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# SECTION 9-D

# POWER BRAKES



## 9-15 DESCRIPTION OF POWER BRAKE MECHANISM

Wheel brake assemblies used in a power brake system are identical with those used in a regular brake system. The power brake unit provides lighter pedal pressures due to vacuum assist. These lighter pedal pressures are obtained with reduced pedal travel making it possible to have the brake pedal height more nearly the same as the accelerator pedal height.

The power brake pedal is suspended from a shaft which is held firmly by a bracket mounted on the dash panel. The pedal pivots on two nylon bushings. The push rod from the power brake unit is connected directly to a brake pedal pin with a special washer and retainer. The mechanical ratio from the pedal to the hydraulic piston is 2½ to 1.

Pivot points in the brake linkage having nylon bushings must be lubricated during assembly, but do not require periodic lubrication. Because there is no pedal stop, the pedal position when released is determined by a stop built into the power cylinder. There is no linkage adjustment and therefore no pedal height adjustment.

The power brake assembly is a self-contained vacuum unit which utilizes the difference between intake manifold vacuum and atmospheric pressure to reduce brake pedal effort. The unit has an air suspended power cylinder. It has a direct acting hydraulic master cylinder which is very similar to the standard master cylinder. See Figure 9-12.

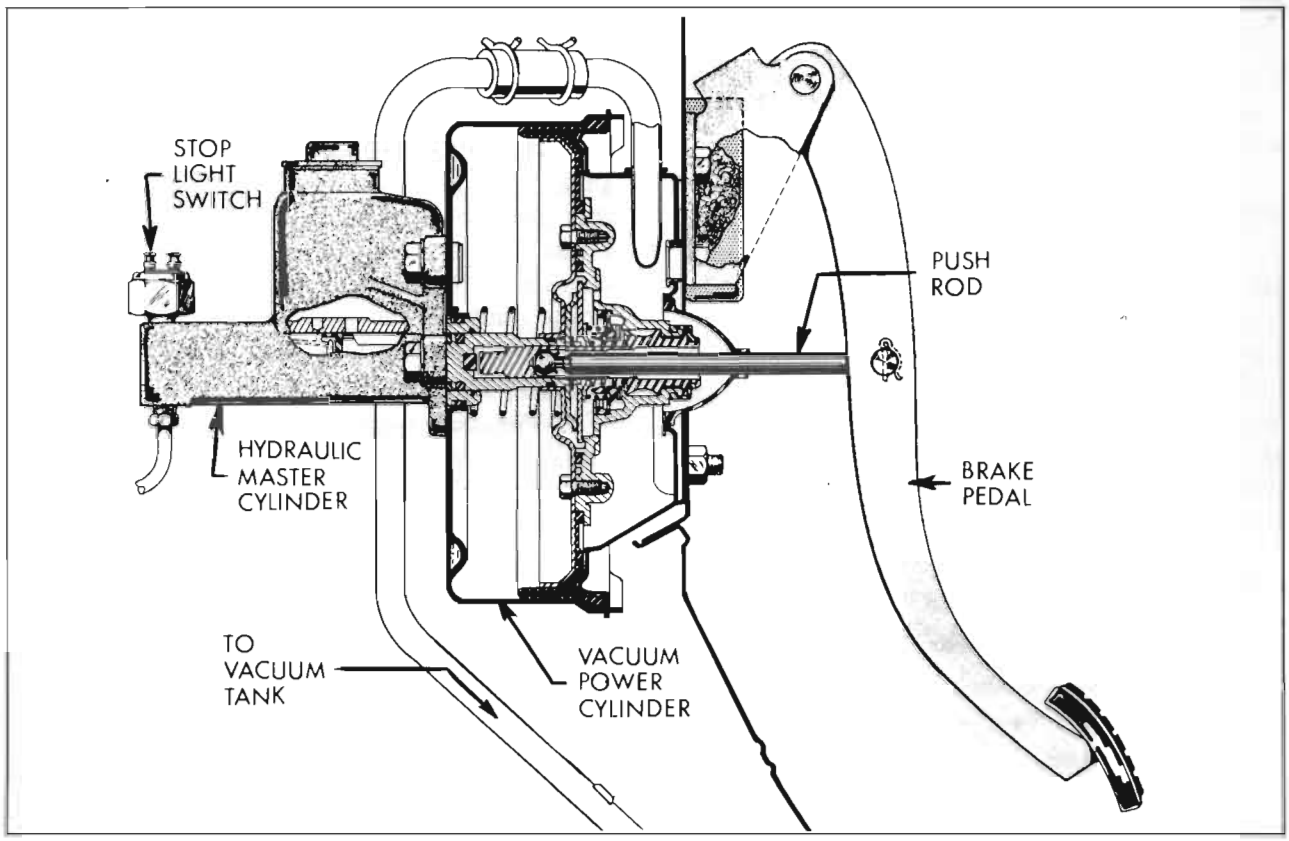


Figure 9-12—Power Brake and Pedal Mechanism

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The power brake cylinder is connected to the intake manifold through pipes and flexible connections. A large capacity vacuum reserve tank is connected into the vacuum line near the power brake cylinder to insure quick and smooth response of the brake cylinder on all power brake applications. A check valve installed in the vacuum line closes to maintain existing vacuum at the power cylinder and in the reserve tank whenever manifold vacuum falls below that in the brake system.

When the engine is stopped and the check valve is closed, the tank provides sufficient reserve vacuum for four to seven normal power brake applications. When reserve vacuum does not exist, the brakes can be applied manually in the same manner as the regular brakes, except that somewhat more effort is required.

## 9-16 REMOVAL, INSTALLATION, ADJUSTING, TESTING OF POWER BRAKE UNIT

### a. Removal of Power Brake Unit

1. Remove connector from stop light switch.

2. Disconnect brake pipe from hydraulic master cylinder and tape end of pipe to prevent entrance of dirt.

3. Remove retainer and special washer from brake pedal pin and disengage push rod eye.

4. Remove air silencer from power cylinder air intake.

5. Remove four nuts holding power brake unit to dash panel.

6. Disconnect vacuum hoses from vacuum tee.

8. Remove power brake unit from car, being careful not to drip brake fluid on car paint.

9. Remove filler cap and turn unit so that any brake fluid will drain out. Pump push rod by hand for full interior drainage. Discard old fluid. Install filler cap and cover hydraulic cylinder outlet with tape to exclude dirt. Clean all loose dirt from outside of unit before disassembling.

### b. Installation of Power Brake Unit

1. Place power brake unit in position and connect vacuum hoses to vacuum tee. This will hold unit in position for installation.

2. Install four nuts on studs and torque to 30 ft. lbs.

3. Install air intake silencer.

4. Install push rod eye over pedal pin. Install special washer and retainer.

5. Connect brake pipe to hydraulic cylinder.

6. Install wiring connector on stop light switch.

7. Bleed hydraulic system according to procedure in paragraph 9-7. Bleed left front wheel cylinder first and check for proper pedal feel. If system still has air in it, bleed other three wheel cylinders.

8. After bleeding, bring fluid level to ½"-1" below lip of filler opening and install filler cap.

NOTE: *When pressure bleeding equipment is not available, do not use any vacuum assist. The engine should not be running and the vacuum reserve should be used up by repeatedly applying the brake before starting the bleeding procedure.*

### c. Testing Power Brake Unit

1. *Vacuum Assist.* With engine stopped, apply brakes several times until all vacuum reserve in system is used up. Then depress brake pedal and start engine while holding a light pedal pressure. If vacuum system is operating properly, pedal will tend to fall away from under the foot, and less foot pressure will be required to hold pedal in same position. If no action is felt, vacuum system is not functioning.

2. *Hydraulic Leak.* Apply a heavy foot pressure on brake pedal with engine running. Hold this pressure at least 15 seconds and observe brake pedal. If pedal goes down gradually, check first for a leak in system outside of power brake unit. When possibility of an external leak is eliminated, leak is in hydraulic cylinder of power brake unit.

3. *Vacuum Leak.* Allow engine to idle a minute to build-up vacuum reserve. Shut off engine and wait several minutes at least (system should hold vacuum for 12 hours) before trying brake action. If brake is not vacuum assisted for at least 5 slow applications there is a leak in the vacuum system. Always check for an external leak before blaming leak on power brake unit.

4. *Road Test.* Apply brakes several times at about 20 m.p.h. to determine if a light pedal pressure stops the car evenly and quickly. Notice pedal feel as compared to other cars of the same model.

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#### d. Trouble-Shooting Power Brakes

Many brake troubles which are blamed on the power brake unit may actually be caused by a defect outside of this unit. Since the brake system beyond the master cylinder is the same in either a standard or a power brake car, one brake trouble-shooting procedure is provided for all cars. See Paragraph 9-6.

## 9-17 DESCRIPTION OF POWER BRAKE UNIT

#### a. Construction of Power Brake Unit

The unit is of the diaphragm type, composed of two main sections: the vacuum power cylinder and the hydraulic master cylinder.

The power cylinder is the "air-suspended" type, meaning that atmospheric pressure is present on both sides of the power piston in the unapplied stage. As shown in Figure 9-13, a front and rear housing interlock to form a large chamber in which the power piston and related parts operate. The section to the rear of the piston is called the *Air* chamber since it is open to atmospheric pressure at all times. The section to the front of the piston is called the *vacuum* chamber since it is subjected to manifold vacuum during power application of brakes. All air entering the cylinder passes through an air filter located in the passenger compartment.

The *air* chamber is sealed-off from the *vacuum* chamber by a diaphragm. The inner edge of this diaphragm is held between two parts of the power piston assembly; the outer edge is clamped between the front and rear housing. A flexible rubber hose connecting the piston with a fixed tube at the top of the rear housing permits the piston to move back and forth while connected to manifold vacuum. Air is exhausted out of the *vacuum* chamber through passages in the piston and through the hose when the control valve is positioned for power application.

The power piston assembly houses the control valve and reaction mechanism. The control valve is made up of the air valve and the floating choke valve assembly. The reaction mechanism consists of a master cylinder piston reaction plate, a reaction disc, three reaction levers, and an air valve reaction plate. A push rod, which operates the air valve, projects out of the power cylinder housing through a boot.

The master cylinder piston is a steel plunger which extends from the heart of the power cylinder section into the master cylinder section. The master cylinder contains a fluid reservoir which supplies fluid to fill the space between the primary cup and the secondary seals through a hole in the casting. When the brake pedal is released quickly, the master cylinder piston returns immediately (to the released position). Since fluid from the lines cannot return as quickly as the piston, compensation is provided by a flow of fluid through holes in the piston, past the collapsed lip of the primary cup. As fluid from the lines returns, the excess fluid in the master cylinder bore flows into the reservoir through a small compensation port.

Connection is made to the wheel cylinders through brake pipes and a conventional check valve. This check valve and a return spring maintain a static residual pressure in the hydraulic brake system.

#### b. Operation of Power Brake Unit

Description of power brake cylinder operation will cover (1) Released Position, (2) Applying, (3) Reaction Pressure, (4) Holding, (5) Releasing, (6) Manual Applying.

(1) *Released Position,* See Figure 9-13. The air valve return spring holds the air valve, push rod, and brake pedal rearward so that the air valve is clear of the floating control valve. Although vacuum is present at the floating control valve through the flexible hose, the control valve return spring holds the rubber face of the valve against its annular seat in the power piston, thereby closing off manifold vacuum.

Atmospheric pressure enters through the air filter into the *air* chamber and flows through holes in the power piston into the reaction lever area. From here is flows past the open annular seat on the air valve and through a passage in the power piston into the *vacuum* chamber. With the vacuum passage closed and the *vacuum* chamber open to outside air, the power piston is balanced by atmospheric pressure on both sides and is held against the rear housing by the return spring.

The air valve return spring and the floating control valve return spring are holding the air valve reaction plate against the inner ends of the reaction levers. Since the outer ends of these levers are against their pivot points in the power piston, the levers are pushing forward against the reaction dics. This disc, in turn, is holding the master cylinder piston and reaction plate assembly forward so that the reaction plate is against its stop. To sum it up,

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in the released position of the power cylinder, the reaction mechanism is fully forward and the two valves are fully rearward.

In the master cylinder the primary cup is in a position just to the rear of the compensating port, permitting flow of brake fluid between the master cylinder bore and the reservoir as required. The check valve is seated and is maintaining static pressure in the brake pipes and wheel cylinders.

(2) *Applying*. See Figure 9-14. As the brake pedal is depressed, the push rod moves the air valve forward until its annular seat contacts the floating control valve, at which point atmospheric pressure is sealed off from the *vacuum* chamber. Further movement of the air valve pushes the floating control valve away from its annular seat in the power piston, thus connecting the *vacuum* chamber to the vacuum source. As air is exhausted out of the *vacuum* chamber, atmospheric pressure in the *air* chamber starts moving the power piston forward.

As the power piston moves forward, it carries the master cylinder piston into the master cylinder. As the primary cup passes the compensating port, pressure starts to build up in the hydraulic system. The fluid displaced by the piston is forced out into the brake pipes and

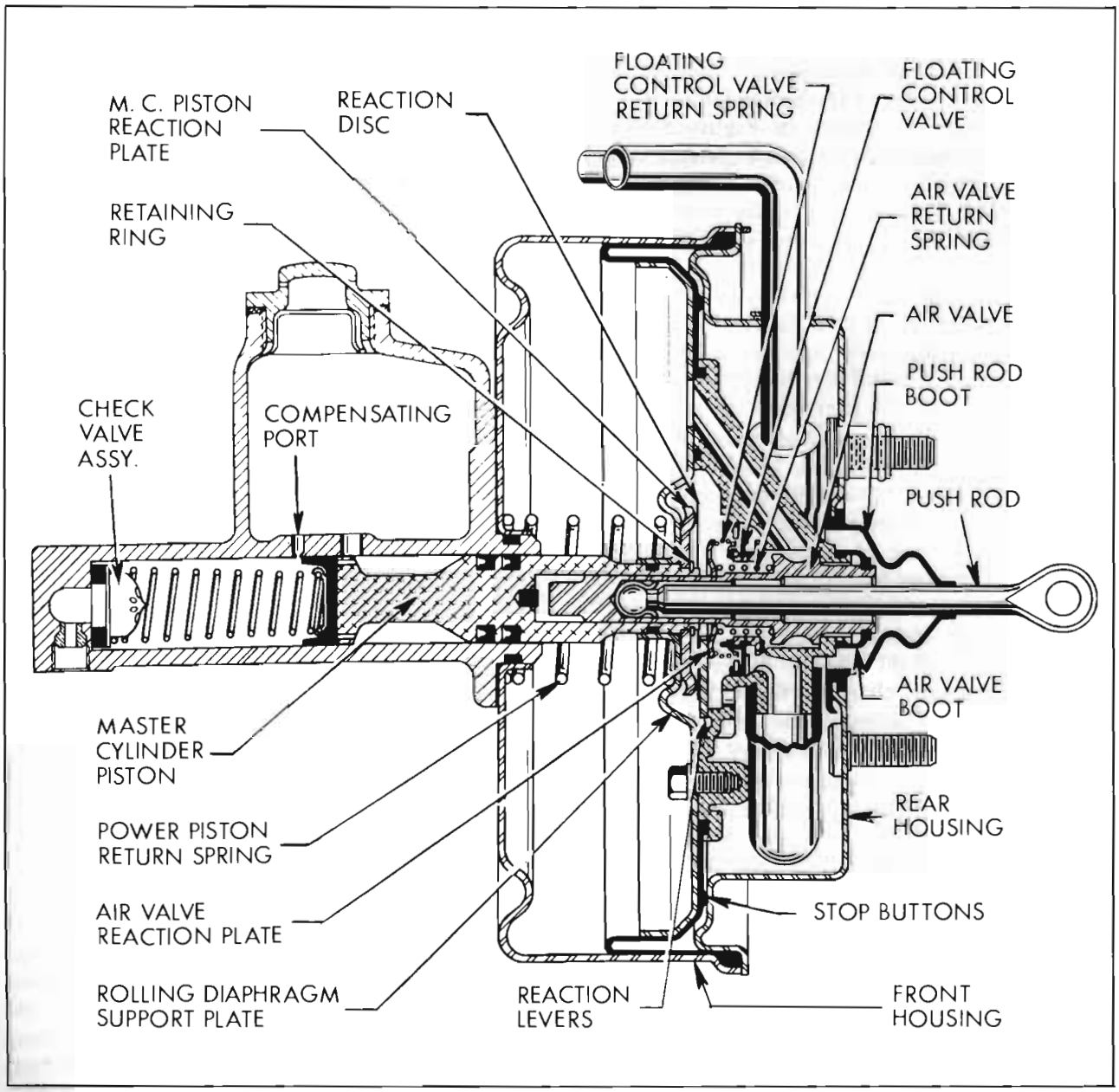


Figure 9-13—Power Brake Unit—Released Position

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wheel cylinders to apply the brake shoes. At the same time, a *reaction pressure* is transmitted back to the brake pedal to give the driver an indication or "feel" of the pressure being applied to the brake shoes.

(3) *Reaction Pressure.* As soon as pressure starts to build up in the hydraulic system, the pressure on the end of the master cylinder piston causes the master cylinder piston reaction plate to move away from its stop and press against the reaction discs and the reaction levers. The levers in turn swing around their pivots in the power piston and push the air valve reaction plate back against the floating control valve snubbers. See Figure 9-14.

In this manner approximately 40% of the load on the master cylinder piston is transferred through the air valve and push rod to the brake pedal to oppose the foot pressure applied by the driver. This reaction pressure gives the driver a "feel" proportional to the degree of brake application, so that he has positive control over the braking operation at all stages. Thus, about 40% of the effort is supplied by the driver's foot on the brake pedal, the remainder being supplied by "boost" from the power piston.

(4) *Holding.* When the desired brake apply pressure is reached and the brake pedal is held still, the air valve and floating control valve are also held motionless. The power piston, however, continues forward momentarily until its annular seat contacts the floating control valve. See Figure 9-15. At this point, both the air valve and the power piston are seated on the floating control valve so that the passage to the

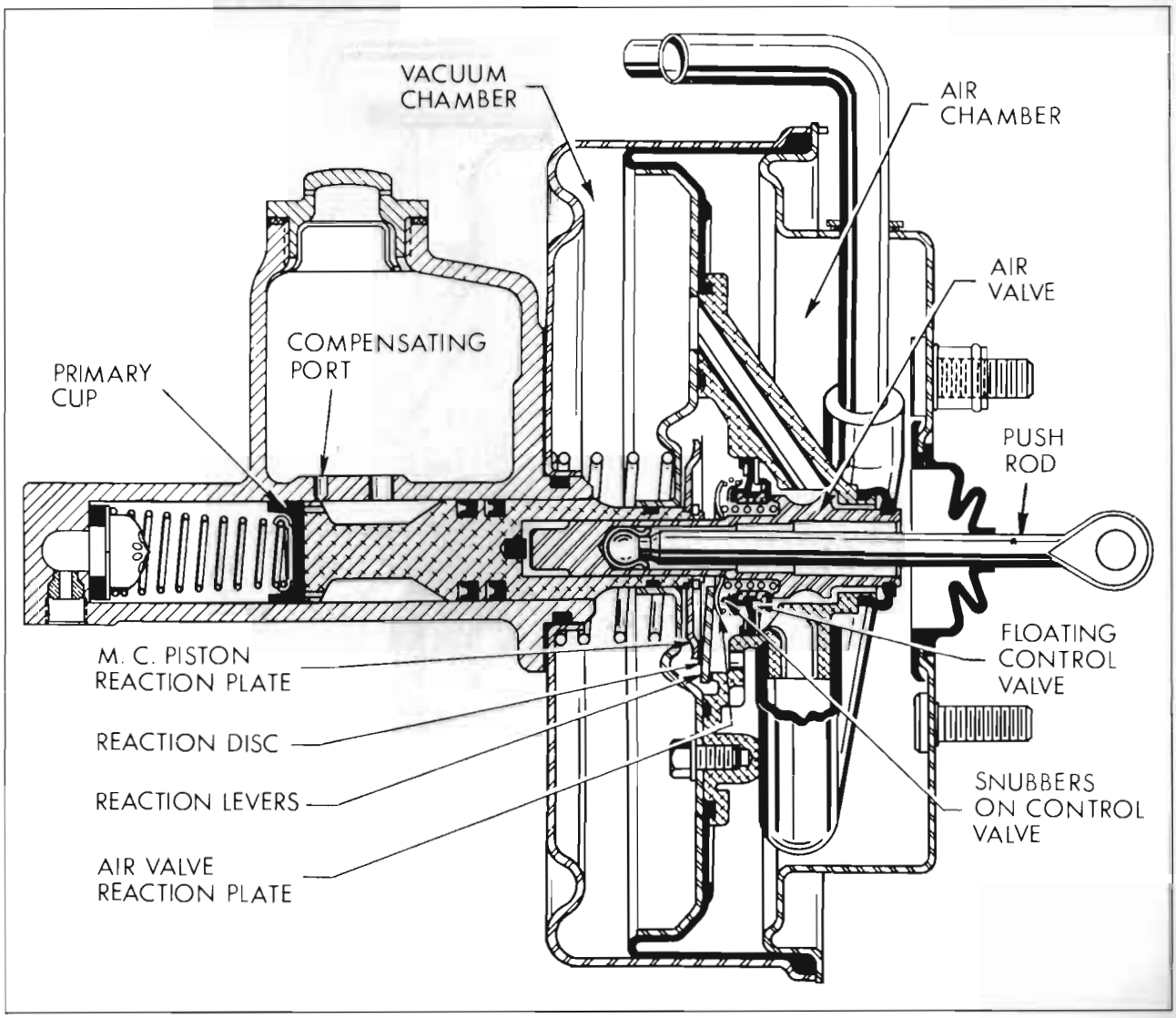


Figure 9-14—Applying

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*vacuum* chamber is closed to atmospheric pressure as well as vacuum; therefore, the power piston is held stationary or poised until the brake pedal is moved in either direction.

(5) *Releasing*. When foot pressure on the brake pedal is released, the air valve return spring forces the air valve away from the floating control valve. This allows the floating control valve return spring to seat the control valve against the power piston, closing the vacuum passage. Since both sides of the power piston are now open to atmospheric pressure, the piston return spring forces the power piston and related parts rearward to the unapplied position (Figure 9-13).

As the master cylinder piston moves out of the master cylinder, the fluid from the wheel cylinder flows back into the master cylinder through the check valve. When the primary cup passes the compensating port, any surplus fluid in the hydraulic system returns to the reservoir. The check valve spring presses the check valve against its seat with sufficient force to maintain a static pressure in the brake pipes and wheel cylinders.

(6) *Manual Applying*. When the engine is not running and all reserve vacuum is exhausted, the brakes are applied entirely by foot pressure on the brake pedal. As the pedal is pushed down, the air valve moves forward beyond its normal travel until the end of the air valve contacts the rubber bumper in the master cylinder piston. Further movement pushes the master cylinder piston into the master cylinder, causing the brakes to be applied in the usual way. However, the pedal pressure for a given brake application is considerably greater.

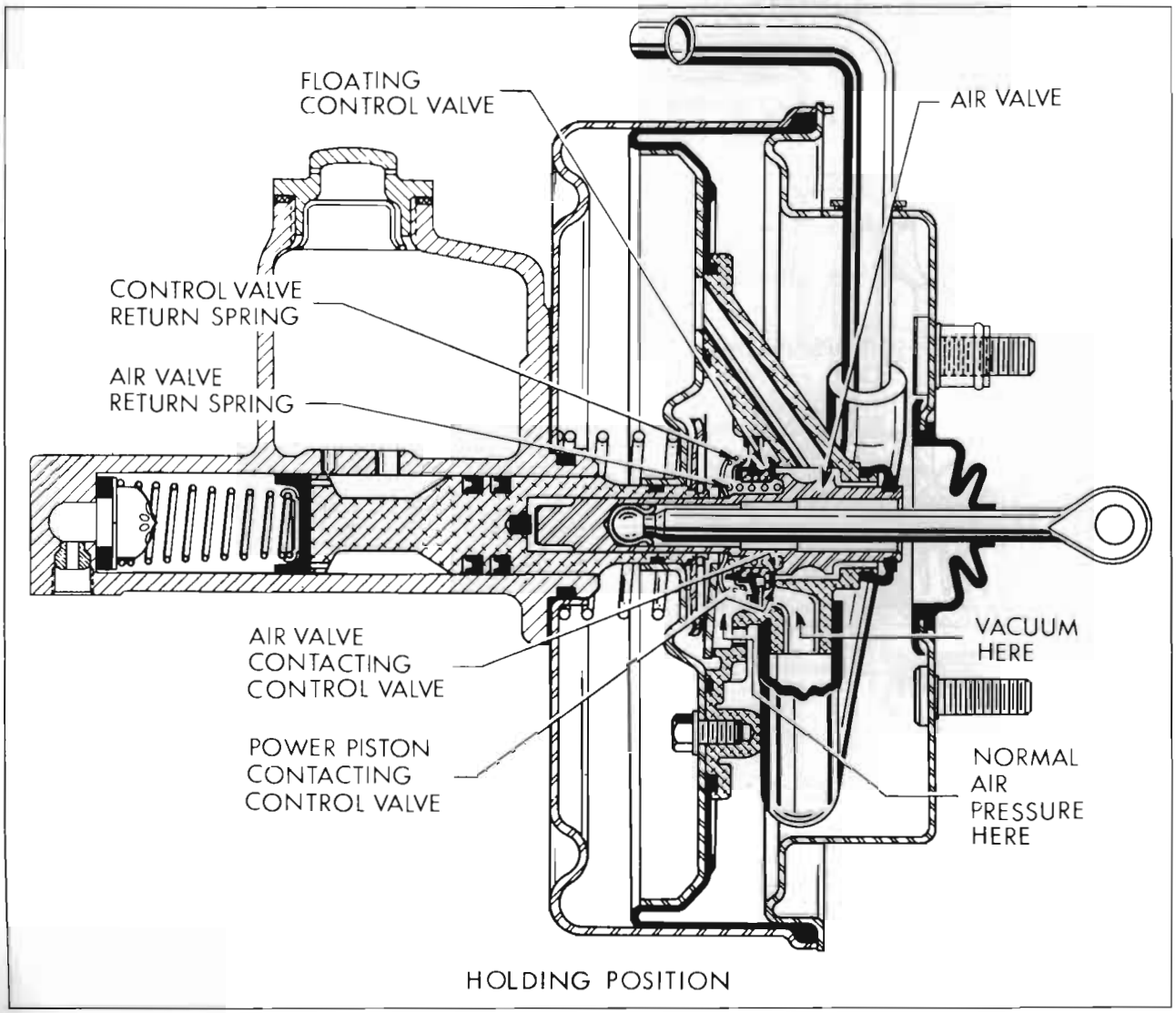


Figure 9-15—Holding

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If the engine is started while the brakes are being manually applied, manifold vacuum will exhaust air from the *vacuum* chamber through the wide open vacuum port at the control valve, and the power piston will move forward. This will make the pedal "fall-away" slightly from under the foot, and less pressure will be required to hold the pedal in the applied position.

## 9-18 DISASSEMBLY, INSPECTION, ASSEMBLY OF POWER BRAKE UNIT

NOTE: *Refer to Figures 9-13 thru 9-16 for identification of parts not shown in figures next to overhaul steps.*

### a. Disassembly of Power Brake Unit

1. Place power brake unit in a vise with push rod up. Clamp unit firmly on sides of master cylinder reservoir.

2. Place a long wooden hammer handle in position to bear against two studs. Rotate rear housing counter-clockwise to separate rear housing from front housing.

3. Lift rear housing assembly and power piston assembly from unit.

4. Remove hose from tube in rear housing. Pull push rod through rear housing and remove push rod boot. Lay rear housing and tube assembly aside.

5. Remove power piston return spring from front housing.

NOTE: *Unless front housing or master cylinder assembly is damaged and must be replaced, there is no need to remove front housing from master cylinder assembly.*

6. In handling the power piston assembly, special care must be taken to guard the diaphragm against grease, oil, or foreign matter and to protect it from nicks or cuts. The master cylinder piston must also be protected from nicks or scratches. Loosen the four screws holding the power piston assembly together.

7. With master cylinder piston up, remove screws and lift master cylinder piston, rolling diaphragm support plate, master cylinder piston reaction plate, and power piston diaphragm from

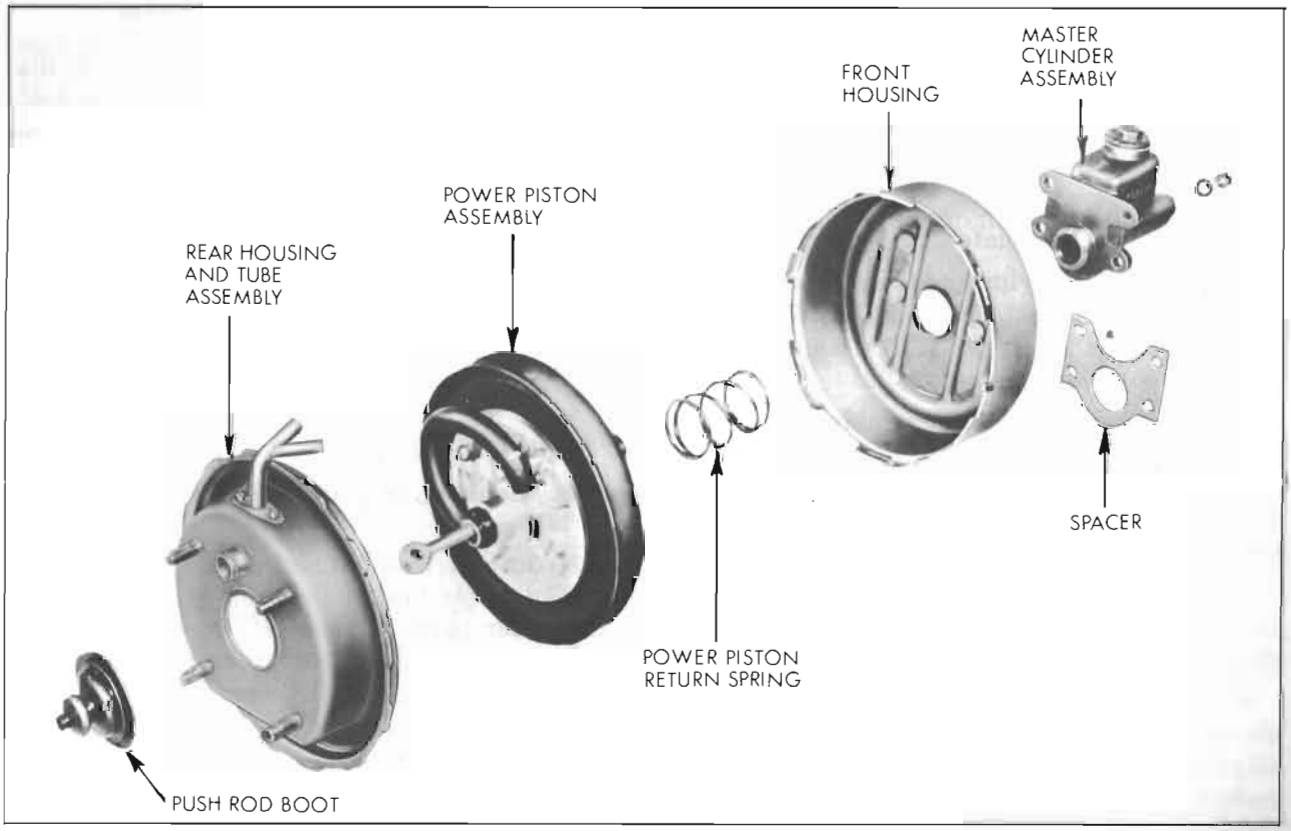


Figure 9-16—Major Parts of Power Brake Unit

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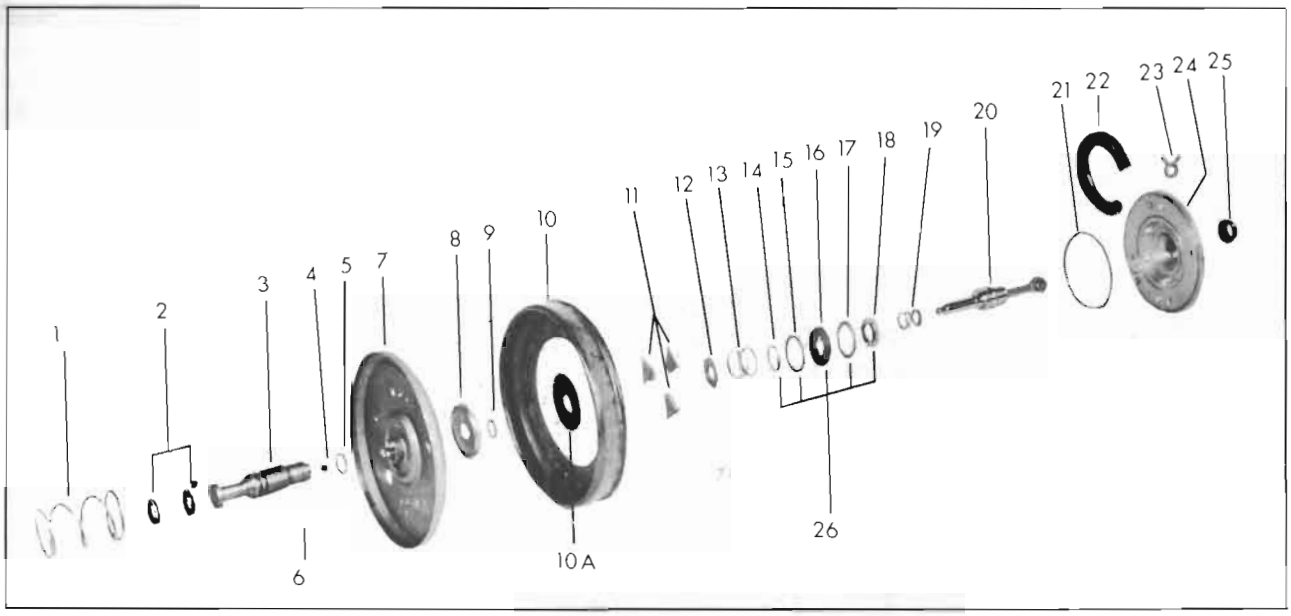


Figure 9-17—Exploded View of Power Piston Assembly

1. Power Piston Return Spring
2. Secondary Seals
3. Master Cylinder Piston
4. Bumper
5. "O" Ring
6. Bolt
7. Rolling Diaphragm Support Plate
8. M.C. Piston Reaction Plate
9. Retaining Ring
10. Power Piston Diaphragm
10A. Reaction Disc
11. Reaction Levers
12. Air Valve Reaction Plate
13. Floating Control Valve Return Spring
14. Floating Control Valve Spring Retainer
15. Reaction Diaphragm Retainer
16. Reaction Diaphragm
17. Reaction Diaphragm Support Plate
18. Floating Control Valve
19. Air Valve Return Spring
20. Air Valve-Push Rod Assembly
21. Seal Ring
22. Exhaust Hose
23. Hose Clamp
24. Power Piston
25. Air Valve Boot
26. Floating Control Valve and Diaphragm Assembly

power piston. Remove power piston diaphragm and inspect for cuts, pin holes, distortion or cracks.

8. Remove retaining ring from master cylinder piston with No. 2 Truarc Pliers J-4880 and remove the reaction plate.

9. Push master cylinder piston through support plate. From master cylinder piston remove O-ring, two secondary seals, and small rubber bumper from inside piston.

10. From power piston assembly remove reaction disc, three reaction levers, air valve reaction plate, floating control valve return spring, and air valve return spring. Remove power piston seal ring. See Figure 9-18.

11. Turn power piston over. Inspect hose carefully. If hose is to be replaced, remove hose clamp using Pliers J-5284 and remove hose.

12. Remove air valve boot. Force push rod-air valve assembly through power piston, dislodging floating control valve and diaphragm assembly. Push rod cannot be disassembled from air valve; therefore, if either part is defective, a new assembly must be installed.

13. From floating control valve and diaphragm assembly (Figure 9-17), remove floating control valve spring retainer. Remove reaction diaphragm retainer from under lip of reaction diaphragm, then remove reaction diaphragm and support plate from hub of floating control valve.

14. From master cylinder bore, remove primary cup, spring and retainer assembly, check valve assembly and valve seat washer.

15. Remove master cylinder filler cap and gasket.

### b. Cleaning, Inspection, Replacement of Parts

As an aid in determining the cause of improper power brake operation, wipe fluid from all rubber parts, then carefully examine these parts for nicks, cuts or other damage. After examination discard all these parts.

Thoroughly clean the remaining parts in diacetone alcohol or clean brake fluid. Blow out all passages, orifices, or holes.

CAUTION: *Do not use anti-freeze alcohol, gasoline, kerosene, or any other cleaning fluid*

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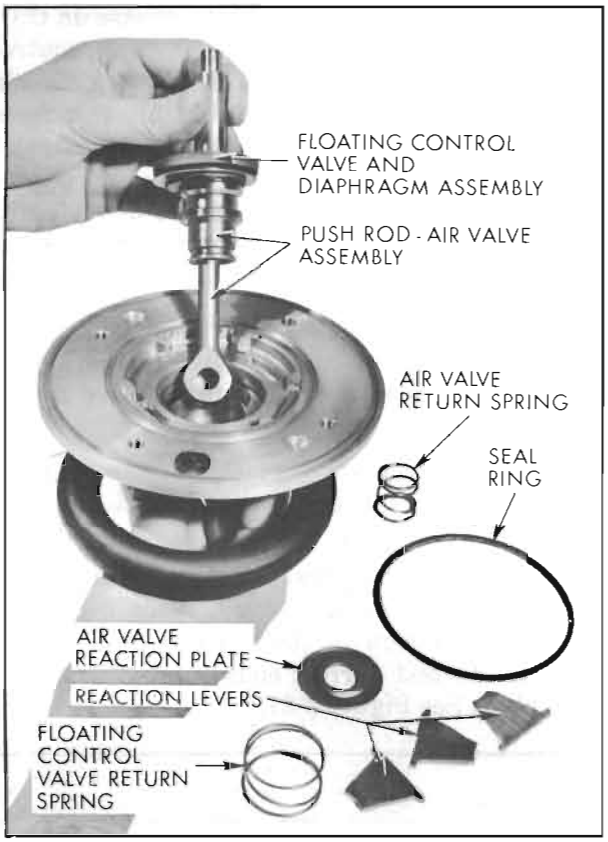


**Figure 9-18—Removing Power Piston Parts**

*that might contain even a trace of mineral oil, as this could cause serious damage to all rubber parts in the brake system.*

Carefully examine the cleaned parts for nicks, burrs, stripped threads, damage or excessive wear. Replace damaged or excessively worn parts or housings. If inside of vacuum power cylinder is rusted or corroded, polish with steel wool or fine emery cloth. Replace if scored.

Make certain that the small compensating port in the master cylinder reservoir is clear.

If the outer surface of the air valve or the master cylinder piston show evidence of abrasion, polish out light scores with crocus cloth or very fine polishing paper, then wash and dry thoroughly. Inspect master cylinder bore for corrosion or pits.

If any parts indicate that heavy corrosion or abrasive action has resulted from contamination of the brake fluid, replace damaged parts and be sure to thoroughly flush the reservoir and wheel cylinder lines.

The Power Brake Cylinder Overhaul Kit (Gr. 4.898) contains all necessary replacement parts for the power brake cylinder. When reassembling the brake cylinder use all the new parts in the kit regardless of whether the old parts appear fit for use. Discard all old rubber parts. In addition, replace any other parts which inspection indicates to be unfit for use.

Lubricate all hydraulic master cylinder parts with clean brake fluid. Lubricate vacuum power cylinder parts with silicone grease as specified. The recommended silicone grease is supplied in the power brake cylinder overhaul kit. Do not lubricate parts until just before installation.

### c. Assembly of Power Brake Unit

1. Install master cylinder filler cap and gasket finger tight.

2. Place assembly in vise with master cylinder bore up and clamp firmly on sides of master cylinder reservoir.

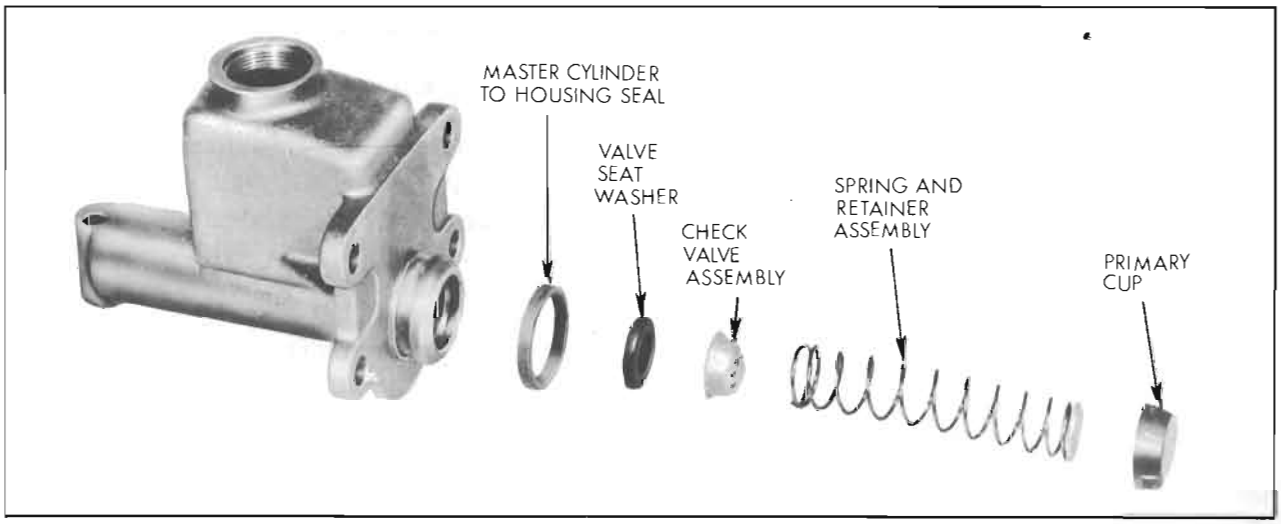


**Figure 9-19—Internal Parts of Master Cylinder**

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3. Wipe master cylinder bore with a coat of clean brake fluid. Into bore, place valve seat washer. See Figure 9-19. Press check valve in open end of spring and retainer; place assembly in bore with check valve down. Dip primary cup in clean brake fluid and place in bore with lip down.

4. To assemble floating control valve and diaphragm assembly, place reaction diaphragm support plate over hub of floating control valve. See Figure 9-20. Assemble reaction diaphragm over hub of floating control valve flat side first so that hub flange fits into groove in I.D. of diaphragm. Insert reaction diaphragm retainer under lip of reaction diaphragm. Firmly press floating control valve spring retainer on center of reaction diaphragm so that retainer fits over six small rubber bumpers.

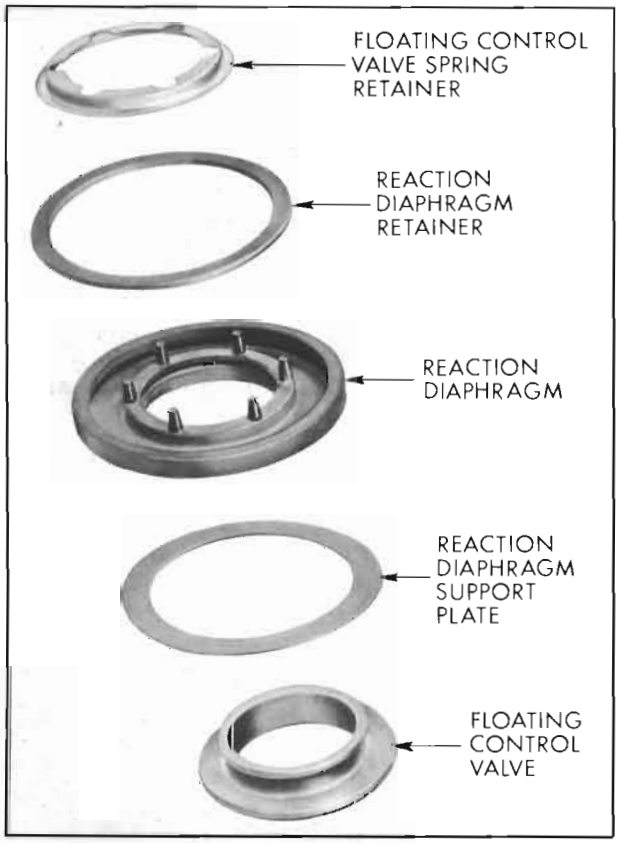


Figure 9-20—Floating Control Valve and Diaphragm Assembly

5. Set power piston casting on jaws of vise with flat surface up. Do not clamp. Wipe a thin coat of silicone grease (from tube included in overhaul kit) on portion of air valve which will slide in bore of master cylinder piston. Insert push rod end of push rod-air valve assembly down through power piston.

6. Wipe a thin film of silicone grease on O.D. of reaction diaphragm. Place floating control valve and diaphragm assembly down over air valve so that rubber face of control valve rests on its seat in power piston. Press outer edge of diaphragm against shoulder in power piston. Make sure that diaphragm is not distorted as assembly is placed into power piston.

7. Place air valve return spring inside floating control valve to its position on air valve.

8. Place floating control valve return spring to its position on floating control valve spring retainer.

9. Position air valve reaction plate over air valve so that low center portion rests on air valve return spring.

10. Wipe a thin coat of silicone grease on both sides of reaction levers. Place wide ends of reaction levers in their seats in the power piston, and rest narrow ends on air valve reaction plate. See Figure 9-21.

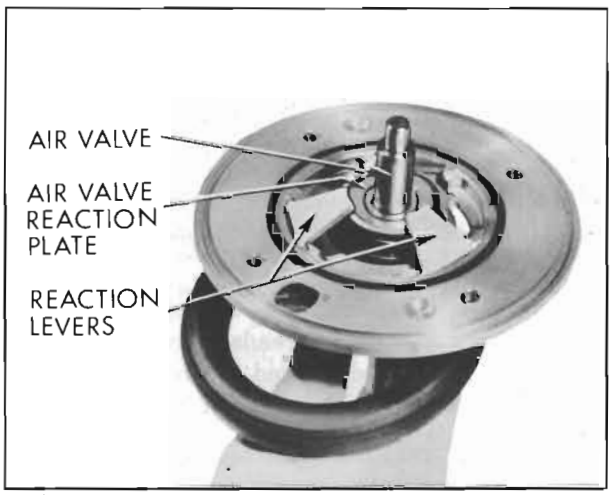


Figure 9-21—Installing Parts in Power Piston

11. Insert seal ring into inner groove on flat surface of power piston face.

12. Place power piston diaphragm over power piston with stop buttons down and with diaphragm folded-over into the shape in which it normally operates. Insert inner bead of diaphragm in outer groove of power piston.

13. Assemble master cylinder piston by inserting small rubber bumper in counterbore. Place two secondary seals in grooves of piston, with lips toward master cylinder end of piston. Place O-ring in second groove from counterbored end of piston.

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14. Lubricate master cylinder piston in area of O-ring and also center hole in rolling diaphragm support plate with a thin coat of silicone grease. Push piston through support plate from flange side.

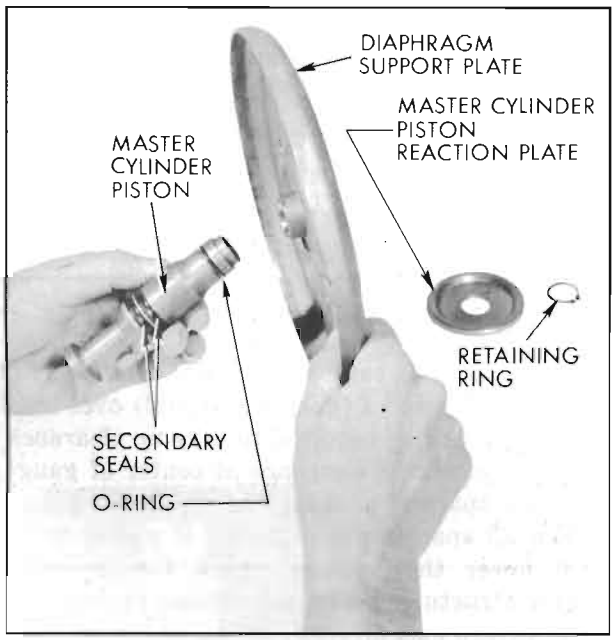


**Figure 9-22—Installing Master Cylinder Piston in Diaphragm Support Plate**

15. Place master cylinder piston reaction plate over piston with raised rim away from support plate and install retaining ring in groove using No. 2 Truarc Pliers J-4880.

16. Wipe a coat of silicone grease on exposed side of master cylinder piston reaction plate and also on both sides of thin reaction disc. Using grease as a binder, stick reaction disc against reaction plate.

17. Make sure power piston assembly parts are correctly located. Then position master cylinder piston and support plate assembly carefully over power piston assembly and align lugs on plate with depressions in power piston. Lower assembly carefully until support plate is pressed tight against power piston. In this step, make sure that wide end of a reaction lever does not jump out of its seat. Hold pressure while installing the four screws.

18. Invert power piston assembly and install air valve boot.

19. If hose was removed, install new hose fully on boss so that it is parallel to power piston. Install hose clamp using Pliers J-5284. Rotate hose clamp outward so that it nearly contacts power piston; otherwise it will strike the rear housing and prevent full return of power piston assembly. See Figure 9-23.

20. Place return spring over flange in center of front housing. Wipe master cylinder piston and secondary seals with a coat of clean brake fluid. Wipe a thin layer of silicone grease on diaphragm bead. With diaphragm folded-over into the shape in which it will operate, position power piston assembly over front housing, and insert master cylinder piston into master cylinder bore. Make sure primary cup is in proper position as piston enters bore.

21. Rotate power piston assembly so that unattached end of hose is in line with master cylinder filler cap. Press power piston down and hold in position while fitting bead of diaphragm into recess in rim of front housing. See Figure 9-23.

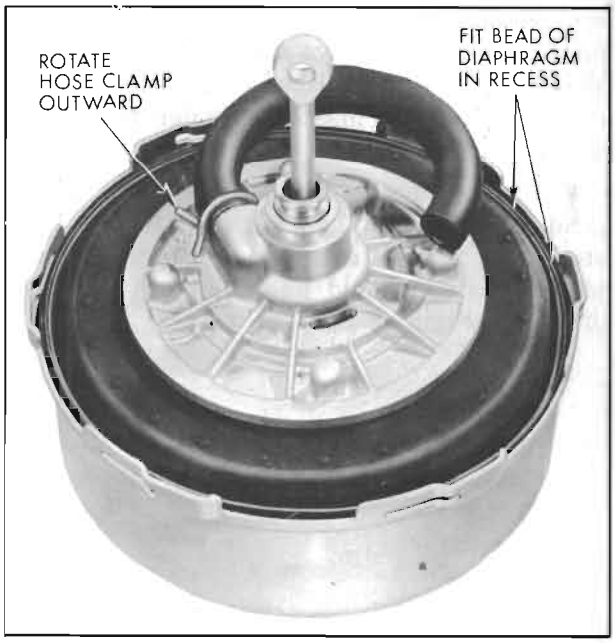


**Figure 9-23—Installing Power Piston Assembly in Front Housing**

22. In rear housing, install push rod boot in center hole. Install hose on tube in rear housing. Force push rod through boot in rear housing.

23. Rotate rear housing so that projecting tube is slightly counter-clockwise of the master cylinder filler cap. Then press housing down to engage locking lugs and rotate clockwise to the locked position. Tube must now be in line with filler cap.

CAUTION: *Extreme care must be taken to keep the diaphragm bead in the recess of the*

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*front housing or the bead will be pinched into the slots as the rear housing is rotated into the locked position.*

**d. Gauging Power Brake Piston**

The following gauging operation is necessary only when a major structural part such as the front or rear housing, the power piston assembly, the master cylinder piston, or the master cylinder assembly is replaced with a new part. The gauge measures how far the master cylinder piston projects from the front housing. This dimension must be correct to insure the proper clearance in the master cylinder between the primary cup and the compensating port.

Make check as follows:

1. Remove master cylinder assembly from front housing by removing four nuts and lockwashers; then pull master cylinder from front housing. Do not remove spacers from studs. Be sure no parts are displaced from bore of master cylinder. Remove master cylinder to housing seal.

2. Place Gauge J-8531 so that it stands perpendicular to front housing next to two lower studs, and bridges over end of master cylinder piston. Piston should be flush with gauge ± .010". See Figure 9-24.

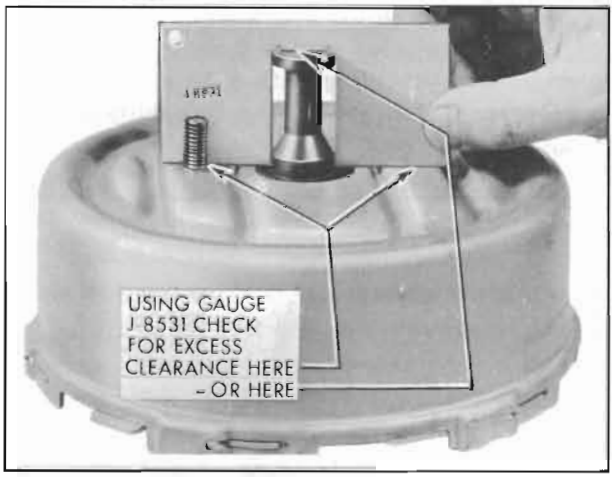


**Figure 9-24—Gauging Master Cylinder Piston**

3. If there is excess clearance under legs of gauge, add spacers (gasket material) over front housing studs as required to take up clearance; if there is excess clearance at center of gauge, remove spacers as required to lower gauge. When all spacers are removed, if piston end is still lower than gauge, check for deformed major structural parts and replace as required.

4. Install new master cylinder to housing seal in groove in master cylinder. Make sure primary cup is properly positioned in master cylinder bore. Insert master cylinder on studs and press into housing. Install four lockwashers and nuts. Torque nuts to 20 foot pounds.

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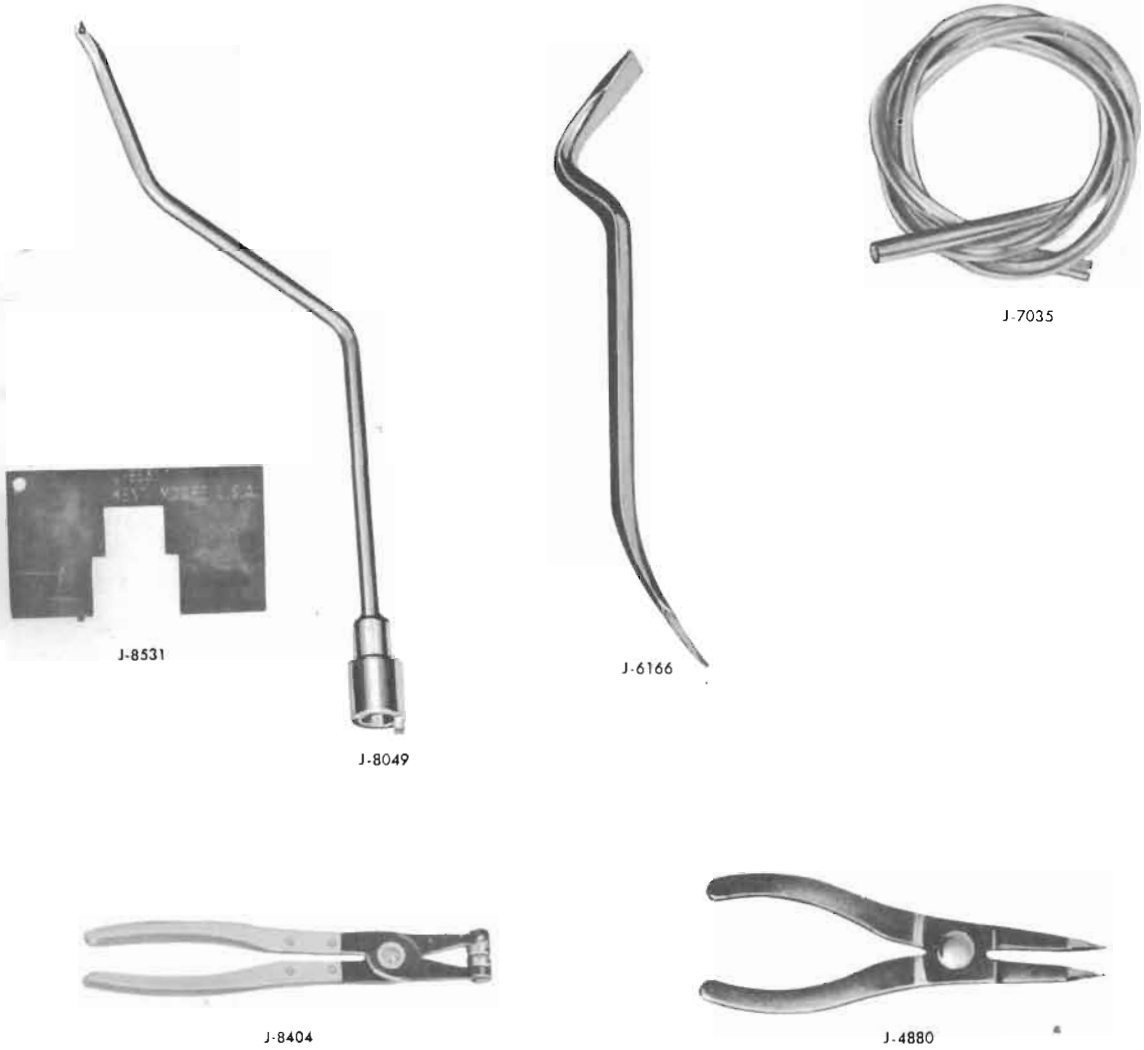


**BRAKE TOOLS**

| | | | |
|---|---|---|---|
| **J-4880** | Truarc Pliers | **J-8049** | Brake Spring Remover and Installer Wrench |
| **J-6166** | Brake Shoe Adjusting Wrench | **J-8404** | Hose Clamp Pliers |
| **J-7035** | Brake Bleeder Tube | **J-8531** | Power Brake Piston Shim Gauge |

**Figure 9-25—Brake Special Tools**

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Model 4739

Model 4829