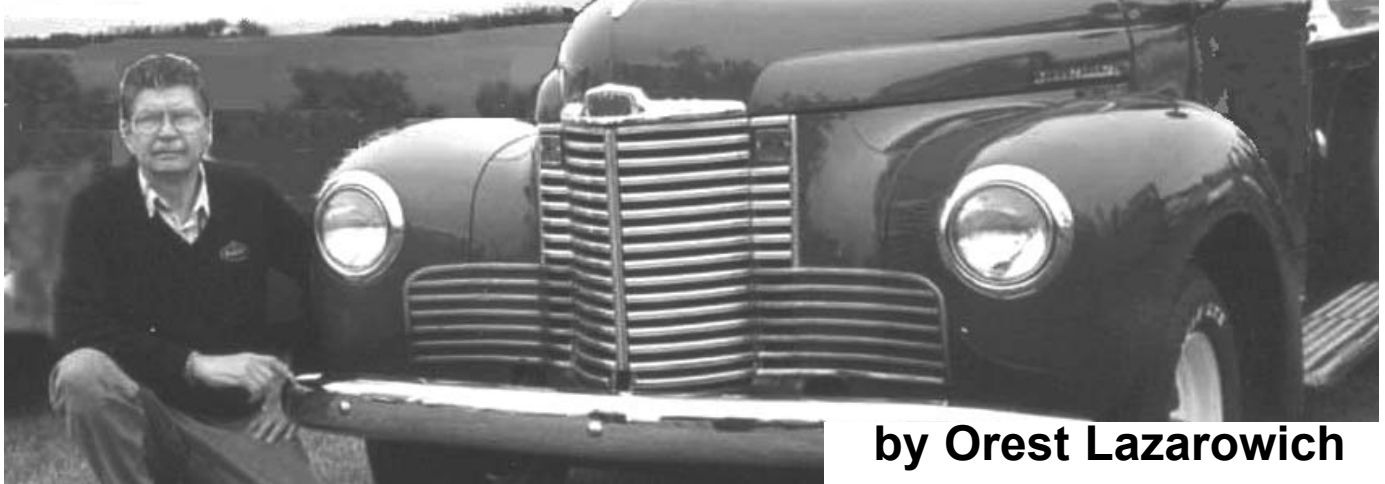


# The Modern Collectible



by Orest Lazarowich

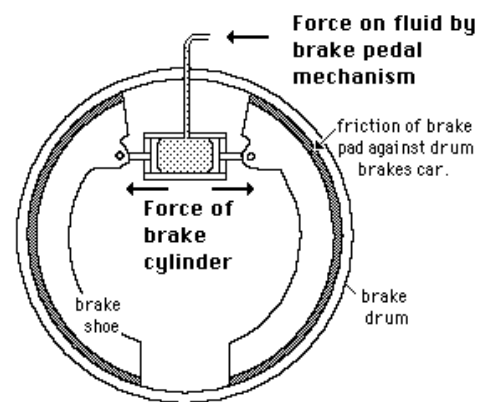
*A DETAILED TECHNICAL COLUMN INTENDED TO TARGET MANY MAKES AND MODELS OF POST-WAR CARS AND PICK-UP TRUCKS*

## The Brake System, Part 3 Dual Brake System and Calipers

On the theory that two independent brake systems on the same vehicle are not likely to fail at the same time, car manufacturers have been installing dual brake systems on their vehicles since the mid 1960s. In the diagonally split system used on smaller vehicles, the left front and the right rear brakes, and the right front and left rear brakes, are coupled. With this system, if one part fails, there will always be braking at the front and at the rear. The front suspension is designed to lessen the car's tendency to swerve toward the working front brake, in the event that either half of the brake system fails. In front-to-rear split systems, the front and rear brakes are paired with each other.

The hydraulic brake system works on the principle that pressure on a liquid in a closed

system is equal throughout the system. When the driver pushes the brake pedal, a piston or pistons in the master cylinder move the brake fluid through metal lines and apply equal force at all the wheel cylinders. The pressure of the brake fluid causes the pistons in the wheel cylinders to be forced outward pressing the linings against the discs or drums. In the older braking system, the



master cylinder has only one piston since the mid-1960s. The dual braking system has a master cylinder with two pistons,

a pressure-differential valve assembly, and a dash warning light switch. One part of the dual master cylinder operates the front wheel brakes, and the other operates the rear wheel brakes. Failure of one system does not impair the opera-

tion of the other. The brake warning light signals a failure of either the front or rear brakes.

When a failure is encountered on either system, the other will stop the vehicle. If one system is not operating properly, it is normal for the brake pedal lash and brake pedal effort to increase. This occurs because of the design of the master cylinder. When the rear system loses fluid, its piston will bottom against the front piston. When the front system loses fluid, its piston will bottom on the end of the main cylinder body. The pressure differential in one of the systems causes an uneven hydraulic pressure balance between the front and rear systems. The pressure differential switch detects the loss of pressure and illuminates the brake alarm indicator light on the instrument panel. The pressure loss is felt at the brake pedal by an apparent lack of brakes for most of the brake travel and then, when the failed chamber is bottomed, the pedal will harden. These symptoms indicate that one of the systems contains air or has failed, and it will be necessary to bleed or repair the brakes

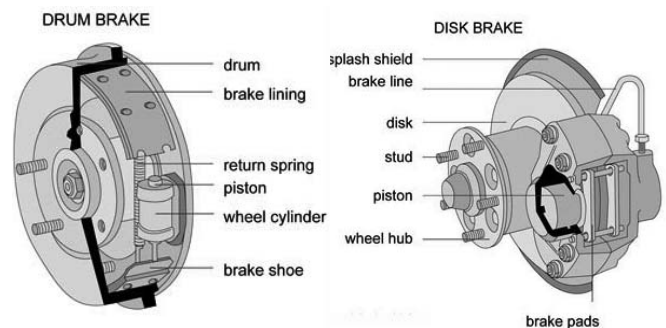
### Dual Master Cylinder Operation

When the brake pedal is depressed, the two pistons in the master cylinder move in tandem. Each piston pressurizes its own half of the split hydraulic braking system and applies braking power to two of the car's wheels. The brake-fluid pressure must first pass through a pressure differential valve. This valve turns on a red light on the instrument panel if either the rear or the front brakes fail. A metering valve is used on disc brake systems and allows the rear brakes to be applied before the front ones. If the front wheels are engaged first, the car could be thrown into a skid. A proportioning valve is used on the front-to-rear split brake systems. It restricts the hydraulic pressure to the rear brakes so that the rear wheels will not lock during a panic stop and cause a skid. In many cars the warning-light valve, the metering valve, and the proportioning valve are combined in a single unit.

The frictional drag of the brake shoes against the brake drums tends to prevent the wheels from rotating, stopping the vehicle. The front wheel drum brakes usually have larger frictional areas than the rear wheel brakes, and the wheel cylinders are larger. This is to take advantage of the transfer of weight to the front wheels

from the rear wheels when the brakes are applied. This article will cover vehicles that use disc brakes at the front wheels to place the most braking power and fade resistance up front where the traction is greatest during a hard stop because of the shift of vehicle weight forward.

The disc brake has a metal disc instead of a drum and two flat brake shoes (pads) located on each side of the disc. A caliper holds the brake shoes in place and houses the wheel cylinders. Early designs use a fixed-caliper brake with two or four hydraulic cylinders per wheel. In newer vehicles a sliding-caliper brake with a single cylinder is used because it is cheaper to manufacturer. When the brakes are applied, the brake fluid flows to the cylinder in the caliper and pushes the piston out. The piston then forces the inner shoe against the disc and the opposing force pulls the caliper over to apply the shoe on the other side. The friction between the shoes and the disc slows and stops the disc, providing the braking action. Vehicles with disc brakes have larger master cylinder reservoirs for the disc brake side (rear). A proportioning valve located in the hydraulic system between the master cylinder and the rear brake wheel cylinders, meters the hydraulic pressure to provide a balance between the front and rear braking system. The valve prevents premature lockup of the front wheels when the brakes are applied. This valve cannot be adjusted or serviced; if defective, it must be replaced.



### Power Brakes

For hard braking and fast stops, considerable pressure must be exerted on the brake pedal. Also, the heavier the vehicle, the greater the braking effort required. A vacuum-assisted braking system has been developed. When the brake pedal is moved to apply the brakes, a valv-

ing arrangement is actuated. The valves admit atmospheric pressure on one side of a diaphragm and apply vacuum to the other side. The diaphragm then moves toward the vacuum side. This movement supplies most of the hydraulic pressure, through the brake fluid, to the wheel cylinders, thereby increasing the total force being applied, which in turn increases the braking action. In case of vacuum failure, the brakes can still be applied, but since there is no power assist more brake-pedal pressure is required.

## Brake Failure

The hydraulic brake system is quite reliable. However, any leak in the system can result in a complete loss of the vehicle's braking ability. Brake failure can be a killer. This is the main reason for the dual brake system. It is not likely that both systems would fail at the same time. If you notice that the brake pedal goes to the floor boards gradually, it may be the result of normal wear of the brake linings. It can be corrected by minor adjustment unless the brake linings are worn out, and should be replaced. A springy or spongy brake pedal can be a sign that the brake shoes need adjusting or that there is air in the hydraulic system. Check the brake shoe adjustment and make the necessary corrections. If pedal action is still soft, bleed the brake system.

If the warning light comes on when braking with a dual brake system, one or two of the braking sections has failed. If you can stop the vehicle by depressing the brake pedal, then only one of the brake sections has failed. Front wheel brake loss increases the stopping distance noticeably while rear wheel brake loss does not affect it as much. You can safely drive the vehicle home or to a service shop. If the brake pedal goes down to the floor boards when it is depressed and the vehicle does not stop rolling, even when the brake pedal is pumped, you have a problem. Do not attempt any road side repair. Phone for a tow truck and bring the vehicle home.

## Troubleshooting

Raise the hood and wipe the top of the master cylinder cover clean. Remove the master cylinder cover and the rubber diaphragm. If there is brake fluid in the master cylinder, it is possible that there is air in the system or the master cylinder

is worn. A defective master cylinder will draw air into the hydraulic system. Make sure the filler vent is not plugged. Pump the brake pedal a number of times to see if you can build up some hard pedal. If the pedal is soft or spongy, there is air in the system. Bleed the brakes. If the brake pedal offers no resistance, the master cylinder should be repaired or replaced. If there is no brake fluid in either cylinder, check for leaks at the wheel cylinders, brake lines and fittings.

## Dual Master Cylinder Service

Starting with the 1978 model year, some GM and Chrysler Corp vehicles use a two-piece aluminum master cylinder/molded plastic fluid reservoir assembly. If the master cylinder bore is corroded, do not hone it. Replace the entire assembly. One-piece master cylinders may differ in external design but are serviced in essentially the same manner. Follow the service manual. Cover the fenders with fender covers or any rubber backed matting. Wipe the master cylinder and lines clean with a soft cloth. Place a dry cloth under the master cylinder to absorb any brake fluid leakage. Disconnect the hydraulic lines at the master cylinder, and cover the line ends with a plastic golf tee or plastic cap. Disconnect the push rod from the brake pedal if the master cylinder is not mounted to the power brake unit. Unbolt and remove the master cylinder from the firewall or power brake unit. Remove the master cylinder brake cover and discard the brake fluid. Pump out any remaining fluid.

## Disassembly

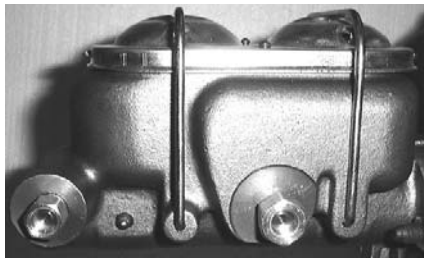
Before you disassemble the master cylinder visit your parts source and make certain a rebuild kit is available. If a rebuild kit is not available, consider a new or an exchange rebuilt master cylinder. You should disassemble the old master cylinder to examine the cylinder bore, pistons and seals for corrosion and wear. Make certain that the master cylinder is the problem. Clamp the master cylinder in a soft-jaw vise. Remove the secondary piston stop bolt from beneath the front fluid reservoir. Unclip the lock ring at the front of the bore, and



**Be certain that a rebuilding kit is available.**

remove the primary piston assembly. Hold a cloth over the bore opening, and remove the secondary piston, piston spring, and retainer by blowing compressed air through the stop bolt hole. If no air is available, hook the secondary piston with a piece of wire bent to make a hook, and pull the piston out. Check the bore and pistons for wear and damage. If the bore is pitted or corroded, you can clean up the pits with a brake cylinder hone.

Stop. Use good judgment. You can only remove very light pit marks. If you remove too much material, there is no oversize repair kit. If you do not have a brake cylinder hone, it is too expensive to have this done at a brake shop and they may not be willing to do it due to liability factors. Buy a new or rebuilt master cylinder. Do not gamble with your safety.



*Buying a new or factory-rebuilt master cylinder might be easier.*

### Installing a Replacement Master Cylinder

Clamp the master cylinder in a soft-jaw vise. Bleed the master cylinder to remove all of the air between the front and rear pistons. Make up two short bleeding tubes, and attach them to the master cylinder outlets. Direct the ends of the tubes into the reservoirs. Fill the reservoirs with DOT 4 brake fluid. The ends of the bleeding tubes must be below the surface of the brake fluid. Use a wooden dowel or round punch to slowly depress the pistons and force the air out of the master cylinder. Bubbles will appear in the brake fluid. Allow the pistons to return under the pressure of the springs. Repeat this procedure until there are no more bubbles as you depress the pistons. Maintain the brake fluid level while bleeding the air out. Remove the bleed tubes, and plug the ports with plastic caps. Install the diaphragm and the cover to prevent brake fluid contamination.



Place the master cylinder in position on the firewall or the power brake unit. Start the nuts on the mounting studs, but do not tighten securely. Lay a dry cloth under the master cylinder and start one of the brakeline fittings by hand. Tighten snug with a flare wrench. Start the other brake line fitting. Tighten snug. Tighten the master cylinder mounting nuts. Have a buddy depress the brake pedal gently to force the remaining air out of the master cylinder. Bleed the master cylinder by using the bleeder valves or by loosening the fittings at the master cylinder. Tighten the connection before releasing the brake pedal. Catch the brake fluid with a cloth. Start at the line nearest the firewall. Wipe up any brake fluid because it will act as a paint remover. There should be hard brake pedal on the first application of the brake pedal. If you have to pump the brake pedal to get hard pedal, bleed the brakes.

### Calipers

There are three general types of disc brakes: floating caliper, sliding caliper, and fixed caliper. The caliper is that part that holds the brake pads on each side of the disc. In the floating caliper brake, two steel guide pins are threaded into the steering knuckle adapter. The caliper floats on four rubber bushings which fit on the inner and outer ends of the guide pins. The rubber bushings allow the caliper to swing in or out slightly when the brakes are applied. When the brakes are applied, the brake fluid flows to the cylinder in the caliper and pushes the piston out.



The piston then forces the pad against the disc. At the same time, the pressure in the cylinder causes the caliper to pivot inward. This movement brings the other

pad into tight contact with the disc, and the braking action is produced. The sliding caliper brake is similar to the floating caliper brake. The difference is that the sliding caliper is suspended from rubber bushings on bolts. This arrangement permits the caliper to slide on the bolts when the brakes are applied.

The fixed caliper brake works in the same way as the floating caliper brake. The only difference is that the fixed caliper brake has four pistons, two on each side of the disc. In this brake the caliper is firmly attached and cannot swing. In operation, the pistons on both sides of the disc push the brake pads against the disc. Budd, Bendix, Delco-Moraine and Kelsey-Hayes all manufacture this type of disc brake assembly. The following is a general overhaul procedure. Read and follow the service manual for your particular make.

## Replacing Front Disc Brake Calipers

Raise the front of the vehicle on safety stands and block the rear wheels. Remove the wheels and tires. Work on only one wheel at a time. Loosen the hydraulic flex line using a flare wrench. Remove the caliper mounting bolts and shims if used. Slide the caliper unit from the disc. Turn the caliper to unscrew it from the flex hose. Plug the end with a plastic golf tee. Check the hose, and if it is cracked, brittle, swollen or spongy, replace it. There should be a copper washer between the caliper and the flex hose. Replace this washer every time. Remove the brake pads, and mark them for reinstallation unless they need replacing. Open the bleed screw, and drain the brake fluid out of the caliper. Blow the outside of the caliper clean with air or pressure wash with water. Remove the bleed screw. Remove the bridge bolts. Remove the pistons and springs. Clean all metal parts with brake cleaner and blow dry with clean, dry air.

Inspect the cylinder bores for scoring, pitting and corrosion. The same technique that is used on wheel cylinders applies here as well. If the bore is very pitted or corroded, the caliper must be replaced. Very light pits can be removed. Use a brake hone with very fine stones. Wash clean with brake cleaner. Inspect the condition of the pistons. The outside of the piston is the primary sealing surface in the caliper. If the surface plating is worn through or if the piston is scored or corroded, replace the pistons. Use a feeler gauge to check piston clearance in the bore. If the clearance exceeds 0.006 inch, replace the caliper. If the piston is okay, clean the groove using an old toothbrush. My own preference is to replace the caliper when there is any sign of brake fluid leakage or any damage to the dust seal which would allow road dirt to enter the bore.

On assembly, lubricate the rubber parts with clean brake fluid or the special lubricant that is usually provided in the overhaul kit. Install the seals and the boots properly. Coat the piston seal with the special lubricant provided, and place into the groove in the cylinder. Lubricate the bore and make sure the seal is seated. Coat the new boot with the special lubricant, and slide the boot over the piston. Make certain the cylinder bore and piston are coated with clean brake fluid, and place the piston in the bore and slide it inward. You can use a C-clamp to hold the piston down while the edge of the boot is fitted into place in the caliper boot groove. Use the end of a rounded dowel. Do not puncture the boot with a screwdriver. Follow the service manual instructions step by step. Do not try any short cuts.



Reconnect the caliper to the brake line. Place the caliper over the rotor, and slide it down until you can fit the caliper mounting bolts. Avoid twisting the brake hose. The grooves in the brake hose should be straight. If they are not, the hose is twisted. Check torque on the mounting bolts. If you are replacing the brake pads, remove some brake fluid from the master cylinder, and bleed the brakes. There will be no pedal on the first brake application because you have to fill the cylinder bore with brake fluid. Do not run the master cylinder dry. Make sure the brake pads are in full contact with the disc. If the pads are not parallel with the disc surface, check your work. Did you leave out some shims? Service the other side. Install the front wheels, and tighten the wheel nuts finger tight. Lower the vehicle to the ground, and tighten the wheel nuts in a criss-cross pattern. Check with a torque wrench. Replace the hub caps. Make sure there is a firm brake pedal before moving the vehicle. S.K.

*For a review on how to bleed and adjust brakes, we suggest that you reread the August 2007 'The Modern Collectible' in Skinned Knuckles.*

**Coming Next Month:  
Steering and Suspension**

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