

BRAKES

Hydraulic Brakes - Coupe And Wagon

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake Hose Bracket Bolt- Front	14 N.m	124 lb in
Brake Hose Bracket Nut- Rear	14 N.m	124 lb in
Brake Hose Fitting Bolt	49 N.m	36 lb ft
Brake Master Cylinder Nut	25 N.m	18 lb ft
Brake Pedal Bracket Nut	25 N.m	18 lb ft
Brake Pedal Pushrod Nut	9 N.m	80 lb in
Brake Pipe Fitting	18 N.m	13 lb ft
Brake Pipe Fitting- Master Cylinder	36 N.m	27 lb ft
Power Brake Booster Auxiliary Pump Bolt and Nut	22 N.m	16 lb ft
Power Brake Booster Pump Bracket M6 Bolt	10 N.m	89 lb in
Power Brake Booster Pump Bracket M12 Bolt	70 N.m	52 lb ft
Rear Brake Intermediate Hose Assembly Nut	14 N.m	124 lb in
Shock Module Bolt	25 N.m	18 lb ft
Steering Column Support Bracket Nut	25 N.m	18 lb ft
Vacuum Brake Booster Bracket Nut	25 N.m	18 lb ft

BRAKE COMPONENT SPECIFICATIONS

Brake Component Specifications

Application	Specification	
	Metric	English
Brake Caliper Bleeder Valve- Front (All)	14 N.m	124 lb in
Brake Caliper Bleeder Valve- Rear (All)	13 N.m	115 lb in

BRAKE SYSTEM SPECIFICATIONS

Brake System Specifications

Application	Specification	
	Metric	English
Brake Pedal Travel	63.5 mm	2.5 in
• Maximum Specification with 445 N (100 lbs) of force		

applied to the pedal with the ignition OFF and the booster power reserve depleted.

SCHEMATIC WIRING DIAGRAMS

HYDRAULIC BRAKE WIRING SCHEMATICS

Hydraulic Brake System

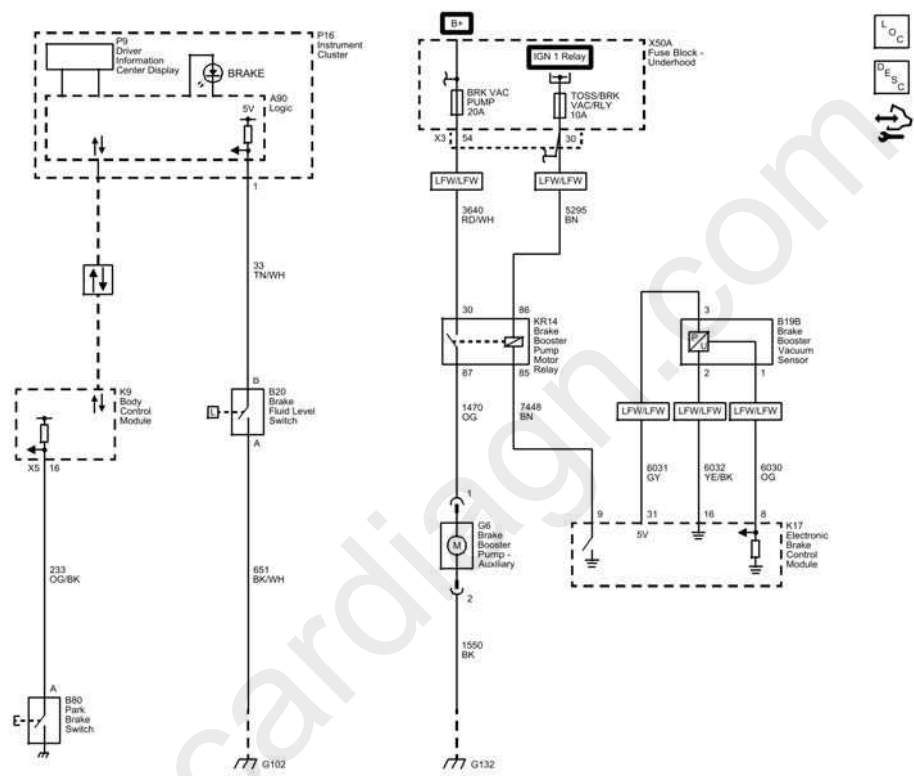


Fig. 1: Hydraulic Brake System
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC C0267	DTC C0267 00 Low Brake Fluid Indicated DTC C0267 71 Low Brake Fluid Indicated Invalid Serial Data
DTC C1100	DTC C1100 01 Brake Booster Vacuum Sensor Circuit Short to Voltage DTC C1100 06 Brake Booster Vacuum Sensor Circuit Short to Ground or

	Open DTC C1100 5A Brake Booster Vacuum Sensor Circuit Plausible Failure DTC C1100 75 Brake Booster Vacuum Sensor Circuit Signal Above Allowable Range
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DTC C0267: LOW BRAKE FLUID INDICATED

Diagnostic Instructions

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

DTC Descriptor

DTC C0267 00

Low Brake Fluid Indicated

DTC C0267 71

Low Brake Fluid Indicated Invalid Serial Data

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Fluid Level Signal	C0267 00	1	1	-
Park Brake Signal	1	1	1	-
Ground	-	1	-	-
1. Brake Warning Indicator Malfunction				

Circuit/System Description

The brake fluid level switch monitors the level of brake fluid in the master cylinder. When the instrument panel cluster (IPC) sees the brake fluid level switch input closed, it turns ON the Red Brake Warning indicator and sends a serial data message to the electronic brake control module (EBCM) that the brake fluid level is low.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

- Low brake fluid is detected.
- A short to ground exists on the signal circuit.

Action Taken When the DTC Sets

- The EBCM disables the antilock brake system (ABS)/traction control system (TCS) dynamic rear proportion (DRP) and vehicle stability enhancement system (VSES).
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX - COUPE AND WAGON

Description and Operation

Brake Warning System Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Inspect for proper brake fluid level, the fluid level should be at or above the proper level.
 - If low, refer to Brake Fluid Loss.
2. Ignition ON, observe the scan tool IPC Brake Fluid parameter. The reading should be OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the brake fluid level switch.
2. Test for less than 10 ohm between the ground circuit terminal A and ground.

- If greater than the specified range, test the ground circuit for an open/high resistance.
- 3. Ignition ON, verify the scan tool IPC Brake Fluid parameter is Ok.
 - If not the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the IPC.
- 4. Install a 3A fused jumper wire between the signal circuit terminal B and ground. Verify the scan tool IPC Brake Fluid parameter is Low.
 - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the IPC.
- 5. If all circuits test normal, test or replace the brake fluid level switch.

Repair Instructions

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

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

DTC C027B: AUXILIARY BRAKE BOOSTER PUMP MALFUNCTION

Diagnostic Instructions

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

DTC Descriptor

DTC C027B 00 or Auxiliary Brake Booster Pump Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Booster Pump Relay Switch B+	1	1	-	-
Brake Booster Pump Relay Coil Ignition	C027B 00	C027B 00	-	-
Brake Booster Pump Relay Control	1	C027B 00	C027B 00	-
Auxiliary Brake Booster Pump Control	1	1	1	-
Auxiliary Brake Booster Pump Ground	-	1	-	-
1. Auxiliary Brake Booster Pump Motor Malfunction				

Circuit/System Description

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. When the vacuum within the system drops, the EBCM turns ON the auxiliary brake booster pump by providing ground to the brake booster pump relay. The relay activates and supplies voltage to the auxiliary brake booster pump motor.

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

A short to ground, open/high resistance is detected on the brake booster pump relay control circuit.

Action Taken When the DTC Sets

The brake warning indicator turns ON.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The EBCM will turn OFF the indicator in the next ignition cycle.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX - COUPE AND WAGON

Description and Operation

Brake Assist System Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, apply and release the brake pedal several times to ventilate the brake booster.
2. Engine running, the Auxiliary Brake Booster Pump should turn ON for a short time.

Circuit/System Testing

1. Ignition OFF, disconnect the harness at the brake booster pump relay.
2. Ignition ON, verify that a test lamp does not illuminate between the auxiliary brake booster pump control circuit terminal 87 and ground.
 - If the test lamp illuminates, test the auxiliary brake booster pump control circuit for a short to voltage.
3. Test for more than 10 ohms between the brake booster pump control circuit terminal 87 and ground.
 - If less than the specified range, test the auxiliary brake booster pump control circuit for a short to ground.
4. Verify that a test lamp illuminates between the brake booster pump relay switch B+ circuit terminal 30 and ground.
 - If the test lamp does not illuminate, test the brake booster pump relay switch B+ circuit for a short to ground or an open/high resistance.
5. Verify that a test lamp illuminates between the brake booster pump relay coil ignition circuit terminal 86 and ground.
 - If the test lamp does not illuminate, test the ignition, circuit for a short to ground or an open/high resistance.
6. Disconnect the harness connector at the auxiliary brake booster pump.
7. Test for less than 10 ohms between the auxiliary brake booster pump ground circuit terminal 2 and ground.
 - If greater than the specified range, test the ground circuit for an open/high resistance.
8. Connect the harness connector at the auxiliary brake booster pump.
9. Connect a 20 A fused jumper wire between the B+, circuit terminal 30 and the control circuit terminal 87. Verify the auxiliary brake booster pump is activated.
 - If the auxiliary brake booster pump does not activate, test the auxiliary brake booster pump motor control circuit for an open/high resistance. If the circuit tests normal, test or replace the auxiliary brake booster pump.
10. Connect a test lamp between the brake booster pump relay coil ignition circuit terminal 86 and the brake booster pump relay control circuit terminal 85.
11. Command the auxiliary brake booster pump ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
 - If the test lamp is always ON, test the brake booster pump relay control circuit for a short to ground. If the circuit tests normal, replace the electronic brake control module.
 - If the test lamp is always OFF, test the brake booster pump relay control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the electronic brake control module.
12. If all circuits test normal, test or replace the brake booster pump relay.

Component Testing

Auxiliary Brake Booster Pump Test

1. Ignition OFF, disconnect the harness connector at the auxiliary brake booster pump.
2. Connect a 20 A fused jumper wire between the control circuit terminal 1 and B+.
3. Connect a jumper wire between the ground circuit terminal 2 and ground, verify the auxiliary brake booster pump activates.
 - If the auxiliary brake booster pump does not activate, replace the auxiliary brake booster pump.

Relay Test

1. Ignition OFF, disconnect the brake booster pump relay.
2. Test for 60-100 ohms between terminals 85 and 86 of the relay.
 - If not within the specified range, replace the brake booster pump relay.
3. Test for infinite resistance between the following terminals:
 - 30 and 85
 - 30 and 86
 - 30 and 87
 - If less than the specified value, replace the brake booster pump relay.
4. Install a fused jumper wire between relay terminal 86 and B+. Install a jumper wire between relay terminal 85 and ground.
5. Test for less than 5 ohms between terminals 30 and 87.
 - If greater than the specified value, replace the brake booster pump relay.

Repair Instructions

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

- **Power Brake Booster Auxiliary Pump Replacement**
- **Relay Replacement (Within an Electrical Center) , Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for EBCM replacement, setup, and programming

DTC C1100: BRAKE BOOSTER VACUUM SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC C1100 01

Brake Booster Vacuum Sensor Circuit Short to Voltage

DTC C1100 06

Brake Booster Vacuum Sensor Circuit Short to Ground or Open

DTC C1100 5A

Brake Booster Vacuum Sensor Circuit Plausible Failure

DTC C1100 75

Brake Booster Vacuum Sensor Circuit Signal Above Allowable Range

Circuit/System Description

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. The electronic brake control module (EBCM) supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the EBCM.

Conditions for Running the DTC

Engine Running.

Conditions for Setting the DTC

C1100 01

The EBCM detects a voltage greater than 4.9 V for more than 100 m/sec on the vacuum sensor 5 V reference circuit.

C1100 06

The EBCM detects a voltage less than 0.2 V for more than 100 m/sec on the vacuum sensor 5 V reference circuit.

C1100 5A

The vacuum sensor signal is not plausible (erractic).

C1100 75

The vacuum sensor is out of range.

Action Taken When the DTC Sets

The DIC displays Service Brake System Soon.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The EBCM will turn OFF the indicator in the next ignition cycle.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX - COUPE AND WAGON

Description and Operation

ABS Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the brake booster vacuum sensor.
2. Ignition OFF, test for less than 10 ohms between the low reference circuit terminal 2 and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the EBCM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the EBCM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the EBCM.
4. Ignition ON, test for 4.5-5.2 V between the 5 V reference circuit terminal 3 and the signal circuit terminal 1.

- If less than the specified range, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the EBCM.
 - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the EBCM.
5. Ignition OFF, disconnect the X1 harness connector at the EBCM.
 6. Ignition OFF, test for infinite resistance between the signal circuit terminal 8 and ground.
 - If not the specified value, test the signal circuit for a short to ground.
 7. If all circuits test normal, replace the power brake booster vacuum sensor.

Repair Instructions

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

- **Power Brake Booster Vacuum Sensor Replacement**
- **Control Module References** for EBCM replacement, setup and programming

SYMPTOMS - HYDRAULIC BRAKES

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

1. Perform **Diagnostic System Check - Vehicle** before using the brake indicator symptom tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control module(s) can communicate via the serial data link.
2. Perform the **Brake System Vehicle Road Test** before using the hydraulic brake symptom tables in order to duplicate the customer's concern.
3. Review the system operation in order to familiarize yourself with the system functions. Refer to the following:
 - **Brake Warning System Description and Operation**
 - **Hydraulic Brake System Description and Operation**
 - **Brake Assist System Description and Operation**
 - **Disc Brake System Description and Operation**
 - **Brake Booster Vacuum Assist Description and Operation**

Visual/Physical Inspection

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

Intermittent

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

Symptom List

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

- **Brake Warning Indicator Malfunction**
- **Brake Pulsation**
- **Brake System Noise**
- **Braking Action Uneven - Pulls to One Side**
- **Braking Action Uneven - Front to Rear**
- **Brake Pedal Excessive Travel**
- **Brake Pedal Excessive Effort**
- **Auxiliary Brake Booster Pump Malfunction - DTC C027B**
- **Brakes Drag**
- **Brake System Slow Release**
- **Brake Fluid Loss**

BRAKE WARNING INDICATOR MALFUNCTION

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Fluid Level Signal	C0267 00	1	1	-
Park Brake Signal	1	1	1	-
Ground	-	1	-	-
1. Brake Warning Indicator Malfunction				

Circuit/System Description

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

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX - COUPE AND WAGON

Description and Operation

Brake Warning System Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the park brake is released and the brake fluid is at or above the proper level.
 - If low, refer to **Brake Fluid Loss**.
2. Command the IPC display test with a scan tool, the warning indicator should turn ON.
 - If the red brake warning indicator does not illuminate, replace the IPC.
3. Ignition ON, observe the scan tool BCM Park Brake Switch parameter while applying and releasing the park brake. The parameter should cycle between Applied and Release.
 - If the parameter does not cycle between the specified values, refer to Park Brake Switch Malfunction.
4. Observe the scan tool IPC Brake Fluid parameter. The reading should be OK.
 - If not the specified value, refer to Brake Fluid Level Switch Malfunction.

Circuit/System Testing

Park Brake Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the park brake switch.
2. Ignition ON, verify the scan tool BCM Park Brake Switch parameter is Released.
 - If not the specified value, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the BCM.

3. Install a 3A fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool BCM Park Brake Switch parameter is Applied.
 - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance.
4. If all circuits test normal, test or replace the park brake switch.

Brake Fluid Level Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the brake fluid level switch.
2. Test for less than 1 ohm between the ground circuit terminal A and ground.
 - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool IPC Brake Fluid parameter is Ok.
 - If not the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the IPC.
4. Install a 3A fused jumper wire between the signal circuit terminal B and ground. Verify the scan tool IPC Brake Fluid parameter is Low.
 - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the IPC.
5. If all circuits test normal, test or replace the brake fluid level switch.

Component Testing

Park Brake Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the park brake switch.
2. Test for infinite resistance between the signal terminal A and ground with the park brake released.
 - If less than the specified value, replace the park brake switch.
3. Test for less than 1 ohm between the signal terminal A and ground with the park brake applied.
 - If greater than the specified range, replace the park brake switch.

Brake Fluid Level Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the brake fluid level switch.
2. Test for infinite resistance between the ground terminal A and the signal terminal B.
 - If less than the specified value, replace the brake fluid level switch.

Repair Instructions

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

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

BRAKE PULSATION

Brake Pulsation

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

BRAKE SYSTEM NOISE

Brake System Noise

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

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

	Did you find and correct a condition?	Go to Step 9	Go to Step 8
8	Inspect the park brake system for proper operation. Refer to <u>Park Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 9	Go to <u>Diagnostic Starting Point - Vehicle</u>
9	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

BRAKING ACTION UNEVEN - PULLS TO ONE SIDE

Test Description

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

4

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

5

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

Braking Action Uneven - Pulls to One Side

Step	Action	Yes	No
DEFINITION: Vehicle pulls to one side only when braking.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	1. Inspect the hydraulic brake system for the following conditions. • Kinked, pinched or damaged brake pipe or flexible brake hose • Sticking or improperly operating caliper piston • Brake fluid leak 2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>.		

	Did you find and correct a condition?	Go to Step 6	Go to Step 3
3	1. Inspect the disc brake system for the following conditions. • Contaminated linings • Glazed linings • Distorted, cracked or damaged linings on one side • Loose, damaged or missing caliper hardware and/or lining hardware • Incorrect linings on one side • Hard spots, heat checks, blueing discoloration of rotor friction surfaces; possibly due to brake drag • Glazed rotor friction surfaces • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>.		
	Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	1. Inspect the suspension system for the following conditions. • Incorrect tire pressures • Loose suspension component connections • Excessively worn or damaged suspension components 2. Adjust, repair or replace components as necessary. Refer to <u>Diagnostic Starting Point - Vehicle</u>.		
	Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	1. Inspect the steering system for the following conditions. • Loose steering component connections • Excessively worn or damaged steering components 2. Adjust, repair or replace components as necessary. Refer to <u>Diagnostic Starting Point - Vehicle</u>.		
	Did you find and correct a condition?	Go to Step 6	Go to <u>Diagnostic Starting Point - Vehicle</u>

6	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u>.		
	Is the condition still present?	Go to Step 2	System OK

BRAKING ACTION UNEVEN - FRONT TO REAR

Test Descriptions

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

4

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

Braking Action Uneven - Front to Rear

Step	Action	Yes	No
DEFINITION: Braking action or stopping force sensitive or grabbing and/or more pronounced at the front or at the rear axle. Sensitive or grabbing brakes: Excessive brake jump-in force relative to brake pedal input.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	1. Inspect the hydraulic brake system for the following conditions: • Improper operation of caliper pistons • Kinked, pinched or damaged brake pipe or flexible brake hose • Brake fluid leak • Improperly functioning proportion valve, if equipped • Improper operation of dynamic rear proportion (DRP) system, if equipped 2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>.		
	Did you find and correct a condition?	Go to Step 6	Go to Step 3
	1. Inspect the disc brake system for the following conditions:		

3	• Contaminated linings • Glazed linings • Distorted, cracked or damaged linings • Excessively worn linings • Aftermarket linings • Damaged or excessively worn caliper hardware and/or lining hardware • Hard spots, heat checks, blueing discoloration of rotor friction surfaces • Glazed rotor friction surfaces 2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 6	Go to Step 4
4	1. Inspect the suspension system for the following conditions: • Loose suspension component connections • Excessively worn or damaged suspension components 2. Adjust, repair or replace components as necessary. Refer to <u>Diagnostic Starting Point - Vehicle</u>. Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	1. Inspect the brake assist system for the following conditions: • Binding, bent or damaged pedal pushrod, pedal, or pedal bracket • Damaged or improperly operating vacuum booster, if equipped • Damaged or improperly operating hydraulic booster, if equipped 2. Adjust, repair or replace components as necessary. 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 - Vehicle</u>
6	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road</u>		

<u>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
DEFINITION: Brake pedal travels further than expected to obtain firm pedal and/or firm pedal cannot be obtained, pedal fades away, or pedal is spongy.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	Inspect the travel and feel of brake pedal applies. Perform the following: 1. Apply the brake pedal several times to fully deplete the power reserve. 2. With power reserve depleted, apply the brake pedal with light, steady pressure and hold for 15 seconds. Observe pedal travel and feel. 3. Apply the brake pedal with light, steady pressure, then without pumping the pedal, reduce pressure and reapply pressure several times. Observe pedal travel and feel for each apply. 4. Apply the brake pedal slowly, then release and apply the pedal quickly. Observe pedal travel and feel for each apply. Did you complete the brake pedal travel and feel inspections?	Go to Step 3	-
	1. Inspect the hydraulic brake system for the conditions listed, based on the following symptoms observed during the pedal travel and feel inspections: • Pedal feel was spongy ○ Air in hydraulic system ○ External brake fluid leaks ○ Soft, weak or damaged hydraulic hoses; expanding under pressure • Pedal fell away and/or traveled to or almost to floor ○ External brake fluid leaks		

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

	Did you find and correct a condition?	Go to Step 8	Go to Step 5
5	Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection.</u> Is the brake pedal travel distance within the acceptable limits?	Go to Step 7	Go to Step 6
6	- Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. - For the brake pedal pushrod component inspection, refer to <u>Brake Pedal Pushrod Inspection.</u> - Inspect the brake pedal bushings for binding, excessive wear and/or damage and inspect the brake pedal for a misaligned, bent, and/or damaged condition. - Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?	Go to Step 8	Go to Step 7
7	- Inspect the brake assist system for the following conditions: - Vacuum leaks and/or improperly operating check valve, if equipped with vacuum assist - Power steering fluid leaks, if equipped with hydraulic power assist - Damaged or improperly operating brake booster assembly - Adjust, repair or replace components as necessary. Refer to <u>Brake Assist System Diagnosis.</u> Did you find and correct a condition?	Go to Step 8	Go to <u>Diagnostic Starting Point - Vehicle</u>
8	- Install or connect components that were removed or disconnected during diagnosis. - Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test.</u> Is the condition still present?	Go to Step 2	System OK

BRAKE PEDAL EXCESSIVE EFFORT

Brake Pedal Excessive Effort

Step	Action	Yes	No

DEFINITION: Brake pedal requires an increased amount of input from the driver to obtain good braking action and/or stopping distance is increased.

1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	- Inspect the brake assist system for the following conditions: - Vacuum leaks, if equipped with vacuum power assist - Power steering fluid leaks, if equipped with hydraulic power assist - Lack of lubrication, binding or excessively worn pushrod or pedal pivots or pivot bushings - Bent or damaged pedal pushrod, pedal, or pedal bracket - Damaged or improperly operating brake booster assembly - Adjust, repair or replace components as necessary. Refer to <u>Brake Assist System Diagnosis</u>. Did you find and correct a condition?	Go to Step 5	Go to Step 3
3	- Inspect the hydraulic brake system for the following conditions: - Binding caliper pistons - Internally damaged flexible brake hoses; hindering fluid flow - External brake fluid leaks - Kinked or damaged flexible brake hoses and/or pipes - Internal brake fluid leaks; improperly operating master cylinder - Poor brake fluid quality; low boiling point - Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 5	Go to Step 4
	- Inspect the disc brake system for the following conditions: - Excessively worn linings		

4	• Glazed linings • Cracked, distorted or damaged linings • Contaminated linings • Binding, damaged or excessively worn caliper hardware and/or lining hardware • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Excessively worn or corroded rotor friction surfaces • Glazed rotor friction surfaces • Hard spots, heat checks, blueing discoloration of rotor friction surfaces 2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 5	Go to <u>Diagnostic Starting Point - Vehicle</u>
5	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

BRAKES DRAG

Brakes Drag

Step	Action	Yes	No
DEFINITION: Brake system does not fully release or has delayed release; vehicle motion may be hindered by brake system without applying brakes.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</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	1. Inspect the stop lamp switch for proper adjustment to ensure that the brake pedal is fully releasing. 2. Inspect the cruise control release switch, if equipped, for proper adjustment to ensure that the brake pedal is fully releasing.		

	Did you find and correct a condition?	Go to Step 14	Go to Step 4
4	Is the vehicle equipped with a drum-in-rotor type of park brake system?	Go to Step 5	Go to Step 7
5	Ensure the park brake shoes are not adjusted too tightly, possibly causing drag under certain conditions. Are the park brake shoes adjusted too tightly?	Go to Step 6	Go to Step 7
6	1. Clean and inspect the park brake shoes for excessive wear and/or damage. 2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration and heat spots. 3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system. Did you find and correct a condition?	Go to Step 14	Go to Step 7
7	Inspect the park brake system for proper operation. Refer to <u>Park Brake System Diagnosis</u> . Did you find and correct a condition?	Go to Step 14	Go to Step 8
8	1. Inspect the disc brake system for the following conditions: • Binding, incorrectly installed or missing caliper hardware and/or lining hardware- Ensure free movement of linings and of caliper, if equipped with sliding type caliper • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Distorted or damaged linings • Damaged or excessively worn caliper hardware and/or lining hardware • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to <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	1. Inspect the pushrod for improper positioning and/or damage. Correctly position or replace the pushrod if necessary. 2. Inspect the brake pedal assembly for damage and replace if necessary. Did you complete the repair or replacement?	Go to Step 14	-
11	1. For vacuum boost systems, disconnect the vacuum check valve from the booster to relieve vacuum reserve. 2. Separate the master cylinder from the brake booster. Do not disconnect any brake pipes. 3. Inspect the brake corners to determine if the brake drag condition is still present. Do the brake corners still exhibit the brake drag condition?	Go to Step 13	Go to Step 12
12	Replace the brake booster assembly. Did you complete the replacement?	Go to Step 14	-
13	1. Inspect the hydraulic brake system for the following conditions. • Improper operation of caliper pistons • Contaminated brake fluid • Internally damaged flexible brake hoses; hindering brake release • Damaged or improperly operating master cylinder 2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 14	Go to <u>Diagnostic Starting Point - Vehicle</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

Step	Action	Yes	No
DEFINITION: Brake system releases and returns to rest slowly; vehicle motion is hindered by brake system briefly after release of brake pedal.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	- Inspect the hydraulic brake system for the following conditions: - Improper operation of caliper pistons - Internally damaged flexible brake hoses; hindering brake release - Contaminated brake fluid - Damaged or improperly operating master cylinder - Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 5	Go to Step 3
3	- Inspect the brake assist system for the following conditions: - Binding, bent or damaged pedal pushrod, pedal, or pedal bracket - Damaged or improperly operating vacuum booster, if equipped - Restricted return hose from hydraulic booster, if equipped - Damaged or improperly operating hydraulic booster, if equipped - Adjust, repair or replace components as necessary. Refer to <u>Brake Assist System Diagnosis</u>. Did you find and correct a condition?	Go to Step 5	Go to Step 4
4	- Inspect the disc brake system for the following conditions: - Damaged or excessively worn caliper hardware and/or lining hardware - Distorted or damaged linings - Lack of lubrication or excessive corrosion on metal to metal contact surfaces		

	• Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 5	Go to <u>Diagnostic Starting Point - Vehicle</u>
5	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 FLUID LOSS

Brake Fluid Loss

Step	Action	Yes	No
DEFINITION: Brake fluid level is low not related to lining wear.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	1. Inspect the following hydraulic brake system components for brake fluid leaks: • Flexible brake hose connections; threaded and bolted • Flexible brake hose crimp joints • Brake pipe fittings • Caliper piston seals • Wheel cylinder piston seals, if equipped • Master cylinder reservoir • Master cylinder reservoir low pressure hose, if equipped • Brake pressure modulator valve (BPMV) assembly, if equipped 2. Repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 8	Go to Step 3
3	Is the vehicle equipped with a vacuum brake booster?	Go to Step 4	Go to Step 6
	1. Disconnect the vacuum check valve from the		

4	booster to relieve vacuum reserve. 2. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. 3. Inspect the rear of the master cylinder for a brake fluid leak. 4. Inspect for brake fluid in the vacuum brake booster. Did you find a brake fluid leak?	Go to Step 5	Go to <u>Diagnostic Starting Point - Vehicle</u>
5	Replace the brake master cylinder and the vacuum brake booster. Did you complete the replacement?	Go to Step 8	-
6	1. Wipe clean the external surface of the master cylinder to hydraulic brake booster area, if equipped. 2. Separate the master cylinder from the hydraulic brake booster, if equipped. Do not disconnect any brake pipes. 3. Inspect the rear of the master cylinder for a brake fluid leak. Did you find a brake fluid leak?	Go to Step 7	Go to <u>Diagnostic Starting Point - Vehicle</u>
7	Replace the brake master cylinder. Did you complete the replacement?	Go to Step 8	-
8	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u> . Is the condition still present?	Go to Step 2	System OK

DISC BRAKE SYSTEM DIAGNOSIS

Test Description

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

9

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

10

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

system components.

12

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

15

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

19

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

22

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

Disc Brake System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the DISC brake system in order to determine if the DISC brake system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to Step 2	Go to <u>Diagnostic Starting Point - Vehicle</u>
2	Visually inspect the disc brake pads for the following conditions: Refer to <u>Front Disc Brake Pads Replacement (JE5, J55 (RWD))</u> , <u>Front Disc Brake Pads Replacement (JE5, J55 (AWD))</u> , <u>Front Disc Brake Pads Replacement (J56)</u> . • Lining thickness below specifications • Uneven and/or abnormal wear- edge-to-edge and/or side-to-side • Looseness or damage-including pad hardware • Evidence of contamination from an external substance Did you find any conditions to indicate a concern with		

	any of the front and/or rear disc brake pads?	Go to Step 3	Go to Step 12
3	Are any of the front and/or rear disc brake pads contaminated?	Go to Step 8	Go to Step 4
4	Are any of the front and/or rear disc brake pads worn unevenly?	Go to Step 7	Go to Step 5
5	Are any of the front and/or rear disc brake pads and/or pad hardware loose or damaged?	Go to Step 7	Go to Step 6
6	1. Remove and inspect the worn disc brake pads for glazing, looseness, heat spots or damage. 2. Replace the worn disc brake pads as a complete axle set. Refer to <u>Front Disc Brake Pads Replacement (JE5, J55 (RWD))</u> , <u>Front Disc Brake Pads Replacement (JE5, J55 (AWD))</u> , <u>Front Disc Brake Pads Replacement (J56)</u> , and/or <u>Rear Disc Brake Pads Replacement (JE5, J55)</u> , <u>Rear Disc Brake Pads Replacement (J56)</u> . Did you complete the inspection and replacement?	Go to Step 12	-
	CAUTION: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak. NOTE: Do NOT disconnect the hydraulic brake flex hoses from the calipers. 1. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets or from the suspension knuckles and support the calipers. Refer to <u>Front Brake Caliper Replacement (JE5, J55 (AWD))</u> , <u>Front Brake Caliper Replacement (JE5, J55 (RWD))</u> , <u>Front Brake Caliper Replacement (J56)</u> , and/or <u>Rear Brake Caliper Replacement (J56)</u> , <u>Rear Brake Caliper Replacement (JE5, J55)</u> . 2. Inspect the disc brake caliper mounting bracket or the suspension knuckles and the		

mounting/sliding hardware for the following conditions:

Refer to **Front Disc Brake Mounting and Hardware Inspection** , and/or **Rear Disc Brake Mounting and Hardware Inspection** .

- Binding or seized hardware
- Worn, damaged or missing hardware components
- Loose, bent, cracked, or damaged caliper mounting bracket or suspension knuckle

3. Replace components as required. Refer to the following procedures, as required:

- **Front Brake Caliper Bracket Replacement (RWD)** , **Front Brake Caliper Bracket Replacement (AWD)**
- **Rear Brake Caliper Bracket Replacement**
- **Front Brake Caliper Hardware Replacement (JE5, J55 (RWD))** , **Front Brake Caliper Hardware Replacement (J56)** , **Front Brake Caliper Hardware Replacement (JE5, J55 (AWD))**
- **Rear Brake Caliper Hardware Replacement (JE5, J55)** , **Rear Brake Caliper Hardware Replacement (J56)**

4. Replace the unevenly-worn, loose or damaged disc brake pads as a complete axle set. Refer to **Front Disc Brake Pads Replacement (JE5, J55 (RWD))** , **Front Disc Brake Pads Replacement (JE5, J55 (AWD))** , **Front Disc Brake Pads Replacement (J56)** , and/or **Rear Disc Brake Pads Replacement (JE5, J55)** , **Rear Disc Brake Pads Replacement (J56)** .

Did you complete the inspection and replacement?

Go to **Step 12**

1. Inspect the disc brake calipers, brake hoses and brake pipes for evidence of an external brake fluid leak.
2. Replace any components found to be leaking brake fluid. Refer to the following procedures as required:
 - **Front Brake Caliper Overhaul (JE5,**

8	<u>J55</u> , <u>Front Brake Caliper Overhaul (J56)</u> , or <u>Front Brake Caliper Replacement (JE5, J55 (AWD))</u> , <u>Front Brake Caliper Replacement (JE5, J55 (RWD))</u> , <u>Front Brake Caliper Replacement (J56)</u> • <u>Rear Brake Caliper Overhaul (JE5, J55)</u> , <u>Rear Brake Caliper Overhaul (J56)</u> , or <u>Rear Brake Caliper Replacement (J56)</u> , <u>Rear Brake Caliper Replacement (JE5, J55)</u> • <u>Front Brake Hose Replacement (RWD)</u>, <u>Front Brake Hose Replacement (AWD)</u> • <u>Rear Brake Hose Replacement</u> • <u>Brake Pipe Replacement</u> Did you find and correct the source of the leak causing contamination of the pads?	Go to Step 11	Go to Step 9
9	1. Inspect the wheel drive shaft outer seals for damage and evidence of a grease leak. 2. Replace any wheel drive shaft seal that is found to be leaking grease which may be the source of the contamination to the pads. Refer to <u>Wheel Drive Shaft Outer Joint Inspection</u> . Did you find and correct the source of the leak causing contamination of the pads?	Go to Step 11	Go to Step 10
10	1. Inspect the automatic transmission cooling system lines, if equipped, for damage and evidence of an external fluid leak which may be the source of the contamination to the pads. 2. Inspect the power steering system hoses for damage and evidence of an external fluid leak which may be the source of the contamination to the pads. 3. Replace any components found to be leaking fluid which may be the source of the contamination to the pads. Did you find and correct the source of the leak causing contamination of the pads?	Go to Step 11	-
	1. Clean the remaining disc brake system components to remove any traces of the contaminant.		

CAUTION:

Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

NOTE:

Do NOT disconnect the hydraulic brake flex hoses from the calipers.

2. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets or the suspension knuckles and support the calipers. Refer to **Front Brake Caliper Replacement (JE5, J55 (AWD))** , **Front Brake Caliper Replacement (JE5, J55 (RWD))** , **Front Brake Caliper Replacement (J56)** , and/or **Rear Brake Caliper Replacement (J56)** , **Rear Brake Caliper Replacement (JE5, J55)** .

3. Inspect the disc brake caliper mounting/sliding hardware for the following conditions:

Refer to **Front Disc Brake Mounting and Hardware Inspection** , and/or **Rear Disc Brake Mounting and Hardware Inspection** .

- Binding or seized hardware
 - Distorted, worn, damaged or missing hardware components
4. Replace the caliper mounting/sliding hardware components as required. Refer to **Front Brake Caliper Hardware Replacement (JE5, J55 (RWD))** , **Front Brake Caliper Hardware Replacement (J56)** , **Front Brake Caliper Hardware Replacement (JE5, J55 (AWD))** , and/or **Rear Brake Caliper Hardware Replacement (JE5, J55)** , **Rear Brake Caliper Hardware Replacement (J56)** .
5. Replace the contaminated disc brake pads as a complete axle set. Refer to **Front Disc Brake Pads Replacement (JE5, J55 (RWD))** , **Front**

	<u>Disc Brake Pads Replacement (JE5, J55 (AWD)) , Front Disc Brake Pads Replacement (J56) , and/or Rear Disc Brake Pads Replacement (JE5, J55) , Rear Disc Brake Pads Replacement (J56) .</u> Did you complete the cleaning, inspection and replacement?	Go to Step 12	
12	Visually inspect each of the disc brake rotor shields/backing plates, if equipped, for evidence of contact with the brake rotors. Are any of the brake rotor shields/backing plates contacting the brake rotors?	Go to Step 13	Go to Step 14
13	Repair or replace the disc brake rotor shields/backing plates as required. Refer to <u>Front Brake Shield Replacement (AWD) , Front Brake Shield Replacement (RWD) .</u> Did you complete the repair or replacement?	Go to Step 14	-
14	1. Check the thickness of each of the disc brake rotors. NOTE: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor. 2. Make a determination for each brake rotor if the rotor can be REFINISHED and REMAIN ABOVE the minimum requirements. Refer to <u>Brake Rotor Thickness Measurement (JE5, J55 Front and Rear, J56 Rear) , Brake Rotor Thickness Measurement (J56 Front)</u> .Does the disc brake rotor meet the minimum requirements for REFINISHING?	Go to Step 15	Go to Step 18
15	NOTE: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor. Inspect each of the disc brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to <u>Brake Rotor Thickness Variation Measurement</u> .Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?	Go to Step 17	Go to Step 16
	1. Inspect each of the disc brake rotors for the following surface and wear conditions:		

16	Refer to <u>Brake Rotor Surface and Wear Inspection</u> . • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level NOTE: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor. 2. Make a determination for each brake rotor if the rotor requires refinishing based upon the results of the inspection. If the brake rotor exhibits any of the conditions listed previously, it requires refinishing. Does the brake rotor require REFINISHING?	Go to Step 17	Go to Step 22
17	1. Refinish the brake rotor. Refer to <u>Brake Rotor Refinishing</u> . 2. Inspect the brake rotor thickness. Refer to <u>Brake Rotor Thickness Measurement (JE5, J55 Front and Rear, J56 Rear)</u> , <u>Brake Rotor Thickness Measurement (J56 Front)</u> . Were you able to REFINISH the brake rotor within the minimum requirements?	Go to Step 22	Go to Step 21
18	Is the brake rotor at or below the MINIMUM THICKNESS requirements?	Go to Step 21	Go to Step 19
19	NOTE: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor. Inspect each of the disc brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to <u>Brake Rotor Thickness Variation Measurement</u> .Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?	Go to Step 21	Go to Step 20
	1. Inspect each of the disc brake rotors for the following surface and wear conditions:		

20	Refer to <u>Brake Rotor Surface and Wear Inspection</u> . • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level NOTE: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor. 2. Make a determination for each brake rotor if the rotor requires replacement based upon the results of the inspection. If the brake rotor exhibits any of the conditions listed previously, it requires replacement. Does the brake rotor require REPLACEMENT?	Go to Step 21	Go to Step 22
21	NOTE: Whenever a brake rotor is replaced, the assembled lateral runout (LRO) of the rotor must be measured to ensure optimum performance of the disc brakes. Replace the brake rotor. Refer to <u>Front Brake Rotor Replacement (JE5, J55 (RWD))</u> , <u>Front Brake Rotor Replacement (JE5, J55 (AWD))</u> , <u>Front Brake Rotor Replacement (J56)</u> , or <u>Rear Brake Rotor Replacement (J56)</u> , <u>Rear Brake Rotor Replacement (JE5, J55)</u> .Did you complete the replacement?	Go to Step 24	-
22	NOTE: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor. Inspect each of the disc brake rotors for assembled lateral runout (LRO) that exceeds the maximum acceptable level. Refer to <u>Brake Rotor Assembled Lateral Runout Measurement</u> .Does the brake rotor exhibit assembled LRO that exceeds the maximum acceptable level?	Go to Step 23	Go to Step 24
	Correct the LRO for each brake rotor that was determined to have LRO exceeding the maximum		

23	acceptable level. Refer to <u>Brake Rotor Assembled Lateral Runout Correction</u> . Did you complete the operation?	Go to Step 24	-
24	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Disc Brake System OK Return to Symptom Table	-

HYDRAULIC BRAKE SYSTEM DIAGNOSIS

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 - Vehicle</u>
2	Inspect and adjust the brake fluid level in the brake master cylinder. Refer to <u>Master Cylinder Reservoir Filling</u> . Was the brake fluid level low?	Go to Step 3	Go to Step 4
3	- Inspect the brake fluid for the following conditions, indicating brake fluid contamination: - Fluid separation, indicating two types of fluid are present - Swirled appearance-oil-based substance - Layered appearance-silicone-based substance - Fluid discoloration - Cloudy appearance-moisture - Dark appearance/suspended particles in fluid-dirt, rust, corrosion, brake dust - Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination. Do any of the above conditions exist?	Go to Step 5	Go to Step 6
	- Inspect the brake fluid for the following conditions, indicating brake fluid contamination: - Fluid separation, indicating two types of fluid are present - Swirled appearance-oil-based substance - Layered appearance-silicone-based		

4	substance • Fluid discoloration ○ Cloudy appearance-moisture ○ Dark appearance/ suspended particles in fluid-dirt, rust, corrosion, brake dust 2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination. Do any of the above conditions exist?	Go to Step 5	Go to Step 12
5	1. Flush the hydraulic brake system. Refer to <u>Hydraulic Brake System Flushing</u>. 2. If the brake fluid WAS contaminated with an oil-based or a silicone-based fluid, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets, perform the following steps. Refer to the procedures indicated. 1. Remove ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. 2. Clean out the hydraulic brake pipes using denatured alcohol, or equivalent. 3. Dry the brake pipes using non-lubricated, filtered air. 4. Repair or replace ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. • <u>Master Cylinder Replacement (RHD), Master Cylinder Replacement (LHD)</u> • 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. • <u>Front Brake Hose Replacement (RWD), Front Brake Hose Replacement (AWD)</u>		-

	• <u>Rear Brake Hose Replacement</u> • <u>Front Brake Caliper Overhaul (JE5, J55) , Front Brake Caliper Overhaul (J56) , or Front Brake Caliper Replacement (JE5, J55 (AWD)) , Front Brake Caliper Replacement (JE5, J55 (RWD)) , Front Brake Caliper Replacement (J56)</u> • <u>Rear Brake Caliper Overhaul (JE5, J55) , Rear Brake Caliper Overhaul (J56) , or Rear Brake Caliper Replacement (J56) , Rear Brake Caliper Replacement (JE5, J55)</u> • <u>Brake Pressure Modulator Valve Replacement (CTS) , Brake Pressure Modulator Valve Replacement (CTS-V)</u> 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 brake master cylinder reservoir cap diaphragm which may have allowed moisture or dirt to enter the system. 4. Refill and bleed the hydraulic brake system. Refer to <u>Hydraulic Brake System Bleeding (Manual)</u>, <u>Hydraulic Brake System Bleeding (Pressure)</u>. Did you complete the operation and any required repairs and/or replacements?		
	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: • <u>Master Cylinder Replacement (RHD)</u>, <u>Master Cylinder Replacement (LHD)</u> • Brake master cylinder reservoir cap diaphragm • <u>Front Brake Hose Replacement (RWD)</u>, <u>Front Brake Hose Replacement (AWD)</u> • <u>Rear Brake Hose Replacement</u> • <u>Brake Pipe Replacement</u> • <u>Front Brake Caliper Overhaul (JE5, J55) , Front Brake Caliper Overhaul (J56) , or Front Brake Caliper Replacement (JE5, J55 (AWD)) , Front Brake Caliper</u>	Go to Step 9	

6	<u>Replacement (JE5, J55 (RWD)) , Front Brake Caliper Replacement (J56)</u> • <u>Rear Brake Caliper Overhaul (JE5, J55) , Rear Brake Caliper Overhaul (J56) , or Rear Brake Caliper Replacement (J56) , Rear Brake Caliper Replacement (JE5, J55)</u> • <u>Brake Pressure Modulator Valve Replacement (CTS) , Brake Pressure Modulator Valve Replacement (CTS-V)</u> 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>, <u>Hydraulic Brake System Bleeding (Pressure)</u>. While bleeding the hydraulic brake system, observe for the following conditions: • The presence of air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder was replaced • 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	Inspect the hydraulic function of the brake calipers for proper operation. Refer to <u>Hydraulic Brake Component Operation Visual Inspection</u>. Was the hydraulic function of the brake calipers operating properly?	Go to Step 21	Go to Step 14
10	Was the flow of brake fluid restricted or uneven through front axle hydraulic components during the bleeding procedure?	Go to Step 13	Go to Step 11
11	Was the flow of brake fluid restricted or uneven through rear axle hydraulic components during the bleeding procedure?	Go to Step 17	-
12	Inspect the hydraulic function of the brake calipers for proper operation. Refer to <u>Hydraulic Brake Component Operation Visual Inspection</u>. Was the hydraulic function of the brake calipers operating properly?	Go to Step 15	Go to Step 13

13	Determine if the brake caliper is restricting the flow of brake fluid and/or not operating properly: 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Remove the tire and wheel assemblies. Refer to <u>Tire and Wheel Removal and Installation</u> . 3. Open the suspected caliper bleeder valve. 4. Using a large C-clamp, compress the caliper piston and observe for an unrestricted flow of brake fluid and for free movement of the caliper piston. 5. Close the caliper bleeder valve. Was the flow of brake fluid unrestricted and did the caliper piston move freely?	Go to Step 17	Go to Step 14
14	Repair or replace any brake caliper that was not operating properly. Refer to the appropriate procedure: • <u>Front Brake Caliper Overhaul (JE5, J55)</u> , <u>Front Brake Caliper Overhaul (J56)</u> , or <u>Front Brake Caliper Replacement (JE5, J55 (AWD))</u> , <u>Front Brake Caliper Replacement (JE5, J55 (RWD))</u> , <u>Front Brake Caliper Replacement (J56)</u> • <u>Rear Brake Caliper Overhaul (JE5, J55)</u> , <u>Rear Brake Caliper Overhaul (J56)</u> , or <u>Rear Brake Caliper Replacement (J56)</u> , <u>Rear Brake Caliper Replacement (JE5, J55)</u> Did you complete the repair and/or replacement?	Go to Step 21	-
15	Bleed the hydraulic brake system to observe for the presence of air in the system and to observe for an unrestricted and even flow of brake fluid per axle during the bleeding procedure. Refer to <u>Hydraulic Brake System Bleeding (Manual)</u>, <u>Hydraulic Brake System Bleeding (Pressure)</u>. Was there air in the system?	Go to Step 19	Go to Step 16
16	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 21	Go to Step 17
	1. Inspect the hydraulic brake pipes and flexible brake hoses for signs of a fluid restriction; such as being bent, kinked, pinched or damaged. Refer to <u>Brake Pipe and Hose Inspection</u>. 2. Replace any of the hydraulic brake pipes and/or		

17	flexible brake hoses found to be bent, kinked, pinched or damaged. Refer to the following procedures as necessary: • <u>Front Brake Hose Replacement (RWD), Front Brake Hose Replacement (AWD)</u> • <u>Rear Brake Hose Replacement</u> • <u>Brake Pipe Replacement</u> 3. If none of the hydraulic brake pipes or flexible brake hoses were visibly bent, kinked, pinched or damaged, replace the hydraulic brake flex hose at the restricted location.		
	Did you find and correct a condition?	Go to Step 21	Go to Step 18
18	Replace the brake pressure modulator valve (BPMV), in order to correct the hydraulic brake dynamic rear proportioning mechanical operation. Refer to <u>Brake Pressure Modulator Valve Replacement (CTS)</u>, <u>Brake Pressure Modulator Valve Replacement (CTS-V)</u>. Did you complete the replacement?	Go to Step 21	-
19	1. Inspect the hydraulic brake system components for brake fluid seepage at a seal and/or fitting location, which may have drawn air into the system. 2. Inspect the hydraulic brake system components for evidence of a recent repair, which may have introduced air into the system. 3. Repair or replace any of the components found to be installed incorrectly or seeping brake fluid. Did you find and correct a condition?	Go to Step 21	Go to Step 20
20	1. Inspect the brake master cylinder for internal fluid leaks. Refer to <u>Brake System Internal Leak Test</u>. 2. Replace the brake master cylinder if it is found to be leaking brake fluid internally. Refer to <u>Master Cylinder Replacement (RHD)</u>, <u>Master Cylinder Replacement (LHD)</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 3	Go to Step 2
2	Were you sent here directly from an electrical diagnostic to investigate vacuum as a possible concern?	Go to Step 5	Go to <u>Diagnostic Starting Point - Vehicle</u>
3	Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u> . Is the brake pedal travel distance within the acceptable limits?	Go to Step 5	Go to Step 4
4	- Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. - For the brake pedal pushrod component inspection, refer to <u>Brake Pedal Pushrod Inspection</u>. - Inspect the brake pedal bushings for excessive wear and/or damage and inspect the brake pedal for a misaligned, bent and/or damaged condition. - Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?	Go to Step 5	Go to <u>Hydraulic Brake System Diagnosis</u> to check for internal and external fluid leaks and air in the hydraulic brake system
5	Check the engine vacuum source that supplies vacuum to the vacuum brake booster. Refer to <u>Brake System Vacuum Source Test</u> . Is the vacuum reading within the acceptable limits?	Go to Step 6	Go to Engine Controls Diagnostics Information to check for vacuum issues, including vacuum pump operation, if equipped
6	Does the condition occur during cold start-up conditions?	Go to Step 7	Go to Step 8
7	Check engine vacuum, and vacuum pump operation, if equipped, under the same cold start-up conditions. Refer to <u>Auxiliary Brake Booster Pump Malfunction - DTC C027B</u> . Did you find and correct a condition?	Go to Step 22	Go to Step 9
8	During the vacuum source test, did the vacuum booster check valve operate properly?	Go to Step 10	Go to Step 9

9	Replace the vacuum booster check valve. Refer to <u>Power Brake Booster Vacuum Check Valve and Hose Replacement (6.2L)</u>, <u>Power Brake Booster Vacuum Check Valve and Hose Replacement (3.0L, 3.6L Left Hand Drive)</u>, <u>Power Brake Booster Vacuum Check Valve and Hose Replacement (3.0L, 3.6L Right Hand Drive)</u>. Did you complete the replacement?	Go to Step 10	-
10	If equipped with a booster mounted separate vacuum sensor, inspect the vacuum sensor grommet for cracks, cuts, dry-rot, or damage. Does the vacuum sensor grommet exhibit any of the conditions listed?	Go to Step 11	Go to Step 12
11	Replace the vacuum sensor grommet. Did you complete the replacement?	Go to Step 12	-
12	1. If the vehicle is equipped with a vacuum sensor, install a scan tool. 2. Using the Data Display function, determine if brake booster vacuum sensor data is available within either the chassis brake controls area or the powertrain engine controls area. Is vacuum sensor data available through the scan tool?	Go to Step 13	Go to Step 16
13	Perform the vacuum booster leak-down test using a scan tool: 1. Release the brake pedal. 2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2-3 seconds and repeat once. 3. Turn the ignition OFF. 4. Turn the ignition ON. Do not start the engine. 5. Observe and record the vacuum sensor reading on the scan tool over a period of 60 seconds. NOTE: Vacuum readings will decrease by approximately 2.7 kPa (0.8 Hg) for every 305 m (1000 ft) of elevation above sea level. 6. Determine the rate of vacuum leak. Specification Maximum allowable vacuum leak rate: 10 kPa		

	(3 in Hg) in 60 seconds		
	Was the rate of vacuum leak within the specified allowable range?	Go to Step 18	Go to Step 14
14	1. Deplete the vacuum reserve by pressing the brake pedal several times, or by removing the vacuum booster check valve. 2. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Refer to <u>Master Cylinder Replacement (RHD)</u>, <u>Master Cylinder Replacement (LHD)</u>. 3. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder. Replace the vacuum seal as necessary. 4. Carefully reinstall the master cylinder to the brake booster. Refer to <u>Master Cylinder Replacement (RHD)</u>, <u>Master Cylinder Replacement (LHD)</u>. Did you complete the operation?	Go to Step 15	-
15	Perform the vacuum booster leak-down test using a scan tool: 1. Release the brake pedal. 2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2-3 seconds and repeat once. 3. Turn the ignition OFF. 4. Turn the ignition ON. Do not start the engine. 5. Observe and record the vacuum sensor reading on the scan tool over a period of 60 seconds. NOTE: Vacuum readings will decrease by approximately 2.7 kPa (0.8 Hg) for every 305 m (1000 ft) of elevation above sea level. 6. Determine the rate of vacuum leak. Specification Maximum allowable vacuum leak rate: 10 kPa		

	(3 in Hg) in 60 seconds		
	Was the rate of vacuum leak within the specified allowable range?	Go to Step 22	Go to Step 21
16	1. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Before removing the master cylinder, first deplete the vacuum by removing the check valve or applying the brake pedal several times. Refer to <u>Master Cylinder Replacement (RHD)</u>, <u>Master Cylinder Replacement (LHD)</u>. 2. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder. 3. If equipped with a vacuum seal that is part of the booster, inspect the seal for damage. Does the vacuum seal exhibit any of the conditions listed?	Go to Step 17	Go to Step 18
17	1. If equipped with a vacuum seal on the rear of the master cylinder, replace the vacuum seal as necessary. Ensure the seal is positioned correctly during installation. 2. If equipped with a vacuum seal that requires replacement and which is part of the booster, the booster assembly must be replaced. 3. Carefully reinstall the master cylinder to the brake booster. Refer to <u>Master Cylinder Replacement (RHD)</u>, <u>Master Cylinder Replacement (LHD)</u>. Did you complete the replacement?	Go to Step 18	-
	Perform the vacuum boost functional test: 1. If still separated, reinstall the master cylinder to the booster. Refer to <u>Master Cylinder Replacement (RHD)</u>, <u>Master Cylinder Replacement (LHD)</u>. 2. If the engine was started after reinstalling the master cylinder to the booster, perform the following: With the engine OFF, depress the brake pedal		

18	several times to deplete the vacuum reserve. - Depress and maintain moderate foot pressure on the brake pedal. - Start the engine and observe pedal operation. - Observe for audible vacuum leaks. The brake pedal should fall slightly, then hold. Is there an audible vacuum leak coming from the brake pedal area?	Go to Step 21	Go to Step 19
19	Did the brake pedal fall slightly after the engine was started, then hold?	Go to Step 20	Go to Step 21
20	Perform the vacuum booster leak-down test: - Release the brake pedal. - Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2-3 seconds and repeat once. - Turn the ignition OFF. - Wait 60 seconds. - Depress the brake pedal 2 times to check for vacuum booster available vacuum reserve. Observe pedal effort. - Both pedal applies should be assisted - The amount of assist could diminish slightly with the second apply Were both pedal applies power assisted?	Go to Step 22	Go to Step 21
21	Replace the vacuum brake booster. Refer to <u>Power Vacuum Brake Booster Replacement (RHD), Power Vacuum Brake Booster Replacement (LHD)</u>. Did you complete the replacement?	Go to Step 22	-
22	Install or connect any components that were removed or disconnected during diagnosis. Did you complete the operation?	Brake Assist System OK Return to Symptom Table	-

BRAKE SYSTEM VEHICLE ROAD TEST

Preliminary Inspections

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

Road Testing Procedure

WARNING: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

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

15. Select a smooth, dry, clean and level road that is as free of heavy traffic as possible for brake system moderate speed road testing.
16. Drive the vehicle at a moderate speed. Observe for a pull and/or incorrect tracking of the vehicle without the brakes applied.
17. While continuing to drive the vehicle at a moderate speed, perform several light applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system noise, pulsation and/or brake drag.
18. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.
19. If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 20.
20. While continuing to drive the vehicle at a moderate speed, perform several moderate applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system pulsation and/or uneven braking action - either side to side, or front to rear.

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

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

BRAKE PEDAL TRAVEL MEASUREMENT AND INSPECTION

Special Tools

CH-28662 Brake Pedal Effort Gauge

For equivalent regional tool, refer to **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 **CH-28662** Brake Pedal Effort Gauge to the brake pedal.

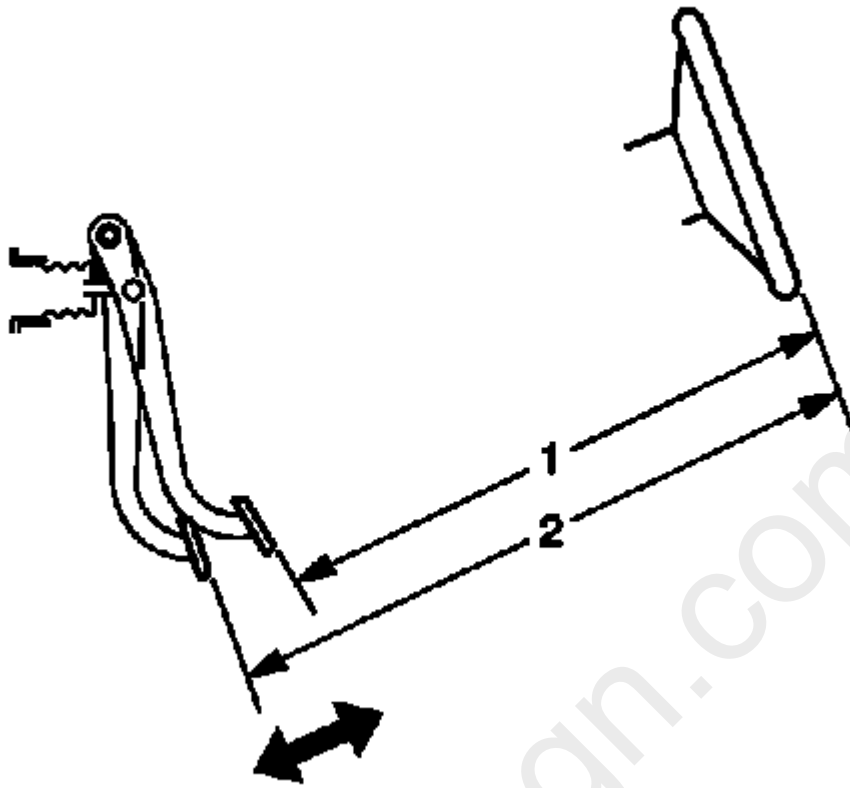


Fig. 2: Measuring Brake Pedal Travel
Courtesy of GENERAL MOTORS COMPANY

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 **CH-28662** Brake Pedal Effort Gauge.
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.
9. Compare the brake pedal travel distance obtained with the specification. Refer to **Brake System Specifications**.

BRAKE SYSTEM VACUUM SOURCE TEST

NOTE:

- Engine temperature, accessory load, and elevation level will affect

engine vacuum.

- **Vacuum readings will decrease by approximately 2.7 kPa (0.8 in Hg) for every 305 m (1000 ft) of elevation above sea level.**

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

Specification

47-68 kPa (14-20 in Hg)

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

Specification

47-68 kPa (14-20 in Hg)

16. If the engine vacuum reading is maintained within the specified normal range, proceed to step 18.
17. If the engine vacuum reading is NOT maintained within the specified normal range, replace the brake booster check valve, then repeat steps 11-15.
18. Inspect the brake booster check valve grommet for the following conditions:

- Loose connection to the vacuum brake booster
- Deformation or contamination
- Cracks, cuts, dry-rot

19. If any of these conditions were found with the check valve grommet, replace the grommet.

BRAKE SYSTEM EXTERNAL LEAK INSPECTION

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

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

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

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

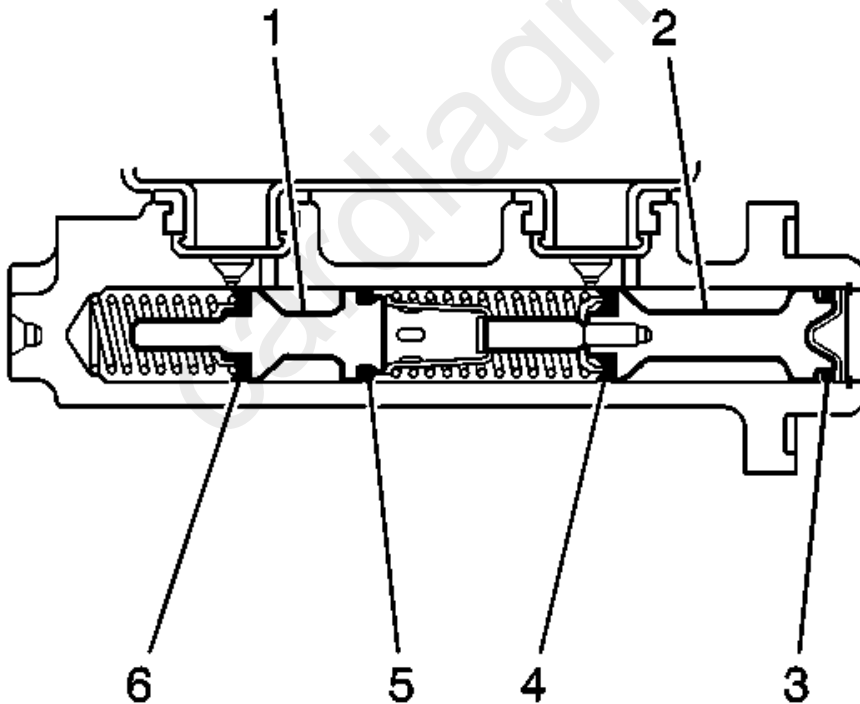


Fig. 3: Identifying Brake Master Cylinder (Cross Sectional View)
Courtesy of GENERAL MOTORS COMPANY

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

HYDRAULIC BRAKE COMPONENT OPERATION VISUAL INSPECTION

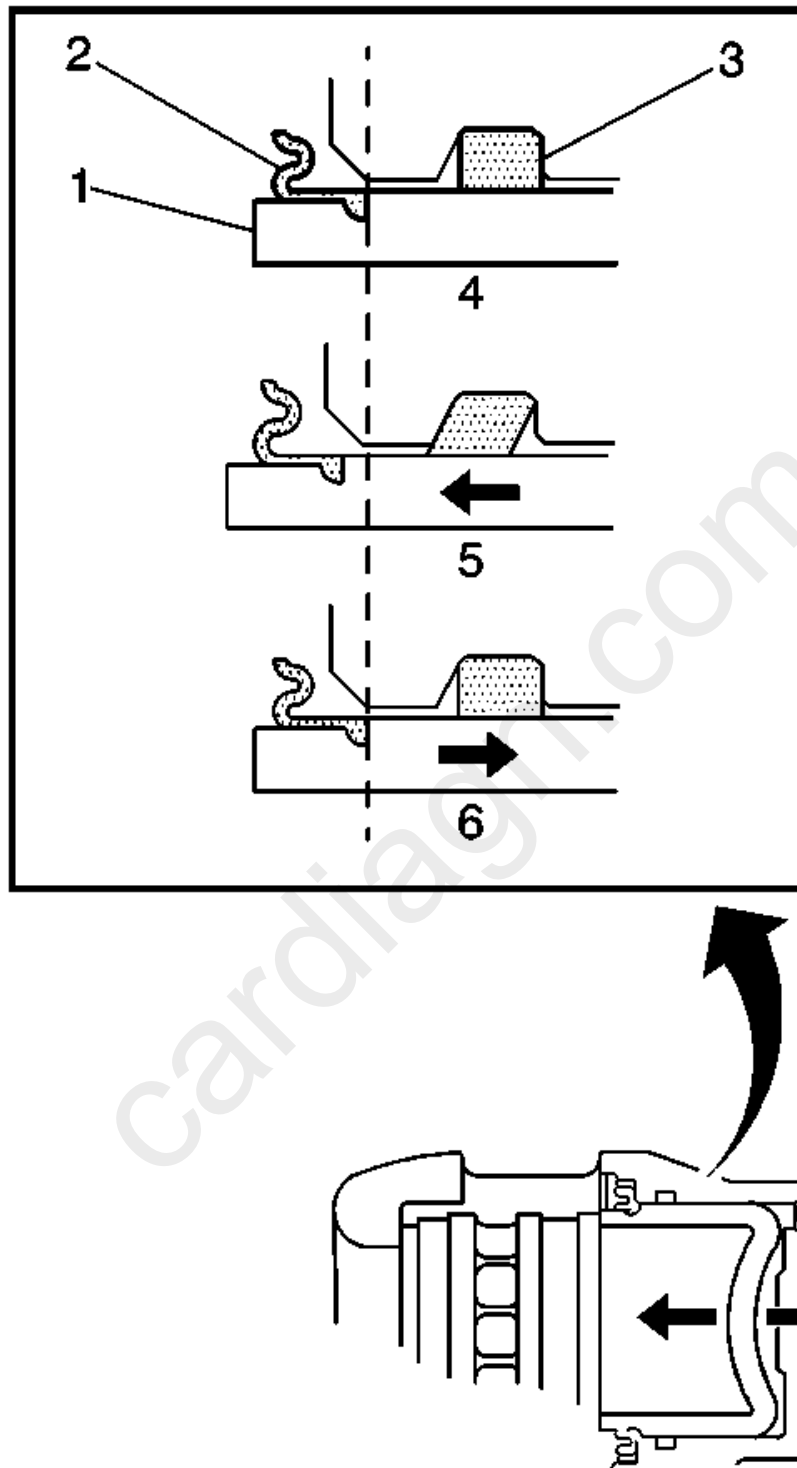


Fig. 4: Identifying Brake Caliper/Pad Inspection Areas
 Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

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

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

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

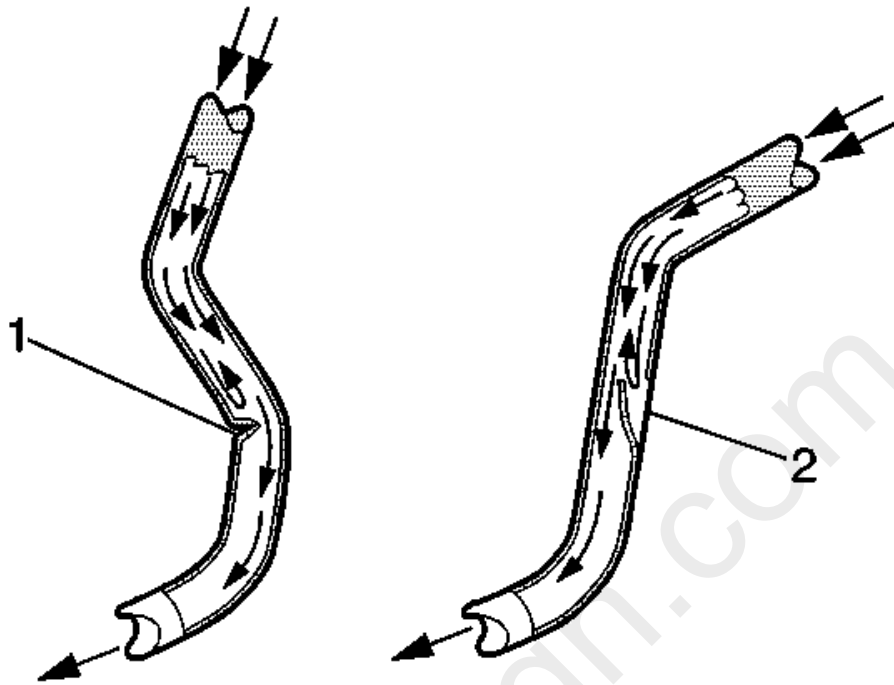


Fig. 5: Identifying Flexible Brake Hose Failure Conditions
Courtesy of GENERAL MOTORS COMPANY

4. Visually inspect all of the flexible brake hoses for the following conditions:
 - Kinks (1), improper routing, twists, chafing, missing or damaged retainers
 - Leaking connections, cracking, dry-rot, blisters, bulges
5. If any of the flexible brake hoses exhibited any of the conditions listed, then the identified flexible brake hose, or hoses require replacement.
6. Squeeze the flexible brake hoses with firm finger pressure to check for soft spots (2), indicating an internal restriction. Check the entire length of each flexible brake hose.
7. If any of the flexible brake hoses were found to have soft spots (2), then the identified flexible brake hose, or hoses require replacement.

BRAKE PEDAL PUSHROD INSPECTION

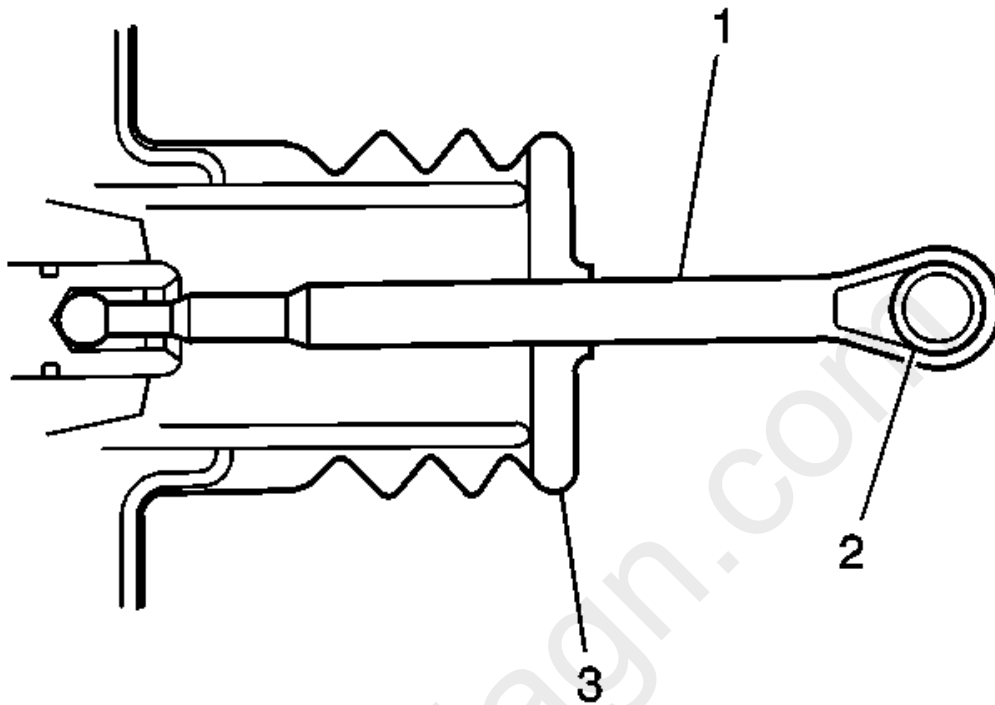


Fig. 6: View of Brake Pedal Pushrod
Courtesy of GENERAL MOTORS COMPANY

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

REPAIR INSTRUCTIONS

MASTER CYLINDER RESERVOIR FILLING

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

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

MASTER CYLINDER RESERVOIR REPLACEMENT (LHD)

Removal Procedure

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Remove the brake fluid from the master cylinder reservoir.
2. Disconnect the brake fluid level indicator switch electrical connector.

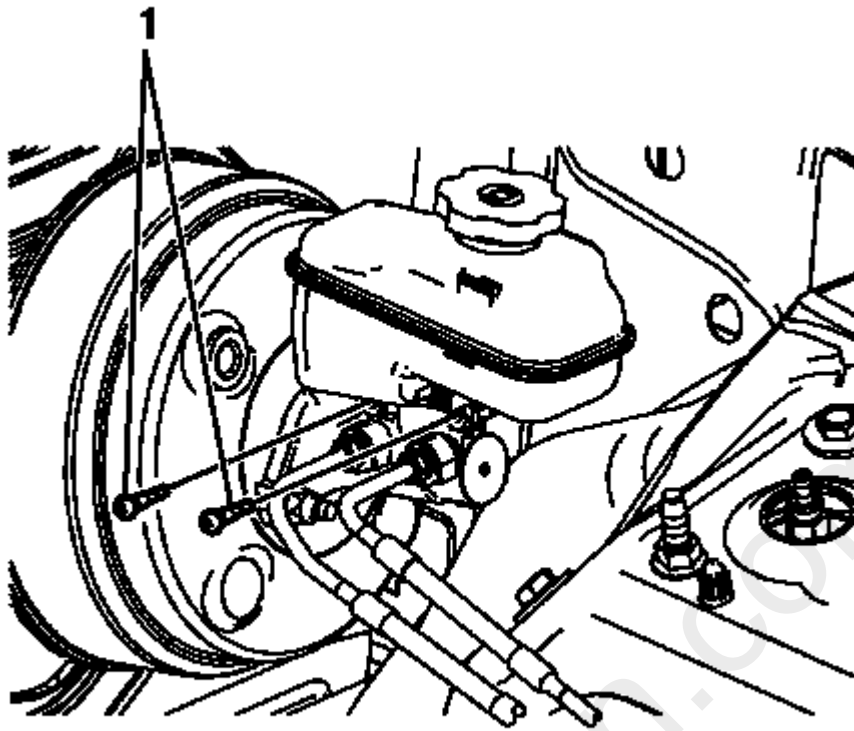


Fig. 7: Master Cylinder Reservoir Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the master cylinder reservoir bolts (1).

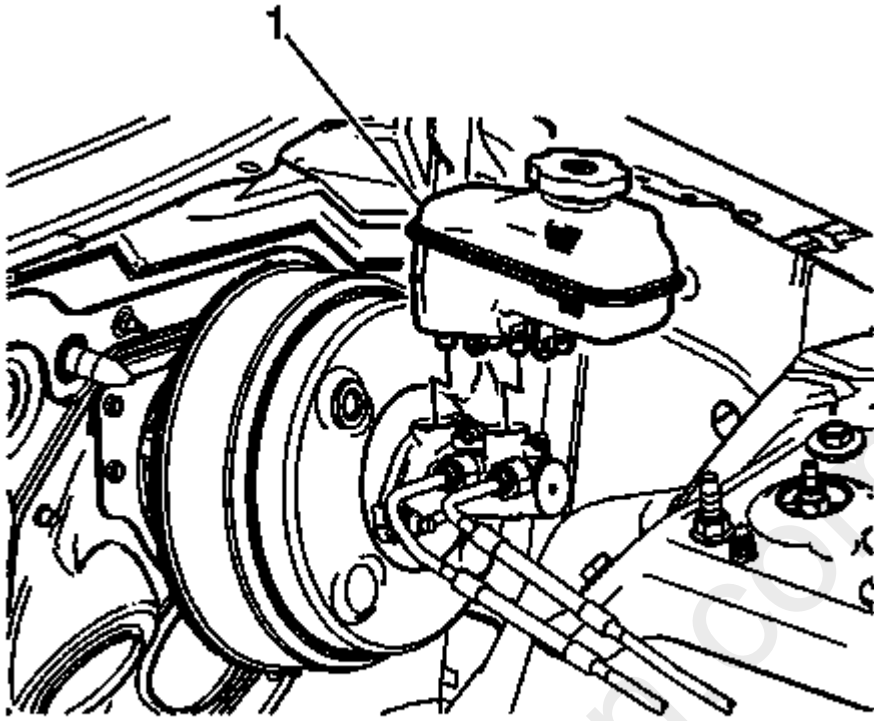


Fig. 8: Master Cylinder Reservoir
Courtesy of GENERAL MOTORS COMPANY

4. Remove the master cylinder reservoir (1).

Carefully pull the reservoir straight upward.

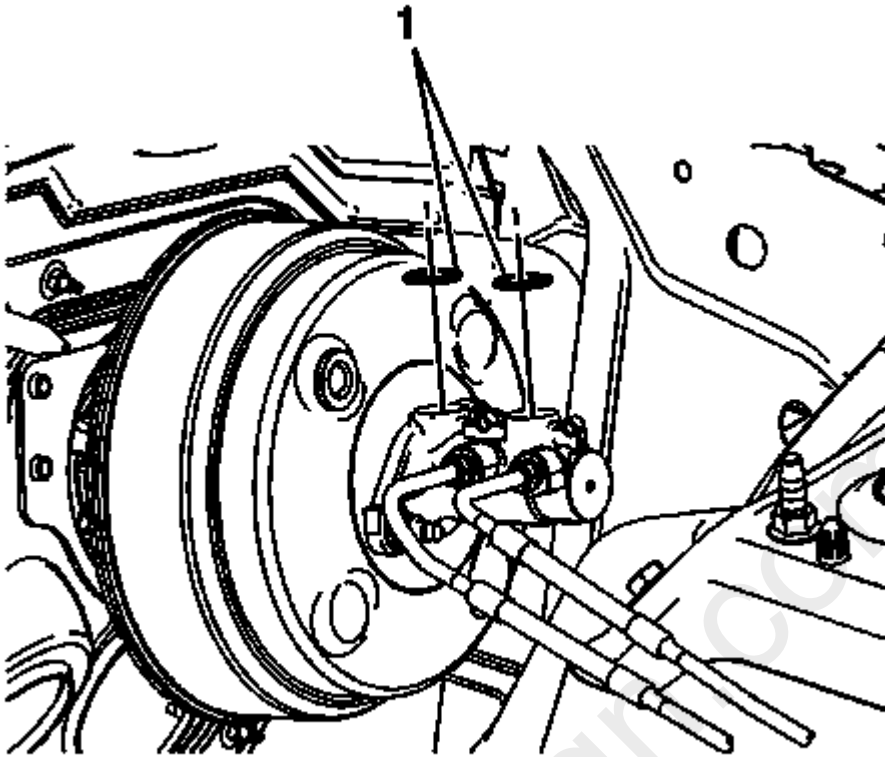


Fig. 9: Master Cylinder Reservoir Seals
Courtesy of GENERAL MOTORS COMPANY

5. Remove the master cylinder reservoir seals (1).
6. If installing a new master cylinder reservoir, remove the brake fluid level indicator switch. Refer to **Brake Fluid Level Indicator Switch Replacement**.

Installation Procedure

1. If installing a new master cylinder reservoir, install the brake fluid level indicator switch. Refer to **Brake Fluid Level Indicator Switch Replacement**.
2. If installing the original master cylinder reservoir, clean the master cylinder reservoir with denatured alcohol and dry with filtered, non-lubricated compressed air.

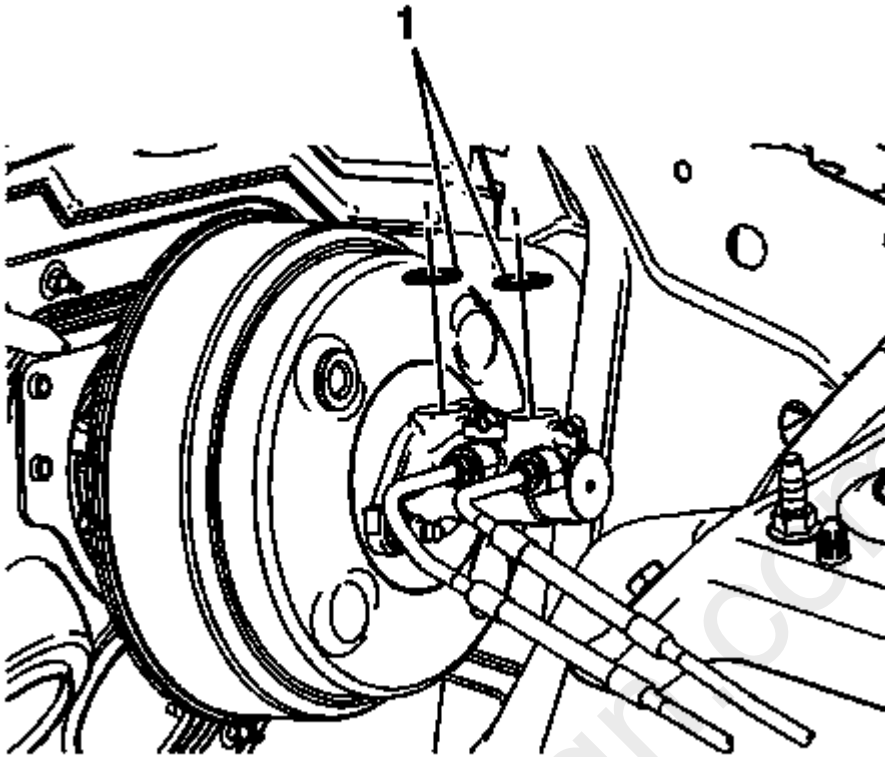


Fig. 10: Master Cylinder Reservoir Seals
Courtesy of GENERAL MOTORS COMPANY

3. Install the master cylinder reservoir seals (1).

Lubricate the seals 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.

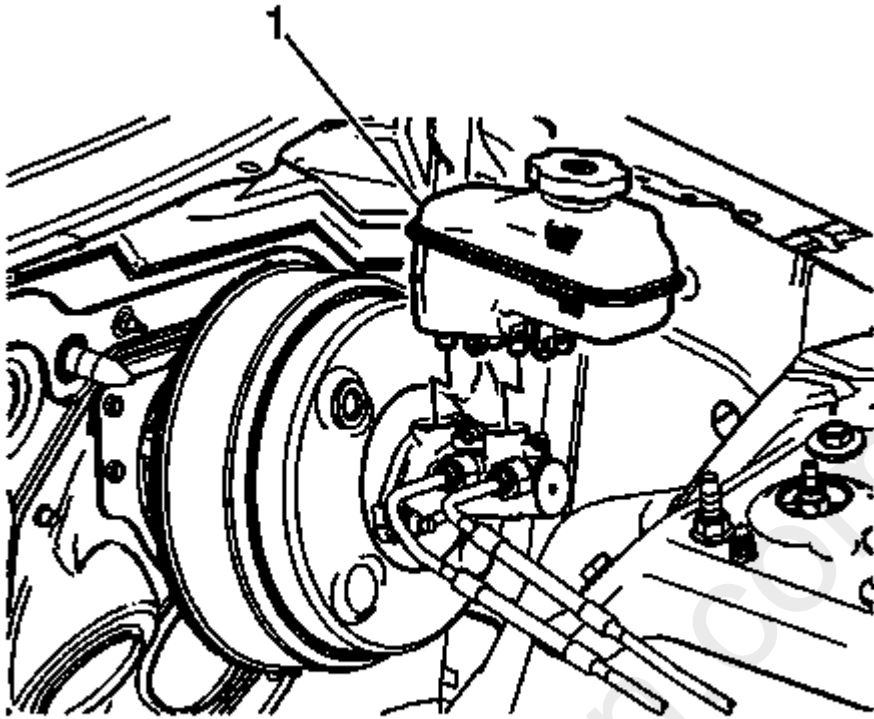


Fig. 11: Master Cylinder Reservoir
Courtesy of GENERAL MOTORS COMPANY

4. Install the master cylinder reservoir (1).

Carefully press the reservoir straight downward.

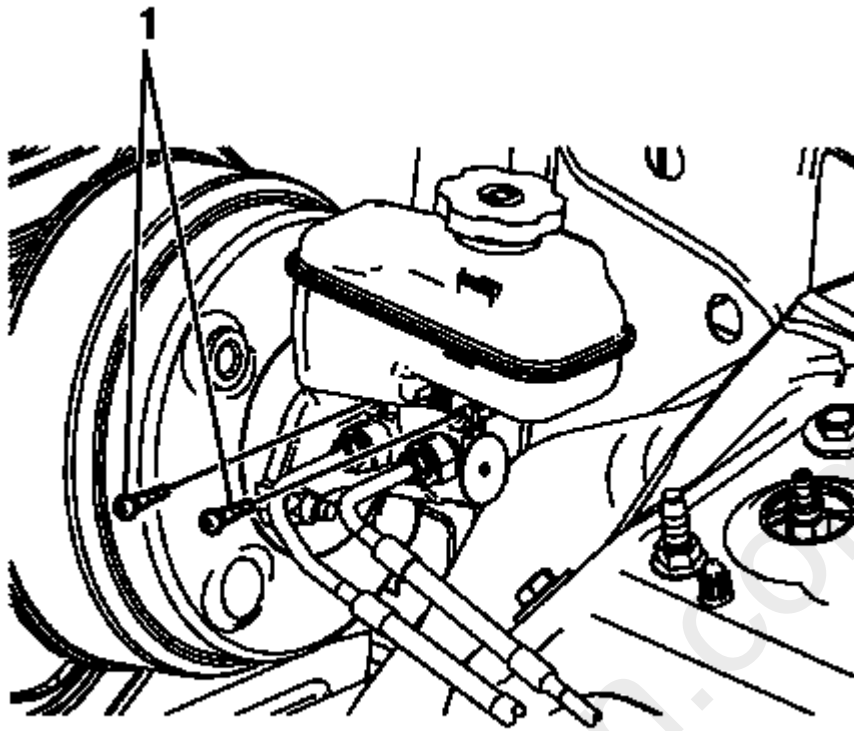


Fig. 12: Master Cylinder Reservoir Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Install the master cylinder reservoir bolts (1) and tighten to 8 N.m (71 lb in).
6. Connect the brake fluid level indicator switch electrical connector.
7. Fill the master cylinder reservoir. Refer to Master Cylinder Reservoir Filling.

MASTER CYLINDER RESERVOIR REPLACEMENT (RHD)

Removal Procedure

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Remove the brake fluid from the master cylinder reservoir.
2. Disconnect the brake fluid level indicator switch electrical connector.

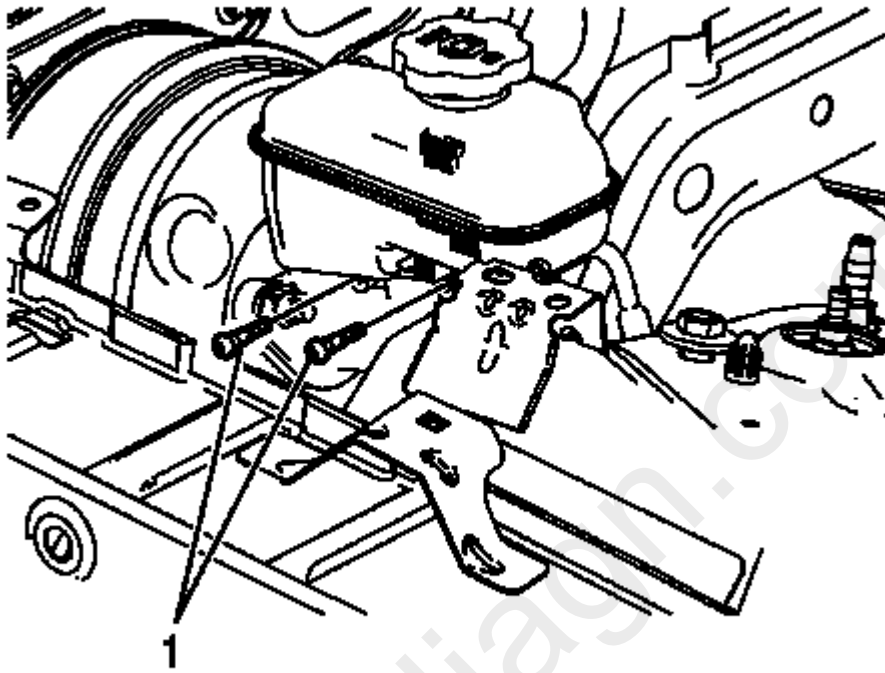


Fig. 13: Master Cylinder Reservoir Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the master cylinder reservoir bolts (1).

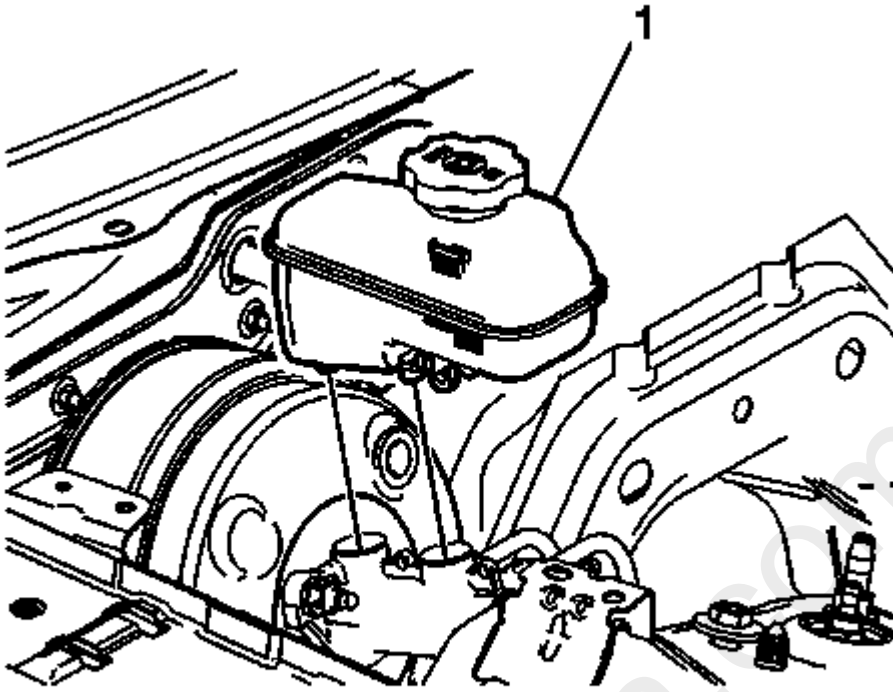


Fig. 14: Master Cylinder Reservoir
Courtesy of GENERAL MOTORS COMPANY

4. Remove the master cylinder reservoir (1).

Carefully pull the reservoir straight upward.

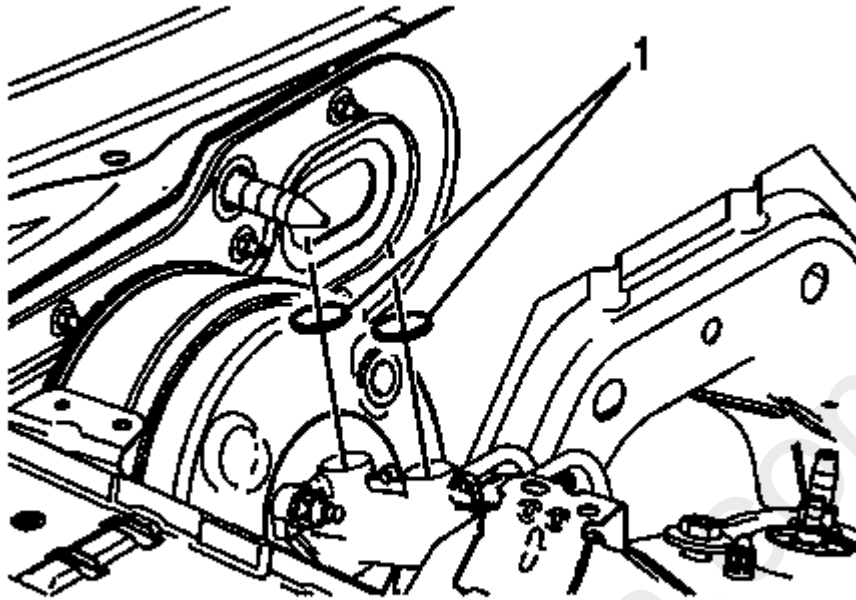


Fig. 15: Master Cylinder Reservoir Seals
Courtesy of GENERAL MOTORS COMPANY

5. Remove the master cylinder reservoir seals (1).
6. If installing a new master cylinder reservoir, remove the brake fluid level indicator switch. Refer to **Brake Fluid Level Indicator Switch Replacement**.

Installation Procedure

1. If installing a new master cylinder reservoir, install the brake fluid level indicator switch. Refer to **Brake Fluid Level Indicator Switch Replacement**.
2. If installing the original master cylinder reservoir, clean the master cylinder reservoir with denatured alcohol and dry with filtered, non-lubricated compressed air.

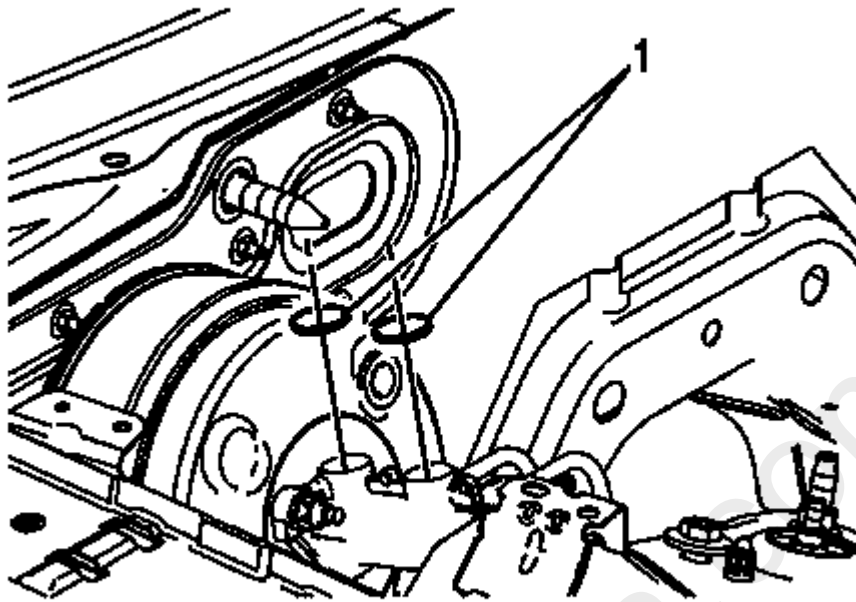


Fig. 16: Master Cylinder Reservoir Seals
Courtesy of GENERAL MOTORS COMPANY

3. Install the master cylinder reservoir seals (1).

Lubricate the seals 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.

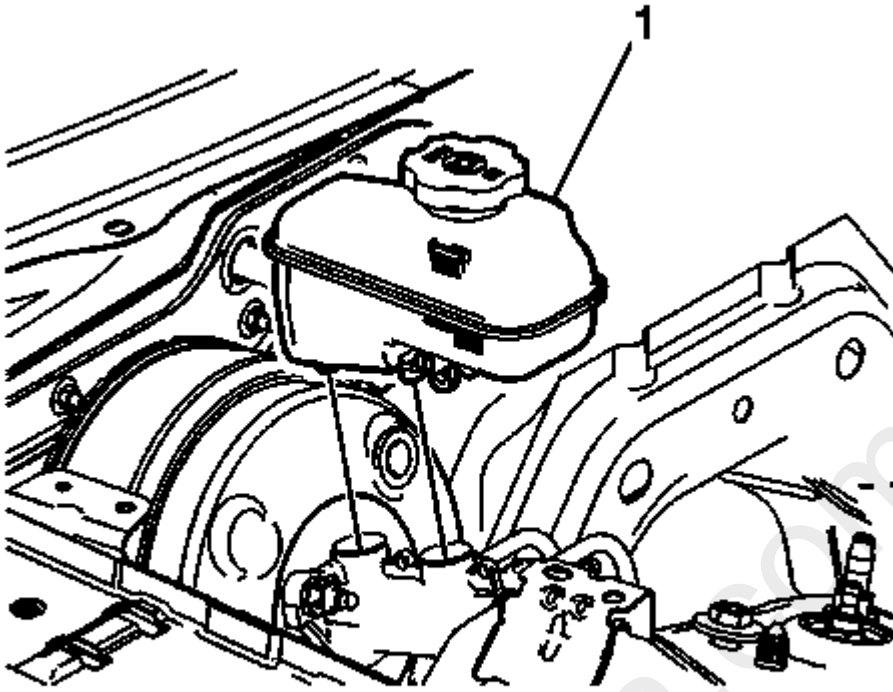


Fig. 17: Master Cylinder Reservoir
Courtesy of GENERAL MOTORS COMPANY

4. Install the master cylinder reservoir (1).

Carefully press the reservoir straight downward.

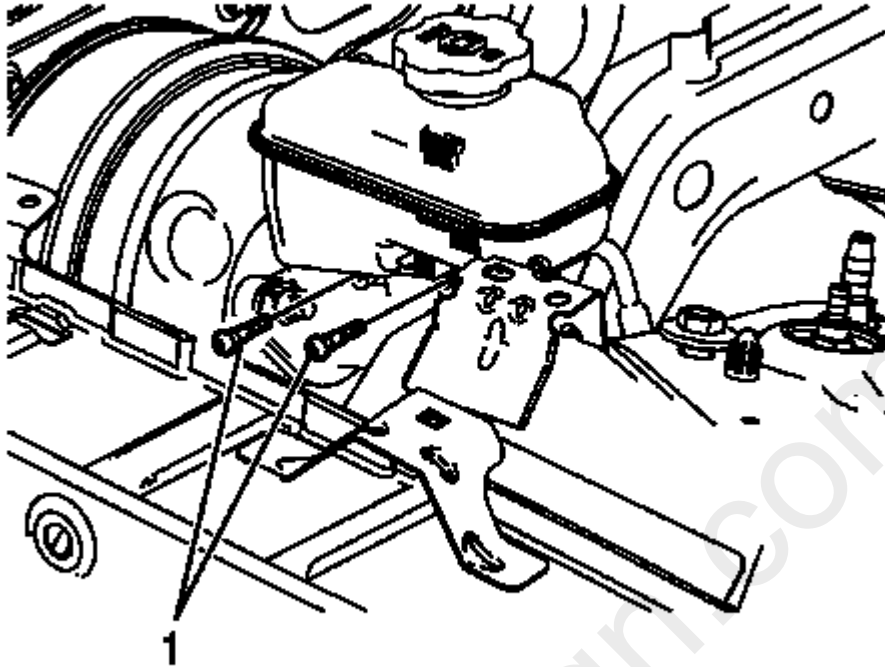


Fig. 18: Master Cylinder Reservoir Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Install the master cylinder reservoir bolts (1) and tighten to 8 N.m (71 lb in).
6. Connect the brake fluid level indicator switch electrical connector.
7. Fill the master cylinder reservoir. Refer to Master Cylinder Reservoir Filling.

MASTER CYLINDER REPLACEMENT (LHD)

Removal Procedure

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. With the engine OFF, apply and release the brake pedal several times until the pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Disconnect the brake fluid level indicator switch electrical connector.
3. Remove the air inlet panel support bracket push nut from the master cylinder mounting stud.
4. Carefully pull the air inlet panel support bracket outward and rotate the panel aside.

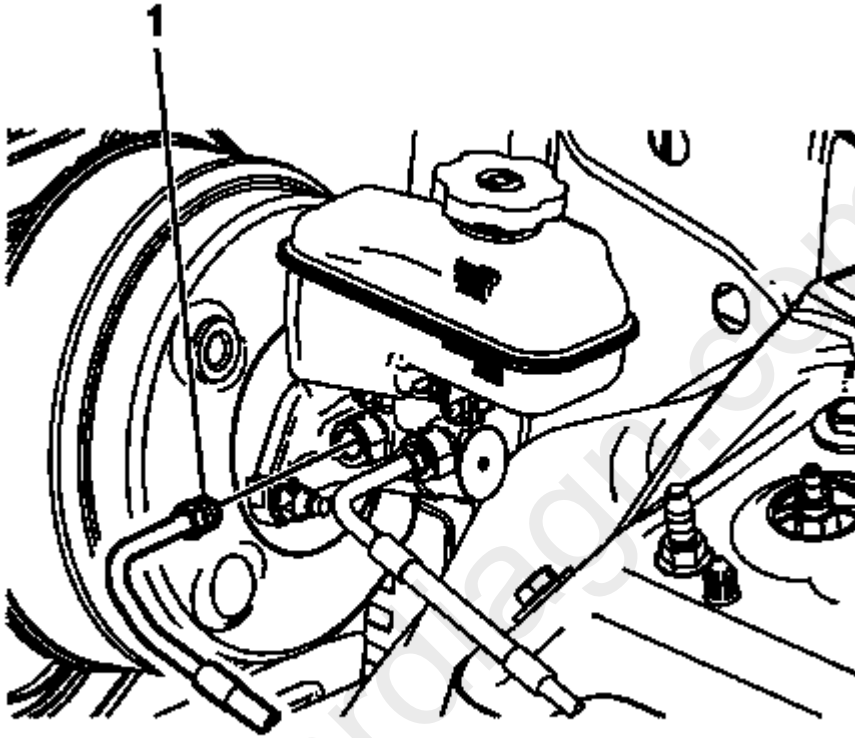


Fig. 19: Master Cylinder Primary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the master cylinder primary brake pipe fitting (1).

Cap the brake pipe fitting and plug the master cylinder outlet port to prevent brake fluid loss and contamination.

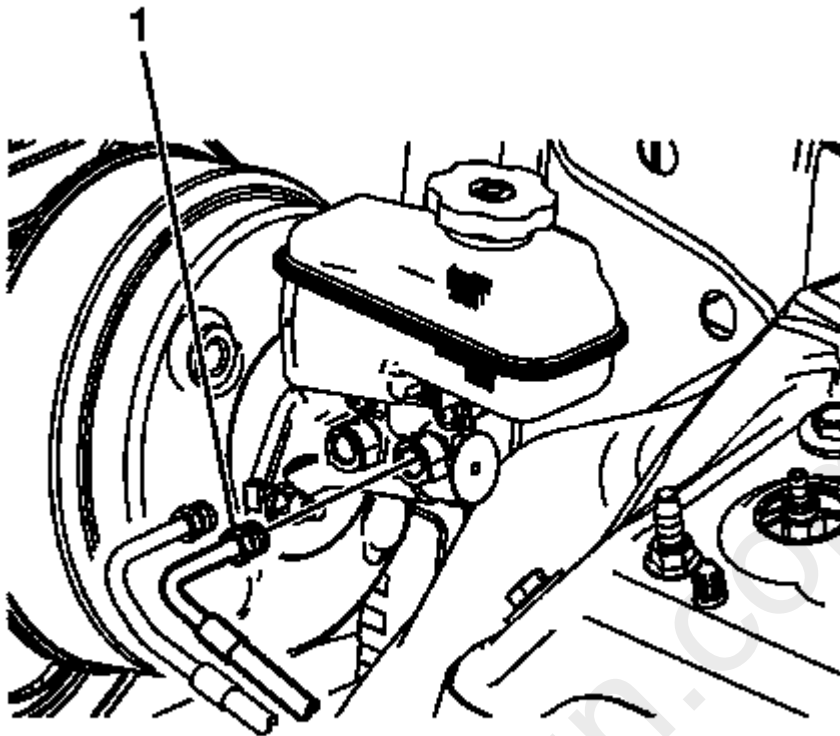


Fig. 20: Master Cylinder Secondary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the master cylinder secondary brake pipe fitting (1).

Cap the brake pipe fitting and plug the master cylinder outlet port to prevent brake fluid loss and contamination.

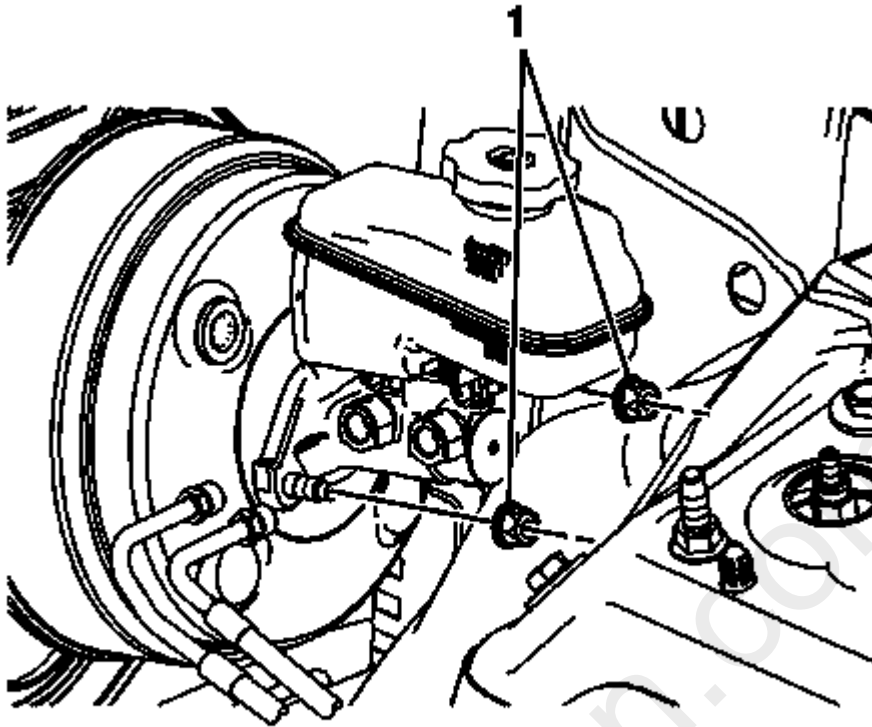


Fig. 21: Master Cylinder Nuts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the master cylinder nuts (1).

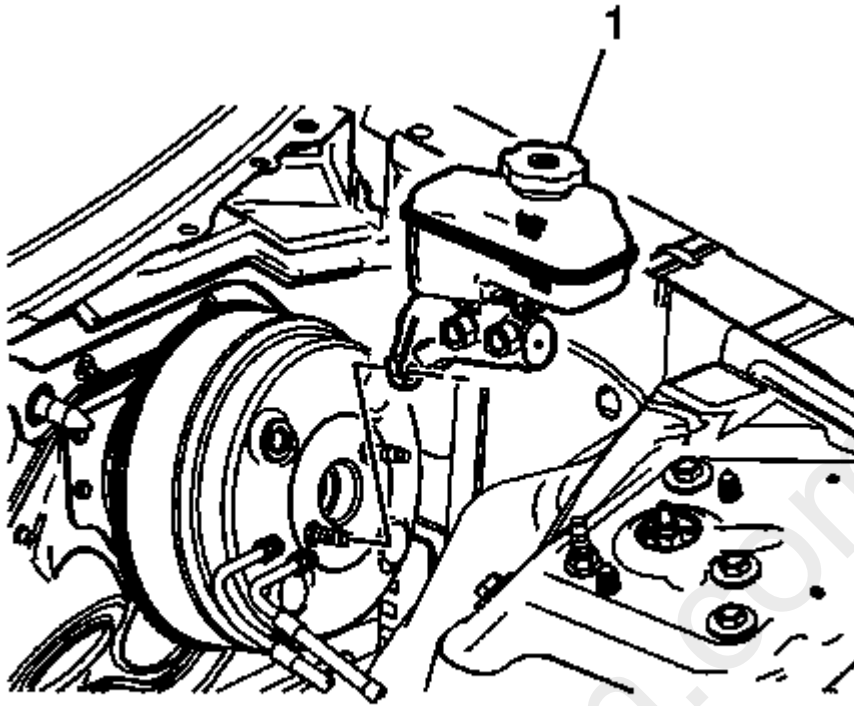


Fig. 22: Master Cylinder

Courtesy of GENERAL MOTORS COMPANY

8. Remove the master cylinder (1) from the power vacuum brake booster.
9. Inspect the master cylinder to power vacuum brake booster seal for damage and replace, if necessary.

Installation Procedure

1. Position the master cylinder to power vacuum brake booster seal to the groove in the master cylinder body.

Ensure the seal is positioned properly and is not deformed.

2. If installing a new master cylinder, bench bleed the master cylinder. Refer to **Master Cylinder Bench Bleeding**.

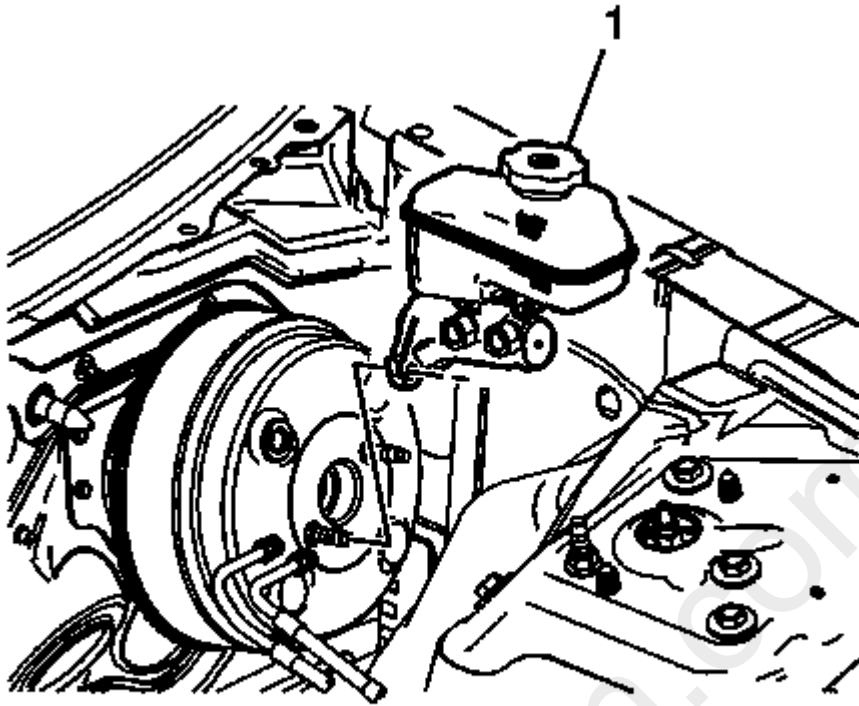


Fig. 23: Master Cylinder

Courtesy of GENERAL MOTORS COMPANY

3. Install the master cylinder (1) to the power vacuum brake booster.

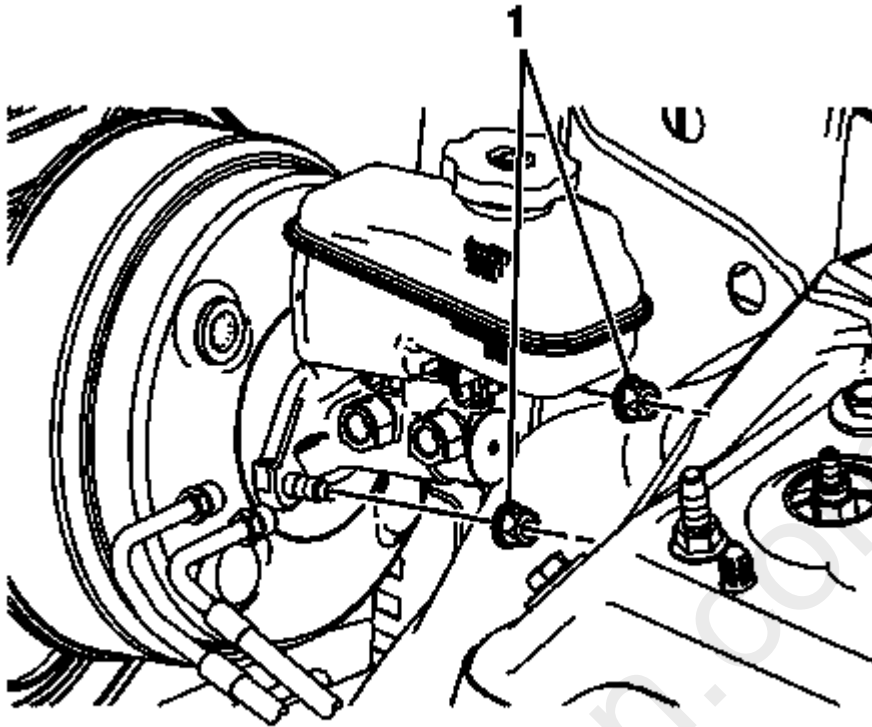


Fig. 24: Master Cylinder Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the master cylinder nuts (1) and tighten to 25 N.m (18 lb ft).

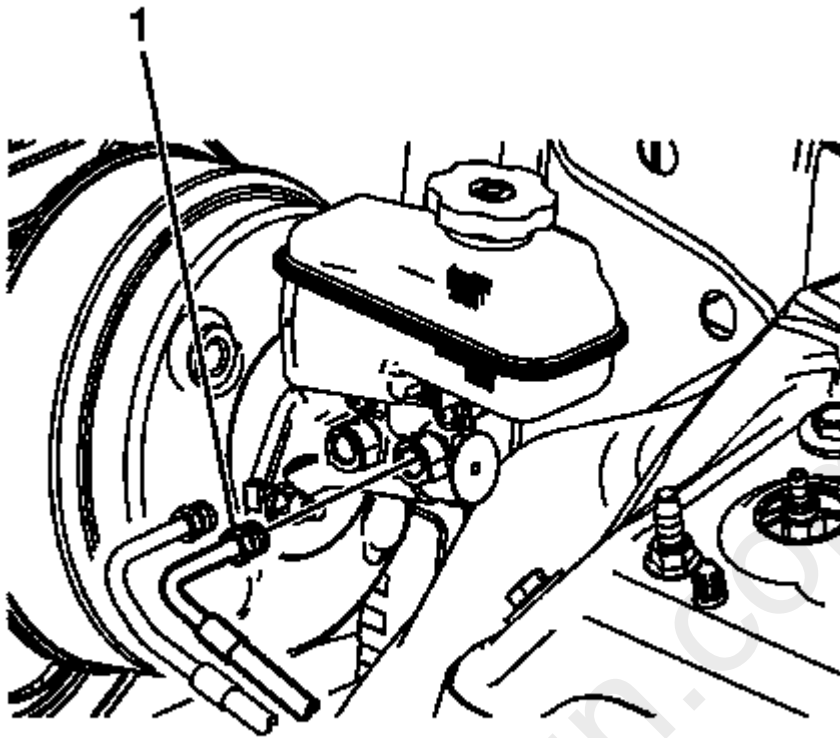


Fig. 25: Master Cylinder Secondary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

5. Connect the master cylinder secondary brake pipe fitting (1) and tighten the fitting to 36 N.m (27 lb ft).

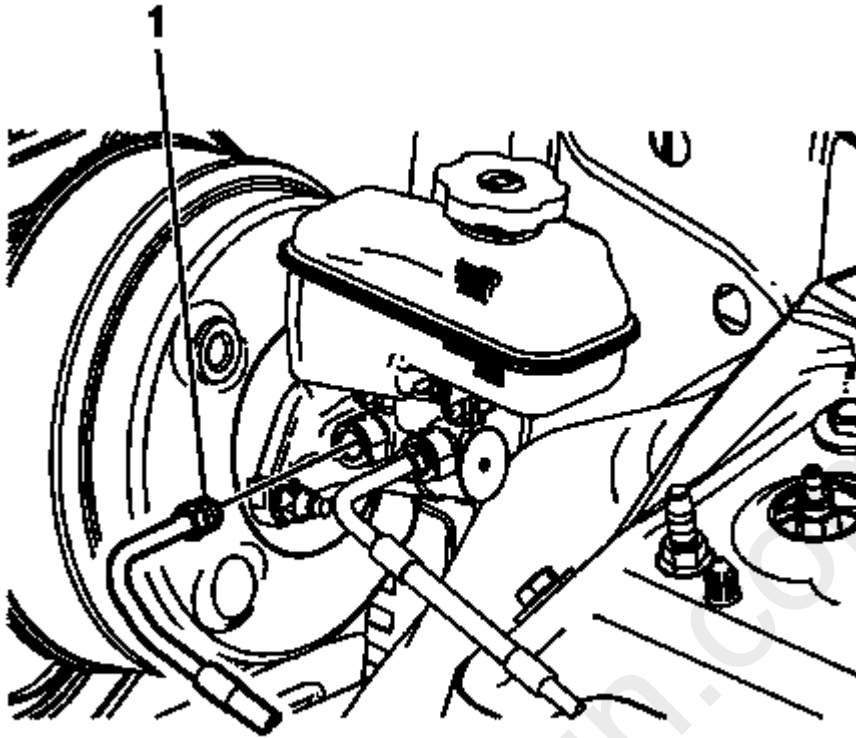


Fig. 26: Master Cylinder Primary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

6. Connect the master cylinder primary brake pipe fitting (1) and tighten the fitting to 36 N.m (27 lb ft).
7. Connect the brake fluid level indicator switch electrical connector.
8. Rotate the air inlet panel and position the support bracket to the master cylinder mounting stud.
9. Install the air inlet panel support bracket push nut.
10. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)**, **Hydraulic Brake System Bleeding (Pressure)**.

MASTER CYLINDER REPLACEMENT (RHD)

Removal Procedure

WARNING: Refer to **Brake Fluid Irritant Warning** .

CAUTION: Refer to **Brake Fluid Effects on Paint and Electrical Components Caution** .

1. With the engine OFF, apply and release the brake pedal several times to deplete the power vacuum brake booster vacuum reserve.
2. Disconnect the brake fluid level indicator switch electrical connector.

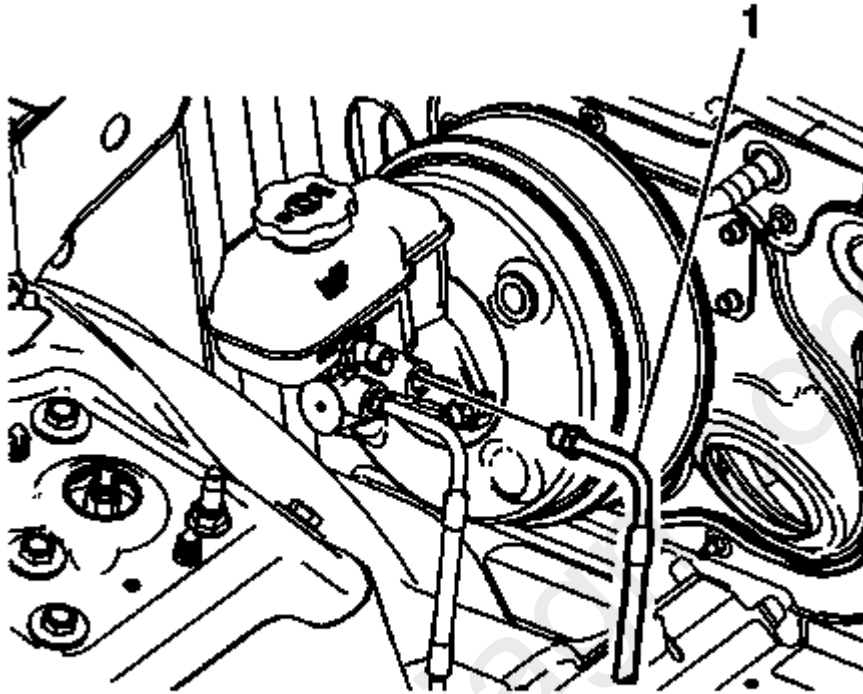


Fig. 27: Master Cylinder Primary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the master cylinder primary brake pipe fitting (1).

Cap the brake pipe fitting and plug the master cylinder outlet port to prevent brake fluid loss and contamination.

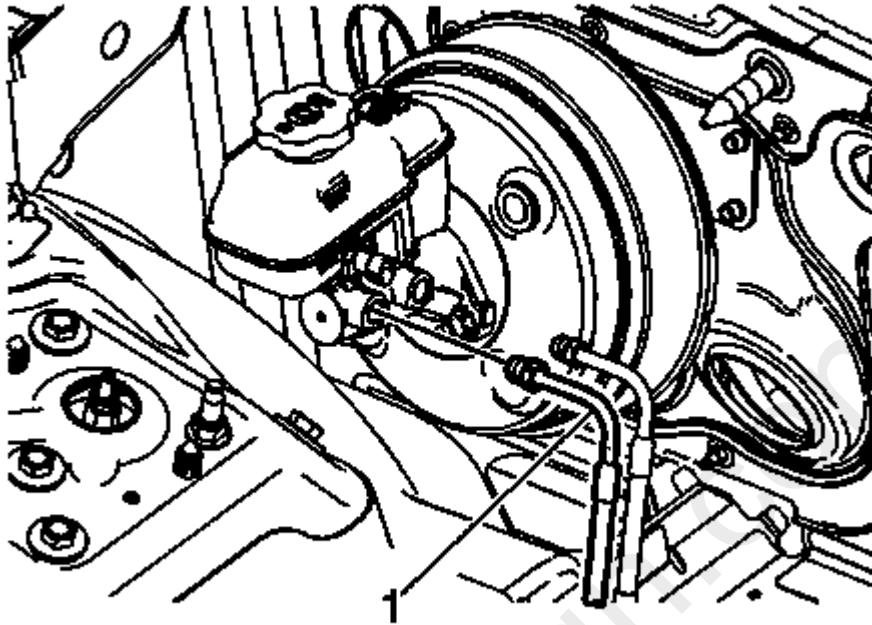


Fig. 28: Master Cylinder Secondary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the master cylinder secondary brake pipe fitting (1).

Cap the brake pipe fitting and plug the master cylinder outlet port to prevent brake fluid loss and contamination.

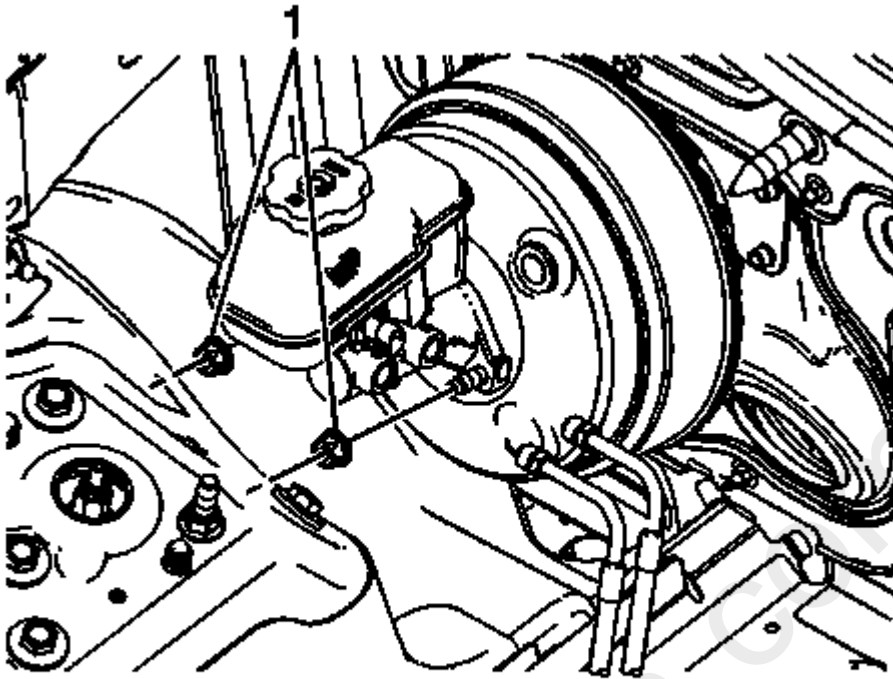


Fig. 29: Master Cylinder Nuts

Courtesy of GENERAL MOTORS COMPANY

5. Remove the master cylinder nuts (1).

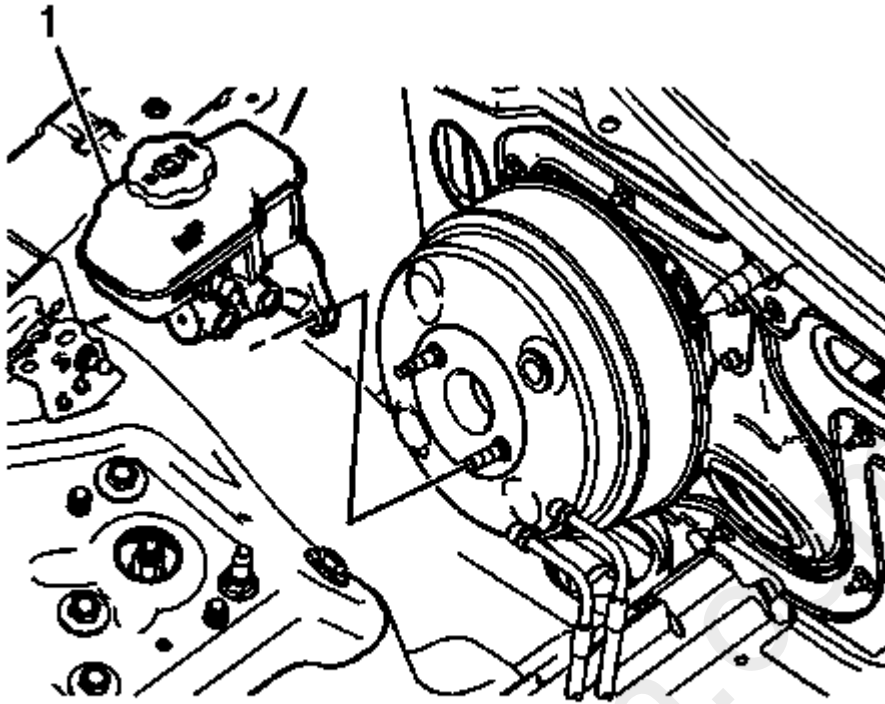


Fig. 30: Master Cylinder
Courtesy of GENERAL MOTORS COMPANY

6. Remove the master cylinder (1) from the power vacuum brake booster.
7. Inspect the master cylinder to power vacuum brake booster seal for damage and replace, if necessary.

Installation Procedure

1. Position the master cylinder to power vacuum brake booster seal to the master cylinder body.

Ensure the seal is positioned properly and is not deformed.

2. If installing a new master cylinder, bench bleed the master cylinder. Refer to **Master Cylinder Bench Bleeding**.

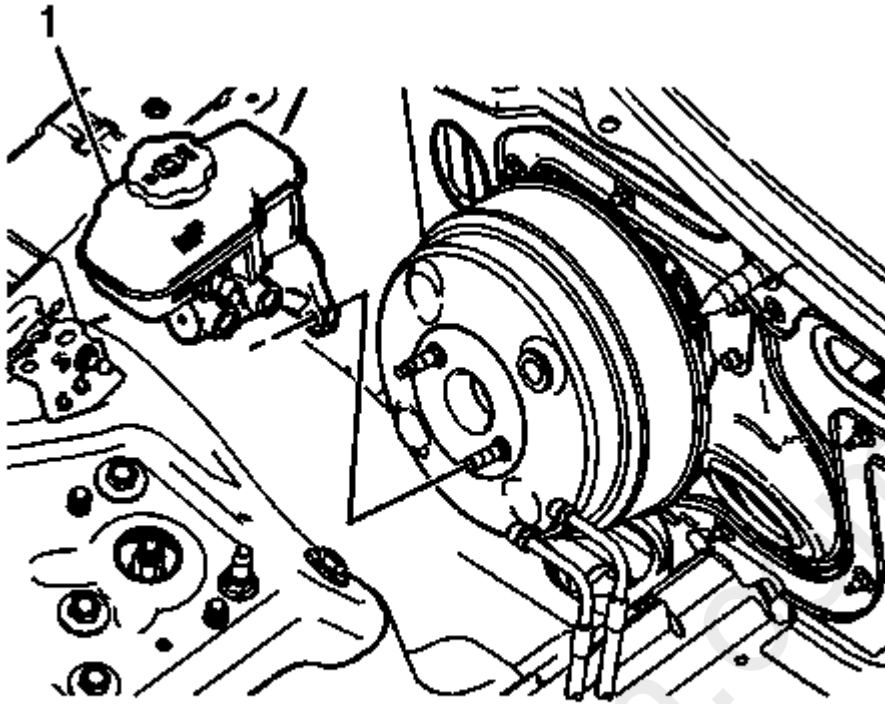


Fig. 31: Master Cylinder

Courtesy of GENERAL MOTORS COMPANY

3. Install the master cylinder (1) to the power vacuum brake booster.

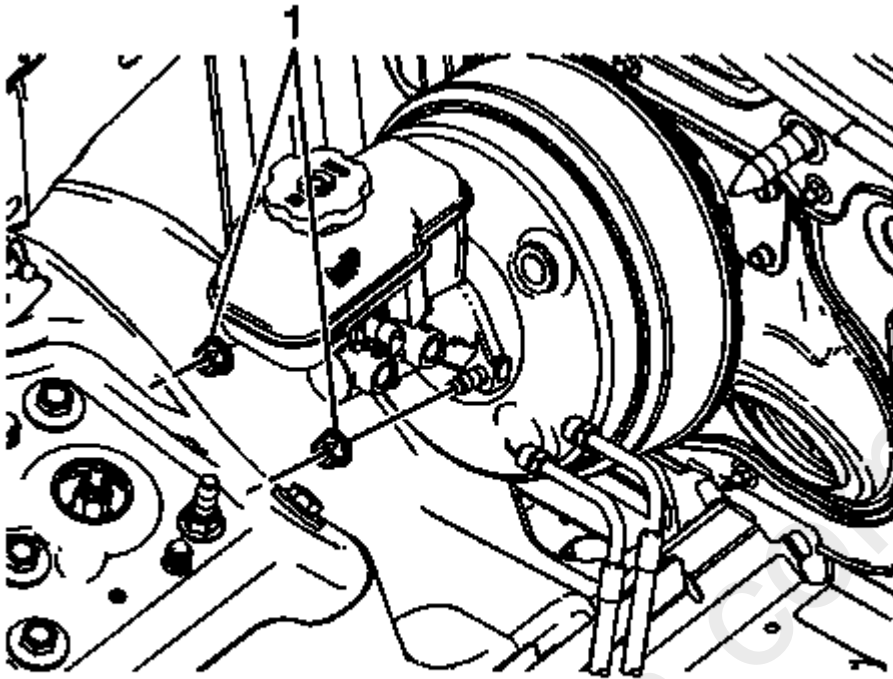


Fig. 32: Master Cylinder Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the master cylinder nuts (1) and tighten to 25 N.m (18 lb ft).

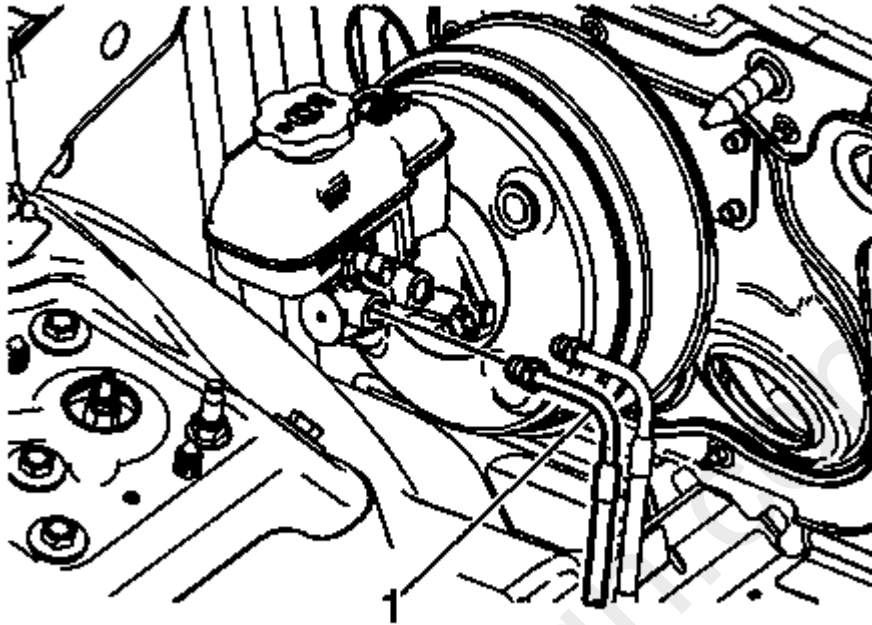


Fig. 33: Master Cylinder Secondary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

5. Connect the master cylinder secondary brake pipe fitting (1) and tighten the fitting to 36 N.m (27 lb ft).

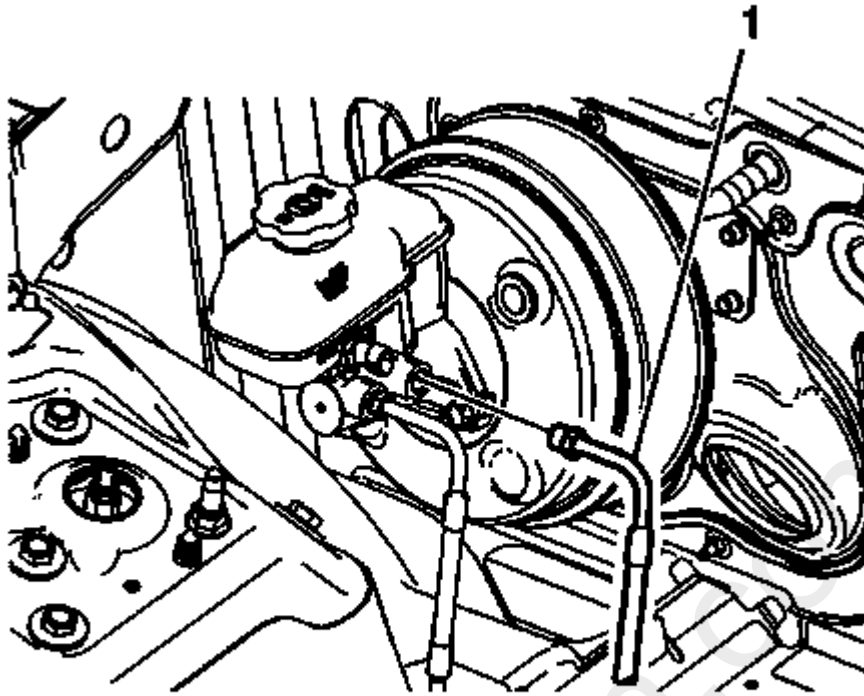


Fig. 34: Master Cylinder Primary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

6. Connect the master cylinder primary brake pipe fitting (1) and tighten the fitting to 36 N.m (27 lb ft).
7. Connect the brake fluid level indicator switch electrical connector.
8. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)**, **Hydraulic Brake System Bleeding (Pressure)**.

MASTER CYLINDER BENCH BLEEDING

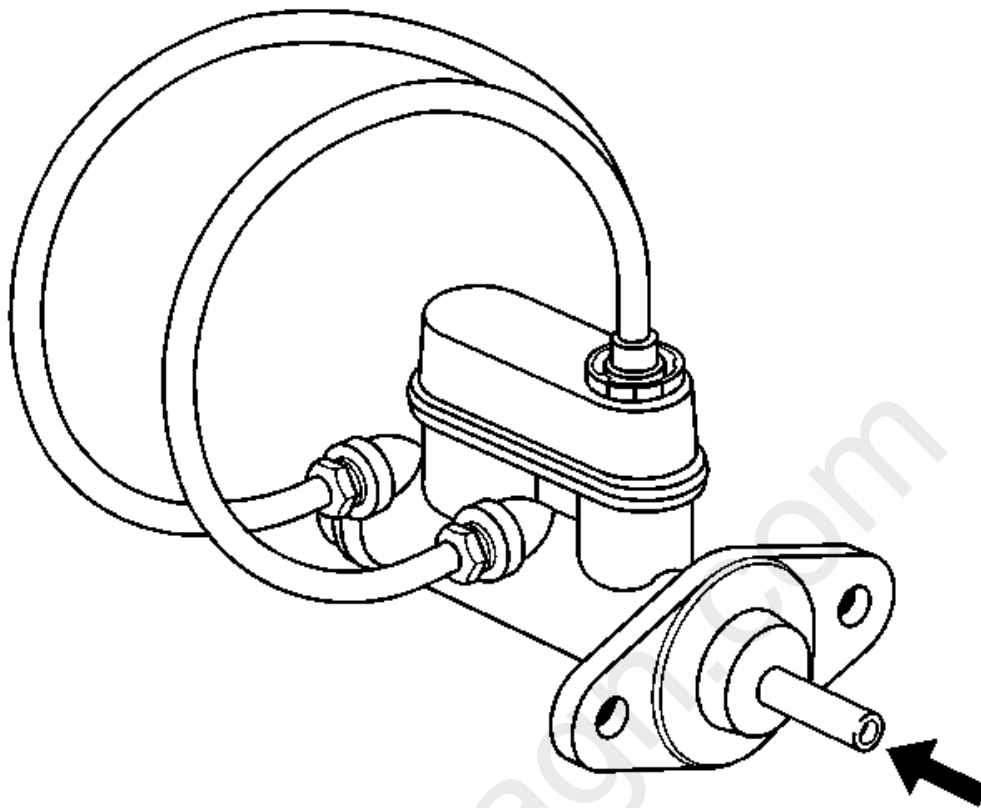


Fig. 35: Bleeding Master Cylinder
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

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 GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Master Cylinder Reservoir Filling**.
6. Ensure that the ends of the transparent hoses running into the master cylinder reservoir are fully submerged in the brake fluid.
7. Using a smooth, round-ended tool, depress and release the primary piston as far as it will travel, a depth of about 25 mm (1 in), several times. Observe the flow of fluid coming from the ports.

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

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

BRAKE FLUID LEVEL INDICATOR SWITCH REPLACEMENT

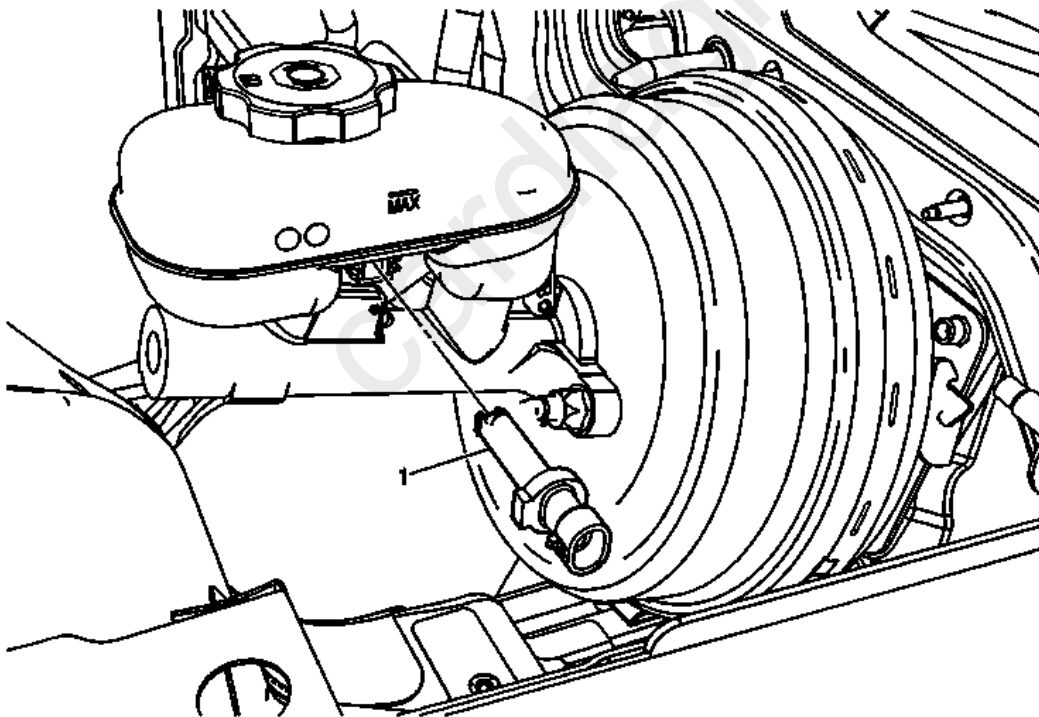


Fig. 36: View Of Brake Fluid Level Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

Brake Fluid Level Indicator Switch Replacement

Callout	Component Name
Preliminary Procedure Disconnect the master cylinder fluid level sensor electrical connector.	
1	Master Cylinder Fluid Level Sensor TIP: Compress the sensor locking tabs on the inboard side of the master cylinder to remove the sensor.

BRAKE PEDAL ASSEMBLY REPLACEMENT (LHD)

Removal Procedure

1. Remove the power vacuum brake booster. Refer to **Power Vacuum Brake Booster Replacement (LHD)**.
2. For vehicles without the electronic parking brake, remove the park brake pedal assembly and front park brake cable and position aside. Refer to **Parking Brake Lever Pedal Assembly Replacement**.
3. Without disconnecting the steering column from the intermediate shaft, lower and support the steering column. Refer to **Steering Column Replacement**.

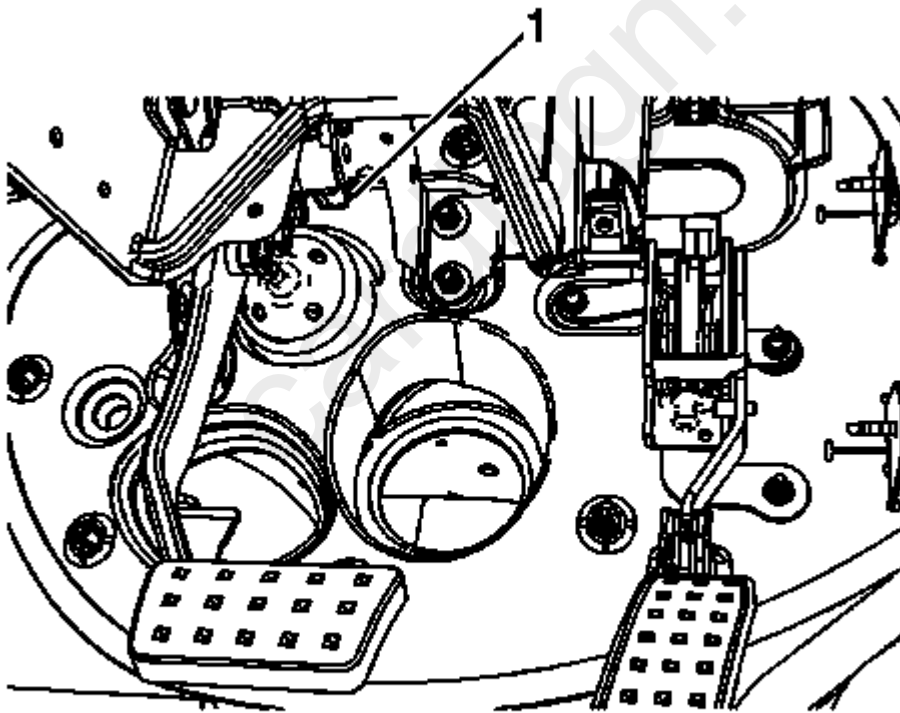


Fig. 37: Brake Pedal Position Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the brake pedal position sensor (1) electrical connector.

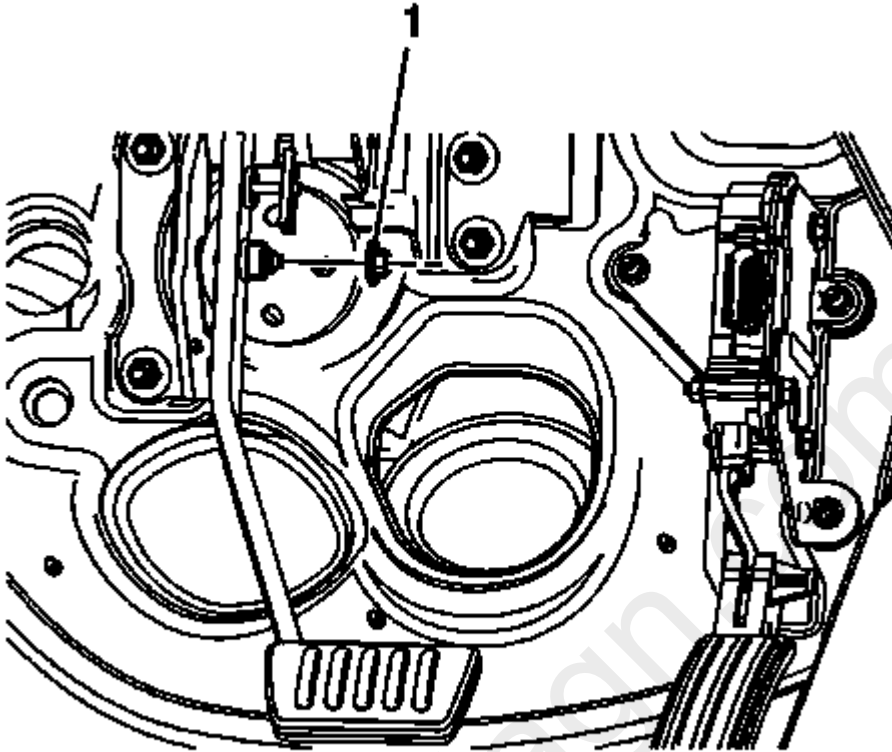


Fig. 38: Power Vacuum Brake Booster Pushrod Nut
Courtesy of GENERAL MOTORS COMPANY

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

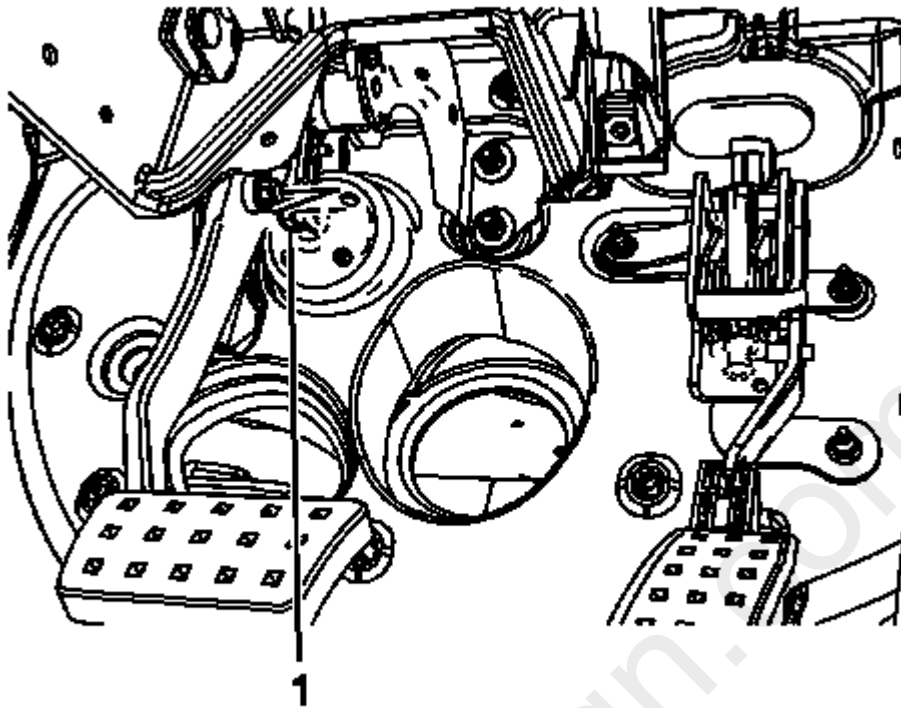


Fig. 39: View Of Vacuum Brake Booster Pushrod
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the power vacuum brake booster pushrod (1) from the brake pedal pivot.

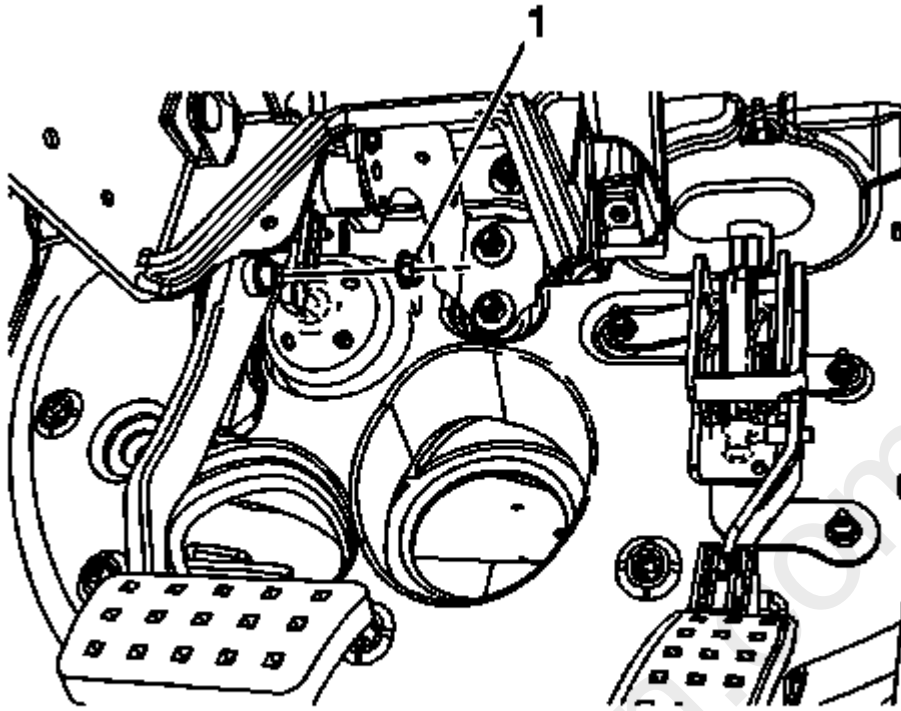


Fig. 40: View Of Vacuum Brake Booster Pushrod Bushing
Courtesy of GENERAL MOTORS COMPANY

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

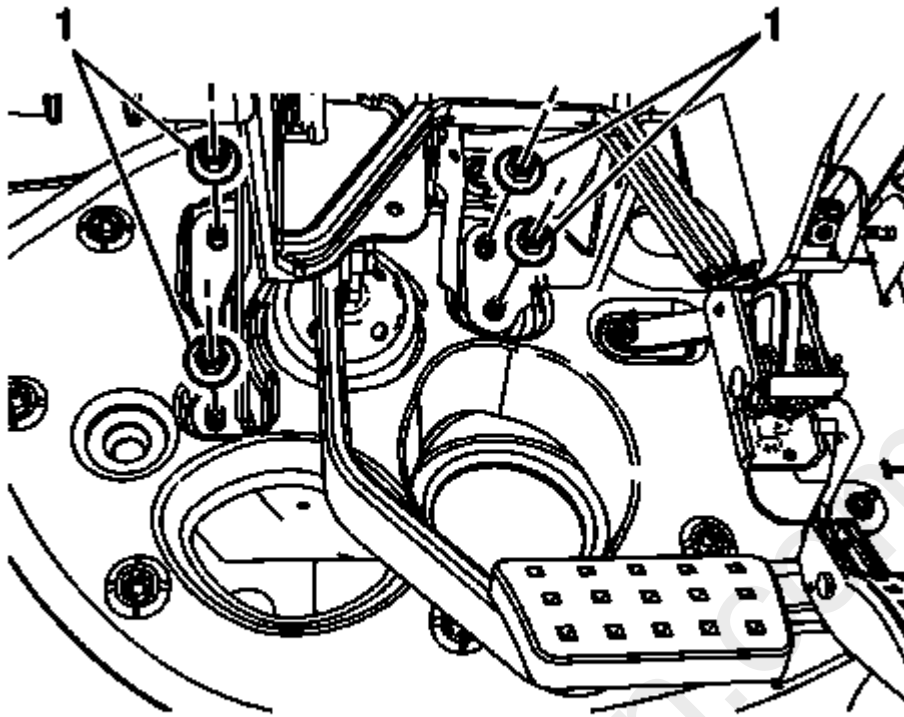


Fig. 41: Vacuum Brake Booster Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the power vacuum brake booster bracket nuts (1).

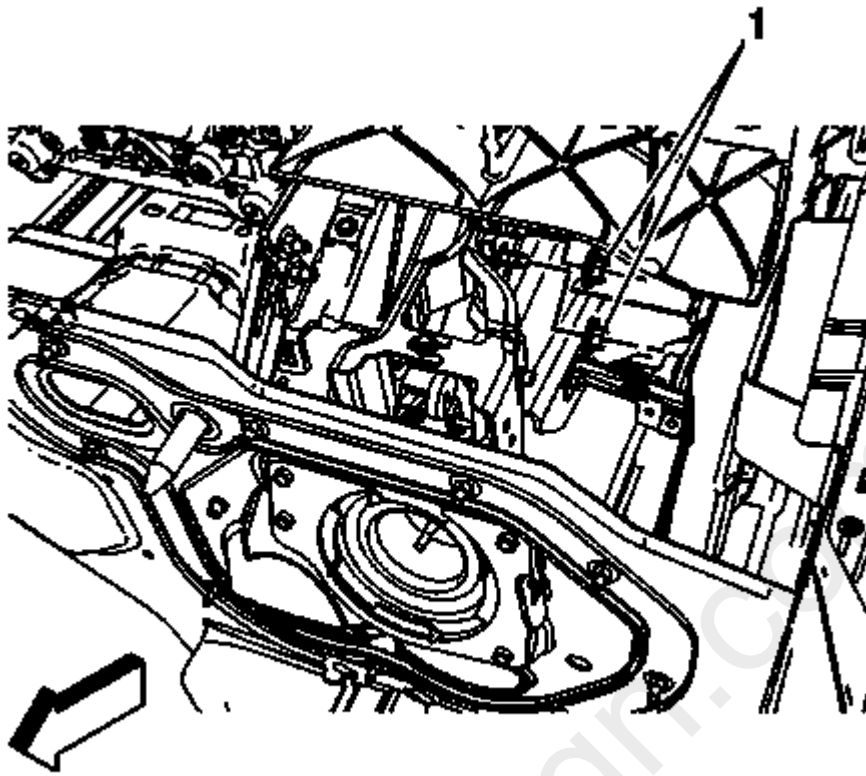


Fig. 42: View Of Brake Pedal Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the brake pedal bracket nuts (1).

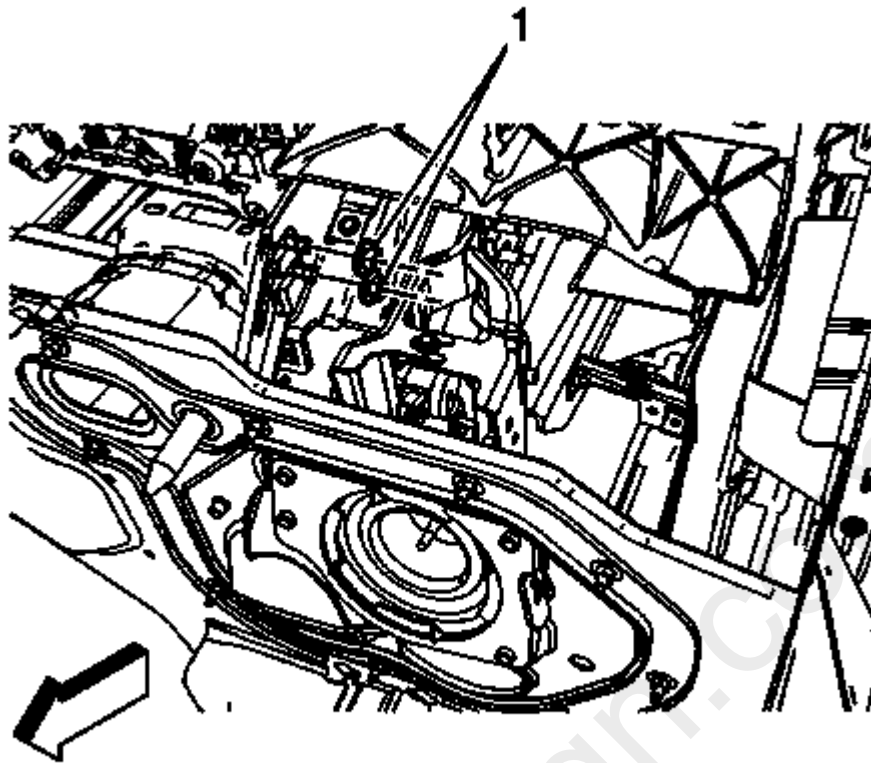


Fig. 43: View Of Upper Steering Column Support Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

10. Remove the upper steering column support bracket nuts (1).

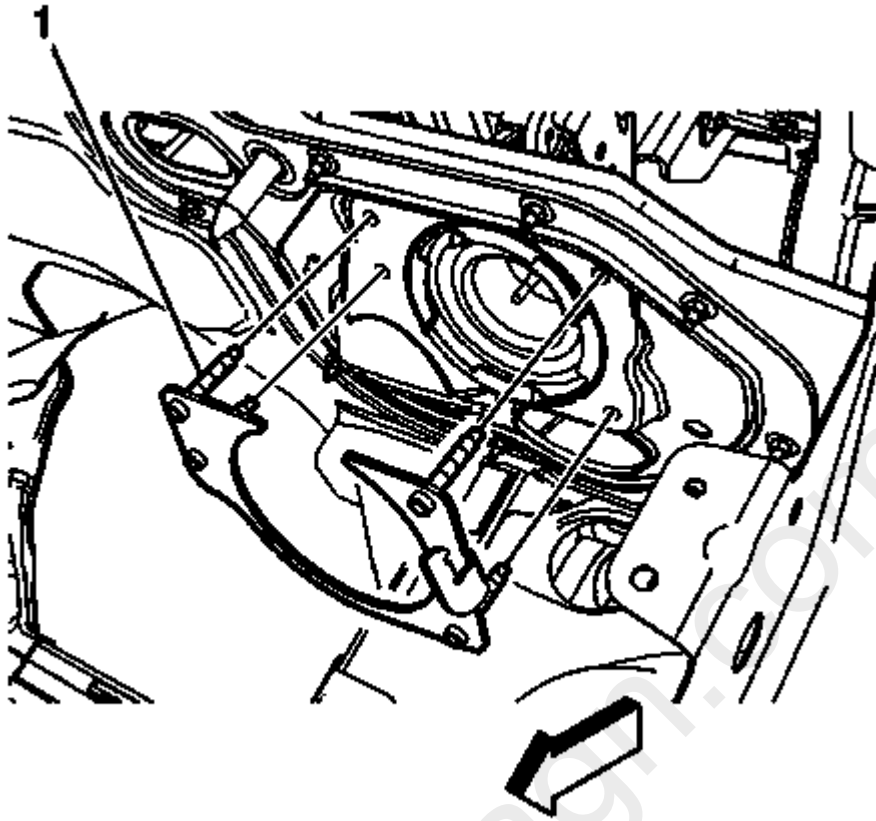


Fig. 44: View of Vacuum Brake Booster Bracket
Courtesy of GENERAL MOTORS COMPANY

11. Remove the power vacuum brake booster bracket (1).

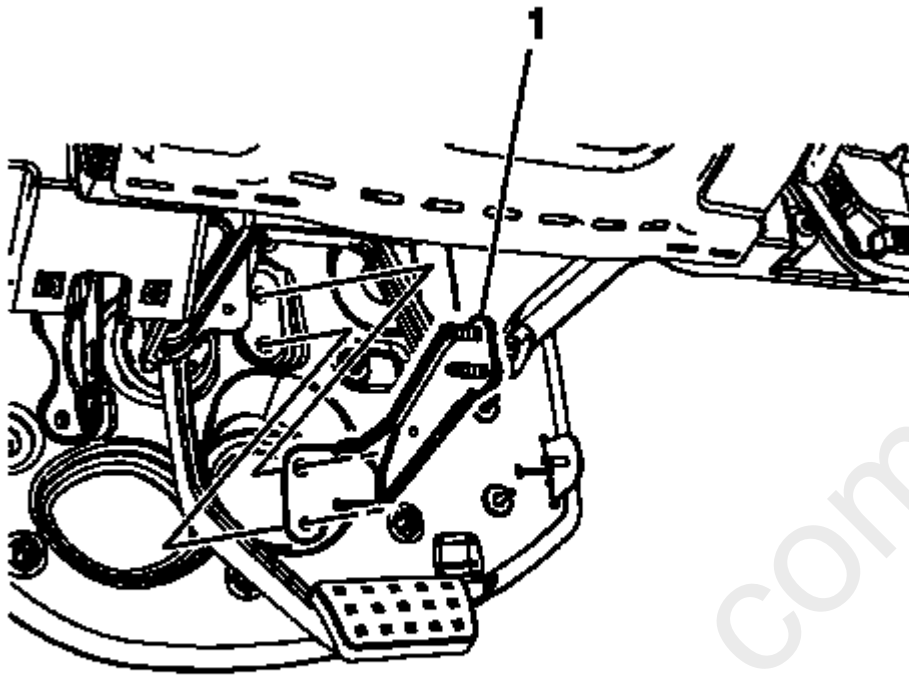


Fig. 45: Steering Column Support Bracket
Courtesy of GENERAL MOTORS COMPANY

12. Remove the steering column support bracket (1).

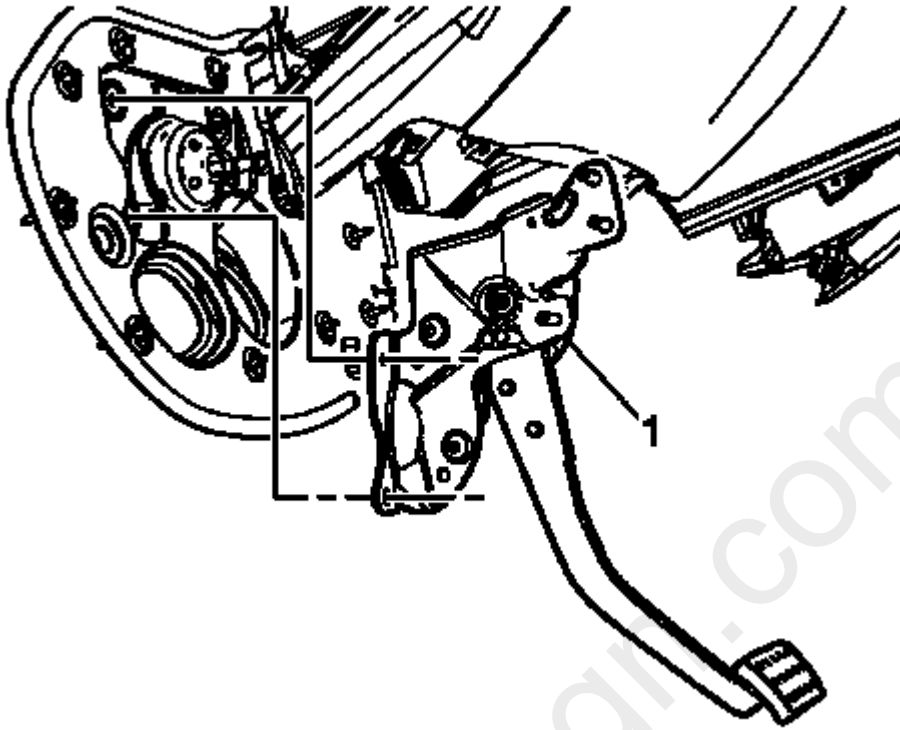


Fig. 46: Brake Pedal Assembly
Courtesy of GENERAL MOTORS COMPANY

13. Remove the brake pedal assembly (1) from the vehicle.

Installation Procedure

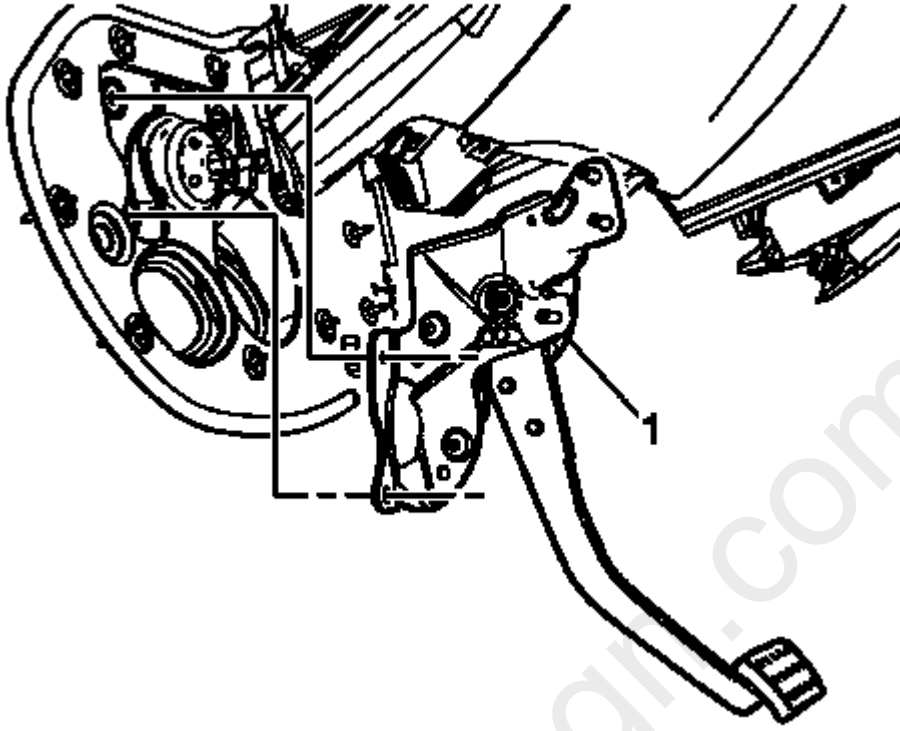


Fig. 47: Brake Pedal Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Install the brake pedal assembly (1) to the vehicle.

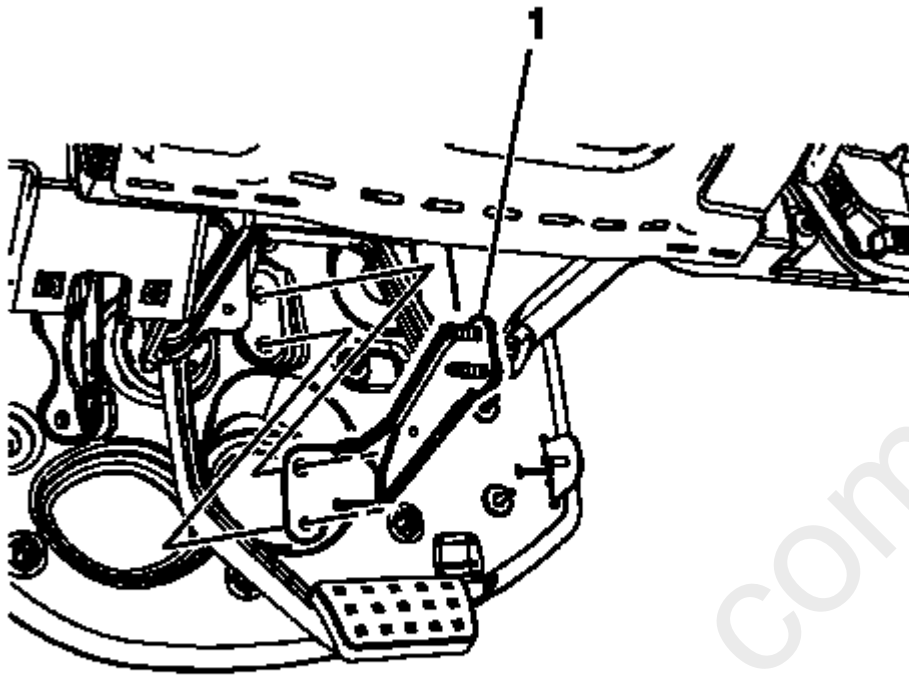


Fig. 48: Steering Column Support Bracket
Courtesy of GENERAL MOTORS COMPANY

2. Install the steering column support bracket (1).

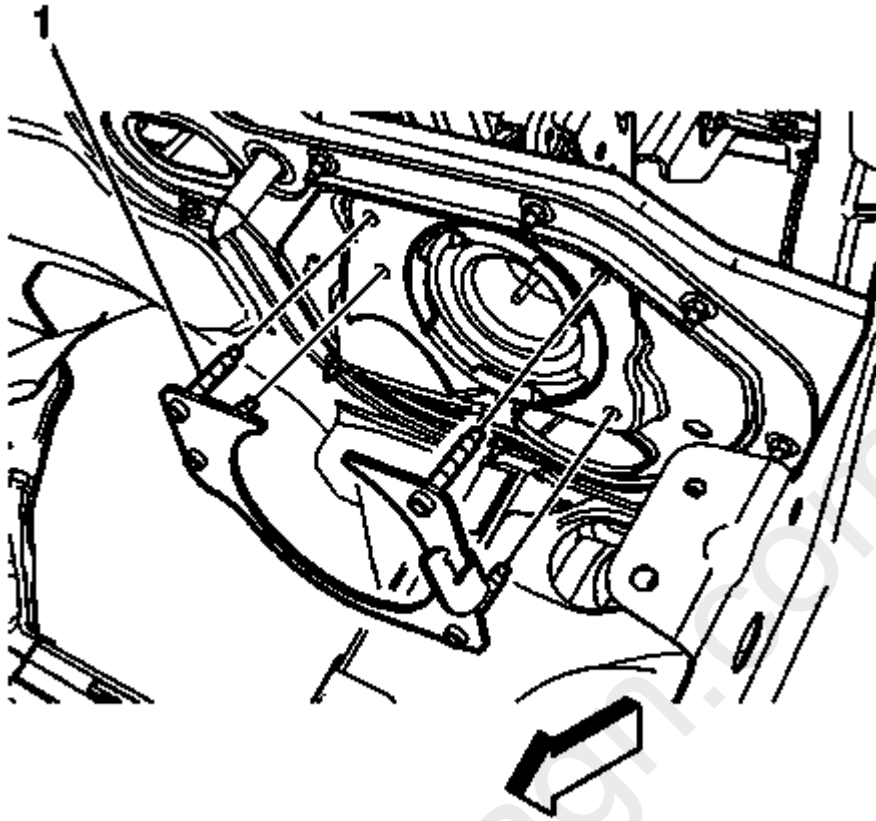


Fig. 49: View of Vacuum Brake Booster Bracket
Courtesy of GENERAL MOTORS COMPANY

3. Install the power vacuum brake booster bracket (1).

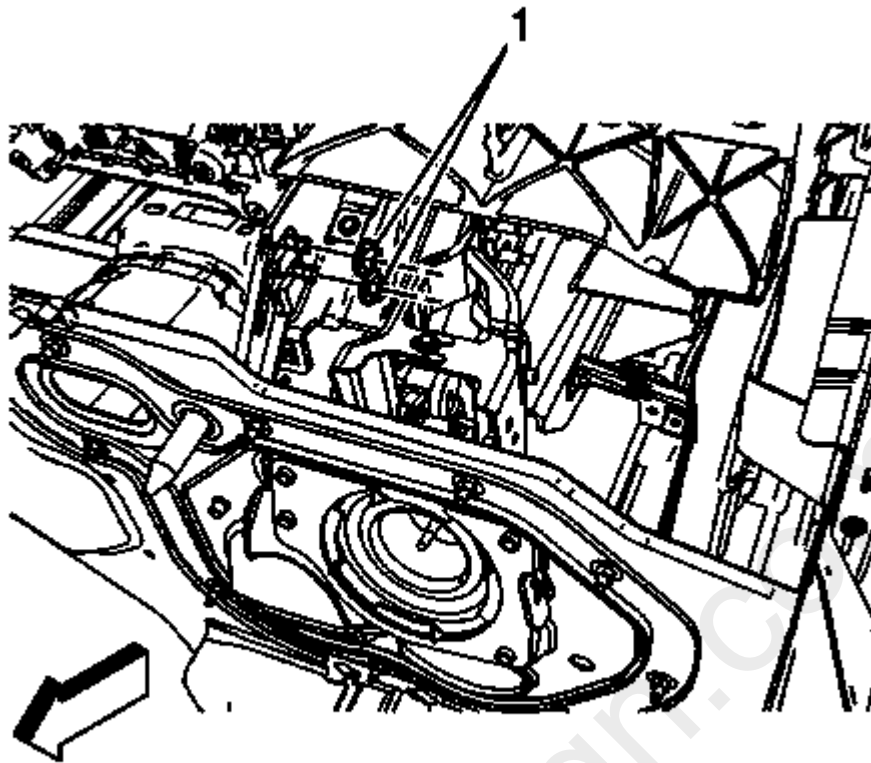


Fig. 50: View Of Upper Steering Column Support Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the upper steering column support bracket nuts (1) and tighten to 25 N.m (18 lb ft).

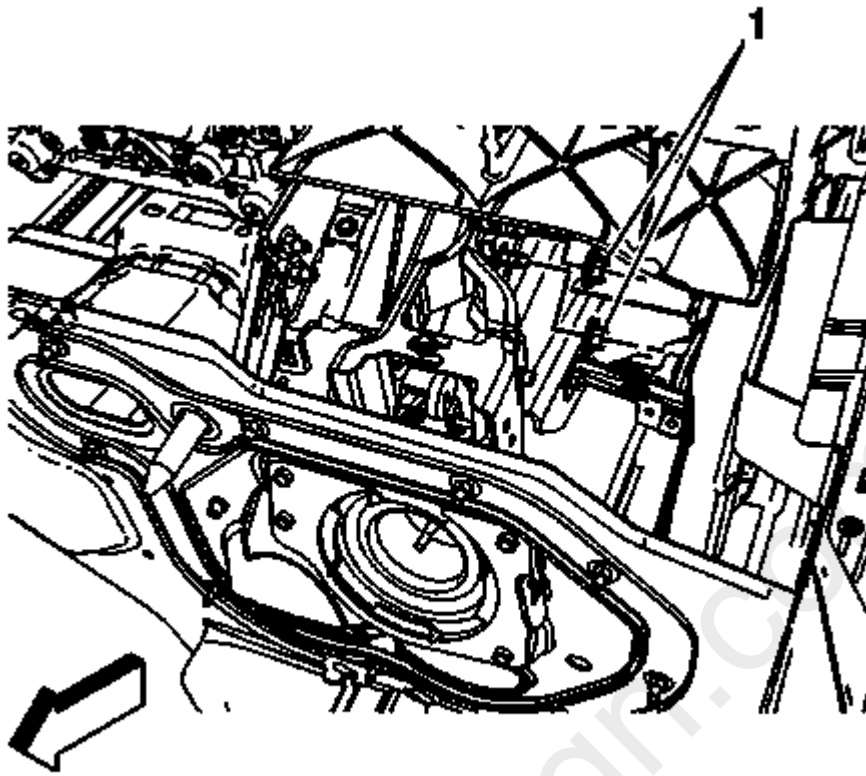


Fig. 51: View Of Brake Pedal Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

5. Install the brake pedal bracket nuts (1) and tighten to 25 N.m (18 lb ft).

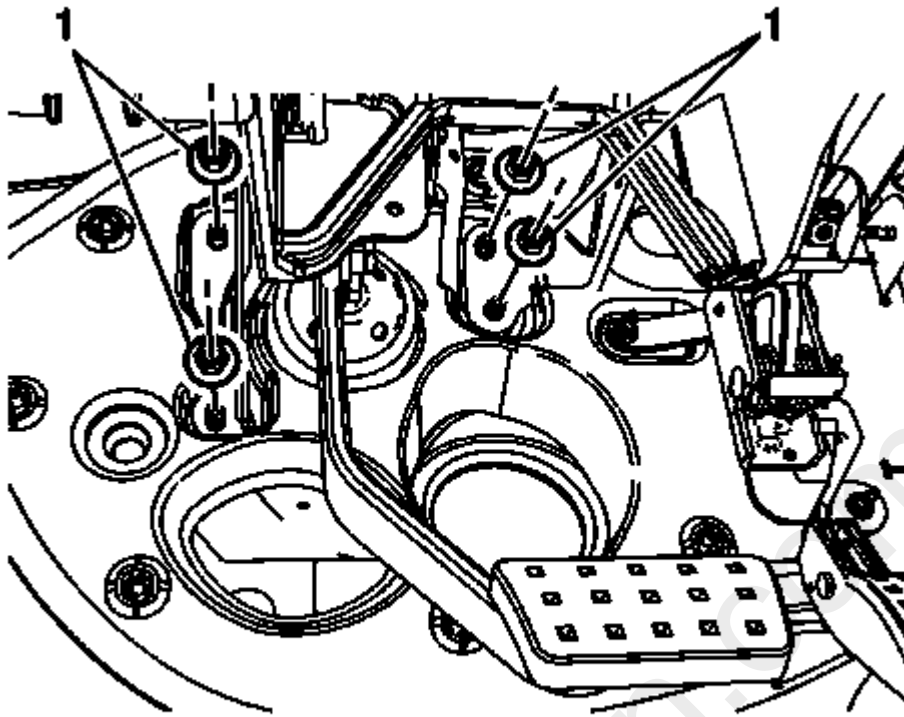


Fig. 52: Vacuum Brake Booster Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

6. Install the power vacuum brake booster bracket nuts (1) and tighten to 25 N.m (18 lb ft).

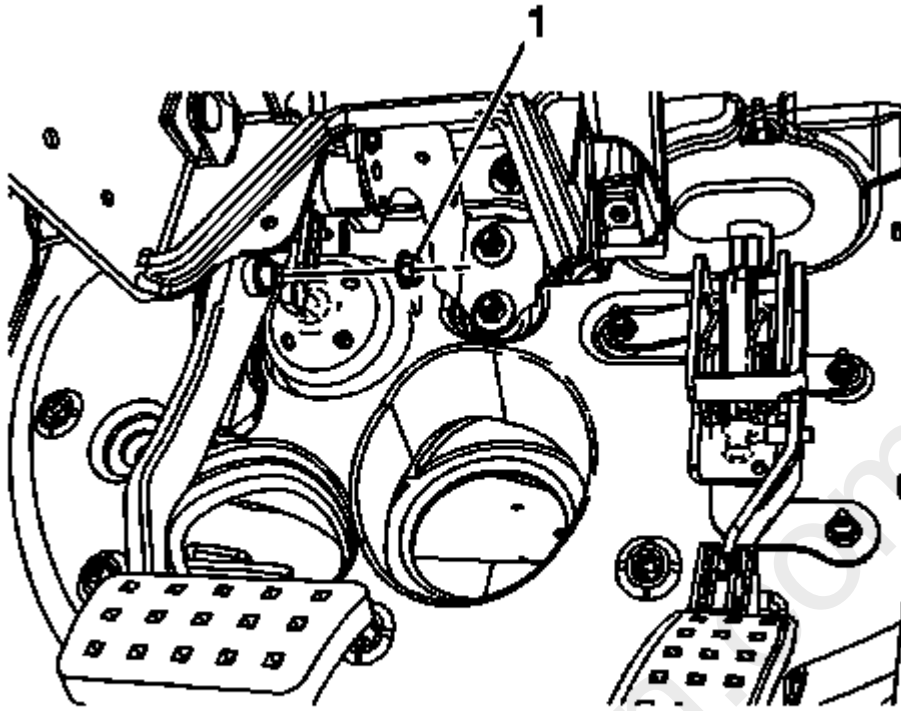


Fig. 53: View Of Vacuum Brake Booster Pushrod Bushing
Courtesy of GENERAL MOTORS COMPANY

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

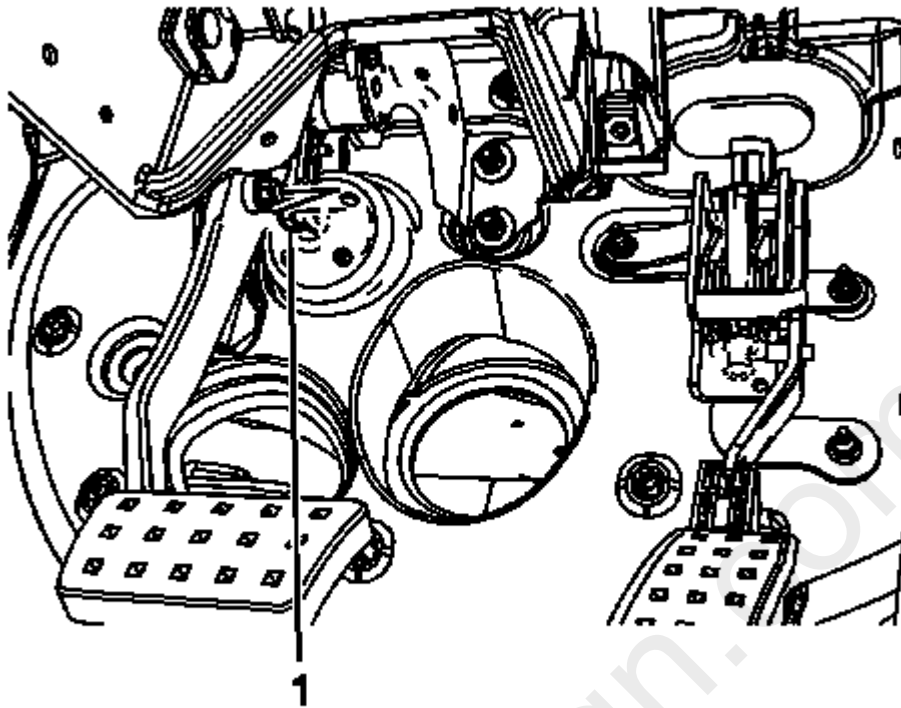


Fig. 54: View Of Vacuum Brake Booster Pushrod
Courtesy of GENERAL MOTORS COMPANY

8. Connect the power vacuum brake booster pushrod (1) to the brake pedal pivot.

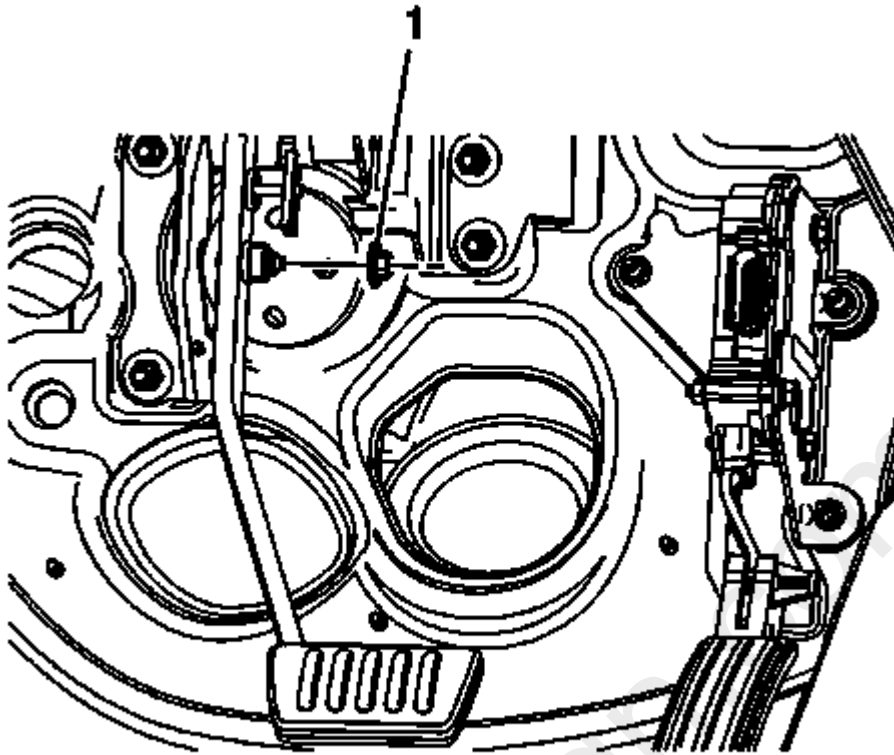


Fig. 55: Power Vacuum Brake Booster Pushrod Nut
Courtesy of GENERAL MOTORS COMPANY

9. Install the power vacuum brake booster pushrod nut (1) and tighten to 9 N.m (80 lb in).

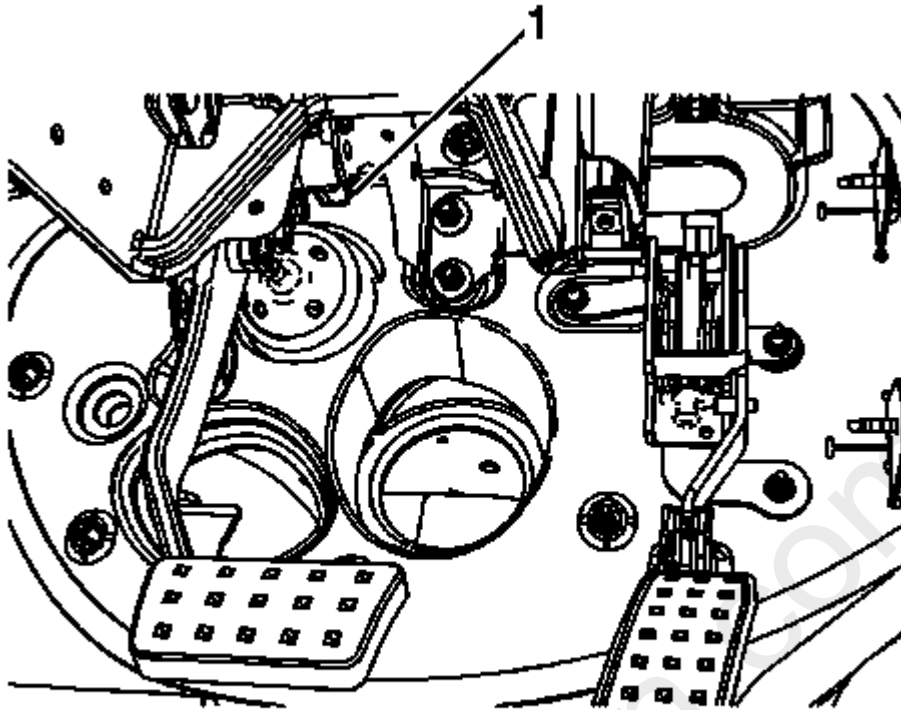


Fig. 56: Brake Pedal Position Sensor
 Courtesy of GENERAL MOTORS COMPANY

10. Connect the brake pedal position sensor (1) electrical connector.
11. Install the steering column. Refer to **Steering Column Replacement** .
12. If removed, install the park brake pedal assembly. Refer to **Parking Brake Lever Pedal Assembly Replacement** .
13. Install the power vacuum brake booster. Refer to **Power Vacuum Brake Booster Replacement (LHD)**.
14. Calibrate the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Calibration** .

BRAKE PEDAL ASSEMBLY REPLACEMENT (RHD)

Removal Procedure

1. Remove the power vacuum brake booster. Refer to **Power Vacuum Brake Booster Replacement (RHD)**.
2. Without disconnecting the steering column from the intermediate shaft, lower and support the steering column. Refer to **Steering Column Replacement** .

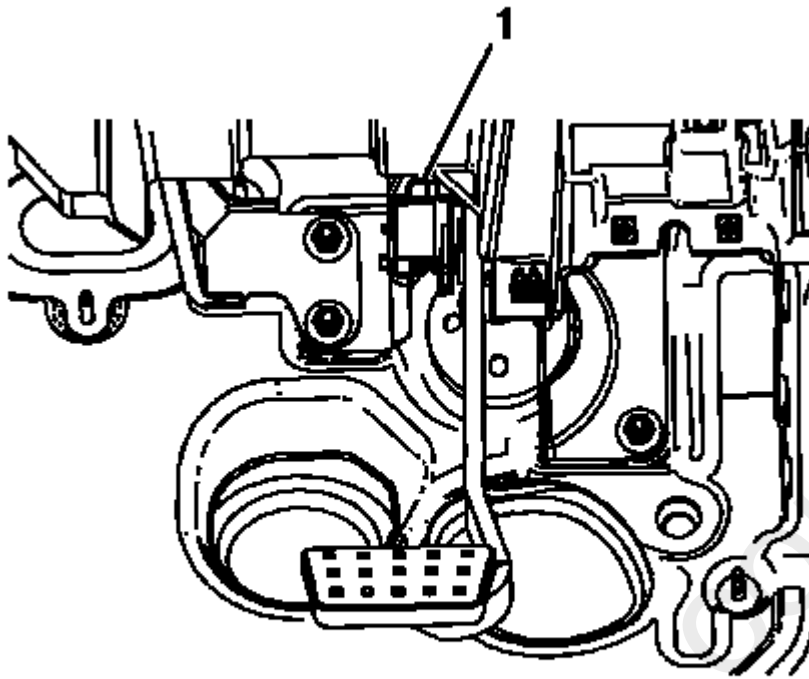


Fig. 57: Brake Pedal Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the brake pedal position sensor (1) electrical connector.

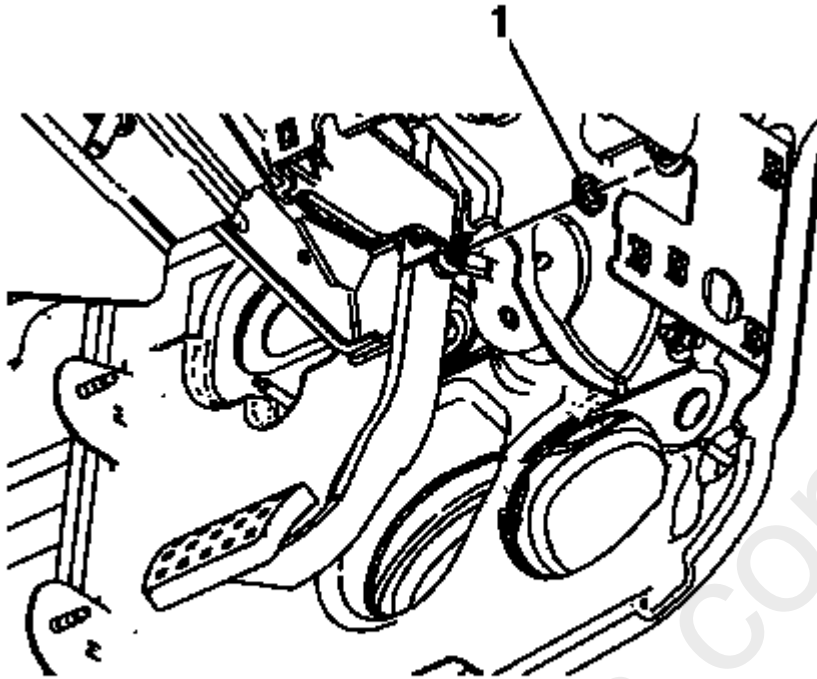


Fig. 58: Power Vacuum Brake Booster Pushrod Nut
Courtesy of GENERAL MOTORS COMPANY

4. Remove the power vacuum brake booster pushrod nut (1).
5. Disconnect the power vacuum brake booster pushrod from the brake pedal pivot.

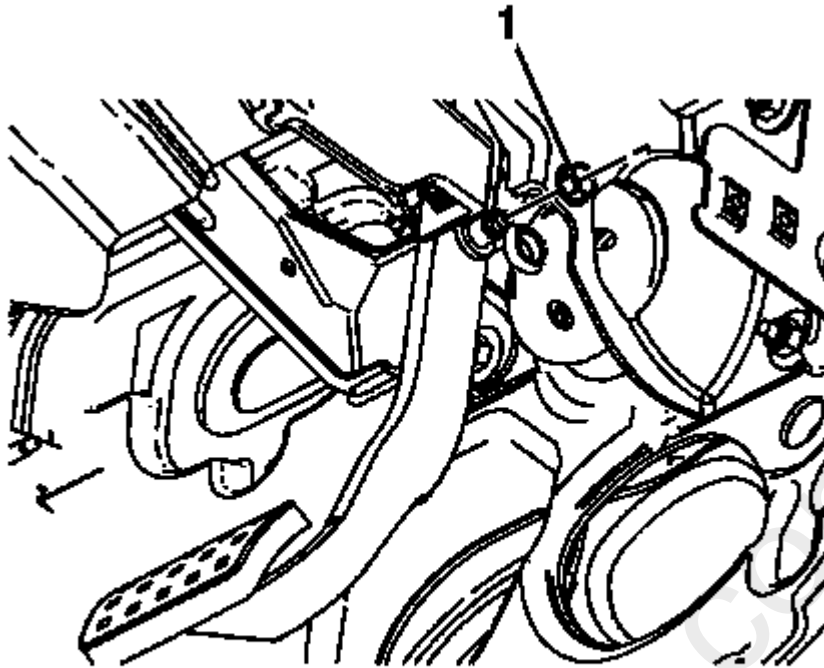


Fig. 59: Power Vacuum Brake Booster Pushrod Bushing
Courtesy of GENERAL MOTORS COMPANY

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

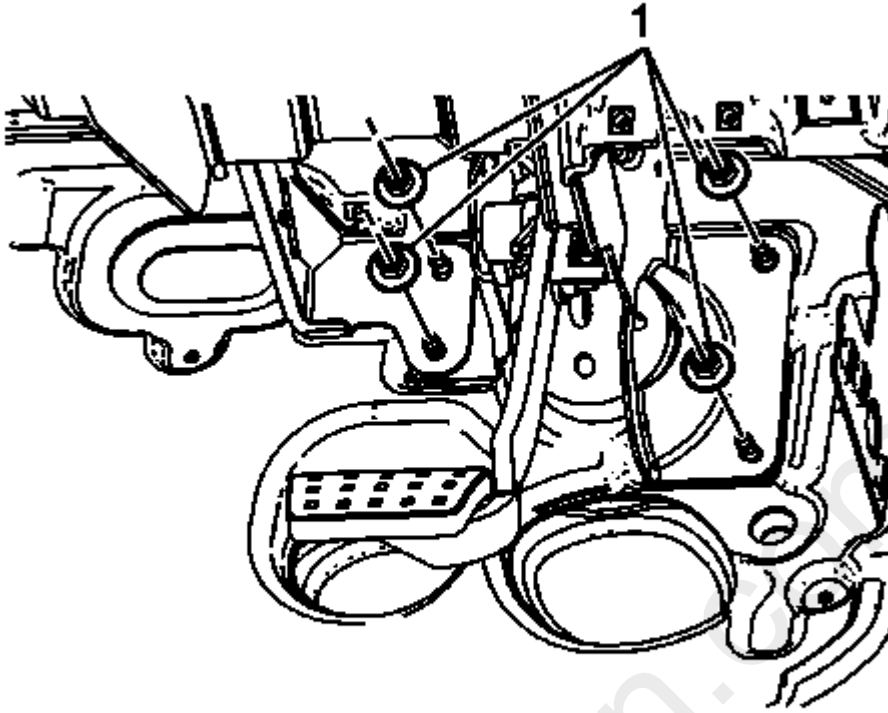


Fig. 60: Power Vacuum Brake Booster Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the power vacuum brake booster bracket nuts (1).

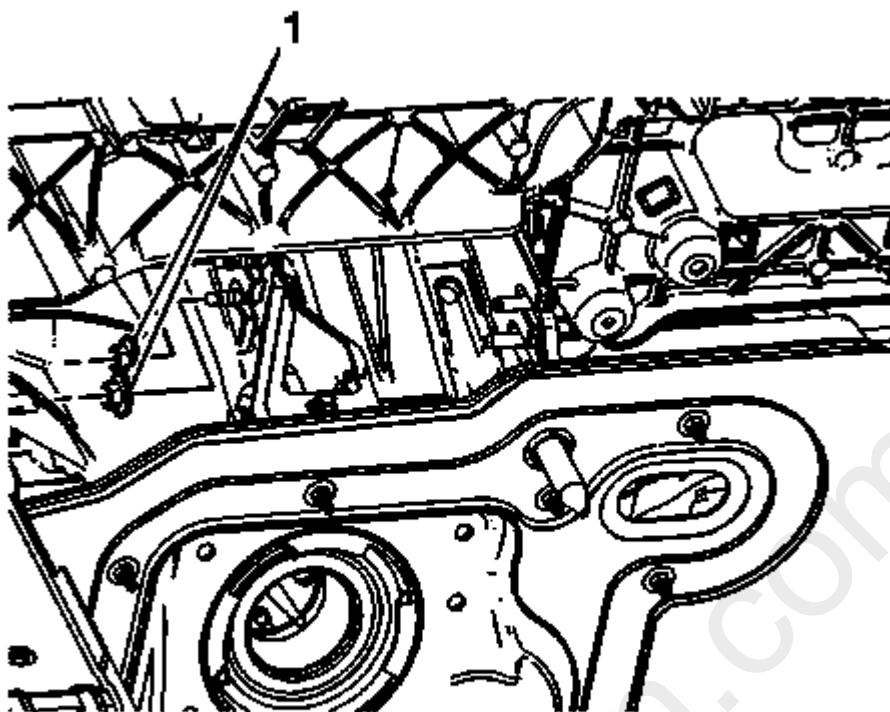


Fig. 61: Brake Pedal Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the brake pedal bracket nuts (1).

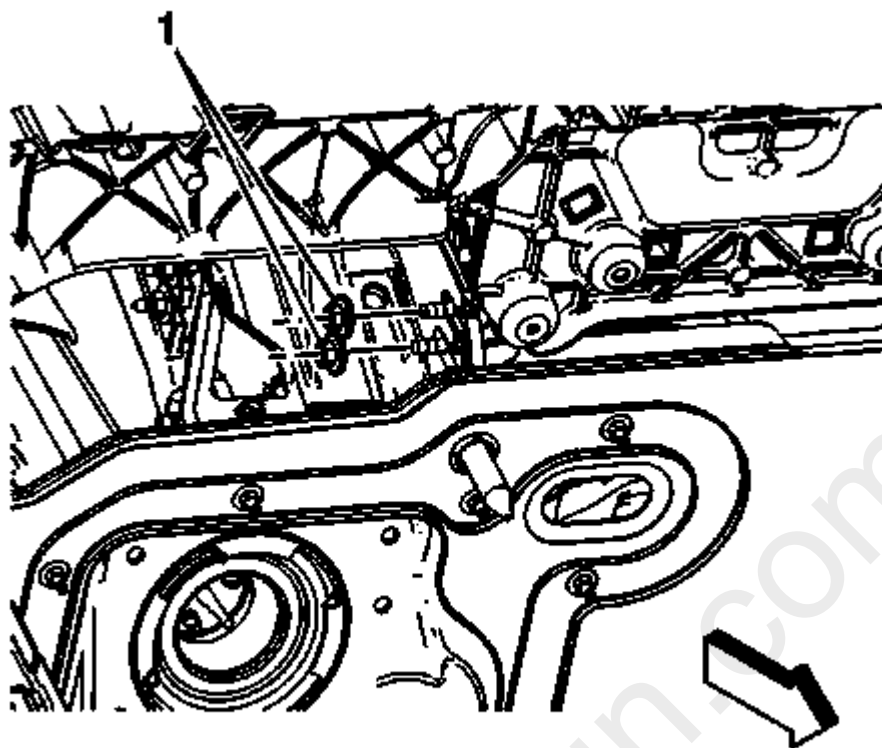


Fig. 62: Upper Steering Column Support Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the upper steering column support bracket nuts (1).

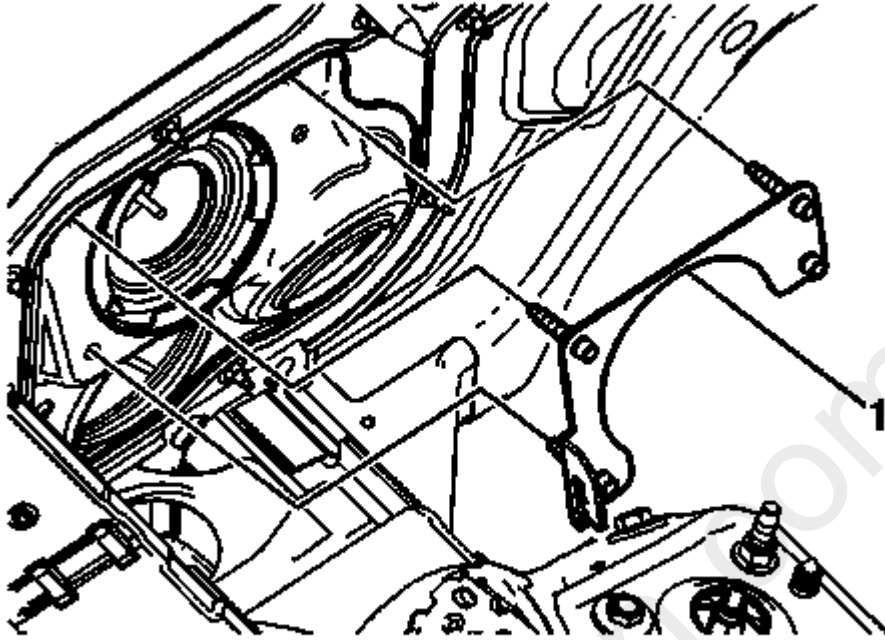


Fig. 63: Power Vacuum Brake Booster Bracket
Courtesy of GENERAL MOTORS COMPANY

10. Remove the power vacuum brake booster bracket (1).

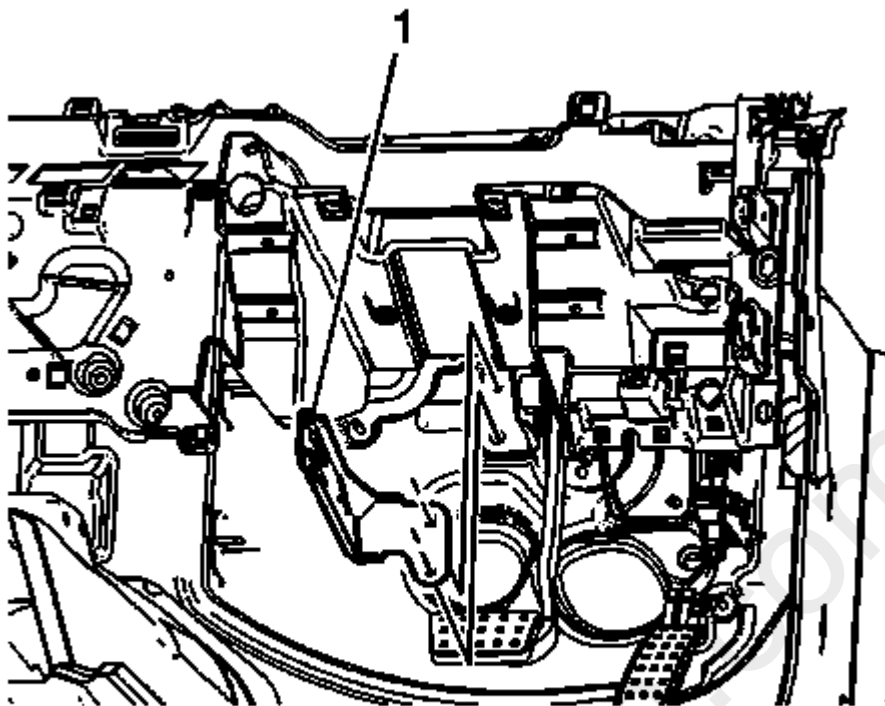


Fig. 64: Steering Column Support Bracket
Courtesy of GENERAL MOTORS COMPANY

11. Remove the steering column support bracket (1).

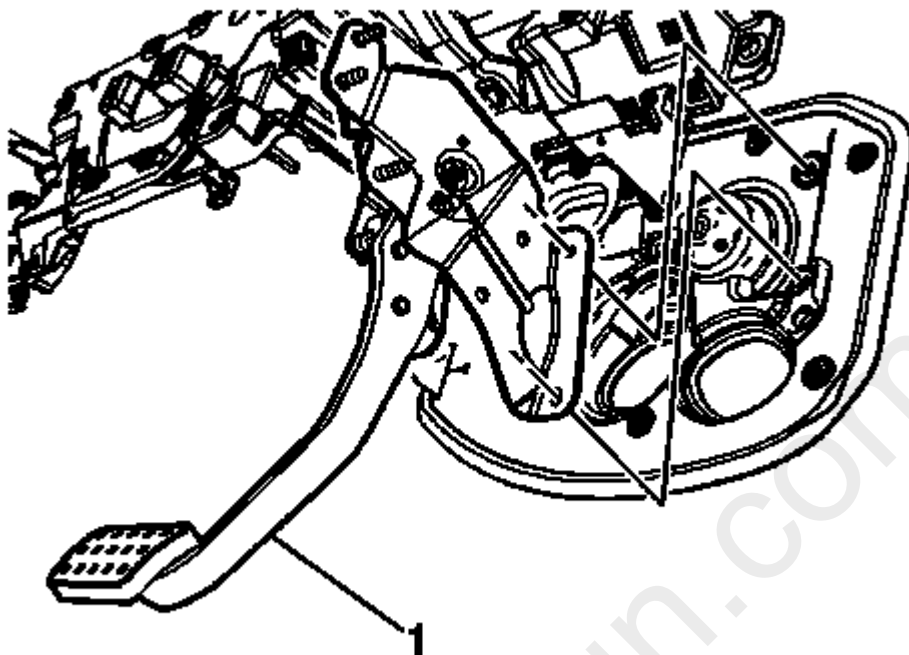


Fig. 65: Brake Pedal Assembly

Courtesy of GENERAL MOTORS COMPANY

12. Remove the brake pedal assembly (1) from the vehicle.

Installation Procedure

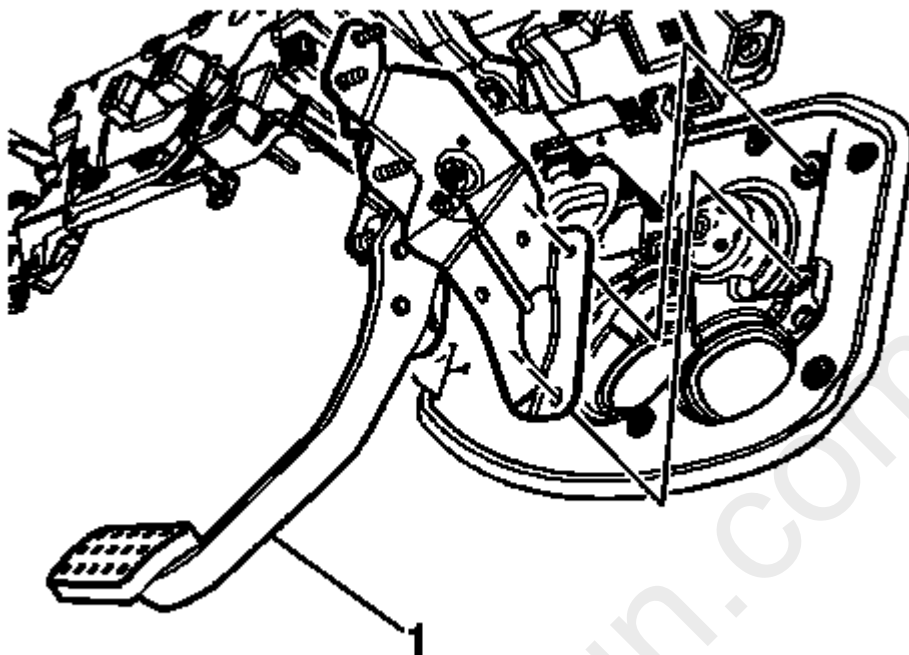


Fig. 66: Brake Pedal Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Install the brake pedal assembly (1) to the vehicle.

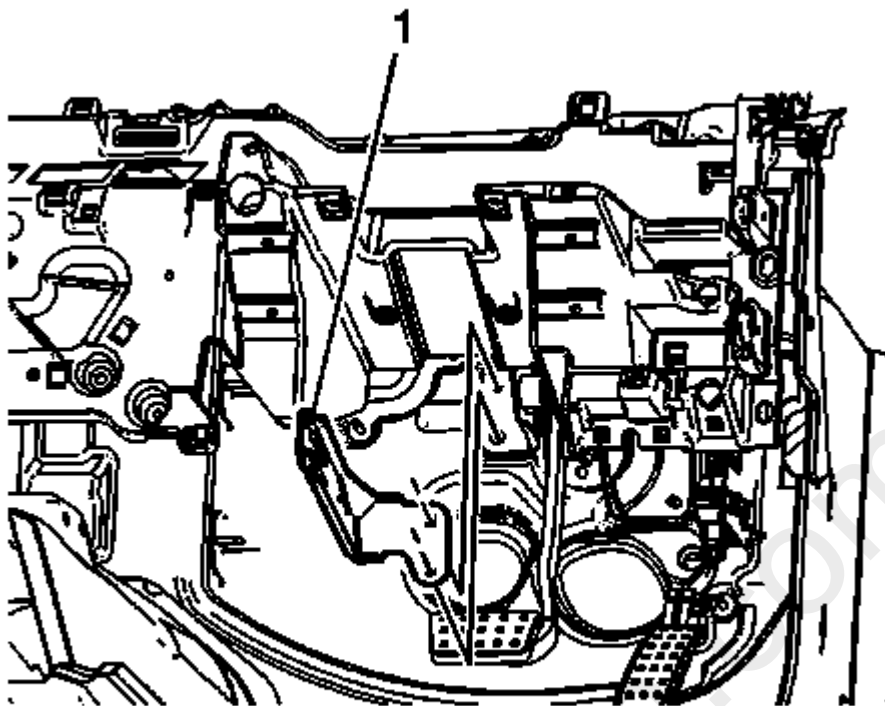


Fig. 67: Steering Column Support Bracket
Courtesy of GENERAL MOTORS COMPANY

2. Install the steering column support bracket (1).

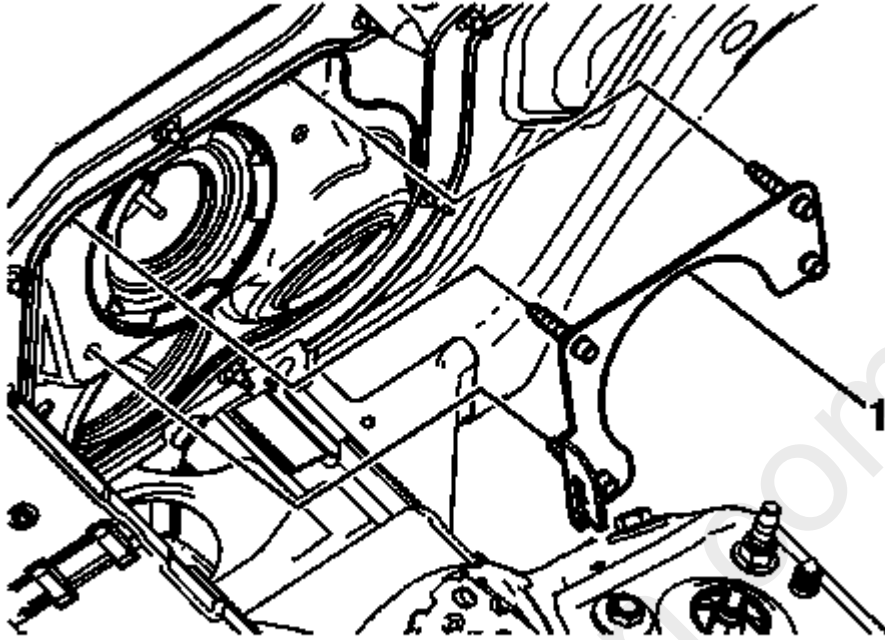


Fig. 68: Power Vacuum Brake Booster Bracket
Courtesy of GENERAL MOTORS COMPANY

3. Install the power vacuum brake booster bracket (1).

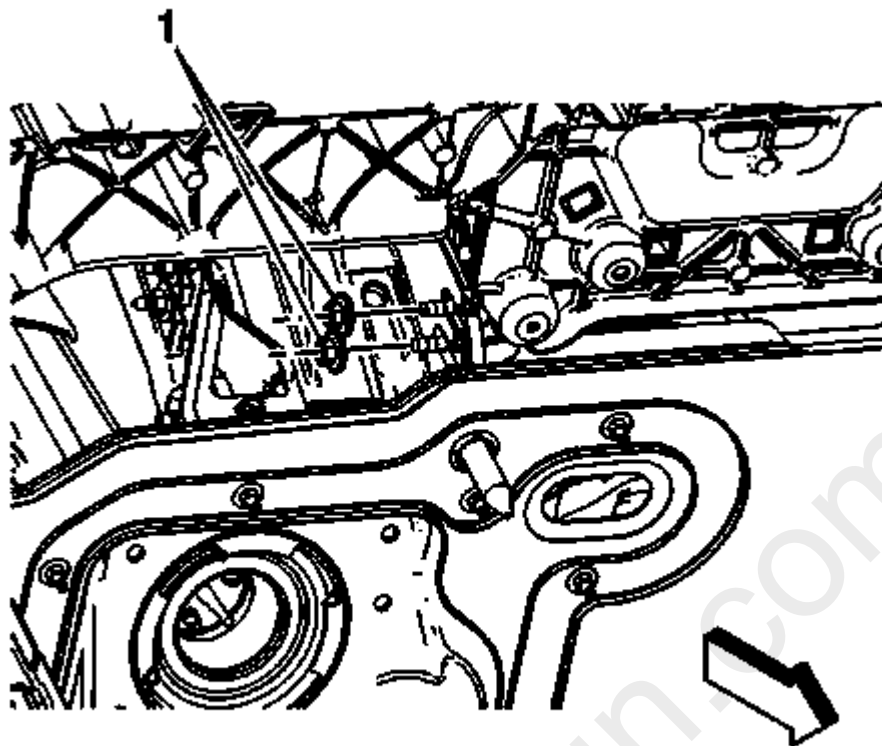


Fig. 69: Upper Steering Column Support Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the upper steering column support bracket nuts (1) and tighten to 25 N.m (18 lb ft).

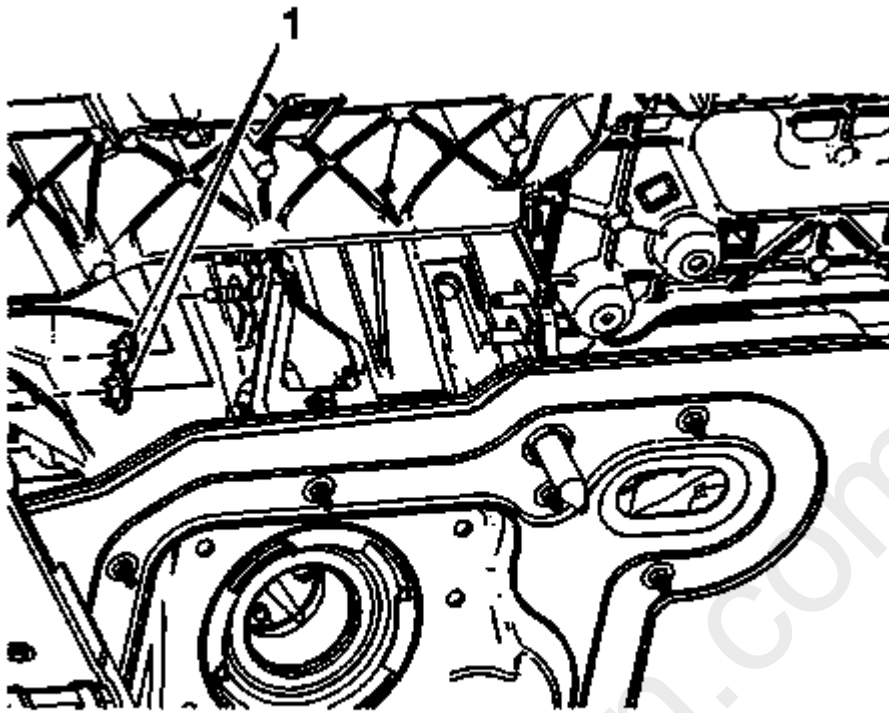


Fig. 70: Brake Pedal Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

5. Install the brake pedal bracket nuts (1) and tighten to 25 N.m (18 lb ft).

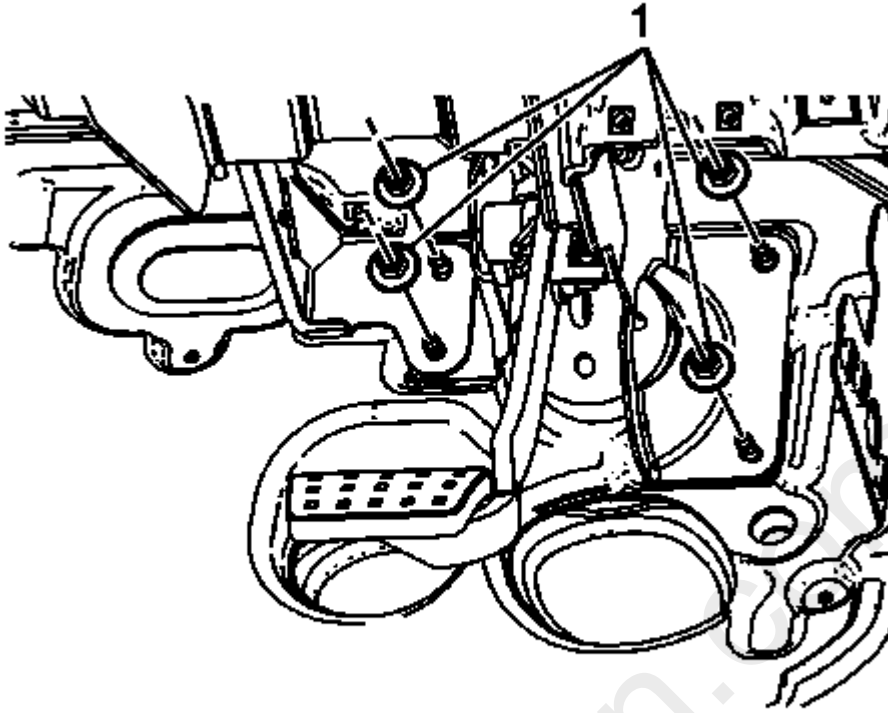


Fig. 71: Power Vacuum Brake Booster Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

6. Install the power vacuum brake booster bracket nuts (1) and tighten to 25 N.m (18 lb ft).

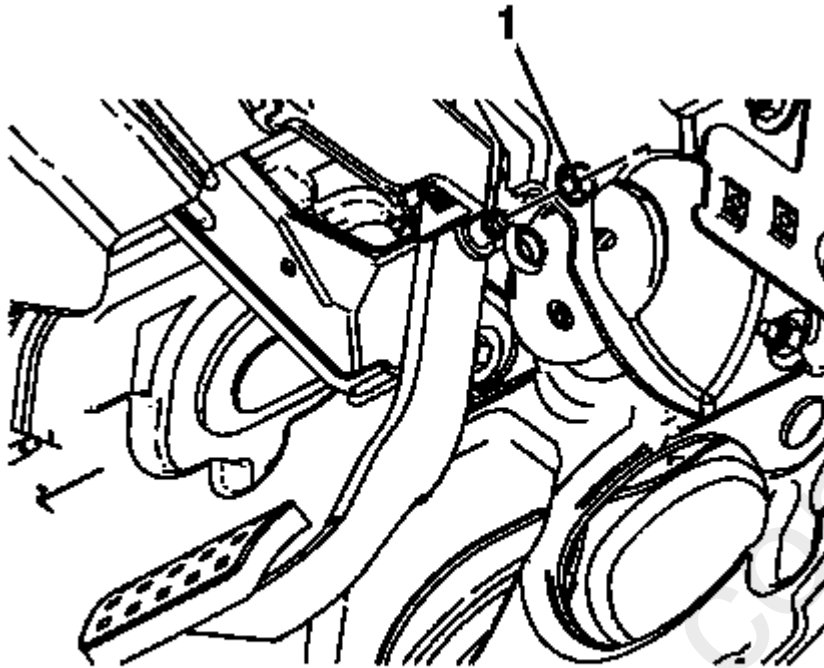


Fig. 72: Power Vacuum Brake Booster Pushrod Bushing
Courtesy of GENERAL MOTORS COMPANY

7. Install the power vacuum brake booster pushrod bushing (1).
8. Connect the power vacuum brake booster pushrod to the brake pedal pivot.

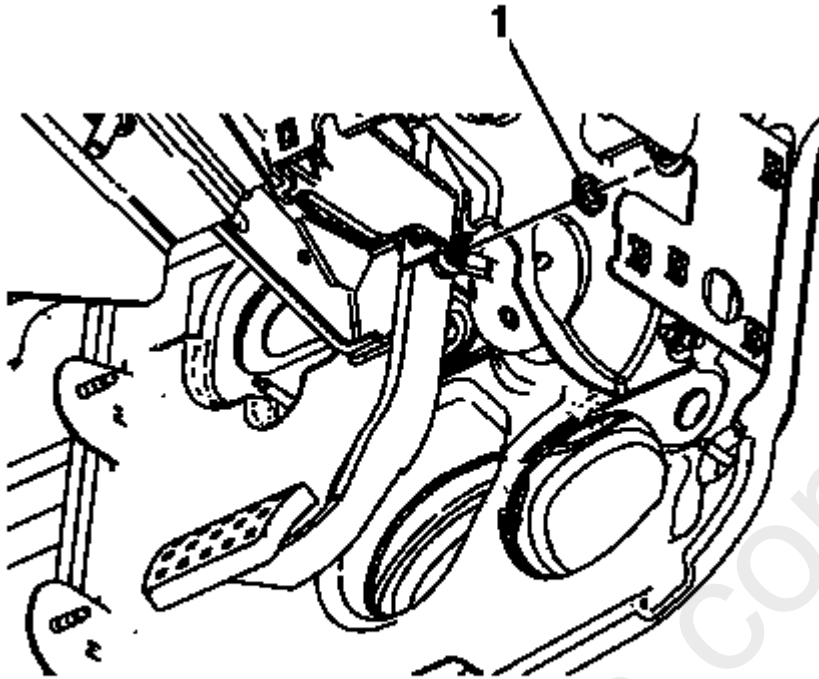


Fig. 73: Power Vacuum Brake Booster Pushrod Nut
Courtesy of GENERAL MOTORS COMPANY

9. Install the power vacuum brake booster pushrod nut (1) and tighten to 9 N.m (80 lb in).

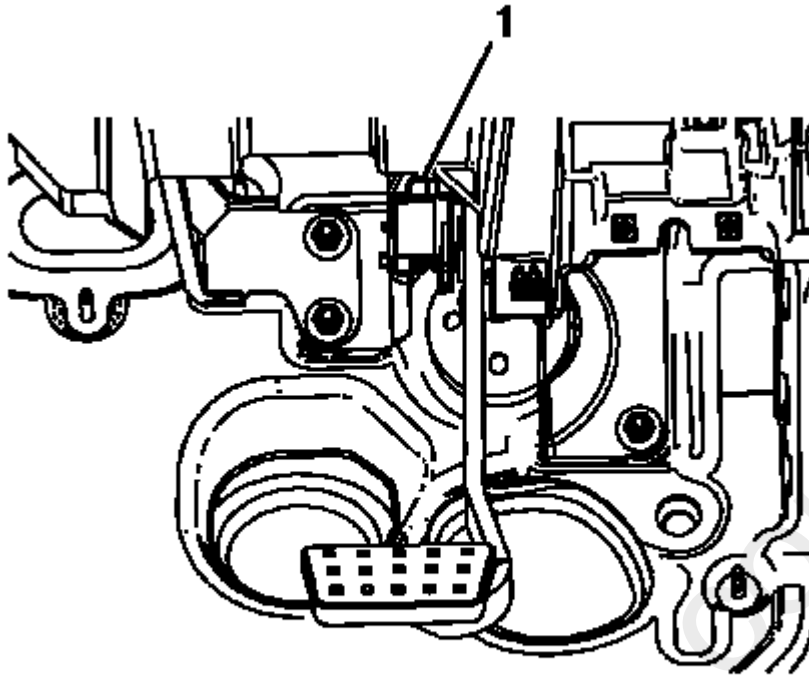


Fig. 74: Brake Pedal Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

10. Connect the brake pedal position sensor (1) electrical connector.
11. Install the steering column. Refer to **Steering Column Replacement** .
12. Install the power vacuum brake booster. Refer to **Power Vacuum Brake Booster Replacement (RHD)**.
13. Calibrate the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Calibration** .

BRAKE PIPE REPLACEMENT

Special Tools

CH-45405 Brake Pipe Flaring Kit

For equivalent regional tools, refer to **Special Tools**.

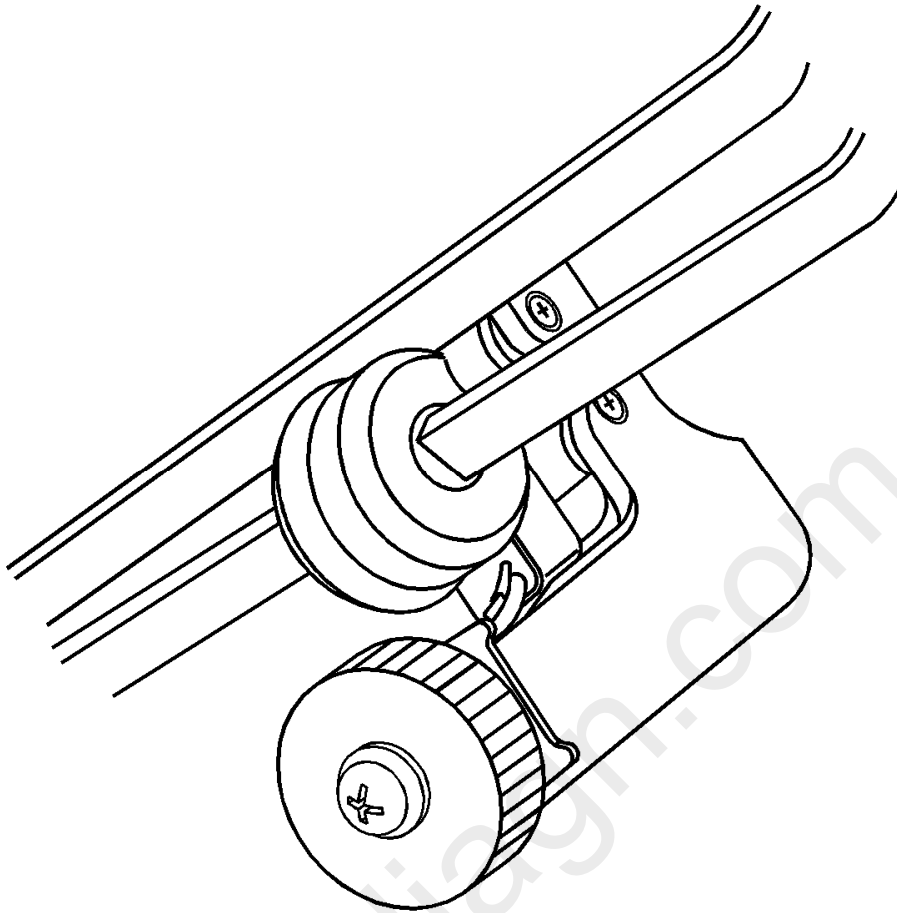


Fig. 75: Sectioning Brake Pipe Using Pipe Cutter
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Brake Fluid Irritant Warning .

WARNING: 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.

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

NOTE: 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.

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 **CH-45405** Brake Pipe Flaring Kit.
 - 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
- 12.67 mm (0.499 in) for 7.94 mm (5/16 in) diameter pipe

NOTE: 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 **CH-45405** Brake Pipe Flaring Kit , carefully cut the brake pipe squarely to the measured length.
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.

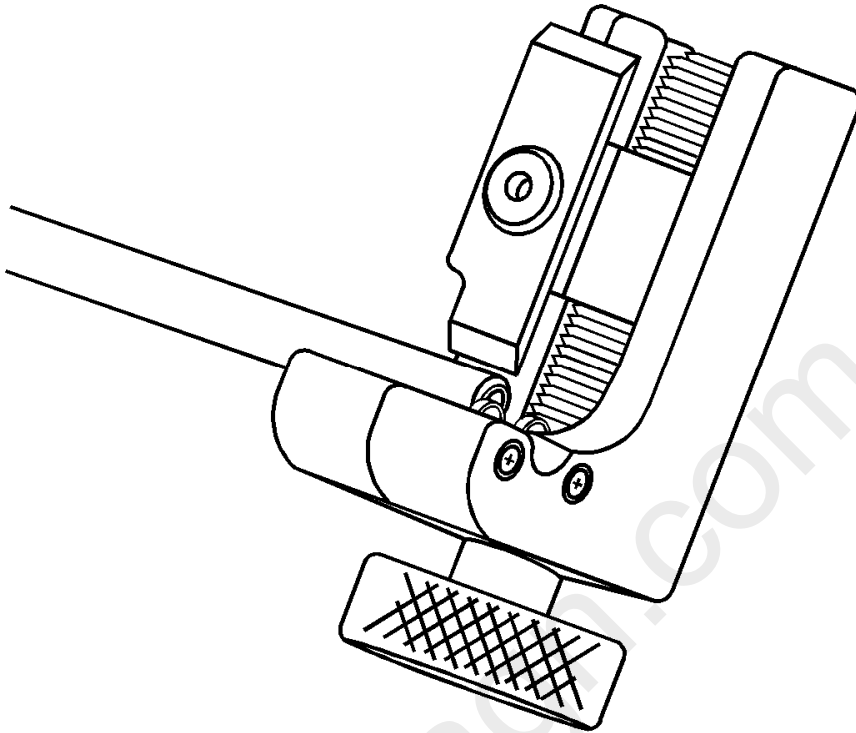


Fig. 76: Stripping Nylon Coating From Brake Pipe Ends
Courtesy of GENERAL MOTORS COMPANY

9. Strip the nylon coating from the brake pipe end to be flared, if necessary.
 1. Select the appropriate blade on the coating stripping tool included in the **CH-45405** Brake Pipe Flaring Kit , by unthreading the blade block from the stripping tool and installing the block with the desired blade facing the tool rollers.

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) and 7.94 mm (5/16 in) diameter pipe
2. Insert the brake pipe end to be flared into the stripping tool to the depth of the ledge on the tool rollers.
 3. 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.

NOTE: **Do not gouge the metal surface of the brake pipe.**

4. Rotate the stripping tool in a clockwise direction, ensuring that the brake pipe end remains against the tool roller ledges.
5. 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.
6. Loosen the thumbwheel of the tool and remove the brake pipe.

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

7. 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) and 7.94 mm (5/16 in) diameter pipe

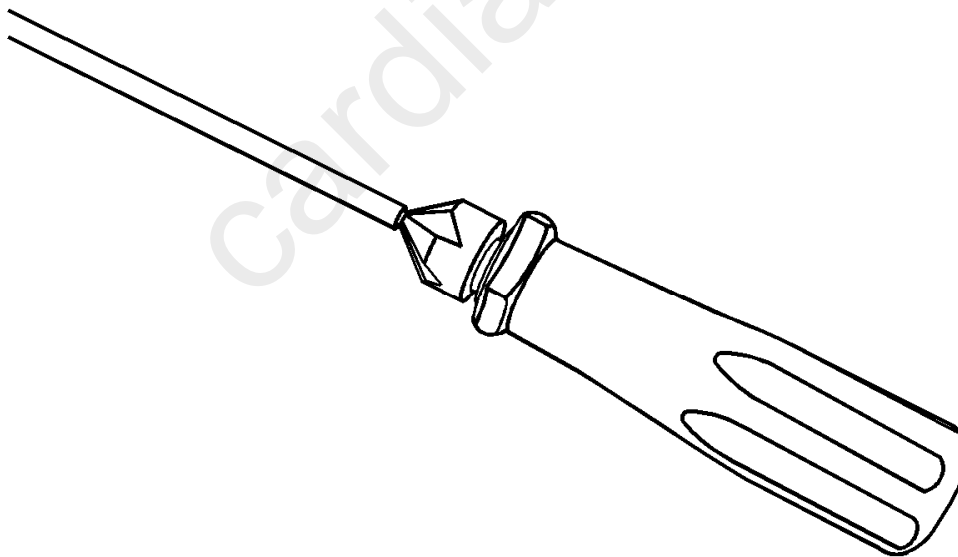


Fig. 77: Chamfering Pipe Using De-Burring Tool
Courtesy of GENERAL MOTORS COMPANY

10. Chamfer the inside and outside diameter of the pipe with the de-burring tool included in the **CH-45405** Brake Pipe Flaring Kit.
11. Install the tube nuts on the brake pipe, noting their orientation.
12. Clean the brake pipe and the **CH-45405** Brake Pipe Flaring Kit of lubricant, contaminants, and debris.

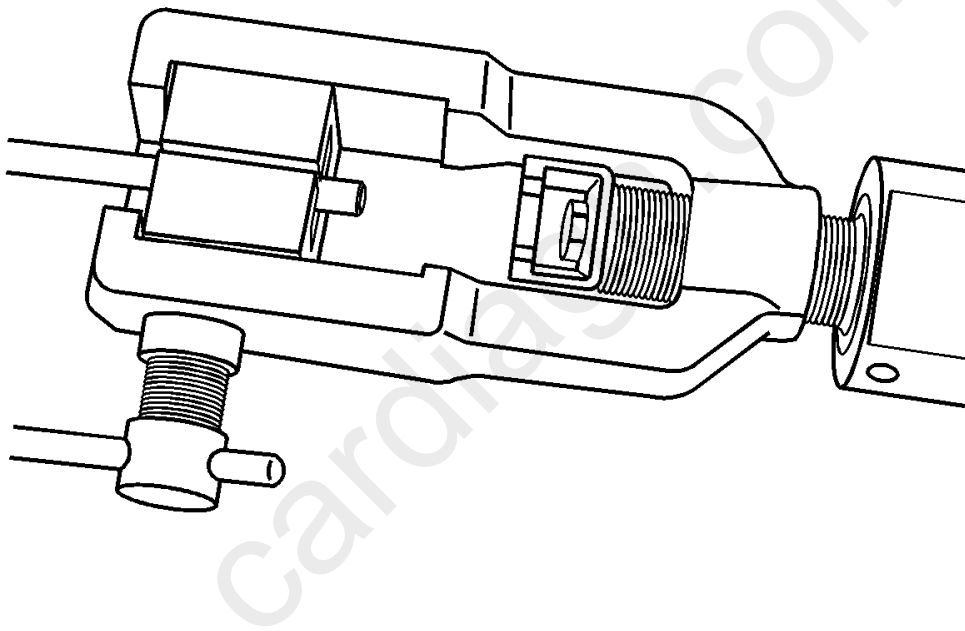


Fig. 78: Installing Die Halves Into Die Cage
Courtesy of GENERAL MOTORS COMPANY

13. Loosen the die clamping screw of the **CH-45405** Brake Pipe Flaring Kit.
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.

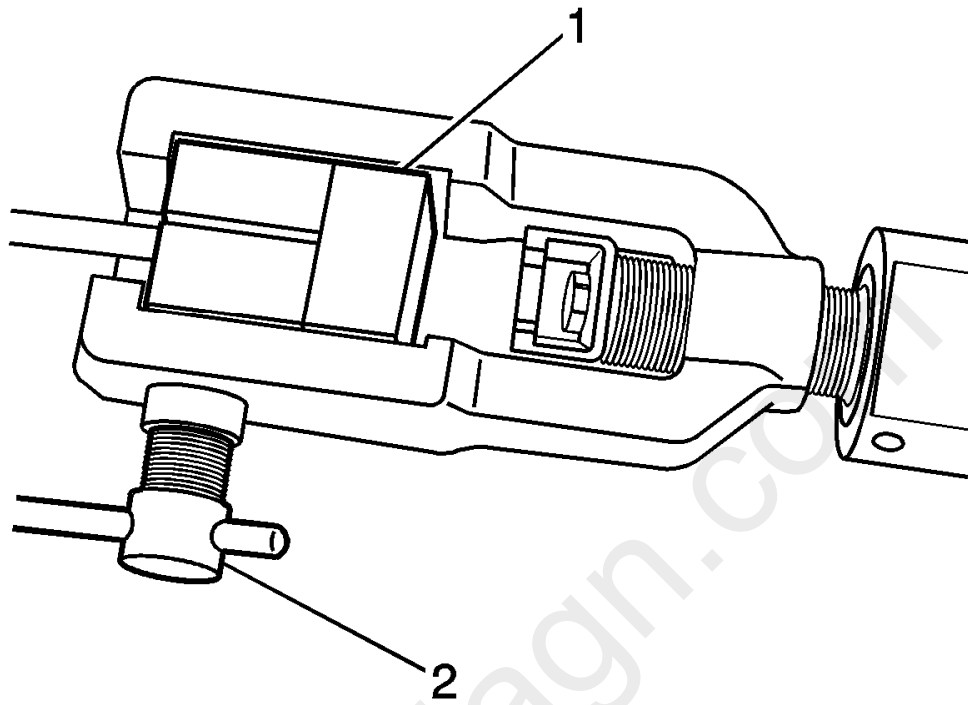


Fig. 79: View Of Clamping Screw & Unused Die
Courtesy of GENERAL MOTORS COMPANY

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.

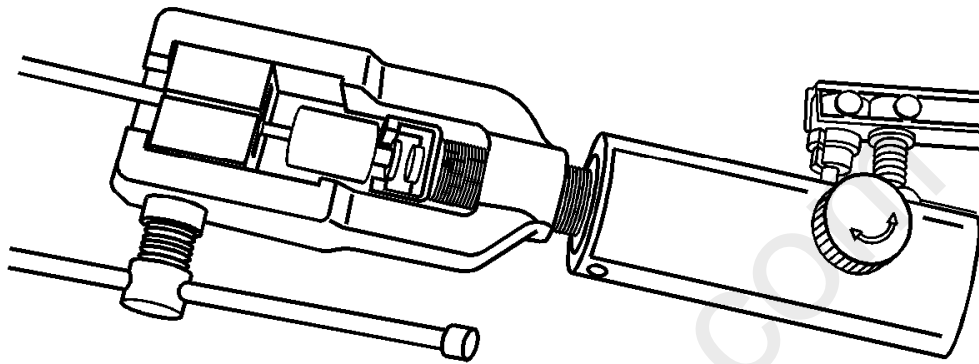


Fig. 80: Rotating J 45405 To Bottom Against Die Cage
Courtesy of GENERAL MOTORS COMPANY

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 **CH-45405** Brake Pipe Flaring Kit until it bottoms against the die cage.

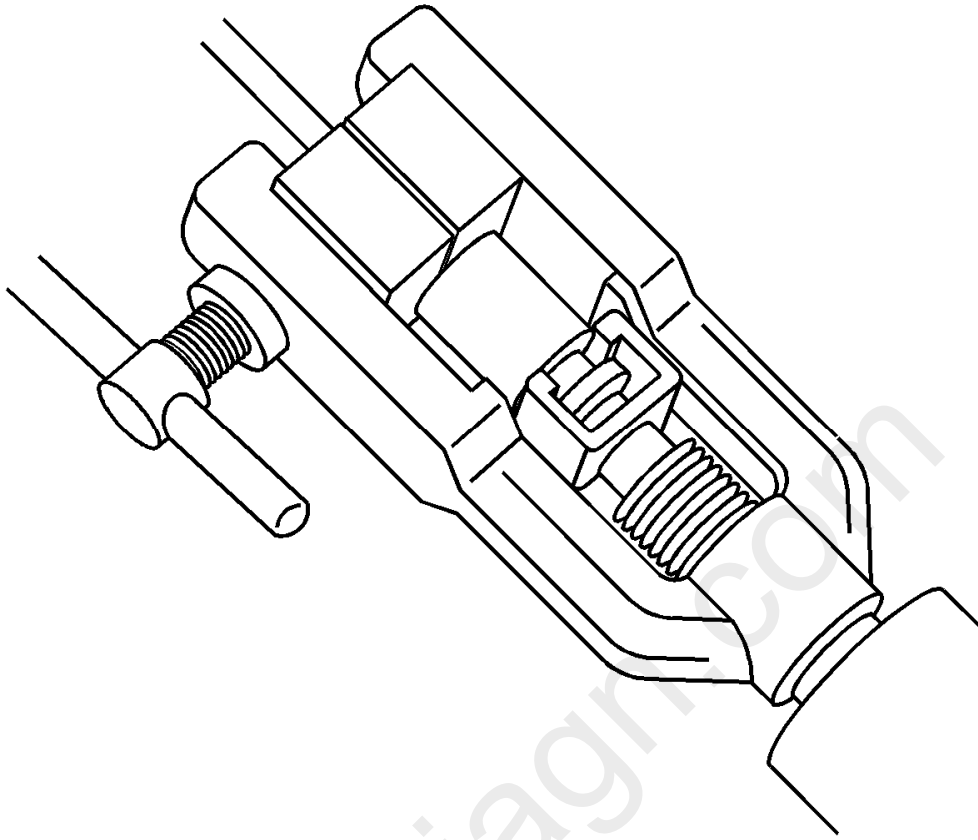


Fig. 81: Bottoming Forming Mandrel Against Clamping Dies Using Pipe Flaring Tool
Courtesy of GENERAL MOTORS COMPANY

23. While guiding the forming mandrel into the exposed end of pipe to be flared, operate the lever of the **CH-45405** Brake Pipe Flaring Kit until the forming mandrel bottoms against the clamping dies.
24. Rotate the hydraulic fluid control valve counterclockwise to the open position to allow the hydraulic forming ram to retract.

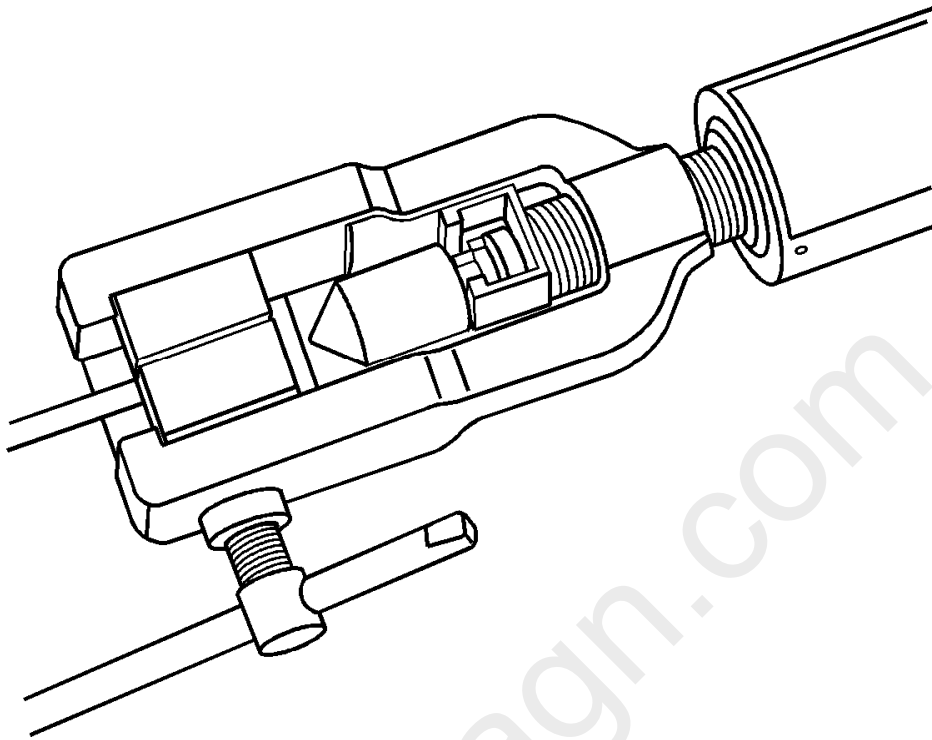


Fig. 82: Using Pipe Flaring Tool
Courtesy of GENERAL MOTORS COMPANY

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 **CH-45405** Brake Pipe Flaring Kit until it bottoms against the die cage.
28. While guiding the finishing cone into the exposed end of pipe to be flared, operate the lever of the **CH-45405** Brake Pipe Flaring Kit until the finishing cone bottoms against the dies.
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.

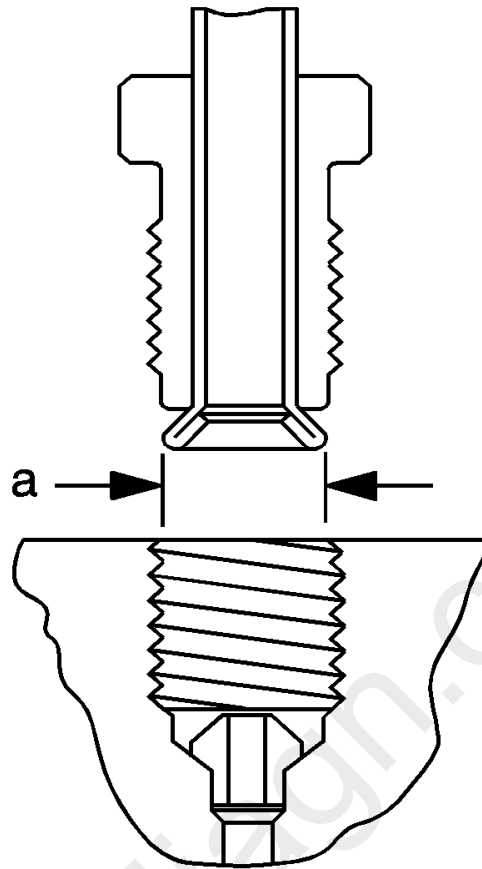


Fig. 83: Identifying Correct Brake Pipe Flare Shape & Diameter
Courtesy of GENERAL MOTORS COMPANY

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

Specification

- 6.74-7.10 mm (0.265-0.279 in) flare diameter for 4.76 mm (3/16 in) diameter pipe
 - 8.57-9.27 mm (0.344-0.358 in) flare diameter for 6.35 mm (1/4 in) diameter pipe
 - 10.42-10.79 mm (0.410-0.425 in) flare diameter for 7.94 mm (5/16 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.

NOTE: **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)**, **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.

FRONT BRAKE HOSE REPLACEMENT (RWD)

Removal Procedure

WARNING: Refer to **Brake Dust Warning** .

WARNING: Refer to **Brake Fluid Irritant Warning** .

CAUTION: Refer to **Brake Fluid Effects on Paint and Electrical Components Caution** .

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

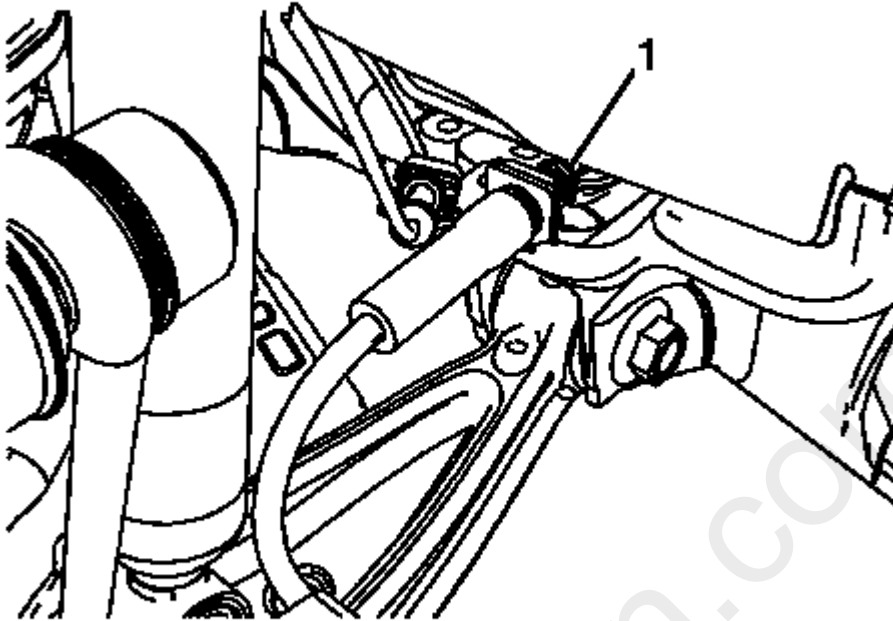


Fig. 84: Front Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the front brake pipe fitting (1).

Cap the brake pipe fitting to prevent brake fluid loss and contamination.

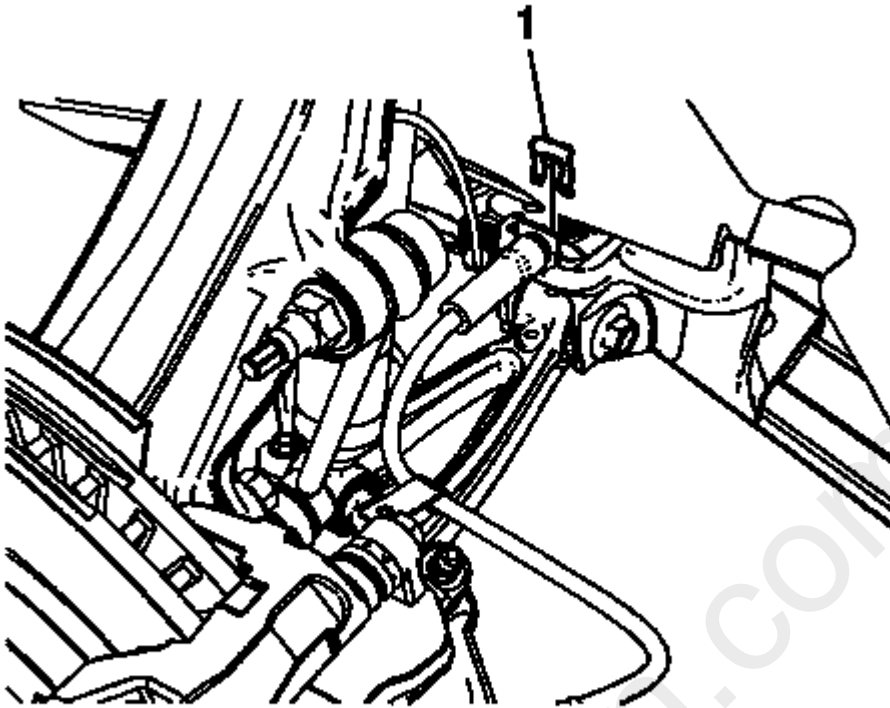


Fig. 85: Front Brake Hose Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

4. Remove the front brake hose retainer clip (1).

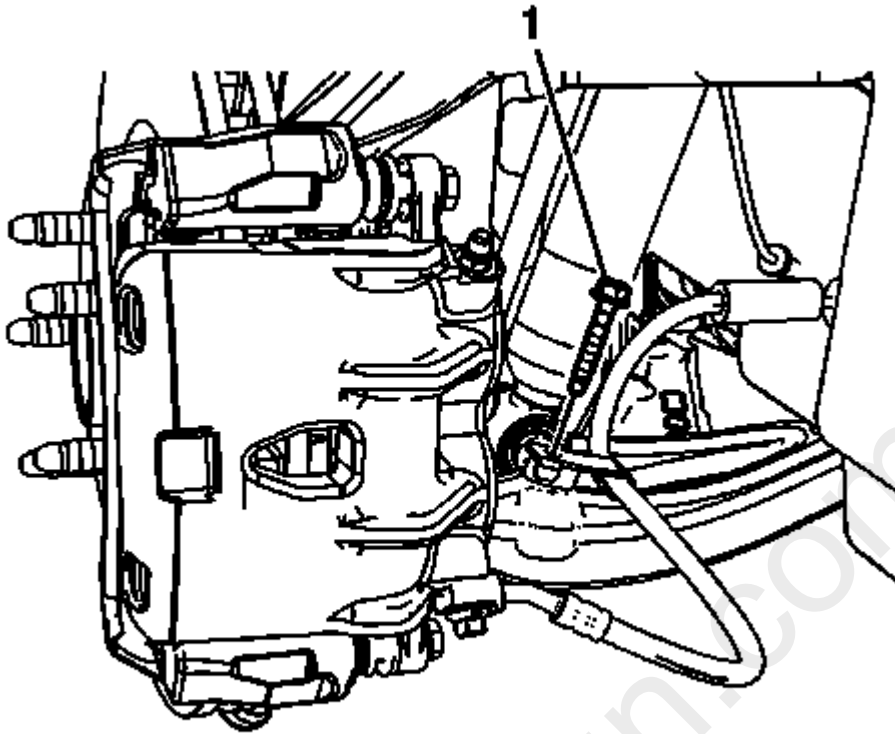


Fig. 86: Rear Lower Shock Module Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the rear lower shock module bolt (1).

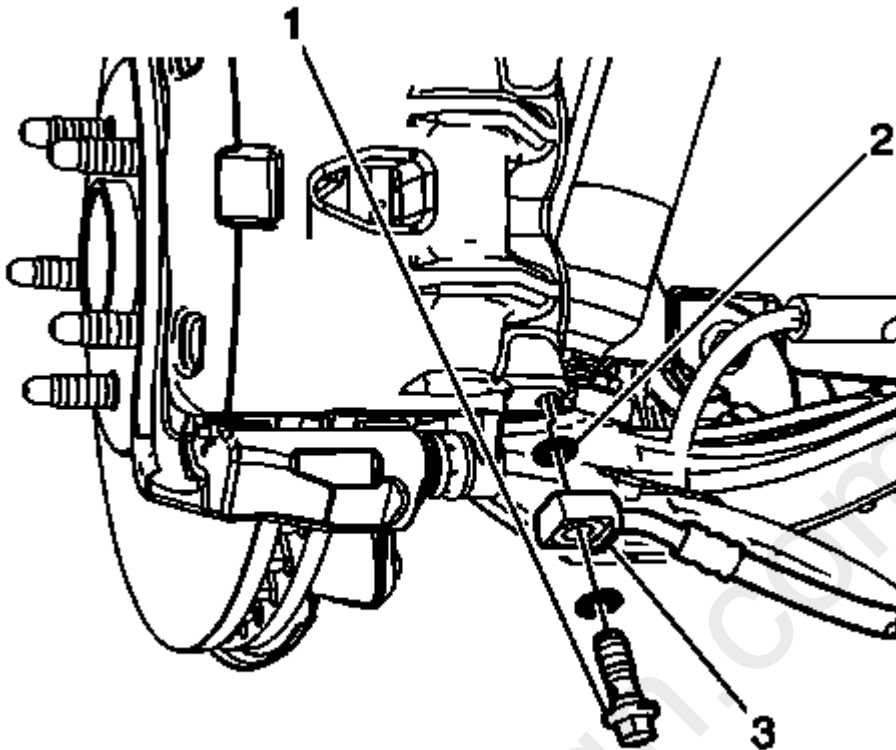


Fig. 87: Hose Fitting and Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the brake hose fitting bolt (1).
7. Remove the brake hose fitting gaskets (2) from the brake hose (3).

Discard the brake hose fitting gaskets.

8. Remove the brake hose.

Installation Procedure

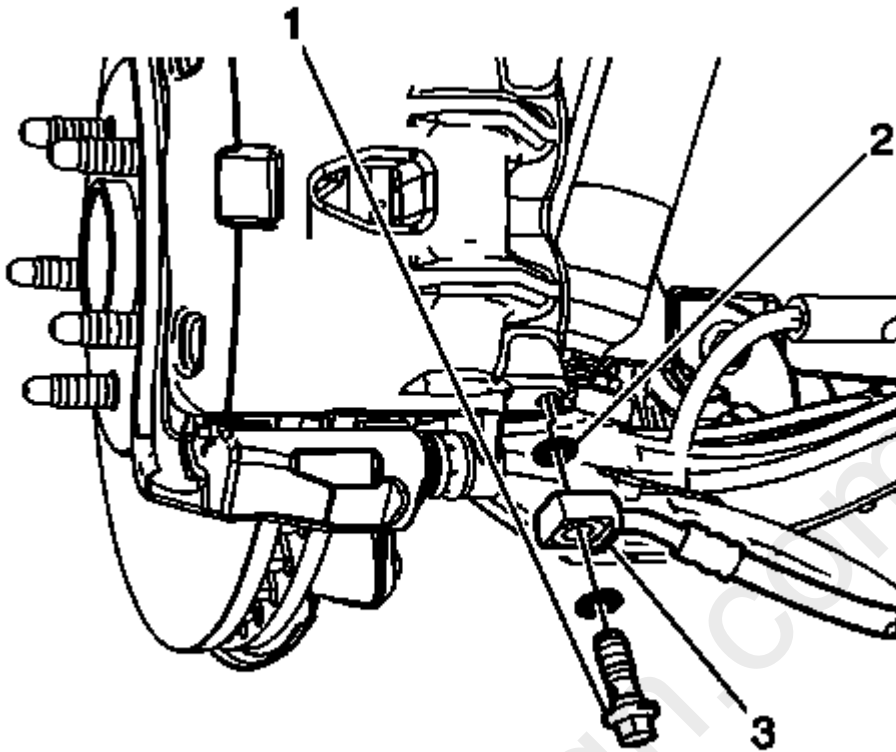


Fig. 88: Hose Fitting and Bolt

Courtesy of GENERAL MOTORS COMPANY

1. Assemble the brake hose fitting bolt (1) with 2 new brake hose fitting gaskets (2) to the brake hose (3).

CAUTION: Refer to Fastener Caution .

2. Install the brake hose assembly to the caliper.

Tighten

Tighten the brake hose fitting bolt to 49 N.m (36 lb ft).

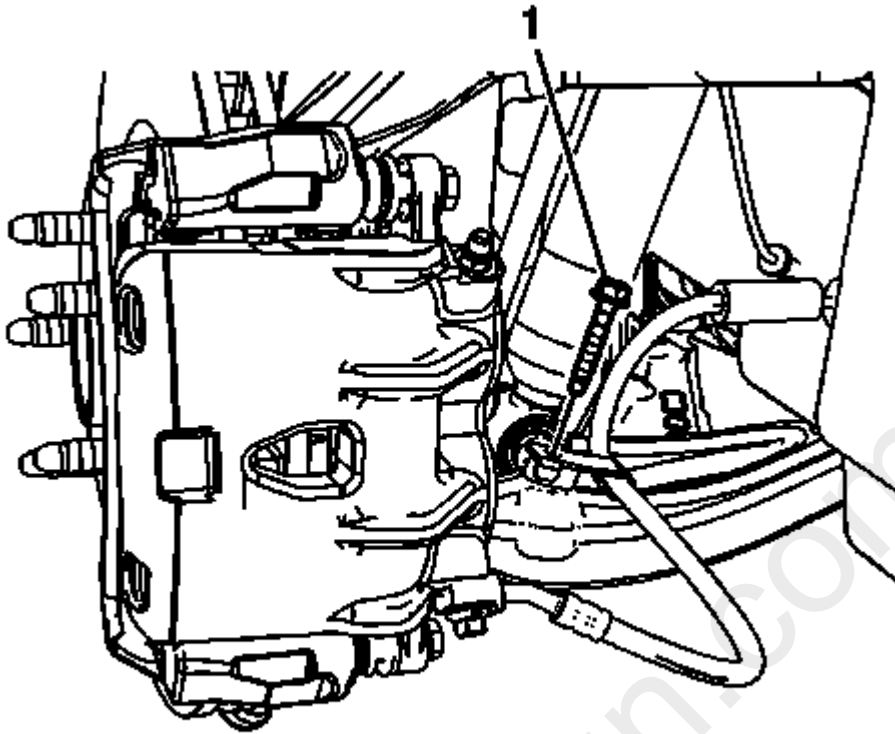


Fig. 89: Rear Lower Shock Module Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install the rear lower shock module bolt (1) through the brake hose bracket and to the lower control arm.

Tighten

Tighten the bolt to 25 N.m (18 lb ft).

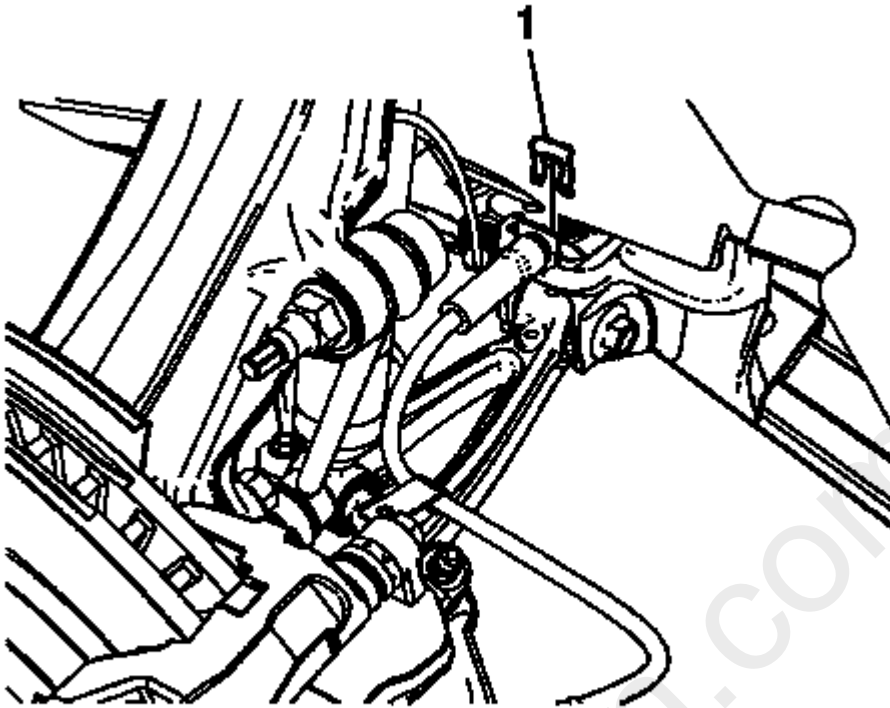


Fig. 90: Front Brake Hose Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

4. Install the front brake hose retainer clip (1).

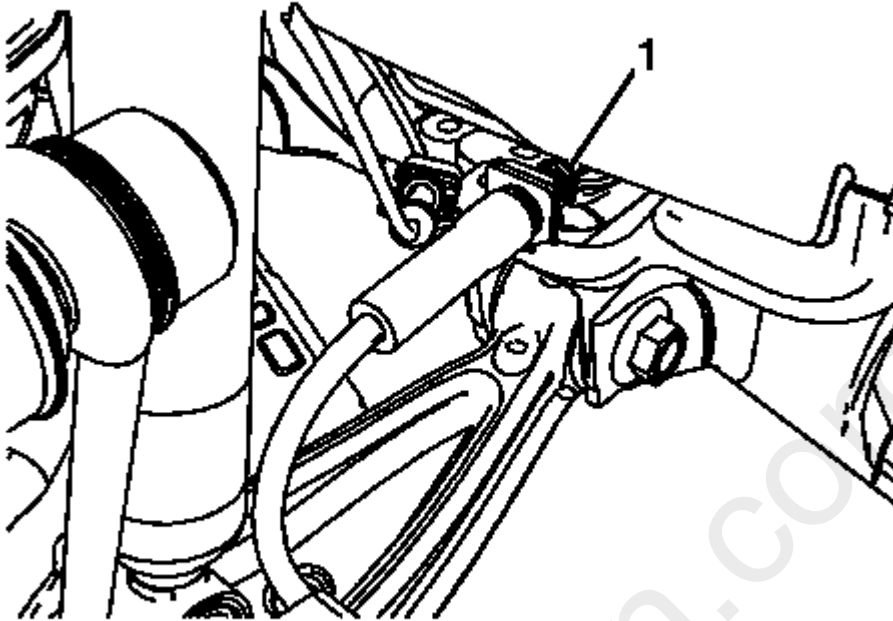


Fig. 91: Front Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

5. Connect the front brake pipe fitting (1).

Tighten

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

6. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)**, **Hydraulic Brake System Bleeding (Pressure)**.
7. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

FRONT BRAKE HOSE REPLACEMENT (AWD)

Removal Procedure

WARNING: Refer to **Brake Dust Warning** .

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

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

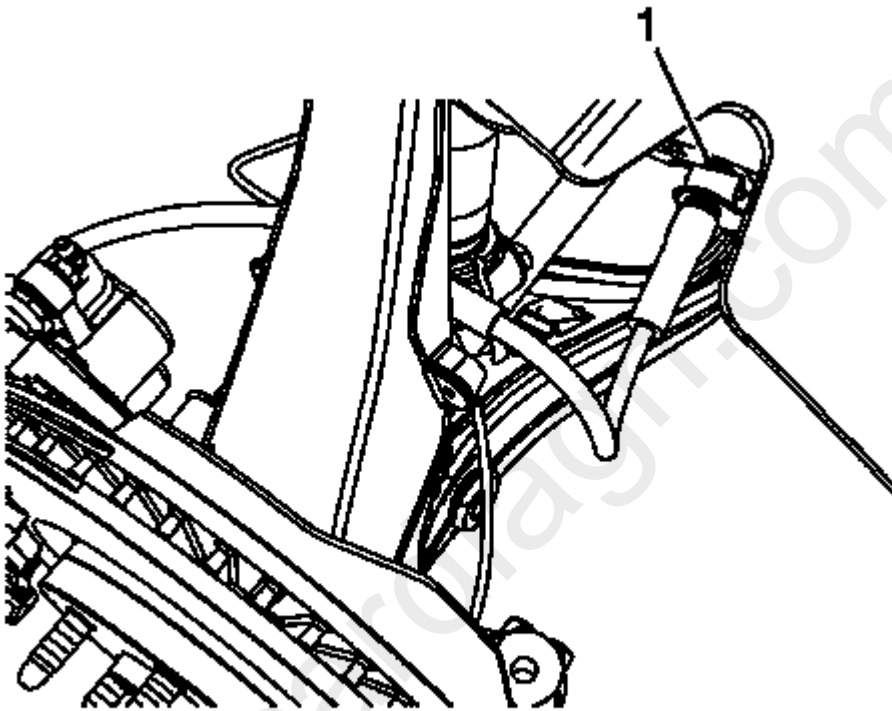


Fig. 92: Front Brake Pipe Fitting

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the front brake pipe fitting (1).

Cap the brake pipe fitting to prevent brake fluid loss and contamination.

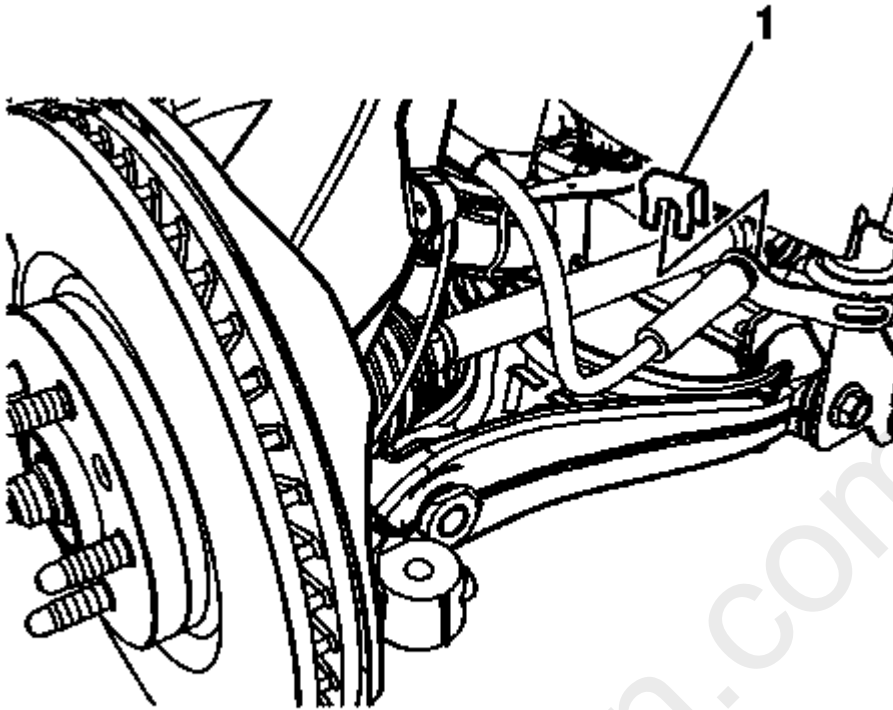


Fig. 93: Front Brake Hose Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

4. Remove the front brake hose retainer clip (1).

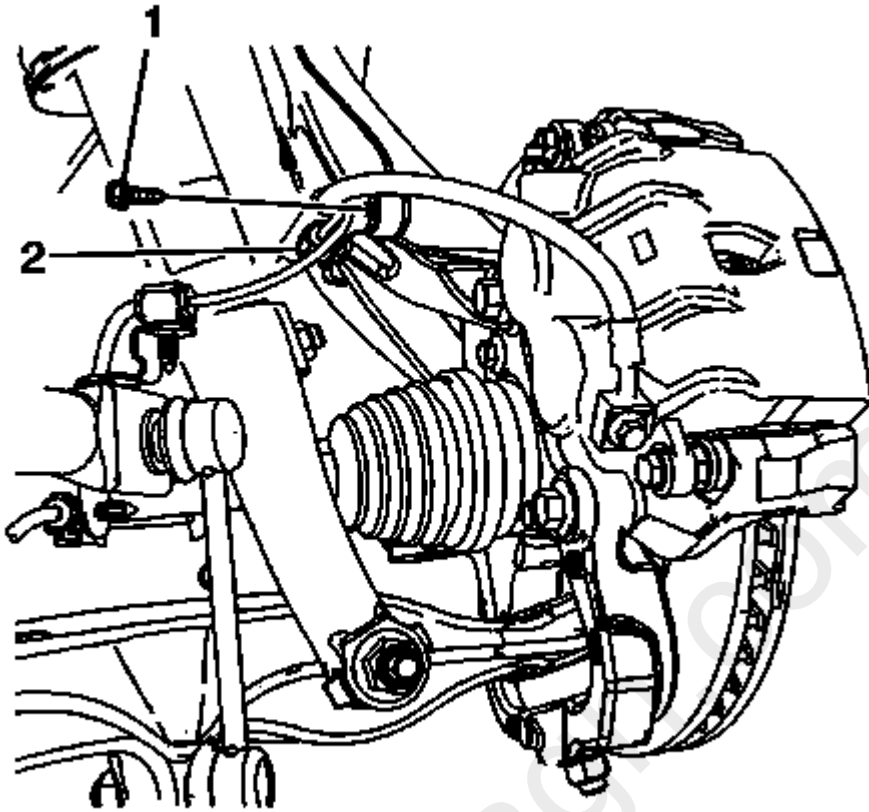


Fig. 94: Brake Hose Retainer Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the brake hose retainer bolt (1).
6. Disconnect the wheel speed sensor wire harness clip (2) from the brake hose retainer.

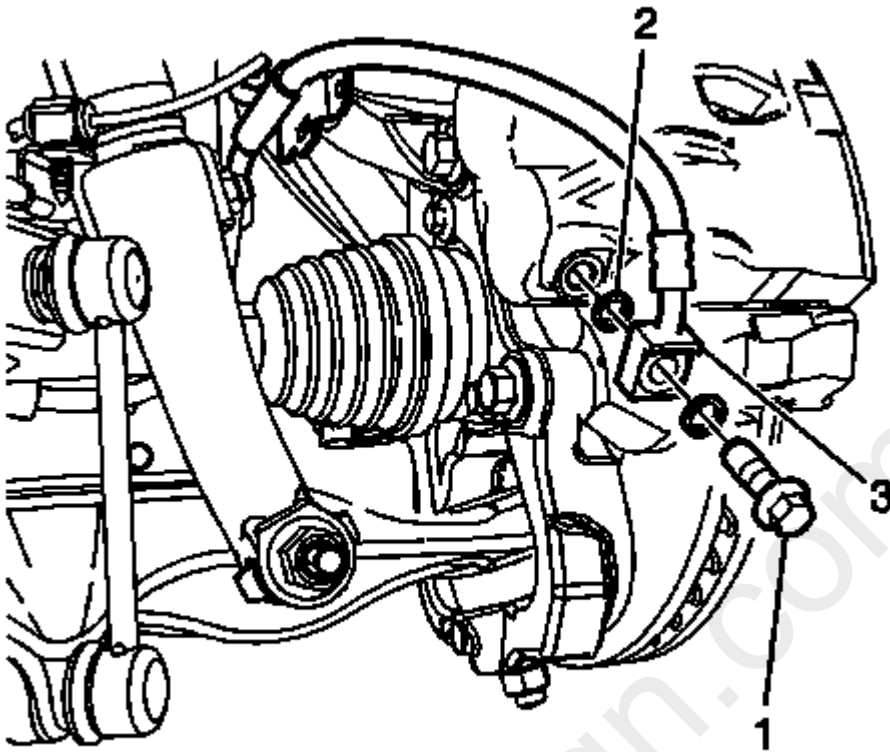


Fig. 95: Brake Hose and Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove the brake hose fitting bolt (1).
8. Remove the brake hose fitting gaskets (2) from the brake hose (3).

Discard the brake hose fitting gaskets.

9. Remove the brake hose.

Installation Procedure

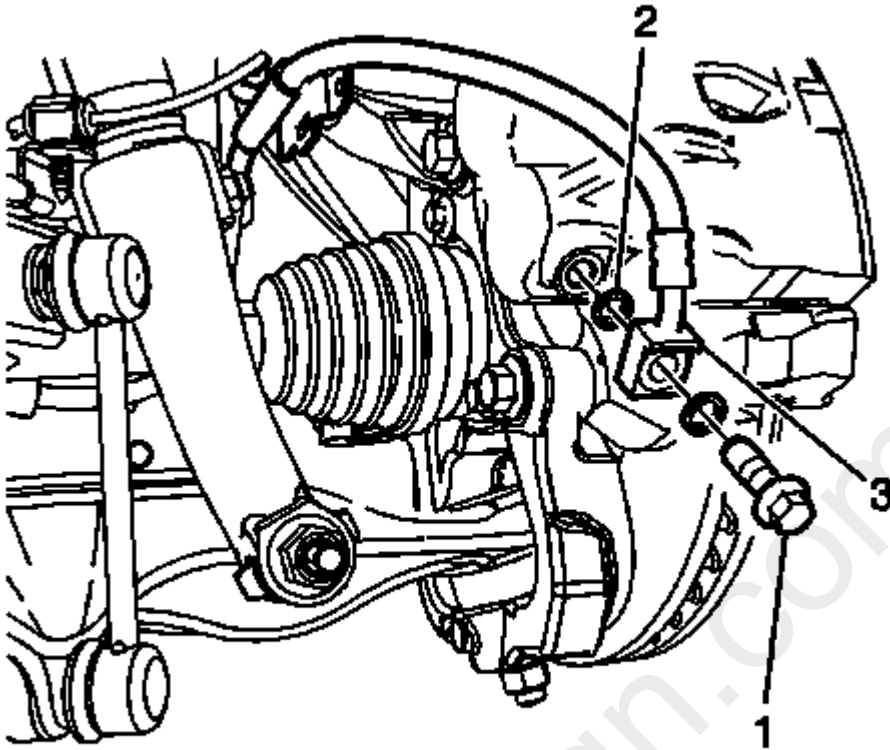


Fig. 96: Brake Hose and Bolt

Courtesy of GENERAL MOTORS COMPANY

1. Assemble the brake hose fitting bolt (1) with 2 new brake hose fitting gaskets (2) to the brake hose (3).

CAUTION: Refer to Fastener Caution .

2. Install the brake hose assembly to the caliper.

Tighten

Tighten the brake hose fitting bolt to 49 N.m (36 lb ft).

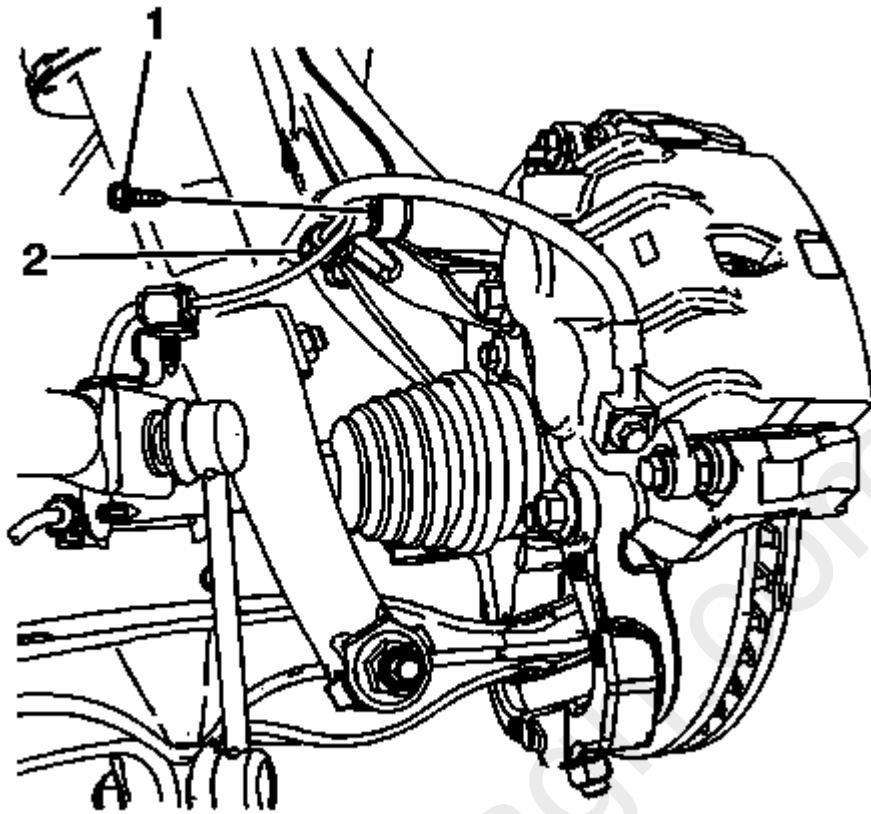


Fig. 97: Brake Hose Retainer Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install the brake hose retainer bolt (1).

Tighten

Tighten the brake hose retainer bolt to 10 N.m (89 lb in).

4. Connect the wheel speed sensor wire harness clip (2) to the brake hose retainer.

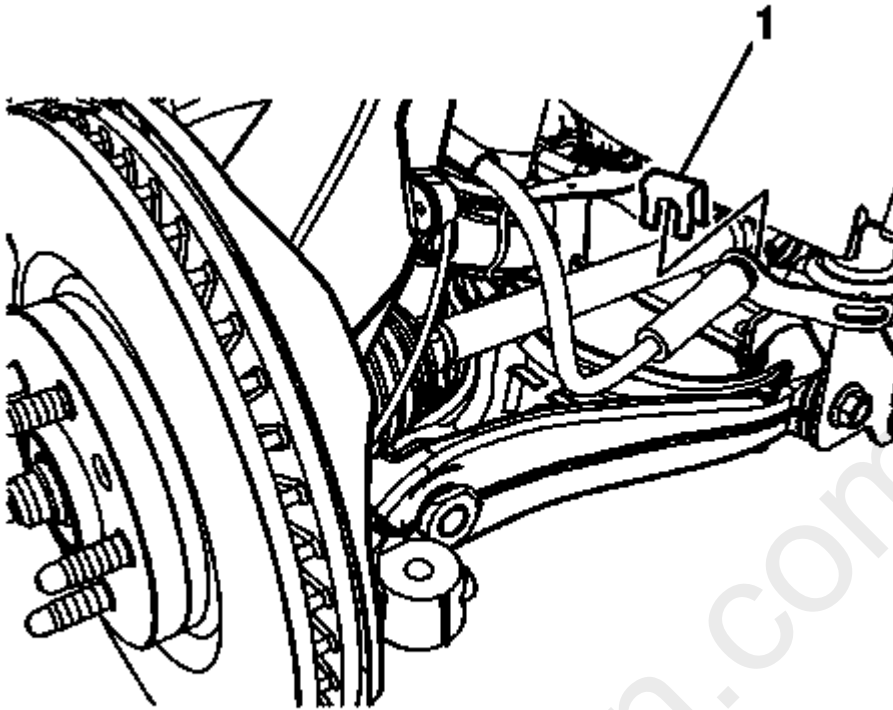


Fig. 98: Front Brake Hose Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

5. Install the front brake hose retainer clip (1).

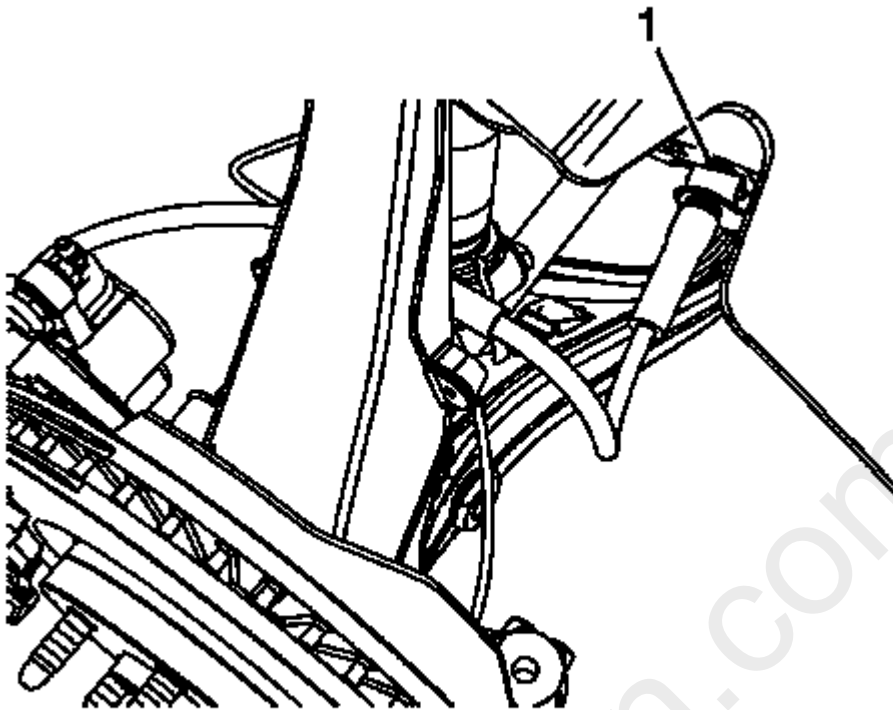


Fig. 99: Front Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

6. Connect the front brake pipe fitting (1).

Tighten

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

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

BRAKE INTERMEDIATE HOSE REPLACEMENT

Removal Procedure

NOTE: **The intermediate brake hose assembly is serviced as an assembly.**

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

3. Clean all dirt and foreign material from the brake hose and the brake pipe fittings.

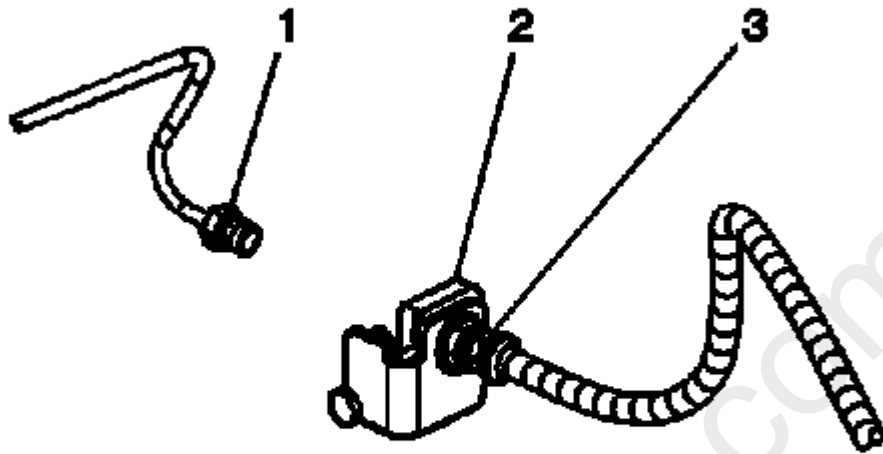


Fig. 100: View Of Brake Line Fitting
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the crossover brake pipe fitting (1) from the intermediate brake hose assembly (3).

Cap the brake pipe fitting to prevent brake fluid loss and contamination.

5. Using a flat-bladed tool, remove the brake hose retainer (2) from the rear frame bracket.
6. Disconnect the brake pipe fittings from the intermediate brake hose assembly.

Cap the brake pipe fittings to prevent brake fluid loss and contamination.

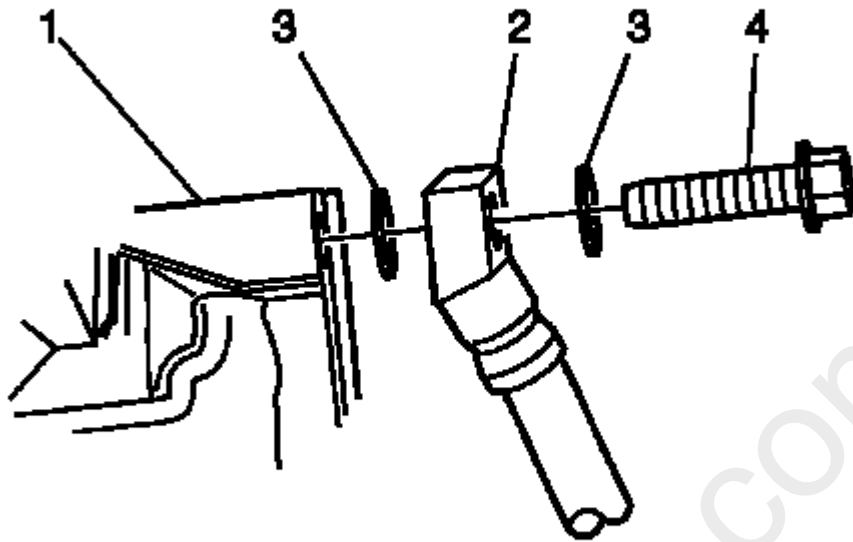


Fig. 101: Brake Hose Banjo Fitting
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the brake hose fitting bolt (4) from the brake caliper (1).
8. Disconnect the brake hose from the brake caliper.

Plug the brake caliper inlet port to prevent brake fluid loss and contamination.

9. Place a shop towel on a hard surface.
10. Tap the threaded end of the brake hose fitting bolt on the shop towel to remove the gaskets (3) from the bolt (4)
11. Remove and discard the 2 copper brake hose gaskets (3). These gaskets may be stuck to the brake caliper and/or the brake hose end (2).

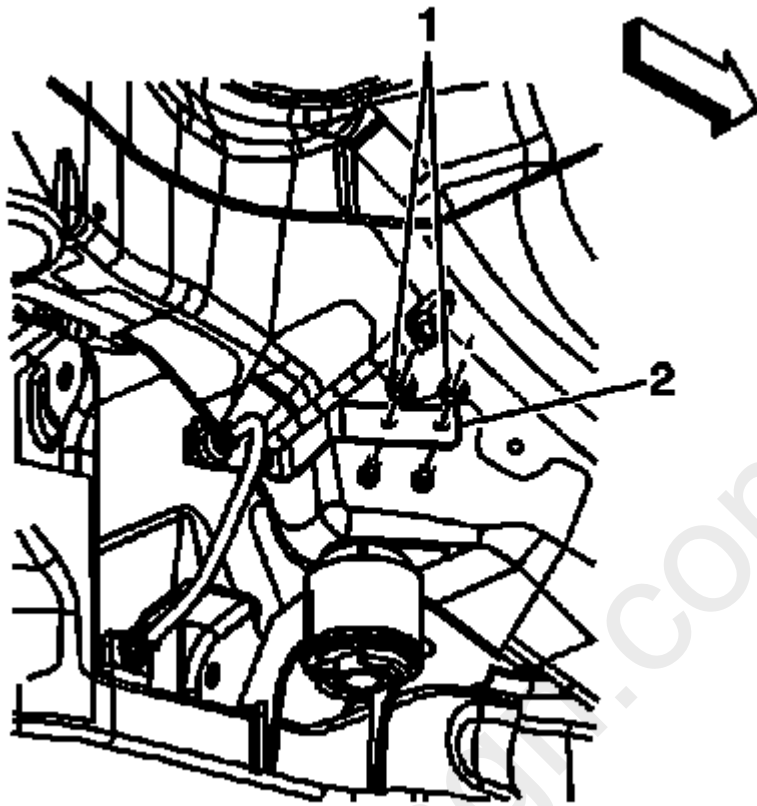


Fig. 102: Intermediate Brake Hose Assembly & Mounting Nuts
Courtesy of GENERAL MOTORS COMPANY

12. Remove the intermediate brake hose assembly mounting nuts (1) from the studs.
13. Remove the intermediate brake hose assembly (2) from the vehicle.

Installation Procedure

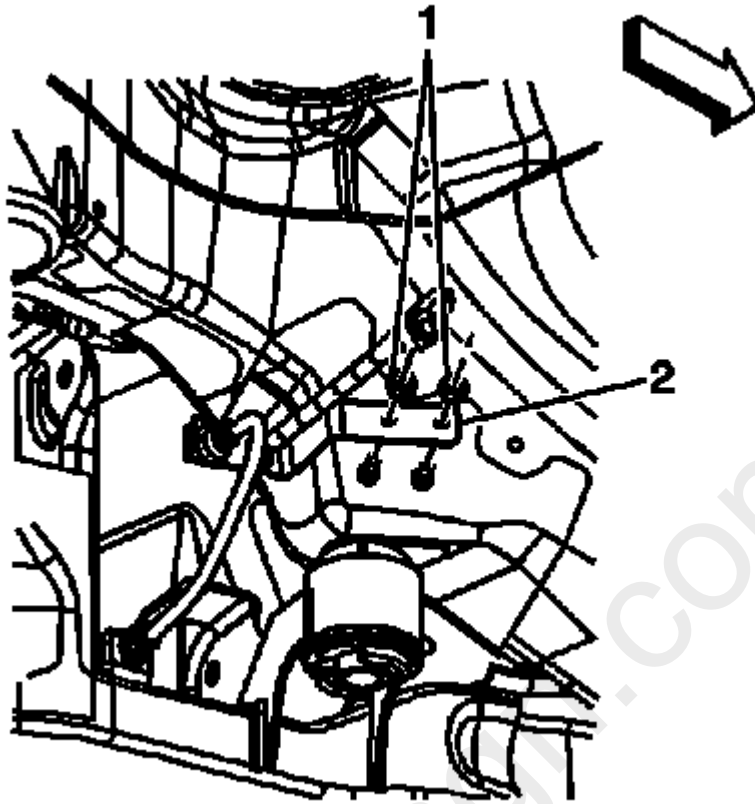


Fig. 103: Intermediate Brake Hose Assembly & Mounting Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Make sure the brake hose is not twisted or kinked after installation.
Damage to the hose could result.

1. Install the intermediate brake hose assembly (2) to the mounting studs.

CAUTION: Refer to Fastener Caution .

2. Install the intermediate brake hose assembly mounting nuts (1) to the mounting studs and tighten to 10 N.m (89 lb in).
3. Connect the 2 brake pipe fittings to the intermediate brake hose assembly.
4. Remove the plug from the brake caliper inlet port.

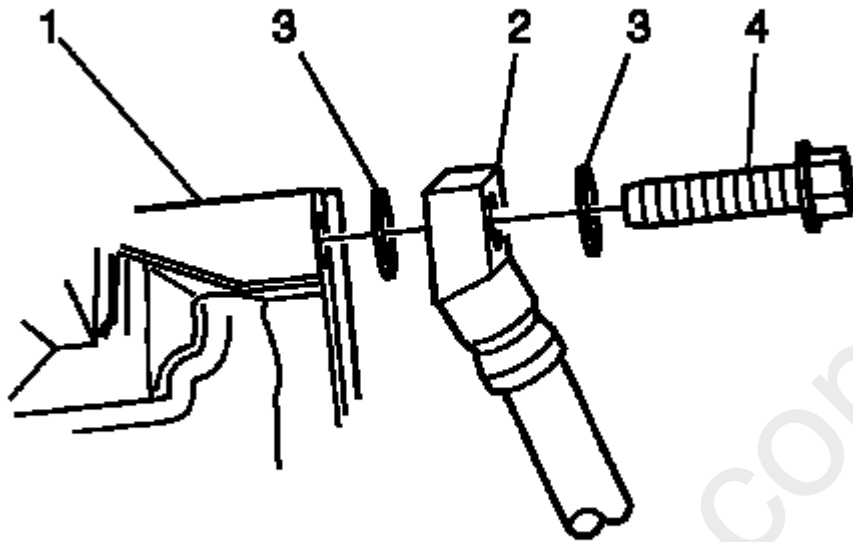


Fig. 104: Brake Hose Banjo Fitting
Courtesy of GENERAL MOTORS COMPANY

NOTE: Install NEW copper brake hose gaskets.

5. Assemble the brake hose (2), the NEW copper brake hose gaskets (3), and the brake hose fitting bolt (4) to the brake hose.
6. Install the brake hose fitting bolt to the brake caliper (1) and tighten to 49 N.m (36 lb ft).

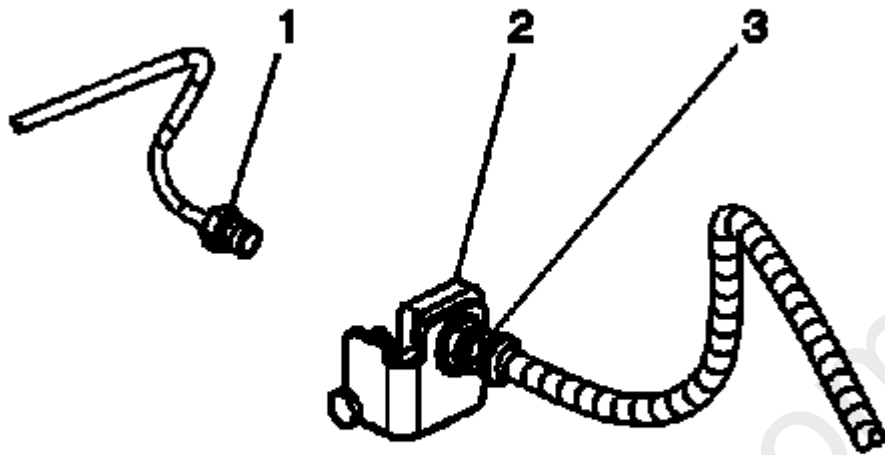


Fig. 105: Brake Line Fitting

Courtesy of GENERAL MOTORS COMPANY

7. Install the brake hose retainer (2) to the rear frame bracket.
8. Connect the crossover brake pipe fitting (1) to the intermediate brake hose assembly (3) and tighten to 18 N.m (13 lb ft).
9. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)**, **Hydraulic Brake System Bleeding (Pressure)**.
10. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation**.

REAR BRAKE HOSE REPLACEMENT

Removal Procedure

WARNING: Refer to **Brake Dust Warning**.

WARNING: Refer to **Brake Fluid Irritant Warning**.

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

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

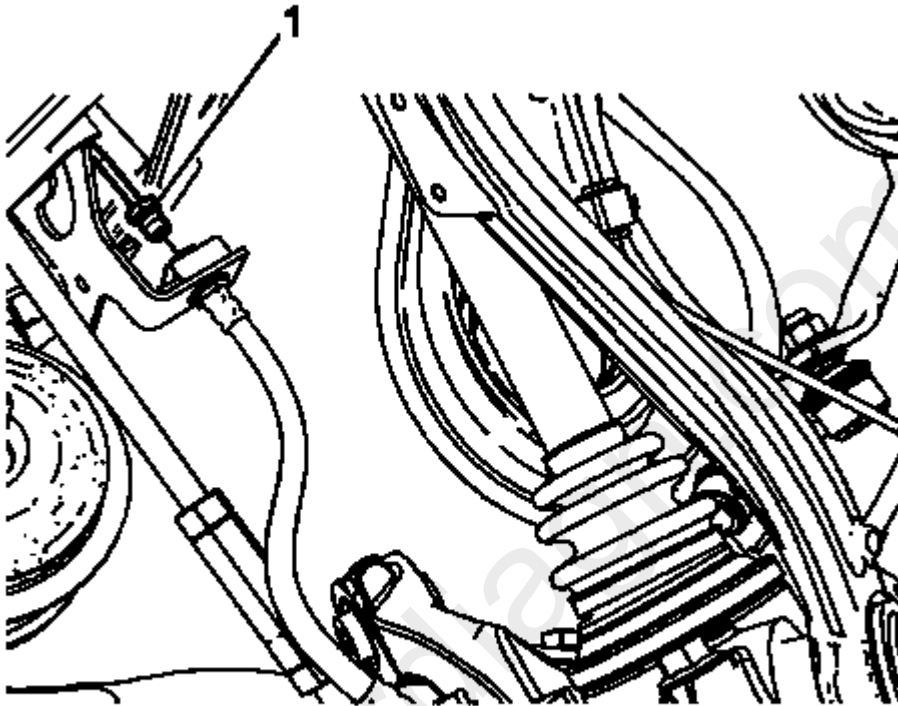


Fig. 106: Rear Brake Pipe Fitting

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the rear brake pipe fitting (1).

Cap the brake pipe fitting to prevent brake fluid loss and contamination.

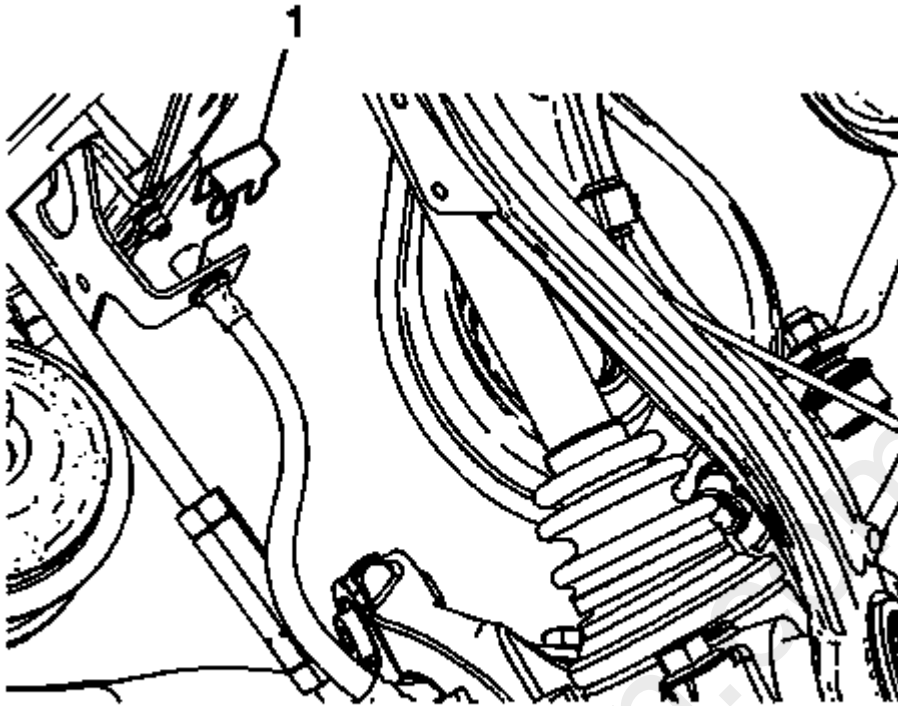


Fig. 107: Brake Hose Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

4. Remove the front brake hose retainer clip (1).

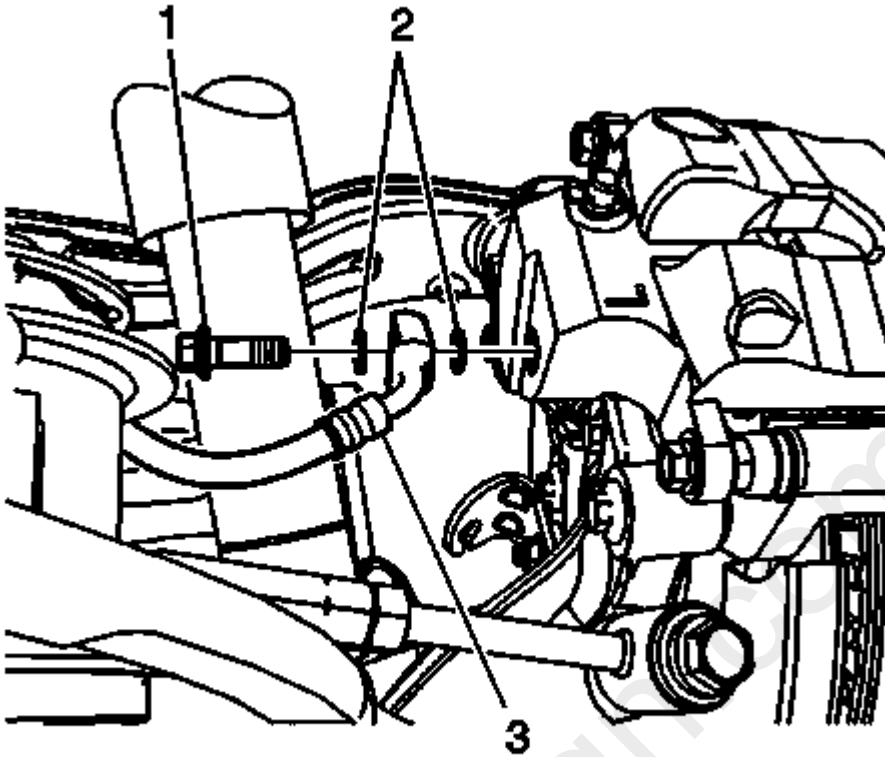


Fig. 108: Brake Hose Fitting Components
Courtesy of GENERAL MOTORS COMPANY

5. Remove the brake hose fitting bolt (1).
6. Remove the brake hose fitting gaskets (2) from the brake hose (3).

Discard the brake hose fitting gaskets.

7. Remove the brake hose.

Installation Procedure

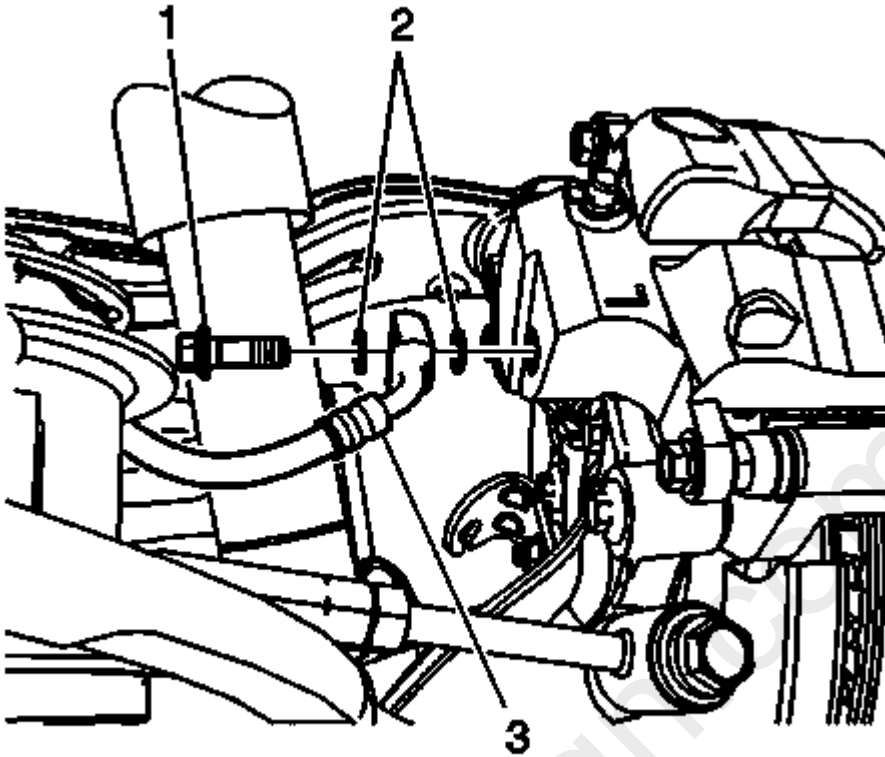


Fig. 109: Brake Hose Fitting Components
Courtesy of GENERAL MOTORS COMPANY

1. Assemble the brake hose fitting bolt (1) with 2 new brake hose fitting gaskets (2) to the brake hose (3).

CAUTION: Refer to Fastener Caution .

2. Install the brake hose assembly to the caliper and tighten to 49 N.m (36 lb ft).

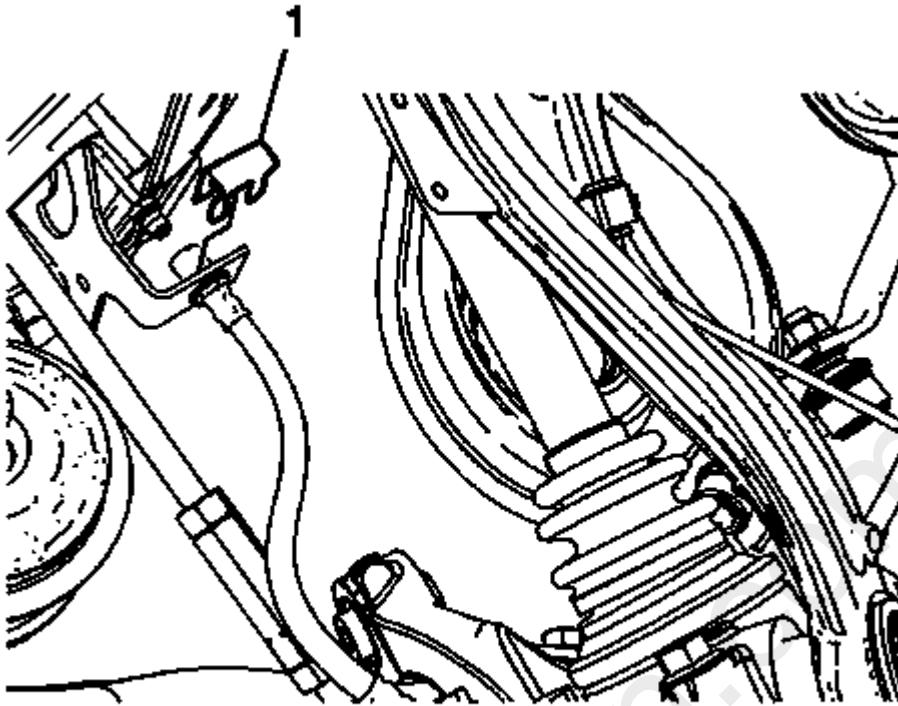


Fig. 110: Brake Hose Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

3. Install the rear brake hose retainer clip (1).

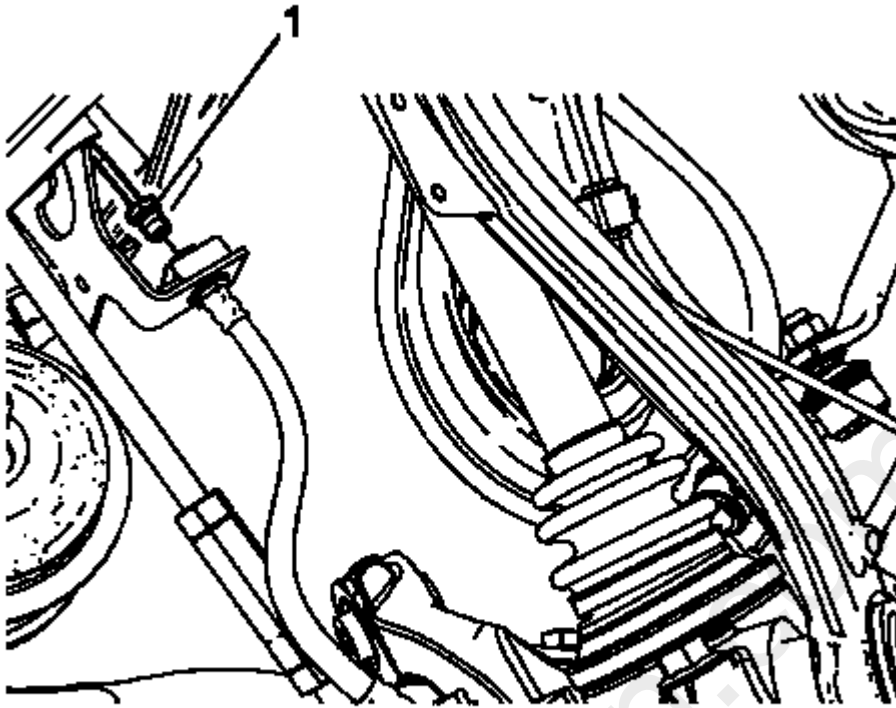


Fig. 111: Rear Brake Pipe Fitting

Courtesy of GENERAL MOTORS COMPANY

4. Connect the rear brake pipe fitting (1) and tighten to 18 N.m (13 lb ft).
5. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)**, **Hydraulic Brake System Bleeding (Pressure)**.
6. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

HYDRAULIC BRAKE SYSTEM BLEEDING (MANUAL)

WARNING: Refer to **Brake Fluid Irritant Warning** .

CAUTION: Refer to **Brake Fluid Effects on Paint and Electrical Components Caution** .

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 GM approved brake fluid from a clean, sealed brake fluid container.

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

2. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe from the front port of the brake master cylinder.
 3. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder.
 4. Reconnect the brake pipe to the master cylinder port and tighten securely.
 5. Have an assistant slowly depress the brake pedal fully and maintain steady pressure on the pedal.
 6. Loosen the same brake pipe to purge air from the open port of the master cylinder.
 7. Tighten the brake pipe, then have the assistant slowly release the brake pedal.
 8. Wait 15 seconds, then repeat steps 3.3-3.7 until all air is purged from the same port of the master cylinder.
 9. With the front brake pipe installed securely to the master cylinder, after all air has been purged from the front port of the master cylinder, loosen and separate the rear brake pipe from the master cylinder, then repeat steps 3.3-3.8.
 10. After completing the final master cylinder port bleeding procedure, ensure that both of the brake pipe-to-master cylinder fittings are properly tightened.
4. Fill the brake master cylinder reservoir with GM approved 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, inboard (fixed caliper), 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 GM approved 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. For fixed caliper models, repeat steps 5-11 for the outboard bleeder valve.
13. With the right rear wheel hydraulic circuit bleeder valve, or valves (fixed caliper), tightened securely - after all air has been purged from the right rear hydraulic circuit - install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit, inner (fixed caliper), bleeder valve.

14. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
15. For fixed caliper models, repeat steps 5-11 for the outboard bleeder valve.
16. With the left front wheel hydraulic circuit bleeder valve, or valves (fixed caliper), tightened securely, after all air has been purged from the left front hydraulic circuit, install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit, inner (fixed caliper), bleeder valve.
17. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
18. For fixed caliper models, repeat steps 5-11 for the outboard bleeder valve.
19. With the left rear wheel hydraulic circuit bleeder valve, or valves (fixed caliper), 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, inner (fixed caliper), bleeder valve.
20. Install a transparent hose over the end of the bleeder valve, then repeat steps 7-11.
21. For fixed caliper models, repeat steps 5-11 for the outboard bleeder valve.
22. After completing the final wheel hydraulic circuit bleeding procedure, ensure that each of the 4 wheel hydraulic circuit bleeder valves, or 8 bleeder valves (fixed caliper), are properly tightened.
23. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved brake fluid from a clean, sealed brake fluid container.
24. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.
25. 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.
26. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

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

27. If the brake system warning lamp remains illuminated. Refer to **Symptoms - Hydraulic Brakes**.

HYDRAULIC BRAKE SYSTEM BLEEDING (PRESSURE)

Special Tools

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

WARNING: Refer to **Brake Fluid Irritant Warning** .

CAUTION: Refer to **Brake Fluid Effects on Paint and Electrical Components Caution** .

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 GM approved 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 GM approved 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** Master Cylinder Bleeder Adapter to the brake master cylinder reservoir.
6. Check the brake fluid level in the **J-29532** Diaphragm Type Brake Pressure Bleeder, or equivalent. Add GM approved 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** Diaphragm Type Brake Pressure Bleeder, or equivalent , to the **J-35589-A** Master Cylinder Bleeder Adapter.
8. Charge the **J-29532** Diaphragm Type Brake Pressure Bleeder, or equivalent , air tank to 175-205 kPa (25-30 psi).
9. Open the **J-29532** Diaphragm Type Brake Pressure Bleeder, or equivalent , fluid tank valve to allow pressurized brake fluid to enter the brake system.
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, inboard (fixed caliper), 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 GM approved 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. For fixed caliper models, repeat steps 11-14 for the outboard bleeder valve.
16. With the right rear wheel hydraulic circuit bleeder valve, or valves (fixed caliper), tightened securely, after all air has been purged from the right rear hydraulic circuit, install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit, inboard (fixed caliper), bleeder valve.
17. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
18. For fixed caliper models, repeat steps 11-14 for the outboard bleeder valve.
19. With the left front wheel hydraulic circuit bleeder valve, or valves (fixed caliper), tightened securely, after all air has been purged from the left front hydraulic circuit, install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit, inner (fixed caliper), bleeder valve.
20. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
21. For fixed caliper models, repeat steps 11-14 for the outboard bleeder valve.
22. With the left rear wheel hydraulic circuit bleeder valve, or valves (fixed caliper), 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, inner (fixed caliper), bleeder valve.
23. Install a transparent hose over the end of the bleeder valve, then repeat steps 13-14.
24. For fixed caliper models, repeat steps 11-14 for the outboard bleeder valve.
25. After completing the final wheel hydraulic circuit bleeding procedure, ensure that each of the 4 wheel hydraulic circuit bleeder valves, or 8 bleeder valves (fixed caliper), are properly tightened.
26. Close the **J-29532** Diaphragm Type Brake Pressure Bleeder, or equivalent , fluid tank valve, then disconnect the **J-29532** Diaphragm Type Brake Pressure Bleeder, or equivalent , from the **J-35589-A** Master Cylinder Bleeder Adapter.
27. Remove the **J-35589-A** Master Cylinder Bleeder Adapter from the brake master cylinder reservoir.
28. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved brake fluid from a clean, sealed brake fluid container.
29. Slowly depress and release the brake pedal. Observe the feel of the brake pedal.
30. 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 **Antilock Brake System Automated Bleed**.
31. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

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

32. If the brake system warning lamp remains illuminated. Refer to **Symptoms - Hydraulic Brakes.**

HYDRAULIC BRAKE SYSTEM FLUSHING

WARNING: Refer to **Brake Fluid Irritant Warning** .

CAUTION: Only use products that comply with GM specifications and check manufacturer information respectively. We recommend the use of GM genuine products. Instructions must be followed at all times. 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.

CAUTION: Refer to **Brake Fluid Effects on Paint and Electrical Components Caution** .

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

Refer to the procedures indicated:

- **Master Cylinder Replacement (RHD), Master Cylinder Replacement (LHD)**
- **Front Brake Hose Replacement (RWD), Front Brake Hose Replacement (AWD)**
- **Brake Intermediate Hose Replacement**
- **Rear Brake Hose Replacement**
- **Front Brake Caliper Replacement (JE5, J55 (AWD)) , Front Brake Caliper**

Replacement (JE5, J55 (RWD)) , Front Brake Caliper Replacement (J56)

- **Rear Brake Caliper Replacement (J56) , Rear Brake Caliper Replacement (JE5, J55)**
- **Brake Pressure Modulator Valve Replacement (CTS) , Brake Pressure Modulator Valve Replacement (CTS-V)**

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 Replacement (RHD), Master Cylinder Replacement (LHD)** -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 (RHD), Master Cylinder Reservoir Replacement (LHD)**.

Replace the brake master cylinder reservoir cap diaphragm.

- **Front Brake Hose Replacement (RWD), Front Brake Hose Replacement (AWD)**
 - **Brake Intermediate Hose Replacement**
 - **Rear Brake Hose Replacement**
 - **Front Brake Caliper Overhaul (JE5, J55) , Front Brake Caliper Overhaul (J56) , or Front Brake Caliper Replacement (JE5, J55 (AWD)) , Front Brake Caliper Replacement (JE5, J55 (RWD)) , Front Brake Caliper Replacement (J56)**
 - **Rear Brake Caliper Overhaul (JE5, J55) , Rear Brake Caliper Overhaul (J56) , or Rear Brake Caliper Replacement (J56) , Rear Brake Caliper Replacement (JE5, J55)**
 - **Brake Pressure Modulator Valve Replacement (CTS) , Brake Pressure Modulator Valve Replacement (CTS-V)**
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 which 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) 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), Hydraulic Brake System Bleeding (Pressure)**.

POWER VACUUM BRAKE BOOSTER REPLACEMENT (LHD)

Special Tools

J-22805-B Brake Booster Holder

Removal Procedure

1. Remove the left side instrument panel insulator panel. Refer to **Instrument Panel Insulator Replacement - Left Side (Left Hand Drive)** .

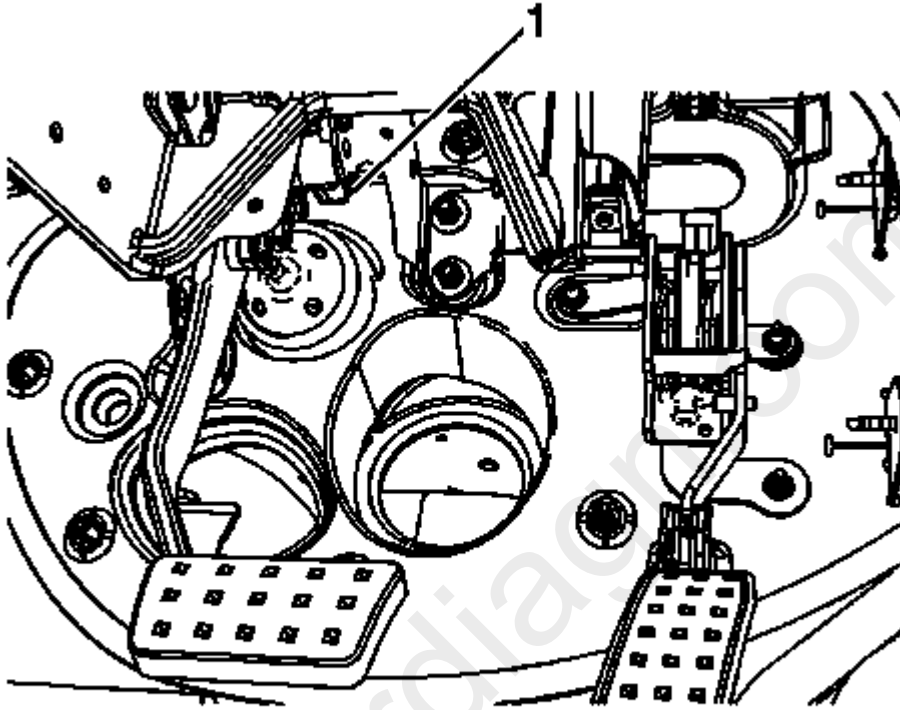


Fig. 112: Brake Pedal Position Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the brake pedal position sensor electrical connector (1).

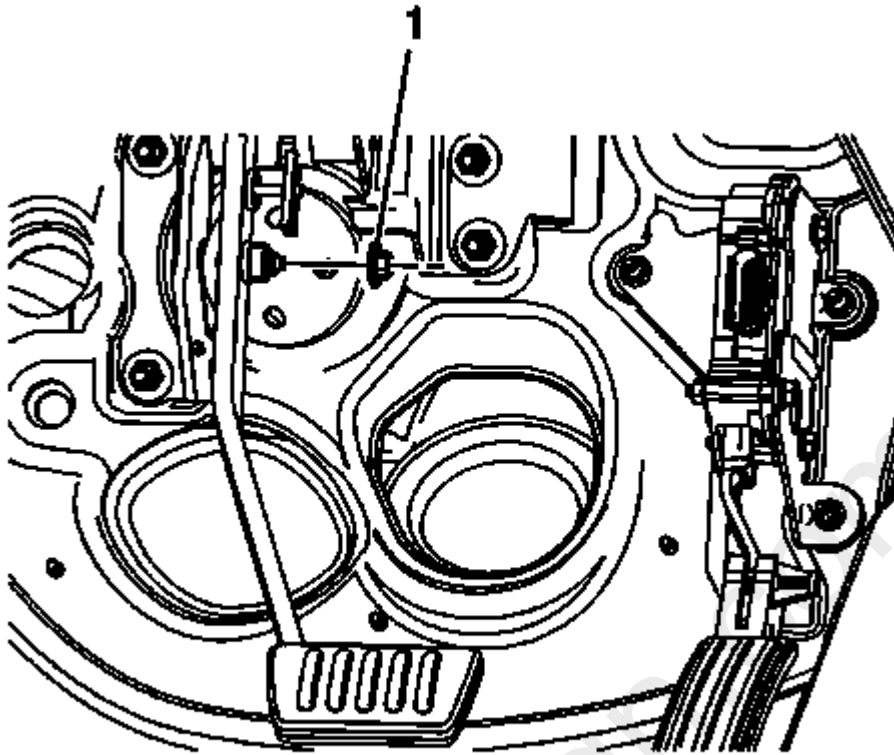


Fig. 113: Power Vacuum Brake Booster Pushrod Nut
Courtesy of GENERAL MOTORS COMPANY

3. Remove the power vacuum brake booster pushrod nut (1).
4. Disconnect the power vacuum brake booster pushrod from the brake pedal pivot.
5. Remove the cross vehicle brace, if equipped. Refer to **Cross Vehicle Brace Replacement** .
6. Disconnect the brake fluid level indicator switch electrical connector.

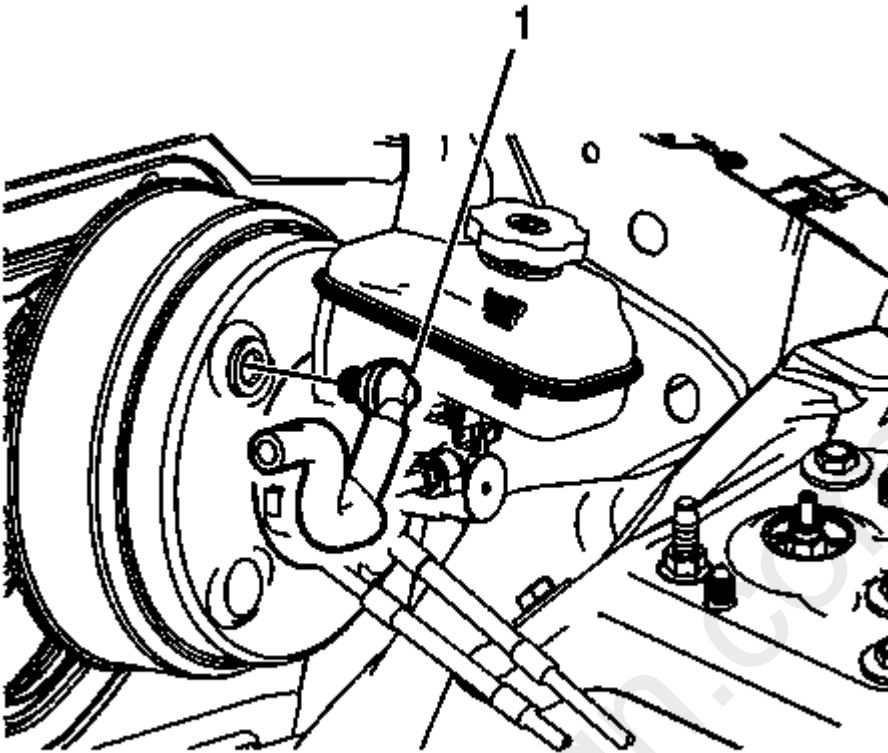


Fig. 114: Power Vacuum Brake Booster Check Valve & Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the power vacuum brake booster check valve and hose assembly (1).

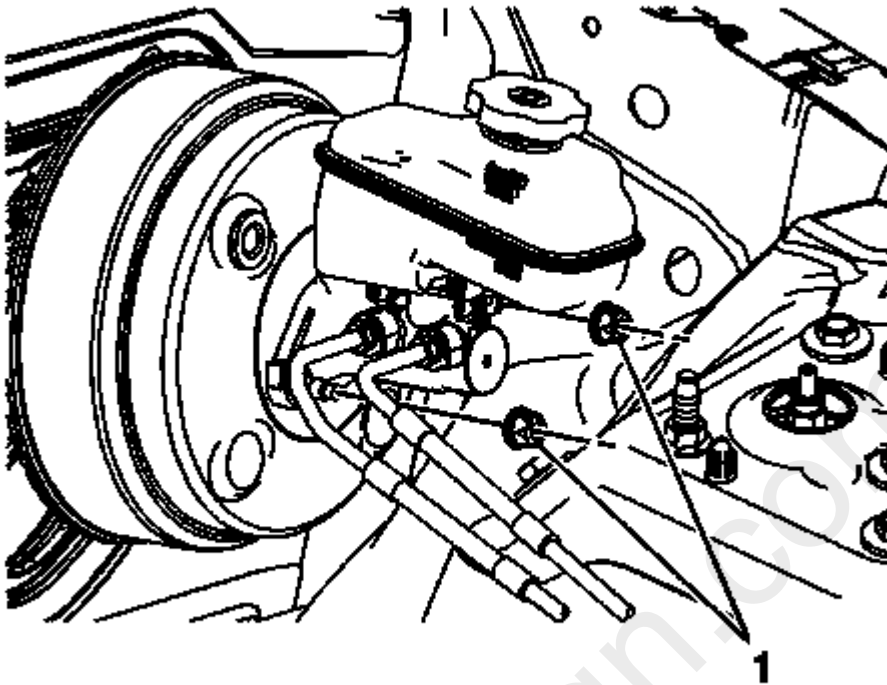


Fig. 115: Master Cylinder Nuts

Courtesy of GENERAL MOTORS COMPANY

8. Remove the master cylinder nuts (1).

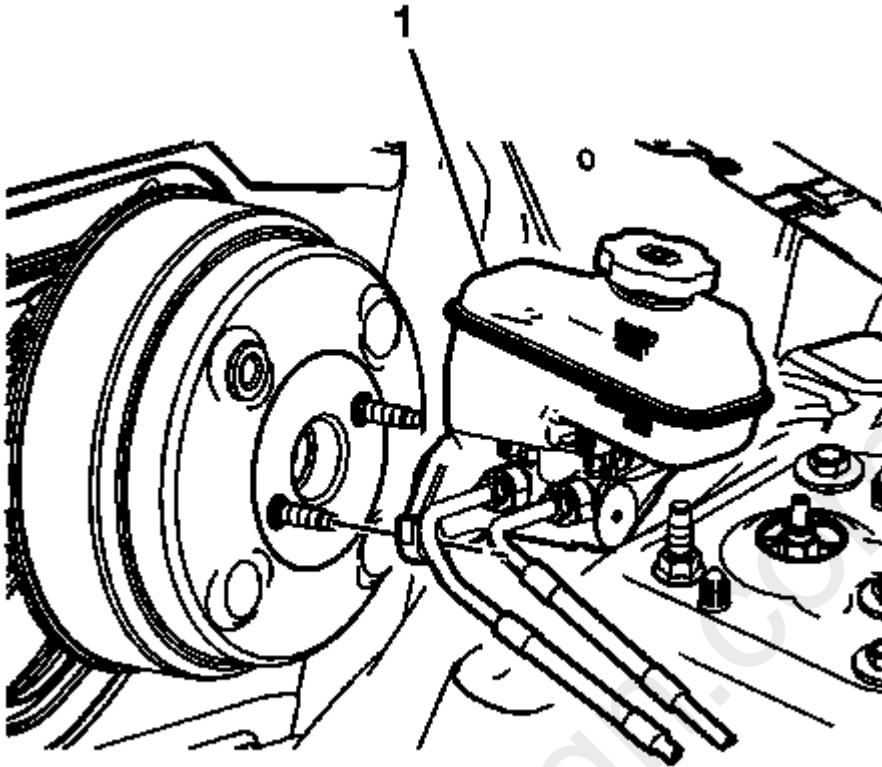


Fig. 116: Master Cylinder

Courtesy of GENERAL MOTORS COMPANY

9. Without disconnecting the brake pipe fittings, position aside the master cylinder (1) and support with heavy mechanics wire or equivalent.
10. Remove the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement** .
11. Without disconnecting the hoses, remove and position aside the surge tank. Refer to **Radiator Surge Tank Replacement** .

NOTE: Do not attempt to lever against the master cylinder mounting studs to remove the power vacuum brake booster.

12. Modify the **J-22805-B** Brake Booster Holder to accommodate the narrower span between the master cylinder mounting studs on the power vacuum brake booster:
 - Using a suitable grinding tool or metal file, elongate the mounting holes of the **J-22805-B** Brake Booster Holder.
 - Remove approximately 6.36 mm (0.25 in) of material from the inner edges of both mounting holes.
 - Remove material from the inner edges of the mounting until the span, from center to center, is approximately 80.00 mm (3.15 in).

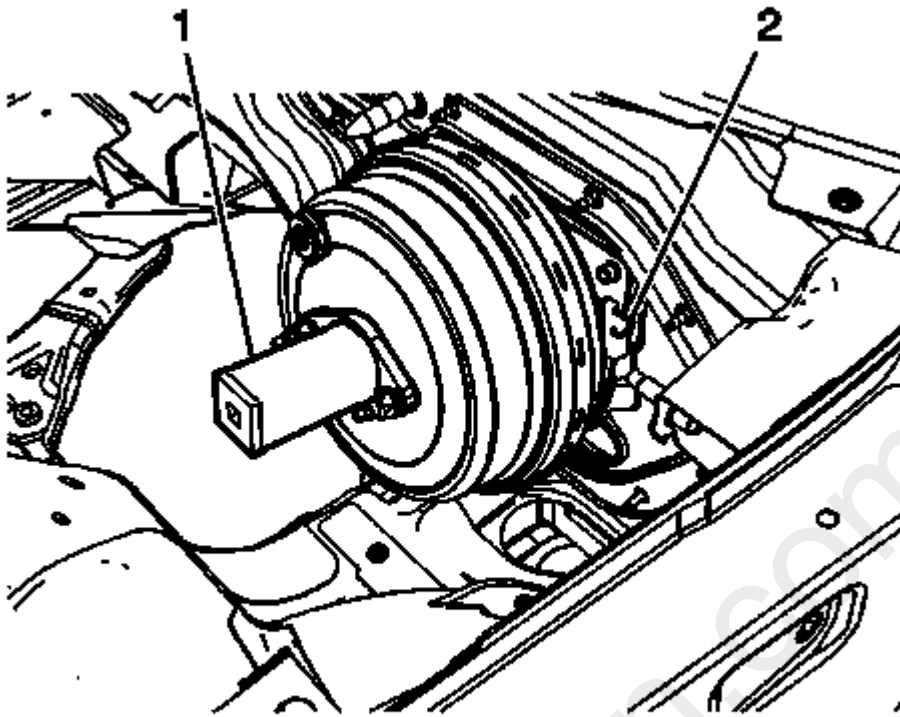


Fig. 117: Identifying Brake Booster Holder & Locking Tab
Courtesy of GENERAL MOTORS COMPANY

13. Install the J-22805-B Brake Booster Holder (1) and secure with the master cylinder nuts.
14. Using a flat-bladed tool, depress the locking tab (2) toward the cowl.

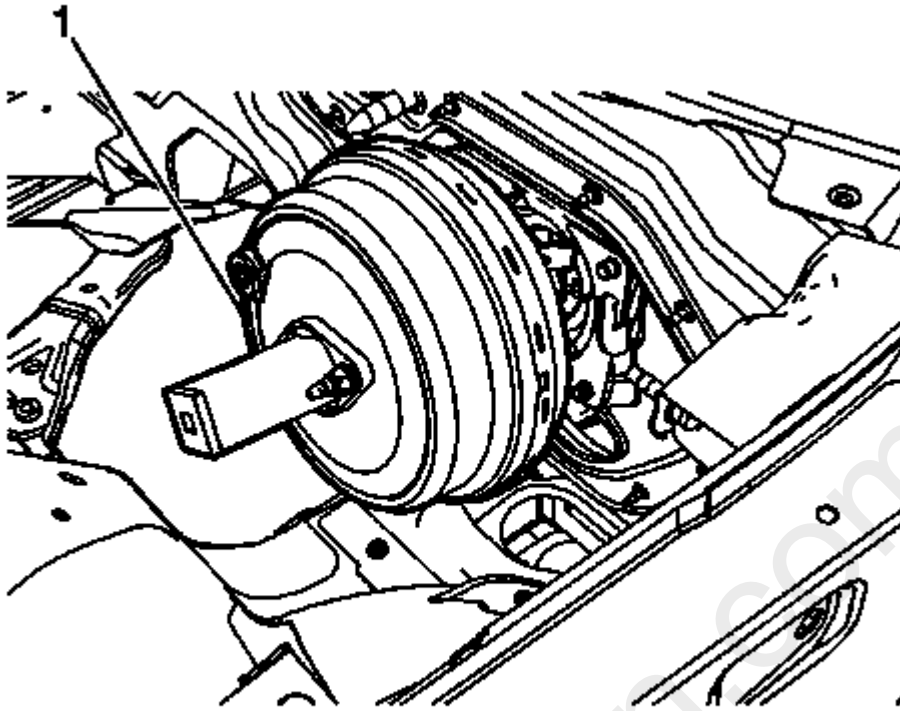


Fig. 118: Vacuum Brake Booster
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not attempt to remove the power vacuum brake booster completely. The power vacuum brake booster pushrod retaining clip must be released prior to booster removal.

15. Rotate the **J-22805-B** Brake Booster Holder and power vacuum brake booster (1) counterclockwise and release the power vacuum brake booster from the bracket.

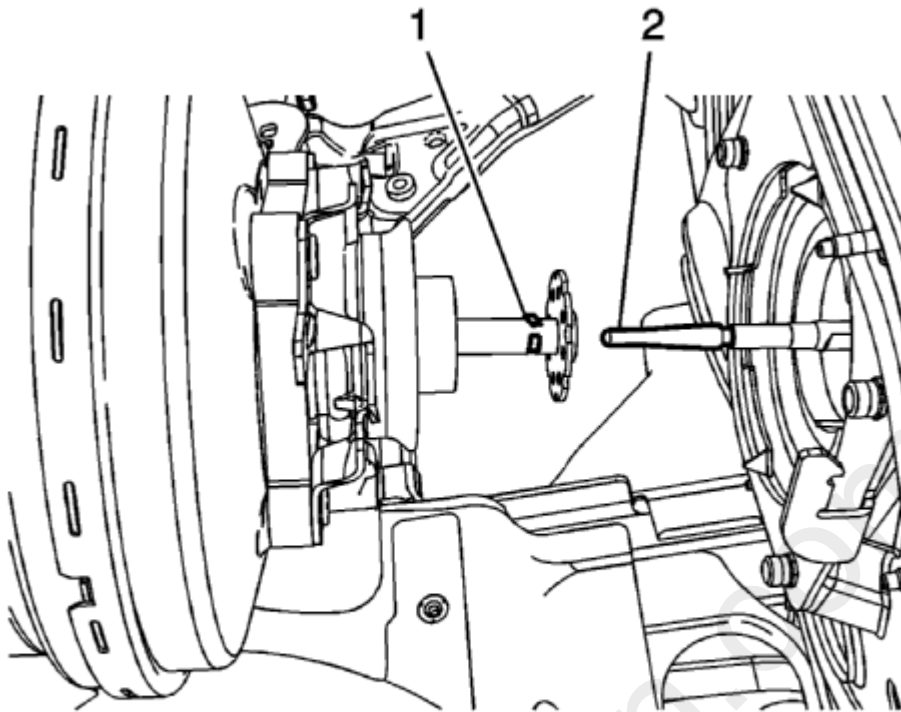


Fig. 119: Brake Booster Pushrod & Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

16. Carefully pull the power vacuum brake booster forward slightly and support the power vacuum booster to access the booster pushrod retaining clip.
17. Compress the power vacuum brake booster foam filter to access the power vacuum brake booster pushrod retaining clip.
18. Disconnect the power vacuum brake booster pushrod (1) from the booster by releasing the retaining clip (2).
19. Remove the power vacuum brake booster from the vehicle.
20. Remove the power vacuum brake booster pushrod through the dust boot from inside of the vehicle, if necessary.

Installation Procedure

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

CAUTION: Internal components of this booster are not serviceable. The housing must not be unstaked and separated. Separating the housing will cause

permanent deformation, preventing the booster from holding proper volume.

1. Install the power vacuum brake booster pushrod through the dust boot from inside of the vehicle, if removed.
2. Install the vacuum brake booster to the vehicle.
3. Compress the power vacuum brake booster foam filter to access the vacuum brake booster pushrod retaining clip.

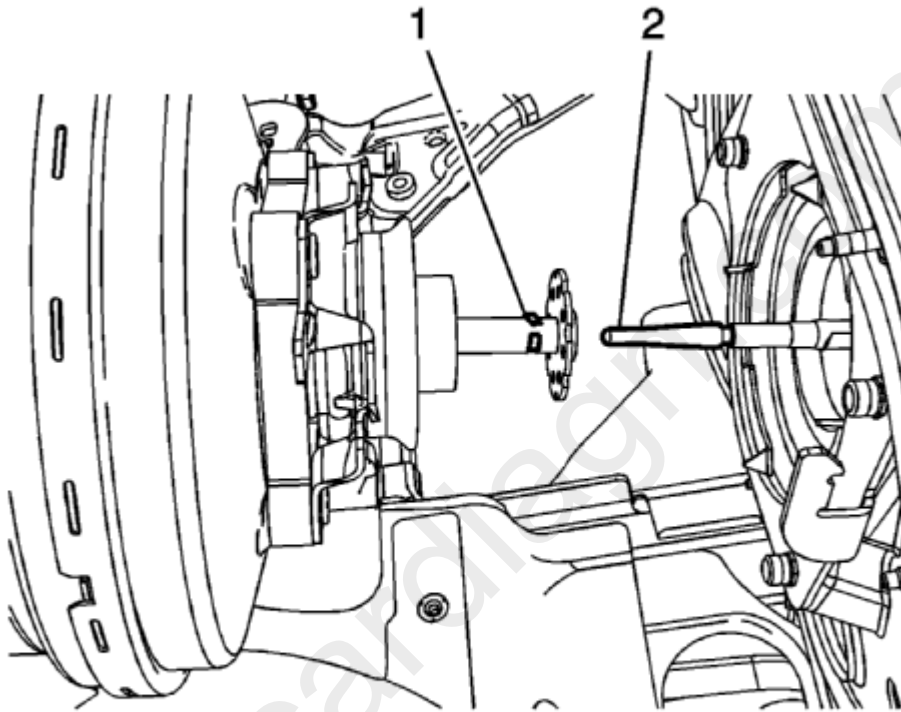


Fig. 120: Brake Booster Pushrod & Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

4. Connect the power vacuum brake booster pushrod (1) to the booster and engage the retaining clip (2).
5. Position the power vacuum brake booster to the booster bracket.

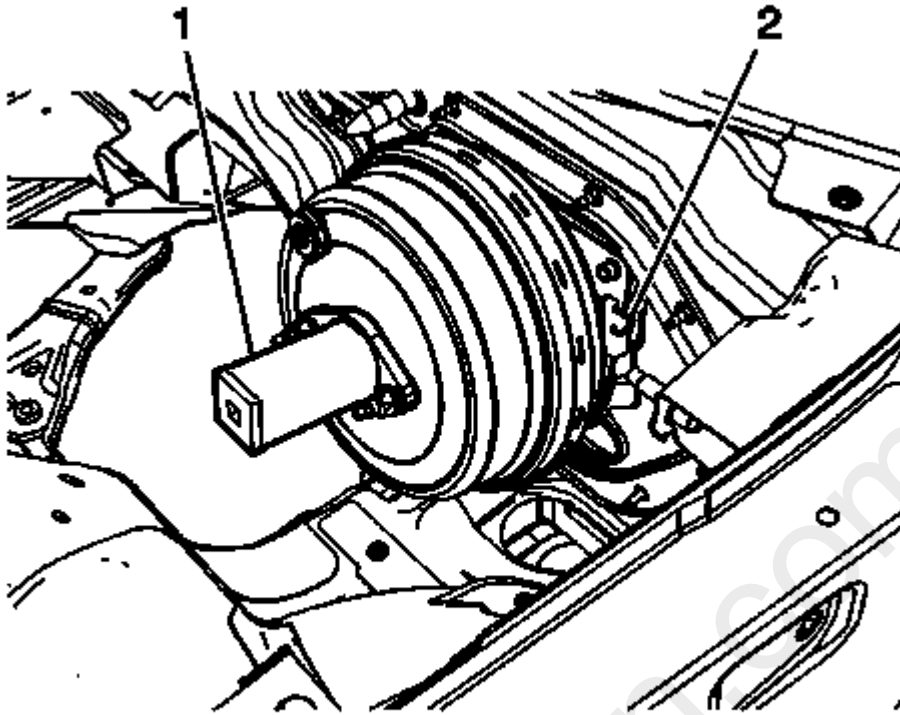


Fig. 121: Brake Booster Holder & Locking Tab
Courtesy of GENERAL MOTORS COMPANY

6. Using the **J-22805-B** Brake Booster Holder (1), rotate the power vacuum brake booster clockwise until the locking tab (2) engages the booster bracket flange.

Ensure the booster locking tab fully engages in the bracket.

7. Remove the **J-22805-B** Brake Booster Holder from the power vacuum brake booster and discard the master cylinder nuts.

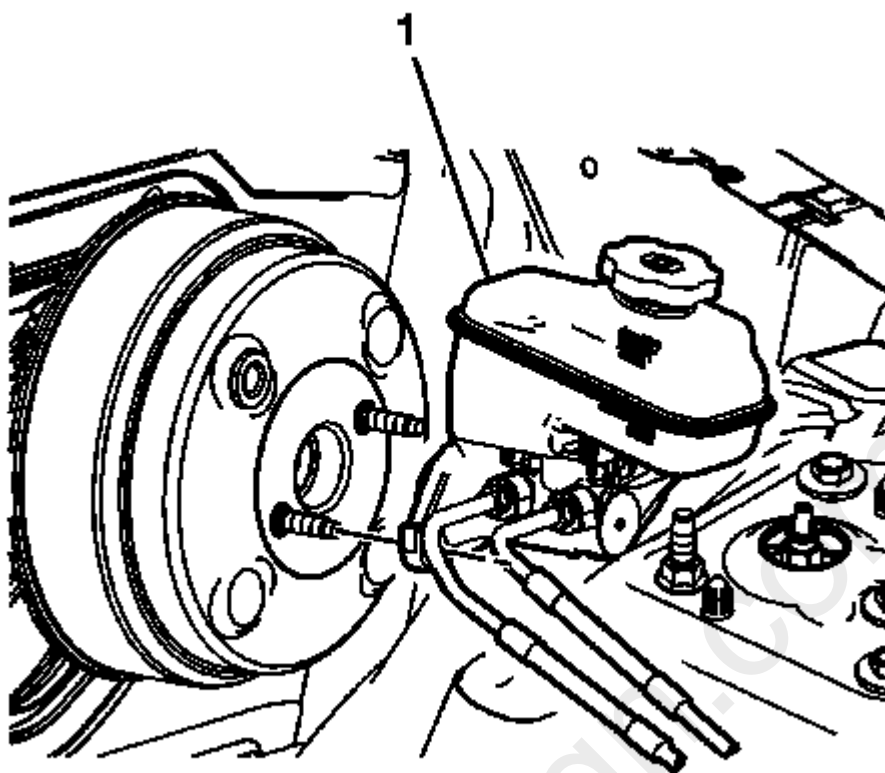


Fig. 122: Master Cylinder

Courtesy of GENERAL MOTORS COMPANY

8. Install the master cylinder (1) to the power vacuum brake booster.

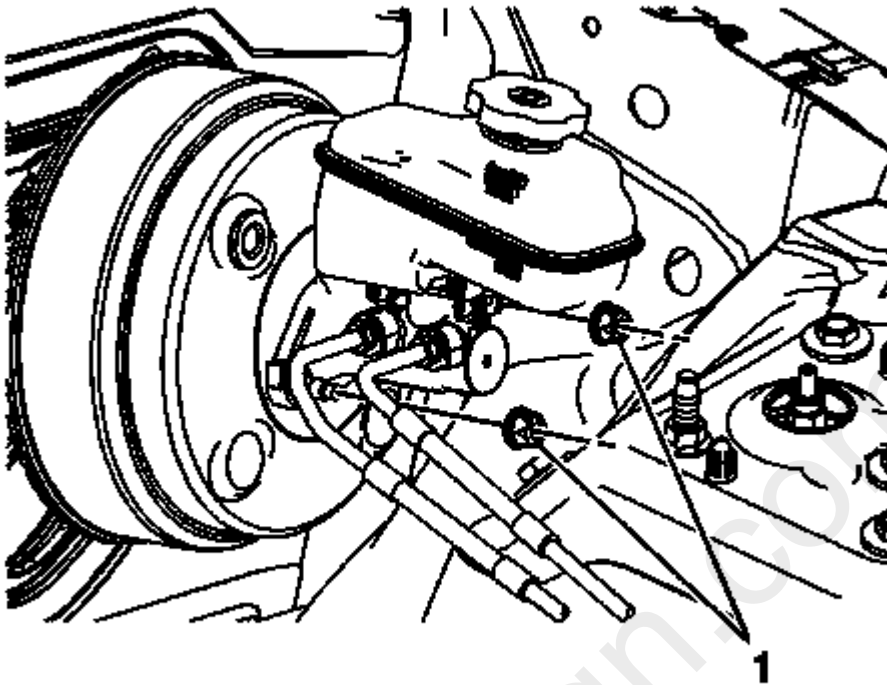


Fig. 123: Master Cylinder Nuts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

9. Install new master cylinder nuts (1) and tighten to 25 N.m (18 lb ft).

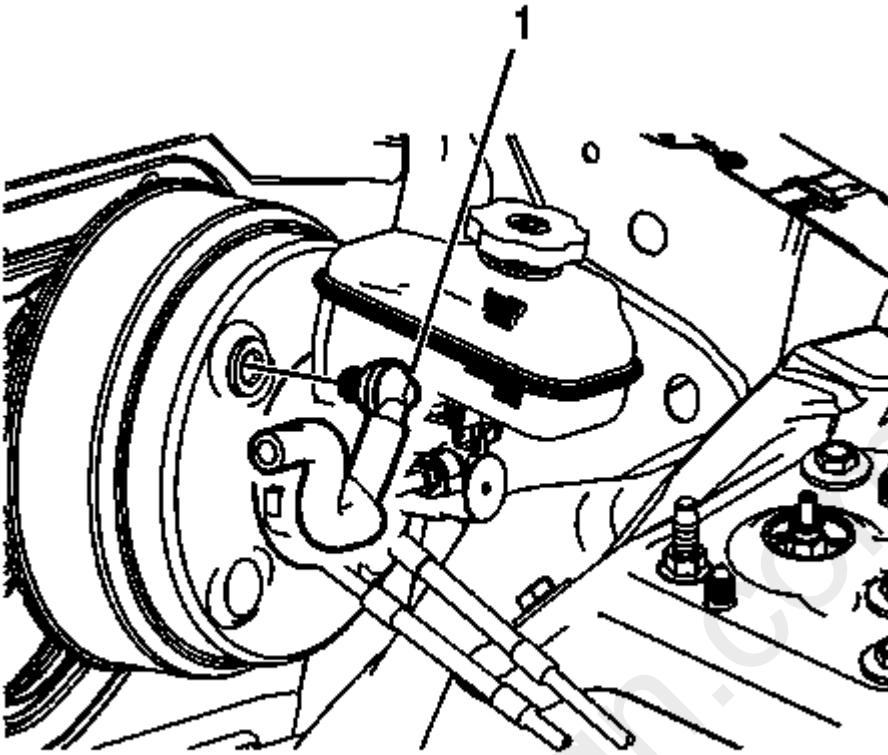


Fig. 124: Power Vacuum Brake Booster Check Valve & Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

10. Connect the power vacuum brake booster check valve and hose assembly (1).

If necessary, a small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.

11. Connect the brake fluid level indicator switch electrical connector.
12. Install the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement** .
13. Install the surge tank. Refer to **Radiator Surge Tank Replacement** .
14. Install the cross vehicle brace, if removed. Refer to **Cross Vehicle Brace Replacement** .

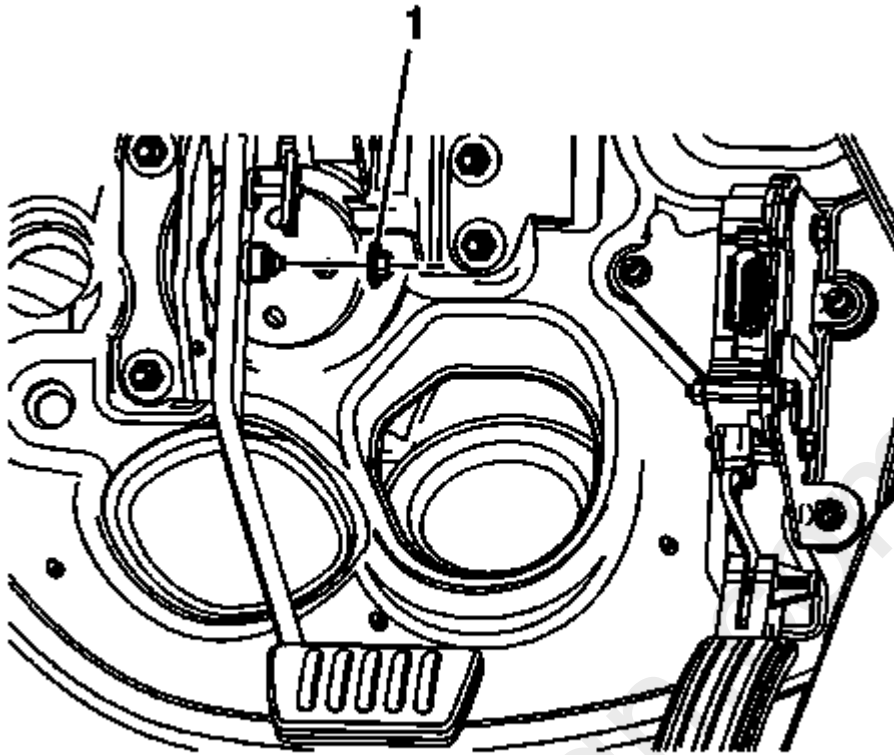


Fig. 125: Power Vacuum Brake Booster Pushrod Nut
Courtesy of GENERAL MOTORS COMPANY

15. Connect the power vacuum brake booster pushrod to the brake pedal pivot.
16. Install the power vacuum brake booster pushrod nut (1) and tighten to 9 N.m (80 lb in).

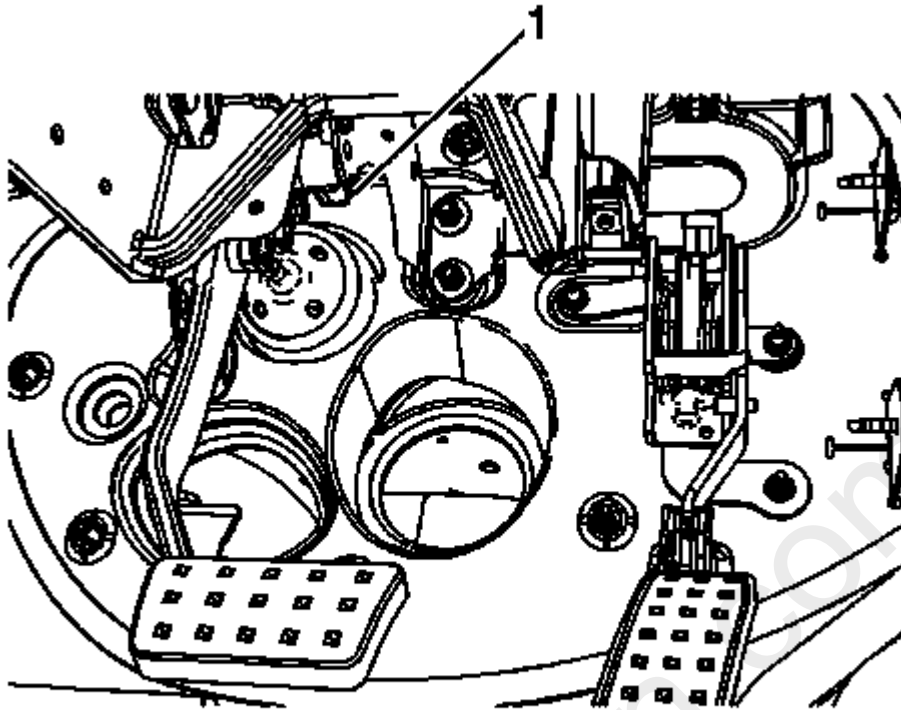


Fig. 126: Brake Pedal Position Sensor
 Courtesy of GENERAL MOTORS COMPANY

17. Connect the brake pedal position sensor electrical connector (1).
18. Calibrate the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Calibration** .
19. Install the left side instrument panel insulator panel. Refer to **Instrument Panel Insulator Replacement - Left Side (Left Hand Drive)** .

POWER VACUUM BRAKE BOOSTER REPLACEMENT (RHD)

Special Tools

J-22805-B Brake Booster Holder

Removal Procedure

1. Remove the right side instrument panel insulator panel. Refer to **Instrument Panel Insulator Replacement - Right Side (Right Hand Drive)** .
2. Without disconnecting the steering column from the intermediate shaft, lower and support the steering column. Refer to **Steering Column Replacement** .

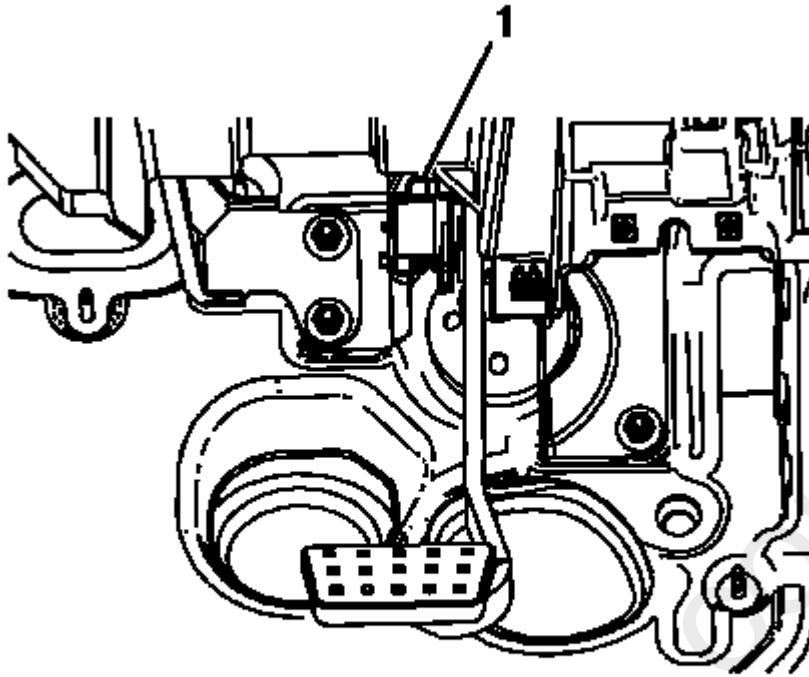


Fig. 127: Brake Pedal Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the brake pedal position sensor electrical connector (1).

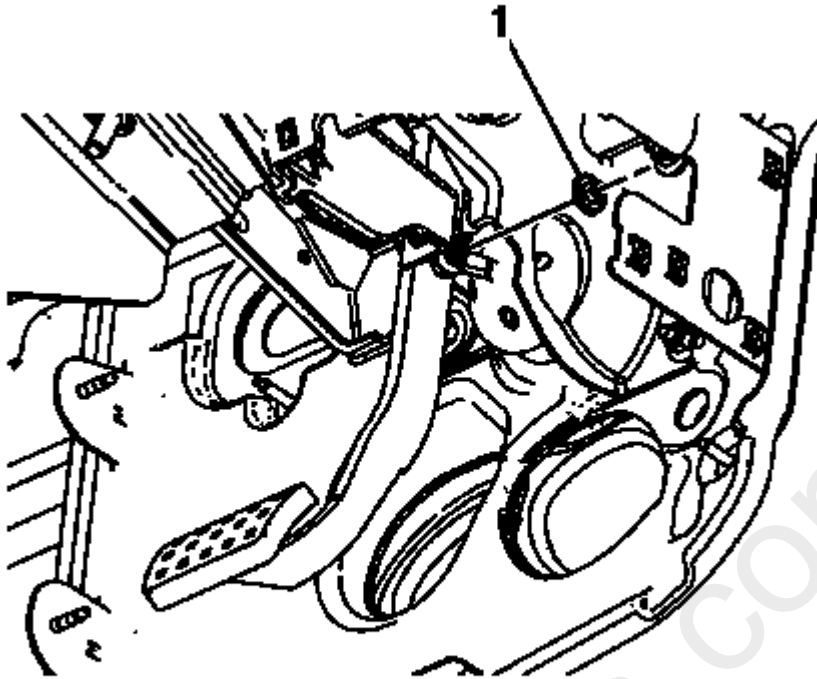


Fig. 128: Power Vacuum Brake Booster Pushrod Nut
Courtesy of GENERAL MOTORS COMPANY

4. Remove the power vacuum brake booster pushrod nut (1).
5. Disconnect the power vacuum brake booster pushrod from the brake pedal pivot.
6. Remove the cross vehicle brace, if equipped. Refer to **Cross Vehicle Brace Replacement** .
7. Disconnect the brake fluid level indicator switch electrical connector.

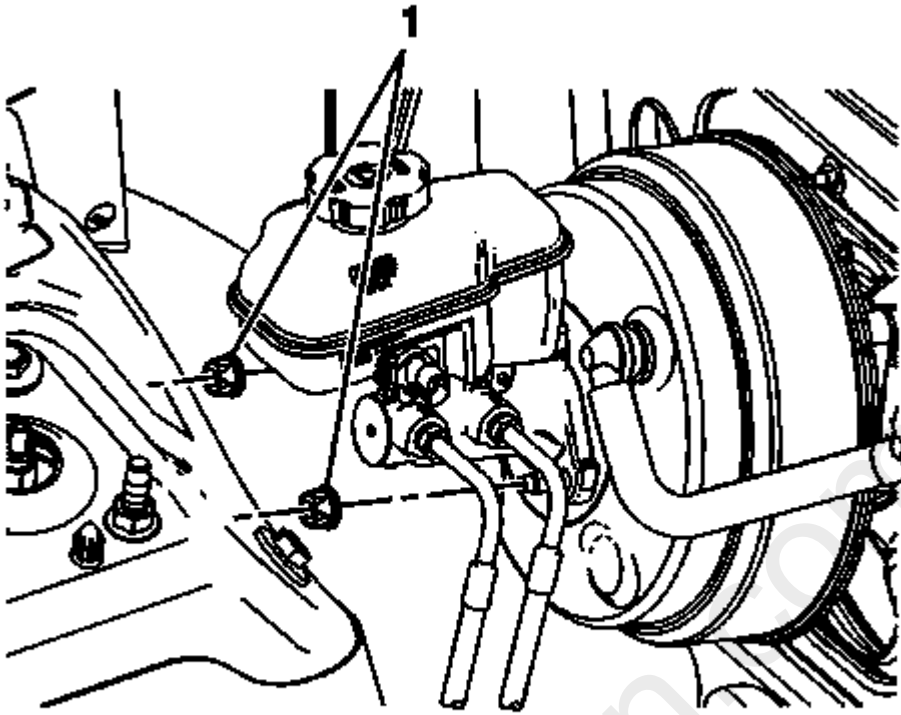


Fig. 129: Master Cylinder Nuts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the master cylinder nuts (1).

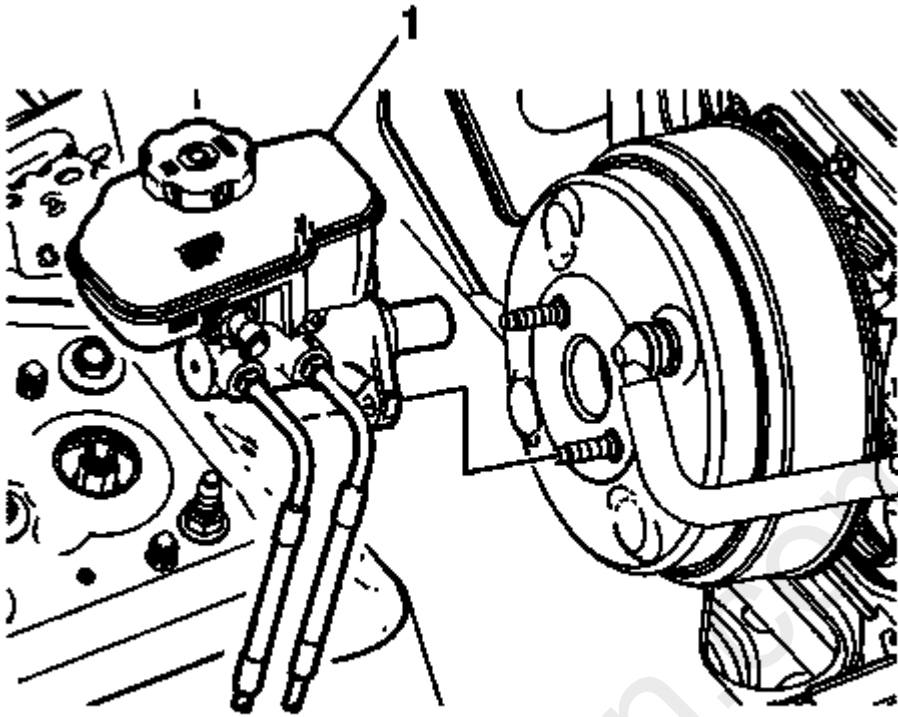


Fig. 130: Master Cylinder

Courtesy of GENERAL MOTORS COMPANY

9. Without disconnecting the brake pipe fittings, position aside the master cylinder (1) and support with heavy mechanics wire or equivalent.

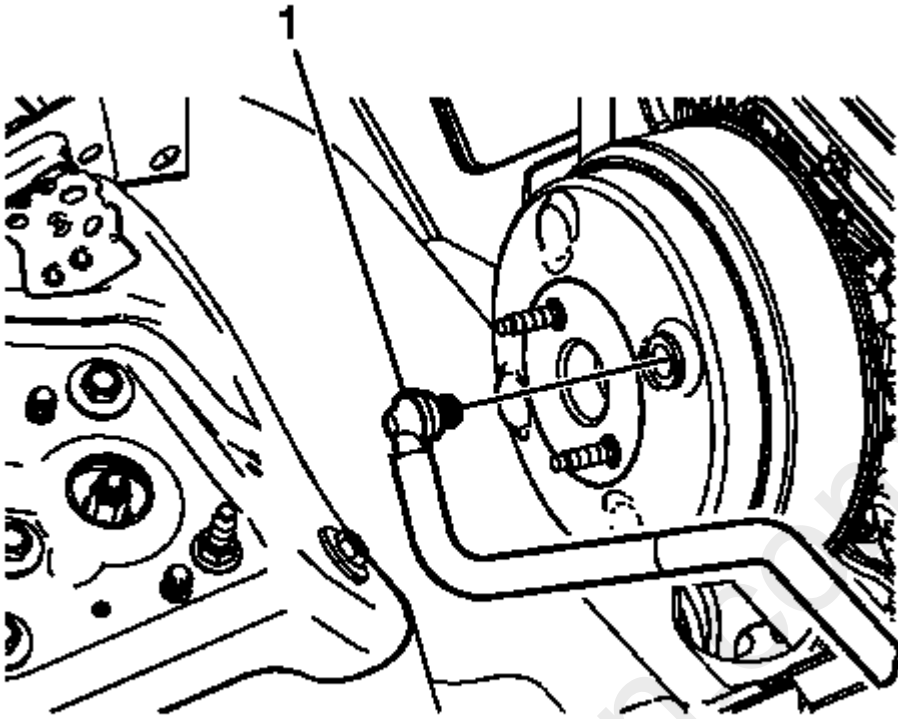


Fig. 131: Power Vacuum Brake Booster Check Valve & Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect the power vacuum brake booster check valve and hose assembly (1).

NOTE: Do not attempt to lever against the master cylinder mounting studs to remove the power vacuum brake booster.

11. Modify the **J-22805-B** Brake Booster Holder to accommodate the narrower span between the master cylinder mounting studs on the power vacuum brake booster:
 - Using a suitable grinding tool or metal file, elongate the mounting holes of the **J-22805-B** Brake Booster Holder.
 - Remove approximately 6.36 mm (0.25 in) of material from the inner edges of both mounting holes.
 - Remove material from the inner edges of the mounting until the span, from center to center, is approximately 80.00 mm (3.15 in).

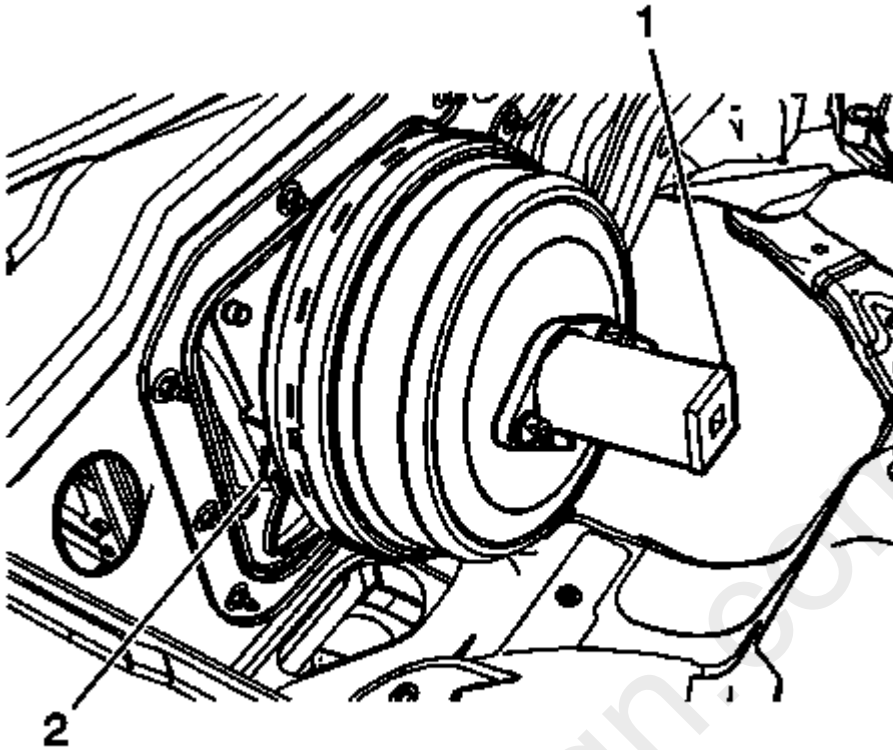


Fig. 132: Brake Booster Holder & Locking Tab
Courtesy of GENERAL MOTORS COMPANY

12. Install the J-22805-B Brake Booster Holder (1) and secure with the master cylinder nuts.
13. Using a flat-bladed tool, depress the locking tab (2) toward the cowl.

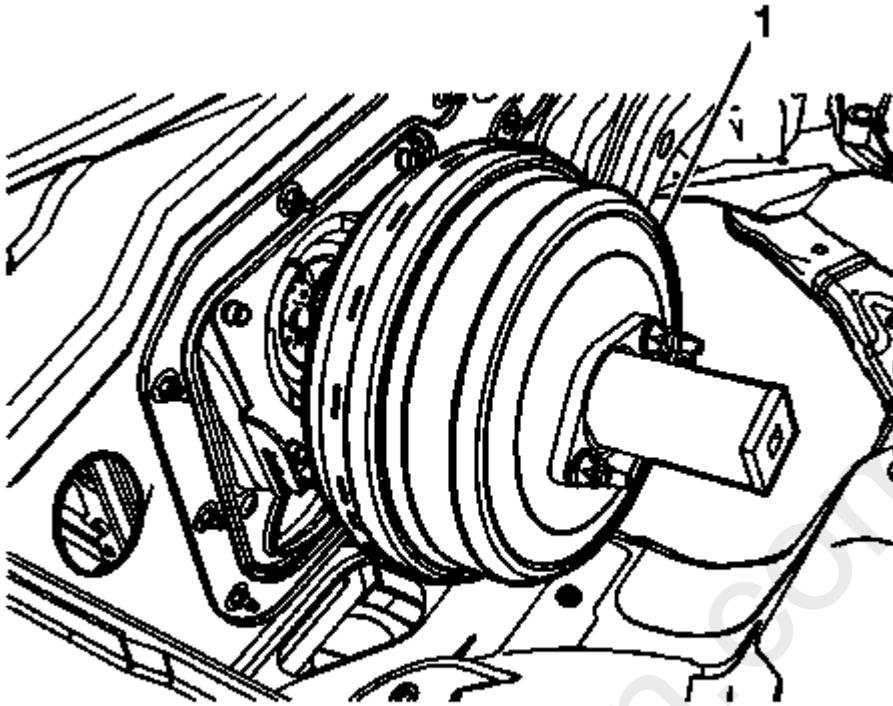


Fig. 133: Vacuum Brake Booster

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not attempt to remove the power vacuum brake booster completely. The power vacuum brake booster pushrod retaining clip must be released prior to booster removal.

14. Rotate the **J-22805-B** Brake Booster Holder and power vacuum brake booster (1) counterclockwise and release the power vacuum brake booster from the bracket.

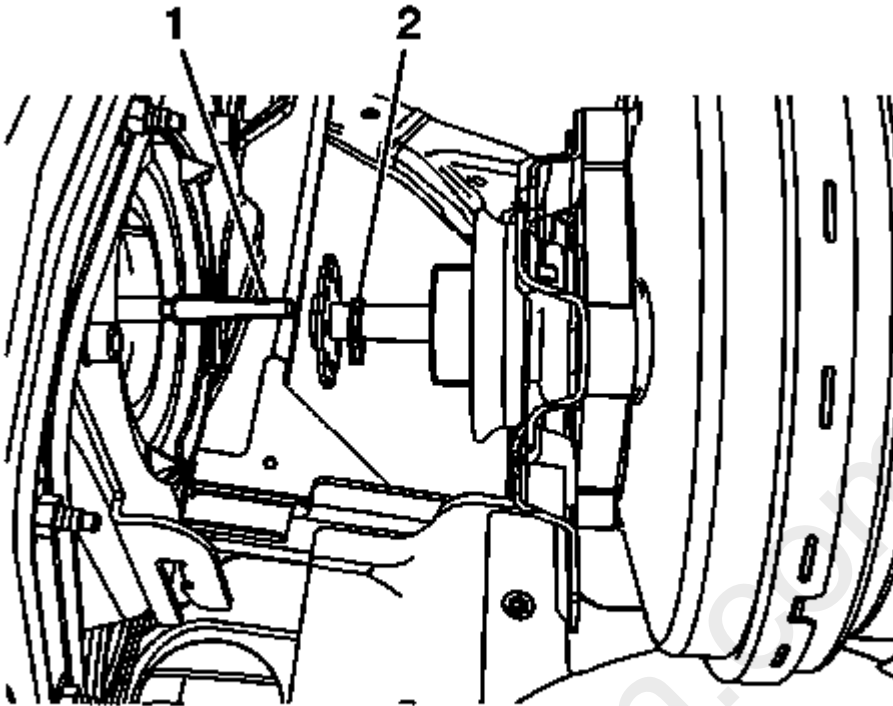


Fig. 134: Brake Booster Pushrod Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

15. Carefully pull the power vacuum brake booster forward slightly and support the power vacuum booster to access the booster pushrod retaining clip.
16. Compress the power vacuum brake booster foam filter to access the power vacuum brake booster pushrod retaining clip.
17. Disconnect the power vacuum brake booster pushrod (1) from the booster by releasing the retaining clip (2).
18. Remove the power vacuum brake booster from the vehicle.
19. Remove the power vacuum brake booster pushrod through the dust boot from inside of the vehicle, if necessary.

Installation Procedure

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

CAUTION: Internal components of this booster are not serviceable. The housing must not be unstaked and separated. Separating the housing will cause

permanent deformation, preventing the booster from holding proper volume.

1. Install the power vacuum brake booster pushrod through the dust boot from inside of the vehicle, if removed.
2. Install the vacuum brake booster to the vehicle.
3. Compress the power vacuum brake booster foam filter to access the vacuum brake booster pushrod retaining clip.

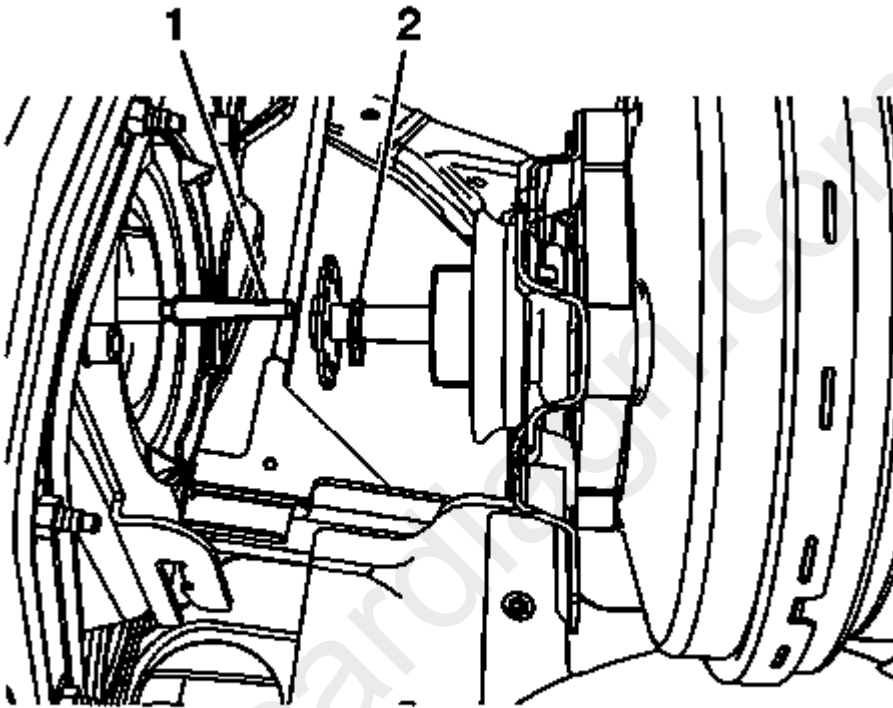


Fig. 135: Brake Booster Pushrod Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

4. Connect the power vacuum brake booster pushrod (1) to the booster and engage the retaining clip (2).

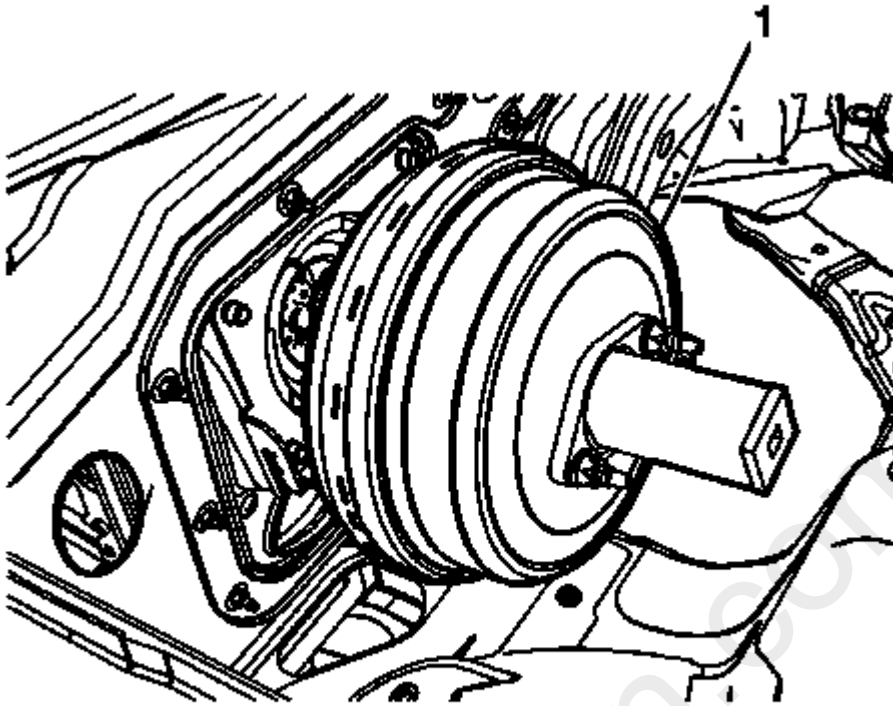


Fig. 136: Vacuum Brake Booster

Courtesy of GENERAL MOTORS COMPANY

5. Position the vacuum power brake booster (1) to the booster bracket.

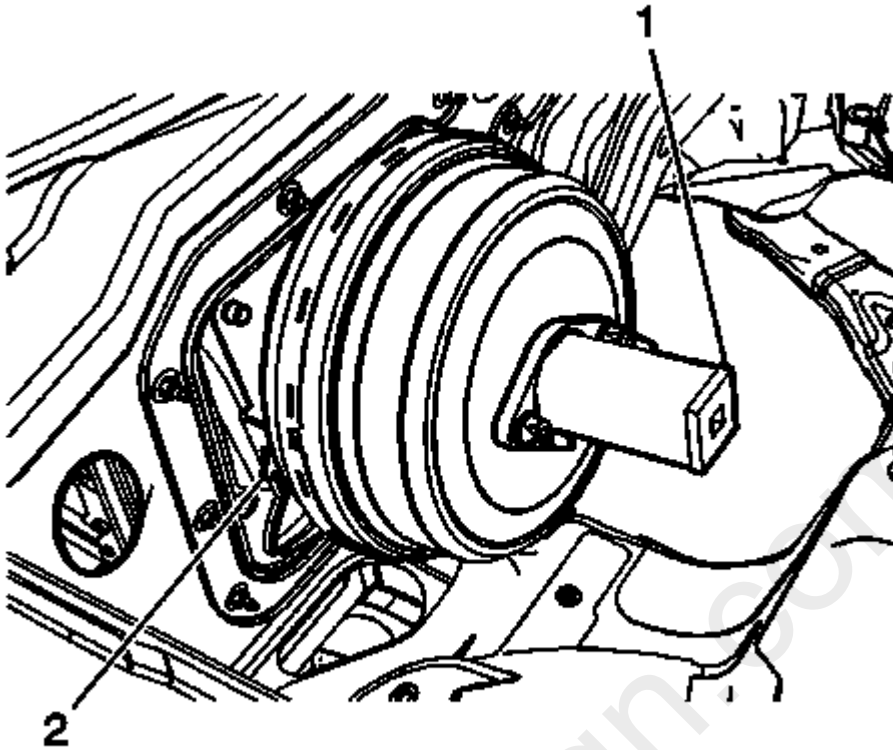


Fig. 137: Brake Booster Holder & Locking Tab
Courtesy of GENERAL MOTORS COMPANY

6. Using the **J-22805-B** Brake Booster Holder (1), rotate the power vacuum brake booster clockwise until the locking tab (2) engages the booster bracket flange.

Ensure the booster locking tab fully engages in the bracket.

7. Remove the **J-22805-B** Brake Booster Holder from the power vacuum brake booster and discard the master cylinder nuts.

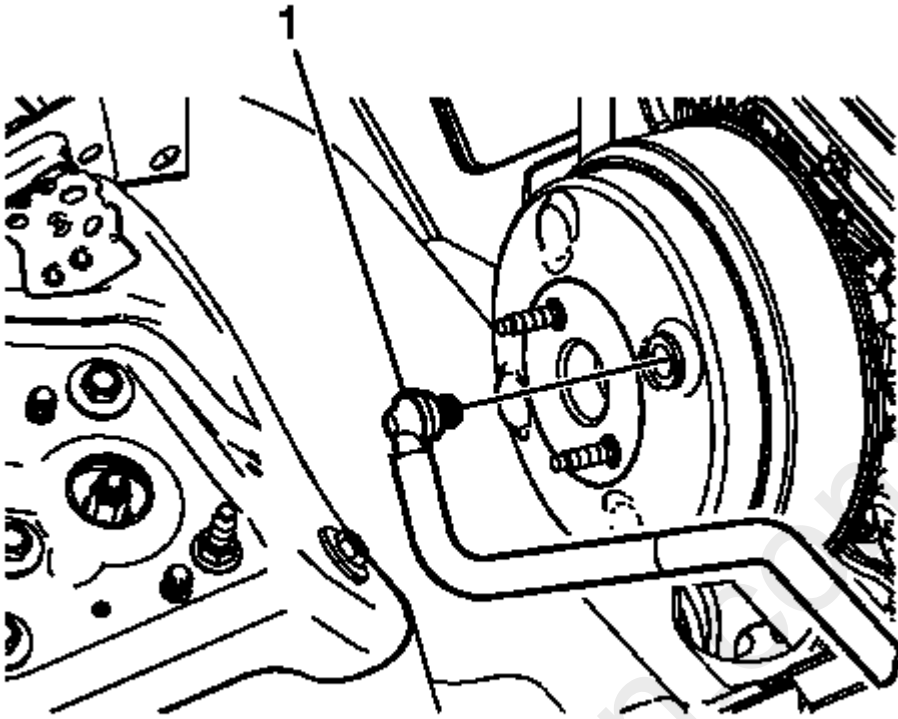


Fig. 138: Power Vacuum Brake Booster Check Valve & Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

8. Connect the power vacuum brake booster check valve and hose assembly (1).

If necessary, a small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.

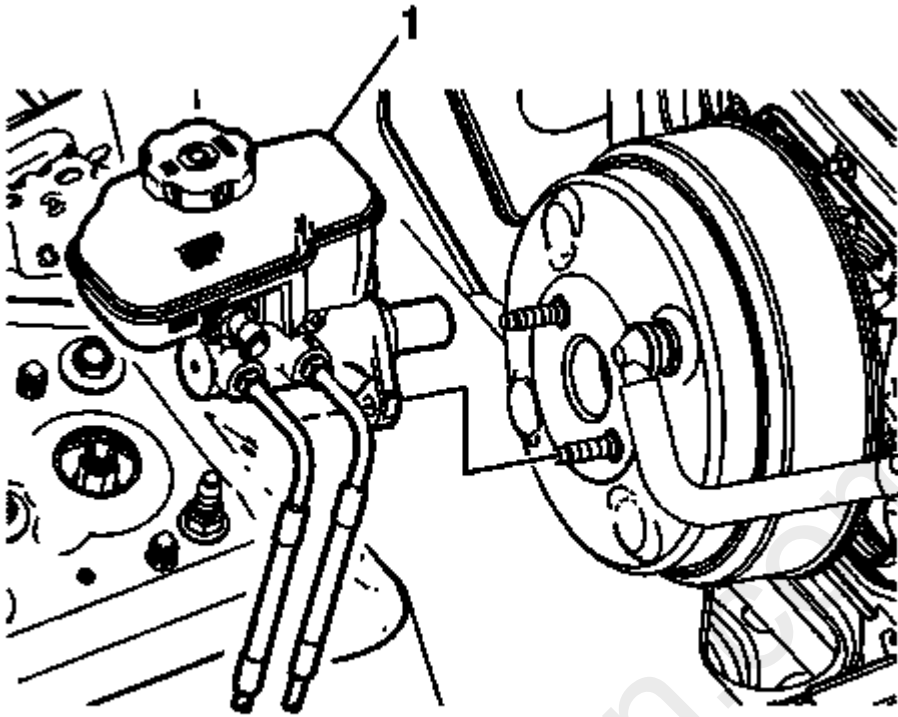


Fig. 139: Master Cylinder

Courtesy of GENERAL MOTORS COMPANY

9. Install the master cylinder (1) to the power vacuum brake booster.

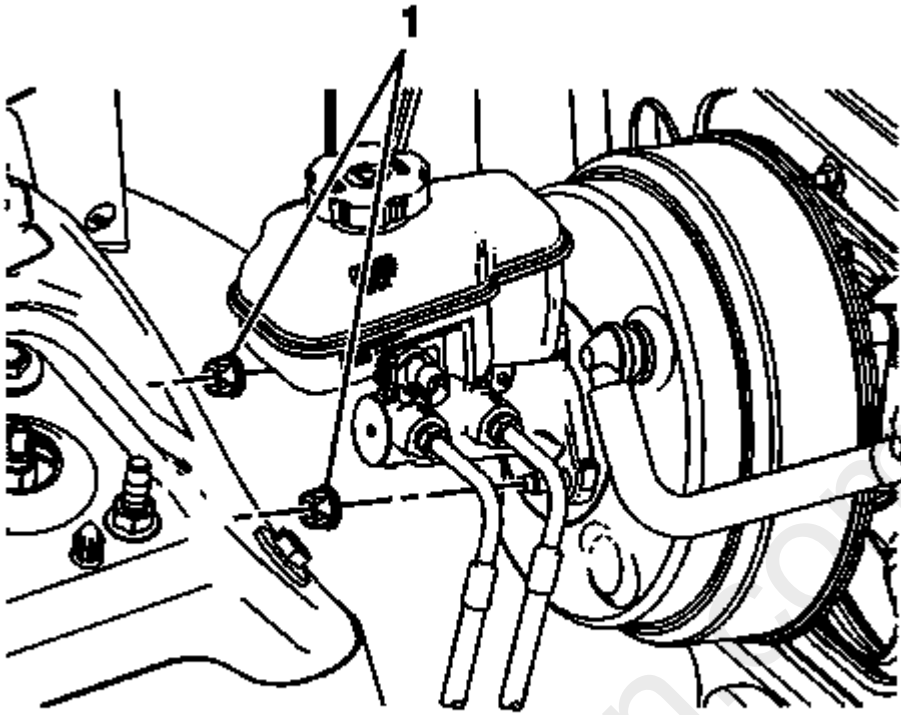


Fig. 140: Master Cylinder Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

10. Install new master cylinder nuts (1) and tighten to 25 N.m (18 lb ft).
11. Connect the brake fluid level indicator switch electrical connector.
12. Install the cross vehicle brace, if removed. Refer to Cross Vehicle Brace Replacement .

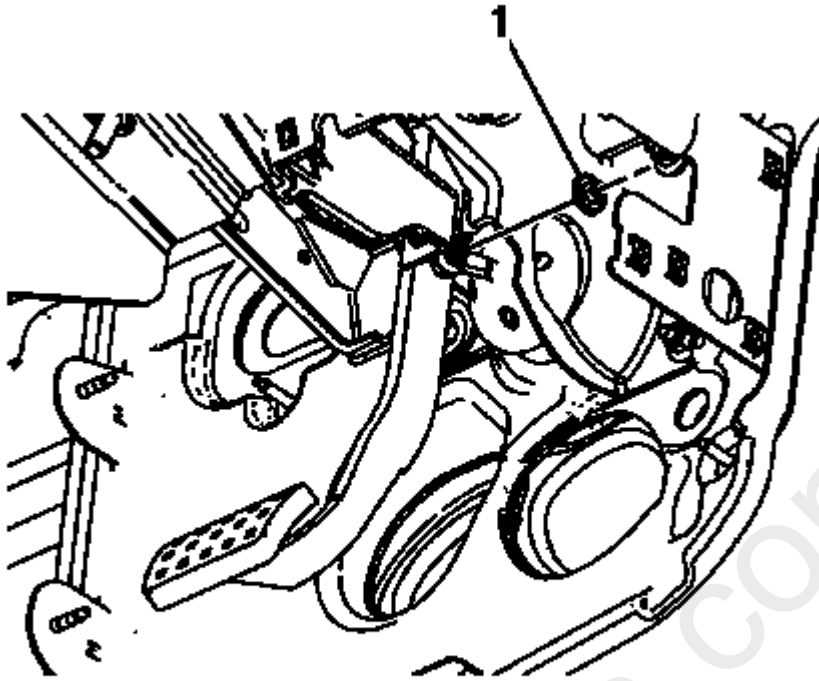


Fig. 141: Power Vacuum Brake Booster Pushrod Nut
Courtesy of GENERAL MOTORS COMPANY

13. Connect the power vacuum brake booster pushrod to the brake pedal pivot.
14. Install the power vacuum brake booster pushrod nut (1) and tighten to 9 N.m (80 lb in).

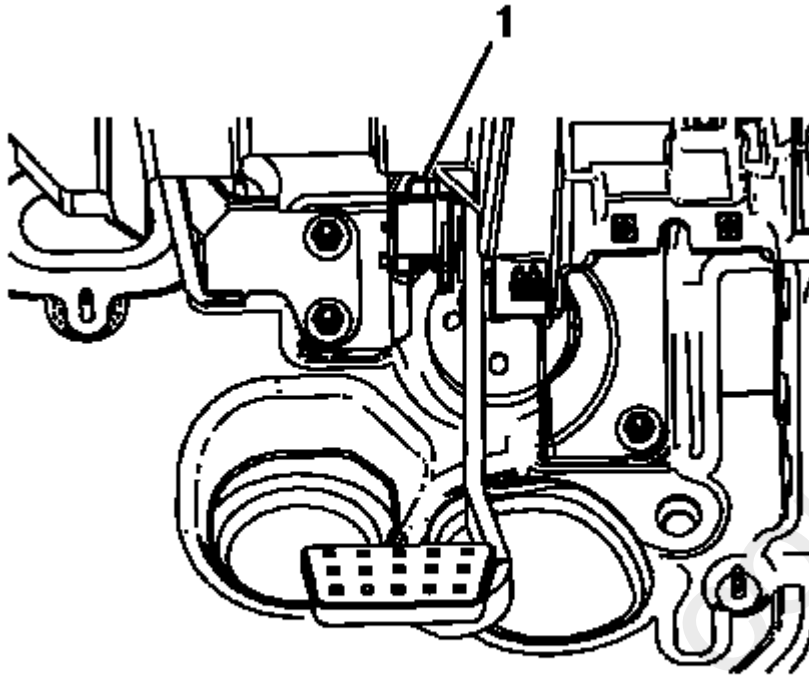


Fig. 142: Brake Pedal Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

15. Connect the brake pedal position sensor electrical connector (1).
16. Install the steering column. Refer to **Steering Column Replacement** .
17. Calibrate the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Calibration** .
18. Install the right side instrument panel insulator panel. Refer to **Instrument Panel Insulator Replacement - Right Side (Right Hand Drive)** .

POWER BRAKE BOOSTER VACUUM CHECK VALVE AND HOSE REPLACEMENT (3.0L, 3.6L LEFT HAND DRIVE)

Removal Procedure

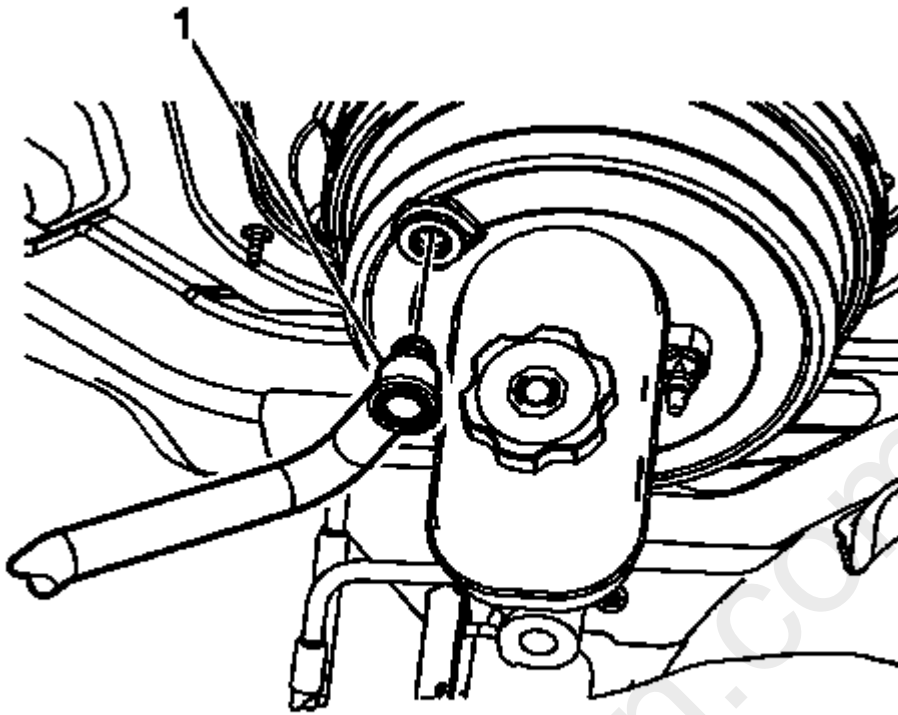


Fig. 143: Check Valve & Vacuum Brake Booster
Courtesy of GENERAL MOTORS COMPANY

1. Apply the brake pedal several times until the pedal becomes firm to deplete the vacuum reserve in the brake booster.
2. Remove the intake manifold insulator. Refer to **Intake Manifold Insulator Replacement** .
3. Remove the check valve (1) from the vacuum brake booster.

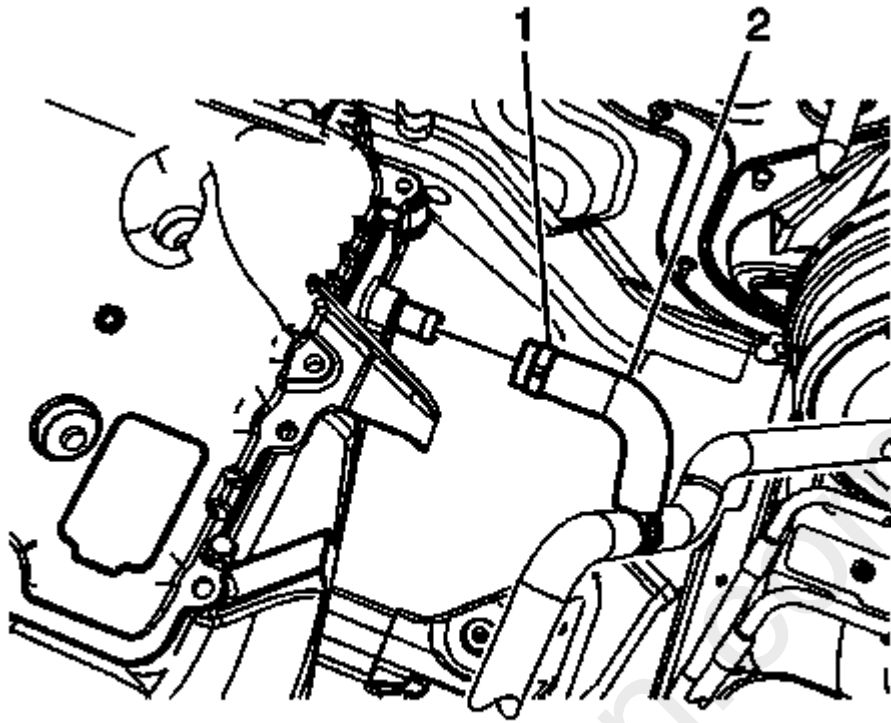


Fig. 144: Vacuum Clamp & Hose
Courtesy of GENERAL MOTORS COMPANY

4. Remove and discard the vacuum hose clamp (1).
5. Remove the vacuum hose (2) from the vacuum port on the left side of the intake manifold.

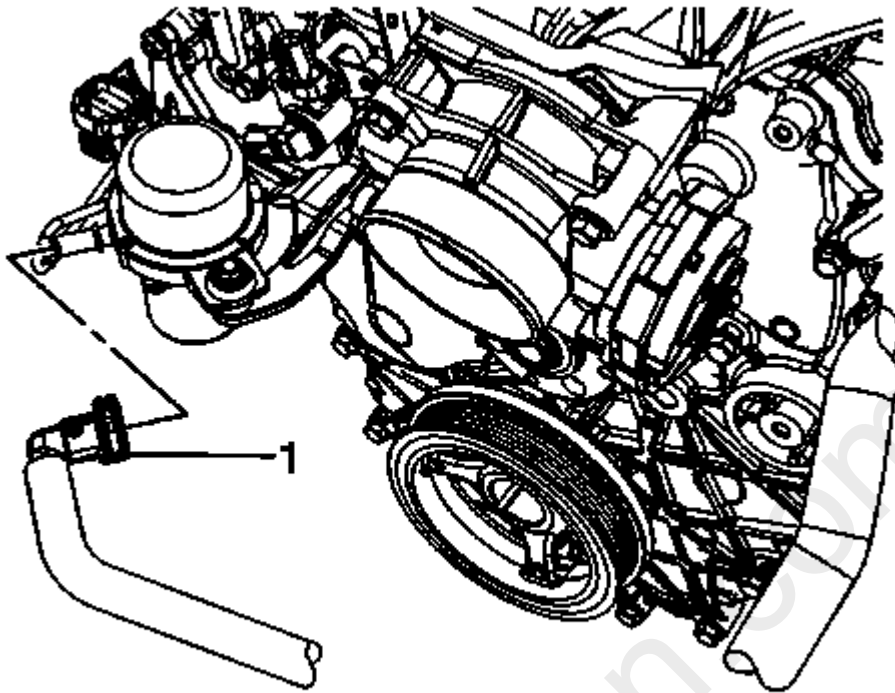


Fig. 145: Vacuum Brake Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

6. Release the vacuum brake booster hose quick connect (1) from the power brake booster auxiliary pump.

Installation Procedure

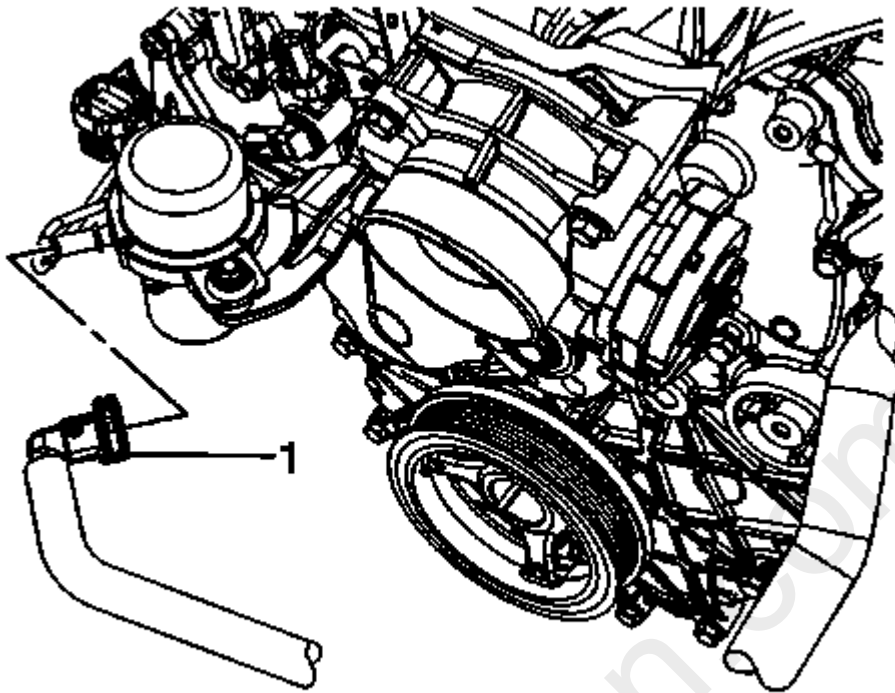


Fig. 146: Vacuum Brake Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

1. Install the vacuum brake booster hose quick connect (1) to the power brake booster auxiliary pump.

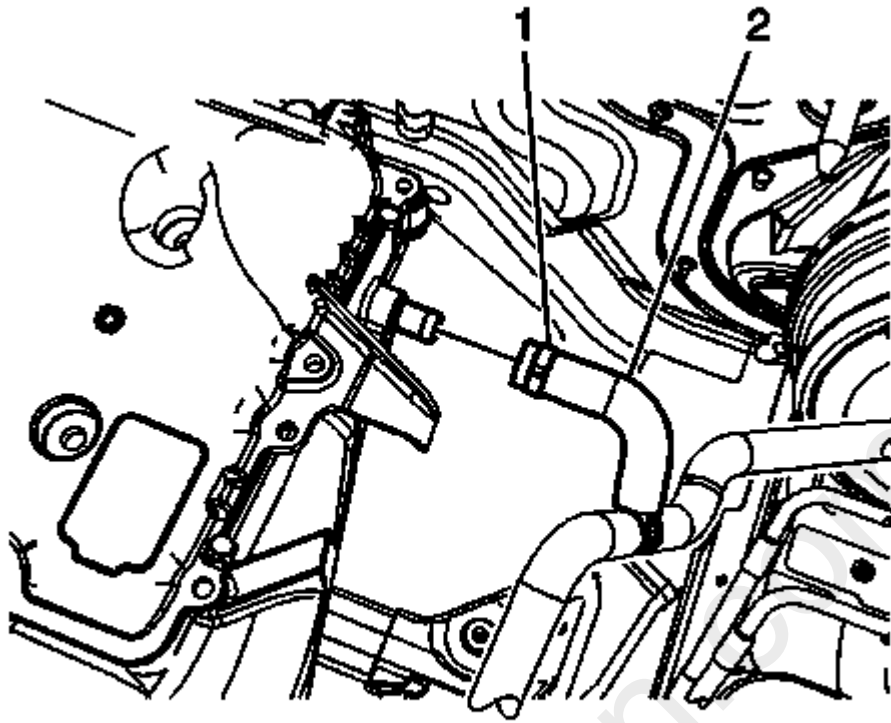


Fig. 147: Vacuum Clamp & Hose
Courtesy of GENERAL MOTORS COMPANY

2. Position a new hose clamp (1) to the vacuum brake booster hose.
3. Install the vacuum hose (2) to the vacuum port on the left side of the intake manifold.
4. Using a suitable tool, compress the clamp to secure the vacuum brake booster hose to the vacuum port fitting.

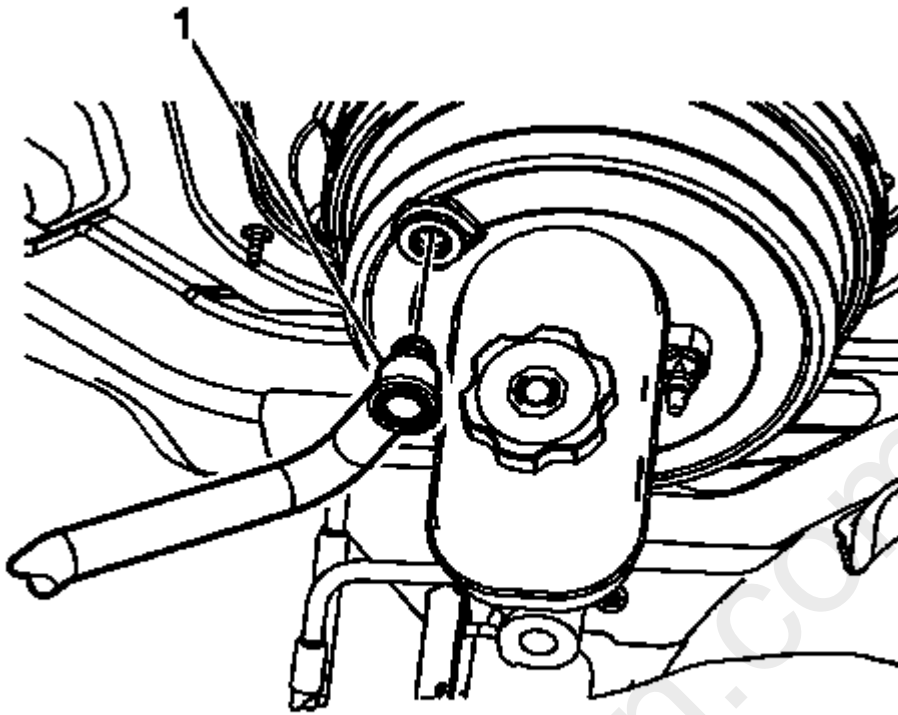


Fig. 148: Check Valve & Vacuum Brake Booster
Courtesy of GENERAL MOTORS COMPANY

NOTE: If necessary, a small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.

5. Install the check valve (1) to the vacuum brake booster.
6. Install the intake manifold insulator. Refer to **Intake Manifold Insulator Replacement** .

POWER BRAKE BOOSTER VACUUM CHECK VALVE AND HOSE REPLACEMENT (3.0L, 3.6L RIGHT HAND DRIVE)

Removal Procedure

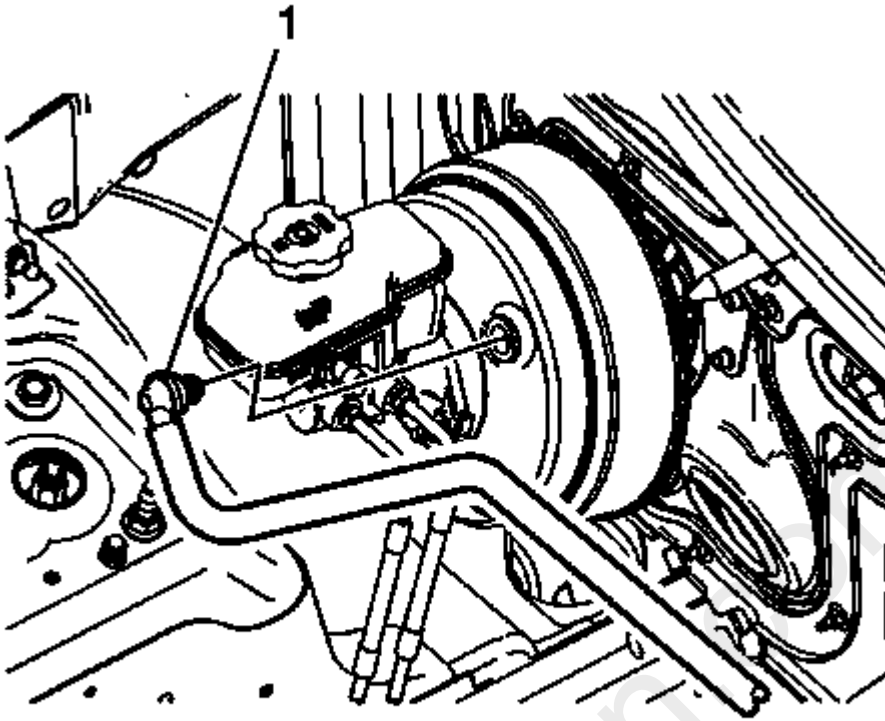


Fig. 149: Power Vacuum Brake Booster Check Valve & Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

1. With the engine OFF, apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Remove the intake manifold insulator. Refer to **Intake Manifold Insulator Replacement** .
3. Remove the power vacuum brake booster check valve and hose assembly (1) from the power vacuum brake booster.

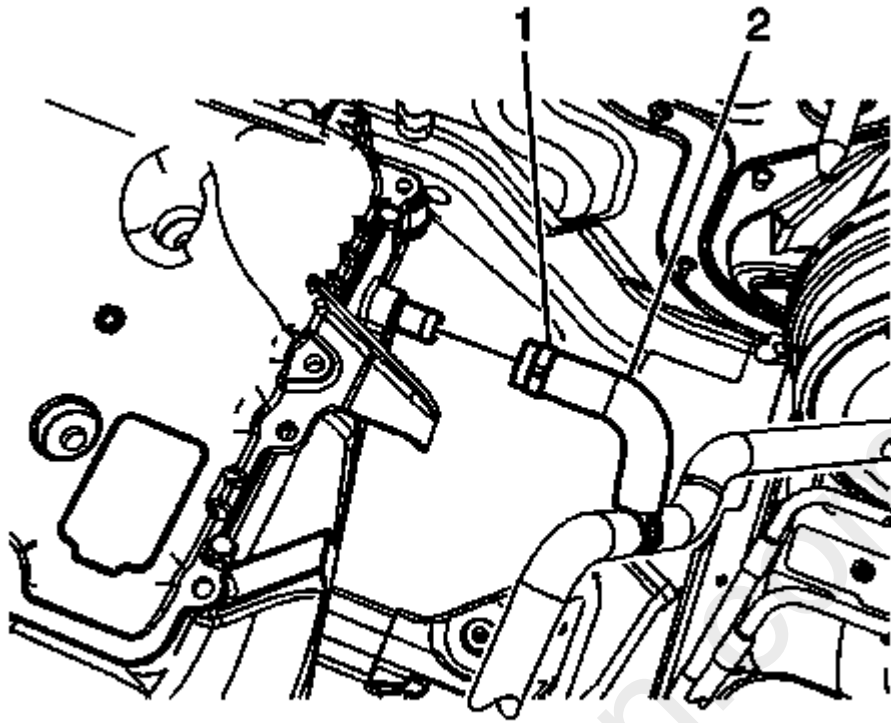


Fig. 150: Vacuum Clamp & Hose
Courtesy of GENERAL MOTORS COMPANY

4. Remove and discard the vacuum hose clamp (1).
5. Remove the vacuum hose (2) from the vacuum port on the left side of the intake manifold.

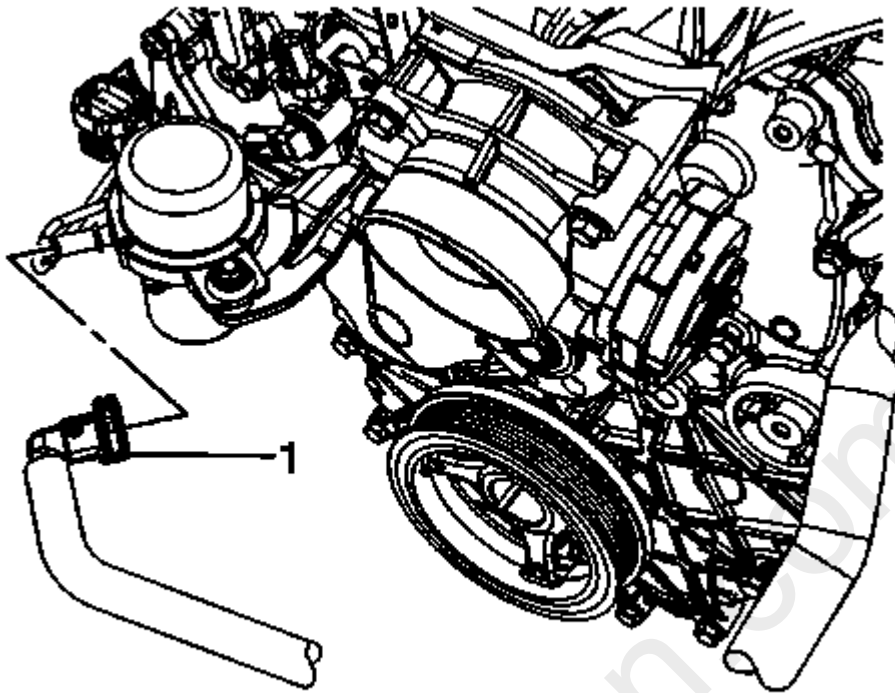


Fig. 151: Vacuum Brake Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

6. Release the power vacuum brake booster hose quick connect (1) from the power vacuum brake booster auxiliary pump.

Installation Procedure

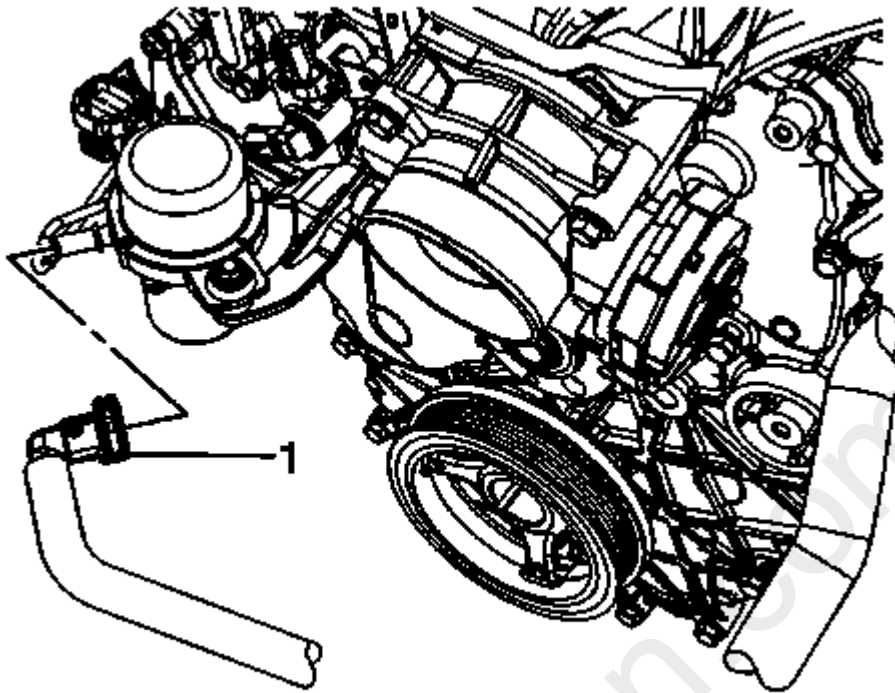


Fig. 152: Vacuum Brake Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

1. Install the power vacuum brake booster hose quick connect (1) to the power vacuum brake booster auxiliary pump.

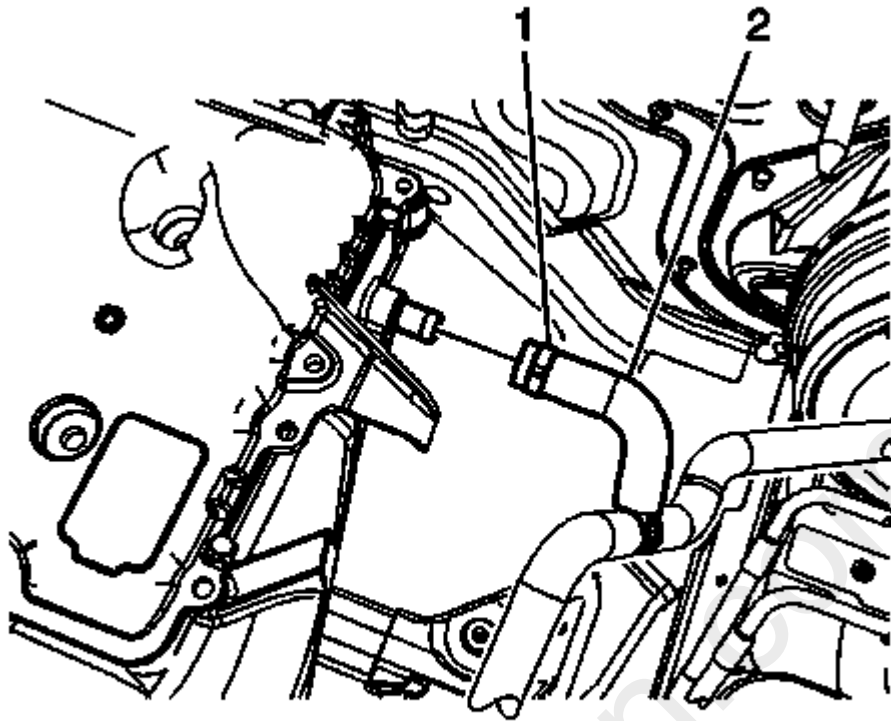


Fig. 153: Vacuum Clamp & Hose
Courtesy of GENERAL MOTORS COMPANY

2. Position a new hose clamp (1) to the power vacuum brake booster hose.

NOTE: If necessary, a small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.

3. Install the vacuum hose (2) to the vacuum port on the left side of the intake manifold.
4. Using a suitable tool, compress the clamp to secure the power vacuum brake booster hose to the vacuum port fitting.

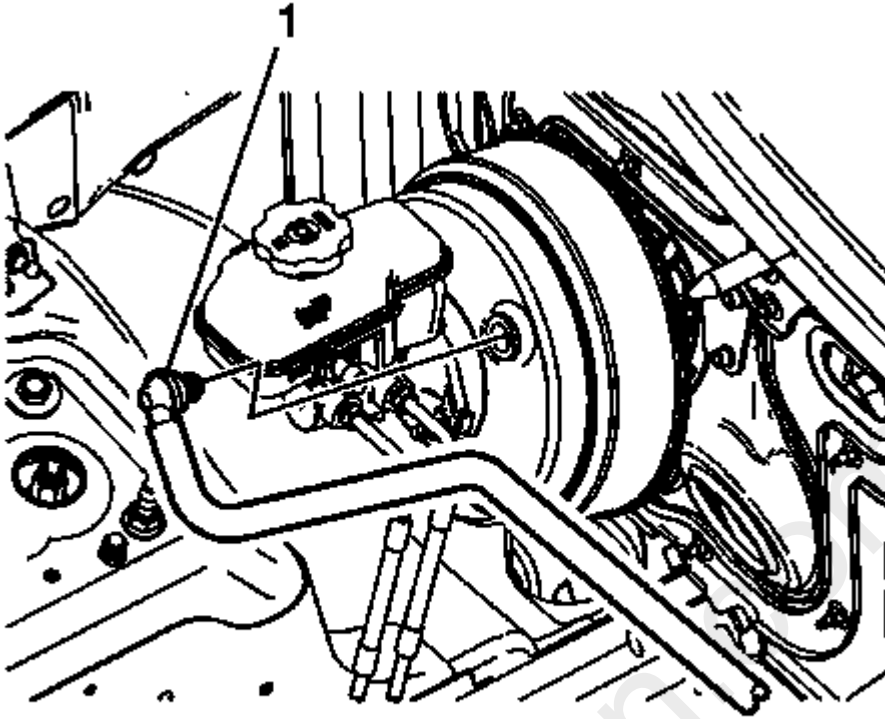


Fig. 154: Power Vacuum Brake Booster Check Valve & Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: If necessary, a small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.

5. Install the power vacuum brake booster check valve and hose assembly (1) to the power vacuum brake booster.
6. Install the intake manifold insulator. Refer to **Intake Manifold Insulator Replacement** .

POWER BRAKE BOOSTER VACUUM CHECK VALVE AND HOSE REPLACEMENT (6.2L)

Removal Procedure

1. With the engine OFF, apply and release the brake pedal several times until the pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
2. Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

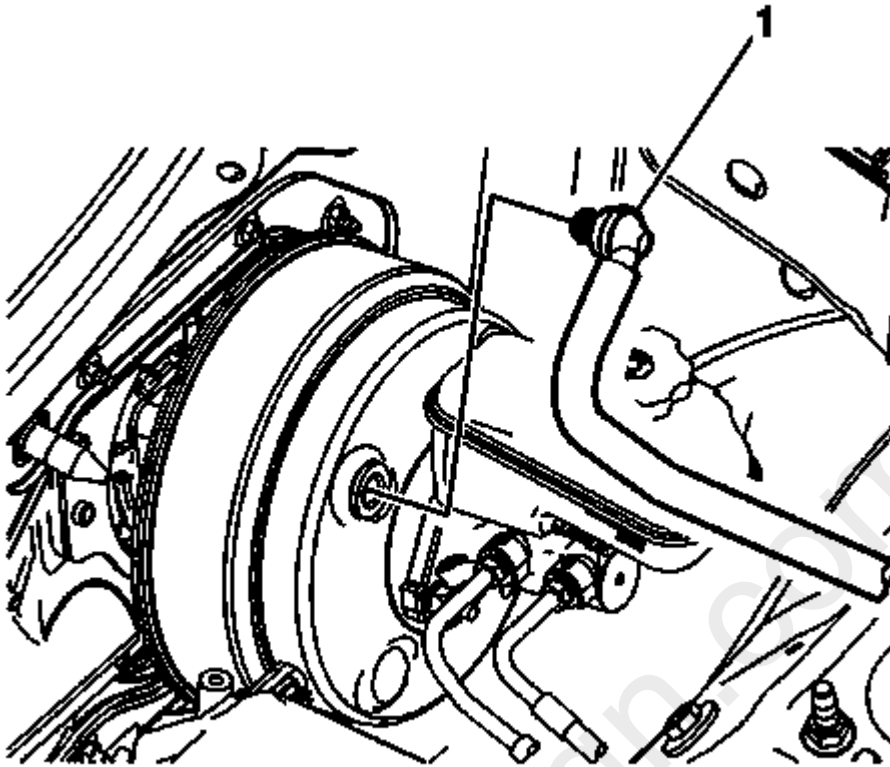


Fig. 155: Vacuum Brake Booster Check Valve & Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Remove the vacuum brake booster check valve and hose (1) assembly from the power vacuum brake booster.

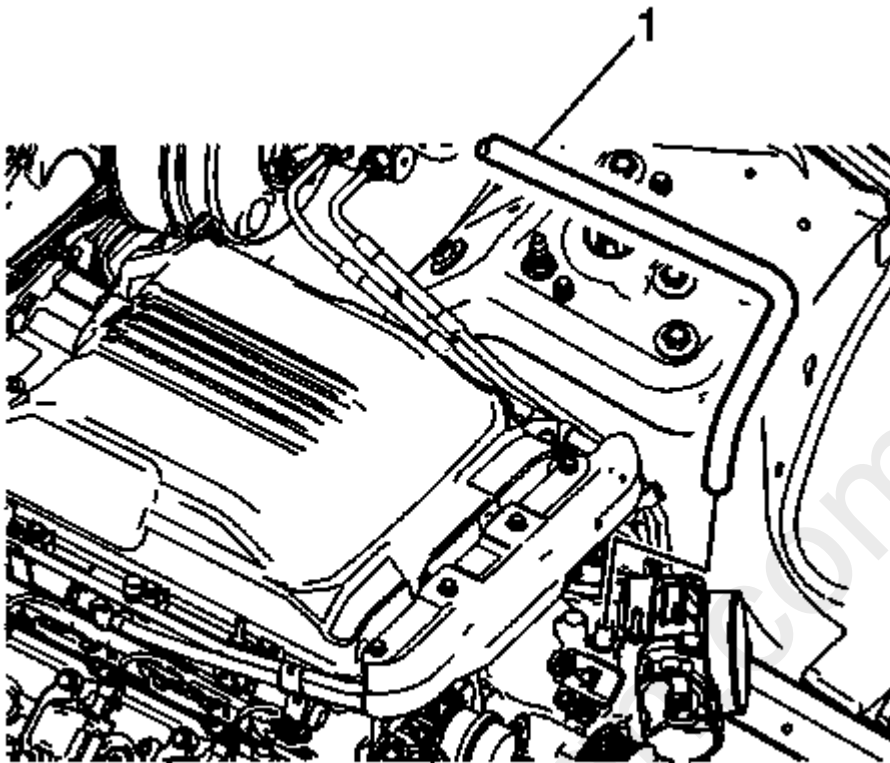


Fig. 156: Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the vacuum brake booster hose (1) from the vacuum port at the front of the engine intake manifold.
5. Remove the vacuum brake booster check valve and hose assembly from the vehicle.

Installation Procedure

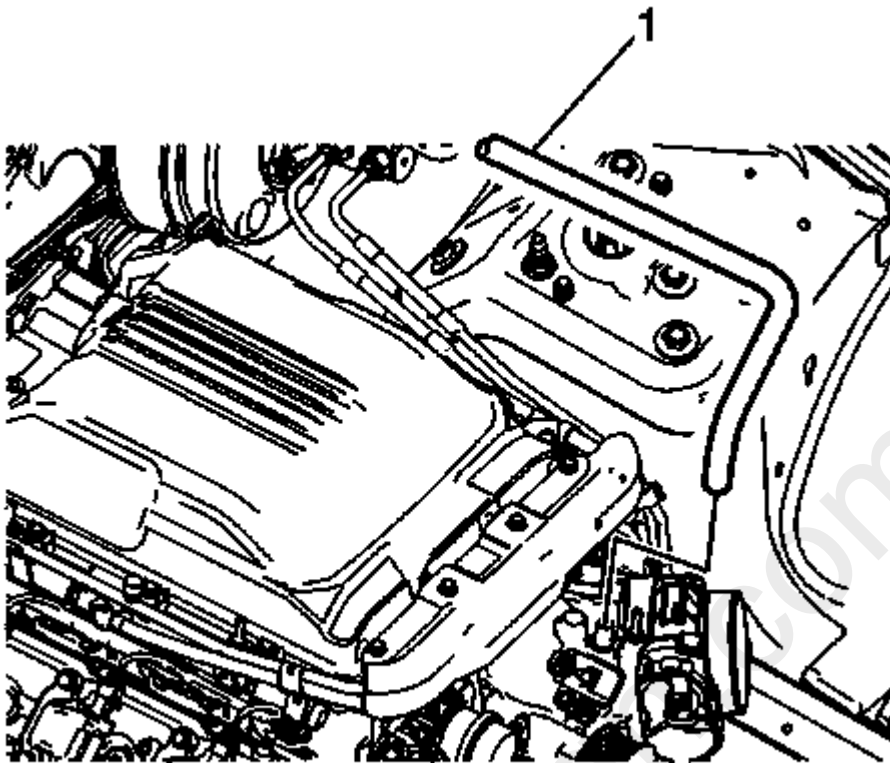


Fig. 157: Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS COMPANY

NOTE: If necessary, a small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.

1. Install the vacuum brake booster hose (1) to the vacuum port at the front of the engine intake manifold.

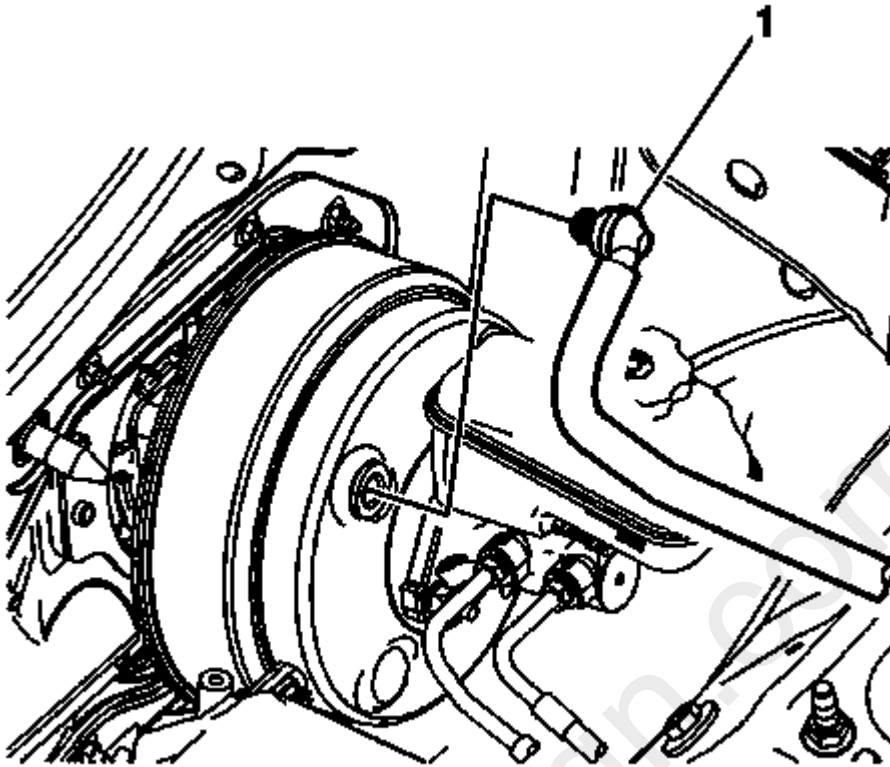


Fig. 158: Vacuum Brake Booster Check Valve & Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: If necessary, a small amount of denatured alcohol may be used as a lubricant for assembly. Do not use soap.

2. Install the vacuum brake booster check valve and hose (1) assembly to the power vacuum brake booster.
3. Install the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

POWER BRAKE BOOSTER VACUUM SENSOR REPLACEMENT

Removal Procedure

1. Turn the engine OFF.

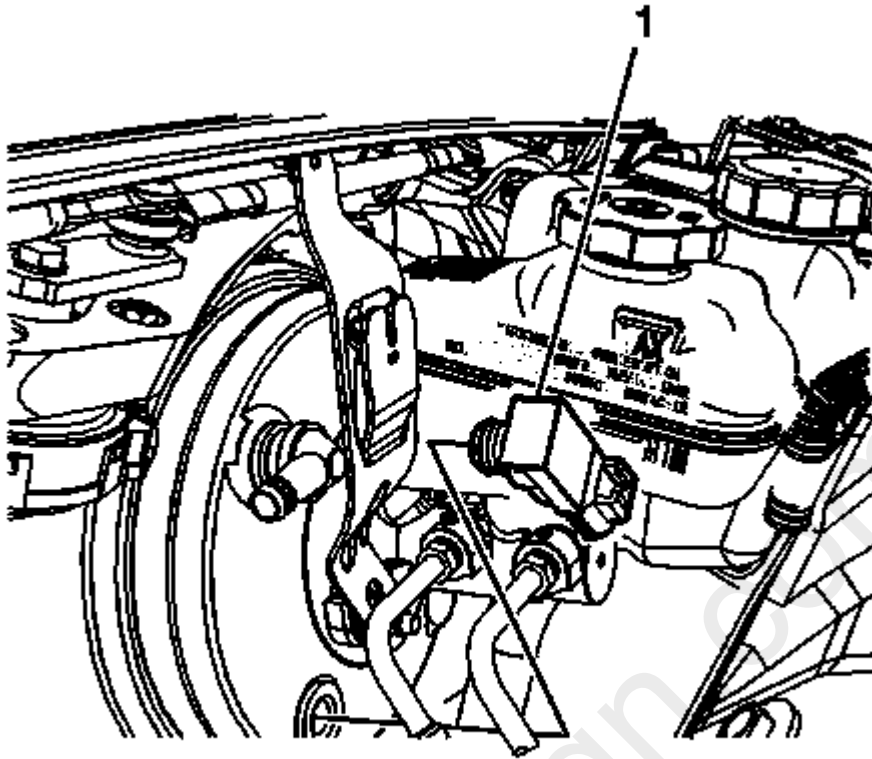


Fig. 159: Power Brake Booster Vacuum Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Apply and release the brake pedal several times until the pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.
3. Disconnect the power brake booster vacuum sensor electrical connector.
4. Remove the power brake booster vacuum sensor (1).

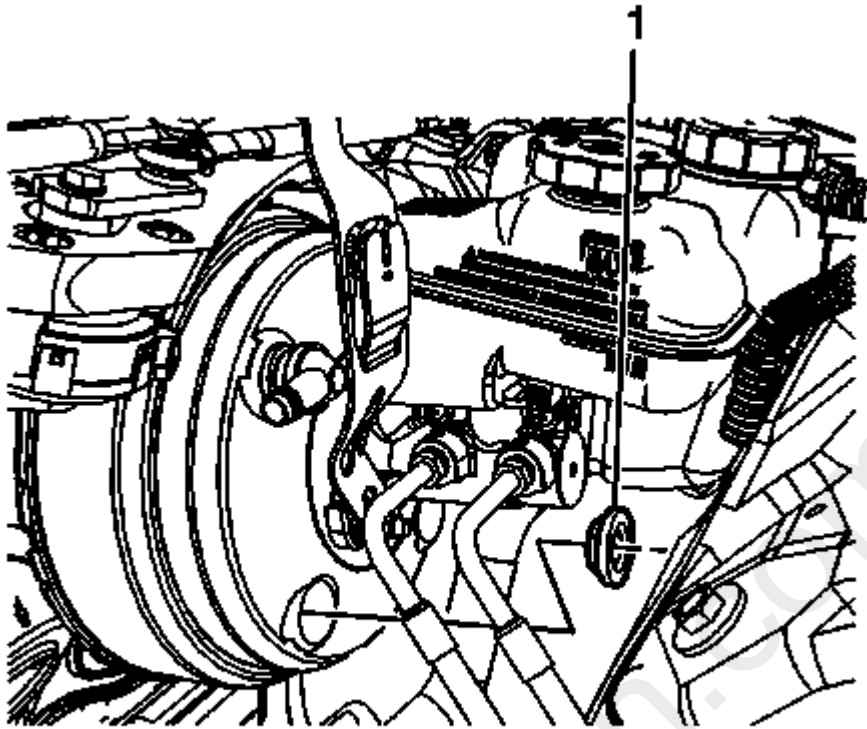


Fig. 160: Power Brake Booster Vacuum Sensor Grommet
Courtesy of GENERAL MOTORS COMPANY

5. Remove the power brake booster vacuum sensor grommet (1).

Installation Procedure

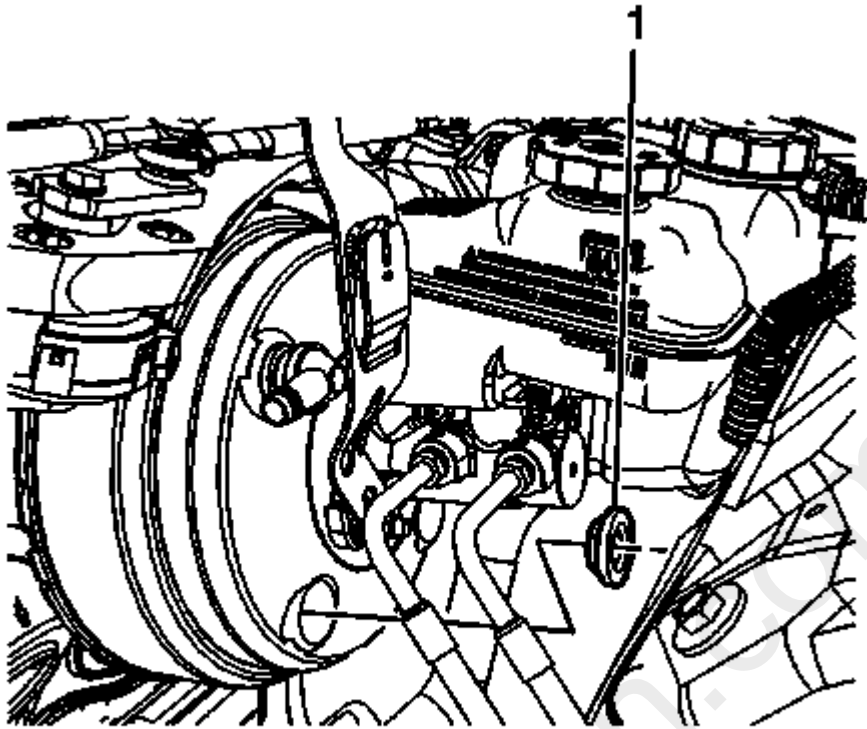


Fig. 161: Power Brake Booster Vacuum Sensor Grommet
Courtesy of GENERAL MOTORS COMPANY

NOTE: A small amount of denatured alcohol may be used to ease installation.

1. Install the power brake booster vacuum sensor grommet (1).

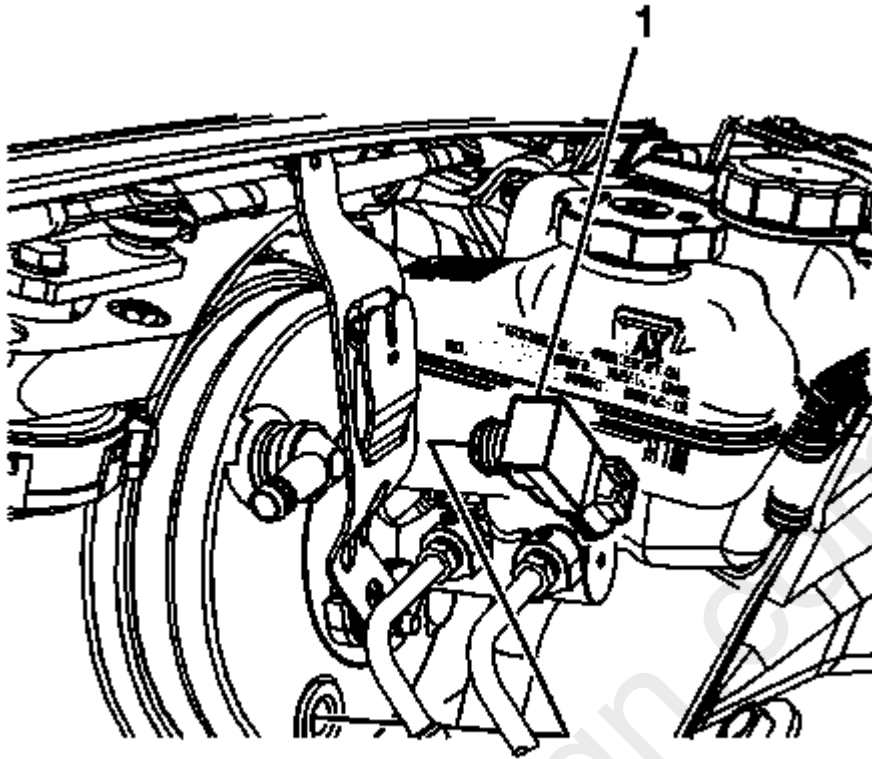


Fig. 162: Power Brake Booster Vacuum Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: A small amount of denatured alcohol may be used to ease installation.

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

POWER BRAKE BOOSTER AUXILIARY PUMP REPLACEMENT

Removal Procedure

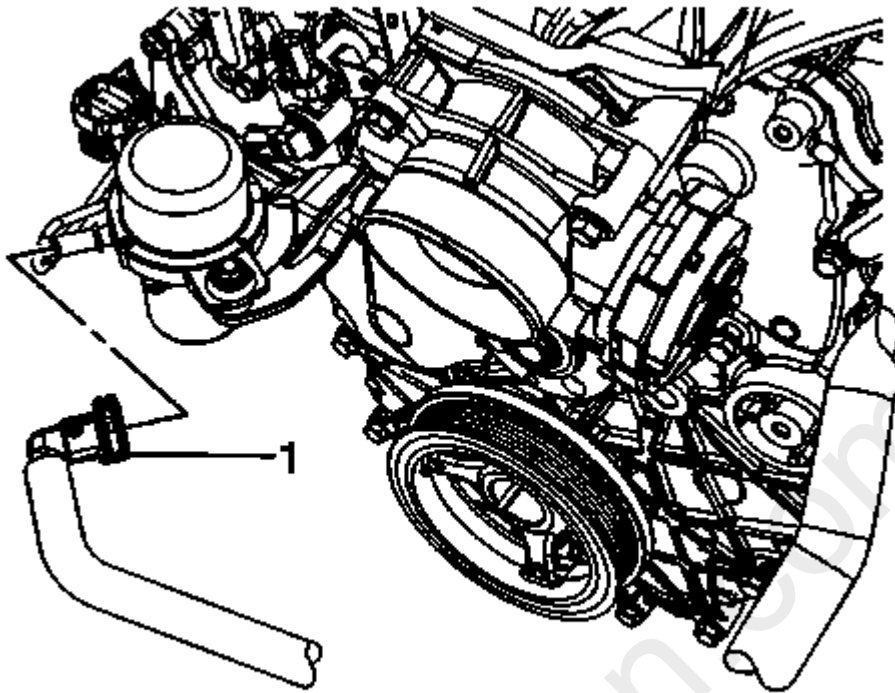


Fig. 163: Vacuum Brake Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
2. Release the power brake booster auxiliary pump hose quick connect (1).
3. Disconnect the power brake booster auxiliary pump electrical connector.

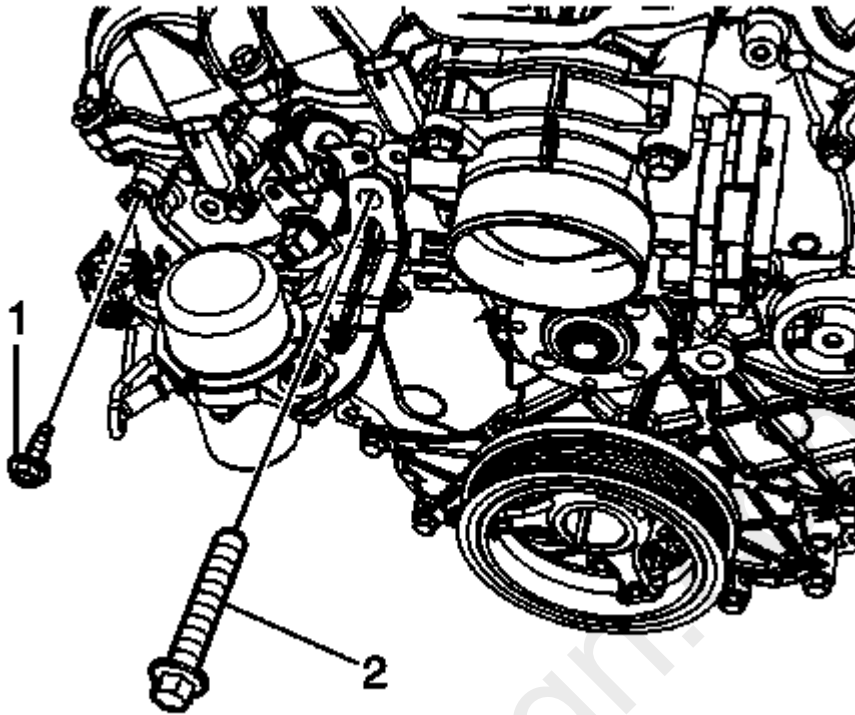


Fig. 164: Power Brake Booster Auxiliary Pump Bracket M6 And M12 Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the power brake booster auxiliary pump bracket M6 bolt (1).
5. Remove the power brake booster auxiliary pump bracket M12 bolt (2).
6. Remove the power brake booster auxiliary pump from the engine.

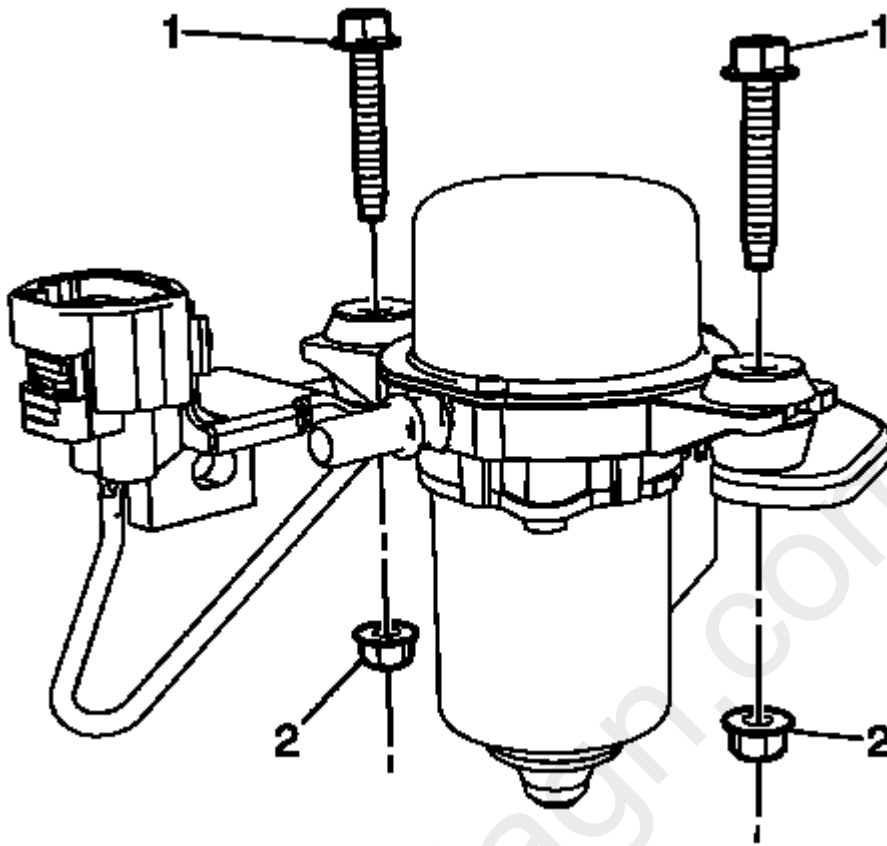


Fig. 165: Auxiliary Pump Bolts & Nuts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the power brake booster auxiliary pump bolts (1) and nuts (2).

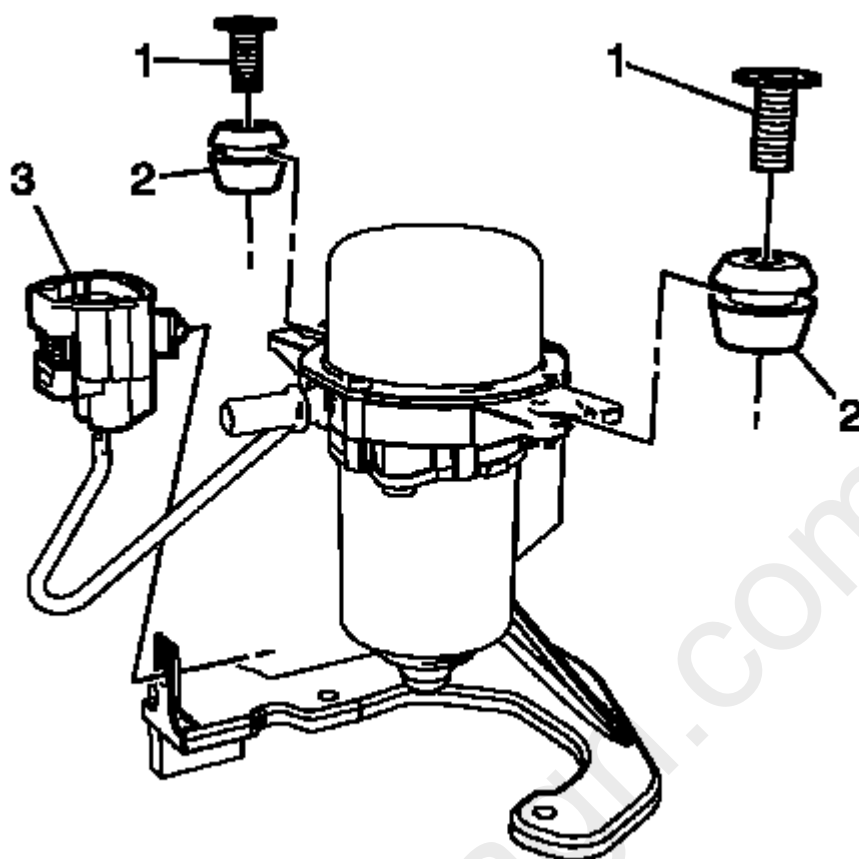


Fig. 166: Auxiliary Pump Insulator Sleeves, Pump Insulators & Pump Electrical Harness Connector

Courtesy of GENERAL MOTORS COMPANY

8. Remove the power brake booster auxiliary pump insulator sleeves (1).
9. Remove the power brake booster auxiliary pump insulators (2).
10. Release the power brake booster auxiliary pump electrical harness connector (3) from the bracket and remove the pump.

Installation Procedure

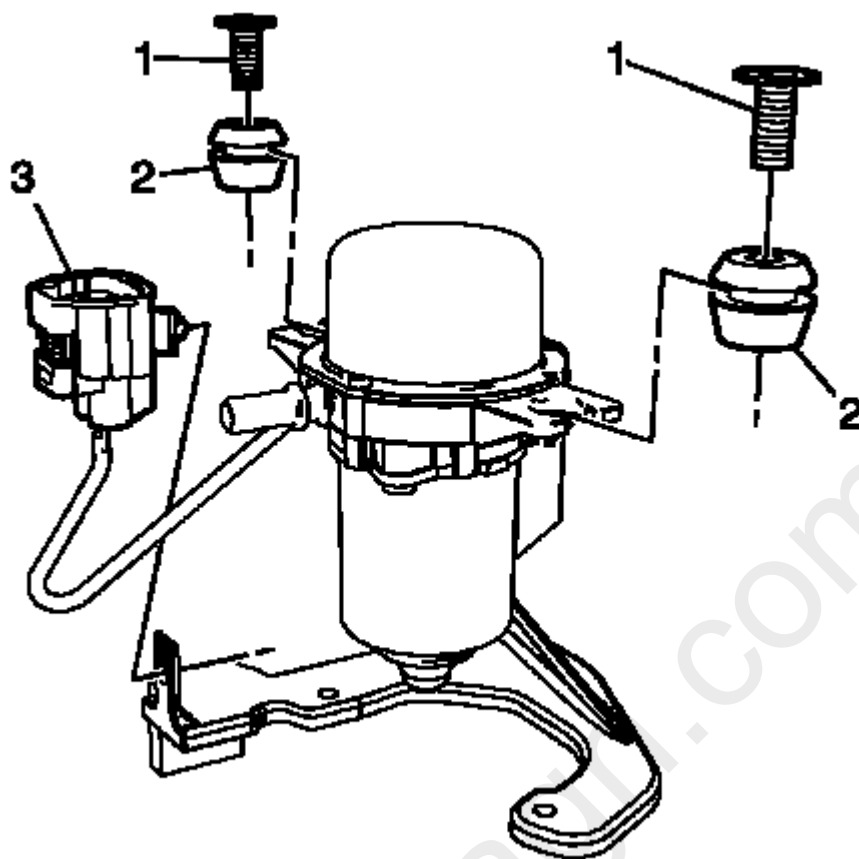


Fig. 167: Auxiliary Pump Insulator Sleeves, Pump Insulators & Pump Electrical Harness Connector

Courtesy of GENERAL MOTORS COMPANY

1. Assemble the power brake booster auxiliary pump sleeves (1) to the insulators (2).
2. Install the power brake booster auxiliary pump insulators.
3. Position the power brake booster auxiliary pump to the bracket and secure the electrical harness connector (3).

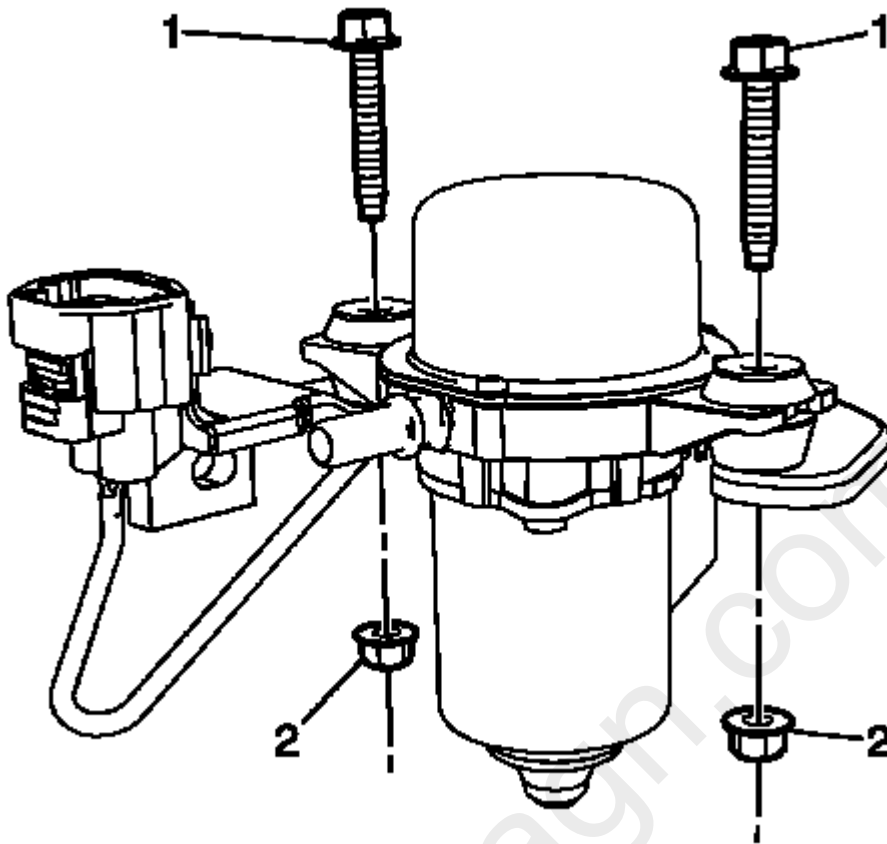


Fig. 168: Auxiliary Pump Bolts & Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the power brake booster auxiliary pump bolts (1) and nuts (2) and tighten the bolts to 22 N.m (16 lb ft).

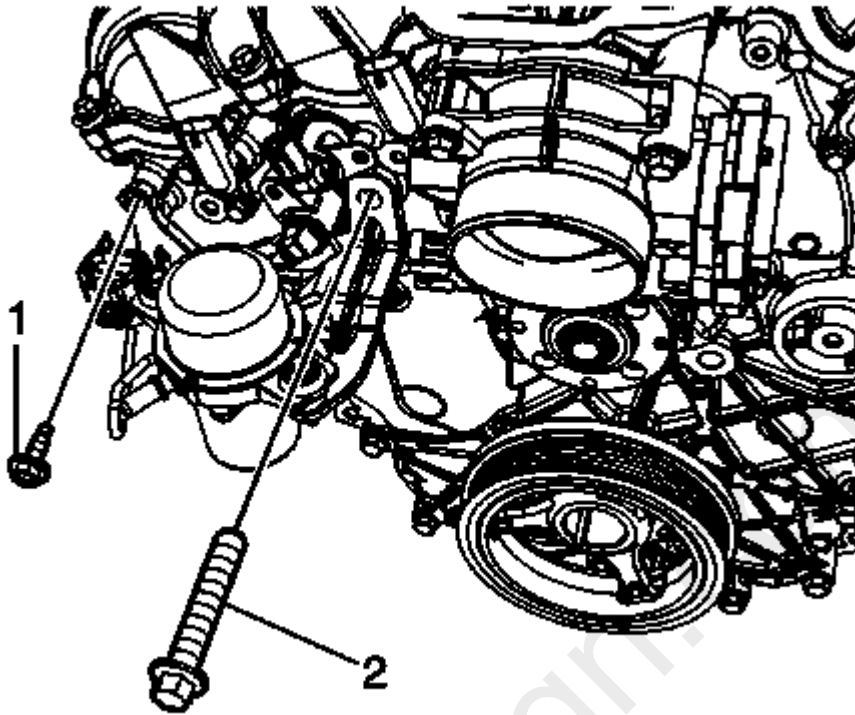


Fig. 169: Power Brake Booster Auxiliary Pump Bracket M6 And M12 Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install the power brake booster auxiliary pump assembly to the engine.
6. Install the power brake booster auxiliary pump bracket M6 bolt (1) and tighten to 10 N.m (89 lb in).
7. Install the power brake booster auxiliary pump bracket M12 bolt (2) and tighten to 70 N.m (52 lb ft).

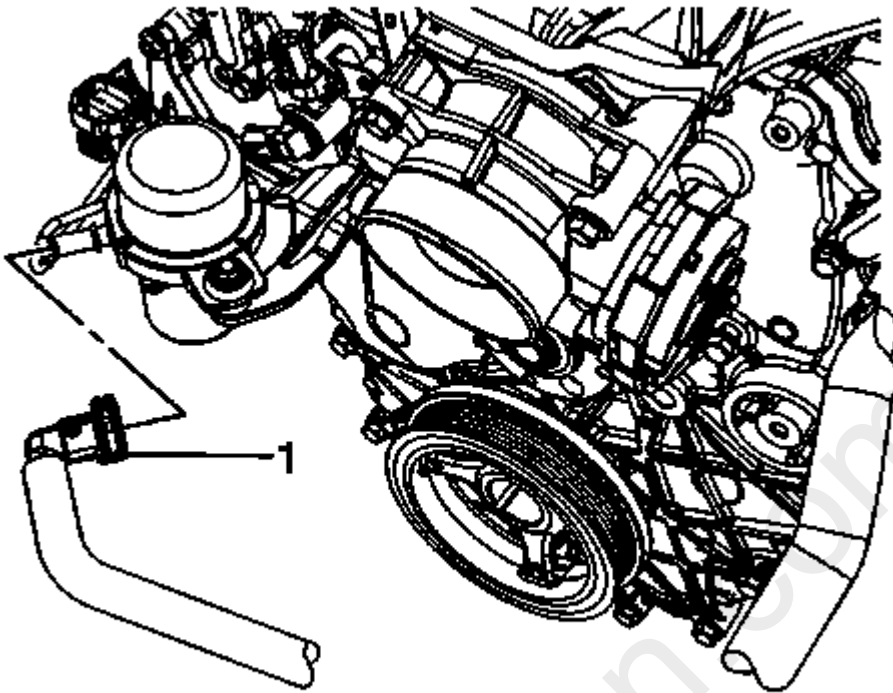


Fig. 170: Vacuum Brake Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

8. Install the power brake booster auxiliary pump hose quick connect (1).
9. Connect the power brake booster auxiliary pump electrical connector.
10. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

DESCRIPTION AND OPERATION

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. At rest, source vacuum is applied to both sides of the vacuum diaphragm for single boosters, or to both sides of each of the diaphragms for tandem boosters. Return springs maintain the booster in a rest position.

When brake system input force is applied, vacuum to the rear of the diaphragm(s) is cut off, and air at atmospheric pressure is admitted in its place. This provides a decrease in brake pedal effort required. When input force is removed, vacuum again replaces atmospheric pressure within the booster.

Vacuum Source

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

The primary source for vacuum is typically the vehicle's internal combustion engine. Some vehicles may use a vacuum pump to ensure an adequate supply of vacuum under various operating conditions, such as during cold start-up, heavy throttle, and high altitude.

Vacuum Pump Relay

Vehicles equipped with a vacuum pump will typically be equipped with a relay used to provide voltage to the vacuum pump motor, when commanded by the powertrain controller.

Vacuum Monitoring System

Provides a feedback voltage signal relative to the amount of vacuum available for the vacuum power brake booster.

This typically consists of a vacuum sensor mounted either into the power vacuum brake booster, integrated with the vacuum check valve, or in-line within the vacuum hose. The sensor feedback is typically monitored by the powertrain control module(s).

Vacuum Source Control

If equipped with a system to monitor available levels of vacuum for the brake assist system, the powertrain control module(s) typically perform the primary monitoring function.

The powertrain controller will typically monitor the feedback signal of a vacuum sensor, as it relates to available vacuum at the vacuum power brake booster. The powertrain controller uses the information to make sure available vacuum remains above predetermined levels. If additional vacuum is required, the powertrain controller may reactivate engine cylinders, if equipped, or command a vacuum pump ON, if equipped, and/or may alter the operation of various other engine controls and devices, as necessary.

Vacuum Source Delivery System

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

This typically consists of a vacuum check valve and a vacuum hose or pipe. If a vacuum pump is used, additional check valves may be used.

System Operation

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

When brake system force is applied, vacuum to the rear of the diaphragm(s) is cut off, and air at atmospheric pressure is admitted in its place. The vacuum acts to pull the diaphragm(s) forward, while the atmospheric pressure acts to push from behind. As a result, the amount of effort required by the driver is reduced. When input force is removed, vacuum again replaces atmospheric pressure within the vacuum power brake booster to help return the booster to rest. Return springs maintain the system in a rest position.

If the vehicle is equipped with a vacuum monitoring system, the powertrain control module(s) typically will alter powertrain functions and/or command the vacuum pump ON, if equipped, to provide for the vacuum needs of the brake assist system, as operating conditions warrant.

BRAKE BOOSTER VACUUM ASSIST DESCRIPTION AND OPERATION

System Component Description

Hydraulic Brakes Block Diagram

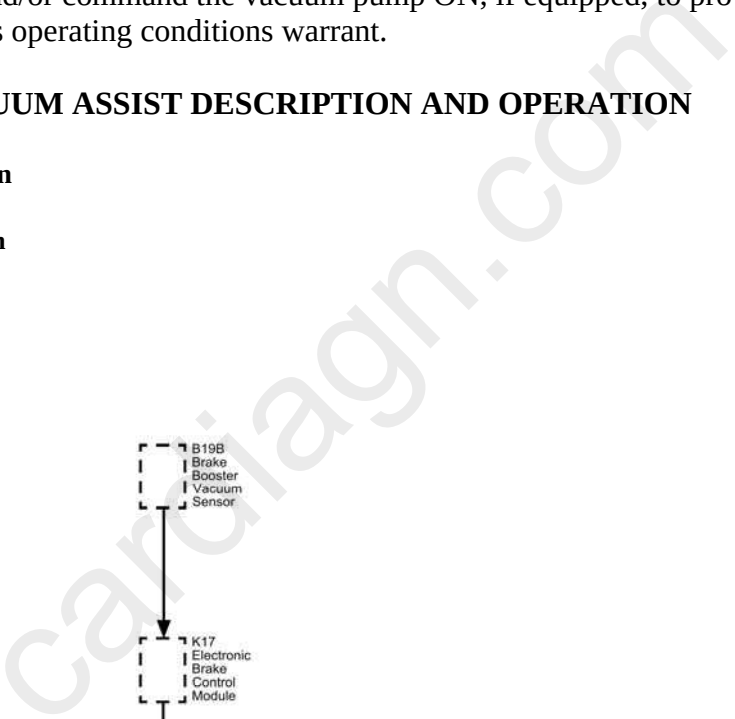


Fig. 171: Hydraulic Brake Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
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HW	Hard-Wired
HW	Hard-Wired
B19B	B19B Brake Booster Vacuum Sensor
K17	K17 Electronic Brake Control Module
M9	M9 Brake Booster Pump Motor

The Brake Booster Vacuum Assist system consists of the following:

Brake Booster Auxiliary Vacuum Pump

The Brake Booster Vacuum Pump is a secondary vacuum supply to the brake booster used to maintain sufficient vacuum for brake assist.

Brake Booster Vacuum Sensor

The vacuum sensor is used to measure the level of vacuum available in the brake booster. The Electronic Brake Control Module supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor is located in the brake booster or vacuum hose. The Brake Booster Vacuum Sensor supplies a voltage signal in relation to the pressure in the brake booster to the Electronic Brake Control Module.

Electronic Brake Control Module

The Electronic Brake Control Module monitors the vacuum in the brake booster using the Brake Booster Vacuum Sensor. When the vacuum within the system drops the Electronic Brake Control Module turns ON the Brake Booster Auxiliary Vacuum Pump by providing a ground to the Brake Booster Pump Relay. The relay activates and supplies voltage to the Brake Booster Auxiliary Vacuum Pump. The Electronic Brake Control Module shuts the pump off by removing the ground to the Brake Booster Pump Relay.

Vacuum Brake Booster

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 the atmospheric pressure within the booster. The booster uses source vacuum to decrease the effort required by driver when applying the brake.

Vacuum Source

Vacuum is supplied by the engine vacuum or by the Brake Booster Auxiliary Vacuum Pump.

System Operation

The pump can be switched on and off by the Electronic Brake Control Module based on the required vacuum. Pressure variations during braking can be measured, and the pump can be activated to generate additional vacuum if required to increase the braking force.

BRAKE WARNING SYSTEM DESCRIPTION AND OPERATION

Brake System Indicators

BRAKE

The IPC illuminates the BRAKE indicator and sends a serial data message in order to activate an audible warning when the following occurs:

- The IPC detects that the park brake is applied-signal circuit is low.
- The IPC detects a low brake fluid condition-signal circuit is low.
- The electronic brake control module (EBCM) detects a malfunction with the antilock brake system. The IPC receives a serial data message from the EBCM requesting illumination.
- The IPC detects a loss of communications with the EBCM and the discrete back-up ABS indicator signal is open.
- The IPC performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 5 seconds.
- The brake indicator will flash to indicate a fault with the electroinc park brake system with the ignition key in the ON or OFF position.

CHECK BRAKE FLUID

The IPC illuminates the CHECK BRAKE FLUID indicator in the DIC and sends a serial data message in order to activate an audible warning when the IPC detects a that the brake fluid level is below the normal operating range.

HYDRAULIC BRAKE SYSTEM DESCRIPTION AND OPERATION

System Component Description

The hydraulic brake system consists of the following:

Hydraulic Brake Master Cylinder Fluid Reservoir

Contains supply of brake fluid for the hydraulic brake system.

Hydraulic Brake Master Cylinder

Converts mechanical input force into hydraulic output pressure.

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

Hydraulic Brake Pressure Balance Control System

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

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

of DRP.

Hydraulic Brake Pipes and Flexible Brake Hoses

Carries brake fluid to and from hydraulic brake system components.

Hydraulic Brake Wheel Apply Components

Converts hydraulic input pressure into mechanical output force.

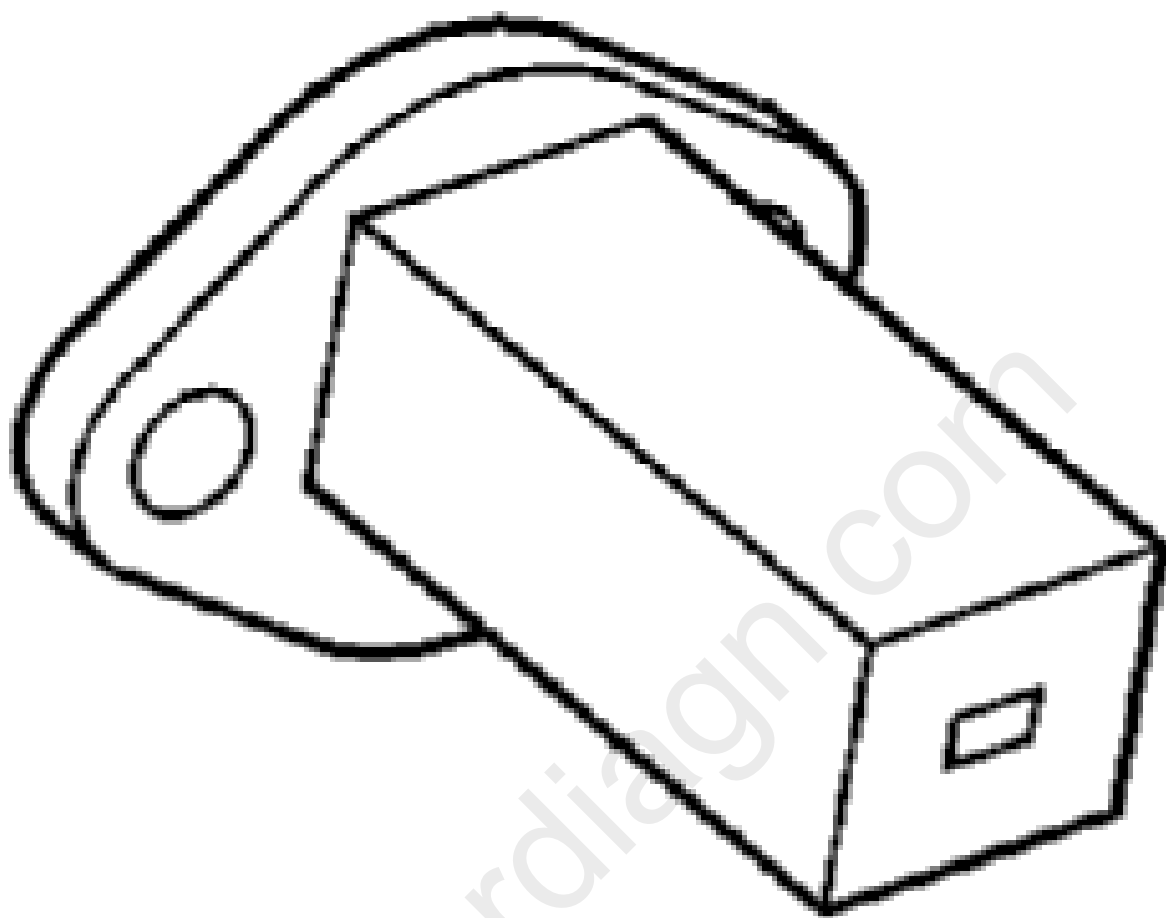
System Operation

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

SPECIAL TOOLS AND EQUIPMENT

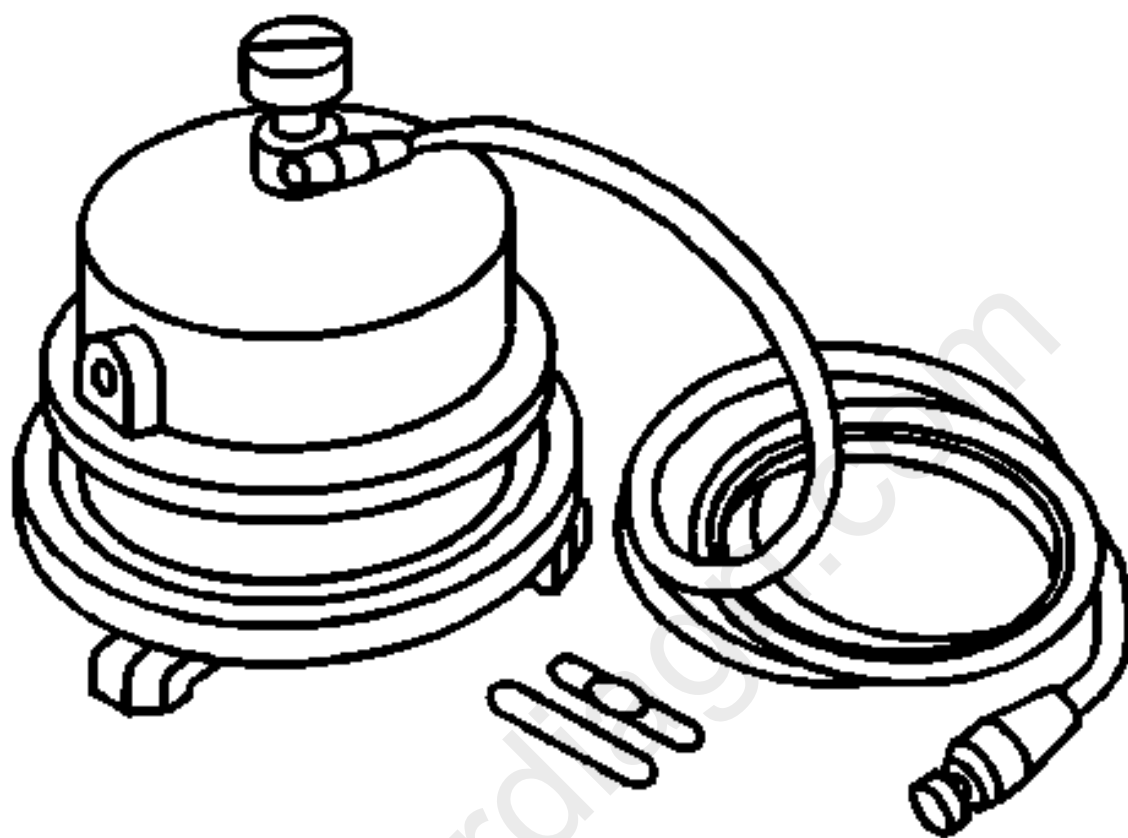
SPECIAL TOOLS

Illustration	Tool Number/ Description
	J 22805-B Brake Booster Holder



J 28662
Brake Pedal
Effort
Gauge

J 29532
Diaphragm
Pressure
Bleeder



J 35589-A
Master
Cylinder
Bleeder
Adapter

J 45405
Pipe Flaring
Tool Kit

