Drum Brake System Principles

Chapter Objectives

At the conclusion of this chapter you should be able to:

- Identify servo and nonservo drum brake designs.
- Describe the operation of servo and nonservo brake systems.
- Describe the types and operation of drum parking brake systems.

KEY TERMS

<table>
<thead>
<tr>
<th>anchor</th>
<th>duo-servo</th>
<th>self-adjuster assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>backing plate</td>
<td>holddown springs and pins</td>
<td>self-energizing</td>
</tr>
<tr>
<td>brake drum</td>
<td>leading-trailing brakes</td>
<td>wheel cylinder</td>
</tr>
<tr>
<td>brake shoes</td>
<td>return springs</td>
<td></td>
</tr>
</tbody>
</table>
Drum brakes have been in use since the earliest days of the automobile; some very early vehicles used a constricting external band around a rotating drum to slow and hold the vehicle in place. As self-propelled vehicles achieved faster speeds, increased braking was needed. This forced manufacturers to move from the external band brake to the internal expansion brake, called a drum brake. Drum brakes are simple in operation and can, by using leverage, apply more braking force than what is supplied by the driver. Drum brakes continue to be used today, though in many cars and light-duty trucks disc brakes have replaced rear drum brakes.

Drum brakes, like disc brakes discussed in Chapter 14, all share similarities in design and operation. On cars and light-duty trucks, the hydraulic drum brake system has not changed very much since hydraulics replaced mechanical brake linkages in the 1930s. The same basic components are still used, and they perform the same functions regardless of the vehicle.

**Drum Brake Systems and Operation**

Drum brakes have had to adapt from purely mechanical applications, as with the Ford Model T, to modern hydraulic and electronically controlled systems. Modern systems use longer-lasting friction linings, but the overall design and operation has not changed.

**ADVANTAGES AND DISADVANTAGES**

Drum brakes, like those shown in Figure 12-1, use a set of brake shoes that expand outward against the inside of the rotating brake drum. Hydraulic pressure acts on the pistons in the wheel cylinder, which then presses the shoes outward. When the brake pedal is released, return springs pull the shoes back to their rest position.

An advantage of drum brakes compared to disc brakes is that when the brakes are applied, the force of the rotating drum can be used to force the forward (primary) shoe as a lever against the rear (secondary) shoe, increasing the amount of brake application force. This allows the drum brake to achieve greater stopping force than is supplied just by the driver pushing on the brake pedal. Because of this advantage, vehicles with four-wheel drum brakes do not require a power-assisted brake system like those using disc brakes do.

The disadvantages of drum brakes include mechanical brake fade as the drum expands from heat generation, poor heat dissipation compared to disc brakes, dust buildup within the drum that often causes brake noise, and the need for a self-adjusting system to maintain shoe-to-drum clearance and correct brake pedal height.

**COMPONENTS**

Most modern drum brake systems use the following components.

- **Backing plate**—the plate, attached to the axle assembly, holds the components of the drum brake assembly. A backing plate, as shown in Figure 12-2, is stamped steel and has various holes for springs, parking brake cables, and wheel cylinder attachment, and support pads for the shoes. The labyrinth seal is formed around the outside of the backing plate to keep water from entering the brake assembly.

- **Brake shoes**—the shoes are the metal backing on which the lining material is attached, shown in Figure 12-3. The brake lining is either riveted or glued to the shoe, as shown in Figure 12-4. Depending on the brake design, all four shoes may be the same, allowing them to be installed on either side in either the leading or the trailing position. Some applications require a specific shoe be used in one location only. The brake shoe lining material varies but often contains abrasives, such as aluminum, iron and silica, friction modifiers including, graphite and ceramic compounds, fillers, and binders. Linings for many years contained asbestos to improve the wear and ability to provide friction at very high temperatures. Research showed that asbestos dust could lodge in the lungs and lead to lung cancer. Because of the health concerns, asbestos was phased out of use in brake linings. However, it is possible that linings produced outside of the United States contain asbestos, and it is impossible to know whether asbestos dust is present in the brake system. For this reason, special brake dust collection and containment procedures...
FIGURE 12-2 The backing plate holds the drum brake components and bolts to an axle or knuckle.

FIGURE 12-3 The brake shoe is the metal piece that supports the lining. The shoe is specifically shaped and configured for each application.

FIGURE 12-4 Brake linings are either bonded (glued) or riveted to the shoes.
are used when working on the brake system. These procedures are discussed in Chapter 13.

- **Brake drum**—the drum has an internal friction surface for the shoes to rub against. Compared to a brake rotor, a drum has significantly less contact area, shown in Figure 12-5. However, the contact area between the shoes and drum is large, much larger than the contact area between brake pads and the rotor. Drums are usually cast iron, but some vehicles use a composite aluminum outer shell and an iron friction surface to save weight. Many larger drums have cooling fins cast into the outer circumference to aid in heat dissipation, as shown in Figure 12-6.

- **Return springs**—the return springs pull the shoes back when the brakes are released. Some designs use one return spring per shoe, while others use one spring bridging both of the shoes. An example is shown in Figure 12-7.

- **Holddown springs and pins**—these springs and pins hold the shoes to the backing plate and keep the shoes in position on the raised pads. Examples are shown in Figure 12-8. One holddown spring per shoe is the most common. A few designs use two springs per shoe.

- **Wheel cylinder**—when the brakes are applied, hydraulic pressure pushes the two pistons in the wheel cylinder outward against the shoes, as shown in Figure 12-9. Figure 12-10 shows the parts of the wheel cylinder. The spring prevents the cups and pistons from retracting too far into the cylinder when

**FIGURE 12-5** A brake drum has less surface area than a brake rotor, but there is much more contact area between the brake shoe linings and the drum than there is between the brake pads and rotor.

**FIGURE 12-6** Most larger brake drums have fins along the outside to aid in cooling the drum. The fins increase the drum’s external surface area, which allows for more rapid heat dissipation.
A self-adjuster is used to expand the shoes slightly when the vehicle is driven in reverse and the brakes are applied. Several methods of self-adjusting linkages are used, and they vary by manufacturer.

The brakes are released. The cups seal the fluid in the cylinder. External dust boots prevent brake dust and debris from entering the cylinder.

- **Self-adjuster assembly**—drum brakes require adjustment to maintain the shoe-to-drum distance.

A self-adjuster is used to expand the shoes slightly when the vehicle is driven in reverse and the brakes are applied. Several methods of self-adjusting linkages are used, and they vary by manufacturer.
though the most common type is the threaded self-adjuster, an example of which is shown in Figure 12-11.

- **Anchor**—used to prevent shoe movement or twisting as the brakes are applied. The torque of the brake drum will try to twist the brake shoes during application. The anchor is used to either limit or eliminate this movement. On servo brake designs, the anchor is located at the top, as shown in Figure 12-12. Non-servo brake designs place the anchor at the bottom of the backing plate, shown in Figure 12-13.

- **Parking brake**—a parking brake lever and strut are used to force the shoes apart and against the drum with the parking brake applied. An example of a parking brake lever on a servo brake is shown in Figure 12-14. Many nonservo brake designs use the self-adjuster mechanism as part of the parking brake.

**SERVO BRAKE DESIGNS**

Drum brake designs that use leverage to increase brake application force are called servo brakes. Also called **duo-servo; dual-servo, or self-energizing** brakes, this
shoe. This places more force on the secondary shoe than was originally applied by the wheel cylinder alone, as shown in Figure 12-16. Because of this servo action, the secondary shoe has a longer brake lining than the primary shoe.

Servo brakes are often used on larger vehicles, such as trucks, vans, SUVs, and larger passenger cars but can also be found on some FWD cars.

**NONSEROV BRAKE DESIGNS**

Nonservo drum brakes, also called leading-trailing brakes, place the anchor at the bottom of the backing plate, between the lower edges of the brake shoes, as shown in Figure 12-17. When the brakes are applied, the wheel cylinder forces both shoes out against the drum, as shown in Figure 12-18. This causes the forward or leading shoe to try to twist with the drum, but since the anchor is at the bottom between the shoes, no force from the leading shoe can be applied to the trailing shoe. Consequently, the brakes only apply with the force provided by the wheel cylinder, as shown in Figure 12-19.

**SELF-ADJUSTMENT MECHANISMS**

Unlike disc brakes, drum brakes do not automatically adjust for wear. To maintain the correct shoe-to-drum clearance, various types of self-adjusting mechanisms are used.

The most common self-adjusters, shown in Figure 12-20, are threaded on one end and can rotate freely on the other. Often called star wheel adjusters, these are usually mounted between the lower sections of the shoes. A spring holds the pieces tightly together. A lever, usually held in place against a shoe by a hold-down spring, and a link or cable attached to the anchor are used to turn the adjuster. When the vehicle moves in reverse and the brakes are applied, the shoes twist. This pulls the shoe away from the link, which in effect
Servo brakes use leverage from the primary shoe to increase the force on the secondary shoe, which increases overall braking power.

A nonservo brake does not allow one shoe to act on the other shoe to increase brake force. The anchor prevents the servo action.

Non servo brakes have leading and trailing shoes. The leading shoe is mounted to the front and the trailing shoe toward the rear.
Ratcheting self-adjusters, like that shown in Figure 12-21, are used on some nonservo brake vehicles. This type of adjuster is activated by using the parking brake.

**Parking Brake System**

The parking brake, also called the emergency or e-brake, is a mechanical brake used primarily to lock the brakes when the vehicle is parked. In the event of hydraulic brake failure, the parking brake can be used to slow and stop the vehicle, albeit over a much longer distance. To help maintain its operation, the parking brake should be used on all vehicles, though it is often only used on vehicles with manual transmissions. Customers who have vehicles with automatic transmissions should also be using the parking brake, at least periodically, to make sure that it remains functional. Additionally, whenever a vehicle with an automatic transmission is parked on a grade, the parking brake should be set before the vehicle is placed in Park. If the vehicle is placed into Park and then rolls slightly into place against the parking pawl in the transmission, it can be difficult to shift the transmission out of Park. When the parking brake is used first, it holds the vehicle in place without adding stress to the parking pawl in the transmission.

**COMPONENTS**

In the majority of vehicles, either a hand-operated lever or a foot-operated pedal sets the parking brake. This too is now changing, as manufacturers are moving toward electrically applied parking brake systems. Several manufacturers have introduced electrically operated parking brake mechanisms in the rear brake calipers and electric motors to pull the brake cables. The caliper operates very similarly to a traditional integral rear parking brake.
Foot-operated parking brakes operate similar to the hand-operated type. When the pedal is depressed, the front cable is pulled forward. This type may use two or three cables, as in the hand-operated system.

The parking brake cables are generally one of two types: a length of exposed steel cable made of many strands of steel wire or a steel cable covered in a protective outer sheath. Exposed cables are often used to connect the parking brake handle to the rear cables or to connect cables together under the vehicle. The outer sheath is used to attach the cable to the body and backing plate and to protect the inner steel cable from rust and corrosion. By bolting the outer sheath to the body, the outside of the cable can be held rigid and the inner steel cable can be pulled to apply the parking brake.

The parking brake cable may have an adjustment bolt to allow for loosening or tightening the cables as needed. Some parking brakes are self-adjusting and any slack is taken up in the pedal or handle assembly.

In the drum brake assembly, the cable attaches to the parking brake lever. The lever is attached to one of the brake shoes with a pin or a hook. The parking brake strut or self-adjuster screw is placed over the lever.

**OPERATION**

When a hand-operated parking brake is pulled, a latch moves along a gear, as shown in Figure 12-23. Once the brake is set, the driver releases the handle and the latch
locks into place on a notch in the gear. To release the brake, the lever must be raised slightly and the release button pressed. This allows the latch to release from the gear and remain retracted so that it does not lock into another gear position.

Foot-operated parking brakes are set the same way as hand-operated systems, but instead of using a release button, a handle is used to release the latch. An example of a foot-operated assembly is shown in Figure 12-24. On some vehicles, to release the parking brake you press the parking brake pedal down and it disengages. Many foot-operated systems now use automatic brake releases. These systems release when the vehicle is shifted out of Park.

Vehicles with electric parking brakes simply have a Parking Brake button on the dash. The driver presses the button, and the brake applies. To release the parking brake, the driver presses the parking brake button. Some vehicles will automatically release the parking brake once the vehicle starts driving.

**FIGURE 12-24** The components of a manually released foot-operated parking brake pedal.

### SUMMARY

Drum brakes use a set of brake shoes that expand outward against the inside of the rotating brake drum. When the brake pedal is released, return springs pull the shoes back to their rest position.

The backing plate is attached to the axle assembly and holds the components of the drum brake assembly.

Shoes are the metal backing on which the lining material is attached.

The drum has an internal friction surface for the shoes to rub against.

The return springs pull the shoes back when the brakes are released.

Holddown springs and pins hold the shoes to the backing plate.

Hydraulic pressure forces the wheel cylinder pistons outward against the shoes.

The self-adjuster assembly is required to maintain the correct shoe-to-drum clearance as the shoes and drum wear.

Duo-servo brakes place the anchor at the top of the brake assembly and allow the shoes to rotate slightly during braking.

Nonservo or leading-trailing brakes place the anchor at the bottom of the backing plate and prevent the shoes from rotating during braking.

### REVIEW QUESTIONS

1. The _______ _______ _______ holds the components of the drum brake assembly.
2. The _______ _______ _______ spring is used to attach the shoe to the backing plate.
3. The type of drum brakes that use leverage between the primary and secondary shoe to increase brake application force are called _______ _______ _______ brakes.
4. Linings are either _______ _______ or glued to the brake shoes.
5. The _______ _______ _______ is the hydraulic output for the drum brakes.
6. Which component seals the fluid in the wheel cylinder?
   a. Dust boot  
   b. Spring  
   c. Cup  
   d. Piston

7. All of the following are components of the drum brake assembly except:
   a. Wheel cylinder  
   b. Self-adjuster  
   c. Holddown pin  
   d. Brake pad

8. Technician A says the parking brake is part of the hydraulic brake system. Technician B says the parking brake is a mechanical brake that is not operated hydraulically. Who is correct?
   a. Technician A  
   b. Technician B  
   c. Both A and B  
   d. Neither A nor B

9. Technician A says all FWD cars and small vans use leading-trailing rear drum brakes. Technician B says modern vehicles may have leading-trailing or servo drum brakes. Who is correct?
   a. Technician A  
   b. Technician B  
   c. Both A and B  
   d. Neither A nor B

10. When the brakes are applied and released, which components are responsible for pulling the brake shoes back from the drum surface?
    a. Holddown springs  
    b. Adjuster  
    c. Return springs  
    d. Wheel cylinder