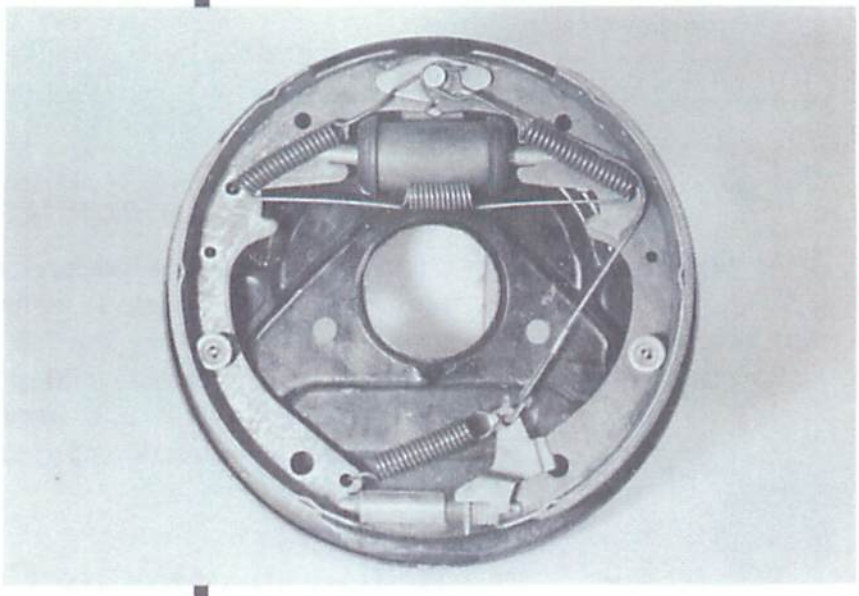
Standard Hydraulic
AND
Power Brake
SERVICE MANUAL



THIS MANUAL

provides instructions for performing brake service on all passenger car hydraulic brake systems from 1950 through 1959, and all power brake units from 1955 through 1959.

AMERICAN
- 1958-59 Bendix Non-Servo

BUICK
- 1950-59 Bendix Duo-Servo — Sliding Anchor

CADILLAC
- 1950-59 Bendix Duo-Servo — Eccentric Anchor
- 1951 (60, 62, 60S) Self-centering (No anchor adjustment necessary)

CHEVROLET
- 1955-59 Bendix Duo-Servo Fixed Anchor
- 1951-54 Bendix Duo-Servo Sliding Anchor
- 1936-50 Huck Hydraulic

CHRYSLER
- 1956-59 Center Plane
- 1950-55 Lockheed Adjustable Anchors

DE SOTO
- 1956-59 Center Plane
- 1950-55 Lockheed Adjustable Anchors

DODGE
- 1957-59 Center Plane
- 1950-56 Lockheed Adjustable Anchors

EDSEL
- 1958-59 Bendix Duo-Servo Fixed Anchor with Automatic Adjusting

FRAZER
- 1950-54 Bendix Non-Servo

FORD
- 1956-59 Bendix Duo-Servo Fixed Anchor
- 1955 Bendix Duo-Servo Sliding Anchor (with primary shoe stop front only)
- 1954 Bendix Duo-Servo Sliding Anchor (with secondary shoe stop front only)
- 1949-53 Bendix Duo-Servo Sliding Anchor

HUDSON
- 1955-57 (Hornet and Wasp) Bendix Duo-Servo Fixed Anchor
- 1950-54 Bendix Duo-Servo Sliding Anchor
- 1953-54 (Jet) Bendix Non-Servo

KAISER
- 1950-54 Bendix Non-Servo

LINCOLN
- 1959 Bendix Duo-Servo Fixed Anchor Automatic Adjusting
- 1956-58 Bendix Duo-Servo Fixed Anchor
- 1954-55 Bendix Duo-Servo Sliding Anchor (with secondary shoe stop front only)
- 1950-53 Bendix Duo-Servo Sliding Anchor

MERCURY
- 1958-59 Bendix Fixed Anchor Automatic Adjusting
- 1956-57 Bendix Fixed Anchor
- 1954-55 Bendix Duo-Servo Sliding Anchor (with secondary shoe stop front only)
- 1949-53 Bendix Duo-Servo Sliding Anchor

NASH
- Amb. 1955-59 Bendix Duo-Servo Fixed Anchor
- Amb. 1950-54 Bendix Duo-Servo Sliding Anchor
- Statesman 1950-54 Bendix Non-Servo

OLDSMOBILE
- 1959 Bendix Duo-Servo Fixed Anchor
- 1950-58 Bendix Duo-Servo Eccentric Anchor

PACKARD
- 1955-58 Bendix Duo-Servo Fixed Anchor
- 1950-54 Bendix Duo-Servo Eccentric Anchor

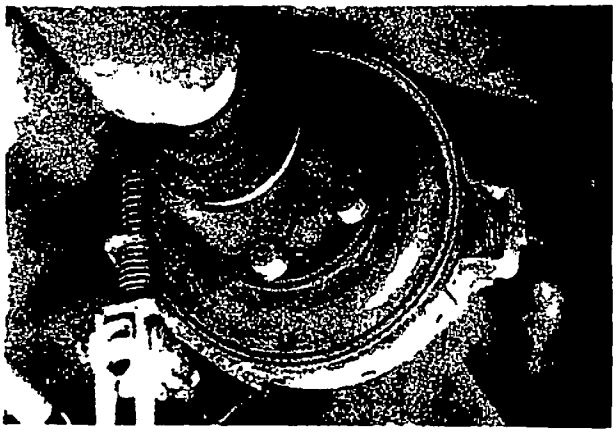
PLYMOUTH
- 1957-59 Center Plane
- 1946-56 Lockheed Adjustable Anchor

PONTIAC
- 1950-59 Bendix Duo-Servo Eccentric Anchor

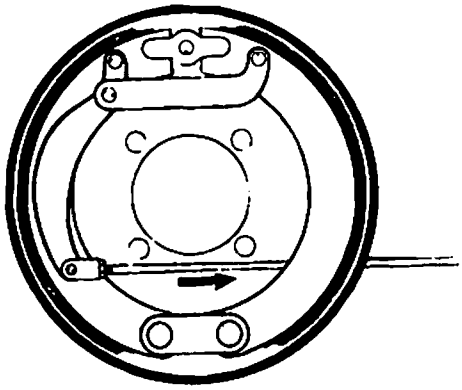
RAMBLER
- 1951-59 Bendix Non-Servo

STUDEBAKER
- 1956-59 Wagner Servo Compound
- 1950-55 Wagner Self-Adjusting (with Self-Adjusting Device)

WILLYS
- 1950-55 Bendix Non-Servo



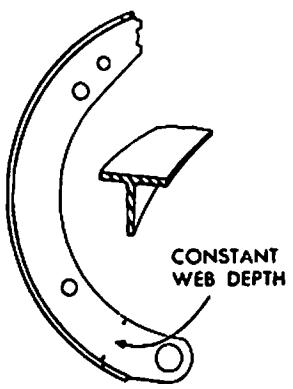
The external contracting type brake due to its limitations is now used almost exclusively as a propeller shaft type of parking brake.



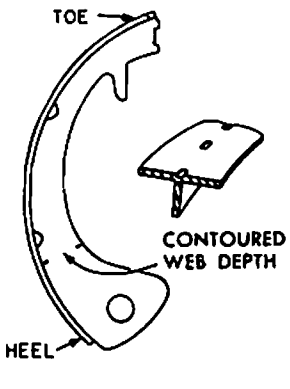
B. Internal Expanding

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 automotive industry as the "Four Wheel Brake System."

Section Four — FUNDAMENTALS OF BRAKE SHOE OPERATION



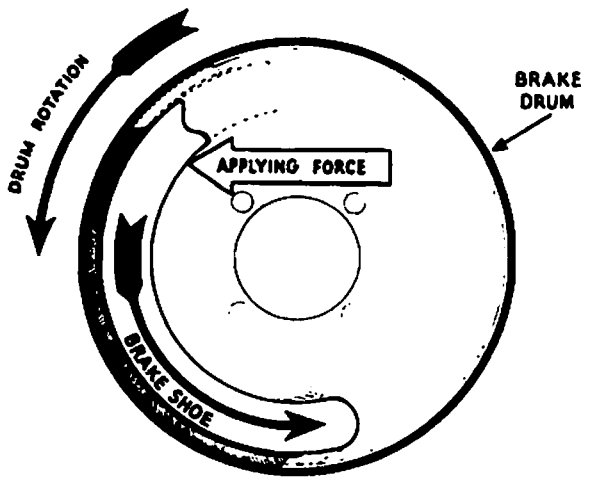
CONVENTIONAL BRAKE



TOTAL CONTACT HEEL

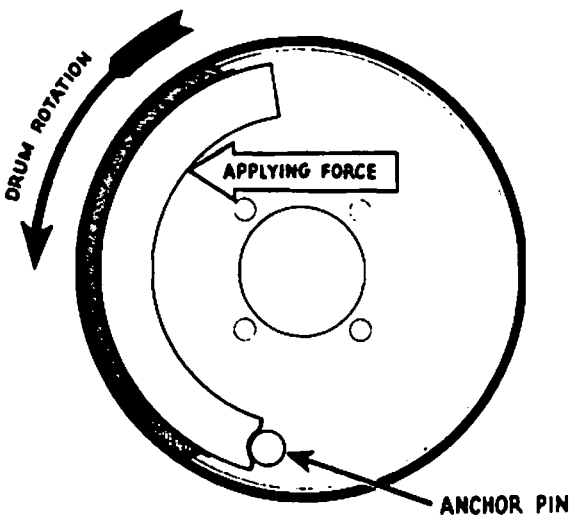
A. General

Brake shoes are that 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

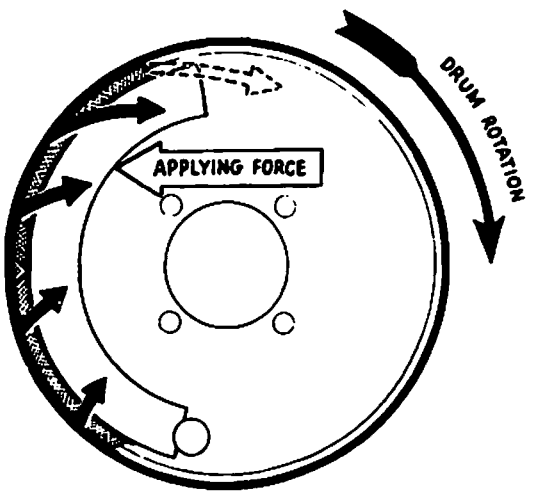
The action of the brake shoe in relation to the drum rotation is governed by forces other than just the applied force. For example: A brake shoe that is free to move within the brake drum when brought into contact with the drum would start to move with the drum unless it were held in some manner. There 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.



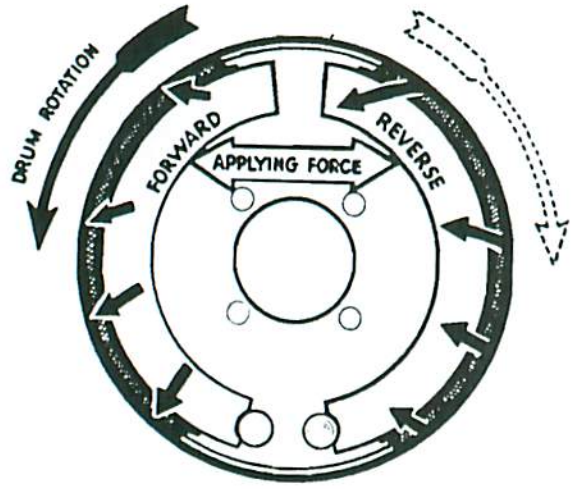
C. Self-Energized Action

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.

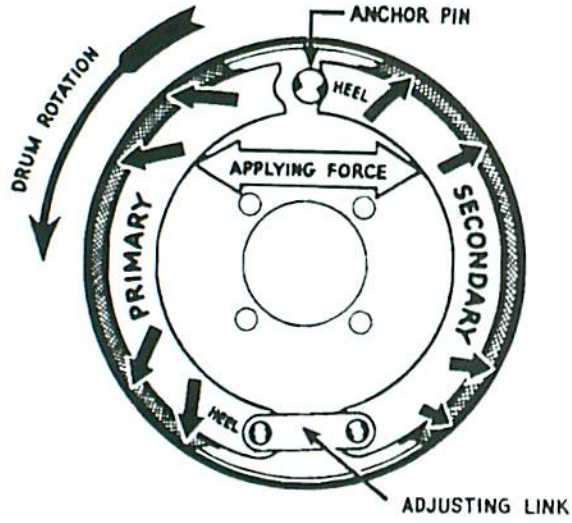


If the rotation of the drum were reversed, the action of the shoe would also reverse. The reverse action of the shoe would require more applied force to equal the braking effort of a self-energized shoe.



D. Forward and Reverse Acting Shoes

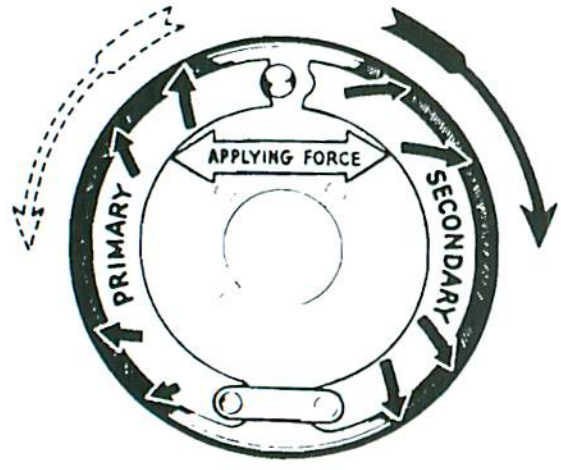
A two shoe, two anchor pin brake as shown, illustrates the action of the brake shoes when the brakes are applied. The shoe that is self-energizing during forward action is known as the forward acting shoe. The forward acting shoe will exert a heavier braking force on the brake drum than the shoe that 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

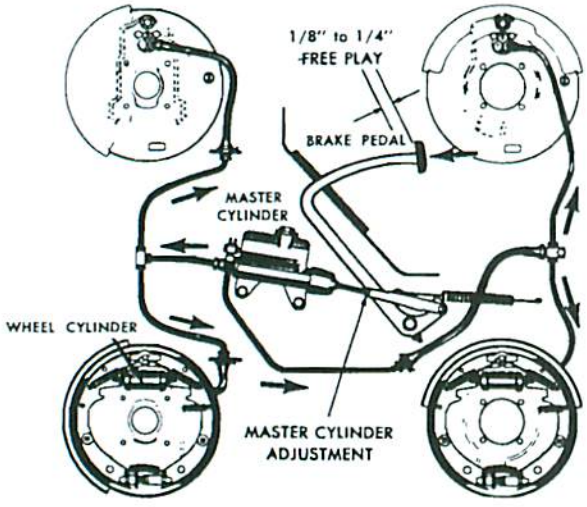
When two shoes are adjusted by an adjusting link as shown (with some type of an anchor pin at the top) the applied force on the primary shoe moving it into drum rotation energizes the shoe through the action of the drum. Action of the primary shoe is applied to the end of the secondary shoe with a greater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



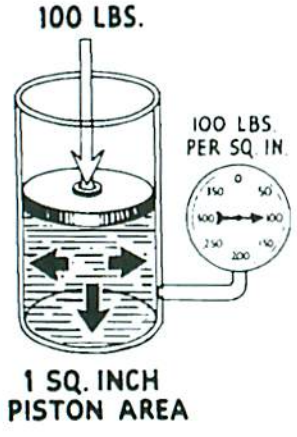
The servo acting brake is equally effective in either direction of drum rotation. If the applied force pushes the shoes apart with equal pressure, the action of the drum may shift the shoe slightly, to conform to the drum. The first shoe pushed into the rotation of the drum will have a tendency to move 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.

Section Five — FUNDAMENTALS OF MASTER CYLINDER AND WHEEL CYLINDER OPERATION

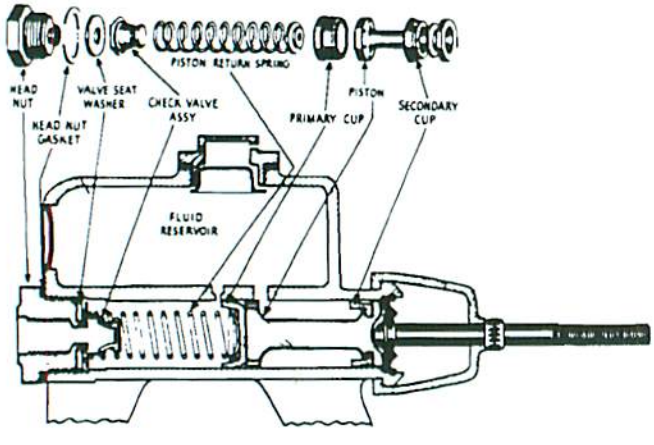


A. General

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.

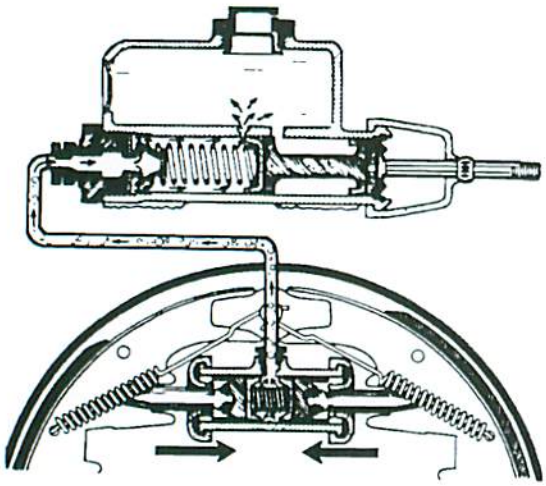


The principle of hydraulics is that pressure exerted at any point on a confined liquid will transmit this pressure through the fluid equally in all directions.



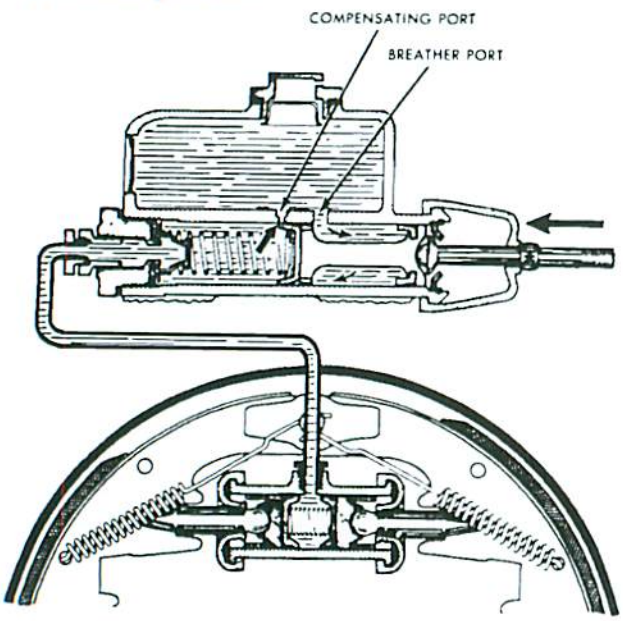
B. Master Cylinder

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.

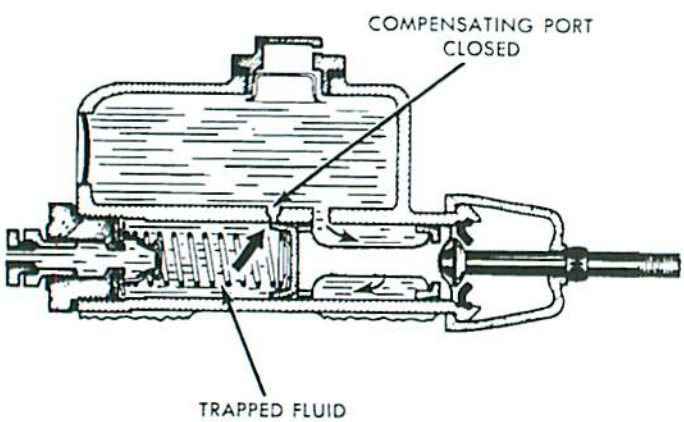


The constant pressure that is maintained in the lines also reduces the possibility of air bubbles getting into the system when the brakes are released.

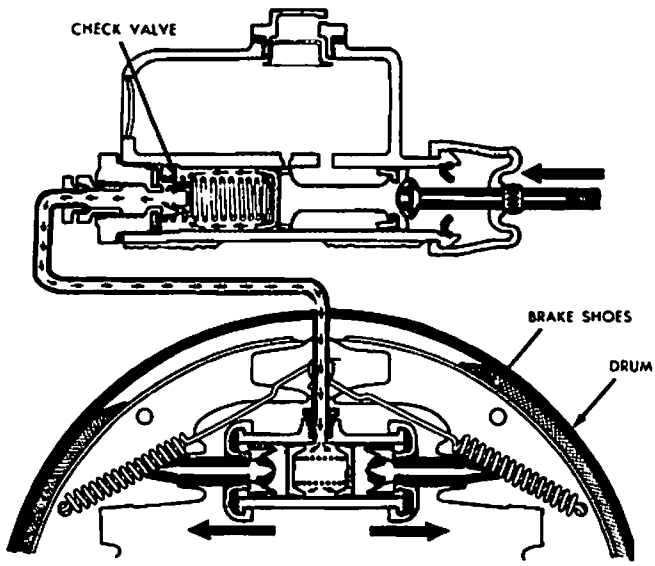
There are three forward and two reverse stages in the operation of the master cylinder. The forward stroke starts from the fully released position to a partially applied, and then to a fully applied position. On the return stroke, it starts from the partially released to the fully released position.



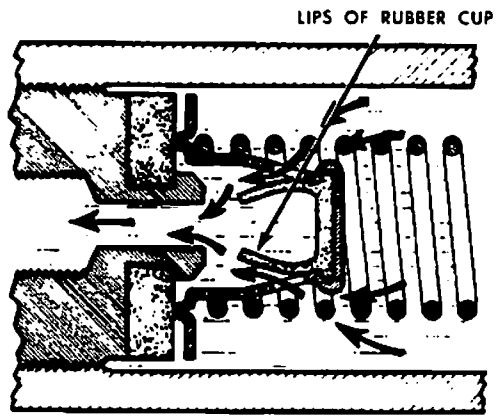
On the forward stroke, in the fully released position, there is no pressure on the master cylinder. The reservoir is vented to atmospheric pressure. Fluid from the reservoir flows down behind the piston through the breather port and ahead of the piston through the compensating port.



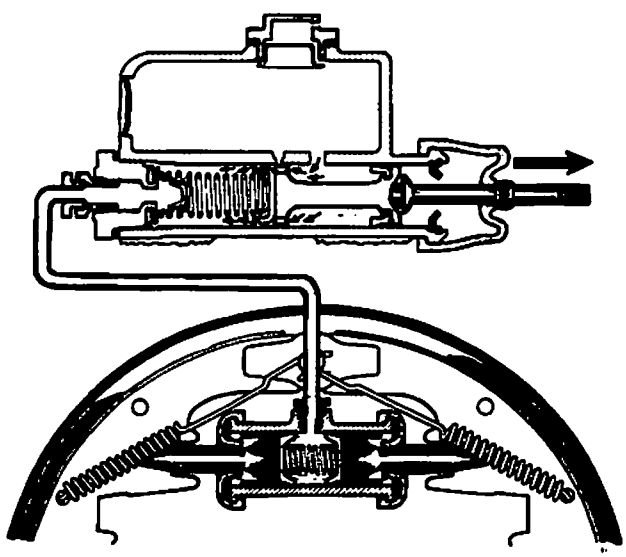
If the master cylinder piston is moved forward by the force on the brake pedal, the rubber lip of the primary cup will cover the compensating port. The fluid is trapped ahead of the piston and the cup. Then the fluid from the reservoir will flow through the breather port as the piston moves forward. This keeps the space between the piston head and secondary cup filled with fluid at all times.



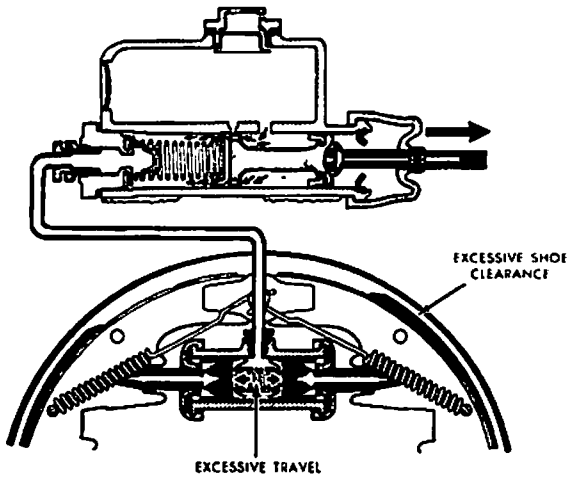
As the piston continues to move forward, the fluid is forced through the check valve into the hydraulic lines and wheel cylinders. The movement of the fluid forces the wheel cylinder pistons out against the brake shoes forcing them into contact with the drums.



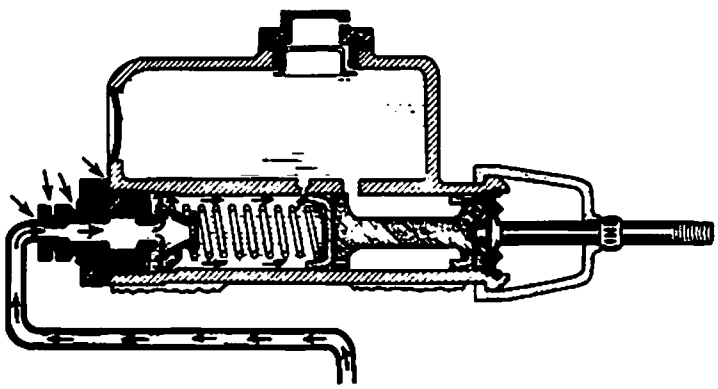
The check valve allows the flow of fluid from the master cylinder to press the lips of the rubber cup away from the opening in the check valve so that the fluid flows in one direction.



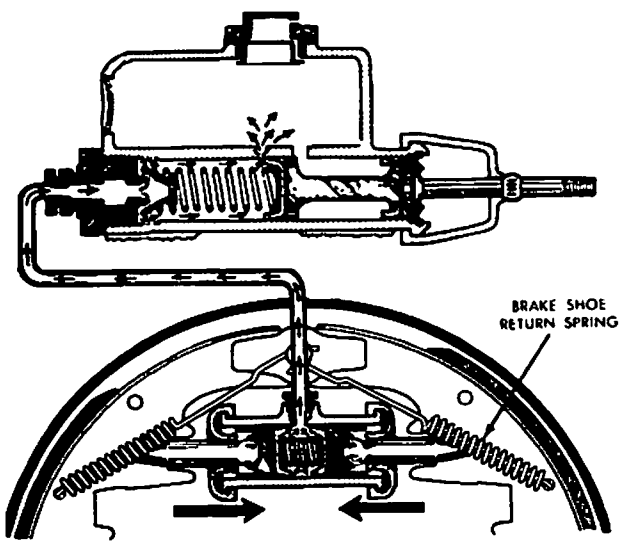
When the brakes are released, and the master cylinder piston starts its return stroke, the check valve restricts the fluid return from the master cylinder. As a result the fluid which is behind the primary cup will flow through the small holes in the piston and over the lip of the primary cup into the pressure side of the master cylinder. This serves two purposes:



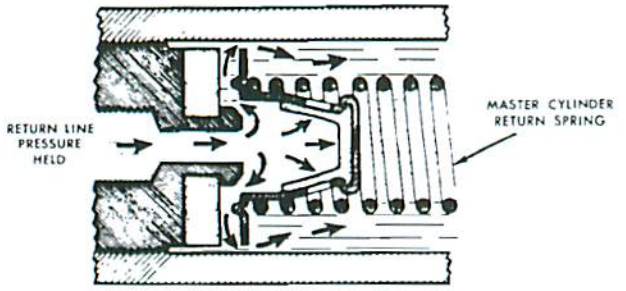
1) First, when brake shoe clearance is excessive, the master cylinder can be pumped to put more fluid into the system so that wheel cylinder pistons can travel far enough to apply the brake shoes.



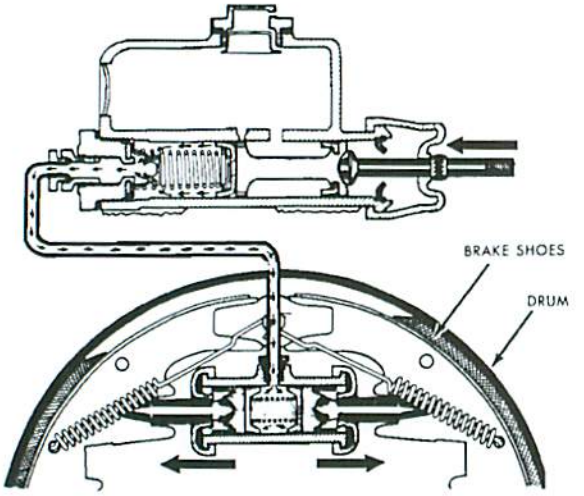
2) Second, it prevents air from entering the system as the master cylinder piston moves to the released position.



As the brake shoe return springs pull the shoe away from the brake drum, the springs also put a return force on the wheel cylinder pistons. The force overcomes the tension on the master cylinder return spring, and the check valve is lifted off its seat. As the lip of the primary cup uncovers the compensating port, the extra fluid which entered the system returns to the master cylinder reservoir.

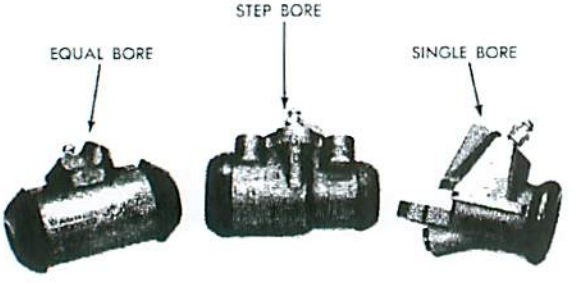


When the return pressure in the brake lines "drops" below the tension of the master cylinder return spring, the check valve will close and retain some pressure in the system. The pressure holds the lips of the wheel cylinder cups against the wheel cylinder bores.

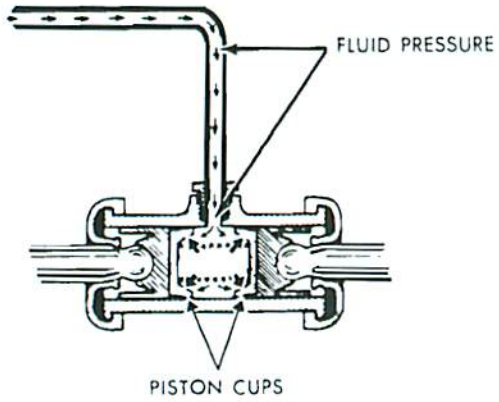


C. Wheel Cylinder

When brakes are applied, fluid displaced by the master cylinder causes the wheel cylinder pistons to move out forcing the brake shoes against the drum.

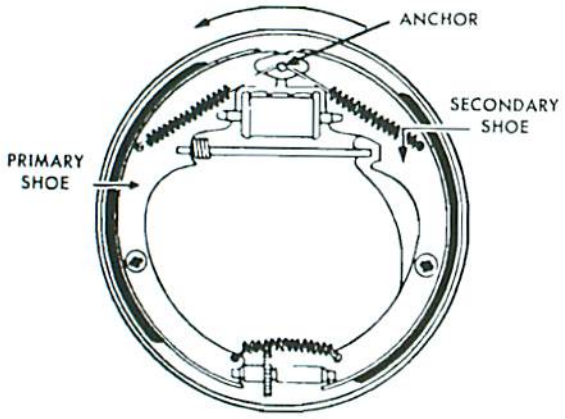


There are three types of wheel cylinders in use; equal bore, step bore, and single piston. The cylinders are made up of pistons, piston cups, piston springs, and rubber boots.



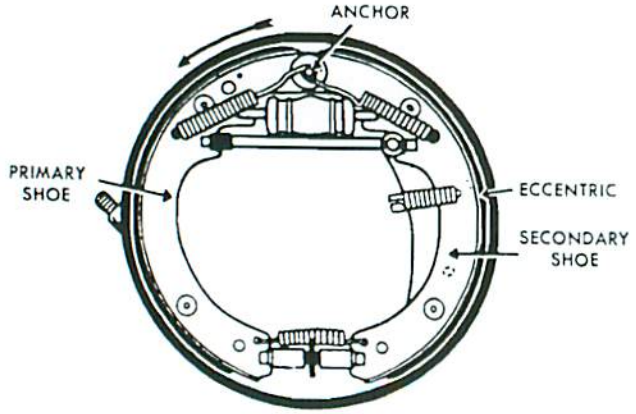
The piston cups are designed so the pressure of the fluid forces the lips of the cups out against the cylinder walls. The greater the pressure, the tighter the lips press against the wall.

Section Six — TYPICAL SERVICE BRAKE DESIGNS



A. Two-Shoe, Single-Anchor, Single-Piston, (Bendix)

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.



B. Two-Shoe, Single-Anchor, Double-Piston, (Bendix)

In this brake, the primary and secondary shoes are energized by wheel rotation. NOTE: The brake may or may not have "cam adjusters" to adjust brake shoe clearance.

CHAPTER II

TROUBLE SHOOTING AND DIAGNOSIS

Section One — GENERAL

When the brake system is installed in a car in production, all adjustments are made to the Manufacturer's Specifications or Standards. Any adjustment made to the brakes after the car is in operation is to maintain these Standards or Specifications.

Trouble Shooting the brake system is to find out what part of the system failed in its operation. Then diagnose the trouble correctly and make the required adjustment or repairs that will bring the system back to Commercial Standards that were first established by the car manufacturer.

This assignment can best be done by following the 4-C's of Good Brake Service.

The 4-C's

Do the job COMPLETELY

Do the job CAREFULLY

Do the job CORRECTLY

Do the job CLEANLY

Following the 4-C method will reduce unnecessary brake service as (1) Trouble Shooting someone else's work, (2) Trouble Shooting your own work.

NOTE: Whenever grease or oil is found on a brake lining, replace the shoes using new linings or reline the old shoes. Work with wheel combinations, both front wheels or both rear wheels. *Never adjust one wheel only.*

Section Two — TROUBLE SHOOTING

Pedal Action — Soft or Spongy

CAUSE	REMEDY
a. Air in the hydraulic brake system.	a. Carefully Bleed all four brakes.
b. Primary cup leaking allowing fluid to leak back into reserve chamber.	b. Repair master cylinder and replace worn rubber cups and bleed system.
c. Brake hoses expanding under hydraulic pressure.	c. Replace any weak hose and bleed wheel or wheels beyond weak hose.
d. Incorrect lining to drum contact.	d. Grind lining to correct specifications.
e. Leaking wheel cylinder cups allowing air to enter system.	e. Check wheel cylinder for leaks and replace rubber cups if necessary. Bleed system.
f. Incorrect type of fluid	f. Flush system and use recommended fluid.
g. Dirty fluid.	g. Flush system and use recommended fluid. Check all rubber cups for wear or damage, replace if required.
h. Shoe not centered in the drum.	h. Make a major adjustment and re-center the shoes on their anchors.
i. Thin brake drums, expanding under pressure.	i. Replace brake drums.
j. Partial lining-to-drum contact caused by incorrect lining thickness or improper grinding.	j. Replace with lining of required thickness, or grind lining to fit drum.

Hard Pedal

a. Linings old and hard.	a. Reline all brake shoes.
b. Foreign matter on face of lining.	b. Reline shoes or burnish lining surface.
c. Obstruction or kinks in brake line. Clogged brake hose.	c. Look for kinks in tubing and correct. Replace clogged brake hose.
d. Relief port in master cylinder restricted due to swollen rubber cup.	d. Check relief port and clear it with a piece of tag wire. Replace rubber cup. Flush the hydraulic system and refill with recommended fluid.
e. Incorrect lining to drum contact.	e. Grind lining to correct specifications.
f. Incorrect shoe adjustment for uneven contact with the drum.	f. Adjust shoes correctly and check brake pedal action.

Brake Fade-Out

CAUSE	REMEDY
a. Fluid leaking from system.	a. Check all wheel cylinders and connections for fluid leaks. Recondition wheel cylinder and replace rubber cup.
b. Excessive brake shoe clearance, between lining and drum.	b. Re-adjust brake shoe clearance.
c. Weak brake hose, expanding under pressure.	c. Replace hose.
d. Thin brake drums, expanding under pressure.	d. Replace brake drums.
e. Incorrect type of lining.	e. Reline with correct brake lining.
f. Lining incorrectly positioned on shoes. Shoe location reversed in assembly.	f. Reline all shoes with long and short or wide and narrow segments in specified position. Re-assemble with "primary" and "secondary" or "forward" and "reverse" shoes in correct position.

Brake Noise or Chatter

a. Brake shoe anchors not adjusted correctly, shoes not centering in the drum.	a. Make a major adjustment. Center shoes in the drum.
b. Loose brake shoe guides, anchor bolts, brake support plate or wheel cylinder.	b. Check all brake parts for misalignment or looseness. Tighten holding bolts or replace damaged parts.
c. Loose linings on shoes.	c. Reline brake shoes.
d. Brake shoes not squarely contacting the drum, bent shoe guides or anchors in backing plate.	d. Re-align brake shoe guides, anchors and replace all damaged parts.
e. Loose backing plate allowing it to vibrate.	e. Tighten brake backing plate holding bolts.
f. Shoes vibrate due to loose or weak holding springs.	f. Replace with new spring (on Chrysler, install a leather or rubber washer between shoe and backing plate at hold-down spring).
g. Drum vibration due to loose hub bolts, out of round drums, tapered or bell shaped drums.	g. Tighten drum holding bolts. Replace or turn brake drum to correct condition found.
h. Loose or worn wheel bearing.	h. Adjust or replace wheel bearings.

Brake Noise or Chatter — Continued

CAUSE	REMEDY
i. Lubrication of brake parts dried out.	i. Lubricate all sliding parts with "Lubri-Plate."
j. Broken springs, loose "U" bolts, shock absorbers or brake supports.	j. Replace broken spring leaves, tighten "U" bolts. Check rubber bushings of shock absorbers, and brake supports.
k. Incorrect type of lining.	k. Reline with correct brake linings.
l. Turned drums have tool marks causing shoes to snap back.	l. Grind or hone drum after turning.
m. Foreign matter on lining.	m. Reline all shoes or burnish lining surface.

Brakes Grab or Pull to One Side

a. Incorrect lining to drum clearance at one or more wheels.	a. Adjust brakes.
b. Obstruction in hoses or lines causing unequal delivery of pressure to wheel cylinder.	b. Check for obstruction in brake lines and correct either by replacing hose or line affected.
c. Wheel cylinders of different sizes, installed on opposite wheels.	c. Check all wheel cylinders for correct size and replace with new cylinders that meet car specifications.
d. Different types of lining on opposite wheels.	d. Reline brake shoes in pairs with recommended linings.
e. Linings loose.	e. Reline brake shoes.
f. Air in the system, sticking wheel cylinders, leaking wheel cylinder cups.	f. Bleed system of air. Check all wheel cylinders for sluggish action and for fluid leaks. Repair or replace wheel cylinders. Replace wheel cylinder cups.
g. Excessive dust in brake drums.	g. Clean brake drums.
h. Loose brake backing plate.	h. Check and tighten all brake backing plate bolts.
i. Shoes not centered in the drum.	i. Make major adjustments, center brake shoes in the drum.
j. Incorrect wheel alignment.	j. Correct alignment.

Brakes Grab or Pull to One Side — Continued

CAUSE	REMEDY
k. Defective wheel bearing.	k. Replace wheel bearing.
l. Improper wheel bearing adjustment.	l. Adjust wheel bearings.
m. Weak car springs allowing axle to roll. Weak shock absorbers.	m. Check correct spring height of car. Replace weak spring or weak shock absorbers.
n. Thin drums expanding under pressure.	n. Replace drums.

Brakes Will Not Hold

a. Sluggish action of fluid. Cups in master cylinder swollen. Sticking wheel cylinders.	a. Recondition master cylinder and wheel cylinders. Flush system and refill with recommended fluid.
b. Wrong linings, linings reversed, linings worn, glazed or greasy linings.	b. Reline shoes with recommended lining.
c. Lining to drum contact incorrect affecting self-energization causing fading.	c. Make major adjustment and center shoes in the drum. Check anchor pins for alignment.

Brake Drag

a. Parking brake adjusted tight, or cable sticking.	a. Adjust parking brake linkage with brake shoes in the released position; free up all cables.
b. Weak, broken or missing brake return springs.	b. Replace all weak, broken or missing brake system return springs.
c. Brake shoes worn at the anchor. Shoes fail to fit.	c. Check clearance of shoe at anchor pin. Replace shoes in pairs. Shoe may be of wrong size, check shoe with contour of the drum.
d. Sticking wheel cylinders, master cylinder ports closed by air. Swollen cups.	d. Flush hydraulic system. Check all units for free operation. Refill hydraulic system with recommended fluid and bleed the system of air. Replace rubber cups.
e. Improper brake pedal adjustment. Not allowing brakes to return to released position.	e. Adjust brake pedal for proper free travel.
f. Collapsed hose or kinked tubing.	f. Remove kinks from tubing or replace if damaged. Replace collapsed hose.

Brake Drag — Continued

CAUSE	REMEDY
g. Shoe guides worn or bent causing cocking of shoe.	g. Free up shoe in guide and lubricate using "Lubri-Plate."
h. Loose wheel bearings.	h. Adjust or replace wheel bearings.
i. Out of round drums.	i. Replace drums.
j. Defective wheel bearings or incorrect bearing adjustment.	j. Replace or adjust wheel bearings.

Brakes Fail to Hold When Wet or Grab When Wet

a. Dust in brake drums. Seals on backing plate missing.	a. Clean brake drums and see that adjusting covers are in place in brake backing plate.
b. Improper lining.	b. Reline with recommended brake lining.

Pedal "Falls Away" Under Sustained Foot Pressure

a. Defective cups in master cylinder permitting by-pass of fluid to reservoir.	a. Repair or replace master cylinder.
b. Leak in hydraulic line.	b. Tighten connections. Replace defective lines.
c. Leaking wheel cylinder.	c. Repair or replace wheel cylinder.
d. Loose bleeder screws.	d. Tighten screws.

Pedal "Rises" On Successive Brake Applications

a. Insufficient free travel.	a. Adjust brake pedal free travel.
b. Swollen cup in master cylinder obstructing relief port.	b. Repair or replace master cylinder.
c. Inferior brake fluid expanding or vaporizing.	c. Drain and flush hydraulic system. Refill with approved fluid. Bleed system.
d. Weak shoe retracting springs or defective wheel cylinder cups.	d. Replace springs. Repair or replace wheel cylinders.

CHAPTER III

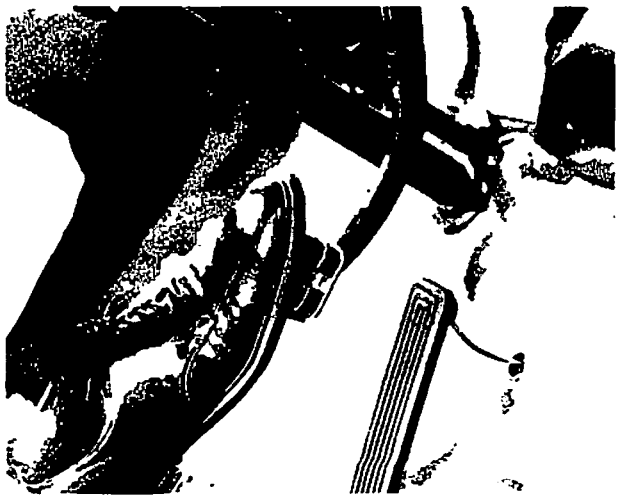
BRAKE SYSTEM SERVICE

Section One — MINOR & MAJOR BRAKE ADJUSTMENTS

Check, inspect or do the following on all brake jobs to ensure quality workmanship and customer satisfaction the first time:

1. Equalize tires to the correct air pressure.
2. Check tires for uneven wear.
3. Correctly adjust all wheel bearings and check bearing condition.
4. Securely tighten all lug bolts or nuts.
5. Check all brake hoses for chafing, cracks, leaks, breaks, brittleness and wear.
6. Inspect all brake lines and connections for leaks, cracks, breaks, holes and rusted out sections.
7. Check the master cylinder and all wheel cylinders for leaks.
8. Check and tighten brake backing plates and steering arms.
9. Inspect all brake drums for scoring, cracks, breaks, taper, bell-mouthed, out-of-round, excessively oversize and for any other adverse drum condition.
10. Check all brake springs for weakness and broken coils.
11. Inspect all brake shoe hold down nails, cups, springs for wear, rust and bent pieces.
12. Check for frozen parking brake cables; free-up or replace them.
13. Inspect all brake shoes for twists, bends, cracks, worn pivot holes and broken out sections.
14. Check all shock absorbers for unequal resistance.
15. Inspect steering gear and connections for looseness.

A. General



Try the brake pedal action to see if the brake system is free acting. If the brake pedal does not snap quickly into the released position, it indicates either weak or broken brake pedal or brake shoe return springs, or sluggishness somewhere in the system.

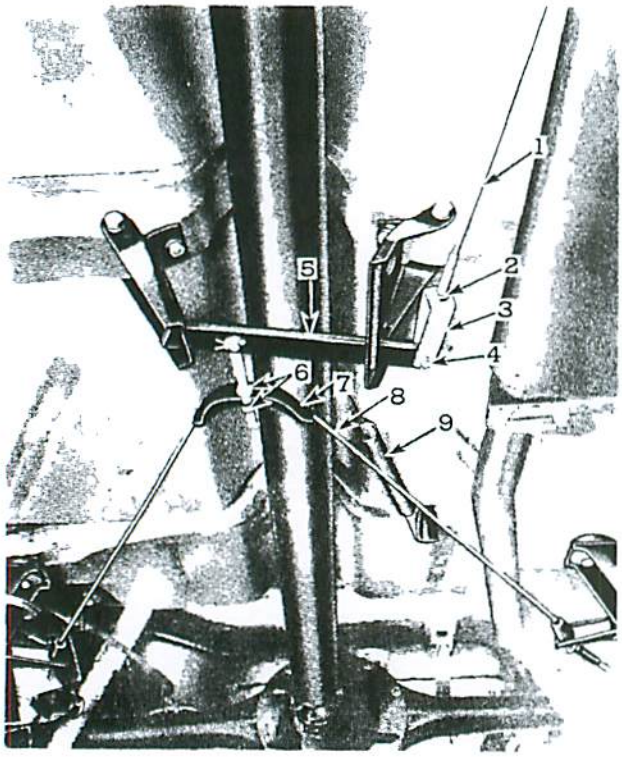
NOTE Always adjust anchor pins when:

Fitting new shoes.

Anchor pins nuts are found loose.

Other adjustments fail to give satisfactory results.

B. Bendix Duo-Servo Fixed, Eccentric & Sliding Anchors



1. *Minor Adjustment*

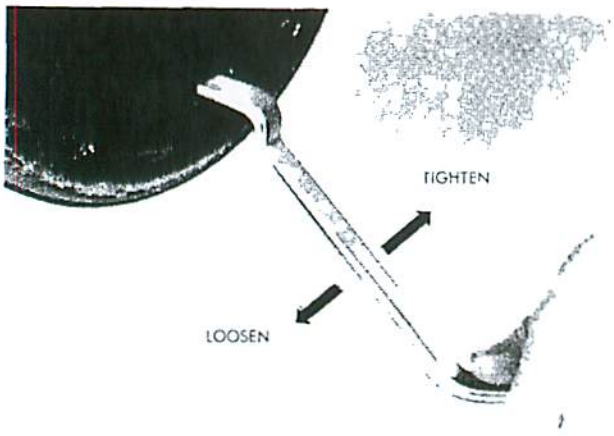
   a. Jack up and support car safely at all 4 wheels.

NOTE Always pull a wheel and brake drum for inspection.

   b. Make sure parking brake cables are fully released or disconnected.

Check the following:

1. Forward pull cable.
2. Pull cable lock nut.
3. Clevis.
4. Clevis pin and cotter pin.
5. Idler lever.
6. Adjusting and check nuts.
7. Equalizer.
8. Cable to rear wheels.
9. Pull back spring.

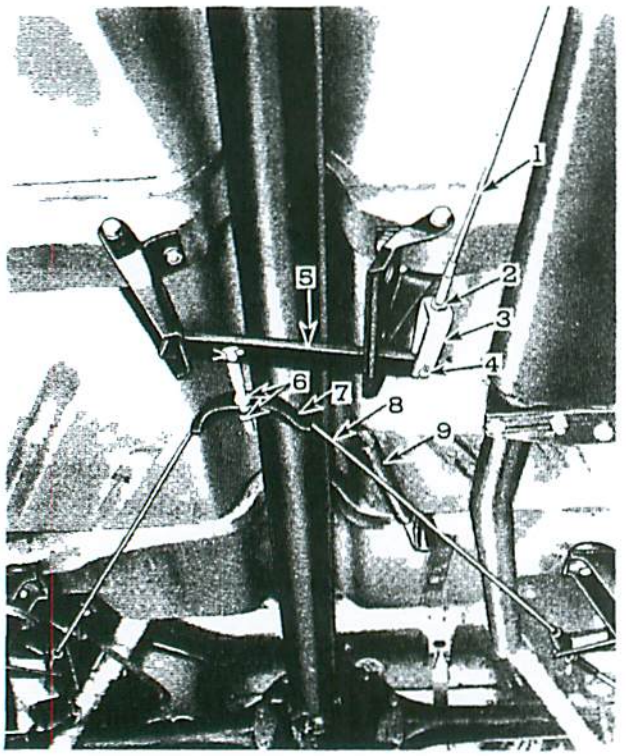


   c. Remove brake shoe adjusting hole covers and using a star wheel brake adjusting tool, tighten the star wheel by moving the outer end of the adjusting tool toward the axle housing or by an upward movement until the brake drum can just be turned by two hands.

   d. Back off the star wheel 12 to 16 clicks with the star wheel adjusting tool. Make sure brake drum turns freely and install brake shoe adjusting hole covers.

NOTE A major brake adjustment will be necessary if the brake drum does not turn freely, requiring an eccentric cam and anchor pin adjustment.

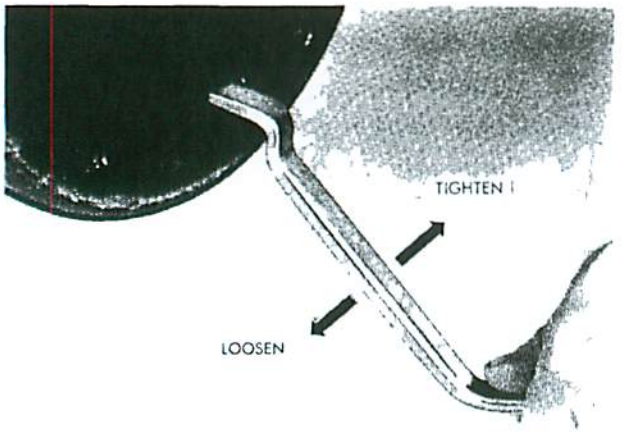
On cars with fixed anchors and self centering anchors, a minor adjustment is the only adjustment that can be accomplished, because the anchor pins cannot be adjusted.



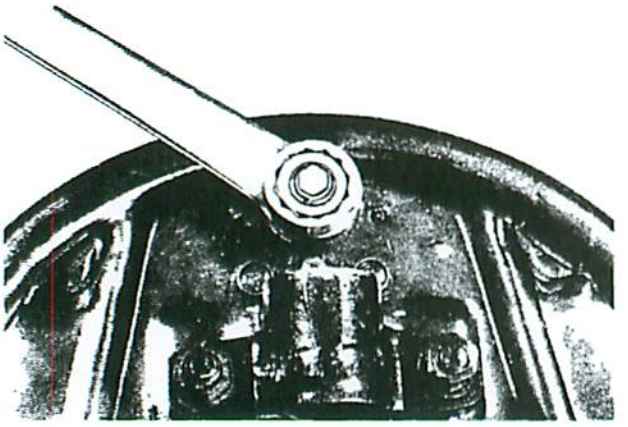
2. *Major Adjustment — Eccentric Anchor*

   a. Support car safely at all four wheels.

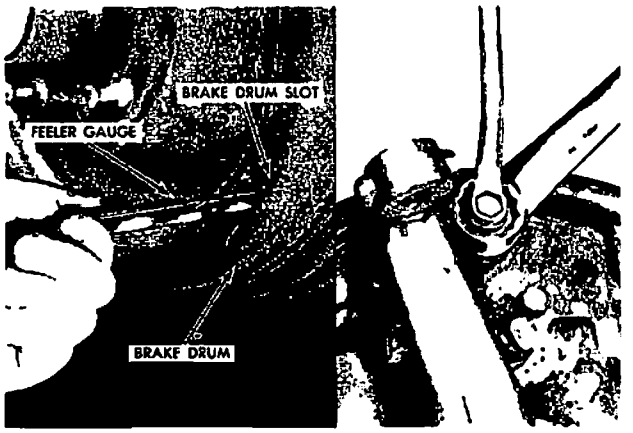
   b. Disconnect the parking brake cables by removing the clevis pins and/or the retaining bolts and nuts from the parking brake equalizer.



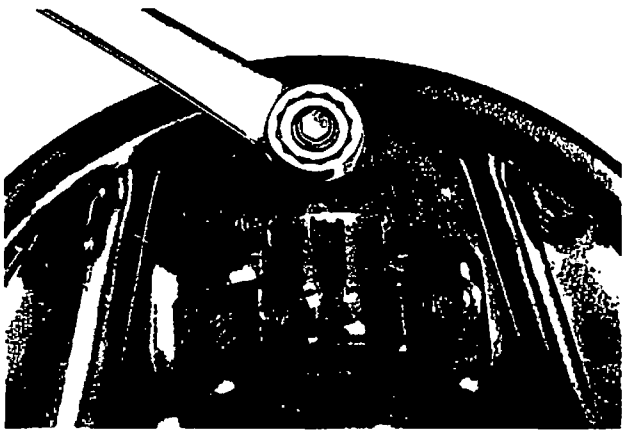
   c. Remove brake shoe adjusting hole covers and with a star wheel brake adjusting tool, tighten the star wheel by moving the outer end of the adjusting tool upward toward the axle until the brake drum drags heavily on the brake lining. Back off the star adjusting wheel 16 "clicks" by moving the outer end of the tool downward or away from the axle.



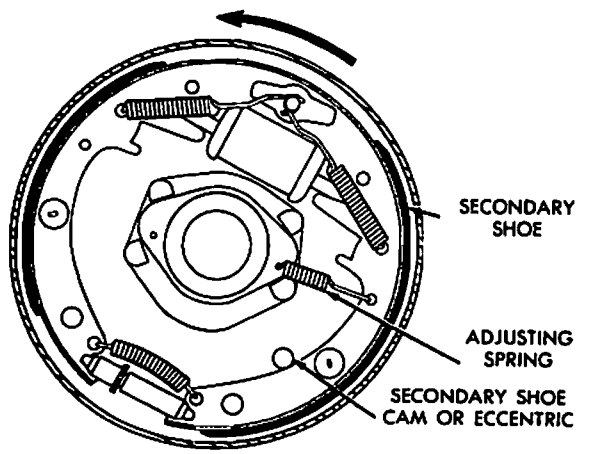
   d. Use a suitable tool to loosen the anchor pin lock nut ½ to ¾ of a turn. Tap the anchor pin with a soft faced mallet to ensure free movement.



e. With the primary shoe forward as far as possible. Alternately rotate the anchor pin and star adjusting wheel until a .015 feeler gauge can just be inserted through the brake drum inspection hole located at the toe and heel ends of the secondary shoe.

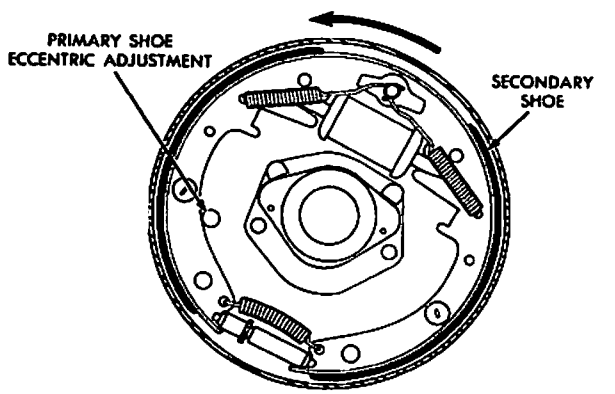


f. Tighten anchor pin lock nut, recheck lining to drum clearance, and install the brake shoe adjusting hole covers.

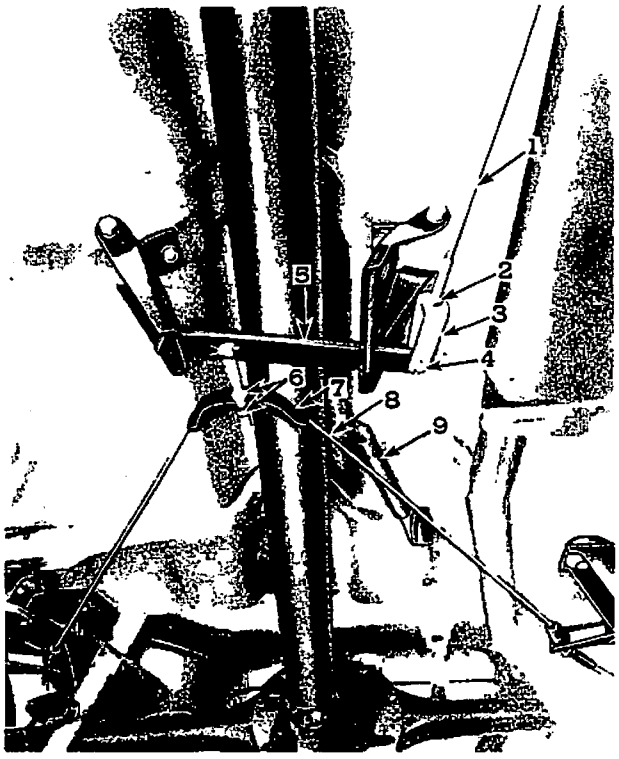


NOTE For the Bendix brakes employing a secondary shoe eccentric cam or stop, the following adjustment procedure is to be followed:

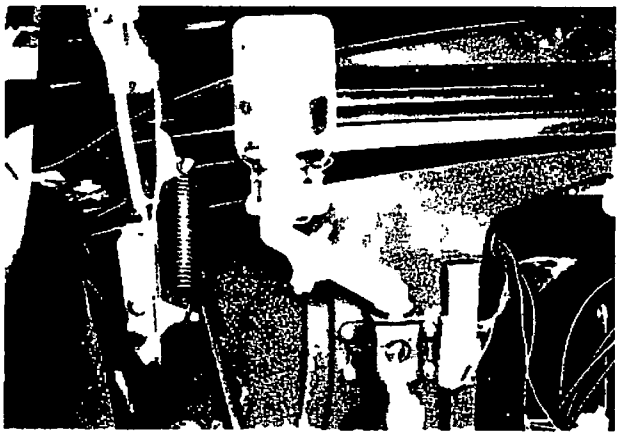
g. Loosen the primary or secondary shoe eccentric cam lock nut and turn the eccentric cam in the direction of forward wheel rotation until a .004" to .010" feeler gauge slightly drags between the center of the shoe lining arc and the brake drum.



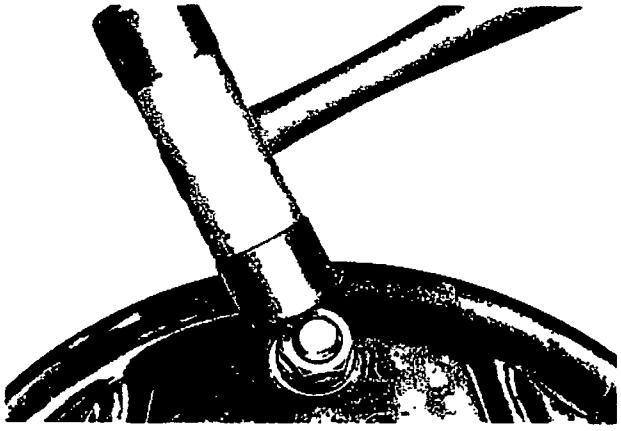
NOTE The primary and secondary shoe eccentric cam adjustment is also utilized on various types of Bendix Duo-Servo brakes regardless of anchor design.



h. Set the parking brake lever in the released position. Adjust the cable ends until the clevis pins can just be installed. Release the parking brake lever and check for dragging rear brakes and slack cables.



i. Check and fill master cylinder with proper amount of hydraulic brake fluid. Lower car to floor and road test car for proper brake performance.

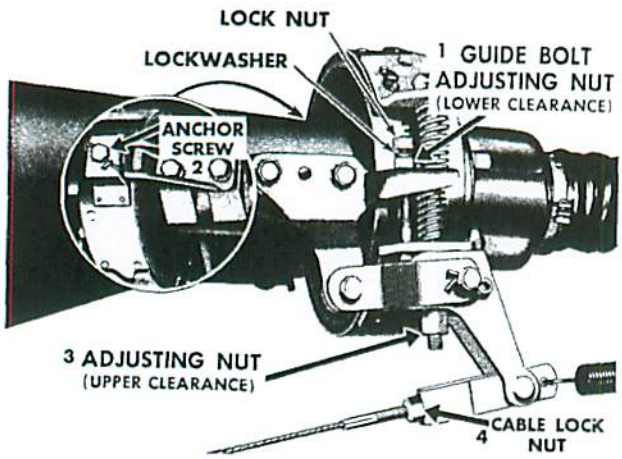


3. *Major Adjustment — Sliding Anchor*

NOTE All adjusting procedures are the same as for previous Bendix brakes except for the anchor. The procedure for adjusting the sliding anchor is as follows:

a. Loosen the anchor pin lock nut ½ to ¾ of a turn. Tap the anchor pin with a soft faced mallet to ensure free movement.

PARKING BRAKES



1. External Type — Standard Transmission

a. Adjust the anchor screw so the clearance between the drum and the lining at the anchor bracket is .020". Lock the anchor screw securely in position.

b. Turn the guide bolt adjusting nut (1) until the clearance between band and bottom of drum is .020". Then lock the guide bolt securely. Turn the adjusting bolt nut (3) until the clearance between the upper half of the band and drum is .020".

c. The lock wire which retains the anchor bolt must not be drawn up tight. Otherwise, it will cause excessive anchor bolt restriction and the result will be uneven wear on the linings and poor braking action.

d. Adjust the hand brake cable by loosening the lock nut (4) and removing the clevis pin from the yoke. Turn the yoke until the cable slack is removed with the actuating cam flat against the end bracket on the band. Do not substitute a cable adjustment for a hand brake adjustment.

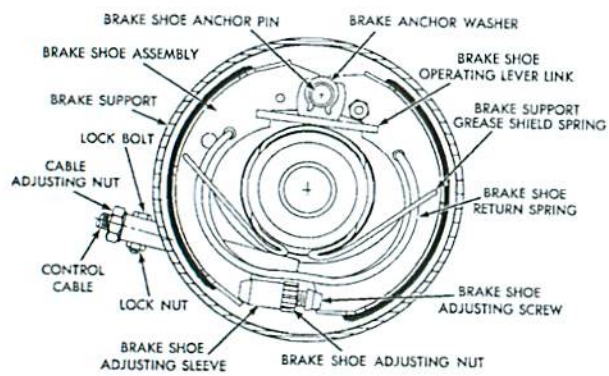
e. When the clearance has been adjusted properly, the hand brake should lock when the lever is pulled back from four to six notches.

f. To lock this adjustment, tighten the cable housing clamp securely and then tighten the cable adjusting nut against the housing.

Never substitute a cable adjustment for a brake shoe adjustment.

2. Internal Type — Automatic Transmission

This brake must be properly adjusted, otherwise, the automatic transmission will not perform satisfactorily.



a. Put the transmission in Neutral (N) position, release the hand brake lever. Then, disconnect the front end of the propeller shaft so that the brake drum may be turned by hand.

b. Remove the adjusting shoe cover and turn the brake shoe adjusting nut until there is a slight drag on the drum. Back off the adjusting nut as least one full notch, to give approximately .010" clearance.

NOTE *Be sure that the two raised shoulders on the adjusting nut are seated in the grooves on the adjusting sleeve.*

c. Test the hand brake lever for travel. When the brakes are properly adjusted, there should be from 3 to 5 notches on the lever rod visible beyond the free plate.

d. Reconnect the front end of the propeller shaft.

3. *Cable Adjustment*

a. The cable length adjusting nut should be positioned against the cable housing so that there is at least .005" and not more than .010" clearance between the operating lever and the brake shoe cable.

The Requirements of a Good Brake Fluid:

Brake fluid is a vital part of the hydraulic brake system and not enough importance is placed on the use of recommended brake fluid. The entire system is made up of various materials such as cast iron, steel, copper, aluminum, and synthetic rubber — all of which have to operate in fluid. Any action of the fluid upon these materials may cause corrosion, deterioration or swelling, resulting in poor brake operation. Make sure that the fluid that you use does have the following qualities:

(a) That it serves as a lubricant to the moving parts without damage to the parts.

(b) That it does not set up an electrolytic action which would pit any part or cause corrosion.

(c) That it does not have a chemical action on any part and will remain efficient over long periods of time.

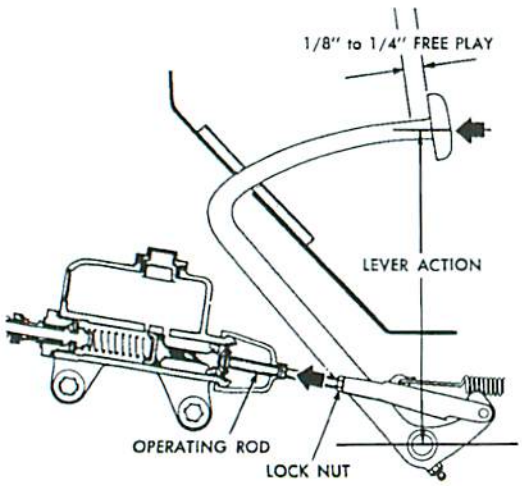
(d) That it will not cause the rubber cups to swell.

(e) That it will operate in any kind of temperature from torrid to sub-zero.

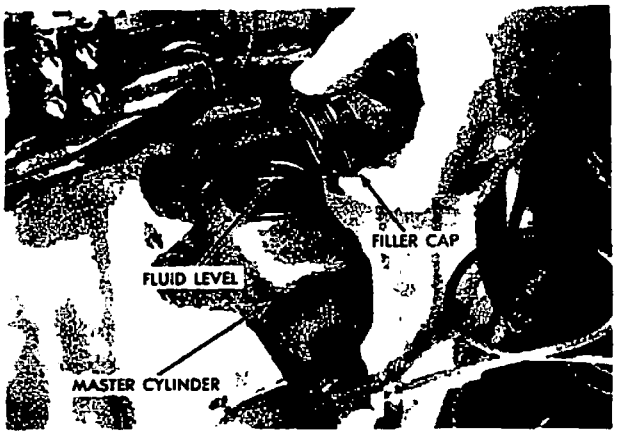
(f) That the fluid used will mix without causing separation.

Always use SAE approved HD Brake Fluid.

I. Bleeding the Brake System and Filling the Master Cylinder

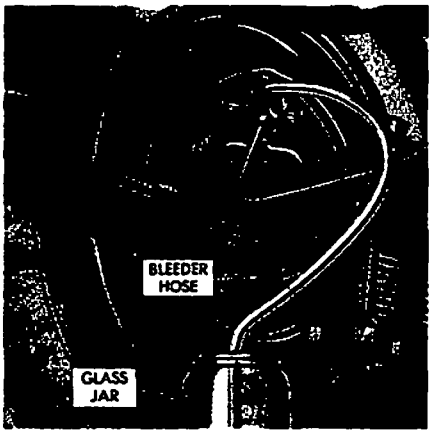


1. Support the car safely on jack stands or on a hoist.
2. Adjust brake pedal-to-master cylinder clearance of ⅛ to ¼ of an inch.

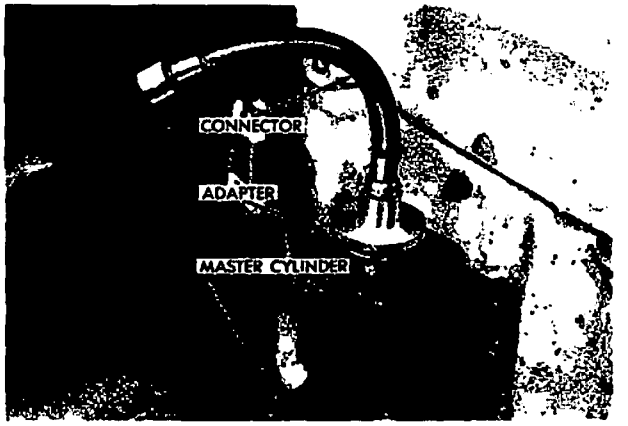


3. Thoroughly clean off the area around the top section and filler plug of the master cylinder.
4. Remove master cylinder filler plug.

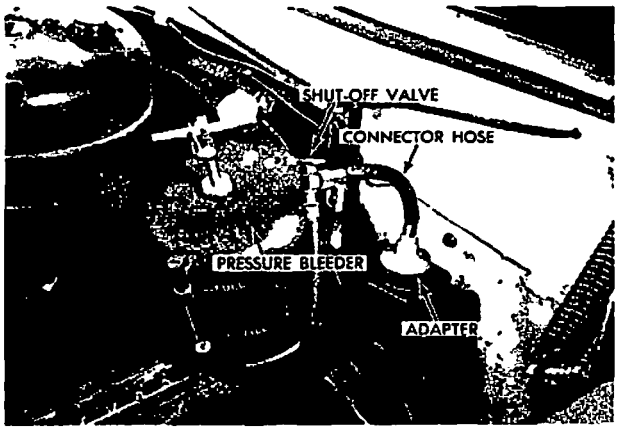
NOTE Use care and be sure dirt does not enter the master cylinder.



5. Attach a bleeder hose to each bleeder screw located at the back of each brake backing plate.

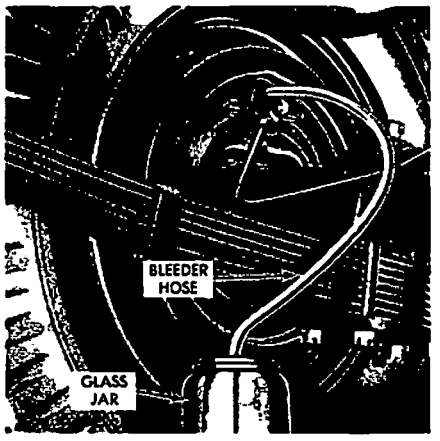


6. Install pressure bleeder adapter to master cylinder and hook-up pressure bleeder to the adapter.



7. Turn the pressure bleeder line valve open and check for hydraulic fluid leaks, at the lines, connections, wheel cylinders and master cylinder.

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

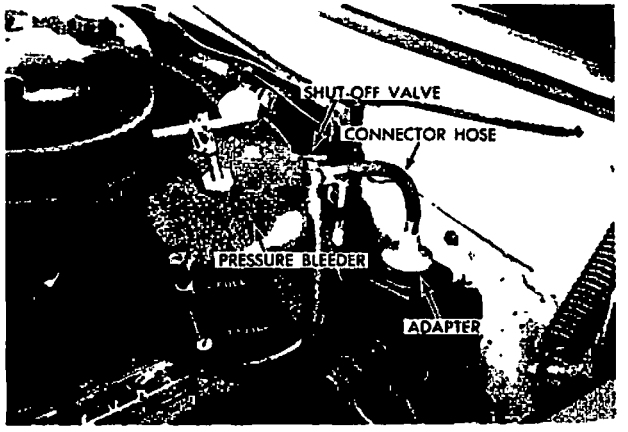


8. Open the brake bleeder screws in sequence at each brake bleeder connection until the brake fluid runs clear with no air bubbles present.

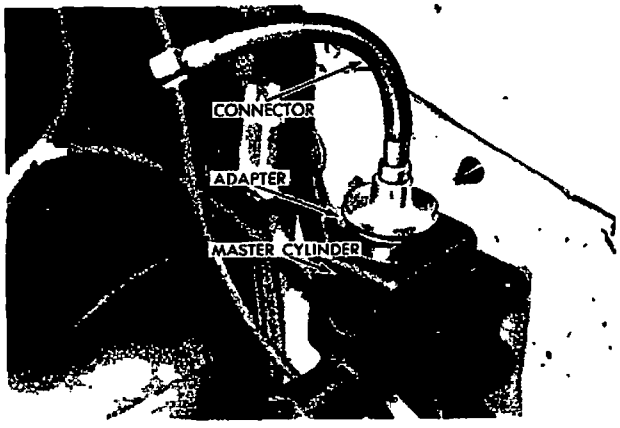
NOTE Use a clean glass jar to collect brake fluid.

9. Flush the hydraulic lines with qualified, high-quality brake fluid.

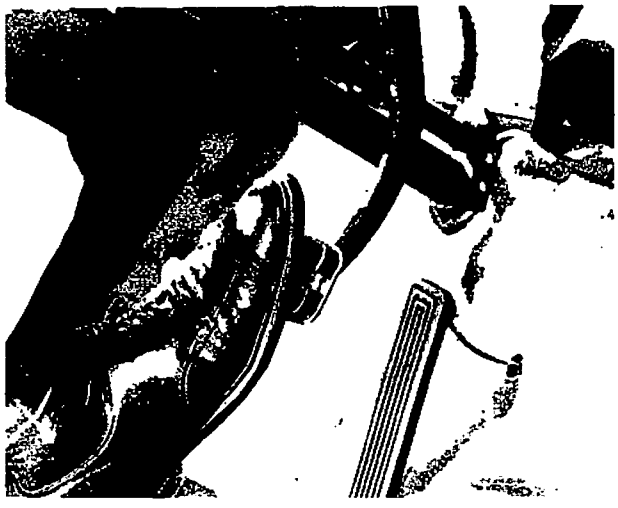
NOTE Always make sure the brake fluid runs clear and is free of all air bubbles.



10. Shut off the brake hydraulic pressure bleeder line valve.



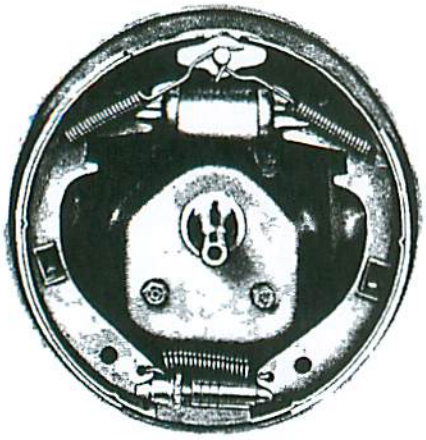
11. Disconnect the pressure bleeder connections from the master cylinder.
12. Lower car to the floor and road test car for proper brake action and brake pedal "feel".



13. Recheck brakes for correct brake pedal reserve.

NOTE Always adjust the brakes before bleeding the brake system.

Section Two — REMOVAL AND INSTALLATION OF BRAKE DRUMS AND SHOES



BENDIX DUO SERVO

A. Bendix Duo Servo

1. *Removal*

STATUS:

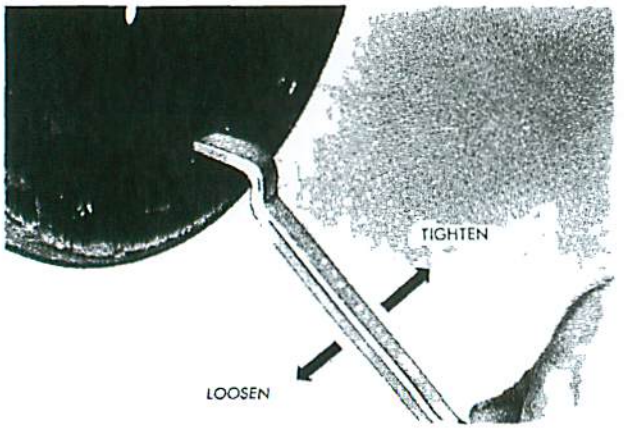
a. Support the car safely at all four wheels or raise car on hoist.

b. All wheels and brake drums removed.

c. Parking brake cables disconnected.

d. All dirt blown out from brake drums, shoes and backing plates.

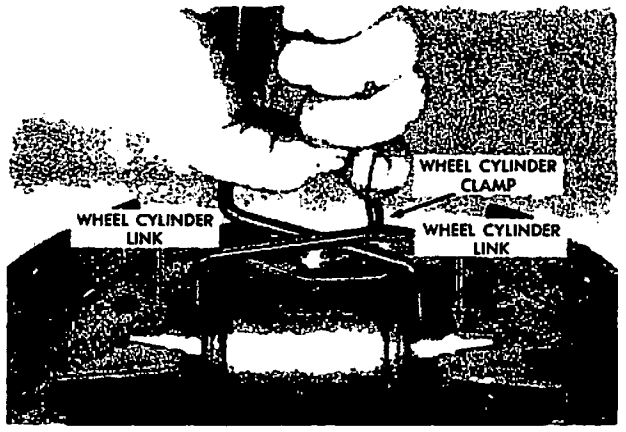
e. Remove the adjusting hole cover from each front brake backing plate.



f. Use a brake star wheel adjusting tool to back off the star wheel 15 to 20 "clicks" on both front and rear brakes.

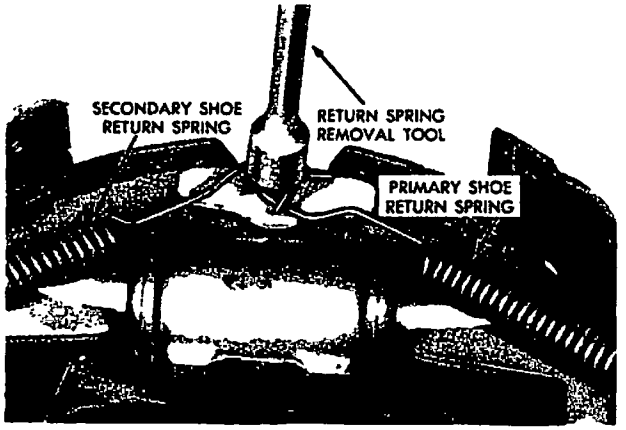
NOTE Moving the outer end of the tool down or away from the axle loosens the brake shoes.

Avoid getting dirt on the front wheel bearings.

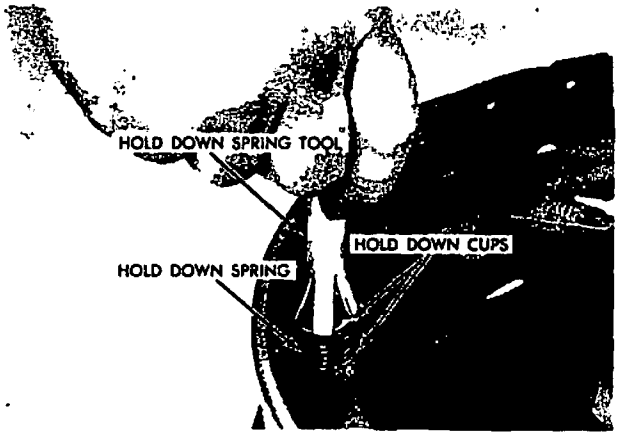


g. Install a wheel cylinder clamp on each wheel cylinder.

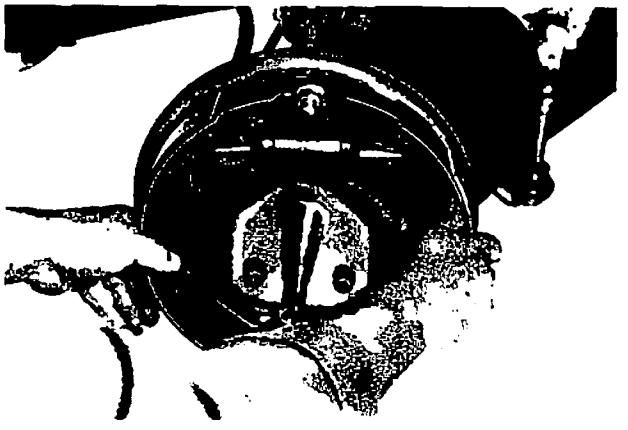
NOTE Many Bendix brake shoe backing plates are equipped with tabs, making wheel cylinder clamps unnecessary. For this reason the wheel cylinder clamp will not be shown in all pictures.



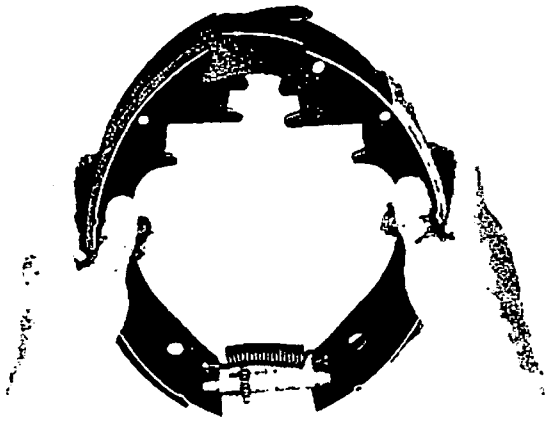
h. Use a brake shoe return spring removing and installing tool to unhook both the secondary and primary upper springs.



i. With a brake shoe hold down spring tool, remove the primary and secondary shoe hold down springs and cups.



j. Lift off the primary and secondary shoes, brake shoe star wheel adjuster and the brake shoe return spring as an assembly.



k. Disassemble the star wheel adjuster and the return spring from the primary and secondary shoe.

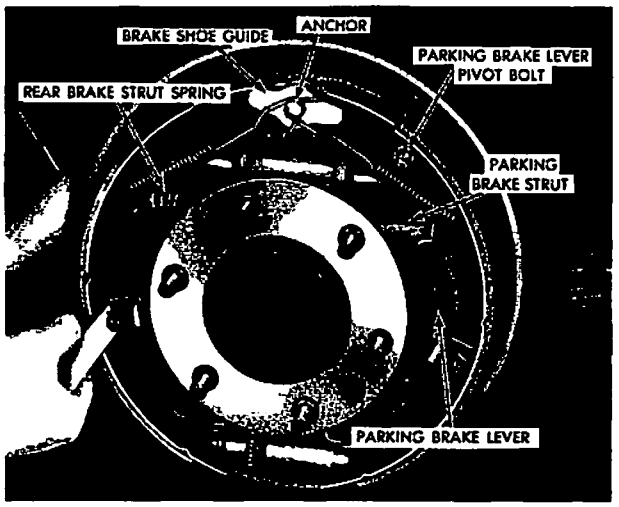
l. At the rear brakes, unhook the parking brake cable from the parking brake operating lever, which is attached to the secondary shoe.

m. Remove the parking brake operating lever pivot retaining nut at the secondary shoe.

n. Remove the parking brake operating lever and pivot from the secondary shoe.

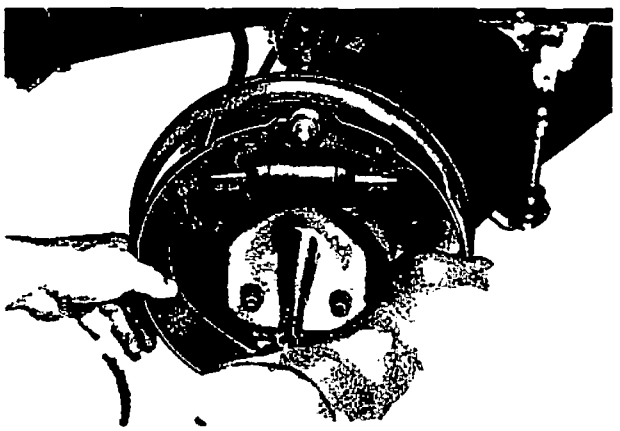
o. Inspect for hydraulic fluid and grease retainer leaks.

p. Check all hydraulic lines and hoses for leaks and deterioration.



2. *Installation*

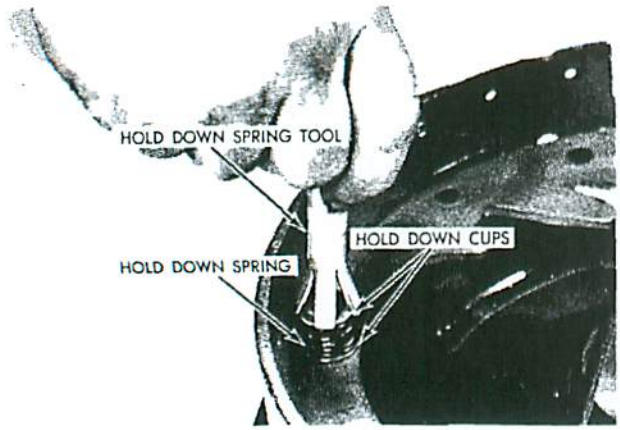
a. Lightly coat brake shoe guide surfaces on front and rear brake backing plates with a heat resistant lubricant. Position the star wheel adjuster between primary and secondary shoes and hook up the lower return spring to the primary and secondary shoes.

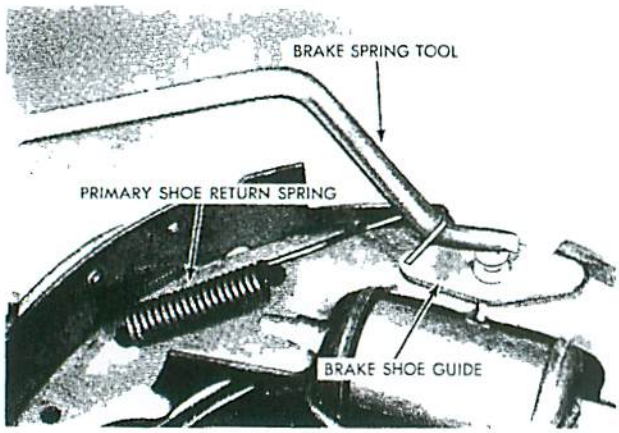


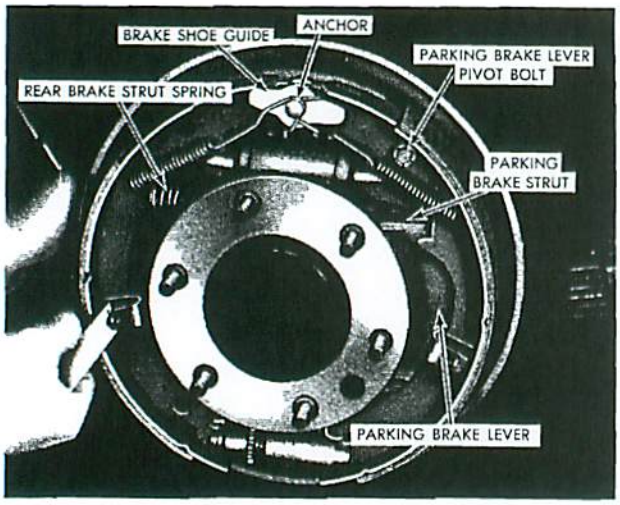
NOTE The primary shoe is the forward shoe of each brake.

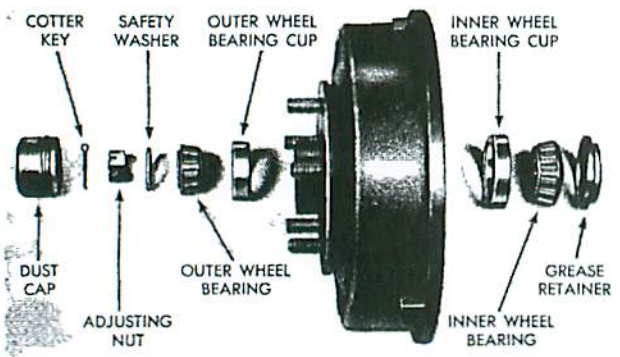
b. Install the primary and secondary shoes return spring and star wheel adjuster as an assembly to the backing plate.

NOTE Be sure the star wheel adjuster is lined up with the adjusting hole in the brake backing plate.









c. Using a brake shoe hold down spring tool, install the shoe hold down cups and springs to their correct position, and then position the shoe guide plate to the anchor pin.

d. Using a brake spring removing and replacing tool, first install the primary shoe return spring to the anchor pin and then install the secondary shoe return spring.

e. Thoroughly lubricate parking brake cables.

f. At the rear brakes, fasten the parking brake operating lever to the secondary shoe with the pivot bolt and retaining nut. Now install the pal lock nut or cotter key.

g. Before positioning the brake shoes to the backing plate, hook the parking brake cable to the parking brake operating lever.

NOTE Be sure parking brake operating strut is correctly installed between the primary shoe and the parking brake operating lever. Always recheck your work to be sure all brake parts are in their proper position.

h. Repack front wheel bearings and replace inner wheel bearing, and grease retainers.

i. Install both front drums, outer wheel bearings, safety washers and wheel bearing adjusting nuts.

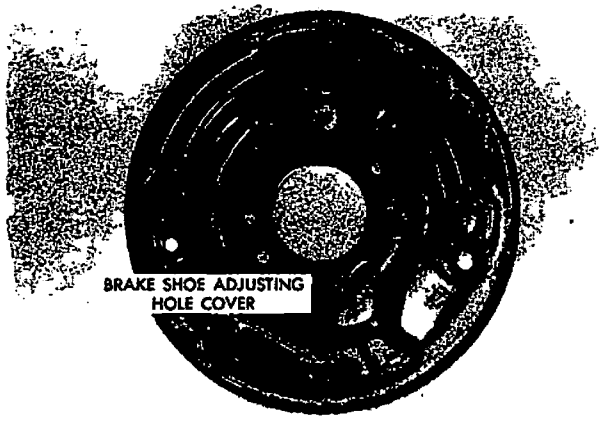
j. Correctly adjust both front wheel bearings to the manufacturer's specifications. Install front wheel bearing adjusting nut cotter pins.

k. Install front wheel bearing brake drum dust caps, front wheels and lug bolts or nuts.

l. Install both rear brake drums and retaining bolts and lockwashers.

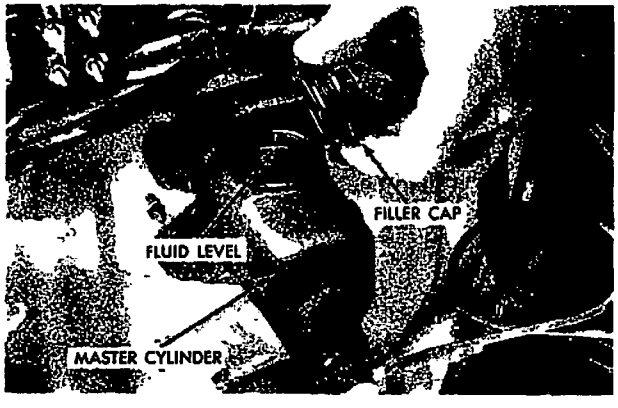
m. Securely tighten both rear brake drum retaining bolts and lockwashers.

n. Position the parking brake lever in the second notch. Adjust the parking brake cable ends until the clevis pins and/or the retaining bolts and nuts can just be installed at the parking brake equalizer and secure in place by a correctly installed cotter key.



o. Perform a major brake adjustment and install the brake backing plate adjusting hole covers.

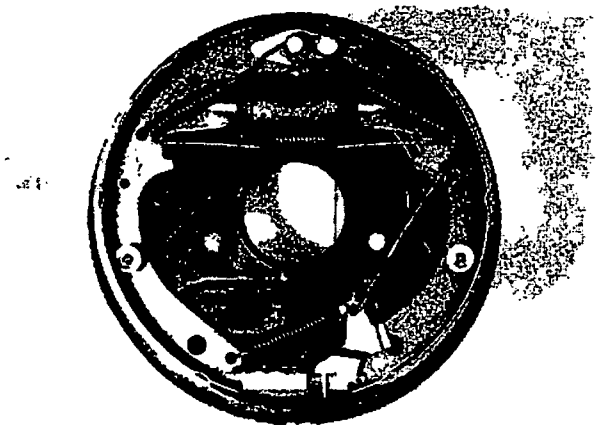
p. Install wheels, attaching lug bolts, or nuts, tighten securely, and install the hub caps.



q. Check brake master cylinder and add necessary brake fluid.

r. Lower car to floor and road test for proper brake action.

NOTE Cleanliness must be the watchword, in brake work.



BENDIX AUTOMATIC ADJUSTING

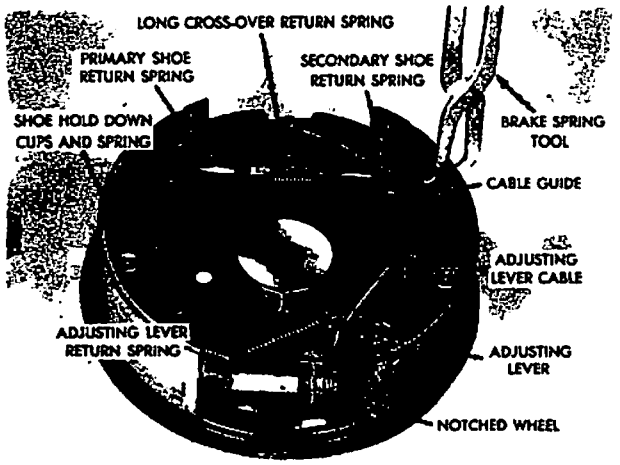
B. Bendix Self Adjusting

1. *Removal*

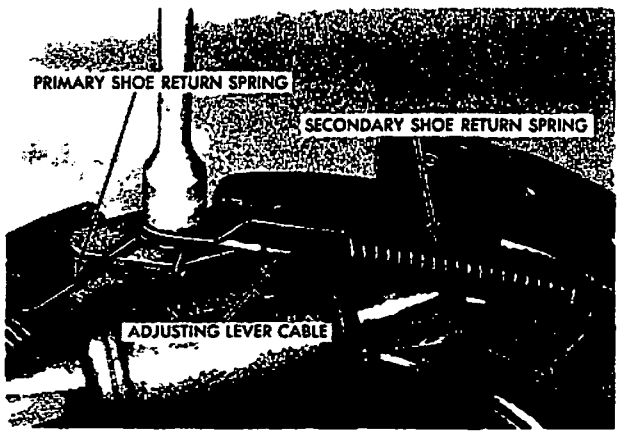
STATUS:

Car safely supported on all four wheels, wheels, drums removed and all dirt blown out from drums and shoes.

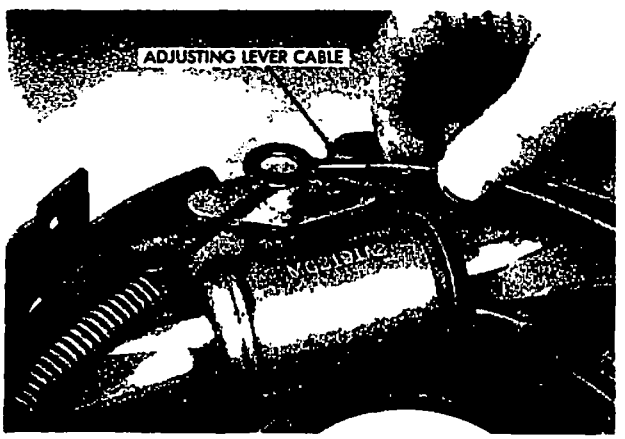
NOTE Install a wheel cylinder clamp if backing plate is not equipped with stops or tabs.



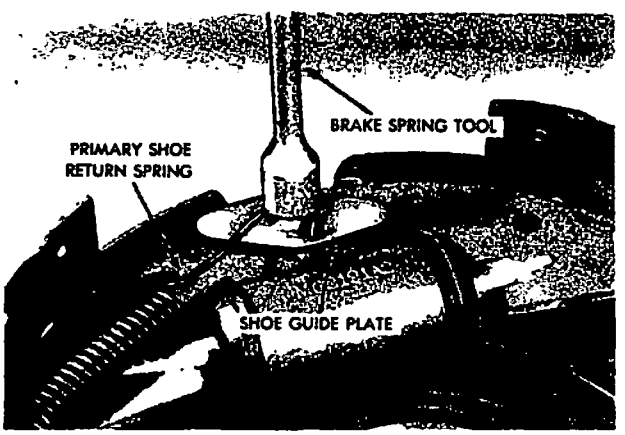
a. Using a pair of brake spring pliers, unhook and remove the long cross-over retraction spring.



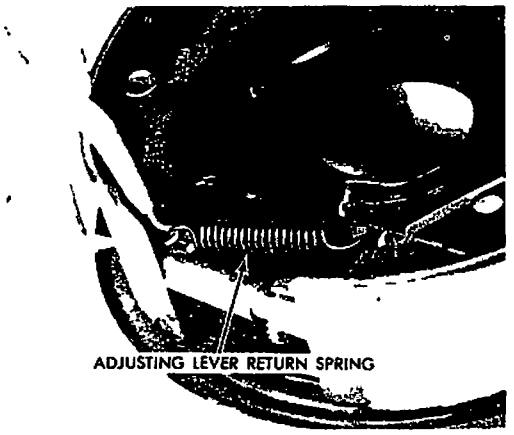
b. With a special brake spring removing tool, unhook and remove the secondary shoe return spring and cable guide.



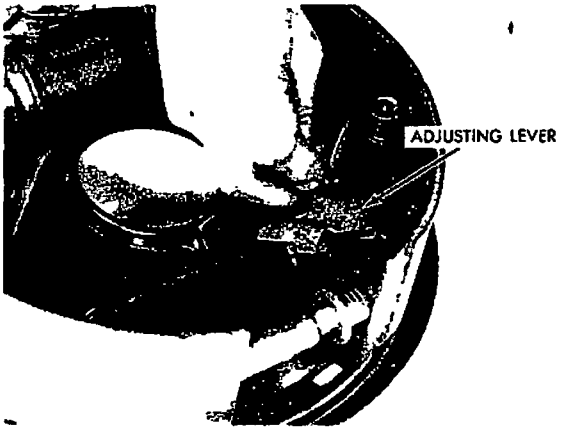
c. Lift off the adjusting cable eye from the anchor pin.



d. Remove the primary shoe return spring using a special brake spring removing tool, and remove the shoe guide plate.

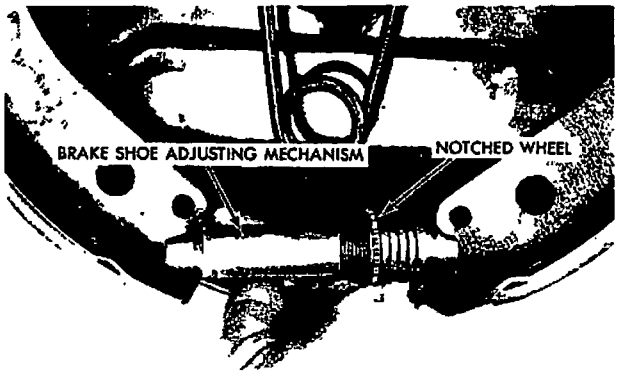


e. Unhook and remove the automatic adjuster operating lever return spring with a pair of brake spring pliers or a special brake spring removing tool.

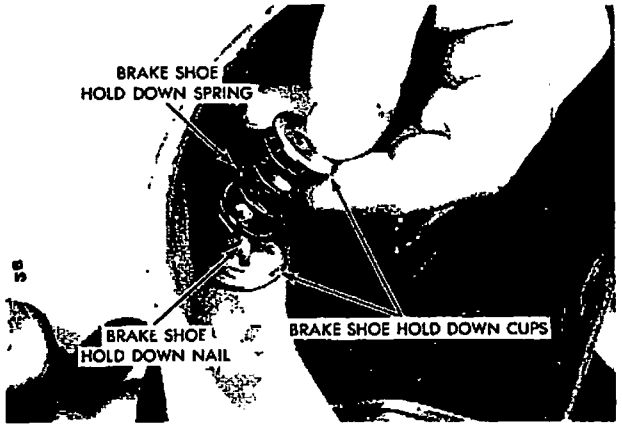


f. Disconnect the automatic adjusting operating lever from the automatic operating cable, and remove from the secondary brake shoe.

g. Remove the automatic adjusting brake cable from the secondary brake shoe.



h. Lift out the brake shoe star wheel adjuster.



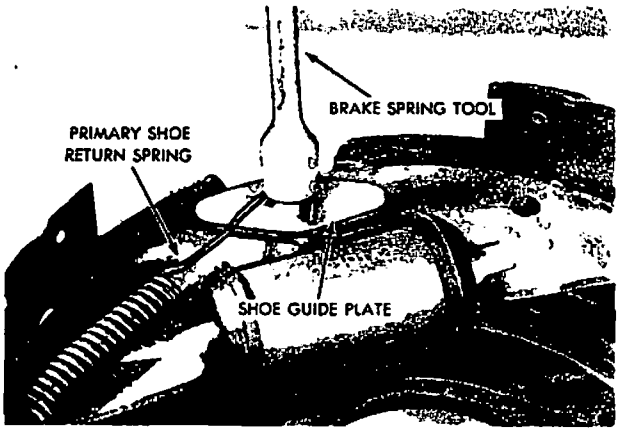
i. Using a brake shoe hold down spring tool, remove the primary and secondary shoe hold down cups and springs and lift off the brake shoes.

NOTE The same removal procedure applies to the rear brake except the parking brake linkage has to be unhooked from the secondary shoes.

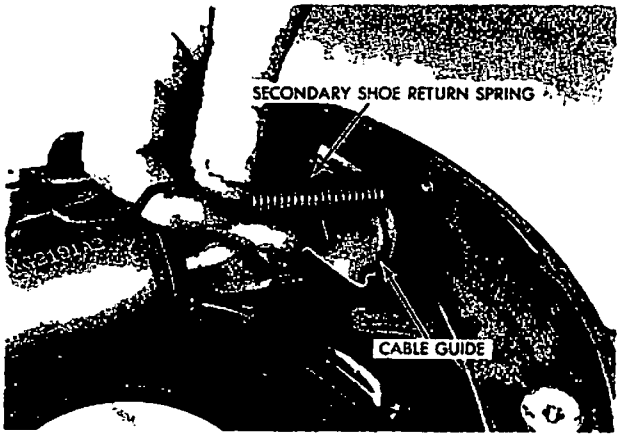
2. *Installation*

   a. Clean both front brake shoe backing plates and lightly lubricate all brake shoe contact pads.

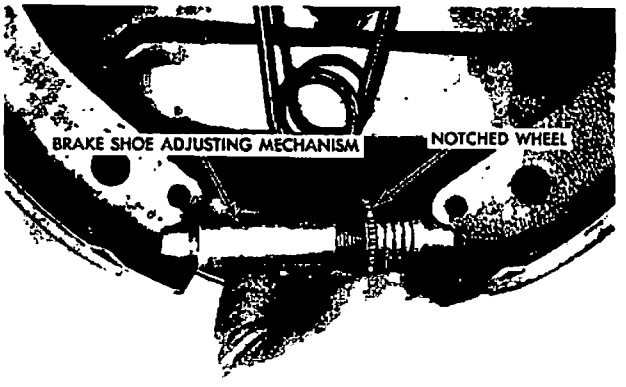
   b. Position the primary and secondary brake shoes and install the brake shoe hold down cups and springs with a brake shoe hold down spring tool.



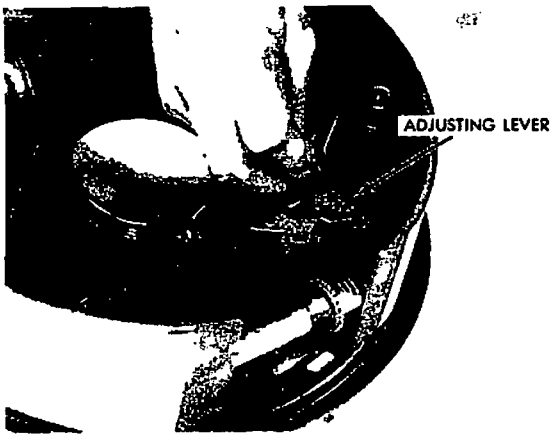
   c. Install the brake shoe guide plate on the anchor pin and using a brake spring installing tool, hook up the primary brake shoe return spring.



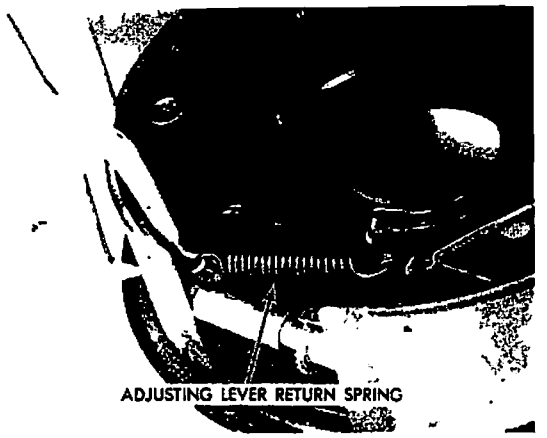
   d. Position the automatic cable adjuster anchor eyelet over the anchor pin and install the secondary brake return spring, and cable guide using a brake spring installing tool.



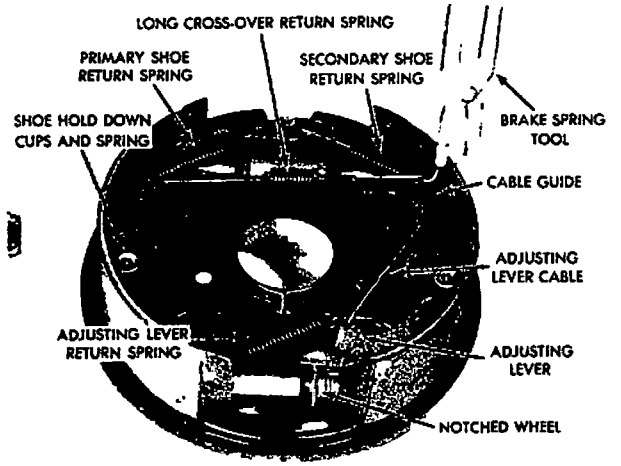
   e. Install the star wheel adjuster in position between the primary and secondary shoe.



f. Hook up the automatic adjusting cable to the automatic adjusting lever and position the automatic adjusting lever to the secondary shoe.



g. Using a brake spring tool, install the automatic adjuster pull back spring.

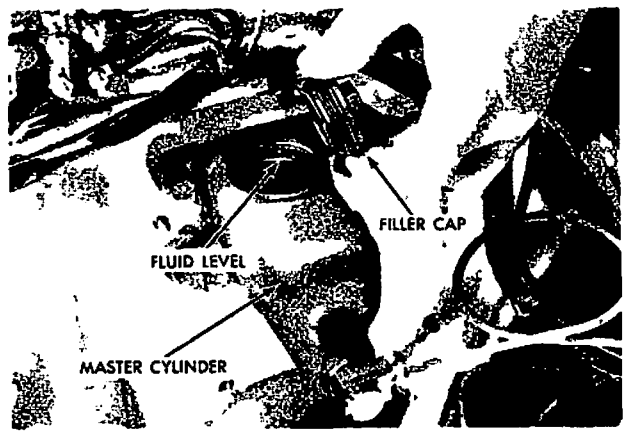


h. Hook up the long cross-over return spring.

The same installation procedure applies to the rear brakes except the parking brake linkage has to be hooked to the secondary shoes. The parking brake linkage procedure is covered in the Bendix Duo-Servo section.

i. Install the front drums, wheels, and hub caps.

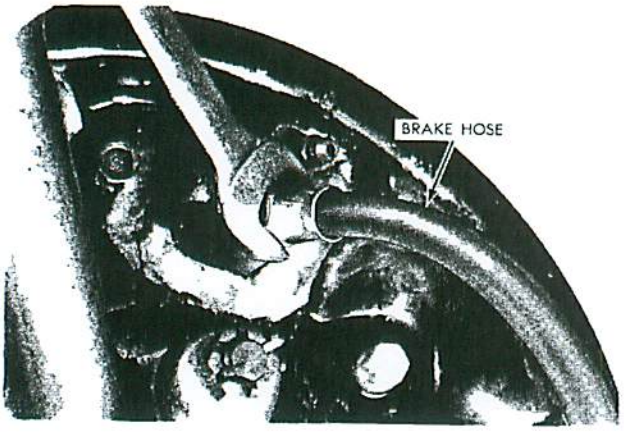
j. Adjust brakes to specifications.



k. Fill master cylinder to proper level and bleed brakes if necessary.

l. Road test the car for correct brake action.

Section Three — REMOVAL AND INSTALLATION OF WHEEL CYLINDERS

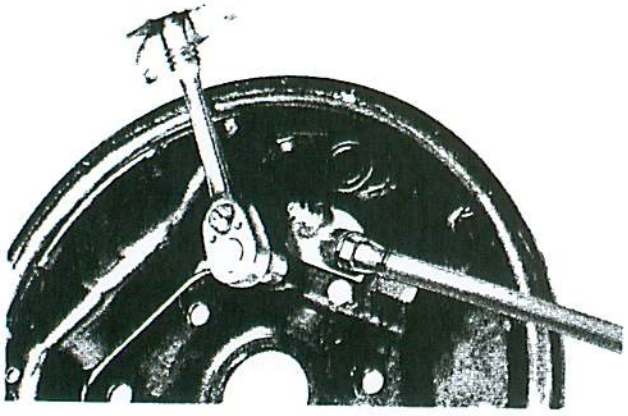


A. Single Cylinder — Double Piston

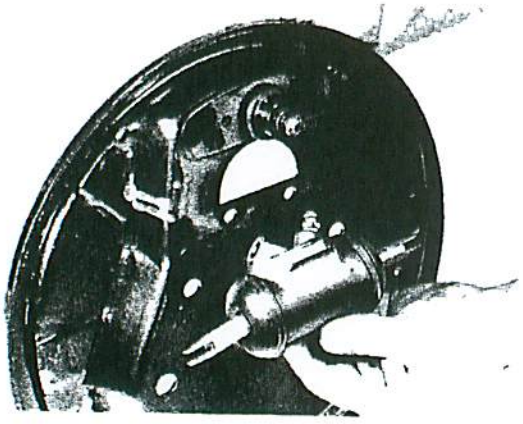
1. Removal

a. Remove brake shoes or tilt them away from the wheel cylinder.

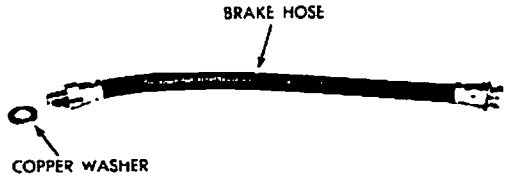
b. Loosen hydraulic brake hose.



c. Remove the wheel cylinder retaining bolts.



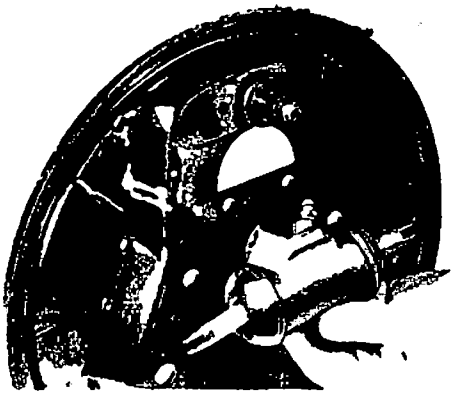
d. Remove the wheel cylinder from the backing plate, and turn the wheel cylinder from the brake hose.



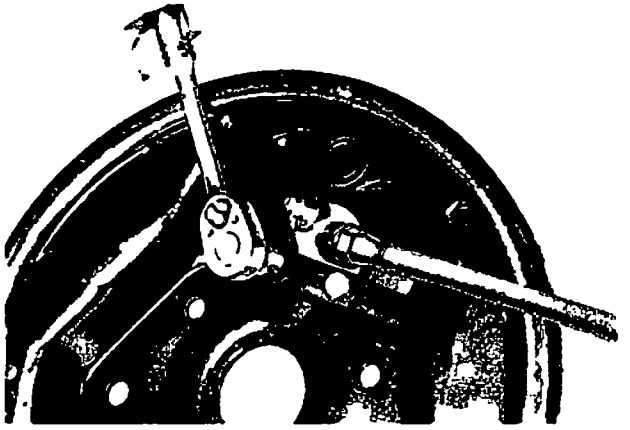
2. *Installation*

a. Install a new copper seal washer over the threaded end of the brake hose.

b. Turn the wheel cylinder on the threaded end of the brake hose until wheel cylinder contacts copper seal washer.

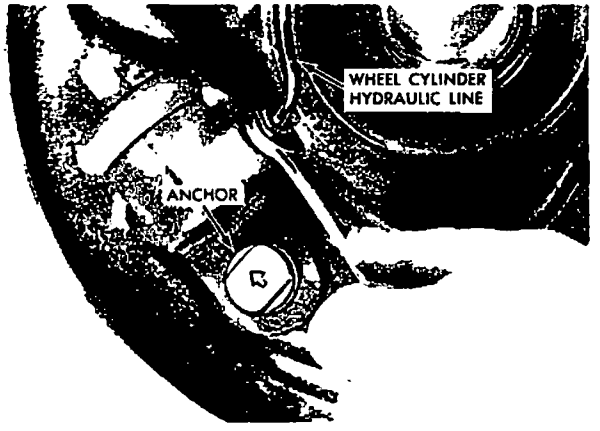


c. Position the wheel cylinder to the backing plate, install and tighten securely the wheel cylinder retaining bolts.



d. Tighten the brake hose to the wheel cylinder.

NOTE Make sure brake hose is not kinked or twisted after tightening securely.



B. Single Cylinder — Single Piston Adjustable Anchor

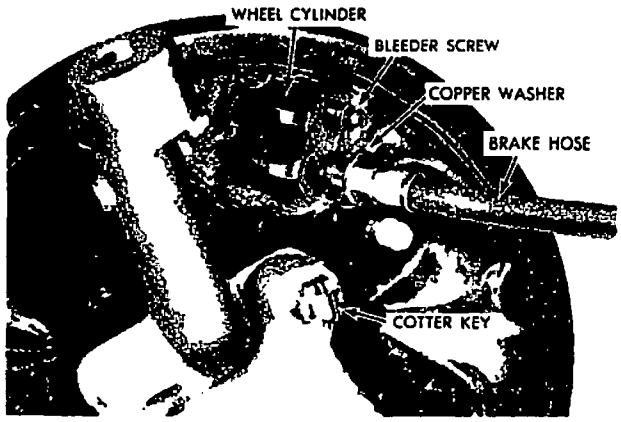
Used only on front brakes.

1. *Removal — Front Wheel Cylinders*

a. Remove brake shoes.

b. Disconnect and remove the hydraulic line connecting the two wheel cylinders.

NOTE Mark anchor arrow position.



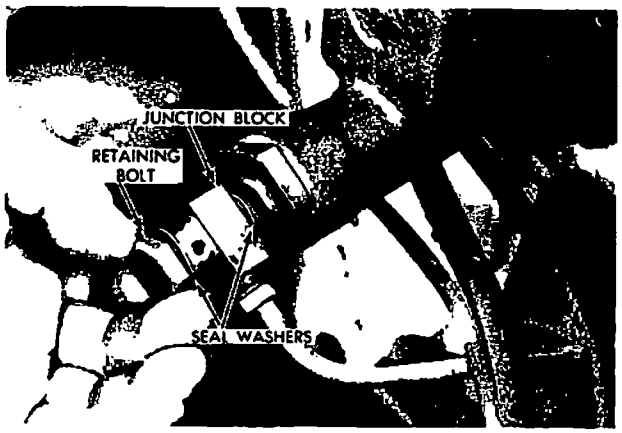
f. Install and securely tighten hydraulic brake hose to wheel cylinder.

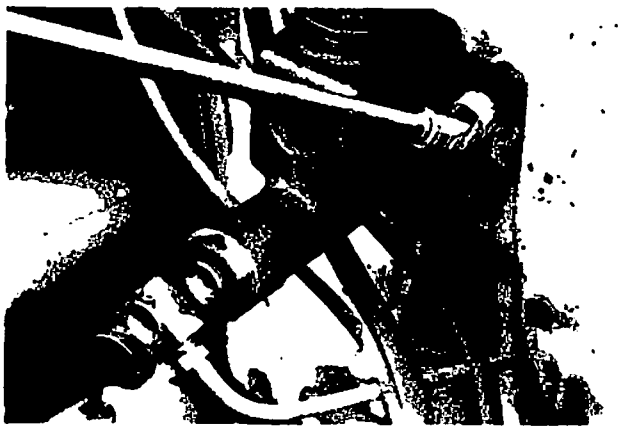
NOTE Use new copper seal washer.

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

NOTE Use care and be extremely clean while doing any type of brake work.

Section Four — REMOVAL AND INSTALLATION OF MASTER CYLINDERS



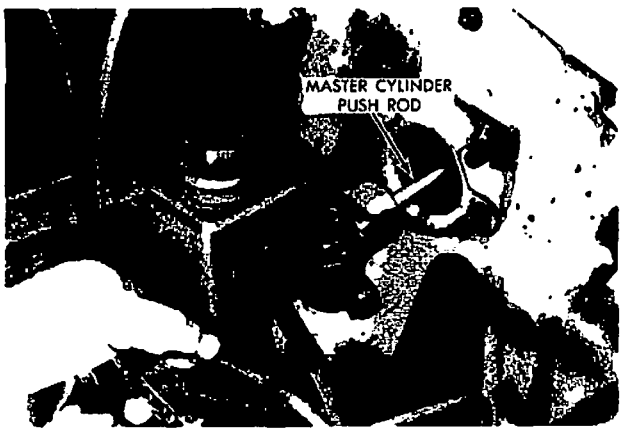


A. Typical Master Cylinder Removal and Installation

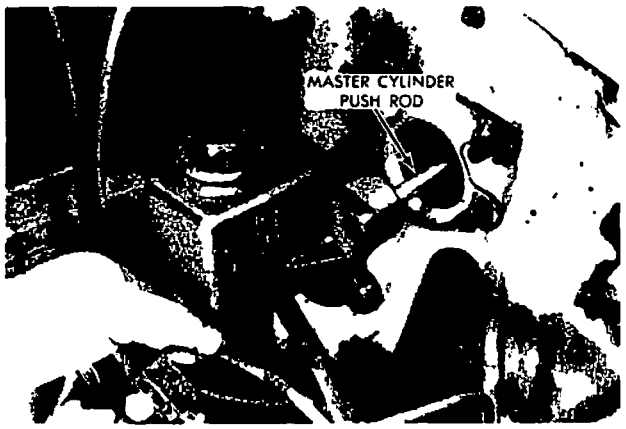
1. Removal

a. Remove the hydraulic junction block retaining bolt and seal washers from each side of the hydraulic junction block.

b. Remove the master cylinder retaining nuts and lock washers.



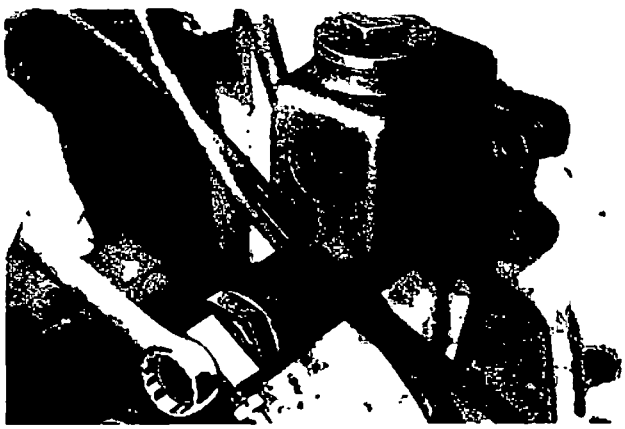
c. Slide master cylinder from the front of the dash panel and off the end of the master cylinder push rod.



2. *Installation*

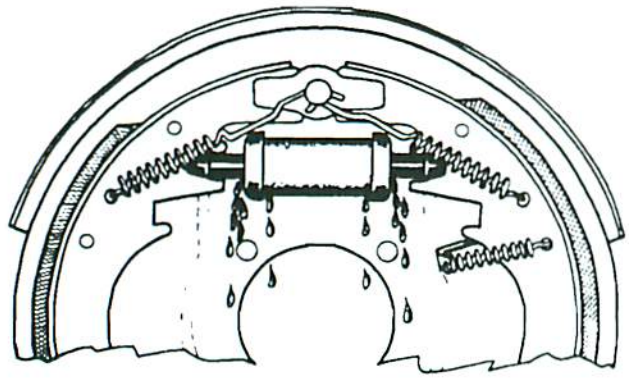
a. Position master cylinder over end of master cylinder push rod and the mounting studs at the dash panel.

b. Install the master cylinder retaining lockwashers, nuts and tighten securely.



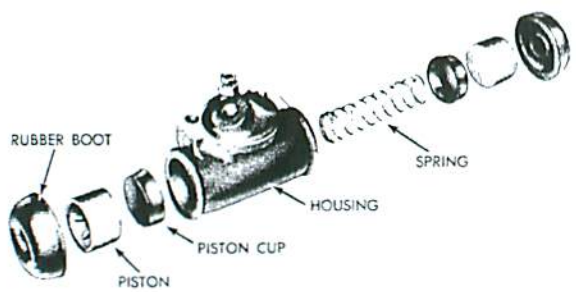
c. Position the junction block sealing washers. Install and tighten the hydraulic junction block retaining bolt.

Section Five — WHEEL CYLINDER OVERHAUL



A. General

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 needed.

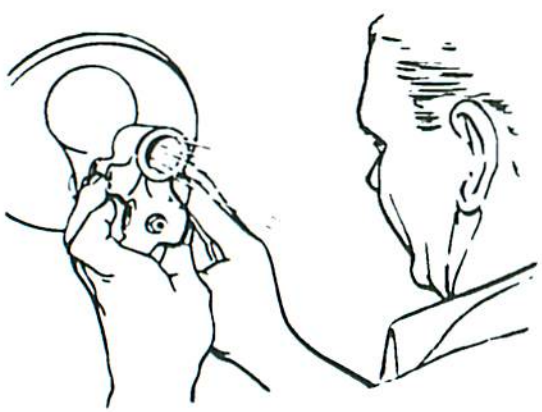


B. Disassembly

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

1. Remove the cylinder boots.
2. Remove the pistons, rubber cups and springs (discard the rubber cups).
3. Wash all parts in clean alcohol.

NOTE Before washing, hands must be clean. Do not wash hands in gasoline or oil. Use soap and water.



C. Inspection

1. 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.
2. It is good insurance to always use new rubber cups.

CHECKING WHEEL CYLINDER PISTON FIT

3. 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.

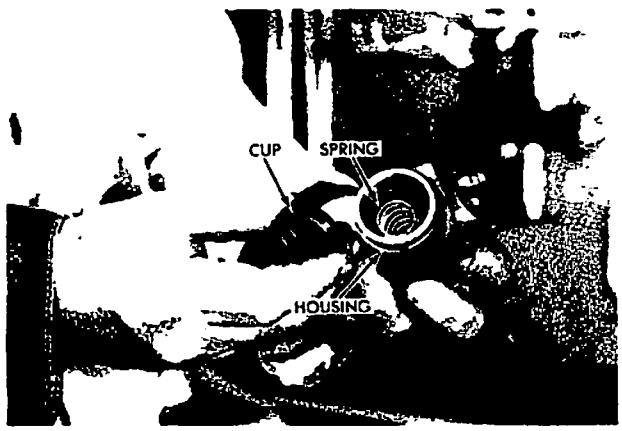
4. Replace the springs if they indicate weakness.

D. Cylinder Honing

1. When honing a wheel cylinder, follow the specific instructions of the equipment manufacturer for each honing operation.

2. 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"

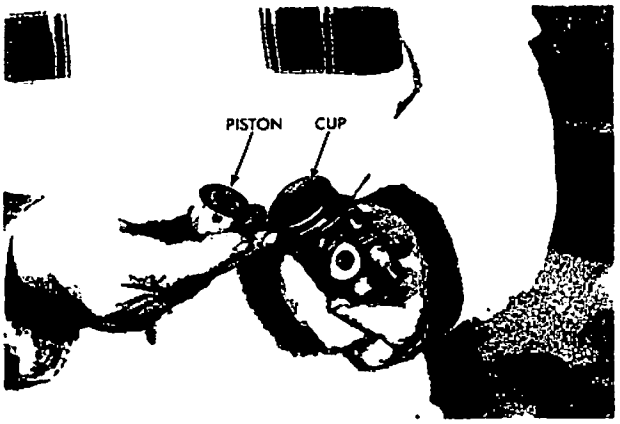


E. Assembly

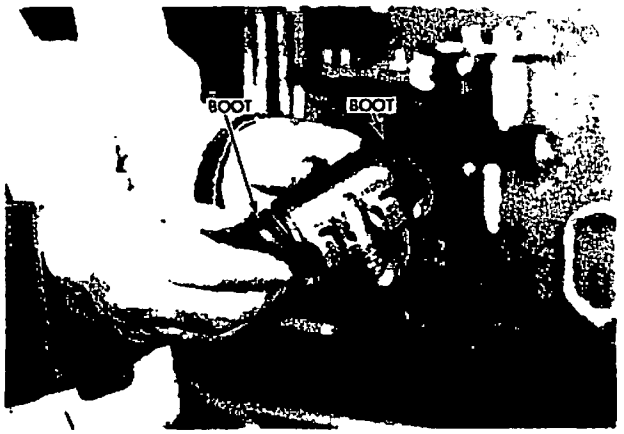
1. Dip the pistons and rubber cups in clean hydraulic brake fluid.

2. Place the spring in the center of the housing.

3. Install the rubber cups at each end of the spring, (making sure the cupped side is toward the spring).

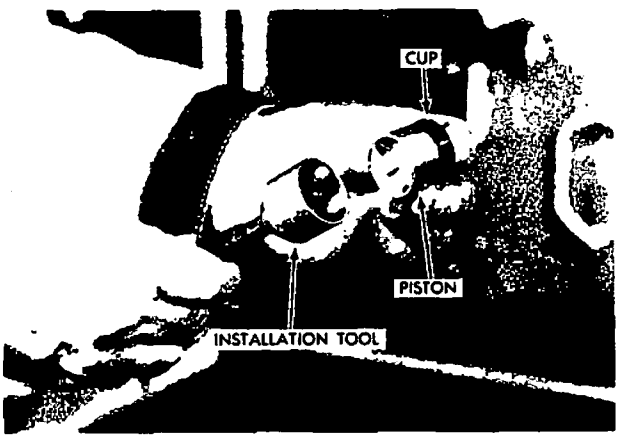


4. Replace the pistons with the flat side against the flat of the rubber cup.



5. Replace the boot, making sure it enters the groove on the outside of the cylinder.

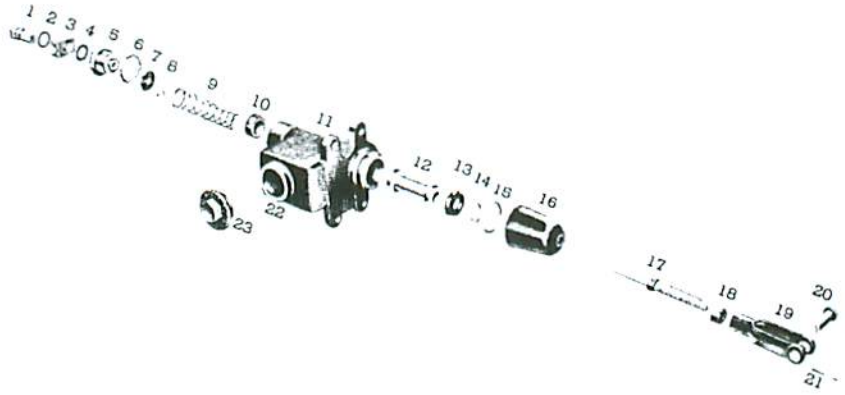
NOTE On step bore cylinders, install each cylinder piston and cup in the correct bore. NEVER slide a piston through the entire length of the cylinder. This may scratch the polished surface and damage the piston cup seal.



6. On Chrysler blind bore cylinder a special tool may be used to insure correct installation of the wheel cylinder cups and piston as shown.

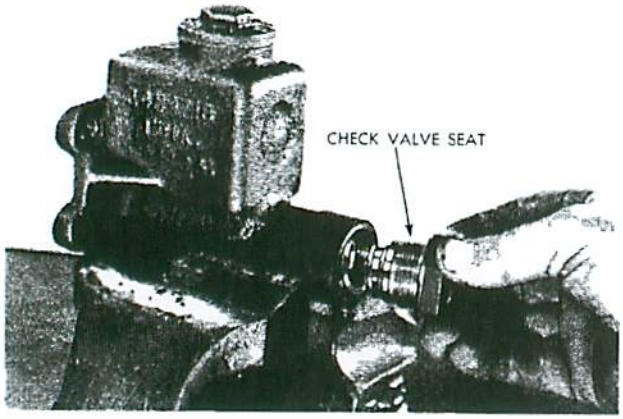
   Vehicles that operate in sub-zero temperatures often have cup expanders between the spring and the cupped side of the cup for the purpose of holding the sealing edge of the cup against the cylinder wall as in cold operation these cups lose some flexibility.

Section Six — MASTER CYLINDER OVERHAUL



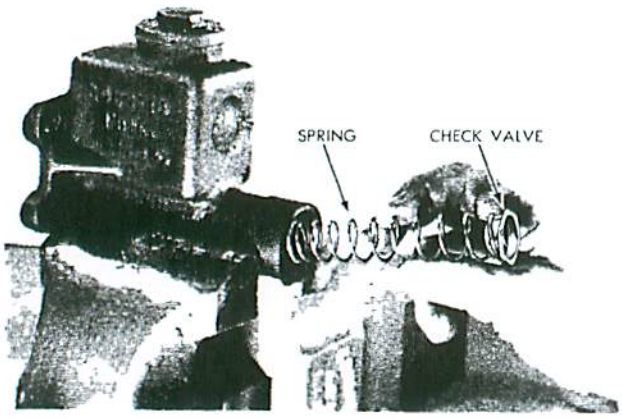
A. General

After a brake diagnosis has been made and there is an indication that the master cylinder is not functioning properly, remove the master cylinder and disassemble for further inspection.

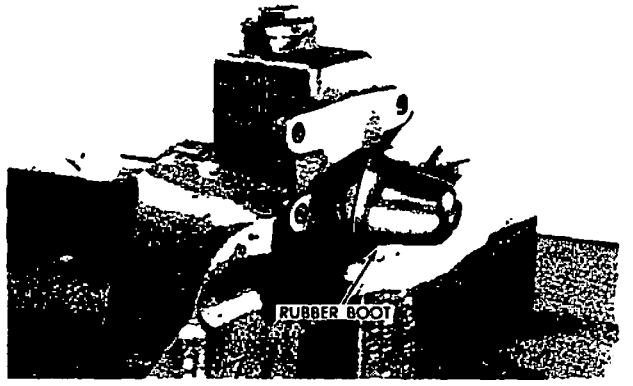


B. Disassembly

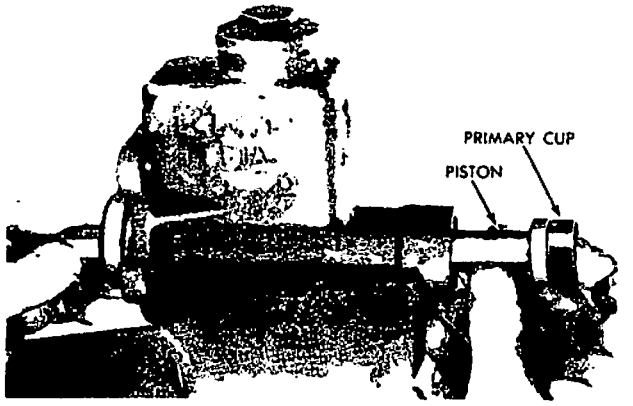
1. Unscrew the end plug and remove the gasket and valve seat.



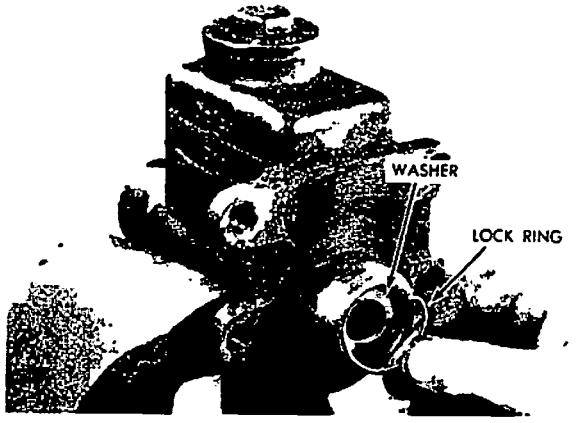
2. Remove the valve assembly and spring.



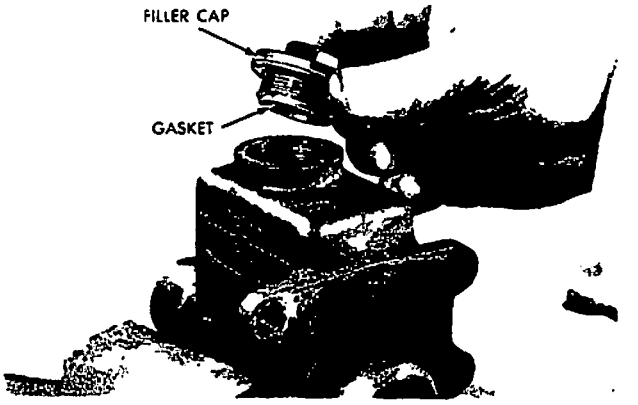
3. Remove the main cylinder rubber boot.



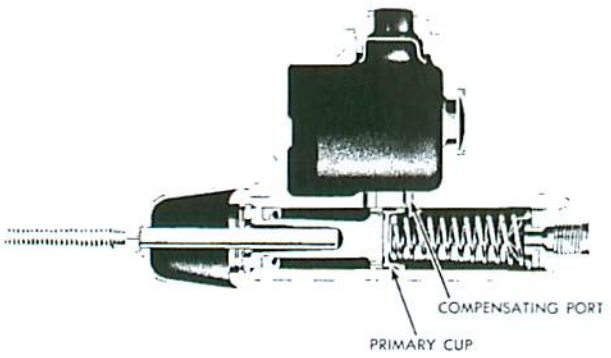
4. Now push out the primary cup, piston and secondary cup by using a long thin punch as a tool.



5. Remove the lock ring and piston stop, washer, from the front of the cylinder.



6. Remove the filler plug and gasket.

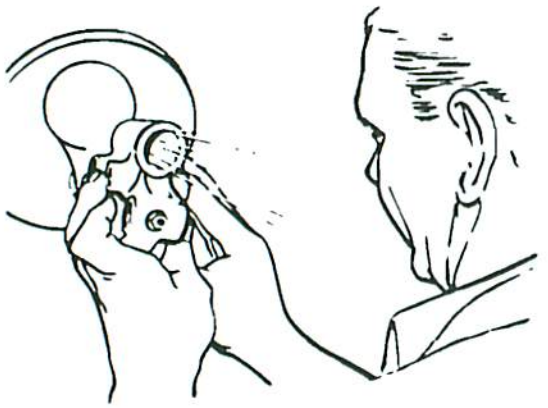


C. Inspection

1. Wash all parts in clean alcohol.

NOTE Before washing, your hands must be clean. Do not wash your hands in gasoline or oil. Use soap and water.

2. Make sure that the compensating port in the cylinder body and the bleeder holes in the piston are open.

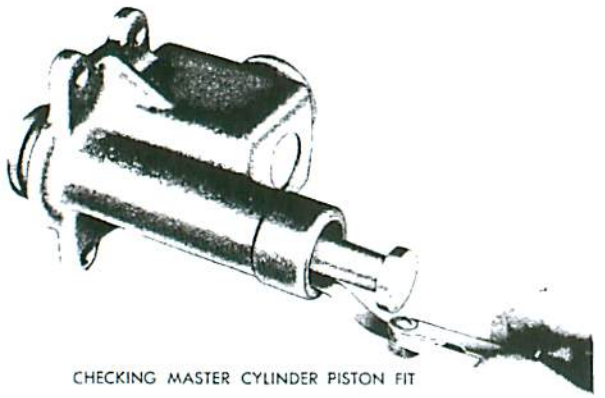


3. Inspect the cylinder bore by holding it in front of a light. Check for corrosion, scratches or pitting. The cylinder should be honed or replaced if the condition warrants.

CUPS

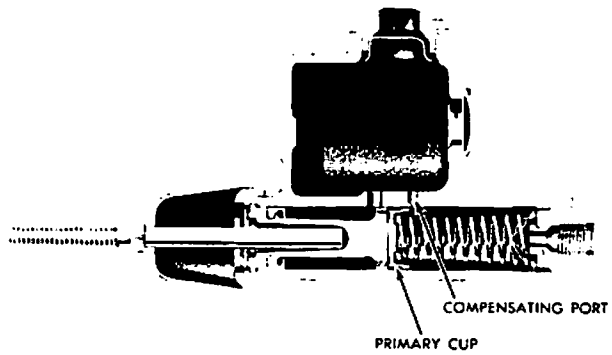
4. Inspect primary and secondary cups, valve and valve seat for damage or swelling. Swelling of rubber parts is due to the use of improper brake fluid or washing parts in gasoline or kerosene.

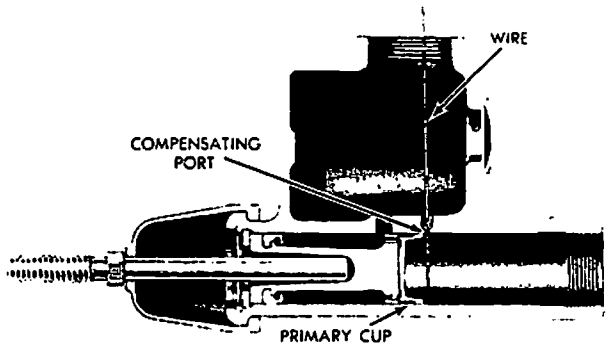
NOTE The primary cup has a brass support ring vulcanized in its base to prevent it from imbedding in the bleeder holes during braking action.



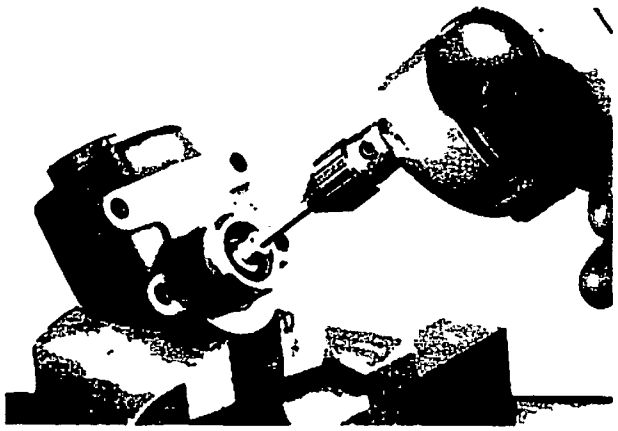
CHECKING MASTER CYLINDER PISTON FIT

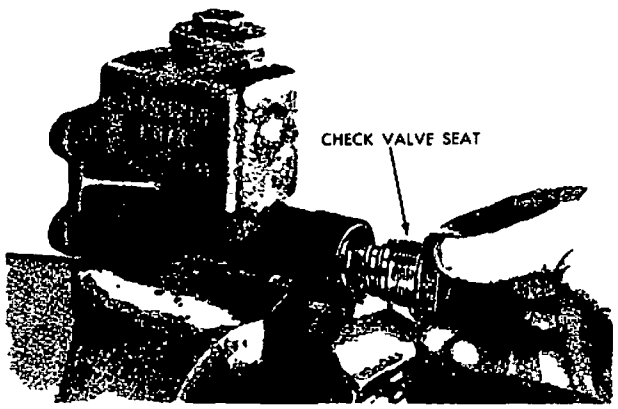
5. Check piston fit in cylinder bore. The clearance between piston and wall of the cylinder should be .001″ to .005″.





CHECKING COMPENSATING PORT CLEARANCE





6. Check clearance between the edge of the primary cup and the center of the compensating port. To check this clearance, proceed as follows:
   a. Install piston stop and lock in place with a snap ring.
   b. Assemble secondary cup on piston and install assembly in body. Place primary cup in the body with the flat side of the cup against the piston.
   c. Push the piston cup against the piston stop and check clearance between edge of primary cup and center of the compensating port.

NOTE This check is made easy by using a wire gauge inserted through the reservoir of the body and extending into the piston chamber. Move the piston toward the wire and check the amount the piston moves before tightening up on the wire. No movement—replace the rubber cups. The clearance should be a minimum of .035". If clearance is less than .035", the primary cup must be replaced.

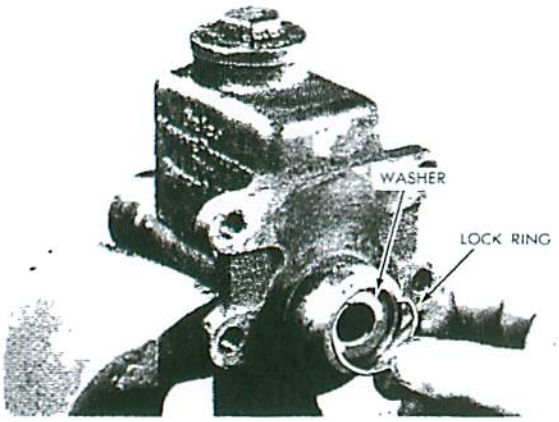
7. After clearance is checked, completely disassemble the main cylinder again as outlined.

D. Cylinder Honing

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—if in doubt, replace the cylinder housing.

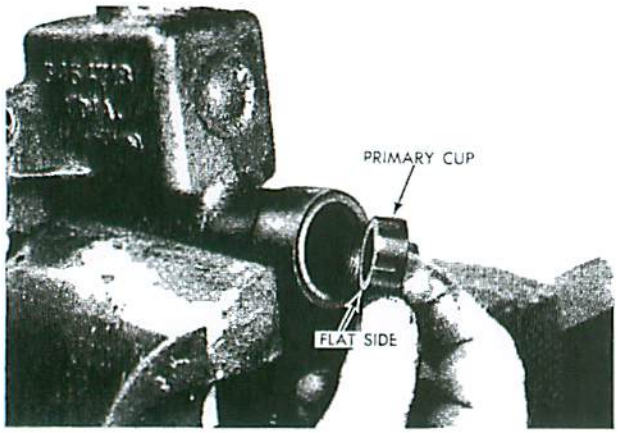
E. Assembly

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 travel. Also, the pedal will have to be depressed or pumped one or more times before actual car braking occurs.

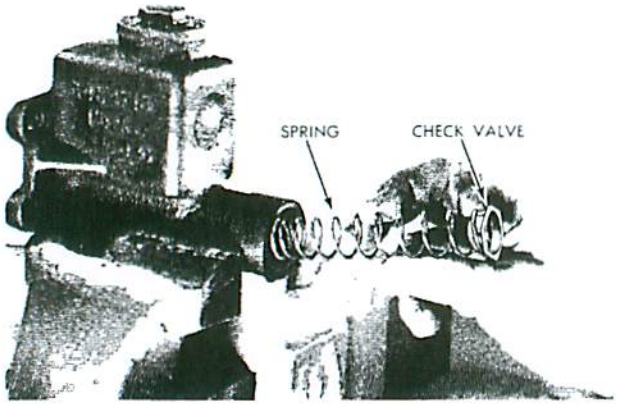


1. Install the piston stop washer lock ring in the front of the main cylinder.

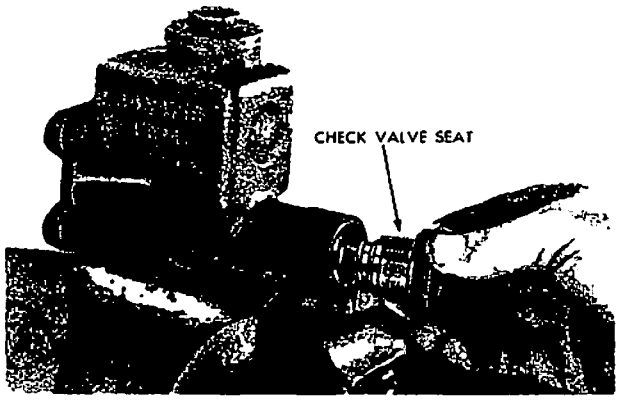
2. Dip the rubber cups and valve in hydraulic brake fluid.



3. Assemble secondary cup to the piston and install assembly in the body so that the bleeder hole end of the piston will be toward the end plug when the assembly is complete.
4. Place the primary cup in the body with the flat side against the piston.

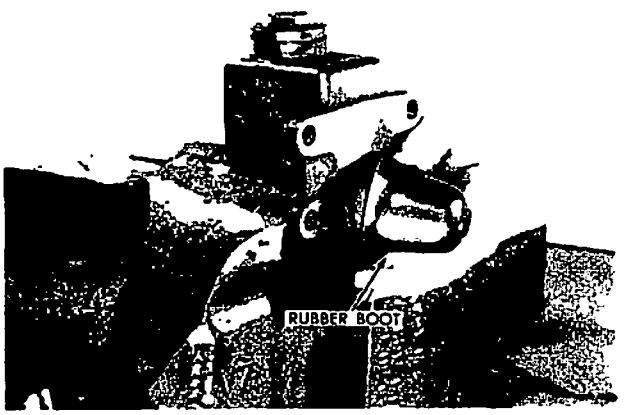


5. Slide the piston spring and check valve as an assembly into the master cylinder bore.
6. Install the valve assembly.



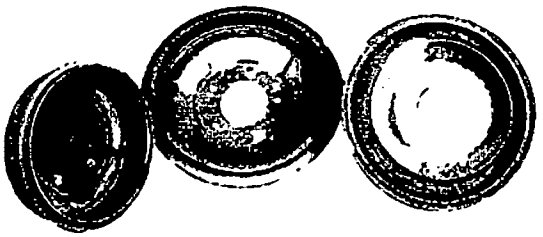
7. Dip a new check valve seat washer in hydraulic brake fluid and assemble over the plug.

8. Assemble a new gasket over the end plug and screw the plug, valve seat washer, and gasket into the main cylinder body and tighten securely.



9. Install the rubber push rod boot, making sure this seal is tight on the body. This seal must be tight enough to keep water and other foreign matter from entering the main cylinder through the pedal stop.

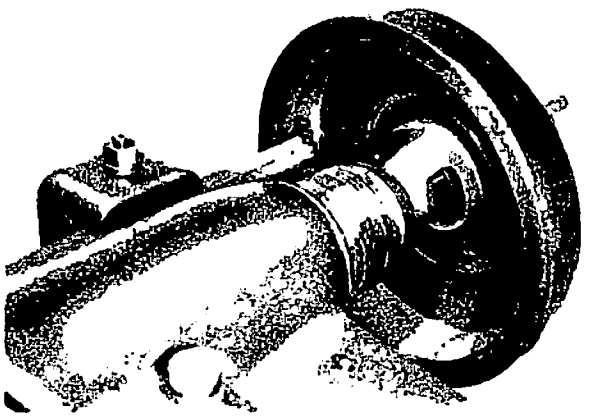
Section Seven — SERVICING BRAKE DRUMS



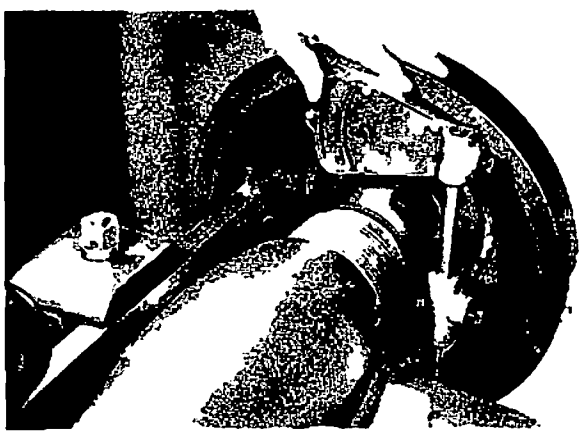
A. Inspection

1. Whenever a brake drum is removed from the wheel, for any purpose, be sure to inspect it for scoring, wear, distortion, threaded surface, cracks or heat checks.

   If any of the conditions illustrated exist, turn the drums.



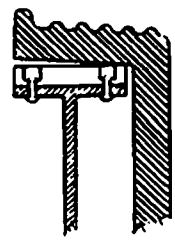
2. To do a good brake job, always turn the drums when the brake shoes are relined. If excessive damage requires the removal of more than .060" on the diameter, or if hard spots are found, replace the drum.



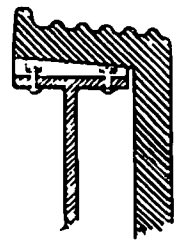
B. Gauging

1. Even though the appearance of drum surface is satisfactory, be sure to check it for out-of-round or squareness.

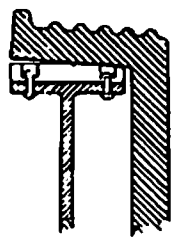
   Brake drums that are bell-mouth, out-of-round or scored should be corrected by turning them on a brake drum lathe.



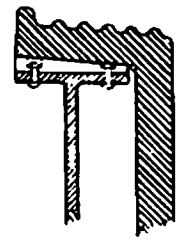
1. at installation



3. full contact



2. increased contact through wear

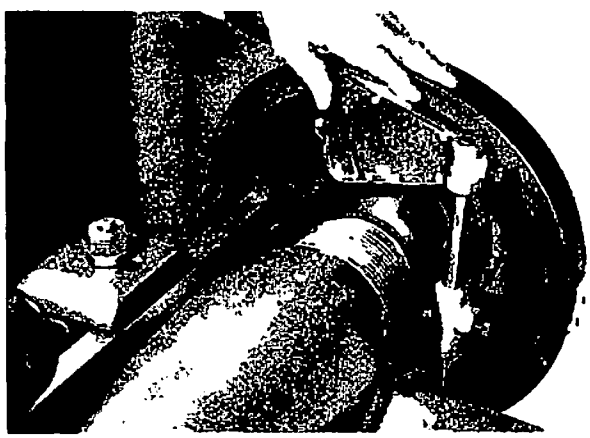


4. bolt head touching drum surface block life ended

2. This diagram illustrates the reason why out-of-round drums should be turned. Proper brake adjustment is impossible when drums are out-of-round.

3. Check for "bell-mouthed drums" (as shown) as new brake linings would be short lived in a "bell-mouthed drum."

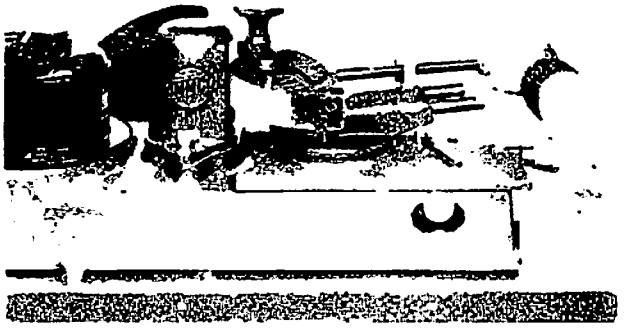
   This type of drum requires reconditioning or replacing.



CAUTION Drum should not be turned more than .060" over the standard diameter of the drum or .030" on the radius. More than this will weaken the drum. If the drum surface cannot be cleared within the limits outlined above, replace the drum. If the drum is out-of-round, it is not good practice to try and round them out on a press as the heat generated by the brakes on hard application may cause the drum to retain part or all of its original distorted shape.

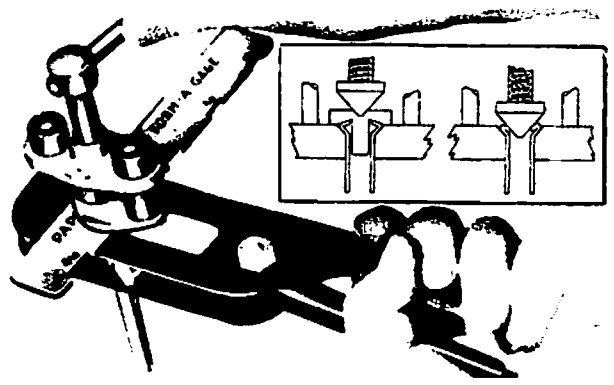
C. Turning

1. Follow the instructions of the brake drum lathe manufacturer when turning brake drums.



2. Increasing drum diameter means that the lining used on the shoe will have to be ground to fit the contour of the newly turned drum.

Section Eight — BRAKE PIPE REPLACEMENT



Brake Pipe Replacement

If any section of the brake lines or pipe becomes damaged, the entire section should be replaced with pipe of the same type, size, shape and length.

CAUTION Copper tubing should *NOT BE USED* in a hydraulic brake system. When the pipe has to be bent to fit the frame or rear axle contours, use care not to kink or crack the pipe.

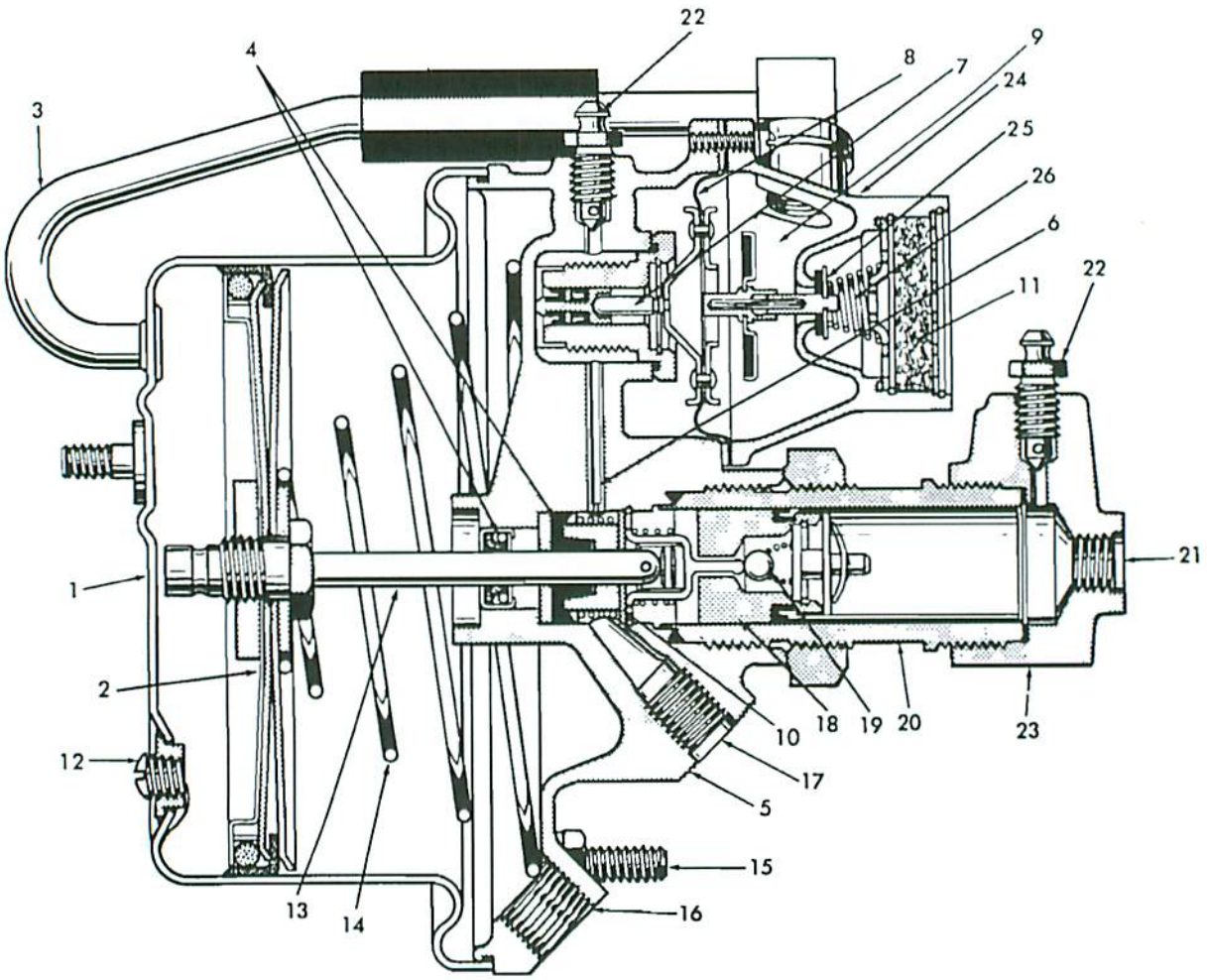
The brake tubing should be double flared to properly provide good leak proof connections. Use the two stage flaring method as shown above. A special flaring tool should be used for this flaring operation. (As shown)

CHAPTER VII

BENDIX HYDROVAC MODEL C

APPLICATION: 1955-1957 Cadillac
1955-1956 Studebaker

Section One — FUNDAMENTALS OF OPERATION



(1) Cylinder Shell
(2) Power Piston
(3) Control Tube
(4) Vacuum Seals
(5) End Plate
(6) Passage
(7) Control Valve Hydraulic Piston
(8) Diaphragm Assembly
(9) Valve Chamber
(10) Piston Stop Washer
(11) Air Cleaner
(12) Lubrication Plug
(13) Push Rod
(14) Piston Return Spring
(15) Attaching Bolts
(16) Vacuum Outlet
(17) Port (Line from Master Cylinder)
(18) Hydraulic Cylinder Chamber
(19) Ball Check Valve Assembly
(20) Cylinder Tube
(21) Port (Line to Wheel Cylinders)
(22) Bleeder Screws
(23) Cylinder End Cap
(24) Valve Housing
(25) Vacuum and Atmospheric Poppet Assembly
(26) Poppet Return Spring

The Bendix Model C Hydrovac for passenger cars is the single piston type with either a single stage valve or a double stage valve. The function of the two stage valve is to permit a lower initial crack point and still maintain a relatively high full application point.

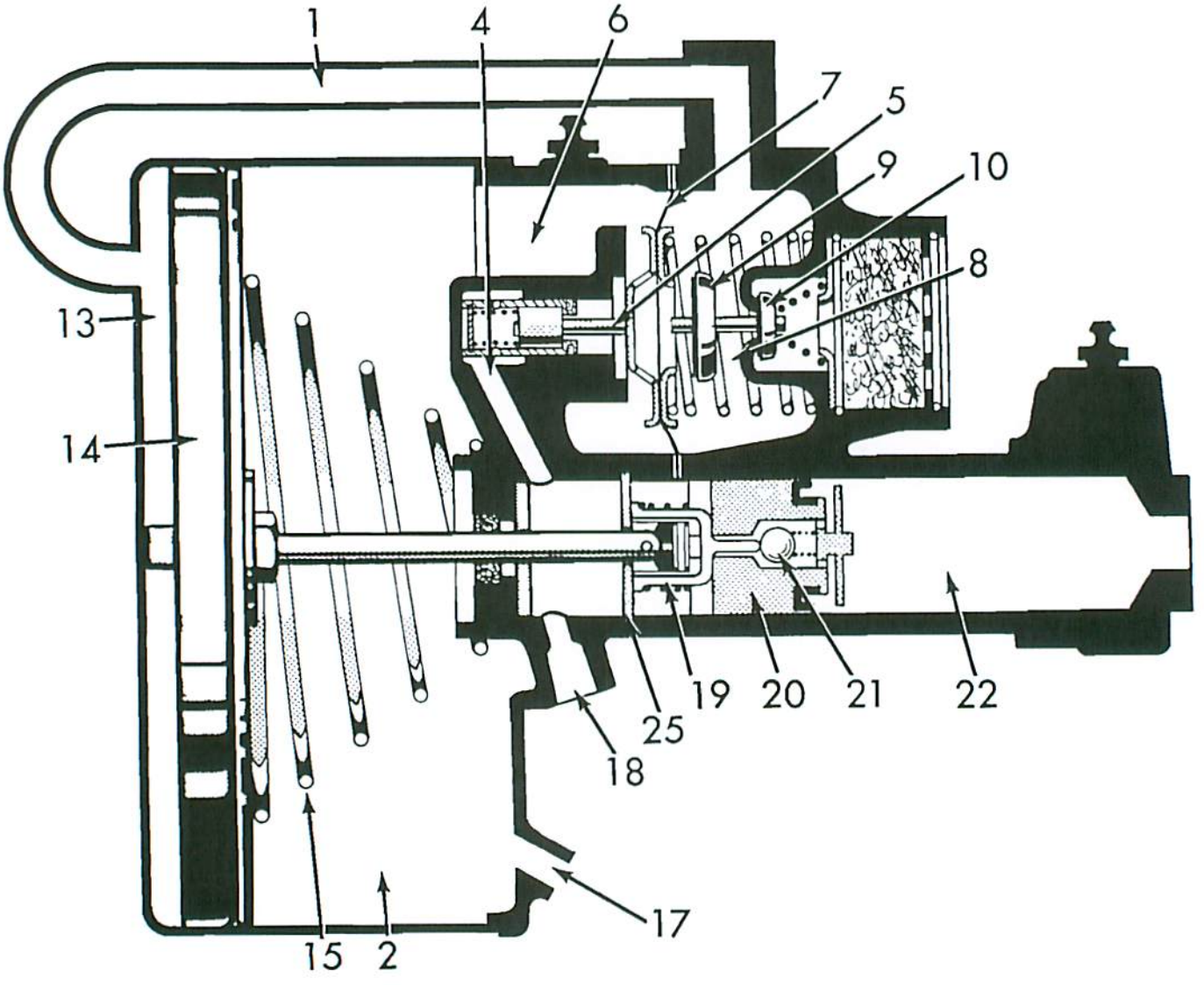
The Hydrovac is composed of three basic units, so combined that they function as a single unit from the hydraulic pressure developed within the vehicle master cylinder. The three basic units are:

(1) A hydraulically actuated vacuum control valve which controls the degree of brake application or release.

(2) A vacuum power cylinder that is connected to the piston of the hydraulic cylinder by means of a push rod.

(3) A hydraulic cylinder which contains a piston and a check valve.

IN OPERATION: As the brake pedal is depressed, the hydraulic pressure from the master cylinder is transmitted to the control valve piston and on to the hydraulic cylinder. Pressure at the control valve piston, closes the vacuum valve, opens the atmospheric valve thus admitting atmospheric pressure to the pressure side of the piston.

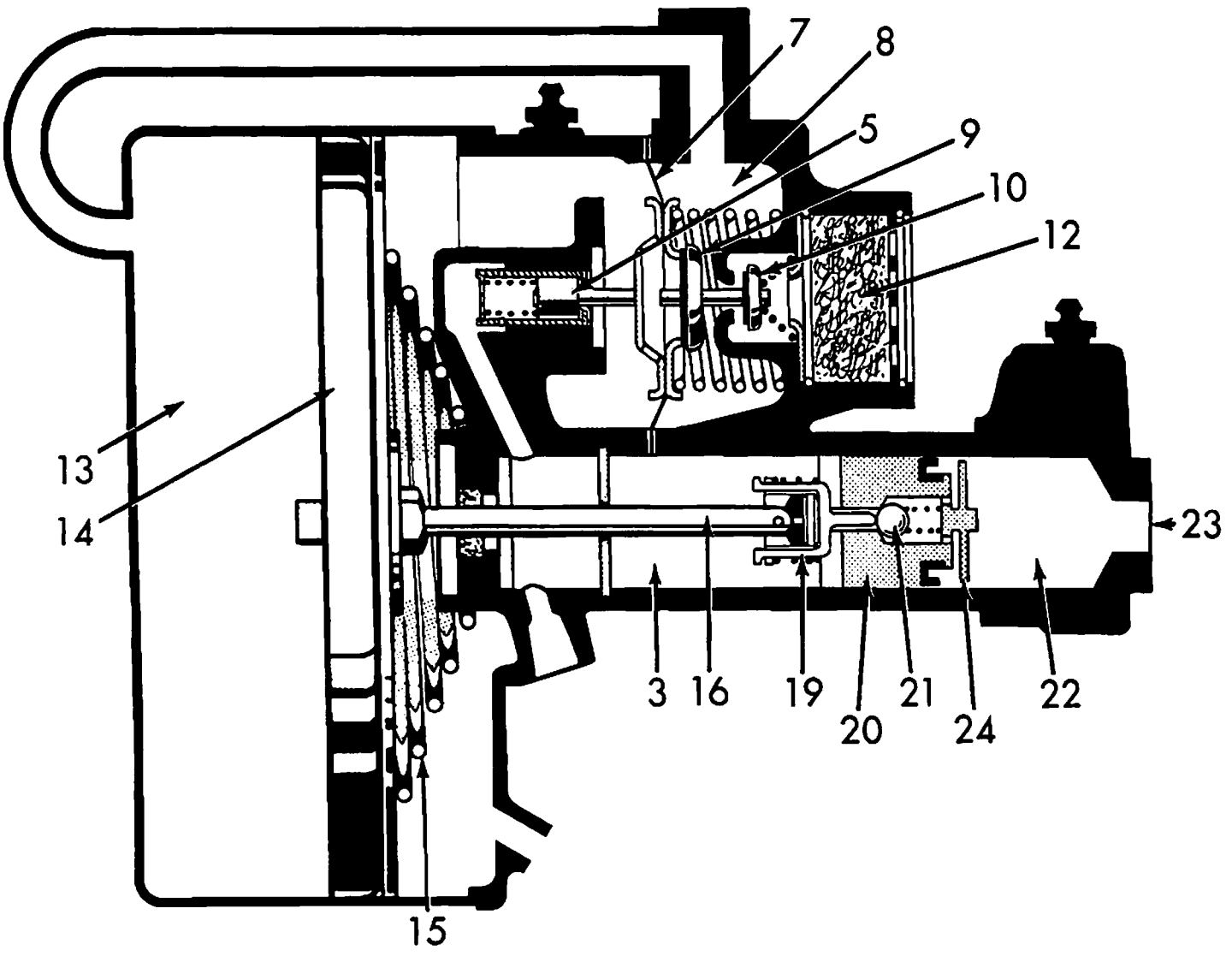


The piston moves toward the hydraulic cylinder, the push rod closes the check valve in the hydraulic cylinder piston. This action traps the fluid in the hydraulic cylinder and further movement of the vacuum piston increases the pressure within the hydraulic cylinder, brake lines, and wheel cylinders.

Released Position

Vacuum from the engine is transmitted through the vacuum check valve (17) to the power brake cylinder chamber (2). Vacuum enters through chamber (6) and passes through the center of the diaphragm assembly (7), past the vacuum poppet (9) to the valve chamber (8). The atmospheric poppet (10) is on its seat in the valve housing closing atmosphere from the chamber (8). The chamber is connected to the cylinder chamber (13) by the tube (1) which applies a constant vacuum to both sides of the power piston (14). Therefore, this unit is referred to as being VACUUM SUSPENDED.

In the released position the power piston (14) is held to the rear in the vacuum cylinder by the return spring (15). In this position, the yoke (19) of the hydraulic piston (20) is against the piston stop washer (25) and the ball of the check valve (21) is lifted from its seat. The valve piston (5) is at its rearward position, permitting the seat at the center of the diaphragm assembly (7) to break its sealing property with the vacuum poppet (9).

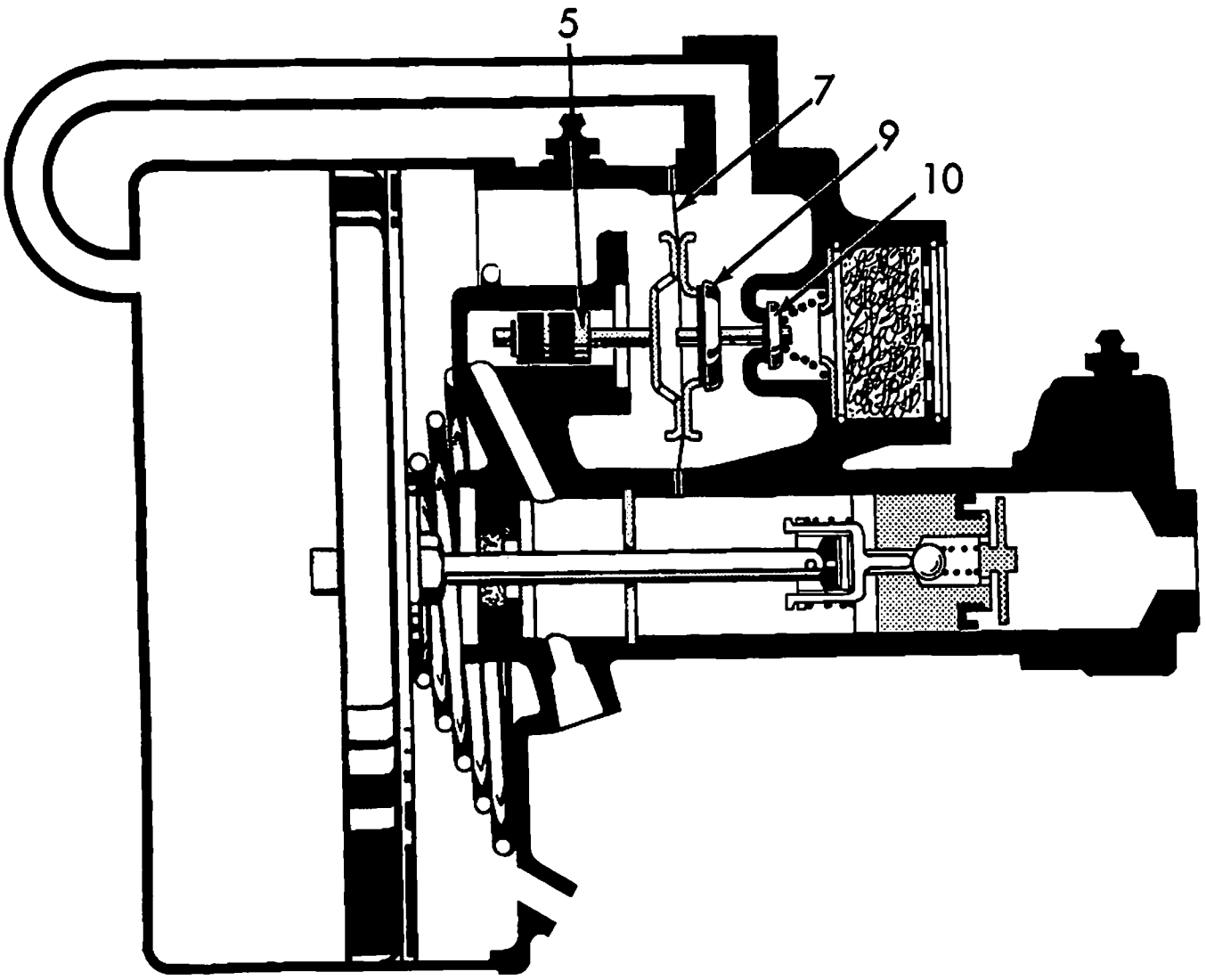


Applying Position

When the brake pedal is applied, fluid under pressure bypasses the ball check valve (21) and enters the cylinder chamber (22), then to the line to the wheel cylinders. At the same time pressure is built up to the left of the valve piston (5) which moves the piston and diaphragm to the right. The diaphragm seat contacts the vacuum poppet (9) and then opens the atmospheric poppet (10). Air (atmosphere) then passes through the air cleaner (12), through the open poppet (10), into the valve chamber (8) and then through the tube to the cylinder chamber (13).

The differential of vacuum across the power piston (14) moves the power piston, the push rod (16) and hydraulic piston (20) forward, compressing the large return-spring (15). With the initial movement of the hydraulic piston (20) the yoke (19) permits the ball of the check valve (21) to seat, which traps hydraulic fluid in the cylinder chamber (22). The fluid under pressure is then forced through the check valve (24) and the brake lines, applying the brakes.

The differential of vacuum across the power piston (14) is the same as that across the diaphragm assembly (7). The differential of vacuum across the diaphragm is balanced by the master cylinder hydraulic pressure at the left side of the valve piston (5). Therefore, the hydraulic fluid out-put pressure in the cylinder chamber (22) is in proportion to the master cylinder



in-put pressure. The total out-put pressure is equal to that from the power piston, plus the pressure in the cylinder chamber from the master cylinder. Since the fluid displacement ahead of the piston in the chamber (22) is the same as that behind the piston (5) in the chamber, the driver has both pressure control and position control, giving him the feel of the brakes.

Holding Position

When the brakes have been applied with the desired foot pressure, the control valve portion of the power unit reaches a "holding position". In this position, the vacuum poppet (9) is seated on the diaphragm assembly (7) while at the same time the atmosphere poppet (10) is seated on its seat in the valve cover. Hydraulic fluid pressure to the left of piston (5) is balanced by the difference in the vacuum across the diaphragm assembly (7). Any decrease or increase of hydraulic in-put pressure causes a corresponding decrease or increase in the vacuum differential as well as a decrease or increase in the hydraulic out-put pressure.

Fully Applied Position

The piston, when in its fully applied position against the stop, lifts the atmosphere poppet from its seat. The cylinder chamber is completely open to the atmosphere. Therefore, the maximum possible differential exists across the power piston.

Power Unit Releasing

When the driver releases foot pressure from the brake pedal, pressure is also released from the left side of the piston. The piston moves to its left and seats the atmosphere poppet. As this action occurs, the vacuum differential presses against the seat on the diaphragm assembly, moving it away from the vacuum poppet. The engine vacuum from the chamber is also transmitted to the cylinder chamber, through the valve chamber and tube. The power piston spring returns the power piston and the hydraulic piston to the fully released position. The yoke releases the ball of the check valve from its seat, which opens the end cap chamber. Therefore, there will be equal pressure throughout the slave cylinder. This permits any fluid expansion, or contraction in the lines to be compensated for by the master cylinder reservoir.

Section Two — DIAGNOSIS GUIDE

Hard Pedal

CAUSE	REMEDY
1. Disconnected, loose, broken or restricted vacuum line.	1. Reconnect line, or replace line. Clear restriction if found.
2. Power piston sticking.	2. Remove power unit, disassemble and free up sticking condition. Clean the cylinder and piston thoroughly.
3. Air filter clogged (power unit).	3. Remove air filter, clean and install.
4. Control valve inoperative.	4. Remove power unit and inspect diaphragm and poppet assembly. Repair or replace.
5. Defective or sticking vacuum check valve.	5. Repair or replace the check valve unit.

Hissing Noise as Brakes are Applied (Momentary)

1. Air passing through the filter unit and atmosphere poppet.	1. Normal condition.

Brakes Drag or Do Not Release Completely	
CAUSE	**REMEDY**
1. Control valve not operating.	1. (a) Remove power unit, disassemble and clean or repair atmospheric poppet. (b) Remove power unit, disassemble and free up sticking valve piston. (c) Remove power unit, disassemble and check for improperly assembled or broken diaphragm return spring.
2. Power piston sluggish.	2. Remove power unit, disassemble and free up sticking condition. Clean the cylinder and piston and check for weak spring action.
3. Hydraulic piston yoke not releasing the ball check.	3. Remove power unit, disassemble and correct cause of sticking ball check.

Brakes Apply when Engine is Started	
1. Broken or improperly assembled atmospheric poppet return spring.	1. Remove power unit, disassemble and install new spring or reinstall correctly.
2. Sticking control valve piston.	2. Remove power unit, disassemble and install new control piston or free up.

CHAPTER VII

Section Three — SERVICING THE POWER UNIT

A. Identification

There are two major types of Hydrovac power brake units which have been installed as original factory equipment on passenger cars.

1. Model C (single stage valve) Single Piston Type
2. Model C (double stage valve) Single Piston Type

Each type has the Air Cleaner built integral with the control valve. The vacuum control check valve is attached directly to the unit.

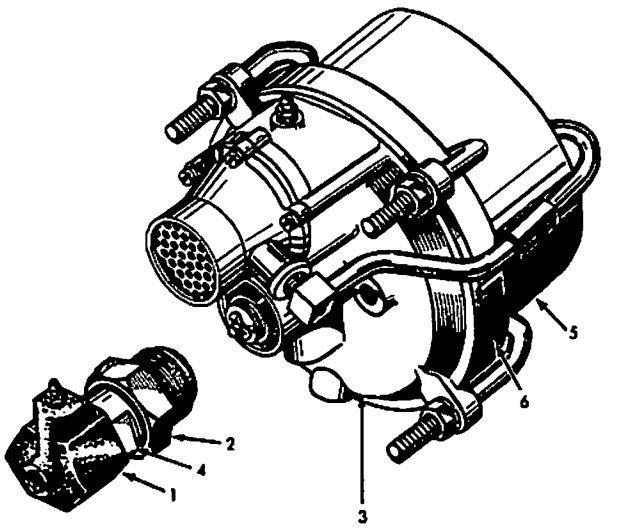
Since it is difficult to determine from outward appearance which type is installed on the car, the application as listed above, clarifys the use of the Single Piston, Double Stage valve type which is the more popular of the two. The text is written in detail for this type since it has greater application as original equipment. The major difference between the two models are also detailed as they apply to the service sequence.

B. Removal of Unit from Car

NOTE This unit is generally connected to the frame of the vehicle on a mounting bracket.

1. Before removing, depress the brake pedal several times (engine shut off) to remove the vacuum from the system.

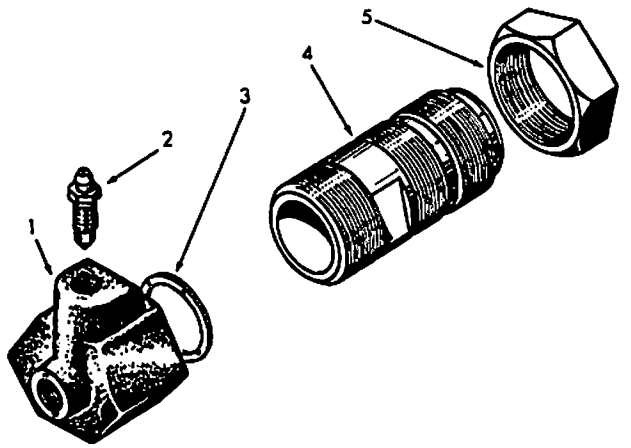
2. Disconnect the hydraulic inlet and outlet fittings and lines. (Use masking tape to cap and seal the lines.)
3. Remove the vacuum hose at the brake booster.
4. Disconnect the wires of the stop-light switch.
5. Remove the mounting bolts that hold the brake booster to the mounting bracket and carefully remove the booster. Some models employ a bracket which is attached to the firewall and the mounting bracket screws must be removed to permit removal of the power unit with the bracket.



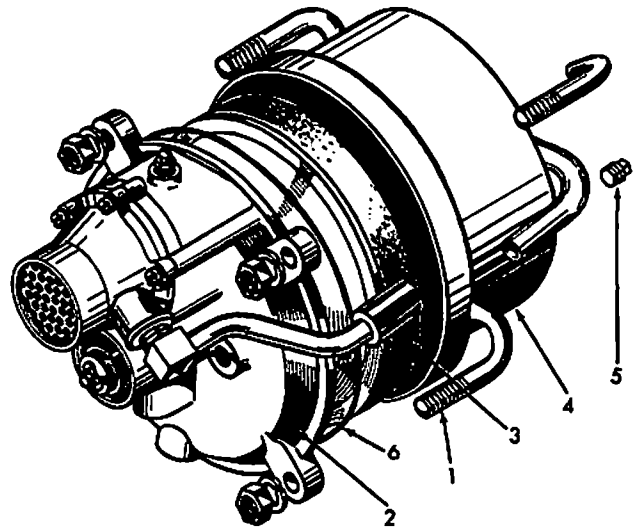
C. Disassembly of Hydrovac

Hydraulic Cylinder

1. Loosen lock nut (2) and with open end wrench on flat (4) unscrew tube from end plate (3). Scratch alignment marks across cylinder shell (5) and end plate (6).



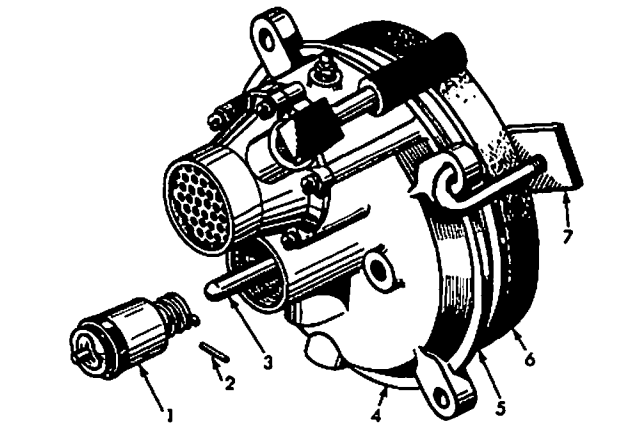
2. Unscrew locknut (5) from tube (4).
3. Clamp end cap (1) in vise and with wrench on flat of tube remove tube (4) and gasket (3) from end cap. Remove bleeder (2) from end cap.



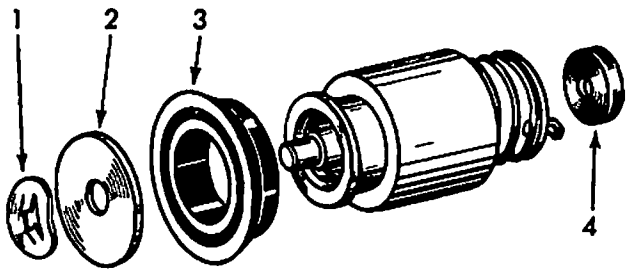
4. Move hose connector (3) forward onto control valve tube.
5. Loosen the cylinder bolt nuts from bolts (1) and unhook bolts from shell (4).
6. Remove shell (4) and end plate gasket (6) from end plate (2).

NOTE If shell sticks to end plate, tap the shell with a plastic tip hammer to loosen.

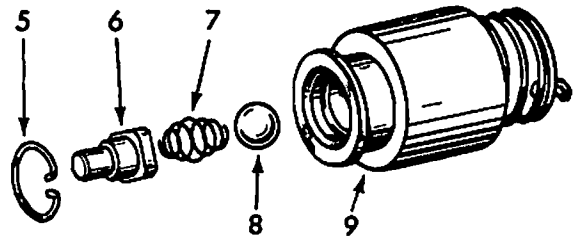
7. Remove pipe plug (5) from shell.



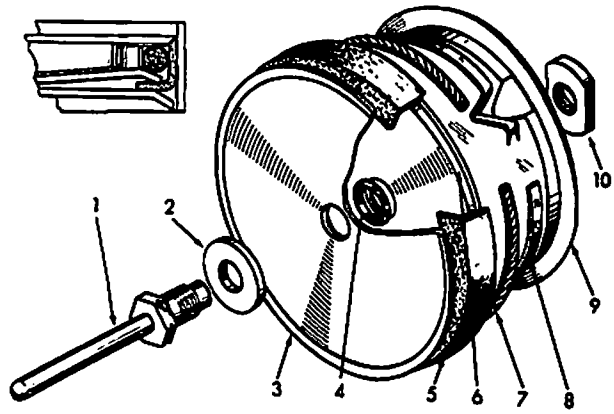
8. Push power cylinder (6) towards end plate (4) compressing spring (5) so that the hydraulic piston (1) protrudes from the end plate.
9. To aid in holding the power piston against the spring tension a special bracket (7) may be made.
10. Disengage the hydraulic piston from the push rod (3) by compressing spring on piston and removing retaining pin (2). Remove holding bracket (7) and slide piston (6) and return spring (5) from the end plate.



11. Use needle nose pliers to remove retaining clip (1) and deflector washer (2) from recess around piston (9).
12. Remove rubber piston cup (3) and cushion (4).



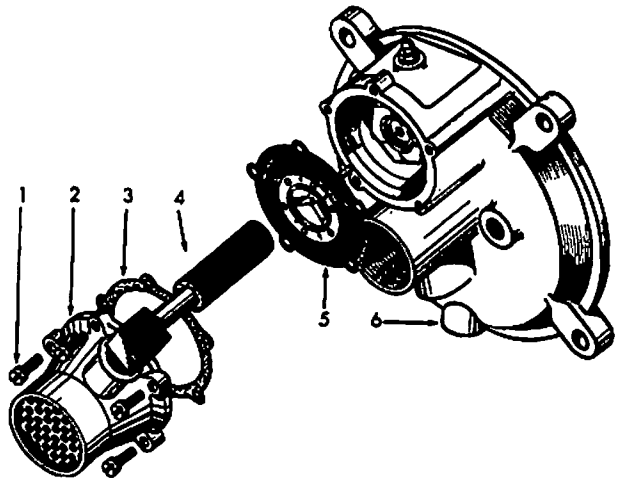
13. Use small screwdriver and needle nose pliers to remove snap ring (5), spring retainer (6), spring (7), and check ball (8).



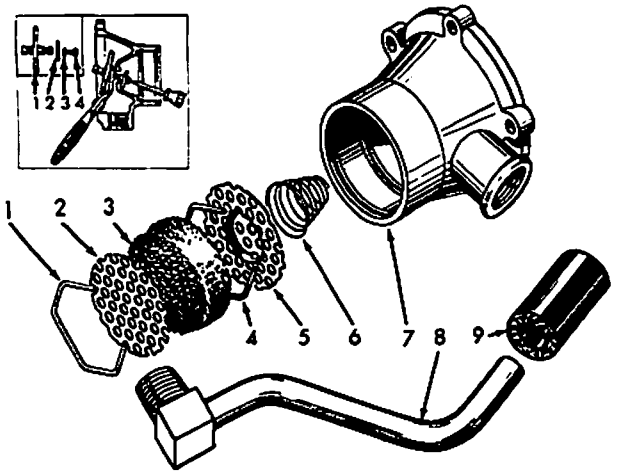
14. Clamp hex shoulder of push rod (1) in vise and with an open end wrench loosen and remove nut (10) from push rod and remove push rod (1) and washer (2).

CAUTION Protect finish of push rod when clamping hex portion in vise.

15. Separate wick retainer plate (9), expander ring (8), packing wick (7), packing plate (6), leather piston packing (5), and push rod seal (4) from the front packing plate (3).

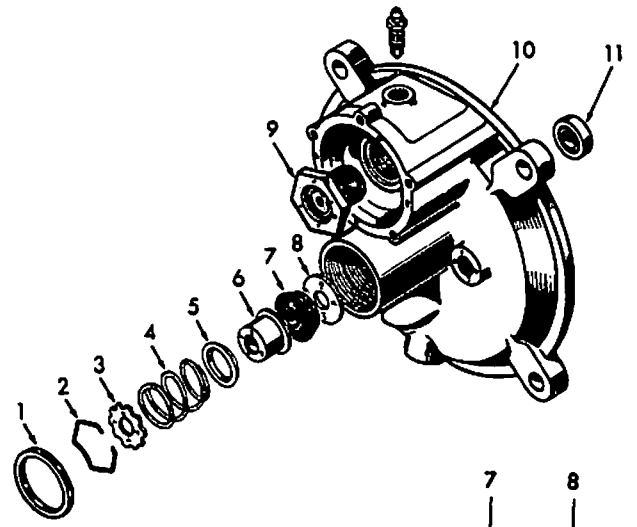


16. Scribe alignment lines across valve housing (2) and end plate (6).
17. Remove the five cover screws (1) and separate valve housing assembly (2), gasket (3), and diaphragm assembly (5) from the end plate (6).



18. Remove outer snap ring (1). Remove retainer (2) and hair (3). Remove inner snap ring (4), spring retainer (5), and poppet spring (6). Remove the hose connector (9) from tube (8) and unscrew the tube from valve housing (7).

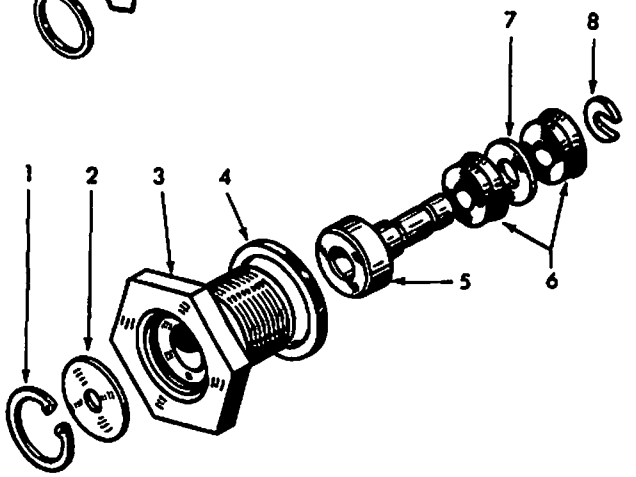
NOTE Do not attempt to remove valve poppets from the housing at this time.



19. Using 1⅛" socket remove the valve nut (9) and remove the bleeder screw.

20. Remove the hydraulic cylinder end seal (1), snap ring (2), and lift out the piston stop washer (3), spring (4), expander washer (5), seal retainer (6), hydraulic cup (7), and guide washer (8).

21. Using a 5/16" O.D. rod, drive the leather seal (11) out of the housing.



22. Remove the "O" ring seal (4) from fitting. Use snap ring pliers to remove snap ring (1) and remove the stop washer (2). Push hydraulic piston (5) out of fitting (3). Remove the C. washer (8), cups (6) and washer (7).

D. Cleaning and Inspection

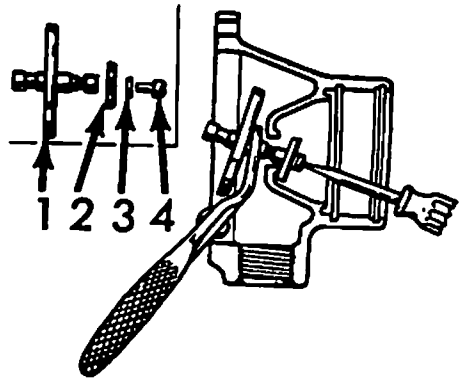
Clean all metal parts with Metalclene or like cleaning fluid and then wash in clean alcohol. Use compressed air to blow dirt and cleaning fluid out of all internal passages. Place all cleaned parts on clean paper while waiting for assembly.

CAUTION It is extremely important that parts are free from dirt when assembling the unit. It is recommended that all parts included in the repair kits be used to insure quality work.

The following parts, not included in the repair kit, should be inspected with extreme care before assembly.

1. Vacuum Cylinder — Inspect bore for scoring or dents.

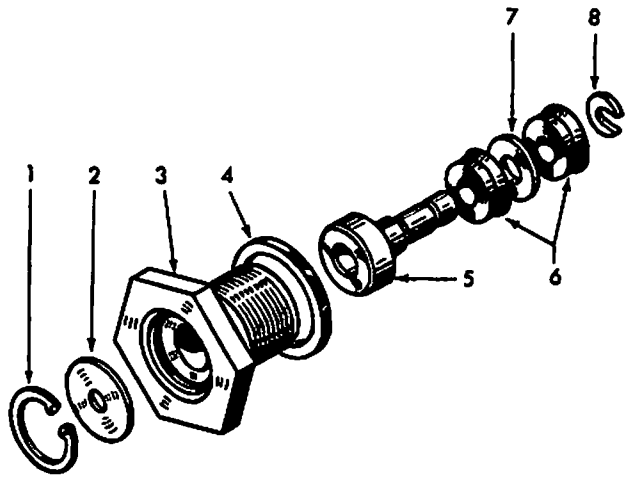
2. Hydraulic Cylinder Tube — Inspect for scoring or points of excessive wear. Check gasket sealing surfaces at end of tube and in hydraulic cylinder and end cap.
3. Power Piston Push Rod — Inspect push rod surfaces for score marks.
4. Hydraulic Piston — Inspect ball seat in end of piston for scoring and/or scratches.
5. Valve Housing and Diaphragm — Inspect vacuum and atmospheric rubber poppets in the valve housing for wear or deterioration. Replace if necessary.

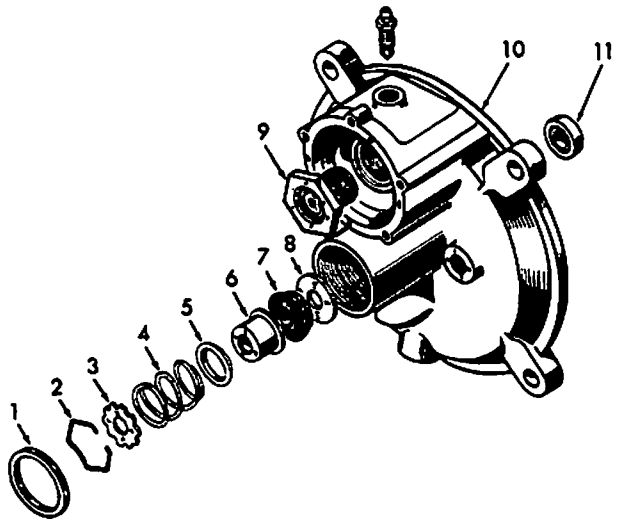


NOTE When necessary to remove rubber poppets from the valve housing, proceed as follows: Use pliers having a 30° offset under large poppet, as a pry bar on edge of housing and pry the two poppets apart. If housing seats are damaged, do not remove poppets, instead replace the housing and poppets as an assembly.

6. End Plate and Valve Fitting — Check bore of valve fitting for scores or corrosion. Inspect end plate bore for scratches where push rod rides.

E. Assembly of Major Components





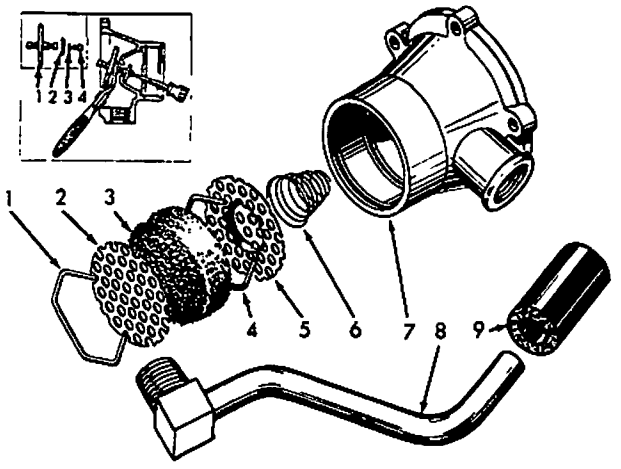
1. Coat piston cups (6) with brake fluid and install cups and washer (7) on piston (5). Lock cups and washer in place on the piston with the "C" washer (8). Install assembled piston in valve fitting (3) from the rear. Install stop washer (2) and snap ring (1) in hex end of fitting. Coat seal (4) with brake fluid and assemble over the threads of the fitting.
2. Screw valve assembly (9) into end plate (10) and tighten until hex section is drawn down into contact with the end plate. Install bleeder screw in end plate, but do not tighten down. Use ¾" O.D. rod with plastic tip hammer and drive leather seal (11) into end plate from the back end.

NOTE Seal lip faces front, the same as the hydraulic cup.

3. Install guide washer (8) in bore of end plate (10), coat the hydraulic cup (7) with brake fluid and place next to the guide washer (8).

NOTE Seal lip away from the washer.

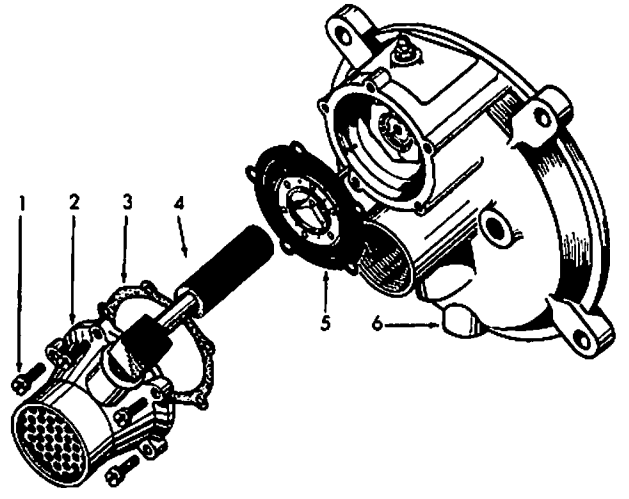
4. Place the seal retainer (6) against cup, install expander washer (5), spring (4), piston stop washer (3) and lock in place with snap ring (2). Coat cylinder end seal (1) with brake fluid and assemble next to the shoulder in the end plate bore.



5. When the valve poppets have been removed, proceed as follows:

NOTE Hold large poppet end with pliers having a 30° offset and insert in the large end of housing. Assemble small poppet, and lead washer to valve stem and hold to secure in place with cap screw.

6. Place small coil of poppet spring (6) in housing (7) and center the spring retainer (5) in the large coil of the spring. Install lock ring (4) to hold in place. Insert quantity of new hair (3) retainer (2) and lock in place by installing snap ring (1). Coat threads of tube connector (8) with a sealing compound, screw in place and install hose connector on the opposite end of the tube.

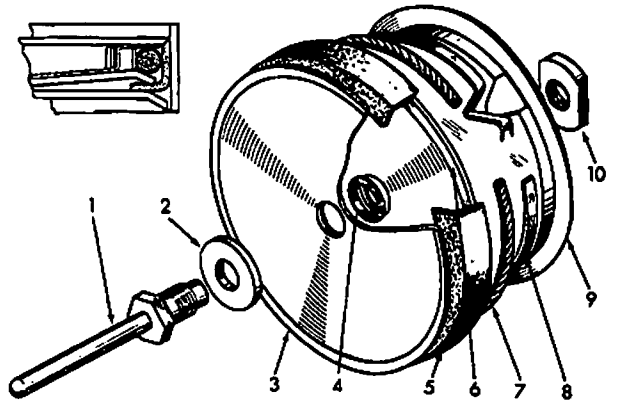


7. Install stem of the diaphragm assembly (5) into the valve fitting in the end plate assembly (6) and align holes in diaphragm with holes in end plate. Assemble gasket (3) and line up holes with those of the diaphragm and housing. Using the alignment marks scribed on the end plate and valve housing at the time of disassembly, assemble the valve housing to the end plate using the five screws.

CAUTION Tighten screws evenly and securely to prevent vacuum leakage.

NOTE As an aid in aligning the diaphragm, gasket and housing, guide pins may be used. To make the guide pins, cut the head off of #8-32 x 2½" machine screws.

NOTE A special Assembly Ring tool is available to insure that the inner diameter of the leather packing is not forced out of the Piston Plates when the assembly is tightened.



8. Place the assembly ring on a flat clean work bench and place the front piston plate (3) in it with the lip (concave side) down.
9. Install a new leather packing (5) on the plate with the lip up.
10. Install a new rubber seal (4) in the center of the plate.
11. Install the rear piston plate (6) with the lip down.

12. Dip the wick (7) in cylinder oil, (Bendix vacuum cylinder oil) *NOT* ordinary oil, and allow excess oil to drain off. Then, coil the wick against the inside lip of the leather packing.

NOTE Cut the wick to proper size if necessary.

13. Install the expander spring (8) inside of the cotton wick with the gripper barbs of the expander spring pointed UP and—notch at the loop end of the expander spring UNDER the clip at the opposite end of the spring.

14. Install the retainer plate (9) on piston parts with the cut-out portion of the plate OVER the loop of the expander spring.

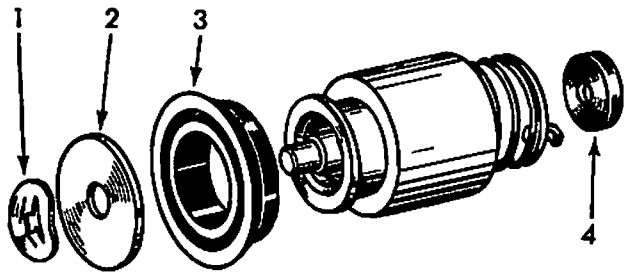
15. Install the push rod washer (2) over the threaded end of the push rod, and clamp the hex end of the push rod (1) in a vise.

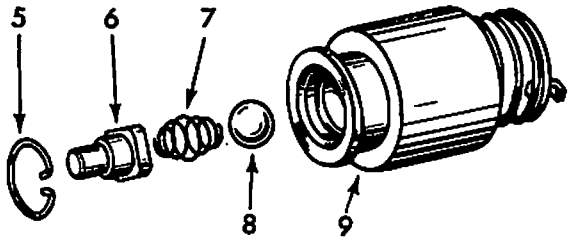
16. Install all of the piston parts (held in position by the special ring assembly tool) over the threaded end of the push rod.

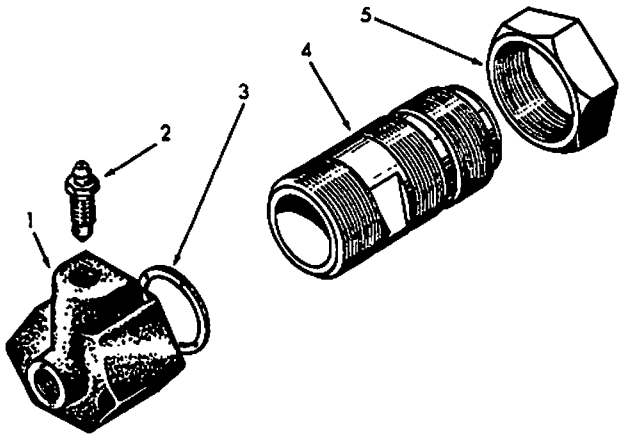
CAUTION Use extreme care not to damage the push rod seal. The large piston plate should rest evenly against the flat washer.

17. Install the push rod nut (10) on the threaded end of the push rod and tighten securely.

NOTE Do not remove assembly ring until ready to install piston in end plate.







18. Install check ball (8) on its seat in the end of piston (9), assemble spring (7), retainer (6) and lock in place with snap ring (5).

19. Coat hydraulic cup (3) with brake fluid and install in recess of piston (9).

NOTE Lip of cup toward ball check end of piston.

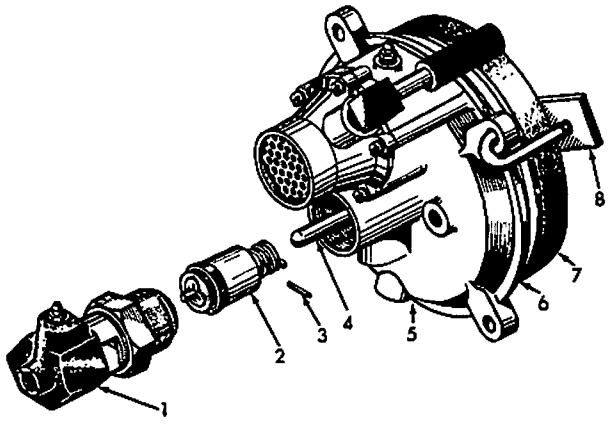
20. Assemble deflector washer (2) over stem of the retainer (6) and install the retaining clip (1). Assemble the cushion (4) to opposite end of piston.

21. Clamp the end cap (1) in jaws of vise, place new copper gasket (3) in end cap and screw the hydraulic cylinder tube (4) into the end cap.

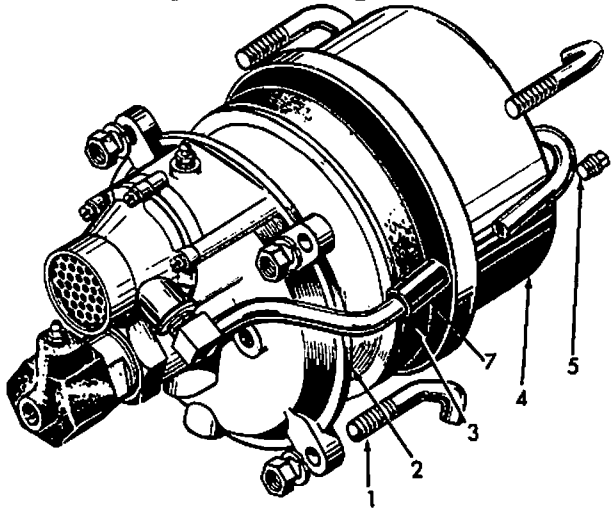
22. Use open end wrench on flat section of tube (4). Tighten the tube in the end cap.

NOTE Tighten tube sufficiently to prevent hydraulic leakage.

23. Screw the tube nut (5) on tube to inner series of threads and install bleed screw (2) into end cap.



24. Remove the assembly ring from the power piston (7), coat piston rod (4) with brake fluid. Place small end of the piston return spring (6) against the end plate assembly (5) and push the push rod (4) through the end plate.
25. Compress the piston return spring, using special plate (8), until the end of the push rod (4) protrudes from the end plate enough to install the piston (2) and cylinder (1).
26. Pull back on retainer spring of the piston (2) and attach piston assembly to the push rod with the retainer pin (3). Coat the bore of the cylinder assembly (2) with brake fluid and install the tube (1) over the cylinder assembly.
27. Check the hydraulic cylinder end tube seal and make sure that it is in position against the shoulder in the end plate bore.
28. Screw the hydraulic cylinder assembly, by hand, into the end plate (5) as far as possible. Back off that portion of one turn necessary to align bleed screw in the hydraulic cylinder end cap with the bleed screw of the end plate. Tighten tube nut against the end plate and remove the piston holding bracket.



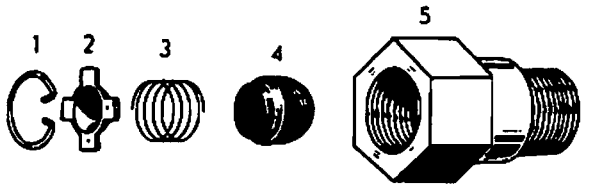
29. Place an end gasket in the groove of the end plate.
30. Coat the inside of the power piston vacuum cylinder (4) with vacuum cylinder oil (Bendix) and also the roll lip of the leather packing (3) on the piston. Let excess oil drip off.
31. Insert the piston in the vacuum cylinder by tipping the piston.

CAUTION Be careful to avoid scoring or cutting the lip of the seal.

32. Align the end plate with the scribe marks made during disassembly.
33. Install the hook bolts, through the end plate lugs, start the nuts, then slowly and evenly tighten the hook nuts to avoid distorting the unit.
34. Slide the hose (3) on the cylinder tube so that approximately half of the hose is on the cylinder tube.
35. Install the plug (5) at the back end of the cylinder shell.

Vacuum Check Valve

If the vacuum check valve is part of the Power Brake Unit (some car models install the vacuum check valve at the intake manifold), install the parts as follows:



1. Snap ring
2. Retainer
3. Spring
4. Ball
5. Valve body

1. Place the end of the spring (3) over the retaining step on the ball check (4) and install in the check valve body (5).
2. Install the spring retainers (2), centering it in the end of the spring (3).
3. Install the snap ring (1) and make sure it is fully seated in the groove.
4. Apply a thin coat of thread compound to the threads and install the check valve in the end plate.

NOTE Inspect the power brake unit to see that all bolts, nuts, and screws are in place. Double check all tubes, clamps, and fittings to see that they are securely tightened.

F. Servicing the Air Cleaner

NOTE The air cleaner should be cleaned or replaced every 1,000 miles. When operating conditions are unusually dusty, the air cleaner should be serviced more frequently.

1. Remove the air cleaner snap ring, the screen and hair filter element and wash in a cleaning solvent.
2. Dry, then lightly oil the filter and reassemble.

CAUTION Do not use an excessive amount of oil. Shake excess oil from filter before installing.

G. Lubrication

1. One (1) ounce of Bendix Power Brake Cylinder Oil should be injected into the unit after it has been installed on the car.
2. Add one (1) ounce of Power Brake Cylinder Oil to the unit every 20,000 miles (or every 6 months, whichever occurs first).

CAUTION Never lubricate the power brake unit until the unit has been installed on the car. Handling of the unit may cause the oil to flow into the hydraulic portion of the unit which would damage the rubber parts. Lubrication should be made only when the engine is stopped and the brakes are in the released position.

H. Bleeding the Hydraulic System

Pressure Type Brake Bleeder Method

CAUTION Do not run the engine when bleeding the hydraulic system. Do not permit brake fluid to spill on the body or fender finish. Pump the brake pedal several times with the engine off to deplete all vacuum in the power brake system.

1. Fill the master cylinder reservoir with a good grade of heavy duty brake fluid. Make certain that the bleeder tank has sufficient fluid.
2. Connect the bleeder tank hose to the master cylinder.
3. Attach a bleeder drain hose to the fitting at the hydraulic cylinder end cap of the power brake unit.

4. Back off the bleeder screw three quarters (¾) of a turn and bleed the fluid into a partially filled jar of clean brake fluid until no bubbles appear.
5. Tighten the bleeder screw and remove the bleeder drain hose.
6. Install the bleeder drain hose to the upper bleeder valve of the power brake booster.
7. Open the bleeder screw three quarters (¾) of a turn and bleed the fluid into a partially filled jar of clean brake fluid until no bubbles appear.
8. Tighten the upper screw, remove the bleeder drain hose and proceed to the wheel cylinders. Bleed the LONGEST brake line first.
9. Replace rubber dust caps on the wheel cylinder bleeder screws (some models only).

BRAKE SERVICE HAND TOOLS

Description	Application	Snap-On	Bonney	Proto.	New Britain	Black Hawk
Chrysler Hand Brake Adjusting Tool	Chrysler line	S-9474				
Brake Clamp Set	All	BL-41	27430			ZT-1001
Bendix Cam Wrench	Bendix	B-1351A	2560			
Brake Eccentric Wrench	Ford	S-8652A				
Brake Bleeder Boxocket	G.M.	B-1456A	2804-L			
Brake Bleeder and Adjusting Boxocket	56-58 Chrysler	B-1460A		2008		
Brake Adjusting Tool	Pontiac	S-9153B		2006	M-104	ZT-1008
Brake Adjusting Tool	Bendix except Chevrolet	B-3404B	2566		M-105	ZT-1005
Brake Adjusting Tool	Late Bendix	S-8353B				ZT-1006
Brake Adjusting Tool	Chevrolet	S-9523				
Brake Pedal Jack	16" to 26" Ext.	GA-36A				
Brake Bleeder Pedal Jack	Continuous Pressure	GA-73A				
Brake Bleeder Wrench	G.M. & Ford	S-9542A		2009		
Brake Adjusting Tool	American Motors	B-1459				
Brake Bleeder Wrench	Universal	B-1458				
Brake Fluid Dispenser	Universal	MBF-1				
Brake Spring Tool	Bendix	BT-11				
Brake Spring Tool	Bendix & Lockheed	131-A		217	P-66	P-1261
Brake Spring Tool	Replaceable Jaws	31-A	2680	215	P-62	
Brake Spring Compressor	Hold Down Springs	OG-14				
Cylinder Hone	Range ¾" to 2¼"	CF-63			R-195	
"C" Washer Pliers	Lockheed	GA-72				