

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

2006 BRAKES

Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake Hose to Frame Bolt	20 N.m	18 lb ft
Brake Pedal Pivot Bolt	25 N.m	19 lb ft
Brake Pipe Fittings	17 N.m	13 lb ft
Brake Master Cylinder Mounting Bolts	36 N.m	27 lb ft
Front Brake Bleeder Valve	7 N.m	62 lb in
Front Brake Hose to Caliper Bolt	44 N.m	33 lb ft
Power Brake Vacuum Booster Mounting Nut	36 N.m	27 lb ft
Rear Brake Bleeder Valve	7 N.m	62 lb in
Rear Brake Hose to Caliper Bolt	44 N.m	33 lb ft
Rear Brake Hose to Frame Bolt	20 N.m	18 lb ft

BRAKE COMPONENT SPECIFICATIONS

Brake Component Specifications

Application	Specification	
	Metric	English
Brake Pressure Modulator Bleeder Valves	9 N.m	80 lb in
Brake Caliper Bleeder Valve, Front	13 N.m	115 lb in
Brake Caliper Bleeder Valve, Rear	11 N.m	97 lb in
Brake System Flushing		
• Brake Fluid Volume from the Brake Pressure Modulator Bleeder Valves	118 ml	4 oz
• Brake Fluid Volume from the Brake Calipers	235 ml	8 oz
Brake System Pressure Bleed		
• Initial Pressure Adjustment Setting, Leak Testing the Hydraulic Brake System.	70 kPa	10 psi

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

- Pressure Bleed Procedure Setting

240 kPa

35 psi

BRAKE SYSTEM SPECIFICATIONS

Brake System Specifications

Application	Specification	
	Metric	English
Brake Pedal Maximum Travel*		
• Vacuum Power Assist	80 mm	3.1 in

* Specification with 445 N (100 lbs) of force applied to the brake pedal, the ignition OFF, and the brake booster power reserve depleted.

SCHEMATIC AND ROUTING DIAGRAMS

BRAKE WARNING SYSTEM SCHEMATICS

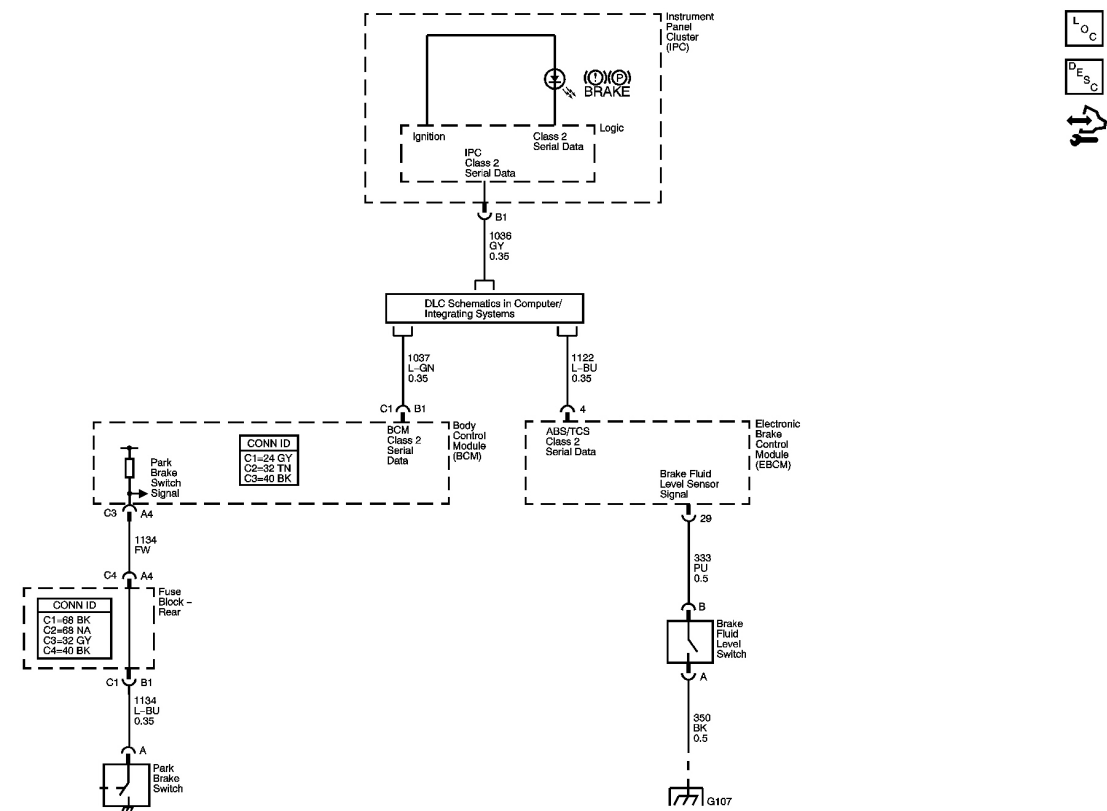


Fig. 1: Brake Warning System Schematic
Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATOR

HYDRAULIC BRAKES COMPONENT VIEWS

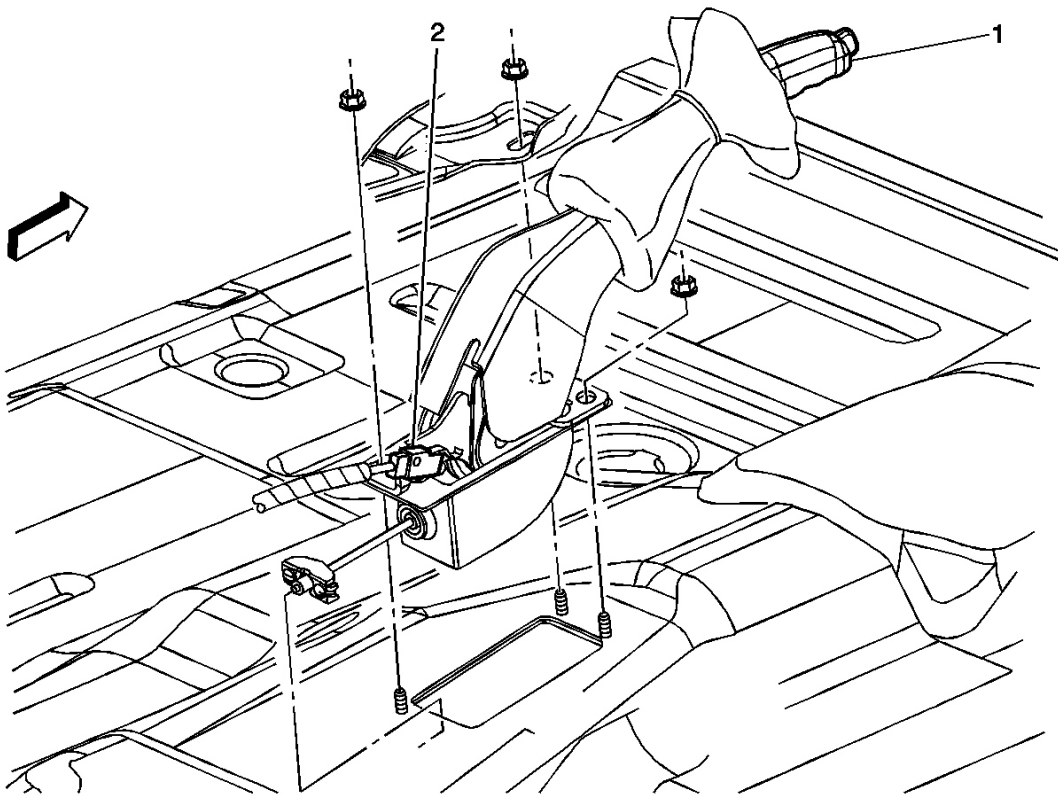


Fig. 2: Park Brake Switch Component View
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 2

Callout	Component Name
1	Park Brake Lever Assembly
2	Park Brake Switch

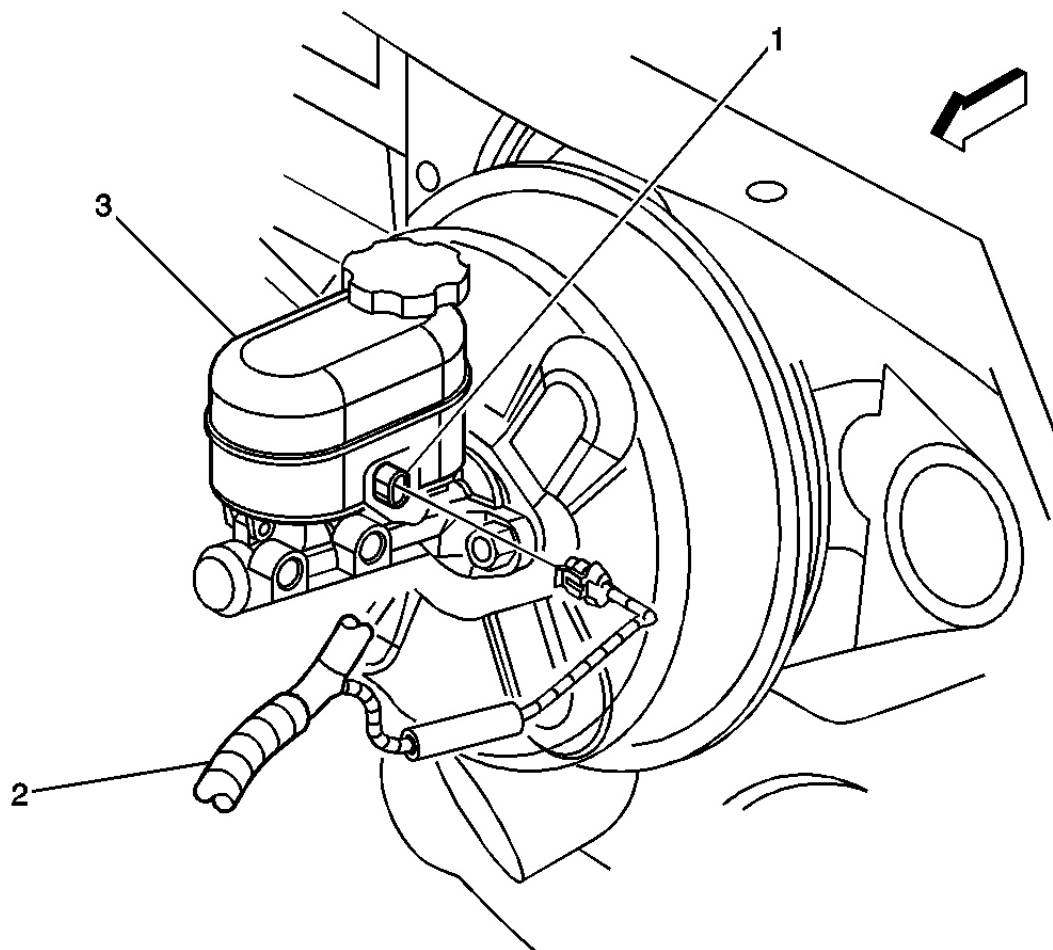


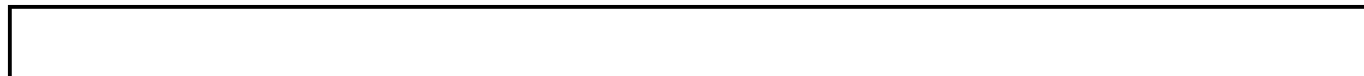
Fig. 3: Brake Fluid Level Switch Component View
 Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 3

Callout	Component Name
1	Brake Fluid Level Switch
2	Chassis Harness
3	Brake Master Cylinder

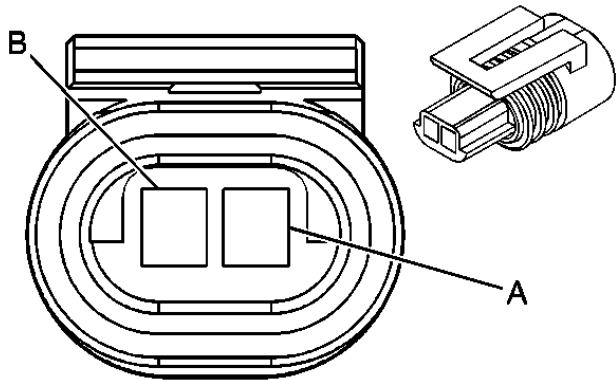
HYDRAULIC BRAKES CONNECTOR END VIEWS

Brake Fluid Level Switch



2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

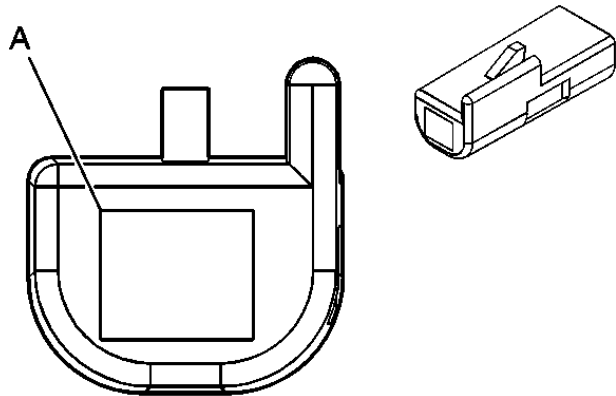


Connector Part Information

- 15304635
- 2-Way F Metri-Pack 150.2 Series Sealed (L-GY)

Pin	Wire Color	Circuit No.	Function
A	BK	350	Ground
B	PU	333	Brake Fluid Level Sensor Signal

Park Brake Switch



Connector Part Information

- 12047682
- 1-Way F Metri-Pack 150 Series Unsealed (BK)

Pin	Wire Color	Circuit No.	Function

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

A

L-BU

1134

Park Brake Switch Signal

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.

DTC C0267

Circuit Description

The electronic brake control module (EBCM) monitors the brake fluid level in the master cylinder reservoir via the brake fluid level switch.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC C0267 Low Brake Fluid Indicated

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The EBCM detects a low brake fluid level condition.

Action Taken When the DTC Sets

The brake warning indicator turns ON.

Conditions for Clearing the DTC

The conditions for setting the DTC are no longer present and you use the scan tool Clear DTCs function.

Diagnostic Aids

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

A lower than normal brake fluid level in the master cylinder may cause the brake fluid level switch to close when the vehicle makes sharp turns or sudden stops. Low brake fluid level may be caused by a brake fluid leak or worn disc brake pads. Thoroughly inspect connections or circuitry that may cause an intermittent malfunction. Refer to the following:

- Testing for Electrical Intermittent
- Testing for Intermittent and Poor Connections
- Wiring Repairs
- Connector Repairs

DTC C0267

Step	Action	Yes	No
Schematic Reference: <u>Brake Warning System Schematics</u>			
Connector End Views Reference: <u>Hydraulic Brakes Connector End Views</u>			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Use a scan tool in order to clear the DTCs. 2. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. Does the DTC set?	Go to Step 3	Go to Diagnostic Aids
3	Inspect the brake fluid level in the master cylinder reservoir. Refer to <u>Master Cylinder Reservoir Filling</u> . Did you find and correct the condition?	Go to Step 8	Go to Step 4
4	1. Disconnect the brake fluid level switch harness connector. 2. Use the scan tool to observe the Brake Fluid Level status. Does the scan tool display Low?	Go to Step 6	Go to Step 5
5	Replace the brake fluid level switch. Refer to <u>Master Cylinder Fluid Level Sensor Replacement</u> . Did you complete the replacement?	Go to Step 8	-

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

6	<ol style="list-style-type: none">1. Turn OFF the ignition.2. Disconnect the electronic brake control module (EBCM) harness connector.3. Test the brake warning indicator supply voltage 1 circuit for a short to ground. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . <p>Did you find and correct the condition?</p>	Go to Step 8	Go to Step 7
7	<p>Replace the EBCM. Refer to <u>Control Module References</u> for replacement, setup, and programming.</p> <p>Did you complete the replacement?</p>	Go to Step 8	-
8	<ol style="list-style-type: none">1. Use the scan tool in order to clear the DTCs.2. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. <p>Does the DTC reset?</p>	Go to Step 3	System OK

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 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**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the hydraulic brake

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

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 Always On**
- **Brake Warning Indicator Inoperative**
- **Brake Pulsation**
- **Braking Action Uneven - Pulls to One Side**
- **Braking Action Uneven - Front to Rear**
- **Brake Pedal Excessive Travel**
- **Brake Pedal Excessive Effort**
- **Brake System Slow Release**
- **Brake Fluid Loss**

BRAKE WARNING INDICATOR ALWAYS ON

Brake Warning Indicator Always On

Step	Action	Yes	No
Schematic Reference: <u>Brake Warning System Schematics</u> Connector End View Reference: <u>Computer/Integrating Systems Connector End Views</u>			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
	1. Turn ON the ignition, with the engine OFF. 2. Release the park brake.		

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

2	<p>3. With a scan tool, observe the Park Brake Switch parameter in the Body Control Module data list.</p> <p>Does the scan tool indicate that the Park Brake Switch parameter is OFF?</p>	<p>Go to <u>Testing for Intermittent Conditions and Poor Connections</u></p>	<p>Go to Step 3</p>
3	<p>1. Turn OFF the ignition.</p> <p>2. Disconnect the park brake switch.</p> <p>3. Turn ON the ignition, with the engine OFF.</p> <p>4. With a scan tool, observe the Park Brake Switch parameter.</p> <p>Does the scan tool indicate that the Park Brake Switch parameter is OFF?</p>	<p>Go to Step 5</p>	<p>Go to Step 4</p>
4	<p>Test the signal circuit of the park brake switch for a short to ground. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> .</p> <p>Did you find and correct the condition?</p>	<p>Go to Step 9</p>	<p>Go to Step 6</p>
5	<p>Inspect for poor connections at the harness connector of the park brake switch. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> .</p> <p>Did you find and correct the condition?</p>	<p>Go to Step 9</p>	<p>Go to Step 7</p>
6	<p>Inspect for poor connections at the harness connector of the body control module (BCM). Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> .</p> <p>Did you find and correct the condition?</p>	<p>Go to Step 9</p>	<p>Go to Step 8</p>
7	<p>Replace the park brake switch. Refer to <u>Park Brake Warning Lamp Switch Replacement</u> .</p> <p>Did you complete the repair?</p>	<p>Go to Step 9</p>	<p>-</p>
8	<p>Replace the BCM. Refer to <u>Control Module References</u> .</p> <p>Did you complete the repair?</p>	<p>Go to Step 9</p>	<p>-</p>

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2
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BRAKE WARNING INDICATOR INOPERATIVE

Brake Warning Indicator Inoperative

Step	Action	Yes	No
Schematic Reference: <u>Brake Warning System Schematics</u> Connector End View Reference: <u>Computer/Integrating Systems Connector End Views</u>			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Turn ON the ignition, with the engine OFF. 2. Apply the park brake. 3. With a scan tool, observe the Park Brake Switch parameter in the Body Control Module data list. Does the scan tool indicate that the Park Brake Switch parameter is ON?	Go to <u>Testing for Intermittent Conditions and Poor Connections</u>	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the park brake switch. 3. Connect a 3-amp fused jumper wire between the signal circuit of the park brake warning lamp switch and ground. 4. Turn ON the ignition, with the engine OFF. 5. With a scan tool, observe the Park Brake Switch parameter. Does the scan tool indicate that the Park Brake Switch parameter is ON?	Go to Step 5	Go to Step 4
4	Test the signal circuit of the park brake switch for an open circuit. Refer to <u>Testing for Intermittent Conditions and Poor</u>		

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

	<u>Connections</u> and <u>Connector Repairs</u> . Did you find and correct the condition?	Go to Step 9	Go to Step 6
5	Inspect for poor connections at the harness connector of the park brake switch. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> . Did you find and correct the condition?	Go to Step 9	Go to Step 7
6	Inspect for poor connections at the harness connector of the body control module (BCM). Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> . Did you find and correct the condition?	Go to Step 9	Go to Step 8
7	Replace the park brake switch. Refer to <u>Park Brake Warning Lamp Switch Replacement</u> . Did you complete the repair?	Go to Step 9	-
8	Replace the BCM. Refer to <u>Control Module References</u> . Did you complete the repair?	Go to Step 9	-
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2

BRAKE PULSATION**Test Description**

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

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

3: Antilock brake system operation could produce feedback through the brake pedal during application of the brake system.

Brake Pulsation

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?		Go to <u>Diagnostic Starting Point - Hydraulic</u>

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

		Go to Step 2	<u>Brakes</u>
2	Inspect the suspension system for proper operation. Refer to <u>Diagnostic Starting Point - Suspension General Diagnosis</u> in Suspension General Diagnosis. Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	Inspect the antilock brake system for proper operation. Refer to <u>Diagnostic Starting Point - Antilock Brake System</u> in Antilock Brake System. Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
6	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 SYSTEM NOISE

Brake System Noise

Step	Action	Yes	No
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 disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 9	Go to Step 3
3	Inspect the brake assist system for proper operation. Refer to <u>Brake Assist System</u>		

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

	<u>Diagnosis.</u> Did you find and correct a condition?	Go to Step 9	Go to Step 4
4	Inspect the hydraulic brake system for proper operation. 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 8
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 8
7	<ol style="list-style-type: none"> 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> in Park Brake. Did you find and correct a condition?	Go to Step 9	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
9	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 - PULLS TO ONE SIDE

Test Description

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

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

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

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

Braking Action Uneven - Pulls to One Side

Step	Action	Yes	No
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 suspension system for proper operation. Refer to <u>Diagnostic Starting Point - Suspension General Diagnosis</u> in Suspension General Diagnosis. Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	Inspect the steering system for proper operation. Refer to <u>Diagnostic Starting Point - Power Steering System (w/o Electro-Hydraulic Steering)</u> in Power Steering System. Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
6	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 Description

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

2: Suspension components that are not operating properly may cause a disturbance to the

2006 Buick Rainier

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vehicle during application of the brake system.

Braking Action Uneven - Front to Rear

Step	Action	Yes	No
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 suspension system for proper operation. Refer to <u>Diagnostic Starting Point - Suspension General Diagnosis</u> in Suspension General Diagnosis. Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	Inspect the brake assist system for proper operation. Refer to <u>Brake Assist System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
6	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**Brake Pedal Excessive Travel**

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

2	<p>Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u>.</p> <p>Is the brake pedal travel distance within the acceptable limits?</p>	Go to Step 5	Go to Step 3
3	<p>1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components.</p> <ul style="list-style-type: none"> • 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. <p>2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Refer to the following procedures as necessary:</p> <ul style="list-style-type: none"> • <u>Brake Pedal Assembly Replacement</u> • <u>Vacuum Brake Booster Replacement</u> - for pedal pushrod replacement <p>Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?</p>	Go to Step 4	Go to Step 5
4	<p>Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u>.</p> <p>Is the brake pedal travel distance within the acceptable limits?</p>	Go to Step 8	Go to Step 5
5	<p>Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u>.</p> <p>Did you find and correct a condition?</p>	Go to Step 8	Go to Step 6

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

6	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 8	Go to Step 7
7	Inspect the brake assist system for proper operation. Refer to <u>Brake Assist System Diagnosis</u> . Did you find and correct a condition?	Go to Step 8	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
8	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

BRAKE PEDAL EXCESSIVE EFFORT

Brake Pedal Excessive Effort

Step	Action	Yes	No
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 brake assist system for proper operation. 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 proper operation. 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 proper operation. 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	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

BRAKES DRAG

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

Brakes Drag

Step	Action	Yes	No
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	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	<ol style="list-style-type: none"> 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. <p>Did you find and correct a condition?</p>	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	<p>Ensure the park brake shoes are not adjusted too tightly, possibly causing drag under certain conditions.</p> <p>Are the park brake shoes adjusted too tightly?</p>	Go to Step 6	Go to Step 7
6	<ol style="list-style-type: none"> 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 <p>Did you find and correct a condition?</p>	Go to Step 14	Go to Step 7
7	<p>Inspect the park brake system for proper operation. Refer to <u>Park Brake System Diagnosis</u> in Park Brake.</p> <p>Did you find and correct a condition?</p>	Go to Step 14	Go to Step 8

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

8	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 14	Go to Step 9
9	1. Separate the brake booster pushrod from the brake 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	Replace the brake pedal assembly. Did you complete the replacement?	Go to Step 14	-
11	1. Separate the master cylinder from the brake booster. Do not disconnect any brake pipes. 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 13	Go to Step 12
12	Replace the brake booster assembly. Did you complete the replacement?	Go to Step 14	-
13	Inspect the hydraulic brake system for proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 14	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
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 <u>Brake System Vehicle Road Test</u> . Is the condition still present?	Go to Step 2	System OK

BRAKE SYSTEM SLOW RELEASE

Brake System Slow Release

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

Step	Action	Yes	No
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 proper operation. 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 proper operation. 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 proper operation. 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	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

BRAKE FLUID LOSS

Brake Fluid Loss

Step	Action	Yes	No
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 proper operation. Refer to <u>Hydraulic Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	Inspect the disc brake system for proper operation. Refer to <u>Disc Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 6	Go to Step 4

2006 Buick Rainier

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4	<ol style="list-style-type: none">1. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Refer to <u>Master Cylinder Replacement</u>.2. Inspect the rear of the master cylinder for a brake fluid leak.3. Inspect for brake fluid in the vacuum brake booster. <p>Did you find a brake fluid leak?</p>	Go to Step 5	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
5	<p>Replace the brake master cylinder and the vacuum brake booster. Refer to <u>Master Cylinder Replacement</u> and <u>Vacuum Brake Booster Replacement</u>.</p> <p>Did you complete the replacement?</p>	Go to Step 6	-
6	<ol style="list-style-type: none">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>. <p>Is the condition still present?</p>	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.

Disc Brake System Diagnosis

Step	Action	Yes	No
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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	<p>Visually inspect the disc brake pads for the following:</p> <ul style="list-style-type: none"> • Lining thickness • Uneven and/or abnormal wear (edge-to-edge and/or side-to-side) • Evidence of contamination from an external substance • Looseness or damage (including pad hardware) <p>Did you find any conditions to indicate a concern with any of the (front and/or rear) disc brake pads?</p>	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	<p>1. Remove and inspect the worn disc brake pads for glazing, looseness, heat spots or damage.</p> <p>2. Replace the worn disc brake pads as a complete axle set. Refer to <u>Brake Pads Replacement - Front</u> and/or <u>Brake Pads Replacement - Rear</u> .</p> <p>Did you complete the inspection and</p>		-

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	replacement?	Go to Step 12	
7	<p>NOTE: Support the brake caliper with heavy mechanic's 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.</p> <ol style="list-style-type: none"> 1. Remove the (front and/or rear) disc brake calipers (as appropriate) from the mounting brackets and support the calipers. Do NOT disconnect the hydraulic brake flex hoses from the calipers. Refer to <u>Brake Caliper Replacement - Front</u> and/or <u>Brake Caliper Replacement - Rear</u>. 2. Inspect the disc brake caliper mounting bracket and the mounting/sliding hardware for the following conditions: <ul style="list-style-type: none"> • Loose, bent, cracked, or damaged caliper mounting bracket • Binding or seized hardware • Worn, damaged or missing hardware components <p>Refer to <u>Disc Brake Mounting and Hardware Inspection - Front</u> and/or <u>Disc Brake Mounting and Hardware Inspection - Rear</u>.</p> 3. Replace components as required. Refer to the following procedures, as required: <ul style="list-style-type: none"> • <u>Brake Caliper Bracket Replacement - Front</u> • <u>Brake Caliper Bracket Replacement - Rear</u> 		-

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	<ul style="list-style-type: none">• <u>Disc Brake Hardware Replacement - Front</u>• <u>Disc Brake Hardware Replacement - Rear</u> <p>4. Replace the unevenly-worn, loose or damaged disc brake pads as a complete axle set. Refer to <u>Brake Pads Replacement - Front</u> and/or <u>Brake Pads Replacement - Rear</u> .</p> <p>Did you complete the inspection and replacement?</p>	Go to Step 12	
8	<p>1. Inspect the disc brake calipers, brake hoses and brake pipes for evidence of an external brake fluid leak.</p> <p>2. Replace any components found to be leaking brake fluid. Refer to the following procedures, as required:</p> <ul style="list-style-type: none">• <u>Brake Caliper Replacement - Front</u>• <u>Brake Caliper Replacement - Rear</u>• <u>Brake Hose Replacement - Front</u>• <u>Brake Hose Replacement - Rear</u>• <u>Brake Pipe Replacement</u> <p>Did you find and correct the source of the leak causing contamination of the pads?</p>	Go to Step 11	Go to Step 9
	<p>1. Inspect the wheel drive shaft outer seals (boots), if equipped, for damage and evidence of a grease leak.</p> <p>2. Replace any wheel drive shaft seal (boot) 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 Seal Replacement</u> , if equipped.</p>		

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

9	<p>3. Inspect the rear axle seals for damage and evidence of a lubricant leak.</p> <p>4. Replace any rear axle seal that is found to be leaking lubricant which may be the source of the contamination to the pads. Refer to <u>Rear Axle Shaft Seal and/or Bearing Replacement</u> .</p> <p>Did you find and correct the source of the leak causing contamination of the pads?</p>	Go to Step 11	Go to Step 10
10	<p>1. Inspect the following systems for damage and evidence of an external fluid leak.</p> <p>2. Replace any components found to be leaking fluid which may be the source of the contamination to the pads. Refer to the following procedures:</p> <ul style="list-style-type: none"> • <u>Diagnostic Starting Point - Power Steering System (w/o Electro-Hydraulic Steering)</u> • <u>Diagnostic Starting Point - Engine Mechanical</u> for the 4.2L engine • <u>Diagnostic Starting Point - Automatic Transmission</u> for the 4L60-E transmission <p>Did you find and correct the source of the leak causing contamination of the pads?</p>	Go to Step 11	-
	<p>1. Clean the remaining disc brake system components to remove any traces of the contaminant.</p> <p>NOTE: Support the brake caliper with heavy mechanic's 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</p>		

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

11	<p>damage to the brake hose and in turn may cause a brake fluid leak.</p> <ol style="list-style-type: none">2. Remove the (front and/or rear) disc brake calipers (as appropriate) from the mounting brackets and support the calipers. Do NOT disconnect the hydraulic brake flex hoses from the calipers. Refer to <u>Brake Caliper Replacement - Front</u> and/or <u>Brake Caliper Replacement - Rear</u> .3. Inspect the disc brake caliper mounting/sliding hardware for the following conditions:<ul style="list-style-type: none">• Binding or seized hardware• Distorted, worn, damaged or missing hardware components <p>Refer to <u>Disc Brake Mounting and Hardware Inspection - Front</u> and/or <u>Disc Brake Mounting and Hardware Inspection - Rear</u> .</p> <ol style="list-style-type: none">4. Replace the caliper mounting/sliding hardware components as required. Refer to <u>Disc Brake Hardware Replacement - Front</u> and/or <u>Disc Brake Hardware Replacement - Rear</u> .5. Replace the contaminated disc brake pads as a complete axle set. Refer to <u>Brake Pads Replacement - Front</u> and/or <u>Brake Pads Replacement - Rear</u> . <p>Did you complete the cleaning, inspection and replacement?</p>	-	
12	<p>Visually inspect each of the disc brake rotor shields/backing plates for evidence of contact with the brake rotors.</p> <p>Are any of the brake rotor shields/backing plates</p>	Go to Step 12	

2006 Buick Rainier

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	contacting the brake rotors?	Go to Step 13	Go to Step 14
13	<p>Repair or replace the disc brake rotor shields/backing plates as required. Refer to <u>Disc Brake Splash Shield Replacement - Front</u> and/or <u>Disc Brake Backing Plate Replacement - Rear</u> .</p> <p>Did you complete the repair or replacement?</p>	Go to Step 14	-
14	<p>1. Check the thickness of each of the disc brake rotors.</p> <p>IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>2. Make a determination for each brake rotor if the rotor can be REFINISHED and REMAIN ABOVE the minimum requirements.</p> <p>Refer to <u>Brake Rotor Thickness Measurement</u> .Does the disc brake rotor meet the minimum requirements for REFINISHING?</p>	Go to Step 15	Go to Step 17
	<p>1. Inspect each of the disc brake rotors for the following surface and wear conditions:</p> <ul style="list-style-type: none"> • Braking surface conditions <ul style="list-style-type: none"> ■ Heavy rust and/or pitting ■ Cracks and/or heat spots ■ Excessive blueing discoloration • Braking surface wear conditions <ul style="list-style-type: none"> ■ Deep or excessive scoring beyond maximum acceptable level ■ Lateral runout beyond maximum acceptable level. ■ Thickness variation beyond maximum acceptable level 		

2006 Buick Rainier

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15	<p style="text-align: center;">Refer to <u>Brake Rotor Surface and Wear Inspection</u> .</p> <p>IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>2. Make a determination for each brake rotor if the rotor requires refinishing based upon the results of the inspection.</p> <p>If the brake rotor exhibits any of the following conditions, it requires refinishing:</p> <ul style="list-style-type: none"> • Rotor exhibits one or more of the braking surface conditions listed previously • Rotor is beyond the acceptable level in one or more of the braking surface wear conditions listed previously <p>Does the brake rotor require REFINISHING?</p>		
16	<p>1. Refinish the brake rotor. Refer to <u>Brake Rotor Refinishing</u> .</p> <p>2. Inspect the brake rotor thickness. Refer to <u>Brake Rotor Thickness Measurement</u> .</p> <p>Were you able to REFINISH the brake rotor within the minimum requirements?</p>	Go to Step 16	Go to Step 20
17	<p>Is the brake rotor at or below the DISCARD requirements?</p>	Go to Step 20	Go to Step 19
	<p>1. Inspect each of the disc brake rotors for the following surface and wear conditions:</p> <ul style="list-style-type: none"> • Braking surface conditions <ul style="list-style-type: none"> ■ Heavy rust and/or pitting ■ Cracks and/or heat spots 		

2006 Buick Rainier

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18	<ul style="list-style-type: none"> ■ Excessive blueing discoloration ● Braking surface wear conditions <ul style="list-style-type: none"> ■ Deep or excessive scoring beyond maximum acceptable level ■ Lateral runout beyond maximum acceptable level ■ Thickness variation beyond maximum acceptable level. <p style="text-align: center;">Refer to <u>Brake Rotor Surface and Wear Inspection</u> .</p> <p>IMPORTANT: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.</p> <p>2. Make a determination for each brake rotor if the rotor requires replacement based upon the results of the inspection.</p> <p>If a brake rotor exhibits any of the following conditions, it requires replacement:</p> <ul style="list-style-type: none"> ● Rotor exhibits one or more of the braking surface conditions listed previously ● Rotor is beyond the acceptable level in one or more of the braking surface wear conditions listed previously <p>Does the brake rotor require REPLACEMENT?</p>	Go to Step 19	Go to Step 20
19	<p>Replace the brake rotor. Refer to <u>Brake Rotor Replacement - Front</u> or <u>Brake Rotor Replacement - Rear</u> .</p> <p>Did you complete the replacement?</p>	Go to Step 20	-
	Install or connect components that were	Disc Brake	

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

20	removed or disconnected during diagnosis. Did you complete the operation?	System OK Return to Symptom Table	-
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HYDRAULIC BRAKE SYSTEM DIAGNOSIS

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	<ol style="list-style-type: none"> Inspect the brake fluid for the following conditions, indicating brake fluid contamination: <ul style="list-style-type: none"> Fluid separation, indicating 2 types of fluid are present <ul style="list-style-type: none"> Swirled appearance-Oil-based substance Layered appearance-Silicone-based substance Fluid discoloration <ul style="list-style-type: none"> 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 		

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

	cylinder grommets for swelling, indicating fluid contamination.		
	Do any of the above conditions exist?	Go to Step 5	Go to Step 6
4	<ol style="list-style-type: none"> Inspect the brake fluid for the following conditions, indicating brake fluid contamination: <ul style="list-style-type: none"> Fluid separation, indicating 2 types of fluid are present <ul style="list-style-type: none"> Swirled appearance-Oil-based substance Layered appearance-Silicone-based substance Fluid discoloration <ul style="list-style-type: none"> 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 12
	<ol style="list-style-type: none"> Flush the hydraulic brake system. Refer to <u>Hydraulic Brake System Flushing</u>. 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 steps. Refer to the procedures indicated. <ol style="list-style-type: none"> 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.

- **Master Cylinder Overhaul or Master Cylinder Replacement**

- Brake master cylinder reservoir- 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.

- **Brake Hose Replacement - Front**

- **Brake Hose Replacement - Rear**

- **Brake Caliper Replacement - Front**

- **Brake Caliper Replacement - Rear**

- **Brake Pressure Modulator Valve (BPMV) Replacement**

3. 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

	<p>brake master cylinder reservoir cap diaphragm which may have allowed moisture or dirt to enter the system.</p> <p>4. Refill and bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manual)</u> or <u>Hydraulic Brake System Bleeding (Pressure)</u>.</p> <p>Did you complete the operation and any required repairs and/or replacements?</p>	Go to Step 9	
6	<p>1. 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 procedures:</p> <ul style="list-style-type: none"> • <u>Master Cylinder Overhaul</u> or <u>Master Cylinder Replacement</u> <p>Brake master cylinder reservoir cap diaphragm</p> <ul style="list-style-type: none"> • <u>Brake Hose Replacement - Front</u> • <u>Brake Hose Replacement - Rear</u> • <u>Brake Pipe Replacement</u> • <u>Brake Caliper Replacement - Front</u> • <u>Brake Caliper Replacement - Rear</u> • <u>Brake Pressure Modulator Valve (BPMV) Replacement</u> <p>2. If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manual)</u> or <u>Hydraulic Brake System Bleeding (Pressure)</u>. While bleeding the hydraulic brake system, observe for the following conditions:</p> <ul style="list-style-type: none"> • The presence of air in the system at a 		

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	<p>bleeder valve location other than at the repair location, except if the brake master cylinder was replaced</p> <ul style="list-style-type: none"> • 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 was 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	<p>Inspect the hydraulic function of the brake calipers for proper operation. Refer to <u>Hydraulic Brake Component Operation Visual Inspection.</u></p> <p>Was the hydraulic function of the brake calipers operating properly?</p>	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	<p>Inspect the hydraulic function of the brake calipers for proper operation. Refer to <u>Hydraulic Brake Component Operation Visual Inspection.</u></p> <p>Was the hydraulic function of the brake calipers operating properly?</p>	Go to Step 15	Go to Step 13
	<p>Determine if the brake caliper is restricting the flow of brake fluid and/or not operating properly:</p> <ol style="list-style-type: none"> 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assemblies. 		

2006 Buick Rainier

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13	<p>Refer to <u>Tire and Wheel Removal and Installation</u> .</p> <ol style="list-style-type: none"> Open the suspected caliper bleeder valve. 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. Close the caliper bleeder valve. <p>Was the flow of brake fluid unrestricted and did the caliper piston move freely?</p>	Go to Step 17	Go to Step 14
14	<p>Replace any brake caliper that was not operating properly. Refer to the appropriate procedure.</p> <ul style="list-style-type: none"> • <u>Brake Caliper Replacement - Front</u> • <u>Brake Caliper Replacement - Rear</u> <p>Did you complete the repair and/or replacement?</p>	Go to Step 21	-
15	<p>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>.</p> <p>Was there air in the system?</p>	Go to Step 19	Go to Step 16
16	<p>Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?</p>	Go to Step 21	Go to Step 17
	<ol style="list-style-type: none"> 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>. Replace any of the hydraulic brake pipes and/or flexible brake hoses found to be bent, kinked, pinched, or damaged. Refer to 		

2006 Buick Rainier

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17	<p>the following procedures as necessary:</p> <ul style="list-style-type: none"> • <u>Brake Hose Replacement - Front</u> • <u>Brake Hose Replacement - Rear</u> • <u>Brake Pipe Replacement</u> <p>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 at the restricted location.</p> <p>Did you find and correct a condition?</p>	Go to Step 21	Go to Step 18
18	<p>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 (BPMV) Replacement</u> .</p> <p>Did you complete the replacement?</p>	Go to Step 21	-
19	<p>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.</p> <p>2. Inspect the hydraulic brake system components for evidence of a recent repair, which may have introduced air into the system.</p> <p>3. Repair or replace any of the components found to be installed incorrectly or seeping brake fluid.</p> <p>Did you find and correct a condition?</p>	Go to Step 21	Go to Step 20
20	<p>1. Inspect the brake master cylinder for internal fluid leaks. Refer to <u>Brake System Internal Leak Test</u>.</p> <p>2. Repair or replace the brake master cylinder if it is found to be leaking brake fluid internally. Refer to <u>Master Cylinder Overhaul</u> or <u>Master Cylinder</u></p>		

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

	<u>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

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 2	Go to <u>Diagnostic Starting Point - Hydraulic Brakes</u>
2	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 3
3	<ol style="list-style-type: none"> Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. <ul style="list-style-type: none"> 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, 		

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

	<p>misaligned, bent or damaged, refer to the following procedures as necessary.</p> <ul style="list-style-type: none"> • <u>Brake Pedal Assembly Replacement</u> • <u>Vacuum Brake Booster Replacement</u> (for a bent or damaged pedal pushrod replacement) <p>Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?</p>	Go to Step 4	Go to Step 5
4	<p>Reinspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u>.</p> <p>Is the brake pedal travel distance within the acceptable limits?</p>	Go to Step 8	Go to Step 5
5	<p>Check the engine vacuum source that supplies vacuum to the vacuum brake booster. Refer to <u>Brake System Vacuum Source Test (STS)</u>.</p> <p>Is the vacuum reading within the acceptable limits?</p>	Go to Step 6	Go to <u>Diagnostic Starting Point - Engine Mechanical</u> in Engine Mechanical - 4.2L
6	<p>During the vacuum source inspection, did the vacuum booster check valve operate properly?</p>	Go to Step 8	Go to Step 7
7	<p>Replace the vacuum booster check valve. Refer to <u>Vacuum Brake Booster Check Valve and/or Hose Replacement</u>.</p> <p>Did you complete the replacement?</p>	Go to Step 8	-
8	<ol style="list-style-type: none"> 1. Pump the brake pedal several times until the brake pedal becomes hard. 2. Maintain moderate foot pressure on the brake pedal and start the engine. Observe pedal operation. <p>Did the brake pedal drop slightly, then remain firm after the engine was started?</p>	Go to Step 9	Go to Step 12
	<ol style="list-style-type: none"> 1. Release the brake pedal. 		

2006 Buick Rainier

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9	<p>2. Turn the ignition OFF, then wait 15 seconds.</p> <p>3. Pump the brake pedal two times to check for vacuum booster available vacuum reserve. Observe pedal effort.</p> <p>(If operating properly, the vacuum brake booster should maintain assist for at least two pedal applications.)</p> <p>Did the brake pedal effort increase significantly?</p>	Go to Step 12	Go to Step 10
10	<p>Inspect the brake pedal pushrod and the brake pedal for misalignment, a bent condition and/or damage.</p> <p>Is the brake pedal pushrod and/or the brake pedal misaligned, bent or damaged?</p>	Go to Step 11	Go to Step 13
11	<p>Replace the brake pedal pushrod and/or the brake pedal, as necessary. Refer to the following procedure(s).</p> <ul style="list-style-type: none"> • <u>Brake Pedal Assembly Replacement</u> • <u>Vacuum Brake Booster Replacement</u> (for a bent or damaged pedal pushrod replacement) <p>Did you complete the replacement?</p>	Go to Step 13	-
12	<p>Replace the vacuum brake booster. Refer to <u>Vacuum Brake Booster Replacement</u>.</p> <p>Did you complete the replacement?</p>	Go to Step 13	-
13	<p>Install or connect any components that were removed or disconnected during diagnosis.</p> <p>Did you complete the operation?</p>	Brake Assist System OK Return to Symptom Table	-

BRAKE SYSTEM VEHICLE ROAD TEST

Preliminary Inspections

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

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

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

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 Gauge. See **Special Tools**.

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**.

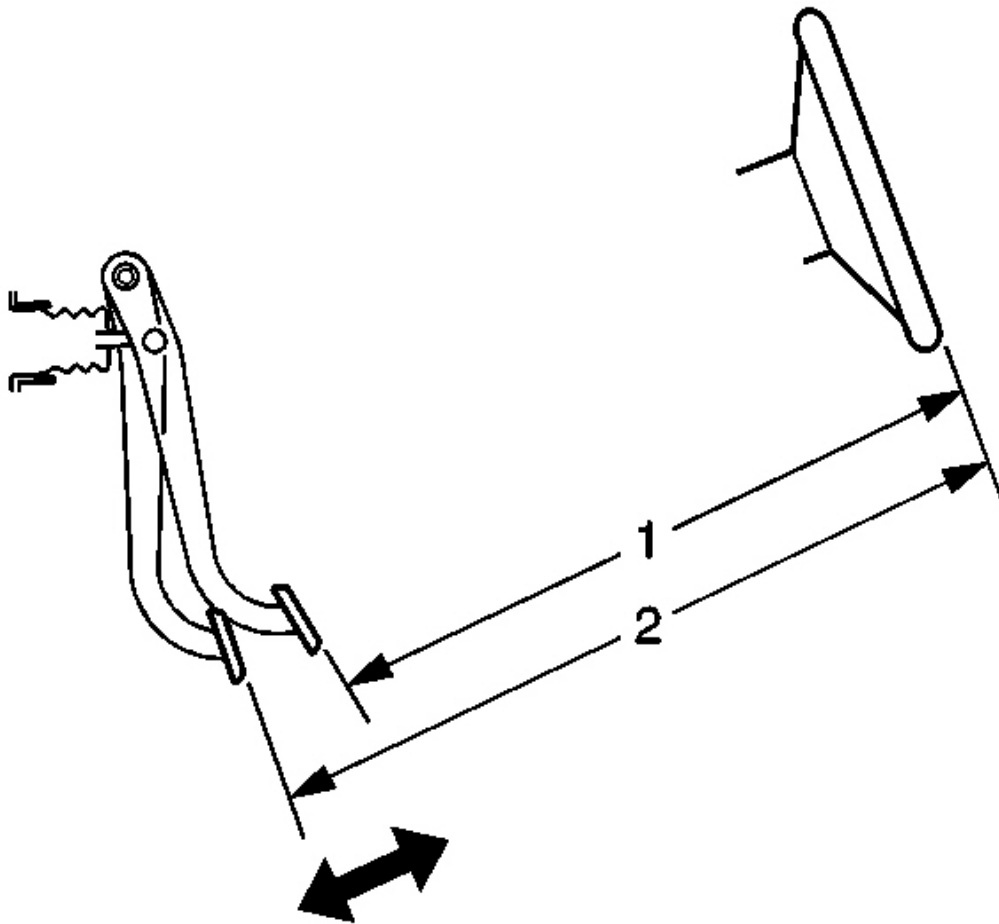


Fig. 4: Measuring Brake Pedal Travel
Courtesy of GENERAL MOTORS CORP.

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): 61 mm (2.4 in).

BRAKE SYSTEM VACUUM SOURCE TEST (STS)

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. 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.
 - Tight 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 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:
 - Firm 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 in Cautions and Notices.

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

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 in Cautions and Notices.

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

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) .

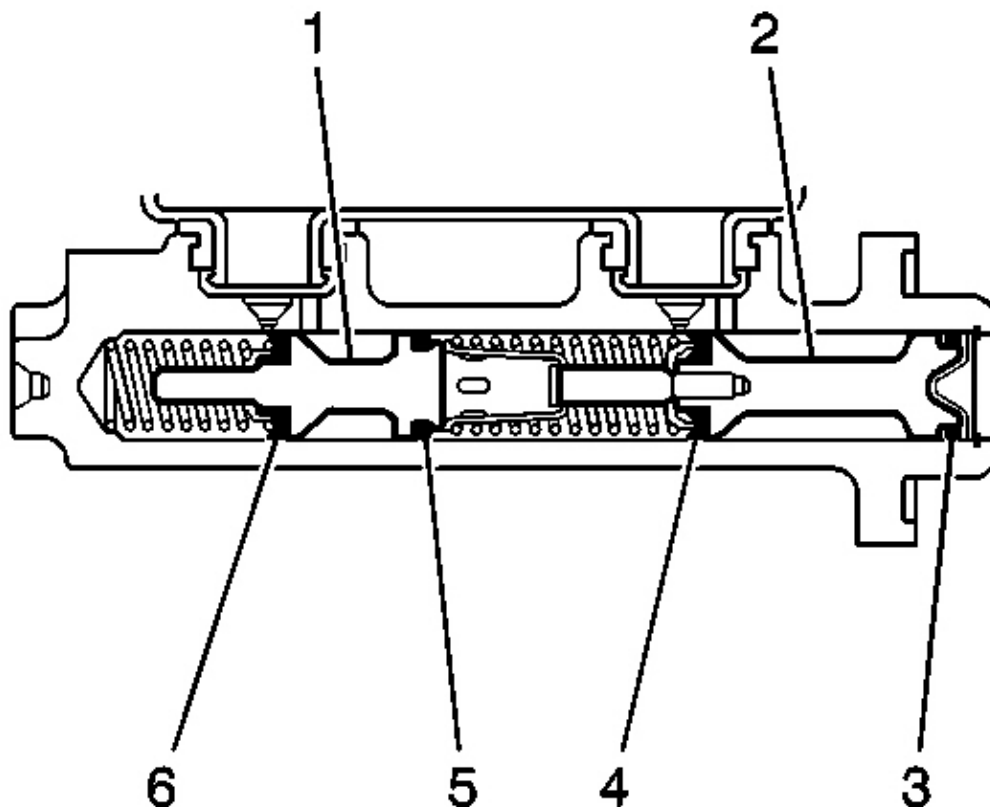


Fig. 5: Cross Sectional View Of Brake Master Cylinder
Courtesy of GENERAL MOTORS CORP.

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.

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

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

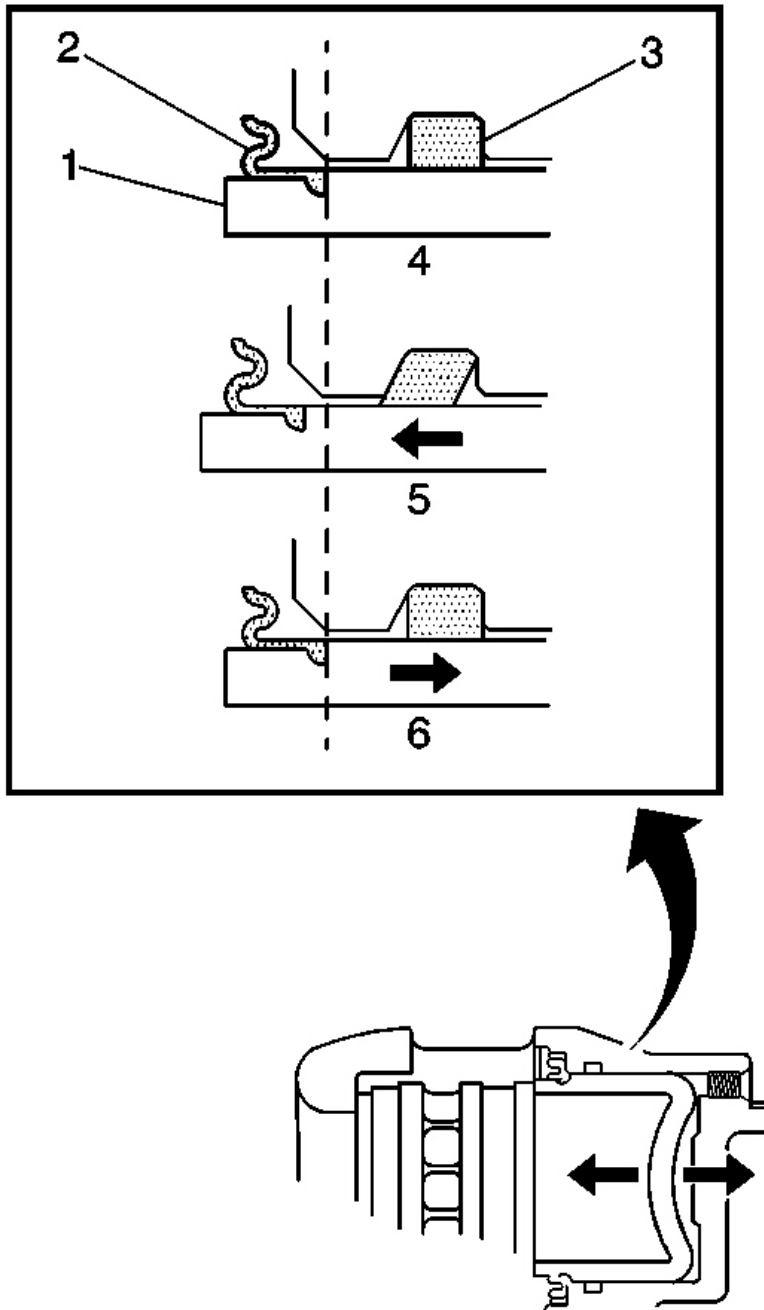


Fig. 6: Identifying Brake Caliper/Pad Inspection Areas
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

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

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 in Cautions and Notices.

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

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.

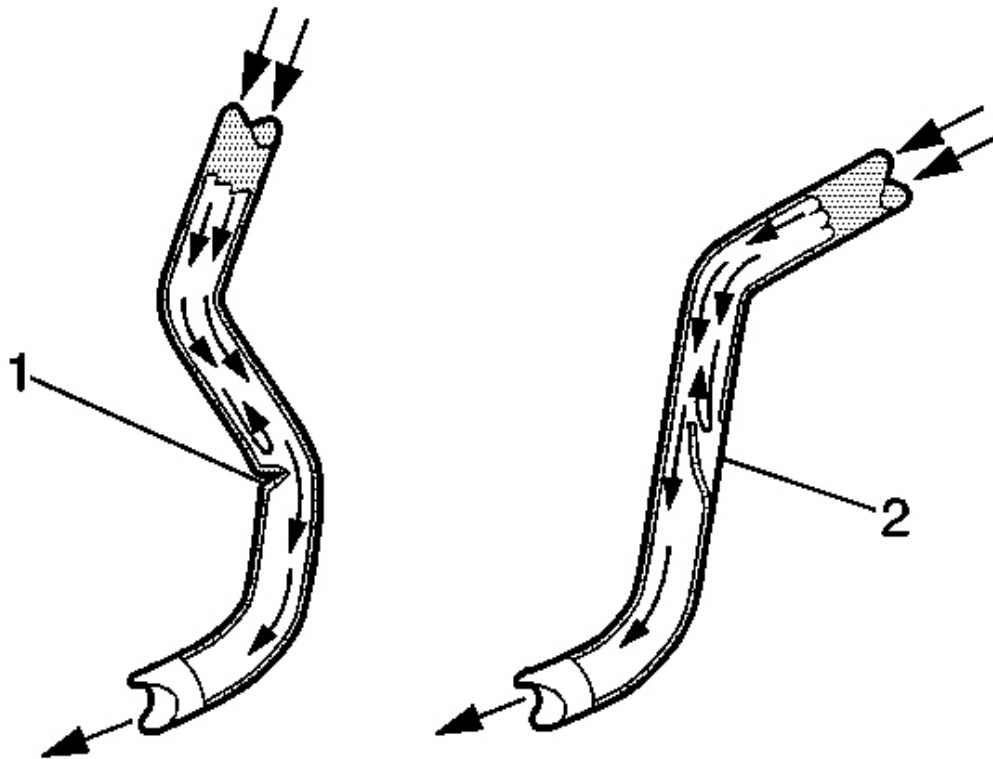


Fig. 7: Identifying Flexible Brake Hose Failure Conditions
Courtesy of GENERAL MOTORS CORP.

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

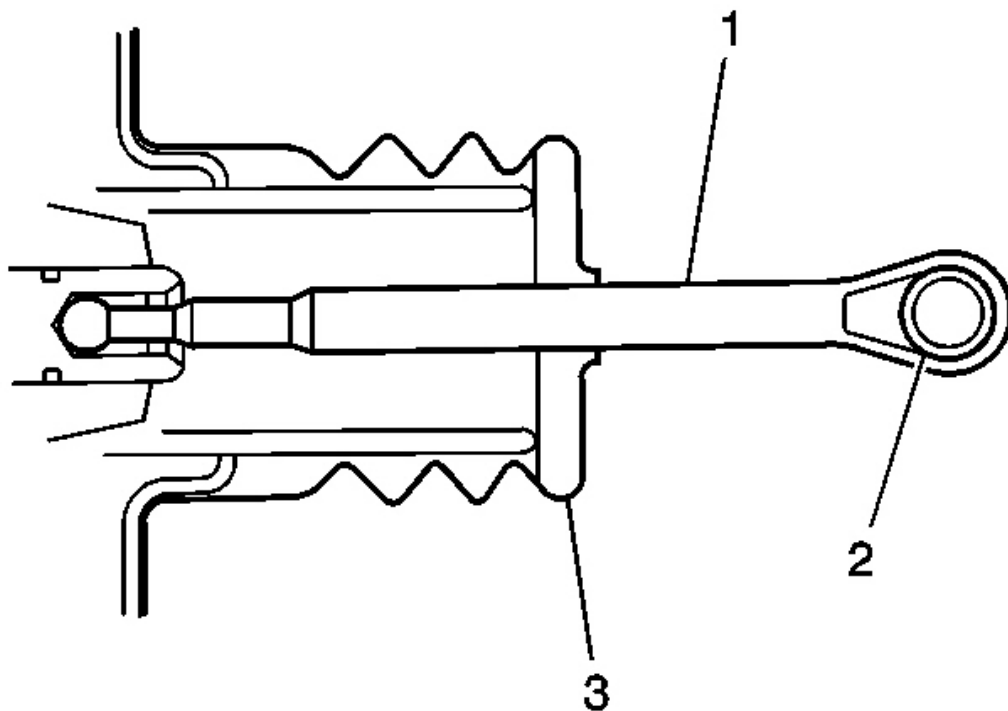


Fig. 8: View of Brake Pedal Pushrod
Courtesy of GENERAL MOTORS CORP.

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 and the vacuum booster require replacement.
7. Return the pedal pushrod boot (3) to its original position on the pedal pushrod (1).

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2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

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

REPAIR INSTRUCTIONS

MASTER CYLINDER RESERVOIR FILLING

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

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

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.

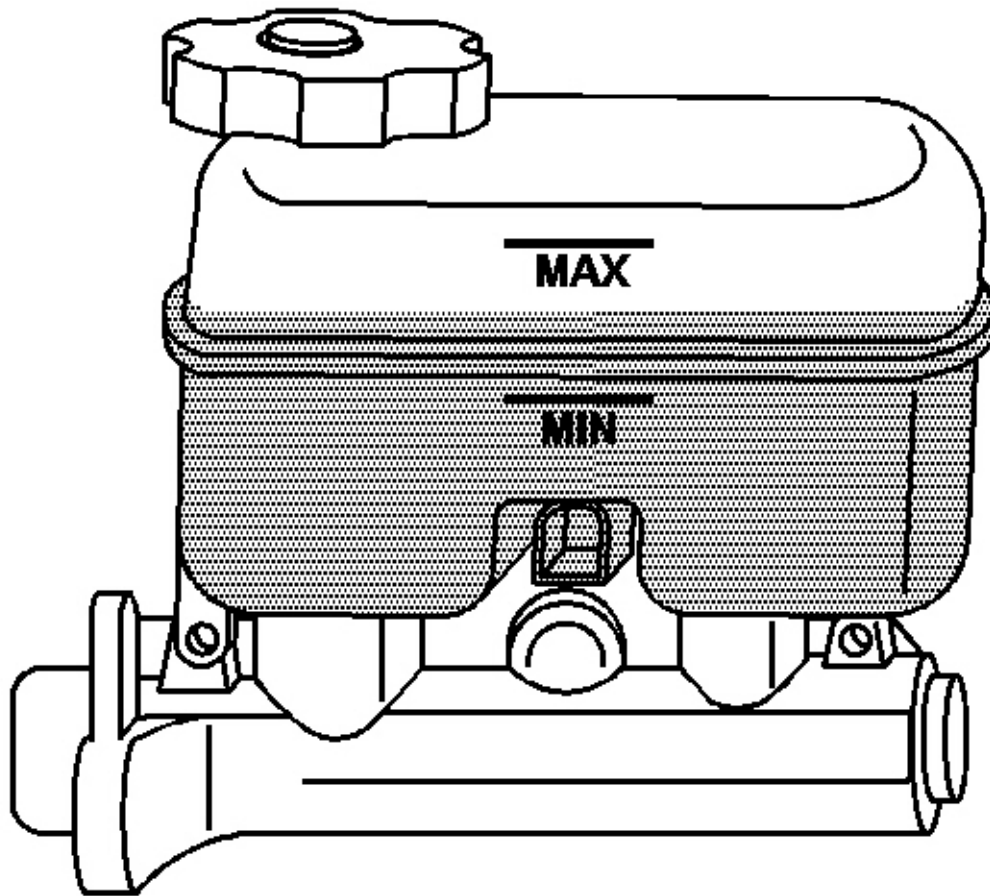


Fig. 9: View Of Half-Full Master Cylinder Reservoir
Courtesy of GENERAL MOTORS CORP.

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 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.

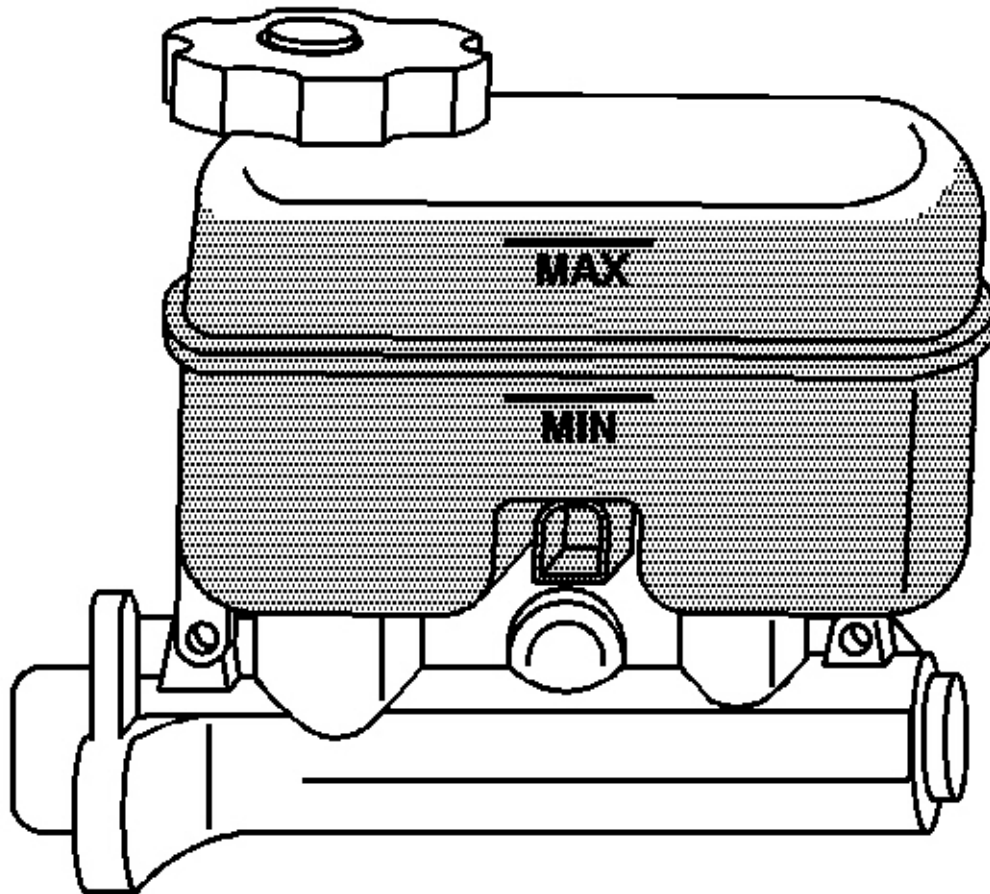


Fig. 10: View Of Full Master Cylinder Reservoir MAX And MIN Marks
Courtesy of GENERAL MOTORS CORP.

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.

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

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

Removal Procedure

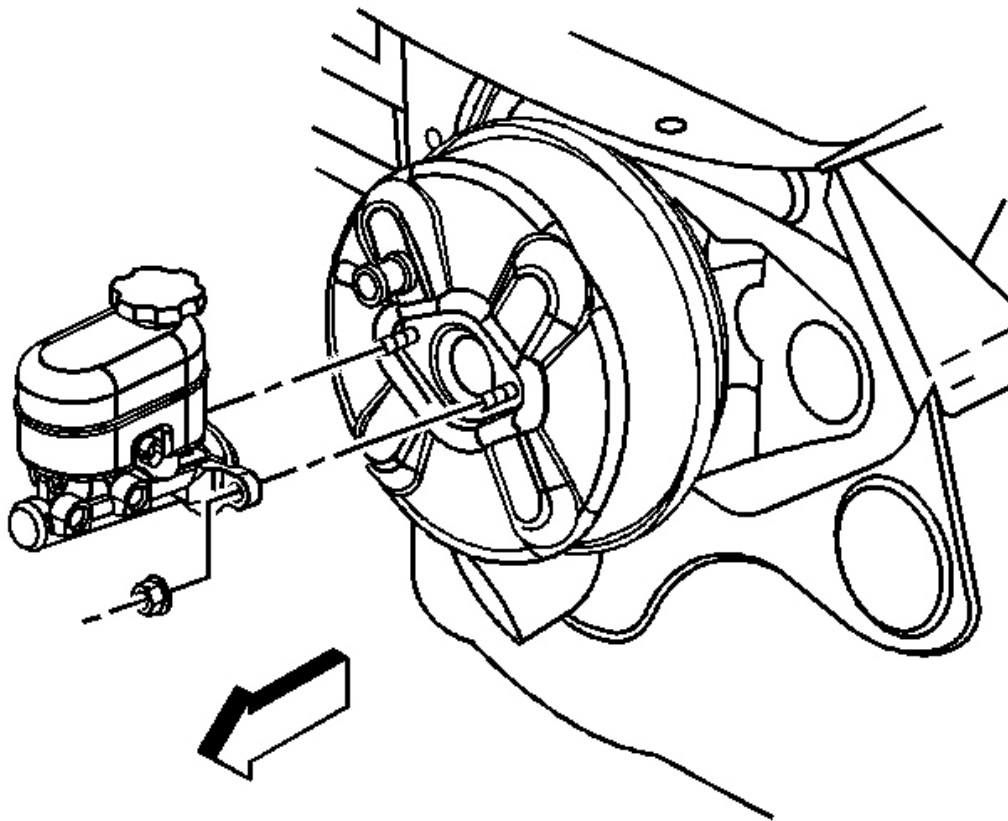


Fig. 11: Master Cylinder To Booster View
Courtesy of GENERAL MOTORS CORP.

1. Remove the brake master cylinder assembly. Refer to Master Cylinder Replacement.
2. Drain the brake fluid from the reservoir.

NOTE: Do not clamp on the master cylinder body. Doing so may damage the master cylinder.

3. Clamp the flange of the master cylinder body in a vise.

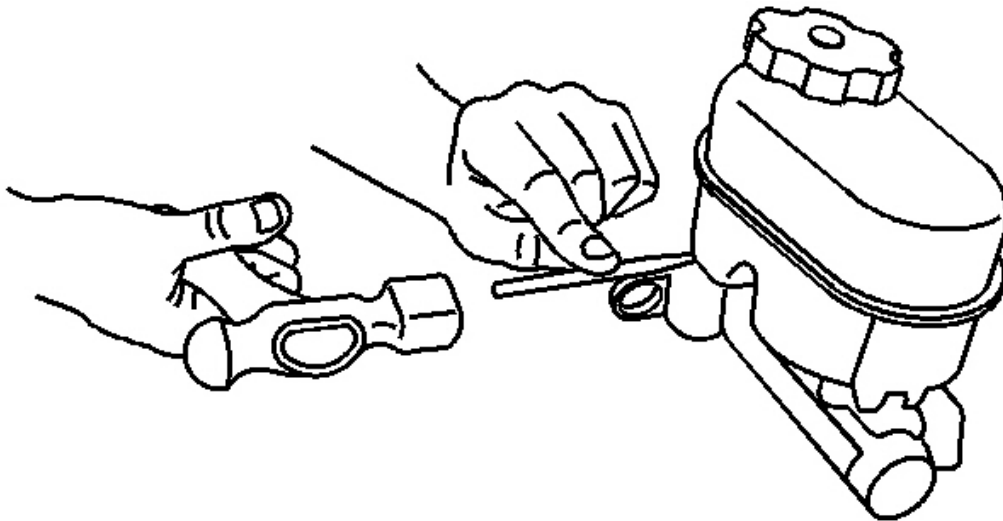


Fig. 12: Removing/Installing Brake Master Cylinder Reservoir Retaining Pins
Courtesy of GENERAL MOTORS CORP.

4. Remove the retaining pins for the brake master cylinder reservoir.

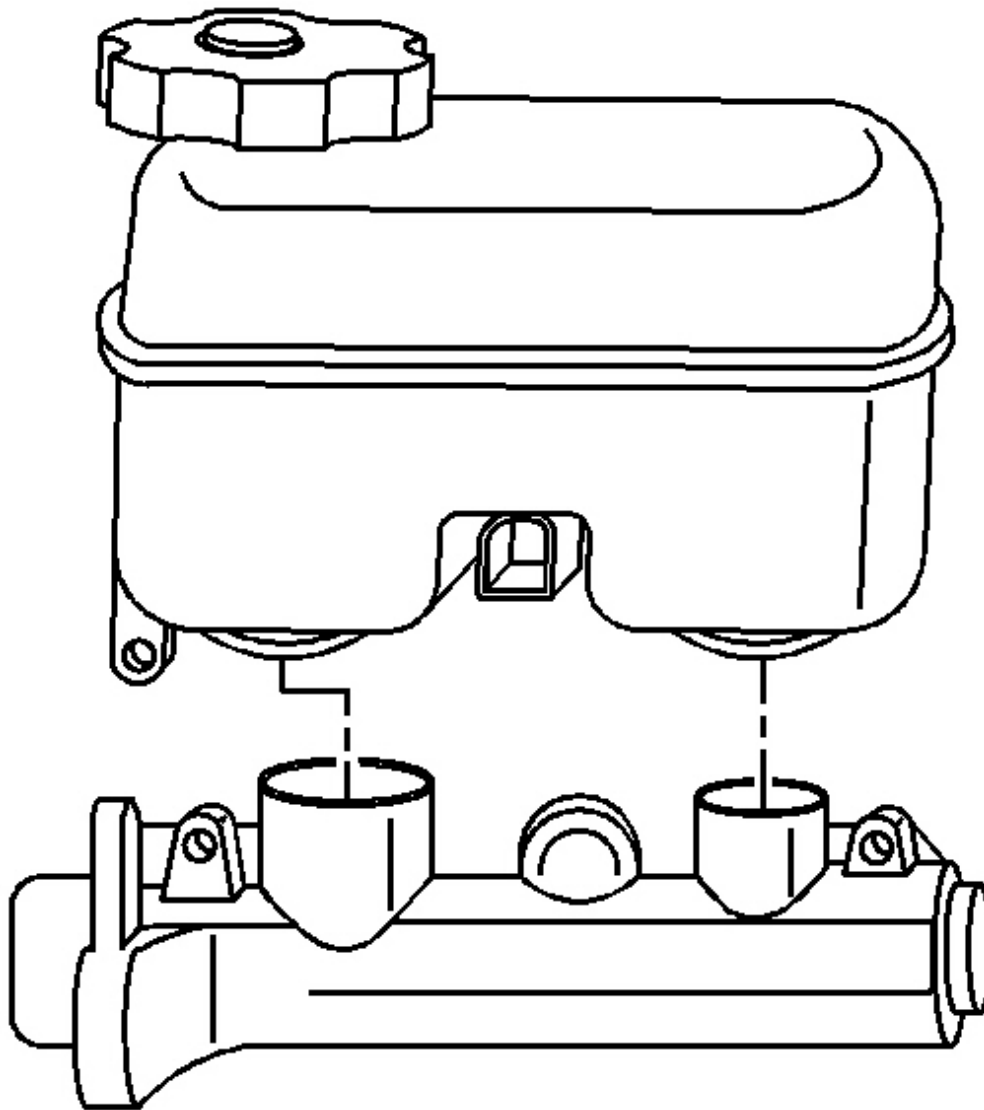


Fig. 13: Removing/Installing Reservoir And Brake Master Cylinder
Courtesy of GENERAL MOTORS CORP.

5. Remove the reservoir from the brake master cylinder.

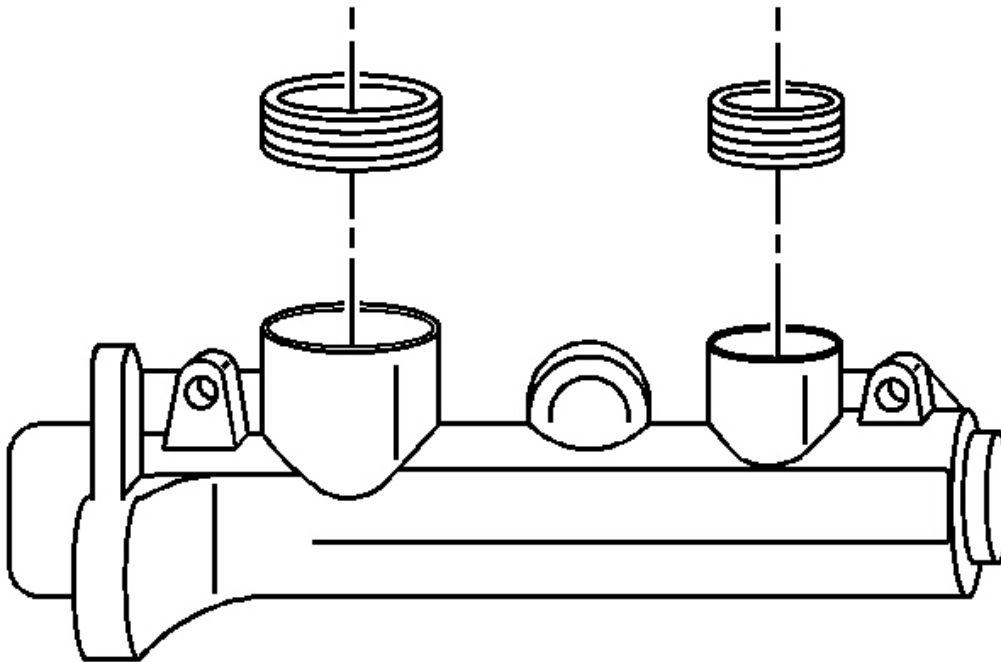


Fig. 14: Brake Master Cylinder Seals
Courtesy of GENERAL MOTORS CORP.

6. Remove the seals from the brake master cylinder.
7. Clean the master cylinder area with denatured alcohol, or equivalent.
8. Dry the master cylinder with non-lubricated, filtered air.

Installation Procedure

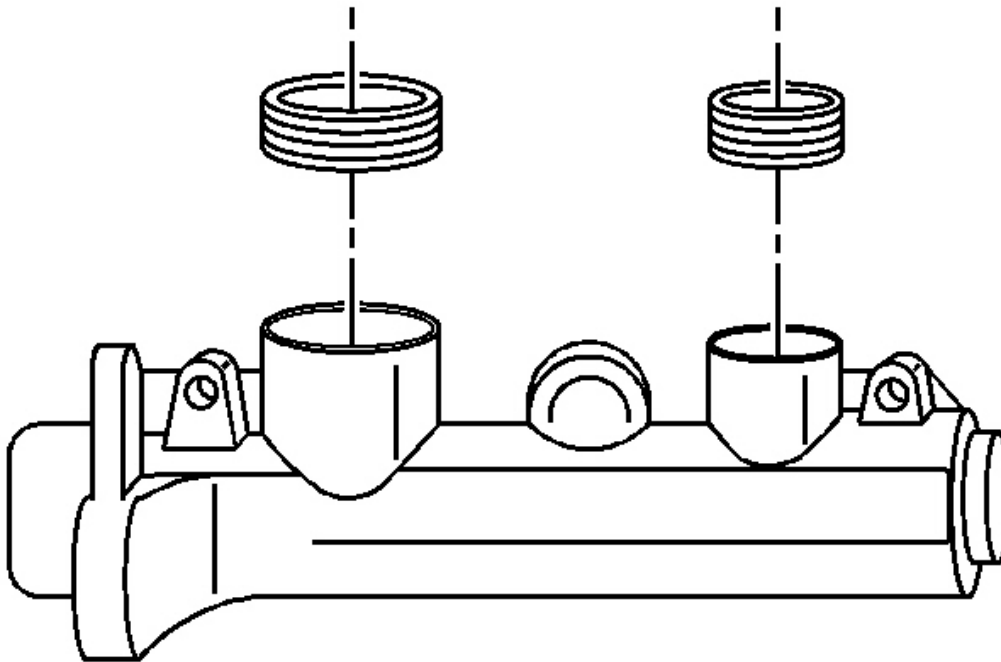


Fig. 15: Brake Master Cylinder Seals
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the new seals 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.
2. Install the lubricated seals, make sure that the seals are fully seated in the brake master cylinder.

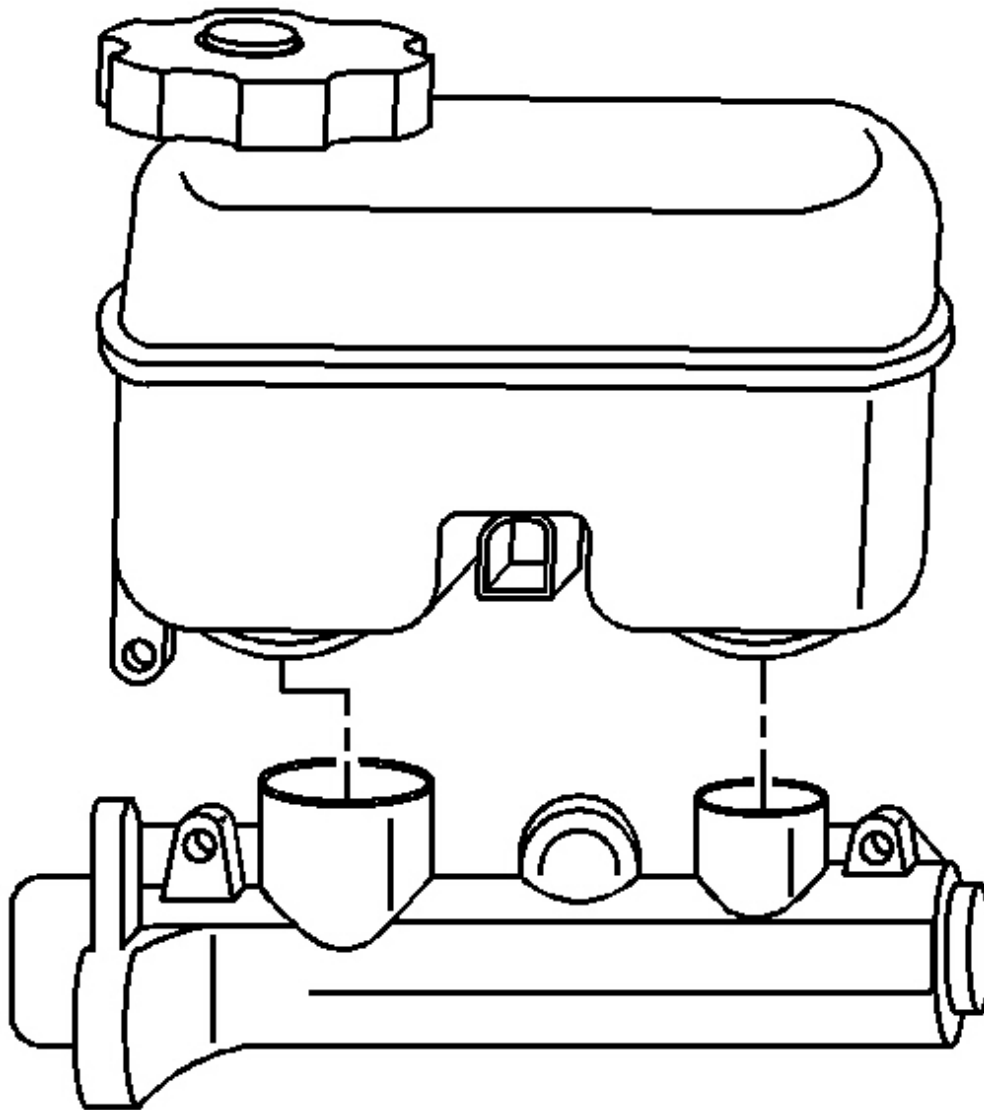


Fig. 16: Removing/Installing Reservoir And Brake Master Cylinder
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: When performing the following service procedure, apply equal pressure to ensure proper seating of the reservoir and the pin holes are aligned.

3. Install the reservoir to the brake master cylinder.

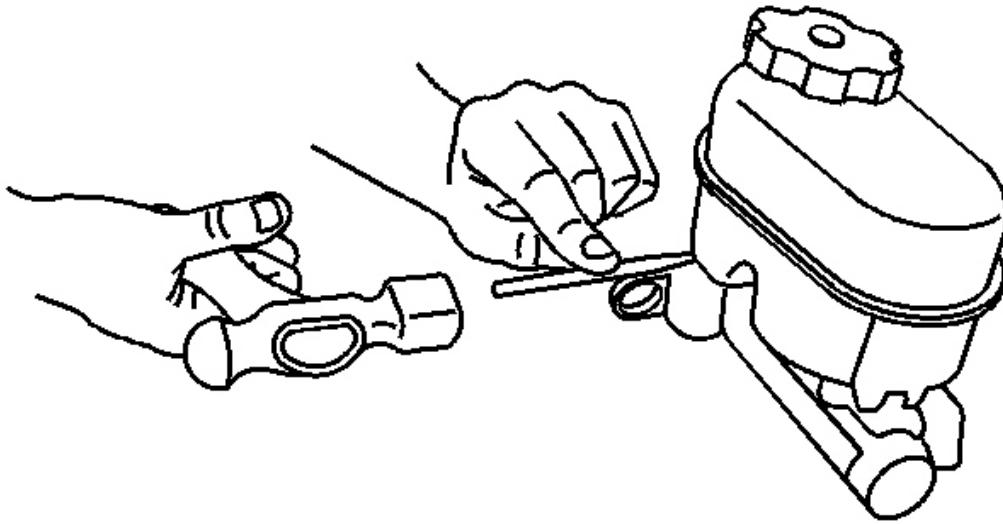


Fig. 17: Removing/Installing Brake Master Cylinder Reservoir Retaining Pins
Courtesy of GENERAL MOTORS CORP.

4. Install the reservoir retaining pins.

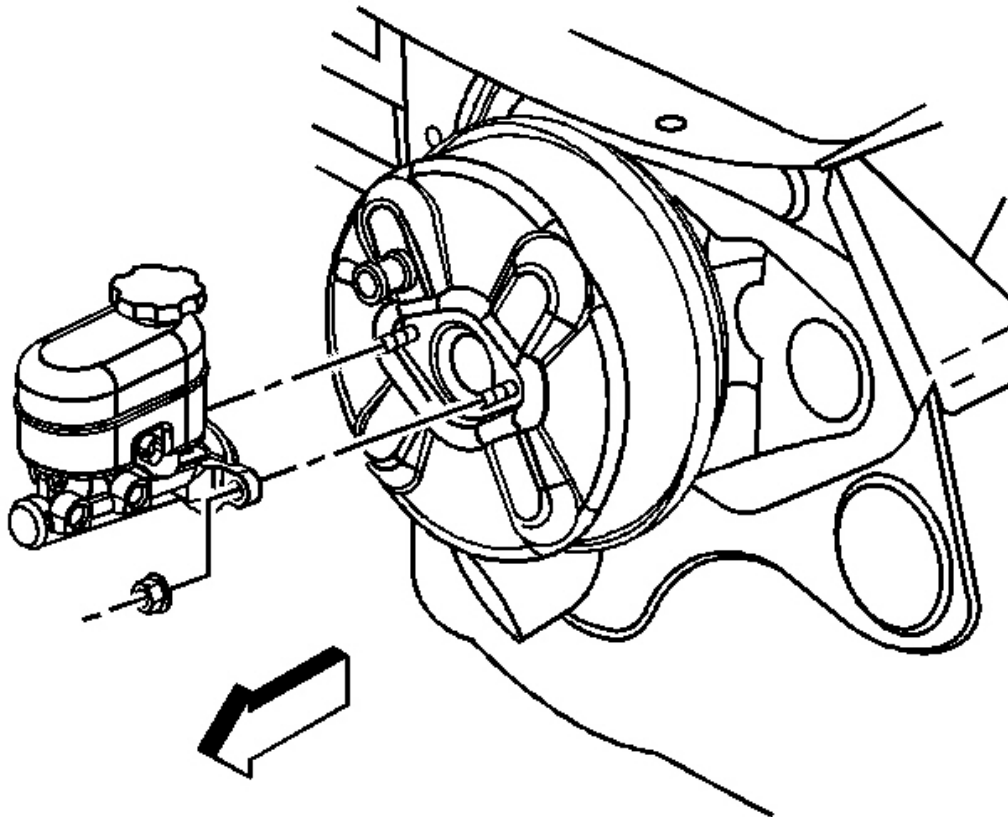


Fig. 18: Master Cylinder To Booster View
Courtesy of GENERAL MOTORS CORP.

5. Remove the brake master cylinder from the vise.
6. Install the brake master cylinder. Refer to **Master Cylinder Replacement**

MASTER CYLINDER REPLACEMENT

CAUTION: Refer to **Brake Fluid Irritant Caution** in Cautions and Notices.

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

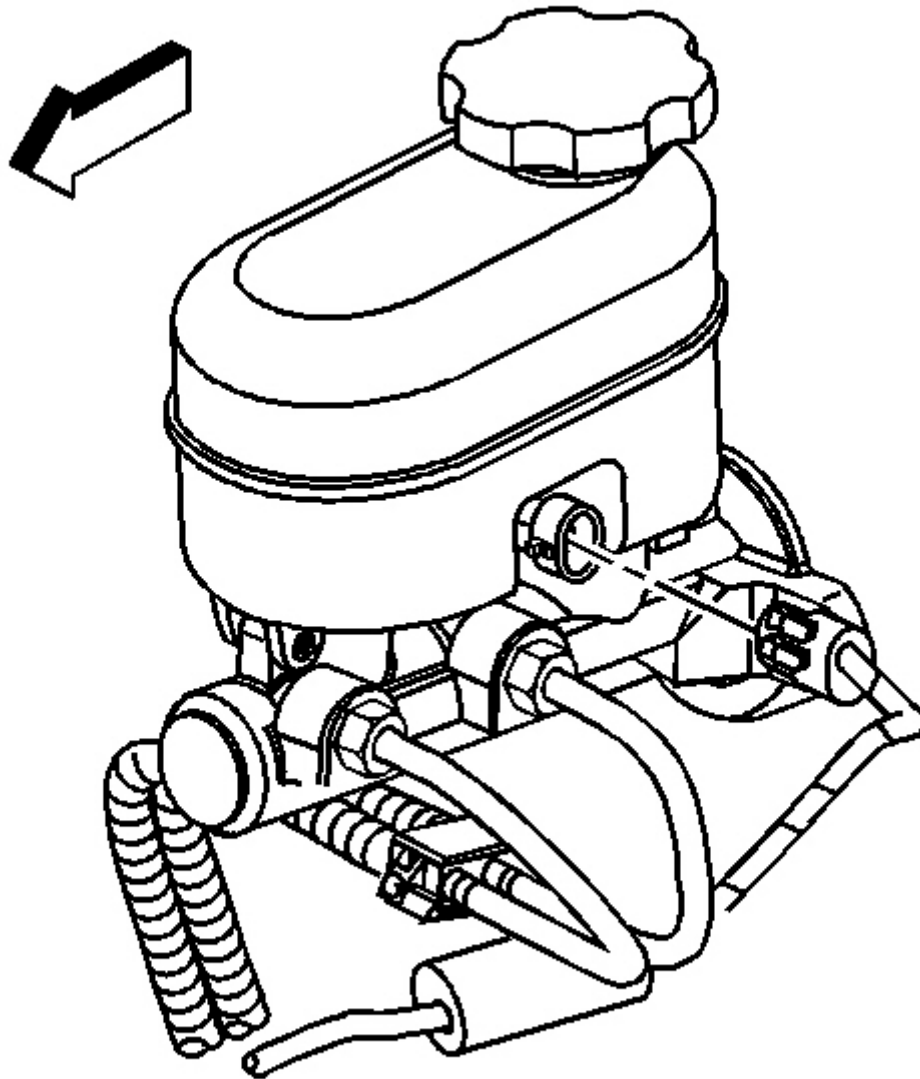


Fig. 19: Removing/Installing Master Cylinder Fluid Level Sensor Connector
Courtesy of GENERAL MOTORS CORP.

1. Apply the parking brake.
2. Disconnect the master cylinder fluid level sensor connector.

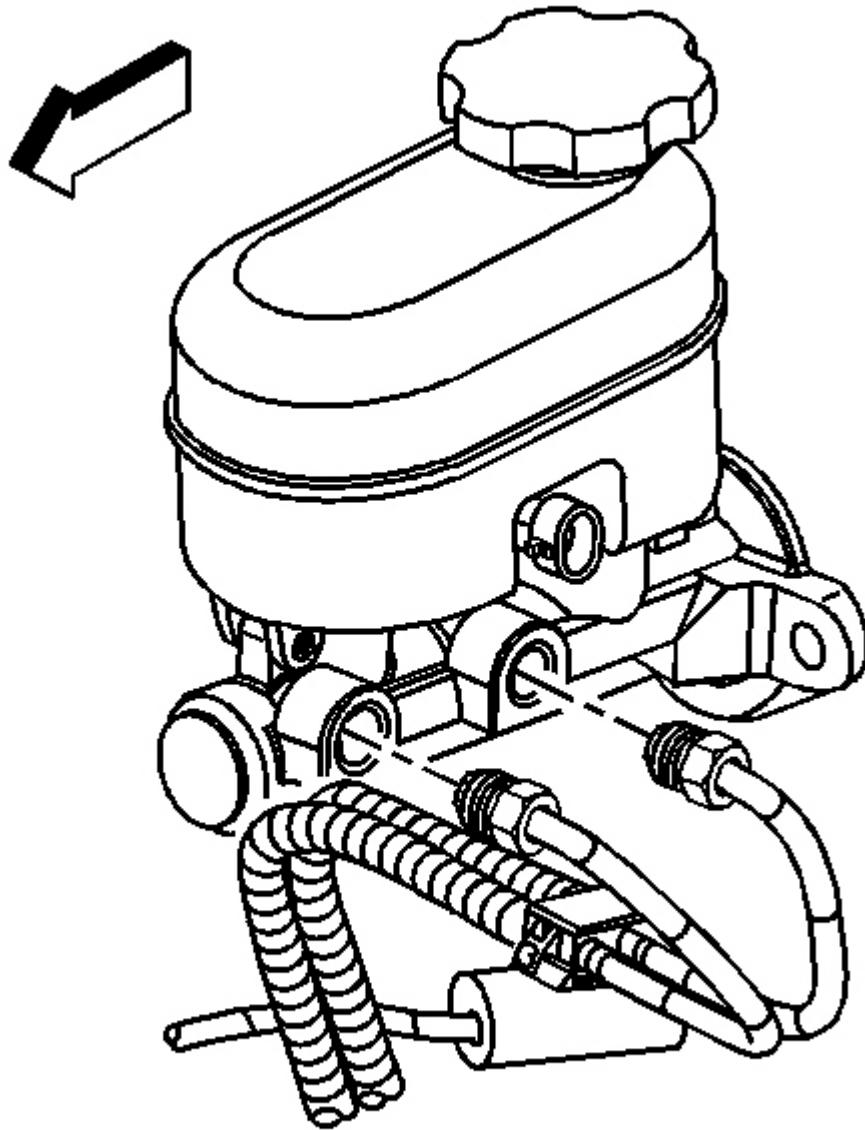


Fig. 20: Removing/Installing Master Cylinder Brake Pipes
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the brake pipes from the master cylinder.

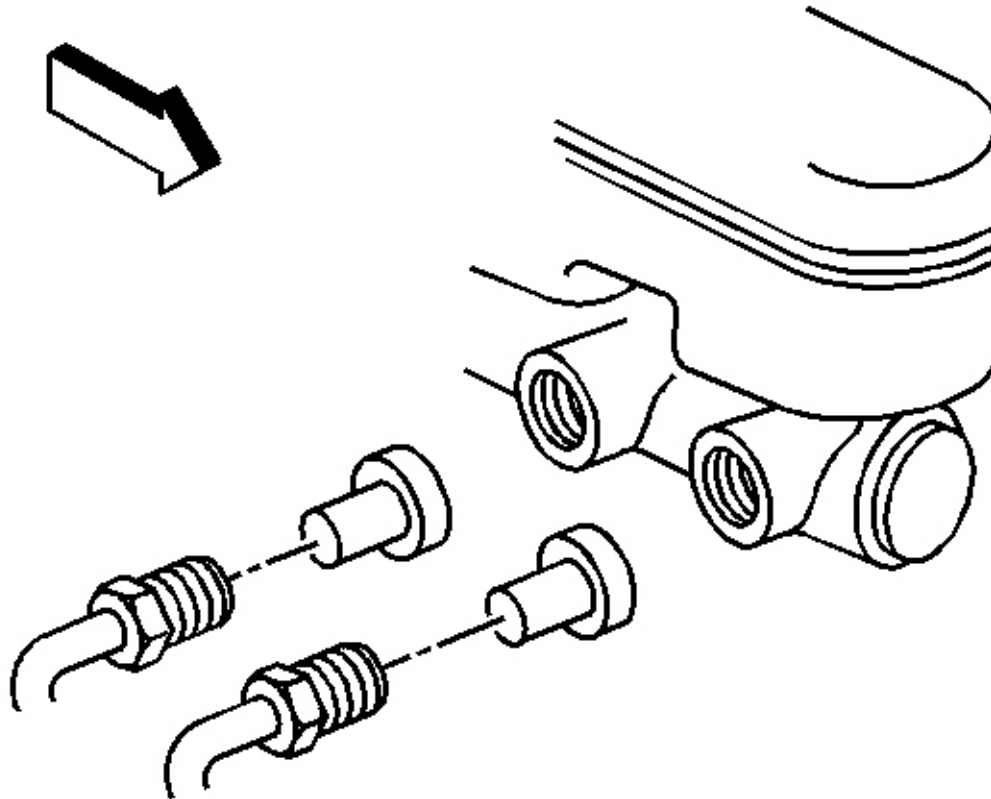


Fig. 21: Removing/Installing Rubber Caps
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install a rubber cap or plug to the exposed brake hose fitting ends in order to prevent brake fluid loss and contamination.

4. Plug the brake pipes.

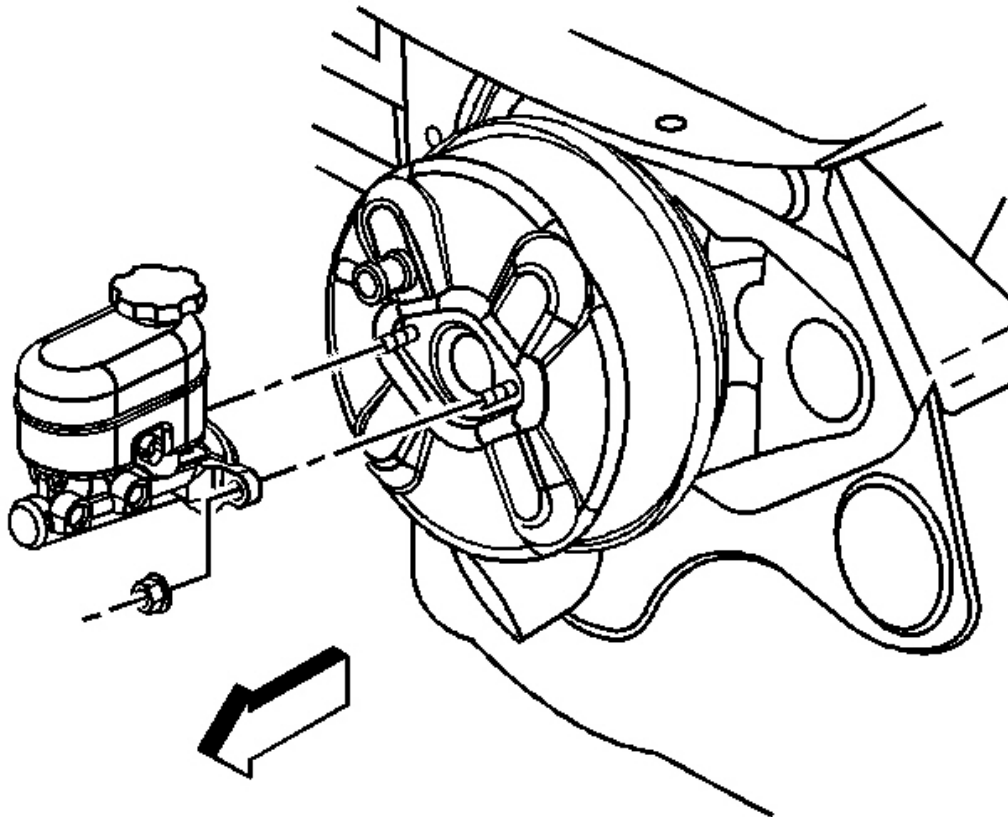


Fig. 22: Master Cylinder To Booster View
Courtesy of GENERAL MOTORS CORP.

5. Remove the master cylinder mounting nuts.
6. Remove the master cylinder assembly.
7. Drain the master cylinder of brake fluid.

Installation Procedure

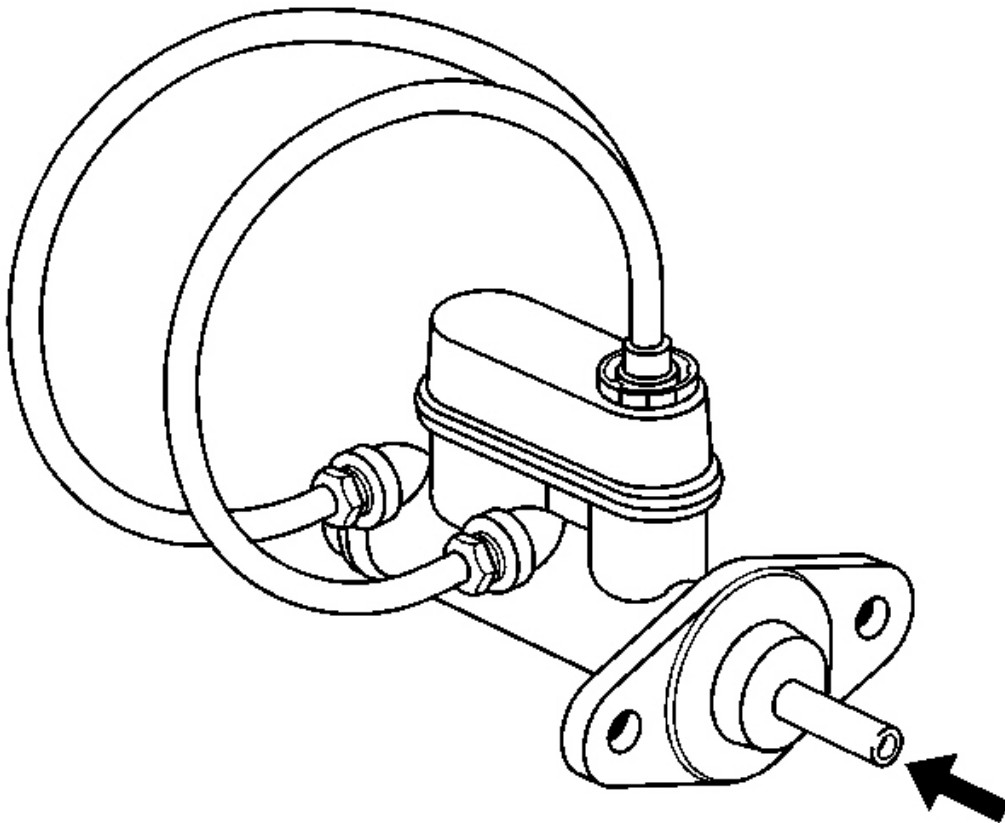


Fig. 23: Bleeding Master Cylinder
Courtesy of GENERAL MOTORS CORP.

1. Bench bleed the master cylinder. Refer to **Master Cylinder Bench Bleeding**.

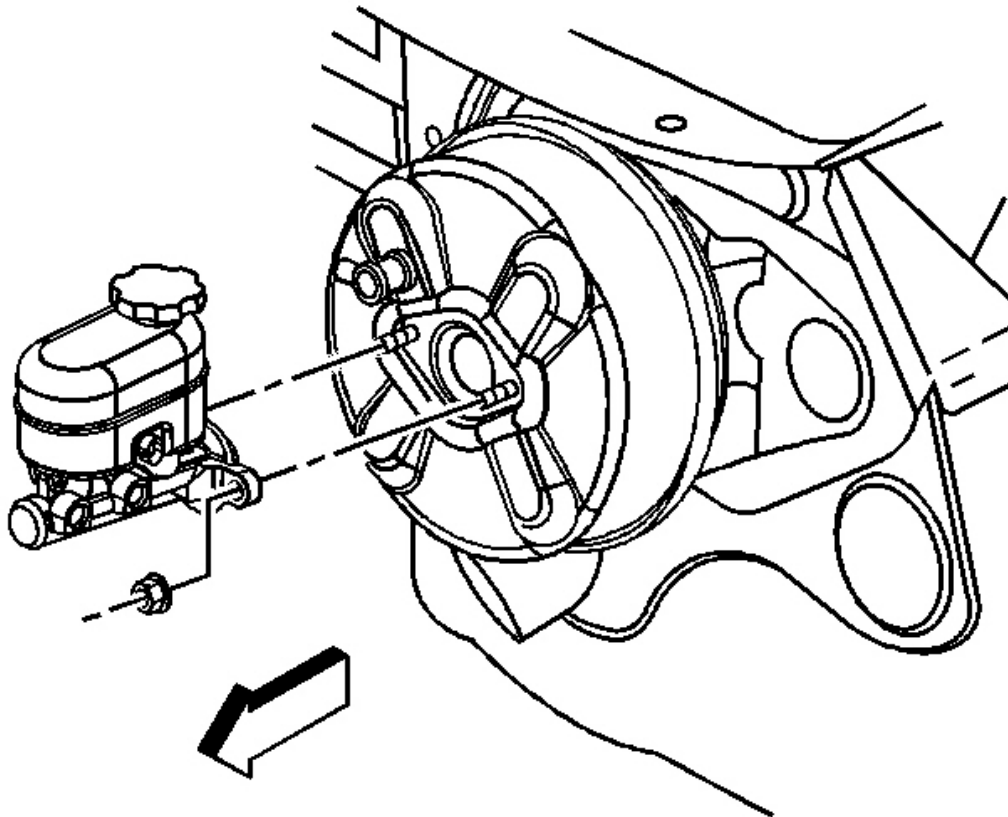


Fig. 24: Master Cylinder To Booster View
Courtesy of GENERAL MOTORS CORP.

2. Install the master cylinder assembly.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Install the master cylinder mounting nuts.

Tighten: Tighten the master cylinder mounting nuts to 36 N.m (27 lb ft).

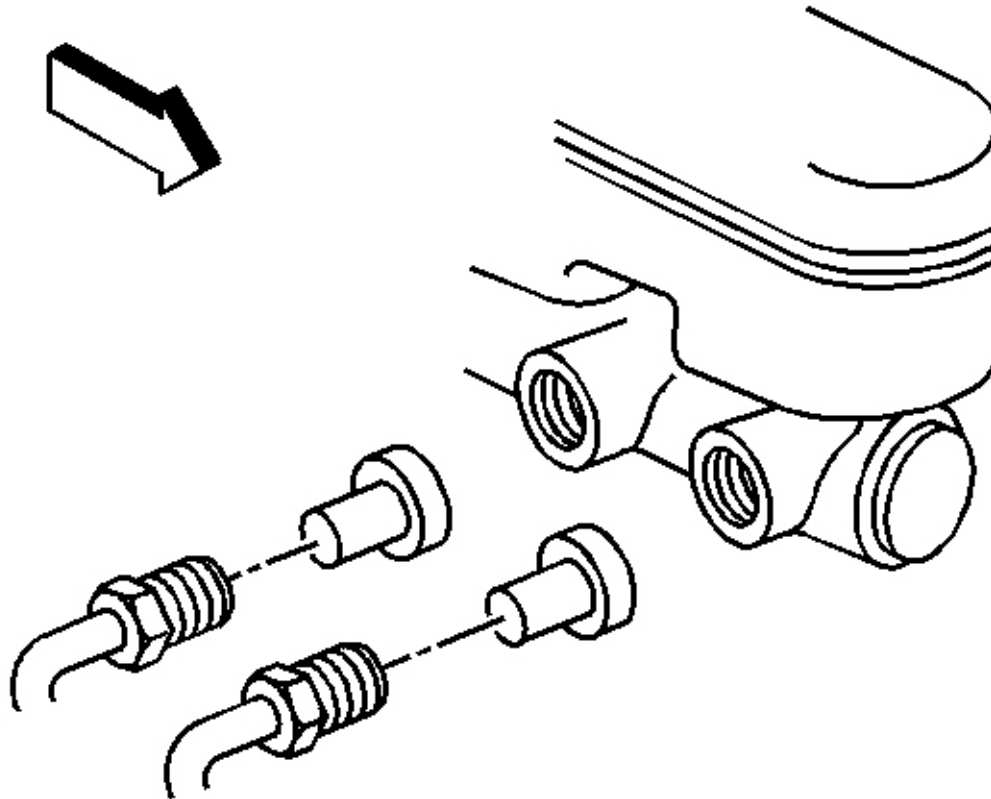


Fig. 25: Removing/Installing Rubber Caps
Courtesy of GENERAL MOTORS CORP.

4. Remove the rubber plugs from the brake lines.

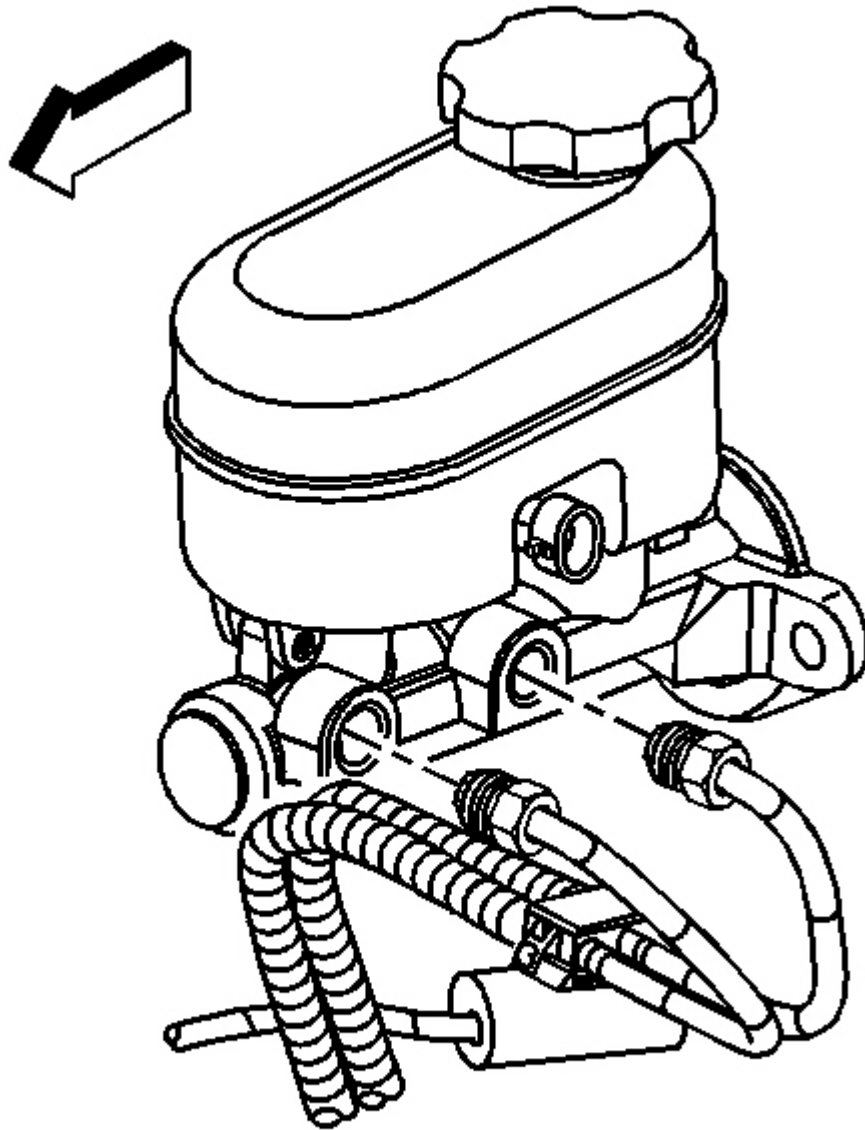


Fig. 26: Removing/Installing Master Cylinder Brake Pipes
Courtesy of GENERAL MOTORS CORP.

5. Connect the brake pipes.

Tighten: Tighten the brake pipe fittings to 17 N.m (13 lb ft).

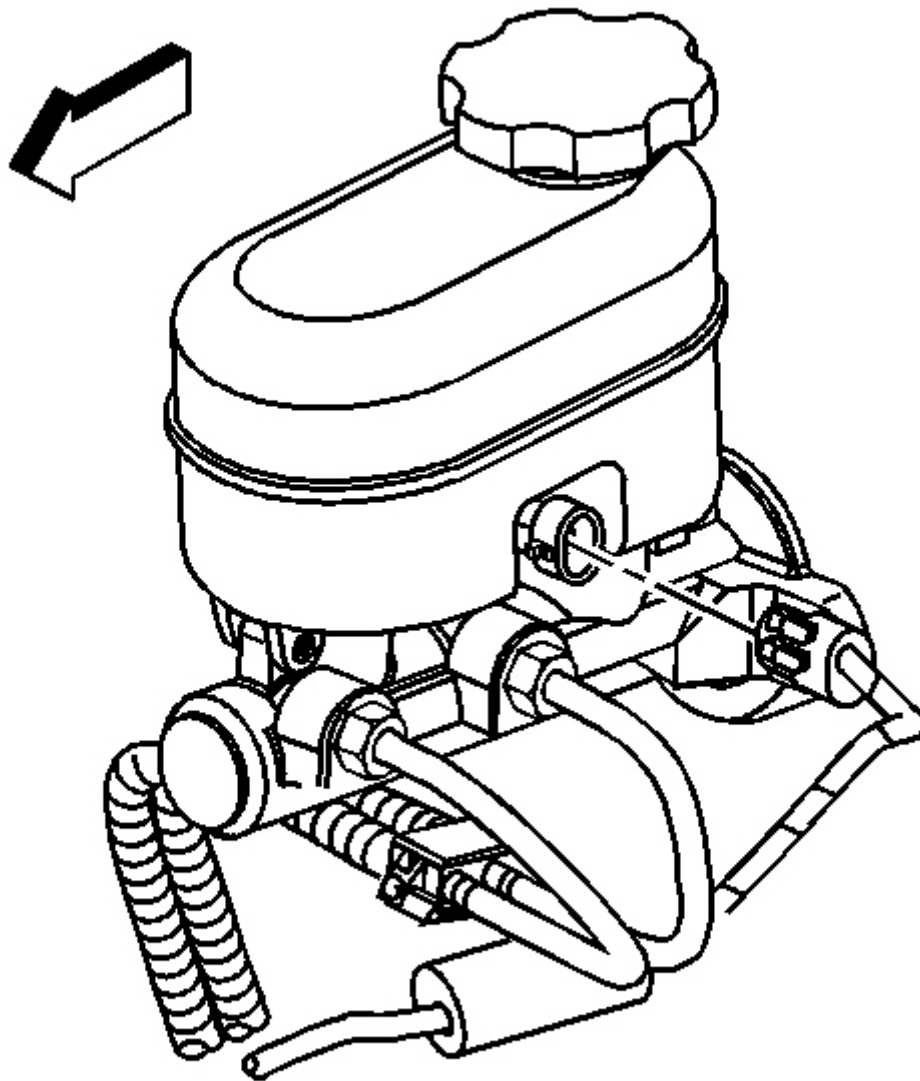


Fig. 27: Removing/Installing Master Cylinder Fluid Level Sensor Connector
Courtesy of GENERAL MOTORS CORP.

6. Connect the master cylinder fluid level sensor connector.
7. Bleed the hydraulic brakes system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.

MASTER CYLINDER OVERHAUL

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

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

Disassembly Procedure

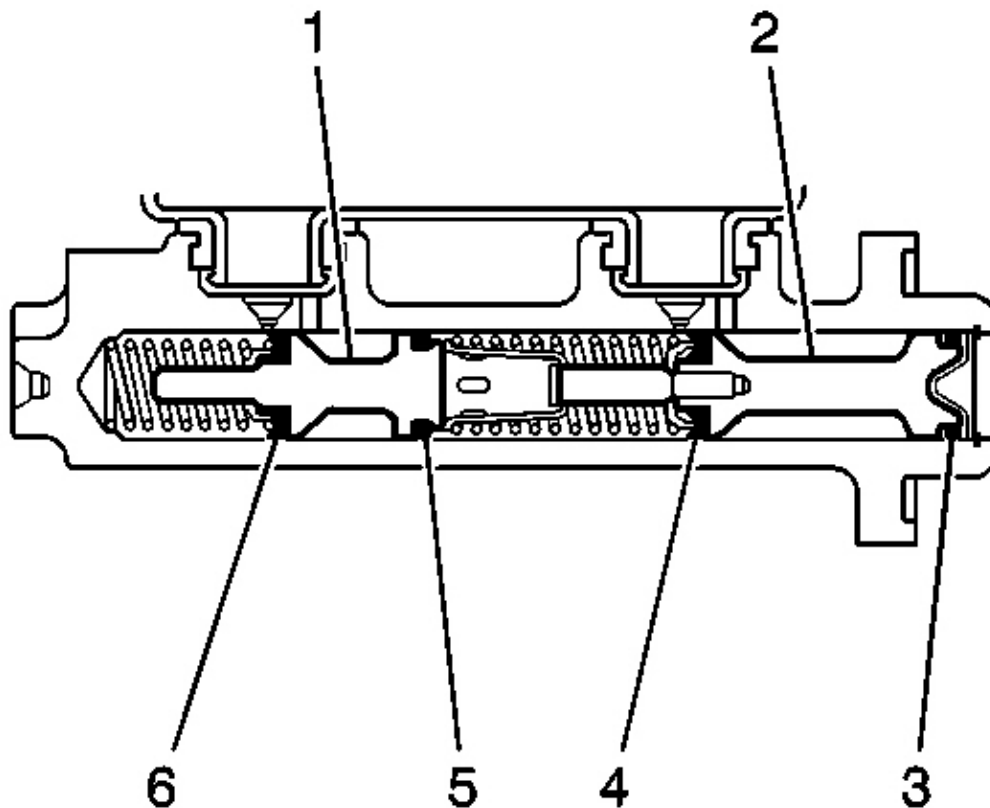


Fig. 28: Cross Sectional View Of Brake Master Cylinder
Courtesy of GENERAL MOTORS CORP.

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.

Assembly Procedure

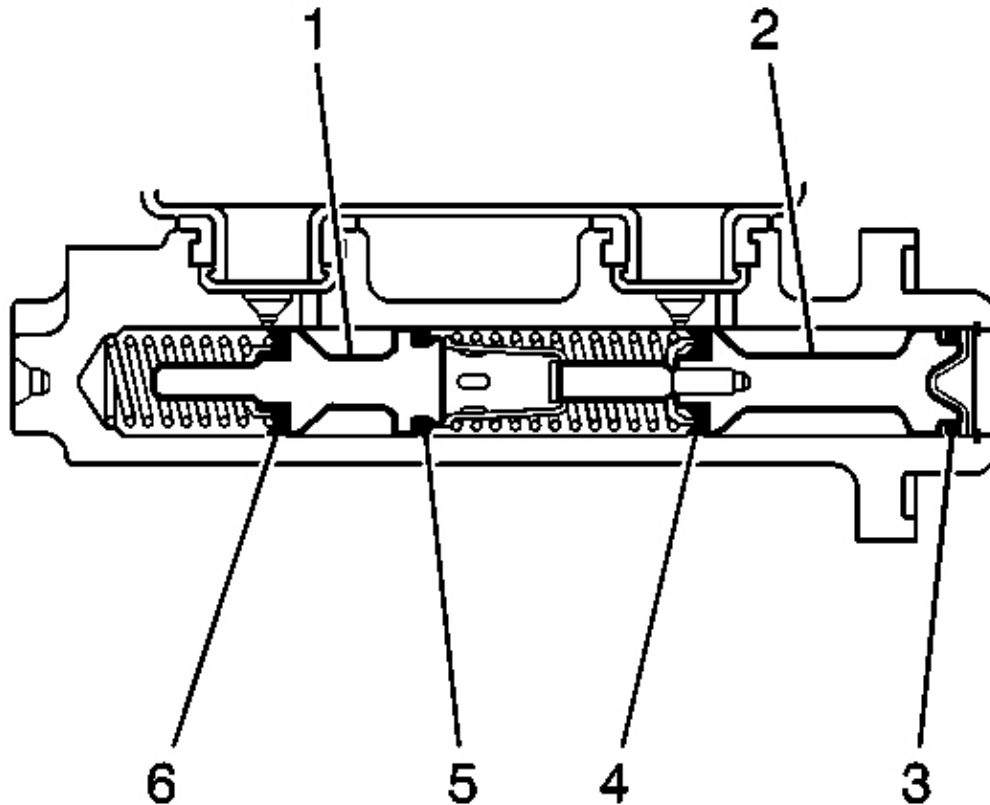


Fig. 29: Cross Sectional View Of Brake Master Cylinder
Courtesy of GENERAL MOTORS CORP.

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

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

- 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** in Cautions and Notices.

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

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.

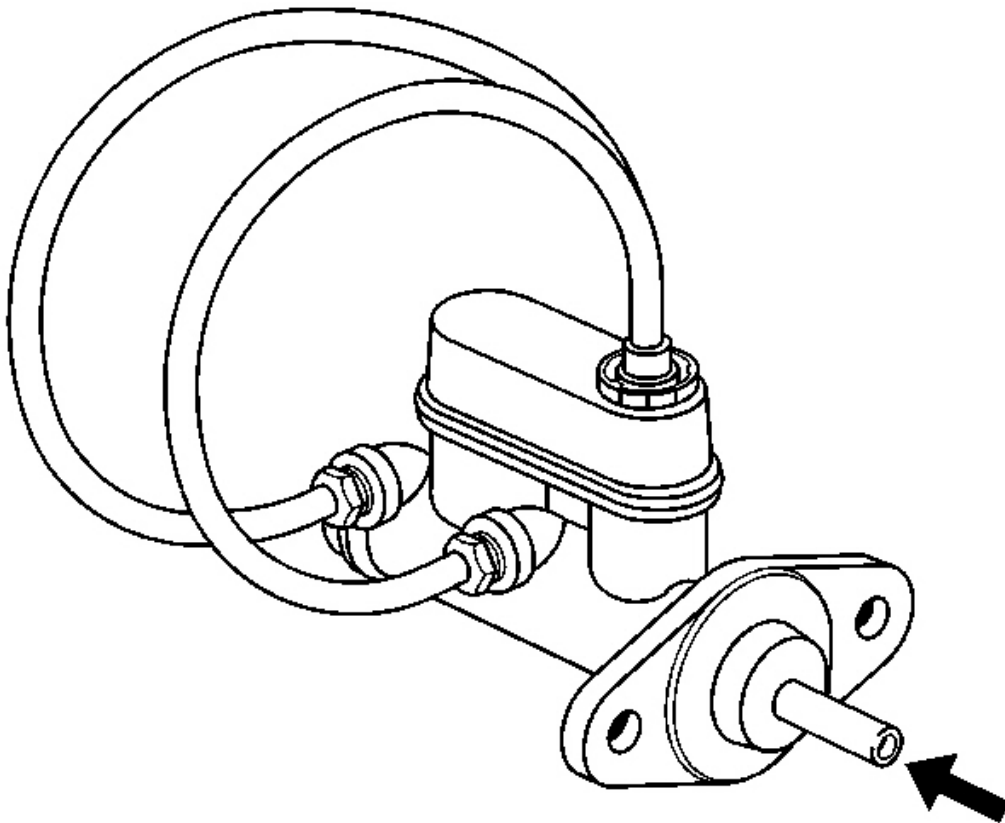


Fig. 30: Bleeding Master Cylinder
Courtesy of GENERAL MOTORS CORP.

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.

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

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.

MASTER CYLINDER FLUID LEVEL SENSOR REPLACEMENT

Removal Procedure

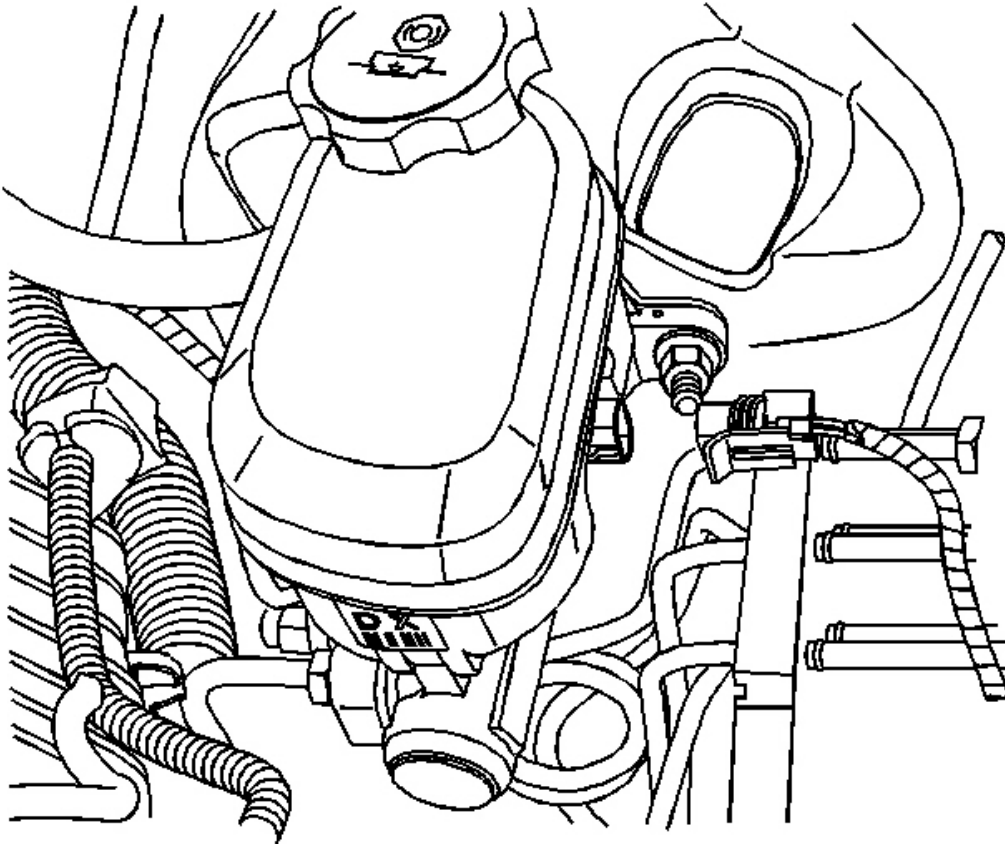


Fig. 31: Fluid Level Sensor View
Courtesy of GENERAL MOTORS CORP.

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

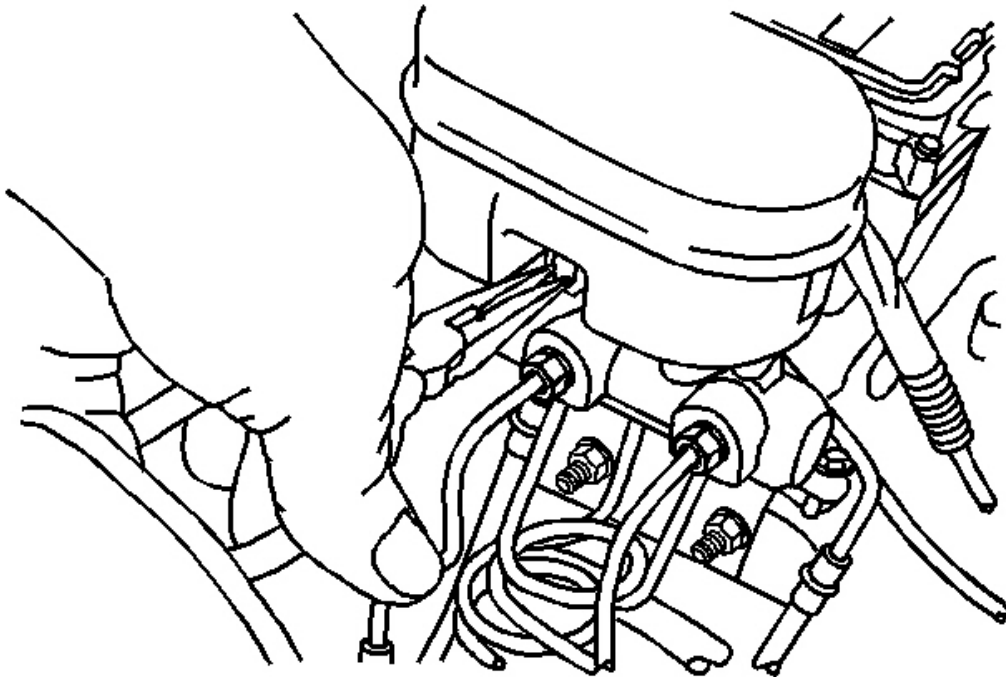


Fig. 32: Compressing Locking Tabs For Fluid Sensor
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: When performing the following service procedure, it is **NOT** necessary to drain the master cylinder reservoir.

2. Using pair of needle nose pliers, compress the locking tabs for the fluid sensor located at the opposite side of the master cylinder.

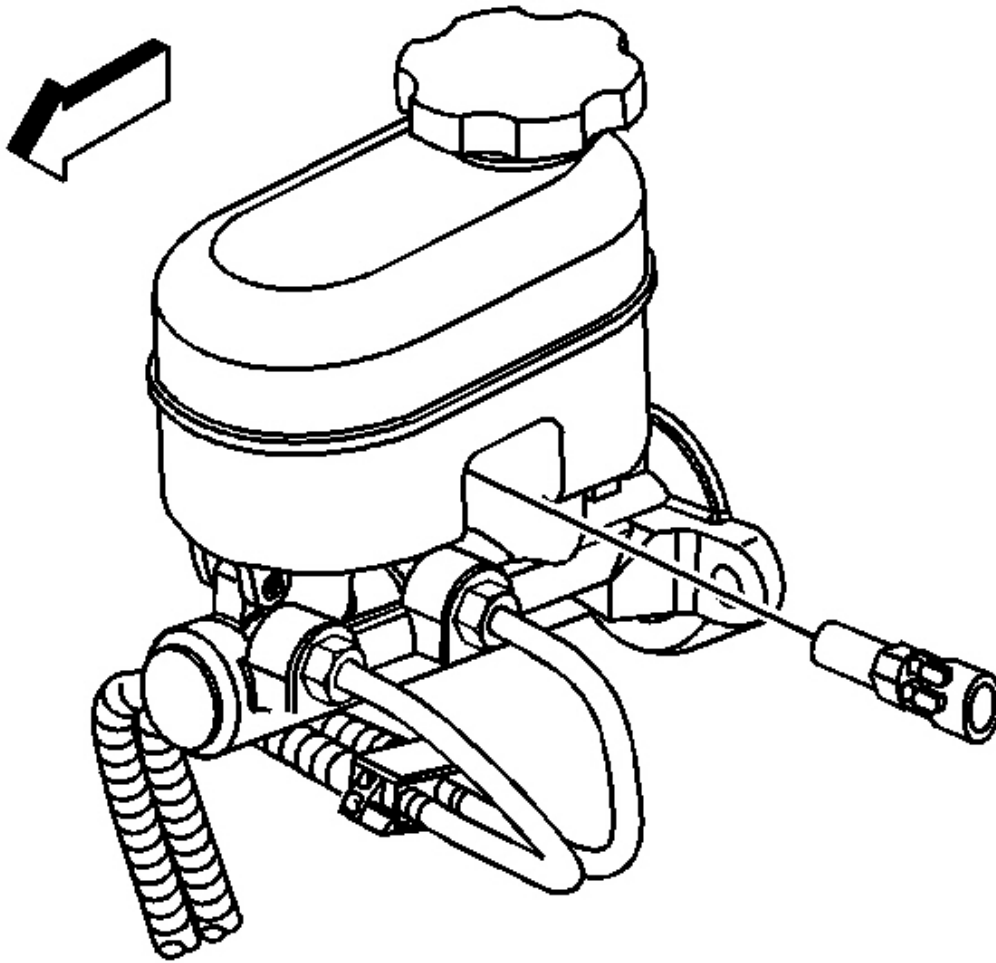


Fig. 33: Fluid Level Sensor Removed From Master Cylinder Reservoir
Courtesy of GENERAL MOTORS CORP.

3. Remove the fluid level sensor from the master cylinder reservoir.

Installation Procedure

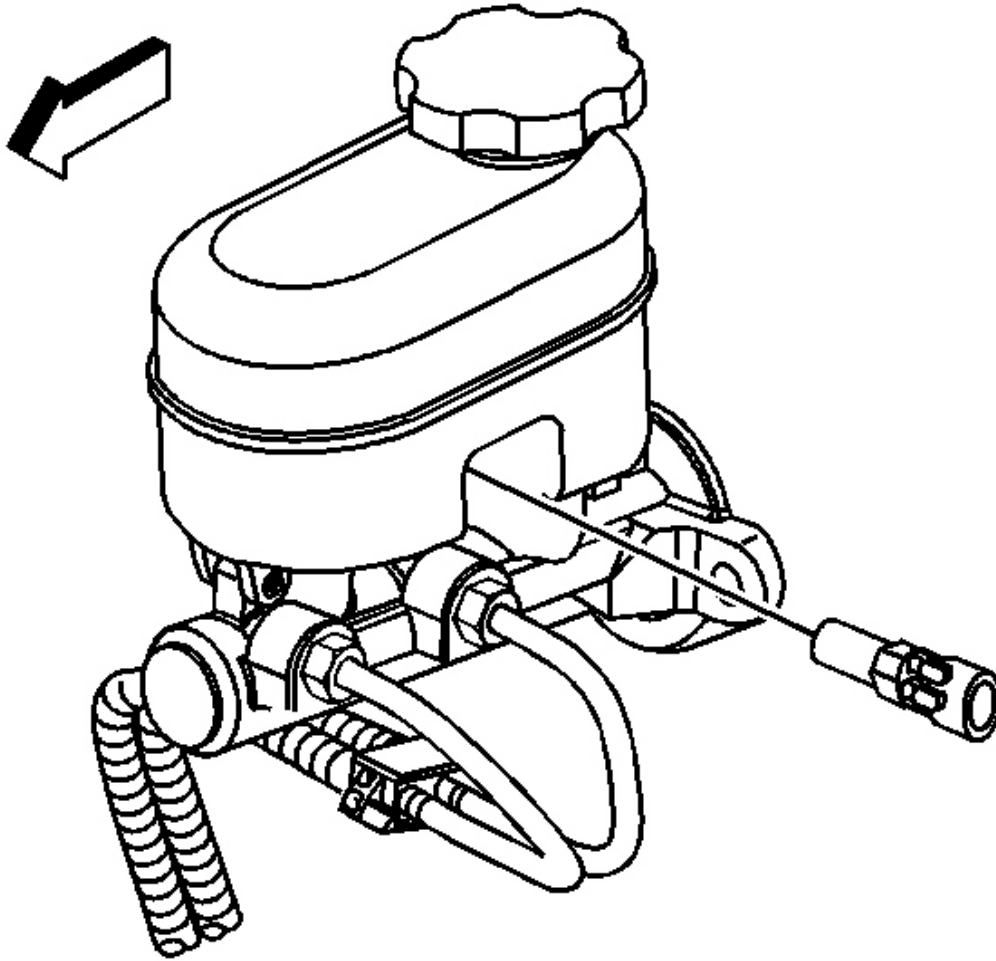


Fig. 34: Fluid Level Sensor Removed From Master Cylinder Reservoir
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure that the fluid sensor is fully seated before releasing the snap ring.

1. Install the fluid level sensor.

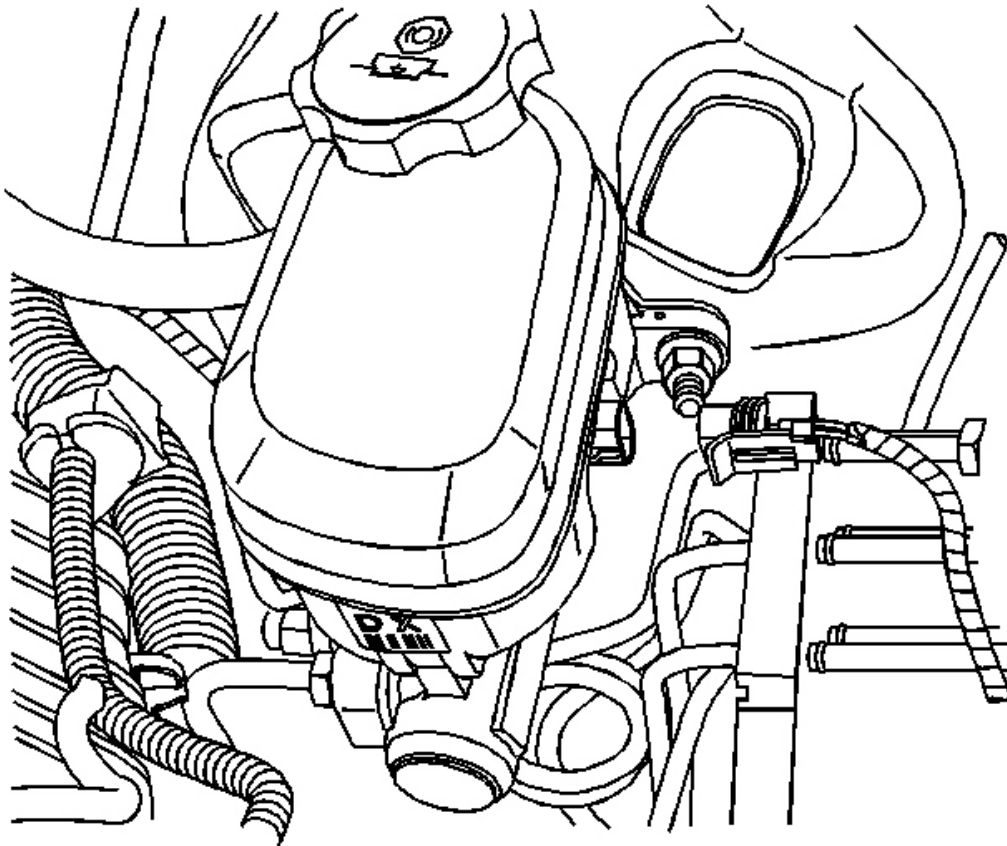


Fig. 35: Fluid Level Sensor View
Courtesy of GENERAL MOTORS CORP.

2. Install the electrical connector to the fluid level sensor.

BRAKE PEDAL ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the closeout/insulator panel. Refer to **Closeout/Insulator Panel Replacement - Left** in Instrument Panel, Gages, and Console.
2. Remove the stoplamp switch from the brake pedal. Refer to **Stop Lamp Switch Replacement** in Lighting Systems.

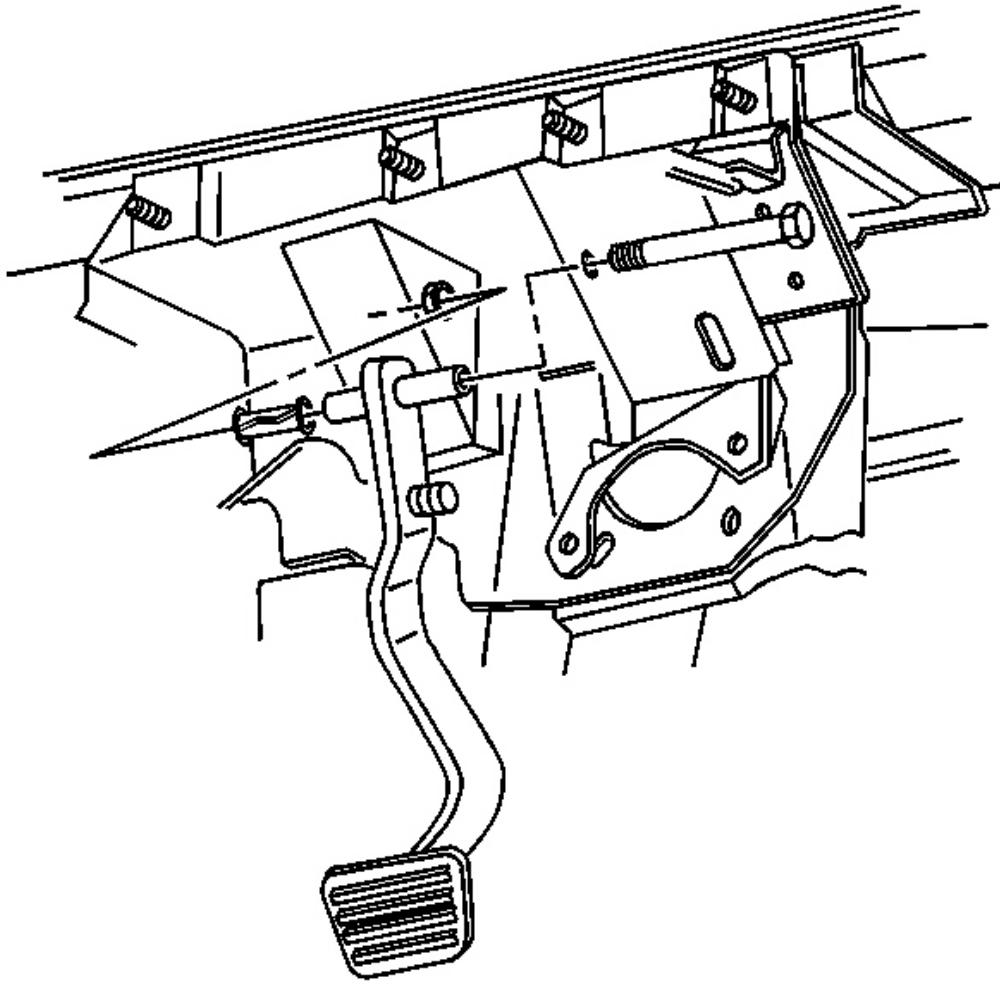


Fig. 36: Brake Pedal And Pivot Bolt Removed
Courtesy of GENERAL MOTORS CORP.

3. Remove the brake pedal pivot bolt and discard the bolt.
4. Remove the brake pedal.
5. Inspect the brake pedal pivot bushing for damage or wear.

Installation Procedure

1. If the brake pedal pivot bushing is damaged or worn, replace the bushing using the following procedure:

1. Squeeze the end that will be facing the brake pedal pivot nut.
2. Insert the bushing into the pivot hub just enough to hold the bushing in place.
3. Push the bushing through the hub until the bushing snaps in place.

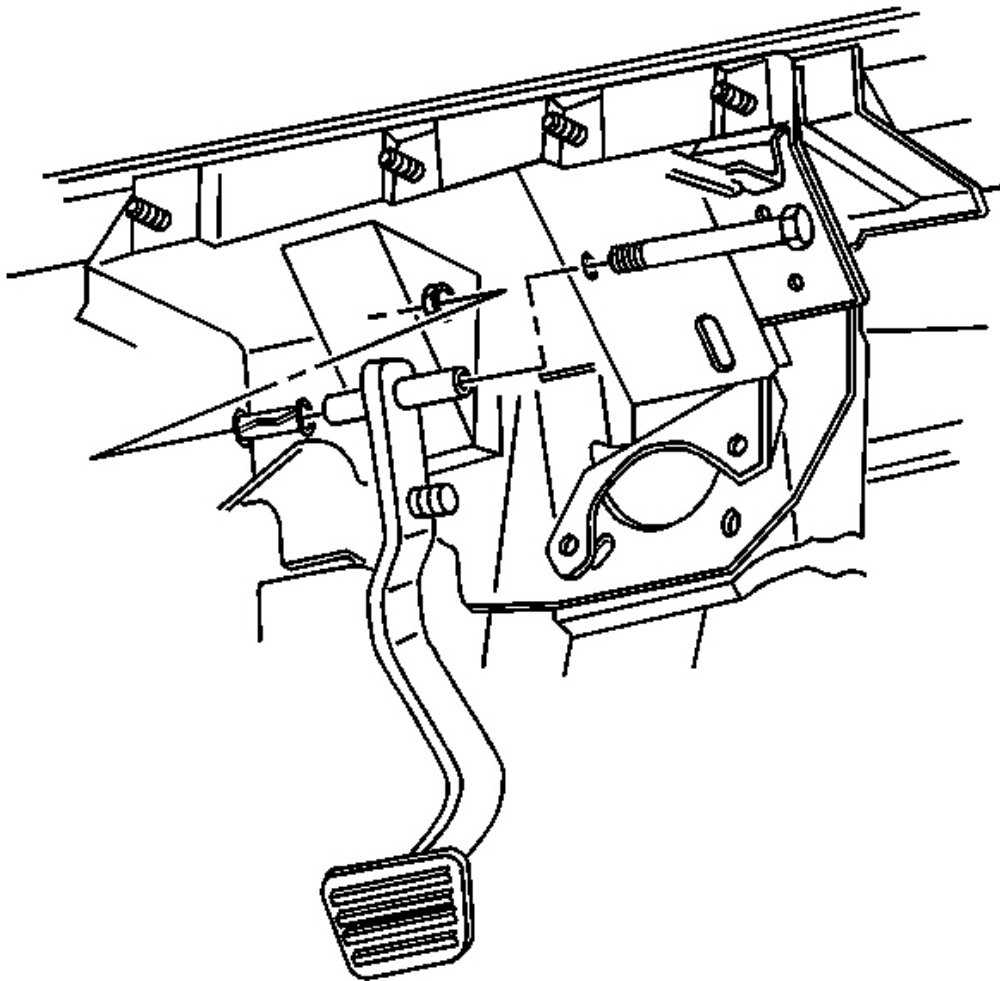


Fig. 37: Brake Pedal And Pivot Bolt Removed
Courtesy of GENERAL MOTORS CORP.

2. Install the brake pedal.

NOTE: Refer to Fastener Notice in Cautions and Notices.

IMPORTANT: The brake pedal pivot bolt is a prevailing torque bolt and must be replaced each time the bolt is removed.

3. Install the new brake pedal pivot bolt and the brake pedal pivot nut.

Tighten: Tighten the brake pedal pivot bolt to 25 N.m (19 lb ft).

4. Install the stoplamp switch to the brake pedal. Refer to Stop Lamp Switch Replacement in Lighting Systems.
5. Install the closeout/insulator panel. Refer to Closeout/Insulator Panel Replacement - Left in Instrument Panel, Gages, and Console.

BRAKE PIPE REPLACEMENT

Tools Required

J 45405 Brake Pipe Flaring Kit. See Special Tools.

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

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 in Cautions and Notices.

IMPORTANT: When servicing the brake pipes, note the following:

- If sectioning the 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.

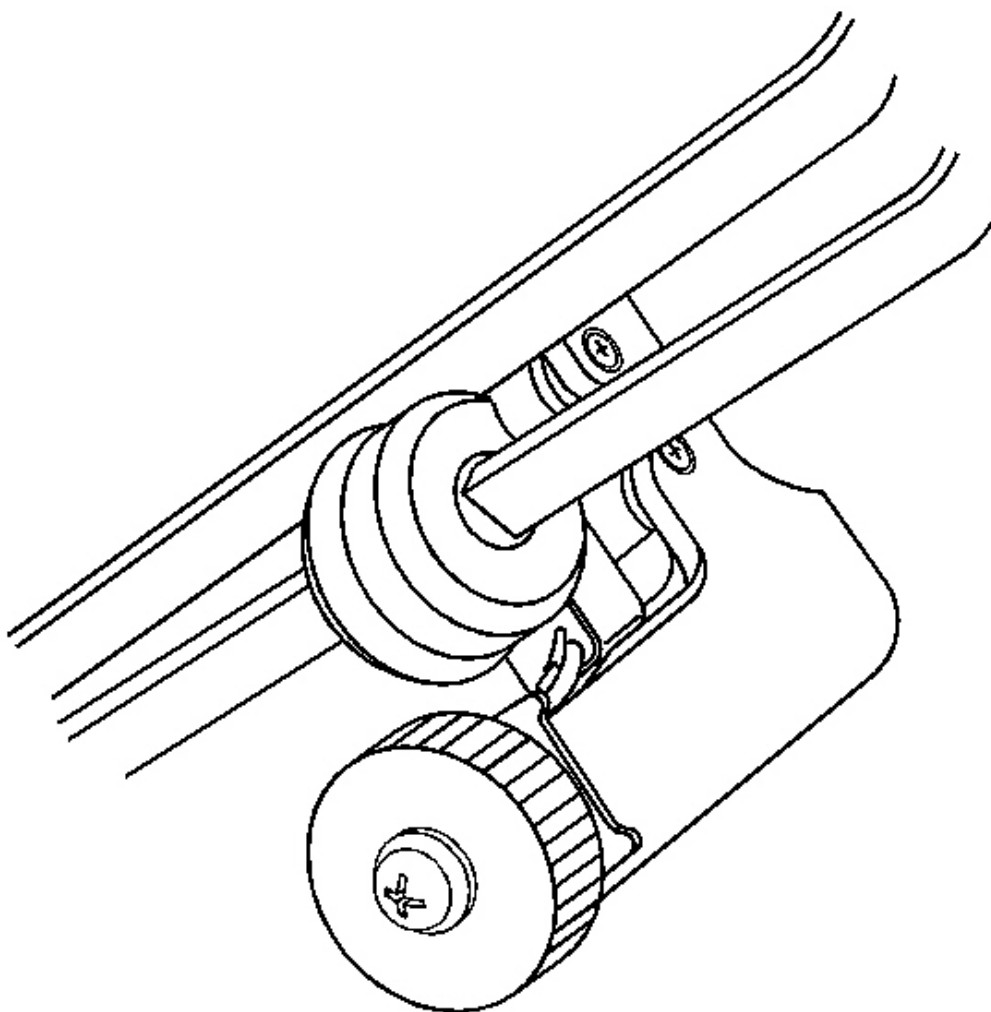


Fig. 38: Sectioning Brake Pipe Using Pipe Cutter
Courtesy of GENERAL MOTORS CORP.

1. Inspect the area of brake pipe to be repaired or 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**.

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

- 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
- 9.50 mm (0.374 in) for 6.35 mm (1/4 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.

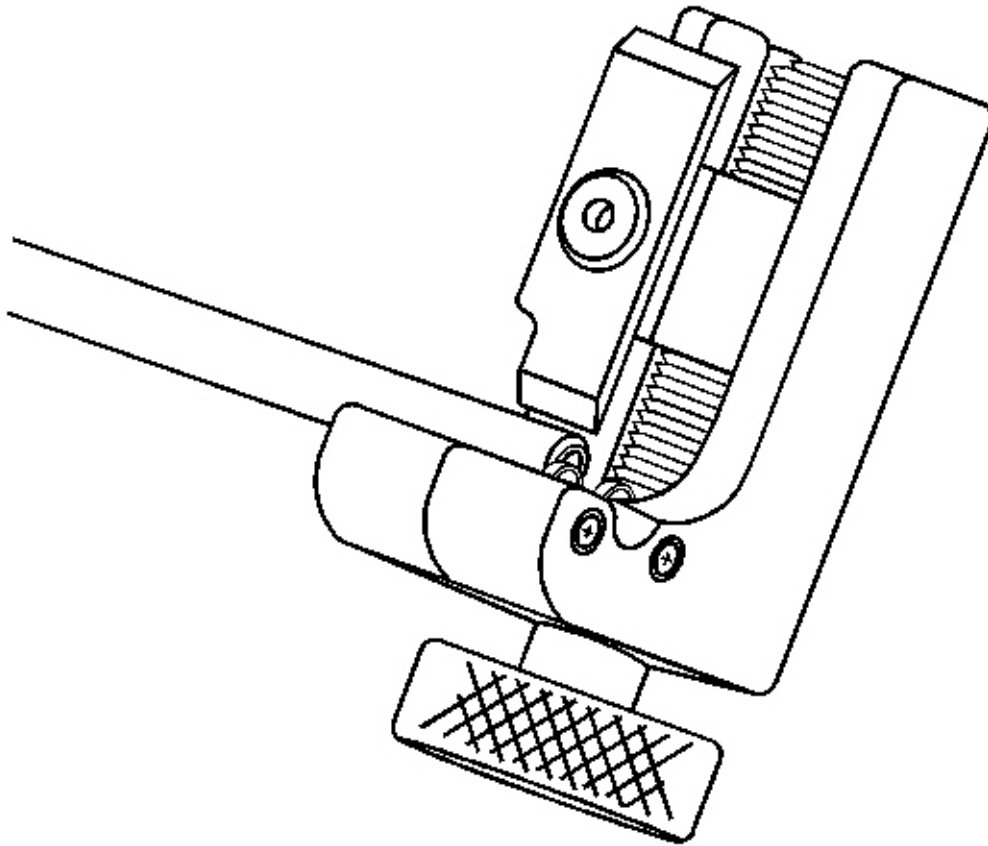


Fig. 39: Stripping Nylon Coating From Brake Pipe Ends
Courtesy of GENERAL MOTORS CORP.

9. Strip the nylon coating from the brake pipe end 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
 - 9.50 mm (0.374 in) blade for 6.35 mm (1/4 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
- 9.50 mm (0.374 in) for 6.35 mm (1/4 in) diameter pipe

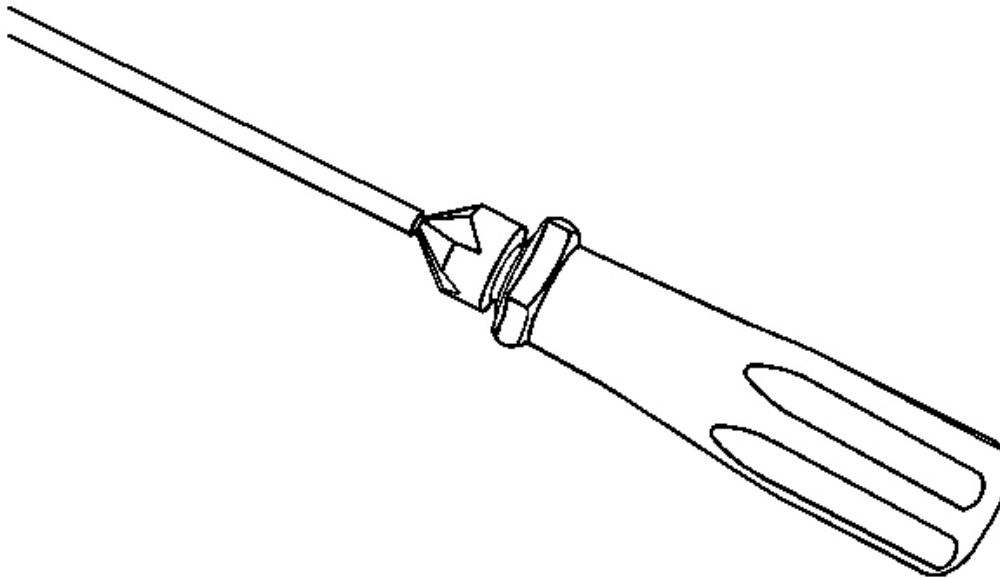


Fig. 40: Chamfering Pipe Using De-Burring Tool
Courtesy of GENERAL MOTORS CORP.

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**.

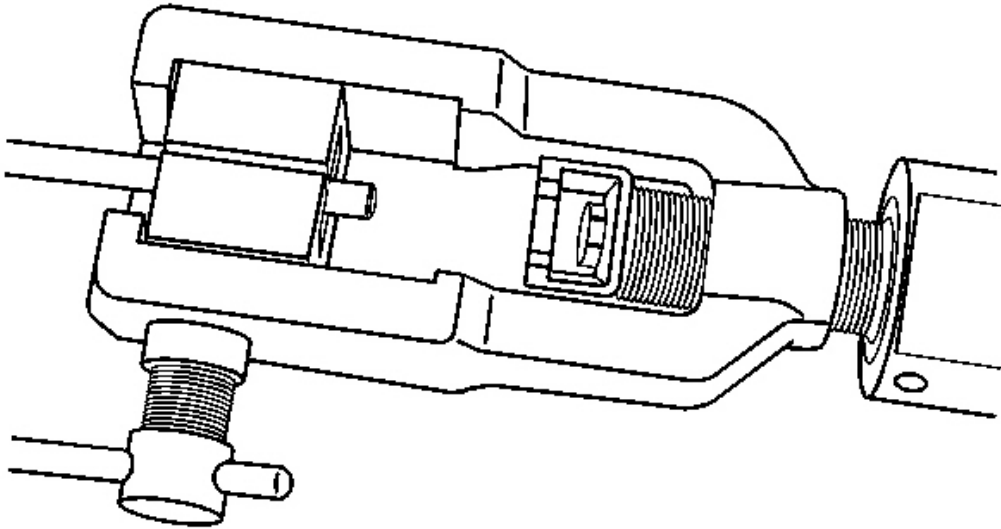


Fig. 41: Installing Die Halves Into Die Cage
Courtesy of GENERAL MOTORS CORP.

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.

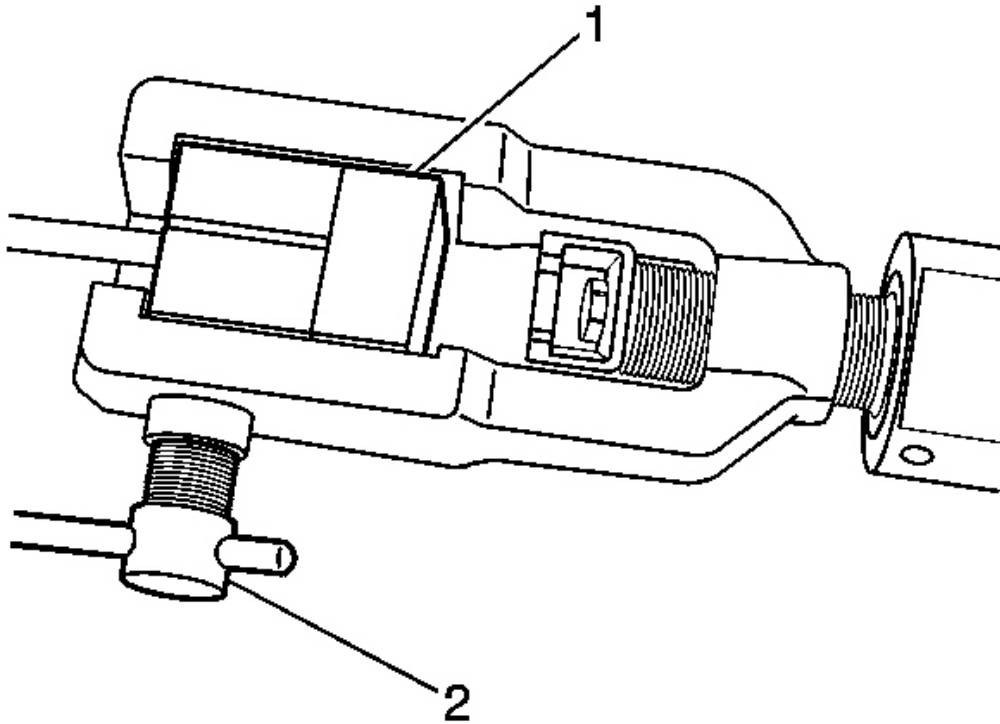


Fig. 42: View Of Clamping Screw & Unused Die
Courtesy of GENERAL MOTORS CORP.

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.

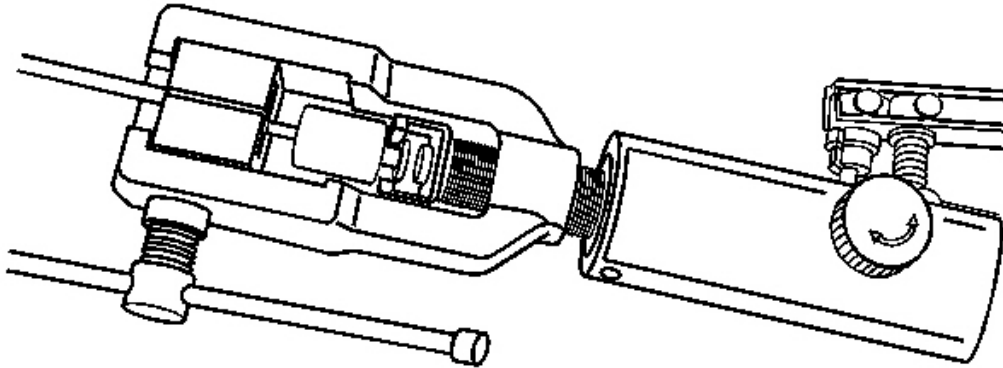


Fig. 43: Rotating J 45405 To Bottom Against Die Cage
Courtesy of GENERAL MOTORS CORP.

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**.

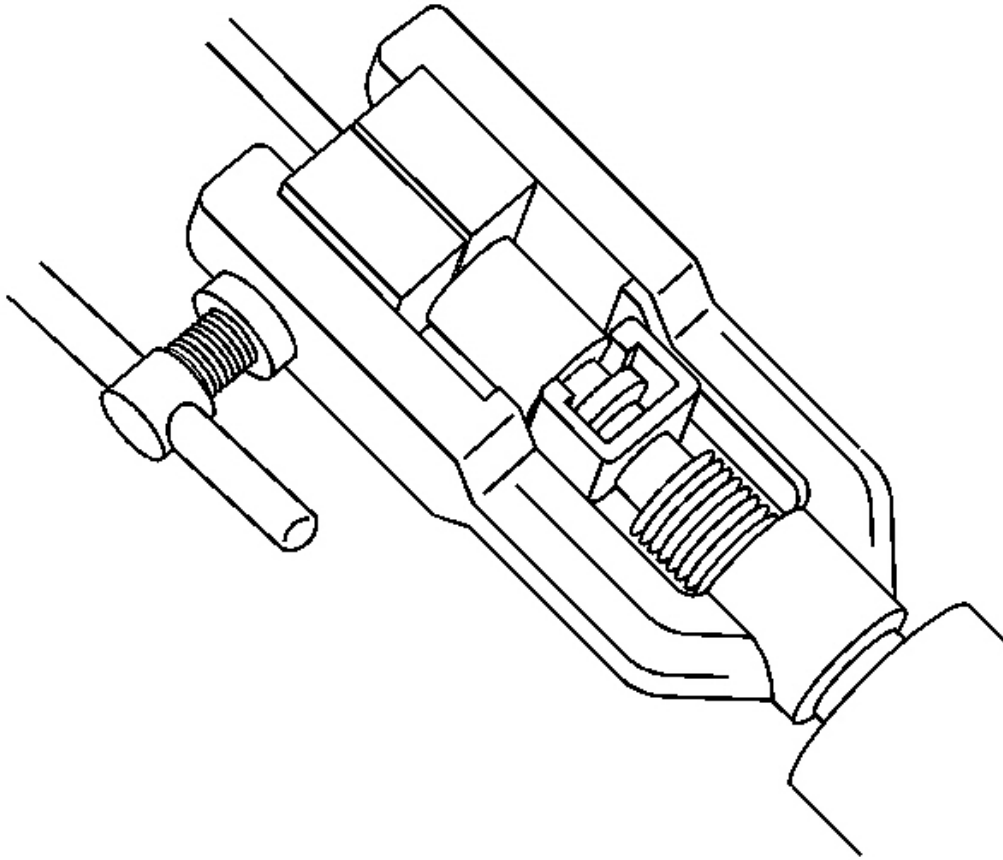


Fig. 44: Bottoming Forming Mandrel Against Clamping Dies Using Pipe Flaring Tool

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.

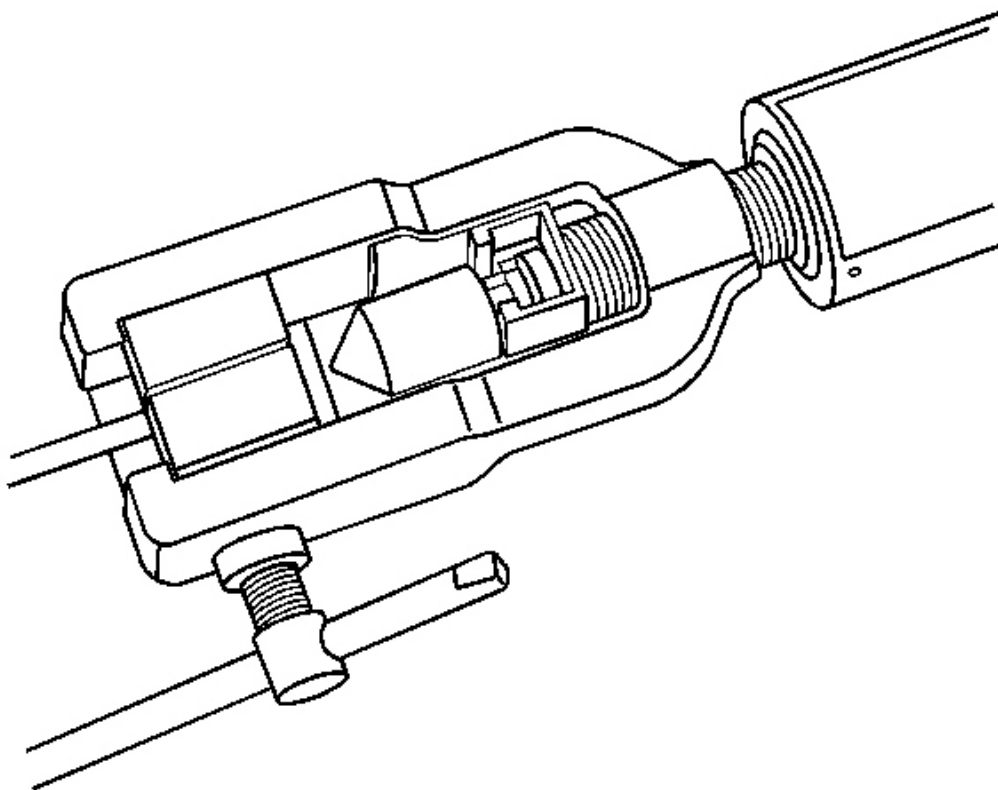


Fig. 45: Using Pipe Flaring Tool
Courtesy of GENERAL MOTORS CORP.

25. Insert the finishing cone into the forming ram.
26. Rotate the hydraulic fluid control valve clockwise to the closed position.
27. Rotate the body of the **J 45405** until it bottoms against the die cage. See **Special Tools**.
28. While guiding the finishing cone into the exposed end of pipe to be flared, operate the lever of the **J 45405** until the finishing cone bottoms against the dies. See **Special Tools**.
29. Rotate the hydraulic fluid control valve counterclockwise to the open position to allow the hydraulic forming ram to retract.
30. Loosen the die clamping screw and remove the dies and pipe.
31. If necessary, lightly tap the dies until the die halves separate.

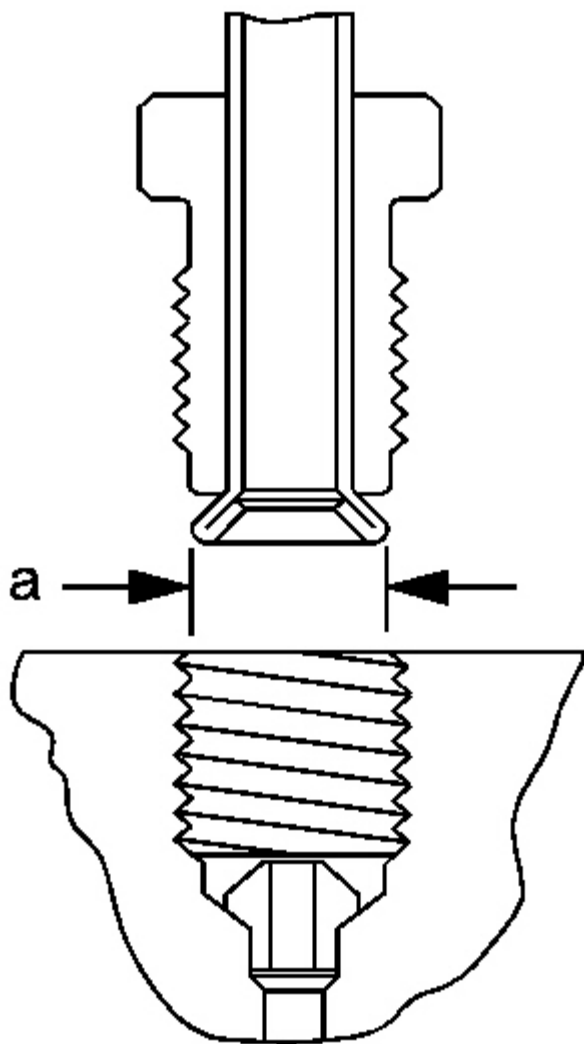


Fig. 46: Identifying Correct Brake Pipe Flare Shape & Diameter
Courtesy of GENERAL MOTORS CORP.

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

Specification:

- 6.92 mm (0.272 in) +/- 0.18 mm (0.007 in) flare diameter for 4.76 mm (3/16 in) diameter pipe

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

- 8.92 mm (0.351 in) +/- 0.18 mm (0.007 in) flare diameter for 6.35 mm (1/4 in) diameter pipe

33. If necessary, using the removed section of brake 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.

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

BRAKE HOSE REPLACEMENT - FRONT

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

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

Removal Procedure

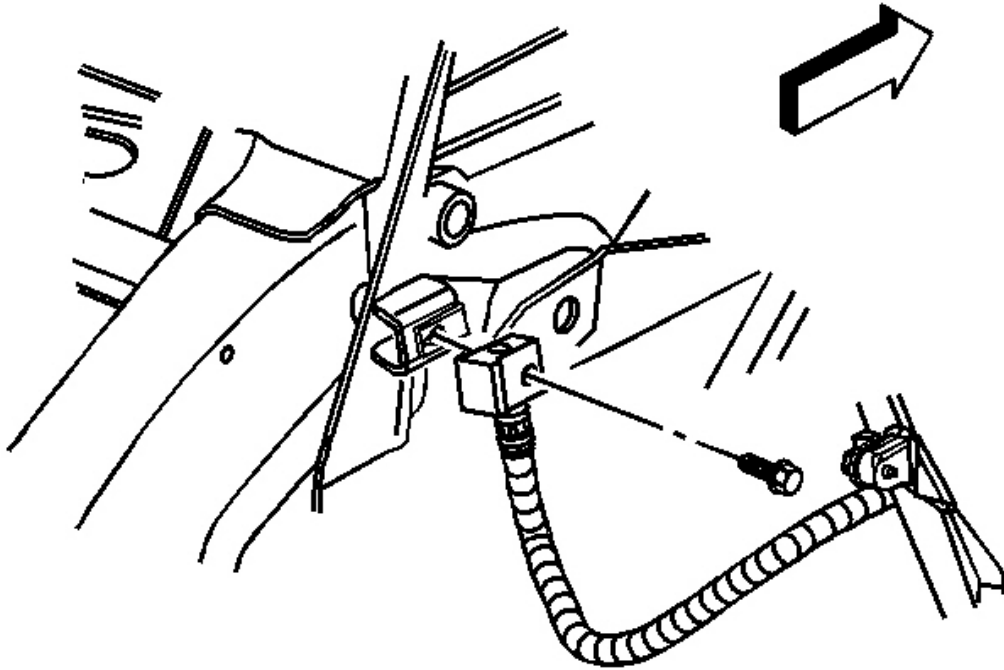


Fig. 47: Brake Hose Retaining Bolt Removed From Frame
Courtesy of GENERAL MOTORS CORP.

1. Remove the brake hose retaining bolt from the frame.

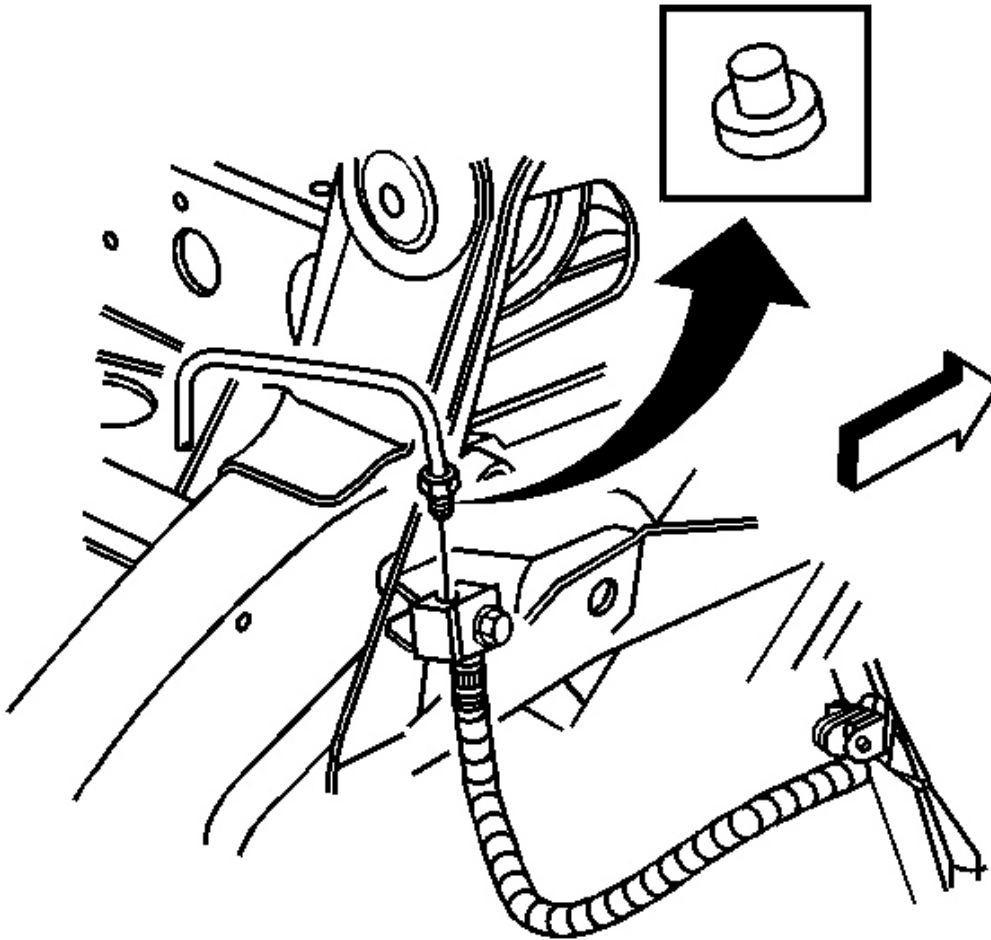


Fig. 48: Brake Pipe Fitting Plug/Rubber Cap Removed
Courtesy of GENERAL MOTORS CORP.

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

2. Install a rubber cap or plug on the brake pipe fitting.

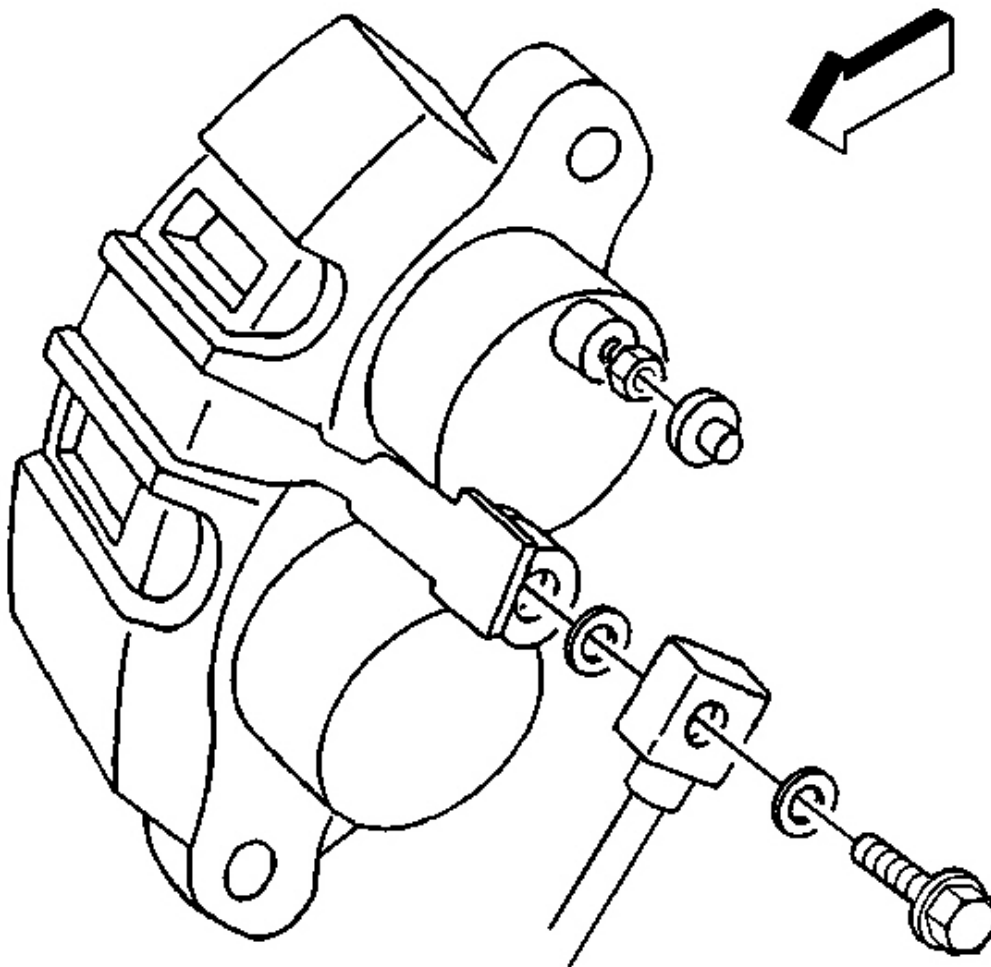


Fig. 49: View Of Banjo Fitting To Caliper
Courtesy of GENERAL MOTORS CORP.

3. Remove the brake hose bolt from the brake caliper assembly.
4. Remove the brake hose from the vehicle.

IMPORTANT: The metal gaskets may be stuck to either the brake caliper or the brake hose end. Ensure that these gaskets are removed from the brake hose end and the brake caliper.

5. Remove and discard the copper gaskets.

Installation Procedure

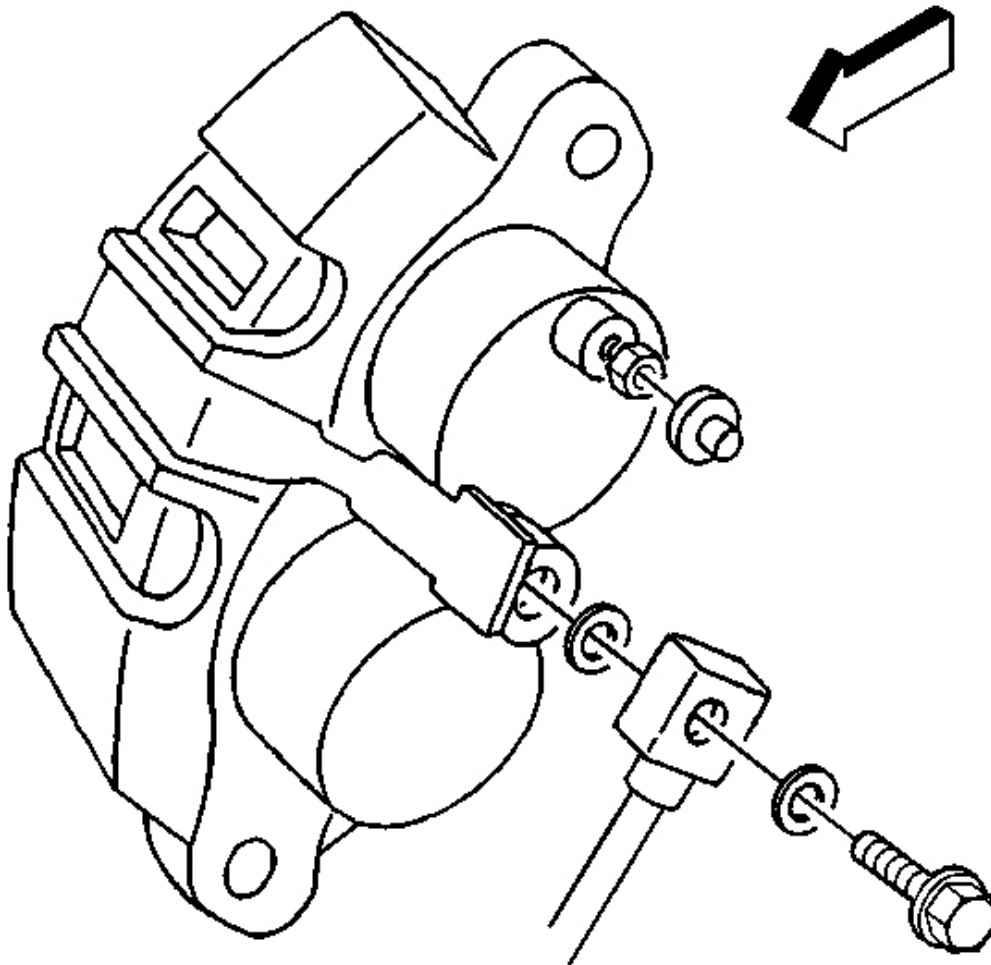


Fig. 50: View Of Banjo Fitting To Caliper
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT reuse the old copper gaskets. Use only **NEW** copper gaskets.

1. Install the **NEW** copper gaskets to the brake hose and bolt.

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

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Install the brake hose to brake caliper.

Tighten: Tighten the brake hose bolt to 44 N.m (33 lb ft).

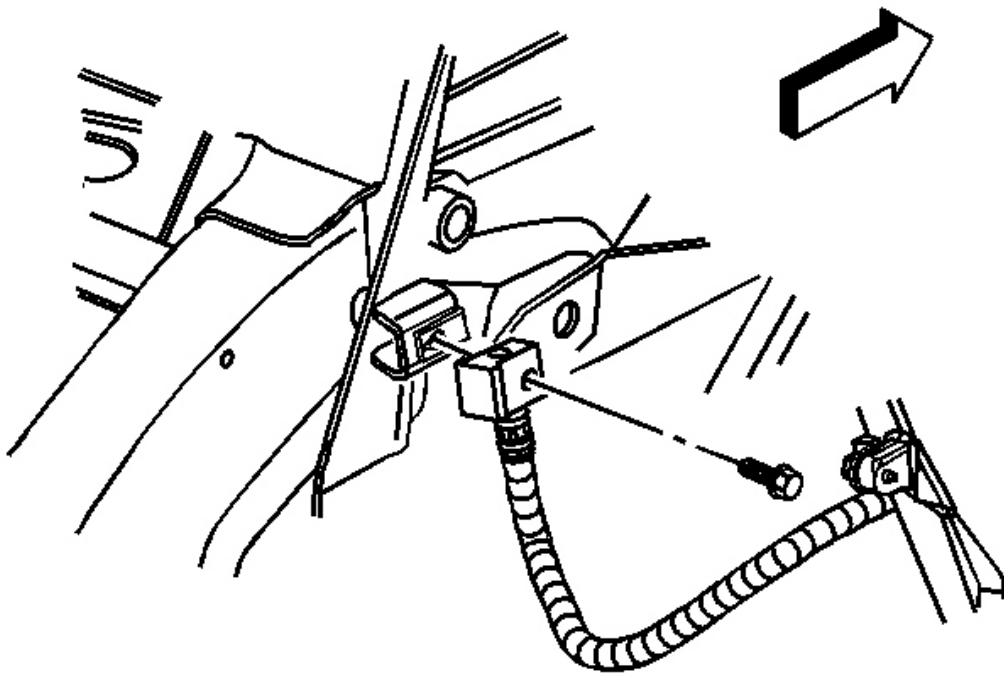


Fig. 51: Brake Hose Retaining Bolt Removed From Frame
Courtesy of GENERAL MOTORS CORP.

4. Install the brake hose retaining bolt to the frame.

Tighten: Tighten the brake hose bolt to 20 N.m (18 lb ft).

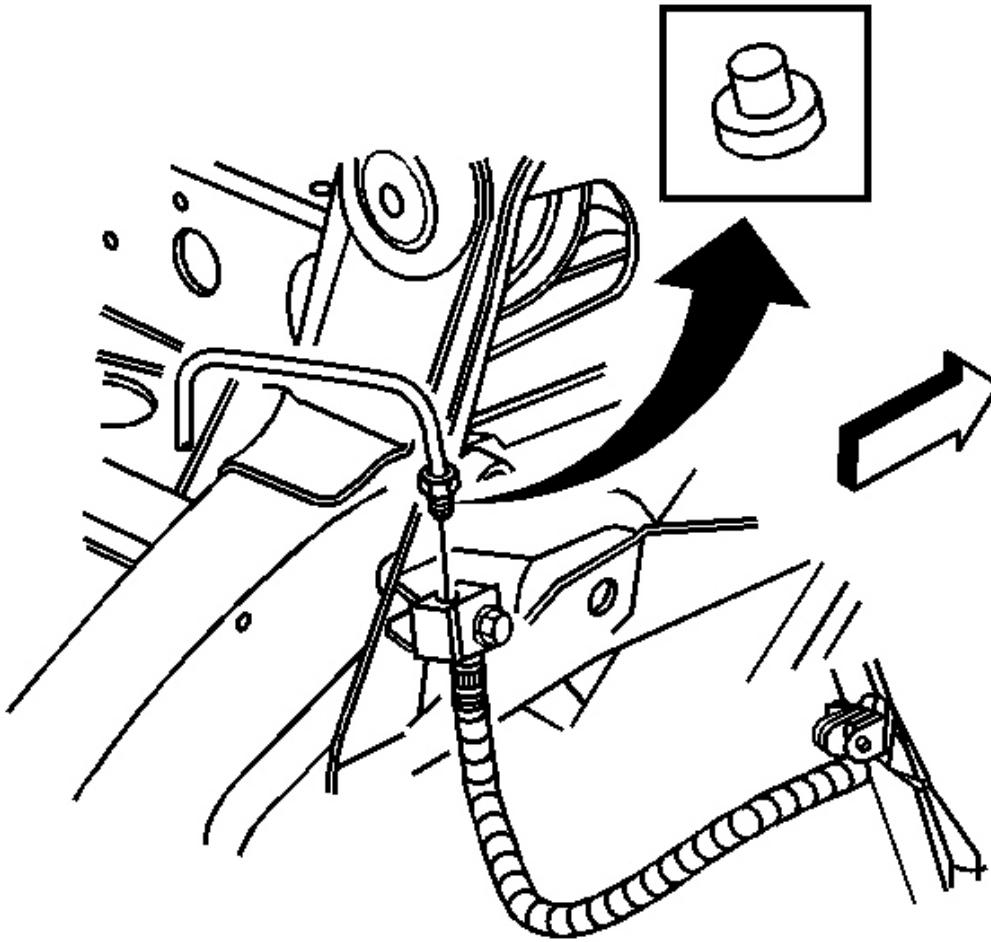


Fig. 52: Brake Pipe Fitting Plug/Rubber Cap Removed
Courtesy of GENERAL MOTORS CORP.

5. Remove the rubber cap or plug from the brake pipe fitting.

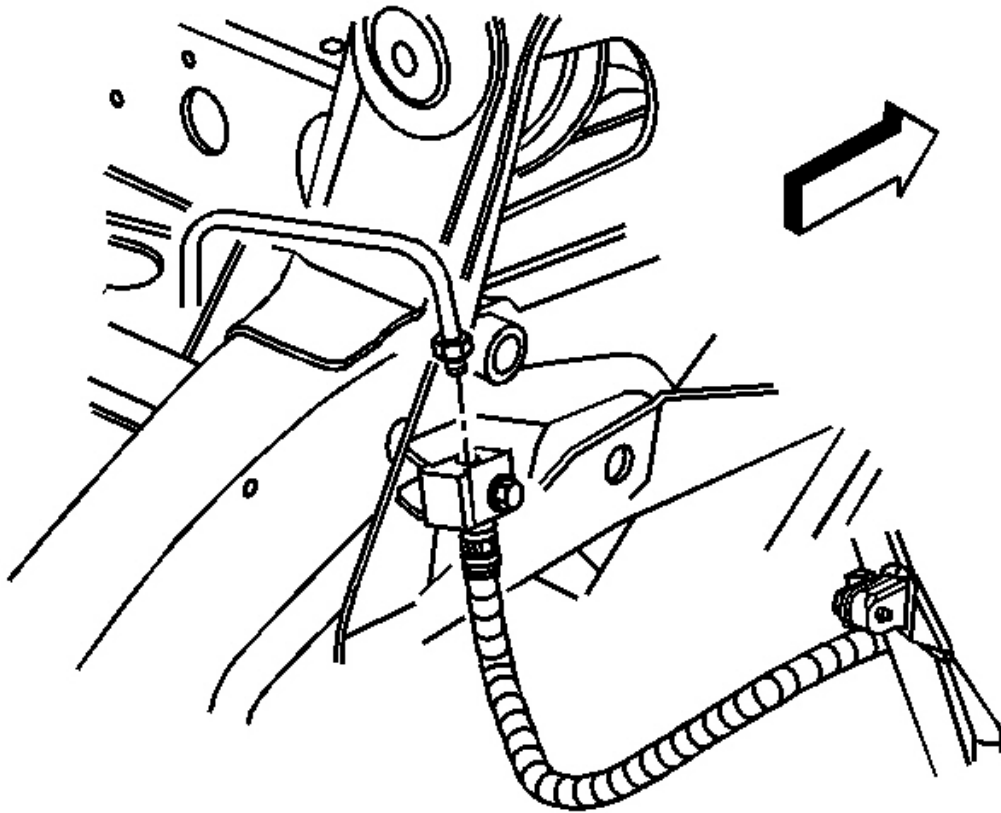


Fig. 53: Installing Brake Pipe To Brake Hose
Courtesy of GENERAL MOTORS CORP.

6. Install the brake pipe to the brake hose.

Tighten: Tighten the brake pipe fitting to 20 N.m (18 lb ft).

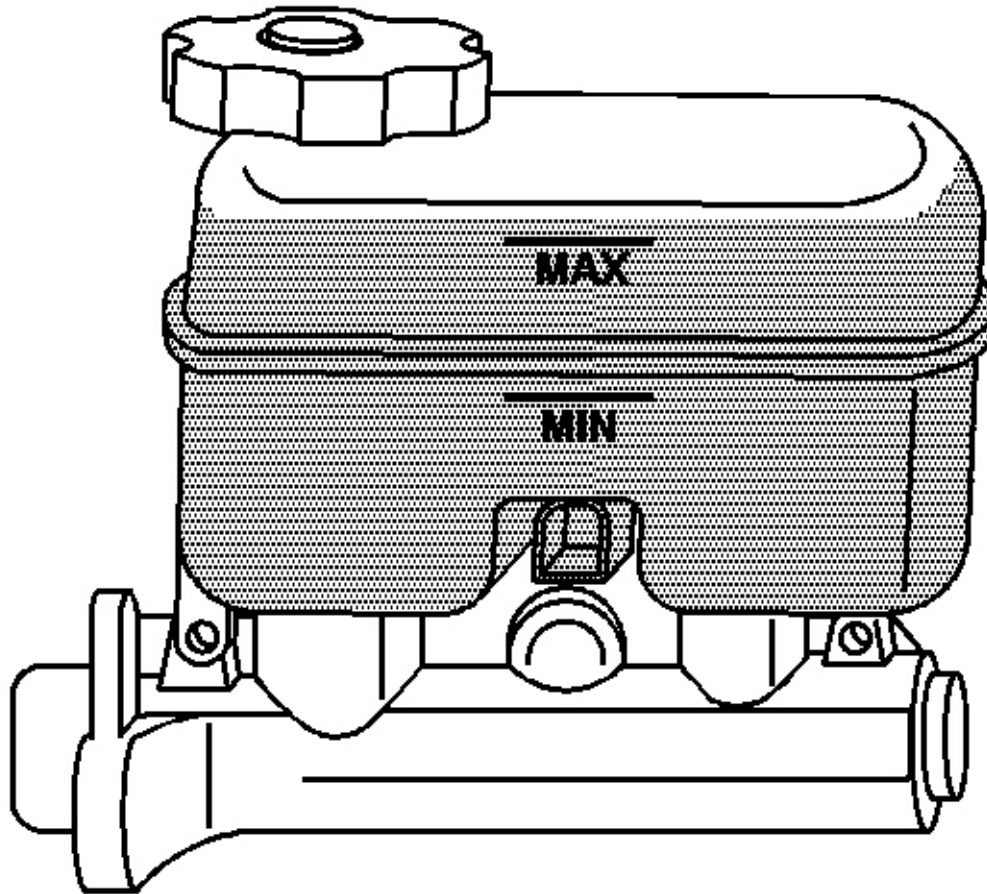


Fig. 54: View Of Full Master Cylinder Reservoir MAX And MIN Marks
Courtesy of GENERAL MOTORS CORP.

7. Fill the brake master cylinder reservoir. Refer to **Master Cylinder Reservoir Filling**.
8. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.
9. Install the front tires and wheels assembly. Refer to **Tire and Wheel Removal and Installation** in Tires and Wheels.
10. Lower the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

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

Removal Procedure

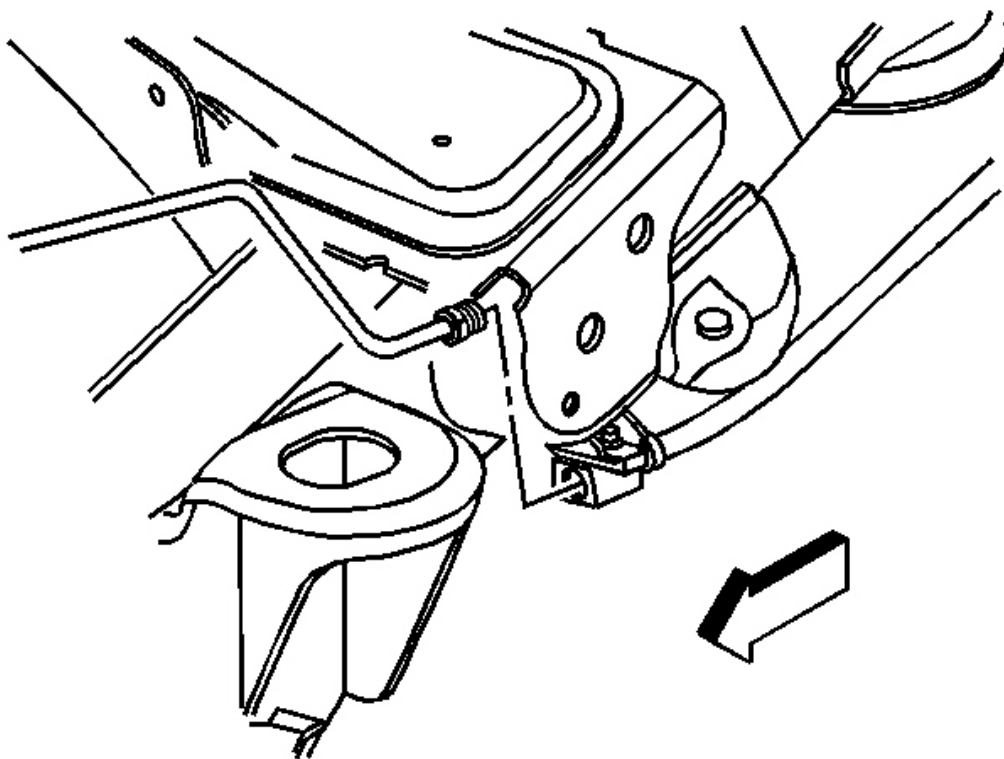


Fig. 55: Rear Brake Hose From Brake Pipe
Courtesy of GENERAL MOTORS CORP.

1. Raise the vehicle. Refer to Lifting and Jacking the Vehicle in General Information.
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation in Tires and Wheels
3. Clean the all dirt and foreign material from the brake hose and brake pipe fittings.

4. Using a backup wrench, remove the rear brake hose from the brake pipe.

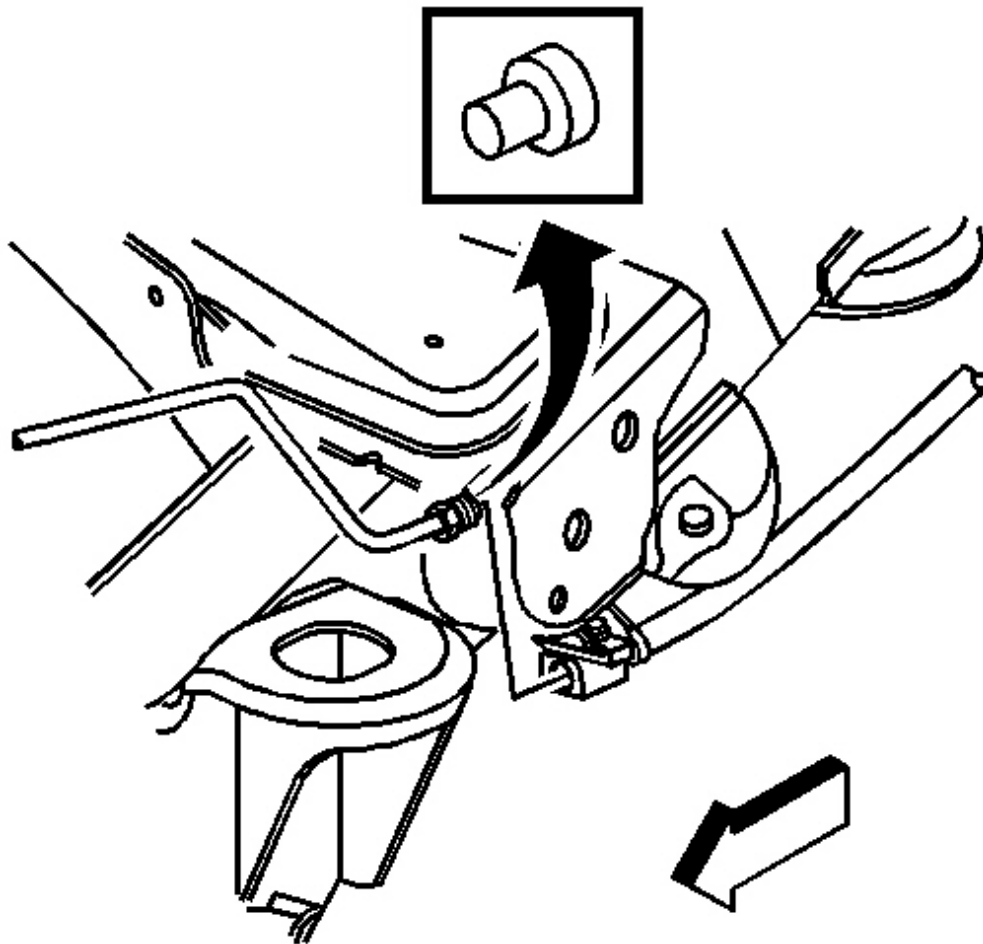


Fig. 56: Rear Brake Pipe Fitting
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Installing a rubber plug and/or cap fitting to the exposed brake pipe fitting ends will prevent brake fluid loss and contamination.

5. Install the rubber plug and/or cap on the rear brake pipe fitting.

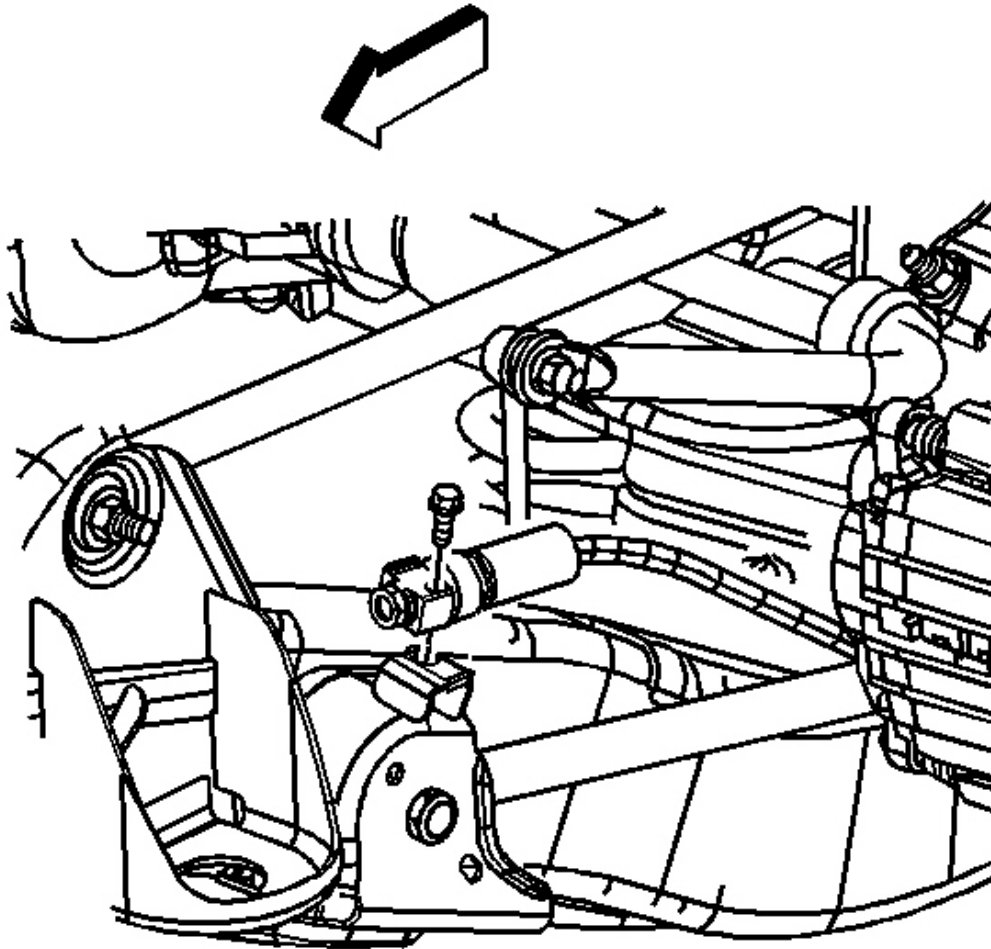


Fig. 57: Removing/Installing Brake Line Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the brake line retaining bolt at the frame.

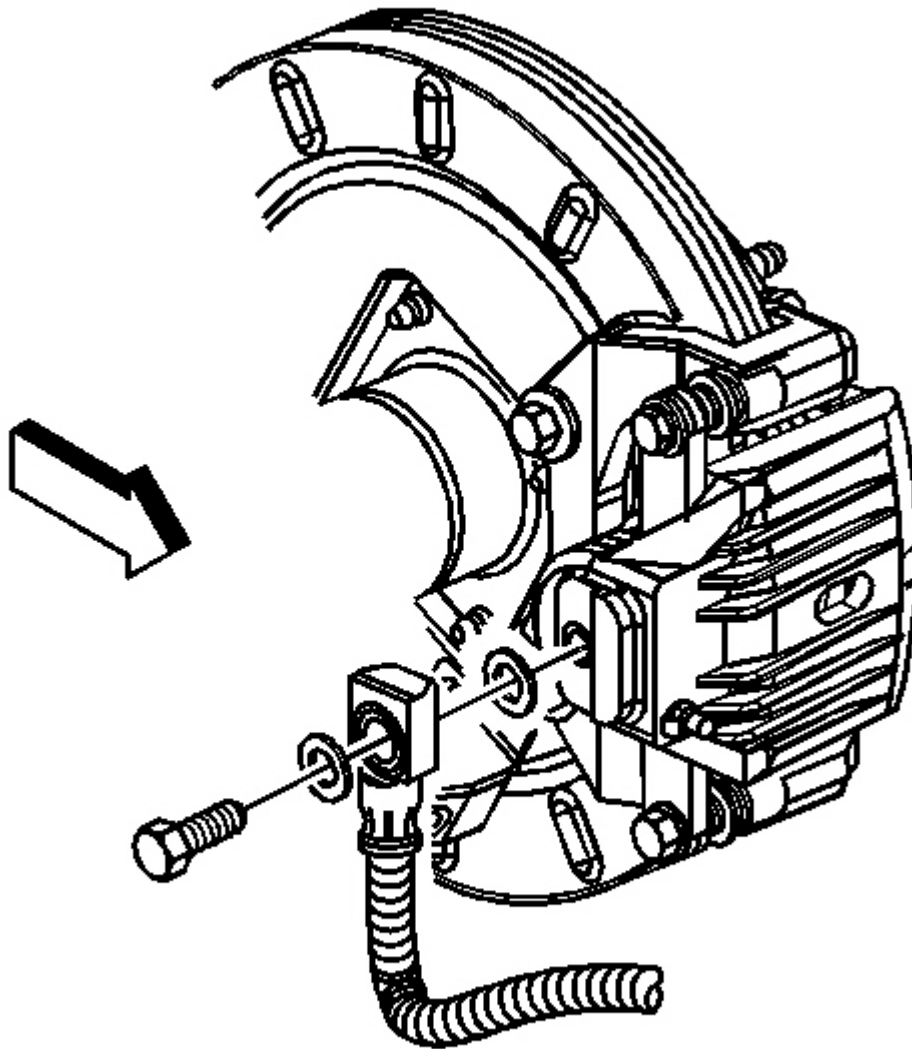


Fig. 58: Brake Hose Bolt From Brake Caliper
Courtesy of GENERAL MOTORS CORP.

7. Remove the brake hose bolt from the brake caliper.

IMPORTANT: The metal gaskets may be stuck to either the brake caliper or the brake hose end. Ensure that these gaskets are removed from the brake hose end and the brake caliper.

8. Remove the copper gaskets from the brake hose end.
9. Discard the copper gaskets.
10. Remove and discard the copper gaskets.

Installation Procedure

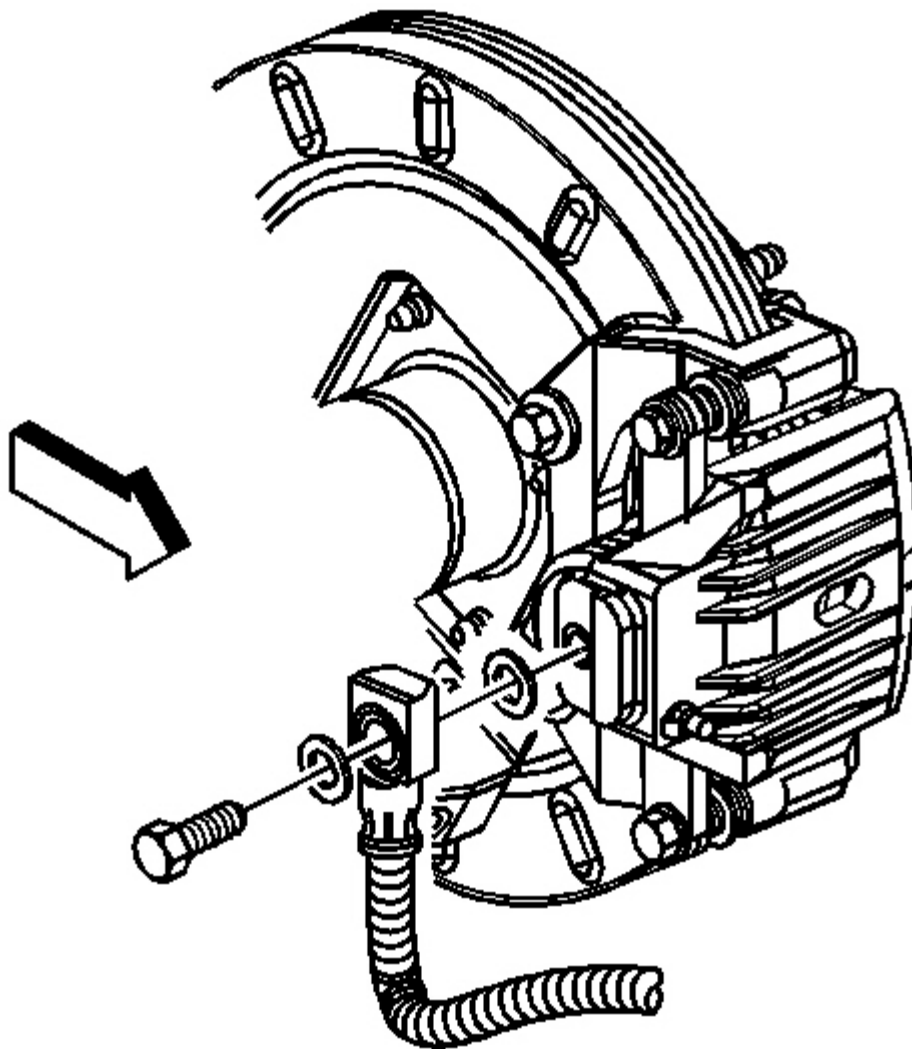


Fig. 59: Brake Hose Bolt From Brake Caliper
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT reuse the old copper gaskets. Use only **NEW** copper gaskets.

1. Install the NEW copper gaskets to the rear brake caliper bolt.

NOTE: Refer to Fastener Notice in Cautions and Notices.

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

Tighten: Tighten the rear brake bolt to 44 N.m (23 lb ft).

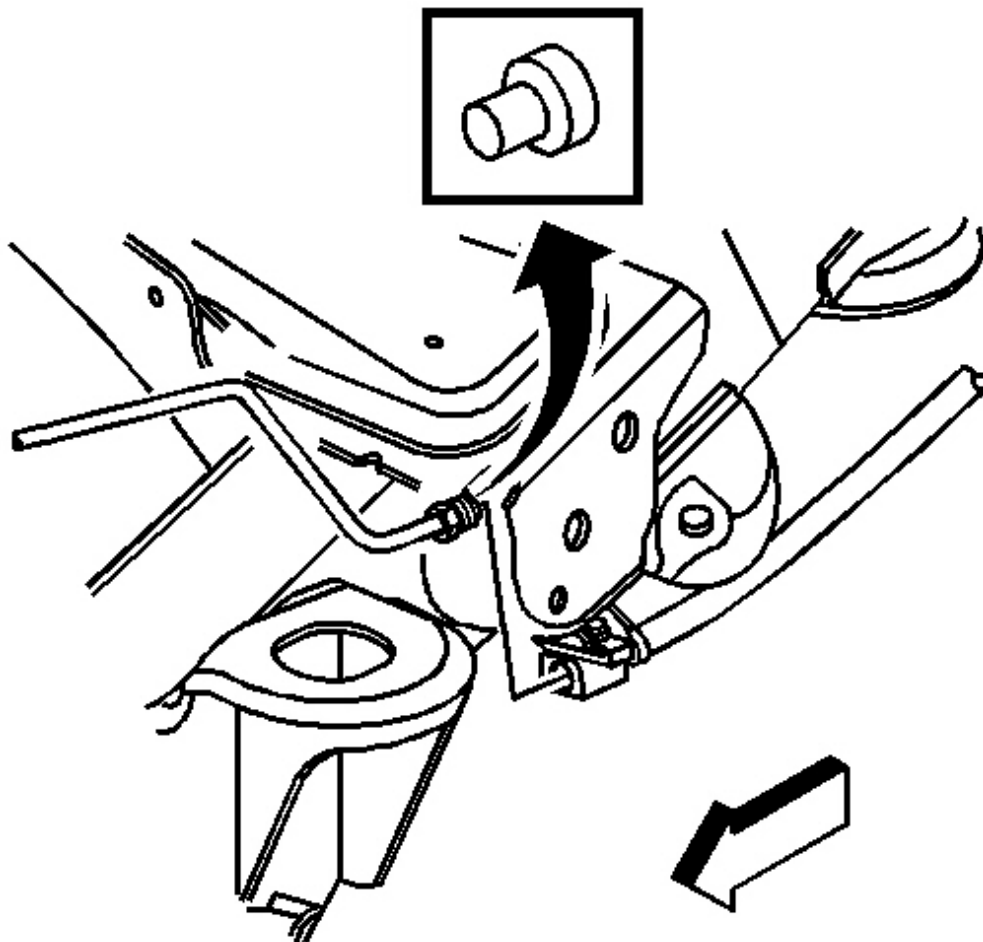


Fig. 60: Rear Brake Pipe Fitting
Courtesy of GENERAL MOTORS CORP.

3. Remove the rubber plug and/or cap from the rear brake pipe fitting.

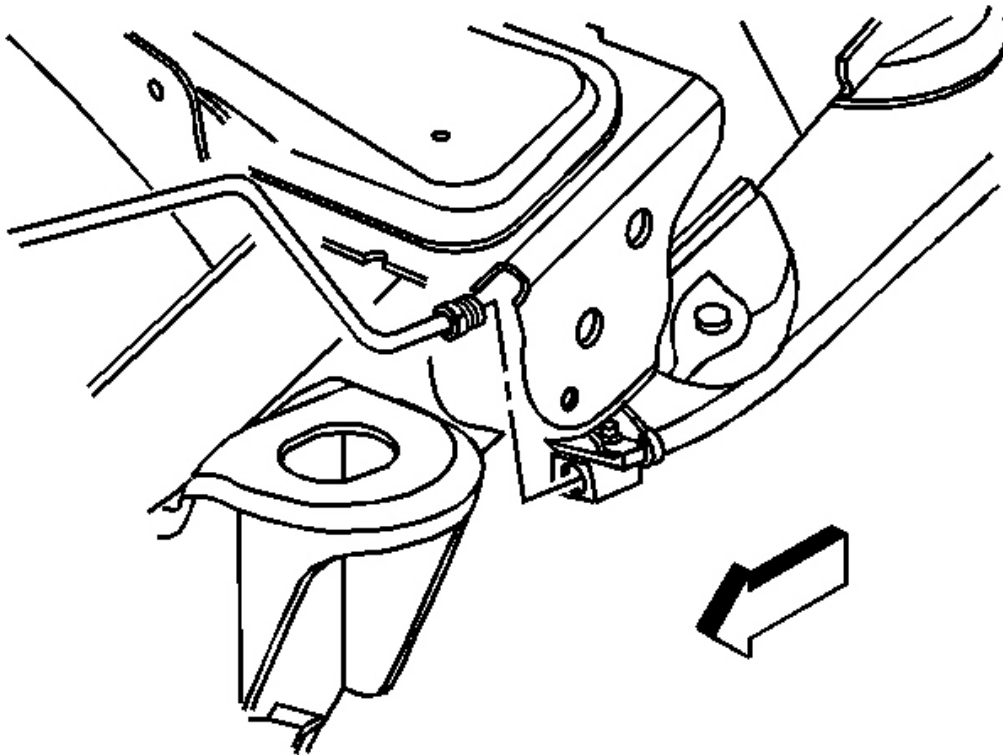


Fig. 61: Rear Brake Hose From Brake Pipe
Courtesy of GENERAL MOTORS CORP.

4. Install the brake pipe to the brake hose.
5. Using a backup wrench, install the rear brake pipe to the brake hose.

Tighten: Tighten the rear brake pipe fitting to 20 N.m (18 lb ft).

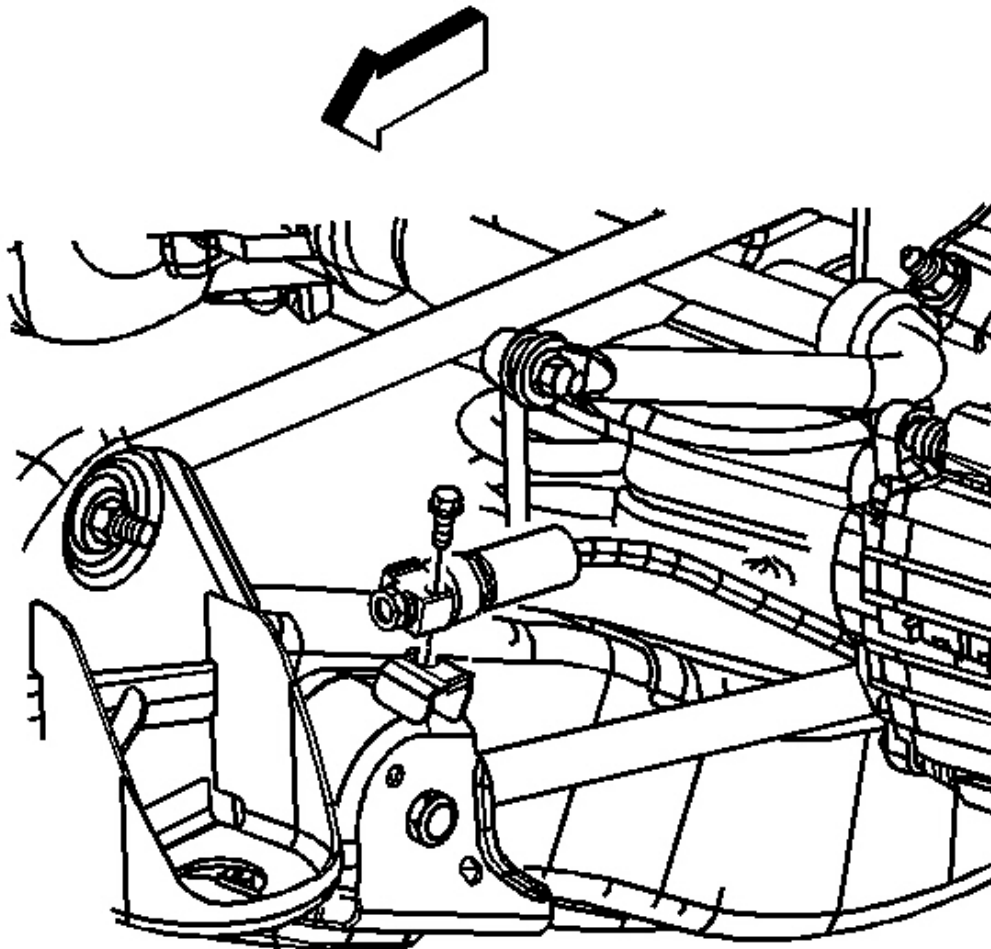


Fig. 62: Removing/Installing Brake Line Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

6. Install the brake pipe retaining bolt at the frame.

Tighten: Tighten the brake pipe retaining bolt to 20 N.m (18 lb ft).

7. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)**.
8. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** in Tires and Wheels.

9. Lower the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

HYDRAULIC BRAKE SYSTEM BLEEDING (MANUAL)

CAUTION: Refer to **Brake Fluid Irritant Caution** in Cautions and Notices.

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

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. 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.

2006 Buick Rainier

2006 BRAKES Hydraulic Brakes - Ascender, Envoy, Rainier & TrailBlazer

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 REAR 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 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.

15. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
16. With the right front wheel hydraulic circuit bleeder valve tightened securely - after all air has been purged from the right front hydraulic circuit - install a proper box-end wrench onto the LEFT 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.
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: If the brake system warning lamp remains illuminated, 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** Brake Pressure Bleeder Adapter. See **Special Tools**.

CAUTION: Refer to Brake Fluid Irritant Caution in Cautions and Notices.

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

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. 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 REAR 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 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.

18. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
19. With the right front wheel hydraulic circuit bleeder valve tightened securely - after all air has been purged from the right front hydraulic circuit - install a proper box-end wrench onto the LEFT 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.
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 BPMV. Refer to **ABS Automated Bleed Procedure** in Antilock Brake System.
27. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

IMPORTANT: If the brake system warning lamp remains illuminated, 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 two 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**
- **Brake Hose Replacement - Front**
- **Brake Hose Replacement - Rear**
- **Brake Caliper Replacement - Front**
- **Brake Caliper Replacement - Rear**

- **Brake Pressure Modulator Valve (BPMV) 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.

- **Brake Hose Replacement - Front**
- **Brake Hose Replacement - Rear**
- **Brake Caliper Replacement - Front**
- **Brake Caliper Replacement - Rear**
- **Brake Pressure Modulator Valve (BPMV) 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 (Canadian 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)**.

Removal Procedure

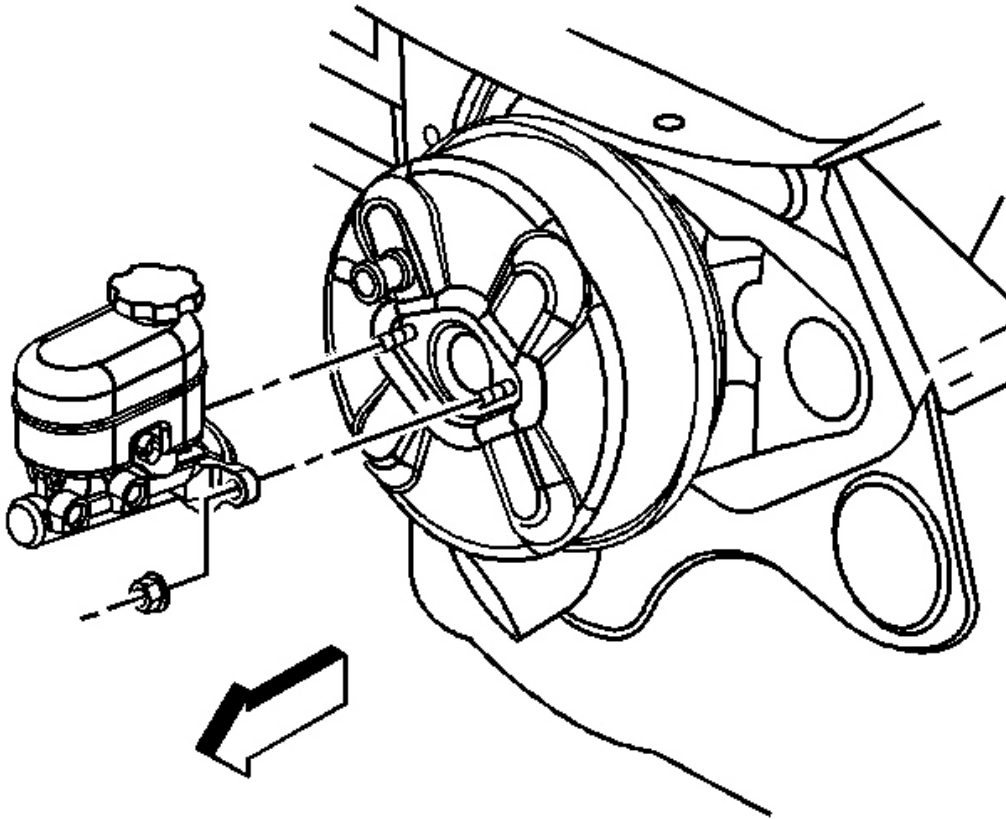


Fig. 63: Master Cylinder To Booster View
Courtesy of GENERAL MOTORS CORP.

1. Apply the parking brake.
2. Remove the master cylinder. Refer to **Master Cylinder Replacement**.

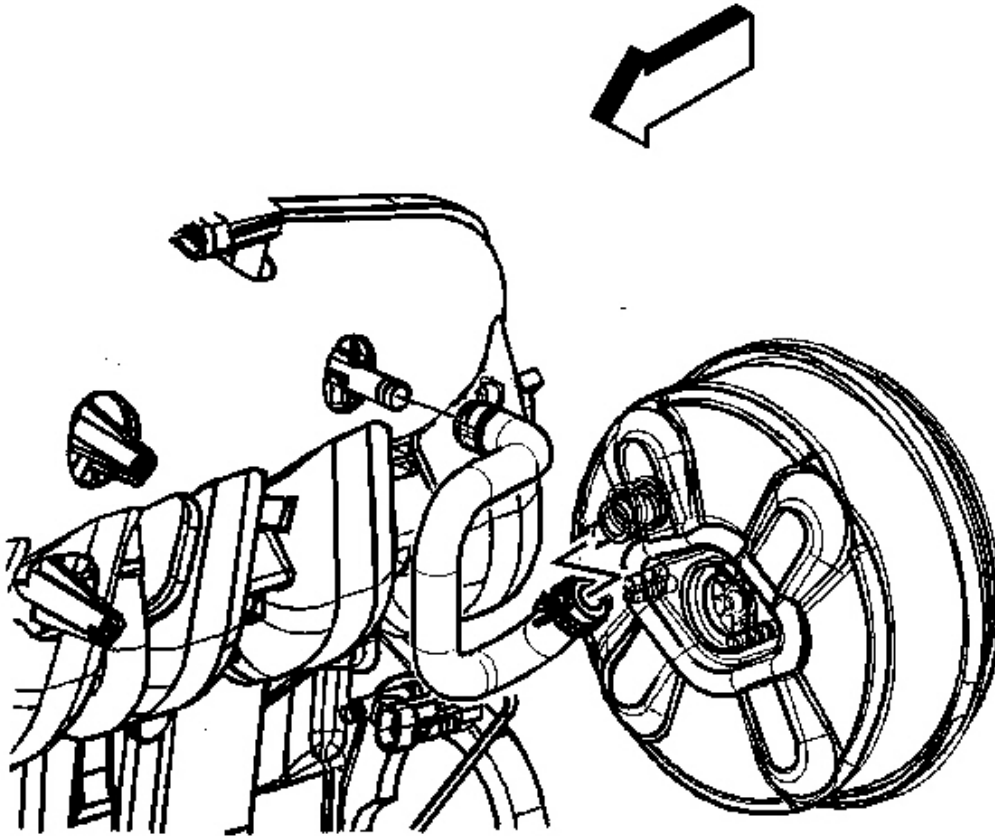


Fig. 64: Vacuum Hose From Vacuum Booster And Engine
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the vacuum hose from the vacuum booster and from the engine.
4. Remove the left closeout/insulator panel. Refer to **Closeout/Insulator Panel Replacement - Left** in Instrument Panel, Gages and Console.

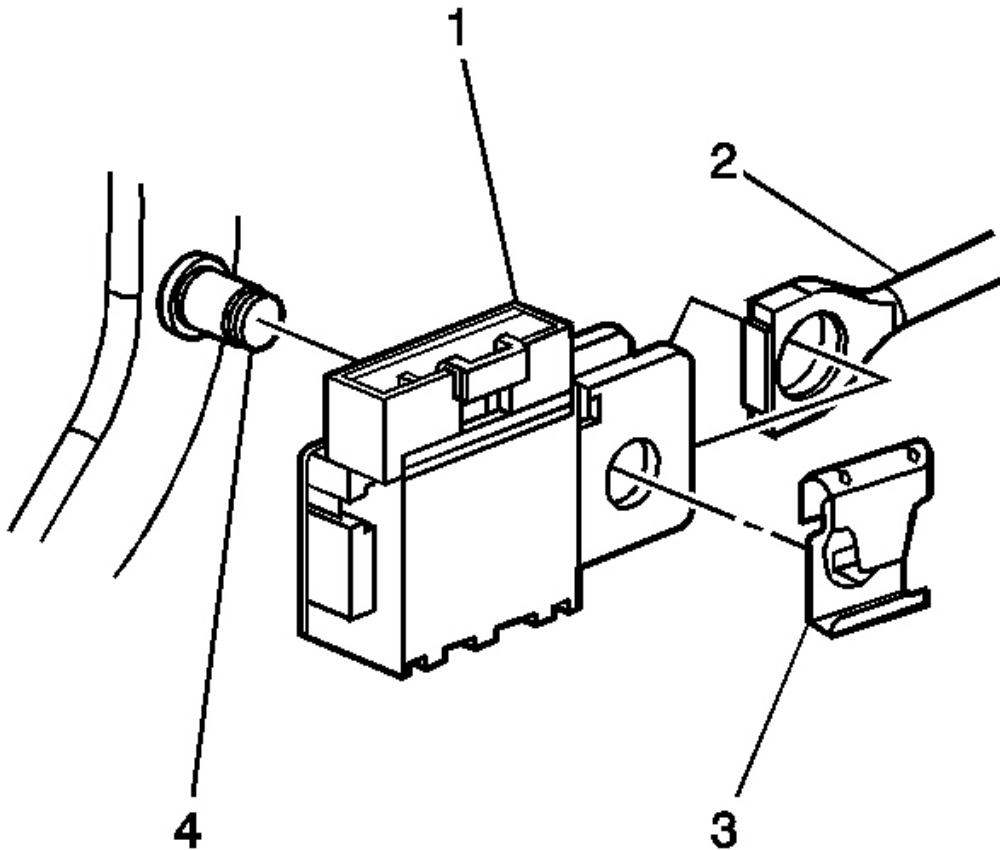


Fig. 65: Removing/Installing Brake Light Switch
Courtesy of GENERAL MOTORS CORP.

5. Remove the pushrod retainer (3) from the brake pedal pin (4).
6. Remove the stop lamp switch (1) and the pushrod (2) from the brake pedal pin (4).

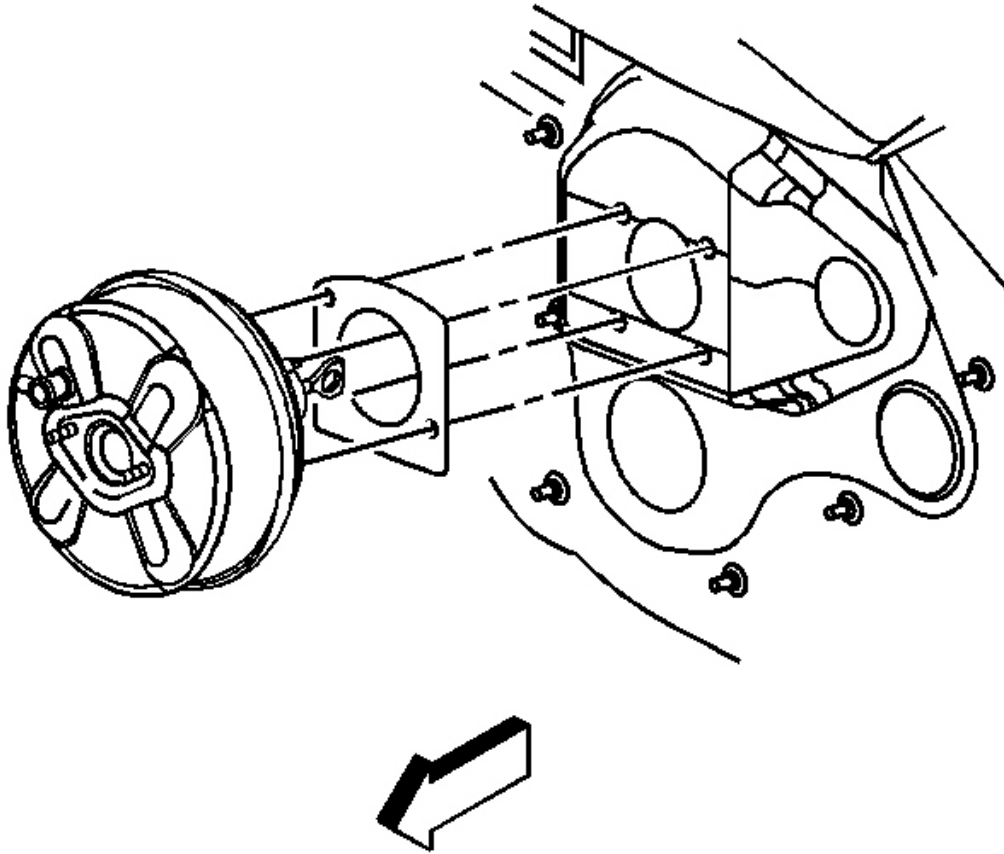


Fig. 66: Vacuum Booster Mounting Nuts, Gasket And Booster Assembly
Courtesy of GENERAL MOTORS CORP.

7. Remove the vacuum booster mounting nuts.
8. Remove the vacuum booster assembly.
9. Remove the gasket.

Installation Procedure

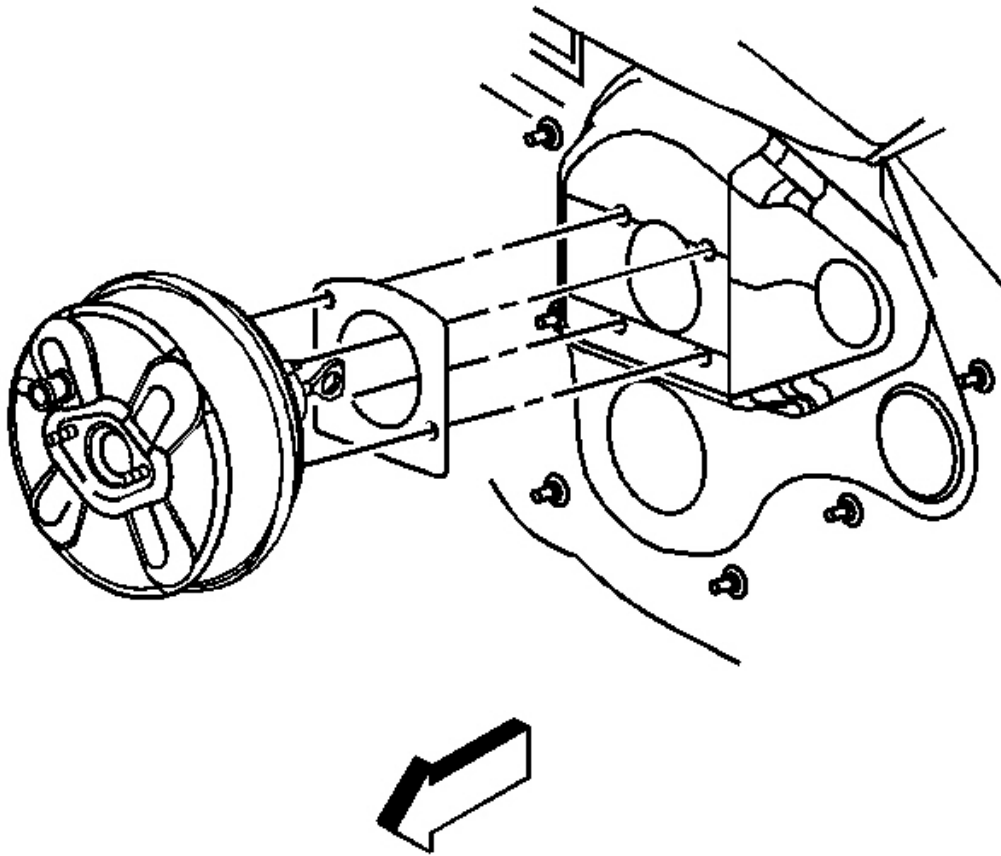


Fig. 67: Vacuum Booster Mounting Nuts, Gasket And Booster Assembly
Courtesy of GENERAL MOTORS CORP.

1. Install the gasket and the vacuum booster assembly.

NOTE: Refer to Fastener Notice in Cautions and Notices.

2. Install the vacuum booster mounting nuts on the vacuum booster.

Tighten: Tighten the vacuum booster mounting nuts to 36 N.m (27 lb ft).

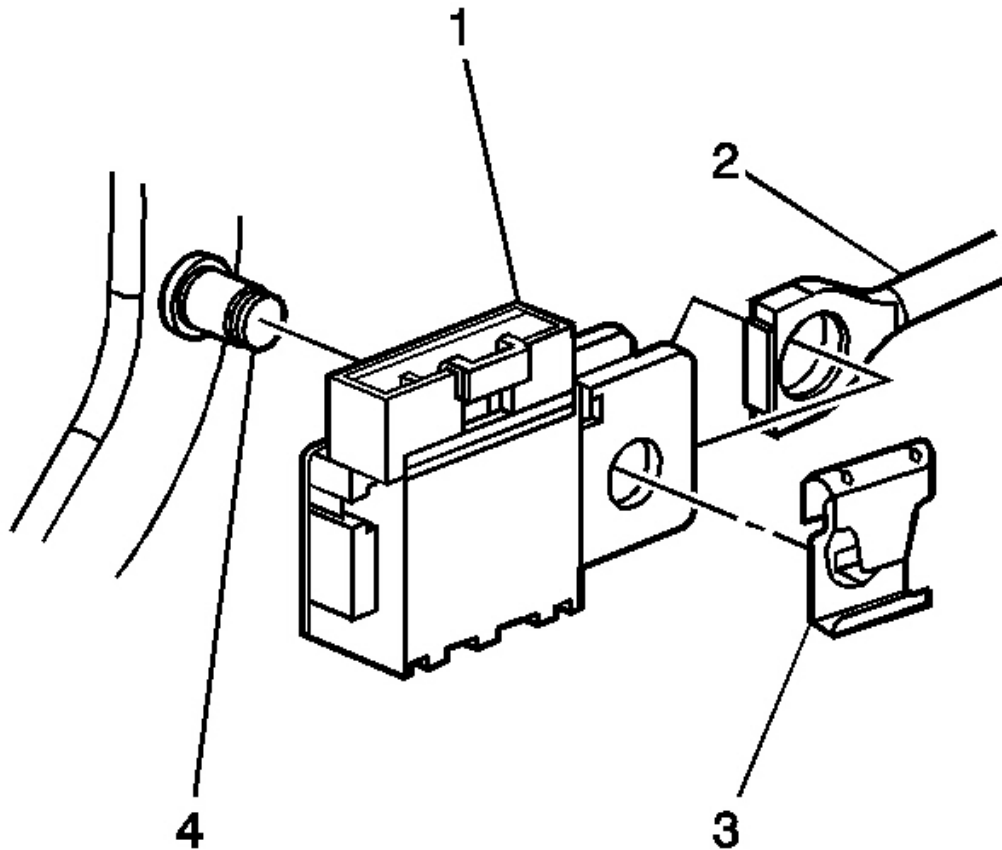


Fig. 68: Removing/Installing Brake Light Switch
Courtesy of GENERAL MOTORS CORP.

3. Position the stop lamp switch (1) on the pushrod (2) and install on the brake pedal pin.
4. Install the pushrod retainer (3) to the brake pedal pin (4). The retainer will snap into place.
5. Install the left closeout/insulator panel. Refer to **Closeout/Insulator Panel Replacement - Left** in Instrument Panel, Gages and Console.

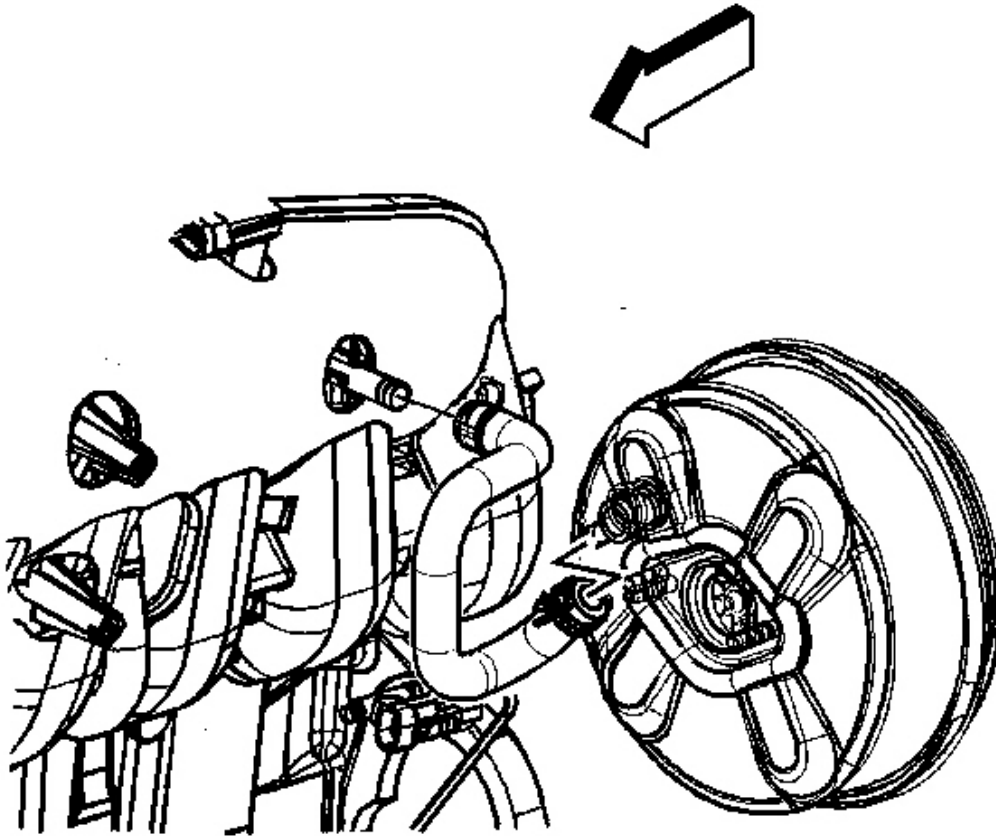


Fig. 69: Vacuum Hose From Vacuum Booster And Engine
Courtesy of GENERAL MOTORS CORP.

6. Install the vacuum hose to the vacuum booster and to the engine.
7. Install the master cylinder. Refer to **Master Cylinder Replacement**.

VACUUM BRAKE BOOSTER CHECK VALVE AND/OR HOSE REPLACEMENT

Removal Procedure

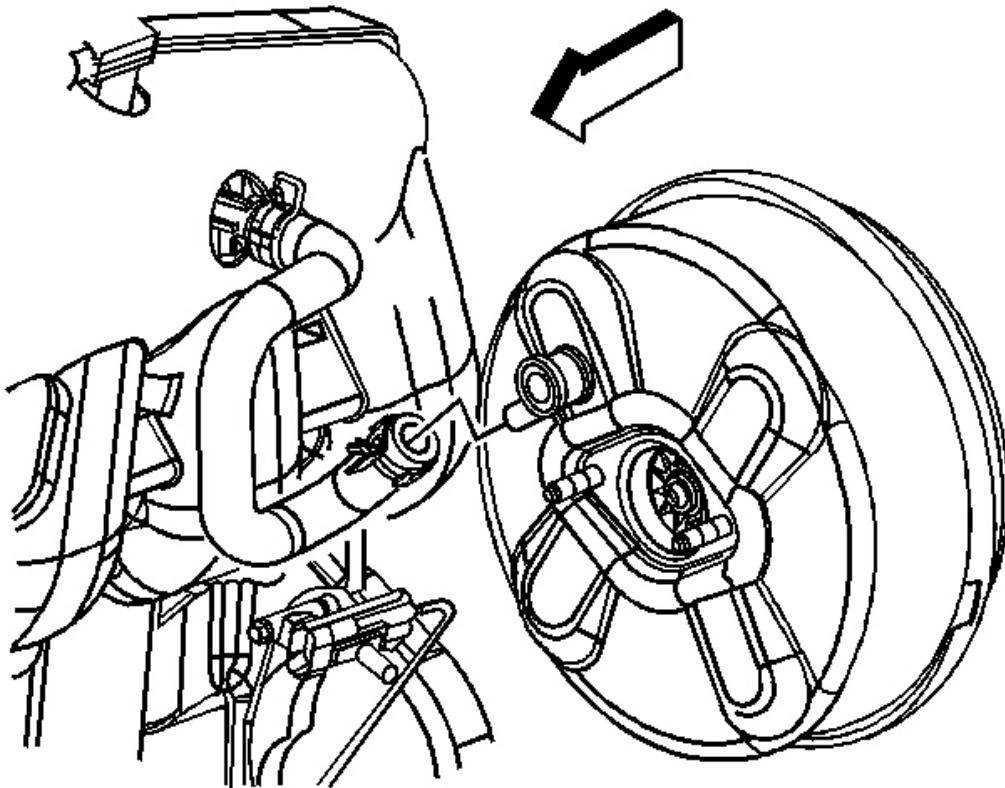


Fig. 70: View Of Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

1. Remove the vacuum brake booster check valve from the vacuum brake booster.
2. Remove the vacuum brake booster hose clamp at the check valve.
3. Remove the vacuum brake booster check valve from the hose.
4. Disconnect the vacuum brake booster hose at the engine.
5. Remove the vacuum brake booster hose from the vehicle.

Installation Procedure

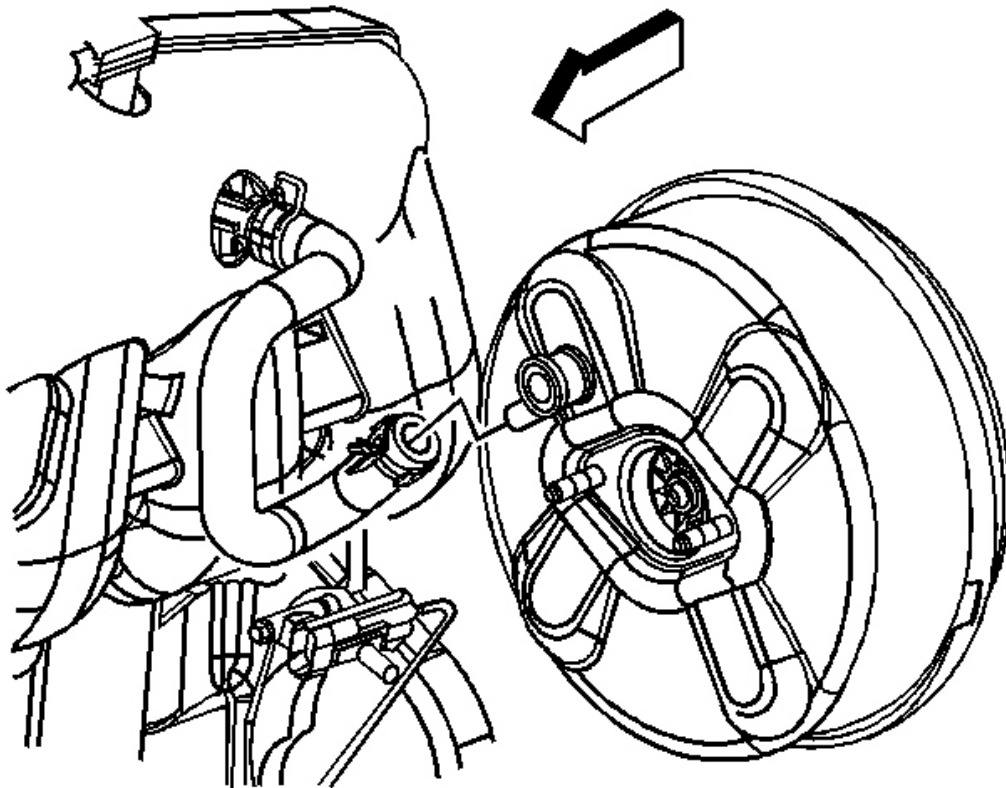


Fig. 71: View Of Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

1. Connect the vacuum brake booster hose at the engine.
2. Install the vacuum brake booster check valve to the hose.
3. Install the vacuum brake booster hose clamp to the check valve.
4. Install the vacuum brake booster check valve to the vacuum brake booster.

DESCRIPTION AND OPERATION

BRAKE WARNING SYSTEM DESCRIPTION AND OPERATION

Brake Warning Indicator

The instrument panel cluster (IPC) illuminates the brake warning indicator when one or more of

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.
- The electronic brake control module (EBCM) detects a low brake fluid condition. The IPC receives a class 2 message from the EBCM requesting illumination.
- The EBCM detects an ABS malfunction which disables dynamic rear proportioning (DRP). The IPC receives a class 2 message from the EBCM requesting illumination.
- The IPC performs the bulb check at the start of each ignition cycle. The brake warning indicator illuminates for approximately 3 seconds before turning OFF.
- The IPC detects a loss of class 2 communications with the BCM or with the EBCM.

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 front-rear 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** in Antilock Brake System 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

2006 Buick Rainier

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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

2006 Buick Rainier

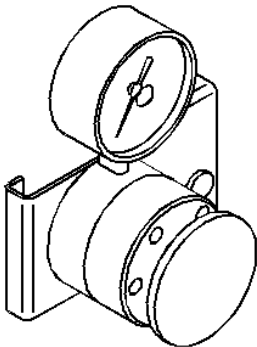
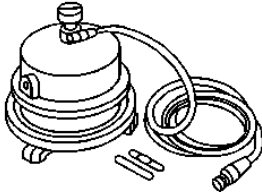
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the hydraulic brake master cylinder. Effort required to apply the brake system is reduced by the vacuum brake booster.

SPECIAL TOOLS AND EQUIPMENT

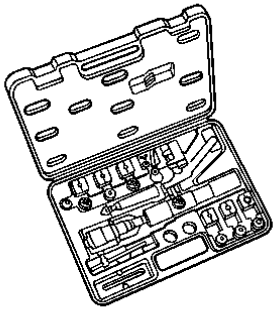
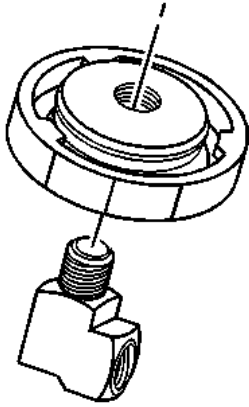
SPECIAL TOOLS

Special Tools

Illustration	Tool Number / Description
	J 28662 Brake Pedal Effort Gage
	J 29532 Diaphragm Pressure Bleeder
	J 35589-A Brake Pressure Bleeder Adapter

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J 45405
Brake Pipe Flaring tool