

2008 BRAKES

Hydraulic Brakes - LaCrosse

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Front Brakes		
• Brake Hose Fitting Bolt	54 N.m	40 lb ft
• Brake Rotor Retention Screw	14 N.m	124 lb in
• Caliper Bracket Bolt	180 N.m	133 lb ft
• Caliper Guide Pin Bolt	36 N.m	27 lb ft
Rear Brakes		
• Brake Hose Fitting Bolt	54 N.m	40 lb ft
• Brake Rotor Retention Screw	14 N.m	124 lb in
• Caliper Bracket Bolt	120 N.m	89 lb ft
• Caliper Guide Pin Bolt	44 N.m	32 lb ft

BRAKE COMPONENT SPECIFICATIONS

Brake Component Specifications

Application	Specification	
	Metric	English
Brake Caliper Bleeder Valve - Front	13 N.m	115 lb in
Brake Caliper Bleeder Valve - Rear	11 N.m	97 lb in

BRAKE SYSTEM SPECIFICATIONS

Application	Specification	
	Metric	English
Brake Pedal Travel		
• Maximum specification with 445 N (100 lbs) of force applied to the brake pedal with the ignition OFF and the booster power reserve depleted	74 mm	2.91 in

SCHEMATIC AND ROUTING DIAGRAMS

HYDRAULIC BRAKE SCHEMATICS

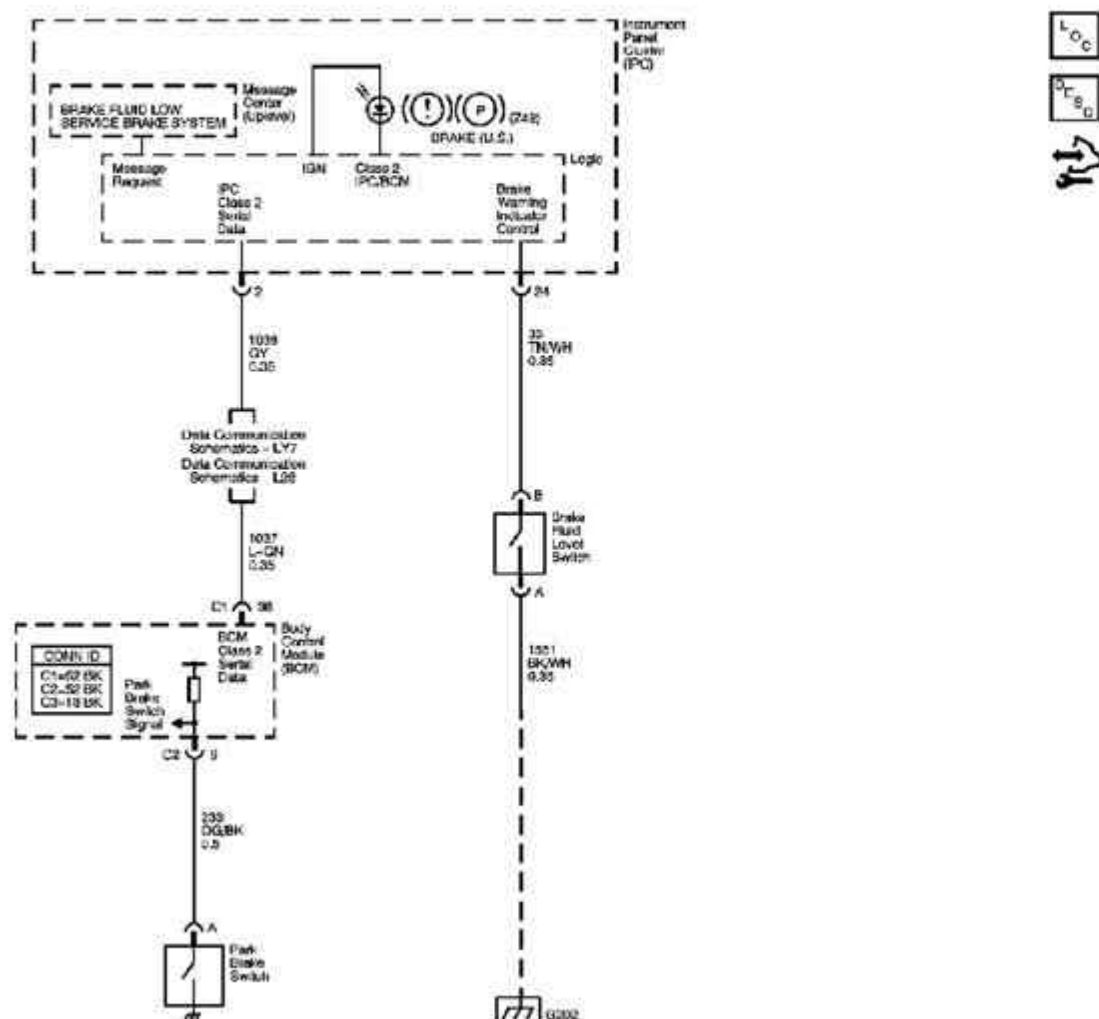


Fig. 1: Hydraulic Brakes/Brake Warning System Schematic
 Courtesy of GENERAL MOTORS CORP.

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC STARTING POINT - HYDRAULIC BRAKES

Begin the system diagnosis by reviewing the system Description and Operation. Reviewing the Description and Operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the Description and Operation information will also help you determine if the condition described by the customer is normal operation. Refer to **Symptoms - Hydraulic Brakes** in order to identify the correct procedure for diagnosing the system and where the procedure is located.

SYMPTOMS - HYDRAULIC BRAKES

IMPORTANT: The following steps must be completed before using the symptom tables.

1. Perform the **Brake System Vehicle Road Test** before using the hydraulic brake symptom tables in order to duplicate the customer's concern.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to the following:
 - **Brake Warning System Description and Operation**
 - **Hydraulic Brake System Description and Operation**
 - **Brake Assist System Description and Operation**
 - **Disc Brake System Description and Operation**

- Inspect for aftermarket devices which could affect the operation of the Hydraulic Brake System. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Brake Warning Indicator Malfunction**
- **Brake Pulsation**
- **Brake System Noise**
- **Braking Action Uneven - Pulls to One Side**
- **Braking Action Uneven - Front to Rear**
- **Brake Pedal Excessive Travel**
- **Brake Pedal Excessive Effort**
- **Brakes Drag**
- **Brake System Slow Release**
- **Brake Fluid Loss**

BRAKE WARNING INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Fluid Level Switch Signal Circuit	-	2	-	-
Brake Fluid Level Switch Ground Circuit	-	2	-	-
Park Brake Switch Signal Circuit	1	1	-	-
1. Always ON 2. Inoperative				

Circuit/System Description

The instrument panel cluster (IPC) sees the brake fluid level switch input grounded and illuminates the red brake indicator. The body control module (BCM) sees the park brake switch input grounded, it sends a serial data message to the IPC requesting illumination of the red brake indicator.

Diagnostic Aids

Inspect the master cylinder reservoir for the proper brake fluid level.

- If brake fluid level is low, refer to **Hydraulic Brake System Diagnosis**.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit/System Verification

With a scan tool, select instrument panel special functions Displays Test. Command the instrument panel lamps OFF. Verify the IPC brake lamp indicator turns off. If the IPC brake lamp indicator does not turn off check the circuit testing Brake Warning Indicator Always On.

With a scan tool, select instrument panel special functions Displays Test. Command the instrument panel lamps ON. Verify the IPC brake lamp indicator turns on. If the IPC brake lamp indicator does not turn on check the circuit testing Brake Warning Indicator Inoperative.

Circuit/System Testing

Brake Warning Indicator Inoperative

1. With the scan tool, select instrument panel special functions Displays Test. Command the instrument panel lamps ON. Verify brake lamp turns ON.
 - If the brake lamp does not turn ON, replace the IPC.
2. Release the park brake. Disconnect the brake fluid level switch. Connect a 3-amp jumper wire between the signal circuit of the brake fluid level switch and the ground circuit of the brake fluid level switch. Ignition ON, verify the brake lamp is ON.
 - If the brake lamp does not turn ON, test the signal circuit and ground circuit for a high resistance/open or replace the brake fluid level switch.
3. Disconnect the park brake switch. Connect a 3-amp jumper wire between signal circuit of the park brake switch and ground. Ignition ON, verify the brake lamp is ON.
 - If the brake lamp does not turn ON, test the signal circuit high resistance/open or replace the BCM.
4. Replace the park brake switch.

Brake Warning Indicator Always On

1. With the scan tool, select instrument panel special functions Lamp Test. Command the instrument panel lamps OFF. Verify brake lamp turns OFF.
 - If the brake lamp does not turn OFF, replace the IPC.
2. Disconnect the park brake switch. With a scan tool, observe the Park Brake Switch parameter. Verify parameter is reading ON.
 - If the parameter is OFF, replace the park brake switch.
3. Test the park brake switch signal circuit for a short to ground. Verify no short is found.
 - If short is found, repair the circuit.
4. Replace the BCM.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Brake Fluid Level Indicator Switch Replacement**
- **Parking Brake Indicator Switch Replacement**
- **Control Module References** for BCM and IPC replacement, setup, and programming

BRAKE PULSATION

Step	Action	Yes	No
DEFINITION: Fluctuation or pulsation is felt through the brake pedal, steering wheel, seat, floor, and/or in the vehicle ONLY when braking.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	1. Inspect the disc brake system for the following conditions. • Excessive thickness variation of rotor friction surfaces • Excessive assembled lateral runout (LRO) of rotor friction surfaces • Hard spots, heat checks, bluing discoloration of rotor friction surfaces; possibly due to brake drag • Excessive corrosion of rotor friction surfaces; including red, gray or black oxidation • Loose, damaged or missing caliper or lining hardware • Bent or damaged caliper or mounting component • Excessive LRO of wheel hub/axle flange; due to damage and/or loose or excessively worn bearings 2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.		Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
	Did you find and correct a condition?	Go to Step 3	<u>Go to Diagnostic Starting Point - Hydraulic Brakes</u>
	1. Install or connect components that were removed or		

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Step	disconnected and diagnosis.	Yes	No
DEFINITION: Road test vehicle for pulsation or felt through the brake pedal, steering wheel, seat, floor, and/or in the vehicle. Refer to Brake System Vehicle Road Test .			
3	Is the condition still present?	Go to Step 2	System OK

BRAKE SYSTEM NOISE

Step	Action	Yes	No
DEFINITION: Vehicle exhibits abnormal noise when braking; vehicle may exhibit abnormal noise during motion just after brake pedal release.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	1. Inspect the disc brake system for the following conditions. • Lining wear indicator contact with rotor • Debris trapped between rotor and splash shield or backing plate; and/or debris trapped between rotor and linings • Contaminated linings • Aftermarket linings • Glazed linings • Distorted, cracked or damaged linings • Excessively worn linings • Damaged or excessively worn caliper hardware and/or lining hardware • Incorrectly installed, loose or missing caliper hardware and/or lining hardware • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Bent or damaged splash shield or backing plate • Hard spots, heat checks, blueing discoloration of rotor friction surfaces • Glazed rotor friction surfaces • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?	Go to Step 9	Go to Step 3
	1. Inspect the brake assist system for the following conditions. • Lack of lubrication or excessively worn pushrod or pedal pivots or pivot bushings • Bent or damaged pedal pushrod, pedal, or		

3	pedal bracket • Damaged or improperly operating vacuum booster and/or check valve, if equipped • Low power steering fluid level, if equipped with hydraulic boost • Improperly tensioned, excessively worn or damaged power steering belt, if equipped with hydraulic boost • Restricted return hose from hydraulic booster, if equipped • Improperly operating hydraulic booster, if equipped • Improperly functioning power steering system, if equipped with a hydraulic booster assembly • Contaminated power steering fluid, if equipped with hydraulic boost 2. Adjust, repair or replace components as necessary. Refer to <u>Brake Assist System Diagnosis</u>. Did you find and correct a condition?	Go to Step 9	Go to Step 4
4	1. Inspect the hydraulic brake system for the following conditions. • Improper operation of caliper pistons • Contaminated brake fluid 2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 9	Go to Step 5
5	Is the vehicle equipped with a drum-in-rotor type of park brake system?	Go to Step 6	Go to Step 9
6	Ensure the park brake shoes are not adjusted too tightly, possibly causing a noise under certain conditions. Are the park brake shoes adjusted too tightly?	Go to Step 7	Go to Step 9
7	1. Clean and inspect the park brake shoes for excessive wear and/or damage. 2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration, heat spots, and excessive radial runout. 3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system. Did you find and correct a condition?	Go to Step 9	Go to Step 8
8	Inspect the park brake system for proper operation. Refer to <u>Park Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 9	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
	1. Install or connect components that were removed or disconnected during diagnosis.		

Step	Action	Yes	No
2.	Road test the vehicle in order to confirm proper operation. Refer to Brake System Vehicle Road Test .		
1.	Were you sent here from the Hydraulic Brake Symptom table?	Go to Diagnostic Starting Point -	System OK

BRAKING ACTION UNEVEN - PULLS TO ONE SIDE

Test Description

The numbers below refer to the step numbers on the diagnostic table.

- 4: Suspension components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.
- 5: Steering components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

Step	Action	Yes	No
DEFINITION: Vehicle pulls to one side only when braking.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	1. Inspect the hydraulic brake system for the following conditions. • Kinked, pinched or damaged brake pipe or flexible brake hose • Sticking or improperly operating caliper piston • Brake fluid leak 2. Adjust, repair or replace components as necessary. Refer to Hydraulic Brake System Diagnosis .		
	Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	1. Inspect the disc brake system for the following conditions. • Contaminated linings • Glazed linings • Distorted, cracked or damaged linings on one side • Loose, damaged or missing caliper hardware and/or lining hardware • Incorrect linings on one side • Hard spots, heat checks, blueing discoloration of rotor friction surfaces; possibly due to brake drag • Glazed rotor friction surfaces • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary.		

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	Refer to <u>Disc Brake System Diagnosis</u> .		
	Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	- Inspect the suspension system for the following conditions. - Incorrect tire pressures - Loose suspension component connections - Excessively worn or damaged suspension components - Adjust, repair or replace components as necessary. Refer to <u>Diagnostic Starting Point - Suspension General Diagnosis</u>.		
	Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	- Inspect the steering system for the following conditions. - Loose steering component connections - Excessively worn or damaged steering components - Adjust, repair or replace components as necessary. Refer to <u>Diagnostic Starting Point - Power Steering System (w/o Electro-Hydraulic Steering)</u>.		
	Did you find and correct a condition?	Go to Step 6	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
6	- Install or connect components that were removed or disconnected during diagnosis. - Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>.		
	Is the condition still present?	Go to Step 2	System OK

BRAKING ACTION UNEVEN - FRONT TO REAR

Test Descriptions

The number below refers to the step number on the diagnostic table.

4: Suspension components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

Step	Action	Yes	No
DEFINITION: Braking action or stopping force sensitive or grabbing and/or more pronounced at the front or at the rear axle. Sensitive or grabbing brakes: Excessive brake jump-in force relative to brake pedal input.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
	Inspect the hydraulic brake system for the following conditions:		

2	• Improper operation of caliper pistons • Kinked, pinched or damaged brake pipe or flexible brake hose • Brake fluid leak • Improperly functioning proportion valve, if equipped • Improper operation of dynamic rear proportion (DRP) system, if equipped 2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>.		
	Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	1. Inspect the disc brake system for the following conditions: • Contaminated linings • Glazed linings • Distorted, cracked or damaged linings • Excessively worn linings • Aftermarket linings • Damaged or excessively worn caliper hardware and/or lining hardware • Hard spots, heat checks, blueing discoloration of rotor friction surfaces • Glazed rotor friction surfaces 2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.		
	Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	1. Inspect the suspension system for the following conditions: • Loose suspension component connections • Excessively worn or damaged suspension components 2. Adjust, repair or replace components as necessary. Refer to <u>Diagnostic Starting Point - Suspension General Diagnosis</u>.		
	Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	1. Inspect the brake assist system for the following conditions: • Binding, bent or damaged pedal pushrod, pedal, or pedal bracket • Damaged or improperly operating vacuum booster, if equipped • Damaged or improperly operating hydraulic booster, if equipped 2. Adjust, repair or replace components as necessary.		

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	Refer to <u>Brake Assist System Diagnosis</u> .		Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
	Did you find and correct a condition?	Go to Step 6	
6	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>.		
	Is the condition still present?	Go to Step 2	System OK

BRAKE PEDAL EXCESSIVE TRAVEL

Step	Action	Yes	No
DEFINITION: Brake pedal travels further than expected to obtain firm pedal and/or firm pedal cannot be obtained, pedal fades away, or pedal is spongy.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	Inspect the travel and feel of brake pedal applies. Perform the following: 1. Apply the brake pedal several times to fully deplete the power reserve. 2. With power reserve depleted, apply the brake pedal with light, steady pressure and hold for 15 seconds. Observe pedal travel and feel. 3. Apply the brake pedal with light, steady pressure, then without pumping the pedal, reduce pressure and reapply pressure several times. Observe pedal travel and feel for each apply. 4. Apply the brake pedal slowly, then release and apply the pedal quickly. Observe pedal travel and feel for each apply. Did you complete the brake pedal travel and feel inspections?	Go to Step 3	-
	1. Inspect the hydraulic brake system for the conditions listed, based on the following symptoms observed during the pedal travel and feel inspections: • Pedal feel was spongy ■ Air in hydraulic system ■ External brake fluid leaks ■ Soft, weak or damaged hydraulic hoses; expanding under pressure • Pedal fell away and/or traveled to or almost to floor ■ External brake fluid leaks		

3	■ Poor brake fluid quality; low boiling point ■ Internal brake fluid leaks; improperly functioning master cylinder ● Pedal was somewhat firm then dropped slightly, or pedal rose with successive applies, or pedal travel was different between slow and quick applies ■ Internal brake fluid leaks; improperly functioning master cylinder ■ Poor brake fluid quality; low boiling point ● Pedal returned to rest slowly after any of the applies ■ Internally damaged flexible brake hoses; hindering fluid return ■ Binding caliper pistons ■ Internal brake fluid leaks; improperly functioning master cylinder 2. Repair or replace components as necessary. Refer to Hydraulic Brake System Diagnosis. 3. Re-inspect brake pedal apply travel and feel. Did you find and correct a condition?	Go to Step 8	Go to Step 4
4	1. Inspect the disc brake system for the following conditions: ● Cracked, excessively worn or damaged linings ● Cracked, excessively worn or damaged rotors ● Improperly operating, binding or damaged caliper hardware and/or lining hardware ● Loose or missing caliper hardware and/or lining hardware ● Excessive assembled lateral runout (LRO) of rotor friction surfaces ● Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to Disc Brake System Diagnosis. 3. Re-inspect brake pedal apply travel and feel. Did you find and correct a condition?	Go to Step 8	Go to Step 5
5	Inspect for proper brake pedal travel. Refer to Brake Pedal Travel Measurement and Inspection. Is the brake pedal travel distance within the acceptable limits?	Go to Step 7	Go to Step 6
	1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. ● For the brake pedal pushrod component		

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6	inspection, refer to <u>Brake Pedal Pushrod Inspection</u> . Inspect the brake pedal bushings for binding, excessive wear and/or damage and inspect the brake pedal for a misaligned, bent, and/or damaged condition. 2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?	Go to Step 8	Go to Step 7
7	1. Inspect the brake assist system for the following conditions: - Vacuum leaks and/or improperly operating check valve, if equipped with vacuum assist - Damaged or improperly operating brake booster assembly 2. Adjust, repair or replace components as necessary. Refer to <u>Brake Assist System Diagnosis</u>. Did you find and correct a condition?	Go to Step 8	Go to Diagnostic Starting Point - Hydraulic Brakes
8	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>. Is the condition still present?	Go to Step 2	System OK

BRAKE PEDAL EXCESSIVE EFFORT

Step	Action	Yes	No
DEFINITION: Brake pedal requires an increased amount of input from the driver to obtain good braking action and/or stopping distance is increased.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	1. Inspect the brake assist system for the following conditions: - Vacuum leaks, if equipped with vacuum power assist - Lack of lubrication, binding or excessively worn pushrod or pedal pivots or pivot bushings - Bent or damaged pedal pushrod, pedal, or pedal bracket - Damaged or improperly operating brake booster assembly 2. Adjust, repair or replace components as necessary.		

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	Refer to <u>Brake Assist System Diagnosis</u> .		
	Did you find and correct a condition?	Go to Step 5	Go to Step 3
3	- Inspect the hydraulic brake system for the following conditions: • Binding caliper pistons • Internally damaged flexible brake hoses; hindering fluid flow • External brake fluid leaks • Kinked or damaged flexible brake hoses and/or pipes • Internal brake fluid leaks; improperly operating master cylinder • Poor brake fluid quality; low boiling point - Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>.		
	Did you find and correct a condition?	Go to Step 5	Go to Step 4
4	- Inspect the disc brake system for the following conditions: • Excessively worn linings • Glazed linings • Cracked, distorted or damaged linings • Contaminated linings • Binding, damaged or excessively worn caliper hardware and/or lining hardware • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Excessively worn or corroded rotor friction surfaces • Glazed rotor friction surfaces • Hard spots, heat checks, blueing discoloration of rotor friction surfaces - Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.		
	Did you find and correct a condition?	Go to Step 5	Go to Diagnostic Starting Point - Hydraulic Brakes
5	- Install or connect components that were removed or disconnected during diagnosis. - Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>.		
	Is the condition still present?	Go to Step 2	System OK

BRAKES DRAG

Step	Action	Yes	No
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DEFINITION: Brake system does not fully release or has delayed release; vehicle motion may be hindered by brake system without applying brakes.

1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	Is the vehicle equipped with an adjustable stop lamp switch and/or an adjustable cruise control release switch?	Go to Step 3	Go to Step 4
3	1. Inspect the stop lamp switch for proper adjustment to ensure that the brake pedal is fully releasing. 2. Inspect the cruise control release switch, if equipped, for proper adjustment to ensure that the brake pedal is fully releasing. Did you find and correct a condition?	Go to Step 14	Go to Step 4
4	Is the vehicle equipped with a drum-in-rotor type of park brake system?	Go to Step 5	Go to Step 7
5	Ensure the park brake shoes are not adjusted too tightly, possibly causing drag under certain conditions. Are the park brake shoes adjusted too tightly?	Go to Step 6	Go to Step 7
6	1. Clean and inspect the park brake shoes for excessive wear and/or damage. 2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration and heat spots. 3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system. Did you find and correct a condition?	Go to Step 14	Go to Step 7
7	Inspect the park brake system for proper operation. Refer to Park Brake System Diagnosis. Did you find and correct a condition?	Go to Step 14	Go to Step 8
8	1. Inspect the disc brake system for the following conditions: • Binding, incorrectly installed or missing caliper hardware and/or lining hardware-Ensure free movement of linings and of caliper, if equipped with sliding type caliper • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Distorted or damaged linings • Damaged or excessively worn caliper hardware and/or lining hardware • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to Disc Brake System Diagnosis. Did you find and correct a condition?	Go to Step 14	Go to Step 9
	1. Separate the brake booster pushrod from the brake		

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9	pedal. 2. Inspect the brake corners to determine if the brake drag condition is still present. Do the brake corners still exhibit the brake drag condition?	Go to Step 11	Go to Step 10
10	1. Inspect the pushrod for improper positioning and/or damage. Correctly position or replace the pushrod if necessary. 2. Inspect the brake pedal assembly for damage and replace if necessary. Did you complete the repair or replacement?	Go to Step 14	-
11	1. For vacuum boost systems, disconnect the vacuum check valve from the booster to relieve vacuum reserve. 2. Separate the master cylinder from the brake booster. Do not disconnect any brake pipes. 3. Inspect the brake corners to determine if the brake drag condition is still present. Do the brake corners still exhibit the brake drag condition?	Go to Step 13	Go to Step 12
12	Replace the brake booster assembly. Did you complete the replacement?	Go to Step 14	-
13	1. Inspect the hydraulic brake system for the following conditions. • Improper operation of caliper pistons • Contaminated brake fluid • Internally damaged flexible brake hoses; hindering brake release • Damaged or improperly operating master cylinder 2. Adjust, repair or replace components as necessary. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?	Go to Step 14	Go to Diagnostic Starting Point - Hydraulic Brakes
14	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to Brake System Vehicle Road Test. Is the condition still present?	Go to Step 2	System OK

BRAKE SYSTEM SLOW RELEASE

Step	Action	Yes	No
DEFINITION: Brake system releases and returns to rest slowly; vehicle motion is hindered by brake system			

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briefly after release of brake pedal.

1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	- Inspect the hydraulic brake system for the following conditions: - Improper operation of caliper pistons - Internally damaged flexible brake hoses; hindering brake release - Contaminated brake fluid - Damaged or improperly operating master cylinder - Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 5	Go to Step 3
3	- Inspect the brake assist system for the following conditions: - Binding, bent or damaged pedal pushrod, pedal, or pedal bracket - Damaged or improperly operating vacuum booster, if equipped - Restricted return hose from hydraulic booster, if equipped - Damaged or improperly operating hydraulic booster, if equipped - Adjust, repair or replace components as necessary. Refer to <u>Brake Assist System Diagnosis</u>. Did you find and correct a condition?	Go to Step 5	Go to Step 4
4	- Inspect the disc brake system for the following conditions: - Damaged or excessively worn caliper hardware and/or lining hardware - Distorted or damaged linings - Lack of lubrication or excessive corrosion on metal to metal contact surfaces - Bent or damaged caliper or mounting component - Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 5	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
5	- Install or connect components that were removed or disconnected during diagnosis. - Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>.		

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Is the condition still present?

Go to **Step 2**

System OK

BRAKE FLUID LOSS

Step	Action	Yes	No
DEFINITION: Brake fluid level is low not related to lining wear.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to Diagnostic Starting Point - Hydraulic Brakes
2	- Inspect the following hydraulic brake system components for brake fluid leaks: - Flexible brake hose connections; threaded and bolted - Flexible brake hose crimp joints - Brake pipe fittings - Caliper piston seals - Wheel cylinder piston seals, if equipped - Master cylinder reservoir - Master cylinder reservoir low pressure hose, if equipped - Brake pressure modulator valve (BPMV) assembly, if equipped - Repair or replace components as necessary. Refer to Hydraulic Brake System Diagnosis. Did you find and correct a condition?	Go to Step 8	Go to Step 3
3	Is the vehicle equipped with a vacuum brake booster?	Go to Step 4	Go to Step 6
4	- Disconnect the vacuum check valve from the booster to relieve vacuum reserve. - Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. - Inspect the rear of the master cylinder for a brake fluid leak. - Inspect for brake fluid in the vacuum brake booster. Did you find a brake fluid leak?	Go to Step 5	Go to Diagnostic Starting Point - Hydraulic Brakes
5	Replace the brake master cylinder and the vacuum brake booster. Did you complete the replacement?	Go to Step 8	-
6	- Wipe clean the external surface of the master cylinder to hydraulic brake booster area, if equipped. - Separate the master cylinder from the hydraulic brake booster, if equipped. Do not disconnect any brake pipes. - Inspect the rear of the master cylinder for a brake fluid leak.		Go to Diagnostic Starting Point -

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	Did you find a brake fluid leak?	Go to Step 7	Hydraulic Brakes
7	Replace the brake master cylinder. Did you complete the replacement?	Go to Step 8	-
8	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u> .		
	Is the condition still present?	Go to Step 2	System OK

DISC BRAKE SYSTEM DIAGNOSIS**Test Description**

The numbers below refer to the step numbers on the diagnostic table.

9: Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.

10: Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.

12: Disc brake rotor shields/backing plates that come in contact with disc brake rotors may cause brake system noise.

15: Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.

19: Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.

22: Disc brake rotor assembled lateral runout (LRO) that exceeds the maximum acceptable level can lead to thickness variation.

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the DISC brake system in order to determine if the DISC brake system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	Visually inspect the disc brake pads for the following conditions: Refer to <u>Brake Pad Inspection</u> . • Lining thickness below specifications • Uneven and/or abnormal wear - edge-to-edge and/or side-to-side • Looseness or damage - including pad hardware • Evidence of contamination from an external substance Did you find any conditions to indicate a concern with		

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	any of the front and/or rear disc brake pads?	Go to Step 3	Go to Step 12
3	Are any of the front and/or rear disc brake pads contaminated?	Go to Step 8	Go to Step 4
4	Are any of the front and/or rear disc brake pads worn unevenly?	Go to Step 7	Go to Step 5
5	Are any of the front and/or rear disc brake pads and/or pad hardware loose or damaged?	Go to Step 7	Go to Step 6
6	1. Remove and inspect the worn disc brake pads for glazing, looseness, heat spots or damage. 2. Replace the worn disc brake pads as a complete axle set. Refer to Front Disc Brake Pads Replacement (JL9) or Rear Disc Brake Pads Replacement (J65). Did you complete the inspection and replacement?		-
7	NOTE: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak. IMPORTANT: Do NOT disconnect the hydraulic brake flex hoses from the calipers. 1. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets and support the calipers. Refer to Front Brake Caliper Replacement (JL9) or Rear Brake Caliper Replacement (J65). 2. Inspect the disc brake caliper mounting bracket and the mounting/sliding hardware for the following conditions: Refer to Front Disc Brake Mounting and Hardware Inspection and/or Rear Disc Brake Mounting and Hardware Inspection. • Binding or seized hardware • Worn, damaged or missing hardware components • Loose, bent, cracked, or damaged caliper mounting bracket 3. Replace components as required. Refer to the following procedures, as required: • Front Brake Caliper Bracket Replacement • Rear Brake Caliper Bracket Replacement		-

	• <u>Front Disc Brake Hardware Replacement</u> • <u>Rear Disc Brake Hardware Replacement</u> 4. Replace the unevenly-worn, loose or damaged disc brake pads as a complete axle set. Refer to <u>Front Disc Brake Pads Replacement</u> and/or <u>Rear Disc Brake Pads Replacement (JL9)</u> or <u>Rear Disc Brake Pads Replacement (J65)</u> . Did you complete the inspection and replacement?	Go to Step 12	
8	1. Inspect the disc brake calipers, brake hoses and brake pipes for evidence of an external brake fluid leak. 2. Replace any components found to be leaking brake fluid. Refer to the following procedures as required: • <u>Front Brake Caliper Overhaul</u> or <u>Front Brake Caliper Replacement</u> • <u>Rear Brake Caliper Overhaul (JL9)</u> <u>Rear Brake Caliper Overhaul (J65)</u> or <u>Rear Brake Caliper Replacement (JL9)</u> <u>Rear Brake Caliper Replacement (J65)</u> • <u>Front Brake Hose Replacement</u> • <u>Rear Brake Hose Replacement</u> • <u>Brake Pipe Replacement</u> Did you find and correct the source of the leak causing contamination of the pads?	Go to Step 11	Go to Step 9
9	1. Inspect the wheel drive shaft outer seals for damage and evidence of a grease leak. 2. Replace any wheel drive shaft seal that is found to be leaking grease which may be the source of the contamination to the pads. Refer to <u>Wheel Drive Shaft Outer Joint and Boot Replacement</u> . Did you find and correct the source of the leak causing contamination of the pads?	Go to Step 11	Go to Step 10
10	1. Inspect the automatic transmission cooling system lines, if equipped, for damage and evidence of an external fluid leak which may be the source of the contamination to the pads. 2. Inspect the power steering system hoses for damage and evidence of an external fluid leak which may be the source of the contamination to the pads. 3. Replace any components found to be leaking fluid which may be the source of the contamination to the pads. Did you find and correct the source of the leak causing contamination of the pads?	Go to Step 11	-
	1. Clean the remaining disc brake system components		

11	to remove any traces of the contaminant. NOTE: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak. IMPORTANT: Do NOT disconnect the hydraulic brake flex hoses from the calipers. 2. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets and support the calipers. Refer to <u>Front Brake Caliper Replacement</u> and/or <u>Rear Brake Caliper Replacement (JL9)</u> or <u>Rear Brake Caliper Replacement (J65)</u> . 3. Inspect the disc brake caliper mounting/sliding hardware for the following conditions: Refer to <u>Front Disc Brake Mounting and Hardware Inspection</u> and/or <u>Rear Disc Brake Mounting and Hardware Inspection</u> . • Binding or seized hardware • Distorted, worn, damaged or missing hardware components 4. Replace the caliper mounting/sliding hardware components as required. Refer to <u>Front Disc Brake Hardware Replacement</u> and/or <u>Rear Disc Brake Hardware Replacement</u> . 5. Replace the contaminated disc brake pads as a complete axle set. Refer to <u>Front Disc Brake Pads Replacement</u> and/or <u>Rear Disc Brake Pads Replacement (JL9)</u> or <u>Rear Disc Brake Pads Replacement (J65)</u> . Did you complete the cleaning, inspection and replacement?	Go to Step 12	-
12	Visually inspect each of the rear disc brake rotor shields/backing plates, if equipped, for evidence of contact with the brake rotors. Are any of the brake rotor shields/backing plates contacting the brake rotors?	Go to Step 13	Go to Step 14
13	Repair or replace the disc brake rotor shields/backing plates as required. Refer to <u>Rear Disc Brake Backing Plate Replacement</u> . Did you complete the repair or replacement?	Go to Step 14	-
	1. Check the thickness of each of the disc brake rotors.		

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14	IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor. 2. Make a determination for each brake rotor if the rotor can be REFINISHED and REMAIN ABOVE the minimum requirements. Refer to <u>Brake Rotor Thickness Measurement</u> .Does the disc brake rotor meet the minimum requirements for REFINISHING?	Go to Step 15	Go to Step 18
15	IMPORTANT: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor. Inspect each of the disc brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to <u>Brake Rotor Thickness Variation Measurement</u> .Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?	Go to Step 17	Go to Step 16
16	1. Inspect each of the disc brake rotors for the following surface and wear conditions: Refer to <u>Brake Rotor Surface and Wear Inspection</u> . • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor. 2. Make a determination for each brake rotor if the rotor requires refinishing based upon the results of the inspection. If the brake rotor exhibits any of the conditions listed previously, it requires refinishing. Does the brake rotor require REFINISHING?	Go to Step 17	Go to Step 22
17	1. Refinish the brake rotor. Refer to <u>Brake Rotor Refinishing</u> . 2. Inspect the brake rotor thickness. Refer to <u>Brake Rotor Thickness Measurement</u> . Were you able to REFINISH the brake rotor within the minimum requirements?	Go to Step 22	Go to Step 21
	Is the brake rotor at or below the DISCARD		

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18	requirements (J55), or below the MINIMUM THICKNESS requirements, (JL9)?	Go to Step 21	Go to Step 19
19	IMPORTANT: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor. Inspect each of the disc brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to <u>Brake Rotor Thickness Variation Measurement</u> .Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?	Go to Step 21	Go to Step 20
20	1. Inspect each of the disc brake rotors for the following surface and wear conditions: Refer to <u>Brake Rotor Surface and Wear Inspection</u> . • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor. 2. Make a determination for each brake rotor if the rotor requires replacement based upon the results of the inspection. If the brake rotor exhibits any of the conditions listed previously, it requires replacement. Does the brake rotor require REPLACEMENT?	Go to Step 21	Go to Step 22
21	IMPORTANT: Whenever a brake rotor is replaced, the assembled lateral runout (LRO) of the rotor must be measured to ensure optimum performance of the disc brakes. Replace the brake rotor. Refer to <u>Front Brake Rotor Replacement</u> or <u>Rear Brake Rotor Replacement</u> .Did you complete the replacement?	Go to Step 24	-
22	IMPORTANT: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor. Inspect each of the disc brake rotors for assembled lateral runout (LRO) that exceeds the maximum acceptable level. Refer to <u>Brake Rotor Assembled Lateral Runout Measurement</u> .Does the brake rotor exhibit assembled LRO that exceeds the maximum acceptable level?	Go to Step 23	Go to Step 24

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23	Correct the LRO for each brake rotor that was determined to have LRO exceeding the maximum acceptable level. Refer to <u>Brake Rotor Assembled Lateral Runout Correction</u> . Did you complete the operation?	Go to Step 24	-
24	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Disc Brake System OK Return to Symptom Table	-

HYDRAULIC BRAKE SYSTEM DIAGNOSIS

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the HYDRAULIC brake system in order to determine if the HYDRAULIC brake system is operating properly. You will be directed by the appropriate Symptom Table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom Table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	Inspect and adjust the brake fluid level in the brake master cylinder. Refer to <u>Master Cylinder Reservoir Filling</u> . Was the brake fluid level low?	Go to Step 3	Go to Step 4
3	- Inspect the brake fluid for the following conditions, indicating brake fluid contamination: - Fluid separation (indicating two types of fluid are present) - Swirled appearance - oil-based substance - Layered appearance - silicone-based substance - Fluid discoloration - Cloudy appearance - moisture - Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust - Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination. Do any of the above conditions exist?	Go to Step 5	Go to Step 6
4	- Inspect the brake fluid for the following conditions, indicating brake fluid contamination: - Fluid separation (indicating 2 types of fluid are present) - Swirled appearance - oil-based substance - Layered appearance - silicone-based substance - Fluid discoloration - Cloudy appearance - moisture - Dark appearance/suspended particles in		

	fluid - dirt, rust, corrosion, brake dust 2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination. Do any of the above conditions exist?	Go to Step 5	Go to Step 12
5	1. Flush the hydraulic brake system. Refer to <u>Hydraulic Brake System Flushing</u>. 2. If the brake fluid WAS contaminated with an oil-based or a silicone-based fluid (indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets), perform the following: 1. Remove ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. 2. Clean out the hydraulic brake pipes using denatured alcohol (or equivalent). 3. Dry the brake pipes using non-lubricated, filtered air. 4. Repair or replace ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. • <u>Master Cylinder Overhaul</u> or <u>Master Cylinder Replacement</u> ; also perform the following: Clean the brake master cylinder reservoir using denatured alcohol (or equivalent), then dry the reservoir using non-lubricated, filtered air, or if necessary, replace the brake master cylinder reservoir. Replace the brake master cylinder reservoir cap diaphragm. • <u>Front Brake Hose Replacement</u> • <u>Rear Brake Hose Replacement</u> • <u>Front Brake Caliper Overhaul</u> or <u>Front Brake Caliper Replacement</u> • <u>Rear Brake Caliper Overhaul (JL9)</u> <u>Rear Brake Caliper Overhaul (J65)</u> or <u>Rear Brake Caliper Replacement (JL9)</u> <u>Rear Brake Caliper Replacement (J65)</u> • <u>Brake Pressure Modulator Valve</u>		-

	<u>Replacement</u> , if equipped - If the brake fluid was NOT contaminated with an oil-based fluid, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm which may have allowed moisture or dirt to enter the system. - Refill and bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manual)</u> or <u>Hydraulic Brake System Bleeding (Pressure)</u>. Did you complete the operation and any required repairs and/or replacements?		
6	- Inspect the following hydraulic brake system components for external fluid leaks; repair or replace any of the components found to be leaking brake fluid. Refer to the appropriate procedure(s): <u>Master Cylinder Overhaul</u> or <u>Master Cylinder Replacement</u> Brake master cylinder reservoir cap diaphragm <u>Front Brake Hose Replacement</u> <u>Rear Brake Hose Replacement</u> <u>Brake Pipe Replacement</u> <u>Front Brake Caliper Overhaul</u> or <u>Front Brake Caliper Replacement</u> <u>Rear Brake Caliper Overhaul (JL9)</u> <u>Rear Brake Caliper Overhaul (J65)</u> or <u>Rear Brake Caliper Replacement (JL9)</u> <u>Rear Brake Caliper Replacement (J65)</u> <u>Brake Pressure Modulator Valve Replacement</u> , if equipped - If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. While bleeding the hydraulic brake system, observe for the following: Refer to <u>Hydraulic Brake System Bleeding (Manual)</u> or <u>Hydraulic Brake System Bleeding (Pressure)</u>. - The presence of air in the system at a bleeder valve location other than at the repair location (except if the brake master cylinder and/or the proportioning valves, if equipped [non-ABS], were replaced)	Go to Step 9	

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	An unrestricted and even flow of brake fluid per axle (during the bleeding procedure)		
	Did you find and correct a condition?	Go to Step 7	Go to Step 12
7	Was there air in the system at a bleeder valve location other than at the repair location, (except if the brake master cylinder and/or the proportioning valves, if equipped (non-ABS), were replaced)?	Go to Step 19	Go to Step 8
8	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 9	Go to Step 10
9	Inspect the hydraulic function of the brake calipers for proper operation. Refer to Hydraulic Brake Component Operation Visual Inspection . Was the hydraulic function of the brake calipers operating properly?	Go to Step 21	Go to Step 14
10	Was the flow of brake fluid restricted or uneven through front axle hydraulic components during the bleeding procedure?	Go to Step 13	Go to Step 11
11	Was the flow of brake fluid restricted or uneven through rear axle hydraulic components during the bleeding procedure?	Go to Step 17	-
12	Inspect the hydraulic function of the brake calipers for proper operation. Refer to Hydraulic Brake Component Operation Visual Inspection . Was the hydraulic function of the brake calipers operating properly?	Go to Step 15	Go to Step 13
13	Determine if the brake caliper is restricting the flow of brake fluid and/or not operating properly: 1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle. 2. Remove the tire and wheel assemblies. Refer to Tire and Wheel Removal and Installation. 3. Open the suspected caliper bleeder valve. 4. Using a large C-clamp, compress the caliper piston and observe for an unrestricted flow of brake fluid and for free movement of the caliper piston. 5. Close the caliper bleeder valve. Was the flow of brake fluid unrestricted and did the caliper piston move freely?	Go to Step 17	Go to Step 14
14	Repair or replace any brake caliper that was not operating properly. Refer to the appropriate procedure (s). Front Brake Caliper Overhaul or Front Brake Caliper Replacement Rear Brake Caliper Overhaul (JL9) or Rear Brake Caliper Overhaul (J65) or Rear Brake Caliper Replacement (JL9) or Rear Brake		-

<u>Caliper Replacement (J65)</u>			
	Did you complete the repair and/or replacement?	Go to Step 21	
15	Bleed the hydraulic brake system to observe for the presence of air in the system and to observe for an unrestricted and even flow of brake fluid per axle (during the bleeding procedure). Refer to <u>Hydraulic Brake System Bleeding (Manual)</u> or <u>Hydraulic Brake System Bleeding (Pressure)</u> . Was there air in the system?	Go to Step 19	Go to Step 16
16	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 21	Go to Step 17
17	1. Inspect the hydraulic brake pipes and flexible brake hoses for signs of a fluid restriction; such as being bent, kinked, pinched or damaged. Refer to <u>Brake Pipe and Hose Inspection</u>. 2. Replace any of the hydraulic brake pipes and/or flexible brake hoses found to be bent, kinked, pinched or damaged. Refer to the following procedures as necessary: • <u>Front Brake Hose Replacement</u> • <u>Rear Brake Hose Replacement</u> • <u>Brake Pipe Replacement</u> 3. If none of the hydraulic brake pipes or flexible brake hoses were visibly bent, kinked, pinched, or damaged, replace the hydraulic brake flex hose(s) at the restricted location.		
	Did you find and correct a condition?	Go to Step 21	Go to Step 18
18	If equipped with Antilock Brakes, replace the brake pressure modulator valve (BPMV), in order to correct the hydraulic brake dynamic rear proportioning mechanical operation. Refer to <u>Brake Pressure Modulator Valve Replacement</u> . Did you complete the replacement?	Go to Step 21	-
19	1. Inspect the hydraulic brake system components for brake fluid seepage at a seal and/or fitting location, which may have drawn air into the system. 2. Inspect the hydraulic brake system components for evidence of a recent repair, which may have introduced air into the system. 3. Repair or replace any of the components found to be installed incorrectly or seeping brake fluid.		
	Did you find and correct a condition?	Go to Step 21	Go to Step 20
	1. Inspect the brake master cylinder for internal fluid leaks. Refer to <u>Brake System Internal Leak Test</u>. 2. Repair or replace the brake master cylinder if it is found to be leaking brake fluid internally. Refer to		

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20	<u>Master Cylinder Overhaul</u> or <u>Master Cylinder Replacement</u> . Did you find and correct a condition?	Go to Step 21	Return to Symptom Table
21	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Hydraulic Brake System OK Return to Symptom Table	-

BRAKE ASSIST SYSTEM DIAGNOSIS

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the brake ASSIST system in order to determine if the brake ASSIST system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 3	Go to Step 2
2	Were you sent here directly from an electrical diagnostic to investigate vacuum as a possible concern?	Go to Step 5	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
3	Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u> . Is the brake pedal travel distance within the acceptable limits?	Go to Step 5	Go to Step 4
4	- Inspect for worn, missing, misaligned, bent, or damaged brake pedal system components. - For the brake pedal pushrod component inspection, refer to <u>Brake Pedal Pushrod Inspection</u>. - Inspect the brake pedal bushings for excessive wear and/or damage and inspect the brake pedal for a misaligned, bent, and/or damaged condition. - Replace the brake pedal system components that are worn, missing, misaligned, bent, or damaged. Did you find and replace any worn, missing, misaligned, bent, or damaged brake pedal system components?	Go to Step 5	Inspect for internal and external fluid leaks and air in the hydraulic brake system Go to <u>Hydraulic Brake System Diagnosis</u>
5	Check the engine vacuum source that supplies vacuum to the vacuum brake booster. Refer to <u>Brake System Vacuum Source Test</u> . Is the vacuum reading within the acceptable limits?	Go to Step 6	Go to Engine Controls Diagnostics Information
6	Does the condition occur during cold start-up conditions?	Go to Step 7	Go to Step 8
7	Check engine vacuum under the same cold start-up conditions. Refer to appropriate Engine Controls Diagnostics article. Did you find and correct a condition?	Go to Step 18	Go to Step 9
8	During the vacuum source test, did the vacuum booster check valve operate properly?	Go to Step 10	Go to Step 9
9	Replace the vacuum booster check valve. Refer to <u>Vacuum Brake Booster Check Valve and/or Hose</u>		-

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	Replacement. Did you complete the replacement?	Go to Step 10	
10	If equipped with a booster mounted separate vacuum sensor, inspect the vacuum sensor grommet for cracks, cuts, dry-rot, or damage. Does the vacuum sensor grommet exhibit any of the conditions listed?	Go to Step 11	Go to Step 12
11	Replace the vacuum sensor grommet. Did you complete the replacement?	Go to Step 12	-
12	1. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Before removing the master cylinder, first deplete the vacuum by removing the check valve or applying the brake pedal several times. Refer to Master Cylinder Replacement. 2. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder. 3. If equipped with a vacuum seal that is part of the booster, inspect the seal for damage. 4. Inspect the master cylinder mating surface of the booster for deformation and or damage. Does the vacuum seal and/or the master cylinder mating surface of the of the booster exhibit any of the conditions listed?	Go to Step 13	Go to Step 14
13	1. If equipped with a vacuum seal on the rear of the master cylinder, replace the vacuum seal as necessary. 2. If equipped with a vacuum seal that requires replacement and which is part of the booster, the booster assembly must be replaced. 3. If the master cylinder mating surface of the booster was deformed and/or damaged, replace the booster. Did you complete the replacement?	Go to Step 14	-
14	Perform the vacuum boost functional test: 1. Reinstall the master cylinder to the booster. 2. If the engine was started after reinstalling the master cylinder to the booster, perform the following: With the engine OFF, depress the brake pedal several times to deplete the vacuum reserve. 3. Depress and maintain moderate foot pressure on the brake pedal. IMPORTANT: The brake pedal should fall slightly, then hold.		

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	4. Start the engine and observe pedal operation.		
	Is there an audible vacuum leak coming from the brake pedal area?	Go to Step 17	Go to Step 15
15	Did the brake pedal fall slightly after the engine was started, then hold?	Go to Step 16	Go to Step 17
16	Perform the vacuum booster leak-down test: 1. Release the brake pedal. 2. Accelerate the engine to approximately 3,000 RPM, then release the throttle. Wait 2-3 seconds and repeat once. 3. Turn the ignition OFF. 4. Wait 60 seconds. IMPORTANT: • Both pedal applies should be assisted. • The amount of assist could diminish slightly with the second apply. 5. Depress the brake pedal 2 times to check for vacuum booster available vacuum reserve. Observe pedal effort. Were both pedal applies power assisted?	Go to Step 18	Go to Step 17
17	Replace the vacuum brake booster. Refer to Power Vacuum Brake Booster Replacement (LY7) or Power Vacuum Brake Booster Replacement (L26) or Power Vacuum Brake Booster Replacement (LS4). Did you complete the replacement?	Go to Step 18	-
18	Install or connect any components that were removed or disconnected during diagnosis. Did you complete the operation?	Brake Assist System OK Return to Symptom Table	-

BRAKE SYSTEM VEHICLE ROAD TEST

Preliminary Inspections

1. Visually inspect easily accessible brake system components for obvious damage and/or leaks which may indicate that the vehicle should not be driven until further inspections have been completed.
2. Inspect the brake master cylinder reservoir fluid level and adjust only if necessary for brake system road testing. Refer to **Master Cylinder Reservoir Filling**.
3. Inspect the tire inflation pressures and adjust as necessary.
4. Inspect the tire tread patterns to ensure that they are the same or very similar, especially per axle.
5. Ensure that the vehicle is not loaded unevenly prior to brake system road testing.

Road Testing Procedure

CAUTION: Road test a vehicle under safe conditions and while obeying all traffic laws.

Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

1. Start the engine and allow it to idle.
2. Check to see if the brake system warning lamp remains illuminated.
3. If the brake system warning lamp remains illuminated, DO NOT proceed to test drive the vehicle until it is diagnosed and repaired. Refer to **Symptoms - Hydraulic Brakes**.
4. Select a smooth, dry, clean and level road or large lot that is as free of traffic and obstacles as possible for brake system low speed road testing.
5. With the transmission in PARK, lightly apply the brake pedal. Observe both the pedal feel and the pedal travel.
6. If the brake pedal apply felt spongy, or the pedal travel was excessive, DO NOT drive the vehicle until it is repaired.
7. If the brake pedal apply did not feel spongy and the pedal travel was not excessive, proceed to step 8.
8. Release and apply the brakes.
9. While continuing to apply the brakes, shift the transmission into DRIVE, release the brakes and allow the engine to idle the vehicle away from the stopped position. Observe for a slow release of the brake system.
10. With the aid of an assistant to observe the vehicle's performance from outside of the vehicle, drive the vehicle at a low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to them, while you observe both the pedal effort and the pedal travel.
11. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.
12. If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 13.
13. Drive the vehicle in the opposite direction, at the same low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to him.
14. Drive the vehicle at a low speed and shift the transmission into NEUTRAL without applying the brakes. Observe for a rapid deceleration in vehicle speed, indicating possible brake drag.
15. Select a smooth, dry, clean and level road that is as free of heavy traffic as possible for brake system moderate speed road testing.
16. Drive the vehicle at a moderate speed. Observe for a pull and/or incorrect tracking of the vehicle without the brakes applied.
17. While continuing to drive the vehicle at a moderate speed, perform several light applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system noise, pulsation and/or brake drag.
18. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.
19. If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 20.
20. While continuing to drive the vehicle at a moderate speed, perform several moderate applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system pulsation and/or uneven braking action - either side to side, or front to rear.

A small amount of vehicle front end dip is expected during a moderate apply of the brakes.

21. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.

BRAKE PEDAL TRAVEL MEASUREMENT AND INSPECTION

Tools Required

J 28662 Brake Pedal Effort Gage. See **Special Tools**.

Inspection Procedure

1. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal becomes firm, in order to deplete the brake booster power reserve.
2. Install the **J 28662** to the brake pedal. See **Special Tools**.

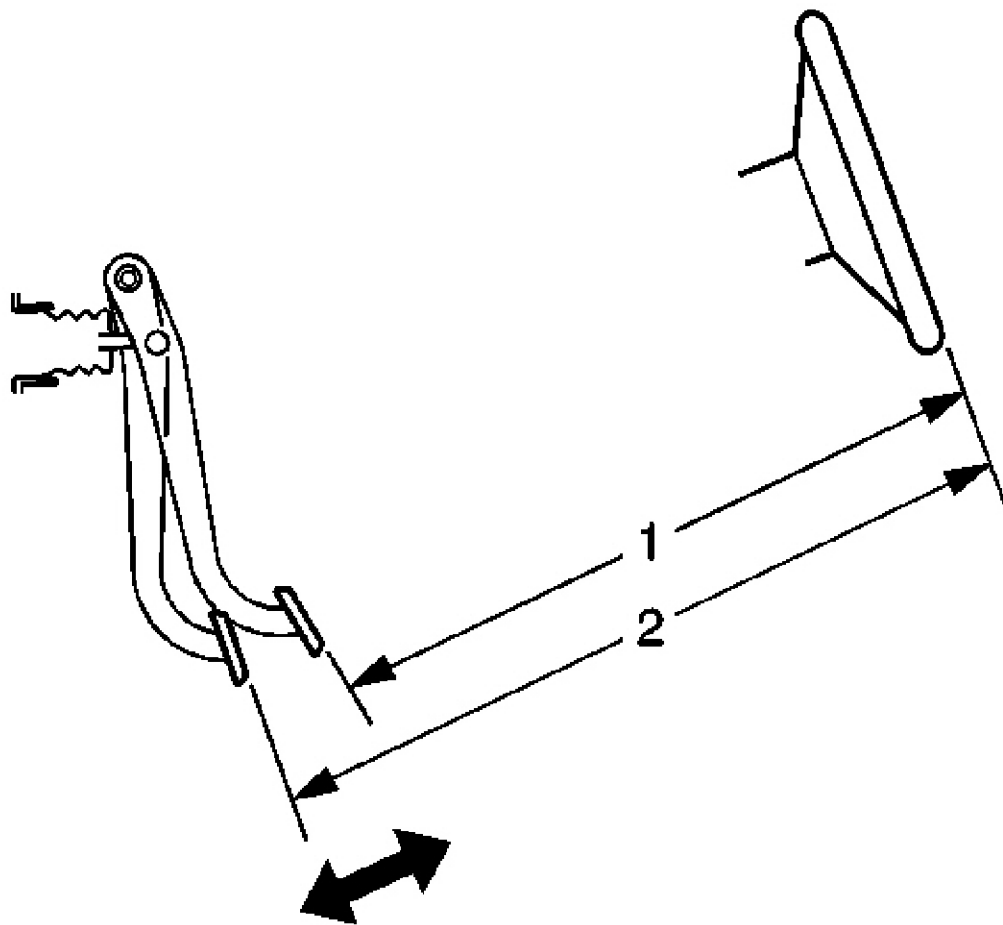


Fig. 2: Measuring Brake Pedal Travel
Courtesy of GENERAL MOTORS CORP.

3. Measure and record the distance (1) from the brake pedal to the rim of the steering wheel. Note the points of measurement.
4. Apply and maintain the brakes with 445 N (100 lb) of force to the brake pedal, as indicated on the **J 28662**. See **Special Tools**.
5. While maintaining 445 N (100 lb) of force to the brake pedal, measure and record the distance (2) from the same point on the brake pedal to the same point on the rim of the steering wheel.
6. Release the brakes and repeat steps 4 and 5 to obtain a second measurement. After obtaining a second measurement, proceed to step 7.
7. Average the first and second measurements recorded during the two applies of the brakes.
8. Subtract the initial measurement, unapplied (1), from the averaged, applied measurement (2) to obtain the brake pedal travel distance.

Specification: Maximum brake pedal travel - measured with the ignition OFF, brake booster power assist depleted, and the brakes cool: 74 mm (2.91 in).

BRAKE SYSTEM VACUUM SOURCE TEST

IMPORTANT:

- Engine temperature, accessory load, and elevation level will affect engine vacuum.
- Vacuum readings will decrease by approximately 2.7 kPa (0.8 in Hg) for every 305 m (1000 ft) of elevation above sea level.

1. Disconnect the engine vacuum hose from the vacuum brake booster check valve.
2. Install a vacuum gage to the engine vacuum hose.
3. Start the engine and allow the engine to idle until normal operating temperatures are reached.
4. With the vehicle in PARK, the engine idling, and the air conditioning (A/C) system OFF, check to see if the engine vacuum reading is within the specified normal engine vacuum range.

Specification: 47-68 kPa (14-20 in Hg)

5. Turn the ignition OFF.
6. If the engine vacuum reading is within the specified normal range, proceed to step 10.
7. If the engine vacuum reading is NOT within the specified normal range, inspect the engine vacuum hose for the following conditions:
 - Loose connection to the engine
 - Collapse, deformation or contamination
 - Cracks, cuts, dry-rot
8. If any of these conditions were found with the engine vacuum hose, replace the hose, then repeat steps 2-4.
9. If none of these conditions were found with the engine vacuum hose, then there is an engine vacuum source problem, check the engine vacuum system.
10. Remove the vacuum brake booster check valve from the booster.
11. Install the check valve to the engine vacuum hose.
12. Install the vacuum gage to the check valve.
13. Start the engine and allow the engine to idle in PARK with the A/C system OFF, until normal operating temperatures are reached.
14. Turn the ignition OFF.
15. Check to see if the engine vacuum reading is maintained within the specified normal engine vacuum range.

Specification: 47-68 kPa (14-20 in Hg)

16. If the engine vacuum reading is maintained within the specified normal range, proceed to step 18.
17. If the engine vacuum reading is NOT maintained within the specified normal range, replace the brake booster check valve, then repeat steps 11-15.
18. Inspect the brake booster check valve grommet for the following conditions:
 - Loose connection to the vacuum brake booster
 - Deformation or contamination
 - Cracks, cuts, dry-rot
19. If any of these conditions were found with the check valve grommet, replace the grommet.

BRAKE SYSTEM EXTERNAL LEAK INSPECTION

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

1. In order to inspect for external brake fluid leaks, first check the fluid level in the master cylinder.

While a slight brake fluid level drop can be considered a normal condition due to brake lining wear, a very low level may indicate a brake fluid leak in the hydraulic system.

2. If the fluid level is abnormally low, adjust the brake fluid level. Refer to **Master Cylinder Reservoir Filling**.
3. Start the engine and allow it to idle.
4. Apply constant, moderate foot pressure to the brake pedal.

If the brake pedal gradually falls away while under foot pressure, there may be a brake fluid leak.

5. Turn OFF the ignition.
6. Visually inspect the following brake system components for brake fluid leaks, excessive corrosion, and damage. Give particular attention to all brake pipe and flexible hose connections to ensure that there are not any slight brake fluid leaks - even though the brake pedal may feel firm and hold steady:
 - Master cylinder brake pipe fittings
 - All brake pipe connections
 - Brake pipes
 - Brake hoses and connections
 - Brake calipers and/or wheel cylinders, if equipped
7. While slight dampness around the master cylinder reservoir can be considered acceptable, brake fluid leaking from any of the brake system components requires immediate attention. If any of these components exhibit signs of brake fluid leakage, repair or replace those components. After the repair or replacement, reinspect the hydraulic brake system to assure proper function.

BRAKE SYSTEM INTERNAL LEAK TEST

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

1. Start the engine and allow it to idle.
2. Apply light, steady pressure to the brake pedal. Observe both the brake pedal feel and travel.
3. Release the brakes and turn OFF the ignition.
4. If the brake pedal apply felt spongy, but the brake pedal travel was not excessive, perform the following steps:
 1. Inspect the brake system for external leaks. Refer to **Brake System External Leak Inspection** .
 2. Pressure bleed the brake system in order to purge any air that may be trapped in the system. Refer to **Hydraulic Brake System Bleeding (Manual)Hydraulic Brake System Bleeding (Pressure)** .

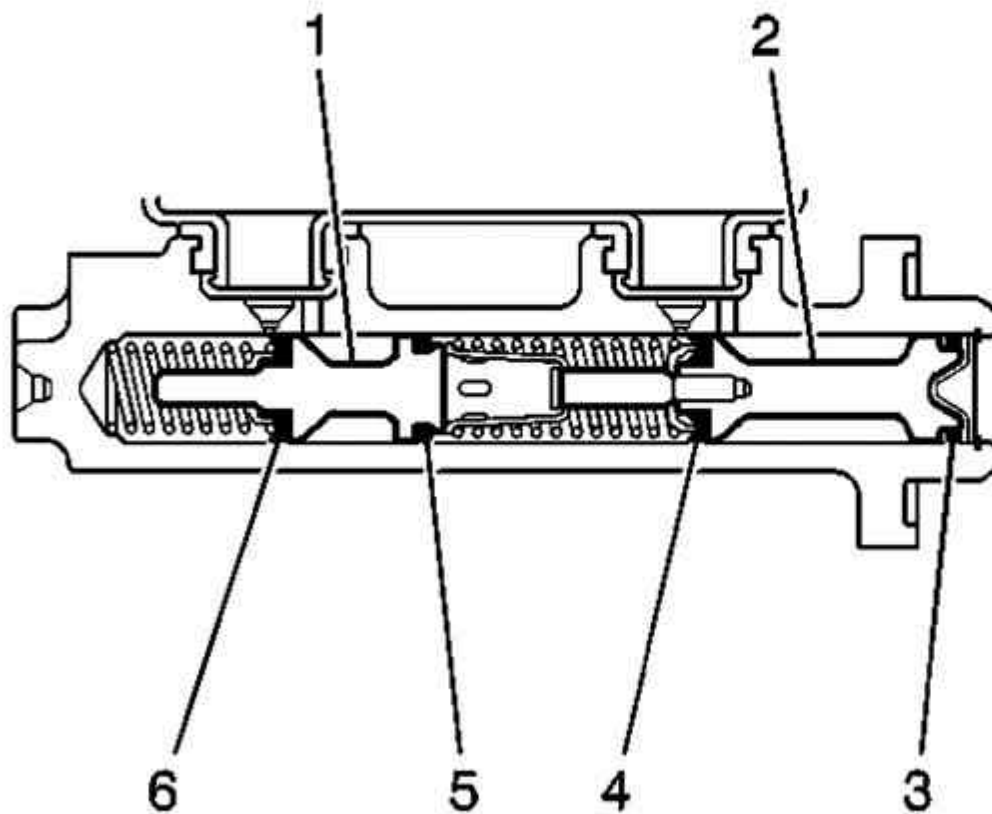


Fig. 3: Identifying Master Cylinder Components
 Courtesy of GENERAL MOTORS CORP.

5. If the brake pedal apply did not feel spongy, but the brake pedal travel was excessive, perform the following steps:
 1. Loosen the master cylinder-to-brake power booster mounting nuts.
 2. Carefully pull the master cylinder away from the brake power booster just enough to inspect the mounting surface of the master cylinder.
 3. Inspect the master cylinder mounting surface at the primary piston (2) for brake fluid leaks.
6. If the master cylinder exhibits any leakage around the primary piston (2), then the primary piston primary seal (4) and/or secondary seal (3) is leaking and the master cylinder requires overhaul or replacement.
7. If the master cylinder primary piston (2) does not exhibit any leakage, pressure bleed the brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.
8. If the brake pedal apply did not feel spongy, and the brake pedal travel was initially steady and not excessive, but then gradually fell, then the master cylinder requires overhaul or replacement due to an internal leak past the secondary piston (1) from the secondary piston primary seal (6) or secondary seal (5).
9. If the brake pedal apply did not feel spongy, and the brake pedal travel was initially steady and not excessive, then fell slightly, then became steady again, then the brake pressure modulator valve (BPMV) may be leaking internally, and may require replacement.

HYDRAULIC BRAKE COMPONENT OPERATION VISUAL INSPECTION

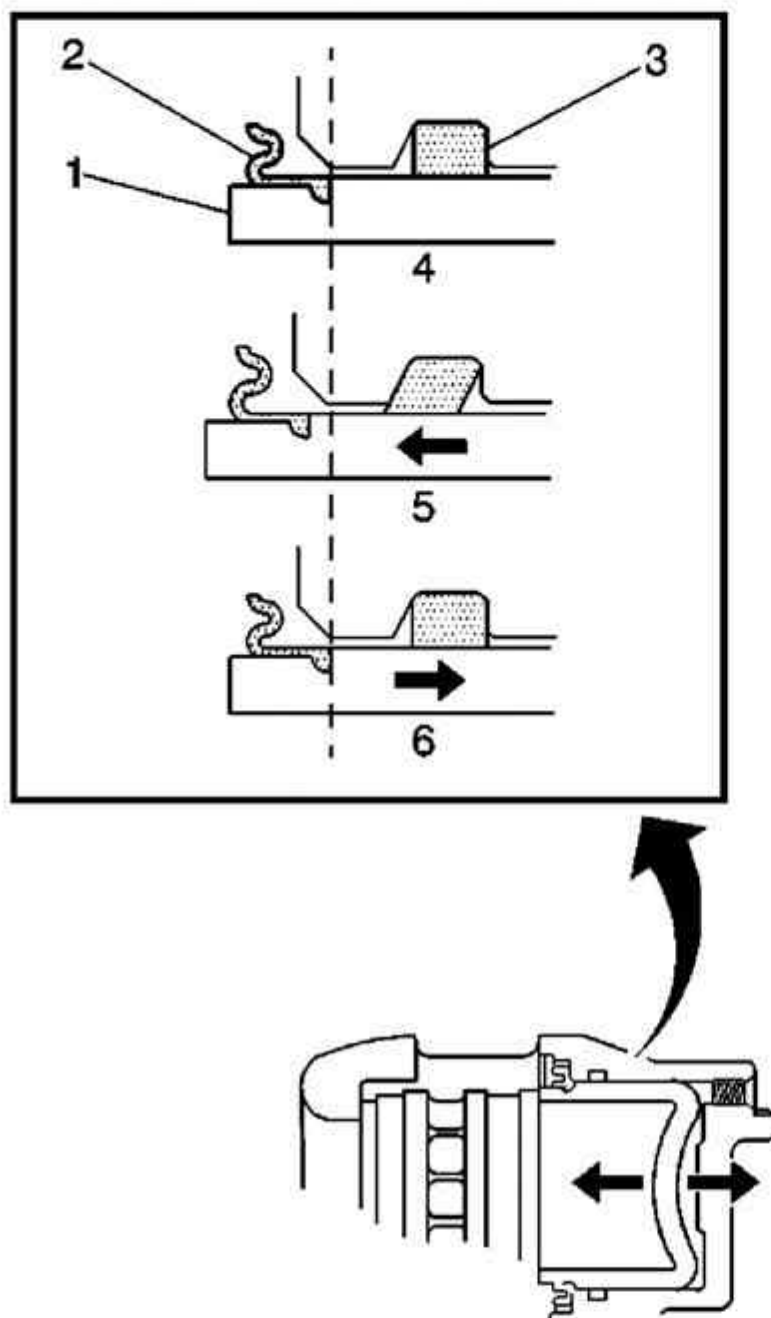


Fig. 4: Identifying Brake Caliper/Pad Inspection Areas
 Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

1. With the tire and wheel assemblies removed and the brake rotors retained by wheel lug nuts, visually inspect the caliper piston dust boot (2) sealing area to ensure that there are no brake fluid leaks.
2. If any evidence of a brake fluid leak is present, the brake caliper requires overhaul or replacement.
3. While the brake system is at rest (4), observe the position of the caliper piston (1) in relation to the caliper housing.
4. Have an assistant apply and release the brake pedal several times while you observe the operation of the hydraulic brake caliper.
 1. Observe the caliper piston (1) for unrestricted and even movement during each apply of the brake

system (5).

2. Observe the caliper piston (1) for an unrestricted and even return motion during each release of the brake system (6).
5. If the caliper piston (1) did not exhibit unrestricted and even movement during brake system apply and/or release, the piston square seal (3) may be worn or damaged and the caliper may require overhaul or replacement.

BRAKE PIPE AND HOSE INSPECTION

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

1. Visually inspect all of the brake pipes for the following conditions:
 - Kinks, improper routing, missing or damaged retainers
 - Leaking fittings, excessive corrosion
2. If any of the brake pipes exhibited any of the conditions listed, then the identified pipe, or pipes, require replacement.
3. Ensure that the vehicle axles are properly supported at ride height in order to maintain the proper relationship of the flexible brake hoses to the chassis.

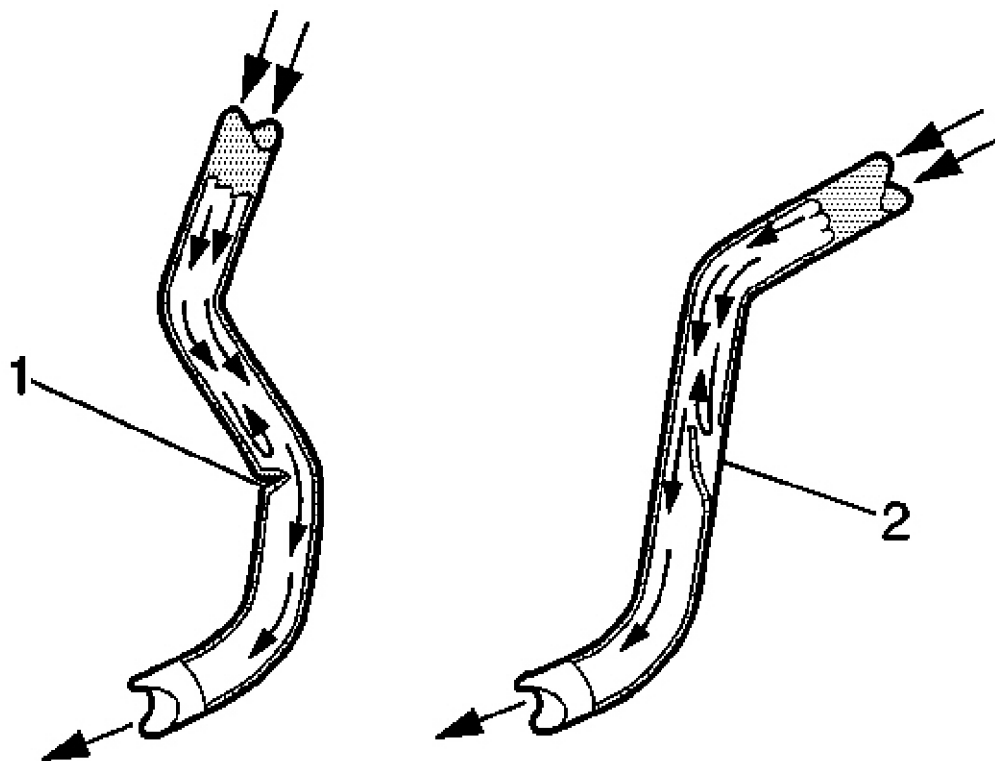


Fig. 5: Identifying Flexible Brake Hose Failure Conditions
Courtesy of GENERAL MOTORS CORP.

4. Visually inspect all of the flexible brake hoses for the following conditions:
 - Kinks (1), improper routing, twists, chafing, missing or damaged retainers

- Leaking connections, cracking, dry-rot, blisters, bulges
5. If any of the flexible brake hoses exhibited any of the conditions listed, then the identified flexible brake hose, or hoses require replacement.
 6. Squeeze the flexible brake hoses with firm finger pressure to check for soft spots (2), indicating an internal restriction. Check the entire length of each flexible brake hose.
 7. If any of the flexible brake hoses were found to have soft spots (2), then the identified flexible brake hose, or hoses require replacement.

BRAKE PEDAL PUSHROD INSPECTION

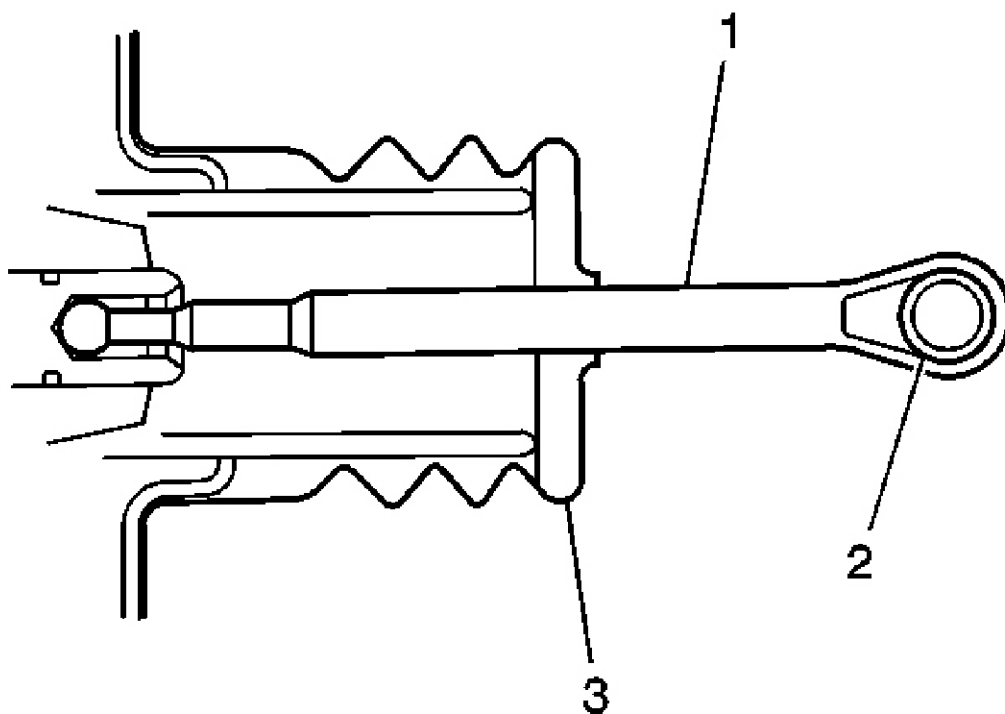


Fig. 6: View of Brake Pedal Pushrod
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the brake pedal pushrod (1) from the brake pedal.
2. Inspect the brake pedal pushrod eyelet bushing (2), if equipped, for cracks and/or excessive wear.
3. Reposition the pedal pushrod boot (3) toward the front of the vehicle to expose as much of the pedal pushrod (1) as possible.
4. Inspect the brake pedal pushrod (1) for straightness.
5. If the brake pedal pushrod eyelet bushing (2) exhibited cracks and/or excessive wear, then the bushing requires replacement.
6. If the brake pedal pushrod (1) is not straight, then the pushrod requires replacement.
7. Return the pedal pushrod boot (3) to its original position on the pedal pushrod (1).
8. Connect the brake pedal pushrod (1) to the brake pedal.

REPAIR INSTRUCTIONS

MASTER CYLINDER RESERVOIR FILLING

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: When adding fluid to the brake master cylinder reservoir, use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

1. Visually inspect the brake fluid level through the brake master cylinder reservoir.
2. If the brake fluid level is at or below the half-full point during routine fluid checks, the brake system should be inspected for wear and possible brake fluid leaks.
3. If the brake fluid level is at or below the half-full point during routine fluid checks, and an inspection of the brake system did not reveal wear or brake fluid leaks, the brake fluid may be topped-off up to the maximum-fill level.
4. If brake system service was just completed, the brake fluid may be topped-off up to the maximum-fill level.
5. If the brake fluid level is above the half-full point, adding brake fluid is not recommended under normal conditions.
6. If brake fluid is to be added to the master cylinder reservoir, clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm. Use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.

MASTER CYLINDER RESERVOIR REPLACEMENT

Removal Procedure

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

1. Remove the master cylinder from the vehicle. Refer to Master Cylinder Replacement.
2. Secure the master cylinder in a vise. Do not clamp the master cylinder body, secure only at the flange.

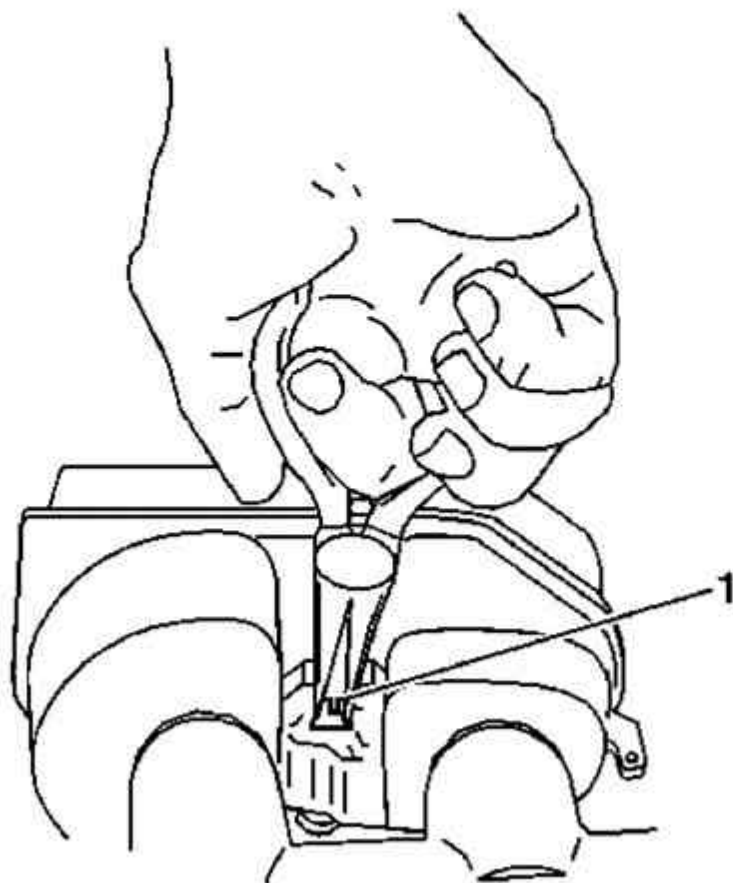


Fig. 7: Identifying Brake Fluid Level Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the brake fluid level sensor. Using needle nose pliers, carefully depress the retaining tabs on the end of the brake fluid level sensor (1) and press the sensor through the reservoir to remove.

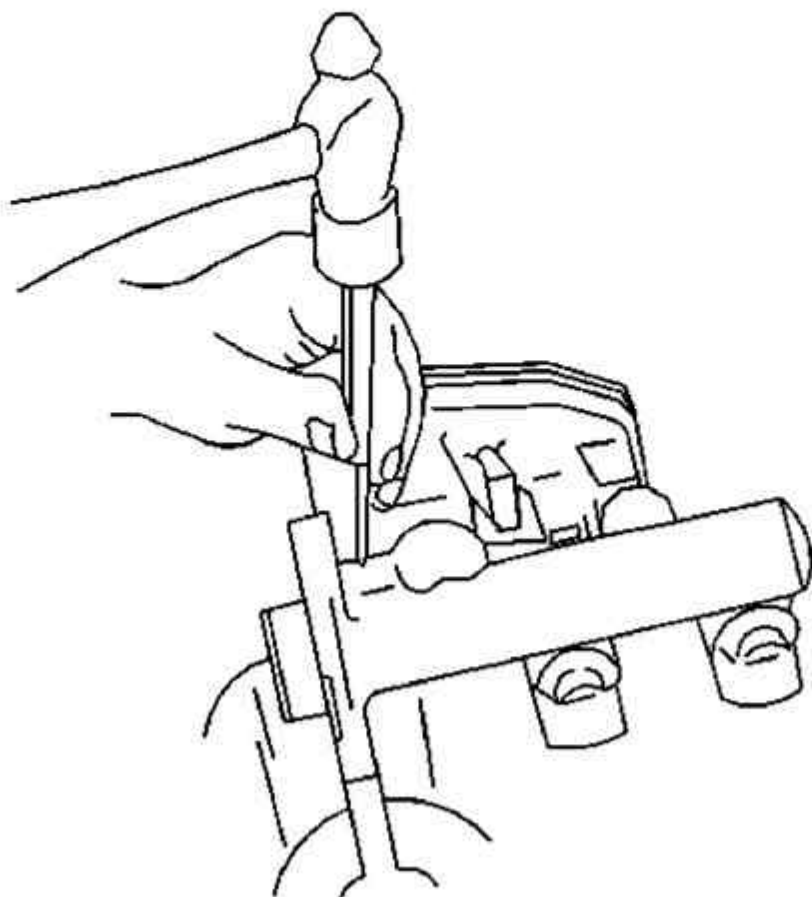


Fig. 8: View Of Reservoir Retaining Pins
Courtesy of GENERAL MOTORS CORP.

4. Carefully tap out the reservoir retaining pins.
5. Remove the reservoir from the master cylinder by pulling the reservoir straight up and away from the cylinder.
6. Remove the seals from the master cylinder.

Installation Procedure

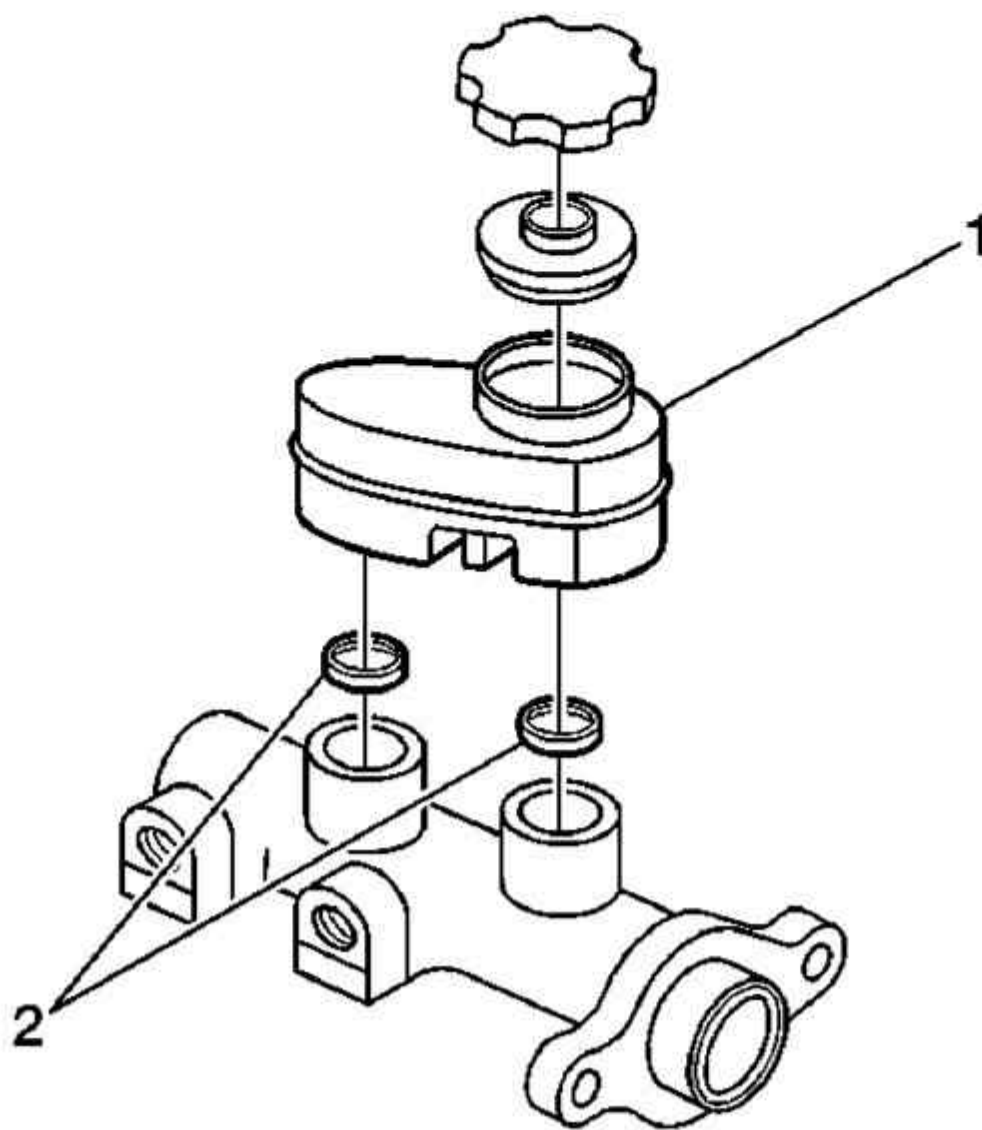


Fig. 9: View Of Master Cylinder Reservoir
Courtesy of GENERAL MOTORS CORP.

1. Inspect the reservoir (1) for cracks or deformation. If found, replace the reservoir.
2. Clean the reservoir with denatured alcohol, or equivalent.
3. Dry the reservoir with non-lubricated, filtered air.
4. Lubricate the new seals (2) and the outer surface area of the reservoir-to-housing barrels with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667) or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
5. Install the lubricated seals (2), make sure they are fully seated.
6. Install the reservoir (1) to the master cylinder, by pressing the reservoir straight down on the master cylinder until the pin holes are aligned.

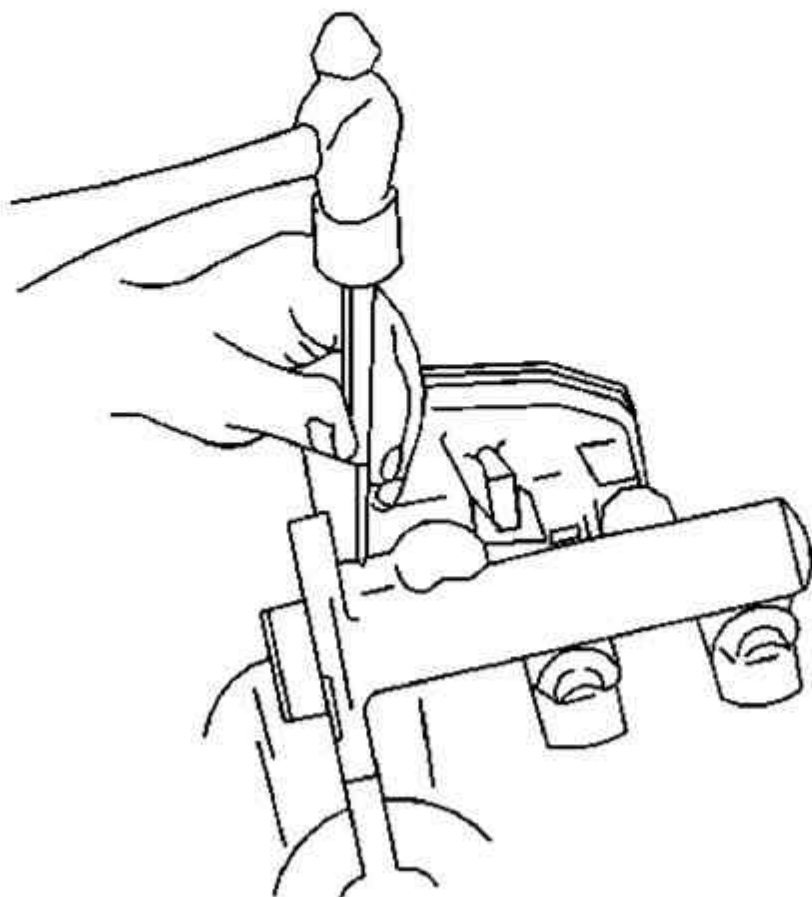


Fig. 10: View Of Reservoir Retaining Pins
Courtesy of GENERAL MOTORS CORP.

7. Carefully tap the reservoir retaining pins into place to secure the reservoir.
8. Place the brake fluid level sensor into the reservoir, press into place to secure the sensor retaining tabs.
9. Remove the master cylinder from the vise.
10. Install master cylinder to the vehicle. Refer to **Master Cylinder Replacement**.

MASTER CYLINDER REPLACEMENT

Removal Procedure

CAUTION: Refer to **Brake Fluid Irritant Caution** .

NOTE: Refer to **Brake Fluid Effects on Paint and Electrical Components Notice** .

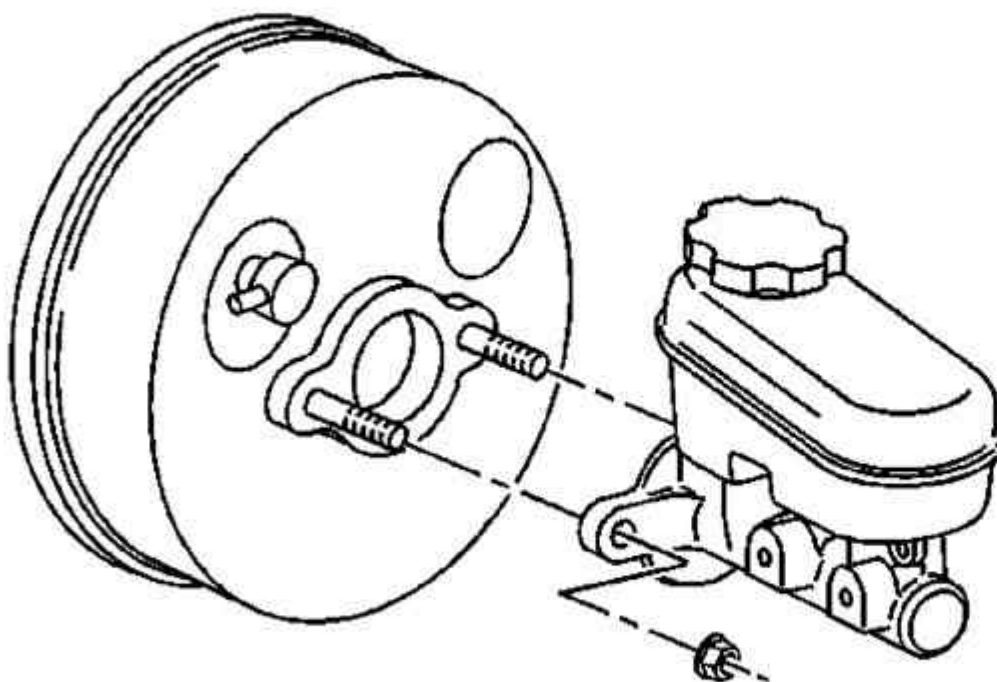


Fig. 11: View Of Master Cylinder
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the electrical connector from the brake fluid level sensor.
2. Disconnect the brake pipe fittings from the master cylinder.

Cap the brake pipe fittings and plug the master cylinder outlet ports to prevent brake fluid loss and contamination.

3. Remove master cylinder mounting nuts.
4. Remove the master cylinder from the vehicle.
5. Remove the brake fluid from the master cylinder reservoir.

Installation Procedure

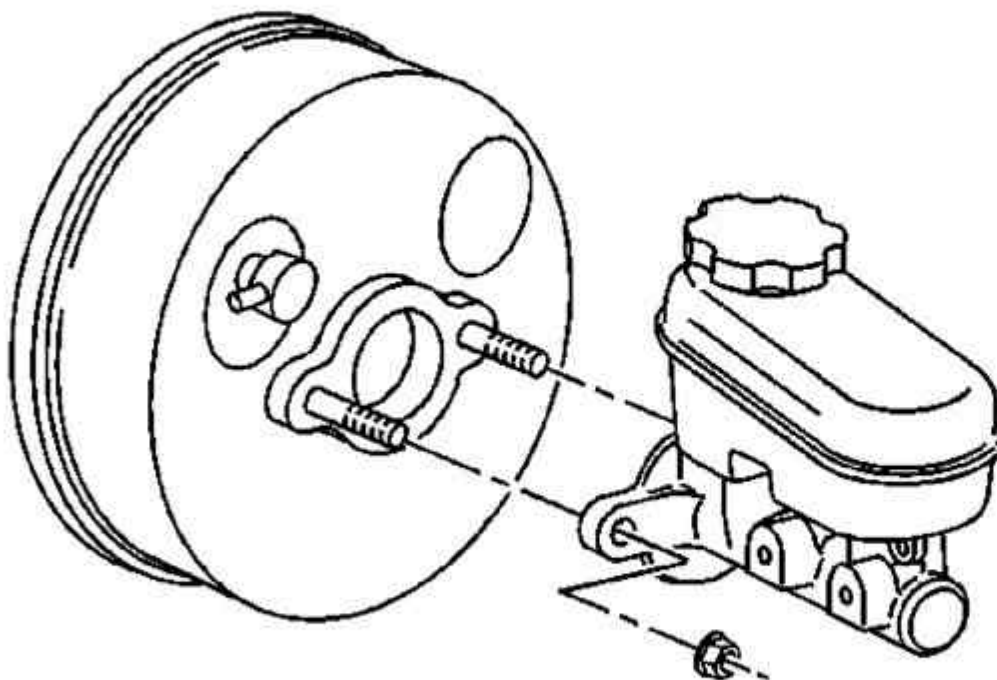


Fig. 12: View Of Master Cylinder
Courtesy of GENERAL MOTORS CORP.

1. Bench bleed the master cylinder. Refer to **Master Cylinder Bench Bleeding**.
2. Install the master cylinder to the vacuum brake booster.

NOTE: Refer to **Fastener Notice** .

3. Install the master cylinder mounting nuts.

Tighten: Tighten the nuts to 33 N.m (24 lb ft).

4. Connect the brake pipe fittings to the master cylinder.

Tighten: Tighten the brake pipe fittings to 30 N.m (22 lb ft).

5. Connect the brake fluid level sensor electrical connector.
6. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.

MASTER CYLINDER OVERHAUL

CAUTION: Refer to **Brake Fluid Irritant Caution** .

NOTE: Refer to **Brake Fluid Effects on Paint and Electrical Components Notice** .

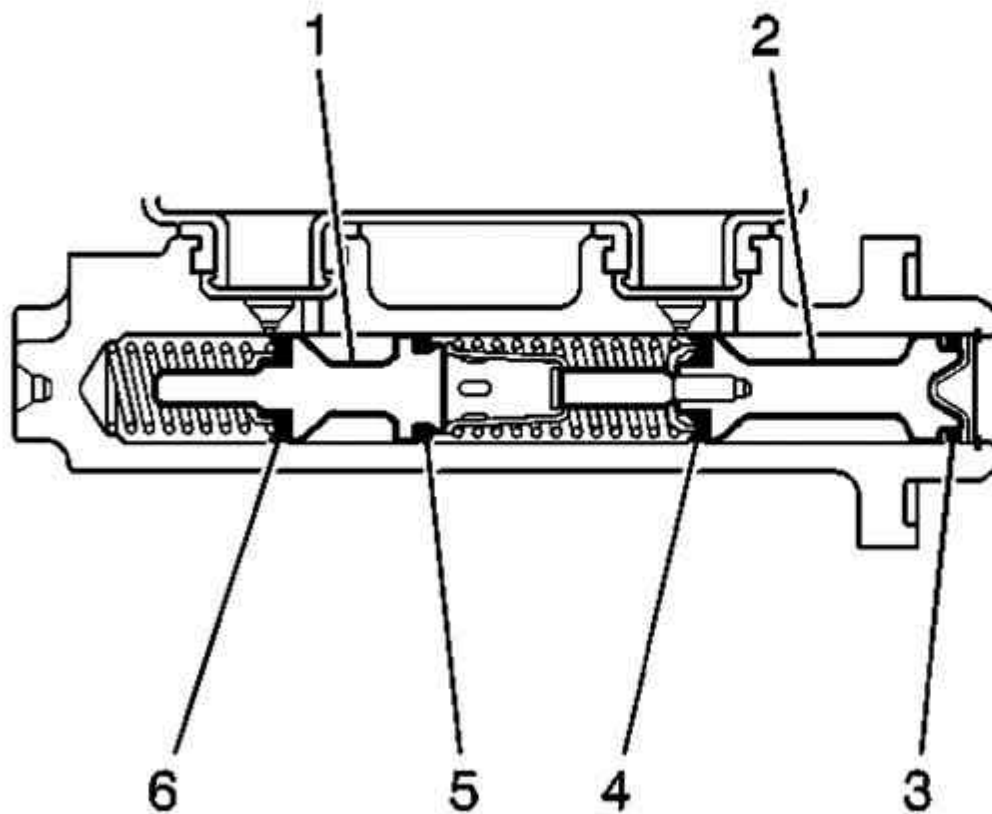


Fig. 13: Identifying Master Cylinder Components
 Courtesy of GENERAL MOTORS CORP.

1. Remove the brake master cylinder from the vehicle. Refer to **Master Cylinder Replacement**.
2. Secure the mounting flange of the brake master cylinder in a bench vise so that the rear of the primary piston is accessible.
3. Clean the outside of the master cylinder reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Remove the reservoir cap and diaphragm from the reservoir.
5. Inspect the reservoir cap and diaphragm for the following conditions. If any of these conditions are present, replace the affected components.
 - Cuts or cracks
 - Nicks or deformation
6. Remove the master cylinder reservoir from the master cylinder. Refer to **Master Cylinder Reservoir Replacement**.
7. Using a smooth, round-ended tool, depress the primary piston (2) and remove the piston retainer.
8. Remove the primary piston assembly from the cylinder bore.
9. Plug the cylinder inlet ports and the rear outlet port. Apply low pressure, non-lubricated, filtered air into the front outlet port, in order to remove the secondary piston (1) with the primary (6) and secondary (5) seals, and the return spring.
10. Discard the primary piston assembly, the piston retainer, and the seals and seal retainer from the secondary piston.

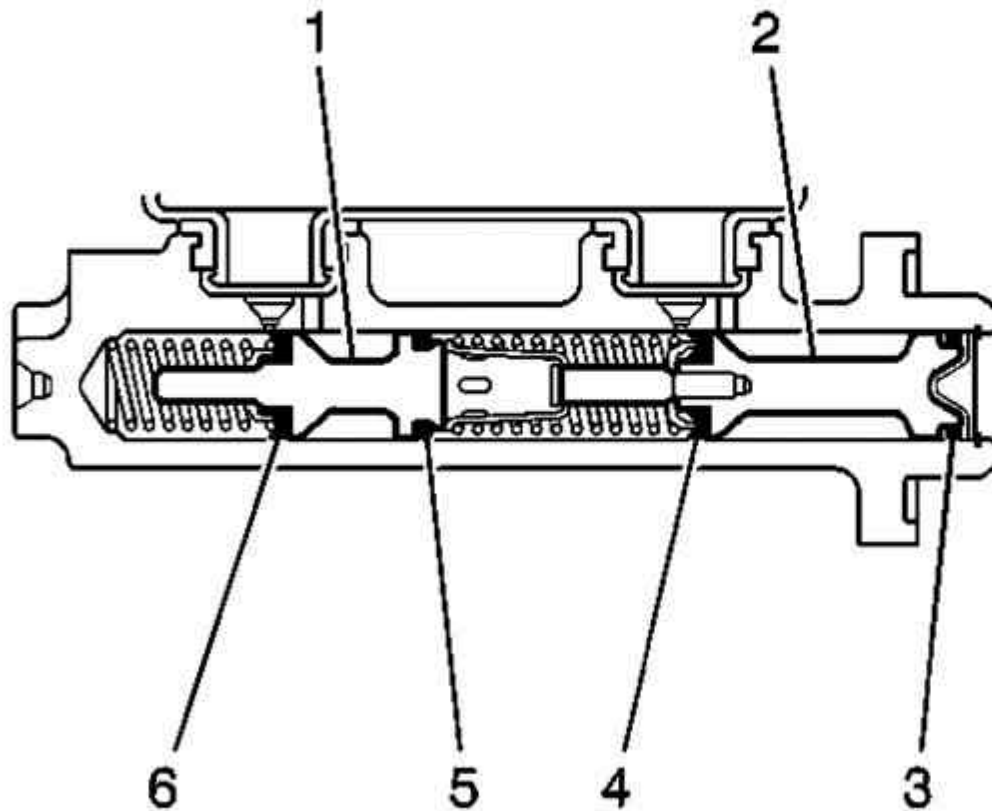


Fig. 14: Identifying Master Cylinder Components
 Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not use abrasives to clean the brake master cylinder bore.

1. Clean the interior and exterior of the master cylinder, the secondary piston (1), and the return spring in denatured alcohol, or equivalent.
2. Inspect the master cylinder bore, inlet and outlet ports, the secondary piston (1), and the return spring for cracks, scoring, pitting, and/or corrosion. Replace the master cylinder if any of these conditions exist.
3. Dry the master cylinder and the individual components with non-lubricated, filtered air.
4. Lubricate the master cylinder bore, the secondary piston (1), the return spring, and all of the individual overhaul components with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
5. Assemble the lubricated, new primary seal (6) and retainer, and new secondary seal (5) onto the secondary piston.
6. Install the lubricated return spring and secondary piston assembly (1) into the cylinder bore.
7. Install the lubricated, new primary piston assembly (2) into the cylinder bore.
8. Using a smooth, round-ended tool, depress the primary piston (2) and install the new piston retainer.
9. Install the master cylinder reservoir to the master cylinder. Refer to **Master Cylinder Reservoir Replacement**.
10. Install the reservoir cap and diaphragm to the reservoir.
11. Install the master cylinder to the vehicle. Refer to **Master Cylinder Replacement**.

MASTER CYLINDER BENCH BLEEDING

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

NOTE: When adding fluid to the brake master cylinder reservoir, use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

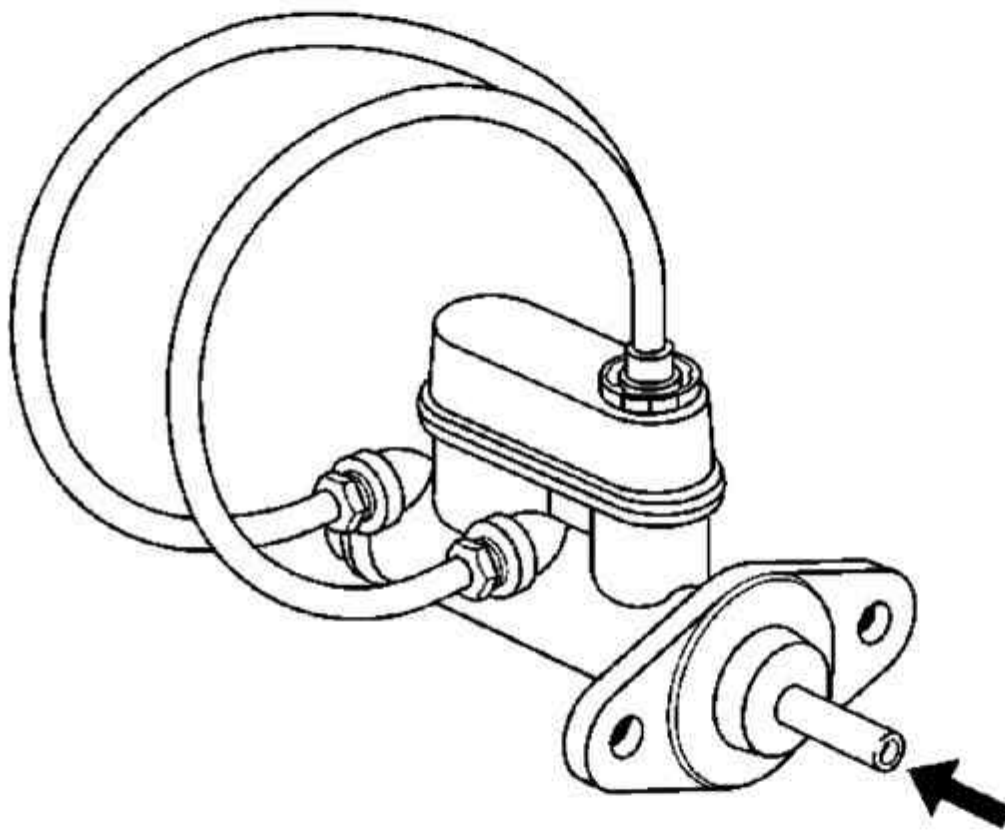


Fig. 15: Bleeding Master Cylinder
Courtesy of GENERAL MOTORS CORP.

1. Secure the mounting flange of the brake master cylinder in a bench vise so that the rear of the primary piston is accessible.
2. Remove the master cylinder reservoir cap and diaphragm.
3. Install suitable fittings to the master cylinder ports that match the type of flare seat required and also provide for hose attachment.
4. Install transparent hoses to the fittings installed to the master cylinder ports, then route the hoses into the master cylinder reservoir.
5. Fill the master cylinder reservoir to at least the half-way point with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
6. Ensure that the ends of the transparent hoses running into the master cylinder reservoir are fully submerged in the brake fluid.

7. Using a smooth, round-ended tool, depress and release the primary piston as far as it will travel, a depth of about 25 mm (1 in), several times. Observe the flow of fluid coming from the ports.

As air is bled from the primary and secondary pistons, the effort required to depress the primary piston will increase and the amount of travel will decrease.

8. Continue to depress and release the primary piston until fluid flows freely from the ports with no evidence of air bubbles.
9. Remove the transparent hoses from the master cylinder reservoir.
10. Install the master cylinder reservoir cap and diaphragm.
11. Remove the fittings with the transparent hoses from the master cylinder ports. Wrap the master cylinder with a clean shop cloth to prevent brake fluid spills.
12. Remove the master cylinder from the vise.

BRAKE FLUID LEVEL INDICATOR SWITCH REPLACEMENT

Removal Procedure

1. Disconnect the electrical connector from brake fluid level sensor.

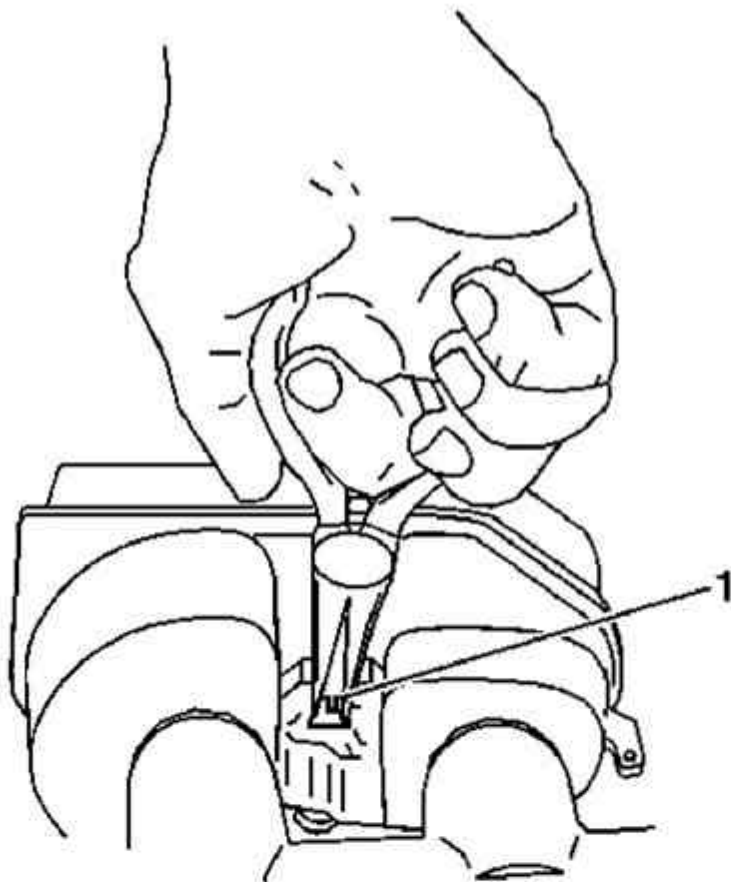


Fig. 16: Identifying Brake Fluid Level Sensor
Courtesy of GENERAL MOTORS CORP.

2. Remove the brake fluid level sensor. Using needle nose pliers, carefully depress the retaining tabs on the end of the brake fluid level sensor (1) and press the sensor through the reservoir to remove.

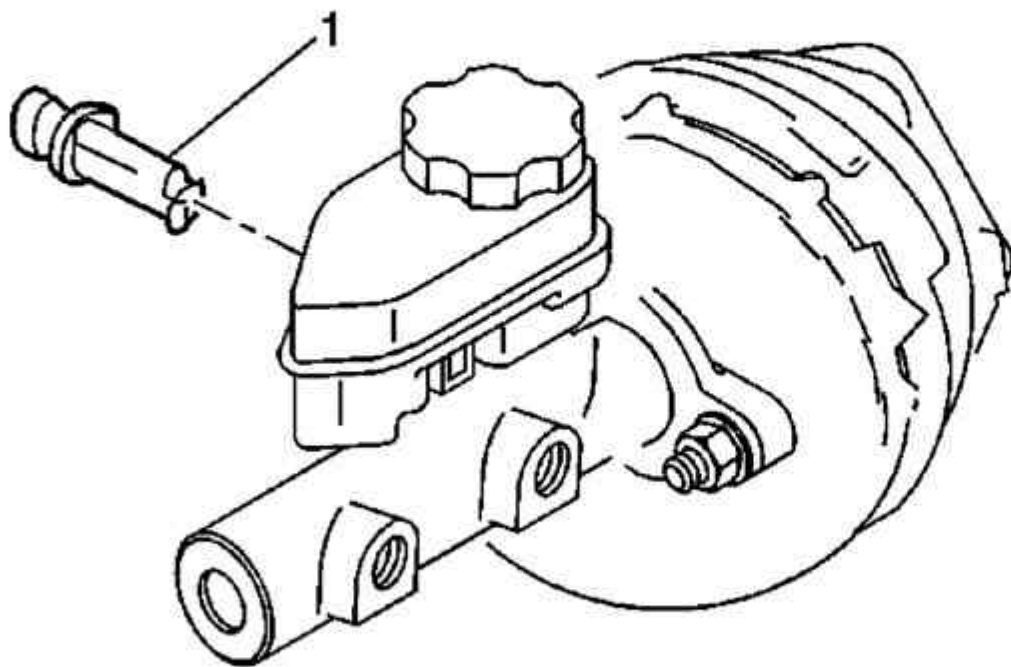
Installation Procedure

Fig. 17: Locating Master Cylinder Fluid Level Sensor
Courtesy of GENERAL MOTORS CORP.

1. Place the brake fluid level sensor (1) into the reservoir, press into place to secure the sensor retaining tabs.
2. Connect the electrical connector to the brake fluid level sensor (1).

BRAKE PEDAL ASSEMBLY REPLACEMENT**Removal Procedure**

1. Remove the left instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side**.
2. Push the body control module (BCM) up and move the bottom of the BCM away from and out of the mounting bracket slot. Position the BCM aside.
3. Remove the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Replacement**.
4. Release the wiring harness clips from the bracket.

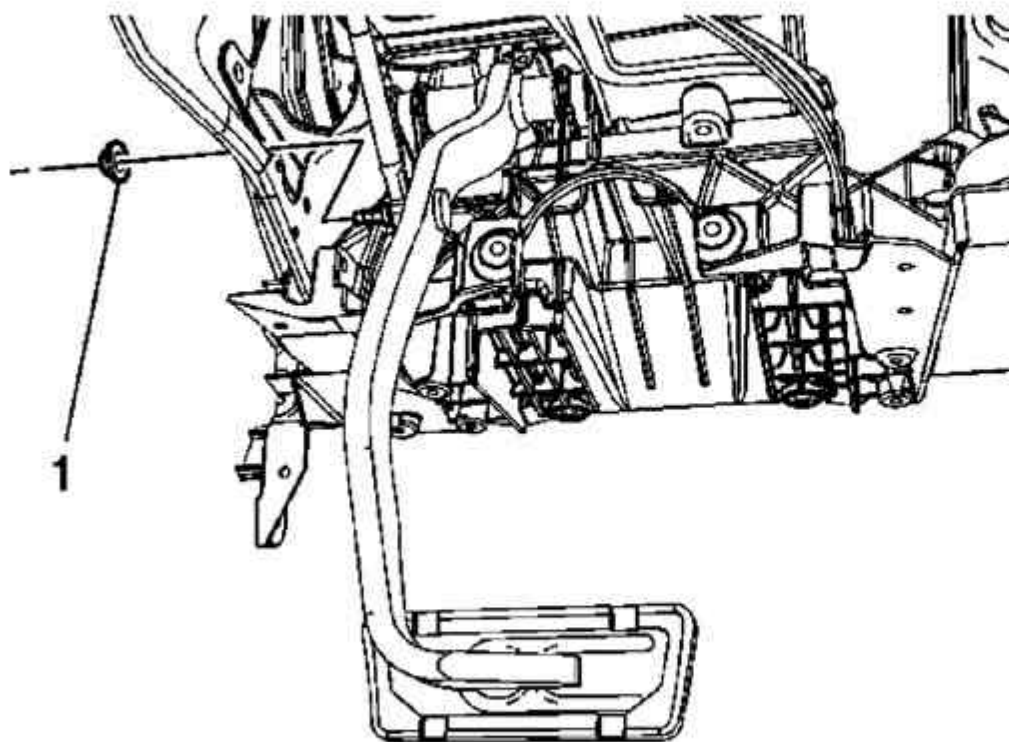


Fig. 18: Identifying Brake Pedal Pushrod Nut
Courtesy of GENERAL MOTORS CORP.

5. Remove the brake pedal pushrod nut (1).

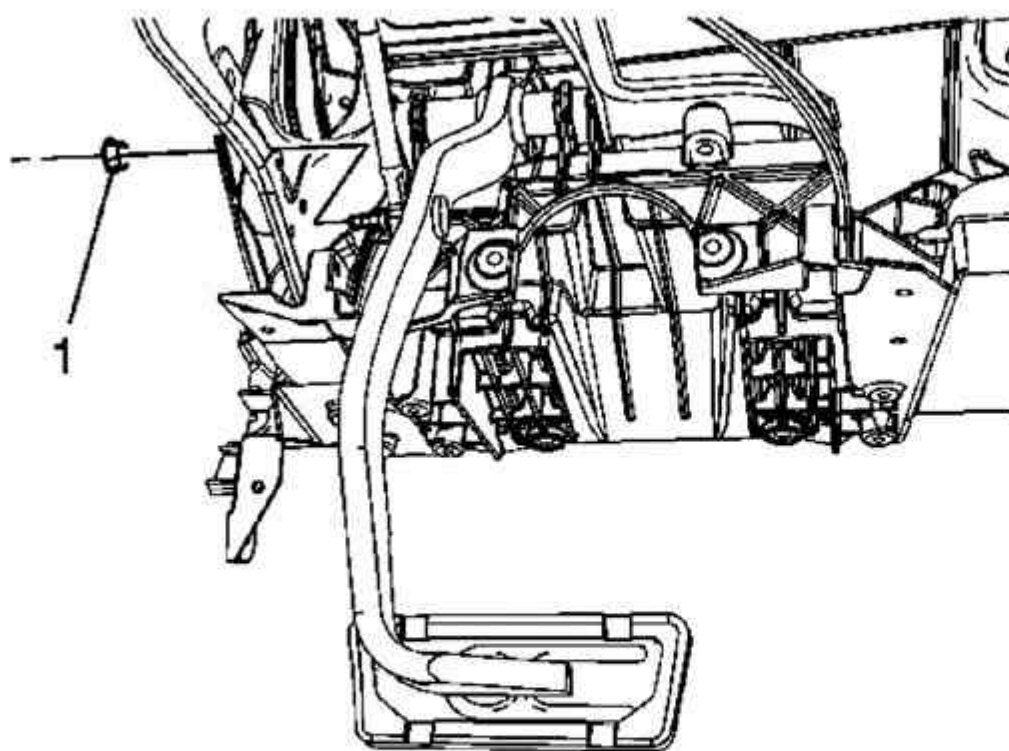


Fig. 19: Identifying Brake Pedal Pushrod Bushing

Courtesy of **GENERAL MOTORS CORP.**

6. Remove the brake pedal pushrod bushing (1).

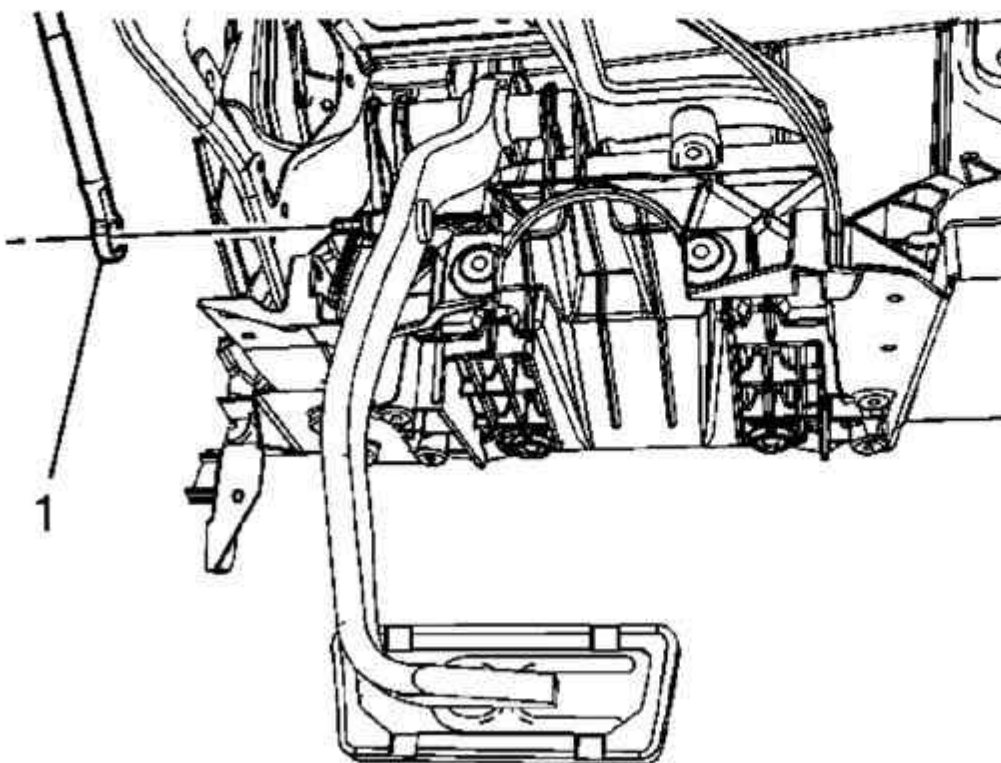


Fig. 20: View Of Brake Pedal Pushrod Nut
Courtesy of **GENERAL MOTORS CORP.**

7. Disconnect the brake pedal pushrod (1) from the brake pedal.

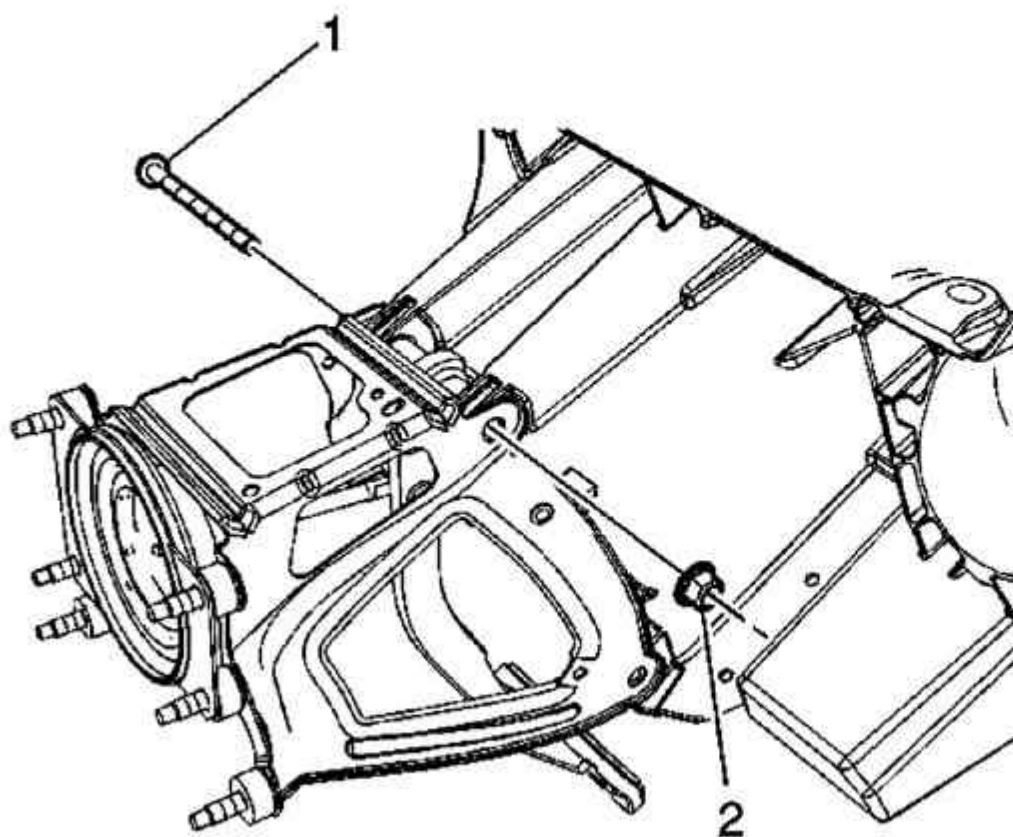


Fig. 21: View Of Brake Pedal Assembly, Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

8. Remove the brake pedal bolt (1) and nut (2).

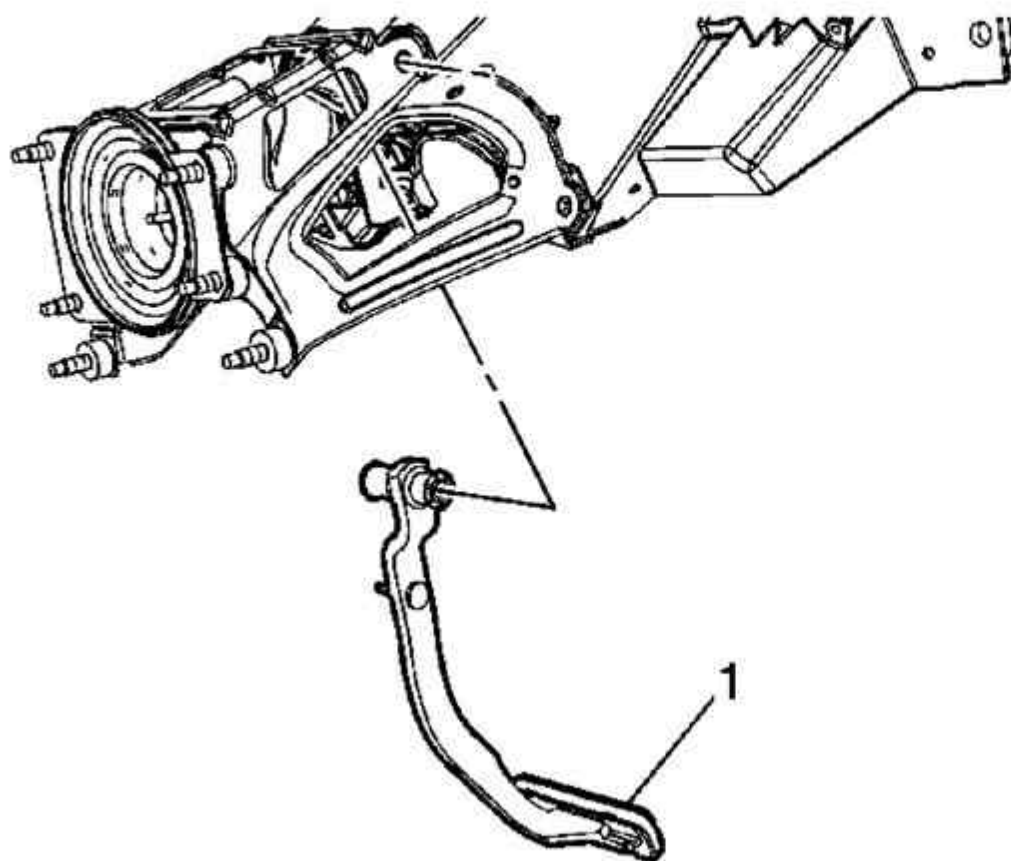


Fig. 22: View Of Brake Pedal Assembly
Courtesy of GENERAL MOTORS CORP.

9. Remove the brake pedal (1).

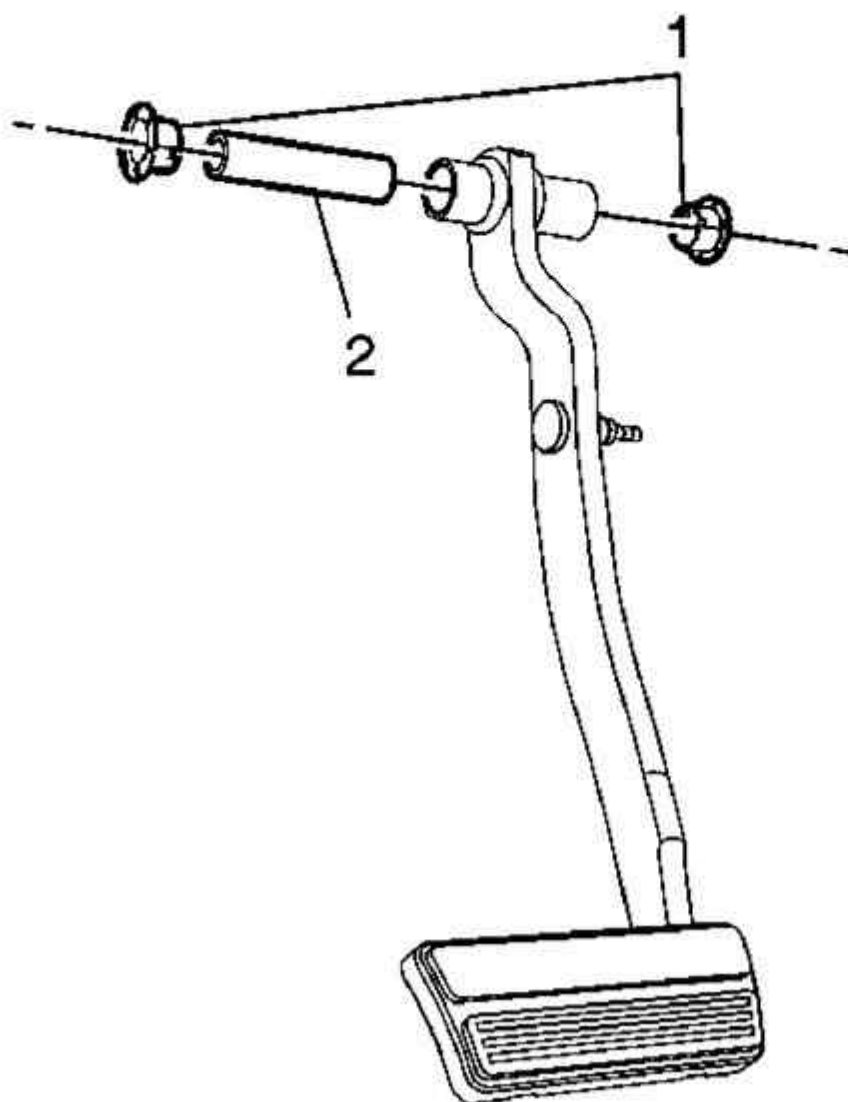


Fig. 23: View Of Brake Pedal Pivot Bushing & Spacer
Courtesy of GENERAL MOTORS CORP.

10. Remove the brake pedal pivot bushings (1) and spacer (2).

Installation Procedure

1. Apply a light coating of silicone lubricant to the brake pedal pivot spacer.

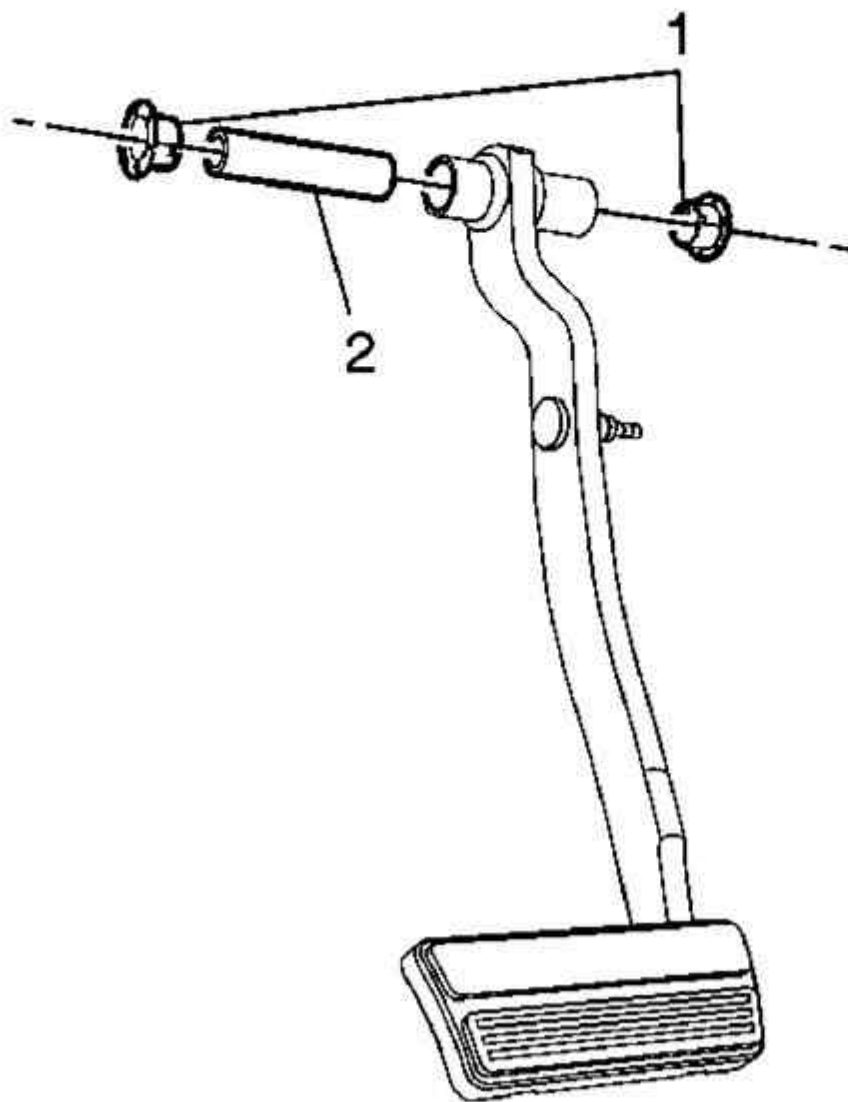


Fig. 24: View Of Brake Pedal Pivot Bushing & Spacer
Courtesy of GENERAL MOTORS CORP.

2. Install the brake pedal pivot bushings (1) and spacer (2).

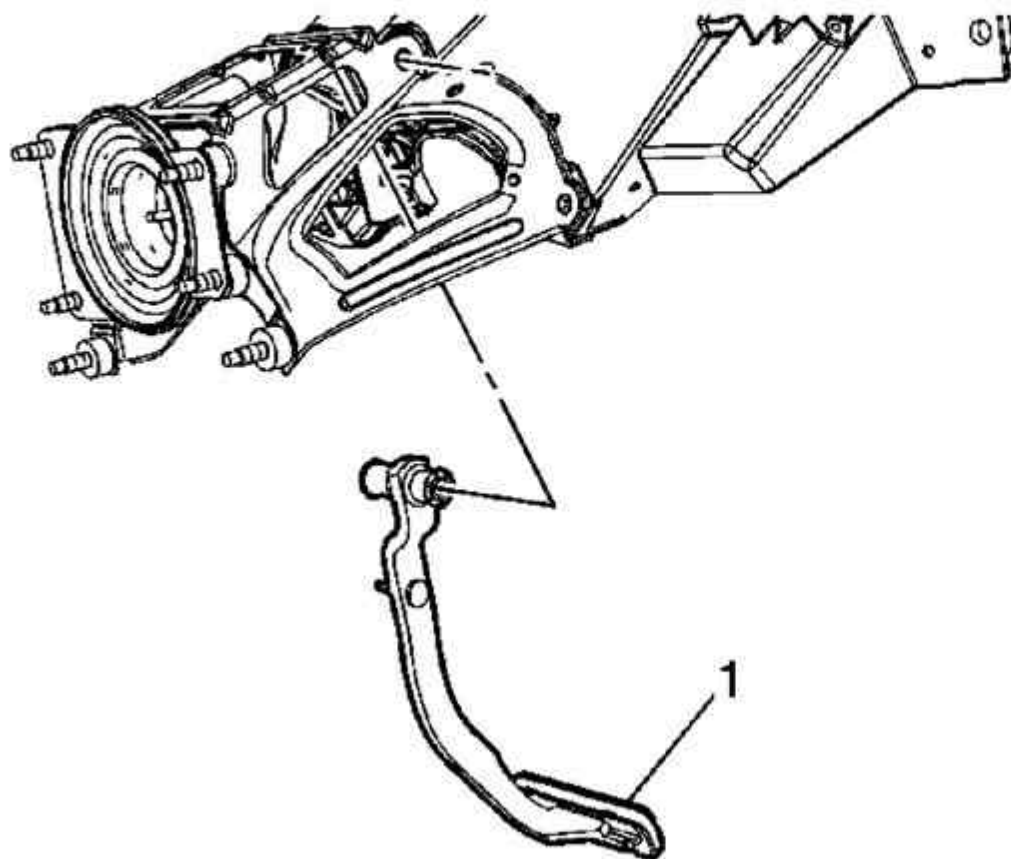


Fig. 25: View Of Brake Pedal Assembly
Courtesy of GENERAL MOTORS CORP.

3. Install the brake pedal (1).

NOTE: Refer to Fastener Notice .

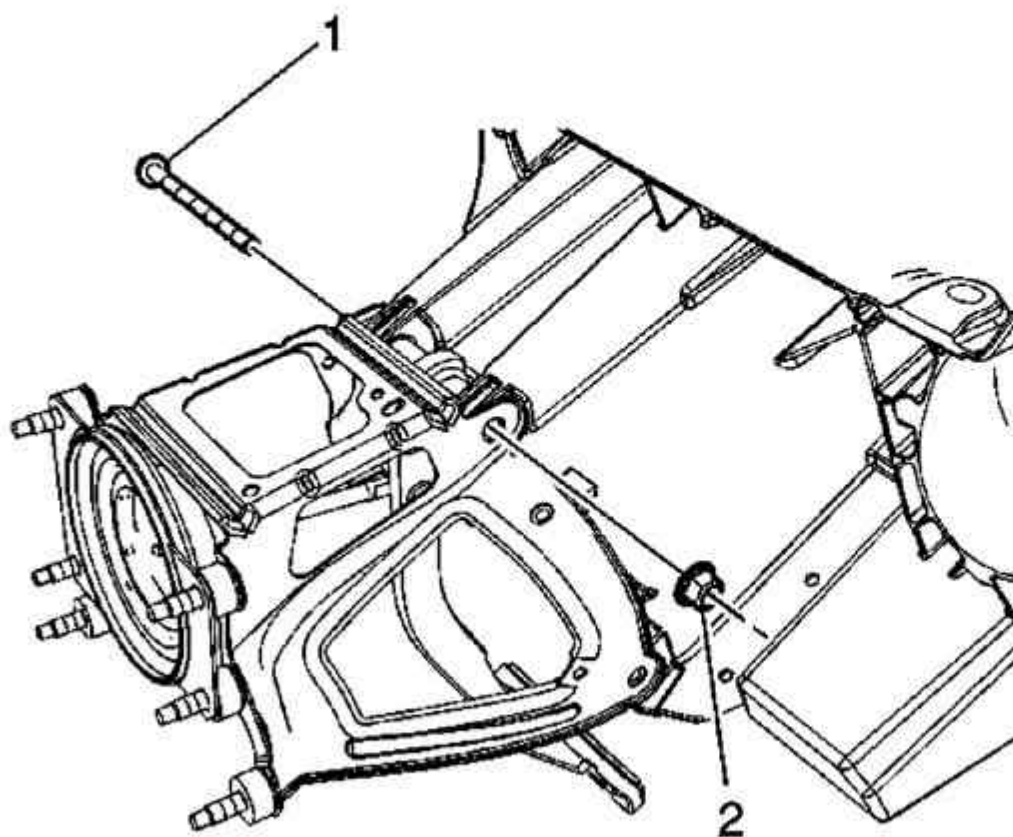


Fig. 26: View Of Brake Pedal Assembly, Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

4. Install the brake pedal bolt (1) and nut (2).

Tighten: Tighten the bolt and nut to 40 N.m (30 lb ft).

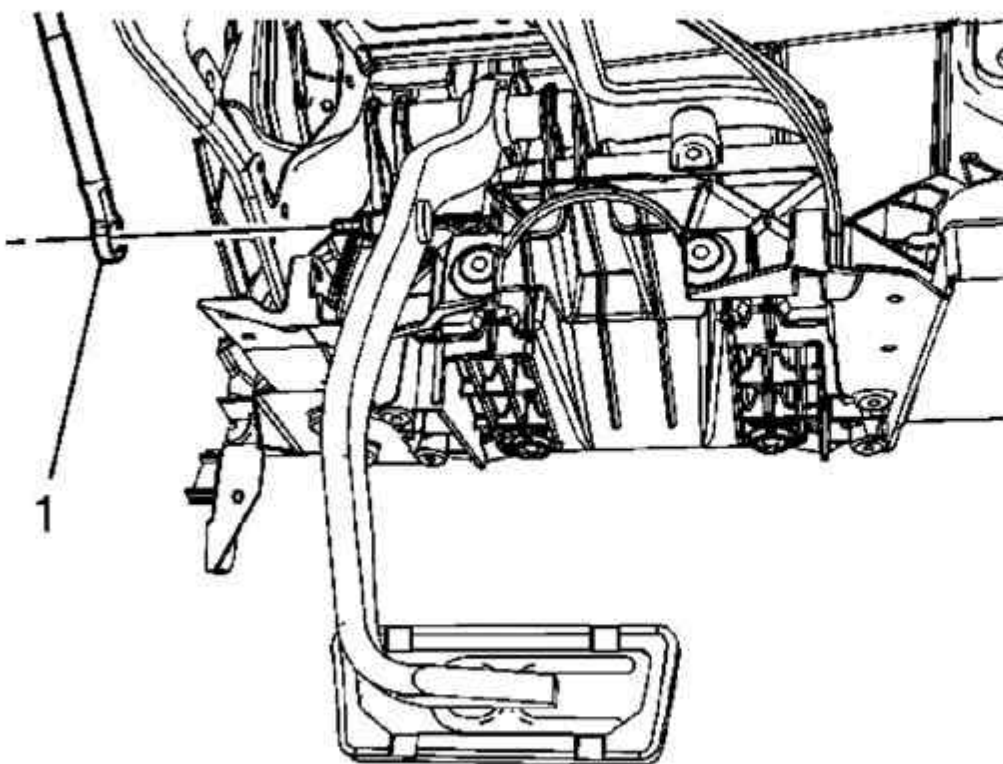


Fig. 27: View Of Brake Pedal Pushrod Nut
Courtesy of GENERAL MOTORS CORP.

5. Connect the brake pedal pushrod (1) to the brake pedal.

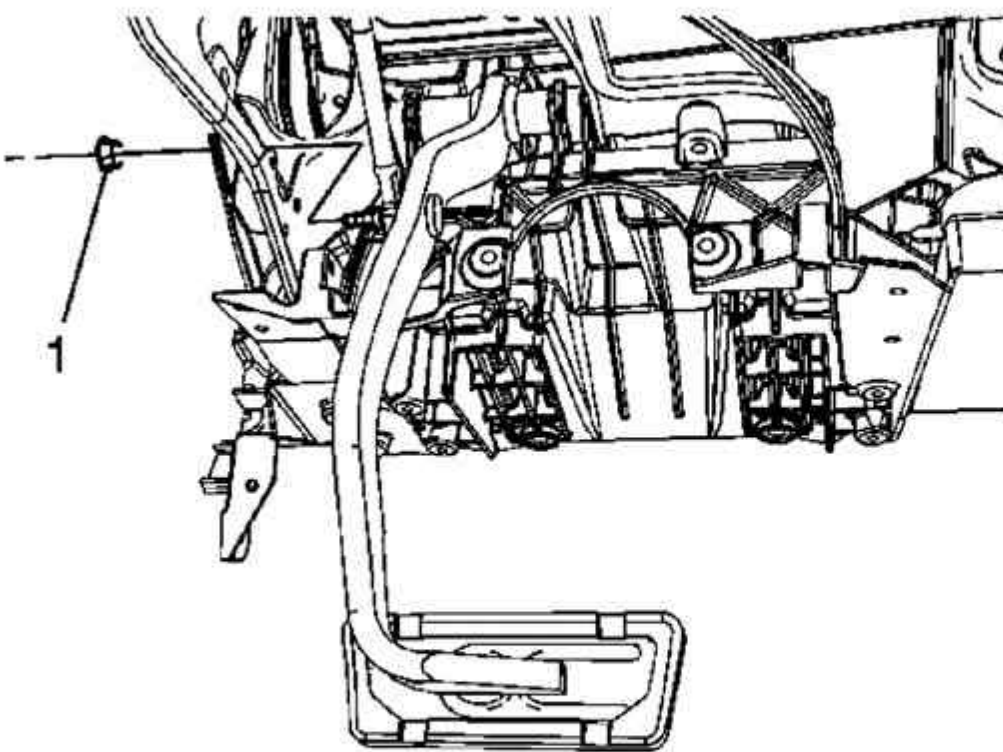


Fig. 28: Identifying Brake Pedal Pushrod Bushing

Courtesy of GENERAL MOTORS CORP.

6. Install the brake pedal pushrod bushing (1).

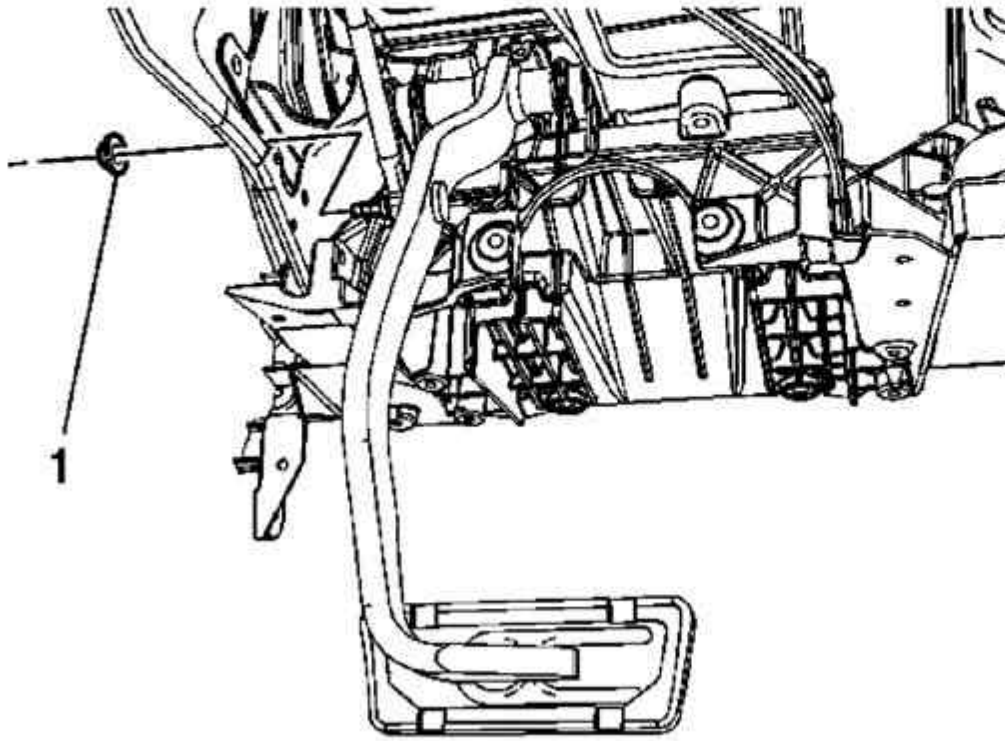


Fig. 29: Identifying Brake Pedal Pushrod Nut
Courtesy of GENERAL MOTORS CORP.

7. Install the brake pedal pushrod nut (1).

Tighten: Tighten the nut to 13 N.m (115 lb in).

8. Install the wiring harness to the bracket clips.
9. Install the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Replacement**.
10. Insert the top of the BCM up into the mounting bracket, then engage the bottom of the BCM into the mounting bracket slot.
11. Install the left instrument panel insulator. Refer to **Instrument Panel Insulator Panel Replacement - Left Side**.

BRAKE PIPE REPLACEMENT

Tools Required

J 45405 Pipe Flaring Tool Kit. See **Special Tools**.

CAUTION: Refer to **Brake Fluid Irritant Caution**.

CAUTION: Always use double walled steel brake pipe when replacing brake pipes. The use of any other pipe is not recommended and may cause brake system failure. Carefully route and retain replacement brake pipes. Always use the

correct fasteners and the original location for replacement brake pipes. Failure to properly route and retain brake pipes may cause damage to the brake pipes and cause brake system failure.

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice.

IMPORTANT: When servicing brake pipes, note the following:

- If sectioning brake pipe, use replacement pipe of the same type and outside diameter.
- Use fittings of the appropriate size and type.
- Only create flares of the same type or design as originally equipped on the vehicle.

Replacement Procedure

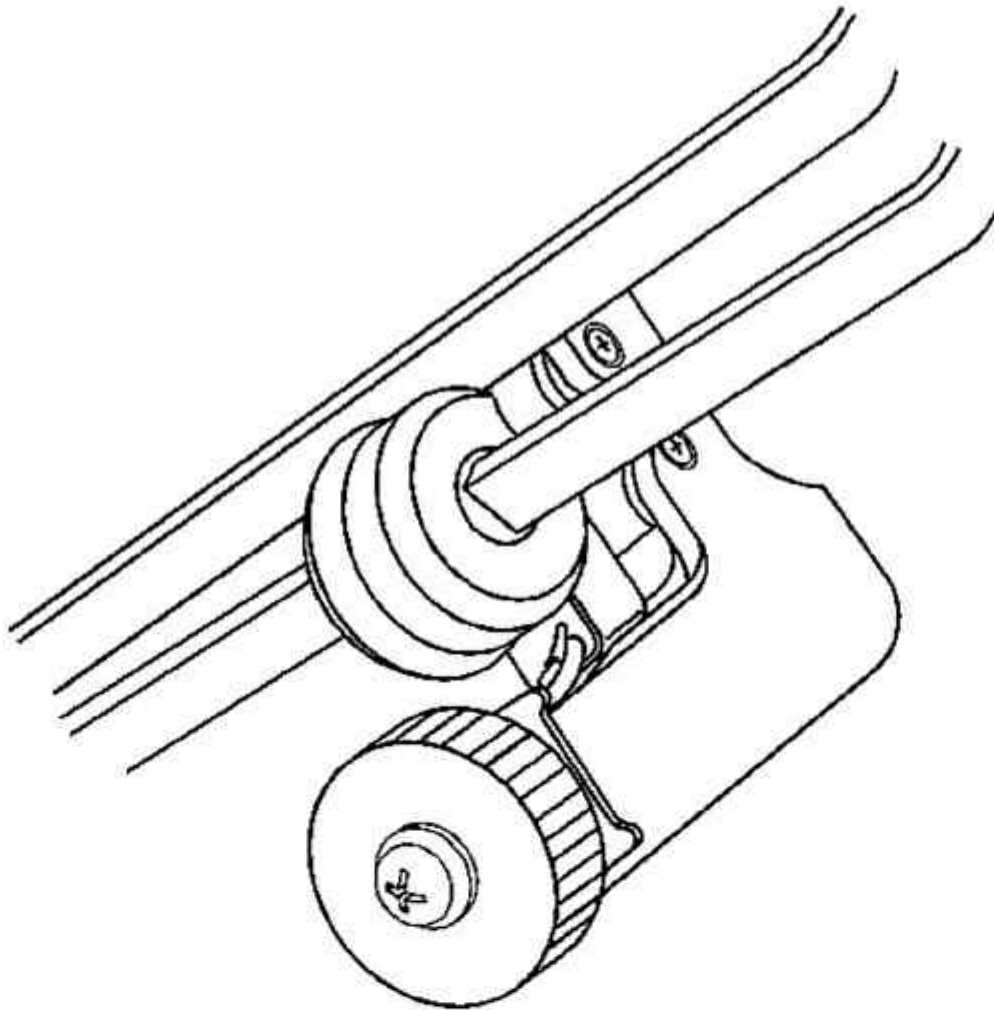


Fig. 30: Sectioning Brake Pipe Using Pipe Cutter
Courtesy of GENERAL MOTORS CORP.

1. Inspect the section of brake pipe to be replaced.
2. Release the brake pipe to be replaced from the retainers, as required.
3. Select an appropriate location to section the brake pipe, if necessary.

- Allow adequate clearance in order to maneuver the **J 45405**. See **Special Tools**.
 - Avoid sectioning the brake pipe at bends or mounting points.
4. Using a string or wire, measure the length of the pipe to be replaced including all pipe bends.
 5. Add to the measurement taken the appropriate additional length required for each flare to be created.

Specification: 6.35 mm (0.250 in) for 4.76 mm (3/16 in) diameter pipe

IMPORTANT: Ensure that the brake pipe end to be flared is cut at a square, 90 degree angle to the pipe length.

6. Using the pipe cutter included in the **J 45405**, carefully cut the brake pipe squarely to the measured length. See **Special Tools**.
7. Remove the sectioned brake pipe from the vehicle.
8. Select the appropriate size of brake pipe and tube nuts, as necessary. The brake pipe outside diameter determines brake pipe size.

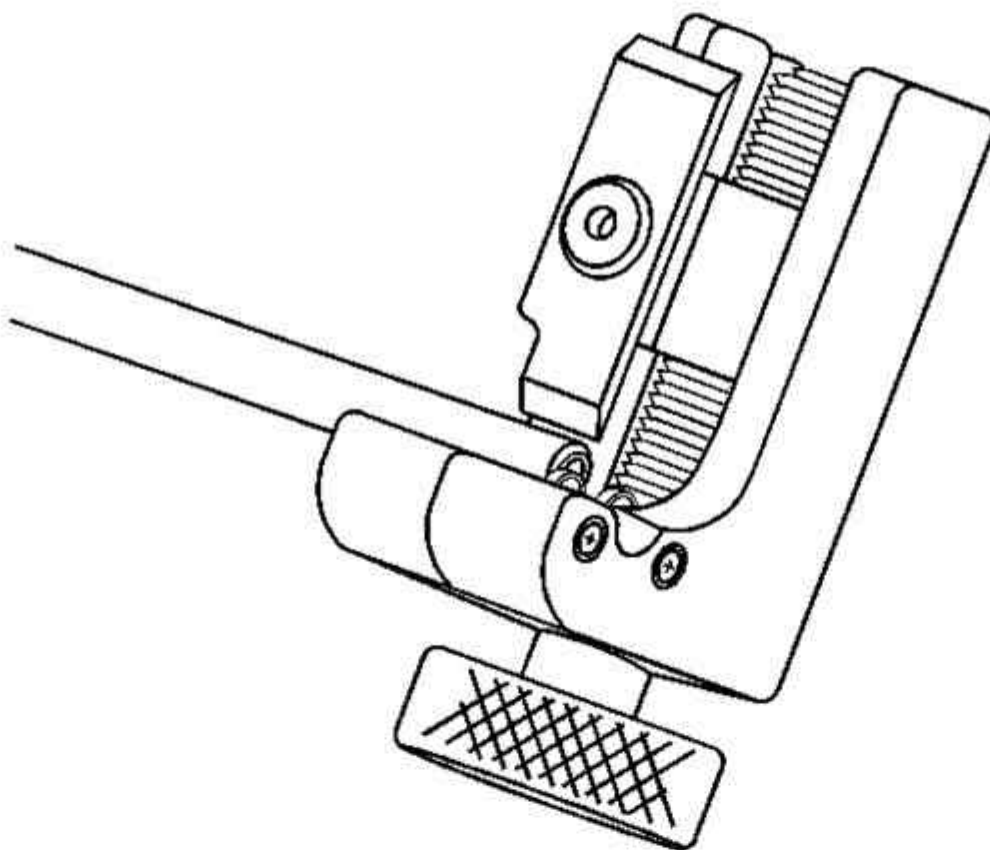


Fig. 31: Stripping Nylon Coating From Brake Pipe Ends
Courtesy of GENERAL MOTORS CORP.

9. Strip the nylon coating from the brake pipe ends to be flared, if necessary.
 - Select the appropriate blade on the coating stripping tool included in the **J 45405**, by unthreading the blade block from the stripping tool and installing the block with the desired blade facing the tool rollers. See **Special Tools**.

Specification: 6.35 mm (0.250 in) blade for 4.76 mm (3/16 in) diameter pipe

- Insert the brake pipe end to be flared into the stripping tool to the depth of the ledge on the tool rollers.
- While holding the brake pipe firmly against the stripping tool roller ledges, rotate the thumbwheel of the tool until the blade contacts the brake pipe coated surface.

IMPORTANT: Do not gouge the metal surface of the brake pipe.

- Rotate the stripping tool in a clockwise direction, ensuring that the brake pipe end remains against the tool roller ledges.
- After each successive revolution of the stripping tool, carefully rotate the thumbwheel of the tool clockwise, in order to continue stripping the coating from the brake pipe until the metal pipe surface is exposed.
- Loosen the thumbwheel of the tool and remove the brake pipe.

IMPORTANT: Ensure that all loose remnants of the nylon coating have been removed from the brake pipe.

- Inspect the stripped end of the brake pipe to ensure that the proper amount of coating has been removed.

Specification: 6.35 mm (0.250 in) for 4.76 mm (3/16 in) diameter pipe

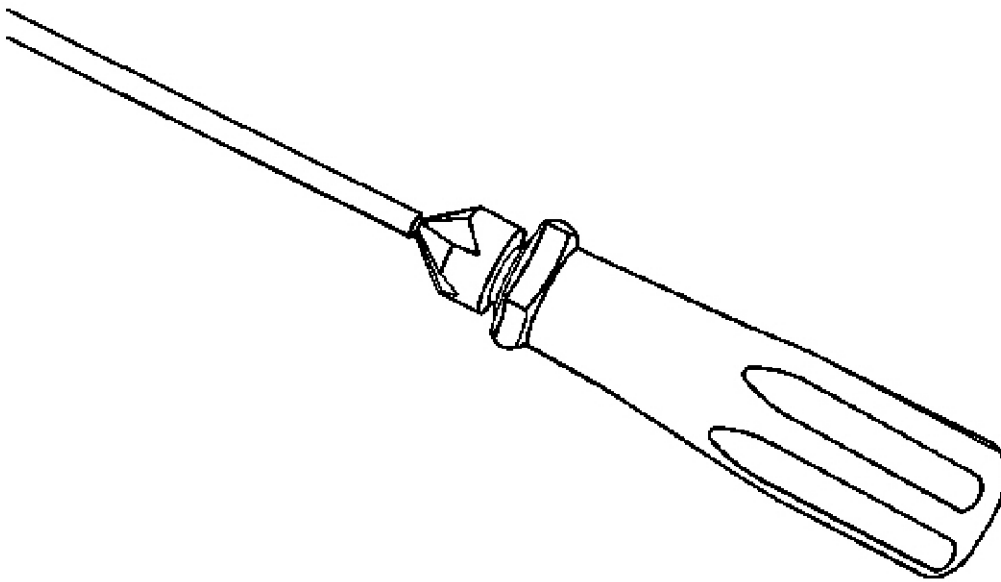


Fig. 32: Chamfering Pipe Using De-Burring Tool
Courtesy of GENERAL MOTORS CORP.

10. Chamfer the inside and outside diameter of the pipe with the de-burring tool included in the **J 45405**. See **Special Tools**.
11. Install the tube nuts on the brake pipe, noting their orientation.
12. Clean the brake pipe and the **J 45405** of lubricant, contaminants, and debris. See **Special Tools**.

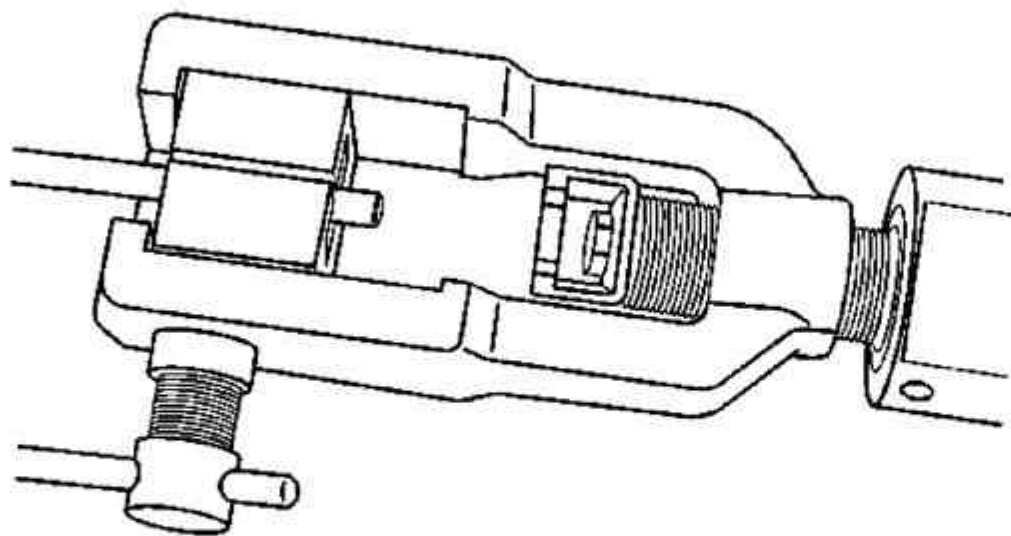


Fig. 33: Installing Die Halves Into Die Cage
 Courtesy of GENERAL MOTORS CORP.

13. Loosen the die clamping screw of the J 45405 . See **Special Tools**.
14. Select the corresponding die set and install the die halves into the die cage with the full, flat face of one die facing the clamping screw, and the counterbores of both dies facing the forming ram.

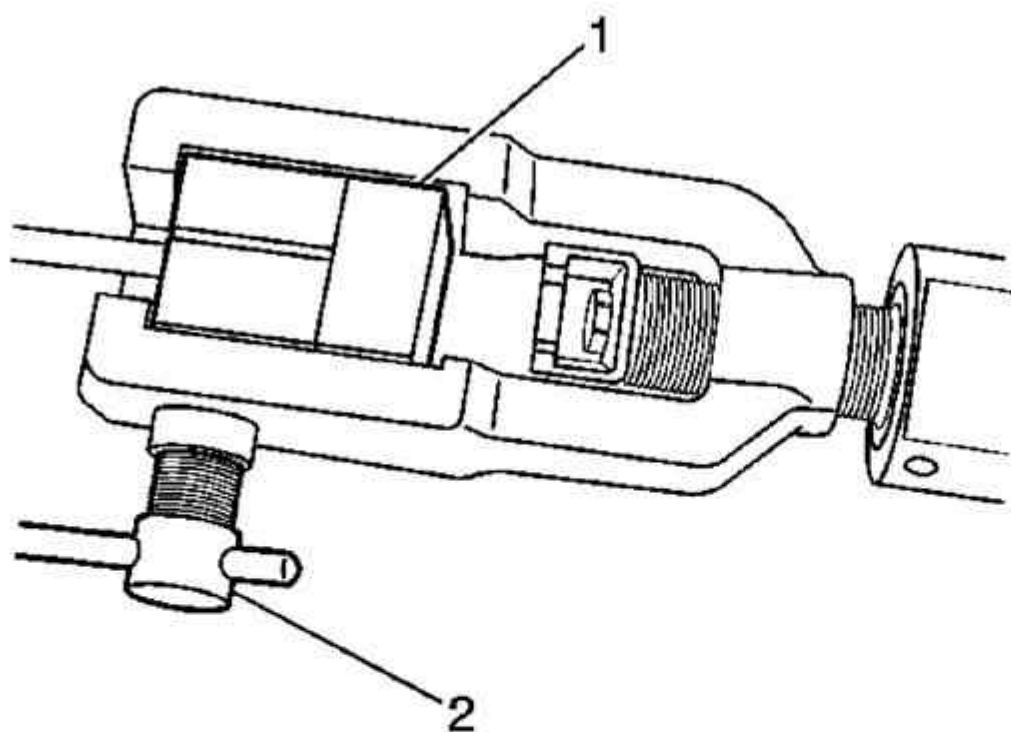


Fig. 34: View Of Clamping Screw & Unused Die
 Courtesy of GENERAL MOTORS CORP.

15. Place the flat face of an unused die (1) against the die halves in the clamping cage and hold firmly against the

counterbored face of the dies.

16. Insert the prepared end of the pipe to be flared through the back of the dies until the pipe is seated against the flat surface of the unused die (1).
17. Remove the unused die (1).
18. Ensure that the rear of both dies are seated firmly against the enclosed end of the die cage.
19. Firmly hand tighten the clamping screw (2) against the dies.

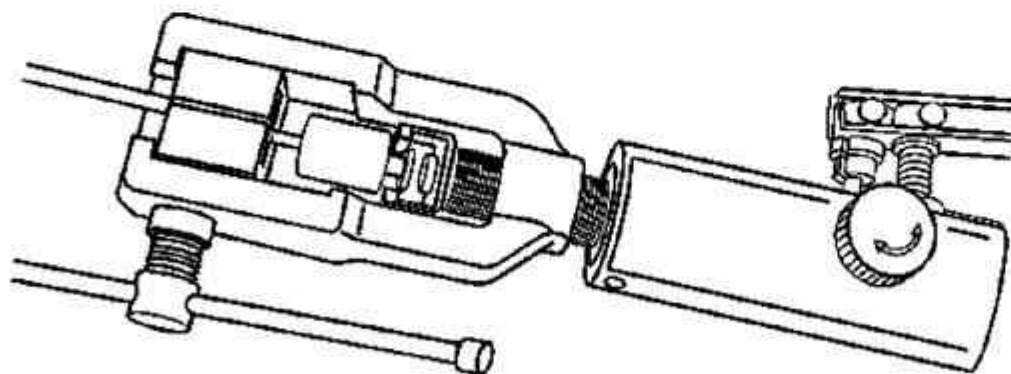


Fig. 35: Rotating J 45405 To Bottom Against Die Cage
Courtesy of GENERAL MOTORS CORP.

20. Select the appropriate forming mandrel and place into the forming ram.
21. Rotate the hydraulic fluid control valve clockwise to the closed position.
22. Rotate the body of the **J 45405** until it bottoms against the die cage. See **Special Tools**.

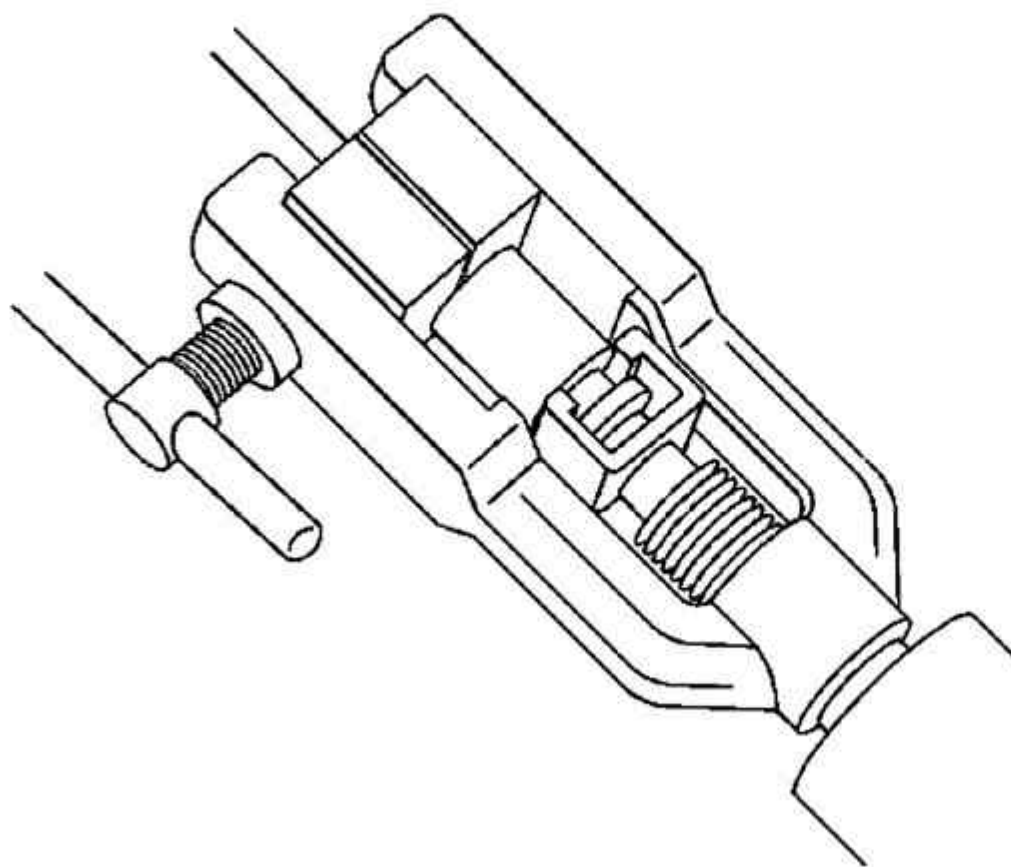


Fig. 36: Bottoming Forming Mandrel Against Clamping Dies Using Pipe Flaring Tool
Courtesy of GENERAL MOTORS CORP.

23. While guiding the forming mandrel into the exposed end of pipe to be flared, operate the lever of the **J 45405** until the forming mandrel bottoms against the clamping dies. See **Special Tools**.
24. Rotate the hydraulic fluid control valve counterclockwise to the open position to allow the hydraulic forming ram to retract.
25. Loosen the die clamping screw and remove the dies and pipe.
26. If necessary, lightly tap the dies until the die halves separate.

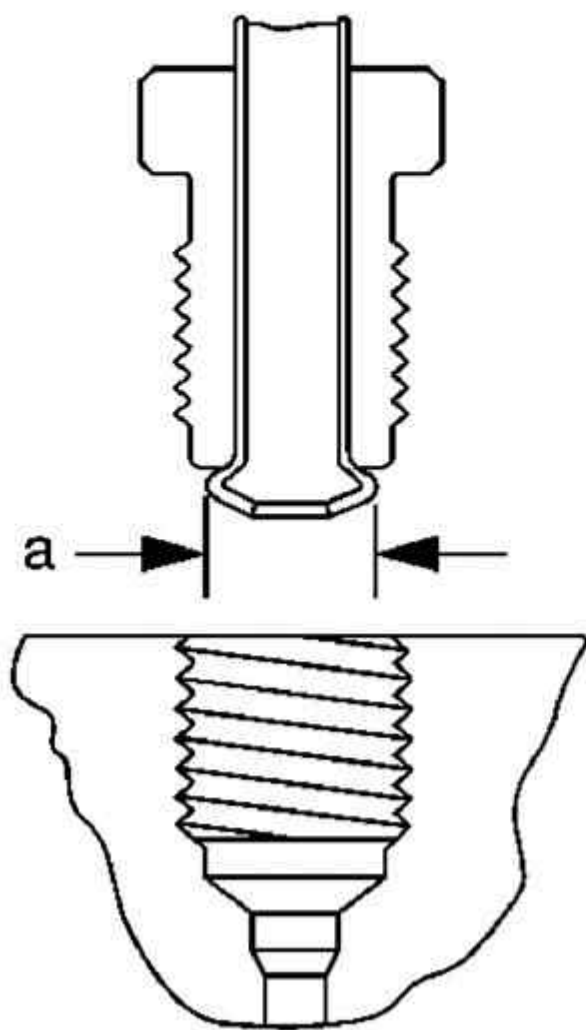


Fig. 37: Inspecting Brake Pipe Flare Diameter
Courtesy of GENERAL MOTORS CORP.

27. Inspect the brake pipe flare for correct shape and diameter (a).

Specification: 7.10 mm (0.279 in) +/- 0.18 mm (0.007 in) flare diameter for 4.76 mm (3/16 in) diameter pipe

28. If necessary, using the removed section of pipe as a template, shape the new pipe with a suitable brake pipe bending tool.

IMPORTANT: When installing the pipe, maintain a clearance of 19 mm (3/4 in) from all moving or vibrating components.

29. Install the pipe to the vehicle with the appropriate brake pipe unions as required.
30. If previously released, secure the brake pipe to the retainers.
31. Bleed the hydraulic brake system. Refer to Hydraulic Brake System Bleeding (Manual) or Hydraulic Brake System Bleeding (Pressure).
32. With the aid of an assistant, inspect the brake pipe flares for leaks by starting the engine and applying the brakes.

Removal Procedure

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the front tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .
3. Clean all dirt and foreign material from the brake hoses and brake pipe fitting.

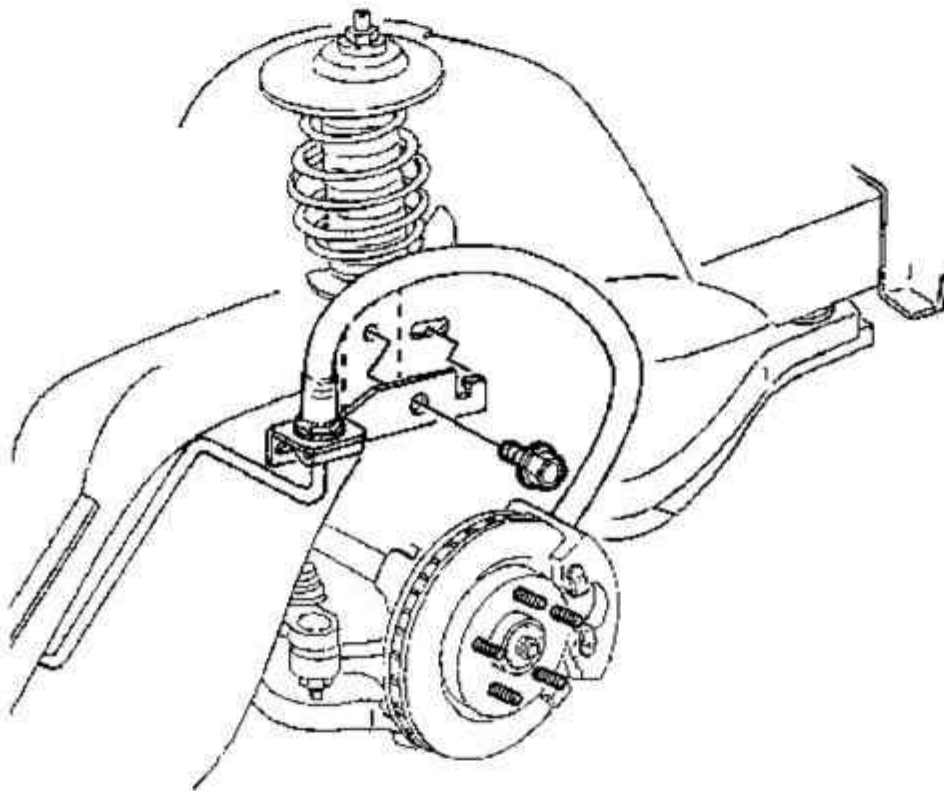


Fig. 38: View Of Front Brake Hose & Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install a rubber cap or plug to the exposed brake pipe fitting end to prevent brake fluid loss and contamination.

4. Use a backup wrench on the hose fitting, disconnect the brake pipe fitting from the brake hose, then cap or plug the brake pipe fitting end.

Do not bend the brake pipe or the bracket.

5. Remove the brake hose retaining clip from the hose mounting bracket.
6. Remove the hose from the bracket.

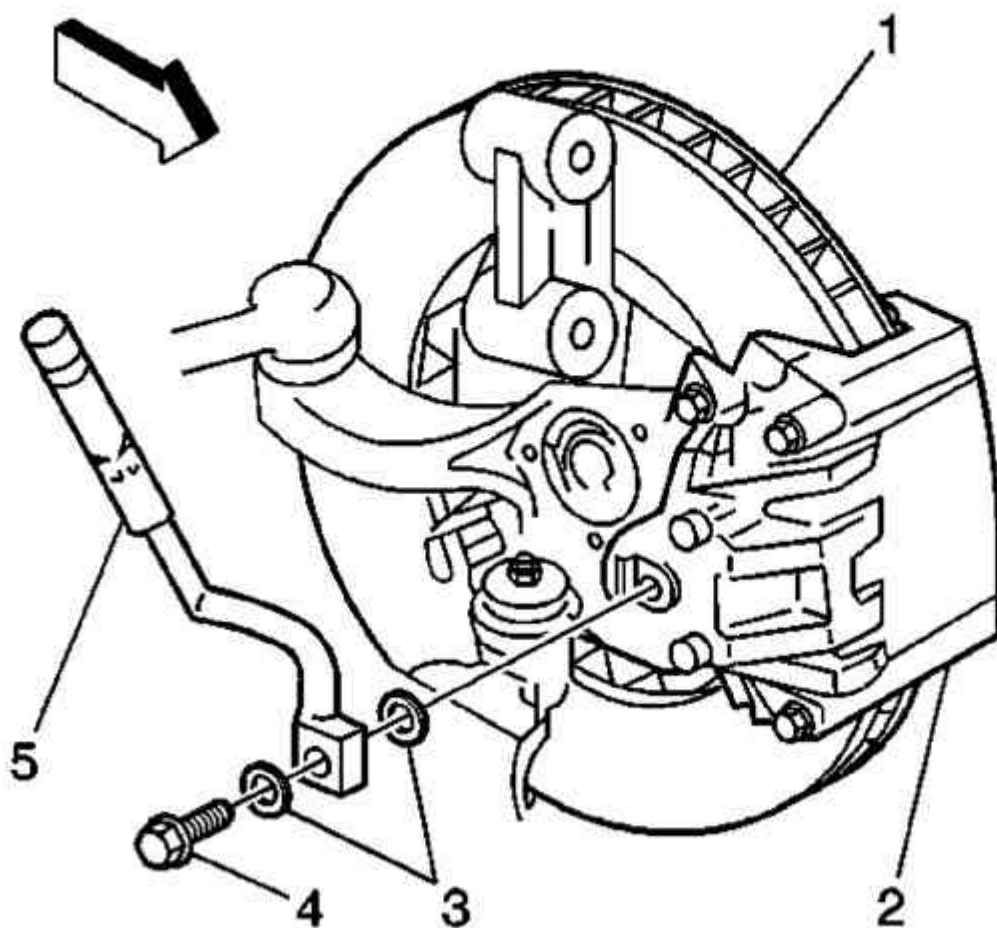


Fig. 39: Identifying Brake Hose At Brake Caliper
Courtesy of GENERAL MOTORS CORP.

7. Remove the brake hose to caliper bolt (4) from the brake caliper (2).
8. Remove the brake hose (5) from the brake caliper (2).
9. Remove and discard the two copper brake hose gaskets (3). These gaskets may be stuck to the brake caliper and/or the brake hose end.

Installation Procedure

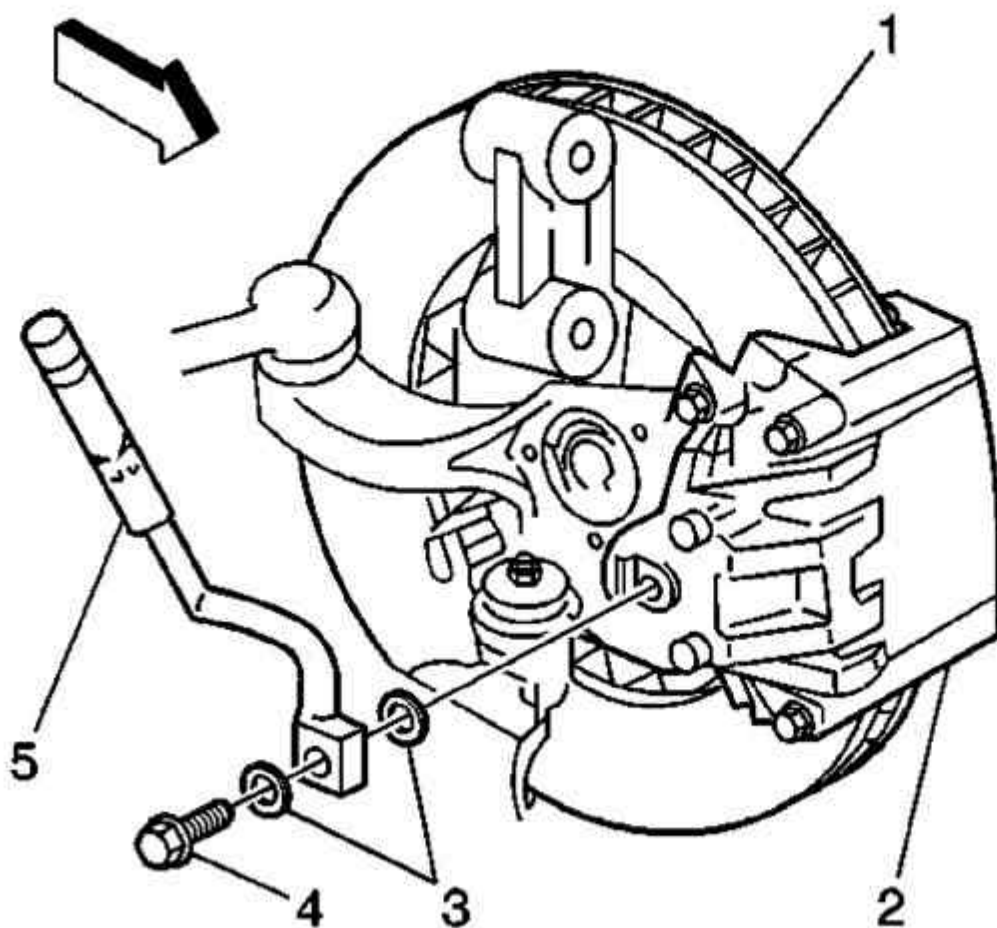


Fig. 40: Identifying Brake Hose At Brake Caliper
 Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install NEW copper brake hose gaskets (3).

1. Assemble the NEW copper brake hose gaskets (3), and the brake hose bolt (4) to the brake hose.

NOTE: Refer to Fastener Notice .

2. Install the brake hose to caliper bolt to the brake caliper.

Tighten: Tighten the brake hose to brake caliper bolt to 54 N.m (40 lb ft).

3. With the weight of the vehicle on the suspension, install the brake hose into the bracket.

There should not be any kinks in the hose.

Align the hose fitting with the notch in the bracket. Use the hose paint stripe as a visual aid.

4. Install the retainer onto the hose fitting at the bracket.
5. Remove the rubber cap or plug from the exposed brake pipe fitting end.

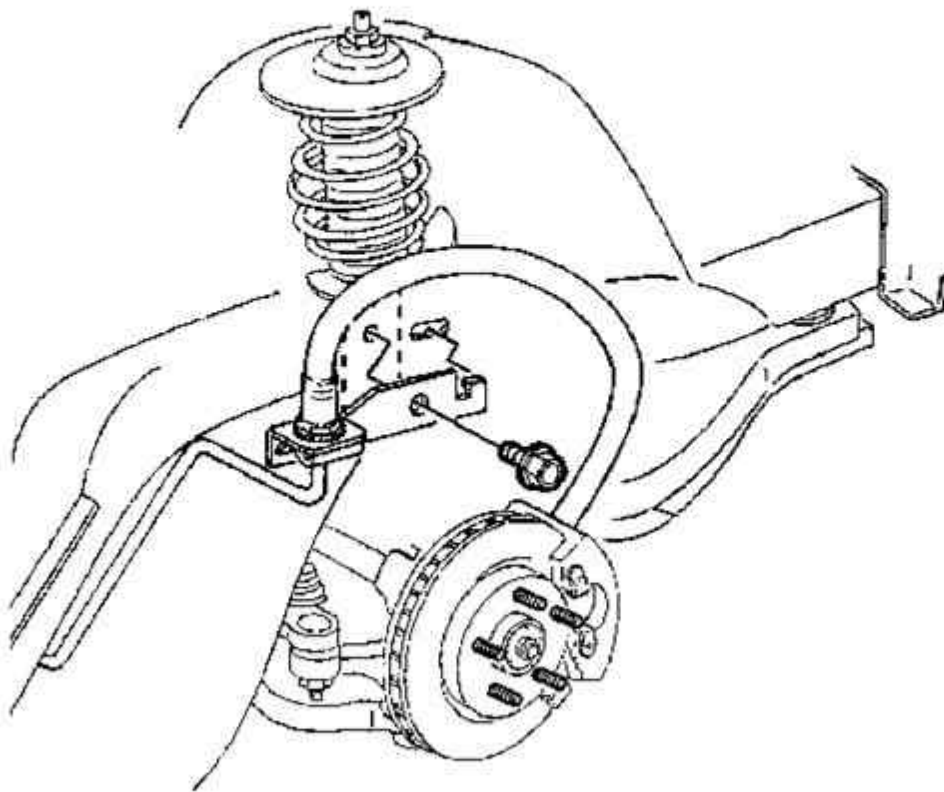


Fig. 41: View Of Front Brake Hose & Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

6. Connect the brake pipe fitting to the brake hose:

- Use a backup wrench on the hose fitting.
- Do not bend the bracket or pipe.

Tighten: Tighten the brake pipe fitting to 18 N.m (13 lb ft).

7. Install the front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation**.
8. Ensure that the hose does not make contact with any part of the suspension. Check the hose in extreme right and extreme left turn conditions. If the hose makes contact, remove the hose and correct the condition.
9. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.
10. Lower the vehicle.

REAR BRAKE HOSE REPLACEMENT

Removal Procedure

CAUTION: Refer to **Brake Fluid Irritant Caution**.

NOTE: Refer to **Brake Fluid Effects on Paint and Electrical Components Notice**.

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
2. Remove the rear tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation**.

3. Clean all dirt and foreign material from the brake hoses and brake pipe fitting.

IMPORTANT: Install a rubber cap or plug to the exposed brake pipe fitting end to prevent brake fluid loss and contamination.

4. Use a backup wrench on the hose fitting, disconnect the brake pipe fitting from the brake hose, then cap or plug the brake pipe fitting end.

Do not bend the brake pipe or the bracket.

5. Remove the brake hose retaining clip from the hose mounting bracket.
6. Remove the hose from the bracket.

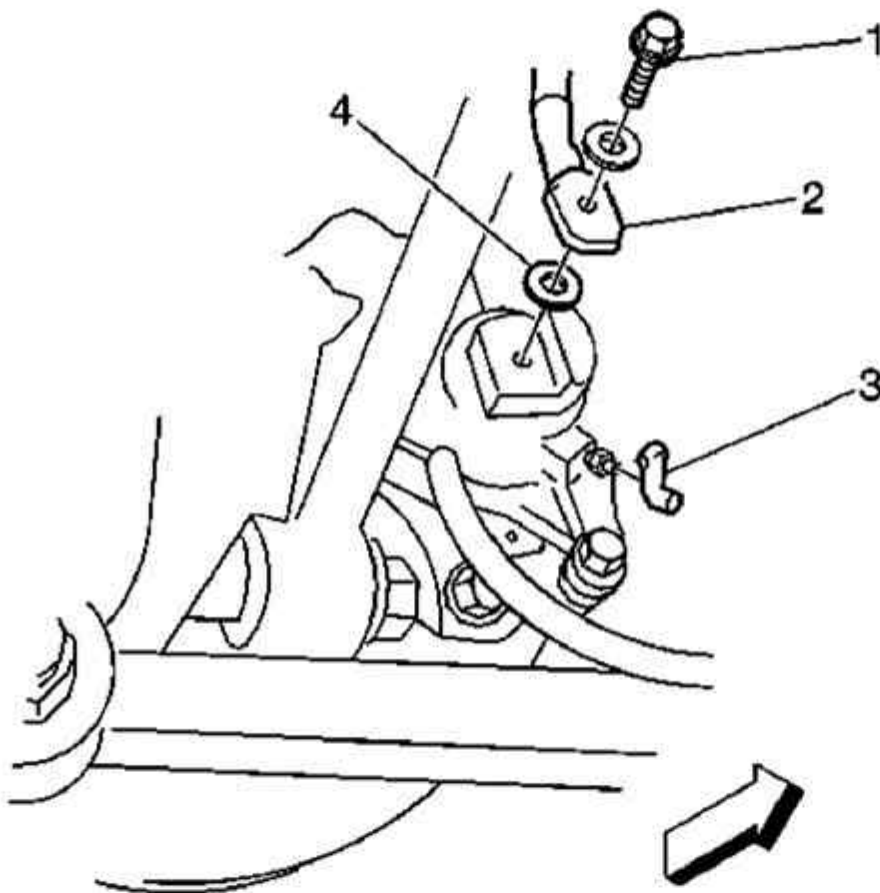


Fig. 42: View Of Rear Brake Hose At Caliper
Courtesy of GENERAL MOTORS CORP.

7. Remove the brake hose to caliper bolt (1) from the brake caliper.
8. Remove the brake hose (2) from the brake caliper.
9. Remove the brake hose from the vehicle.
10. Remove and discard the two copper brake hose gaskets (4). These gaskets may be stuck to the brake caliper and/or the brake hose end.

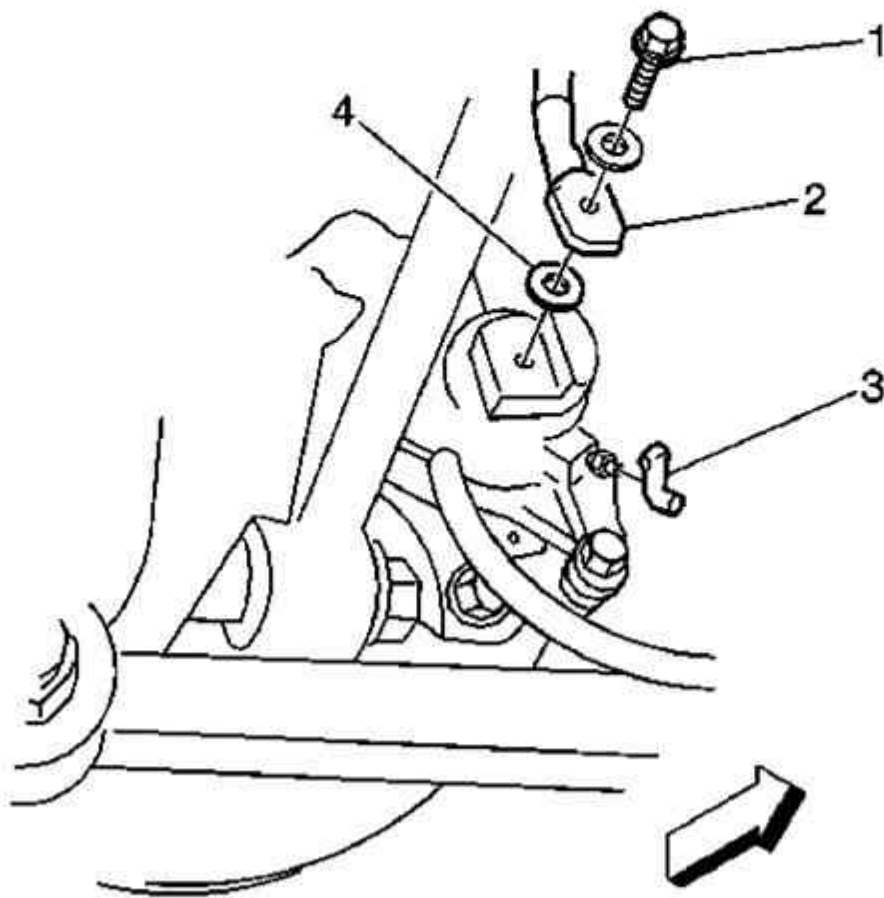


Fig. 43: View Of Rear Brake Hose At Caliper
Courtesy of GENERAL MOTORS CORP.

1. Position the brake hose in the vehicle.

IMPORTANT: Install NEW copper brake hose gaskets (4).

2. Assemble the NEW copper brake hose gaskets (4), and the brake hose bolt (1) to the brake hose (2).

NOTE: Refer to Fastener Notice .

3. Install the brake hose to caliper bolt (1) to the brake caliper.

While installing the right rear brake hose to caliper, hold up while tightening bolt.

Tighten: Tighten the brake hose to brake caliper bolt to 54 N.m (40 lb ft).

4. With the weight of the vehicle on the suspension, install the brake hose into the bracket.
 - There should not be any kinks in the hose.
 - Align the hose fitting with the notch in the bracket. Use the hose paint stripe as a visual aid.
5. Install the retainer onto the hose fitting at the bracket.
6. Remove the rubber cap or plug from the exposed brake pipe fitting end.
7. Connect the brake pipe fitting to the brake hose:
 - Use a backup wrench on the hose fitting.

- Do not bend the bracket or pipe.

Tighten: Tighten the brake pipe fitting to 18 N.m (13 lb ft).

8. Install the rear tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation**.
9. Ensure that the hose does not make contact with any part of the suspension. If the hose makes contact, remove the hose and correct the condition.
10. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.
11. Lower the vehicle.

HYDRAULIC BRAKE SYSTEM BLEEDING (MANUAL)

CAUTION: Refer to **Brake Fluid Irritant Caution**.

NOTE: When adding fluid to the brake master cylinder reservoir, use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

NOTE: Refer to **Brake Fluid Effects on Paint and Electrical Components Notice**.

1. Place a clean shop cloth beneath the brake master cylinder to prevent brake fluid spills.
2. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
3. If you have performed a brake master cylinder bench bleeding on this vehicle, or if you disconnected the brake pipes from the master cylinder, you must perform the following steps:
 1. Ensure that the brake master cylinder reservoir is full to the maximum-fill level. If necessary, add Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.

If removal of the reservoir cap and diaphragm is necessary, clean the outside of the reservoir on and around the cap prior to removal.

2. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe from the front port of the brake master cylinder.
3. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder.
4. Reconnect the brake pipe to the master cylinder port and tighten securely.
5. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
6. Loosen the same brake pipe to purge air from the open port of the master cylinder.
7. Tighten the brake pipe, then have the assistant slowly release the brake pedal.
8. Wait 15 seconds, then repeat steps 3.3-3.7 until all air is purged from the same port of the master cylinder.
9. With the front brake pipe installed securely to the master cylinder, after all air has been purged from the front port of the master cylinder, loosen and separate the rear brake pipe from the master cylinder, then repeat steps 3.3-3.8.
10. After completing the final master cylinder port bleeding procedure, ensure that both of the brake pipe-

to-master cylinder fittings are properly tightened.

4. Fill the brake master cylinder reservoir with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. Ensure that the brake master cylinder reservoir remains at least half-full during this bleeding procedure. Add fluid as needed to maintain the proper level.

Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.

5. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
6. Install a transparent hose over the end of the bleeder valve.
7. Submerge the open end of the transparent hose into a transparent container partially filled with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
8. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
9. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
10. Tighten the bleeder valve, then have the assistant slowly release the brake pedal.
11. Wait 15 seconds, then repeat steps 8-10 until all air is purged from the same wheel hydraulic circuit.
12. With the right rear wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the right rear hydraulic circuit, install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve.
13. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
14. With the left front wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the left front hydraulic circuit, install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve.
15. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
16. With the left rear wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the left rear hydraulic circuit, install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve.
17. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
18. After completing the final wheel hydraulic circuit bleeding procedure, ensure that each of the 4 wheel hydraulic circuit bleeder valves are properly tightened.
19. Fill the brake master cylinder reservoir to the maximum-fill level with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
20. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.

IMPORTANT: If it is determined that air was induced into the system upstream of the ABS modulator prior to servicing, the Antilock Brake System Automated Bleed Procedure must be performed.

21. If the brake pedal feels spongy, repeat the bleeding procedure again. If the brake pedal still feels spongy after repeating the bleeding procedure, perform the following steps:
 1. Inspect the brake system for external leaks. Refer to **Brake System External Leak Inspection**.
 2. Pressure bleed the hydraulic brake system in order to purge any air that may still be trapped in the system.
22. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

IMPORTANT: DO NOT allow the vehicle to be driven until it is diagnosed and repaired.

23. If the brake system warning lamp remains illuminated, refer to Symptoms - Hydraulic Brakes.

HYDRAULIC BRAKE SYSTEM BLEEDING (PRESSURE)

Tools Required

- **J 29532** Diaphragm Type Brake Pressure Bleeder, or equivalent. See Special Tools.
- **J 35589-A** Master Cylinder Bleeder Adapter. See Special Tools.

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: When adding fluid to the brake master cylinder reservoir, use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

1. Place a clean shop cloth beneath the brake master cylinder to prevent brake fluid spills.
2. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
3. If you have performed a brake master cylinder bench bleeding on this vehicle, or if you disconnected the brake pipes from the master cylinder, you must perform the following steps:
 1. Ensure that the brake master cylinder reservoir is full to the maximum-fill level. If necessary, add Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.

If removal of the reservoir cap and diaphragm is necessary, clean the outside of the reservoir on and around the cap prior to removal.
 2. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe from the front port of the brake master cylinder.
 3. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder.
 4. Reconnect the brake pipe to the master cylinder port and tighten securely.
 5. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
 6. Loosen the same brake pipe to purge air from the open port of the master cylinder.
 7. Tighten the brake pipe, then have the assistant slowly release the brake pedal.
 8. Wait 15 seconds, then repeat steps 3.3-3.7 until all air is purged from the same port of the master cylinder.
 9. With the front brake pipe installed securely to the master cylinder, after all air has been purged from the front port of the master cylinder, loosen and separate the rear brake pipe from the master cylinder, then repeat steps 3.3-3.8.
10. After completing the final master cylinder port bleeding procedure, ensure that both of the brake pipe-to-master cylinder fittings are properly tightened.
4. Fill the brake master cylinder reservoir to the maximum-fill level with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.

Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.

5. Install the **J 35589-A** to the brake master cylinder reservoir. See **Special Tools**.
6. Check the brake fluid level in the **J 29532** , or equivalent. See **Special Tools**. Add Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container as necessary to bring the level to approximately the half-full point.
7. Connect the **J 29532** , or equivalent, to the **J 35589-A** . See **Special Tools**.
8. Charge the **J 29532** , or equivalent, air tank to 175-205 kPa (25-30 psi). See **Special Tools**.
9. Open the **J 29532** , or equivalent, fluid tank valve to allow pressurized brake fluid to enter the brake system. See **Special Tools**.
10. Wait approximately 30 seconds, then inspect the entire hydraulic brake system in order to ensure that there are no existing external brake fluid leaks.

Any brake fluid leaks identified require repair prior to completing this procedure.

11. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
12. Install a transparent hose over the end of the bleeder valve.
13. Submerge the open end of the transparent hose into a transparent container partially filled with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
14. Loosen the bleeder valve to purge air from the wheel hydraulic circuit. Allow fluid to flow until air bubbles stop flowing from the bleeder, then tighten the bleeder valve.
15. With the right rear wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the right rear hydraulic circuit, install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve.
16. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
17. With the left front wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the left front hydraulic circuit, install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve.
18. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
19. With the left rear wheel hydraulic circuit bleeder valve tightened securely, after all air has been purged from the left rear hydraulic circuit, install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve.
20. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
21. After completing the final wheel hydraulic circuit bleeding procedure, ensure that each of the 4 wheel hydraulic circuit bleeder valves are properly tightened.
22. Close the **J 29532** , or equivalent, fluid tank valve, then disconnect the **J 29532** , or equivalent, from the **J 35589-A** . See **Special Tools**.
23. Remove the **J 35589-A** from the brake master cylinder reservoir. See **Special Tools**.
24. Fill the brake master cylinder reservoir to the maximum-fill level with Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
25. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.

IMPORTANT: If it is determined that air was induced into the system upstream of the ABS modulator prior to servicing, the Antilock Brake System Automated Bleed Procedure must be performed.

26. If the brake pedal feels spongy, perform the following steps:

1. Inspect the brake system for external leaks. Refer to **Brake System External Leak Inspection** .
 2. Using a scan tool, perform the antilock brake system automated bleeding procedure to remove any air that may have been trapped in the brake pressure modulator valve (BPMV). Refer to **Antilock Brake System Automated Bleed Procedure** .
27. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

IMPORTANT: DO NOT allow the vehicle to be driven until it is diagnosed and repaired.

28. If the brake system warning lamp remains illuminated, refer to **Symptoms - Hydraulic Brakes**.

HYDRAULIC BRAKE SYSTEM FLUSHING

CAUTION: Refer to Brake Fluid Irritant Caution .

NOTE: Refer to Brake Fluid Effects on Paint and Electrical Components Notice .

NOTE: When adding fluid to the brake master cylinder reservoir, use only Delco Supreme 11®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:
 - Fluid separation, indicating 2 types of fluid are present; a substance other than the recommended brake fluid has been introduced into the brake hydraulic system
 - Swirled appearance - oil-based substance
 - Layered appearance - silicone-based substance
 - Fluid discoloration, indicating the presence of moisture or particles that have been introduced into the brake hydraulic system
 - Cloudy appearance - moisture
 - Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust
2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating brake fluid contamination.
3. If the brake fluid WAS contaminated with an oil-based or a silicone-based substance, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets, perform the following:
 1. Remove ALL of the following components listed from the vehicle. Each component contains internal rubber seals/linings which have been contaminated by the contaminated brake fluid in the brake hydraulic system.

Refer to the procedures indicated:

- **Master Cylinder Replacement**
- **Front Brake Hose Replacement**
- **Rear Brake Hose Replacement**
- **Front Brake Caliper Replacement**

- **Rear Brake Caliper Replacement (JL9) Rear Brake Caliper Replacement (J65)**
- **Brake Pressure Modulator Valve Replacement**

2. Clean out all the hydraulic brake pipes using denatured alcohol, or equivalent.
3. Dry the brake pipes using non-lubricated, filtered air.
4. Repair or replace ALL of the following components listed and install them to the vehicle. Each component contains internal rubber seals/linings which have been contaminated by the contaminated brake fluid in the brake hydraulic system.

Refer to the procedures indicated:

- **Master Cylinder Overhaul** or **Master Cylinder Replacement** ; also perform the following:

Clean the brake master cylinder reservoir using denatured alcohol, or equivalent, then dry the reservoir using non-lubricated, filtered air. Inspect the reservoir for cracks and/or damage and replace if necessary. Refer to **Master Cylinder Reservoir Replacement** .

Replace the brake master cylinder reservoir cap diaphragm.

- **Front Brake Hose Replacement**
- **Rear Brake Hose Replacement**
- **Front Brake Caliper Overhaul** or **Front Brake Caliper Replacement**
- **Rear Brake Caliper Overhaul (JL9) Rear Brake Caliper Overhaul (J65) or Rear Brake Caliper Replacement (JL9) Rear Brake Caliper Replacement (J65)**
- **Brake Pressure Modulator Valve Replacement**

4. If the brake fluid was NOT contaminated with an oil-based or a silicone-based substance, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm. The diaphragm may have allowed the moisture or particles to enter the hydraulic system.
5. Fill the brake master cylinder reservoir to the maximum-fill level with Delco Supreme 11®, GM P/N 12377967 (Canada P/N 992667) or equivalent, DOT-3 brake fluid from a clean, sealed brake fluid container.
6. Pressure bleed the hydraulic brake system. Begin the procedure with the pressure bleeder reservoir filled to the maximum-fill level with the correct brake fluid as indicated. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.

POWER VACUUM BRAKE BOOSTER REPLACEMENT (LY7)

Tools Required

J 22805-B Power Brake Booster Holder. See **Special Tools**.

Removal Procedure

CAUTION: When replacing the power booster brake, make sure that the cruise control cable is not routed between the booster and the cowl. If the cable is damaged or pinched, it must be replaced. Failure to do this could result in personal injury.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)** or **Battery Negative Cable Disconnection and Connection (LY7)** or **Battery Negative Cable Disconnection and Connection (LS4)** .
2. Remove the left instrument panel insulator. Refer to **Instrument Panel Insulator Panel Replacement -**

Left Side

3. Remove the brake apply sensor (BAS).
4. Remove the retaining clip and disconnect the brake booster pushrod from the brake pedal.
5. Remove the exhaust crossover pipe. Refer to **Exhaust Crossover Pipe Replacement (3.6L)** or **Exhaust Crossover Pipe Replacement (3.8L)**.
6. Disconnect the brake fluid level sensor electrical connector from the brake fluid level sensor.
7. Remove the brake pressure modulator valve (BPMV) bracket and fasteners. Refer to **Brake Pressure Modulator Valve Bracket Replacement**.
8. Remove the master cylinder mounting nuts and separate the master cylinder from the vacuum brake booster and position aside.

IMPORTANT: It is not necessary to disconnect the brake hydraulic pipes from the master cylinder or brake pressure modulator valve.

9. Disconnect the vacuum brake booster check valve from the brake booster. Position aside the vacuum hose and the check valve as an assembly.
10. Drain the cooling system. Refer to **Cooling System Draining and Filling (L26, LY7 GE 47716 Fill)** or **Cooling System Draining and Filling (L26 Static Fill)** or **Cooling System Draining and Filling (LY7 Static Fill)** or **Cooling System Draining and Filling (LS4 GE47716 Fill)** or **Cooling System Draining and Filling (LS4 Static Fill)**.
11. Remove the coolant heater pipes from the engine.
12. Attach the **J 22805-B** to the booster using the master cylinder retaining nuts. See **Special Tools**.

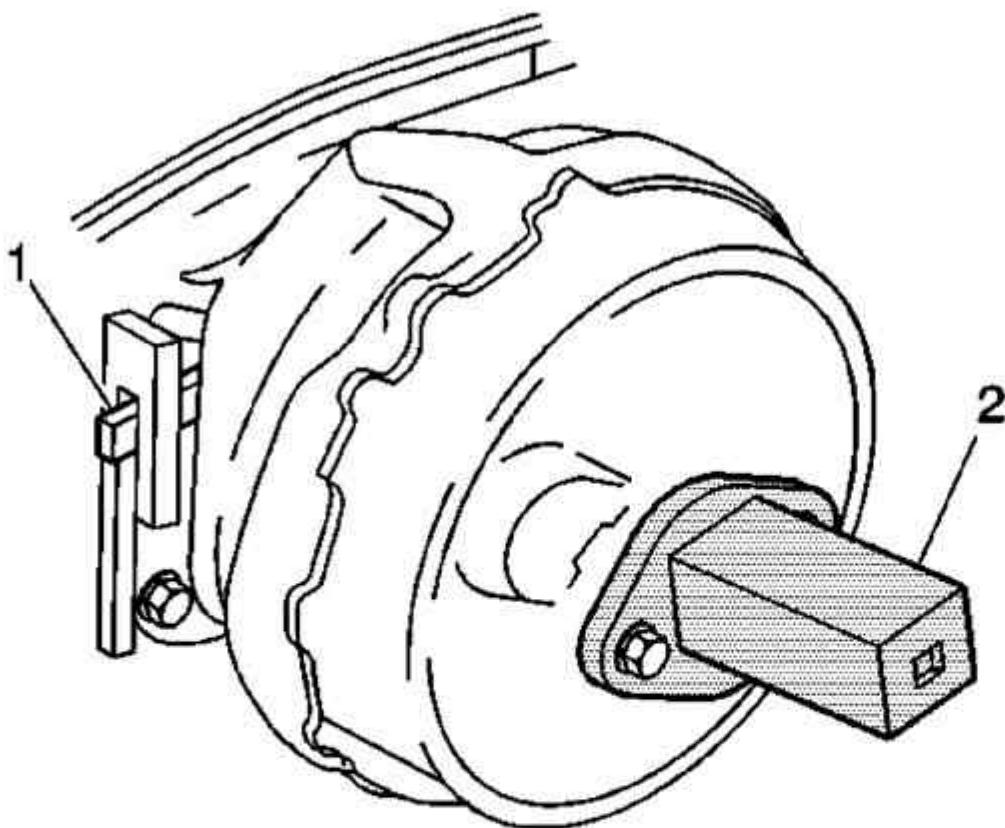


Fig. 44: Identifying Booster At Cowl
Courtesy of GENERAL MOTORS CORP.

13. Unlock the booster from the front of the cowl.

Use a flat bladed tool to depress the brake booster locking tab (1) out of the cowl mounting flange, while turning the booster counterclockwise with a ratchet on the (2).

14. Remove the vacuum brake booster.
15. Remove the **J 22805-B** (2) from the booster. See **Special Tools**.

Installation Procedure

1. Install the vacuum brake booster.

Position the vacuum brake booster on the cowl counterclockwise from the final installation position so that the locking flanges on the vacuum brake booster and on the cowl mounting flange engage.

IMPORTANT: Ensure the locking tab and the flanges are in the fully engaged position.

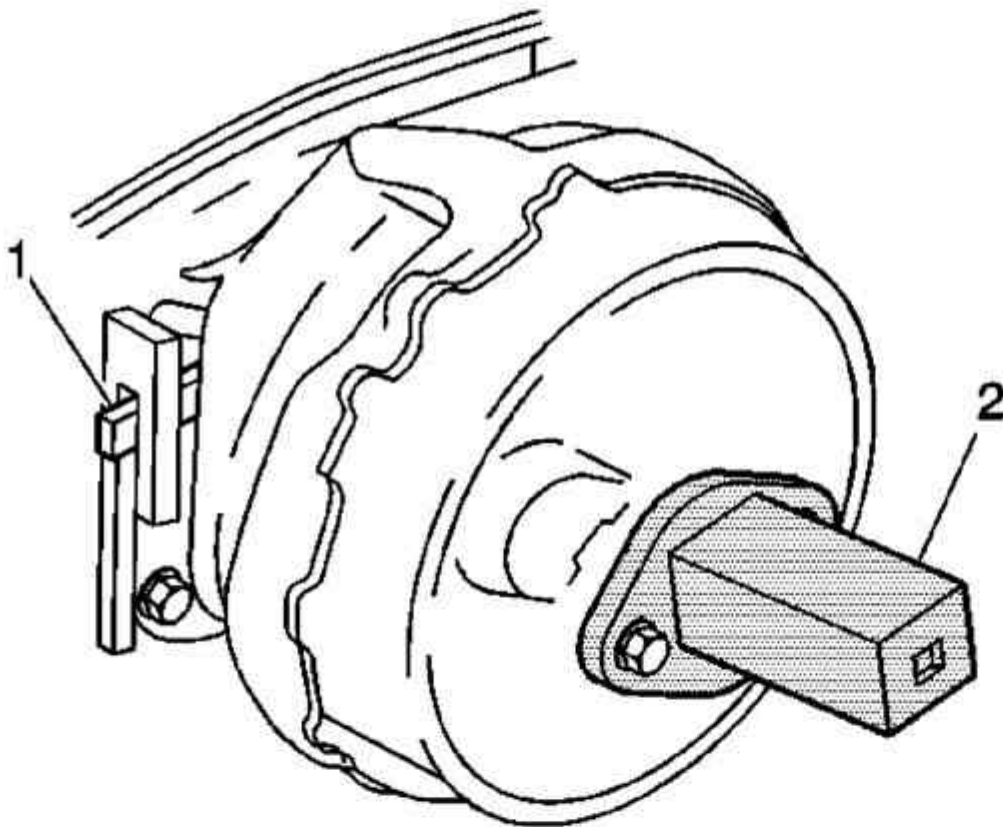


Fig. 45: Identifying Booster At Cowl
Courtesy of GENERAL MOTORS CORP.

2. Rotate the vacuum brake booster clockwise with a ratchet on the **J 22805-B** (2). See **Special Tools**. DO NOT use a flat bladed tool in the locking tab to install the vacuum brake booster. When the vacuum brake booster is correctly installed, the locking tab (1) slides up the flange and engages the locking notch.
3. Remove the **J 22805-B** (2) from the installed vacuum brake booster. See **Special Tools**.
4. Install the coolant heater pipes.
5. Position and connect the vacuum hose and check valve assembly to the booster.

NOTE: Refer to Fastener Notice .

6. Position the master cylinder to the booster and install the master cylinder retaining nuts.

Tighten: Tighten the master cylinder retaining nuts to 33 N.m (24 lb ft).

7. Install the BPMV bracket and fasteners. Refer to Brake Pressure Modulator Valve Bracket Replacement .
8. Connect the brake fluid level sensor electrical connector to the brake fluid level sensor.
9. Install the exhaust crossover pipe. Refer to Exhaust Crossover Pipe Replacement (3.6L) or Exhaust Crossover Pipe Replacement (3.8L)
10. Refill the cooling system. Refer to Cooling System Draining and Filling (L26, LY7 GE 47716 Fill) or Cooling System Draining and Filling (L26 Static Fill) or Cooling System Draining and Filling (LY7 Static Fill) or Cooling System Draining and Filling (LS4 GE47716 Fill) or Cooling System Draining and Filling (LS4 Static Fill)
11. Connect the brake booster pushrod to the brake pedal and install the retaining clip.
12. Install the BPMV to the bracket. Refer to Brake Pressure Modulator Valve Replacement .
13. Install the left instrument panel insulator. Refer to Instrument Panel Insulator Panel Replacement - Left Side .
14. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection (L26) or Battery Negative Cable Disconnection and Connection (LY7) or Battery Negative Cable Disconnection and Connection (LS4) .

POWER VACUUM BRAKE BOOSTER REPLACEMENT (L26)

Tools Required

J 22805-B Power Brake Booster Holder. See Special Tools.

Removal Procedure

1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection (L26) or Battery Negative Cable Disconnection and Connection (LY7) or Battery Negative Cable Disconnection and Connection (LS4) .
2. Remove the left instrument panel insulator. Refer to Instrument Panel Insulator Panel Replacement - Left Side .
3. Remove the retaining clip and disconnect the brake booster pushrod from the brake pedal.

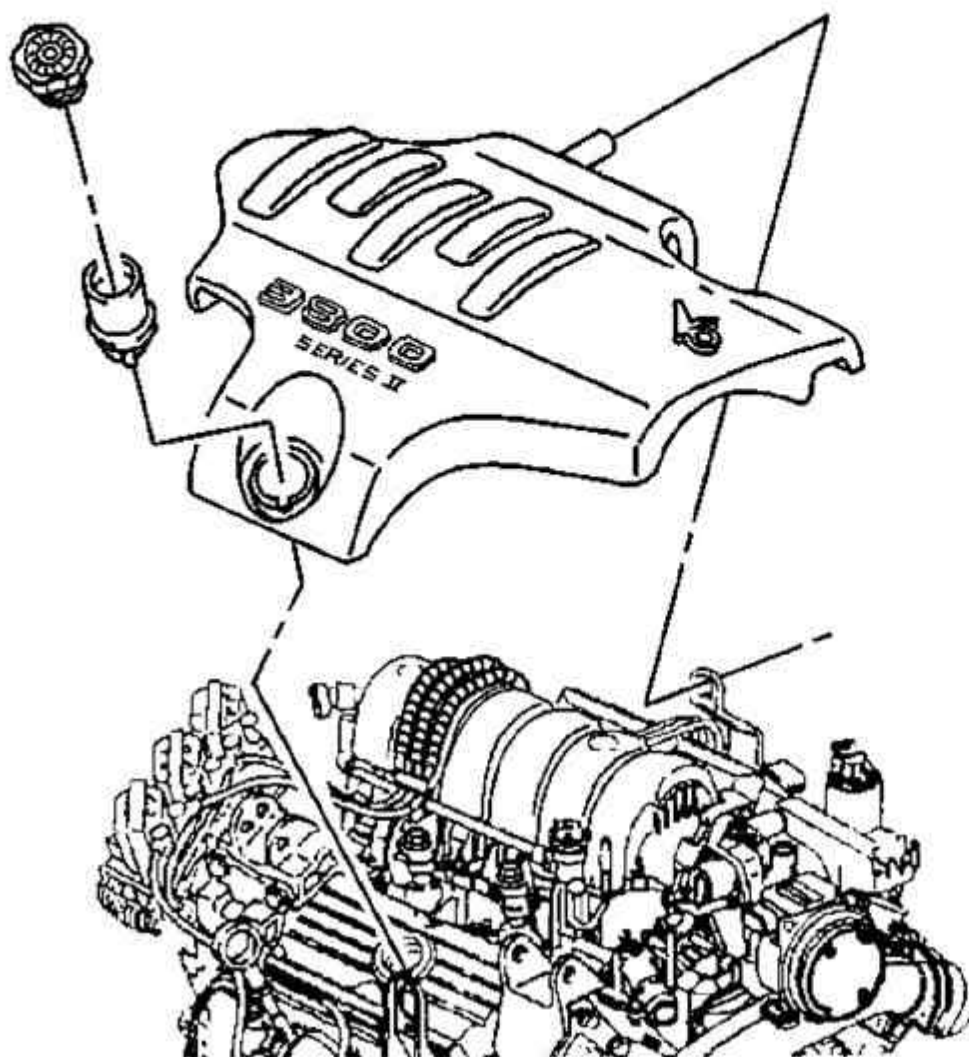


Fig. 46: View Of Fuel Injector Sight Shield
Courtesy of GENERAL MOTORS CORP.

4. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
5. Disconnect the brake fluid level sensor electrical connector from the brake fluid level sensor.

IMPORTANT: It is not necessary to disconnect the brake pipes from the master cylinder to the brake pressure modulator valve (BPMV).

6. Remove the 2 master cylinder retaining nuts and position the master cylinder aside.
7. Disconnect the vacuum brake booster check valve from the brake booster. Position aside the vacuum hose and the check valve as an assembly.
8. Rotate the engine forward for service access. Refer to **Rotating the Engine for Service Access**.

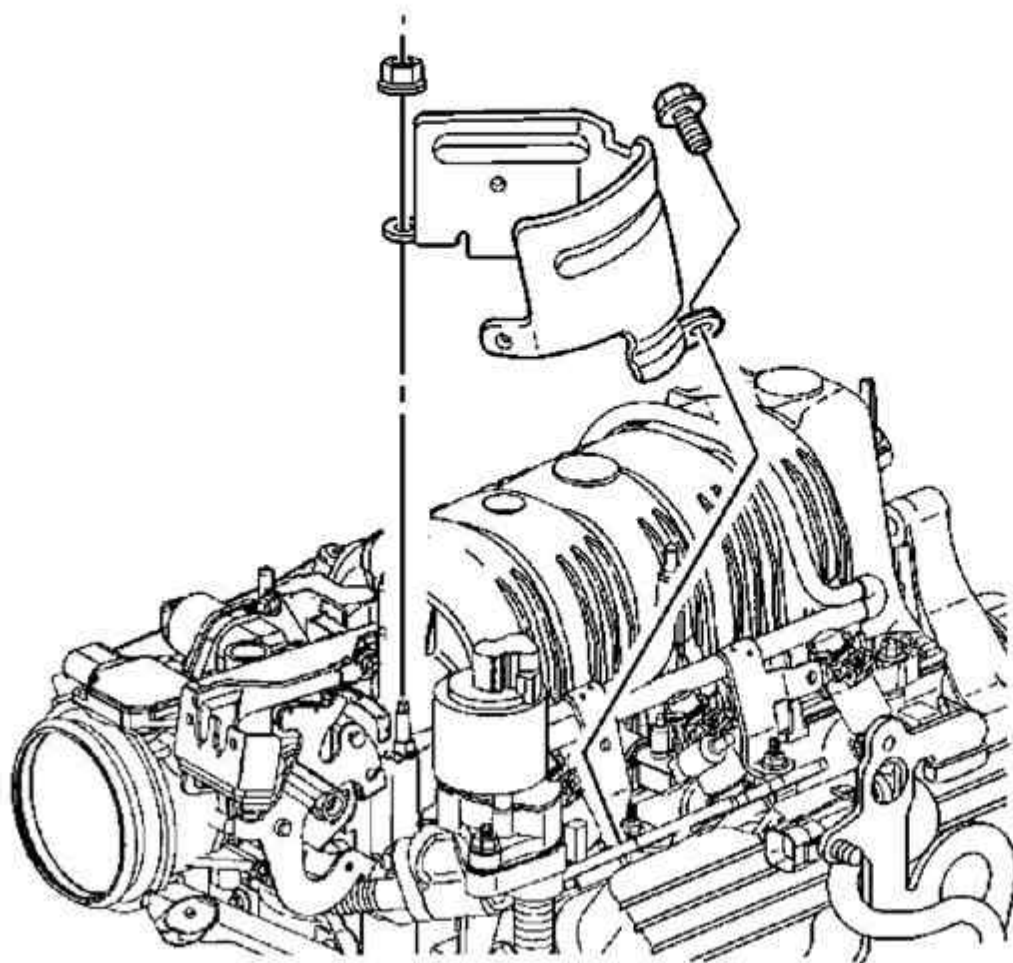


Fig. 47: View Of EGR Valve Wiring Harness Heat Shield
Courtesy of GENERAL MOTORS CORP.

9. Remove the EGR valve and wiring harness heat shield. Refer to **Exhaust Gas Recirculation Valve Replacement**.
10. Remove the transmission fluid filler tube bracket retainer and position the filler tube aside. Refer to **Transmission Fluid Filler Tube Replacement**.
11. Remove the brake pressure modulator valve (BPMV) bracket. Refer to **Brake Pressure Modulator Valve Bracket Replacement**.
12. Attach the **J 22805-B** to the booster using the master cylinder retaining nuts. See **Special Tools**.

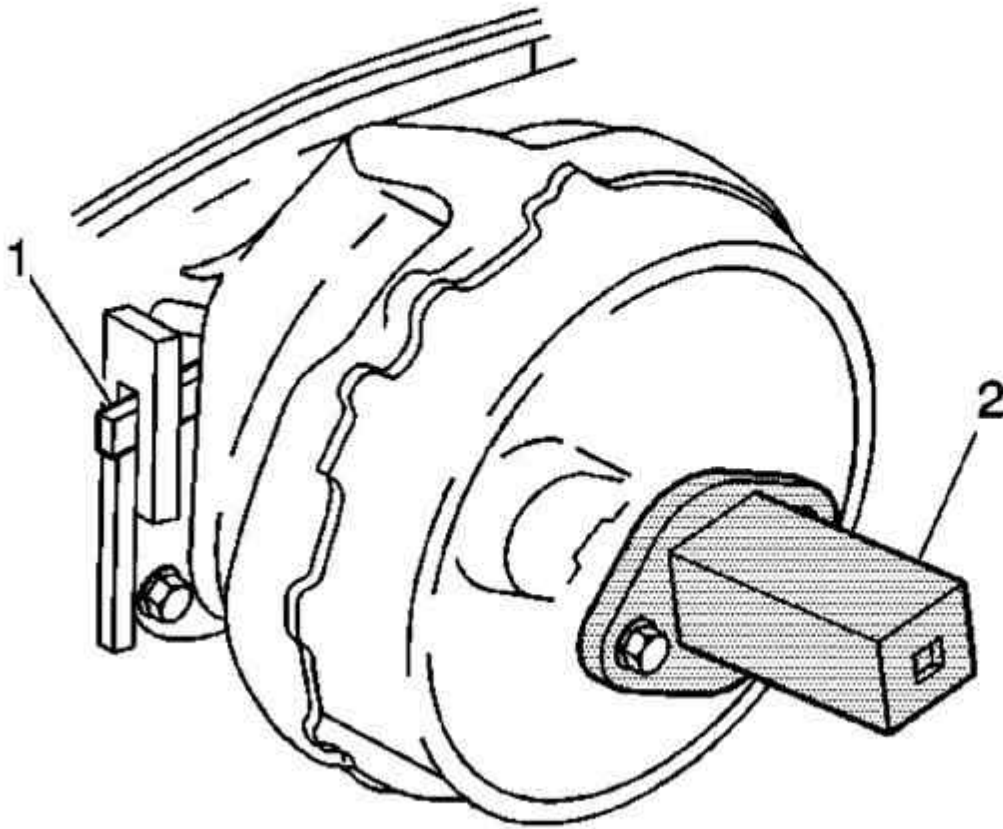


Fig. 48: Identifying Booster To Cowl
Courtesy of GENERAL MOTORS CORP.

13. Unlock the booster from the front of the cowl.

Use a flat bladed tool to depress the brake booster locking tab (1) out of the cowl mounting flange, while turning the booster counterclockwise with a ratchet on the **J 22805-B** (2). See **Special Tools**.

14. Remove the vacuum brake booster.
15. Remove the **J 22805-B** (2) from the booster. See **Special Tools**.

Installation Procedure

NOTE: Internal components of this booster are not serviceable. The housing must not be unstaked and separated. Separating the housing will cause permanent deformation, preventing the booster from holding proper volume.

NOTE: Inspect the locking flanges on booster and mounting plate. Replace the booster and mounting plate if the locking flanges are bent or damaged.

1. Install the vacuum brake booster.

Position the vacuum brake booster on the cowl counterclockwise from the final installation position so that the locking flanges on the vacuum brake booster and on the cowl mounting flange engage.

IMPORTANT: Ensure that the locking tab and the flanges are in the fully engaged position.

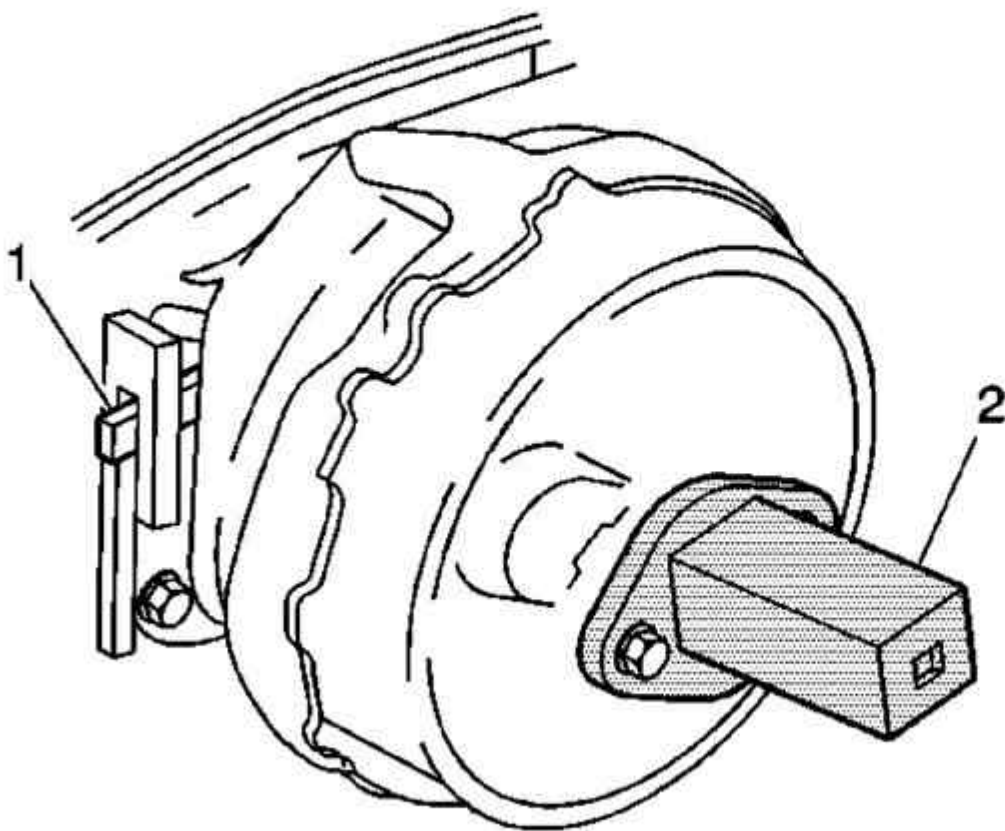


Fig. 49: Identifying Booster At Cowl
Courtesy of GENERAL MOTORS CORP.

2. Turn the vacuum brake booster clockwise with a ratchet on the **J 22805-B** (2). See **Special Tools**. DO NOT use a flat bladed tool in the locking tab to install the vacuum brake booster. When the vacuum brake booster is correctly installed, the locking tab (1) slides up the flange and engages the locking notch.
3. Remove the **J 22805-B** (2) from the installed vacuum brake booster. See **Special Tools**.
4. Install the BPMV bracket. Refer to **Brake Pressure Modulator Valve Bracket Replacement**.
5. Install the transmission fluid filler tube bracket retainer and reposition the filler tube. Refer to **Transmission Fluid Filler Tube Replacement**.
6. Install the EGR valve and wiring harness heat shield. Refer to **Exhaust Gas Recirculation Valve Replacement**.

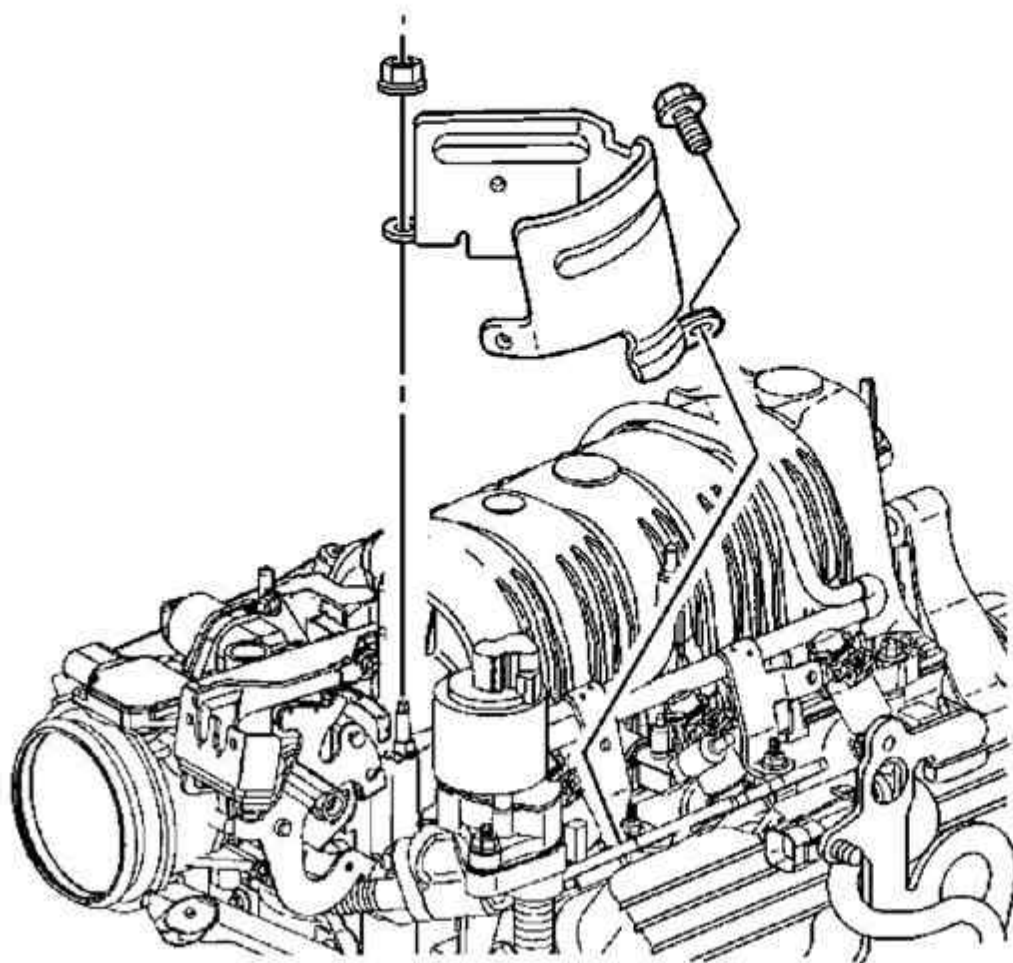


Fig. 50: View Of EGR Valve Wiring Harness Heat Shield
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

7. Install the EGR valve wiring harness heat shield.

Tighten: Tighten the EGR valve wiring harness heat shield nut and bolt to 10 N.m (89 lb in).

8. Return the engine to the original rest position. Install the left and right engine mount struts. Refer to Engine Mount Strut Replacement - Left Side and Engine Mount Strut Replacement - Right Side .
9. Connect the vacuum hose and check valve assembly to the booster.

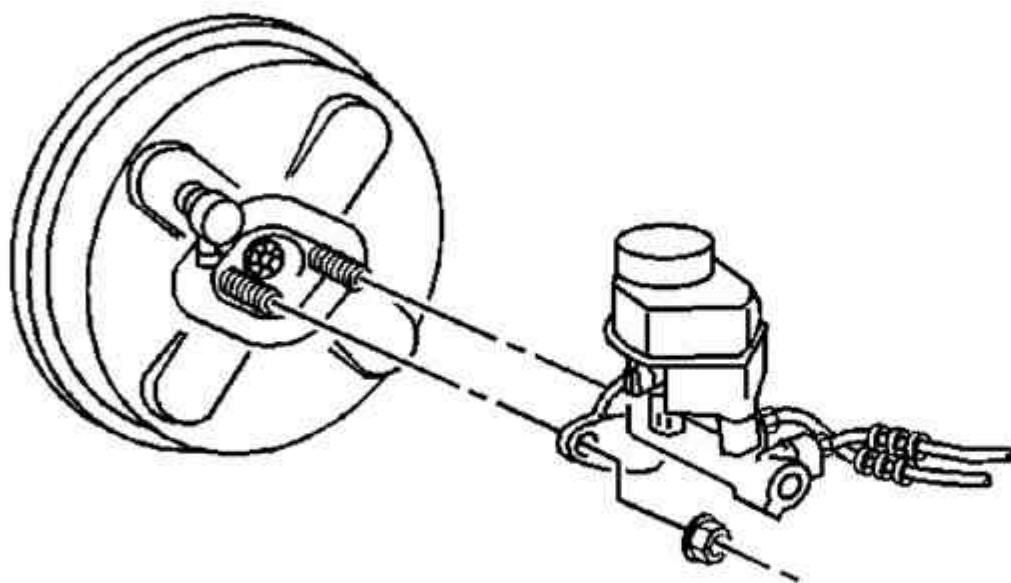


Fig. 51: Identifying Master Cylinder & Vacuum Brake Booster
Courtesy of GENERAL MOTORS CORP.

10. Reposition the master cylinder onto the booster and install the master cylinder retaining nuts.

Tighten: Tighten the master cylinder retaining nuts to 33 N.m (24 lb ft).

11. Connect the brake fluid level sensor electrical connector to the brake fluid level sensor.

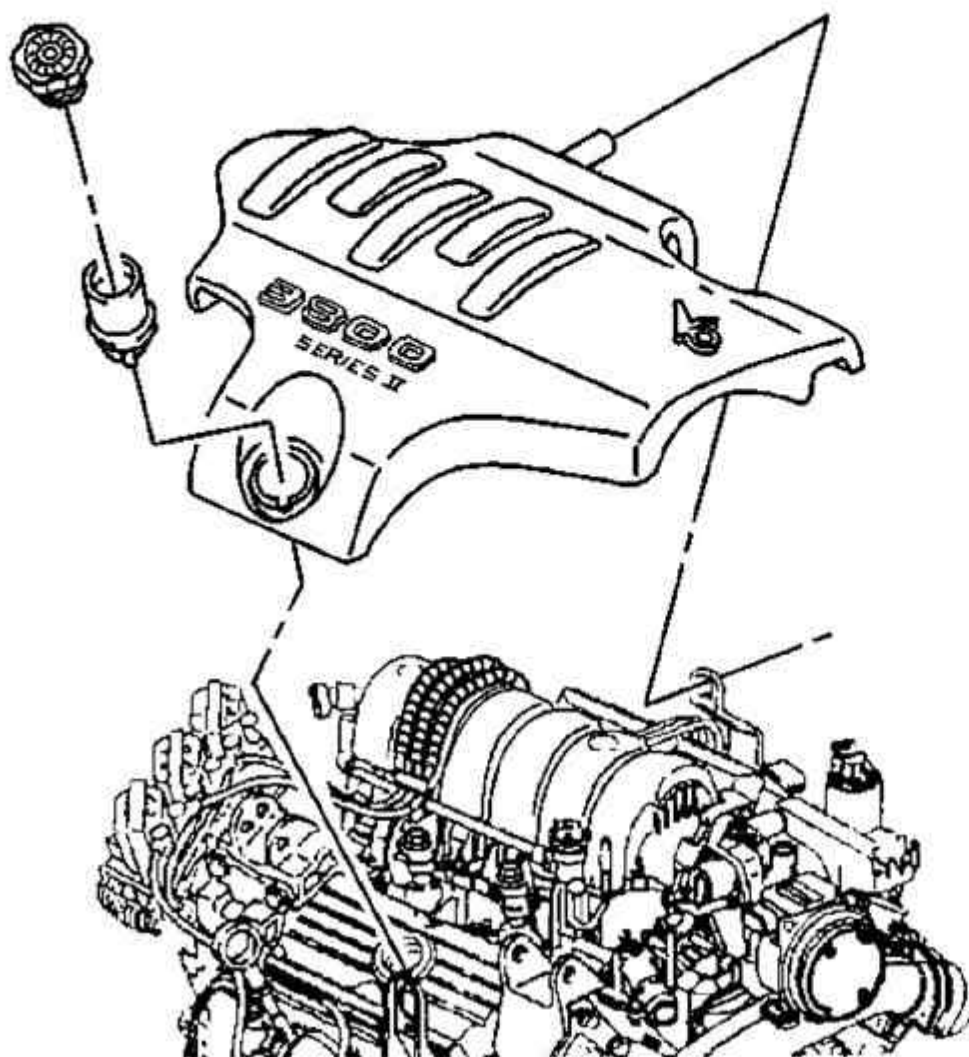


Fig. 52: View Of Fuel Injector Sight Shield
 Courtesy of GENERAL MOTORS CORP.

12. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
13. Connect the brake booster pushrod to the brake pedal and install the retaining clip.
14. Install the left instrument panel insulator.
15. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)** or **Battery Negative Cable Disconnection and Connection (LY7)** or **Battery Negative Cable Disconnection and Connection (LS4)**.

POWER VACUUM BRAKE BOOSTER REPLACEMENT (LS4)

Tools Required

J 22805-B Brake Booster Holder. See **Special Tools**.

Removal Procedure

1. Remove the upper intake manifold sight shield. Refer to **Upper Intake Manifold Sight Shield Replacement**.
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
3. Remove the brake pressure modulator valve (BPMV) bracket. Refer to **Brake Pressure Modulator Valve**

Bracket Replacement .

4. Remove the exhaust crossover pipe. Refer to **Exhaust Crossover Pipe Replacement (3.6L)** or **Exhaust Crossover Pipe Replacement (3.8L)** .

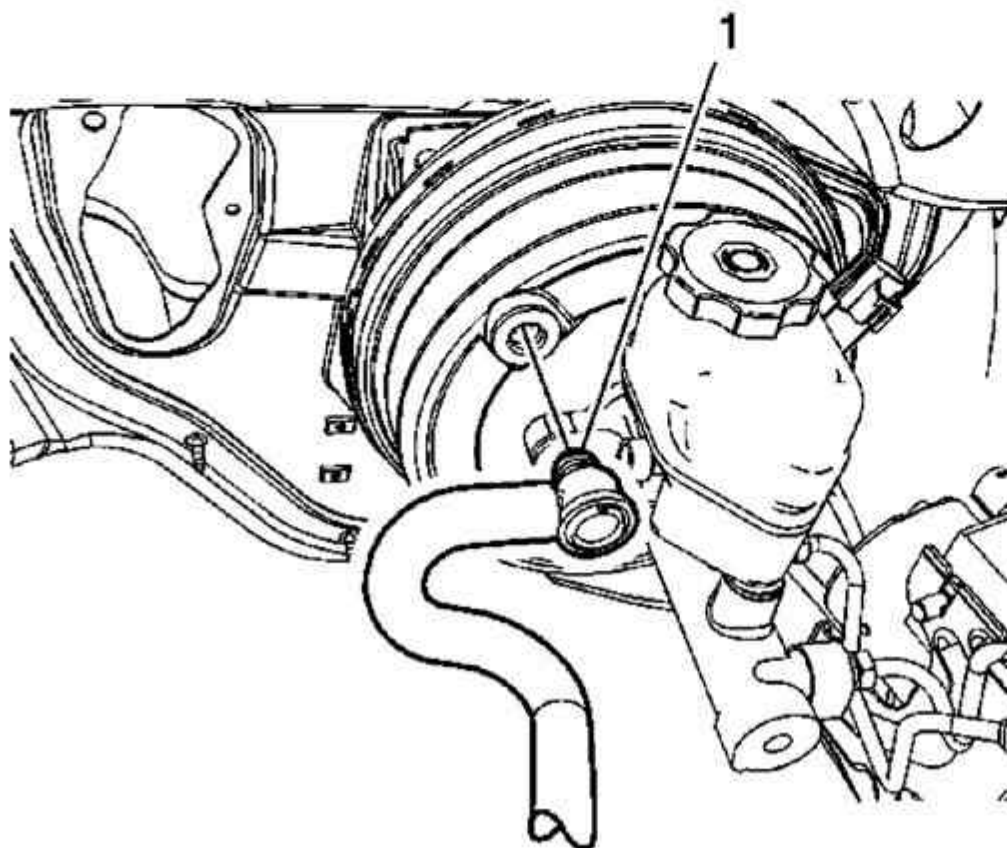


Fig. 53: Identifying Vacuum Power Brake Booster Check Valve & Hose Assembly
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the vacuum power brake booster check valve and hose assembly (1).
6. Disconnect the vacuum power brake booster vacuum sensor electrical connector.
7. Remove the left side instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .

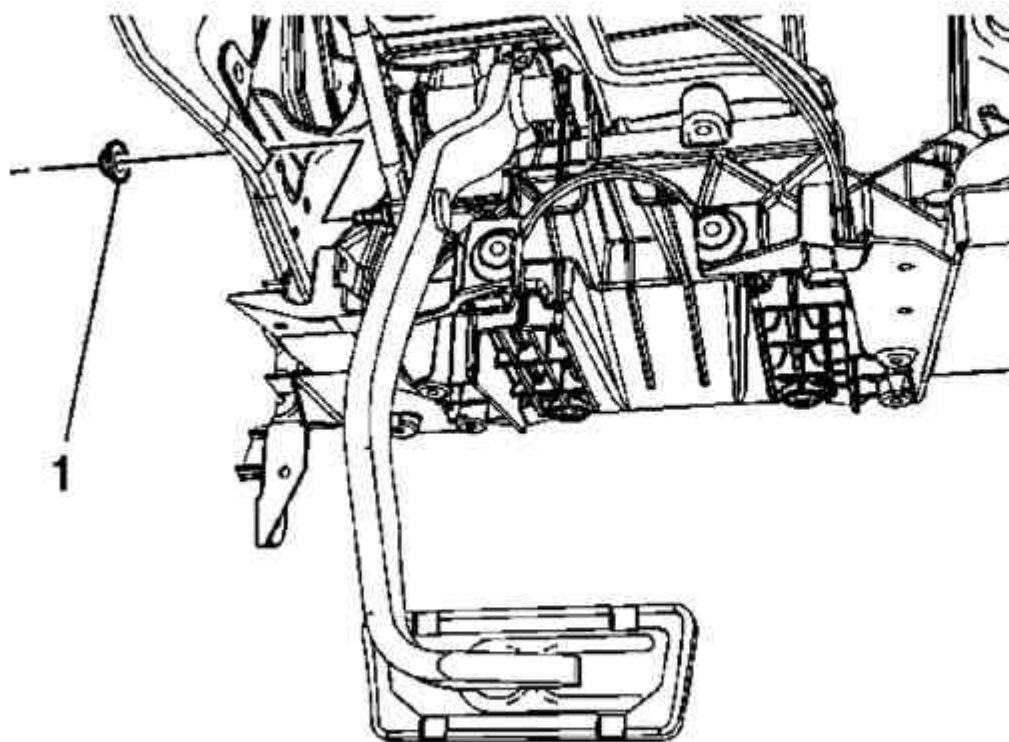


Fig. 54: Identifying Brake Pedal Pushrod Nut
Courtesy of GENERAL MOTORS CORP.

8. Remove the vacuum power brake booster pushrod nut (1).

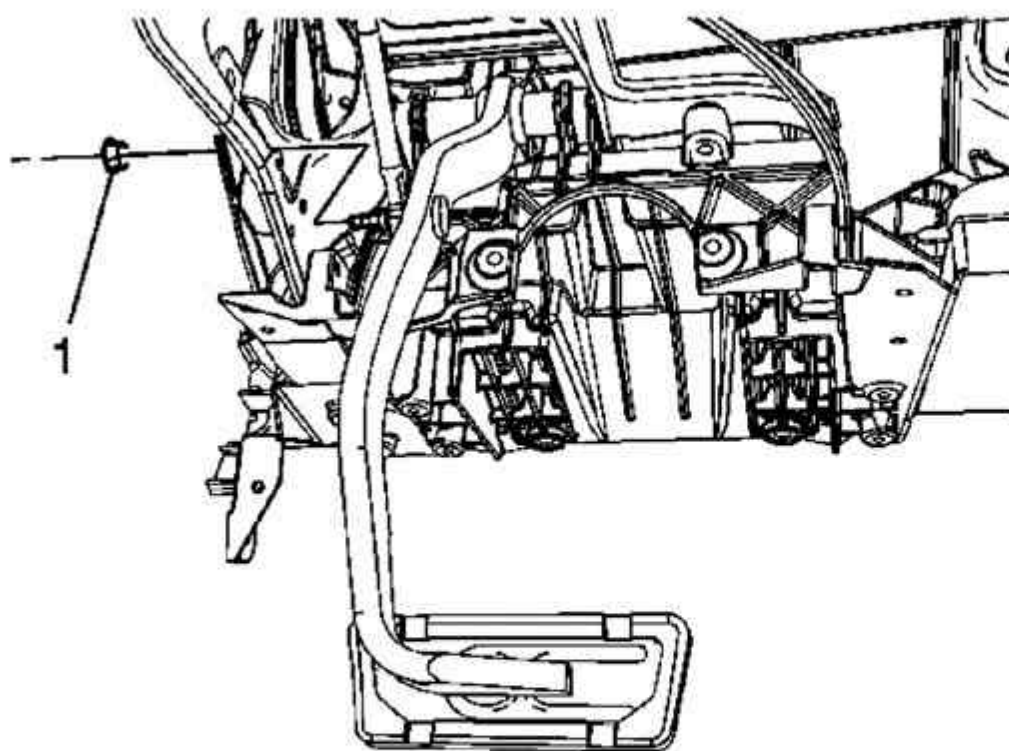


Fig. 55: Identifying Brake Pedal Pushrod Bushing

Courtesy of **GENERAL MOTORS CORP.**

9. Remove the vacuum power brake booster pushrod bushing (1).

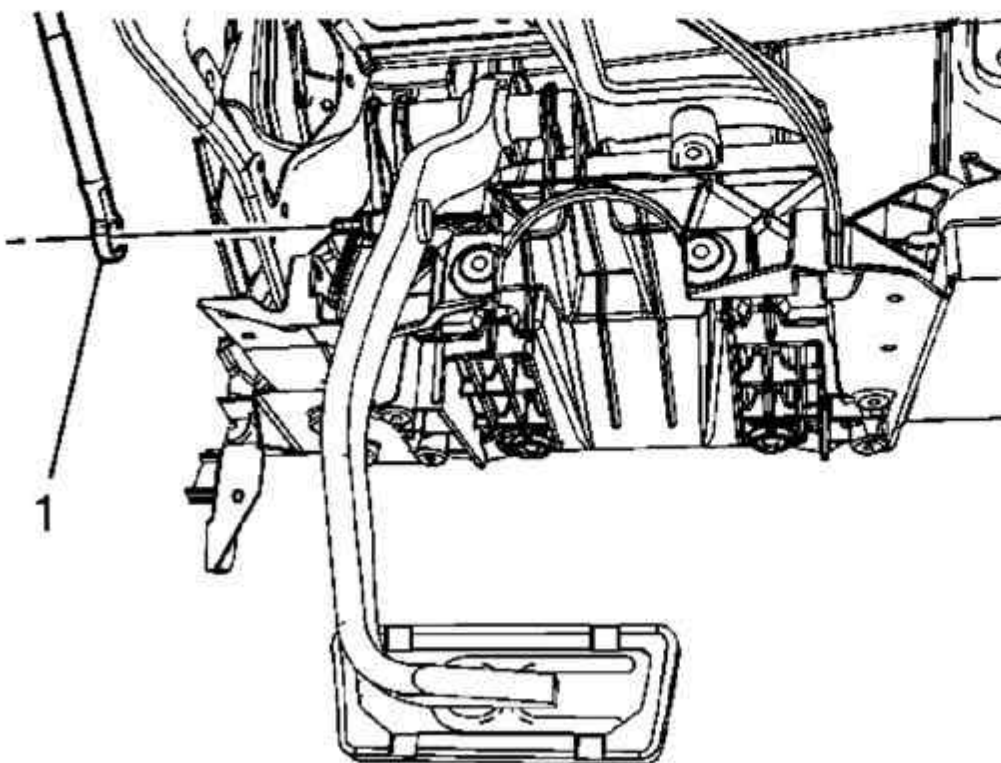


Fig. 56: View Of Brake Pedal Pushrod Nut
Courtesy of **GENERAL MOTORS CORP.**

10. Remove the vacuum power brake pushrod (1) from the brake pedal pin.

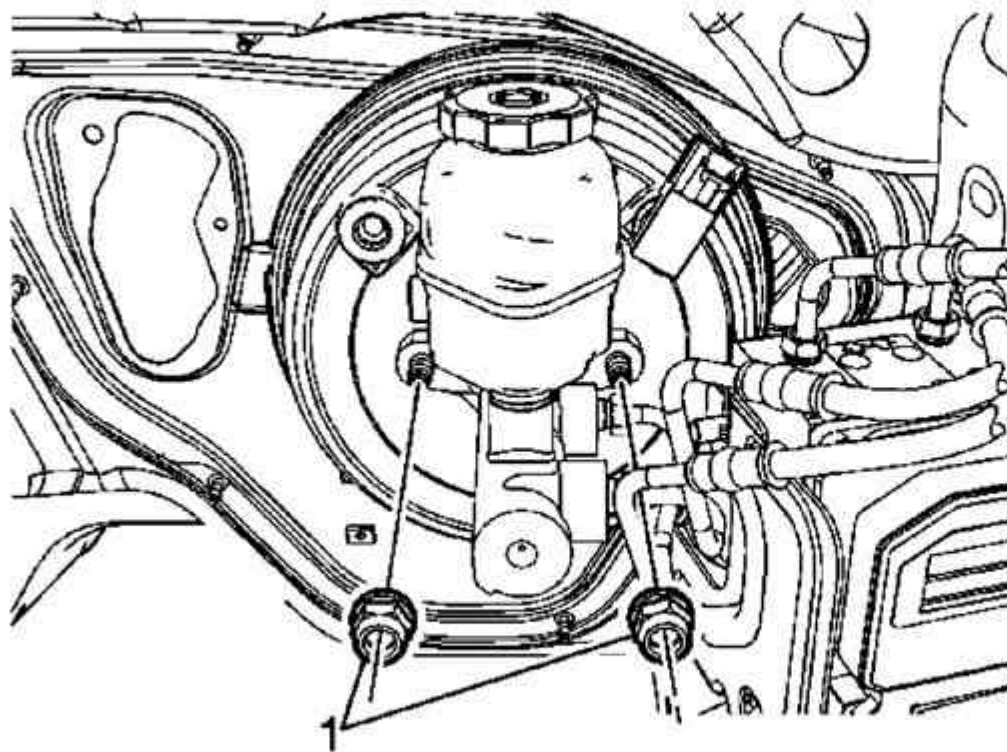


Fig. 57: Identifying Master Cylinder Nuts
Courtesy of GENERAL MOTORS CORP.

11. Remove the master cylinder nuts (1).
12. Without disconnecting the brake pipes, remove and position aside the brake master cylinder.

Secure the master cylinder with heavy mechanics wire or equivalent.

13. Install the **J 22805-B** to the vacuum power brake booster and secure with the master cylinder nuts. See **Special Tools**.

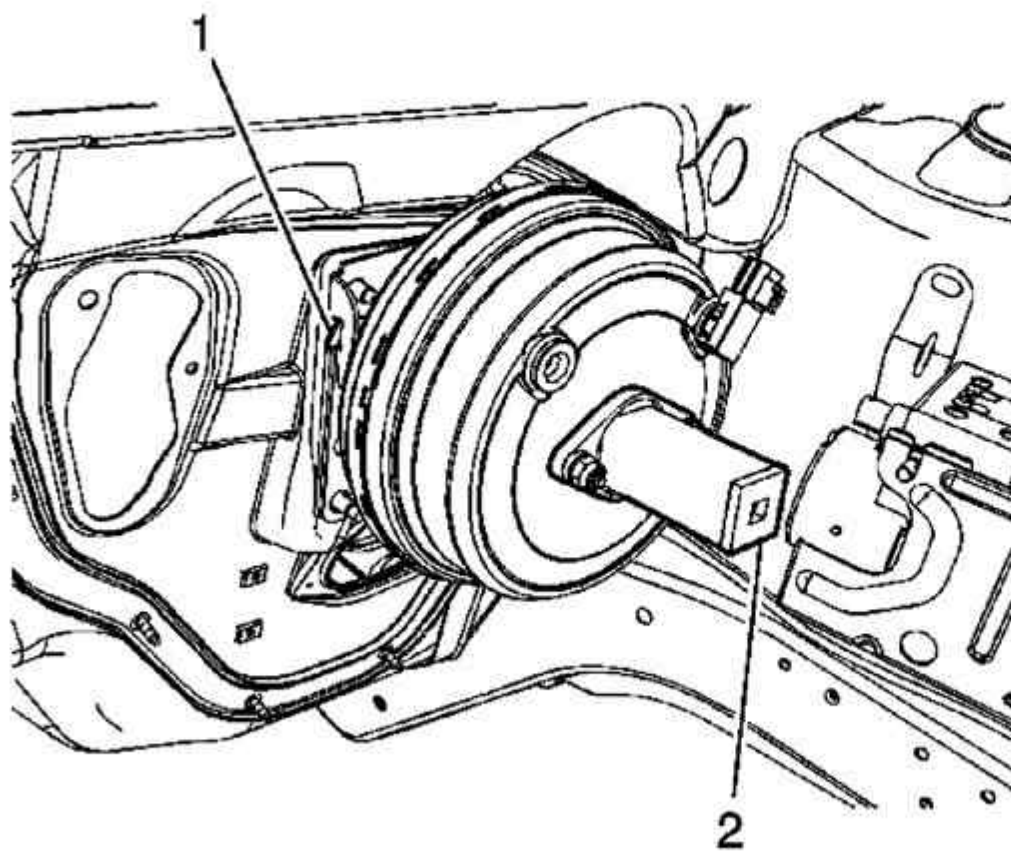


Fig. 58: View Of Power Brake Booster Assembly
Courtesy of GENERAL MOTORS CORP.

14. Press the vacuum power brake booster locking tab (1) while rotating the **J 22805-B** (2) counter clockwise. See **Special Tools**.
15. Remove the vacuum power brake booster.

Installation Procedure

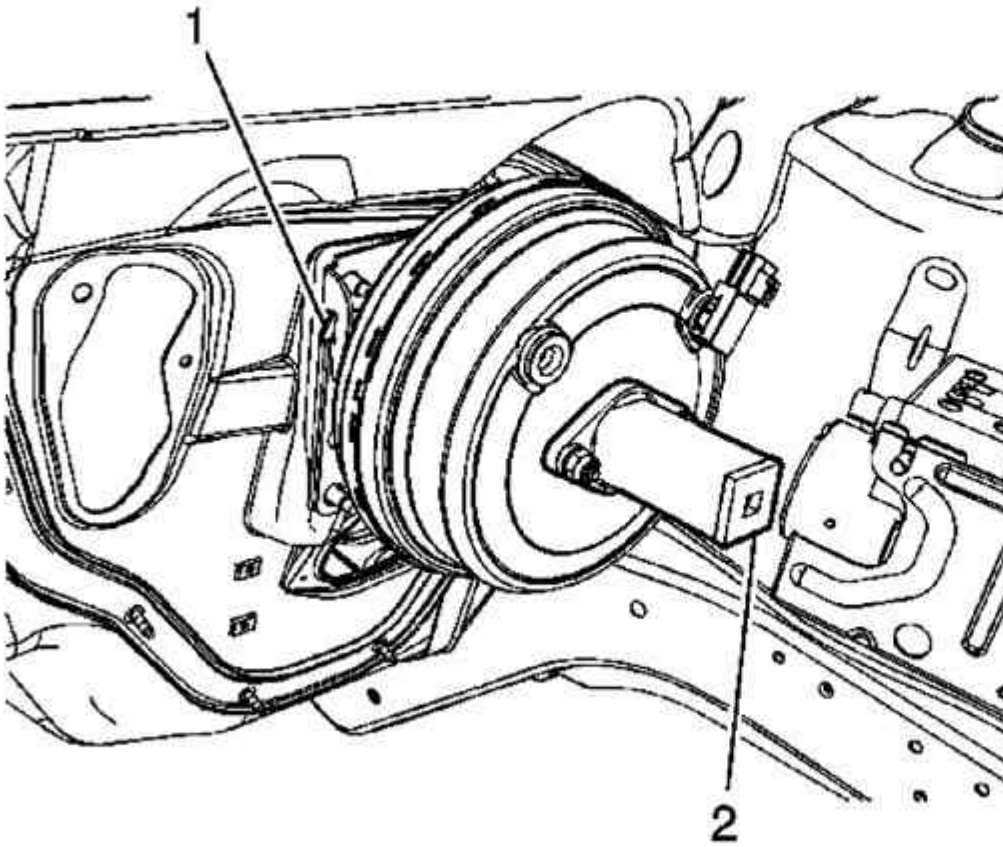


Fig. 59: View Of Power Brake Booster Assembly
Courtesy of GENERAL MOTORS CORP.

1. Install the vacuum power brake booster.
2. Press the vacuum power brake booster locking tab (1) while rotating the **J 22805-B** (2) clockwise. See **Special Tools**.

Ensure the locking tab is fully engaged in the vacuum brake booster mounting plate.

3. Remove the **J 22805-B** from the vacuum power brake booster and discard the master cylinder nuts. See **Special Tools**.

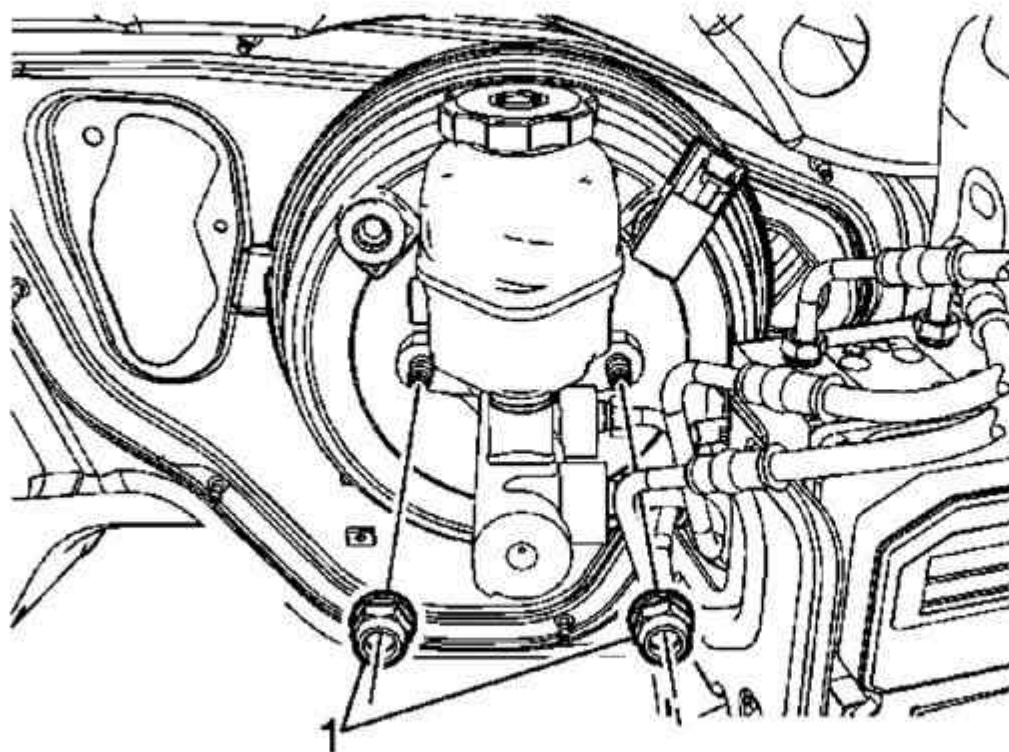


Fig. 60: Identifying Master Cylinder Nuts
Courtesy of GENERAL MOTORS CORP.

4. Install the master cylinder to the vacuum power brake booster.

NOTE: Refer to Fastener Notice .

5. Install new master cylinder nuts (1).

Tighten: Tighten the nuts to 33 N.m (24 lb ft).

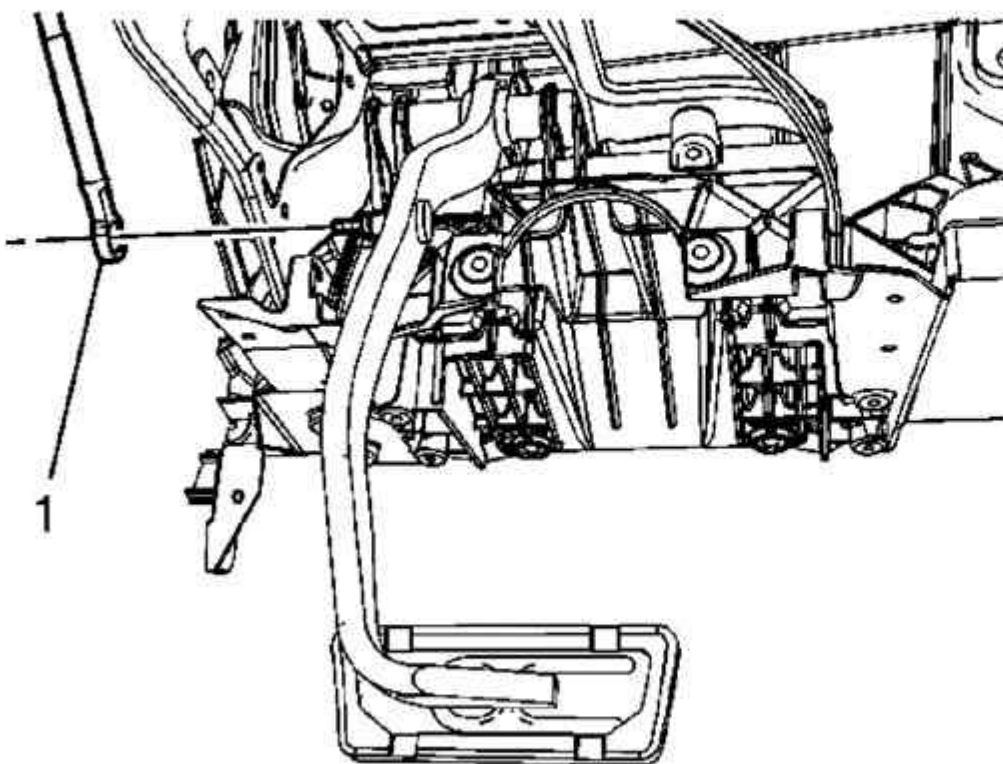


Fig. 61: View Of Brake Pedal Pushrod Nut
Courtesy of GENERAL MOTORS CORP.

6. Install the vacuum power brake pushrod (1) to the brake pedal pin.

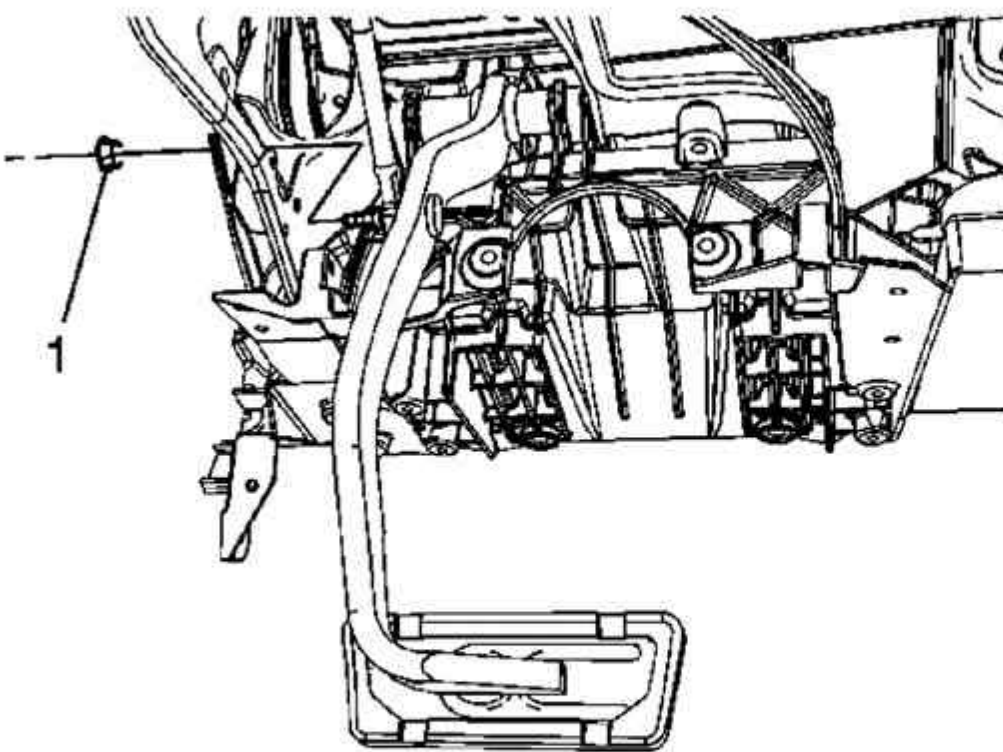


Fig. 62: Identifying Brake Pedal Pushrod Bushing

Courtesy of GENERAL MOTORS CORP.

7. Install the vacuum power brake booster pushrod bushing (1).

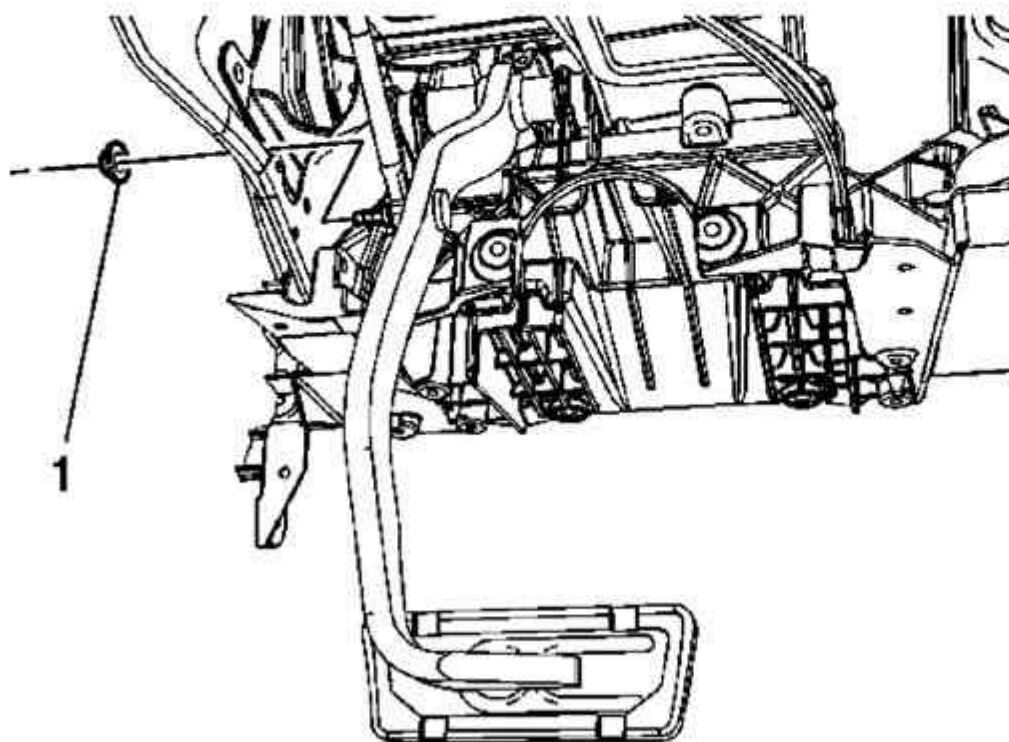


Fig. 63: Identifying Brake Pedal Pushrod Nut
Courtesy of GENERAL MOTORS CORP.

8. Install the vacuum power brake booster pushrod nut (1).

Tighten: Tighten the nut to 13 N.m (115 lb in).

9. Install the left side instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side**.

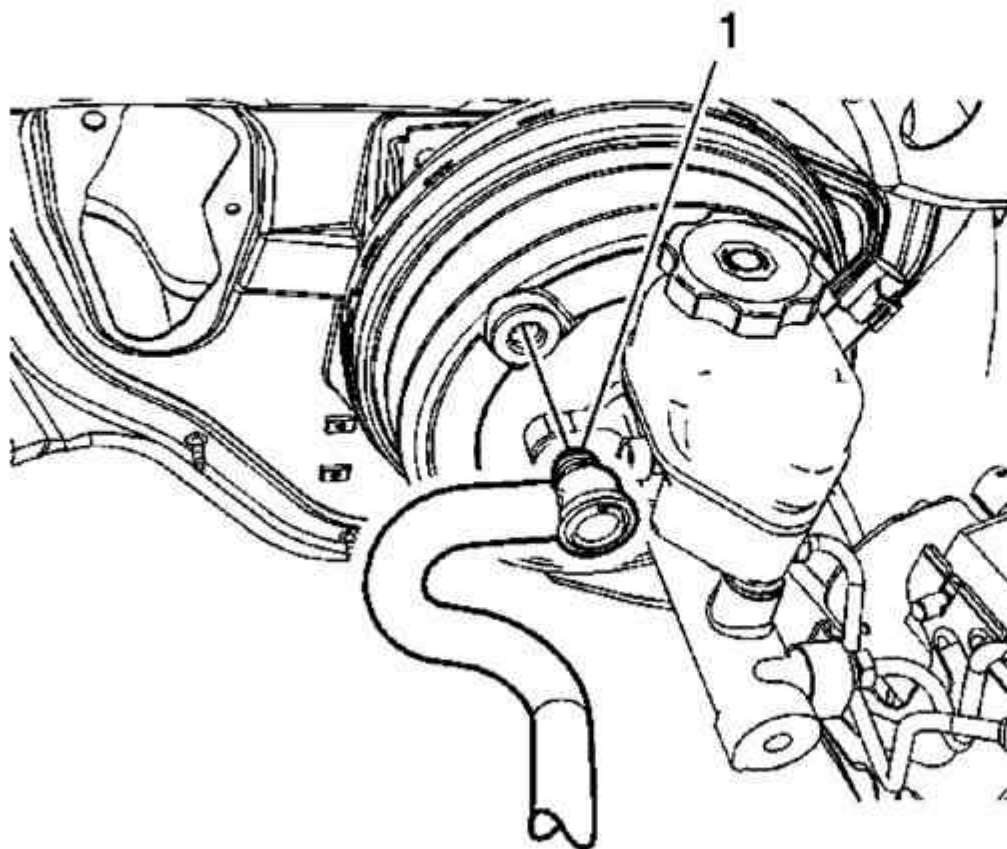


Fig. 64: Identifying Vacuum Power Brake Booster Check Valve & Hose Assembly
Courtesy of GENERAL MOTORS CORP.

10. Connect the vacuum power brake booster check valve and hose assembly (1).
11. Connect the vacuum power brake booster vacuum sensor electrical connector.
12. Install the exhaust crossover pipe. Refer to **Exhaust Crossover Pipe Replacement (3.6L)** or **Exhaust Crossover Pipe Replacement (3.8L)**.
13. Install the BPMV bracket. Refer to **Brake Pressure Modulator Valve Bracket Replacement**.
14. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
15. Install the upper intake manifold sight shield. Refer to **Upper Intake Manifold Sight Shield Replacement**.

VACUUM BRAKE BOOSTER CHECK VALVE AND/OR HOSE REPLACEMENT

Removal Procedure

1. Remove the fuel injector sight shield, 3.8L engine only. Refer to **Fuel Injector Sight Shield Replacement**.

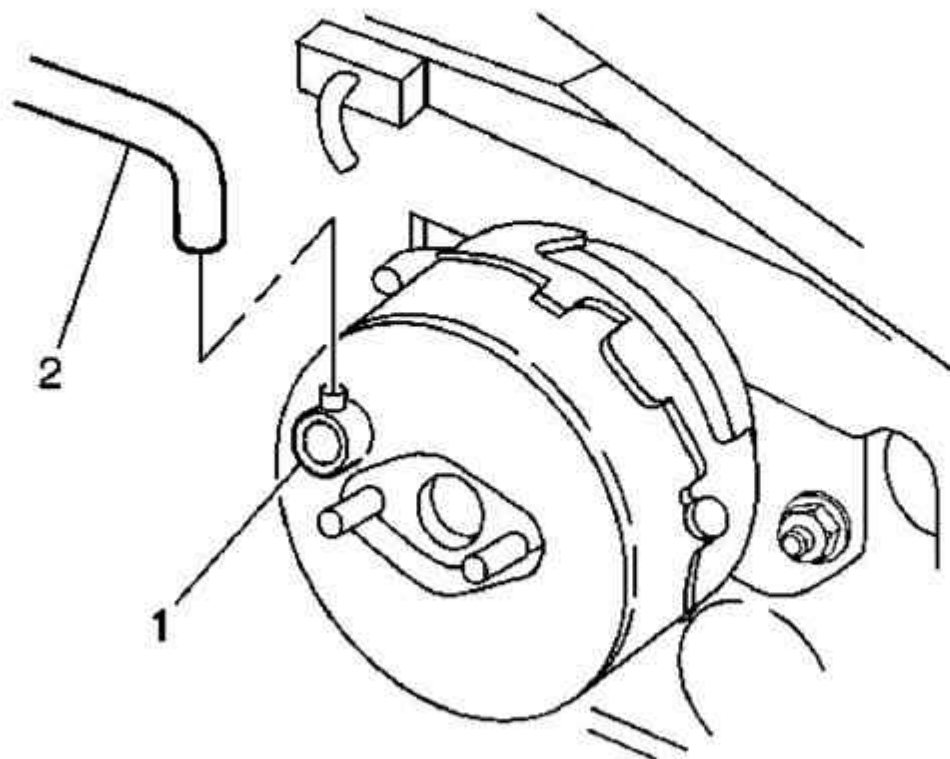


Fig. 65: Locating Vacuum Hose & Brake Booster Check Valve
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the vacuum hose from the intake manifold.
3. Disconnect the vacuum hose (2) from the vacuum brake booster check valve (1).
4. Remove the vacuum brake booster check valve (1) from the vacuum brake booster.

Installation Procedure

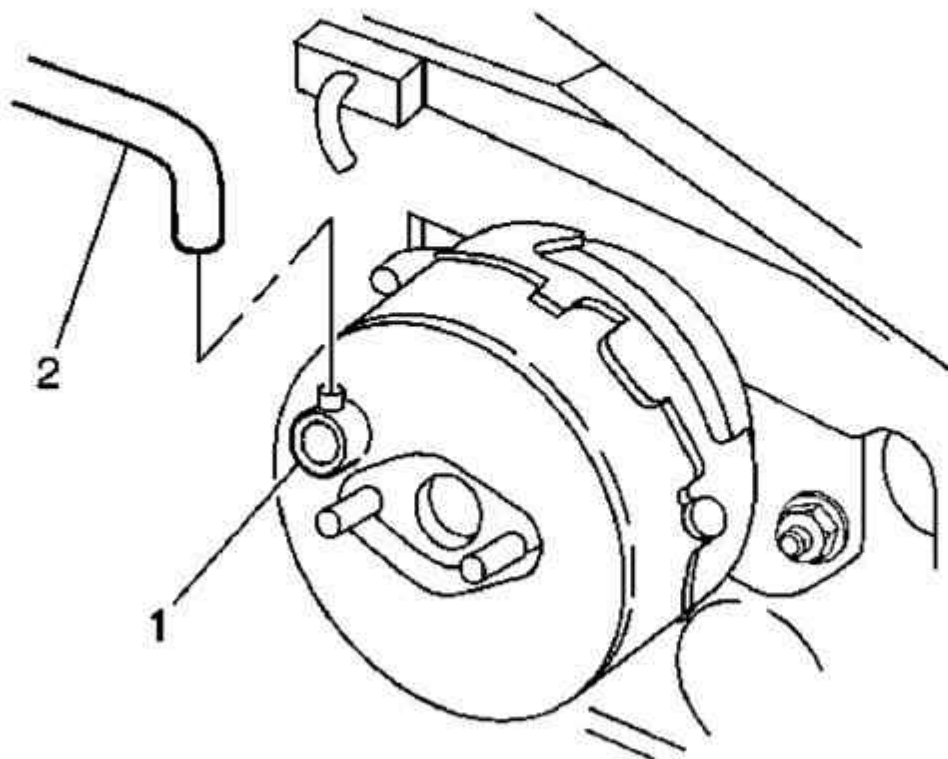


Fig. 66: Locating Vacuum Hose & Brake Booster Check Valve
Courtesy of GENERAL MOTORS CORP.

1. Install the vacuum brake booster check valve (1) onto the vacuum brake booster.
2. Connect the vacuum hose (2) to the vacuum brake booster (1).
3. Connect the vacuum hose to the intake manifold.
4. Install the fuel injector sight shield, 3.8L engine only. Refer to **Fuel Injector Sight Shield Replacement**.

POWER BRAKE BOOSTER VACUUM SENSOR REPLACEMENT

Removal Procedure

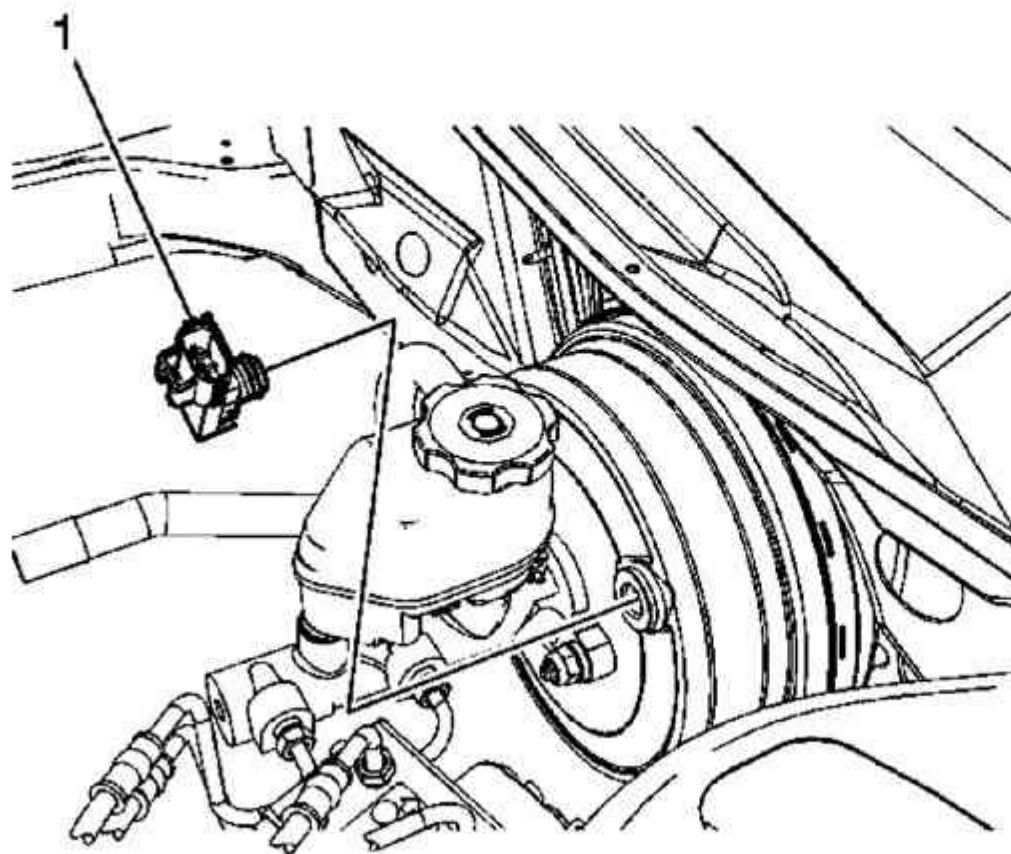


Fig. 67: Identifying Power Brake Booster Vacuum Sensor
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition switch to the OFF position.
2. Apply and release the brake pedal until the pedal becomes firm to deplete the vacuum power brake booster vacuum reserve.
3. Disconnect the power brake booster vacuum sensor electrical connector.
4. Remove the power brake booster vacuum sensor (1).

Installation Procedure

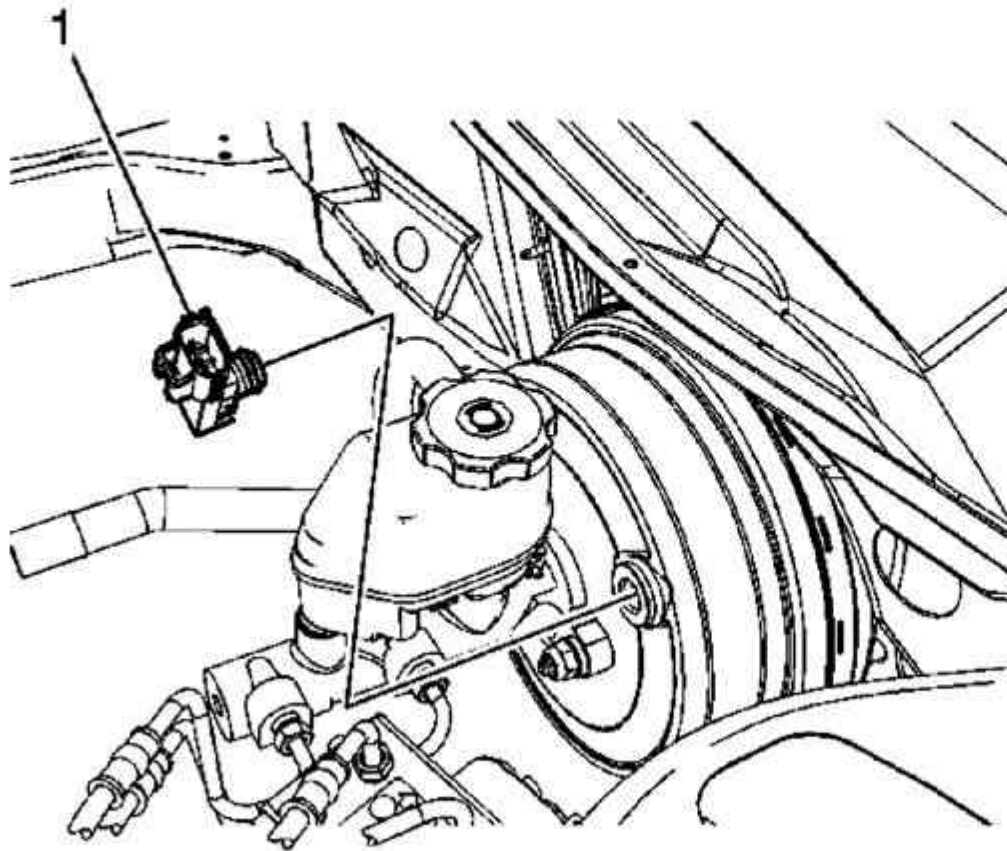


Fig. 68: Identifying Power Brake Booster Vacuum Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the power brake booster vacuum sensor (1).
2. Connect the power brake booster vacuum sensor electrical connector.

DESCRIPTION AND OPERATION

BRAKE FLUID AND BRAKE FLUID HANDLING

CAUTION: Brake fluid may irritate eyes and skin. In case of contact, take the following actions:

- Eye contact-rinse thoroughly with water.
- Skin contact-wash with soap and water.
- If ingested-consult a physician immediately.

CAUTION: Use only Delco Supreme 11, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT 3 brake fluid from a clean, sealed container. Do not use fluid from an open container that may be contaminated with water. Improper or contaminated fluid could result in damage to components, or loss of braking, with possible injury.

NOTE: When filling the master cylinder, use only Delco Supreme 11, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT 3 brake fluid. Do not use a container which has been used for petroleum based fluids, or a container which is wet with

water. Petroleum based fluids will cause swelling and distortion of rubber parts in the hydraulic brake system, and water will mix with brake fluid, lowering the boiling point. Keep all fluid containers capped to prevent contamination.

- NOTE:** Brake fluid will damage electrical connections and painted surfaces. Use shop cloths, suitable containers, and fender covers to prevent brake fluid from contacting these areas. Always re-seal and wipe off brake fluid containers to prevent spills.
- NOTE:** Avoid spilling brake fluid on any of the vehicle's painted surfaces, wiring, cables or electrical connectors. Brake fluid will damage paint and electrical connections. If any fluid is spilled on the vehicle, immediately flush the area with water to minimize the potential for damage.
- NOTE:** Power steering fluid, engine oil, brake fluid, or any mineral based fluids cannot be mixed. If brake seals contact power steering fluid or steering seals contact brake fluid, seal damage will result.

- IMPORTANT:**
- Do not reuse the brake fluid collected during the hydraulic brake system bleeding.
 - Always store brake fluid in a closed container.
 - Reseal brake fluid containers immediately after use.
 - Do not use brake fluid left in an open container.
 - Do not use brake fluid left in an improperly sealed container.
 - Do not use the following fluids in the hydraulic brake system:
 - Power steering fluid
 - Automatic transmission fluid
 - DOT 5 silicone hydraulic brake fluid

BRAKE WARNING SYSTEM DESCRIPTION AND OPERATION

Brake System Indicator

The IPC illuminates the brake indicator when the following occurs:

- The body control module (BCM) detects that the park brake is engaged. The IPC receives a class 2 message from the BCM requesting illumination. If the vehicle is shifted out of park with the park brake engaged, the BCM activates an audible warning.
- The IPC detects a low brake fluid condition (signal circuit is low).
- The IPC performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.

HYDRAULIC BRAKE SYSTEM DESCRIPTION AND OPERATION

System Component Description

The hydraulic brake system consists of the following:

Hydraulic Brake Master Cylinder Fluid Reservoir

Contains supply of brake fluid for the hydraulic brake system.

Hydraulic Brake Master Cylinder

Converts mechanical input force into hydraulic output pressure.

Hydraulic output pressure is distributed from the master cylinder through two hydraulic circuits, supplying diagonally-opposed wheel apply circuits.

Hydraulic Brake Pressure Balance Control System

Regulates brake fluid pressure delivered to hydraulic brake wheel circuits, in order to control the distribution of braking force.

Pressure balance control is achieved through dynamic rear proportioning (DRP), which is a function of the ABS modulator. Refer to **ABS Description and Operation** for specific information on the operation of DRP.

Hydraulic Brake Pipes and Flexible Brake Hoses

Carries brake fluid to and from hydraulic brake system components.

Hydraulic Brake Wheel Apply Components

Converts hydraulic input pressure into mechanical output force.

System Operation

Mechanical force is converted into hydraulic pressure by the master cylinder, regulated to meet braking system demands by the pressure balance control system, and delivered to the hydraulic brake wheel circuits by the pipes and flexible hoses. The wheel apply components then convert the hydraulic pressure back into mechanical force which presses linings against rotating brake system components.

BRAKE ASSIST SYSTEM DESCRIPTION AND OPERATION

System Component Description

The brake assist system consists of the following:

Brake Pedal

Receives, multiplies and transfers brake system input force from driver.

Brake Pedal Pushrod

Transfers multiplied input force received from brake pedal to brake booster.

Vacuum Brake Booster

Uses source vacuum to decrease effort required by driver when applying brake system input force.

When brake system input force is applied, air at atmospheric pressure is admitted to the rear of both vacuum diaphragms, providing a decrease in brake pedal effort required. When input force is removed, vacuum replaces atmospheric pressure within the booster.

Vacuum Source

Supplies force used by vacuum brake booster to decrease brake pedal effort.

Vacuum Source Delivery System

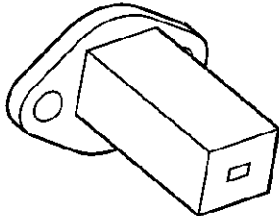
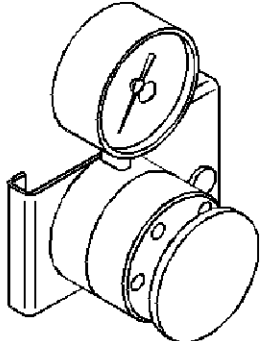
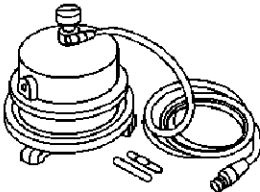
Enables delivery and retention of source vacuum for vacuum brake booster.

System Operation

Brake system input force is multiplied by the brake pedal and transferred by the pedal pushrod to the hydraulic brake master cylinder. Effort required to apply the brake system is reduced by the vacuum brake booster.

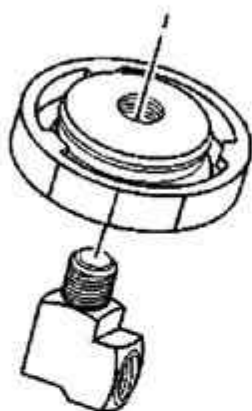
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Description
	J 22805-B Brake Booster Holder
	J 28662 Brake Pedal Effort Gauge
	J 29532 Diaphragm Type Brake Pressure Bleeder
	J 35589-A Brake Pressure Bleeder Adapter

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J 45405
Pipe Flaring Tool Kit

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