

2002 ENGINES**4.8L, 5.3L & 6.0L V8 - Sierra & Silverado****DIAGNOSTIC INFORMATION AND PROCEDURES****DIAGNOSTIC STARTING POINT - ENGINE MECHANICAL**

Begin the system diagnosis by reviewing the **DISASSEMBLED VIEWS** , **ENGINE COMPONENT DESCRIPTION** , **LUBRICATION DESCRIPTION** , and **NEW PRODUCT INFORMATION** in the Engine Unit Repair Manual, and the **Drive Belt System Description**. Reviewing the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is normal operation. Refer to **Symptoms - Engine Mechanical** in order to identify the correct procedure for diagnosing the system and where the procedure is located.

SYMPTOMS - ENGINE MECHANICAL**Strategy Based Diagnostics**

1. Perform **DIAGNOSTIC SYSTEM CHECK - ENGINE CONTROLS** before using the symptom tables (if applicable).
2. Review the system operations in order to familiarize yourself with the system functions. Refer to **DISASSEMBLED VIEWS** , **ENGINE COMPONENT DESCRIPTION** , **LUBRICATION DESCRIPTION** , and **NEW PRODUCT INFORMATION** in Engine Unit Repair Manual, and to **Drive Belt System Description**.

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system problem. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to **STRATEGY BASED DIAGNOSIS** in General Information.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Engine.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Check for the correct oil level, proper oil viscosity, and correct filter application.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.
- Compare the engine sounds (if applicable) to a known good engine and make sure you are not trying to correct a normal condition.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating

properly.

Symptom List

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

- Base Engine Misfire without Internal Engine Noises
- Base Engine Misfire with Abnormal Internal Lower Engine Noises
- Base Engine Misfire with Abnormal Valve Train Noise
- Base Engine Misfire with Coolant Consumption
- Base Engine Misfire with Excessive Oil Consumption
- Engine Compression Test (Mechanical Throttle) or Engine Compression Test (Electronic Throttle)
- Engine Noise on Start-Up, but Only Lasting a Few Seconds
- Upper Engine Noise, Regardless of Engine Speed
- Lower Engine Noise, Regardless of Engine Speed
- Engine Noise Under Load
- Engine Will Not Crank - Crankshaft Will Not Rotate
- Oil Consumption Diagnosis
- Oil Pressure Diagnosis and Testing
- Oil Leak Diagnosis
- Drive Belt Chirping Diagnosis
- Drive Belt Squeal Diagnosis
- Drive Belt Whine Diagnosis
- Drive Belt Rumbling Diagnosis
- Drive Belt Vibration Diagnosis
- Drive Belt Falls Off Diagnosis
- Drive Belt Excessive Wear Diagnosis
- Drive Belt Tensioner Diagnosis

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Base Engine Misfire Without Internal Engine Noises

Cause	Correction
Abnormalities, such as severe cracking, bumps, or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to <u>Drive Belt Replacement - Accessory</u> .
Worn, damaged, or misaligned accessory drive components or excessive pulley runout and may lead to a misfire DTC.	Inspect the components, and repair or replace as required.

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A misfire code may be present without an actual misfire condition.	
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required. Refer to <u>Engine Flywheel Replacement</u> or <u>Crankshaft Balancer Replacement</u> .
Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace as required.
Improperly installed or damaged vacuum hoses	Repair or replace as required.
Improper sealing between the intake manifold and cylinder heads or throttle body.	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body as required.
Improperly installed or damaged MAP sensor The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor as required.
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position.	Replace the valve rocker arms as required.
Worn or bent pushrods	• Replace the pushrods. • Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or misaligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump-up and loss of compression.	• Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace the oil pump as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Refer to <u>DIAGNOSTIC STARTING POINT - ENGINE COOLING</u> in Engine Cooling. Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. • Inspect the cylinder heads, engine block, and/or head gaskets. • Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test (Mechanical Throttle)</u> or <u>Engine</u>

	<u>Compression Test (Electronic Throttle).</u> • Perform cylinder leak down and compression testing to identify the cause. • Repair or replace as required.
A damaged crankshaft reluctor wheel A damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the damage. • Systems with electronic communications, DIS or coil per cylinder, and severe reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then sync the crankshaft position. • Systems with electronic communication, DIS or coil per cylinder, and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a P0300 DTC may be set. • Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and effect fuel and spark delivery to the point of generating a P0300 DTC or P0336.	Replace the sensor and/or crankshaft as required.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Base Engine Misfire with Abnormal Internal Lower Engine Noises

Cause	Correction
Abnormalities, such as severe cracking, bumps or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to <u>Drive Belt Replacement - Accessory.</u>
Worn, damaged, or misaligned accessory drive components or excessive pulley runout A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required. Refer to <u>Engine Flywheel Replacement</u> or <u>Crankshaft Balancer Replacement.</u>
Worn piston rings	• Inspect the spark plugs for oil deposits.

Oil consumption may or may not cause the engine to misfire.

- Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test (Mechanical Throttle)** or **Engine Compression Test (Electronic Throttle)**.
- Perform cylinder leak down and compression testing to determine the cause.
- Repair or replace as required.

Worn crankshaft thrust bearings
Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft and create a DTC without an actual misfire condition.

Replace the crankshaft and bearings as required.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Base Engine Misfire with Abnormal Valve Train Noise

Cause	Correction
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact within the rocker arm assembly.	Replace the valve rocker arms as required.
Worn or bent pushrods	• Replace the pushrods. • Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or misaligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Sticking lifters	Replace as required.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Base Engine Misfire with Coolant Consumption

Cause	Correction
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Refer to <u>DIAGNOSTIC STARTING POINT - ENGINE COOLING</u> in Engine Cooling. Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. • Perform a cylinder leak down test. • Inspect the cylinder heads and engine block for damage to the coolant passages and/or a faulty head gasket. • Repair or replace as required.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION**Base Engine Misfire with Excessive Oil Consumption**

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals	- Inspect the spark plugs for oil deposits. - Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	- Inspect the spark plugs for oil deposits. - Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test (Mechanical Throttle)</u> or <u>Engine Compression Test (Electronic Throttle)</u>. - Perform cylinder leak down and compression testing to determine the cause. - Repair or replace as required.

ENGINE NOISE ON START-UP, BUT ONLY LASTING A FEW SECONDS**Engine Noise on Start-Up, but Only Lasting a Few Seconds**

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	- Drain the oil. - Install the correct viscosity oil.
High valve lifter leak down rate	Replace the lifters as required.
Worn crankshaft thrust bearing	- Check the crankshaft end play. - Inspect the thrust bearing and crankshaft. - Repair or replace as required.
Damaged or faulty oil filter by-pass valve	- Inspect the oil filter by-pass valve for proper operation. - Repair or replace as required.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED**Upper Engine Noise, Regardless of Engine Speed**

Cause	Correction
Low oil pressure	- Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. - Repair or replace as required.
Loose and/or worn valve rocker arm attachments	- Inspect the valve rocker arm, bolt, and pedestal. - Repair or replace as required.
Worn or damaged valve rocker arm	

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	• Inspect the rocker arm for wear or missing needle bearings • Replace the valve rocker arms as required.
Bent or damaged push rod	Inspect the following components and replace as required: • The valve rocker arm • The valve push rod • The valve lifter • The valve lifter guide • The piston Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Improper lubrication to the valve rocker arms	Inspect the following components and repair or replace as required: • The valve rocker arm • The valve push rod • The valve lifter • The oil filter bypass valve • The oil pump and pump screen • The engine block oil galleries
Broken valve spring	Replace the valve spring and spring shim.
Worn or dirty valve lifters	Replace the valve lifters.
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn engine camshaft lobes	• Inspect the engine camshaft lobes. • Replace the camshaft and valve lifters as required.
Worn valve guides or valve stems	Inspect the following components and repair as required: • The valves • The valve guides
Stuck valves Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the following components and repair as required: • The valves • The valve guides

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED**Lower Engine Noise, Regardless of Engine Speed**

Cause	Correction
Low oil pressure	- Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. - Repair or replace damaged components as required.
Worn accessory drive components Abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of system components.	- Inspect the accessory drive system. - Repair or replace as required.
Loose or damaged crankshaft balancer	- Inspect the crankshaft balancer. - Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition controls system. Refer to Engine Controls.
Loose torque converter bolts	- Inspect the torque converter bolts and flywheel. - Repair or replace as required.
Loose or damaged flywheel	Repair or replace the flywheel.
Oil pump screen loose, damaged or restricted	- Inspect the oil pump screen. - Repair or replace as required.
Excessive piston-to-cylinder bore clearance	- Inspect the piston and cylinder bore. - Repair as required.
Excessive piston pin-to-bore clearance	- Inspect the piston, pin, and connecting rod. - Replace the piston, pin and connecting rod as an assembly, as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required: - The connecting rod bearings - The connecting rods - The crankshaft - The crankshaft journals
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: - The crankshaft bearings - The crankshaft journals
Incorrect piston, piston pin and connecting rod installation.	Verify the pistons, piston pins and connecting rods are installed correctly. Refer to

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Pistons must be installed with the mark or dimple on the top of the piston facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.

PISTON, CONNECTING ROD & BEARING INSTALLATION

- Repair as required.

ENGINE NOISE UNDER LOAD**Engine Noise Under Load**

Cause	Correction
Low oil pressure	• Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition controls. Refer to <u>DETONATION/SPARK KNOCK</u> .
Loose torque converter bolts	• Inspect the torque converter bolts and flywheel. • Repair as required.
Cracked flywheel - automatic transmission	• Inspect the flywheel bolts and flywheel. • Repair as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required: • The connecting rod bearings • The connecting rods • The crankshaft
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: • The crankshaft bearings • The crankshaft journals • The cylinder block crankshaft bearing bore

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE**Engine Will Not Crank - Crankshaft Will Not Rotate**

Cause	Correction
Seized accessory drive system component	1. Remove the accessory drive belts. 2. Confirm that the engine will rotate. Rotate the crankshaft by hand at the crankshaft balancer or flywheel location. 3. Repair or replace the components as required.
Seized automatic transmission torque	1. Remove the torque converter-to-flywheel bolts.

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converter	2. Confirm that the engine will rotate. Rotate the crankshaft by hand at the crankshaft balancer or flywheel location. 3. Repair or replace the components as required.
Seized manual transmission	1. Disengage the clutch by depressing the clutch pedal. 2. Confirm that the engine will rotate. Rotate the crankshaft by hand at the crankshaft balancer or flywheel location. Refer to Manual Transmission in the Transmission/Transaxle/Transfer Case Unit Repair Manual.
Broken timing chain	• Inspect the timing chain and gears. • Repair or replace the components as required.
Seized timing chain or timing gears	• Inspect the timing chain and gears for foreign material or a seized chain. • Repair or replace the components as required.
Seized or broken camshaft	• Inspect the camshaft and the camshaft bearings. • Repair or replace the components as required.
Bent valve in the cylinder head	• Inspect the valves and the cylinder heads. • Repair or replace the components as required.
Seized oil pump	• Inspect the oil pump assembly. • Repair or replace as required.
Hydraulically locked cylinder • Coolant/antifreeze in the cylinder • Oil in the cylinder • Fuel in the cylinder	1. Remove spark plugs and check for fluid in the cylinder. When rotating the engine with the spark plugs removed, the piston, on compression stroke, will push fluid from the combustion chamber. 2. Inspect for failed/broken head gaskets. 3. Inspect for a cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Repair or replace the components as required.
Material in the cylinder • Broken valve • Broken piston rings • Piston material • Foreign material	• Inspect the cylinder for damaged components and/or foreign materials. • Repair or replace the components as required.
Seized crankshaft or connecting rod bearings	• Inspect crankshaft and connecting rod bearings. • Repair or replace the components as required.

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Bent or broken connecting rod	• Inspect the connecting rods. • Replace the piston, pin and connecting rod as an assembly, as required.
Broken crankshaft	• Inspect the crankshaft. • Repair or replace the components as required.

COOLANT IN COMBUSTION CHAMBER

Coolant in Combustion Chamber

Cause	Correction
DEFINITION : Excessive white smoke and/or coolant type odor coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage.	
1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to Engine Will Not Crank - Crankshaft Will Not Rotate. 2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore. 3. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component. 4. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to Engine Compression Test (Mechanical Throttle) or Engine Compression Test (Electronic Throttle).	
Cracked intake manifold or failed gasket	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to CYLINDER HEAD CLEANING & INSPECTION and Cylinder Head Replacement - Left or Cylinder Head Replacement - Right .
Warped cylinder head	Machine the cylinder head to the proper flatness, if applicable and replace the cylinder head gasket. Refer to CYLINDER HEAD CLEANING & INSPECTION .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head or engine block porosity	Replace the components as required.

COOLANT IN ENGINE OIL

Coolant in Engine Oil

Cause	Correction
DEFINITION : Foamy or discolored oil or an engine oil "overfill" condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage. Contaminated	

engine oil and oil filter should be changed.

1. Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to **Lower Engine Noise, Regardless of Engine Speed**.
2. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component.
3. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block with low compression may indicate a failed cylinder head gasket. Refer to **Engine Compression Test (Mechanical Throttle)** or **Engine Compression Test (Electronic Throttle)**.

Faulty external engine oil cooler	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <u>CYLINDER HEAD CLEANING & INSPECTION</u> and <u>Cylinder Head Replacement - Left</u> or <u>Cylinder Head Replacement - Right</u> .
Warped cylinder head	Machine the cylinder head to proper flatness, if applicable, and replace the cylinder head gasket. Refer to <u>CYLINDER HEAD CLEANING & INSPECTION</u> .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head, block, or manifold porosity	Replace the components as required.

CYLINDER LEAKAGE TEST

Tools Required

J 35667-A Cylinder Head Leakdown Tester or equivalent

IMPORTANT: A leakage test may be performed in order to measure cylinder/combustion chamber leakage. High cylinder leakage may indicate one or more of the following conditions:

- Worn or burnt valves
- Broken valve springs
- Stuck valve lifters
- Incorrect valve lash
- Damaged piston
- Worn piston rings
- Worn or scored cylinder bore
- Damaged cylinder head gasket
- Cracked or damaged cylinder head

- **Cracked or damaged engine block**

CAUTION: Refer to BATTERY DISCONNECT CAUTION in Cautions and Notices.

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs.
3. Rotate the crankshaft to place the piston in the cylinder being tested at top dead center (TDC) of the compression stroke.
4. Install the J 35667-A or equivalent.

IMPORTANT: It may be necessary to hold the crankshaft balancer bolt to prevent the crankshaft from rotating.

5. Apply shop air pressure to the J 35667-A and adjust according to the manufacturers instructions.
6. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:
 - Air leakage noise at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
 - Air leakage noise at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring.
 - Air leakage noise from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.
 - Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.
7. Perform the leakage test on the remaining cylinders and record the values.

ENGINE COMPRESSION TEST (MECHANICAL THROTTLE)

1. Charge the battery if the battery is not fully charged.
2. Disable the ignition system.
3. Disable the fuel injection system.
4. Remove all the spark plugs.
5. Block the throttle plate wide open.
6. Start with the compression gauge at zero and crank the engine through four compression strokes, four puffs.
7. Make the compression check for each cylinder. Record the reading.
8. If a cylinder has low compression, inject approximately 15 ml (1 tablespoon) of engine oil into the combustion chamber through the spark plug hole.

Recheck the compression and record the reading.

9. The minimum compression in any one cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). For example, if the highest pressure in any one cylinder is 1035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). ($1035 \times 70\% = 725$) ($150 \times 70\% = 105$).
 - Normal - Compression builds up quickly and evenly to the specified compression for each cylinder.
 - Piston Rings Leaking - Compression is low on the first stroke. Compression then builds up with the following strokes but does not reach normal. Compression improves considerably when you add oil.
 - Valves Leaking - Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.
 - If two adjacent cylinders have lower than normal compression and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the cylinders.

ENGINE COMPRESSION TEST (ELECTRONIC THROTTLE)

1. Charge the battery if the battery is not fully charged.
2. Disable the ignition system.
3. Disable the fuel injection system.
4. Remove all the spark plugs.
5. Turn the ignition to the ON position.
6. Depress the accelerator pedal to position the throttle plate wide open.
7. Start with the compression gauge at zero and crank the engine through four compression strokes, four puffs.
8. Check the compression for each cylinder. Record the readings.
9. If a cylinder has low compression, inject approximately 15 ml (1 tablespoon) of engine oil into the combustion chamber through the spark plug hole. Recheck the compression and record the reading.
10. The minimum compression in any one cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). For example, if the highest pressure in any one cylinder is 1 035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). ($1\ 035 \times 70\% = 725$) ($150 \times 70\% = 105$).
 - Normal - Compression builds up quickly and evenly to the specified compression for each cylinder.
 - Piston Rings Leaking - Compression is low on the first stroke. Then compression builds up with the following strokes but does not reach normal. Compression improves considerably when you add oil.
 - Valves Leaking - Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.
 - If two adjacent cylinders have lower than normal compression, and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the cylinders.

OIL CONSUMPTION DIAGNOSIS

Oil Consumption Diagnosis

Checks	Causes
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Excessive oil consumption, not due to leaks, is the use of 1 L (1 qt) or more of engine oil within 3 200 kilometers (2,000 miles).

Preliminary

The causes of excessive oil consumption may include the following conditions:

- External oil leaks

Refer to **Oil Leak Diagnosis**.

- Incorrect oil level or improper reading of the oil level indicator

With the vehicle on a level surface, run the engine for a few minutes, allow adequate drain down time, 2-3 minutes, and check for the correct engine oil level.

- Improper oil viscosity

Refer to the vehicle owners manual and use the recommended SAE grade and viscosity for the prevailing temperatures.

- Continuous high speed driving and/or severe usage
- Crankcase ventilation system restrictions or malfunctioning components
- Worn valve guides and/or valve stems
- Worn or improperly installed valve stem oil seals
- Piston rings broken, worn, or not seated properly

Allow adequate time for the rings to seat.

Replace worn piston rings as necessary.

- Piston and rings improperly installed or not fitted to the cylinder bore

OIL PRESSURE DIAGNOSIS AND TESTING

Tools Required

- **J 21867** Pressure Gage. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 42907** Oil Pressure Testing Tool. See **SPECIAL TOOLS AND EQUIPMENT**.

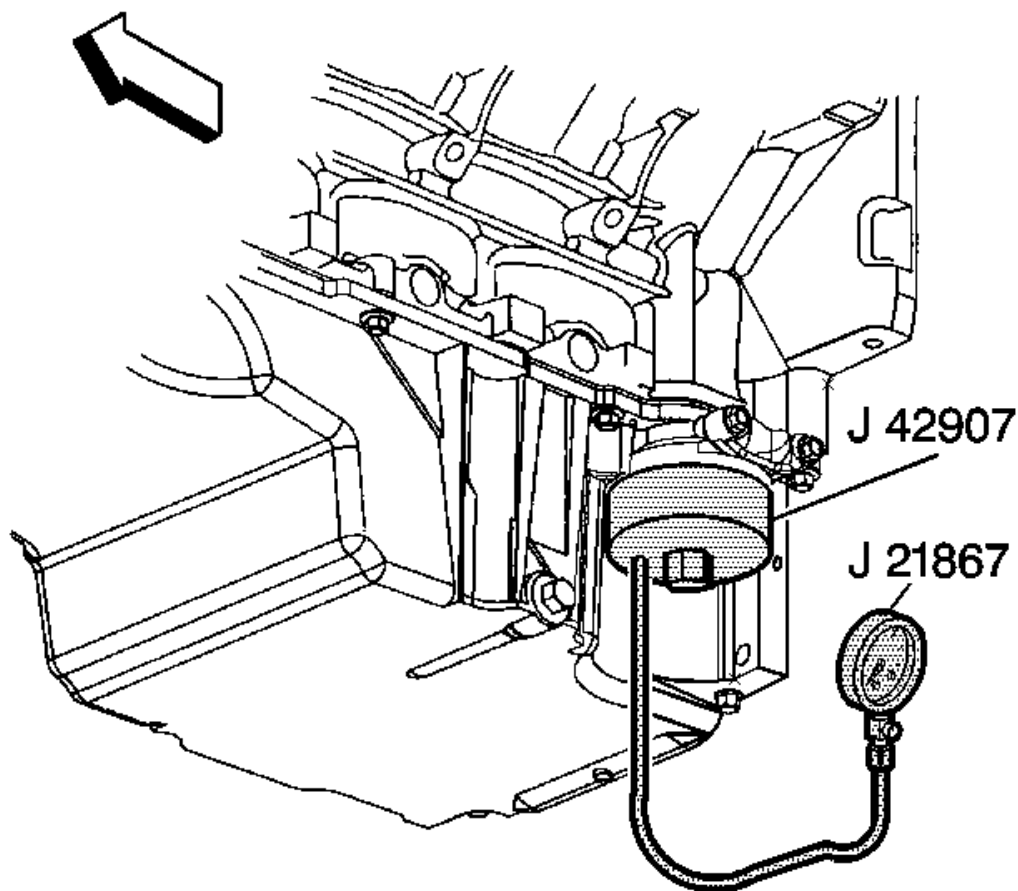


Fig. 1: Measuring Engine Oil Pressure
Courtesy of GENERAL MOTORS CORP.

1. With the vehicle on a level surface, run the vehicle for a few minutes, allow adequate drain down time of 2-3 minutes, and measure the oil level.
2. If required, add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.
3. Run the engine briefly, approximately 10-15 seconds, and verify low or no oil pressure on the vehicle gage or light.
4. Listen for a noisy valve train or a knocking noise.
5. Inspect for the following:
 - Oil diluted by water or glycol - anti freeze
 - Foamy oil
6. Remove the oil filter and install the **J 42907** . See **SPECIAL TOOLS AND EQUIPMENT**.

7. Install **J 21867** or equivalent to the **J 42907** . See **SPECIAL TOOLS AND EQUIPMENT**.
8. Run the engine and measure the engine oil pressure.
9. Compare the readings to **Engine Mechanical Specifications (LR4 VIN V)** or **Engine Mechanical Specifications (LM7 VIN T/L59 VIN Z)** or **Engine Mechanical Specifications (LQ4 VIN U/LQ9 VIN N)**.
10. If the engine oil pressure is below specifications, inspect the engine for one or more of the following:
 - Oil pump worn or dirty

Refer to **OIL PUMP CLEANING & INSPECTION** .

- Oil pump-to-engine block bolts loose

Refer to **OIL PUMP, PUMP SCREEN & DEFLECTOR REMOVAL** .

- Oil pump screen loose, plugged, or damaged
- Oil pump screen O-ring seal missing or damaged
- Malfunctioning oil pump pressure regulator valve
- Excessive bearing clearance
- Cracked, porous, or restricted oil galleries
- Oil gallery plugs missing or incorrectly installed

Refer to **ENGINE BLOCK PLUG INSTALLATION** .

- Broken valve lifters

Repair as necessary

11. If the oil pressure reading on the **J 21867** or equivalent is within specifications, inspect for the following:
See **SPECIAL TOOLS AND EQUIPMENT**.

- Plugged or incorrect oil filter and/or malfunctioning oil bypass valve
- Malfunctioning oil pressure gage or sensor

Repair as necessary

OIL LEAK DIAGNOSIS

Oil Leak Diagnosis

Step	Action	Yes	No
IMPORTANT: You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.			
	1. Operate the vehicle until it reaches normal		

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1	operating temperature. 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Check for drippings. Are drippings present?	Go to Step 2	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 3
3	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 4
4	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several kilometers - miles at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 4. Wait 15 minutes. 5. Identify the type of fluid, and the approximate location of the leak. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 5
5	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 6
	1. Completely clean the entire engine and surrounding components.		

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6	2. Apply an aerosol-type powder, baby powder, foot powder, etc., to the suspected area. 3. Operate the vehicle for several kilometers (miles) at normal operating temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 7
7	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 8
8	Use J 28428-E High Intensity Black Light Kit in order to identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 9
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	System OK
	1. Inspect the engine for mechanical damage. Special attention should be shown to the following areas: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves		

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10	• Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces 2. Inspect the engine for customer modifications. Is there mechanical damage, or customer modifications to the engine?	Go to Step 11	System OK
11	Repair or replace all damaged or modified components. Does the engine still leak oil?	Go to Step 1	System OK

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS**Crankcase Ventilation System Inspection/Diagnosis**

Symptom	Correction
External oil leak	Inspect for any of the following conditions: • Restricted positive crankcase ventilation (PCV) valve • Restricted or kinked PCV hose or engine vent hose • Damaged, incorrect, or incorrectly installed PCV valve or hose • Excessive crankcase pressure
Rough Idle	Inspect for any of the following conditions: • Restricted PCV valve • Restricted or kinked PCV hose or engine vent hose • Leaking (damaged) PCV valve or hose • Vacuum hoses worn or not properly installed
Stalling or slow idle speed	Inspect for any of the following conditions: • Restricted PCV valve • Restricted or kinked PCV hose or engine vent hose • Leaking (damaged) PCV valve or hose
High idle speed	Inspect for a leaking (damaged) PCV valve or hose
Sludge in the engine	Inspect for any of the following conditions: • Restricted PCV valve

- Restricted or kinked PCV hose or engine vent hose

DRIVE BELT CHIRPING DIAGNOSIS

Diagnostic Aids

The chirping noise may be intermittent due to moisture on the drive belt(s) or the accessory drive pulley(s). In order to duplicate the customer's concern, it may be necessary to spray a small amount of water onto the drive belt(s). If spraying water onto the drive belt(s) duplicates the symptom, cleaning the accessory drive pulley(s) may be the most probable solution.

A loose or improper installation of a body or suspension component, or other item(s) on the vehicle may also cause the chirping noise.

Test Description

The number(s) below refer to the step(s) in the diagnostic table.

2: The chirping noise may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed any further in this table.

3: The noise may be an internal engine noise. Remove the drive belt(s) and operate the engine for a few seconds, this will verify if the chirping noise is related to the drive belt(s) or not. With the drive belt(s) removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belt(s) removed.

4: Inspect the drive belt(s) for signs of pilling. Pilling is the small balls, pills, or strings in the drive belt grooves caused by the accumulation of rubber dust.

6: Misalignment of the accessory drive pulley(s) may be caused from improper mounting or incorrect installation of an accessory drive component, or the pulley may be bent inward or outward from a previous repair. Test for a misaligned accessory drive pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found, refer to that accessory drive component for the proper removal and installation procedure for that pulley.

10: Inspection of the fasteners can eliminate the possibility that a incorrect bolt, nut, spacer, or washer was installed.

12: Inspection of the accessory drive pulley(s) should include inspecting for bends, dents, or other damage to the pulley(s) that would prevent the drive belt(s) from seating properly in the pulley grooves or on the smooth surface of the pulley when the back side of the drive belt is used to drive the pulley.

14: Replacing the drive belt(s) when it is not damaged or there is not excessive pilling will only be a temporary repair.

Drive Belt Chirping Diagnosis

Step	Action	Yes	No
NOTE: Refer to Belt Dressing Notice in Cautions and Notices.			
DEFINITION : The following items are indications of chirping:			

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- A high pitched noise that is heard once per revolution of the drive belt(s) or a accessory drive pulley.
- Chirping may occur on cold damp start up conditions and will subside once the vehicle reaches normal operating temperature.

1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that there is a chirping noise. Does the engine make the chirping noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt(s). Refer to <u>Drive Belt Replacement - Accessory</u> or <u>Drive Belt Replacement - Air Conditioning</u> . 2. Operate the engine for no longer than 30 to 40 seconds. Does the chirping noise still exist?	Go to Engine Noise on Start-Up, but Only Lasting a Few Seconds	Go to Step 4
4	Inspect for severe drive belt pilling exceeding 1/3 of the drive belt groove depth. Do the drive belt grooves have pilling?	Go to Step 5	Go to Step 6
5	Clean the accessory drive pulley(s) with a suitable wire brush. Were the accessory drive pulley(s) cleaned?	Go to Step 15	-
6	Inspect for a misaligned accessory drive pulley(s). Is there a misaligned accessory drive pulley(s)?	Go to Step 7	Go to Step 8
7	Replace and/or repair the misaligned accessory drive pulley(s). Were the misaligned accessory drive pulley(s) replaced and/or repaired?	Go to Step 15	-
8	Inspect for a bent or cracked accessory drive bracket(s). Did you find any bent or cracked accessory drive bracket(s)?	Go to Step 9	Go to Step 10
9	Replace the bent and/or cracked accessory drive bracket(s). Was the bent and/or cracked accessory drive bracket(s) replaced?	Go to Step 15	-
10	Inspect for incorrect, loose and/or missing fasteners. Were there any incorrect, loose, and/or missing fasteners found?	Go to Step 11	Go to Step 12
11	1. Replace any incorrect and/or missing fasteners. 2. Tighten any loose fasteners. Refer to <u>TORQUE SPECIFICATIONS</u> . Were the fasteners replaced and/or tightened?	Go to Step 15	-
	Inspect for a bent accessory drive pulley(s).		

12	Was a bent accessory drive pulley(s) found?	Go to Step 13	Go to Step 14
13	Replace the bent accessory drive pulley(s). Was the bent accessory drive pulley(s) replaced?	Go to Step 15	-
14	Replace the drive belt(s). Refer to <u>Drive Belt Replacement - Accessory</u> or <u>Drive Belt Replacement - Air Conditioning</u> . Was the drive belt(s) replaced?	Go to Step 15	-
15	1. Clear any codes. 2. Run the engine in order to verify the repair. Does the chirping noise still exist?	-	System OK

DRIVE BELT SQUEAL DIAGNOSIS

Diagnostic Aids

A loose or improper installation of a body, or suspension component, or other item(s) on the vehicle may cause the squeal noise.

If the squeal is intermittent, verify that it is not the accessory drive component(s) by varying their load(s), making sure they are operating to their maximum capacity. An overcharged air conditioning (A/C) system, a power steering system restriction or the incorrect fluid, or a failing generator are suggested items to inspect.

Test Description

The number(s) below refer to the step(s) in the diagnostic table.

2: The squeal may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed further in this table

3: The squeal may be an internal engine noise. Remove the drive belt(s) and operate the engine for a few seconds, this will verify if the squealing noise is related to the drive belt(s) or an accessory drive component. With the drive belt(s) removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belt(s) removed.

4: This test is to verify that an accessory drive component(s) does not have a seized bearing. With the belt (s) removed, test the bearings in the accessory drive component(s) for smooth operation. Also test the accessory drive component(s) with the engine operating by varying the load on the accessory drive component(s) to verify that the component(s) is operating properly.

5: This test is to verify that the drive belt(s) tensioner(s) are not operating properly. If the drive belt tensioner(s) are not operating properly, proper belt tension may not be achieved to keep the drive belt(s) from slipping which could cause a squealing noise.

6: This test is to verify that the drive belt(s) is not too long, which would prevent the drive belt tensioner (s) from operating properly. Also if the incorrect length drive belt(s) was installed, it may not be routed correctly and may be turning an accessory drive component in the incorrect direction.

7: Misalignment of the accessory drive pulley(s) may be caused from improper mounting or incorrect

installation of a accessory drive component, or the pulley may be bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found, refer to that accessory drive component for the proper removal and installation procedure for that pulley.

8: Inspect the accessory drive pulley(s) to verify that they are the correct diameter or width. Using a known good vehicle, compare the accessory drive pulleys.

Drive Belt Squeal Diagnosis

Step	Action	Yes	No
NOTE: Refer to Belt Dressing Notice in Cautions and Notices.			
DEFINITION : The following items are indications of drive belt squeal: • A loud screeching noise that is caused by a slipping drive belt(s) (this is unusual for a drive belt with multiple ribs) • The squeal occurs when a heavy load is applied to the drive belt(s), such as an A/C compressor engagement, snapping the throttle, slipping on a seized pulley, or a faulty accessory drive component.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a squealing noise. Does the engine make the squeal noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt(s). Refer to <u>Drive Belt Replacement - Accessory</u> or <u>Drive Belt Replacement - Air Conditioning</u> . 2. Operate the engine for no longer than 30 to 40 seconds. Does the squealing noise still exist?	Go to <u>Engine Noise on Start-Up, but Only Lasting a Few Seconds</u>	Go to Step 4
4	Inspect for a seized accessory drive component bearing or a faulty accessory drive component. Did you find and correct the condition?	Go to Step 9	Go to Step 5
5	Inspect the drive belt tensioner for proper operation. Refer to <u>Drive Belt Tensioner Diagnosis</u> . Did you find and correct the condition?	Go to Step 9	Go to Step 6
6	Check for the correct length drive belt(s). Did you find and correct the condition?	Go to Step 9	Go to Step 7
7	Inspect for a misaligned pulley. Did you find and correct the condition?	Go to Step 9	Go to Step 8
8	Inspect for an incorrect size pulley. Did you find and correct the condition?	Go to Step 9	-
	1. Install the drive belt(s). Refer to <u>Drive Belt</u>		

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9	<u>Replacement - Accessory or Drive Belt</u> <u>Replacement - Air Conditioning.</u>		
	2. Clear any codes. 3. Run the engine in order to verify the repair.	-	
Does the squealing noise still exist?			System OK

DRIVE BELT WHINE DIAGNOSIS**Diagnostic Aids**

The drive belt(s) will not cause the whine.

If the whine is intermittent, verify that it is not the accessory drive component(s) by varying their loads, making sure they are operating to their maximum capacity. An overcharged air conditioning (A/C) system, a power steering system restriction or the incorrect fluid, or a failing generator are suggested items to inspect.

Test Description

The number(s) below refer to the step(s) in the diagnostic table.

3: This test is to verify that the whine is being caused by the accessory drive component(s). Remove the drive belt(s) and operate the engine for a few seconds, this will verify if the whining noise is related to the accessory drive component. With the drive belt(s) removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belt(s) removed.

4: This inspection should include checking the drive belt tensioner and the drive belt idler pulley bearings. The drive belt(s) may have to be installed and the accessory drive components operated separately by varying their loads. Refer to the suspected accessory drive component for the proper removal and installation procedure.

Drive Belt Whine Diagnosis

Step	Action	Yes	No
NOTE: Refer to Belt Dressing Notice in Cautions and Notices.			
DEFINITION : A high pitched continuous noise that may be caused by an accessory drive component failed bearing.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a whining noise. Does the engine make the whining noise?	Go to Step 3	Go to Diagnostic Aids
	1. Remove the drive belt(s). Refer to <u>Drive Belt Replacement - Accessory or Drive Belt</u>		

3	<u>Replacement - Air Conditioning.</u> 2. Operate the engine for no longer than 30 to 40 seconds. Does the whining noise still exist?	Go to <u>Engine Noise on Start-Up, but Only Lasting a Few Seconds</u>	Go to Step 4
4	1. Inspect for a failed accessory drive component bearing. 2. Install the drive belt(s). Refer to <u>Drive Belt Replacement - Accessory</u> or <u>Drive Belt Replacement - Air Conditioning.</u> Did you find and correct the condition?	Go to Step 5	-
5	1. Clear any codes. 2. Run the engine in order to verify the repair. Does the whining still exist?	-	System OK

DRIVE BELT RUMBLING DIAGNOSIS

Diagnostic Aids

Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise.

The drive belt(s) may have a condition that can not be seen or felt. Sometimes replacing the drive belt(s) may be the only repair for the symptom.

If after replacing the drive belt(s) and completing the diagnostic table, the rumbling is only heard with the drive belt(s) installed, there might be an accessory drive component failure. Varying the load on the accessory drive component(s) may aid in identifying which component is causing the rumbling noise.

Test Description

The number(s) below refer to the step(s) in the diagnostic table.

2: This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom.

3: This test is to verify that the drive belt(s) is causing the rumbling. Rumbling may be confused with an internal engine noise due to the similarity in the description. Remove only one drive belt at a time if the vehicle has multiple drive belts. Operate the engine for a few seconds, this will verify if the rumbling noise is related to the drive belt(s) or not. With the drive belt(s) removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belt(s) removed.

4: Inspect the drive belt(s) to ensure that the drive belt(s) is not the cause of the noise. Small cracks across the ribs of the drive belt(s) will not cause the noise. Belt separation is identified by the plys of the belt

separating, this may be seen at the edge of the belt or felt as a lump in the belt.

5: Small amounts of pilling is a normal condition and acceptable. When the pilling is severe the drive belt (s) does not have a smooth surface for proper operation.

Drive Belt Rumbling Diagnosis

Step	Action	Yes	No
NOTE: Refer to Belt Dressing Notice in Cautions and Notices.			
DEFINITION : • A low pitch tapping, knocking, or thumping noise heard at or just above idle. • Heard once per revolution of the drive belt(s) or pulley(s). • Rumbling may be caused from: ◦ Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt(s) pulley groove ◦ The separation of the drive belt(s) ◦ A damaged drive belt(s)			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that there is a rumbling noise. Does the engine make the rumbling noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt(s). Refer to <u>Drive Belt Replacement - Accessory</u> or <u>Drive Belt Replacement - Air Conditioning</u> . 2. Operate the engine for no longer than 30 to 40 seconds. Does the rumbling noise still exist?	Go to <u>Engine Noise on Start-Up, but Only Lasting a Few Seconds</u>	Go to Step 4
4	Inspect the drive belt(s) for damage, separation, or sections of missing ribs. Were any of these conditions found?	Go to Step 7	Go to Step 5
5	Inspect for severe pilling of more than 1/3 of the drive belt groove depth. Do the drive belt grooves have pilling?	Go to Step 6	Go to Step 7
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belt(s). Refer to <u>Drive Belt Replacement - Accessory</u> or <u>Drive Belt Replacement - Air Conditioning</u> . Did you complete the repair?	Go to Step 8	-

7	Install a new drive belt(s). Refer to <u>Drive Belt Replacement - Accessory</u> or <u>Drive Belt Replacement - Air Conditioning</u> . Did you complete the replacement?	Go to Step 8	-
8	1. Clear any codes. 2. Run the engine in order to verify the repair. Does the rumbling noise still exist?	-	System OK

DRIVE BELT VIBRATION DIAGNOSIS

Diagnostic Aids

The accessory drive components may have an affect on engine vibration. An overcharged air conditioning (A/C) system, a power steering system restriction, or the incorrect fluid, or an extra load placed on the generator are suggested items to inspect. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

Test Description

The number(s) below refer to the step(s) in the diagnostic table.

2: This test is to verify that the vibration is present during diagnosing. Other vehicle components may cause a similar symptom such as the exhaust system, or the drivetrain.

3: This test is to verify that the drive belt(s) or accessory drive components may be causing the vibration. Remove the drive belt(s) and operate the engine for a few seconds, this will verify if the vibration is related to the drive belt(s) or not. With the drive belt(s) removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belt(s) removed.

4: The drive belt(s) may cause a vibration. While the drive belt(s) is removed this is the best time to inspect the condition of the drive belt(s).

6: Inspection of the fasteners can eliminate the possibility that a incorrect bolt, nut, spacer, or washer was installed.

8: This step should only be performed if the fan is driven by the drive belt. Inspect the engine cooling fan for bent, twisted, loose, or cracked blades. Inspect the fan clutch for smooth operation. Inspect for a bent fan shaft or bent mounting flange.

9: Inspect the water pump drive shaft for being bent. Also inspect the water pump bearings for smooth operation and excessive play. Compare the water pump with a known, good water pump.

10: Accessory drive component brackets that are bent, cracked, or loose may put an extra strain on that accessory drive component causing it to vibrate.

Drive Belt Vibration Diagnosis

Step	Action	Yes	No
NOTE:			

Refer to Belt Dressing Notice in Cautions and Notices.

DEFINITION : The following items are indications of drive belt vibration:

- The vibration is engine-speed related.
- The vibration may be sensitive to accessory load.

1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that the vibration is engine related. Does the engine make the vibration?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt(s). Refer to Drive Belt Replacement - Accessory or Drive Belt Replacement - Air Conditioning . 2. Operate the engine for no longer than 30 to 40 seconds. Does the engine still make the vibration?	Go to Diagnostic Starting Point - Vibration Diagnosis and Correction in Vibration Diagnosis and Correction	Go to Step 4
4	Inspect the drive belt(s) for wear, damage, debris build-up and missing drive belt ribs. Were any of these conditions found?	Go to Step 5	Go to Step 6
5	Install a new drive belt(s). Refer to Drive Belt Replacement - Accessory or Drive Belt Replacement - Air Conditioning . Did you complete the replacement?	Go to Step 11	-
6	Inspect for incorrect, loose, and/or missing fasteners. Were any of these conditions found?	Go to Step 7	Go to Step 8
7	Replace any incorrect and/or missing fastener. Tighten any loose fasteners. Refer to TORQUE SPECIFICATIONS . Were the fasteners replaced and/or tightened?	Go to Step 11	-
8	Inspect for damaged fan blades or a bent fan clutch shaft. Did you find and correct the condition?	Go to Step 11	Go to Step 9
9	Inspect for a bent water pump drive shaft. Did you find and correct the condition?	Go to Step 11	Go to Step 10
10	Inspect for a bent or cracked accessory drive bracket(s). Did you find and correct the condition?	Go to Step 11	-
11	1. Clear any codes. 2. Run the engine in order to verify the repair. Does the vibration still exist?	-	System OK

DRIVE BELT FALLS OFF DIAGNOSIS

Diagnostic Aids

If the drive belt(s) repeatedly falls off the accessory drive pulley(s), this may be caused by a pulley misalignment.

An extra load that is quickly applied or released by an accessory drive component may also cause the drive belt(s) to fall off. Verify that the accessory drive component(s) are operating properly.

If the drive belt(s) is the incorrect length, the drive belt tensioner may not maintain the proper tension on the drive belt(s).

Test Description

The number(s) below refer to the step(s) in the diagnostic table.

2: This inspection is to verify the condition of the drive belt(s). Damage may have occurred to the drive belt(s) when the drive belt(s) fell off the pulley. Inspect the drive belt(s) for cuts, tears, sections of ribs missing, or damaged belt plys.

4: Misalignment of the accessory drive pulley(s) may be caused from improper mounting or incorrect installation of a accessory drive component, or the pulley may be bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found, refer to that accessory drive component for the proper removal and installation procedure of that pulley.

5: Inspection of the accessory drive pulley(s) should include inspecting for bends, dents, or other damage that would prevent the drive belt from seating properly in the pulley grooves or on the smooth surface of a pulley when the back side of the drive belt(s) is used to drive the pulley.

6: Accessory drive component brackets that are bent or cracked will also cause the drive belt(s) to fall off.

7: Inspection of the fasteners can eliminate the possibility that a incorrect bolt, nut, spacer, or washer was installed. Missing, loose, or incorrect fasteners may cause pulley misalignment from the accessory drive bracket(s) moving under load. Over tightening the fasteners may cause misalignment of the accessory component bracket(s).

Drive Belt Falls Off Diagnosis

Step	Action	Yes	No
NOTE: Refer to Belt Dressing Notice in Cautions and Notices.			
DEFINITION : The drive belt(s) falls off the pulleys or may not ride correctly on the pulleys.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Inspect for a damaged drive belt(s). Was a damaged drive belt(s) found?	Go to Step 3	Go to Step 4
3	Install a new drive belt(s). Refer to Drive Belt Replacement - Accessory or Drive Belt Replacement - Air Conditioning .		

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	Does the drive belt(s) continue to fall off?	Go to Step 4	System OK
4	Inspect for a misaligned accessory drive pulley(s). Did you find and correct the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented accessory drive pulley(s). Did you find and correct the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked accessory drive bracket (s). Did you find and correct the condition?	Go to Step 12	Go to Step 7
7	Inspect for incorrect, loose and/or missing fasteners. Were there any incorrect, loose and/or missing fasteners?	Go to Step 8	Go to Step 9
8	1. Replace any incorrect and/or missing fasteners. 2. Tighten any loose fasteners. Refer to <u>TORQUE SPECIFICATIONS</u> . Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Test the drive belt tensioner for correct operation. Refer to <u>Drive Belt Tensioner Diagnosis</u> . Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Refer to <u>Drive Belt Tensioner Replacement - Accessory</u> or <u>Drive Belt Tensioner Replacement - Air Conditioning</u> . Does the drive belt continue to fall off?	Go to Step 11	System OK
11	Inspect for a failed drive belt idler and/or tensioner pulley bearing. Did you find and repair the condition?	Go to Step 12	-
12	Run the engine in order to verify the repair. Does the drive belt still fall off?	-	System OK

DRIVE BELT EXCESSIVE WEAR DIAGNOSIS**Diagnostic Aids**

Excessive wear on a drive belt(s) is usually caused by incorrect installation or the incorrect drive belt(s) for the application.

Minor misalignment of the accessory drive pulley(s) will not cause excessive wear, but will probably cause the drive belt(s) to make a noise or fall off.

Excessive misalignment of the accessory drive pulley(s) will cause excessive wear and may also make the drive belt(s) fall off.

Test Description

The number(s) below refer to the step(s) in the diagnostic table.

2: This inspection is to verify that the drive belt(s) is correctly installed on all of the accessory drive

pulleys. Wear on the drive belt(s) may be caused by mis-positioning the drive belt(s) by one or more grooves on a pulley(s).

3: The installation of a drive belt(s) that is too wide or too narrow will cause wear on the drive belt(s). The drive belt(s) ribs should match all of the grooves on the pulleys.

4: This inspection is to verify that the drive belt(s) is not contacting any part of the engine or body while the engine is operating. There should be sufficient clearance when the accessory drive components load varies. The drive belt(s) should not come in contact with an engine or a body component when snapping the throttle.

Drive Belt Excessive Wear Diagnosis

Step	Action	Yes	No
NOTE: Refer to Belt Dressing Notice in Cautions and Notices.			
DEFINITION : Wear at the outside ribs of the drive belt(s) due to incorrect installation of the drive belt (s).			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Inspect the drive belt(s) for proper installation. Is the drive belt(s) installed properly?	Go to Step 5	Go to Step 3
3	Inspect for the correct drive belt(s). Is the correct drive belt installed?	Go to Step 5	Go to Step 4
4	Inspect the drive belt(s) for signs of rubbing against a bracket, hose, or wiring harness. Was the drive belt(s) rubbing against anything?	Go to Step 5	Go to Diagnostic Aids
5	Replace the drive belt(s). Refer to Drive Belt Replacement - Accessory or Drive Belt Replacement - Air Conditioning . Did you complete the replacement?	Go to Step 6	-
6	Run the engine in order to verify the repair. Is there still excessive drive belt wear?	-	System OK

DRIVE BELT TENSIONER DIAGNOSIS

Inspection Procedure

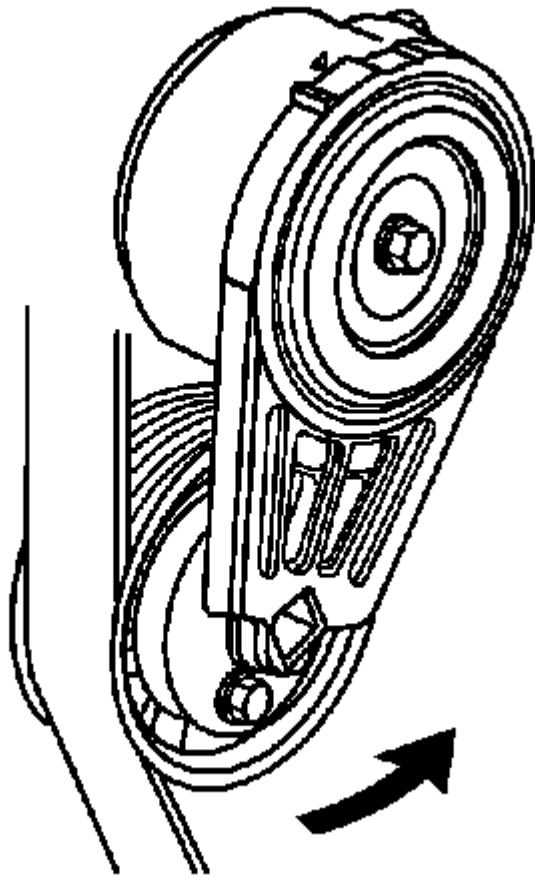


Fig. 2: Releasing Drive Belt Tension

Courtesy of GENERAL MOTORS CORP.

NOTE: Allowing the drive belt tensioner to snap into the free position may result in damage to the tensioner.

IMPORTANT: When the engine is operating the drive belt tensioner arm will move. Do not replace the drive belt tensioner because of movement in the drive belt tensioner arm.

1. Remove the drive belt. Refer to Drive Belt Replacement - Accessory or Drive Belt Replacement - Air Conditioning.
2. Move the drive belt tensioner through its full travel.
 - The movement should feel smooth.
 - There should be no binding.
 - The tensioner should return freely.
3. If any binding is observed, replace the drive belt tensioner. Refer to Drive Belt Tensioner Replacement - Accessory or Drive Belt Tensioner Replacement - Air Conditioning.

4. Install the drive belt. Refer to of **Drive Belt Replacement - Accessory** or **Drive Belt Replacement - Air Conditioning**.

REPAIR INSTRUCTIONS

DRIVE BELT REPLACEMENT - ACCESSORY

Removal Procedure

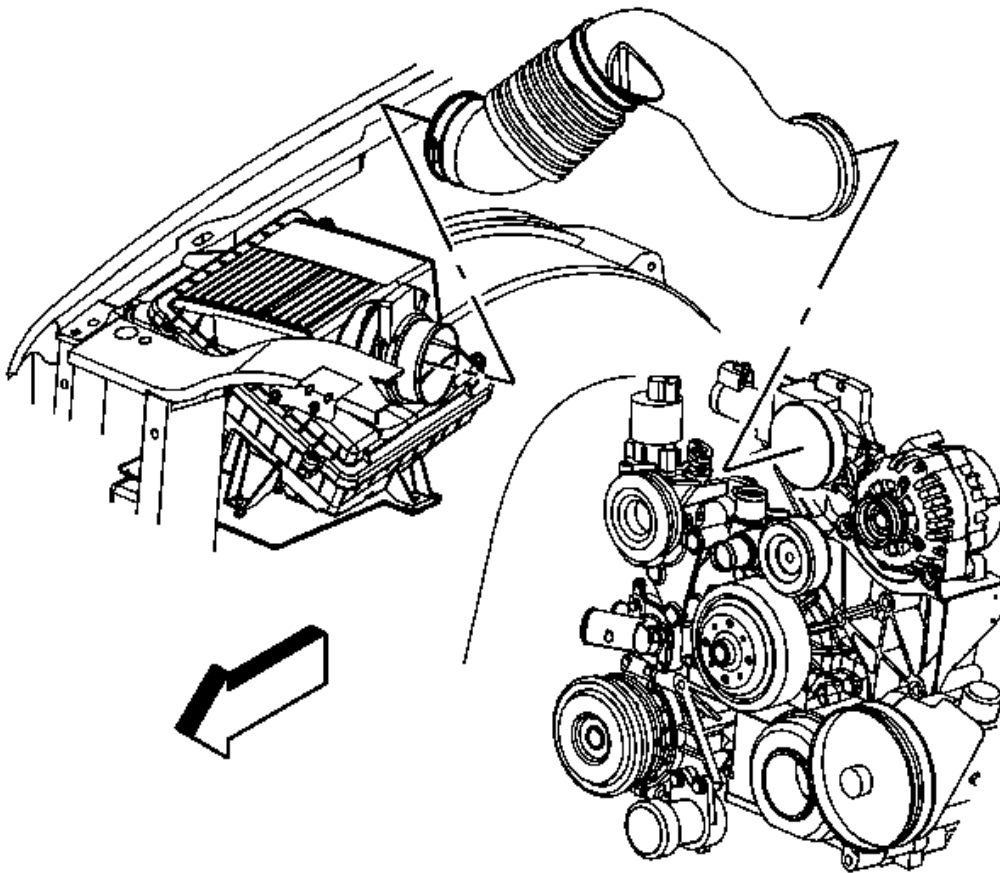


Fig. 3: View Of Air Cleaner Outlet Duct (W/HP2 Front)
Courtesy of GENERAL MOTORS CORP.

1. Loosen the air cleaner outlet duct clamps at the following locations:
 - Throttle body
 - Mass airflow/intake air temperature (MAF/IAT) sensor

2. Remove the radiator inlet hose clip from the outlet duct.
3. Remove the air cleaner outlet duct.

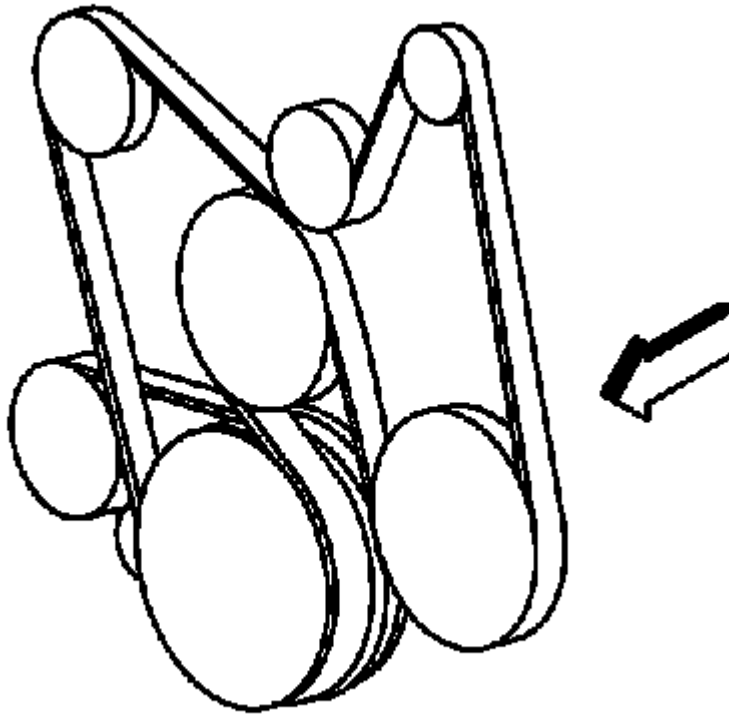


Fig. 4: Drive Belt Routing

Courtesy of GENERAL MOTORS CORP.

4. Install a breaker bar with hex-head socket to the drive belt tensioner bolt.
5. Rotate the drive belt tensioner clockwise in order to relieve tension on the belt.
6. Remove the belt from the pulleys and the drive belt tensioner.
7. Slowly release the tension on the drive belt tensioner.
8. Remove the breaker bar and socket and from the drive belt tensioner bolt.
9. Clean and inspect the belt surfaces of all the pulleys.

Installation Procedure

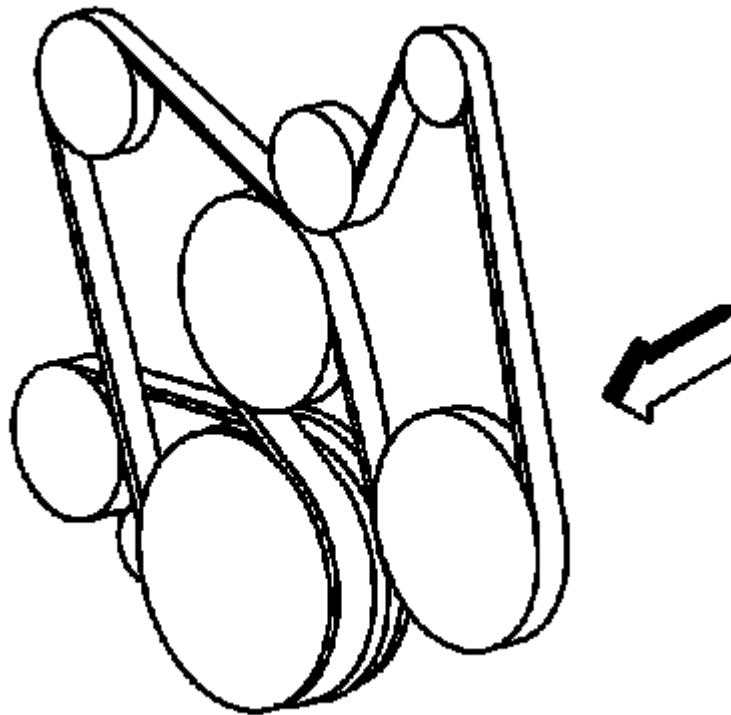


Fig. 5: Drive Belt Routing

1. Route the drive belt around all the pulleys except the idler pulley.
2. Install the breaker bar with hex-head socket to the belt tensioner bolt.
3. Rotate the belt tensioner clockwise in order to relieve the tension on the tensioner.
4. Install the drive belt under the idler pulley.
5. Slowly release the tension on the belt tensioner.
6. Remove the breaker bar and socket from the belt tensioner bolt.
7. Inspect the drive belt for proper installation and alignment.

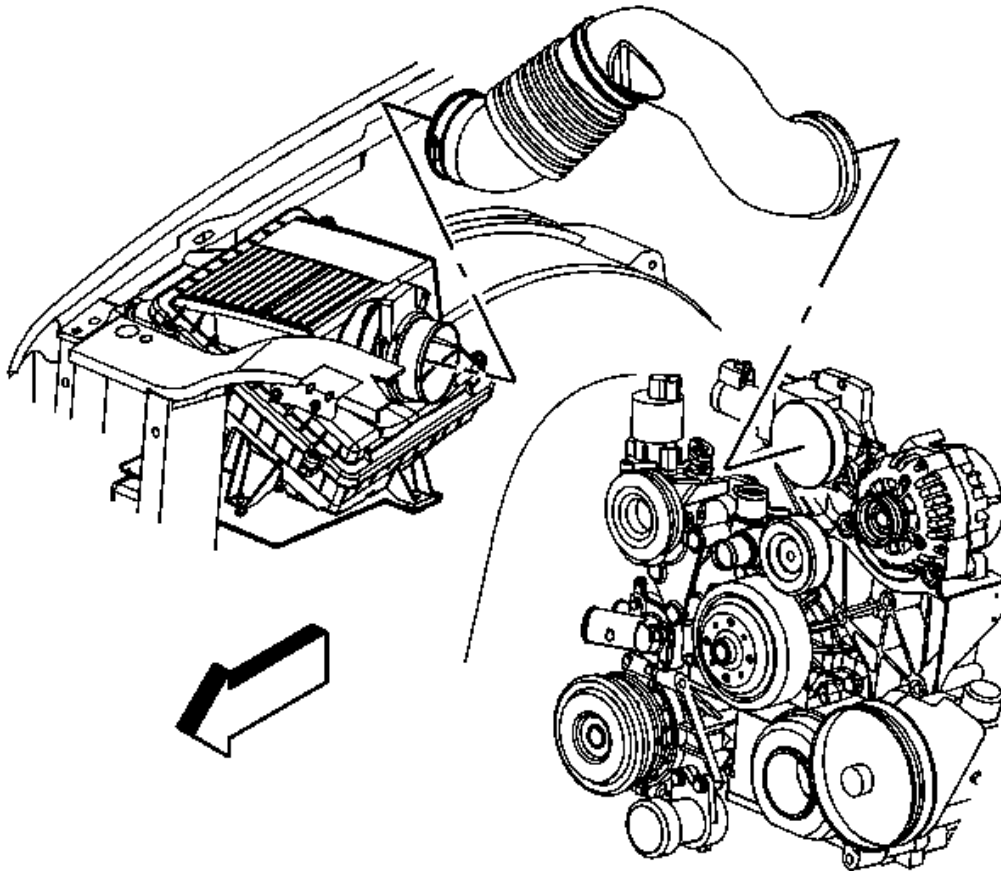


Fig. 6: View Of Air Cleaner Outlet Duct (W/HP2 Front)
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Align the arrow at the throttle body end of the duct with the throttle body attaching stud.

8. Install the air cleaner outlet duct.
9. Install the radiator inlet hose clip to the outlet duct.

NOTE: Refer to Fastener Notice in Cautions and Notices.

10. Tighten the air cleaner outlet duct clamps at the following locations:
 - Throttle body
 - MAF/IAT sensor

Tighten: Tighten the air cleaner outlet duct clamp screws to 7 N.m (62 lb in).

DRIVE BELT REPLACEMENT - AIR CONDITIONING

Removal Procedure

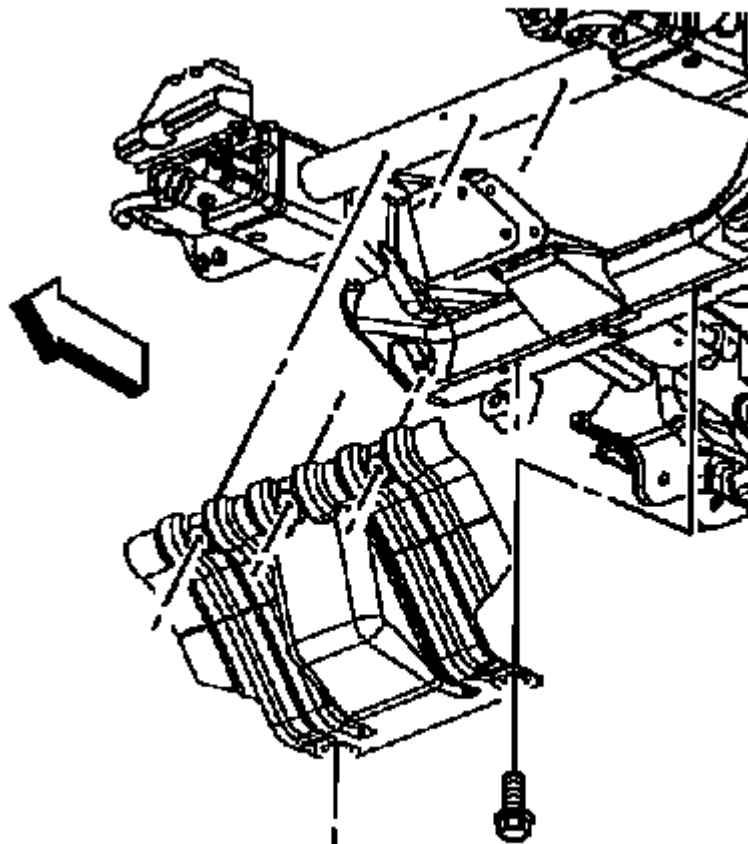


Fig. 7: View Of Engine Protection Shield
Courtesy of GENERAL MOTORS CORP.

1. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory.
2. Raise and suitably support the vehicle. Refer to LIFTING AND JACKING THE VEHICLE in General Information.
3. Remove the engine shield bolts.
4. Remove the engine shield.

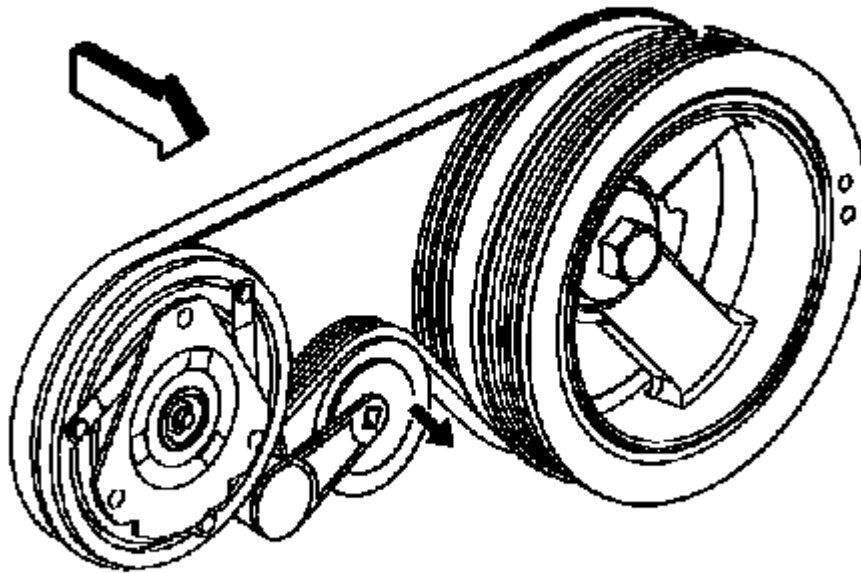


Fig. 8: A/C Belt Tensioner

Courtesy of GENERAL MOTORS CORP.

5. Install a ratchet into the air conditioning (A/C) belt tensioner adapter opening.
6. Rotate the A/C belt tensioner clockwise in order to relieve tension on the belt.
7. Remove the A/C belt from the pulleys.
8. Slowly release the tension on the A/C belt tensioner.
9. Remove the ratchet from the A/C belt tensioner.
10. Clean and inspect the belt surfaces of all the pulleys.

Installation Procedure

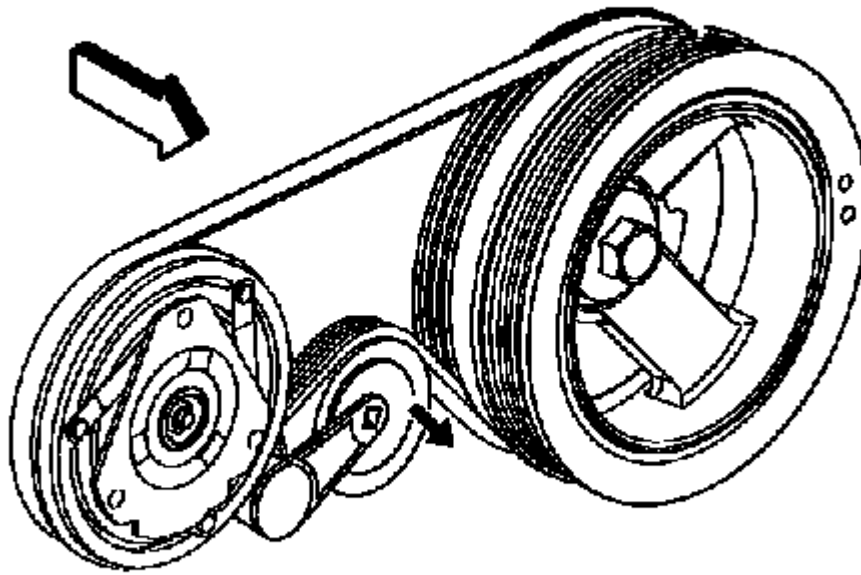


Fig. 9: A/C Belt Tensioner

Courtesy of GENERAL MOTORS CORP.

1. Install the A/C belt around the crankshaft balancer.
2. Install a ratchet into the A/C drive belt tensioner adapter opening
3. Rotate the A/C belt tensioner clockwise in order to relieve tension on the tensioner.
4. Install the A/C belt over the idler pulley.
5. Install the A/C belt around the A/C compressor pulley.
6. Slowly release the tension on the A/C belt tensioner.
7. Remove the ratchet from the A/C belt tensioner.
8. Inspect the A/C belt for proper installation and alignment.

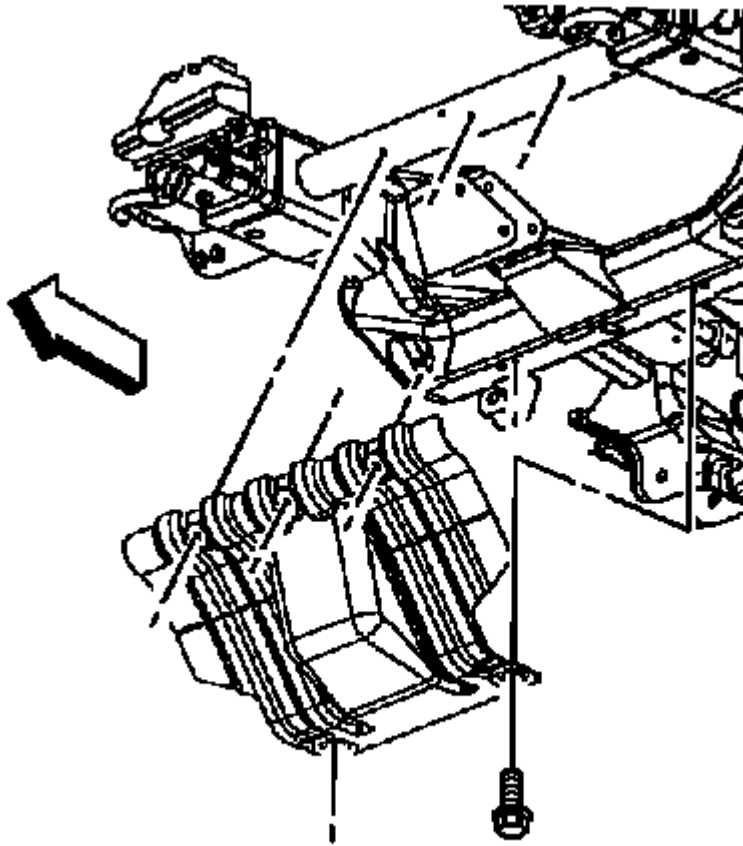


Fig. 10: View Of Engine Protection Shield
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

9. Install the engine shield.
10. Install the engine shield bolts.

Tighten: Tighten the bolts to 20 N.m (15 lb ft).

11. Lower the vehicle.
12. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.

DRIVE BELT IDLER PULLEY REPLACEMENT

Removal Procedure

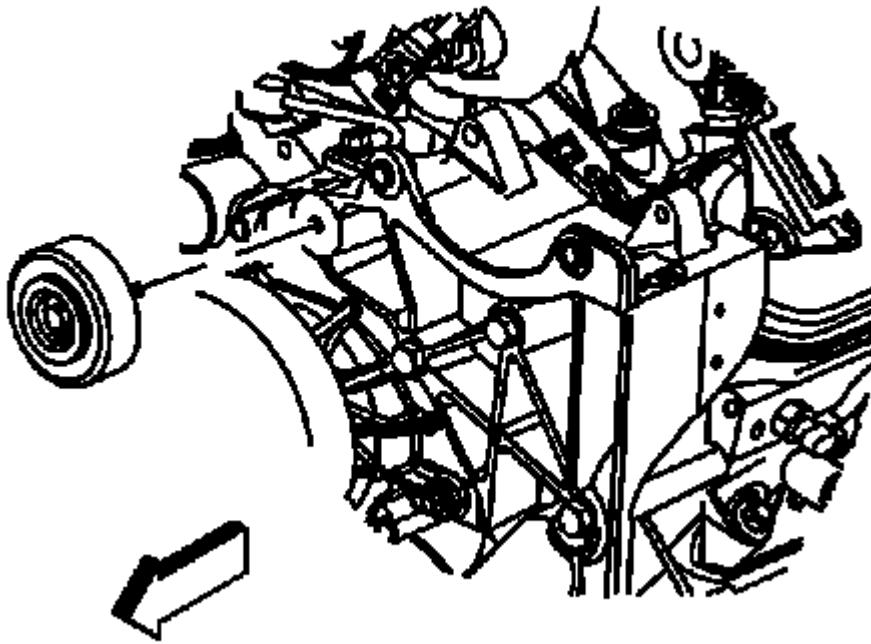


Fig. 11: View Of Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

1. Loosen the drive belt idler pulley bolt.
2. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory.**
3. Remove the drive belt idler pulley and bolt.

Installation Procedure

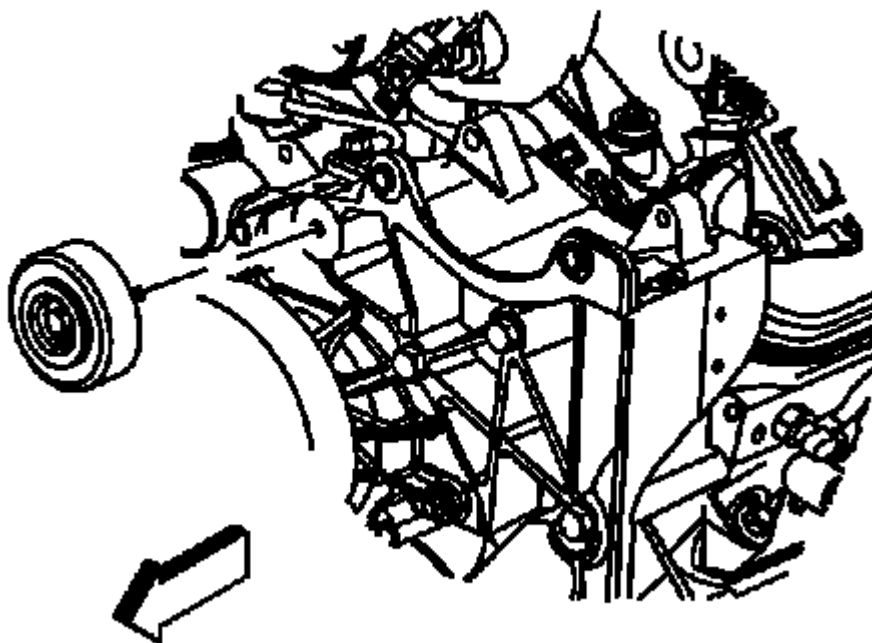


Fig. 12: View Of Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt idler pulley and bolt to the generator bracket.

Snug the bolt finger tight.

2. Install the drive belt. Refer to **Drive Belt Replacement - Accessory**.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Tighten the drive belt idler pulley bolt.

Tighten: Tighten the bolt to 50 N.m (37 lb ft).

DRIVE BELT TENSIONER REPLACEMENT - ACCESSORY

Removal Procedure

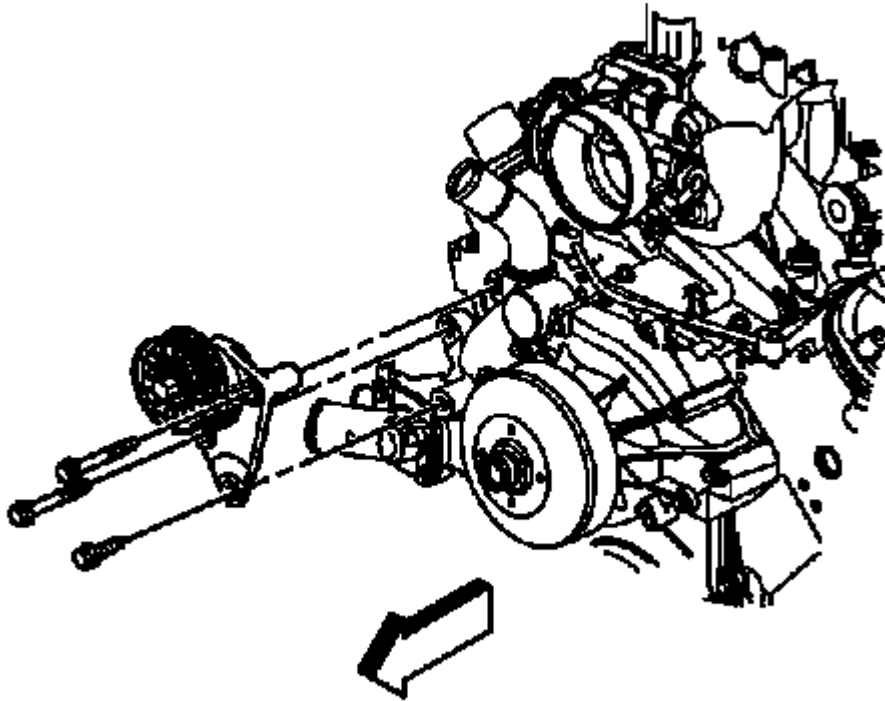


Fig. 13: View Of Drive Belt Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
2. Remove the drive belt tensioner bolts.
3. Remove the drive belt tensioner.

Installation Procedure

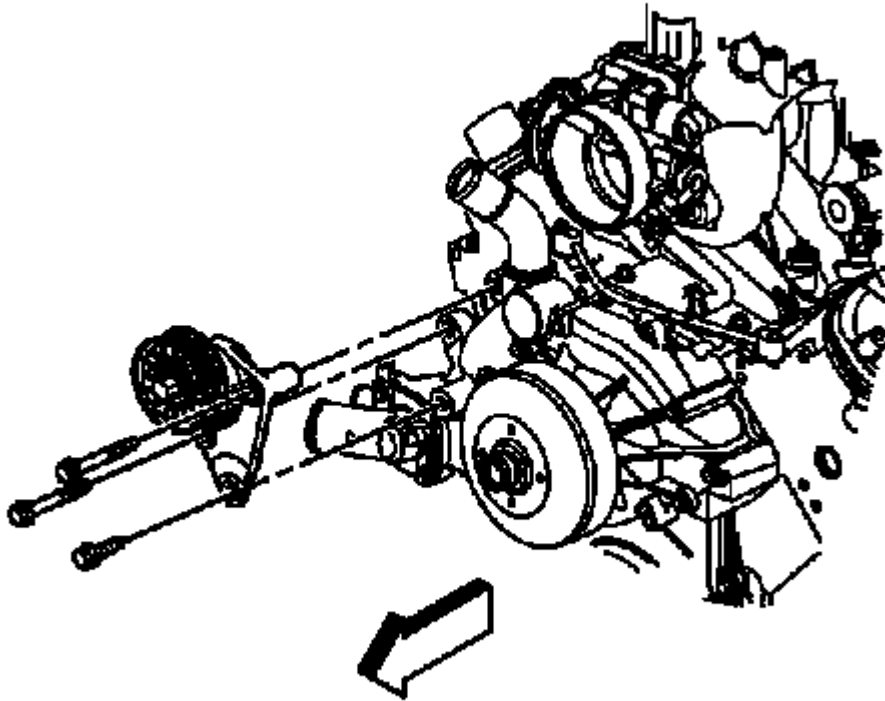


Fig. 14: View Of Drive Belt Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt tensioner.
2. Install the drive belt tensioner bolts.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Tighten the drive belt tensioner bolts.

Tighten: Tighten the accessory drive belt tensioner bolts to 50 N.m (37 lb ft).

4. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory.**

DRIVE BELT TENSIONER REPLACEMENT - AIR CONDITIONING

Removal Procedure

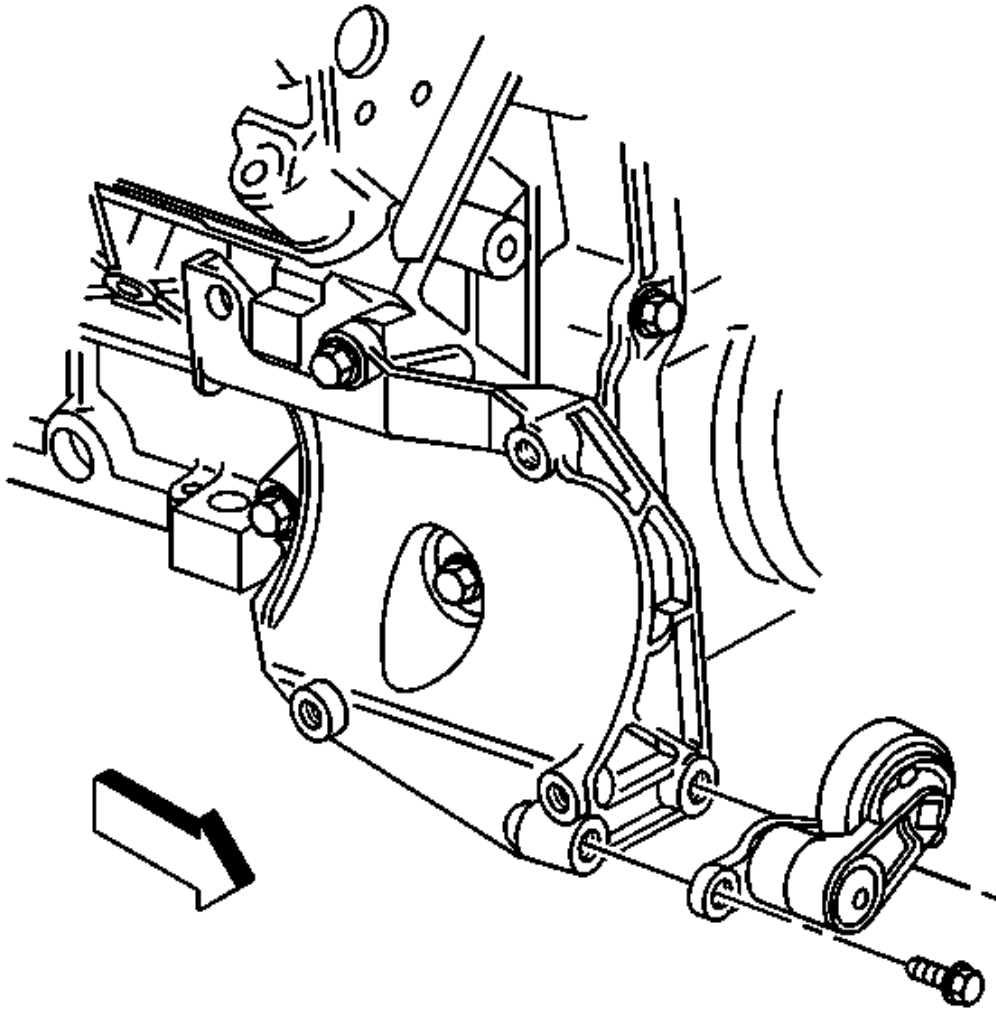


Fig. 15: View Of A/C Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Remove the air conditioning (A/C) drive belt. Refer to **Drive Belt Replacement - Air Conditioning**.
2. Remove the A/C belt tensioner bolts.
3. Remove the A/C belt tensioner.

Installation Procedure

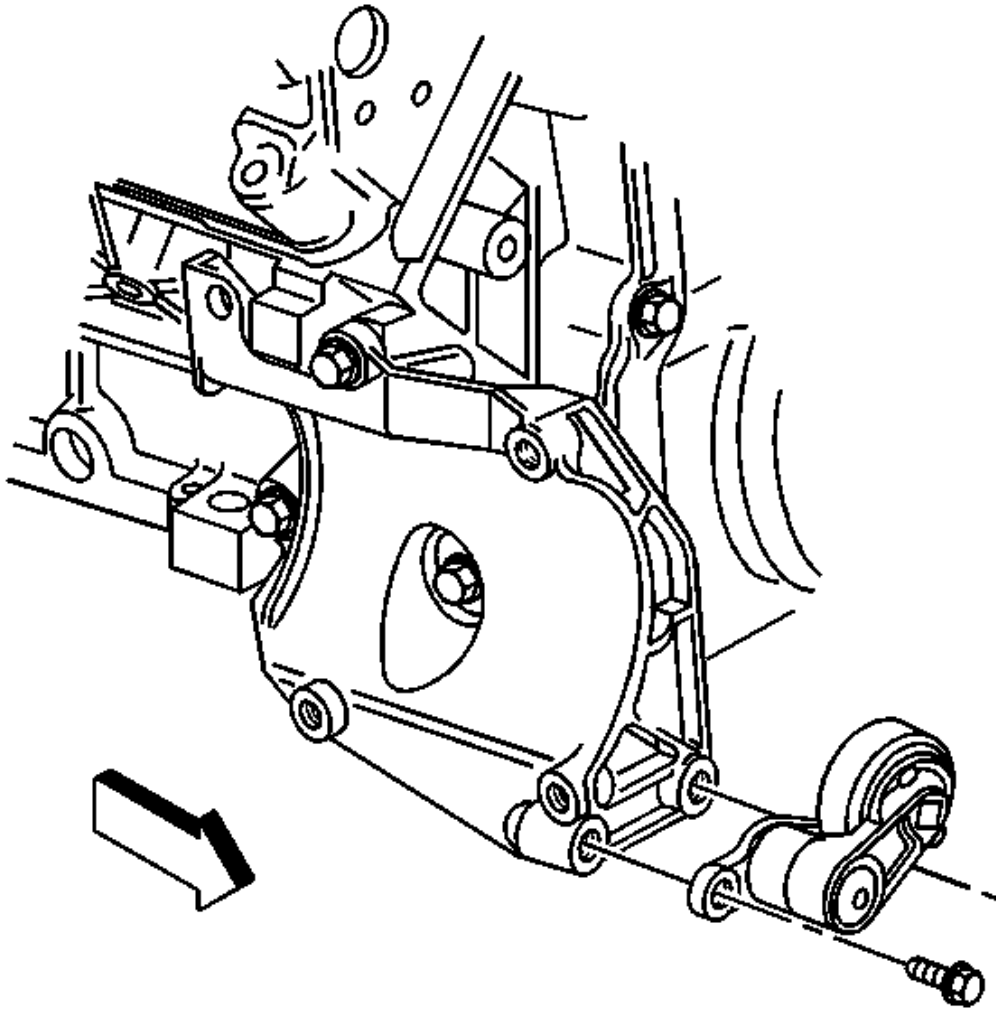


Fig. 16: View Of A/C Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Install the A/C belt tensioner.
2. Install the A/C belt tensioner bolts.

Tighten: Tighten the A/C belt tensioner bolts to 50 N.m (37 lb ft).

3. Install the A/C drive belt. Refer to **Drive Belt Replacement - Air Conditioning**.

ENGINE MOUNT INSPECTION

- NOTE:** Broken or deteriorated mounts can cause misalignment and destruction of certain drive train components. When a single mount breaks, the remaining mounts are subjected to abnormally high stresses.
- NOTE:** When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause the pan to be bent against the pump screen. This will result in a damaged oil pickup unit.
1. Measure the engine movement at the engine mount in order to check for damage to the rubber portions of the mount.
 1. Apply the park brake.
 2. Start the engine.
 3. Firmly apply and hold the primary brakes.
 4. Have an assistant stand to the side of the vehicle in order to observe for engine movement.
 5. Slightly load the engine shifting from drive to reverse a few times.
 6. If the engine moves more than 24 mm (0.945 in) from the at rest position, in either direction, check for loose engine mount bolts.
 2. If the engine mount bolt torque is within specifications, check the condition of the engine mount.
 3. Replace the engine mount if any of the following conditions exist:
 - Heat check cracks cover the rubber cushion surface.
 - The rubber cushion is separated from the metal plate of the mount.
 - There is a split through the rubber cushion.

ENGINE MOUNT REPLACEMENT - LEFT**Removal Procedure**

- NOTE:** When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause the pan to be bent against the pump screen. This will result in a damaged oil pickup unit.
1. Raise the vehicle. Refer to **LIFTING AND JACKING THE VEHICLE** in General Information.
 2. Remove the tire and wheel.
 3. Remove the wheelhouse panel from the vehicle. Refer to **WHEELHOUSE PANEL REPLACEMENT**.
 4. For vehicles with 4WD, remove the front propeller shaft. Refer to **PROPELLER SHAFT REPLACEMENT - FRONT**.

IMPORTANT: DO NOT raise and/or support the engine by the crankshaft balancer, or oil pan.

5. Raise and suitably support the engine using adjustable (screw type) jack stands.

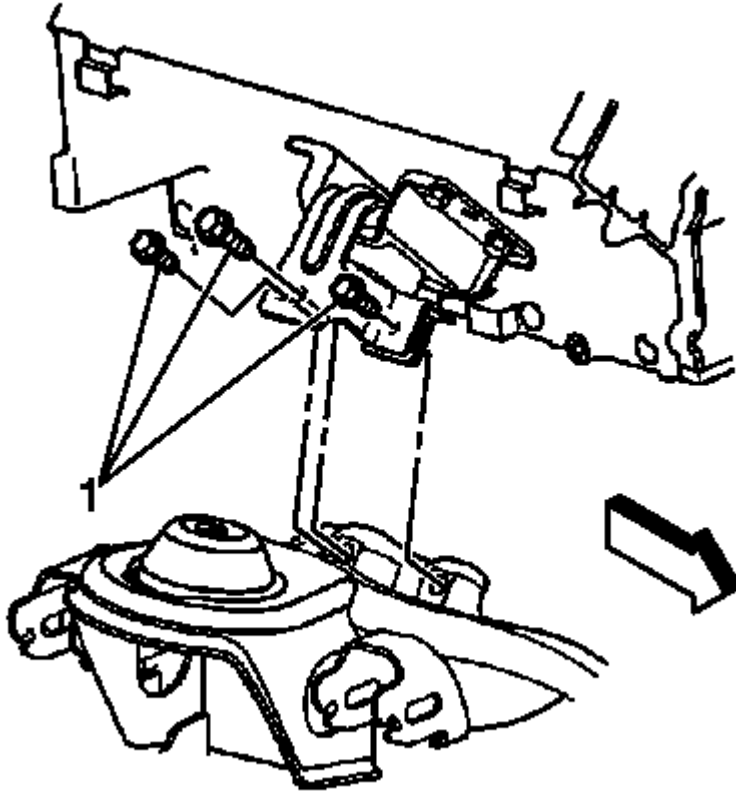


Fig. 17: View Of Engine Mount-To-Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine mount-to-engine mount bracket bolts. (Right side shown, left side similar).

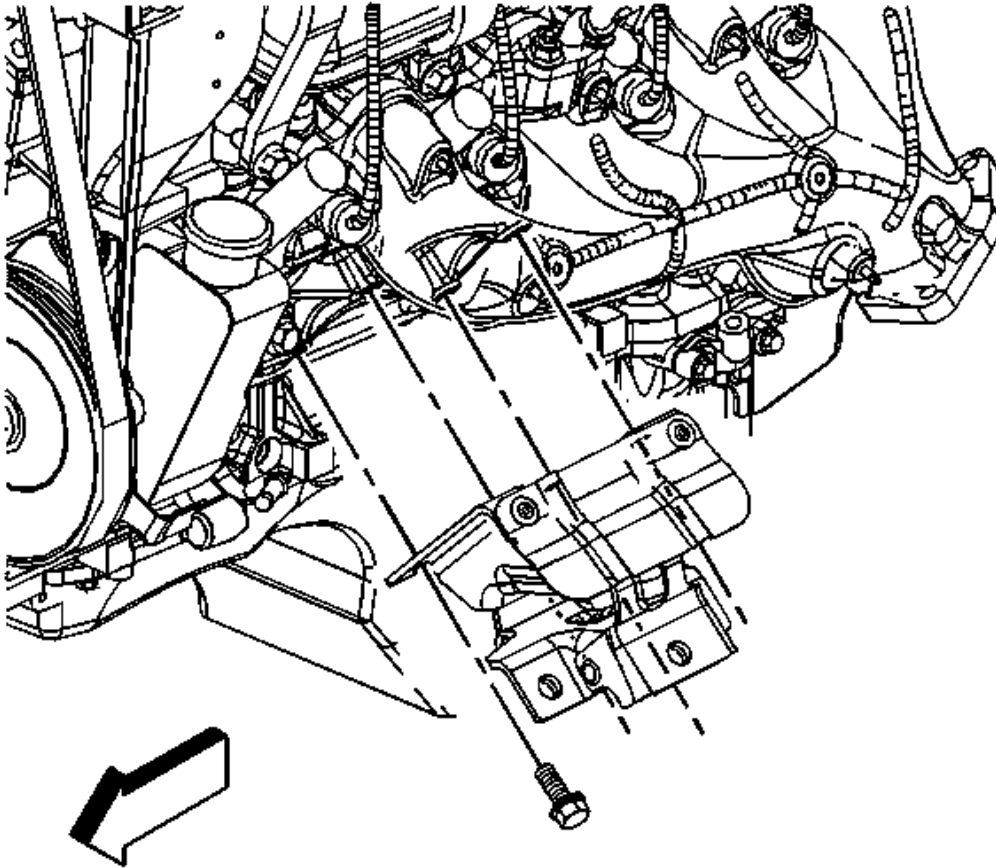


Fig. 18: Removed Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

7. Remove the engine mount bolts.
8. Remove the left engine mount.

Installation Procedure

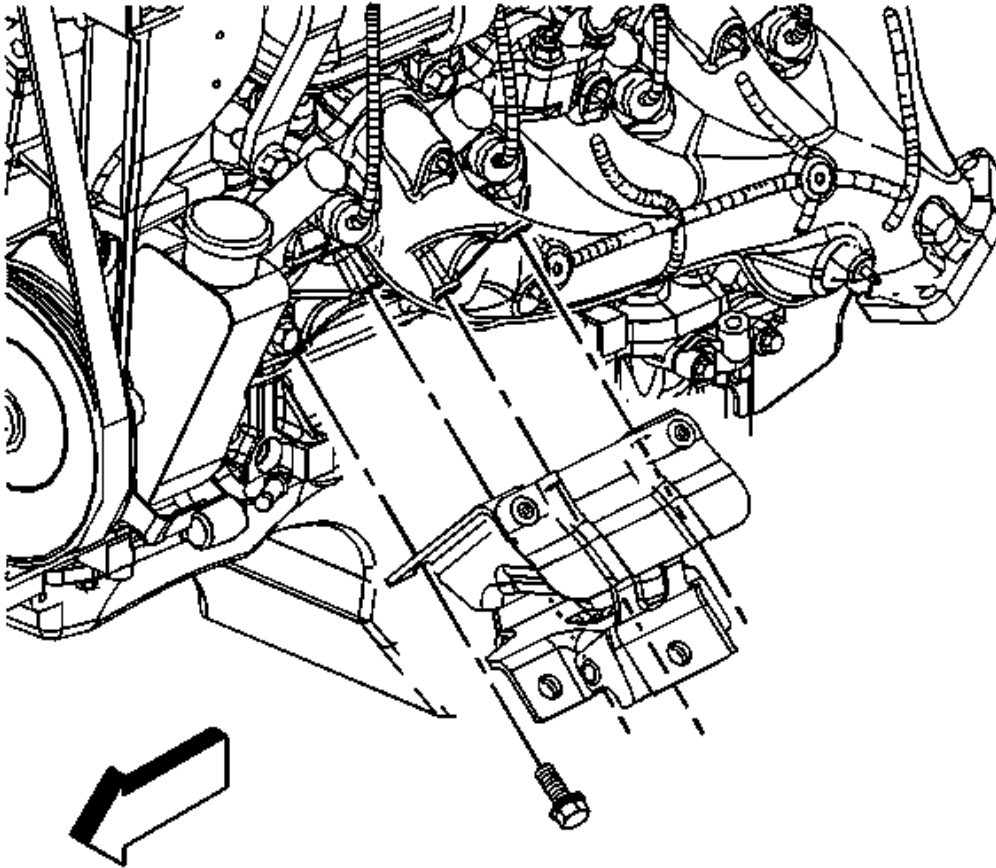


Fig. 19: Removed Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Install the left engine mount to the engine.
2. Install the engine mount bolts to the engine.

Tighten: Tighten the engine mount bolts to 50 N.m (37 lb ft).

3. Lower the engine.
4. Remove the adjustable jack stands.
5. For vehicles with 4WD, install the front propeller shaft. Refer to **PROPELLER SHAFT REPLACEMENT - FRONT**.

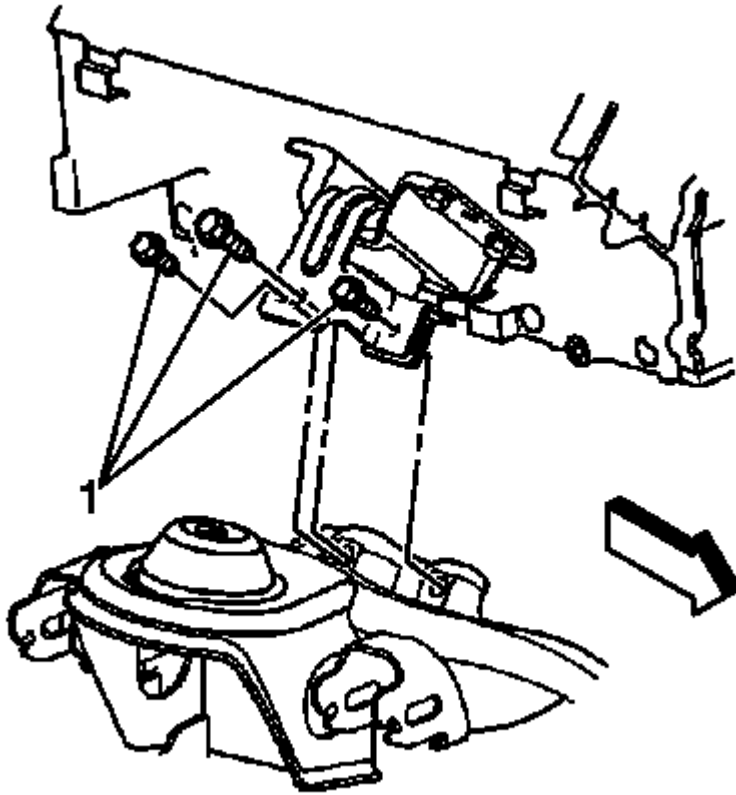


Fig. 20: View Of Engine Mount-To-Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

6. Install the engine mount-to-engine mount bracket bolts. (Right side shown, left side similar).

Tighten: Tighten the engine mount-to-engine mount bracket bolts to 65 N.m (48 lb ft).

7. Install the wheelhouse panel from the vehicle. Refer to **WHEELHOUSE PANEL REPLACEMENT** .
8. Install the tire and wheel.
9. Lower the vehicle.

ENGINE MOUNT BRACKET REPLACEMENT - LEFT

Removal Procedure

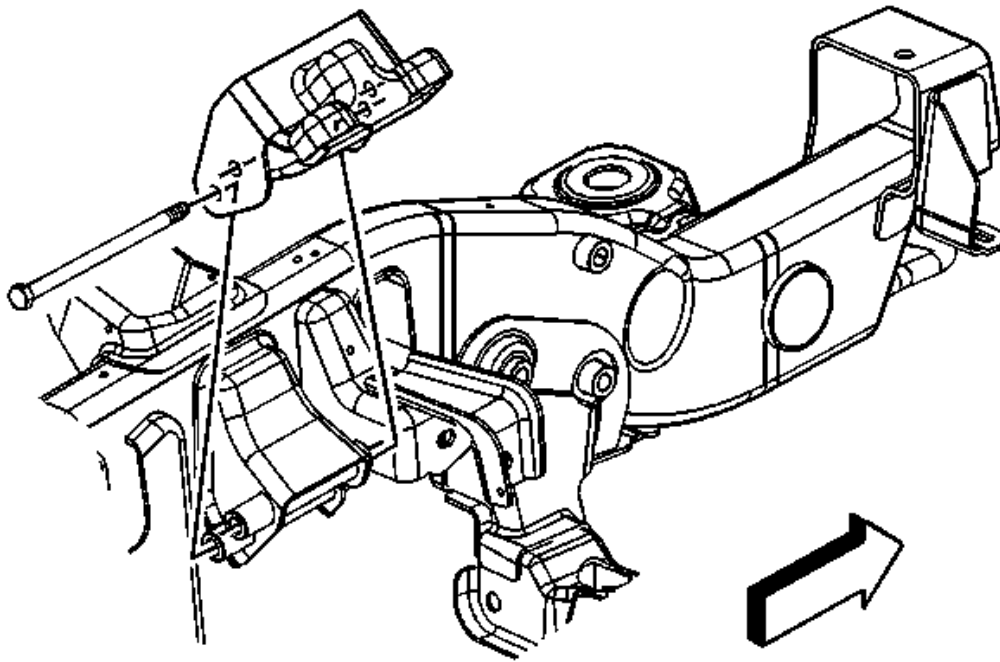


Fig. 21: Removed Left Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine mount. Refer to **Engine Mount Replacement - Left.**
2. Remove the engine mount bracket bolts.
3. Remove the engine mount bracket.

Installation Procedure

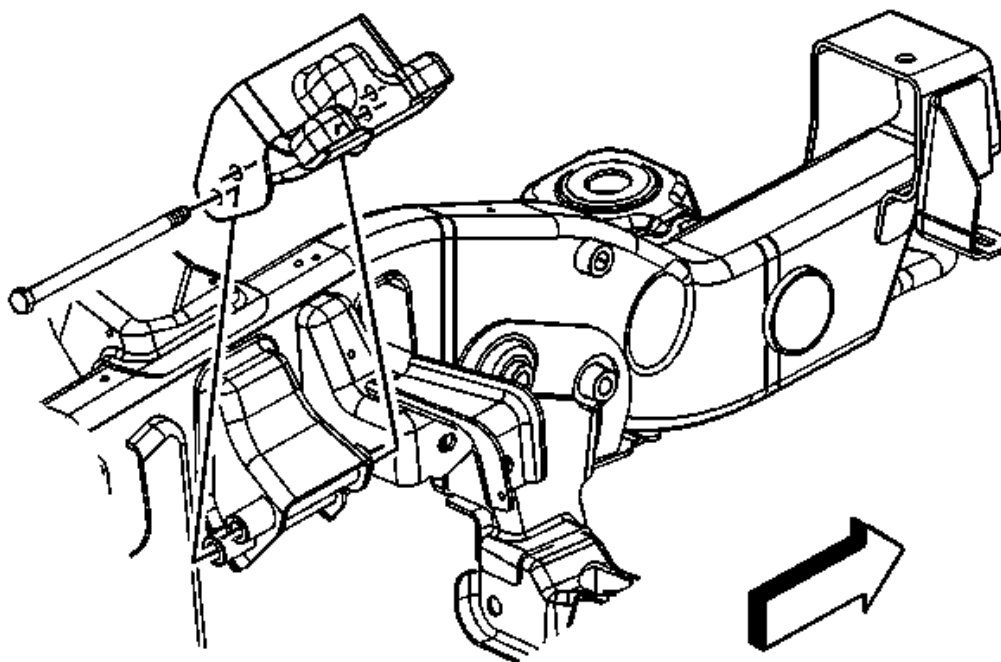


Fig. 22: Removed Left Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount bracket.
2. Perform the following procedure prior to installing the engine mount bracket bolts.
 - Remove all traces of the original adhesive patch.
 - Clean the threads of the bolt with denatured alcohol or equivalent and allow to dry.
 - Apply threadlocker GM P/N 12345382 (Canadian P/N 10953489) or equivalent to the bolts.

NOTE: Refer to Cautions and Notices.

3. Install the engine mount bracket bolts.

Tighten: Tighten the engine mount bracket bolts to 75 N.m (55 lb ft).

4. Install the engine mount. Refer to **Engine Mount Replacement - Left**.

ENGINE MOUNT REPLACEMENT - RIGHT

Removal Procedure

1. Remove the exhaust manifold. Refer to **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (4.8L, 5.3L & 6.0L Engine)** .

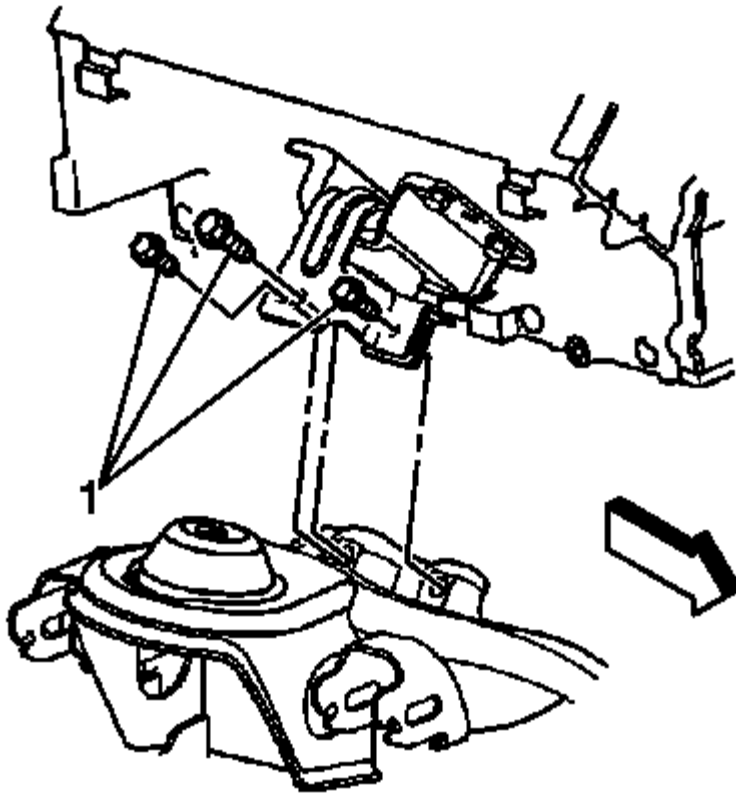


Fig. 23: View Of Engine Mount-To-Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

2. Remove the engine mount-to-engine mount bracket bolts.
3. Raise and suitably support the vehicle. Refer to **LIFTING AND JACKING THE VEHICLE** in General Information.
4. Remove the tire and wheel.
5. Remove the inner wheelhouse panel. Refer to **WHEELHOUSE PANEL REPLACEMENT** .
6. Remove the engine protection shield, if equipped.

IMPORTANT: DO NOT raise and/or support the engine by the crankshaft balancer, or oil pan.

7. Raise and suitably support the engine using adjustable (screw type) jack stands.

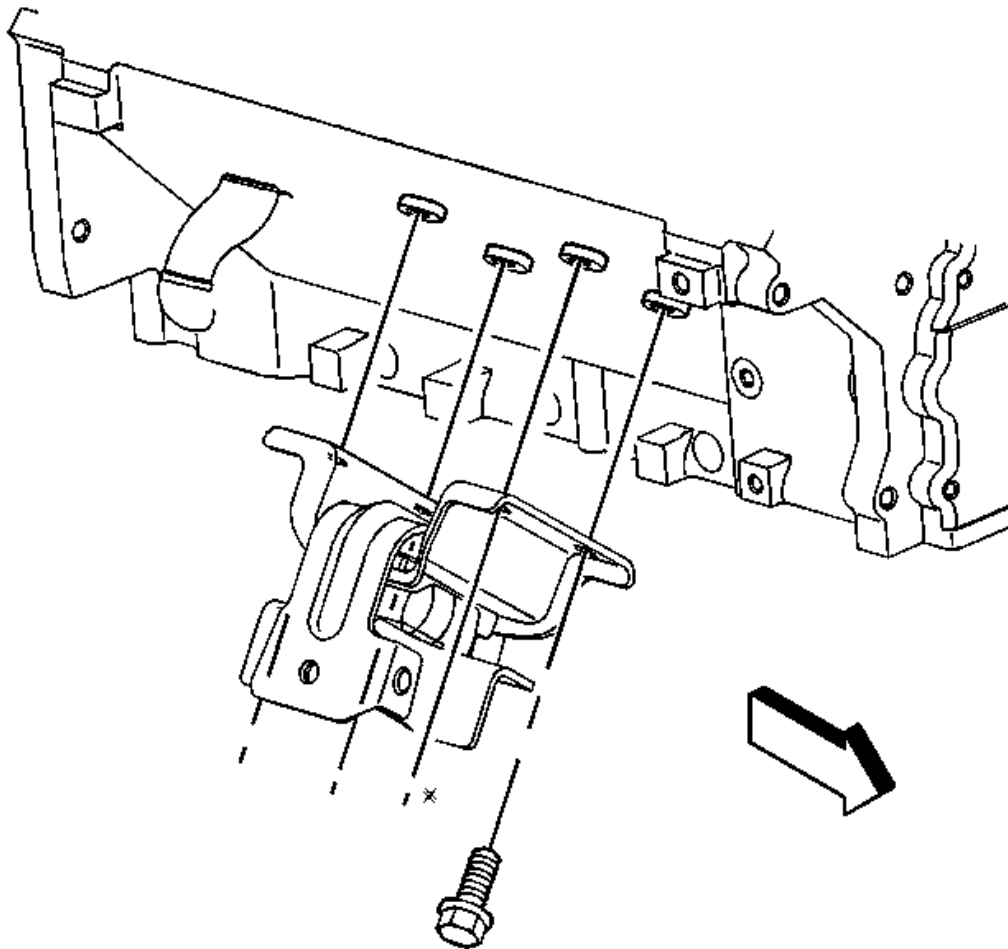


Fig. 24: Removed Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

8. Remove the engine mount to engine bolts.
9. Remove the right engine mount.

Installation Procedure

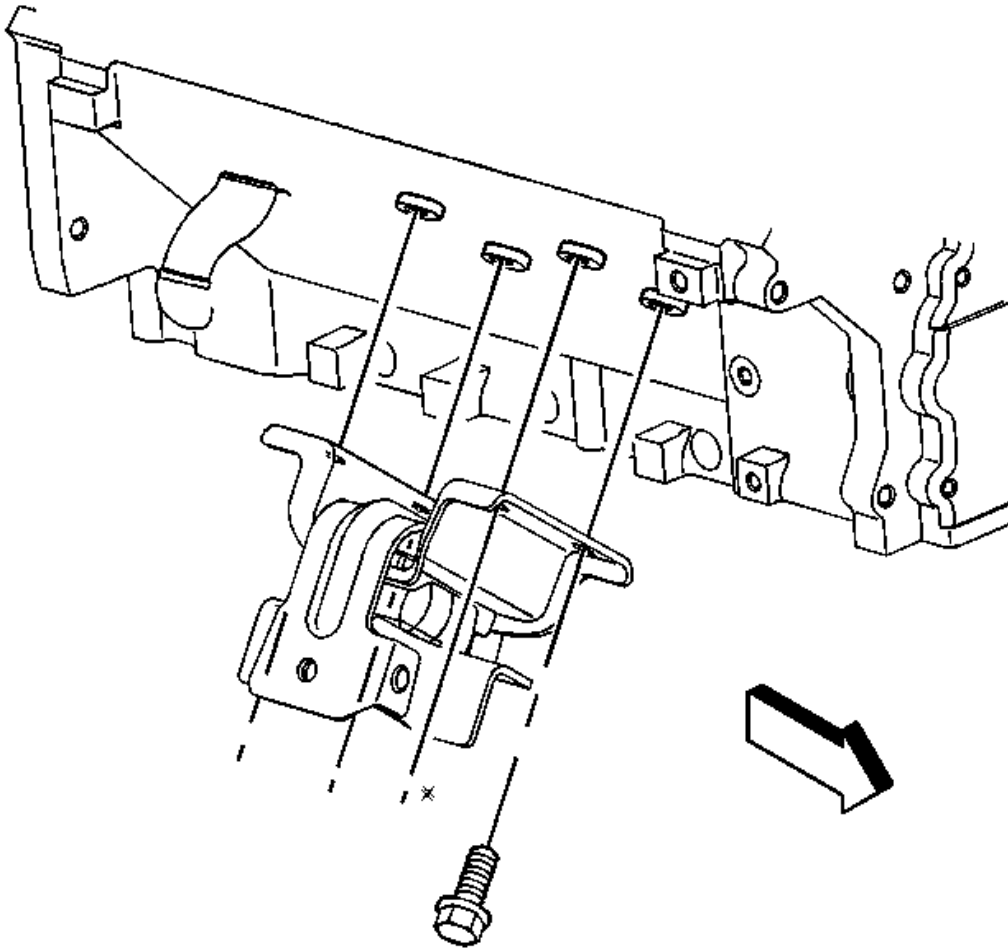


Fig. 25: Removed Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Position the right engine mount to the engine.
2. Install the engine mount bolts.

Tighten: Tighten the engine mount bolts to 50 N.m (37 lb ft).

3. Lower the engine.
4. Remove the adjustable jack stands.

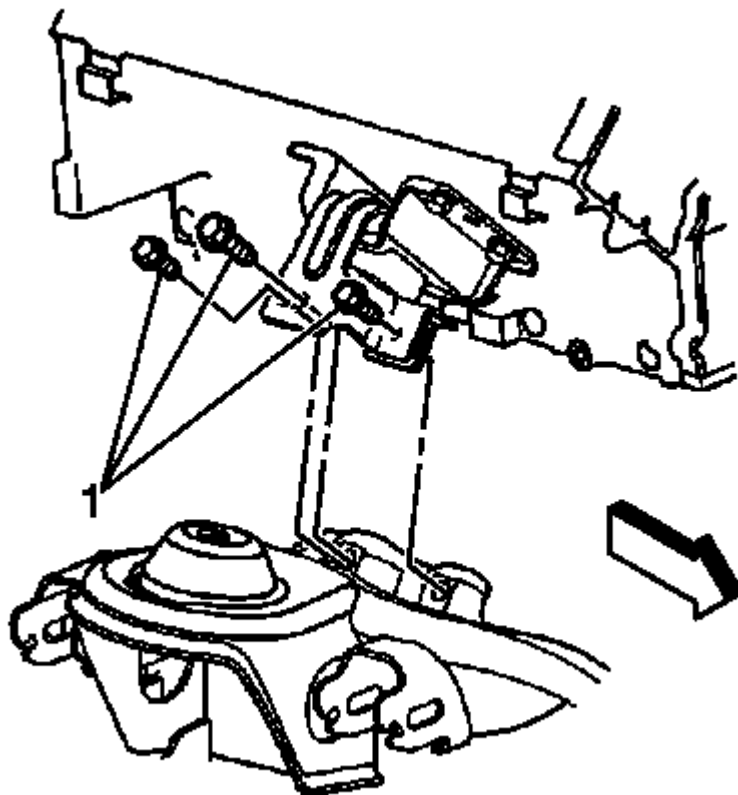


Fig. 26: View Of Engine Mount-To-Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

5. Install the engine mount-to-engine mount bracket bolts.

Tighten: Tighten the engine mount-to-engine mount bracket bolts to 65 N.m(48 lb ft).

6. Install the exhaust manifold. Refer to **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (4.8L, 5.3L & 6.0L Engine)** in Engine Exhaust.
7. Install the inner wheelhouse panel. Refer to **WHEELHOUSE PANEL REPLACEMENT** .
8. Install the tire and wheel.
9. Install the engine protection shield, if equipped.
10. Lower the vehicle.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT

Removal Procedure

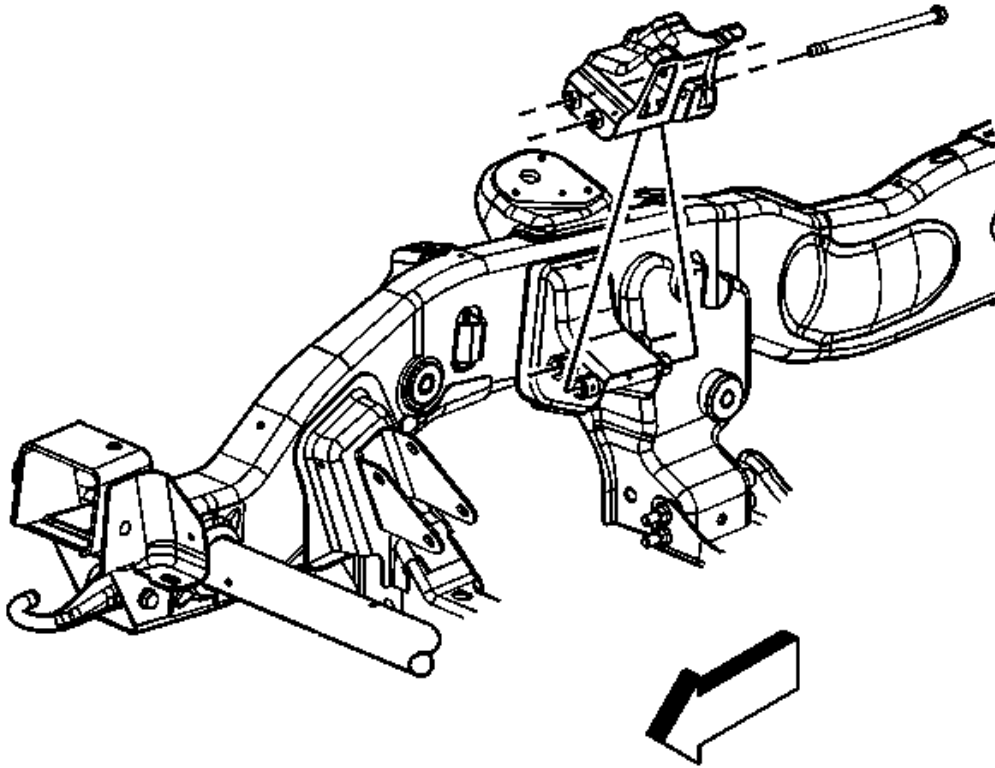


Fig. 27: Removed Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine mount. Refer to **Engine Mount Replacement - Right**.
2. Remove the engine mount bracket bolts.
3. Remove the engine mount bracket.

Installation Procedure

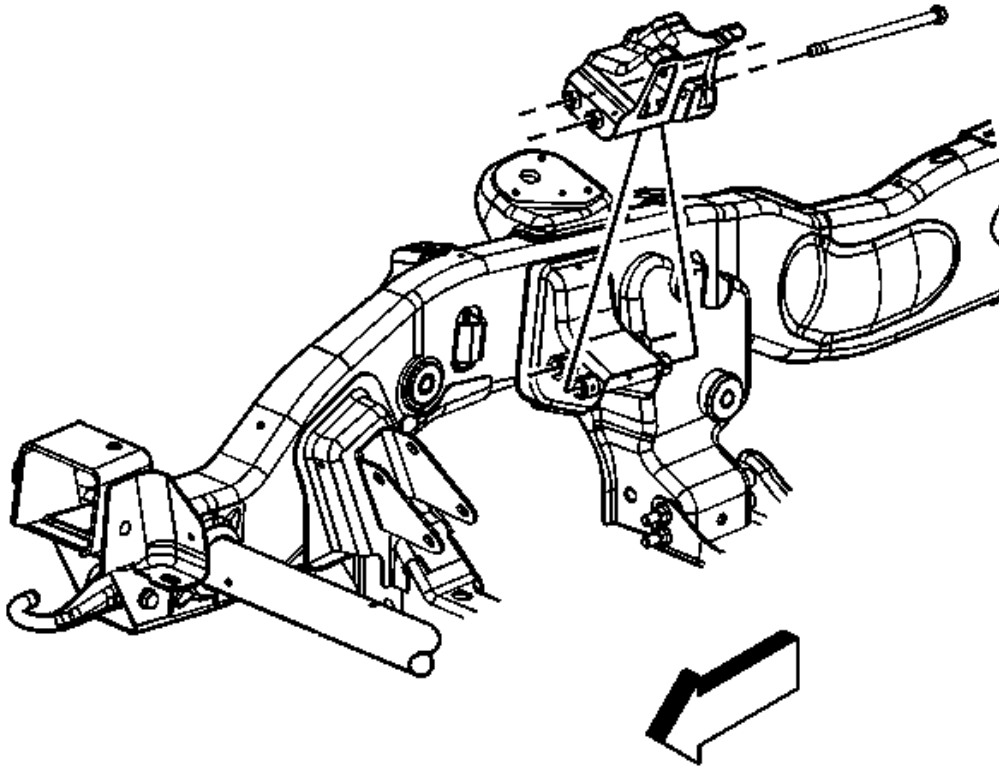


Fig. 28: Removed Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount bracket.
2. Perform the following procedure prior to installing the engine mount bracket bolts.
 - Remove all traces of the original adhesive patch.
 - Clean the threads of the bolt with denatured alcohol or equivalent and allow to dry.
 - Apply threadlocker GM P/N 12345382 (Canadian P/N 10953489) or equivalent to the bolts.

NOTE: Refer to Cautions and Notices.

3. Install the engine mount bracket bolts.

Tighten: Tighten the engine mount bracket bolts to 75 N.m (55 lb ft).

4. Install the engine mount. Refer to **Engine Mount Replacement - Right**.

ENGINE SIGHT SHIELD REPLACEMENT (4.8L, 5.3L, AND 6.0L ENGINES)

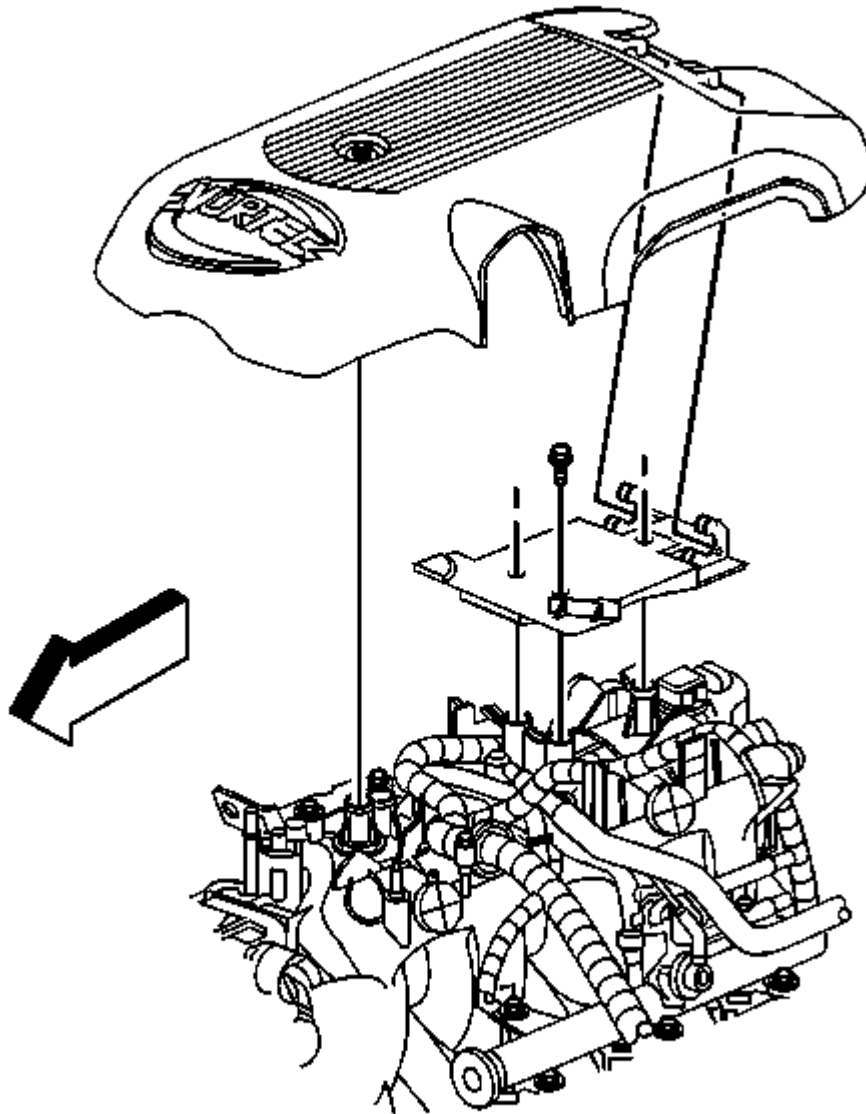
Removal Procedure

Fig. 29: View Of Top Engine Cover
Courtesy of GENERAL MOTORS CORP.

1. Loosen the engine sight shield bolt.
2. Remove the engine sight shield from the sight shield retainer.

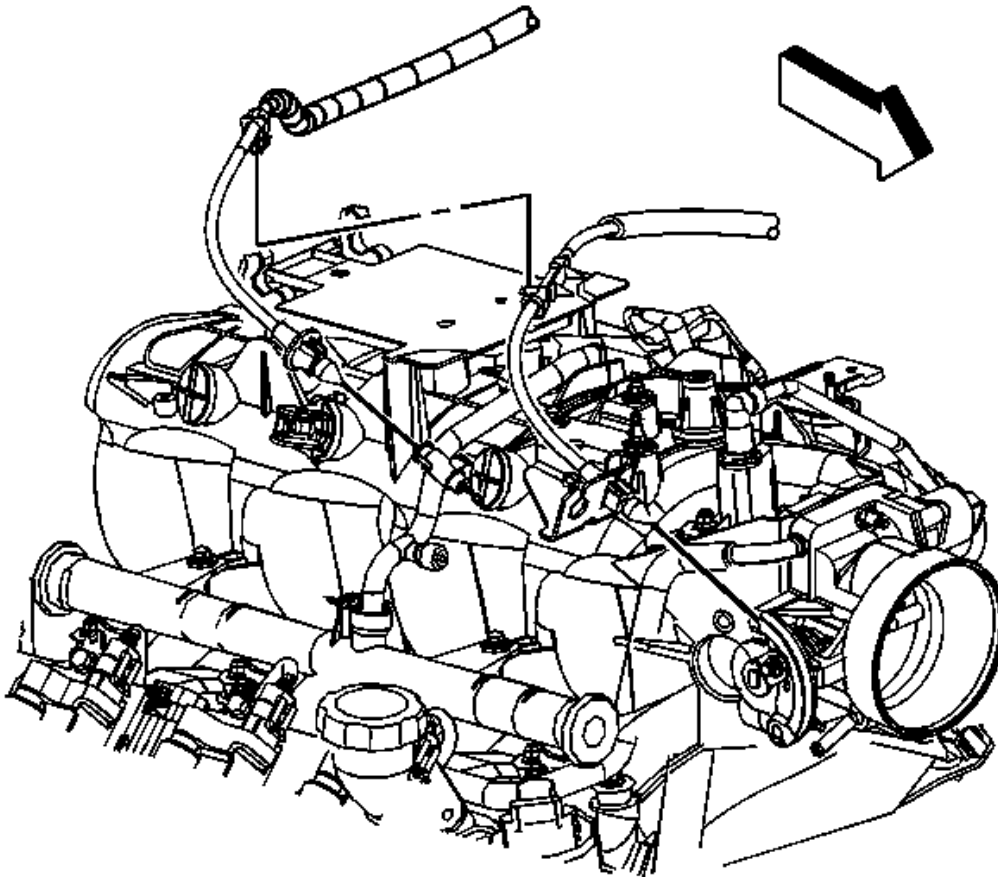


Fig. 30: Accelerator Control Cable Clip
Courtesy of GENERAL MOTORS CORP.

3. If removal of the engine sight shield retainer is required, disconnect the accelerator control cable clip from the retainer.

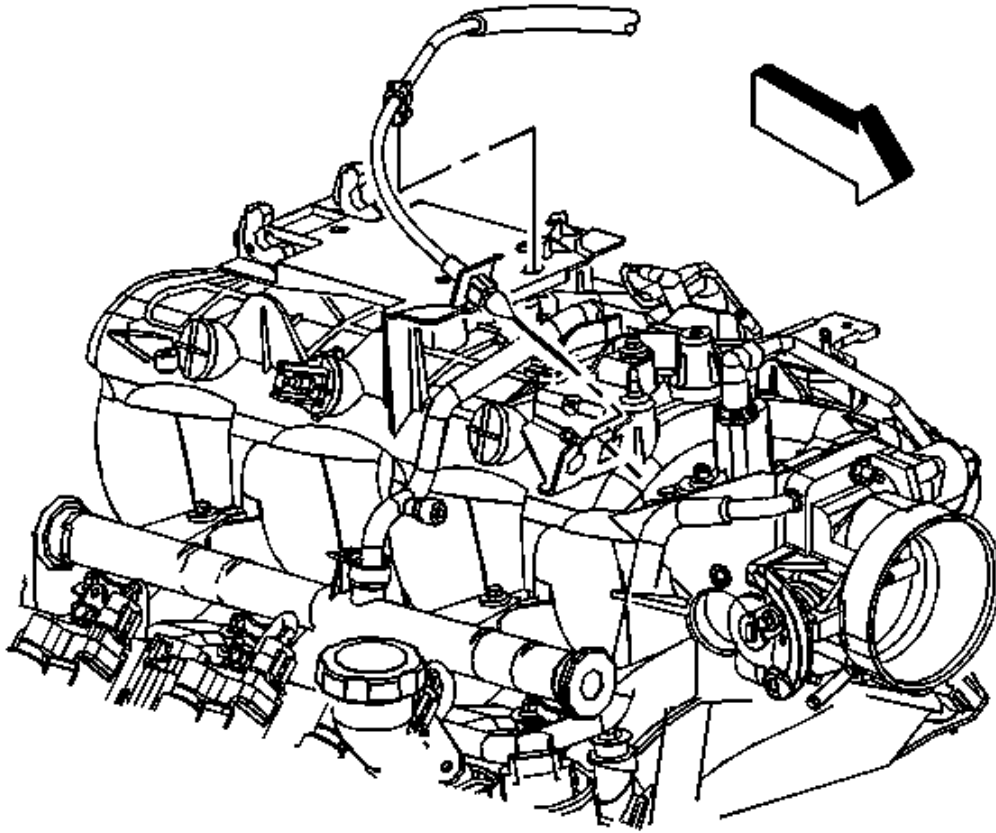


Fig. 31: Cruise Control Cable Clip
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the cruise control cable clip from the retainer.
5. Remove the engine sight shield retainer bolts and the retainer, if required.

Installation Procedure

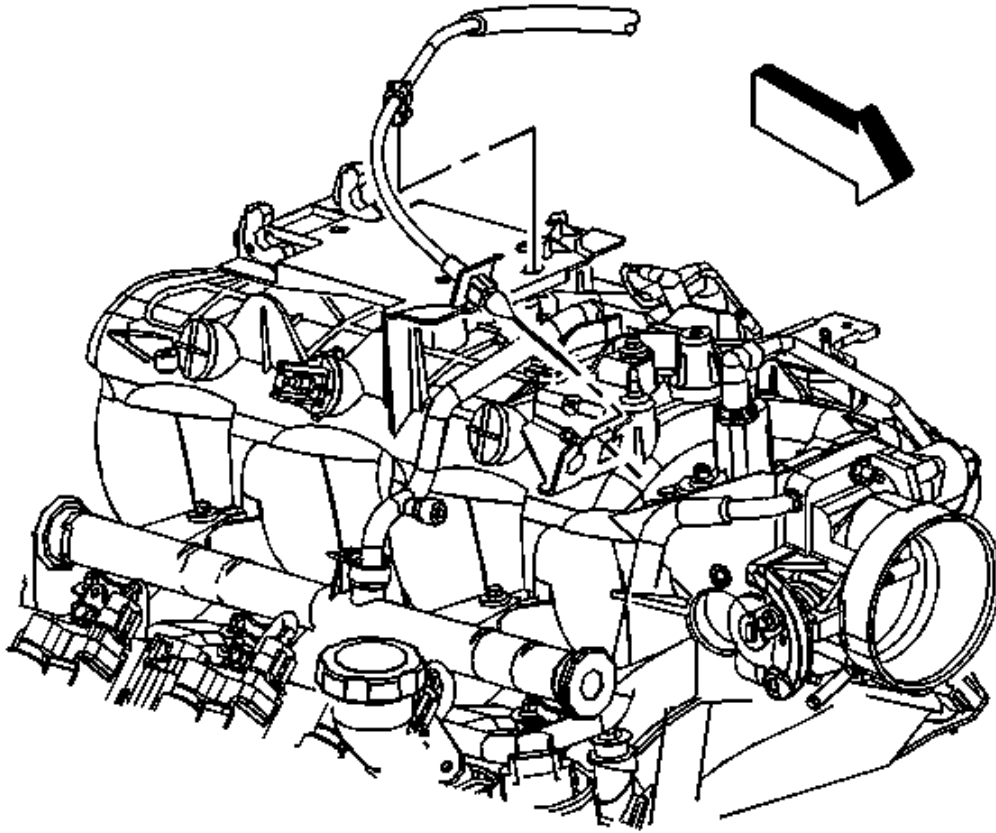


Fig. 32: Cruise Control Cable Clip
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Install the engine sight shield retainer and the bolts, if required.

Tighten: Tighten the engine sight shield retainer bolts to 5 N.m (44 lb in).

2. Install the cruise control cable clip to the retainer.

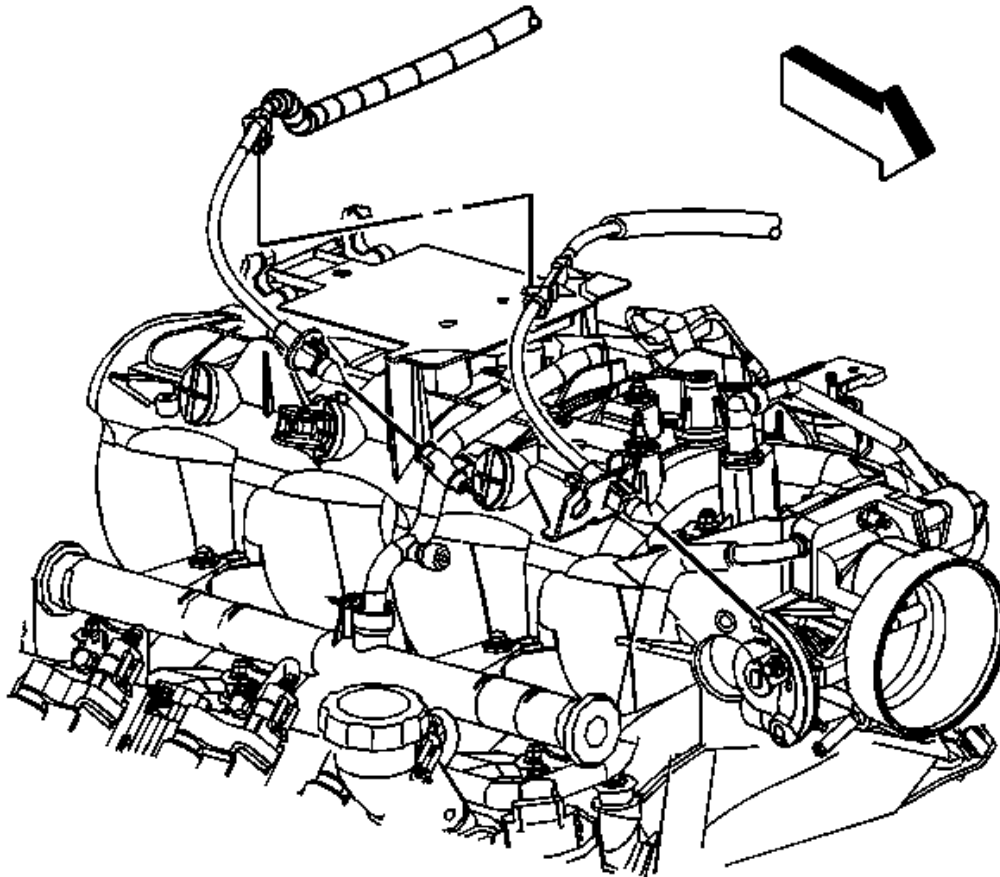


Fig. 33: Accelerator Control Cable Clip
Courtesy of GENERAL MOTORS CORP.

3. Install the accelerator control cable clip to the retainer.

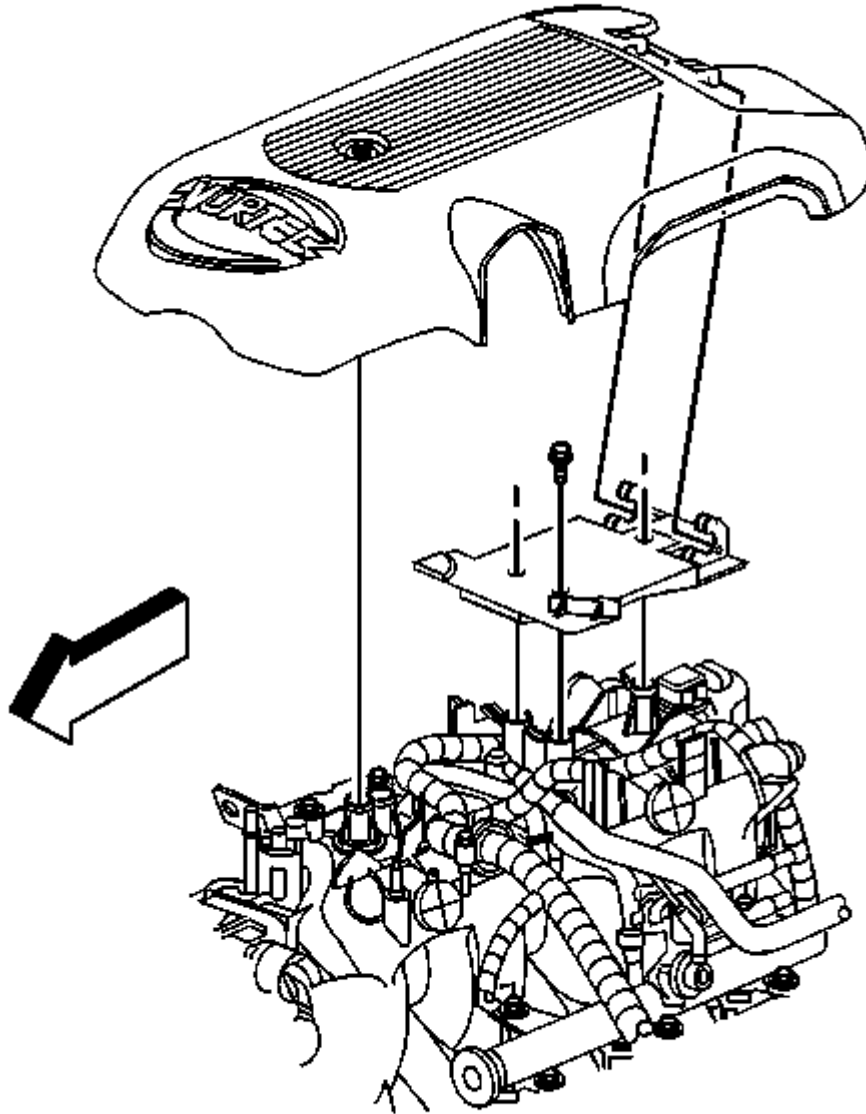


Fig. 34: View Of Top Engine Cover
Courtesy of GENERAL MOTORS CORP.

NOTE: Use care when installing the engine sight shield to avoid contacting the manifold absolute pressure (MAP) sensor wire harness connector. Loss of engine performance or engine damage may result.

4. Install the engine sight shield to the retainer.

5. Tighten the engine sight shield bolt.

Tighten: Tighten the engine sight shield bolt to 10 N.m (89 lb in).

ENGINE SIGHT SHIELD REPLACEMENT (6.0L ENGINE W/ RPOS Y91 AND Z88)

Removal Procedure

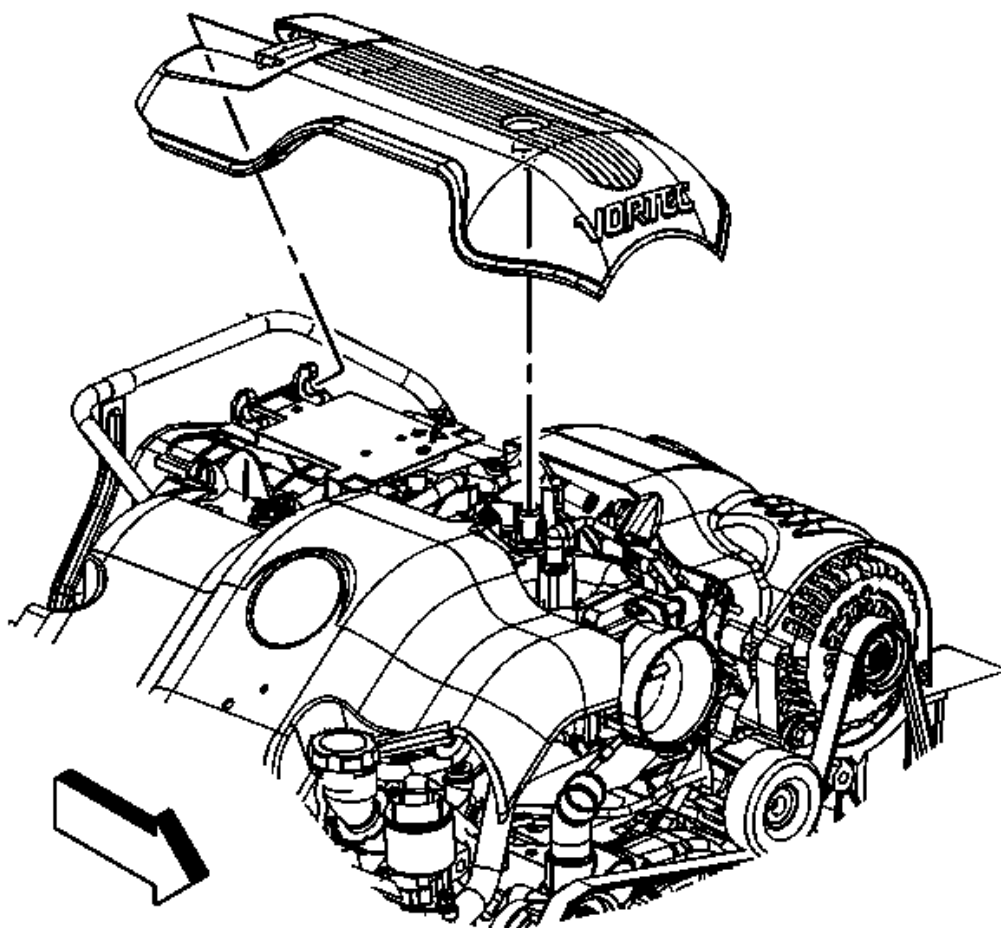


Fig. 35: Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS CORP.

1. Loosen the intake manifold sight shield bolt.
2. Remove the sight shield from the sight shield retainer.
3. If required, remove the sight shield retainer bolts and the retainer.

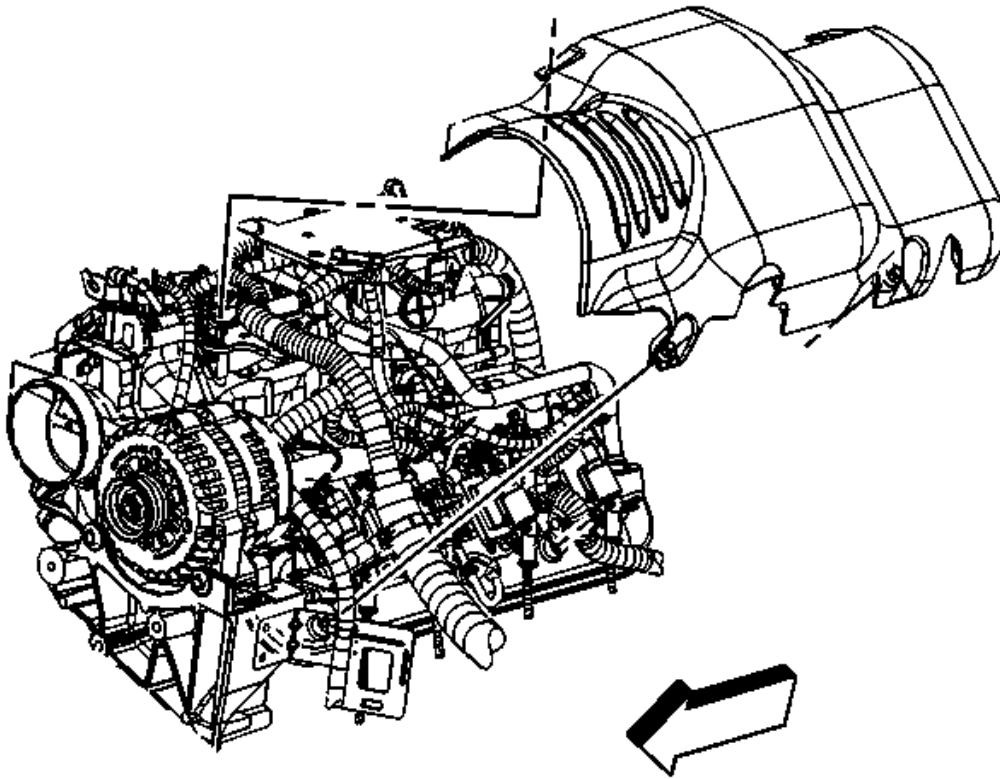


Fig. 36: Left Fuel Rail Cover
Courtesy of GENERAL MOTORS CORP.

4. Loosen the left fuel rail cover bolts.
5. Remove the left fuel rail cover.

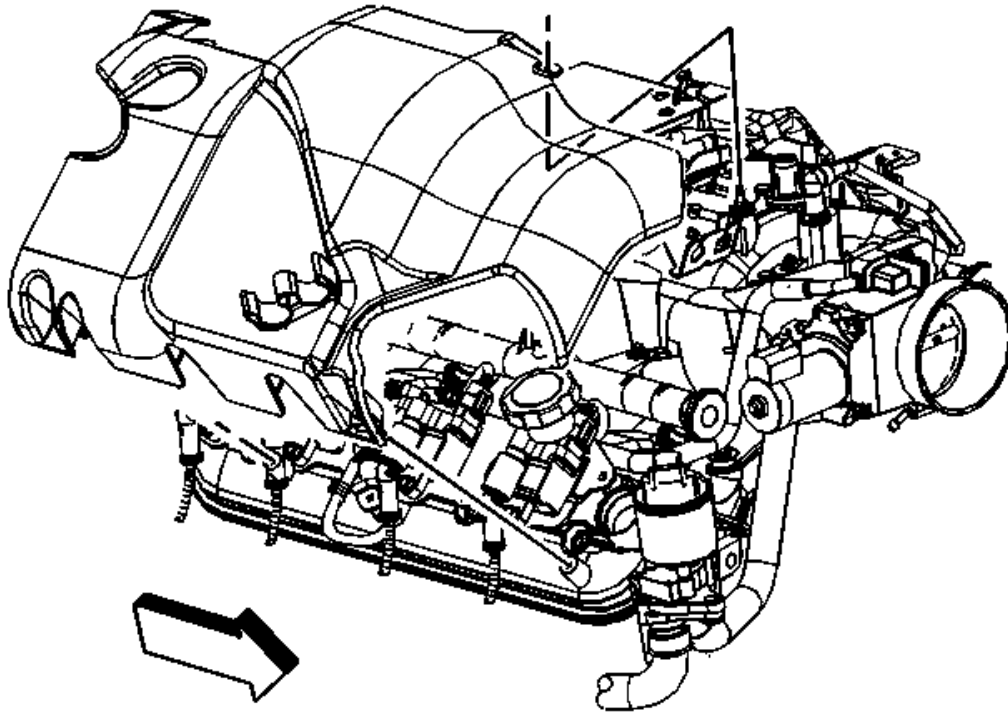


Fig. 37: Left Fuel Rail Cover
Courtesy of GENERAL MOTORS CORP.

6. Remove the surge tank/heater hoses from the clip on the right fuel rail cover.
7. Loosen the right fuel rail cover bolts.
8. Remove the right fuel rail cover.

Installation Procedure

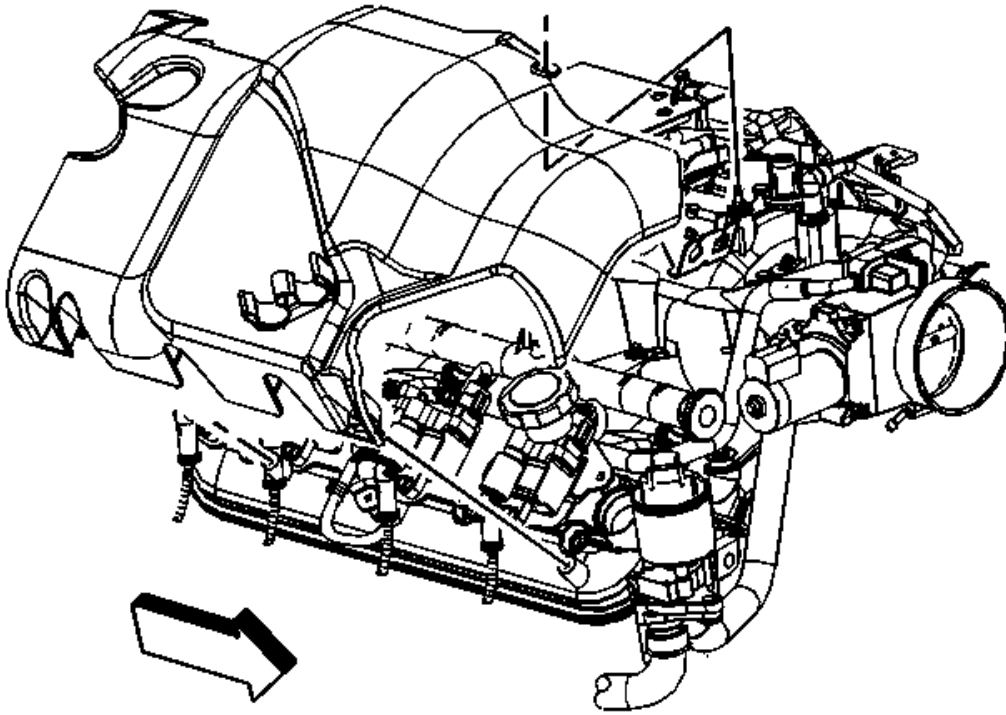


Fig. 38: Left Fuel Rail Cover
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Install the right fuel rail cover.
2. Tighten the right fuel rail cover bolts.

Tighten: Tighten the fuel rail cover bolts to 9 N.m (80 lb in)

3. Install the surge tank/heater hoses to the clip on the right fuel rail cover.

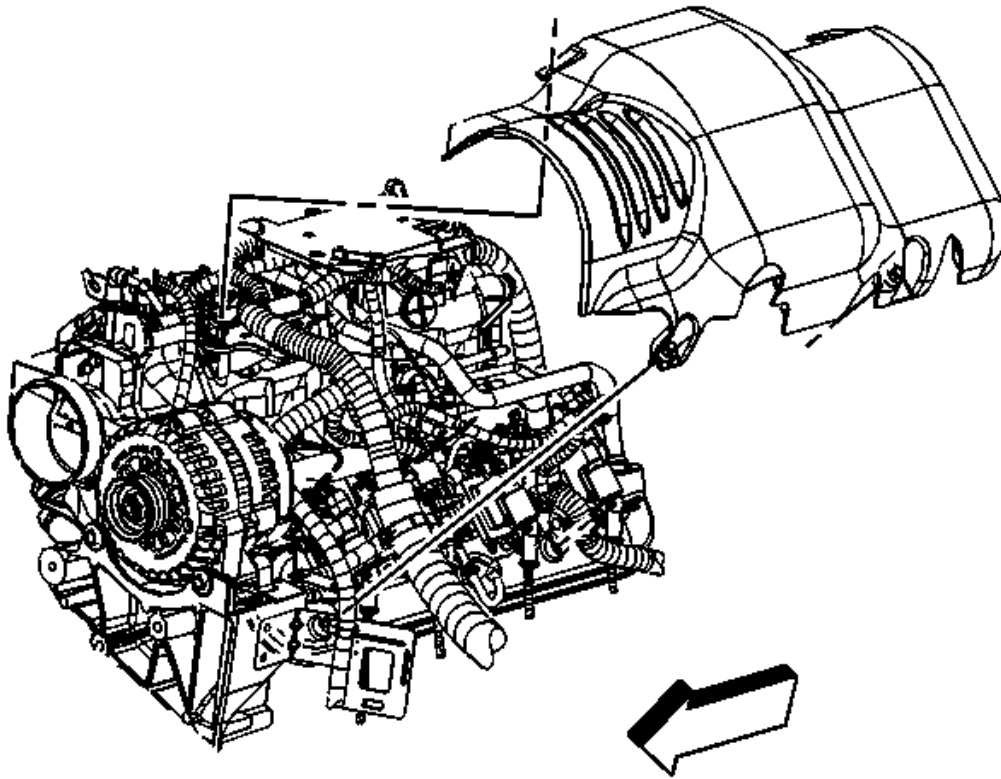


Fig. 39: Left Fuel Rail Cover
Courtesy of GENERAL MOTORS CORP.

4. Install the left fuel rail cover.
5. Tighten the left fuel rail cover bolts.

Tighten: Tighten the fuel rail cover bolts to 9 N.m (80 lb in)

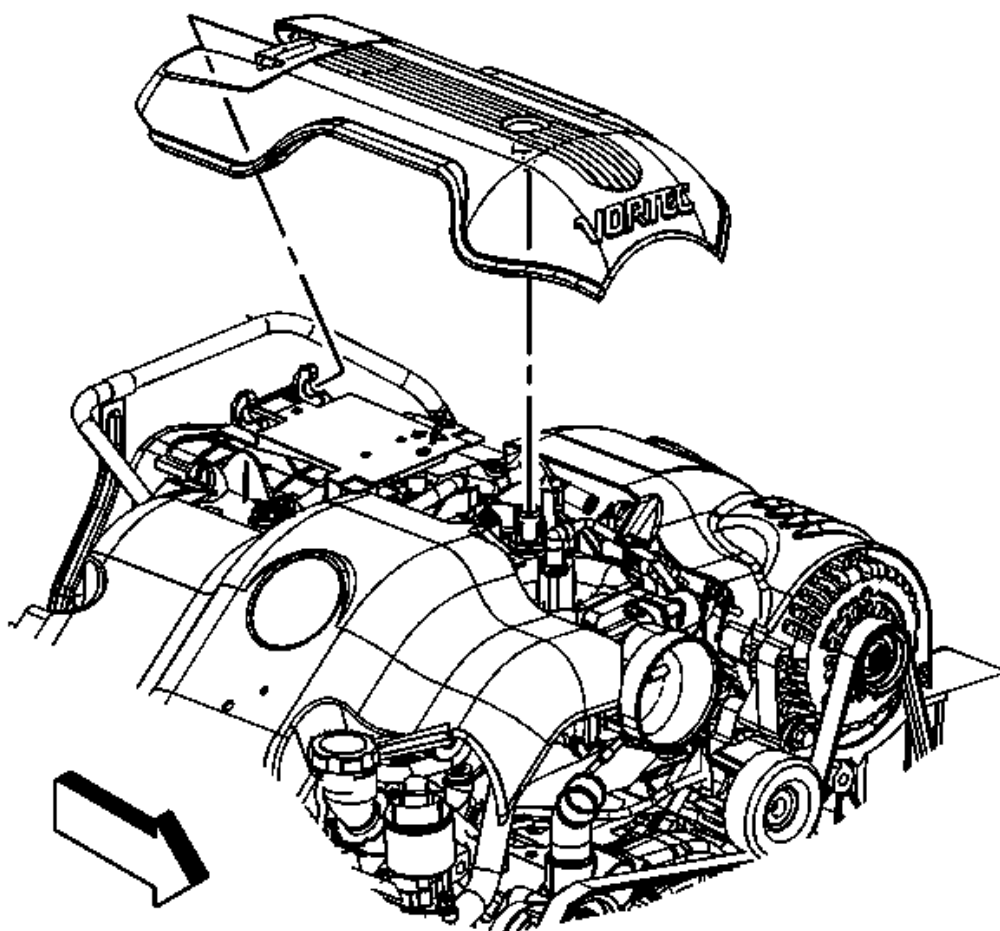


Fig. 40: Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS CORP.

NOTE: Use care when installing the engine sight shield to avoid contacting the manifold absolute pressure (MAP) sensor wire harness connector. Loss of engine performance or engine damage may result.

6. Install the sight shield retainer and the bolts, if required.

Tighten: Tighten the intake manifold sight shield retainer bolts to 5 N.m (44 lb in).

7. Install the intake manifold sight shield to the retainer.
8. Tighten the intake manifold sight shield bolt.

Tighten: Tighten the intake manifold sight shield bolt to 9 N.m (80 lb in)

POSITIVE CRANKCASE VENTILATION (PCV) VALVE REPLACEMENT

Removal Procedure

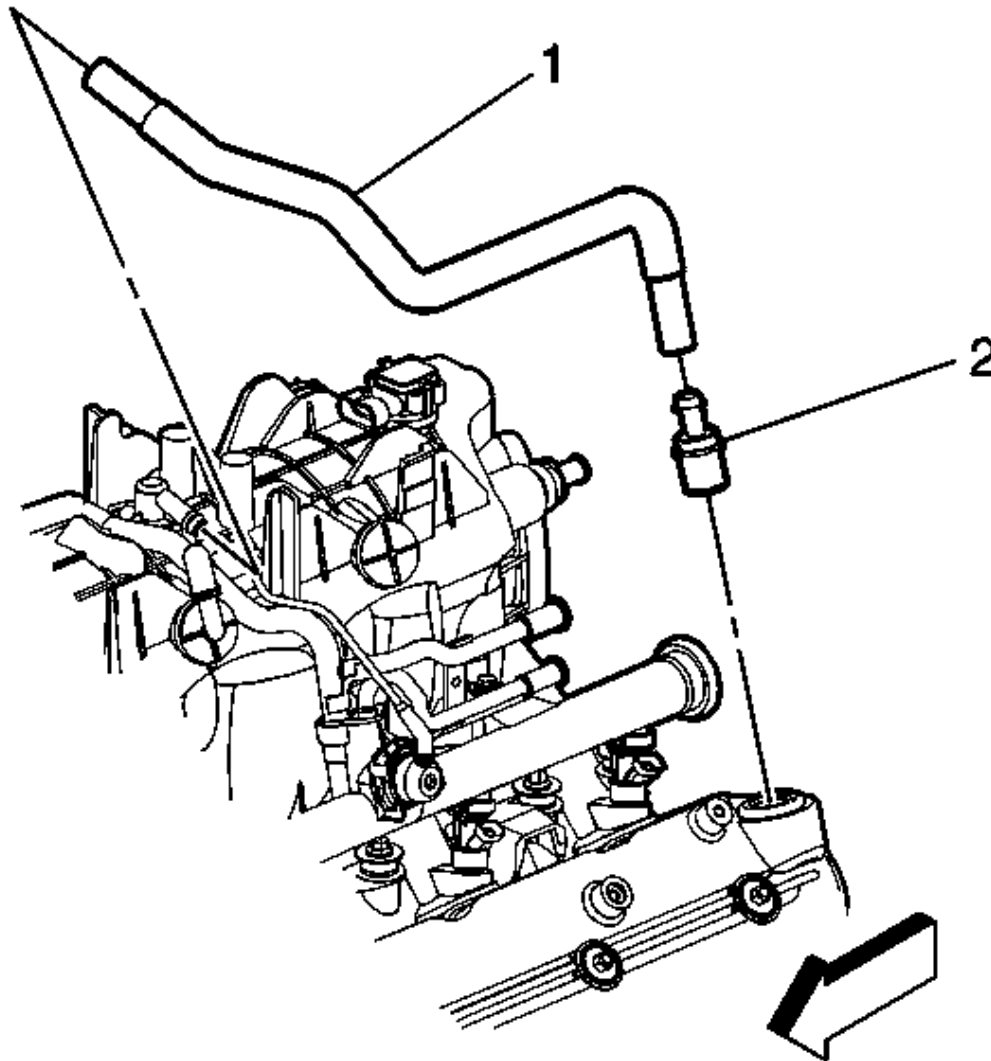


Fig. 41: Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine sight shield, if required. Refer to **Engine Sight Shield Replacement (4.8L, 5.3L, and**

6.0L Engines) or Engine Sight Shield Replacement (6.0L Engine w/ RPOs Y91 and Z88).

2. Remove the positive crankcase ventilation (PCV) tube (1) from the rocker arm cover.
3. Remove the PCV valve (2) from the PCV tube (1).

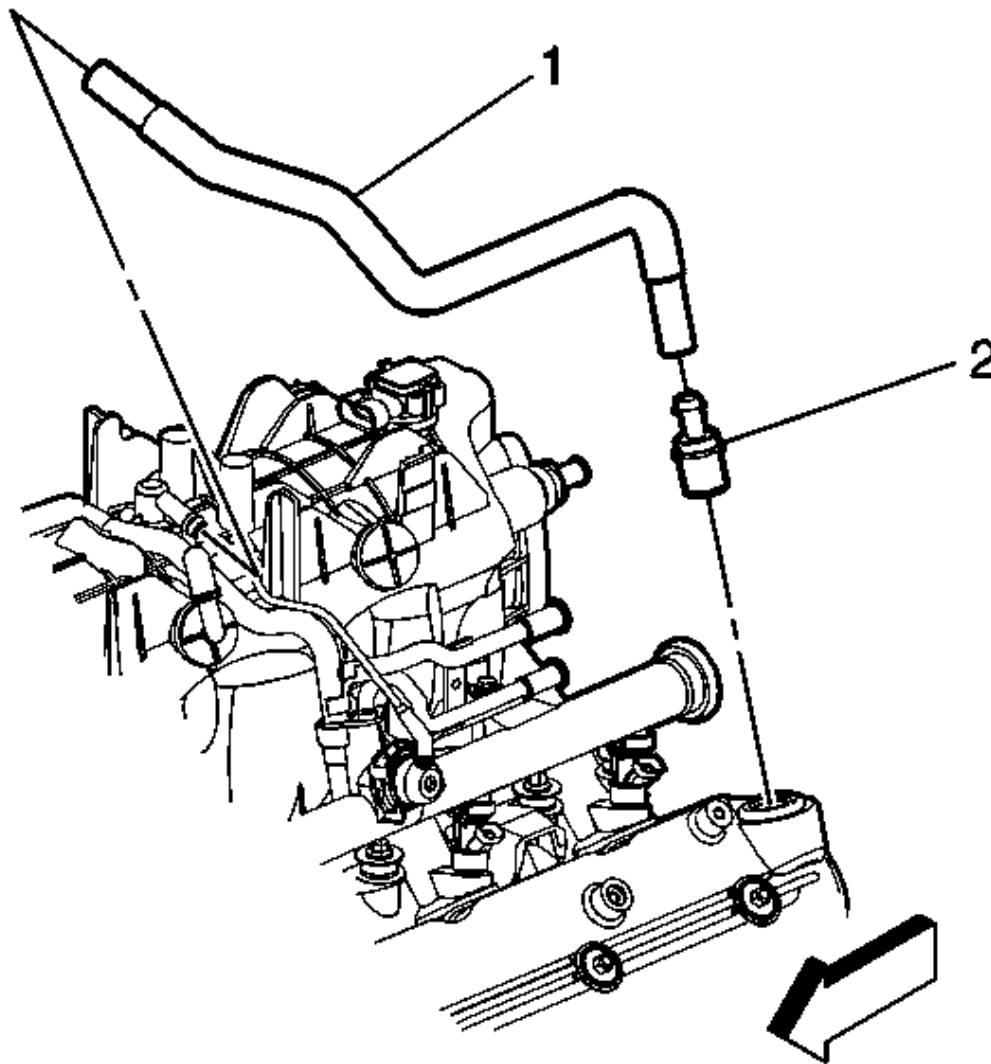
Installation Procedure

Fig. 42: Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS CORP.

1. Install a new PCV valve (2) to the PCV tube (1).

2. Install the PCV tube (1) to the rocker arm cover.
3. Install the engine sight shield, if required. Refer to **Engine Sight Shield Replacement (4.8L, 5.3L, and 6.0L Engines)** or **Engine Sight Shield Replacement (6.0L Engine w/ RPOs Y91 and Z88)**.

CRANKCASE VENTILATION HOSES/PIPES REPLACEMENT

Removal Procedure

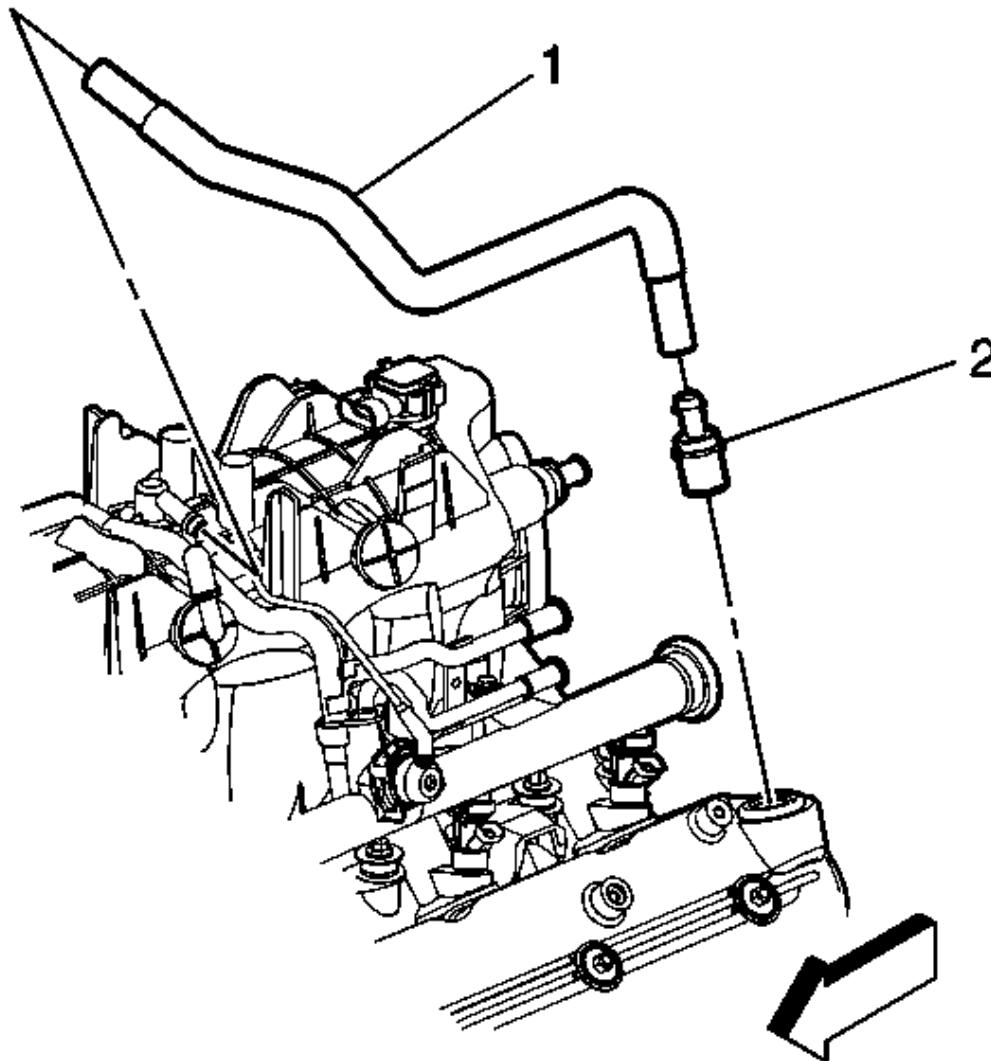


Fig. 43: Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine sight shield. Refer to **Engine Sight Shield Replacement (4.8L, 5.3L, and 6.0L Engines)** or **Engine Sight Shield Replacement (6.0L Engine w/ RPOs Y91 and Z88)**.
2. Remove the positive crankcase ventilation (PCV) tube (1) from the intake manifold and valve rocker arm cover.
3. Remove the PCV valve (2) from the PCV tube (1).

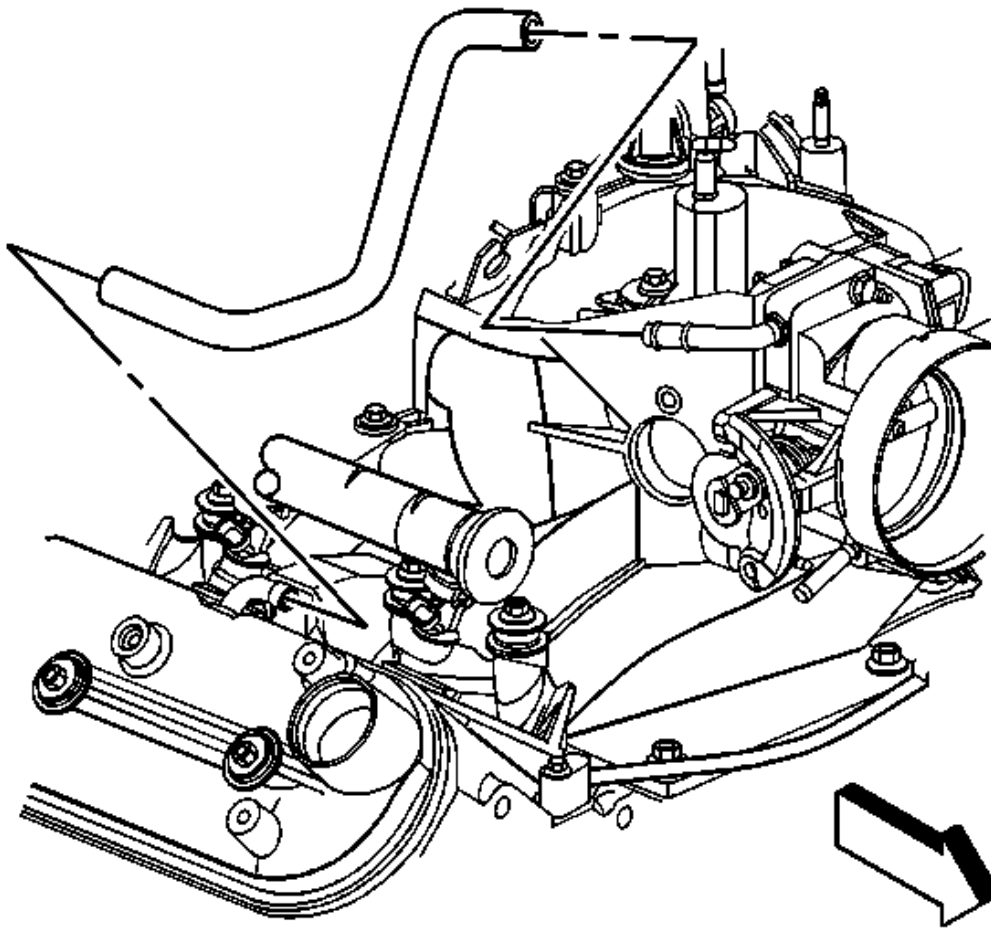


Fig. 44: Locating Breather Hose
Courtesy of GENERAL MOTORS CORP.

4. Remove the vent hose from the throttle body and the valve rocker arm cover.
5. Replace the hose/tube as necessary.

Installation Procedure

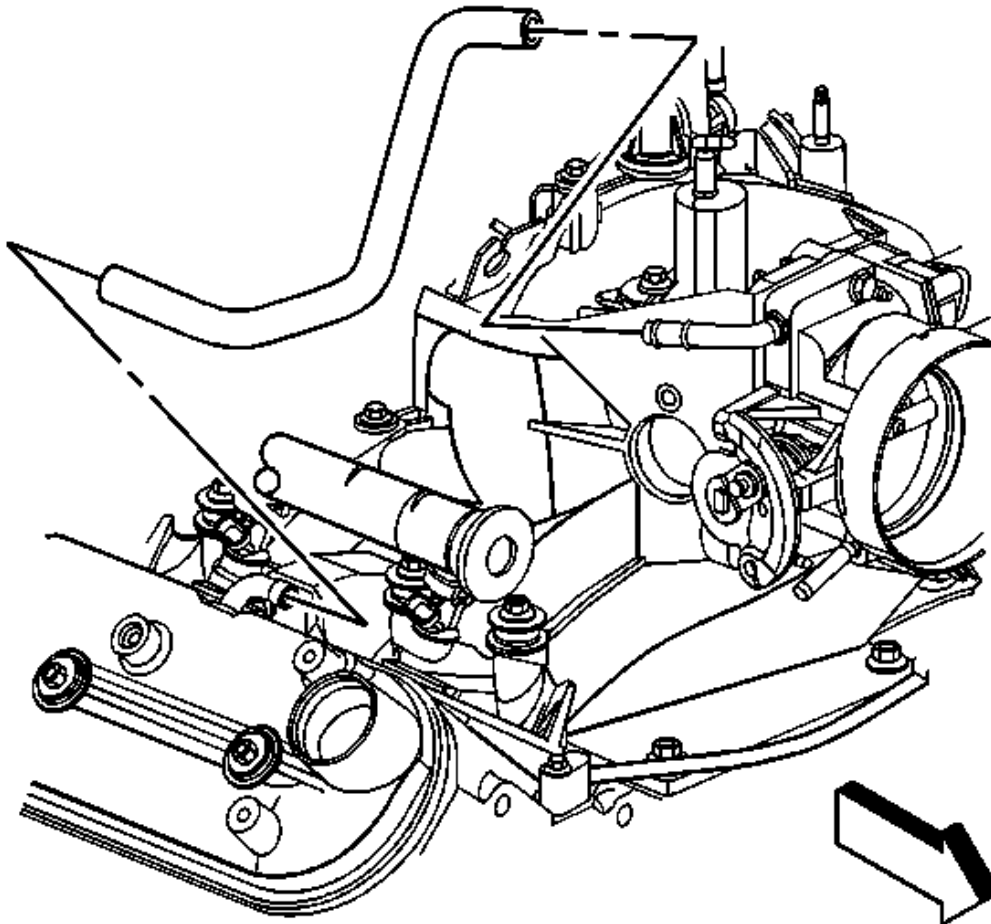


Fig. 45: Locating Breather Hose
Courtesy of GENERAL MOTORS CORP.

1. Install the hose/tube as necessary.
2. Install the vent hose to the throttle body and the valve rocker arm cover.

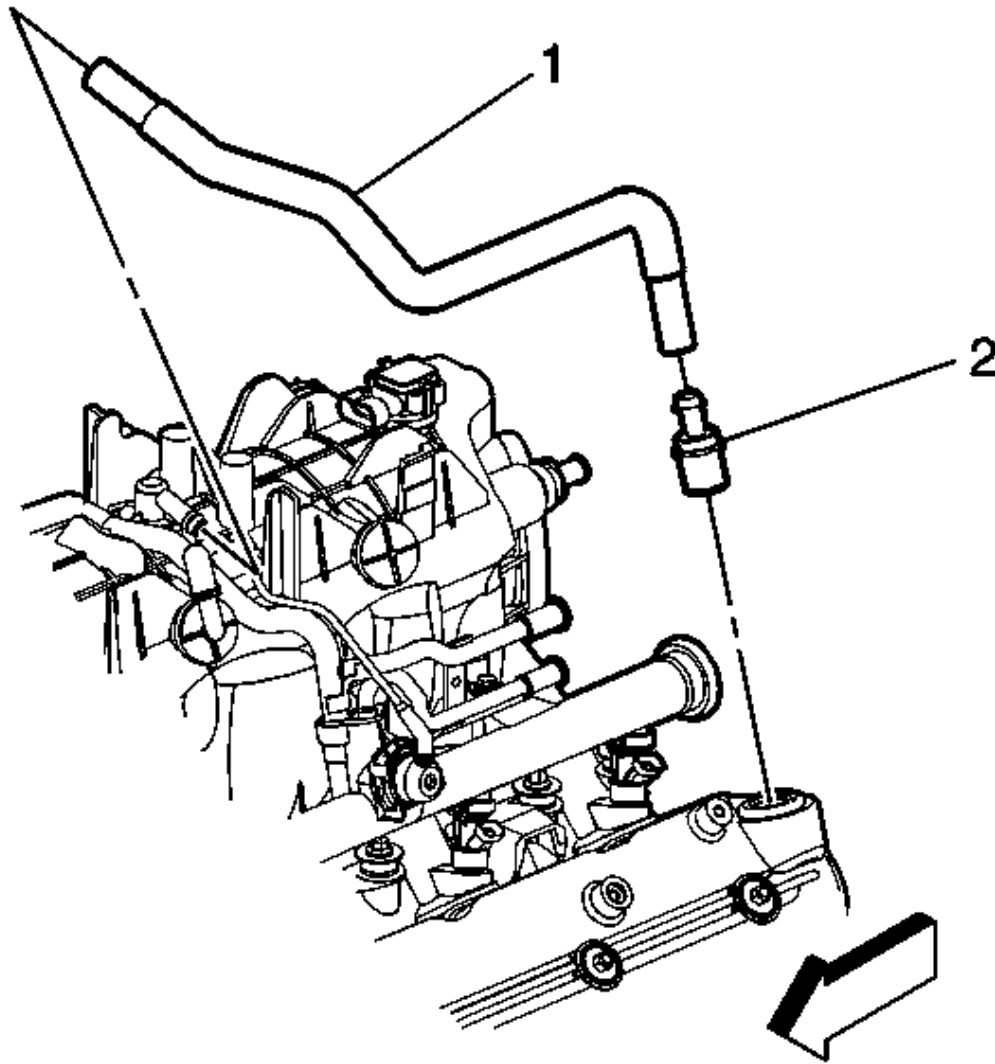


Fig. 46: Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS CORP.

3. Install the PCV valve (2) to the tube (1).
4. Install the PCV tube (1) to the intake manifold and valve rocker arm cover.
5. Install the engine sight shield. Refer to **Engine Sight Shield Replacement (4.8L, 5.3L, and 6.0L Engines)** or **Engine Sight Shield Replacement (6.0L Engine w/ RPOs Y91 and Z88)**.

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

IMPORTANT: The intake manifold, throttle body, fuel rail, and injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the throttle body. Refer to THROTTLE BODY REMOVAL.
2. Remove the fuel injectors. Refer to FUEL RAIL & INJECTORS REMOVAL.

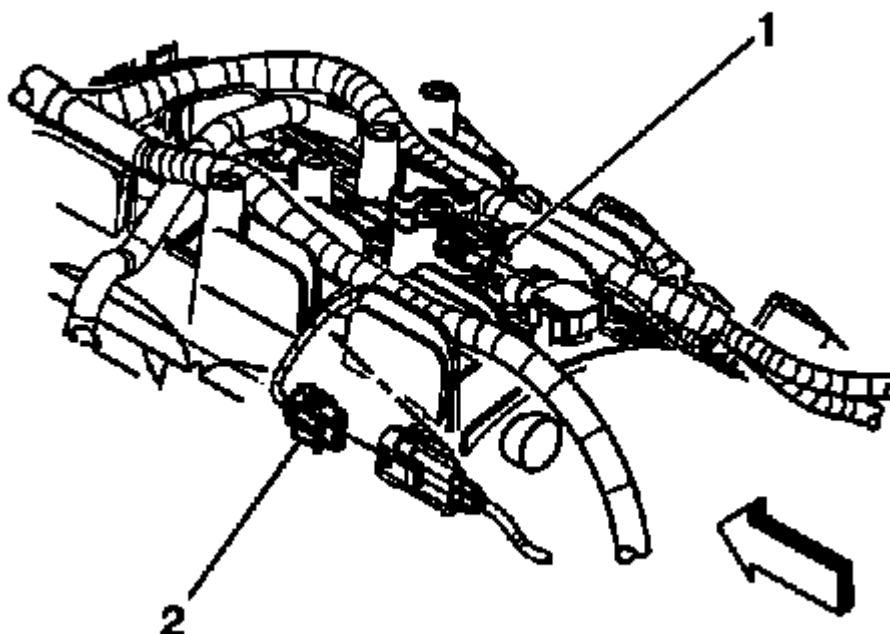


Fig. 47: View Of MAP Sensor & Knock Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the following electrical connectors:
 - Manifold absolute pressure (MAP) sensor (1)
 - Knock sensor (2)
 - Exhaust gas recirculation (EGR) valve, if equipped
4. Remove the knock sensor harness electrical connector from the intake manifold.
5. Set the electrical harness aside.

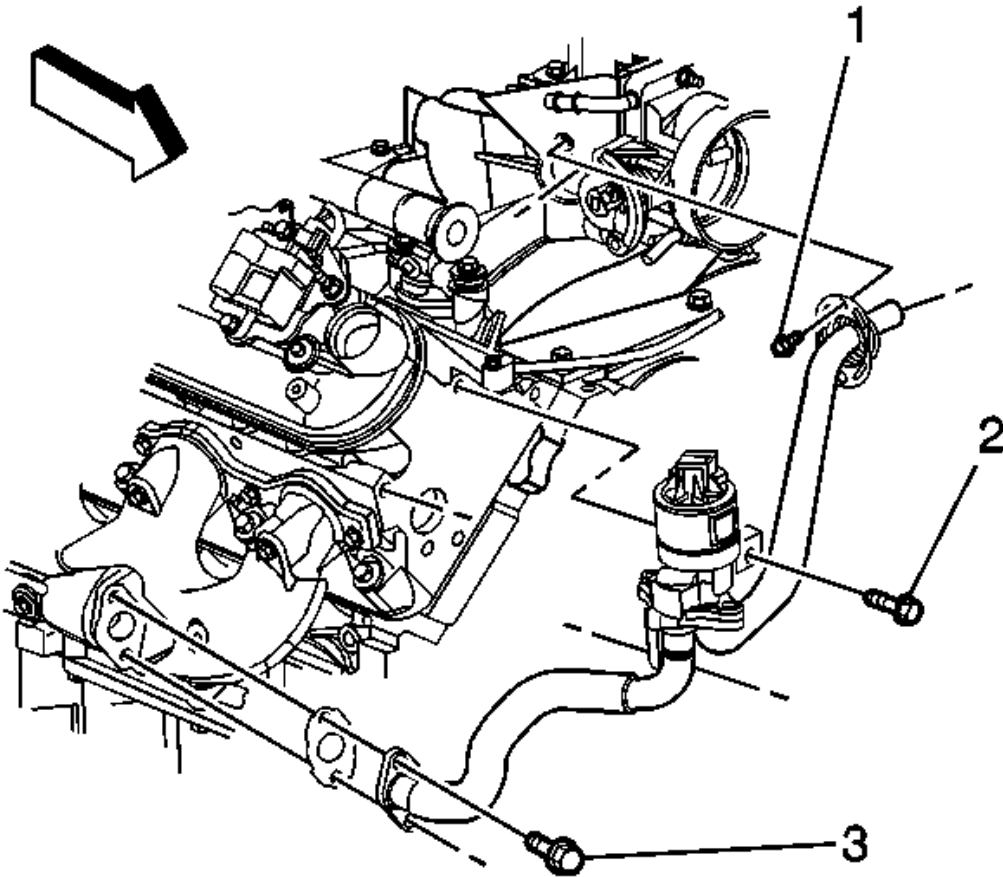


Fig. 48: Removed EGR Pipe

Courtesy of GENERAL MOTORS CORP.

6. If equipped, remove the following EGR pipe bolts:
 - Intake manifold (1)
 - Cylinder head (2)
 - Exhaust manifold (3)
7. If equipped, remove the EGR pipe (with valve).
8. If equipped, remove the EGR pipe gasket from the exhaust manifold.

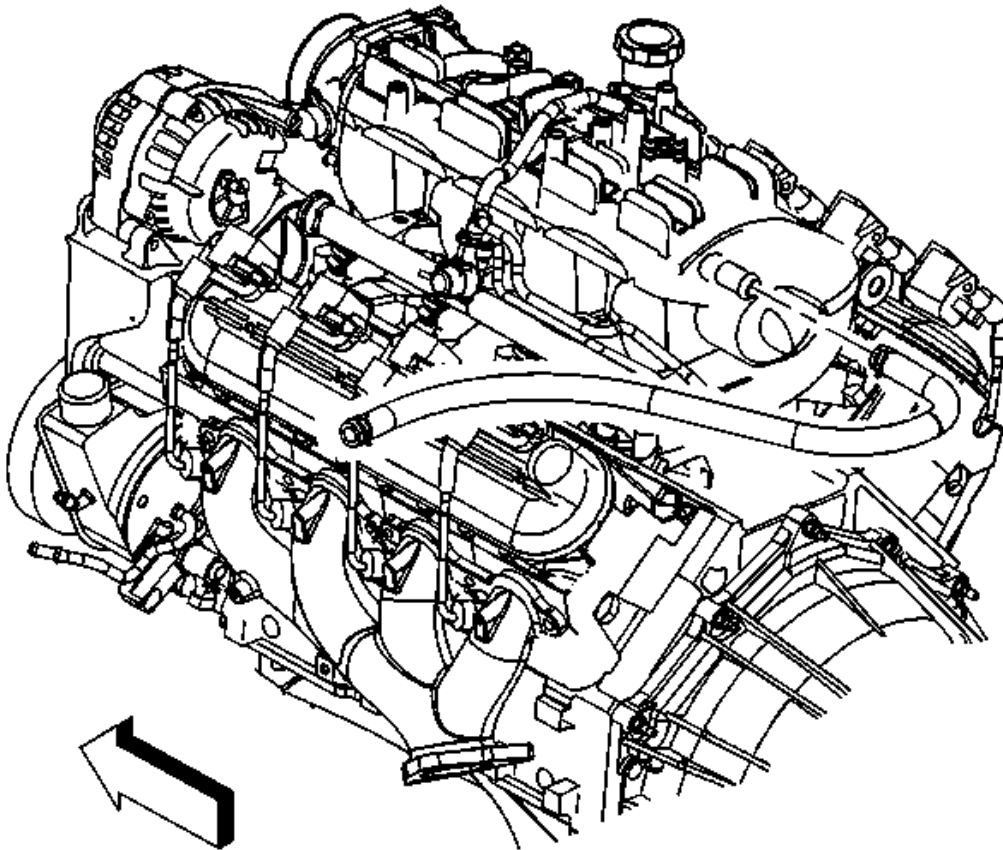


Fig. 49: Disconnected Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

9. IF equipped, remove the vacuum brake booster hose from the rear of the intake manifold.

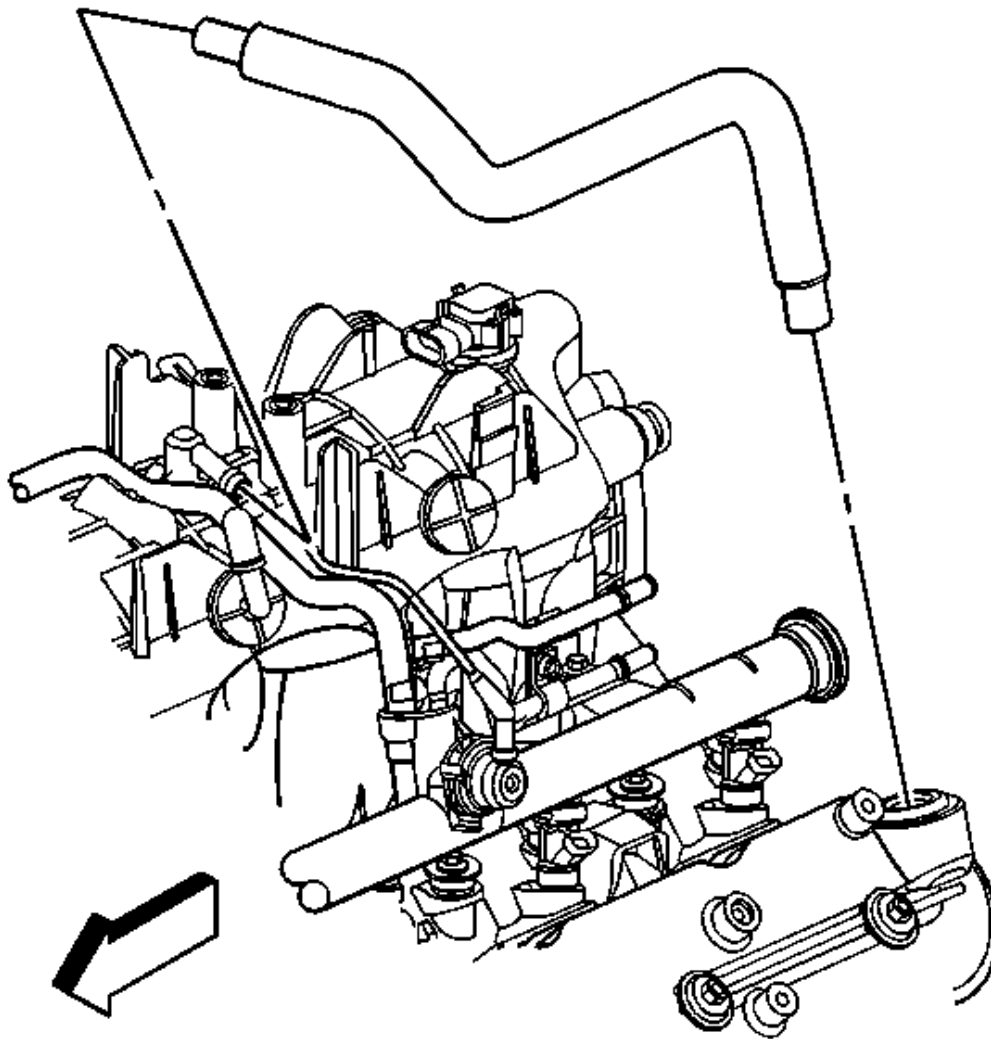


Fig. 50: Breather Crossover Tube View
Courtesy of GENERAL MOTORS CORP.

10. Remove the positive crankcase ventilation (PCV) hose (with valve).

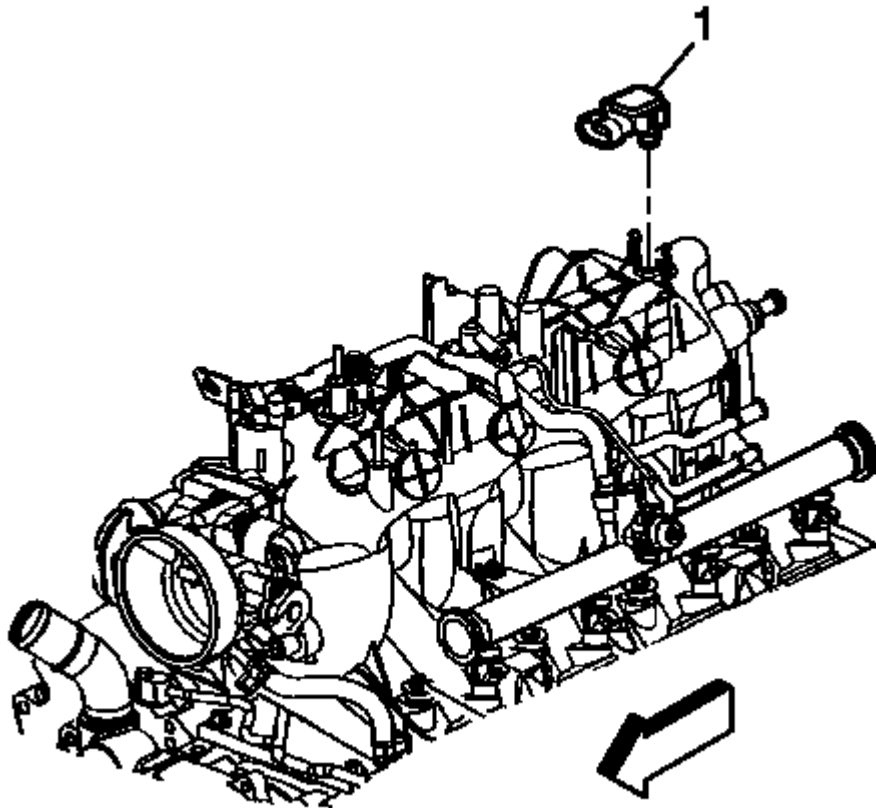


Fig. 51: Removed MAP Sensor
Courtesy of GENERAL MOTORS CORP.

11. Remove the MAP sensor (1) from the intake manifold.

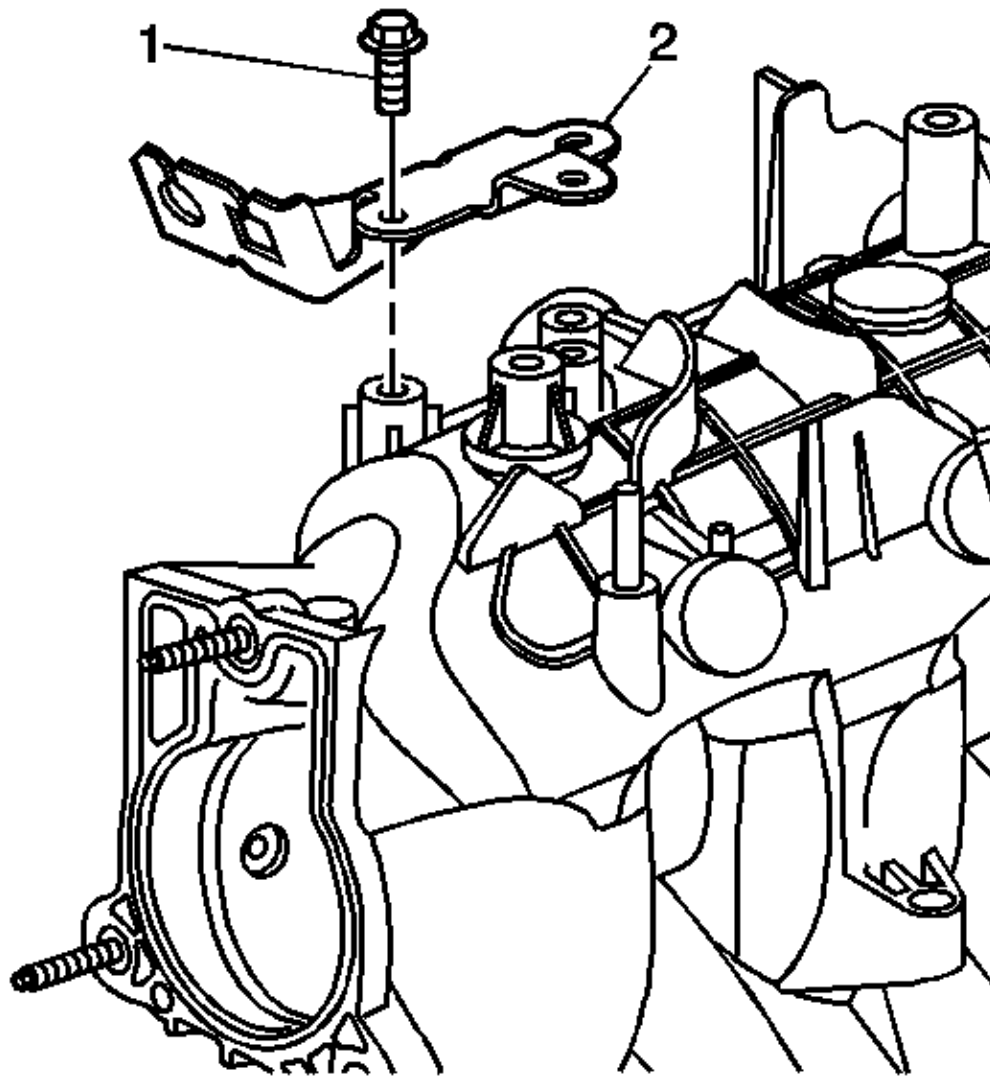


Fig. 52: Removed Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

12. Remove the accelerator control cable bracket bolts (1).
13. Remove the accelerator control cable bracket (2) from the intake manifold.

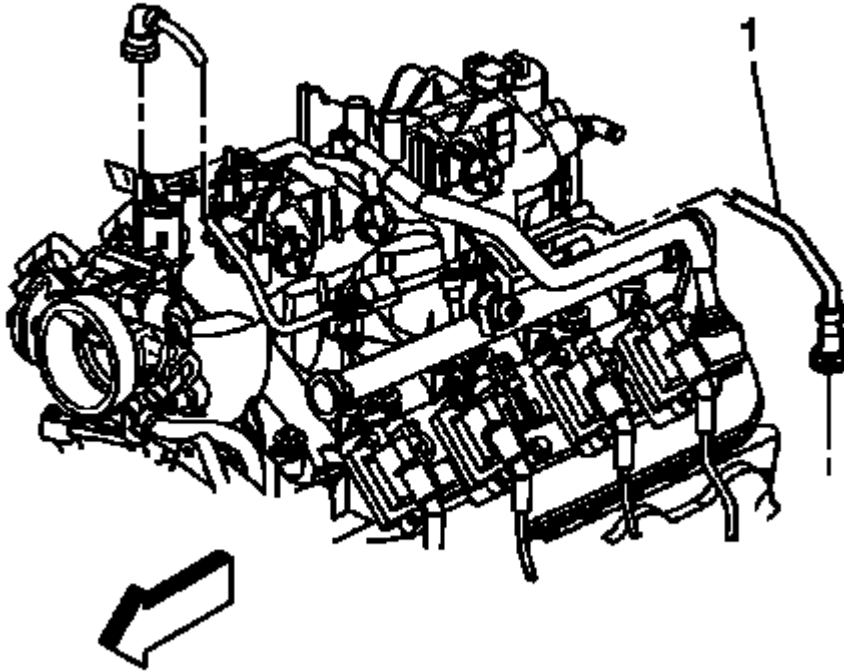


Fig. 53: View Of EVAP Purge Solenoid Vent Tube
Courtesy of GENERAL MOTORS CORP.

14. Remove the evaporative emission (EVAP) purge solenoid vent tube by performing the following:
 1. Remove the EVAP tube end (2) from the solenoid (1).
 2. Squeeze the EVAP pipe quick connect fitting (3) retainer together.
 3. Remove the EVAP tube end (3) from the vapor pipe.

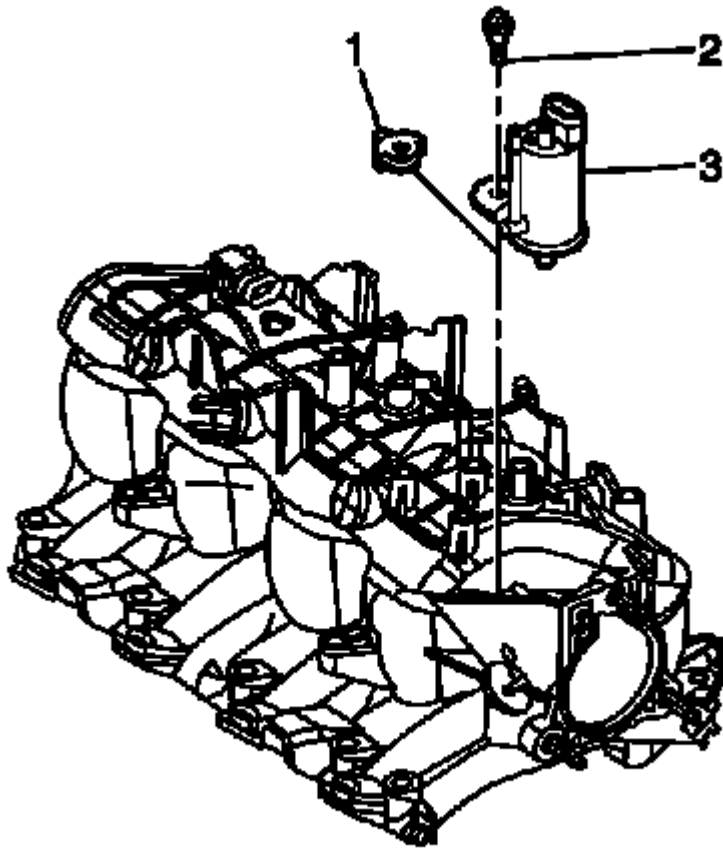


Fig. 54: View Of EVAP Purge Solenoid Bolt, Solenoid & Isolator
Courtesy of GENERAL MOTORS CORP.

15. Remove the EVAP purge solenoid bolt (2), solenoid (3), and isolator (1) from the intake manifold.

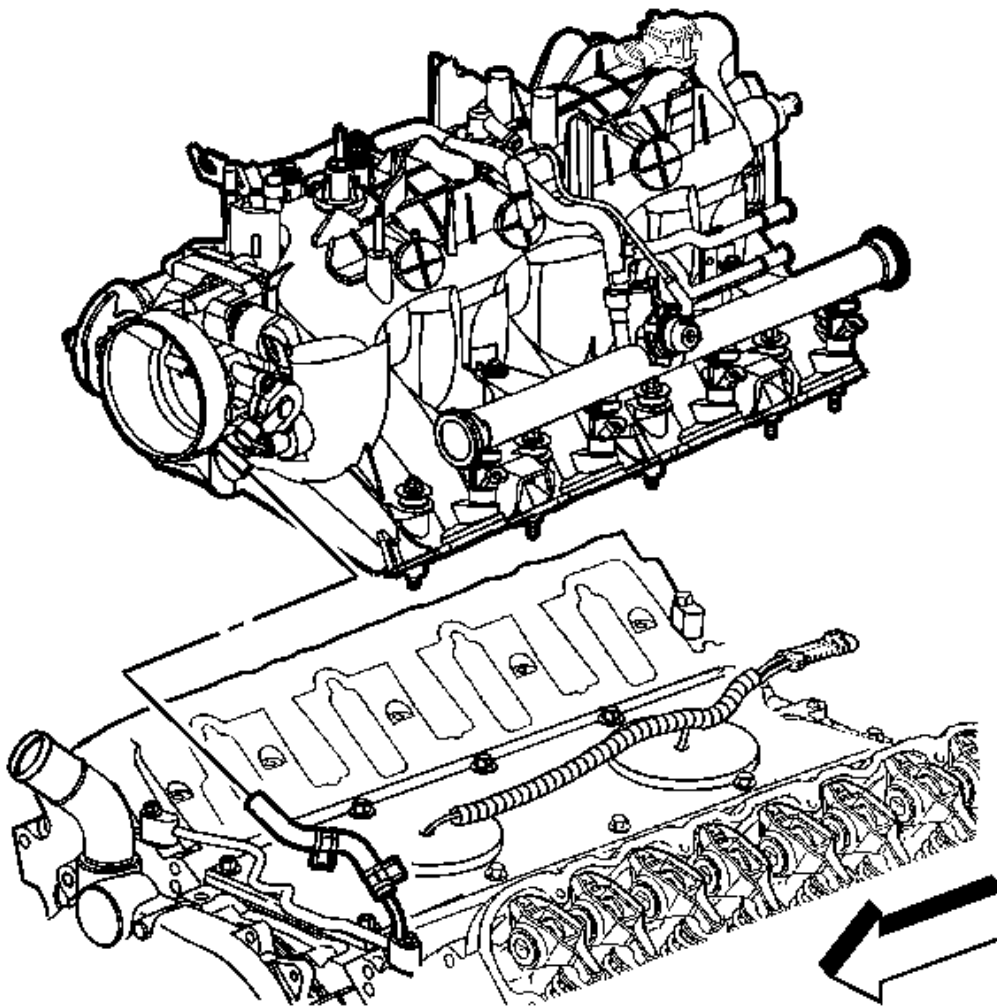


Fig. 55: Removed Intake Manifold
Courtesy of GENERAL MOTORS CORP.

16. Remove the intake manifold bolts.
17. Remove the intake manifold.

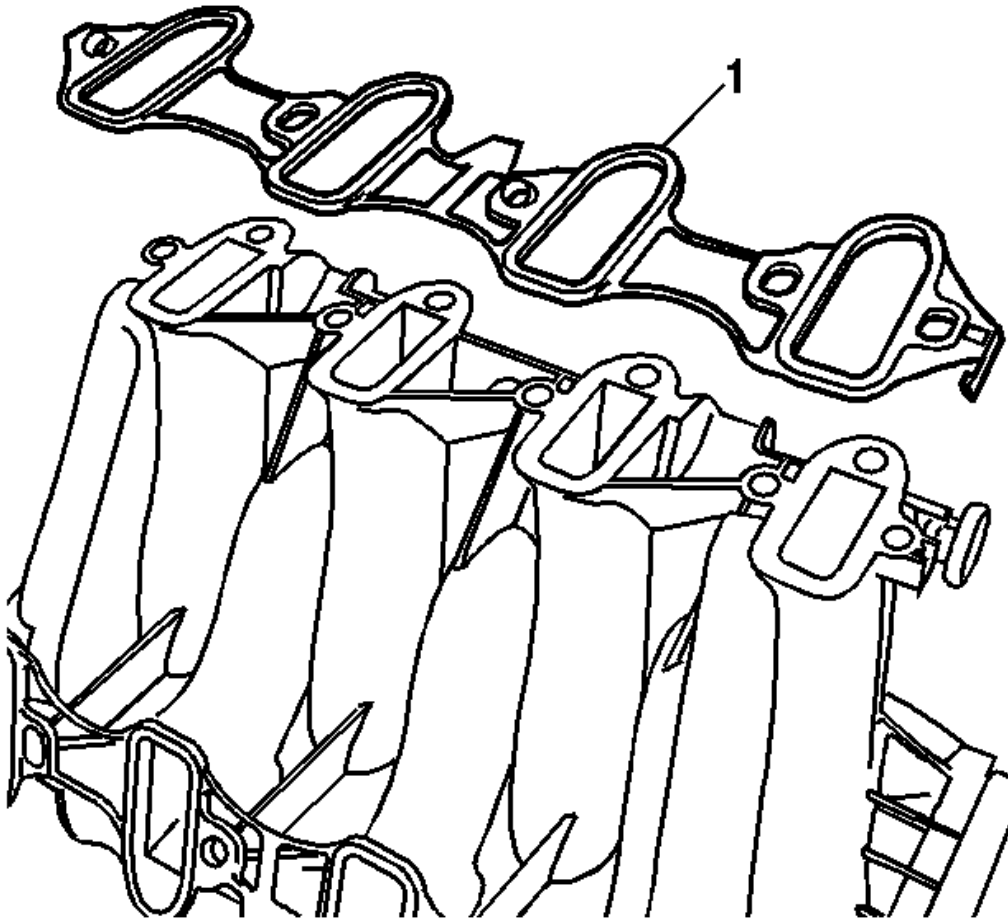


Fig. 56: View Of Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

18. Remove the intake manifold gaskets (1) from the intake manifold.
19. Discard the old intake manifold gaskets.
20. Clean the gasket surfaces of the EGR pipe and the exhaust manifold, if equipped.

Installation Procedure

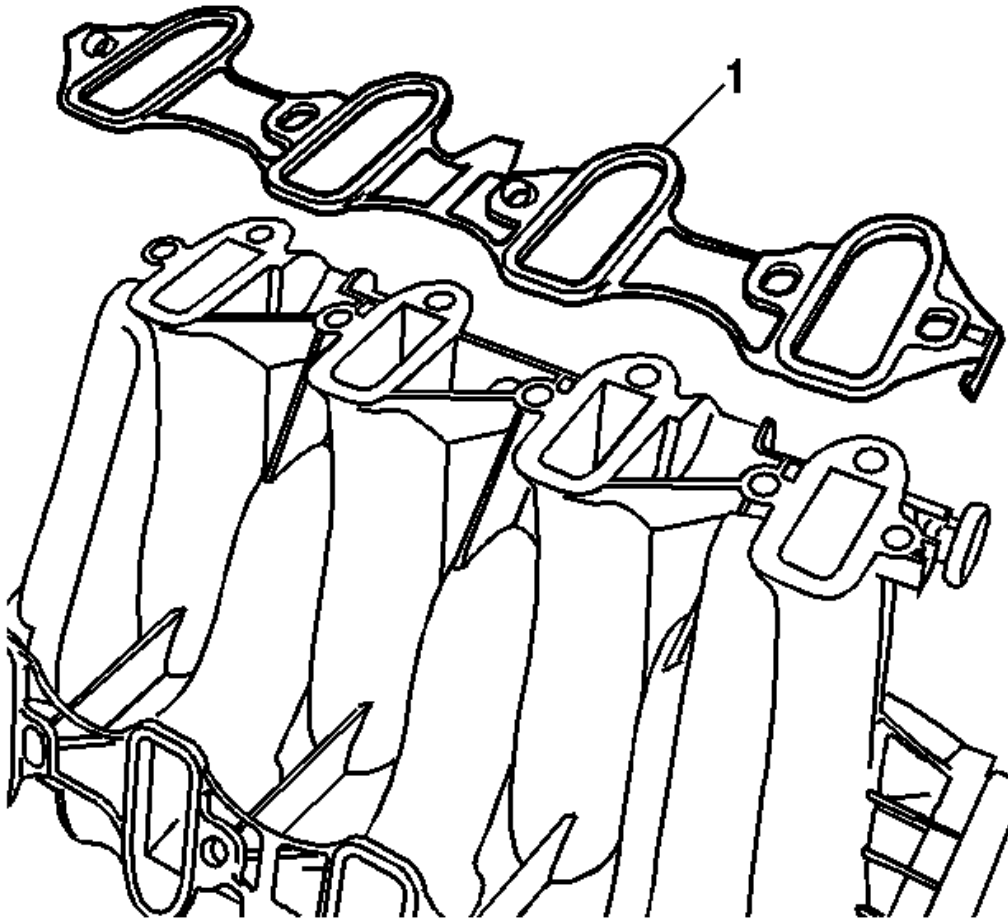


Fig. 57: View Of Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install new intake manifold gaskets (1) to the intake manifold.

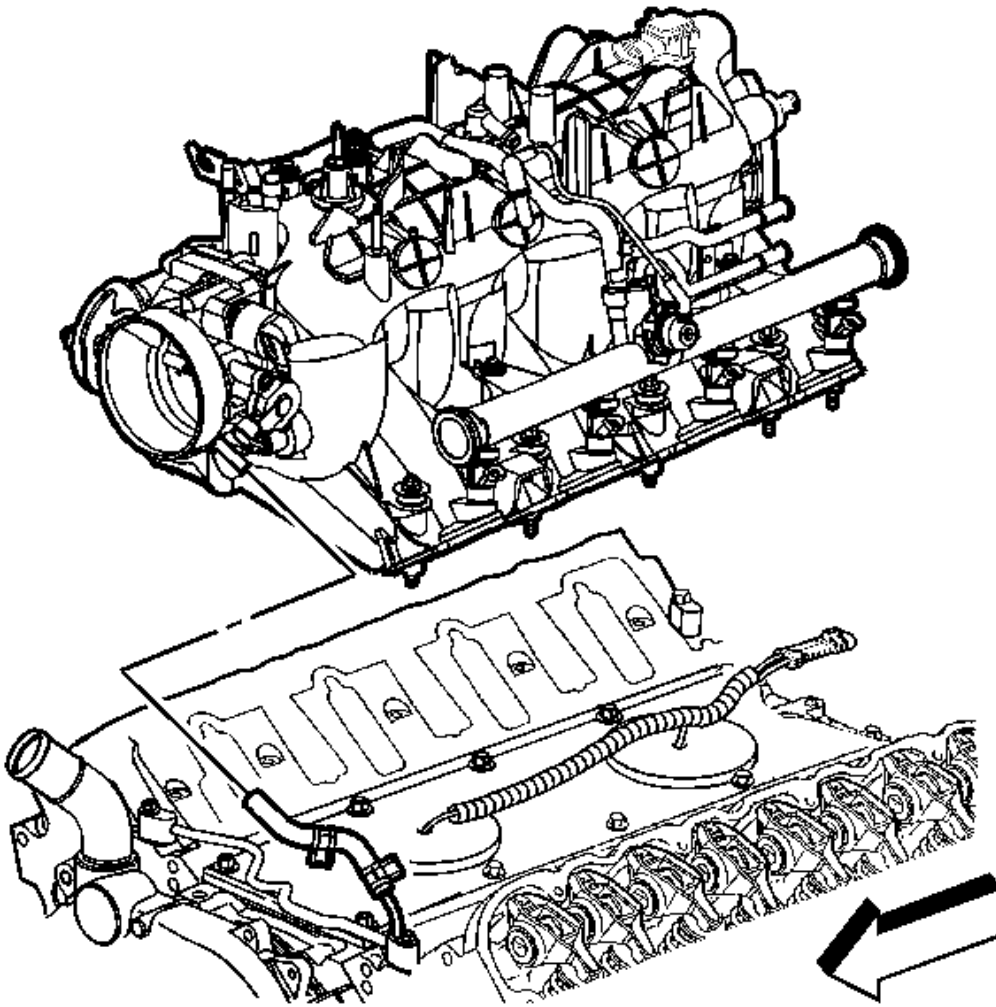


Fig. 58: Removed Intake Manifold
Courtesy of GENERAL MOTORS CORP.

2. Install the intake manifold.
3. Apply a 5 mm (0.20 in) band of threadlock GM U.S. P/N 12345382, Canada P/N 10953489, or equivalent to the threads of the intake manifold bolts.

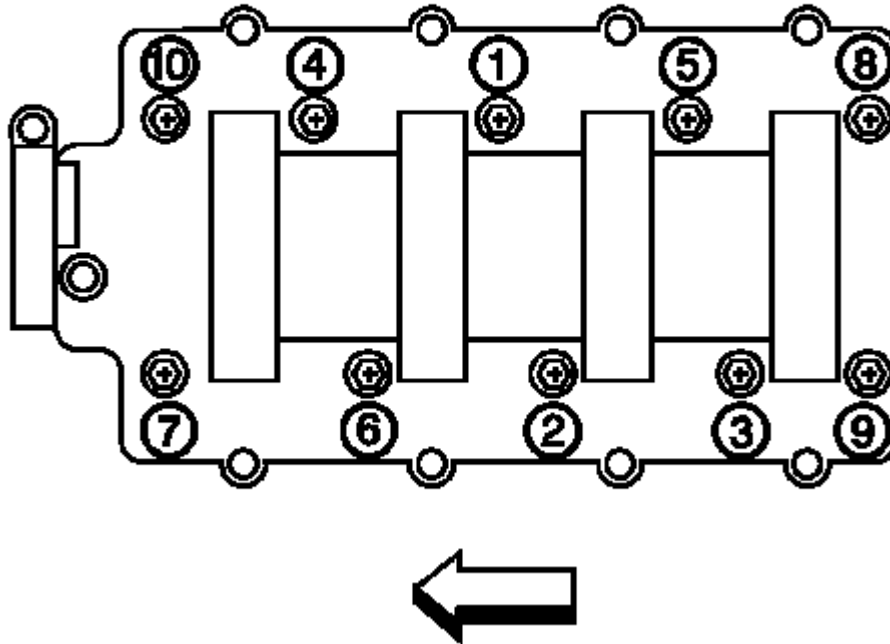


Fig. 59: Identifying Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

4. Install the intake manifold bolts.

Tighten:

1. Tighten the intake manifold bolts a first pass in sequence to 5 N.m (44 lb in).
2. Tighten the intake manifold bolts a final pass in sequence to 10 N.m (89 lb in).

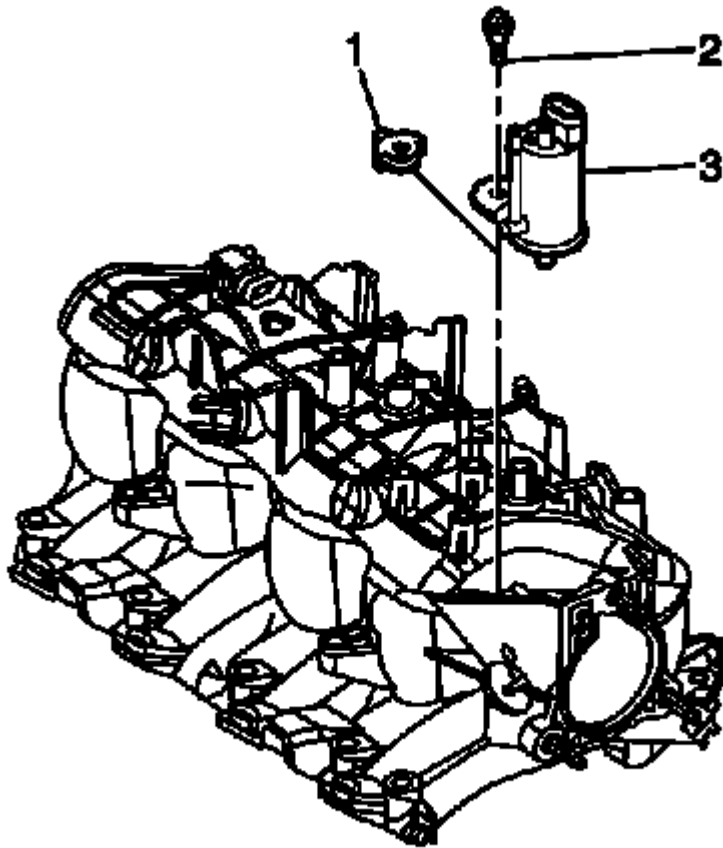


Fig. 60: View Of EVAP Purge Solenoid Bolt, Solenoid & Isolator
Courtesy of GENERAL MOTORS CORP.

5. Install the EVAP purge solenoid (3), isolator (1), and bolt (2) to the intake manifold.

Tighten: Tighten the EVAP purge solenoid bolt to 10 N.m (89 lb in).

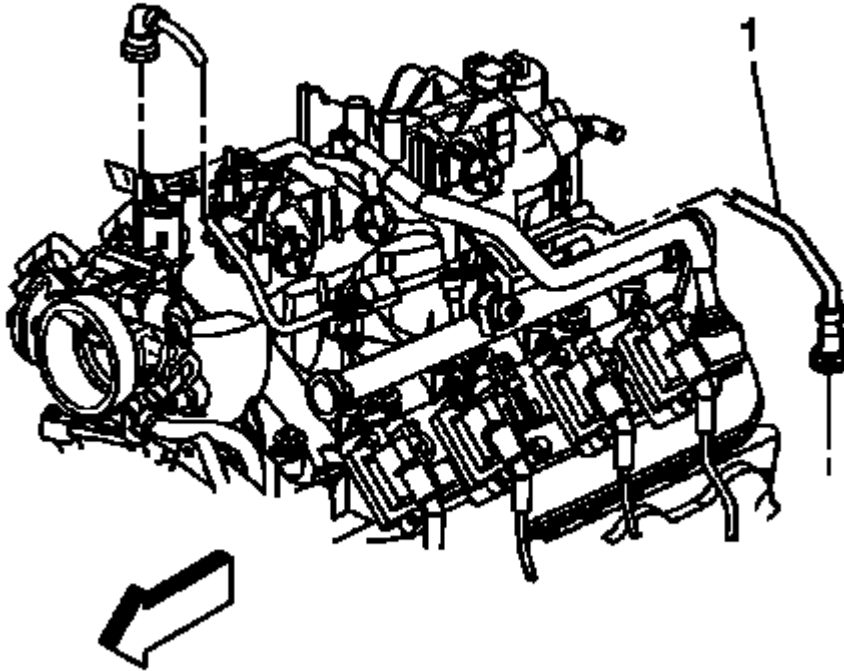


Fig. 61: View Of EVAP Purge Solenoid Vent Tube
Courtesy of GENERAL MOTORS CORP.

6. Install the EVAP purge solenoid vent tube to the solenoid (1) and vapor pipe.

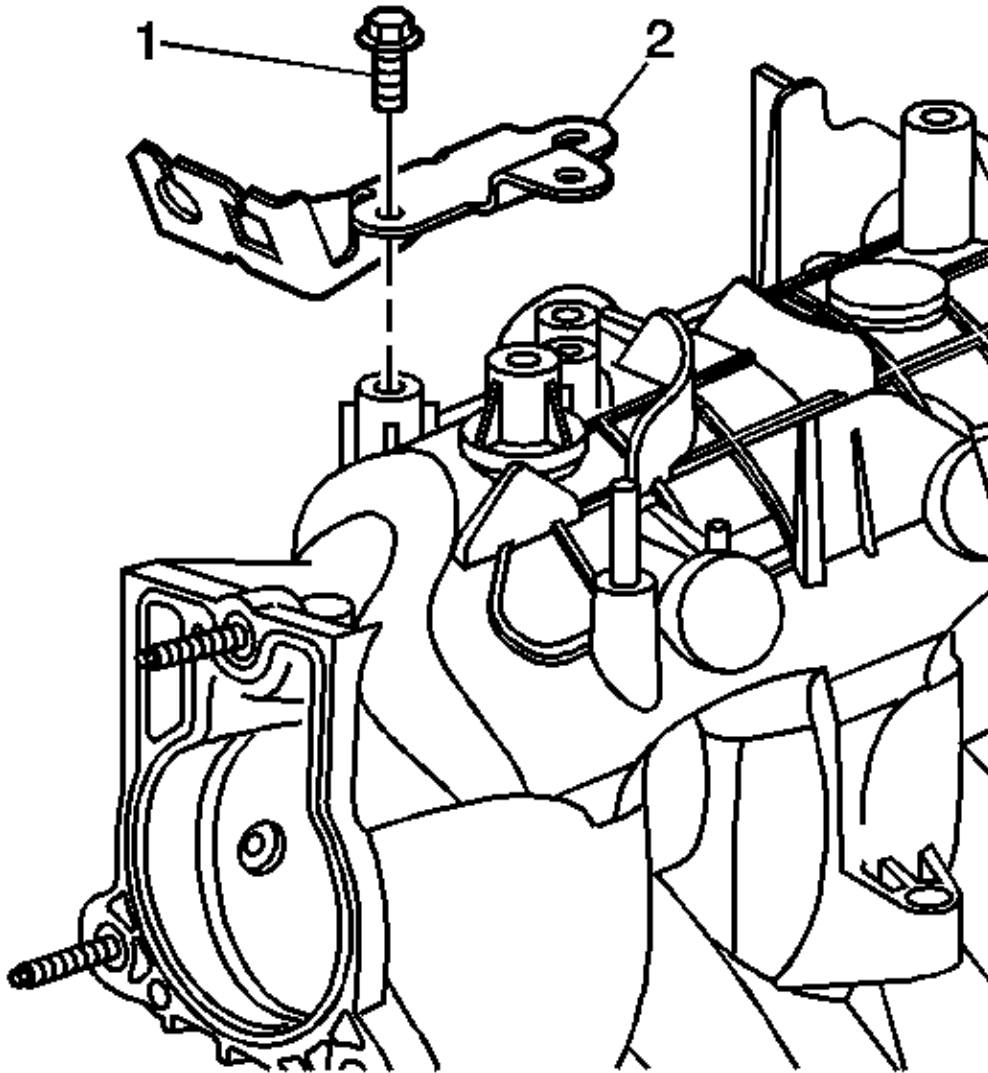


Fig. 62: Removed Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

7. Install the accelerator control cable bracket (2) to the intake manifold.
8. Install the accelerator control cable bracket bolts (1).

Tighten: Tighten the accelerator control cable bracket bolts to 10 N.m (89 lb in).

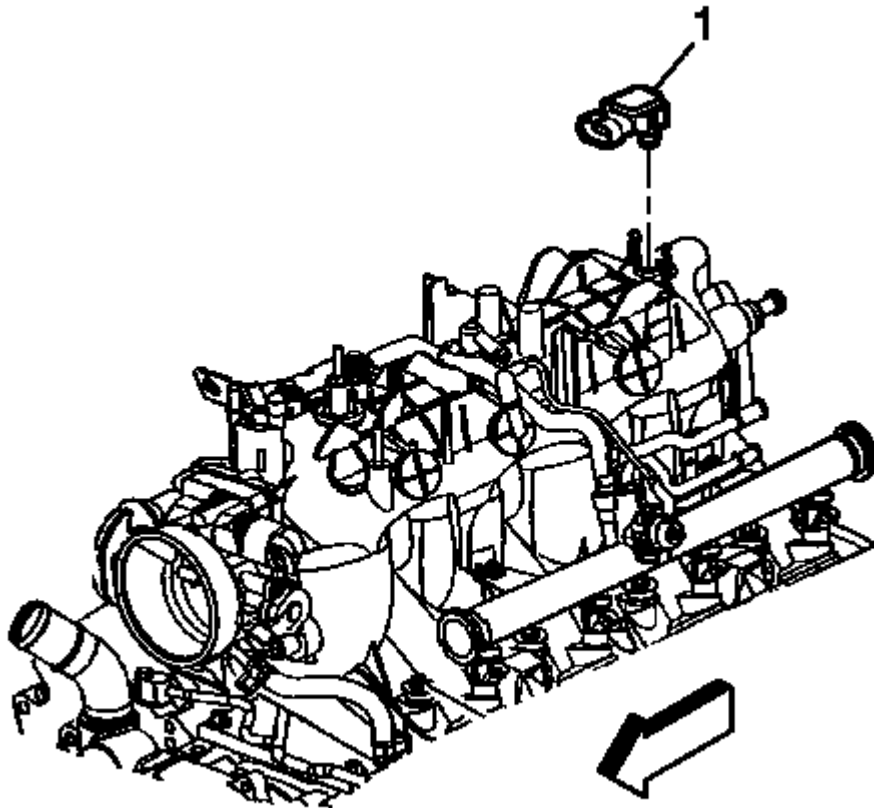


Fig. 63: Removed MAP Sensor
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Lightly coat the MAP sensor seal with clean engine oil before installing.

9. Install the MAP sensor (1) to the intake manifold.

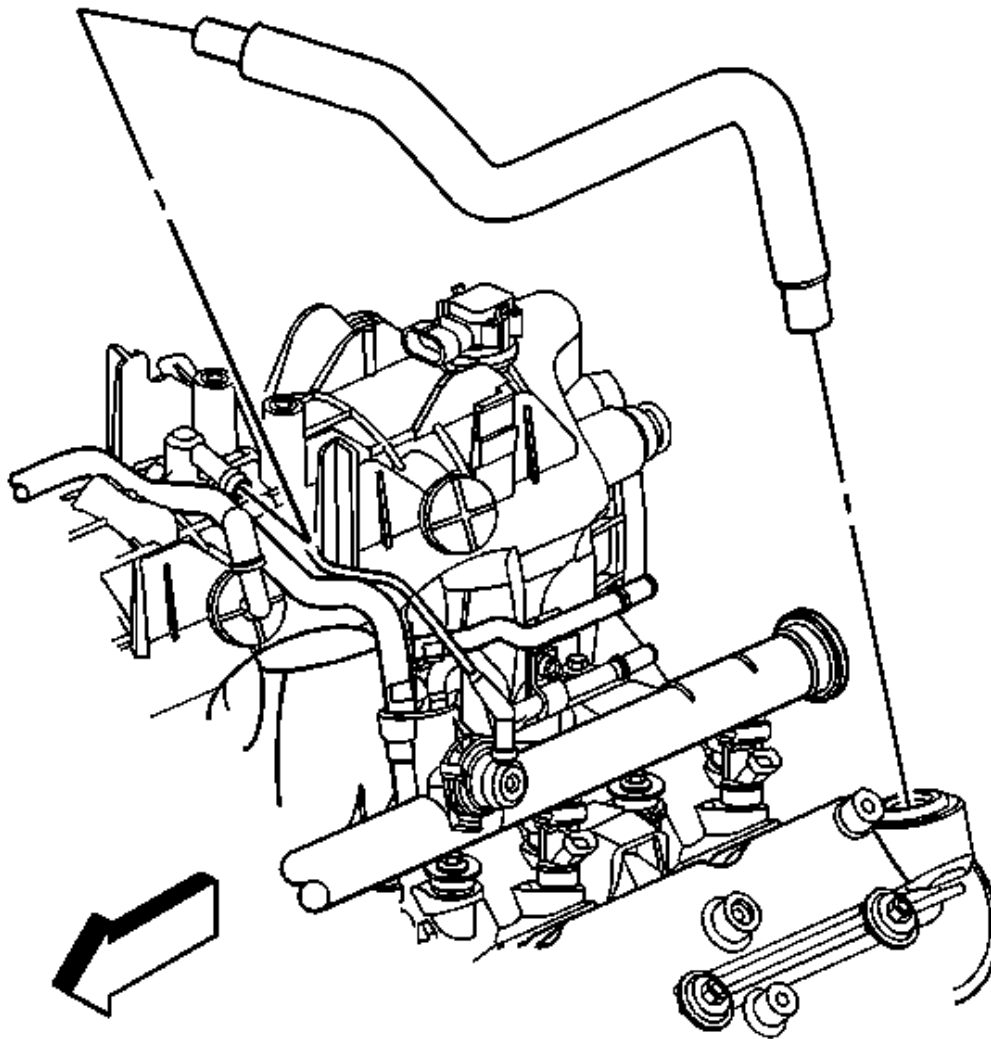


Fig. 64: Removed PCV Hose
Courtesy of GENERAL MOTORS CORP.

10. Install the PCV hose (with valve).

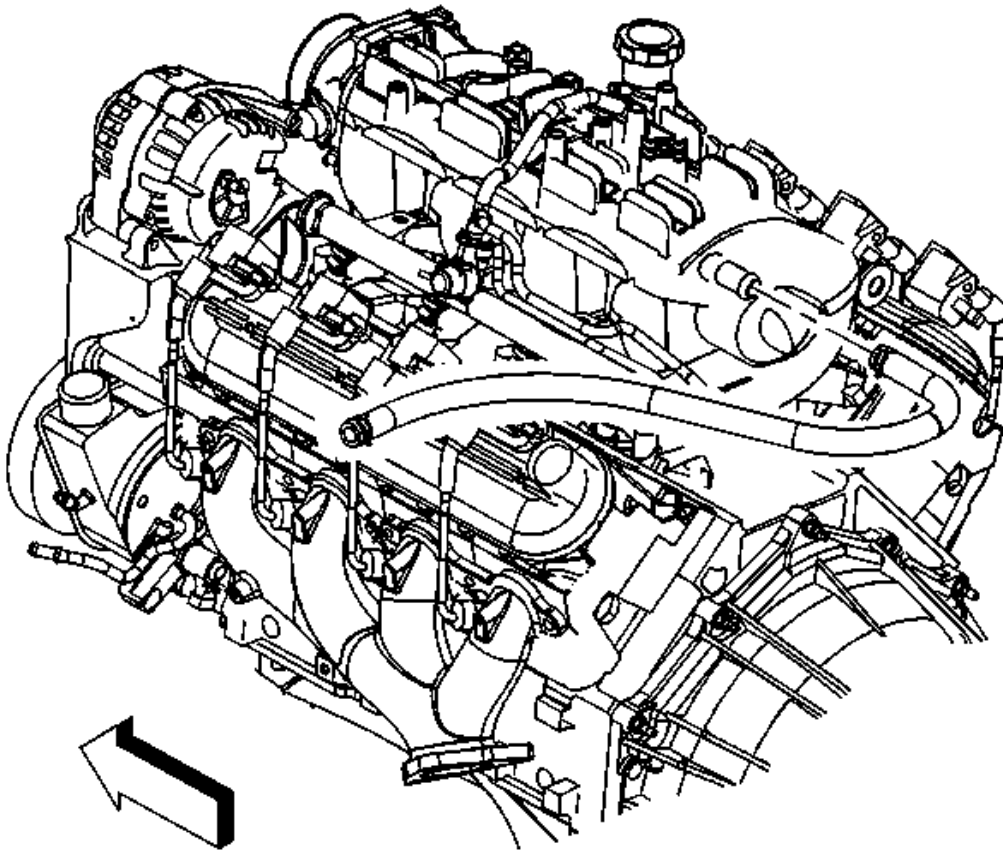


Fig. 65: Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

11. Install the vacuum brake booster hose to the rear of the intake manifold, if equipped.

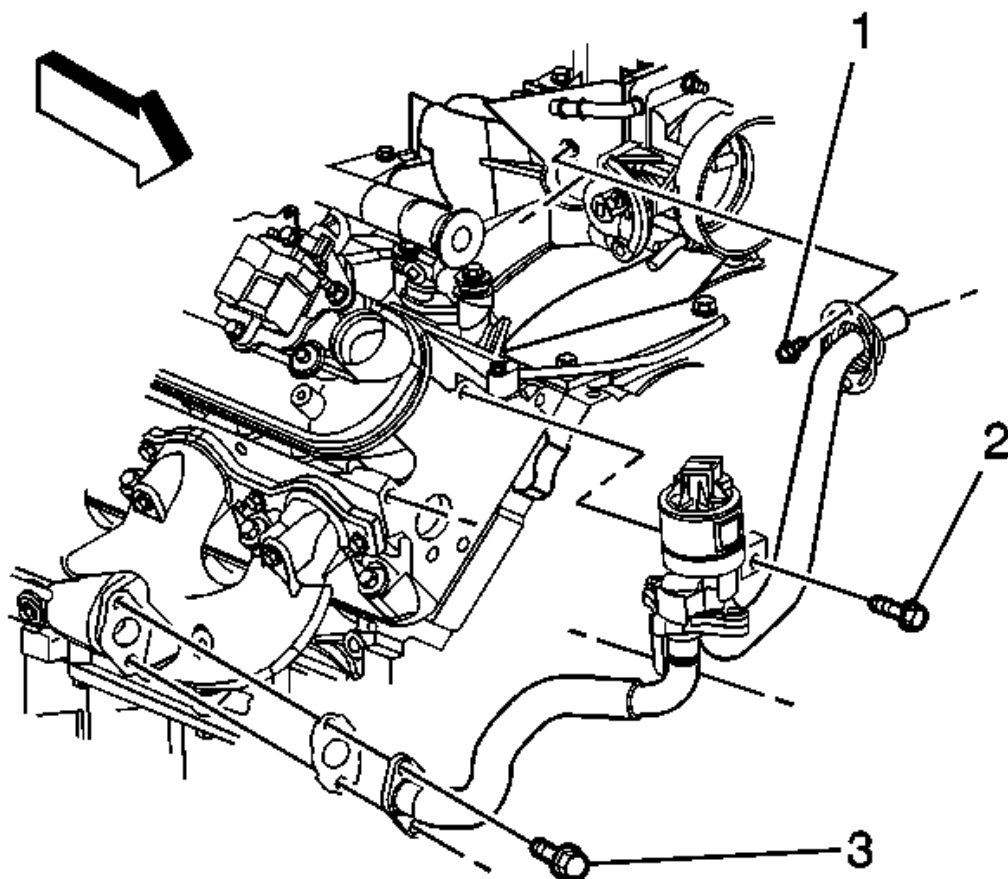


Fig. 66: EGR Pipe

Courtesy of GENERAL MOTORS CORP.

12. If equipped, position a new EGR pipe gasket on the exhaust manifold.
13. If equipped, install the EGR pipe (with valve).
14. If equipped, install the following EGR pipe bolts until snug:
 - Intake manifold (1)
 - Cylinder head (2)
 - Exhaust manifold (3)
15. If equipped, tighten the EGR pipe bolts.

Tighten:

- Tighten the EGR valve pipe-to-intake manifold bolts to 10 N.m (89 lb in).
- Tighten the EGR valve pipe-to-cylinder head bolts to 50 N.m (37 lb ft).

- Tighten the EGR valve pipe-to-exhaust manifold bolts to 30 N.m (22 lb ft).

16. Route the electrical harness into position over the engine.

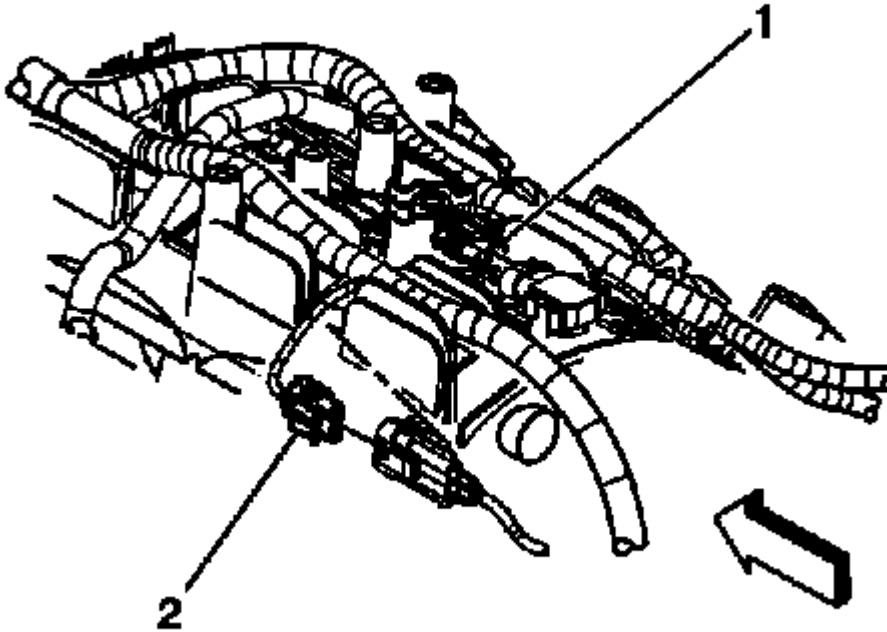


Fig. 67: View Of MAP Sensor & Knock Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

17. Connect the knock sensor harness electrical connector to the intake manifold.
18. Connect the following electrical connectors.
 - MAP sensor (1)
 - Knock sensor (2)
 - EGR valve, if equipped
19. Install the fuel injectors. Refer to **FUEL RAIL & INJECTORS INSTALLATION** .
20. Install the throttle body. Refer to **THROTTLE BODY INSTALLATION** .

ENGINE VALLEY COVER REPLACEMENT

Removal Procedure

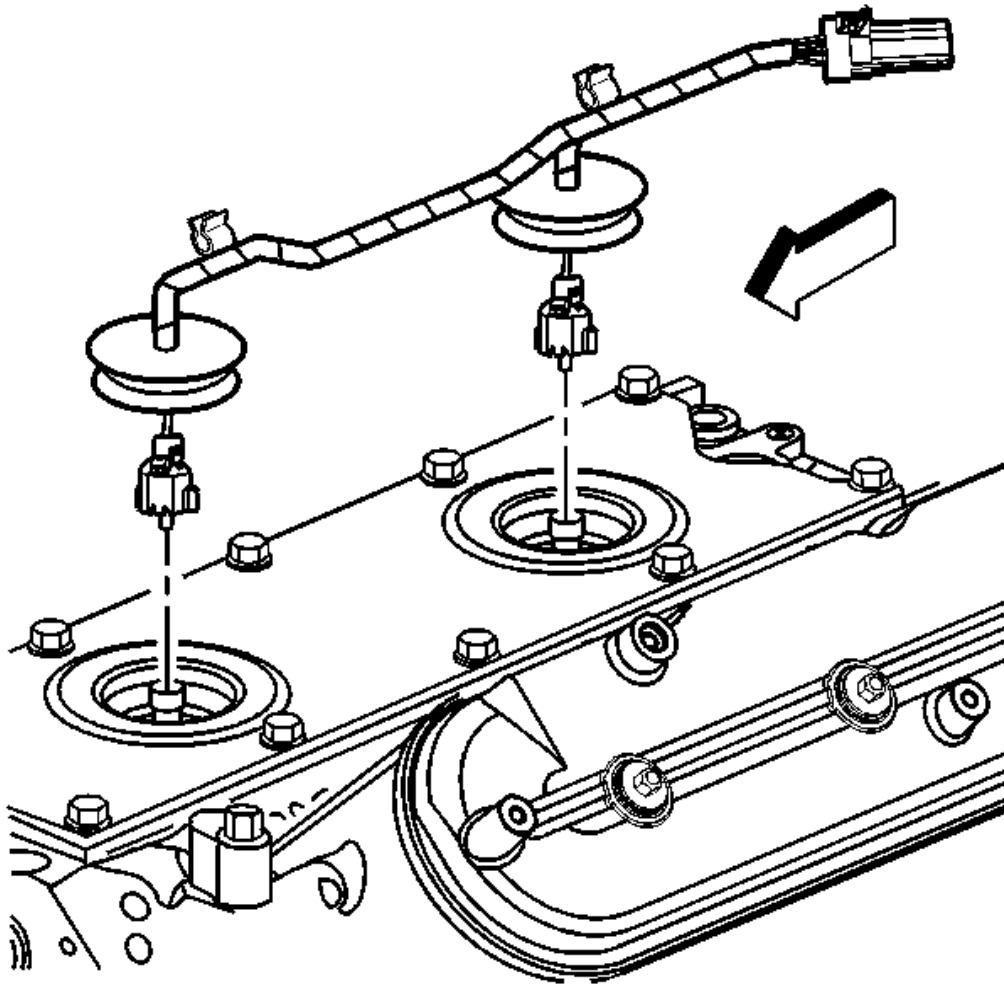


Fig. 68: View Of Knock Sensor Wire Harness
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Gently pry up the rubber covers.
3. Disconnect the knock sensor electrical connectors.

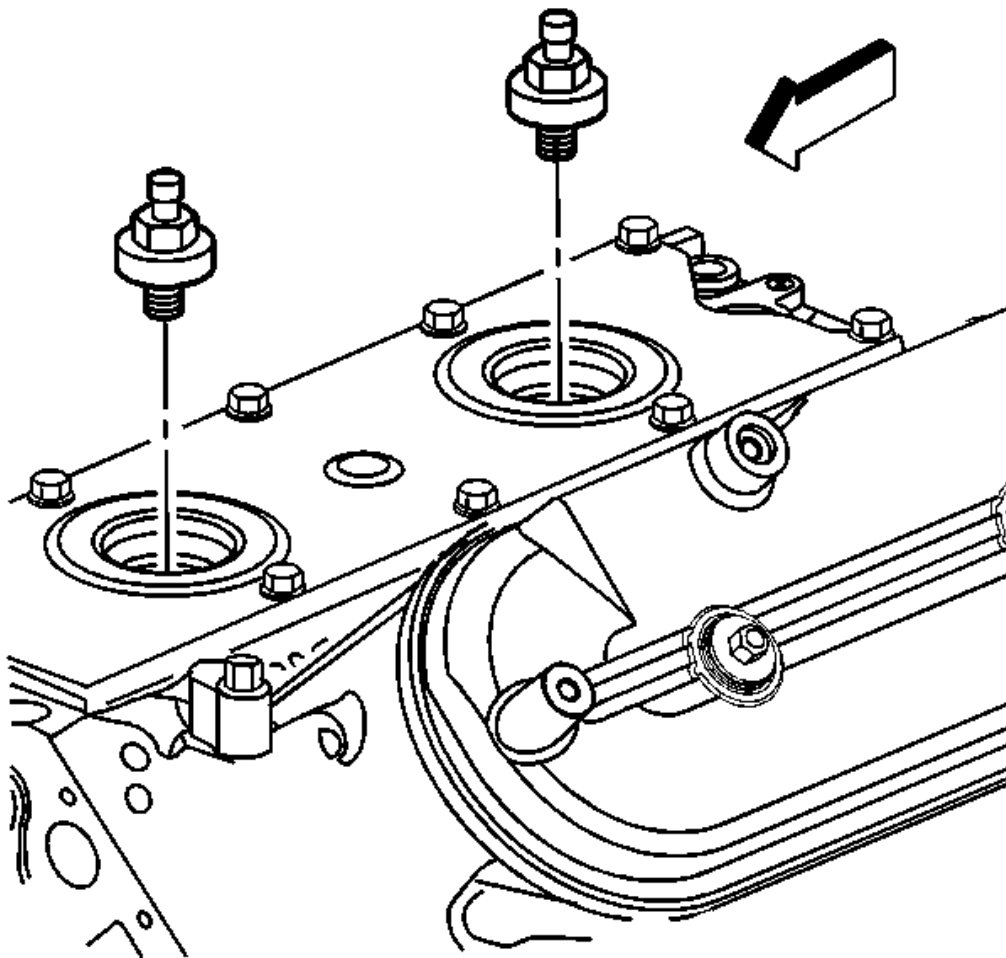


Fig. 69: View Of Knock Sensors
Courtesy of GENERAL MOTORS CORP.

4. Remove the knock sensors.

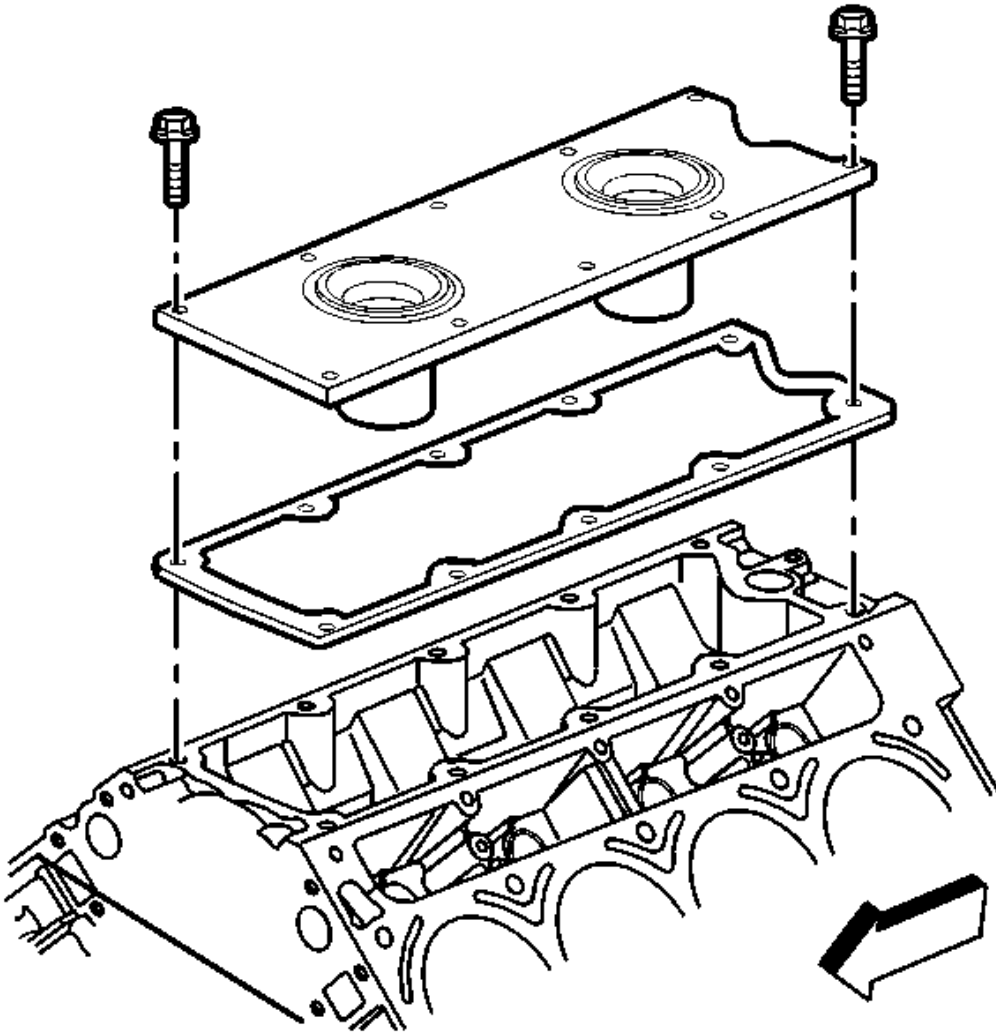


Fig. 70: View Of Engine Valley Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine valley cover bolts.
6. Remove the engine valley cover and gasket.
7. Discard the old gasket.

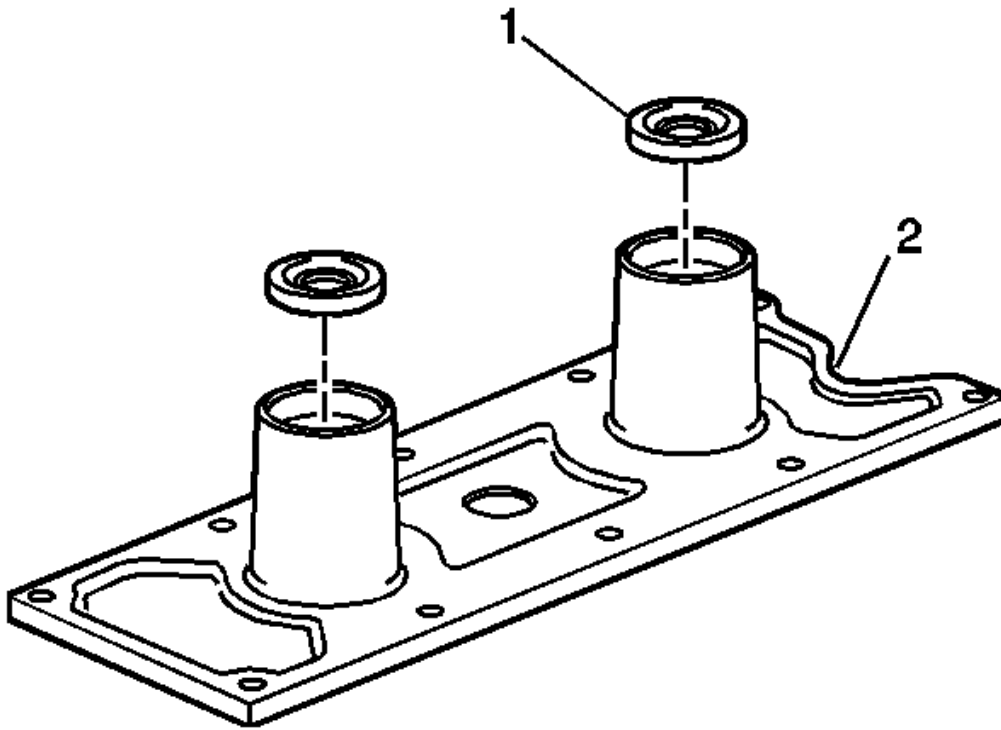


Fig. 71: View Of Knock Sensor Oil Seals & Cover
Courtesy of GENERAL MOTORS CORP.

8. Remove the knock sensor oil seals (1) from the cover (2).
9. Clean and inspect the engine valley cover. Refer to **ENGINE VALLEY COVER CLEANING & INSPECTION**.

Installation Procedure

IMPORTANT: All gasket surfaces should be free of oil or other foreign material during assembly.

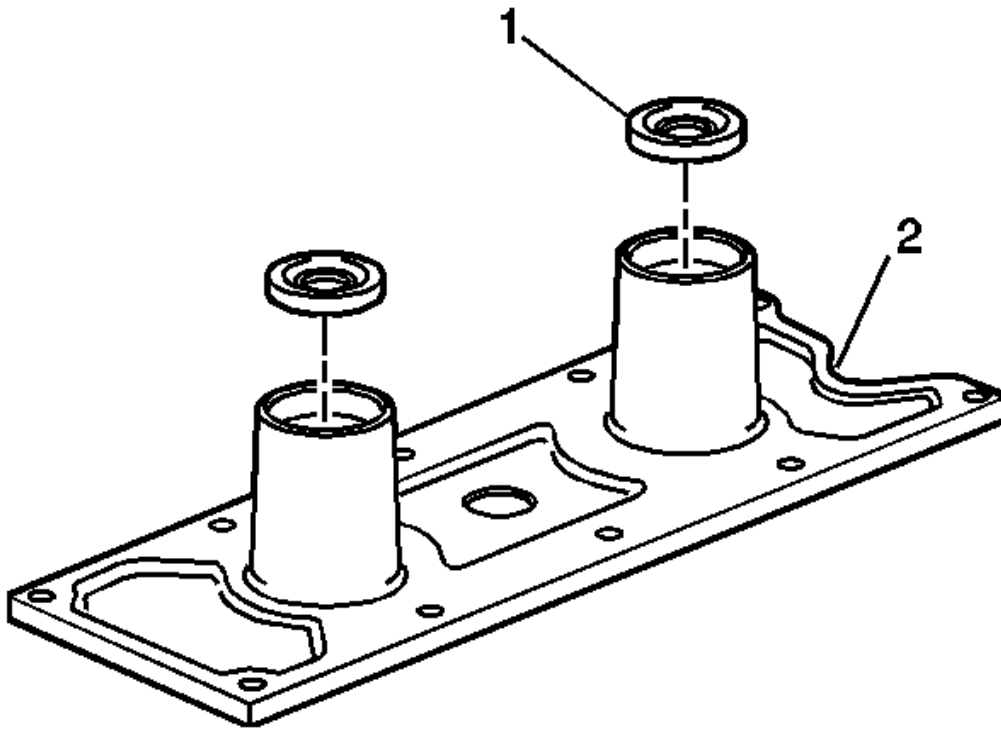


Fig. 72: View Of Knock Sensor Oil Seals & Cover
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the NEW knock sensor seals (1) with clean engine oil.
2. Install the knock sensor oil seals (1) into the engine valley cover (2).

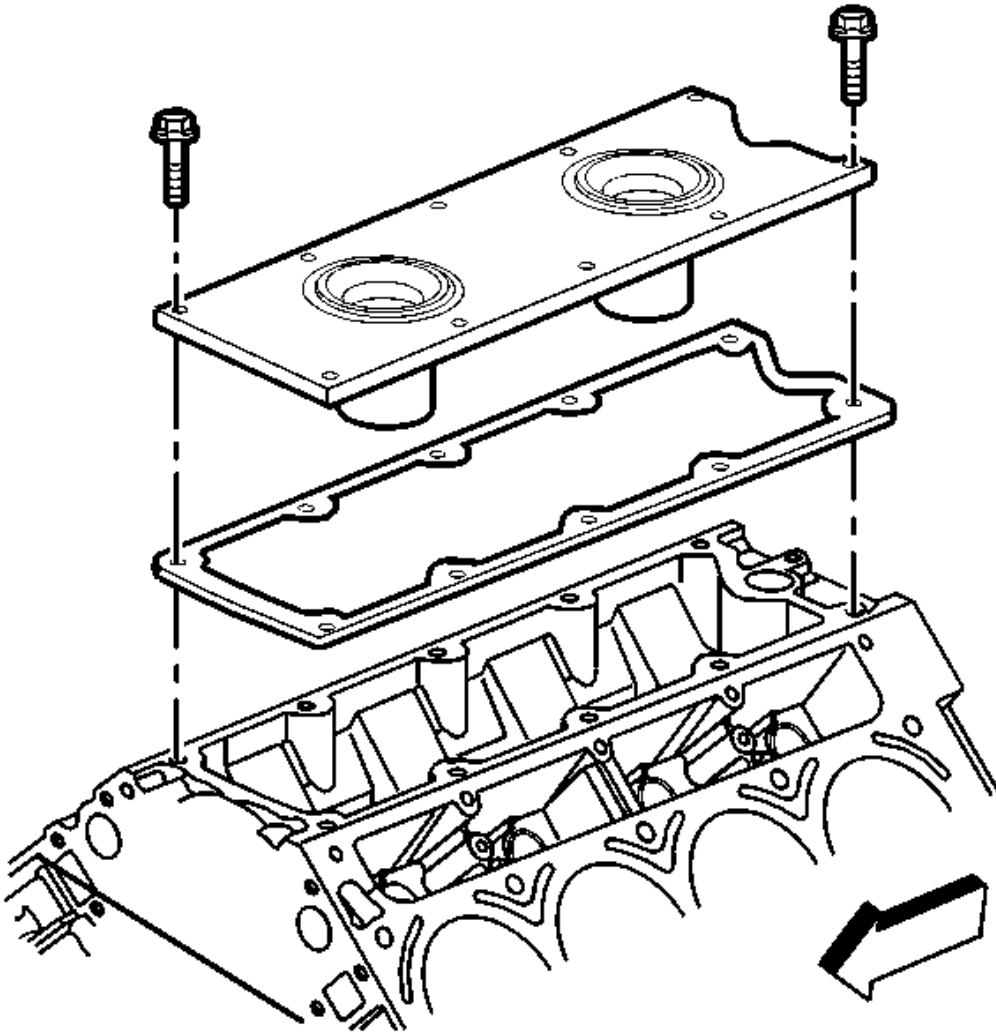


Fig. 73: View Of Engine Valley Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Install the engine valley cover and a NEW gasket onto the engine block.
4. Install the engine valley cover bolts.

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

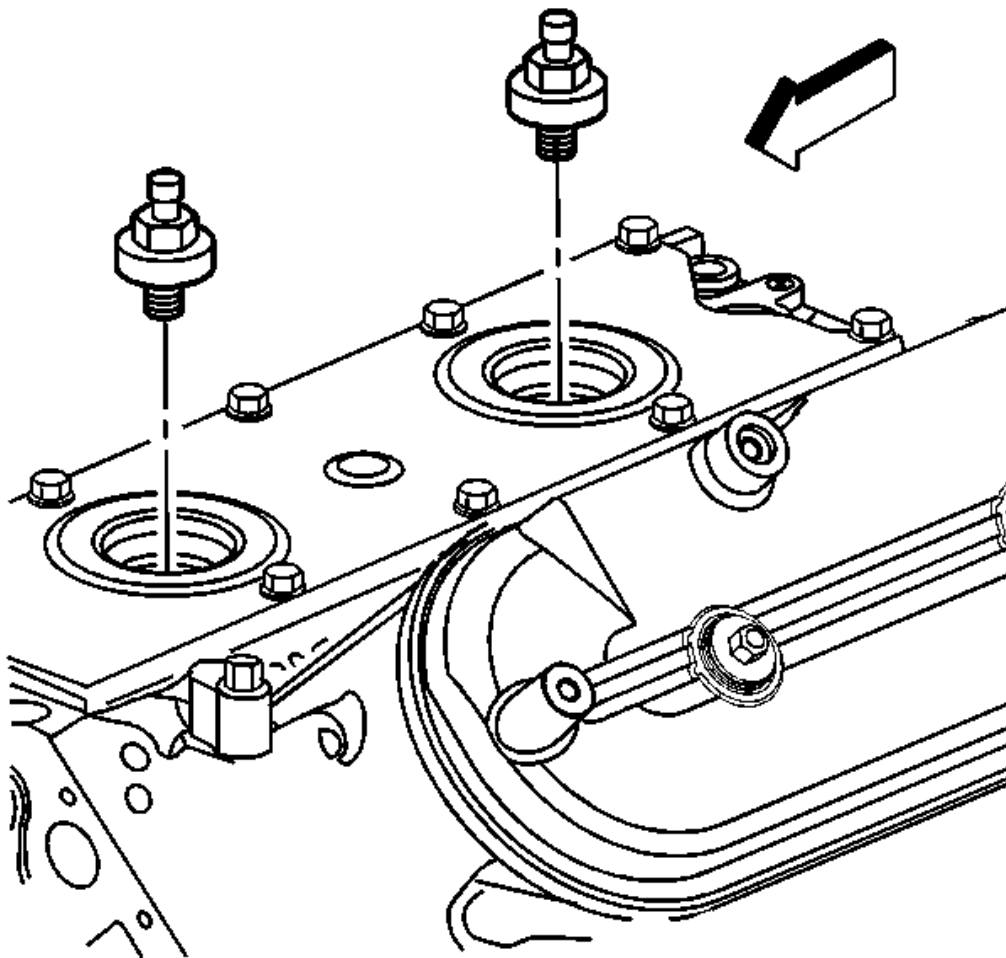


Fig. 74: View Of Knock Sensors
Courtesy of GENERAL MOTORS CORP.

5. Install the knock sensors.

Tighten: Tighten the sensors to 20 N.m (15 lb ft).

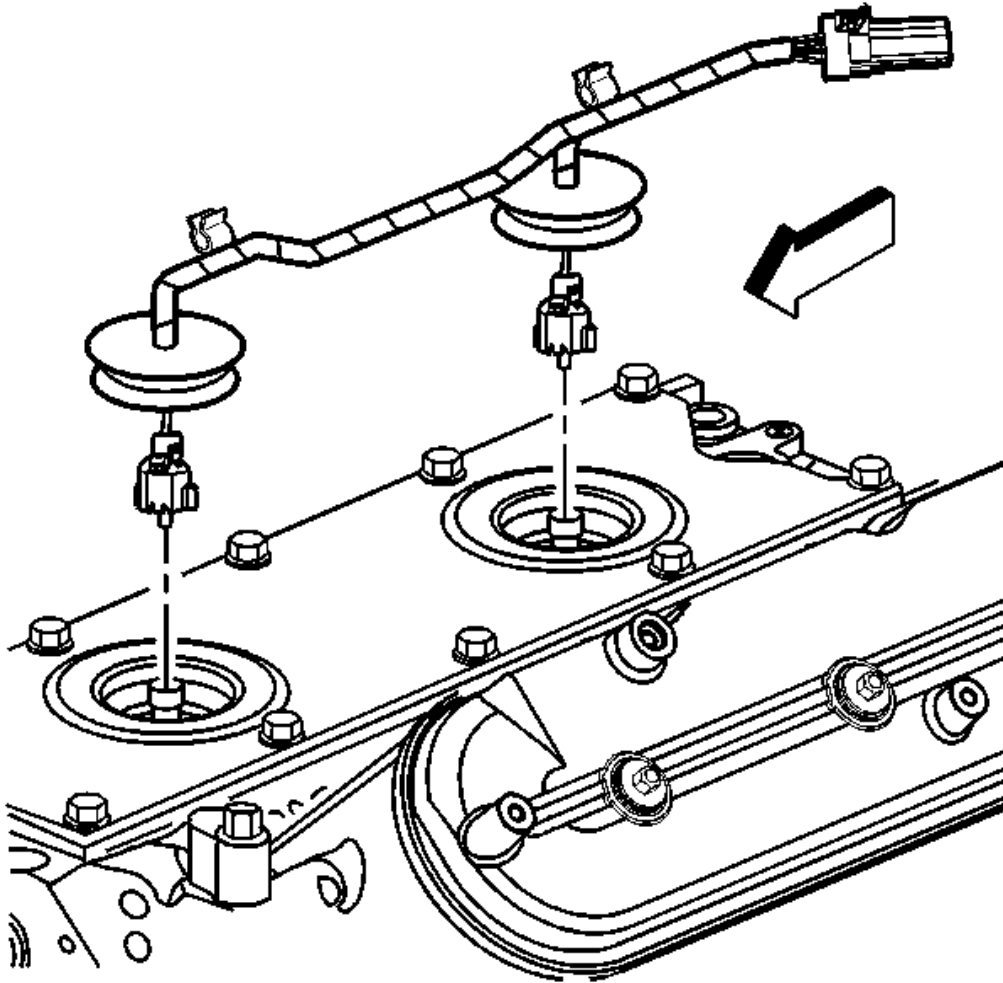


Fig. 75: View Of Knock Sensor Wire Harness
Courtesy of GENERAL MOTORS CORP.

6. Connect the knock sensor electrical connectors.
7. Push down on the rubber covers.
8. Install the intake manifold. Refer to **Intake Manifold Replacement**.

VALVE ROCKER ARM COVER REPLACEMENT - LEFT

Removal Procedure

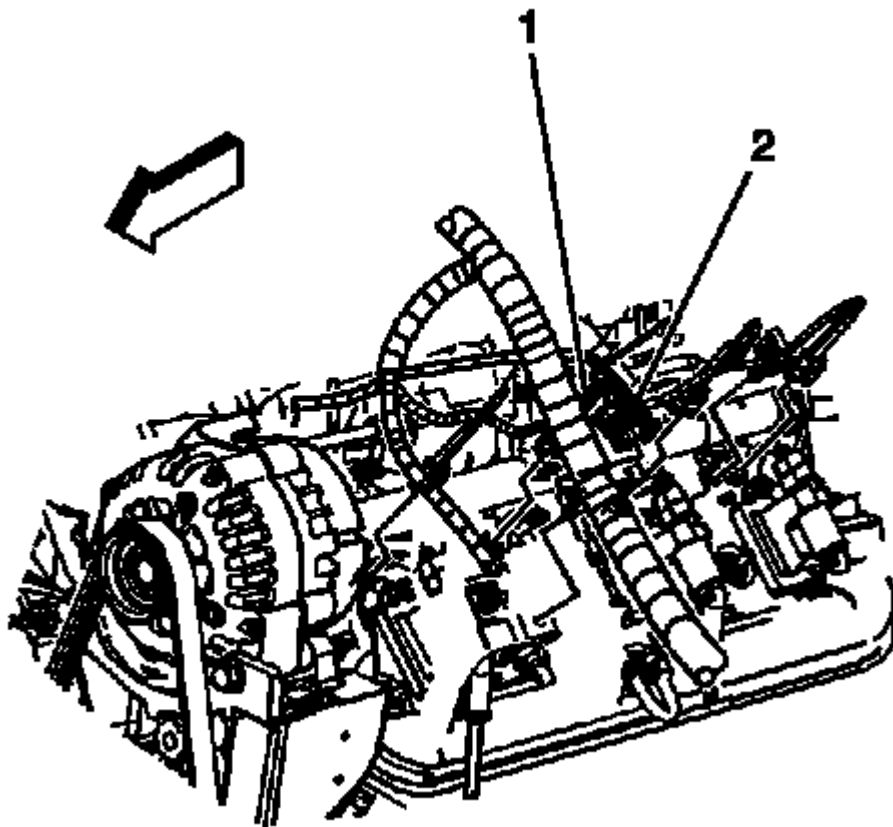


Fig. 76: View Of Main Ignition Coil Wire Harness Connector & Clips
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine sight shield, if required. Refer to **Engine Sight Shield Replacement (4.8L, 5.3L, and 6.0L Engines)** or **Engine Sight Shield Replacement (6.0L Engine w/ RPOs Y91 and Z88)**.
2. Remove the connector position assurance (CPA) lock.
3. Disconnect the main electrical connector (2) to the ignition coil wire harness.
4. Remove the harness clips (1).
5. Reposition the engine harness, if necessary.
6. Remove the spark plug wires from the ignition coils.
 - Twist each plug wire 1/2 turn.
 - Pull only on the boot in order to remove the wire from the ignition coil.

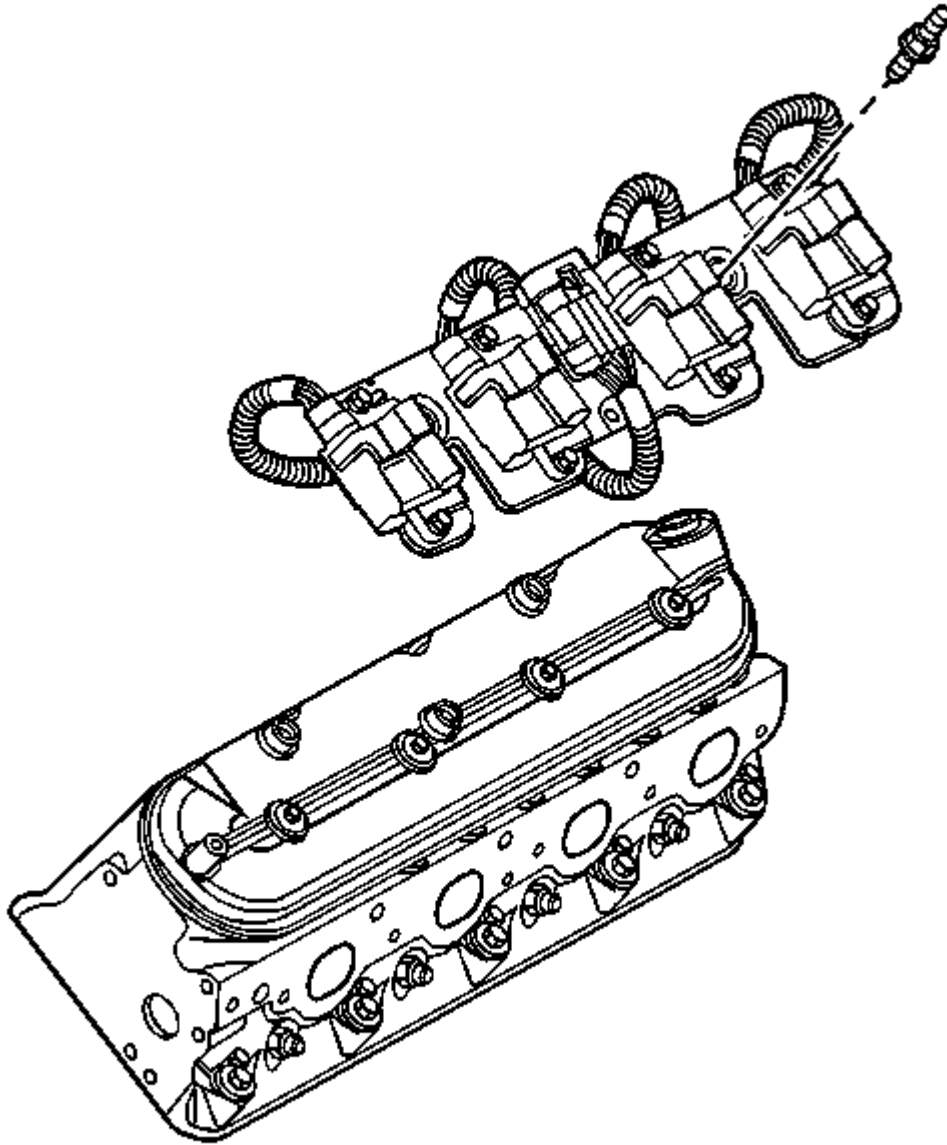


Fig. 77: Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS CORP.

7. Remove the ignition coil bracket studs from the rocker arm cover.
8. Remove the ignition coils and bracket from the rocker arm cover.

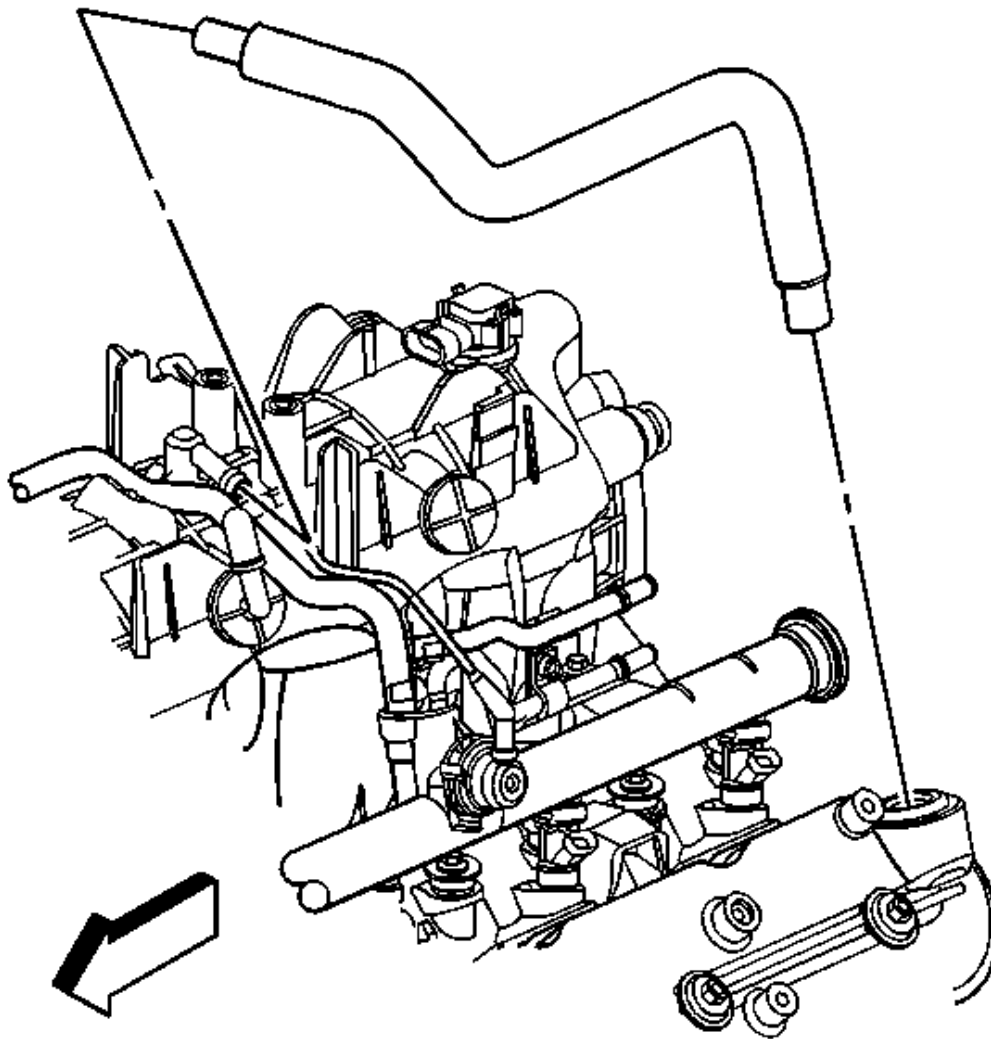


Fig. 78: Breather Crossover Tube
Courtesy of GENERAL MOTORS CORP.

9. Remove the positive crankcase ventilation (PCV) hose from the rocker arm cover.

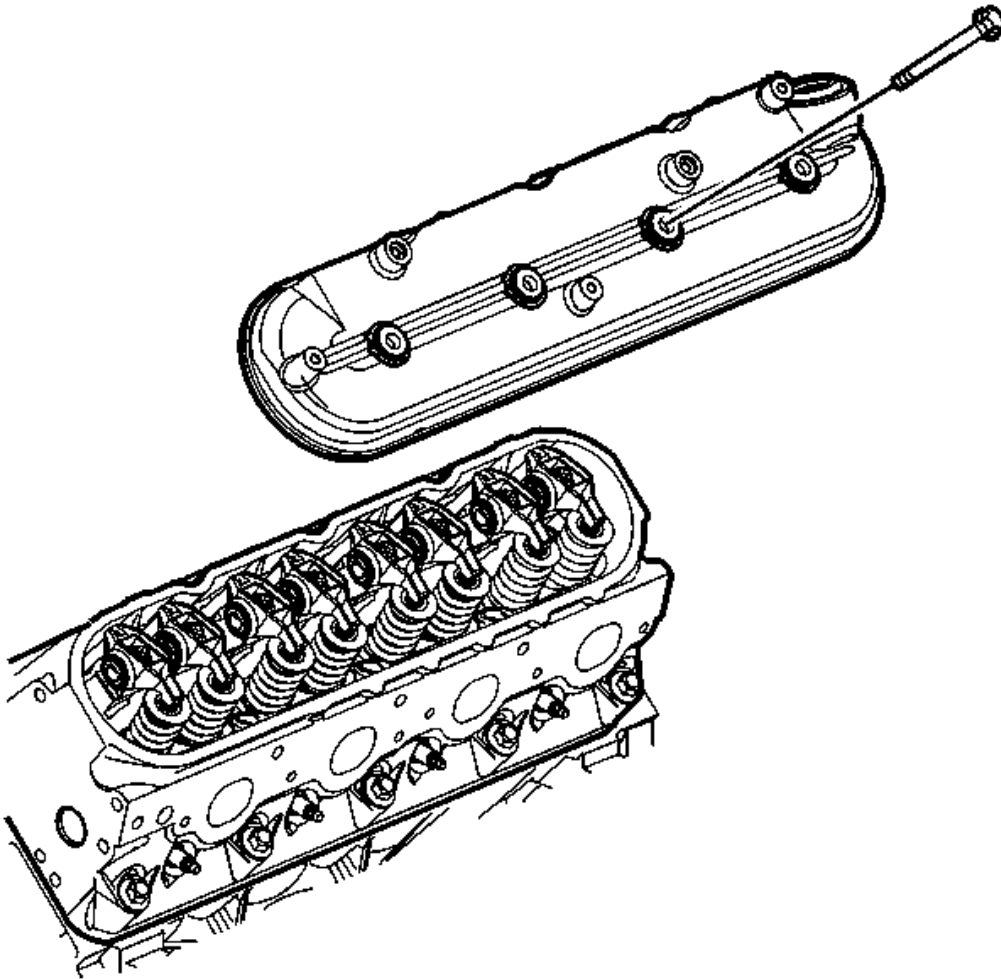


Fig. 79: Valve Cover To Cylinder Head View
Courtesy of GENERAL MOTORS CORP.

10. Remove the valve rocker arm cover bolts.
11. Remove the valve rocker arm cover.

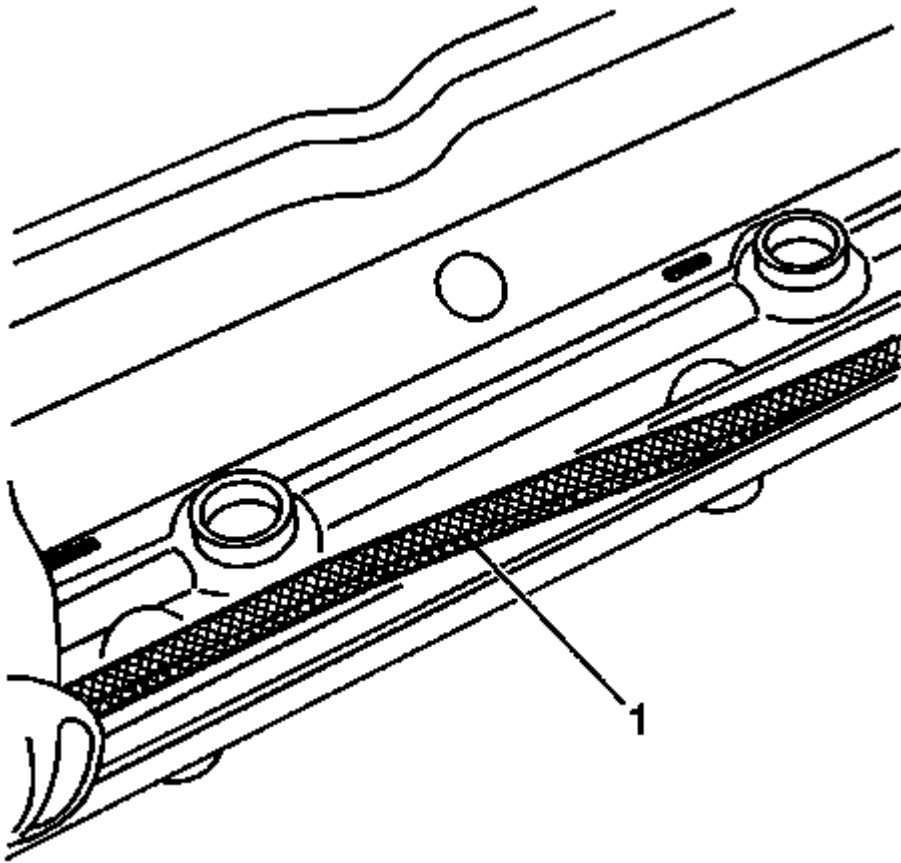


Fig. 80: Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

12. Remove the gasket (1) from the rocker cover.
13. Discard the OLD gasket.

Installation Procedure

IMPORTANT:

- All gasket surfaces should be free of oil an/or other foreign material during assembly.
- **DO NOT** reuse the valve rocker arm cover gasket.
- The valve rocker arm cover bolt grommets may be reused.
- If the PCV valve grommet has been removed from the rocker cover, install a **NEW** grommet during assembly.

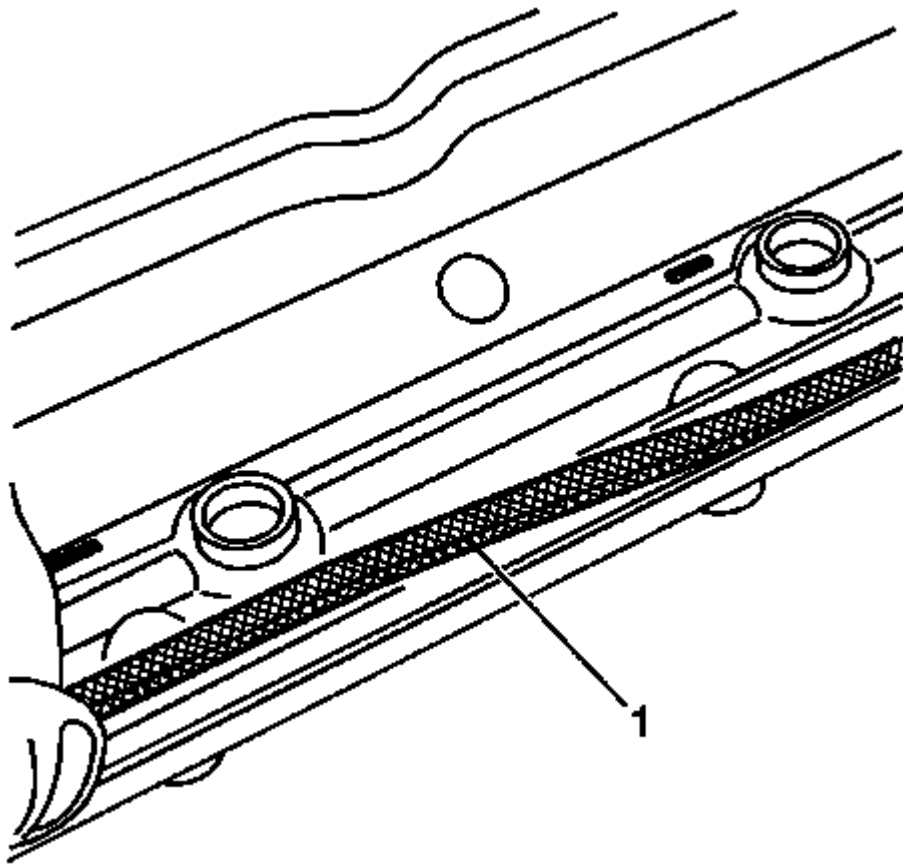


Fig. 81: Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW rocker cover gasket (1) into the groove of the valve rocker arm cover.

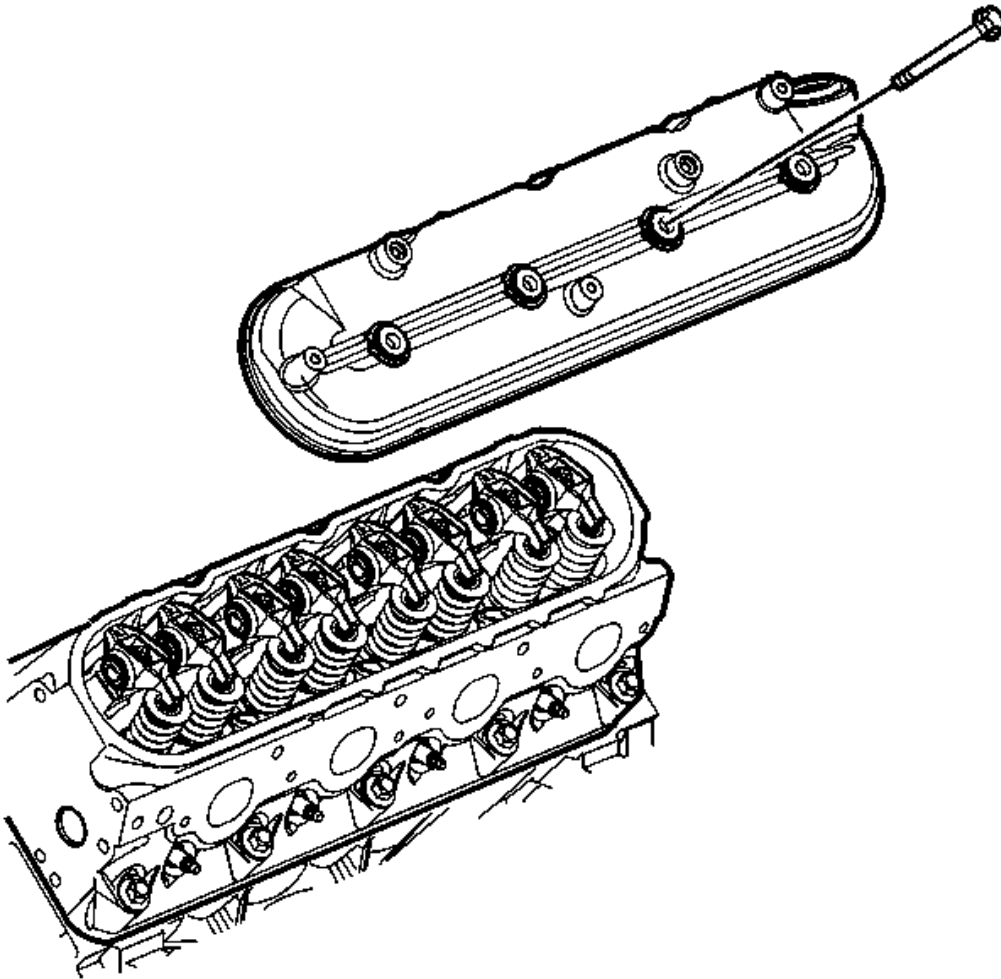


Fig. 82: Valve Cover To Cylinder Head View
Courtesy of GENERAL MOTORS CORP.

2. Install the valve rocker arm cover onto the cylinder head.
3. Install new rocker arm cover grommets, if necessary.

NOTE: Refer to Fastener Notice in Cautions and Notices.

4. Install the rocker arm cover bolts.

Tighten: Tighten the valve rocker arm cover bolts to 12 N.m (106 lb in).

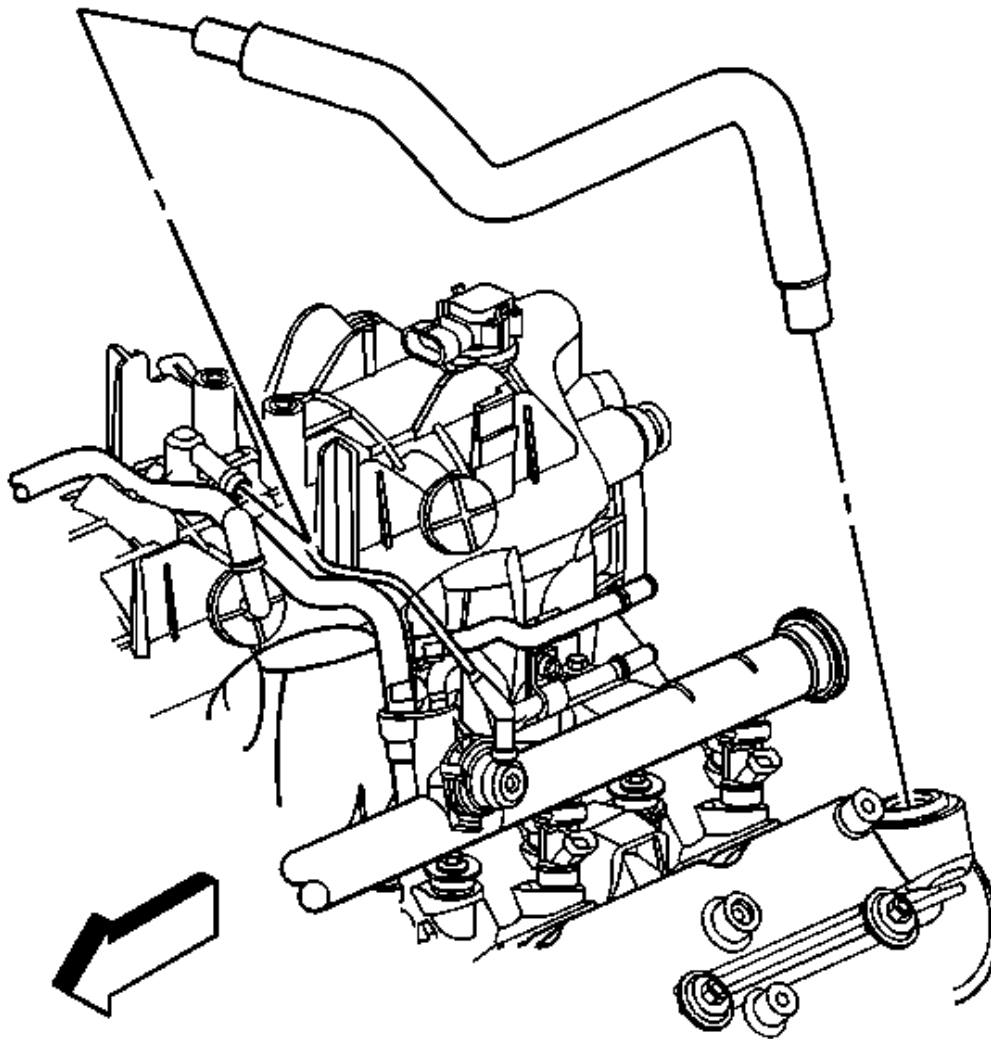


Fig. 83: Breather Crossover Tube
Courtesy of GENERAL MOTORS CORP.

5. Install the PCV hose to the rocker arm cover.

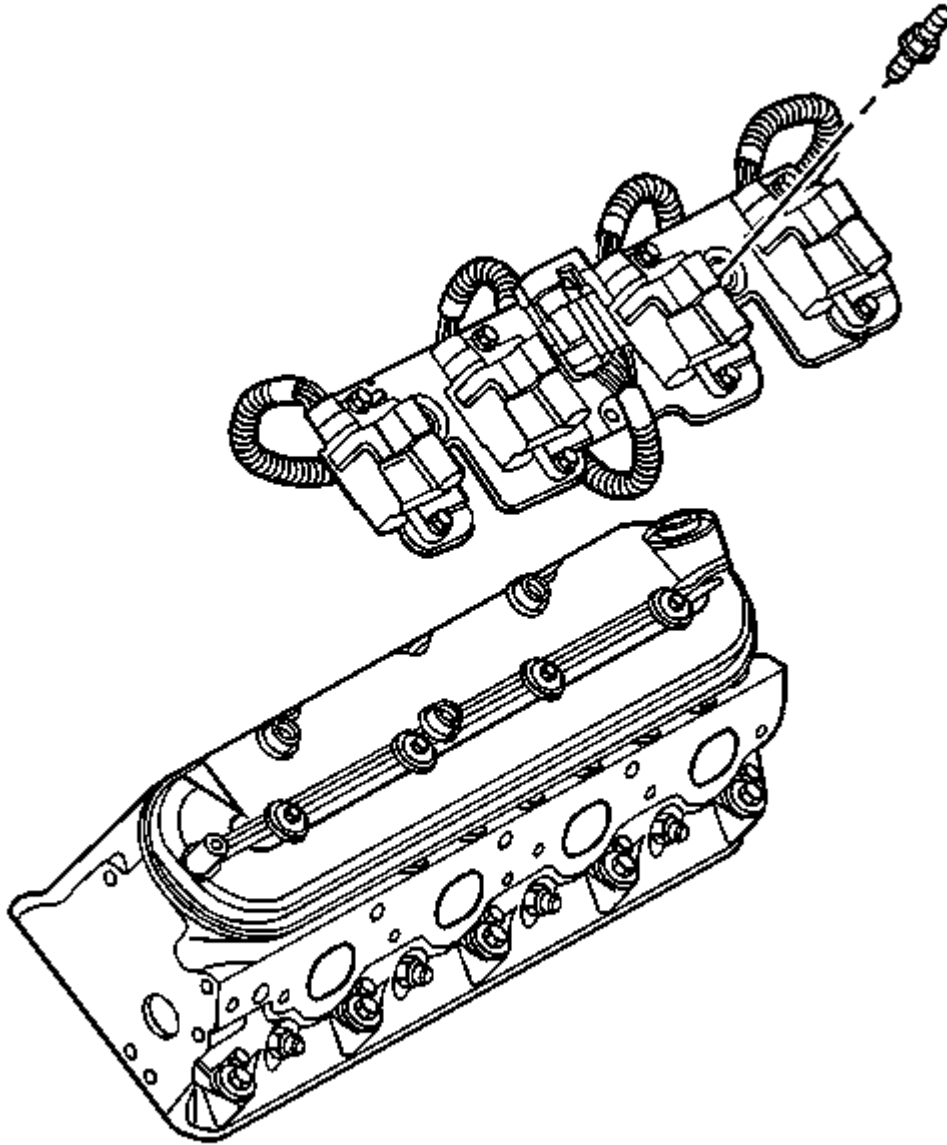


Fig. 84: Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS CORP.

6. Apply threadlock GM U.S. P/N 12345382, Canada P/N 10953489, or equivalent to the threads of the bracket bolts.
7. Install the ignition coils and bracket to the rocker arm cover.
8. Install the ignition coil bracket studs to the rocker arm cover.

Tighten: Tighten the ignition coil bracket studs to 12 N.m (106 lb in).

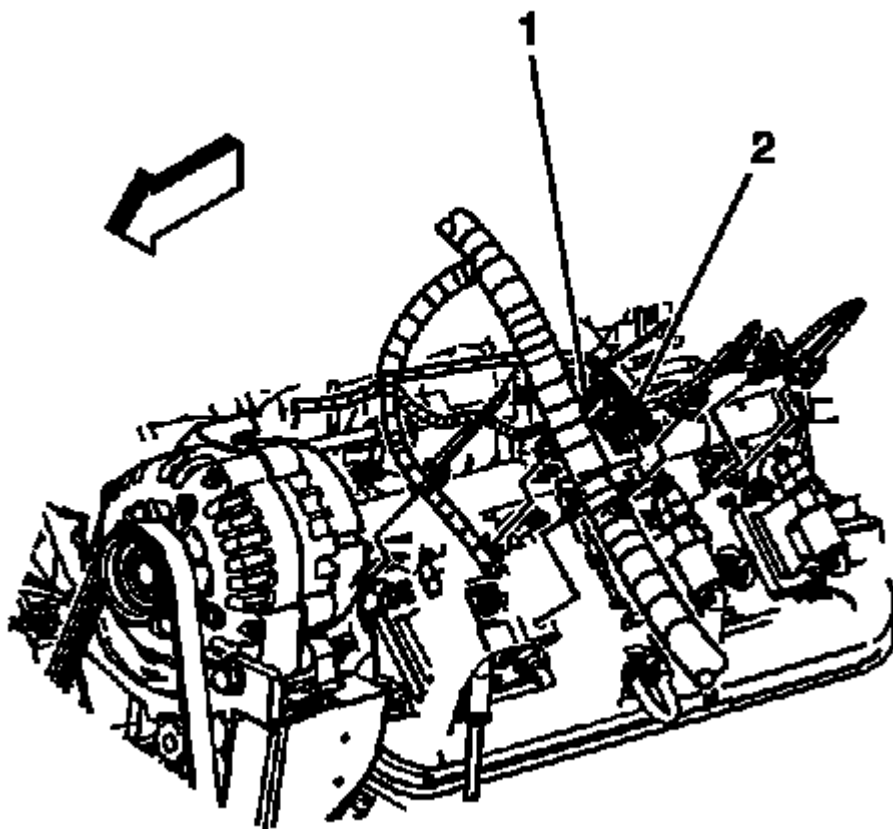


Fig. 85: View Of Main Ignition Coil Wire Harness Connector & Clips
Courtesy of GENERAL MOTORS CORP.

9. Install the spark plug wires to the ignition coils.
10. Position the engine harness, if necessary.
11. Install the harness clips (1).
12. Connect the main electrical connector (2) to the ignition coil wire harness.
13. Install the CPA lock.
14. Install the engine sight shield, if required. Refer to Engine Sight Shield Replacement (4.8L, 5.3L, and 6.0L Engines) or Engine Sight Shield Replacement (6.0L Engine w/ RPOs Y91 and Z88).

VALVE ROCKER ARM COVER REPLACEMENT - RIGHT

Removal Procedure

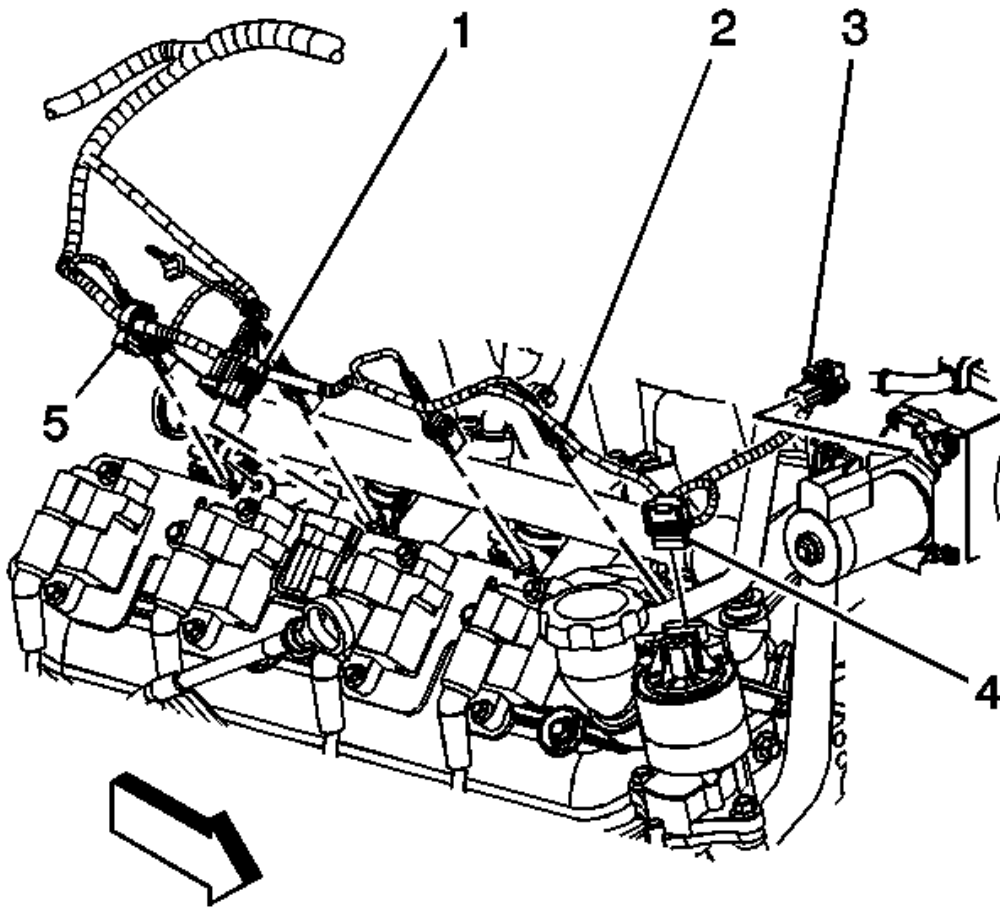


Fig. 86: Engine Harness

Courtesy of GENERAL MOTORS CORP.

1. Remove the engine sight shield, if required. Refer to **Engine Sight Shield Replacement (4.8L, 5.3L, and 6.0L Engines)** or **Engine Sight Shield Replacement (6.0L Engine w/ RPOs Y91 and Z88)**.
2. Remove the connector position assurance (CPA) lock.
3. Disconnect the main electrical connector (1) to the ignition coil wire harness.
4. Remove the harness clips (2).
5. Reposition the engine harness, if necessary.
6. Remove the spark plug wires from the ignition coils.
 - Twist each plug wire 1/2 turn.
 - Pull only on the boot in order to remove the wire from the ignition coil.

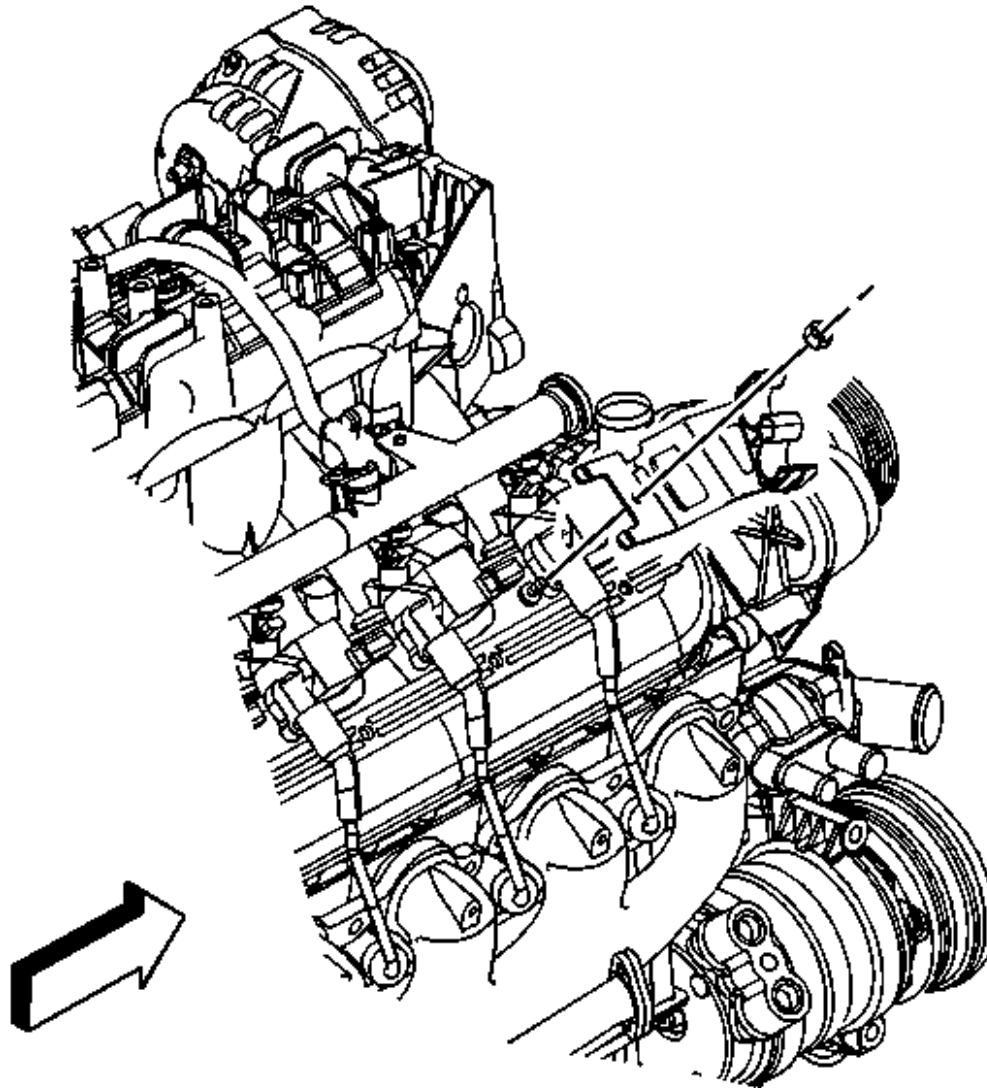


Fig. 87: Heater Hose Bracket Nut And Bracket
Courtesy of GENERAL MOTORS CORP.

7. Reposition the surge tank/heater hoses from the heater hose bracket.
8. Remove the heater hose bracket nut and bracket.

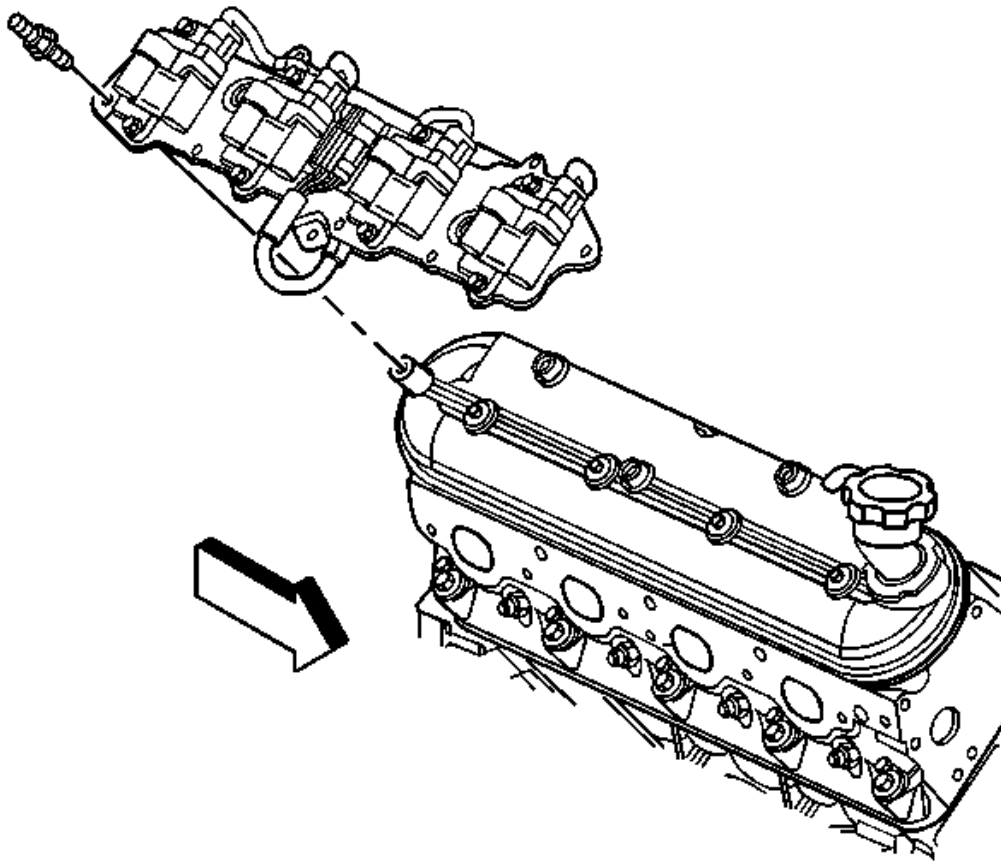


Fig. 88: Ignition Coils And Bracket
Courtesy of GENERAL MOTORS CORP.

9. Remove the ignition coil bracket studs from the rocker arm cover.
10. Remove the ignition coils and bracket from the rocker cover.

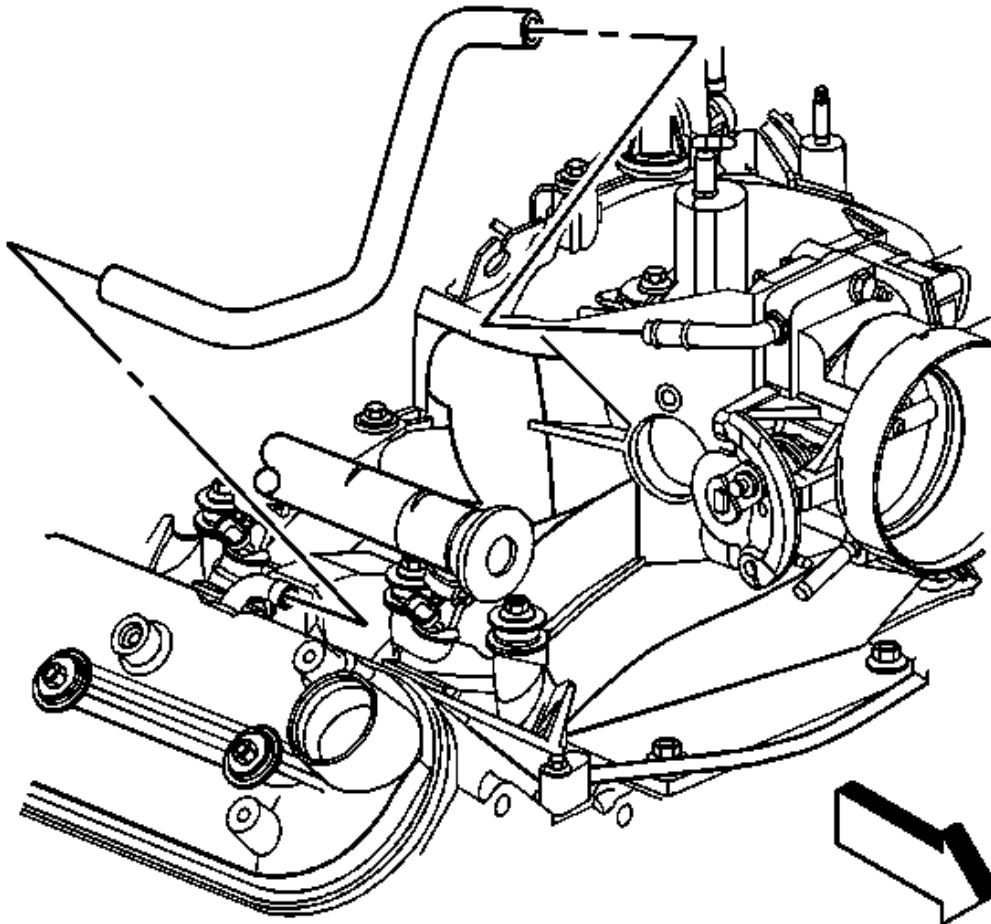


Fig. 89: Locating Breather Hose
Courtesy of GENERAL MOTORS CORP.

11. Remove the vent hose from the throttle body and valve rocker arm cover.

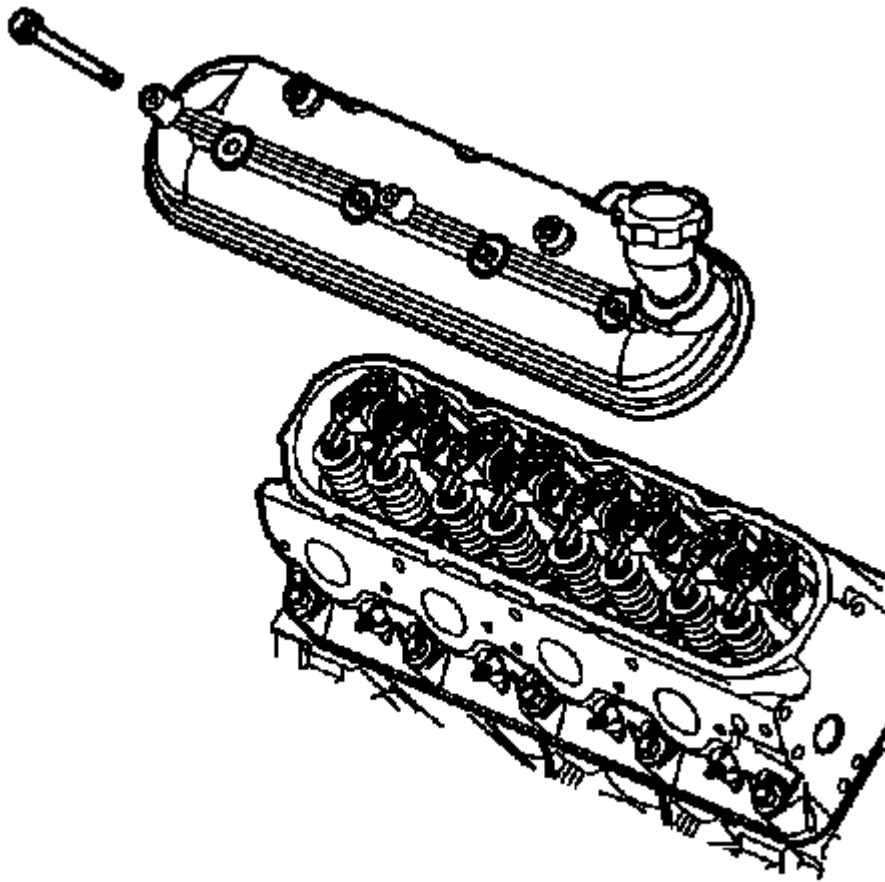


Fig. 90: View Of Valve Rocker Arm Cover & Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

12. Remove the valve rocker arm cover bolts.
13. Remove the valve rocker arm cover.

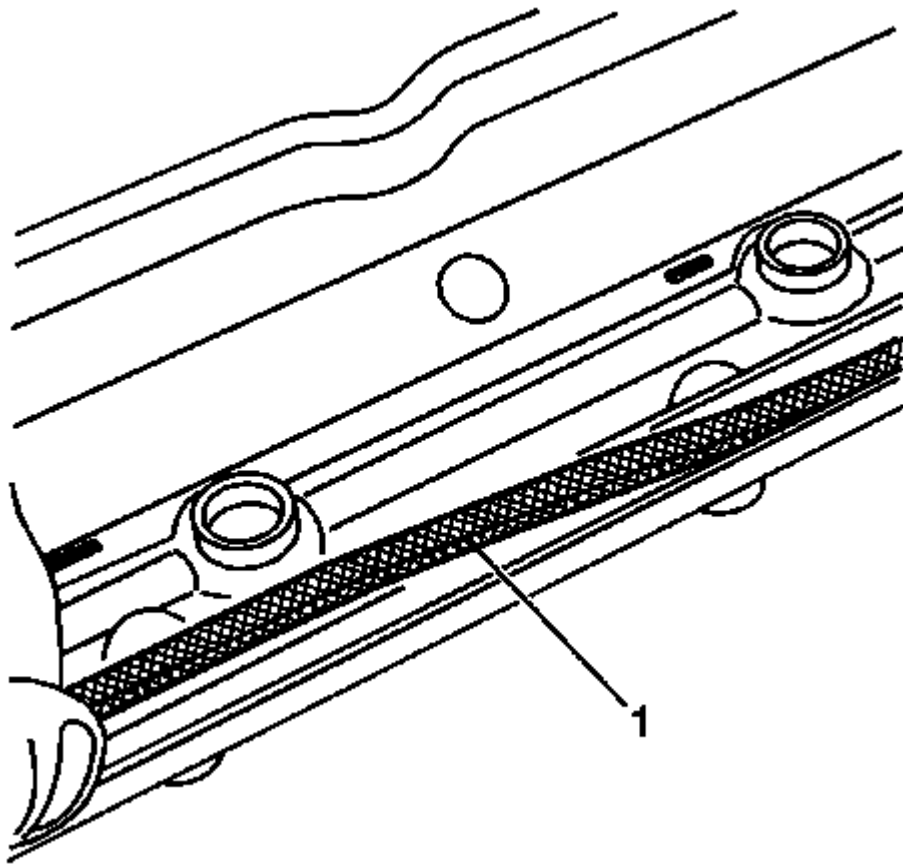


Fig. 91: Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

14. Remove the gasket (1) from the rocker cover.
15. Discard the OLD gasket.

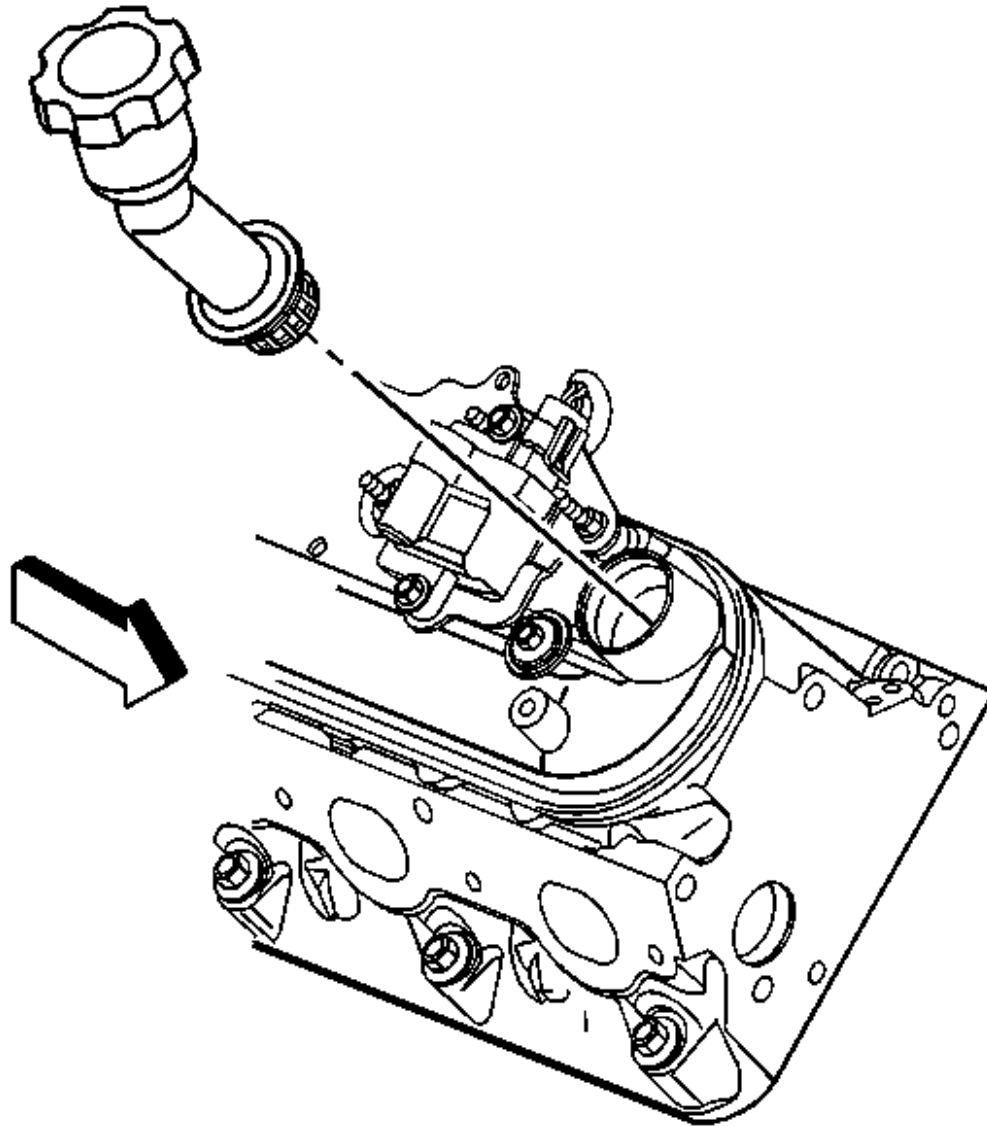


Fig. 92: View Of Oil Fill Tube
Courtesy of GENERAL MOTORS CORP.

16. Remove the oil fill cap from the oil fill tube.
17. Remove the oil fill tube from the rocker cover, if required.
18. Discard the oil fill tube.

Installation Procedure

IMPORTANT:

- All gasket surfaces should be free of oil or other foreign material during assembly.
- **DO NOT** reuse the valve rocker arm cover gasket.
- The valve rocker arm cover bolt grommets may be reused.
- If the oil fill tube has been removed from the rocker arm cover, install a **NEW** fill tube during assembly.

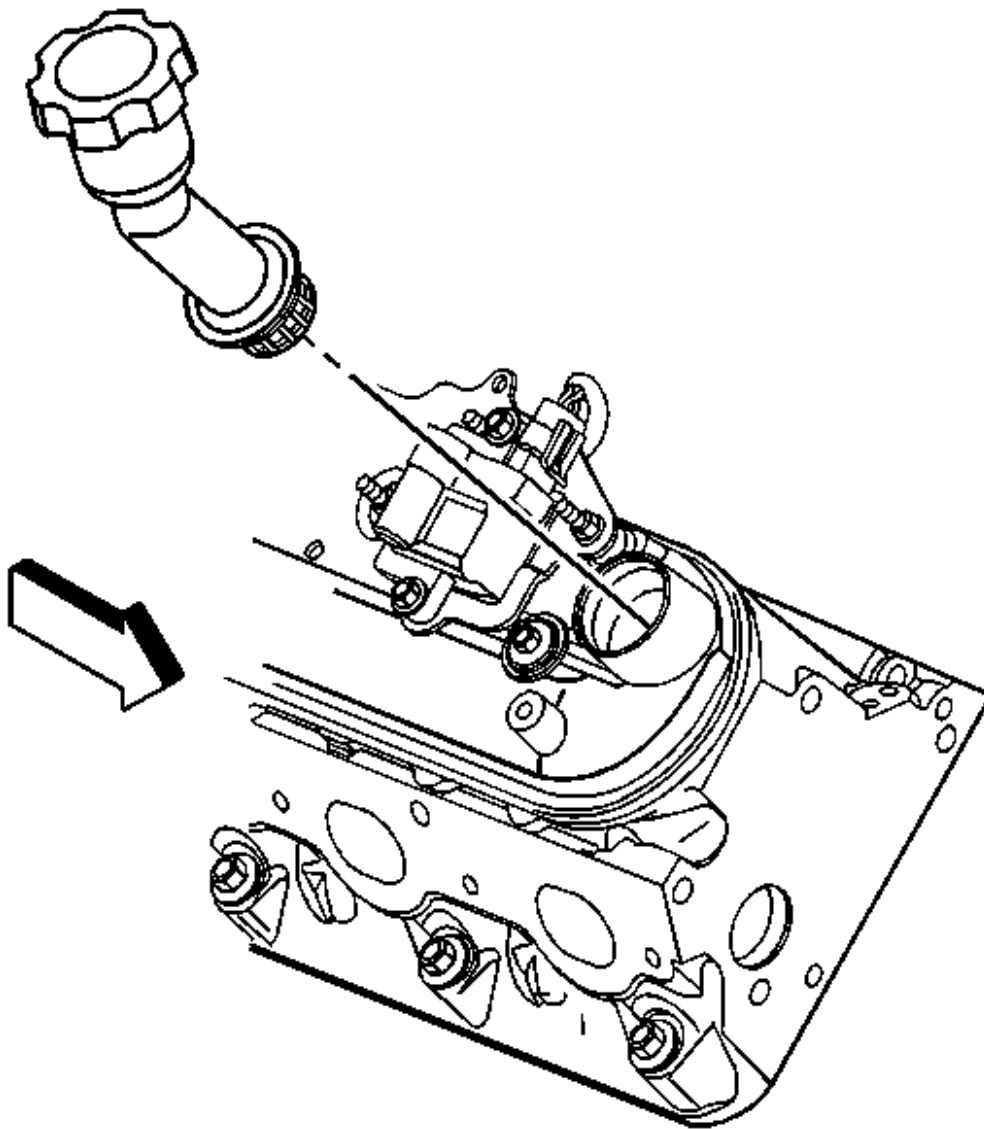


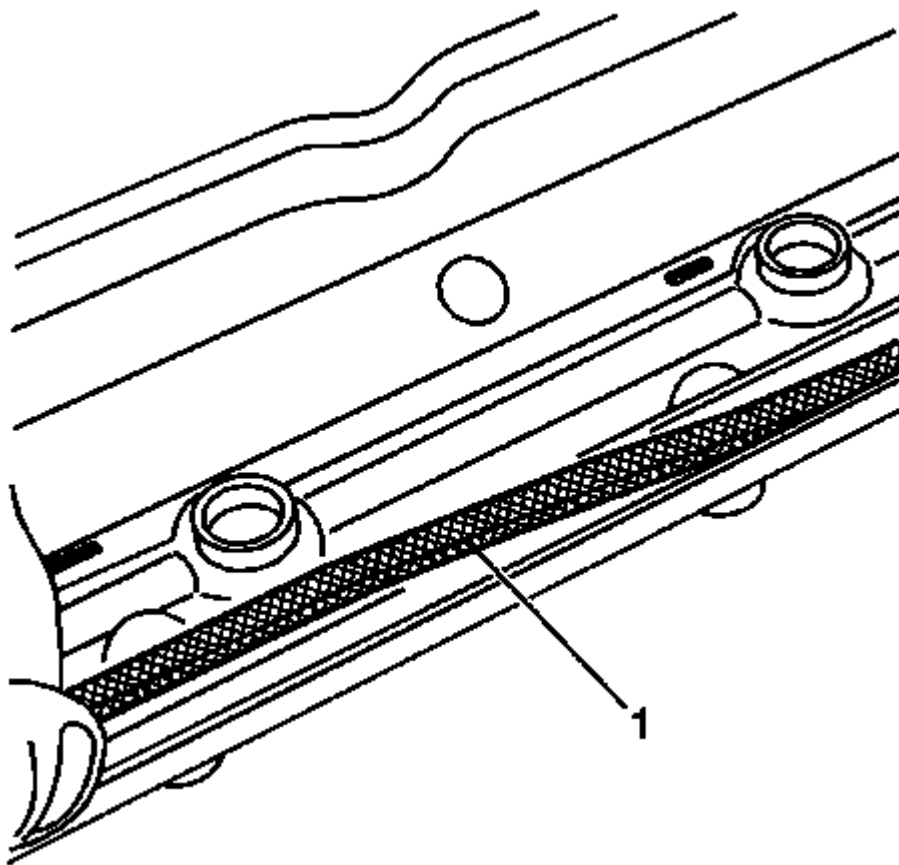
Fig. 93: View Of Oil Fill Tube**Courtesy of GENERAL MOTORS CORP.**

1. Lubricate the O-ring seal of the NEW oil fill tube with clean engine oil.
2. Insert the NEW oil fill tube into the rocker arm cover.

Rotate the tube clockwise until locked in the proper position.

3. Install the oil fill cap into the tube.

Rotate the cap clockwise until locked in the proper position.

**Fig. 94: Rocker Arm Cover Gasket****Courtesy of GENERAL MOTORS CORP.**

4. Install a NEW rocker cover gasket (1) into the valve rocker arm cover.

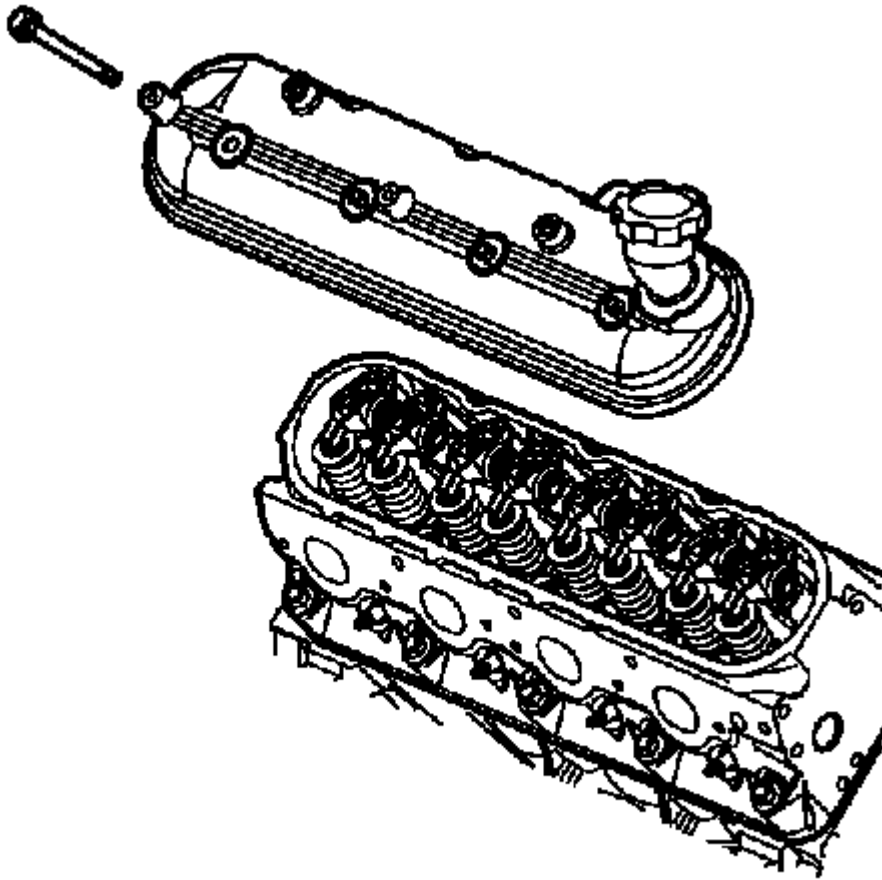


Fig. 95: View Of Valve Rocker Arm Cover & Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

5. Install the valve rocker arm cover onto the cylinder head.
6. Install new rocker arm cover grommets, if necessary.

NOTE: Refer to Fastener Notice in Cautions and Notices.

7. Install the rocker arm cover bolts and grommets.

Tighten: Tighten the valve rocker arm cover bolts to 12 N.m (106 lb in).

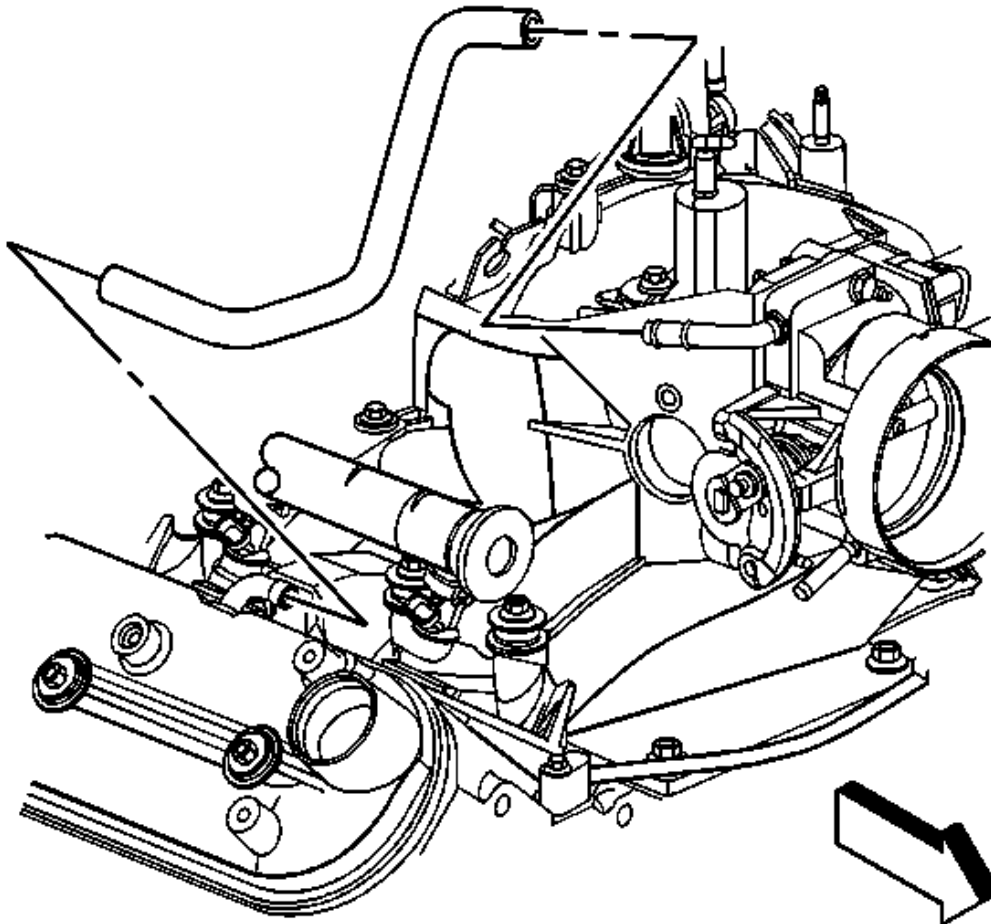


Fig. 96: Locating Breather Hose
Courtesy of GENERAL MOTORS CORP.

8. Install the vent hose to the throttle body and valve rocker arm cover.

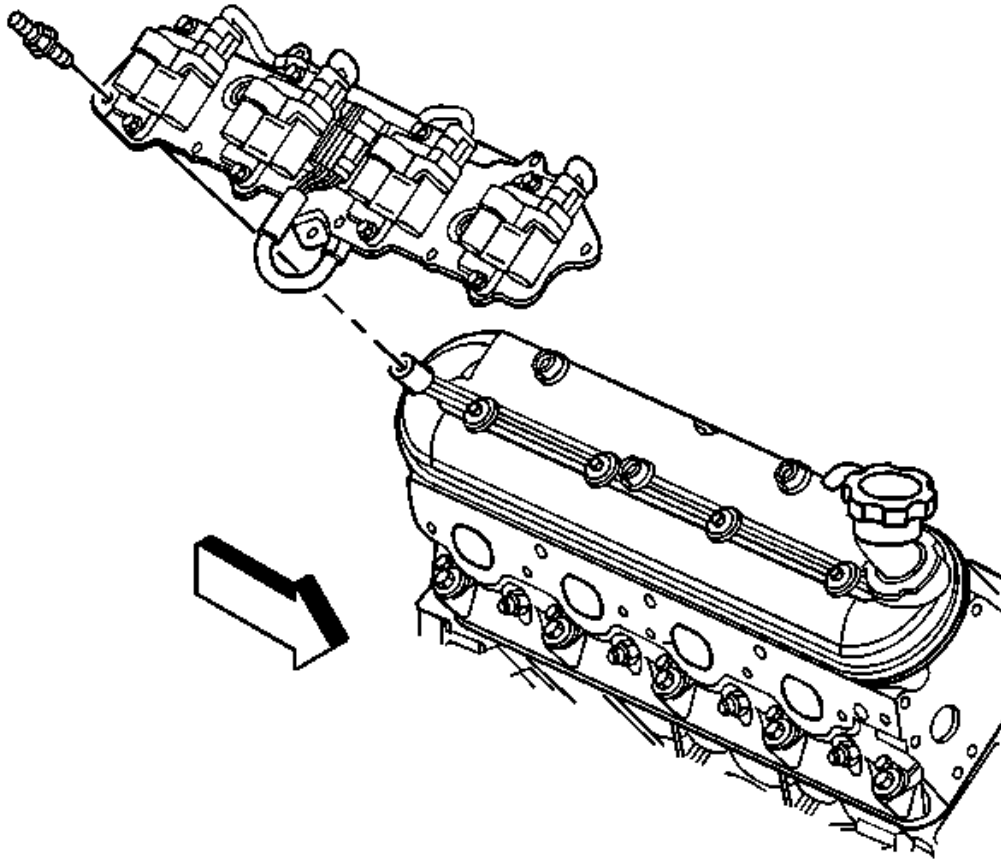


Fig. 97: Ignition Coil Bracket

Courtesy of GENERAL MOTORS CORP.

9. Apply threadlock GM U.S. P/N 12345382, Canada P/N 10953489, or equivalent to the threads of the bracket bolts.
10. Install the ignition coils and bracket to the rocker arm cover.
11. Install the ignition coil bracket studs to the rocker cover.

Tighten: Tighten the ignition coil bracket studs to 12 N.m (106 lb in).

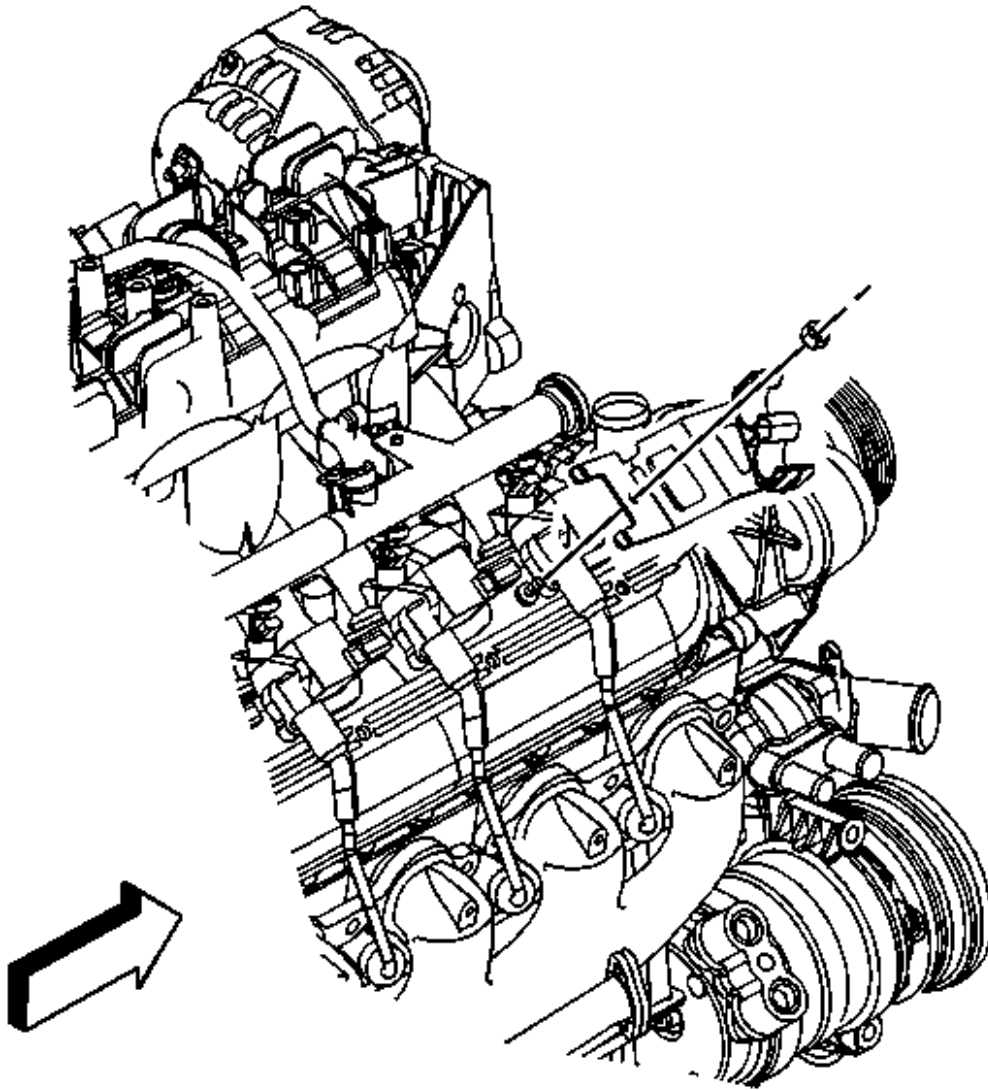


Fig. 98: Heater Hose Bracket Nut
Courtesy of GENERAL MOTORS CORP.

12. Install the heater hose bracket and nut.

Tighten: Tighten the heater hose bracket nut to 9 N.m (80 lb in).

13. Position the surge tank/heater hoses to the heater hose bracket.

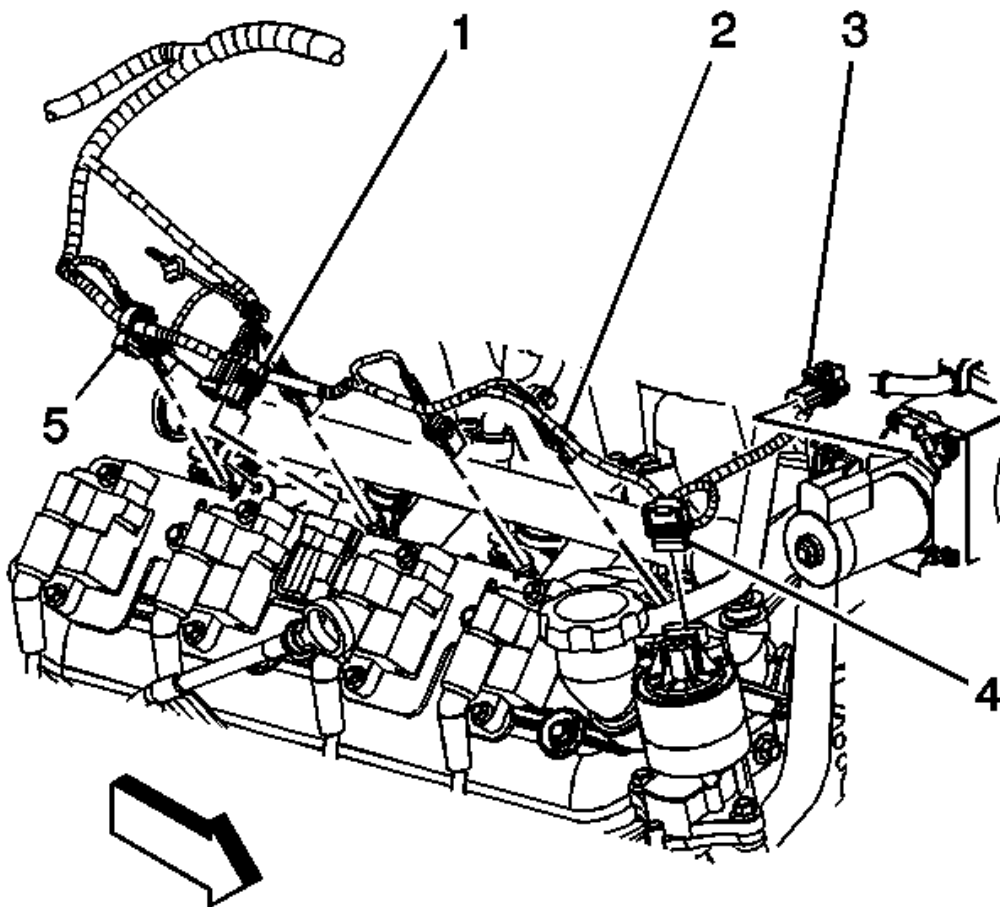


Fig. 99: Engine Harness

Courtesy of GENERAL MOTORS CORP.

14. Install the spark plug wires to the ignition coils.
15. Position the engine harness, if necessary.
16. Install the harness clips (2).
17. Connect the main electrical connector (1) feeding the ignition coils.
18. Install the CPA lock.
19. Install the engine sight shield, if required. Refer to **Engine Sight Shield Replacement (4.8L, 5.3L, and 6.0L Engines)** or **Engine Sight Shield Replacement (6.0L Engine w/ RPOs Y91 and Z88)**.

VALVE ROCKER ARM AND PUSH ROD REPLACEMENT

Removal Procedure

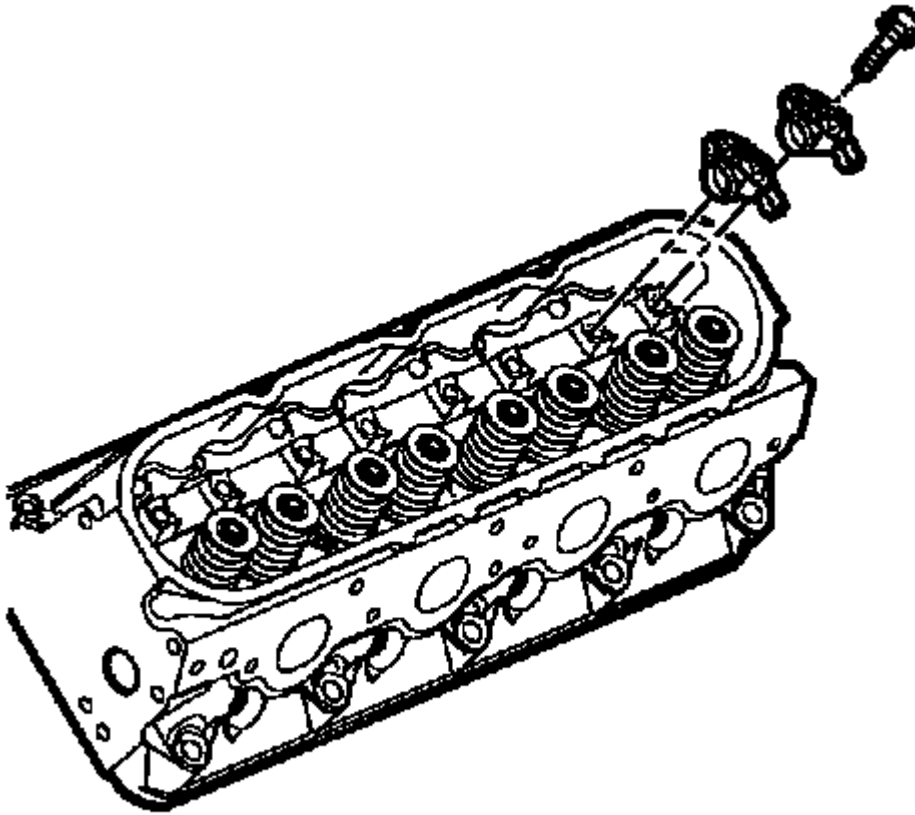


Fig. 100: View Of Rocker Arms & Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Place the valve rocker arms, pushrods, and pivot support, in a rack so that the can be installed in the same location from which they were removed.

1. Remove the valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Left or Valve Rocker Arm Cover Replacement - Right.
2. Remove the valve rocker arm bolts.
3. Remove the valve rocker arms.

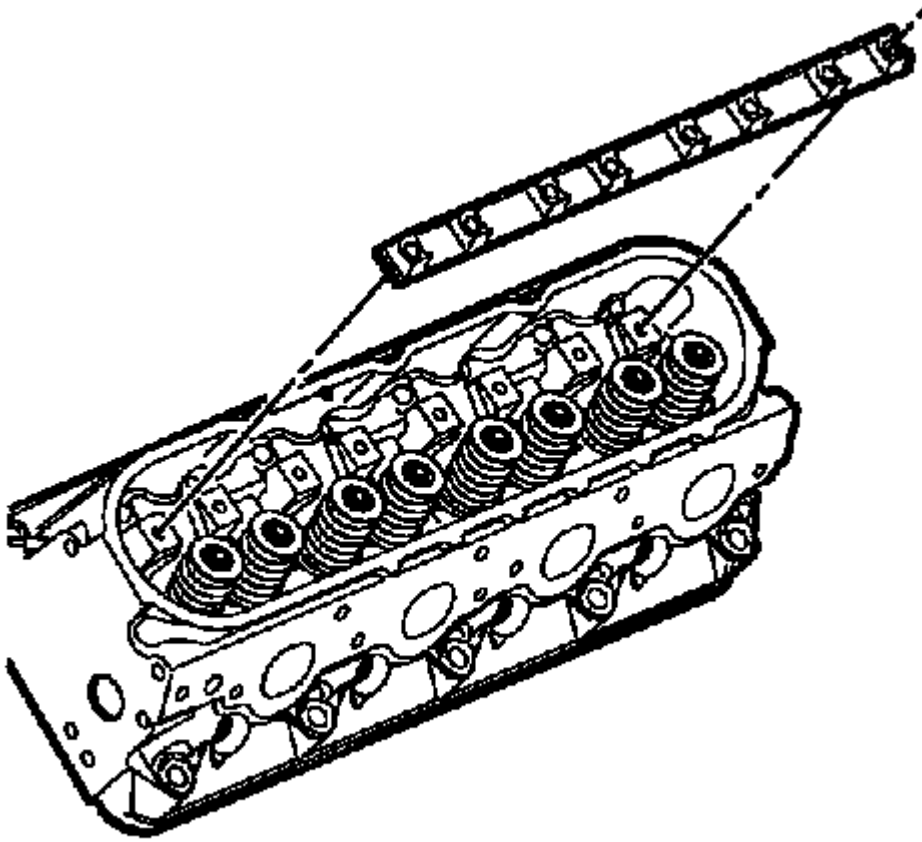


Fig. 101: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

4. Remove the valve rocker arm pivot support.

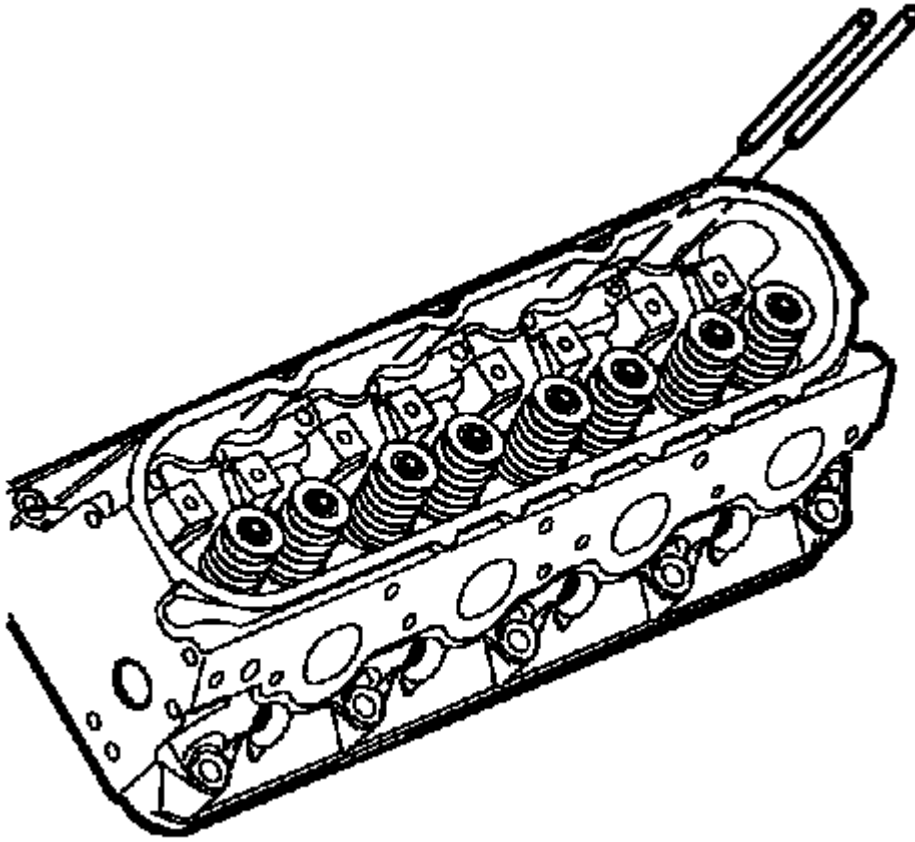


Fig. 102: View Of Pushrods

Courtesy of GENERAL MOTORS CORP.

5. Remove the pushrods.
6. Clean and inspect the valve rocker arms and pushrods. Refer to **VALVE ROCKER ARM & PUSH RODS CLEANING & INSPECTION** .

Installation Procedure

IMPORTANT: When reusing the valve train components, always install the components to the original location and position.

Valve lash is net build, no valve adjustment is required.

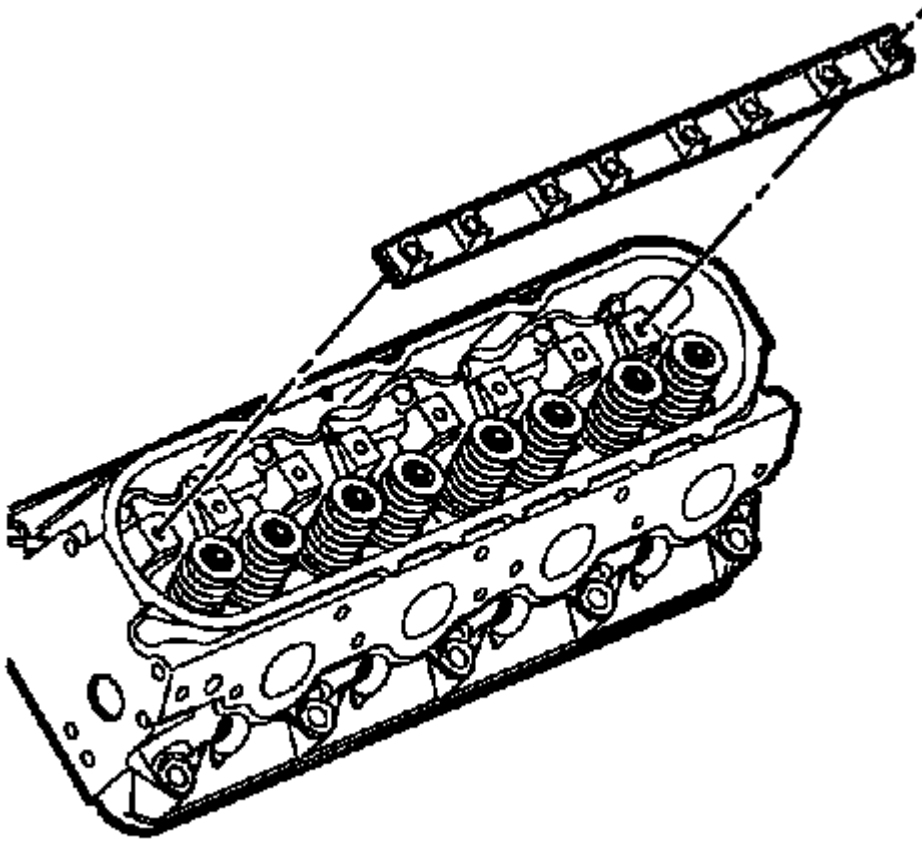


Fig. 103: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the valve rocker arms and pushrods with clean engine oil.
2. Lubricate the flange of the valve rocker arm bolts with clean engine oil.

Lubricate the flange or washer surface of the bolt that will contact the valve rocker arm.

3. Install the valve rocker arm pivot support.

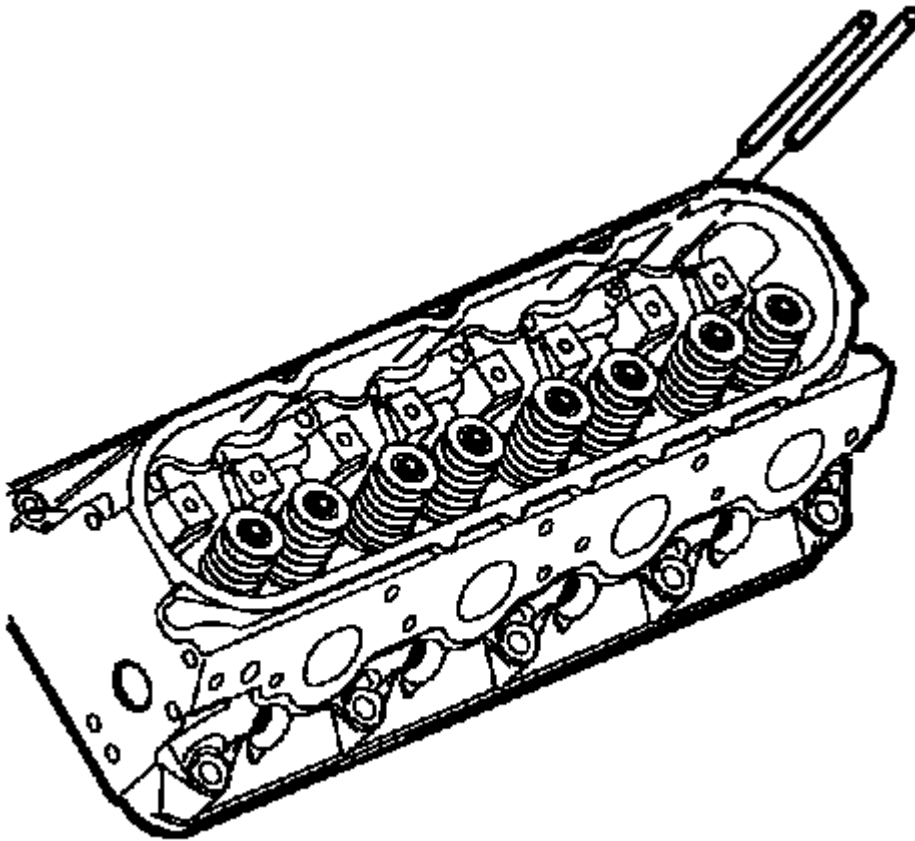


Fig. 104: View Of Pushrods
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure that the pushrods seat properly to the valve lifter sockets.

4. Install the pushrods.

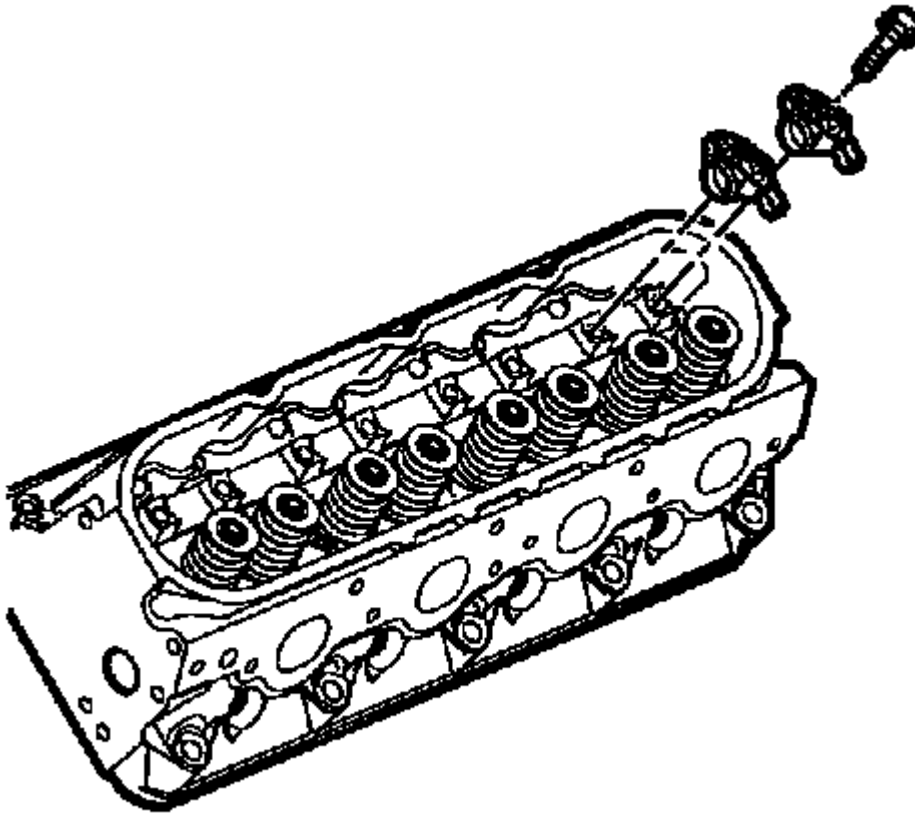


Fig. 105: View Of Rocker Arms & Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure that the pushrods seat properly to the ends of the rocker arms.
DO NOT tighten the rocker arm bolts at this time.

5. Install the rocker arms and bolts.

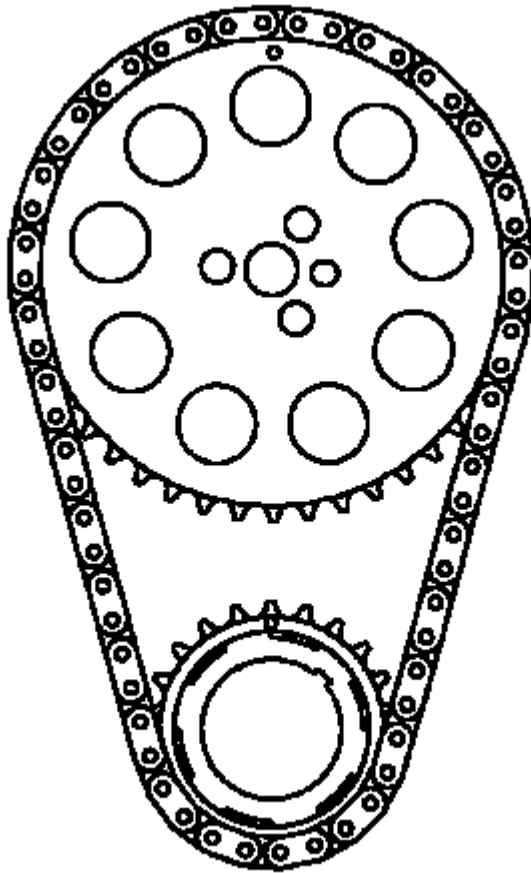


Fig. 106: View of Crankshaft/Camshaft In Position For Number 1 Piston At TDC
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

6. Rotate the crankshaft until the number one piston is at top dead center (TDC) of the compression stroke.

In this position, cylinder number one rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position.

The engine firing order is 1,8,7,2,6,5,4,3.

Cylinders 1,3,5 and 7 are the left bank.

Cylinder 2,4,6 and 8 are the right bank.

7. With the engine in the number one firing position, tighten the following valve rocker arm bolts:

Tighten:

- Tighten the cylinders 1,2,7 and 8 exhaust valve rocker arm bolts to 30 N.m (22 lb ft).

- Tighten the cylinders 1,3,4 and 5 intake valve rocker arm bolts to 30 N.m (22 lb ft).
8. Rotate the crankshaft 360 degrees.
 9. Tighten the following valve rocker arm bolts:
Tighten:
 - Tighten the cylinders 3, 4, 5 and 6 exhaust valve rocker arm bolts to 30 N.m (22 lb ft).
 - Tighten the cylinders 2, 6, 7 and 8 intake valve rocker arm bolts to 30 N.m (22 lb ft).
 10. Install the valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Left** or **Valve Rocker Arm Cover Replacement - Right**.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Tools Required

- **J 22794** Spark Plug Port Adapter. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 38606** Valve Spring Compressor. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 42078** Valve Stem Oil Seal Installer. See **SPECIAL TOOLS AND EQUIPMENT**.

Removal Procedure

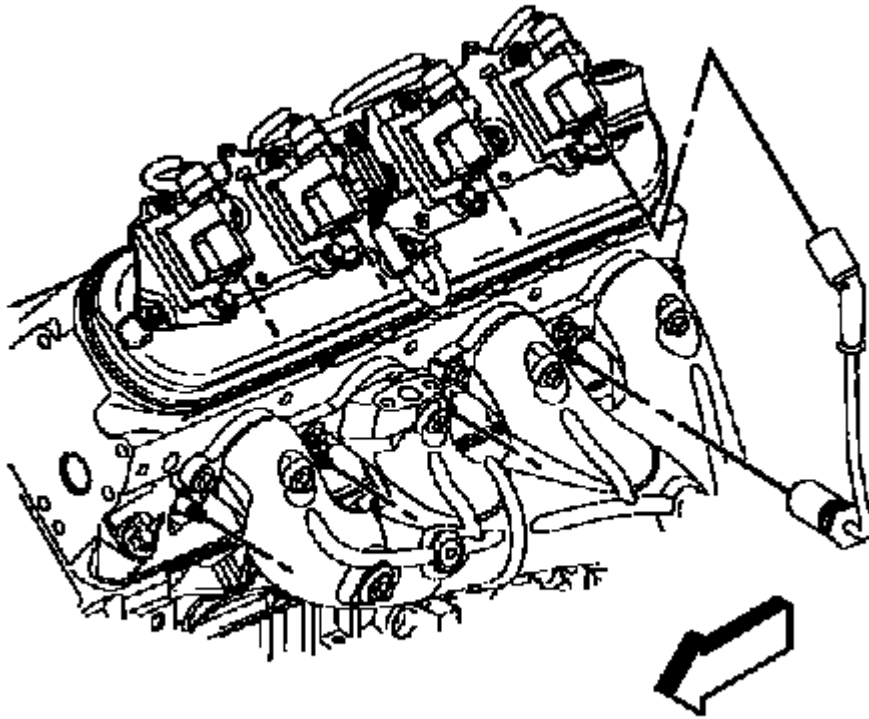


Fig. 107: View Of Spark Plug Wire & Boot
Courtesy of GENERAL MOTORS CORP.

1. Remove the valve rocker arm. Refer to **Valve Rocker Arm and Push Rod Replacement**.
2. Disconnect the spark plug wire at the spark plug.
 - Twist each plug wire boot 1/2 turn.
 - Pull only on the boot in order to remove the wire from the spark plug.

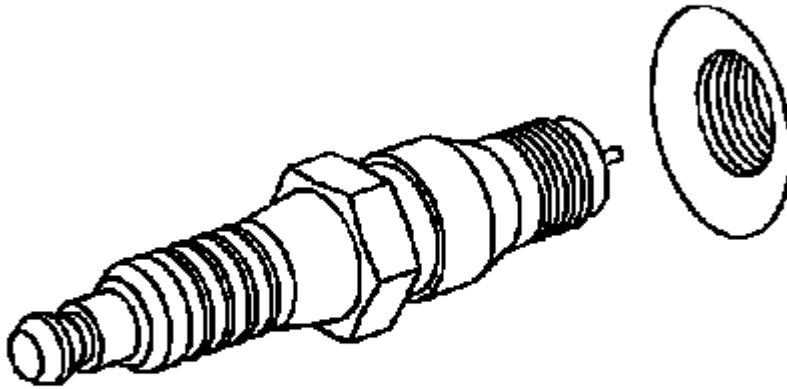


Fig. 108: View Of Spark Plug And Sparkplug Seat
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Remove the spark plugs from the cylinder head with the engine at room temperature.

3. Loosen the spark plug 1 or 2 turns.
4. Brush or air blast away any dirt or debris from around the spark plug.
5. Remove the spark plug.

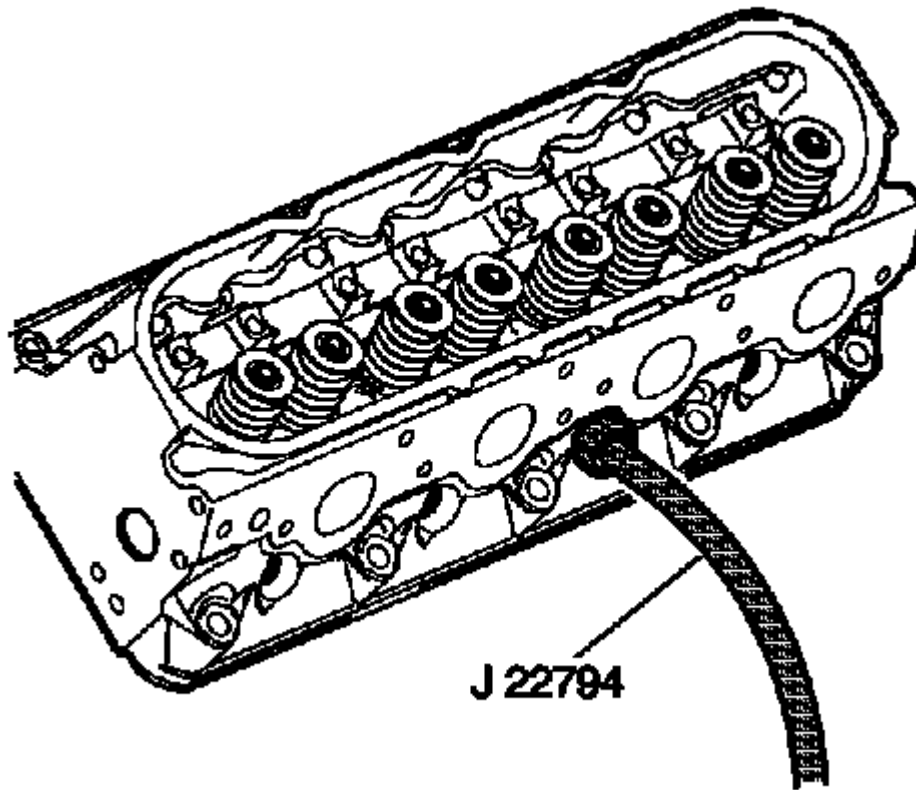


Fig. 109: Air Hose

Courtesy of GENERAL MOTORS CORP.

6. Install **J 22794** into the spark plug hole. See SPECIAL TOOLS AND EQUIPMENT.
7. Attach an air hose to **J 22794** . See SPECIAL TOOLS AND EQUIPMENT.
8. Apply compressed air to **J 22794** in order to hold the valves in place. See SPECIAL TOOLS AND EQUIPMENT.

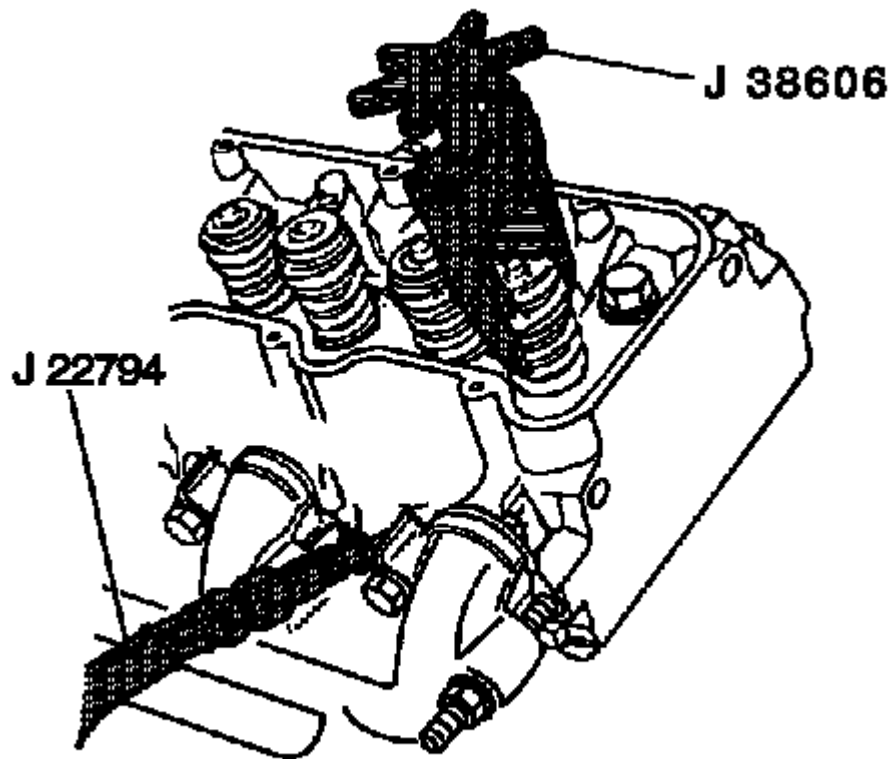


Fig. 110: Compress The Valve Spring (Cylinder Head Installed) Using Special Tools
Courtesy of GENERAL MOTORS CORP.

9. Use **J 38606** in order to compress the valve spring. See **SPECIAL TOOLS AND EQUIPMENT**.

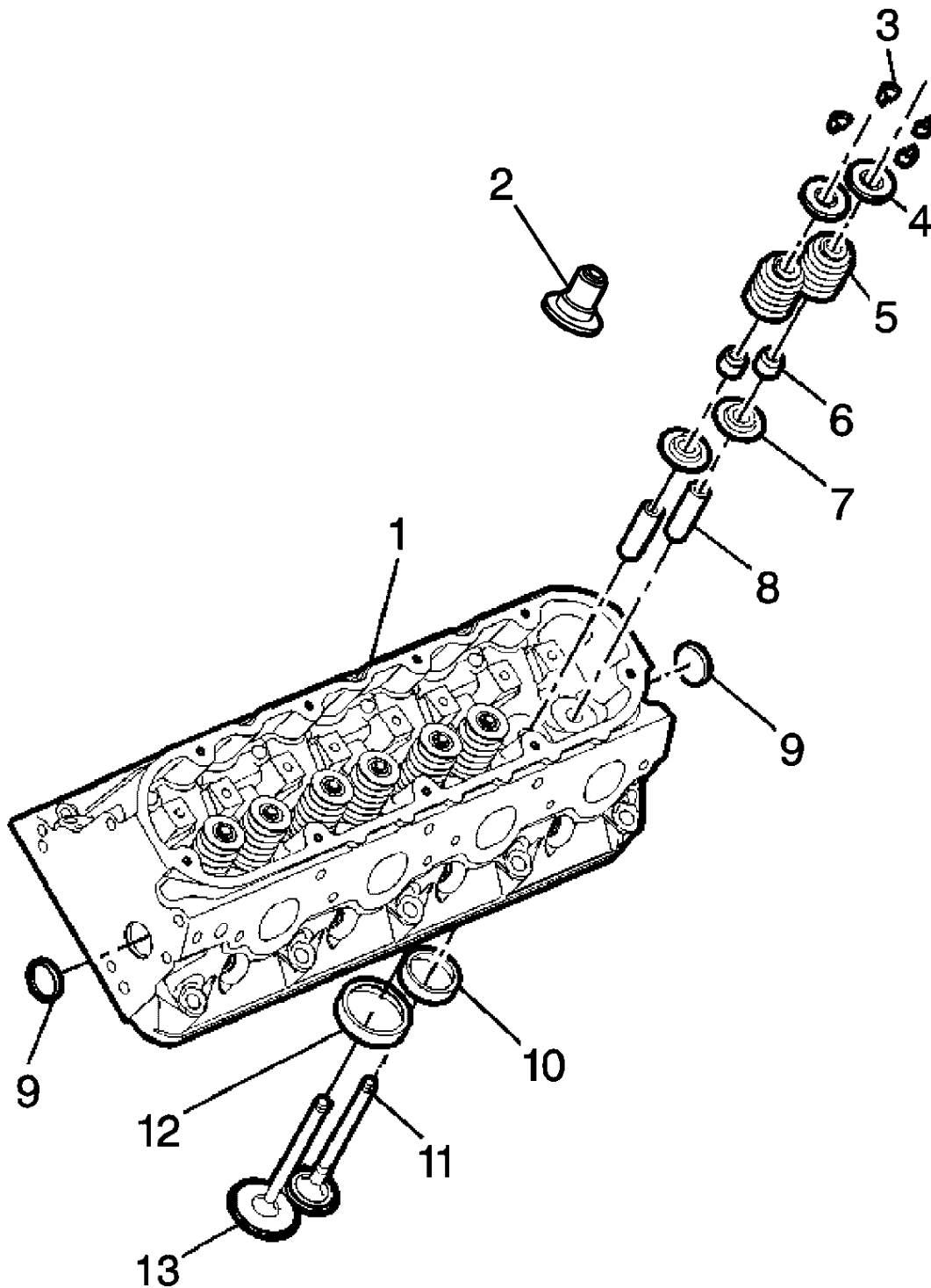


Fig. 111: Valve Stem Assembly
Courtesy of GENERAL MOTORS CORP.

10. Remove the valve stem keys (3).
11. Carefully release the valve spring tension.
12. Remove the **J 38606** . See **SPECIAL TOOLS AND EQUIPMENT**.
13. Remove the valve spring cap (4).
14. Remove the valve spring (5).

IMPORTANT: A second design valve stem oil seal and shim may be used on later engines.

A separate spring shim is not required with the second design seal and shim.

15. Remove the valve stem oil seal (6) (first design).
16. Remove the valve spring shim (7) (first design).
17. Remove the valve stem oil seal and shim (2) (second design)

Installation Procedure

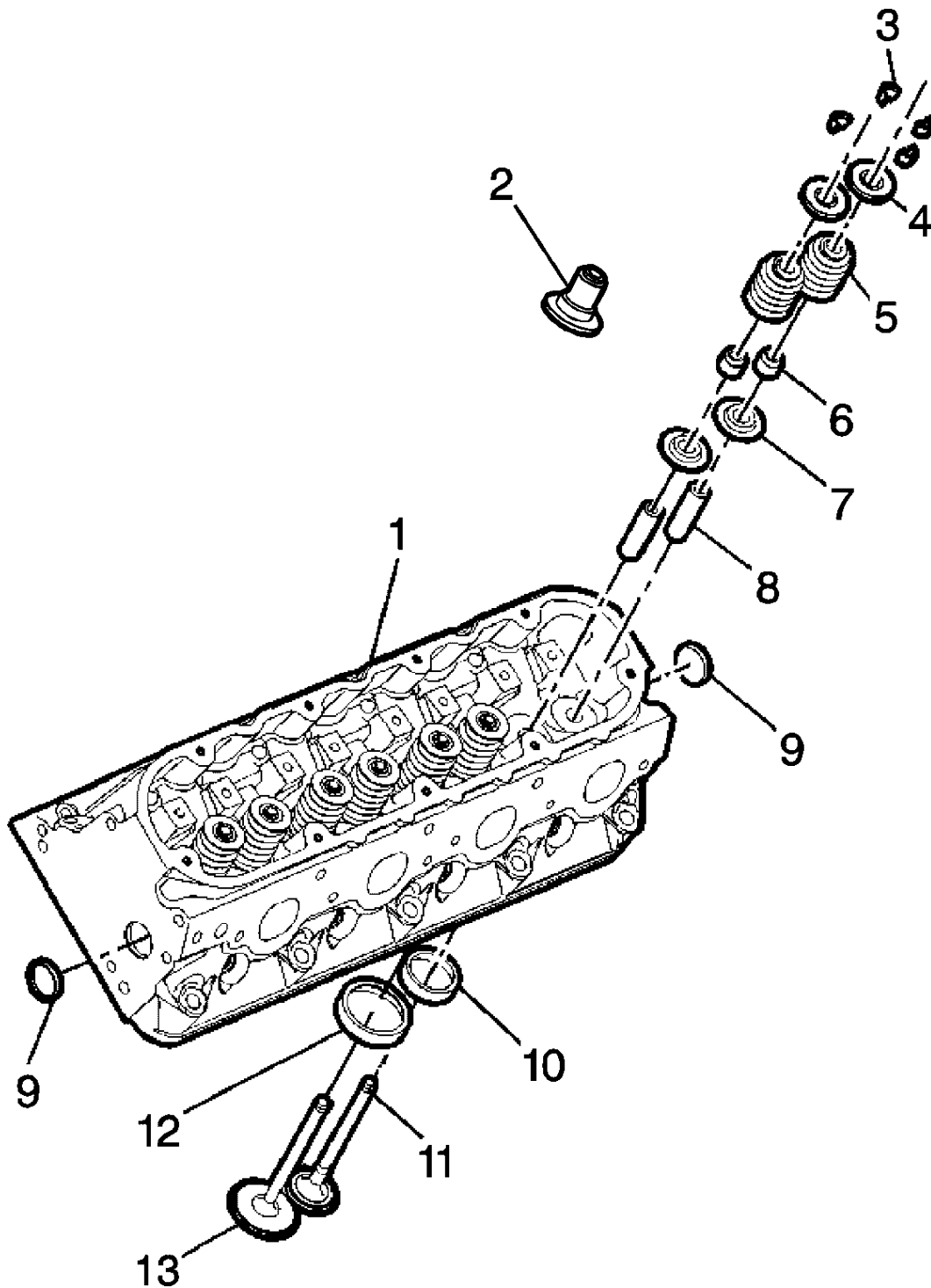


Fig. 112: Valve Stem Assembly
Courtesy of GENERAL MOTORS CORP.

2002 GMC Sierra 1500

2002 ENGINES 4.8L, 5.3L & 6.0L V8 - Sierra & Silverado

1. Clean the cylinder head valve spring seat and/or shim area.
2. Install the valve spring shim (7) (first design).
3. Install the valve stem oil seal and shim (2) (second design).

J 42078 is not required for installation of the second design seal and shim. See **SPECIAL TOOLS AND EQUIPMENT**.

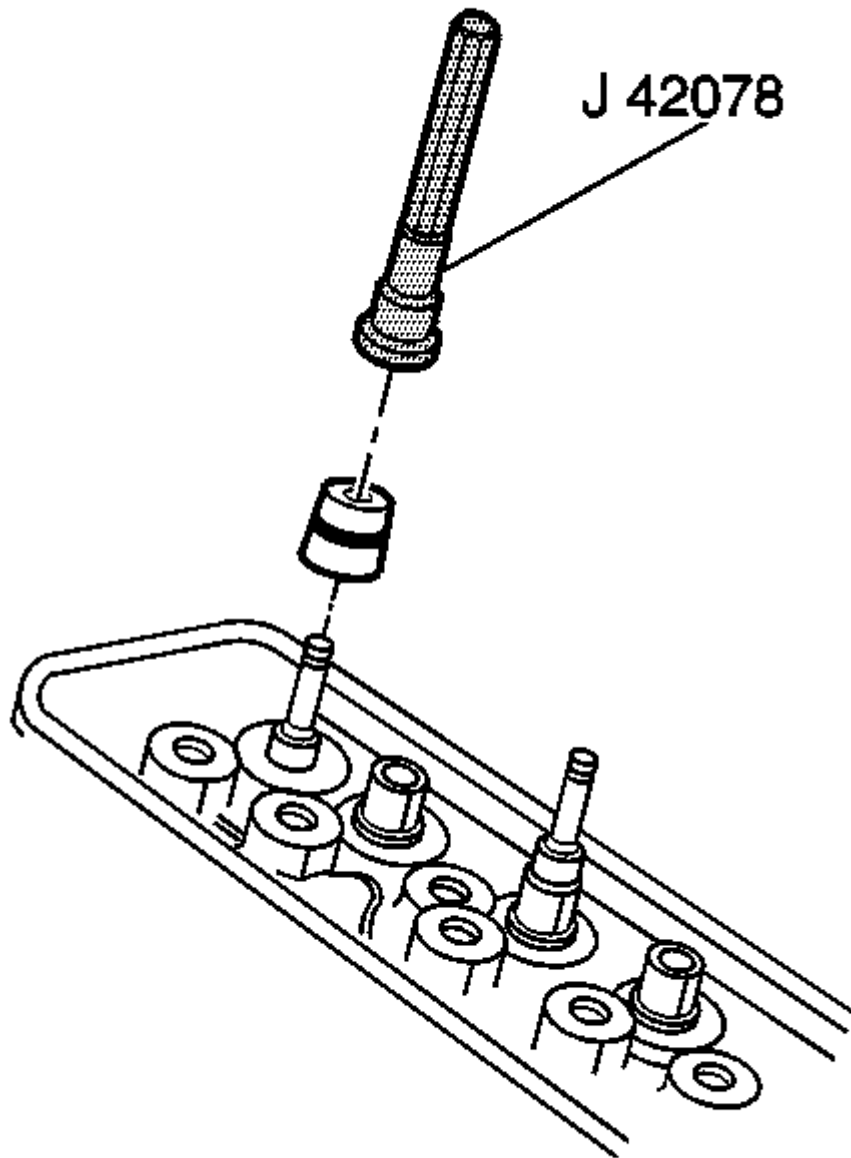


Fig. 113: Valve Stem Oil Seal

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The valve stem oil seal alignment and position on the valve guide is critical.

An improperly installed valve stem oil seal may lead to excessive oil consumption, increased vehicle emissions, or component damage.

4. Install the valve stem oil seal (first design) onto the guide.
 1. Lubricate the valve guide and valve stem oil seal with clean engine oil.
 2. Install the valve stem oil seal (first design) onto the valve stem. Push the seal down until the seal contacts the valve guide.
 3. Use the **J 42078** in order to install the valve stem oil seal. See **SPECIAL TOOLS AND EQUIPMENT**.

Push or lightly tap the tool until the tool bottoms against the valve spring shim.

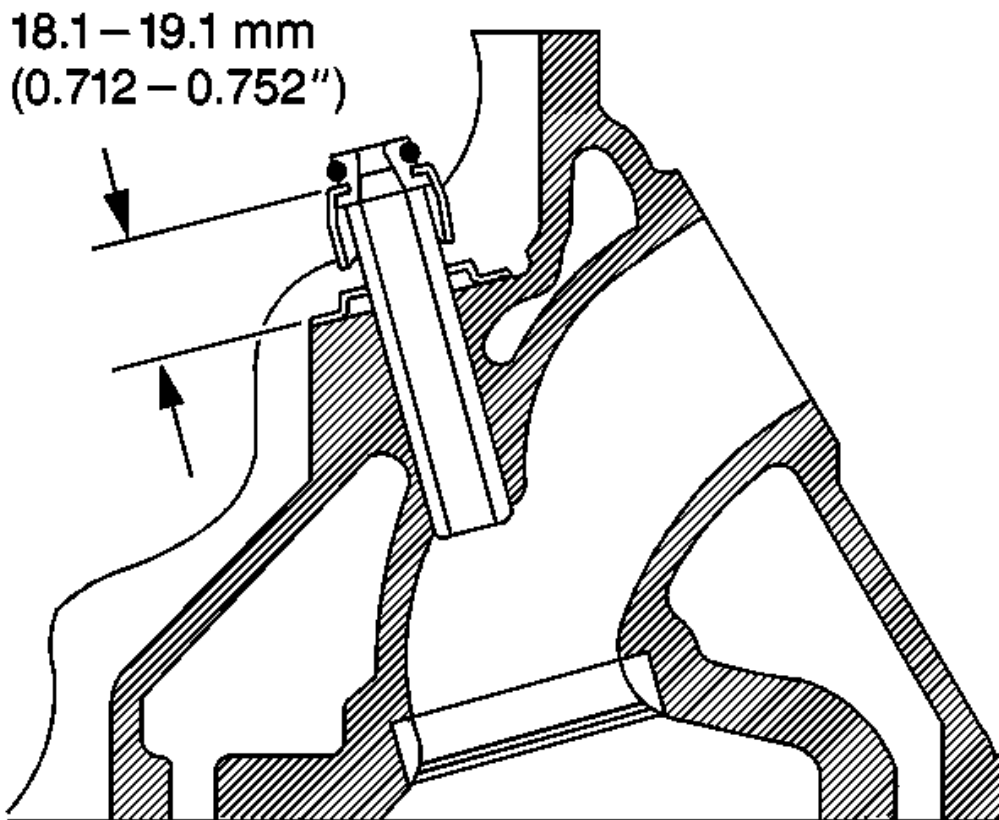


Fig. 114: Measure Valve Stem Oil Seals
Courtesy of GENERAL MOTORS CORP.

5. Measure the valve stem oil seals (first design) for the properly installed height.

There should be a 18.1-19.1 mm (0.712-0.752 in) gap between the top edge of the oil seal body and the valve spring shim surface.

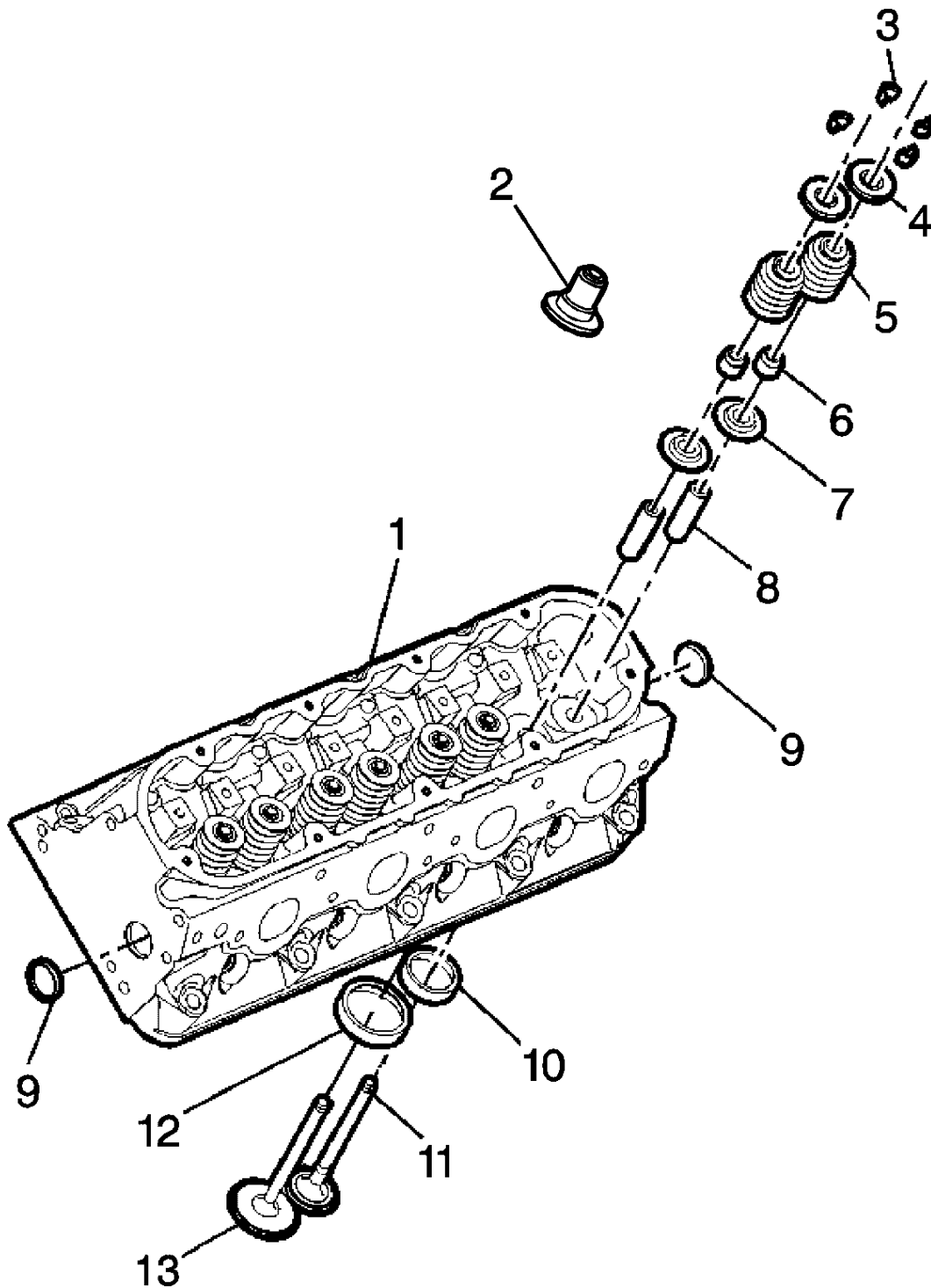


Fig. 115: Valve Stem Assembly
 Courtesy of GENERAL MOTORS CORP.

6. Install the valve spring (5).
7. Install the valve spring cap (4).

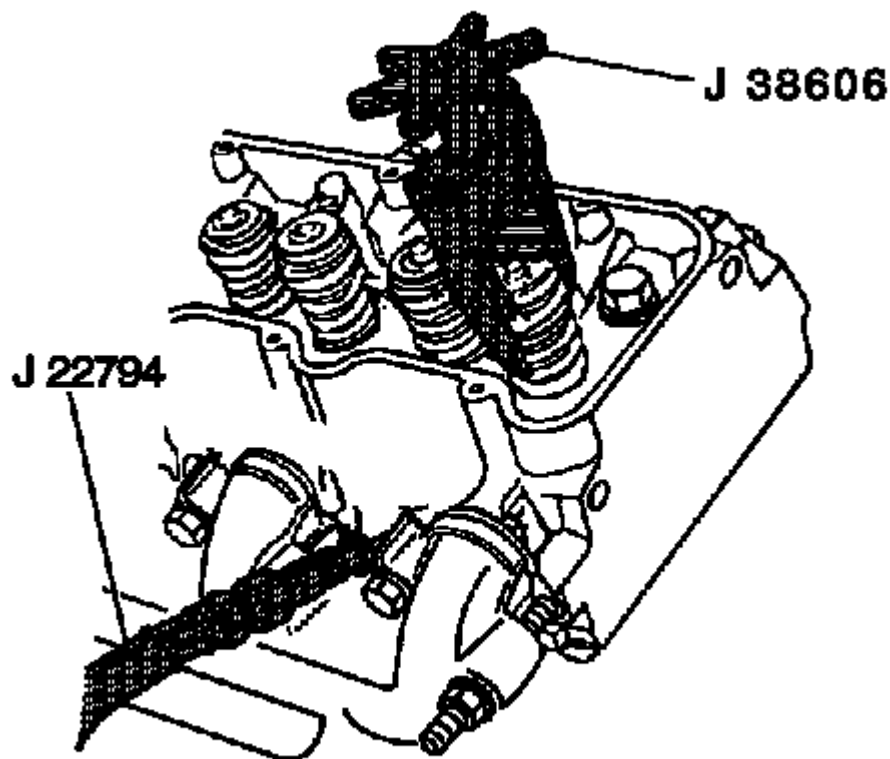


Fig. 116: Compress The Valve Spring (Cylinder Head Installed) Using Special Tools
Courtesy of GENERAL MOTORS CORP.

8. Compress the valve spring using the **J 38606** . See **SPECIAL TOOLS AND EQUIPMENT**.
9. Install the valve keys.
 - Use grease in order to hold the valve keys in place.
 - Make sure the keys seat properly in the groove of the valve stem.
 - Carefully release the valve spring pressure, making sure the valve keys stay in place.
 - Remove the **J 38606** . See **SPECIAL TOOLS AND EQUIPMENT**.
 - Tap the end of the valve stem with a plastic faced hammer to seat the keys (if necessary).

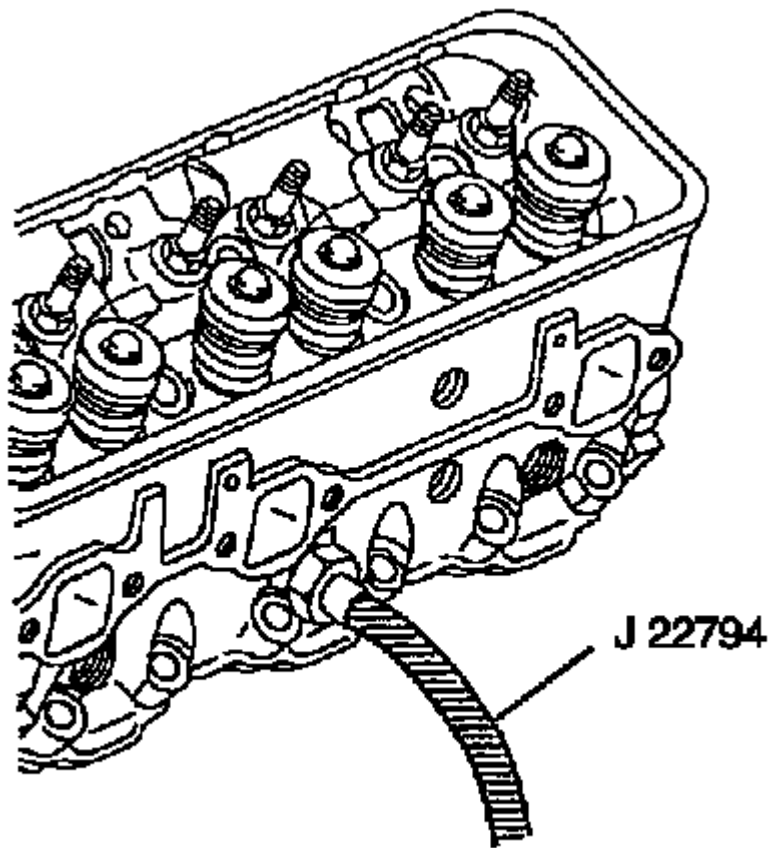


Fig. 117: J 22794 In Spark Plug Port
Courtesy of GENERAL MOTORS CORP.

10. Remove **J 22794** from the spark plug port. See **SPECIAL TOOLS AND EQUIPMENT**.

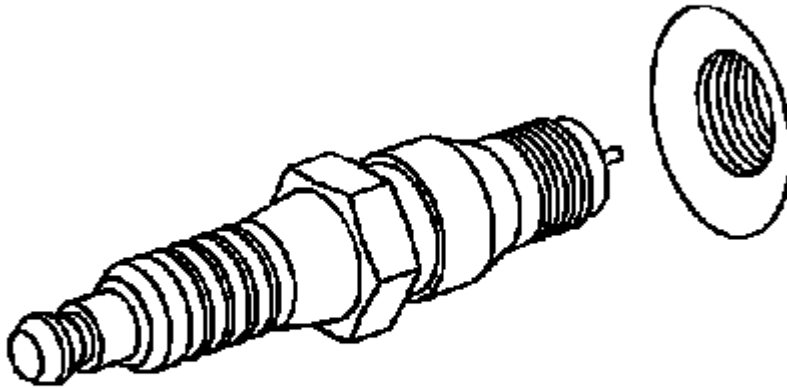


Fig. 118: View Of Spark Plug And Sparkplug Seat
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

11. Hand start the spark plug.

Tighten: Tighten the spark plug to 15 N.m (11 lb ft).

12. Install the spark plug wires at the ignition coil.
13. Install the spark plug wire to the spark plug.
14. Inspect the wires for proper installation:
 - Push sideways on each boot in order to check for proper installation.
 - Reinstall any loose boot.
15. Install the valve rocker arm. Refer to **Valve Rocker Arm and Push Rod Replacement**.

OIL LEVEL INDICATOR AND TUBE REPLACEMENT

Removal Procedure

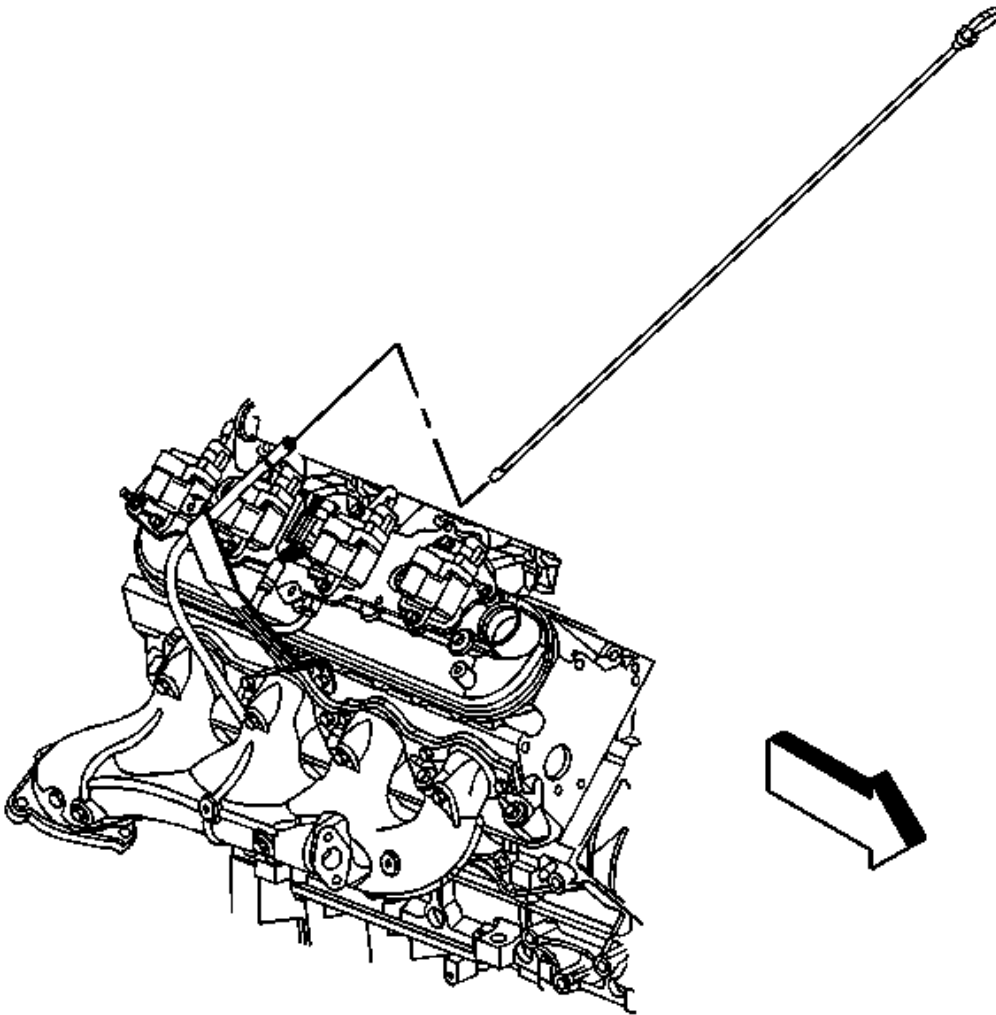


Fig. 119: Oil Level Indicator

Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator from the tube.

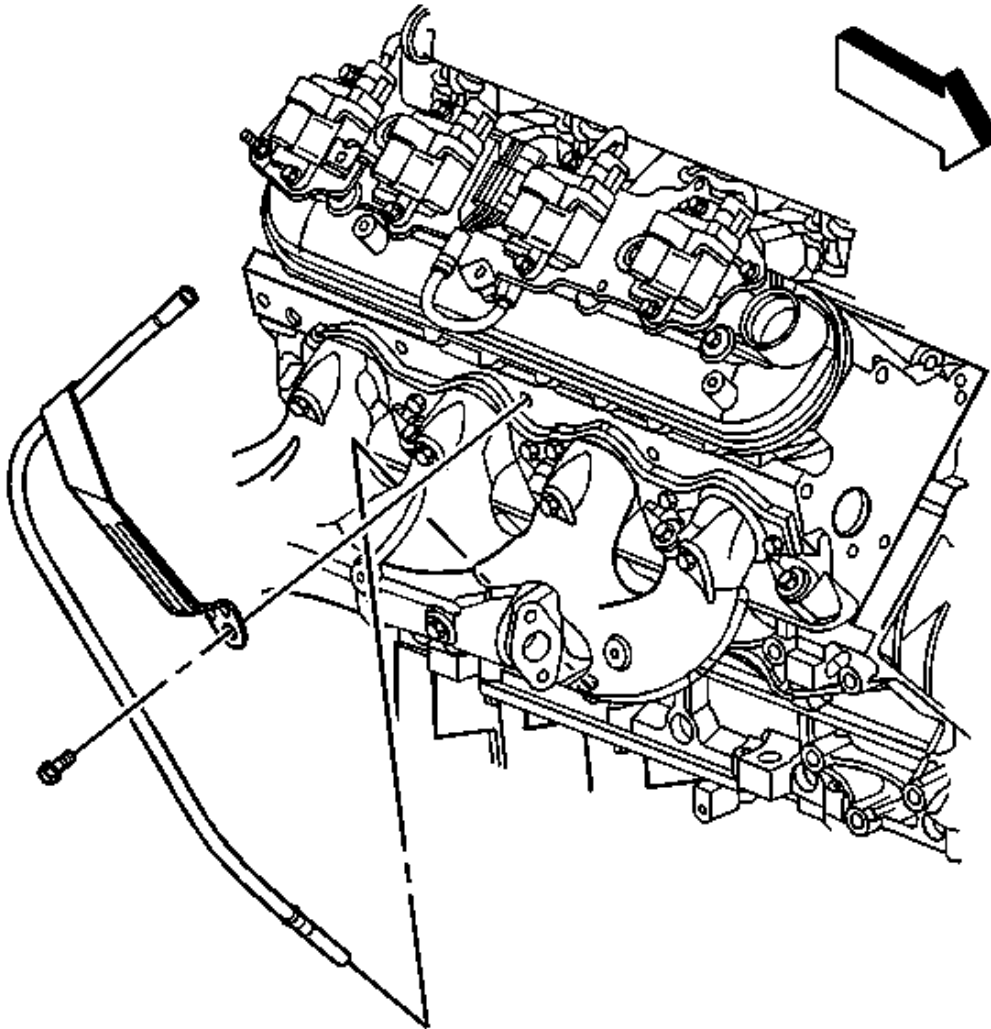


Fig. 120: Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil level indicator tube bolt.
3. Remove the oil level indicator tube from the engine block.

IMPORTANT: The O-ring seal may be reused if not cut or damaged.

4. Inspect the O-ring seal for cuts or damage.
5. Remove the O-ring seal from the tube (if required).

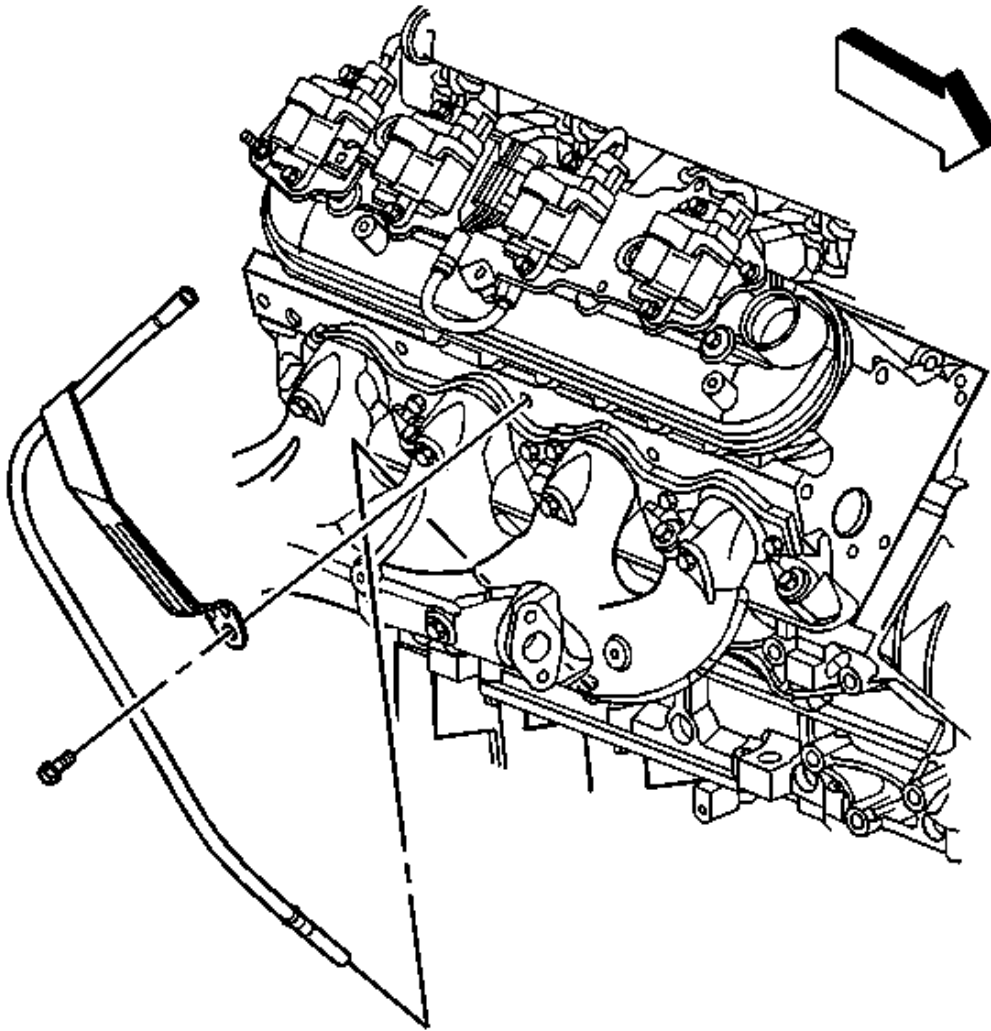
Installation Procedure

Fig. 121: Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the O-ring seal with clean engine oil.
2. Install the O-ring seal onto the oil level indicator tube.
3. Install the oil level indicator tube behind the exhaust manifold.
4. Raise and suitably support the vehicle. Refer to **LIFTING AND JACKING THE VEHICLE** in General Information.

5. Install the oil level indicator tube into the block. The tube must be installed with the collar flush to the block.
6. Lower the vehicle.

NOTE: Refer to Fastener Notice in Cautions and Notices.

7. Install the oil level indicator tube bolt

Tighten: Tighten the oil level indicator tube bolt to 25 N.m (18 lb ft).

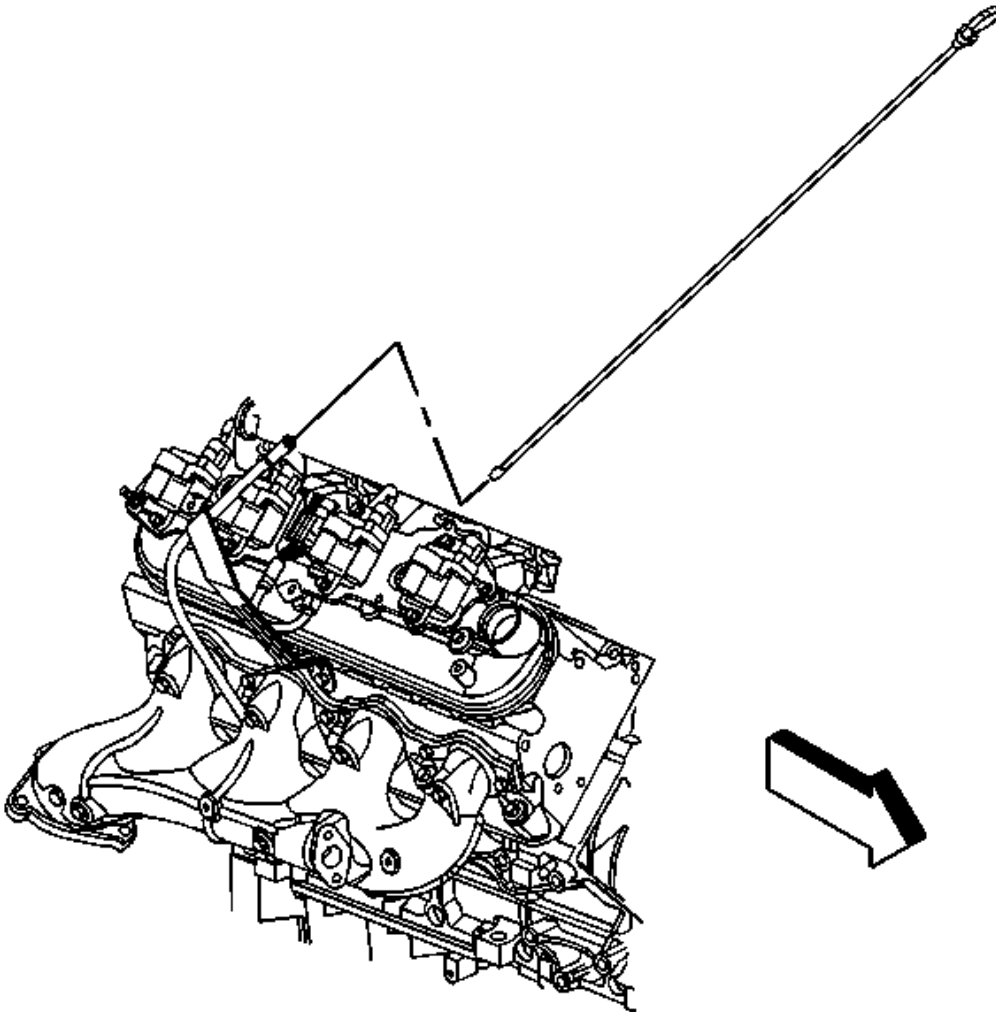


Fig. 122: Oil Level Indicator

Courtesy of GENERAL MOTORS CORP.

8. Install the oil level indicator to the tube.

CYLINDER HEAD REPLACEMENT - LEFT

Tools Required

- **J 36660-A** Torque Angle Meter. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 42385-200** Thread Repair Kit. See **SPECIAL TOOLS AND EQUIPMENT**.

Removal Procedure

1. Remove the generator bracket. Refer to **GENERATOR (4.8L, 5.3L & 6.0L ENGINES)** .
2. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
3. Remove the coolant air bleed pipe. Refer to **COOLANT AIR BLEED HOSE REPLACEMENT (4.8L, 5.3L, AND 6.0L ENGINES)** .
4. Remove the left exhaust manifold. Refer to **EXHAUST MANIFOLD REPLACEMENT -- LEFT (4.8L, 5.3L, AND 6.0L ENGINES)** .
5. Remove the pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.

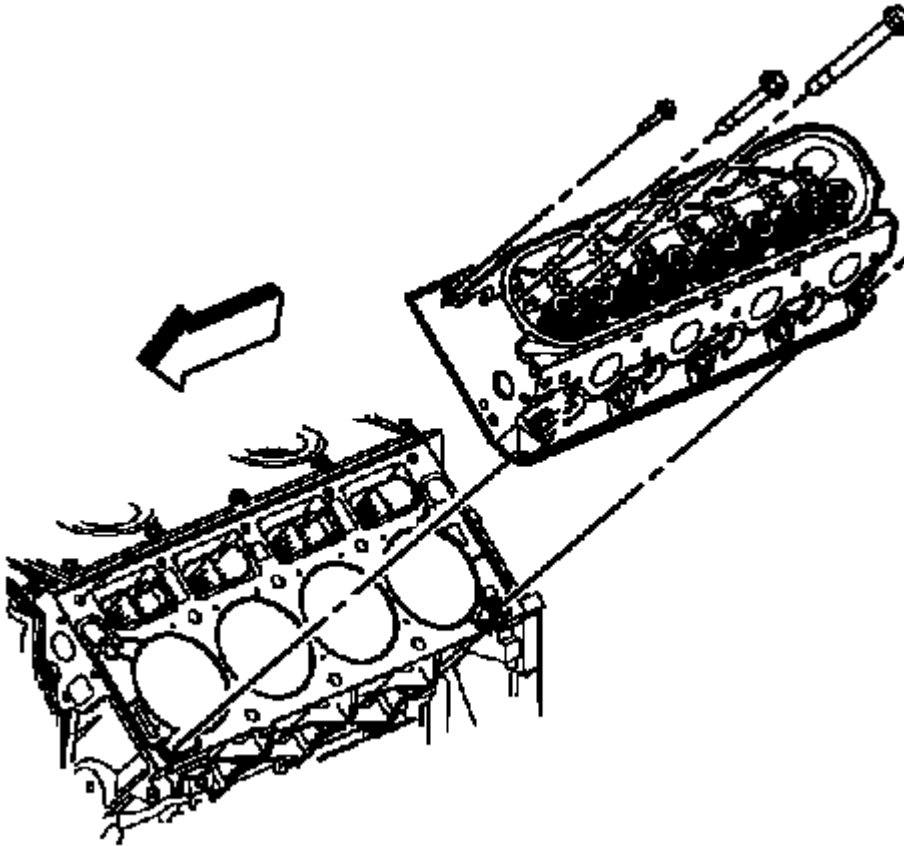


Fig. 123: View Of Cylinder Head & Bolts (Left)
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The cylinder head bolts are NOT reusable.

NOTE: After removal, place the cylinder head on two wood blocks to prevent damage to the sealing surfaces.

6. Remove the cylinder head bolts.
7. Remove the cylinder head.

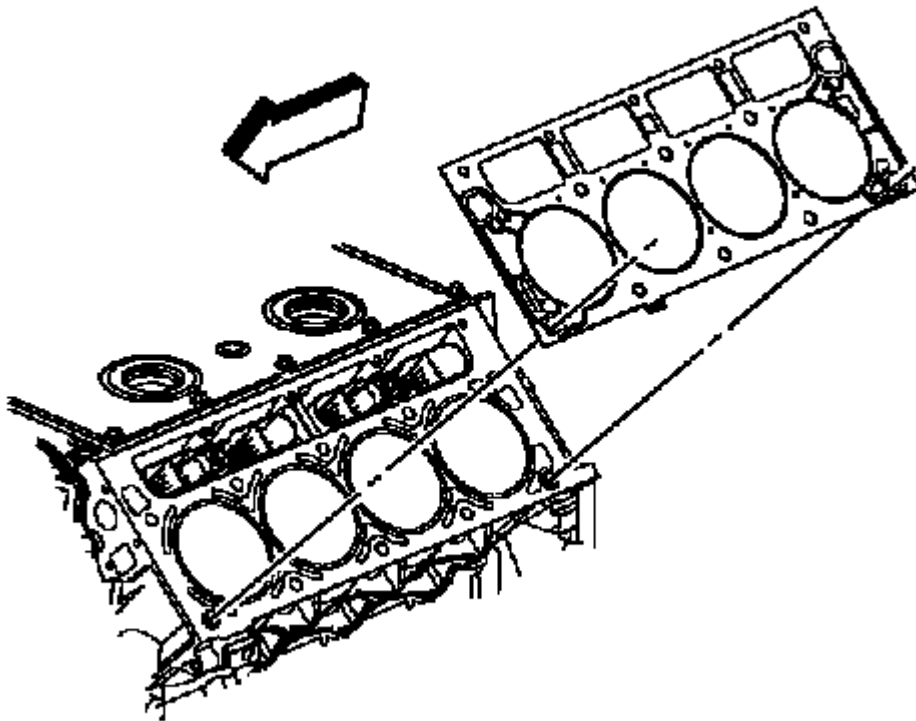


Fig. 124: View Of Left Cylinder Head Gasket & Locator Pins
Courtesy of GENERAL MOTORS CORP.

8. Remove the cylinder head gasket.
9. Discard the gasket.
10. Discard the cylinder head bolts.
11. Clean and inspect the cylinder head. Refer to **CYLINDER HEAD CLEANING & INSPECTION** in Engine Mechanical - 4.8L, 5.3L, and 6.0L Unit Repair.

Installation Procedure

CAUTION: Wear safety glasses in order to avoid eye damage.

NOTE: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

IMPORTANT:

- Do not reuse the cylinder head bolts. Install NEW cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket (unless specified).
- The cylinder head gaskets must be installed in the proper direction and position.

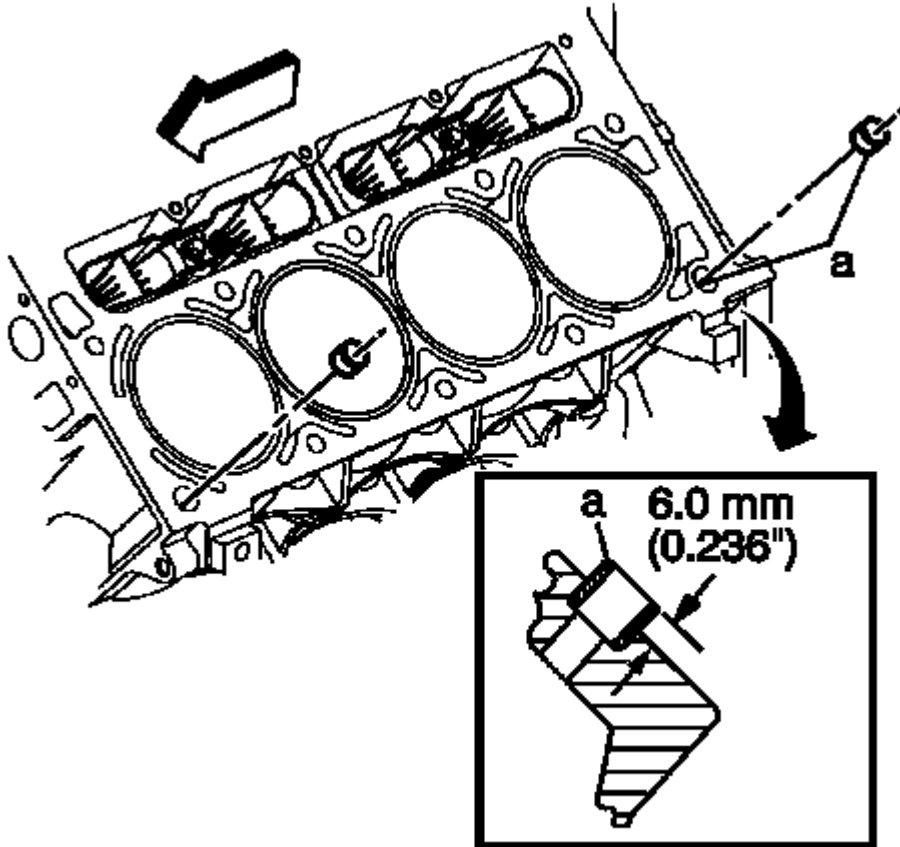


Fig. 125: Identifying Cylinder Head Locating Pins Installation Position
Courtesy of GENERAL MOTORS CORP.

1. Clean the engine block cylinder head bolt holes (if required).

Thread repair tool J 42385-107, found in **J 42385-200** may be used to clean the threads of old threadlocking material. See **SPECIAL TOOLS AND EQUIPMENT**.

2. Use spray cleaner GM U.S. P/N 12346139, P/N 12377981, Canada P/N 10953463, or equivalent into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Check the cylinder head locating pins for proper installation.

IMPORTANT: When properly installed, the tab on the left cylinder head gasket will be located left of center or closer to the front of the engine.

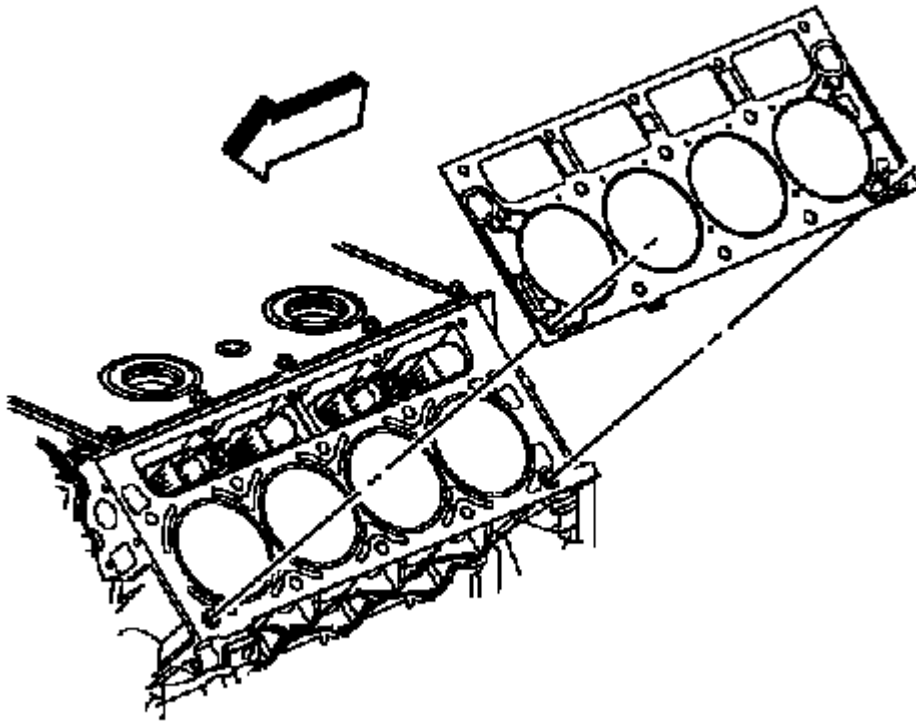


Fig. 126: View Of Left Cylinder Head Gasket & Locator Pins
Courtesy of GENERAL MOTORS CORP.

5. Install the NEW left cylinder head gasket onto the locating pins.

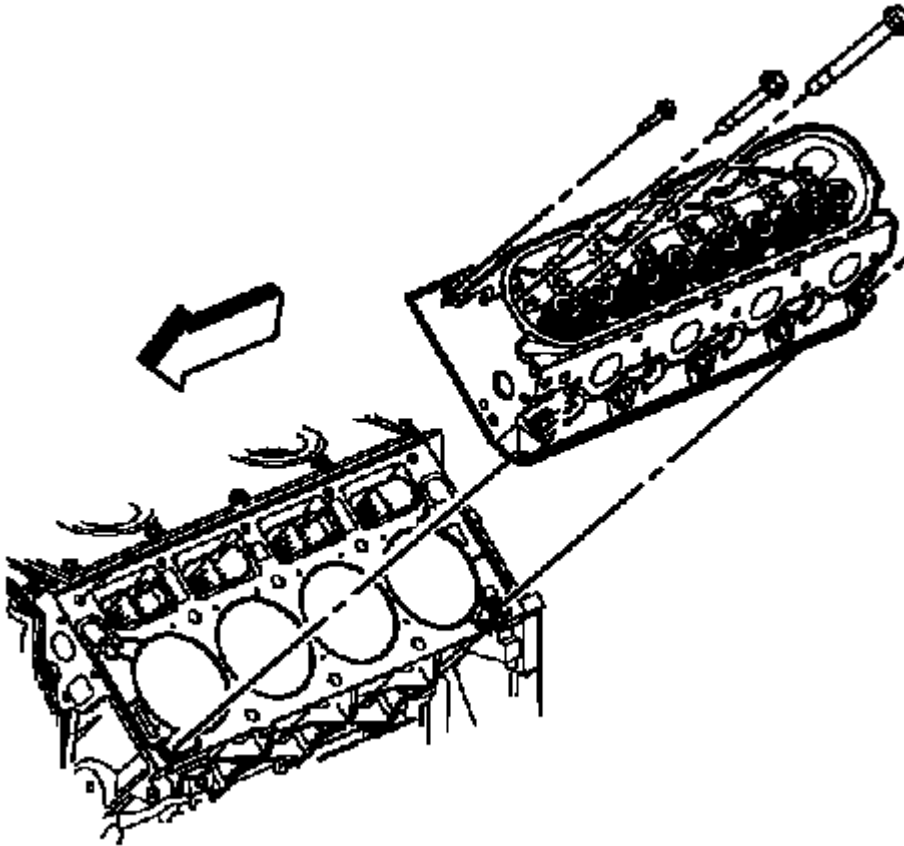


Fig. 127: View Of Cylinder Head & Bolts (Left)
Courtesy of GENERAL MOTORS CORP.

6. Install the cylinder head onto the locating pins and gasket.
7. Install the NEW cylinder head bolts.

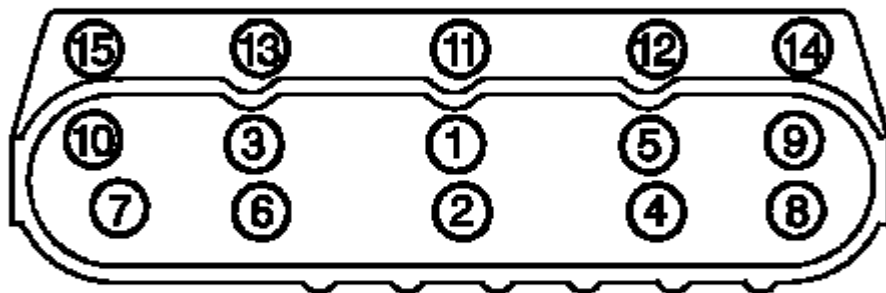


Fig. 128: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

8. Tighten the cylinder head bolts.

Tighten:

1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).
2. Tighten the M11 cylinder head bolts a second pass in sequence to 90 degrees using **J 36660-A** . See **SPECIAL TOOLS AND EQUIPMENT**.
3. Tighten the M11 cylinder head bolts (1,2,3,4,5,6,7,8) to 90 degrees and the M11 cylinder head bolts (9 and 10) to 50 degrees a final pass in sequence using **J 36660-A** . See **SPECIAL TOOLS AND EQUIPMENT**.
4. Tighten the M8 cylinder head bolts (11,12,13,14,15) to 30 N.m (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

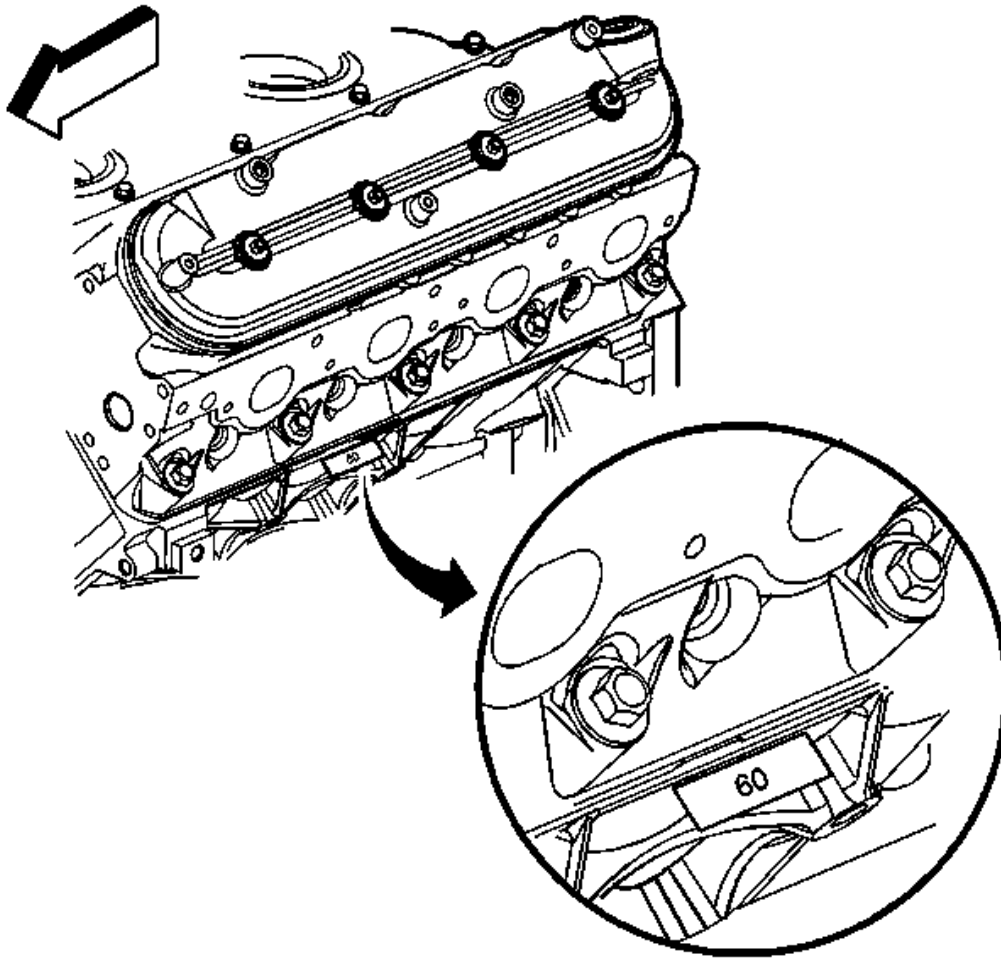


Fig. 129: Head Gasket Stamp

Courtesy of GENERAL MOTORS CORP.

9. The cylinder head gasket displacement can be verified by markings visible on the top side of the left gasket locating tab.
 - Some 4.8/5.3 L head gaskets may have 53 stamped onto the locating tab.
 - Some 6.0 L head gaskets may have 60 stamped onto the locating tab.
10. Install the pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
11. Install the left exhaust manifold. Refer to **EXHAUST MANIFOLD REPLACEMENT – LEFT (4.8L, 5.3L, AND 6.0L ENGINES)**.
12. Install the coolant air bleed pipe. Refer to **COOLANT AIR BLEED PIPE ASSEMBLY REPLACEMENT (4.8L, 5.3L, AND 6.0L ENGINES)**.

13. Install the intake manifold. Refer to **Intake Manifold Replacement**.
14. Install the generator bracket. Refer to **GENERATOR (4.8L, 5.3L & 6.0L ENGINES)** .

CYLINDER HEAD REPLACEMENT - RIGHT

Tools Required

- **J 36660-A** Torque Angle Meter. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 42385-200** Thread Repair Kit. See **SPECIAL TOOLS AND EQUIPMENT**.

Removal Procedure

1. Remove the oil level indicator. Refer to **Oil Level Indicator and Tube Replacement**.
2. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
3. Remove the coolant air bleed pipe. Refer to **COOLANT AIR BLEED PIPE ASSEMBLY REPLACEMENT (4.8L, 5.3L, AND 6.0L ENGINES)** .
4. Remove the right exhaust manifold. Refer to **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (4.8L, 5.3L & 6.0L Engine)** .
5. Remove the pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.

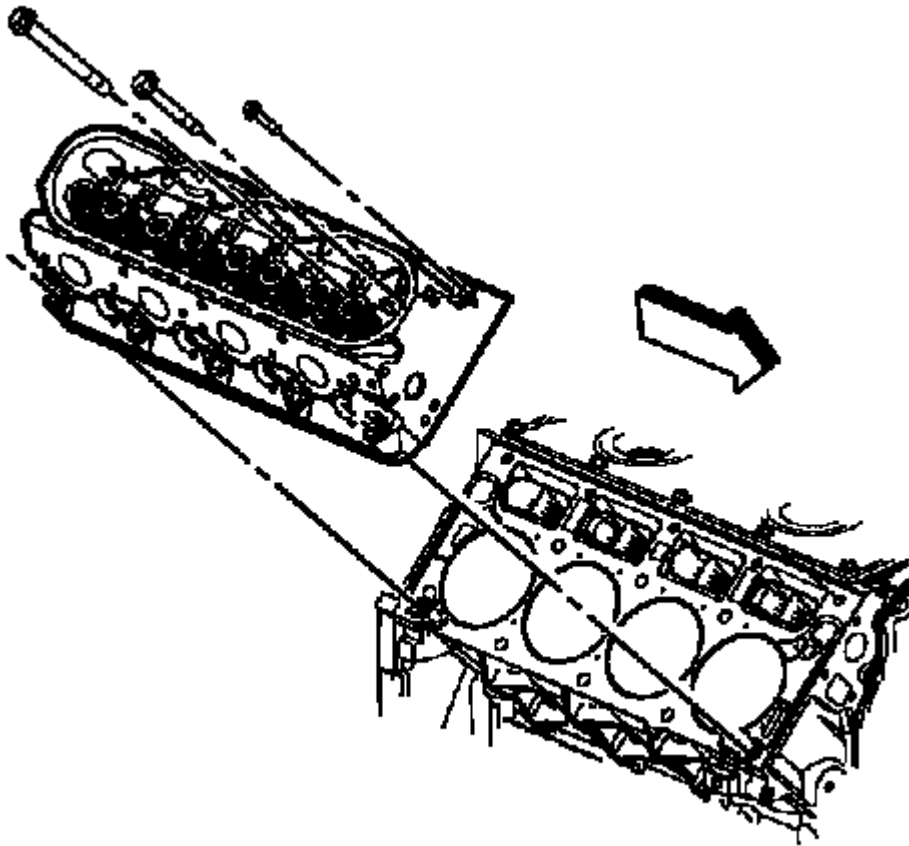


Fig. 130: View Of Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The cylinder head bolts are NOT reusable.

NOTE: After removal, place the cylinder head on two wood blocks to prevent damage to the sealing surfaces.

6. Remove the cylinder head bolts.
7. Remove the cylinder head.

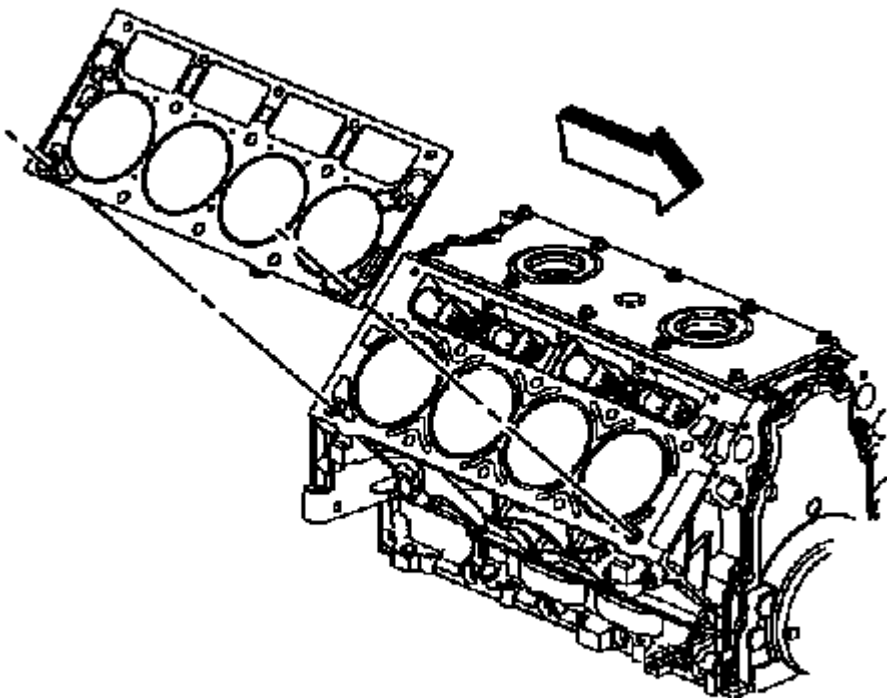


Fig. 131: View Of Right Cylinder Head Gasket And Alignment Pins
Courtesy of GENERAL MOTORS CORP.

8. Remove the cylinder head gasket.
9. Discard the gasket.
10. Discard the cylinder head bolts.
11. Clean and inspect the cylinder head. Refer to **CYLINDER HEAD CLEANING & INSPECTION** in Engine Mechanical - 4.8 L, 5.3 L, and 6.0 L Unit Repair.

Installation Procedure

CAUTION: Wear safety glasses in order to avoid eye damage.

NOTE: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

IMPORTANT:

- Do not reuse the cylinder head bolts. Install **NEW** cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket (unless specified).
- The cylinder head gaskets must be installed in the proper direction and position.

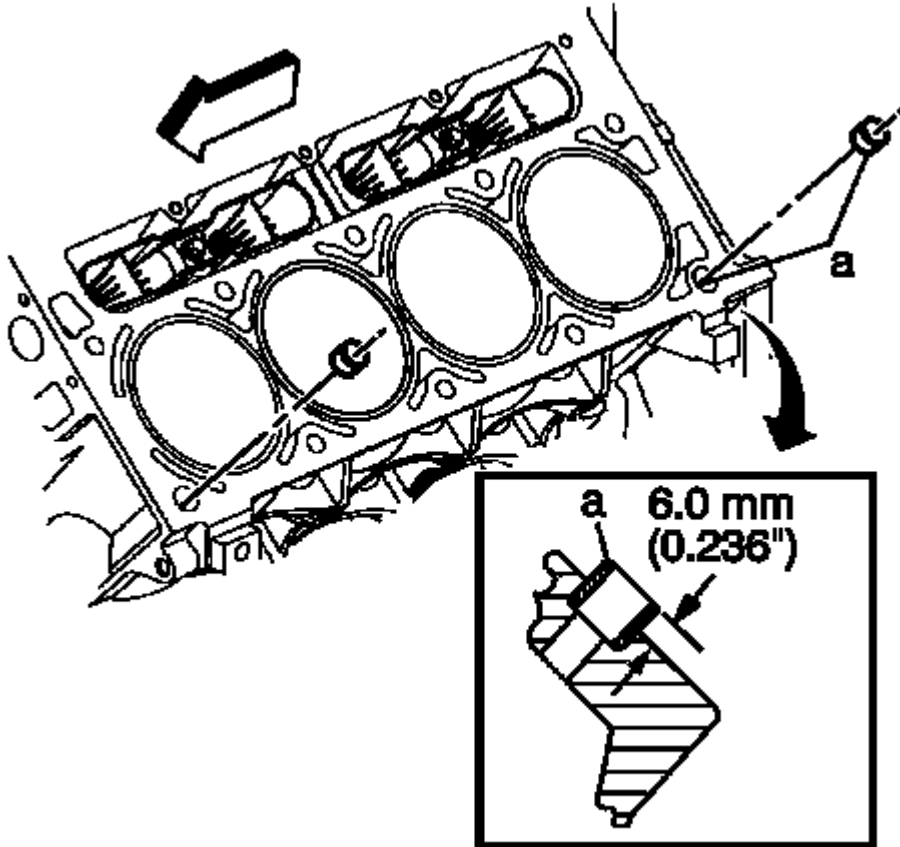


Fig. 132: Identifying Cylinder Head Locating Pins Installation Position
Courtesy of GENERAL MOTORS CORP.

1. Clean the engine block cylinder head bolt holes (if required).

Thread repair tool J 42385-107, found in **J 42385-200** may be used to clean the threads of old threadlocking material. See **SPECIAL TOOLS AND EQUIPMENT**.

2. Use spray cleaner GM U.S. P/N 12346139, P/N 12377981, Canada P/N 10953463, or equivalent into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Check the cylinder head locating pins for proper installation.

IMPORTANT: When properly installed, the tab on the right cylinder head gasket will be located right of center or closer to the front of the engine.

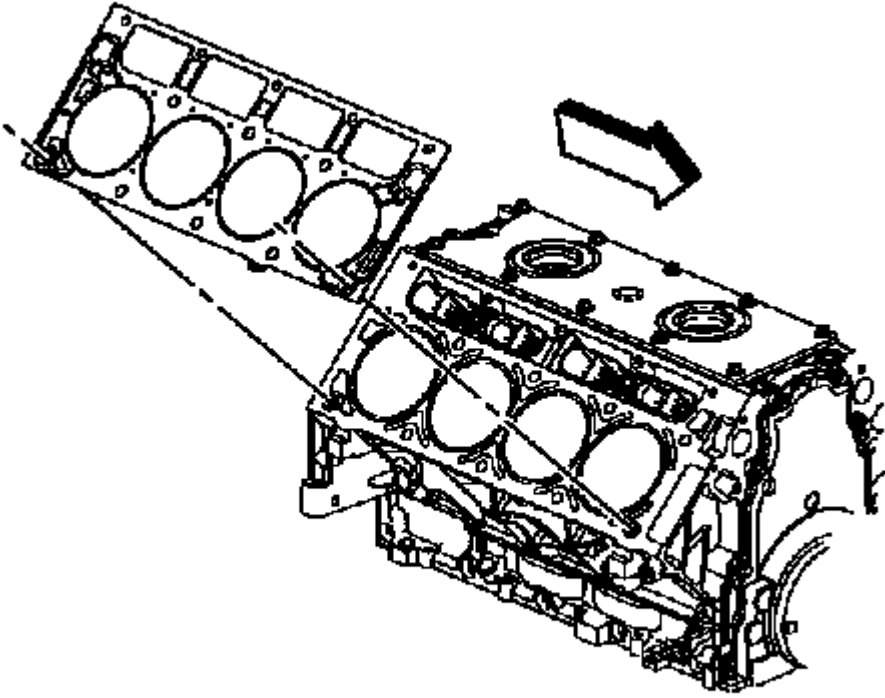


Fig. 133: View Of Right Cylinder Head Gasket And Alignment Pins
Courtesy of GENERAL MOTORS CORP.

5. Install the NEW right cylinder head gasket onto the locating pins.

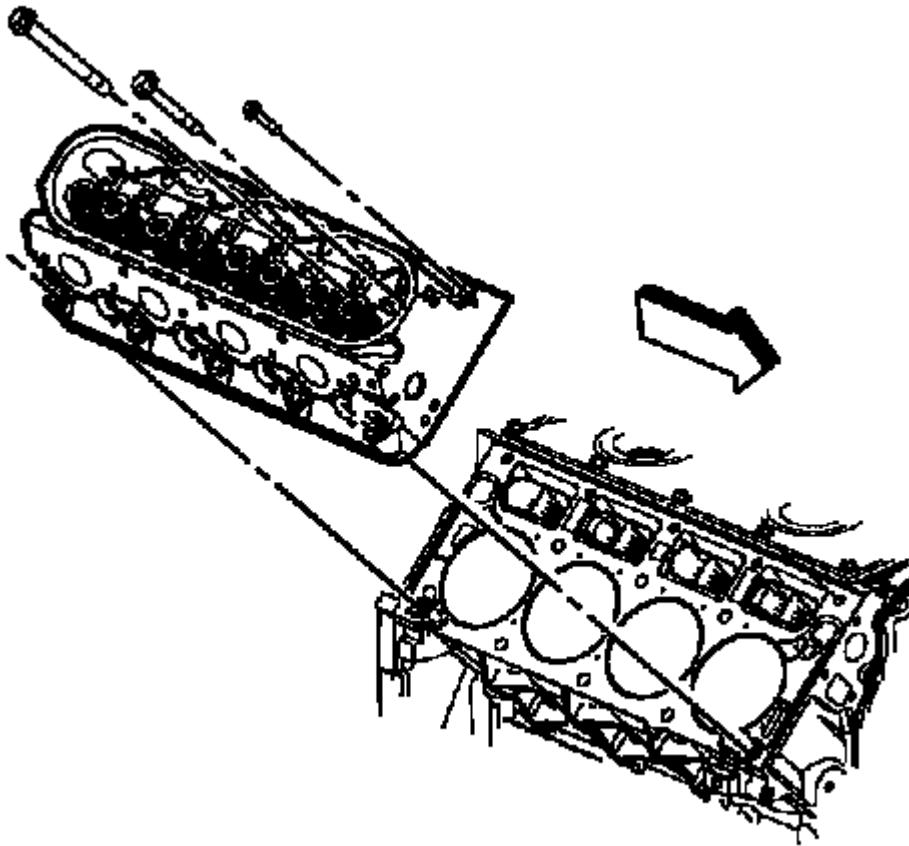


Fig. 134: View Of Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the cylinder head onto the locating pins and gasket.
7. Install the NEW cylinder head bolts.

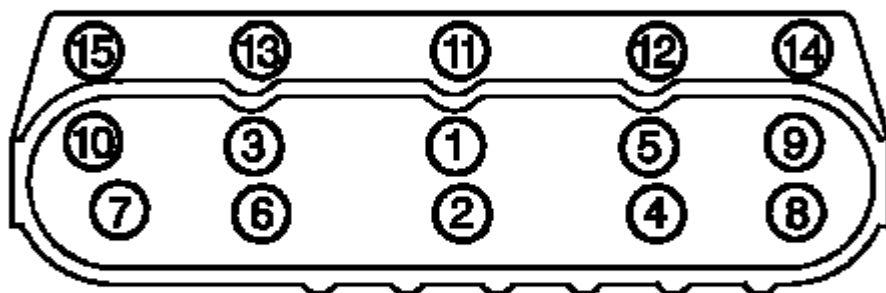


Fig. 135: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

8. Tighten the cylinder head bolts.

Tighten:

1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).
2. Tighten the M11 cylinder head bolts a second pass in sequence to 90 degrees using **J 36660-A** . See **SPECIAL TOOLS AND EQUIPMENT**.
3. Tighten the M11 cylinder head bolts (1,2,3,4,5,6,7,8) to 90 degrees and the M11 cylinder head bolts (9 and 10) to 50 degrees a final pass in sequence using **J 36660-A** . See **SPECIAL TOOLS AND EQUIPMENT**.
4. Tighten the M8 cylinder head bolts (11,12,13,14,15) to 30 N.m (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

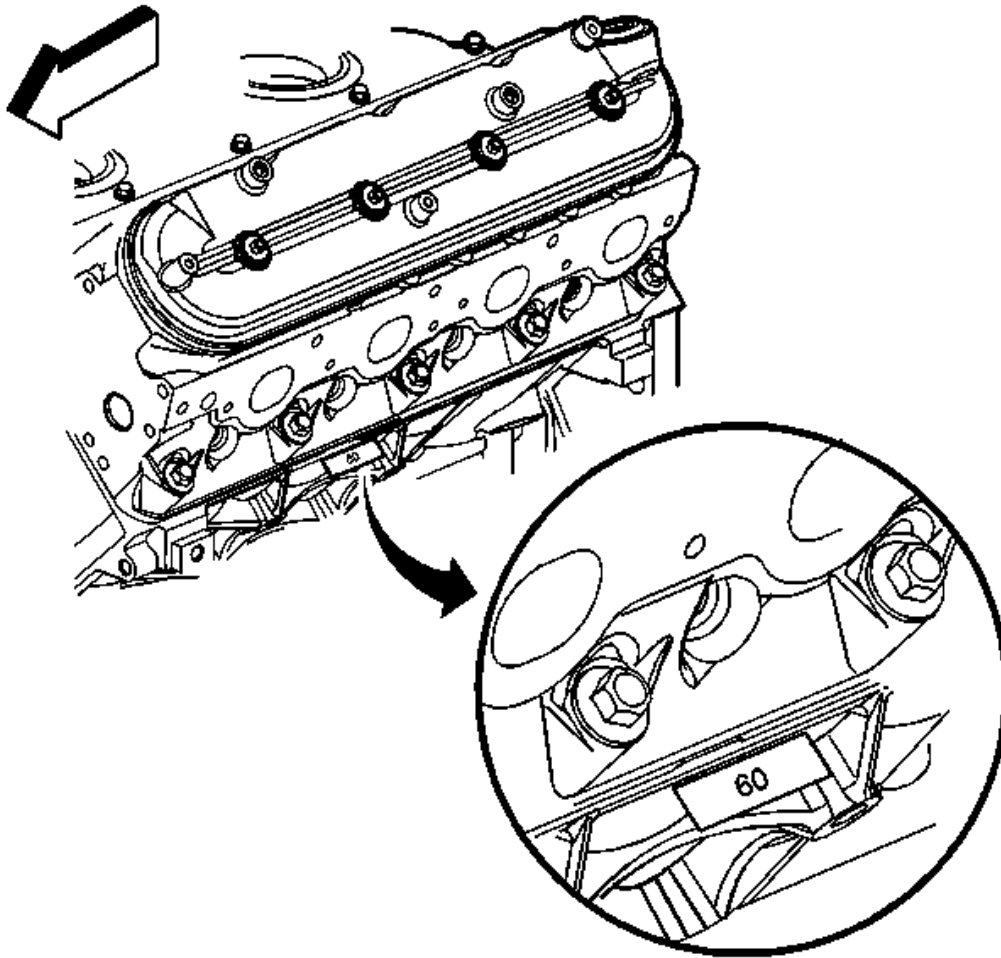


Fig. 136: Locating Head Gasket Stamp
Courtesy of GENERAL MOTORS CORP.

9. The cylinder head gasket displacement can be verified by markings visible on the top side of the left gasket locating tab.
 - Some 4.8/5.3 L head gaskets may have 53 stamped onto the locating tab.
 - Some 6.0 L head gaskets may have 60 stamped onto the locating tab.
10. Install the pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
11. Install the right exhaust manifold. Refer to **EXHAUST MANIFOLD REPLACEMENT – RIGHT (4.8L, 5.3L & 6.0L Engine)**.
12. Install the coolant air bleed pipe. Refer to **COOLANT AIR BLEED PIPE ASSEMBLY REPLACEMENT (4.8L, 5.3L, AND 6.0L ENGINES)**.

13. Install the intake manifold. Refer to **Intake Manifold Replacement**.
14. Install the oil level indicator. Refer to **Oil Level Indicator and Tube Replacement**.

VALVE LIFTER REPLACEMENT

Tools Required

J 3049-A Valve Lifter Remover. See **SPECIAL TOOLS AND EQUIPMENT**.

Removal Procedure

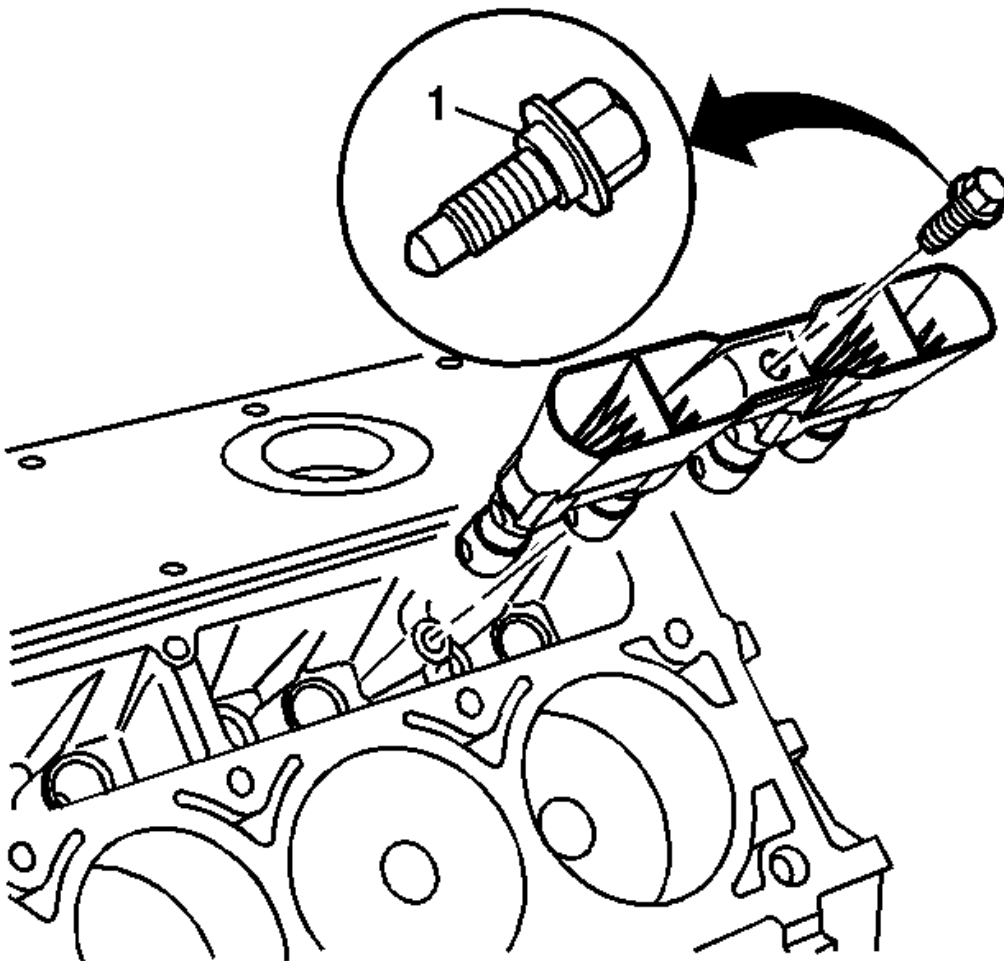


Fig. 137: View Of Valve Lifter Guide And Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the cylinder head and gasket. Refer to Cylinder Head Replacement - Left or Cylinder Head Replacement - Right.
2. Remove the valve lifter guide bolts (1).
3. Remove the valve lifters and guide.

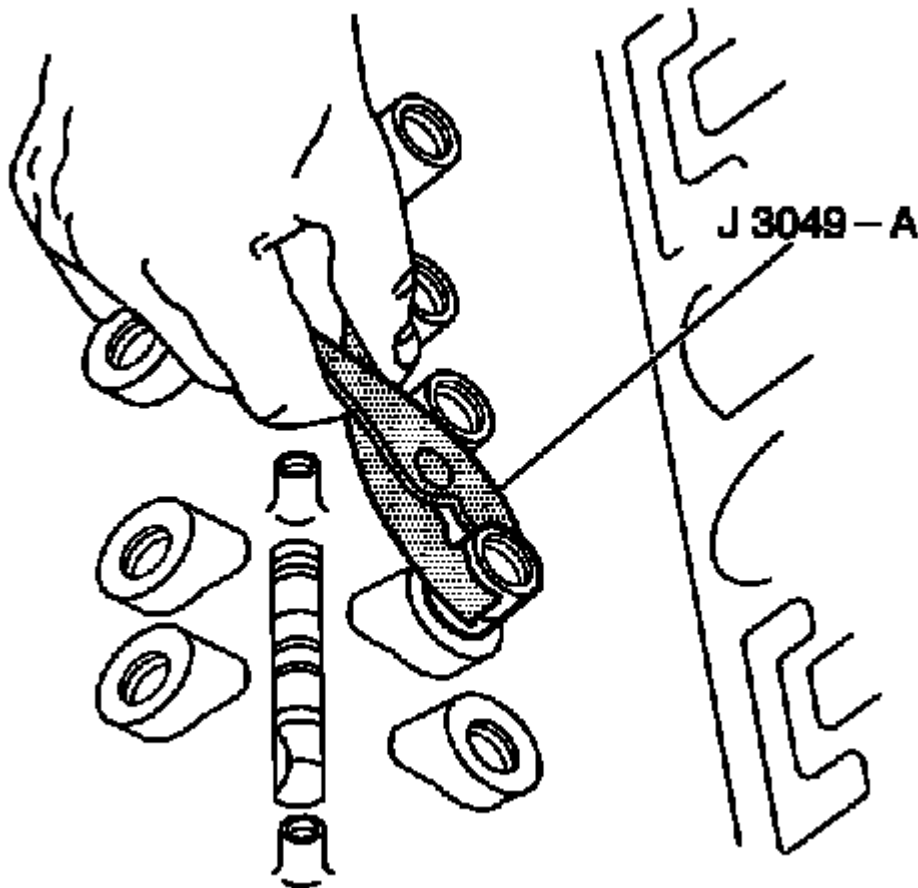


Fig. 138: Using J 3049-A To Remove The Stuck Valve Lifters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Some valve lifters may be stuck in their bores because of gum or varnish deposits.

4. Use **J 3049-A** or equivalent in order to remove the valve lifters (if required). See SPECIAL TOOLS AND EQUIPMENT.

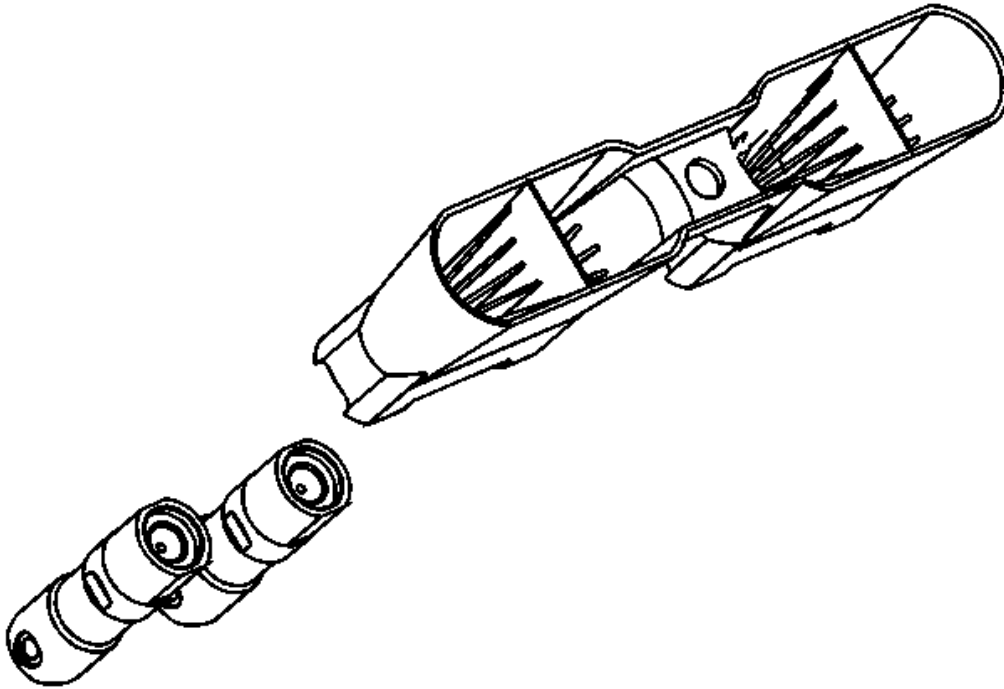


Fig. 139: View Of Valve Lifters & Lifter Guides
Courtesy of GENERAL MOTORS CORP.

5. Remove the valve lifters from the guide.
6. Organize or mark the components so that they can be installed in the same location from which they were removed.
7. Clean and inspect the valve lifters. Refer to **VALVE ROCKER ARM & PUSH RODS CLEANING & INSPECTION** in Engine Mechanical - 4.8L, 5.3L, and 6.0L.

Installation Procedure

IMPORTANT: When reusing valve lifters, install the lifters to their original locations.

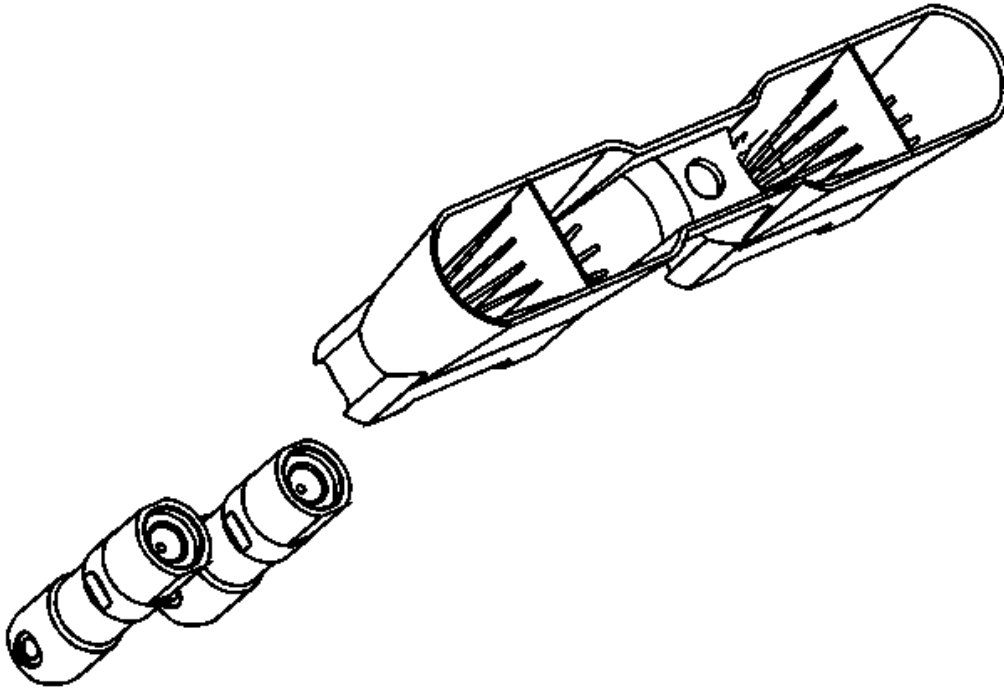


Fig. 140: View Of Valve Lifters & Lifter Guides
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the valve lifters and engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters into the lifter guides.

Align the flat area on the top of the lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.

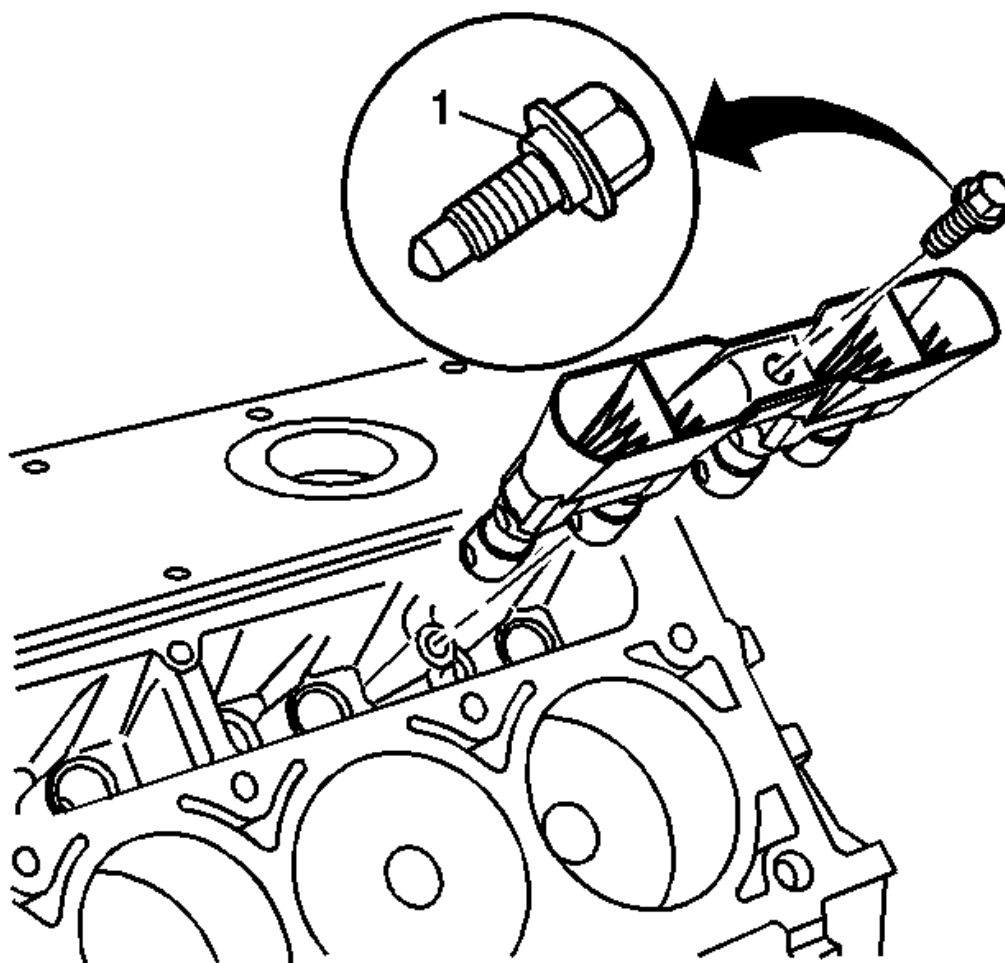


Fig. 141: View Of Valve Lifter Guide And Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Install the valve lifters and guide to the engine block.
4. Install the valve lifter guide bolt (1).

Tighten: Tighten the valve lifter guide bolt (1) to 12 N.m (106 lb in).

5. Install the cylinder head and gasket. Refer to Cylinder Head Replacement - Left or Cylinder Head Replacement - Right.

CRANKSHAFT BALANCER REPLACEMENT**Tools Required**

- **J 41816** Crankshaft Balancer Remover. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 41816-2** Crankshaft End Protector. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 42386-A** Flywheel Holding Tool. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 41665** Crankshaft Balancer and Sprocket Installer. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 36660-A** Torque Angle Meter. See **SPECIAL TOOLS AND EQUIPMENT**.

Removal Procedure

1. Remove the air conditioning (A/C) drive belt, if equipped. Refer to **Drive Belt Replacement - Air Conditioning**.
2. Remove the accessory drive belt, if not equipped with A/C. Refer to **Drive Belt Tensioner Replacement - Air Conditioning**.
3. Remove the fan shroud - lower. Refer to **FAN SHROUD REPLACEMENT - LOWER**.
4. Remove the starter motor. Refer to **REMOVAL (4.8L, 5.3L & 6.0L ENGINE)**.

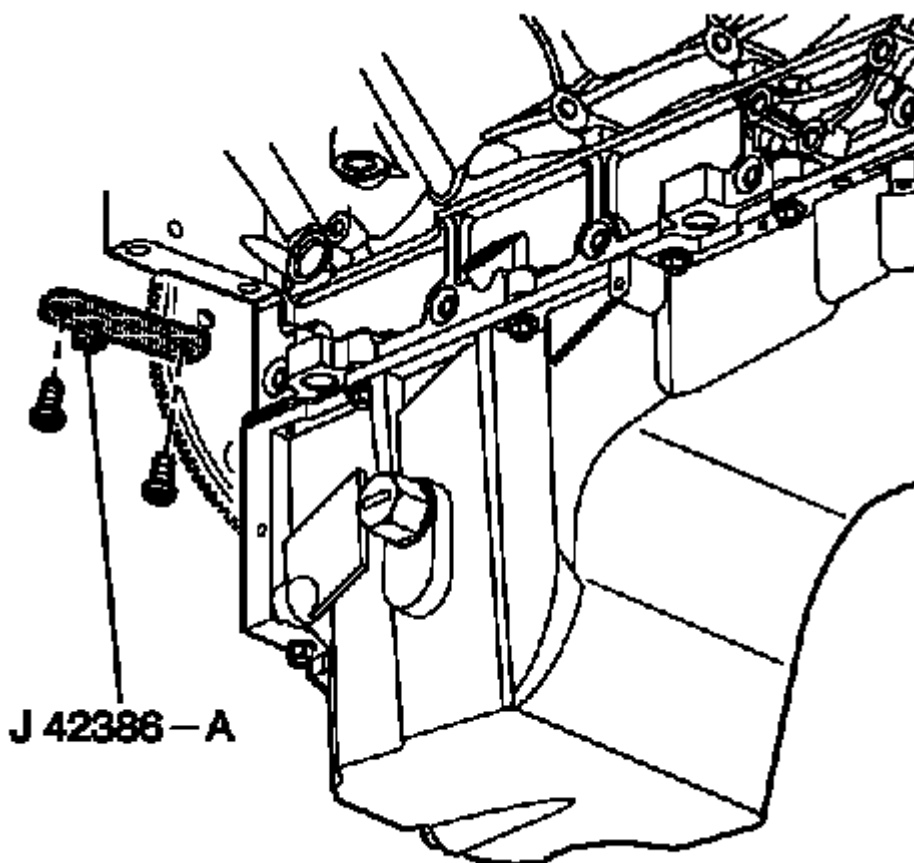


Fig. 142: Using J 42386-A To Lock Flywheel
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- Make sure that the teeth of the J 42386-A mesh with the teeth of the engine flywheel. See SPECIAL TOOLS AND EQUIPMENT.
- The crankshaft balancer is balanced as an individual component. It is not necessary to mark the balancer prior to removal.

NOTE:

Refer to Fastener Notice in Cautions and Notices.

5. Install the J 42386-A and bolts. See SPECIAL TOOLS AND EQUIPMENT.

Use one M10-1.5 x 120 mm and one M10-1.5 x 45 mm bolt for proper tool operation.

Tighten: Tighten the J 42386-A bolts to 50 N.m (37 lb ft). See SPECIAL TOOLS AND EQUIPMENT.

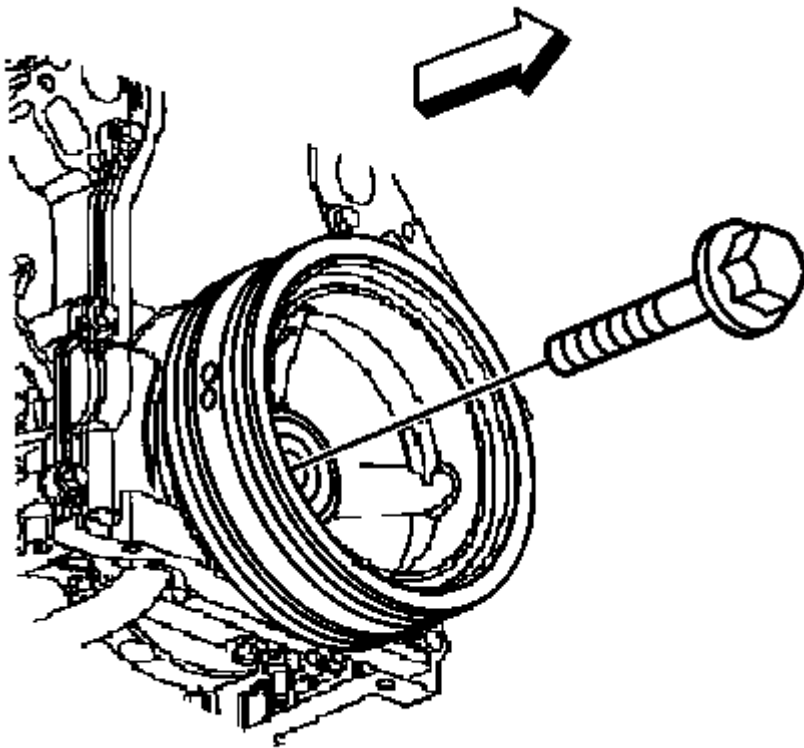


Fig. 143: Crankshaft Balancer And Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the crankshaft balancer bolt.

Do not discard the crankshaft balancer bolt. The balancer bolt will be used during the balancer installation procedure.

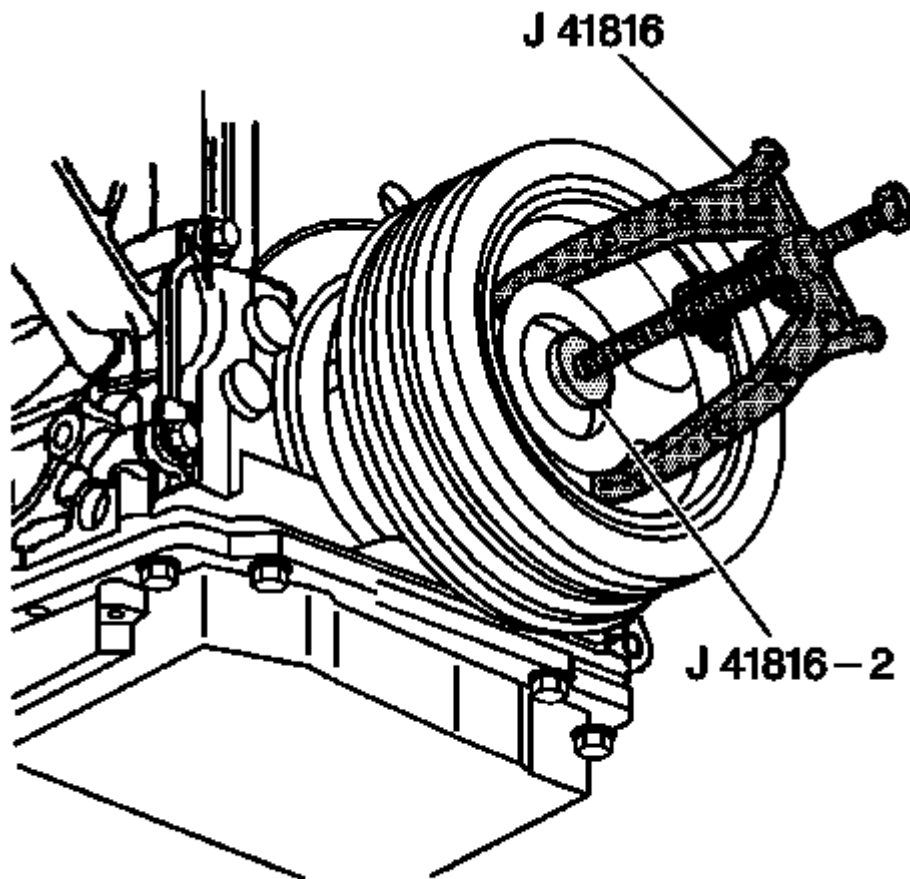


Fig. 144: Removing The Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

7. Use the **J 41816** and **J 41816-2** in order to remove the crankshaft balancer. See **SPECIAL TOOLS AND EQUIPMENT**.
8. Remove the **J 41816** and the **J 41816-2** from the crankshaft balancer. See **SPECIAL TOOLS AND EQUIPMENT**.
9. Clean and inspect the crankshaft balancer. Refer to **CRANKSHAFT & BEARINGS CLEANING & INSPECTION**.

Installation Procedure

IMPORTANT:

- Make sure that the teeth of **J 42386-A** mesh with the teeth of the engine flywheel. See **SPECIAL TOOLS AND EQUIPMENT**.

- The used crankshaft balancer bolt will be used only during the first pass of the balancer installation procedure. Install a **NEW** bolt and tighten as described in the second, third and forth passes of the balancer bolt tightening procedure.
- The crankshaft balancer installation and bolt tightening involves a four stage tightening process. The first pass ensures that the balancer is installed completely onto the crankshaft. The second, third, and forth passes tighten the new bolt to the proper torque.

IMPORTANT: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

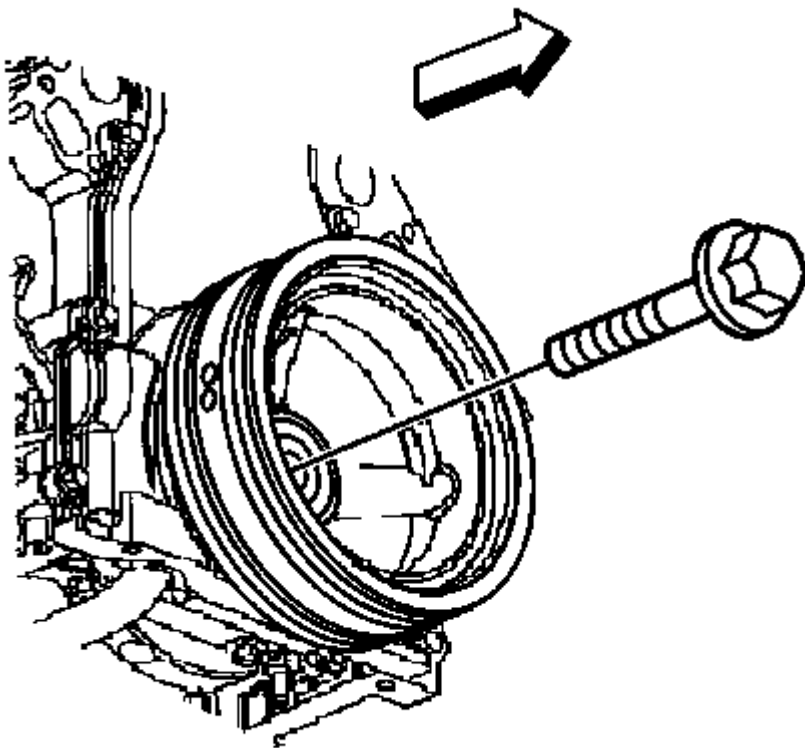


Fig. 145: Crankshaft Balancer And Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft balancer onto the end of the crankshaft.

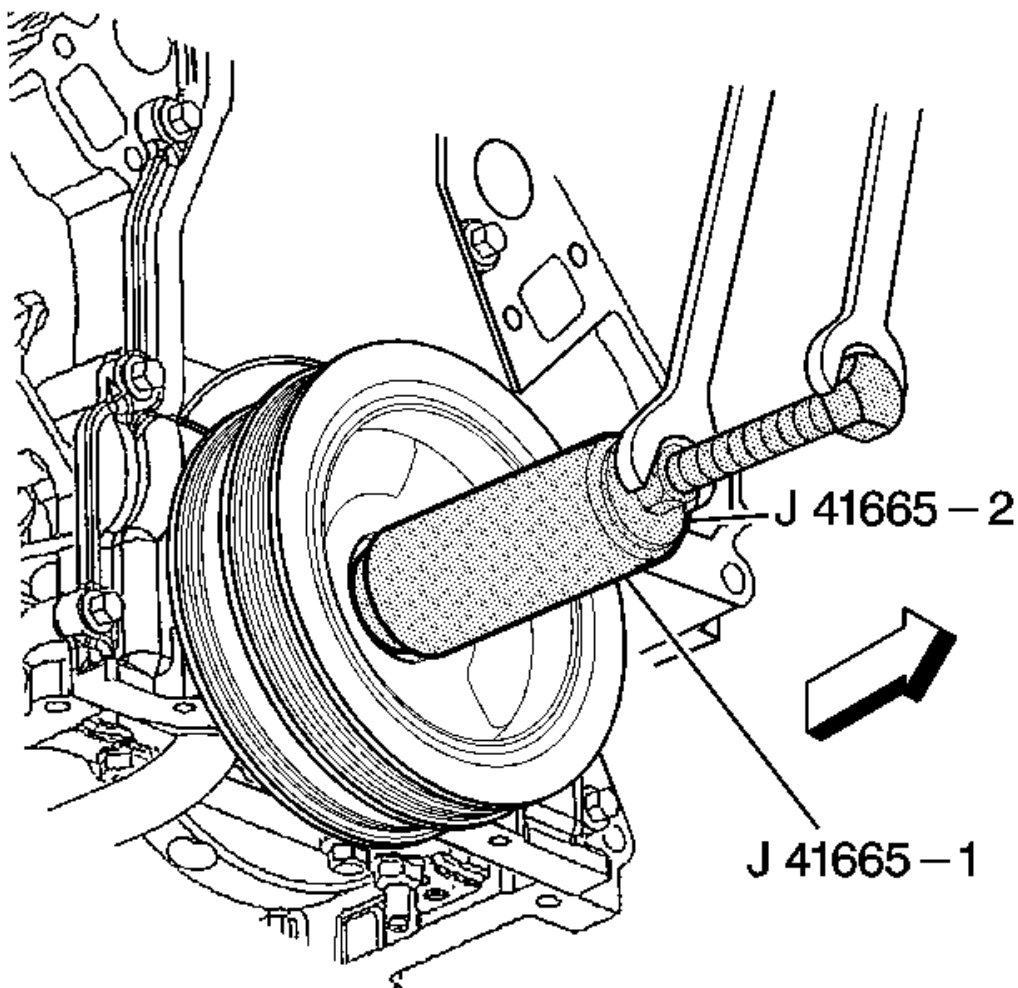


Fig. 146: Installing Balancer Using J 41665
Courtesy of GENERAL MOTORS CORP.

2. Use the **J 41665** in order to install the crankshaft balancer. See **SPECIAL TOOLS AND EQUIPMENT**.
 1. Assemble the threaded rod, nut, washer and installer.

Insert the smaller end of the installer into the front of the balancer.

2. Use a wrench and hold the hex end of the threaded rod.
3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.
4. Remove the tool and reverse the installation tool.

Position the larger end of the installer against the front of the balancer.

5. Use a wrench and hold the hex end of the threaded rod.
6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
7. Remove the balancer installation tool.

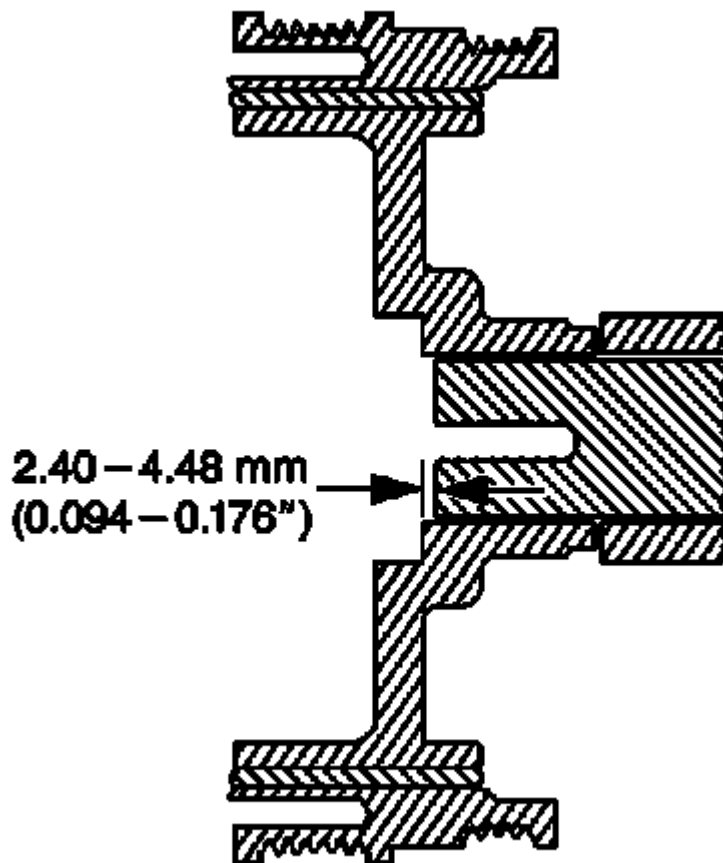


Fig. 147: Identifying Hub To Crankshaft Distance
Courtesy of GENERAL MOTORS CORP.

3. Install the used crankshaft balancer bolt.

Tighten: Tighten the USED crankshaft balancer bolt to 330 N.m (240 lb ft).

4. Remove the used crankshaft balancer bolt.

IMPORTANT: The nose of the crankshaft should be recessed 2.4-4.48 mm (0.094-0.176 in) into the balancer bore.

5. Measure for a correctly installed balancer.

If the balancer is not installed to the proper dimensions, install the **J 41665** and repeat the installation procedure. See **SPECIAL TOOLS AND EQUIPMENT**.

6. Install a NEW crankshaft balancer bolt.

Tighten:

1. Tighten the crankshaft balancer bolt a first pass to 50 N.m (37 lb ft).
2. Tighten the crankshaft balancer bolt a second pass to 140 degrees using **J 36660-A** . See **SPECIAL TOOLS AND EQUIPMENT**.
7. Remove the **J 42386-A** and bolts. See **SPECIAL TOOLS AND EQUIPMENT**.
8. Install the starter motor. Refer to **INSTALLATION (4.8L, 5.3L & 6.0L ENGINE)** .
9. Install the fan shroud - lower. Refer to **FAN SHROUD REPLACEMENT - LOWER** .
10. Install the accessory drive belt (if not equipped with A/C). Refer to **Drive Belt Replacement - Accessory**.
11. Install the A/C drive belt (if equipped). Refer to **Drive Belt Replacement - Air Conditioning**.
12. Perform the crankshaft position (CKP) system variation learn procedure. Refer to **CRANKSHAFT POSITION SENSOR** .

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Tools Required

J 41478 Crankshaft Front Oil Seal Installer. See **SPECIAL TOOLS AND EQUIPMENT**.

Removal Procedure

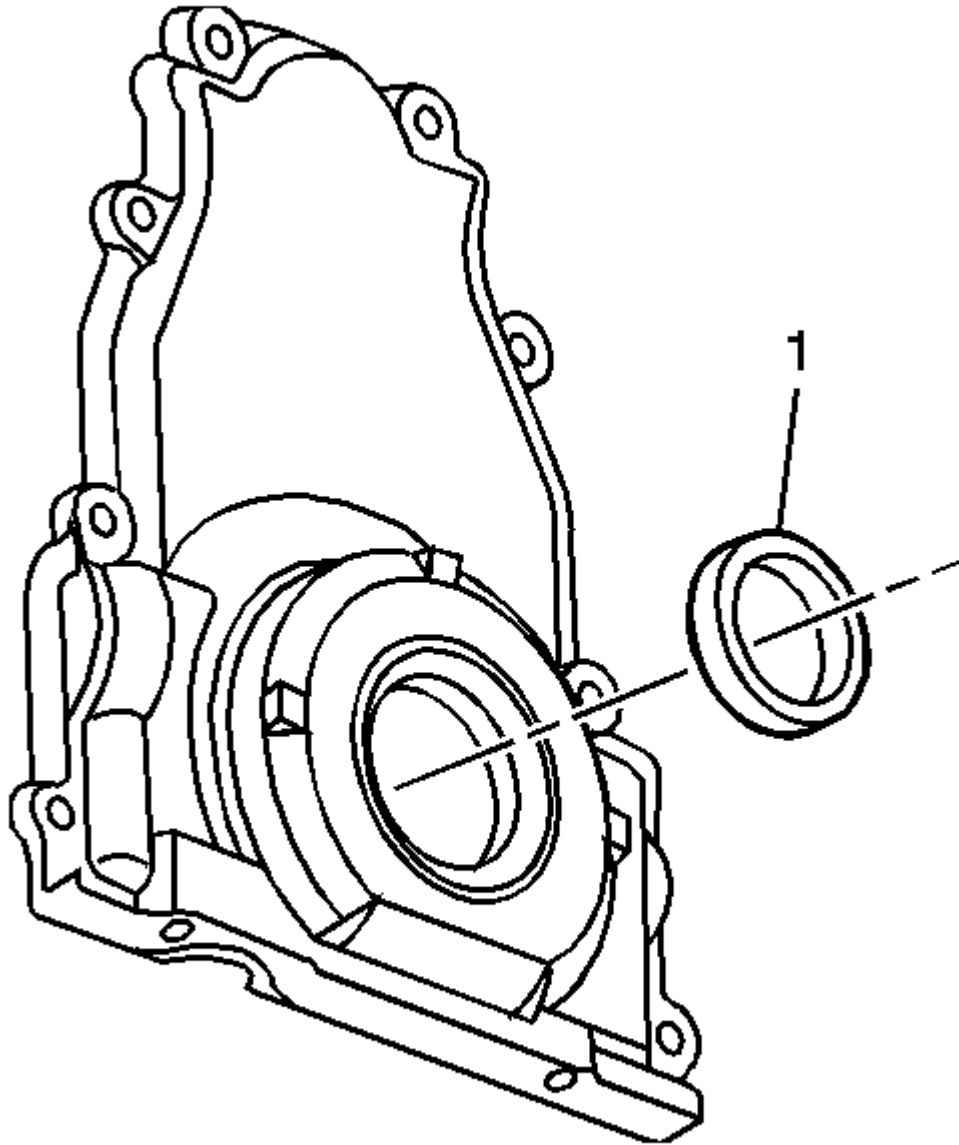


Fig. 148: View Of Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Remove the crankshaft oil seal (1) from the front cover.

Installation Procedure

IMPORTANT:

- Do not lubricate the oil seal sealing surface.
- Do not reuse the crankshaft oil seal.

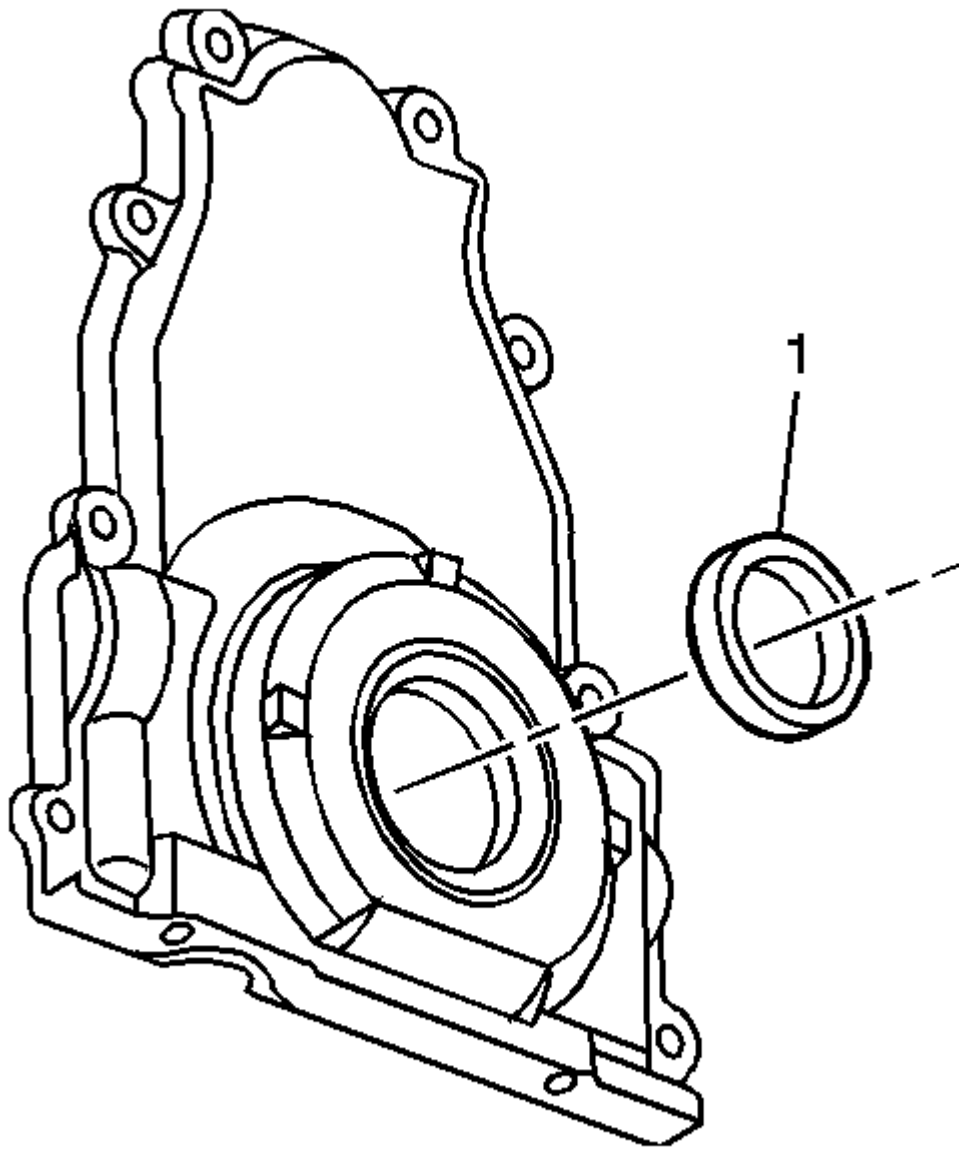


Fig. 149: View Of Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the outer edge of the oil seal (1) with clean engine oil.
2. Lubricate the front cover oil seal bore with clean engine oil.

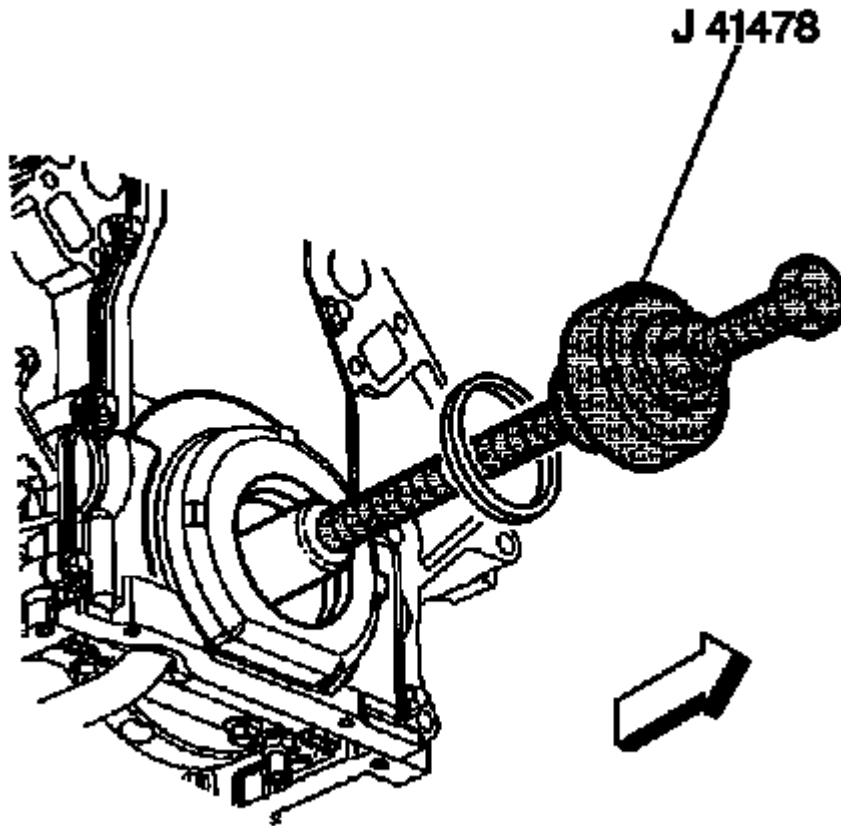


Fig. 150: Installing The Crankshaft Front Oil Seal Using J 41478
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft front oil seal onto the **J 41478** guide. See **SPECIAL TOOLS AND EQUIPMENT**.
4. Install the **J 41478** threaded rod (with nut, washer, guide, and oil seal) into the end of the crankshaft. See **SPECIAL TOOLS AND EQUIPMENT**.
5. Use the **J 41478** in order to install the oil seal into the cover bore. See **SPECIAL TOOLS AND EQUIPMENT**.
 1. Use a wrench and hold the hex on the installer bolt.
 2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.
 3. Remove the **J 41478** . See **SPECIAL TOOLS AND EQUIPMENT**.
 4. Inspect the oil seal for proper installation.

The oil seal should be installed evenly and completely into the front cover bore.

6. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

ENGINE FRONT COVER REPLACEMENT**Tools Required**

J 41476 Front and Rear Cover Alignment (at crankshaft seal area). See **SPECIAL TOOLS AND EQUIPMENT**.

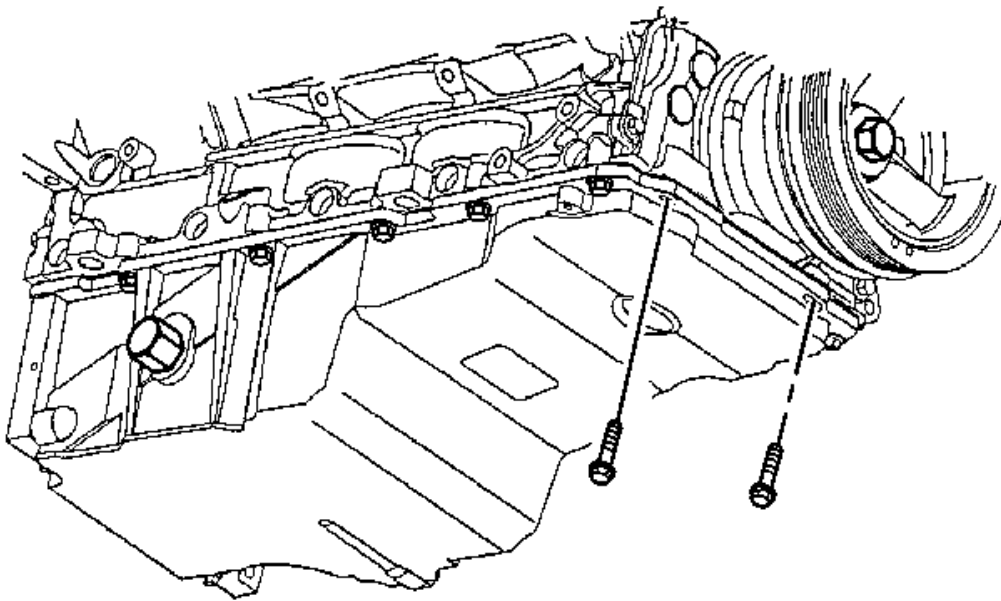
Removal Procedure

Fig. 151: Oil Pan-To-Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump. Refer to **WATER PUMP REPLACEMENT (4.8L, 5.3L & 6.0L ENGINES)**.
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
3. Remove the oil pan-to-front cover bolts.

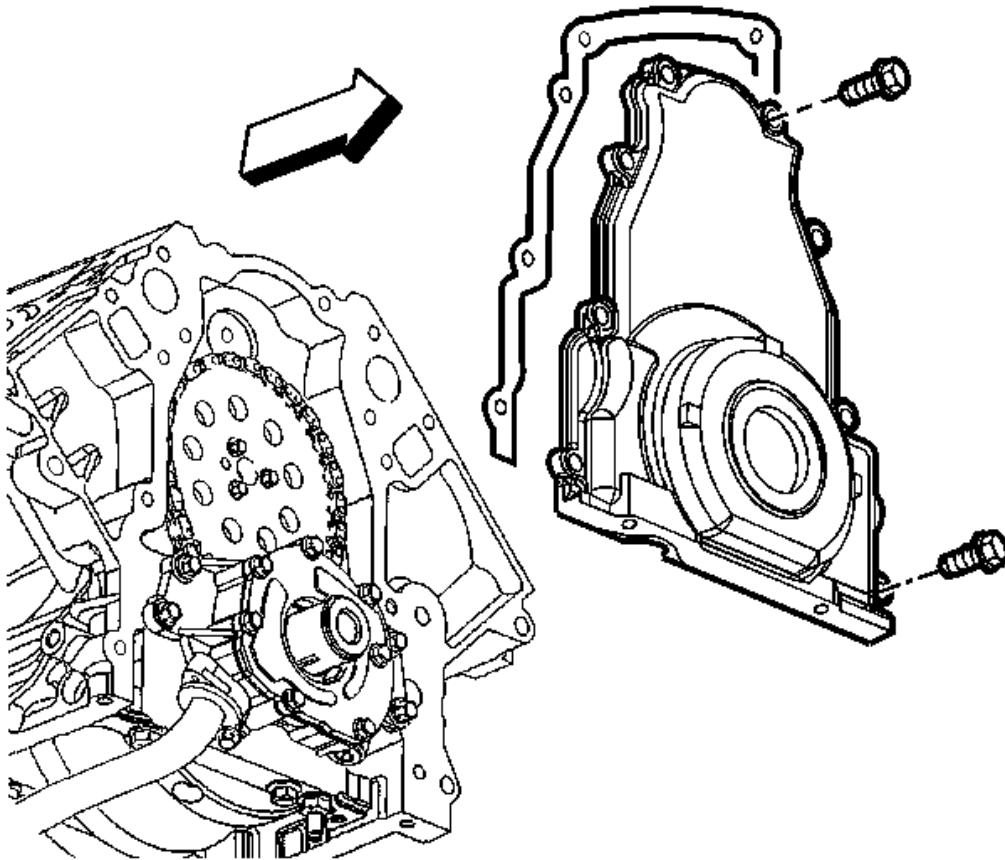


Fig. 152: View Of Front Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

4. Remove the front cover bolts.
5. Remove the front cover and gasket.
6. Discard the front cover gasket.
7. Clean and inspect the engine front cover. Refer to **ENGINE FRONT COVER CLEANING & INSPECTION**.

Installation Procedure

IMPORTANT:

- Do not reuse the crankshaft oil seal or front cover gasket.
- Do not apply any type of sealant to the front cover gasket (unless specified).
- The special tool in this procedure is used to properly center the front

crankshaft front oil seal.

- All gasket surfaces should be free of oil or other foreign material during assembly.
- The crankshaft front oil seal **MUST** be centered in relation to the crankshaft.
- An improperly aligned front cover may cause premature front oil seal wear and/or engine oil leaks.

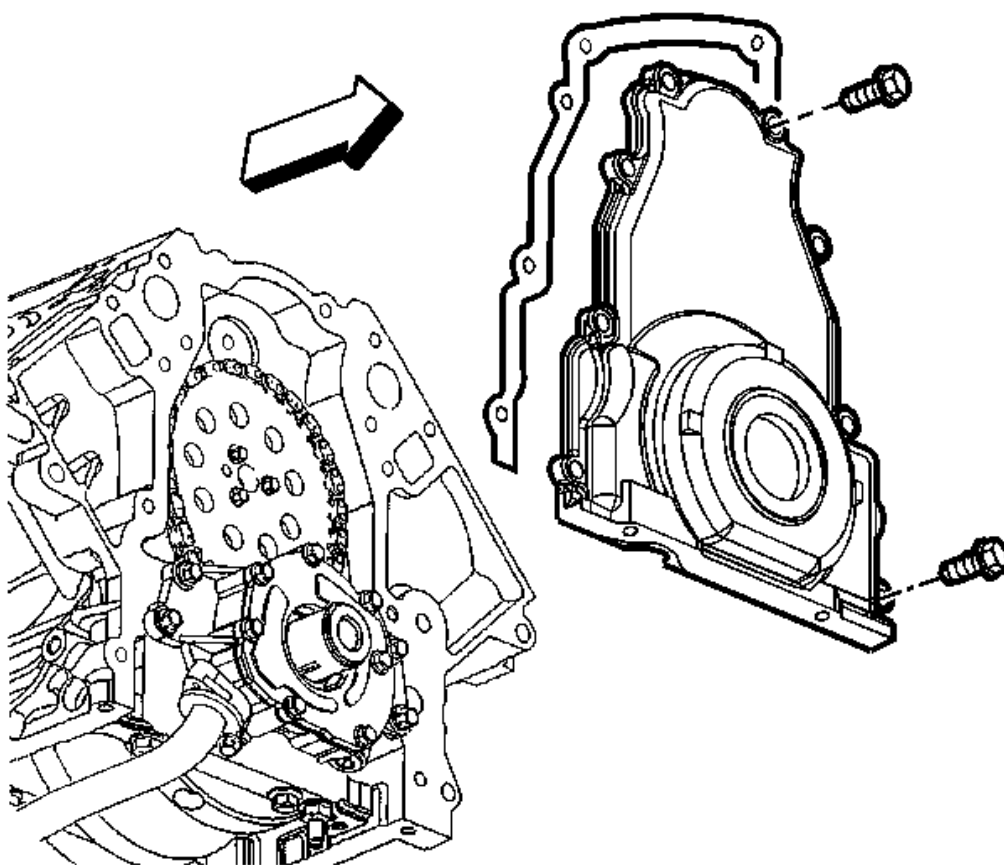


Fig. 153: View Of Front Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Apply a 5 mm (0.20 in) bead of sealant GM U.S. P/N 12378190, or equivalent 20 mm (0.80 in) long to the oil pan to engine block junction.
2. Install the front cover gasket and cover.
3. Install the front cover bolts until snug. Do not overtighten.

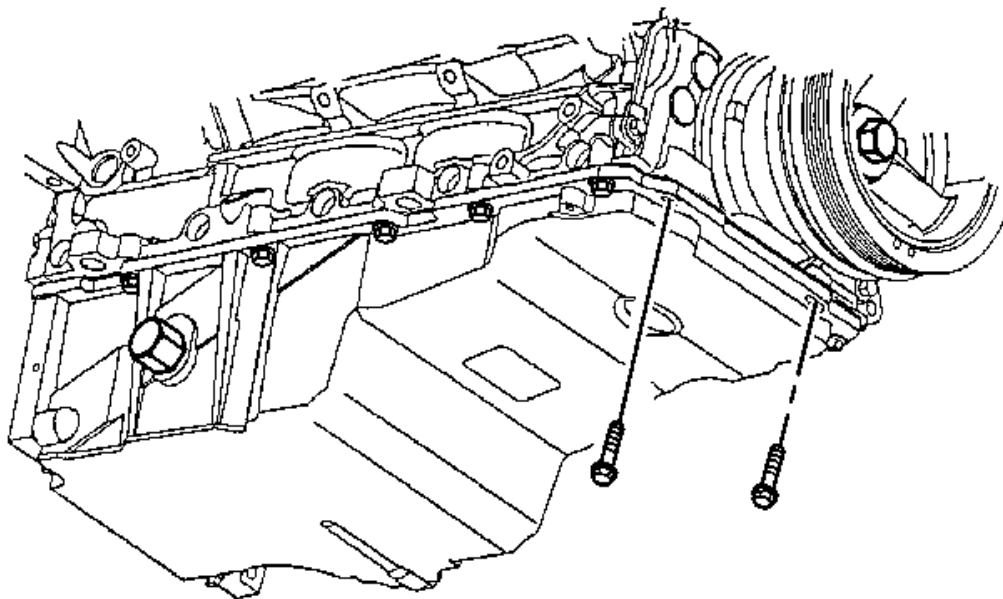


Fig. 154: View Of Oil Pan-To-Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the oil pan-to-front cover bolts until snug. Do not over tighten.

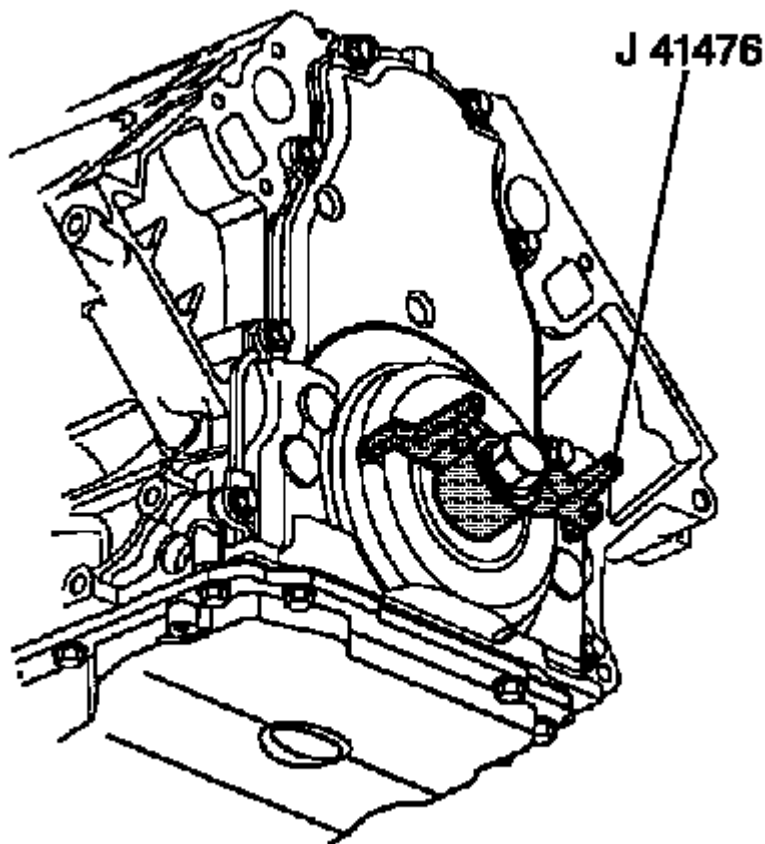


Fig. 155: View of J 41476 Installed To Front Cover
Courtesy of GENERAL MOTORS CORP.

5. Install **J 41476** to the front cover. See **SPECIAL TOOLS AND EQUIPMENT**.
6. Align the tapered legs of the **J 41476** with the machined alignment surfaces on the front cover. See **SPECIAL TOOLS AND EQUIPMENT**.

NOTE: Refer to Fastener Notice in Cautions and Notices.

7. Install the crankshaft balancer bolt until snug. Do not overtighten.

Tighten:

1. Tighten the oil pan to front cover bolts to 25 N.m (18 lb ft).
 2. Tighten the engine front cover bolts to 25 N.m (18 lb ft).
8. Remove the **J 41476** . See **SPECIAL TOOLS AND EQUIPMENT**.
 9. Install a NEW crankshaft front oil seal. Refer to **Crankshaft Front Oil Seal Replacement**.
 10. Install the water pump. Refer to **WATER PUMP REPLACEMENT (4.8L, 5.3L & 6.0L ENGINES)** .

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Tools Required

J 41479 Crankshaft Rear Oil Seal Installer. See SPECIAL TOOLS AND EQUIPMENT.

Removal Procedure

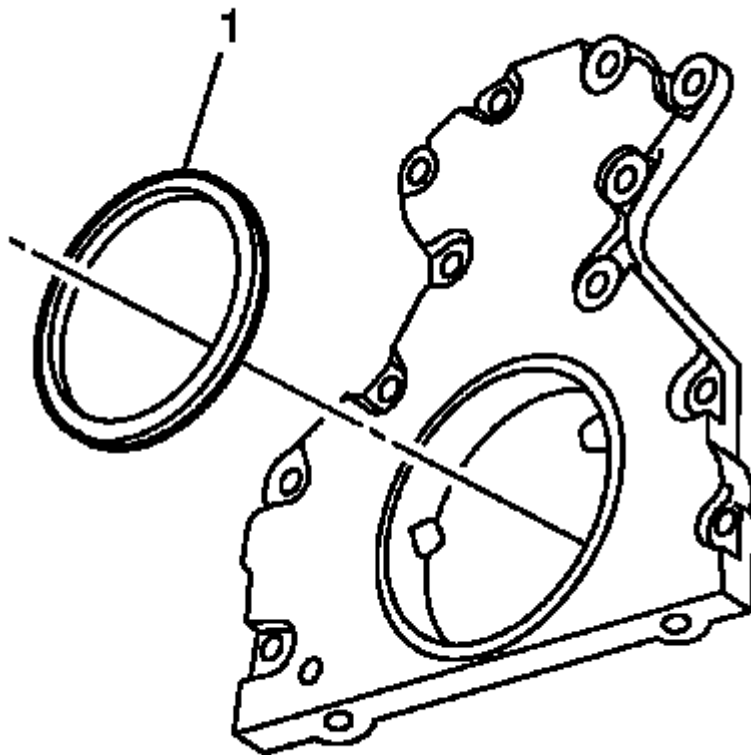


Fig. 156: View Of Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine flywheel. Refer to Engine Flywheel Replacement.
2. Remove the crankshaft rear oil seal (1) from the rear cover.

Installation Procedure

IMPORTANT:

- The flywheel spacer (if applicable) must be removed prior to oil seal installation.
- Do not lubricate the oil seal inside diameter (ID) or the crankshaft surface.
- Do not reuse the crankshaft rear oil seal.

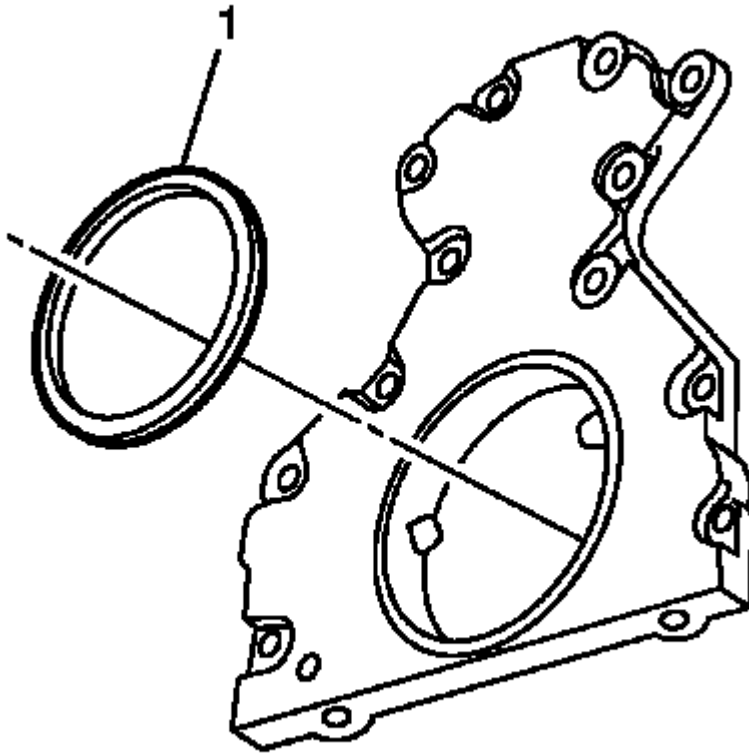


Fig. 157: View Of Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the outside diameter (OD) of the oil seal (1) with clean engine oil.

DO NOT allow oil or other lubricants to contact the seal surface.

2. Lubricate the rear cover oil seal bore with clean engine oil.

DO NOT allow oil or other lubricants to contact the crankshaft surface.

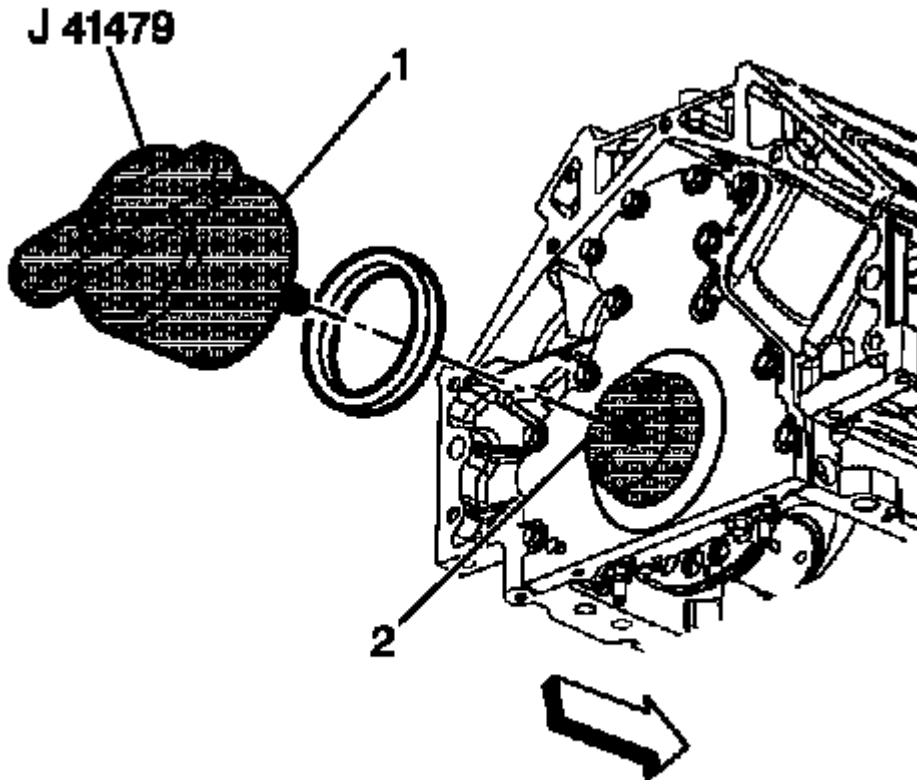


Fig. 158: Installing Crankshaft Rear Oil Seal Using J 41479
Courtesy of GENERAL MOTORS CORP.

3. Install the **J 41479** tapered cone (2) and bolts onto the rear of the crankshaft. See **SPECIAL TOOLS AND EQUIPMENT**.
4. Tighten the bolts until snug. Do not overtighten.
5. Install the rear oil seal onto the tapered cone (2) and push the seal to the rear cover bore.
6. Thread the **J 41479** threaded rod into the tapered cone until the tool (1) contacts the oil seal. See **SPECIAL TOOLS AND EQUIPMENT**.
7. Align the oil seal into the tool (1).
8. Rotate the handle of the tool (1) clockwise until the seal enters the rear cover and bottoms into the cover bore.
9. Remove the **J 41479** . See **SPECIAL TOOLS AND EQUIPMENT**.
10. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.

ENGINE REAR COVER REPLACEMENT

Tools Required

J 41476 Front and Rear Cover Alignment (at crankshaft seal area). See **SPECIAL TOOLS AND EQUIPMENT**.

Removal Procedure

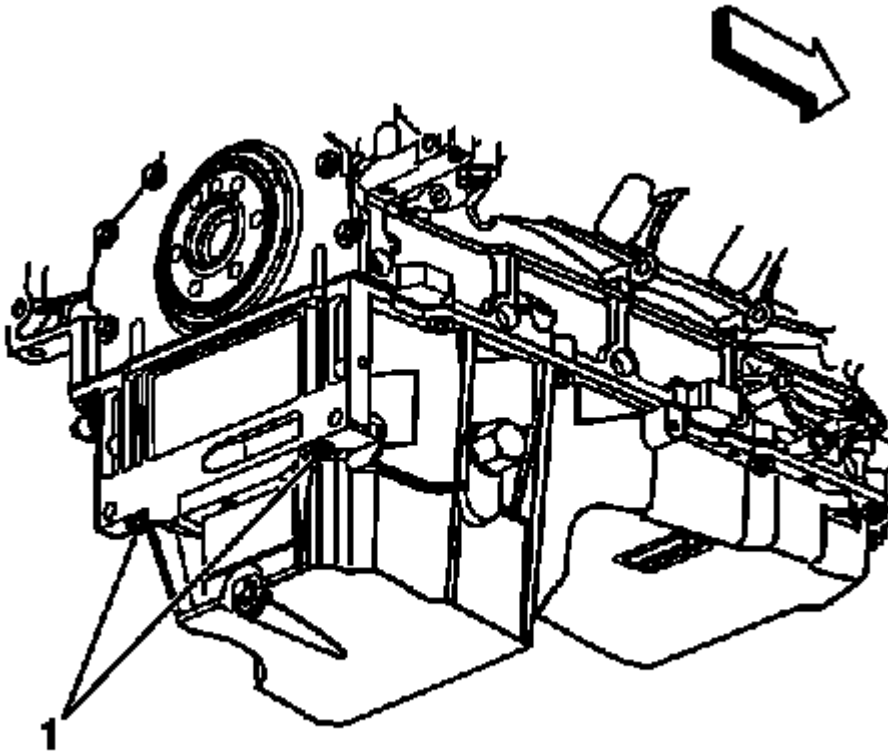


Fig. 159: View Of Oil Pan-To-Rear Cover Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine flywheel. Refer to **Engine Flywheel Replacement**.
2. Remove the oil pan-to-rear cover bolts (1).

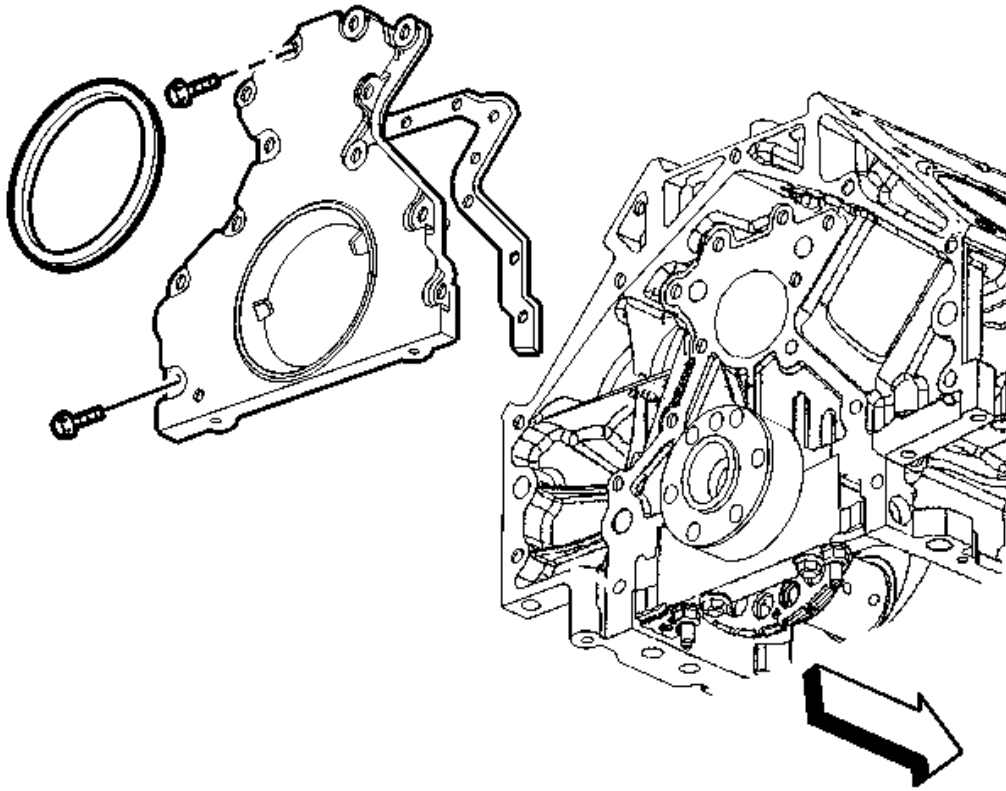


Fig. 160: Rear Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

3. Remove the rear cover bolts.
4. Remove the rear cover and gasket.
5. Discard the rear cover gasket.
6. Clean and inspect the rear cover. Refer to **ENGINE REAR COVER CLEANING & INSPECTION** .

Installation Procedure

IMPORTANT:

- Do not reuse the crankshaft oil seal or rear cover gasket.
- Do not apply any type of sealant to the rear cover gasket (unless specified).
- The special tool in this procedure is used to properly center the crankshaft rear oil seal.
- The crankshaft rear oil seal will be installed after the rear cover has been

installed and aligned.

Install the rear cover without the crankshaft oil seal.

- All gasket surfaces should be free of oil or other foreign material during assembly.
- The crankshaft rear oil seal **MUST** be centered in relation to the crankshaft.
- An improperly aligned rear cover may cause premature rear oil seal wear and/or engine assembly oil leaks.

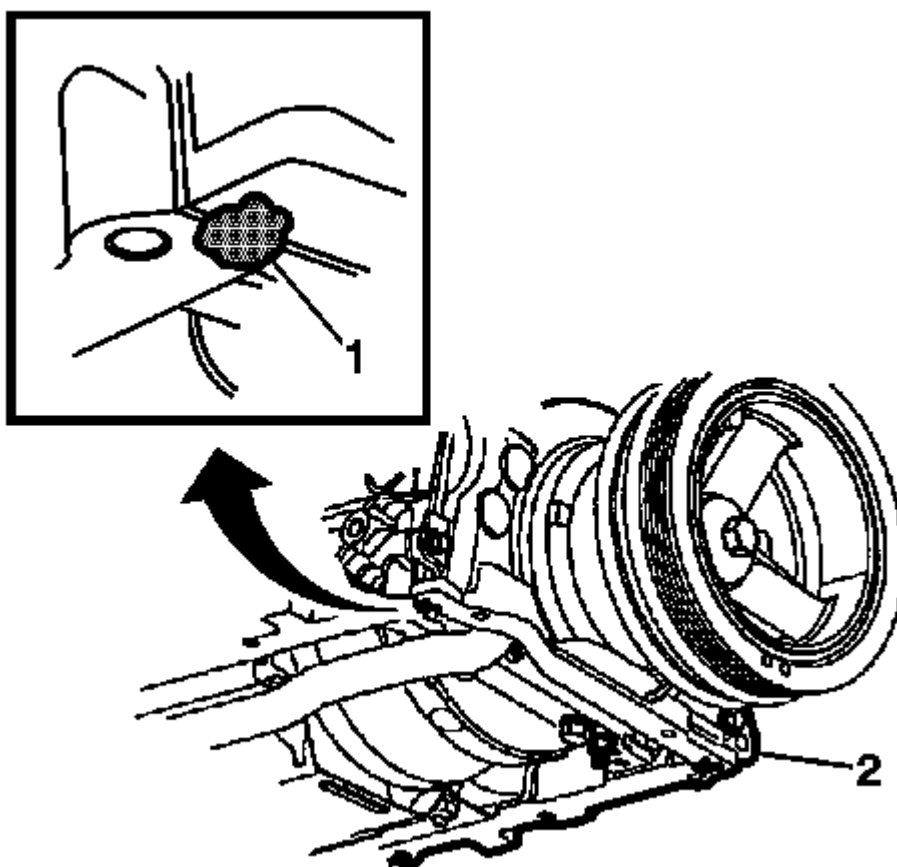


Fig. 161: View Of Sealant Applied To Front Oil Pan-To-Engine Block Junction
Courtesy of GENERAL MOTORS CORP.

1. Apply a 5 mm (0.20 in) bead of sealant GM U.S. P/N 12378190, or equivalent 20 mm (0.80 in) long to the oil pan to engine block junction.

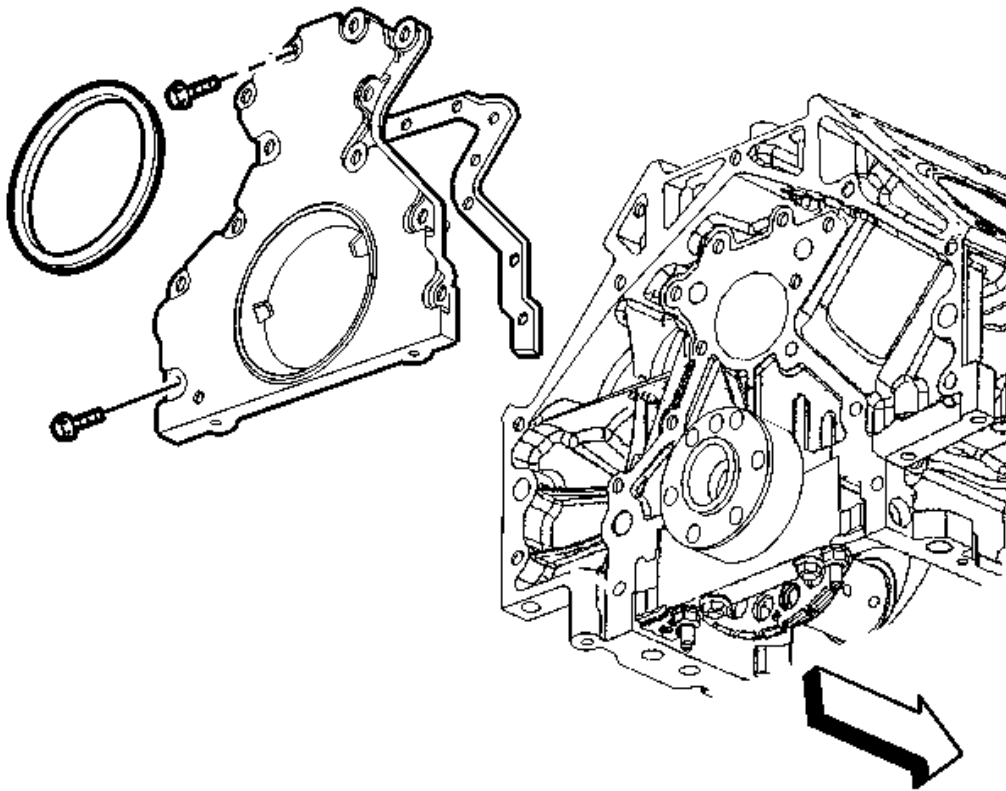


Fig. 162: Rear Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install the rear cover gasket and cover.
3. Install the rear cover bolts until snug. Do not overtighten.

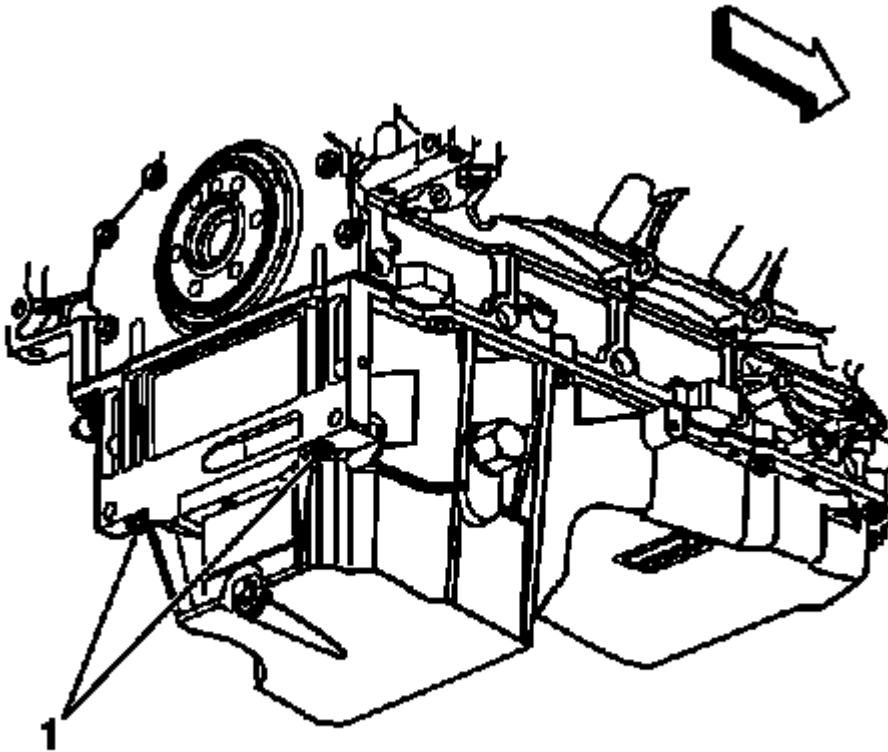


Fig. 163: View Of Oil Pan-To-Rear Cover Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the oil pan-to-rear cover bolts (1) until snug. Do not overtighten.

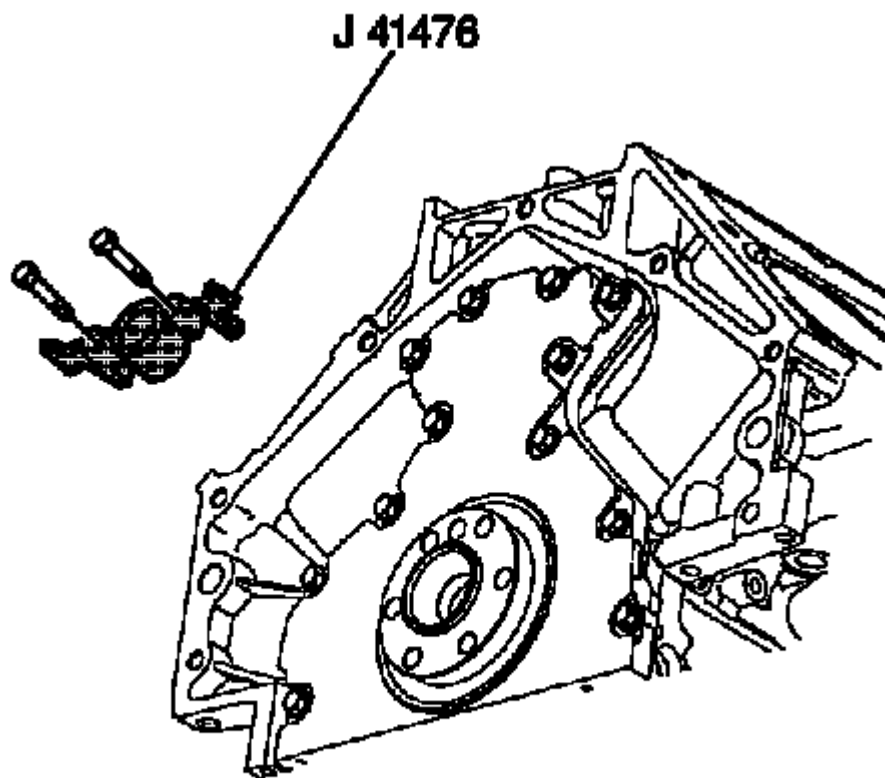


Fig. 164: View Of J 41476

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The tapered legs of the alignment tool must enter the rear cover oil seal bore.

5. Rotate the crankshaft until two opposing flywheel bolt holes are parallel to the oil pan surface.
6. Install the **J 41476** and bolts onto the rear of the crankshaft. See **SPECIAL TOOLS AND EQUIPMENT**.

NOTE: Refer to Fastener Notice in Cautions and Notices.

7. Tighten the **J 41476** mounting bolts until snug. Do not overtighten. See **SPECIAL TOOLS AND EQUIPMENT**.

Tighten:

1. Tighten the oil pan-to-rear cover bolts to 12 N.m (106 lb in).
2. Tighten the engine rear cover bolts to 25 N.m (18 lb ft).

8. Remove the **J 41476** . See **SPECIAL TOOLS AND EQUIPMENT**.
9. Install a NEW crankshaft rear oil seal. Refer to **Crankshaft Rear Oil Seal Replacement**.
10. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.

OIL FILTER ADAPTER REPLACEMENT

Removal Procedure

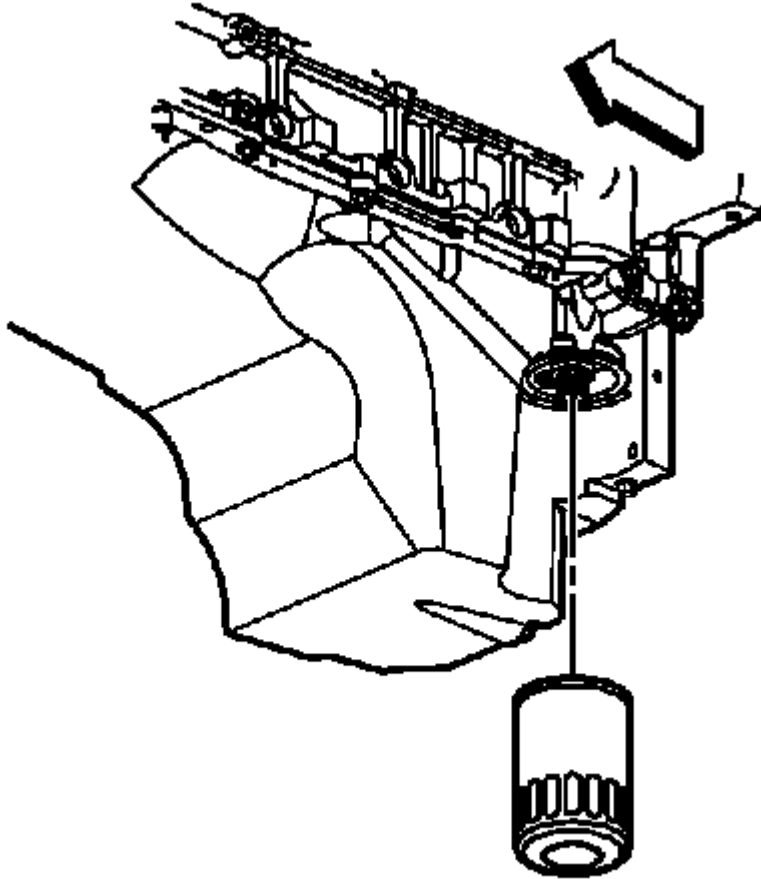


Fig. 165: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

1. Drain the engine oil.
2. Remove the oil filter.

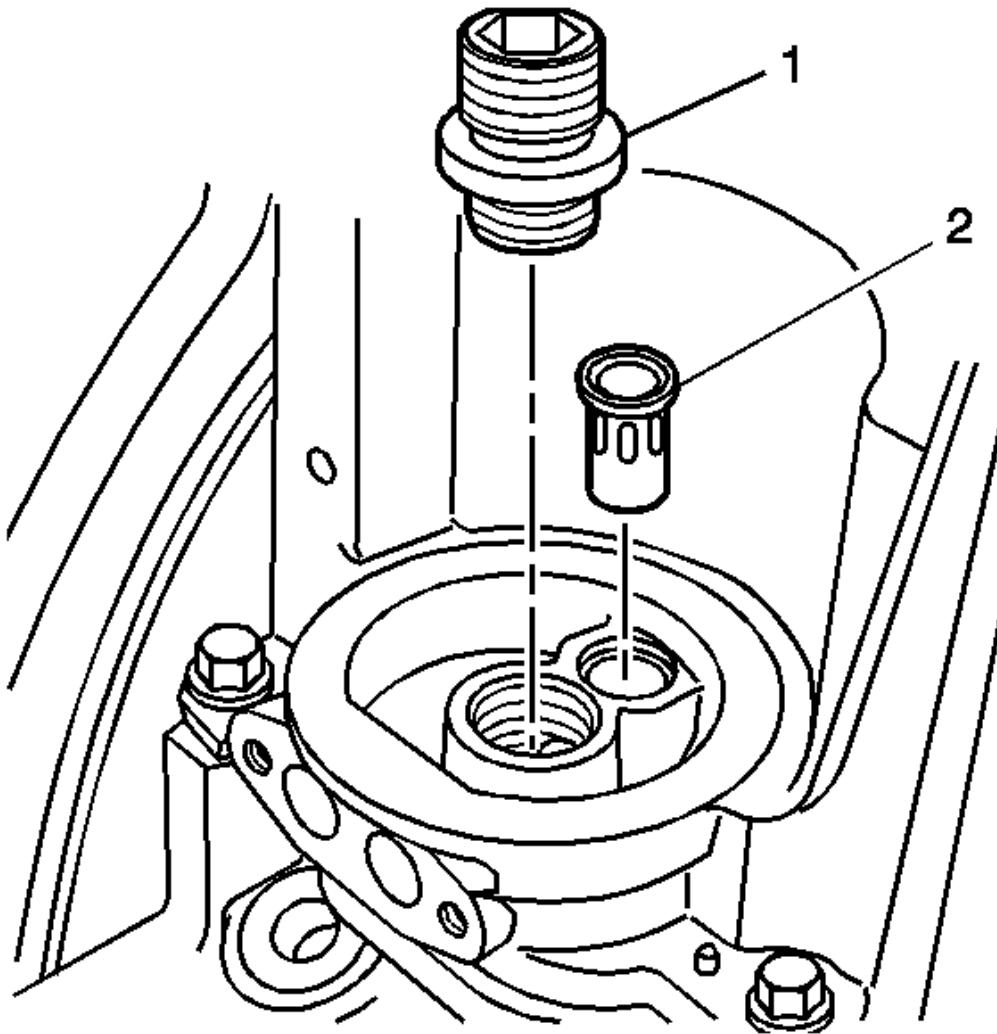


Fig. 166: View Of Oil Filter Adapter & Bypass Valve
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil filter adapter (1).

Installation Procedure

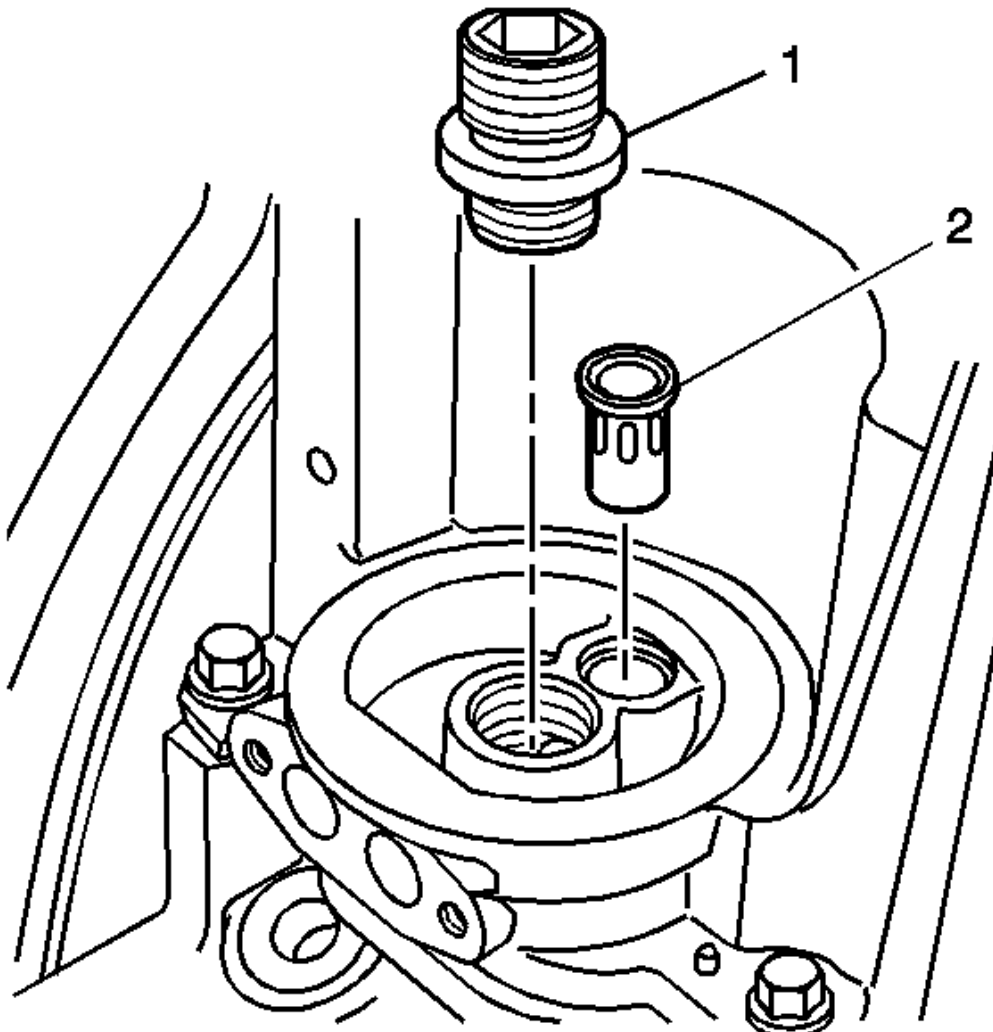


Fig. 167: View Of Oil Filter Adapter & Bypass Valve
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Install the oil filter adapter (1).

Tighten: Tighten the adapter to 55 N.m (40 lb ft).

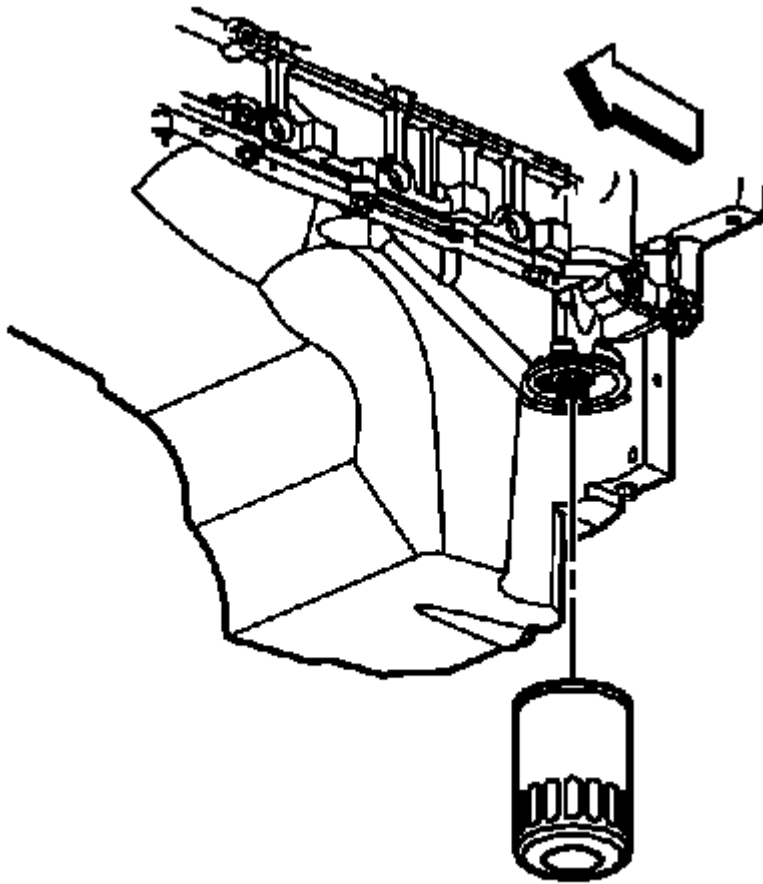


Fig. 168: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

2. Install the oil filter.
3. Refill the engine oil. Refer to **SEALERS, ADHESIVES & LUBRICANTS** and/or **DRAINING FLUIDS & OIL FILTER REMOVAL**.

OIL FILTER BYPASS VALVE REPLACEMENT

Removal Procedure

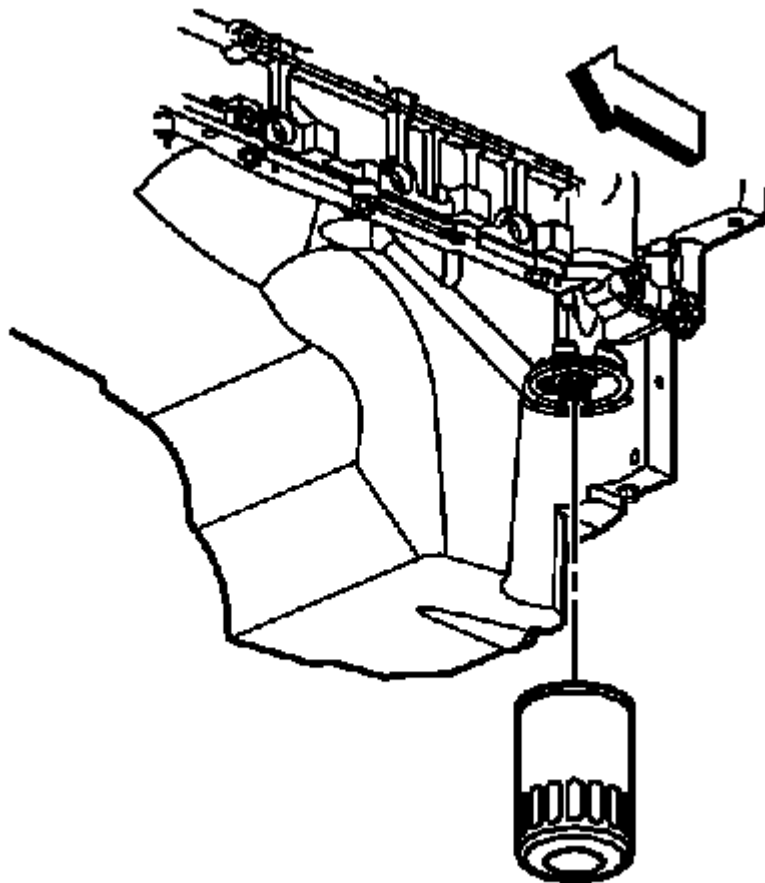


Fig. 169: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

1. Drain the engine oil.
2. Remove the oil filter.

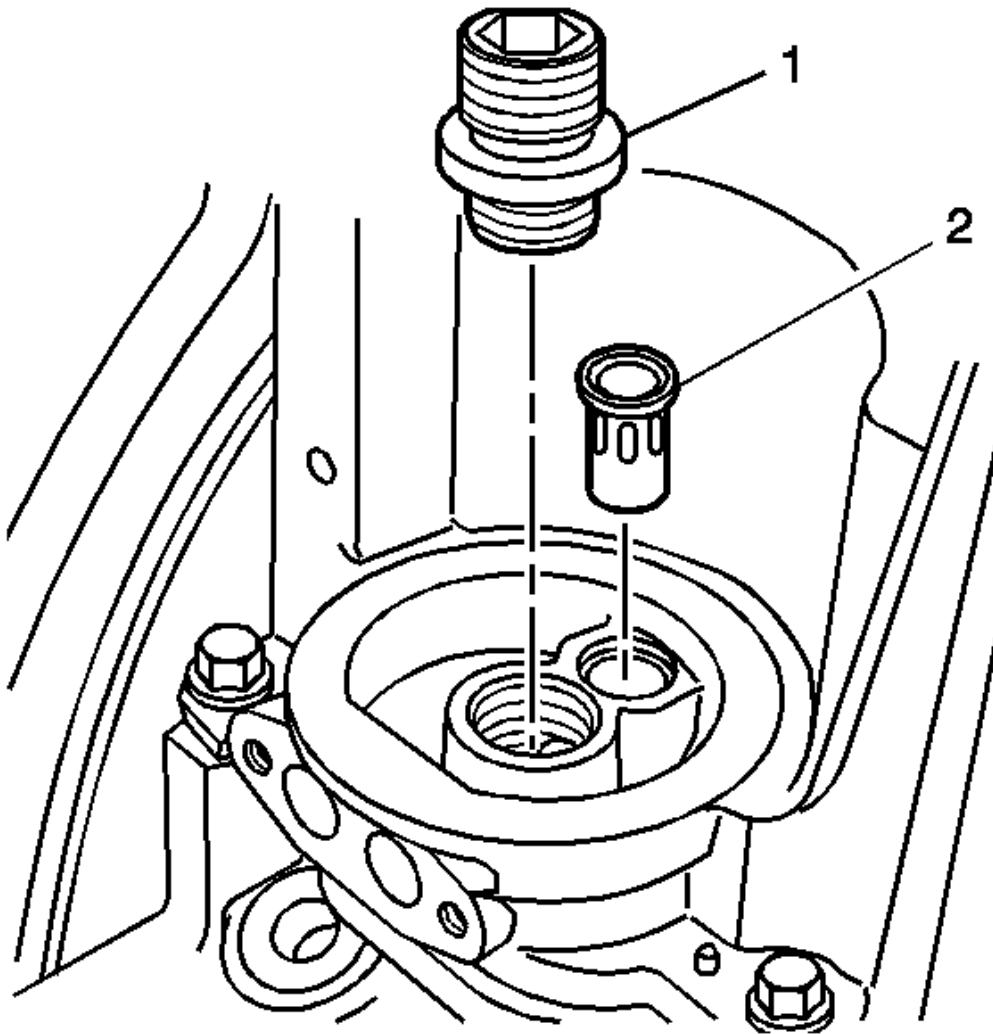


Fig. 170: View Of Oil Filter Adapter & Bypass Valve
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil filter adapter (1).
4. Remove the oil filter bypass valve (2).

Installation Procedure

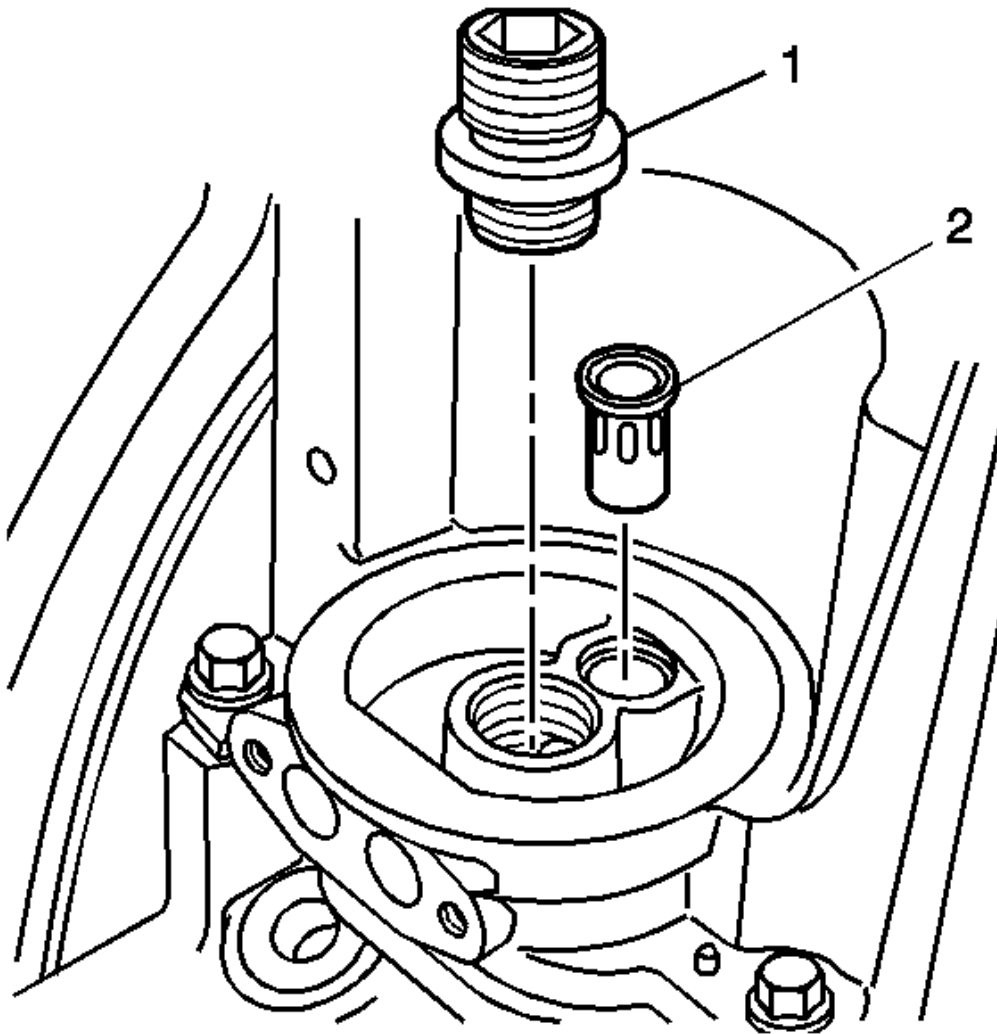


Fig. 171: View Of Oil Filter Adapter & Bypass Valve
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Install the oil filter bypass valve (2).
2. Install the oil filter adapter (1).

Tighten: Tighten the oil filter adapter to 55 N.m (40 lb ft).

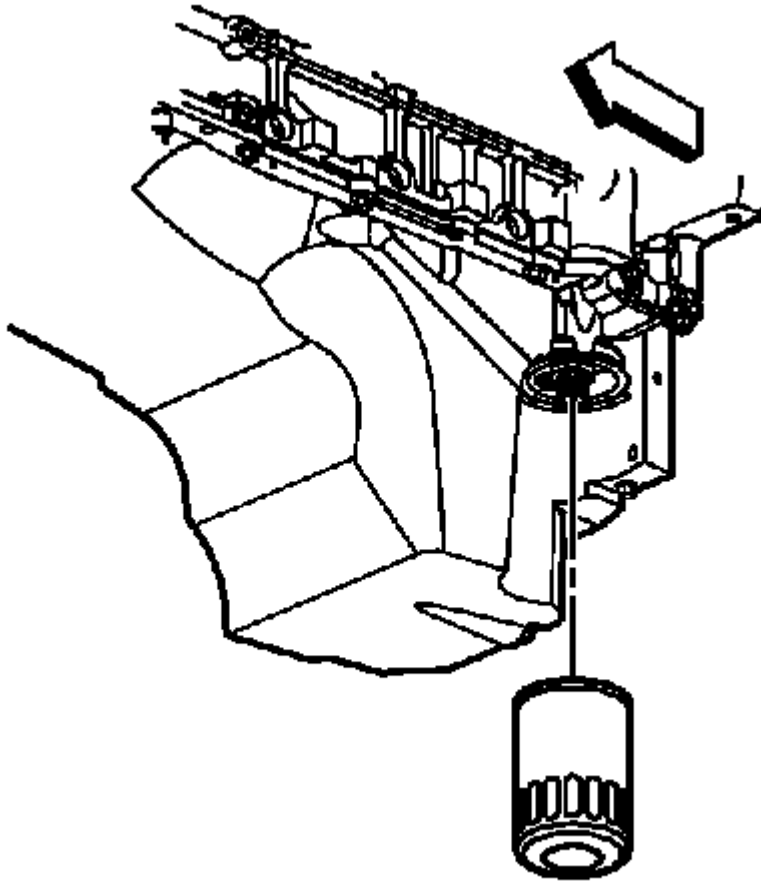


Fig. 172: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

3. Install the oil filter.

Tighten: Tighten the oil filter to 30 N.m (22 lb ft).

4. Refill the engine oil. Refer to SEALERS, ADHESIVES & LUBRICANTS and/or DRAINING FLUIDS & OIL FILTER REMOVAL .

OIL PAN COVER REPLACEMENT

Removal Procedure

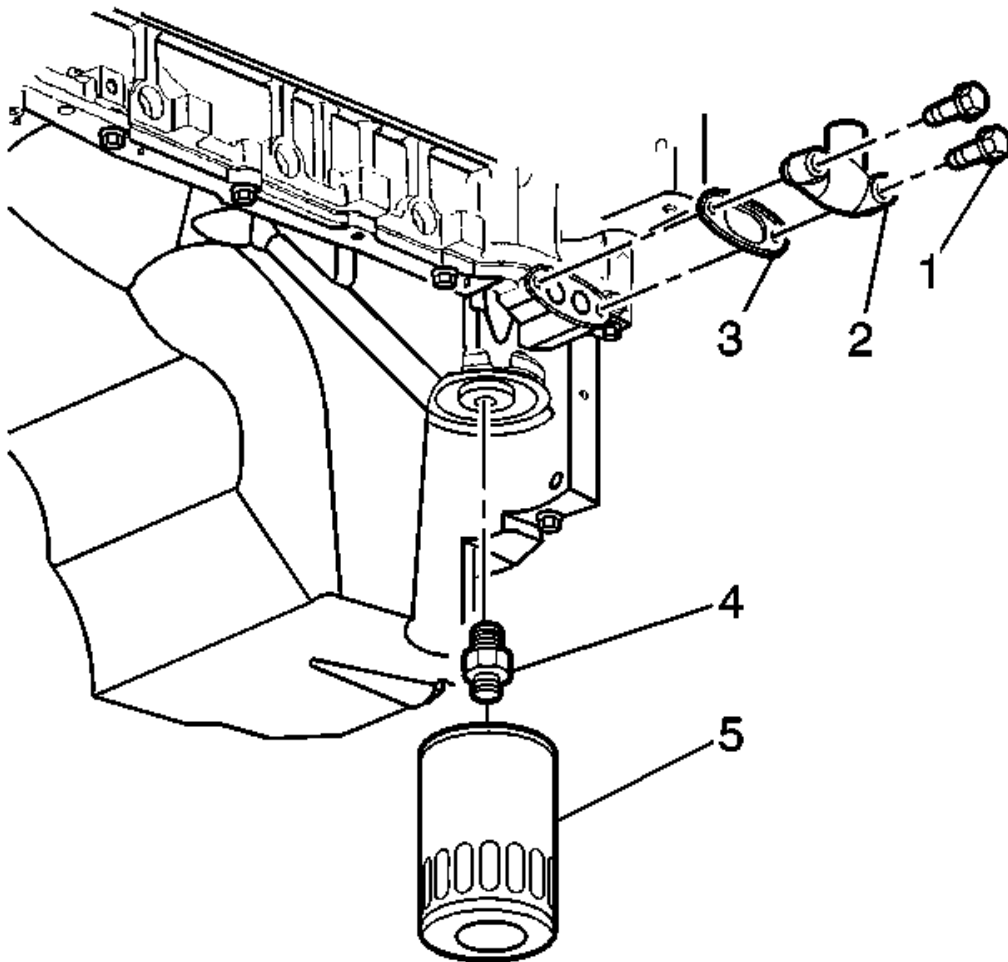


Fig. 173: Oil Pan Cover Bolts, Cover, And Gasket
Courtesy of GENERAL MOTORS CORP.

1. Drain the engine oil.
2. Remove the oil pan cover bolts (1), cover (2), and gasket (3).
3. Discard the gasket.

Installation Procedure

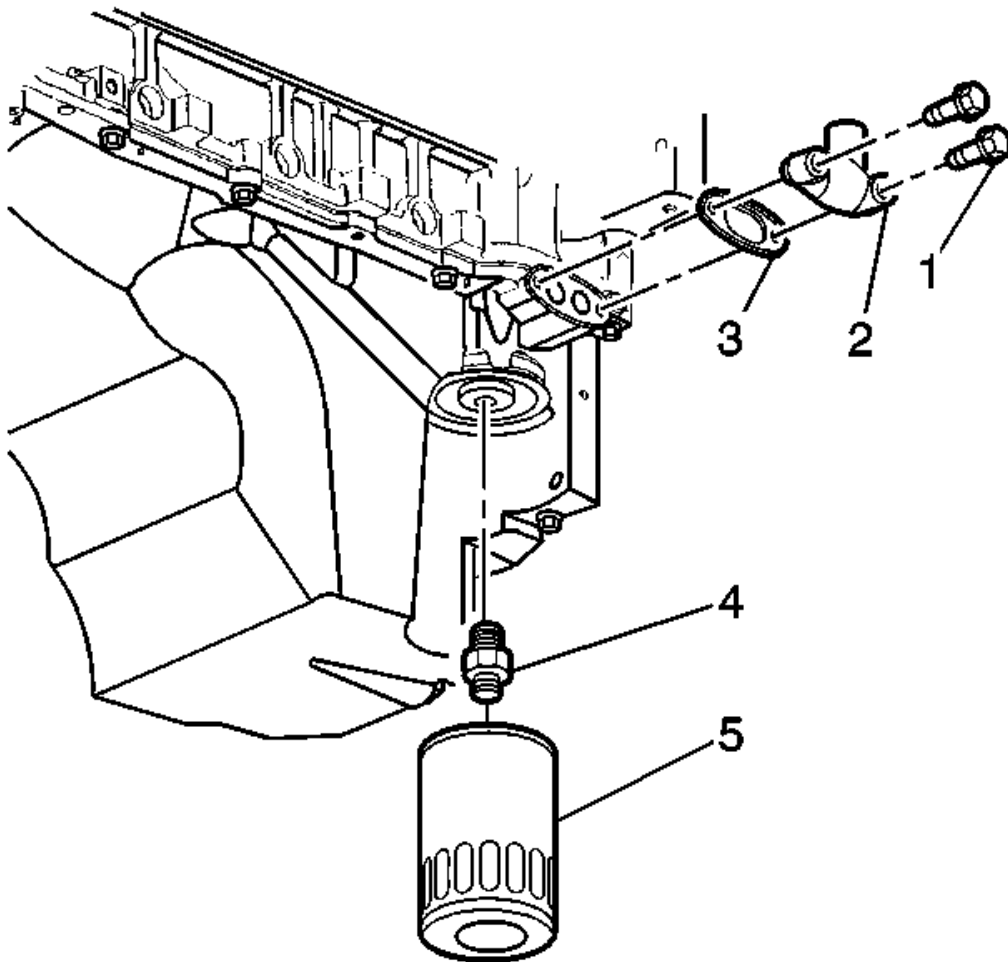


Fig. 174: Oil Pan Cover Bolts, Cover, And Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Install a new oil pan cover gasket (3), the cover (2) and bolts (1).

Tighten: Tighten the bolts to 12 N.m (106 lb in).

2. Refill the engine oil. Refer to **SEALERS, ADHESIVES & LUBRICANTS** and/or **DRAINING FLUIDS & OIL FILTER REMOVAL**.

OIL PAN REPLACEMENT

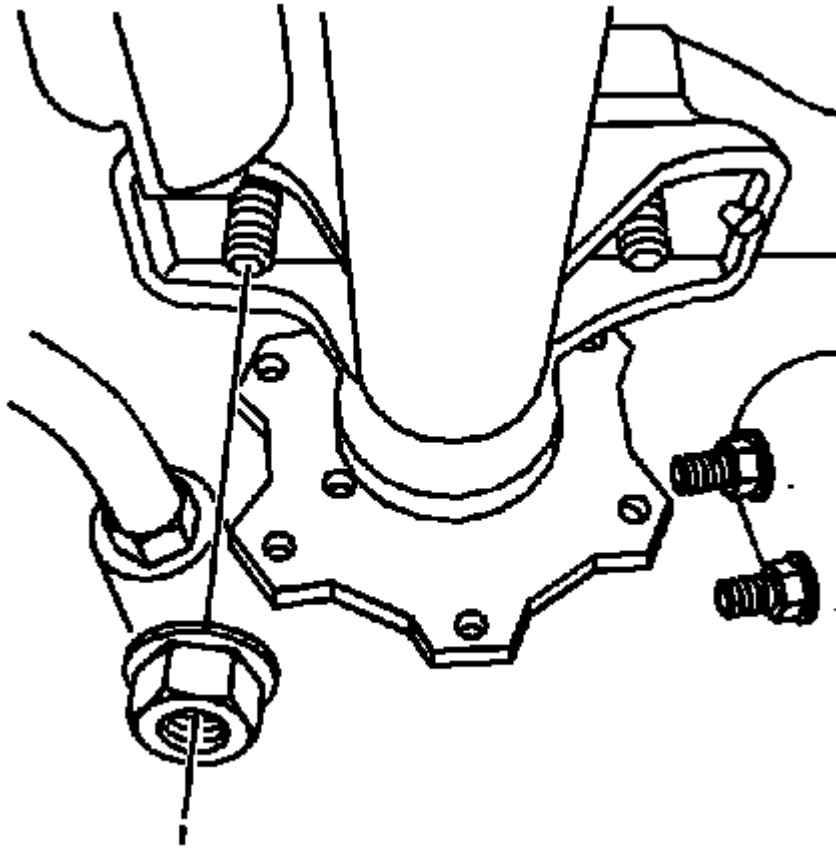
Removal Procedure

Fig. 175: View Of Inner Axle Housing Nuts
Courtesy of GENERAL MOTORS CORP.

1. If equipped with four wheel drive (4WD), remove the inner axle housing nuts and washers from the bracket.
2. Support the front drive axle with a suitable jack.

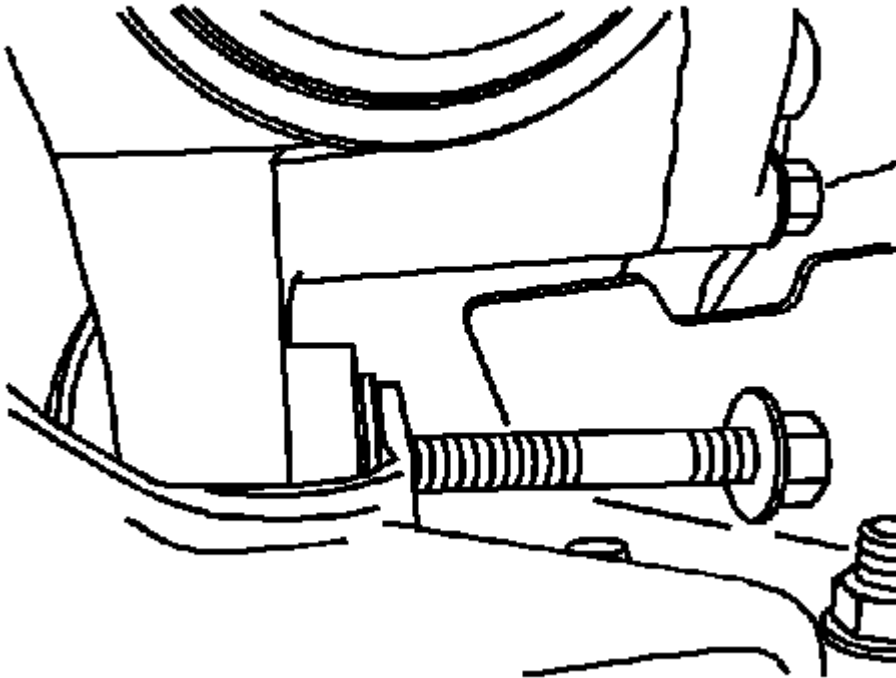


Fig. 176: View Of Differential Carrier Lower Mounting Bolt
Courtesy of GENERAL MOTORS CORP.

3. If equipped with 4WD, remove the differential carrier lower mounting bolt and nut.

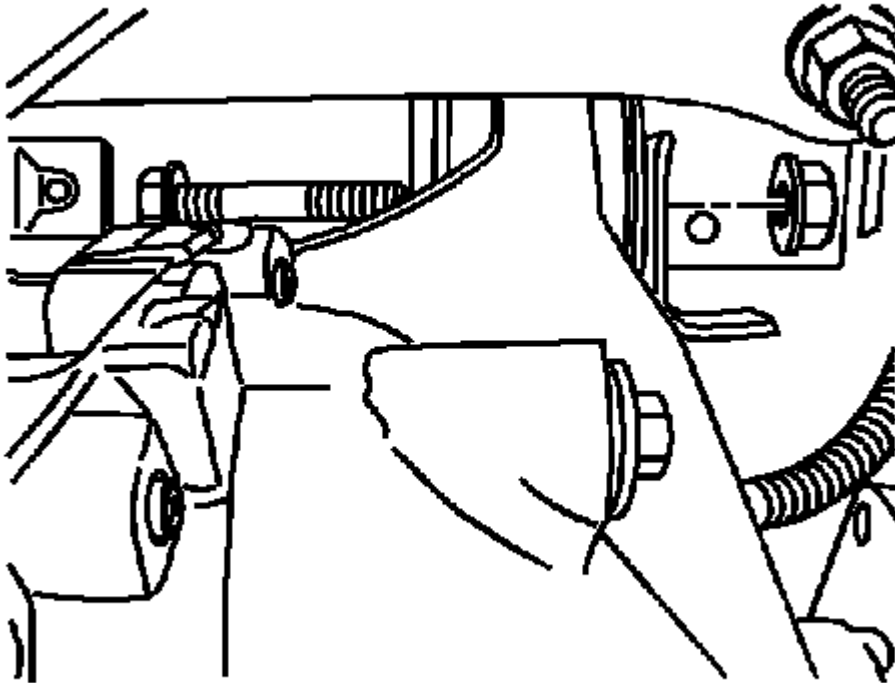


Fig. 177: View Of Differential Carrier Upper Mounting Bolt
Courtesy of GENERAL MOTORS CORP.

4. If equipped with 4WD, remove the differential carrier upper mounting bolt and nut.
5. Lower the front drive axle.

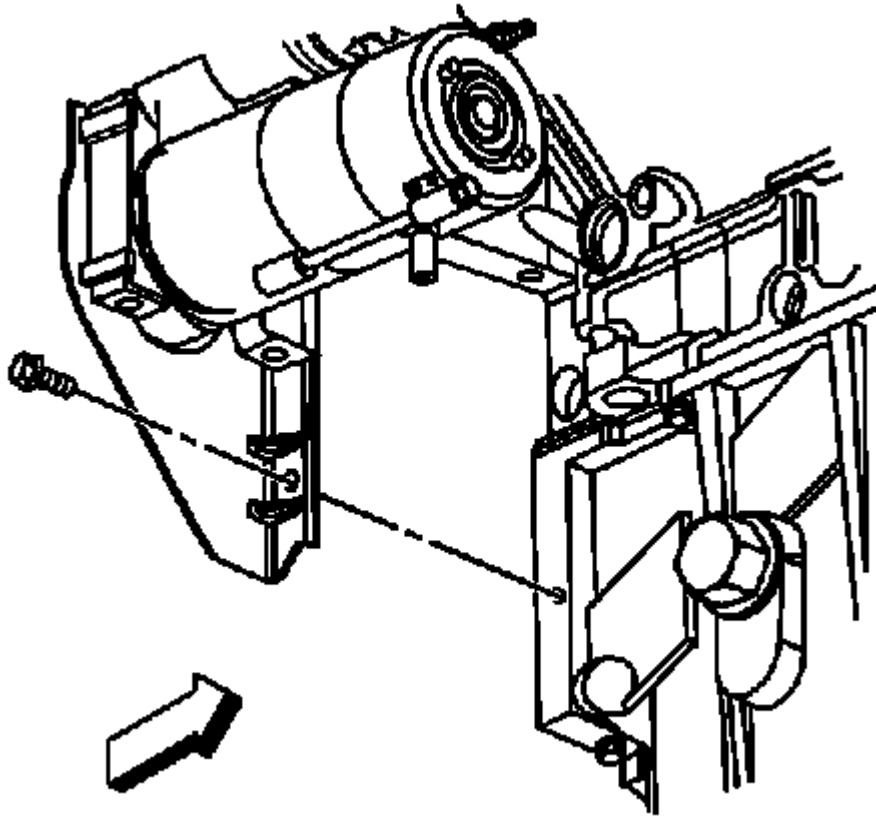


Fig. 178: View Of Transmission Cover Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the transmission cover bolts.

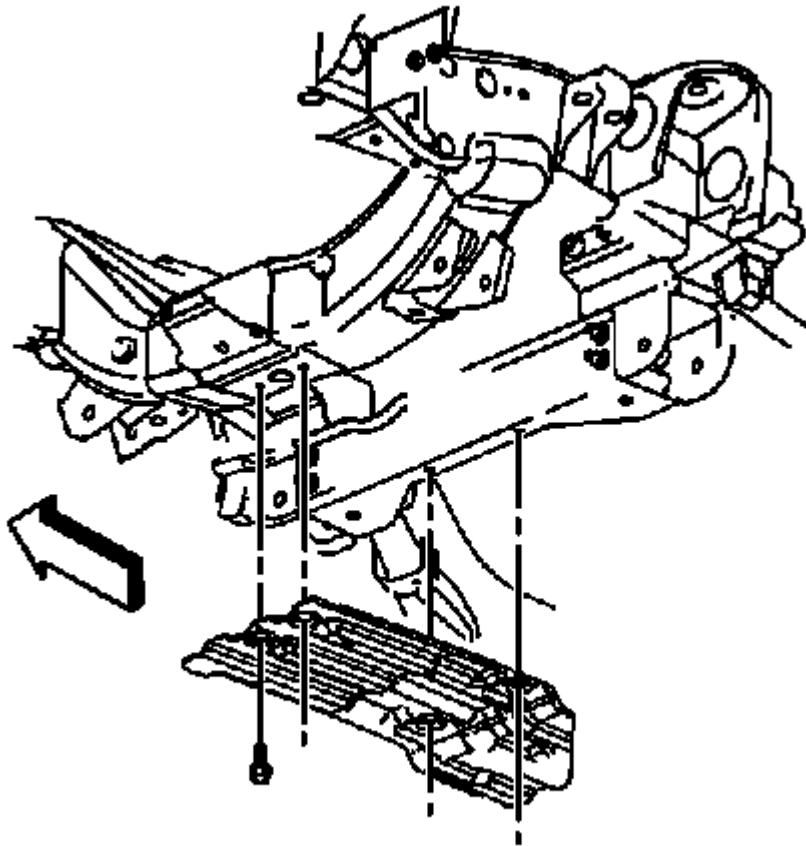


Fig. 179: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

7. If equipped, remove the oil pan skid plate bolts.
8. Remove the oil pan skid plate.

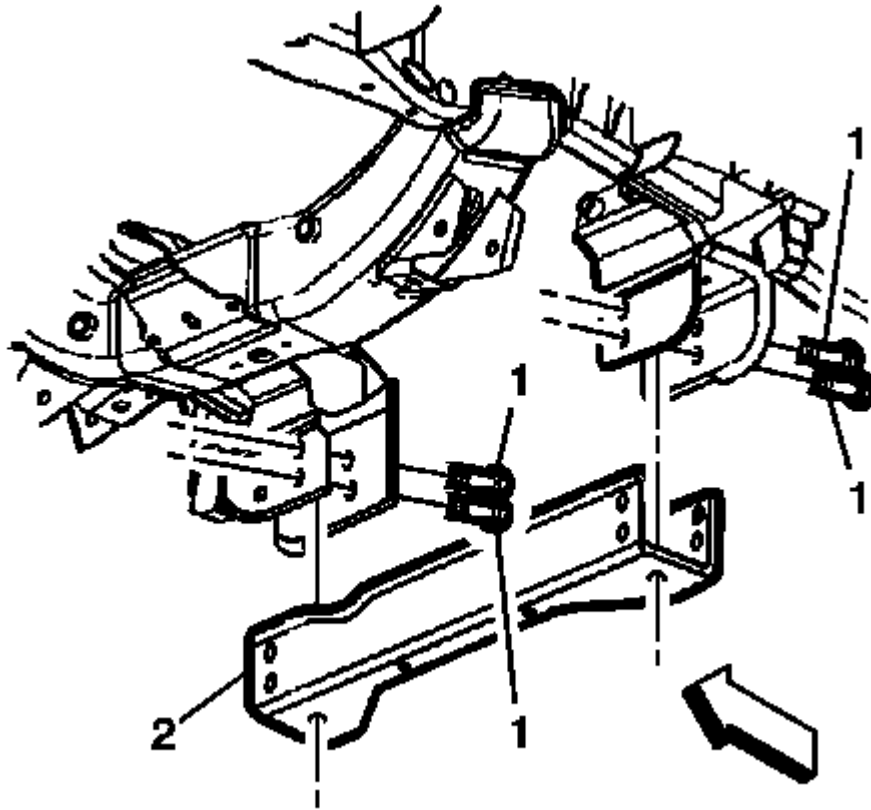


Fig. 180: View Of Crossbar Bolts & Bar (2WD)
 Courtesy of GENERAL MOTORS CORP.

9. Remove the crossbar bolts.
10. Remove the crossbar.

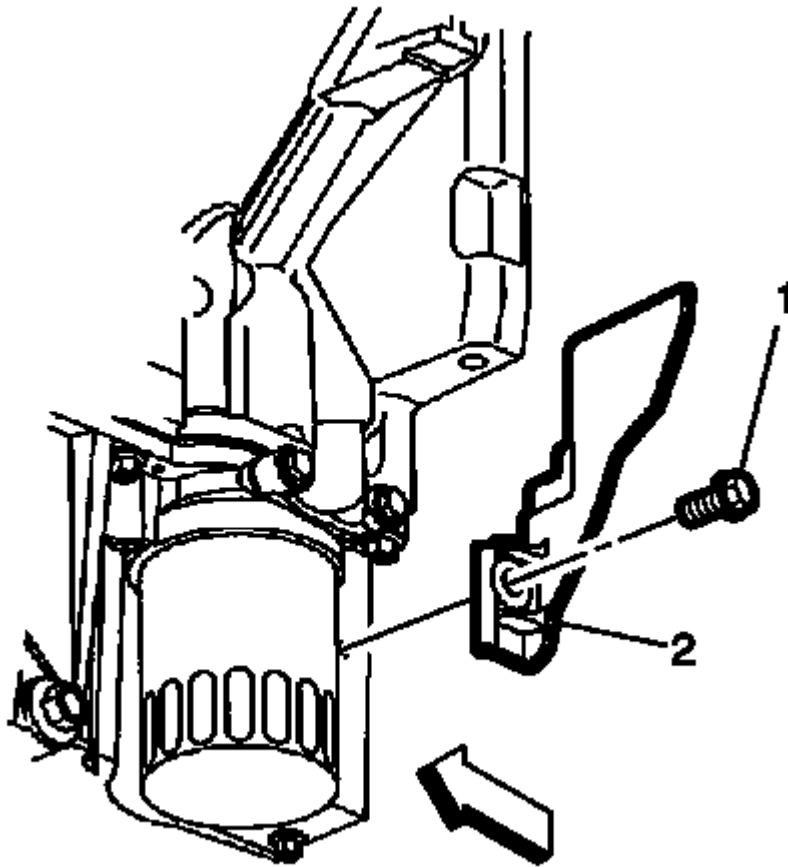


Fig. 181: View Of Left Closeout Cover & Bolt
Courtesy of GENERAL MOTORS CORP.

11. Remove the transmission cover bolt and cover.
12. Drain the engine oil and remove the engine oil filter.
13. Re-install the drain plug and oil filter until snug.

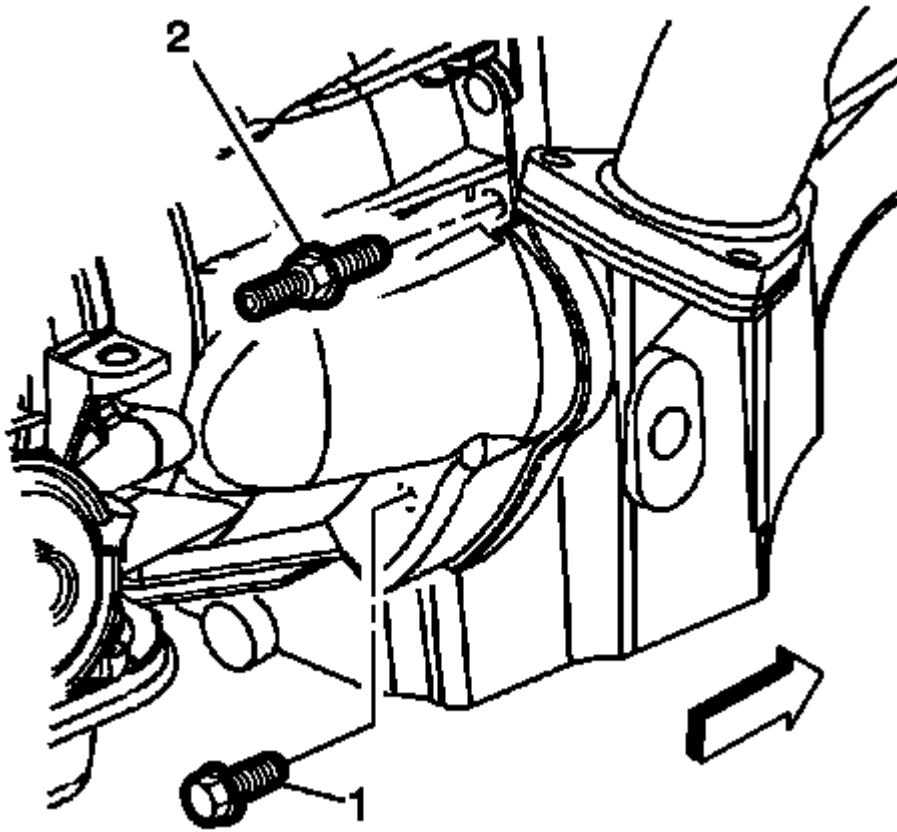


Fig. 182: Identifying Stud & Bolt Securing Transmission To Engine (Right Side)
Courtesy of GENERAL MOTORS CORP.

14. If equipped with the 4L60-E automatic transmission, remove the transmission bolt and stud on the right side.

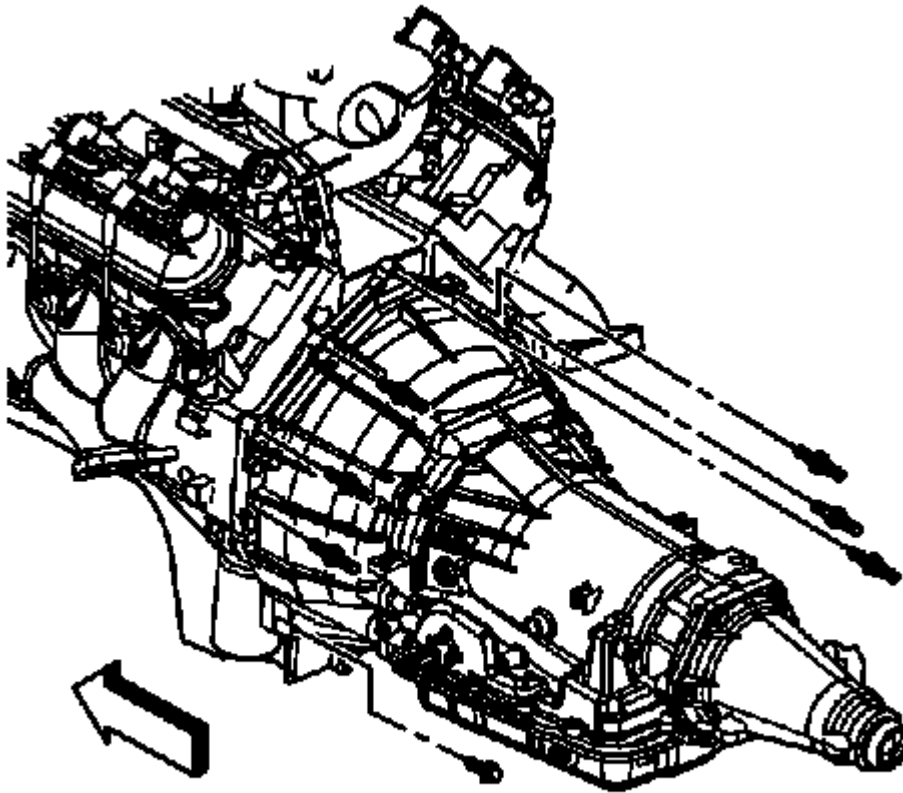


Fig. 183: Identifying Six Studs & One Bolt Securing Transmission To Engine
Courtesy of GENERAL MOTORS CORP.

15. Remove the bottom bolt on the left side.

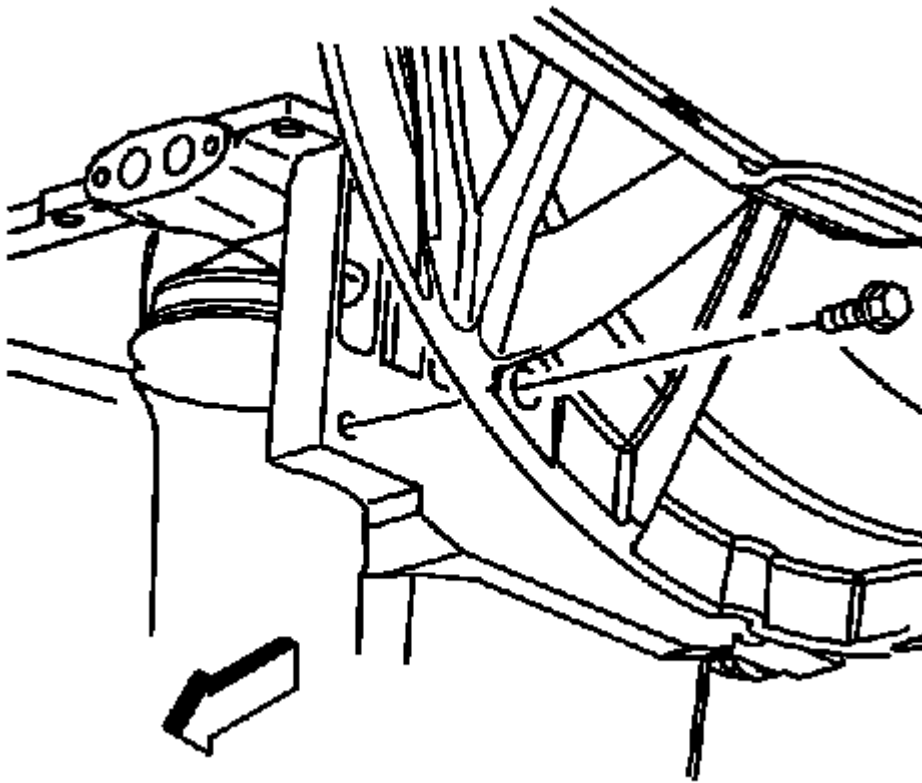


Fig. 184: View Of Transmission Converter Cover Bolt (4L80-E)
Courtesy of GENERAL MOTORS CORP.

16. If equipped with the 4L80-E automatic transmission, remove the transmission converter cover bolts.

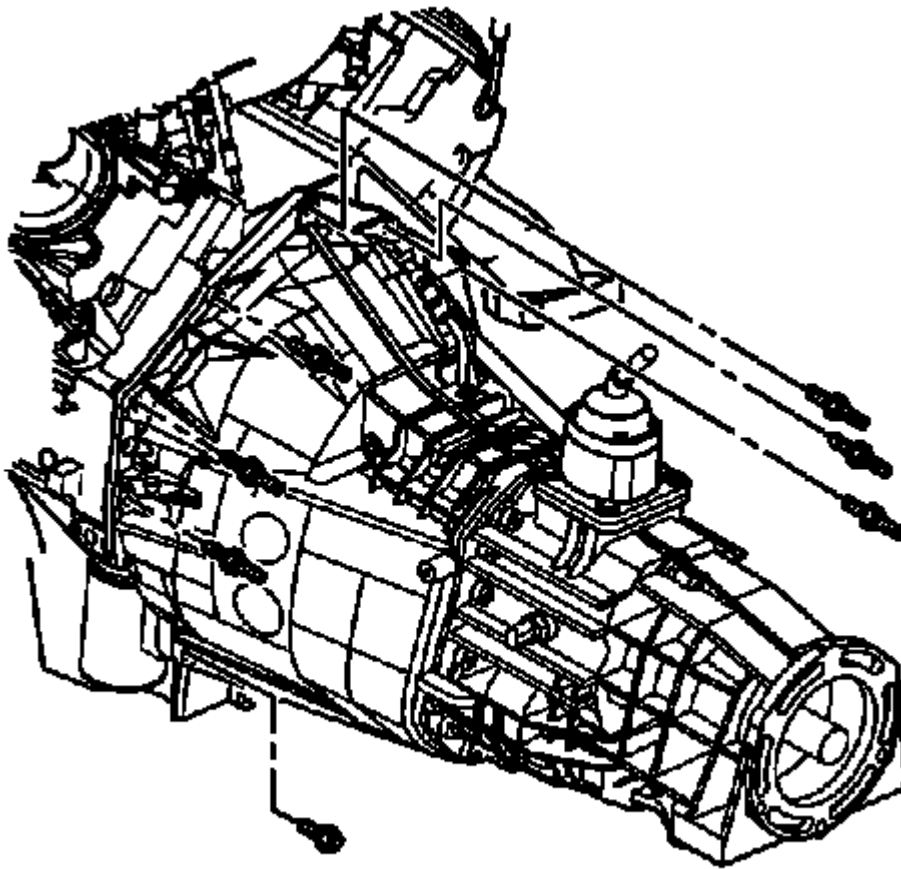


Fig. 185: Stud And Bolt Securing The Transmission To The Engine
Courtesy of GENERAL MOTORS CORP.

17. If equipped with a manual transmission, remove the two bottom bellhousing bolts.

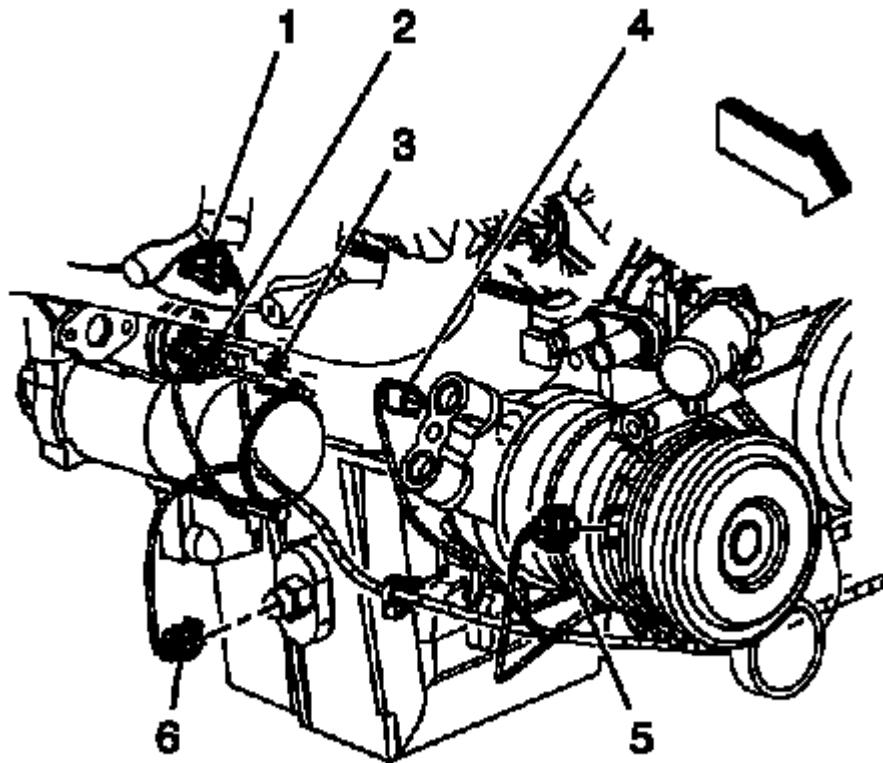


Fig. 186: Identifying Electrical Connector (Right Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

18. Disconnect the oil level sensor electrical connector (6).

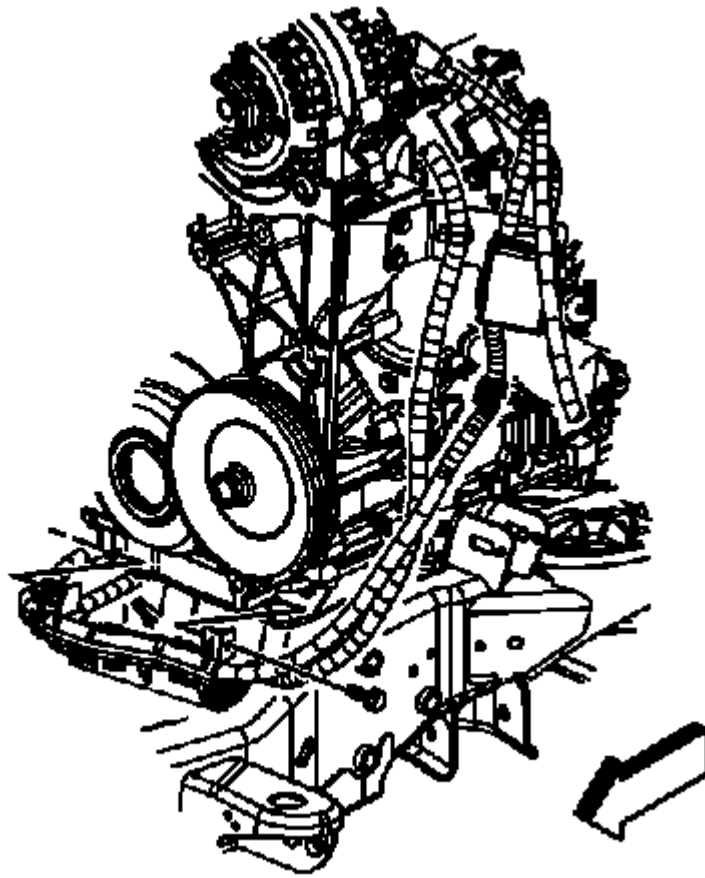


Fig. 187: View Of Positive Battery Cable, Channel & Bolt
Courtesy of GENERAL MOTORS CORP.

19. Remove the battery cable channel bolt.
20. Slide the channel pin out of the oil pan tab.

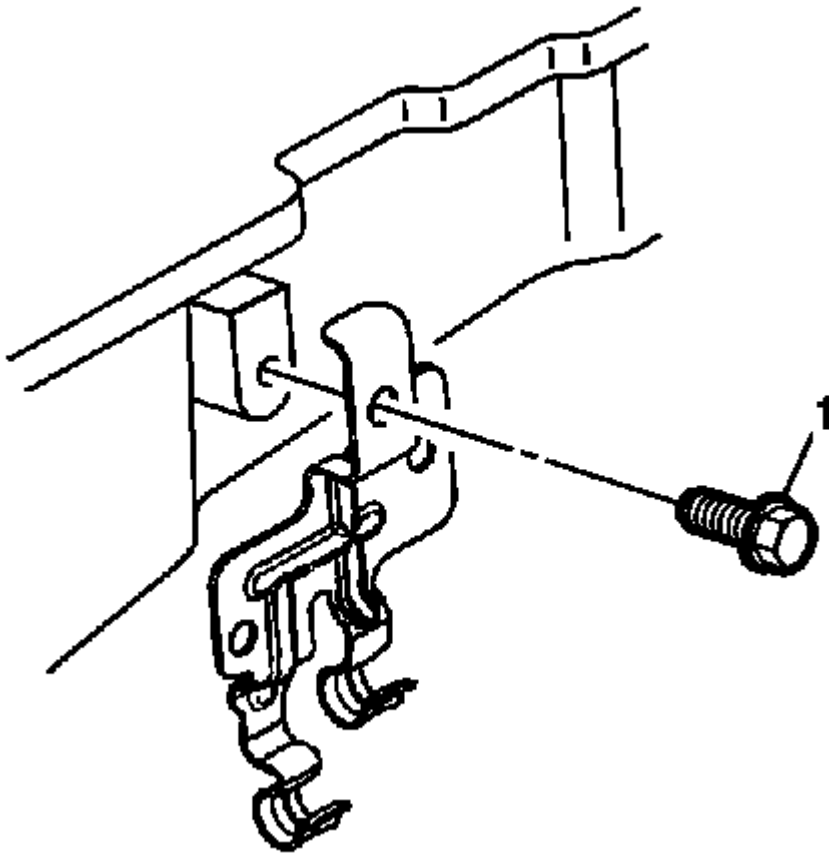


Fig. 188: View Of Positive Battery Cable Clip & Bolt
Courtesy of GENERAL MOTORS CORP.

21. Remove the positive battery cable clip bolt and clip.

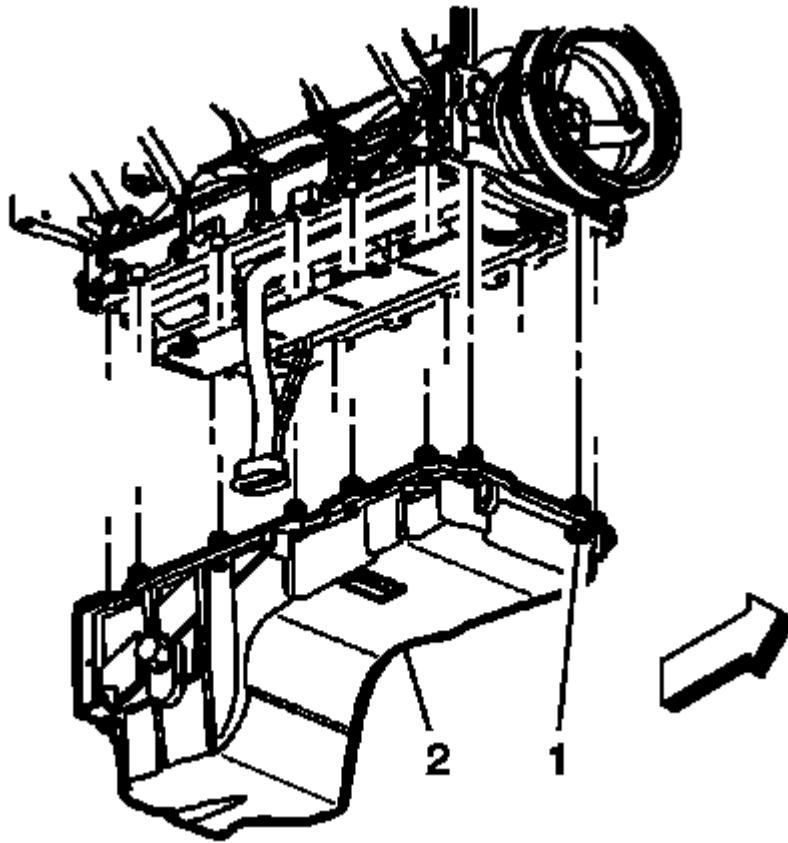


Fig. 189: Oil Pan & Bolts

Courtesy of GENERAL MOTORS CORP.

22. Remove the oil pan bolts.
23. Remove the oil pan.

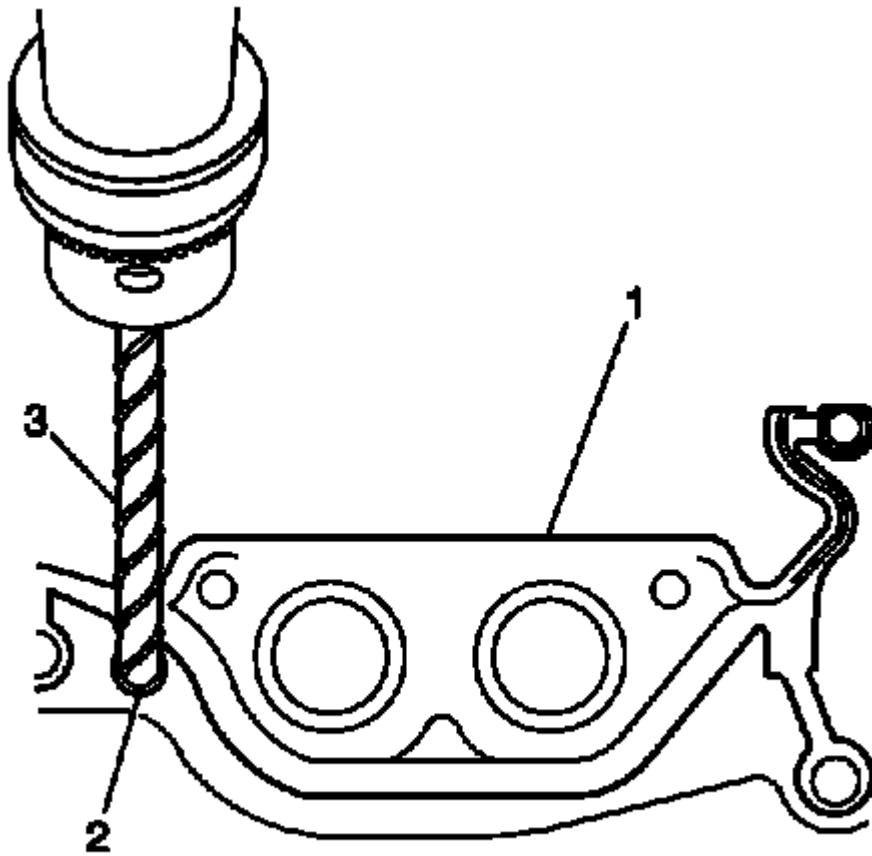


Fig. 190: Oil Pan Gasket Retaining Rivets
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT allow foreign material to enter the oil passages of the oil pan, cap or cover the openings as required.

24. Drill (3) out the oil pan gasket retaining rivets (2), if required.
25. Remove the gasket (1) from the pan.
26. Discard the gasket and rivets.
27. Clean and inspect the engine oil pan.

Installation Procedure

- IMPORTANT:**
- The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission bellhousing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan must **NEVER** protrude beyond the engine block and transmission bellhousing plane.

- Do not reuse the oil pan gasket.
- It is not necessary to rivet the NEW gasket to the oil pan.

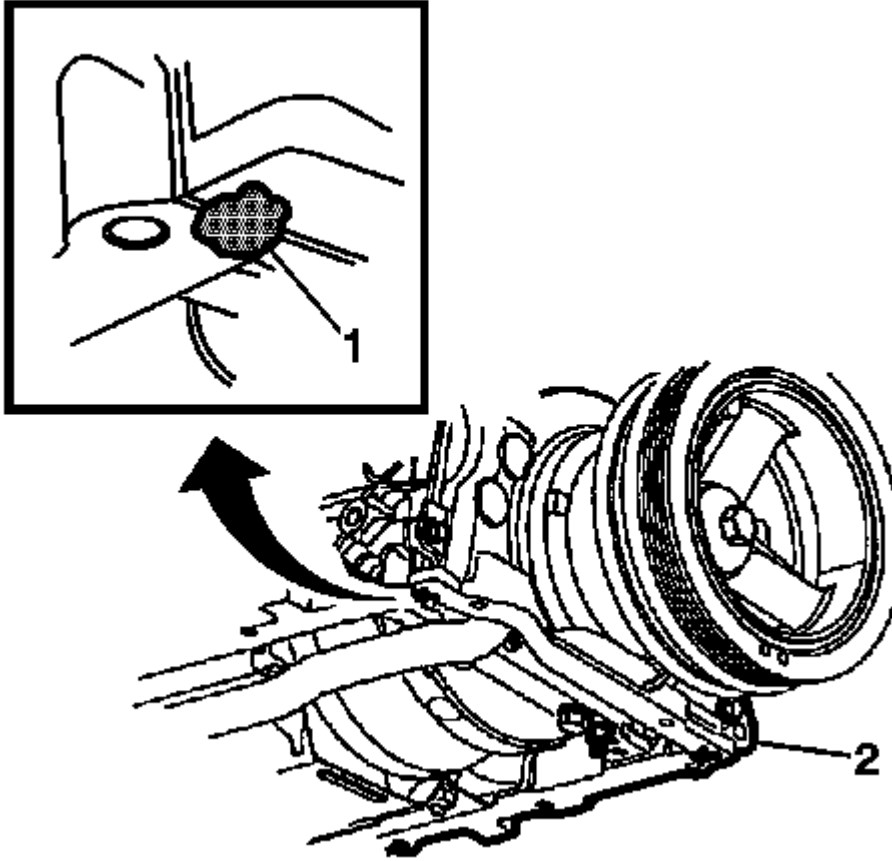


Fig. 191: View Of Sealant Applied To Front Oil Pan-To-Engine Block Junction
Courtesy of GENERAL MOTORS CORP.

1. Apply a 5 mm (0.20 in) bead of sealant GM P/N United States 12378190, or equivalent 20 mm (0.80 in) long to the engine block. Apply the sealant directly onto the tabs of the front cover gasket that protrudes into the oil pan surface.

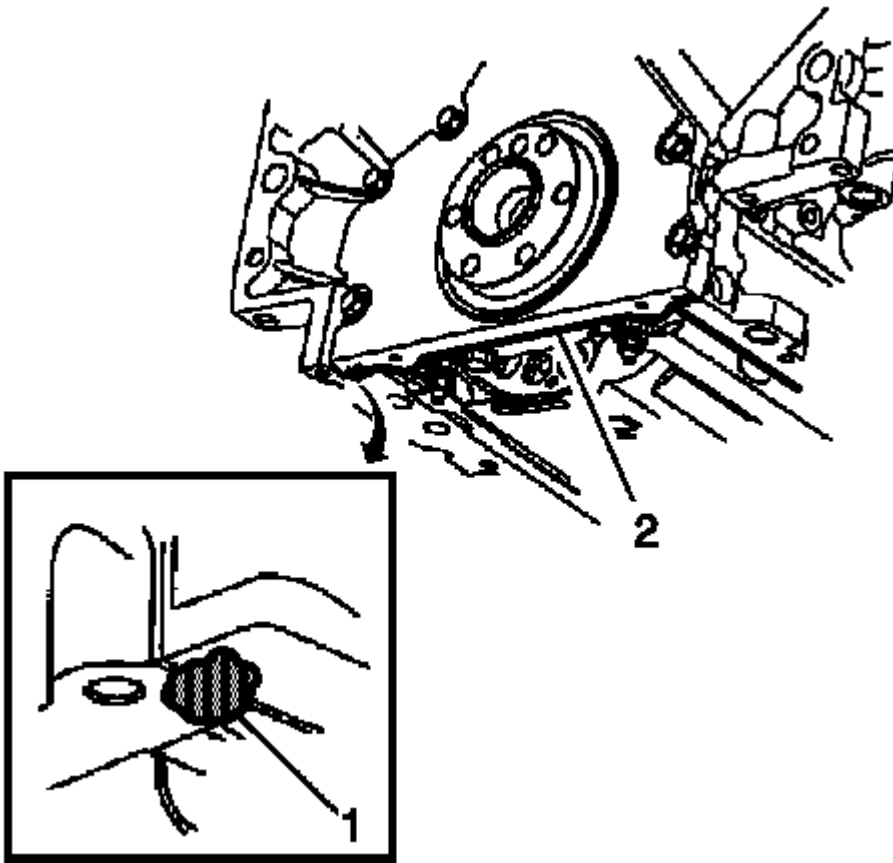


Fig. 192: View Of Sealant Applied To Rear Oil Pan-To-Engine Block Junction
Courtesy of GENERAL MOTORS CORP.

2. Apply a 5 mm (0.20 in) bead of sealant GM P/N United States 12378190, or equivalent 20 mm (0.8 in) long to the engine block. Apply the sealant directly onto the tabs of the rear cover gasket that protrudes into the oil pan surface.

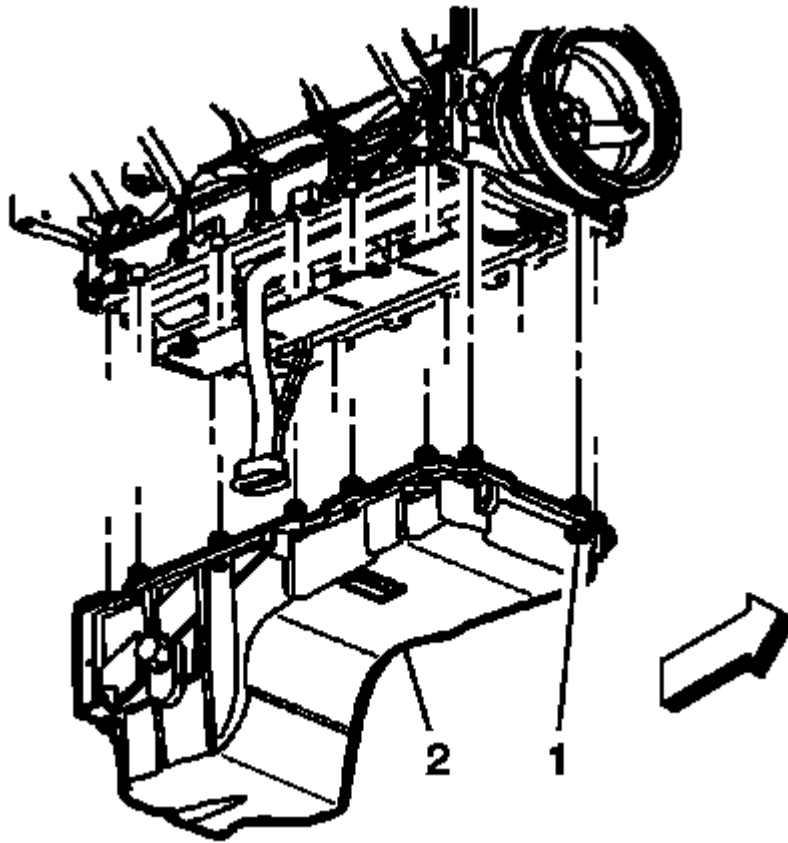


Fig. 193: Oil Pan & Bolts

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Be sure to align the oil gallery passages in the oil pan and engine block properly with the oil pan gasket.

3. Pre-assemble the oil pan gasket to the pan.
 - Install the gasket onto the pan.
 - Install the oil pan bolts to the pan and through the gasket.
4. Install the oil pan, gasket and bolts to the engine block.
5. Tighten the oil pan bolts until snug. Do not overtighten.

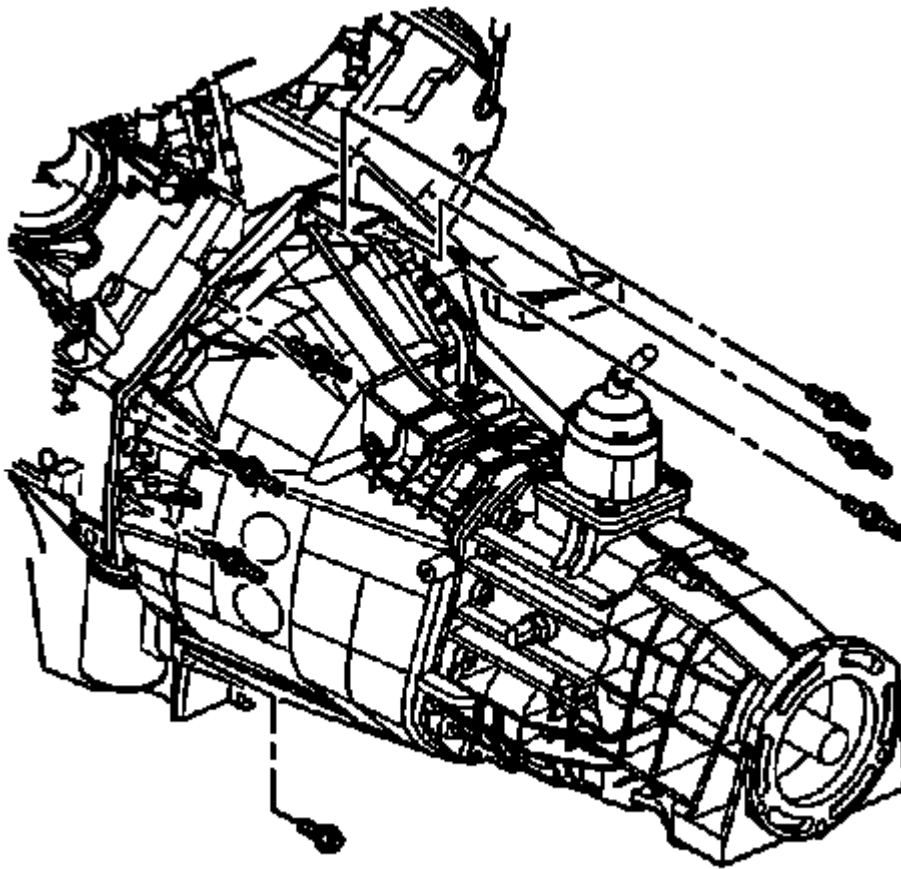


Fig. 194: Manual Transmission Bellhousing Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the two bottom bellhousing bolts until snug, if equipped with a manual transmission.

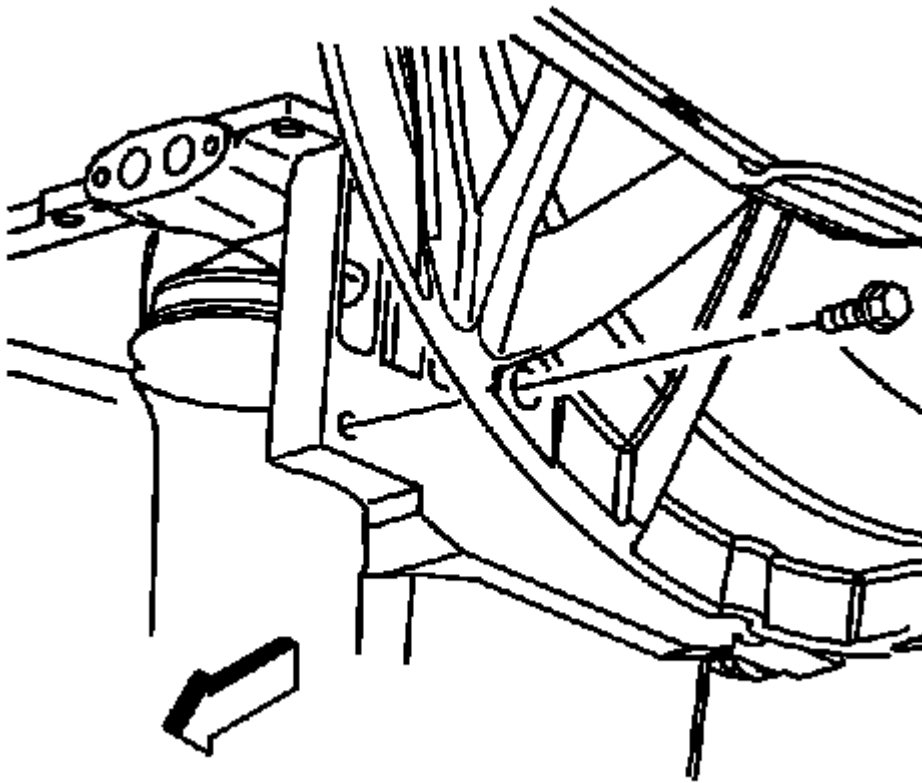


Fig. 195: View Of Transmission Converter Cover Bolt (4L80-E)
Courtesy of GENERAL MOTORS CORP.

7. Install the transmission converter cover bolts until snug, if equipped with the 4L80-E automatic transmission.

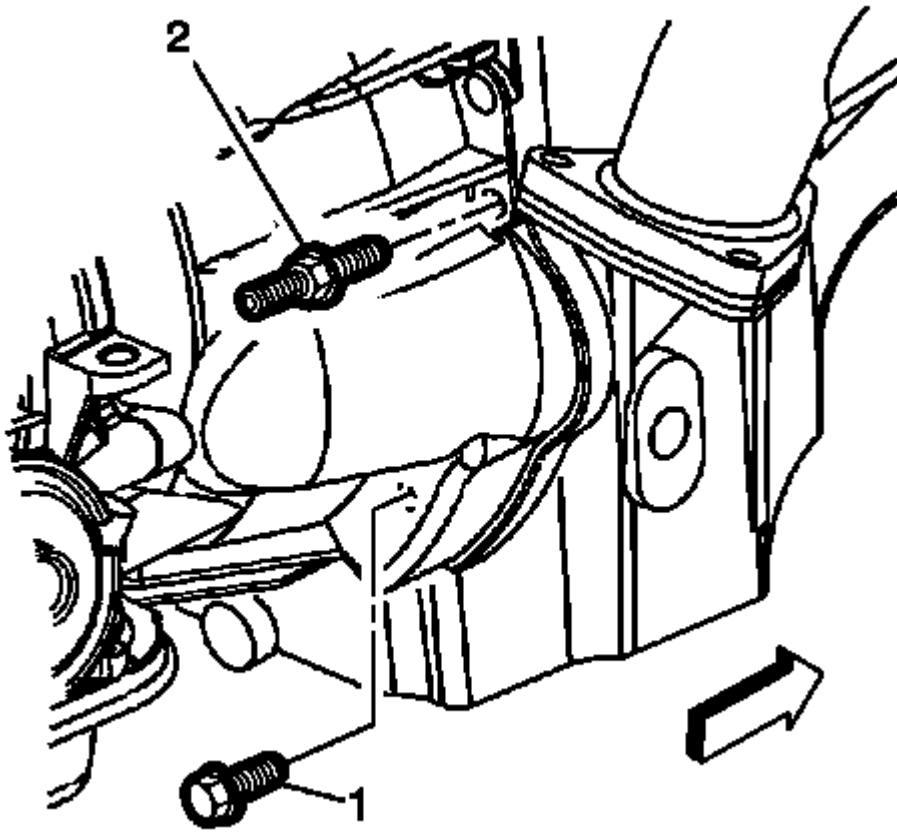


Fig. 196: Identifying Stud & Bolt Securing Transmission To Engine (Right Side)
Courtesy of GENERAL MOTORS CORP.

8. Install the transmission bolt and stud on the right side until snug, If equipped with the 4L60-E automatic transmission.

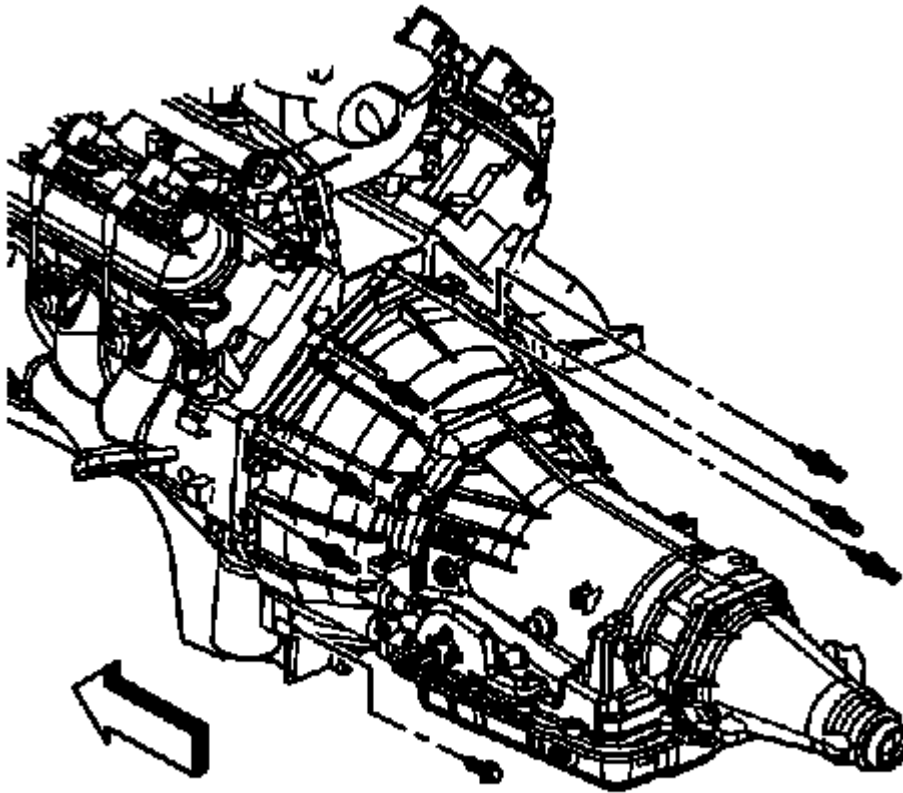


Fig. 197: Identifying Six Studs & One Bolt Securing Transmission To Engine
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

9. Install the bottom bolt on the left side until snug.

Tighten:

1. Tighten the oil pan, and oil pan-to-front cover bolts to 25 N.m (18 lb ft).
2. Tighten the oil pan-to-rear cover bolts to 12 N.m (106 lb in).
3. Tighten the bellhousing, converter cover, and transmission bolts/stud to 50 N.m (37 lb ft).

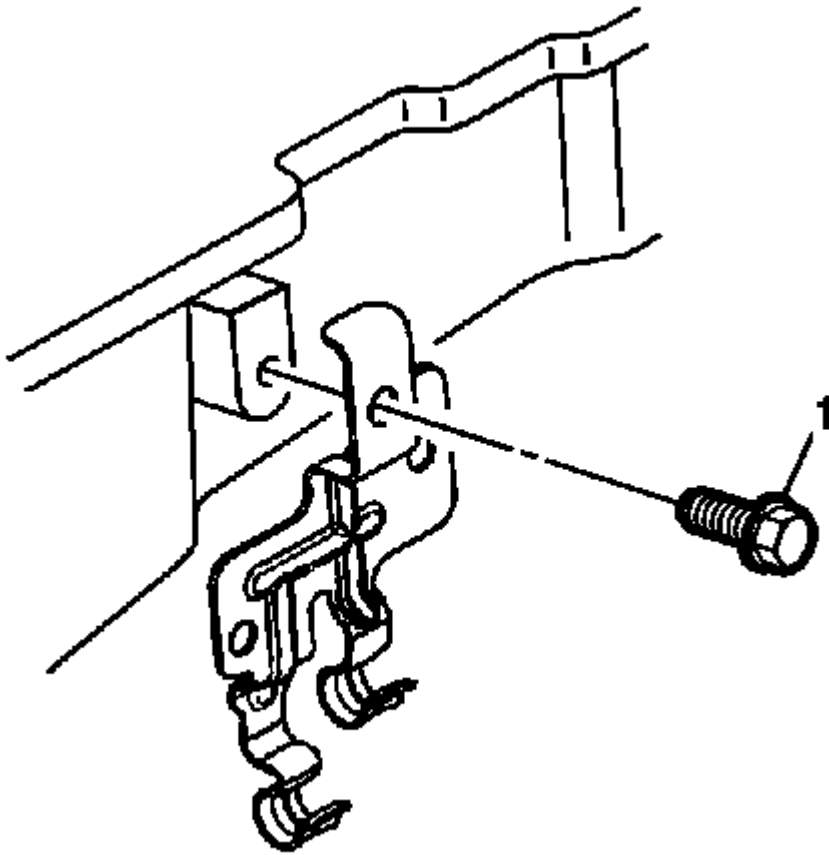


Fig. 198: View Of Positive Battery Cable Clip & Bolt
Courtesy of GENERAL MOTORS CORP.

10. Install the positive battery cable clip and bolt to the oil pan.

Tighten: Tighten the positive battery cable clip bolt to 9 N.m (80 lb in).

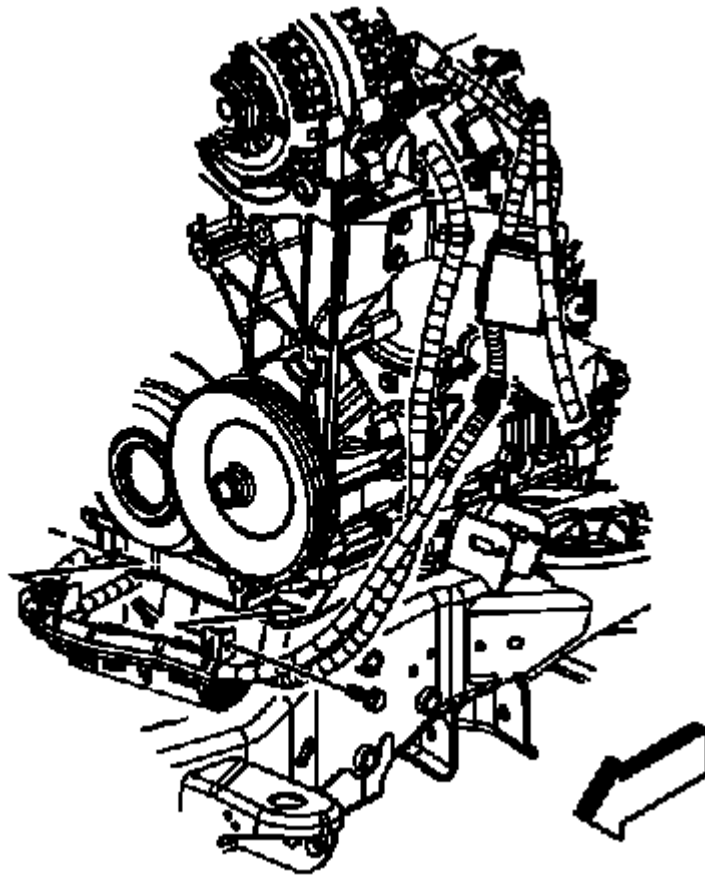


Fig. 199: View Of Positive Battery Cable, Channel & Bolt
Courtesy of GENERAL MOTORS CORP.

11. Slide the channel pin in to the oil pan tab.
12. Install the battery cable channel bolt.

Tighten: Tighten the battery cable channel bolt to 12 N.m (106 lb in).

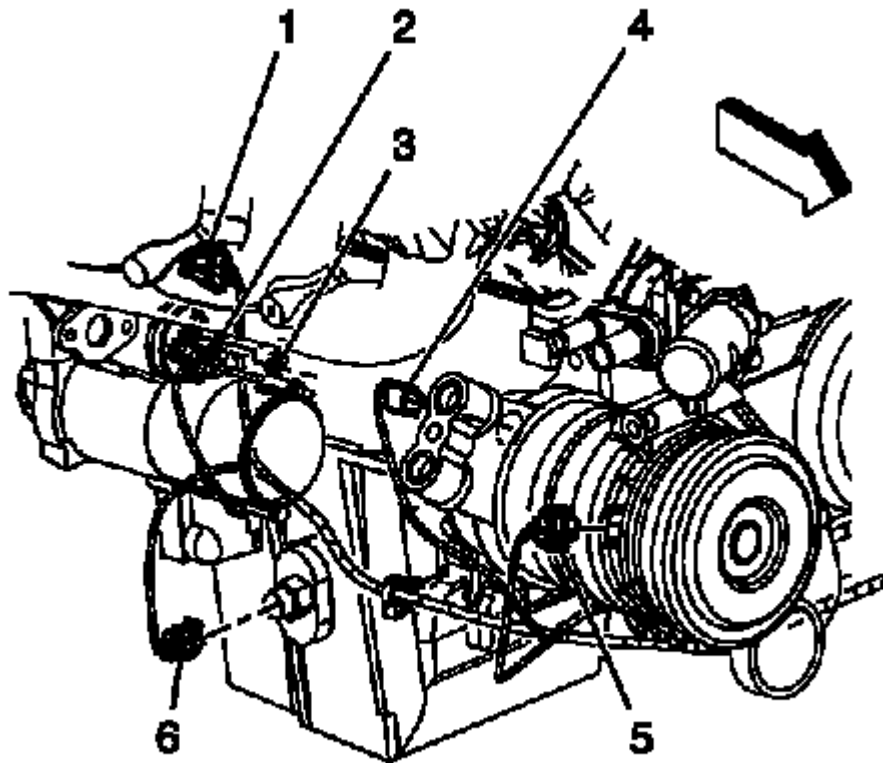


Fig. 200: Identifying Electrical Connector (Right Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

13. Connect the oil level sensor electrical connector (6).

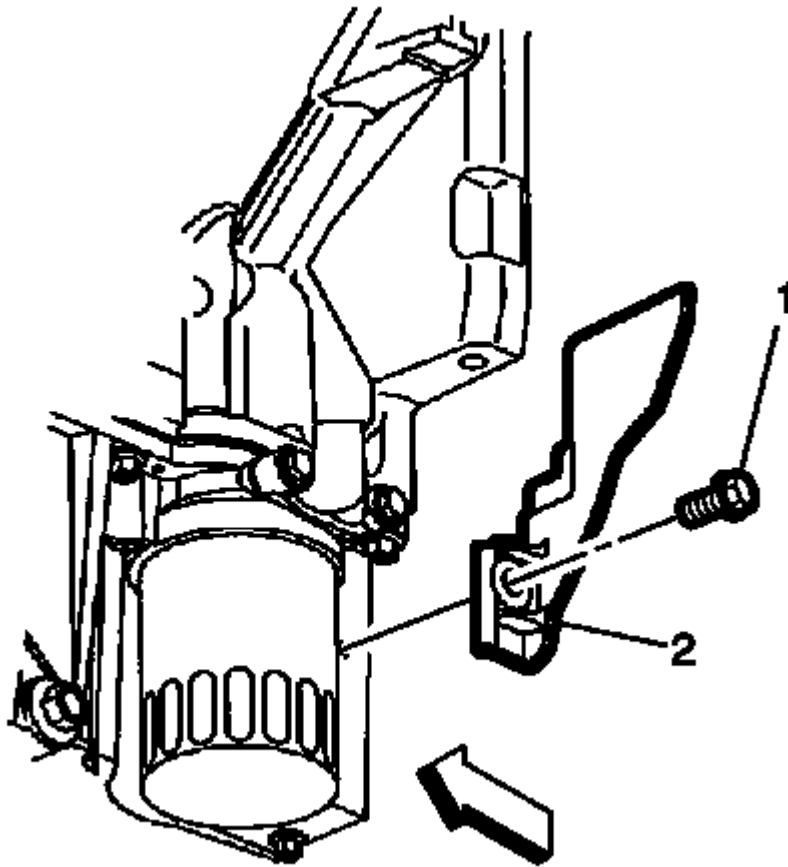


Fig. 201: View Of Left Closeout Cover & Bolt
Courtesy of GENERAL MOTORS CORP.

14. Install the transmission cover and bolt.

Tighten: Tighten the transmission cover bolt to 12 N.m (106 lb in).

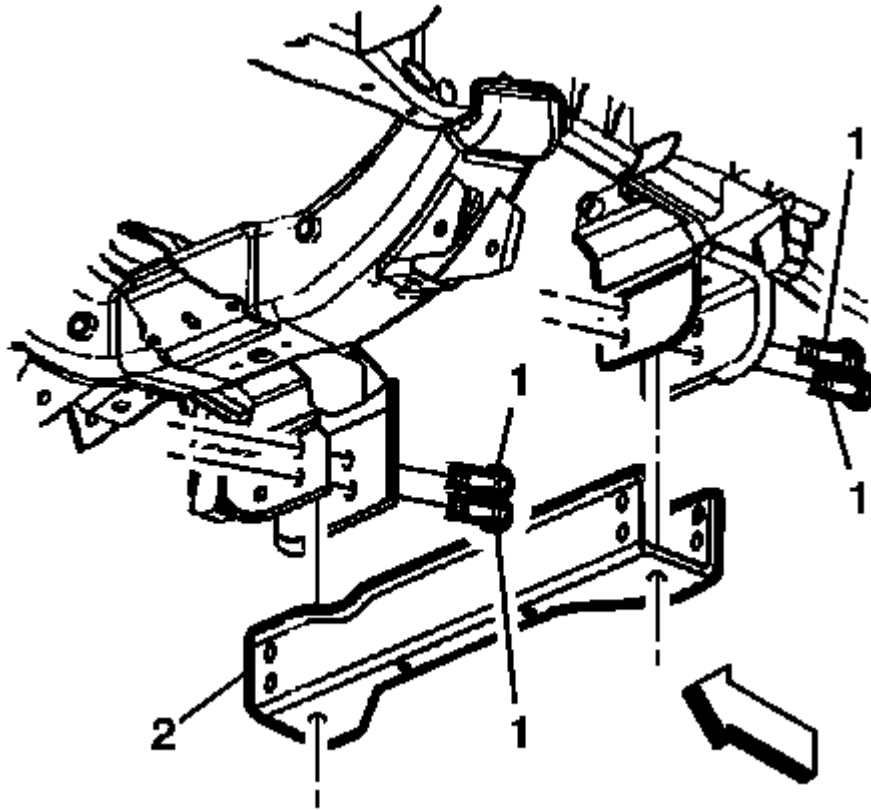


Fig. 202: View Of Crossbar Bolts & Bar (2WD)
Courtesy of GENERAL MOTORS CORP.

15. Install the crossbar.
16. Install the crossbar bolts.

Tighten: Tighten the crossbar bolts to 100 N.m (74 lb ft).

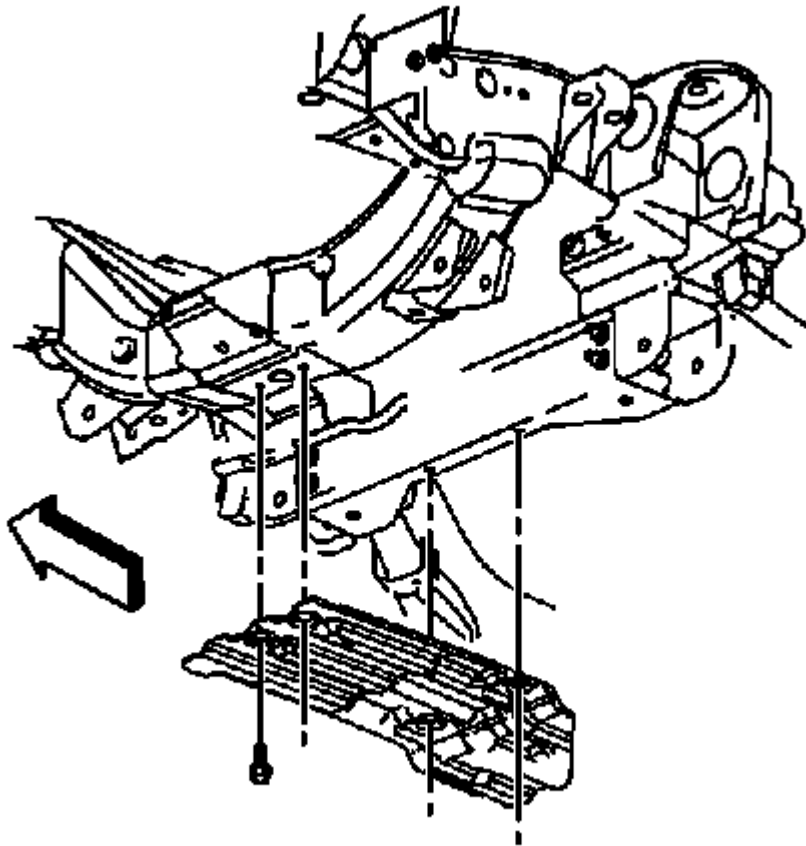


Fig. 203: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

17. If equipped, install the oil pan skid plate.
18. Install the oil pan skid plate bolts.

Tighten: Tighten the oil pan skid plate bolts to 20 N.m (15 lb ft).

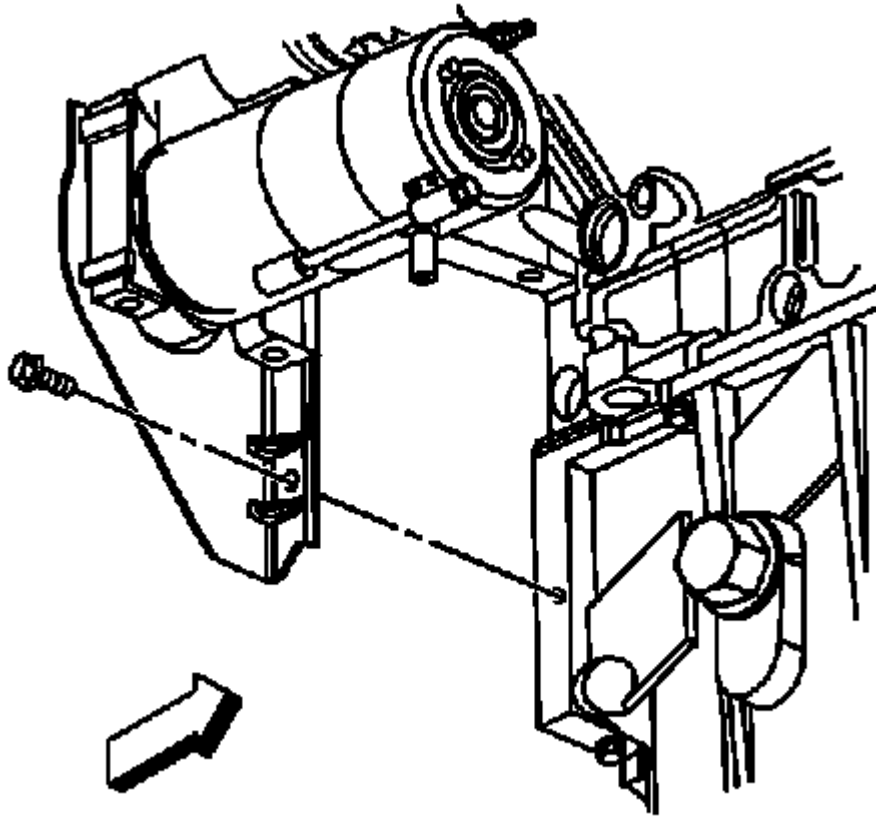


Fig. 204: View Of Transmission Cover Bolt
Courtesy of GENERAL MOTORS CORP.

19. Install the transmission cover bolts.

Tighten: Tighten the transmission cover bolt to 12 N.m (106 lb in).

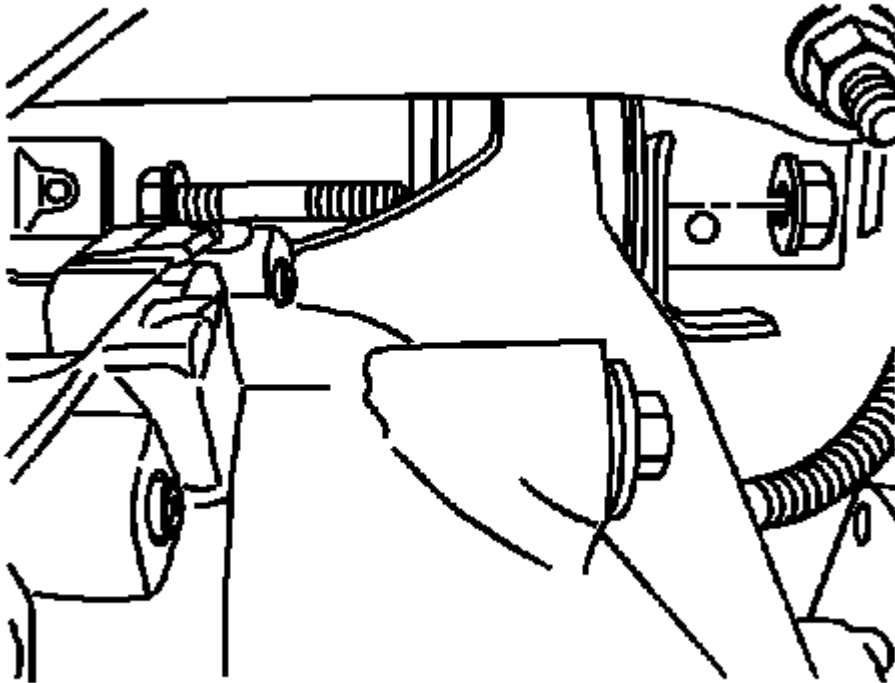


Fig. 205: View Of Differential Carrier Upper Mounting Bolt
Courtesy of GENERAL MOTORS CORP.

20. Raise the front drive axle into position.
21. If equipped with 4WD, install the differential carrier upper mounting bolt and nut until snug. Do not tighten at this time.

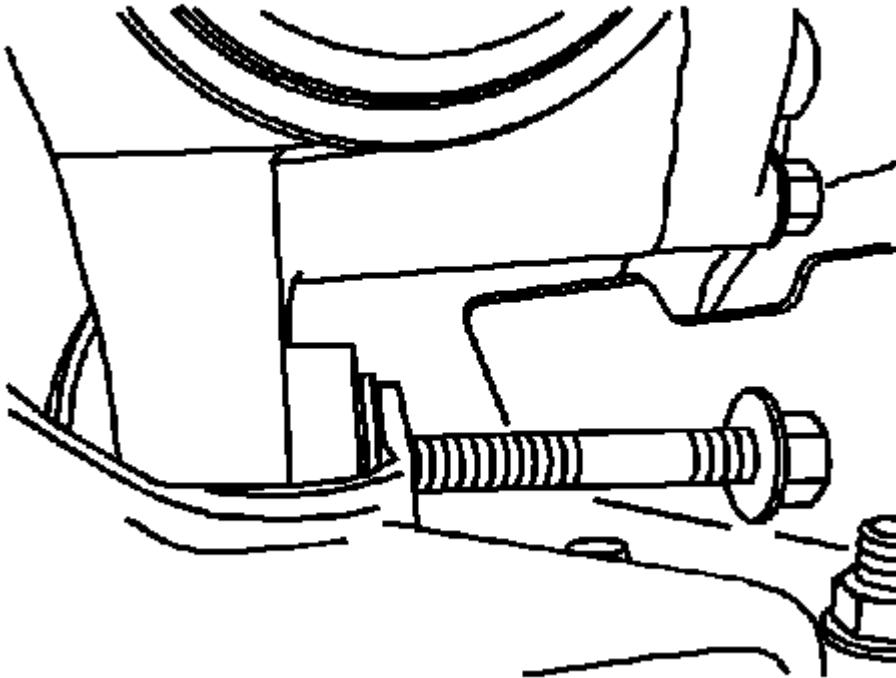


Fig. 206: View Of Differential Carrier Lower Mounting Bolt
Courtesy of GENERAL MOTORS CORP.

22. If equipped with 4WD, install the differential carrier lower mounting bolt and nut.

Tighten: Tighten the bolts to 100 N.m (75 lb ft).

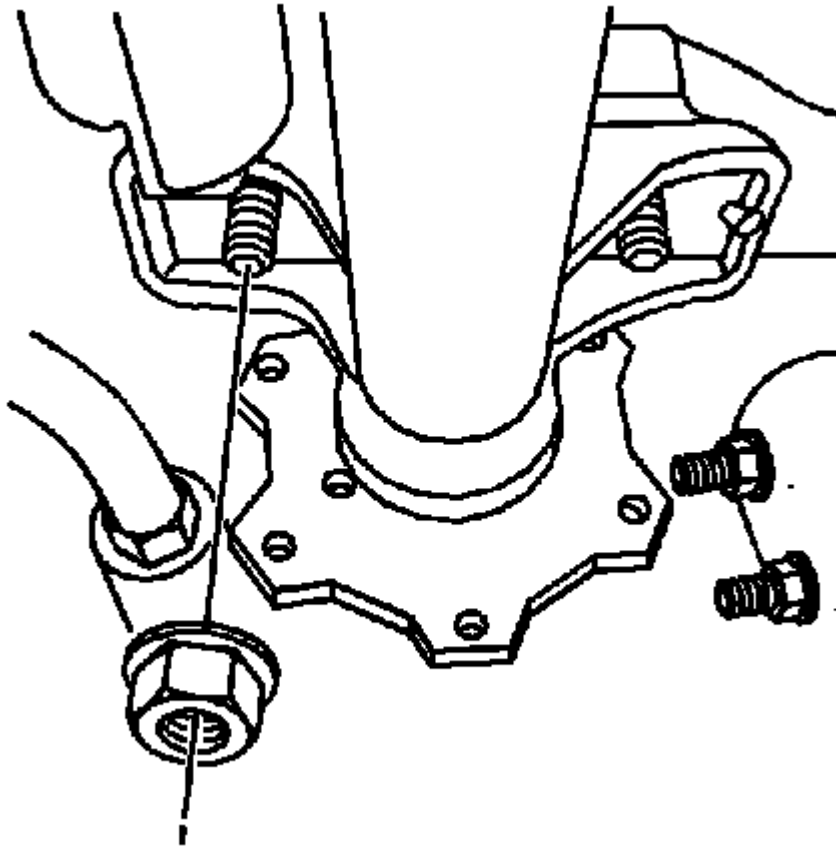


Fig. 207: View Of Inner Axle Housing Nuts
Courtesy of GENERAL MOTORS CORP.

23. If equipped with 4WD, install the inner axle housing nuts and washers to the bracket.

Tighten: Tighten the nuts to 100 N.m (75 lb ft).

24. Remove the jack from the front drive axle.
25. Install new engine oil and a new oil filter. Refer to Engine Oil and Oil Filter Replacement.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

Tools Required

J 41712 Oil Pressure Switch Socket. See SPECIAL TOOLS AND EQUIPMENT.

Removal Procedure

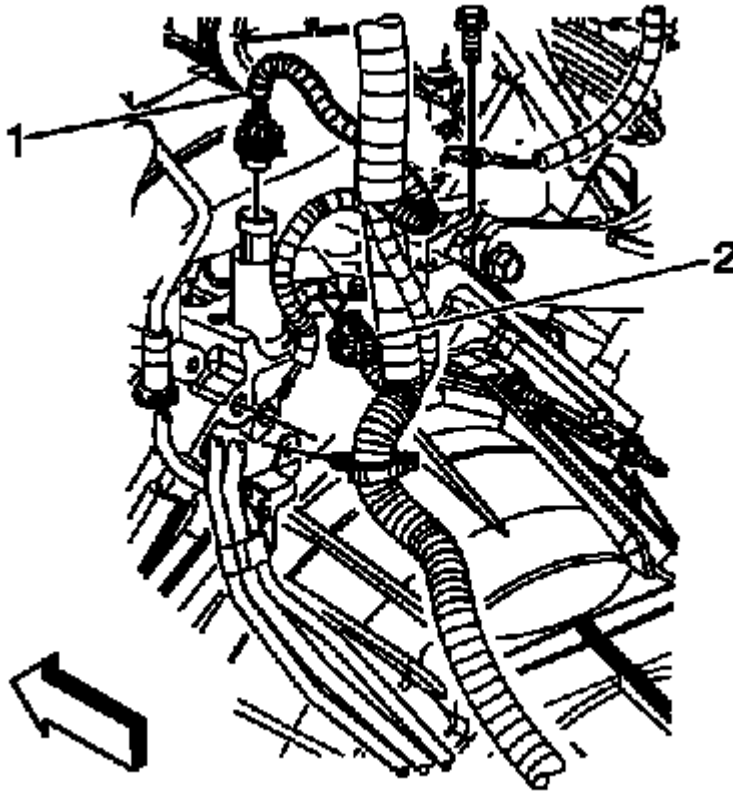


Fig. 208: View Of Oil Pressure Sensor & CMP Sensor Connectors
Courtesy of GENERAL MOTORS CORP.

1. If necessary, remove the engine sight shield. Refer to **Engine Sight Shield Replacement (4.8L, 5.3L, and 6.0L Engines)** or **Engine Sight Shield Replacement (6.0L Engine w/ RPOs Y91 and Z88)**.
2. Disconnect the oil pressure sensor electrical connector (1).

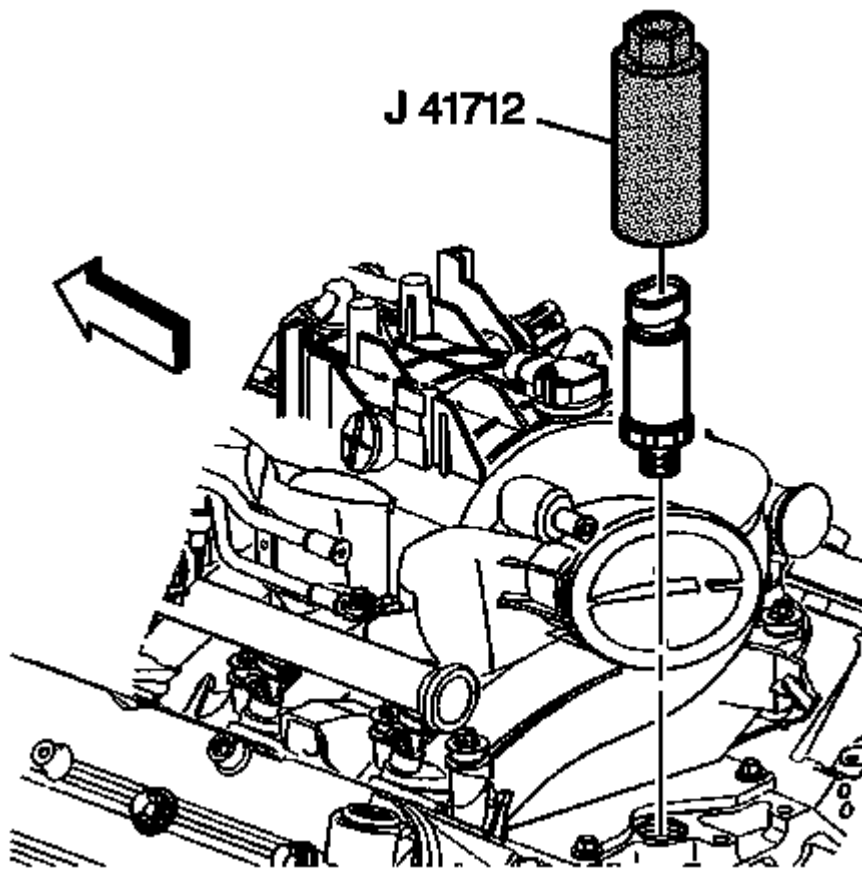


Fig. 209: J 41712 Removing The Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

3. Using **J 41712** or equivalent, remove the oil pressure sensor. See **SPECIAL TOOLS AND EQUIPMENT**.

Installation Procedure

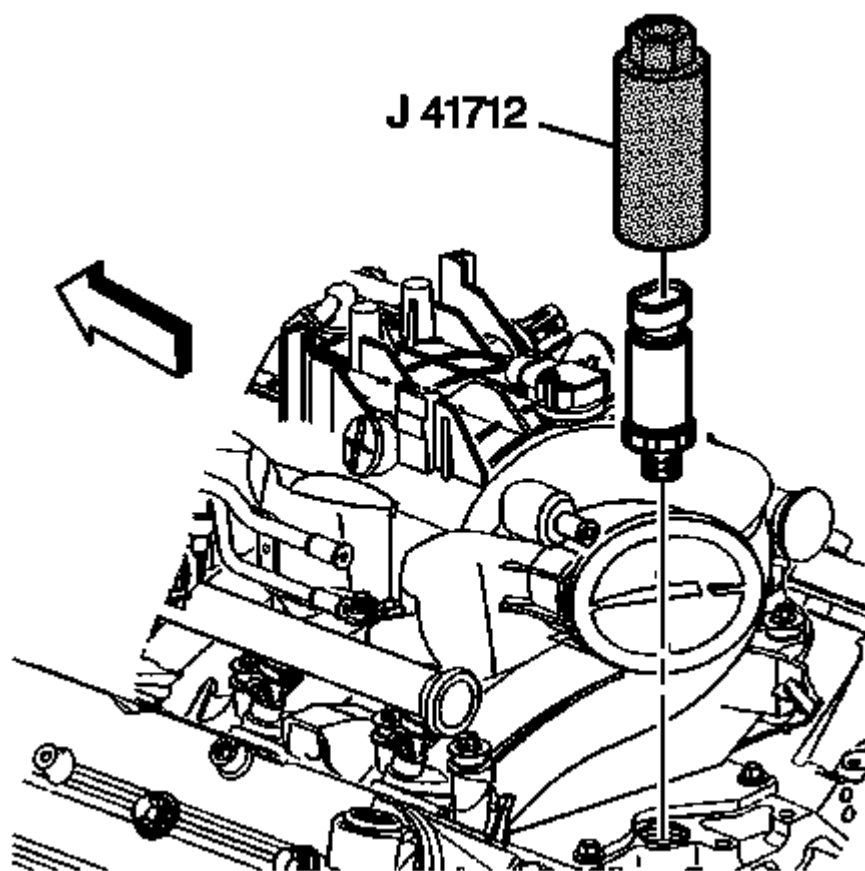


Fig. 210: J 41712 Installing The Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Apply sealant GM P/N 12346004, (Canadian P/N 10953480), or equivalent, to the threads of the oil pressure sensor.
2. Using **J 41712** or equivalent, install the oil pressure sensor. See **SPECIAL TOOLS AND EQUIPMENT**.

Tighten: Tighten the oil pressure sensor to 20 N.m (15 lb ft).

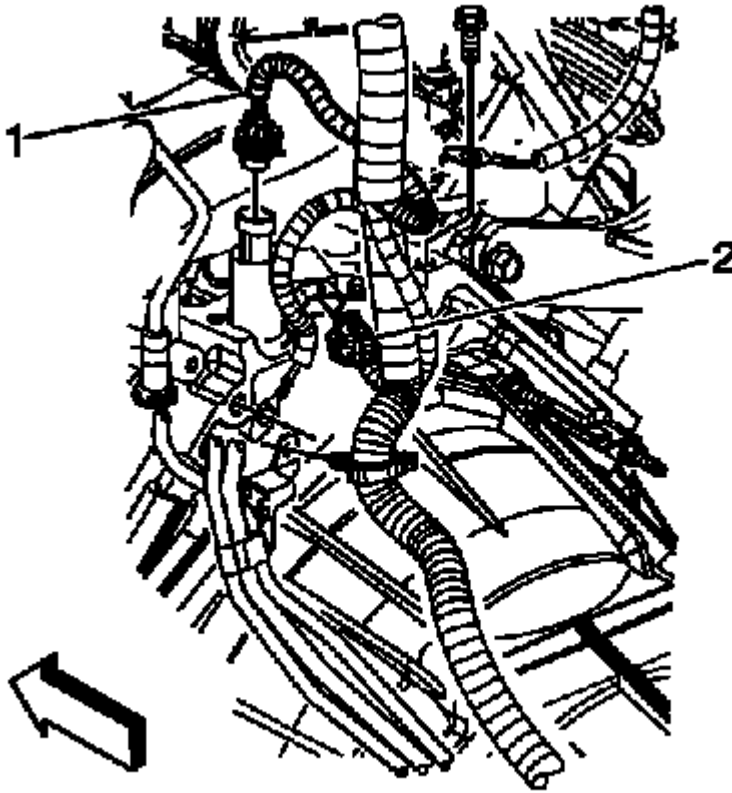


Fig. 211: View Of Oil Pressure Sensor & CMP Sensor Connectors
Courtesy of GENERAL MOTORS CORP.

3. Connect the oil pressure sensor electrical connector (1).
4. If necessary, install the engine sight shield. Refer to **Engine Sight Shield Replacement (4.8L, 5.3L, and 6.0L Engines)** or **Engine Sight Shield Replacement (6.0L Engine w/ RPOs Y91 and Z88)**.

ENGINE OIL LEVEL SENSOR AND/OR SWITCH REPLACEMENT

Removal Procedure

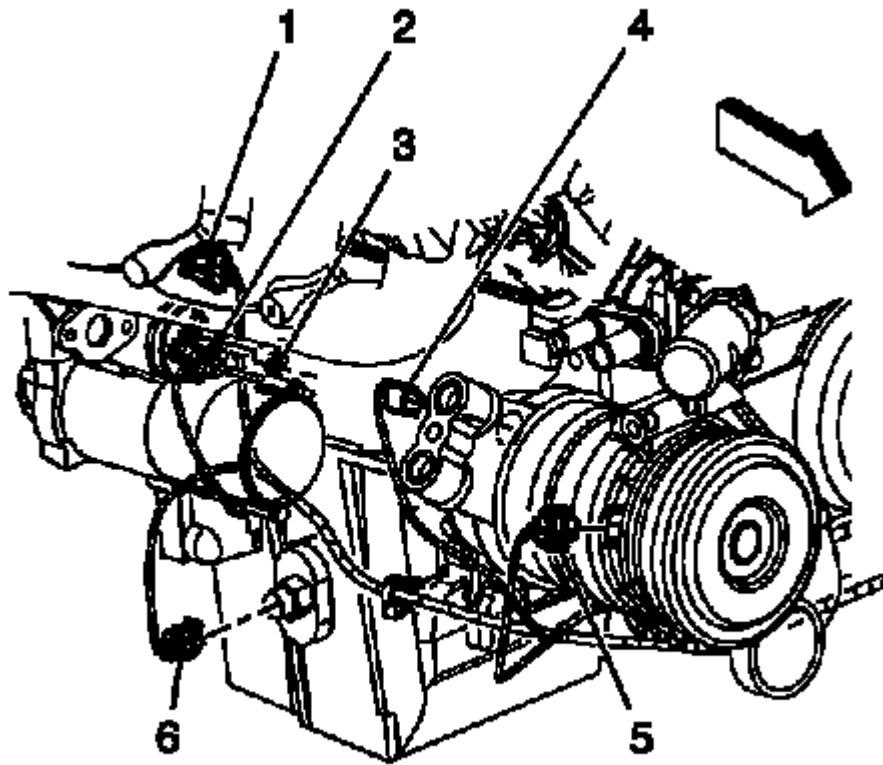


Fig. 212: Identifying Electrical Connector (Right Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

1. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
2. Disconnect the oil level sensor electrical connector (6).

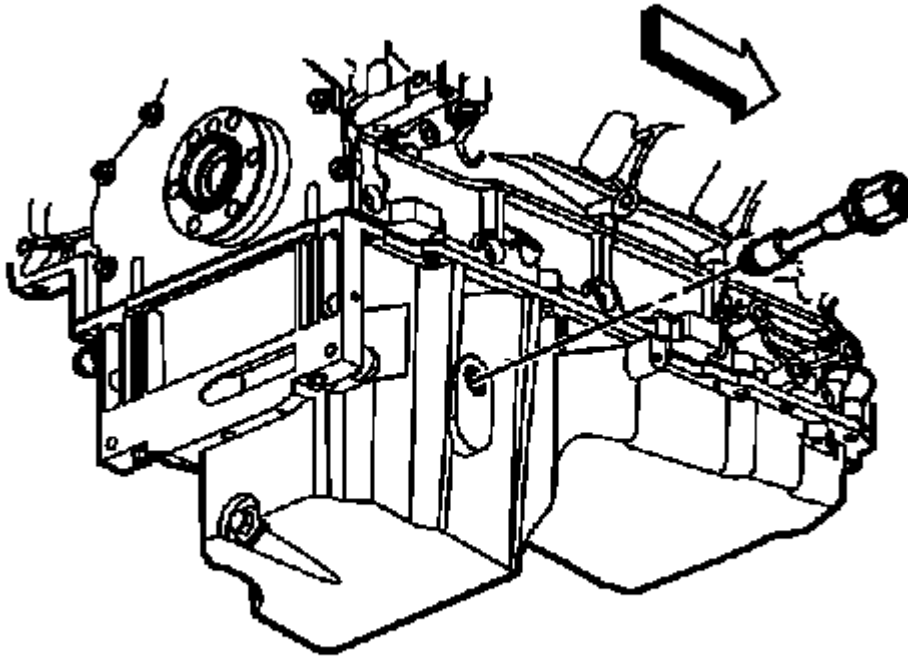


Fig. 213: View Of Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil level sensor from the oil pan.

Installation Procedure

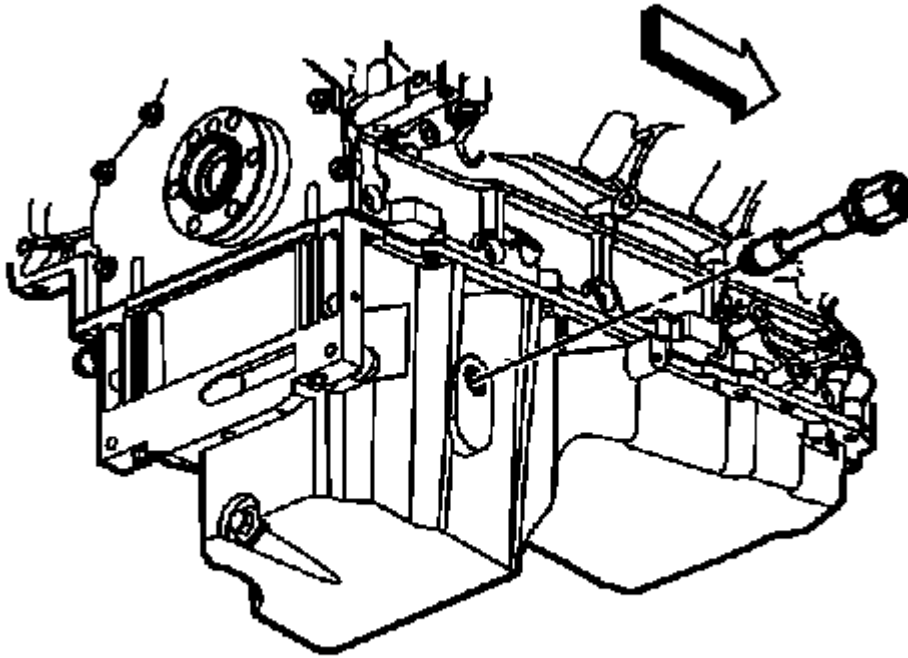


Fig. 214: View Of Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Install the oil level sensor to the oil pan.

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

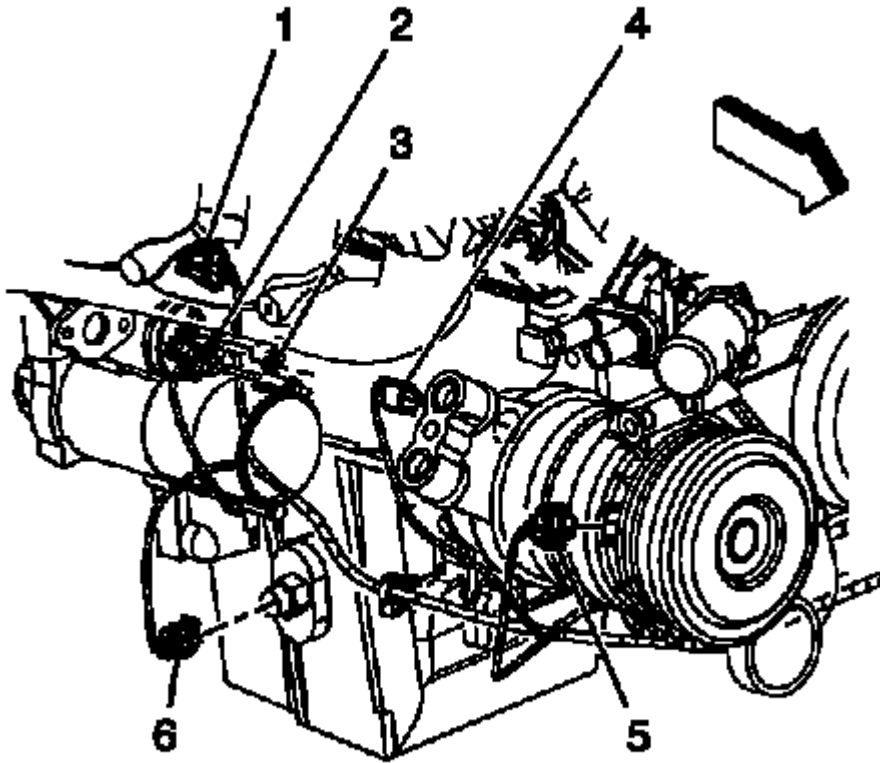


Fig. 215: Identifying Electrical Connector (Right Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

2. Connect the oil level sensor electrical connector (6).
3. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

OIL PUMP, PUMP SCREEN AND DEFLECTOR REPLACEMENT

Removal Procedure

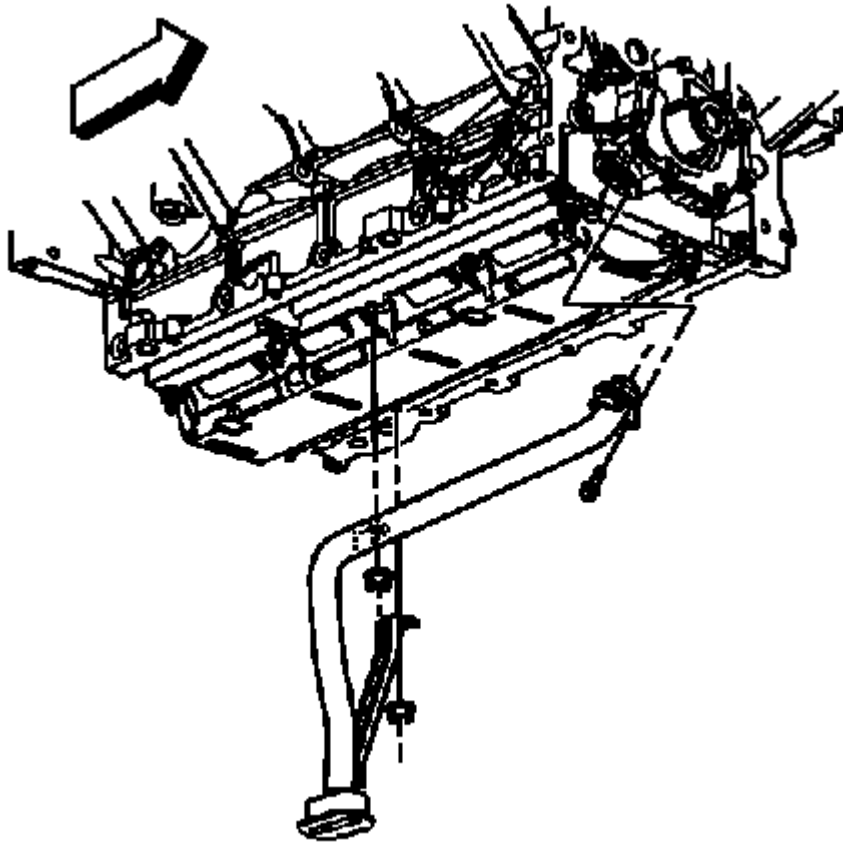


Fig. 216: Oil Pump Screen & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pan. Refer to **Oil Pan Replacement**.
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Remove the oil pump screen bolt and nuts.
4. Remove the oil pump screen with O-ring seal.
5. Remove the O-ring seal from the pump screen.
6. Discard the O-ring seal.

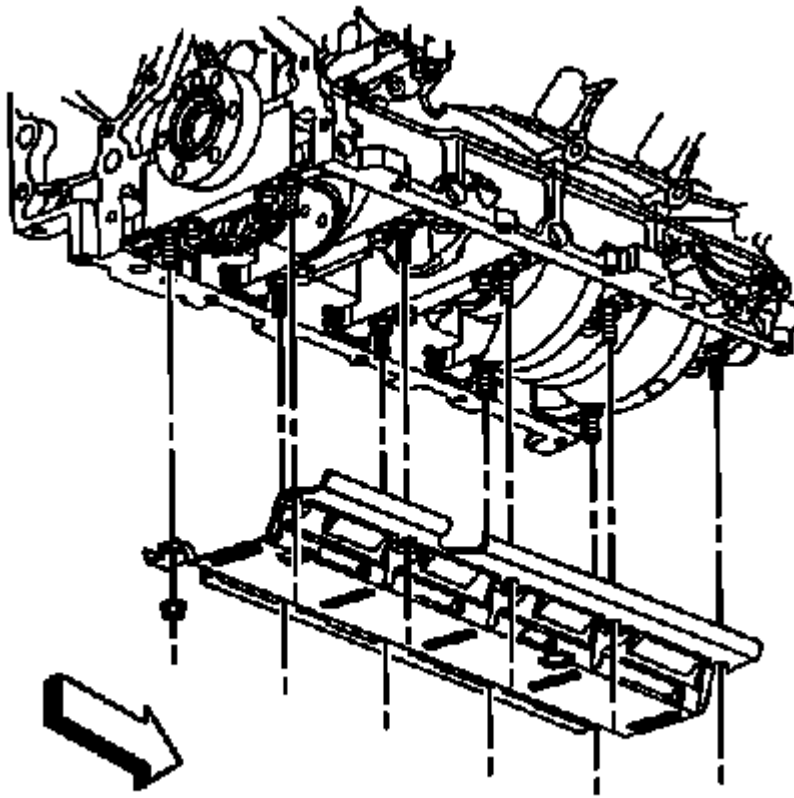


Fig. 217: View Of Crankshaft Oil Deflector & Nuts
Courtesy of GENERAL MOTORS CORP.

7. Remove the remaining crankshaft oil deflector nuts.
8. Remove the crankshaft oil deflector.

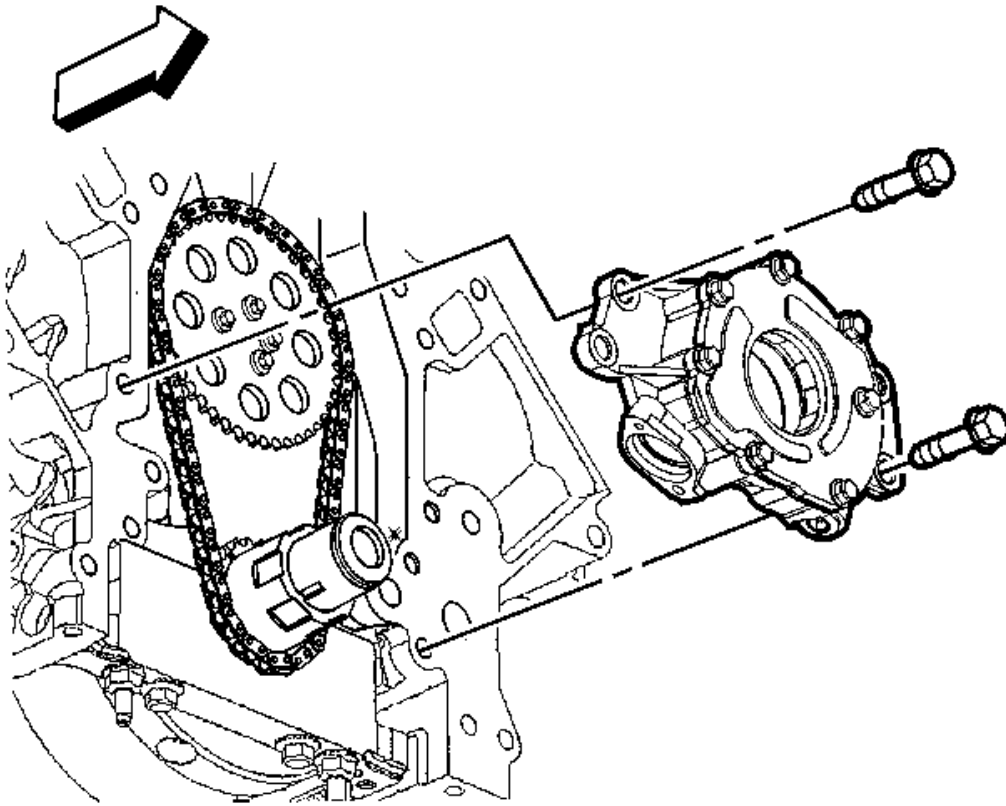


Fig. 218: View Of Oil Pump & Bolt
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not allow dirt or debris to enter the oil pump assembly, cap end as necessary.

9. Remove the oil pump bolts.
10. Remove the oil pump.
11. Clean and inspect the oil pump. Refer to **OIL PUMP CLEANING & INSPECTION** .

Installation Procedure

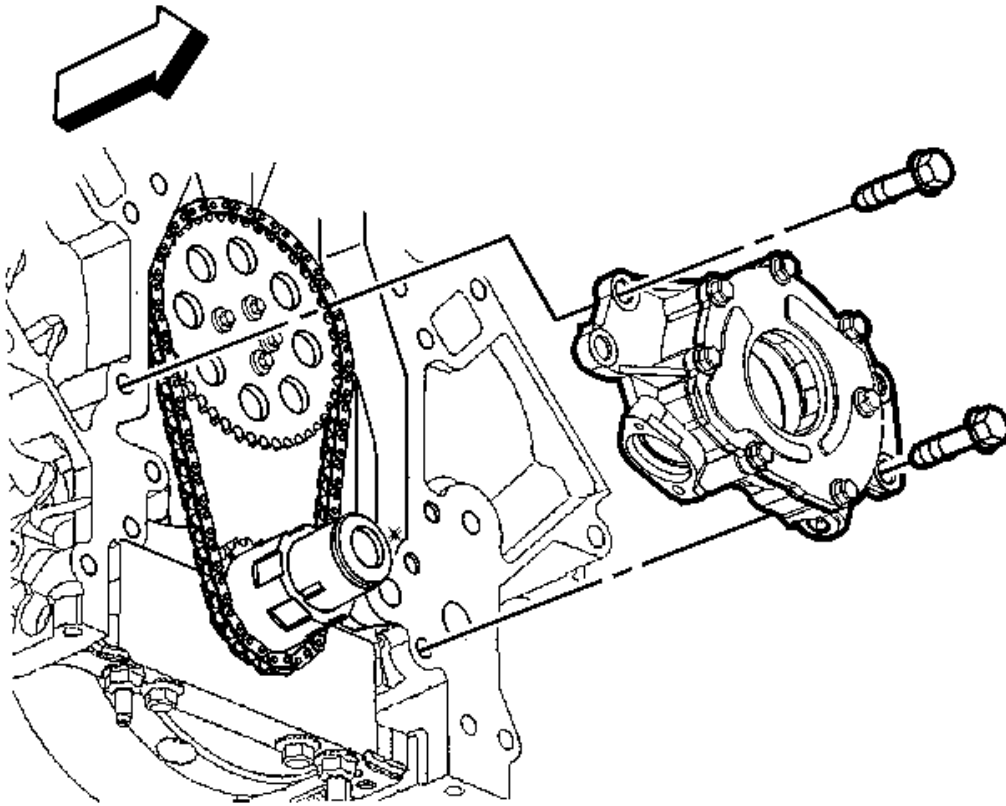


Fig. 219: View Of Oil Pump & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump.
2. Install the oil pump onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Install the oil pump bolts.

Tighten: Tighten the oil pump bolts to 25 N.m (18 lb ft).

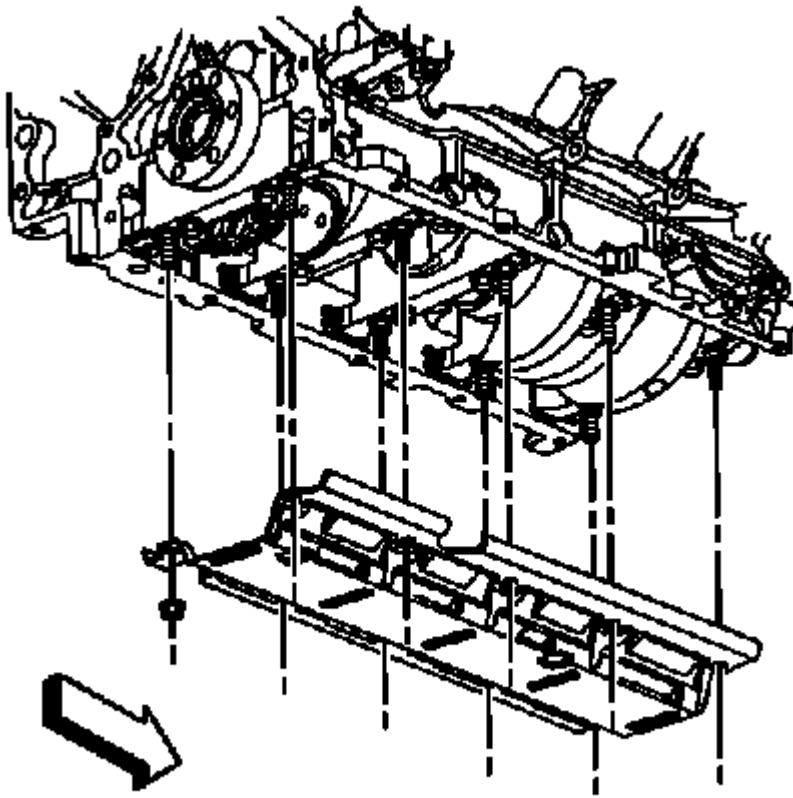


Fig. 220: View Of Crankshaft Oil Deflector & Nuts
Courtesy of GENERAL MOTORS CORP.

4. Install the crankshaft oil deflector and nuts until snug.

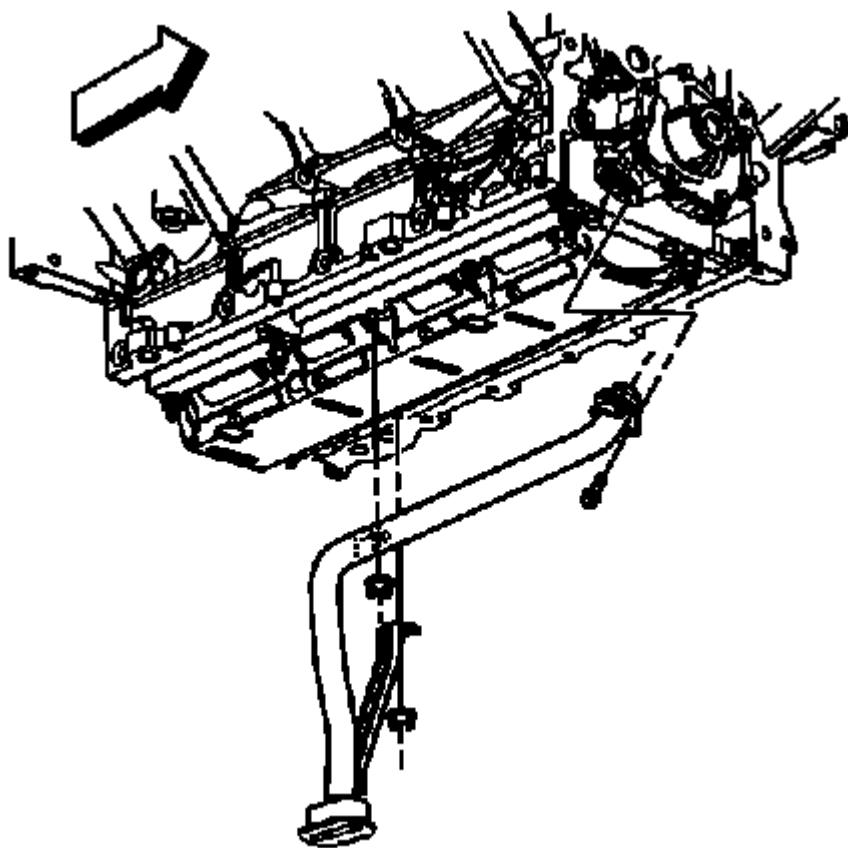


Fig. 221: Oil Pump Screen & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

5. Lubricate a NEW oil pump screen O-ring seal with clean engine oil.
6. Install the NEW O-ring seal onto the oil pump screen.

IMPORTANT: Push the oil pump screen tube completely into the oil pump prior to tightening the bolt. Do not allow the bolt to pull the tube into the pump.

Align the oil pump screen mounting brackets with the correct crankshaft bearing cap studs.

7. Install the oil pump screen.
8. Install the oil pump screen bolt and nuts.

Tighten:

1. Tighten the oil pump screen bolt to 12 N.m (106 lb in).
 2. Tighten the crankshaft oil deflector/oil pump screen nuts to 25 N.m (18 lb ft).
9. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
 10. Install the oil pan. Refer to **Oil Pan Replacement**.

TIMING CHAIN AND SPROCKETS REPLACEMENT**Tools Required**

- **J 8433** Pulley Puller. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 41816-2** Crankshaft End Protector. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 41558** Crankshaft Sprocket Remover. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 41665** Crankshaft Balancer and Sprocket Installer. See **SPECIAL TOOLS AND EQUIPMENT**.

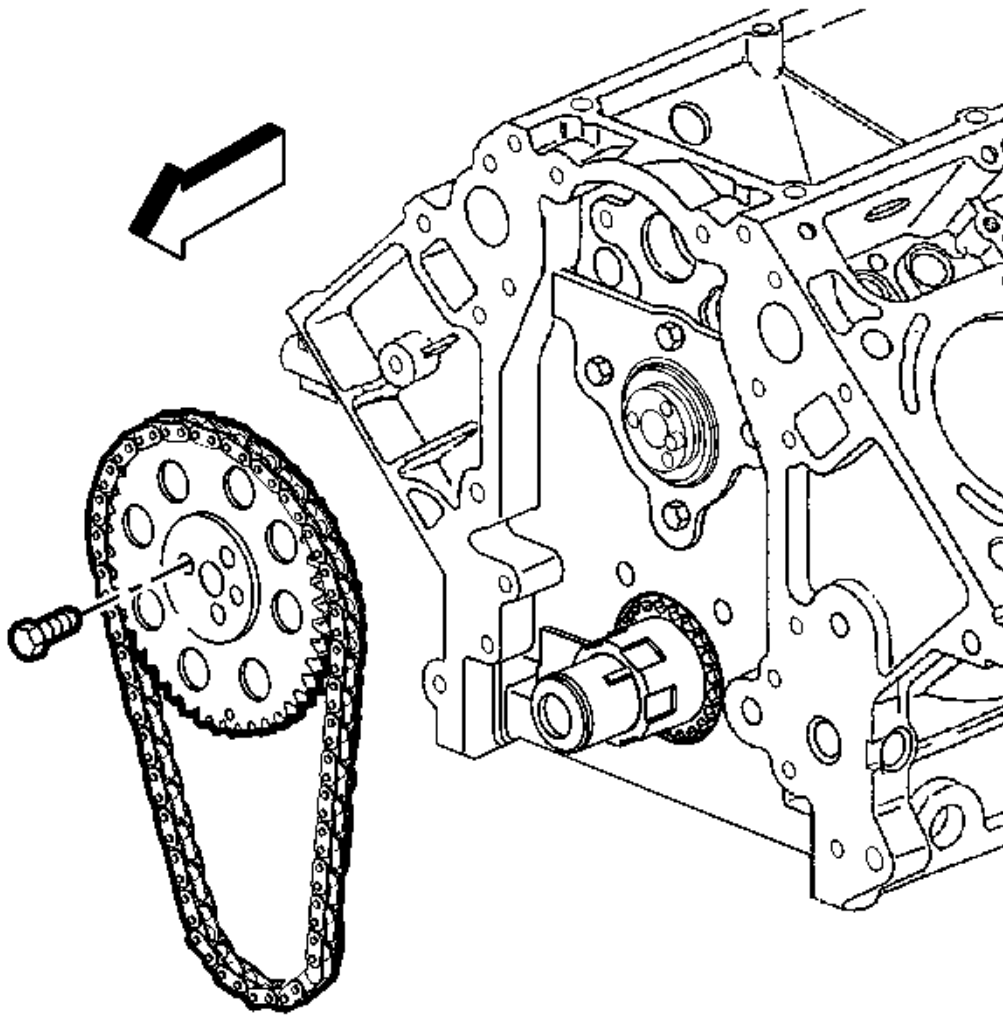
Removal Procedure

Fig. 222: Camshaft Sprocket, Bolt & Timing Chain
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump. Refer to **Oil Pump, Pump Screen and Deflector Replacement**.
2. Rotate the crankshaft until the timing marks on the crankshaft and the camshaft sprockets are aligned.

NOTE: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

3. Remove the camshaft sprocket bolts.
4. Remove the camshaft sprocket and timing chain.

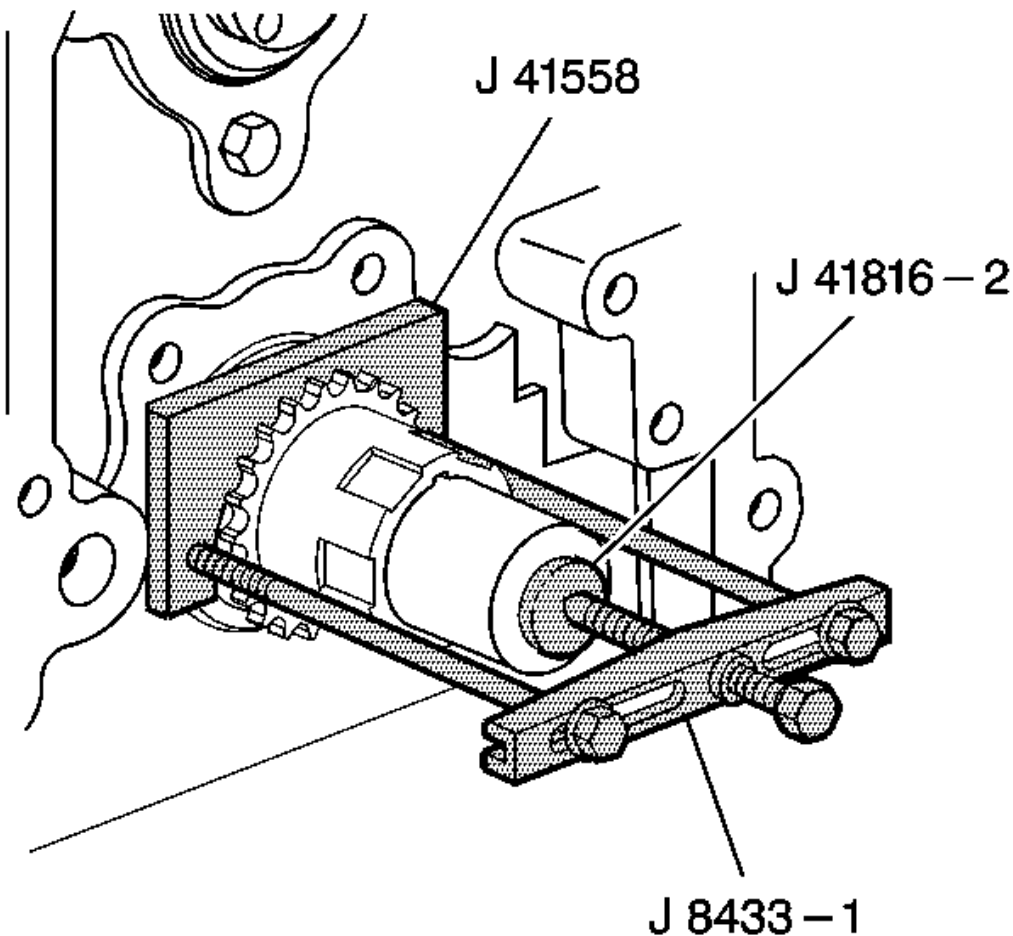


Fig. 223: Removing The Crankshaft Sprocket Using J 8433-1, J 41816-2 & J 41558

Courtesy of GENERAL MOTORS CORP.

5. Use the **J 8433** , the **J 41816-2** and the **J 41558** in order to remove the crankshaft sprocket. See **SPECIAL TOOLS AND EQUIPMENT**.

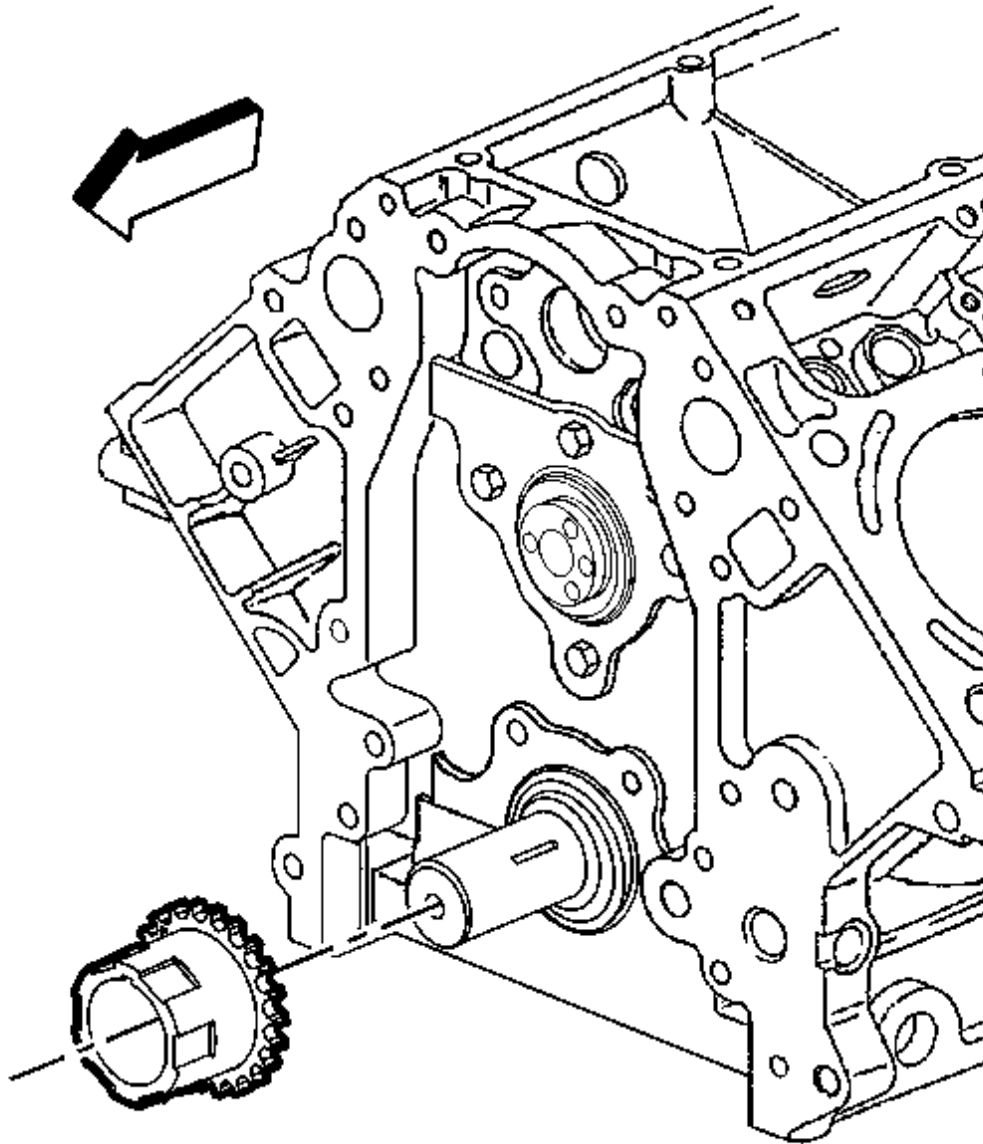


Fig. 224: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

6. Remove the crankshaft sprocket.

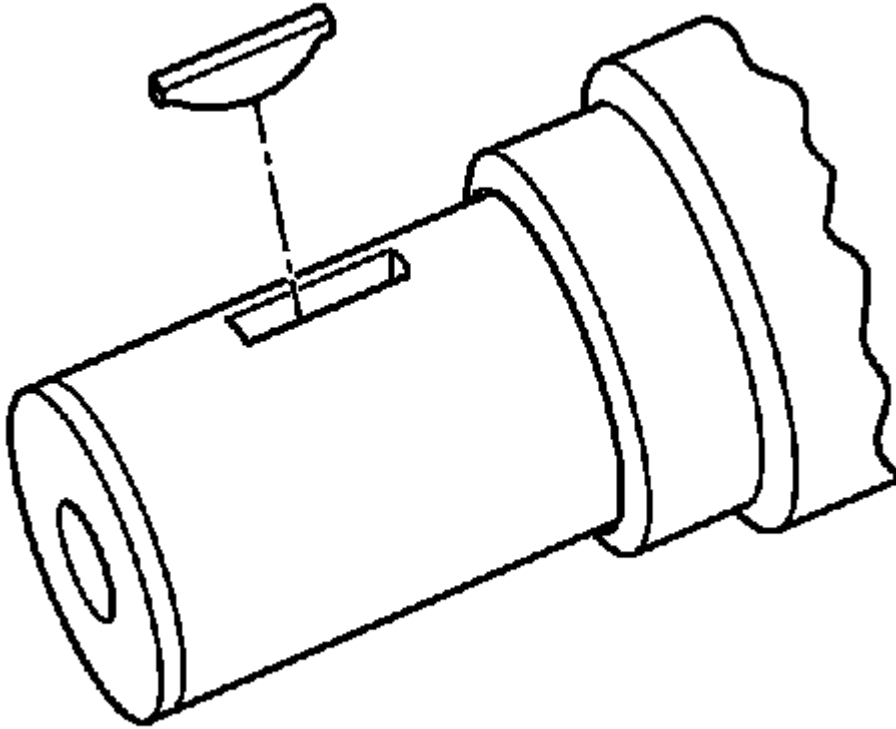


Fig. 225: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

7. Remove the crankshaft sprocket key, if required.
8. Clean and inspect the timing chain and sprockets. Refer to **TIMING CHAIN & SPROCKETS CLEANING & INSPECTION**.

Installation Procedure

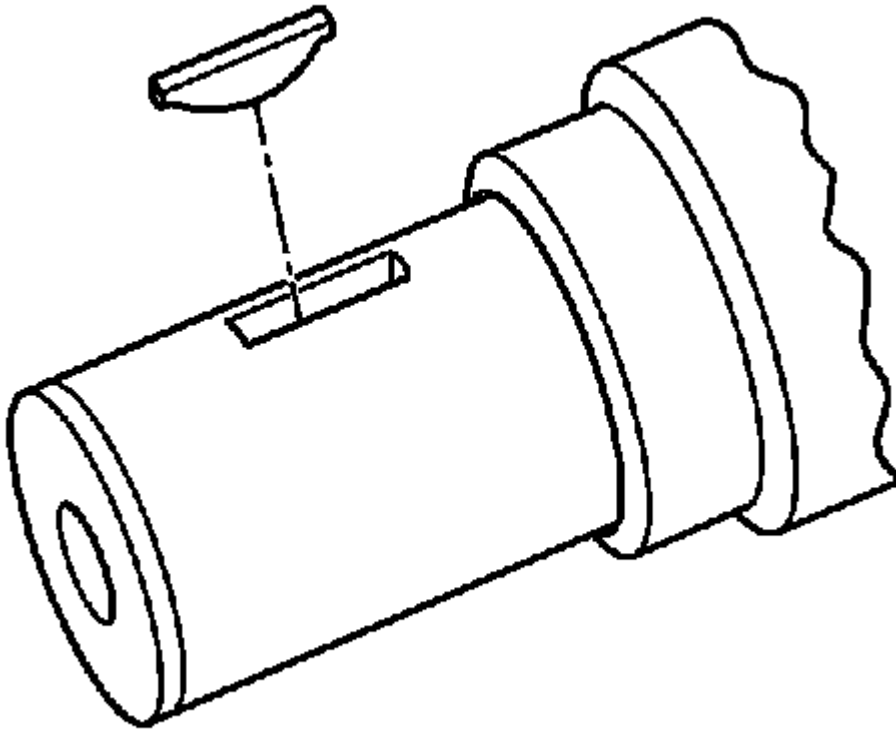


Fig. 226: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

1. Install the key into the crankshaft keyway, if previously removed.

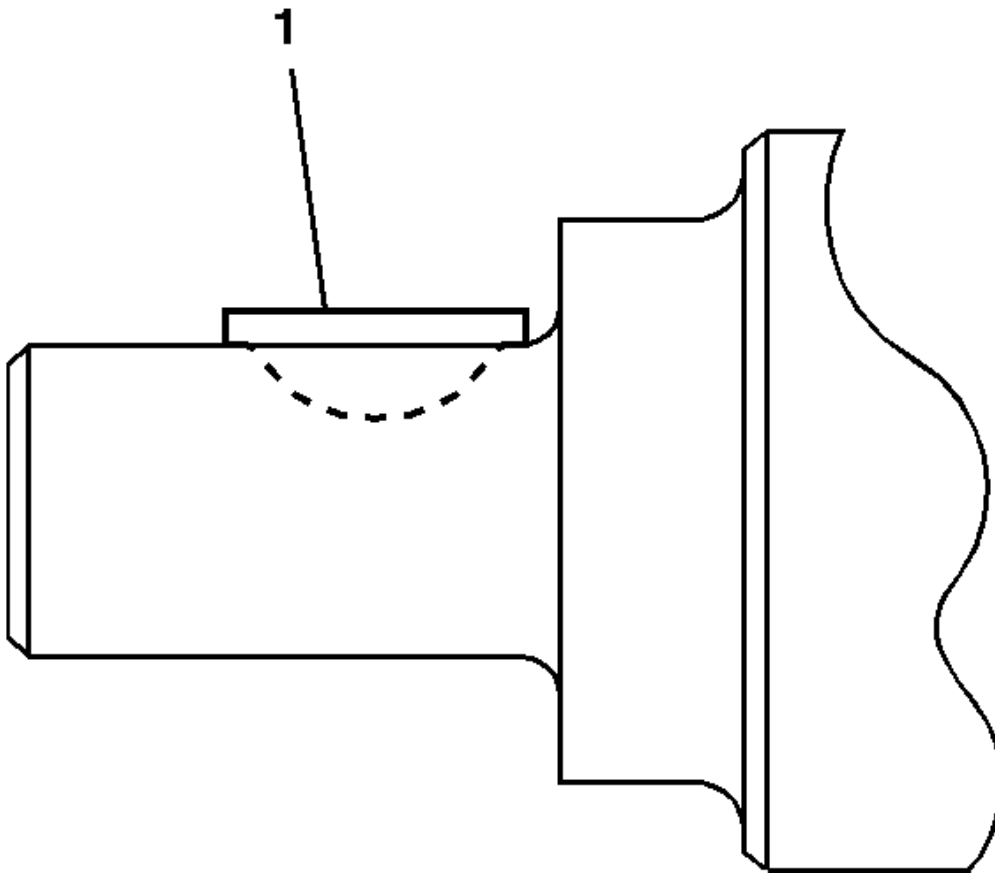


Fig. 227: Crankshaft Sprocket Key Installation Position
Courtesy of GENERAL MOTORS CORP.

2. Tap the key (1) into the keyway until both ends of the key bottom onto the crankshaft.

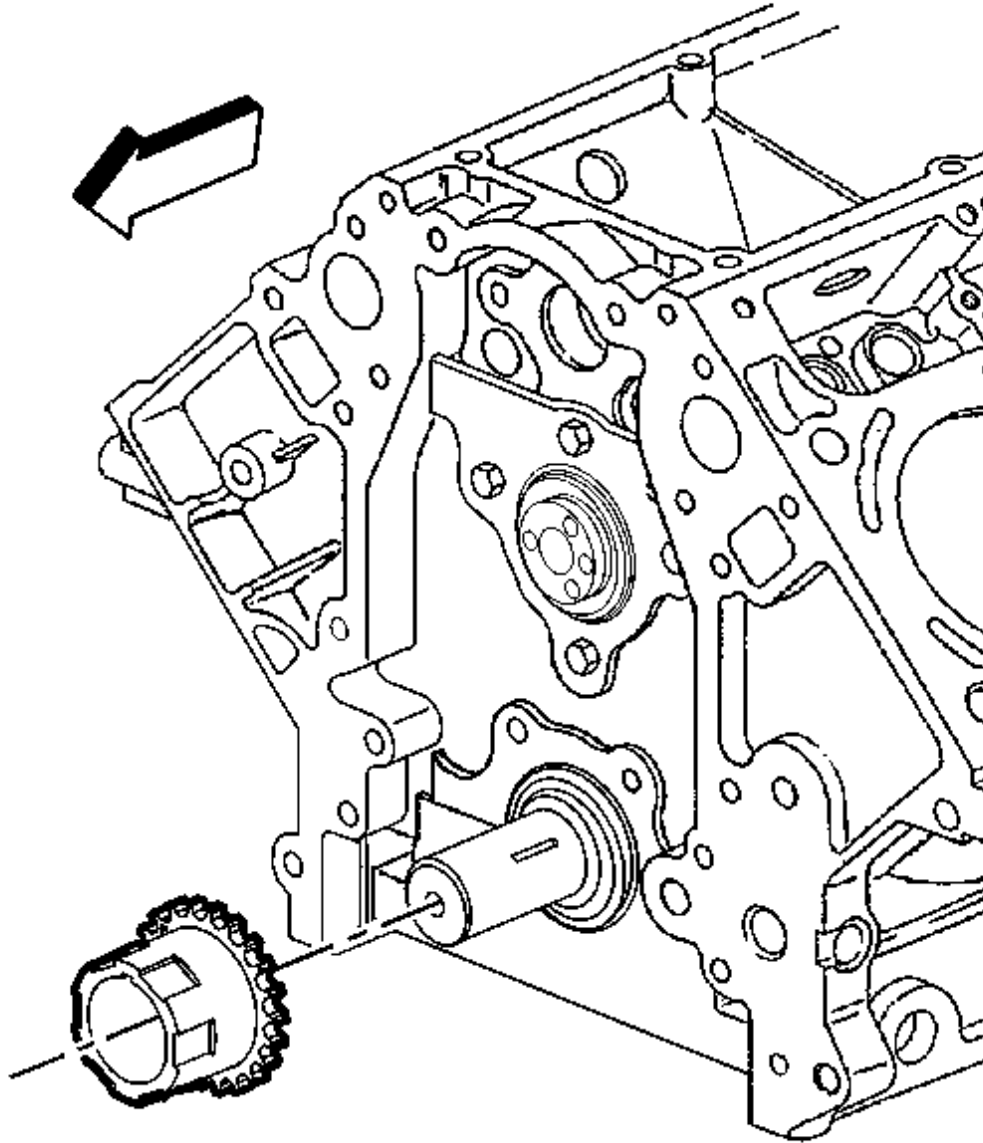


Fig. 228: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft sprocket onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

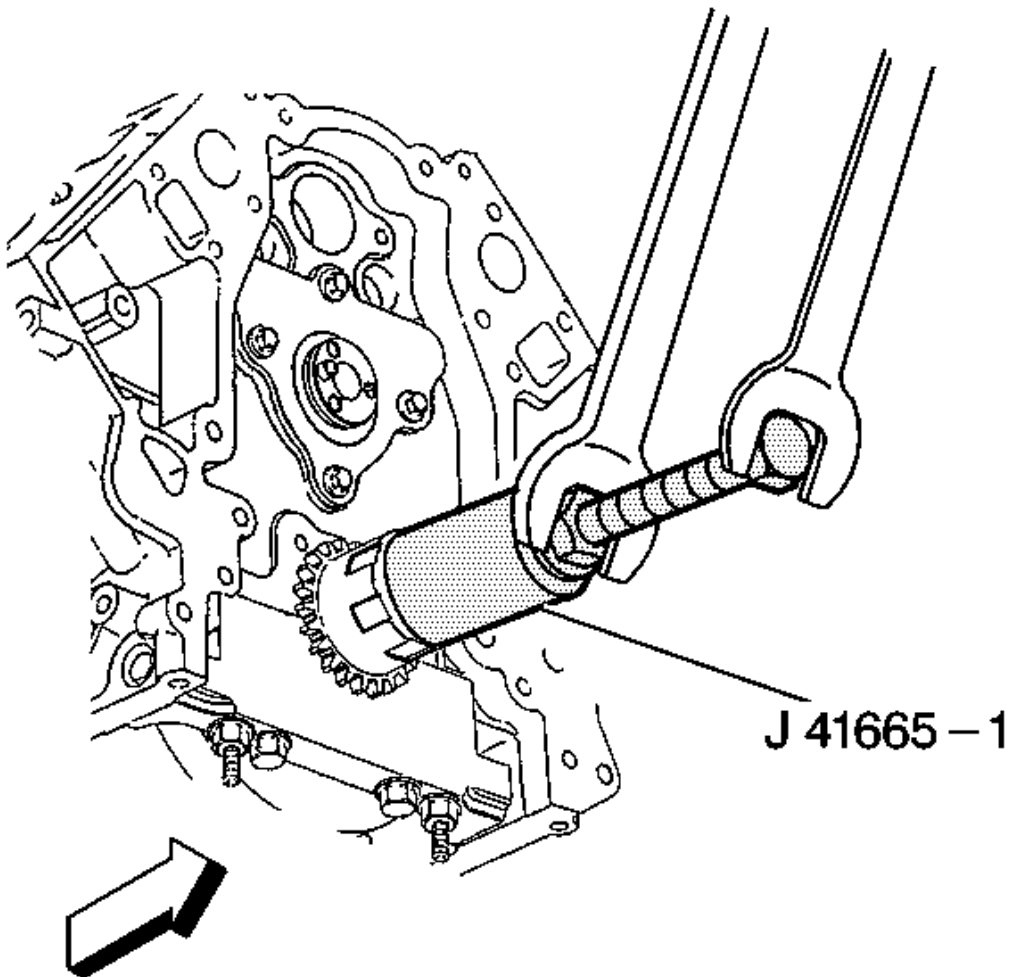


Fig. 229: Using J 41665 To Install Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 41665** in order to install the crankshaft sprocket. See **SPECIAL TOOLS AND EQUIPMENT**.
Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.
5. Rotate the crankshaft sprocket until the alignment mark is in the 12 o'clock position.

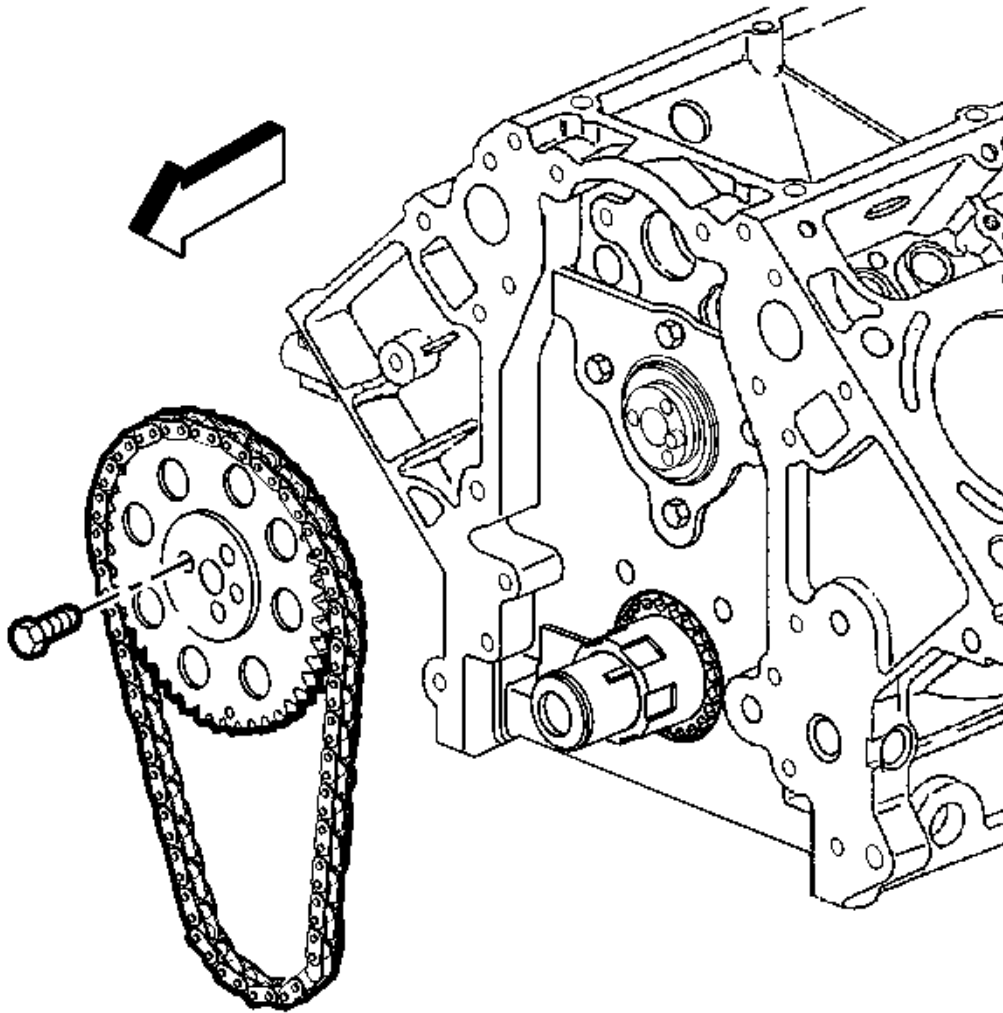


Fig. 230: Camshaft Sprocket, Bolt & Timing Chain
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- Properly locate the camshaft sprocket locating pin with the camshaft sprocket alignment hole.
- The sprocket teeth and timing chain must mesh.
- The camshaft and the crankshaft sprocket alignment marks **MUST** be aligned properly.

Locate the camshaft sprocket alignment mark in the 6 o'clock position.

6. Install the camshaft sprocket and timing chain.

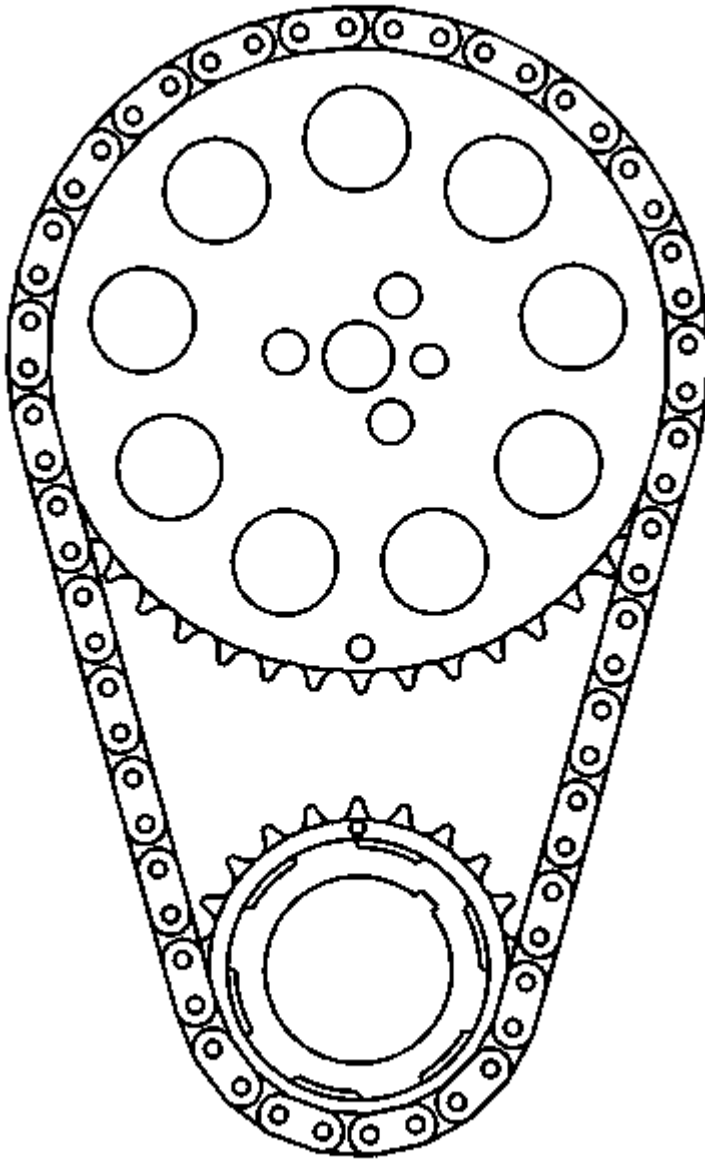


Fig. 231: View Of Camshaft & Crankshaft Sprockets Timing Marks Aligned
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

7. If necessary, rotate the camshaft or crankshaft sprockets in order to align the timing marks.
8. Install the camshaft sprocket bolts.

Tighten: Tighten the camshaft sprocket bolts to 35 N.m (26 lb ft).

9. Install the oil pump. Refer to **Oil Pump, Pump Screen and Deflector Replacement**.

CAMSHAFT REPLACEMENT

Removal Procedure

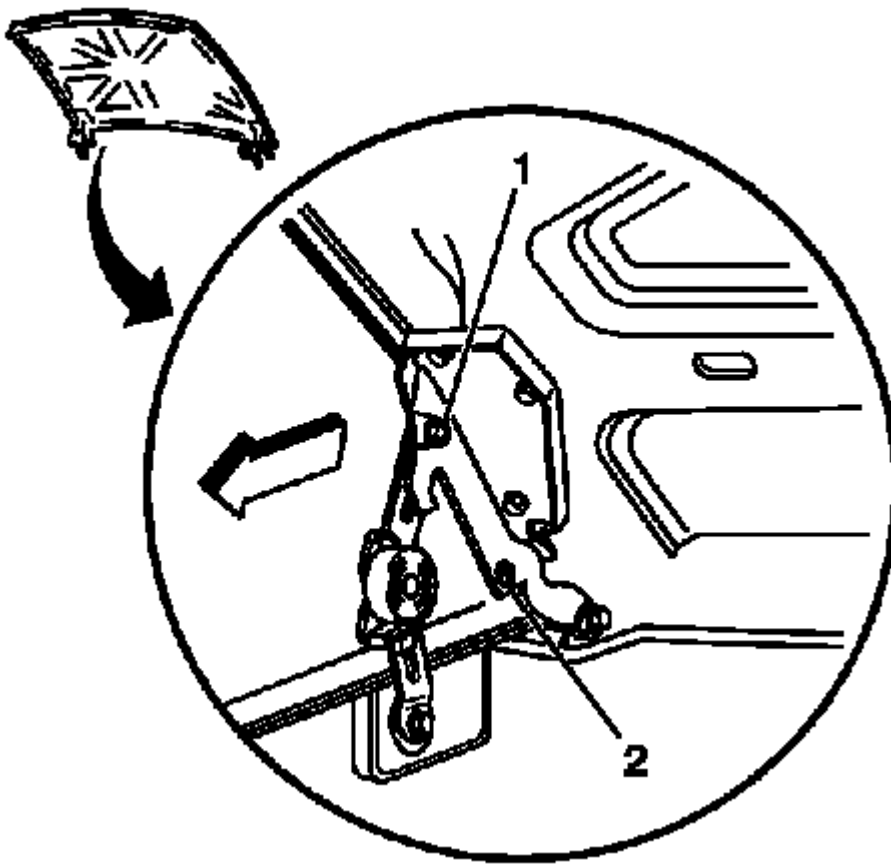


Fig. 232: Identifying Hood Hinge Normal And Service Position Bolt Holes
Courtesy of GENERAL MOTORS CORP.

1. Raise the hood to the service position, perform the following:
 - Remove the hood hinge bolts (1).
 - Raise the hood until vertical.
 - Install the hood hinge bolts until snug in the service position (2).
2. Remove the radiator support. Refer to **RADIATOR SUPPORT REPLACEMENT**.
3. Remove the front cover. Refer to **Engine Front Cover Replacement**.

4. Remove the valve lifters. Refer to **Valve Lifter Replacement**.

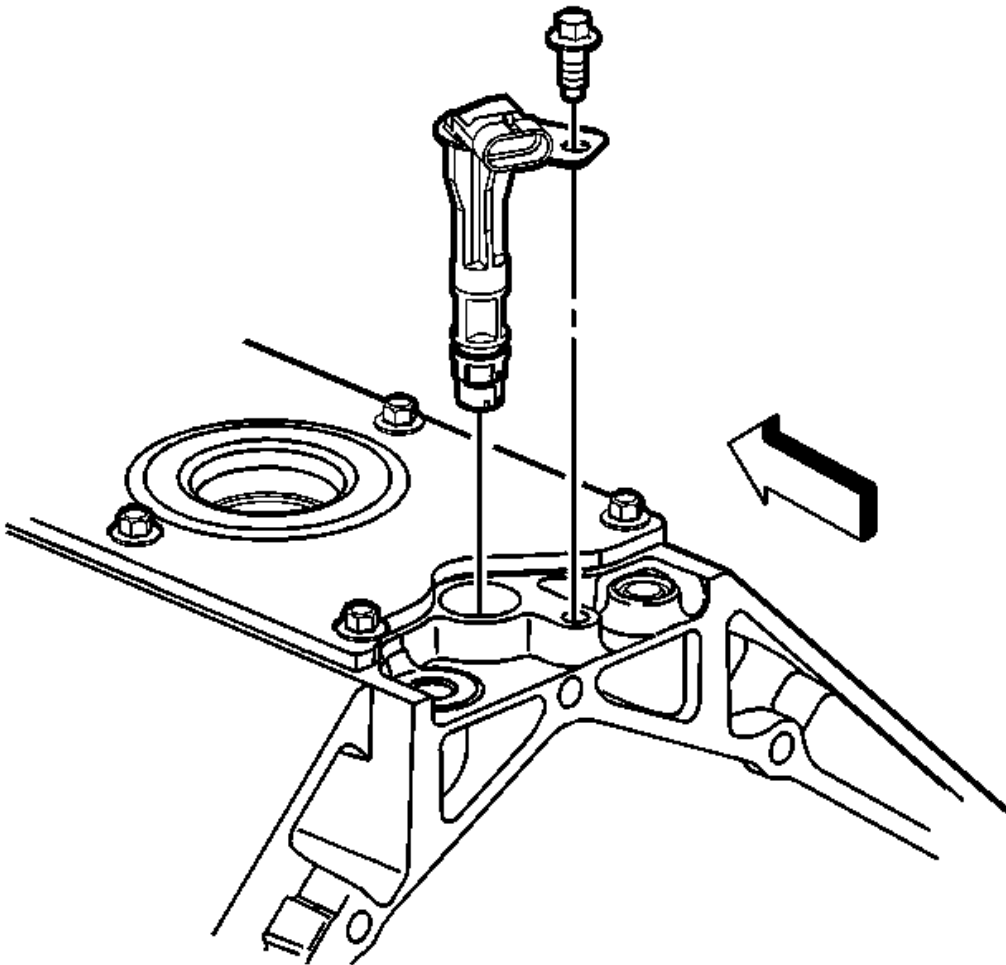


Fig. 233: View Of Camshaft Position (CMP) Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the camshaft sensor bolt and sensor.

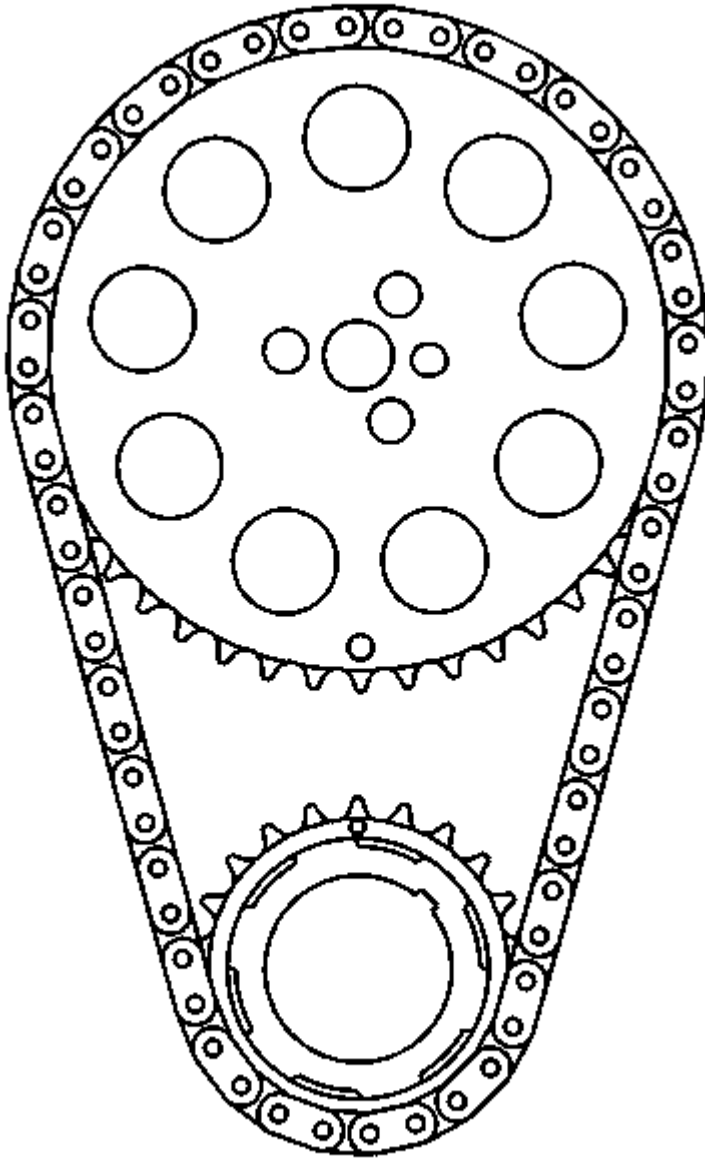


Fig. 234: View Of Camshaft & Crankshaft Sprockets Timing Marks Aligned
Courtesy of GENERAL MOTORS CORP.

6. Rotate the crankshaft until the timing marks on the crankshaft and camshaft sprockets are aligned.

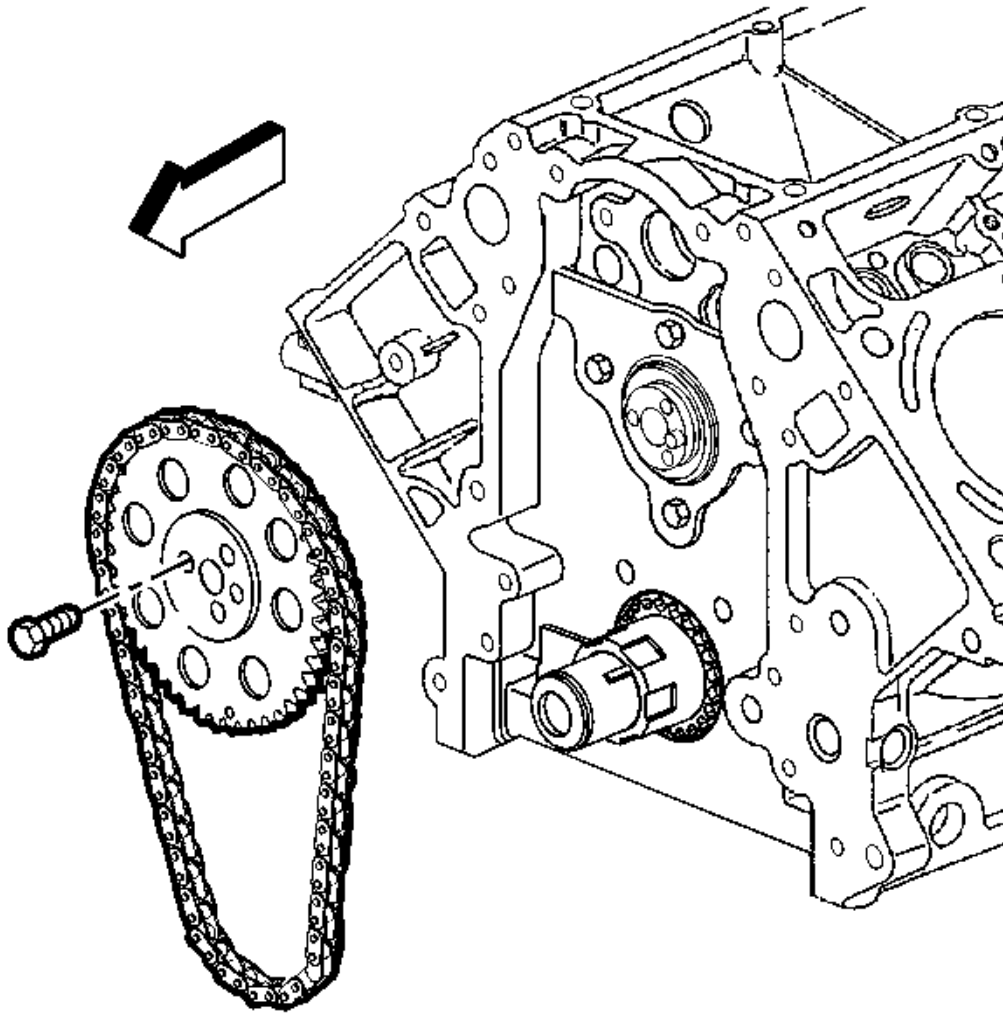


Fig. 235: Camshaft Sprocket, Bolt & Timing Chain
Courtesy of GENERAL MOTORS CORP.

7. Remove the camshaft sprocket bolts.

NOTE: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

8. Remove the camshaft sprocket and reposition the timing chain.

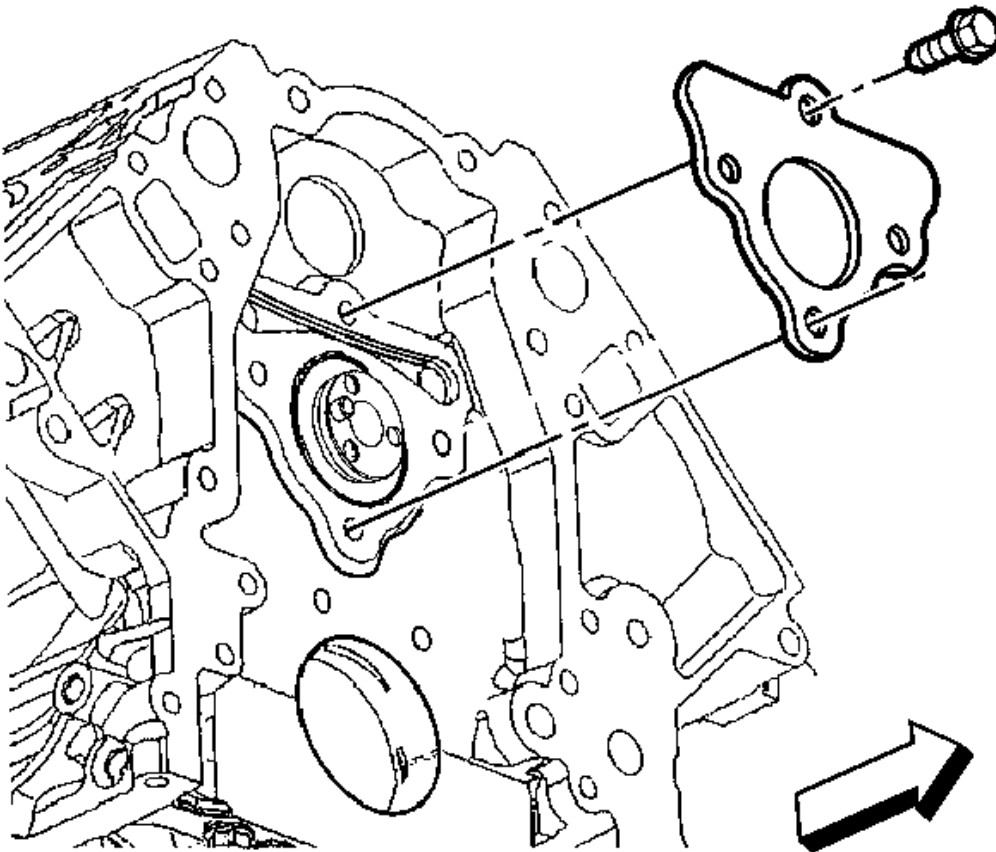


Fig. 236: View Of Camshaft Retainer Plate
Courtesy of GENERAL MOTORS CORP.

9. Remove the camshaft retainer bolts and retainer.

NOTE: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

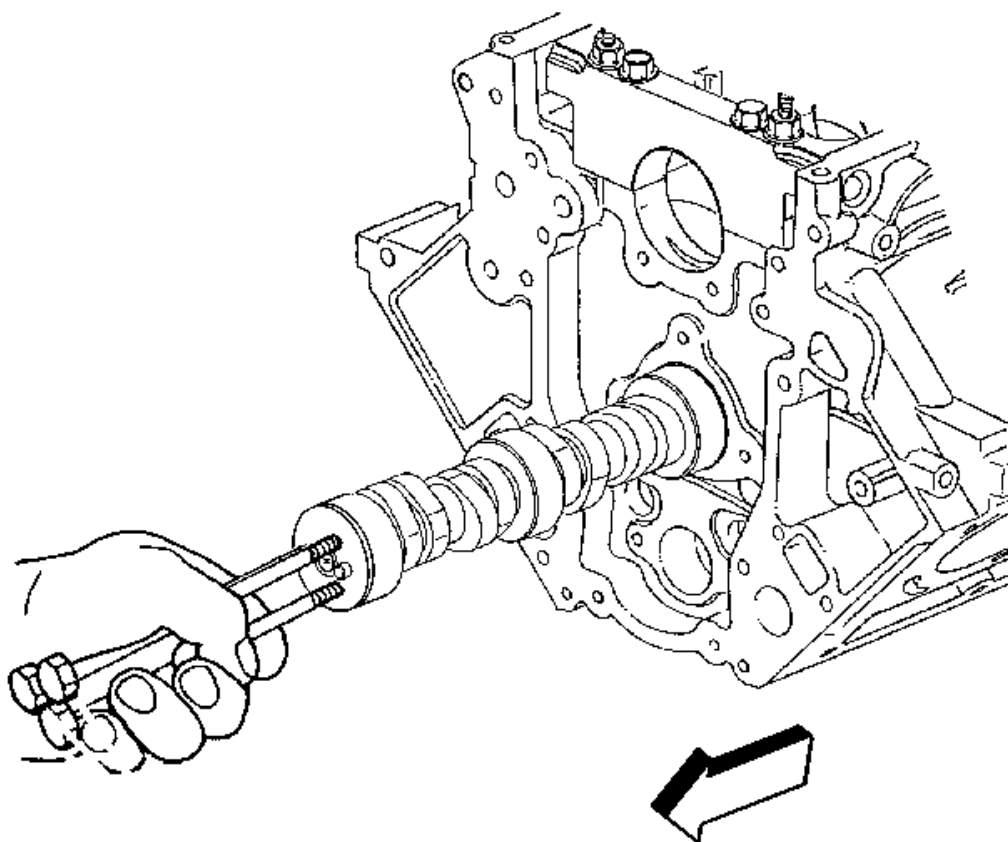


Fig. 237: View Of Bolts installed In Camshaft Front Bolt Holes
Courtesy of GENERAL MOTORS CORP.

10. Remove the camshaft.
 1. Install three M8-1.25 x 100 mm (M8-1.25 x 4.0 in) bolts to the bolt holes in the front of the camshaft.
 2. Using the bolts as a handle, carefully rotate and pull the camshaft out of the engine block.
 3. Remove the three bolts from the camshaft.
11. Clean and inspect the camshaft and bearings. Refer to **CAMSHAFT & BEARINGS CLEANING & INSPECTION** .

Installation Procedure

IMPORTANT: If camshaft replacement is required, the valve lifters must also be replaced.

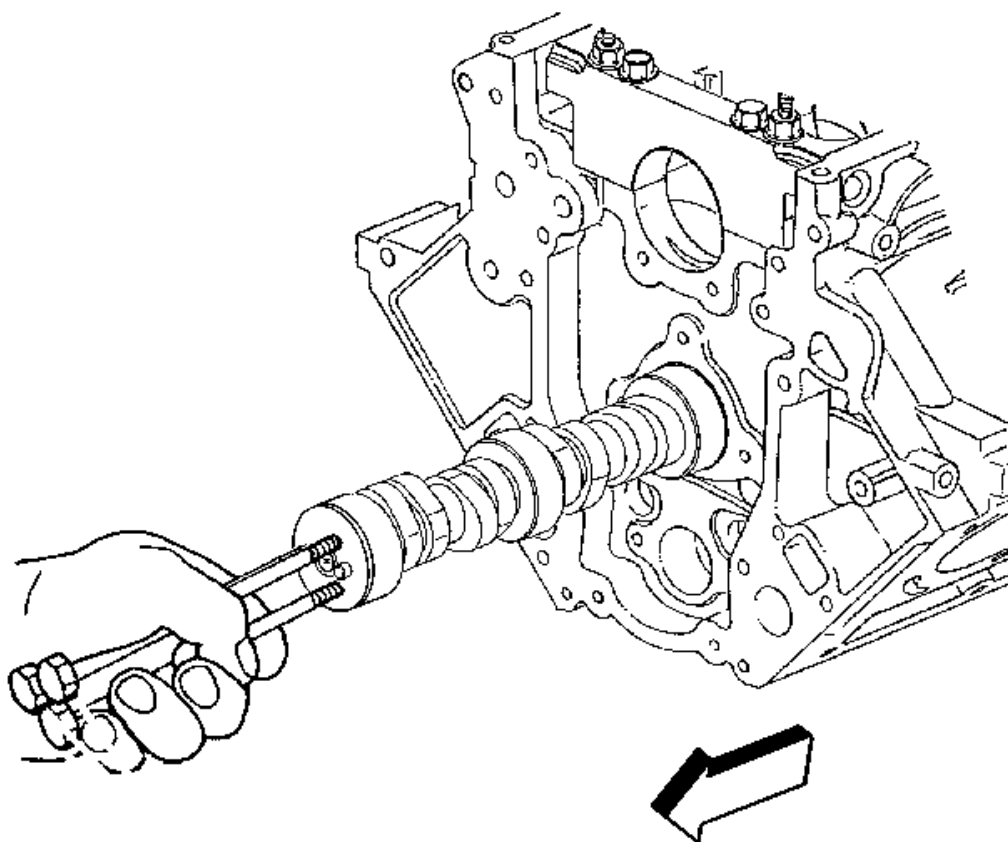


Fig. 238: View Of Bolts installed In Camshaft Front Bolt Holes
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the camshaft journals and the bearings with clean engine oil.
2. Install three M8-1.25 x 100 mm (M8-1.25 x 4.0 in) bolts to the bolt holes in the front of the camshaft.

NOTE: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

3. Using the bolts as a handle, carefully install the camshaft into the engine block.
4. Remove the three bolts from the front of the camshaft.

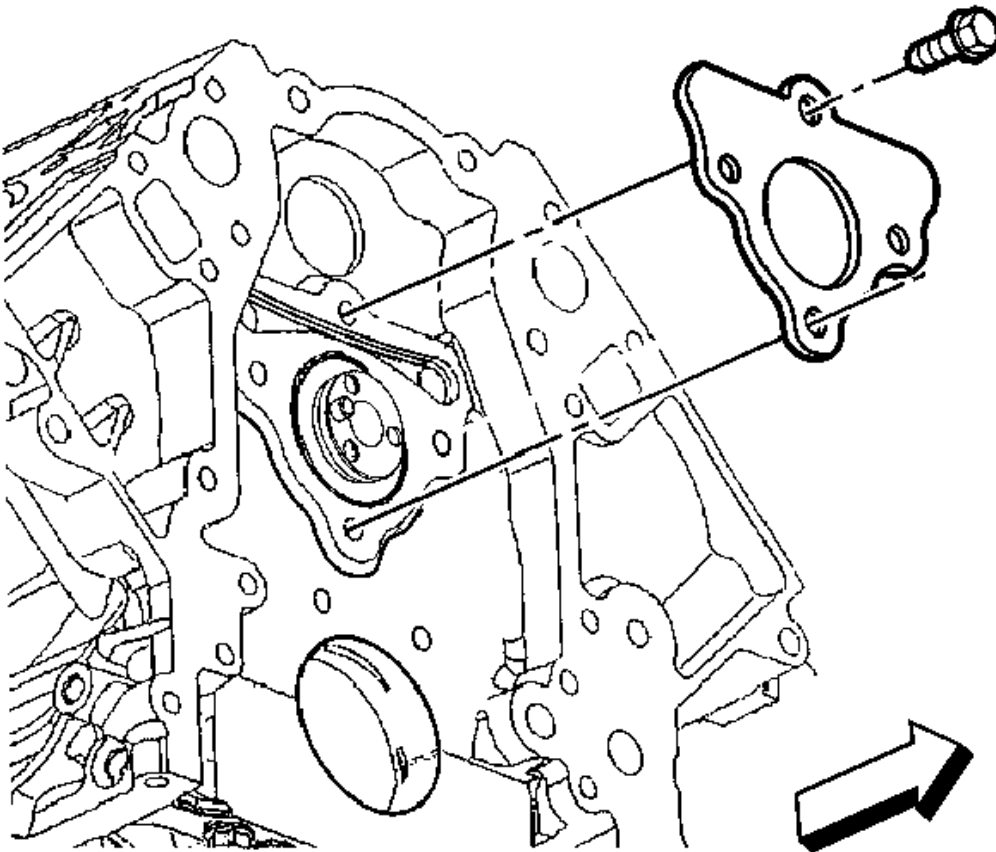


Fig. 239: View Of Camshaft Retainer Plate
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install the retainer plate with the sealing gasket facing the engine block. The gasket surface on the engine block should be clean and free of dirt and/or debris.

NOTE: Refer to Fastener Notice in Cautions and Notices.

5. Install the camshaft retainer and bolts.

Tighten: Tighten the camshaft retainer bolts to 25 N.m (18 lb ft).

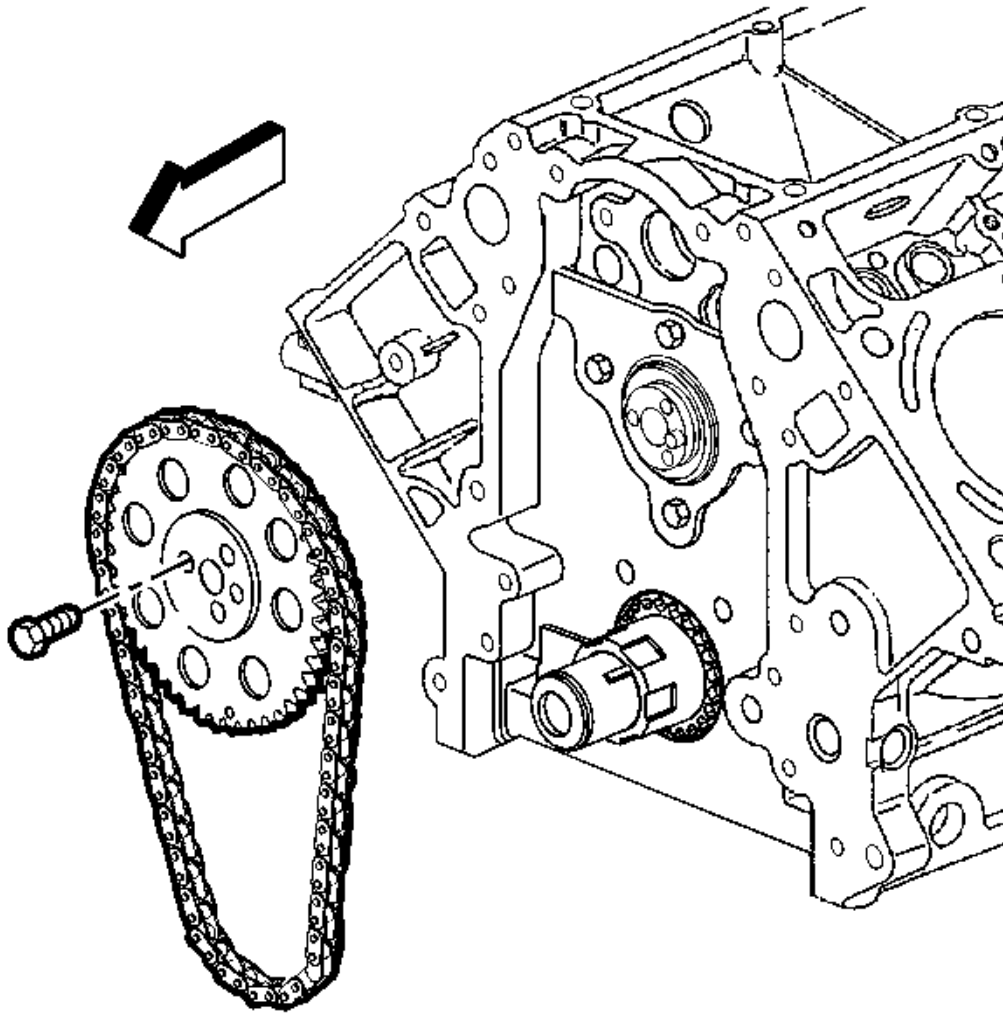


Fig. 240: Camshaft Sprocket, Bolt & Timing Chain
Courtesy of GENERAL MOTORS CORP.

6. Install the camshaft sprocket and position the timing chain.
7. Install the camshaft sprocket bolts.

Tighten: Tighten the camshaft sprocket bolts to 35 N.m (26 lb ft).

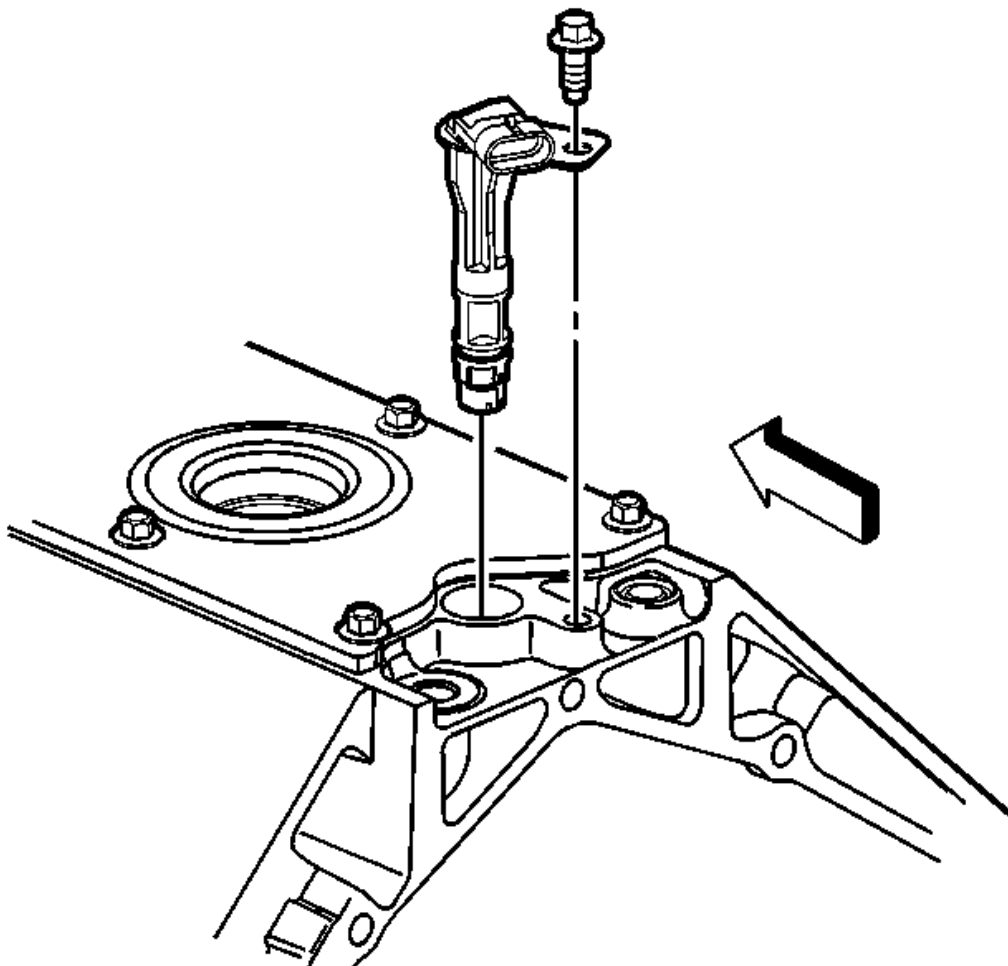


Fig. 241: View Of Camshaft Position (CMP) Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

8. Inspect the camshaft sensor O-ring seal. If the O-ring seal is not cut or damaged, it may be reused.
9. Lubricate the O-ring seal with clean engine oil.
10. Install the camshaft sensor and bolt.

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

11. Install the valve lifters. Refer to **Valve Lifter Replacement**.
12. Install the front cover. Refer to **Engine Front Cover Replacement**.
13. Install the radiator support. Refer to **RADIATOR SUPPORT REPLACEMENT**.

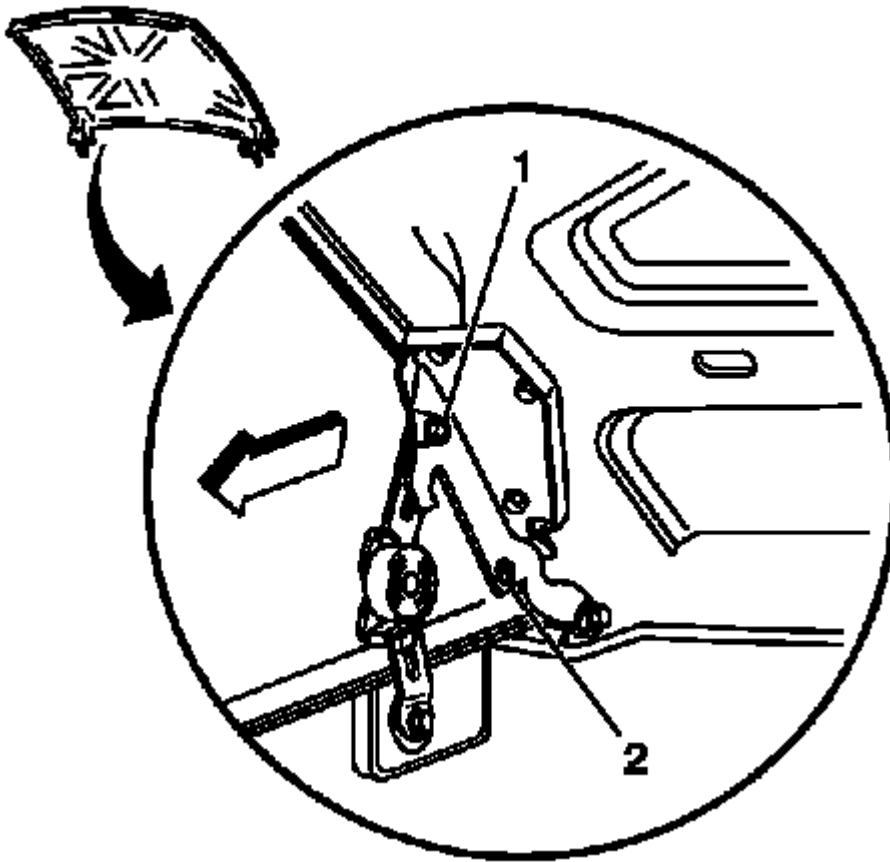


Fig. 242: Identifying Hood Hinge Normal And Service Position Bolt Holes
Courtesy of GENERAL MOTORS CORP.

14. Remove the hood hinge bolts from the service position (2).
15. Lower the hood to the normal position.
16. Install the hood hinge bolts.

Tighten: Tighten the hood hinge bolts to 25 N.m (18 lb ft).

ENGINE FLYWHEEL REPLACEMENT

Removal Procedure

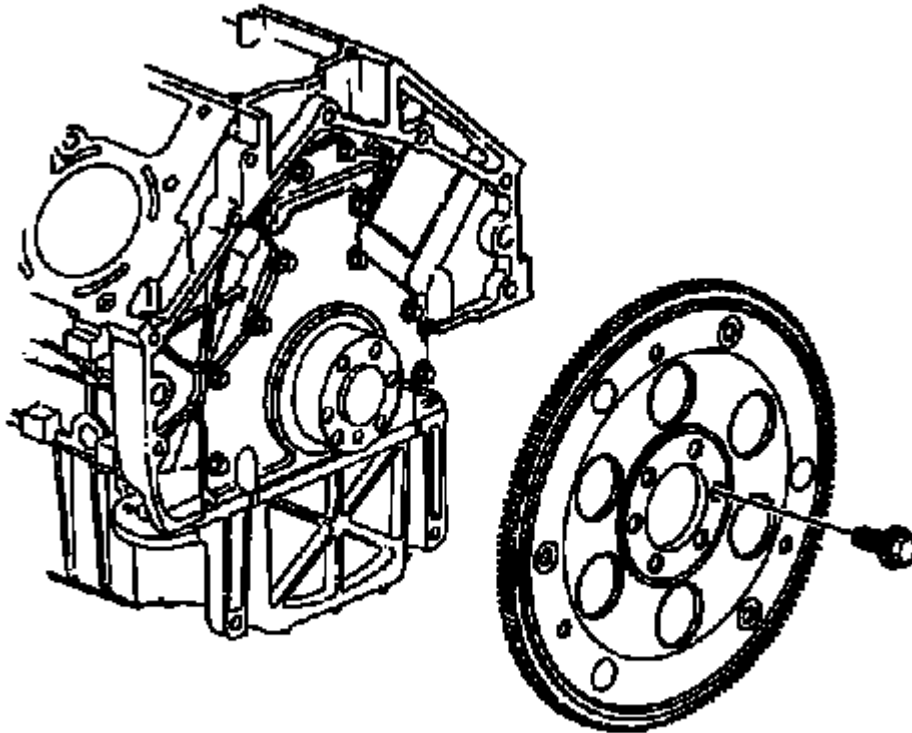


Fig. 243: View Of Engine Flywheel & Bolt
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Note the position and direction of the engine flywheel before removal.

1. Remove the automatic transmission, if equipped. Refer to **REMOVAL & INSTALLATION** for Automatic Transmission - 4L60-E or **REMOVAL & INSTALLATION** for Automatic Transmission - 4L80-E.
2. Remove the engine flywheel bolts.
3. Remove the automatic transmission engine flywheel, if applicable.

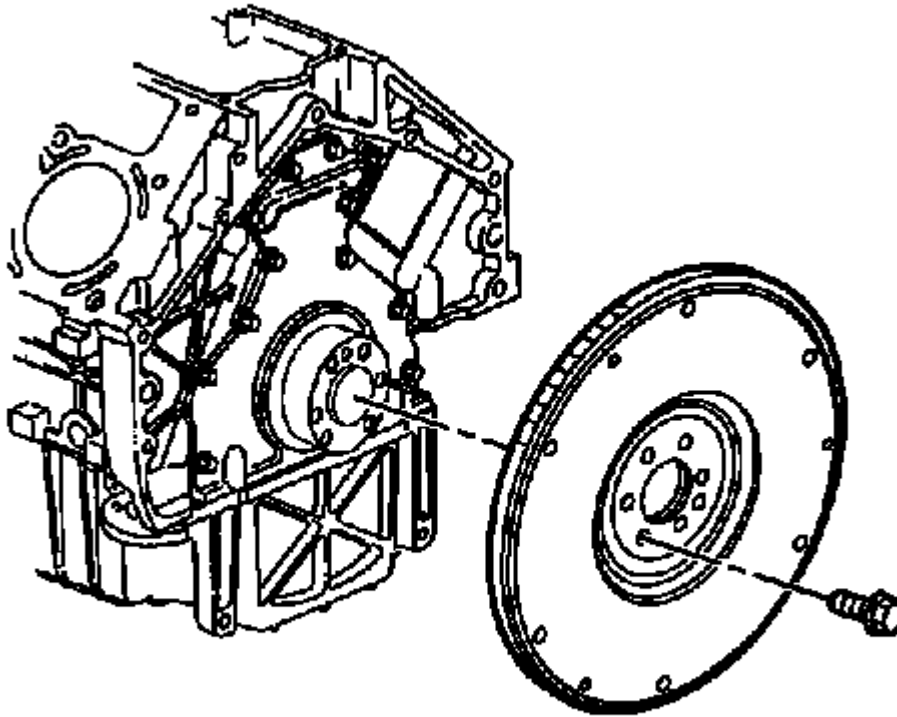


Fig. 244: Engine Flywheel & Bolts (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Note the position and direction of the engine flywheel before removal.

4. Remove the clutch, if equipped with a manual transmission. Refer to **REMOVAL & INSTALLATION** Clutch.
5. Remove the engine flywheel bolts.
6. Remove the manual transmission engine flywheel, if applicable.
7. Clean and inspect the engine flywheel. Refer to **ENGINE FLYWHEEL CLEANING & INSPECTION** .

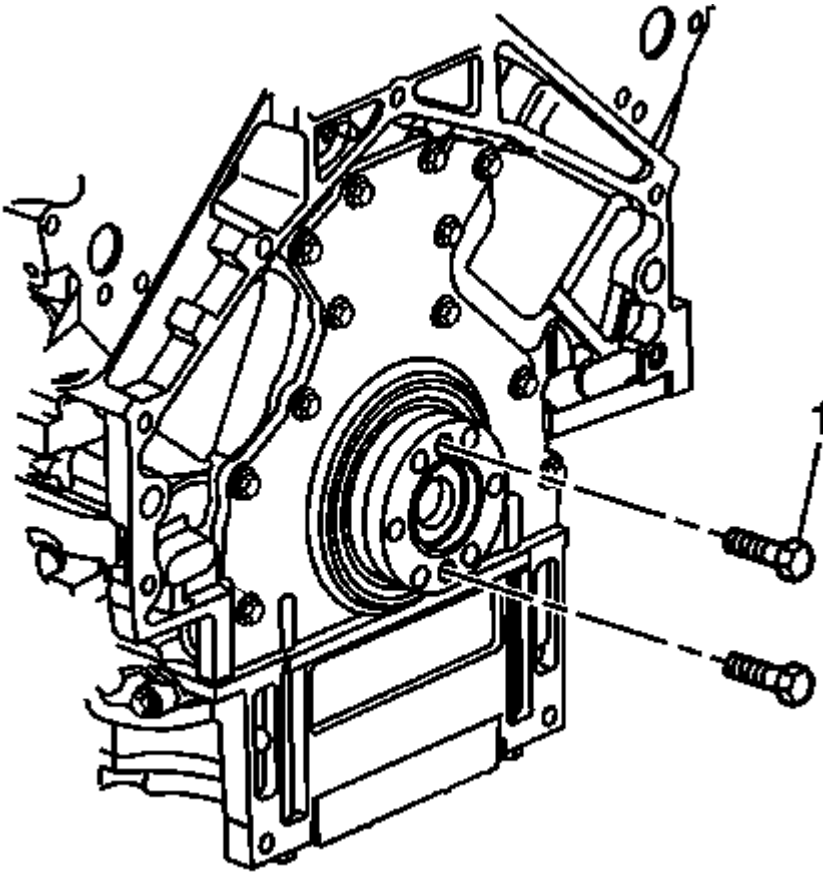


Fig. 245: Bolt, Spacer & Flywheel
Courtesy of GENERAL MOTORS CORP.

8. Install two M11x1.5 mm bolts (1) to the threaded holes of the spacer, if applicable.
9. Rotate the bolts clockwise to remove the spacer.

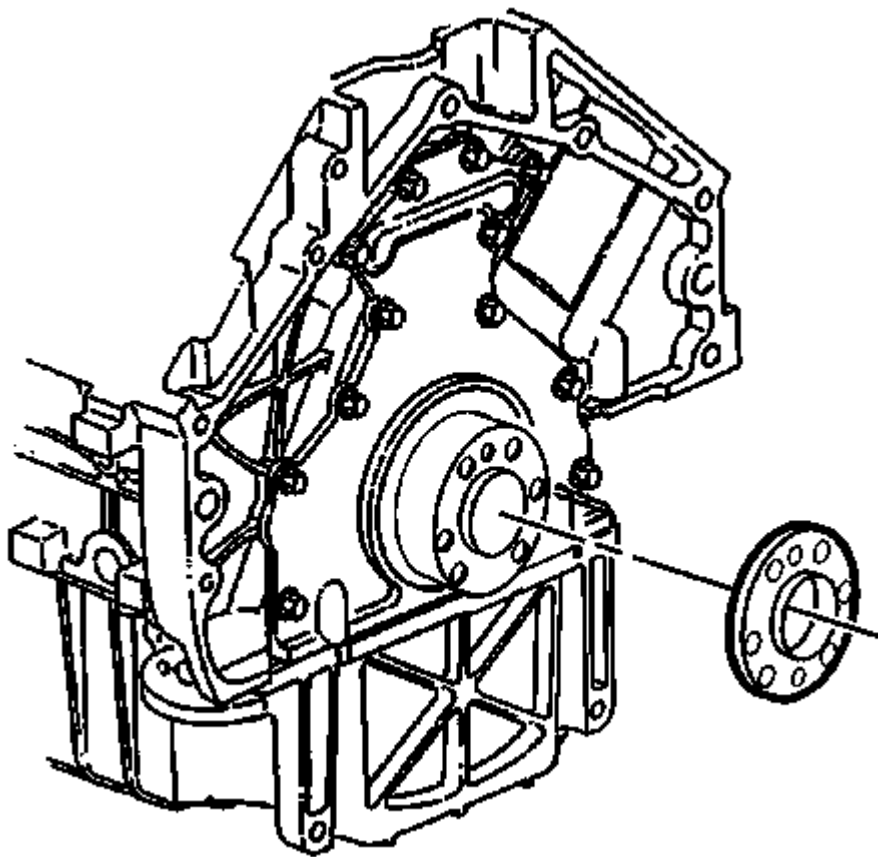


Fig. 246: View Of Spacer & Crankshaft Rear
Courtesy of GENERAL MOTORS CORP.

10. Remove the spacer from the rear of the crankshaft, if applicable.

Installation Procedure

IMPORTANT:

- The flywheel does not use a locating pin for alignment and will not initially seat against the crankshaft flange or spacer (if applicable), but will be pulled onto the crankshaft by the engine flywheel bolts. This procedure requires a three stage tightening process.
- Certain applications (4.8 L manual transmissions or all 6.0 L) require a spacer and longer bolts for proper flywheel position.

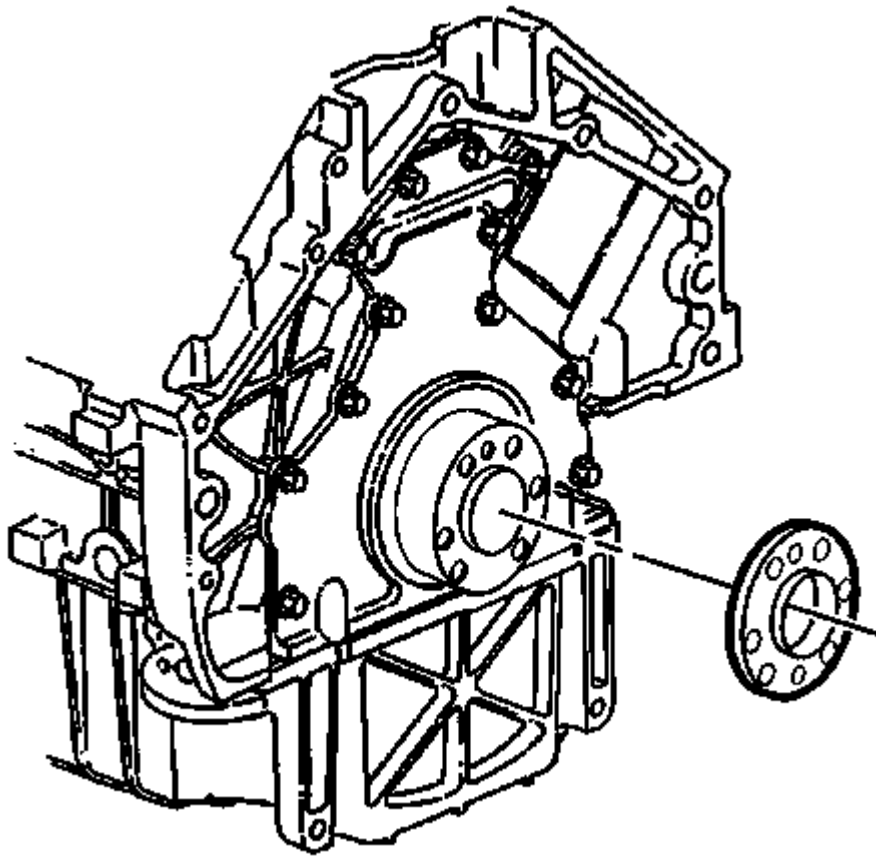


Fig. 247: View Of Spacer & Crankshaft Rear
Courtesy of GENERAL MOTORS CORP.

1. Install the spacer (if applicable) onto the rear of the crankshaft.

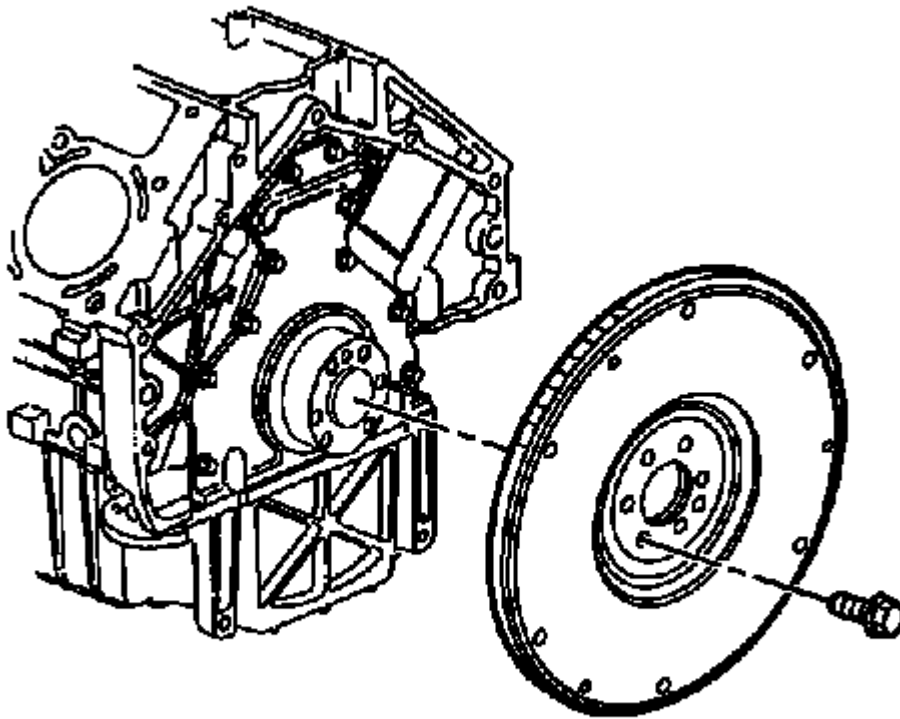


Fig. 248: Engine Flywheel & Bolts (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

2. Install the manual transmission engine flywheel to the crankshaft, if applicable.

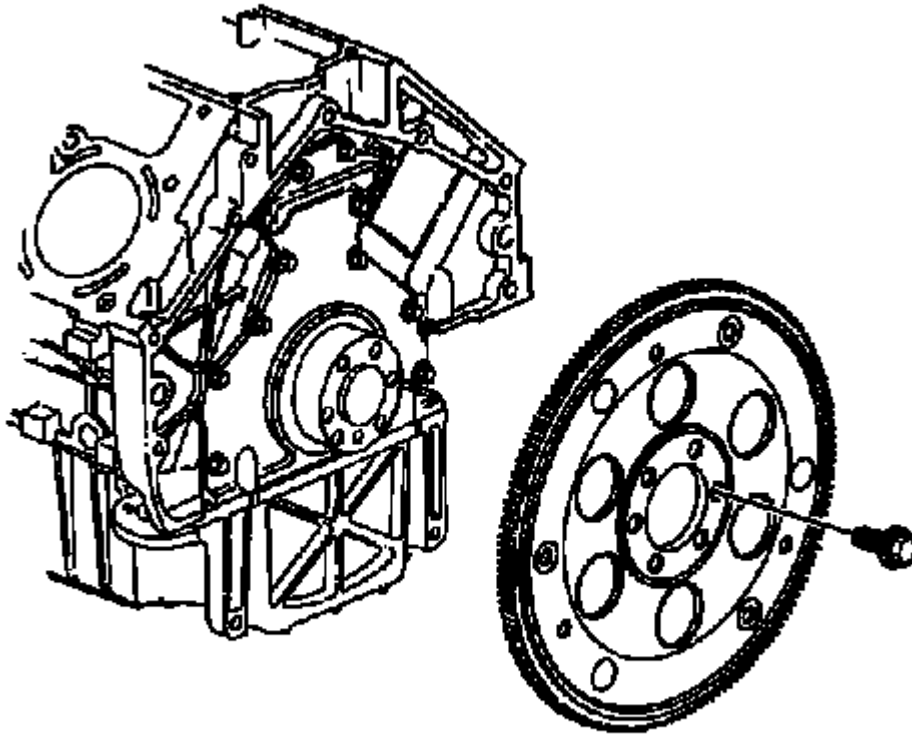


Fig. 249: View Of Engine Flywheel & Bolt
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Longer flywheel bolts must be used on applications using a flywheel spacer.

3. Install the automatic transmission engine flywheel to the crankshaft, if applicable.
4. Apply threadlock GM U.S. P/N 12345382, Canada P/N 10953489, or equivalent to the threads of the flywheel bolts.

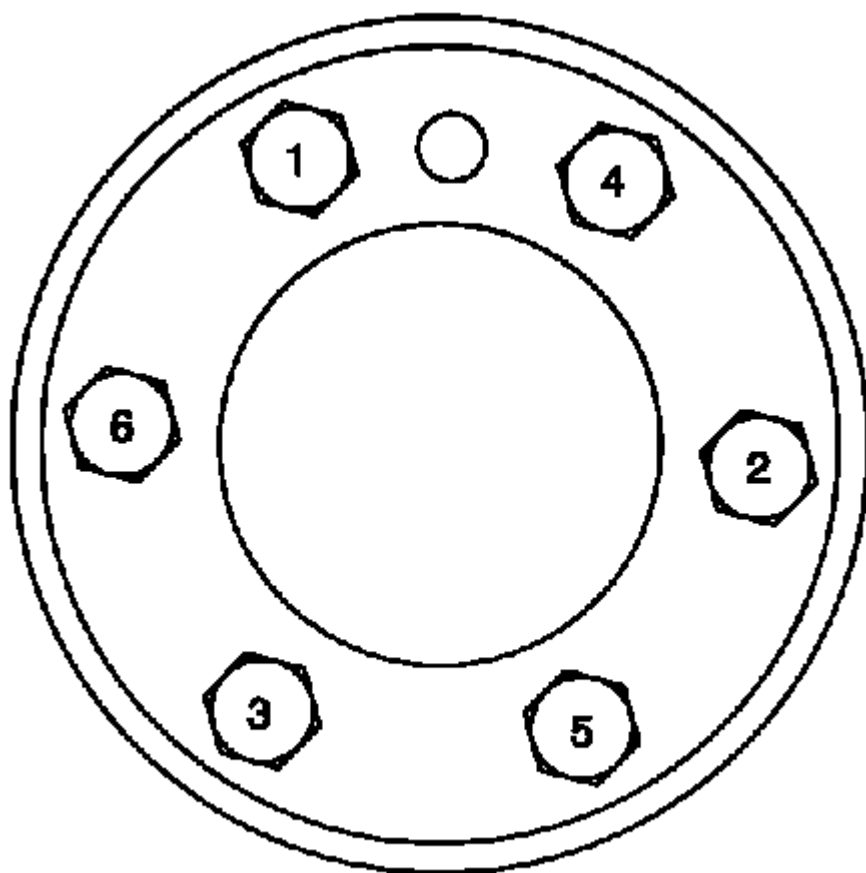


Fig. 250: Identifying Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

5. Install the engine flywheel bolts.

Tighten:

1. Tighten the engine flywheel bolts a first pass in sequence to 20 N.m (15 lb ft).
 2. Tighten the engine flywheel bolts a second pass in sequence to 50 N.m (37 lb ft).
 3. Tighten the engine flywheel bolts a final pass in sequence to 100 N.m (74 lb ft).
6. Install the clutch, if equipped with a manual transmission. Refer to **REMOVAL & INSTALLATION** Clutch.
 7. Install the automatic transmission, if equipped. Refer to **REMOVAL & INSTALLATION** for Automatic Transmission - 4L60-E or **REMOVAL & INSTALLATION** for Automatic Transmission - 4L80-E.

ENGINE REPLACEMENT

Tools Required

- **J 41798** Engine Lifting Brackets. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 21366** Converter Holding Strap. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 42371** Clutch Line Removal Tool. See **SPECIAL TOOLS AND EQUIPMENT**.
- **J 5824-A** Clutch Alignment Tool. See **SPECIAL TOOLS AND EQUIPMENT**.

Removal Procedure

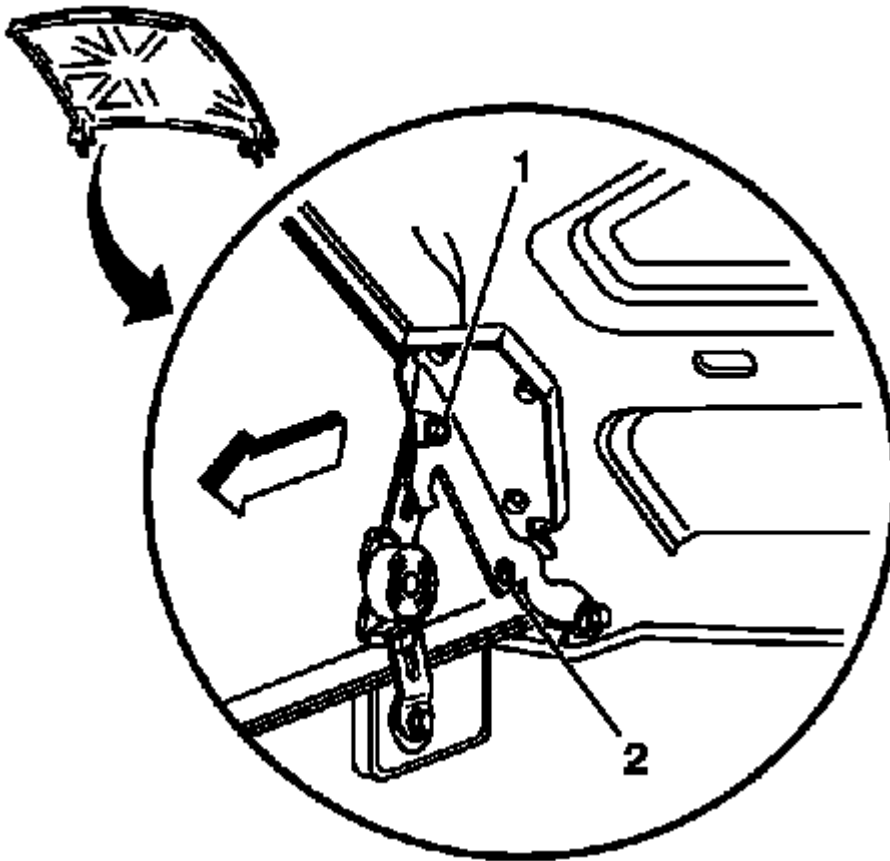


Fig. 251: Identifying Hood Hinge Normal And Service Position Bolt Holes
Courtesy of GENERAL MOTORS CORP.

1. Open the hood.
2. Place fender covers over both fenders.
3. Raise the hood to the service position, perform the following:
 1. Remove the hood hinge bolts (1).
 2. Raise the hood until vertical.
 3. Install the hood hinge bolts until snug in the service position (2).
4. Remove the air conditioning (AC) compressor. Refer to **COMPRESSOR REPLACEMENT (L35 W/HARRISON)** or **COMPRESSOR REPLACEMENT (LB7 W/DENSO)** or **COMPRESSOR**

REPLACEMENT (LB7 W/HARRISON) or COMPRESSOR REPLACEMENT (LR4, LM7, LQ4, L18 W/DENSO) or COMPRESSOR REPLACEMENT (L18 W/HARRISON) in HVAC.

5. Remove the radiator supports. Refer to **RADIATOR SUPPORT REPLACEMENT** .

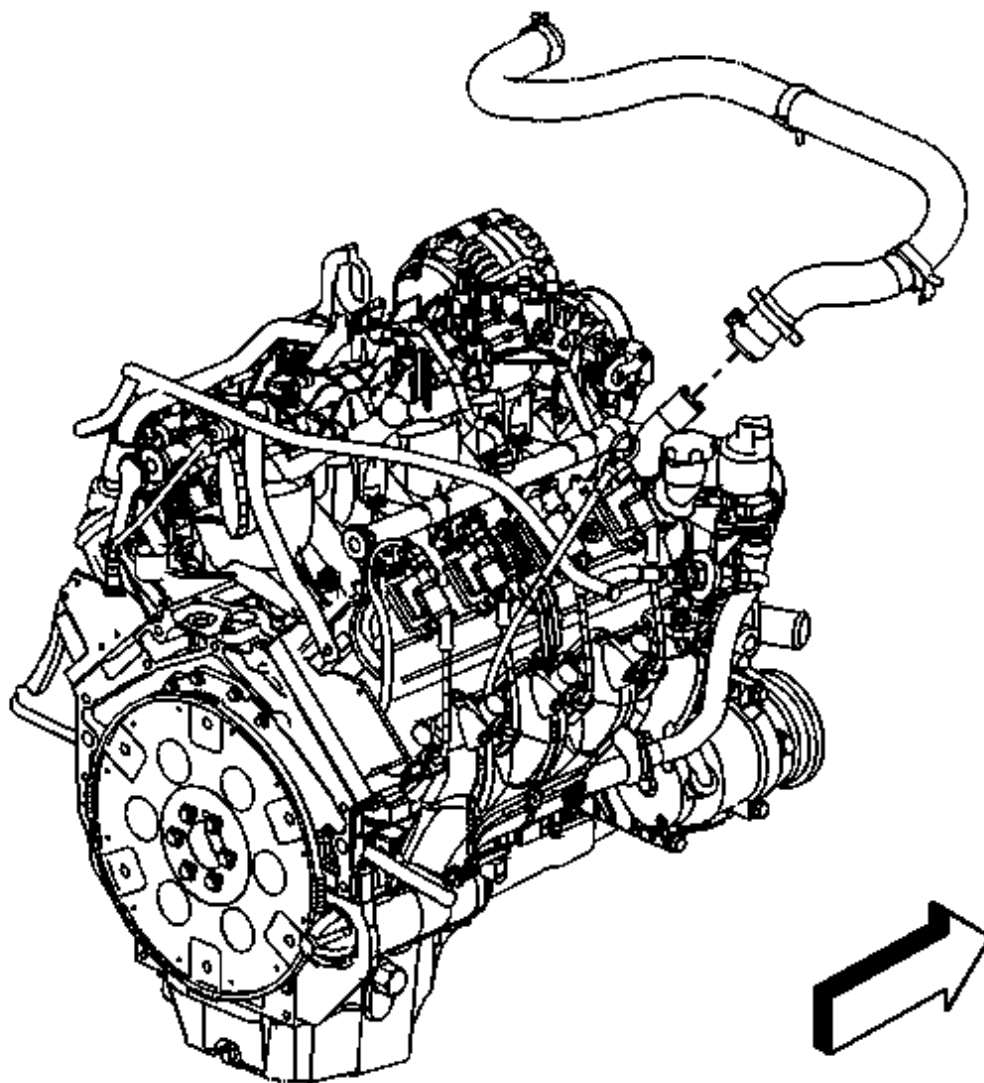


Fig. 252: View Of Inlet Hose & Water Pump
Courtesy of GENERAL MOTORS CORP.

6. Reposition the radiator inlet hose clamp at the water pump.
7. Remove the radiator inlet hose from the water pump.

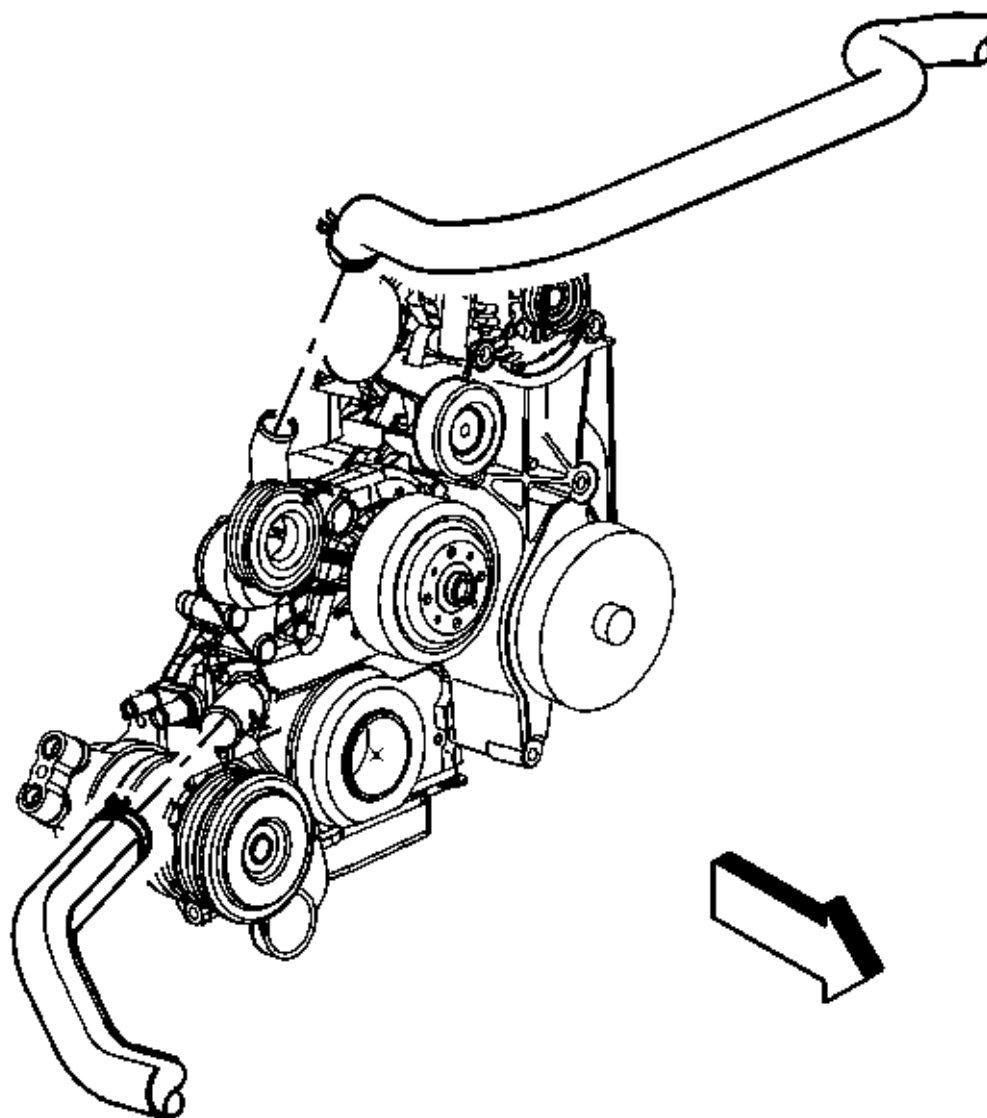


Fig. 253: Radiator Outlet Hose
Courtesy of GENERAL MOTORS CORP.

8. Reposition the radiator outlet hose clamp at the water pump.
9. Remove the radiator outlet hose from the water pump.
10. Remove the heater hoses. Refer to **HEATER HOSE REPLACEMENT -- INLET (L18)** or **HEATER HOSE REPLACEMENT -- INLET (LB7)** or **HEATER HOSE REPLACEMENT -- INLET (L35)** or **HEATER HOSE REPLACEMENT -- INLET (LR4, LM7 & LQ4)** and **HEATER HOSE**

REPLACEMENT -- OUTLET (L18) or HEATER HOSE REPLACEMENT -- OUTLET (LB7) or HEATER HOSE REPLACEMENT -- OUTLET (L35) or HEATER HOSE REPLACEMENT -- OUTLET (LR4, LM7, & LQ4) in Heating, Ventilation, and Air Conditioning.

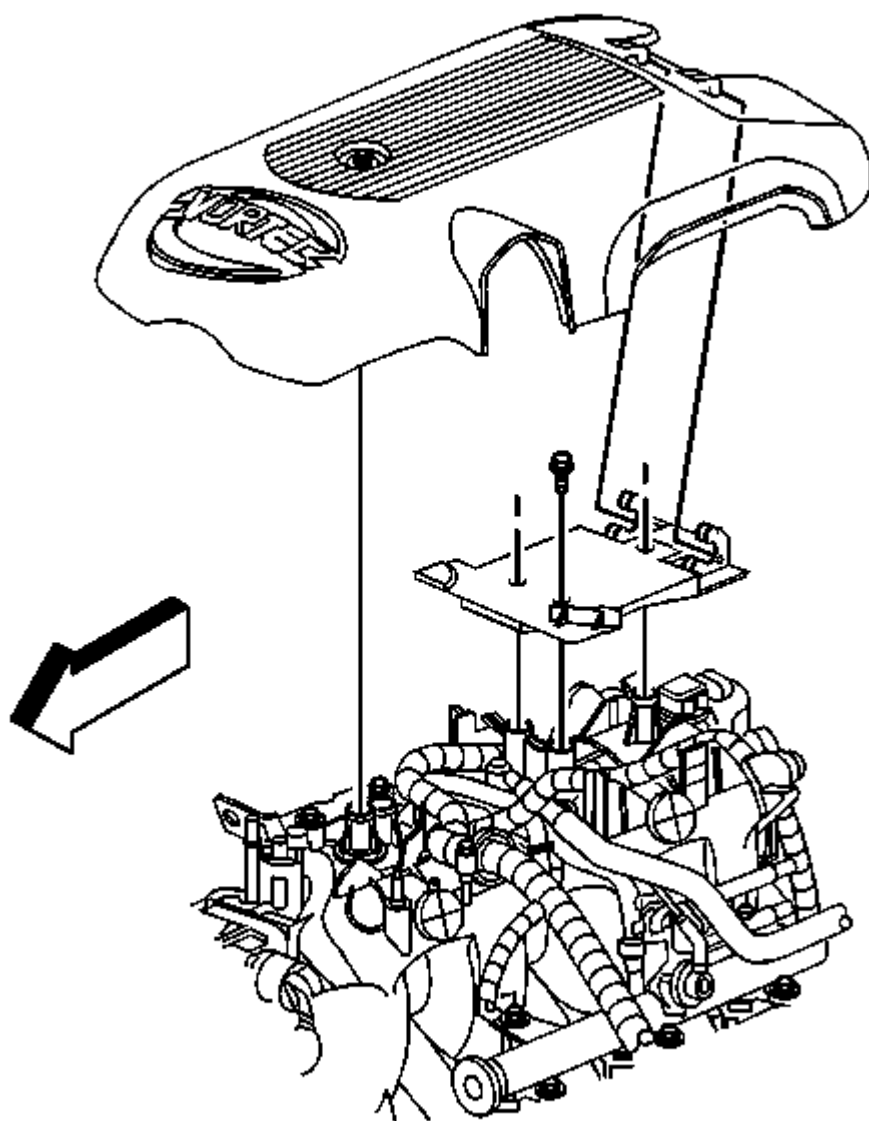


Fig. 254: View Of Top Engine Cover
Courtesy of GENERAL MOTORS CORP.

11. If equipped with the 4.8L, 5.3L, or 6.0L without regular production options (RPO's) Y91 and Z88, loosen

the intake manifold sight shield bolt.

12. Remove the sight shield from the retainer.

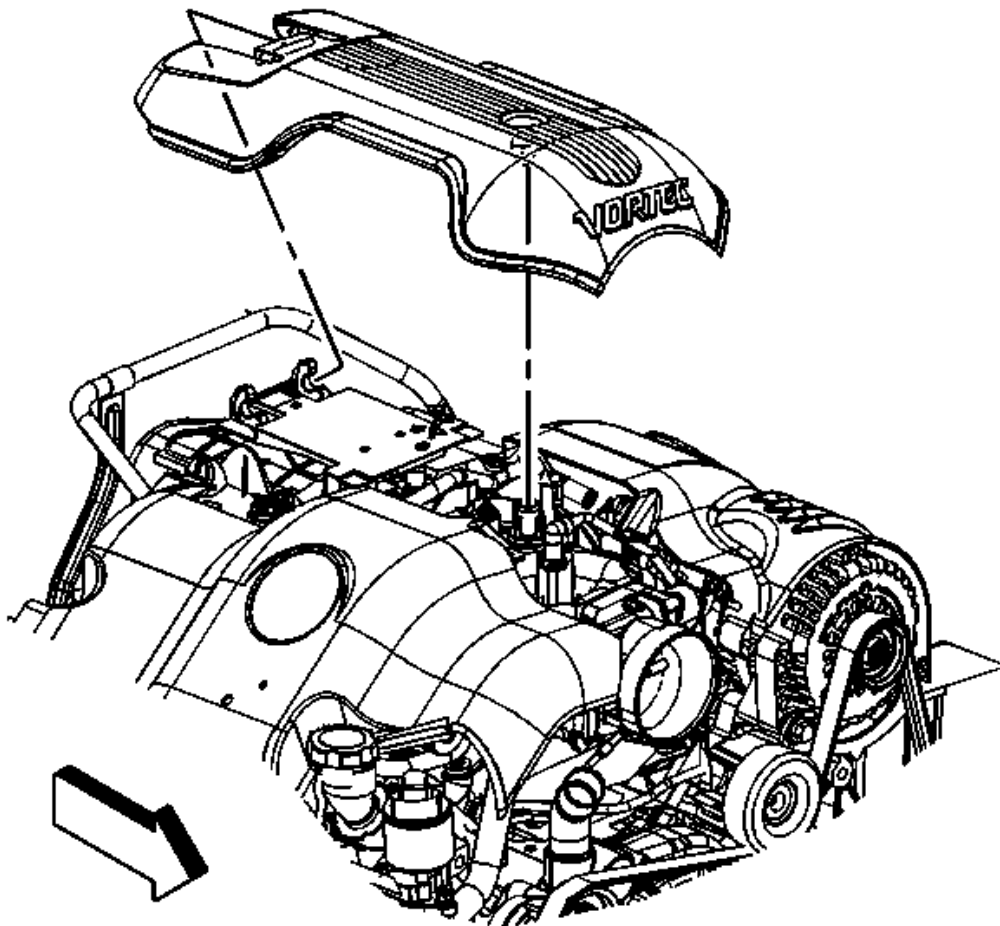


Fig. 255: Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS CORP.

13. If equipped with the 6.0L with RPO's Y91 and Z88, loosen the intake manifold sight shield bolt.
14. Remove the sight shield from the retainer.

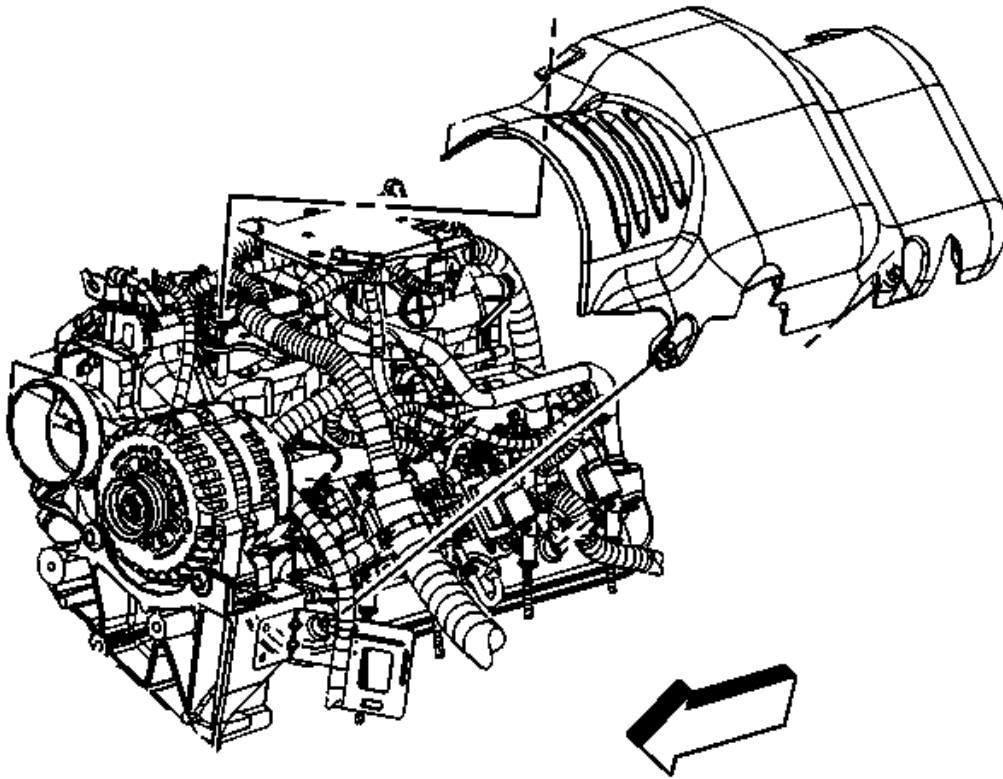


Fig. 256: Left Fuel Rail Cover
Courtesy of GENERAL MOTORS CORP.

15. If equipped with the 6.0L with RPO's Y91 and Z88, loosen the left fuel rail cover bolts.
16. Remove the left fuel rail cover.

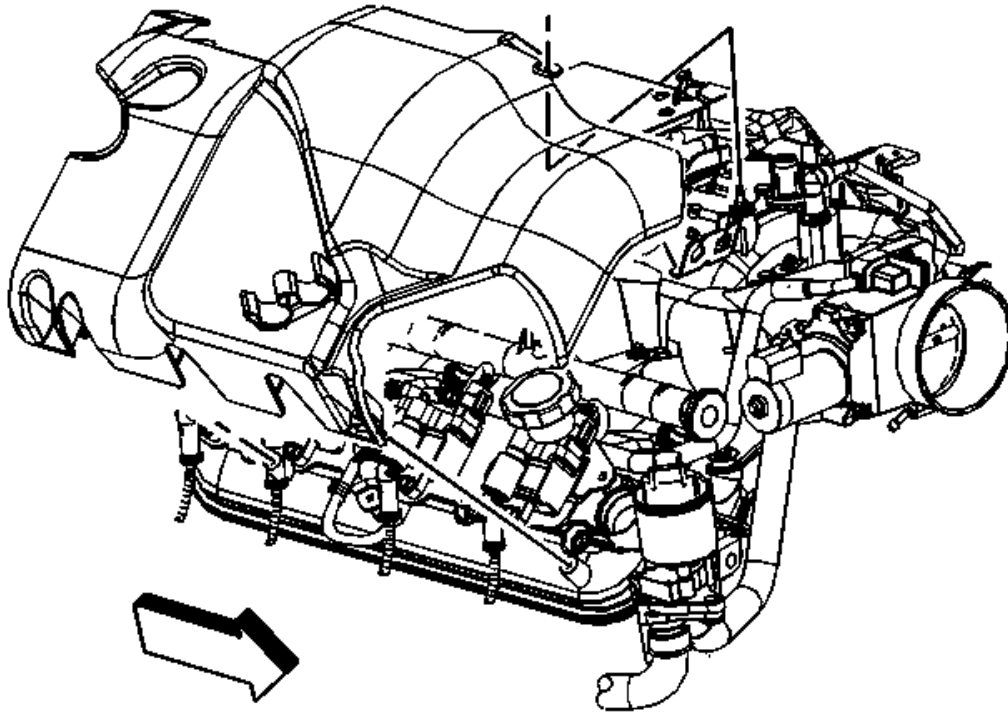


Fig. 257: Left Fuel Rail Cover
Courtesy of GENERAL MOTORS CORP.

17. If equipped with the 6.0L with RPO's Y91 and Z88, loosen the right fuel rail cover bolts.
18. Remove the right fuel rail cover.

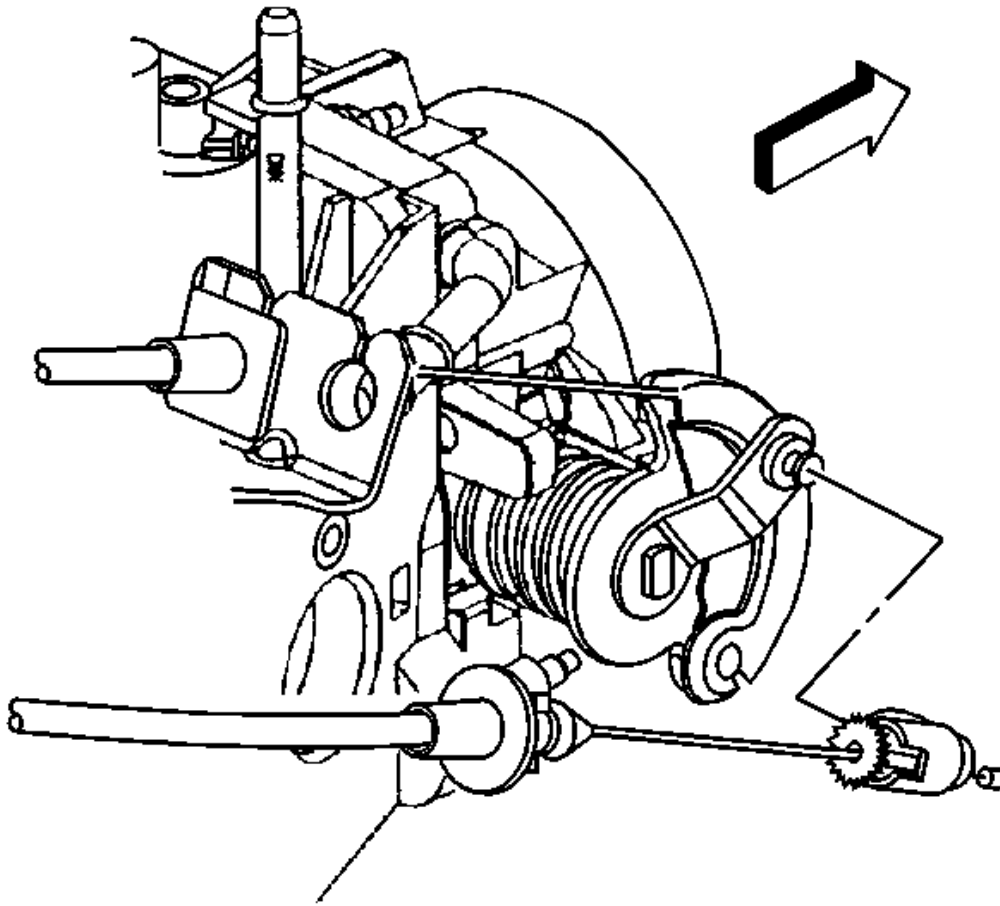


Fig. 258: Cruise Control Cable
Courtesy of GENERAL MOTORS CORP.

19. Unsnap the cruise control cable from the throttle body lever, if equipped.
20. Remove the cruise control cable from the bracket, if equipped.

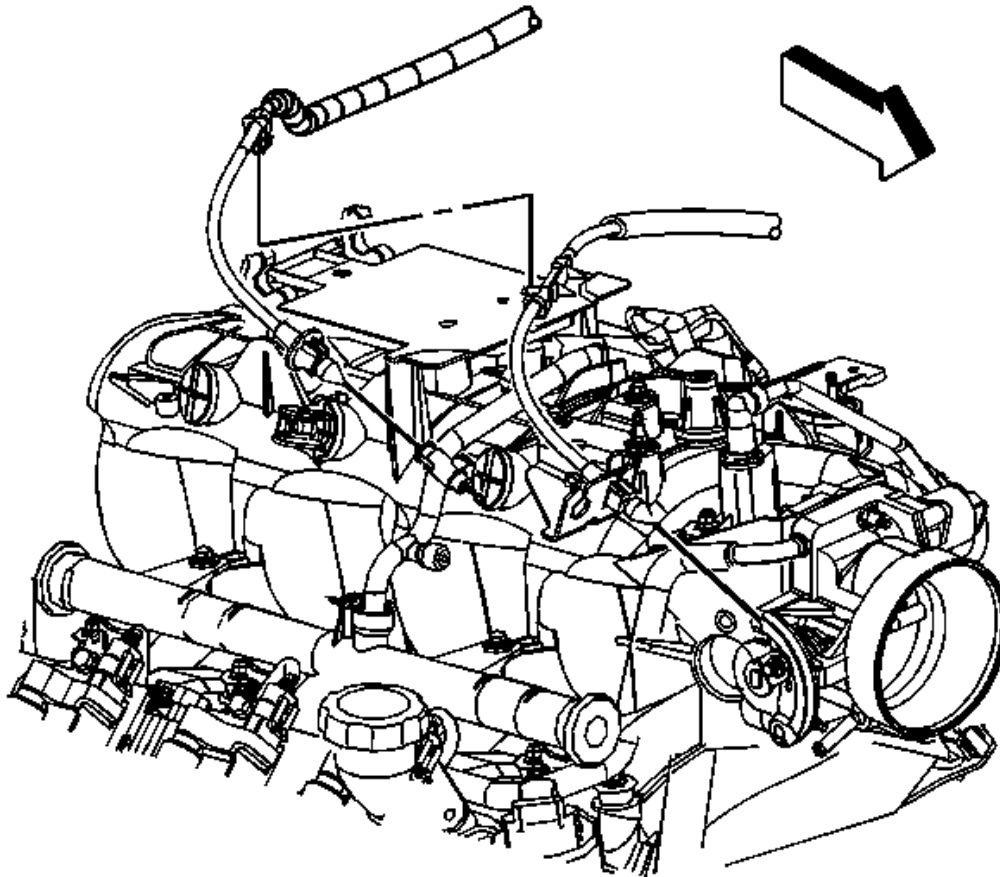


Fig. 259: Accelerator Control Cable Clip
Courtesy of GENERAL MOTORS CORP.

21. Remove the cruise control cable clip from the sight shield retainer, if equipped.

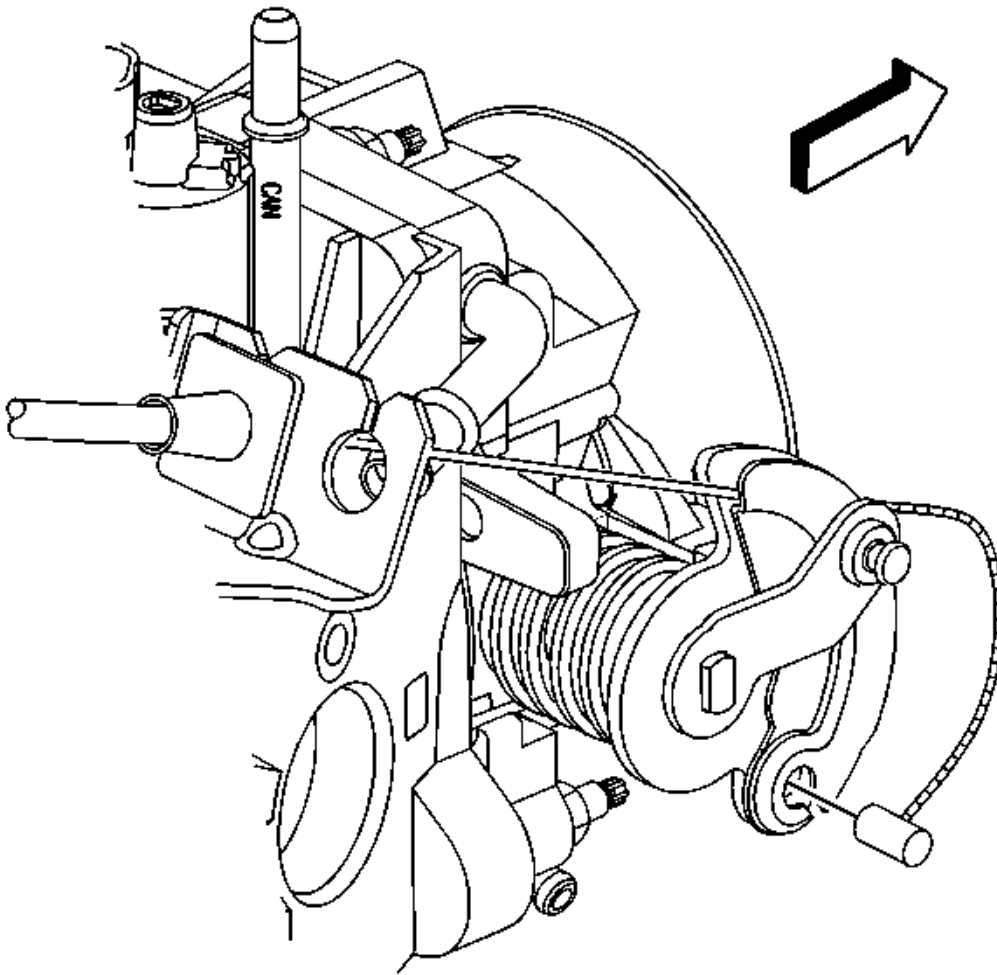


Fig. 260: View Of Accelerator/Throttle Cable
Courtesy of GENERAL MOTORS CORP.

22. Disconnect the accelerator control cable from the throttle body lever, if required.
23. Remove the accelerator control cable from the bracket, if required.

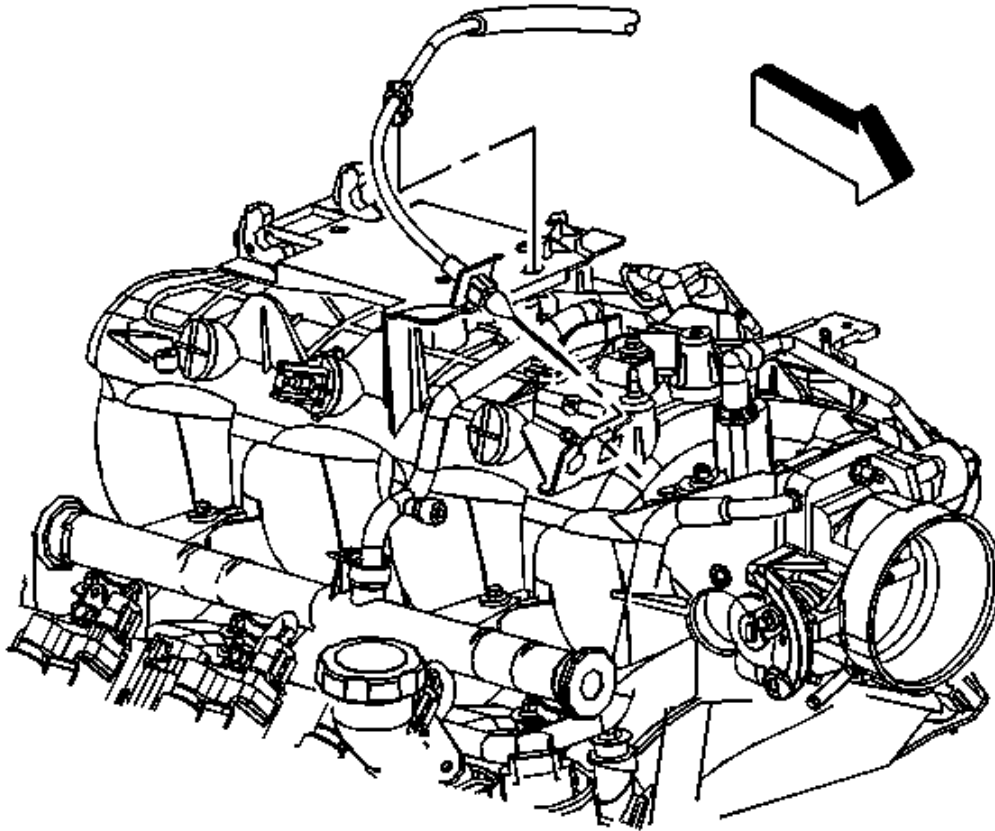


Fig. 261: Cruise Control Cable Clip
Courtesy of GENERAL MOTORS CORP.

24. Remove the accelerator control cable from the sight shield retainer, if required.
25. Remove the upper intake manifold sight shield retainer bolts and retainer, if necessary.

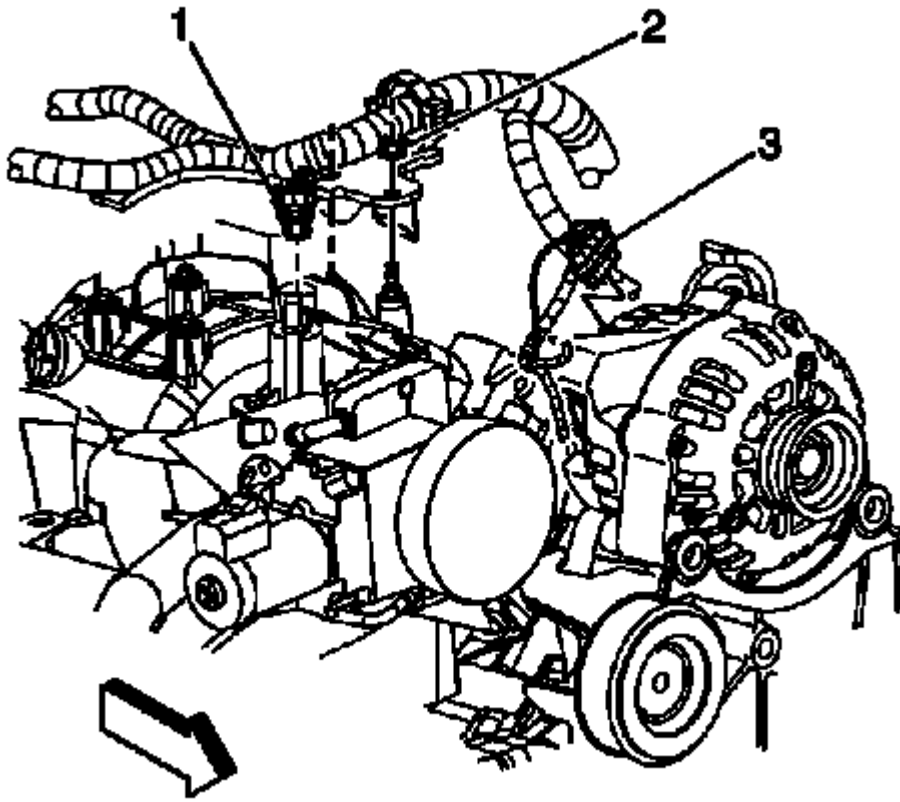


Fig. 262: Identifying Purge Solenoid Electrical Connector, Wiring Harness Nut & Generator Electrical Connector

Courtesy of GENERAL MOTORS CORP.

26. Disconnect the following electrical connectors:
 - Evaporative emissions (EVAP) canister purge solenoid (1)
 - Generator (3)
27. Remove the harness bracket nut (2) in order to remove the engine harness from the intake manifold.

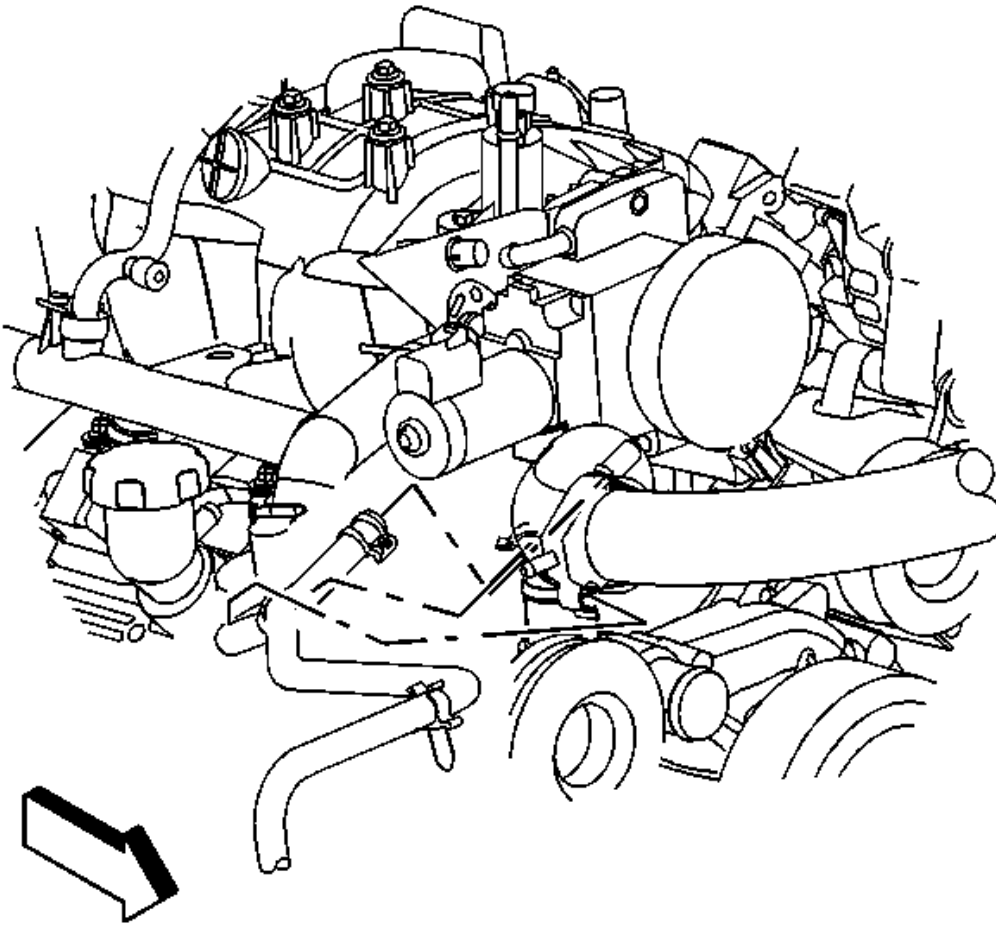


Fig. 263: View Of Vent Inlet Hose At Throttle Body
Courtesy of GENERAL MOTORS CORP.

28. Reposition the vent inlet hose clamp at the throttle body.
29. Remove the radiator vent inlet hose from the throttle body.

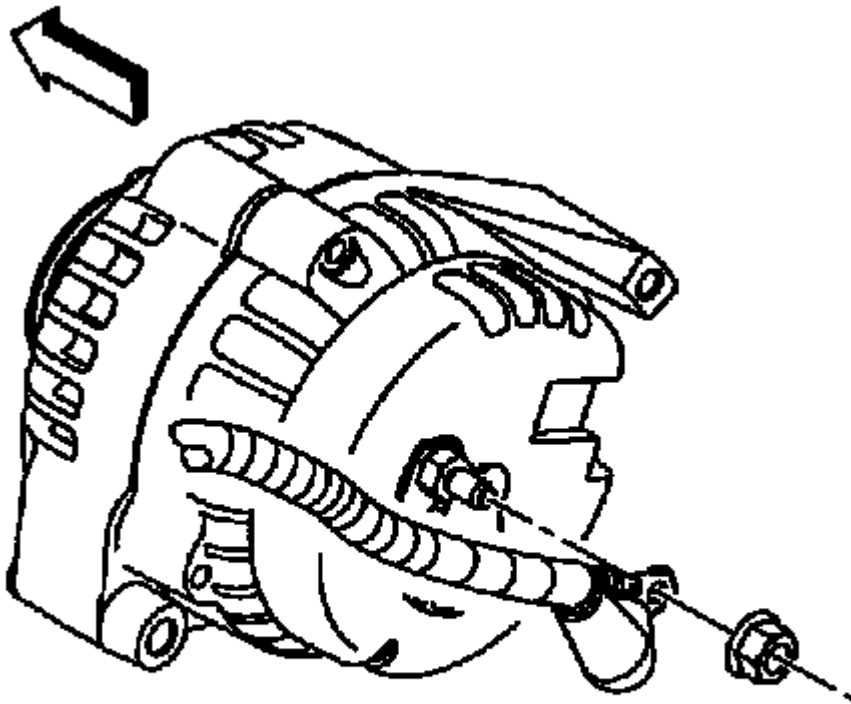


Fig. 264: View Of Generator Cable & Nut
Courtesy of GENERAL MOTORS CORP.

30. Remove the generator cable from the generator, perform the following:
- Slide the boot down revealing the terminal stud.
 - Remove the generator cable nut from the terminal stud.
 - Remove the generator cable.

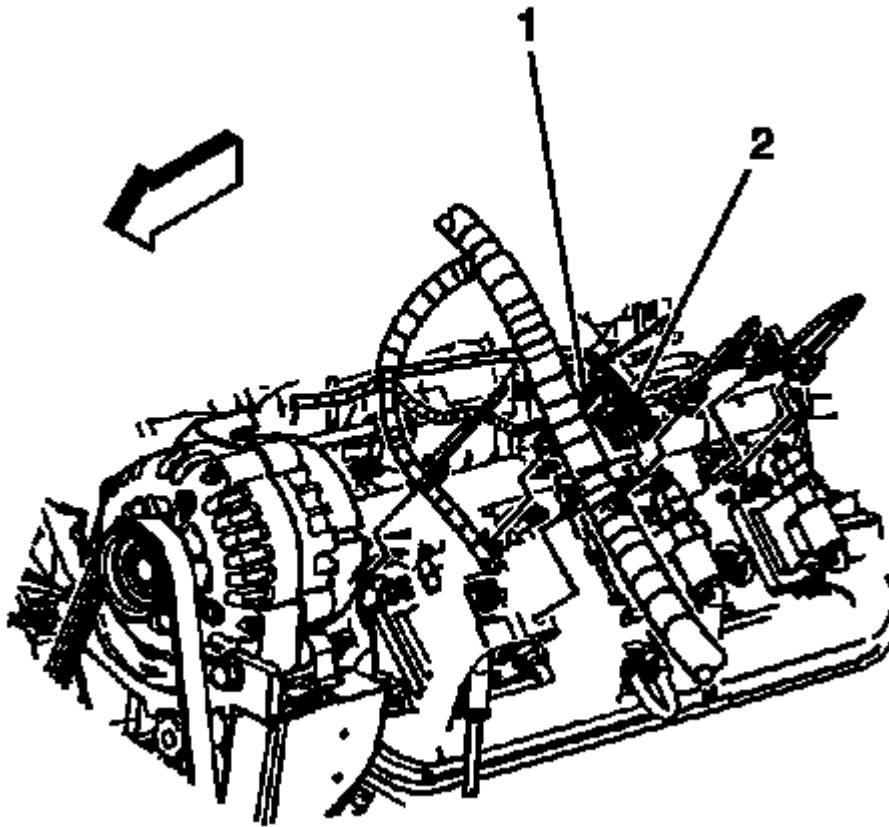


Fig. 265: View Of Main Ignition Coil Wire Harness Connector & Clips
Courtesy of GENERAL MOTORS CORP.

31. Disconnect the main coil harness (2) and fuel injector electrical connectors on the left side.

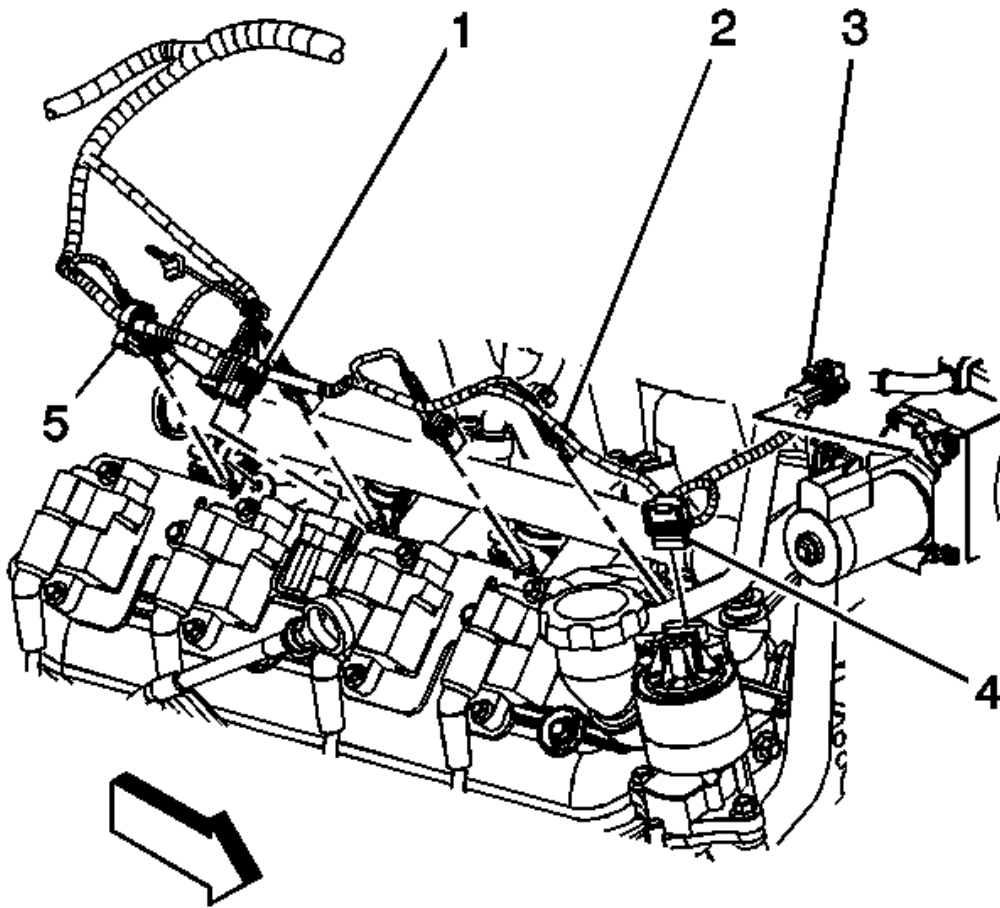


Fig. 266: Main Ignition Coil Wire Harness Connector & Clips
Courtesy of GENERAL MOTORS CORP.

32. Disconnect the following electrical connectors:

- Main coil harness (1)
- Fuel injectors (2)
- Electronic throttle control (ETC) (3)
- Exhaust gas recirculation (EGR) valve (4), if equipped

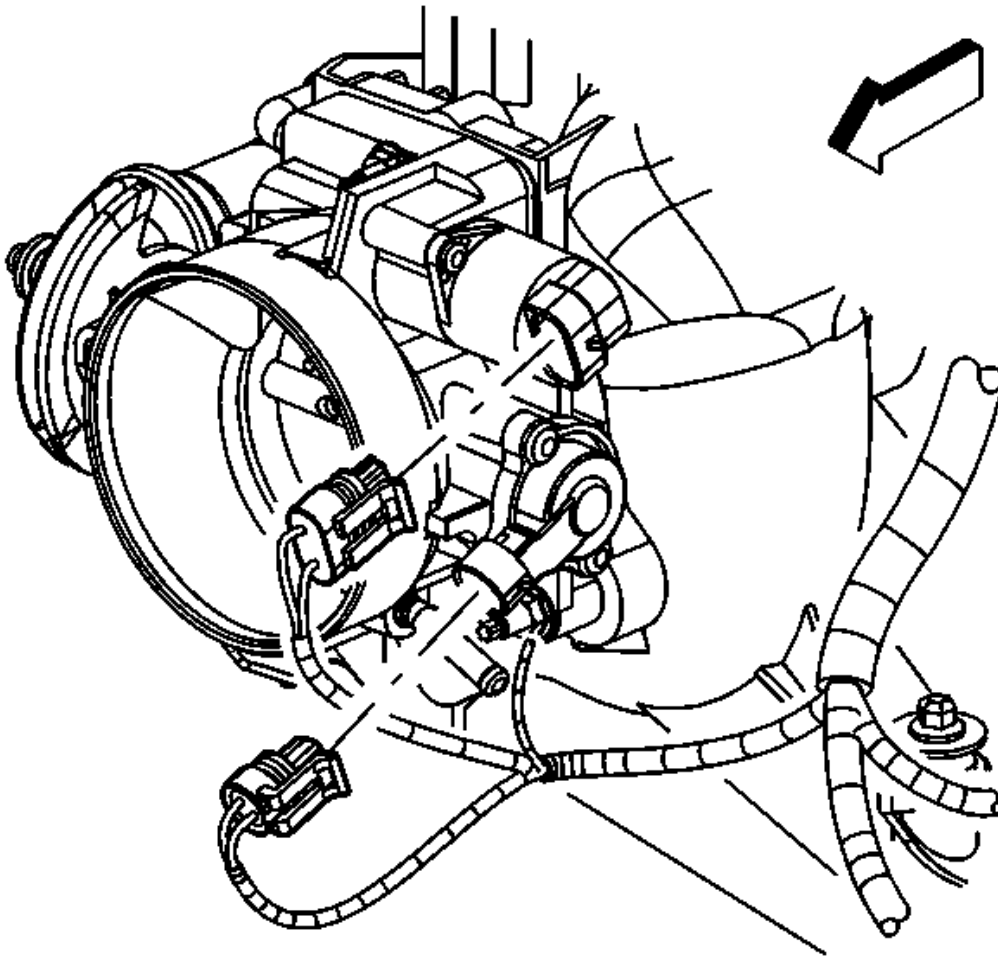


Fig. 267: TP Sensor & IAC Valve Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

33. Disconnect the throttle position (TP) sensor and idle air control (IAC) valve electrical connectors.

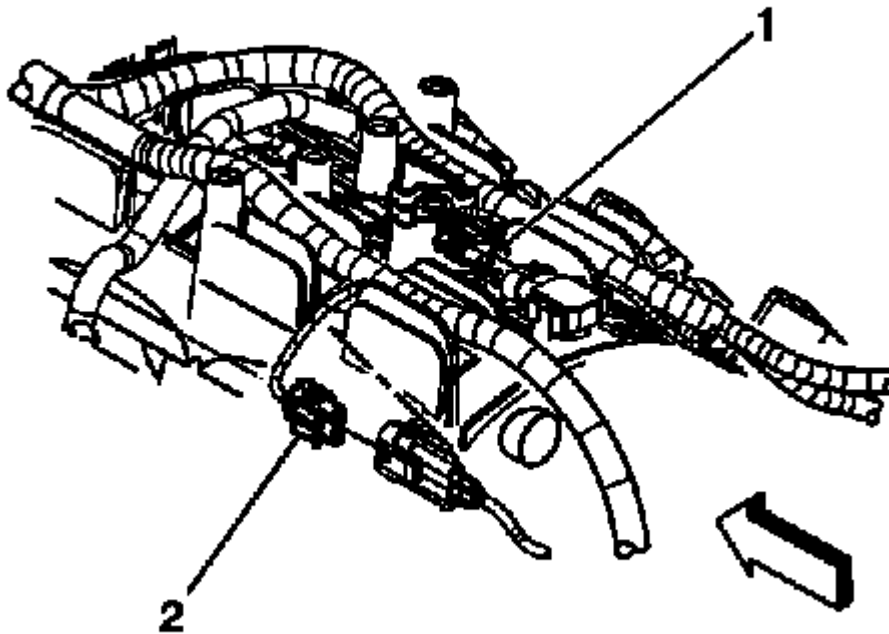


Fig. 268: View Of MAP Sensor & Knock Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

34. Disconnect the manifold absolute pressure (MAP) sensor (1) and knock sensor (2) electrical connectors.

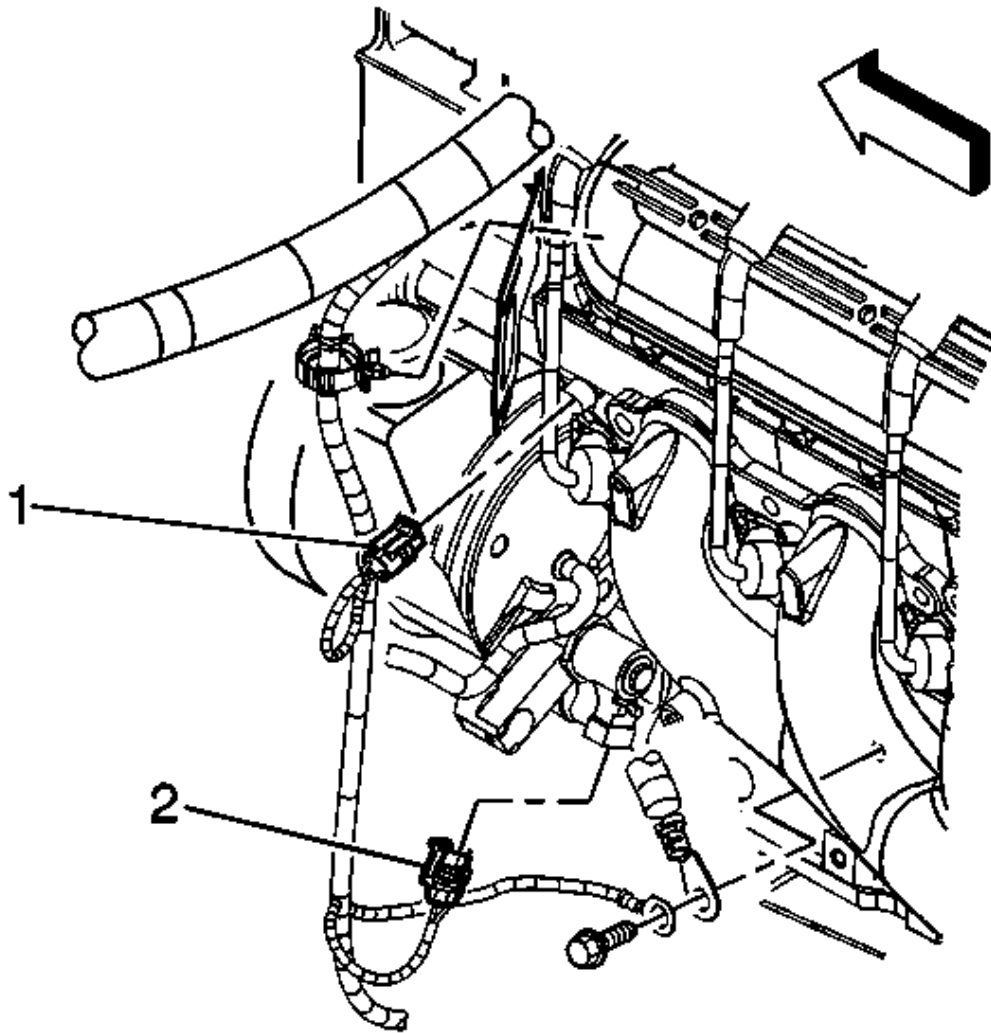


Fig. 269: Coolant Temperature Sensor & Electronic Variable Orifice Switch Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

35. Remove the harness ground bolt.
36. Reposition the harness ground and negative battery cable from the block.
37. Disconnect the following electrical connectors:
 - Coolant temperature sensor (1)
 - Electronic variable orifice switch (2)

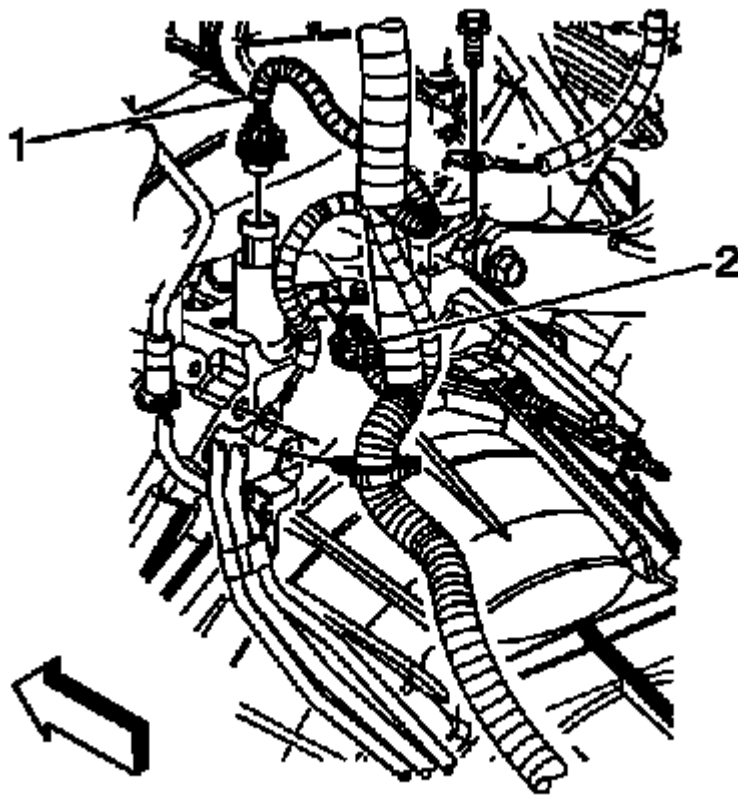


Fig. 270: View Of Oil Pressure Sensor & CMP Sensor Connectors
Courtesy of GENERAL MOTORS CORP.

38. Remove the harness ground bolt at the right rear of the engine block.
39. Reposition the harness ground, and auxiliary negative battery cable, (if equipped) from the block.
40. Remove the harness ground bolt at the left rear of the engine block
41. Reposition the harness ground, and engine ground strap from the block.
42. Disconnect the following electrical connectors:
 - Oil pressure sensor (1)
 - Camshaft position (CMP) sensor (2)
43. Unclip all of the engine harness clips from the engine.

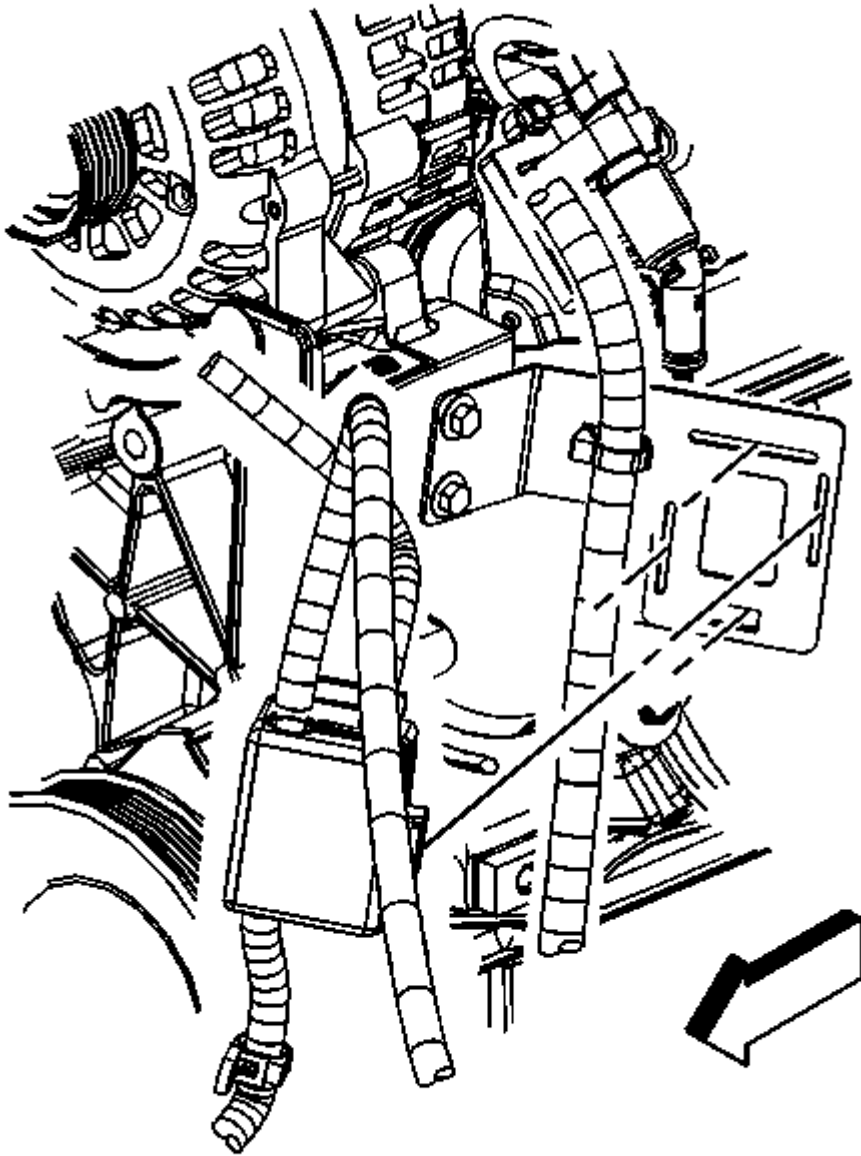


Fig. 271: Battery Cable Junction Block
Courtesy of GENERAL MOTORS CORP.

44. Remove the battery cable junction block from the junction block bracket.

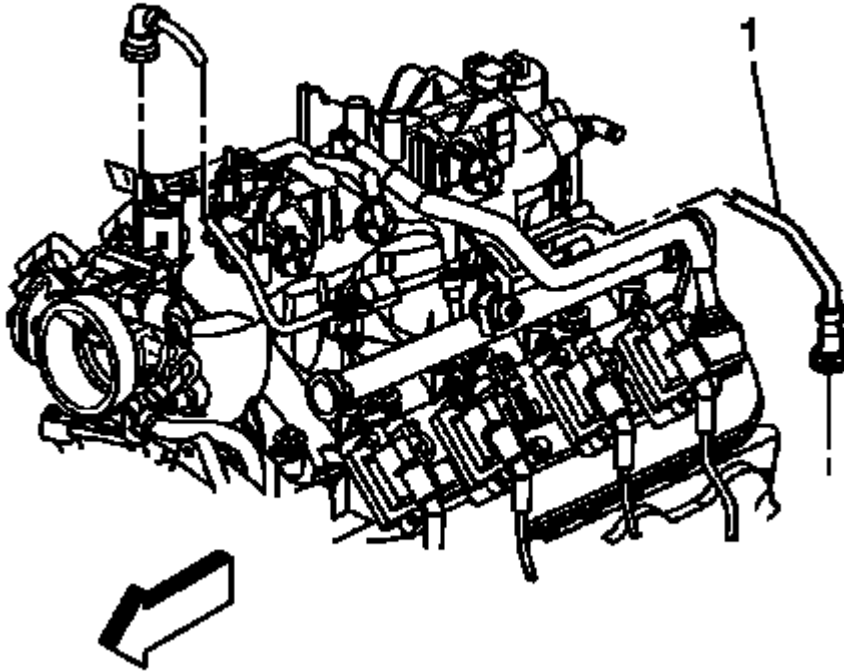


Fig. 272: View Of EVAP Purge Solenoid Vent Tube
Courtesy of GENERAL MOTORS CORP.

45. Remove the EVAP purge solenoid vent tube, perform the following:
 - Remove the EVAP tube end (2) from the solenoid (1).
 - Remove the EVAP tube end (3) from the vapor pipe.
46. Disconnect the fuel pipes. Refer to **QUICK CONNECT FITTINGS (METAL COLLAR)** or **QUICK CONNECT FITTINGS (PLASTIC COLLAR)** .
47. Raise the vehicle.

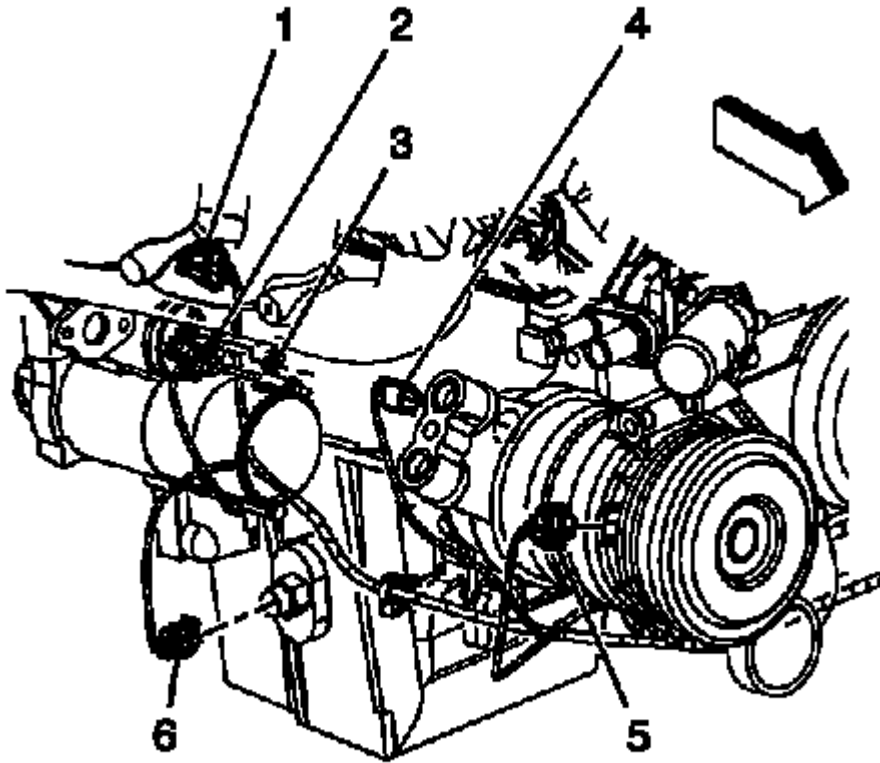


Fig. 273: Identifying Electrical Connector (Right Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

48. Disconnect the following electrical connectors:
- The crankshaft position (CKP) sensor (1)
 - The engine oil level sensor (6)
 - The coolant heater, if equipped

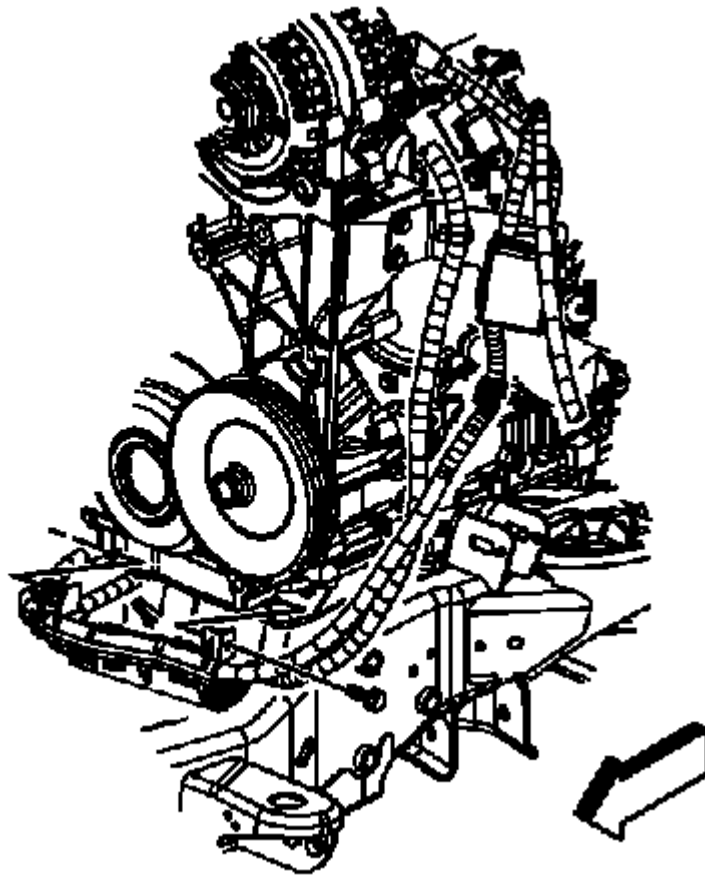


Fig. 274: View Of Positive Battery Cable, Channel & Bolt
Courtesy of GENERAL MOTORS CORP.

49. Remove the battery cable channel bolt.
50. Slide the channel pin out of the oil pan tab.
51. Gather all branches of the engine wiring harness and reposition off to the side.
52. Lower the vehicle.

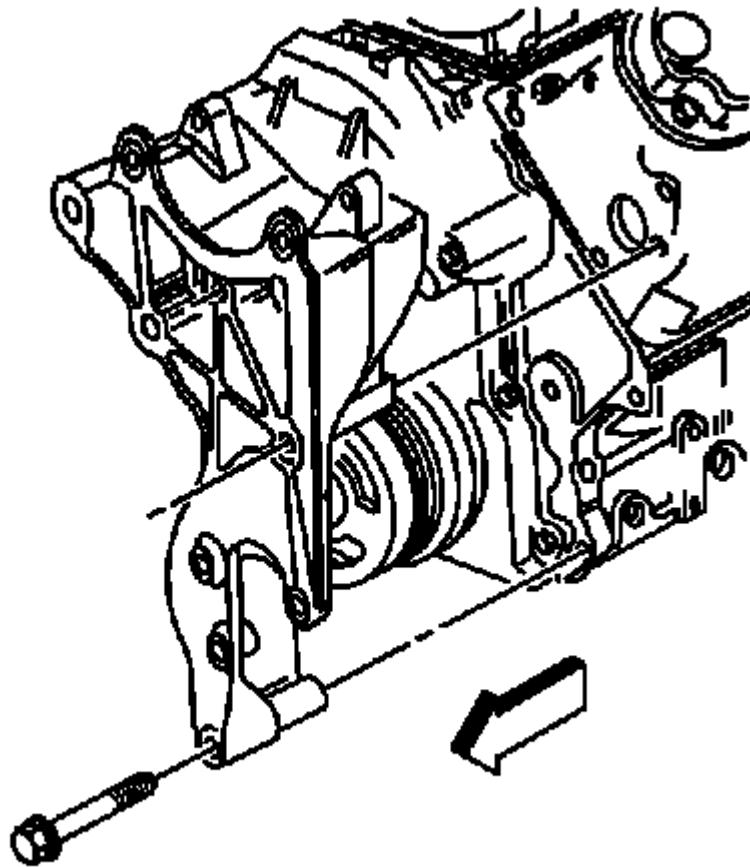


Fig. 275: View Of Generator Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

53. Remove the rear power steering pump-to-engine block bolt.
54. Remove the generator bracket mounting bolts.
55. Position the bracket aside.

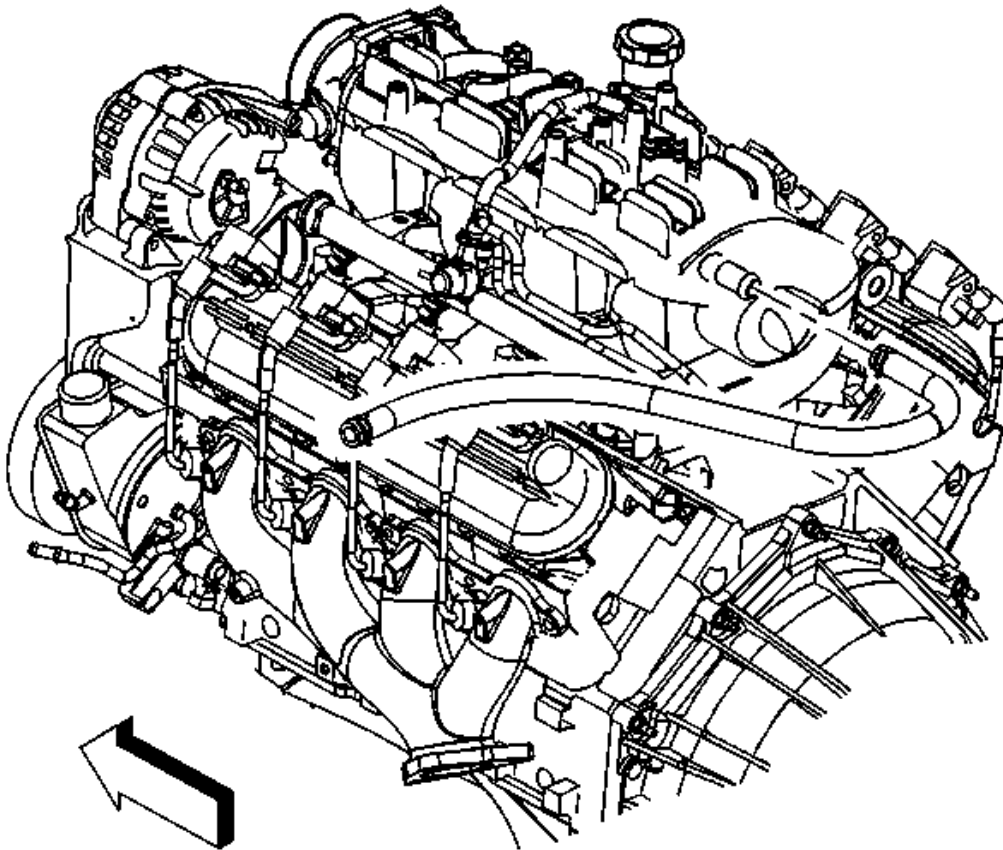


Fig. 276: Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

56. Remove the vacuum brake booster hose.
57. Remove the ignition coil(s) (as required) for the proper fit of the **J 41798** before lifting the engine. See **SPECIAL TOOLS AND EQUIPMENT**. Refer to **IGNITION COILS**.

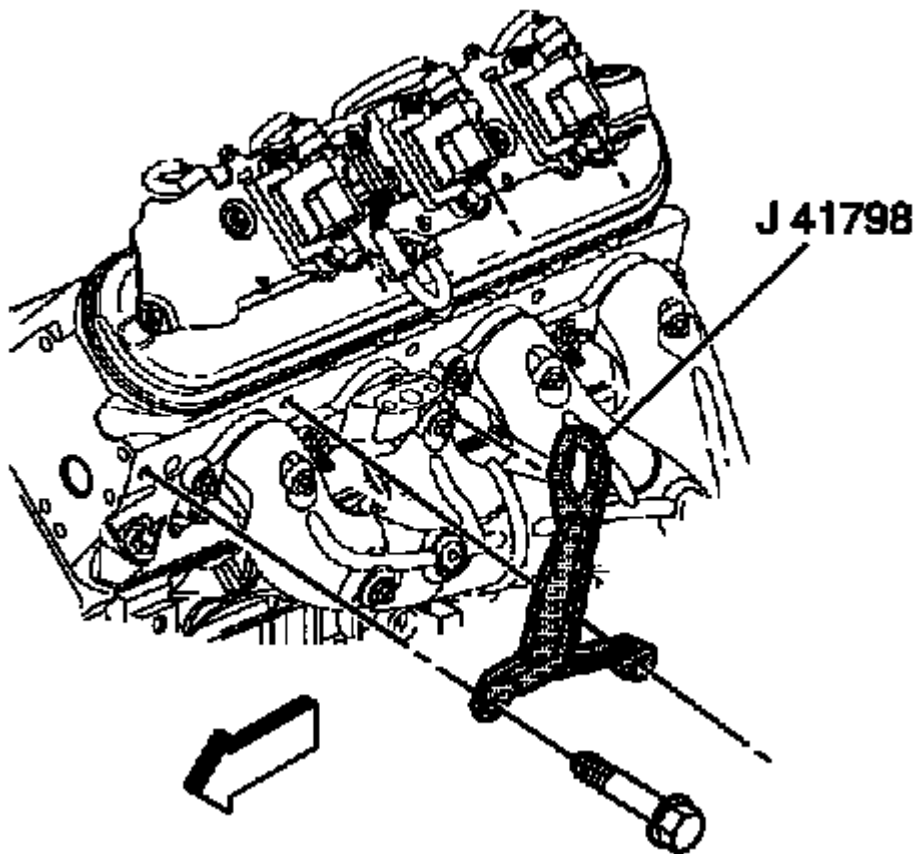


Fig. 277: View Of J 41798

Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

58. Install the **J 41798** to the cylinder heads. See **SPECIAL TOOLS AND EQUIPMENT**.

Tighten:

- Tighten the M8 engine lift bracket bolts to 25 N.m (18 lb ft).
- Tighten the M10 engine lift bracket bolts to 50 N.m (37 lb ft).

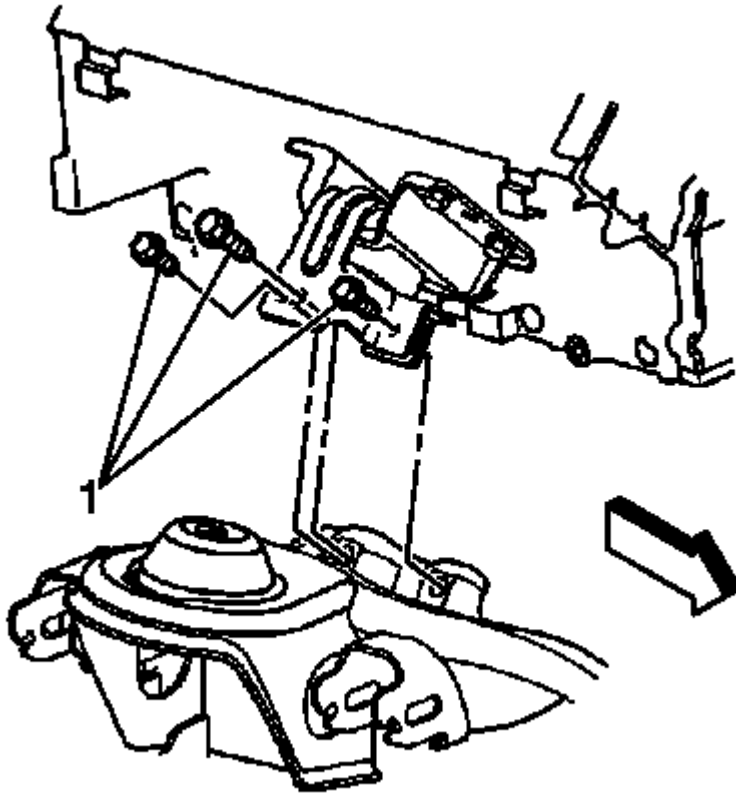


Fig. 278: View Of Engine Mount-To-Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

59. Remove the left and right engine mount-to-engine mount bracket bolts.
60. Raise and suitably support the vehicle. Refer to **LIFTING AND JACKING THE VEHICLE** in General Information.

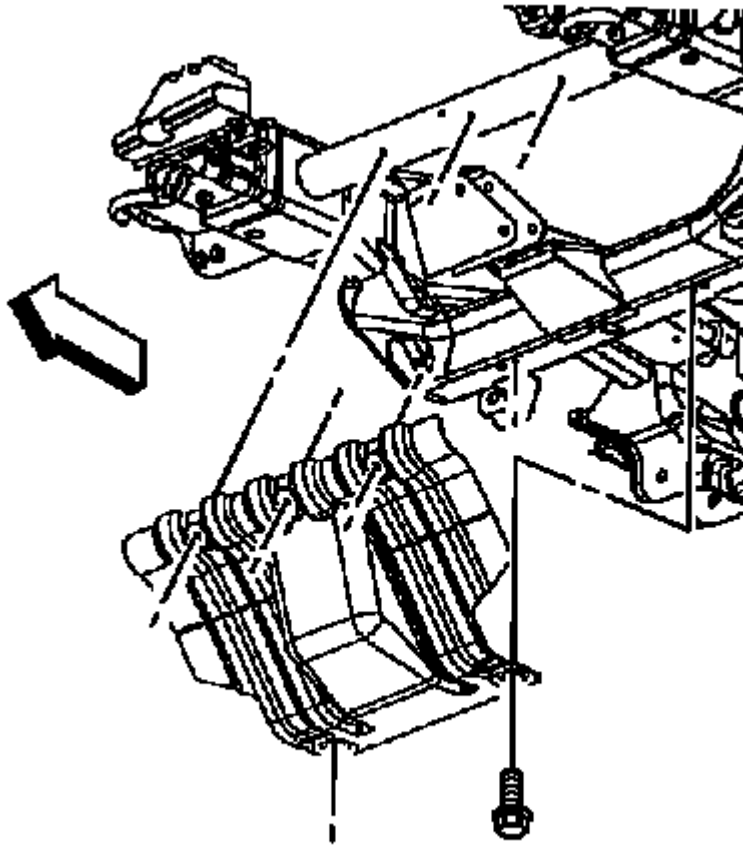


Fig. 279: View Of Engine Protection Shield
Courtesy of GENERAL MOTORS CORP.

61. Remove the engine shield bolts and shield.

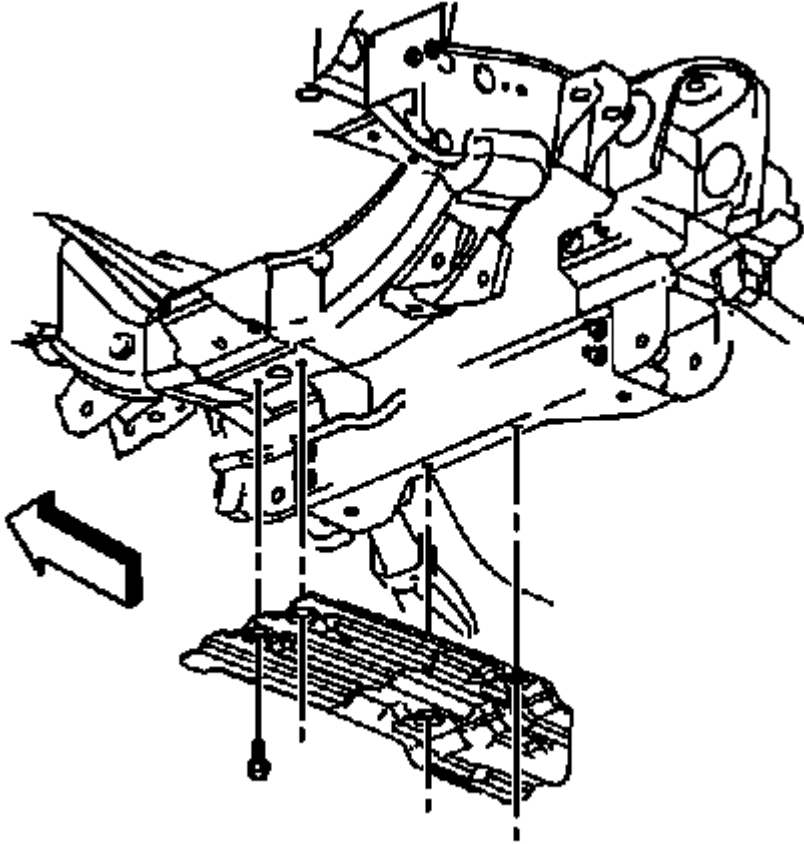


Fig. 280: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

62. Remove the oil pan skid plate bolts and plate, if equipped.
63. Drain the engine oil.
64. Remove the starter motor. Refer to **REMOVAL (4.8L, 5.3L & 6.0L ENGINE)** .
65. Remove the catalytic converter. Refer to **CATALYTIC CONVERTER REPLACEMENT (4.3L, 4.8L & 5.3L ENGINES)** in Engine Exhaust.

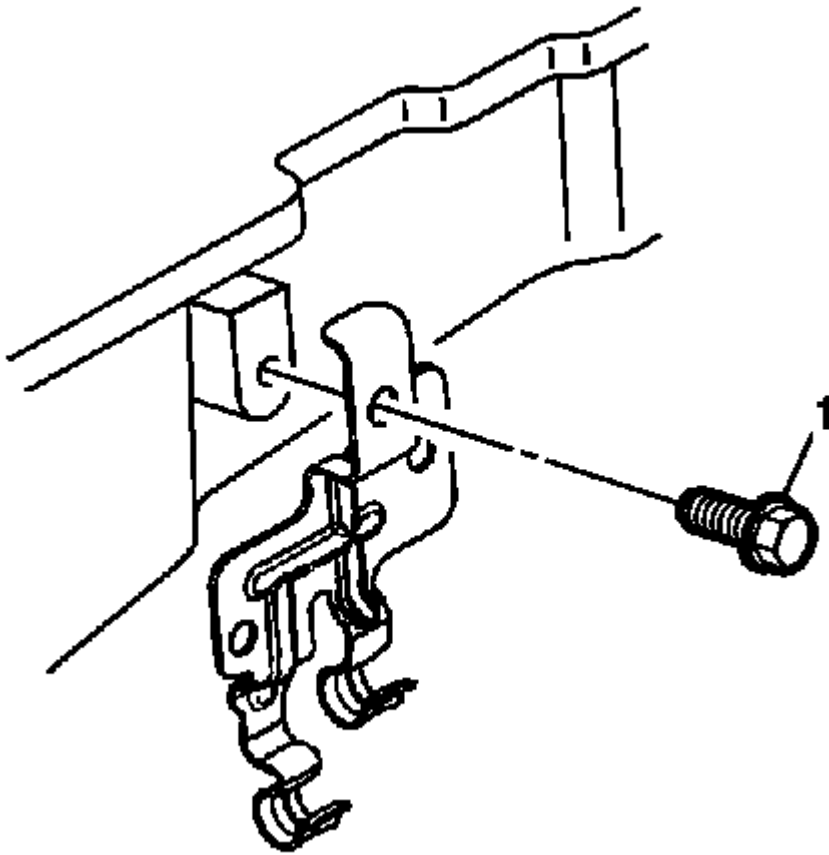


Fig. 281: View Of Positive Battery Cable Clip & Bolt
Courtesy of GENERAL MOTORS CORP.

66. Remove the positive battery cable clip bolt and clip.

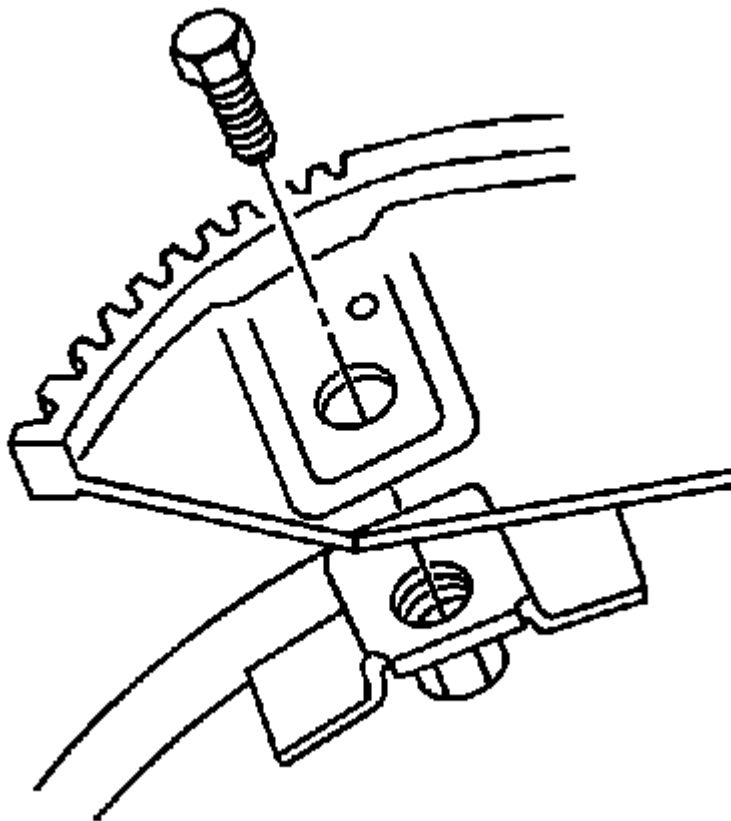


Fig. 282: Flywheel-To-Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

67. Remove the torque converter bolts, if equipped.

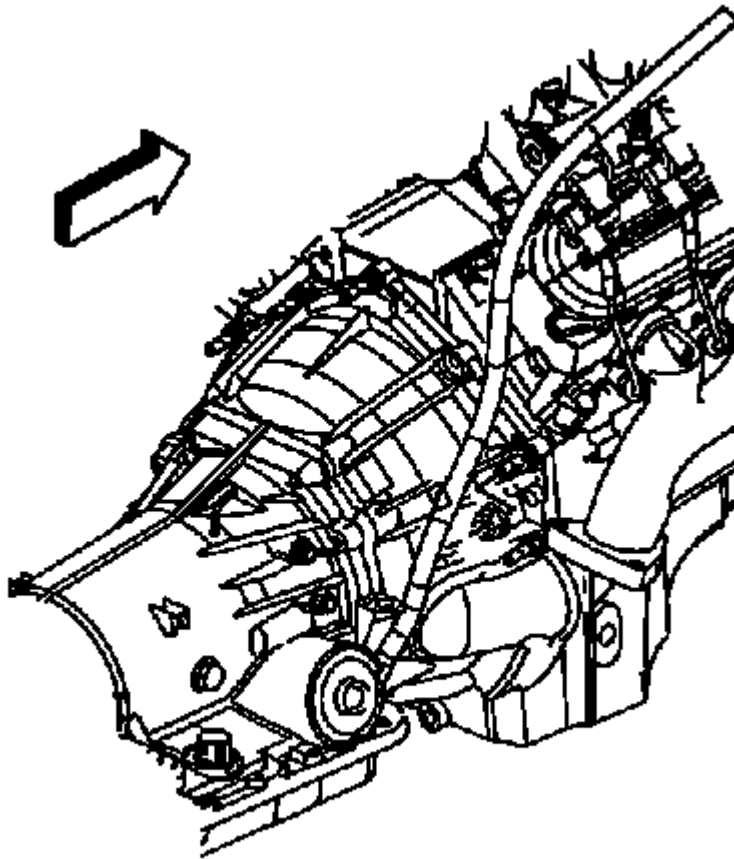


Fig. 283: View Of Oil Level Indicator Tube Nut
Courtesy of GENERAL MOTORS CORP.

68. Remove the transmission oil level indicator tube nut, if equipped.

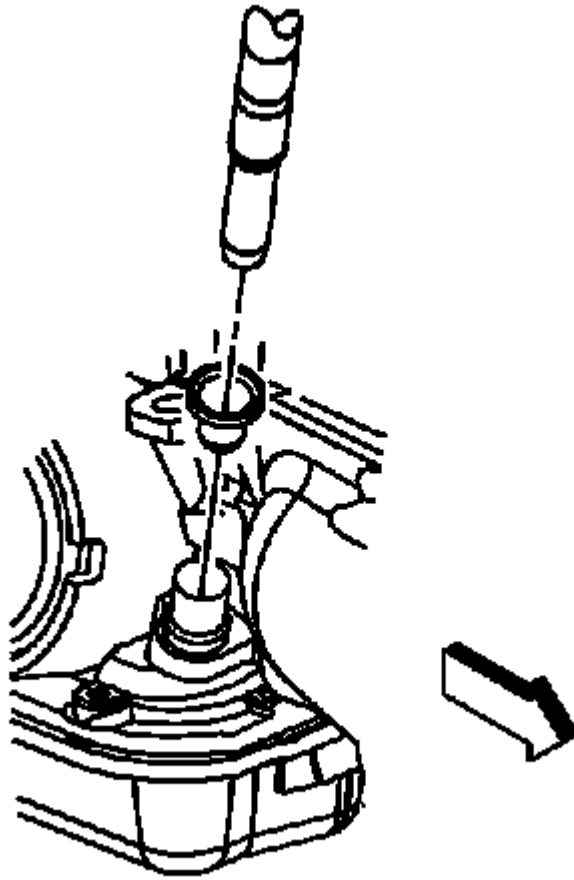


Fig. 284: View Of Oil Level Indicator Tube & Seal
Courtesy of GENERAL MOTORS CORP.

69. Remove the transmission oil level indicator tube, if equipped.

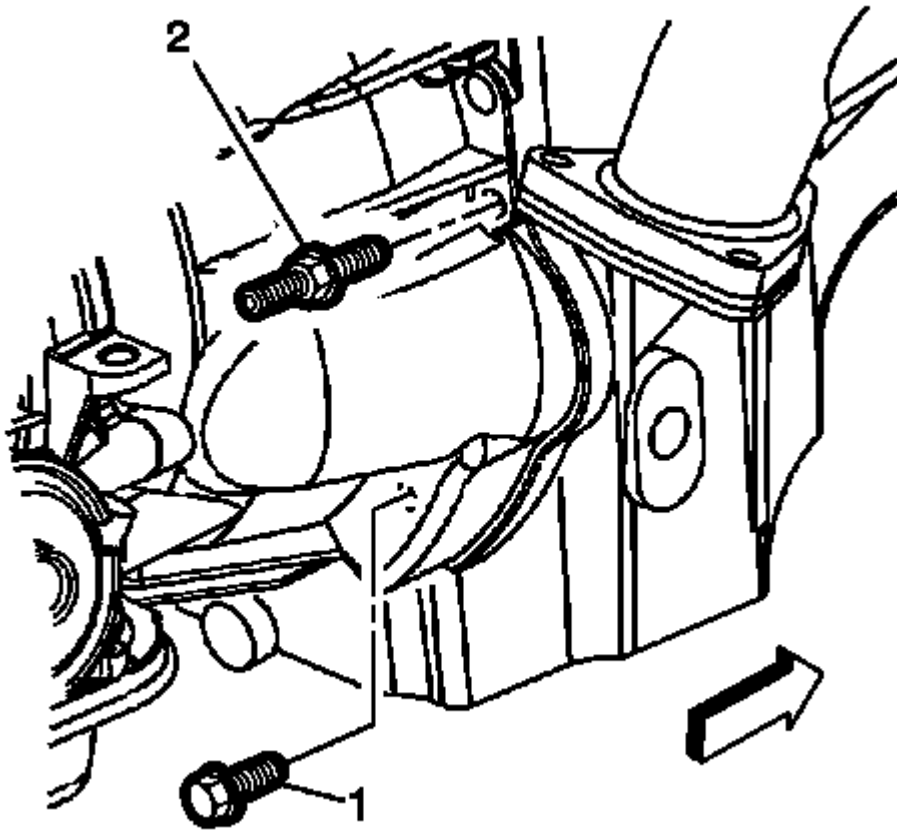


Fig. 285: Identifying Stud & Bolt Securing Transmission To Engine (Right Side)
Courtesy of GENERAL MOTORS CORP.

70. If equipped with the 4L60-E automatic transmission, remove the transmission bolt and stud on the right side.

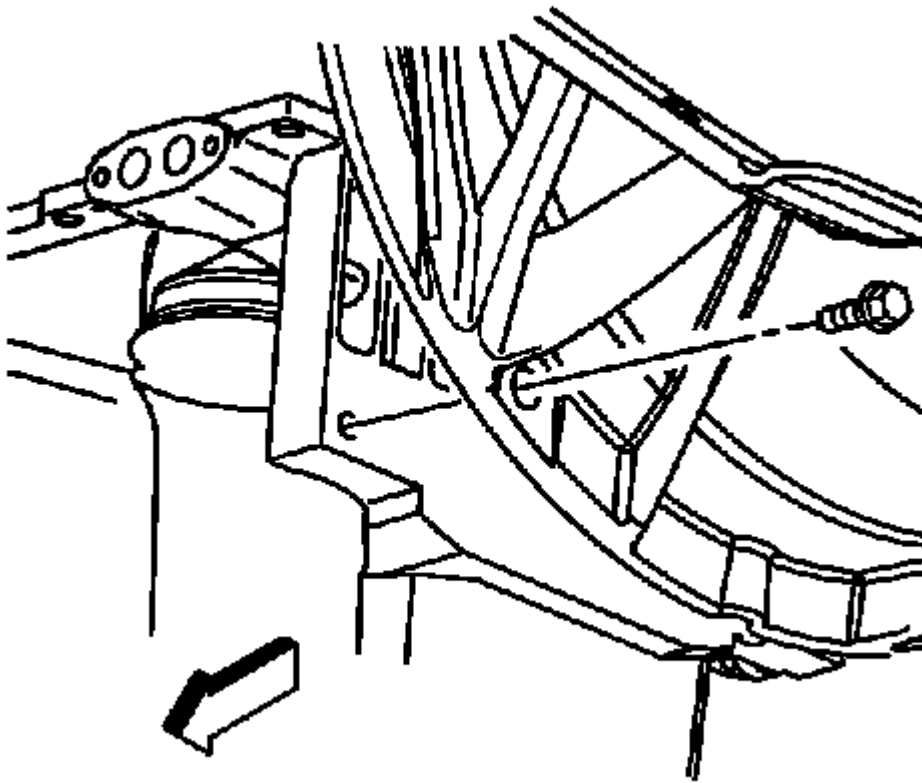


Fig. 286: View Of Transmission Converter Cover Bolt (4L80-E)
Courtesy of GENERAL MOTORS CORP.

71. If equipped with the 4L80-E automatic transmission, remove the transmission converter cover bolts.

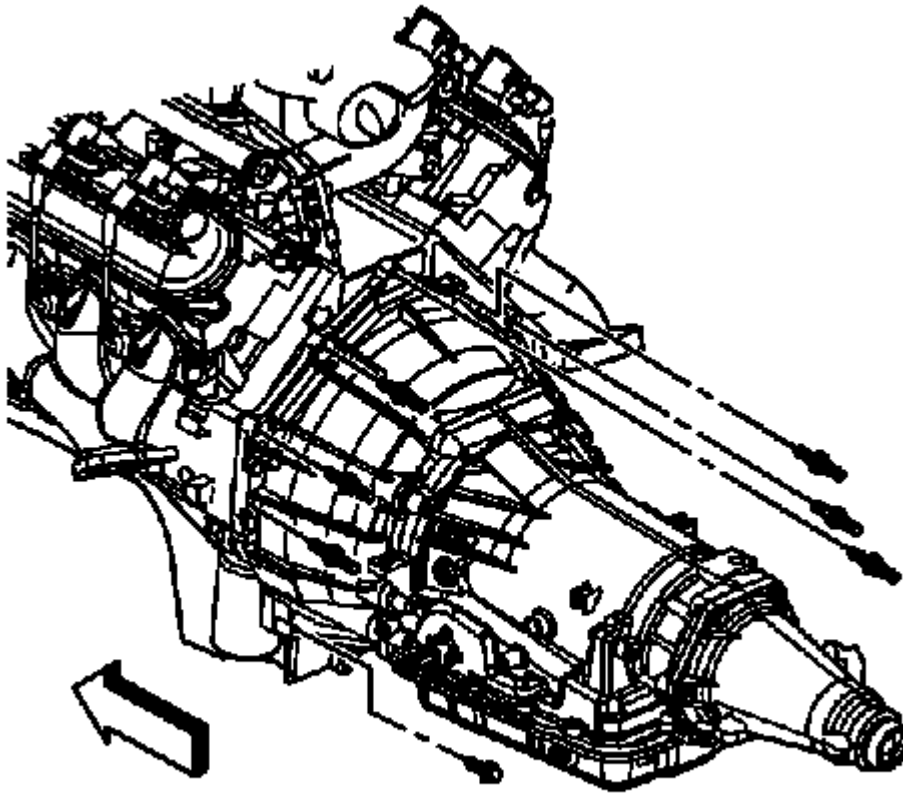


Fig. 287: Identifying Six Studs & One Bolt Securing Transmission To Engine
Courtesy of GENERAL MOTORS CORP.

72. Remove the automatic transmission bolt/studs, if equipped.
73. Separate the engine from the automatic transmission, if equipped.

Install the **J 21366** to the transmission in order to hold the torque converter. See **SPECIAL TOOLS AND EQUIPMENT**.

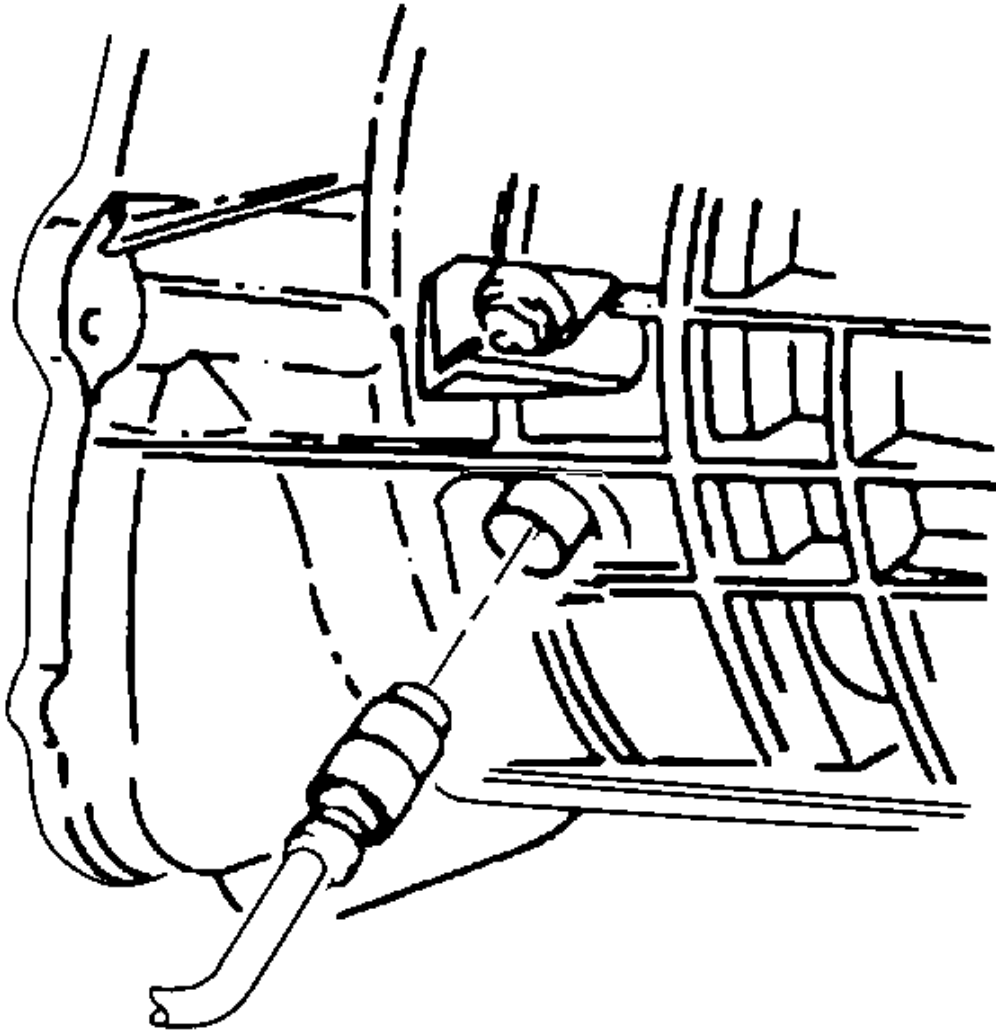


Fig. 288: Clutch Line & Concentric Slave Cylinder
Courtesy of GENERAL MOTORS CORP.

74. Using the **J 42371** , remove the clutch line from the concentric slave cylinder. See **SPECIAL TOOLS AND EQUIPMENT**.

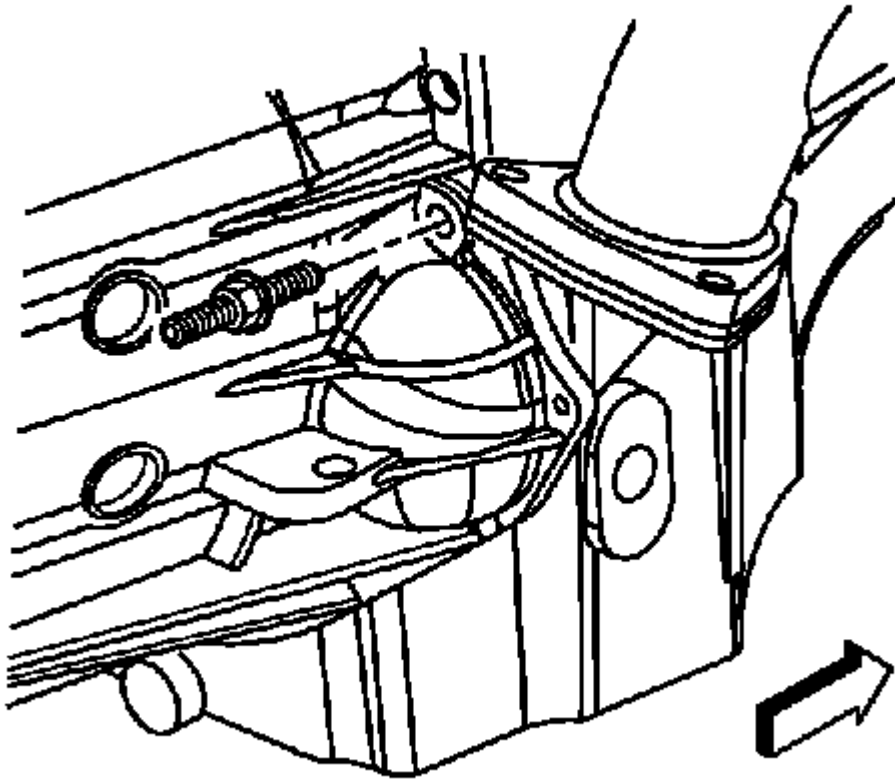


Fig. 289: Manual Transmission Stud
Courtesy of GENERAL MOTORS CORP.

75. Remove the manual transmission stud on the right side of the transmission, if equipped.

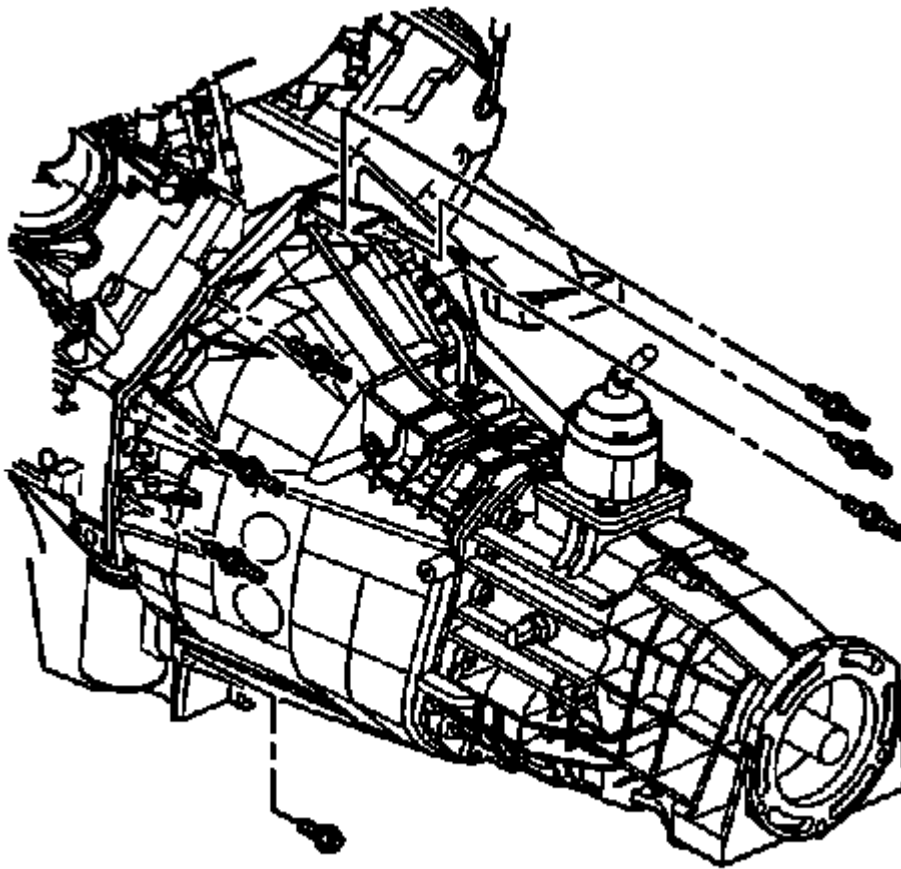


Fig. 290: Manual Transmission Bellhousing Bolts
Courtesy of GENERAL MOTORS CORP.

76. Remove the manual transmission bolt/studs, if equipped.
77. Separate the manual transmission from the engine, if equipped.

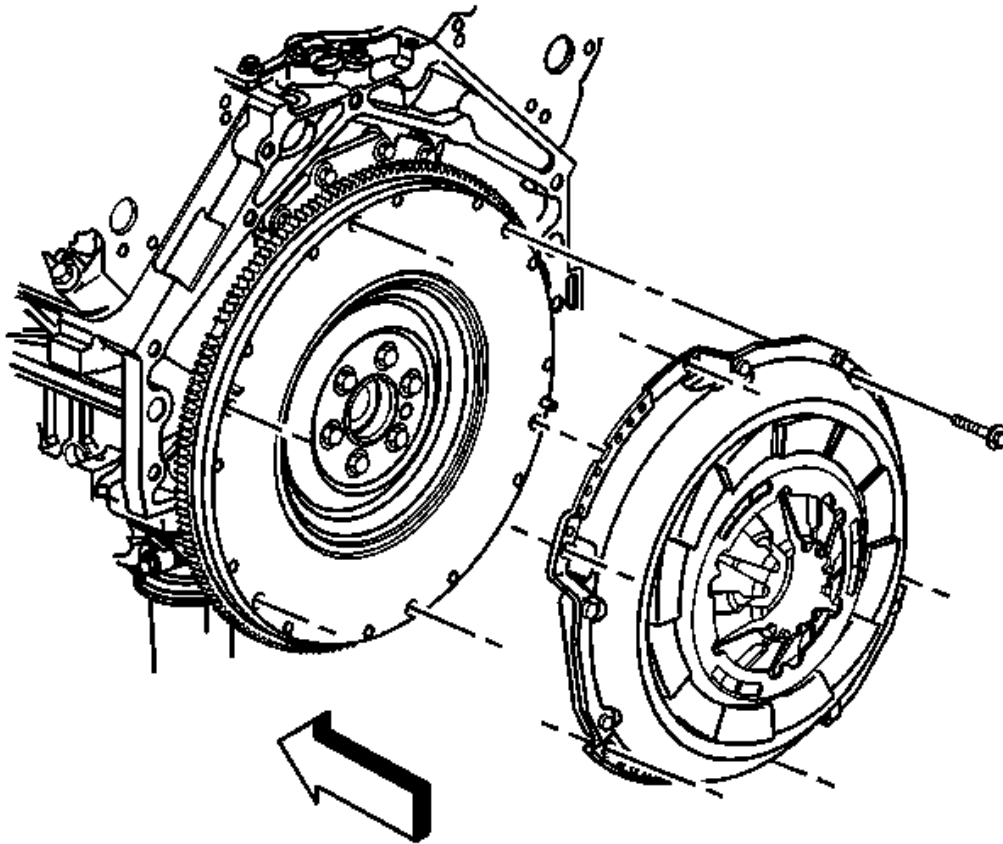


Fig. 291: Clutch Pressure Plate & Disc
Courtesy of GENERAL MOTORS CORP.

78. Mark the flywheel and a clutch pressure plate lug for installation alignment.
79. Remove the clutch pressure plate bolts, if equipped.
80. Remove the clutch pressure plate and disc, if equipped.
81. Lower the vehicle.
82. Install an engine hoist to the **J 41798** . See **SPECIAL TOOLS AND EQUIPMENT**.
83. Install a floor jack under the transmission for support.

NOTE: Use care while moving the engine assembly in order to avoid breaking the MAP sensor locating tabs. Broken MAP sensor tabs may result in decreased engine performance.

84. Remove the engine.

85. Install the engine to an engine stand.
86. Remove the engine hoist.

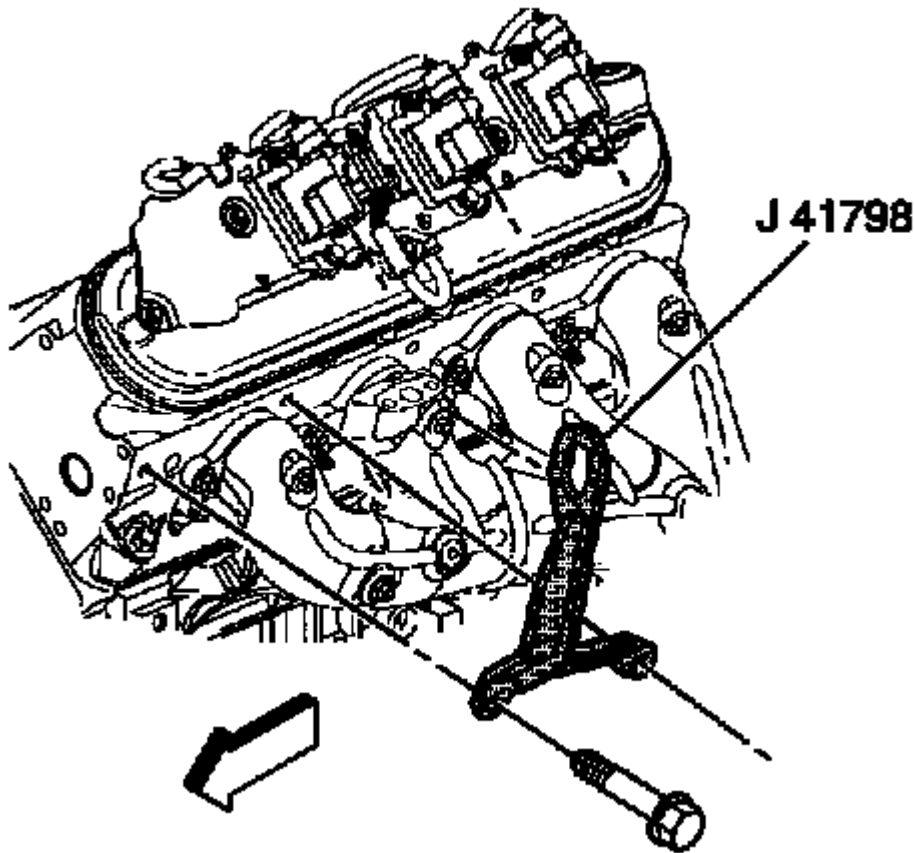


Fig. 292: View Of J 41798

Courtesy of GENERAL MOTORS CORP.

87. Remove the **J 41798** from the engine. See **SPECIAL TOOLS AND EQUIPMENT**.

Installation Procedure

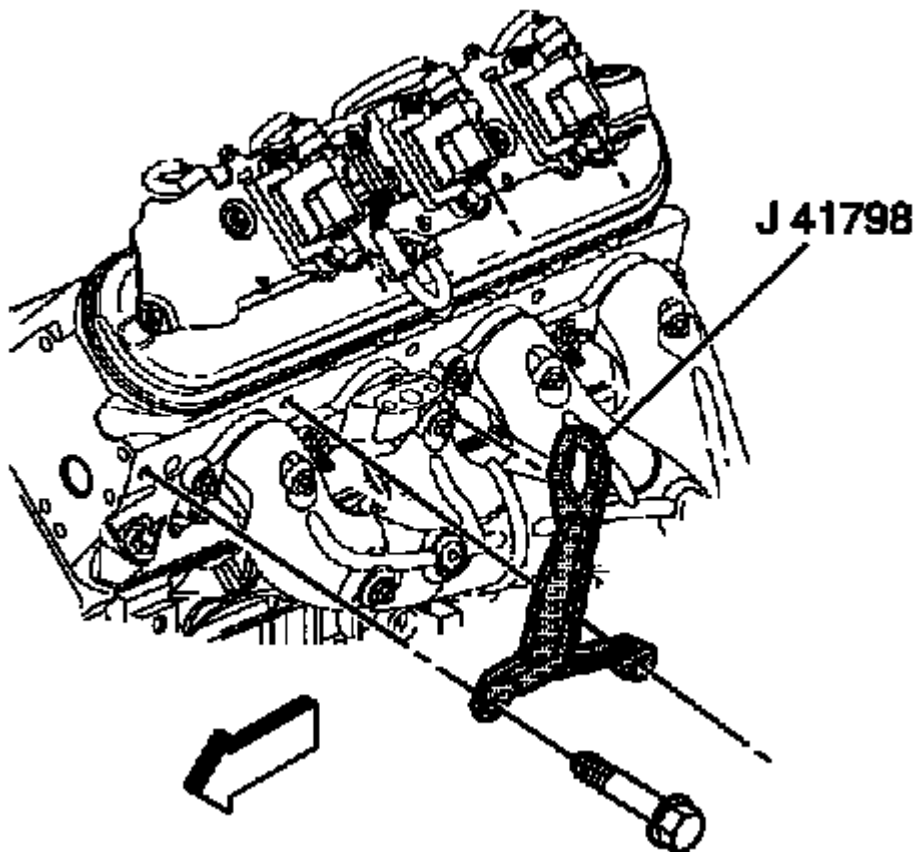


Fig. 293: View Of J 41798

Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Install the **J 41798** to the engine. See **SPECIAL TOOLS AND EQUIPMENT**.

Tighten:

- Tighten the M8 engine lift bracket bolts to 25 N.m (18 lb ft).
 - Tighten the M10 engine lift bracket bolts to 50 N.m (37 lb ft).
2. Install an engine hoist to the **J 41798** . See **SPECIAL TOOLS AND EQUIPMENT**.
 3. Remove the engine from the engine stand.
 4. Install the engine to the vehicle.
 5. Align the engine and transmission.

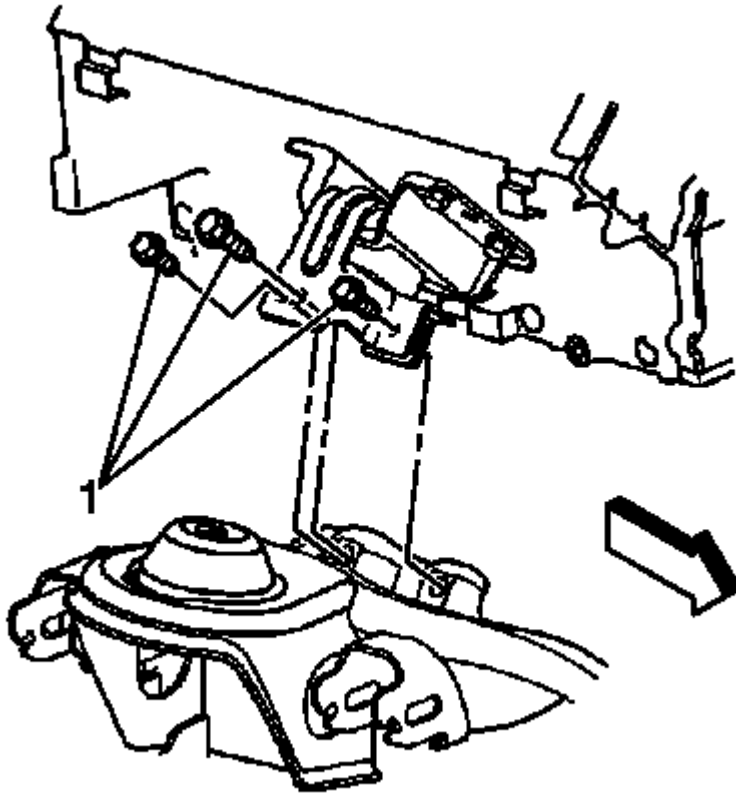


Fig. 294: View Of Engine Mount-To-Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

6. Install the left and right engine mount-to-engine mount bracket bolts.

Tighten: Tighten the engine mount-to-engine mount bracket bolts to 65 N.m (48 lb ft).

7. Install the upper transmission bolts until snug.
8. Remove the floor jack from under the transmission.
9. Remove the engine hoist.

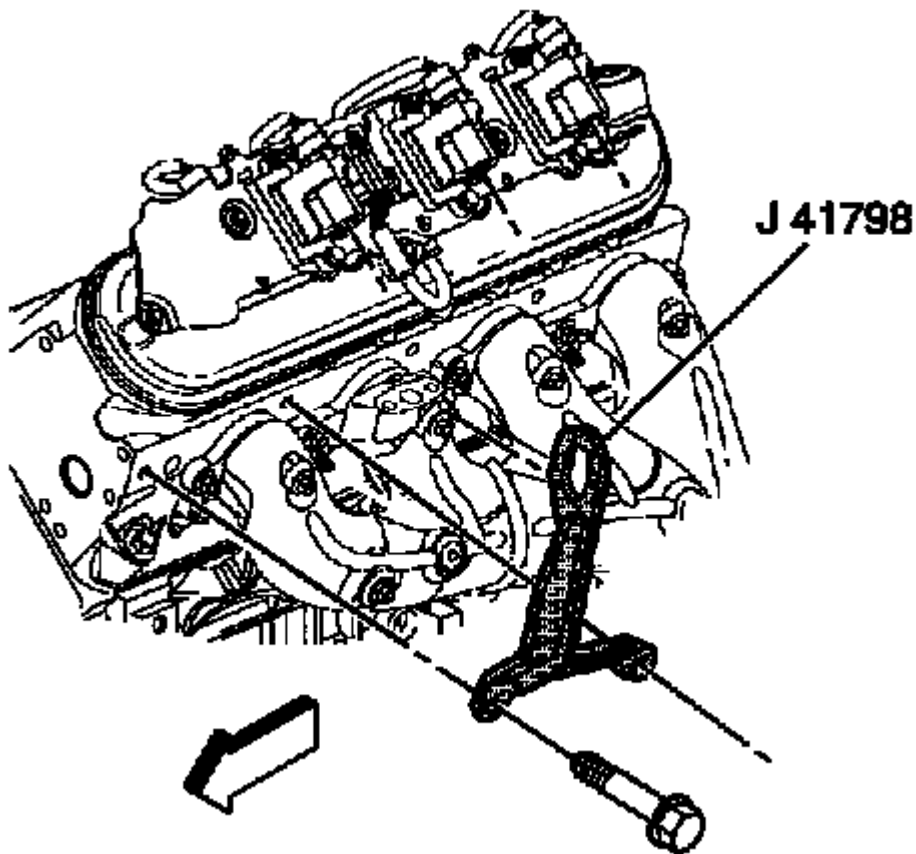


Fig. 295: View Of J 41798

Courtesy of GENERAL MOTORS CORP.

10. Remove the **J 41798** from the engine. See **SPECIAL TOOLS AND EQUIPMENT**.

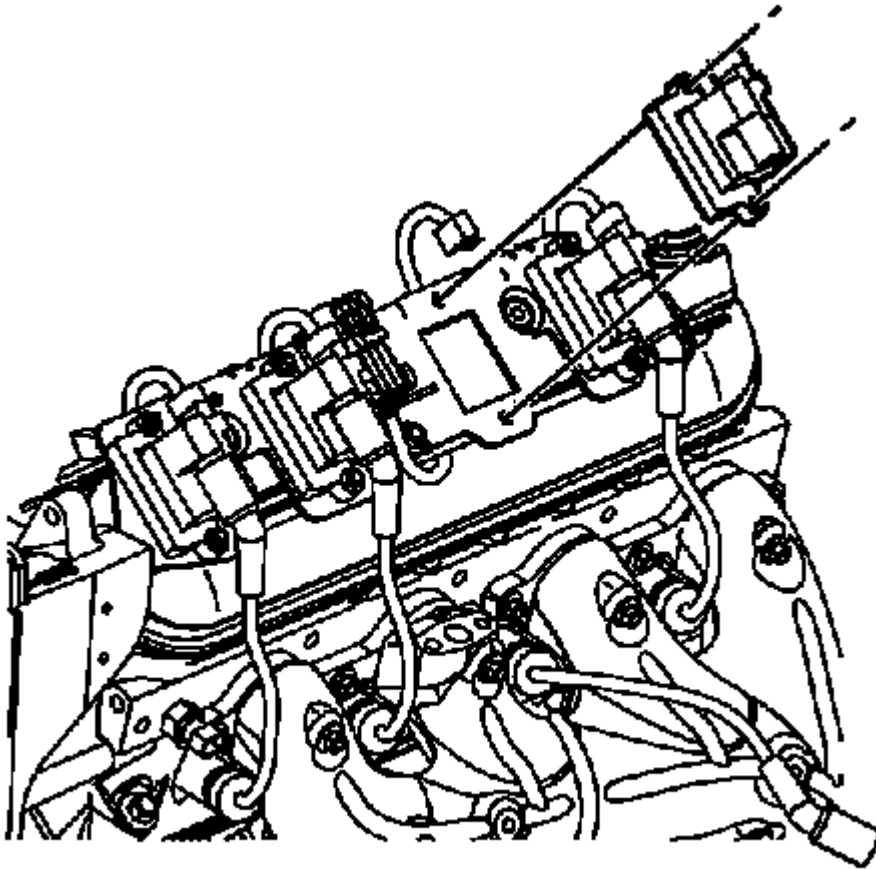


Fig. 296: View Of Ignition Coils & Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

11. Install the ignition coil(s) and the spark plug wire(s). Refer to **IGNITION COILS** .
12. Raise the vehicle.

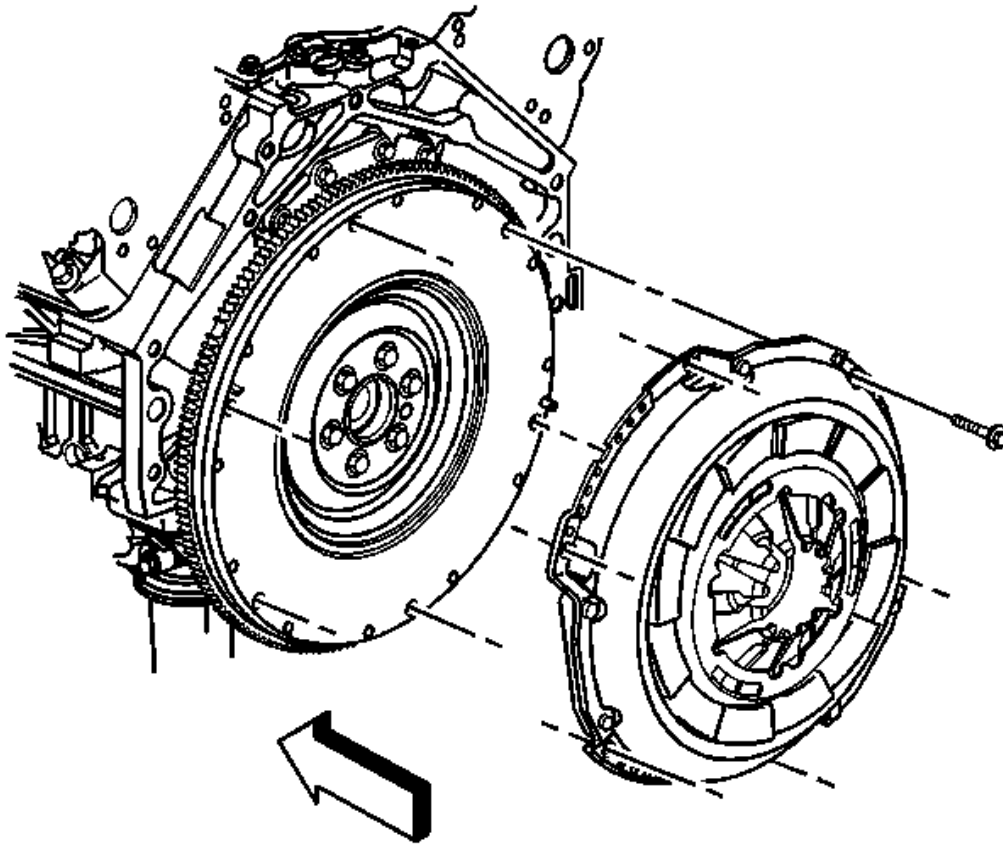


Fig. 297: Clutch Pressure Plate & Disc
Courtesy of GENERAL MOTORS CORP.

13. Install the disc and clutch pressure plate and bolts until snug, if equipped.
14. Use the **J 5824-A** to align the clutch disc splines with the pilot bearing. See **SPECIAL TOOLS AND EQUIPMENT**.
15. Align the marks made during removal.

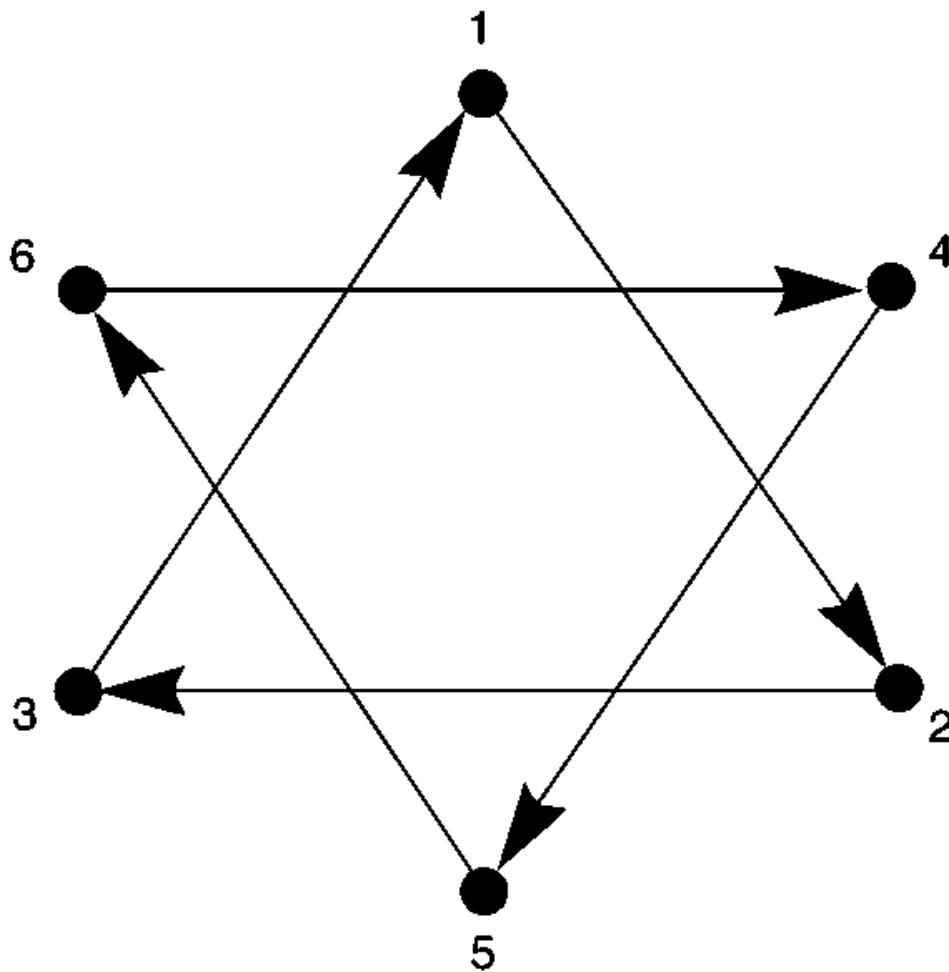


Fig. 298: Clutch Pressure Plate Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

16. Tighten the clutch pressure plate bolts.

Tighten: Tighten the clutch pressure plate bolts in sequence (as shown) and evenly over 3 increments with the fourth increment to 70 N.m (52 lb ft).

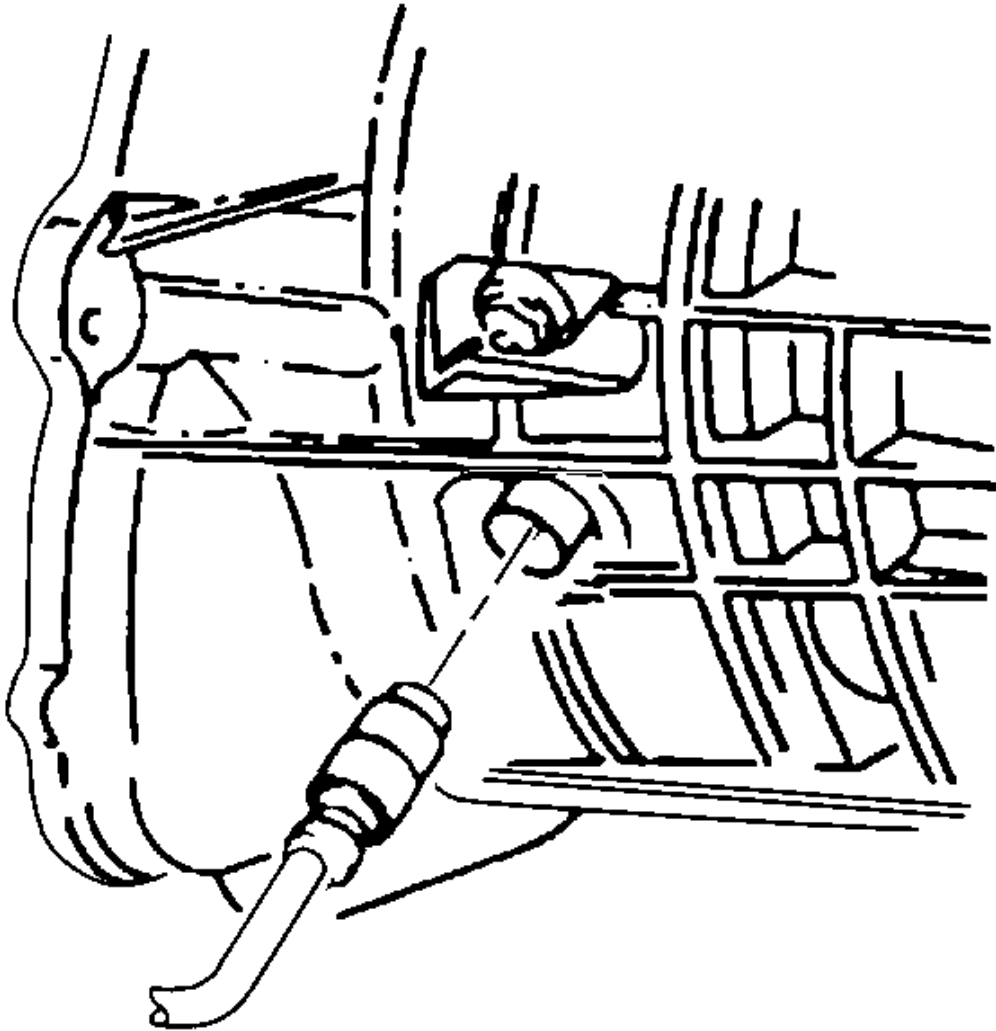


Fig. 299: Clutch Line & Concentric Slave Cylinder
Courtesy of GENERAL MOTORS CORP.

17. Install the clutch line to the concentric slave cylinder.

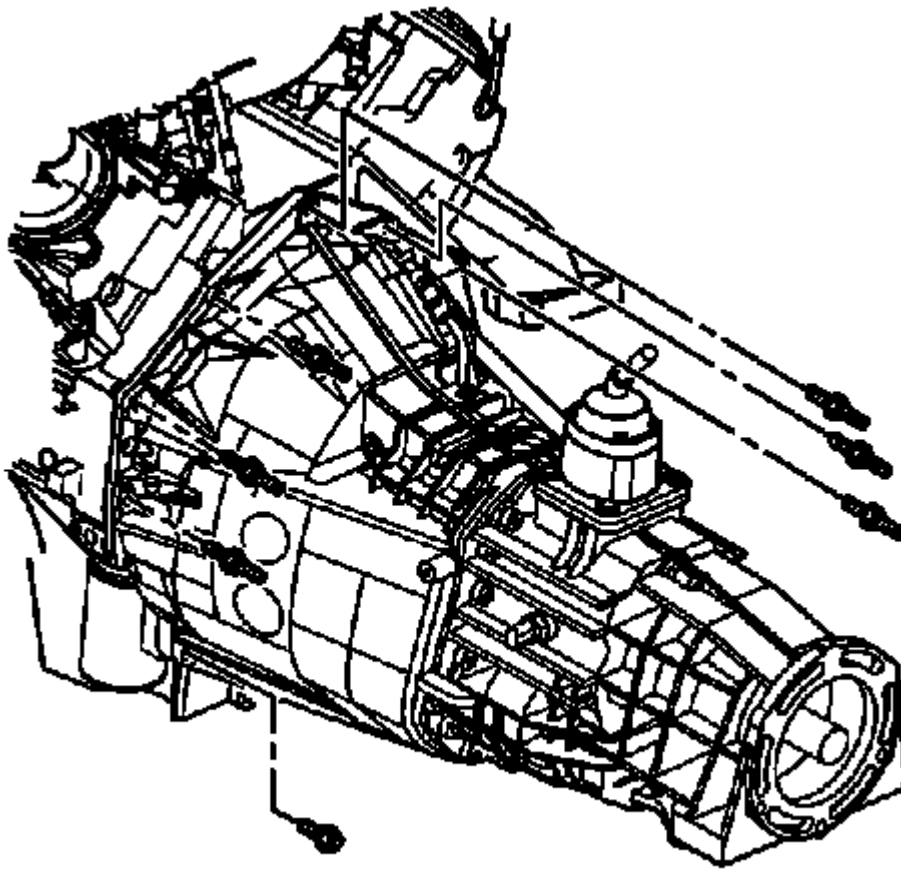


Fig. 300: Manual Transmission Bellhousing Bolts
Courtesy of GENERAL MOTORS CORP.

18. Install the manual transmission bolt/studs, if equipped.

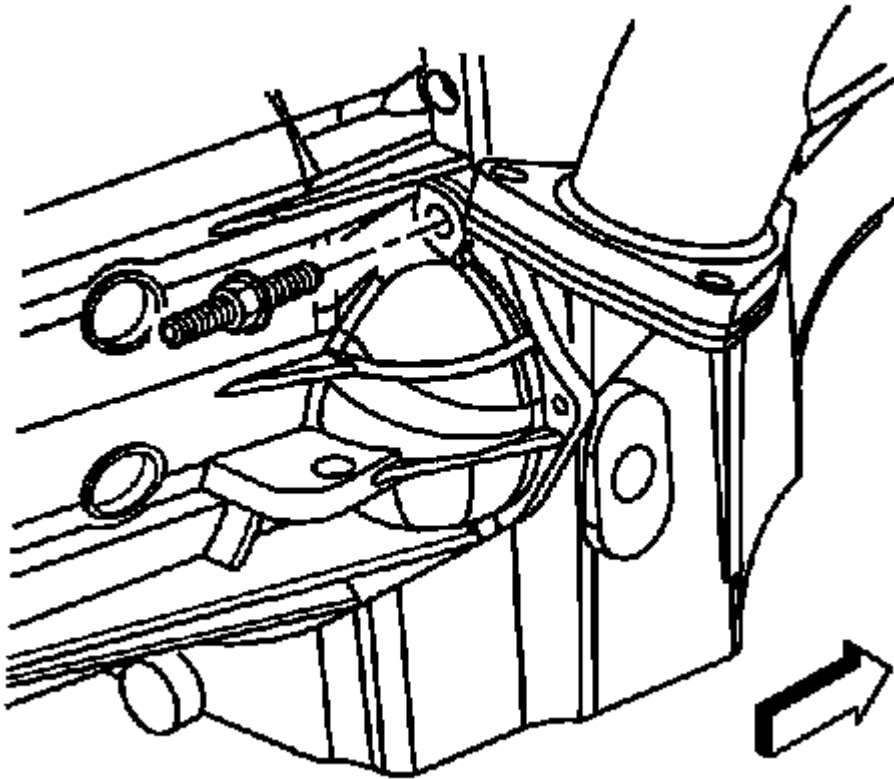


Fig. 301: Manual Transmission Stud
Courtesy of GENERAL MOTORS CORP.

19. Install the manual transmission stud on the right side of the transmission, if equipped.

Tighten: Tighten the manual transmission bolt/studs to 50 N.m (37 lb ft).

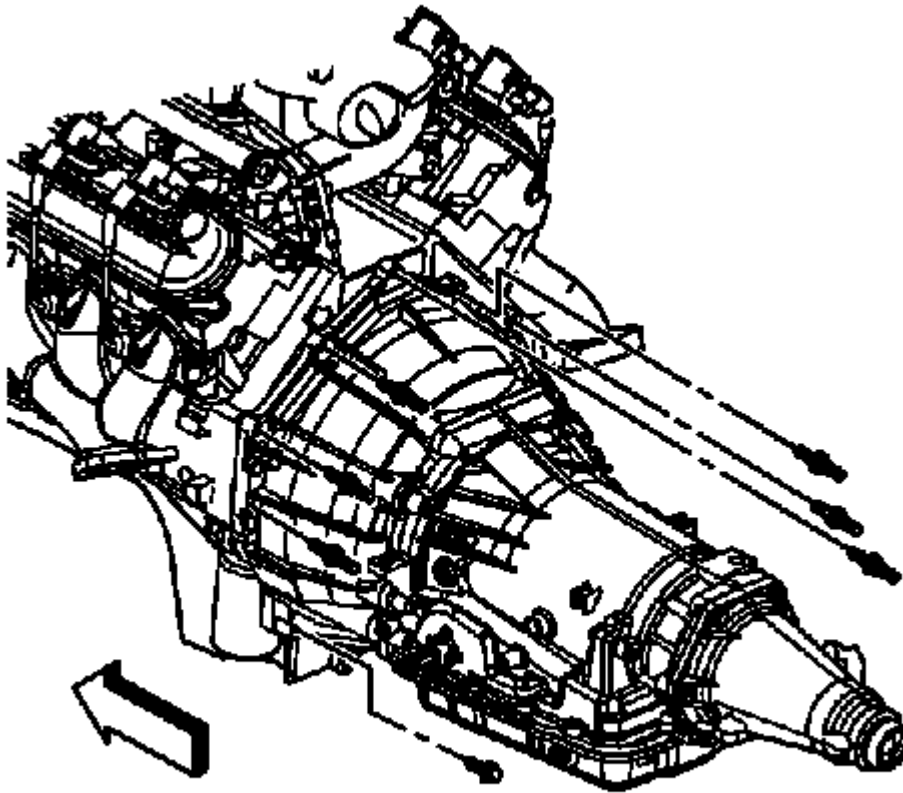


Fig. 302: Identifying Six Studs & One Bolt Securing Transmission To Engine
Courtesy of GENERAL MOTORS CORP.

20. Remove the **J 21366** from the transmission. See **SPECIAL TOOLS AND EQUIPMENT**.
21. Install the automatic transmission bolt/studs, if equipped.

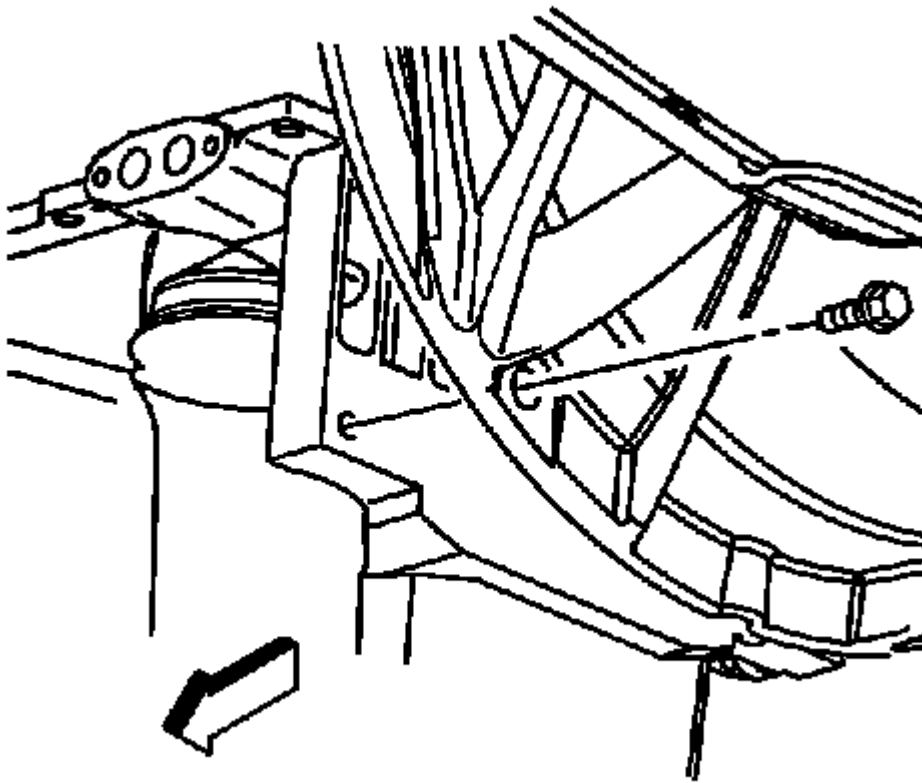


Fig. 303: View Of Transmission Converter Cover Bolt (4L80-E)
Courtesy of GENERAL MOTORS CORP.

22. If equipped with the 4L80-E automatic transmission, install the transmission converter cover bolts.

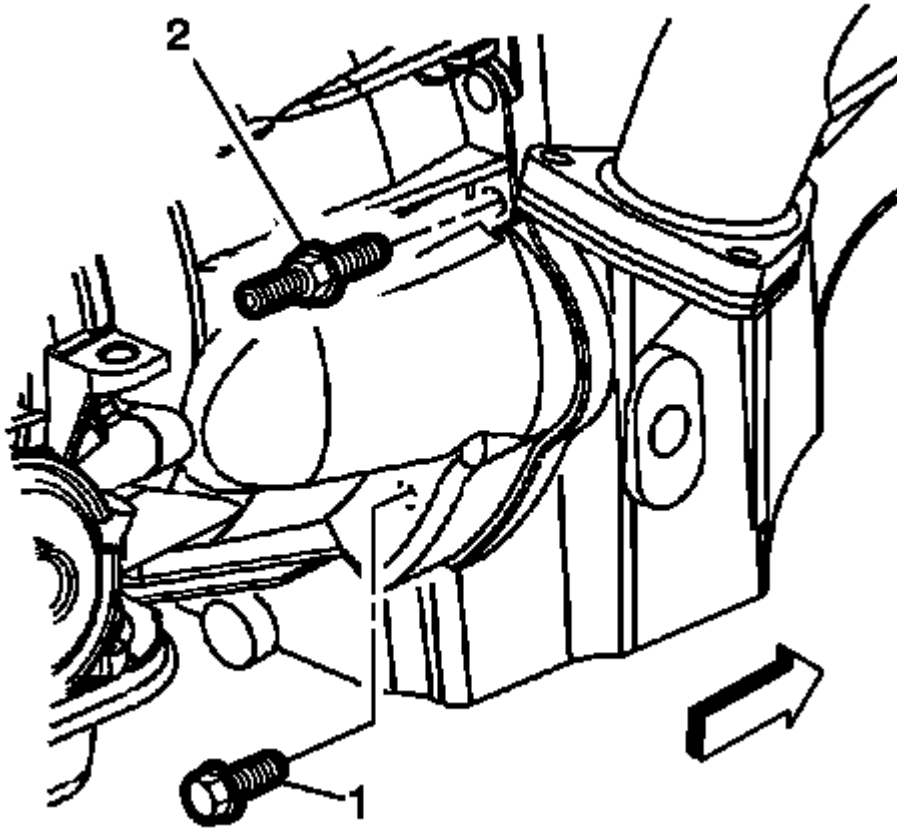


Fig. 304: Identifying Stud & Bolt Securing Transmission To Engine (Right Side)
Courtesy of GENERAL MOTORS CORP.

23. If equipped with the 4L60-E automatic transmission, install the transmission bolt and stud on the right side.

Tighten: Tighten the automatic transmission bolts/studs to 50 N.m (37 lb ft).

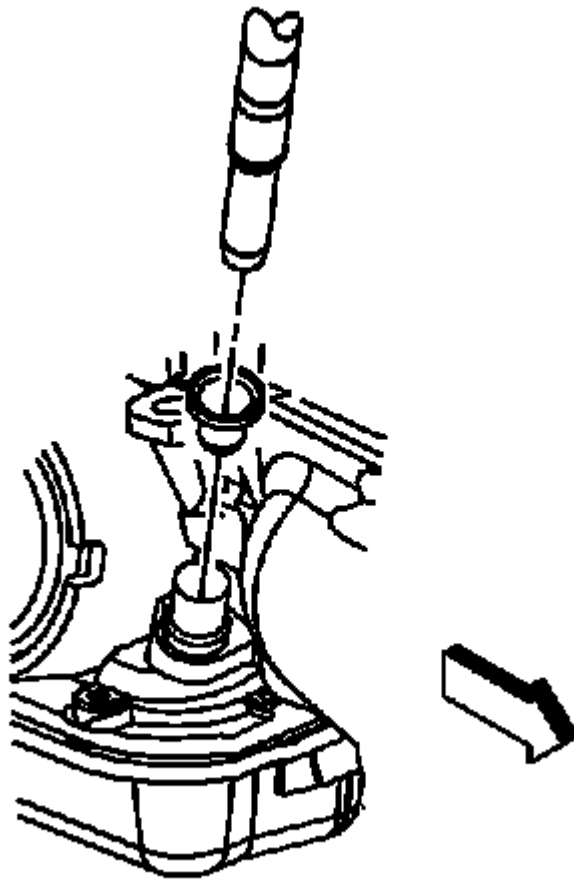


Fig. 305: View Of Oil Level Indicator Tube & Seal
Courtesy of GENERAL MOTORS CORP.

24. Install the automatic transmission oil level indicator tube, if equipped.

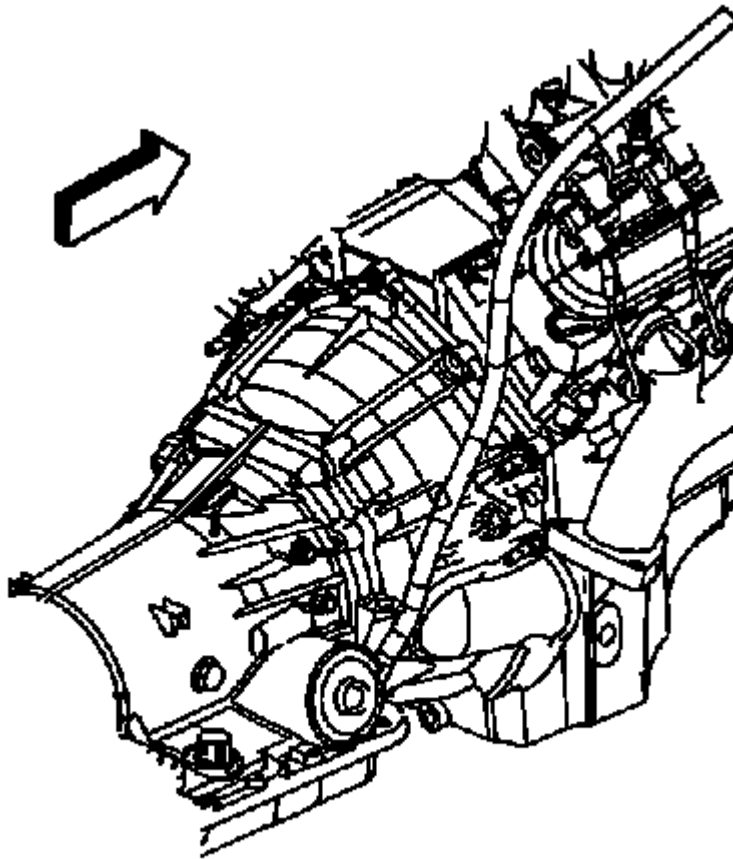


Fig. 306: View Of Oil Level Indicator Tube Nut
Courtesy of GENERAL MOTORS CORP.

25. Install the automatic transmission oil level indicator tube nut, if equipped.

Tighten: Tighten the automatic transmission oil level indicator tube nut to 18 N.m (13 lb ft).

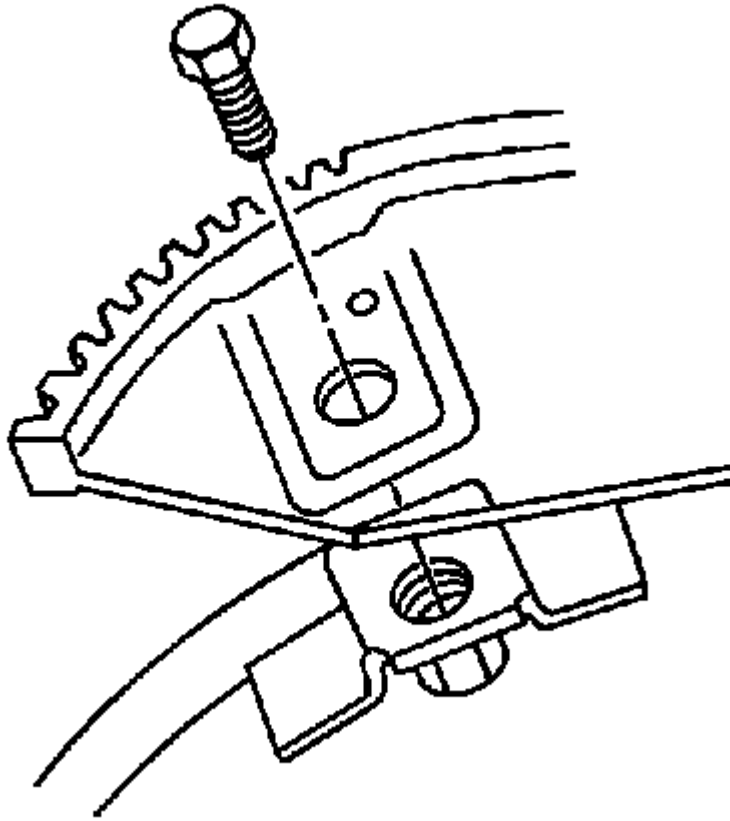


Fig. 307: Flywheel-To-Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

26. Install the torque converter bolts, if equipped.

Tighten:

- If equipped with the 4L60-E, tighten the torque converter bolts to 63 N.m (37 lb ft).
- If equipped with the 4L80-E, tighten the torque converter bolts to 60 N.m (44 lb ft).

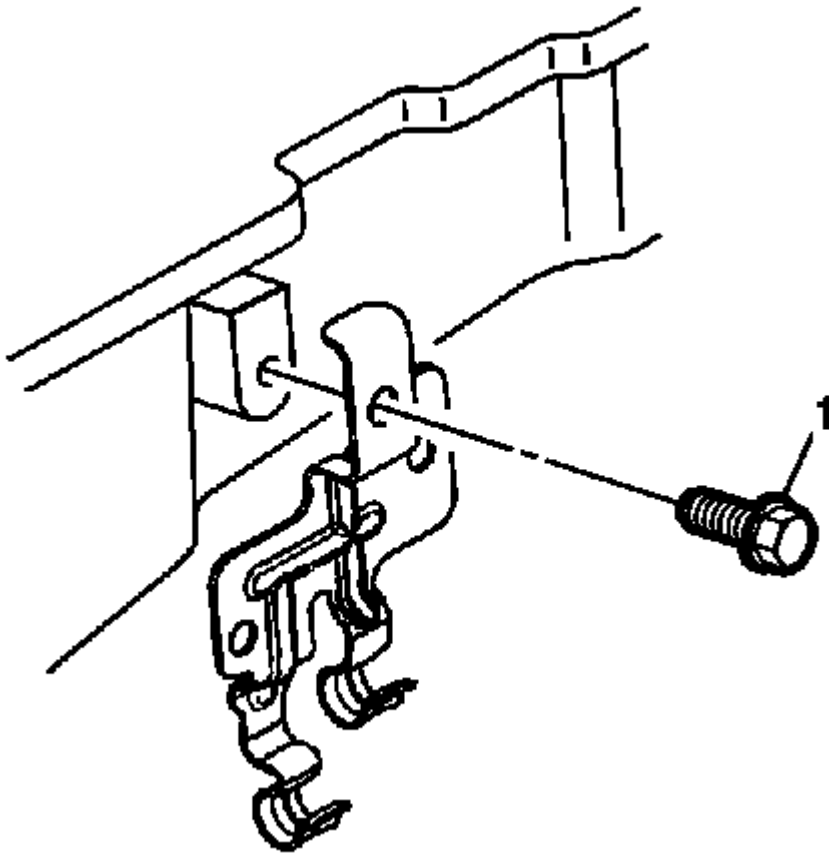


Fig. 308: View Of Positive Battery Cable Clip & Bolt
Courtesy of GENERAL MOTORS CORP.

27. Install the positive battery cable clip and bolt.

Tighten: Tighten the positive battery cable clip bolt to 9 N.m (80 lb in).

28. Install the catalytic converter. Refer to **CATALYTIC CONVERTER REPLACEMENT (4.3L, 4.8L & 5.3L ENGINES)** in Engine Exhaust.
29. Install the starter motor. Refer to **INSTALLATION (4.8L, 5.3L & 6.0L ENGINE)** .

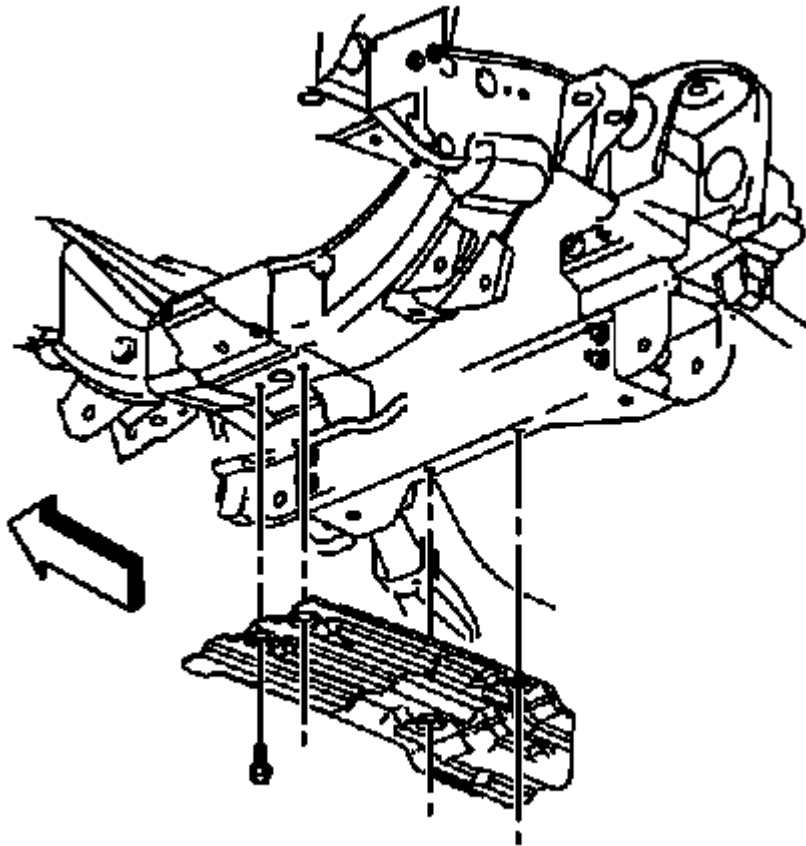


Fig. 309: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

30. Install the oil pan skid plate and bolts, if equipped.

Tighten: Tighten the oil pan skid plate bolts to 20 N.m (15 lb ft).

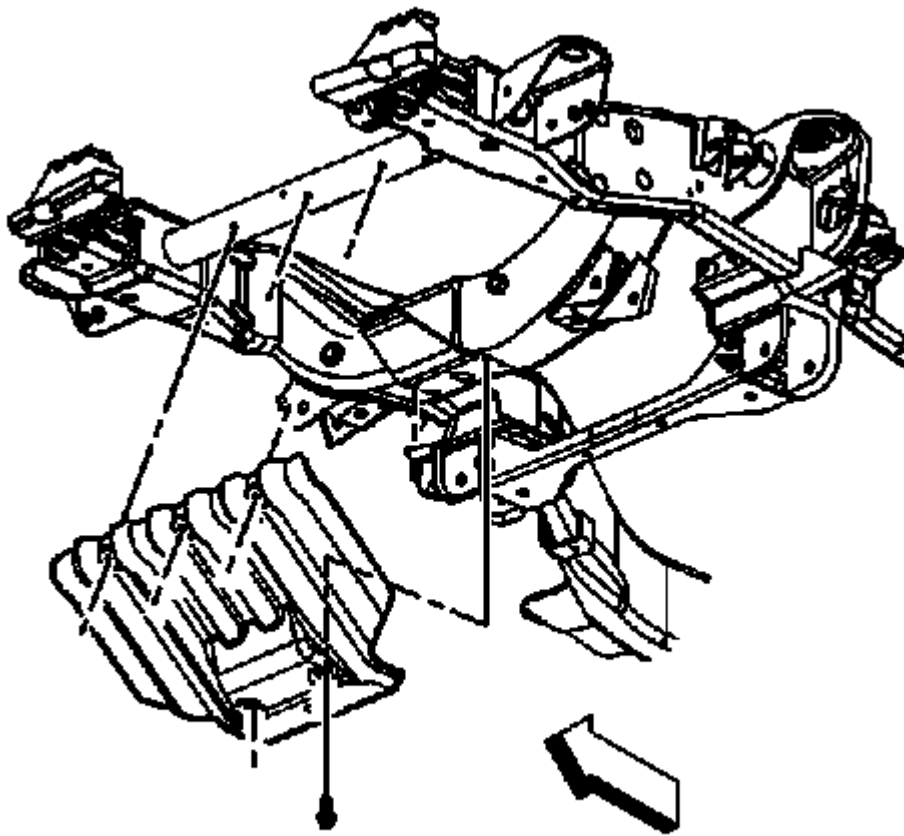


Fig. 310: Identifying Engine Shield And Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

31. Install the engine shield and bolts.

Tighten: Tighten the engine shield bolts to 20 N.m (15 lb ft).

32. Lower the vehicle.

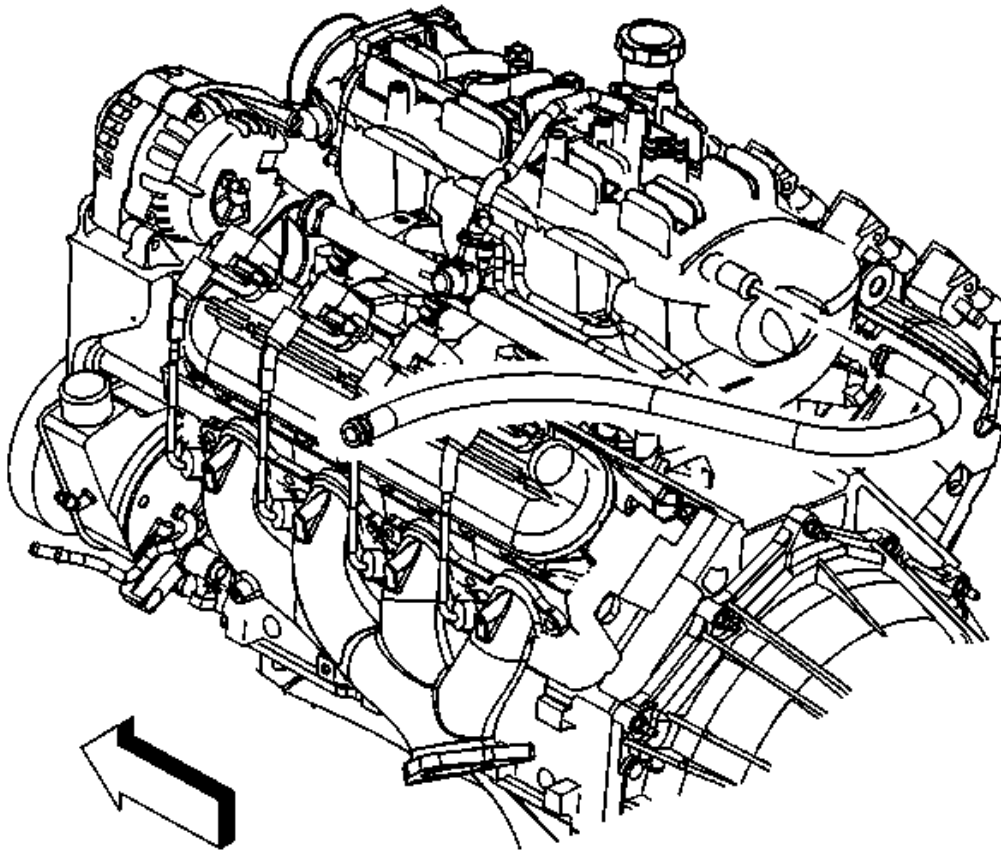


Fig. 311: Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

33. Install the vacuum brake booster hose.

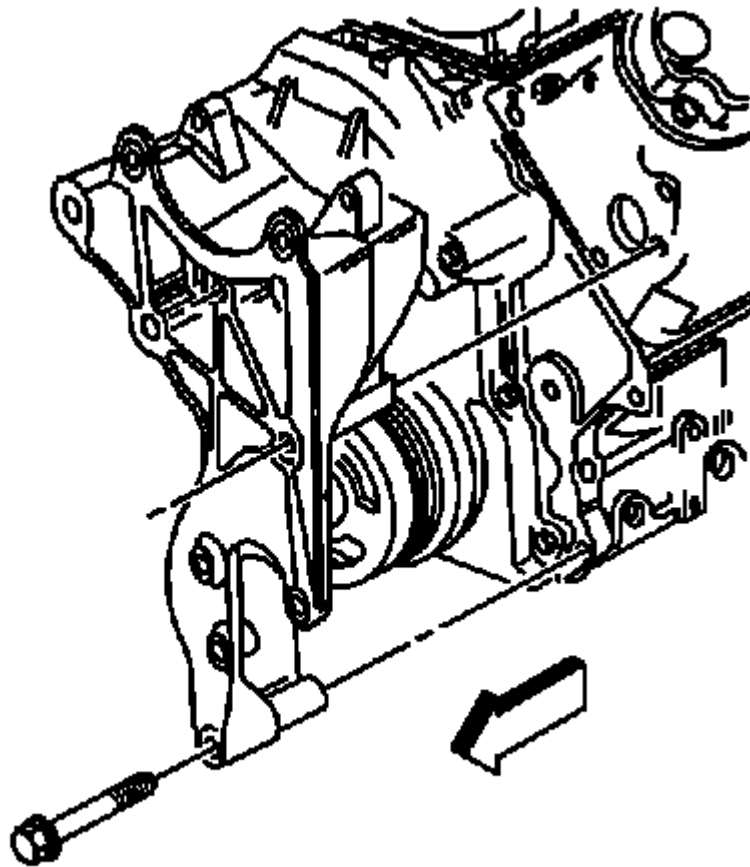


Fig. 312: View Of Generator Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

34. Position the generator bracket to the front of the engine.
35. Install the generator bracket bolts until snug.
36. Install the rear power steering pump-to-engine block bolt until snug.

Tighten:

- Tighten the rear power steering pump bolt to 50 N.m (37 lb ft).
 - Tighten the generator bracket bolts to 50 N.m (37 lb ft).
37. Route the engine wiring harness to the lower engine area.
 38. Raise the vehicle.

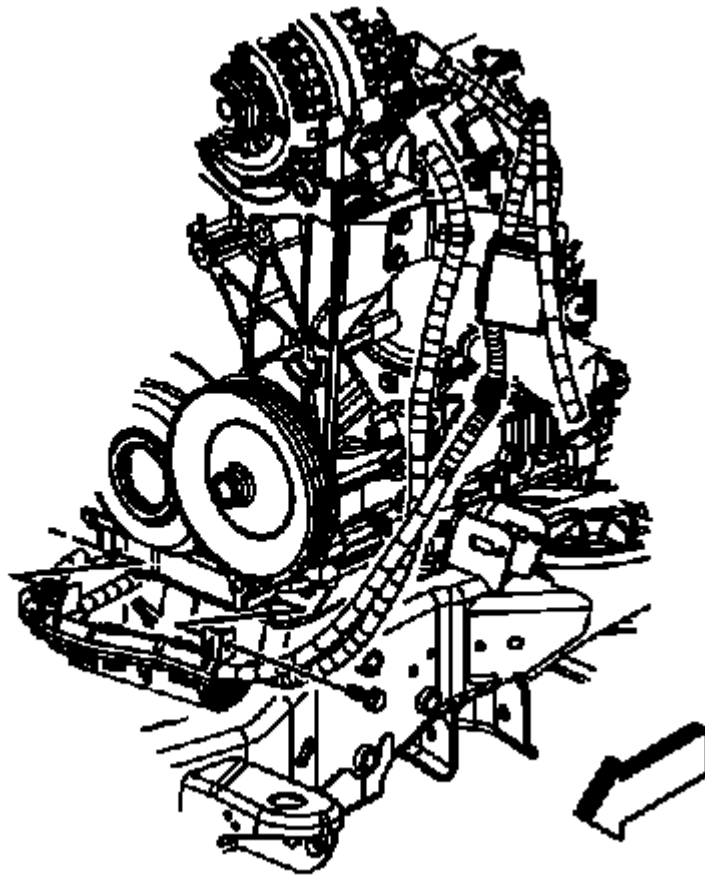


Fig. 313: View Of Positive Battery Cable, Channel & Bolt
Courtesy of GENERAL MOTORS CORP.

39. Slide the channel pin into the oil pan tab.
40. Install the battery cable channel bolt.

Tighten: Tighten the battery cable channel bolt to 12 N.m (106 lb in).

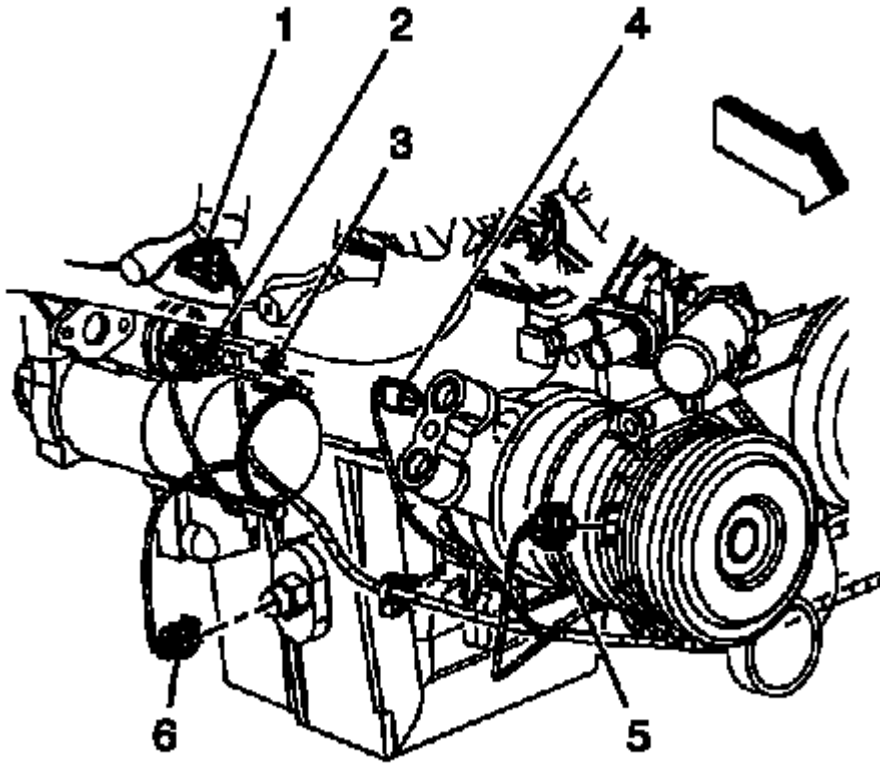


Fig. 314: Identifying Electrical Connector (Right Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

41. Connect the following electrical connectors:
 - The CKP sensor (1)
 - The engine oil level sensor (6)
 - The coolant heater, if equipped
42. Lower the vehicle.
43. Connect the fuel pipes.

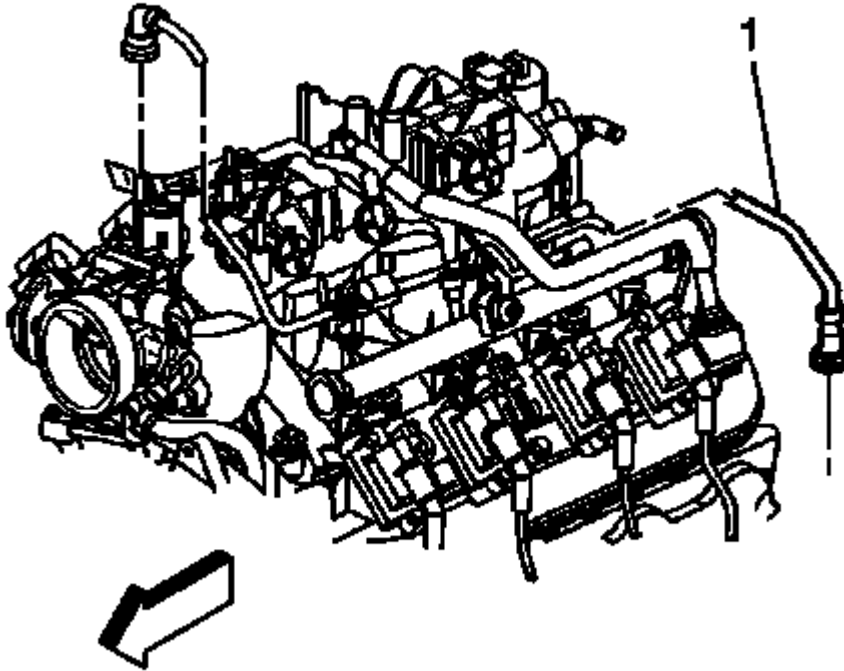


Fig. 315: View Of EVAP Purge Solenoid Vent Tube
Courtesy of GENERAL MOTORS CORP.

44. Install the EVAP purge solenoid vent tube to the solenoid (1).
45. Install the EVAP tube end (3) to the vapor pipe.

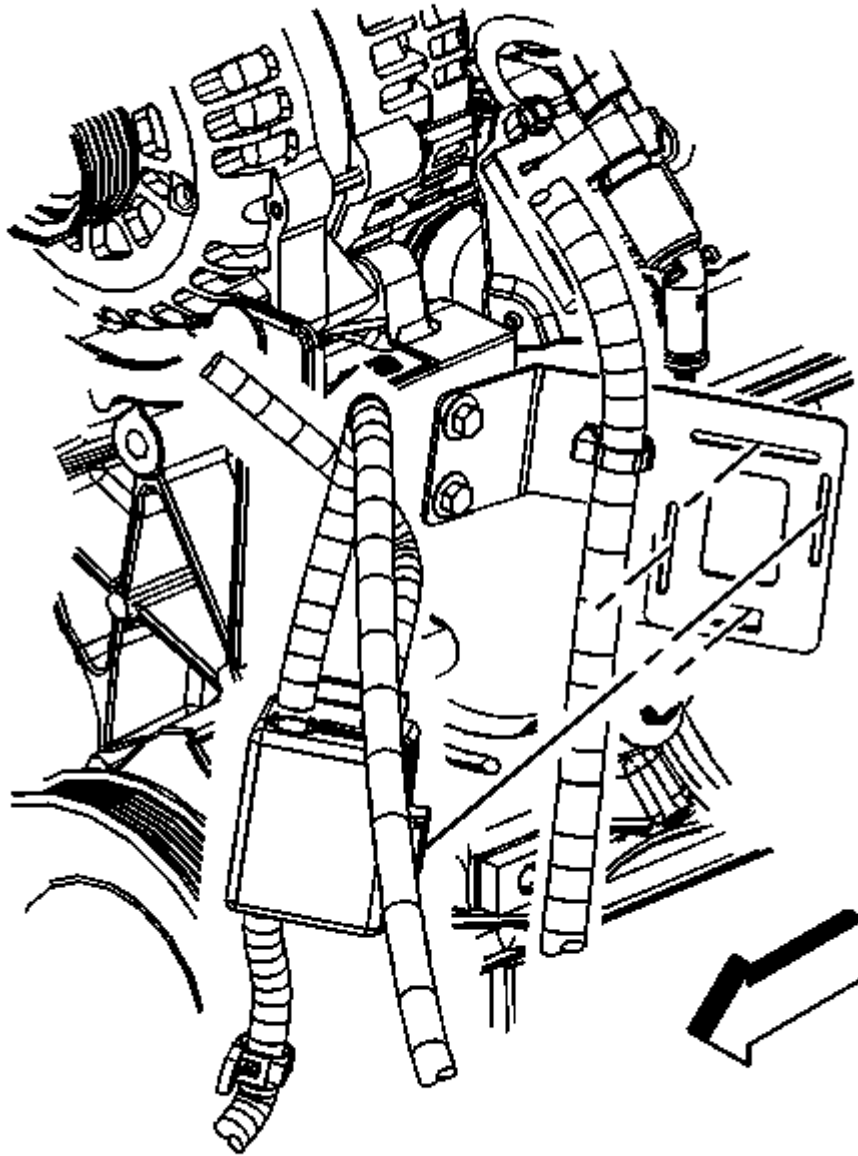


Fig. 316: Battery Cable Junction Block
Courtesy of GENERAL MOTORS CORP.

46. Install the battery cable junction block to the junction block bracket.
47. Clip all of the engine wiring harness clips to their correct location.

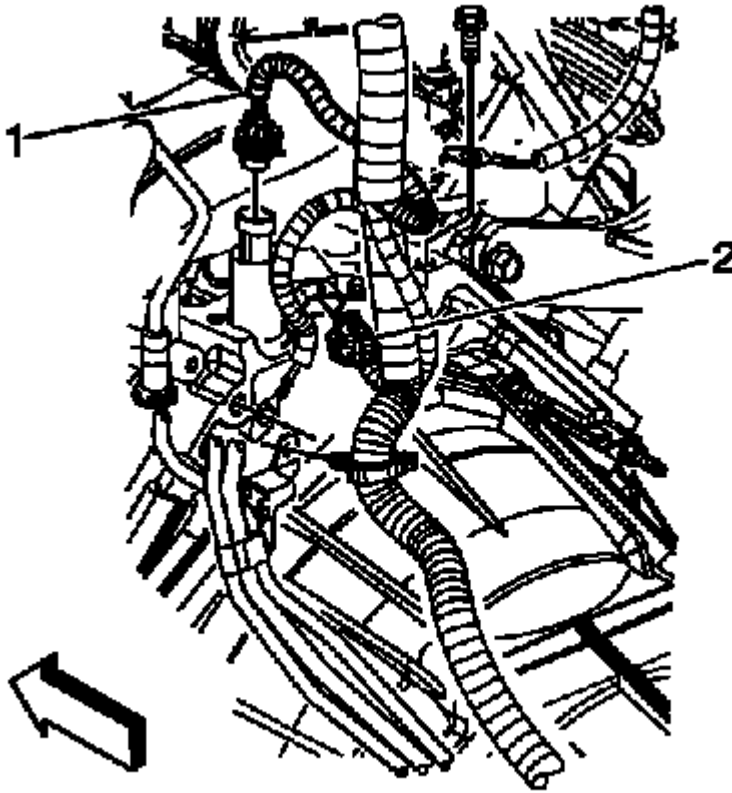


Fig. 317: View Of Oil Pressure Sensor & CMP Sensor Connectors
Courtesy of GENERAL MOTORS CORP.

48. Connect the following electrical connectors:
 - Oil pressure sensor (1)
 - CMP sensor (2)
49. Position the harness ground and the engine ground strap to the block.
50. Install the harness ground bolt at the left rear of the engine block.
51. Position the harness ground, and auxiliary negative battery cable (if equipped) to the block.
52. Install the harness ground bolt at the right rear of the engine block.

Tighten: Tighten the harness ground bolts at the rear of the block to 16 N.m (12 lb ft).

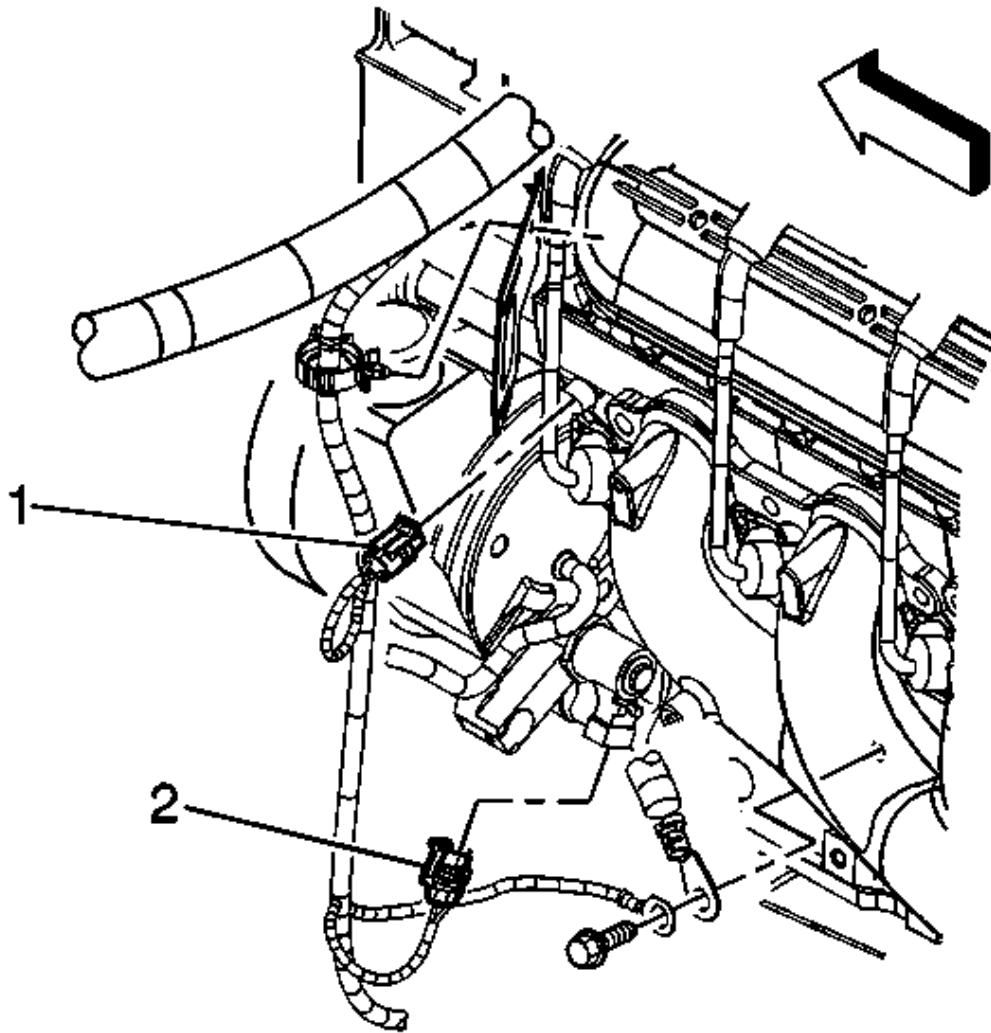


Fig. 318: Coolant Temperature Sensor & Electronic Variable Orifice Switch Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

53. Connect the following electrical connectors:
 - Coolant temperature sensor (1)
 - Electronic variable orifice switch (2)
54. Position the harness ground and negative battery cable to the block.
55. Install the harness ground bolt.

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

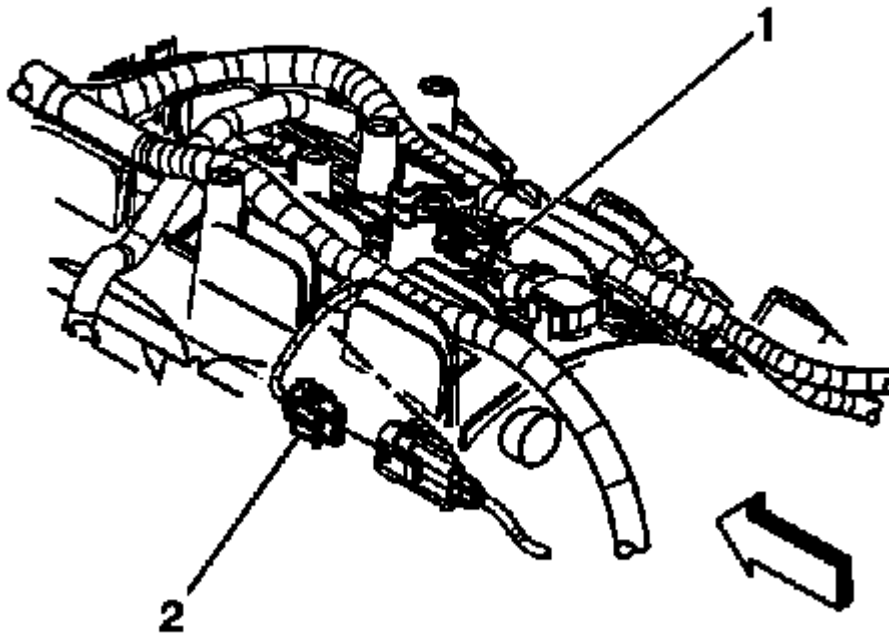


Fig. 319: View Of MAP Sensor & Knock Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

56. Connect the MAP sensor (1) and knock sensor (2) electrical connectors.

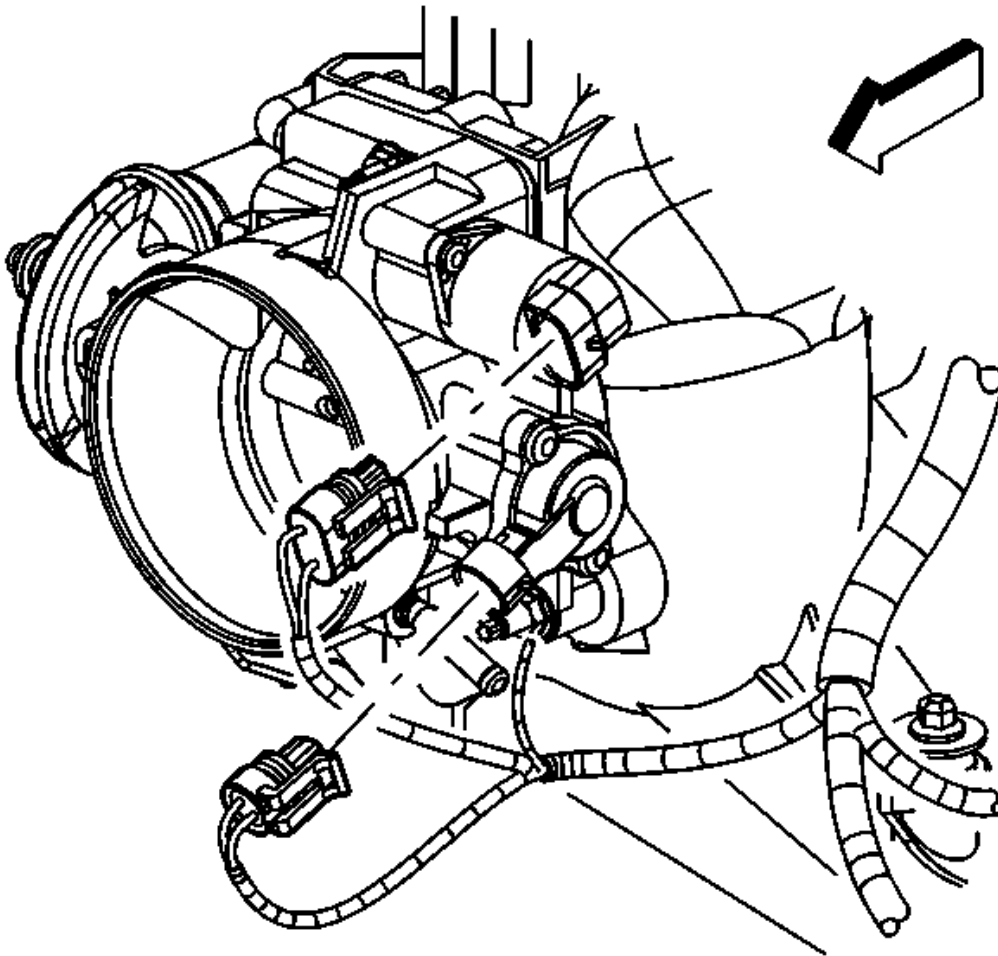


Fig. 320: TP Sensor & IAC Valve Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

57. Connect the TP sensor and IAC valve electrical connectors.

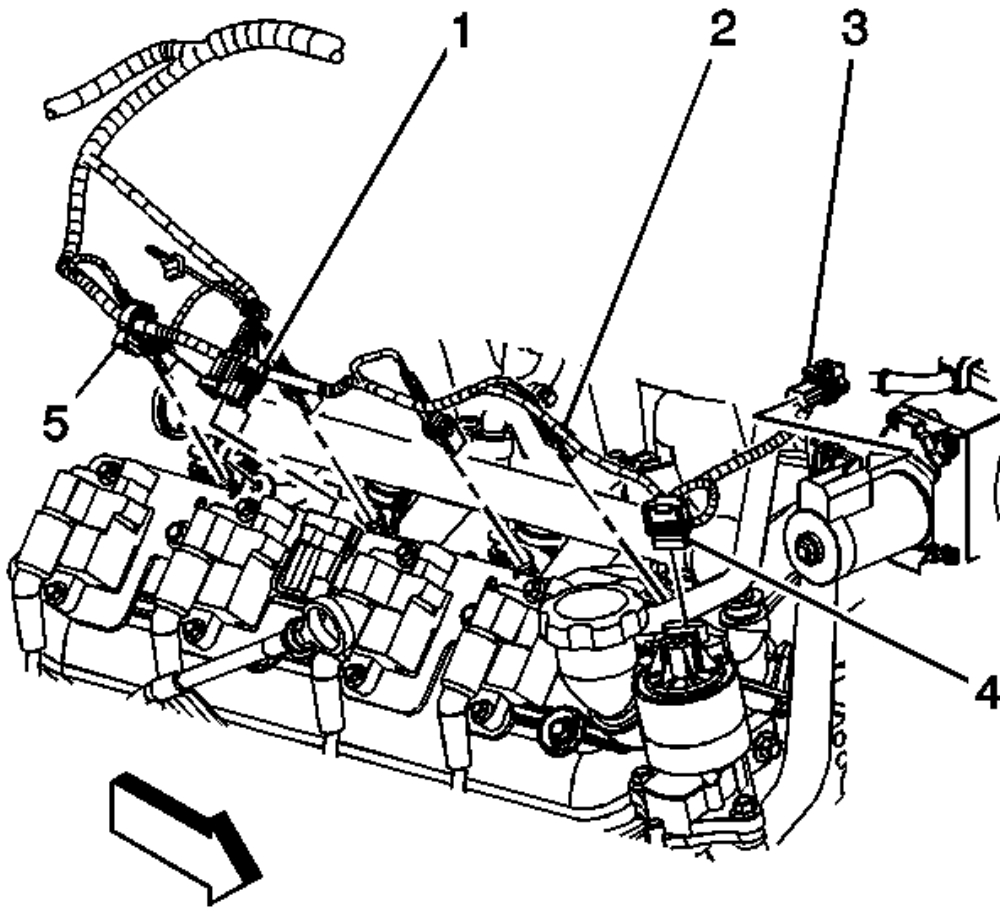


Fig. 321: Main Ignition Coil Wire Harness Connector & Clips
Courtesy of GENERAL MOTORS CORP.

58. Connect the following electrical connectors:

- Main coil harness (1)
- Fuel injectors (2)
- ETC (3)
- EGR valve (4), if equipped

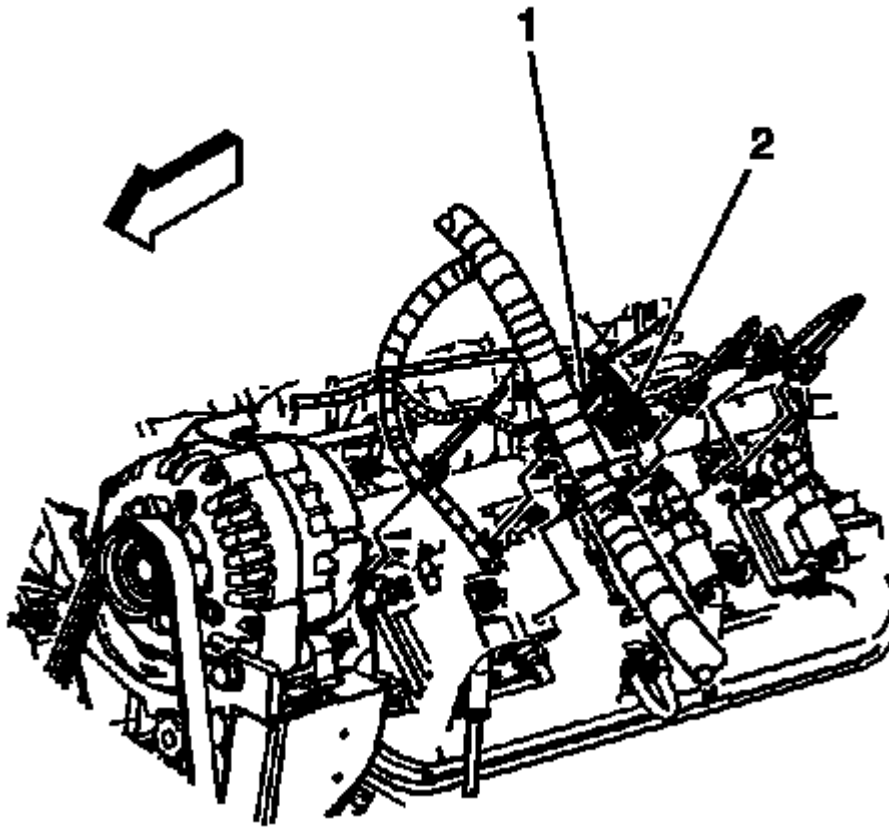


Fig. 322: View Of Main Ignition Coil Wire Harness Connector & Clips
Courtesy of GENERAL MOTORS CORP.

59. Connect the main coil harness (2) and fuel injector electrical connectors on the left side.

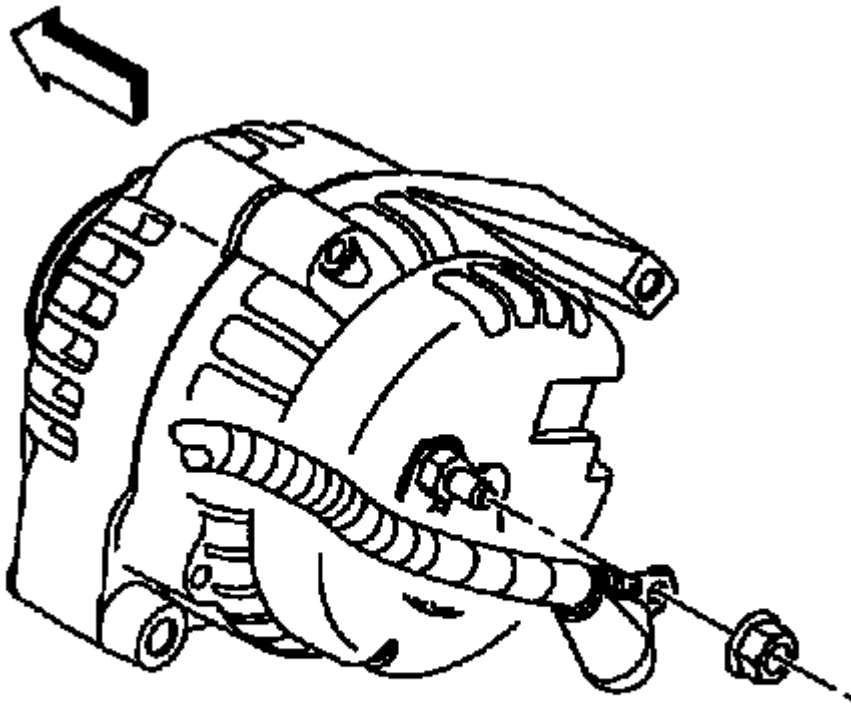


Fig. 323: View Of Generator Cable & Nut
Courtesy of GENERAL MOTORS CORP.

60. Install the generator cable to the generator, perform the following:

- Install the generator cable.
- Install the generator cable nut to the terminal stud.

Tighten: Tighten the generator output terminal nut to 9 N.m (80 lb in).

- Slide the boot over the terminal stud.

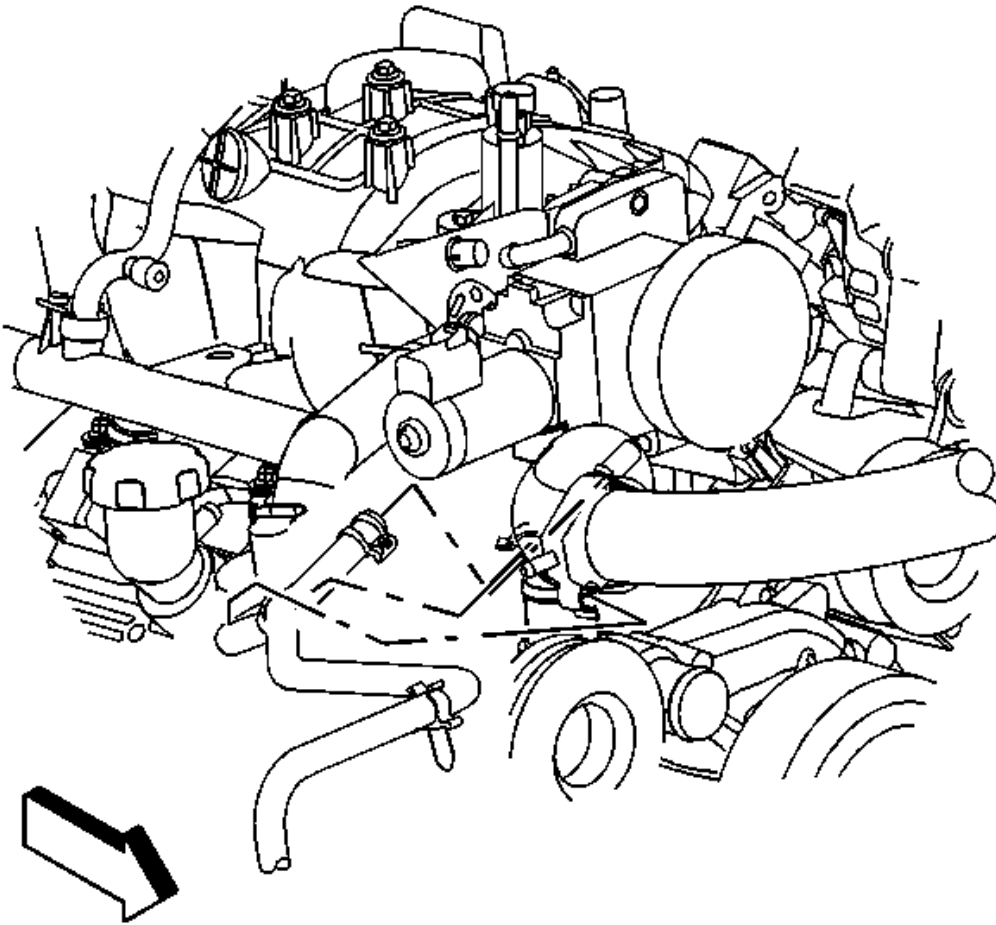


Fig. 324: View Of Vent Inlet Hose At Throttle Body
Courtesy of GENERAL MOTORS CORP.

61. Install the radiator vent inlet hose to the throttle body.
62. Position the vent inlet hose clamp at the throttle body.

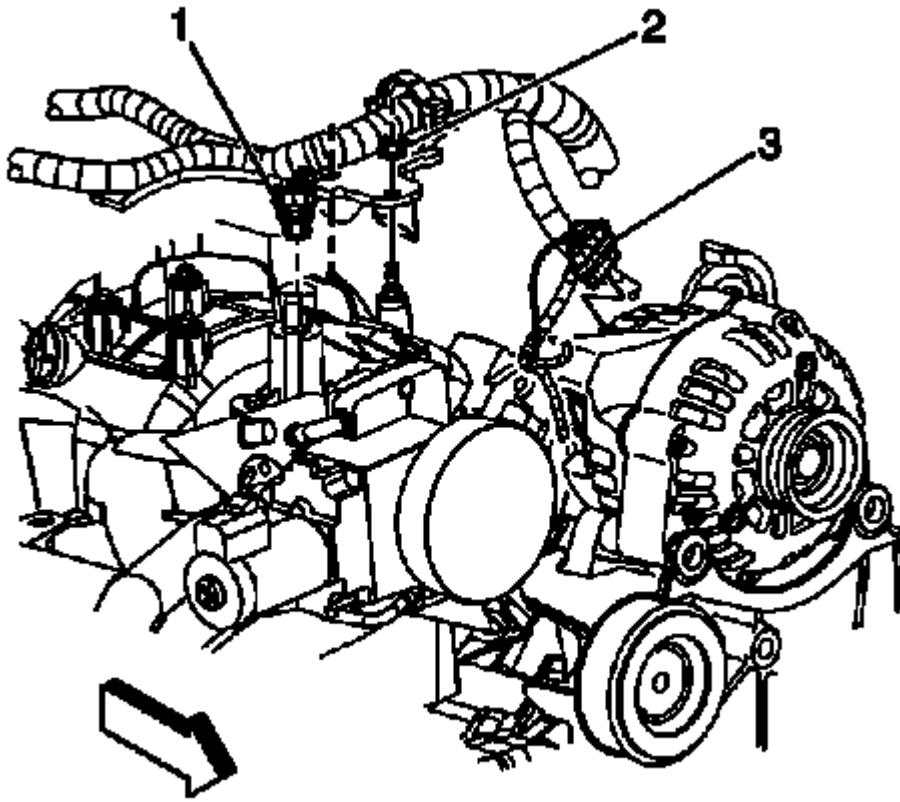


Fig. 325: Identifying Purge Solenoid Electrical Connector, Wiring Harness Nut & Generator Electrical Connector

Courtesy of GENERAL MOTORS CORP.

63. Install the engine wiring harness bracket and nut (2).

Tighten: Tighten the engine wiring harness bracket nut to 5 N.m (44 lb in).

64. Connect the following electrical connectors:

- EVAP canister purge solenoid (1)
- Generator (3)

65. Install the engine sight shield retainer and bolts.

Tighten: Tighten the engine sight shield retainer bolts to 5 N.m (44 lb in).

CAUTION: In order to avoid possible injury or vehicle damage, always replace the accelerator control cable with a NEW cable whenever you remove the engine from the vehicle.

In order to avoid cruise control cable damage, position the cable out of the way while you remove or install the engine. Do not pry or lean against the cruise control cable and do not kink the cable. You must

replace a damaged cable.

66. Install a NEW accelerator control cable. If required.

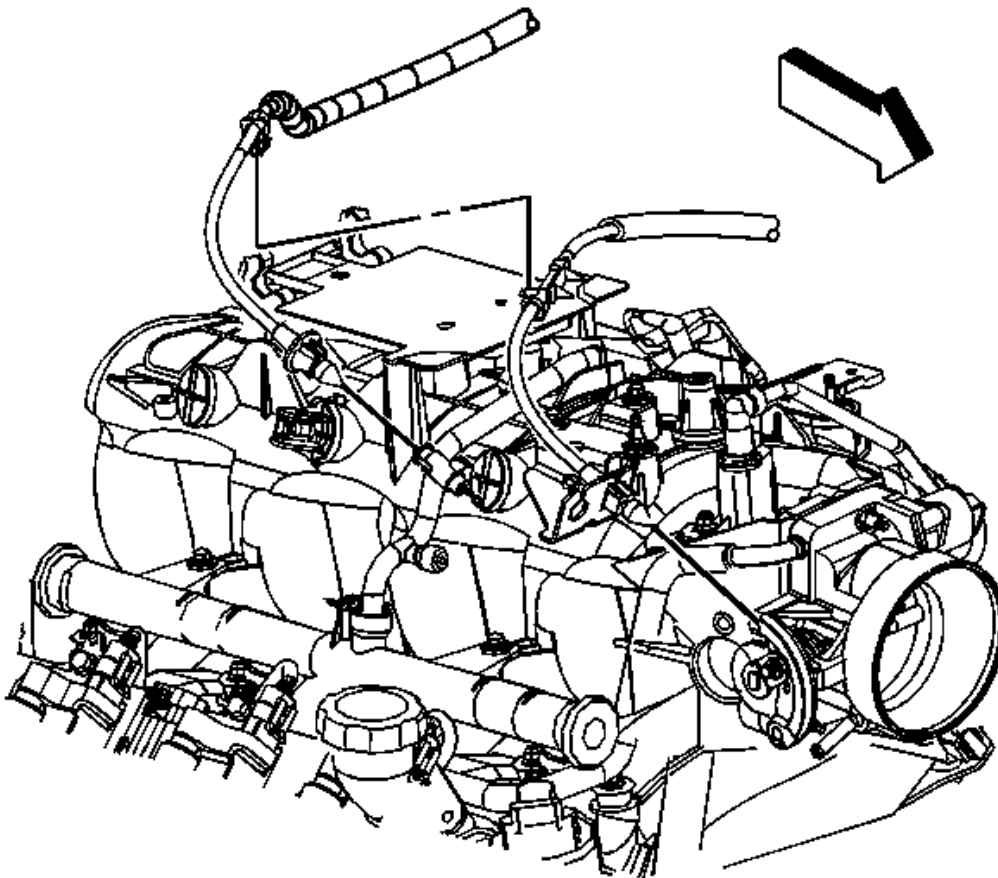


Fig. 326: Accelerator Control Cable Clip
Courtesy of GENERAL MOTORS CORP.

67. Install the cruise control cable clip to the sight shield retainer, if equipped.

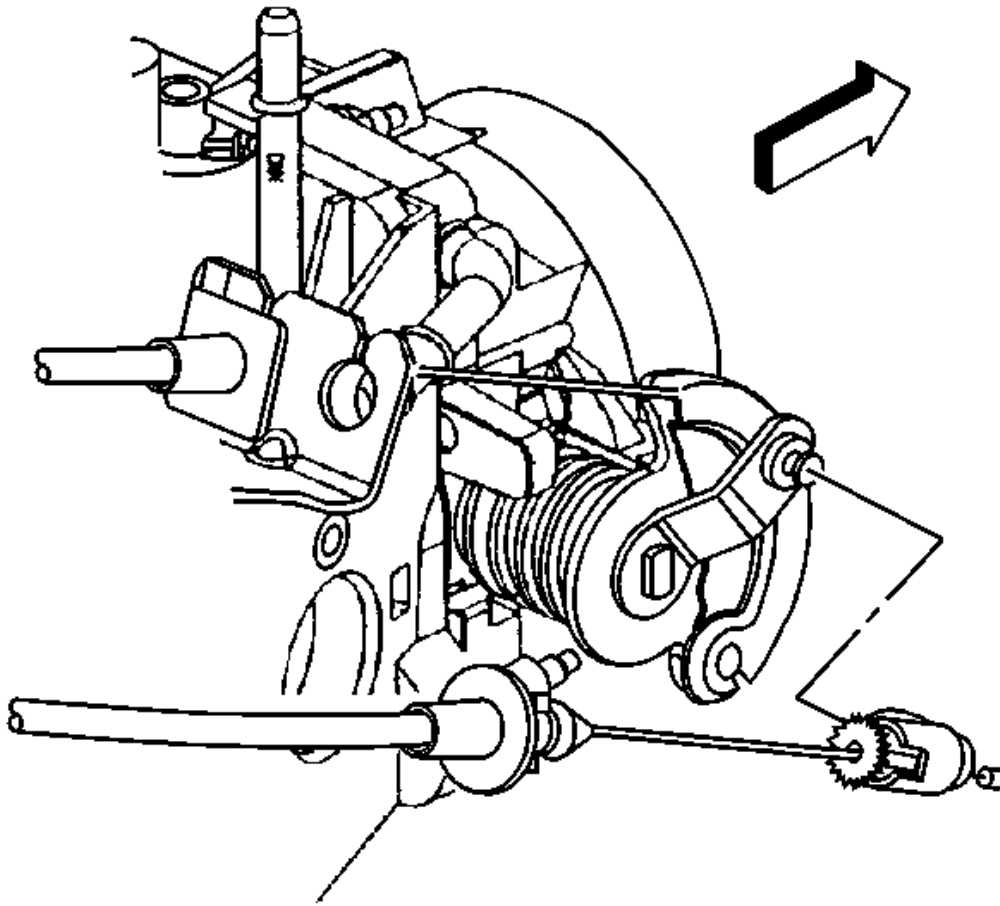


Fig. 327: Cruise Control Cable
Courtesy of GENERAL MOTORS CORP.

68. Install the cruise control cable to the bracket, if equipped.
69. Snap the cruise control cable to the throttle body lever, if equipped.

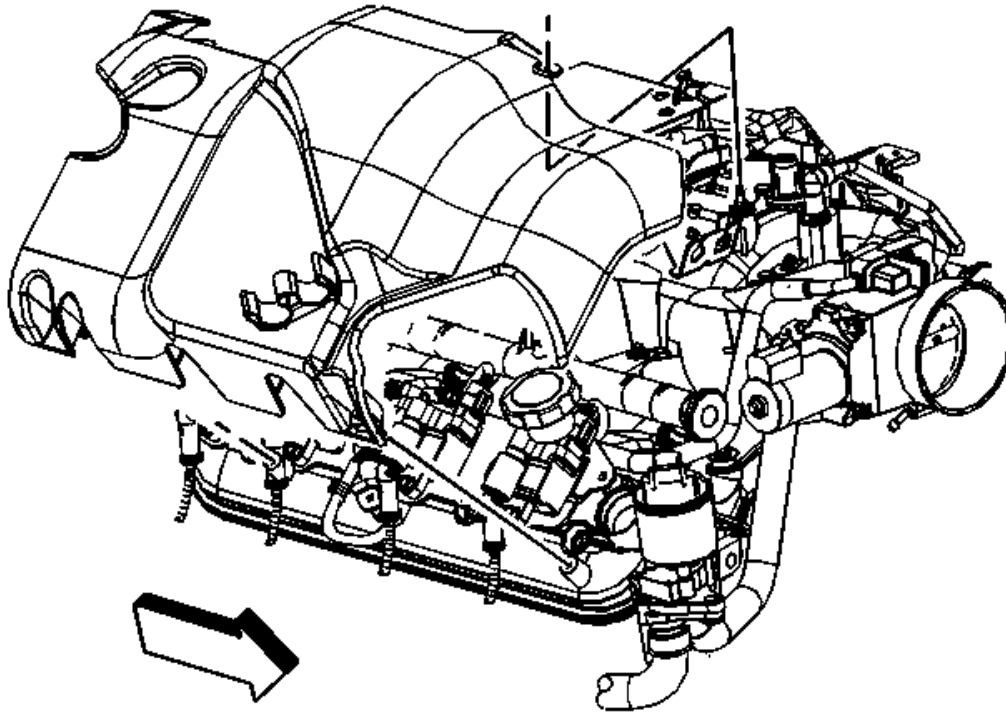


Fig. 328: Left Fuel Rail Cover
Courtesy of GENERAL MOTORS CORP.

70. If equipped with the 6.0L with PRO's Y91 and Z88, install the right fuel rail cover.
71. Tighten the fuel rail cover bolts.

Tighten: Tighten the fuel rail cover bolts to 9 N.m (80 lb in).

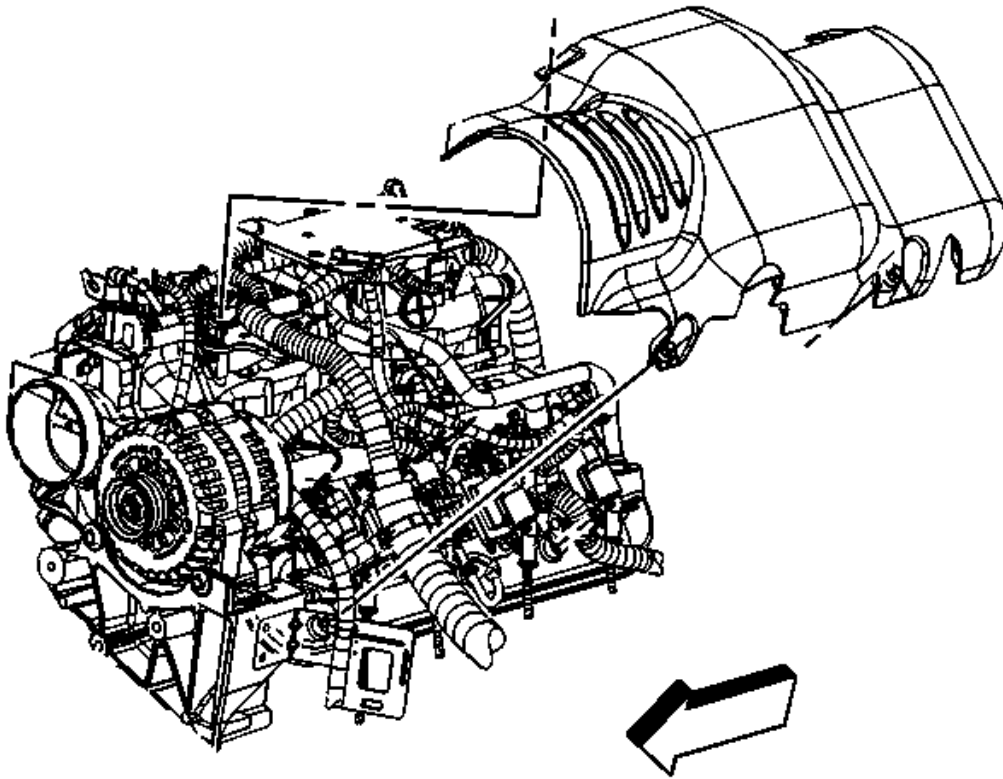


Fig. 329: Left Fuel Rail Cover
Courtesy of GENERAL MOTORS CORP.

72. If equipped with the 6.0L with PRO's Y91 and Z88, install the left fuel rail cover.
73. Tighten the fuel rail cover bolts.

Tighten: Tighten the fuel rail cover bolts to 9 N.m (80 lb in).

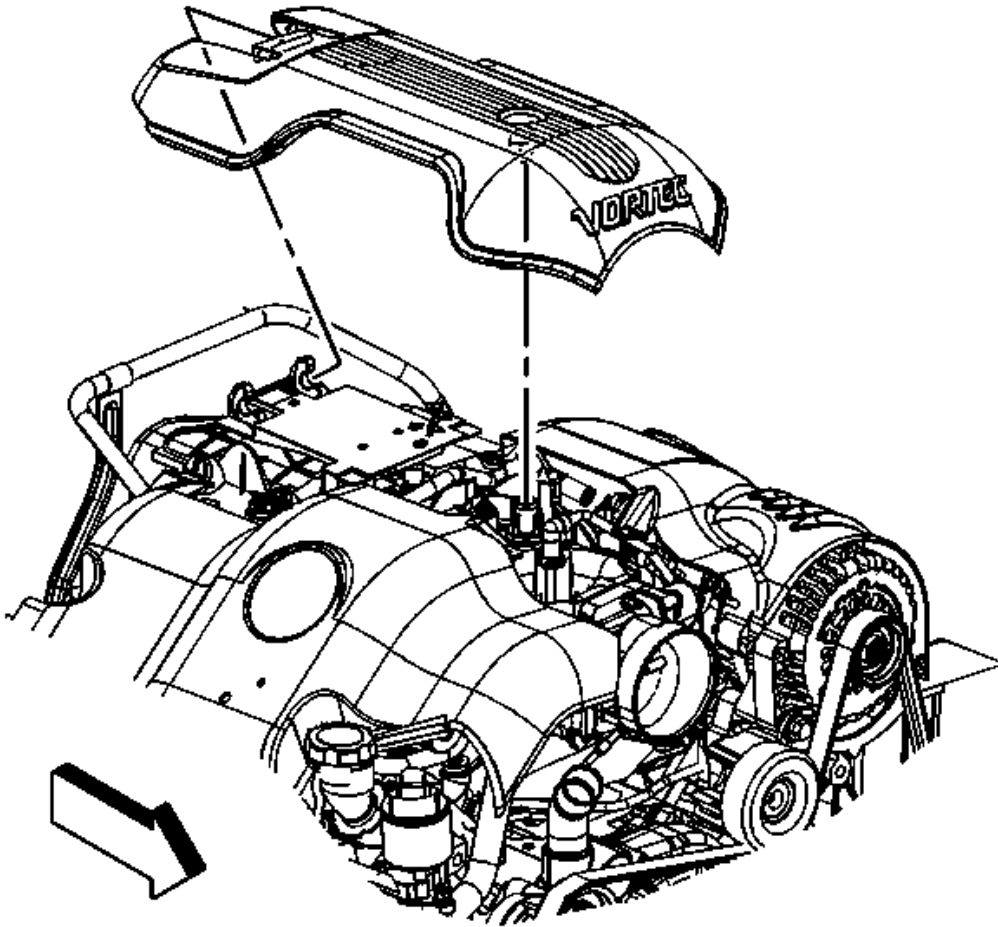


Fig. 330: Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS CORP.

74. If equipped with the 6.0L with PRO's Y91 and Z88, install the engine sight shield to the retainer.
75. Tighten the engine sight shield bolt.

Tighten: Tighten the engine sight shield bolt to 9 N.m (80 lb in)

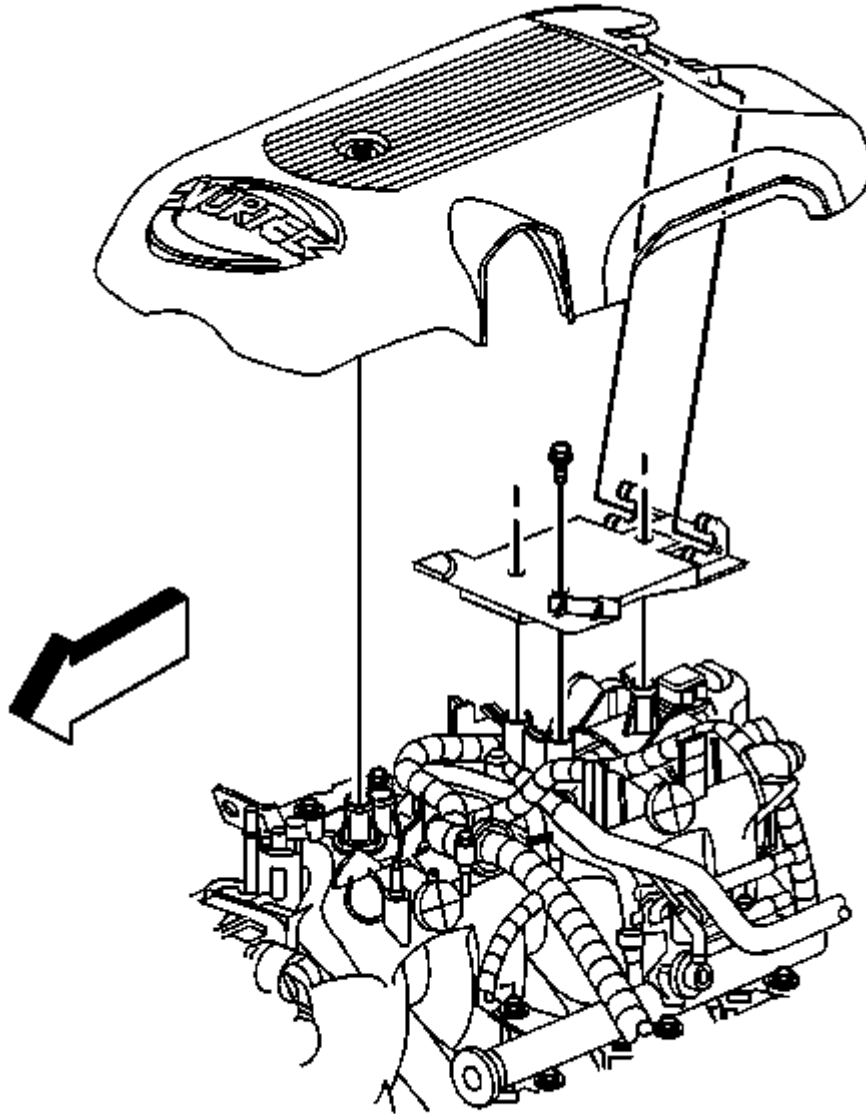


Fig. 331: View Of Top Engine Cover
Courtesy of GENERAL MOTORS CORP.

76. If equipped with the 4.8L, 5.3L, or 6.0L without RPO's Y91 and Z88, install the engine sight shield to the retainer.
77. Tighten the engine sight shield bolt.

Tighten: Tighten the engine sight shield bolt to 10 N.m (89 lb in)

78. Install the heater hoses. Refer to HEATER HOSE REPLACEMENT -- INLET (L18) or HEATER HOSE REPLACEMENT -- INLET (LB7) or HEATER HOSE REPLACEMENT -- INLET (L35) or HEATER HOSE REPLACEMENT -- INLET (LR4, LM7 & LQ4) and HEATER HOSE REPLACEMENT -- OUTLET (L18) or HEATER HOSE REPLACEMENT -- OUTLET (LB7) or HEATER HOSE REPLACEMENT -- OUTLET (L35) or HEATER HOSE REPLACEMENT -- OUTLET (LR4, LM7, & LQ4) in Heating, Ventilation, and Air Conditioning.

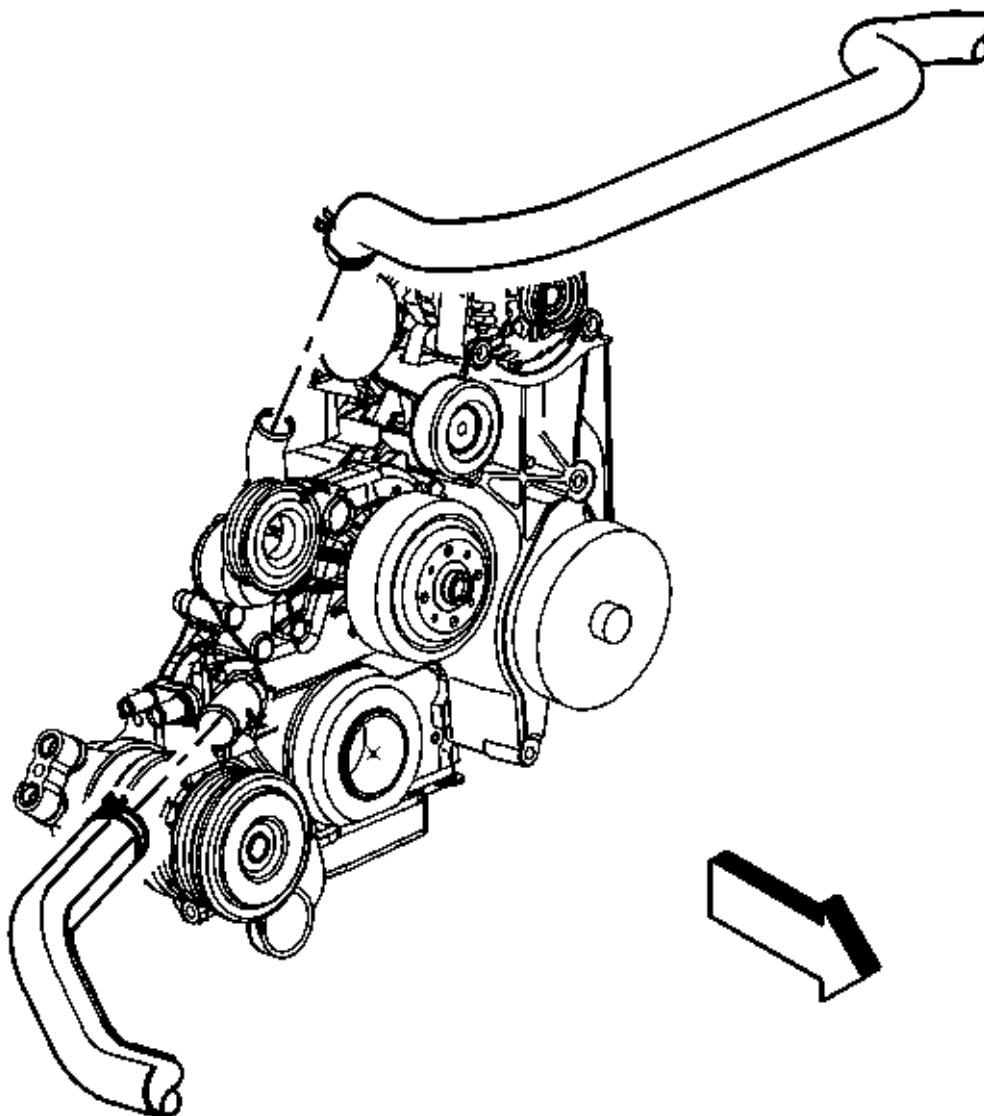


Fig. 332: Radiator Outlet Hose

Courtesy of GENERAL MOTORS CORP.

79. Install the radiator outlet hose to the water pump.
80. Position the radiator outlet hose clamp at the water pump.

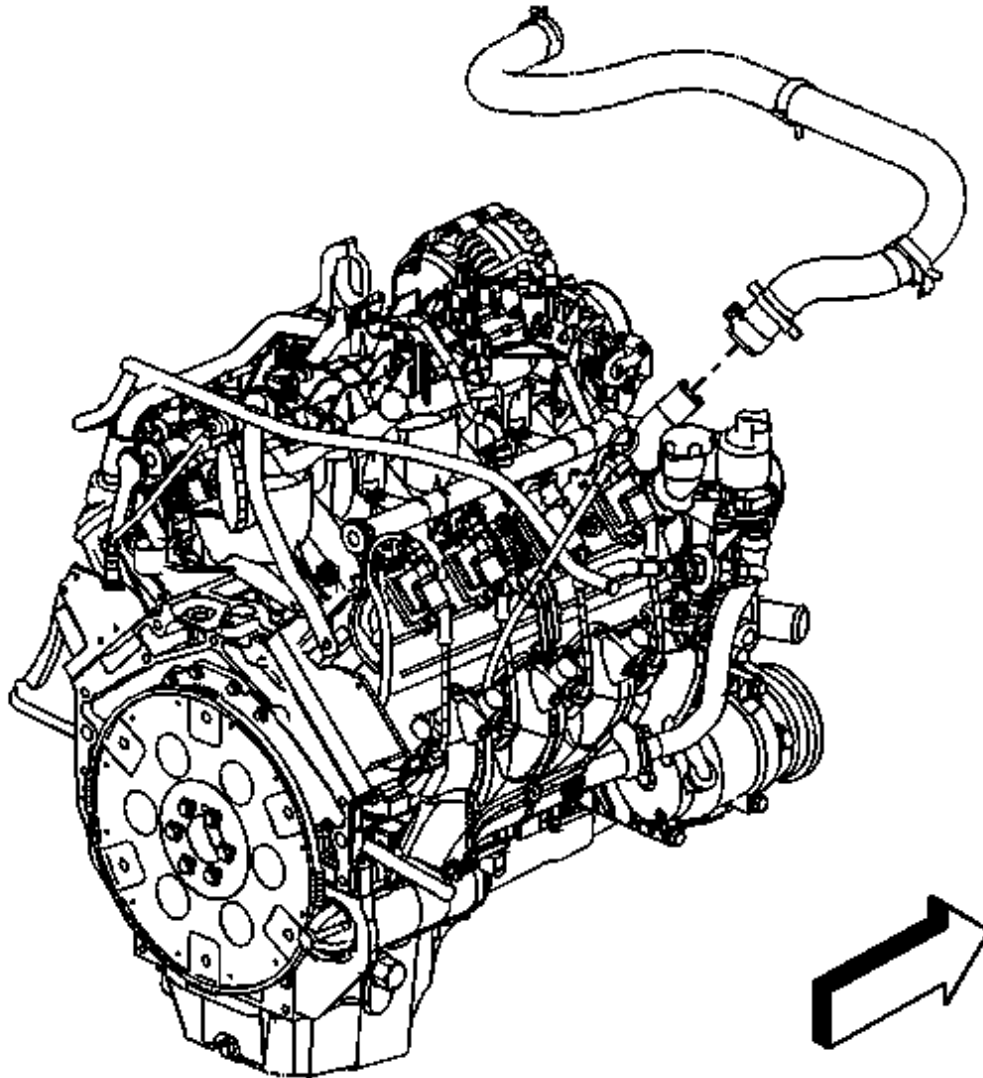


Fig. 333: View Of Inlet Hose & Water Pump
Courtesy of GENERAL MOTORS CORP.

81. Install the radiator inlet hose to the water pump.

82. Position the radiator inlet hose clamp at the water pump.
83. Install the radiator supports. Refer to **RADIATOR SUPPORT REPLACEMENT** .
84. Install the A/C compressor. Refer to **COMPRESSOR REPLACEMENT (L35 W/HARRISON)** or **COMPRESSOR REPLACEMENT (LB7 W/DENSO)** or **COMPRESSOR REPLACEMENT (LB7 W/HARRISON)** or **COMPRESSOR REPLACEMENT (LR4, LM7, LQ4, L18 W/DENSO)** or **COMPRESSOR REPLACEMENT (L18 W/HARRISON)** in HVAC.

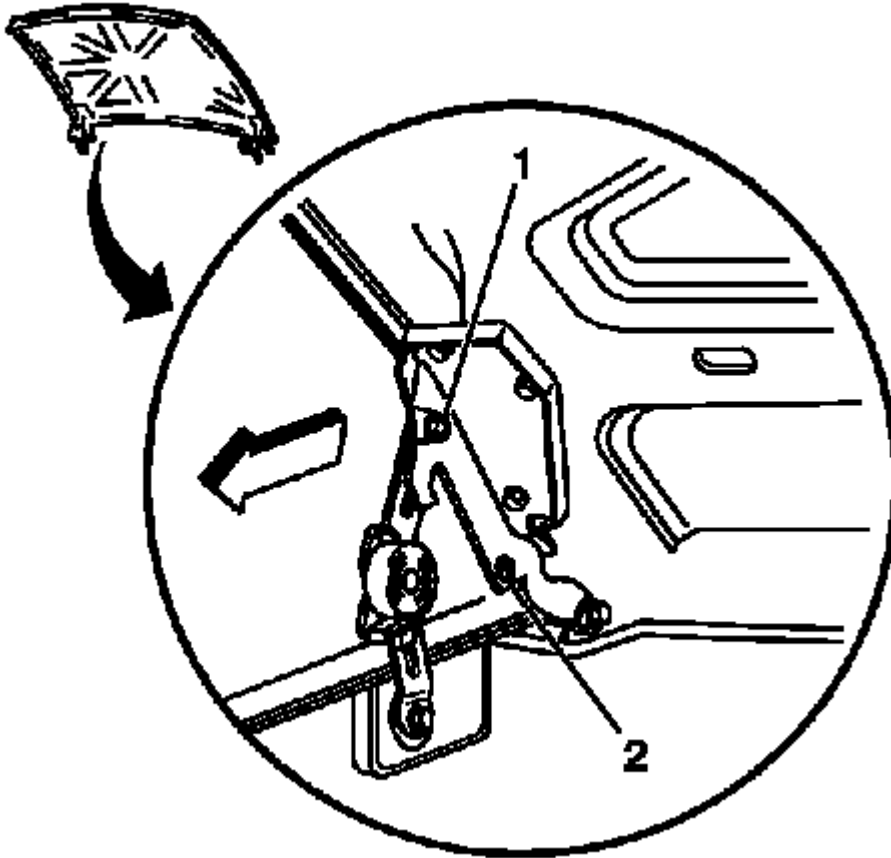


Fig. 334: Identifying Hood Hinge Normal And Service Position Bolt Holes
Courtesy of GENERAL MOTORS CORP.

85. Remove the hood hinge bolts from the service position (2).
86. Lower the hood to the normal position.
87. Install the hood hinge bolts.

Tighten: Tighten the hood hinge bolts to 25 N.m (18 lb ft).

88. Remove the fender covers.
89. Fill the crankcase with the proper quantity and grade of engine oil. Refer to **SEALERS, ADHESIVES & LUBRICANTS** and/or **DRAINING FLUIDS & OIL FILTER REMOVAL** .
90. Bleed the hydraulic clutch, if equipped. Refer to **BLEEDING** in Clutch.

91. Perform the CKP system variation learn procedure. Refer to **CRANKSHAFT POSITION SENSOR SYSTEM VARIATION LEARN PROCEDURE** .

IMPORTANT: After an overhaul, the engine should be tested. Use the following procedure after the engine is installed in the vehicle.

1. Disable the ignition system.
 2. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
 3. Enable the ignition system.
 4. Start the engine and listen for unusual noises.
 5. Check the vehicle oil pressure gauge or light and confirm that the engine has acceptable oil pressure.
 6. Run the engine speed at about 1000 RPM until the engine has reached normal operating temperature.
 7. Listen for sticking lifter and other unusual noises.
 8. Inspect for fuel, oil and/or coolant leaks while the engine is running.
 9. Perform a final inspection for the proper engine oil and coolant levels.
92. Close the hood.

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

IMPORTANT: In order to completely drain the oil from the oil pan internal baffling, the bottom of the oil pan must be level during the oil drain procedure.

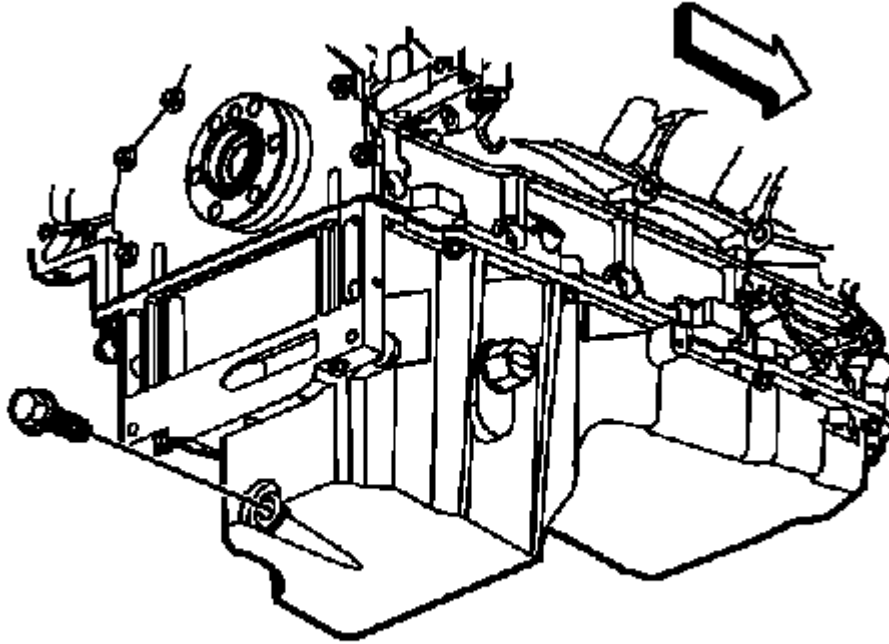


Fig. 335: View Of Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

1. Open the hood.
2. Remove the oil fill cap.
3. Raise and suitably support the vehicle. Refer to **LIFTING AND JACKING THE VEHICLE** in General Information.
4. Place a oil drain pan under the oil pan drain plug.
5. Remove the oil pan drain plug.
6. Drain the engine oil.
7. Wipe the excess oil from the drain plug hole and plug.

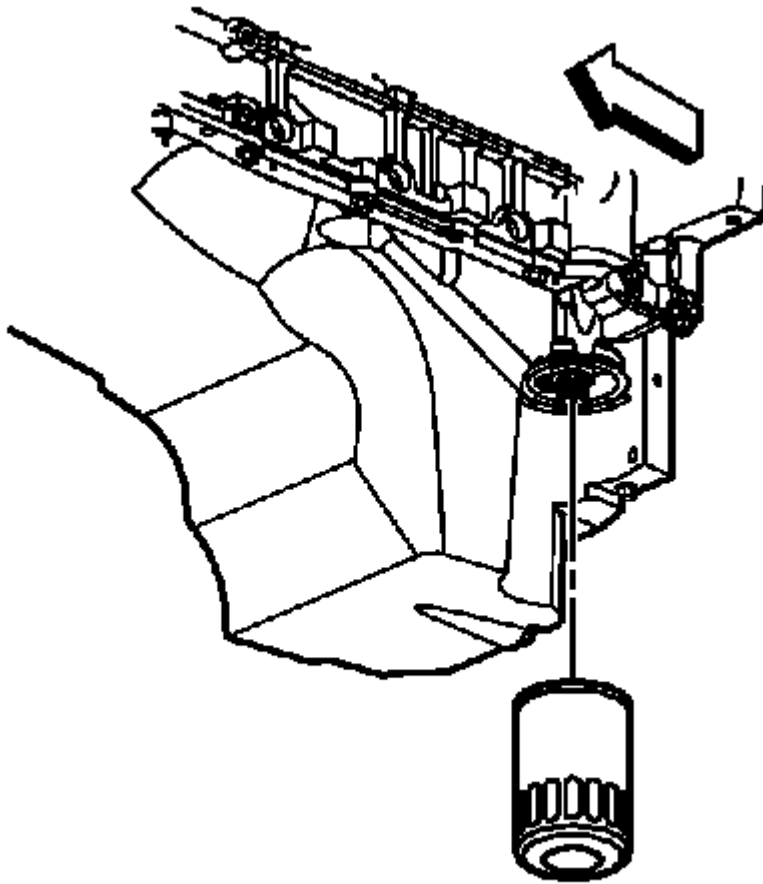


Fig. 336: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Check the old oil filter to ensure that the filter seal is not left on the engine block.

8. Remove the oil filter from the engine block.
9. Wipe the excess oil from the oil filter mounting.

Installation Procedure

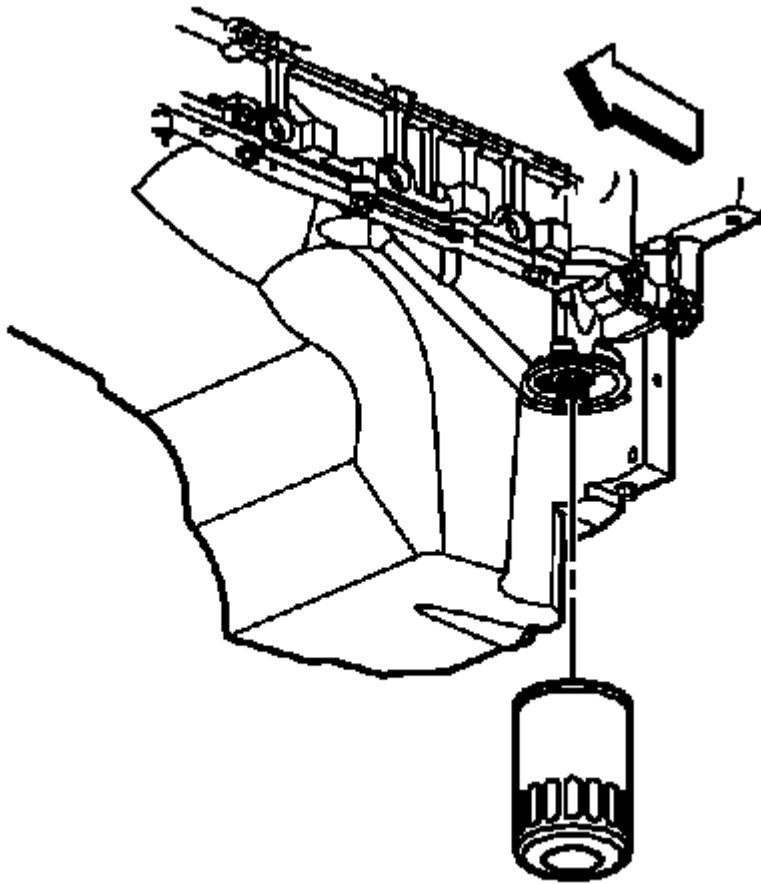


Fig. 337: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Lubricate the oil filter seal with clean engine oil.
2. Install the oil filter to the engine block.

Tighten: Tighten the oil filter to 30 N.m (22 lb ft).

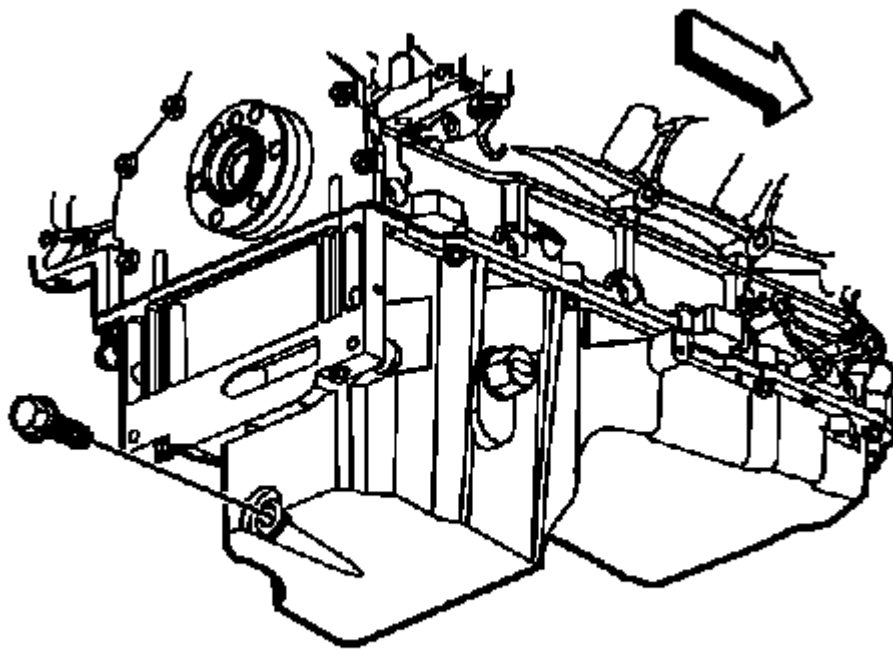


Fig. 338: View Of Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

3. Install the oil drain plug to the engine block.

Tighten: Tighten the oil pan drain plug to 25 N.m (18 lb ft).

4. Lower the vehicle.
5. Fill the crankcase with the proper quantity and grade of engine oil. Refer to **SEALERS, ADHESIVES & LUBRICANTS** and/or **DRAINING FLUIDS & OIL FILTER REMOVAL** .
6. Remove the oil level indicator.
7. Wipe the indicator with a clean cloth.
8. Install the oil level indicator.
9. Remove the oil level indicator in order to check the level.
10. Add oil if necessary.
11. Close the hood.

DESCRIPTION AND OPERATION

CRANKCASE VENTILATION SYSTEM INSPECTION/DESCRIPTION

A closed crankcase ventilation system is used in order to provide a more complete scavenging of the crankcase vapors. Fresh air from the throttle body is supplied to the crankcase, mixed with blow-by gases, and then passed through a crankcase ventilation valve into the intake manifold.

The primary control is through the crankcase ventilation valve which meters the flow at a rate depending on manifold vacuum. To maintain idle quality, the crankcase ventilation valve restricts the flow when intake manifold vacuum is high. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent tube into the engine air inlet to be consumed by normal combustion.

Filtered fresh air is routed from up-stream of the throttle blade to the front of the right rocker arm cover via a formed rubber hose. To reduce the potential of oil pullover into the throttle bore area due to back flow of the ventilation system, the fitting in the right rocker arm cover is shielded from the rocker arms. From there fresh air and gases are routed through the crankcase and up to the opposite rocker arm cover where the positive crankcase ventilation (PCV) valve is located. Gases are then routed through a hose to the intake manifold.

DRIVE BELT SYSTEM DESCRIPTION

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner
- The drive belt idler pulley
- The crankshaft balancer pulley
- The accessory drive component mounting brackets
- The accessory drive components
 - The power steering pump, if belt driven
 - The generator
 - The A/C compressor, if equipped
 - The engine cooling fan, if belt driven
 - The water pump, if belt driven
 - The vacuum pump, if equipped
 - The air compressor, if equipped

The drive belt system may use 1 belt or 2 belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. The drive belts are made of different types of rubbers - chloroprene or EPDM - and have different layers or plys containing either fiber cloth or cords for reinforcement.

Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

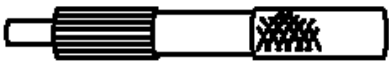
The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys. Some systems use an idler pulley in place of an accessory drive component when the vehicle is not equipped with the accessory.

SPECIAL TOOLS AND EQUIPMENT

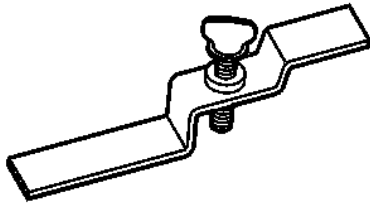
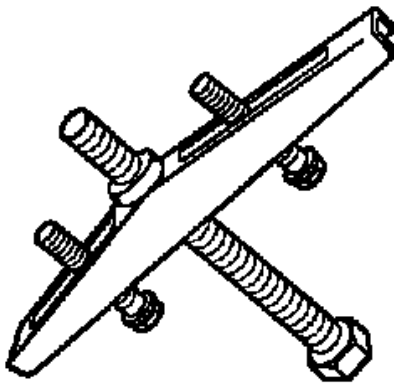
SPECIAL TOOLS

Special Tools

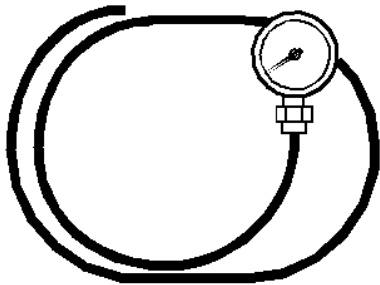
Illustration	Tool Number/ Description
	J 3049-A Valve Lifter Remover
	J 5824-01 Clutch Alignment Tool
	J 8433 Pulley Puller

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J 21366
Converter Holding Strap



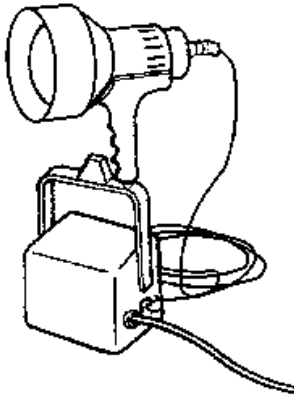
J 21867
Pressure Gauge



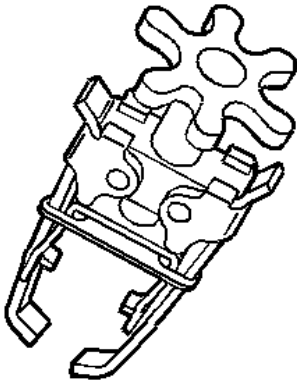
J 22794
Spark Plug Port Adapter

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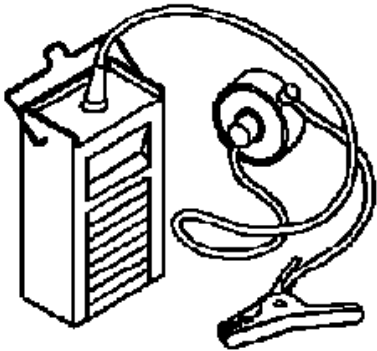
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J 28428-E
Leak Detector Kit



J 38606
Valve Spring Compressor

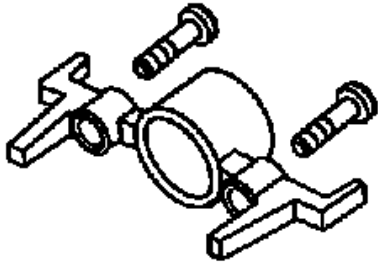


J 36660-A
Torque Angle Meter

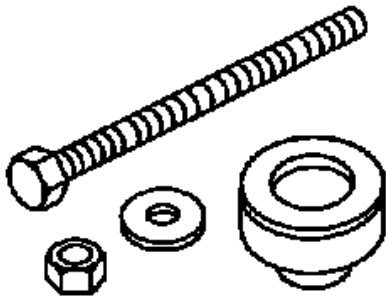
J 41476
Front and Rear Cover Alignment (at crankshaft seal

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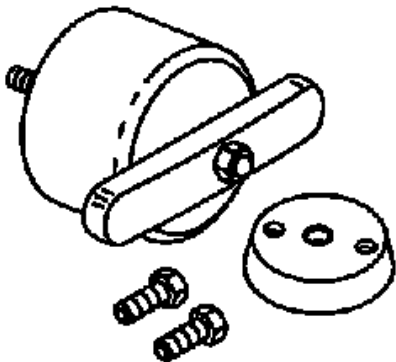
2002 ENGINES 4.8L, 5.3L & 6.0L V8 - Sierra & Silverado



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J 41478
Crankshaft Front Oil Seal Installer

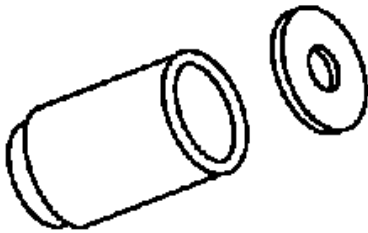
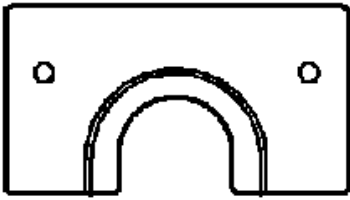


J 41479
Crankshaft Rear Oil Seal Installer

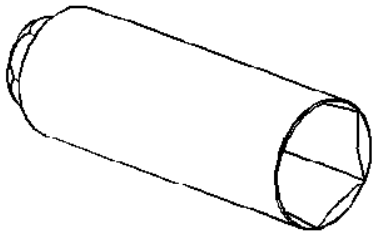
J 41558
Crankshaft Sprocket Remover

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J 41665
Crankshaft Balancer and Sprocket Installer

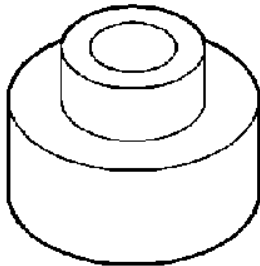
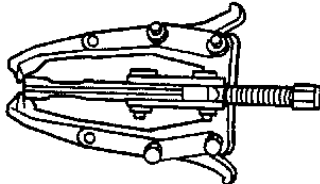
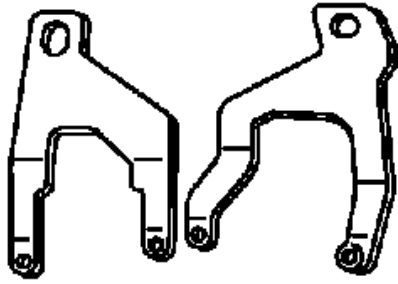


J 41712
Oil Pressure Sensor Socket

J 41798
Engine Lifting Brackets

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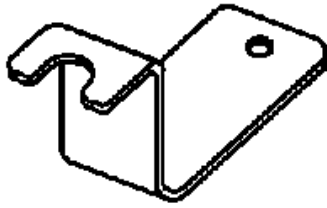
J 41816
Crankshaft Balancer Remover

J 41816-2
Crankshaft End Protector

J 42078
Valve Stem Oil Seal Installer

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J 42371
Clutch Line Removal Tool

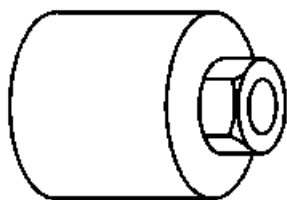


J 42385-200
Thread Repair Kit



J 42386-A
Flywheel Holding Tool

J 42907
Oil Pressure Testing Tool



SPECIFICATIONS

ENGINE MECHANICAL SPECIFICATIONS (LR4 VIN V)

Engine Mechanical Specifications (LR4 VIN V)

Engine Mechanical Specifications (2017 V8 V6)		
Application	Metric	English
General Data		
• Engine Type	V8	
• Displacement	4.8L	293 CID
• Bore	96.000-96.018 mm	3.779-3.78 in
• Stroke	83.0 mm	3.268 in
• Compression Ratio	9.45:1	
• Firing Order	1-8-7-2-6-5-4-3	
• Spark Plug Gap	1.524 mm	0.06 in
Lubrication System		
• Oil Capacity (without Oil Filter Change)	4.73 Liters	5.0 Quarts
• Oil Capacity (with Oil Filter Change)	5.68 Liters	6.0 Quarts
• Oil Pressure (Minimum-Hot)	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
• Oil Type	5W-30	
Camshaft		
• Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
• Camshaft Journal Diameter	54.99-55.04 mm	2.164-2.166 in
• Camshaft Journal Diameter Out-of-Round	0.025 mm	0.001 in

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• Camshaft Lobe Lift (Intake)	6.82 mm	0.268 in
• Camshaft Lobe Lift (Exhaust)	6.96 mm	0.274 in
• Camshaft Runout (Measured at the Intermediate Journals)	0.05 mm	0.002 in
Connecting Rod		
• Connecting Rod Bearing Bore Diameter	56.505-56.525 mm	2.224-2.225 in
• Connecting Rod Bearing Bore Out-of-Round	0.004-0.008 mm	0.00015-0.0003 in
• Connecting Rod Bearing Clearance (Production)	0.023-0.065 mm	0.0009-0.0025 in
• Connecting Rod Bearing Clearance (Service Limit)	0.023-0.076 mm	0.0009-0.003 in
• Connecting Rod Side Clearance	0.11-0.51 mm	0.0043-0.02 in
Crankshaft		
• Crankshaft Bearing Clearance (Production)	0.020-0.052 mm	0.0008-0.0021 in
• Crankshaft Bearing Clearance (Service)	0.020-0.065 mm	0.0008-0.0025 in
• Crankshaft Connecting Rod Journal Diameter (Production)	53.318-53.338 mm	2.099-2.1 in
• Crankshaft Connecting Rod Journal Diameter (Service Limit)	53.308 mm (Minimum)	2.0987 in (Minimum)
• Crankshaft Connecting Rod Journal Taper (Production)	0.005 mm (Maximum for one half of the Journal Length)	0.0002 in (Maximum for one half of the Journal Length)
• Crankshaft Connecting Rod Journal Taper (Service Limit)	0.02 mm (Maximum)	0.00078 in (Maximum)
• Crankshaft Connecting Rod Journal Out-of-Round (Production)	0.005 mm	0.0002 in
• Crankshaft Connecting Rod Journal Out-of-Round (Service Limit)	0.01 mm	0.0004 in
• Crankshaft End Play	0.04-0.2 mm	0.0015-0.0078 in
• Crankshaft Main Journal Diameter (Production)	64.993-65.007 mm	2.558-2.5593 in
• Crankshaft Main Journal Diameter (Service Limit)	64.993 mm (Minimum)	2.558 in (Minimum)
• Crankshaft Main Journal Out-of-Round (Production)	0.003 mm	0.0001 in
• Crankshaft Main Journal Out-of-Round (Service Limit)	0.008 mm	0.0003 in
• Crankshaft Main Journal Taper (Production)	0.01 mm	0.0004 in
• Crankshaft Main Journal Taper (Service Limit)	0.02 mm	0.00078 in
• Crankshaft Reluctor Ring Runout (Measured 1.0 mm (0.04 in) Below the Tooth Diameter)	0.7 mm (Maximum)	0.028 in (Maximum)

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2002 ENGINES 4.8L, 5.3L & 6.0L V8 - Sierra & Silverado

• Crankshaft Runout (at Rear Flange)	0.05 mm (Maximum)	0.002 in (Maximum)
• Crankshaft Thrust Wall Runout	0.025 mm	0.001 in
• Crankshaft Thrust Wall Width (Production)	26.14-26.22 mm	1.029-1.0315 in
• Crankshaft Thrust Wall Width (Service)	26.2 mm (Maximum)	1.0315 in (Maximum)
Cylinder Bore		
• Cylinder Bore Diameter (Production)	96.0-96.018 mm	3.779-3.78 in
Cylinder Head		
• Cylinder Head Engine Block Deck Flatness (Measured within a 156 mm (6.1 in) area)	0.08 mm	0.003 in
• Cylinder Head Engine Block Deck Flatness (Measuring the Overall Length of the Cylinder Head)	0.1 mm	0.004 in
• Cylinder Head Exhaust Manifold Deck Flatness	0.13 mm	0.005 in
• Cylinder Head Height (Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface)	120.2 mm (Minimum)	4.732 in (Minimum)
• Cylinder Head Intake Manifold Deck Flatness	0.08 mm	0.0031 in
Engine Block		
• Camshaft Bearing Bore 1 and 5 Diameter	59.12-59.17 mm	2.327-2.329 in
• Camshaft Bearing Bore 2 and 4 Diameter	58.87-58.92 mm	2.317-2.319 in
• Camshaft Bearing Bore 3 Diameter	58.62-58.67 mm	2.307-2.309 in
• Engine Block Cylinder Head Deck Surface Flatness (Measured within a 156 mm (6.1 in) area)	0.11 mm	0.004 in
• Engine Block Cylinder Head Deck Surface Flatness (Measuring the Overall Length of the Block Deck)	0.22 mm	0.008 in
• Engine Block Cylinder Head Deck Height (Measuring from the Centerline of Crankshaft to the Deck Face)	234.57-234.82 mm	9.235-9.245 in
• Main Bearing Bore Diameter (Production)	69.871-69.889 mm	2.750-2.751 in
• Main Bearing Bore Diameter Out-of-Round	0.006 mm	0.0002 in
• Valve Lifter Bore Diameter (Production)	21.417-21.443 mm	0.843-0.844 in
Intake Manifold		
• Intake Manifold Cylinder Head Deck Flatness (Measured within a 200 mm (7.87 in) Area that Includes Two Runner Port Openings)	3.0 mm	0.118 in
Oil Pan and Front/Rear Cover Alignment		
• Oil Pan to Rear of Engine Block Alignment (at Transmission Bellhousing Mounting Surface)	0.0-0.25 mm (Maximum)	0.0-0.01 in (Maximum)

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• Front Cover Alignment (at Oil Pan Surface)	0.0-0.5 mm	0.0-0.02 in
• Rear Cover Alignment (at Oil Pan Surface)	0.0-0.5 mm	0.0-0.02 in
Piston		
• Piston - Piston Diameter Measured Over Skirt Coating	96.002-96.036 mm	3.779-3.78 in
• Piston - Piston-to-Bore Clearance - Production	-0.036 to +0.016 mm	-0.0014 to +0.0006 in
• Piston - Piston-to-Bore Clearance - Service Limit - with Skirt Coating Worn Off	0.07 mm	0.0028 in
Piston Pin		
• Piston Pin Clearance to Piston Bore (Production)	0.007-0.020 mm	0.00027-0.00078 in
• Piston Pin Clearance to Piston Bore (Service Limit)	0.007-0.021 mm (Maximum)	0.00027-0.00082 in (Maximum)
• Piston Pin Diameter	23.997-24.0 mm	0.9447-0.9448 in
• Piston Pin Fit in Connecting Rod	0.020-0.043 mm (Interference)	0.00078-0.00169 in (Interference)
Piston Rings		
• Piston Compression Ring End Gap (Production-Top) (Measured in Cylinder Bore)	0.23-0.44 mm	0.009-0.017 in
• Piston Compression Ring End Gap (Production-2nd) (Measured in Cylinder Bore)	0.44-0.70 mm	0.0173-0.0275 in
• Piston Oil Ring End Gap (Production) (Measured in Cylinder Bore)	0.18-0.75 mm	0.007-0.0295 in
• Piston Compression Ring End Gap (Service-Top) (Measured in Cylinder Bore)	0.23-0.50 mm (Maximum)	0.009-0.02 in (Maximum)
• Piston Compression Ring End Gap (Service-2nd) (Measured in Cylinder Bore)	0.44-0.76 mm (Maximum)	0.0173-0.03 in (Maximum)
• Piston Oil Ring End Gap-Service Limit (Measured in Cylinder Bore)	0.18-0.81 mm (Maximum)	0.007-0.032 in (Maximum)
• Piston Compression Ring Groove Clearance (Production-Top)	0.04-0.085 mm	0.00157-0.003346 in
• Piston Compression Ring Groove Clearance (Production-2nd)	0.04-0.078 mm	0.00157-0.0031 in
• Piston Oil Ring Groove Clearance (Production)	0.012-0.20 mm	0.0005-0.0078 in
• Piston Compression Ring Groove Clearance (Service-Top)	0.04-0.085 mm (Maximum)	0.00157-0.003346 in (Maximum)
• Piston Compression Ring Groove Clearance (Service-2nd)	0.04-0.078 mm (Maximum)	0.00157-0.0031 in (Maximum)
• Piston Oil Ring Groove Clearance (Service Limit)	0.012-0.20 mm (Maximum)	0.0005-0.0078 in (Maximum)

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2002 ENGINES 4.8L, 5.3L & 6.0L V8 - Sierra & Silverado

Valve System

• Valve Face Angle	45 degrees	
• Valve Guide Installed Height (Aluminum Head-Measured from the Cylinder Head Spring Seat Surface to the Top of the Valve Guide)	17.32 mm	0.682 in
• Valve Lash	Net Lash-No Adjustment	
• Valve Lift (Exhaust)	11.85 mm	0.466 in
• Valve Lift (Intake)	11.6 mm	0.457 in
• Valve Lifter	Hydraulic Roller	
• Valve Margin	1.25 mm	0.05 in
• Valve Rocker Arm Ratio	1.70:1	
• Valve Seat Angle	46 degrees	
• Valve Seat Runout	0.05 mm (Maximum)	0.002 in (Maximum)
• Valve Seat Width (Exhaust)	1.78 mm	0.07 in
• Valve Seat Width (Intake)	1.02 mm	0.04 in
• Valve Spring Free Length	52.9 mm	2.08 in
• Valve Spring Installed Height (Exhaust)	45.75 mm	1.8 in
• Valve Spring Installed Height (Intake)	45.75 mm	1.8 in
• Valve Spring Pressure (Closed)	340 N at 45.75 mm	76 lb at 1.8 in
• Valve Spring Pressure (Open)	980 N at 33.55 mm	220 lb at 1.32 in
• Valve Stem Clearance (Production-Exhaust)	0.025-0.066 mm	0.001-0.0026 in
• Valve Stem Clearance (Production-Intake)	0.025-0.066 mm	0.001-0.0026 in
• Valve Stem Clearance (Service-Exhaust)	0.093 mm (Maximum)	0.0037 in (Maximum)
• Valve Stem Clearance (Service-Intake)	0.093 mm (Maximum)	0.0037 in (Maximum)
• Valve Stem Diameter (Production)	7.955-7.976 mm	0.3132-0.314 in
• Valve Stem Diameter (Service)	7.95 mm (Minimum)	0.313 in (Minimum)
• Valve Stem Oil Seal Installed Height (Measured from the Valve Spring Shim to Top Edge of Seal Body - First Design Seal)	18.1-19.1 mm	0.712-0.752 in

ENGINE MECHANICAL SPECIFICATIONS (LM7 VIN T/L59 VIN Z)**Engine Mechanical Specifications (LM7 VIN T/L59 VIN Z)**

Application	Metric	English
General Data		
• Engine Type	V8	

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• Displacement	5.3L	325 CID
• Bore	96.000-96.018 mm	3.779-3.78 in
• Stroke	92.0 mm	3.622 in
• Compression Ratio	9.45:1	
• Firing Order	1-8-7-2-6-5-4-3	
• Spark Plug Gap	1.524 mm	0.06 in
Lubrication System		
• Oil Capacity (without Oil Filter Change)	4.73 Liters	5.0 Quarts
• Oil Capacity (with Oil Filter Change)	5.68 Liters	6.0 Quarts
• Oil Pressure (Minimum-Hot)	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
• Oil Type	5W-30	
Camshaft		
• Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
• Camshaft Journal Diameter	54.99-55.04 mm	2.164-2.166 in
• Camshaft Journal Diameter Out-of-Round	0.025 mm	0.001 in
• Camshaft Lobe Lift (Intake)	6.82 mm	0.268 in
• Camshaft Lobe Lift (Exhaust)	6.96 mm	0.274 in
• Camshaft Runout (Measured at the Intermediate Journals)	0.05 mm	0.002 in
Connecting Rod		
• Connecting Rod Bearing Bore Diameter	56.505-56.525 mm	2.224-2.225 in
• Connecting Rod Bearing Bore Out-of-Round	0.004-0.008 mm	0.00015-0.0003 in
• Connecting Rod Bearing Clearance (Production)	0.023-0.065 mm	0.0009-0.0025 in
• Connecting Rod Bearing Clearance (Service Limit)	0.023-0.076 mm	0.0009-0.003 in
• Connecting Rod Side Clearance	0.11-0.51 mm	0.00433-0.02 in
Crankshaft		
• Crankshaft Bearing Clearance (Production)	0.020-0.052 mm	0.0008-0.0021 in
• Crankshaft Bearing Clearance (Service)	0.020-0.065 mm	0.0008-0.0025 in
• Crankshaft Connecting Rod Journal Diameter (Production)	53.318-53.338 mm	2.099-2.1 in
• Crankshaft Connecting Rod Journal Diameter	53.308 mm (Minimum)	2.0987 in (Minimum)

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2002 ENGINES 4.8L, 5.3L & 6.0L V8 - Sierra & Silverado

(Service Limit)		
• Crankshaft Connecting Rod Journal Taper (Production)	0.005 mm (Maximum for one half of the Journal Length)	0.0002 in (Maximum for one half of the Journal Length)
• Crankshaft Connecting Rod Journal Taper (Service Limit)	0.02 mm (Maximum)	0.00078 in (Maximum)
• Crankshaft Connecting Rod Journal Out-of-Round (Production)	0.005 mm	0.0002 in
• Crankshaft Connecting Rod Journal Out-of-Round (Service Limit)	0.01 mm	0.0004 in
• Crankshaft End Play	0.04-0.2 mm	0.0015-0.0078 in
• Crankshaft Main Journal Diameter (Production)	64.993-65.007 mm	2.558-2.5593 in
• Crankshaft Main Journal Diameter (Service Limit)	64.993 mm	2.558 in
• Crankshaft Main Journal Out-of-Round (Production)	0.003 mm	0.0001 in
• Crankshaft Main Journal Out-of-Round (Service Limit)	0.008 mm	0.0003 in
• Crankshaft Main Journal Taper (Production)	0.01 mm	0.0004 in
• Crankshaft Main Journal Taper (Service Limit)	0.02 mm	0.00078 in
• Crankshaft Reluctor Ring Runout (Measured 1.0 mm (0.04 in) Below the Tooth Diameter)	0.7 mm (Maximum)	0.028 in (Maximum)
• Crankshaft Runout (at Rear Flange)	0.05 mm (Maximum)	0.002 in (Maximum)
• Crankshaft Thrust Wall Runout	0.025 mm	0.001 in
• Crankshaft Thrust Wall Width (Production)	26.14-26.32 mm	1.029-1.0315 in
• Crankshaft Thrust Wall Width (Service)	26.2 mm (Maximum)	1.0315 in (Maximum)
Cylinder Bore		
• Cylinder Bore Diameter (Production)	96.0-96.018 mm	3.779-3.78 in
Cylinder Head		
• Cylinder Head Engine Block Deck Flatness (Measured within a 156 mm (6.1 in) area)	0.08 mm	0.003 in
• Cylinder Head Engine Block Deck Flatness (Measuring the Overall Length of the Cylinder Head)	0.1 mm	0.004 in
• Cylinder Head Exhaust Manifold Deck Flatness	0.13 mm	0.005 in
• Cylinder Head Height (Measured from the Head Deck to the Valve Rocker Arm Cover Seal Surface)	120.2 mm	4.732 in
• Cylinder Head Intake Manifold Deck Flatness	0.08 mm	0.003 in
Engine Block		

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2002 ENGINES 4.8L, 5.3L & 6.0L V8 - Sierra & Silverado

• Camshaft Bearing Bore 1 and 5 Diameter	59.12-59.17 mm	2.327-2.329 in
• Camshaft Bearing Bore 2 and 4 Diameter	58.87-58.92 mm	2.317-2.319 in
• Camshaft Bearing Bore 3 Diameter	58.62-58.67 mm	2.307-2.309 in
• Engine Block Cylinder Head Deck Surface Flatness (Measured within a 156 mm (6.1 in) area)	0.11 mm	0.004 in
• Engine Block Cylinder Head Deck Surface Flatness (Measuring the Overall Length of the Block Deck)	0.22 mm	0.008 in
• Engine Block Cylinder Head Deck Height (Measuring from the Centerline of Crankshaft to the Deck Face)	234.57-234.82 mm	9.235-9.245 in
• Main Bearing Bore Diameter (Production)	69.871-69.889 mm	2.750-2.751 in
• Main Bearing Bore Diameter Out-of-Round	0.006 mm	0.0002 in
• Valve Lifter Bore Diameter (Production)	21.417-21.443 mm	0.843-0.844 in
Intake Manifold		
• Intake Manifold Cylinder Head Deck Flatness (Measured within a 200 mm (7.87 in) Area that Includes Two Runner Port Openings)	0.3 mm	0.118 in
Oil Pan and Front/Rear Cover Alignment		
• Oil Pan to Rear of Engine Block Alignment (at Transmission Bellhousing Mounting Surface)	0.0-0.25 mm (Maximum)	0.0-0.01 in (Maximum)
• Front Cover Alignment (at Oil Pan Surface)	0.0-0.5 mm	0.0-0.02 in
• Rear Cover Alignment (at Oil Pan Surface)	0.0-0.5 mm	0.0-0.02 in
Piston		
• Piston - Piston Diameter - Measured Over Skirt Coating	96.002-96.036 mm	3.779-3.78 in
• Piston - Piston-to-Bore Clearance - Production	-0.036 to +0.016 mm	-0.0014 to +0.0006 in
• Piston - Piston-to-Bore Clearance - Service Limit with Skirt Coating Worn Off	0.07 mm	0.0028 in
Piston Pin		
• Piston Pin Clearance to Piston Bore (Production)	0.007-0.020 mm	0.00027-0.00078 in
• Piston Pin Clearance to Piston Bore (Service Limit)	0.007-0.021 mm (Maximum)	0.00027-0.00082 in (Maximum)
• Piston Pin Diameter	23.997-24.0 mm	0.9447-0.9448 in
• Piston Pin Fit in Connecting Rod	0.020-0.043 mm (Interference)	0.00078-0.00169 in (Interference)
Piston Rings		
• Piston Compression Ring End Gap (Production- Top) (Measured in Cylinder Bore)	0.23-0.44 mm	0.009-0.017 in

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2002 ENGINES 4.8L, 5.3L & 6.0L V8 - Sierra & Silverado

• Piston Compression Ring End Gap (Production-2nd) (Measured in Cylinder Bore)	0.44-0.70 mm	0.0173-0.0275 in
• Piston Oil Ring End Gap (Production) (Measured in Cylinder Bore)	0.18-0.75 mm	0.007-0.0295 in
• Piston Compression Ring End Gap (Service-Top) (Measured in Cylinder Bore)	0.23-0.50 mm (Maximum)	0.009-0.02 in (Maximum)
• Piston Compression Ring End Gap (Service-2nd) (Measured in Cylinder Bore)	0.44-0.76 mm (Maximum)	0.0173-0.03 in (Maximum)
• Piston Oil Ring End Gap-Service Limit (Measured in Cylinder Bore)	0.18-0.81 mm (Maximum)	0.007-0.032 in (Maximum)
• Piston Compression Ring Groove Clearance (Production-Top)	0.04-0.085 mm	0.00157-0.003346 in
• Piston Compression Ring Groove Clearance (Production-2nd)	0.04-0.078 mm	0.00157-0.0031 in
• Piston Oil Ring Groove Clearance (Production)	0.012-0.20 mm	0.0005-0.0078 in
• Piston Compression Ring Groove Clearance (Service-Top)	0.04-0.085 mm (Maximum)	0.00157-0.003346 in (Maximum)
• Piston Compression Ring Groove Clearance (Service-2nd)	0.04-0.078 mm (Maximum)	0.00157-0.0031 in (Maximum)
• Piston Oil Ring Groove Clearance (Service Limit)	0.012-0.20 mm (Maximum)	0.0005-0.0078 in (Maximum)
Valve System		
• Valve Face Angle	45 degrees	
• Valve Guide Installed Height (Measured from the Cylinder Head Spring Seat Surface to the Top of the Valve Guide)	17.32 mm	0.682 in
• Valve Lash	Net Lash - No Adjustment	
• Valve Lift (Exhaust)	11.85 mm	0.466 in
• Valve Lift (Intake)	11.6 mm	0.457 in
• Valve Lifter	Hydraulic Roller	
• Valve Margin	1.25 mm	0.05 in
• Valve Rocker Arm Ratio	1.70:1	
• Valve Seat Angle	46 degrees	
• Valve Seat Runout	0.05 mm (Maximum)	0.002 in (Maximum)
• Valve Seat Width (Exhaust)	1.78 mm	0.07 in
• Valve Seat Width (Intake)	1.02 mm	0.04 in
• Valve Spring Free Length	52.9 mm	2.08 in

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• Valve Spring Installed Height (Exhaust)	45.75 mm	1.8 in
• Valve Spring Installed Height (Intake)	45.75 mm	1.8 in
• Valve Spring Pressure (Closed)	340 N at 45.75 mm	76 lb at 1.8 in
• Valve Spring Pressure (Open)	980 N at 33.55 mm	220 lb at 1.32 in
• Valve Stem Clearance (Production-Exhaust)	0.025-0.066 mm	0.001-0.0026 in
• Valve Stem Clearance (Production-Intake)	0.025-0.066 mm	0.001-0.0026 in
• Valve Stem Clearance (Service-Exhaust)	0.093 mm (Maximum)	0.0037 in (Maximum)
• Valve Stem Clearance (Service-Intake)	0.093 mm (Maximum)	0.0037 in (Maximum)
• Valve Stem Diameter (Production)	7.955-7.976 mm	0.3132-0.314 in
• Valve Stem Diameter (Service)	7.95 mm (Minimum)	0.313 in (Minimum)
• Valve Stem Oil Seal Installed Height (Measured from the Valve Spring Shim to Top Edge of Seal Body - First Design Seal)	18.1-19.1 mm	0.712-0.752 in

ENGINE MECHANICAL SPECIFICATIONS (LQ4 VIN U/LQ9 VIN N)**Engine Mechanical Specifications (LQ4 VIN U/LQ9 VIN N)**

Application	Metric	English
General Data		
• Engine Type	V8	
• Displacement	6.0L	364 CID
• Bore	101.618-101.636 mm	4.0007-4.0014 in
• Stroke	92.0 mm	3.622 in
• Compression Ratio - LQ4 VIN U	9.40:1	
• Compression Ratio - LQ9 VIN N	10.0:1	
• Firing Order	1-8-7-2-6-5-4-3	
• Spark Plug Gap	1.524 mm	0.06 in
Lubrication System		
• Oil Capacity (without Oil Filter Change)	4.73 Liters	5.0 Quarts
• Oil Capacity (with Oil Filter Change)	5.68 Liters	6.0 Quarts
• Oil Pressure (Minimum-Hot)	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
• Oil Type	5W-30	

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2002 ENGINES 4.8L, 5.3L & 6.0L V8 - Sierra & Silverado

Camshaft

• Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
• Camshaft Journal Diameter	54.99-55.04 mm	2.164-2.166 in
• Camshaft Journal Diameter Out-of-Round	0.025 mm	0.001 in
• Camshaft Lobe Lift (Intake)	6.96 mm	0.274 in
• Camshaft Lobe Lift (Exhaust)	7.13 mm	0.281 in
• Camshaft Runout (Measured at the Intermediate Journals)	0.05 mm	0.002 in

Connecting Rod

• Connecting Rod Bearing Bore Diameter	56.505-56.525 mm	2.224-2.225 in
• Connecting Rod Bearing Bore Out-of-Round - LQ4	0.004-0.008 mm	0.00015-0.0003 in
• Connecting Rod Bearing Bore Out-of-Round - LQ9	0.006 mm	0.00023 in
• Connecting Rod Bearing Clearance (Production)	0.023-0.065 mm	0.0009-0.0025 in
• Connecting Rod Bearing Clearance (Service Limit)	0.023-0.076 mm	0.0009-0.003 in
• Connecting Rod Side Clearance	0.11-0.51 mm	0.00433-0.02 in

Crankshaft

• Crankshaft Bearing Clearance (Production)	0.020-0.052 mm	0.0008-0.0021 in
• Crankshaft Bearing Clearance (Service)	0.020-0.065 mm	0.0008-0.0025 in
• Crankshaft Connecting Rod Journal Diameter (Production)	53.318-53.338 mm	2.099-2.1 in
• Crankshaft Connecting Rod Journal Diameter (Service Limit)	53.308 mm (Minimum)	2.0987 in (Minimum)
• Crankshaft Connecting Rod Journal Taper (Production)	0.005 mm (Maximum for one half of the Journal Length)	0.0002 in (Maximum for one half of the Journal Length)
• Crankshaft Connecting Rod Journal Taper (Service Limit)	0.02 mm (Maximum)	0.00078 in (Maximum)
• Crankshaft Connecting Rod Journal Out-of-Round (Production)	0.005 mm	0.0002 in
• Crankshaft Connecting Rod Journal Out-of-Round (Service Limit)	0.01 mm	0.0004 in
• Crankshaft End Play	0.04-0.2 mm	0.0015-0.0078 in
• Crankshaft Main Journal Diameter (Production)	64.993-65.007 mm	2.558-2.5593 in
• Crankshaft Main Journal Diameter (Service Limit)	64.993 mm	2.558 in
• Crankshaft Main Journal Out-of-Round (Production)	0.003 mm	0.0001 in
• Crankshaft Main Journal Out of Round (Service Limit)	0.008 mm	0.0003 in

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• Crankshaft Main Journal Taper (Production)	0.01 mm	0.0004 in
• Crankshaft Main Journal Taper (Service Limit)	0.02 mm	0.00078 in
• Crankshaft Reluctor Ring Runout (Measured 1.0 mm (0.04 in) Below the Tooth Diameter)	0.7 mm (Maximum)	0.028 in (Maximum)
• Crankshaft Runout (at Rear Flange)	0.05 mm (Maximum)	0.02 in (Maximum)
• Crankshaft Thrust Wall Runout	0.025 mm	0.001 in
• Crankshaft Thrust Wall Width (Production)	26.14-26.22 mm	1.029-1.0315 in
• Crankshaft Thrust Wall Width (Service)	26.2 mm (Maximum)	1.0315 in (Maximum)
Cylinder Bore		
• Cylinder Bore Diameter (Production)	101.618-101.636 mm	4.0007-4.0014 in
Cylinder Head		
• Cylinder Head Engine Block Deck Flatness (Measured within a 156 mm (6.1 in) area)	0.08 mm	0.003 in
• Cylinder Head Engine Block Deck Flatness (Measuring the Overall Length of the Cylinder Head)	0.1 mm	0.004 in
• Cylinder Head Exhaust Manifold Deck Flatness	0.13 mm	0.005 in
• Cylinder Head Height (Measured from the Head Deck to the Valve Rocker Arm Cover Seal Surface)	120.2 mm (Minimum)	4.732 in (Minimum)
• Cylinder Head Intake Manifold Deck Flatness	0.08 mm	0.003 in
Engine Block		
• Camshaft Bearing Bore 1 and 5 Diameter	59.12-59.17 mm	2.327-2.329 in
• Camshaft Bearing Bore 2 and 4 Diameter	58.87-58.92 mm	2.317-2.319 in
• Camshaft Bearing Bore 3 Diameter	58.62-58.67 mm	2.307-2.309 in
• Engine Block Cylinder Head Deck Surface Flatness (Measured within a 156 mm (6.1 in) area)	0.11 mm	0.004 in
• Engine Block Cylinder Head Deck Surface Flatness (Measuring the Overall Length of the Block Deck)	0.22 mm	0.008 in
• Engine Block Cylinder Head Deck Height (Measuring from the Centerline of Crankshaft to the Head Deck)	234.57-234.82 mm	9.235-9.245 in
• Main Bearing Bore Diameter (Production)	69.871-69.889 mm	2.750-2.751 in
• Main Bearing Bore Diameter Out-of-Round	0.006 mm	0.0002 in
• Valve Lifter Bore Diameter (Production)	21.417-21.443 mm	0.843-0.844 in
Intake Manifold		
• Intake Manifold Cylinder Head Deck Flatness (Measured within a 200 mm Area that Includes Two	0.3 mm	0.118 in

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Runner Port Openings)		
Oil Pan and Front/Rear Cover Alignment		
• Oil Pan to Rear of Engine Block Alignment (at Transmission Bellhousing Mounting Surface)	0.0-0.25 mm (Maximum)	0.0-0.01 in (Maximum)
• Front Cover Alignment (at Oil Pan Surface)	0.0-0.5 mm	0.0-0.02 in
• Rear Cover Alignment (at Oil Pan Surface)	0.0-0.5 mm	0.0-0.02 in
Piston		
• Piston - Piston Diameter - LQ4 Measured Over Skirt Coating	101.606-101.640 mm	4.0002-4.0016 in
• Piston - Piston Diameter - LQ9 Measured Over Skirt Coating	101.611-101.642 mm	4.0-4.001 in
• Piston - Piston-to-Bore Clearance - LQ4 Production	-0.022 to +0.03 mm	-0.0009 to +0.0012 in
• Piston - Piston-to-Bore Clearance - LQ9 Production	-0.022 to +0.030 mm	-0.009 to +0.0012 in
• Piston - Piston-to-Bore Clearance - LQ4 Service Limit with Skirt Coating Worn Off	0.07 mm	0.0028 in
• Piston - Piston-to-Bore Clearance - LQ9 Service Limit with Skirt Coating Worn Off	0.08 mm	0.0031 in
Piston Pin		
• Piston Pin Diameter - Press Fit Pin	23.997-24.0 mm	0.9447-0.9448 in
• Piston Pin Diameter - Full-Floating Pin	23.952-23.955 mm	0.943-0.943 in
• Piston Pin Fit in Connecting Rod - Press Fit Pin	0.020-0.043 mm (Interference)	0.00078-0.00169 in (Interference)
• Piston Pin Fit in Connecting Rod - Full-Floating Pin Production	0.007-0.020 mm	0.00027-0.00078 in
• Piston Pin Fit in Connecting Rod - Full-Floating Pin Service Limit	0.007-0.022 mm	0.00027-0.00086 in
• Piston Pin to Piston Bore Clearance - LQ4 Production	0.007-0.020 mm	0.00027-0.00078 in
• Piston Pin to Piston Bore Clearance - LQ4 Service Limit	0.007-0.021 mm	0.00027-0.00082 in
• Piston Pin to Piston Bore Clearance - LQ9 Production Measured at Pin End	0.002-0.010 mm	0.00008-0.0004 in
• Piston Pin to Piston Bore Clearance - LQ9 Service Limit Measured at Pin End	0.002-0.015 mm	0.00008-0.0006 in
Piston Rings		
• Piston Compression Ring End Gap - LQ4 Production - Top Measured in Cylinder Bore	0.31-0.52 mm	0.0122-0.02 in
• Piston Compression Ring End Gap - LQ4 Production - 2nd Measured in Cylinder Bore	0.51-0.77 mm	0.02-0.03 in

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• Piston Oil Ring End Gap - LQ4 Production Measured in Cylinder Bore	0.31-0.87 mm	0.0122-0.034 in
• Piston Compression Ring End Gap - LQ4 Service - Top Measured in Cylinder Bore	0.31-0.59 mm	0.0122-0.023 in
• Piston Compression Ring End Gap - LQ4 Service - 2nd Measured in Cylinder Bore	0.51-0.84 mm	0.02-0.033 in
• Piston Oil Ring End Gap - LQ4 Service Measured in Cylinder Bore	0.31-0.94 mm	0.0122-0.037 in
• Piston Compression Ring End Gap - LQ9 Production - Top Measured in Cylinder Bore	0.31-0.52 mm	0.0122-0.020 in
• Piston Compression Ring End Gap - LQ9 Production - 2nd Measured in Cylinder Bore	0.51-0.77 mm	0.020-0.030 in
• Piston Oil Ring End Gap - LQ9 Production Measured in Cylinder Bore	0.31-0.87 mm	0.0122-0.034 in
• Piston Compression Ring End Gap - LQ9 Service - Top Measured in Cylinder Bore	0.31-0.59 mm	0.0122-0.023 in
• Piston Compression Ring End Gap - LQ9 Service - 2nd Measured in Cylinder Bore	0.51-0.84 mm	0.020-0.033 in
• Piston Oil Ring End Gap - LQ9 Service Measured in Cylinder Bore	0.31-0.94 mm	0.0122-0.037 in
• Piston Compression Ring Groove Clearance - LQ4 Production - Top	0.04-0.08 mm	0.00157-0.0031 in
• Piston Compression Ring Groove Clearance - LQ4 Production - 2nd	0.039-0.079 mm	0.0015-0.0031 in
• Piston Oil Ring Groove Clearance - LQ4 Production	0.015-0.2 mm	0.0006-0.0079 in
• Piston Compression Ring Groove Clearance - LQ4 Service - Top	0.04-0.08 mm	0.00157-0.0031 in
• Piston Compression Ring Groove Clearance - LQ4 Service - 2nd	0.039-0.079 mm	0.0015-0.0031 in
• Piston Oil Ring Groove Clearance - LQ4 Service	0.015-0.2 mm	0.0006-0.0079 in
• Piston Compression Ring Groove Clearance - LQ9 Production - Top	0.035-0.080 mm	0.0014-0.0031 in
• Piston Compression Ring Groove Clearance - LQ9 Production - 2nd	0.034-0.079 mm	0.0013-0.0030 in
• Piston Oil Ring Groove Clearance - LQ9 Production	0.012-0.20 mm	0.00047-0.00078 in
• Piston Compression Ring Groove Clearance - LQ9 Service - Top	0.035-0.080 mm	0.0014-0.0031 in
• Piston Compression Ring Groove Clearance - LQ9 Service - 2nd	0.034-0.079 mm	0.0013-0.0030 in

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• Piston Oil Ring Groove Clearance - LQ9 Service	0.012-0.20 mm	0.00047-0.0078 in
Valve System		
• Valve Face Angle	45 degrees	
• Valve Lash	Net Lash-No Adjustment	
• Valve Lift (Exhaust)	12.16 mm	0.479 in
• Valve Lift (Intake)	11.79 mm	0.464 in
• Valve Lifter	Hydraulic Roller	
• Valve Margin	1.25 mm	0.05 in
• Valve Rocker Arm Ratio	1.70:1	
• Valve Seat Angle	46 degrees	
• Valve Seat Runout	0.05 mm (Maximum)	0.002 in (Maximum)
• Valve Seat Width (Exhaust)	1.78 mm	0.07 in
• Valve Seat Width (Intake)	1.02 mm	0.04 in
• Valve Spring Free Length	52.9 mm	2.08 in
• Valve Spring Installed Height (Exhaust)	45.75 mm	1.8 in
• Valve Spring Installed Height (Intake)	45.75 mm	1.8 in
• Valve Spring Pressure (Closed)	340 N at 45.75 mm	76 lb at 1.8 in
• Valve Spring Pressure (Open)	980 N at 33.55 mm	220 lb at 1.32 in
• Valve Stem Clearance (Production-Exhaust)	0.025-0.066 mm	0.001-0.0026 in
• Valve Stem Clearance (Production-Intake)	0.025-0.066 mm	0.001-0.0026 in
• Valve Stem Clearance (Service-Exhaust)	0.093 mm (Maximum)	0.0037 in (Maximum)
• Valve Stem Clearance (Service-Intake)	0.093 mm (Maximum)	0.0037 in (Maximum)
• Valve Stem Diameter (Production-Exhaust)	7.955-7.976 mm	0.3132-0.314 in
• Valve Stem Diameter (Production-Intake)	7.955-7.976 mm	0.3132-0.314 in
• Valve Stem Diameter (Service-Exhaust)	7.95 mm (Minimum)	0.313 in (Minimum)
• Valve Stem Diameter (Service-Intake)	7.95 mm (Minimum)	0.313 in (Minimum)
• Valve Stem Oil Seal Installed Height (Measured from the Valve Spring Seat to Top Edge of Seal Body - First Design Seal)	18.1-19.1 mm	0.712-0.752 in

SEALERS, ADHESIVES, AND LUBRICANTS**Sealers, Adhesives, and Lubricants**

Application	Type of Material	GM Part Number
United States	Canada	

2002 GMC Sierra 1500

2002 ENGINES 4.8L, 5.3L & 6.0L V8 - Sierra & Silverado

Engine Flywheel Bolt Threads	Threadlock	12345382	10953489
Ignition Coil Bracket Bolts	Threadlock	12345382	10953489
Intake Manifold Bolt Threads	Threadlock	12345382	10953489
Oil Pan Surface at Front and Rear Covers	Sealant	12378190	-
Oil Pressure Sensor Threads	Sealant	12346004	1093480
Spray Cleaner	Cleaner	12346139	10953463
Spray Cleaner	Cleaner	12377981	10953463

TORQUE SPECIFICATIONS**TORQUE SPECIFICATIONS**

Application	Ft. Lbs (N.m)
Accessory Drive Belt Tensioner Bolt	37 (50)
Air Conditioning Belt Tensioner Bolt	37 (50)
Automatic Transmission Oil Level Indicator Tube Nut	13 (18)
Camshaft Retainer Bolt	18 (25)
Camshaft Sensor Bolt	18 (25)
Camshaft Sprocket Bolt	26 (35)
Clutch Pressure Plate Bolt	52 (70)
Crankshaft Balancer Bolt	
Installation Tightening Pass (Ensure Balancer Is Completely Installed)	240 (330)
First Tightening Pass (Install NEW Bolt After Installation Pass & Tighten As Described In First & Final Passes)	37 (50)
Final Tightening Pass	140 Degrees
Crankshaft Oil Deflector Nut	18 (25)
Crossbar Bolt	74 (100)
Cylinder Head Bolt ⁽¹⁾	
First Tightening Pass (All M11 Bolts)	22 (30)
Second Tightening Pass (All M11 Bolts)	90 Degrees
Final Tightening Pass (All M11 Bolts-Excluding Medium Length Bolts At Front & Rear Of Each Cylinder Head)	90 Degrees
Final Tightening Pass (M11 Medium Length Bolts At Front & Rear Of Each Cylinder Head)	50 Degrees
M8 Inner Bolts	22 (30)
Drive Belt Idler Pulley Bolt	37 (50)
Engine Flywheel Bolt ⁽²⁾	
First Tightening Pass	13 (20)

2002 GMC Sierra 1500

2002 ENGINES 4.8L, 5.3L & 6.0L V8 - Sierra & Silverado

Second Tightening Pass	37 (50)
Final Tightening Pass	74 (100)
Engine Front Cover Bolt	18 (25)
Engine Mount Bolt	37 (50)
Engine Mount Bracket Bolt	55 (75)
Engine Mount-To-Engine Mount Bracket Bolt	37 (50)
Engine Rear Cover Bolt	18 (25)
Engine Service Lift Bracket	
M10 Bolt	37 (50)
M8 Bolt	18 (25)
Engine Shield Bolt	15 (20)
Engine Valley Cover Bolt	18 (25)
EGR Valve Pipe-To-Cylinder Head Bolt	37 (50)
EGR Valve Pipe-To-Exhaust Manifold Bolt	22 (30)
Generator Bracket Bolt	37 (50)
Harness Ground Bolt	18 (25)
Harness Ground-At-Rear of Block Bolt	12 (16)
Hood Hinge Bolt	18 (25)
Knock Sensor	15 (20)
Oil Filter	22 (30)
Oil Filter Adapter	40 (50)
Oil Level Indicator Tube Bolt	18 (25)
Oil Pan Drain Plug	18 (25)
Oil Pan Bolt	18 (25)
Oil Pan-To-Front Cover Fastener	18 (25)
Oil Pan Skid Plate Bolt	15 (20)
Oil Pressure Sensor	15 (20)
Oil Pump Bolt	18 (25)
Oil Pump Screen Nut	18 (25)
Power Steering Pump Rear Bolt	37 (50)
Spark Plug	11 (15)
Torque Converter Bolt	
4L60-E Transmission	47 (63)
4L80-E Transmission	44 (60)
Transmission Bolt/Stud	37 (50)
Valve Rocker Arm Bolt	22 (30)
INCH Lbs. (N.m)	
Accelerator Control Cable Bracket Bolt	89 (10)
Battery Cable Channel Bolt	106 (12)
Engine Wiring Harness Bracket Nut	44 (5)
EGR Valve Pipe-To-Intake Manifold Bolt	89 (10)
Evaporative Emission Purge Solenoid Bolt	

2002 GMC Sierra 1500

2002 ENGINES 4.8L, 5.3L & 6.0L V8 - Sierra & Silverado

	89 (10)
Fuel Rail Cover Bolt	80 (9)
Generator Output Terminal Nut	80 (9)
Ignition Coil Bracket Stud	106 (12)
Intake Manifold Bolt ⁽³⁾	
First Tightening Pass	44 (5)
Final Tightening Pass	89 (10)
Intake Manifold Sight Shield Bolt	
6.0L Engine With RPO's Y91 & Z88	80 (9)
4.8L, 5.3L & RPO LQ4-6.0L Engines	89 (10)
Intake Manifold Sight Shield Retainer Bolt	44 (5)
Oil Level Sensor	115 (13)
Oil Pan-To-Rear Cover Fastener	106 (12)
Oil Pump Screen Bolt	106 (12)
Positive Battery Cable Clip Bolt	80 (9)
Transmission Cover Bolt	106 (12)
Valve Lifter Guide Bolt	106 (12)
Valve Rocker Arm Cover Bolt	106 (12)

(1) Tighten bolts following sequence as shown. See **Fig. 339**.

(2) Tighten bolts following sequence as shown. See **Fig. 340**.

(3) Tighten bolts following sequence as shown. See **Fig. 341**.

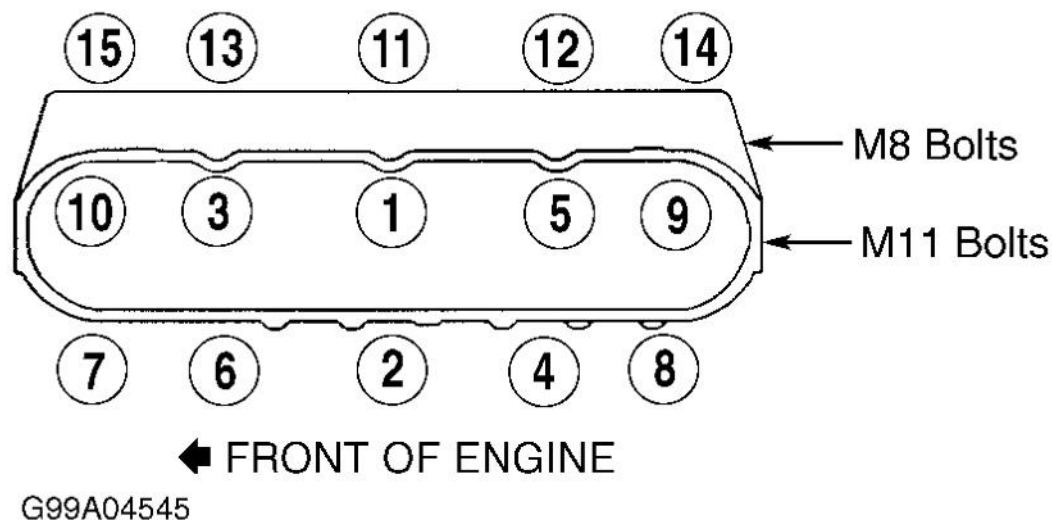


Fig. 339: Identifying Cylinder Head Bolt Tightening Sequence

Courtesy of GENERAL MOTORS CORP.

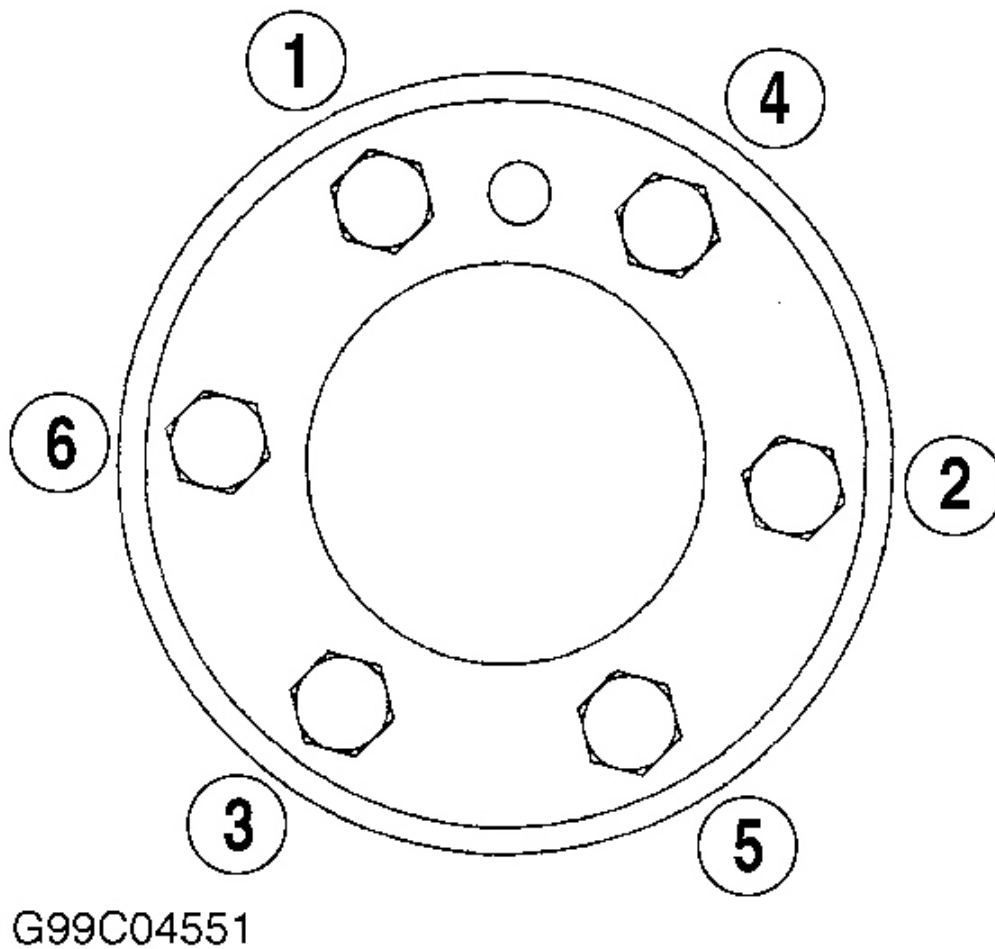
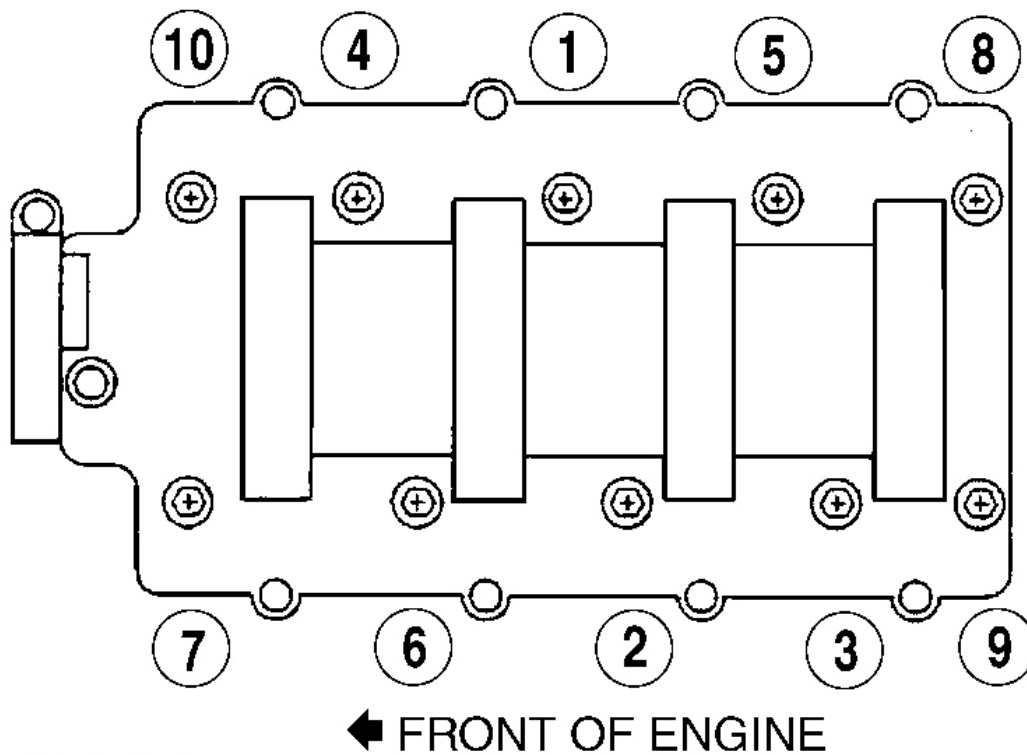


Fig. 340: Identifying Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.



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Fig. 341: Identifying Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.