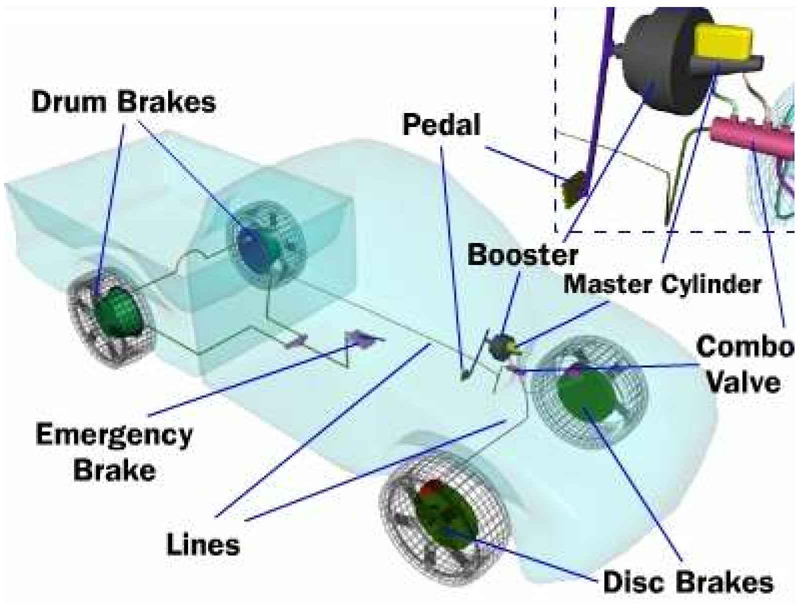
The Braking System



History of Automotive Brakes

The first automotive brakes were simple adaptations of the brakes used on wagons at the turn of the century. The brake, controlled by a lever, rubbed against a friction block. It did not offer a lot of braking action. However, because the roads were poor and horsepower was limited, it was sufficient to stop the early cars.

As cars improved, the wagon brake gave way to the external band brake. This, as the name implies, consisted of a steel band with leather friction material. It wrapped around a hub or drum and, when tightened by a lever or pedal, stopped the vehicle. As you might imagine, since the brake was external-- that is, exposed-- moisture, dirt, and gravel from the road were a problem.

As cars, tires, and roads improved, manufacturers upgraded brakes to keep pace. The first of these major improvements was mechanical brakes, still "external" or outside the car. First, external brakes were only on the rear wheels; later they were added to the front. A "hand brake" or "emergency brake" was added to hold the car when it was parked.

A major breakthrough came with the introduction of the internal brake. Like the brakes before it, it was mechanical, but this one used a variety of devices-- cams, levers, rods, linkage, brake shoes, and a drum-- to stop the car. Unfortunately, since the braking action was not distributed equally among the four wheels, the car often stopped well off the side of the road.

In the 1920's, a new idea in brakes was introduced. The 1921 Dusenberg had brakes that used "hydraulics" to carry the pressure from the driver's foot to the brakes, instead of the cumbersome mechanical linkages. During the next decade, other manufacturers, including Chrysler (1928) and Oldsmobile (1934), adopted hydraulic brakes. The last manufacturer to make the switch from mechanical brakes to hydraulics was Ford in 1939.

In not quite four decades, from the early years of the century until the years just before World War II, the automobile brake had developed from a simple wagon brake attached to a "horseless carriage" to a sophisticated hydraulic system capable of safely stopping a car traveling at speeds the "horseless carriage" drivers would have never thought possible.

You could make an argument that the brake system is the single most important system on a car. A brake system in need of repair will be noisy and annoying at best. **At worst, it is extremely dangerous**

Brake Basics

Basic to the operation of any automotive brake system are two well-known principles of physics. They are:

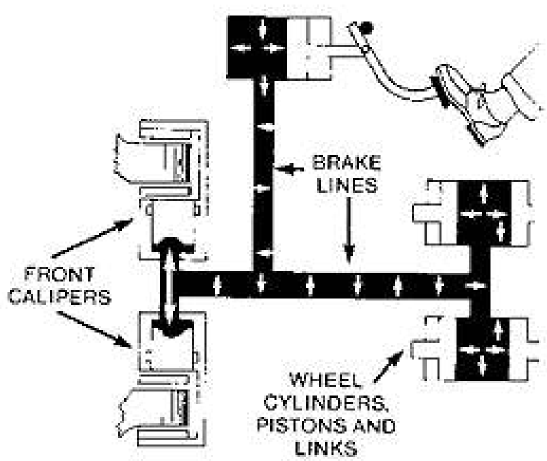
- A liquid in a closed container transmits applied pressure equally in all directions
- Energy cannot be created or destroyed. It can, however, be converted into other forms of energy.

If the applications of these two principles to automotive brake systems are not immediately obvious, do not be concerned. The rest of this section deals with these principles.

To see how the first principle, hydraulics, relates to brakes, consider how the hydraulic break system works. The driver presses the brake pedal. This pressure is applied to a non-compressible fluid in the system, the "brake fluid", and the fluid transmits the pressure to the wheel circuits.

The fact that the master cylinder applies pressure equally to each wheel channel, is what allows properly adjusted brakes to stop the car evenly.

Another important term to remember is "non-compressible." This means that the fluid pressure from the brake pedal is transmitted through the system as a solid form. Air can be compressed, but a liquid is virtually non-compressible in an automotive application. Air in the system results in a soft pedal and possibly a brake failure.



Example of Simple Hydraulic Operation

Another important point to note about brake fluid is that although all brake fluids are non-compressible, they are not all alike. If you look on the label, you will notice that each container of brake fluid has a DOT (Department of Transportation) designation-DOT 3, 4, or 5. Each fluid has its own characteristics.

The difference between DOT 3 and DOT 4 is their boiling point. Both of these are polyglycol based; however, DOT 3, the type specified in most American and Japanese vehicles, has a minimum dry boiling point of 401 degrees Fahrenheit. DOT 4, the type specified for most European cars, has a dry boiling point of 446 degrees. (Dry boiling point means free of water. Water lowers the boiling point of the brake fluid and may affect performance.)

Because glycol-based brake fluids do absorb moisture (hygroscopic), corroding brake parts over time, and damaging painted surfaces, many car enthusiasts have converted their vehicles to DOT 5 silicone brake fluid. It has a boiling point of more than 500 degrees Fahrenheit, does not damage the vehicle's paint and, because it does not absorb water, it will not corrode the brake system components. This means that-all other things being equal, the use of DOT 5 brake fluid will mean a longer life for the cylinders and the hydraulic brake system. That does not mean, however, that DOT 5 brake fluid should be put into every car. **DOT 5 (silicone) fluid should never be used on a vehicle equipped with an ABS brake system.**

Few manufacturers equip their vehicles with silicone brake fluid and, since silicone brake fluid and glycol-based DOT 3, 4-brake fluid do not mix, the only way to convert to silicone is to completely purge the polyglycol brake fluid from the system by doing a complete brake system overhaul.

The final point to remember about brake fluid is that it does not last forever. Over time, the brake fluid accumulates sediment and moisture. This affects the brake fluid's performance and harms the other components of the hydraulic system.

Car care experts recommend that all brake systems be flushed every two years. This involves purging all of the old brake fluid out of the system and replacing it with new fluid. Although flushing the system is not a complicated operation, you should keep in mind that petroleum products should be kept out of the brake system. If petroleum-based products are introduced into the hydraulic brake system, the rubber seals will swell; creating a problem that can only be solved by a complete overhaul including replacement of all rubber components.

Bleeding the System

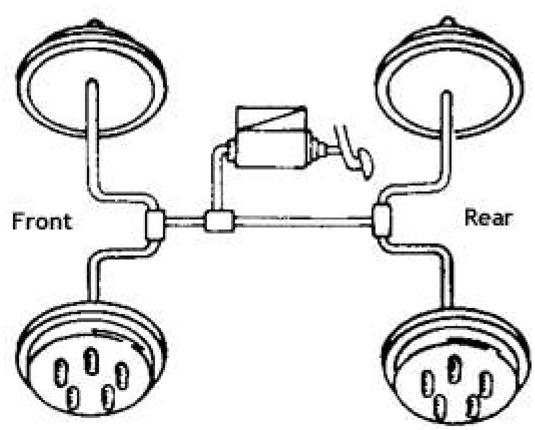
After a brake job, air and old fluid must be removed. This is called "bleeding the system". It can be done manually by two people or by one person with a pressure or vacuum bleeder. The air is bled from the system through bleeder screws, located on the uppermost part of the master cylinder (if present), calipers, and wheel cylinders. If a bleeder screw is broken off, it must be repaired or air will remain in the system. Air retained in the system can result in a "soft or spongy pedal" or in a complete loss of pedal.

Since brake fluid absorbs moisture from the atmosphere, it is important to keep the cap on the brake fluid and the cover on the master cylinder. Once moisture enters the hydraulic system, either during repair or because of condensation, it can eventually rust and pit the bore and finish on the cylinder, resulting in frozen or leaking wheel cylinders and calipers.

Every DOT 3 or DOT 4 brake system should be flushed periodically, at least every two years, for best hydraulic system operation.

Types of Hydraulic Brake Systems

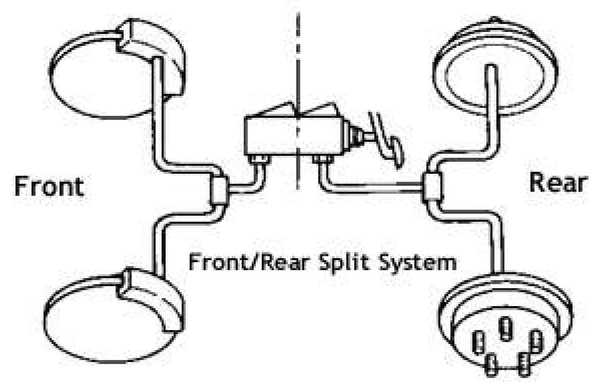
There are basically three types of hydraulic brake systems in automobiles. Prior to 1967, a single piston master cylinder was used to provide hydraulic brake system pressure to all four wheels simultaneously. This type of system was effective but offered no provision for braking in the event of a failure in any part of the system.



Simple Hydraulic System

Dual system

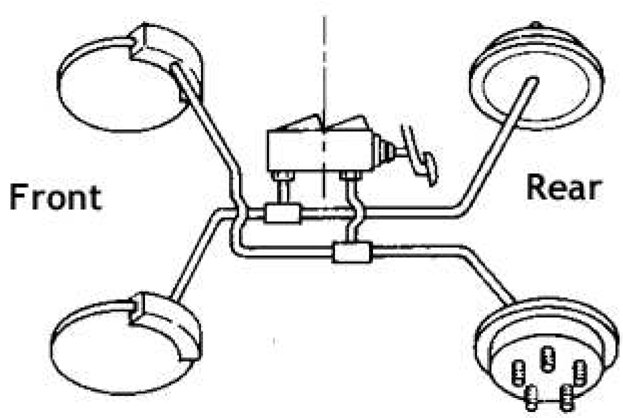
A **dual system, or front/rear split**, utilizes a dual piston master cylinder that separates, or makes independent of each other, the front and rear hydraulic portion of the system.



Front/Rear Split System

Dual Diagonal System

A **Dual Diagonal System**, like the dual system, uses a dual-piston master cylinder and two independent braking systems. The dual diagonal system, however, links the right front and left rear wheels on one part of the system and the left front and right rear are on the other.



Dual Diagonal System

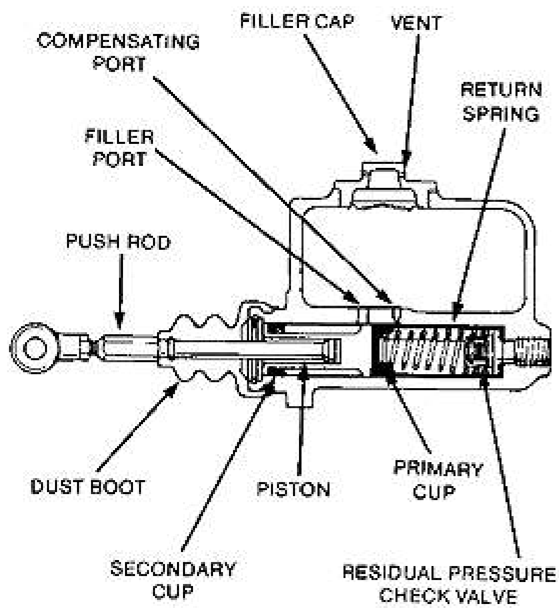
THE BRAKE SYSTEM

The following section will identify and briefly explain the major components in a brake hydraulic system.

Master Cylinder

The brake system utilizes a basic hydraulic principle: liquid is virtually non compressible. In order for a brake system to function properly, there must be a complete column of fluid throughout the entire system. If fluid is not present, then air is. Air is a gas and any gas is compressible. If there is air in the brake system, then it will not be able to function properly, which could present problems when trying to apply the brakes and make the vehicle stop.

The master cylinder is a form of hydraulic pump. Pressure is applied to it from the brake pedal, and it moves brake fluid through the brake lines to the calipers and wheel cylinders, which cause the friction material to contact the rotors and drums. The master cylinder is critically important. If it does not work, the brake system does not work well either.



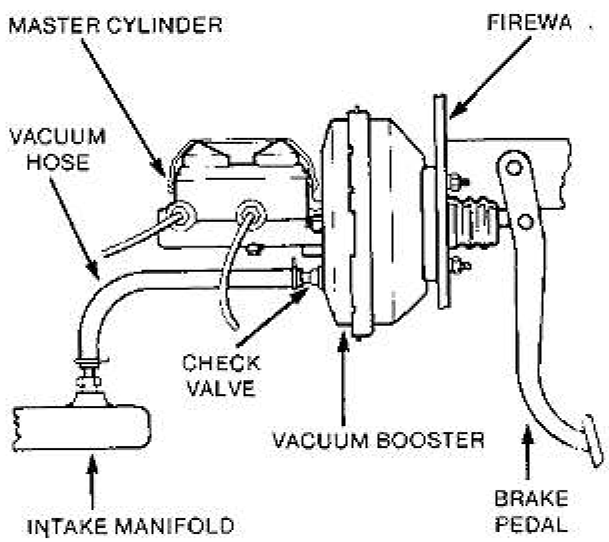
Master Cylinder Problems

If the brakes drag, it is possible that the master cylinder pistons are not releasing, perhaps because of contamination between the seal or piston or because of an overextended pushrod. If the brakes do not hold pressure, rust or corrosion may have damaged the primary seal. External leaks or a low brake fluid level in the reservoir may indicate a problem in the master cylinder. However, do not rule out leaks elsewhere in the hydraulic system.

POWER BOOSTERS

Power boosters or "power brakes" help the driver stop the car by adding to the hydraulic pressure going to the brakes. Today, power brakes are standard equipment on most automobile models.

The power boosters that you will find on an automobile will be one of three types: vacuum suspended, Hydro-Boost, or electric/hydraulic actuated. They are manufactured in a variety of designs; however, the operation and testing procedures for all power boosters are similar.



Typical vacuum booster and related components

BRAKE LINES AND HOSES

The brake lines and hoses connect all of the parts of the brake system. Because they are under the car, they are assaulted by road grime, stones bouncing up from the road, and constant vibrations from the motion of the car. Since brake lines and hoses have to take this kind of punishment, and because a leak in the brake lines will result in the loss of brake fluid and possible brake failure, their condition should be checked carefully.

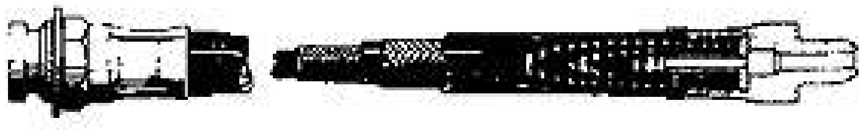
Brake lines-- double walled, welded steel tubing-- are routed along the vehicle chassis and held in place by mounting brackets. Flexible rubber hoses are used to connect the steel tubing at points where the vehicle suspension or chassis moves.

Brake lines are coated for rust resistance, and the ends are double or bubble (ISO) flared to adapt to tube nuts and hydraulic cylinder inlet holes. The most common brake line diameters for automobiles are 3/16 inch and 1/4 inch. The tubing is available in different lengths with the ends flared and provided with fittings. Tubing can be cut to length and flared using special tools.

Do not substitute copper tubing for steel brake lines. Steel brake lines have a much greater resistance to fatigue caused by vibration or to kinking caused by improper installation or debris bouncing up from the road.

Iso Flare

Double Flare



Cutaway of Brake Hose

The brake hoses mount between the wheels and axles of the vehicle. These specially made hoses, constructed of two braids and three tubes, have to be able to withstand high fluid pressures without expanding and need to flex freely without damage. Brake hoses come in a variety of sizes and lengths for specific applications.

PROBLEMS WITH BRAKE HOSES

Damage to brake hoses or lines will often result in a total or partial brake failure. Generally, a kinked or deteriorated line will leak, but the damage may just show up as a restriction in the line, causing unevenness in the application and release of the brakes. Damage to steel brake lines can generally be found by visual inspection; check for dents or missing routing clips.

Unfortunately, visual inspection does not usually detect damage to brake hoses. Hoses that look fine on the outside can be contaminated or deteriorated on the inside. These internal problems can restrict the flow of brake fluid to and from the hydraulic cylinders, causing unevenness in braking or decreasing braking efficiency.

External leaks, caused by cracking or chafing, may develop at end fittings or hoses. The chaffing may be due to the substitution of longer hoses, improper installation, or missing tube clips, any of which will allow the hose to rub against the vehicle's suspension. Leaks may result in a visible loss of brake fluid or in the formation of bubbles between the hose layers.

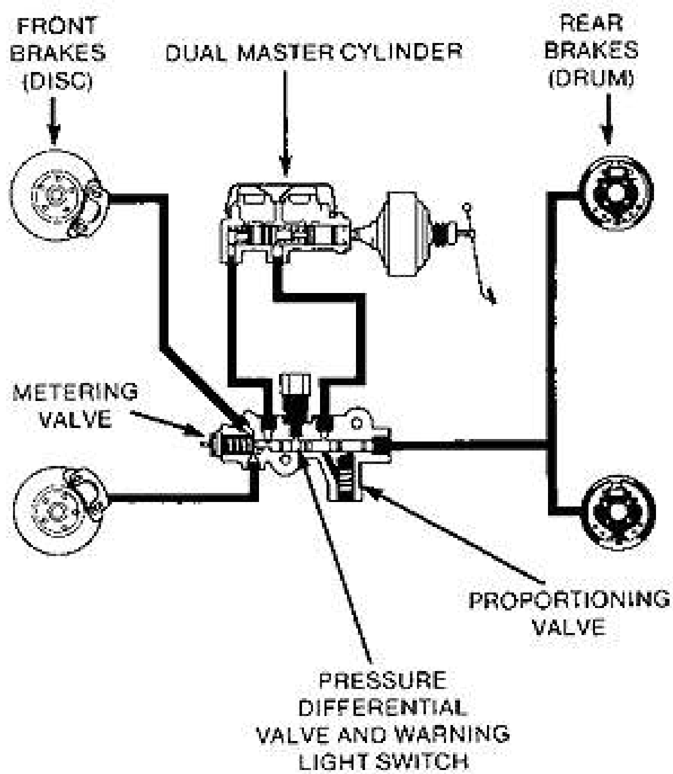
HYDRAULIC VALVES

Many brake systems use hydraulic valves to vary hydraulic pressure to the disc or drum brakes, balancing the pressure to them. Depending on the vehicle design, it may use a metering valve for the front brakes or a proportioning valve for the rear brakes.

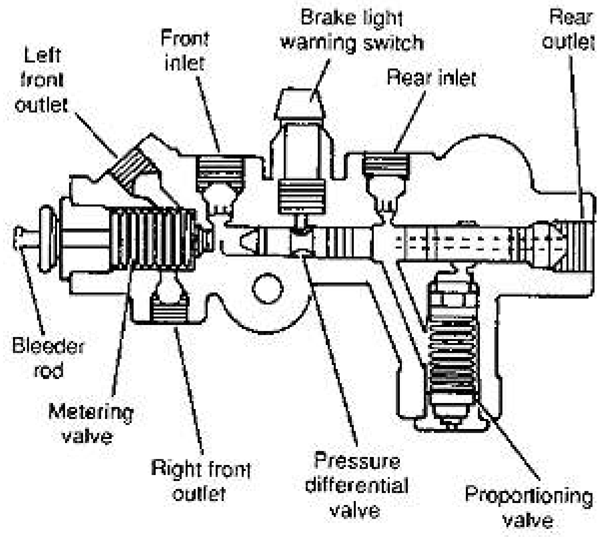
Some early models had only a proportioning valve that limited rear brake pressure during hard braking. This helped to prevent wheel lock-up.

Early disc brake systems used a metering valve in conjunction with a proportioning valve. The metering valve holds off pressure to the front brakes to give the rear shoes an opportunity to overcome spring tension. It also helps prevent premature wear on the front pads as well as prevents front wheel lock-up. Today, some vehicles do not use a metering valve because of brake system configurations.

Many systems will incorporate a metering and proportioning valve and also utilize a pressure differential switch that will activate the red brake warning light on the dash when there is a problem in the system. It senses low brake fluid level or loss of pressure in the system. The brake warning light is also connected to the parking brake and may be connected to a low vacuum switch on some vehicles. If the light comes on, there may be a problem with the switch or booster itself, and not necessarily indicate a problem with the hydraulic system. In today's vehicles, these valves and switches are usually incorporated into a combination valve.

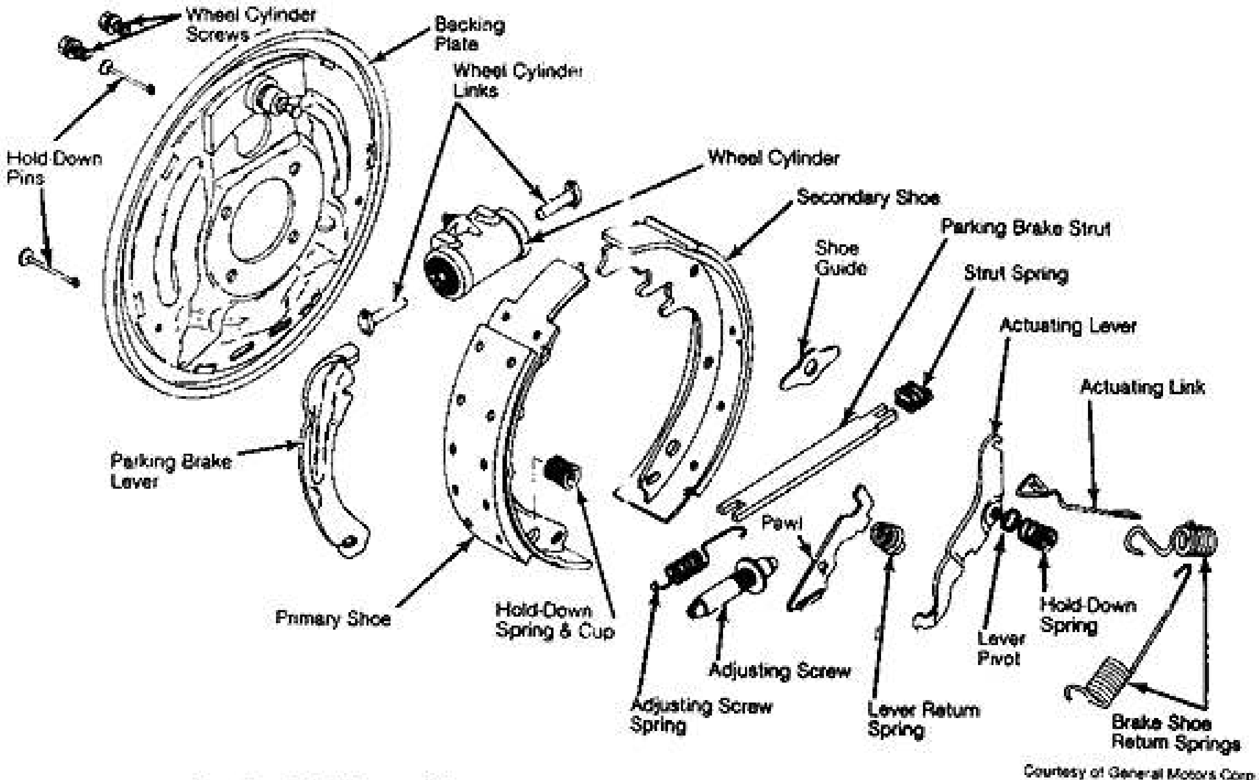


Typical System with Combination Valve



Exploded View of Combination Valve

THE DRUM BRAKE



Exploded View of Conventional Type Rear Drum Brake Assembly

Since the drum brake was introduced more than fifty years ago, various changes and improvements have made it smoother operating, more dependable, and easier to service. Some of the changes include: automatic adjustment, finned drums, improved dust boot designs, sintered iron pistons, cap expanders, direct action pistons, mounting clips, heavy-duty return springs, and improved rubber components in the wheel cylinder cups and boots.

Most drum brakes are similar in design. The brake shoes, wheel cylinder, and all of the parts, except the brake drum, mount on the backing plate. The brake drum either mounts on a spindle or is centered on bearings, or it is mounted on an axle flange.

BRAKE DRUMS

Automotive brake drums are made of cast iron or aluminum with an inner surface of machined cast iron. Some drum types are finned for better heat dissipation.

The brake drum provides the contact area for the brake shoes. The heat from the braking action is transferred from the contact surface through the brake drum to the atmosphere.

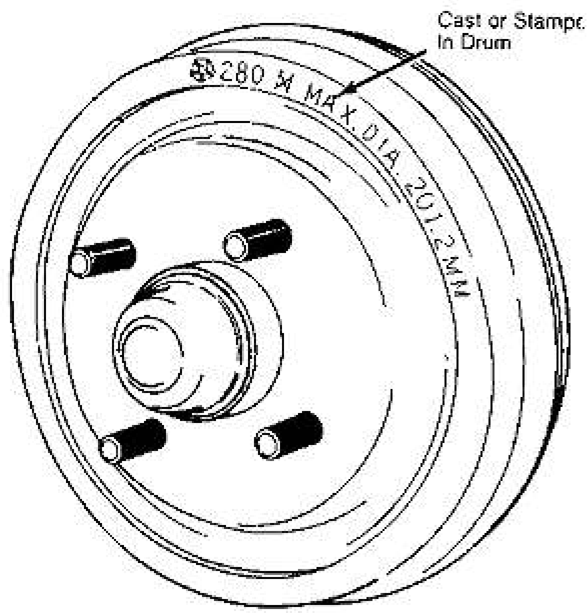
Excessively worn drums, or overheating, affect the surface contact and, consequently, braking efficiency. When the drums are larger than the specified diameter, either because of expansion due to overheating or because they are worn beyond safety limits, the brakes may have to be pumped several times to stop the car. If the wheel cylinder hydraulic displacement is not sufficient to compensate for the excessive lining-to-drum clearance, the brakes may not work at all.

The inner drum surface should be smooth and concentric. Improper drum surface contact results in a loss of friction, erratic brake performance, a pulsating brake pedal, and brake noise. The most common drum defects are corrected by machining the surface on a brake lathe while the brake job is being done.

The brake drum diameter should not exceed the specifications stamped or forged on the outer housing. Drums worn or machined beyond this specification do not allow correct brake shoe contact, resulting in extreme operating temperatures, low brake pedal, and limited brake performance. Good brake operation depends to a great degree on correct drum diameter and surface finish.

Although most brake drums are hubless, some do have an integral hub. Bearings in the hub or axle flange hold the drum in correct alignment with the shoes.

Problems with brake drums may come from a variety of causes, most having to do with improperly maintained or worn parts. Worn bearings, shoes, brake hardware, and wheel cylinders can affect drum surface contact. Dragging brake shoes caused by a frozen parking brake or wheel cylinder generate excessive heat, causing the cast iron or aluminum metal in the drum to turn blue and changing the heat dissipating properties to the metal. If a drum can no longer efficiently dissipate heat, it decreases the life of the brake shoes and causes a loss of friction.



Specifications Stamped on Drum

Always measure drums before machining them to ensure they will not be too thin when finished. The reason for the limit on drum thickness is heat. If the drum is too thin, heat from normal braking will distort the drum. This causes uneven, grabby, increased distance braking. In severe cases, total brake failure could result.

Also, to do any good, all scoring, glazing, and out-of-round conditions must be removed by turning. It makes no sense to turn a drum to its limit and leave half the scoring intact. Many drums can be turned 0.060". Any scoring deeper than 0.030" means drum replacement, because to remove 0.030" deep scores on one side of the drum, you must cut 0.030" from the other side of the drum. The two sides add up to 0.060", the maximum allowed. If the minimum specification is in metric, it may be converted by multiplying the inch value by 25.4. Always check applicable specifications.

DRUM DEFECTS

Brake drums have two basic dimensions: diameter and width, and it is critical to proper shoe contact that both dimensions be correct. Diameter is measured with a drum micrometer, and the drums that, when measured, exceed the manufacturer's tolerances, should be discarded.

Some basic drum defects occur through normal wear or because of a lack of preventive maintenance. These include out-of-roundness, tapered wear, bell mouthing, hard spots, glazing, cracking, and scoring. Some of these defects, notably hard spots or cracked or scored drums, can be found on visual inspection; others will be found only with a drum micrometer or when the drums are being machined on a brake lathe.

Except for cracked drums or excessive hard spots, most of the problems listed above can be corrected by machining the drums on the lathe.

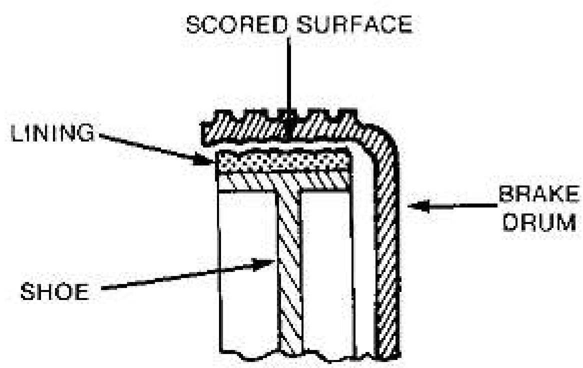
It is recommended that brake drums on the same axle are within .010 (ten thousandths) of an inch of each other; therefore, drums may have to be replaced in axle sets.

New brake drums are usually coated with an anti-rust compound. The protective finish must be removed before the drums are installed. Any compound not removed may reduce shoe-to-drum friction. The recommended solvent for removing this anti-rust compound is alcohol or brake cleaner. Petroleum-based products should not be used; they can penetrate the cast iron pores and contaminate the lining.

Following is a list of common drum defects, their causes, and the preferred solutions for them:

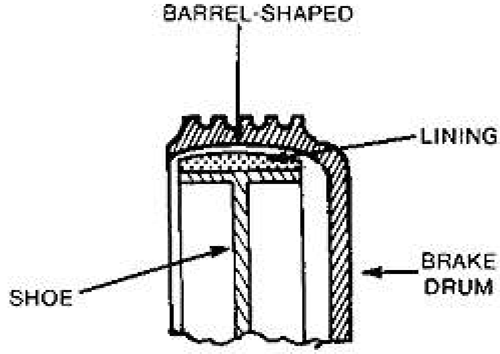
Cracks: Cracks may be due to a worn drum or to excessive heat. In either case, the drum should be replaced.

Scoring: Scoring is usually caused by mud splashing in the brake drum and becoming trapped between the lining and the drum. Other causes may be iron particles trapped in the rivet holes or lining worn to the rivet heads. Drums with light scoring can usually be machined on the brake lathe.



Scored Brake Drum

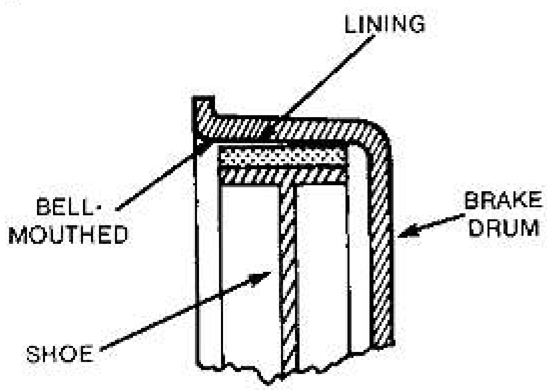
Barrel Shape: Sometimes the center of a brake drum will wear excessively. This is usually due to extreme braking pressure and a distorted shoe table, exerting pressure only at the center of the lining. Minor distortion can be corrected by machining the drum. More severely distorted drums should be replaced.



Barrel-Shaped Drum

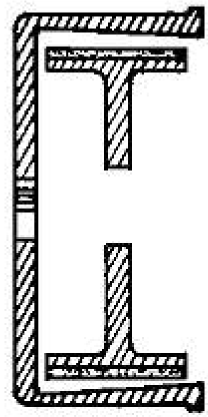
Out-0f-Round: A non-concentric drum has a center hole or hub off center from the braking surface. Causes include overheating or warping. Improper lug nut torque can cause the drum to warp when it gets hot or cools.

Bell mouthing: Extreme pressure and temperature can cause bell mouthing on a wide drum. The open end of the drum distorts because it has less support and dissipates less heat than the closed end. If the drum cannot be machined, it should be replaced.



Bell-Mouthed Wear

Taper: Tapered wear occurs at the closed end of the drum when the drum overheats. Since there is more heat and greater shoe pressure at the closed end, it tapers out. As with other surface irregularities, if the drum cannot be machined, it should be replaced.



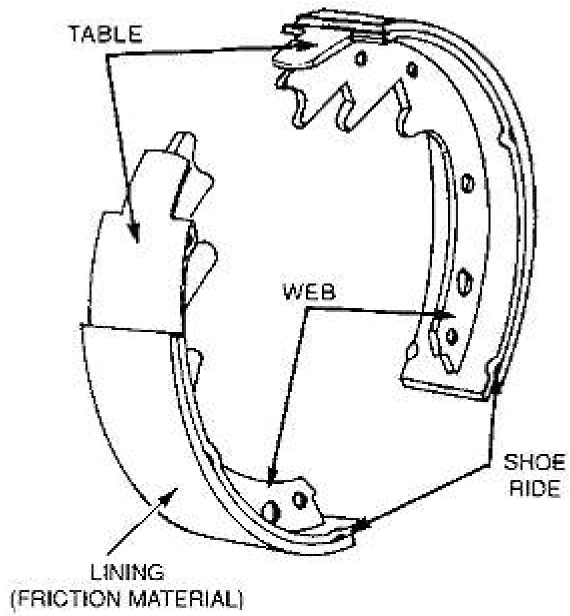
Tapered Wear Drum

Hard Spots: Hard spots, caused by extreme heat and pressure, show up as bumps on the friction surface after the drum is machined. The bumps may be removed by grinding, but grinding only removes the surface bumps, not the hard spots themselves. As the drum wears the hard spots may reappear. Since excessive hard spots will cause erratic brake performance, noise, and wear, the best advice is to replace any drum with a significant number of hard spots.

Drum Distortion: the normal heating of the brake drum may cause Drum distortion during the braking action. If only new shoes are installed, the drums should be machined to remove the distortion for correct lining wear.

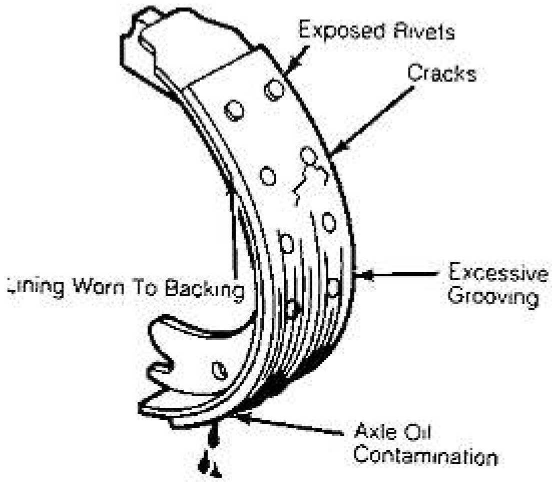
BRAKE SHOES AND LININGS

An automotive brake shoe is made of two pieces of stamped metal, the table, and the web, which are-welded together. The web, made of heavy gauge metal, transmits the wheel cylinder's mechanical force to the table. The web's shape and drilled holes are designed so that the brake hardware anchors the shoes to the backing plate.



The table is arched and welded to the center of the web. Many shoes have nibs or indented places along the edge of the table. The nibs rest against the backing plate ledges and keep the shoes from chattering and hanging up.

The brake linings may be held to the table by either of two methods: (1) rivets or (2) a bonding agent or cement. There are no real comparative advantages or disadvantages to either method of attaching linings; however, bonded linings are more rigid and usually have a longer life than riveted linings.



Typical Brake Shoe Problems

A visual inspection of the shoes is all that is necessary to tell you whether or not they can still be used. If there is less than 1/32" of lining remaining above the rivets, replace the shoes. On bonded linings, there should be a minimum of 3/32-1/8" of lining remaining. Some states may have specific inspection requirements that must be followed.

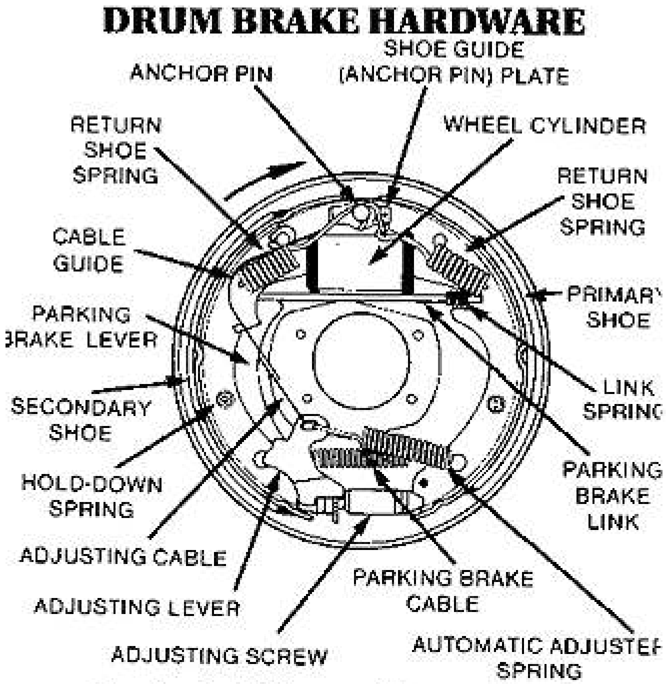
As with the brake drum, if you can see any cracks or excessive wear areas, replace the shoes.

In some cases, the brake shoes will have overheated to a point of being dangerous. Galling, carbonizing warping, or excessive wear will indicate this. If you see any signs of overheating, replace the shoes.

Replace shoes soaked in brake or rear axle fluid, grease, or oil. Such contamination causes grabbing and can cause loss of car control. Besides changing the shoes, investigate and cure the cause of contamination, such as a leaky wheel cylinder or rear axle seal.

Most drum brake service is performed when changing shoes because of wear or contamination. Therefore, there is usually little need to decide if the shoes should be replaced. If you are faced with the possibility of reusing borderline shoes, do not. Marginal shoes should be replaced because good shoes are both inexpensive and mandatory for good braking.

DRUM BRAKE HARDWARE

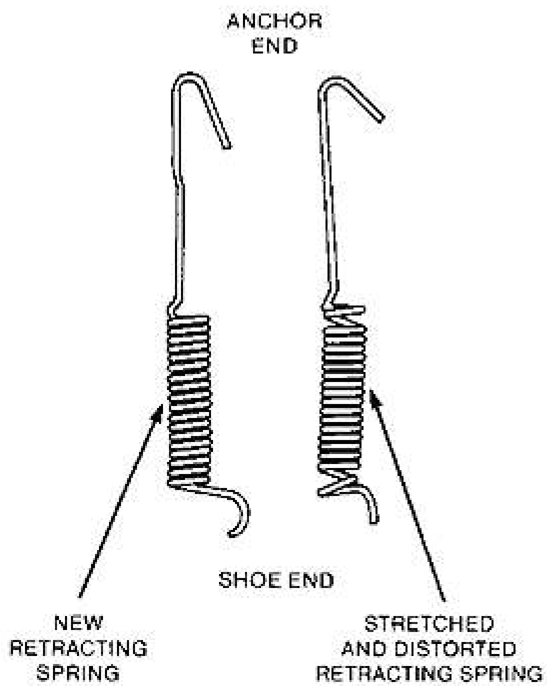


Exploded View of Drum Brake Components (Typical)

The hardware on the drum brake does more than simply hold the brake components together. It causes the shoes to apply and release together, anchors the shoes to the backing plate, and prevents the shoes from cocking or dragging. That's what the brake hardware does when it is well maintained and in good working order. Hardware that is reused and not in good working order causes noisy brakes and premature brake lining failure. Brake hardware wears with use and should be replaced each time the brakes are relined. As we discuss the various hardware parts of the brake drum, take the time to find the part in the appropriate diagram and relate it to the brake assembly. Basically, the drum brake consists of an anchor, return springs, hold-down springs, adjuster springs, adjusting hardware, and parking brake hardware. Let's briefly consider what each piece of hardware does:

Anchor: At the top of the backing plate (at approximately twelve o'clock) is the anchor. It absorbs the torque of the brake shoes. The anchors may be bolted, welded, or riveted to the backing plate.

Springs: The return springs retract the brake shoes when the pedal is released. When hydraulic pressure is applied, the wheel cylinder pushes the shoes into the drum, overcoming the pressure of the return springs. When the hydraulic pressure falls, the springs quickly return the brake shoes to the "non-applied" position. Many drum brakes use a heavier return spring on the secondary shoe than on the primary shoe. This allows the primary shoe to initiate the self-energizing action.



Typical Return Springs

Weak return springs can cause the slow return of the brake shoes (brake drag), and contribute to short lining life and potential rear brake lockup. Hold-down springs hold the shoes to the backing plate. Most brake shoes have one hold-down assembly consisting of a nail, a spring, and two cups per shoe. If the spring loses its tension, the brake shoe will not apply evenly. Since brake shoe nails help align the brake shoes, they should be straight and free from corrosion.

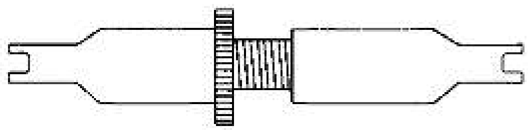
ADJUSTING HARDWARE

Adjusting mechanisms are found on drum brakes. (Disc brakes are inherently self-adjusting by their design.) This adjusting mechanism allows the mechanic to adjust the clearance between the shoes and the brake drum so the shoes are in an "almost" braked condition even when they are not being applied. (Brake return springs are used to pull the shoes away from the drums when the brake pedal is not pressed.)

Proper pedal height depends on properly adjusted shoe-to-drum clearance. As the brake shoe friction material wears, they must maintain proper contact. The adjusting hardware helps maintain this proper contact.

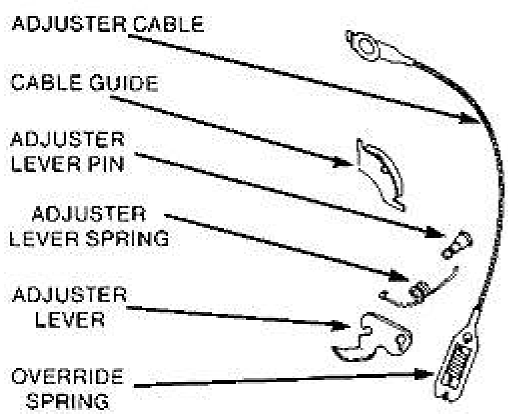
Proper brake adjustment became critical when the tandem master was introduced. Because the master cylinder stroke and displacement of fluid volume was decreased, there was not enough fluid to compensate for excessive shoe-to-drum clearance when the pedal was pressed once. The pedal had to be pumped to stop the vehicle; or if the clearance was too great, the brakes failed to work at all.

Drum brake adjusters are either manual or automatic. Manual adjusters are usually found on vehicles manufactured before 1962. Since 1962, most manufacturers have used automatic adjusting drum brakes. On cars with manual adjusters, the brakes must be adjusted periodically. Servo brakes have a star wheel with large notches to accommodate an adjusting tool, and non-servo brakes have cams or a fixed anchor with a star wheel adjuster.



Typical Starwheel Adjuster

Self-adjusting brakes adjust the shoe-to-drum clearance, either automatically or when the parking brake is applied or when the brakes are applied while the car is moving in reverse. The most common self-adjuster for servo brakes is a star wheel with fine notches and a cable or link attached to the secondary shoe or adjusting lever. The tightening of the cable or link, causing the adjusting lever to adjust the star wheel, causes the adjustment.



Typical Self-Adjusting Components

Non-servo brakes use an adjusting strut. It is the only link between the brake shoes and serves as a parking brake lever. The parking brake adjusts the proper lining-to-drum clearance when it is applied. Other types of adjusting struts are automatic and adjust for brake shoe wear when the service brake is applied.

Typical Parking Brake Adjusting Strut

PARKING BRAKE HARDWARE

The parking brake cable attaches to the lever mounted to the secondary shoe. When the pedal is applied, the lever pivots, applying the secondary shoe, and the force is transferred through the strut to the primary shoe. There is a spring on the parking brake cable that pushes the lever to the release position, and there is a spring between the strut and the primary shoe to help center the strut. Worn or missing strut springs can cause the parking brake to drag.

Good brake maintenance requires that the brake hardware be replaced when the brakes are relined. This is important to noise-free operation as well as even and safe braking. Brake hardware should be replaced in axle sets for best operation.

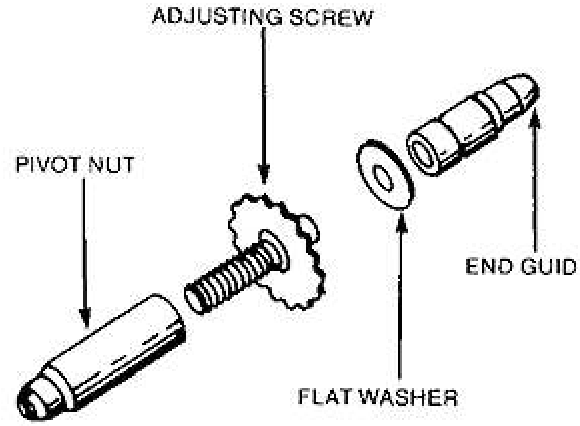
HARDWARE PROBLEMS AND SOLUTIONS

Remember that drum hardware discolors, stretches, loses its tension, and distorts because of brake heat or just normal wear. A widely known-but not very useful-test for springs is to drop the spring on the floor and listen to the sound it makes when it lands. According to the "test", the spring will make a dull sound if it is good and a ringing sound if it is bad. (What decibel level is acceptable?)

It's true that good springs and worn springs make different sounds, but it's also true that springs may sound "good" and still be worn or distorted. The safest procedure is to replace the return springs, the hold-down springs, and adjusting springs each time the brakes are relined.

Of the many different types of drum brake adjusting mechanisms, the most common is a star wheel mounted between the brake shoes. It can usually be reused, but it should be cleaned and adjusted with each reline. If it is frozen, or if the adjusting teeth are worn, it should be replaced.

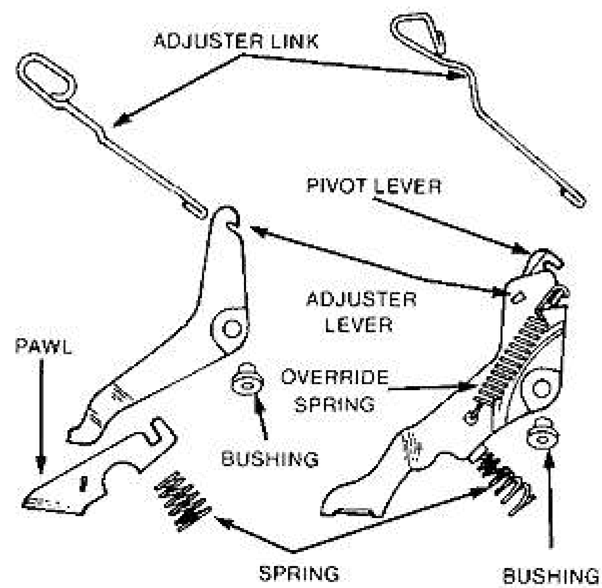
On vehicles with star wheels, the adjusters for the right brakes are different from the adjusters on the left. The right brake uses a screw with left-handed threads; the left brake uses a screw with right-handed threads. Star wheels are marked ³L² (for left wheels) and ³R² (for right wheels). The pivot nuts are usually marked with one mark or groove for a left-handed thread and two marks or grooves for a right-handed thread.



Starwheel Adjuster Assembly

General Motors uses a link to apply the parking adjusting brake lever. When the brake is applied in reverse, the lever moves down, making contact with a notch on the star wheel. If shoe adjustment is needed, the screw will rotate out on the pivot nut threads. When the brake pedal is released, the lever moves to the normal position.

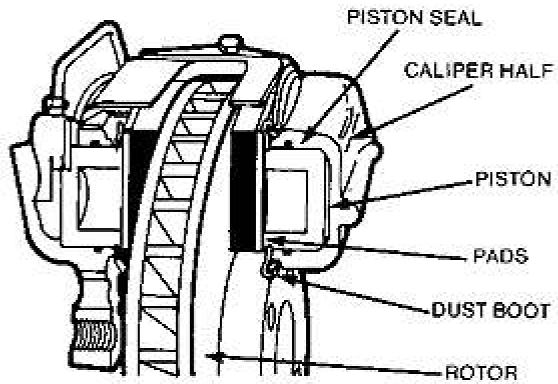
Ford, American Motors, and Chrysler use a cable that tightens when the brake is applied while the vehicle is moving in reverse. If adjustment is needed, the lever will rotate the screw out on the pivot nut threads. Frayed or stretched cables, and grooved and worn cable guides and adjuster levers will prevent the self-adjuster from working properly. All of these parts should be inspected and replaced if necessary each time the brakes are relined.



GM Self-Adjusting Hardware

DISC BRAKES

Disc brakes were introduced on American production cars in 1962, and by 1965 they were standard equipment on certain models of Fords, General Motors, and American Motor cars. The combination of front disc brakes and rear drum brakes represents a major improvement in automotive braking.



Cutaway - Typical Disc Caliper

Unfortunately, the improvement was not totally satisfactory. The first disc brakes, the four-piston, fixed caliper design, was prone to freeze ups, leaks, and noise. A better caliper design, the single-piston floating caliper, was introduced in 1968.

The new caliper used only one piston to actuate two brake pads. It was lightweight, easy to service, and more dependable than the four-piston type. This caliper design is used on the majority of today's brake systems.

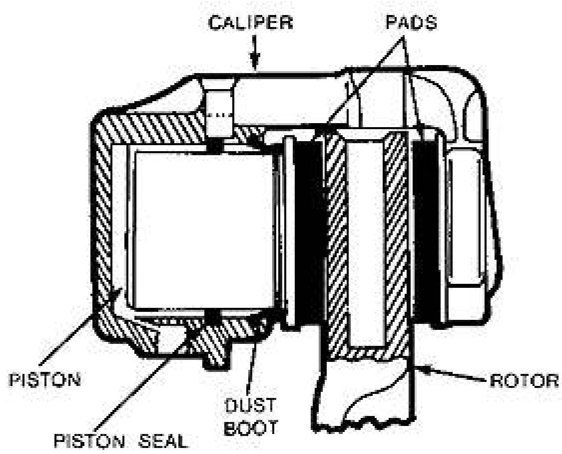
Whether it uses the floating caliper or the fixed caliper, the disc brake consists of the following components: a rotor (braking surface) that turns with the vehicle, a caliper (hydraulic cylinder), and disc brake pads (frictional force).

CALIPERS

When hydraulic pressure is applied, the caliper piston pushes the brake pads against the rotor surface, braking the automobile. As the brake pads wear, the caliper automatically adjusts itself.

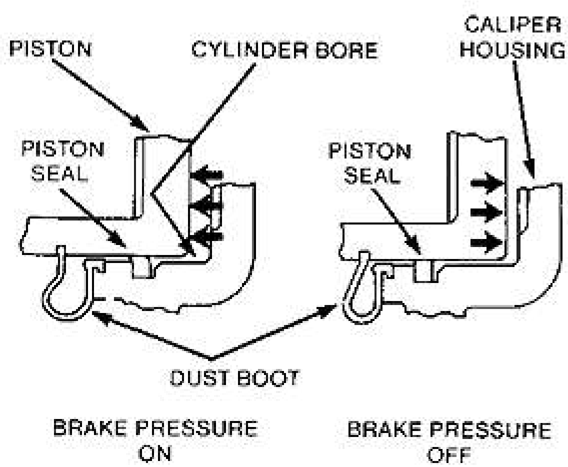
Brake calipers consist of four major components: the dust boot, the seal, the piston, and the housing. Depending on its design, the caliper may have one, two, three, or four pistons, seals and boots in a single housing. In either case, however, the operation is essentially the same.

Calipers ride in anchor plates, which are either mounted to the suspension or frame. When the brakes are applied, hydraulic pressure causes the piston to move out of the caliper bore, and the opposing reaction slides the caliper in the anchor plate pushing the friction pads to the rotor with equal pressure. The piston seal prevents leakage from the cylinder bore and also acts as a return spring. Under pressure, the square-cut piston seal distorts. When the brakes are released, the seal returns to its normal position, retracting the piston enough to provide running clearance for the pads. This design provides a means for self-adjustment.



Disc Caliper Components

Since the caliper seal is there to prevent brake fluid leakage, a proper sealing surface against the piston is critical. Pistons are made of steel with a chrome plating, aluminum, and phenolic, and are subject to corrosion, scratching, and normal wear, any of which can mar the surface sufficiently to prevent a good seal. That, and other caliper problems, such as a frozen piston due to a damaged or incorrectly installed dust boot or bore corrosion due to contaminants, can be prevented by overhauling the caliper each time the brakes are relined.



Caliper Functions

The basic caliper designs are termed "fixed", "floating", and "sliding", the difference being how each caliper operates. A fixed caliper has a piston or pistons for each brake pad and the caliper does not move. A floating or sliding caliper usually has a single piston for both brake pads, "floating" on guide bolts or machined surfaces.

For the single piston caliper to operate properly, the caliper must move to activate the outboard brake pad. If it does not, the other pad will have to work harder, causing the brake to overheat. (And, you will remember that overheating can result in premature lining failure.)

When the brakes are released, the caliper piston should retract quickly, releasing the brake pads. If the piston is sticking or frozen, both brake pads will remain against the rotor surface creating rapid wear. It also affects the handling of the vehicle when the brake is applied. A frozen or sticking brake may pull or lock up causing a loss of steering control.

It is recommended that calipers should be overhauled each time the brakes are relined. Seals and boots should be replaced, the old fluid should be completely flushed, and the pistons should be cleaned and inspected. If the piston is worn or corroded, it should be replaced.

The caliper overhaul must also include the cleaning and inspection of the sliding or floating brake hardware. The rubber or metal bushings that hold the caliper in alignment with the adapter or mounting plate should be replaced at each overhaul; and other caliper mounting bolts, pins, guides, keys, and springs should be replaced if they are corroded or worn.

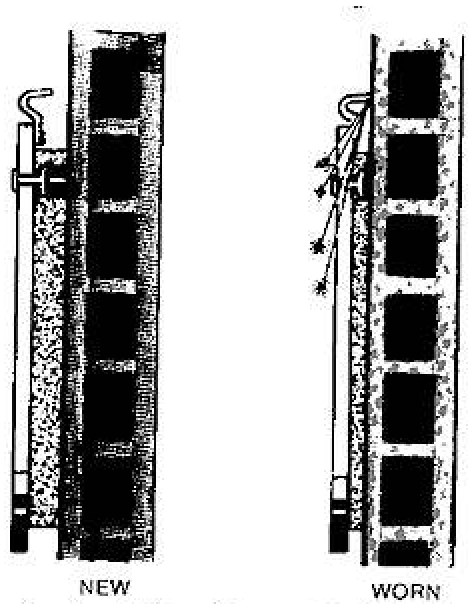
DISC BRAKE PADS

Since brake pads provide the friction necessary to stop the rotor, they must have heat resistance and physical strength. While that is true of all brake pads, each of the available types, semi-metallic or NAO, provides these properties in different degrees.

Many vehicles today use semi-metallic brake pads to handle the higher operating temperatures, resulting from the changes in front brake rotors and downsized brake parts. With these changes, disc brake operating temperatures jump from 500 degrees Fahrenheit up to 700+ degrees. Only the semi-metallic pads, with an operating temperature range of 900+ degrees, can work properly at that heat. NAO pads are designed for operating temperatures of 350 to 500 degrees. The ceramic variation is designed to care for noise and dusting problems.

Using brake pads other than the type the application requires can result in premature pad failure and possible rotor damage. Proper procedure calls for replacing pads strictly according to application requirements, Semi-metallic or NAO pads can sometimes be installed on earlier model vehicles for severe braking requirements.

Many brake pads have wear indicators to let drivers know when their pads are worn below safe limits. When the brake pad wears down to the replacement point, the metal indicator attached to the pad comes in contact with the rotor surface, causing a squealing noise. Replacing the pads as soon as the wear indicator starts making noise will prevent excess rotor damage.



Typical Wear Sensor Indicator

Disc Brake Pad Characteristics

Brake pad performance can vary according to the grade of the friction material. Quality brake pads will offer a longer life and more dependable stopping.

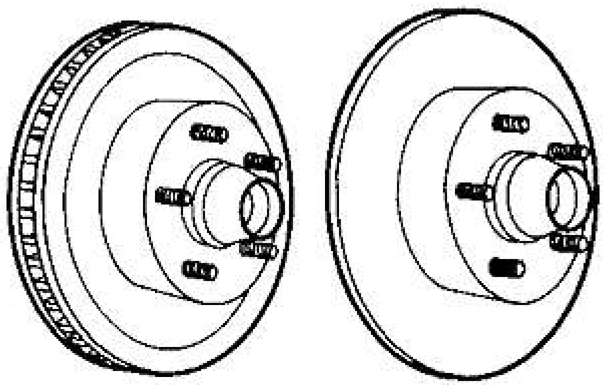
If organic linings are exposed to the extreme operating temperatures found in today's downsized disc brakes, they will wear quickly. In 1978, semi-metallic brake pads were introduced, providing improved operating characteristics and longer life, even at high operating temperatures.

Today's disc brake pad characteristics are suited to the extreme operating temperatures, but a number of other factors, caliper operation, rotor condition and environmental operating conditions, impact directly on pad life.

BRAKE ROTOR

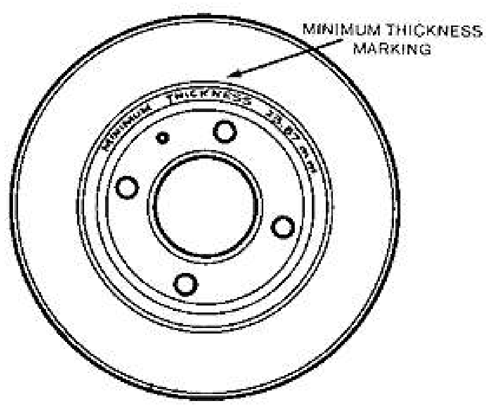
The disc brake rotor is similar to the drum on the drum brake; it serves the same purpose and has many of the same problems. The braking action of the vehicle comes from the friction of the brake pad against the rotor, and as with the brake drum, proper contact depends on the surface being free of defects.

A part of the rotor's function is to dissipate heat into the atmosphere, and the disc brake has splash shields or plates to direct the flow of air over the rotor surface, cooling the brake while the vehicle is moving. Many small vehicles have solid rotors, and larger vehicles have vented rotors with fan-like cooling fins cast between the brake surfaces.



Vented Rotor - Solid Rotor Fitted on Hub

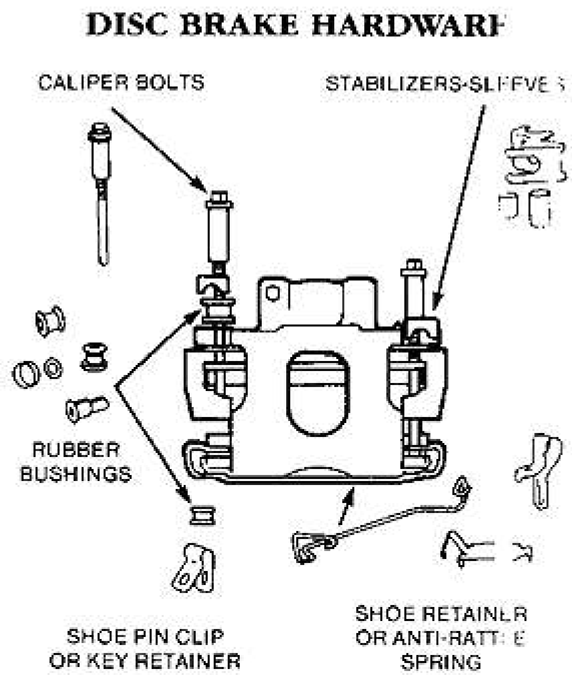
When performing a brake job, the rotor surface is usually machined to ensure a smooth, blemish-free surface. However, care should be taken that the rotor is not machined beyond the minimum thickness stamped or forged on it. Machining the rotor beyond recommended tolerances may affect the cooling capacity of the rotor and the balance of the brake system. This may also result in a loss of braking in severe cases. Some states, in fact, have a law against exceeding recommended tolerances; rotor thickness should be checked with a micrometer. If the rotor does not meet minimum thickness specifications before machining or will not meet those specifications after it is machined, it should be replaced.



Rotors are Stamped with Minimum Thickness Specifications

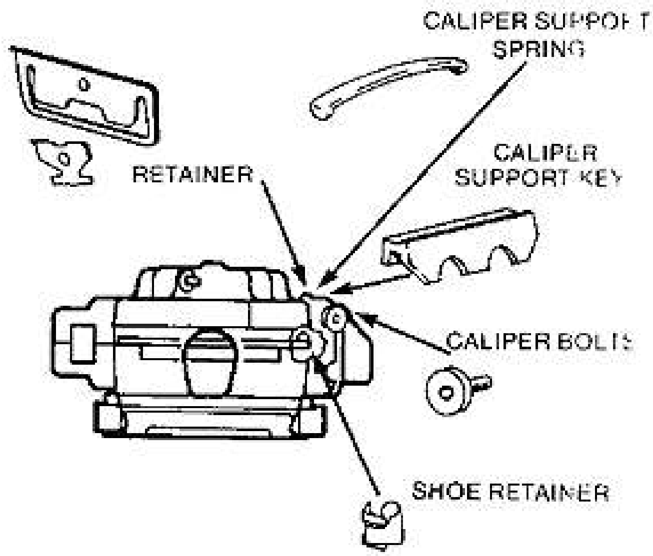
DISC BRAKE HARDWARE

Similar to the hardware on the drum brake, the hardware on the disc brake is affected by high operating temperatures, weather conditions, abrasive elements, and normal wear. Since hardware in good operating condition is important in holding the caliper in proper alignment with the rotor and getting the maximum life from disc pads, it should be replaced whenever the brakes are relined.



Typical Disc Caliper Hardware

The design of the disc brake hardware depends on whether it is used with fixed calipers, sliding, or floating calipers. In either case, however, the most common hardware includes caliper pins, bolts, insulator bushings, sleeves, anti-rattle clips, springs, and the caliper support key.



Typical Hardware Components for Sliding Calipers

Caliper Guide Bolts: Floating calipers are supported and held in alignment with the rotor surface by guide bolts that fasten it to the adapter or mounting plate. The caliper moves back and forth on the caliper guide bolts. Guide bolts should be replaced if they are bent, worn, or corroded. The bolts and bushings require a light coating of silicone lubricant to ensure complete application release of the caliper.

Insulators: Guide bolts are insulated from metal-to-metal contact by stabilizers, sleeves, and bushings. Insulators help eliminate brake noise, vibrations, and caliper bolt freeze-up caused by corrosion.

Guide Pins: Some fixed, floating, and sliding calipers use pins to hold the disc brake pads in the caliper housing. Pins are held in place by pin retainers.

Anti-Rattle Clips: Most calipers use anti-rattle clips or shoe retainer springs to prevent the inboard or outboard pads from moving. New clips secure the pads in the caliper housing to prevent vibration.

Caliper Support Key: Sliding caliper designs are held to the fixed machine adapter by a support key and spring between the caliper and adapter. The spring and key act like a wedge, holding the caliper secure. The caliper slides back and forth on the adapter when the brake is applied or released.

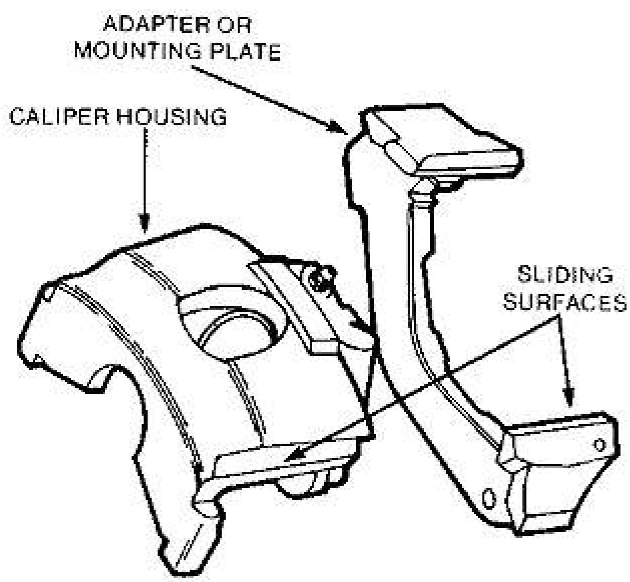
Caliper hardware in good operating condition reduces the vibration and noise when the pads are pressed against the rotor. The hardware is important to the proper operation of the disc brakes, and replacing it should be a part of the brake job. Always use a silicone lubricant when replacing or installing hardware.

Disc Brake Noise

One common complaint that people have after a disc brake job is that the brakes are noisy. A noise or squeal may be caused by the metal-to-metal friction and rotor rubbing surfaces and is amplified through the backing plate against the caliper housing. The use of pad shims will help prevent metal-to-metal contact between the metal backing plate of the disc pad and the caliper housing.

Another source of noise may be the metal ears that many brake pads have on the outboard pad. The ears should be press fitted to the caliper housing.

The floating or sliding caliper moves on guide bolts or on a machined adapter. If the sliding surfaces are rusted or corroded, they may vibrate. Clean, and lubricate to help eliminate this problem.



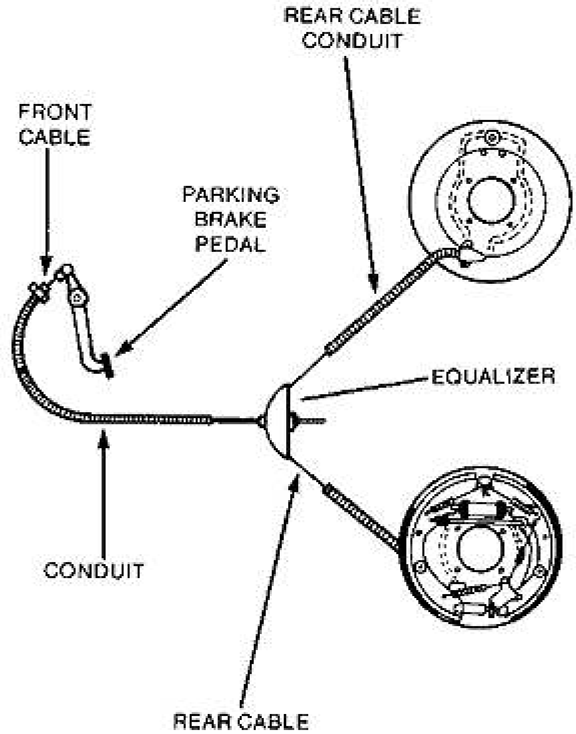
Pad wear should be equal on both sides of the vehicle and caliper. If the inboard pad is worn more than the outboard pad, the sliding surfaces or hardware may not be working properly. The recommended lubricant for these surfaces is silicone. Petroleum-based lubricants must not be used as they may damage brake system components.

PARKING BRAKE DESIGNS

In contrast with the drum or disc brake that stops the automobile when it is moving, the parking brake is designed to keep the stopped automobile from moving. Although it has been called an "emergency brake" for years, the more proper name is "parking brake."

Today's cars may have either a lever or a pedal to engage the parking brake. The lever is more commonly found on small, manual transmission automobiles, and the foot pedal on cars with automatic transmissions.

Regular use of the parking brake is necessary for proper brake adjustment on some vehicles. An example of this is certain GM cars with four-wheel disc brakes. A low pedal on these vehicles is often a result of the driver not regularly using the parking brake.



Common Parking Brake Set-up

WHEEL BEARINGS

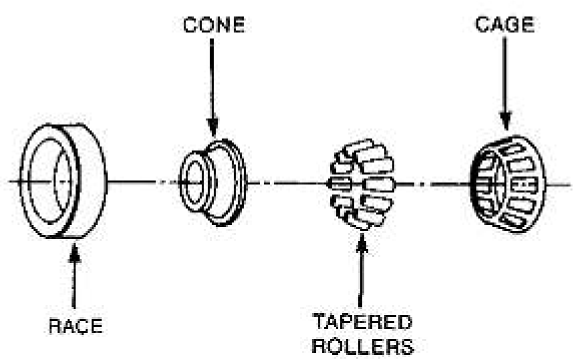
On most vehicles, the non-drive wheels are mounted on cast iron hubs. To reduce the friction between the hub and the axle, the hub usually contains one or two bearings.

There are several types of bearings used in today's automotive applications. These include roller bearings, ball bearings, and tapered bearing types. Front wheel drive vehicles will typically use some type of sealed bearing.

One of the most common bearings in automotive applications is the tapered roller bearing. It is designed to accept the radial and axial thrust loads of today's vehicles. Since bearing adjustments are critical to the service life of tapered bearings, they should be serviced regularly. Failure to service these bearings and maintain the grease seals can lead to damage to the vehicle spindle.

Improper installation can shorten the bearing¹s life, damage the hub of the vehicle, and affect braking stability.

Whenever a bearing is serviced, it is important that the original equipment torque specifications be followed. The brake system depends on proper tolerances for good operation.



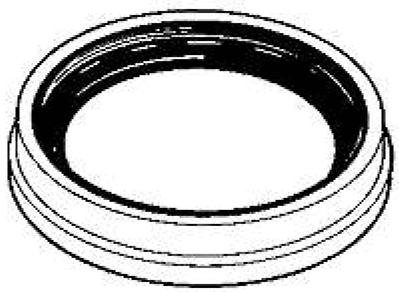
Exploded View of Typical Wheel Bearing

GREASE SEALS

One of the most important parts, and one of the most overlooked, of a complete brake job is the replacement of the wheel bearing grease seal. Whenever there is a rotating shaft, hub, or bearing, there are one or more grease seals. Their job is to retain the grease or oil for the wheel bearings. Each time the brake job is done, the seals are removed so the bearings can be serviced.

Some people think that the seal is taken care of when it has been wiped off, cleaned, inspected, or reinstalled. That practice can lead to premature bearing failure and possible spindle damage. Proper procedures call for the replacement of the seal.

When you are replacing the seal, be sure to use the proper tool. A seal installation tool places an even pressure around the seal, seating it properly. Other methods of installation may cause a seal to cock, or to distort and leak.



Grease Seal

Common Brake Problems

Symptoms	Suggestions
Vehicle has a low or spongy pedal	Air in hydraulic system Rear shoe adjustment Pushrod adjustment Master cylinder internal bypass
Vehicle will not stop after reline	Improper rotor finish Incorrect friction material Friction damaged during initial break-in (burnishing)
Squeal during application	Friction improperly installed Shims not installed Caliper hardware not replaced
Grinding metal-to-metal sound during braking	Improper rotor finish Rotor not cleaned after machining
One or more rear wheels lock up during braking	Weak brake springs Out of round/oversized brake drums Damaged backing plates Loose wheel cylinders Contaminated lining
What are proper machine specifications for specification drums and rotors	Refer to appropriate specification manual as per manufacturer, year and model. Realize that the manufacturers machine-to specification will supercede the branded discard dimension.
Severe pedal pulsation during braking	Warped the rotors during installation lack of torque specifications Rust ridge on hub face or axle flange Warped rotors excessive heat
How to adjust rear caliper pad to rotor clearance on GM calipers	Apply and release parking brake 60 times, or remove levers from calipers and use ratchet and socket to extract piston assembly to clearance of .030 - .060
Are DOT 3, 4, and 5 brake fluids compatible, and what is the difference	DOT brake fluids are compatible with each other, but will not mix DOT 3/4 are glycol based and will absorb moisture (hygroscopic) DOT 5 is silicone based and does not absorb moisture

Common Brake Problems

Symptoms	Suggestions
What procedure is used to diagnose metering, proportioning, and/or combination valve	Brake pressure gauges should be used in conjunction with a shop service manual
The vehicle pulls to one side when braking	Loose or defective steering component (tie rod, ball joint, etc.) Defective brake hose Defective caliper
Pedal is still low and spongy after master cylinder has been replaced	Isolate brake components (use pinch off method) to locate air trapped in the hydraulic system Check for excessive mechanical movement at a caliper or wheel cylinder
Pedal is high and hard when the brake pedal is applied	Low vacuum supply to booster Defective booster? Restriction in vacuum supply line Defective booster check valve Frozen/seized calipers or wheel cylinders
Red brake warning light stays on in GM P/U with rear wheel anti-lock	Check parking brake switch Check pressure differential switch Check for ABS codes and repair if necessary using appropriate service manual

Brake System Quick Reference

- Master Cylinder-- Supplies hydraulic pressure to the wheels. The types found on vehicles are single, dual, and quick take-up master cylinders.
- Disc Brake Hardware-- Keeps the caliper and pads in correct alignment with the rotor. Allows for even movement when pressure is applied and released.
- Power Booster-- Increases the pressure applied to the master cylinder primary piston. It may be actuated by vacuum or power steering pump hydraulic pressure.
- Brake Hoses-- Form flexible links between steel brake tubing and the caliper or wheel cylinder. Every vehicle uses one for each front wheel, and one or two for both rear wheels.
- Combination Valve-- Provides a housing for as many as three individual valve entities. Proportioning valve, which reduces hydraulic pressure to the rear axle. Metering valve, which holds pressure off the front axle until 115psi is reached. Pressure differential switch, monitors front axle pressure opposing the rear. Steel Brake Lines-- Connect the master cylinder to the front and rear brake hoses.
- Disc Brake-- Front or rear brake assembly consisting of a caliper, pads, rotor, and hardware Drum Brake-- Front or rear brake assembly consisting of a wheel cylinder, shoes, drum, and hardware.
- Caliper-- Hydraulic cylinder that clamps the brake pads against the rotor. It consists of four basic parts: The housing, piston, seal, and dust boot. Wheel
- Cylinder-- Hydraulic component that pushes the brake shoes into the brake drum. It consists of five basic parts: the casting, spring, cups, pistons, and dust boots.
- Brake Pads-- Consist of a rigid steel plate with friction material attached. There are different friction compounds, able to withstand different operating temperatures. The friction material is attached to the plate by integral molding, or riveting.
- Brake Shoes-- Converts motion to heat applied against the drum surface. There are different compounds to withstand different operating temperatures.
- Rotor-- Provides a surface for the disc brake pads to contact. Rotors vary in thickness and diameter to accommodate disc brake operating temperatures.
- Brake Drum-- Provides a surface for the drum brake shoes to contact. Drums vary in design to allow for various cooling rates.
- Parking Brake-- Provides a cable-actuated auxiliary brake. Generally found on the rear axle inside the disc or drum brake. Drum Brake Hardware-- Holds the brake shoes in correct alignment to backing plate, allows even application and release, and allows brake shoes to maintain correct adjustment as lining wears.
- Brake Pedal-- The pedal inside the car used to begin the hydraulic/mechanical action that slows or stops the car. Backing Plate-- Steel plate used as a mounting for brake shoes, wheel cylinders, and hardware.

Vocabulary

- **Access Slots** - Hole in the backing plates or drums that allows access to the star wheel adjusters.
- **Accumulator** - A canister attached or integral to the hydro boost unit that stores a small quantity of fluid under pressure.
- **Adapters** - Used to mount hubless drums or rotors on the arbor of a brake lathe.
- **Anchor** - A steel stud, mounted on the backing plate. The anchor keeps the brake shoes centered and from turning with the drum.
- **Arbor** - The rotating shaft of a lathe on which a drum or rotor is mounted with various adapters for machining.
- **Arc Grinding** - The machining operation by which oversized linings on brake shoes are ground to fit the drum in which they will be used.
- **Backing Plate** - A pressed steel plate upon which the wheel cylinder, anchor pin, and brake shoes mount with hardware
- **Bail** - The spring-wire that secures the cover on most master cylinder reservoirs.
- **Ball Bearing** - An anti-friction bearing that uses steel balls held between inner and outer bearing races.
- **Barrel Shape** - Excessive wear at the center of the brake drum surface.
- **Bearing** - Tapered rollers or balls in a housing. They are used to prevent friction between two moving parts.
- **Bearing Cone** - The inner race for a ball or roller bearing.
- **Bearing Cup** - The outer race for a ball or roller bearing.
- **Bearing Race** - The inner and outer ring that provides the smooth, hard contact surface for the balls or rollers in a bearing.
- before the machining. The belt dampens vibrations that affect the quality of the finished surface.
- **Bell Mouth** - A drum defect caused by excessive wear, expansion, or both at the open end of a brake drum.
- **Bellows Seal** - An expanding diaphragm used as a seal between the master cylinder reservoir and the reservoir cap. It prevents leaks and air from contacting the fluid, yet it allows the fluid to change in volume.
- **Bench Bleeding** - A method of removing air from a master cylinder prior to installation.
- **Bleeder Screw** - A valve placed on cylinders or valves in a hydraulic system where it can be opened to allow the release of air.

Bleeding - The procedure by which air is removed from a hydraulic system.

Bonded Lining - Brake lining that is attached to a brake shoe by a thermal-setting adhesive.

Boot - A flexible rubber cover used over the open ends of master cylinders, wheel cylinders, and calipers to keep out water and contaminants.

Bore - The walls of a cylinder or diameter of a cylinder.

Bosses - Raised ledges or platforms on a backing plate, which evenly support the web of brake shoes.

Brake Drum - A round cast iron or aluminum housing that rotates around fixed brake shoes and is slowed or stopped when the shoes are expanded.

Brake Fade - The loss of coefficient of friction and brake performance caused by heat.

Brake Fluid - A compressible liquid used in hydraulic disc or drum brake systems.

Brake Hose - Flexible tubing, which is mounted at points where the chassis or suspension moves.

Brake Lathe - A machine that is used to refinish the surface of a brake drum or rotor.

Brake Line - Special double wall steel tubing used to transmit pressure to the disc or drum hydraulic cylinders.

Brake Lining - A friction material that is fastened to the brake shoes.

Brake Shoe - The stamped table and web to which the brake lining is attached.

Brake Shoe Grinder - A machine used to grind the lining is on a brake shoe so that it will fit a particular drum.

Caliper - The actuating cylinder of a disc brake. A hydraulic clamp that forces brake pads into contact with a rotor.

Centering Cones - Devices used to mount floating drums or hubless rotors on the arbor of a brake drum lathe.

Check Valve - A valve in the master cylinder that maintains residual pressure.

Check Valve - A valve that allows full pressure to the drum brakes. Upon release of brakes, it holds slight line pressures of 8-15 PSI. Usually is not used in disc brake system. Exceptions are import cars.

Coefficient of Friction - A relative measurement of friction between two surfaces in contact with each other.

Combination Valve - A valve used in some combination disc/drum brake systems. It combines two or more valves in one housing. A combination valve may contain a pressure differential valve, a proportioning valve, and a metering valve.

- **Compensating Port** - A small hole in the master cylinder to the bore. The primary seal is behind it when the brakes are released, and in front of it when the brakes are applied.
- **Cup Expanders** - Conical discs or springs formed to fit inside piston cups to keep the lip of the cup in tight contact with the cylinder walls while the hydraulic system is not pressurized to prevent air or leaks.
- **Cylinder Hone** - A rotating tool that uses abrasive stones to remove minor imperfections and to polish the bores of wheel cylinders, master cylinders, and calipers.
- **Dampening Belt** - A rubber belt that is wound around the brake drum or rotor
- **Diaphragm** - A flexible rubber membrane found in the power assist unit that separates one or two chambers.
- **Disc Brake** - A brake system that utilizes a rotor that is slowed or stopped by clamping action of a caliper and brake pads.
- **Double Flare** - The expanded end of tubing that is folded back to provide a double thickness for a hydraulic tube nut.
- **Drum Brake** - A brake system that utilizes a drum, wheel cylinder, and brake shoes that expands to slow or stop the inside wall of the drum.
- **Dual Brake System** - A brake system with a tandem master cylinder that utilizes two separate hydraulic systems.
- **Dual Master Cylinder** - A hydraulic pump that has two reservoirs and two pistons, usually in tandem. The tandem or dual cylinder isolates two hydraulic systems.
- **Duo-Servo** - A drum brake with a two Piston wheel cylinder design that provides self-energizing action by the additional mechanical rotating force of the rotating drum regardless of the direction of the drum rotation.
- **Dust Covers** - Plugs made of rubber or metal that keep access holes in backing plates and drums from letting in moisture or contamination.
- **Eccentric** - An out-of-round drum defect as the result of unequal wear or drum distortion.
- **Equalizer** - A device used in parking brake systems to equalize the pull of the rear brake cables.
- **Filter Port** - A large hole connecting the master cylinder reservoir with the master cylinder bore. The filler port Permits fluid to flow from the bore or reservoir.
- **Fixed Anchor** - A non-adjustable anchor pin, riveted, welded, or bolted to the backing plate.
- **Floating Caliper** - A single-piston caliper positioned by pins or bolts and mounted on an adapter.

- **Floating Drum** - A hubless brake drum that mounts on an axle flange.
- **Flushing** - A method of cleaning a hydraulic system by bleeding brake fluid through the system.
- **Force** - A push or pushing effort measured in pounds per square inch (PSI).
- **Friction** - The resistance to motion between two surfaces in contact with each other.
- **Gravity Bleeding** - A method of bleeding air from a hydraulic system by allowing the fluid to force air out of an open bleeder screw by its own weight.
- **Hard Spots** - Scattered raised areas on the friction surface of a brake drum. Hard spots are caused by excessive heat and pressure, which change the molecular structure of the cast iron.
- **Heat Dissipation** - The transfer of heat. In brake systems the heat produced by braking is transferred to the atmosphere.
- **Heel** - The end of the brake shoe that touches the drum after the toe.
- **Herringbone Pattern** - The characteristic pattern cut by a tool bit when a brake drum or rotor is machined without a dampening belt.
- **High Pedal** - The condition in which the brake pedal moves only a slight amount.
- **Hold-Down** - A spring, nail, and cup assembly that holds a brake shoe against a backing plate.
- **Hub** - The center part of a wheel and housing for the bearing upon which the wheel rotates around the spindle or drive shaft.
- **Hub Drum or Rotor** - A brake drum or rotor that has a hub, which mounts on a spindle.
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- **Hubless Adapter** - Used to center hubless drums and rotors on the arbor of a brake lathe.
- **Hydraulic** - Non-compressible fluid to transmit force to mechanical motion.
- **Hydraulic Brakes** - Disc or drum brakes that are actuated by hydraulic pressure.
- **Hygroscopic** - Absorbs water from the atmosphere
- **International Standards Flare (ISO)** - A bubble flare used with a metric tube nut and no seat insert.
- **Kinetic Energy** - The energy of motion.
- **Link** - The rod between the wheel cylinder piston and the brake shoe.
- **Low Pedal** - The condition in which the brake pedal must travel before the brakes are applied.

- **Lubricant** - Any material, usually liquid or semi-liquid, that reduces friction when placed between two moving parts. Brake system rubber parts are only compatible with silicone grease.
- **Manual Bleeding** - A method of purging air from a hydraulic system by two people, one manually operating the brake pedal and the other opening the bleeder screws.
- **Master Cylinder** - The part of the brake system that converts the brake pedal force of the driver to hydraulic pressure.
- **Mechanical Brakes** - A brake system that is actuated mechanically by cables, rods, levers, and cams.
- **Metering Valve** - A valve used in some disc/drum brake systems that shut off the hydraulic pressure to the front calipers during light pedal applications. It acts to delay the operation of the front brakes until the rear brakes have started to apply.
- **Out-of Round** - A drum defect in which the friction surface is no longer round, but is warped into an oval or elliptical shape.
- **Pad** - A common term for a brake friction material for disc brakes.
- **Parallelism** - The parallel misalignment of the two surfaces of a brake rotor.
- **Parking Brake** - A mechanical brake system used to keep a parked car from moving. It is separate from the service brakes.
- **Pascal's Law** - The basic law of hydraulics. "When pressure is exerted on a confined liquid, the pressure is transmitted equally and in all directions."
- **Piston** - A moveable cylinder that fits in a bore.
- **Piston Cup** - A rubber disc shaped part that seals a wheel or master cylinder and eliminates leakage between the piston and the bore walls.
- **Piston Stops** - Tabs or protrusions on a backing plate positioned to prevent the wheel cylinder pistons from leaving the wheel cylinder when the shoes are removed.
- **Pits** - The holes or roughness left on a bore surface as a result of rust or corrosion.
- **Play** - Actual distance between parts measured in movement.
- **Power Brakes** - A power booster that utilizes vacuum or hydraulic pressure to boost the braking effort of the driver.
- **Pressure** - Force applied to a definite area, measure in pounds per square inch (PSI).
- **Pressure Bleeder** - A tank of pressurized brake fluid separated by a diaphragm. It is used to circulate clean brake fluid and bleed the brake system.
- **Pressure Bleeding** - Purge air from a hydraulic system by forcing fluid through the brake system.

- **Pressure Differential Valve** - A valve used in dual brake systems to detect any difference in pressure between the two systems and electrically connected to the brake warning light.
- **Primary Brake Shoe** - The self-energizing brake shoe that is pulled away from the anchor by the rotation of the drum. It is the shoe toward the front of the vehicle
- **Proportioning Valve** - A valve that regulates pressure to the rear brakes in proportion to pedal force, and minimizes the possibility of rear wheel lock during panic stops.
- **Pull** - The tendency of a car to steer or lead to one side when the brakes are applied.
- **Push Rod** - The rod that transmits movement between the brake pedal and the master cylinder piston.
- **Reservoir** - A storage area for brake fluid for the master cylinder.
- **Residual Pressure** - Slight pressure that remains in the hydraulic system after the brake pedal is released.
- **Retaining spring** - A spring used to connect the brake shoes together at the star-wheel adjuster.
- **Retracting spring** - A spring used to return the brake shoes to the fully released position.
- **Roller Bearing** - A bearing that uses a series of steel rollers held between inner and outer bearing races.
- **Rotor** - A cast iron disc that is attached to a wheel hub to provide a friction surface for the brake pads.
- **Rotor & Drum Lathe** - A machine used to refinish the surfaces of a brake rotor.
- **Run-out** - A rotating object exhibits side-to-side movement during rotation.
- **Score** - Scratches or grooves commonly found on the friction surface of drums and rotor.
- **Sealed Bearing** - A bearing that has been lubricated and sealed at the time of manufactures and requires no periodic maintenance.
- **Secondary Brake Shoe** - In self-energizing brakes, the brake shoe that is pushed into contact with an anchor by the rotation of the drum. The shoe toward the rear of the car.
- **Self-Adjusting Brake** - A drum brake that automatically maintains the correct lining-to-drum clearance.
- **Self-Energizing Brake** - A brake design in which the brake shoes utilize the rotational force of the drum and hydraulic pressure to stop the drum.
- **Servo Action** - A braking action in which one shoe serves the application force of the other.

Sliding Caliper - A single piston caliper that is positioned by machine surfaces on the anchor plate or adapter.

Snap-Ring - A split ring that is held in a groove by its own tension.

Soft Pedal -The soft, springy feeling detected when the brake pedal is depressed.

Spindle - That part of the front or rear suspension used to support brake drums or rotors by means of wheel bearings.

Splash Shield - A deflector used to protect a disc brake rotor from road splash.

Star-wheel Adjuster - A threaded screw used to actuate the brake shoe linings to the drum.

Taper - The thickness of the drum or rotor at the outer edge differs from its thickness at the inner edge.

Tapered Roller Bearing - A bearing that uses a series of tapered steel rollers held between inner and outer races.

Toe - The end of a brake shoe that contacts the drum first.

Vacuum - A pressure less than atmospheric pressure.

Vented Rotor - A disc brake rotor with cooling fins cast between its friction surfaces.

Wheel Cylinder - The output cylinder in a drum brake system.