

2013 Chevrolet Cruze

2013 BRAKES Hydraulic Brakes - Cruze

2013 BRAKES

Hydraulic Brakes - Cruze

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Brake Booster Bolts	19 Y	14 lb ft
Brake Hose-To-Brake Caliper Bolt	40 Y	30 lb ft
Brake Master Cylinder Nut	50 N.m (1)	37 lb ft (1)
Brake Master Cylinder Reservoir Bolt	2.5 N.m	22 lb in
Brake Pedal Bracket Bolt	20 N.m	15 lb ft
Brake Pipe Fitting	18 N.m	13 lb ft
Brake Pressure Modulator Valve Bracket Bolt	20 N.m	15 lb ft
Clutch Master Cylinder Nut	18 Y	13 lb ft
Master Cylinder Primary Brake Pipe Fitting	18 Y	13 lb ft
Rear Brake Hose Bracket Bolt	8 N.m	71 lb in
Power Brake Booster Pump Bolt	7.5 N.m	66 lb in
Power Brake Booster Pump Bracket Bolts	22 N.m	15 lb ft
1 = Use NEW Fastener.		

BRAKE COMPONENT SPECIFICATIONS

Brake Component Specifications

Application	Specification	
	Metric	English
Brake Caliper Bleeder Valve- Front	17 N.m	12 lb ft
Brake Caliper Bleeder Valve- Rear	17 N.m	12 lb ft

BRAKE SYSTEM SPECIFICATIONS

Brake System Specifications

Application	Specification	
	Metric	English
Brake Pedal Travel Maximum specification with 445 N (100 lb F) of force applied to the brake pedal with the	40 to 55 mm	1.57 to 2.17 in

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ignition OFF and the booster power reserve depleted		
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ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number	
		United States	Canada
Hydraulic Brake System	DOT 3 Motor Vehicle Brake Fluid	12377967	89021320

SCHEMATIC WIRING DIAGRAMS

HYDRAULIC BRAKE WIRING SCHEMATICS

Hydraulic Brakes Wiring Schematics

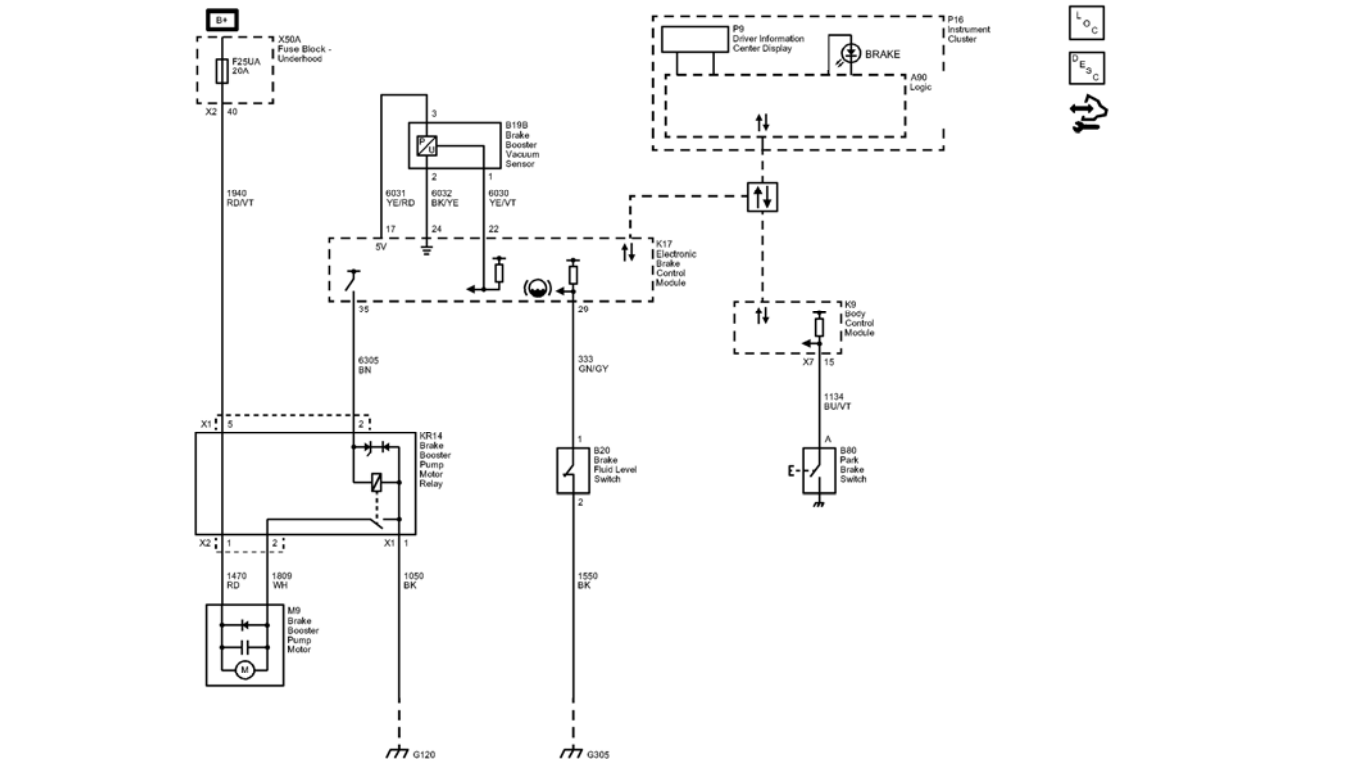


Fig. 1: Hydraulic Brakes Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1940	Battery Positive Voltage

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1940_RD/VT	1940 RD/VT
CAV_5	5
CONN_X1	X1
CAV_40	40
CONN_X2	X2
6305	Brake Vacuum Switch Signal
6305_BN	6305 BN
CAV_2	2
CAV_35	35
6031	Brake Vacuum Sensor 5 Volt Reference
6031_YE/RD	6031 YE/RD
CAV_3	3
CAV_17	17
6032	Brake Vacuum Sensor Low Reference
6032_BK/YE	6032 BK/YE
CAV_24	24
CAV_2	2
6030	Brake Vacuum Sensor Signal
6030_YE/VT	6030 YE/VT
CAV_22	22
CAV_1	1
1470	Brake Booster Pump Motor Supply Voltage
1470_RD	1470 RD
CAV_1	1
CONN_X2	X2
1809	Brake Booster Vacuum Sensor Signal
1809_WH	1809 WH
CAV_2	2
1050	Ground
1050_BK	1050 BK
CAV_1	1
CONN_X1	X1
1550	Ground
1550_BK	1550 BK
CAV_2	2
333	Brake Fluid Level Sensor Signal
333_GN/GY	333 GN/GY

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CAV_1	1
CAV_29	29
1134	Park Brake Switch Signal
1134_BU/VT	1134 BU/VT
CAV_A	A
CAV_15	15
CONN_X7	X7
SD	Serial Data
Data_Communication_Schematics_REF	Data Communication Schematics
G120	G120
G305	G305
F25UA	F25UA 20A
K9	
B80	
X50A	
M9	
KR14	
K17	
B20	
B19B	
P16	
P9	
A90	Logic

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC C0267</u>	DTC C0267 00 Low Brake Fluid Indicated
<u>DTC C027B</u>	DTC C027B 00 Brake Booster Electric Vacuum Pump
<u>DTC C0299</u>	DTC C0299 5A Brake Booster Large Vacuum Leak Detected Not Plausible
<u>DTC C1100</u>	DTC C1100 00 Brake Booster Vacuum Sensor Circuit Malfunction DTC C1100 01 Brake Booster Vacuum Sensor Circuit Short to Battery DTC C1100 02 Brake Booster Vacuum Sensor Circuit Short to Ground DTC C1100 08 Brake Booster Vacuum Sensor

	Circuit Performance Signal Invalid DTC C1100 09 Brake Booster Vacuum Sensor Circuit Too Fast Transitions
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DTC C0267

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	-	C0267 00	-	-
Ground	-	C0267 00	-	-

Circuit/System Description

The brake fluid level switch monitors the level of brake fluid in the brake fluid reservoir. When the electronic brake control module sees the brake fluid level switch input open, the DTC is set.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

- An open is detected on the brake fluid level signal circuit for 20 s.
- Low brake fluid level is detected for 20 s.

Action Taken When the DTC Sets

- The electronic brake control module disables the traction control and stability control for the duration of the ignition cycle.
- The traction control/stability control-active indicator turns ON.
- The brake warning indicator turns ON.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Hydraulic Brake 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 that the brake fluid has the proper level. The fluid level should be above minimum level.
 - **If low**

Refer to **Brake Fluid Loss**.

- **If above minimum level**
2. Ignition ON.
3. Verify the scan tool Brake Fluid Level Sensor parameter is Ok.
 - **If the parameter is Low**

Refer to Circuit/System Testing below.

- **If the parameter is Ok**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B20 Brake Fluid Level Switch.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Brake Fluid Level Sensor parameter is Low.
 - **If the parameter is not Low**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K17 Electronic Brake Control Module.
 - **If the parameter is Low**
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and ground.
6. Verify the scan tool Brake Fluid Level Sensor parameter is Ok.
 - **If the parameter is not Ok**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V.
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If the parameter is Ok**
7. Test or replace the B20 Brake Fluid Level Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Brake Fluid Level Indicator Switch Replacement**
- **Control Module References** for electronic brake control module replacement, programming and setup

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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 C027B 00

Brake Booster Electric Vacuum Pump

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Vacuum Pump Relay B+	-	-	-	-
Vacuum Pump Relay Control	C027B 00	C027B 00	C027B 00	-
Vacuum Pump Relay Ground	-	-	-	-

Circuit/System Description

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. The electronic brake control module 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 electronic brake control module. When the vacuum within the system becomes weak, the electronic brake control module turns ON the brake booster pump motor by providing battery voltage to the brake booster pump motor relay. The relay activates and supplies ground to the brake booster pump motor.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

A short to ground, short to voltage or open/high resistance is detected on the control circuit.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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. Verify that the brake booster vacuum system has no damage, leakage or incorrect installation.
 - **If damage, leakage or incorrect installation is found**

Refer to **Brake Assist System Diagnosis**

- **If no damage, leakage or incorrect installation is found**
2. Ignition ON.
 3. Verify the brake booster pump motor turns ON and OFF when commanding the brake booster electric vacuum pump ON and OFF with a scan tool.
 - **If the brake booster pump motor does not turn ON and OFF**

Refer to Circuit/System Testing below.

- **If the brake booster pump motor turn ON and OFF**
4. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the KR14 Brake Booster Pump Motor Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.
 - **If 10 ohms or greater**

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1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify that a test lamp illuminates between the B+ circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M9 Brake Booster Pump Motor.
 - **If the test lamp illuminates**
 - 5. Connect a test lamp between the control circuit terminal 2 and ground.
 - 6. Verify the test lamp turns ON and OFF when commanding the brake booster electric vacuum pump ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K17 Electronic Brake Control Module.
 - **If the test lamp turns ON and OFF**
 - 7. Replace the KR14 Brake Booster Pump Motor Relay.

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Perform the **Diagnostic Repair Verification** after completing the repair.

- **Power Brake Booster Pump Replacement**
- **Control Module References** for electronic brake control module replacement, programming and setup.

DTC C0299

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 C0299 5A

Brake Booster Large Vacuum Leak Detected Not Plausible

Circuit/System Description

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. The electronic brake control module 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 electronic brake control module.

Conditions for Running the DTC

Engine running.

Conditions for Setting the DTC

The electronic brake control module detected a weak vacuum in the brake booster assembly for 120 s.

Action Taken When the DTC Sets

The DTC is stored in memory.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The electronic brake control module 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

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**Circuit/System Testing**

1. Ignition ON.
2. Verify that DTC C1100 is not set.
 - **If the DTC is set**

Refer to **DTC C1100**.

- **If the DTC is not set**

3. Verify that the brake booster vacuum system has no damage, leakage or incorrect installation.
 - **If damage, leakage or incorrect installation is found**

Refer to **Brake Assist System Diagnosis**.

- **If the inspection is OK**

4. Replace the B19B Brake Booster Vacuum Sensor.
5. Verify the DTC does not set while operating the vehicle under the Conditions for Running the DTC.
 - **If the DTC sets**

Replace the K17 Electronic Brake Control Module.

- **If the DTC does not set**

6. All OK.

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Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Power Brake Booster Vacuum Pipe Replacement (without Electric Pump), Power Brake Booster Vacuum Pipe Replacement (with Electric Pump)** for Brake Booster Vacuum Sensor replacement.
- **Control Module References** for Electronic Brake Control Module replacement, programming and setup

DTC C1100

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 00

Brake Booster Vacuum Sensor Circuit Malfunction

DTC C1100 01

Brake Booster Vacuum Sensor Circuit Short to Battery

DTC C1100 02

Brake Booster Vacuum Sensor Circuit Short to Ground

DTC C1100 08

Brake Booster Vacuum Sensor Circuit Performance Signal Invalid

DTC C1100 09

Brake Booster Vacuum Sensor Circuit Too Fast Transitions

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	C1100 02	C1100 00	C1100 01	-
Signal	C1100 00	C1100 00	C1100 00	C1100 08, C1100 09
Low Reference	-	C1100 00	-	-

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Circuit/System Description

The brake booster vacuum sensor monitors the pressure 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 supplies a voltage signal in relation to the pressure in the brake booster to the electronic brake control module.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

C1100 00

- A short to ground, short to voltage or open/high resistance is detected on the 5 V reference circuit.
- The electronic brake control module detects an erratic vacuum sensor signal.

C1100 01

A short to voltage is detected on the vacuum sensor signal circuit.

C1100 02

A short to ground is detected on the vacuum sensor signal circuit.

C1100 08, 09

The vacuum sensor signal is not plausible.

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 electronic control module 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

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 Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B19B Brake Booster Vacuum Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Disconnect the harness connector at the K17 Electronic Brake Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.

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2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K17 Electronic Brake Control Module.
 - **If between 4.8-5.2 V**
5. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, Ignition ON.
6. Test for less than 1 V between the B19B Brake Booster Vacuum Sensor signal circuit terminal 1 and ground.
 - **If greater than 1 V**

Repair the short to voltage on the circuit.
 - **If less than 1 V**
7. Ignition OFF.
8. Test for infinite resistance between the B19B Brake Booster Vacuum Sensor signal circuit terminal 1 and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.
 - **If infinite resistance**
9. Test for less than 2 ohms in the B19B Brake Booster Vacuum Sensor signal circuit terminal 1 and the K17 Electronic Brake Control Module signal circuit terminal 22.
 - **If 2 ohms or greater**

Repair the open/high resistance in the circuit.
 - **If less than 2 ohms**
10. Replace the B19B Brake Booster Vacuum Sensor.
11. Verify the DTC does not set while operating the vehicle under Conditions for Running the DTC.
 - **If the DTC sets**

Replace the K17 Electronic Brake Control Module.
 - **If the DTC does not set**
12. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Electronic Brake Control Module replacement, programming and setup.

SYMPTOMS - HYDRAULIC BRAKES

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

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

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the hydraulic brake 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 - Front to Rear**
- **Brake Pedal Excessive Travel**
- **Brake Pedal Excessive Effort**
- **Brakes Drag**
- **Brake System Slow Release**
- **Brake Fluid Loss**

BRAKE BOOSTER PUMP MOTOR 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.

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- **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
Vacuum Pump Relay B+	1	1	-	-
Vacuum Pump Relay Control	C027B 00	C027B 00	C027B 00	-
Vacuum Pump Relay Ground	-	1	-	-
1. Brake Booster Pump Motor Always Off				

Circuit/System Description

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. The electronic brake control module 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 electronic brake control module. When the vacuum within the system becomes weak, the electronic brake control module turns ON the brake booster pump motor by providing battery voltage to the brake booster pump motor relay. The relay activates and supplies ground to the brake booster pump motor.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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. Verify that the brake booster vacuum system has no damage, leakage or incorrect installation.

- **If damage, leakage or incorrect installation is found**

Refer to **Brake Assist System Diagnosis**

- **If no damage, leakage or incorrect installation is found**

2. Ignition ON.
 3. Verify the brake booster pump motor turns ON and OFF when commanding the brake booster electric vacuum pump ON and OFF with a scan tool.
- **If the brake booster pump motor does not turn ON and OFF**

Refer to Circuit/System Testing below.

- **If the brake booster pump motor turn ON and OFF**

4. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the KR14 Brake Booster Pump Motor Relay. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the ground circuit terminal 1 and ground.

- **If 10 ohms or greater**

1. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 10 ohms**

3. Ignition ON.
4. Verify that a test lamp illuminates between the B+ circuit terminal 5 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.
2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M9 Brake Booster Pump Motor.

- **If the test lamp illuminates**

5. Connect a test lamp between the control circuit terminal 2 and ground.
6. Verify the test lamp turns ON and OFF when commanding the brake booster electric vacuum pump ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K17 Electronic Brake Control Module.
 - **If the test lamp turns ON and OFF**
 - 7. Replace the M9 Brake Booster Pump Motor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Power Brake Booster Pump Replacement**
- **Control Module References** for Electronic Brake Control Module replacement, programming and setup.

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	1	C0267 00	1	-
Park Brake Signal	1	1	1	-
Ground	-	1	-	-

1. Brake Warning Indicator Malfunction

Circuit/System Description

The instrument cluster turns ON the brake warning indicator for 5 s after ignition ON. The body control module monitors the parking brake switch and will request the instrument cluster via serial data to turn the brake warning indicator ON when the parking brake is applied. When the electronic brake control module detects a fault, it sends a serial data message to the instrument cluster commanding the indicator ON.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Hydraulic Brake 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 that the brake fluid has the proper level. The fluid level should be above minimum level.
 - **If low**

Refer to Brake Fluid Loss.

- **If above minimum level**
2. Ignition ON.
3. Verify the scan tool Electronic Brake Control Module, Brake Fluid Level Sensor parameter. The reading should be Ok.

- **If the parameter is Low**

Refer to Brake Fluid Level Switch Malfunction below.

- **If the parameter is Ok**

4. Verify the scan tool Body Control Module, Park Brake Switch parameter changes between Active and Inactive while applying and releasing the parking brake.

- **If the parameter does not change**

Refer to Park Brake Switch Malfunction below.

- **If the parameter changes**

5. Verify the brake warning indicator turns ON and OFF, when commanding the instrument cluster All Indicators ON and OFF with a scan tool.

- **If the brake warning indicator does not turn ON and OFF**

Replace the P16 Instrument Cluster.

- **If the brake warning indicator turns ON and OFF**

6. All OK.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before Circuit/System Testing.**

Brake Fluid Level Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the B20 Brake Fluid Level Switch.
2. Test for less than 10 ohms between the ground circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
3. Ignition ON.
4. Verify the scan tool Electronic Brake Control Module, Brake Fluid Level Sensor parameter is Low.
 - **If the parameter is not Low**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K17 Electronic Brake Control Module.

○ **If the parameter is Low**

5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and ground.
6. Verify the scan tool Electronic Brake Control Module, Brake Fluid Level Sensor parameter is OK.
 - **If the parameter is not OK**
 1. Ignition OFF, disconnect the harness connector at the K17 Electronic Brake Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V.
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K17 Electronic Brake Control Module.
 - **If the parameter is Ok**
7. Test or replace the B20 Brake Fluid Level Switch.

Park Brake Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the B80 Park Brake Switch.
2. Verify that the B80 Park Brake Switch has no physical damage or incorrect installation.
 - **If physical damage or incorrect installation is found**

Test or replace the B80 Park Brake Switch.
 - **If the inspection is OK**
3. Ignition ON.
4. Verify the scan tool Body Control Module, Park Brake Switch parameter is Inactive.
 - **If the parameter is Active**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal A and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If the parameter is Inactive**
5. Install a 3 A fused jumper wire between the signal circuit terminal A and ground.
6. Verify the scan tool Body Control Module, Park Brake Switch parameter is Active.
 - **If the parameter is Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V.

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3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K9 Body Control Module.
 - **If the parameter is Active**
7. Test or replace the B80 Park Brake Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

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

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>Symptoms - Hydraulic Brakes</u>
2	1. Inspect the disc brake system for the following conditions. • Excessive thickness variation of rotor friction surfaces • Excessive assembled lateral runout (LRO) of rotor friction surfaces • Hard spots, heat checks, blueing discoloration of rotor friction surfaces; possibly due to brake drag • Excessive corrosion of rotor friction surfaces; including red, gray or black oxidation • Loose, damaged or missing caliper or lining hardware • Bent or damaged caliper or mounting component • Excessive LRO of wheel hub/axle flange; due to damage and/or loose or excessively worn bearings 2. Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System</u>		

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	<u>Diagnosis.</u>	Go to Step 4	Go to Step 3
	Did you find and correct a condition?		
3	- Inspect the drum brake system, if equipped, for the following conditions. - Out of round or damaged drum - Excessive radial runout of drum friction surface - Hard spots, heat checks, blueing discoloration of drum friction surface; possibly due to brake drag - Bent or damaged drum - Excessive radial runout 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>Drum Brake System Diagnosis.</u>	Go to Step 4	Go to <u>Symptoms - Hydraulic Brakes</u>
	Did you find and correct a condition?		
4	- 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>	Go to Step 2	System OK
	Is the condition still present?		

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>Symptoms - Hydraulic Brakes</u>
	- 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		

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2	• 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 10	Go to Step 3
3	1. Inspect the drum brake system, if equipped, for the following conditions. • Glazed linings • Contaminated linings • Aftermarket linings • Distorted, damaged or excessively worn linings • Improper adjustment • Weak or damaged return spring or springs • Weak or damaged hold down spring or springs • Cracked, scored, excessively worn or damaged drum • Out of round or damaged drum • Hard spots, heat checks, blueing discoloration of drum friction surface • Threaded or spiral grooves in drum friction surface • Distorted or damaged backing plate		

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	• Lack of lubrication on backing plate • Excessive dust or foreign matter in drum 2. Adjust, repair or replace components as necessary. Refer to <u>Drum Brake System Diagnosis</u>.		
	Did you find and correct a condition?	Go to Step 10	Go to Step 4
4	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 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 10	Go to Step 5
5	1. Inspect the hydraulic brake system for the following conditions. • Improper operation of wheel cylinder pistons, if equipped • 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 10	Go to Step 6

6	Is the vehicle equipped with a drum-in-rotor type of park brake system?	Go to Step 7	Go to Step 9
7	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 8	Go to Step 9
8	- Clean and inspect the park brake shoes for excessive wear and/or damage. - Inspect the drum portion of the rotors for excessive wear, blueing discoloration, heat spots, and excessive radial runout. - If any of these conditions are present, replace the affected components. - Adjust the park brake system. Did you find and correct a condition?	Go to Step 10	Go to Step 9
9	Inspect the park brake system for proper operation. Refer to <u>Park Brake System Diagnosis (Drum Brakes)</u> , <u>Park Brake System Diagnosis (Disc Brakes)</u> . Did you find and correct a condition?	Go to Step 10	Go to <u>Symptoms - Hydraulic Brakes</u>
10	- Install or connect components that were removed or disconnected during diagnosis. - Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test.</u> Is the condition still present?	Go to Step 2	System OK

BRAKING ACTION UNEVEN - PULLS TO ONE SIDE

Test Description

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

5

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

6

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

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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>Symptoms - Hydraulic Brakes</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 • Sticking or improperly operating wheel cylinder pistons, if equipped • 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 7	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 7	Go to Step 4
	1. Inspect the drum brake system, if equipped, for the following conditions. • Improper adjustment or improper adjuster operation • Weak or damaged return spring or springs		

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4	• Glazed linings • Contaminated linings • Distorted or damaged linings • Incorrect linings on one side • Excessively worn or damaged drum on one side 2. Adjust, repair or replace components as necessary. Refer to <u>Drum Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 7	Go to Step 5
5	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>Symptoms - Suspension General Diagnosis</u> . Did you find and correct a condition?	Go to Step 7	Go to Step 6
6	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>Symptoms - Power Steering System</u> . Did you find and correct a condition?	Go to Step 7	Go to <u>Symptoms - Hydraulic Brakes</u>
7	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 Description**

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

5

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>Symptoms - Hydraulic Brakes</u>
2	- Inspect the hydraulic brake system for the following conditions. - Improper operation of wheel cylinder pistons, if equipped - Improper operation of caliper pistons - Kinked, pinched or damaged brake pipe or flexible brake hose - Brake fluid leak - Improperly functioning proportioning valve, if equipped - Improper operation of dynamic rear proportioning (DRP) system, if equipped - 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 7	Go to Step 3
3	- Inspect the disc brake system for the following conditions. - Contaminated linings - Glazed linings - Distorted, cracked or damaged linings - Excessively worn linings - Aftermarket linings - Damaged or excessively worn caliper hardware and/or lining hardware - Hard spots, heat checks, blueing discoloration of rotor friction surfaces - Glazed rotor friction surfaces		

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	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 7	Go to Step 4
4	1. Inspect the drum brake system, if equipped, for the following conditions. • Contaminated linings • Improper adjustment • Excessively worn or damaged linings • Weak or damaged return spring or springs • Excessively worn or damaged drums • Hard spots, heat checks, blueing discoloration of drum friction surface • Distorted or damaged backing plate 2. Adjust, repair or replace components as necessary. Refer to <u>Drum Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 7	Go to Step 5
5	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>Symptoms - Suspension General Diagnosis</u>. Did you find and correct a condition?	Go to Step 7	Go to Step 6
6	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 7	Go to <u>Symptoms - Hydraulic Brakes</u>
	1. Install or connect components that were removed		

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7	or disconnected during diagnosis.		
	2. Road test the vehicle in order to confirm proper operation. Refer to <u>Brake System Vehicle Road Test</u> .		
	Is the condition still present?	Go to Step 2	System OK

BRAKE PEDAL EXCESSIVE TRAVEL

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>Symptoms - Hydraulic Brakes</u>
2	Inspect the travel and feel of brake pedal applies. Perform the following: 1. Apply the brake pedal several times to fully deplete the power reserve. 2. With power reserve depleted, apply the brake pedal with light, steady pressure and hold for 15 seconds. Observe pedal travel and feel. 3. Apply the brake pedal with light, steady pressure, then without pumping the pedal, reduce pressure and reapply pressure several times. Observe pedal travel and feel for each apply. 4. Apply the brake pedal slowly, then release and apply the pedal quickly. Observe pedal travel and feel for each apply. Did you complete the brake pedal travel and feel inspections?	Go to Step 3	-
	1. Inspect the hydraulic brake system for the conditions listed, based on the following symptoms observed during the pedal travel and feel inspections. • Pedal feel was spongy. ○ Air in hydraulic system ○ External brake fluid leaks ○ Soft, weak or damaged hydraulic hoses; expanding under pressure • Pedal fell away and/or traveled to or almost to floor.		

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3	○ External brake fluid leaks ○ 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 ○ Binding wheel cylinder pistons, if equipped ● Pedal returned to rest slowly after any of the applies. ○ Internally damaged flexible brake hoses; hindering fluid return ○ Binding caliper pistons ○ Binding wheel cylinder pistons, if equipped ○ 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 9	Go to Step 4
4	1. Inspect the drum brake system, if equipped, for the following conditions: ● Improper adjustment or improper adjuster operation ● Glazed or excessively worn linings ● Cracked, distorted or damaged linings ● Cracked, excessively worn, distorted or damaged drums ● Bell-mouth or barrel-shaped drum friction surface ● Hard spots, heat checks, blueing discoloration of drum friction surface		

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	2. Adjust, repair or replace components as necessary. Refer to <u>Drum Brake System Diagnosis</u>. 3. Re-inspect brake pedal apply travel and feel.	Go to Step 9	Go to Step 5
	Did you find and correct a condition?		
5	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.	Go to Step 9	Go to Step 6
	Did you find and correct a condition?		
6	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 8	Go to Step 7
7	1. 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. 2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged.	Go to Step 9	Go to Step 8
	Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?		
	1. Inspect the brake assist system for the following conditions:		

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8	• 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 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 <u>Symptoms - Hydraulic Brakes</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

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>Symptoms - Hydraulic Brakes</u>
2	1. 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 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 Step 3

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3	- Inspect the hydraulic brake system for the following conditions: • Binding caliper pistons • Binding wheel cylinder pistons, if equipped • 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 6	Go to Step 4
4	- Inspect the disc brake system for the following conditions: • Excessively worn linings • Glazed linings • Cracked, distorted or damaged linings • Contaminated linings • Binding, damaged or excessively worn caliper hardware and/or lining hardware • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Excessively worn or corroded rotor friction surfaces • Glazed rotor friction surfaces • Hard spots, heat checks, blueing discoloration of rotor friction surfaces - Adjust, repair or replace components as necessary. Refer to <u>Disc Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 6	Go to Step 5
	- Inspect the drum brake system, if equipped, for the following conditions: • Excessively worn linings • Improper adjustment or improper adjuster operation • Glazed linings		

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5	• Cracked, distorted or damaged linings • Contaminated linings • Out of round or damaged drum • Bell-mouth or barrel-shaped drum friction surface • Hard spots, heat checks, blueing discoloration of drum friction surface • Lack of lubrication on backing plate • Excessive dust or foreign matter in drum 2. Adjust, repair or replace components as necessary. Refer to <u>Drum Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 6	Go to <u>Symptoms - Hydraulic Brakes</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

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>Symptoms - Hydraulic Brakes</u>
2	Is the vehicle equipped with an adjustable stop lamp switch and/or an adjustable cruise control release switch?	Go to Step 3	Go to Step 4
3	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 15	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.	Go to Step	

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	Are the park brake shoes adjusted too tightly?	6	Go to Step 8
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.	Go to Step 15	Go to Step 8
	Did you find and correct a condition?		
7	1. Inspect the drum brake system, if equipped, for the following conditions: • Improper adjustment • Weak or damaged return spring or springs • Distorted or damaged linings • Out of round or damaged drum • Weak or damaged hold down spring or springs • Lack of lubrication on backing plate • Distorted or damaged backing plate 2. Adjust, repair or replace components as necessary. Refer to <u>Drum Brake System Diagnosis</u>.	Go to Step 15	Go to Step 8
	Did you find and correct a condition?		
8	Inspect the park brake system for proper operation. Refer to <u>Park Brake System Diagnosis (Drum Brakes)</u> , <u>Park Brake System Diagnosis (Disc Brakes)</u> .	Go to Step 15	Go to Step 9
	Did you find and correct a condition?		
9	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		

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	• 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 15	Go to Step 10
10	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 12	Go to Step 11
11	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 15	-
12	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 14	Go to Step 13
13	Replace the brake booster assembly. Did you complete the replacement?	Go to Step 15	-
14	1. Inspect the hydraulic brake system for the following conditions: • Improper operation of wheel cylinder pistons, if equipped • Improper operation of caliper pistons • Contaminated brake fluid • Internally damaged flexible brake hoses; hindering brake release • Damaged or improperly operating master cylinder		

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	2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u> .	Go to Step 15	Go to <u>Symptoms - Hydraulic Brakes</u>
	Did you find and correct a condition?		
15	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> .	Go to Step 2	System OK
	Is the condition still present?		

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>Symptoms - Hydraulic Brakes</u>
2	1. Inspect the hydraulic brake system for the following conditions: • Improper operation of wheel cylinder pistons, if equipped • Improper operation of caliper pistons • Internally damaged flexible brake hoses; hindering brake release • Contaminated brake fluid • Damaged or improperly operating master cylinder 2. Adjust, repair or replace components as necessary. Refer to <u>Hydraulic Brake System Diagnosis</u> .	Go to Step 6	Go to Step 3
	Did you find and correct a condition?		
3	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 • Restricted return hose from hydraulic booster, if equipped		

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	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 Step 4
4	1. Inspect the drum brake system, if equipped, for the following conditions: - Weak or damaged return spring or springs - Distorted or damaged linings - Out of round or damaged drum - Lack of lubrication on backing plate - Distorted or damaged backing plate 2. Adjust, repair or replace components as necessary. Refer to <u>Drum Brake System Diagnosis</u>. Did you find and correct a condition?	Go to Step 6	Go to Step 5
5	1. 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 6	Go to <u>Symptoms - Hydraulic Brakes</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

BRAKE FLUID LOSS

Brake Fluid Loss

Step	Action	Yes	No
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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>Symptoms - Hydraulic Brakes</u>
2	- Inspect the following hydraulic brake system components for brake fluid leaks: - Flexible brake hose connections; threaded and bolted - Flexible brake hose crimp joints - Brake pipe fittings - Caliper piston seals - Wheel cylinder piston seals, if equipped - Master cylinder reservoir - Master cylinder reservoir low pressure hose, if equipped - Brake pressure modulator valve (BPMV) assembly, if equipped - Repair or replace components as necessary. Refer to <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
4	- Disconnect the vacuum check valve from the booster to relieve vacuum reserve. - Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. - Inspect the rear of the master cylinder for a brake fluid leak. - Inspect for brake fluid in the vacuum brake booster.		
	Did you find a brake fluid leak?	Go to Step 5	Go to <u>Symptoms - Hydraulic Brakes</u>
5	Replace the brake master cylinder and the vacuum brake booster. Did you complete the replacement?	Go to Step 8	-
6	- Wipe clean the external surface of the master cylinder to hydraulic brake booster area, if equipped. - Separate the master cylinder from the hydraulic brake booster, if equipped. Do not disconnect any brake pipes. - Inspect the rear of the master cylinder for a brake		

	fluid leak.		
	Did you find a brake fluid leak?	Go to Step 7	Go to <u>Symptoms - Hydraulic Brakes</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

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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	-
2	Visually inspect the disc brake pads for the following conditions: Refer to <u>Brake Pad Inspection</u> . • Lining thickness below specifications • Uneven and/or abnormal wear - edge-to-edge and/or side-to-side • Looseness or damage - including pad hardware • Evidence of contamination from an external substance Did you find any conditions to indicate a concern with 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</u> , and/or <u>Rear Disc Brake Pads Replacement</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 and support the calipers. Refer to **Front Brake Caliper Replacement** , and/or **Rear Brake Caliper Replacement** .
2. Inspect the disc brake caliper mounting bracket and the mounting/sliding hardware for the following conditions:

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

- Binding or seized hardware
 - Worn, damaged or missing hardware components
 - Loose, bent, cracked, or damaged caliper mounting bracket
3. Replace components as required. Refer to the following procedures, as required:
 - **Front Brake Caliper Bracket Replacement**
 - **Rear Brake Caliper Bracket Replacement**
 - **Front Brake Caliper Hardware Replacement**
 - **Rear Brake Caliper Hardware Replacement**
 4. Replace the unevenly-worn, loose or damaged disc brake pads as a complete axle set. Refer to **Front Disc Brake Pads Replacement** , and/or **Rear Disc Brake Pads Replacement** .

Did you complete the inspection and replacement?

Go to **Step 12**

7

-

8

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

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	• <u>Rear Brake Hose Replacement (Drum Brake), Rear Brake Hose Replacement (Disc Brake)</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>Front Wheel Drive Shaft Outer Joint and Boot Replacement</u>. Did you find and correct the source of the leak causing contamination of the pads?	Go to Step 11	Go to Step 10
10	1. Inspect the automatic transmission cooling system lines, if equipped, for damage and evidence of an external fluid leak which may be the source of the contamination to the pads. 2. Inspect the power steering system hoses for damage and evidence of an external fluid leak which may be the source of the contamination to the pads. 3. Replace any components found to be leaking fluid which may be the source of the contamination to the pads. Did you find and correct the source of the leak causing contamination of the pads?	Go to Step 11	-
	1. Clean the remaining disc brake system components 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.		

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11	2. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets and support the calipers. Refer to <u>Front Brake Caliper Replacement</u> , and/or <u>Rear Brake Caliper Replacement</u> . 3. Inspect the disc brake caliper mounting/sliding hardware for the following conditions: Refer to <u>Front Disc Brake Mounting and Hardware Inspection</u> , and/or <u>Rear Disc Brake Mounting and Hardware Inspection</u> . • Binding or seized hardware • Distorted, worn, damaged or missing hardware components 4. Replace the caliper mounting/sliding hardware components as required. Refer to <u>Front Brake Caliper Hardware Replacement</u> , and/or <u>Rear Brake Caliper Hardware Replacement</u> . 5. Replace the contaminated disc brake pads as a complete axle set. Refer to <u>Front Disc Brake Pads Replacement</u> , and/or <u>Rear Disc Brake Pads Replacement</u> . Did you complete the cleaning, inspection and replacement?	Go to Step 12	-
12	Visually inspect each of the rear disc brake rotor shields/backing plates, if equipped, for evidence of contact with the brake rotors. Are any of the brake rotor shields/backing plates contacting the brake rotors?	Go to Step 13	Go to Step 14
13	Repair or replace the disc brake rotor shields/backing plates as required. Refer to <u>Rear Wheel Bearing and Hub Replacement (Drum Brake)</u> , <u>Rear Wheel Bearing and Hub Replacement (Disc Brake)</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.		

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	Refer to <u>Brake Rotor Thickness Measurement</u> .Does the disc brake rotor meet the minimum requirements for REFINISHING?	Go to Step 15	Go to Step 18
15	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
16	1. Inspect each of the disc brake rotors for the following surface and wear conditions: Refer to <u>Brake Rotor Surface and Wear Inspection</u> . • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level 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</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 DISCARD requirements?	Go to Step 21	Go to Step 19

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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
20	1. Inspect each of the disc brake rotors for the following surface and wear conditions: Refer to <u>Brake Rotor Surface and Wear Inspection</u> . • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level 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 (J60)</u> , <u>Front Brake Rotor Replacement (J67)</u> , or <u>Rear Brake Rotor Replacement</u> .Did you complete the replacement?	Go to Step 24	-
	NOTE: Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor.		

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

DRUM BRAKE SYSTEM DIAGNOSIS**Test Description**

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

18

Drum brake backing plates that come in contact with brake drums may cause brake system noise.

Drum Brake System Diagnosis

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the DRUM brake system in order to determine if the DRUM 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	-
2	1. Remove the brake drums. Refer to <u>Brake Drum Replacement</u> . 2. Inspect the drum brake shoes for the following conditions: • Lining thickness below specifications • Uneven and/or abnormal wear - edge-to-edge and/or side-to-side • Contamination from an external substance • Looseness, damage, glazing, or incorrect lining material Did you find any conditions to indicate a concern with any of the drum brake shoes?	Go to Step 3	Go to Step 7

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3	Are any of the brake shoes contaminated?	Go to Step 4	Go to Step 5
4	1. Inspect the wheel cylinders for evidence of an external brake fluid leak. 2. Replace any wheel cylinder that is found to be leaking brake fluid. Refer to <u>Rear Brake Cylinder Replacement</u> . Did you complete the inspection and replacement?	Go to Step 6	-
5	1. Inspect the drum brake hardware for any components which are worn, damaged, discolored due to stress, broken or missing. Refer to <u>Drum Brake Hardware Inspection</u> . 2. Replace components as required. Refer to <u>Drum Brake Hardware Replacement</u> . 3. Replace the drum brake shoes. Refer to <u>Brake Shoe Replacement</u> . Did you complete the inspection and replacement?	Go to Step 8	-
6	1. Clean the remaining drum brake system components to remove any traces of the contaminant. 2. Inspect the drum brake hardware for any components which are worn, damaged, discolored due to stress, broken or missing. Refer to <u>Drum Brake Hardware Inspection</u> . 3. Replace the drum brake hardware components as required. Refer to <u>Drum Brake Hardware Replacement</u> . 4. Replace the contaminated brake shoes. Refer to <u>Brake Shoe Replacement</u> . Did you complete the cleaning, inspection and replacement?	Go to Step 8	-
7	1. Inspect the drum brake hardware for any components which are worn, damaged, discolored due to stress, broken or missing. Refer to <u>Drum Brake Hardware Inspection</u> . 2. Replace components as required. Refer to <u>Drum Brake Hardware Replacement</u> . Did you complete the inspection and, if necessary, the replacement?	Go to Step 8	-
	1. Check the diameter of each of the brake drums.		

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8	NOTE: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH drum. 2. Make a determination for each brake drum if the drum can be REFINISHED and REMAIN ABOVE the minimum requirements. Refer to <u>Brake Drum Diameter Measurement</u> .Does the brake drum meet the minimum requirements for REFINISHING?	Go to Step 9	Go to Step 11
9	1. Inspect each of the brake drums for the following surface and wear conditions: Refer to <u>Brake Drum Surface and Wear Inspection</u> . • Braking Surface Conditions ○ Heavy rust and/or pitting ○ Cracks and/or heat spots ○ Excessive blueing discoloration ○ Missing balance weights • Braking Surface Wear Conditions ○ Deep or excessive scoring beyond maximum acceptable level ○ Radial runout beyond maximum acceptable level NOTE: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH drum. 2. Make a determination for each brake drum if the drum requires refinishing based upon the results of the inspection. If the brake drum exhibits any of the following conditions, it requires refinishing. • Drum exhibits one or more of the Braking Surface Conditions listed previously • Drum is beyond the acceptable level in one or more of the Braking Surface Wear Conditions listed previously		

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	Does the brake drum require REFINISHING?	Go to Step 10	Go to Step 14
10	1. Refinish the brake drum. Refer to <u>Rear Brake Drum Refinishing</u> . 2. Inspect the brake drum diameter. Refer to <u>Brake Drum Diameter Measurement</u> . Were you able to REFINISH the brake drum within the minimum requirements?		
11	Is the brake drum at or below the DISCARD requirements?	Go to Step 14	Go to Step 13
12	Is the brake drum at or below the DISCARD requirements? 1. Inspect each of the brake drums for the following surface and wear conditions: Refer to <u>Brake Drum Surface and Wear Inspection</u> . • Braking Surface Conditions ○ Heavy rust and/or pitting ○ Cracks and/or heat spots ○ Excessive blueing discoloration ○ Missing balance weights • Braking Surface Wear Conditions ○ Deep or excessive scoring beyond maximum acceptable level ○ Radial runout beyond maximum acceptable level NOTE: Make the following determination AND ANSWER the question INDIVIDUALLY for EACH drum. 2. Make a determination for each brake drum if the drum requires replacement based upon the results of the inspection. If a brake drum exhibits any of the following conditions, it requires replacement. • Drum exhibits one or more of the Braking Surface Conditions listed previously • Drum is beyond the acceptable level in one or more of the Braking Surface Wear Conditions listed previously	Go to Step 13	Go to Step 12

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	Does the brake drum require REPLACEMENT?	Go to Step 13	Go to Step 14
13	Replace the brake drum. Refer to <u>Brake Drum Replacement</u> . Did you complete the replacement?	Go to Step 14	-
14	Inspect the brake shoes for proper adjustment. Refer to <u>Drum Brake Adjustment</u> . Are the brake shoes adjusted properly?	Go to Step 18	Go to Step 15
15	Inspect the components of the brake drum adjustment hardware system for free movement and correct operation. Refer to <u>Drum Brake Adjusting Hardware Inspection</u> . Do the drum brake adjusting hardware components operate freely and correctly?	Go to Step 17	Go to Step 16
16	Replace the drum brake adjusting hardware components as necessary. Refer to <u>Drum Brake Adjusting Hardware Replacement</u> . Is the replacement complete?	Go to Step 17	-
17	Adjust the drum brake shoes. Refer to <u>Drum Brake Adjustment</u> . Were you able to complete the adjustment?	Go to Step 20	Return to Symptom Table
18	Inspect the drum brake backing plate for the following: • Excessive wear or rust • Damage and/or evidence of contact with the brake drum Does the drum brake backing plate exhibit any of these conditions?	Go to Step 19	Go to Step 20
19	Repair or replace the drum brake backing plate as necessary. Refer to <u>Rear Brake Backing Plate Replacement</u> . Did you complete the repair or replacement?	Go to Step 20	-
20	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Drum 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 <u>Symptoms</u> -

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		Go to Step 2	Hydraulic Brakes
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	1. 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 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 6
4	1. 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 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
	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.
 - Replace the brake master cylinder reservoir cap diaphragm.
 - **Master Cylinder Replacement**
 - Brake master cylinder reservoir: Clean the brake master cylinder reservoir using denatured alcohol, or equivalent, then dry the reservoir using non-lubricated, filtered air, or if necessary, replace the brake master cylinder reservoir.
 - **Front Brake Hose Replacement**
 - **Rear Brake Hose Replacement (Drum Brake), Rear Brake Hose Replacement (Disc Brake)**
 - **Front Brake Caliper Overhaul** , or **Front Brake Caliper Replacement**
 - **Rear Brake Caliper Replacement** , if equipped
 - **Rear Brake Cylinder Replacement** , if equipped
 - **Brake Pressure Modulator Valve Replacement**
3. If the brake fluid was NOT contaminated with an oil-based fluid, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the 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 **Hydraulic Brake System Bleeding (Manual Bleeding)**, **Hydraulic Brake System Bleeding (Pressure Bleeding)**.

Did you complete the operation and any required repairs and/or replacements?

Go to **Step 9**

6

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:
 - Brake master cylinder reservoir cap diaphragm
 - **Master Cylinder Replacement**
 - **Front Brake Hose Replacement**
 - **Rear Brake Hose Replacement (Drum Brake)**, **Rear Brake Hose Replacement (Disc Brake)**
 - **Brake Pipe Replacement**
 - **Front Brake Caliper Overhaul** , or **Front Brake Caliper Replacement**
 - **Rear Brake Caliper Replacement** , if equipped
 - **Rear Brake Cylinder Replacement** , if equipped
 - **Brake Pressure Modulator Valve Replacement**
2. If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual Bleeding)**, **Hydraulic Brake System Bleeding (Pressure Bleeding)**. 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, and/or the proportioning valve assembly, was replaced
 - An unrestricted and even flow of brake fluid per axle during the bleeding procedure

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	Did you find and correct a condition?	Go to Step 7	Go to Step 12
7	Was there air in the system at a bleeder valve location other than at the repair location, except if the brake master cylinder, and/or the proportioning valve assembly, 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 and/or wheel cylinders, if equipped for proper operation. Refer to <u>Hydraulic Brake Component Operation Visual Inspection</u> . Was the hydraulic function of the brake calipers/wheel cylinders 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/wheel cylinders for proper operation. Refer to <u>Hydraulic Brake Component Operation Visual Inspection</u> . Was the hydraulic function of the brake calipers/wheel cylinders 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
	Repair or replace any brake caliper/wheel cylinder that was not operating properly. Refer to the appropriate procedure. • <u>Front Brake Caliper Overhaul</u> , or <u>Front Brake</u>		

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14	<u>Caliper Replacement</u> • <u>Rear Brake Caliper Replacement</u> , if equipped • <u>Rear Brake Cylinder Replacement</u> , if equipped		-
	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 Bleeding)</u>, <u>Hydraulic Brake System Bleeding (Pressure Bleeding)</u>. Was there air in the system?	Go to Step 19	Go to Step 16
16	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to Step 21	Go to Step 17
17	1. Inspect the hydraulic brake pipes and flexible brake hoses for signs of a fluid restriction; such as being bent, kinked, pinched or damaged. Refer to <u>Brake Pipe and Hose Inspection</u>. 2. Replace any of the hydraulic brake pipes and/or flexible brake hoses found to be bent, kinked, pinched, or damaged. Refer to the following procedures as necessary: • <u>Front Brake Hose Replacement</u> • <u>Rear Brake Hose Replacement (Drum Brake)</u>, <u>Rear Brake Hose Replacement (Disc Brake)</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 modulator assembly, in order to correct the hydraulic brake dynamic rear proportioning mechanical operation. Refer to <u>Brake Pressure Modulator Valve Replacement</u> . Did you complete the replacement?	Go to Step 21	-
19	1. Inspect the hydraulic brake system components for brake fluid seepage at a seal and/or fitting location, which may have drawn air into the system. 2. Inspect the hydraulic brake system components for evidence of a recent repair, which may have		

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	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. Repair or replace the brake master cylinder if it is found to be leaking brake fluid internally. Refer to <u>Master Cylinder Replacement</u> .		
	Did you find and correct a condition?	Go to Step 21	Return to Symptom Table
21	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Hydraulic Brake System OK Return to Symptom Table	-

BRAKE ASSIST SYSTEM DIAGNOSIS**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>Symptoms - Hydraulic Brakes</u>
3	Inspect for proper brake pedal travel. Refer to <u>Brake Pedal Travel Measurement and Inspection</u> . Is the brake pedal travel distance within the acceptable limits?	Go to Step 5	Go to Step 4
4	1. 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.		

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	2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?	Go to Step 5	Go to Hydraulic Brake System Diagnosis 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 Brake System Vacuum Source Test. 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 Engine Controls Diagnostics. 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 Power Brake Booster Replacement. Did you complete the replacement?	Go to Step 10	-
10	If equipped with a booster mounted separate vacuum sensor, inspect the vacuum sensor grommet for cracks, cuts, dry-rot, or damage. Does the vacuum sensor grommet exhibit any of the conditions listed?	Go to Step 11	Go to Step 12
11	Replace the vacuum sensor grommet. Did you complete the replacement?	Go to Step 12	-
12	1. 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
	Perform the vacuum booster leak-down test using a scan tool:		

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13	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</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</u>. Did you complete the operation?	Go to Step 15	-
	Perform the vacuum booster leak-down test		

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15	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</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

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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</u>. Did you complete the replacement?	Go to Step 18	-
18	Perform the vacuum boost functional test: 1. If still separated, reinstall the master cylinder to the booster. Refer to <u>Master Cylinder Replacement</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 several times to deplete the vacuum reserve. 3. Depress and maintain moderate foot pressure on the brake pedal. 4. Start the engine and observe pedal operation. 5. 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
	Perform the vacuum booster leak-down test: 1. Release the brake pedal. 2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait		

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20	2-3 seconds and repeat once. 3. Turn the ignition OFF. 4. Wait 60 seconds. 5. 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 power brake booster. Refer to Power Brake Booster Replacement . 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**.

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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 tools, 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** gauge to the brake pedal.

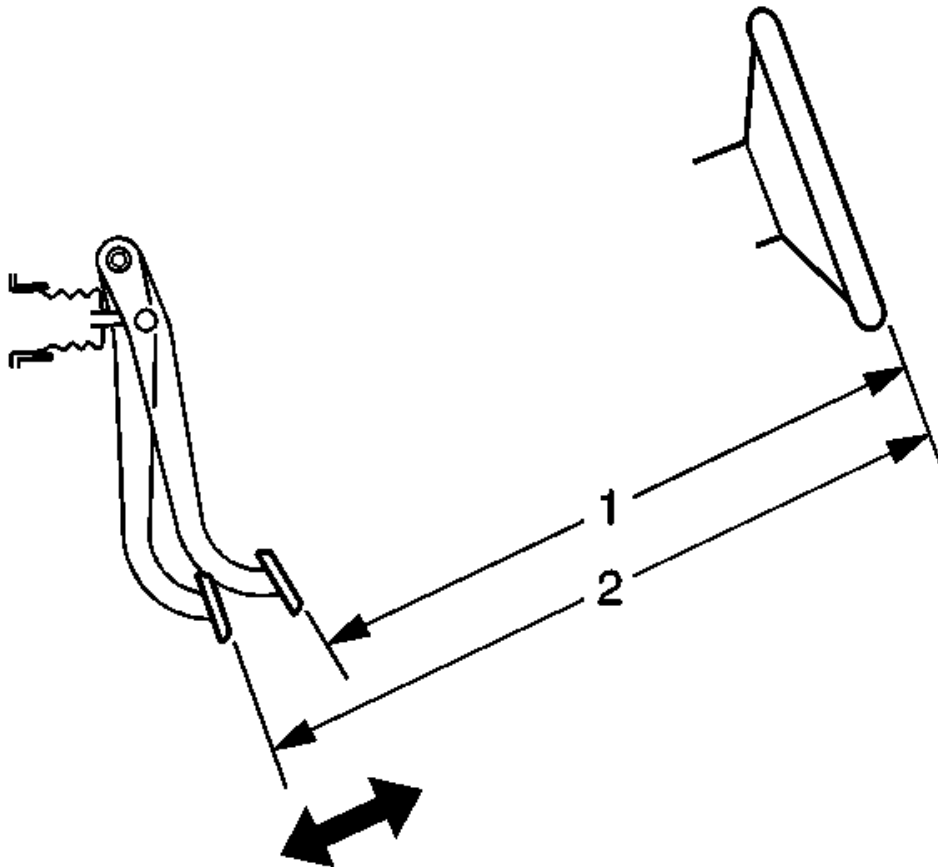


Fig. 2: Measuring Brake Pedal Travel

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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 F) of force to the brake pedal, as indicated on the **CH-28662** gauge.
5. While maintaining 445 N (100 lb F) 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 3 and 4 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. For the maximum brake pedal travel (measured with the ignition OFF, brake booster power assist depleted, and the brakes cool), 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.

If the fluid level is abnormally low, adjust the brake fluid level. Refer to Master Cylinder Reservoir Filling.

2. Start the engine and allow it to idle.
3. 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.

4. Turn OFF the ignition.
5. 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
6. 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 Bleeding)**, **Hydraulic Brake System Bleeding (Pressure Bleeding)**.

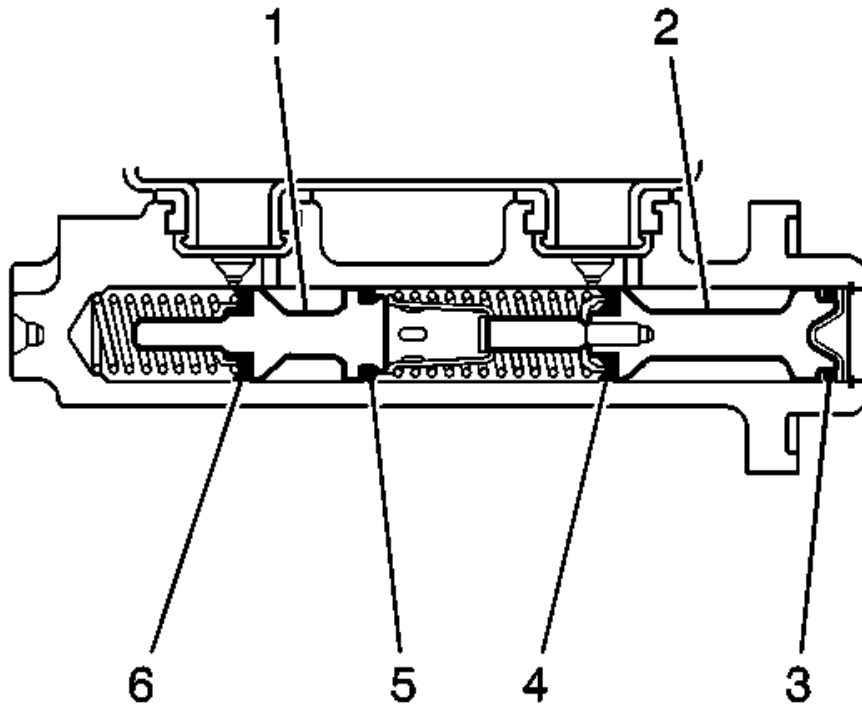


Fig. 3: Identifying Brake Master Cylinder (Cross Sectional View)

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 Bleeding)**, [Hydraulic Brake System Bleeding \(Pressure Bleeding\)](#).
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).

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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

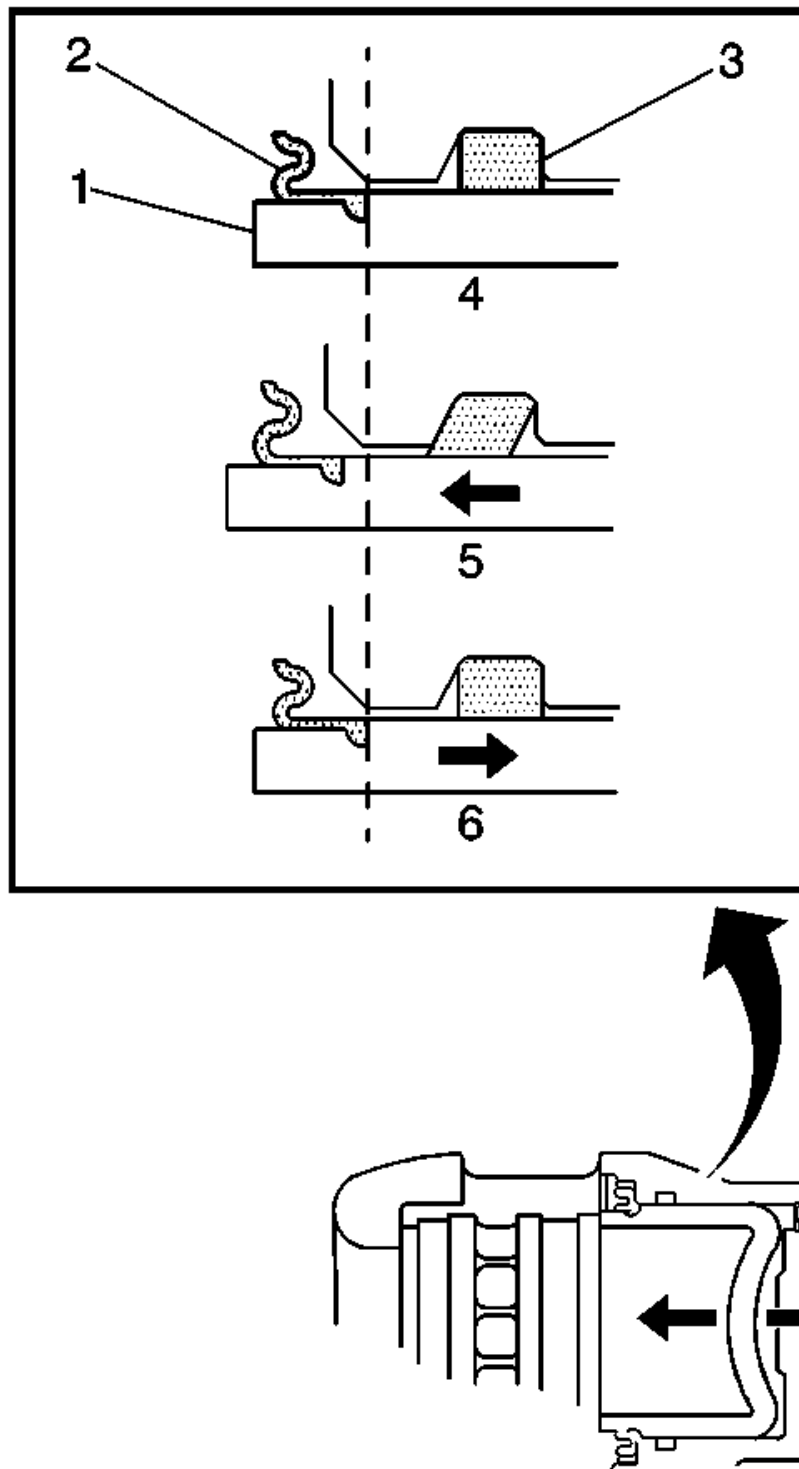


Fig. 4: Identifying Brake Caliper/Pad Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

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.

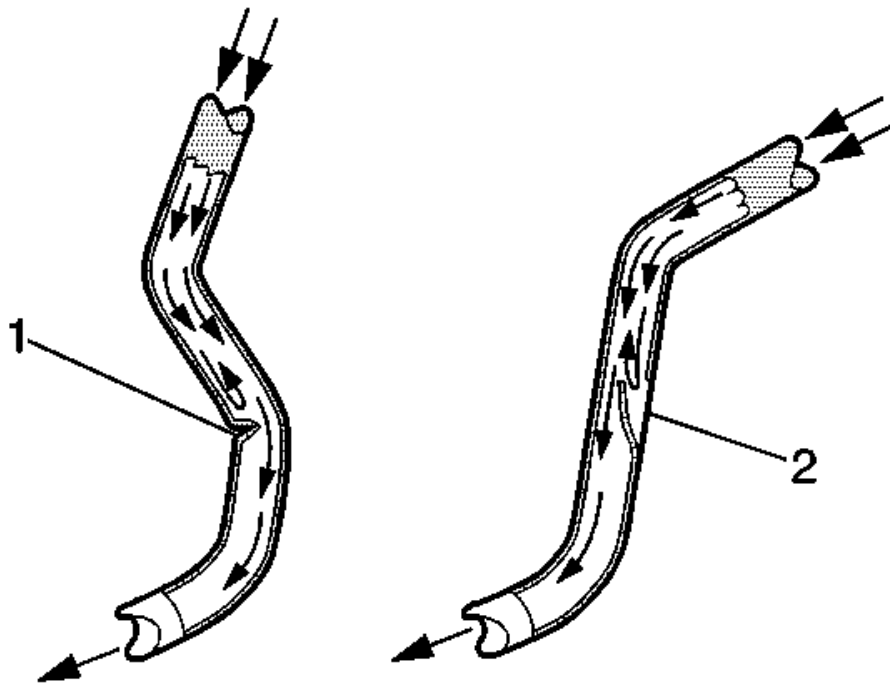


Fig. 5: Identifying Flexible Brake Hose Failure Conditions

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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

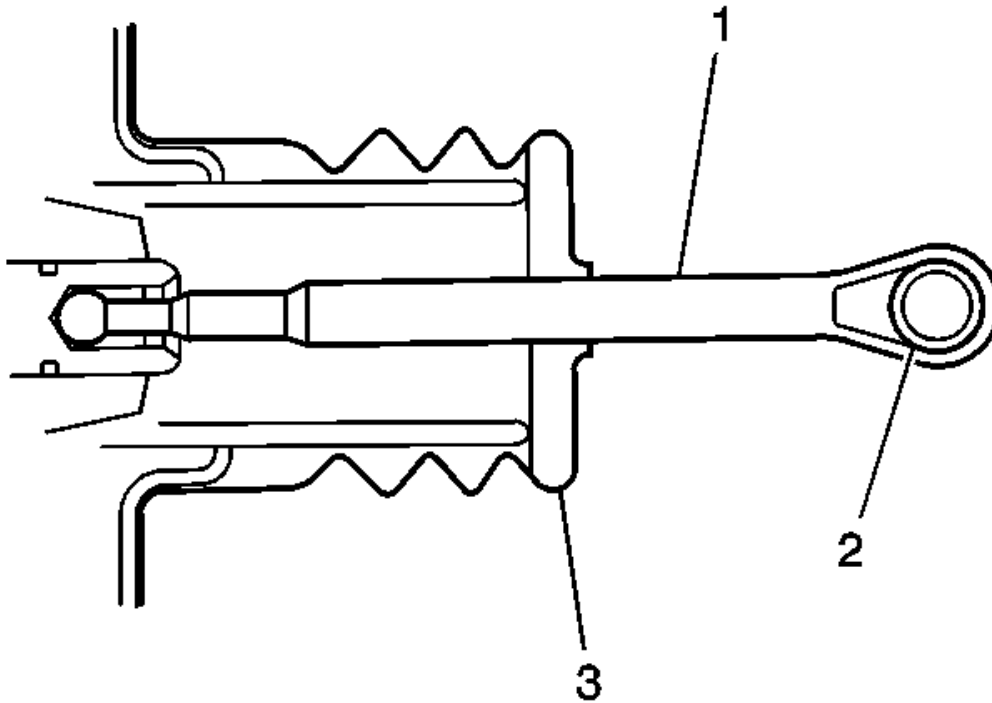


Fig. 6: View of Brake Pedal Pushrod

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: When adding fluid to the brake master cylinder reservoir, use only GM approved or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container. The use of any type of fluid other than the recommended type of brake fluid may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

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

1. Visually inspect the brake fluid level through the brake master cylinder auxiliary 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 auxiliary reservoir, clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.

MASTER CYLINDER RESERVOIR REPLACEMENT

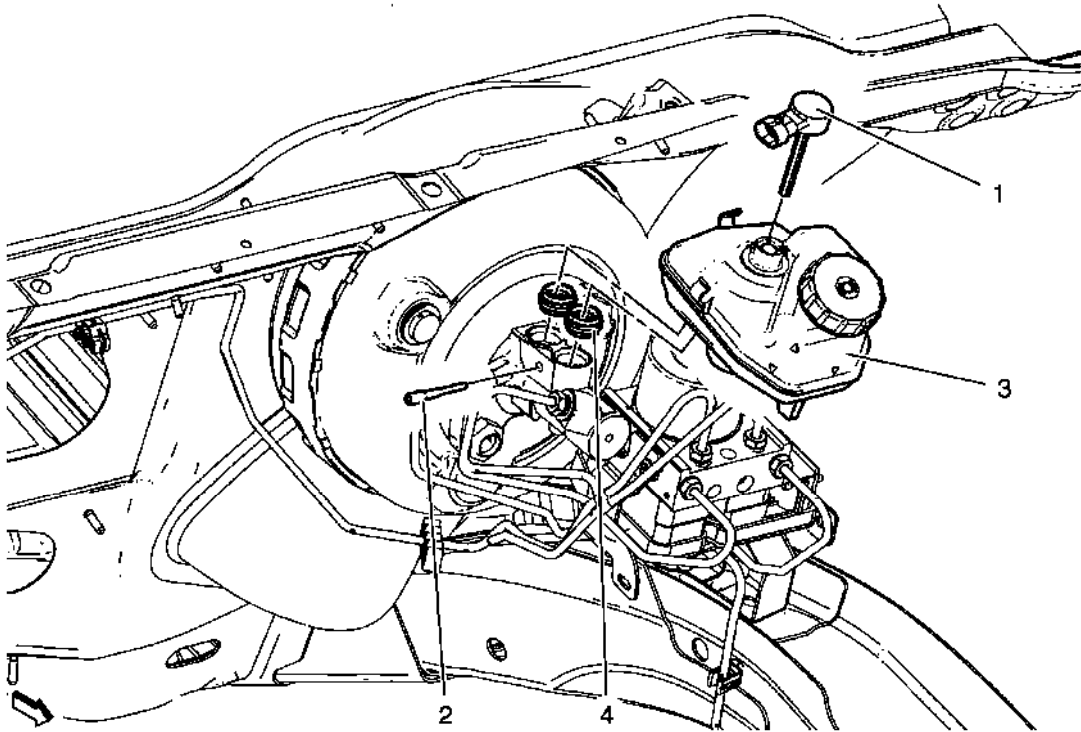


Fig. 7: Master Cylinder Reservoir

Courtesy of GENERAL MOTORS COMPANY

Master Cylinder Reservoir Replacement

Callout	Component Name
WARNING: Refer to <u>Brake Fluid Irritant Warning</u> .	
CAUTION: Refer to <u>Brake Fluid Effects on Paint and Electrical Components Caution</u> .	
Preliminary Procedure Remove and discard the brake fluid from the master cylinder reservoir.	
1	Brake Fluid Level Indicator Switch Procedure 1. Disconnect electrical connector. 2. Rotate level indicator clockwise and remove upwards.
2	Master Cylinder Reservoir Bolt CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 2.5 N.m (22 lb in)
3	Master Cylinder Reservoir Procedure 1. Inspect the master cylinder for damage and replace, if necessary. 2. Clean the reservoir with denatured alcohol. 3. Dry the reservoir with filtered, non-lubricated compressed air.
4	Master Cylinder Reservoir Seal (Qty: 2) 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. Procedure 1. Lubricate the seals and the reservoir caps with brake fluid. Refer to <u>Brake Fluid and Brake Fluid Handling</u> for the recommended brake fluid. 2. Lubricate the seals and the reservoir bayonets with brake fluid. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>.

MASTER CYLINDER REPLACEMENT

Removal Procedure

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

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

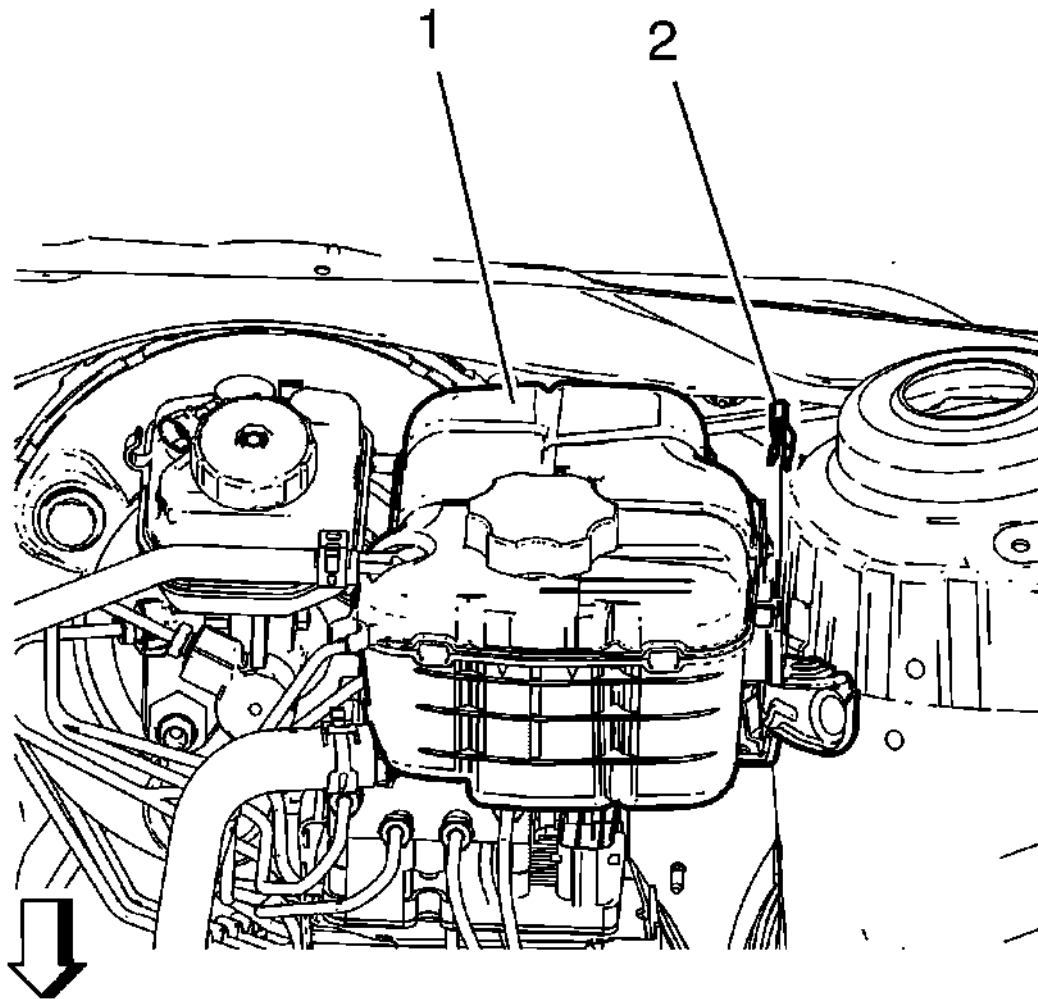


Fig. 8: View Of Radiator Surge Tank And Radiator Surge Tank Clip
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT disconnect engine coolant hoses.

1. Remove the radiator surge tank clip (2).
2. Remove the radiator surge tank (1) and put aside.
3. Disconnect the brake fluid level indicator switch electrical connector and separate from brake fluid reservoir.

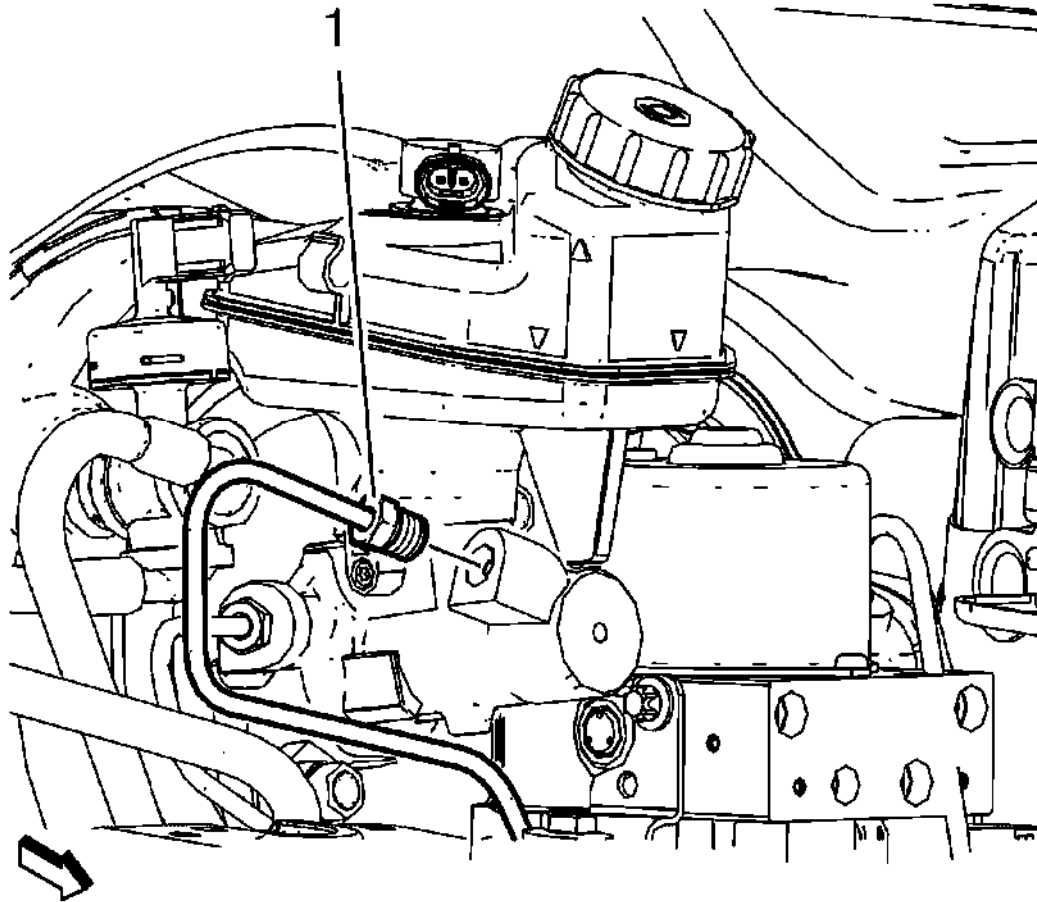


Fig. 9: Master Cylinder Secondary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

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.

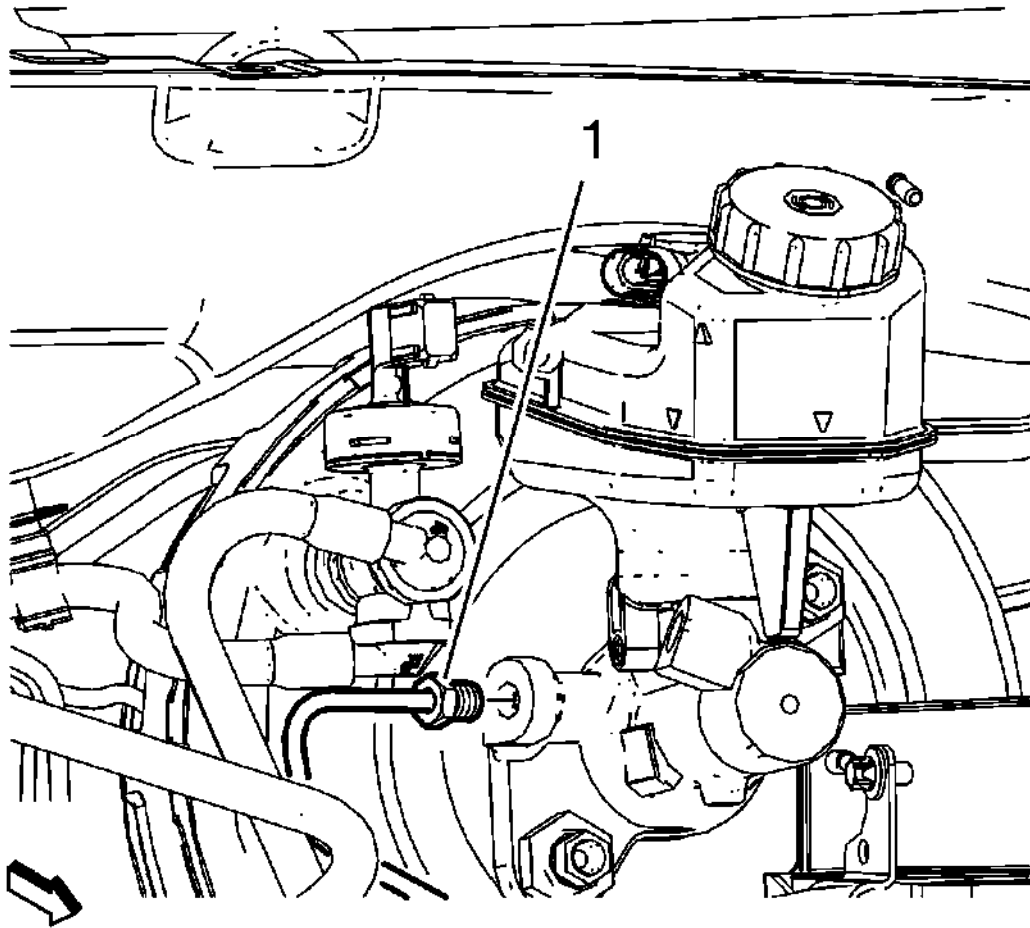


Fig. 10: Master Cylinder Primary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

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.

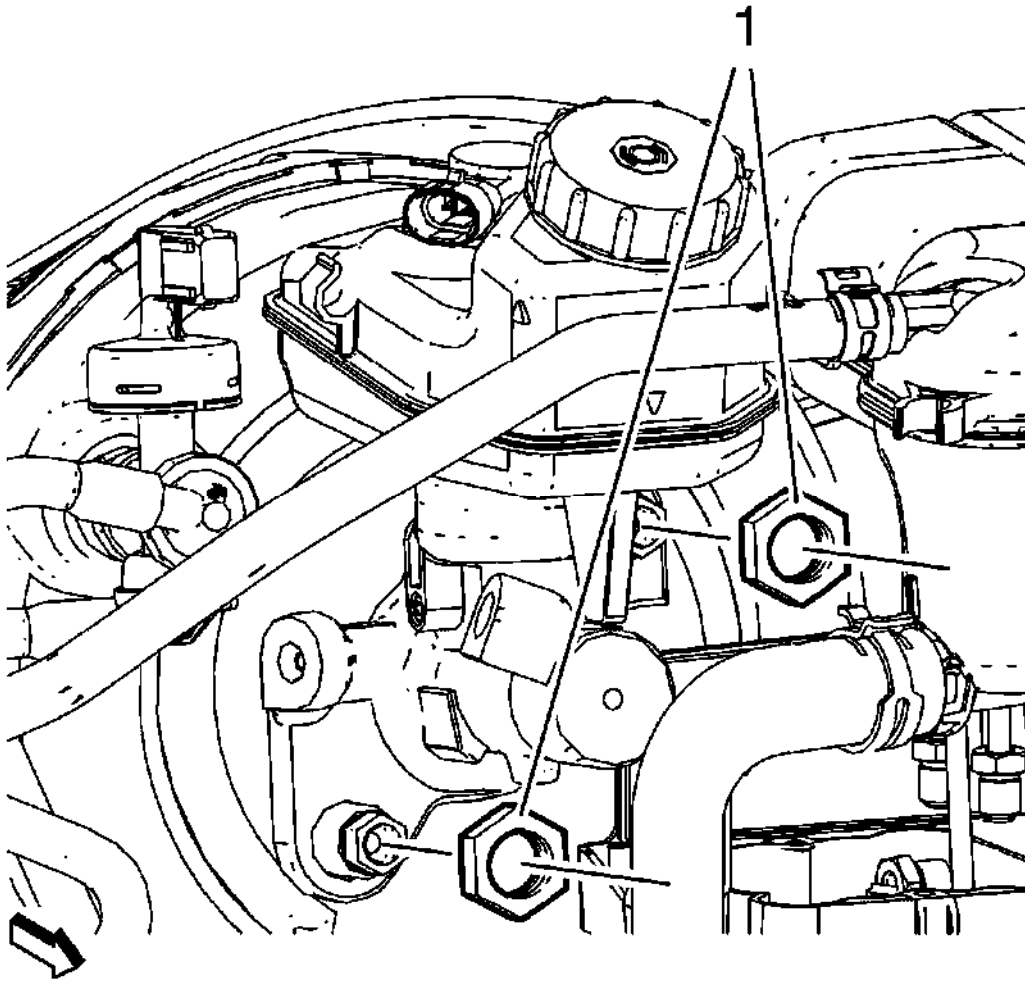


Fig. 11: Master Cylinder Nuts

Courtesy of GENERAL MOTORS COMPANY

6. Remove and DISCARD master cylinder nuts (1).
7. Remove master cylinder with brake fluid reservoir.
8. Inspect the master cylinder to vacuum brake booster seal for damage and replace, if necessary.
9. Remove the master cylinder reservoir, if necessary. Refer to **Master Cylinder Reservoir Replacement**.

Installation Procedure

1. Install the brake fluid reservoir to master cylinder. Refer to **Master Cylinder Reservoir Replacement**.
2. Ensure the master cylinder to vacuum brake booster seal is properly seated on the master cylinder barrel.
3. Perform the master cylinder bench bleeding. Refer to **Master Cylinder Bench Bleeding**.

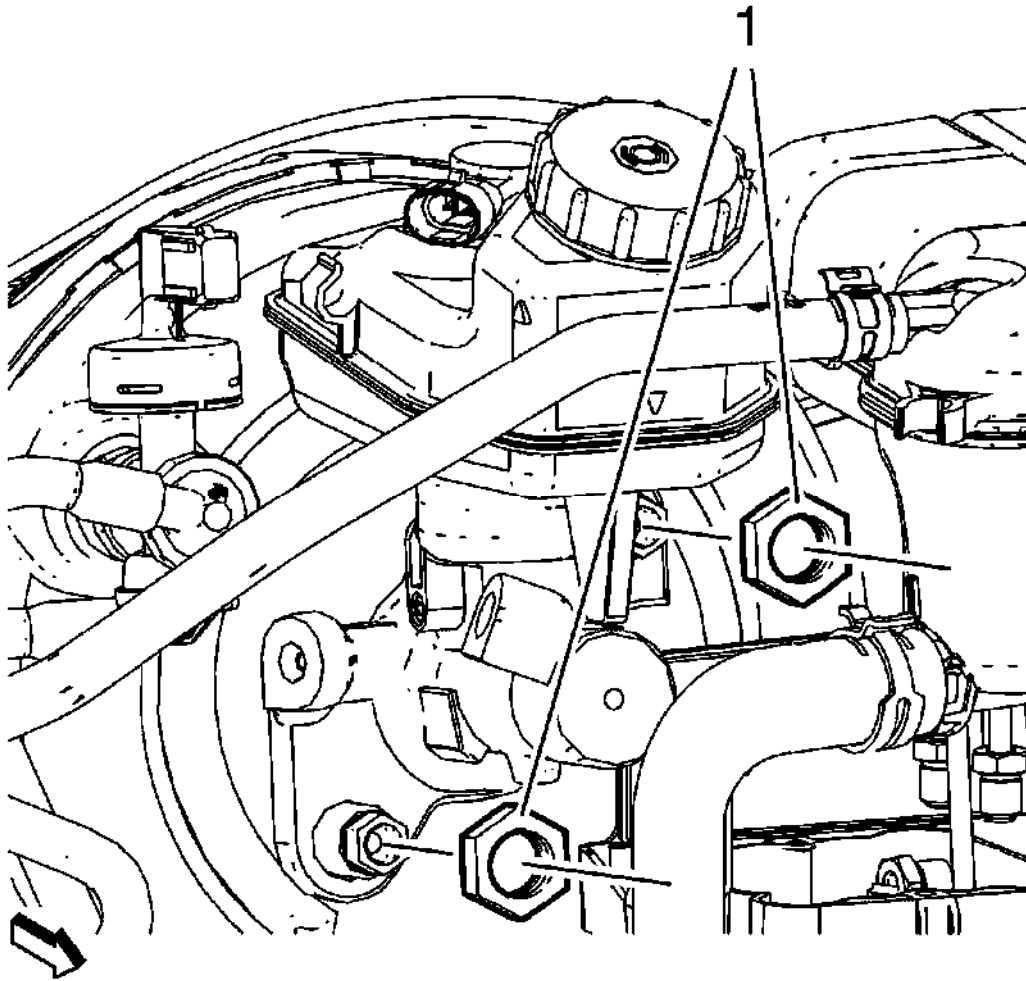


Fig. 12: Master Cylinder Nuts

Courtesy of GENERAL MOTORS COMPANY

4. Install the master cylinder.

WARNING: Refer to Torque-to-Yield Fastener Warning .

CAUTION: Refer to Fastener Caution .

5. Install NEW master cylinder nuts (1) and tighten to 50 N.m (37 lb ft).
6. Install the brake fluid level indicator switch harness to the brake fluid reservoir and connect the electrical connector.

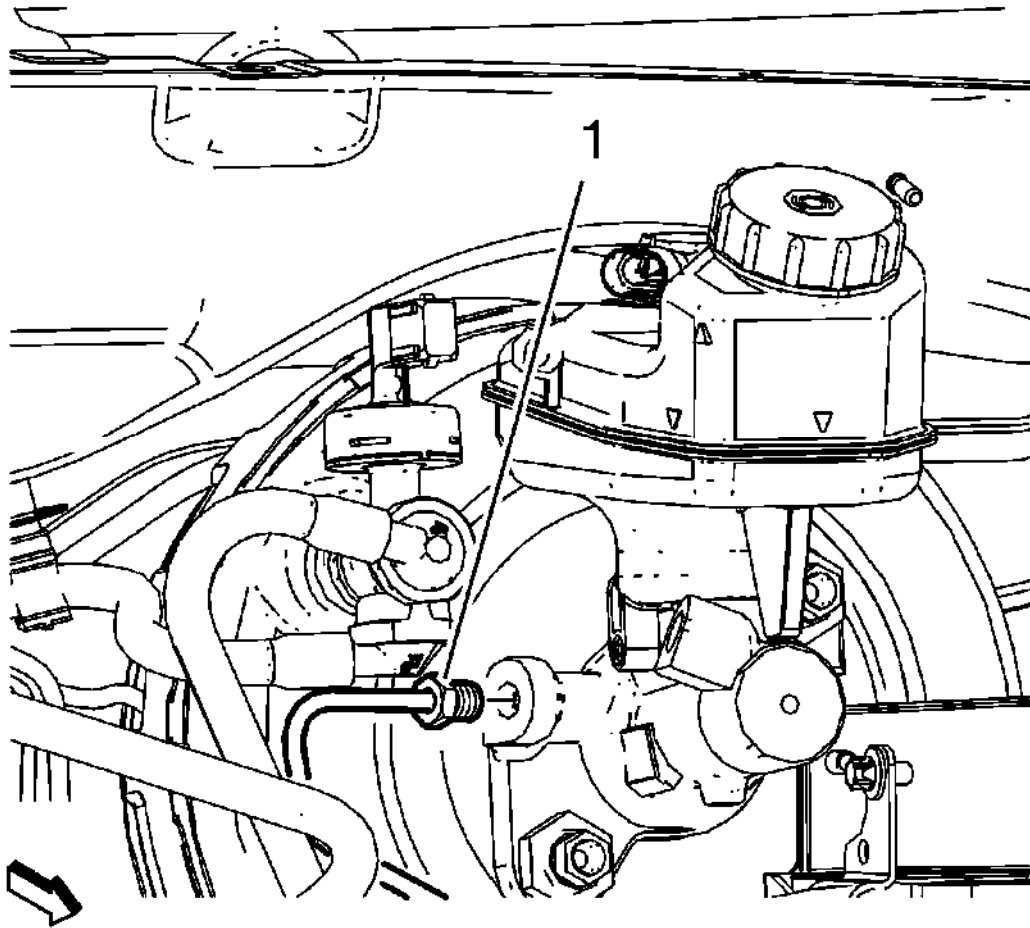


Fig. 13: Master Cylinder Primary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

7. Connect the master cylinder primary brake pipe fitting (1) and tighten to 18 N.m (13 lb ft).

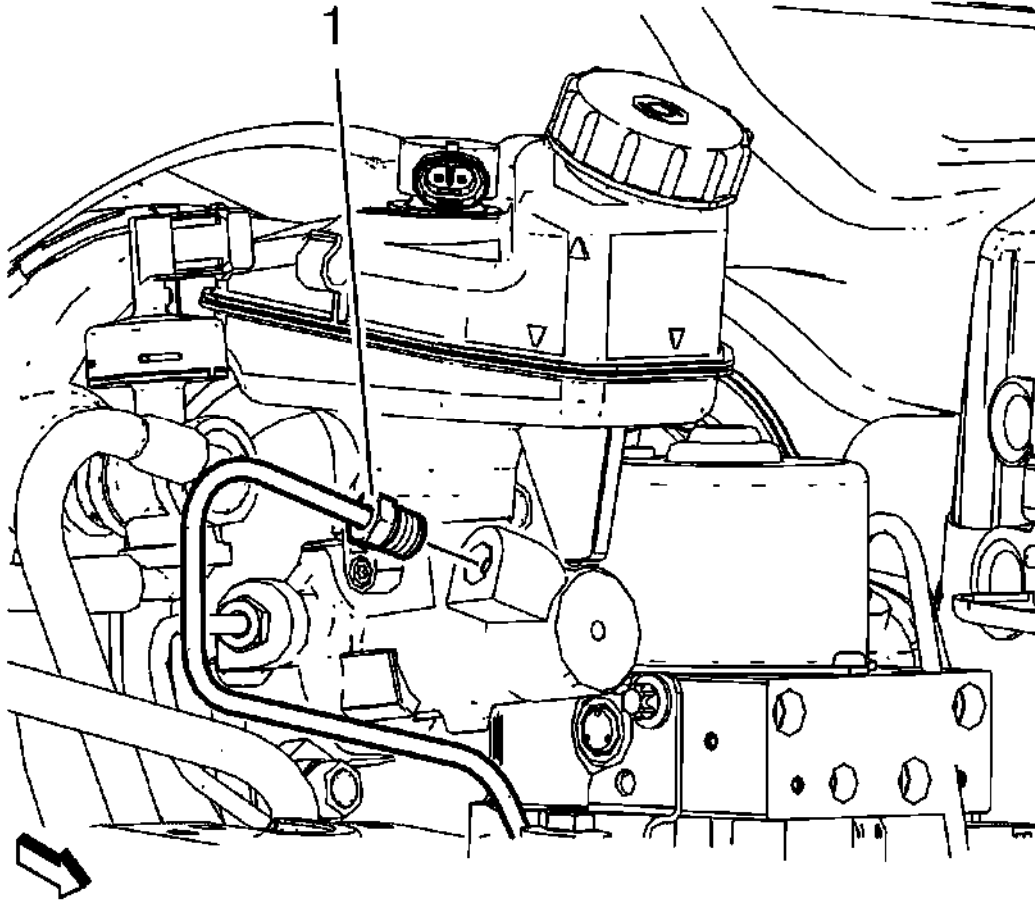


Fig. 14: Master Cylinder Secondary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

8. Connect the master cylinder secondary brake pipe fitting (1) and tighten to 18 N.m (13 lb ft).

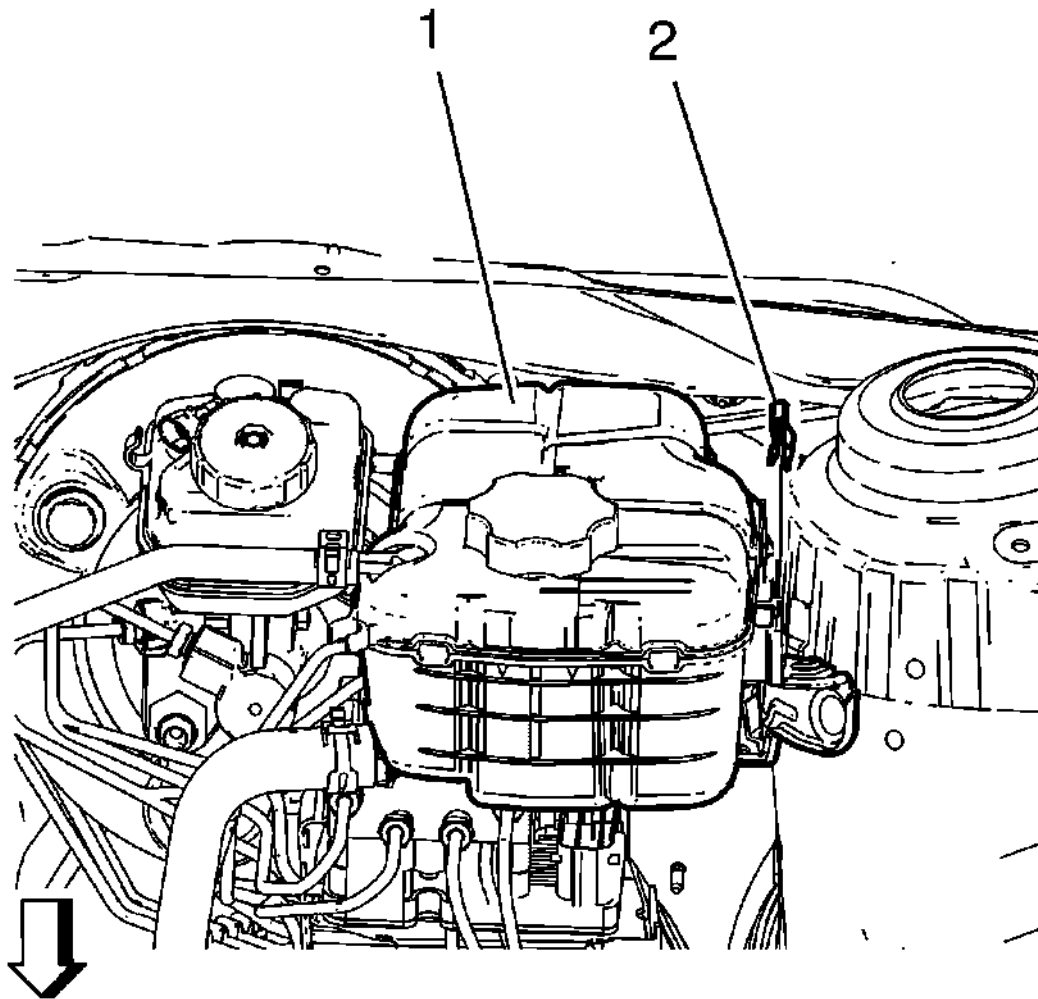


Fig. 15: View Of Radiator Surge Tank And Radiator Surge Tank Clip
Courtesy of GENERAL MOTORS COMPANY

9. Reposition and install the radiator surge tank (1).
10. Install the radiator surge tank clip (2).
11. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual Bleeding)**, **Hydraulic Brake System Bleeding (Pressure Bleeding)**.

MASTER CYLINDER BENCH BLEEDING

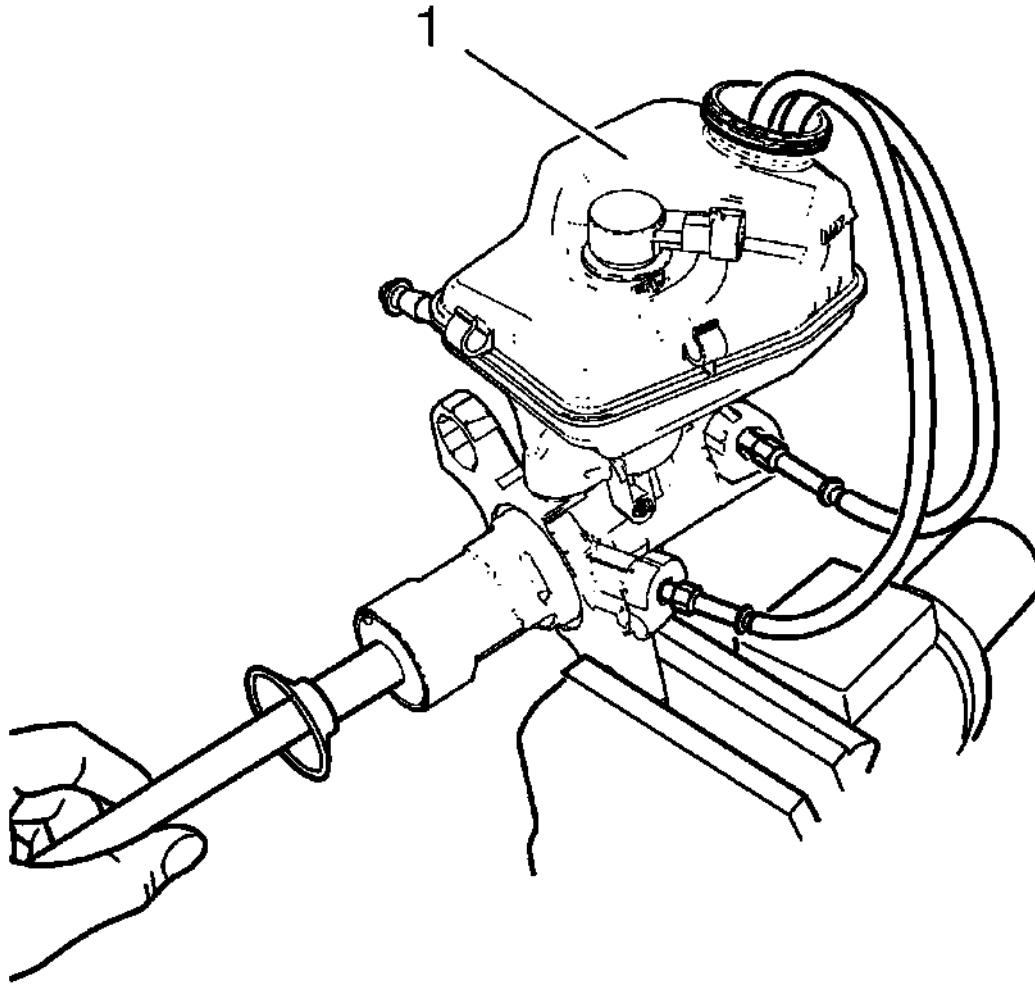


Fig. 16: Master Cylinder Reservoir
Courtesy of GENERAL MOTORS COMPANY

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 (1).

5. Fill the master cylinder reservoir to at least the half-way point with brake fluid. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended brake fluid.
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 (1).
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

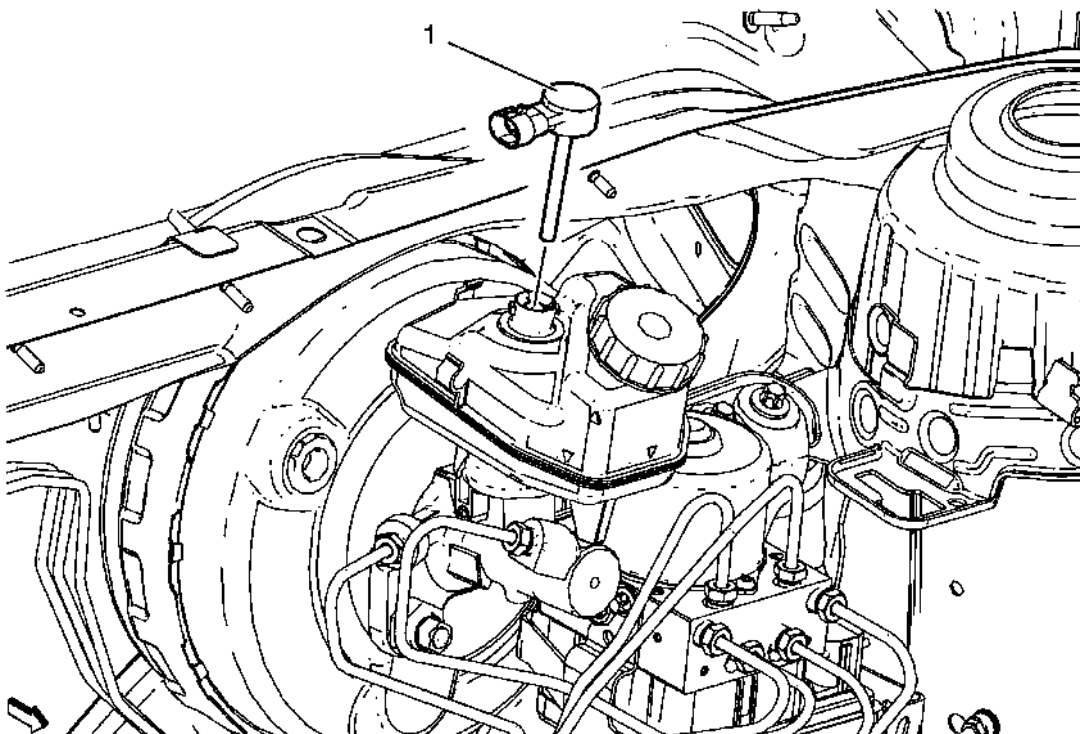


Fig. 17: Brake Fluid Level Indicator Switch
 Courtesy of GENERAL MOTORS COMPANY

Brake Fluid Level Indicator Switch Replacement

Callout	Component Name
WARNING: Refer to <u>Brake Fluid Irritant Warning</u> .	
CAUTION: Refer to <u>Brake Fluid Effects on Paint and Electrical Components Caution</u> .	
Preliminary Procedure Remove and discard the brake fluid from the master cylinder reservoir.	
1	Brake Fluid Level Indicator Switch Procedure 1. Disconnect electrical connector. 2. Rotate indicator switch clockwise to remove.

BRAKE, ACCELERATOR, AND CLUTCH PEDAL REPLACEMENT

Special Tools

- **DT-6202-A** Pliers
- **DT-6202-B** Pliers
- **DT-6202-20** Adapter to DT-6202-A
- **DT-50894** Remover

For equivalent regional tools, refer to Special Tools.

Removal Procedure

1. Remove the battery. Refer to Battery Replacement .
2. Remove the battery tray. Refer to Battery Tray Replacement .

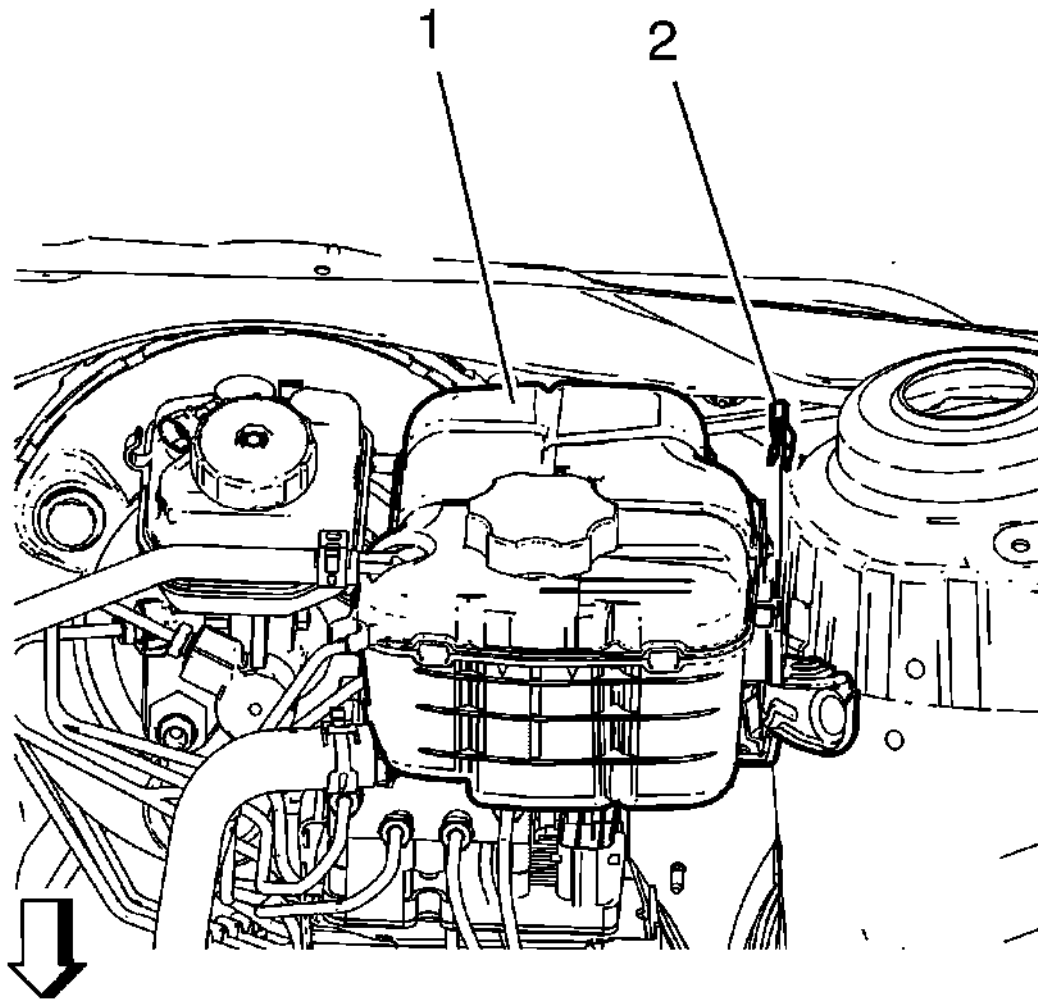


Fig. 18: View Of Radiator Surge Tank And Radiator Surge Tank Clip
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT disconnect the engine coolant hoses.

3. Remove the radiator surge tank clip (2).
4. Remove the radiator surge tank (1).
5. Position the radiator surge tank (1) aside.

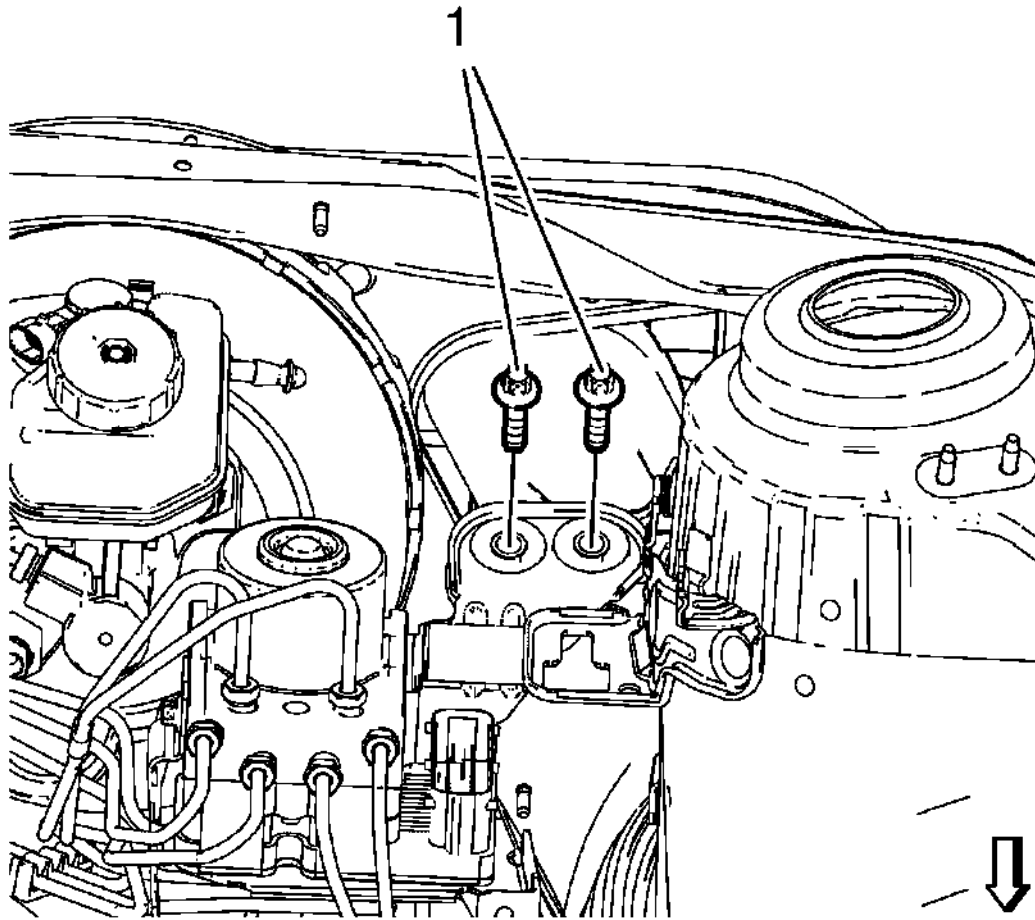


Fig. 19: BPMV Bracket Bolts

Courtesy of GENERAL MOTORS COMPANY

6. Remove the BPMV bracket bolts (1).

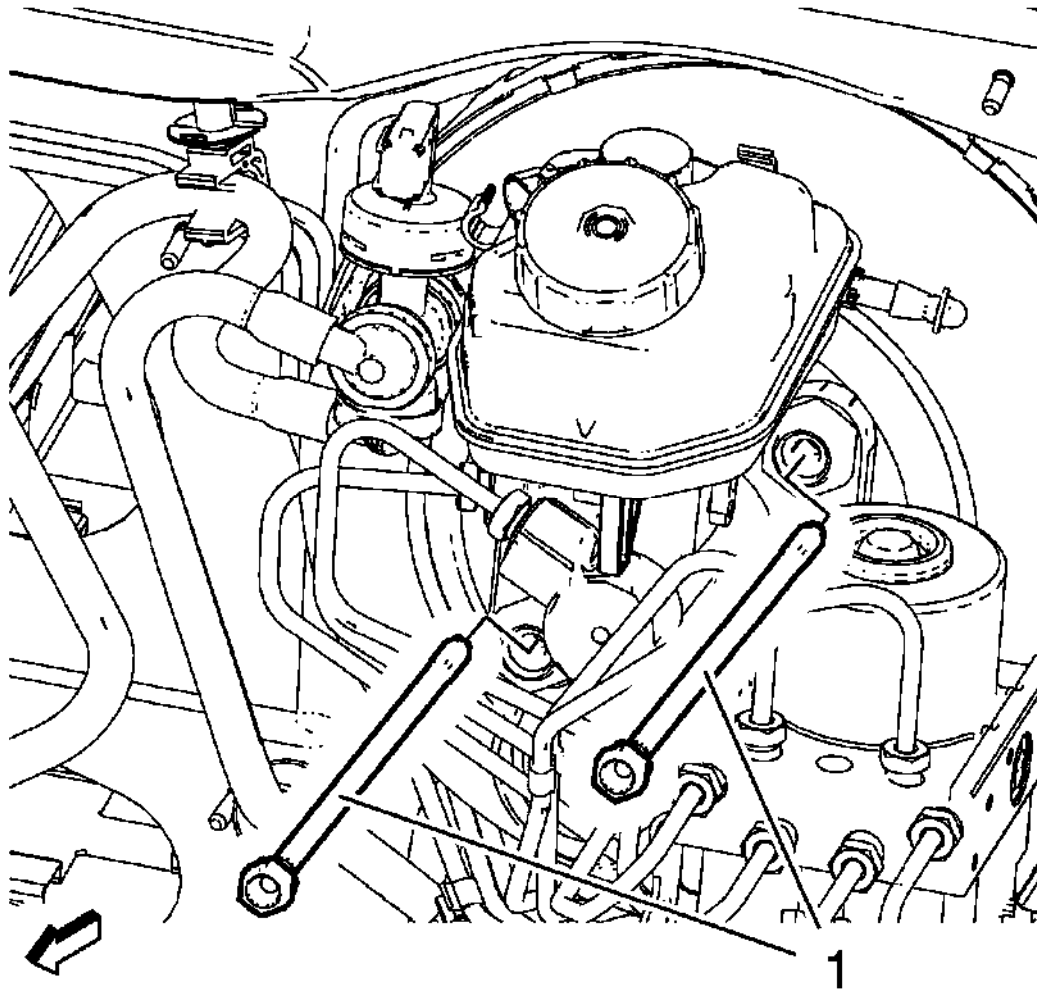


Fig. 20: Brake Booster Bolts

Courtesy of GENERAL MOTORS COMPANY

7. Remove the brake booster bolts (1).

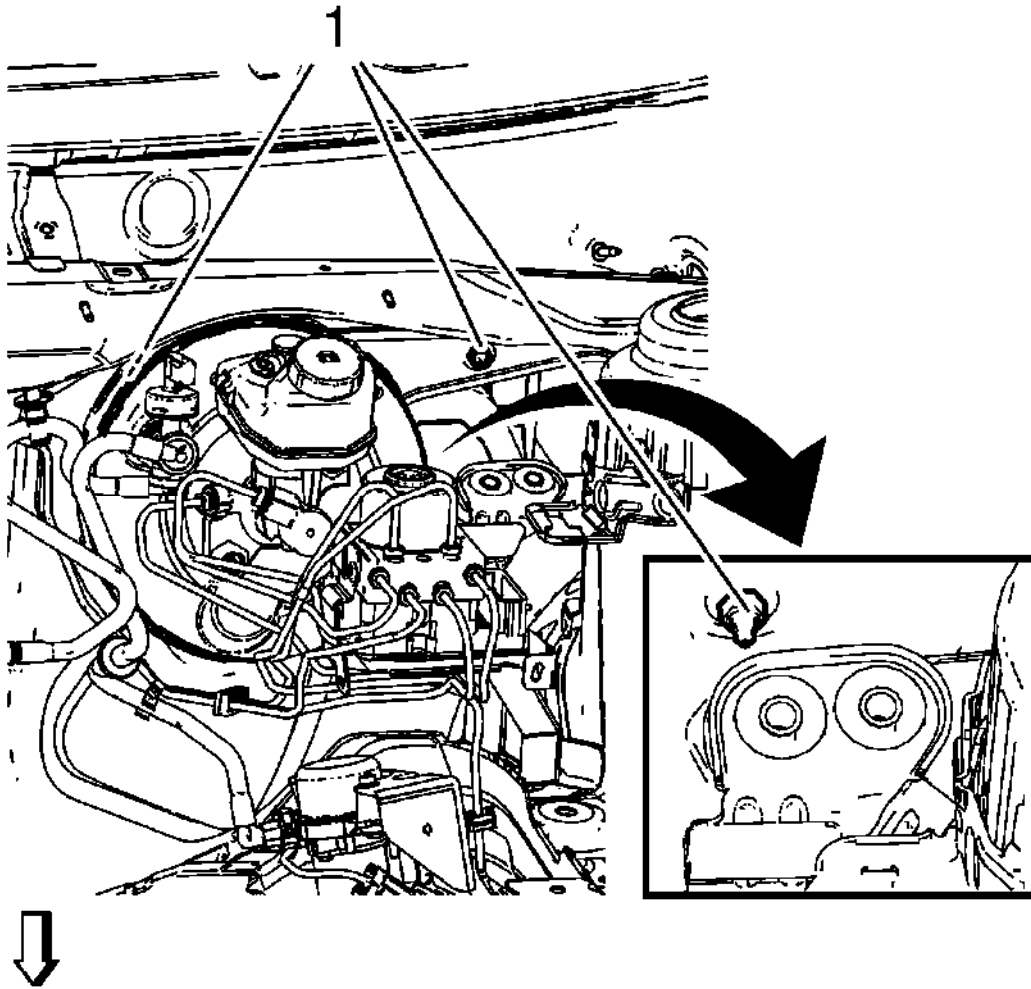


Fig. 21: Identifying Brake Pedal Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Do NOT open the hydraulic brake system.
- Second mechanic is required.

8. Pull the brake booster and the BPMV assembly forward in order to get an access to the brake pedal bracket nuts (1).
9. Remove the brake pedal bracket nuts (1).
10. Remove the instrument panel lower trim pad cover. Refer to **Instrument Panel Lower Trim Pad Cover Replacement (without Knee Airbag)** , **Instrument Panel Lower Trim Pad Cover Replacement (with Knee Airbag)** .
11. Remove the steering column upper trim cover. Refer to **Steering Column Upper Trim Cover Replacement** .
12. Remove the steering column lower trim cover. Refer to **Steering Column Lower Trim Cover Replacement** .

13. Remove the intermediate steering shaft. Refer to [Intermediate Steering Shaft Replacement](#) .
14. Remove the steering column. Refer to [Steering Column Replacement](#) .

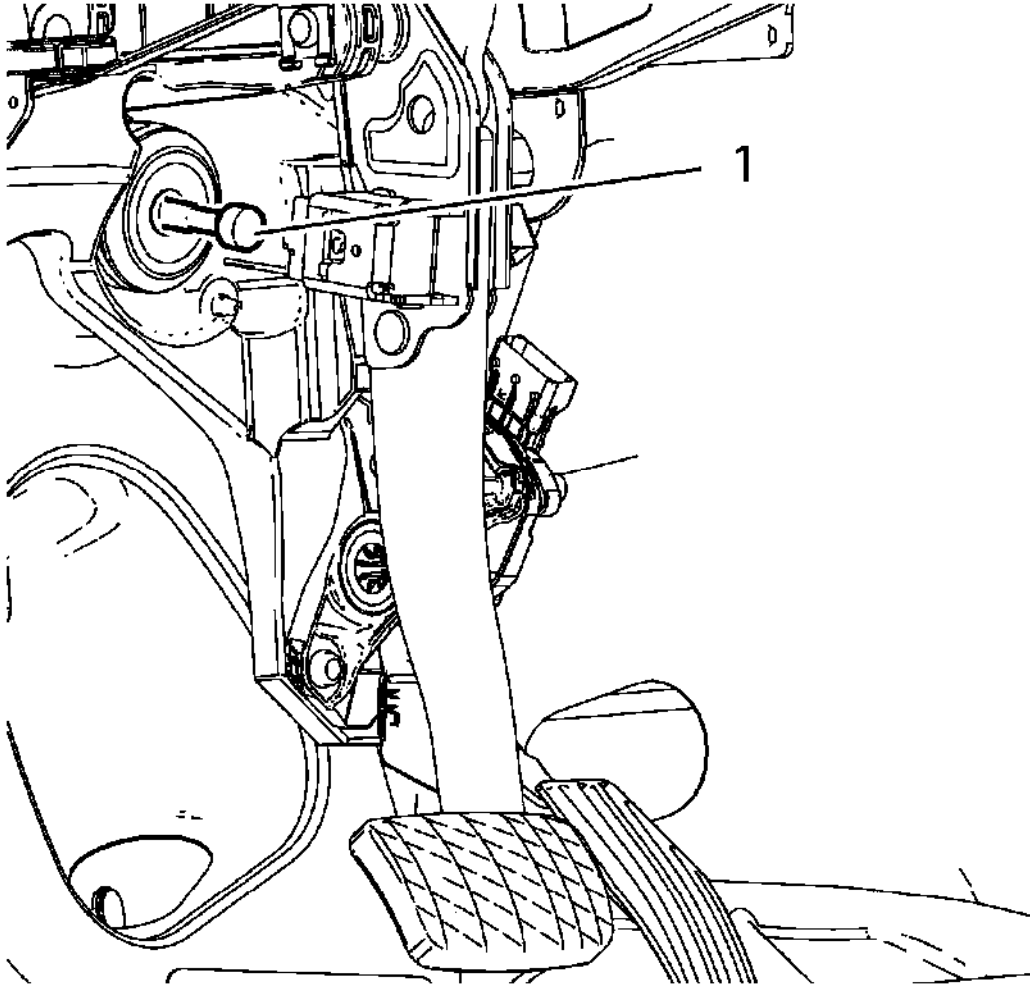


Fig. 22: Brake Pedal Pushrod

Courtesy of GENERAL MOTORS COMPANY

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

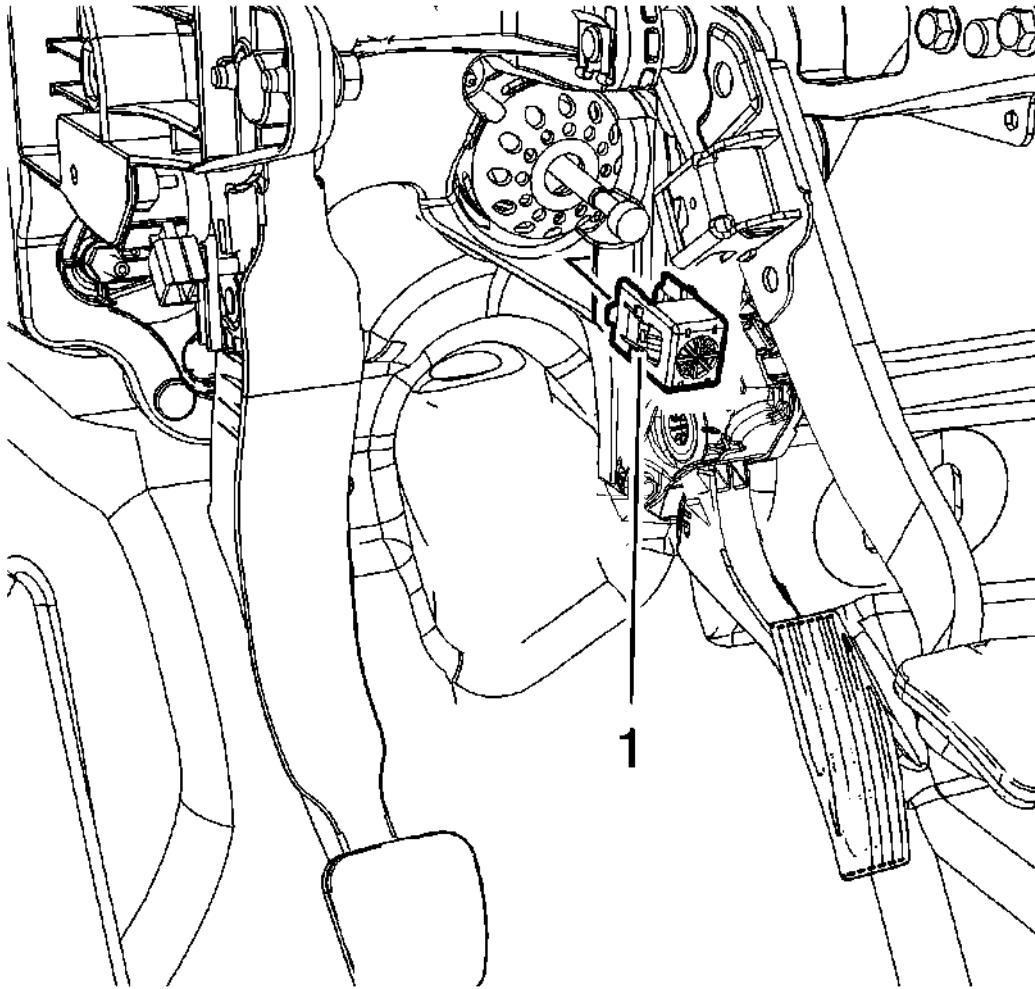


Fig. 23: Click Fit Connector

Courtesy of GENERAL MOTORS COMPANY

16. Replace the click fit connector (1) between the booster pushrod and the brake pedal with new part.
17. Remove the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Replacement** .
18. Remove the accelerator pedal position sensor.
 - For 1.4L LUJ, refer to **Accelerator Pedal Position Sensor Replacement** .
 - For 1.8L LUW, refer to **Accelerator Pedal Position Sensor Replacement** .

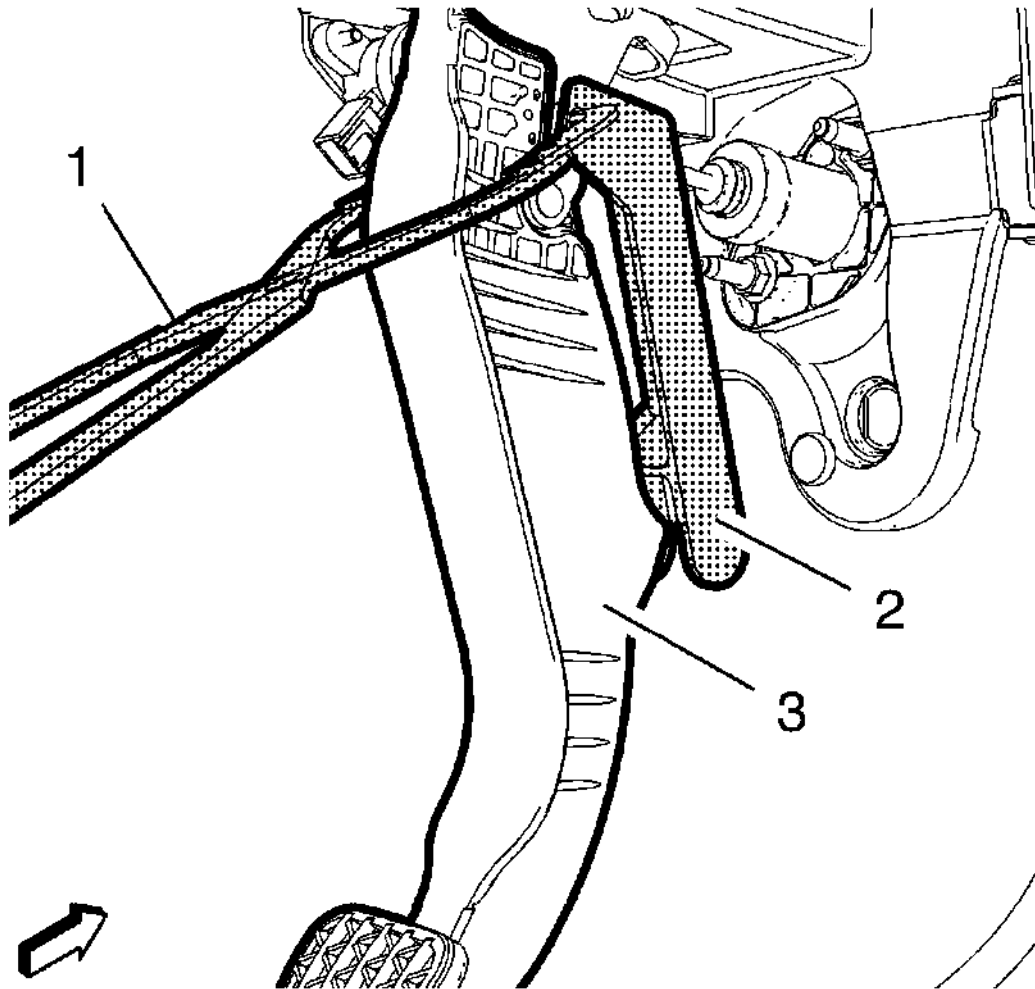


Fig. 24: Clutch Pedal And Push Rod Removal Tools

Courtesy of GENERAL MOTORS COMPANY

19. If equipped, disconnect the clutch master cylinder push rod from the clutch pedal (3), using either the **DT-6202-A** pliers (1) and the **DT-6202-20** adapters in conjunction with the **DT-50894** remover (2), or the **DT-6202-B** pliers (1) in conjunction with the **DT-50894** remover (2).

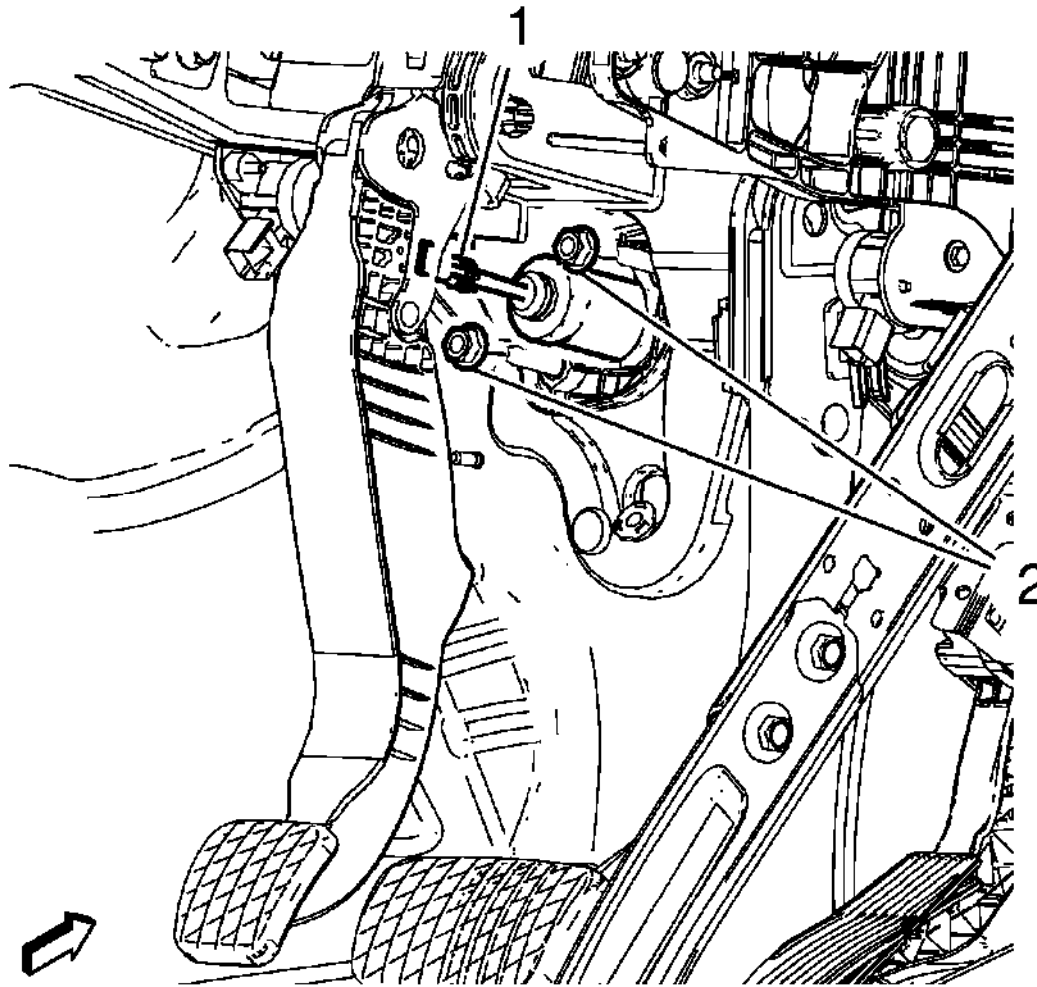


Fig. 25: Clutch Master Cylinder Nuts At Clutch Pedal Bracket
Courtesy of GENERAL MOTORS COMPANY

20. Remove the clutch master cylinder nuts (1) from the pedal bracket, if equipped.

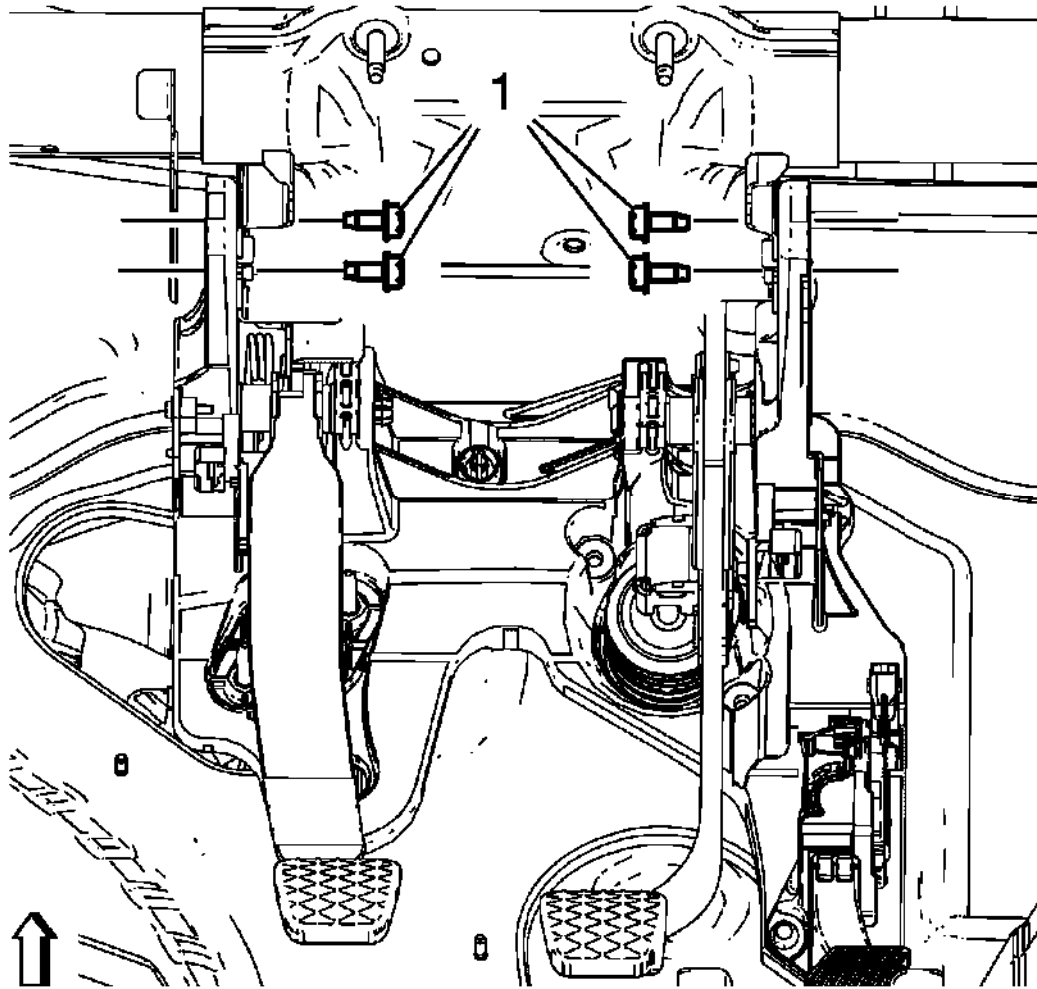


Fig. 26: Clutch Pedal And Brake Pedal Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

21. Remove the brake pedal bracket bolt (1) from the tie bar.
22. Separate the wiring harness from the pedal bracket.
23. Disconnect the electrical connectors.
24. Remove the brake and accelerator and clutch pedal assembly from the vehicle.
25. Transfer component parts as needed.

Installation Procedure

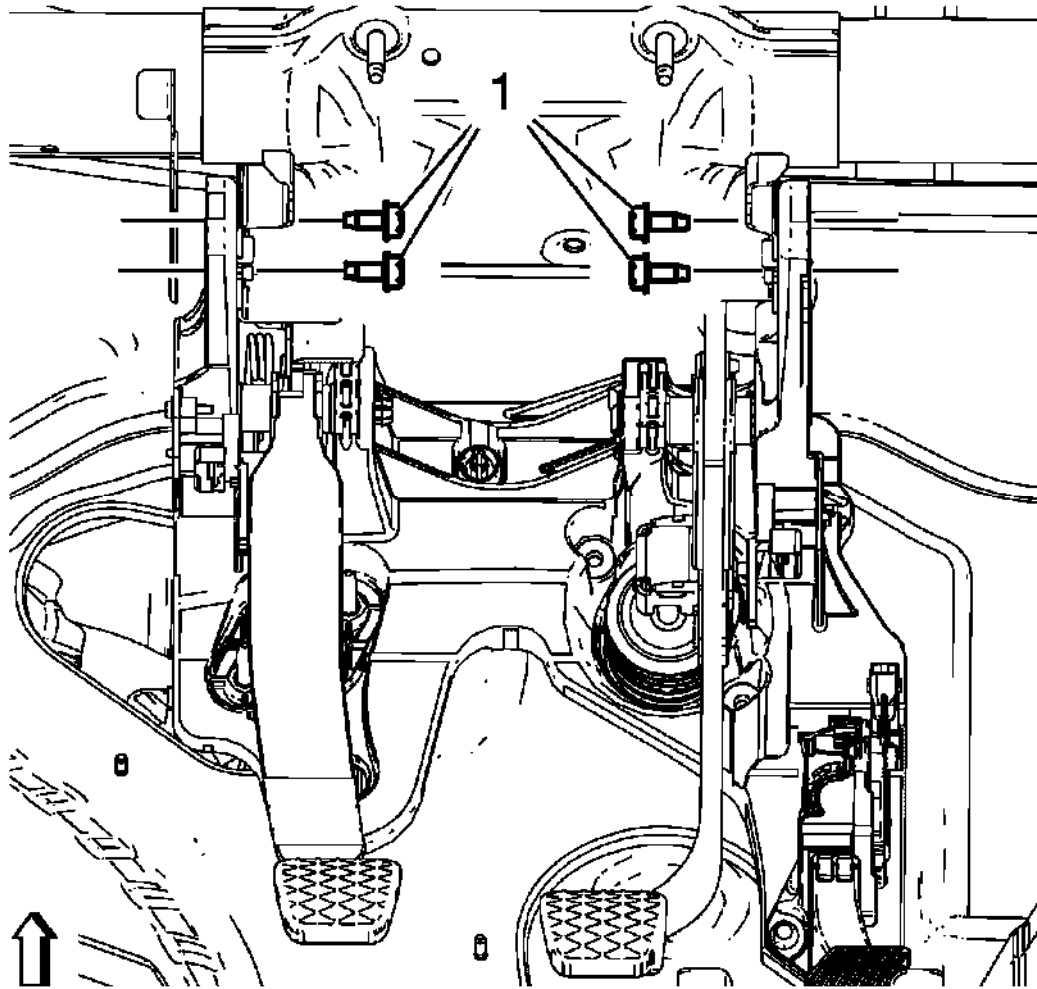


Fig. 27: Clutch Pedal And Brake Pedal Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the brake and accelerator and clutch pedal assembly to the vehicle.
2. Install the wiring harness to the brake pedal bracket.
3. Connect the electrical connectors.

CAUTION: Refer to Fastener Caution .

4. Install the brake pedal bracket bolts and tighten to 20 N.m (15 lb ft).
5. Connect clutch master cylinder pushrod (1) to the clutch pedal, if equipped.

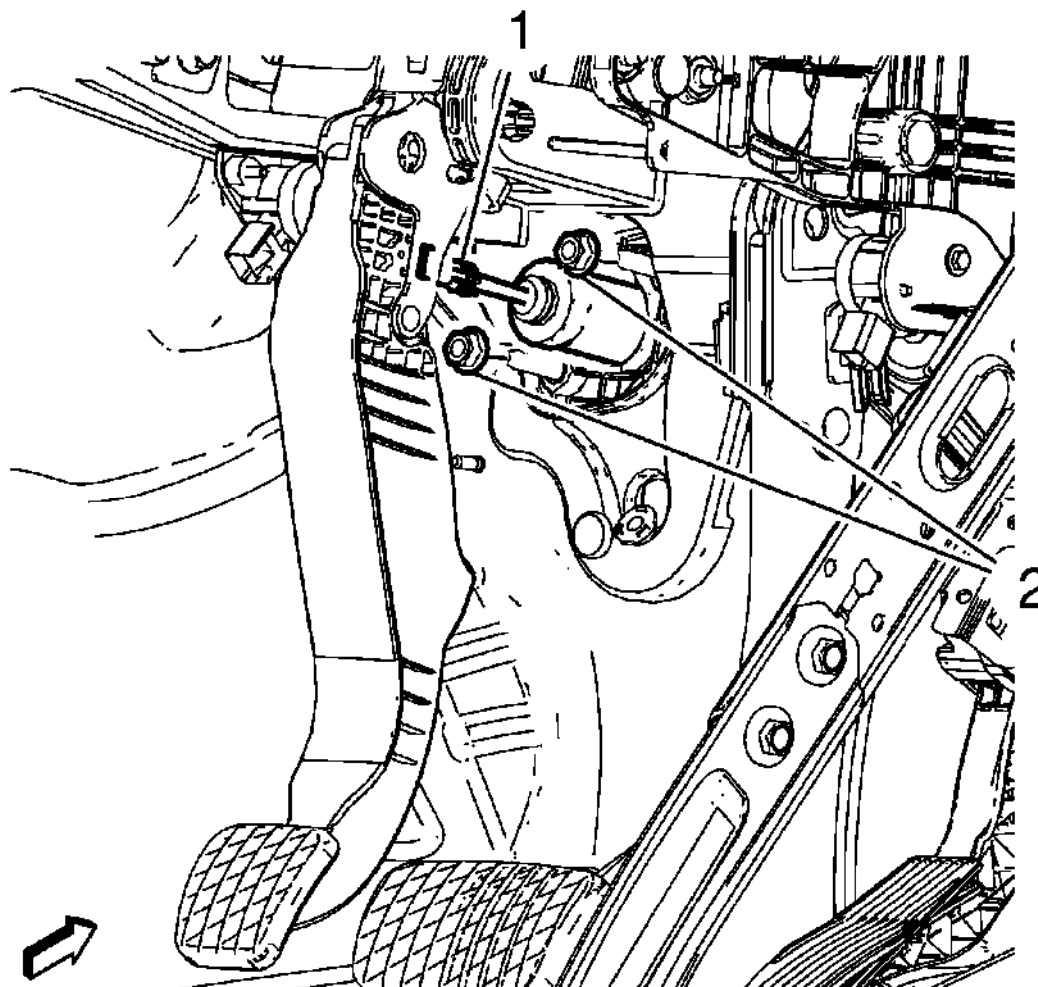


Fig. 28: Clutch Master Cylinder Nuts At Clutch Pedal Bracket

Courtesy of GENERAL MOTORS COMPANY

6. Install the clutch master cylinder nuts (2) to the pedal bracket, if equipped and tighten to 18 N.m (13 lb ft).
7. Install the accelerator pedal position sensor.
 - For 1.4L LUJ, refer to **Accelerator Pedal Position Sensor Replacement** .
 - For 1.8L LUW, refer to **Accelerator Pedal Position Sensor Replacement** .
8. Install the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Replacement** .

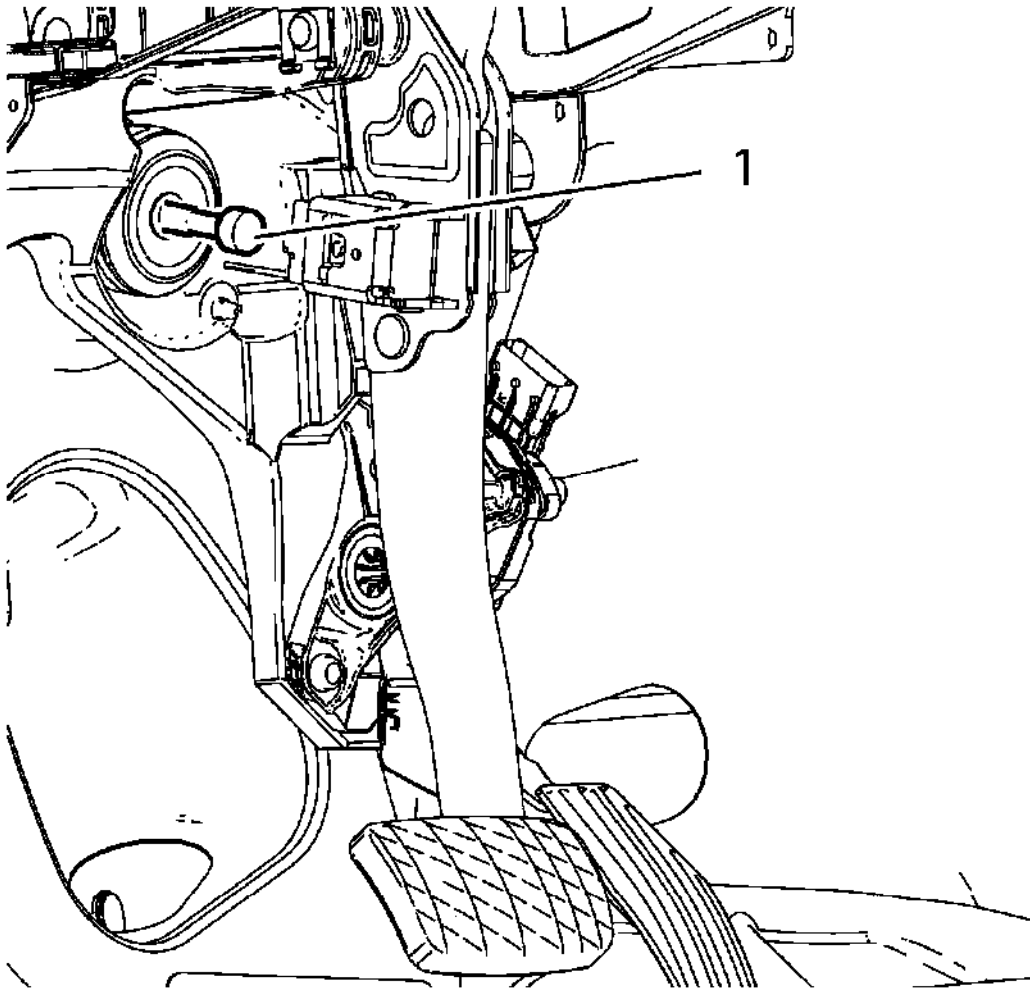


Fig. 29: Brake Pedal Pushrod

Courtesy of GENERAL MOTORS COMPANY

9. Connect the brake pedal pushrod (1) to the brake pedal.
10. Install the steering column. Refer to **Steering Column Replacement** .
11. Install the intermediate steering shaft. Refer to **Intermediate Steering Shaft Replacement** .
12. Install the steering column lower trim cover. Refer to **Steering Column Lower Trim Cover Replacement** .
13. Install the steering column upper trim cover. Refer to **Steering Column Upper Trim Cover Replacement** .
14. Install the instrument panel lower trim pad cover. Refer to **Instrument Panel Lower Trim Pad Cover Replacement (without Knee Airbag)** , **Instrument Panel Lower Trim Pad Cover Replacement (with Knee Airbag)** .

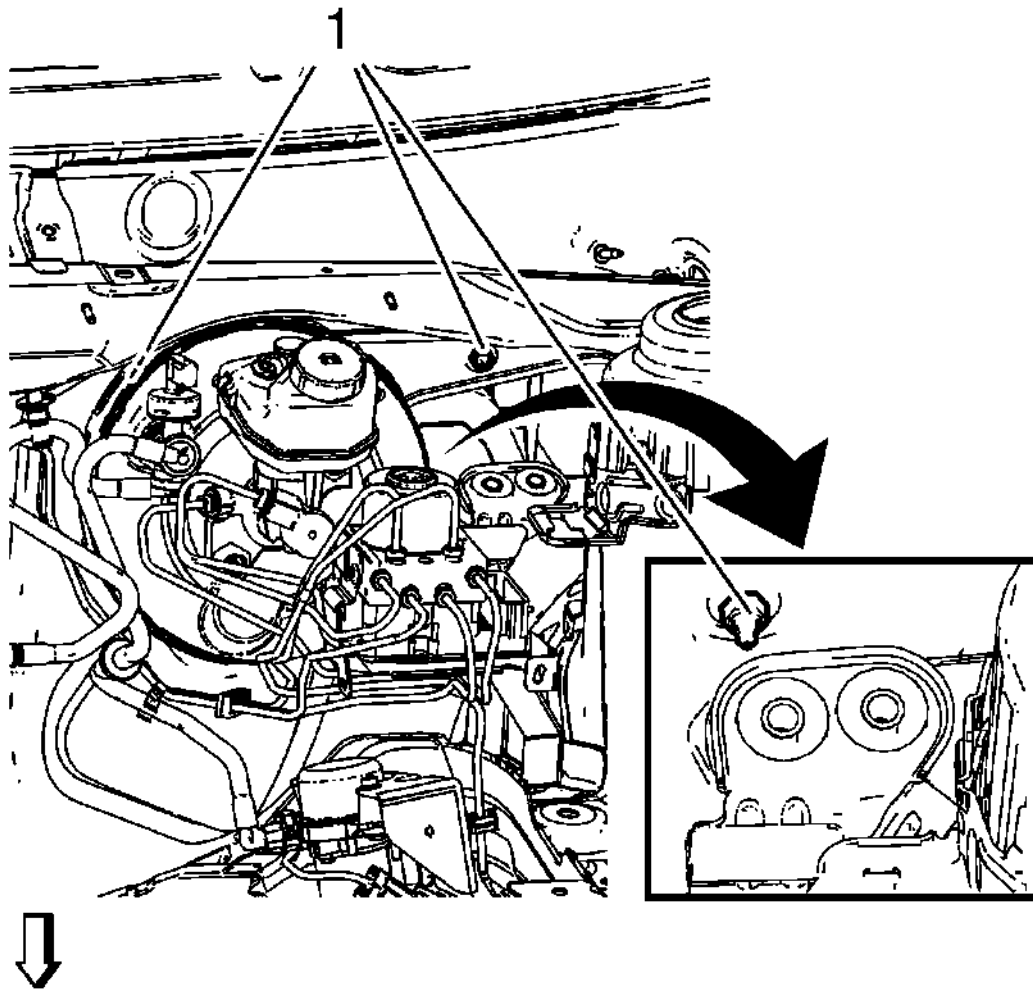


Fig. 30: Identifying Brake Pedal Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Do NOT open the hydraulic brake system.
- Second mechanic is required.

15. Pull the brake booster and the BPMV assembly forward in order to get an access to the brake pedal bracket nuts (1).
16. Install the pedal bracket nuts (1) and tighten to 20 N.m (15 lb ft).

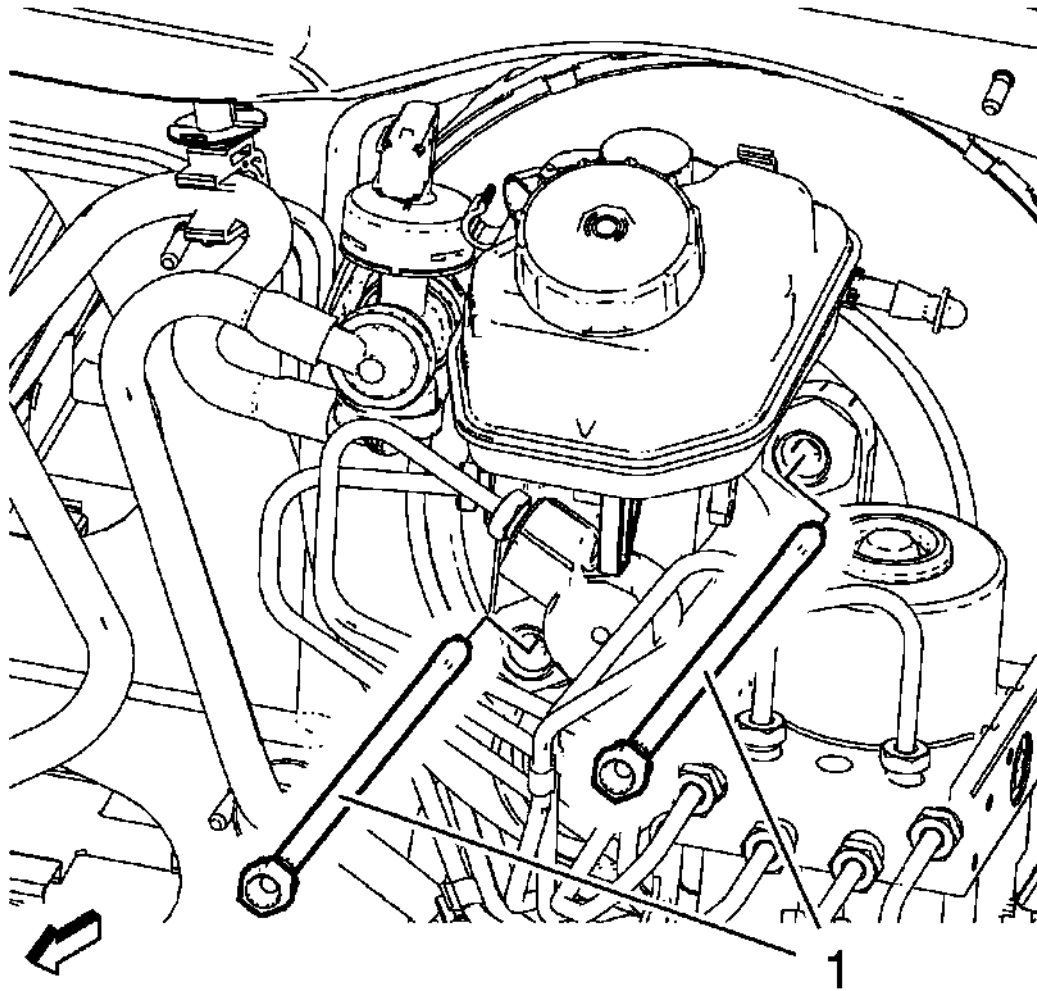


Fig. 31: Brake Booster Bolts

Courtesy of GENERAL MOTORS COMPANY

17. Install the brake booster bolts (1) and tighten to 19 N.m (14 lb ft).

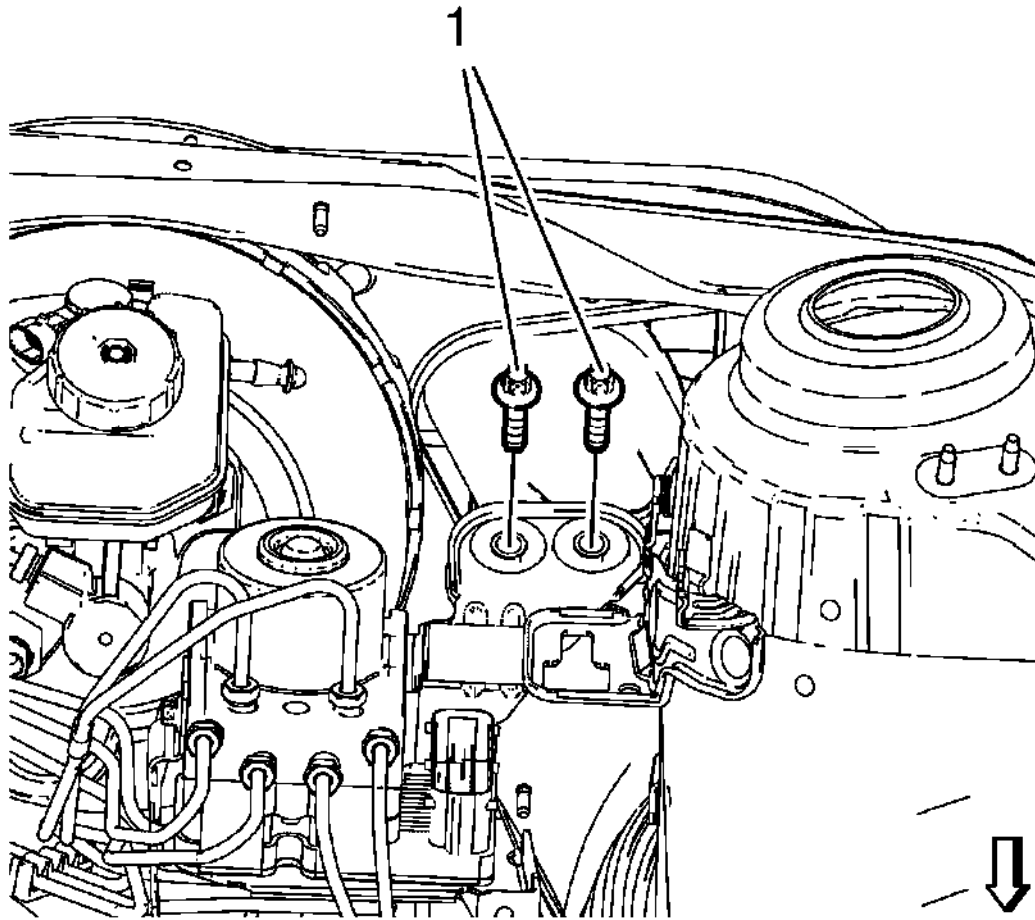


Fig. 32: BPMV Bracket Bolts

Courtesy of GENERAL MOTORS COMPANY

18. Install the BPMV bracket bolts (1) and tighten to 20 N.m (15 lb ft).

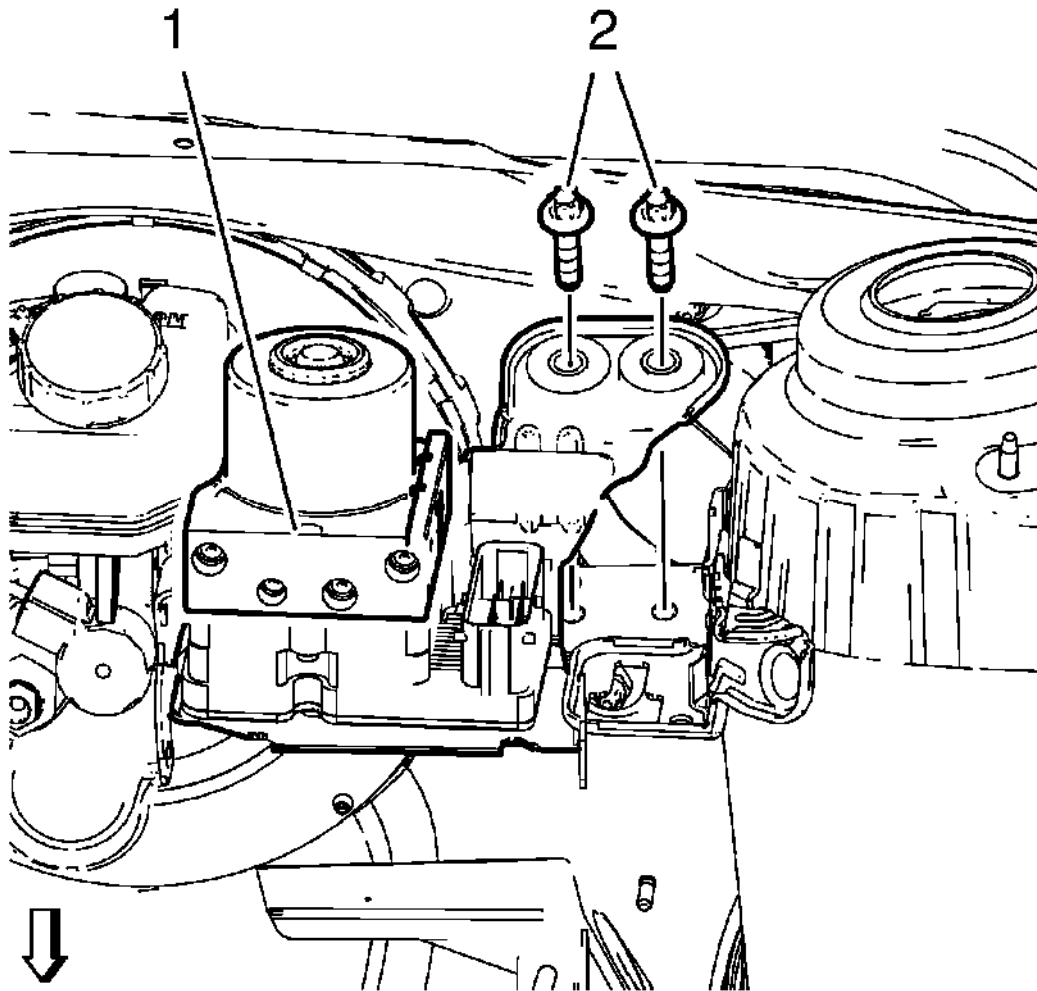


Fig. 33: BPMV and BPMV Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

19. Install the BPMV bracket assembly (1).
20. Install the BPMV bracket bolts (2) and tighten to 20 N.m (15 lb ft).

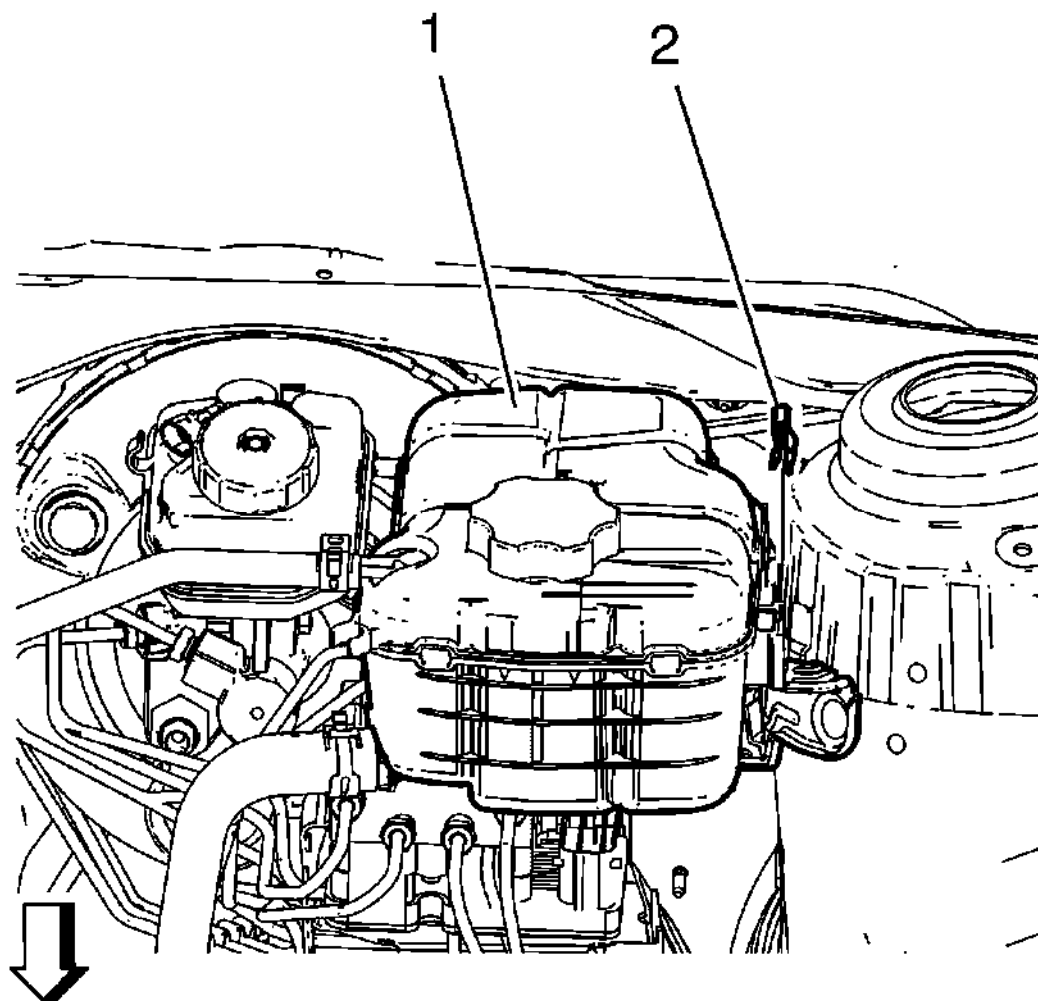


Fig. 34: View Of Radiator Surge Tank And Radiator Surge Tank Clip
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT disconnect the engine coolant hoses.

21. Install the radiator surge tank (1).
22. Install the radiator surge tank clip (2).
23. Install the battery tray. Refer to **Battery Tray Replacement** .
24. Install the battery. Refer to **Battery Replacement** .
25. Calibrate the brake pedal position sensor. Refer to **Brake Pedal Position Sensor Calibration** .

BRAKE PIPE REPLACEMENT

Special Tools

CH-45405 Pipe Flaring Tool Kit

2013 Chevrolet Cruze

2013 BRAKES Hydraulic Brakes - Cruze

For equivalent regional tools, refer to Special Tools.

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.

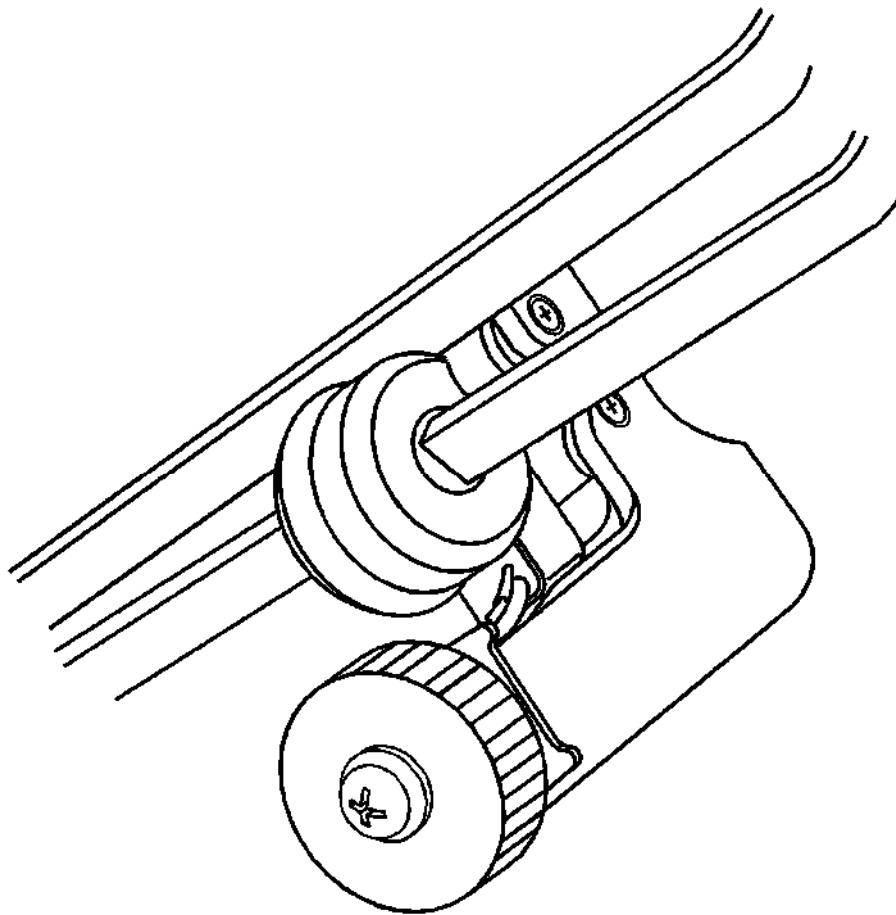


Fig. 35: Sectioning Brake Pipe Using Pipe Cutter
Courtesy of GENERAL MOTORS COMPANY

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** flaring tool.
 - 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** flaring tool, 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.

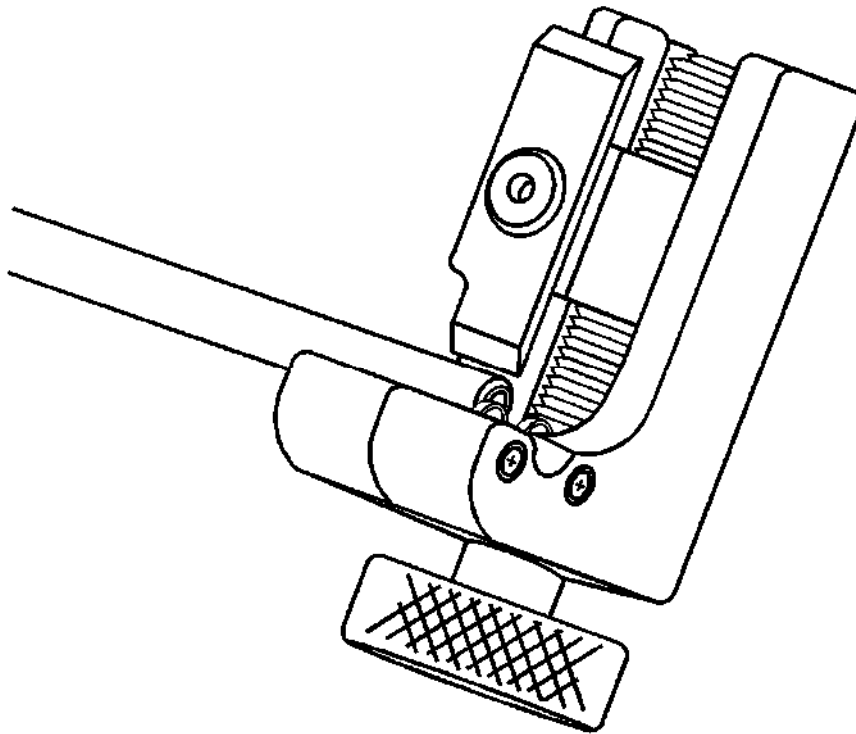


Fig. 36: Stripping Nylon Coating From Brake Pipe Ends
Courtesy of GENERAL MOTORS COMPANY

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

Specification

2013 Chevrolet Cruze

2013 BRAKES Hydraulic Brakes - Cruze

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

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

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

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

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

Specification

- 6.35 mm (0.250 in) for 4.76 mm (3/16 in) diameter pipe
- 9.50 mm (0.374 in) for 6.35 mm (1/4 in) and 7.94 mm (5/16 in) diameter pipe

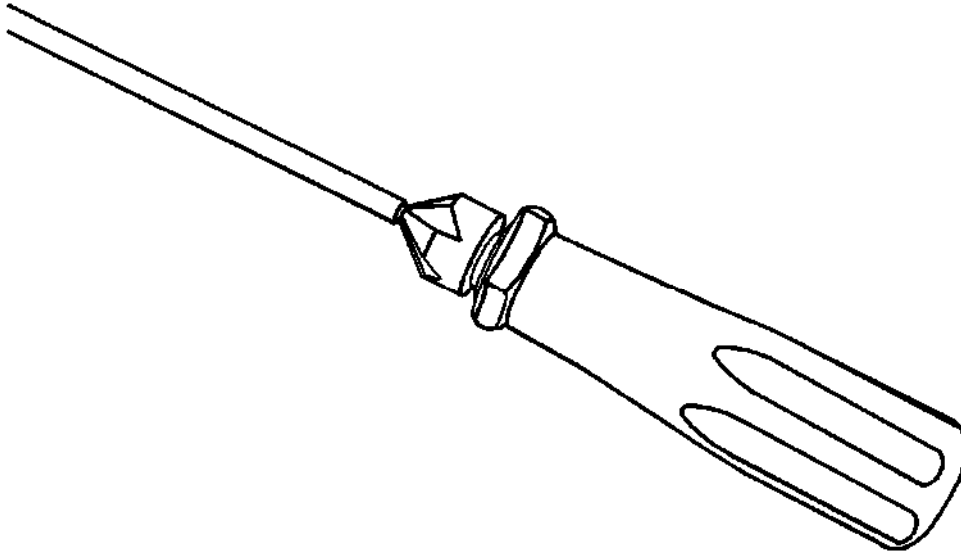


Fig. 37: Chamfering Pipe Using De-Burring Tool
Courtesy of GENERAL MOTORS COMPANY

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

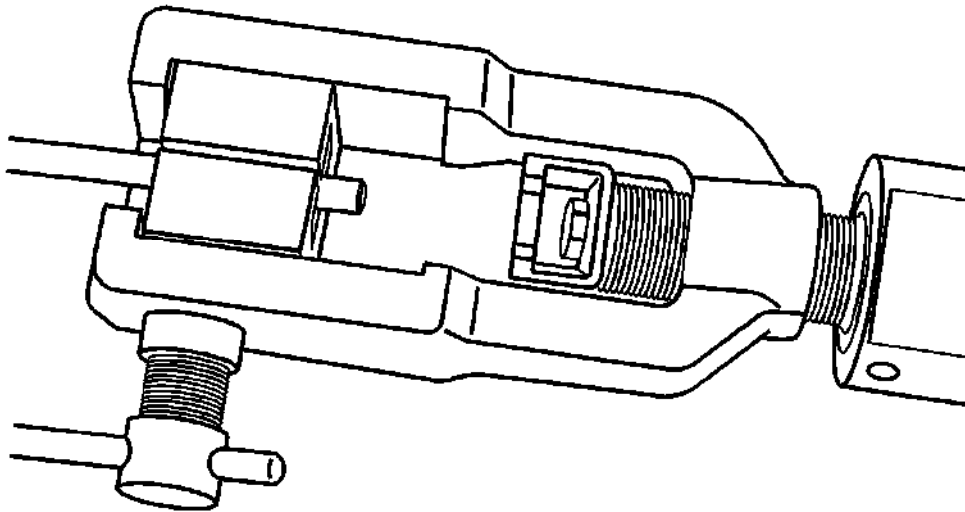


Fig. 38: Die Halves And Die Cage

Courtesy of GENERAL MOTORS COMPANY

13. Loosen the die clamping screw of the **CH-45405** flaring tool.
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.

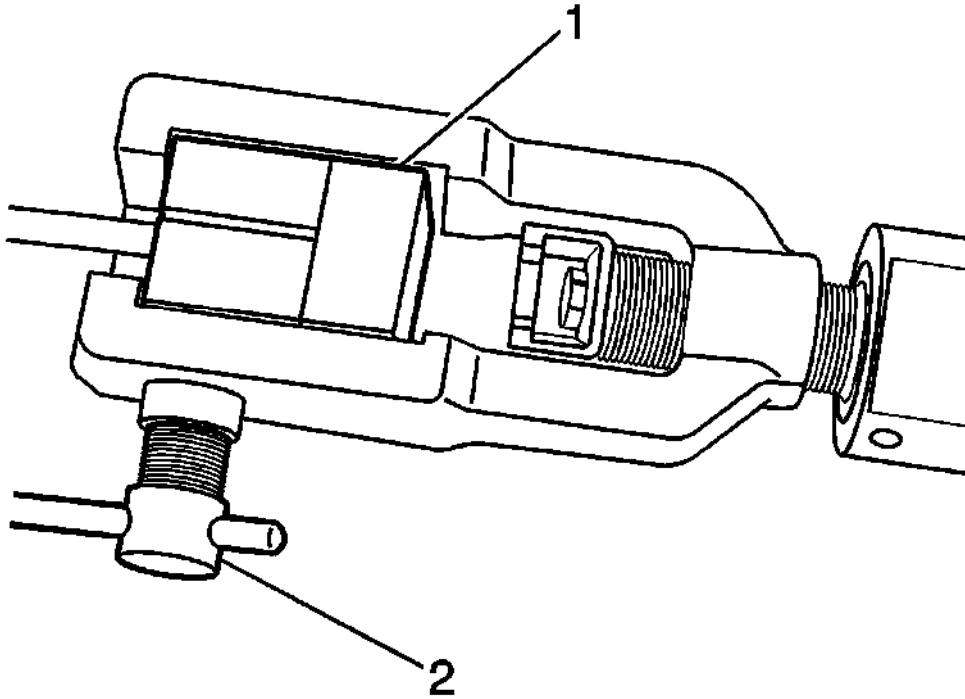


Fig. 39: View Of Clamping Screw & Unused Die
Courtesy of GENERAL MOTORS COMPANY

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.

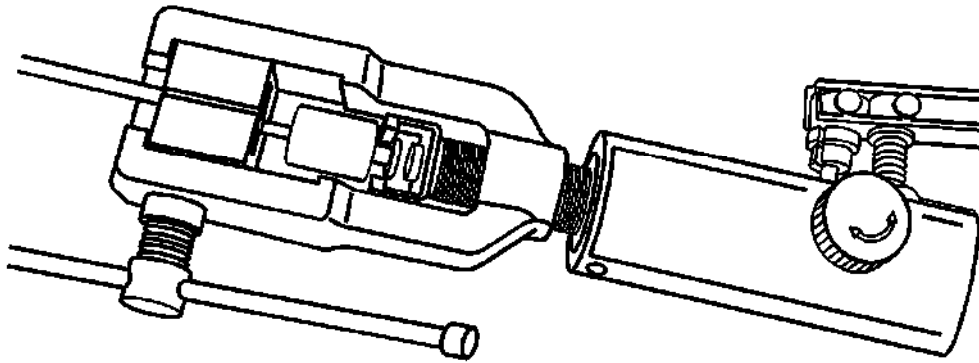


Fig. 40: View Of J 45405 And Die Cage
Courtesy of GENERAL MOTORS COMPANY

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** flaring tool until it bottoms against the die cage.

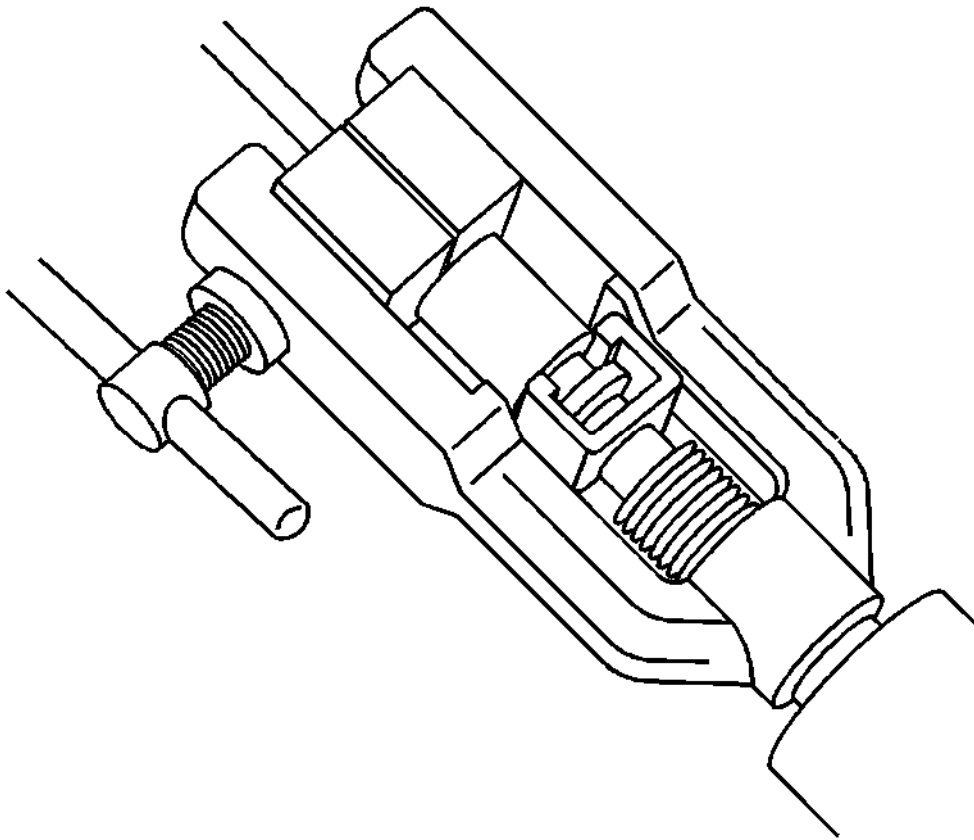


Fig. 41: View Of J 45405

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** flaring tool 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.

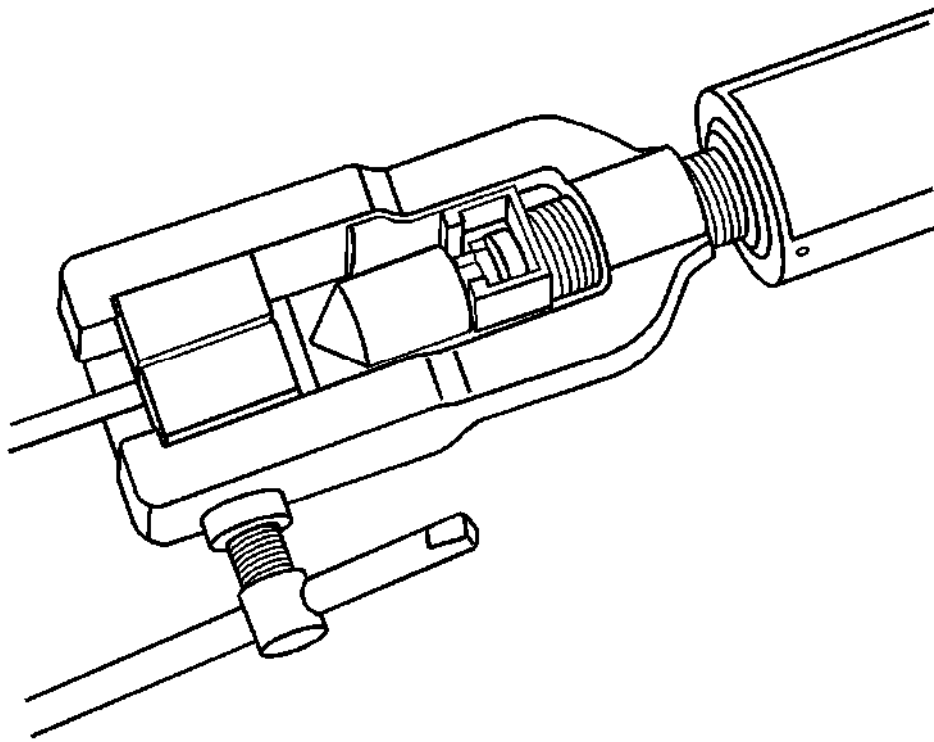


Fig. 42: Using Pipe Flaring Tool

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** flaring tool 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** flaring tool 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.

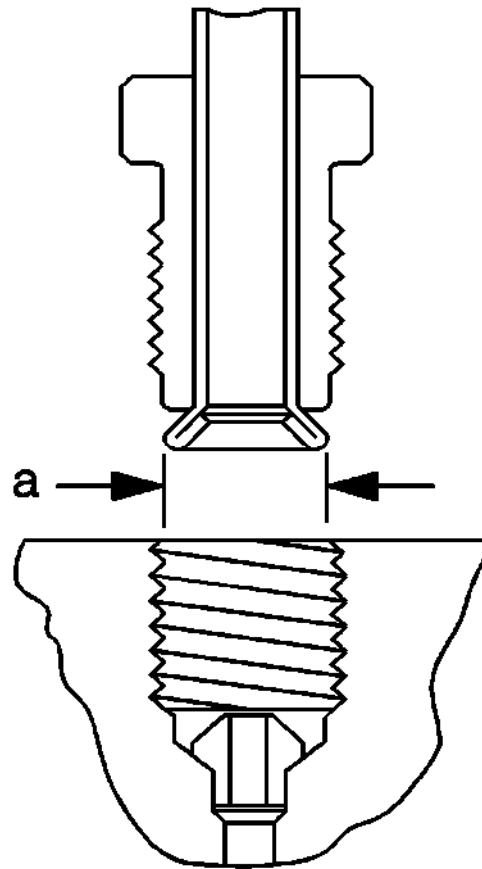


Fig. 43: Identifying Correct Brake Pipe Flare Shape & Diameter
 Courtesy of GENERAL MOTORS COMPANY

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.

2013 Chevrolet Cruze

2013 BRAKES Hydraulic Brakes - Cruze

36. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual Bleeding)**, **Hydraulic Brake System Bleeding (Pressure Bleeding)**.
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

Removal Procedure

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** .

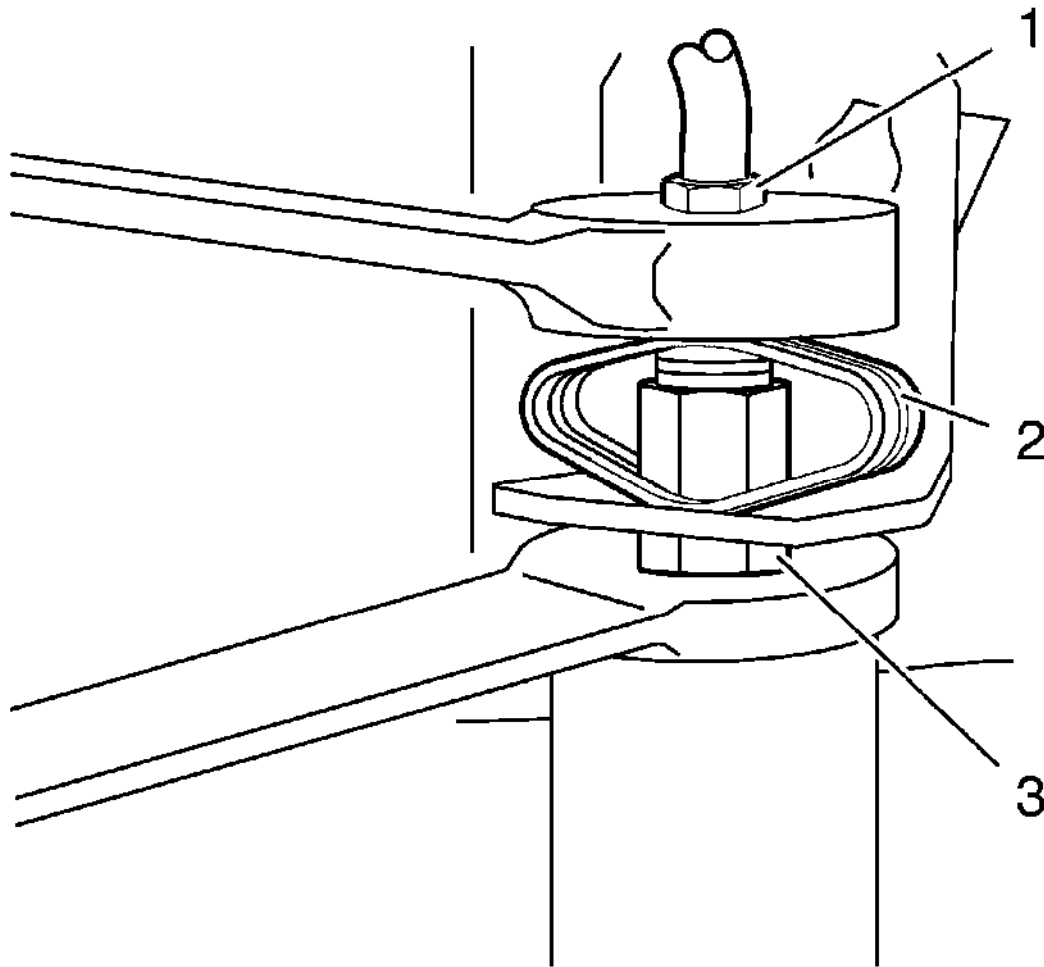


Fig. 44: Brake Pipe Fitting, Brake Hose And Brake Hose Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Clean all dirt and foreign material from the brake hose ends and the brake pipe fitting.
4. Use a flare nut wrench on the brake pipe fitting (1) and a backup wrench on the brake hose (3) under the brake hose retainer (2) as shown.

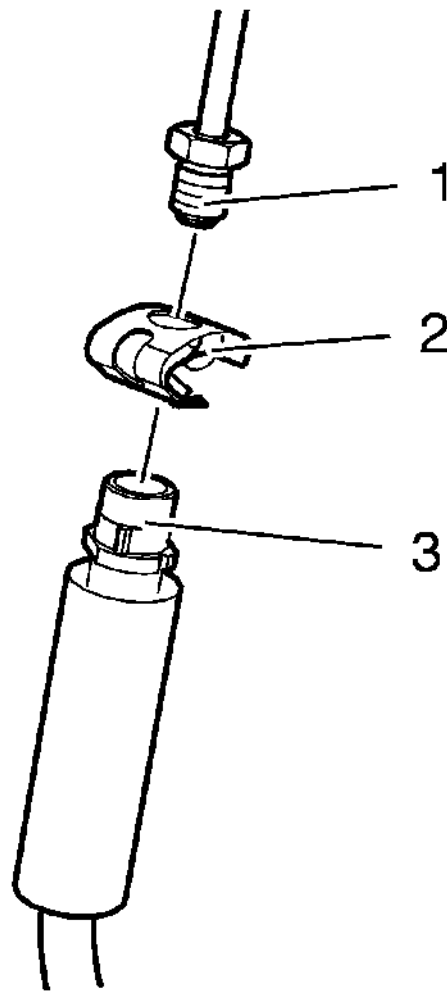


Fig. 45: Brake Pipe Fitting Disconnected From Brake Hose
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the brake pipe fitting (1) from the brake hose (3). Cap or plug the brake pipe fitting end and the brake hose end to prevent fluid loss and contamination.
6. Remove the brake hose retainer.
7. Remove the brake hose from the strut.
8. Remove the brake hose-to-caliper bolt from the brake caliper.
9. Remove the brake hose (3) from the brake caliper.
10. Remove and discard the 2 copper brake hose gaskets. These gaskets may be stuck to the brake caliper and/or the brake hose end.
11. Cap or plug the opening in the brake caliper and the brake hose to prevent fluid loss and contamination.

Installation Procedure

1. Remove the caps or plugs from the opening in the brake caliper and the brake hose.

NOTE: Install NEW copper brake hose gaskets.

2. Assemble the NEW copper brake hose gaskets and the brake hose bolt to the brake hose.

CAUTION: Refer to Fastener Caution .

3. Install the brake hose-to-brake caliper bolt to the brake caliper and tighten the bolt to 40 N.m (30 lb ft).

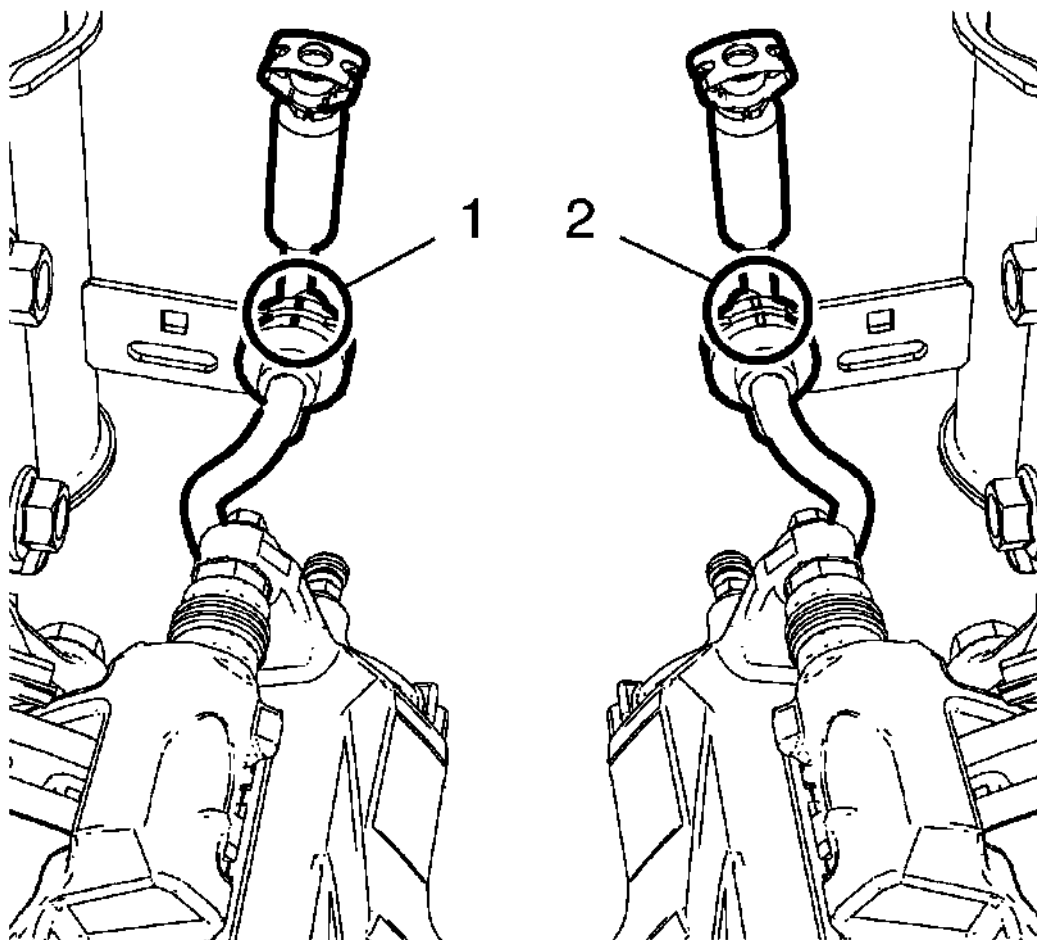


Fig. 46: Brake Hoses And Struts

Courtesy of GENERAL MOTORS COMPANY

NOTE: If replacing the brake hose, compare the old and new brake hose. There is a new version of brake hoses, which has a labeling to differentiate left and right side. The new version has a brake grommet with a flattened side, which has to face to the open side of the brake hose bracket.

4. Install the brake hose to the strut.

Align the blue marking at the front brake hose grommet with the center of the bracket notch for the right front brake hose.

Align the white marking at the front brake hose grommet with the center of the bracket notch for the left front brake hose.

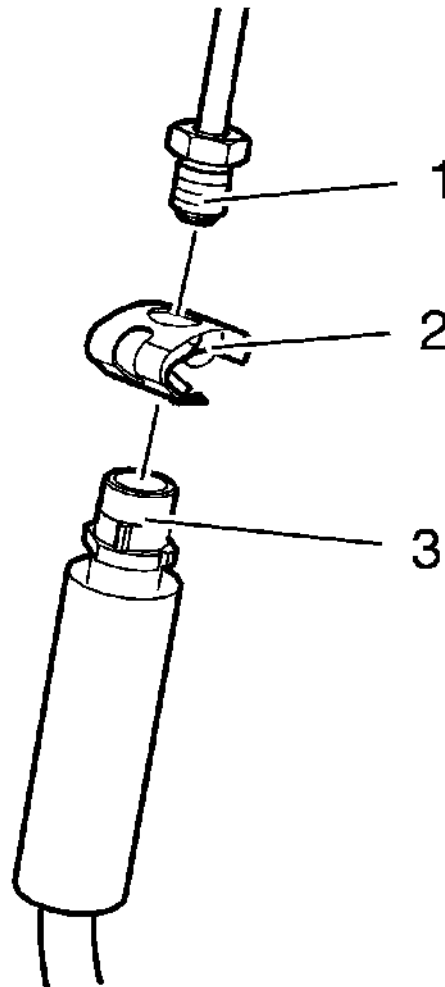


Fig. 47: Brake Pipe Fitting Disconnected From Brake Hose
Courtesy of GENERAL MOTORS COMPANY

5. Remove the caps or plugs from the brake pipe fitting end and the brake hose end.
6. Install the brake hose to the brake hose body bracket.
7. Install the brake hose retainer (2) over the anti-rotation tabs of the brake hose (3).
8. Connect the brake pipe fitting (1) to the brake hose.
9. Use a backup wrench on the brake hose.

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10. Tighten the brake pipe fitting to 18 N.m (14 lb ft).
11. Ensure that the hose does not make contact with any part of the suspension. Check the hose in extreme right and extreme left turn conditions. If the hose makes contact, remove the hose and correct the condition.
12. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual Bleeding)**, **Hydraulic Brake System Bleeding (Pressure Bleeding)**.
13. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
14. Lower the vehicle.

REAR BRAKE HOSE REPLACEMENT (DISC BRAKE)

Removal Procedure

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** .
3. Remove rear wheel speed sensor from brake hose. Refer to **Rear Wheel Speed Sensor Replacement (Disc Brake)** , **Rear Wheel Speed Sensor Replacement (Drum Brake)** .

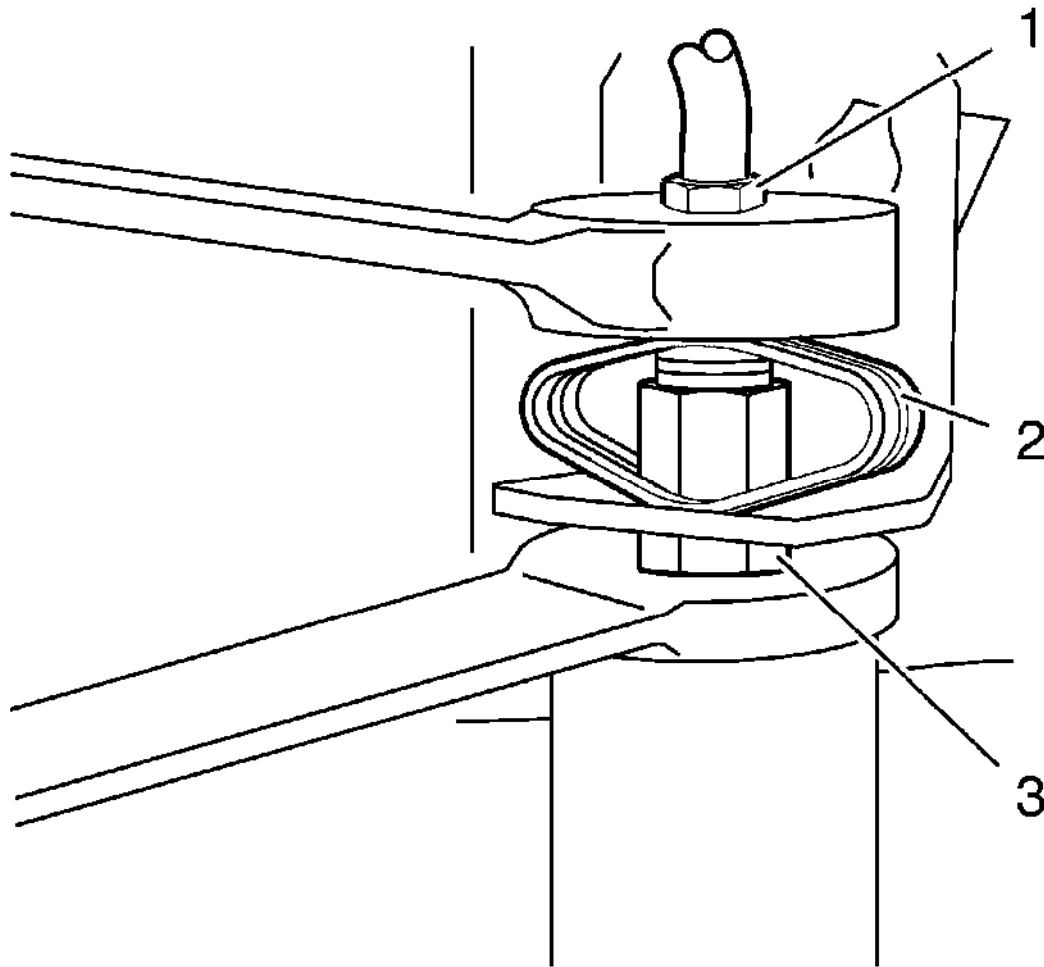


Fig. 48: Brake Pipe Fitting, Brake Hose And Brake Hose Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Clean all dirt and foreign material from the brake hose ends and the brake pipe fitting.
5. Use a flare nut wrench on the brake pipe fitting (1) and a backup wrench on the brake hose (3) under the brake hose retainer (2).

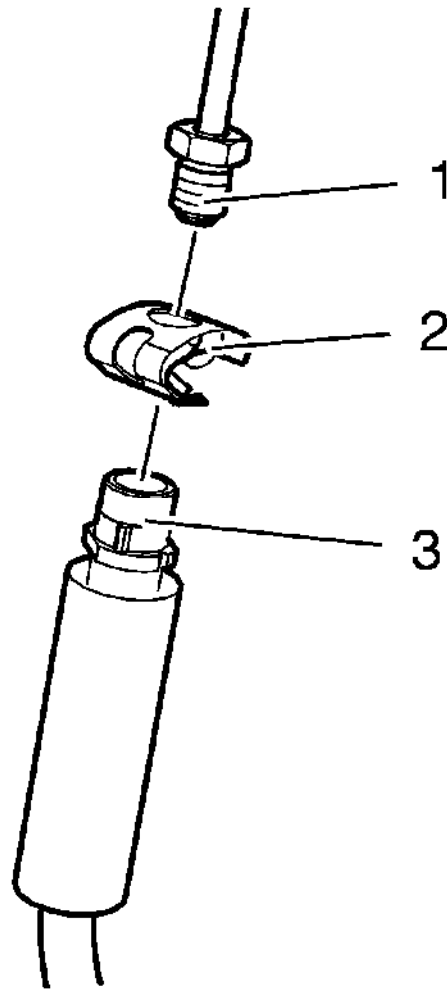


Fig. 49: Brake Pipe Fitting Disconnected From Brake Hose
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the brake pipe fitting (1) from the brake hose (3). Cap or plug the brake pipe fitting end and the brake hose end to prevent fluid loss and contamination.
7. Remove the brake hose retainer (2).

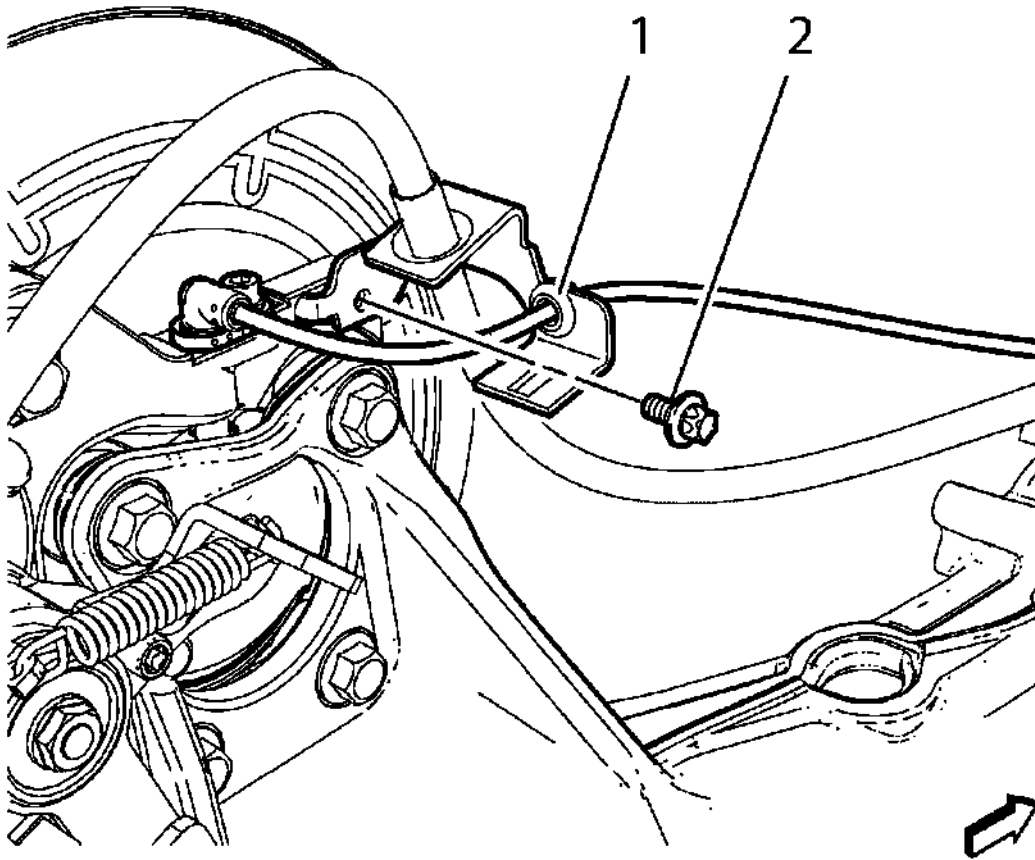


Fig. 50: Brake Hose Bracket

Courtesy of GENERAL MOTORS COMPANY

8. Remove the brake hose bolt (2) attaching the hose to the rear brake caliper bracket.
9. Remove wiring harness (1) from brake hose bracket.

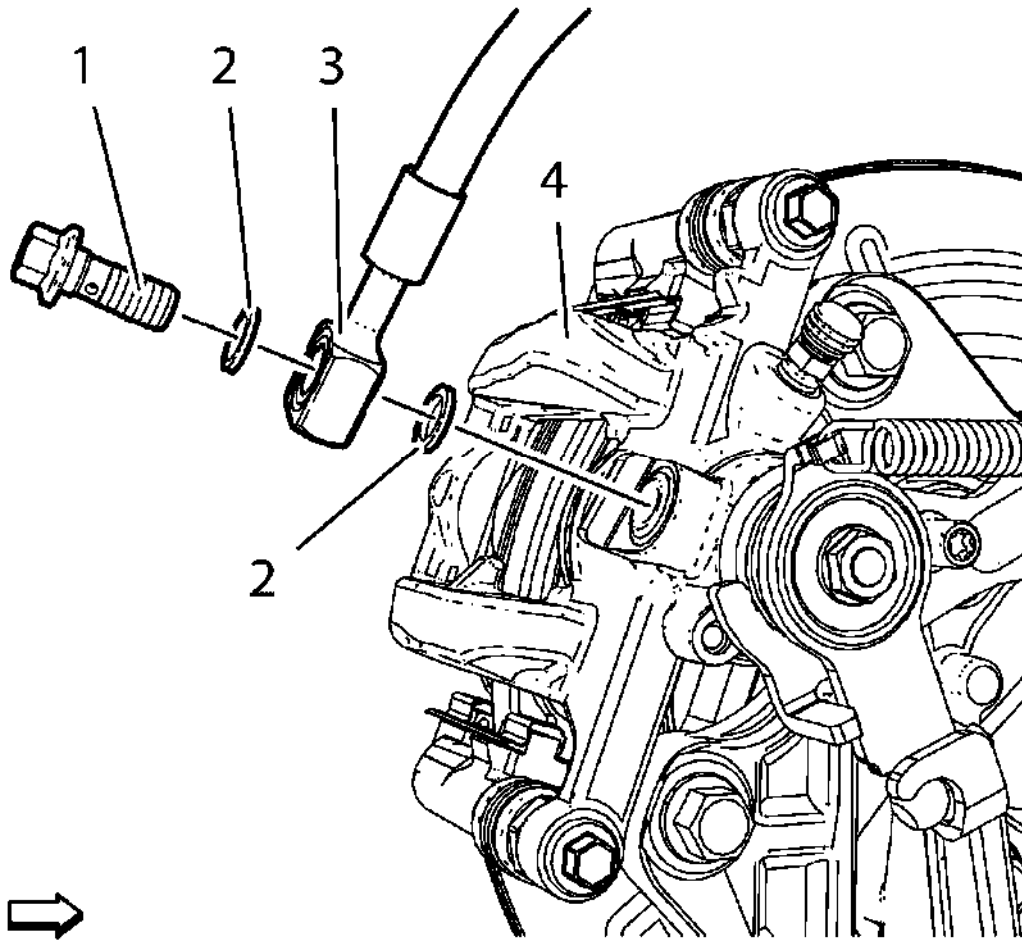


Fig. 51: Brake Hose-To-Caliper Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove the brake hose-to-caliper bolt (1) from the brake caliper (4).
11. Remove the brake hose (3) from the brake caliper.
12. Remove and discard the 2 copper brake hose gaskets (2). These gaskets may be stuck to the brake caliper and/or the brake hose end.
13. Cap or plug the opening in the brake caliper and the brake hose to prevent fluid loss and contamination.

Installation Procedure

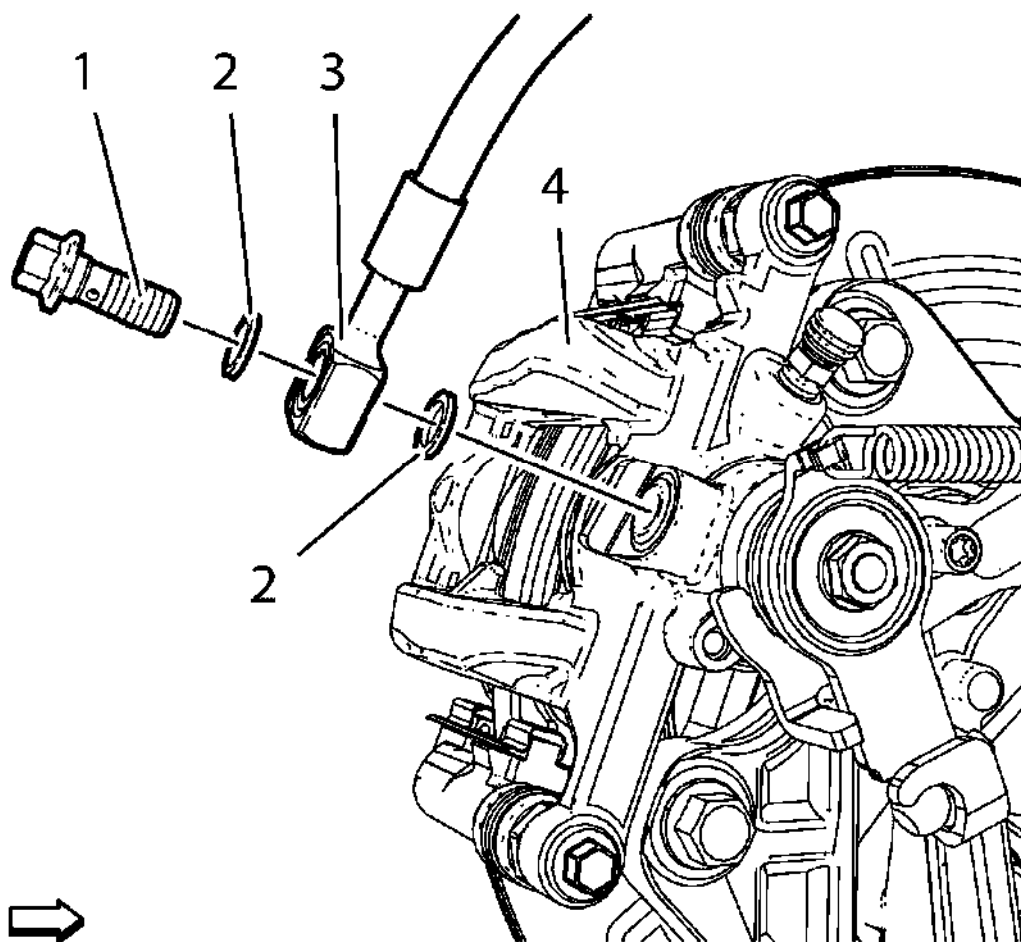


Fig. 52: Brake Hose-To-Caliper Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the caps or plugs from the opening in the brake caliper and the brake hose.

NOTE: Install NEW copper brake hose gaskets.

2. Assemble the NEW copper brake hose gaskets (2), and the brake hose bolt (1), to the brake hose (3).

CAUTION: Refer to Fastener Caution .

3. Install the brake hose-to-brake caliper bolt to the brake caliper (4) and tighten the bolt to 40 N.m (30 lb ft).

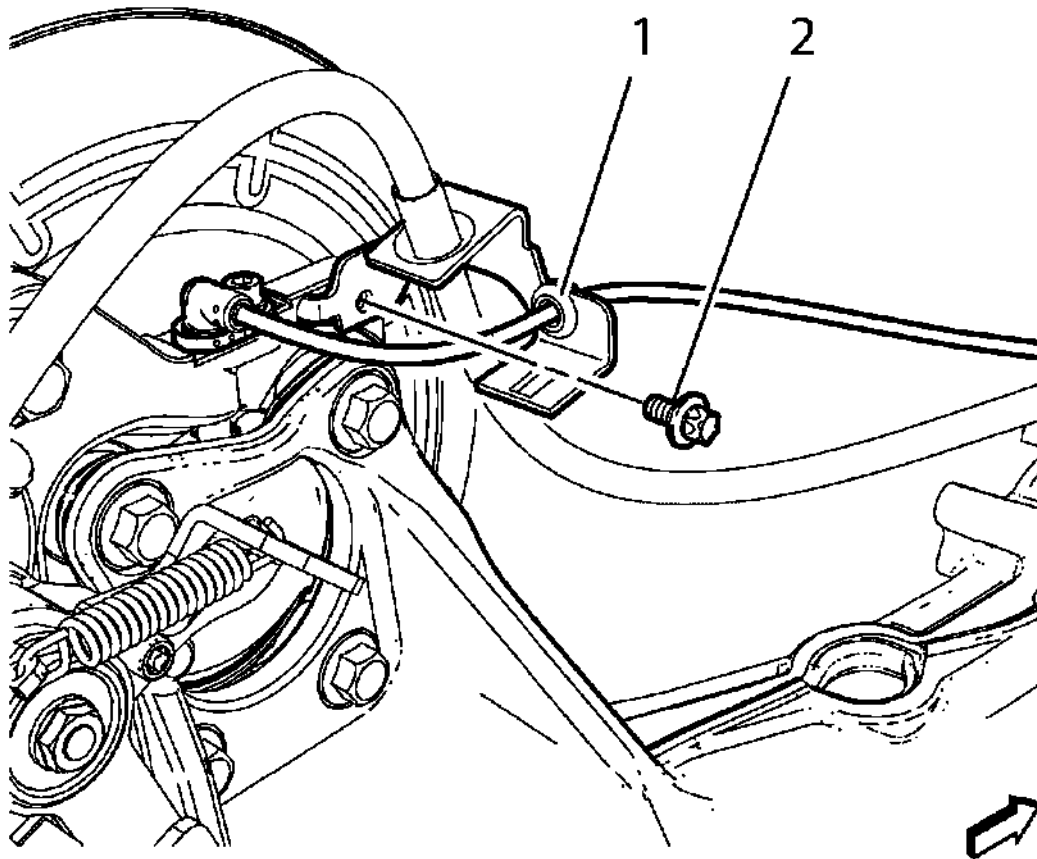


Fig. 53: Brake Hose Bracket

Courtesy of GENERAL MOTORS COMPANY

4. Install the brake hose bolt (2) attaching the hose to the rear brake caliper bracket and tighten the bolt to 9 N.m (80 lb in).
5. Install wiring harness (1) at the brake hose bracket.

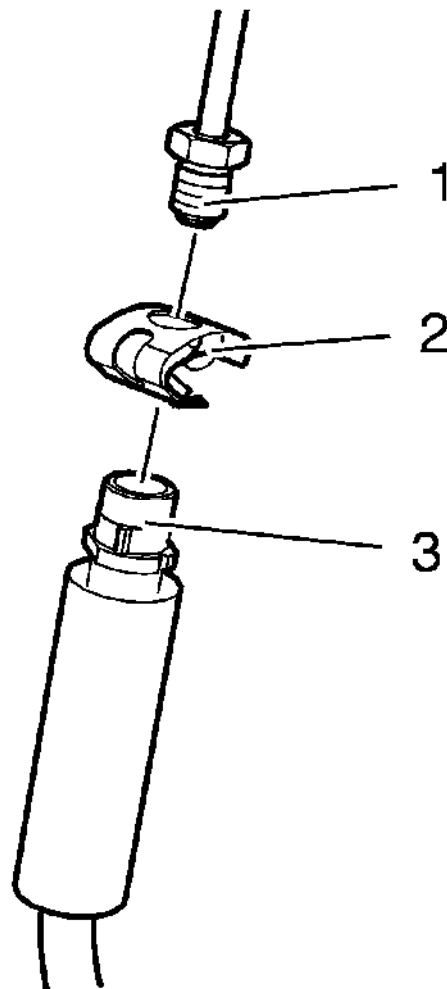


Fig. 54: Brake Pipe Fitting Disconnected From Brake Hose
Courtesy of GENERAL MOTORS COMPANY

6. Remove the caps or plugs from the brake pipe fitting end and the brake hose end.
7. Install the brake hose to the brake hose body bracket.
8. Install the brake hose retainer (2) over the anti-rotation tabs of the brake hose (3).
9. Connect the brake pipe fitting (1) to the brake hose (3).
10. Use a backup wrench on the brake hose (3).
11. Tighten the brake pipe fitting to 18 N.m (13 lb ft).
12. Ensure that the hose does not make contact with any part of the suspension. Check the hose in extreme right and extreme left turn conditions. If the hose makes contact, remove the hose and correct the condition.
13. Install rear wheel speed sensor to brake hose. Refer to **Rear Wheel Speed Sensor Replacement (Disc Brake)** , **Rear Wheel Speed Sensor Replacement (Drum Brake)** .
14. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual Bleeding)**.

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Hydraulic Brake System Bleeding (Pressure Bleeding).

15. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
16. Lower the vehicle.

REAR BRAKE HOSE REPLACEMENT (DRUM BRAKE)

Removal Procedure

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** .
3. Remove rear wheel speed sensor from brake hose. Refer to **Rear Wheel Speed Sensor Replacement (Disc Brake)** , **Rear Wheel Speed Sensor Replacement (Drum Brake)** .

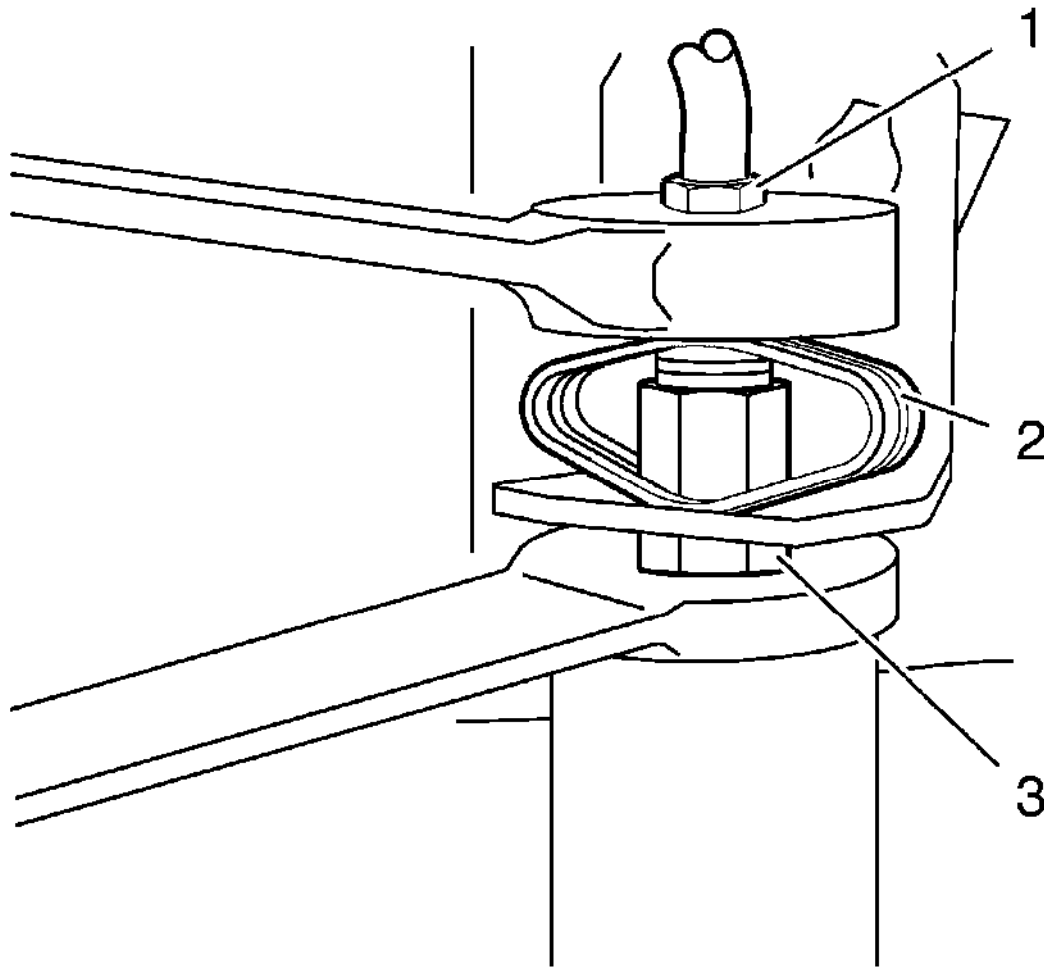


Fig. 55: Brake Pipe Fitting, Brake Hose And Brake Hose Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Clean all dirt and foreign material from the brake hose ends and the brake pipe fitting.
5. Use a flare nut wrench on the brake pipe fitting (1) and a backup wrench on the brake hose (3) under the brake hose retainer (2).

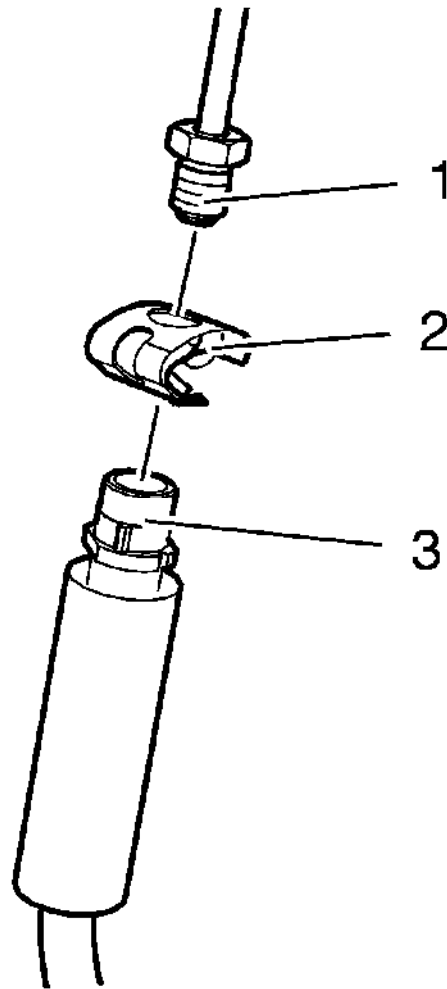


Fig. 56: Brake Pipe Fitting Disconnected From Brake Hose
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the brake pipe fitting (1) from the brake hose (3). Cap or plug the brake pipe fitting end and the brake hose end to prevent fluid loss and contamination.
7. Remove the brake hose retainer (2).

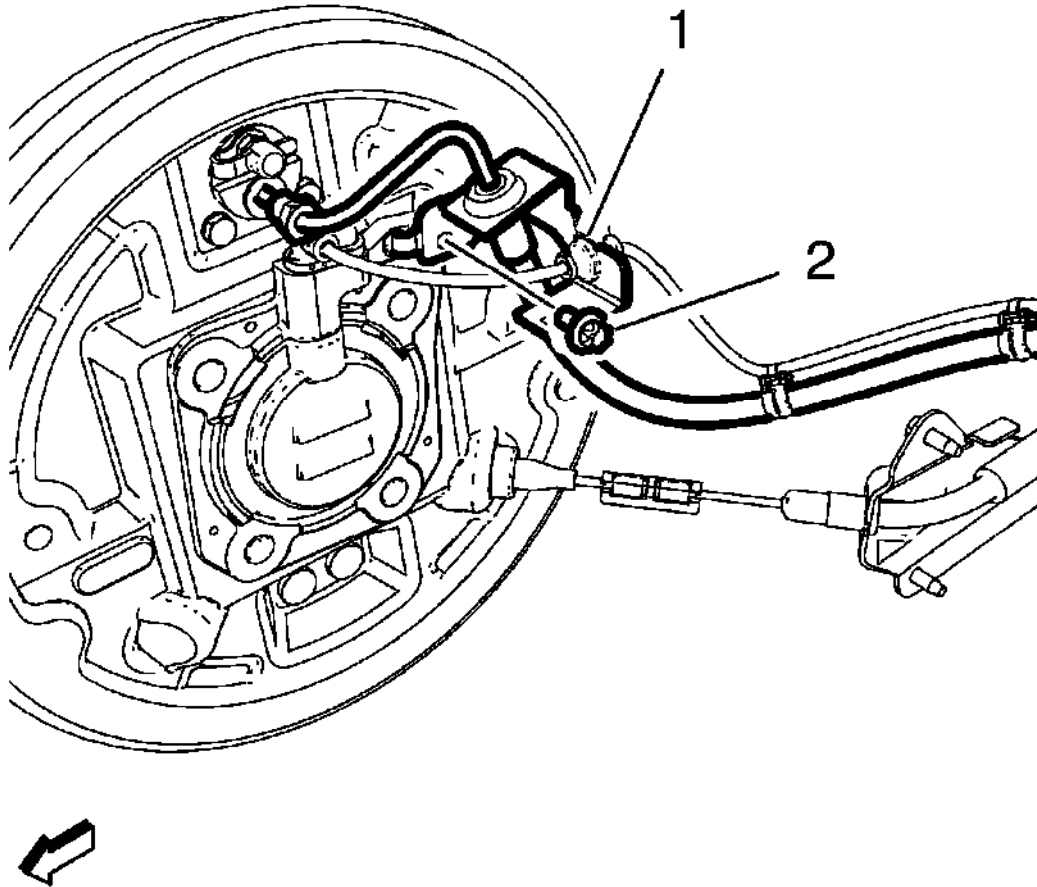


Fig. 57: Brake Hose Bracket And Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

8. Remove the brake hose bolt (2) attaching the hose to the rear backing plate.
9. Remove wiring harness (1) from brake hose bracket.

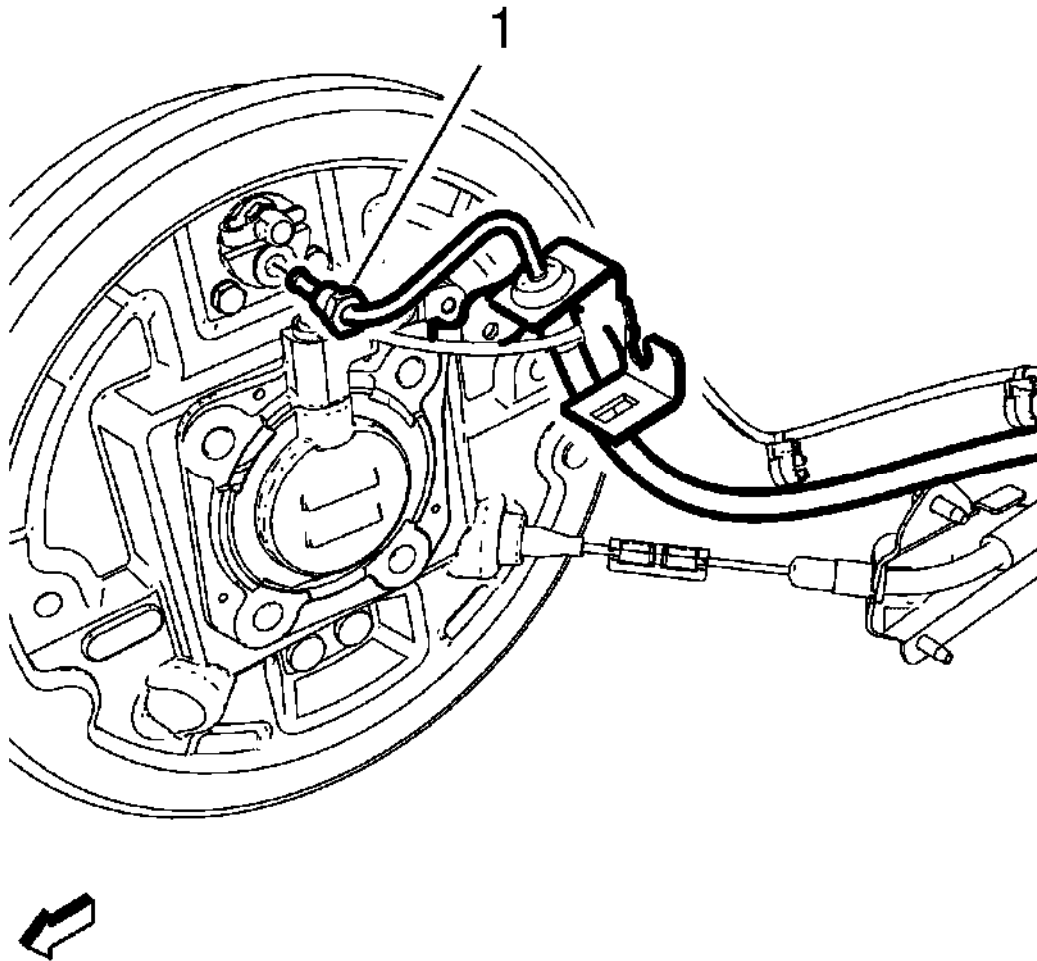


Fig. 58: Brake Hose And Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

10. Remove the brake hose / pipe fitting (1) from the wheel cylinder and cap the opening to prevent brake fluid contamination.

Installation Procedure

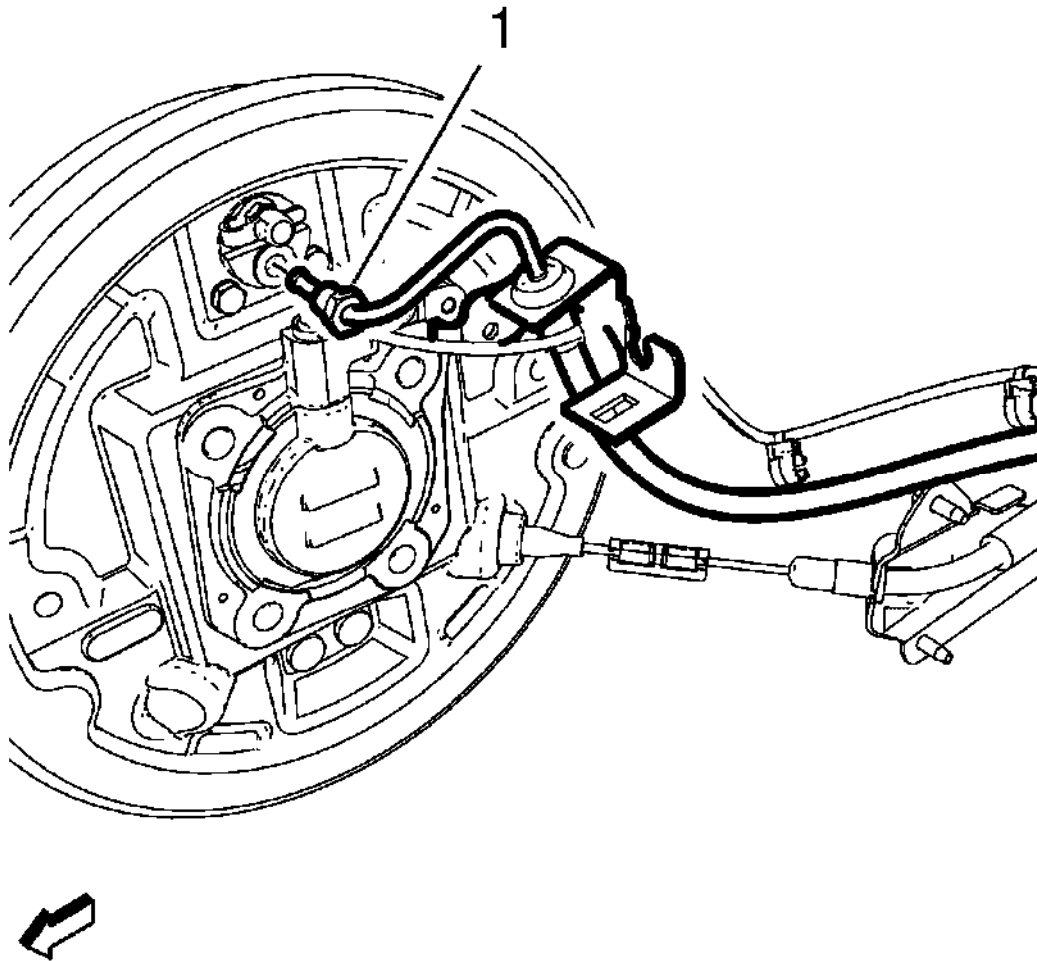


Fig. 59: Brake Hose And Pipe Fitting

Courtesy of GENERAL MOTORS COMPANY

1. Remove the caps or plugs from the opening in the wheel cylinder and the brake hose / pipe fitting.

CAUTION: Refer to Fastener Caution .

2. Install the brake hose / pipe fitting (1) to the wheel cylinder and tighten the brake pipe fitting to 18 N.m (13 lb ft)

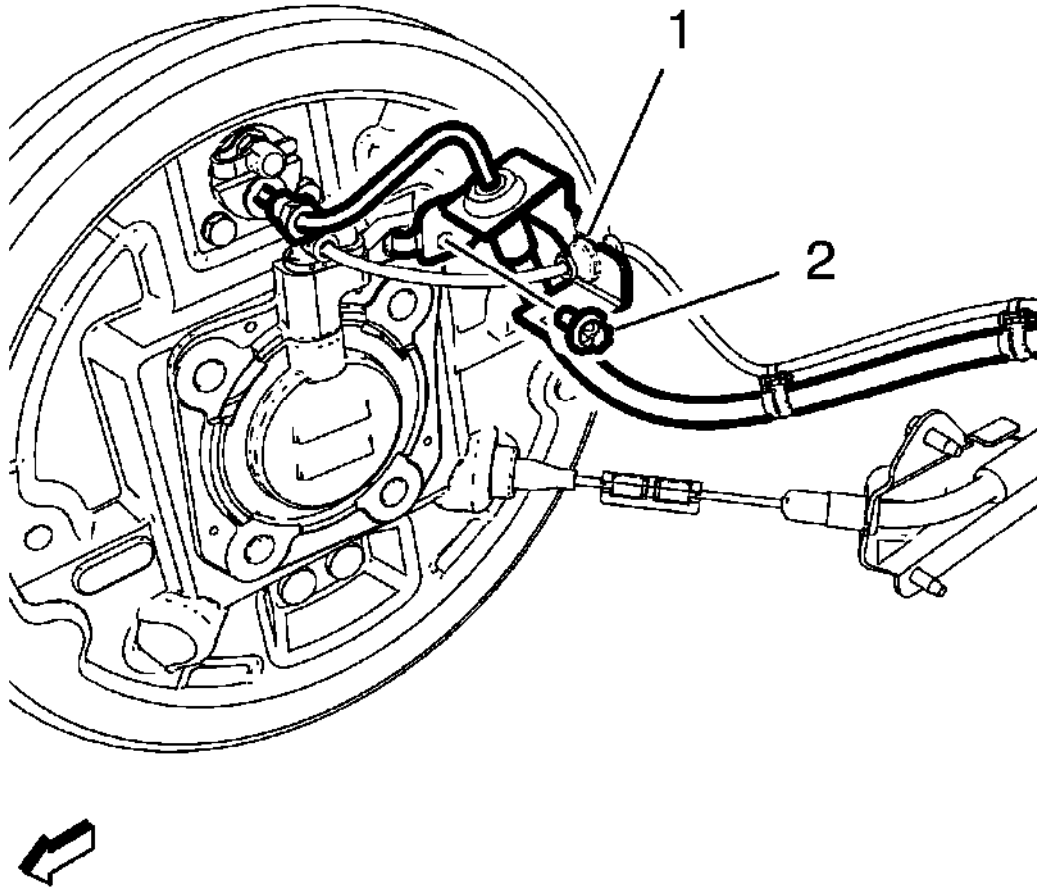


Fig. 60: Brake Hose Bracket And Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

3. Install the brake hose bolt (2) attaching the hose to the rear backing plate and tighten the bolt to 8 N.m (71 lb in).
4. Install wiring harness (1) at the brake hose bracket.

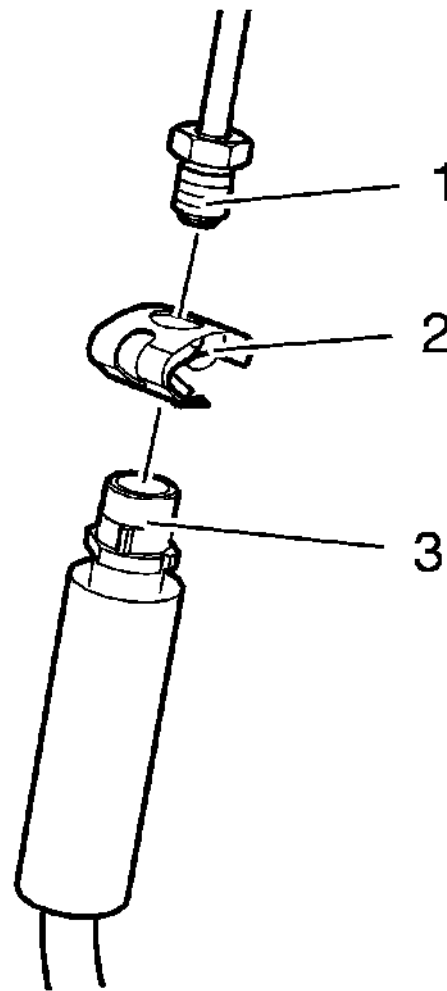


Fig. 61: Brake Pipe Fitting Disconnected From Brake Hose
Courtesy of GENERAL MOTORS COMPANY

5. Remove the caps or plugs from the brake pipe fitting end and the brake hose end.
6. Install the brake hose to the brake hose body bracket.
7. Install the brake hose retainer (2) over the anti-rotation tabs of the brake hose (3).
8. Connect the brake pipe fitting (1) to the brake hose (3).
9. Use a backup wrench on the brake hose (3).
10. Tighten the brake pipe fitting to 18 N.m (13 lb ft).
11. Ensure that the hose does not make contact with any part of the suspension. Check the hose in extreme right and extreme left turn conditions. If the hose makes contact, remove the hose and correct the condition.
12. Install rear wheel speed sensor to brake hose. Refer to **Rear Wheel Speed Sensor Replacement (Disc Brake)** , **Rear Wheel Speed Sensor Replacement (Drum Brake)** .
13. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual Bleeding)**.

Hydraulic Brake System Bleeding (Pressure Bleeding).

14. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
15. Lower the vehicle.

HYDRAULIC BRAKE SYSTEM BLEEDING (PRESSURE BLEEDING)

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

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

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.

If hydraulic components were serviced on only one wheel hydraulic circuit, perform the following procedure.

Bleeding a Single Hydraulic Brake Circuit

1. 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.
2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Fluid and Lubricant Recommendations** .

NOTE: **The pressure bleeding equipment must be the diaphragm type. The rubber diaphragm between the air supply and the brake fluid prevents air, moisture, oil, and other contaminants from entering the hydraulic system.**

5. Following the brake pressure bleeder manufacturer's instructions, fill the brake pressure bleeder with GM approved brake fluid from a clean, sealed brake fluid container.
6. Install the appropriate master cylinder reservoir adapter and connect the brake pressure bleeder.
7. Charge the brake pressure bleeder air tank to 170-200 kPa/1.7-2.0 bar (25-30 psi), or as recommended by the brake pressure bleeder manufacturer's instructions.
8. Open the brake pressure bleeder fluid tank valve to allow pressurized brake fluid to enter the brake hydraulic system.

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

9. Wait approximately 30 seconds, then inspect the entire hydraulic brake system for external brake fluid leaks.
10. Install a proper box-end wrench onto the wheel hydraulic circuit bleeder valve which has been serviced.
11. Install a transparent hose over the end of the bleeder valve.
12. Submerge the open end of the transparent hose into a transparent container partially filled with brake fluid from a clean, sealed brake fluid container.
13. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
14. Allow fluid to flow until air bubbles stop flowing from the bleeder.
15. After all air has been purged from the hydraulic circuit, tighten the bleeder valve and install the dust cap.

NOTE: The brake reservoir may have residual pressure after the bleeding operation is complete. Wrap a clean shop towel around the bleeder adapter and all hose connections before disconnecting the pressure bleeding equipment to prevent brake fluid from contacting and damaging vehicle components and painted surfaces.

16. Close the brake pressure bleeder fluid tank valve then disconnect the brake pressure bleeder from the master cylinder reservoir bleeder adapter.
17. Remove the master cylinder reservoir bleeder adapter from the master cylinder reservoir.
18. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved brake fluid from a clean, sealed brake fluid container.
19. Slowly press and release the brake pedal. Observe the brake pedal feel.
20. If the brake pedal feels spongy, perform the Bleeding the Complete Brake Hydraulic System procedure:
21. 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.

22. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle**.

Bleeding the Complete Brake Hydraulic System

1. 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.
2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Fluid and Lubricant Recommendations**.
5. If the master cylinder was replaced, the master cylinder must be bench bled. Refer to **Master Cylinder**

Bench Bleeding.

6. If the brake pipes have been removed from the master cylinder, the following steps must be performed.
 1. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe fitting from the front port of the brake master cylinder.
 2. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder. Capture and properly dispose of the brake fluid in an approved container.
 3. Install the front brake pipe fitting to the front port of the brake master cylinder and tighten the fitting.
 4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
 5. Loosen the front brake pipe fitting from the front port of the brake master cylinder to purge air from the master cylinder port.
 6. Tighten the front brake pipe fitting, then have the assistant slowly release the brake pedal.
 7. Wait 15 seconds, then repeat steps 6.4-6.6 until all air is purged from the front brake pipe fitting of the front port of the master cylinder.
 8. After all air is purged from the front port of the brake master cylinder, tighten the front master cylinder brake pipe fitting. Refer to **Fastener Tightening Specifications**.
 9. With the front brake pipe fitting installed securely to the front port of the brake master cylinder, loosen and separate the rear brake pipe fitting from the rear port of the brake master cylinder.
 10. Repeat steps 6.2-6.7 for the rear port of the brake master cylinder.
 11. After all air is purged from the rear port of the brake master cylinder, tighten the rear master cylinder brake pipe fitting. Refer to **Fastener Tightening Specifications**.
 12. Slowly press and release the brake pedal. Observe the brake pedal feel.
 13. If the brake pedal feels spongy, proceed to step 7.
 14. If the brake pedal feels firm, proceed to step 24.
7. If the brake pipes have been removed from the brake pressure modulator valve (BPMV) assembly, if equipped, or the brake proportion valve assembly, if equipped, air must be purged from each port of the respective assembly beginning with the feed pipes from the master cylinder.
 1. Loosen and separate one of the master cylinder brake pipe fittings from the inlet port of the assembly to be bled.
 2. Allow a small amount of brake fluid to gravity bleed from the open port of the assembly. Capture and properly dispose of the brake fluid in an approved container.
 3. Install the brake pipe fitting and to the inlet port of the assembly and tighten securely.
 4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
 5. Loosen the same brake pipe fitting to purge air from the open port of the assembly.
 6. Tighten the brake pipe fitting, then have the assistant slowly release the brake pedal.
 7. Wait 15 seconds, then repeat steps 7.4-7.6 until all air is purged from the brake pipe fitting of the assembly.
 8. Repeat steps 7.1-7.7 for all of the remaining ports of the assembly.
 9. After bleeding each port of the assembly, tighten all of the brake pipe fittings on the assembly. Refer to **Fastener Tightening Specifications**.
 10. Fill the master cylinder reservoir to the maximum-full level with GM approved brake fluid from a

clean, sealed brake fluid container.

11. Slowly press and release the brake pedal. Observe the brake pedal feel.
12. If the brake pedal feels spongy, proceed to step 8.
13. If the brake pedal feels firm, proceed to step 24.

NOTE: **The pressure bleeding equipment must be the diaphragm type. The rubber diaphragm between the air supply and the brake fluid prevents air, moisture, oil, and other contaminants from entering the hydraulic system.**

8. Following the brake pressure bleeder manufacturer's instructions, fill the brake pressure bleeder with GM approved brake fluid from a clean, sealed brake fluid container.
9. Install the appropriate master cylinder reservoir adapter and connect the brake pressure bleeder.
10. Charge the brake pressure bleeder air tank to 170-200 kPa/1.7-2.0 bar (25-30 psi), or as recommended by the brake pressure bleeder manufacturer's instructions.
11. Open the brake pressure bleeder fluid tank valve to allow pressurized brake fluid to enter the brake hydraulic system.

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

12. Wait approximately 30 seconds, then inspect the entire hydraulic brake system for external brake fluid leaks.
13. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
14. Install a transparent hose over the end of the bleeder valve.
15. 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.
16. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the brake pedal.
17. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
18. Tighten the bleeder valve, then have the assistant slowly release the brake pedal.
19. Wait 15 seconds, then repeat steps 11-13 until all air is purged from the wheel hydraulic circuit.
20. Tighten the RIGHT REAR hydraulic wheel circuit bleeder valve securely.
21. Install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve, then repeat steps 9-14.
22. Install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14.
23. Install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14.
24. After completing the final wheel hydraulic circuit bleeding procedure, tighten all of the wheel hydraulic circuit bleeder valves and install the bleeder valve dust caps.
25. Close the brake pressure bleeder fluid tank valve.

NOTE: **The brake reservoir may have residual pressure after the bleeding**

operation is complete. Wrap a clean shop towel around the bleeder adapter and all hose connections before disconnecting the pressure bleeding equipment to prevent brake fluid from contacting and damaging vehicle components and painted surfaces.

26. Remove the brake pressure bleeding equipment from the vehicle.
27. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Fluid and Lubricant Recommendations** .
28. Slowly press and release the brake pedal. Observe the brake pedal feel.
29. If the brake pedal feels spongy, perform the following procedure.
 1. If equipped with antilock brakes, install a scan tool and perform the **Antilock Brake System Automated Bleed** to remove air which may be trapped in the BPMV.
 2. Inspect the hydraulic brake system for external leaks. Refer to **Brake System External Leak Inspection**.
 3. Repeat the Bleeding the Complete Brake Hydraulic System procedure.
30. If the brake pedal still feels spongy, pressure bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual Bleeding)**, **Hydraulic Brake System Bleeding (Pressure Bleeding)**.
31. Turn the ignition switch 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 the brake system is diagnosed and repaired.**

32. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle** .

HYDRAULIC BRAKE SYSTEM BLEEDING (MANUAL BLEEDING)

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

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

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.

If hydraulic components were serviced on only one wheel hydraulic circuit, perform the following procedure.

Bleeding a Single Hydraulic Brake Circuit

1. 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.
2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Add brake fluid as needed to ensure that the brake master cylinder reservoir remains at least half-full throughout the bleed procedure. The reservoir cap must be installed at all times except when filling the reservoir. Refer to **Fluid and Lubricant Recommendations**.
5. Install a proper box-end wrench onto the wheel hydraulic circuit bleeder valve which has been serviced.
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 brake fluid from a clean, sealed brake fluid container.
8. Have an assistant slowly press 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 wheel hydraulic circuit.
12. After all air has been purged from the hydraulic circuit, tighten the bleeder valve and install the dust cap.
13. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved brake fluid from a clean, sealed brake fluid container.
14. Slowly press and release the brake pedal. Observe the brake pedal feel.
15. If the brake pedal feels spongy, perform the Bleeding the Complete Brake Hydraulic System procedure:
16. 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.**

17. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle**.

Bleeding the Complete Brake Hydraulic System

1. 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.
2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Add brake fluid as needed to ensure that the brake master cylinder reservoir remains at least half-full throughout the bleed procedure. The reservoir cap must be installed at all times except when filling the reservoir. Refer to **Fluid and Lubricant Recommendations**.
5. If the master cylinder was replaced, the master cylinder must be bench bled. Refer to **Master Cylinder Bench Bleeding**.

6. If the brake pipes have been removed from the master cylinder, the following steps must be performed.
 1. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe fitting from the front port of the brake master cylinder.
 2. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder. Capture and properly dispose of the brake fluid in an approved container.
 3. Install the front brake pipe fitting to the front port of the brake master cylinder and tighten the fitting. Refer to **Fastener Tightening Specifications**.
 4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
 5. Loosen the front brake pipe fitting from the front port of the brake master cylinder to purge air from the master cylinder port.
 6. Tighten the front brake pipe fitting, then have the assistant slowly release the brake pedal.
 7. Wait 15 seconds, then repeat steps 6.4-6.6 until all air is purged from the front brake pipe fitting of the front port of the master cylinder.
 8. After all air is purged from the front port of the brake master cylinder, tighten the front master cylinder brake pipe fitting. Refer to **Fastener Tightening Specifications**.
 9. With the front brake pipe fitting installed securely to the front port of the brake master cylinder, loosen and separate the rear brake pipe fitting from the rear port of the brake master cylinder.
 10. Repeat steps 6.2-6.7 for the rear port of the brake master cylinder.
 11. After all air is purged from the rear port of the brake master cylinder, tighten the rear master cylinder brake pipe fitting. Refer to **Fastener Tightening Specifications**.
 12. Slowly press and release the brake pedal. Observe the brake pedal feel.
 13. If the brake pedal feels spongy, proceed to step 7.
 14. If the brake pedal feels firm, proceed to step 24.
7. If the brake pipes have been removed from the brake pressure modulator valve (BPMV) assembly, if equipped, or the brake proportion valve assembly, if equipped, air must be purged from each port of the respective assembly beginning with the feed pipes from the master cylinder.
 1. Loosen and separate one of the master cylinder brake pipe fittings from the inlet port of the assembly to be bled.
 2. Allow a small amount of brake fluid to gravity bleed from the open port of the assembly. Capture and properly dispose of the brake fluid in an approved container.
 3. Install the brake pipe fitting and to the inlet port of the assembly and tighten securely.
 4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
 5. Loosen the same brake pipe fitting to purge air from the open port of the assembly.
 6. Tighten the brake pipe fitting, then have the assistant slowly release the brake pedal.
 7. Wait 15 seconds, then repeat steps 7.4-7.6 until all air is purged from the brake pipe fitting of the assembly.
 8. Repeat steps 7.1-7.7 for all of the remaining ports of the assembly.
 9. After bleeding each port of the assembly, tighten all of the brake pipe fittings on the assembly. Refer to **Fastener Tightening Specifications**.
 10. Fill the master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container.

11. Slowly press and release the brake pedal. Observe the brake pedal feel.
12. If the brake pedal feels spongy, proceed to step 8.
13. If the brake pedal feels firm, proceed to step 24.
8. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
9. Install a transparent hose over the end of the bleeder valve.
10. 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.
11. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the brake pedal.
12. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
13. Tighten the bleeder valve, then have the assistant slowly release the brake pedal.
14. Wait 15 seconds, then repeat steps 11-13 until all air is purged from the wheel hydraulic circuit.
15. Tighten the RIGHT REAR hydraulic wheel circuit bleeder valve securely.
16. Install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
17. Install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
18. Install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
19. After completing the final wheel hydraulic circuit bleeding procedure, tighten all of the wheel hydraulic circuit bleeder valves and install the bleeder valve dust caps.
20. Fill the master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container.
21. Slowly press and release the brake pedal. Observe the brake pedal feel.
22. If the brake pedal feels spongy, perform the following procedure.
 1. If equipped with antilock brakes, install a scan tool and perform the **Antilock Brake System Automated Bleed** to remove air which may be trapped in the BPMV.
 2. Inspect the hydraulic brake system for external leaks. Refer to **Brake System External Leak Inspection**.
 3. Repeat the Bleeding the Complete Brake Hydraulic System procedure.
23. If the brake pedal still feels spongy, pressure bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual Bleeding)**, **Hydraulic Brake System Bleeding (Pressure Bleeding)**
24. Turn the ignition switch 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 the brake system is diagnosed and repaired.**

25. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle** .

HYDRAULIC BRAKE SYSTEM FLUSHING

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.

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

Refer to the procedures indicated:

- **Master Cylinder Replacement**
 - **Front Brake Hose Replacement**
 - **Rear Brake Hose Replacement (Drum Brake), Rear Brake Hose Replacement (Disc Brake)**
 - **Front Brake Caliper Replacement**
 - **Rear Brake Caliper Replacement**
 - **Brake Pressure Modulator Valve Replacement**
 - **Hydraulic Brake System Bleeding (Manual Bleeding), Hydraulic Brake System Bleeding (Pressure Bleeding)**
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** ; also perform the following:
 - Clean the brake master cylinder reservoir using denatured alcohol, or equivalent, then dry the reservoir using non-lubricated, filtered air. Inspect the reservoir for cracks and/or damage and replace if necessary. Refer to **Master Cylinder Reservoir Replacement**.
 - Replace the brake master cylinder reservoir cap diaphragm.
 - **Front Brake Hose Replacement**
 - **Rear Brake Hose Replacement (Drum Brake), Rear Brake Hose Replacement (Disc Brake)**
 - **Front Brake Caliper Overhaul** , or **Front Brake Caliper Replacement**
 - **Rear Brake Caliper Replacement**
4. If the brake fluid was NOT contaminated with an oil-based or a silicone-based substance, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm. The diaphragm may have allowed the moisture or particles to enter the hydraulic system.
 5. Fill the brake master cylinder reservoir to the maximum-fill level with GM recommended brake fluid. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended brake fluid.
 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 Bleeding), Hydraulic Brake System Bleeding (Pressure Bleeding)**.

POWER BRAKE BOOSTER VACUUM PIPE REPLACEMENT (WITHOUT ELECTRIC PUMP)

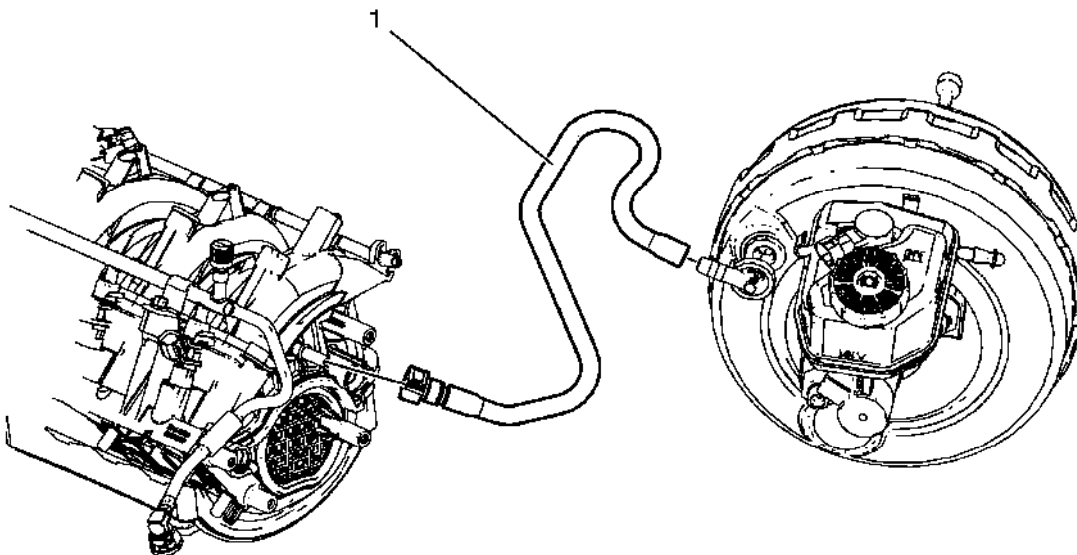


Fig. 62: Power Brake Booster Vacuum Pipe

Courtesy of GENERAL MOTORS COMPANY

Power Brake Booster Vacuum Pipe Replacement (without Electric Pump)

Callout	Component Name
1	Power Brake Booster Vacuum Pipe Procedure 1. Disconnect quick fitting from inlet exhaust. 2. Disconnect vacuum pipe from power brake booster.

POWER BRAKE BOOSTER VACUUM PIPE REPLACEMENT (WITH ELECTRIC PUMP)

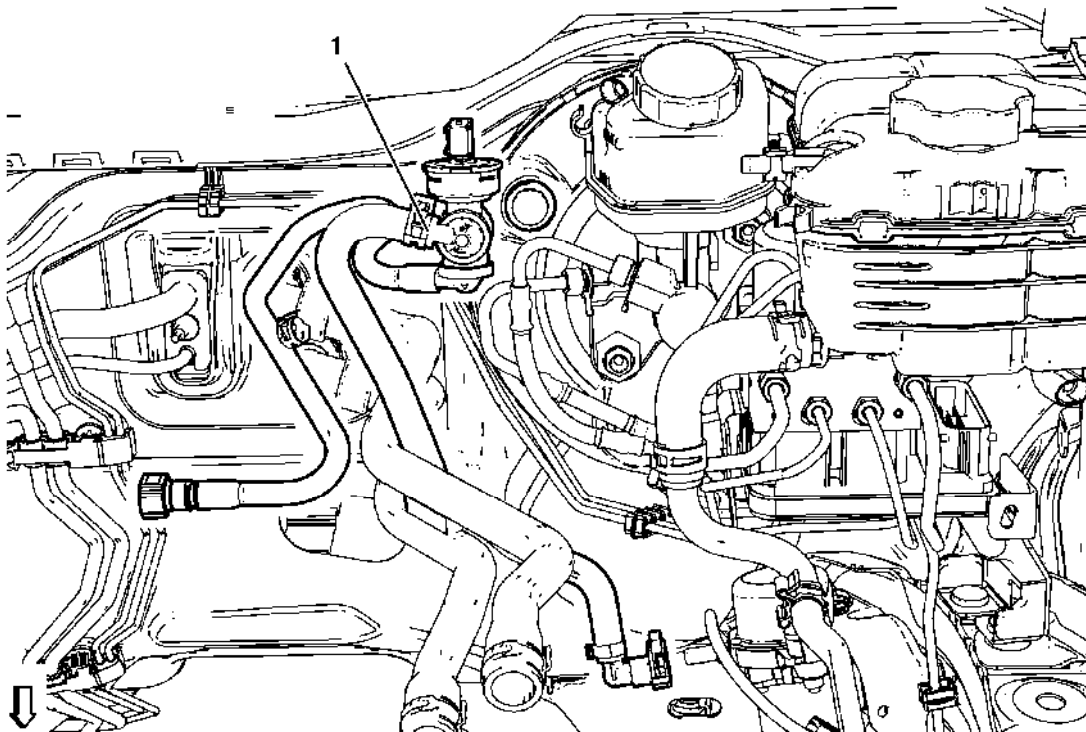


Fig. 63: Power Brake Booster Vacuum Pipe (With Electric Pump)

Courtesy of GENERAL MOTORS COMPANY

Power Brake Booster Vacuum Pipe Replacement (with Electric Pump)

Callout	Component Name
1	Power Brake Booster Vacuum Pipe Procedure 1. Disconnect quick fitting from intake manifold. 2. Disconnect wiring harness plug.

3. Disconnect vacuum pipe from power brake booster.
4. Disconnect vacuum pipe from power brake booster pump.

POWER BRAKE BOOSTER REPLACEMENT

Removal Procedure

WARNING: Refer to Brake Fluid Irritant Warning .

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

1. Turn the ignition to the OFF position.

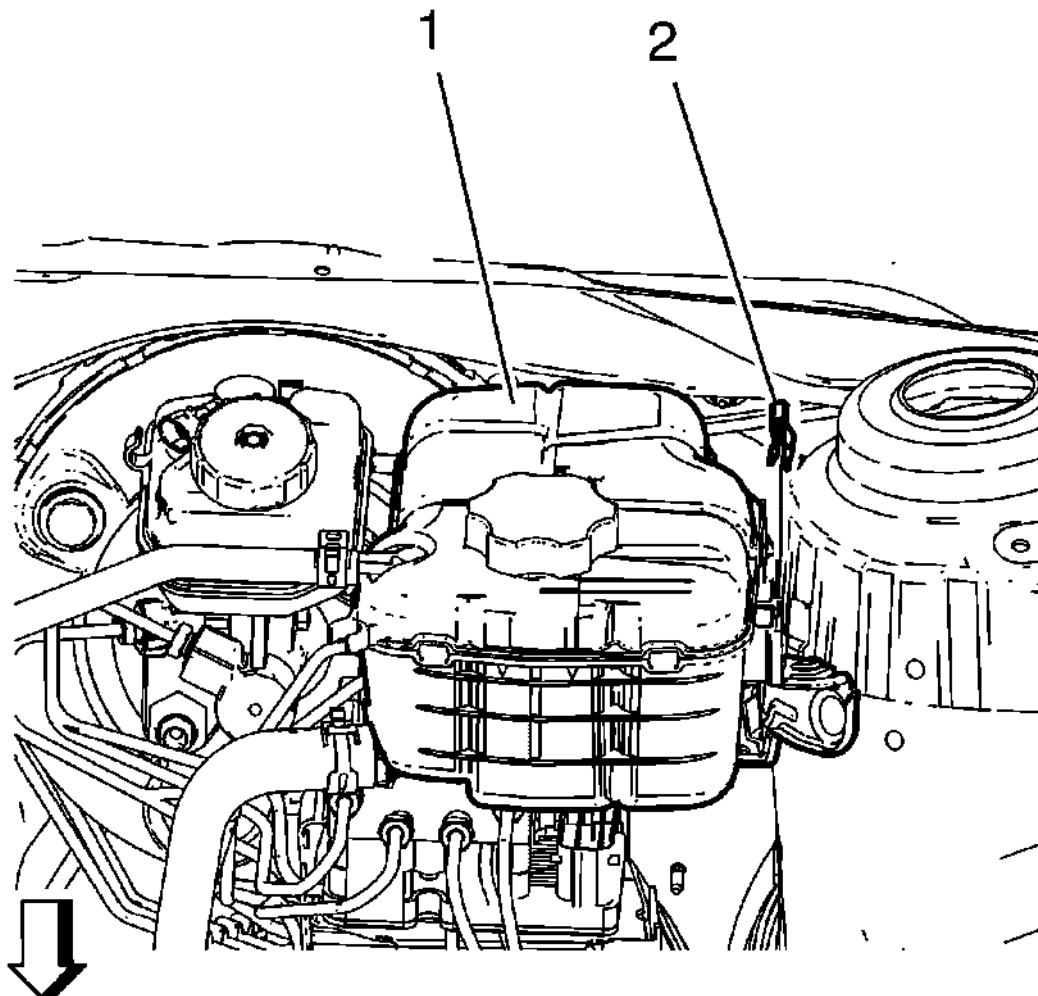


Fig. 64: View Of Radiator Surge Tank And Radiator Surge Tank Clip
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT disconnect engine coolant hoses.

2. Remove the radiator surge tank clip (2).
3. Remove the radiator surge tank (1).

Position the radiator surge tank (1) aside.

CAUTION: Always connect or disconnect the wiring harness connector from the EBCM/EBTCM with the ignition switch in the OFF position. Failure to observe this precaution could result in damage to the EBCM/EBTCM.

4. Disconnect the electrical connector from the EBCM/EBTCM.

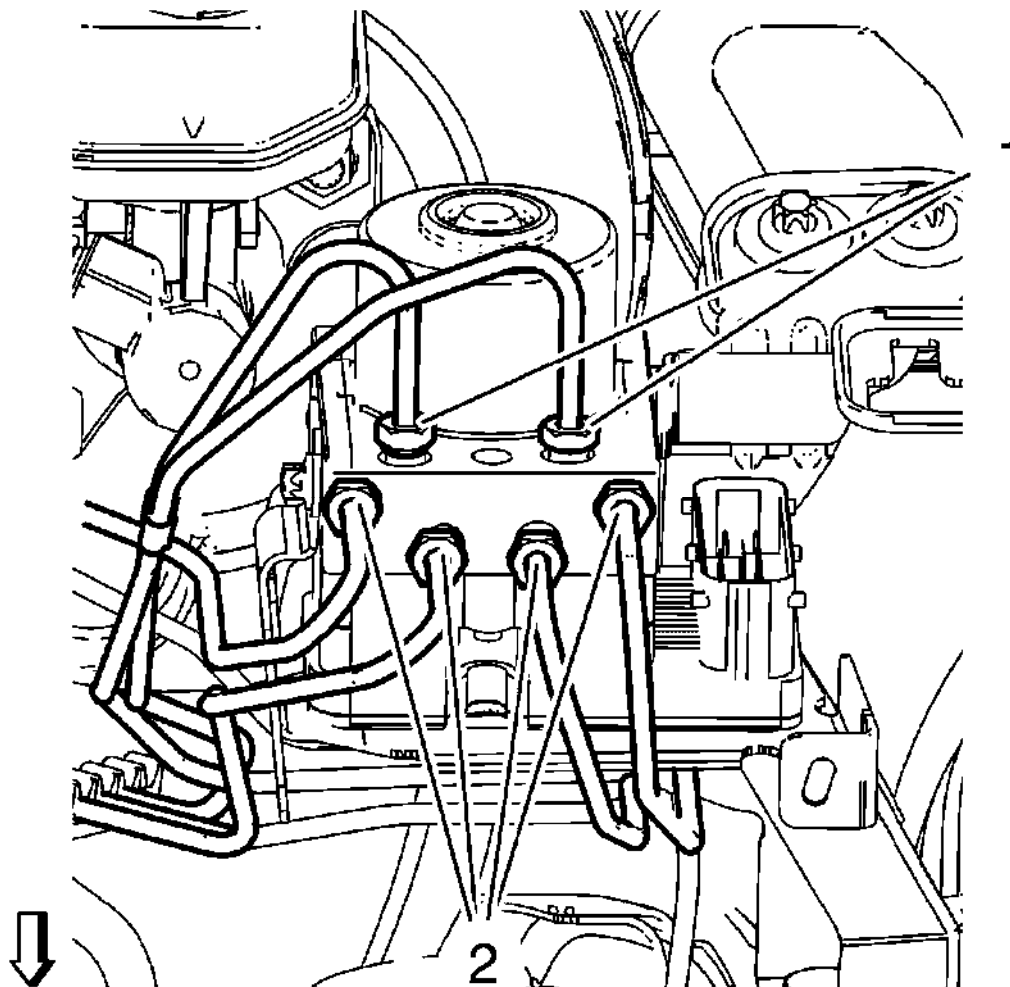


Fig. 65: Brake Pipe Fittings At BPMV

Courtesy of GENERAL MOTORS COMPANY

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

5. Remove the 6 brake pipes (1, 2) from the BPMV.

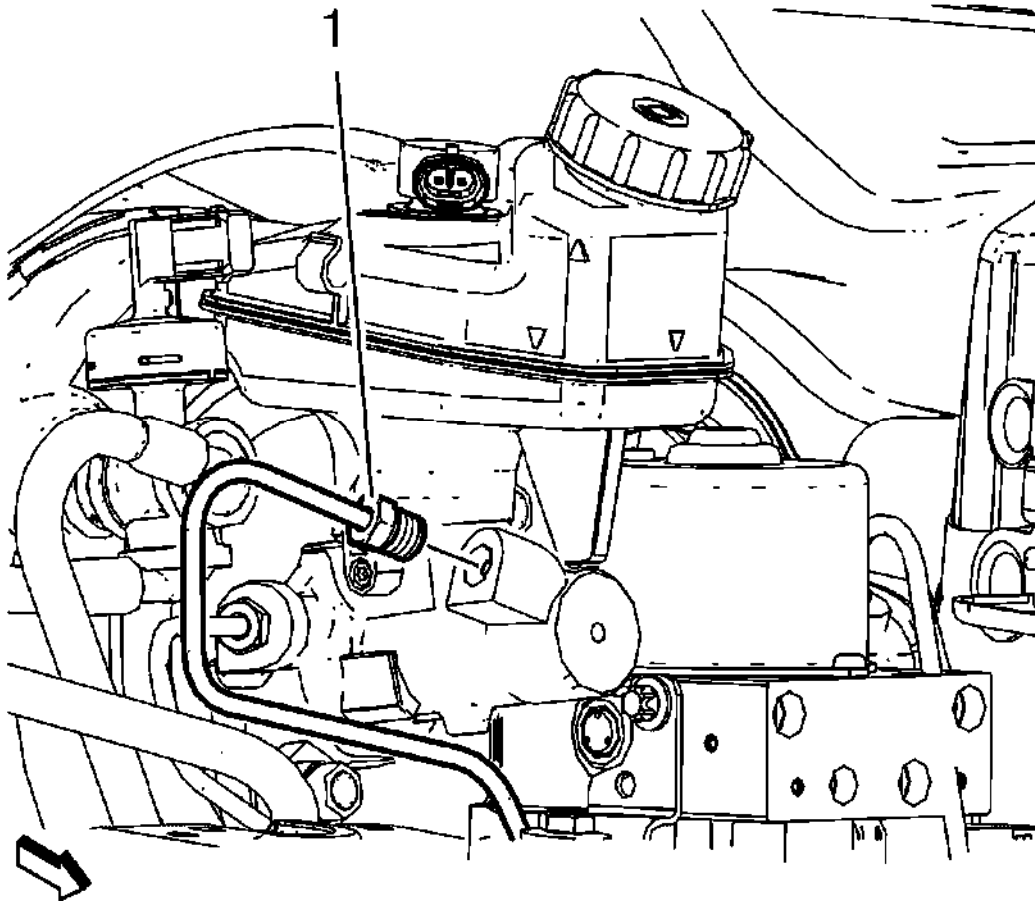


Fig. 66: Master Cylinder Secondary Brake Pipe Fitting

Courtesy of GENERAL MOTORS COMPANY

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

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

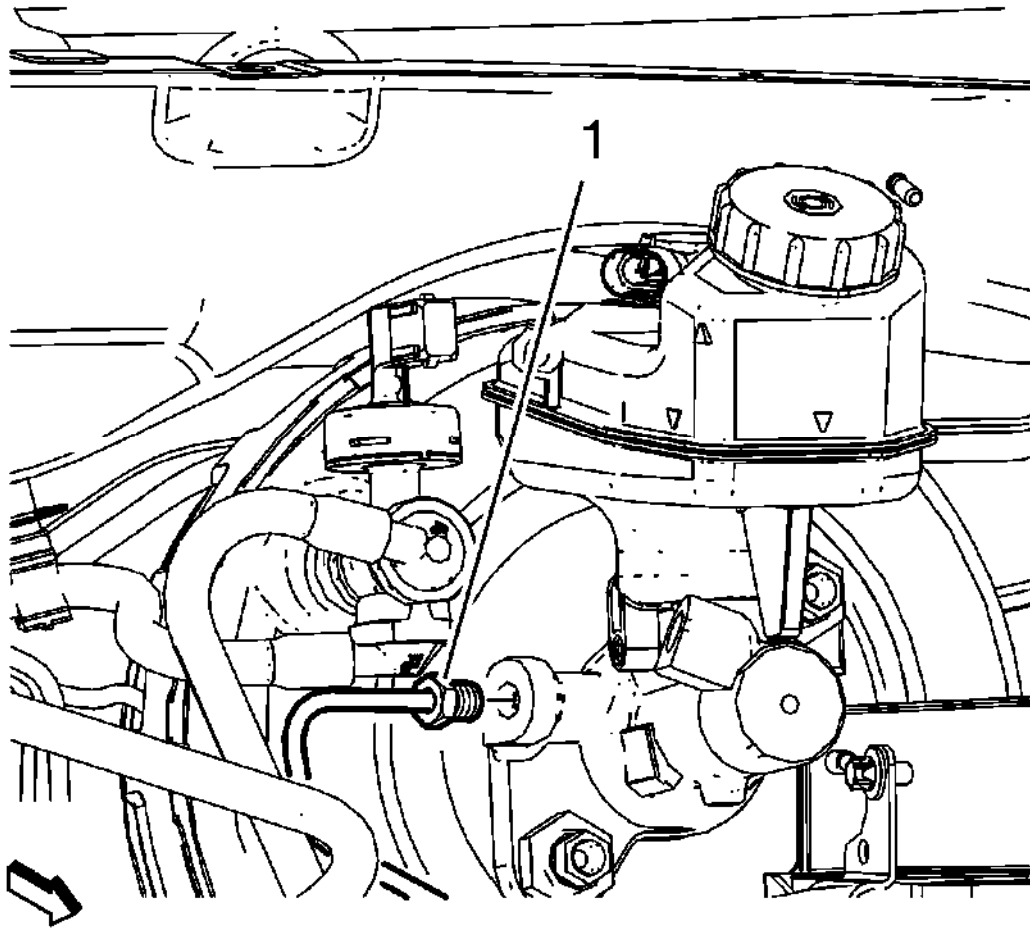


Fig. 67: Master Cylinder Primary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

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

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

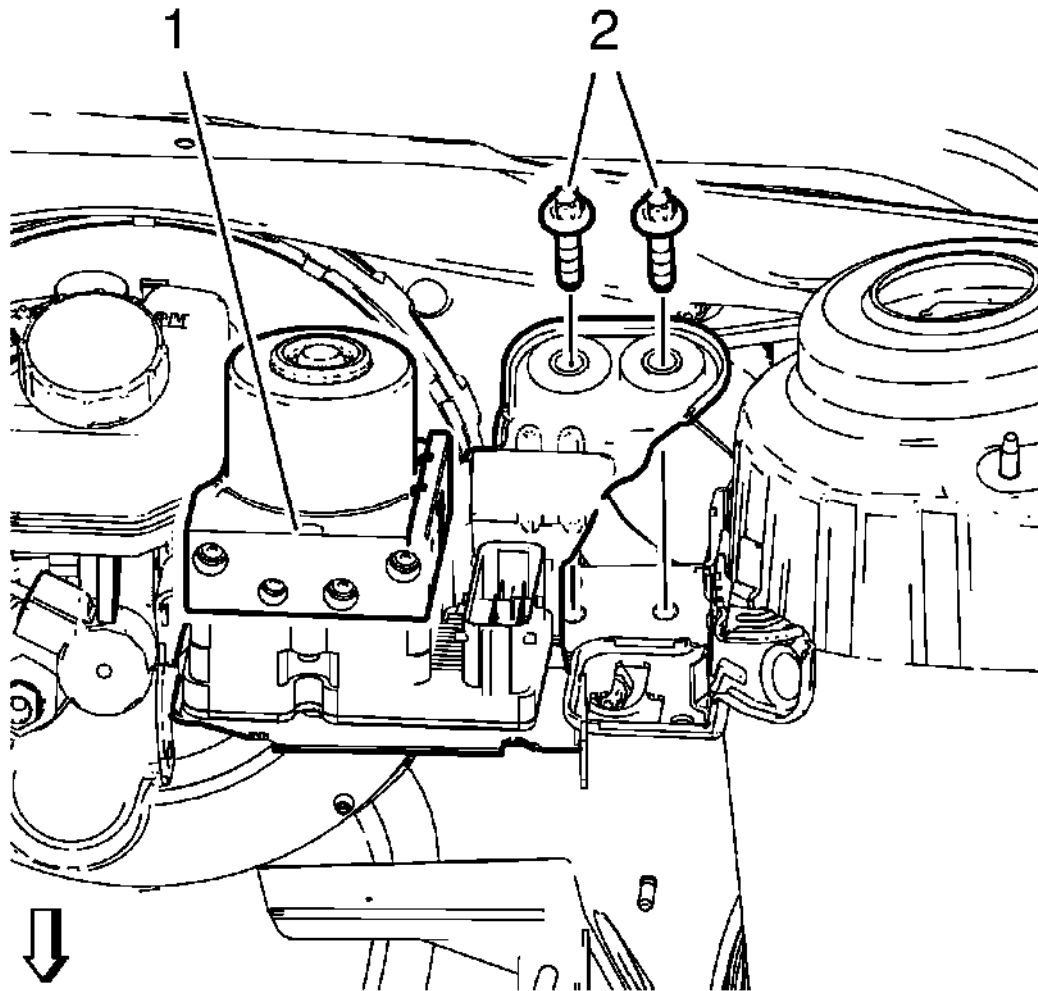


Fig. 68: BPMV and BPMV Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the BPMV bracket bolts (2).
9. Remove the BPMV bracket assembly (1).
10. Remove the brake master cylinder assembly from the booster. Refer to **Master Cylinder Replacement**.

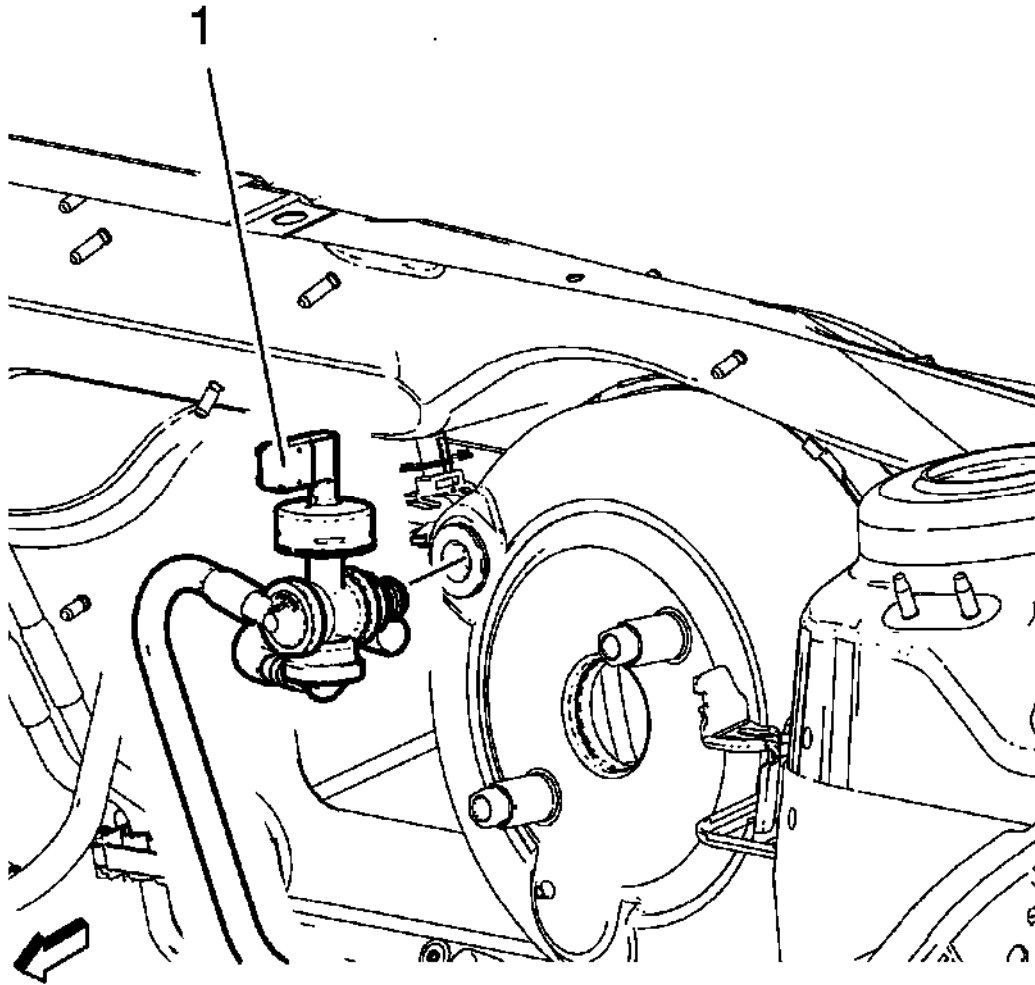


Fig. 69: Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

11. Remove the booster vacuum pipe (1) from the booster.

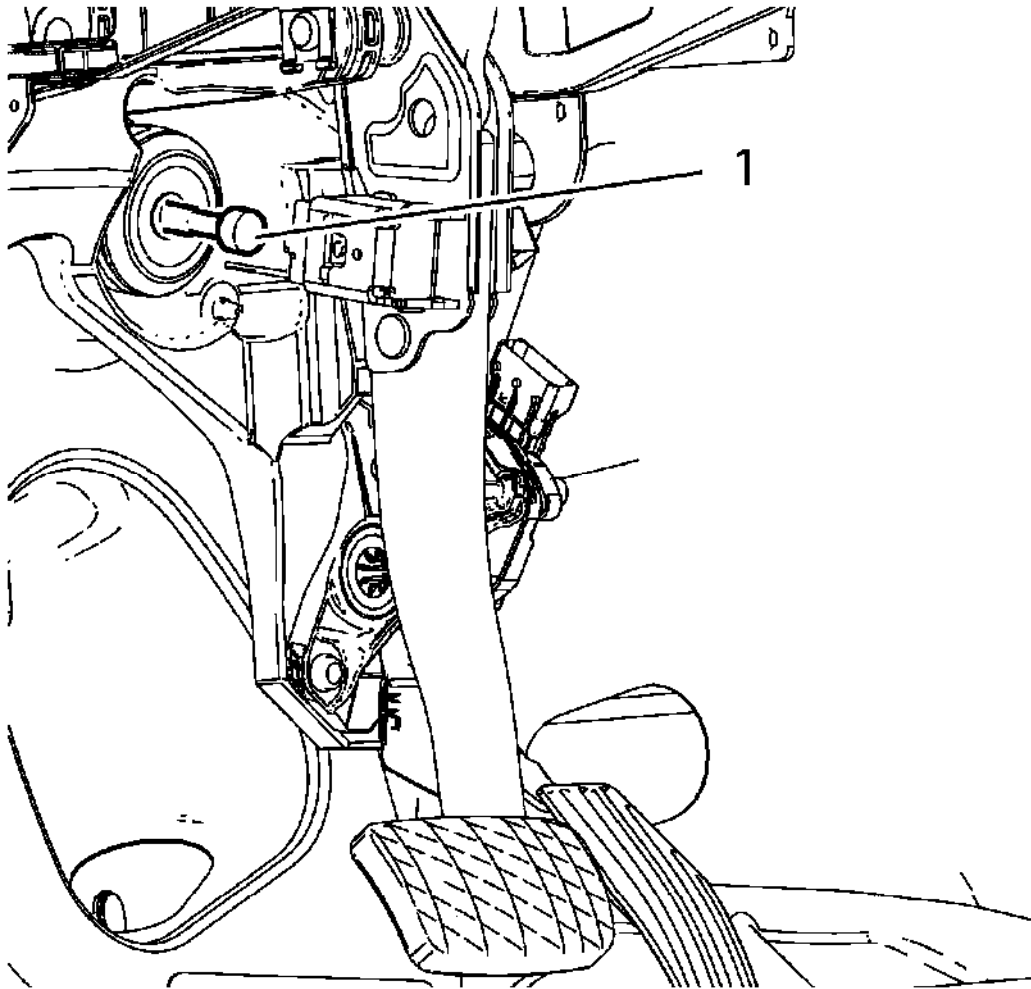


Fig. 70: Brake Pedal Pushrod

Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the brake pedal pushrod (1) from the brake pedal.
13. Replace the click fit connector between booster pushrod and brake pedal with a new part.

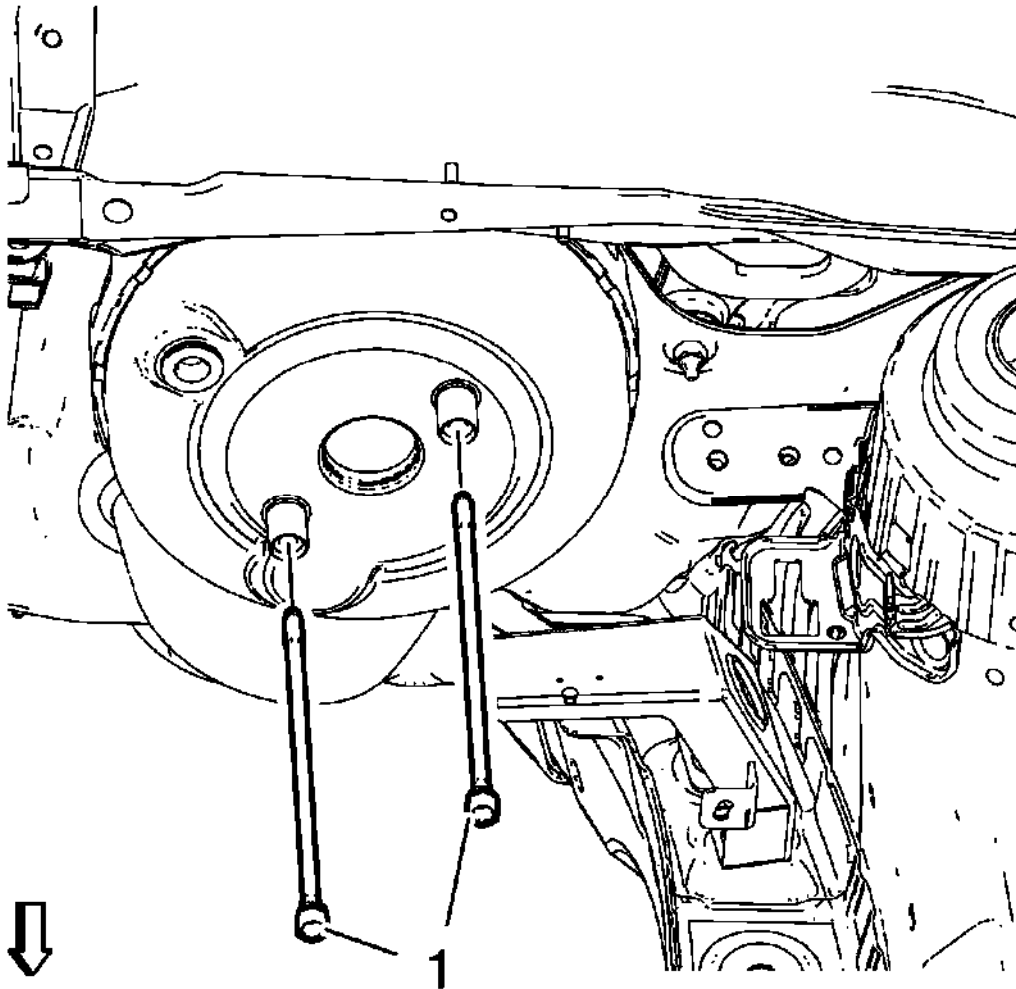


Fig. 71: Brake Booster Bolts

Courtesy of GENERAL MOTORS COMPANY

14. Remove the brake booster bolts (1).
15. Remove the booster from the vehicle.

Installation Procedure

WARNING: Refer to Brake Fluid Irritant Warning .

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

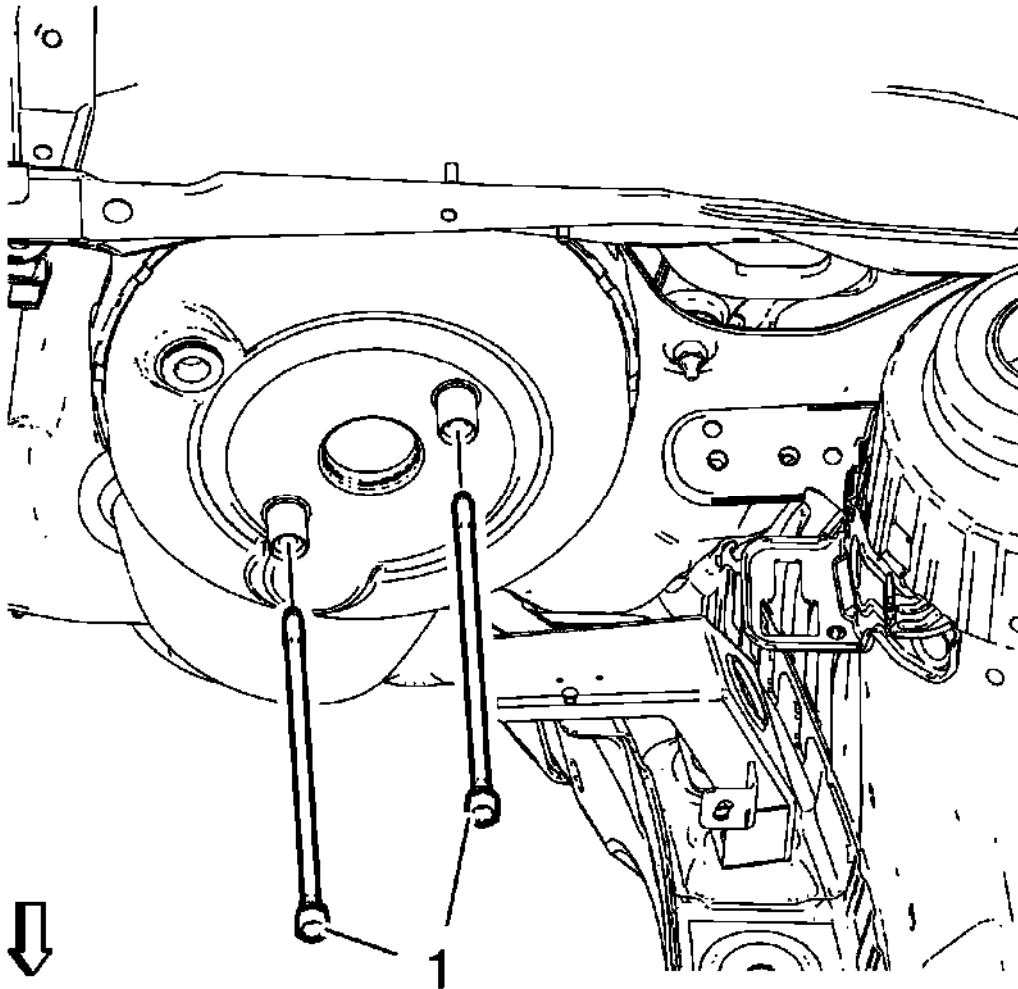


Fig. 72: Brake Booster Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Install the booster to the vehicle.

CAUTION: Refer to Fastener Caution .

2. Install the brake booster bolts (1) and tighten to 19 N.m (15 lb ft).

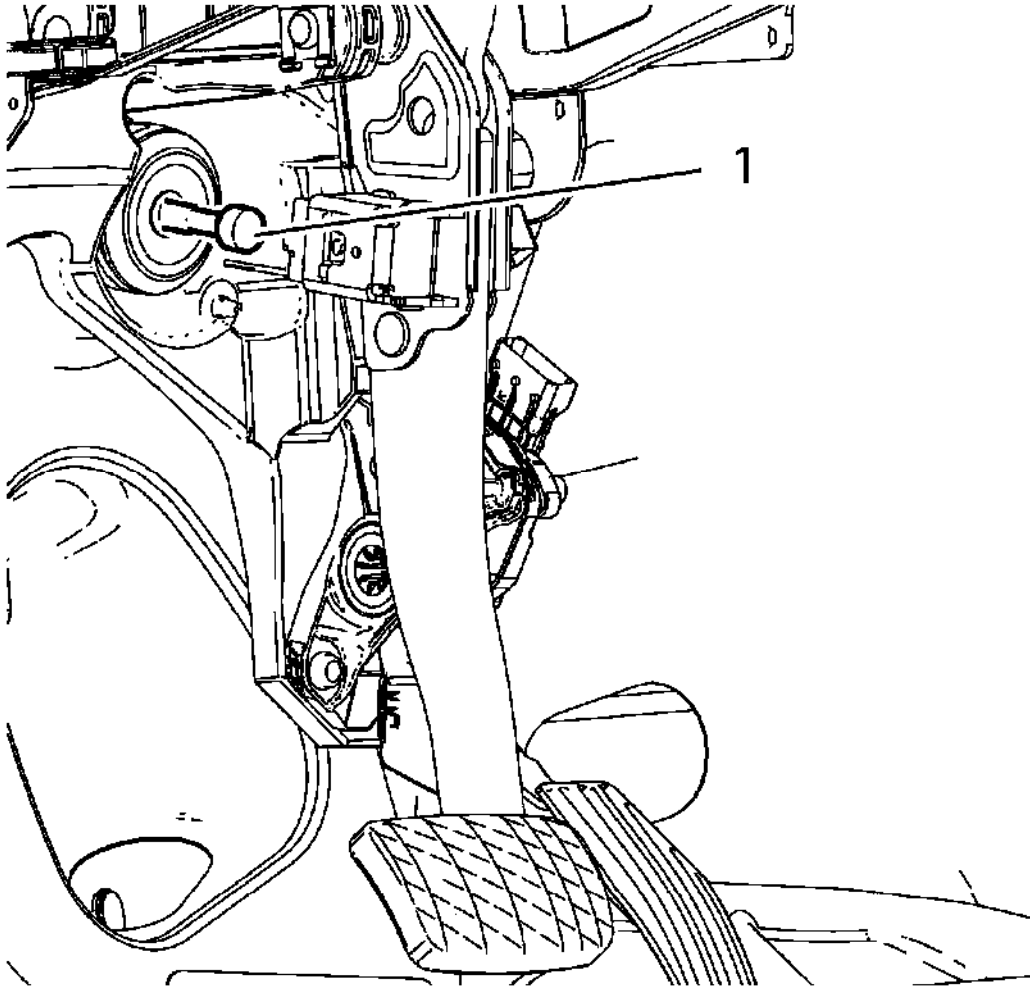


Fig. 73: Brake Pedal Pushrod

Courtesy of GENERAL MOTORS COMPANY

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

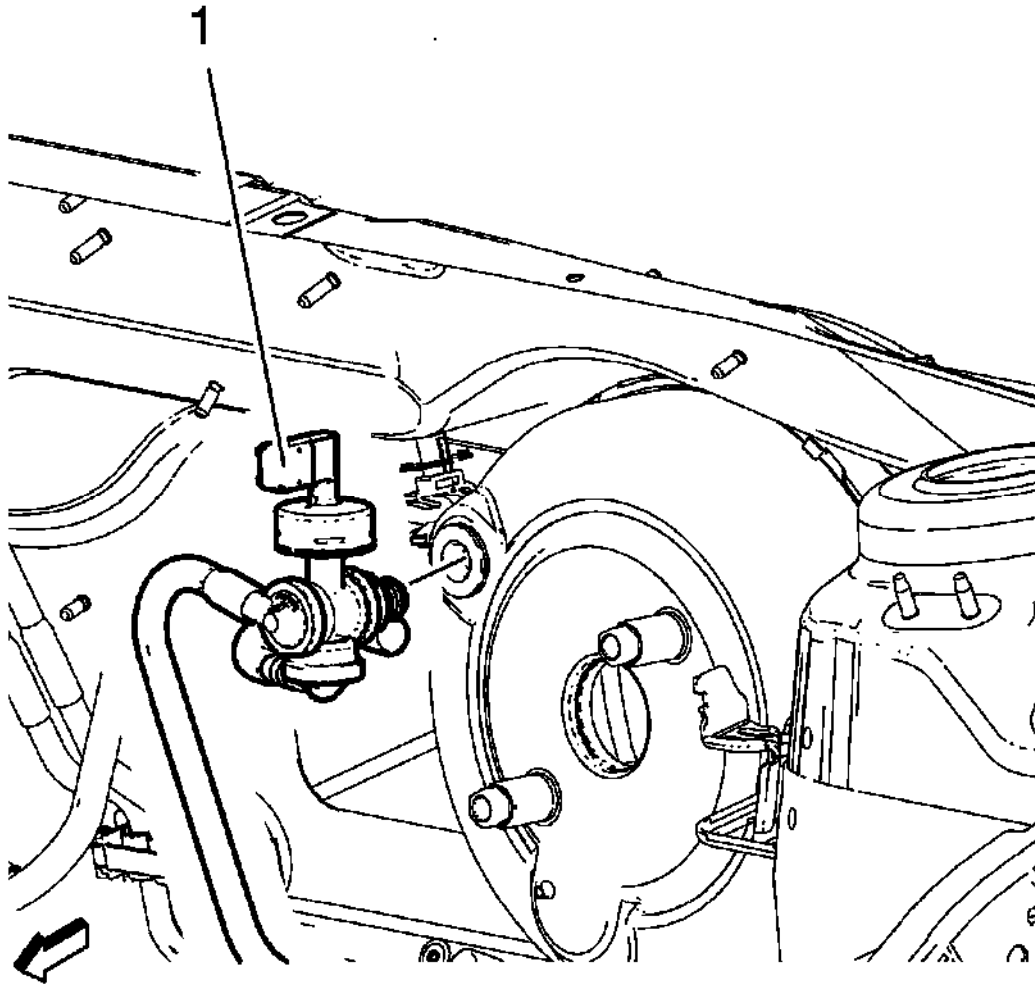


Fig. 74: Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Install the booster vacuum pipe (1) to the booster.
5. Install the master cylinder assembly to the booster. Refer to **Master Cylinder Replacement**.

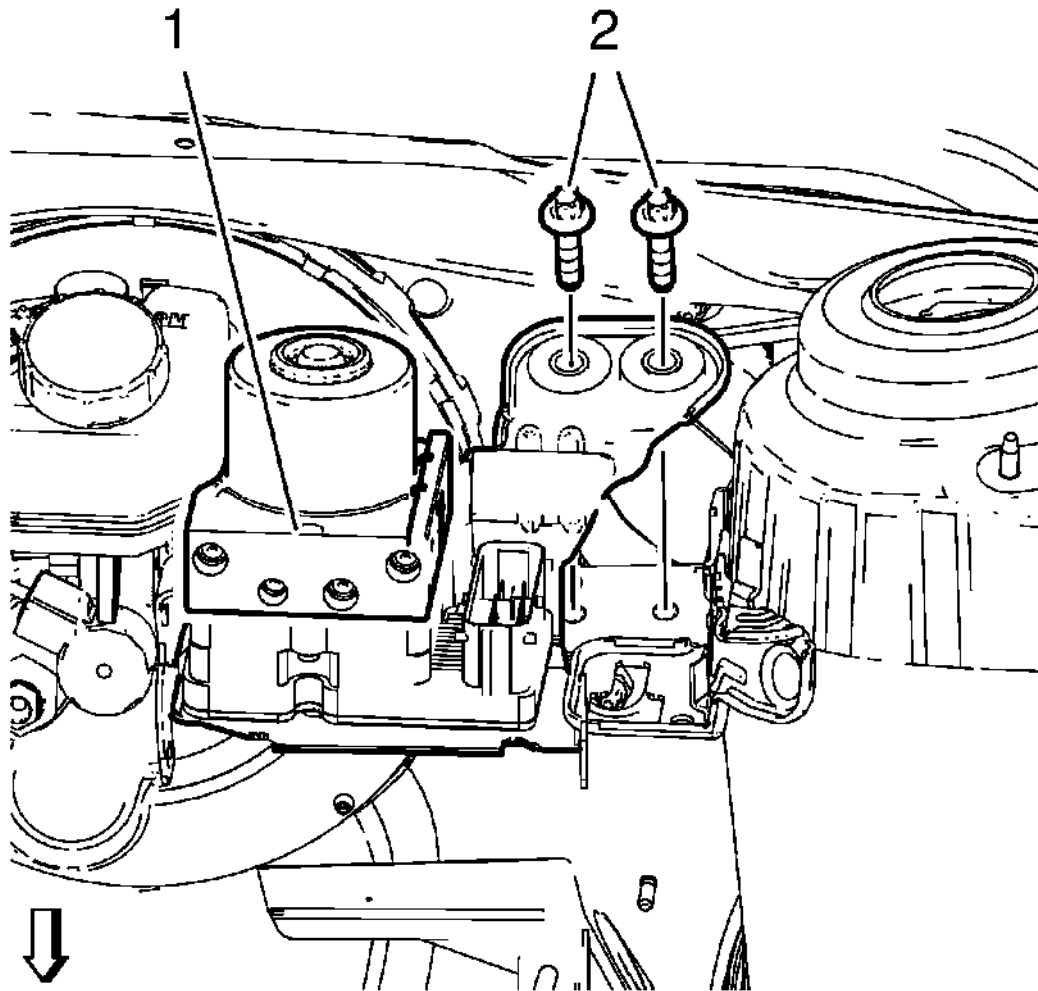


Fig. 75: BPMV and BPMV Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install the BPMV bracket assembly (1).
7. Install the BPMV bracket bolts (2) and tighten to 20 N.m (15 lb ft).

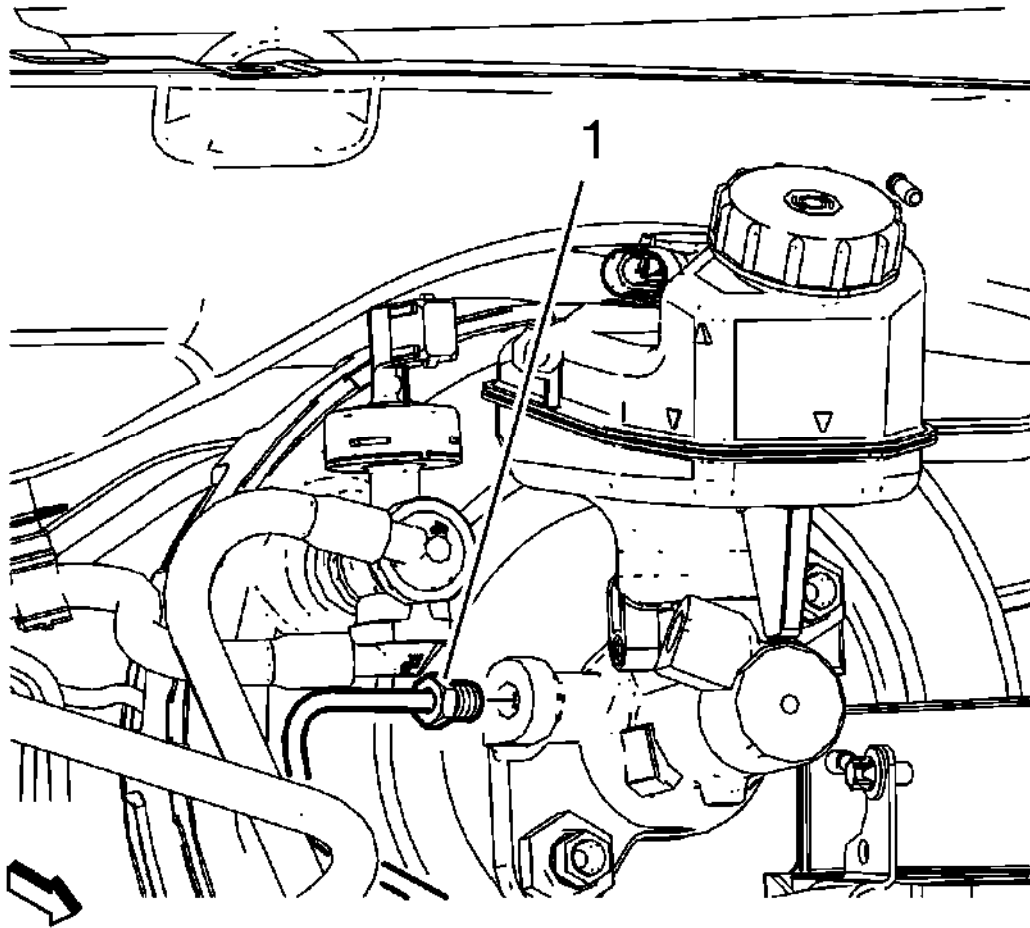


Fig. 76: Master Cylinder Primary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

8. Connect the master cylinder primary brake pipe fitting (1) and tighten to 18 N.m (14 lb ft).

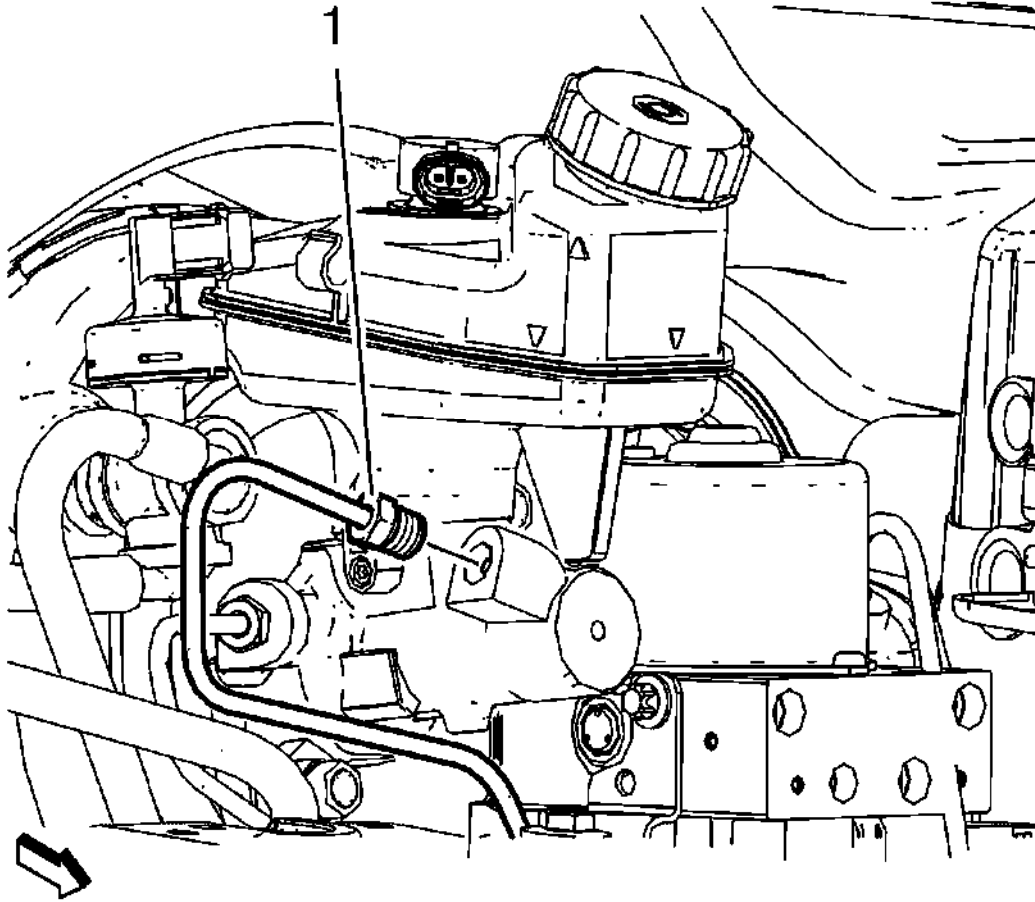


Fig. 77: Master Cylinder Secondary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

9. Connect the master cylinder primary brake pipe fitting (1) and tighten to 18 N.m (14 lb ft).

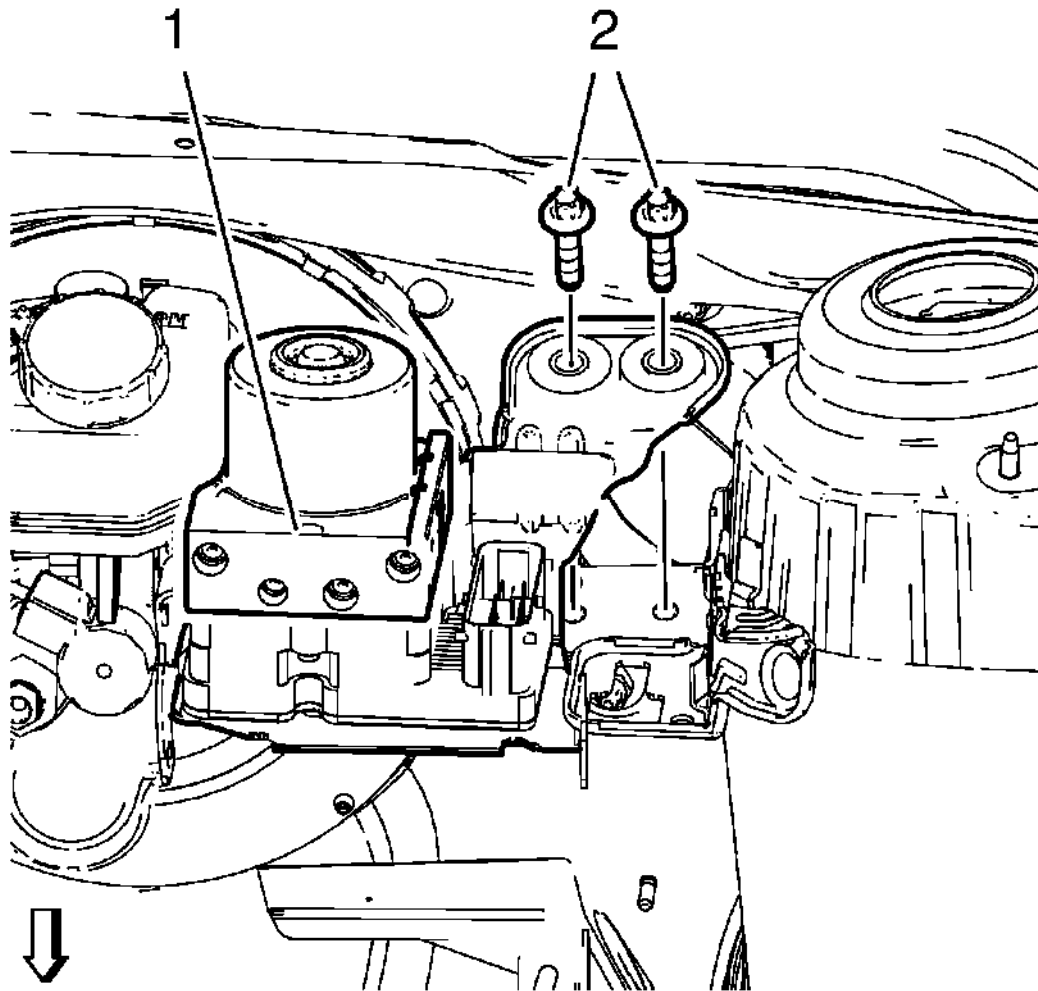


Fig. 78: BPMV and BPMV Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

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

10. Install the 6 brake pipes (1, 2) to the BPMV and tighten to 18 N.m (14 lb ft).
11. Connect the electrical connector with to the EBCM/EBTCM.

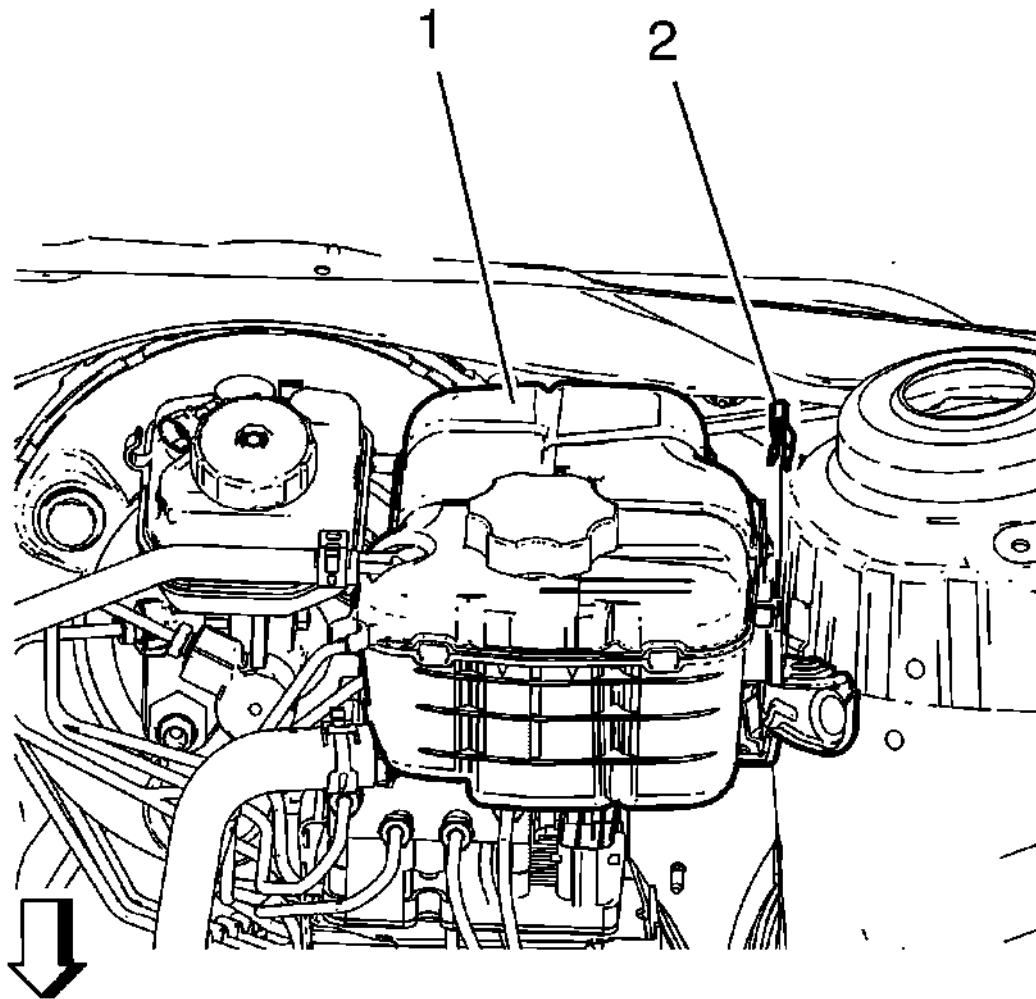


Fig. 79: View Of Radiator Surge Tank And Radiator Surge Tank Clip
Courtesy of GENERAL MOTORS COMPANY

12. Install the radiator surge tank (1).
13. Install the radiator surge tank clip (2).
14. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual Bleeding)**, **Hydraulic Brake System Bleeding (Pressure Bleeding)**.

POWER BRAKE BOOSTER PUMP REPLACEMENT

Removal Procedure

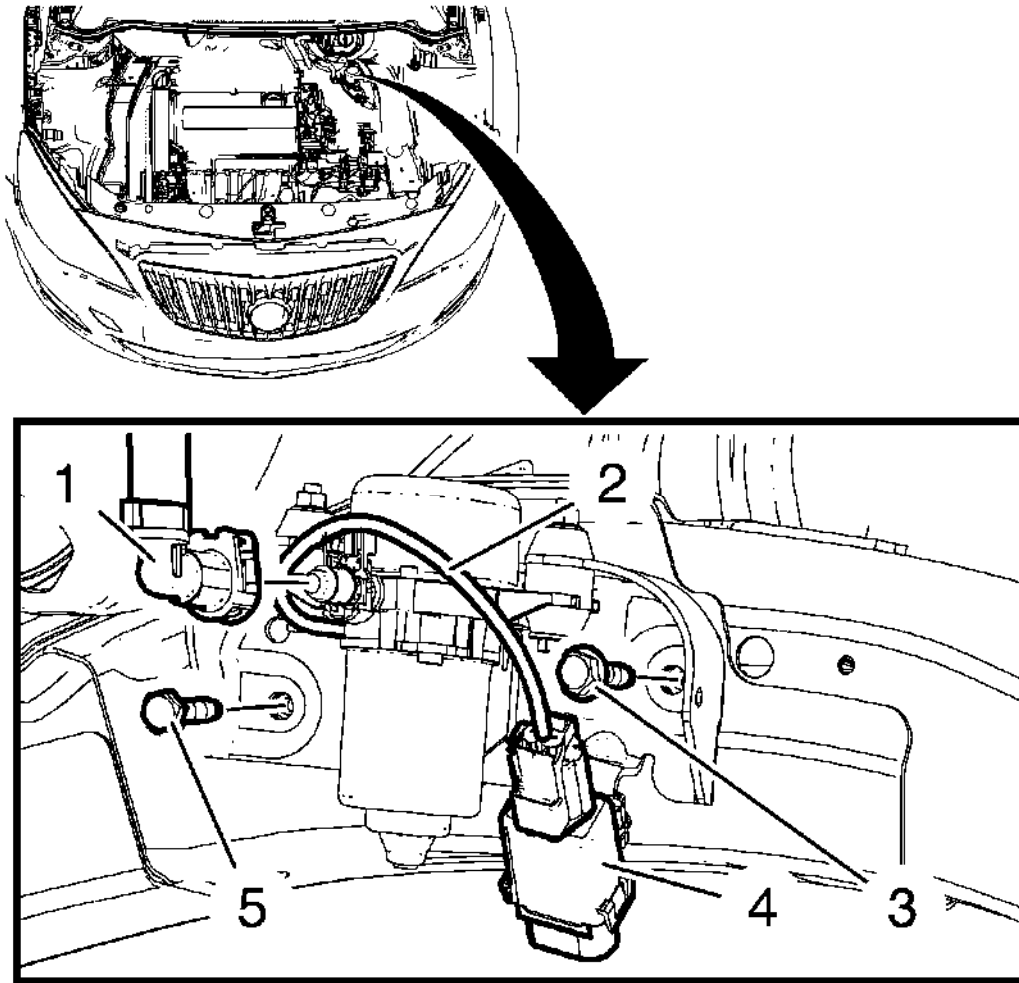


Fig. 80: Brake Booster Vacuum Pump
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect electrical connector (4).
2. Disconnect the vacuum hose quick fitting (1) from power brake booster vacuum pump (2).
3. Remove the bolts (3, 5).
4. Remove the power brake booster vacuum pump (2) with bracket from the vehicle.

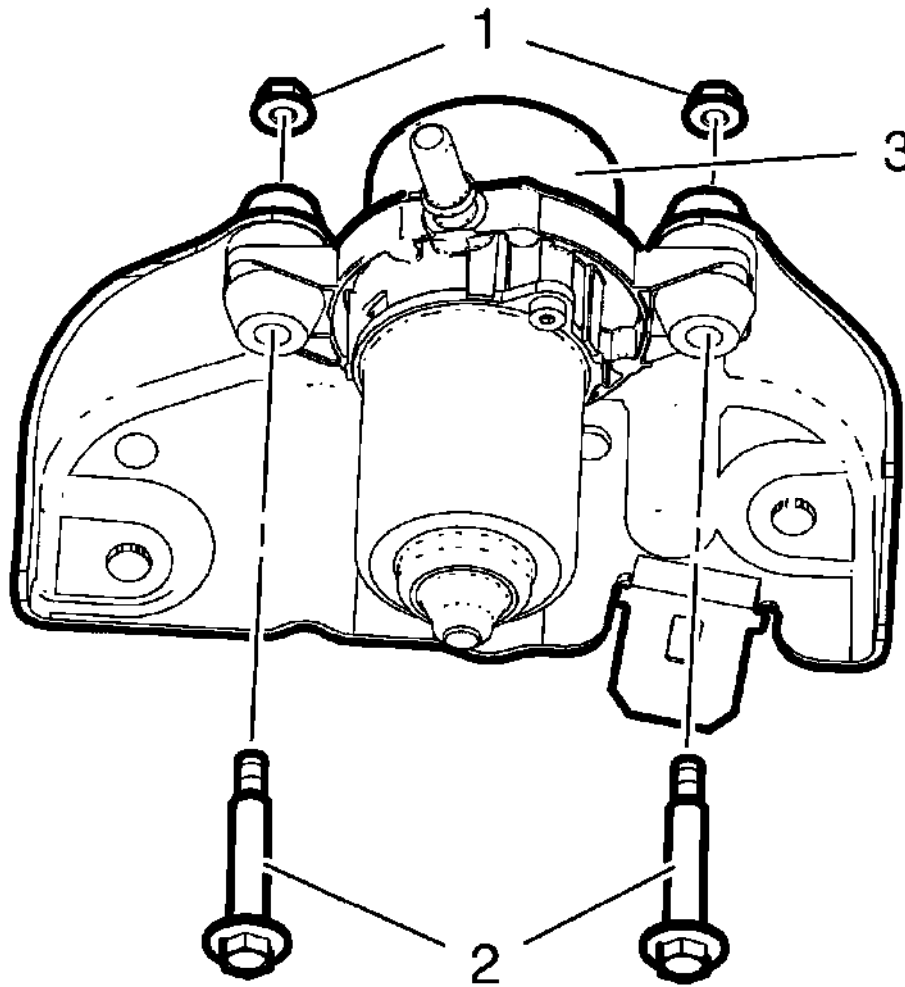


Fig. 81: Pump Screws And Nuts

Courtesy of GENERAL MOTORS COMPANY

5. Remove pump screws and nuts (1, 2) from the power brake booster pump (3).

Installation Procedure

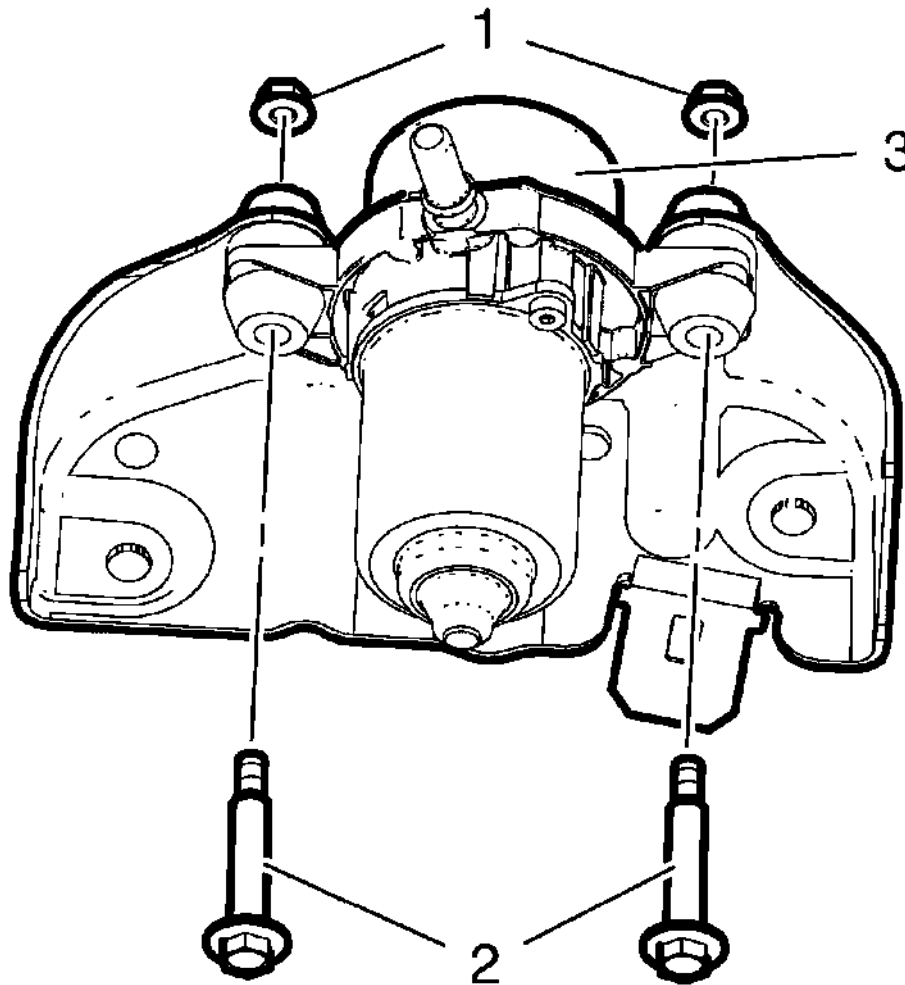


Fig. 82: Pump Screws And Nuts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution

1. Install the pump screws and nuts (1, 2) to the power brake booster pump (3) and tighten to 7.5 N.m (66 lb in).

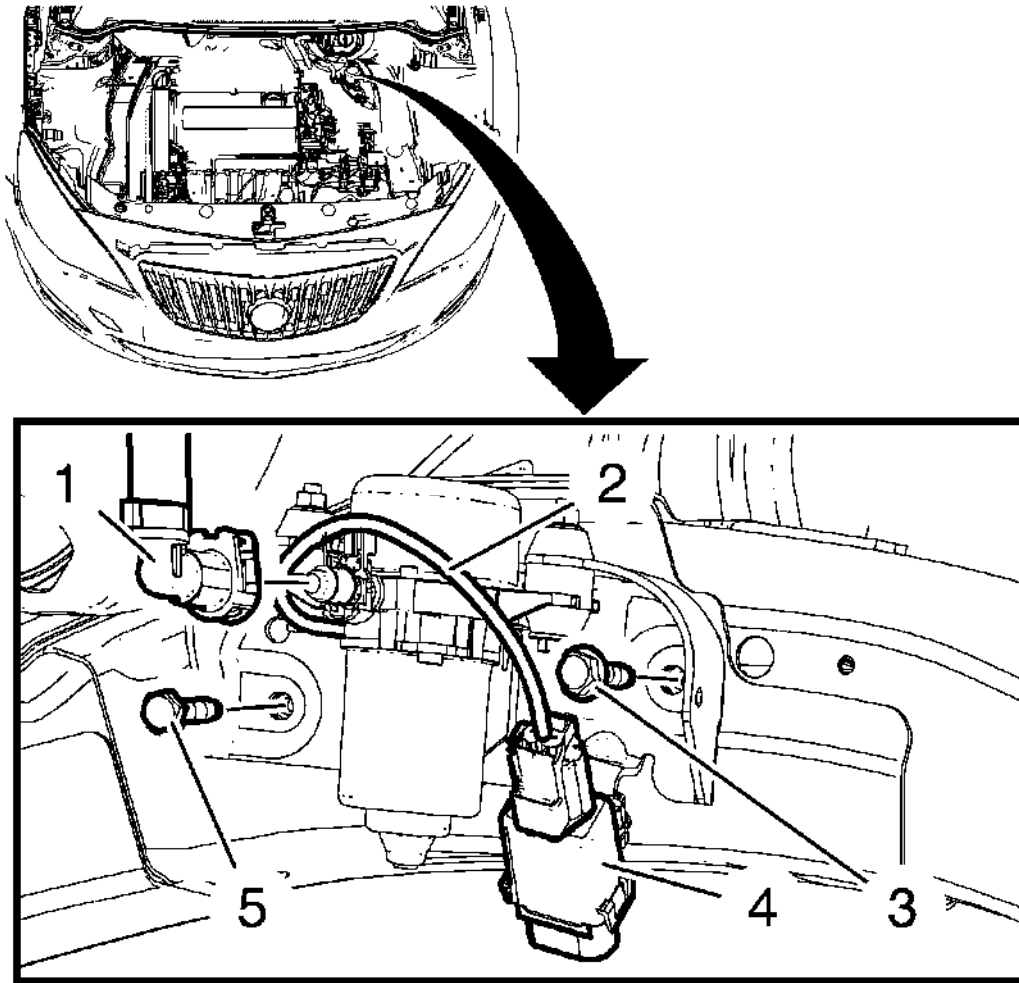


Fig. 83: Brake Booster Vacuum Pump
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect electrical connector (4).
3. Remove the power brake booster vacuum pump (2) with bracket from the vehicle.
4. Install the bolts (3, 5) and tighten to 20 N.m (15 lb ft).
5. Connect the vacuum hose quick fitting (1) to the power brake booster vacuum pump (2).
6. Connect the electrical connector (4).

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

In order to assure that vacuum is available to the vacuum brake booster, the car can contain a vacuum pump either in addition to the normal intake manifold vacuum source or as stand-alone. The pump provides negative pressure when the engine cannot properly accommodate the requirement, e.g. cold start, heavy throttle, high altitude and turbo pressure.

Mechanical

The mechanical vacuum pump is driven by a camshaft. The pump delivers maximum vacuum irrespective of engine RPM. This means that the pump, in certain situations, delivers more negative pressure than the system uses.

Electrical

A low vacuum switch controls the 12 V to the relay coil in the brake vacuum assist pump. When more vacuum is needed the vacuum switch closes. The relay coil closes the relay contact and connects the electric motor to ground. The electric motor is fed with 12 V. When sufficient vacuum is reached the switch opens and the pump stops.

A venturi is connected between the intake manifold and the vacuum brake booster, amplifying the vacuum. This reduces the on-time for the pump. To prevent air flowing in the wrong direction check valves are used.

BRAKE FLUID AND BRAKE FLUID HANDLING

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

following actions:

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

CAUTION: 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: Brake fluid will damage electrical connections and painted surfaces. Use shop cloths, suitable containers, and fender covers to prevent brake fluid from contacting these areas. Always re-seal and wipe off brake fluid containers to prevent spills.

CAUTION: Avoid spilling brake fluid on any of the vehicle's painted surfaces, wiring, cables or electrical connectors. Brake fluid will damage paint and electrical connections. If any fluid is spilled on the vehicle, immediately flush the area with water to minimize the potential for damage.

CAUTION: Power steering fluid, engine oil, brake fluid, or any mineral based fluids cannot be mixed. If brake seals contact power steering fluid or steering seals contact brake fluid, seal damage will result.

NOTE:

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

BRAKE WARNING SYSTEM DESCRIPTION AND OPERATION

Brake Warning Indicator

The instrument cluster turns the brake warning indicator ON when the following occurs:

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2013 BRAKES Hydraulic Brakes - Cruze

- The instrument cluster performs the bulb check. The brake warning indicator illuminates for 5 s.
- When the Electronic Brake Control Module (EBCM) detects low brake fluid level it sets DTC C0267 and sends a serial data message to the instrument cluster, which will illuminate the red brake indicator.
- The Body Control Module (BCM) detects that the parking brake is engaged. The instrument cluster receives a serial data message from the BCM requesting illumination.

Driver Information Center Messages

When the Electronic Brake Control Module (EBCM) detects low brake fluid level it sets DTC C0267 and sends a serial data message to the Driver Information Center, which will display Brake Fluid Low message.

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

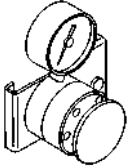
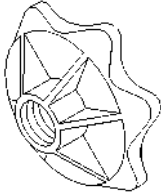
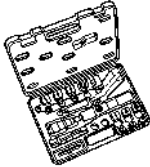
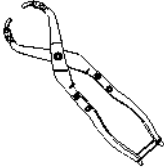
2013 Chevrolet Cruze

2013 BRAKES Hydraulic Brakes - Cruze

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.

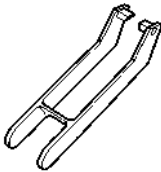
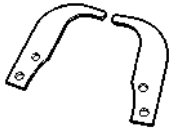
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
	CH-28662 J-28662 Brake Pedal Effort Gauge
	CH-29532-A J-29532-A Brake Pressure Bleeder
	CH-35798 J-35798 Brake Bleeder Adapter
	CH-45405 J-45405 Pipe Flaring Tool Kit
	DT-6202-A Pliers
	DT-6202-B Pliers
	DT-6202-20 Adapter to DT-6202-A

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DT-50894
Remover