GROUP 9-D

KELSEY-HAYES POWER BRAKES

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9-15 DESCRIPTION OF POWER BRAKE MECHANISM

a. General Description of Power Brake Unit

The Kelsey-Hayes power brake unit is a combined vacuum and hydraulic unit which utilizes engine intake manifold vacuum and atmospheric pressure to provide power assisted application of vehicle brakes. The power unit provides lighter pedal pressures. These lighter pressures are obtained in combination with a reduced pedal travel which makes it possible to bring the pedal down to the approximate height of the accelerator pedal when at closed throttle condition. Thus the driver, after closing the throttle, can shift his toe from one pedal to the other without lifting his heel from the floor.

The power brake unit, which is self-contained and eliminates external rods or levers, mounts on the engine side of the cowl. The unit is externally connected to the rest of the system at three points. It is connected by a pedal push rod to the brake pedal. It is connected by a vacuum line to the carburetor (through a vacuum check valve). Finally, a hydraulic connection is required. From the hydraulic master cylinder connection outward to the wheel units there is no other difference in the brake system from the conventional system.

The vacuum check valve, which is connected to the vacuum line at

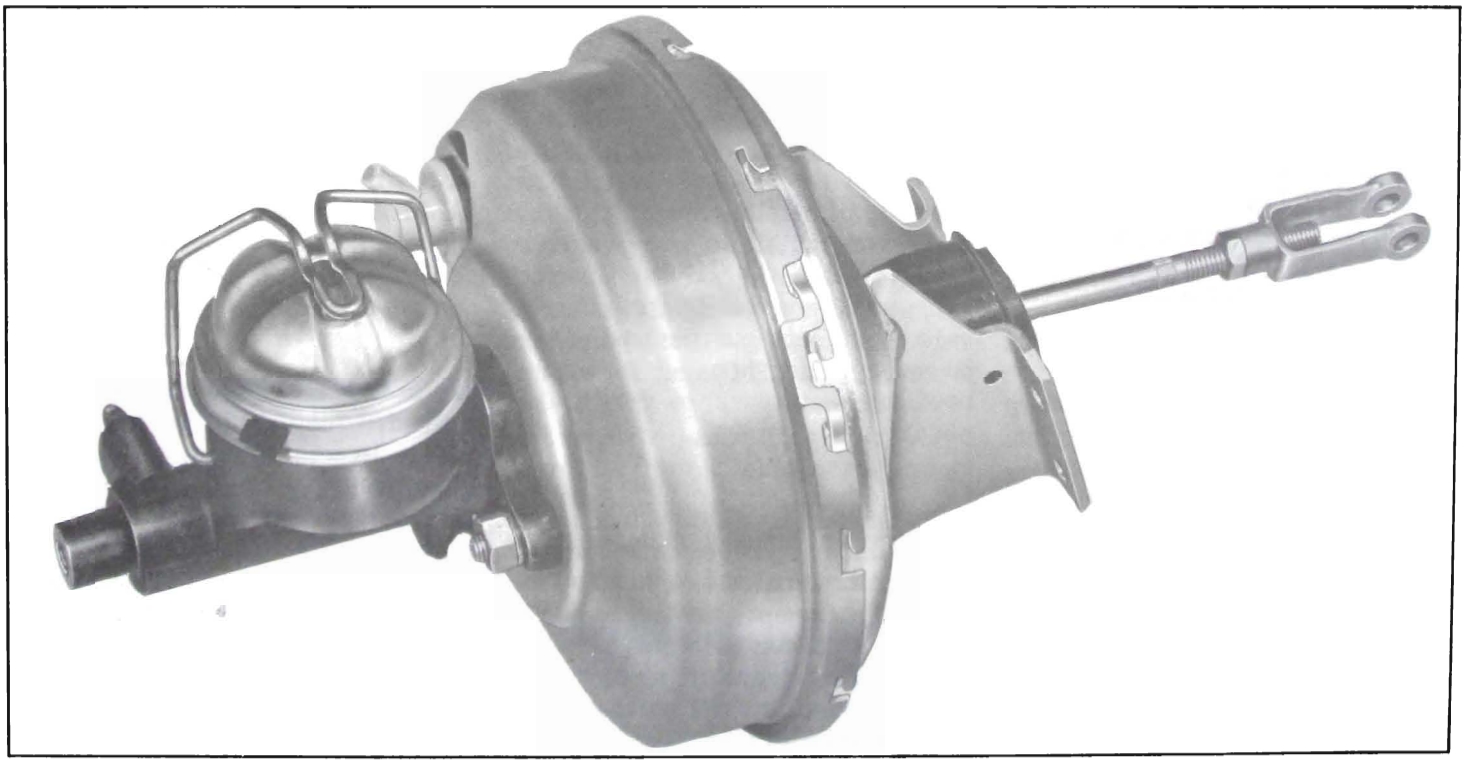

Figure 9-14—External View - Power Brake and Master Cylinder Assembly

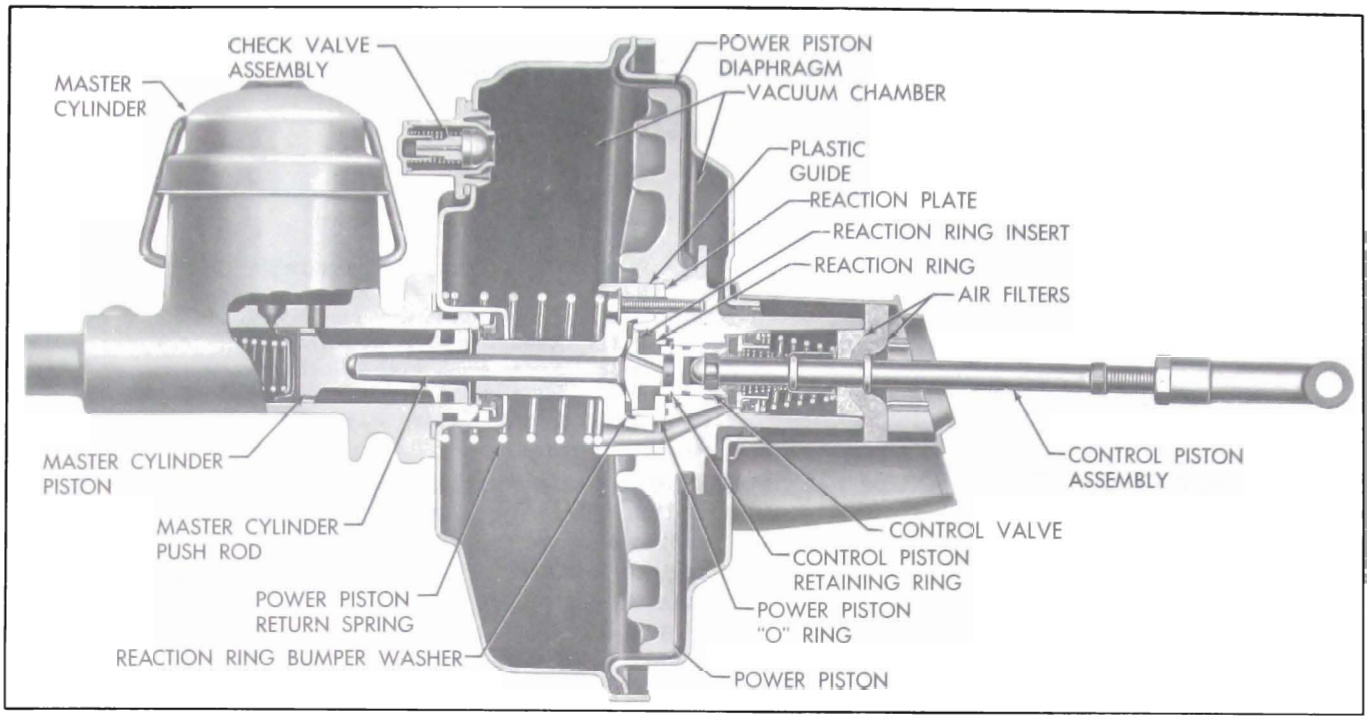

Figure 9-15—Power Brake and Master Cylinder

the front of the housing, prevents loss of vacuum when manifold vacuum falls below that in the power brake system. In case of engine failure and consequent loss of engine vacuum, several applications of the brakes are possible by using vacuum retained in the power unit. When vacuum reserve is exhausted, brakes can be applied manually in the same manner as manual brakes, except that more pedal pressure is required.

b. Construction of Power Brake Unit

The power unit is composed of two main sections, a vacuum power section and a hydraulic master cylinder. (A cross sectional view of the power brake is shown in Figure 9-15).

The vacuum power section contains the power piston assembly which houses the control valve and reaction mechanism, the return spring, and the master cylinder push rod which contacts the piston in the hydraulic master cylinder. The control valve is made up of a single poppet with an atmospheric port and a vacuum port. A power piston and return spring gives quick response, lighter pedal effort, and improved control.

The reaction mechanism consists of a soft rubber ring which distributes pressure between the power piston assembly and the control piston in proportion to their contact areas and provides brake "feel". A valve operating rod, which operates the control valve, projects out the end of the power cylinder housing through a boot and attaches to the brake pedal.

The master cylinder attaches to the vacuum power cylinder. A seal between these two units seals against atmospheric pressure leaks. A secondary seal around the master cylinder piston prevents hydraulic fluid in the master cylinder from entering the vacuum area in the power cylinder.

A fluid reservoir is cast integrally with the master cylinder. Inside the master cylinder are the conventional parts: a snap ring which retains a piston and secondary seal, a primary cup, check valve spring and retainer, and check valve. See Figure 9-15.

c. Operation of Power Brake Unit

(1) Released Position

With the engine running and the brake pedal released, vacuum from the intake manifold is admitted through the vacuum check valve to the front (left side of Figure 9-16) vacuum chamber. In the released position (no pressure applied to the brake pedal), the valve operating rod and control piston are held to the right in the valve housing by the valve return spring to CLOSE the atmospheric port and OPEN the vacuum port. With the valve in this position, the chamber to the rear of the diaphragm is also

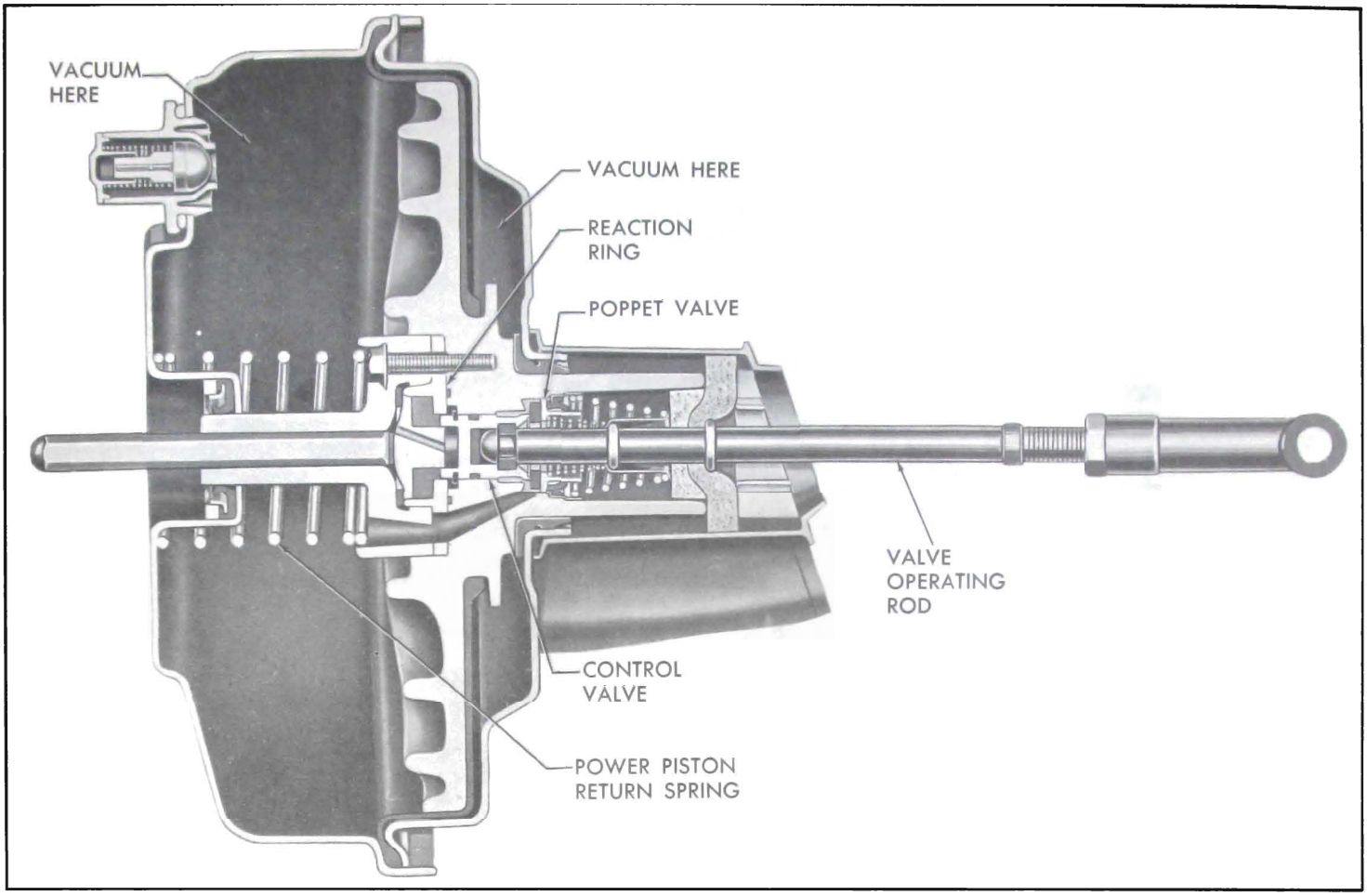

Figure 9-16—Power Brake - Released Position

open to vacuum through the porting in the valve housing. The vacuum power diaphragm is then balanced or suspended in vacuum since vacuum is present on both sides of the diaphragm and the power piston return spring is then free to return the power piston assembly with the hydraulic push rod to the fully released position.

With the hydraulic push rod in the released position, the hydraulic compensating port in the hydraulic master cylinder is open to permit brake fluid to either return from the brake system to the fluid reservoir or enter the brake system from the fluid reservoir to compensate the expansion of/or loss of fluid from the brake system.

(2) Applying Position

As the brakes are applied by the driver the valve operating rod and control piston move forward (to the left in Figure 9-17) in the power piston assembly to compress the valve return spring and bring the poppet valve into contact with the vacuum valve seat in the valve housing to CLOSE the vacuum port. Any additional movement of the valve operating rod in the applied direction moves the control valve away from the poppet valve to OPEN the atmospheric port and admit atmosphere through the air filter and passages to the chamber at the right of the vacuum power piston assembly. With vacuum on the left side of the diaphragm and atmospheric pressure on the right side of the diaphragm, a force is developed to move the vacuum power piston assembly, hydraulic push rod, and hydraulic piston to the left to close the compensating port and force hydraulic fluid under pressure through the residual check valve and brake tubes into the brake wheel cylinders. As hydraulic pressure is developed in the hydraulic cylinder, a counter force (to the right) acting through the hydraulic push rod sets up a reaction force against the vacuum power piston and control piston through the rubber reaction ring at the end of the hydraulic push rod. The rubber ring reacts similarly to a column of fluid to distribute the pressure between the vacuum power piston assembly and the control piston in proportion to their respective contact areas.

The pressures acting against the control piston and valve operating rod tend to move the control piston slightly to the right in relation to the valve housing assembly to close off the atmospheric port. Since part of the counter force

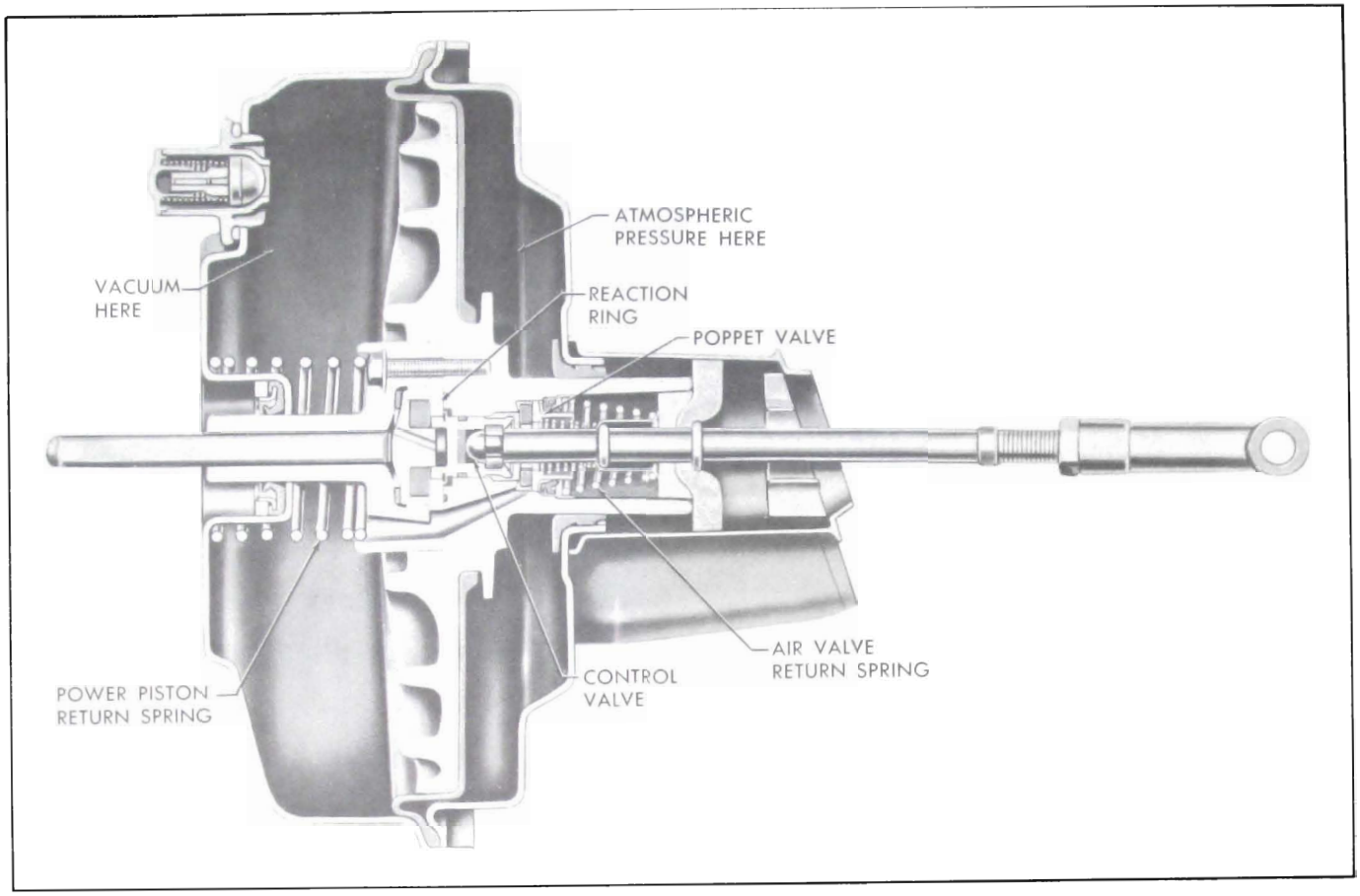

Figure 9-17—Power Brake - Applying Position

(to the right) reacts through the control piston and valve operating rod against the driver's foot, a "feel" of the braking effort is provided. The amount of reaction transmitted to the control piston is designed into the power brake unit to assure maximum power consistent with the assurance that the driver always maintains a "feel" of the amount of brake that is being applied. This reaction force is in direct proportion to the hydraulic pressure developed within the brake system.

(3) Holding Position

During application of the brakes, the "reaction" against the control piston is working against the driver to close the atmospheric port. With both atmospheric and vacuum ports closed, the power brake is said to be in the holding position. When both valves are closed, any degree of braking application attained will be held until either the atmospheric port is reopened by an increase in pedal pressure to further increase the brake application, or by a decrease in pedal pressure to reopen the vacuum port to decrease the brake application. Whenever the pressure applied to the brake pedal is held constant for a moment, the valve returns to its holding position. However, upon reaching the fully applied position, the control piston is held away from the valve poppet atmospheric valve seat to admit maximum atmospheric pressure to the chamber to the right of the diaphragm. With the chamber to the left of the power piston open to manifold vacuum, full power application is attained. Any increase in hydraulic pressure beyond this point must be supplied by physical effort of the driver.

As the power piston and hydraulic master cylinder piston move back, the fluid from the wheel cylinders flows back into the hydraulic master cylinder (by unseating the residual pressure check valve) and into the reservoir.

The fluid reservoir, cast integrally with the master cylinder, supplies fluid to the space between a primary and secondary seal through a by-pass hole in the casting. When the brake pedal is released quickly, fluid pressure, check valve spring, and the power piston return spring force the master cylinder piston to return immediately (to the released position). If hydraulic fluid from the lines cannot return as quickly as the master cylinder piston,

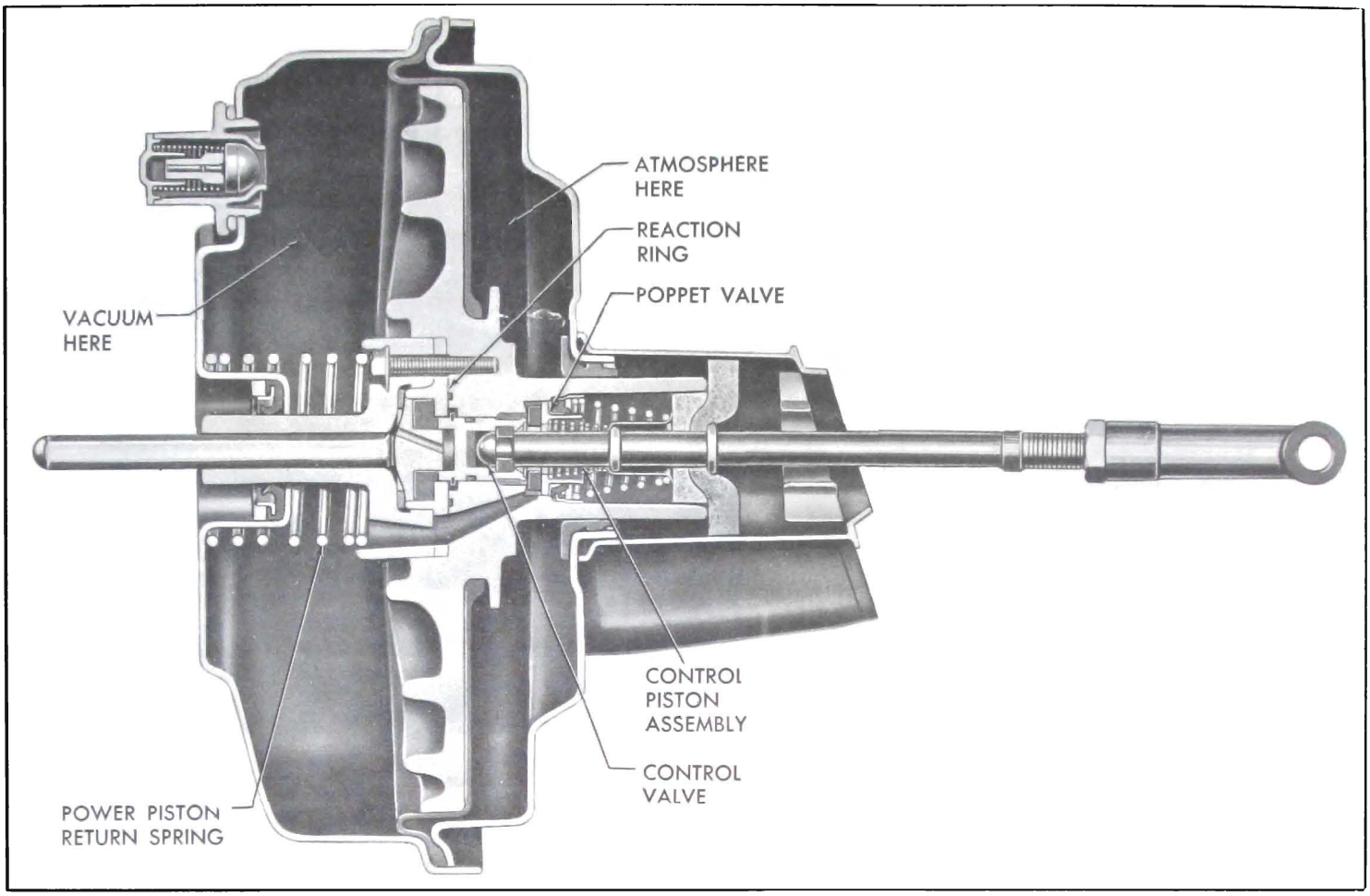

Figure 9-18—Power Brake - Holding Position

compensation is provided by a flow of fluid from the space between the primary cup and secondary seals through the holes in the master cylinder piston. The excess fluid in the brake system can flow back through the compensating port. See Figure 9-18.

9-16 TROUBLE DIAGNOSIS

The same types of brake trouble may be encountered with power brakes as with standard brakes. Before checking power brake system for source of trouble, refer to trouble diagnosis of standard brakes. After these possible causes have been eliminated, check for cause as outlined below.

HARD PEDAL

a. Vacuum failure due to:

1. Faulty vacuum check valve.

2. Vacuum hose or pipe collapsed, plugged, kinked, or disconnected.

3. Internal leaks in power brake unit.

b. Power brake unit trouble

1. Vacuum

(a) Vacuum leaks in unit caused by improper assembly, missing parts, damaged parts and foreign material.

2. Hydraulic

(a) Cups swollen by improper fluid

(b) Compensating port not cleared by primary cup

3. Mechanical

(a) Badly dented vacuum cylinder

(b) Bound up pedal linkage

(c) Improperly adjusted stop light switch

(d) Scored valve plunger

(e) Broken or missing springs

GRABBY BRAKES (APPARENT OFF-AND-ON CONDITION)

a. Faulty pedal linkage.

b. Dented vacuum cylinder.

c. Sticking control piston.

d. Defective vacuum check valve.

e. Loose vacuum connections.

9-17 POWER BRAKE CHECKS AND ADJUSTMENTS ON CAR

1. Check for free operation of brake pedal. If binding exists, check all pivot points for binding

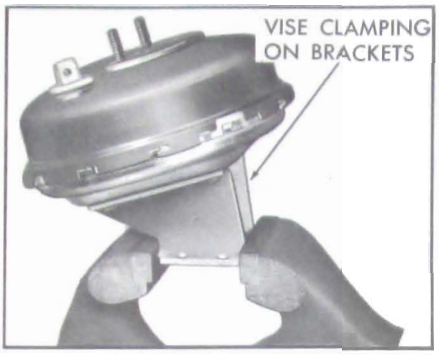

Figure 9-19—Power Brake Unit Positioned in Vise

and lubricate as required. For pedal height adjustment, see paragraph 9-8, subparagraph b.

2. Check stop light switch for proper setting and operation.

3. Check fluid level in hydraulic cylinder reservoir.

4. Check vacuum line and connections at carburetor and vacuum check valve for possible vacuum leaks.

5. Check engine for good stall-free idle and correct as required.

9-18 REMOVAL OF POWER BRAKE AND MASTER CYLINDER ASSEMBLY

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

2. Remove retainer and special washer from brake pedal pin and disengage push rod clevis.

3. Remove four nuts holding power brake unit to dash.

4. Disconnect vacuum hose from power brake unit.

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

6. Remove the nuts and lock washers from vacuum housing studs and remove the master cylinder.

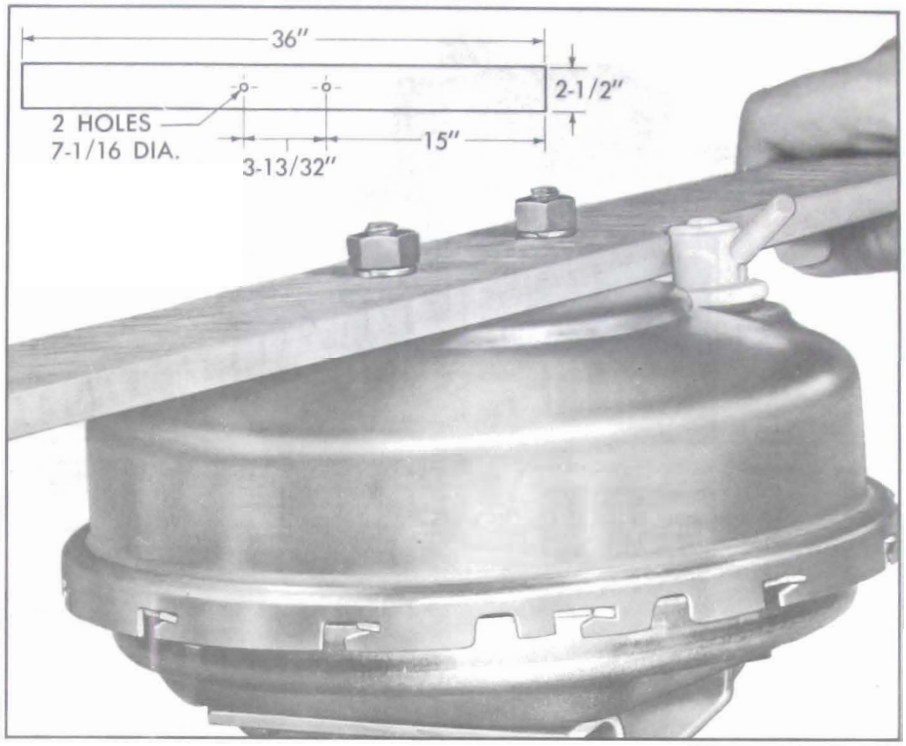

Figure 9-20—Removing Housing with Wooden Lever

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

NOTE: All parts of the master cylinder except the body casting and piston are identical to those used in the standard master cylinder. The master cylinder should be serviced the same as the standard master cylinder. See paragraph 9-14.

9-19 DISASSEMBLY OF POWER BRAKE UNIT

a. Disassembly of Overall Power Brake Unit

1. Remove the master cylinder push rod.

2. Remove push rod clevis and clevis lock nut.

3. Remove plastic air inlet seal by squeezing its sides together until the projections clear the matching holes in the mounting bracket.

4. Mount power brake unit in vise, clamping mounting brackets as shown in Figure 9-19.

5. Scribe a line across the front housing and rear cover to facilitate reassembly.

6. Pry out housing lock, noting its location on one of the two long tangs on the housing cover. Do not bend the lock on removal as it must be reinstalled.

7. Position special wooden lever against mounting studs, secure it with the nuts and rotate housing counterclockwise to unlock from housing cover.

NOTE: Wooden lever for removing housing may be made using dimensions given in Figure 9-20.

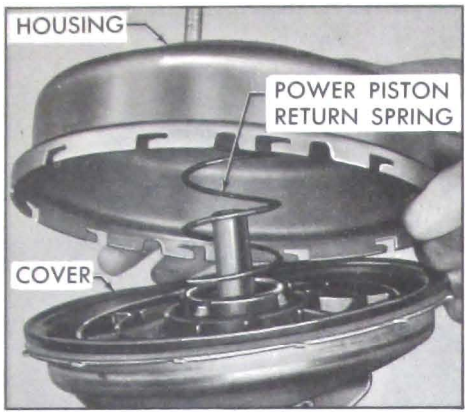

Figure 9-21—Removing Power Piston Return Spring

CAUTION: Rotate lever slowly as housing is under spring load.

8. Remove power piston return spring. See Figure 9-21.

9. Remove power piston assembly by lifting straight up slowly and lay it aside on a clean smooth surface. See Figure 9-22.

10. If check valve needs replacing, push it and its "O" ring out front of housing.

11. Remove housing air cleaner and guide seal and its retainer from center hole of housing. See Figure 9-23.

12. Remove seal in center hole of housing cover by using Puller

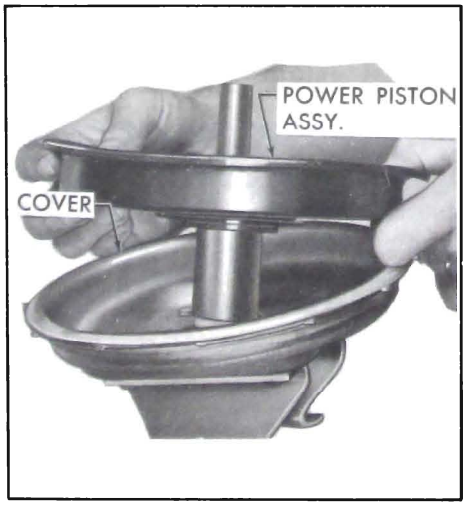

Figure 9-22—Removing Power Piston

Figure 9-23—Removing Housing Air Cleaner and Guide Seal

J-5822 with Adapter J-2919-4 and slide hammer. Avoid scratching bore of cover as this may cause a vacuum leak. See Figure 9-24.

13. Remove housing cover and bracket assembly from vise.

b. Disassembly of Power Piston Assembly

CAUTION: Exercise extreme care in handling of power piston diaphragm and metal parts in this assembly. The diaphragm should be guarded against grease, oil, and foreign matter and must be protected from nicks or cuts that might be caused by rough surfaces, damaged tools, or dropping the piston.

1. Remove the power piston diaphragm from the power piston and lay it aside on a clean smooth surface.

2. Loosen and remove the three screws which attach the plastic guide to the plastic power piston. See Figure 9-26.

3. From the guide, remove the rubber reaction insert bumper.

4. From the power piston assembly, remove the reaction insert, rubber reaction ring and the reaction plate. NOTE: If the reaction plate sticks in the power piston, it may be removed by

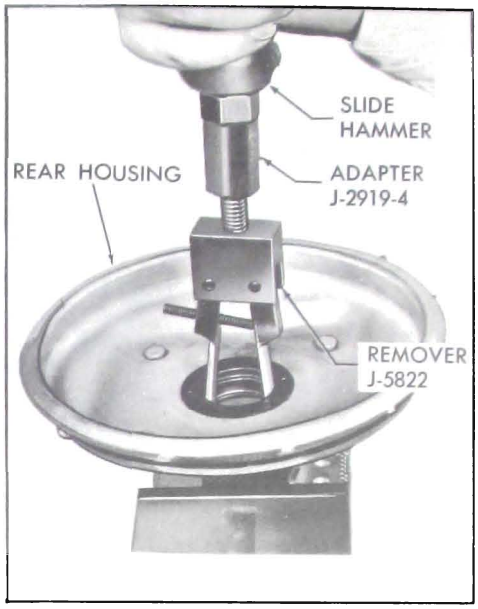

Figure 9-24—Remove Cover Seal

pushing on the operating rod. When doing so, care should be taken to avoid pushing too far as this could cause damage to the floating valve assembly.

5. Remove the reaction plate "O" ring from the power piston.

6. Depress the operating rod slightly and remove the retaining ring from the control piston. See Figure 9-28.

7. Remove the control piston assembly by pulling the operating rod straight out of the power piston.

8. Remove the "O" ring seal from the control piston.

9. Remove the filter elements from the push rod.

9-20 INSPECTION AND CLEANING OF DISASSEMBLED POWER BRAKE UNIT

Thoroughly wash all metal parts in alcohol and air dry. The power diaphragm, plastic power piston,

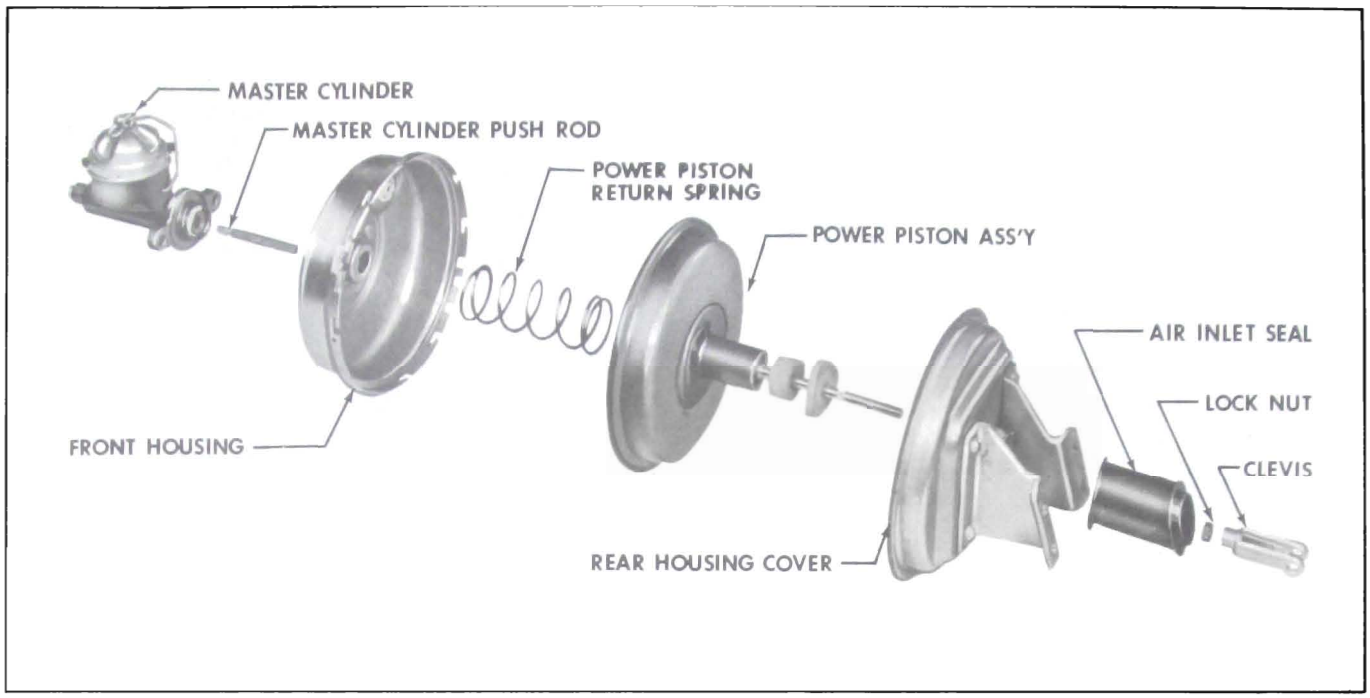

Figure 9-25—Exploded View of Power Brake Unit

and guide should be washed with mild soap and water. Blow dust and cleaning fluid out of all internal passages. All other rubber parts should be replaced regardless of condition with those supplied in the repair kit. Also replace all air filters.

Inspect all parts for scoring, pitting, dents, or nicks. Small imperfections can be smoothed out with fine emery cloth or parts replaced if badly nicked, scored, or otherwise damaged.

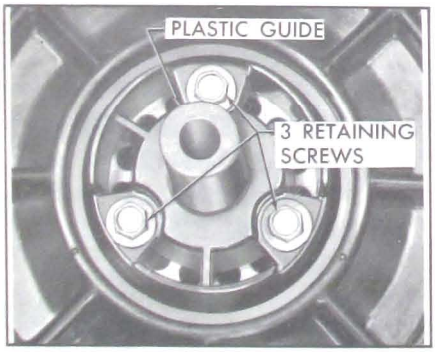

Figure 9-26—Location of Guide Screws

9-21 ASSEMBLY OF POWER BRAKE UNIT

a. Assembly of Power Piston Assembly

1. Install the control piston "O" ring on the control piston and lubricate with silicone grease.

2. Lubricate the control piston with silicone grease, insert the assembly into the power piston and install the retaining ring in its groove. Wipe all lubricant off the end of the control piston (see Figure 9-28). Check the location of the floating valve seal to be sure that it is seated against the shoulder of the power piston.

3. Install the air filter elements on the push rod and slide them past the retaining shoulder on the rod.

4. Insert the reaction plate into the power piston, aligning three of the holes with the threaded holes in the power piston.

5. Place the rubber reaction ring in the reaction plate. (Do not lubricate the rubber reaction ring.)

6. Lubricate the outer diameter of the reaction insert with silicone grease and assemble it into the reaction ring.

7. Install the reaction insert bumper into the guide. NOTE: Several small spots of silicone grease will hold the bumper in position while the guide is being installed into the power piston.

8. Place the guide into the power piston, align the holes with the aligning points on the power piston (Figure 9-29), position the three screws, and torque to 80-100 inch pounds.

9. Assemble the power diaphragm on the power piston, making sure that the diaphragm is seated in groove in power piston.

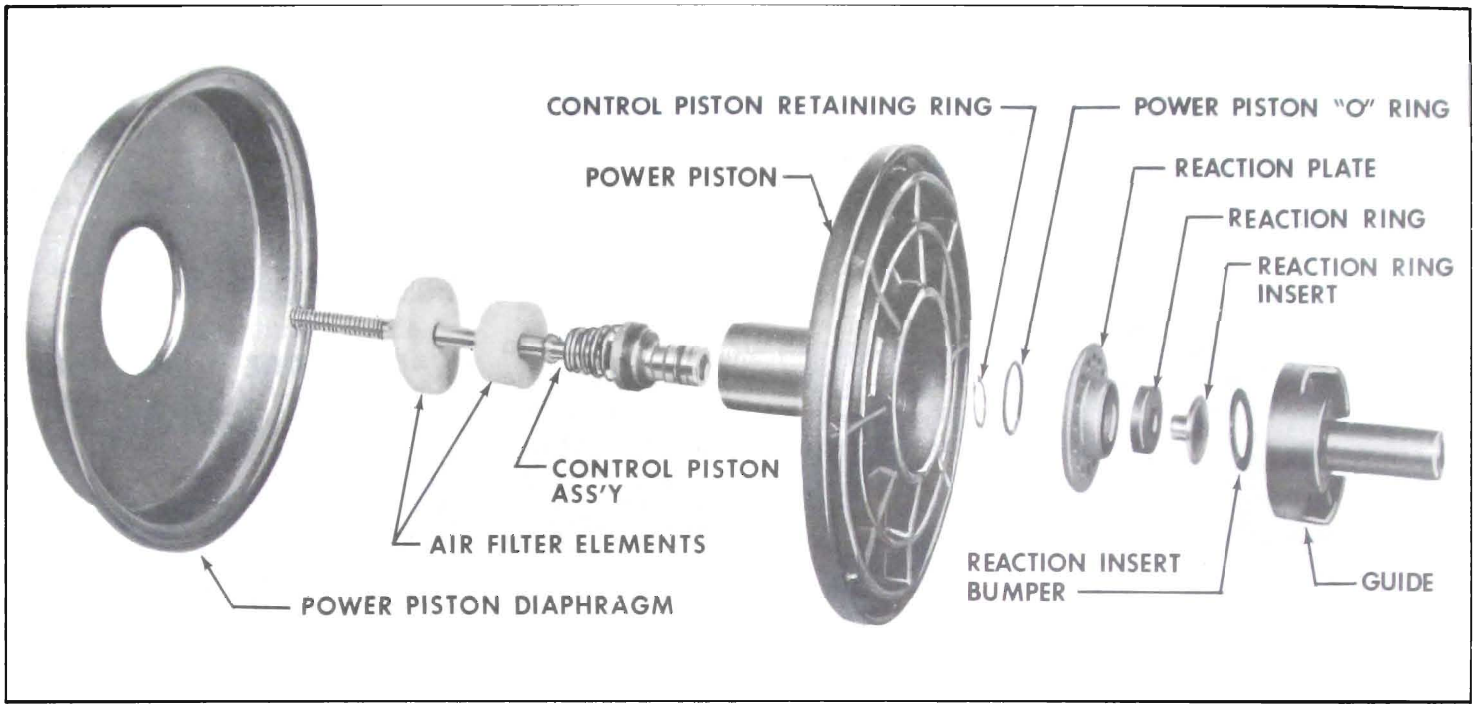

Figure 9-27—Exploded View of Power Piston Assembly

b. Assembly of Overall Power Brake Unit

1. Lubricate the cover seal with silicone grease and install it in the housing cover by pressing it down using a flat plate as shown in Figure 9-30.

2. Install a new housing seal on the housing seal retainer, lubricate the seal thoroughly both inside and outside and install it in the housing bore. Install a new air filter in the housing bore (Figure 9-31).

3. If check valve assembly was removed, install a new check valve and "O" ring into hole in the housing.

4. Clamp housing cover and bracket assembly in the vise.

5. Apply silicone grease to both sides of the bead (outer edge) of the power piston diaphragm.

6. Insert power piston assembly into cover with the operating rod down.

7. Locate the return spring within the flange of the guide.

8. Place the housing over the return spring and press down on the housing, guiding the guide into the housing seal. Be sure that the scribe lines put on the housing and housing cover at disassembly will align when the parts are locked together.

9. Using the special tool that was used for disassembly, rotate the

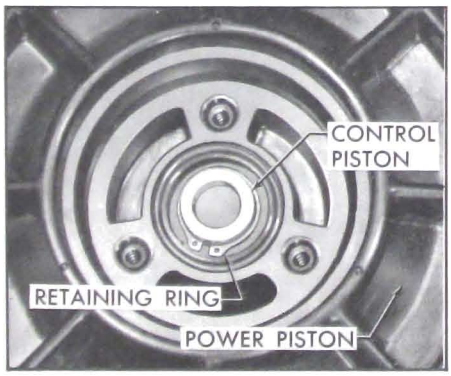

Figure 9-28—Retaining Ring Location

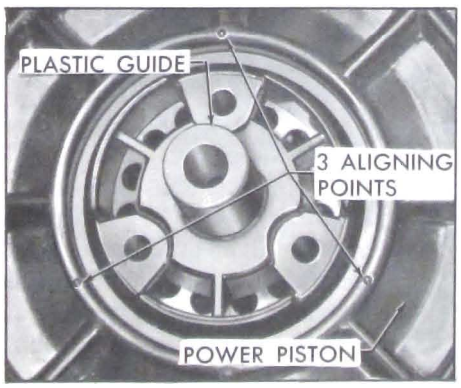

Figure 9-29—Aligning Points - Power Piston to Guide

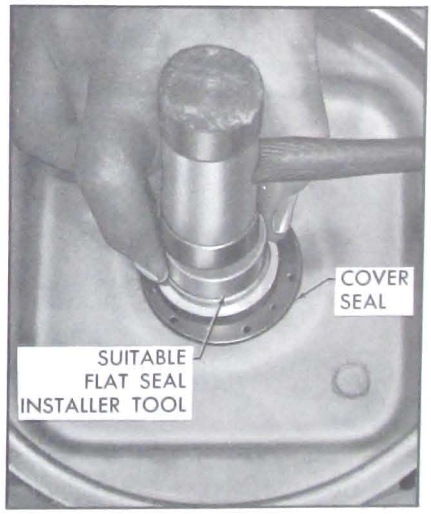

Figure 9-30—Installing Cover Seal

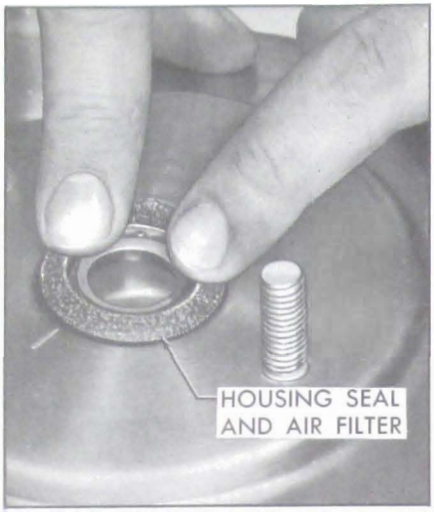

Figure 9-31—Installing Housing Seal and Air Filter

housing to lock it to the cover. CAUTION: Be sure the diaphragm is not pinched during assembly.

10. Install the housing lock on the long tang of the cover (Figure 9-32). NOTE: This lock will not be satisfactory if installed incorrectly. If installed on one of the short tangs, the unit could become unlocked with use.

11. Remove the assembled unit from the vise.

12. Push the air inlet seal down between the brackets until the projections on the sides snap into the holes in the mounting brackets. NOTE: The face of the air inlet seal should be parallel to the mounting face of the brackets.

13. Reinstall the clevis lock nut and clevis and set the pedal height as shown in Figure 9-33. Tighten the lock nut to a 5-10 foot pound torque.

14. Insert the master cylinder push rod assembly into the guide.

NOTE: Before reassembling master cylinder to power section, the distance from the outer end of the push rod to the master cylinder must be measured as explained under Push Rod Adjustment below.

9-22 PEDAL PUSH ROD ADJUSTMENT

The push rod supplied with the unit was selected at the time of original assembly to provide the correct relationship between the vacuum power piston and the master cylinder piston. Under normal service conditions, it does not require any further attention providing the push rod remains in the original unit.

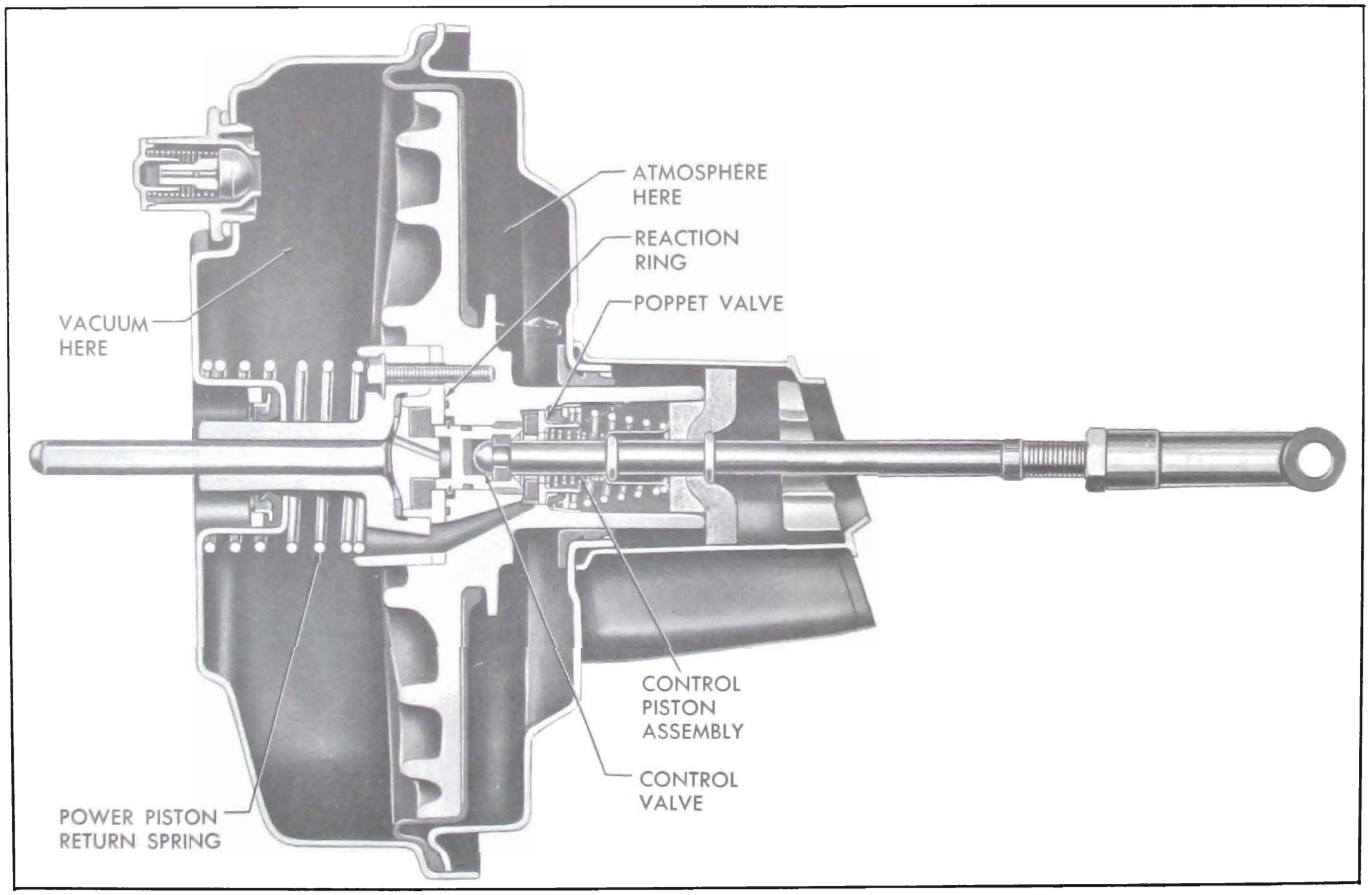

Figure 9-32—Housing Lock in Position

If the unit is rebuilt or the push rod is transferred to a unit other than the original one, the distance from the end of the push rod to the mounting face of the housing should be rechecked either with a micrometer depth gauge to a dimension of 1.220 to 1.228 or with height gauge J-21183. This is to be done with vacuum applied to the unit. If this dimension is too long, the rod should be shortened by grinding off the flat end until the correct dimension is obtained (Figure 9-34). Extreme care must be taken to maintain the ground face flat and square with the rod center line. If the dimension is too short, the rod must be replaced with one of the correct length. NOTE: All new rods provided for service will be long and must be ground to the correct length.

When the push rod dimension is correct, assemble master cylinder assembly to the vacuum cylinder at two studs. Secure with two nuts and lock washers tightening to 15-20 lb. ft. torque.

After assembly of the master cylinder to the power unit, the piston cup of the hydraulic cylinder must clear the compensating hole when the unit is in the released position. This can be checked by partially filling the reservoir and then stroking the power unit. If air bubbles appear or fluid spurts, the compensating port is clear. If the primary cup overlaps the compensating port, there will be no flow of air or fluid through the compensating port when stroked. If this condition exists, the push rod should be shortened a slight amount, or until the compensating port is open. Failure to clear the compensating port in the released position traps fluid in the hydraulic lines and wheel cylinders and causes brake drag when the fluid warms up. It also prevents complete bleeding.

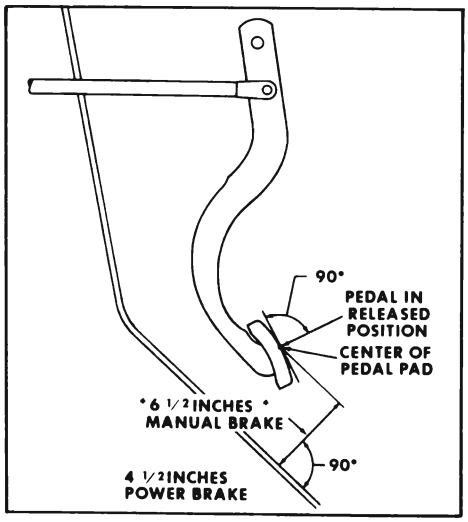

Figure 9-33—Measuring Brake Pedal Height

9-23 INSTALLATION OF POWER BRAKE UNIT

1. Place power brake into position and install four nuts. Tighten nuts to 20-28 lb. ft. torque.

2. Attach clevis to the brake pedal assembly with the clevis pin and its retainer.

3. Adjust stop light switch if necessary. See paragraph 9-8, subparagraph b. Attach wire.

4. Attach vacuum line.

5. Attach hydraulic line.

6. Bleed brakes as necessary and fill fluid reservoir.

9-24 SYSTEM TESTS

1. Vacuum Leak in Released Position

With transmission in Neutral or Park, and brake released, stop engine and wait one minute. Apply brake several times. Each application should provide less and less pedal travel following normal depletion of reserve vacuum. Number of applications on reverse vacuum will depend on how hard pedal is pressed and how far pedal moves. If vacuum assist is not present, an air leak is indicated.

2. Unit Operation

After depleting reserve vacuum, put light pressure on pedal and start engine. If power system is functioning properly, pedal will fall away slightly.

3. Vacuum Leak in Holding Position

With transmission in Neutral or Park, stop engine while holding a moderately heavy load steadily on pedal. After one minute, release and apply pedal several times. If there is no vacuum assist during this test but system was normal during test No. 1 above, there is an air leak within the unit. NOTE: Some units on this test will leak air internally if pedal load is light. This is a normal condition.

4. Hydraulic Leak

a. Depress brake pedal while engine is running, maintaining constant pressure. If pedal falls noticeably in one minute, the hydraulic system is leaking.

b. If pedal has a spongy feel when applying the brakes, air may be present in the hydraulic system.

Road test brakes by making a brake application at about 40 MPH to determine if vehicle stops evenly and quickly.

If system checks are satisfactory and the brake pedal travels to within 1" of the floor board, brake shoes require adjustment or replacement.

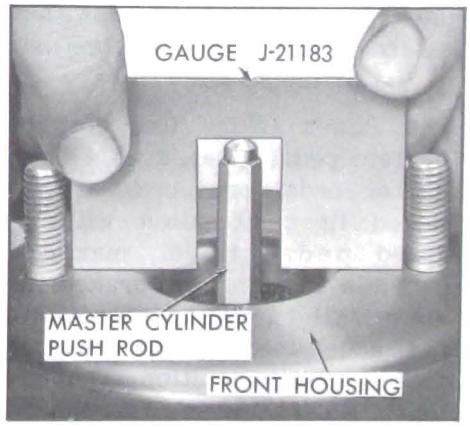

Figure 9-34—Measuring Push Rod Height