PLAINTIFF'S EXHIBIT

MAR-330

SCI

COURSE A-1

PASSENGER CAR BRAKES

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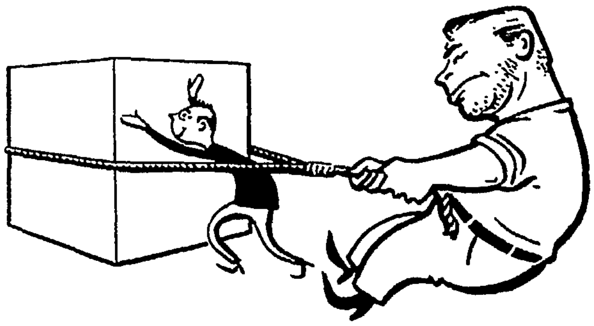
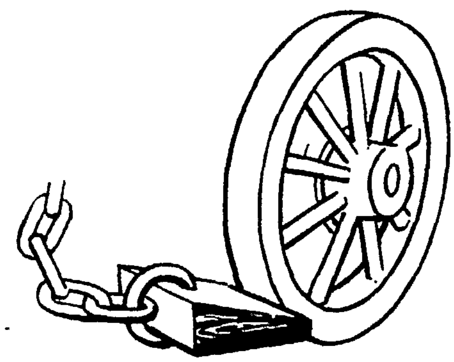
CHAPTER 1 FUNDAMENTALS OF OPERATION

Factors Involved in Brake Application

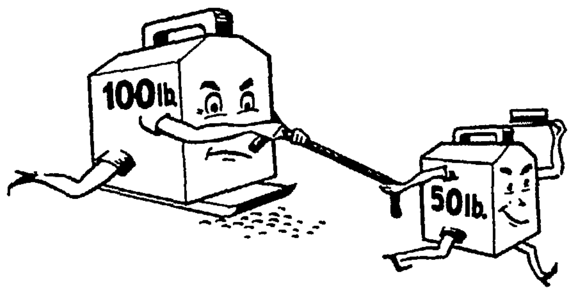


A. Friction

Friction is that force which acts upon a surface of two bodies to keep them from sliding upon each other. As a result of friction you are able to walk. The friction between your feet and the floor allows you to step forward. Without friction, brakes would never stop an automobile.

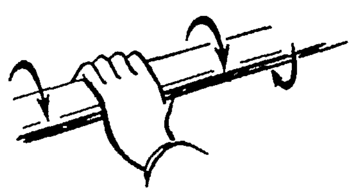


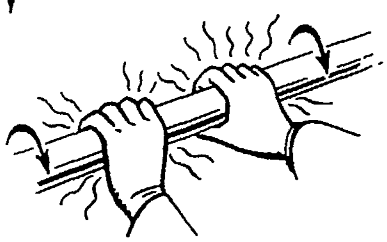
When a force is applied to slow up or stop an object that is in motion, it is known in the automotive field as "braking action". There are three factors governing the amount of friction developed in braking action; and a fourth factor which is the result of friction.



B. Pressure

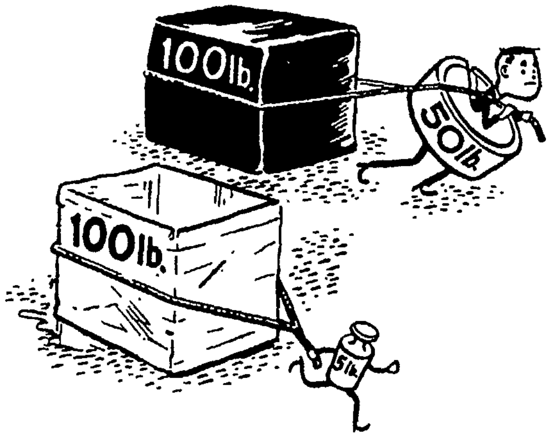
The first factor is pressure. When pressure is applied to two frictional surfaces, it will cause the surfaces to grip each other harder and resist any movement between them.





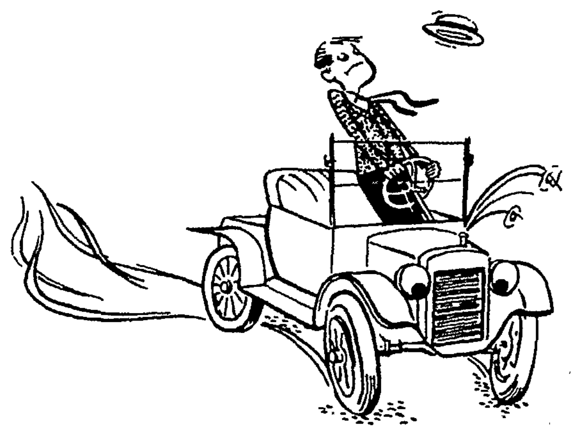
C. Frictional Contact Surface

The second factor is the amount of frictional surface in contact. Two hands will stop a revolving shaft faster than one hand; just the same as 10 square inches of brake surface is more effective than 5 square inches.



D. Coefficient of Friction

The third factor is the quality of material used in making up the frictional surface. Some materials require more force to move them over a surface than others, even though the applied pressure is the same. This means that different materials have different frictional characteristics. This is known as the "coefficient of friction". Mathematically it would work out this way: The force required to slide an object over a surface, divided by the weight of the object gives an answer known as the "coefficient of friction".



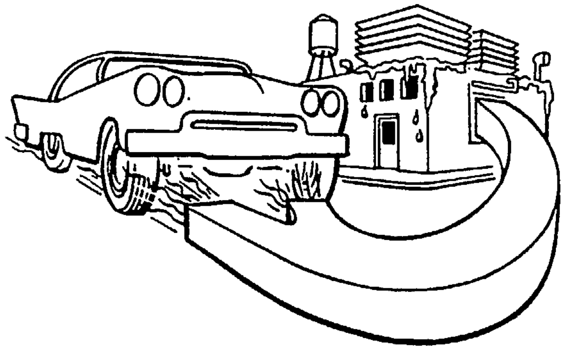
If the "coefficient of friction" is too high, brakes may grab and cause the wheels to slide. If the "coefficient of friction" is too low, excessive pressure on the brake pedal is required to stop the car.

E. Heat

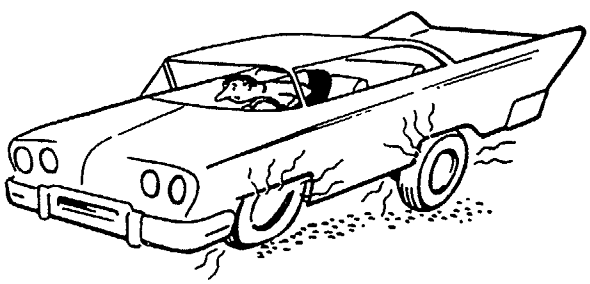
The fourth factor which is a result of friction, is heat. Brakes used in an automobile change horsepower into heat in order to stop the car. Friction caused by motion and the heat produced results in wear at the contact surfaces. Heat is expressed in terms of units of heat, or a British Thermo Unit (B.T.U.).

1 B.T.U. = the heat required to raise 1 lb. of water 1°F.

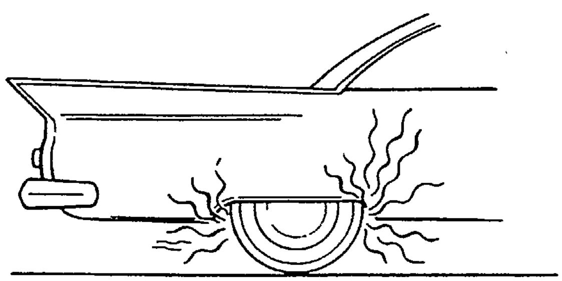
When brakes are applied to any car; the speed and the weight of the car determine the amount of power to be converted into heat. For example: a 100 horsepower engine may accelerate a 3500 lb. car up to 60 MPH in a distance of 750 feet. The question is — how fast can this same car be stopped? The brakes may be able to stop it in 150 feet which means that they would have to be 5 times more powerful than the engine.



To fully understand the fundamentals of brake operation we must keep in mind that to dissipate the heat that develops in a brake system, while stopping a car at 60 MPH, would require an 18 ton refrigeration plant to keep the brakes cool. Another way to explain it would be that the amount of heat generated by the brakes of an average car driven around the city each day would heat an average house for 24 hours on a cold winter's day.

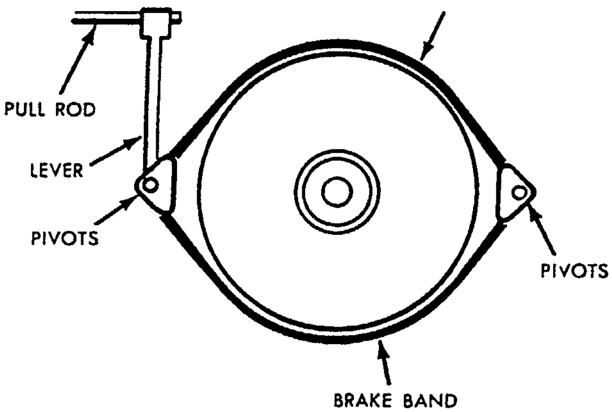


Under severe brake applications, most of the heat passes through the brake drum where it is cooled by the air circulation of the moving car. The heat developed between the brake lining and the drum may reach the melting point of some of the softer metals.



As the weight and the speed of the modern car is increased, requiring more braking action to stop them, it presents a problem in service to make sure that the cooling efficiency of the brake system is being maintained. On some of these cars the brake drums are enclosed due to the shape of the wheel disc, and required fins on the drum and wheel to deflect the air to the drum while the car is in motion. Since friction and heat are the causes of wear, it is extremely important that these cooling fins be cleaned whenever the brake system is worked upon.

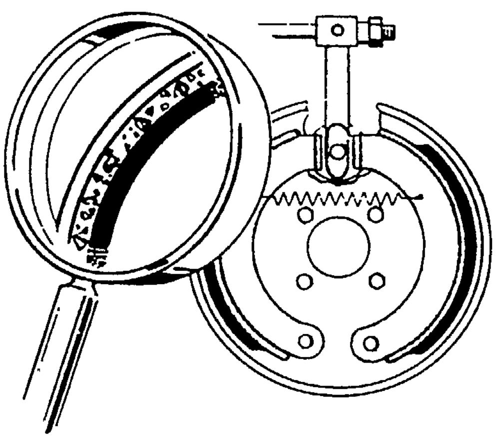
2-2 Brake Application Types



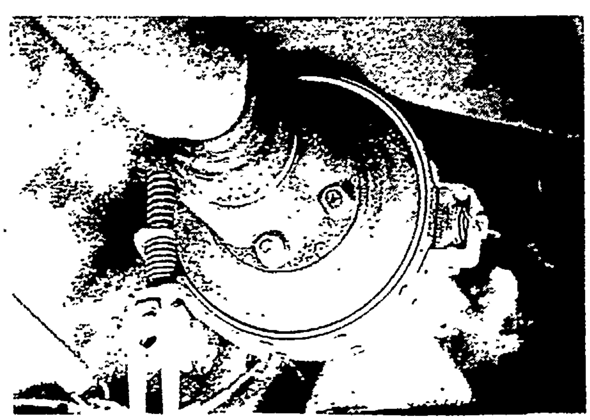
A. External Contracting

One of the first brakes put into use incorporated a flexible steel band wrapped around a steel drum. Each end of the band was connected through pivots to a brake operating lever. Moving the lever would tighten the band on the drum causing friction which would stop the drum from rotating. This type of brake was very inefficient, as the wear was rapid.

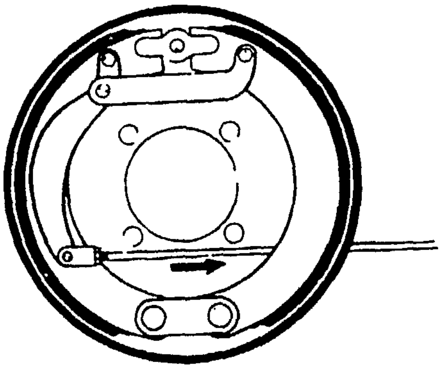
Brake lining materials such as wood blocks or woven material riveted to the inside of the brake band were used. Riveting the brake lining to the inside of the brake band increased the efficiency of the brake. As a result, the external contracting brake has been used for many years in automotive brakes; first on the propeller shaft, and then as a rear wheel brake.



The linings and drums were exposed to road dirt, grit and sand causing rapid wear. And, as car speeds and weights increased, the brake was subjected to greater braking loads. This also resulted in rapid lining and brake drum wear.



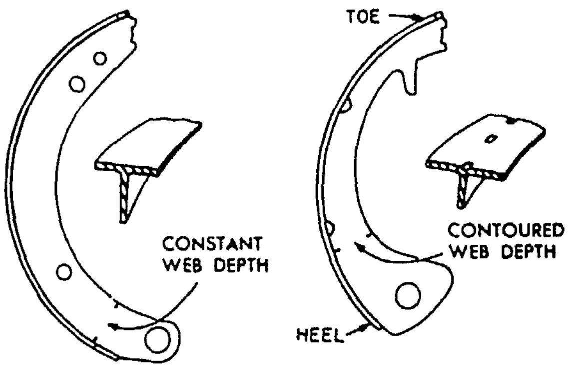
The external contracting type brake due to its limitations is now used almost exclusively as a propeller shaft type of parking brake.



B. Internal Expanding

The early models of the internal expanding type brake made it possible to apply a greater braking effort to the wheels in an emergency. As cars became more powerful with increased car speeds, two wheel brakes became inadequate. As a result, brakes were placed at all four wheels. The first four wheel brake was used in 1923 and was quickly adopted by the entire automobile industry as the "Four Wheel Brake System."

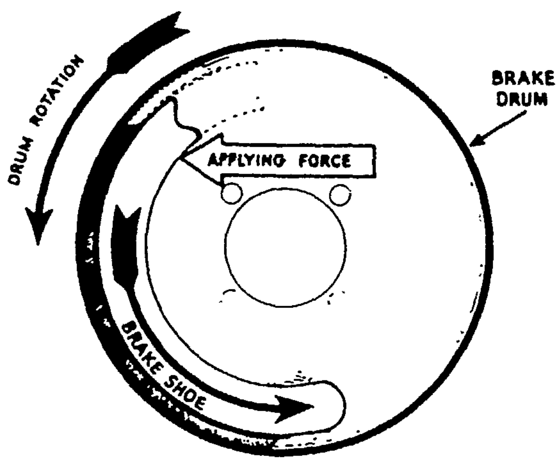
2-3 Fundamentals of Brake Shoe Operation



CONVENTIONAL BRAKE　　TOTAL CONTACT HEEL

A. General

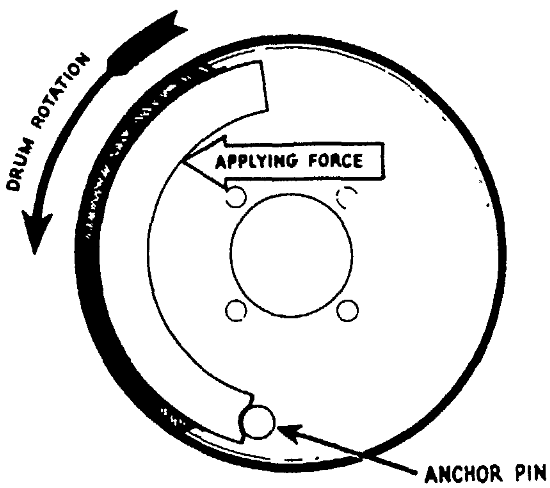
Brake shoes are the part of the brake mechanism that supports the brake lining. The lining is either riveted or "bonded" to the face or table of the shoe. The face is formed to the contour of the drum and is strengthened by the web of the shoe. The web of the shoe at the "toe" end is shaped to fit the unit that applies the braking force. The web at the "heel" of the shoe incorporates the eye of the shoe for anchored brakes.



B. Applied Force Action

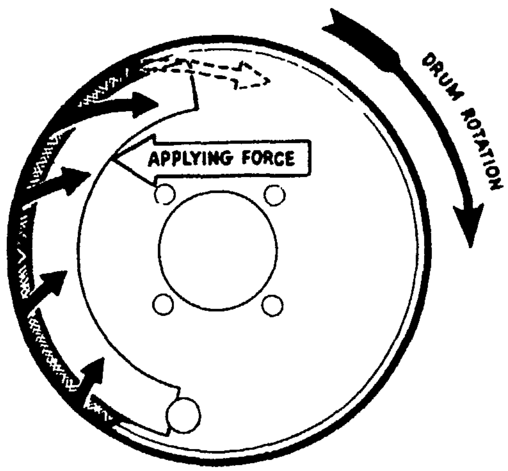
The action of the brake shoe in relation to the drum rotation is governed by forces other than just the applied force. For example: A brake shoe that is free to move within the brake drum when brought into contact with the drum would start to move with the drum unless it were held in some manner. There would be no braking action as there would be no resistance to cause friction. The brake shoe has to be held to keep it from turning with the rotation of the brake drum.

C. Self-Energized Action



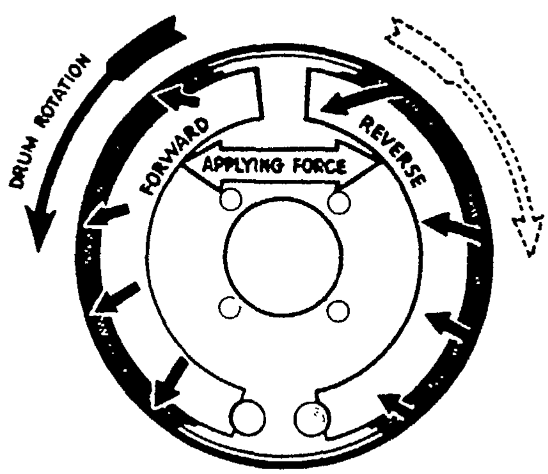
Adding an anchor pin to the brake backing plate will keep the shoe from turning with the drum and develop friction between the lining and the drum as the brakes are applied. The frictional force tries to turn the shoe around the anchor pin. However, the result is that the shoe is pulled tighter against the drum with a force greater than the applied force that first moved the shoe against the drum. Therefore, the total force pushing the shoe against the drum is:

1) The applied force plus, 2) the frictional force which caused the "self-energizing action" of the brake shoe.

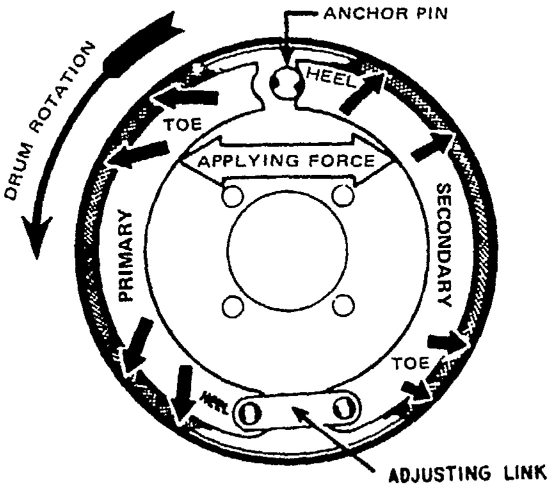


If the rotation of the drum were reversed, the action of the shoe would also reverse. The reverse action of the shoe would require more applied force to equal the braking effort of a self-energized shoe.

D. Forward and Reverse Acting Shoes



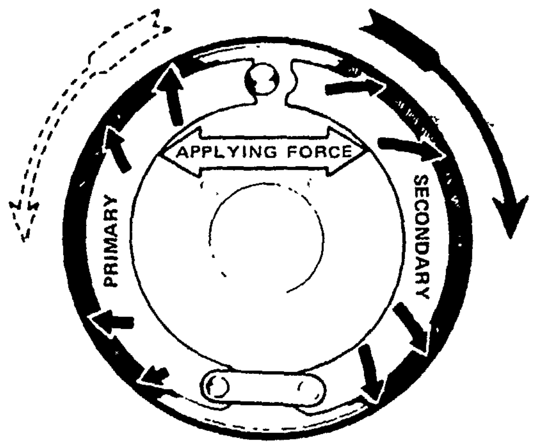
A two shoe, two anchor pin brake as shown, illustrates the action of the brake shoes when the brakes are applied. The shoe that is self-energizing during forward action is known as the forward acting shoe. The forward acting shoe will exert a heavier braking force on the brake drum than the shoe that is de-energized by the rotation of the drum. The second shoe is known as the reverse acting shoe. If the direction of rotation of the drum is reversed, the reverse acting shoe will exert a greater force on the drum than the forward acting shoe. A brake of this type has equal braking action in either direction of drum rotation.



E. Primary and Secondary Shoe Action

When two shoes are adjusted by an adjusting line as shown (with some type of an anchor pin at the top) the applied force on the primary shoe moving it into drum rotation energizes the shoe through the action of the drum. Action of the primary shoe is applied to the end of the secondary shoe with a greater pressure.

The greater pressure (or applied force) to the secondary shoe is again increased by the action of the drum if the shoe pivots on the anchor. Therefore, the braking efficiency of the secondary shoe is greater than that of the primary shoe through self-energized action. The action of both shoes has a tendency to force them tighter into the drum as they are both energized by drum rotation. The operating principle of both shoes becoming self-energized in either direction of drum rotation is known as "servo action" or the unit is known as a "servo acting" type of brake.

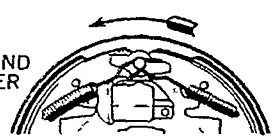


The servo acting brake is equally effective in either direction of drum rotation. If the applied force pushes the shoes apart with equal pressure, the action of the drum may shift the shoe slightly, to conform to the drum. The first shoe pushed in to the rotation of the drum will have a tendency to move away from the anchor pins and the second shoe will move up tight against the anchor pin. Both shoes increase the applied pressure through self-energization.

TYPICAL SERVICE BRAKE DESIGNS

3-1 Two-Shoe, Single Anchor, Single-End Wheel Cylinder (Bendix)

SERVO, SINGLE-END WHEEL CYLINDER



This is a duo-servo type brake and has one wheel cylinder acting against the primary shoe. The only force received by the secondary shoe is through the adjustment linkage connection to the heel of the primary and toe of the secondary shoes. This type of brake is used on front wheels only.

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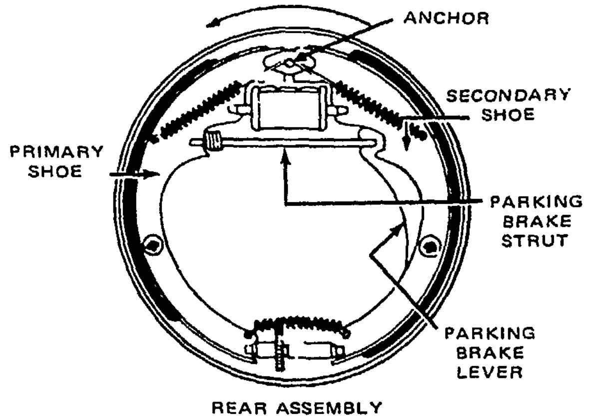
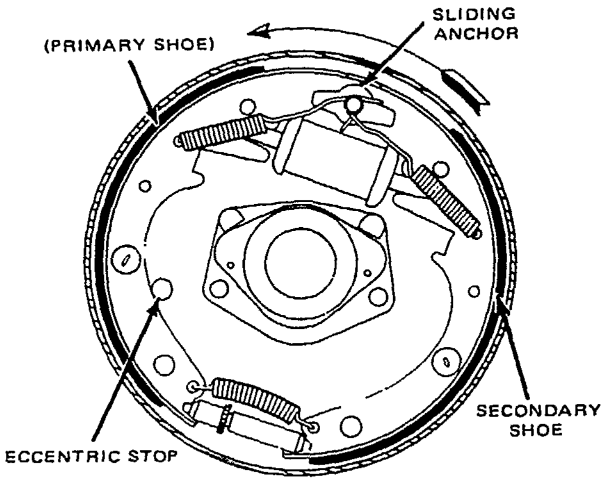
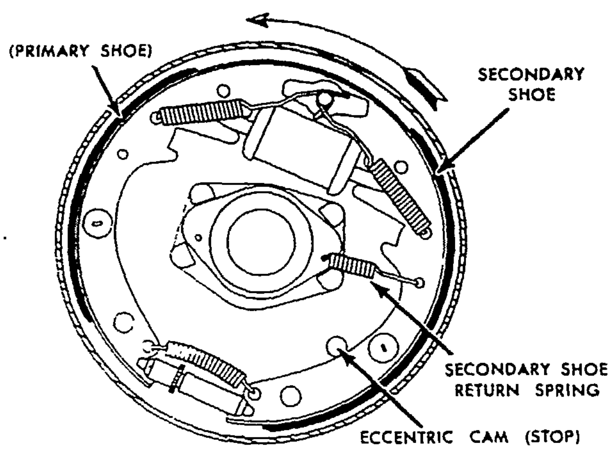
3-2 Two-Shoe, Single-Anchor, Double-Piston, (Bendix)



In this brake the wheel cylinder has two pistons one actuating the primary shoe and one actuating the secondary shoe. Therefore, the primary and secondary shoes are energized by wheel rotation. NOTE: The brake may have "cam adjusters" or "star wheel" assemblies as shown to adjust brake shoe clearance.



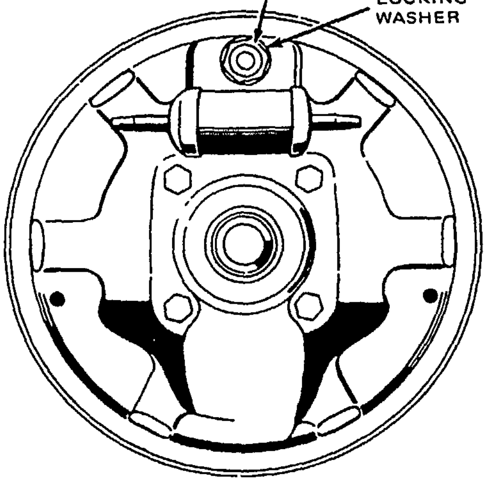
When used on the front wheel assembly of the 1954 Ford, the wheel cylinder was tipped back of the wheel centerline as shown, so that the primary shoe is the upper, resting on the eccentric stop (no hold back spring was required). The second shoe toward the bottom required an additional return spring to keep it from dragging on the drum. A sliding anchor is used on this brake.



A cam stop was incorporated in 1955 on the front only of the Fords, Mercurys, and Lincolns. The eccentric cam is used as the stop against the lip of the primary shoe in Ford, and against the secondary shoe in Mercury and Lincoln.

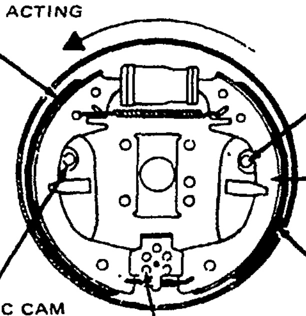
NOTE: The brake shoe return spring is used on the secondary shoe to hold it against the eccentric stop and to prevent it from dragging on the drum.

3-3 Two-Shoe, Fixed, Single-Anchor, Double-Piston, (Bendix)



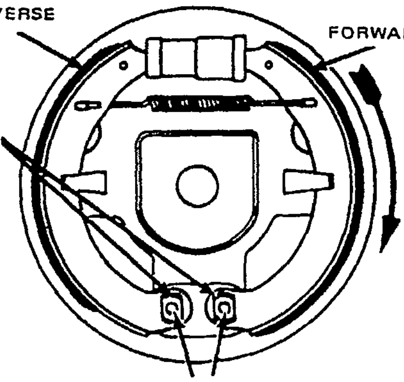
A duo-servo type brake using a non-adjustable fixed anchor. The only adjustment that can be made is through the star wheel adjuster.

3-4 Two-Shoe, Non-Servo, Self-Centering Anchor, (Bendix)



This is a non-servo brake using the abutment type of anchor. The abutment anchor allows the heel of the forward and reverse acting shoes to slide on the abutment as they become self-centered with the drum. The only adjustment that can be made to the shoes is through the eccentric cams.

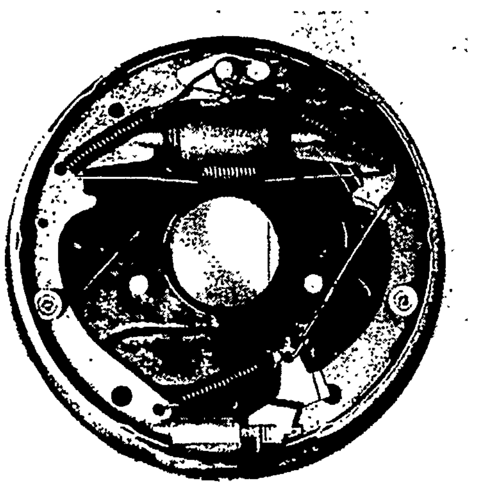
3-5 Two-Shoe, Double-Anchor, Self-Centering Shoes, (Ford-Lockheed)



This brake uses a fixed anchor but has self-centering shoes. At the heel of each shoe is an elongated slot. The slot contains a "two flat side" bushing that rides on the anchor. Upon brake application, the shoes move and become centered in the drum.

MAR 001462

3-6 Two-Shoe, Self-Adjusting, Fixed-Anchor, (Bendix)



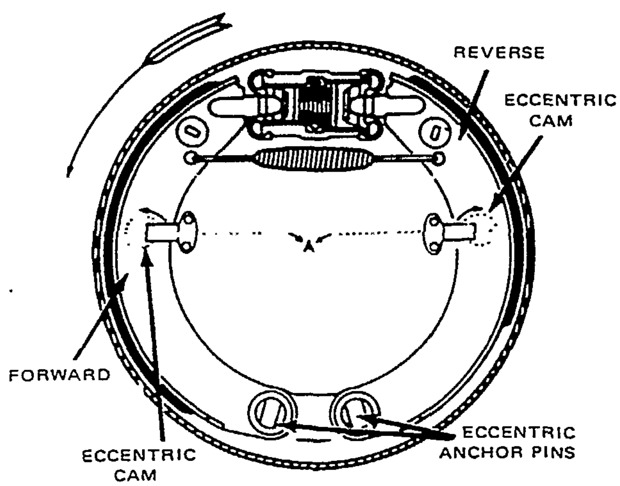
The self-adjusting brake mechanisms consist of a cable system (61-68) Ford, Lincoln, Mercury, Thunderbird, Plymouth & Dodge or pawl and lever system (62-68 GM Products), adjusting lever, and adjuster spring. The cable is hooked over the anchor pin at the top and is connected to the secondary brake shoe by means of the cable guide. The adjuster spring is hooked to the primary brake shoe and to the lever.

The automatic adjuster operates only when brake pressure is applied while the car is moving rearward.

With the car moving rearward and the brake applied, the "wrap-around" action of the shoes following the drum forces the upper end of the primary shoe against the anchor pin. The movement of the secondary shoe causes the cable or lever to pull the adjusting lever upward and against the end of a tooth on the adjusting screw starwheel. The upward travel of the lever increases as lining wear increases. When the lever can move upward far enough, it passes over the end of the tooth and engages the tooth. Then when the brakes are released, the adjuster spring pulls the lever downward causing the star-wheel to turn and expand the shoes. The star-wheel is turned one tooth at a time as the linings progressively wear.

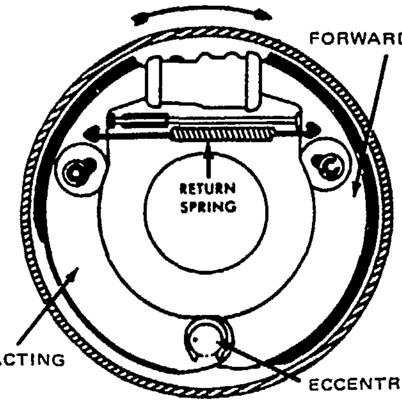
The essential difference between the Bendix type self-adjusting brake and the Delco Moraine is that the Bendix mechanism uses the cable system for actuation where as Delco uses the pawl and lever system. Also sliding anchors are used on some Delco applications.

3-7 Two-Shoe, Double-Anchor, (Lockheed)



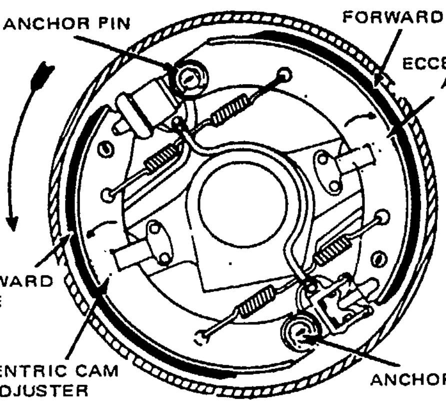
This is a non-servo type of brake and uses an eccentric anchor pin at the heel of the forward and reverse acting shoe. The pins are used to adjust the heel clearance of each shoe on a major adjustment. The clearance at the toe of each shoe is adjusted by an eccentric cam.

3-8 Two-Shoe, Single-Anchor, (Lockheed)



This brake uses one eccentric anchor. When turned, the anchor adjusts the heel clearance of the forward acting shoe only. The toe clearance of the forward and reverse acting shoes is established by the eccentric cams near the toe of each shoe. A friction spring on each adjusting cam holds the cam in position.

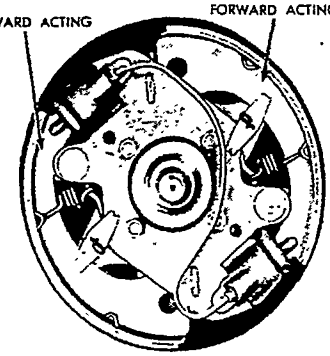
3-9 Two-Shoe, Two-Cylinder, Double-Anchor, (Lockheed)



This brake makes use of the self-energized action of the forward acting shoe. Both shoes are forward acting by the use of two wheel cylinders. One cylinder is connected to the toe of each shoe and when the brakes are applied, each shoe is energized by drum rotation. Anchor pins at the heel of each shoe are of the eccentric type and are used to adjust heel clearance of the shoe. Eccentric cam adjusters are used to adjust the toe of each shoe.

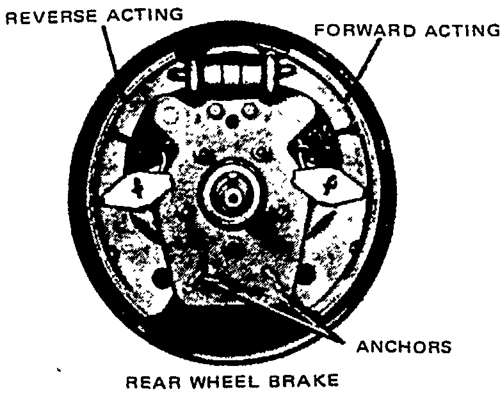
NOTE: This type of brake is used on front wheel only in conjunction with a conventional double-anchor brake on the rear wheels.

3-10 Two-Shoe, Center Plane, Total Contact, (Chrysler)

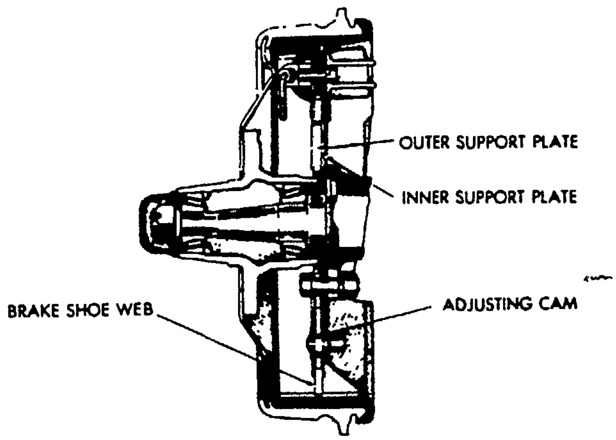


FRONT WHEEL BRAKE

Both shoes in the brakes of the front wheels are forward acting as well as the front shoe of each rear brake. With this combination of front and rear brakes, there are 6 forward acting shoes and 2 reverse acting shoes. All brake shoes are of the full floating type, and are self-centering.



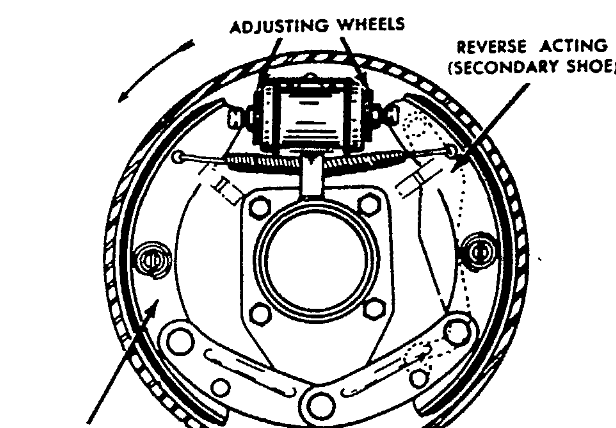
When the brakes are applied and the shoes move out contacting the drum, the step contour rolls out over the anchor ramp until the linings are in full contact with the brake drum. As the self-energizing action of the shoes begins to take effect, the shoes slide into tighter contact with the anchor ramp and drum.



The web of each brake shoe is centralized between the outer and inner support plates. The plates align the shoes so that the face of the brake lining contacts the drum squarely. The applying force from the hydraulic piston and brake return springs are all in the center plane, preventing the shoe from twisting. The brake shoe lining clearance is adjusted by an adjusting cam at the toe of each shoe. When the cam is moved, the heel of the shoe will move on the anchor maintaining equal clearance between the linings and the drum. The brake shoe return spring link keeps a uniform load on the return springs.

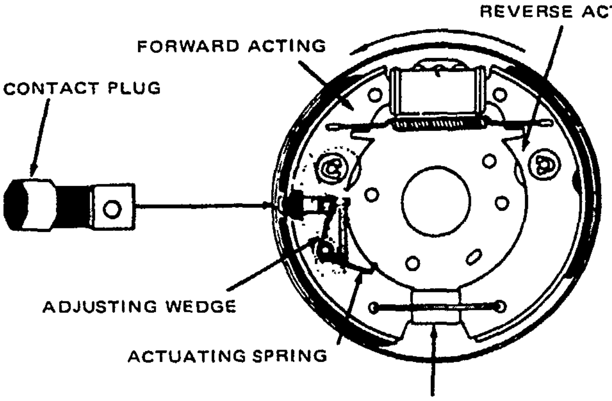
NOTE: Three coil return springs are used on the front wheel brakes and six coil return springs are used on the rear brakes. This applies to eleven inch brakes only. 12" brakes have four coil return springs on the front and five coil return springs on the rear.

3-11 Two-Shoe, Anchor Links, Single Fixed Anchor (Huck Type)



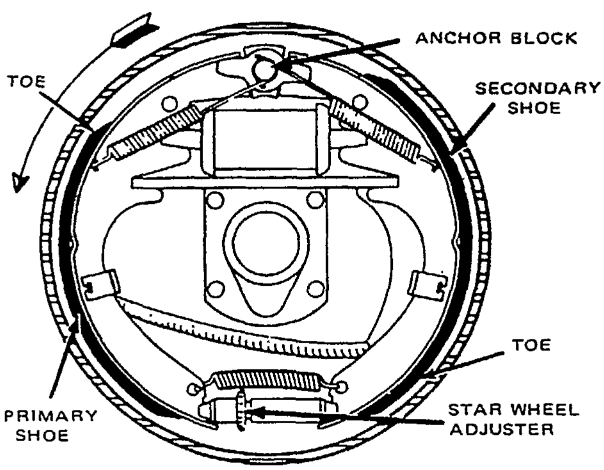
The forward acting shoe in this brake is connected to an anchor link. This increases the force of the shoe against the drum as the shoe is energized by drum rotation. The reverse acting shoe operates in the same way when the brakes are applied with the car moving backwards. In this design, the full length of the brake lining contacts the drum as the brakes are applied. Adjustment for each shoe is made by turning the adjusting wheel at the end of each wheel cylinder.

3-12 Two-Shoe, Self-Centering, Self-Adjusting (Wagner)



This brake has an abutment type of fixed anchor, and when the brakes are applied the shoes center themselves by moving on the sides of the anchor. The forward acting shoe is energized by drum rotation and moves slightly, centering itself with the drum. The self-adjusting feature of the brake is made possible through the use of a contact plug mounted on the forward acting shoe. When the brakes are applied, the shoe is forced against the drum and carries the contact plug with it. The plug is held in a pre-set position to the lining surface, by means of an actuating spring. Since the plug does not wear as fast as the lining, it will extend out from the lining when wear occurs. As lining wear takes place and the brakes are applied, the plug will be pushed in by the brake drum. The action will move the actuating lever in relation to the wedge, advancing the wedge. As the brakes are released the shoe will not return to its original position, but will remain in the newly adjusted position compensating for lining wear.

3-13 Two-Shoe, Self-Centering, Single-Anchor, Double Piston, (Wagner)



This is a duo-servo brake, similar to the Bendix single-anchor, double-piston brake. The exception is in the type of anchor. The anchor on this brake is a keystone shaped anchor block at the toe end of the primary shoe and at the heel end of the secondary shoe. Adjustment of the brake is made through a star wheel adjuster assembly. In 1959 a self-adjusting mechanism of the cable type was added as optional equipment.

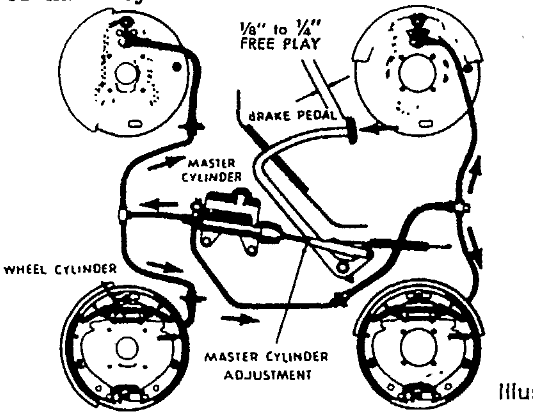
CHAPTER 2 BRAKE HYDRAULIC SYSTEMS

Now that you have completed Lesson #1 and have become generally familiar with the various types of passenger car brake systems, we will study the more popular types in greater detail. The lessons ahead will deal with the vital functioning parts of brake systems used on virtually every American-made passenger car.

Lesson #2 deals specifically with the fundamental operation of the hydraulic system and offers some time-tested tips for better servicing. The procedures for servicing outlined in this lesson are your guide for doing perfect hydraulic system work. Short cuts or omitting steps in these procedures can result in brake failure and costly come-backs.

Fundamentals of Master Cylinder Operation

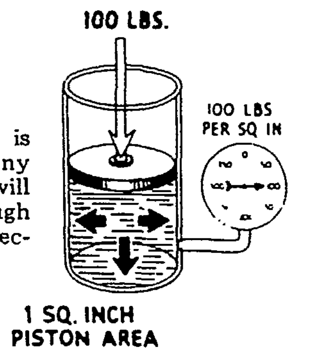
There are three major types of master cylinder systems. They are: (1) The Double End Opening Type; (2) The Single End Opening Type; (3) The Dual Safety Reservoir Type. After a brake diagnosis has been made and there is an indication that the master cylinder is not functioning properly the assembly should be replaced. If a new unit is not available it will have to be rebuilt. The first step is to remove the master cylinder and disassemble for further service. The following applies to all types of master cylinders.



Illust. 2-1

A hydraulic brake system transmits motion and pressure from the brake pedal to the brake shoes using a liquid or fluid which cannot be compressed. *See Illustration 2-1.*

The principle of hydraulics is that pressure exerted at any point on a confined liquid will transmit this pressure through the fluid equally in all directions. *See Illustration 2-2.*

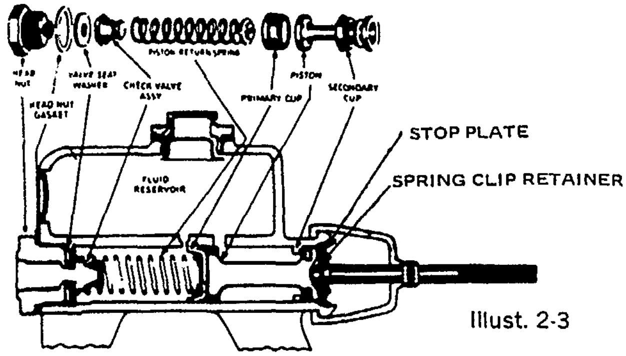


Illust. 2-2

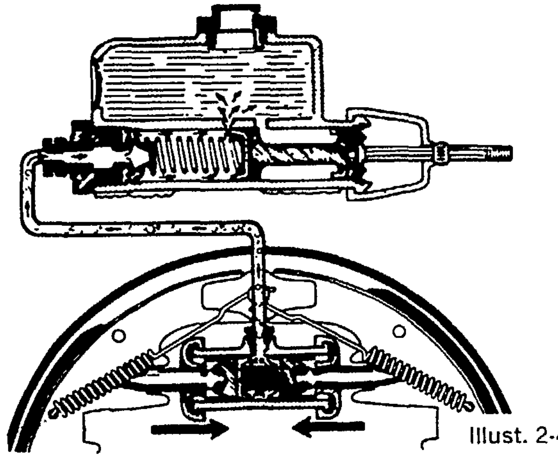
Master Cylinder

The master cylinder is composed of a fluid reservoir, a piston assembly and a valve assembly. The valve assembly maintains a constant pressure in the brake lines for fast brake action. *See Illustration 2-3.*

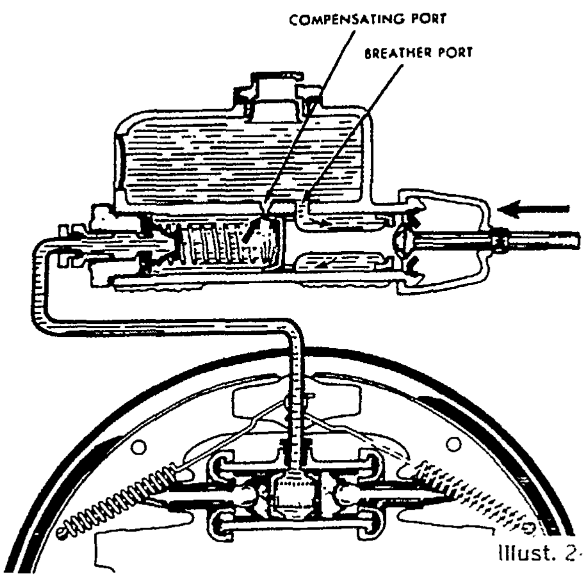
The constant pressure that is maintained in the lines also reduces the possibility of air bubbles getting into the system when the brakes are released.



Illust. 2-3

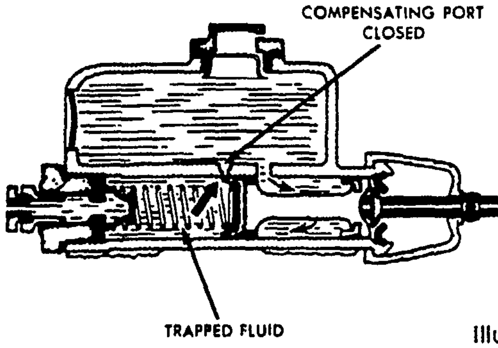

Illust. 2-4

There are three forward and two reverse stages in the operation of the master cylinder: The forward stroke starts from the fully released position to partially applied, and then to a fully applied position. On the return stroke, it starts from the partially released to the fully released position. *See Illustration 2-4.*



Illust. 2-5

On the forward stroke, in the fully released position, there is no pressure on the master cylinder. The reservoir is vented to atmospheric pressure. Fluid from the reservoir flows down behind the piston through the breather port and ahead of the piston through the compensating port. *See Illustration 2-5.*

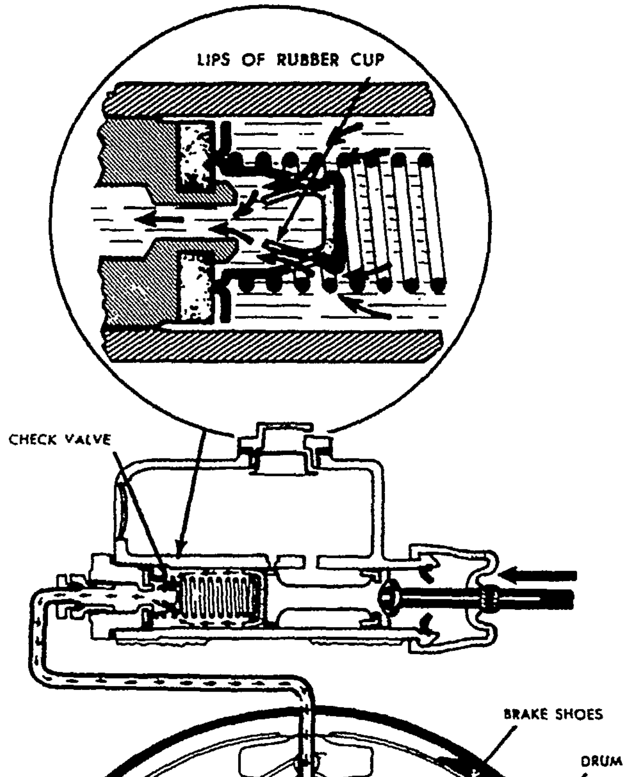


Illust. 2-6

If the master cylinder piston is moved forward by the force of the brake pedal, the rubber lip of the primary cup will cover the compensating port.

The fluid is trapped ahead of the piston and the cup. Then the fluid from the reservoir will flow through the breather port as the piston moves forward. This keeps the space between the piston head and secondary cup filled with fluid at all times. *See Illustration 2-6.*

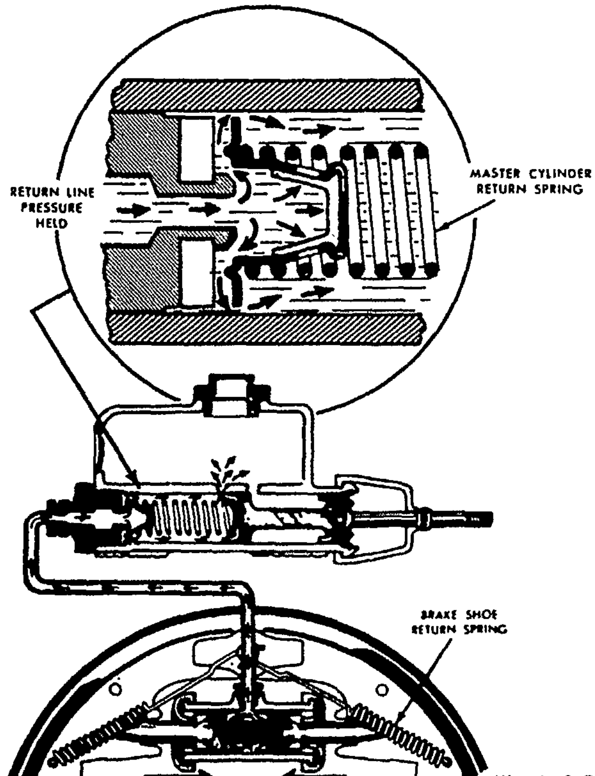
Residual line pressure, controlled by the master cylinder piston return spring and check valve, keeps the brake lines full of fluid at all times and prevents air from entering the system. This allows immediate expansion of the wheel cylinders the instant the brake pedal is depressed. Residual line pressure also keeps the wheel cylinder piston cups expanded out against the cylinder walls to prevent fluid leaks past the wheel cylinder cups.



Illust. 2-7

The Master Cylinder Check Valve and Seat

This check valve allows fluid to pass in one direction only, that is, toward the wheel cylinders at the time of brake applications. *See Illustration 2-7.*



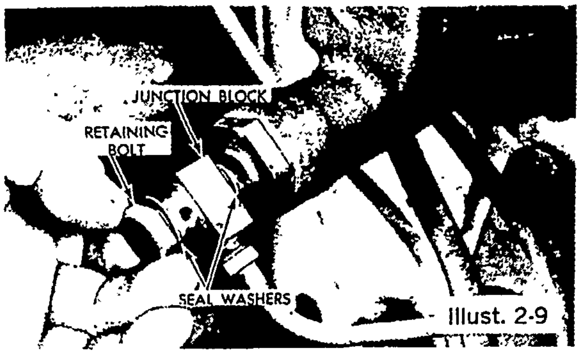
Illust. 2-8

Brake Application Release

When the brake pedal is released, pressure exerted by the brake shoe return springs against the wheel cylinder piston raises the check valve off its seat allowing the brake fluid to flow back into the master cylinder bore, through the compensating port hole and into the fluid reservoir. *See Illustration 2-8.* This compensating port hole is approximately .017" diameter. A defective master cylinder check valve can cause a low brake pedal even though the brake shoes are adjusted properly. This is because the brake fluid drains back out of the brake lines into the master cylinder. Then, on brake application, the first part of the brake pedal stroke fills the brake lines and you get brake application on the last part of the brake pedal stroke.

NOTE: **If the brake fluid is varnished up, discolored or too thick, it causes very slow brake shoe release, which in turn causes brake shoes to drag a long time before releasing. This creates extra heat which results in rapid lining wear. A dragging brake can cause heat to build up temperatures to 600 degrees F. At 600 degrees F., the brake lining wear ratio is 20 times faster than normal temperature.**

As the master cylinder piston returns to the off or released position, a low pressure area is created in front of the piston. This draws fluid through the supply hole from the reservoir through the holes in the piston, over or through the piston cup grooves to the front of the piston. If this extra supply of fluid is not used, it then returns to the master cylinder reservoir through the small compensating port hole.

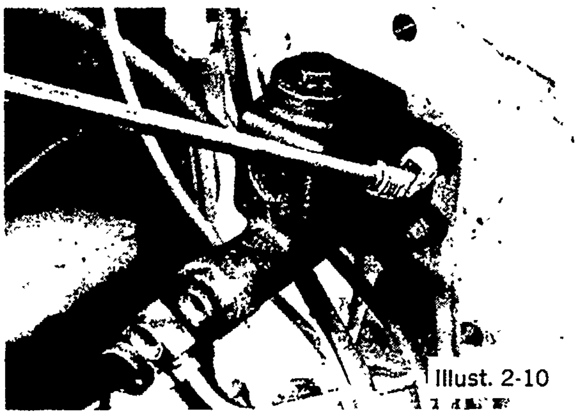


Illust. 2-9

SERVICING:

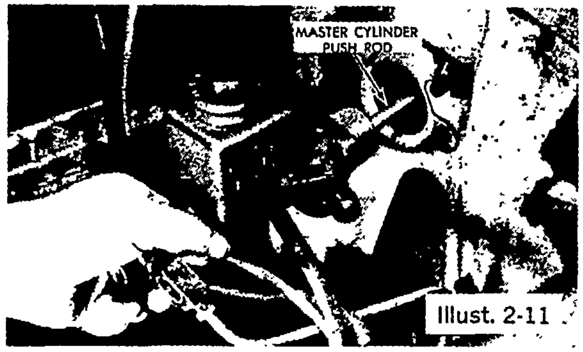
Typical Procedure for Master Cylinder Overhaul

Remove the hydraulic junction block retaining bolt and seal washers from each side of the hydraulic junction block. *See Illustration 2-9.*


Illust. 2-10

Remove the master cylinder retaining nuts and lock washers. *See Illustration 2-10.*

Slide master cylinder from the front of the dash panel and off the end of the master cylinder push rod. *See Illustration 2-11.*



Illust. 2-11

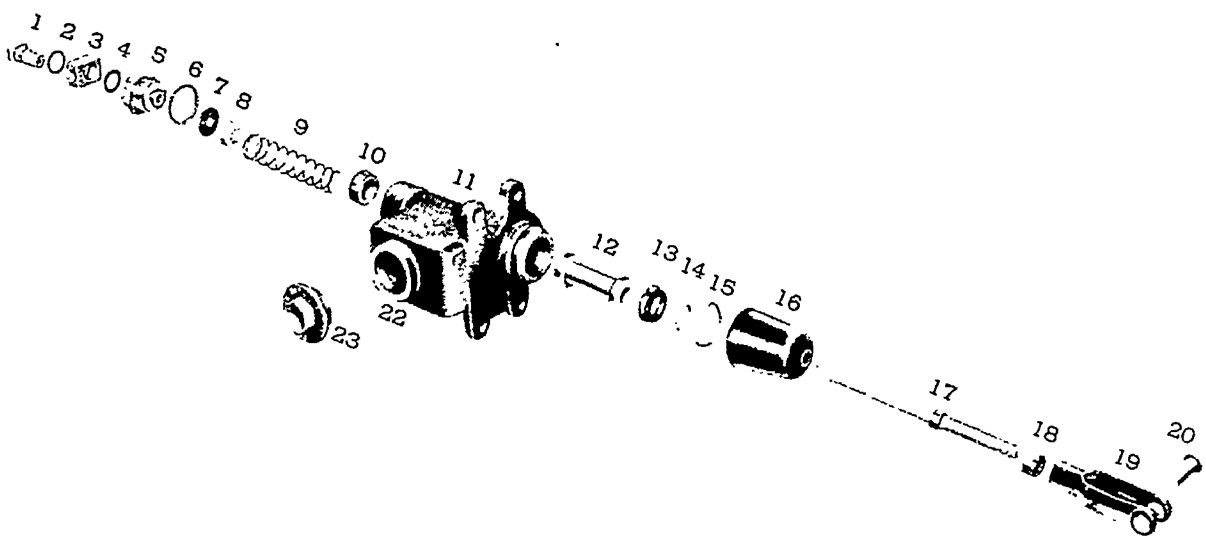
Master Cylinder Disassembly

See Illustration 2-12.

1. Brush off all external dirt before disassembly.
2. Unscrew outlet bolt (1) remove gasket (2) connector (3) gasket (4).
3. Remove valve seat (5) gasket (6) seal (7).
4. Remove check valve (8) return spring assembly (9).
5. Remove main cylinder boot (16) insert a long thin punch from cylinder mounting side and push out primary cup (10) piston (12) secondary cup (13).
6. Remove lock ring (15) stop washer (14) from mounting side of cylinder.
7. Remove filler plug (23) and gasket (22).

Discard all old parts that are replaced by new parts in the repair kit. Alcohol should be used on all rubber parts. Bodies and other metal parts could be cleaned with mineral base solvents, being careful not to allow solvent to enter reservoir or bore. A final wash in alcohol, or suitable substitute, should be made to remove any harmful mineral oil films which could affect the rubber parts.

1. **Body**
   (a) Check body for soundness–no cracks, bad threads; sand holes or other visual faults.
   (b) Check inside bore for finish (must be glass smooth) and for freedom from deposits, pits or scores.
   (c) Check to see that the compensating port is open.
   (d) Check for burr around the compensating port.



Illust. 2-12

*** 2. Internal Rubber Parts**

Check for wear, scuffing tears, softening, hardening, gumming, swelling, and size. Actually, it is always best to install new internal rubber parts for deterioration not visible which can always be present.

*** 3. Pistons**

Inspect for corrosion, scoring, plugged compensating holes, cup groove marks, diameter, size, etc. Stem corrosion may not affect operation. Check for clearance between piston and cylinder bore (tolerance—.003"-.006").

*** 4. Springs**

Check for distortion, corrosion, cracks, loss of tension, etc.

*** 5. Check Valves and Seats**

Inspect for swelling and softening. These parts should be replaced whenever the master cylinder is overhauled.

*** 6. Rubber Boot**

Check for hardening, softening, cracks, cuts, holes, etc.

*NOTE: Replacement parts supplied in repair kit must be used to replace original parts.

7. Filler Cap

Be sure that vent holes are open and baffle is in place. Check gasket.

8. Bore

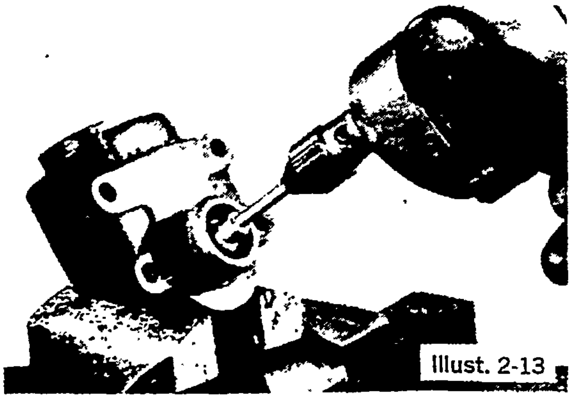
Check cylinder bore carefully. It must not be pitted, scored or otherwise marred. Cylinder bores slightly corroded or built up with deposits can be cleaned and polished to a satisfactory finish by using a wheel cylinder hone.

9. Compensating Port

Blow out port with air if hole is plugged with dirt.

10. Replacing Parts

Replace all the internal rubber parts in the master cylinder.



Illust. 2-13

Cylinder Honing

See Illustration 2-13.

Follow the specific instructions of the equipment manufacturer for honing a master cylinder. The purpose of honing is to remove slight scratches or to clean up cylinder. Use care in this operation. On single opening cylinders be sure that the cylinder valve seat is not damaged. If in doubt, replace the cylinder housing.

Assembly of Master Cylinder

Whenever a master cylinder is overhauled, care must be taken to reassemble the valve and seat correctly. Improper assembly of the check valve seat rubber washer will result in its distortion. If the check valve seat is distorted, there will be no check valve seal and will result in a loss of brake pedal height. Also, the pedal will have to be depressed or pumped one or more times before actual car braking occurs.

Before assembly, be sure that all parts and the assembly bench are clean. Dip all internal rubber parts in clean uncontaminated brake fluid. Coat the inside of the cylinder with brake fluid. *See Illustration 2-12.*

Install the piston stop washer (14), lock ring (15), in the front end of the main cylinder.

Dip the rubber cups (10 and 13) and valve (8) in hydraulic brake fluid.

Assemble secondary cup (13) to the piston (12) and install assembly into the body so that the bleeder hole end of the piston will be toward the end plug when assembly is completed.

Place the primary cup (10) in the body with the flat side against the piston (12).

Slide the piston spring (9) and check valve (8) as an assembly into the master cylinder bore.

Install a new check valve seat washer (7) over the plug (5).

Assemble a new gasket (6) over the end plug (5) and screw the plug, valve seat washer (7), and gasket (6) into the main cylinder body and tighten securely.

Install the rubber push rod boot (16), making sure there is a good seal between it and the body. This seal must be tight enough to keep water and other foreign matter from entering the main cylinder through the pedal stop.

Installation of Master Cylinder

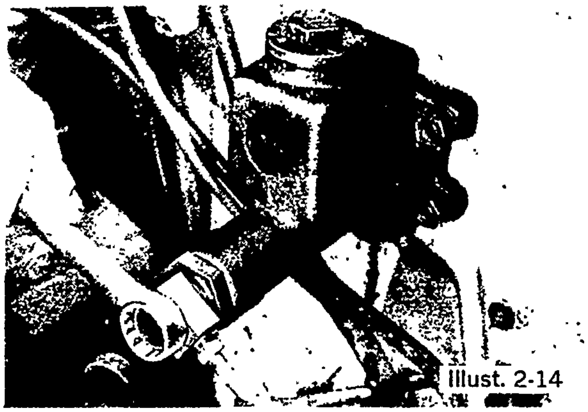
Position master cylinder over end of master cylinder push rod and the mounting studs at the dash panel. *See Illustration 2-11.*

Install the master cylinder retaining lockwashers, nuts and tighten securely. *See Illustration 2-10.*

Position the junction block sealing washers. Install and tighten the hydraulic junction block retaining bolt. *See Illustration 2-14.*

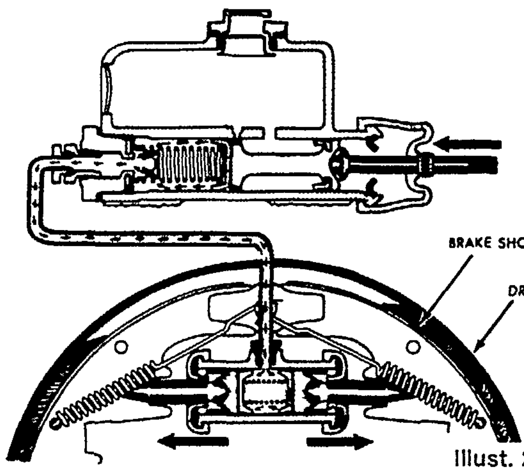
Adjust brake-pedal-to-master-cylinder clearance from 1/8" to 1/4". *See Illustration 2-1.*

The piston and cup must always come back far enough to clear the Master Cylinder compensating porthole. A restricted porthole causes excess pressure to build up in hydraulic system and can cause brakes to lock up. To check this, depress pedal. There should be a surge of fluid from the bore into the reservoir.



Illust. 2-14

The hydraulic pressure exerted by the master cylinder is determined by the mechanical leverage of the brake pedal and the size of the master cylinder piston. The mechanical pressure applied to the end of the master cylinder piston against an opposing fluid pressure. Therefore, a larger master cylinder, bore, or piston requires greater pedal pressure with less brake pedal travel.



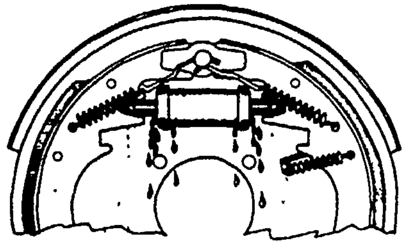
Illust. 2-15

Fundamentals of Wheel Cylinder Operation

When brakes are applied, fluid pressure displaced by the master cylinder causes the wheel cylinder pistons to move out forcing the brake shoes against the drum, retarding the revolving brake drum and wheel. *See Illustration 2-15.*

Illust. 2-16

There are three types of wheel cylinders in use: equal bore, step bore, and single piston. The cylinders are made up of pistons, piston cups, piston springs, and rubber boots. *See Illustration 2-16.*

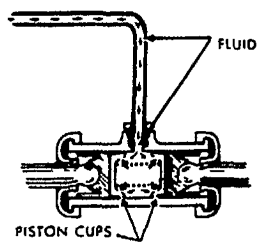


Illust. 2-17

SERVICING:

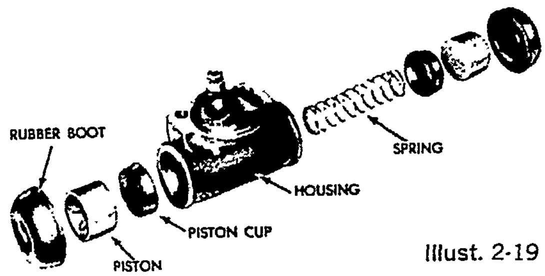
Typical Procedure for Wheel Cylinder Overhaul

Whenever a brake drum is removed from a wheel, the wheel cylinder should be inspected for leaks caused by wear. This can be done by lifting the rubber boot at each end and checking for a fluid leak. There is always a small amount of seepage by the wheel cylinder piston cup, but a large amount indicates a replacement of piston cups or wheel cylinder reconditioning is needed. Inspect to see that there is no trace of brake fluid on the brake linings. Also, take care not to get brake fluid on the linings during removal of the wheel cylinder from the backing plate. *See Illustration 2-17.*



Illust. 2-18

The piston cups are designed so the pressure of the fluid forces the lips of the cups out against the cylinder walls. The greater the pressure, the tighter the lips press against the wall. *See Illustration 2-18.*

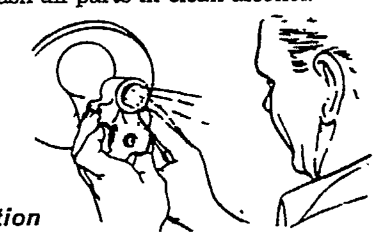


Illust. 2-19

Disassembly

After the wheel cylinder has been removed from the brake backing plate, disassemble as follows:

Remove the cylinder boots.
Remove the pistons, rubber cups and springs (discard the rubber cups). *See Illustration 2-19.*
Wash all parts in clean alcohol.



Illust. 2-20

Inspection

Inspect the cylinder bore (hold it in front of a light). Check for scratches, pitting or ridges. If this condition exists, the cylinder should be replaced or honed. *See Illustration 2-20.*

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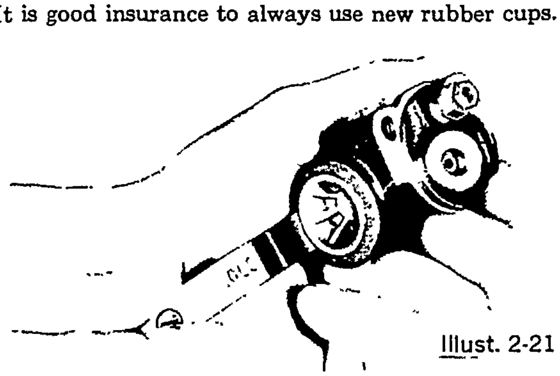
It is good insurance to always use new rubber cups.



Illust. 2-21

CHECKING WHEEL CYLINDER PISTON FIT

Check the fit of the piston in the cylinder bore by using a feeler gauge. This clearance should be from .002" to .004". Replace cylinder if over this limit. Check piston for scratches, corrosion or pitting. If damaged, replace. *See Illustration 2-21.*

Replace the springs if they indicate weakness.

Illust. 2-22

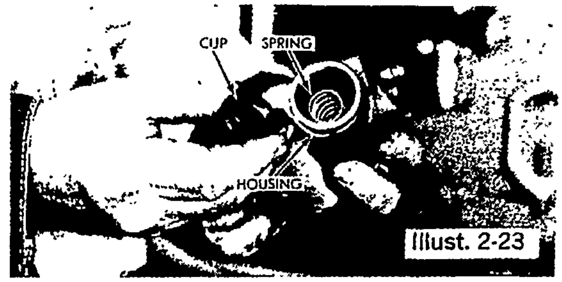
Cylinder Honing

When honing a wheel cylinder, follow the specific instructions of the equipment manufacturer for each honing operation. *See Illustration 2-22.*

NOTE: 1961-62 Falcon & Meteor have a built-in baffle. Therefore, no honing possible.

After a cylinder has been honed, it should be checked for oversize. Oversize cylinders should be replaced. Listed below are actual cylinder sizes (inside diameter).

CYLINDER SIZE	ACTUAL DIAMETER (I.D.)
3/4"	0.7500" –0.7550"
13/16"	0.8125" –0.8175"
7/8"	0.8750" –0.8800"
15/16"	0.9375" –0.9425"
1"	1.0000" –1.0070"
1-1/16"	1.0625" –1.0695"
1-3/32"	1.09375"–1.10075"
1-1/8"	1.1250" –1.1320"
1-3/16"	1.1875" –1.1945"
1-1/4"	1.2500" –1.2570"
1-3/8"	1.3750" –1.3820"
1-1/2"	1.5000" –1.5070"
1-5/8"	1.6250" –1.6320"
1-3/4"	1.7500" –1.7570"
1-7/8"	1.8750" –1.8820"
2"	2.0000" –2.0050"



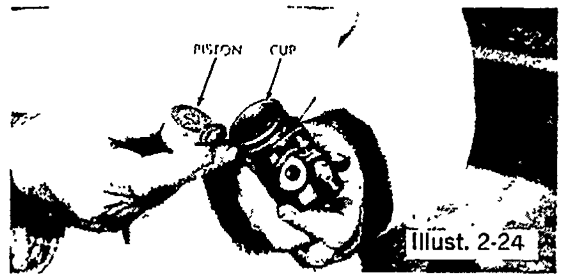
Illust. 2-23

Assembly

Dip the pistons and rubber cups in clean hydraulic brake fluid.

Place the spring in the center of the housing.

Install the rubber cups at each end of the spring, (making sure the cupped side is toward the spring). *See Illustration 2-23.*



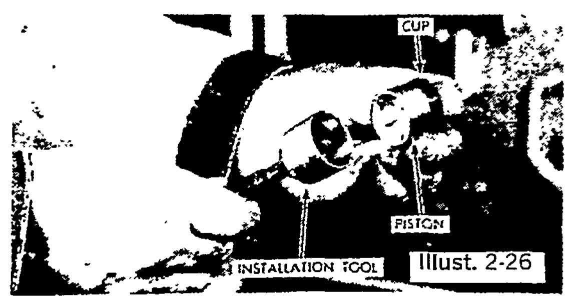
Illust. 2-24

Replace the pistons with the flat side against the flat of the rubber cup. *See Illustration 2-24.*

Illust. 2-25

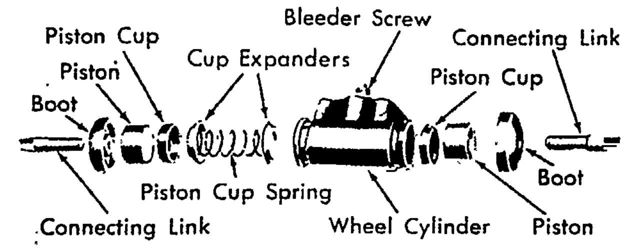
Replace the boot, making sure it enters the groove on the outside of the cylinder. *See Illustration 2-25.*

NOTE: On step bore cylinders, install each cylinder piston and cup in the correct bore. NEVER slide a piston through the entire length of the cylinder. This may scratch the polished surface and damage the piston cup seal.



Illust. 2-26

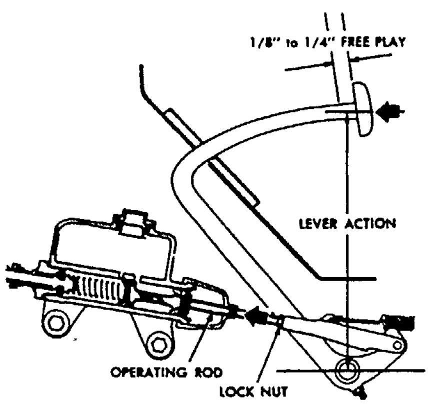
On Chrysler blind bore cylinder, a special tool may be used to insure correct installation of the wheel cylinder cup and piston as shown. *See Illustration 2-26.*



Illust. 2-27

Vehicles that operate in sub-zero temperatures often have cup expanders between the spring and the cupped side of the cup. This is for the purpose of holding the sealing edge of the cup against the cylinder wall. In cold weather operation, these cups may loose some of their flexibility. *See Illustration 2-27.*

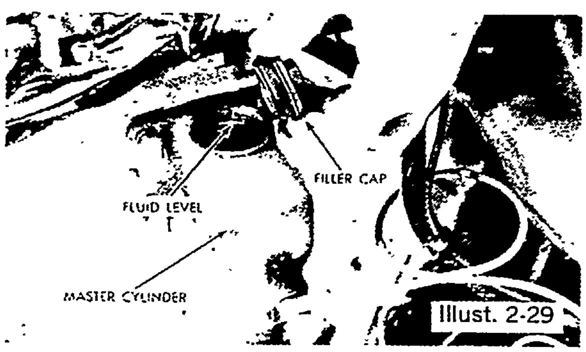
BLEEDING OF THE BRAKE HYDRAULIC SYSTEM: *Using Brake Pressure Bleeder*



Illust. 2-28

Support the car safely on jack stands or on a hoist. Make sure car is level in order to prevent air lock in master cylinder bore.

Adjust brake-pedal-to-master-cylinder clearance of ⅛ to ¼ of an inch. *See Illustration 2-28.*

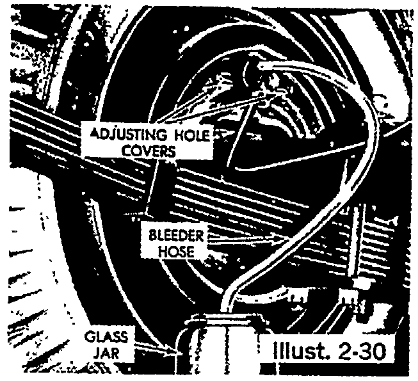


Illust. 2-29

Thoroughly clean off the area around the top section and filler plug of the master cylinder.

Remove master cylinder filler plug. *See Illustration 2-29.*

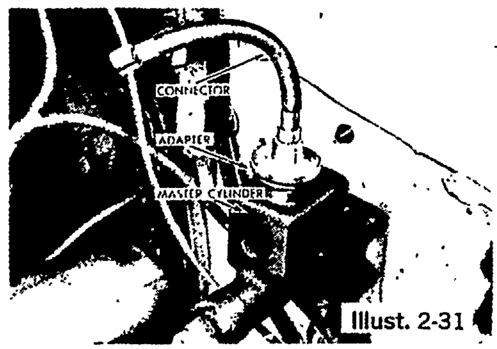
NOTE: Use care and be sure dirt does not enter the master cylinder.



Illust. 2-30

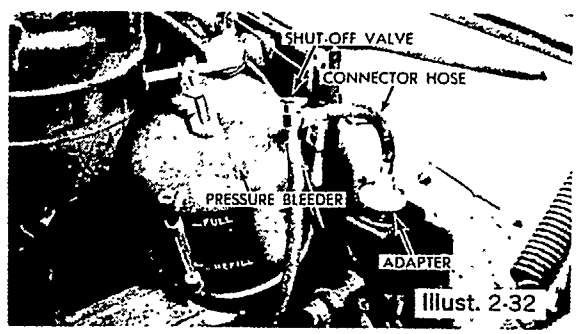
Attach a bleeder hose to each bleeder screw located at the back of each brake backing plate. *See Illustration 2-30.*

NOTE: Chrysler cars have six bleeders.



Illust. 2-31

Install pressure bleeder adapter to master cylinder and hook up pressure bleeder to the adapter. *See Illustration 2-31.*



Illust. 2-32

Turn the pressure bleeder line valve open and check for hydraulic fluid leaks at the lines, connections, wheel cylinders and master cylinder. *See Illustration 2-32.*

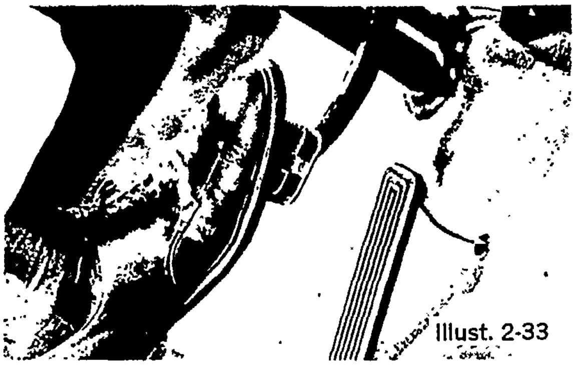
NOTE: A pressure of 15 to 20 P.S.I. is sufficient to bleed regular hydraulic brake systems.

Open the brake bleeder screws in sequence—left and right rear—right and left front—at each brake bleeder connection until the brake fluid runs clear with no air bubbles present. Use a clean glass or jar to collect brake fluid so you can observe when air bubbles have ceased. *See Illustration 2-30.*

Shut off the brake hydraulic pressure bleeder line valve. *See Illustration 2-32.* Loosen adapter slightly to release pressure before removing connector.

Disconnect the pressure bleeder connections from the master cylinder. *See Illustration 2-31.*

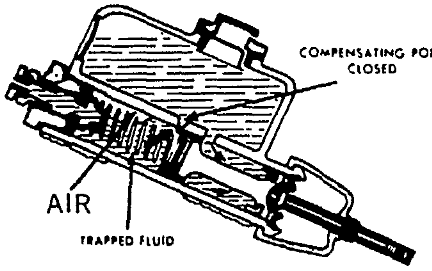
Lower car to the floor and road test for proper brake action and brake pedal "feel."



Illust. 2-33

Recheck brakes for correct brake pedal release. *See Illustration 2-33.*

Manual Bleeding



Illust. 2-34

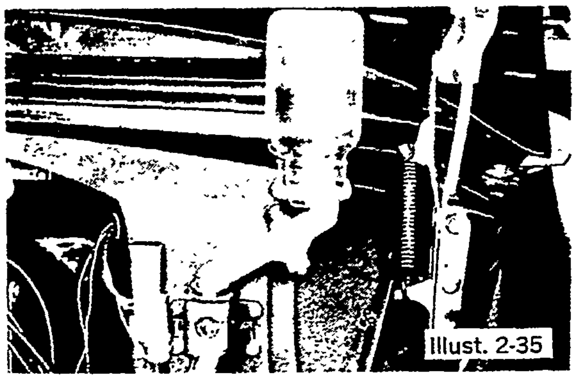
Make sure car is level. This prevents an air lock in the master cylinder.

If the outlet end of the master cylinder is elevated, a large bubble of air remains in the cylinder bore regardless of how much fluid is bled through hydraulic system. *See Illustration 2-34.*

Air can be flushed out of a brake line, but air being lighter than fluid prevents it from coming down and bleeding out of a large area.

Remove master cylinder filler cap. Be sure all dirt and foreign matter is removed from around cap before removal. *See Illustration 2-29.*

Fill master cylinder reservoir, replace filler cap and pump brake pedal several times (this will prime master cylinder, if dry, and push some fluid into the brake lines before bleeding operation starts).



Illust. 2-35

By using a constant level filler it prevents refilling of the master cylinder reservoir after each brake is bled. *See Illustration 2-35.*

Go to the left rear wheel, have a helper depress brake pedal.

Open bleeder screw, allow air and fluid to escape.

Close bleeder screw just as the fluid stops running out.

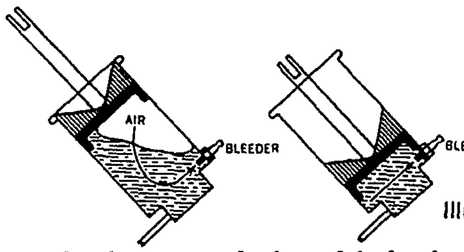
With helper pumping brake pedal continue bleeding until the brake fluid is clear and all air is out of brake lines. *See Illustration 2-30.*

NOTE: **Bleeding each wheel cylinder until fluid is clear has a twofold purpose. First, it flushes out the brake lines. Secondly, it gives you one brand of clean fluid in the system.**

Repeat this operation on the right rear, right front and left front brakes.

NOTE: **Chrysler products with Lockheed brakes have two bleeder outlets or screws on each front brake.**

Special Instructions for Bleeding Chrysler Products Center Plane Brakes



Illust. 2-36

Prevent that low spongy brake pedal after brake overhaul by using the following precedure.

Before bleeding brakes, make sure brake shoe adjustment is completely loosened. This pushes the wheel cylinder piston and cup down in the wheel cylinder bore, thus reducing the area. This reduced area, being somewhat in line with the wheel cylinder bleeder screw, will then allow the air to be bled out.

If the brake shoes are adjusted out against the brake drum, the wheel cylinder piston and cup follows, creating an air space above the bleeder screw. *See Illustration 2-36.*

As previously stated, air will not come down to a lower area and bleed out.

After the bleeding operation is completed, adjust the brakes to manufacturer's specifications. This should give you a good solid high brake pedal. If not, check into the possibility of a defective master cylinder check valve, as previously outlined in this lesson.

NOTE: **This procedure is also used on trucks and buses that have upright wheel cylinders.**

Also, when using a pressure bleeder that admits the air pressure on top of the brake fluid, *do not exceed 25 lbs. of air pressure.* Higher air pressure tends to mix with some fluids. If this happens in your bleeder, remove the air pressure and the filler cap. Let it sit overnight. This permits the air to come up out of the fluid.

The next lesson (#3) will deal in detail with the *Chrysler Center Plane Brake System* (Wagner-Lockheed).

Save all lessons for future reference. Proper use of them can build your experience and prevent costly come-backs.

DO A COMPLETE BRAKE JOB.
DO A CLEAN BRAKE JOB.
DO A GOOD BRAKE JOB.
USE GOOD MATERIALS.
PROPER TOOLS MAKES THE JOB EASIER.

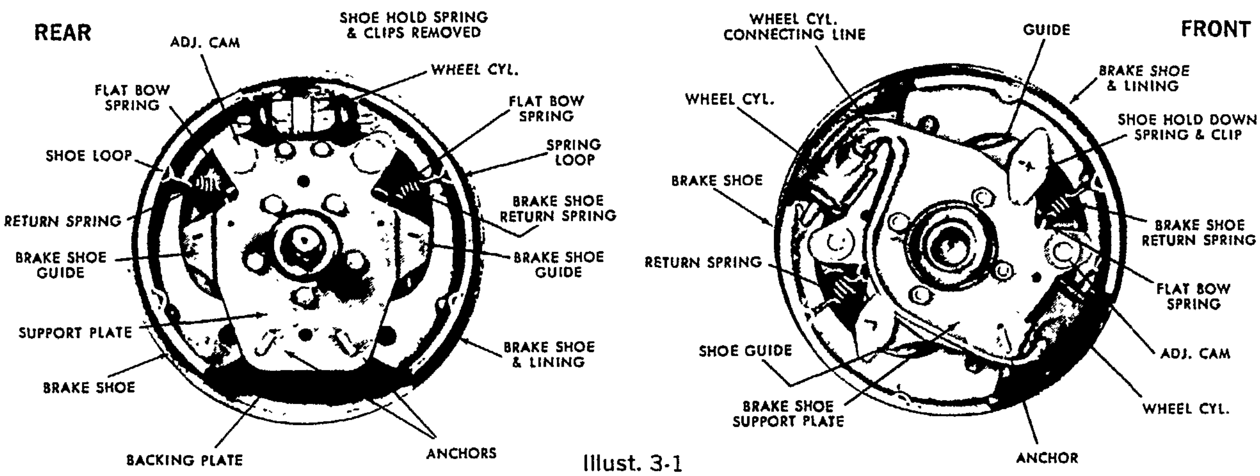
CHAPTER 3
CHRYSLER CENTER PLANE BRAKE SYSTEM

This lesson is devoted to the Chrysler Center Plane Brake System, also known as the Total Contact Brake. This is the brake system that gives most mechanics the greatest amount of trouble.

Unless exact procedures are followed in servicing this system, difficulties will arise in brake performance, brake noise, and brake lining wear.

The exclusive service tips offered in this lesson may very well make the difference between a high quality, successful brake job and a troublesome comeback.

2. Remove lug bolts and all wheels.
3. Remove rear axle cotter pin and nut.
4. Remove flat washer behind nut and thread nut back on axle shaft until nut is flush with the ends of axle —this prevents damage to end of axle shaft during pulling operation.
5. Lubricate end of axle shaft—this helps get more pull with puller.
6. Install hub puller making sure lug bolts holding puller are equal.



Illust. 3-1

Chrysler Center Plane Brakes
(See Illustration 3-1)

Chrysler and DeSoto started using this brake in 1956 but Chrysler changed to Bendix in 1963.

Dodge and Plymouth started using this brake in 1957 but changed to Bendix in 1962.

Servicing the Chrysler Center Plane Brake can be very troublesome and critical. However, this can be a very good brake if you do a complete and thorough job and follow the right procedures.

There are three critical areas where extra care should be exercised when servicing this brake system. They are:

1. Brake shoe alignment and clearance.
2. Brake shoe return springs and hold down springs.
3. Brake shoe lubrication.

In order to leave as little room for error as possible, turning brake drums on each center plane brake overhaul is a must. Untrue brake drums (unless in severe condition) cannot be determined by visual inspection only. The only accurate method of detecting untrue brake drums is by placing them on a brake drum lathe.

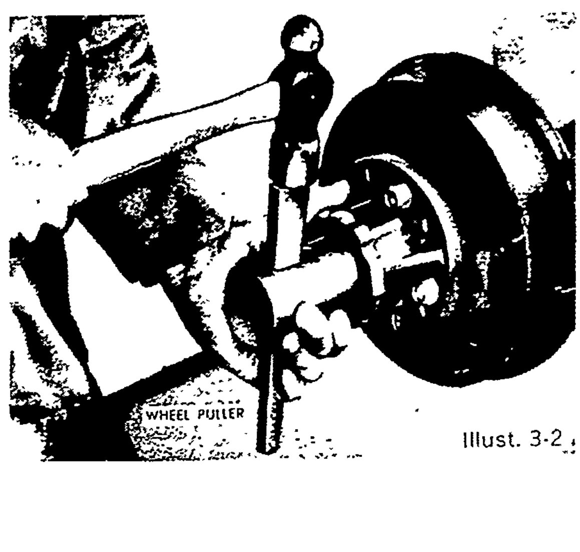
Correct Brake Service or Overhaul Procedure

1. Place car on jack stands or lift.

7. Tighten puller against axle shaft. *See Illustration 3-2.*
8. Strike puller with 3-to-5 pound hammer.

NOTE: **If in three solid blows the hub does not come loose, tighten puller again and leave pressure on puller for 20 minutes before continuing. Leaving this pressure on usually makes pulling easier.**

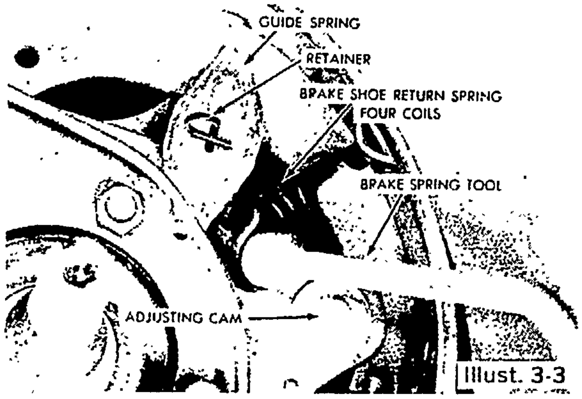
9. Remove front hubs and drums.



Illust. 3-2

10. Turn brake drums.

NOTE: Drums can be turned or ground while other brake work is continued.

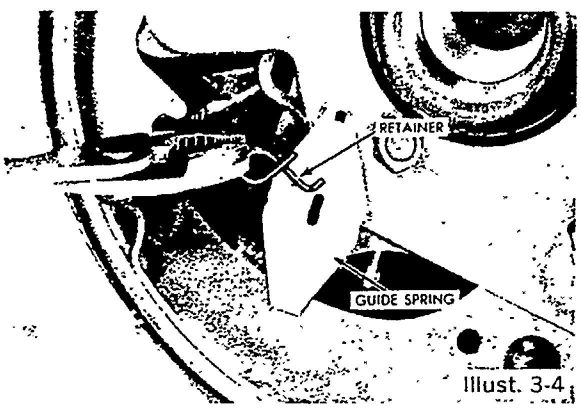


Illust. 3-3

11. Using a special type spring removing tool remove the brake shoe return springs on all brake shoes. *See Illustration 3-3.*

NOTE: 12" front brakes use two 4-coil shoe return springs. Rear brakes use two 5-coil shoe return springs. 11" front brakes use 3-coil springs prior to April, 1959.

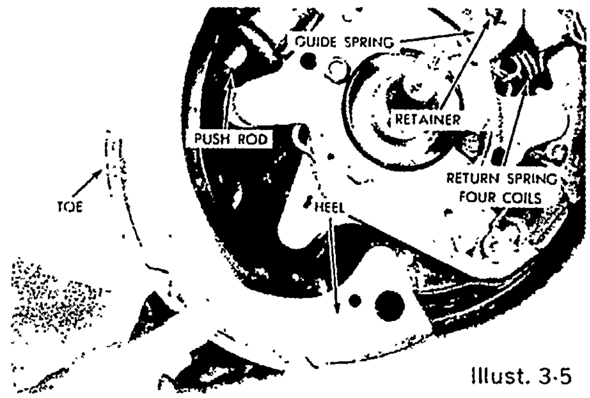
Do not use conventional brake spring pliers since they will damage the linings.



Illust. 3-4

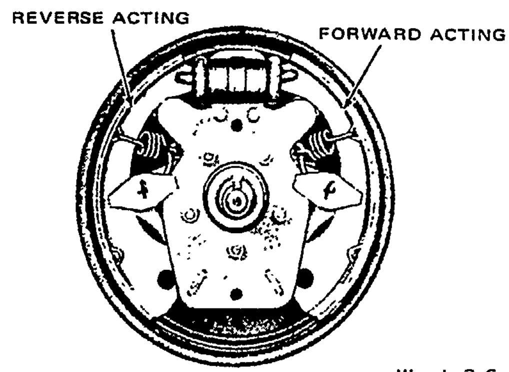
12. Turn the guide spring retainer one-fourth turn and lift the retainer and guide spring off the support plate. The lip on the end of guide rod is used for positioning the rod into the slot of the spring retainer. *See Illustration 3-4.*

NOTE: Several modifications have been made on this type of brake, such as location of guide spring, loops, and crimps in brake shoe.



Illust. 3-5

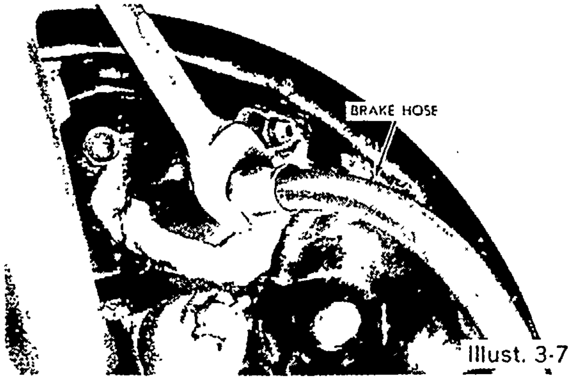
13. Slide the brake shoes from between the support plate, tilt and lift off from the support plate. *See Illustration 3-5.*



RIGHT REAR WHEEL BRAKE Illust. 3-6

14. Rear brake shoe removal is identical to the front brake shoe removal, except the rear brakes utilize a 5-coil return spring hooked to a loop on the *inner circumference* of the brake shoe. *See Illustration 3-6.* On 12" brakes, the front brakes use a 4-coil shoe return spring hooked to a hole in the *web* of the brake shoe. On 11" brakes, a 3-coil spring is used. These springs have one short and one long spring end hook.

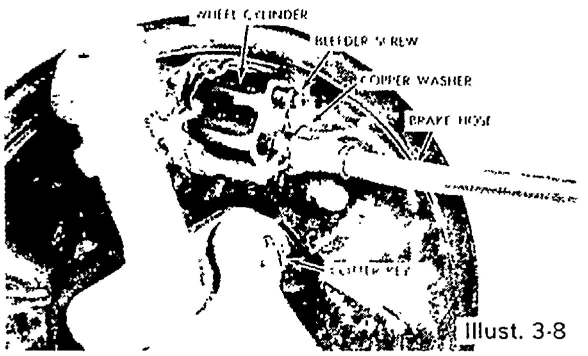
15. On all brake jobs, always check for hydraulic fluid and grease leaks. Many good brake jobs have been ruined by overlooking leaky hydraulic cylinders and worn out grease retainers.



Illust. 3-7

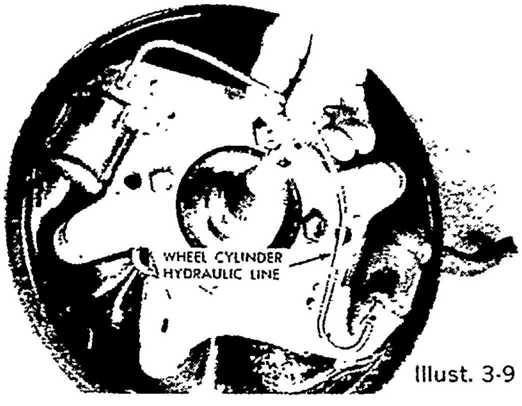
16. *Wheel Cylinder Removal*

a. Remove brake hose retaining clip at frame bracket and disconnect hydraulic brake line from the brake hose. *See Illustration 3-7.*



Illust. 3-8

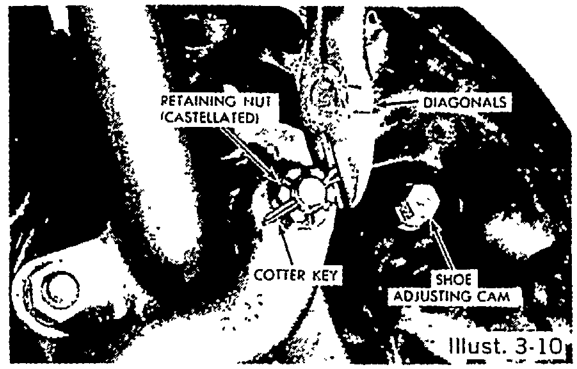
b. Turn the hydraulic brake hose counter-clockwise and remove the hose. *See Illustration 3-8.*



Illust. 3-9

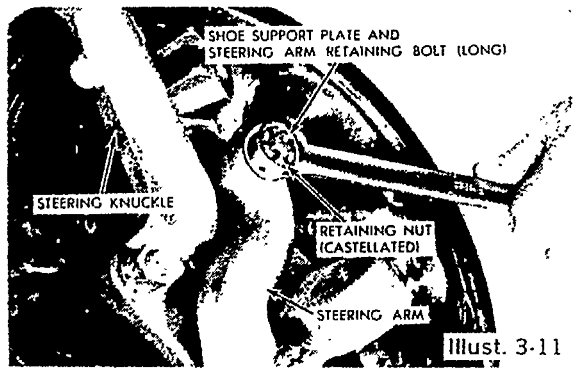
c. Loosen and remove the hydraulic line connecting the wheel cylinders. *See Illustration 3-9.*

NOTE: **Be sure and clean this line. A restriction will cause side pull.**



Illust. 3-10

d. Remove the cotter keys from the steering arm castellated retaining nuts. *See Illustration 3-10.*

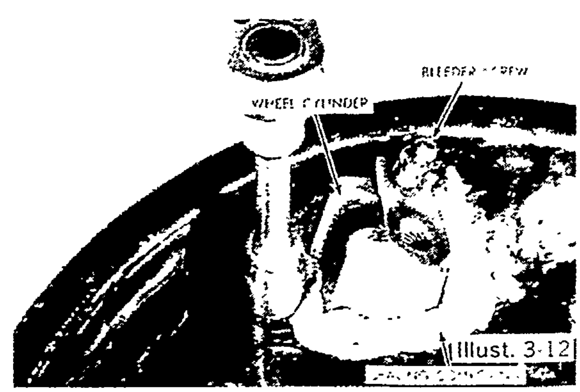


Illust. 3-11

e. Loosen and remove the castellated retaining nuts from the brake backing plate bolts at steering arm. *See Illustration 3-11.*

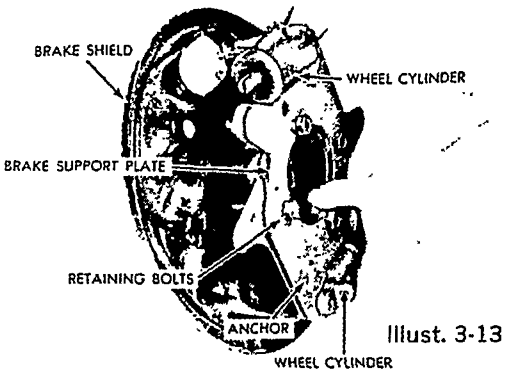
NOTE: **The shorter of the two brake backing-plate mounting bolts is positioned at the front steering arm hole.**

f. Remove the brake backing-plate mounting bolts, nuts and lock washers.



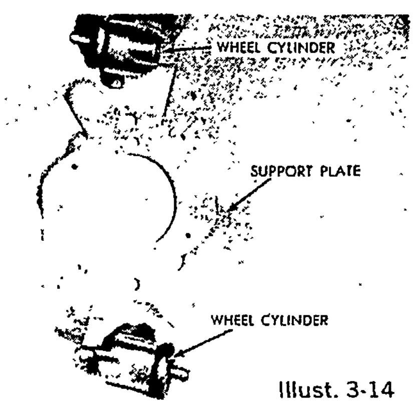
Illust. 3-12

g. Remove upper and lower wheel cylinder attaching cap screws. *See Illustration 3-12.*



Illust. 3-13

h. Slide the entire assembly away from the brake backing plate. *See Illustration 3-13.*



Illust. 3-14

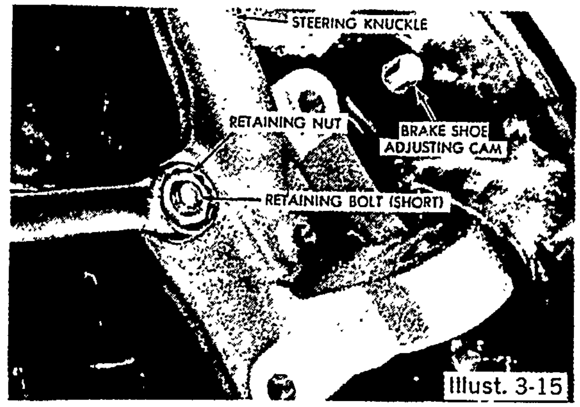
i. Slip out wheel cylinders from the support plate. Inspect support plate anchors, lubricate adjusting cams and check flat connecting link spring for condition and position. *See Illustration 3-14.*

   If any excessive wear or damage shows on support plate and attached parts, replace support plate assembly. Overhaul or replace wheel cylinders as outlined in Lesson #2.

Installation Procedure

1. Position the support plate retaining bolts, support plate and wheel cylinders to the brake shield and steering knuckle as an assembly. *See Illustration 3-13.*

2. Install and tighten the wheel cylinder attaching cap screws. *See Illustration 3-12.*



Illust. 3-15

3. Install both backing plate mounting bolts, lock washers, retaining nuts and tighten to 50 foot pounds. *See Illustration 3-15.*

4. Install the backing-plate-to-steering-arm castellated retaining nuts and tighten to 50 pounds. *See Illustration 3-11.*

NOTE: Make sure cotter keys are correctly installed and ends bent over.

5. Position and install hydraulic line connecting upper and lower wheel cylinders. Be sure threads are not crossed before tightening. *See Illustration 3-9.*

6. Install and securely tighten hydraulic brake hose to wheel cylinder. *See Illustration 3-8.*

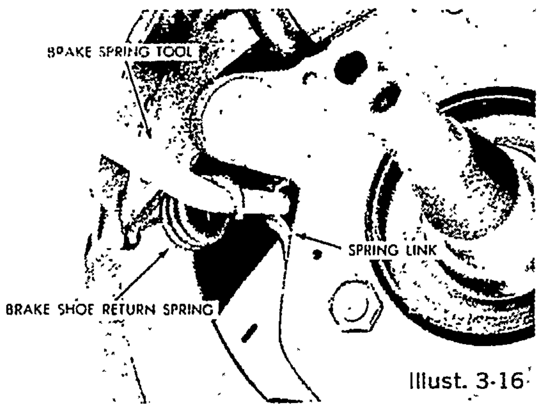
NOTE: Use new copper seal washer.

7. Attach hydraulic hose to frame bracket, thread brake line connector to brake hose and tighten securely.

NOTE: Always use care and be extremely clean while doing any type of brake work.

8. Lightly lubricate the *web* of the shoes with a special brake shoe lubricant wherever they contact the support and at the end of the shoe anchor plate.

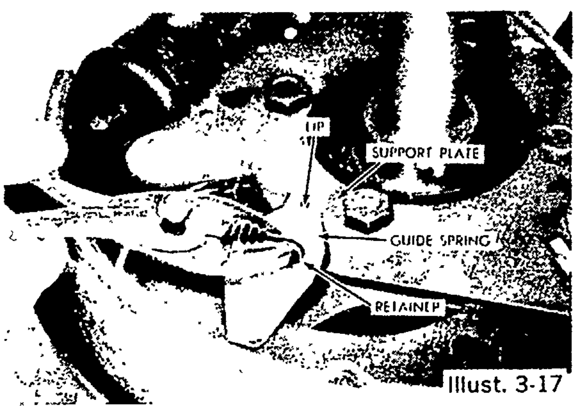
9. Position the brake shoes in the brake shoe support making sure that the toe end of the shoes engage the ends of the wheel cylinder push rods correctly, and the heel ends of the shoes slide freely on the anchors. Make sure the heel ends of the brake shoes are free of burrs. Side clearance between shoe web and support plate should not exceed .005".



Illust. 3-16

10. With a brake spring installation tool, hook up the two brake shoe return springs on the front brakes to the *web* of the brake shoes (prior to April 1, 1959). On rear brakes, hook up the brake shoe return springs to the loops in the brake shoe table. *See Illustration 3-16.*

11. Lightly lubricate and position the brake shoe guide springs and install the guide spring retainers with a suitable tool.



Illust. 3-17

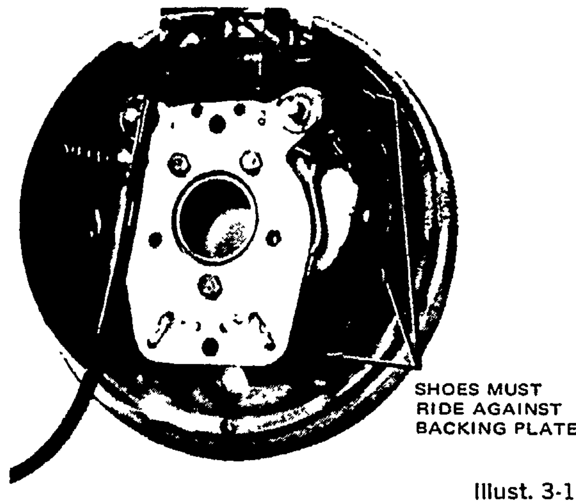
CAUTION: **Be sure the lips of the guide springs seat in the positioning holes in the brake shoe support. See Illustration 3-17**

Special Tips for Better Chrysler Center Plane Brake Service

For Better Alignment

Carefully examine the pattern of wear on the old brake shoes. Shoe guide or lug must hold shoe table square to the drum surface.

One of the main causes of Chrysler Center Plane brake noise and side pull is the brake shoe spring loops digging into the brake backing plate or the shoe itself, dragging on the backing plate (this is on all Center Plane Brakes before April 1, 1959).



Illust. 3-18

Models from May 59 thru 61 were of an improved design, the shoes having "loops" on the table to provide a vibration free, 3 point positive contact with the support pads on the backing plate.

This also helps to keep the lining square to the drum surface. *See Illustration 3-18.*

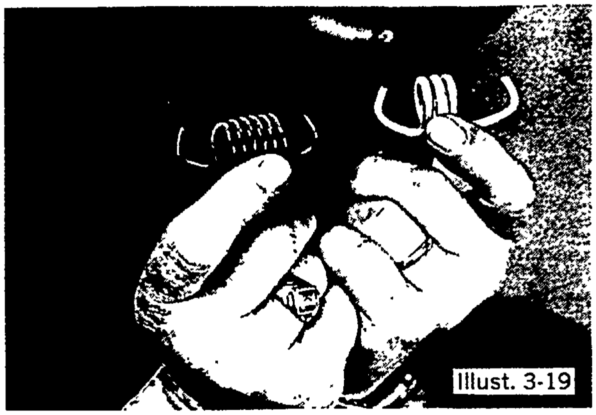
Make sure brake shoe web is straight and that there is no roughness of burrs where it contacts the anchor.

Check the heel end of web for burrs which may prevent shoe from centering properly.

If the brake shoe does not slide on the anchor, it will only contact the cylinder end of shoe and cause excessive wear at this point. A specified brake shoe lubricant is a *must* on the *anchor*, the *shoe guide* and the *adjusting cam.* If the shoe is not lubricated properly, it will not make total contact with the brake drum. This causes noise and erratic brakes.

Spring Tension

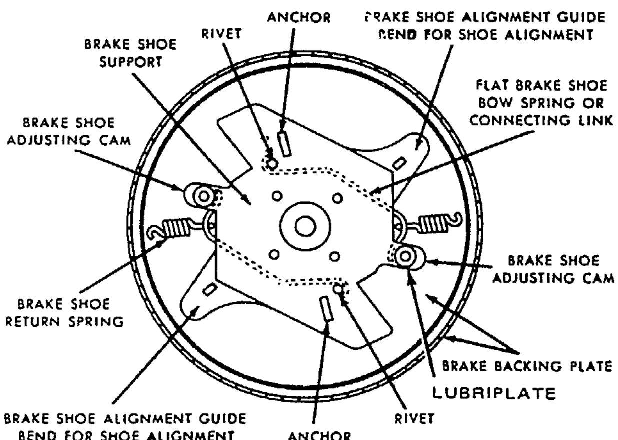
Spring tension is very important on this brake since only one spring has the job of returning and centering the entire brake shoe. On the *front* brakes up to April 1, 1959, the brake return spring fastens in the *web* of the shoe. On later models, all springs are connected to spring loops on the *table* of the shoe.



As previously stated, on 11" brakes this is a 3-coil spring with a long and short end.

On 12" brakes it requires a 4-coil spring.

Rear wheel brake return springs fasten in the *table* of the shoe. This spring has 5 to 7 coils and both end hooks are the same length. *See Illustration 3-19.*



Illust. 3-20

All Center Plane brake shoe return springs fasten into another long flat spring that is much like the string on an archer's bow. One end of this bow-like spring hooks over a pin near the flat anchor on the brake shoe support. The other end attaches as it half circles the back side of the adjusting cam. Lubriplate between spring and cam lobe.

If this long flat bow spring becomes bent or comes loose from either end, complete replacement is definitely necessary. However, the spring is not available as a single item and must be purchased as part of the whole brake shoe support assembly. Therefore, you should be particularly careful when servicing.

Before April 1, 1959, the front brake shoe return springs were 45 pound test; after this date, the three platform brakes were used and a stronger 55 to 70 pound return spring was incorporated. This spring is much too strong for the long flat bow spring (the bow spring and the coil spring work together). On severe service applications such as police cars, cabs, and other high speed drivers, the extra heat bends and distorts the long flat bow spring. This results in spring tension becoming too weak to affect proper brake shoe return. *See Illustration 3-20.*

Here Are The Costly Results of Improper Spring Tension

1. Fast lining wear (brake shoe temperatures of 600 degrees F can accelerate lining wear as much as 20 to 1 over normal operating temperature).
2. Burned up brake drums and hard spots.
3. Erratic brake action.
4. Very poor quality brake performance overall.

Special Tips For Correcting Problems

1. *Replace* the complete brake shoe supports whenever long flat springs are damaged.
2. Get the *old type* 3 or 4 coil brake return springs for the front and fasten them in the *web* of the shoe. This holds the brake shoe straight and this 45 pound test spring will not damage the long flat bow spring. Heavier coil springs makes the flat bow spring do all the work.

   The long flat bow spring rides on the adjusting cam. Thus, when the heavier type brake shoe coil return springs are fastened, they never change tension as they follow the cam each time the adjustment is changed. Coils on brake shoe return springs must separate when connected to brake shoes. This indicates springs are holding brake shoes properly.

Axle and Wheel Bearings

Always check rear axle end play after the drums and hubs have been removed. Should be .004" to .006". If you have excessive end play, remove backing plate and remove necessary shims to take end play out of axles. Taking shims out of one side corrects end play in both sides as axles have a spacer in the center. Loose *front* wheel bearings and loose rear axle bearings allow shoes to vibrate creating severe brake noise. *See Illustration 3-20 again.*

Brake Anchors

This is a small flat anchor that the brake shoe must slide on when the brakes are applied. If this anchor is loose, it will cause severe brake noise. The best way to detect loose anchors is to notice the dust pattern on anchor ends when the hub and drums are first removed and before cleaning. If the anchors are loose, replace entire brake shoe support or secure both anchors by electric welding. *See Illustration 3-20.*

NOTE: **Do not attempt to rebrad anchors. It is impossible to re-fasten them in this manner where they won't vibrate. Weld them or completely replace brake shoe support. REMEMBER, VIBRATION IS NOISE!**

Brake Drums on Chrysler Products

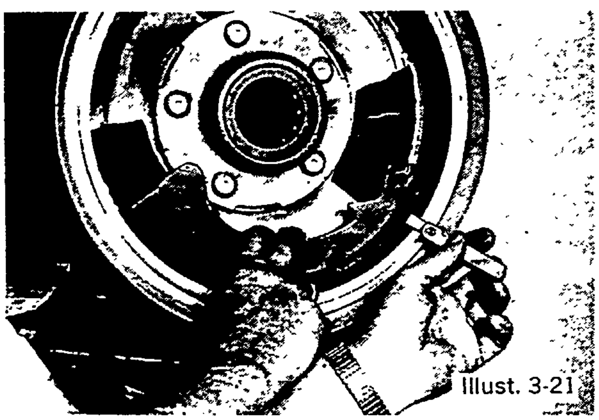
Often, Chrysler vehicles come from the factory with an undersize brake drum on one wheel and a standard or oversize brake drum on the opposite side. Different brake drum thicknesses mean drums differ in their ability to dissipate heat. A thin brake drum has less exposed surface; and thus, cannot dissipate heat as well as a thick one. On high speed stops unequal drum thicknesses can cause brake action to be erratic and car may pull to one side. Keep out of "brake trouble" by keeping the drums on each axle within .005" of each other. It is all right to have a difference between front and rear brake drums. But, by all means, have both *front brake drums the same size, and both rear brake drums the same size.*

Assuring Trueness of Brake Drums

For a better brake job *always* turn the brake drums. Most brake drum conditions cannot be detected by visual inspection only. There is *always* one or more drums out of round on most any vehicle.

Out of round brake drums can only be found by putting drums on a drum lathe. Out of round brake drums cause poor contact, hard brake pedal and noise.

Poor brake drum contact means unsatisfactory brake performance and comebacks. Comebacks never occur at convenient times and they never help your business or your reputation.



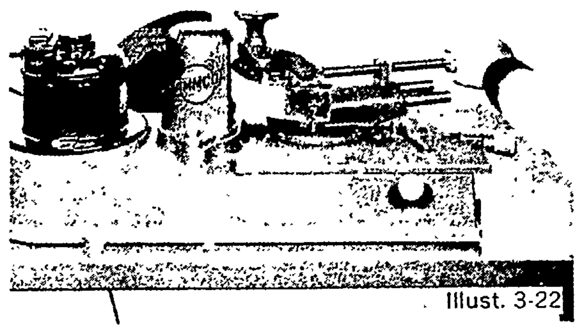
Illust. 3-21

Assuring Chrysler Center Plane Brake-Shoe-to-Brake-Drum Fit

Center plane brake shoes are very rigid and do not flex or tend to straighten out when brakes are applied. Chrysler Center Plane brake shoes operate independently of each other. One brake shoe does not help the other to energize as Bendix brake shoes do. Brake Lesson #4 explains this in greater detail. However, it is important to remember that for proper friction, a Center Plane brake shoe requires a more perfect fit between the brake shoe lining surface and brake drum than Bendix system brake shoes do. *See Illustration 3-21.*

To determine proper fit, place brake shoe in refinished brake drum, hold center section of brake shoe tight against the brake drum. Measure the clearance between the brake drum and each end of the brake shoe. This clearance should be approximately .005". Excessive brake shoe toe and heel clearance creates a soft or spongy brake pedal. This objectionable condition could last until brakes wear in, which could take as long as 10,000 miles.

Holding the brake shoe firmly, slide it back and forth on the brake drum surface. Shoe lining surface should show markings of full contact on the total lining surface. If not, carefully regrind brake shoe for more precise fit in brake drum. *See Illustration 3-21.*



Illust. 3-22

Procedure For Arc Grinding Chrysler Product Center Plane Brake Shoes

These brake shoes are ground using an open head brake shoe grinder without anchor attachment.

Place brake shoe in grinder, set grinder to proper brake size, set brake shoe grinder micrometer up to finished brake drum size, then back off micrometer to .015" *under* drum size.

Arc grind lined brake shoe just enough to clean total brake lining surface. If in doubt, chalk entire lining surface, then arc grind shoe until all chalk markings have been erased. *See Illustration 3-22.*

In other words, always arc grind center plane brake shoes .015" under refinished brake drum size. This gives enough heel and toe clearance to prevent brake noise and side pull and not enough heel and toe clearance to cause a soft spongy brake pedal. *See Illustration 3-21.*

Proper brake lining friction is a very important factor on the Chrysler Center Plane brake. High friction brake lining should *never* be used. Always use a low or medium friction lining only.

High friction brake lining will seem to work well until the brakes are fully seated to the brake drum, then the trouble begins. Starting out with the brakes cold, on the first brake application, one or more of the brakes will lock up. The driver must back the car up in order to get the brakes to release. After this, the brakes may seem to work satisfactorily. However, once they have completely cooled again, the problem repeats itself.

Brake shoes with high friction linings will wedge against the brake drum so tight that the brake shoe return springs cannot release the brakes even though all springs are in perfect condition. (Weak brake shoe return springs may cause this condition even when proper brake lining friction is used.)

NOTE: **When complaints of this condition occur, there will be no visual evidence to indicate trouble. The brake system will appear to function perfectly. Replacing brake shoes with correct lining friction will solve this problem. If weak brake shoe return springs are at fault, they must be replaced.**

Proper Procedure For Breaking In The Brakes

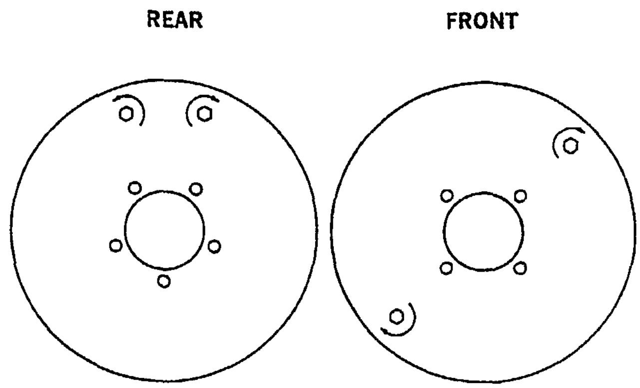
By all means, brake lining should be broken in properly and it should not be abused until they at least have 1,000 miles of normal driving on them.

Even though the brake shoes are carefully ground to fit the brake drums, perfect contact is not possible until they have been used for approximately 1,000 miles. In addition, during this break-in period, the brake lining receives an additional "cure" that cannot be duplicated in the manufacturer's oven.

A recommended procedure is to:

1. Make 20 MPH stops at one minute intervals, alternating one heavy stop (keep tires from skidding) with one light stop. The one minute interval between stops allows brakes to cool.
2. Make eight of these stops. After this, if the brake action is still not equal, there is something wrong with your installation. Make sure you followed the correct procedure during servicing.
3. For *high speed drivers*, 20 such stops will be more beneficial.
4. No panic stops for first 1000 miles.

NOTE: Let brakes cool before returning car to customer. (The so-called "burning-in" of brakes harms them.)



Illust. 3-23

Correct Procedure For Adjusting Center Plane Brakes

1. *Rear wheel brakes*—Tighten the *rear* brake shoe adjustment in the same direction the wheel rotates when car is moving *backwards*. On the rear wheel brake *front* shoe, tighten in direction wheel rotates while car is moving *forward.*
2. *Front wheel brakes*—Tighten both brake shoe adjustment in direction of wheel rotation when car is moving *forward. See Illustration 3-23.*
3. Loosen brake adjustment until wheel turns freely.

If the front brakes are tightened in the wrong direction, it disturbs the critical cam angle on the rear shoe and it causes brakes to be noisy and erratic. In addition, each time the brakes are released the shoe knocks against the cam causing the brake adjustment to loosen further.

Lesson #4 will take up the widely used *Bendix Brake System*. The contrast between the Chrysler Center Plane System and the Bendix System will be easily seen. A good working knowledge of the procedures for servicing both of these systems can help build your reputation as a skilled brake service technician.

Save all lessons for future reference. Proper use of them can build your experience and prevent costly comebacks.

MAR 001482

CHAPTER 4 BENDIX BRAKE SYSTEMS

In the previous Lesson #3 we dealt with the Chrysler Center Plane Brake System, its method of operation, and the correct procedure for servicing.

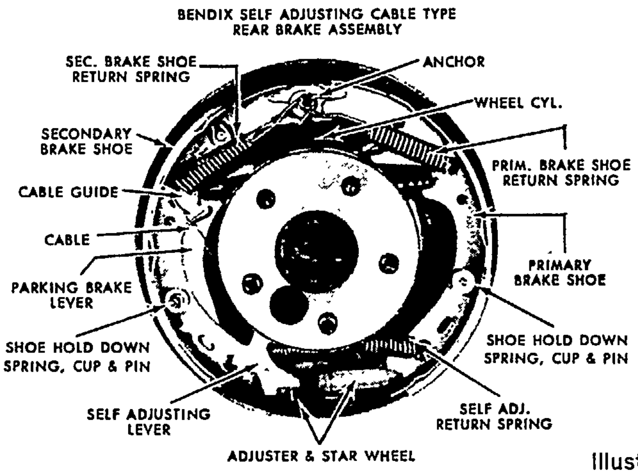
In Lesson #4 we will study the Bendix Brake System. While studying this lesson material you will no doubt learn of the contrasting methods of operation between the Chrysler Center Plane System and the Bendix System.

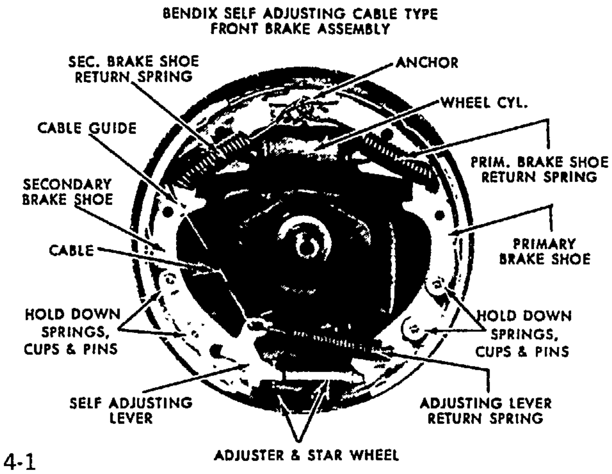
As you go through this material you will first be shown how the Bendix System operates. Then, you will be shown the correct procedure for servicing with some unique tips that will help you to do a better job for your customer. Refer back to previous lessons as necessary.

How To Service Bendix Brakes (Self-adjusting Type)

There are two types of self-adjusting brakes: The cable type used by Ford and Chrysler, and the lever type used by General Motors. The difference between these two types of self-adjusting brakes will be discussed in applicable portions of the lesson dealing with methods of servicing.

1. Place car on lift or jacks and stands.
2. Disconnect parking brake cables at equalizer bar (usually located under the car behind the transmission).
3. Remove hub caps and wheel lug bolts.





Illust. 4-1

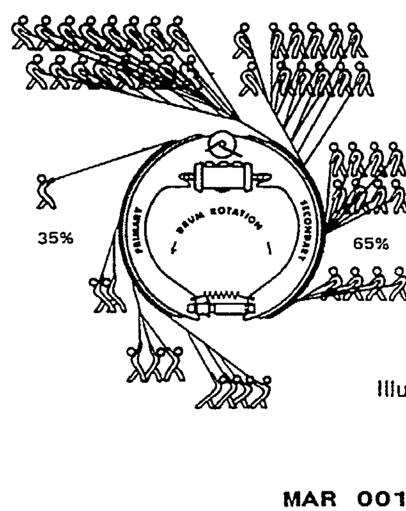
Operation of The Bendix Self-Energizing Brake

Bendix is the most popular brake in the passenger car field. It is used by General Motors, Ford, Chrysler, and many others. *See Illustration 4-1.*

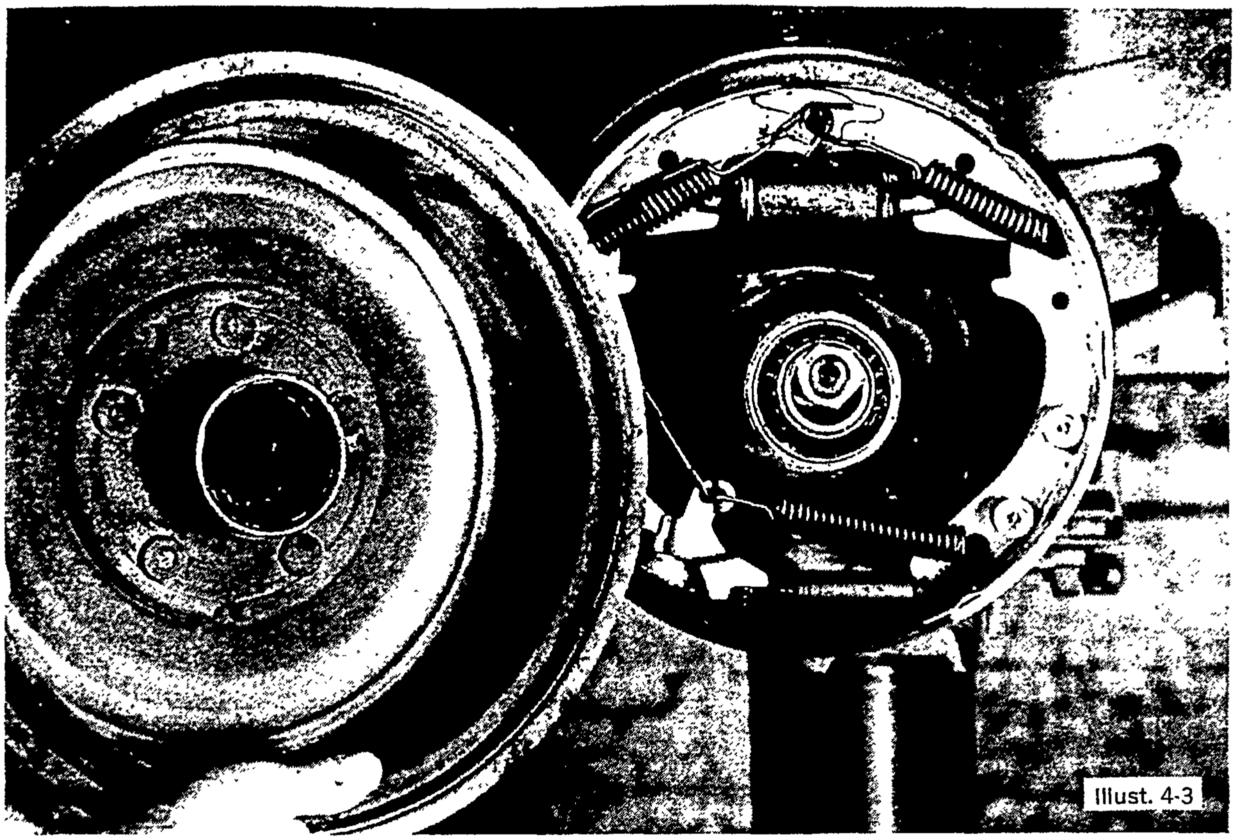
This brake borrows motion from the revolving brake drum to provide a wrapping or self-energizing action which lessens amount of pedal and hydraulic line pressure required to make a stop.

On a normal city stop at 30 MPH, the hydraulic line pressure is 200 pounds P.S.I. This pressure starts out at the anchor end of the primary shoe as 1-to-1 ratio and progresses up to 16-to-1 pressure ratio at the anchor end of the secondary shoe. 16 x 200 pounds equals 3200 pounds of pressure that is exerted by the last quarter of the secondary shoe to the brake drum. This far greater pressure is why the lining on the secondary brake shoe always wears out before the primary lining. *See Illustration 4-2.*

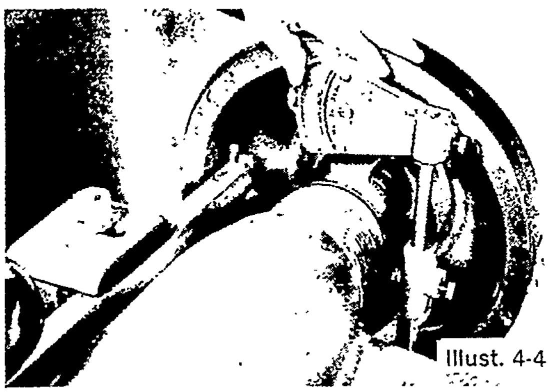
4. Remove pal nuts or cap screws that hold rear brake drum to axle flange.
5. Remove rear brake drums.
6. Remove front hub dust cap, cotter pins, and spindle nuts.
7. Remove front brake drums.
8. Remove front hub inner bearing and grease seal.



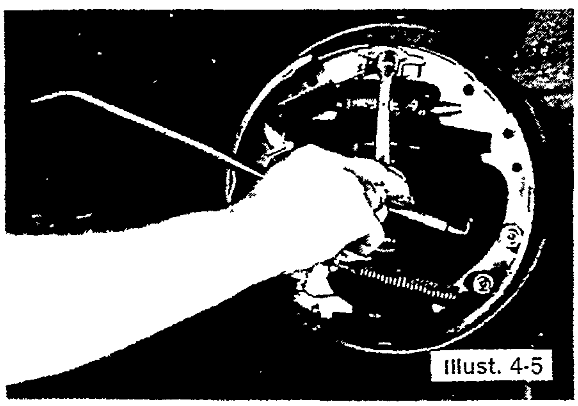
Illust. 4-2



Illust. 4-3



Illust. 4-4



Illust. 4-5

To remove quickly and easily, screw spindle nut back on spindle. Place inner bearing over spindle nut, a quick jerk usually leaves bearing and seal hanging on spindle. This process is much faster than using a drift and hammer. *See Illustration 4-3.*

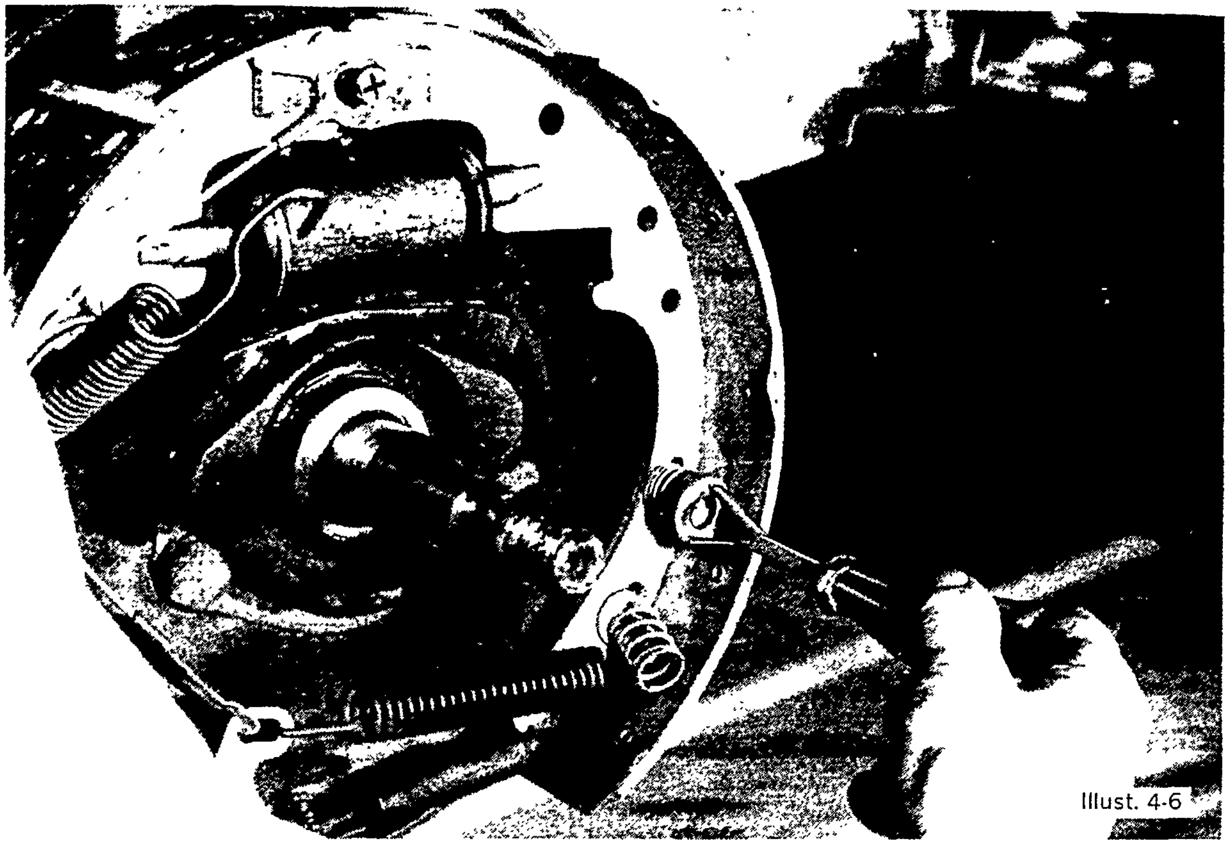
1959 and later Chevrolet front drums will readily slip off the front hubs. To center these drums properly for machining, replace drum on hub and install three of the lugs to hold the drum tight to the hub. Mount the hub and drum assembly on the lathe, using the bearing cup surfaces.

9. Resurface brake drums.

NOTE: The brake drums can now be resurfaced on a brake drum lathe while you are continuing with the rest of the brake service. *See Illustration 4-4.*

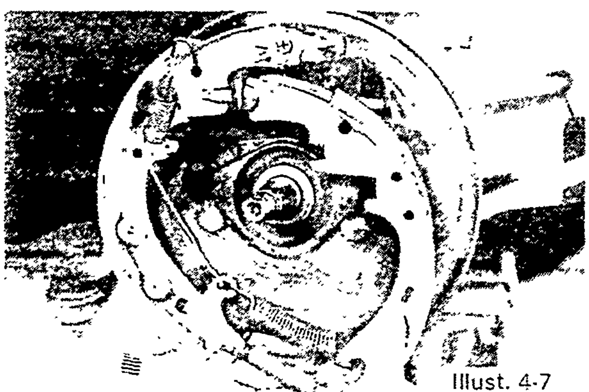
10. Blow all dirt and dust from the brake assemblies with air hose nozzle.

11. With a special Bendix brake spring removing tool, remove the brake shoe return springs. *See Illustration 4-5.*



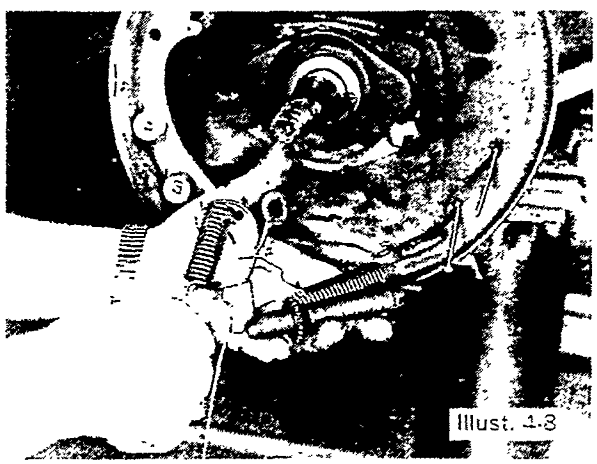
Illust. 4-6

12. Remove primary shoe hold down springs. Use special tool. *See Illustration 4-6.*



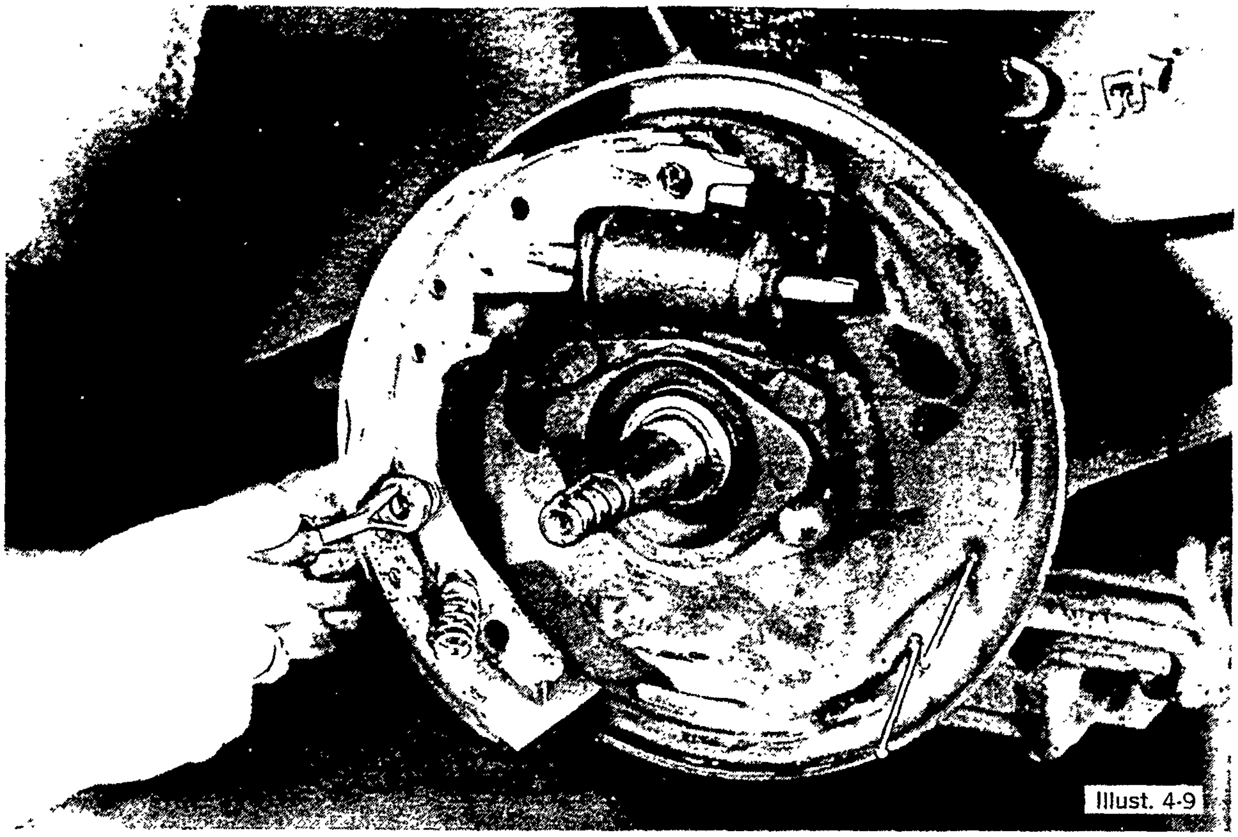
Illust. 4-7

13. Pull primary shoe away from brake shoe anchor. Then tilt toward back of vehicle until adjuster parts come loose. *See Illustration 4-7.*



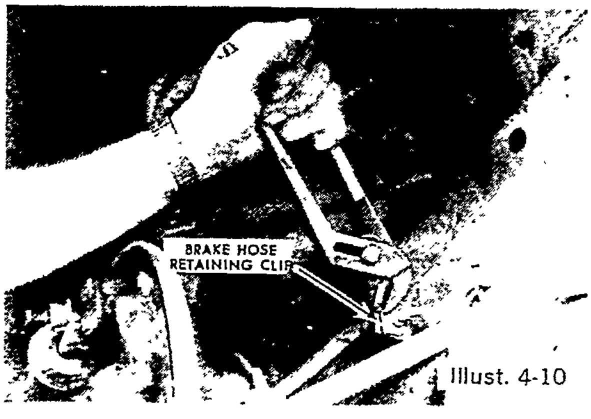
Illust. 4-8

14. Remove all self-adjusting parts. *See Illustration 4-8.*



Illust. 4-9

15. Remove secondary shoe hold down springs and brake shoe. *See Illustration 4-9.*



Illust. 4-10

16. Remove wheel cylinder.

   a. Remove brake hose retaining clip at frame end. Disconnect brake line from brake hose. *See Illustration 4-10.*

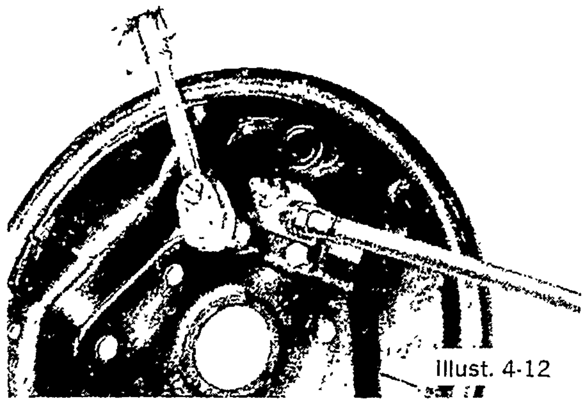
   b. Remove brake hose from wheel cylinder. (using 5/8" flare nut wrench).

   c. Remove wheel cylinder from brake backing plate by first removing the wheel cylinder retaining bolts. *See Illustration 4-12.*

   d. Overhaul or replace wheel cylinder as outlined in wheel cylinder overhaul in Lesson #2. To replace wheel cylinder reverse sequence.

17. Clean backing plate and all brake parts such as springs, adjusters, etc.

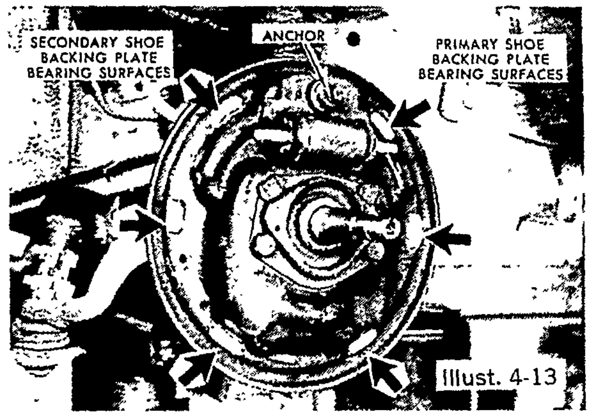
NOTE: **It is very important to have all parts clean before assembly. Also, greasy hands can affect brake performance. Brake shoes must be kept free of grease and oil at all times.**



Illust. 4-12

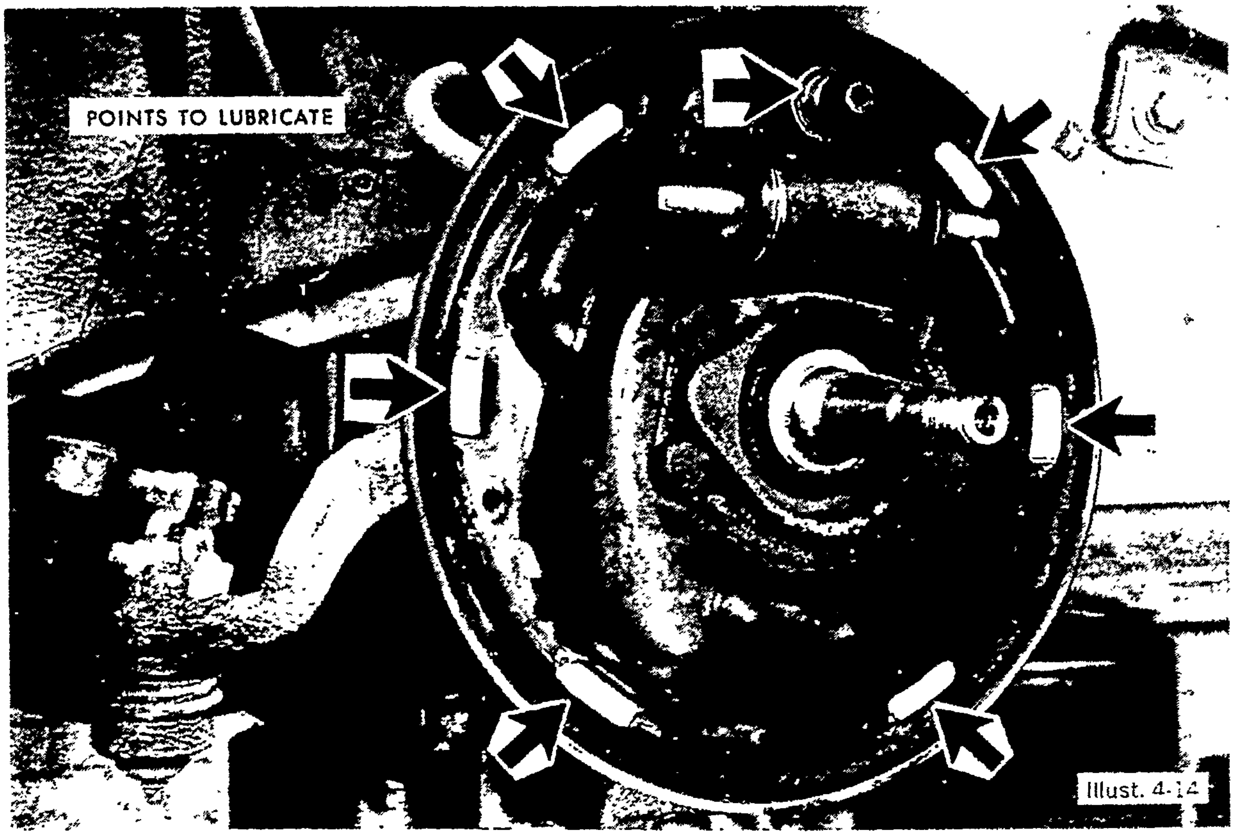
18. Inspect brake backing plate bearing surfaces for grooves and roughness. If grooves are too deep — replace backing plate.

NOTE: A groove or roughness on backing plate bearing surface can cause brake shoe to hang, which can cause brake shoe drag, misalignment of shoes, vibration, noise and pulling or erratic action. Smooth rough surfaces or replace backing plate. *See Illustration 4-13.*



Illust. 4-13

19. Lubricate brake backing plate bearing surfaces. Lubricate brake anchor. Disassemble, clean, and lubricate brake adjuster. *See Illustration 4-14.*



Illust. 4-14

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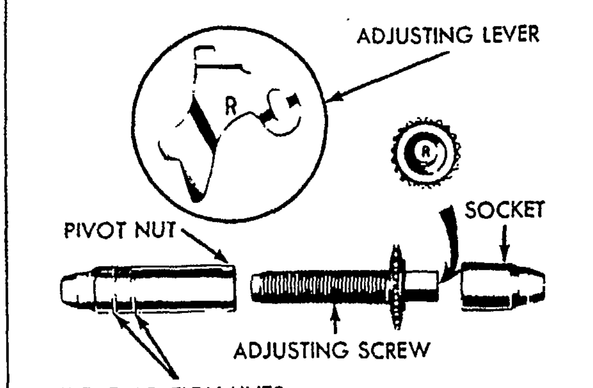


Illust. 4-15

The adjusters are marked right and left on the thimble end of the adjuster screw. Also, the adjusting levers on cable type are marked left and right. *See Illustration 4-15.*

20. Use only oversize brake shoes and grind to fit the newly resurfaced brake drums.

NOTE: Brake drums should not be turned or ground in excess of .060" over standard size except in the case of Ford and Mercury, 1961 through 1963, which should not be turned or ground in excess of .030" oversize.

An oversize set of brake shoes should be used on all brake relines. This will necessitate the arc-grinding of every piece of brake lining so that it will properly fit the drum.

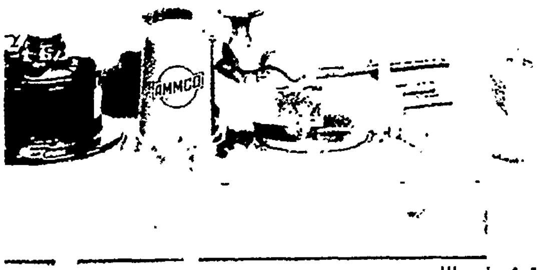
21. Place the new brake shoes in the finished brake drum. Hold the brake shoe in the center tight against the brake drum. You should be able to rock shoe in drum. This shows you the amount of heel and toe clearance you have on the brake shoe. This clearance should be approximately .010" between shoe and brake drum on each end of the brake shoe.

Inadequate heel and toe clearance causes brake noise and side pull.

Grinding The Brake Shoes

Grinding the brake shoes to fit the individual brake drum gives a more tailor-made fit of the brake shoes to the brake drum surface and is a must with oversize shoes. *See Illustration 4-16.*

During brake applications, Bendix passenger car brake shoes have a tendency to straighten out. This is why proper brake shoe heel and toe clearance is very necessary.


Illust. 4-16

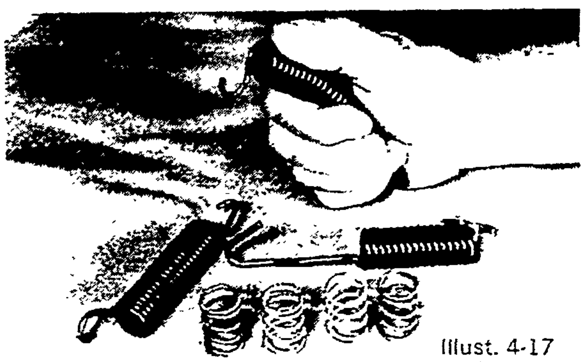
When grinding brake shoe to an anchor position (many brake shoe grinders do not have anchor grind), in order to get a cam grind on the brake shoe, always set the brake shoe grinder micrometer up to the brake drum finished size and then back off micrometer .030". In other words, the brake shoes should be ground *.030" under* brake drum size using <u>anchor position grind.</u>

If an open head brake shoe grinder is used (without anchor attachment), the brake shoes should be ground *.050" under* the brake drum finished size.

For example: A finished brake drum of .060" oversize on an 11" brake would be 11.060". When grinding the shoe .050" under drum size, the micrometer should be set at 11.010". This will allow about .012" to .015" clearance at toe and heel of each shoe.

There is another advantage to the grinding of the brake shoe .050" under drum size. It allows better alignment of the brake shoes to the anchor in relation to the 360 degree circle of the brake drum.

NOTE: When grinding brake shoes, grind off only enough lining to permit the grinding wheel to contact the full length and breadth of the lining. One technique used is to coat lining surface with chalk. Lined brake shoe is then passed through grinder. If grinder erases all of the chalk, complete surface contact has been made.


Illust. 4-17

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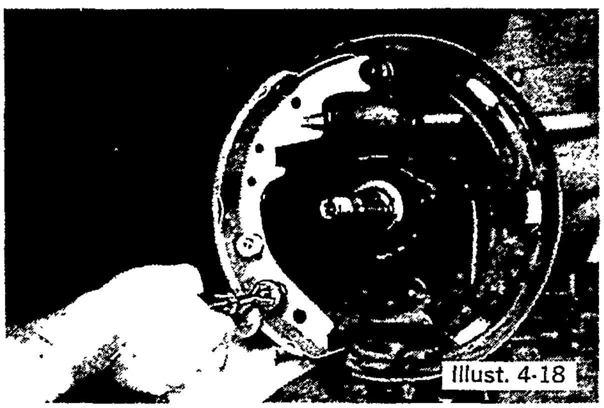
Installation

1. Visually inspect brake return springs and brake shoe hold down springs, feel them for flexibility. Compare them with new ones. If the brake springs show signs of being overheated, or if the coils are separated or if there is any doubt as to quality, then by all means, replace them with new ones. *See Illustration 4-17.* It is best to replace brake shoe springs in sets. Do not replace the springs on one side only without doing the same on the opposite brake.

Unequal Brake Spring Pressures Cause Unequal Brake Action

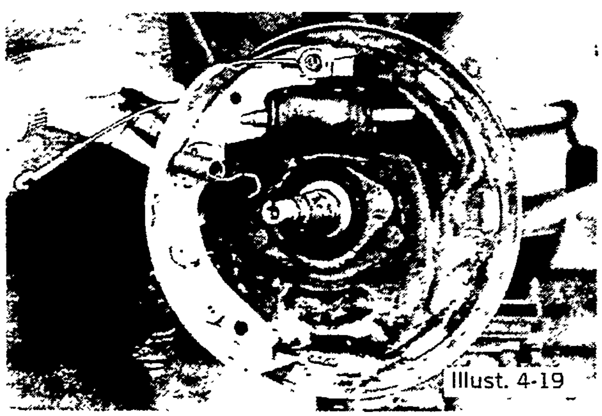
NOTE: **Some brake system applications have one large and one small brake shoe return spring. The heavy or stronger spring always goes on the secondary brake shoe. If the primary brake shoe spring is stronger than the secondary spring, it causes the secondary brake shoe to be applied first. This causes a car to pull to one side or to "zig-zag" when brakes are applied.**

Weak brake springs cause dragging brakes, unequal brakes and brake noise.



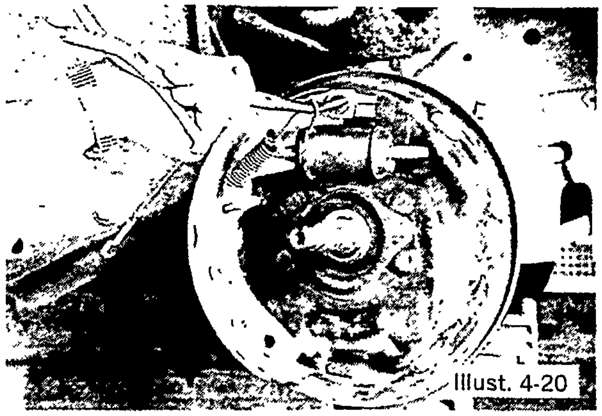
Illust. 4-18

2. Install secondary brake shoe and hold down springs. Be sure to use special brake spring tool. *See Illustration 4-18.*



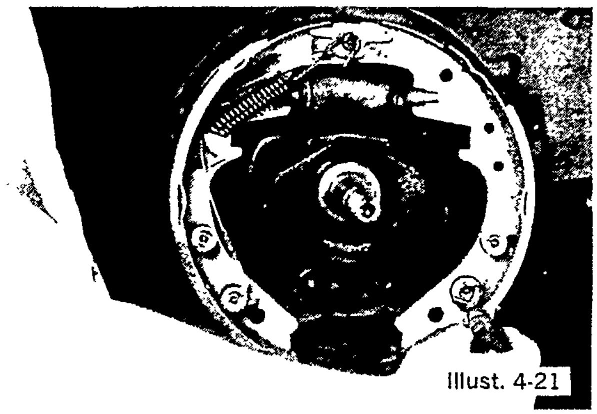
Illust. 4-19

3. Install self-adjuster cable over anchor pin. *See Illustration 4-19.*



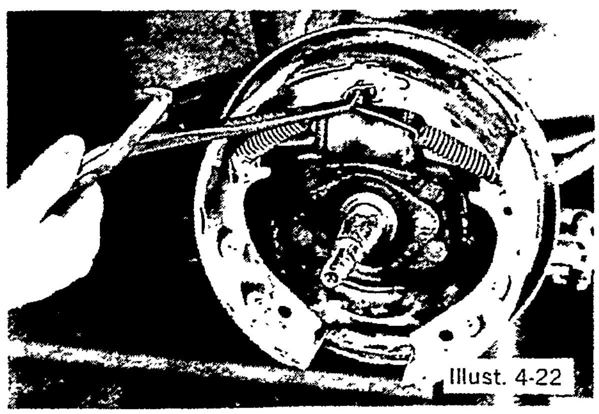
Illust. 4-20

4. Install secondary brake shoe return spring and cable guide. *See Illustration 4-20.*



Illust. 4-21

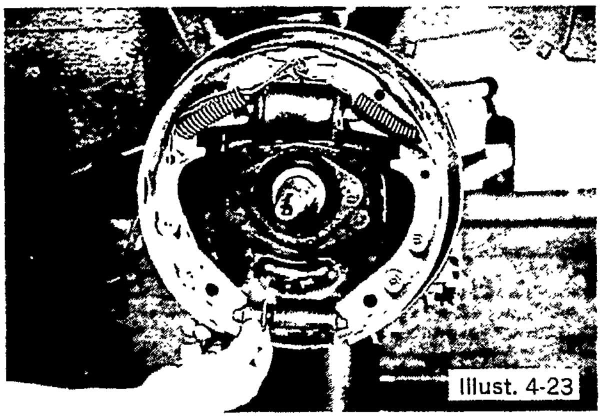
5. Install primary brake shoe and hold down springs. *See Illustration 4-21.*



Illust. 4-22

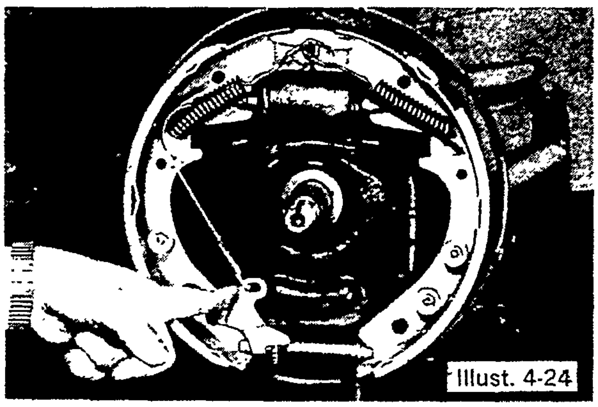
6. Install primary brake shoe return springs. *See Illustration 4-22.*

NOTE: If the brake shoe return spring hooks have been spread apart or become distorted, or show signs of excessive heat, they should be replaced. This can make a 20 lb. difference in spring tension.



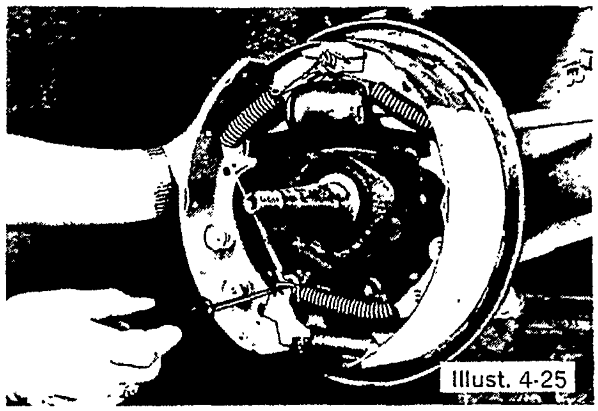
Illust. 4-23

7. Place brake shoe adjuster in position between brake shoes with adjuster wheel on secondary brake shoe side. *See Illustration 4-23.*



Illust. 4-24

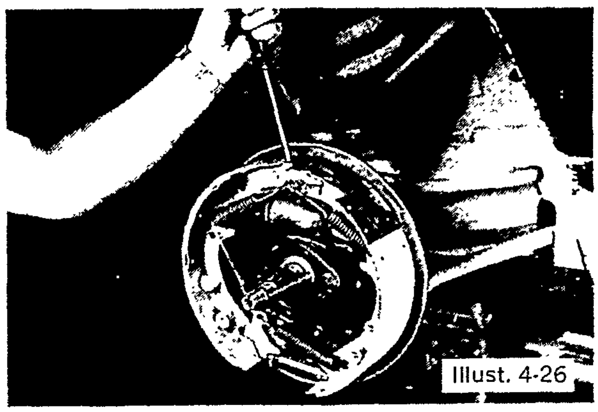
8. Place brake shoe adjuster cable over cable guide. Be sure cable guide is flush against the shoe, so that cable doesn't slip behind shoe and bind. *See Illustration 4-24.*



Illust. 4-25

9. Connect brake shoe adjusting spring into primary brake shoe. With special tool, "toggle" spring-hook into brake self-adjusting lever. *See Illustration 4-25.*

NOTE: **Jar brake shoes at anchor end with soft mallet or end of hammer handle. This centers the brake shoes. Work the brake self-adjuster by hand to check its operation.**



Illust. 4-26

10. Place long screw driver behind secondary brake shoe at anchor end. Pry secondary shoe away from anchor and then let it return to anchor and at the same time carefully notice the operation of the self-adjuster. *See Illustration 4-26.*

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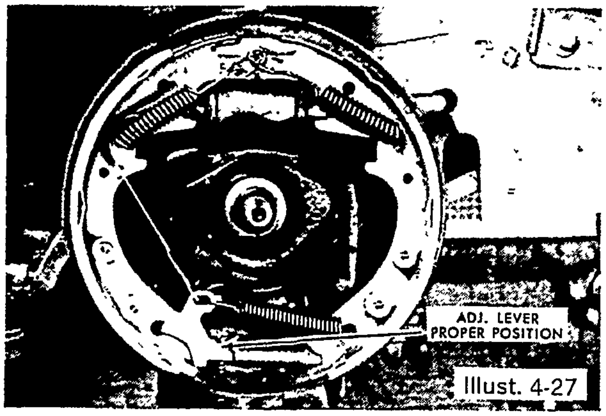
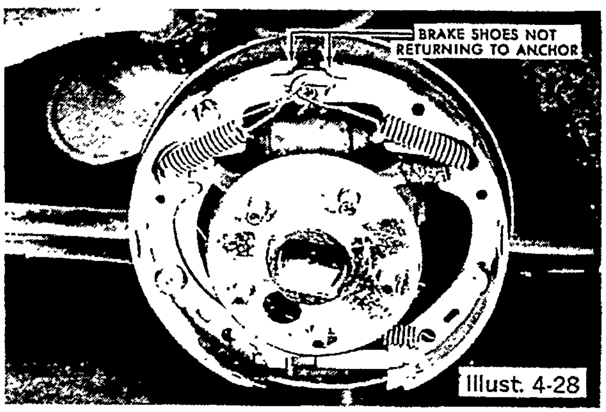


Illust. 4-27

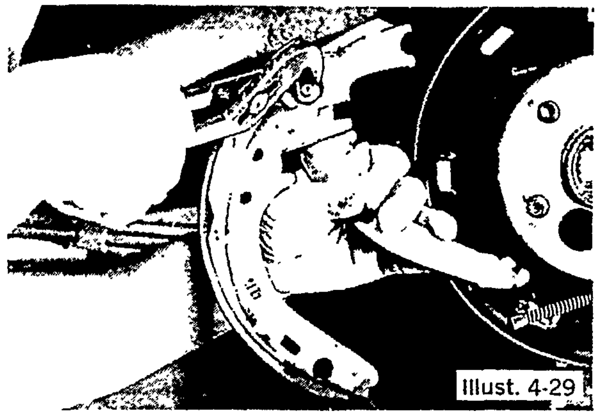
NOTE: To judge the proper brake shoe adjuster cable length, the cable should hold the self-adjusting lever so that it splits the adjusting wheel in half. A cable too short will over adjust the brake. A cable too long will not adjust enough. *See Illustration 4-27.*



Illust. 4-28

Rear Brake Shoe Installation

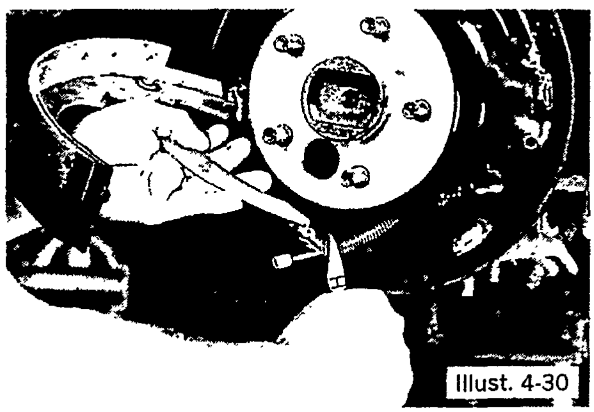
11. Before installing rear brake shoes, pull the parking brake cables back through the backing plate. Lubricate them and be sure they are working freely. Sticking parking brake cables can cause dragging brakes. Do not let sticking cables be the source of a comback. If they cannot be freed up with lube, replace cable and housing assembly. *See Illustration 4-28.*



Illust. 4-29

12. Install parking brake lever to secondary brake shoe. *See Illustration 4-29.*

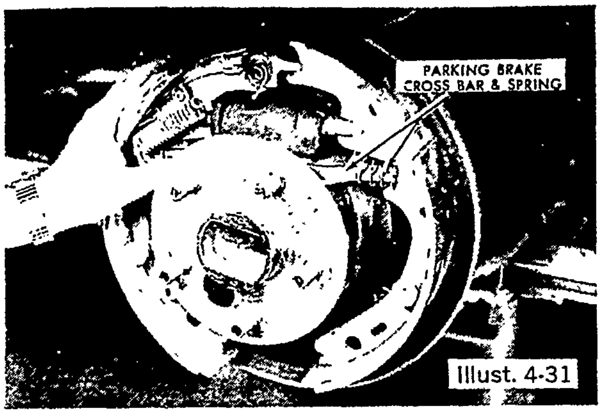
NOTE: Some of the levers are fastened with a "horseshoe" lock. Others are secured with a threaded nut. On either type, however, make sure the spring washer is installed, do not leave it out. It prevents rattle.



Illust. 4-30

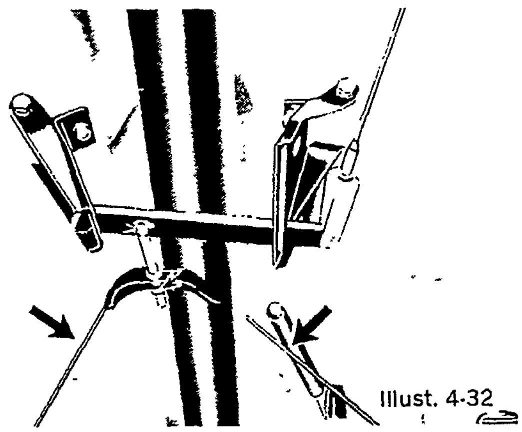
13. Install parking brake lever to parking brake cable. *See Illustration 4-30.*

14. Install primary and secondary shoe hold down springs as outlined in front brakes procedure.



15. Install parking brake cross bar or link between parking lever and brake shoe. *See Illustration 4-31.*

16. Do the balance of the installation work as outlined in front brake procedure.

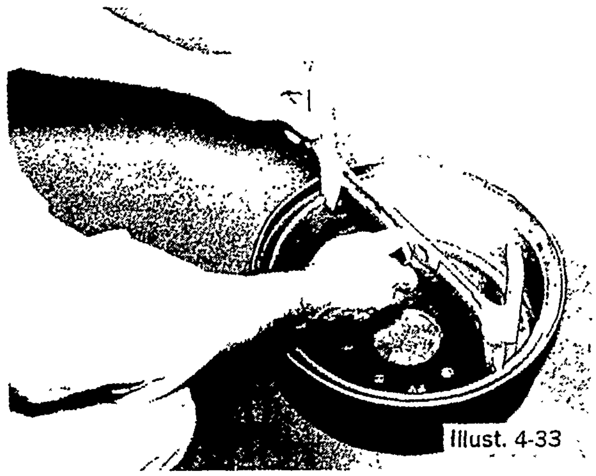


17. Adjust parking brake cables so that there is some slack in cables. Any cable that is too tight will cause brake drag. *See Illustration 4-32.*

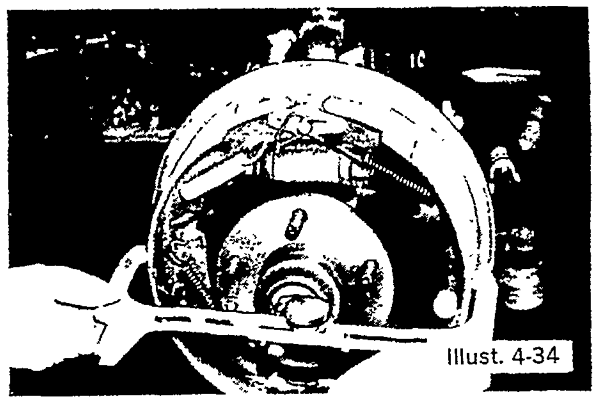
NOTE: **Before installing rear brake drums, have someone apply the parking brake and then release it. As it is released, brake shoe return springs should pull brake shoes back to the anchor with good solid action. If the brake shoes do not come back against the anchor when parking brake is released, the brake shoes will drag and cause damage to brake. Lubrication and spring tension are particularly important.**
See illustration 4-28

Tips on Bendix Brake Adjustments

On any passenger car Bendix Brake, the brakes can be adjusted before replacing the brake drums, providing you have an Ammco 8650 brake adjusting gauge.

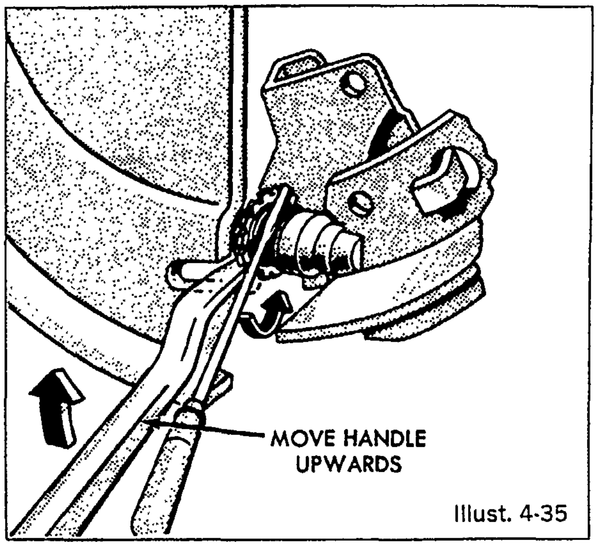


Loosen adjusting gauge nut just enough to slip. Place adjusters in brake drum. Spread adjusting tool so it contacts brake drum straight across the center of the brake drum. Tighten gauge lock nut. *See Illustration 4-33.*



Adjust brake shoes out until the gauge will just touch the brake shoes as gauge is passed up and down. This gauge is designed so it will give .010" clearance between each brake shoe and the brake drum. *See Illustration 4-34.*

Bendix Brake shoes have to have .010" clearance per shoe in order to give the wrapping action the brakes were designed to have.



Illust. 4-35

If this gauge is not available, the following procedure may be used for brake adjustment on the cable type self-adjusters:

Remove brake adjusting hole cover from backing plate.

With brake adjusting spoon, tighten adjustment so that brake shoes press tight against brake drum.

NOTE: To tighten brake adjustment, pull adjusting spoon downward. This is opposite to the standard brake adjustment motion.

To release or back adjustment off, use an ice pick or similar object to pass through adjusting hole, over brake adjusting screw and against the self-adjusting lever.

The adjusting lever has to be held away from teeth on the brake adjuster in order to back off or loosen adjustment.

Loosen brake adjustment approximately 20 teeth on adjuster. *See Illustration 4-35.*

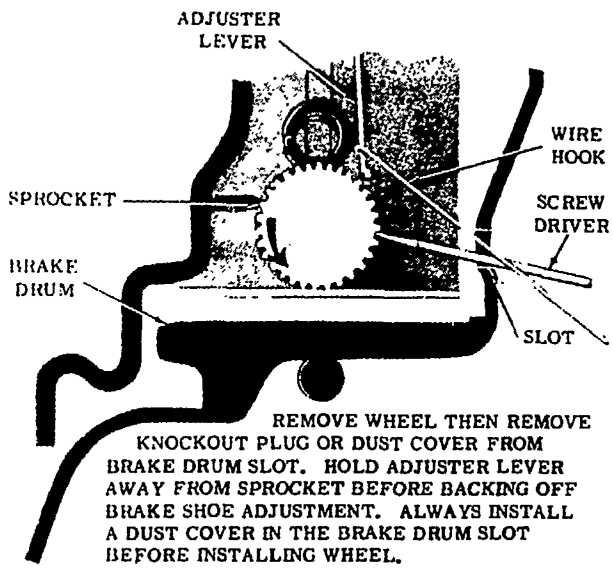
Lever Type Self-Adjusting Brakes

Many of these (such as several General Motors models) do not have adjusting holes in the brake backing plate.

The wheels have to be removed from the brake drum to gain access to the brake adjusting hole located on the wheel side of the brake drum.

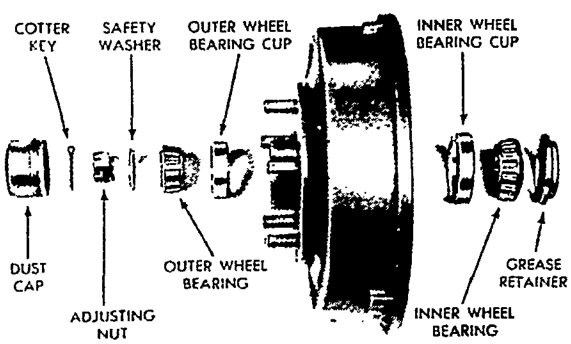
Some of these brake drums have a clip or snap-on cover in the brake adjusting hole. Others, such as Chevrolet II, have a stamped imprinted lug that must be knocked out with a drift and hammer.

The brake adjustment can be tightened with a screw driver through this hole in the brake drum.



Illust. 4-36

To loosen the adjustment, take a length of steel wire (choke wire) and bend a small hook on one end. Place the wire through the adjusting hole and use the hook to pull the adjusting lever away from the adjuster's teeth. Then, with a screw driver, back or loosen adjusting screw approximately 20 teeth. *See Illustration 4-36.*



Illust. 4-37

When installing brake drums be sure to place the brake drum back on the same brake it was removed from.

Inspect the front wheel bearings for wear and damage and then repack.

Be sure and replace the front wheel bearing grease retainer. *See Illustration 4-37.*

NOTE: Do not take a chance on ruining a good brake job by reusing the old wheel bearing grease retainers.

Bleed the hydraulic brake system in the same manner as outlined in Lesson #2.

18. *Road Test Vehicle*—(Make several backward stops for final brake adjustment.)
19. *Brake-in and Seat the Brakes*—This is one of the most important parts of a new brake job.

    Do not burn or overheat the brake lining. This can cause a difference in friction characteristics of the brake lining from one side to the other.

    Use the following procedures for good brake performance and to assure the use of complete lining life:

    a. Make 20 MPH stops at one minute intervals.
    b. Alternate one heavy stop and one light stop (*do not skid tires*). Make eight such stops. If the brakes do not apply equally at the end of eight such stops, there is something wrong with your installation. Take it back to the shop to find and correct the problem.

NOTE: Let the brakes cool as much as possible before turning car back to owner. Tell the owner: "Please do not abuse the brakes until you at least have one thousand miles of normal driving on them."

This one-thousand miles of driving seats the brake lining to the brake drum. Even though the brake shoes are ground to fit the brake drum, 100% perfect contact is not possible until they have been driven approximately one-thousand miles.

This procedure also gives an additional "*cure*" to the brake lining that cannot be duplicated in a manufacturer's curing oven.

If you are the car owner who takes a car out with a new brake job to see how many 80 MPH stops can be made, your abuse will damage the brake lining and will quickly fade. However, if linings are broken in properly, your brakes will have greater resistance to fade. In addition, you will get better all-around brake performance and faster brake action.

SPECIAL
NOTE: **Some drivers cannot successfully use self-adjusting brakes, while other drivers can use them with never a minute's trouble. Some drivers run their car backward at high speed and stop quickly. This can over-adjust self-adjusting brakes.**

If brakes are used to the extent of overheating, they will adjust out to the expanded size of the brake drum. This causes them to drag because it reduces the brake-shoe-to-brake-drum clearance. In addition, the brake cannot provide its unique wrapping action designed to lessen foot pedal pressure. This causes a very hard brake pedal.

If a car owner continuously has trouble with self-adjusting brakes, the only satisfactory solution may be to remove the self-adjusters and revert the brakes back to the more conventional manual adjusting type.

Brake change-over kits are available for this purpose in Div. 28.

Adjusting Standard or Manual Adjusting Bendix Passenger Car Brakes

Some mechanics have had customers come back after a routine brake adjustment on Bendix equipped passenger cars and complain about a hard brake pedal. Many mechanics follow an incorrect procedure for adjusting Bendix standard brakes. They turn the brake adjustment until the brake locks the wheel. Then, they loosen the brake adjustment until the wheel turns freely. This brake will usually free up the wheel in four to six notches or clicks "off." This is where the mechanic makes his mistake and stops. This is the cause of a hard brake pedal.

Why??

There is not *enough* slack or clearance between the brake lining and brake drum to provide the wrapping action that the brake was designed to create.

For a Bendix passenger car brake to have proper wrapping action, as illustrated in first part of this lesson, each brake shoe should have approximately .010" clearance between brake shoe lining surface and brake drum.

For proper brake adjustment on 11" brakes, tighten brake adjustment tight. Then back adjuster off *12 clicks or notches.*

The 12" brake should be adjusted tight and then backed off *15 clicks or notches.* This will give the approximate .010" clearance that is desired for each shoe.

Try this and note the improvement in brake action:

NOTE: Whenever a gradual side pull is encountered on Bendix equipped passenger cars with power steering, most mechanics start working on the front brakes. This condition, in most cases, is caused by the rear brakes. Usually, one rear brake is too loose and overworking or one rear brake is not working at all. This is a good point to remember because many brake specialists have gotten grey hair over this specific problem.

Lessons #3 and #4 have been devoted to Bendix and Chrysler Center Plane Brake Systems and how they meet the demands of today's motoring public.

But How About the Driver of Tomorrow?

In Lesson #5 we will study the *disc brake.* It is considered by many to be the *brake* of tomorrow. However, some passenger cars already have this new automotive idea. You'll learn more about them and how to properly service *conventional brake drums* too in Lesson #5.

Save all lessons for future reference. Proper use of them can build your experience and help you prevent costly comebacks.

CHAPTER 5
SERVICING CONVENTIONAL BRAKE DRUMS AND OPERATION OF DISC BRAKES

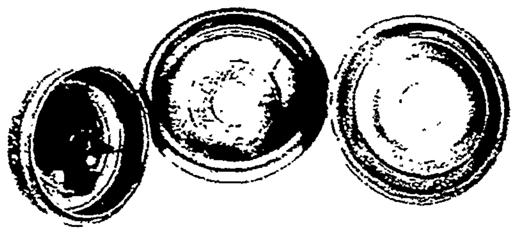
In Lessons #3 and #4 we have studied Chrysler Center Plane Brakes and Bendix Brakes. Each system has its own distinct characteristics that we must learn to service properly. However, both systems have, as all brake systems have, basic principles of design by which they function.

Brakes are heat machines. The basic functions of brakes are to provide enough friction to slow down and stop a moving vehicle. Friction creates heat and it must be dissipated adequately to prevent lining temperatures from exceeding safe operating limits.

In this lesson we will study the different way disc brakes dissipate heat as compared to conventional drum type brakes. As you will see, although one system has proven to be superior at dissipating heat, it has other disadvantages that prevent it from completely replacing the other system at this time.

Conventional Brake Drums

The conventional drum or shoe type brake can provide braking action when lining temperatures do not exceed 600 degrees F. Beyond this point, brake failure due to lining "fade" occurs. Brake lining "fade" is caused by the brake drum's inability to dissipate heat at an adequate rate. As a result, the lining itself heats up and remains so hot that it loses its ability to create friction. As it cools, friction characteristics return.



Illust. 5-1

Proper Technique for Servicing Conventional Brake Drums

The purpose of the conventional brake drum is to furnish a suitable friction surface for the lined brake shoe. The drum also has the job of carrying off or dissipating all the heat created by the brake shoe friction material as it presses against the brake drum. Cast iron brake drums or drums with cast iron inner liners are the most widely used. *See Illustration 5-1.*

Cast iron has been found to be one of the most effective materials to be used as a friction material against brake lining. Aluminum alloy brake drums are used by one or more car manufacturers, but do not seem to be quite as successful as cast iron.

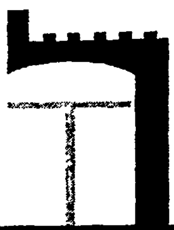
Brake drums are ignored by too many mechanics when doing a brake job. The statement heard most from the mechanic is: "The drums look good—they must be perfect." In order to prevent comebacks, always do a complete brake job. The brake job is not complete unless the drums have been turned.

Don't rely on visual inspection. The only way brake drum trueness can be determined is by placing the brake drum on a drum lathe. Turn the lathe on and let the cutter touch the highest spot. Stop the lathe. Revolve drum so that first mark on drum made by cutter is opposite cutting tool. Measure distance between cutting tool and brake drum with a feeler gauge. This will tell the amount of out-of-roundness of the brake drum in thousandths-of-an-inch. (Dial indicators could also be used for greater accuracy.) Needless to say, if measurement exceeds manufacturer's drum thickness limitations, drum must be replaced.

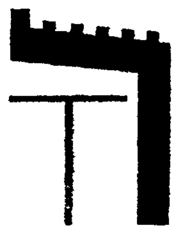
Passenger car brake drums should *never* be turned or ground in excess of .060" over standard size. Always use a brake drum gauge on drum to determine size *before* turning or grinding the drum.

Ford and Mercury, 1961-1963, brake drums should not be turned or ground to more than .030" oversize beyond original standard diameter dimension of 11.030".

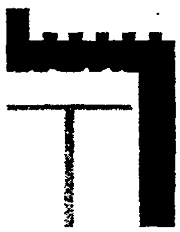
Lincoln, since 1961, has a .060" over standard 11.000" or 11.060". This drum is not to be turned in excess of 11.120". Because of variations, always refer to manufacturers specification and recommendations.



BARREL SHAPED DRUM



BELL MOUTH DRUM



DEEPLY SCORED DRUM

The brake drum must furnish a perfect surface for the brake shoe to contact. Any variation in surface contact between one brake and another results in unequal friction and creates erratic brake performance.

The brake drums can be grooved, scored, bell shaped and barrel shaped. Any of these conditions can cause poor brakes. *See Illustration 5-2.*

A front brake drum that is only as much as .010" out of round will vibrate forcefully on a 60 MPH stop on some vehicles. This out of round condition creates noise, especially on low speed, slow stops.

Two brake drums can be out of round only .010" and at 60 MPH the car will be twice as hard to stop as it would with true brake drums.

The reason for this hard brake pedal on high speed stops is that the high point of the untrue brake drum keeps hammering the brake shoe away from the brake drum. Therefore, much more foot and hydraulic pressure is required to hold the brake shoe out against the untrue brake drum to slow the vehicle down. (Pulsations in the pedal might also be apparent.)

Matching Drum Sizes

It is always a good practice to have both front drums near the same diameter. Both rear drums should be the same size too. It is all right to have a variation in size between front and rear drums, but never vary in size from opposite sides of a vehicle. Never turn one drum only—turn opposite side also, in order to balance friction. It is also a good practice to turn all new brake drums before installation because they can warp or get damaged during shipment.

(Variations in diameter up to .010" or .015" will not cause adverse effects except under repeated, heavy braking, resulting in excessive heat.

Variable Drum Thickness

It is possible to turn some brake drums that are out of round then place them on the vehicle; and as soon as the drum is heated up, it becomes out of round again. This is due to the varying thickness or density of the metal at various points around the drum. Replacement of the drum is the only way to cure this condition.

Brake Noise

Brake noise is the result of vibration. This vibration can originate from untrue brake drums, poorly fitted brake shoes, weak brake springs, sticking wheel cylinders. etc. Correcting these situations will eliminate noise.

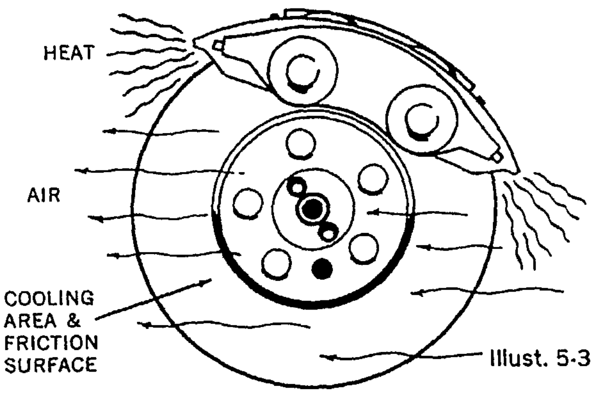
It is recognized that some types of brake linings may be more susceptible to vibration than others. In these situations, more careful attention must be given to the brake service job. There is no reason why any brake job, regardless of lining, cannot be made noiseless.

Special Procedure for American Compact Cars with Four Lug Bolts

Improper tightening of wheel lug bolts can warp the brake drums to the degree that the brake pedal will move in and out on a low speed stop.

This condition is caused by tightening one wheel lug bolt completely tight with a strong impact wrench before the others are even started. This can warp the brake drum.

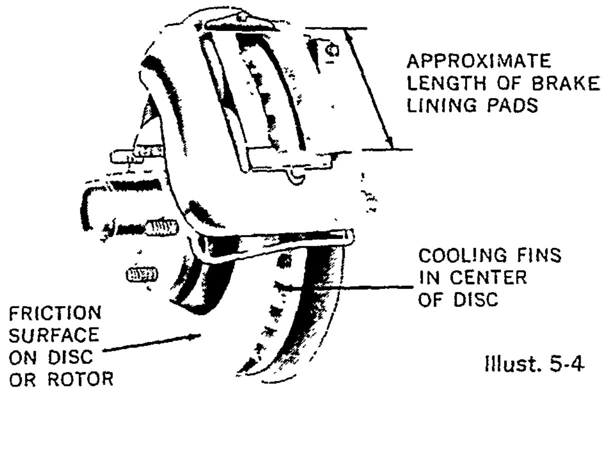
This condition can usually be corrected by loosening all lug bolts then retightening them evenly (preferably with a torque wrench to manufacturer's specifications).



Illust. 5-3

Conventional Drums vs. Disc Brakes

The caliper or disc type brake has a definite advantage over conventional drum or shoe brakes. Disc brakes can dissipate heat at a fantastic rate. Although friction surface temperatures may exceed 600 degrees F. the heat does not have a chance to transfer into the lining. Thus, disc brakes have a greater ability to resist fade. This allows for safer high speed stops and provides more safety when driving down steep mountain roads. The disc brake can easily provide braking action with temperatures up to 1200 degrees F because of its ability to dissipate this heat before the friction material begins to fade. *See Illustration 5-3.*



Illust. 5-4

The difference between conventional drum brakes and the newer disc type caliper brakes is best seen as the difference in the amount of cooling surface available for dissipating heat. More lining material area contacts the brake drum in conventional shoe brakes, thus, there is more friction but less area available for air cooling and heat dissipation. However, on disc brakes, the square inch area of brake lining per pound of vehicle weight is severely reduced creating less total friction area but a greater cooling surface area available for faster cooling action. *See Illustration 5-4.*

Because of the reduced amount of friction material used, it requires 15 to 20 per cent more brake pedal and hydraulic pressure to stop a vehicle equipped with disc brakes than it does with drum type brakes. To help drivers provide the extra disc brake foot pedal pressure that is necessary, a brake power booster is required. However, the greater amount of pressure and higher operating temperature in a disc brake accelerates the rate of brake pad lining wear.

Another interesting fact is that many disc brake pads drag constantly. It is possible for them to heat up to 400 degrees F. without ever applying the brakes.

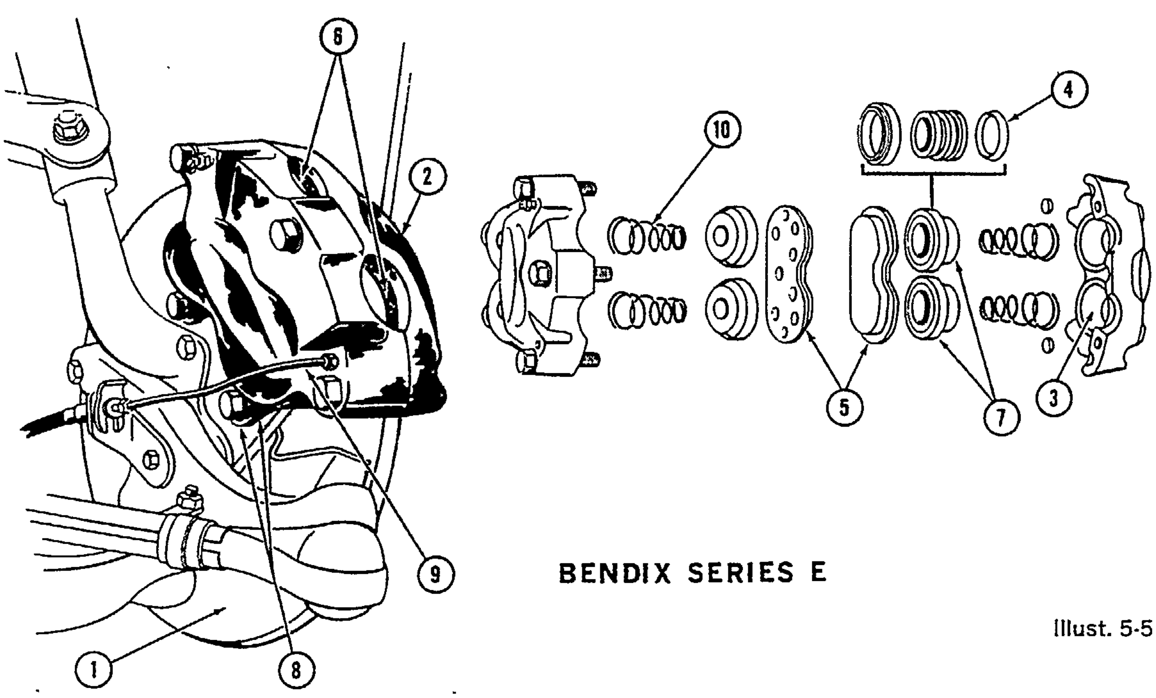
Therefore, it is a common occurrence to have linings wear out faster on vehicles equipped with disc brakes than those equipped with drum type or shoe brakes.

At present, there are four American manufacturers of disc brakes. They are: Budd Automotive Division, Kelsey-Hayes, Bendix, and Delco-Moraine.

Kelsey-Hayes is the principle supplier of disc brakes to Ford Motor Company. Delco-Moraine supplies Chevrolet.

For the most part, American made cars equipped with disc brakes use them on the front only. There are three principle reasons for this. First, about 60% or more of the braking effort is supplied at the front wheels. Secondly, disc brakes on the rear wheels prevent the economical installation of an associated parking brake that would work in conjunction with the rear wheel braking system. Third, original equipment disc brake installation is more costly *per unit* than conventional drum brakes.

Generally, widespread acceptance of four wheel disc brakes will be a slow gradual process and will be closely dependent on how fast future consumer demands grow for this feature.



BENDIX SERIES E

Illust. 5-5

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NOMENCLATURE: *(See Illustration 5-5)*

1. Disc or rotor.
2. The caliper.
3. Wheel cylinders.
4. Piston seals (on many American makes).
5. Brake shoes or plates and brake lining pads.
6. Inspection holes on Bendix Series E.
7. Pistons.
8. Mounting bolts and shims.
9. Brake line.
10. Springs (not found on some American makes).

The disc is either made a part, or mounted to, the hub that the wheel bolts to. In pincher fashion, the brake lining pads make contact with both sides of the rotating disc and provides friction. The back-to-back surfaces of the disc corresponds to the inside surface of a conventional brake drum, but provides a far greater amount of area for heat dissipation. *See Illustration 5-4 and 5-5.*

On lightweight foreign cars, the disc is comparatively thinner than those used on the much heavier American made passenger cars. However, the heavier, thicker discs are ventilated through the center. This extra ventilation on heavier American passenger car disc brakes provides even faster heat dissipation than on the lighter foreign cars. *See Illustration 5-3 and 5-4.*

The Problem of Disc Resurfacing or Grinding

Some manufacturers of disc brakes have suggested discs be replaced rather than resurfaced. The thickness of the disc can be extremely critical to the disc's ability to dissipate heat. Resurfacing may effect heat dissipation and alter the performance of the assembled brake unit drastically. Another factor that discourages resurfacing of the disc is the extra fine finish that is required. If disc faces are rough or distorted, it will cause vibration during braking and accelerate lining wear.

Many manufacturers of brake servicing equipment have already produced attachments for their regular brake drum lathes that will resurface the new brake disc.

At the present time, manufacturers have various opinions as to how much metal can be removed from a disc safely and to what degree of micro-inch finish there should be. Some manufacturers recommend the replacement of rotors rather than resurfacing. Others allow removal of metal up to a maximum of .020" per side.

Hydraulics of the Disc Brake System

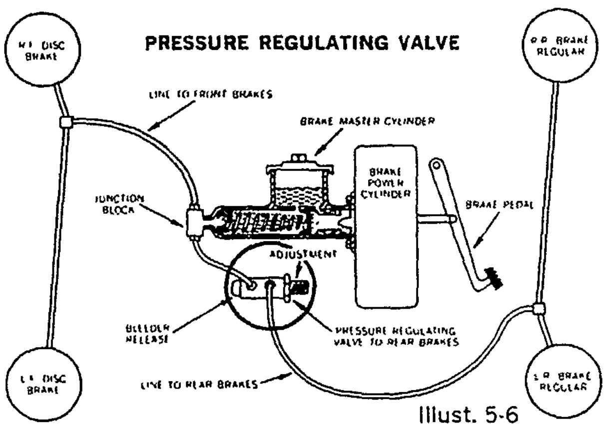
The brake line connects on the inside or control arm side of the caliper. Passages are drilled through the caliper to each of the wheel cylinder bores for brake fluid travel. The bleeder passage and bleeder screws are mounted on the opposite side of the brake line entrance. The wheel cylinder and pistons are very large in comparison to those used on conventional drum type brakes. These larger pistons give much more square inch area for the fluid to work against.

For example: The Ford Mustang disc uses a smaller piston than the others. These pistons are 1⅝" in diameter, using a 1⅛" bore master cylinder.

The disc brake does not have the leverage advantage or wrapping action such as the Bendix drum brake.

Most of the pistons in the disc brake have a piston seal instead of piston cups. Some of them use springs behind the piston to hold it out against the brake shoe and the brake shoe drags constantly against the disc, causing temperature build-up and the accelerated wear mentioned previously. The Kelsey-Hayes unit does not use a spring; they have a quad ring recessed in the cylinder bore approximately ¼ the distance from outer end of cylinder bore. This square surfaced quad ring seal flexes out on brake application. Then, this flex pulls the piston away from the brake shoes. This should give a small amount of air space between the brake pad and disc. The disc brake requires no adjustment.

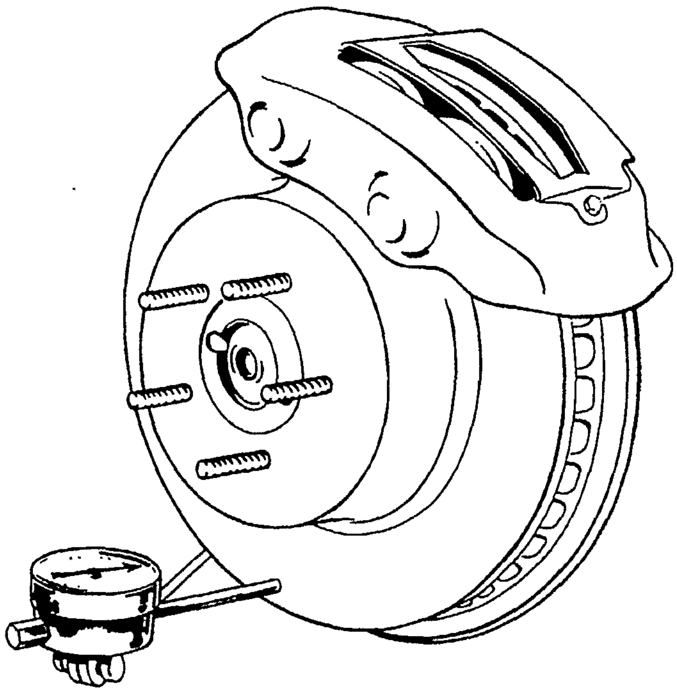
The Corvette also has disc brakes in the rear. A special small 6" drum brake is mounted behind the disc on each rear wheel as a parking brake. To adjust this cable operated parking brake, remove the rear wheels in order to get access to the adjusting hole in the disc. Adjust with an adjusting spoon as on regular Bendix brakes. The cables are adjusted in the same manner as the conventional Bendix parking brake.



Illust. 5-6

The Pressure Regulating Valve

This valve is usually located under or around the master cylinder and is also referred to as the proportioning valve. The purpose of this valve is to regulate and reduce the hydraulic pressure going to the rear wheels. Without this valve the rear brakes would lock up long before the fronts. As we mentioned before, it takes 15% to 20% more pedal pressure to operate the front disc brakes. Therefore, this much *less* would be required at the rear wheel drum type brakes to create equal braking action. This valve does not open until the front brakes have sufficient wheel cylinder pressure to perform equally with the rear brakes. The amount of applied pressure in the Kelsey-Hayes unit can be adjusted. This valve is not required when disc brakes are on all four wheels. *See Illustration 5-6.*



Illust. 5-7

Servicing of Typical Disc Brake Problems

The disc must be carefully balanced during manufacturing. Should the disc spin erratically or wobble, it pushes wheel cylinder pistons too far into the cylinder bore. Brake fluid must move the piston an excessive distance to make brake pads contact the disc. This results in a low brake pedal.

The front disc runout should not exceed .002". The rear disc runout on a Corvette should not exceed .003".

Loose wheel bearings can cause the disc to run untrue. Therefore, wheel bearings must be preloaded or torqued exactly to manufacturer's specifications.

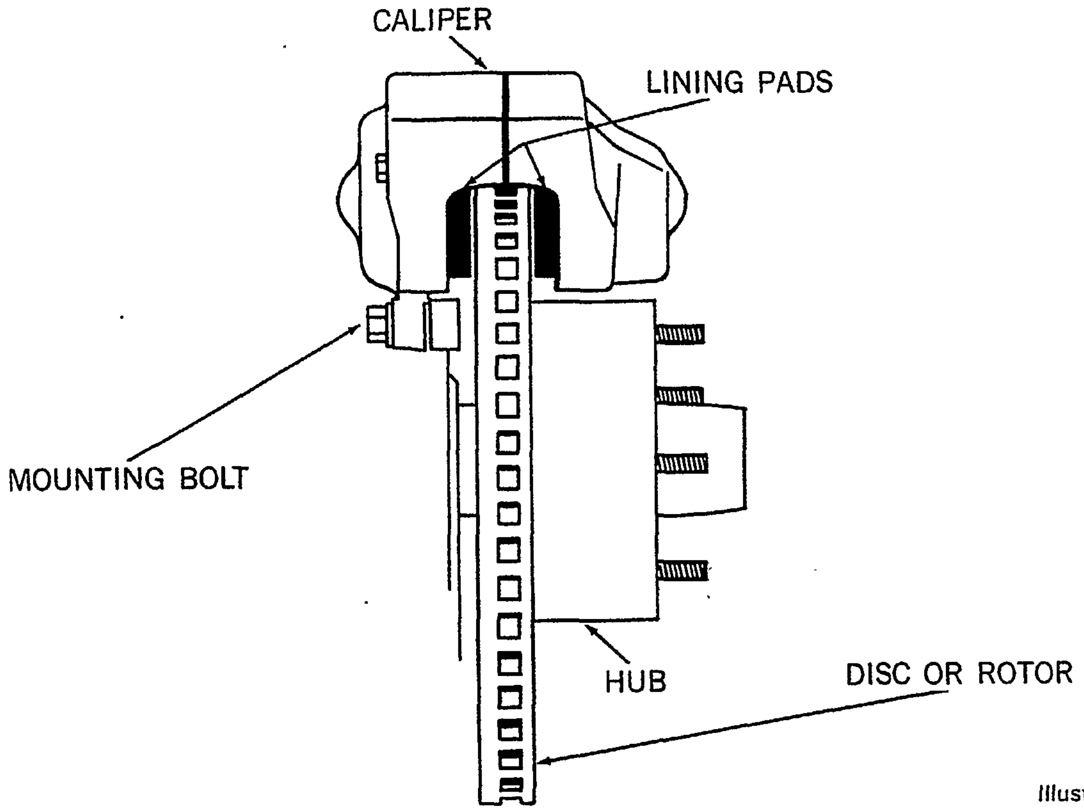
Rear axle end play is a critical element in proper disc brake performance. The Corvette specifications suggest rear axle end play may vary between .001" to .008". However, .008" axle end play can cause disc runout.

Procedure for Disc Brake Runout Test

1. Place car on jack or lift.
2. Adjust wheel bearings to manufacturer's specifications.
3. Siphon some of the brake fluid out of the brake master cylinder to prevent fluid from running over when wheel cylinder pistons are pushed back into cylinder bores.
4. With suitable tool, push wheel cylinder pistons back into cylinder bore so that wheel will turn freely.

NOTE: **This step is also necessary when balancing front wheels and tires.**

5. Attach dial indicator. Dial indicator button should ride approximately one inch below the outer rim of the disc.
6. Revolve wheel and disc slowly and note reading. Runout should not exceed .002" on front disc and not to exceed .003" runout on rear disc. *See Illustration 5-7.*



Illust. 5-8

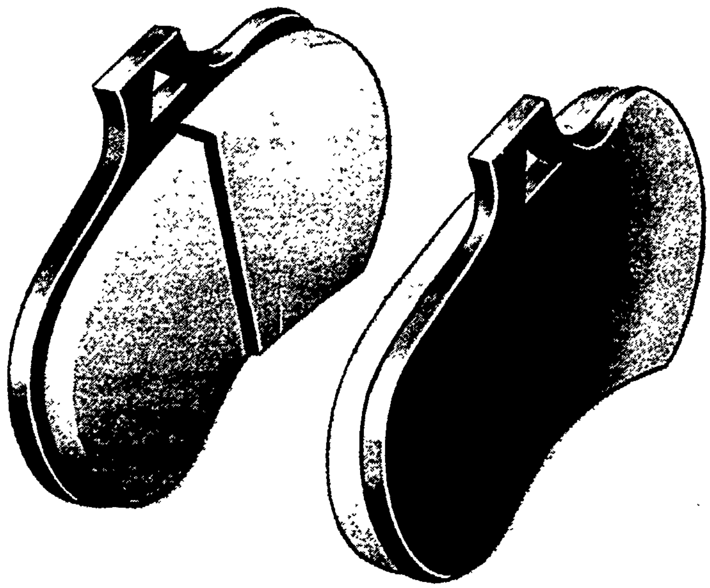
Servicing the Caliper Unit

The caliper is the housing unit that straddles the rotating disc. This unit houses the hydraulic wheel cylinders and the associated lined brake pads. The caliper assembly holds the brake pads in just the right position so they can make proper contact with the disc during brake applications. Proper alignment of the caliper is very important to correct brake performance.

The caliper assembly allows the brake pads to contact the rotating disc in much the same way the jaws of a bench vise grips an object. The brake pads then pinch the spinning disc with tremendous pressure to slow the vehicle down and stop it. *See Illustration 5-8.*

Most American-made caliper assemblies house four cylinder bores and pistons arranged two on each side of the disc. Each two pistons control a lined brake shoe about two inches wide and five inches long. Foreign cars generally have only one piston on each side of the disc and each controls a small friction pad.

NOTE: When removing or replacing caliper unit, make sure the same shims (if used) go back in their respective places on the caliper mounting bolts. A safe practice is to place aligning shims back on the caliper mounting bolt that they were removed from with the bolt placed back in proper position in the control arm. They provide the critical caliper alignment needed for precise brake pad contact.



Illust. 5-9

Servicing Brake Shoes and Lining or Pads

The brake shoe is a stamped piece of metal with the brake lining bonded to it in somewhat the same manner as conventional brake shoes on drum type brakes. *See Illustration 5-9.* Some disc type brake shoes have several large holes drilled through them and the lining is extruded through these holes and cured to the shoe under pressure. This is one process that holds the lining to the shoe. *See Illustration 5-9.*

They may also be riveted.

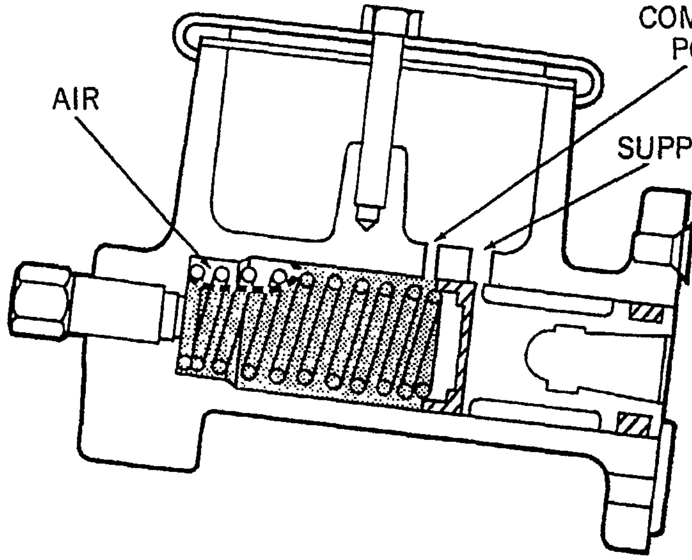
Brake shoes or pads can be replaced on all but the Bendix Series E in approximately five minutes.

NOTE: **Before replacing disc brake friction pads always siphon enough brake fluid from brake master cylinder to prevent running over when wheel cylinders are pushed back to the bore.**

On Kelsey-Hayes units, remove the two inspection cover screws, press the wheel cylinder back into the wheel cylinder bore and slide the brake shoe pad out. Others have pins or springs to remove but, are removed somewhat in the same manner. The Bendix Series E has only two small peep holes in the top of the caliper for lining inspection. To replace shoes, remove brake line holding clip (do not disconnect brake line), remove caliper mounting bolts and shims, raise caliper up, turn bottom up, remove dust shield and press pistons back to remove shoes.

NOTE: **Make sure caliper bolt aligning shims go back in the same original location.**

No adjustment is required on the disc brake. As the pad wears, the piston follows it out and the fluid level will go down in the master cylinder. Some brake shoes have small metal lugs (called tell tale tabs) which drag when the lining is worn out; others require regular inspection. Delco-Moraine has grooved linings. When the groove is gone, the brake shoe pads need replacing.



Illust. 5-10

Procedure for Bleeding the Caliper Disc Brake

It is important on *all cars* with firewall mounted master cylinders, or in any case where the outlet of the master cylinder points toward the front, that the front end of the vehicle be level or lower than the rear. If the outlet end of the master cylinder is high, air will be trapped in the upper part of the master cylinder bore and no amount of bleeding will make the air come down and be pushed out through the brake line, or bleed back through the brake master cylinder compensating port hole. It does bleed back through the compensating port hole if the outlet end of the master cylinder is lower. If a car comes in with a sagging or low rear end due to excess weight and the hydraulic system is bled with the front end high and it is lowered from the lift in the same manner, a low and spongy brake pedal will result. *See Illustration 5-10.*

Fill the master cylinder, bleed air out of the brake bleeder where it connects to the cylinder. Bleed rear wheels in the normal procedure that is used on drum type brakes and as outlined in Lesson #2.

IMPORTANT: Push front wheel disc brake wheel cylinder pistons back all the way to the bottom of the cylinder bore.

Wedge or block them in this retracted position, then bleed them in the normal procedure. Having the wheel cylinder pistons in the bottom of the cylinder bore reduces the fluid area and more air can be bled out. Tap the caliper housing during bleeding to dislodge air bubbles which could lodge inside the housing.

NOTE: **Proper brake bleeding technique is a very critical process, and it is very essential to obtain top brake performance. Too many people disregard or take short cuts through all of the necessary procedures that are required to get top brake performance.**

It must be remembered that hydraulic fluid will *not* compress. However, air does compress. Compressed air in brake lines and hydraulic cylinders mean a spongy brake pedal and excessive pedal travel. *See Illustration 5-10.*

NOTE: **When bleeding a Lincoln hydraulic system equipped with disc brakes, a button on the pressure regulating valve must be held down during the bleeding operation of the front brakes. The regulating valve is located under the master cylinder.**

Lesson #6 will be devoted exclusively to troubleshooting brake systems. You will get firsthand tips from the experts on how to diagnose brake problems and how to solve them correctly.

Save all lessons for future reference. Proper use of them can build your experience and prevent costly comebacks.

CHAPTER 6 BRAKE TROUBLE SYMPTOMS AND SERVICE TIPS

In Lessons #1 through #5 we have discussed in great detail the various brake systems you will encounter when you do brake service work. You have been given time-tested tips that will help you build a reputation as a skilled craftsman in brake servicing.

Lesson #6 continues in that tradition. This lesson gives you the kind of information you need to isolate brake problems and do a high quality brake job. Lesson #6 is devoted solely to diagnosing common brake problems and methods used to correct them.

Each brake trouble symptom listed may have several possible causes. You must make the proper judgment about the cause of the problem and apply the correct solution.

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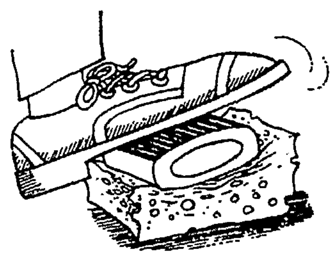


SYMPTOM:

Brake Pedal Action Soft or Spongy

(A) Problem: Air in hydraulic brake system.

(A) Solution: If the air entered the brake hydraulic system while vehicle was in use, this would indicate defective master cylinder check valve. The pressure held in the system by the check valve keeps wheel cylinder piston cups sealed against the wheel cylinder walls. In this case, overhaul or replace the brake master cylinder. This condition can also be caused by poor condition of wheel cylinder piston cups. After necessary corrections, bleed the brake system.

NOTE: **Be sure car is level during bleeding operation. This prevents air lock in master cylinder bore. Also, on Chrysler center plane angle mounted wheel cylinders and truck and bus upright mounted wheel cylinders, always bleed brakes before adjusting the brake shoes to the brake drum.**

(B) Problem: Brake shoe lining-to-drum contact improper.

(B) Solution: Brake shoe arc improperly ground. Bendix brake shoes ground with anchor attachment should be ground .030" under drum size. If they are ground on open head grinder (without anchor attachment), they should be ground .050" under drum size. This gives proper brake shoe heel and toe clearance which helps prevent brake noise and side pull.

The purpose of the .050" undersize grind on Bendix brake shoes (without anchor attachment) is to allow better alignment of the brake shoe to the anchor in relation to the 360 degree circle of the brake drum.

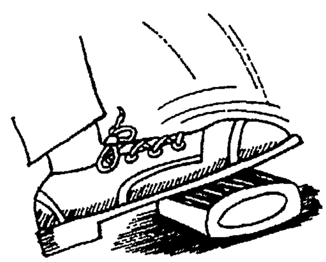
Chrysler center plane brake shoes should only be ground .015" under drum size. Grinding .030" or more of the arc off the lining surface causes spongy brake pedal.

Vehicles having adjustable anchors cause improper brake-shoe-to-drum contact if anchors are not adjusted properly. Anchors need to be adjusted whenever new brake shoes are installed or when the brake is noisy.

(C) Problem: Thin brake drums caused by turning brake drums past safe limits.

(C) Solution: Replace brake drums. Passenger car brake drums should never be turned or ground in excess of .060" over standard size.

NOTE: **It is important to always have brake drums the same size and finish on each axle— both fronts the same, both rears the same.**



SYMPTOM:

Brake Pedal Slowly Goes to Floor Under Constant Pressure

(A) Problem: Master cylinder primary cup defective, letting fluid leak past cup back into cylinder reservoir.

(A) Solution: Overhaul or replace master cylinder.

NOTE: **Do not hone master cylinder over specified limits.**

(B) Problem: External hydraulic fluid leak, such as wheel cylinders, brake lines, brake hose and connections.

(B) Solution: Make necessary correction and bleed brakes.

SYMPTOM:
Brake Noise

(A) Problem: Brake noise is a high pitched vibration.

(A) Solution: Correcting vibration corrects the noise. Brake lining itself does not cause noise. It is generally the result of several factors. However, some brake linings are noisier than others. This is due to the structure and materials of the lining.

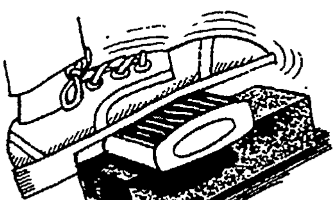
Some of the main causes of brake noise:

1. Improper arc on brake shoes.
2. Weak brake springs.
3. Sticking wheel cylinders.
4. Crooked or bent brake shoes.
5. Improper anchor adjustment (on anchor type).
6. Loose wheel and axle bearings.
7. Out-of-round brake drums—only .010" out can cause noise.
8. Excessive rear axle end play.
9. Brake shoe spring loops (Chrysler Center Plane) digging into backing plate.
10. Brake lining loose on shoe.
11. Improper brake shoe lubrication.

NOTE: **All brake shoe moving parts and backing plate bearing surfaces should be lubricated with a special lubricant.**

CAUTION: Do not use a petroleum base lubricant. If it gets on brake lining it causes damage to lining.

12. Excessive wear on the brake shoe where it contacts the anchor.



SYMPTOM:
Hard Brake Pedal

(A) Problem: On Bendix brakes, one of the main causes is brake shoes adjusted too close to brake drum. This prevents wrapping action which the brake was designed to have. This is also caused by self-adjusting brakes over-adjusting or tightening themselves too much.

(A) Solution: **Each Bendix passenger car brake shoe should have approximately .006" to .010" clearance between brake lining and brake drum in order for the brake to have proper wrapping action. If the shoes are adjusted too closely, the wrapping action won't help apply the brakes. On 11" brakes, tighten completely and back off *12* notches. On 12" brakes, tighten completely and back off *16* nothces.**

On self-adjusting brakes, use Ammco 8650 brake adjusting tool.

It may be necessary on Bendix self-adjusting brakes to remove the self-adjusting mechanism and change over to a standard brake system whenever over-adjusting continuously causes hard brake pedal, unequal brake performance or dragging brakes. Some people cannot use a self-adjusting brake successfully. They back up too fast or back up when brake drum is overheated and expanded, over-adjusting the brakes and causing them to drag.

(B) Problem: Grease or foreign matter on brake lining can cause a loss of friction.

(B) Solution: Reline brakes and correct cause of grease, fluid or oil leaks.

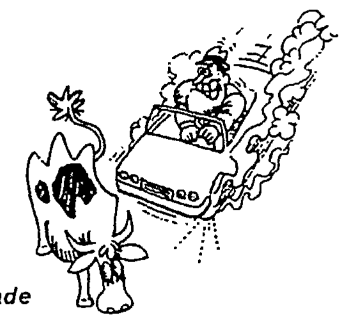
(C) Problem: Restricted or plugged brake hose or line.

(C) Solution: Replace necessary hose. Clean brake lines.

NOTE: **Replace front brake hose in pairs.**

(D) Problem: Incorrect lining-to-drum contact.

(D) Solution: See answer (B) under "Spongy Brake Pedal." This condition can cause a hard pedal due to a small lining contact area. Maximum brake efficiency depends on the right square inch of lining area contact per vehicle weight. For good brakes, you must have total brake-lining-to-brake-drum contact and the contact has to be the same on each axle.



SYMPTOM:
Brake Lining Fade

(A) Problem: Brake lining fade is a loss of friction caused by either excessive heat or some form of lubricant getting on the lining surface. The temperature at which brake lining fade occurs is determined by the manufacturing process and material used in the lining. This can vary from

300° F. to 700° F., depending on the materials used in the brake lining formula and the method of manufacturing.

The brake drum has the job of carrying off and dissipating heat that is created by the friction between the brake lining and brake drum. When the brake drum cannot carry the heat away at a fast enough rate, the heat starts entering the brake lining and building up beyond safe operating limits.

Brake lining is not a good conductor of heat. Therefore, it is slow to heat up and slow in cooling off.

Whenever the lining reaches its own specific fade temperature, the lubricants, binders or both bleed to the surface of the lining, lubricating it. This causes a temporary loss of friction. Fast recovery back to normal friction characteristics is a very important factor in a good brake lining.

The causes of brake lining fade are:

1. Excessive high speed stops in relation to the fade characteristic of the lining.
2. Repeated low speed stops in rapid succession that builds up excess heat faster than it can be dissipated.
3. Dragging brakes due to weak brake shoe return springs, sticking or short parking brake cables, sticking wheel cylinder pistons, etc.
4. Thick brake fluid causing slow release of brake shoes and overheating, thus accelerating wear. Thick brake fluid can cause wear ratio to accelerate as much as 5 to 1 over normal lining life.
5. Poor contact of lining surface to brake drum surface.
6. **Brake drum too thin. The thinner the brake drum, the less heat it can carry off and the greater the expansion or distortion.**

(A) Solution: Reline brakes with better grade of lining if this is causing fade. Correct brake shoe lining-to-drum contact. Correct dragging condition. Clean brake hydraulic system and install new fluid. Install new brake drum if existing drum thickness is too thin.

NOTE: Be sure **to break in new brake lining as outlined in previous lessons.** *No panic stops for first 1000 miles.*

SYMPTOM:

Brakes Grab When Applied

(A) Problem: Brake lining friction too high.

(A) Solution: Install correct type of lining.

(B) Problem: Cold, heavy grease on lining.

(B) Solution: Correct grease leak, install new brake shoes.

(C) Problem: Over action of power brake unit at low speeds.

(C) Solution: Overhaul or exchange power brake unit.

(D) Problem: Brake lining affected by moisture or water.

(D) Solution: Replace poor quality brake shoes with known good grade.

SYMPTOM:

Brakes Pull to One Side

(A) Problem: Restricted or plugged front brake hose.

(A) Solution: Replace hose, flush brake hydraulic system and bleed brakes.

NOTE: Front brake hose should be replaced in pairs.

(B) Problem: Weak brake springs on one front wheel.

(B) Solution: Replace brake springs on both front brakes so application will be equal.

(C) Problem: Out-of-round or untrue brake drum on one front wheel.

(C) Solution: **Turn both front brake drums. Replace drums if not within specified limits. Grind linings to fit new diameter.**

NOTE: **It is always good practice to take a light cut out of new brake drums because they may be warped or knocked out-of-round during shipping. (Sometimes they have a rust preventative on the surface.)**

(D) Problem: Improper brake-shoe-lining-to-drum contact.

(D) Solution: Regrind or replace brake shoes as outlined in "Spongy Brake Pedal" Solution A.

(E) Problem: Improper brake adjustment.

(E) Solution: Make proper brake adjustment.

(F) Problem: Grease, oil or foreign matter on one brake.

(F) Solution: Correct source of grease or oil and reline brake. Same job should be done on opposite wheel for equal friction.

(G) Problem: Anchor out of adjustment (on adjustable anchor brake systems).

(G) Solution: Adjust anchors as outlined in Bendix Brake lesson.

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(H) Problem: Sticking wheel cylinder piston on one brake.

(H) Solution: Overhaul or replace wheel cylinder. Do same job on opposite brake for equal brake action.

(I) Problem: Front tire tread worn round. When brakes are applied, the tires have a tendency to follow any small groove or slant in pavement. This causes a driver to think he has brake trouble.

(I) Solution: Replace tires or rotate rear tires to front.

NOTE: If front tire tread is worn round, it is a good policy at time of brake job to rotate rear tires to front.

(J) Problem: Dragging brake on one side.

(J) Solution: Correct cause of dragging brake by referring to brake Lessons #3, #4, and #5.

(K) Problem: Defective shock absorbers.

(K) Solution: Replace shock absorbers.

(L) Problem: Excessive wear on front end parts and alignment.

(L) Solution: Replace necessary parts and align front end.

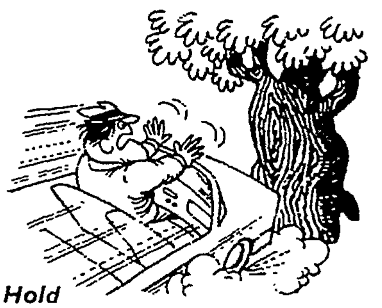
(M) Problem: Thin brake drum on one wheel.

(M) Solution: Replace brake drum.

NOTE: Some cars equipped with power steering gradually pull to one side when brakes are applied. This is usually caused by one of the rear brakes and not the front, or an improperly adjusted power steering unit.

One rear brake can be over-braking (this can happen on Bendix brakes if adjustment is too loose giving it more wrapping action). Another cause is one rear brake not holding at all.

To determine if the rear brakes are causing pull, make stops at 20-30 MPH and keep a slight pressure on accelerator with other foot. If pull is no longer evident, trouble is in the rear brakes.



SYMPTOM:

Brakes Will Not Hold

(A) Problem: On Bendix brakes, primary and secondary shoes may have been mixed during installation.

(A) Solution: Reinstall brake shoes in proper position. Place primary shoe in front of the anchor and secondary in rear of the anchor. See page 6 in Brake Lesson #1.

(B) Problem: Improper brake-shoe-lining-to-brake-shoe-drum contact causing reduced brake lining working area. This can be caused by improper brake shoe arc grind, improper anchor setting or poor brake drum contact surface. Small contact surface will heat up and fade quickly.

(B) Solution: Make corrections necessary to create proper amount of contact between brake shoe and brake drum.

(C) Problem: Sticking wheel cylinder pistons.

(C) Solution: Overhaul or replace wheel cylinders.

CAUTION: Be sure the same work is done on opposite wheel in order to have equal friction.

(D) Problem: Grease, oil, or foreign matter on brake lining.

(D) Solution: Stop cause of grease or oil condition. *Replace brake shoes.*

NOTE: Never try to clean grease or oil from a brake shoe for reuse. This is not practical because heat will draw more grease or oil to the brake lining surface. Again, work brakes in pairs, both fronts or both rears. Never replace brake shoe springs, wheel cylinders, etc., on one brake only.

(E) Problem: Excessively thick brake fluid caused by contamination or age.

(E) Solution: Clean and flush brake system and replace any necessary parts.

(F) Problem: Brake lining worn out or brake lining friction very low.

(F) Solution: Replace brake shoes and overhaul brake system as needed.

SYMPTOM:

Brake Drag

(A) Problem: Parking brake cable sticking or adjusted too short.

(A) Solution: Free up and adjust parking brake cables.

(B) Problem: Self-adjusting brakes over adjusting due to backing up too fast and making a quick, hard stop. If the brake drums are overheated and expanded when backward stops are made, it will adjust the brake shoe out to the expanded dimension of the brake drum causing brake to drag when drum starts cooling. This can cause unequal brakes, poor brake results and rapid wear.

(B) **Solution:** Adjust brakes properly. In many cases, it will be necessary to remove the self-adjusters and install standard brake adjusters. This, however, depends on the driver. Some people can use a self-adjusting brake very successfully while others cannot.

(C) **Problem:** Weak brake springs.

(C) **Solution:** Replace brake springs in sets. Do the same to opposite brake.

(D) **Problem:** Sticking wheel cylinder pistons.

(D) **Solution:** Overhaul or replace wheel cylinder.

(E) **Problem:** Thick brake fluid causing very slow release of brakes.

(E) **Solution:** Clean and flush brake hydraulic system.

(F) **Problem:** No lubricant on moving brake shoe parts.

(F) **Solution:** Lubricate all moving parts with special brake shoe lubricant.

(G) **Problem:** Compensating port hole in master cylinder restricted. This prevents the return of brake fluid to the master cylinder reservoir. This can cause the brakes to completely lock up. If this occurs, bleed out some fluid. This will release brakes enough to be driven to the shop.

(G) **Solution:** If this condition is caused by improper brake master cylinder linkage adjustment, adjust the linkage. If a swollen master cylinder piston cup covers or restricts the compensating port hole, fluid can not return to the cylinder reservoir and will cause brakes to drag or lock up. Overhaul or replace master cylinder.

NOTE: In order to locate this condition, remove master cylinder filler cap. Have someone depress and release brake pedal. As the pedal is released, brake fluid should squirt up through the compensating port hole. If there is no movement of fluid in the master cylinder reservoir, the compensating port hole is restricted.

(H) Problem: Loose wheel or axle bearings.

(H) Solution: Replace or adjust bearing as needed.

(I) Problem: Restricted or plugged brake hose.

(I) Solution: Replace brake hose. If front brake hose, replace both front hoses, clean, flush, and bleed brakes.

SYMPTOM:
Brakes Fail to Hold When Wet

(A) **Problem:** Excessive dust and dirt in brake drums.

(A) **Solution:** Clean all brakes. Make sure adjusting holes have covers.

(B) **Problem:** In high water, grease can be washed from wheel bearings onto brake lining.

(B) Solution: Machine drums and replace brake shoes. Clean and repack wheel bearings and then replace wheel bearing grease seals.

NOTE: Front wheel bearing grease seals should always be replaced at the time of brake job.

Prevent costly comebacks while providing more safety for your customer by always doing a *complete brake* job. The margin of difference between a high quality professional brake job and a sloppy, unsafe one is in the mechanic who follows the right procedures all the way. To build a professional reputation for yourself always use the best in replacement parts and lining. Do a good clean and complete brake job. You'll soon have the reputation as the best Car Care brake specialist in town. It will be profitable and satisfying.

In Lesson #7 we will begin a study of passenger car shock absorbers and suspension systems. The knowledge you have acquired from the six lessons on brakes will supply a good foundation for the lessons ahead.

Save all lessons for future reference. Proper use of them can build your experience and prevent costly comebacks.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