

# SECTION E

## 45-46-48-49000 BENDIX POWER BRAKES

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### DIVISION I SPECIFICATIONS AND ADJUSTMENTS

#### 50-15 BRAKE SPECIFICATIONS

Specifications for the Bendix hydraulic master cylinder and the power brake unit are the same as listed for the Delco-Moraine units, see Section A for hydraulic master cylinder or Section D for power brake unit.

### DIVISION II DESCRIPTION AND OPERATION

#### 50-16 DESCRIPTION OF POWER BRAKE MECHANISM

##### a. General Description of Power Brake Unit

The Bendix 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 unit takes the place of the master cylinder in a conventional brake system. From the master cylinder connection outward to the wheel units, there is no other change in the brake system. In addition to the master cylinder connections, the unit requires a vacuum connection to the engine intake manifold (through a vacuum check valve) and a mechanical connection to the brake pedal. As shown in Figure 50-71 or 72, the unit is self-contained with no external rods or levers exposed to dirt or moisture.

The power brake unit provides lighter pedal pressures. These lighter pedal pressures are obtained in combination with reduced pedal travel making it possible to bring the brake pedal down to the approximate height of the accelerator pedal when at closed throttle position. 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 vacuum check valve mounted on the power brake front shell permits several applications of the power brake unit with vacuum-assist after the engine has stopped or after any other loss of vacuum. When the vacuum stored in the unit has been lost or in case of vacuum failure at the unit or its vacuum connections, the brakes can be applied

**NOTE:** See Section A for hydraulic master cylinder.

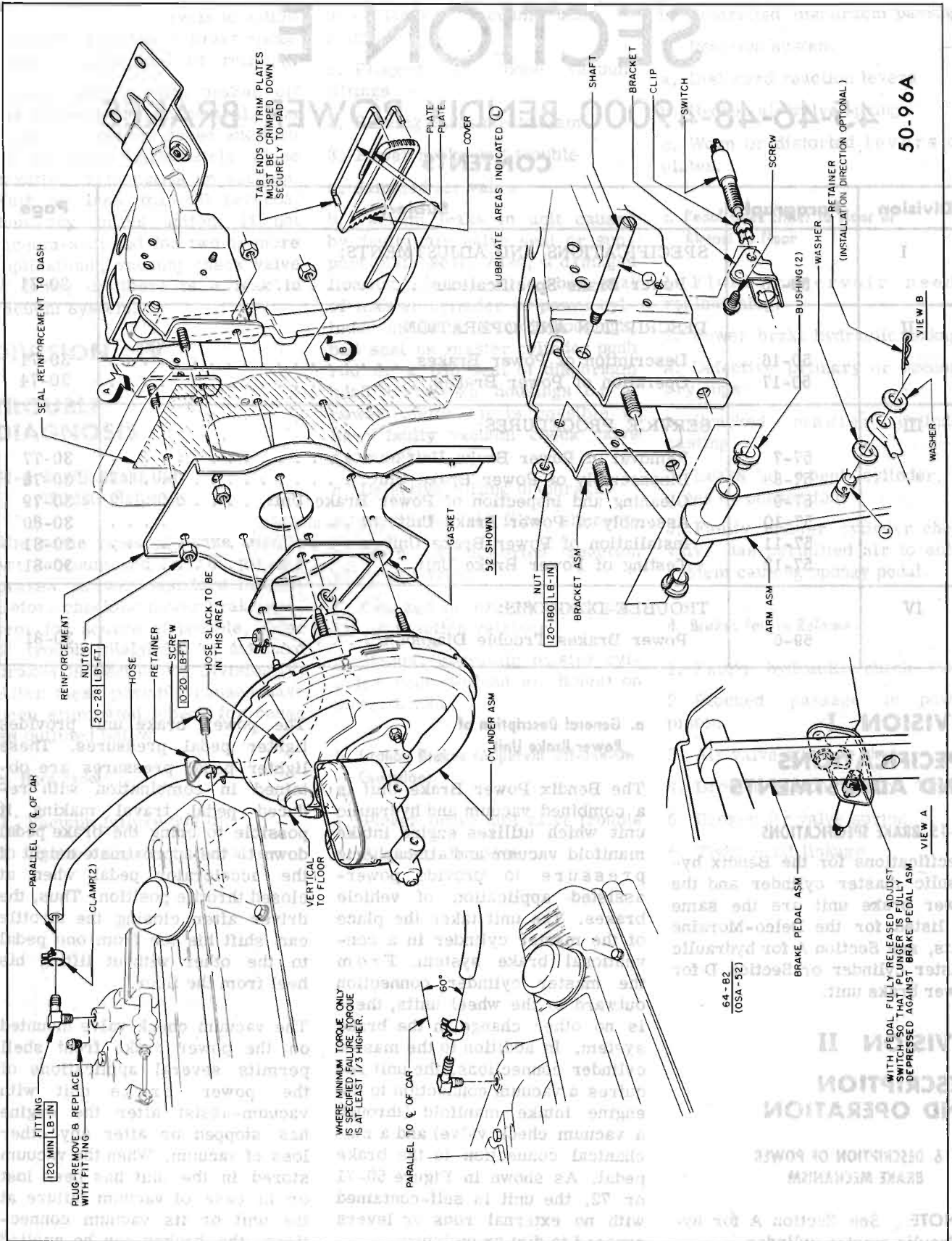


Figure 50-71 45-46-48-49000 Power Brake Mounting

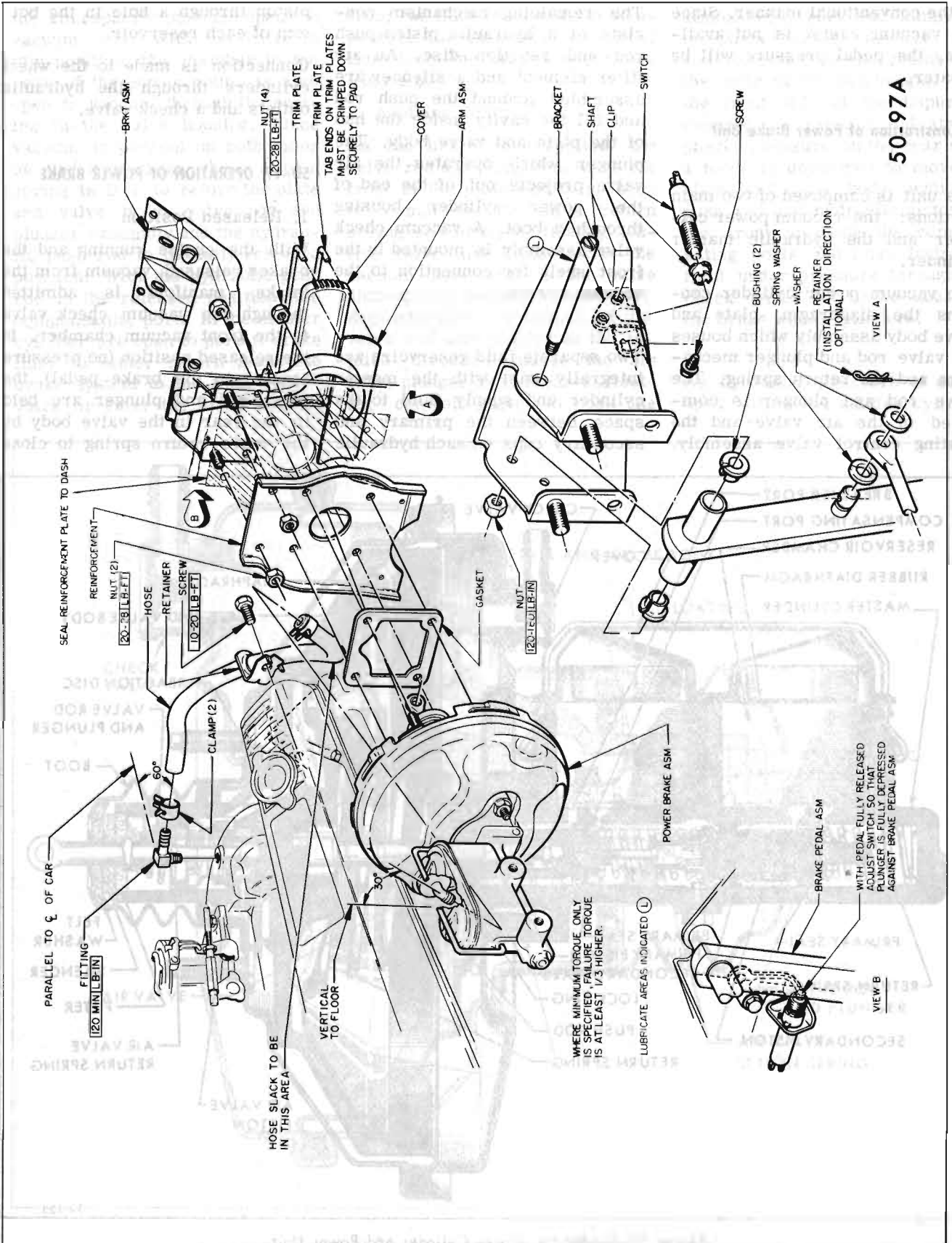


Figure 50-72 49000 Power Brake Mounting

in the conventional manner. Since the vacuum assist is not available, the pedal pressure will be greater.

#### b. Construction of Power Brake Unit

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

The vacuum power cylinder contains the diaphragm, plate and valve body assembly which houses the valve rod and plunger mechanism and the return spring. The valve rod and plunger is composed of the air valve and the floating control valve assembly.

The remaining mechanism consists of a hydraulic piston push rod and reaction disc. An air filter element and a silencer are assembled around the push rod and fill the cavity inside the hub of the plate and valve body. The plunger which operates the air valve projects out of the end of the power cylinder housing through a boot. A vacuum check valve assembly is mounted in the front shell for connection to the vacuum source.

Two separate fluid reservoirs are integrally cast with the master cylinder and supply fluid to the space between the primary and secondary cups on each hydraulic

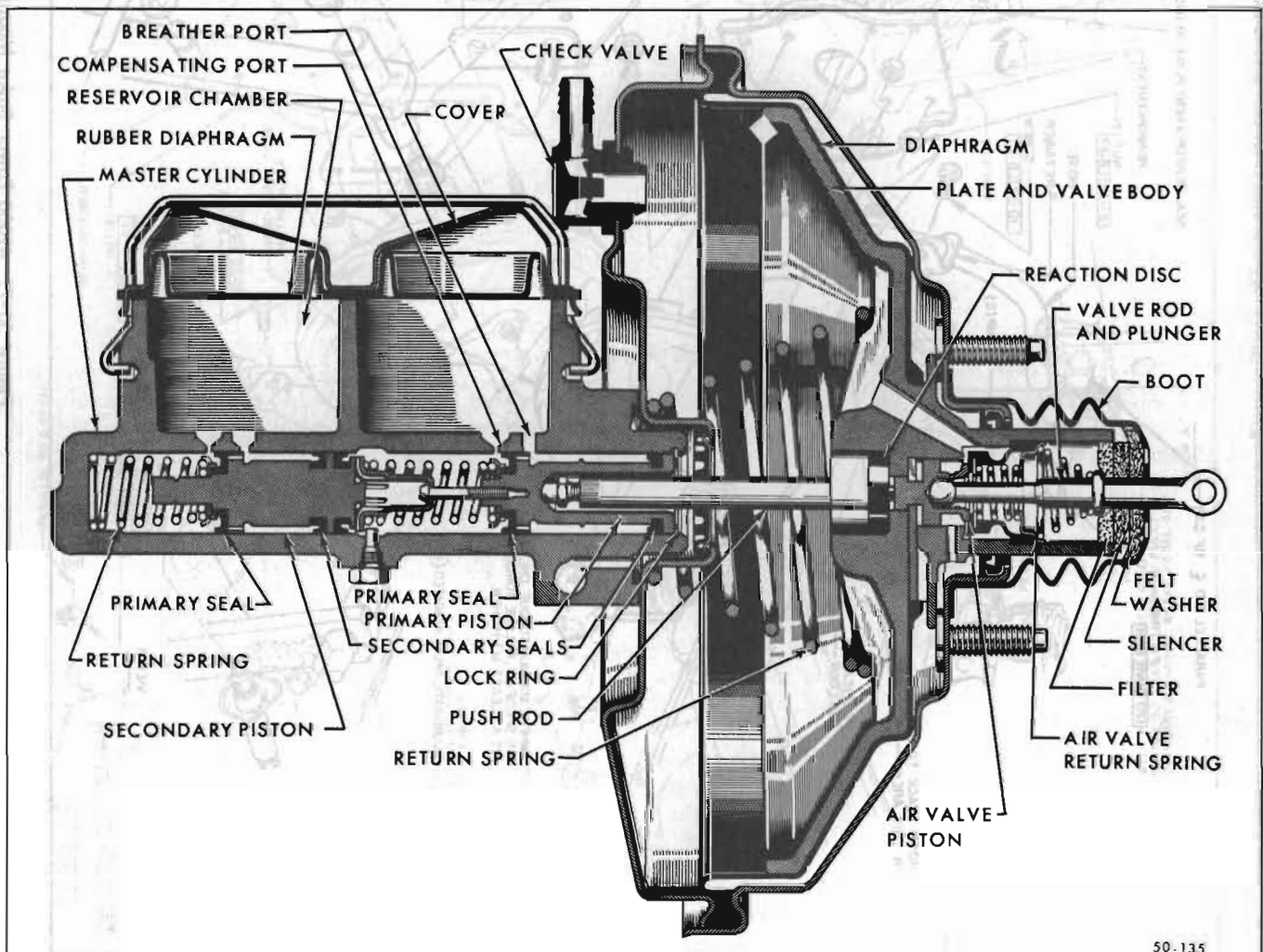
piston through a hole in the bottom of each reservoir.

Connection is made to the wheel cylinders through the hydraulic outlets and a check valve.

#### 50-17 OPERATION OF POWER BRAKE

##### 1. Released Position

With the engine running and the brakes released, vacuum from the intake manifold is admitted through the vacuum check valve to the front vacuum chamber. In the released position (no pressure applied to the brake pedal), the valve rod and plunger are held to the rear in the valve body by the valve return spring to close



50-135

Figure 50-73—Bendix Master Cylinder and Power Unit

the atmospheric port and open the vacuum port. With the valve in this position, the chamber to the rear of the power piston is also open to vacuum through the porting in the valve housing. Since vacuum is present on both sides of the diaphragm, the return spring is free to return the plate and valve body, valve rod and plunger assembly and the hydraulic push rod to the fully released position. With the hydraulic push rod in the released position, the compensating ports in the master cylinder are open to permit brake fluid to either return from the brake system to the fluid reservoirs or enter the brake system

from the fluid reservoirs to compensate for expansion or loss of fluid from the brake system. See Figure 50-74.

2. Applying Position

As the brakes are applied, the valve rod and plunger move to the front in the plate and valve body to compress the valve return spring and bring the floating control valve into contact with the vacuum port seat in the valve housing to close the vacuum port. Any additional movement of the valve rod and plunger in the applied direction moves the air valve plunger away from the floating control valve to open the

atmospheric port and admit atmosphere through the air filter and passages to the chamber at the rear of the diaphragm. With the front side of the diaphragm exposed to vacuum and atmospheric pressure on the rear side, a force is developed to move the plate and valve body, hydraulic push rod and hydraulic pistons to the front to close the compensating ports and force hydraulic fluid under pressure through the check valves and brake tubes into the brake wheel cylinders.

As hydraulic pressure is developed within the master cylinder,

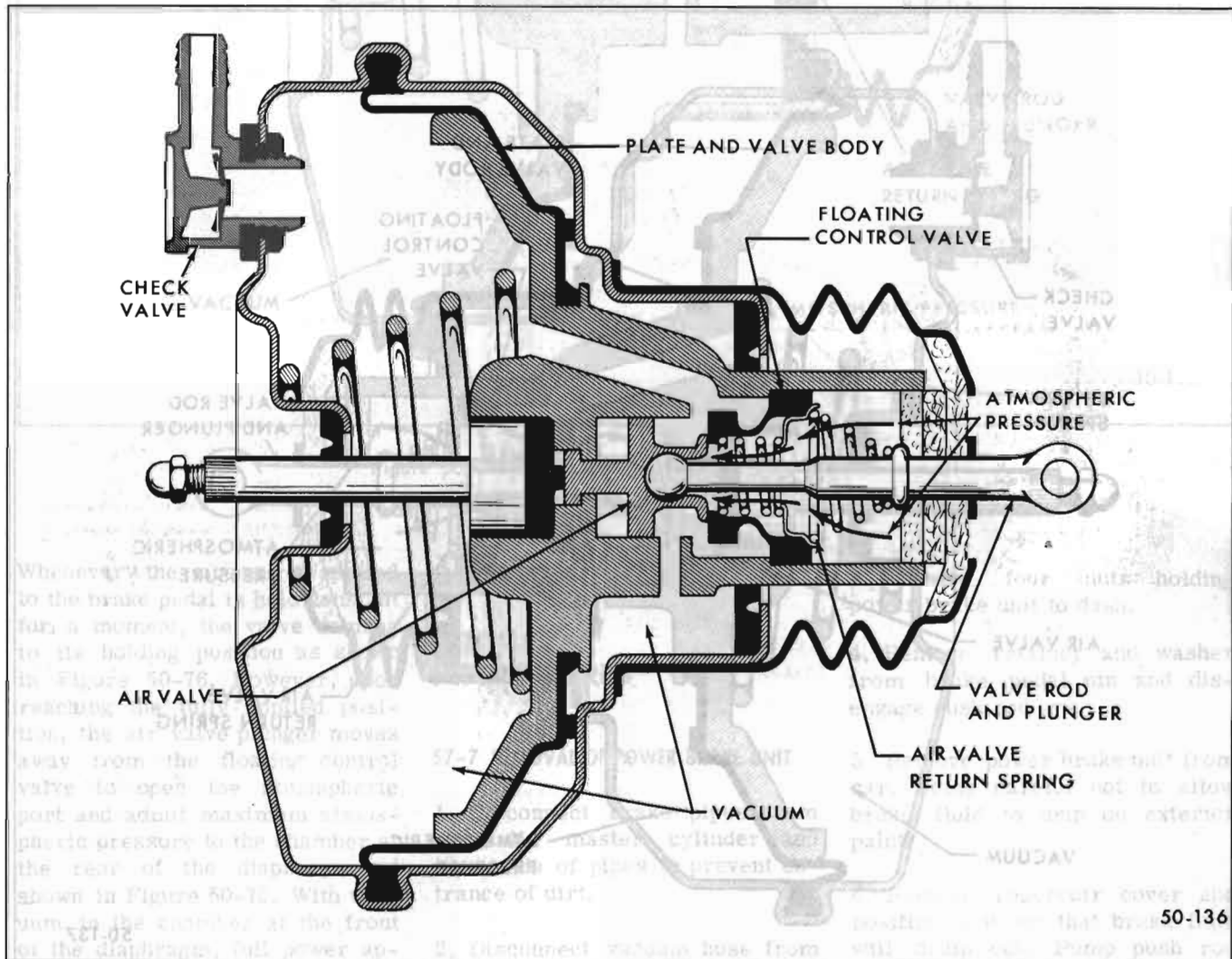


Figure 50-74—Power Brake Unit - Released Position

a counter force (to the rear), acting through the hydraulic push rod and rubber reaction disc, sets up a reaction force against the valve rod and plunger. The rubber reaction disc distributes the pressure between the plate and valve body and the valve rod and plunger in proportion to their respective contact areas. The pressure acting against the valve rod and plunger tends to move the plunger slightly to the rear in relation to the plate and valve body to close off the atmospheric port. Since this counter force or reaction force is in direct proportion to the hydraulic pressure developed within the brake sys-

tems, the driver is able to maintain a "feel" of the degree of brake application attained. See Figure 50-75.

In case of vacuum source interruption, as the pedal is pushed down, the valve rod and plunger assembly contacts the reaction disc and forces the hydraulic push rod against the master cylinder pistons, which builds up the hydraulic line pressure.

The pedal pressure required for a manual application, such as described, is considerably greater than with vacuum assist.

### 3. Holding Position

During application of the brakes, the "reaction" against the air valve plunger is working against the driver to close the atmospheric port. With both atmospheric and vacuum ports closed, the power brake is 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 and decrease the brake application.

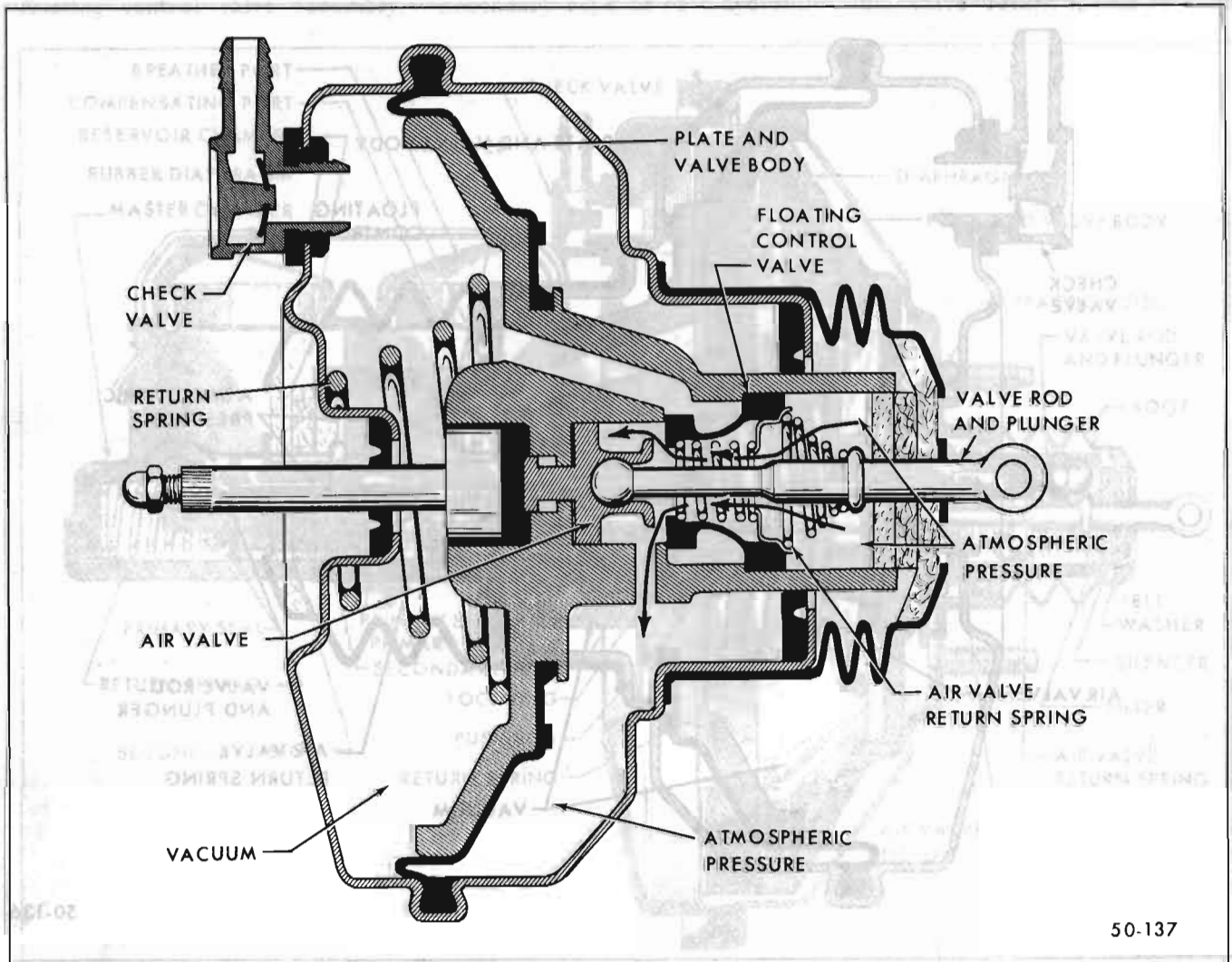


Figure 50-75—Power Brake Unit - Applying Position

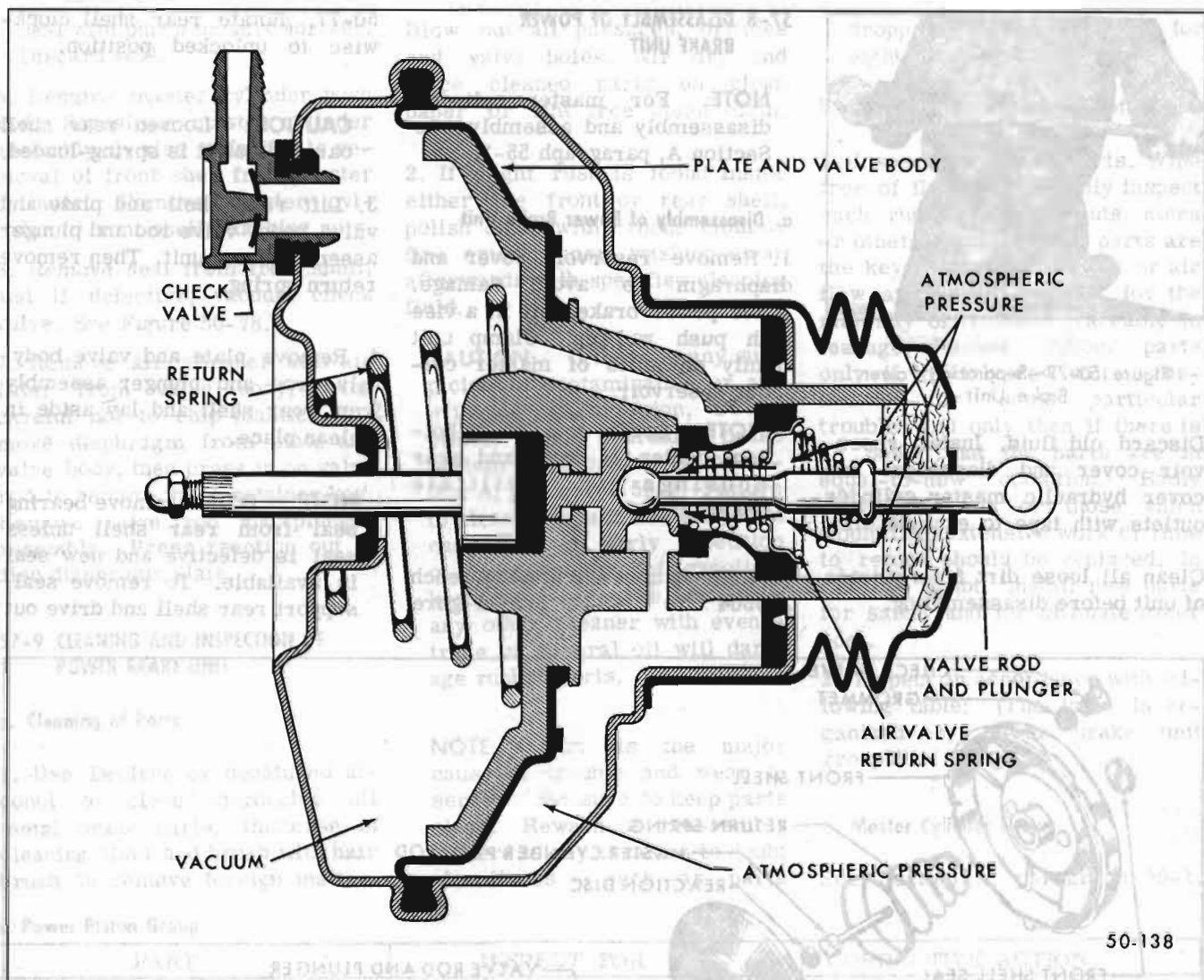


Figure 50-76—Power Brake Unit - Holding Position

Whenever the pressure applied to the brake pedal is held constant for a moment, the valve returns to its holding position as shown in Figure 50-76. However, upon reaching the fully applied position, the air valve plunger moves away from the floating control valve to open the atmospheric port and admit maximum atmospheric pressure to the chamber at the rear of the diaphragm as shown in Figure 50-75. With vacuum in the chamber at the front of the diaphragm, full power application is attained.

### DIVISION III

#### SERVICE PROCEDURES

##### 57-7 REMOVAL OF POWER BRAKE UNIT

1. Disconnect brake pipes from hydraulic master cylinder and tape ends of pipes to prevent entrance of dirt.
2. Disconnect vacuum hose from cylinder.

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

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

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

6. Remove reservoir cover and position unit so that brake fluid will drain out. Pump push rod by hand for full interior drainage.



Figure 50-77—Separating Power Brake Unit

**57-8 DISASSEMBLY OF POWER BRAKE UNIT**

**NOTE:** For master cylinder disassembly and assembly, see Section A, paragraph 55-1.

**a. Disassembly of Power Brake Unit**

1. Remove reservoir cover and diaphragm to avoid damage. Place power brake unit in a vise with push rod up. Clamp unit firmly on sides of master cylinder reservoir.

**NOTE:** Scribe a mark on bottom center of front and rear housings to facilitate reassembly.

2. Remove boot and attach Wrench J-9504 to studs. See Figure

50-77. Rotate rear shell clockwise to unlocked position.

**CAUTION:** Loosen rear shell carefully as it is spring-loaded.

3. Lift rear shell and plate and valve body, valve rod and plunger assembly from unit. Then remove return spring.

4. Remove plate and valve body, valve rod and plunger assembly from rear shell and lay aside in a clean place.

**NOTE:** Do not remove bearing seal from rear shell unless seal is defective and new seal is available. To remove seal, support rear shell and drive out

Discard old fluid. Install reservoir cover and diaphragm and cover hydraulic master cylinder outlets with tape to exclude dirt.

Clean all loose dirt from outside of unit before disassembling.

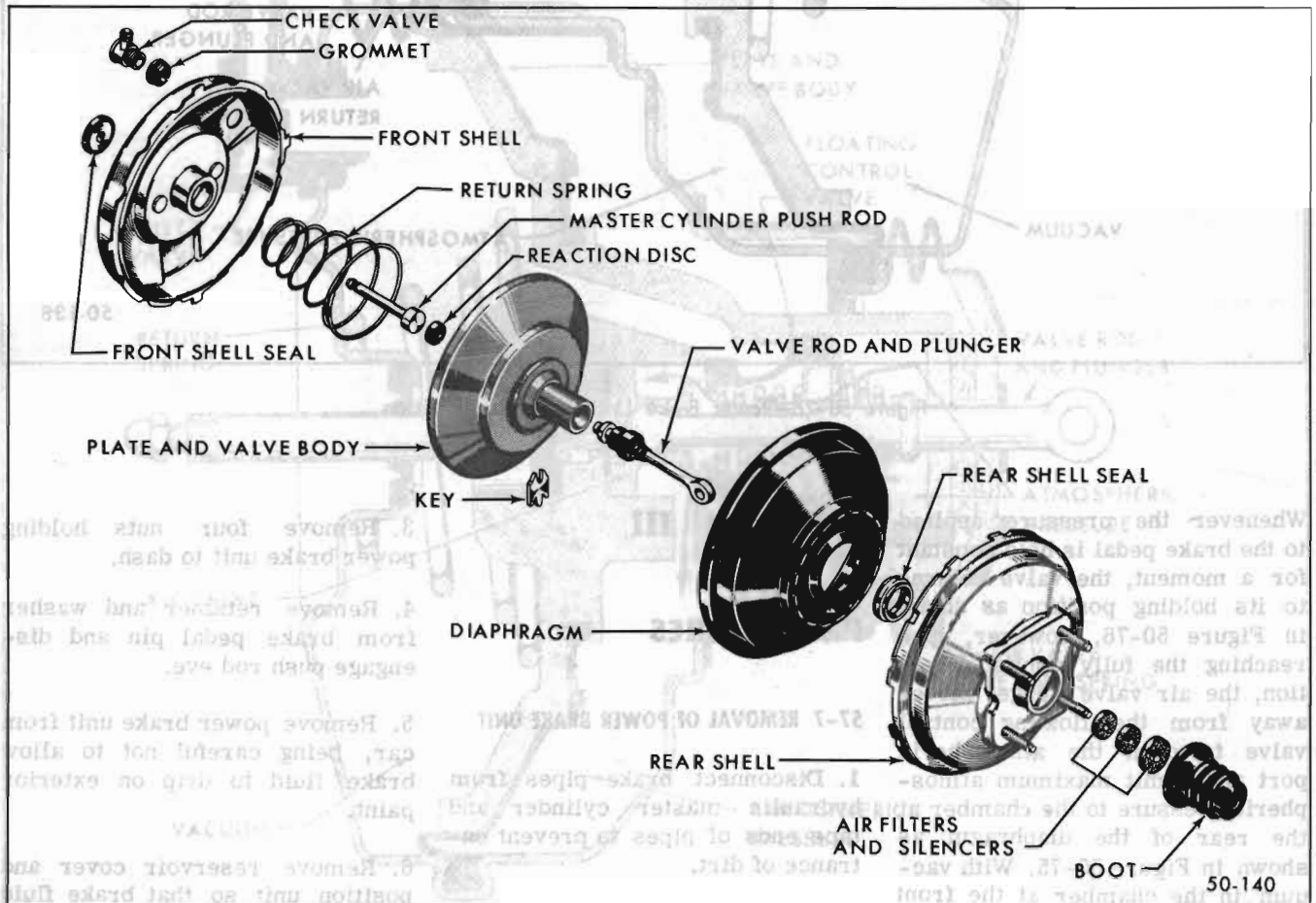


Figure 50-78—Bendix Power Brake - Exploded View



seal with punch or screwdriver. Discard seal.

5. Remove master cylinder push rod. Reposition master cylinder assembly in vise to facilitate removal of front shell from master cylinder. Remove master cylinder to front shell attaching nuts.

6. Remove seal from front shell, and if defective, vacuum check valve. See Figure 50-78.

7. Remove air silencer with air filter from valve body, being careful not to chip plastic. Remove diaphragm from plate and valve body, then press in on valve rod to remove valve retainer key. Remove valve rod and plunger assembly. Press reaction out of disc diaphragm plate.

**57-9 CLEANING AND INSPECTION OF POWER BRAKE UNIT**

**a. Cleaning of Parts**

1. Use Declene or denatured alcohol to clean thoroughly all metal brake parts. Immerse in cleaning fluid and brush with hair brush to remove foreign matter.

**b. Power Piston Group**

Blow out all passages, orifices and valve holes. Air dry and place cleaned parts on clean paper or lint free clean cloth.

2. If slight rust is found inside either the front or rear shell, polish clean with crocus cloth or fine emery paper, washing clean afterwards with specified cleaning fluid.

**CAUTION:** If there is any suspicion of contamination or any evidence of corrosion, completely flush hydraulic brake system in accordance with Section A, paragraph 56-2. Failure to clean hydraulic brake system can result in early repetition of trouble. Use of gasoline, kerosene, antifreeze alcohol or any other cleaner with even a trace of mineral oil will damage rubber parts.

**NOTE:** Dirt is the major cause of trouble and wear in service. Be sure to keep parts clean. Rewash at reassembly if there is any occasion to doubt cleanliness -- such as parts

dropped or left exposed for eight hours or longer.

**b. Inspection and Replacement of Parts**

1. Inspect all rubber parts. Wipe free of fluid and carefully inspect each rubber part for cuts, nicks or other damage. These parts are the key to control of fluid or air flow and should account for the majority of troubles traceable to leakage. Re-use rubber parts only if a fairly new unit is dismantled for some particular trouble, and only then if there is no doubt that the parts are in equal-to-new condition. Badly damaged items or those which would take extensive work or time to repair should be replaced. In case of doubt, install new parts for safety and for ultimate lower cost.

2. Inspect in accordance with following table: (The table is organized by power brake unit groups).

**a. Master Cylinder Group**

See Section A, paragraph 55-1.

PART	INSPECT FOR	CORRECTIVE ACTION
Plate and Valve Body	Cracks, distortion, chipping, damaged seats, pitted or rough holes. Worn seal surfaces (tubes).  Rough or uneven floating valve seat.	Cleanup or replace.  Replace.
Reaction Disc	Open passages and flow holes.  Deterioration of rubber or wear.	Clean.  Replace.
Valve Rod and Plunger	Air valve: scratches, dents, distortion, or corrosion of I.D. or O.D. All seats to be smooth and free of nicks and dents.  Push rod must move freely in air valve, but must not pull out.	Do not repair; replace.  If worn, replace valve rod and plunger.

## c. Over-All Unit

PART	INSPECT FOR	CORRECTIVE ACTION
Front and Rear Shell	Scratches, scores, pits, dents or other damage affecting rolling or sealing of diaphragm or other seals.  Cracks, damage at ears, damaged threads on studs.  Bent or nicked locking lugs.  Loose studs.	Replace unless easily repaired.  Replace unless easily repaired.  Replace unless easily repaired.  Repair or replace.
Air Filters and Silencer	Dirty	Replace.

## 57-10 ASSEMBLY OF POWER BRAKE UNIT

Be certain that all rubber parts are clean at reassembly. Rewash in specified cleaning fluid if there is any doubt of cleanliness. Be careful during rebuild process that no grease or mineral oil comes in contact with rubber parts of power brake unit. Lubricate rubber parts with Delco Moraine approved lubricant or equivalent.

## a. Assembly of Power Brake Unit

1. If rear bearing seal is to be replaced, use Installer J-22671 to press bearing seal in rear shell with plastic side down. See Figure 50-79.

2. Apply power brake lubricant to O.D. of tube section of plate and valve body and to bearing surfaces of valve rod and plunger. Insert air valve plunger and rod assembly in valve body of plate. Press down on valve rod to position air valve plunger in housing and align groove in valve plunger with slot in power piston.

3. Insert retainer key and assemble diaphragm on plate and valve body making certain diaphragm is seated in the groove. Assemble air filter and air silencer over rod and position in valve body.

4. Apply lubricant liberally to entire surface of reaction disc and install disc in plate and valve body with small rubber button side first, toward valve plunger.

5. Coat outer bead of diaphragm with power brake lube or silicone where it bears against outer rim of front and rear shell to aid in assembly. Apply power brake lubricant liberally to seal in rear shell and carefully guide tube end of plate and valve body, valve rod and plunger assembly through seal in rear shell.

6. Apply power brake lubricant sparingly to hydraulic push rod keeping lubricant away from adjusting screw. Insert push rod through front plate and seal and install both in front shell.

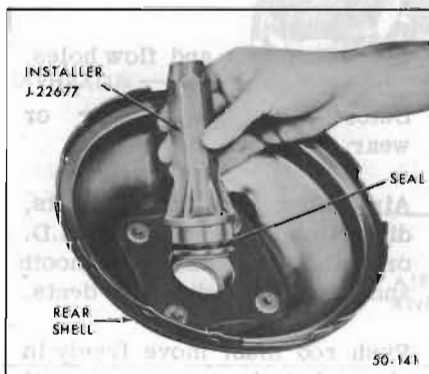


Figure 50-79—Install Rear Shell Seal

7. Remove reservoir cover and diaphragm to avoid damage. Install master "square ring" splash seal and retainer on hub of master cylinder. Seal first. Install master cylinder on front shell and firmly clamp assembly, by master cylinder, in a vise.

8. Install return spring and then install rear shell assembly by using Wrench J-9504 to rotate rear shell counterclockwise until scribe lines align.

**CAUTION:** Press rear shell down firmly, maintaining pressure until shell flanges are fully locked.

9. Place grommet on check valve and press check valve into shell to lock valve in place.

10. Assemble felt washer in boot. Install boot over valve rod and press flange of boot down against rear shell.

## b. Gaging Power Brake Piston

The following gaging operation is necessary only when a major structural part such as front or rear shell, plate and valve body, master cylinder piston or master cylinder assembly is replaced with a new part. The gage measures how far the master cylinder push rod projects from front

shell. This dimension must be correct to insure proper clearance in master cylinder between primary cup and compensating port.

Make check as follows:

1. Set power brake assembly on open jaws of a vise so master cylinder is up. NOTE: Do not grip plastic valve hub (tube) or valve rod in vise. Remove master cylinder from front shell. Master cylinder push rod is now exposed.

2. Place Gage J-22644 over piston rod so that it fits between studs on front shell. It should be parallel to studs and resting on surface of shell. The cutout portion of gage should never be lower than end of piston rod and gap between cutout in gage and end of piston rod should never be more than .010 inch. See Figure 50-80.

3. Any variation beyond these limits must be compensated for by adjusting screw in or out to match height of gage.

**NOTE:** Reaction disc must be installed with small button side against valve plunger, flat side against master cylinder push rod.

4. Replace master cylinder on studs on front housing. Install nuts and washers on studs and torque to 24 lb. ft.

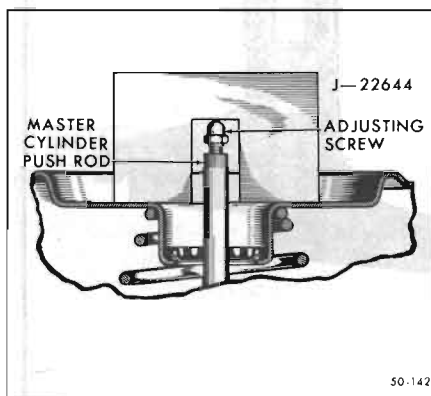


Figure 50-80—Gaging Master Cylinder Push Rod

### 57-11 INSTALLATION OF POWER BRAKE UNIT

1. Place power brake unit in position on dash and connect push rod to brake pedal pin using retainer and washer.

2. Install four nuts on studs. Torque to 24 lb. ft.

3. Connect brake pipes to hydraulic cylinder.

4. Connect vacuum hose to check valve on front shell.

5. Bleed hydraulic system according to procedure in Section A, paragraph 56-2.

6. After bleeding, bring fluid to 1/8" below top of reservoir openings and install reservoir cover and diaphragm.

7. Check pedal for full return and check stop light switch adjustment as described in Section A, paragraph 50-2 (b).

### 57-12 TESTING OF POWER BRAKE UNIT

1. Road test brakes by making a brake application at about 20 MPH to determine if vehicle stops evenly and quickly. If pedal has a spongy feel when applying brakes, air may be present in hydraulic system. Bleed system as described in Section A, paragraph 56-2.

2. With engine stopped and transmission in Neutral, apply brakes several times to deplete all vacuum reserve in system. Depress brake pedal, hold light-foot pressure on pedal and start the engine. If vacuum system is operating, pedal will tend to fall away under foot pressure and less pressure will be required to hold pedal in applied position. If no action is felt, vacuum system is not functioning.

3. Stop engine. Again deplete all vacuum reserve in system. Depress brake pedal and hold foot pressure on pedal. If pedal gradually falls away under foot pressure, hydraulic system is leaking internally or externally.

4. If brake pedal travels to within one inch of toeboard, brake shoes require adjustment or relining.

5. Start engine with brakes off and transmission in Neutral. Run engine to medium speed and turn off ignition. Immediately close throttle. This builds up vacuum. Wait no less than 90 seconds, then try brake action. If not vacuum-assisted for two or more applications, vacuum check valve is faulty or there is a leak in vacuum system.

## DIVISION IV

### TROUBLE DIAGNOSIS

#### 59-6 POWER BRAKE UNIT TROUBLE DIAGNOSIS

The same types of brake trouble are encountered with power brakes as with standard brakes. Before checking power brake system for source of trouble, refer to trouble diagnosis of standard brakes in Section A, Division IV. After these possible causes have been eliminated, check for cause as outlined below:

#### a. Hard Pedal

1. Vacuum failure due to:
  - a. Faulty vacuum check valve
  - b. Collapsed vacuum hose to manifold.
  - c. Plugged or loose vacuum fittings
2. Binding pedal mechanism
3. Power brake unit trouble
  - a. Jammed air valve

- b. Vacuum leaks in unit caused by faulty air valve seal or support plate seal. Also, a damaged floating control valve, bad seal of master cylinder or power cylinder mounting studs in shells, bad seal on master cylinder push rod or a bad seal of diaphragm bead between shells or at power piston. It is possible to have faulty vacuum check valve grommet.
- c. Defective rolling diaphragm
- d. Restricted air filter elements
- e. Worn or distorted reaction disc or disc installed backward
- f. Cracked or broken plate and valve body
- g. Manual hydraulic master cylinder boot (without air holes) on power brake

**b. Grabby Brakes (Apparent Off-and-On Condition)**

- 1. Power brake unit valve trouble
  - a. Sticking air valve
  - b. Restricted diaphragm passage
- 2. Reaction system
  - a. Dislodged reaction disc or disc installed backward
  - b. Broken air valve spring
  - c. Worn or distorted reaction disc
- c. Pedal Goes Either to Floor or Almost to Floor
  - 1. Fluid reservoir needs replenishing
  - 2. Power brake hydraulic leakage
    - a. Defective primary or secondary cups

- b. Cracked master cylinder casting
- c. Leaks at wheel cylinder, in pipes or connections
- 3. Faulty master cylinder check valve has permitted air to enter system causing spongy pedal.
- d. Brakes Fail to Release
  - 1. Faulty hydraulic check valve
  - 2. Blocked passage in power piston
  - 3. Air valve sticking shut
  - 4. Broken piston return spring
  - 5. Broken air valve spring
  - 6. Tight pedal linkage
  - 7. Reaction disc installed backward

The same types of brake trouble are encountered with wheel brakes. Before checking power brake system for trouble, check for air in lines. Refer to Section A for air brakes in Section IV. After these possible causes have been eliminated, check for causes as outlined below.

1. Check pedal for full return. Check stop light switch adjustment as described in Section A (Fig. 50-27).

2. Check pedal for full return. Check stop light switch adjustment as described in Section A (Fig. 50-27).

3. With engine stopped and transmission in neutral, apply brakes several times to bleed air from lines. Check for air in lines. Refer to Section A for air brakes in Section IV. After these possible causes have been eliminated, check for causes as outlined below.

4. Check pedal for full return. Check stop light switch adjustment as described in Section A (Fig. 50-27).

5. Check pedal for full return. Check stop light switch adjustment as described in Section A (Fig. 50-27).

6. Check pedal for full return. Check stop light switch adjustment as described in Section A (Fig. 50-27).

7. Check pedal for full return. Check stop light switch adjustment as described in Section A (Fig. 50-27).

8. Check pedal for full return. Check stop light switch adjustment as described in Section A (Fig. 50-27).

9. Check pedal for full return. Check stop light switch adjustment as described in Section A (Fig. 50-27).

10. Check pedal for full return. Check stop light switch adjustment as described in Section A (Fig. 50-27).

1. Road test brakes by making a slight application. If pedal has a spongy feel when applied, check for air in the system. Refer to Section A for air brakes in Section IV. After these possible causes have been eliminated, check for causes as outlined below.

2. With engine stopped and transmission in neutral, apply brakes several times to bleed air from lines. Check for air in lines. Refer to Section A for air brakes in Section IV. After these possible causes have been eliminated, check for causes as outlined below.

3. With engine stopped and transmission in neutral, apply brakes several times to bleed air from lines. Check for air in lines. Refer to Section A for air brakes in Section IV. After these possible causes have been eliminated, check for causes as outlined below.

4. With engine stopped and transmission in neutral, apply brakes several times to bleed air from lines. Check for air in lines. Refer to Section A for air brakes in Section IV. After these possible causes have been eliminated, check for causes as outlined below.

5. With engine stopped and transmission in neutral, apply brakes several times to bleed air from lines. Check for air in lines. Refer to Section A for air brakes in Section IV. After these possible causes have been eliminated, check for causes as outlined below.

6. With engine stopped and transmission in neutral, apply brakes several times to bleed air from lines. Check for air in lines. Refer to Section A for air brakes in Section IV. After these possible causes have been eliminated, check for causes as outlined below.

7. With engine stopped and transmission in neutral, apply brakes several times to bleed air from lines. Check for air in lines. Refer to Section A for air brakes in Section IV. After these possible causes have been eliminated, check for causes as outlined below.

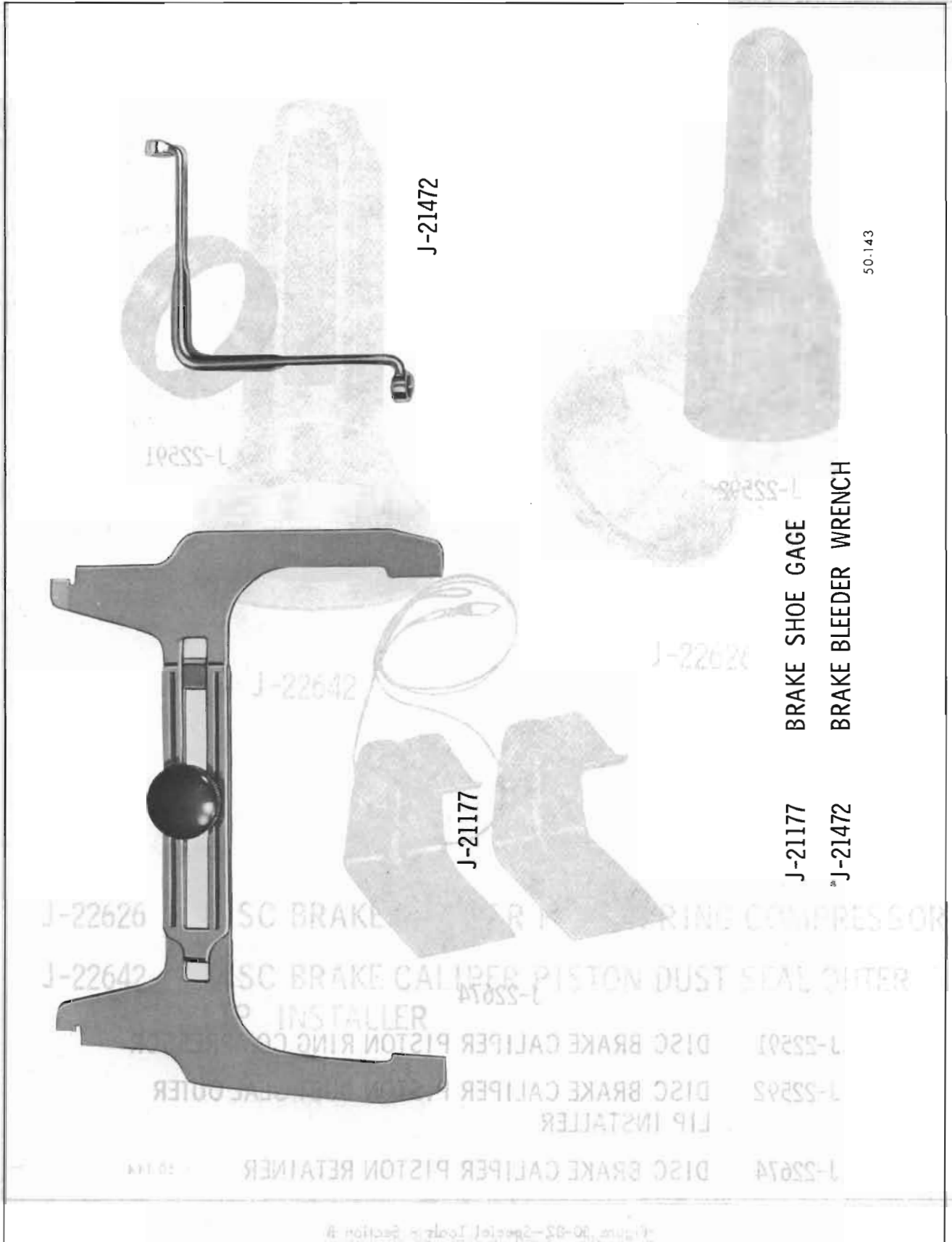
8. With engine stopped and transmission in neutral, apply brakes several times to bleed air from lines. Check for air in lines. Refer to Section A for air brakes in Section IV. After these possible causes have been eliminated, check for causes as outlined below.

9. With engine stopped and transmission in neutral, apply brakes several times to bleed air from lines. Check for air in lines. Refer to Section A for air brakes in Section IV. After these possible causes have been eliminated, check for causes as outlined below.

10. With engine stopped and transmission in neutral, apply brakes several times to bleed air from lines. Check for air in lines. Refer to Section A for air brakes in Section IV. After these possible causes have been eliminated, check for causes as outlined below.



Fig. 50-82 - Section of Master Cylinder Push Rod



J-21472

50.143

J-21177  
BRAKE SHOE GAGE

J-21472  
BRAKE BLEEDER WRENCH

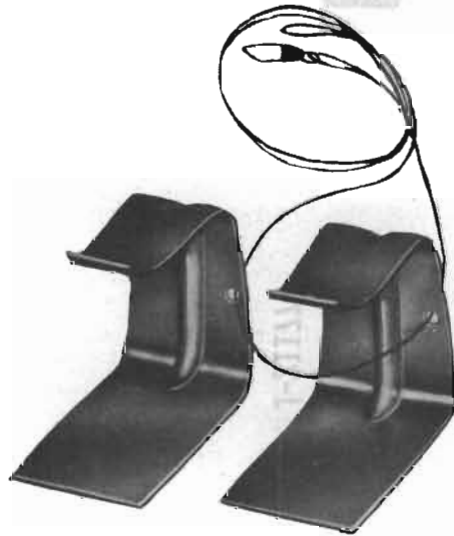
Figure 50-81 -Special Tools - Section A



J-22592



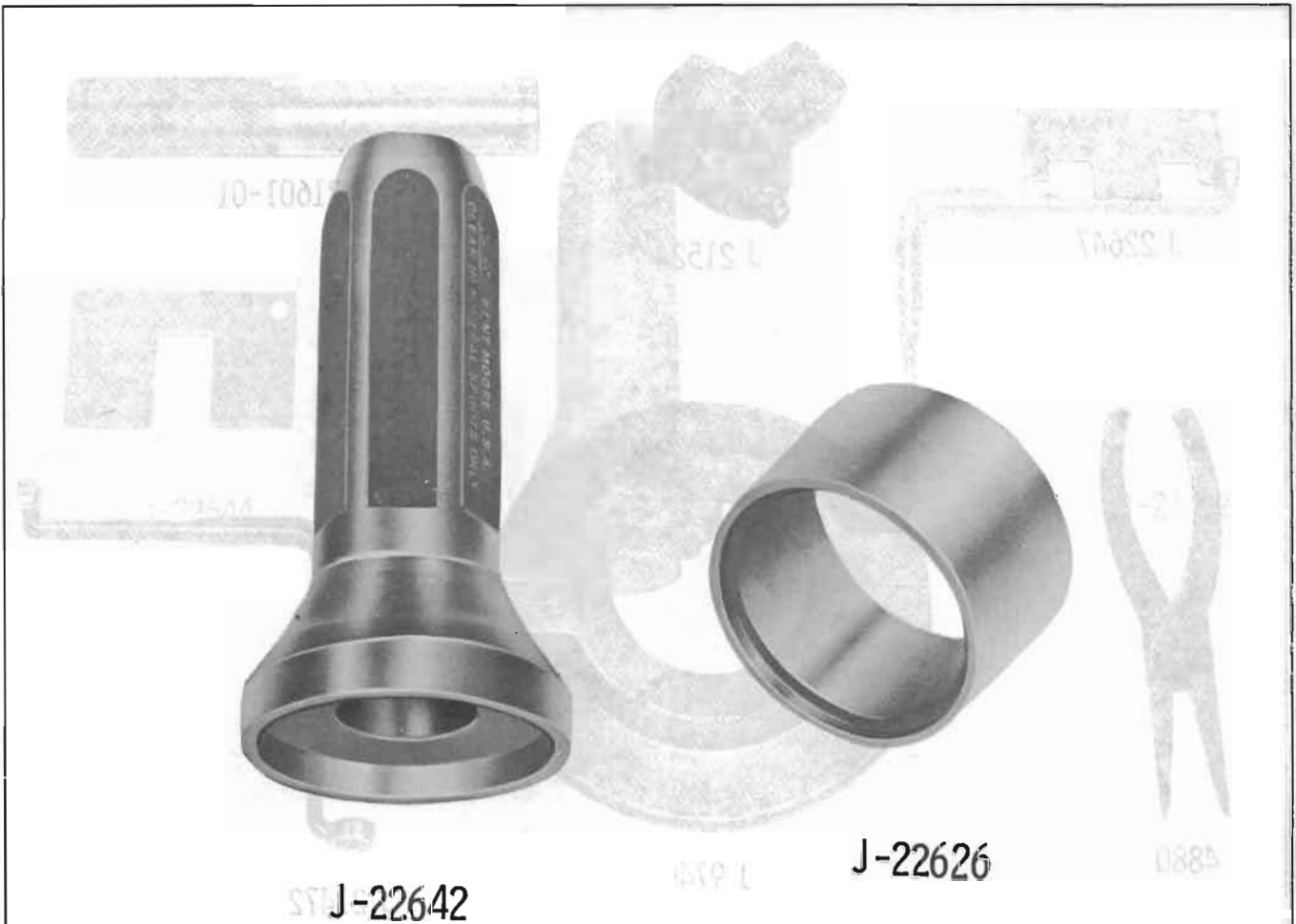
J-22591



J-22674

- J-22591 DISC BRAKE CALIPER PISTON RING COMPRESSOR
- J-22592 DISC BRAKE CALIPER PISTON DUST SEAL OUTER LIP INSTALLER
- J-22674 DISC BRAKE CALIPER PISTON RETAINER

50-144



- J-22626 DISC BRAKE CALIPER PISTON RING COMPRESSOR
- J-22642 DISC BRAKE CALIPER PISTON DUST SEAL OUTER LIP INSTALLER

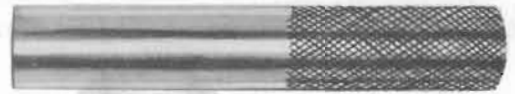
Figure 50-83—Special Tools - Section C



J 22647



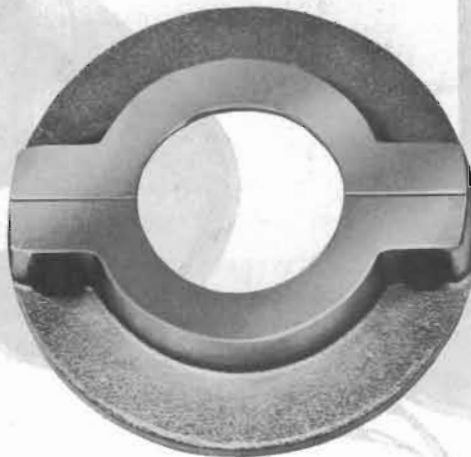
J 21524



J 21601-01



J 4880



J 9746



J 21472

- J 4880 - SNAP RING PLIERS
- J22647 - POWER BRAKE PUSH ROD HEIGHT GAGE
- J 9746 - REAR PINION BEARING REMOVER
- J 21472 - BRAKE BLEEDER WRENCH
- J 21524 - POWER PISTON REMOVER AND INSTALLER
- J 21601-01 - POWER BRAKE RETAINER INSTALLER





J-22644



J-22677



J-21472

INCLUDES

Group 60—Engine Mechanical

Group 64—Engine Fuel

Group 65—Electro Cruise

J-22644 PUSH ROD HEIGHT GAGE

J-22677 BRAKE REAR SHELL SEAL INSTALLER

Group 68—Air Injection Reactor

J-21472 BRAKE BLEEDER WRENCH

System

50-95A

Group 68—Engine Electrical

Group 69—Engine Tune-Up

Figure 50-85—Special Tools - Section E