ASE 5 - Brakes

Module 4
Wheel Brake Systems
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Drum Brakes

Objectives

After completing this section, the student will be able to:

• Describe which special tools to use during drum brake service
• Demonstrate how to use the special tools during drum brake service
• Demonstrate how to prevent brake system contamination during service
• Perform brake drum inspection
• Perform brake drum service on duo-servo, leading-trailing, and advance leading-trailing systems
• Demonstrate the proper wheel lug tightening sequence
• Demonstrate how to use a torque limiter
• Explain wheel cylinder operation
• Describe the function of hold-down springs
• Describe self-adjuster operation
Drum Brakes

Drum brakes include two brake shoes mounted on a stationary backing plate. Return springs hold the shoes retracted.

There are three types of drum brakes used on GM vehicles:

- Duo-servo
- Leading-trailing
- Advanced leading-trailing

Figure 4-1, Duo-Servo Drum Brake
**Duo-Servo Drum Brake**

In the duo-servo unit, braking forces increase (energize) in both forward and reverse motion (refer to Figure 4-1).

The energizing force transfers from one shoe to the other when the wheel rotates in either direction. A wheel cylinder actuates both the primary (front) and secondary (rear) brake shoes. Return springs hold the upper end of each shoe against a single anchor. An adjusting screw assembly and spring connect the lower ends of the shoes.

**Duo-Servo Operation**

The wheel cylinder mounts on the backing plate at the top of the brake. When the driver applies the brakes (Figure 4-2):

1. Hydraulic pressure in the wheel cylinder forces both pistons outward to apply the brakes.

2. When the primary (forward) brake shoe contacts the rotating drum, the frictional forces drag the shoe and turn it outward from its pivot points.

3. The shoe is energized when it wedges into the drum with a force greater than the hydraulic pressure applied to the wheel cylinder.

4. The rotational force from the primary shoe transfers through the adjusting screw to the secondary shoe.

5. The shoe wedges against the drum with the same energizing action as the primary shoe.

6. The secondary shoe overcomes the wheel cylinder force and returns the secondary shoe to the anchor pin.

The secondary shoe performs more of the braking. Therefore, the secondary brake lining is usually thicker and has more surface area than the primary brake lining.

**Self-Adjuster Operation**

The self-adjuster on duo-servo brakes operates only after the vehicle has
been driven in reverse and the brake has been applied and then driven in forward and the brake applied. This action causes the adjuster lever to rotate the adjuster wheel.

**Leading-Trailing Drum Brake**

In the leading-trailing type of drum brake, the leading shoe performs the greater portion of the braking. Leading-trailing brakes have a fixed anchor at the bottom of the brake backing plate (Figure 4-3).

**Leading-Trailing Operation**

On brake application during forward motion:

1. Wheel cylinder forces the lining of the leading (forward) shoe into contact with the rotating drum.
2. Friction between the drum and lining energizes the leading shoe and places pressure against the anchor pin at the bottom of the shoe. The forward shoe rotates outward until the drum prevents further outward movement.
3. The wheel cylinder also actuates the trailing (rear) shoe. Rotational force does not energize the trailing shoe. The friction force is the same as the input force from the wheel cylinder.

**Advance Leading-Trailing Operation**

The advanced leading/trailing drum brake (Figure 4-4) operation is the same as the leading/trailing design except for the return and hold-down spring. Advance leading-trailing uses one component to work as the return and hold-down spring. This design extends lining life and reduces cost due to fewer components.
Wheel Cylinder

The wheel cylinder transfers hydraulic pressure from the master cylinder to the brake shoes.

The wheel cylinder is mounted on the brake backing plate and contains two pistons and seals (Figure 4-5). Hydraulic pressure from the master cylinder moves the pistons outward, moving the brake shoes outward.

![Figure 4-5, Wheel Cylinder](image-url)
Brake Drum

The brake drum provides a friction surface for the brake shoes to contact. It mounts to the axle shaft and physically stops the axle from rotating (Figure 4-6).

Figure 4-6, Brake Drum
Brake Drum Inspection

Inspect and measure brake drums when (Figure 4-7):

- Replacing brake linings
- The following symptoms occur:
  - Pulsation
  - Brake fade
  - Chatter
  - Wheel drag
  - Brakes too sensitive
  - Springy/spongy pedal

Always be sure to measure brake drums in two or more places to ensure measurement accuracy.

Resurface drums if:

- Taper or out-of-roundness exceeds approximately 0.006 in. (0.15 mm)
- Scoring in excess of approximately 0.060 in. (1.52 mm)

Do not resurface drums due to light scoring or grooves.

Replace drums if:

- The maximum diameter reading equals or exceeds the discard dimension marked on the drum. Discard even if the drums are smooth and true
- The drum is under the discard dimension but refinishing would not leave at least 0.030 in. (0.76 mm) allowance for wear

Important:
The discard dimension marked on the drum is the maximum allowable wear dimension and not the allowable machining dimension. Leave at least 0.030 in. (0.76 mm) for wear after turning a drum.
Setting the Micrometer to the Drum Diameter

1. Loosen the two lock screws and move both the dial and the anvil along the shaft until the "whole" number of the drum diameter is visible at each arrow.

**Important:**
The metrically graduated shaft has "even" numbers scribed on one side and "odd" numbers on the other side. The English graduated shaft has identical scales front and back.

2. Set a fractional drum measurement, if necessary.
   a. English - Tighten the anvil lock screw and slide the dial along the shaft in precise 0.125 in. increments.
   b. Metric - Tighten the dial lock screw and slide the anvil along the shaft in precise 2 mm increments.

Thus, one arrow will point to the whole number of the drum diameter and the other arrow will indicate the desired fraction.

For drum measurements between 15 in. and 16 in. English, or 39 cm to 41 cm Metric, the fractional procedures a. and b. are reversed.

**Brake Drum Measuring Procedure**

Place the micrometer inside the drum and across the greatest diameter to be measured (refer to Figure 4-7). The anvil, or left end of the micrometer, is held steady and the dial, or right end, is moved back and forth slowly to obtain the highest reading.

This “highest reading” is the amount in thousandths of millimeters that the drum is oversize or undersize.

When measuring brake drum dimensions, it may be necessary to convert measurements from inches to millimeters or vice versa. To do so, use the conversion formulas below:

\[
\text{Inches} \times 25.4 = \text{Millimeters} \\
\text{Millimeters Stamped On Drum} = \text{Inches} \times 25.4 \\
0.03937 \text{ inches} = 1 \text{ millimeter}
\]
Brake Drum Taper and Out of Round

Taper and out of round may occur due to normal drum wear or due to damage. Taper is a difference in diameter from the top of the drum to the bottom (Figure 4-8). Out of round is a difference in diameter across the face of the drum (Figure 4-9).

Hand sand drums with a fine emery cloth only if the drums:

- Are true
- Are lightly scored
- Have only minor surface defects

Replacement drums are normally fully finished and do not require additional machining.

Important:
Turning the drums with a very fine feed obtains best brake performance. Only qualified personnel using reliable equipment should perform drum refinishing. Remove only enough metal to obtain a true, smooth surface. It is important to follow service manual or equipment manufacturers directions during any resurfacing operation.

Notice:
A rustproof coating protects replacement drums. Use a volatile, non-oil base solvent, such as brake cleaner or denatured alcohol, to remove the coating as well as any traces of oil or grease.
Drum Brake Service

Duo-Servo Example

Tools required:

- J 8049 Brake spring remover and installer
- J 8057 Brake spring pliers
- Disassemble

1. Remove wheel and tire. Mark the relationship of the wheel to the axle flange.
2. Mark the relationship of the drum to the axle flange. Remove the brake drum.
   - Make sure the parking brake is released.
   - Back off the parking brake adjustment if necessary.
   - Remove the adjusting hole plug or knockout plate from the backing plate and back off the adjusting screw using a screwdriver and brake adjusting tool (Figure 4-10).
   - Tap gently on the outer rim of the drum or around the inner drum diameter by the axle flange. Take care not to deform the drum by excessive use of force.
3. Use the J 8049 tool to remove the return springs (1 and 2) (see Figure 4-11).
4. Remove the hold down spring (3) and hold down pin (5) using pliers.
5. Remove the lever pivot (4).
6. Remove the actuator link (6) while lifting up on the actuator lever (7).
7. Remove the actuator lever, (7) pawl (8), if equipped, and lever return spring (9).
8. Remove the shoe guide (10), parking brake strut (11) and strut spring (12).
9. Remove the primary and secondary shoes (13 and 14) from the backing plate and parking brake cable.
10. Remove the adjusting screw assembly (31) and adjusting screw spring (15).
11. Remove the parking brake lever (20) by unhooking lever tab from slot in primary or secondary shoe and lining.
Clean and Inspect

1. Clean and lubricate adjuster screw assembly (31)
2. Clean backing plate and lubricate contact surfaces with brake lubricant GM part number 5450032 or equivalent on all contact surfaces.
3. Verify the adjusting screw threads rotate smoothly for their full length.
4. Inspect all parts. Replace any parts of doubtful strength or quality due to discoloration from heat, overstress or wear.

Figure 4-11, Drum Brake Components
Reassembly

1. Install the parking brake lever (20) by hooking lever tab into slot in appropriate shoe and lining.
2. Install adjusting screw assembly (31) and adjusting screw spring (15).
3. Attach primary and secondary shoe and lining (13 and 14) to parking brake cable and backing plate.
4. Install parking brake strut (11) and strut spring (12) by spreading primary and secondary shoes and linings apart. The end without the spring engages the parking brake lever. The end with the spring engages the brake shoe.
5. Install the shoe guide (10), pawl (8), if equipped, actuator lever (7) and lever return spring.
6. Install hold-down pin (5), lever pivot (4) and holddown spring (3).
7. Install the actuator link (6) on anchor pin. Install the actuator link onto the actuator lever (7) while holding up on the actuator lever.
8. Install return springs (1 and 2) using J 8057.

Preliminary Brake Adjustment

Tool required:

• J 21177-1 A Drum to brake shoe clearance gauge

1. Set J 21177-1 A so it contacts the inside diameter of the brake drum (Figure 4-12).
2. Position the J 21177-1 A over the primary and secondary shoes and linings (13 and 14) (Figure 4-13).
3. Turn the star wheel on the adjusting screw (19) until the primary and secondary shoes and linings contact J 21177-1 A.
4. Reinstall brake drums and wheels, realigning marks on the brake drum and wheel.

Figure 4-12, Setting Tool to Drum

Figure 4-13, Setting Brake Shoes to Tool
Final Brake Adjustment

Final brake shoe-to-drum clearance adjustment may vary from vehicle to vehicle. For example:

- Remove the knock-out area of the backing plate.
- Turn the adjusting screws until the wheels can just be turned by hand in both directions. Drag should be equal at both wheels.
- Back off the adjusting screw 24 notches. The brakes should have no drag after about 12 notches.
- Install the adjusting hole cover.
- Check parking brake adjustment.

Wheel Lug Tightening Sequence

Incorrect wheel lug tightening sequence may distort the drum or rotor which may cause excessive lateral runout. If the customer comments of brake pedal pulsation:

1. Remove wheel lug nuts.
2. Inspect the rotor/wheel contact face and clean off any debris or rust.
3. Use a torque wrench or J 39544 torque limiter with air impact wrench. Follow the manufacturers directions and the appropriate service manual torque specification.
4. Use a star pattern to tighten the wheel nuts in two stages (Figure 4-14).
5. Road test the vehicle. If the condition is not corrected, check for thickness variation, lateral runout or wheel bearing looseness.

Figure 4-14, Wheel Nut Tightening Sequence
Torque Limiter Operation
1. Remove any rust or dirt from studs, nuts, wheels and hub with wire brush and repair or replace any damaged components prior to installing wheels.

**Caution**
Safety glasses must be worn when using these adapters.

**Notice:**
Adapters are for use with a ½-inch drive pneumatic wrench only! Use of a breaker bar or ratchet may damage adapters. Maximum air wrench setting is 250 psi.

**Important:**
Do not hold adapter while torquing. Torque will be affected.

2. Select correct torque limiter and fit it to the air wrench.
3. Torque wheel nuts using the appropriate tightening sequence.
4. Check nuts for tightness after torquing and a short test drive.
Disc Brakes

Objectives

After completing this section, the student will be able to:

• Perform disc brake service
• Describe which special tools to use during disc brake service
• Demonstrate how to use the special tools during disc brake service
• Prevent brake system contamination during service
• Replace brake pads
• Overhaul a front caliper
• Demonstrate how to make caliper and mounting bracket wear adjustments
• Perform rear caliper service
• Replace rear brake pads
• Adjust parking brake free travel
• Replace hubless rotors
• Replace hubbed rotors
• Perform bearing and bearing race replacement
• Demonstrate how to measure rotor thickness and thickness variation
• Measure rotor lateral runout
• Perform rotor refinishing
• Identify rotor refinishing guidelines
• Demonstrate how to qualify a brake lathe
• Mount hubbed rotors onto a bench lathe
• Mount hubless rotors onto a bench lathe
• Demonstrate how to use a bench brake lathe
• Demonstrate how to use an on-car lathe
Disc Brakes

Disc brakes have a caliper that clamps two brake pads against a rotor (Figure 4-15). Some rotors have cooling fins between the two braking surfaces that circulate air between the braking surfaces, making them less sensitive to heat buildup and more resistant to brake fade (temporary reduction of brake effectiveness resulting from heat).

The various types of disc brake caliper (Figure 4-16) used by GM vehicles include:

- Single-piston and dual-piston floating or sliding calipers
- Rear calipers
- Rear calipers with integral parking brake

Brake Pads

GM brake linings are designed and tested for specific vehicle applications. The brake friction coefficient of the pad material is vehicle matched to optimize brake operation and wear characteristics.

Stamped on the side of GM brake pads is an alpha numeric stamping which indicates the friction coefficient of the pad as well as other information.

Important:

Using brake pads other than those intended for the vehicle may affect brake operation and/or increase stopping distances.
Single-Piston and Dual-Piston Calipers

Single and dual piston calipers operate the same (Figure 4-17). In the dual piston design, two pistons provide more piston surface area in a smaller package. Both single and dual piston calipers use a floating design.

In the floating caliper, the piston is on the inboard side of the caliper. When the brakes are applied, the caliper moves along either:

- Mounting bolts, or
- Machined guides on the caliper and mounting bracket (see Figure 4-18)

*Figure 4-17, Single-and Dual-Piston Calipers*

*Figure 4-18, Machined Guide Sliding Caliper*
Floating Caliper Operation

When the driver applies the brakes:

1. Fluid pressure behind the piston presses against the caliper piston and the piston bore (Figure 4-19).

2. The piston pressure forces the pad against the inboard rotor surface. Pressure applied to the piston bore forces the caliper to move on its slides.

3. Caliper movement applies pressure against the outboard brake pad, forcing the pad against the rotor surface.

4. Both brake pads press against the rotor surfaces, bringing the vehicle to a stop.

5. When hydraulic pressure is released, the square cut seal retracts the piston (Figure 4-20). This allows the system to reduce brake pad drag improving brake release and fuel economy.

Figure 4-19, Caliper Operation

Figure 4-20, Seal Function
Brake Pad Wear Compensation

As the brake pads wear, the caliper piston moves out further in its bore to compensate for brake material wear (Figure 4-21). The brake fluid fills the area behind the piston, allowing the caliper to keep the pads in the proper relationship to the rotor.

The wear compensation results in a lower brake fluid level in the reservoir. Therefore, do not refill the reservoir before depressing the pistons during brake pad replacement. If the reservoir is near full, remove fluid before depressing the pistons.

- A Floating Caliper which binds on its mounting bolt can cause uneven brake pad wear - A caliper mount which fails to release can cause the outboard pad to wear prematurely
  - A seized caliper mount, where the caliper does not float or move on the bushings, can cause the inboard pad to wear prematurely
  - A piston which binds and does not fully release will cause premature wear of both brake pads
- A seized piston will prevent the brakes from applying and will cause premature wear of the opposite side brake pads. Typically, this will cause a pull when the brakes are applied. For example, a seized right caliper piston will cause the vehicle to pull left and vise versa

![Figure 4-21, Disc Brake Pad Wear Compensation](image)
Rear Caliper with Parking Brake

Rear caliper brake (hydraulic) operation is nearly the same as front calipers: The piston assembly applies the inboard brake pad. The caliper housing moves on the caliper slides and applies the outboard pad (Figure 4-22). Since the rear brakes are used for the parking brake, some rear calipers are designed with an integral parking brake mechanism.

Rear caliper parking brake operation is mechanical.

Drum-in-hat style caliper operation is the same as front caliper operation.

Figure 4-22, Rear Disc Brake Caliper with Integral Parking Brake
Brake Pad Replacement

Removal Procedure

Use only GM replacement brake lining material. GM replacement brake parts provide the proper brake balance for stopping distance and for braking control. The intended brake balance for this vehicle can change if GM replacement brake lining materials are not used.

Important:
Do not disconnect the brake hose from the caliper.

1. Remove the caliper.

Notice:
Do not allow the brake components to hang from the flexible brake hoses. Damage to the brake hoses could result.

2. Suspend the caliper (Figure 4-23).

3. Remove the anchor bracket (if necessary).

4. Remove the inboard lining from the caliper (Figure 4-24).

5. Remove the retainer spring from the inboard brake shoe.

6. Remove the outboard lining from the caliper.

Figure 4-23, Suspend Caliper

Figure 4-24, Remove Inboard Lining
Installation Procedure

1. Install the anchor bracket and tighten. Tighten the anchor bracket mounting bolts to 110 Nom (81 lb. Ft.).
   Notice:
   Refer to Fastener Notice in Cautions and Notices. Keep grease, oil and dirt from contacting the brake pad surface during service.

2. Install the outboard lining.

3. Install the retainer spring on the inboard brake shoe.

4. Install inboard lining in the caliper.
   Notice:
   Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

5. Install the caliper.

Important:
Before moving the vehicle, pump the brake pedal several times in order to make sure the pedal is firm. Do not move the vehicle until you get a firm brake pedal. Check the brake fluid level in the master cylinder reservoir after pumping the brake pedal.
Rear Brake Pad Replacement

Removal Procedure Example

1. Remove caliper.
2. Remove the outboard shoe and pad (Figure 4-25). Use a screwdriver to disengage the buttons on the shoe from the holes in the caliper housing.
3. Remove the inboard shoe and pad.

Installation Procedure

1. Before installing new shoes and linings, clean the outside surface of the boot. Use clean denatured alcohol.
2. Bottom the piston into the caliper bore. Use a C-clamp over the caliper and piston, tighten it slowly to press the piston into the bore. Be careful not to damage the piston or the boot.

Important:
The boot must lay flat. Ensure the convolutions are tucked back into place.

3. After bottoming the piston, use a small plastic or wood tool to lift the inner edge of the boot next to the piston, and press out any trapped air (Figure 4-26).
4. Connect the inboard shoe and lining by snapping the shoe retainer spring into the piston (Figure 4-27). The shoe must lay flat against the piston. After installing the shoe and lining, check that the boot is not touching the shoe. If it is, remove the shoe and lining and re-set or re-position the boot.
5. Connect the outboard shoe and lining with the wear sensor at the trailing edge of the shoe during forward wheel rotation. The back of the shoe must lay flat against the caliper.
6. Install the caliper.
7. Apply approximately 778 N (175 lb.) force three times to the brake pedal to seat the lining.
**Rotor Inspection**
Inspect and measure disc brake rotors:
- When installing new linings
- If you note pulls, pulsations, or poor braking
- After refinishing the rotor, if required

**Rotor Tolerance and Surface Finish**
New rotors on General Motors' vehicles have a surface finish of 0.25 to 1.27 micrometers (10 to 50 microinches) with a non-directional swirl pattern. Although it is not customary to measure the surface finish of rotors, check them for deep scoring, which may require rotor refinishing or replacement.

Refinish rotors only in cases of:
- Excessive surface scoring
- Excessive thickness variation
- Excessive lateral runout

**Surface Scoring**
Do not refinish or replace the rotor if the surface has light scoring less than 1.5 mm (0.060 in.) in depth. A dime may be used as a quick check to determine disc brake scoring groove depth. Place a dime in the scored groove, with Roosevelt's head toward the scored groove. If the dime goes into the scored groove beyond the top of his head, the groove exceeds 0.060 in. and the rotor may need to be replaced or machined (Figure 4-28).

Further rotor service procedures are covered later in this section.
Micrometer Reading

Accurate micrometer reading is critical to disc brake service. Obtaining a correct micrometer measurement is accomplished by combining three readings on the micrometer.

English Standard Micrometers

1. Figure 4-29 illustrates a 2-3 inch micrometer. All readings will fall between two and three inches (see A).

2. The numeral scale on the barrel, which measures 0.100 in. increments, is pulled back to reveal the whole number two, indicating 0.200 in. (see B).

3. A closer look shows the barrel is pulled back to reveal the first segment to the right of the number two. These individual segments measure 0.025 in. increments (see C).

4. The numbers and segments on the thimble measure 0.001 in. increments. Since the 15 on the thimble is aligned with the horizontal scale on the stem, this indicates 0.015 in. (see D).

5. Letter key E in the inset comes from the Vernier Scale. To read the scale, identify the Vernier number that is perfectly aligned with a thimble number and/or segment. In this case, the 3 on the Vernier Scale lines up with the 20 on the thimble. Note: Disregard the special thimble number when using the Vernier Scale. What matters is the alignment of a thimble marking, not the thimble number.

6. By adding each of the individual readings, an overall reading is obtained (2.000 + 0.2000 + 0.0250 + 0.0150 + 0.0003 = 2.2403 in.).

Figure 4-29, Using a Micrometer
Using Metric Micrometers

Reading a metric micrometer is accomplished in a similar manner as reading an English micrometer.

1. Figure 6-16 illustrates a 50-75 mm micrometer. All readings will fall between 50 and 75 mm (see A).

2. The numeral (upper) scale on the barrel, which measures 1.0 mm increments, is pulled back to reveal the number 69 indication (see B in the inset).

3. The lower individual barrel segments measure 0.5 mm increments. A closer look shows that the barrel is pulled back to reveal the lower segment to the right of the 69 indication (see C in the inset).

4. The numbers and segments on the thimble measure 0.01 mm increments. Since the 45 on the thimble is aligned with the horizontal scale on the stem, this indicates 0.45 in. (see D in inset).

5. By adding each of the individual readings, an overall reading is obtained (69.00 + 0.50 + 0.45 = 69.95 mm).

Figure 4-30, Metric Micrometer
Measuring Rotor Thickness and Thickness Variation

Brake pedal pulsation may result from a difference in the thickness of the rotor. Pulsation resulting from thickness variation is far more common than pulsation resulting from bent or warped rotors. Thickness variation can result from:

- Bound up calipers
- Rotor wear due to distortion from improper lug nut torquing
- Rotor wear due to lateral runout

To measure rotor thickness, use a micrometer that reads ten-thousandths (0.0001) inch (Figure 4-31).

1. Take all measurements within the lining contact area of the rotor.
2. Take all measurements the same distance from the outer edge of the rotor.
3. Measure rotor thickness at four or more points, equally spaced around the rotor, and record each measurement (Figure 4-32).

If any measurement is less than the minimum allowable specification marked on the rotor, replace the rotor. Thickness variations of more than 0.0127 mm (0.0005 in.) can cause pedal pulsation or vibration when braking. Refinish the rotor to specifications or replace.

All brake rotors have a discard thickness dimension cast into them. This dimension is the minimum wear dimension and not a refinish dimension. The refinish dimension is greater than the discard dimension. Do not use a brake rotor that will not meet final finish thickness specifications.
Measuring Rotor Lateral Runout

Lateral runout can result in worn rotors and pedal pulsation complaints. Lateral runout can be caused by improper lug nut torquing or excessive bearing runout. Lateral runout can also be the result of normal rotor wear or improper refacing procedures.

Measuring for lateral runout requires:

- Dial indicator
- C-clamp or magnetic base stand

**Important:**
If the wheel has adjustable bearings, temporarily tighten the wheel bearings just enough to remove end play. Then begin the runout check procedure. Failure to re-adjust the wheel bearings correctly after runout measurements are complete may result in damage to the bearings.

To measure lateral runout (Figure 4-33):

1. On two-wheel drive vehicles, tighten adjustable wheel bearings slightly to take out any free play. For non-adjustable bearings, refer to the service information on end play diagnosis.

2. Attach the dial indicator to the fixed part of the axle or suspension so the dial indicator tip contacts the rotor face approximately one inch from the outside edge of the rotor. Attach the indicator firmly in place so it does not vibrate.

3. Set the dial indicator to zero.

4. Slowly move the rotor through one complete revolution while observing the dial indicator.

5. As a rule, if the total dial indicator deflection (add maximum readings on both sides of zero) is greater than 0.08 mm (0.003 in.), refinish or replace the rotor. Refer to the specific service information for the vehicle you are servicing.

6. If the wheel bearings were tightened to measure runout, re-adjust to specification.
Rotor Remove and Replace-Hubless

1. Raise and support the front of the vehicle, mark the relationship of the tire, hub and rotor assembly, then remove the wheel and tire assembly.

2. Remove the caliper mounting bolts, then lift the caliper from the mounting with the brake hose attached and suspend it from the chassis using a piece of wire (Figure 4-34).

3. Slide the disc brake rotor from the hub. Thoroughly clean the mounting contact surfaces of both the rotor and the hub to ensure proper mating during reassembly.

4. Reverse the above procedure to install being careful to realign the index marks. Refer to the disc brake torque and specification chart for the caliper mounting bolt torque.

Rotor Remove and Replace-Hubbed

1. Remove the brake caliper. Refer to front disc brake caliper section of the service manual (section 5).

2. Remove the dust cap from the hub. Remove the cotter pin, nut and washer from spindle.

3. Carefully pull hub assembly from spindle.

4. Remove the outer roller bearing assembly from hub. The inner bearing assembly will remain in the hub and may be removed after prying out the inner bearing lip seal. Discard seal.

5. Inspect the bearing and races for damage or wear. Replace if the bearing and/or race is damaged. Bearings and races must be replaced as a set.

Figure 4-34, Replacing Disc Brake Rotor (4WD)
**Burnishing Linings and Rotors**

After you replace brake linings and/or refinish rotors, it is recommended that the new braking surface be broken in, or "burnished." To do this, make 20 stops from 30 mph using medium to firm brake pedal pressure. During this procedure, use care to avoid overheating the brakes.

**Bearing and Bearing Race Replacement**

This is a procedure to remove the hub and replace the wheel bearings and bearing races. Tool Required:

- J 29117-A Wheel Bearing Cup Remover
- Wheel and tire removed (Figure 4-35)

1. Remove the brake caliper. Refer to front disc brake caliper section of the appropriate service information (section 5 of the service manual).

2. Remove the dust cap from the hub. Remove the cotter pin, nut and washer from spindle.

3. Carefully pull hub assembly from spindle.

![Figure 4-35, Wheel Bearing Assembly](image-url)
4. Remove the outer roller bearing assembly from hub. The inner bearing assembly will remain in the hub and may be removed after prying out the inner bearing lip seal. Discard seal.

5. Inspect the bearing and races for damage or wear. Replace if the bearing and/or race is damaged (refer to Figure 4-35). Bearings and races must be replaced as a set.

6. Drive out old races from hub with a drift or J 29117-A inserted behind races (Figure 4-36).

7. Clean the brake disc in clean solvent. Air dry.

8. Drive or press the new races into the hub (Figure 4-37).

Clean all grease from the hub and spindle, and thoroughly clean out any grease in the bearings. Use clean solvent and a small brush with no loose bristles to clean out all old grease.

---

**Figure 4-36, Removing Front Wheel Bearing Race**

**Figure 4-37, Installing Inner and Outer Bearing Outer Race**
Notice:
Do not spin the bearing with compressed air while drying it or the bearing may be damaged.

Notice:
Apply an approved high temperature front wheel bearing grease. Do not mix greases. Mixing may change the grease properties and result in poor performance.

9. Clean and inspect spindle for wear or damage.

10. Grease the hub and bearings carefully:
   - Apply a thin film of grease to the spindle at the inner bearing seat and at the outer bearing seat, shoulder and seal seat.
   - Put a small quantity of grease inboard of each bearing cup in the hub. This can be applied with your finger, forming a dam to provide extra grease to the bearing and to keep thinned grease from flowing out of the bearing.
   - Fill the bearing cone and roller assemblies full of grease. A preferred method for doing this is with a cone type grease machine (J 33067) that forces grease into the bearing. If a cone greaser is not available, the bearings can be packed by hand.

   Notice:
   If hand packing, it is extremely important to work the grease thoroughly into the bearings between the rollers, cone, and the cage. Failure to do this could result in premature bearing failure.

   - Place the inner bearing assembly in the hub. Then, using your finger, put an additional quantity of grease outboard of the bearing.

11. Install a new grease seal using a bearing installer until the seal is flush with the hub. Lubricate the seal lip with a thin layer of grease.

12. Carefully install the hub and rotor assembly taking care not to damage the inner seal. Place the outer bearing cone and roller assembly in the outer bearing cup. Install the washer and nut.

13. Torque the wheel hub spindle nut as specified in the service manual while rotating the wheel assembly by hand.

14. Back off the nut to the zero preload position. Do not back the nut off more than 1/4 turn.

15. Hand tighten the spindle nut. Loosen spindle nut until either hole in the spindle lines up with a slot in the nut (not more than 1/2 flat).

16. Install new cotter pin. Bend the ends of the cotter pin against the nut, cut off extra length to ensure ends will not interfere with the dust cap.

17. Using a dial indicator, check the hub assembly. There should be from 0.03 to 0.13 mm (0.001 to 0.005 in.) end play when properly adjusted.

18. Install dust cap on hub taking care not to damage the cap.
Tapered Roller Bearing Diagnosis

When diagnosing a bearing condition:

- Consider the general condition of all parts during disassembly and inspection
- Identify the bearing wear condition (Figure 4-38)
- After identifying the bearing problem, refer to the diagnostic chart to identify the cause and appropriate repair procedures. Whenever a bearing is replaced, the race must also be replaced

Figure 4-38, Tapered Wheel Bearing Diagnosis
## Tapered Roller Bearing Diagnosis Chart

<table>
<thead>
<tr>
<th>Condition</th>
<th>Cause</th>
<th>Repair Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bent Cage</td>
<td>Damage due to improper handling or tool usage.</td>
<td>Replace bearing and race.</td>
</tr>
<tr>
<td>Galling</td>
<td>Metal smears on roller ends due to overheating. Lubricant failure or overload.</td>
<td>Replace bearing and race. Check seals. Ensure proper lubrication.</td>
</tr>
<tr>
<td>Abrasive Step Wear</td>
<td>Pattern on roller ends caused by fine abrasives.</td>
<td>Clean all parts and housings. Check seals, bearings and races. Replace if leaking, rough, or noisy.</td>
</tr>
<tr>
<td>Etching</td>
<td>Bearing surfaces appear gray or grayish black in color with related etching away of material usually at roller spacing.</td>
<td>Replace bearings and races. Check seals. Ensure proper lubrication.</td>
</tr>
<tr>
<td>Misalignment</td>
<td>Race misalignment due to a foreign object or improper installation.</td>
<td>Clean related parts and replace bearing and race. Make sure races are properly seated.</td>
</tr>
<tr>
<td>Indentations</td>
<td>Surface depressions on race and rollers caused by hard particles of foreign material.</td>
<td>Clean all parts and housings. Check seals and replace bearings and races if rough or noisy.</td>
</tr>
<tr>
<td>Fatigue Spalling</td>
<td>Flaking of surface metal resulting from fatigue.</td>
<td>Replace bearing and race. Clean all related parts.</td>
</tr>
<tr>
<td>Brinelling</td>
<td>Surface indentations in raceway caused by rollers either under impact loading or vibration while bearing is not rotating.</td>
<td>Replace bearing and race if rough or noisy.</td>
</tr>
<tr>
<td>Cage Wear</td>
<td>Wear around outside diameter of cage and roller packets caused by abrasive material and insufficient lubrication.</td>
<td>Replace bearing and race. Check seals. Ensure proper lubrication.</td>
</tr>
<tr>
<td>Abrasive Roller Wear</td>
<td>Pattern on races and rollers caused by fine abrasives.</td>
<td>Clean all parts and housings. Check seals, bearings and races. Replace if leaking, rough, or noisy.</td>
</tr>
<tr>
<td>Cracked Race</td>
<td>Race cracked due to improper fit, cocking, or poor bearing seats.</td>
<td>Replace race and bearing.</td>
</tr>
<tr>
<td>Smears</td>
<td>Smearing of metal due to slippage. Slippage can be caused by poor fits, poor lubrication, overheating, overloads, or handling damage.</td>
<td>Replace bearings and races. Clean related parts and check for proper fit and lubrication. Replace shaft if damaged.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>Cause</th>
<th>Repair Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fretting</td>
<td>Corrosion set up by small relative movement of parts with no lubrication.</td>
<td>Replace bearing and race. Clean related parts. Check seals for proper lubrication.</td>
</tr>
<tr>
<td>Heat Discoloration</td>
<td>Discoloration can range from faint yellow to dark blue and can result from overloading or incorrect lubricant, and overheating. Excessive heat can cause softening of the races and rollers. To check for heat damage on races or rollers a file test can be done. A file drawn over a soft part will grab and cut metal. A file drawn over a hard part will glide easily without cutting the metal.</td>
<td>Replace bearings and races if overheating damage is indicated. Check seals. Ensure proper lubrication.</td>
</tr>
<tr>
<td>Stain Discoloration</td>
<td>Discoloration can range from light brown to black and can be caused by incorrect lubricant or moisture.</td>
<td>Reuse bearings and races if stains can be removed by light polishing and if there is no evidence of overheating. Check seals and related parts for damage. Check for proper lubrication.</td>
</tr>
<tr>
<td>Roller Coaster Pattern</td>
<td>Pattern is inconsistent around the outer race due to misalignment or insufficient preload.</td>
<td>Replace bearing and race assembly. Properly adjust wheel bearings.</td>
</tr>
<tr>
<td>Hourglass Pattern</td>
<td>Pattern is inconsistent in two areas 180° apart. The housing is most likely damaged or incorrectly machined.</td>
<td>Replace the hub/housing.</td>
</tr>
</tbody>
</table>
Rotor Refinishing

Rotor refinishing requires:
- Brake lathe
- Non-directional attachment
- 150 grit sanding block

Refinishing Guidelines

There are three basic conditions that a brake rotor needs to be effective when stopping a vehicle.
- Both sides of the rotor need to be flat and parallel
- The surface finish needs to be 50 RA (roughness analysis) or lower
- The machined sides of the rotor need to be perpendicular to the center line of the hub

Important:
Improper rotor refinishing techniques will cause a high pedal effort comment.

- Do not reface new rotors from stock unless excessive runout is apparent
- Do not reface rotors as a routine part of lining replacement unless there is excessive runout, scoring or thickness variation
- Do not reface rotors due to minor surface rust, discoloration, hot spots or brake squeal
- After refacing, always sand each side 60 seconds with 150 grit aluminum oxide sandpaper to provide a smooth, non-directional finish
- Always clean the rotor with brake cleaning solvent after turning and sanding to remove sanding grit. Rotate rotor 180° on mounting and measure runout
- Pad replacement does not necessitate rotor refacing or surface deglazing

Important:
The peaks and valleys on a turned rotor reduce the friction contact surface area. Sanding each side reduces the peak height, smoothing the rotor surface and increasing friction area for improved braking.
Qualify Brake Lathe

In order to produce an acceptable rotor surface finish, it is imperative to make sure that the lathe is operating properly. To qualify a brake lathe, use the following generic check list. It emphasizes what is necessary for the lathe to produce the best rotor it is capable of machining.

1. Check for proper operation and that all motors, switches, feed controls, engage and disengage levers function properly.
2. Make sure radius cones, bell clamps, and taper cones are free of all nicks, burrs, rust, and foreign debris. To restore flatness, use an eighty grit silicon carbide hone and WD-40 lubricant. Apply light pressure using short figure eight movements to prevent rounding of the edges.
3. Check the tapered surfaces on the arbor and spindle to ensure these surfaces are totally free of any contamination. The arbor should not run out over two thousandths total indicator reading.
4. The shoulder of the arbor must also be free of nicks or debris. Spray the shoulder of the arbor with WD-40 and use the arbor shaft for a guide to hold the hone perpendicular to the shoulder. Turn the lathe on and hone the shoulder. Apply pressure on the hone with a finger on the arbor.
5. Check fit of the rotor truer and the top of the dovetail way. A one thousandths feeler gauge should not be able to fit between the top dovetail surface and the bottom of the rotor. Remove the rotor truer and hone the top dovetail surface and the bottom of the rotor truer until the feeler gage stock can not be inserted.
6. The tool bit holder slots on the rotor truer should be clean. Make sure the bottom of the tool bit holder is also clean. The tool bit holder bottom can be cleaned by rubbing it on a hone or a single cut file. The carbide bit seat on the tool bit holder should be clean and flat. If the surface is not flat, replace the tool bit holder.
7. All end bell clamps can be remachined to reduce runout. Mount the bell clamp with the machined hub mating with the shoulder of the arbor. Use the two small radius adapters next on the arbor and space out to the threads with available radius adapters or one inch spacer. Tighten the arbor nut. Put a reference mark on the bell clamp that lines up with the two marks on the spindle and arbor. Machine the face of the bell clamp with the rotor truer. True all four bell clamps.
8. Always align the inside bell clamp with the reference mark put on the hub after machining the bell clamp. Keep all mounting surfaces clean and occasionally check accuracy of setup by holding the inside bell clamp and rotating the rotor one hundred eighty degrees. Reclamp and check with the dial indicator. If runout is excessive, hone the adapter. If runout persists, remachine the adapter.
9. The inside of the hat section of the rotor must be cleaned of all rust, burrs, and any foreign matter. If any debris is present on this surface, the rotor will not reference properly while machining.

10. All surfaces of the lathe, arbor and all of the adapter surfaces must be free of all nicks and burrs, and free of all foreign debris. Follow lathe manufacturer's specific operating and maintenance instructions.

**Mounting Hubbed Rotors**

1. Select the correct self-aligning spacer and adapter and slide them onto the arbor shaft.
2. Slide the rotor onto the adapter cone.
3. Install spacer and arbor nut.
4. Install silencer band and proceed with machining.

**Mounting Composite (Hubless) Rotors**

Composite rotors do not have an integral hub. When mounting a composite rotor on a lathe, the stamped center must be squeezed, just as it would be when the wheel is tightened against it (Figure 4-40).

![Figure 4-40, Mounting Composite Rotors](image-url)
**Important:**
An approved support adaptor is required when refacing any composite rotor to ensure proper support.

Adapters that bolt two plates together through the rotor stud holes squeeze the rotor center to provide support.

1. Index the rotor to the hub before removal.
2. Clean the rotor mounting surfaces with a wire brush.
3. File or scrape off any high spots as necessary.
4. Check the rotor for flatness using a straight edge.
5. Before installing adapters, inspect the inside and outside mounting surfaces to ensure they are smooth and free of:
   - Rust
   - Nicks
   - Burrs
6. Select the correct clamping plate and adapter cone and slide them onto the arbor shaft.
7. Slide the rotor onto the adapter cone.
8. Slide the second plate onto the arbor shaft and torque bolt to specification utilizing the approved star pattern.
9. Install spacer and arbor nut.
10. Install silencer band and proceed with machining.

**Important:**
Clean all corrosion from both the inside hat section of the rotor and the hub flange.
Off-Car Brake Lathe Set-Up

Important:
The Accu-turn® brake lathe (see Figure 4-41) uses a single cut operation to resurface rotors.

To machine the rotor:
1. Mount the rotor and install the vibration dampener.
2. Bottom the tip of the tool bit in the deepest groove of the rotor. Zero the scale and back out the tool bit. Repeat for the other side of the rotor.
3. Move the cutters to the inner edge of the rotor face. Adjust the micrometer knobs for approximately 0.0127 mm (0.005 In.) more than the original reading.
4. Start resurfacing operation.
5. After cutting is complete, dress the rotor for a non-directional finish. Sand each rotor with 150 grit aluminum oxide sandpaper on a sanding block with the rotor turning at the manufacturer's recommended cutting speed for 60 seconds. Then wipe the rotor with brake cleaning solvent.
6. Check that the refinished rotor meets all inspection requirements.

<table>
<thead>
<tr>
<th>Spindle Speed</th>
<th>105 rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of Cut per Side</td>
<td>As necessary</td>
</tr>
<tr>
<td>Total Cross Feed per Revolution</td>
<td>0.076 mm (0.003 inch)</td>
</tr>
<tr>
<td>Vibration Dampener</td>
<td>Yes</td>
</tr>
<tr>
<td>Non-directional Finish</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Important:
L Speeds and feeds other than those specified in the table can result in an unsatisfactory finish.

Notice:
Replace the rotor if refinishing reduces rotor thickness to within 0.015 in. of the minimum allowable marked on the rotor.
Figure 4-41, Off-Car Brake Lathe
On-Car Brake Lathe

Vehicle Preparation

The front wheels should be straight, the parking brake off and the transmission in neutral. Raise the vehicle until the wheel hub is about belt level.

- Remove the wheels. Remove the brake calipers and suspend them out of the way of moving parts such as half shafts and CV joints.

- If the rotor is free on the hub, mark and remove it in order to assess the mating surface. Use a Scotch-Brite-type wheel on a die grinder to remove rust or debris. Clean all material from the mounting area.

- The rotor on the opposite side of the vehicle should be marked and removed if it is free on the hub. Marking rotors to match a certain alignment on the hub is very important.

- Visually inspect for deep rust or grooves.

Lathe Preparation

Cutting Bits

Check the cutting bits and make sure they are ready for use. Each cutting bit has three corners which may be used. A correctly installed bit has the letters V, B and G facing up. An improperly installed bit has no letters facing up, and from the side you can clearly see that it does not fit correctly.

Bit life is affected by variables such as rust or ridges. In order to determine when to rotate bits, monitor rotor finish. If the rotor finish begins to look inconsistent or feels rough to the touch, bits should be rotated. Bits that are chipped or cracked should never be used. The bits can be switched from the left to the right tool holder to use the back sides of each corner.

Be sure that the bit pocket is clean before positioning the bit. Any foreign material pinched under the bit will cause problems and may even break the bit when you tighten the screw.

Use only the bits recommended by the manufacturer.
The Pro-Cut mounts directly to the hub of the vehicle, at the center flange. Begin with the lathe right side up, with the cutting head to the right of the hub, set-up to cut where the caliper normally rides. On a vehicle where the calipers ride in front of the hub, always start on the passenger side. If the caliper rides to the rear of the hub, begin on the driver side.

**Important:**
The on-vehicle lathe machines both front and rear rotors. The lathe's operations do not change at all in the rear of the vehicle.

**Important:**
The lathe has a 3/4-hp motor. This requires 20 amp service. All extension cords must be at least 12 gauge and less than 25 feet—drop light cords are not recommended.

**Mounting the Lathe**

**Adapters**
First, choose the proper adapter. Most passenger cars use either the four (50-687) or five lug (50-688) adapter. For most trucks and vans, you will use the larger adapter with many holes. See the lathe manufactures equipment manual for more detailed information.

Try each bolt pattern until you find the one that fits the vehicle evenly. Use the nuts and bolts provided.

The adapters are made of cast iron, not aluminum or steel like wheels. They are NOT designed to withstand the use of impact tools.

**Caution**

*Do not use impact tools to attach these adapters. Only use 20-30 ft-lbs. Of torque to secure the adapter to the vehicle.*
Mount the Lathe to the Adapter

Disengage the feed knob by pulling out the feed engage plunger (Figure 4-42). Turn the knob to move the cutting bits away from the middle of the lathe. This allows the tools to clear the rotor when the lathe is being attached to the hub.

Notice the four screws on the face of the mount flange called RUNOUT screws. When tightened, they protrude beyond the face of the mounting flange.

**Important:**
Make sure that the runout screws are backed out completely so that they do not protrude beyond the face of the mounting flange.

Roll the machine into place and attach it to the adapter. The adapter has a dowel pin which must line up with one of two holes in the mounting flange. Once the flange is flush to the adapter, the shaft of the machine bolts onto the adapter by turning the large mounting knob.

Make sure the trolley handle is loose. Rotate the machine so that the cutting head is in a position where there is enough room to cut the rotor, typically in the brake caliper area. Lock the machine in place by tightening the trolley handle.

With the lathe in the `right side up' position, notice that the opening in the dust shield is on the right of the hub. Depending on which vehicle you are servicing, this opening will either be on the left or the right. Always begin with the lathe right side up.

*Figure 4-42, Mount Lathe to the Adaptor*
Position Cutting Head and Set Shut Off Cam

Use the T-handle 6-mm alien wrench to remove the securing screw found in one of five mounting holes in the slide plate used to lock the cutting head. Center the head so the cutting arms will straddle the rotor.

The cutting head assembly can be secured into any one of the five holes. Clean out these holes as well as the dovetail and plate surfaces when changing cutting head position, as they can easily fill up with metal chips.

It is absolutely critical to pull the tool holder plate back into the dovetail so that it is square before tightening the securing screw. Push the cutting head firmly back into the dovetail while tightening the set screw.

**Notice:**
If the tool holder is not squarely and firmly pressed into the dovetail, a poor surface finish will result.

The cutting head must be moved in or out for each vehicle. On large trucks, the head will actually be mounted as far out as it can possibly go. Even though the head hangs over the edge of the base plate, the lathe will cut smoothly provided the head is squarely pressed into the dovetail.

When cutting on the other side of the vehicle, the lathe will be mounted in the upside down position. The offset of the cutting head will already be set, with the cutting head firmly in the dovetail. That is why it's important to begin with the machine right-side up.

**Caution**
Do not attempt to move the cutting head laterally with the lathe upside down.
Adjustment for Lateral Runout

Since the lathe is bolted to the hub, any wobble or runout in the hub will be passed on to the machine. Before cutting the rotor, measure the runout in the machine and compensate for it with two of the four runout adjustment screws. Runout should be less than 0.003 inches.

Set Up the Indicator and Measure the Run Out

Attach the visegrip to the vehicle hub and position the dial indicator tip against a flat surface on or near the cutting head or on a flat surface on the motor (Figure 6-28). The surface should be parallel to the rotor surface, smooth and not curved.

Disengage the feed by pulling out the feed knob until it clicks. This will stop the cutting head from feeding when the motor is turned on.

Turn on the lathe, observe the movement in the dial indicator. Turn the face of the indicator so that zero is at the low (furthest counterclockwise) point.

Determine the total needle sweep between the high (furthest clockwise) and low (furthest counterclockwise).

Caution

The lathe is fitted with a knob on the back of the motor. Do not touch the knob when the motor is turning. Do not remove the safety cover.

Compensate for the Run-Out

Stop the lathe so that the needle reaches the extreme low (counter clockwise) or high (clockwise) end of its sweep using the motor crank knob on the back of the motor.

Give the lathe two test pulls, one at either end of the lathe. The test pulls will indicate which runout screw to tighten first. If pulling on the cutting head end causes the needle to go towards the middle of the sweep, tighten the screw nearest the cutting head. If pulling on the motor end causes the needle to go towards the middle of the sweep, tighten the screw nearest the motor end. Tighten the appropriate screw until the dial needle moves about half of the sweep. A little less than half is preferable. Remember the number that is stamped next to this screw.

Turn the lathe on and note the new runout. If runout is still above three thousandths of an inch, repeat the process, with one exception - If the test pulls indicate to tighten the runout screw directly opposite one previously tightened, loosen the original screw instead.
Notice:
Runout adjustment is accomplished by turning one, possibly two, screws adjacent to one another.

Never turn screws that are across from one another. For example, first turning screw #1, then screw #3.

When the dial indicator shows less than 0.003 in. begin cutting. Realize the dial indicator is much farther out than the rotor, giving an exaggerated runout reading. By ensuring less than 0.003 in. on the indicator, a cut of less than 0.002 in. on the rotor is virtually guaranteed.

If the dial indicator does not make an even back and forth motion like a windshield wiper, this may be an indication of another problem. There may be foreign matter behind the rotor, causing a wobble, or there may even be a driveline part that has been damaged. Runout cannot be eliminated if it is not an even once-per-revolution sweep.

Improper lathe setup can include:
• Loose dial indicator or gooseneck
• Dial indicator tip is on an uneven surface or edge
• Loose dial indicator tip
• Vise-grip attached to a loose part on the vehicle
• The lathe is not fully engaged to the adapter
• The adapter is not fully seated
• Run-out screws were not backed off before you began
• The lug nuts are loose on the adapter

Uneven motion can indicate other vehicle problems and warrants further investigation if one of the issues listed above is not the problem.
Making the Cut

- Loosen the clamp knob on top of the cutting head.
- Set the shutoff cam.
- Crank the feed knob until the bits clear the outside edge of the rotor. Loosen the cam screw and slide the cam back until it contacts the automatic shutoff switch plunger. Tighten the cam screw. This cam will contact the shutoff switch when the bits clear the rotor.
- Turn cut depth knobs counter clockwise until the bits can clear both sides of the rotor. Turn on the lathe. Crank the cutting head into the middle of the braking surface of the rotor.
- Start with the inside (behind the rotor) tool arm. Turn the depth knob clockwise (tighten) until the tool bit just barely makes contact with the rotor surface. Listen for the contact. Do the same with the outside tool.
- Advance the cutting head in towards the center of the rotor.

**Important:**
Do not to touch the hat of the rotor with the tool bit! This will damage or break the tool holder plate.

- At the inside edge of the pad contact surface, adjust the lathe for depth. Each line on the adjustment knob moves the cutting bit 0.002 in. Cut at least 0.002 in. on each side with each pass. The maximum depth is 0.020 in. on each side.
- Tighten the clamp knob (over the cutting arms) to minimize vibration. Place the chip deflector/silencer over the cutting bits.

**Important:**
The silencer should be used on every rotor to prevent vibration.

- Press the feed engage crank handle in to engage the automatic feed. The machine will shut off when the cut is finished.

**Notice:**
If the rotor is severely worn it may be necessary to machine away the ridges on the inside and outside of the pad contact area before machining the pad contact surface.

- When finished cutting, loosen all runout adjustment screws. Loosen the mounting knob and remove the lathe from the adapter. Be careful not to bump either the rotor or the wheel well with the brake lathe. Take special care not to bump the bits into the rotor. This can fracture bits.

**Important:**
Careful cleaning of the adapter prior to removal is important on vehicles with exposed bearings.

- If the rotor is loose on the hub, be certain that it is match marked to the hub before removing the adapter. Clean any dust or debris from the finished rotor with 150 grit sand paper and then a damp rag.
Machining the Opposite Side

To prepare the lathe for the other side of the vehicle, loosen the trolley handle and rotate the machine into the upside down position.

The procedure for cutting in the upside down position is the same. The cutting head has already been moved to the proper position so it will no need to be set. The lathe mounts in the same manner. Often the shut-off switch will still be depressed from the previous cut, so the machine will not turn on until the head is moved. Measuring and adjusting for runout is exactly the same as in the upright position. The entire cutting process is also the same, right down to the silencer clip which mounts upside down in the exact same position.

Advancing the cutting head towards the hat of the rotor requires even more care in the upside down position. **Do not bump the hat of the rotor.**

Brake Align Kit

If the lateral runout measurement is not within specifications after the rotor has been refinished or replaced, GM has approved a new technology for the correction of lateral runout. This new method is called Brake Align®. It allows the technician to meet the requirement of 0.0015 inch or less of lateral runout by installing a specially selected, tapered correction plate between the rotor and the hub.

The Brake Align® Correction system does not require the use of an on-vehicle brake lathe to correct for lateral runout.

The Brake Align® Starter Kit can be found at your dealer.

- It contains an ample supply of correction plates, in various correction sizes, to cover most current GM passenger car applications
- It also includes a Brake Align® tool kit that contains a dial indicator and retaining washers, along with other useful tools.

Figure 4-43,
Front Caliper Service
Unit repair (overhaul) procedures for all front calipers are basically the same. Illustrations are typical. Some parts may vary from those shown.

Notice:
Contamination of the brake hydraulic system with dirt particles or fluids other than clean brake fluid can result in system failure. Repair the calipers in a clean environment

Notice:
Do not use petroleum-based oil, grease or cleaning compounds at the cliper repair station. Do not repair the calipers with oily or greasy hands. Use only denatured alcohol to clean caliper parts. Use only clean brake fluid to lubricate the parts at assembly

Preliminary Procedures
1. Disconnect the brake hose fitting and remove the caliper from the vehicle. Discard the copper sealing washers. New copper sealing washers are required during installation.
2. Use a wire brush to clean the exterior of the caliper, removing any corrosion or road dirt. After brushing thoroughly, clean the caliper with denatured alcohol before moving it to a clean work bench for disassembly.
Removing Piston

3. Drain fluid from the caliper. Discard the drained fluid.

Caution

In the following step, use just enough air pressure to ease the piston out of the caliper.

Do not place fingers under the piston in an attempt to catch or protect it. The piston may be expelled with sufficient force to cause injury.

4. Pad the inside of the caliper with clean shop cloths. Remove the piston by gradually directing compressed air into the caliper fluid inlet as shown in Figure 4-44. The piston will blow out of the housing with considerable force.

5. Use a screwdriver to pry the boot out of the caliper as shown in Figure 4-45. Extend the screwdriver across the caliper bore, under the boot, and pry up. Use care not to scratch the caliper bore or the seal groove.

Caution

In the following step, do not use a metal tool of any kind to avoid damaging the caliper bore or seal groove.

6. Use a small wood or plastic tool to remove the piston seal from the groove in the caliper bore.

7. Remove the bleeder valve from the caliper.

8. Discard the boot and the piston seal.
Cleaning and Inspection

9. Inspect mounting bolts and sleeves for corrosion. DO NOT attempt to clean corrosion from sleeves and bolts. Replace corroded bolts and sleeves. (See the appropriate service information.)

Notice:
Do not use lubricated shop air to dry brake parts. Drying with lubricated shop air will leave a film of oil on the parts. This may damage the rubber parts.

Clean the parts in denatured alcohol, using a bristle brush if necessary. Use dry, filtered, compressed air to dry parts and blow out all passages in the caliper and the bleeder valve.

Caution
The outside diameter of the piston is the primary sealing surface in the caliper. It is manufactured and finished to close tolerances. Never refinish or use abrasives to remove corrosion on metal pistons.

10. Carefully check the OD of the piston for scoring, nicks, corrosion or worn or damaged plating. If surface defects are noted, replace the piston.

11. Check the piston bore and seal groove in the caliper for scoring, nicks or corrosion. The caliper bore is not plated. Minor stains and corrosion can be polished away by using crocus cloth. Do not use emery cloth or any other form of coarse abrasive. Thoroughly clean the caliper after using the crocus cloth. If the caliper bore cannot be cleaned up in this manner, replace the caliper. Make sure all parts are clean and dry.
Assembly

Notice:
In the following step do not over-torque the bleeder valve.

12. Install the bleeder valve in the caliper and torque it to 9-16 Nom (80-140 in. lb.).

13. Lubricate the bore of the caliper and the new piston seal with clean brake fluid. Fit the piston seal in the groove in the caliper. Make sure the seal is not twisted.

14. Lubricate the piston with clean brake fluid. Put the new boot into the piston groove (Figure 4-46).

15. Lubricate the bore of the caliper with clean brake fluid and insert the piston. Use care not to unseat the piston seal. Force the piston to the bottom of the caliper bore (a force of 50-100 pounds may be required) (Figure 4-47). Use care not to tilt or jam the piston in the bore.

16. Position the OD of the boot in the caliper counter bore and seat it with the boot seating tool (Figure 4-48). On some applications it is necessary to install the boot into the caliper bore prior to installing the piston.

17. Check the boot installation. Make sure the metal retainer molded into the boot is not bent and that the boot is seated fully and evenly all around.

18. Install new mounting bolt sleeves and bushings or caliper slides, as needed.

Figure 4-46, Assembled Boot in Piston Groove

Figure 4-47, Installing Piston

Figure 4-48, Seating Boot
Caliper and Mounting Bracket Wear Adjustments

Before returning the vehicle to the customer, measure the caliper-to-knuckle clearance. If wear is excessive, a rattle sound can be heard from the front brake area, if the clearance is too little, brake lead and excessive pad wear may result. Refer to service information for specifications.

Example:

1. Remove caliper.
2. Clean contact surfaces with a wire brush.
3. Smooth any deep nicks and/or gouges with a file.
4. Measure clearance between the caliper and mounting bracket (Figure 4-49) with a feeler gauge. Total clearance should be 0.010 to 0.024 in. (0.26 to 0.60 mm) and constant from top to bottom. Caliper clearance may vary. Check the service manual for correct specification.
5. Adjust for correct clearance as necessary, as described in the service information.

Figure 4-49, Measuring Caliper and Mounting Bracket Wear
Measure caliper slide clearance on calipers utilizing machined guides (Figure 4-50). Correct if necessary, utilizing approved service manual procedures.

![Image](image.png)

*Figure 4-50, Bendix® Caliper Wear Adjustment*

**Bendix® Caliper Wear Shim Specifications**

<table>
<thead>
<tr>
<th>MORE THAN</th>
<th>BUT NOT EXCEEDING</th>
<th>SHIM THICKNESS</th>
<th>SHIM P/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.058 inch</td>
<td>None Required</td>
<td>None Required</td>
</tr>
<tr>
<td>0.058 inch</td>
<td>0.101 inch</td>
<td>0.025 inch</td>
<td>15625734</td>
</tr>
<tr>
<td>0.101 inch</td>
<td>0.145 inch</td>
<td>0.045 inch</td>
<td>15625736</td>
</tr>
<tr>
<td>0.145 inch</td>
<td>—</td>
<td>See Note</td>
<td>See Note</td>
</tr>
</tbody>
</table>

Note: If the bumper gap exceeds 0.145 inch, remove old caliper and replace with a new caliper and remeasure the bumper gap. If the bumper gap with the new caliper is between 0.058 inch and 0.145 inch, select a shim from the table. If the bumper gap with the new caliper exceeds 0.145 inch, replace the anchor plate also. Use a new key and spring when assembling the new components.
Rear Caliper Service - Integral Parking Brake

Important:
If the caliper pistons are to be depressed in their bore, make sure the master cylinder reservoir is approximately one-third full. Remove fluid if necessary.

Brake fluid is removed to prevent master cylinder overflow when piston is pushed back into caliper bore.

Example:

1. Loosen the tension on the parking brake cable at the equalizer and disconnect the cable from the parking brake lever (Figure 4-52). Remove the spring. Holding the lever, remove the nut. Remove the lever, lever seal and anti-friction washer.

   Notice:
   In the following step, do not allow the C-clamp to contact the actuator screw.

2. Position a large C-clamp across the inboard side of the caliper housing and outboard shoe, at the caliper cutout (Figure 4-53). Tighten the C-clamp to push the piston back into the caliper bore.

3. Temporarily reinstall the anti-friction washer, lever seal, lever and nut.

---

Figure 4-52, Remove Parking Brake Lever

Figure 4-53, Pushing Piston Back
4. Remove the bolt attaching the caliper inlet fitting (Figure 4-54). Discard the copper sealing washers.

5. Remove the mounting bolts. Lift the caliper from the rotor and mounting bracket.

Figure 4-54, PInlet Fitting and Mounting
**Disassembly**

1. Remove the caliper from the vehicle (Figure 4-55)

2. Clean the exterior of the caliper with a wire brush and brake cleaner before moving the caliper to a clean work bench for disassembly.

3. Drain fluid from the caliper and discard safely.

4. Remove the shoe dampening spring from the end of the piston. Remove the two-way check valve and discard.

5. Remove the parking brake lever. Remove and discard lever seal and anti-friction washer.
6. Support caliper in a vise (Figure 4-56). Pad the inside of the caliper with shop cloths. Using a wrench on the hex of the actuator screw, turn the actuator screw to move the piston out of the bore.

7. Remove the balance spring.

8. Press on lever end of actuator screw to remove from housing. Remove shaft seal and discard. Retain the thrust washer.

9. Pry boot out of caliper (Figure 4-57). Extend screwdriver across caliper bore under the boot and pry up. Do not scratch the caliper bore, the piston seal groove or the boot groove. Discard boot.

10. Use a small wood or plastic tool to remove the piston seal from the caliper bore. Discard seal.

11. Remove bleeder valve.

Cleaning and Inspection

1. Clean the piston by wiping with a clean cloth. Do not use solvent.

2. Clean other parts with alcohol-based brake cleaner. Use a bristle brush if necessary. Dry with dry shop air.

   Notice:
   Do not use lubricated shop air

3. Carefully check the outside of the piston. Replace if there is:
   • Scoring
   • Nicks
   • Corrosion
   • Worn or damaged plating

4. Check piston bore and piston seal grooves for scoring, nicks, or corrosion. Minor stains or corrosion can be cleaned up with crocus cloth. Do not use emery cloth or other form of abrasive. Replace caliper if corrosion does not respond to crocus cloth.
Assembly

1. Install bleeder valve in caliper.

2. Lubricate caliper bore and piston seal with clean brake fluid. Fit piston seal into groove in the caliper bore. Make sure the seal is not twisted.

3. Lubricate the piston and new two-way check valve with clean brake fluid. Install the check valve in the piston. Install new boot on piston with inside bead of boot in piston groove. Fold the boot away from the caliper.

4. Position thrust washer on actuator screw.

5. Lubricate the shaft seal with clean brake fluid and fit it in the groove on the actuator screw.

6. Lubricate the actuator screw with clean brake fluid and install it with the thrust washer in the piston.

7. Position balance spring in the piston recess and start the piston into the caliper bore. Use the appropriate piston installation tool (Figure 4-58).

---

Figure 4-58, Reinstall Piston
8. Before removing piston installation tool, lubricate a new anti-friction washer and lever seal with silicone grease. Install in the end of the actuator screw. Make sure the lever seal bead is against the housing.

9. Install the lever on the actuator screw and rotate the lever away from the caliper stop. Hold the lever and install nut with appropriate torque. Move the lever back against the stop. Remove the piston installing tool.

10. Position the outside of the boot in the caliper counterbore and seat with a boot seating tool (Figure 4-59).

11. Check boot installation to make sure its metal retainer is not bent. The boot should be seated firmly and evenly.

12. Install shoe vibration dampening spring in the groove at the end of the piston (Figure 4-60). Move the parking brake lever if necessary. Install new pads. Reinstall caliper.

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*Figure 4-59, Install Piston Boot*

*Figure 4-60, Install Shoe Vibration Dampening Spring*
Installation

1. Inspect the mounting bolts and sleeves for corrosion. Lubricate the bolts with silicone grease.

   **Important:**
   If the bolts or sleeves are corroded, use new parts when installing the caliper. Do not attempt to polish away the corrosion.

2. To install, position the caliper over the rotor in the mounting bracket. Align the holes and install the mounting bolts. Torque the bolts as specified in the service manual.

3. Install the inlet fitting with the new copper sealing washers and torque the attaching bolt as specified in the service manual.

4. Remove the nut and lever temporarily installed at step 3. Remove and discard the old lever seal and the old anti-friction washer. Clean any contamination from the caliper surface in the area of the lever seal and lubricate it with silicone grease. Lubricate the new anti-friction washer and the new lever seal with silicone grease. Install with the sealing bead on the lever seal against the housing.

5. Install the lever in position with the lever away from the stop on the caliper housing. Holding the lever away from the stop, install the nut and tighten to the torque specified in the service manual. Then, rotate the lever back against the stop.

6. Install the spring and connect the parking brake cable to the lever.

7. Tighten the parking brake cable at the equalizer until the lever just moves off the stop on the caliper housing. Loosen the adjustment until the lever moves back against the stop. Lock the adjustment at the equalizer.