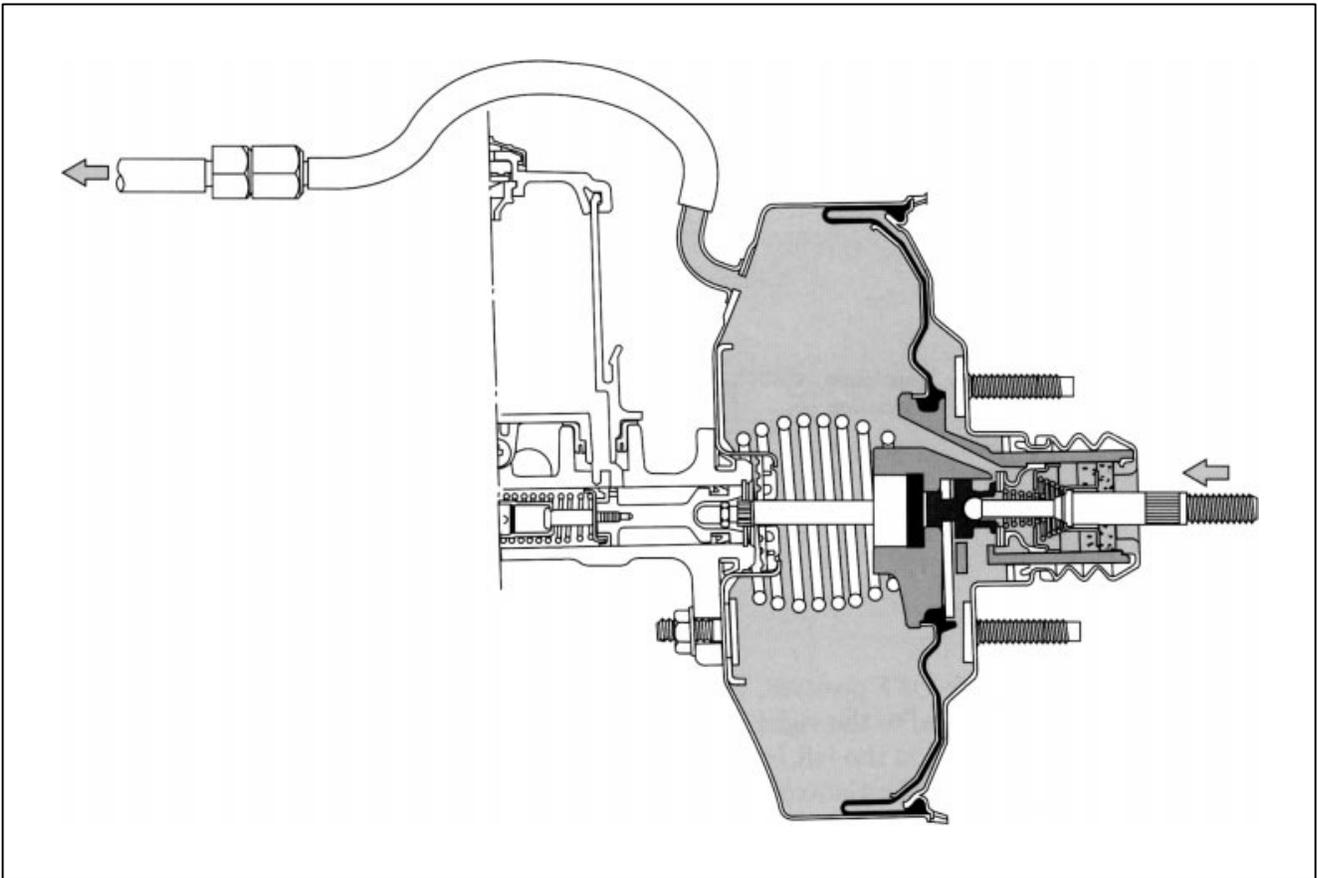


Section 5

BRAKE BOOSTER



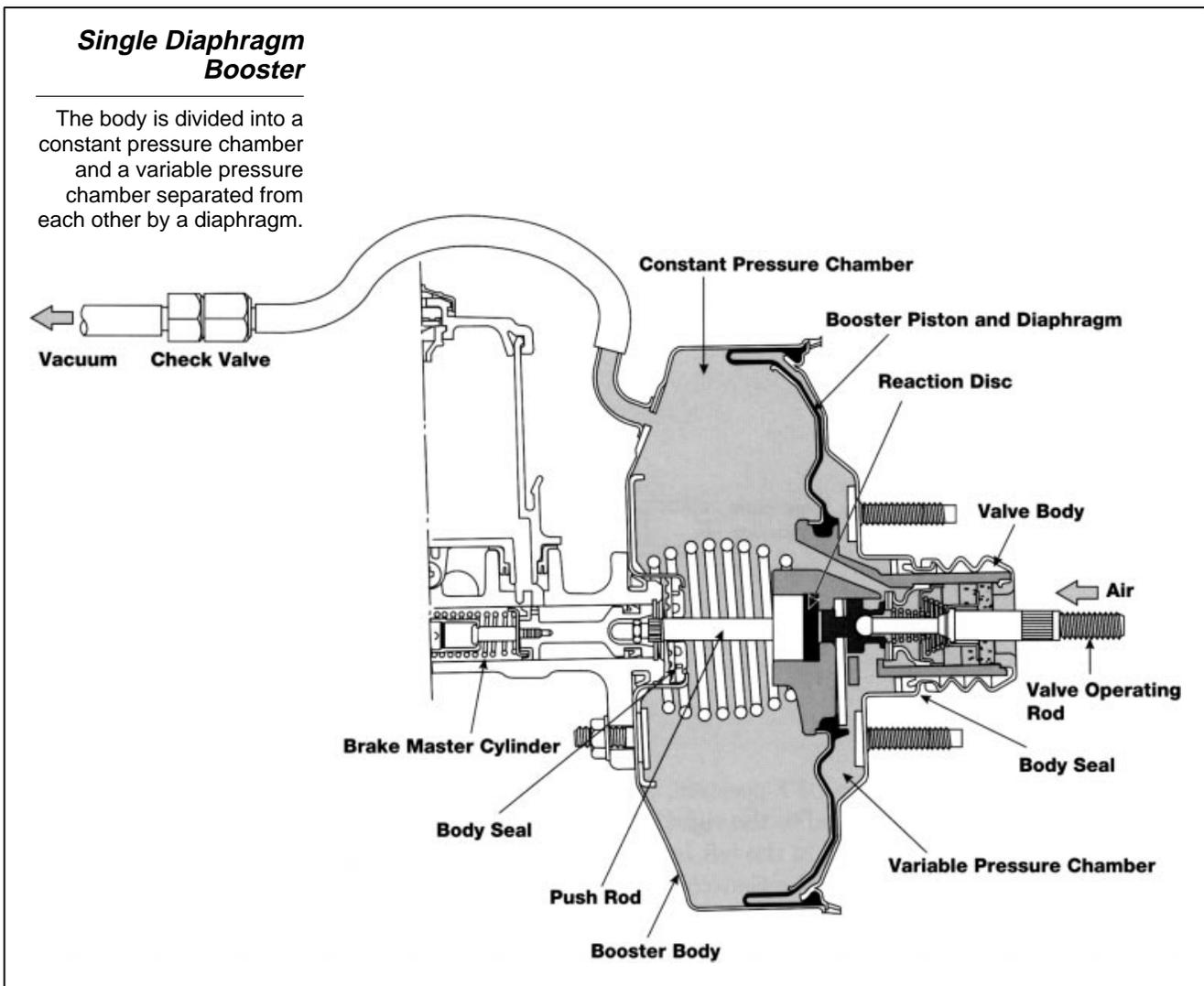
- Lesson Objectives**
1. Explain the function of engine vacuum in providing brake assist to the master cylinder.
 2. Perform the following booster tests using the brake pedal:
 - operating test
 - air tightness check
 - air tightness under load
 3. Using a brake booster push rod gauge SST, measure booster push rod clearance and determine needed adjustment.
 4. List the symptoms of an improperly adjusted booster push rod.

Brake Booster The brake booster is designed to create a greater braking force from a minimum pedal effort, using a difference in atmospheric pressure and the engine's manifold vacuum. It increases the pedal force 2 to 4 times depending on the size of the diaphragm. The brake booster is located between the brake pedal and the master cylinder.

When pressure is applied to the brake pedal, pressure is exerted on the booster air valve. With pressure created by the booster the master cylinder is applied. Should the booster malfunction, the normal mechanical braking force of the master cylinder is maintained.

Construction The brake booster consists of the **body, booster piston, piston return spring, reaction mechanism, and control valve mechanism.**

The body is divided into a constant pressure chamber and a variable pressure chamber. The chambers are separated from each other by a diaphragm. The control valve mechanism regulates the pressure inside the variable pressure chamber.

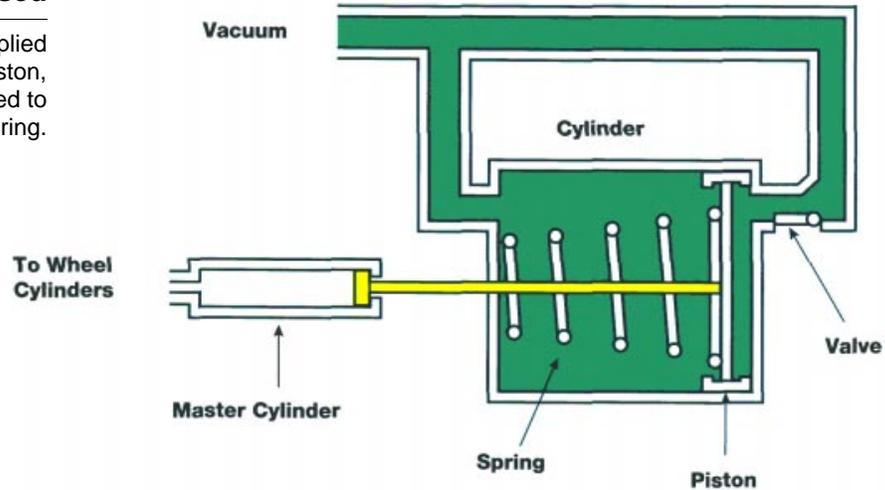


Basic Booster Operation

The basic principle of the brake booster is pressure differential. When vacuum is applied to both sides of the piston, the piston is pushed to the right by the spring and remains there.

Control Valve Closed

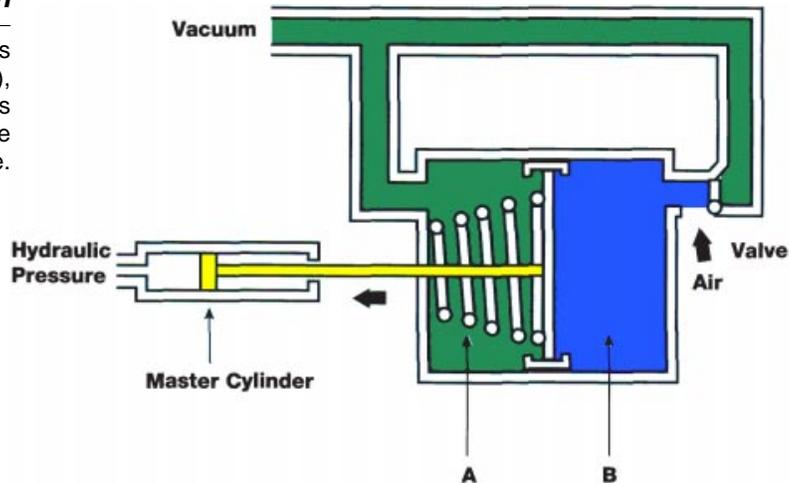
When vacuum is applied to both sides of the piston, the piston is pushed to the right by the spring.



When atmospheric air is allowed into chamber B the piston starts to compress the spring, due to the difference in pressure, and moves to the left. This causes the piston rod to move the piston of the master cylinder, generating hydraulic pressure.

Control Valve Open

When atmospheric air is allowed into chamber (A), the piston starts to compress the spring due to the difference in pressure.



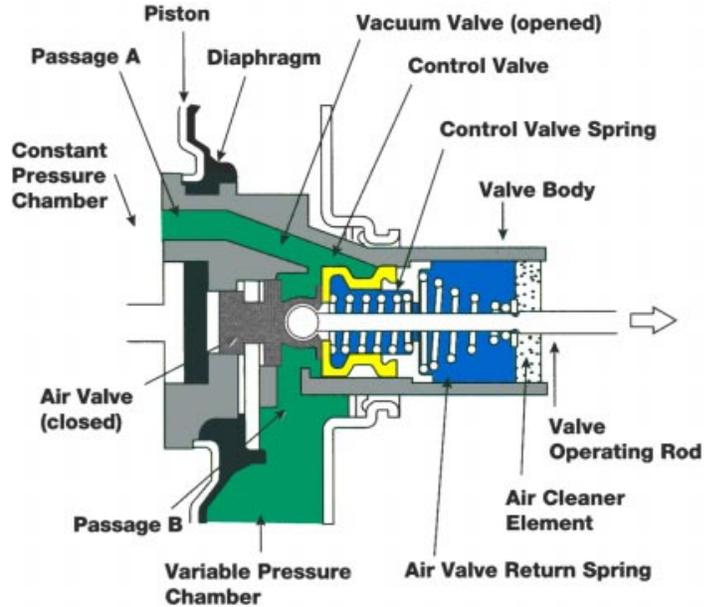
Booster Air Valve Operation

In the OFF position, the Air Valve (connected to the Valve Operating Rod) is pulled to the right by the Air Valve Return Spring. The Control Valve is pushed to the left by the Control Valve Spring. This causes the Air Valve to contact the Control Valve. Therefore, the atmospheric air that passes through the air cleaner element is prevented from entering the Variable Pressure Chamber.

The piston's Vacuum Valve is separated from the Control Valve in this position, providing an opening between passage A and passage B. Since there is always vacuum in the Constant Pressure Chamber, the opening allows vacuum into the Variable Pressure Chamber. As a result, the piston is pushed to the right by the piston return spring.

**Booster Air Valve
Brakes Not Applied**

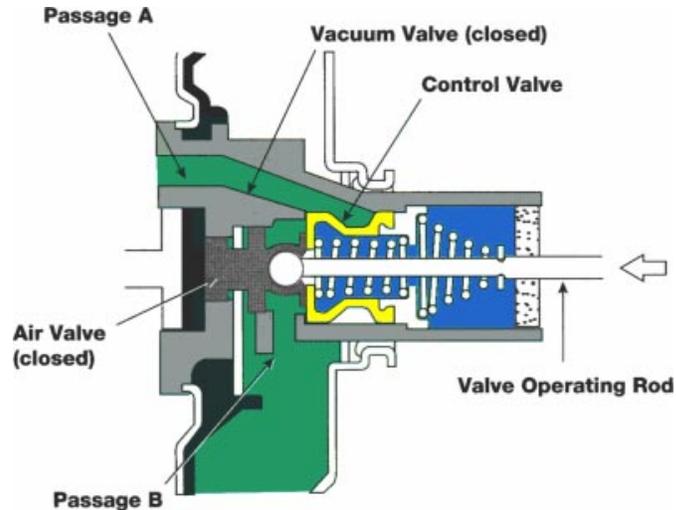
The Vacuum Valve is open allowing vacuum on both sides of the booster piston.



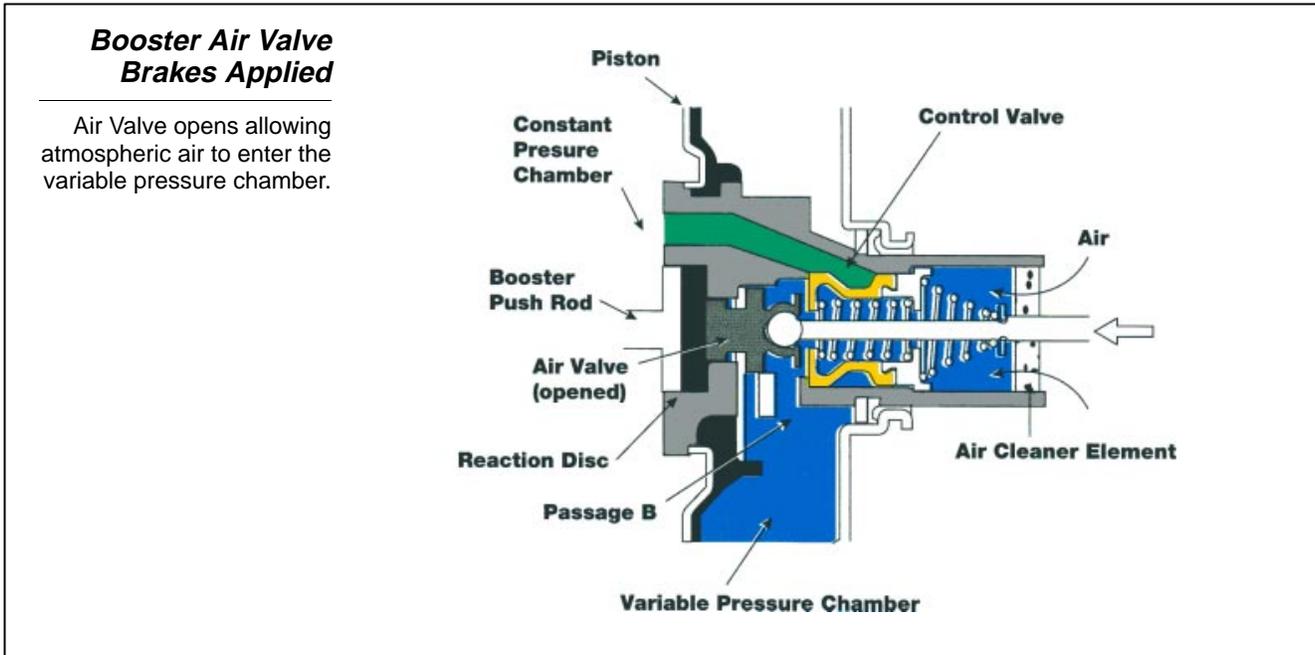
In the ON position, when the brake pedal is depressed, the Valve Operating Rod pushes the Air Valve to the left. The Control Valve which is pushed against the Air Valve by the Control Valve Spring, moves to the left until it touches the Vacuum Valve. This blocks off the opening between passage A and passage B (Constant Pressure Chamber (A) and Variable Pressure Chamber (B)).

**Booster Air Valve
Brakes Applied**

The vacuum valve is closed, cutting off the vacuum source to the variable pressure chamber.



As the Air Valve moves further to the left, it moves away from the Control Valve. This allows atmospheric pressure to enter the Variable Pressure Chamber through passage B. The pressure difference between the Constant Pressure Chamber and the Variable Pressure Chamber causes the piston to move to the left. This, in turn, causes the Reaction Disc to move the Booster Push Rod to the left and exert braking force.

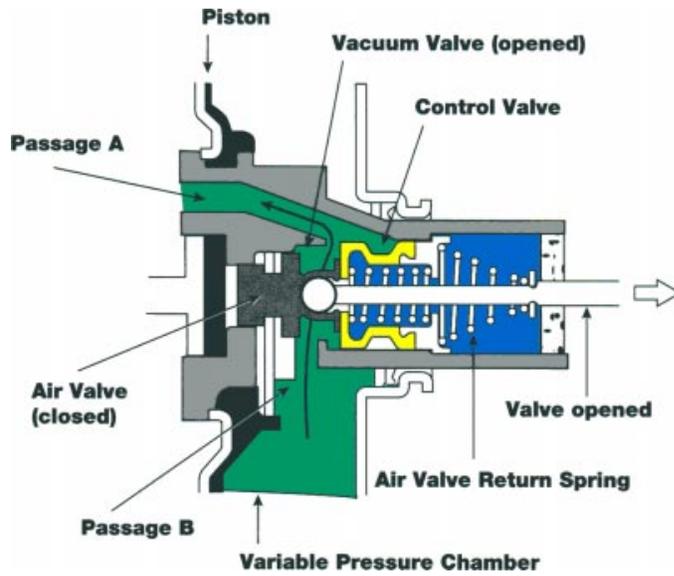


Released Position When the brake pedal is released, the Valve Operating Rod and the Air Valve are moved to the right by the Air Valve Return Spring and reaction force of the master cylinder. This movement causes the Air Valve to contact the Control Valve, blocking atmospheric pressure from the Variable Pressure Chamber. At the same time, the Air Valve also retracts the Control Valve Spring. The Control Valve moves away from the Vacuum Valve, connecting passage A with passage B.

This allows atmospheric pressure from the Variable Pressure Chamber to flow into the Constant Pressure Chamber. The pressure difference is eliminated between the two chambers and the piston is pushed back to the right by the Diaphragm/Piston Return Spring. The booster returns to the released position.

Booster Air Valve Released Position

Pressure equalizes in the two chambers and the air valve is closed.



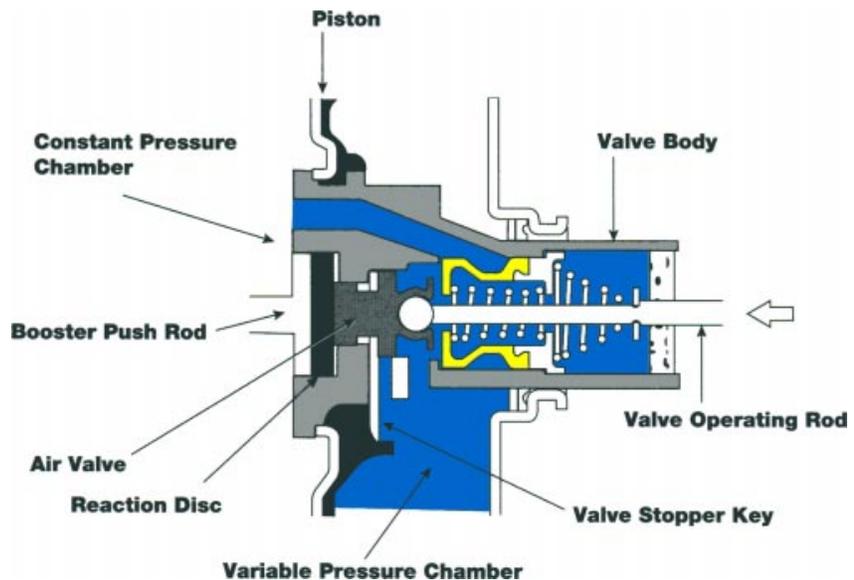
Lack Of Vacuum

If vacuum fails to act on the brake booster, for any reason, there will be no difference in pressure between the Constant Pressure Chamber and the Variable Pressure Chamber. When the brake is in the “OFF” position, the piston is returned to the right by the Piston Return Spring.

When the brake pedal is depressed, the Valve Operating Rod advances to the left and pushes the Air Valve, Reaction Disc, and Booster Push Rod. This movement causes the master cylinder piston to apply braking force to the brake system, maintaining brake system operation.

Booster Air Valve No Vacuum

Although the booster loses self-energizing force when vacuum is lost, it still generates hydraulic pressure mechanically and can maintain brake system operation.

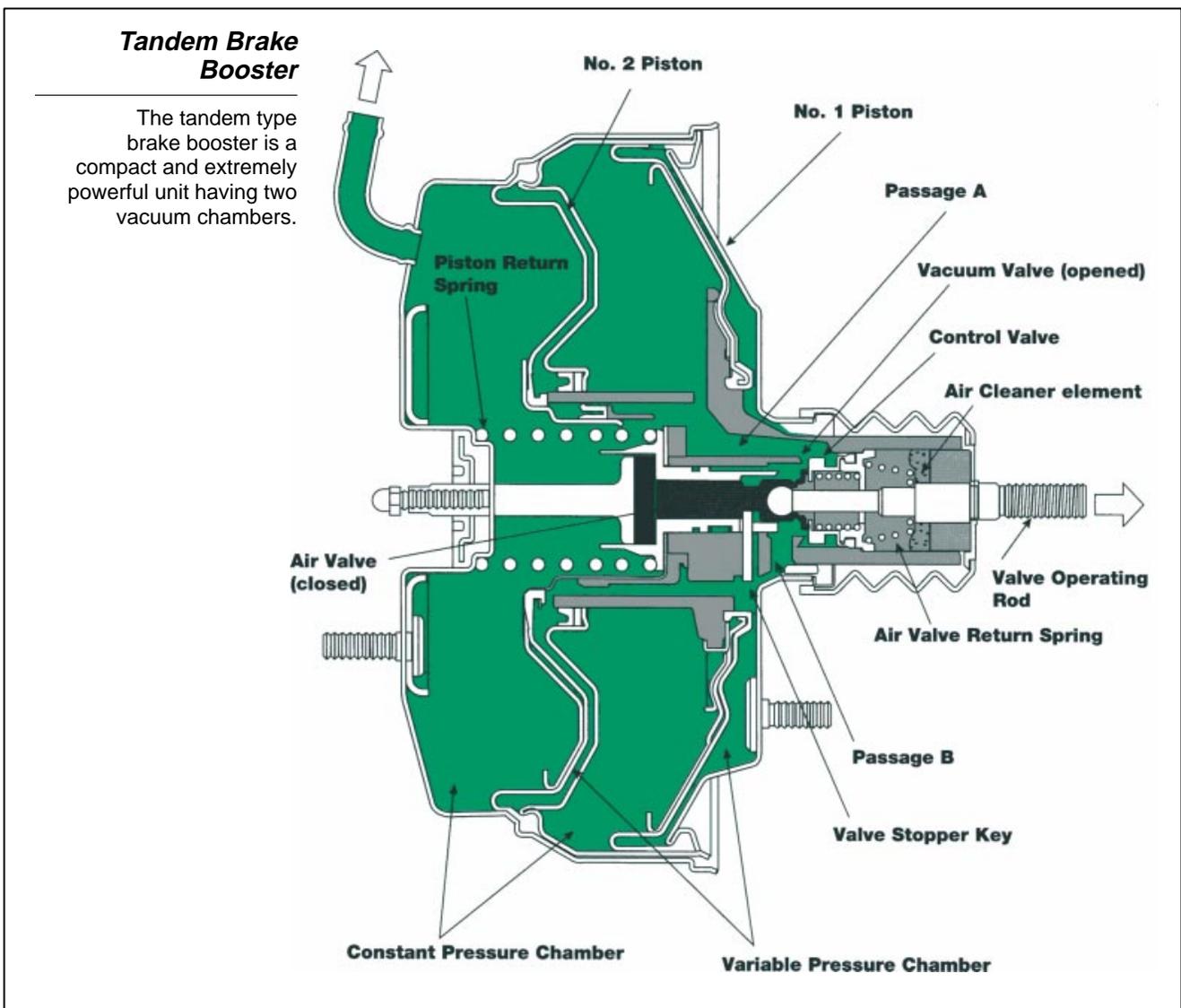


Tandem Brake Booster

The tandem type brake booster is a compact and extremely powerful unit having two Constant Pressure Chambers and two Variable Pressure Chambers. A Piston separates each variable and constant pressure chamber. With two pistons incorporated into this design, a large surface area provides additional boost while taking up less space.

When the brakes are not applied the Air Valve and Valve Operating Rod are pushed to the right by the tension of the Air Valve Return Spring, and stop when they contact the Valve Stopper Key. Since the Air Valve pushes the Control Valve back toward the right, the passage through which atmospheric air from the air cleaner element enters the booster, is closed. Since the Vacuum Valve and the Control Valve are not in contact with each other, pressure is equalized between the two chambers through passage (A) and passage (B).

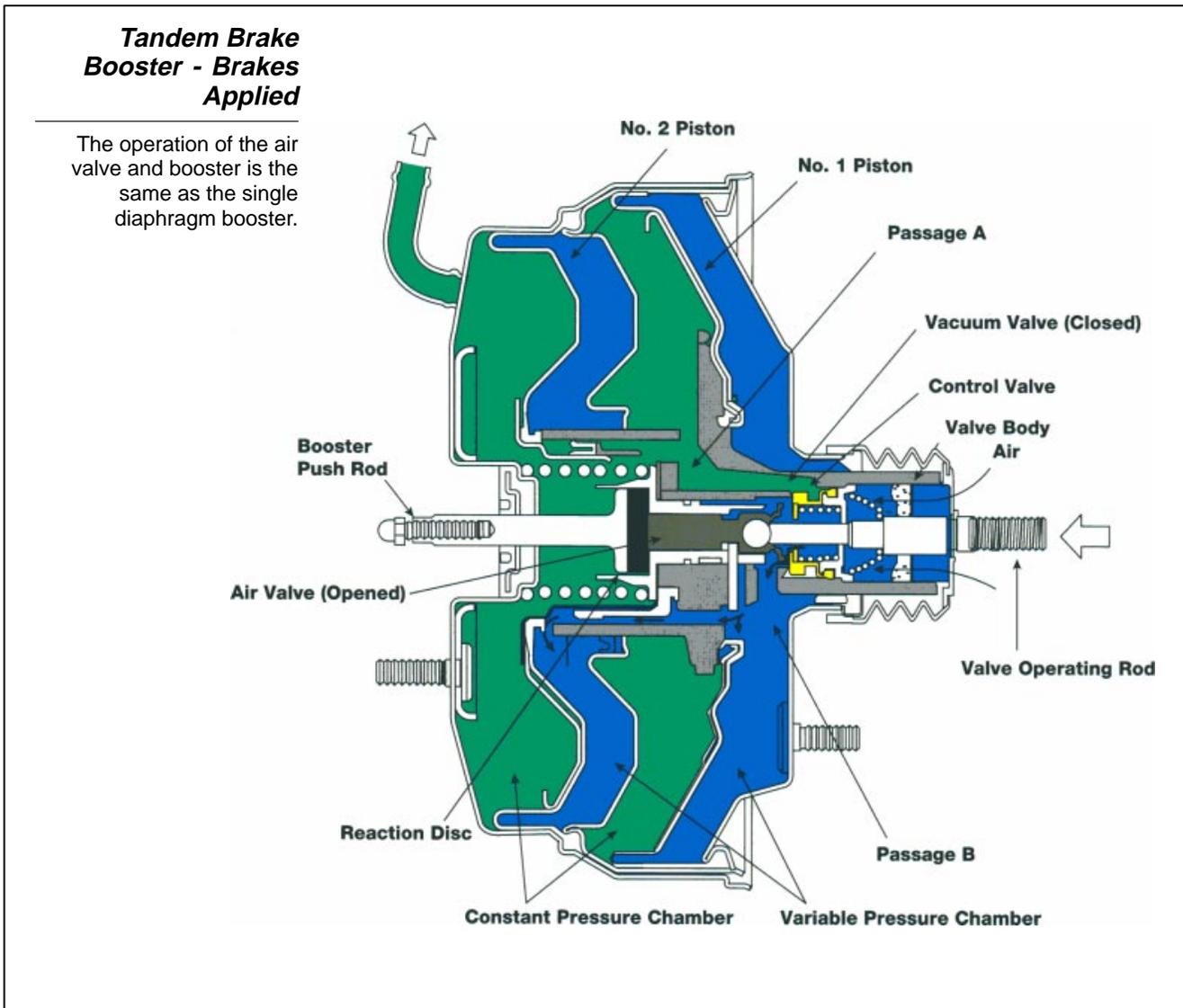
Therefore, vacuum is applied to both the Constant Pressure Chambers and the Variable Pressure Chambers; so, there is no difference in pressure between the chambers on both sides of the piston.



Brakes Applied When the brake pedal is depressed, both the Valve Operating Rod and Air Valve are pushed to the left together. As a result, the Control Valve and Vacuum Valve come into contact with each other, closing passages (A) and (B) (the constant pressure chamber and variable pressure chamber).

Next, the Air Valve moves away from the Control Valve, and atmospheric air from the air cleaner element passes through passage (B) and enters the Variable Pressure Chamber. This generates a pressure difference between the Variable Pressure Chamber and the Constant Pressure Chamber, and the pistons move to the left.

The forces applied by the pistons, which occur due to the pressure difference, are transmitted to the Reaction Disc via the Valve Body. They are further transmitted to the Booster Push Rod, becoming the booster output force. The combined surface area of pistons No. 1 and No. 2, multiplied by the pressure difference between the Constant Pressure Chamber and Variable Pressure Chamber, equals the booster output force.



Booster Diagnosis The following steps are taken to diagnose the brake booster.

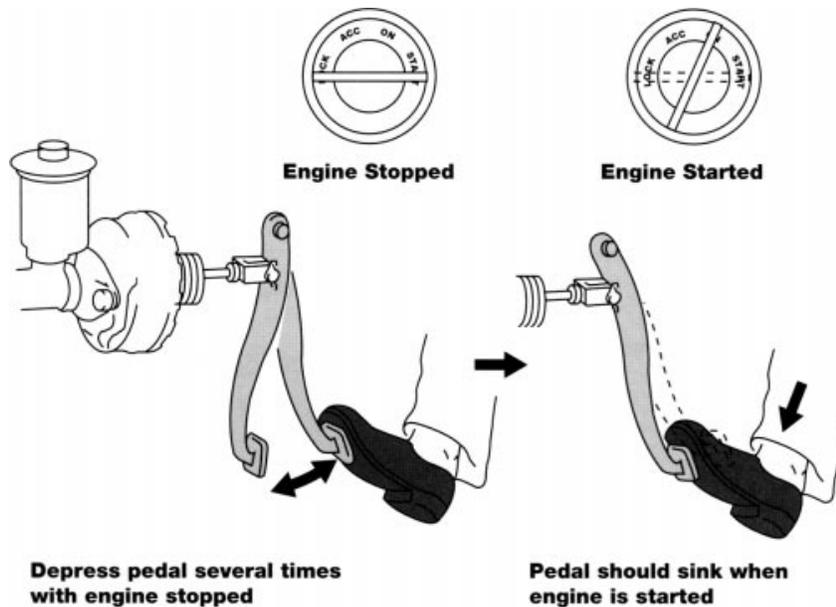
Operating Check With the engine stopped, depress the brake pedal normally, several times. The brake pedal must be depressed before the engine is started in order to remove vacuum from the booster.

With the brake pedal depressed start the engine. When the engine is started, vacuum is created and operates the booster. This causes the brake pedal to go down.

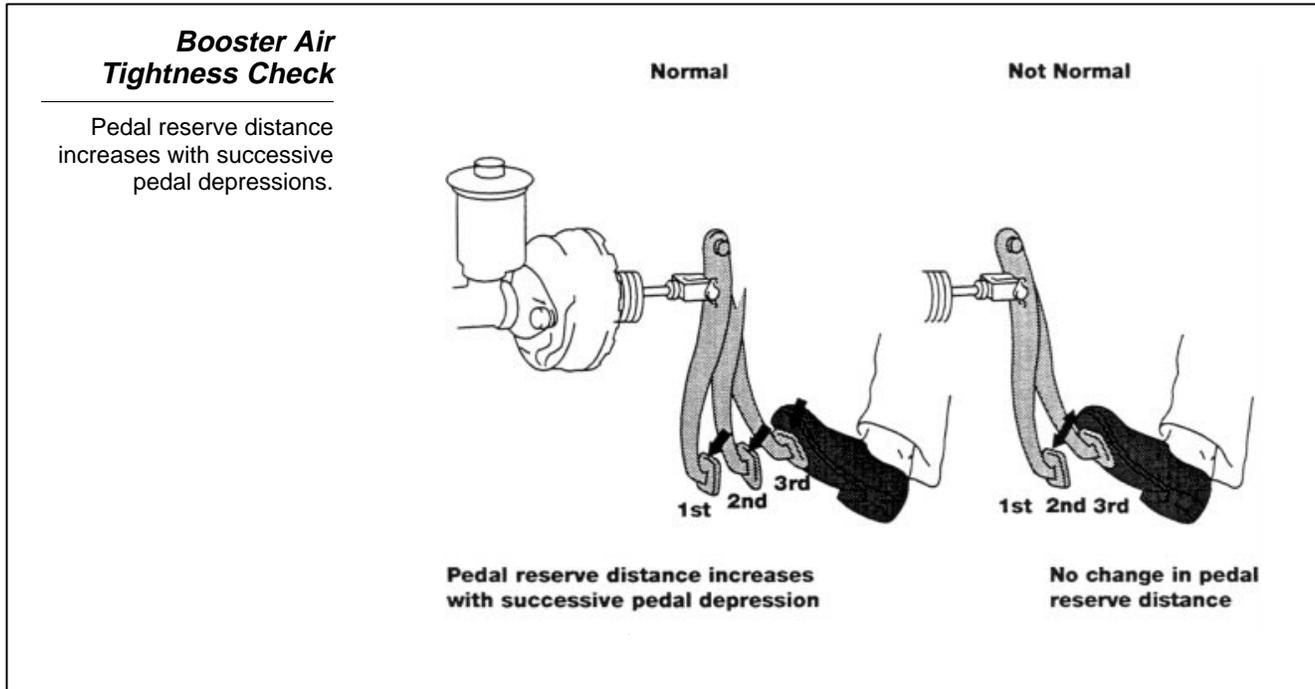
If the brake pedal goes down slightly, the booster is operating normally. If the brake pedal does not move, the booster is not receiving manifold vacuum, or is malfunctioning.

Booster Operating Check

The brake pedal should sink when the engine starts.



Air Tightness Check Start the engine and let it run for one or two minutes, then shut it off. Now step on the brake pedal several times, applying normal pressure. Be sure to wait about five seconds between each depression of the pedal. If the brake pedal reserve distance increases every time the pedal is depressed, the booster has good air tightness.



The brake pedal reserve distance changes every time the pedal is depressed, because the vacuum that is stored in the booster is reduced every time the brake pedal is depressed.

The brake pedal reserve distance will not change if the Check Valve is defective. The check valve is located on the vacuum booster body or between the booster body and the source of engine vacuum. Its purpose is to act as a one-way valve and seal vacuum in the booster to provide at least two power assist stops should the engine stop running. To check the Check Valve and vacuum hose piping use the following procedure:

- Remove the vacuum hose and valve from the booster.
- Block the valve with a finger and start the engine.
- A strong vacuum should be felt if the piping and valve are operating.
- The vacuum must remain unchanged for approximately one minute after the engine is stopped.

Lack of vacuum indicates a malfunction in the check valve or the vacuum hose piping. If the vacuum appears normal, there may be a problem in the booster itself.

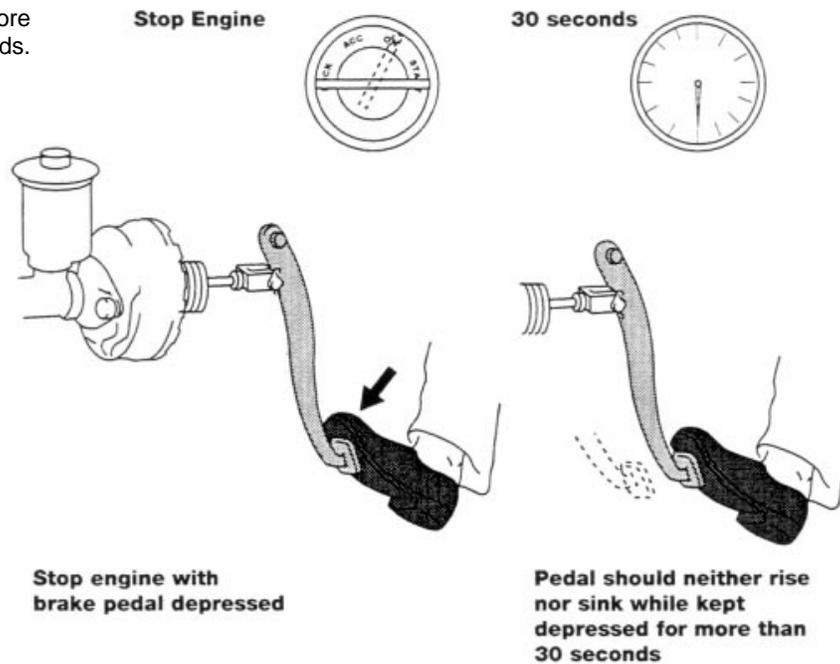
Air Tightness Test Under Load

Depress the brake pedal when the engine is running, then stop the engine and wait for about 30 seconds. If the brake pedal position does not change, the brake booster is functioning normally. It is defective if the brake pedal moves up.

The brake pedal reserve distance remains unchanged because vacuum is maintained in the Constant Pressure Chamber.

Booster Air Tightness Under Load

Stop the engine with the brake pedal depressed, the brake pedal should maintain the same height for more than 30 seconds.



Booster Push Rod Adjustment

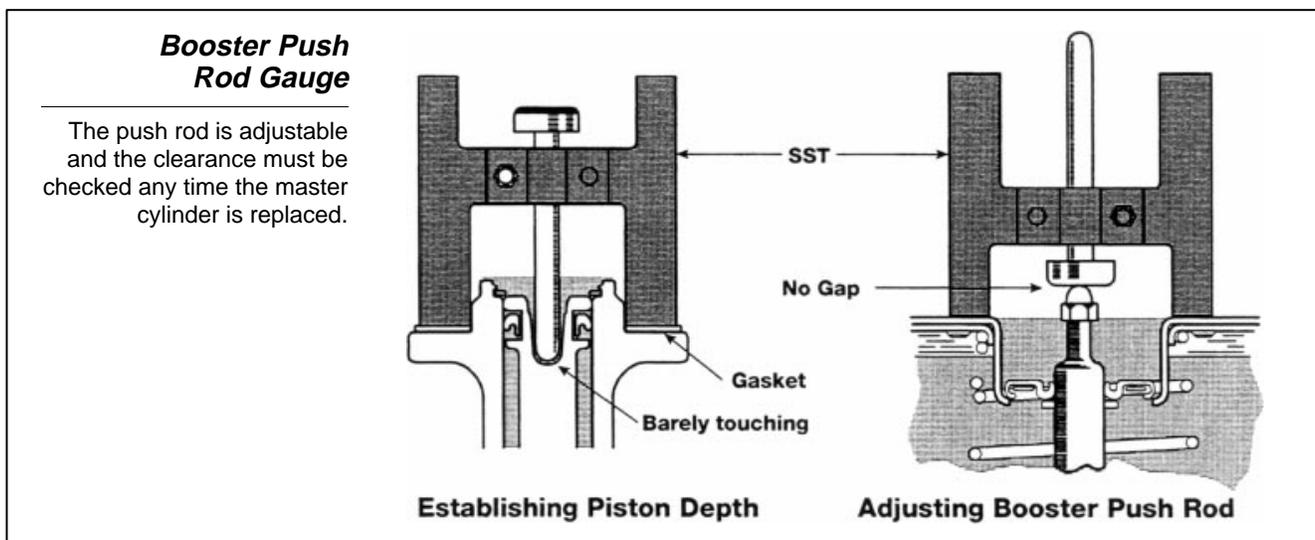
The Booster Push Rod projects from the front of the Brake Booster and activates the master cylinder. The push rod is adjustable and the clearance must be checked any time the master cylinder or booster is replaced. This is required to ensure the correct gap between the master cylinder piston and the booster push rod.

Problems can occur if the push rod is improperly adjusted:

- If the gap is too small, it may cause brake drag and premature brake wear.
- If the gap is too large, it may cause brake delay and reduced pedal reserve distance.

Prior to making the adjustment:

- Check the brake pedal freeplay to ensure the booster is not partially applied.
- Make the adjustment with the engine running to ensure the booster has vacuum. The booster body will change shape when a vacuum is applied and may reduce the clearance.



Adjusting Procedure:

1. Place a new gasket on the flange of the master cylinder. Set the push rod gauge over the end of the master cylinder with the rounded end of the tool plunger toward the piston.
2. Push the plunger down until it just touches the bottom of the piston bore.
3. Turn the gauge over and set the flat plunger end of the gauge on the booster and over the push rod. There should be no clearance between the booster push rod and the plunger.
4. Adjust the booster push rod if necessary. (If the brake pedal is depressed to expose the adjustment nut, be sure to start the engine before checking the adjusted clearance.)

Alternate Method for Booster Adjustment

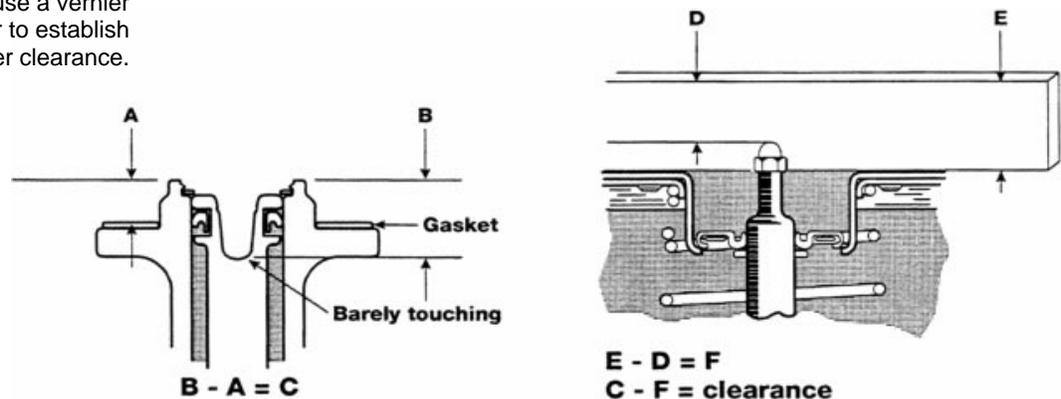
The preferred method of adjustment is the Booster Push Rod Gauge procedure just described. If the special service tool is not available the measurement procedure described here can be used to ensure a calculated clearance prior to installation of the master cylinder.

In this procedure, measure the distance between the bottom of the bore in the master cylinder primary piston to the top of the flange gasket using a depth micrometer or vernier caliper.

1. Measure from the rim of the cylinder bore to the new gasket on the flange, (measurement "A")
2. Measure from the rim of the cylinder bore to the bottom of the bore in the primary piston, (measurement "B")
3. Subtract A from B will give the depth of the piston bore from the master cylinder flange gasket, (measurement "C")

Alternate Measurement Method

If the Booster Push Rod Gauge is not available, use a vernier caliper to establish proper clearance.



Next, measure the height of the booster push rod.

1. Place a precision straight edge across the face of the booster body adjacent to the push rod.
2. Measure from the top of the straight edge to the top of the push rod. (measurement "D")
3. Measure the width of the straight edge, (measurement "E")
4. Subtract measurement "D" from "E" will give the height of the push rod. (measurement "F")
5. Clearance is determined by subtracting "F" from "C".
6. Adjust the push rod to obtain approximately 0.1 mm to 0.5 mm clearance.



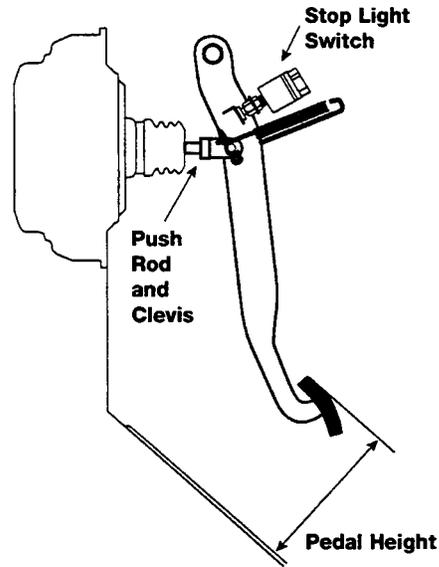
WORKSHEET 5-1 (ON-CAR)
Brake Pedal Measurement

Vehicle	Year/Prod. Date	Engine	Transmission
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In this Worksheet you will practice the procedure for measuring pedal height, pedal free play and pedal reserve distance.

Tools and Equipment:

- Measuring tape.
- Assortment of open-end wrenches.
- Feeler gauge.
- Trim removal tool.



Pedal Height:

1. Pull the carpet down from the bulkhead to the foot well to reveal the asphalt melt sheet, (remove sill plate or trim as needed)
2. Using the measuring tape, measure at a right angle from the brake pedal pad to the melt sheet.
3. Record your measurement in the box below.

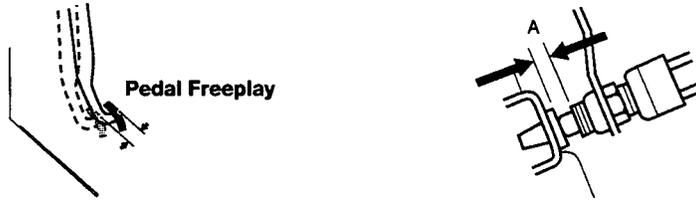
Measured Brake Pedal Height	Specification	Pass/Fail

1. Is the brake pedal height adjustable? If yes, explain how.

2. What effect would a low pedal height have on the brake system? Explain your answer.

Brake Pedal Freeplay:

1. Stop the engine and depress the brake pedal several times until there is no vacuum in the booster.
2. Depress the pedal by hand until the beginning of resistance is felt. Record this measurement below.



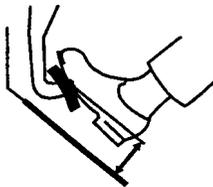
Measured Brake Pedal Freeplay	Specification	Pass/Fail

1. Why is the vacuum booster depleted before checking brake pedal freeplay?

2. If brake pedal freeplay is less than specification, what possible adjustment should be checked?

Brake Pedal Reserve Distance:

1. Release the parking brake.
2. With the engine running, depress the pedal with approximately 110 pounds of force.
3. Measure the pedal reserve distance at a right angle from the pedal pad to the melt sheet.



Measured Brake Pedal Reserve Distance	Specification	Pass/Fail

1. If the brake pedal height is within specification but pedal reserve distance is insufficient, list several possible causes?

2. Is brake pedal reserve distance adjustable? If yes, explain.



WORKSHEET 5-2 (ON-CAR)
Booster Push Rod Adjustment

Vehicle	Year/Prod. Date	Engine	Transmission
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Worksheet Objectives

In this Worksheet you will practice the procedure for measuring booster push rod to master cylinder clearance.

Tools and Equipment:

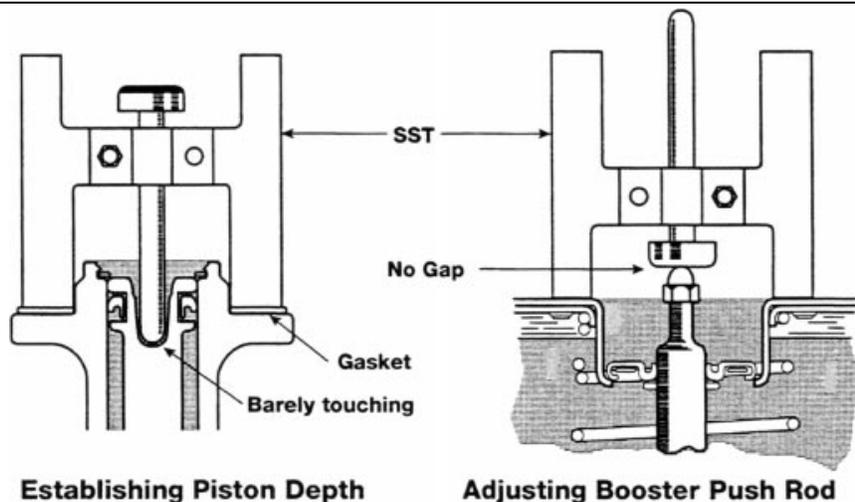
- Depth Micrometer.
- Straight Edge.
- Push Rod Gauge. (SST 09737-00010)
- 10mm combination wrench.
- Tubing Wrench set.
- Plugs for master cylinder ports.

Preparation:

- With the engine off, pump the brake pedal several times to reduce vacuum in the booster.
- Loosen and remove the brake tubes from the master cylinder.
- Remove the master cylinder from the brake booster.

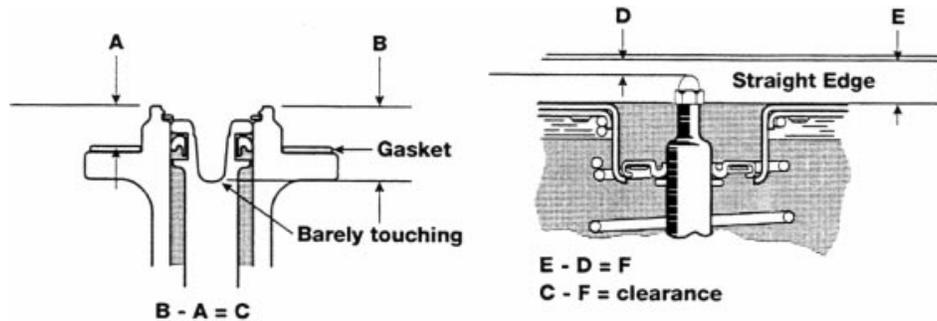
Measurement: (Using the special service tool)

1. Place a new gasket on the master cylinder.
2. Centering the Push Rod Gauge pin over the master cylinder piston and position the gauge on the gasket of the master cylinder.
3. Lower the pin into the piston until it lightly touches the bottom of the bore.
4. Start the engine and turn the opposite end of the gauge and center the head of the pin over the booster push rod.
5. Adjust the push rod as needed to ensure no gap between the push rod and the head of the pin.
6. Turn the engine OFF, deplete the vacuum in the booster by depressing the brake pedal several times.
7. Place the gauge over the booster push rod and push the pin toward the push rod. Did it move? Why?



Measurement: (Using the depth gauge)

- Place a new gasket on the master cylinder.
- Using a depth micrometer measure from the rim flange of the cylinder bore to the new gasket. This is measurement A.
- Using a depth micrometer measure from the rim flange of the cylinder bore to the bottom of the piston bore. This is measurement B.
- Place a straight edge over the brake booster gasket mating surface.
- Measure from the top side of the straight edge to the top of the booster push rod. This is measurement C.
- Subtract measurement C from the width of the straight edge to get measurement F. (push rod height)



Summary:

1. Using the measurements below, calculate the push rod clearance.
A = 13.76 mm
B = 20.8 mm
D = 28.5 mm
E = 35.5 mm

2. List two occasions when this adjustment should be done.

3. What difference is there between performing the adjustment with the engine running and not running?

4. If the push rod was too long, what is the most likely result?

5. If the push rod is too short (the clearance between the push rod and master cylinder piston is too great), what is the most likely result?
