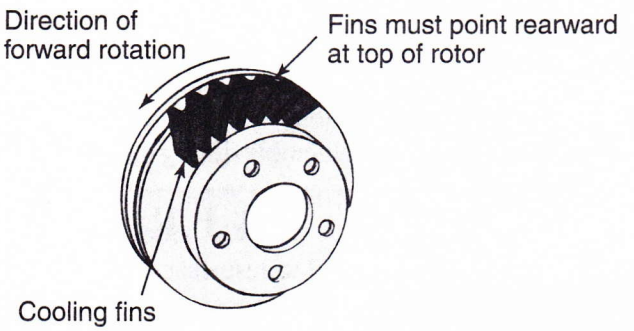


Figure 46-28 Some ventilated rotors have curved cooling fins and are directional. *Courtesy of EIS—Standard Motor Products*

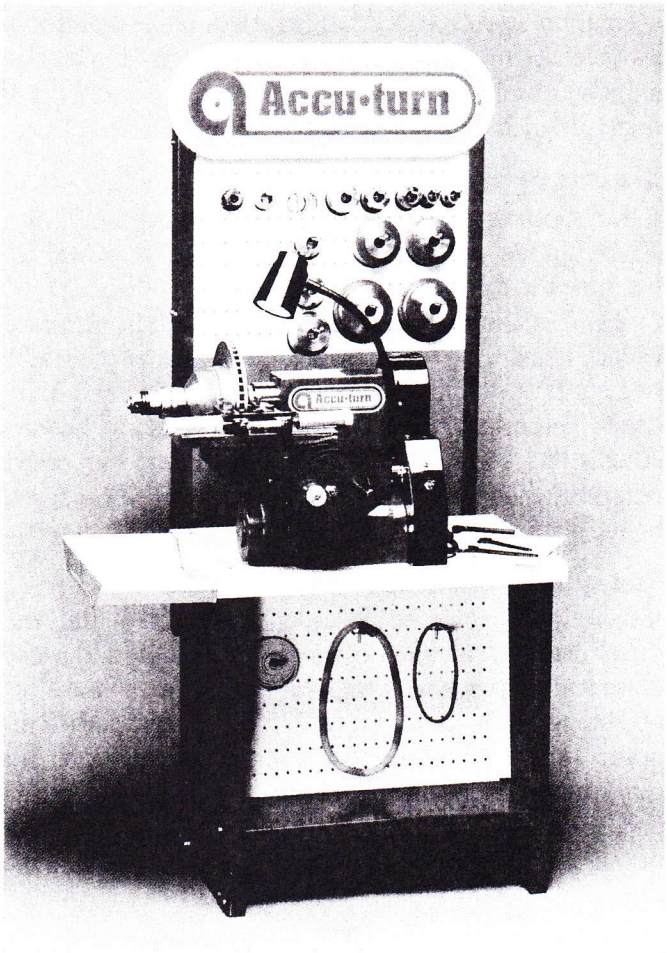


Figure 46-29 A typical brake lathe. *Courtesy of Accu Industries*

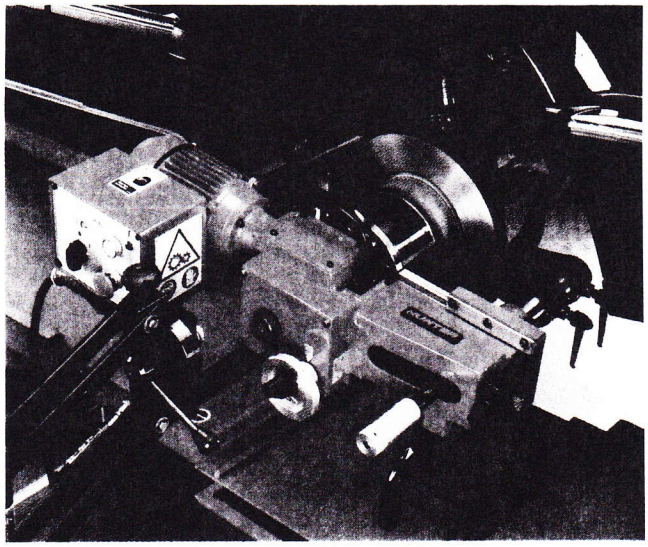


Figure 46-30 An on-the-vehicle brake lathe. *Courtesy of Hunter Engineering Company*

Rotors that have minor imperfections or are slightly unparallel can be turned true and smooth with a brake lathe. A brake lathe cuts metal away to achieve the desired surface finish. There are basically two types of brake disc lathes used by the industry. The first is one that has the capability of resurfacing brake drums and brake discs **(Figure 46–29)** after they have been removed from the vehicle. The lathe rotates the disc as cutting tools work their way across the braking surface of the disc. The second type is an on-vehicle brake lathe **(Figure 46–30)**. This type of brake lathe is a time saver because the rotor does not need to be removed from the vehicle. Special fixtures are used to straddle the rotor so the cutting tools can precisely cut both sides of the rotor. An electric motor is used to rotate the disc and hub assembly during cutting.

SHOP TALK

Special cutters are required to resurface composite rotors. Make sure you have the correct machine and cutting tools before attempting to true up a composite brake rotor. ■

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 that the rest of the braking system is in fine working order.

The technician inspects the front brakes and finds that 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

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.
- In a rear disc brake system 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.
- 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 46 of the *Tech Manual* that accompanies this book:

1. Inspecting and measuring brake pads and rotors.
2. Replacing brake pads.

REVIEW QUESTIONS

1. Name four major advantages of disc brakes over drum brakes.
2. Name the three major assemblies that make up a disc brake.
3. Name the three types of calipers used on disc brakes.
4. What type of brake uses the inside of each rear wheel hub and rotor assembly as a parking brake drum?

   How many cylinder bores and pistons can a caliper assembly contain?
6. Which of the following statements concerning disc brakes is incorrect?
   a. Disc brakes can handle more heat than drum brakes.
   b. Disc brakes are not as likely to fade during heavy braking as are drum brakes.
   c. Disc brakes stay in adjustment automatically.
   d. Disc brakes do not tolerate water well.
7. How do disc brakes self-adjust?
8. What are the two basic types of brake rotors used on today's vehicles?
9. What channels the flow of air over the exposed rotor surfaces?
   a. webs
   b. hub assembly
   c. splash shield
   d. caliper assembly
10. Which of the following statements concerning caliper assembly is incorrect?

a. The caliper housing is usually a two-piece construction of aluminum and cast iron.

b. Caliper action converts hydraulic pressure into mechanical force.

c. A caliper assembly can contain as many as four cylinder bores and pistons.

d. The caliper assembly provides a means of forcing the brake pads against the rotor.

11. What prevents moisture from entering the cylinder bore?

a. phenolic piston **c.** splash shield

b. drag caliper **d.** dust boot

12. When servicing disc brakes on a vehicle, Technician A works on one wheel before beginning work on another. Technician B uses a minimum of 50 psi (345 kPa) of air pressure to force the piston from the caliper housing. Who is correct?

a. Technician A **c.** Both A and B

b. Technician B **d.** Neither A nor B

13. When examining disc brakes, Technician A visually inspects the rotor and says the rotor can be reused if it is not damaged or scored. Technician B says it is normal for the inboard pad to be worn more than the outside pad. Who is correct?

a. Technician A **c.** Both A and B

b. Technician B **d.** Neither A nor B

14. What should be done to remove rust, corrosion, pitting, and scratches from the piston bore?

15. Which term refers to variations in thickness of the rotor?

a. torque **c.** parallelism

b. lateral runout **d.** pedal pulsation

16. Technician A cleans brake components in denatured alcohol. Technician B cleans brake components in clean brake fluid. Who is correct?

a. Technician A **c.** Both A and B

b. Technician B **d.** Neither A nor B

17. Technician A states that rotor wear can be caused by worn pad linings. Technician B states that hard spots in a rotor usually result from manufacturing defects. Who is correct?

a. Technician A **c.** Both A and B

b. Technician B **d.** Neither A nor B

18. Which of the following is not likely to cause a pulsating brake pedal?

a. loose wheel bearings

b. worn brake pad linings

c. excessive lateral runout

d. nonparallel rotors

19. Technician A replaces the pads if they are 1/32-inch (.79 mm) thick or less. Technician B says the calipers must be replaced if the pads have a slightly tapered wear pattern. Who is correct?

a. Technician A **c.** Both A and B

b. Technician B **d.** Neither A nor B

20. While discussing how to remove the piston from a brake caliper, Technician A says the dust boot should be removed, then a large dull screwdriver should be inserted into the piston groove to pry the piston out. Technician B says air pressure should be injected into the bleeder screw's bore to force the piston out of the caliper. Who is correct?

a. Technician A **c.** Both A and B

b. Technician B **d.** Neither A nor B