

2013 Engine

Engine Mechanical - 6.6L (LML) - Repair Instructions - On Vehicle - Sierra, Silverado

REPAIR INSTRUCTIONS - ON VEHICLE

DRIVE BELT REPLACEMENT

Removal Procedure

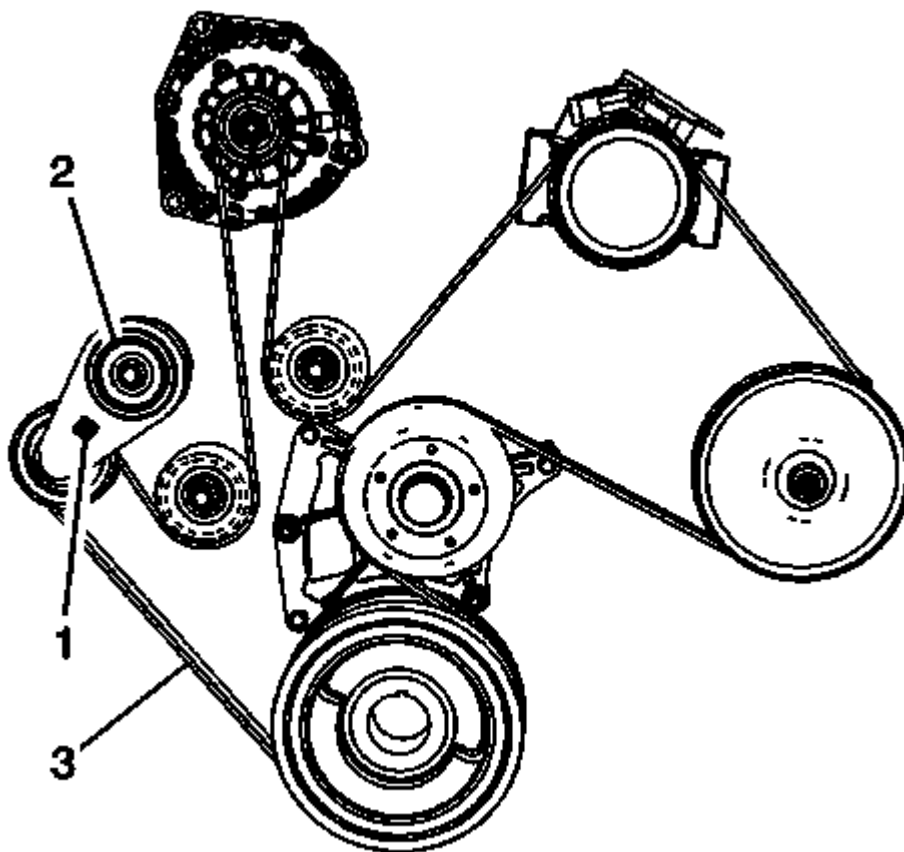


Fig. 1: Identifying Drive Belt Routing
Courtesy of GENERAL MOTORS COMPANY

1. Remove fan clutch. Refer to **Fan Clutch Replacement (Diesel)** .
2. Install a 1/2 inch breaker bar into the tensioner opening (1) and rotate the tensioner counterclockwise.
3. Remove the belt from the tensioner.
4. Slowly release the tension on the tensioner arm.
5. Remove the drive belt from the drive pulleys , if equipped with a single generator.

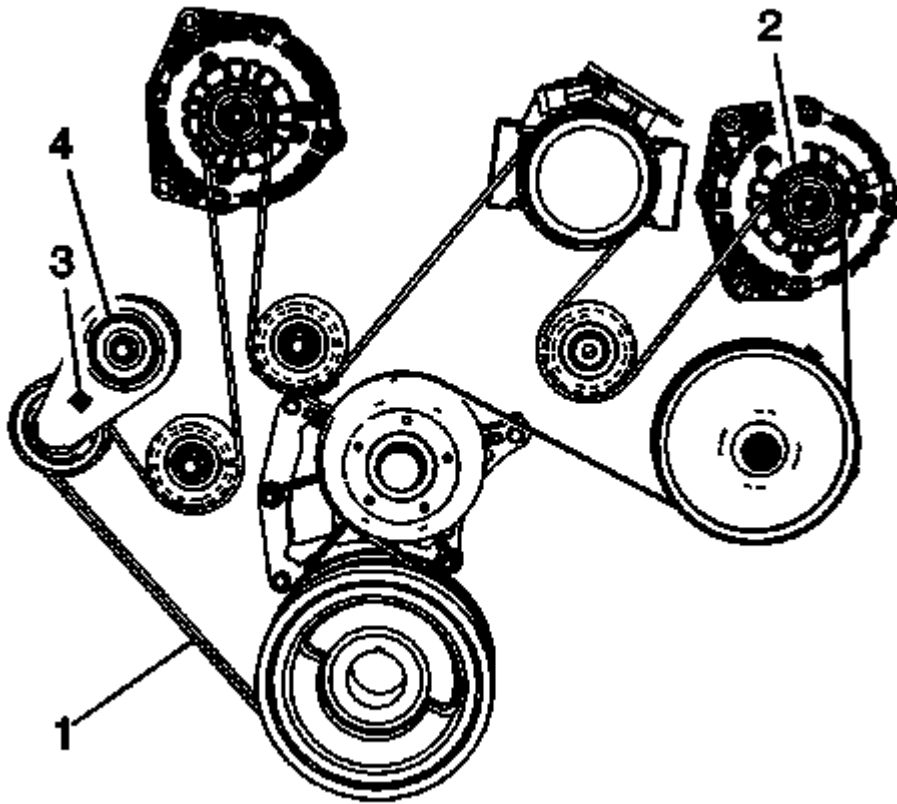


Fig. 2: Identifying Drive Belt Routing (With Dual Generators)
Courtesy of GENERAL MOTORS COMPANY

6. Remove the drive belt (1) from the drive pulleys, if equipped with dual generators.
7. Inspect the drive belt for excessive cracking or any visible damage and replace if necessary.

Installation Procedure

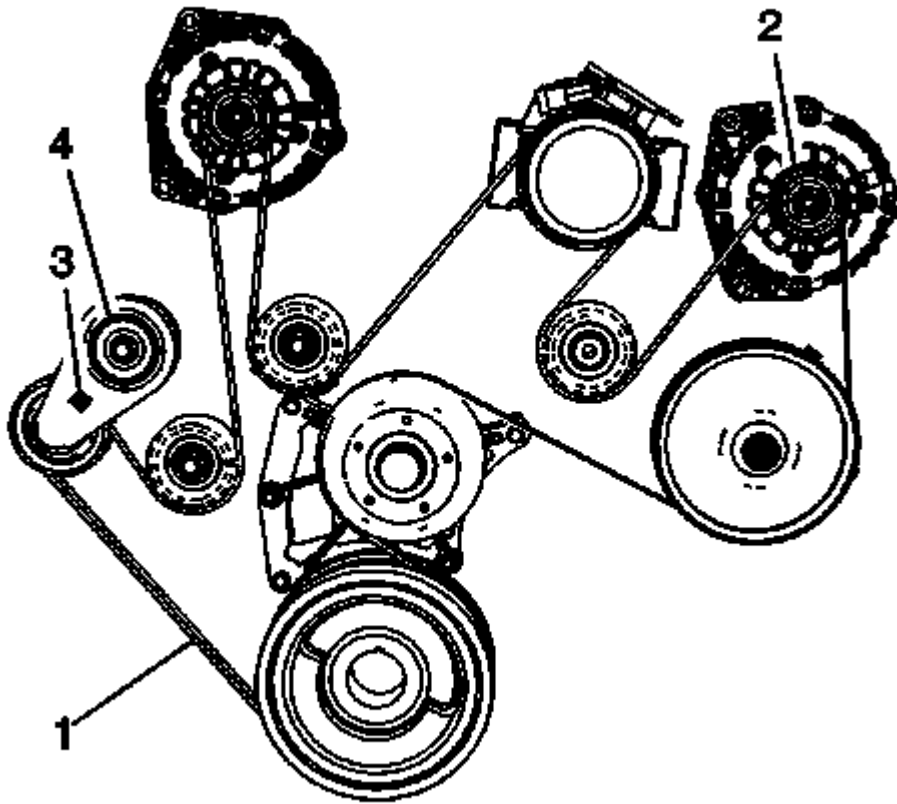


Fig. 3: Identifying Drive Belt Routing (With Dual Generators)
Courtesy of GENERAL MOTORS COMPANY

1. Install a 1/2 inch breaker bar into the tensioner opening (3) and rotate the tensioner counterclockwise.
2. Install the drive belt (1), if equipped with dual generators.
3. Route the drive belt over and/or around all the drive pulleys except for the tensioner.

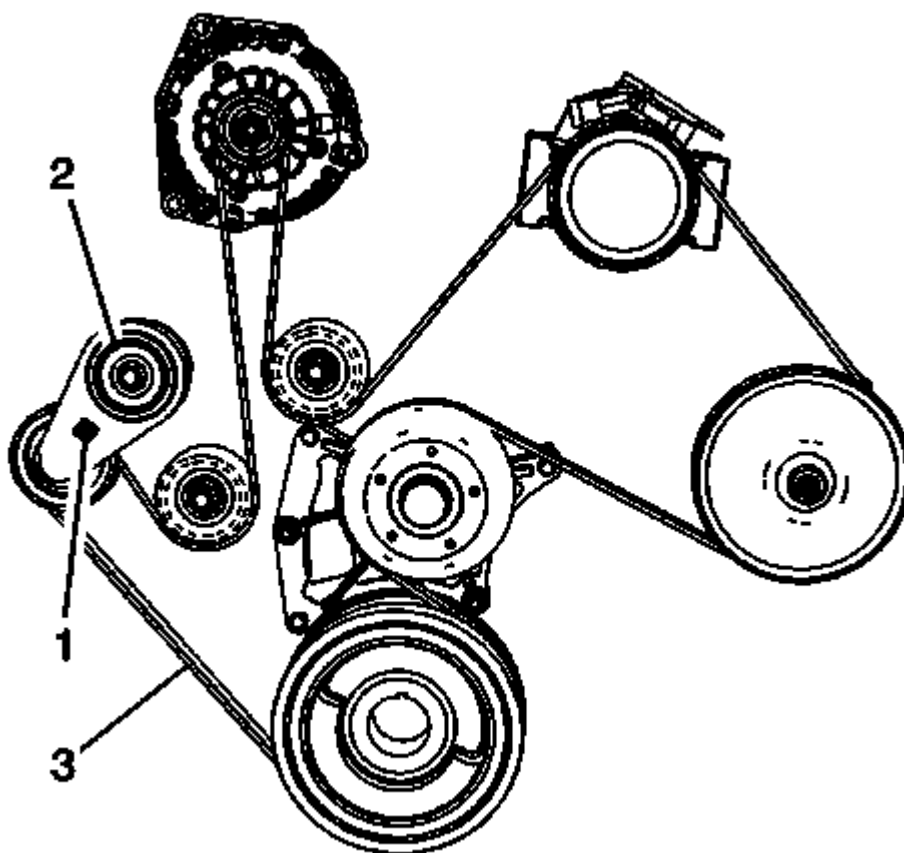


Fig. 4: Identifying Drive Belt Routing
Courtesy of GENERAL MOTORS COMPANY

4. Install the drive belt (3), if equipped with a single generator.
5. Route the drive belt over and/or around all the drive pulleys except for the tensioner.
6. Install the belt over and/or around the tensioner.
7. Slowly release the tension on the tensioner arm (1).
8. Inspect the drive belt for proper installation on and/or around all pulleys.
9. Install fan clutch. Refer to **Fan Clutch Replacement (Diesel)** .

DRIVE BELT TENSIONER REPLACEMENT

Removal Procedure

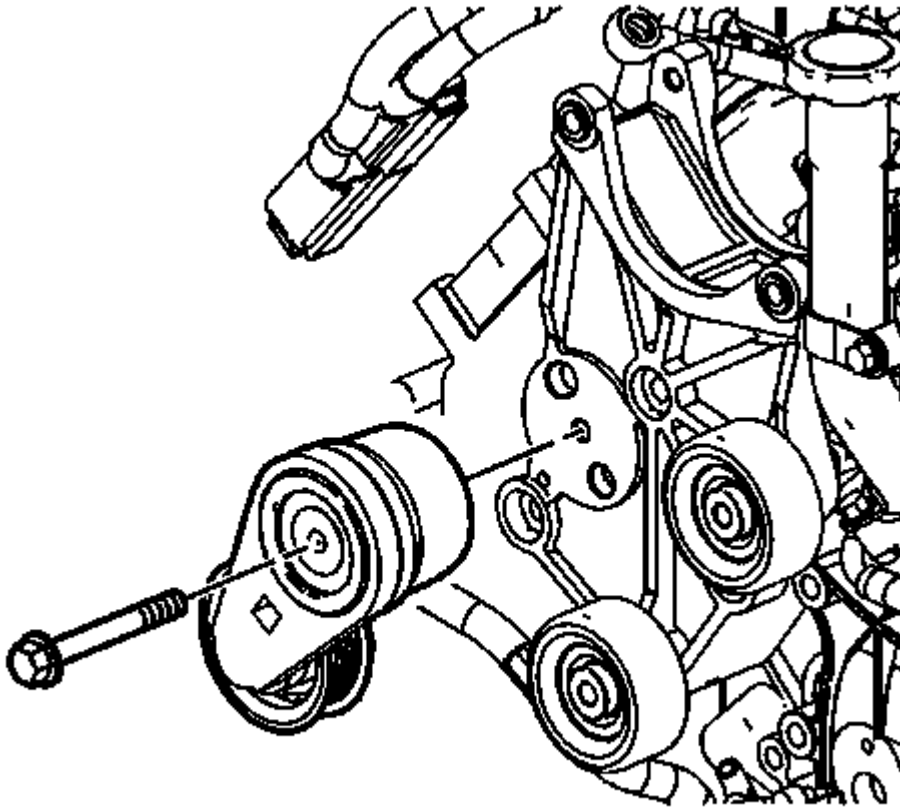


Fig. 5: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Remove the drive belt tensioner bolt.
3. Remove the drive belt tensioner.

Installation Procedure

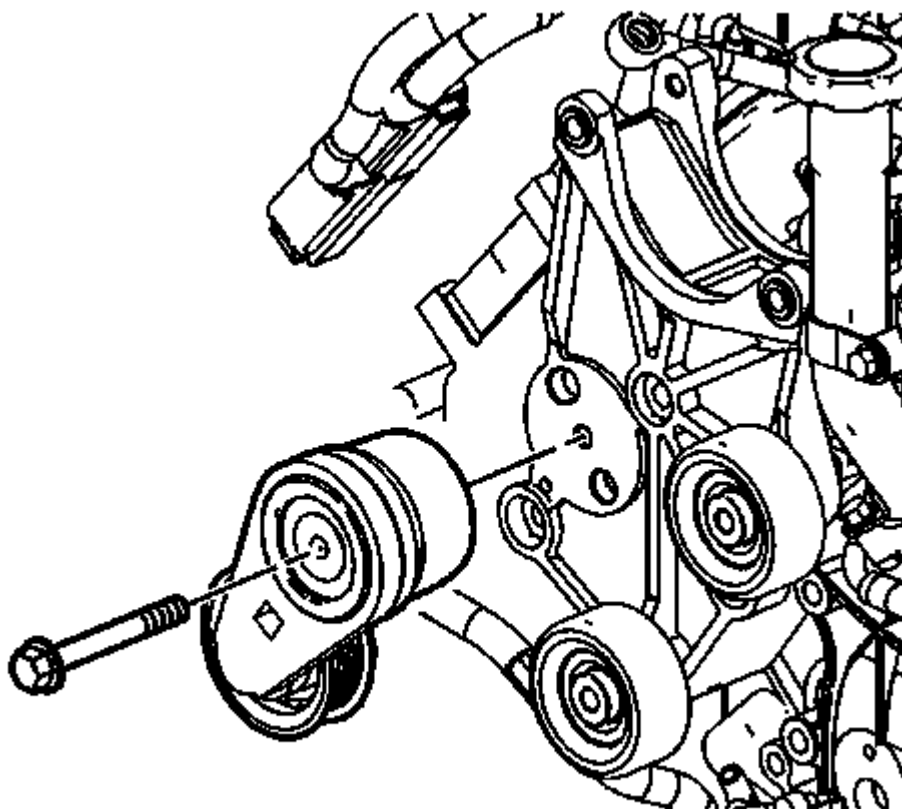


Fig. 6: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Install the drive belt tensioner. Align the pin with the hole in the generator bracket.

CAUTION: Refer to Fastener Caution .

2. Install the drive belt tensioner bolt and tighten to 50 N.m (37 lb ft).
3. Install the drive belt. Refer to **Drive Belt Replacement**.

DRIVE BELT IDLER PULLEY REPLACEMENT

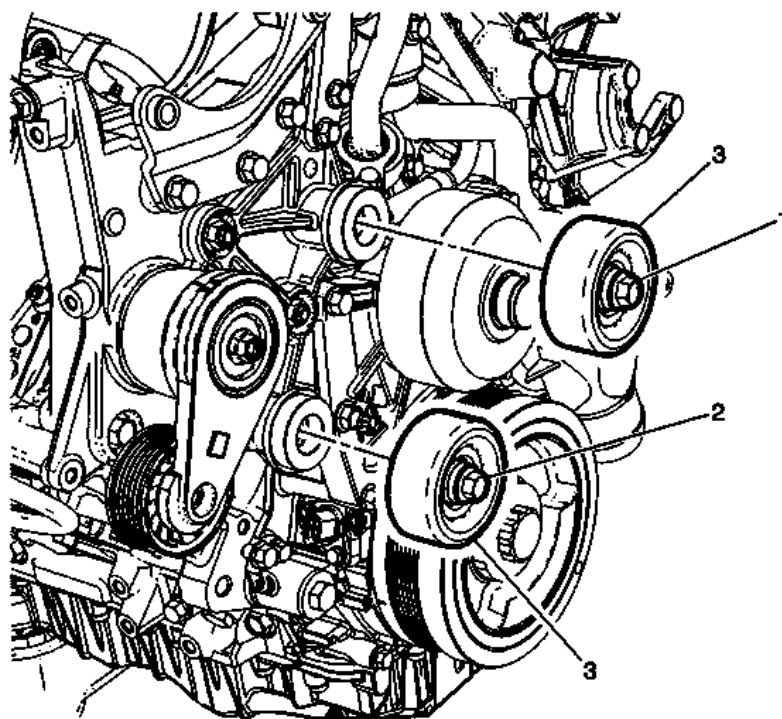
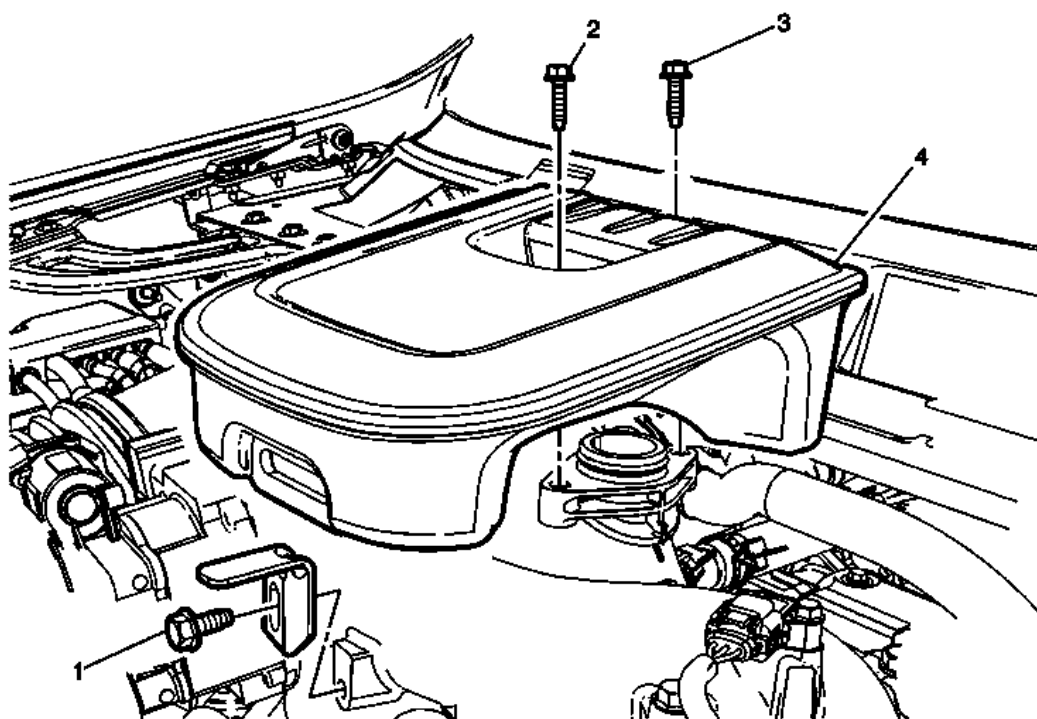


Fig. 7: View Of Drive Belt Idler Pulley
 Courtesy of GENERAL MOTORS COMPANY

Drive Belt Idler Pulley Replacement

Callout	Component Name
Preliminary Procedure Remove the drive belt. Refer to <u>Drive Belt Replacement</u> .	
1	Drive Belt Idler Upper Pulley Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 50 N.m (37 lb ft)
2	Drive Belt Idler Lower Pulley Fastener Tighten 50 N.m (37 lb ft)
3	Drive Belt Idler Pulley Procedure Transfer components as necessary.

INTAKE MANIFOLD COVER REPLACEMENT

**Fig. 8: Intake Manifold Cover And Bolts**

Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Cover Replacement

Callout	Component Name
1	Upper Intake Manifold Cover Bracket Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 8 N.m (71 lb in)
2	Upper Intake Manifold Cover Bolt Tighten 6 N.m (53 lb in)
3	Upper Intake Manifold Cover Bolt Tighten 6 N.m (53 lb in)
4	Upper Intake Manifold Cover Procedure Install a NEW upper intake manifold cover seal.

ENGINE MOUNT INSPECTION

CAUTION: 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.

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 rest position, in either direction, check for loose, or missing engine mount bolts in the following locations:
 - Engine mount to engine
 - Engine mount bracket to frame
 - Engine mount to engine mount bracket
2. If a engine mount bolt is missing, replace the bolt.
3. If the engine mount bolt torque is within specifications, check the condition of the engine mount.
4. 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 SIDE

Removal Procedure

1. If RWD vehicle, raise the vehicle to a height to work through the front wheelhouse opening. Refer to **Lifting and Jacking the Vehicle** .
2. If 4-wheel drive (4WD) vehicle, raise the vehicle in order to remove the front tires and wheels and support with jackstands.
3. Remove the wheelhouse inner panel. Refer to **Front Wheelhouse Liner Replacement - Left Side (GMC)** , **Front Wheelhouse Liner Replacement - Left Side (Chevrolet)** .

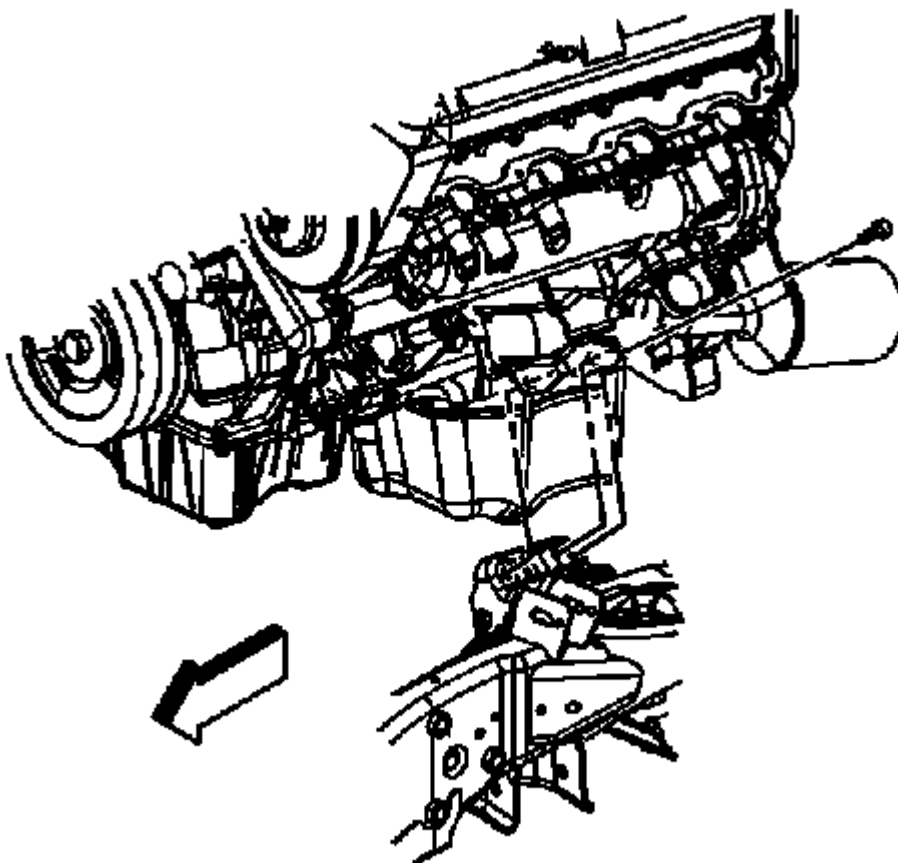


Fig. 9: View Of Engine Mount To Engine Mount Frame Bracket
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Broken engine mountings can cause misalignment of certain drive-train components. Misalignment of drive-train components causes eventual destruction of the drive-train components.

If one engine mount breaks, the rest of the engine mounts will have increased stress put on them. This could cause the rest of the engine mounts to break.

4. Working through the wheelhouse opening remove the 3 bolts retaining the engine mount to the frame.

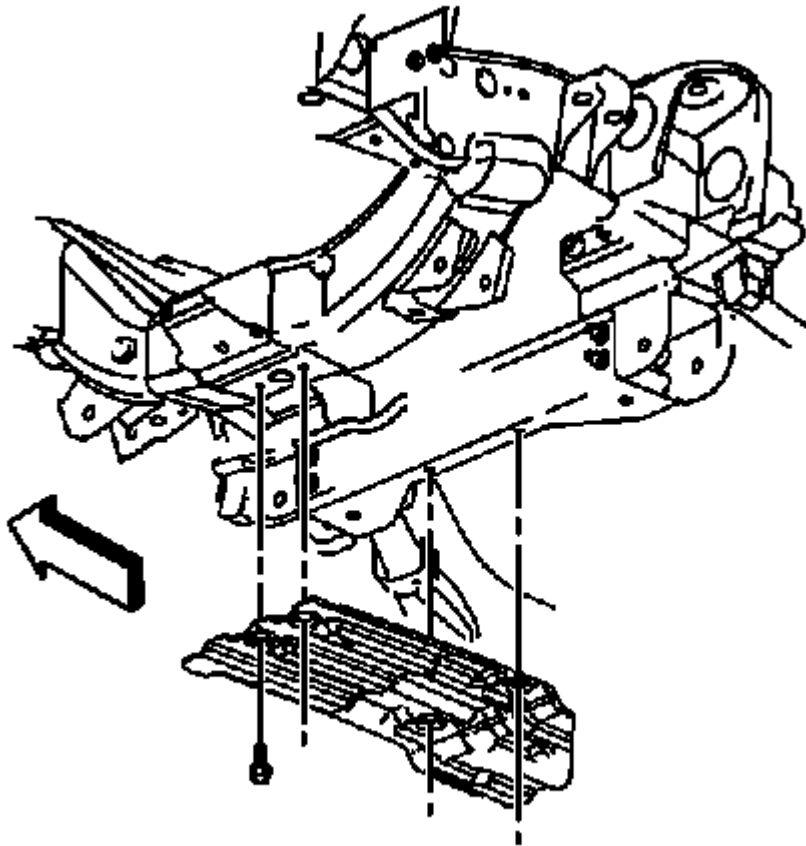


Fig. 10: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS COMPANY

5. Remove the oil pan skid plate, if equipped.

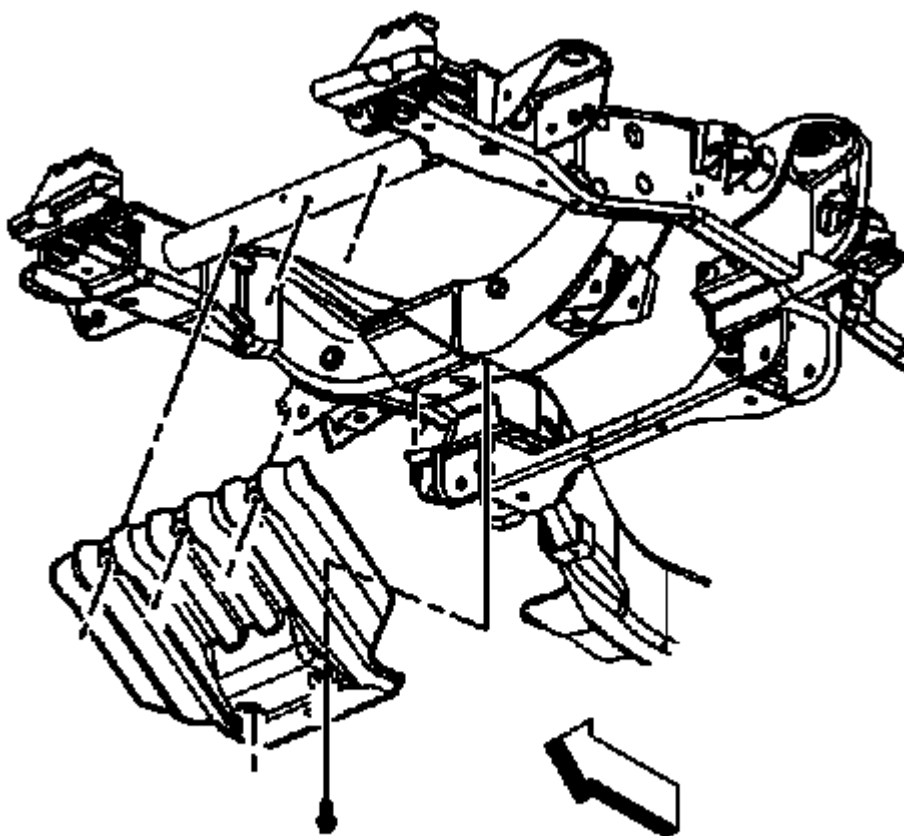


Fig. 11: Identifying Engine Shield And Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine protection shield from the vehicle, if equipped.

CAUTION: 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. Lifting the engine in an unapproved manner may cause component damage.

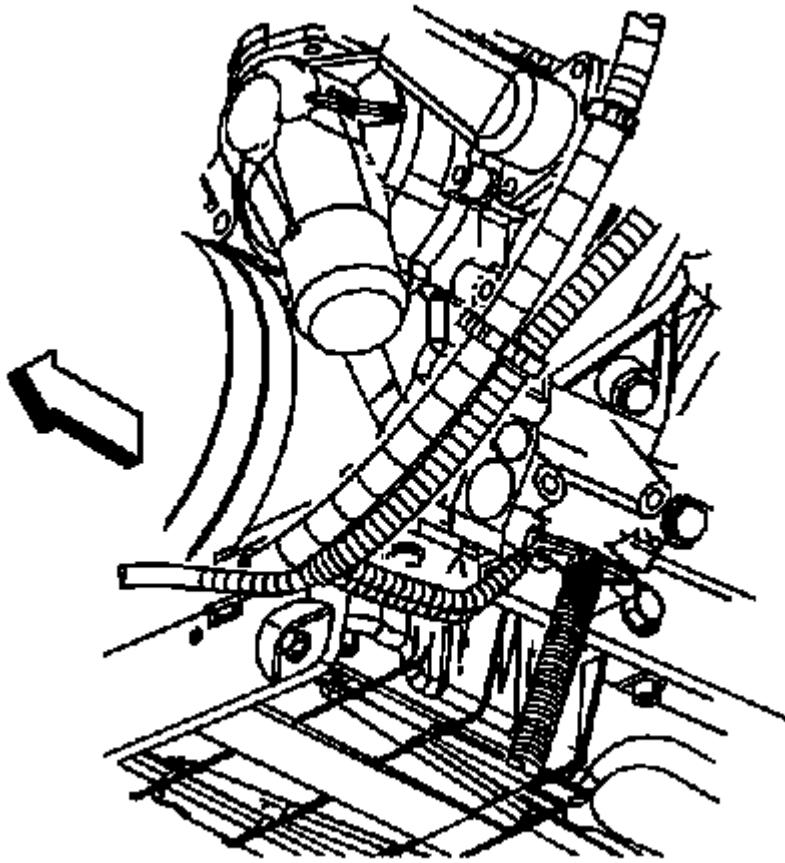


Fig. 12: View Of Ground Wire Bolt Bosses (Left Side)
Courtesy of GENERAL MOTORS COMPANY

NOTE: When raising the engine only raise enough to separate the engine mount from the engine mount bracket. Raising any further will require removal of the fan shroud or the exhaust pipe .

7. If RWD vehicle, using a suitable jack on the ground wire bolt bosses, raise the engine.

Only raise the engine enough to separate the engine mount to engine mount bracket.

8. If 4WD vehicle, attach a chain to the front of the engine. Use accessible mounting bolts for the generator mounting bracket and the power steering pump mounting bracket.
9. Raise the engine with a suitable lifting device to remove the engine mount.

Only raise the engine enough to separate the engine mount to engine mount bracket.

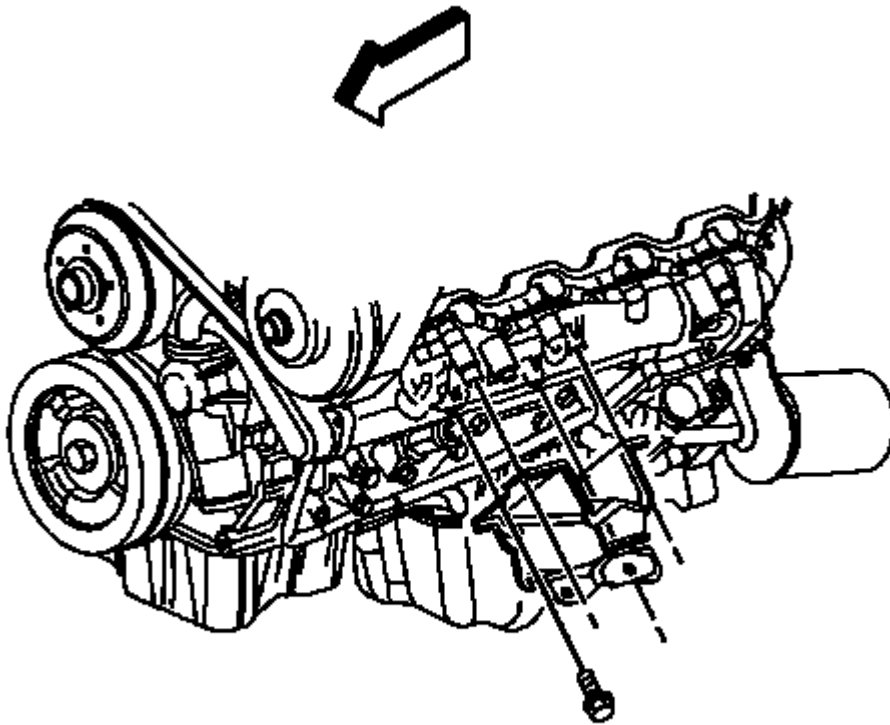


Fig. 13: Identifying Engine Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove the bolts holding the engine mount to the engine.
11. Remove the engine mount.

Installation Procedure

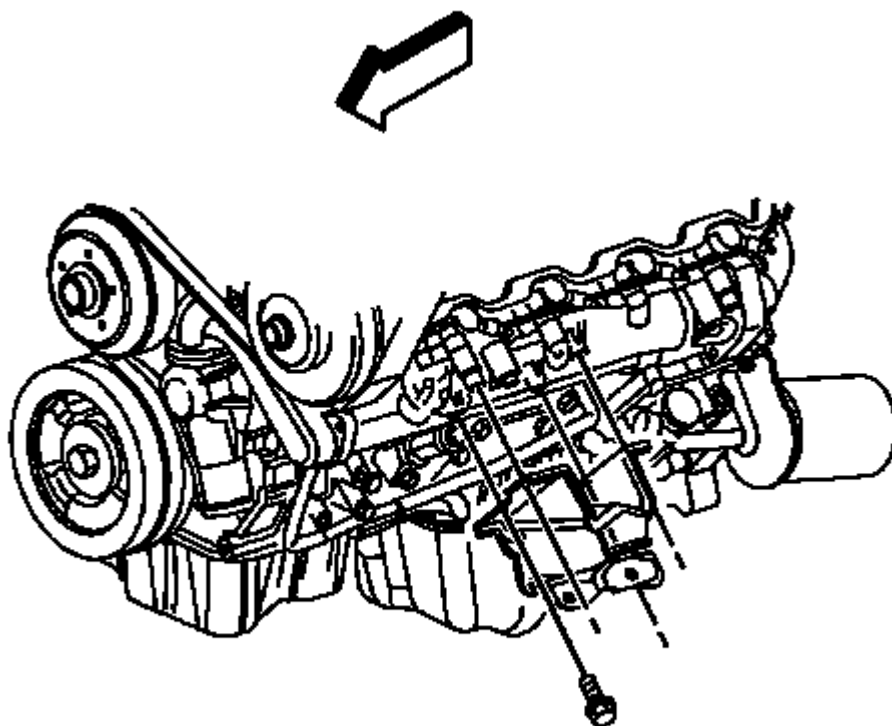


Fig. 14: Identifying Engine Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

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

Tighten

Tighten the engine mount bolts to 58 N.m (43 lb ft).

3. Lower the engine.
4. If 4WD vehicle remove the chain from the front of the engine.
5. If 4WD vehicle, install the generator mounting bracket and the power steering mount bracket bolt.

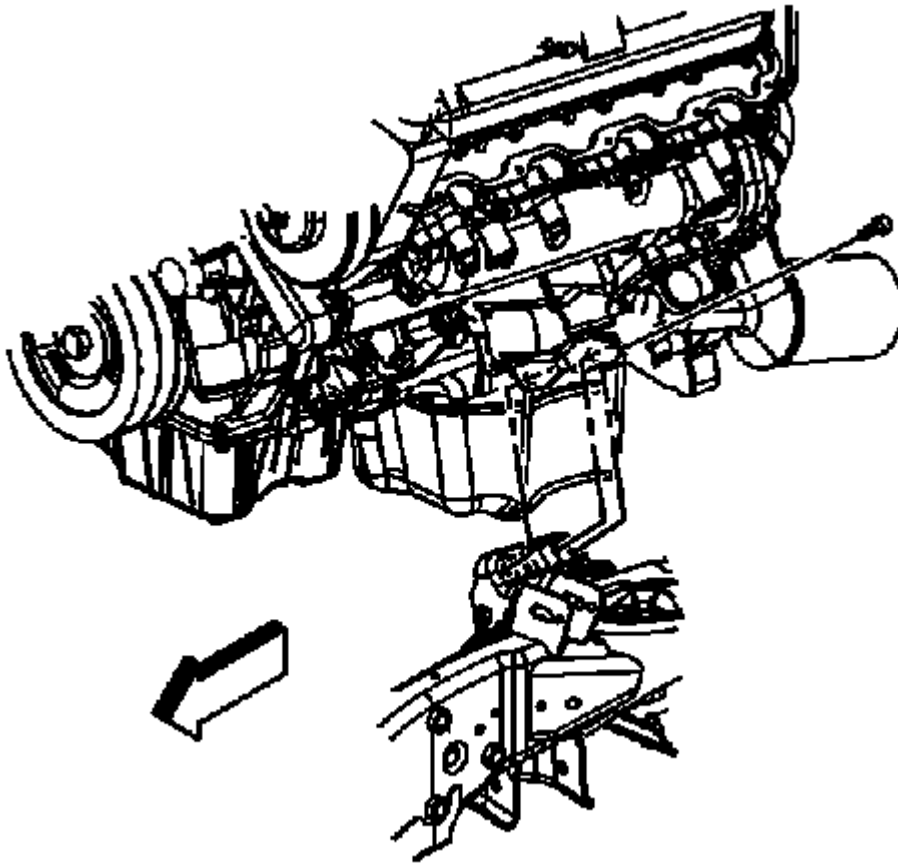


Fig. 15: View Of Engine Mount To Engine Mount Frame Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Install the 3 bolts holding the engine mount to the engine mount frame bracket.

Tighten

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

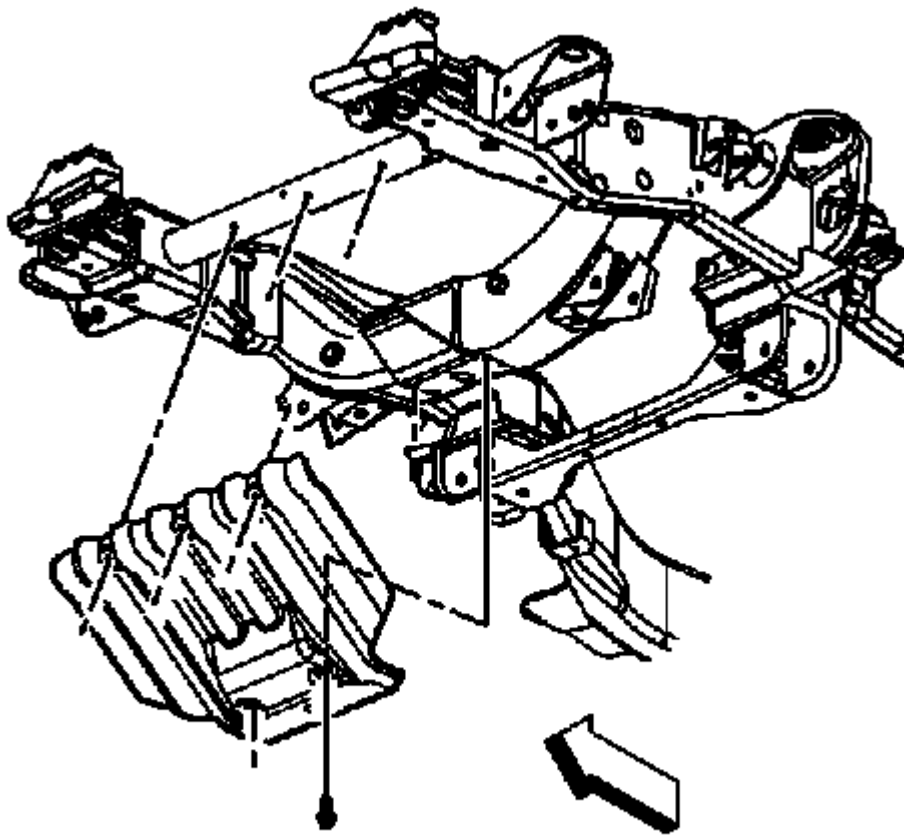


Fig. 16: Identifying Engine Shield And Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the engine protection shield and bolts.

Tighten

Tighten the engine protection shield bolts to 20 N.m (15 lb ft).

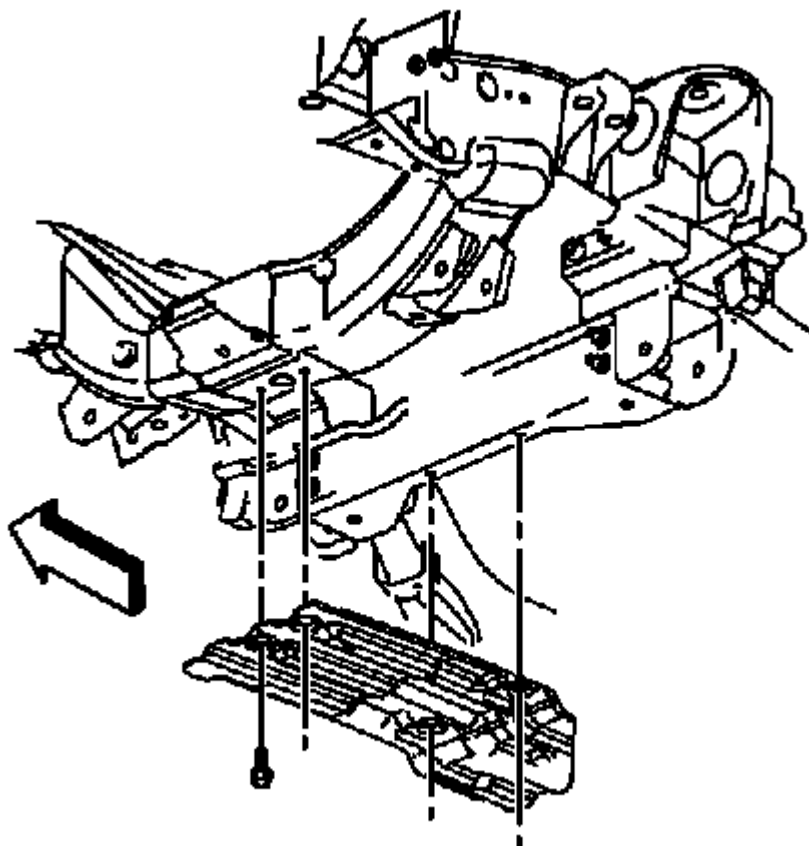


Fig. 17: Identifying Oil Pan Skid Plate
 Courtesy of GENERAL MOTORS COMPANY

8. Install the oil pan skid plate.

Tighten

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

9. Remove the wheelhouse inner panel. Refer to **Front Wheelhouse Liner Replacement - Left Side (GMC)** , **Front Wheelhouse Liner Replacement - Left Side (Chevrolet)** .
10. Lower the vehicle.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

Removal Procedure

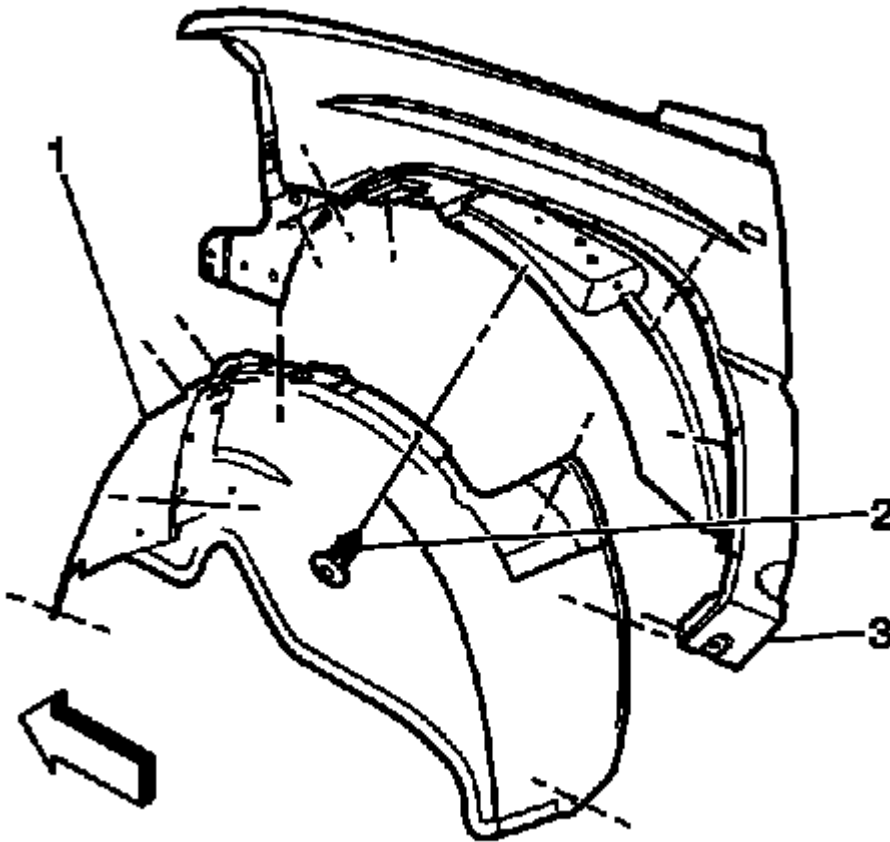


Fig. 18: View Of Wheelhouse Panel & Push-In Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Remove the starter motor. Refer to **Starter Replacement (Diesel)** .
2. If RWD vehicle, raise the vehicle to a height to work through the front wheelhouse opening. Refer to **Lifting and Jacking the Vehicle** .
3. If 4-wheel drive (4WD) vehicle, raise the vehicle in order to remove the front tires and wheels and support with jackstands.
4. Remove the right front tire and wheel, if necessary. Refer to **Tire and Wheel Removal and Installation (6-Lug Wheel)** , **Tire and Wheel Removal and Installation (8-Lug Wheel)** .
5. Remove the pushpins holding the right front fender wheelhouse inner panel (1).
6. Remove the wheelhouse inner panel.

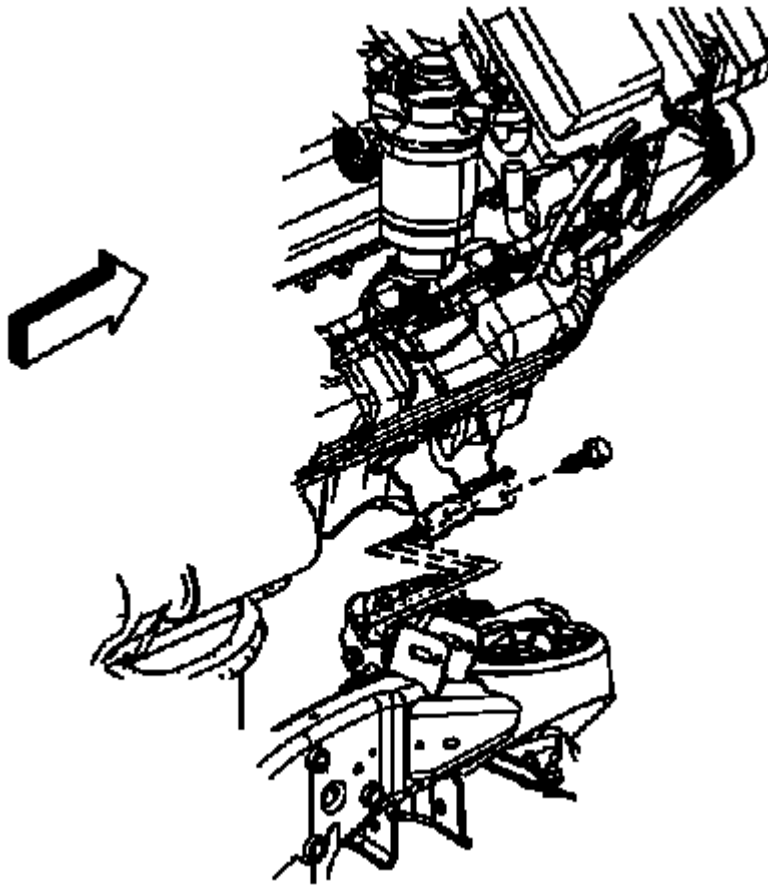


Fig. 19: View Of Engine Mount To Engine Mount Frame Bracket Bolt (Right)
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Broken engine mountings can cause misalignment of certain drive-train components. Misalignment of drive-train components causes eventual destruction of the drive-train components.

If one engine mount breaks, the rest of the engine mounts will have increased stress put on them. This could cause the rest of the engine mounts to break.

7. Working through the wheelhouse opening remove the 3 bolts retaining the engine mount to the engine mount frame bracket.

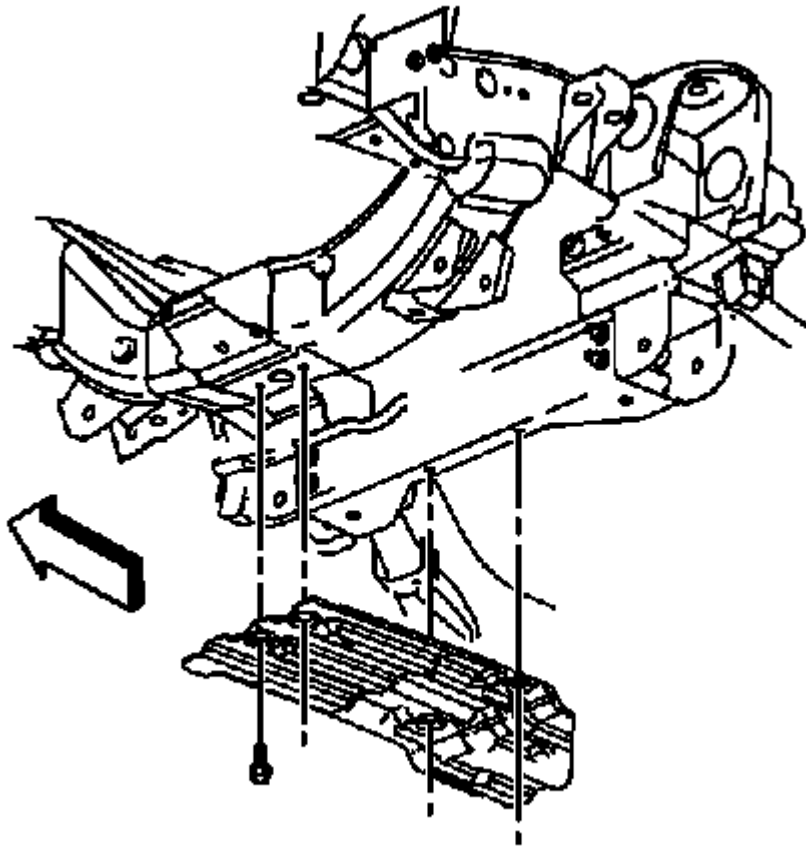


Fig. 20: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS COMPANY

8. Remove the oil pan skid plate, if equipped.

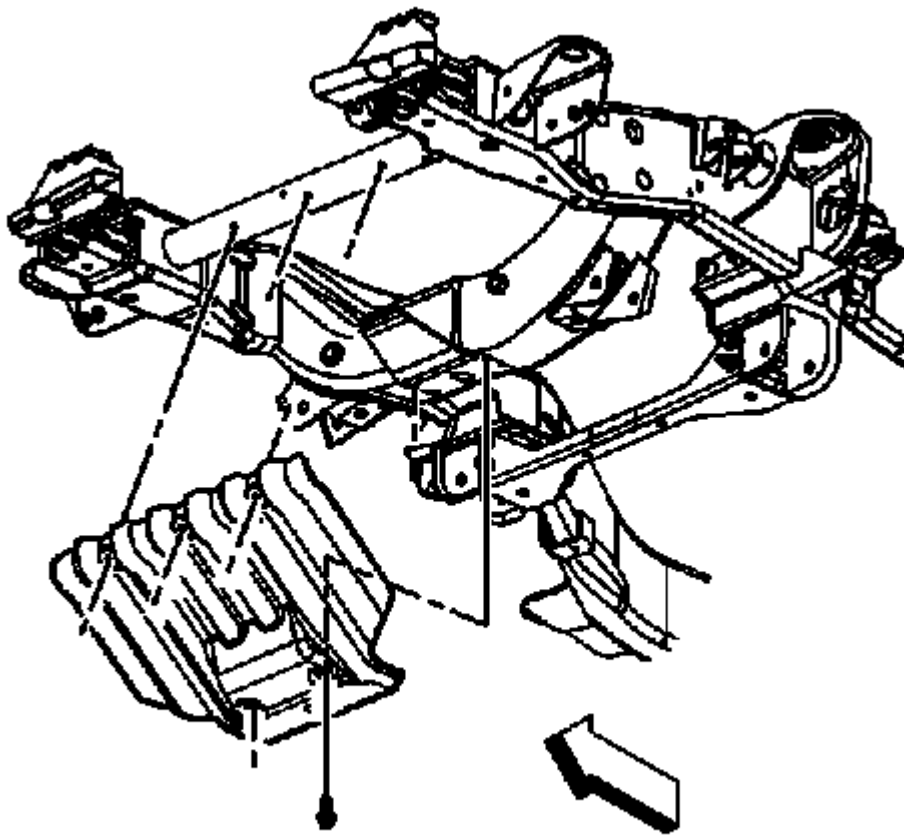


Fig. 21: Identifying Engine Shield And Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the engine protection shield from the vehicle, if equipped.

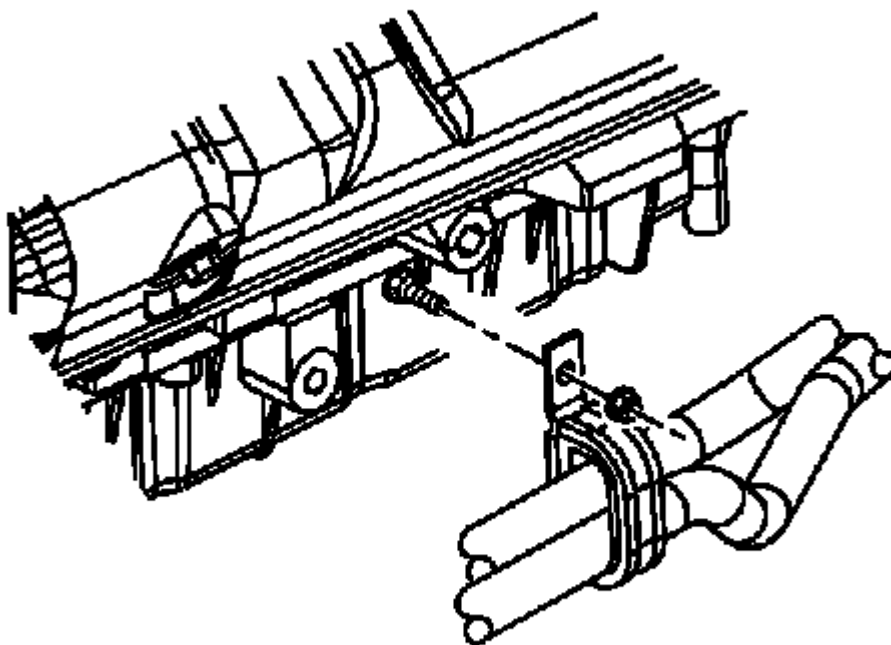


Fig. 22: View Of Transmission Oil Cooler Lines, Bracket & Bolt
Courtesy of GENERAL MOTORS COMPANY

10. If RWD vehicle and equipped with an automatic transmission, remove the bracket bolt for the transmission oil cooler lines to the engine.
11. Move the transmission oil cooler lines aside.

CAUTION: 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. Lifting the engine in an unapproved manner may cause component damage.

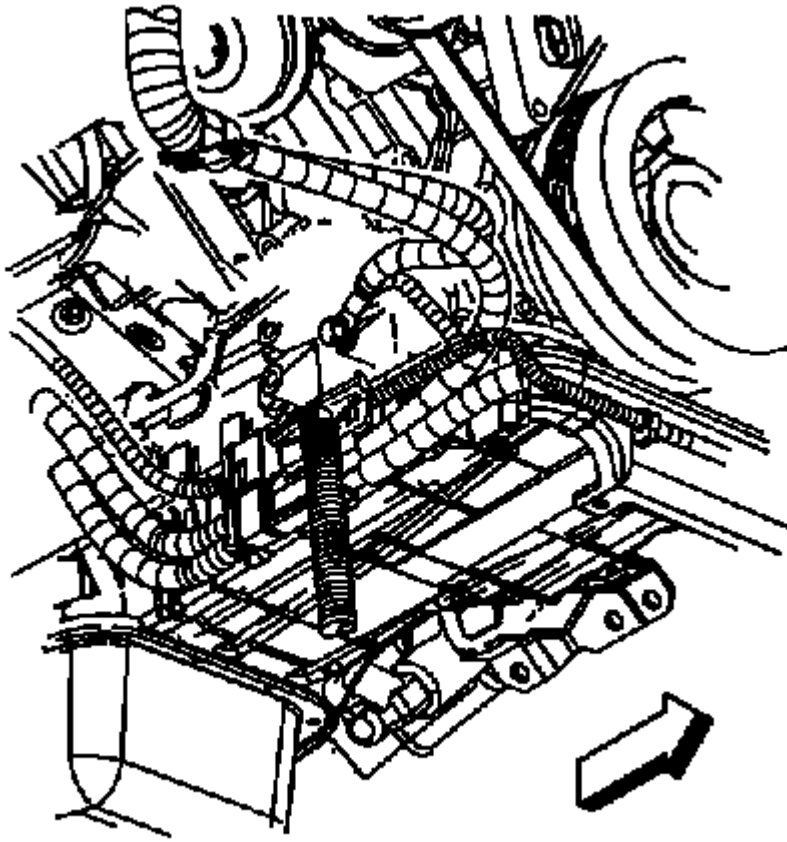


Fig. 23: View Of Ground Wire Bolt Bosses (Right Side)
 Courtesy of GENERAL MOTORS COMPANY

NOTE: When raising the engine only raise enough to separate the engine mount from the engine mount bracket. Raising any further the fan shroud or the exhaust pipe will require removal.

12. If RWD vehicle, using a suitable jack on the ground wire bolt bosses, raise the engine.

Only raise the engine enough to separate the engine mount to engine mount bracket.

13. If 4WD vehicle, attach a chain to the front of the engine. Use accessible mounting bolts for the generator mounting bracket and the power steering pump mounting bracket.
14. Raise the engine with a suitable lifting device to remove the engine mount.

Only raise the engine enough to separate the engine mount to frame.

15. Remove the engine mount.

Installation Procedure

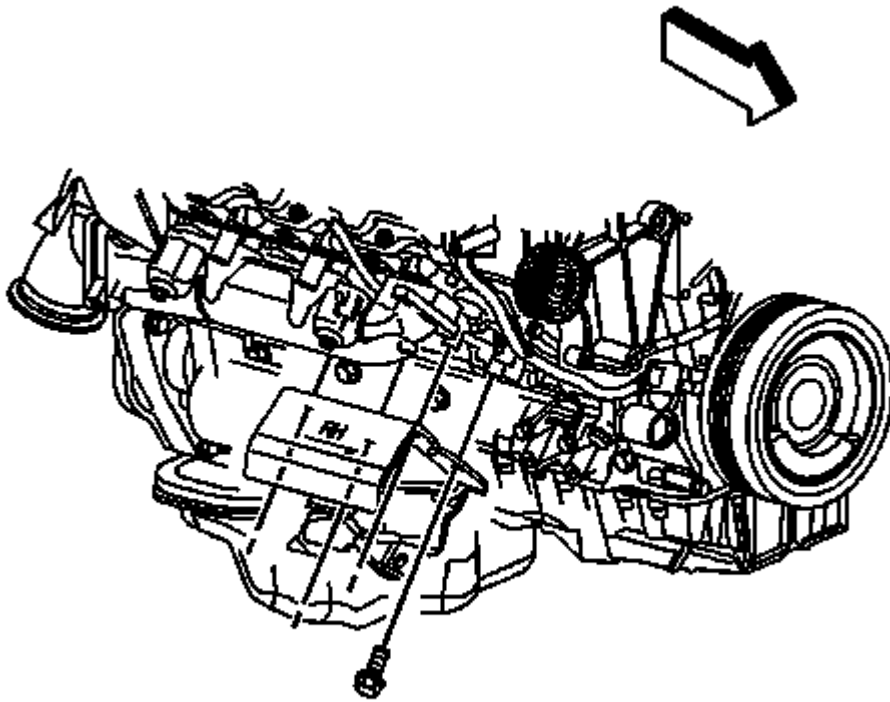


Fig. 24: Identifying Engine Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the bolts holding the engine mount to the engine.

Tighten

Tighten the engine mount bolts to 58 N.m (43 lb ft).

2. Lower the engine.
3. If 4WD vehicle, remove the chain from the front of the engine.

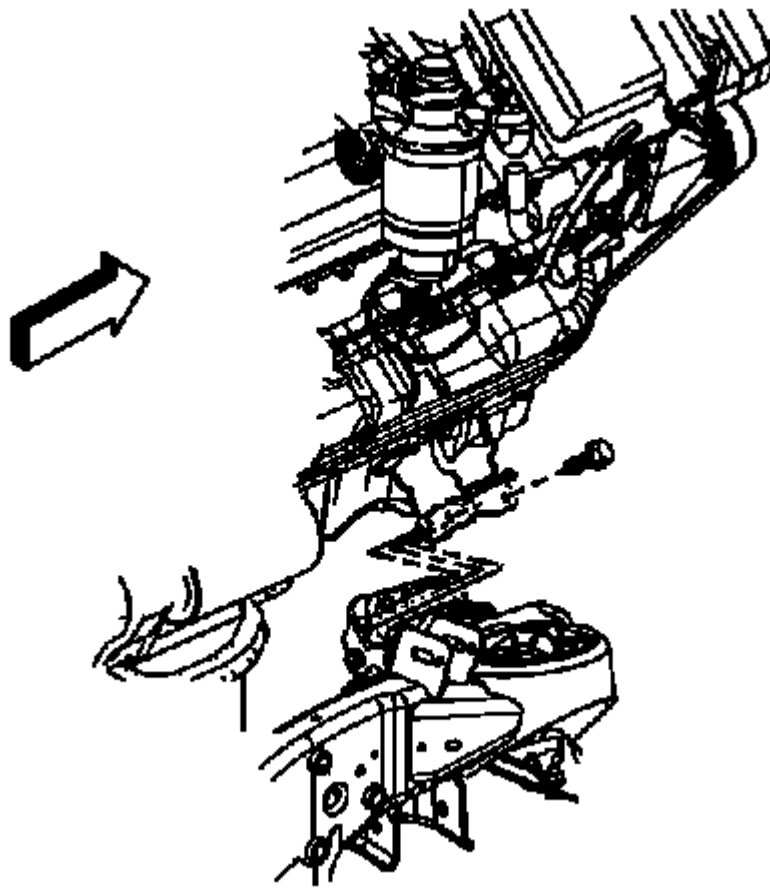


Fig. 25: View Of Engine Mount To Engine Mount Frame Bracket Bolt (Right)
Courtesy of GENERAL MOTORS COMPANY

4. Install the 3 bolts holding the engine mount to the engine mount frame bracket.

Tighten

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

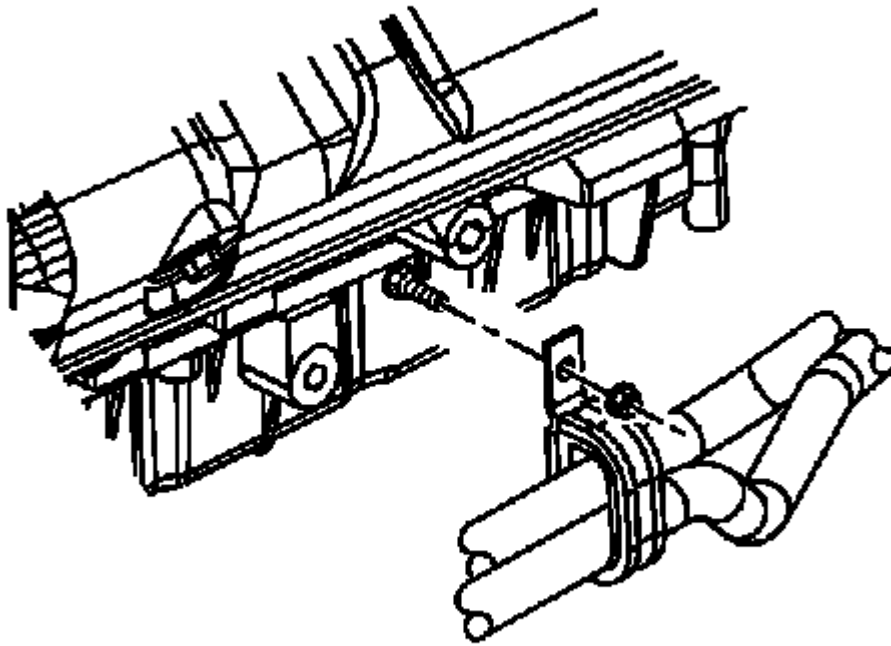


Fig. 26: View Of Transmission Oil Cooler Lines, Bracket & Bolt
Courtesy of GENERAL MOTORS COMPANY

5. If RWD vehicle with an automatic transmission, install the bolt for the transmission oil cooler line bracket.

Tighten

Tighten the transmission oil cooler line bracket bolt to 9 N.m (80 lb in).

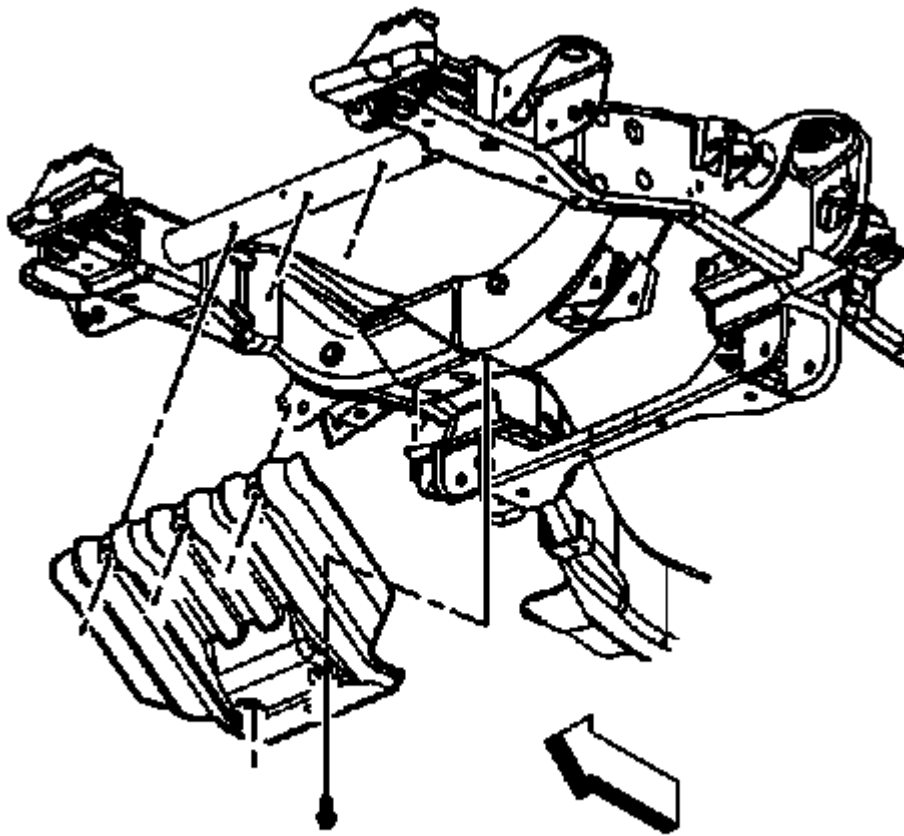


Fig. 27: Identifying Engine Shield And Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install the engine protection shield and bolts.

Tighten

Tighten the engine protection shield bolts to 20 N.m (15 lb ft).

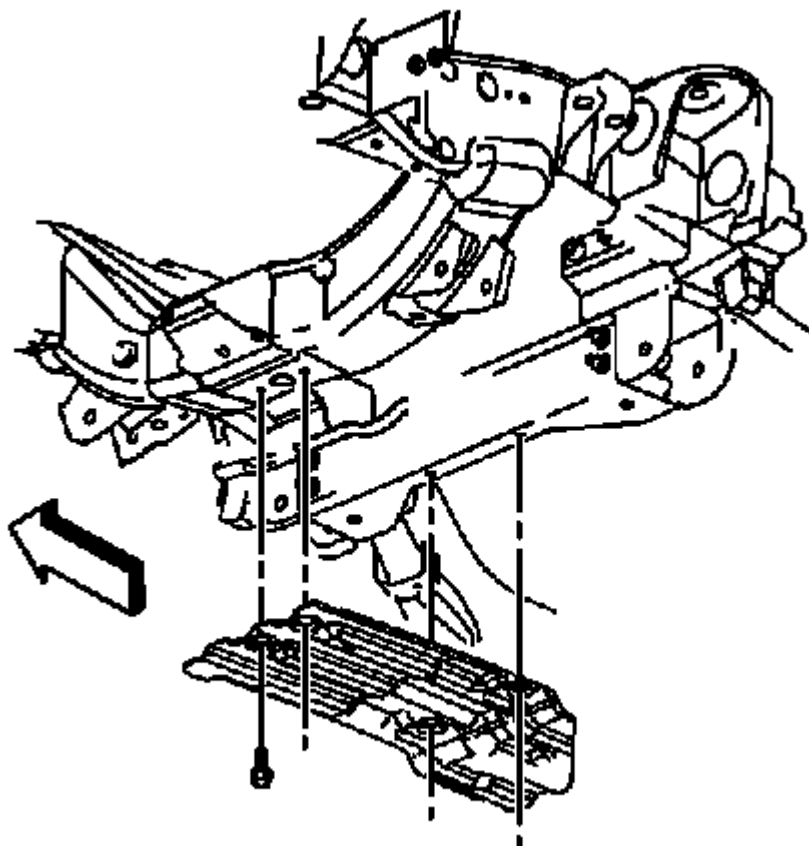


Fig. 28: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS COMPANY

7. Install the oil pan skid plate.

Tighten

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

8. Install the right front tire and wheel. Refer to **Tire and Wheel Removal and Installation (6-Lug Wheel)** , **Tire and Wheel Removal and Installation (8-Lug Wheel)** .
9. Install the front fender wheelhouse inner panel.
10. Install the starter motor. Refer to **Starter Replacement (Diesel)**
11. Lower the vehicle.

POSITIVE CRANKCASE VENTILATION OIL SEPARATOR REPLACEMENT

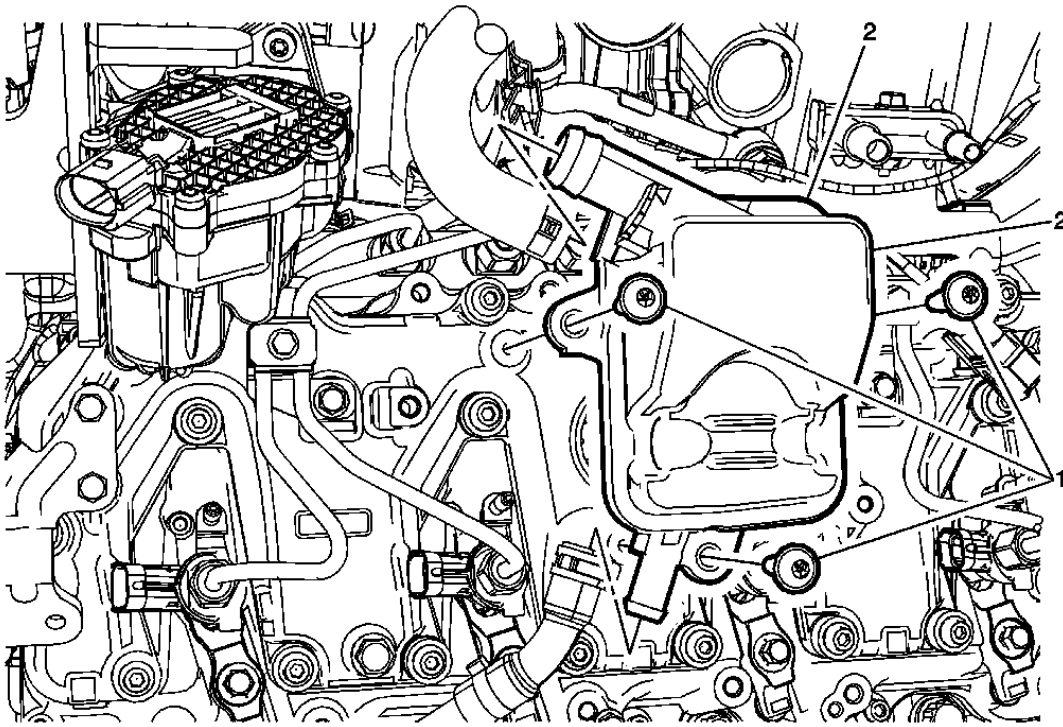


Fig. 29: Positive Crankcase Ventilation Oil Separator
 Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Oil Separator Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the fuel feed and return pipe. Refer to <u>Fuel Feed and Return Pipe Replacement</u> . 2. Remove the left side fuel injection fuel return hoses at the injectors only. Refer to <u>Fuel Return Hose Replacement</u> . 3. Disconnect the positive crankcase ventilation tubes/pipes at the positive crankcase ventilation oil separator only. Refer to <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Regulator Valve to Separator)</u>. 4. Reposition the charge air cooler inlet pipe. Refer to <u>Charge Air Cooler Inlet Pipe Replacement</u> . 	
1	Positive Crankcase Ventilation Oil Separator Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Procedure <ol style="list-style-type: none"> 1. Using a suitable tool, cut a slot in the tamper-resistant positive crankcase ventilation (PCV) oil separator bolt heads and remove with a flat-bladed tool.

	<p>2. Use EN-50956 Tamper Proof Drive Bit to install the NEW bolts.</p> <p>Tighten 10 N.m (89 lb in)</p> <p>Special Tools EN-50956 Tamper Proof Drive Bit For equivalent regional tools, refer to Special Tools .</p>
2	<p>Positive Crankcase Ventilation Oil Separator</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Use the appropriate tool to remove the clamp before removing the hose. 2. Use J 43218 Clamp Pliers to install the new clamps. 3. Disconnect the electrical connectors, as necessary. 4. Transfer components as necessary. <p>NOTE: Inspect the PCV hose for any physical damage that may allow it to leak. If damage is found, replace the hose.</p> <p>Special Tools J 43218 Clamp Pliers For equivalent regional tools, refer to Special Tools .</p>

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (REGULATOR VALVE TO SEPARATOR)

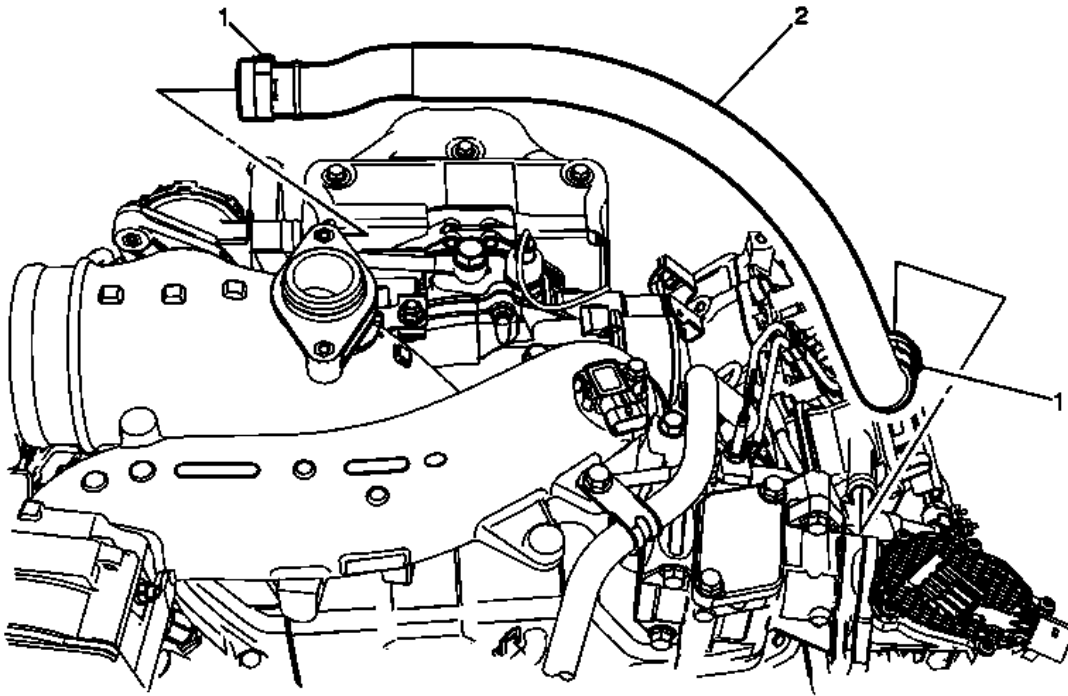


Fig. 30: Positive Crankcase Ventilation Hose And Clamps
 Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Regulator Valve to Separator)

Callout	Component Name
Preliminary Procedure	
1. Remove the charge air cooler inlet pipe. Refer to Charge Air Cooler Inlet Pipe Replacement . 2. Remove the Fuel Feed and Return Pipe . Refer to Fuel Feed and Return Pipe Replacement .	
1	Positive Crankcase Ventilation Hose Clamp (Qty: 2) Procedure 1. Cut the clamp and replace with new. 2. Tighten the clamp using CH-48894 pliers. Special Tools CH-48894 Drive Axle Boot Clamp Pliers For equivalent regional tools, refer to Special Tools .
	Positive Crankcase Ventilation Hose/Pipe/Tube NOTE: Inspect the PCV hose for any physical damage that may allow it to leak. If damage is found, replace the hose.

2

Procedure

1. Disconnect the electrical connectors, as necessary.
2. Transfer components as necessary.

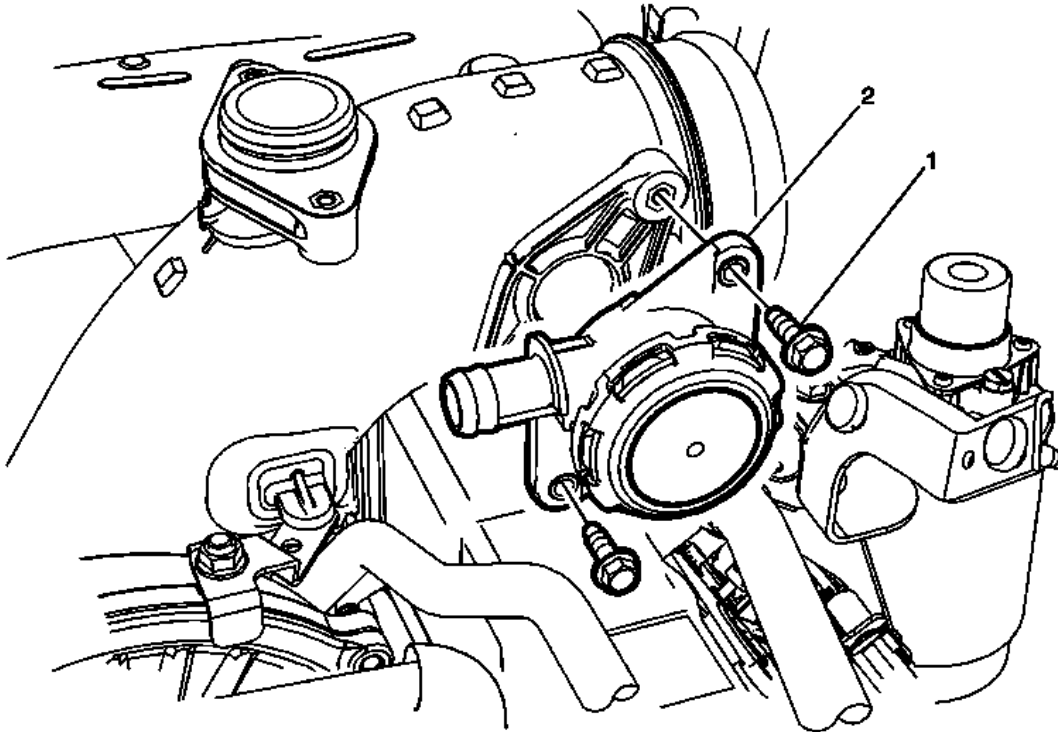
CRANKCASE DEPRESSION REGULATOR VALVE REPLACEMENT

Fig. 31: Positive Crankcase Ventilation Valve And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Crankcase Depression Regulator Valve Replacement

Callout	Component Name
1	Crankcase Depression Regulator Valve Fastener (Qty: 2)
	CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
	Crankcase Depression Regulator Valve Procedure

2

1. Cut the clamp and remove the hose.
2. Ensure to install a NEW clamp whenever removing the crankcase depression regulator valve hose.
3. Disconnect electrical connectors as needed.
4. Transfer components as necessary.

INTAKE MANIFOLD TUBE REPLACEMENT

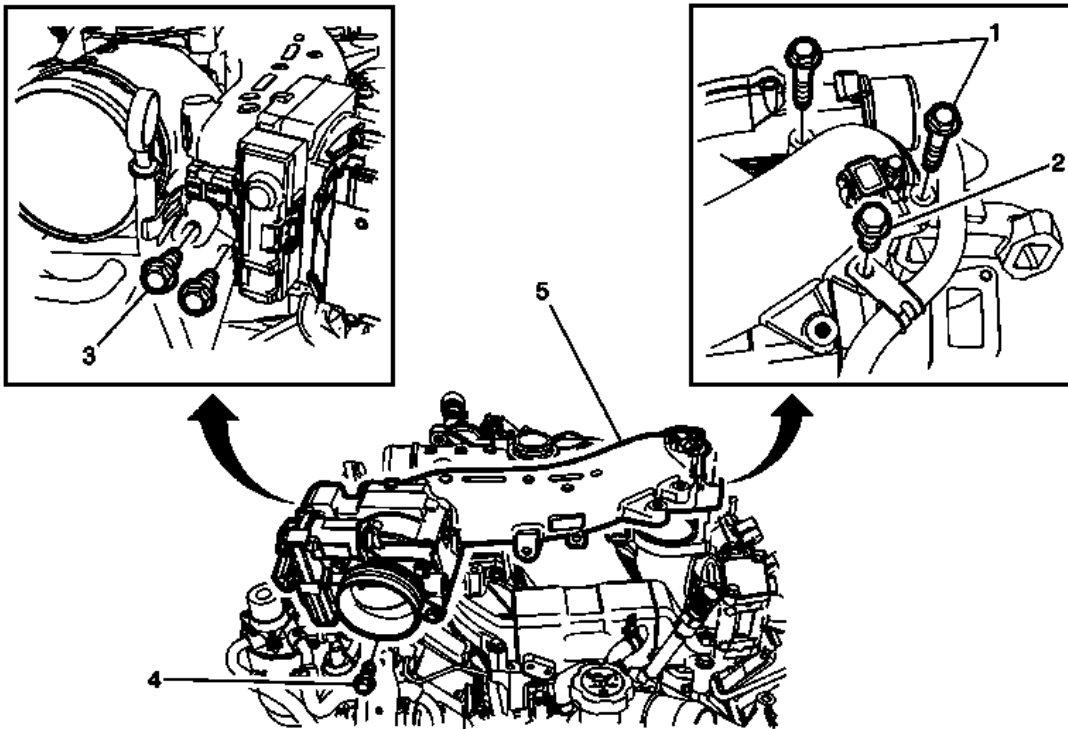


Fig. 32: Intake Manifold Tube And Fasteners
Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Tube Replacement

Callout	Component Name
Preliminary Procedures	
<ol style="list-style-type: none"> 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection (TP2)</u> , <u>Battery Negative Cable Disconnection and Connection (Single Battery)</u> . 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>. 3. Remove the Air Cleaner Outlet Duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> . 4. Remove the charge air cooler outlet pipe from the throttle body. Refer to <u>Charge Air Cooler Outlet Pipe Replacement</u> . 	
	Intake Manifold Tube Fastener (Qty: 2)

1	CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 N.m (18 lb ft)
2	Intake Manifold Tube Fastener Tighten 25 N.m (18 lb ft)
3	Intake Manifold Tube Fastener (Qty: 2) Tighten 25 N.m (18 lb ft)
4	Intake Manifold Tube Fastener Procedure Reposition the wire harness as necessary. Tighten 6 N.m (53 lb in)
5	Intake Manifold Tube Procedure <ol style="list-style-type: none"> 1. Disconnect the battery positive feed to throttle body heater. Refer to <u>Battery Positive Junction Block Cable Replacement (Air Intake Heater - Diesel)</u> , <u>Battery Positive Junction Block Cable Replacement (Glow Plug Module - Diesel)</u> . 2. Ensure to replace the intake manifold tube gasket whenever the tube is removed. 3. Disconnect electrical connectors as needed. 4. Transfer components as necessary.

CENTER INTAKE MANIFOLD REPLACEMENT

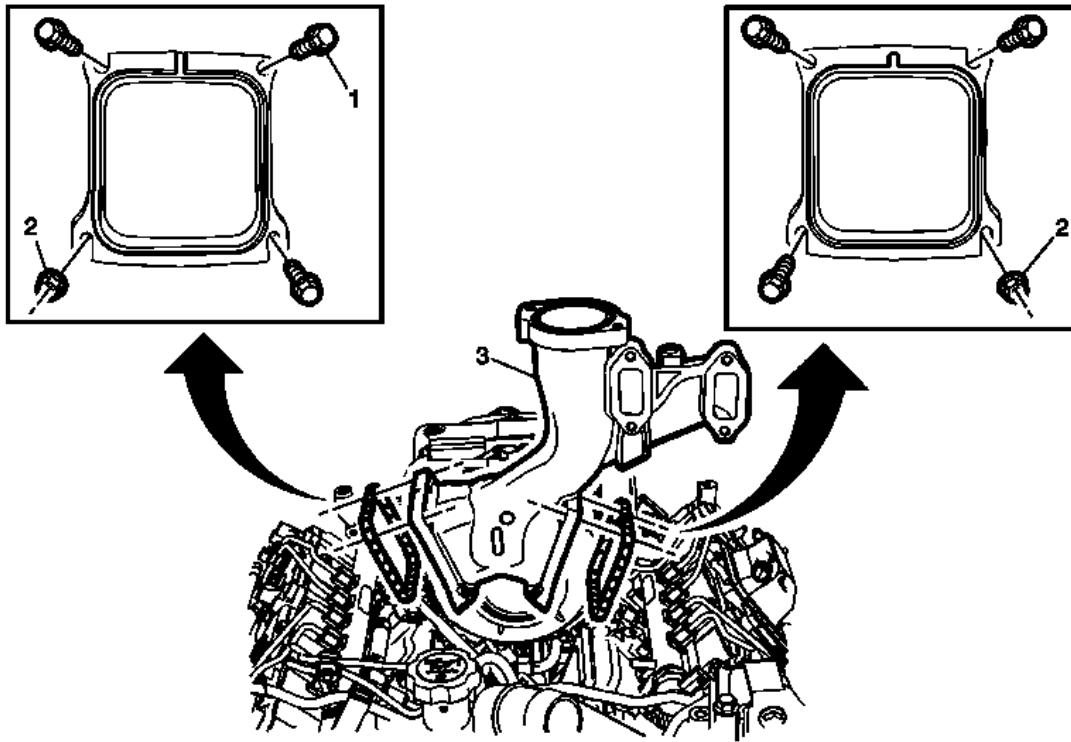


Fig. 33: Identifying Center Intake Manifold And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Center Intake Manifold Replacement

Callout	Component Name
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the front EGR cooler. Refer to Exhaust Gas Recirculation Valve Cooler Replacement (Rear) , Exhaust Gas Recirculation Valve Cooler Replacement (Front) . 2. Remove the turbocharger air Inlet adapter . Refer to Turbocharger Air Inlet Adapter Replacement . 	
1	Center Intake Manifold Fastener (Qty: 6) CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Center Intake Manifold Fastener (Qty: 2) Tighten 10 N.m (89 lb in)
	Center Intake Manifold Procedure

3

1. Ensure to replace the center intake manifold gasket whenever the intake is removed.
2. Disconnect electrical connectors as needed.
3. Transfer components as necessary.

INTAKE MANIFOLD REPLACEMENT - LEFT SIDE**Special Tools****J-37228 Seal Cutter**

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

Removal Procedure

1. Remove the turbocharger. Refer to **Turbocharger Replacement (LML)**.
2. Remove the injection pump. Refer to **Fuel Injection Pump Replacement** .
3. Remove the left fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (Left Side)** .

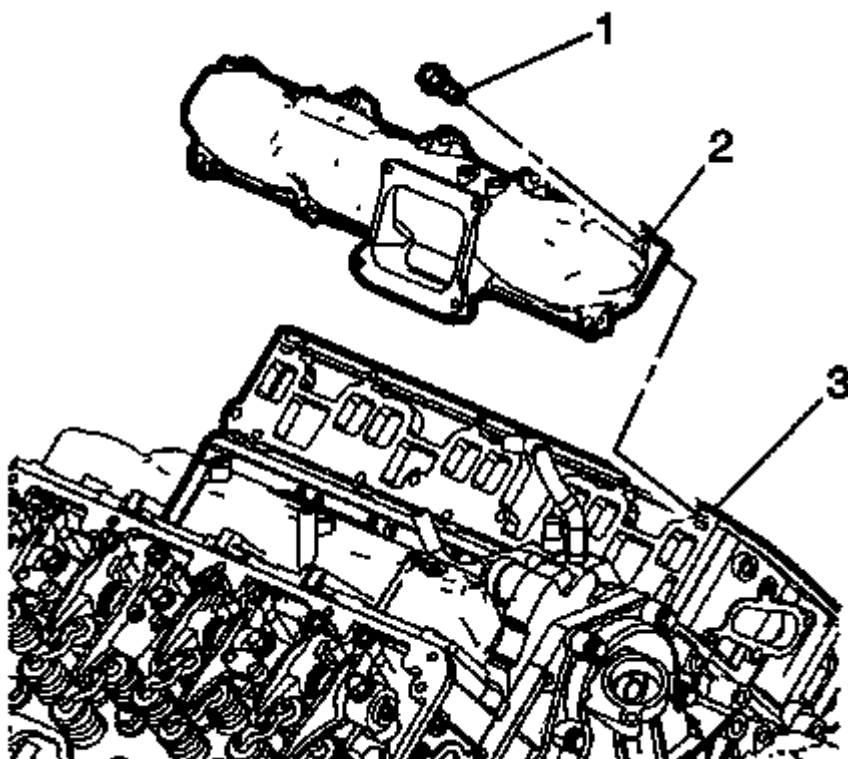
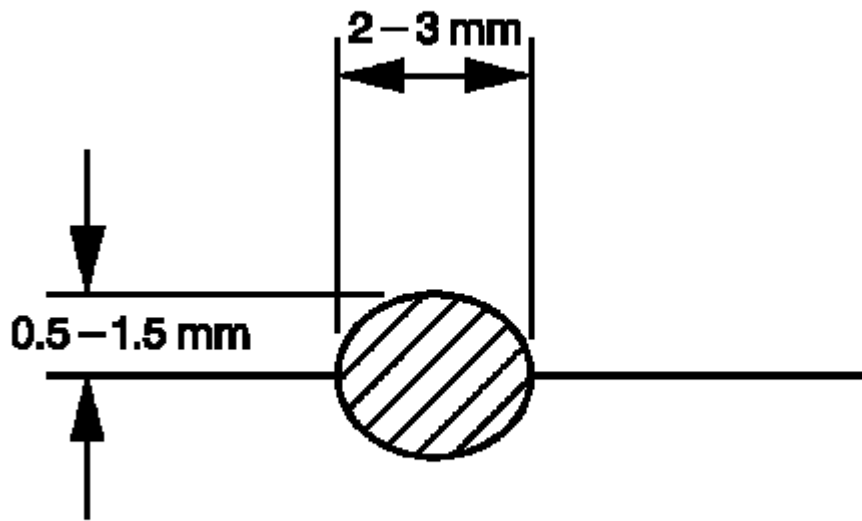


Fig. 34: View Of Intake Manifold (Left)

Courtesy of GENERAL MOTORS COMPANY

NOTE: The intake manifold uses sealer. Pry at the area by the fuel rail bolt holes in order to avoid damage to the sealing surface.

4. Remove the left intake manifold bolts (1). Do not forget to remove the bolt inside the intake manifold tube.
5. Separate the intake manifold (2) from the cylinder head using **J-37228** cutter.
6. Remove the left intake manifold.
7. Inspect and clean. Refer to **Intake Manifold Cleaning and Inspection** .

Installation Procedure**Fig. 35: Determining Sealant Bead Dimensions**

Courtesy of GENERAL MOTORS COMPANY

1. Apply a 2-3 mm (1/8 in) wide by 0.5-1.5 mm (1/16 in) high bead of sealant on the intake manifold mating surface. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

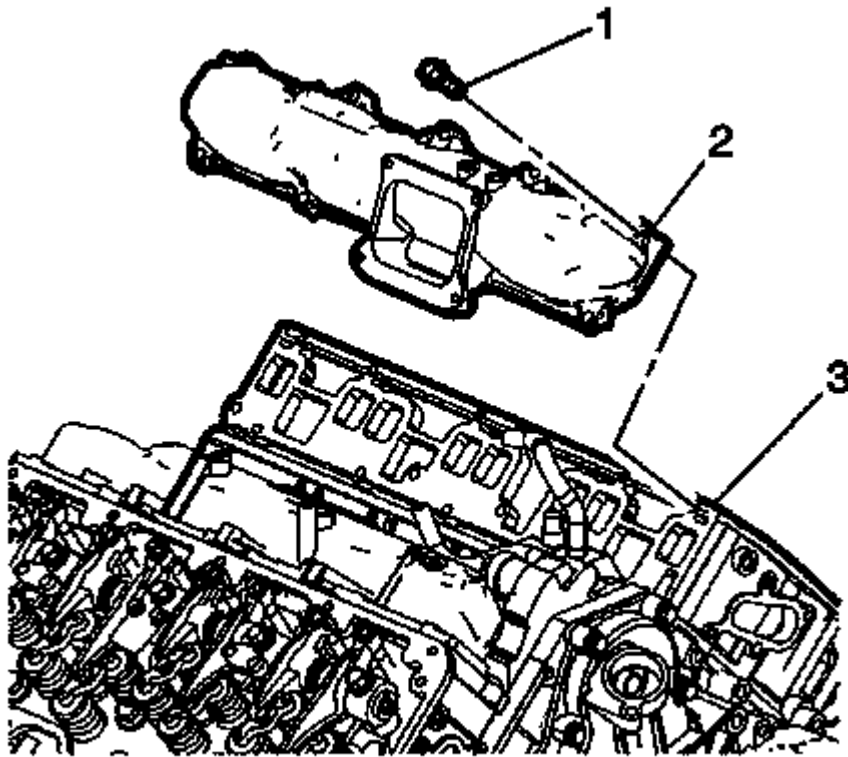


Fig. 36: View Of Intake Manifold (Left)
Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold (2).

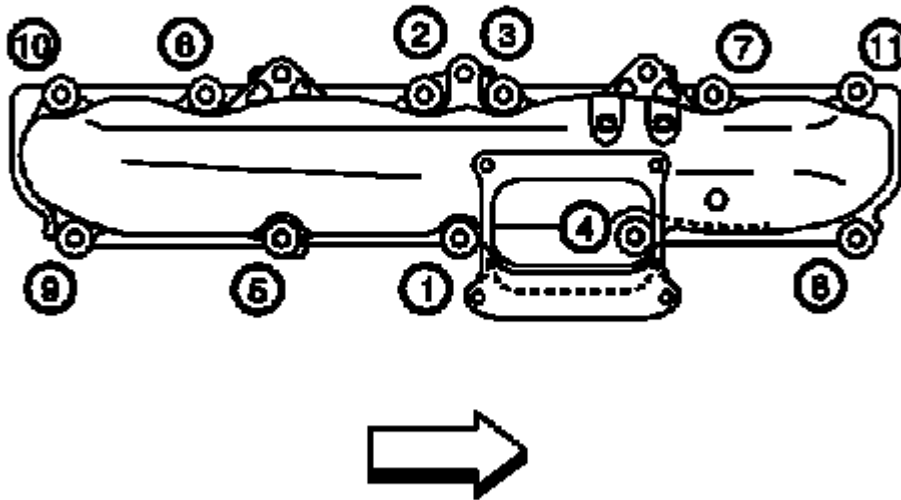


Fig. 37: Intake Manifold Bolt Tightening Sequence (Left)
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the intake manifold bolts and nuts and tighten in sequence to 25 N.m (18 lb ft).
4. Install the injection pump. Refer to Fuel Injection Pump Replacement .
5. Install the left fuel rail. Refer to Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (Left Side) .
6. Install the turbocharger. Refer to Turbocharger Replacement (LML).

INTAKE MANIFOLD REPLACEMENT - RIGHT SIDE

Special Tools

J-37228 Seal Cutter

For equivalent regional tools, refer to Special Tools .

Removal Procedure

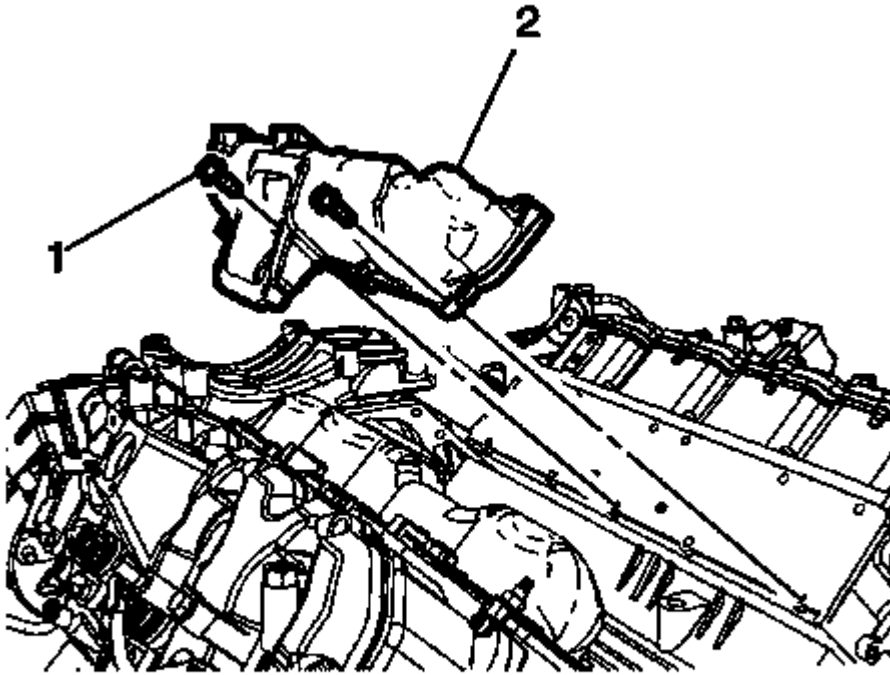


Fig. 38: Identifying right intake manifold nuts/bolts
 Courtesy of GENERAL MOTORS COMPANY

1. Remove the turbocharger. Refer to **Turbocharger Replacement (LML)**.
2. Remove the right fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (Right Side)** .
3. Remove the injection pump. Refer to **Fuel Injection Pump Replacement** .
4. Remove the intake manifold bolts/nuts (1).

NOTE: **The intake manifold uses sealer. Pry at the area by the fuel rail bolt holes in order to avoid damage to the sealing surfaces.**

5. Remove the left intake manifold (2).
6. To prevent entry of debris in the cylinder head, tape the openings.

Installation Procedure

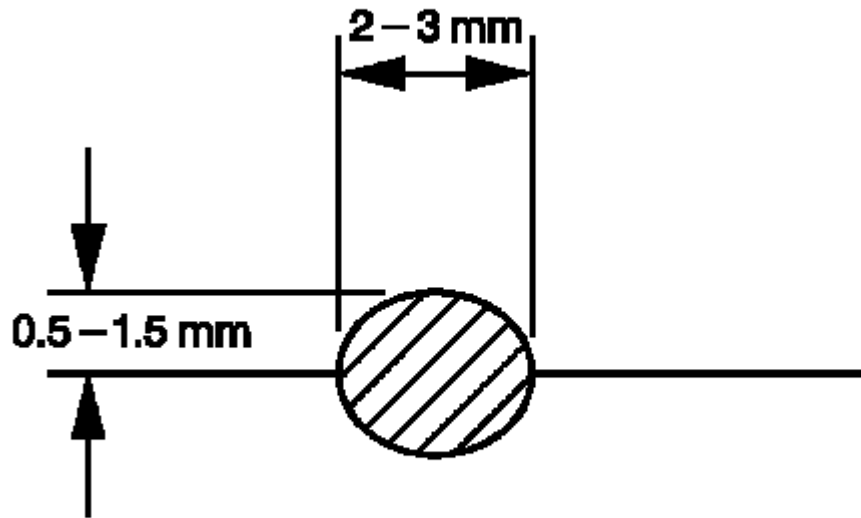


Fig. 39: Determining Sealant Bead Dimensions

Courtesy of GENERAL MOTORS COMPANY

1. Apply a 2-3 mm (1/8 in) wide by 0.5-1.5 mm (1/16 in) high bead of sealant on the intake manifold mating surface. Refer to Adhesives, Fluids, Lubricants, and Sealers .

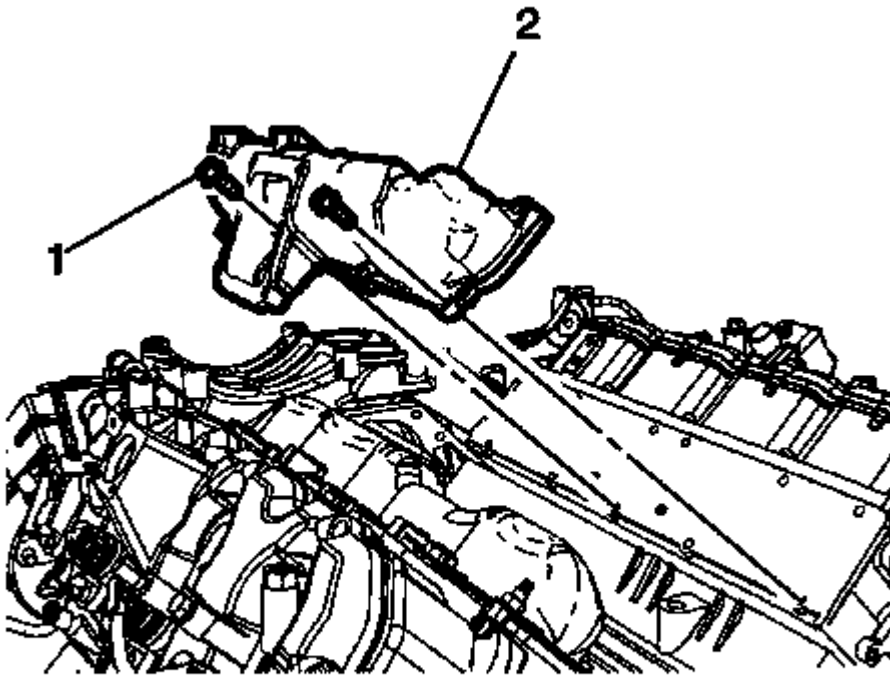


Fig. 40: Identifying right intake manifold nuts/bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold (2).
3. Install the intake manifold bolts/nuts (1).
4. Install the injection pump. Refer to **Fuel Injection Pump Replacement** .

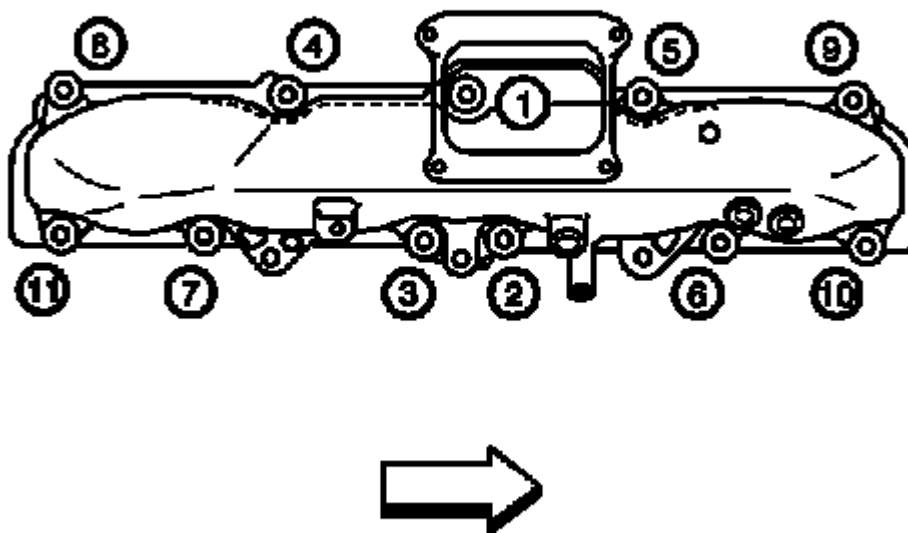
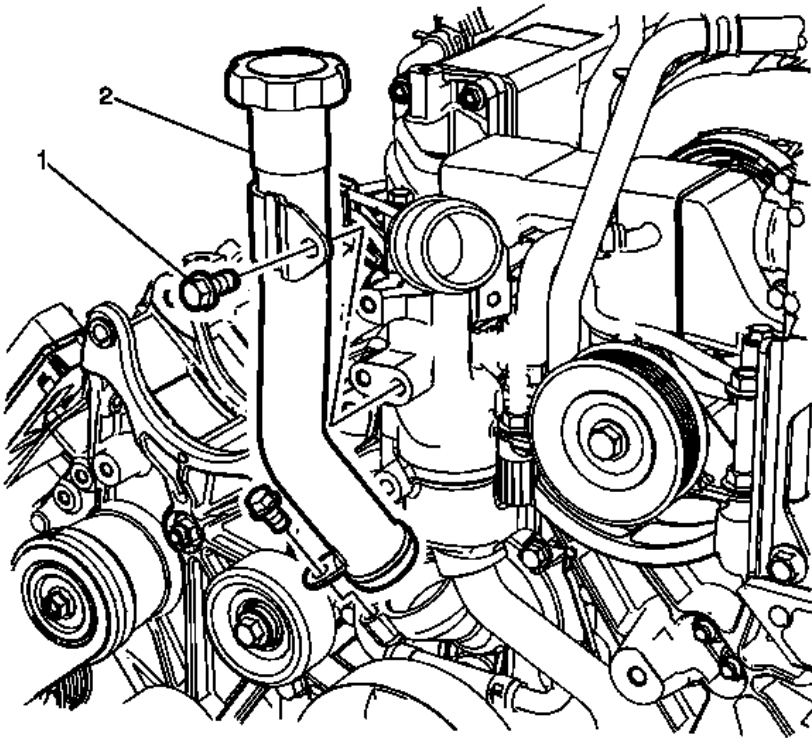


Fig. 41: Intake Manifold Bolt Tightening Sequence (Right)
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Tighten the intake manifold bolts/nuts in the sequence shown to 25 N.m (18 lb ft).
6. Install the right fuel rail. Refer to Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (Right Side) .
7. Install the turbocharger. Refer to Turbocharger Replacement (LML).

OIL FILLER TUBE REPLACEMENT

**Fig. 42: Oil Filler Tube**

Courtesy of GENERAL MOTORS COMPANY

Oil Filler Tube Replacement

Callout	Component Name
Preliminary Procedure Remove the upper fan shroud. Refer to <u>Engine Coolant Fan Upper Shroud Replacement (Diesel)</u> .	
1	Oil Filler Tube Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 N.m (18 lb ft)
2	Oil Filler Tube Procedure <ol style="list-style-type: none"> 1. Ensure to replace the oil filler tube gasket whenever the tube is removed. 2. Disconnect electrical connectors as needed. 3. Transfer components as necessary.

OIL LEVEL INDICATOR TUBE REPLACEMENT

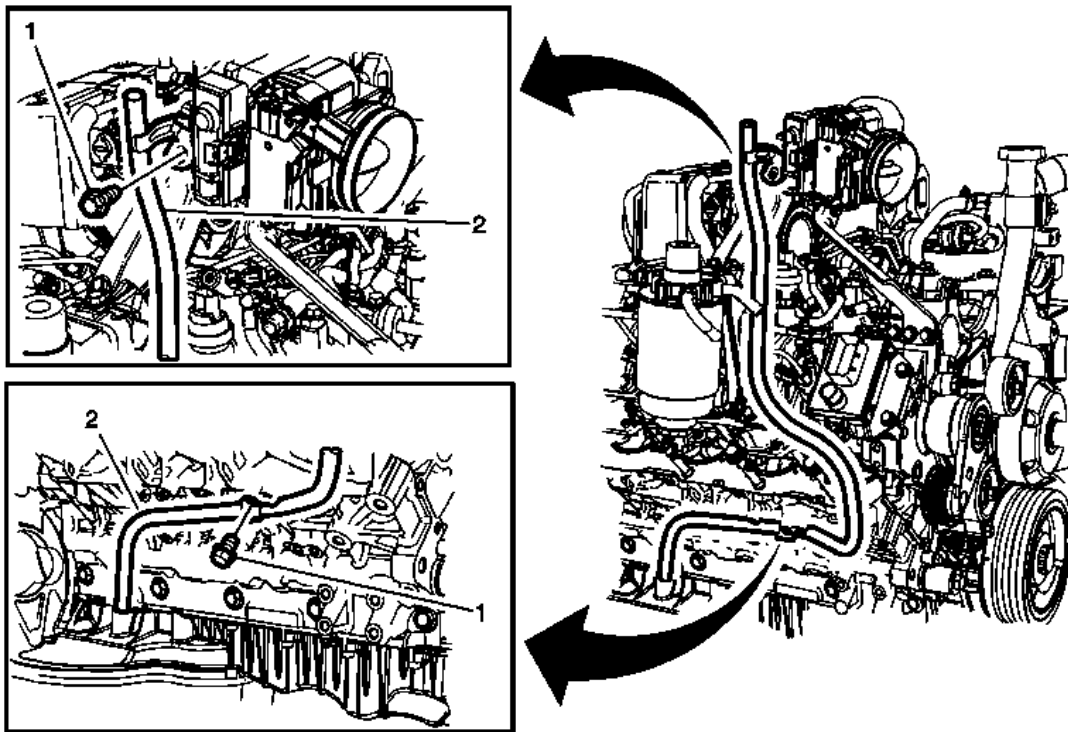


Fig. 43: Oil Level Indicator Tube
 Courtesy of GENERAL MOTORS COMPANY

Oil Level Indicator Tube Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the right engine mount and bracket. Refer to <u>Engine Mount Replacement - Right Side.</u> 2. Remove the starter. Refer to <u>Starter Replacement (Diesel)</u>	
1	Oil indicator Tube Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 N.m (18 lb ft)
2	Oil indicator Tube Procedure 1. Ensure to replace the oil indicator tube gasket whenever the tube is removed.

2. Disconnect electrical connectors as needed.
3. Transfer components as necessary.

VALVE ROCKER ARM UPPER COVER REPLACEMENT - LEFT SIDE

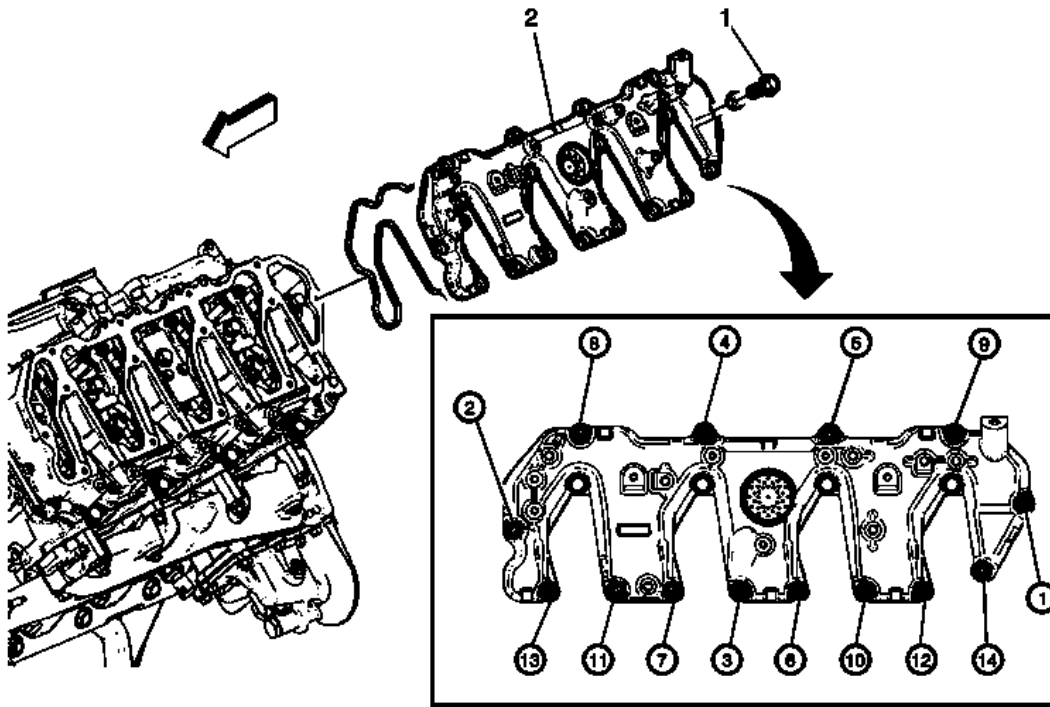


Fig. 44: Valve Rocker Arm Upper Cover And Fasteners With Tightening Sequence - Left Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Upper Cover Replacement - Left Side

Callout	Component Name
CAUTION: Label all the injector electrical connectors before the connectors are removed in order to prevent reconnecting to the wrong injector. Failure to properly connect the injectors in the correct sequence will cause severe engine damage.	
Preliminary Procedures <ol style="list-style-type: none"> 1. Remove the positive crankcase ventilation oil separator. Refer to <u>Positive Crankcase Ventilation Oil Separator Replacement</u>. 2. Remove the fuel injection fuel feed pipe left side. Refer to <u>Fuel Injection Fuel Feed Pipe Replacement - Left Side</u>. 3. Remove the auxiliary generator, if equipped. Refer to <u>Auxiliary Generator Replacement (KD9)</u>. 4. Remove the fuel line protective bracket. 	
	Valve Rocker Arm Cover Fastener (Qty: 18)

1	<p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Ensure to replace the grommets and gasket whenever the cover is removed. 2. Ensure to tighten the bolts in sequence shown. <p>Tighten 10 N.m (89 lb in)</p>
2	<p>Valve Rocker Arm Cover</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Disconnect the electrical connectors, as necessary. 2. Transfer components as necessary.

VALVE ROCKER ARM UPPER COVER REPLACEMENT - RIGHT SIDE

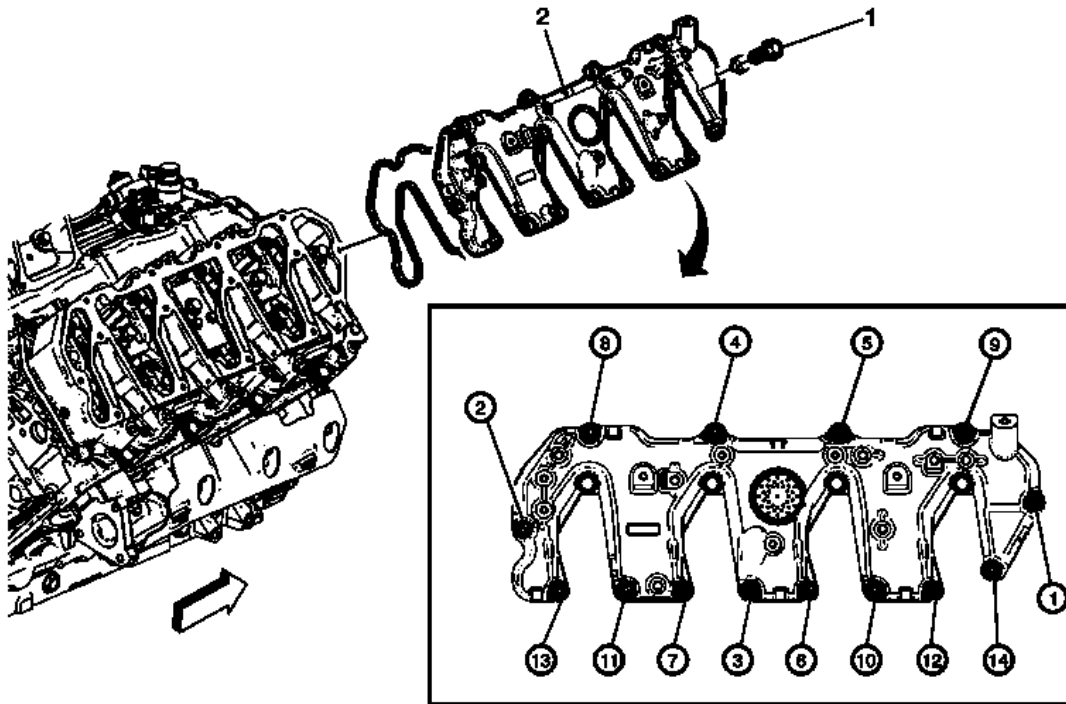


Fig. 45: Valve Rocker Arm Upper Cover And Fasteners With Tightening Sequence - Right Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Upper Cover Replacement - Right Side

Callout	Component Name
<p>CAUTION: Label all the injector electrical connectors before the connectors are removed in order to prevent reconnecting to the wrong injector. Failure to properly connect the injectors in the correct sequence will cause severe engine damage.</p> <p>Preliminary Procedures</p> <ol style="list-style-type: none"> 1. Remove the generator. Refer to <u>Generator Replacement (Diesel)</u> . 2. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u> . 3. Remove the oil indicator tube. Refer to <u>Oil Level Indicator Tube Replacement</u>. 4. Remove the Indirect Fuel Injector. Refer to <u>Indirect Fuel Injector Replacement</u> 5. Remove the fuel filter assembly. Refer to <u>Fuel Filter Assembly Replacement</u> 6. Remove the fuel injection fuel feed pipe right side. Refer to <u>Fuel Injection Fuel Feed Pipe Replacement - Right Side</u> . 	
1	<p>Valve Rocker Arm Cover Fastener (Qty: 18)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Ensure to replace the grommets and gasket whenever the cover is removed. 2. Ensure to tighten the bolts in sequence shown. <p>Tighten 10 N.m (89 lb in)</p>
2	<p>Valve Rocker Arm Cover</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Disconnect the electrical connectors, as necessary. 2. Transfer components as necessary.

VALVE ROCKER ARM LOWER COVER REPLACEMENT - LEFT SIDE

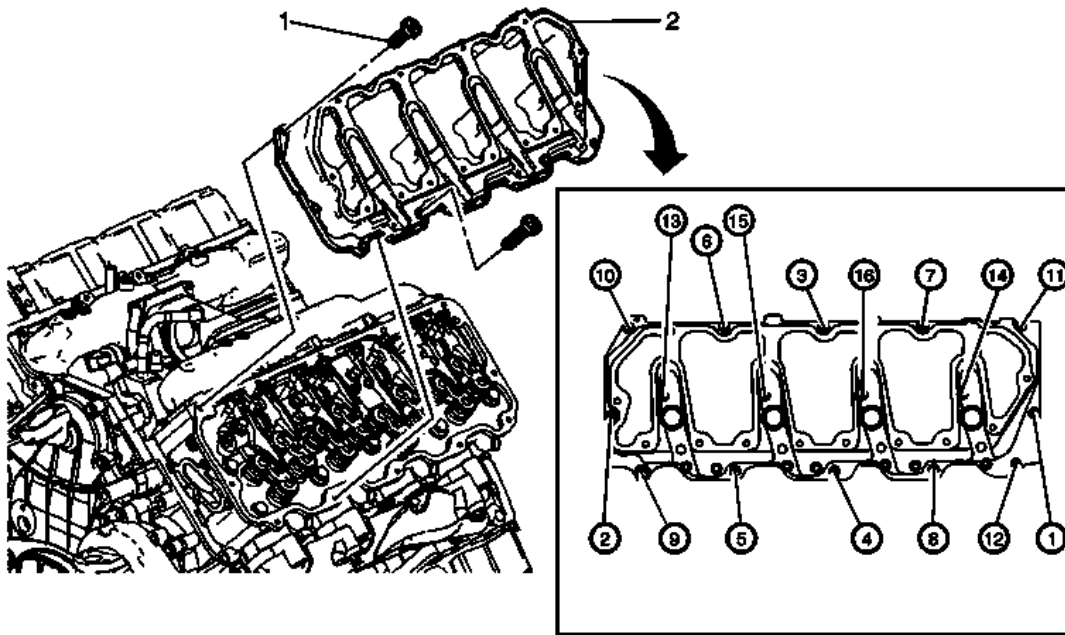


Fig. 46: Valve Rocker Arm Lower Cover And Fasteners With Tightening Sequence - Left Side
 Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Lower Cover Replacement - Left Side

Callout	Component Name
CAUTION: Label all the injector electrical connectors before the connectors are removed in order to prevent reconnecting to the wrong injector. Failure to properly connect the injectors in the correct sequence will cause severe engine damage.	
Preliminary Procedures	
1. Remove the valve rocker arm cover upper left side. Refer to <u>Valve Rocker Arm Upper Cover Replacement - Left Side</u> . 2. Remove the 4 fuel injectors. Refer to <u>Fuel Injector Replacement (Right Side)</u> , <u>Fuel Injector Replacement (Left Side)</u> . 3. Remove the A/C bracket. Refer to <u>Air Conditioning Compressor Bracket Replacement (LGH, LML)</u>	
	Valve Rocker Arm Cover Fastener (Qty: 16) CAUTION: Refer to <u>Fastener Caution</u> . Procedure

1	<ol style="list-style-type: none"> 1. The gasket may be reused if it is not torn, cracked, stretched, or swollen. 2. Ensure to tighten the bolts in sequence shown. <p>Tighten 10 N.m (89 lb in)</p>
2	<p>Valve Rocker Arm Cover</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Disconnect the electrical connectors, as necessary. 2. Transfer components as necessary.

VALVE ROCKER ARM LOWER COVER REPLACEMENT - RIGHT SIDE

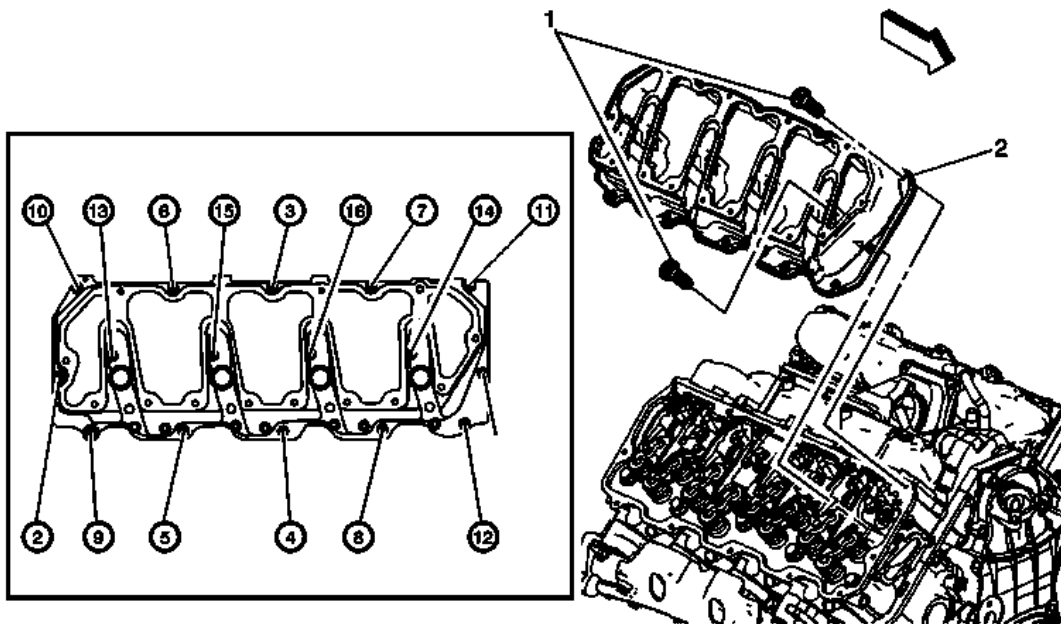


Fig. 47: Valve Rocker Arm Lower Cover And Fastener With Tightening Sequence - Right Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Lower Cover Replacement - Right Side

Callout	Component Name
<p>CAUTION:</p> <p>Label all the injector electrical connectors before the connectors are removed in order to prevent reconnecting to the wrong injector. Failure to properly connect the injectors in the correct sequence</p>	

will cause severe engine damage.

Preliminary Procedures

1. Remove the valve rocker arm cover upper right side. Refer to **Valve Rocker Arm Upper Cover Replacement - Right Side**.
2. Remove the four fuel injectors. Refer to **Fuel Injector Replacement (Right Side)** , **Fuel Injector Replacement (Left Side)** .
3. Remove the generator bracket. Refer to **Generator Bracket Replacement (Diesel)**

1	<p>Valve Rocker Arm Cover Fastener (Qty: 16)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. The gasket may be reused if it is not torn, cracked, stretched, or swollen. 2. Ensure to tighten the bolts in sequence shown. <p>Tighten 10 N.m (89 lb in)</p>
2	<p>Valve Rocker Arm Cover</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Disconnect the electrical connectors, as necessary. 2. Transfer components as necessary.

VALVE ROCKER ARM, SHAFT, AND PUSH ROD REPLACEMENT

Removal Procedure

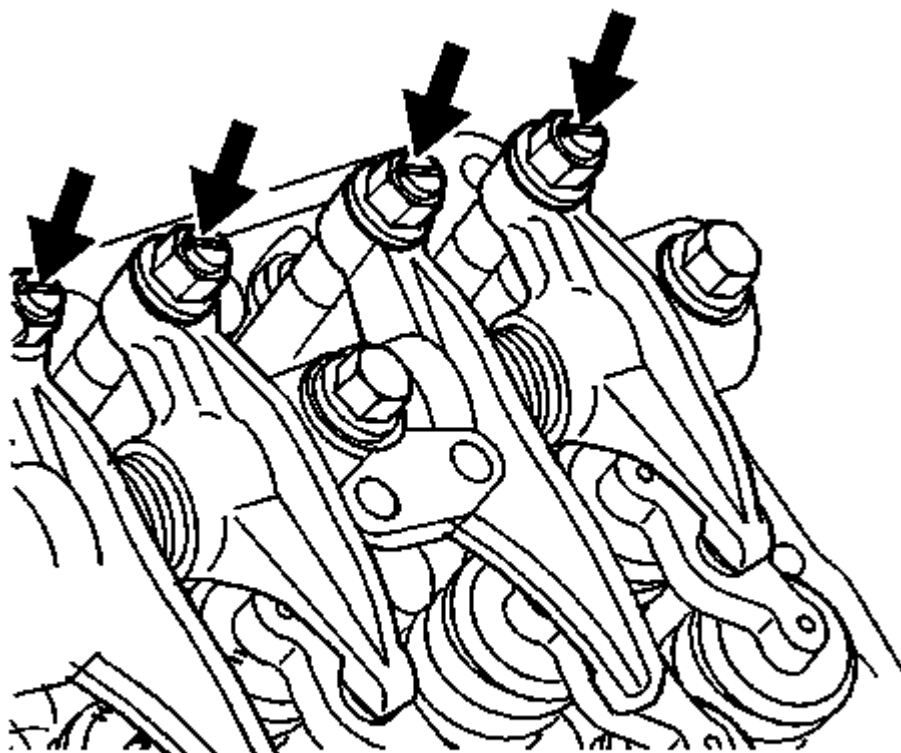


Fig. 48: View Of Valve Clearance Adjusting Screw
Courtesy of GENERAL MOTORS COMPANY

1. Remove the valve rocker arm lower cover - right side. Refer to **Valve Rocker Arm Lower Cover Replacement - Right Side**
2. Remove the valve rocker arm lower cover - left side. Refer to **Valve Rocker Arm Lower Cover Replacement - Left Side**
3. Loosen the valve clearance lock nuts on each rocker arm.
4. Loosen the valve clearance adjusting screw on each rocker arm in order to relieve tension on the valvetrain.

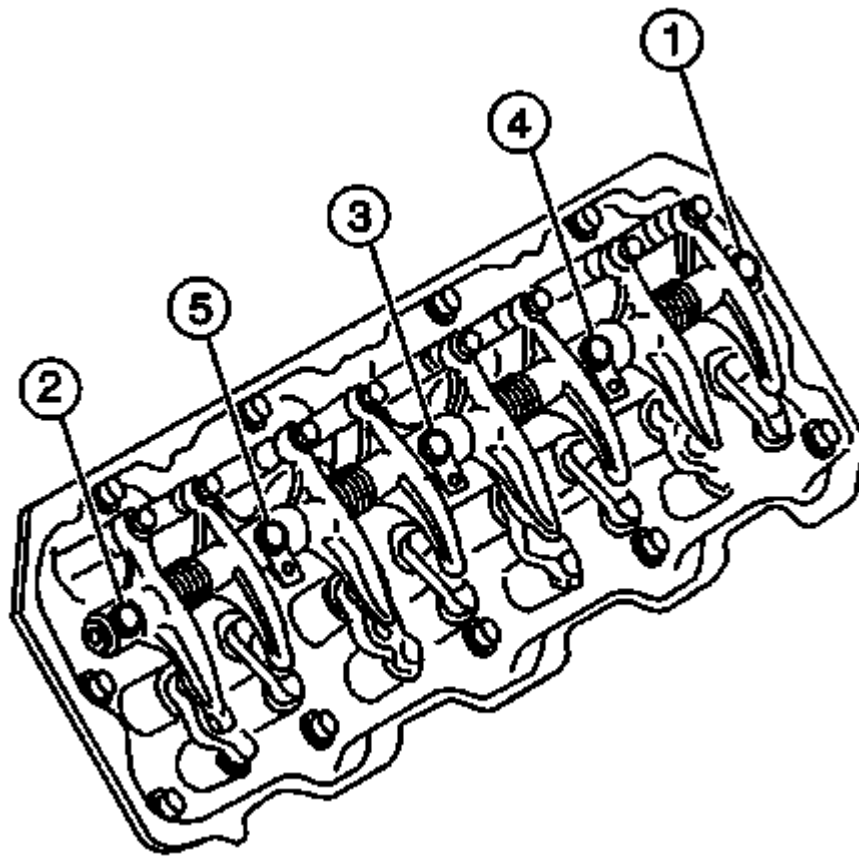


Fig. 49: Rocker Arm Shaft Bolts Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

5. Remove the rocker arm shaft assembly bolts in the sequence shown. Leave the bolts in the rocker arm shaft brackets.

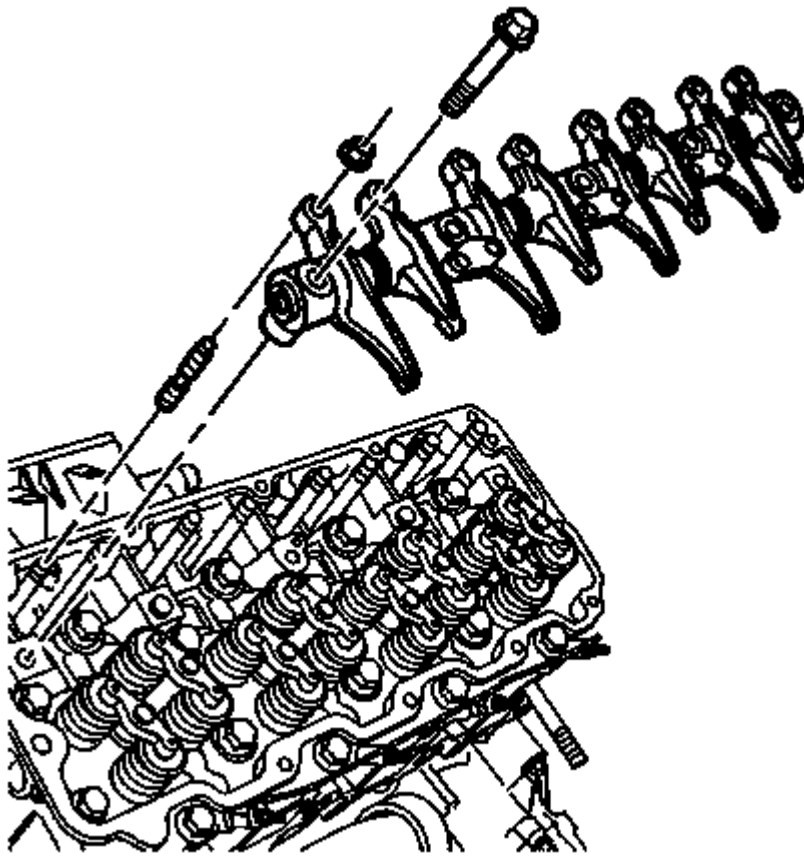


Fig. 50: View Of Rocker Arm Shaft
Courtesy of GENERAL MOTORS COMPANY

6. Remove the rocker arm shaft assembly from the cylinder head.

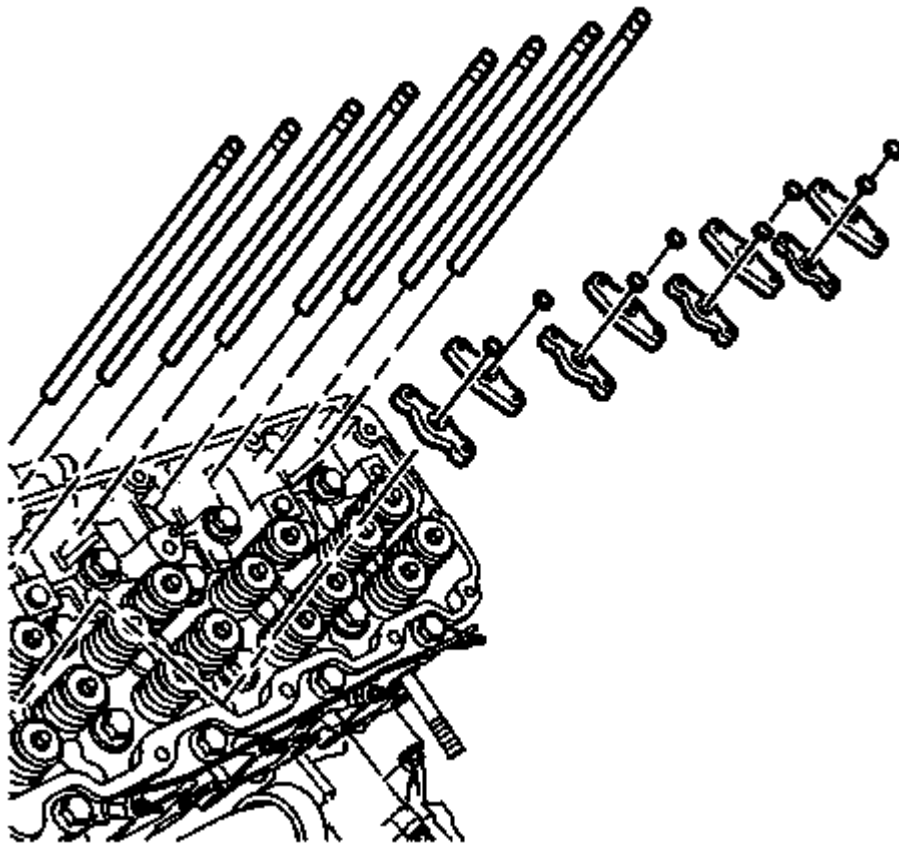


Fig. 51: View Of Pushrods, Valve Spring Caps & Valve Lifter Bridges
Courtesy of GENERAL MOTORS COMPANY

7. Remove the valve bridge pins.
8. Remove the valve bridges.
9. Remove the pushrods.

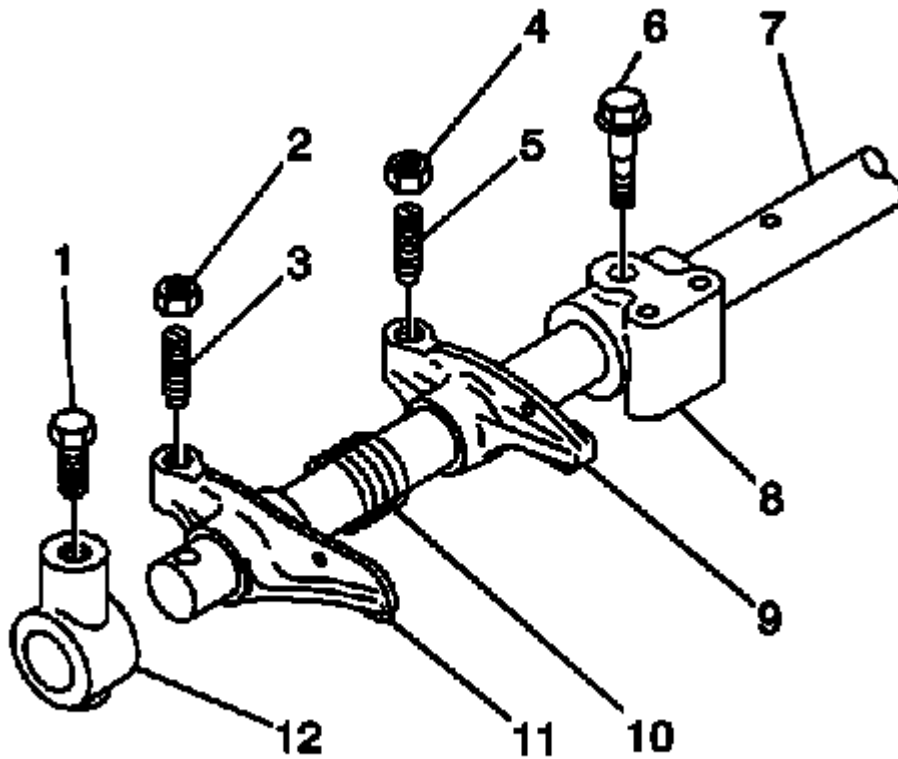


Fig. 52: View Of Rocker Arm Components
Courtesy of GENERAL MOTORS COMPANY

10. Remove the rocker arm shaft bracket bolts (1), if necessary.
11. Remove the bracket (12), rocker arm (11), and spring (10), if necessary.
12. Remove the remaining rocker arms, springs, and brackets, if necessary.
13. If required, clean and inspect the valve rocker arm and shaft. Refer to **Valve Rocker Arm and Shaft Cleaning and Inspection** .

Installation Procedure

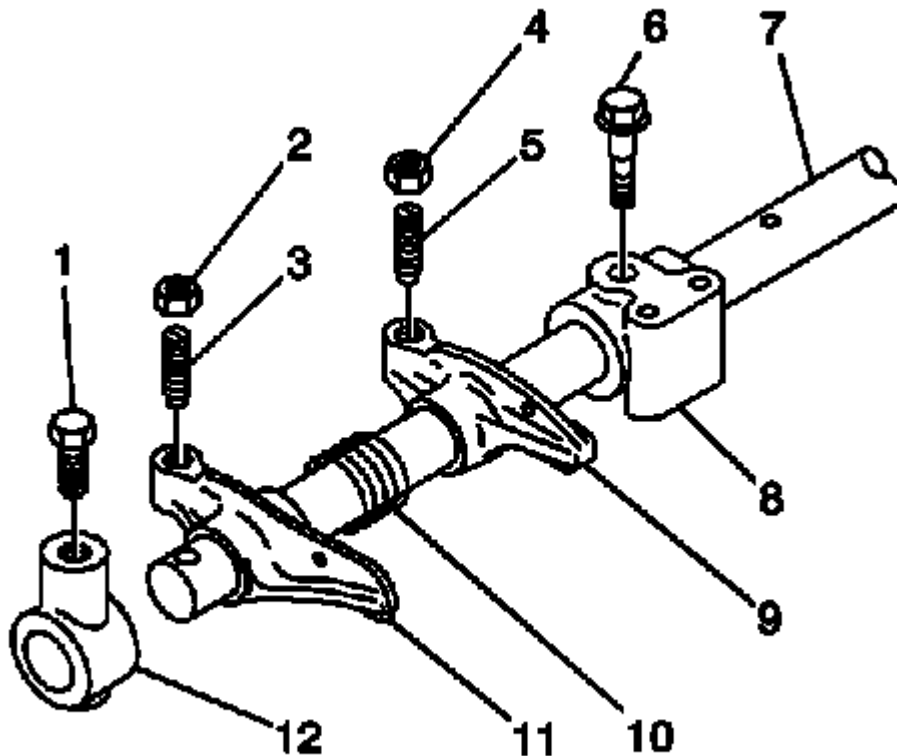


Fig. 53: View Of Rocker Arm Components
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the rocker arm shaft (7) and the inside of the rocker arms with clean engine oil, if necessary.
2. Install the rocker arm bracket (12) and bolt (1) on one end of the rocker arm shaft, if necessary.
3. Install the intake rocker arm (9), spring (10), exhaust rocker arm (11), and bracket (12) with bolt (1). Continue in the same sequence to the last bracket, if necessary.
4. Push the bracket (12) to compress the springs and then install the bolt (1), if necessary.

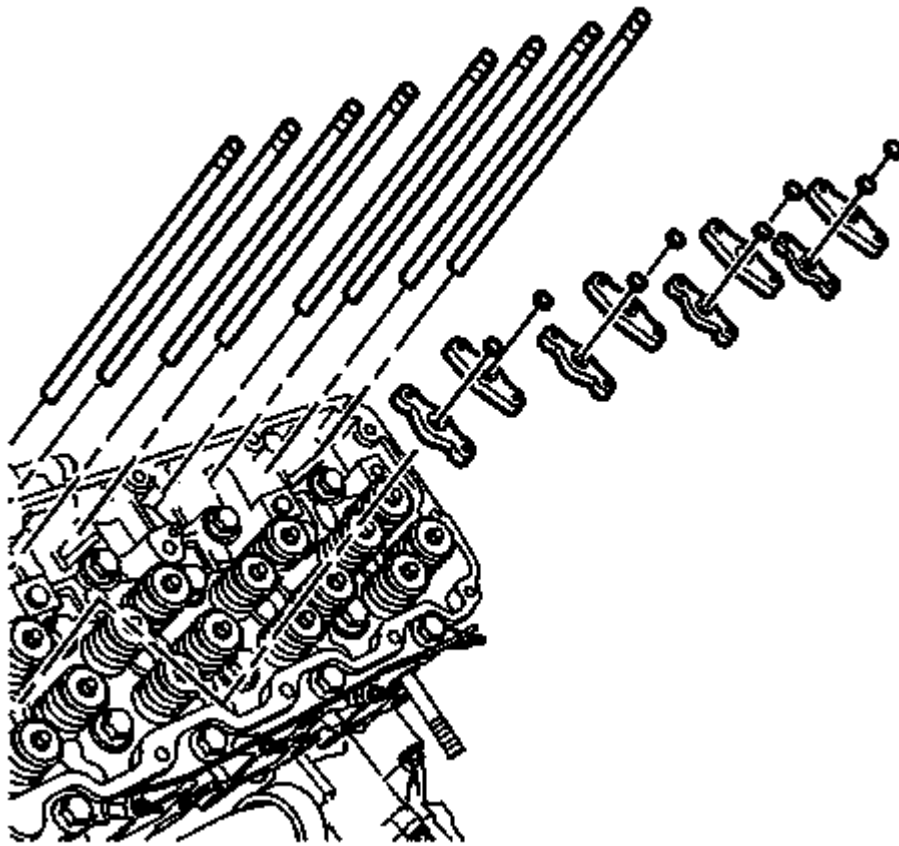


Fig. 54: View Of Pushrods, Valve Spring Caps & Valve Lifter Bridges
Courtesy of GENERAL MOTORS COMPANY

5. Lubricate the top of the valves, the valve bridge stem, the valve lifter bridge, and the valve spring caps with clean engine oil.
6. Install the valve bridge.
7. Install the valve bridge pins.
8. Lubricate the valve lifter end of the pushrod with clean engine oil.
9. Install the pushrods.

To ensure the pushrod is properly installed, gently pull up on the pushrod. Resistance should be felt from the pushrod trying to lift the valve lifter.

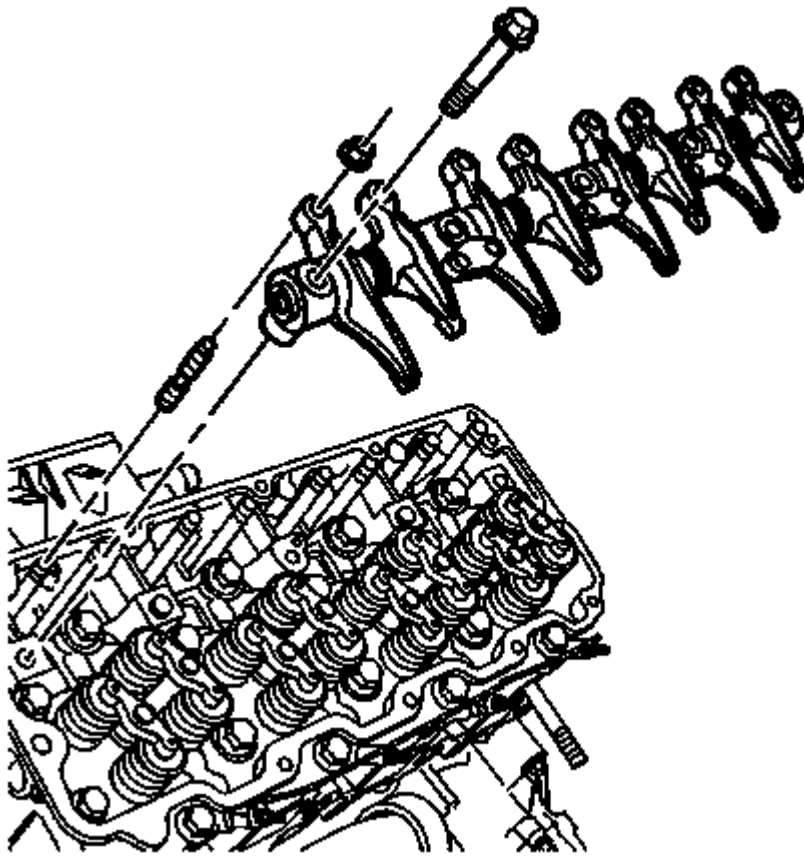


Fig. 55: View Of Rocker Arm Shaft
Courtesy of GENERAL MOTORS COMPANY

CAUTION: The pushrods must be correctly seated in the valve lifter and valve rocker arms before the rocker arm shaft assembly is torqued into place. Improper seating of the pushrods can cause damage to the pushrods or the valve rocker arm shaft assembly components.

10. Install the rocker arm shaft assembly.

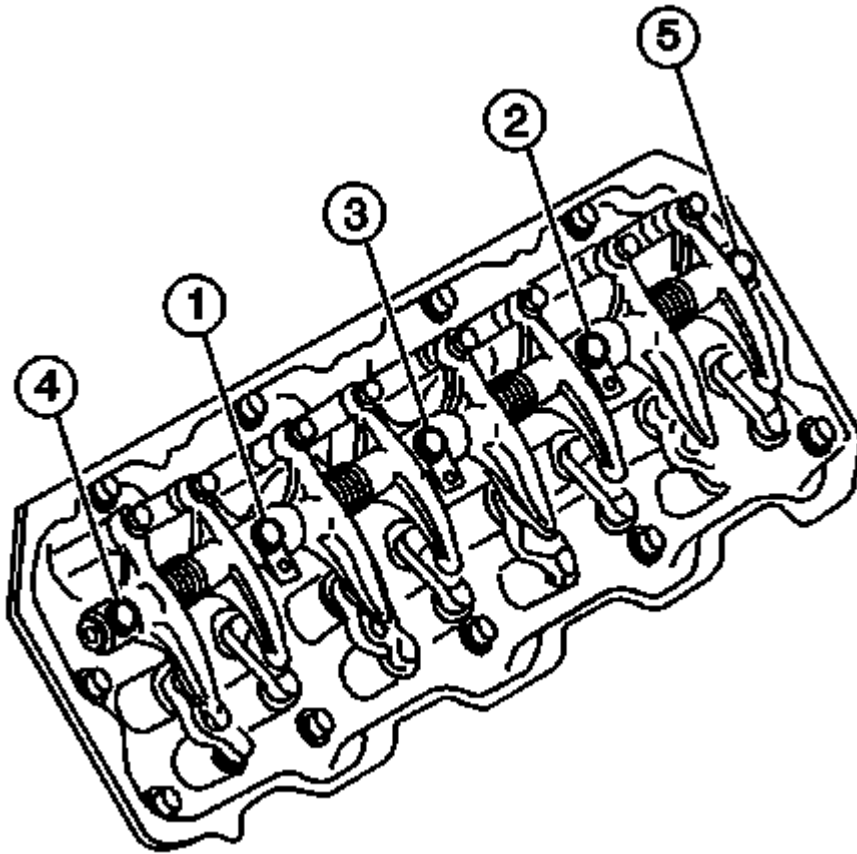


Fig. 56: Rocker Arm Shaft Bolts Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

11. Tighten the rocker arm shaft bolts in the sequence shown.

Tighten

Tighten the bolts to 41 N.m (30 lb ft).

12. Adjust the valve clearance. Refer to Valve Clearance Adjustment .
13. Install the valve rocker arm lower cover - right side. Refer to Valve Rocker Arm Lower Cover Replacement - Right Side.
14. Install the valve rocker arm lower cover - left side. Refer to Valve Rocker Arm Lower Cover Replacement - Left Side

VALVE CLEARANCE ADJUSTMENT

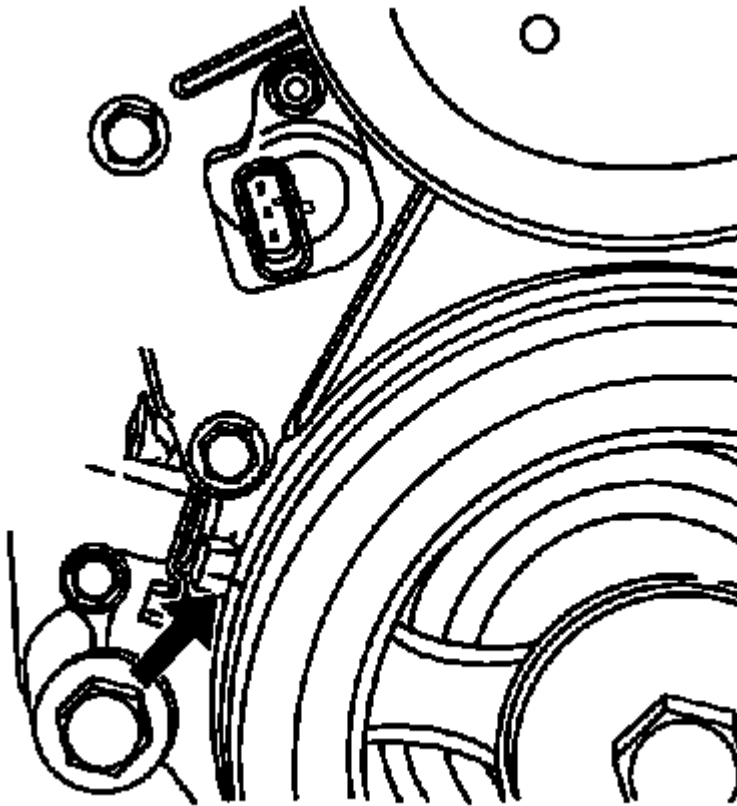


Fig. 57: View Of Crankshaft Balancer Mark Aligned With Engine Mark
Courtesy of GENERAL MOTORS COMPANY

1. Rotate the crankshaft to bring the number 1 cylinder at the top dead center of the compression stroke. The number 1 cylinder is the front cylinder on the right bank. The mark on the crankshaft balancer should be aligned with the mark on the engine.

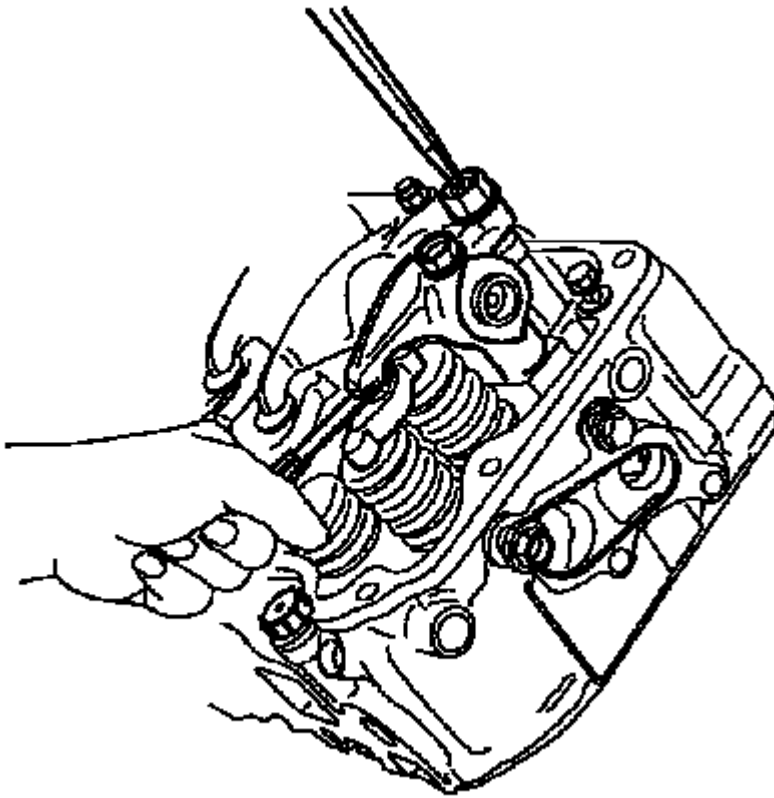


Fig. 58: View Of Feeler Gage Between Tip Of Rocker Arm & Valve Lifter Bridge
Courtesy of GENERAL MOTORS COMPANY

2. Loosen the valve adjusting screws.
3. Insert a feeler gauge between the tip of the rocker arm and the valve bridge.

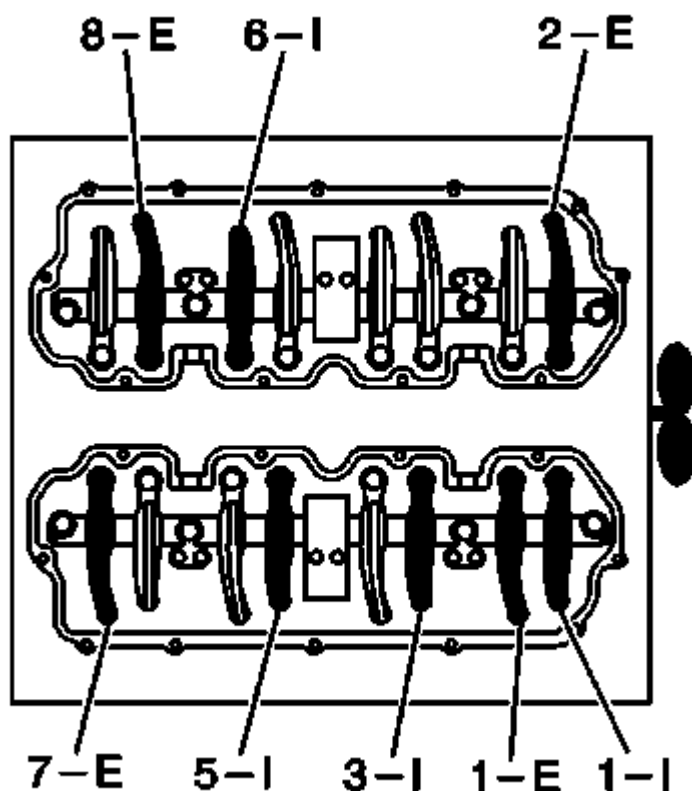


Fig. 59: View Of Rocker Arm Intake & Exhaust Valves 1, 2, 3, 5, 6, 7 & 8
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Adjust the valve lash to 0.3 mm (0.012 in). Refer to Valve Clearance Adjustment Specifications to determine which valves that can be adjusted when the engine is at Top Dead Center. Tighten the valve lash lock nut to 22 N.m (16 lb ft).

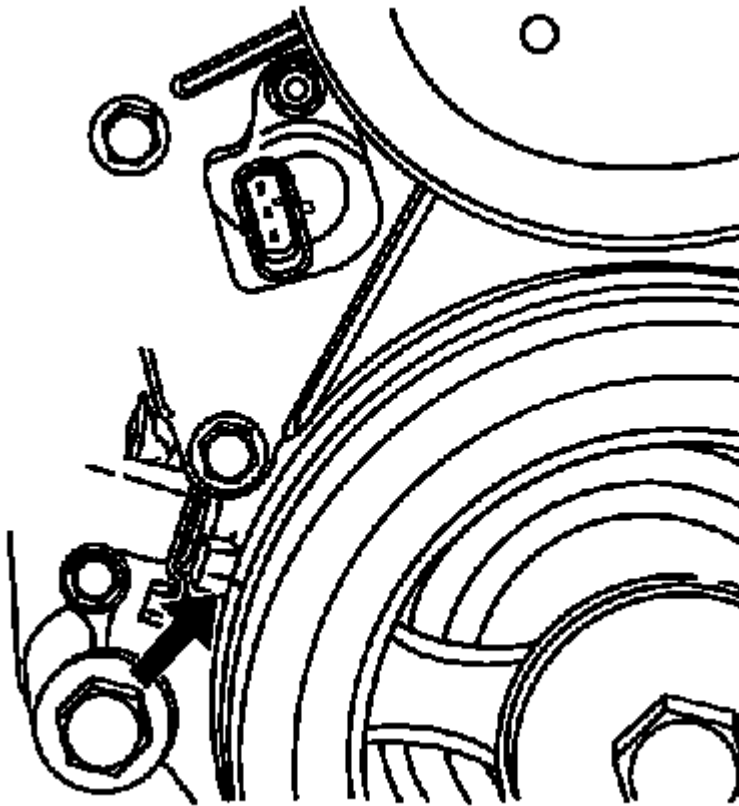


Fig. 60: View Of Crankshaft Balancer Mark Aligned With Engine Mark
Courtesy of GENERAL MOTORS COMPANY

5. Rotate the crankshaft one revolution to bring the number 1 cylinder at Top Dead Center of the exhaust stroke.

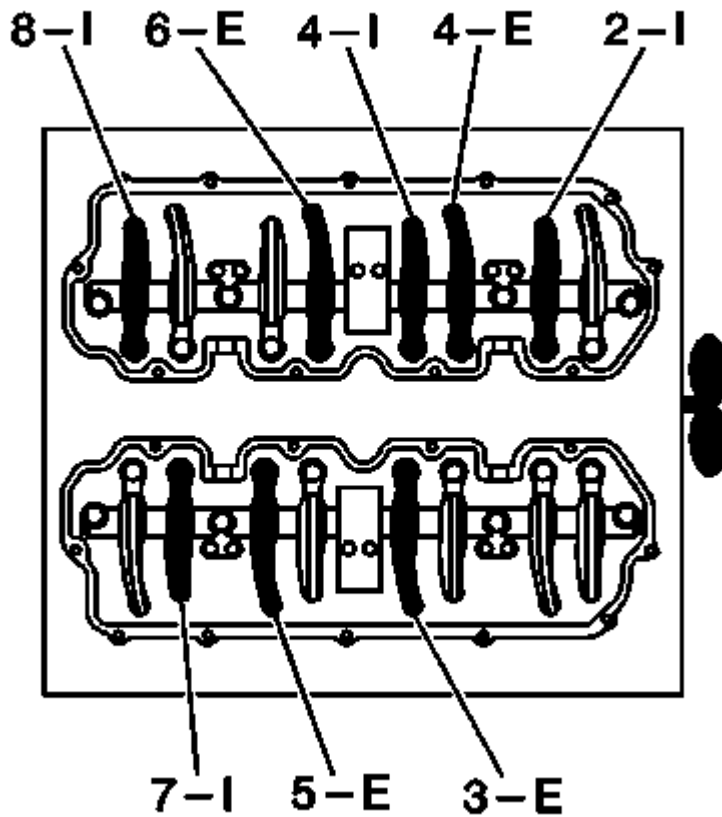


Fig. 61: View Of Rocker Arm Intake & Exhaust Valves 2, 3, 4, 5, 6, 7 & 8
 Courtesy of GENERAL MOTORS COMPANY

6. Adjust the valve lash to 0.3 mm (0.012 in). Refer to Valve Clearance Adjustment Specifications to determine which valves that can be adjusted when the engine is at Top Dead Center. Tighten the valve lash lock nut to 22 N.m (16 lb ft).

TURBOCHARGER REPLACEMENT (LML)

Removal Procedure

CAUTION: If a turbocharger has failed, clean any turbocharger debris or excessive oil from the charge air cooler system before installing the new turbocharger. Failure to clean debris from the charge air cooler system will cause severe turbocharger and engine damage upon startup. Failure to clean excessive oil from the charge air cooler system may cause an engine runaway condition on startup, resulting in severe engine damage.

1. Remove the turbocharger exhaust pipe. Refer to Turbocharger Exhaust Pipe Replacement .
2. Remove the exhaust rear gas recirculation manifold cooling feed pipe. Refer to Exhaust Gas Recirculation Coolant Hoses/Pipes Replacement (Cooler to Cooler Hose-LML) , Exhaust Gas Recirculation Coolant Hoses/Pipes Replacement (EGR Bypass Pipe-LML) , Exhaust Gas

Recirculation Coolant Hoses/Pipes Replacement (Manifold Feed Pipe to Cooler Hose-LML) , Exhaust Gas Recirculation Coolant Hoses/Pipes Replacement (Manifold Feed Hose to Cooler-LML) , Exhaust Gas Recirculation Coolant Hoses/Pipes Replacement (EGR Manifold Return Hose-LGH,LML) .

3. Remove the right side exhaust pipe. Refer to **Exhaust Manifold Outlet Pipe Replacement - Right Side (LML) .**
4. Remove the left side exhaust pipe. Refer to **Exhaust Manifold Outlet Pipe Replacement - Left Side .**
5. Remove the exhaust rear gas recirculation cooler assembly. Refer to **Exhaust Gas Recirculation Valve Cooler Replacement (Rear) , Exhaust Gas Recirculation Valve Cooler Replacement (Front) .**

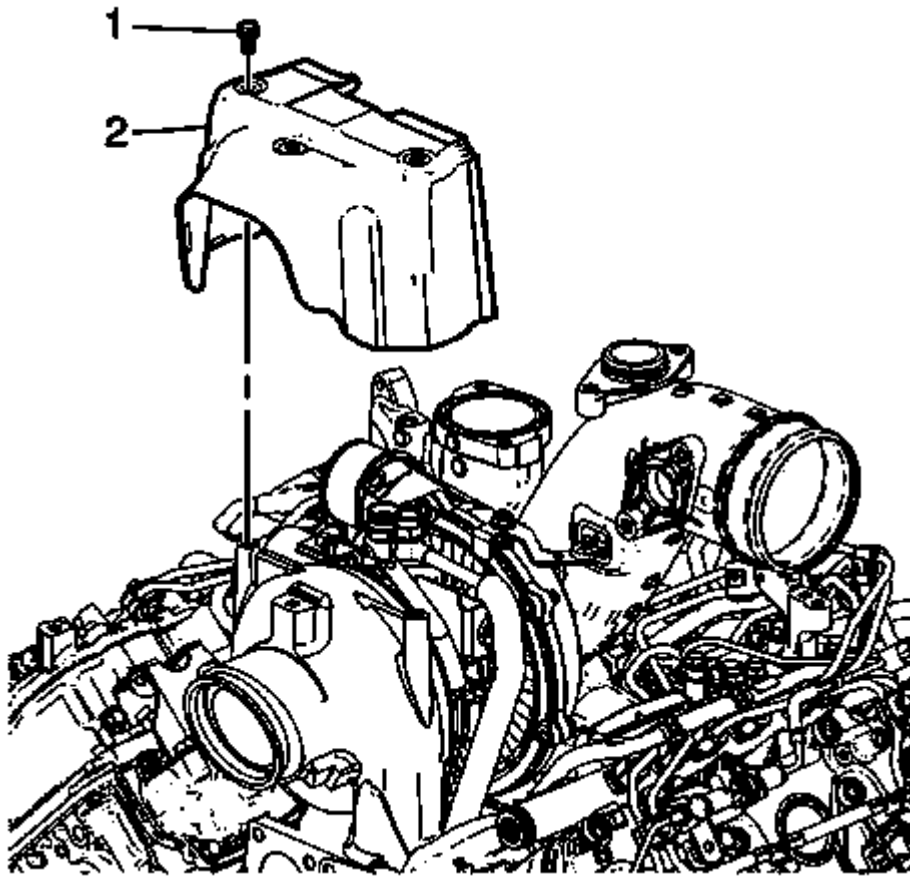


Fig. 62: Turbocharger Upper Heat Shield And Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the turbocharger upper heat shield bolts (1).
7. Remove the turbocharger upper heat shield (2).
8. Disconnect the turbo valve solenoid and sensor connectors.

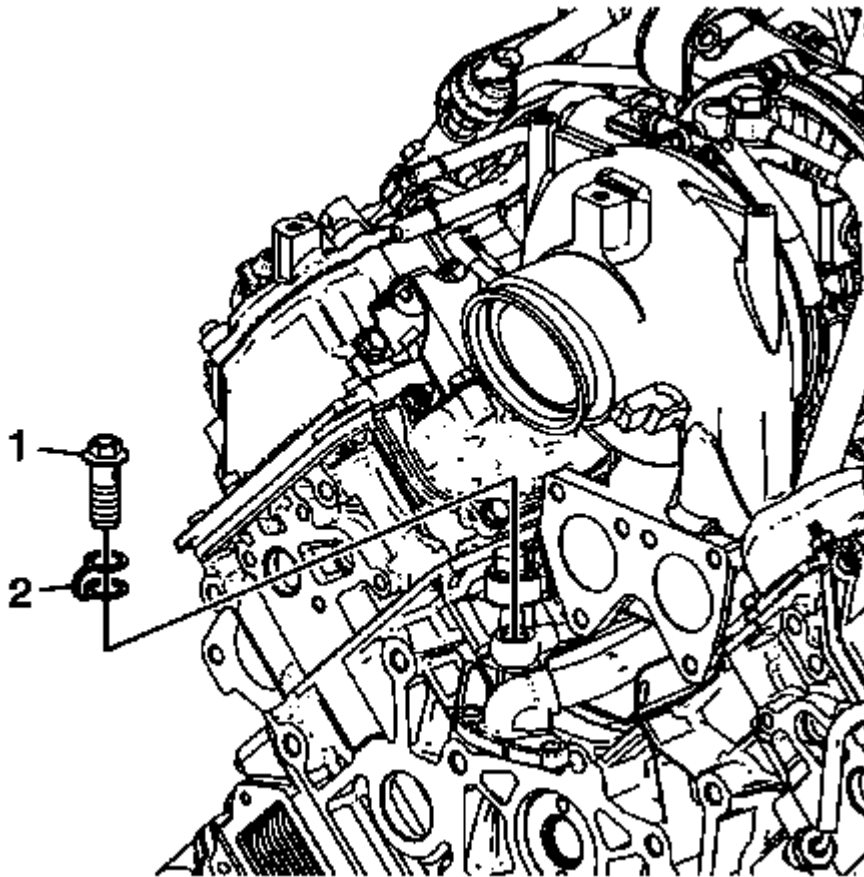


Fig. 63: View Of Turbocharger Oil Feed Pipe Eye Bolt & Washers
Courtesy of GENERAL MOTORS COMPANY

9. Remove the eye bolt (1) and washers (2) from the turbocharger oil feed pipe.

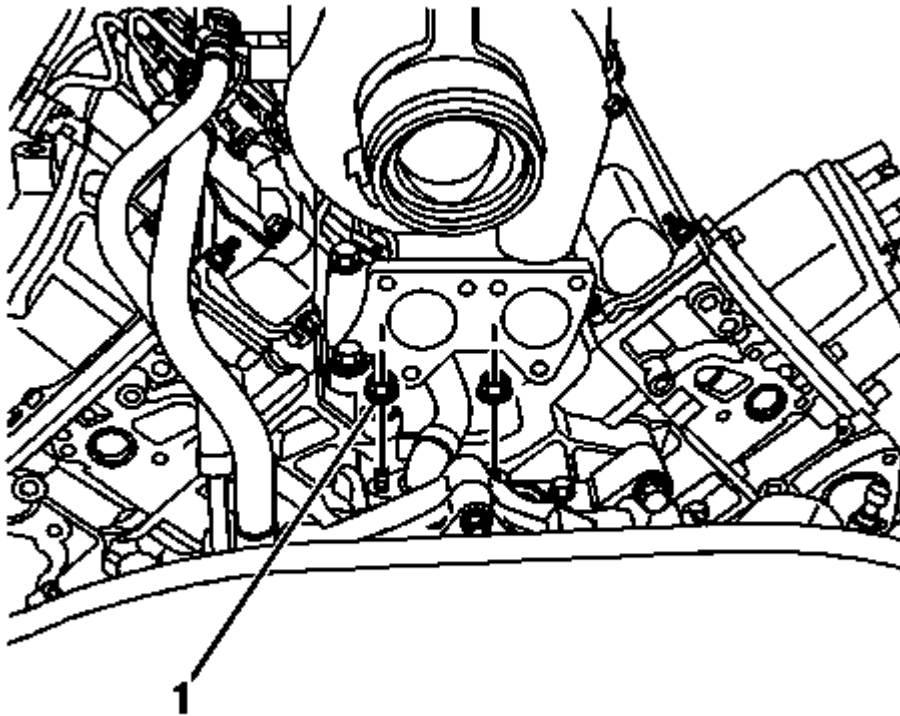


Fig. 64: Turbo Oil Return Pipe Fastener
Courtesy of GENERAL MOTORS COMPANY

10. Remove the 2 turbo oil return pipe fasteners (1).

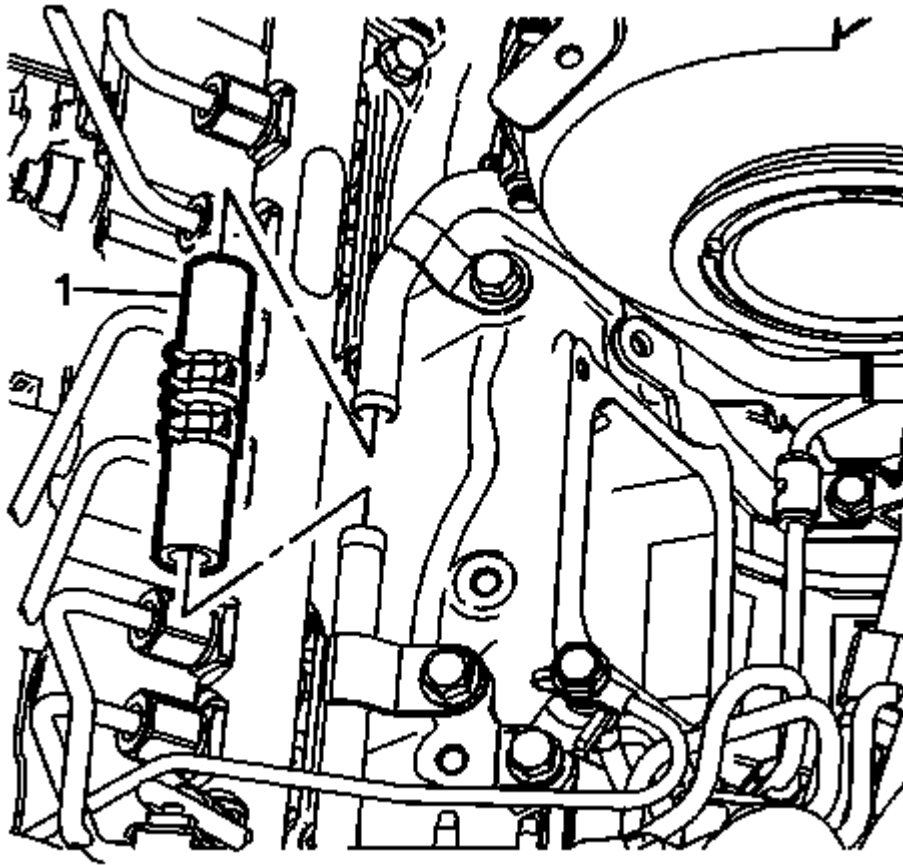


Fig. 65: Turbo Coolant Feed Hose
Courtesy of GENERAL MOTORS COMPANY

11. Remove the turbo coolant feed hose (1).

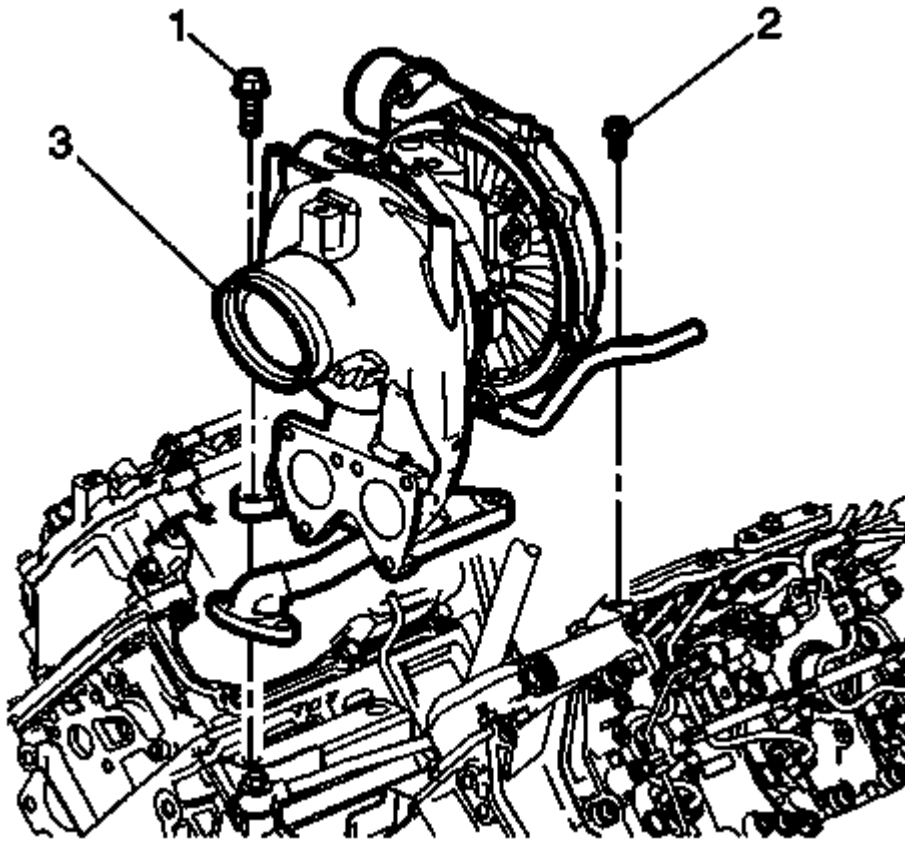


Fig. 66: Turbocharger, Mounting Bolts And Turbocharger Cooling Return Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

12. Remove the turbocharger mounting bolts (1).
13. Remove the turbocharger cooling return pipe bolt (2).
14. Remove the turbocharger assembly (3) with the oil feed pipe, oil return pipe and cooling return pipe.

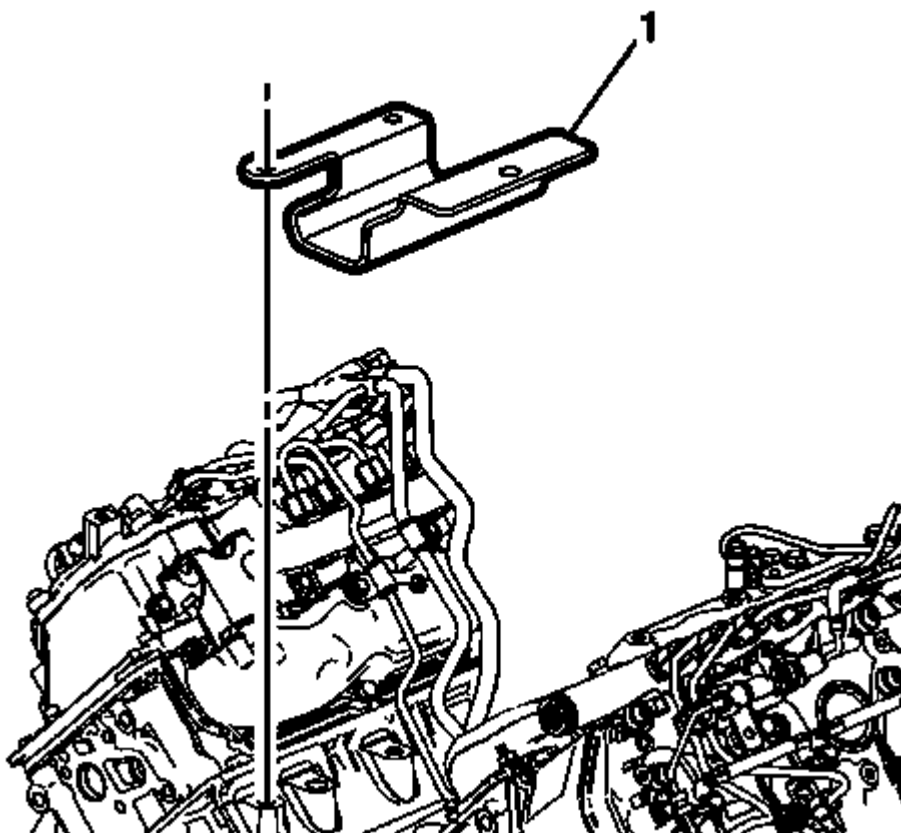


Fig. 67: Turbocharger Lower Heat Shield
Courtesy of GENERAL MOTORS COMPANY

15. Remove the turbocharger lower heat shield (1).
16. Transfer parts as necessary.
17. Clean and inspect the turbocharger. Refer to **Turbocharger Cleaning and Inspection** .

Installation Procedure

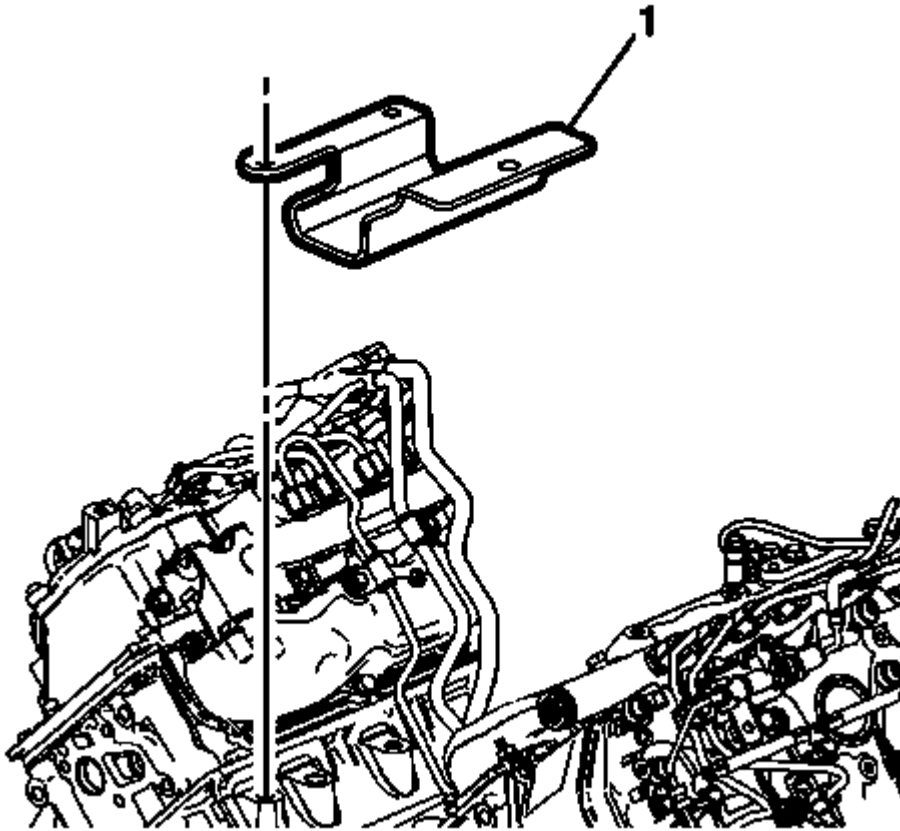


Fig. 68: Turbocharger Lower Heat Shield
Courtesy of GENERAL MOTORS COMPANY

1. Install the turbocharger lower heat shield (1).

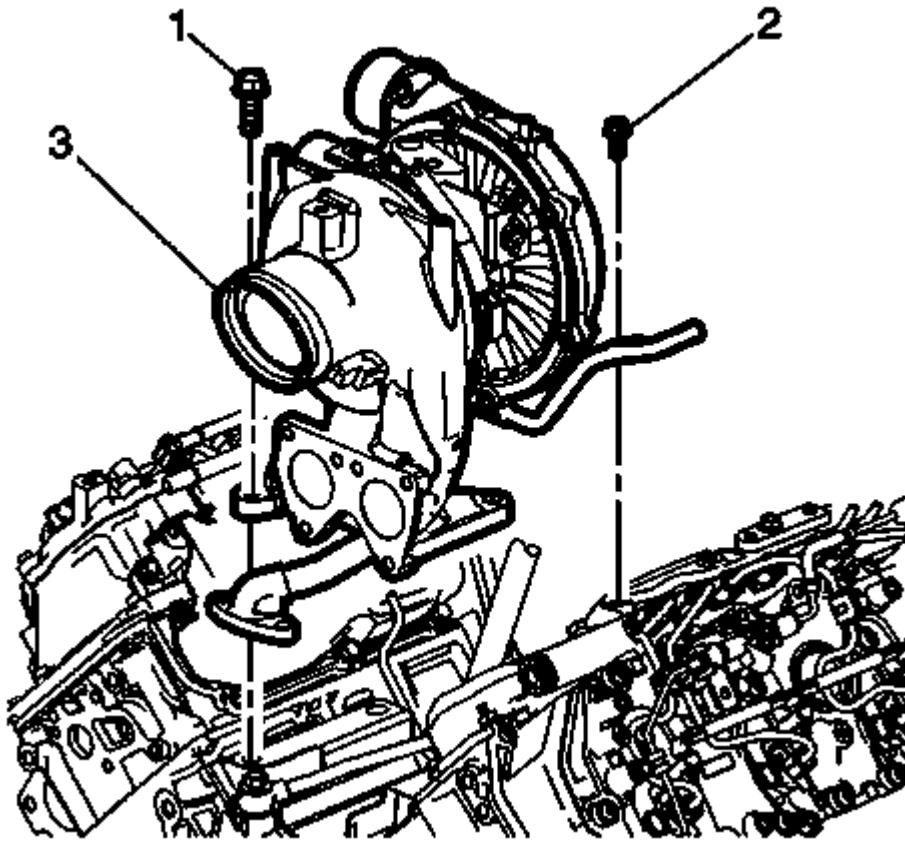


Fig. 69: Turbocharger, Mounting Bolts And Turbocharger Cooling Return Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

2. Install the turbocharger assembly (2) with the oil feed pipe, oil return pipe and cooling return pipe.

CAUTION: Refer to Fastener Caution .

3. Install the turbocharger mounting bolts (1) and tighten to 78 N.m (58 lb ft).
4. Install the turbocharger cooling return pipe bolt (3) and tighten to 35 N.m (26 lb ft).

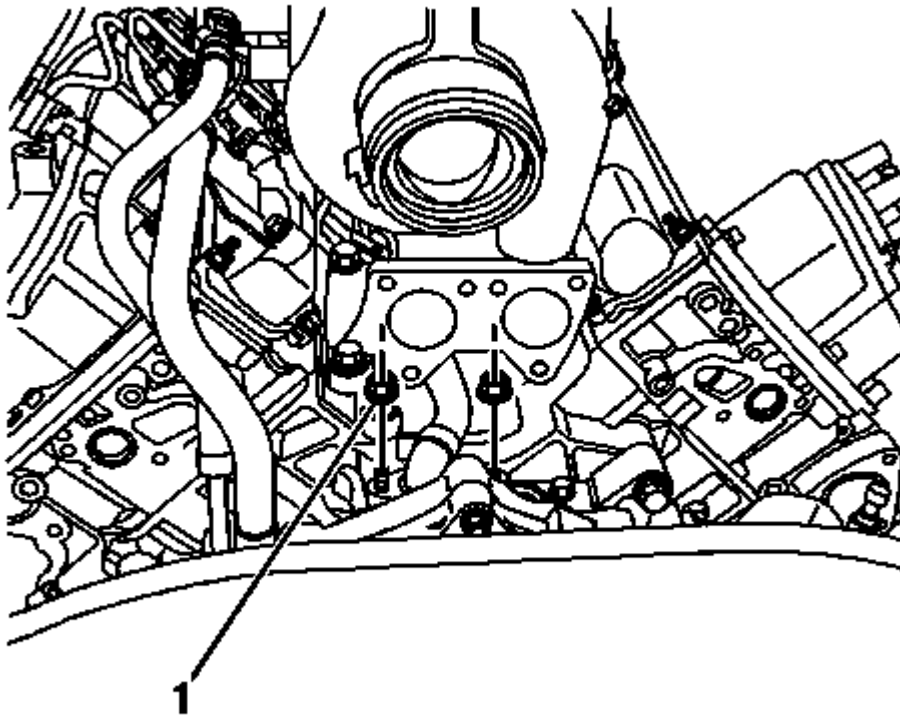


Fig. 70: Turbo Oil Return Pipe Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Install the 2 turbo oil return pipe fasteners (1) and tighten to 25 N.m (18 lb ft).
6. Install the turbo coolant feed hose.

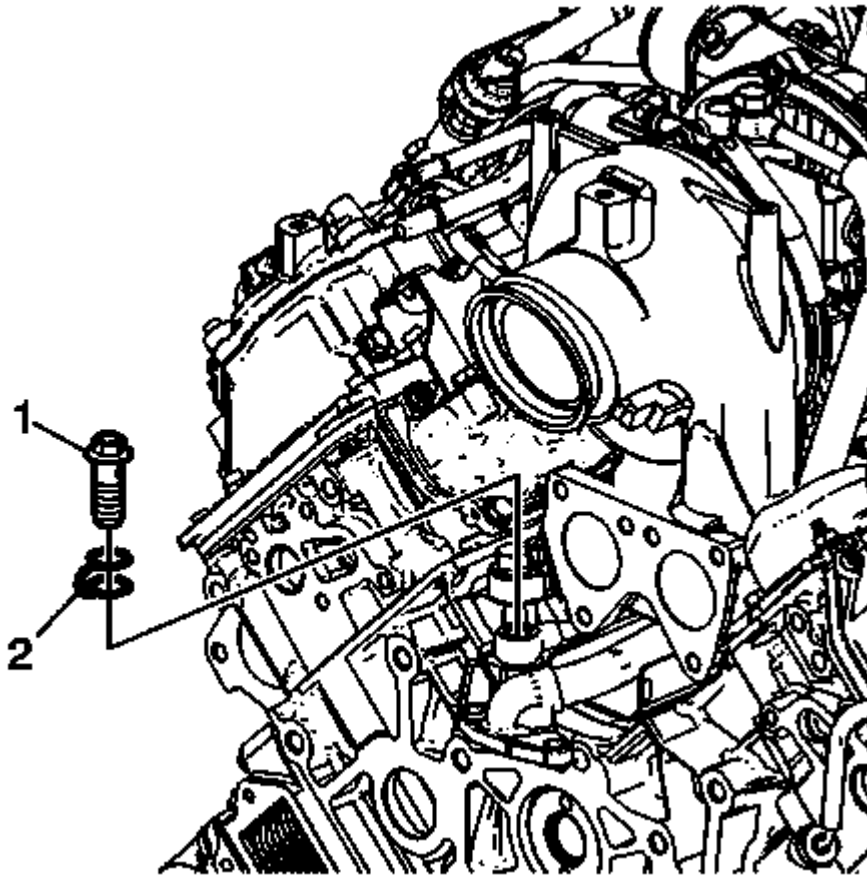


Fig. 71: View Of Turbocharger Oil Feed Pipe Eye Bolt & Washer
Courtesy of GENERAL MOTORS COMPANY

NOTE: Lubricate the washers with diesel fuel before installing.

7. Install the turbocharger oil feed pipe eye bolt (1) and washers (2). Tighten the eye bolt to 50 N.m (37 lb ft).

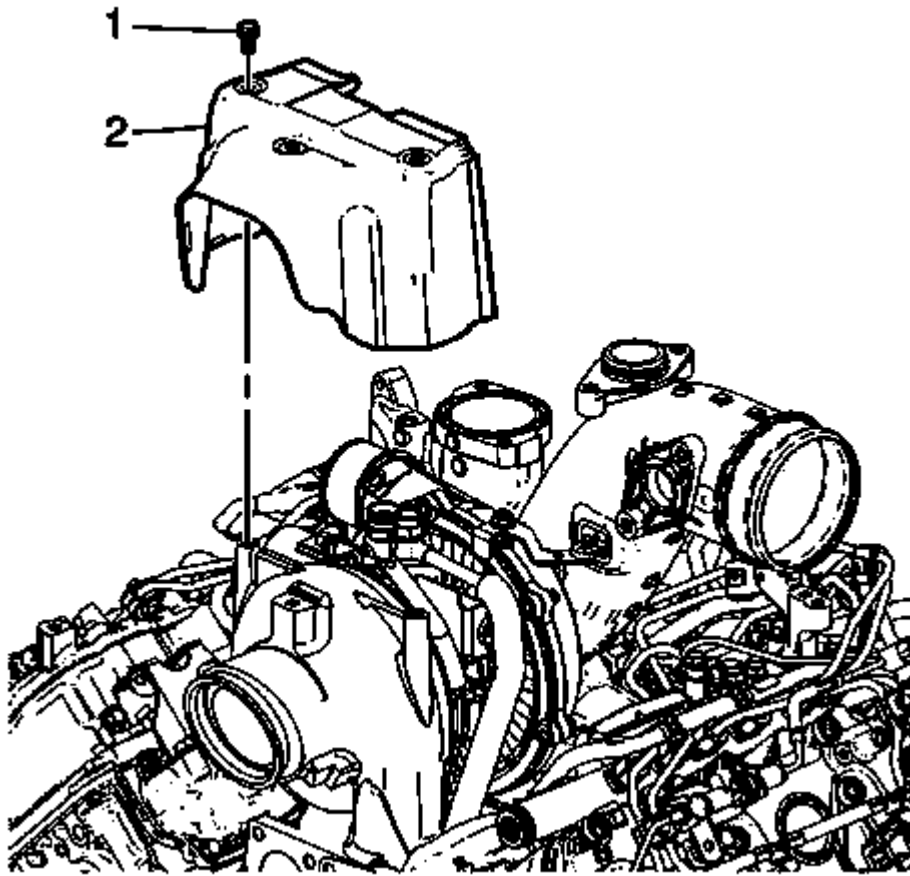


Fig. 72: Turbocharger Upper Heat Shield And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Connect the turbo valve solenoid and sensor connectors.
9. Install the turbocharger heat shield (2).
10. Install the turbocharger upper heat shield bolts (1) and tighten to 10 N.m (89 lb in).
11. Install the charge air cooler inlet pipe. Refer to **Charge Air Cooler Inlet Pipe Replacement** .
12. Install the exhaust gas recirculation cooler assembly. Refer to **Exhaust Gas Recirculation Valve Cooler Replacement (Rear)** , **Exhaust Gas Recirculation Valve Cooler Replacement (Front)** .
13. Install the left side exhaust pipe. Refer to **Exhaust Manifold Outlet Pipe Replacement - Left Side** .
14. Install the right side exhaust pipe. Refer to **Exhaust Manifold Outlet Pipe Replacement - Right Side (LML)** .
15. Install the exhaust gas recirculation manifold cooling feed pipe. Refer to **Exhaust Gas Recirculation Coolant Hoses/Pipes Replacement (Cooler to Cooler Hose-LML)** , **Exhaust Gas Recirculation Coolant Hoses/Pipes Replacement (EGR Bypass Pipe-LML)** , **Exhaust Gas Recirculation Coolant Hoses/Pipes Replacement (Manifold Feed Pipe to Cooler Hose-LML)** , **Exhaust Gas Recirculation Coolant Hoses/Pipes Replacement (Manifold Feed Hose to Cooler-LML)** , **Exhaust Gas Recirculation Coolant Hoses/Pipes Replacement (EGR Manifold Return Hose-LGH,LML)** .
16. Install the turbocharger exhaust pipe. Refer to **Turbocharger Exhaust Pipe Replacement** .
17. Perform the scan tool Diesel Particulate Filter (DPF) Regeneration Enable. Refer to **Diesel Particulate**

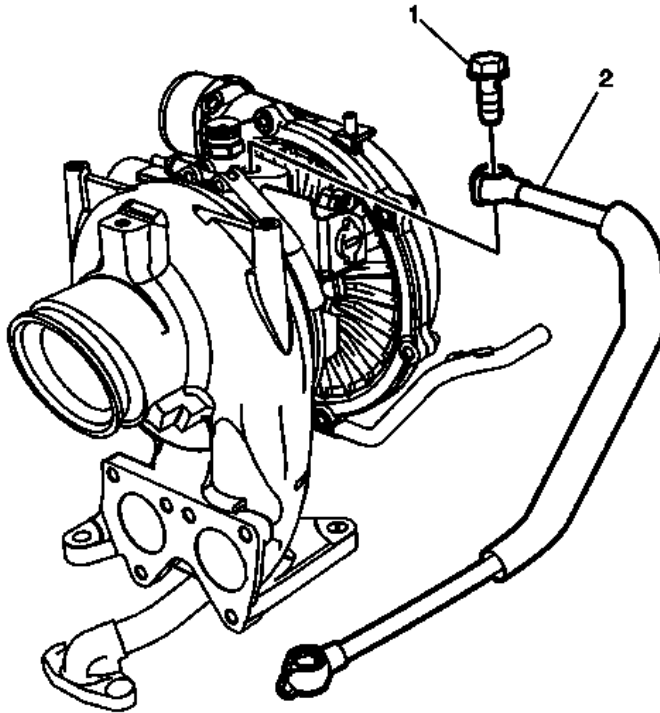
Filter (DPF) Regeneration Enable .**TURBOCHARGER OIL FEED PIPE REPLACEMENT**

Fig. 73: View Of Turbocharger Oil Feed Pipe & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Oil Feed Pipe Replacement

Callout	Component Name
Preliminary Procedure Remove the turbocharger. Refer to <u>Turbocharger Replacement (LML)</u> .	
1	Oil Feed Pipe Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 35 N.m (26 lb ft)
2	Oil Feed Pipe Procedure Transfer parts as necessary.

CYLINDER HEAD REPLACEMENT - LEFT SIDE

Special Tools

J-45059 Angle Meter

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

Removal Procedure

1. Remove the engine assembly. Refer to **Engine Replacement**.
2. Remove the valve rocker arm shaft, pushrods, and valve bridges. Refer to **Valve Rocker Arm, Shaft, and Push Rod Replacement**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement - Left Side**.
4. Remove the exhaust pipe. Refer to **Exhaust Pipe Removal - Left Side** .
5. Remove the exhaust manifold. Refer to **Exhaust Manifold Removal - Left Side** .

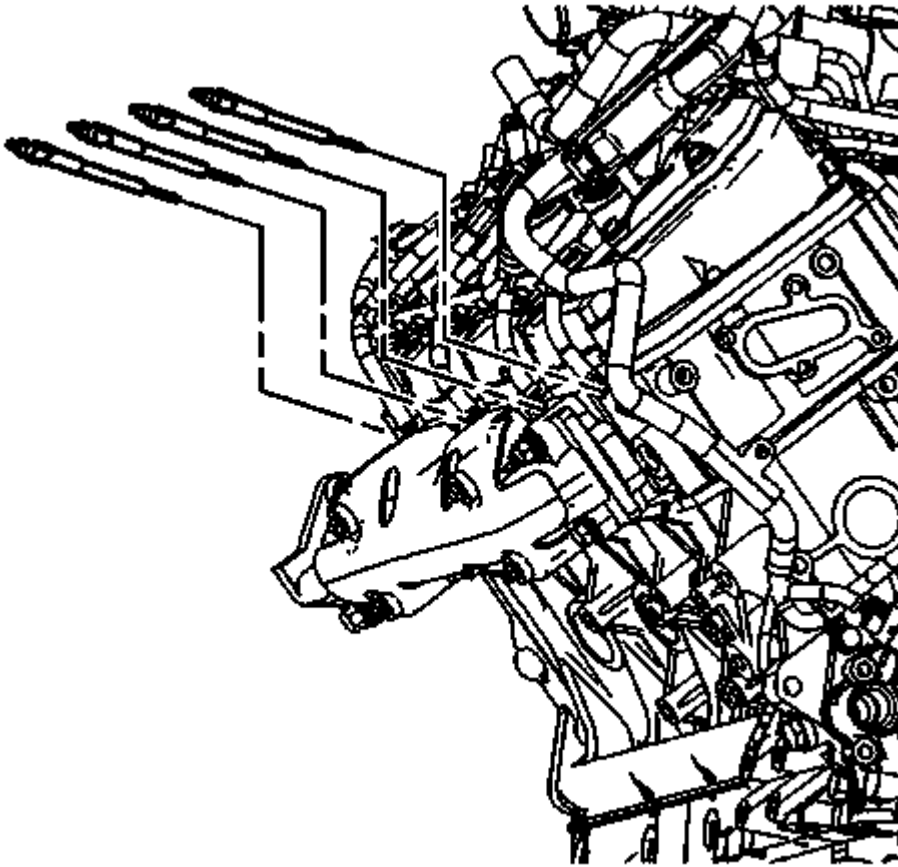


Fig. 74: View Of Right Glow Plugs
Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine wiring harness nut(s) from the glow plug(s).
7. Remove the engine wiring harness lead(s) from the glow plug(s).

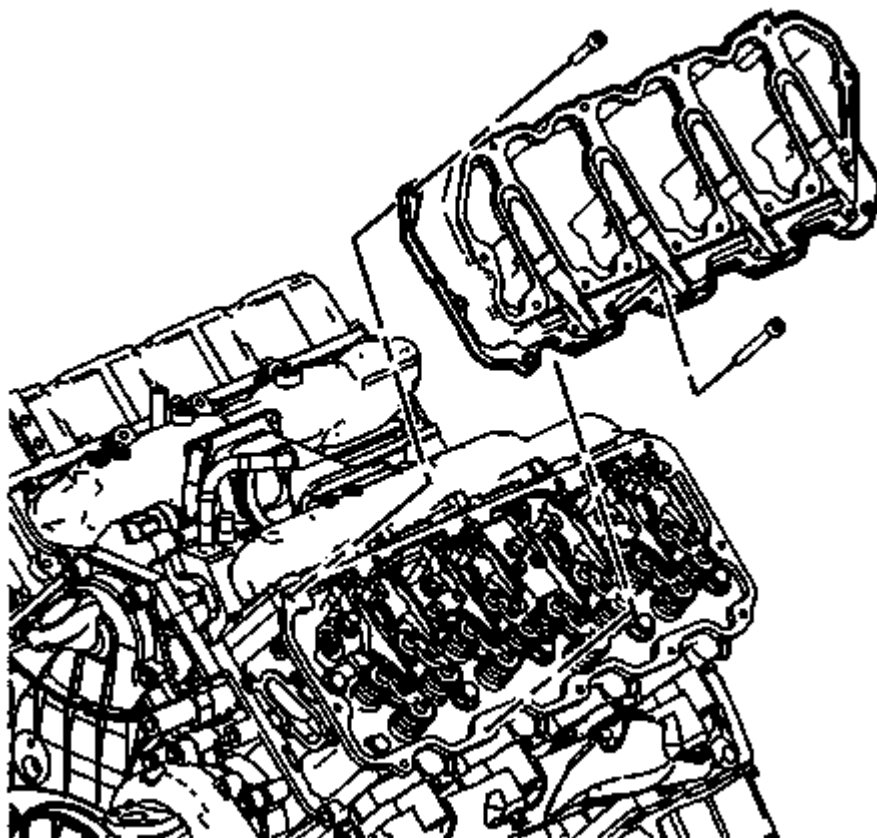


Fig. 75: View Of Lower Valve Rocker Arm Cover (Left)

Courtesy of GENERAL MOTORS COMPANY

8. Remove the left lower valve rocker arm cover and cover bolts. Refer to **Valve Rocker Arm Lower Cover Replacement - Left Side**.
9. Remove the valve rocker arm shaft, pushrods, and valve bridges. Refer to **Valve Rocker Arm, Shaft, and Push Rod Replacement**
10. Remove and discard the valve rocker arm cover gasket, valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.

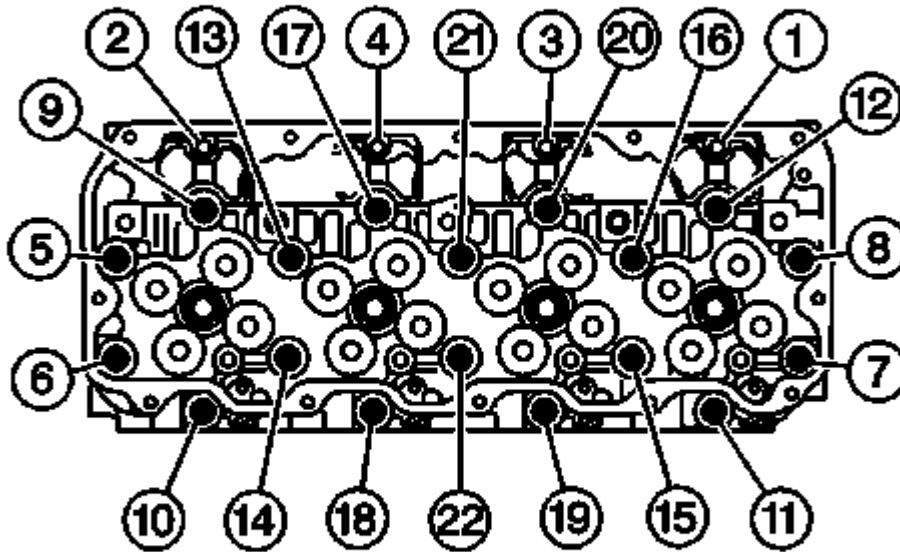


Fig. 76: Cylinder Head Bolt Removal Sequence
Courtesy of GENERAL MOTORS COMPANY

11. Remove the cylinder head bolts in the sequence shown.
12. Discard the large M12 bolts.

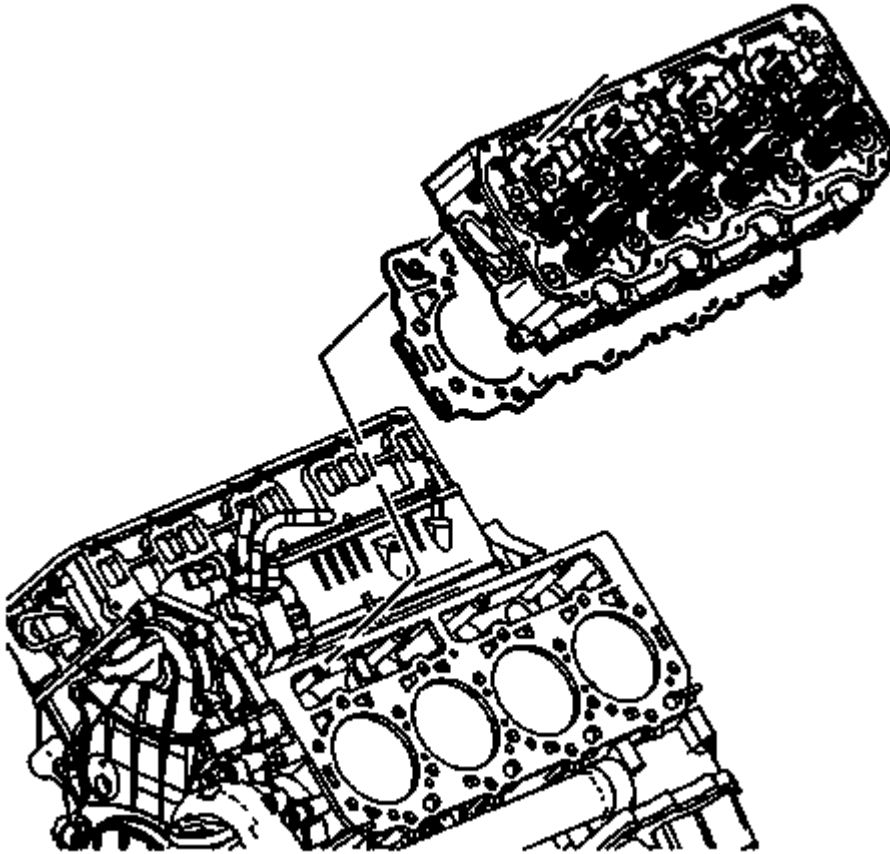


Fig. 77: View Of Left Cylinder Head Gasket
 Courtesy of GENERAL MOTORS COMPANY

13. Remove the cylinder head and discard the cylinder head gasket.
14. Clean the sealing surface of the engine block and the cylinder head.

CAUTION: 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.

15. Clean the cylinder head bolt holes in the engine block.
16. For service to the cylinder head, refer to the following:
 - **Cylinder Head Disassemble**
 - **Cylinder Head Cleaning and Inspection**
 1. Place clean rags in the cylinder bores and push rod openings in order to keep out debris.
 2. Use the J-28410 or equivalent to carefully clean the gasket sealing surface of large sealing or corrosion matter. When scraping, take care not to scratch or gouge the metal surfaces. Do not push the debris into oil, coolant, and combustion openings or bolt holes.
 3. Inspect the gasket sealing surfaces for corrosion, especially in the areas that were in contact

with the crimped tabs of the first generation head gasket. If corrosion is present, continue with the rest of the steps in this procedure for proper cleaning. If the sealing surface is sufficiently clean and smooth, then torque to specification.

4. For surfaces that have corrosion or pitting, wrap a piece of flat steel (4"x 2" or larger) with 600 grit wet grade sand paper. Using Moisture Displacing Lubricant, P/N 88862629 (in Canada, use 89020803) or equivalent, wet sand the block surface to remove any remaining gasket material or corrosion. Do not use any paper coarser than 600 grit.

NOTE: **Do not use any power type sanding devices. Do not use a wire brush or wheel to clean gasket surfaces. Do not use chemical cleaning agents on gasket surfaces.**

5. Take care to keep the sanding block parallel to the block surface and evenly sand the sealing surface. Some areas of corrosion will still show a stain. Do not attempt to wet sand these areas down to a shiny metal surface.
6. Change the sanding paper when it becomes clogged. Carefully and frequently wipe the surface, using a clean cloth each time, to prevent sanding debris from building up and contaminating the oil and coolant cavities.
7. Clean the bolt threads and holes and remove the rags from the bore cavities and pushrod openings.
8. Repeat the above cleaning procedure on the cylinder head gasket surface.
9. Clean the engine block and cylinder head gasket surfaces with Brake Parts Cleaner, P/N 88862650 (in Canada, use 88901247) or equivalent, to remove any traces of oil or debris.

- **Cylinder Head Assemble**

Installation Procedure

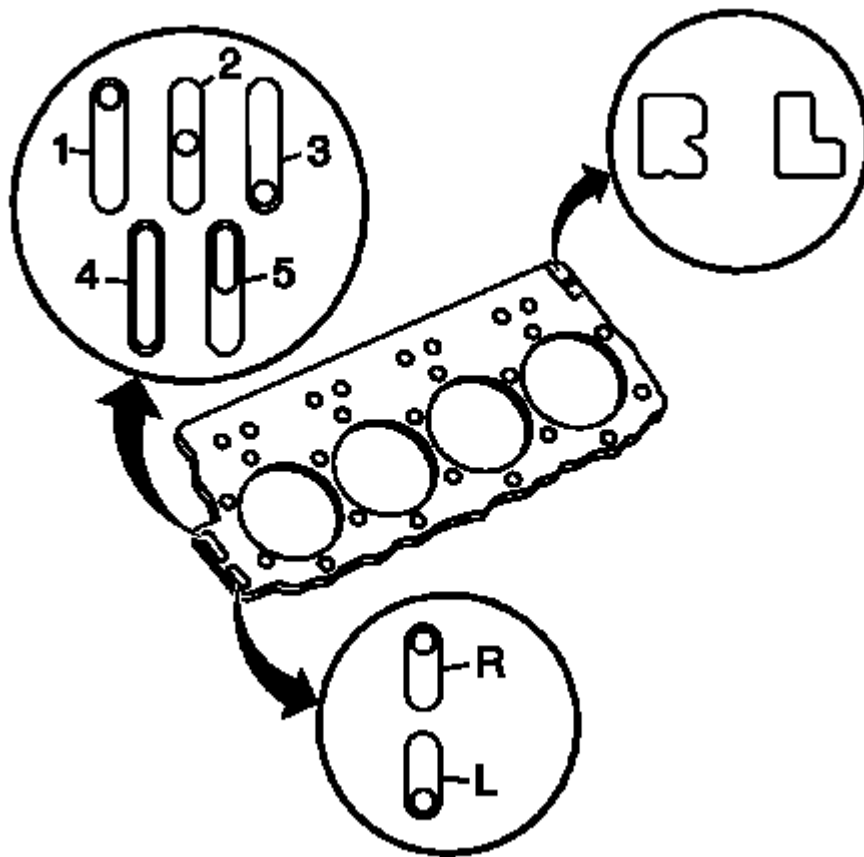


Fig. 78: View Of Cylinder Head Gasket Markings
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: The left and right cylinder head gaskets are not interchangeable. Improper placement of the cylinder head gasket will block coolant and oil passages. Blocked coolant and oil passages will cause severe engine damage.

NOTE: The stamped letter, R or L, must face up. R is the right bank, L is the left bank.

1. The markings on the gasket are as follows:
 - Grade A (1)
 - Grade B (2)
 - Grade C (3)
 - Block over-bored 0.010-0.030 in (0.254-0.762 mm) (4)
 - Block over-bored 0.010-0.030 in (0.254-0.762 mm) and deck milled 0.008 in (0.203 mm) (5)
2. Install the left cylinder head gasket of the correct grade. The left and right cylinder head gaskets are not interchangeable. Refer to Cylinder Head Gasket Selection .

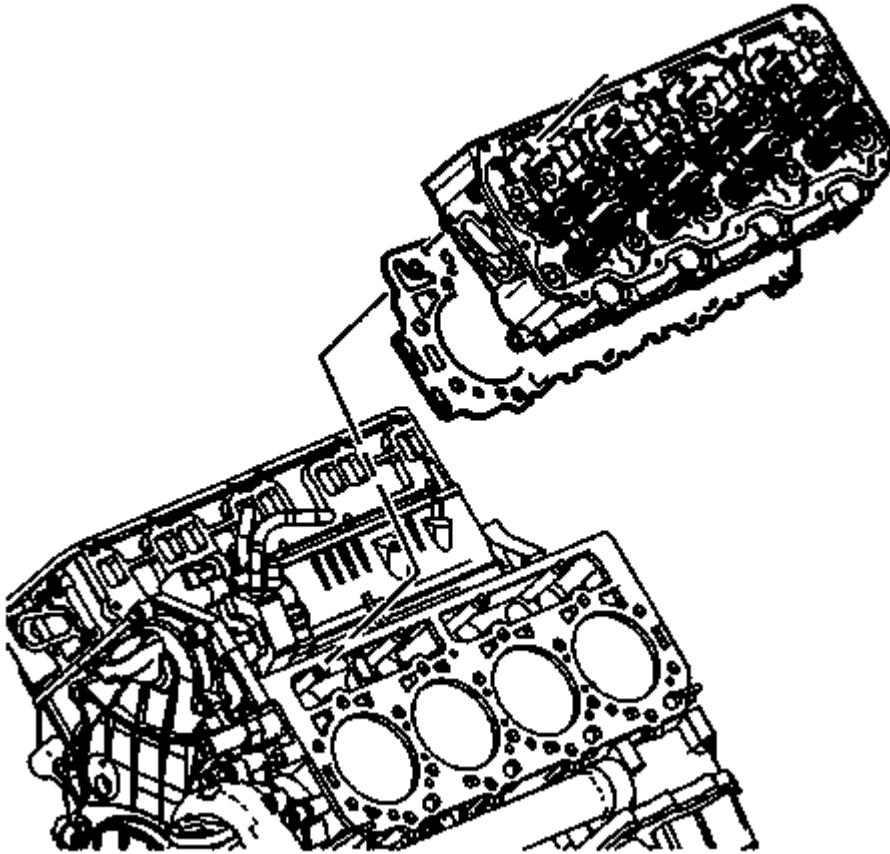


Fig. 79: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

3. Install the cylinder head.

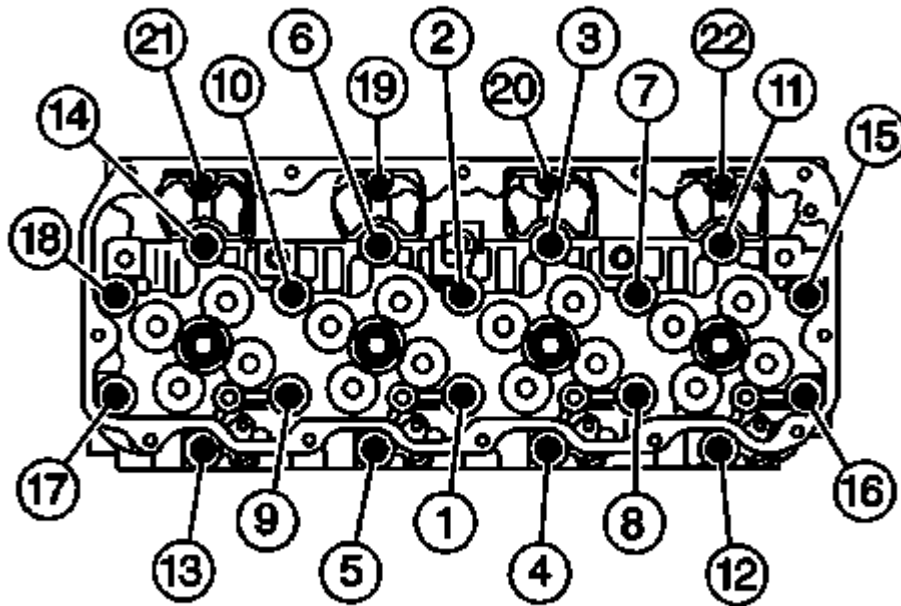


Fig. 80: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install NEW M12 cylinder head bolts.
5. Tighten the M12 cylinder head bolts in four steps:
 1. 1st step 50 N.m (37 lb ft).
 2. 2nd step 80 N.m (59 lb ft).
 3. 3rd step tighten 60 degrees using **J-45059** meter.
 4. Final step tighten 60 degrees using **J-45059** meter
6. Reuse the M8 bolts. Install the M8 bolts and tighten the M8 cylinder head bolts to 25 N.m (18 lb ft).

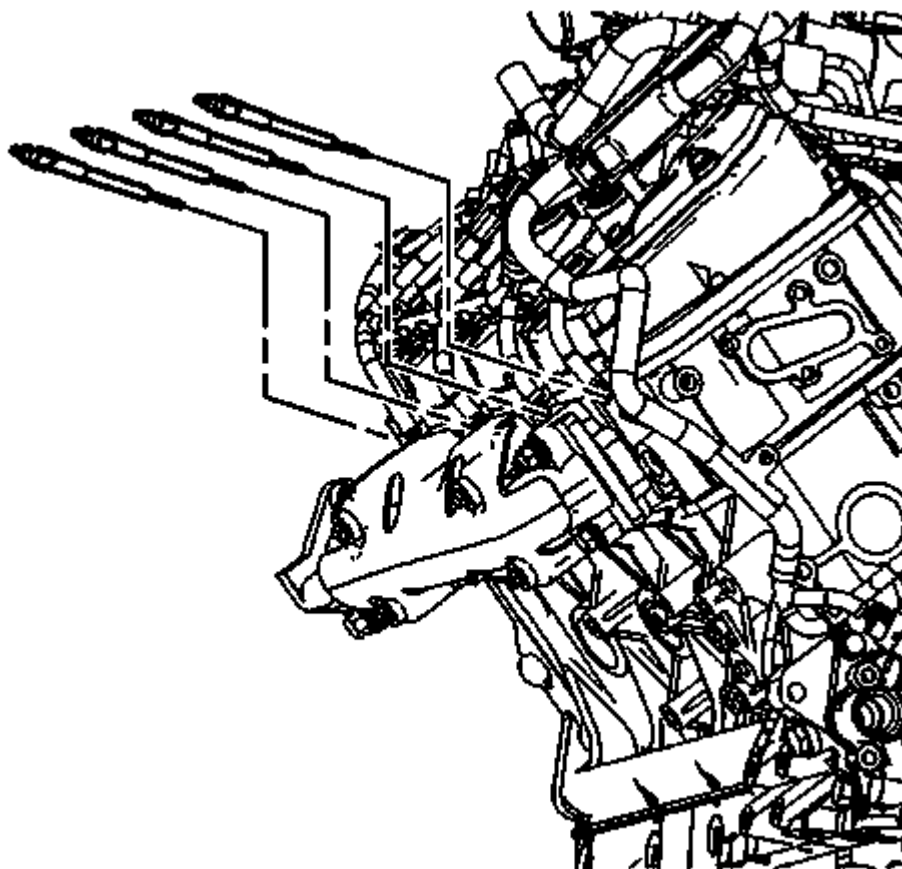


Fig. 81: View Of Right Glow Plugs
Courtesy of GENERAL MOTORS COMPANY

7. Install the glow plug(s) to the cylinder head and tighten to 18 N.m (13 lb ft).
8. Install the engine wiring harness lead(s) to the glow plug(s).
9. Install the engine wiring harness nut(s) to the glow plug(s) and tighten to 1.7 N.m (15 lb in).
10. Install the valve rocker arm shaft, pushrods, and valve bridges. Refer to **Valve Rocker Arm, Shaft, and Push Rod Replacement**.

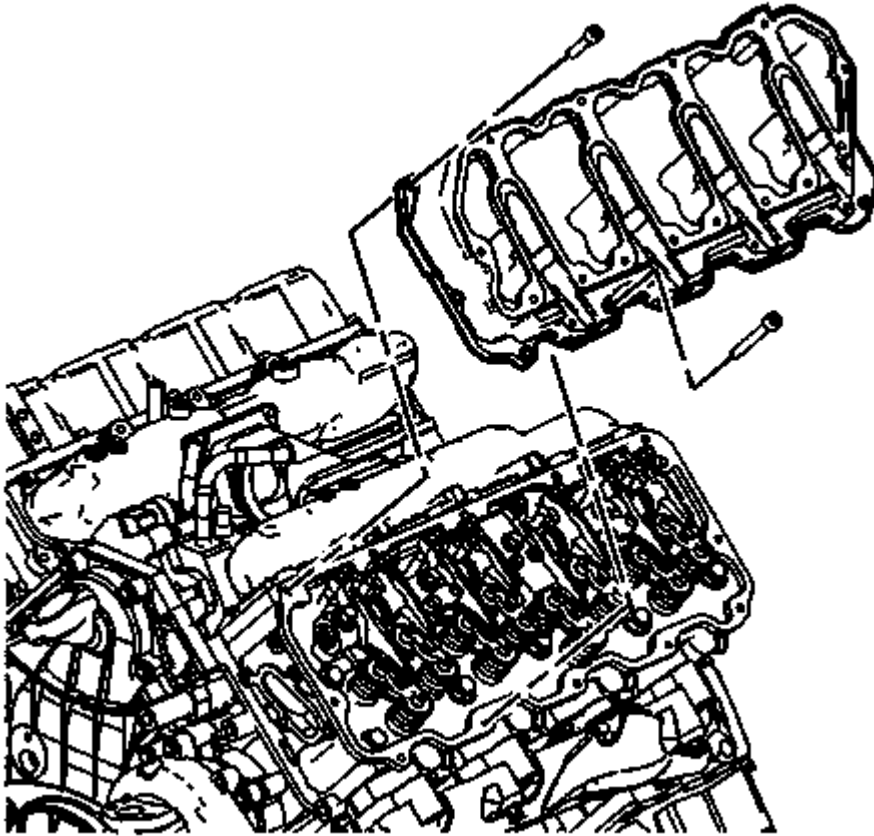


Fig. 82: View Of Lower Valve Rocker Arm Cover (Left)
Courtesy of GENERAL MOTORS COMPANY

11. Install the left lower valve rocker arm cover and cover bolts. Refer to Valve Rocker Arm Lower Cover Replacement - Left Side.
12. Install the exhaust manifold. Refer to Exhaust Manifold Installation - Left Side.
13. Install the exhaust pipe. Refer to Valve Rocker Arm Lower Cover Replacement - Left Side.
14. Install the intake manifold. Refer to Intake Manifold Replacement - Left Side.
15. Install the engine assembly. Refer to Engine Replacement.
16. Road test the vehicle for normal operation.

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

Special Tools

J-45059 Angle Meter

For equivalent regional tools, refer to Special Tools.

Removal Procedure

1. Remove the engine assembly. Refer to **Engine Replacement**.
2. Remove the valve rocker arm shaft, pushrods, and valve bridges. Refer to **Valve Rocker Arm, Shaft, and Push Rod Replacement**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement - Right Side**.
4. Remove the exhaust pipe. Refer to **Exhaust Pipe Removal - Right Side (LML)**.
5. Remove the exhaust manifold. Refer to **Exhaust Manifold Removal - Right Side**.

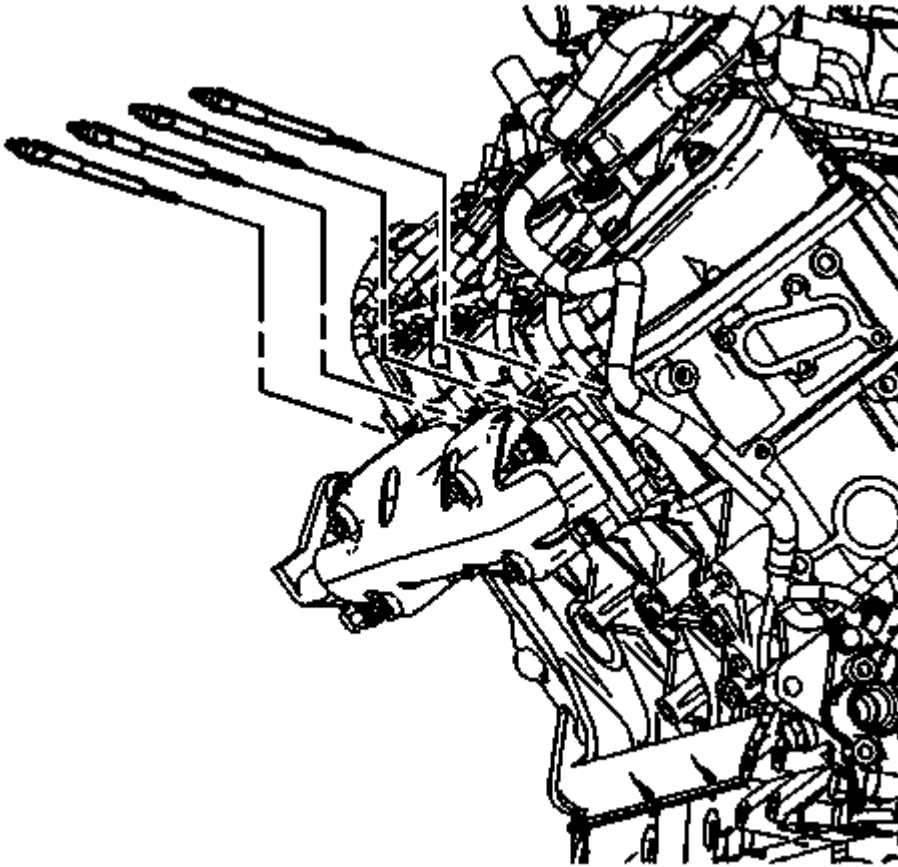


Fig. 83: View Of Right Glow Plugs
Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine wiring harness nut(s) from the glow plug(s).
7. Remove the engine wiring harness lead(s) from the glow plug(s).

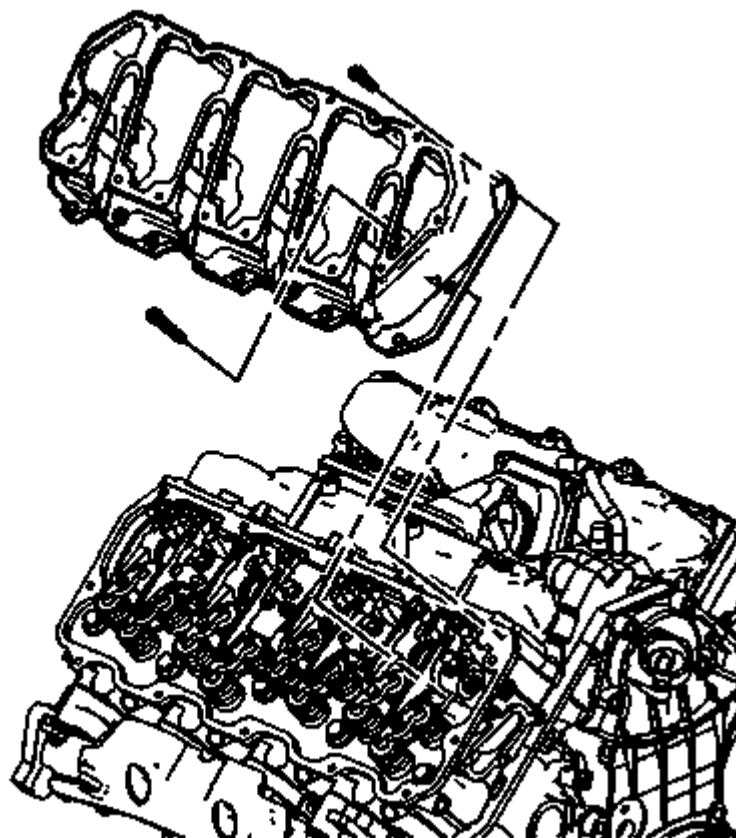


Fig. 84: View Of Lower Valve Rocker Arm Cover (Right)

Courtesy of GENERAL MOTORS COMPANY

8. Remove the lower valve rocker arm cover and cover bolts. Refer to **Valve Rocker Arm Lower Cover Replacement - Right Side**.
9. Remove the valve rocker arm shaft, pushrods, and valve bridges. Refer to **Valve Rocker Arm, Shaft, and Push Rod Replacement**.
10. Remove and discard the valve rocker arm cover gasket, valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.

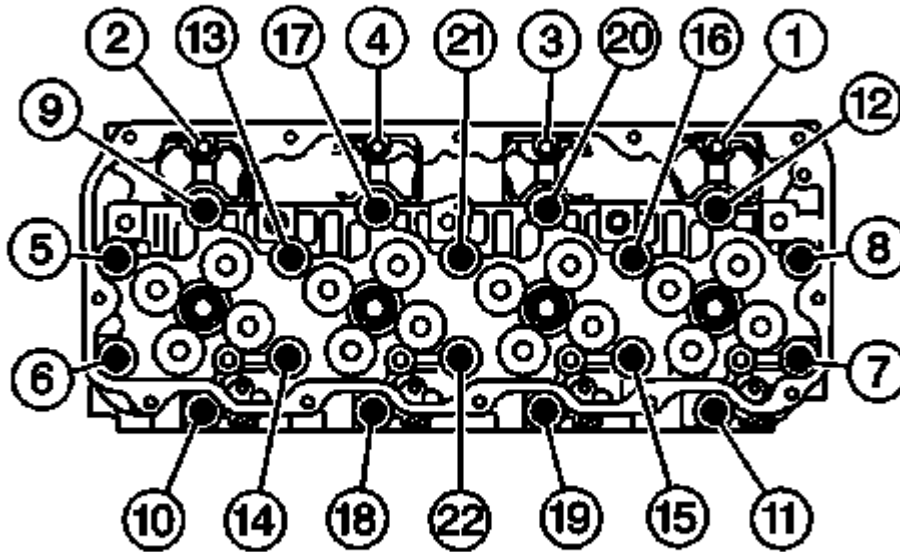


Fig. 85: Cylinder Head Bolt Removal Sequence
Courtesy of GENERAL MOTORS COMPANY

11. Remove the cylinder head bolts in the sequence shown.
12. Discard the large M12 bolts.

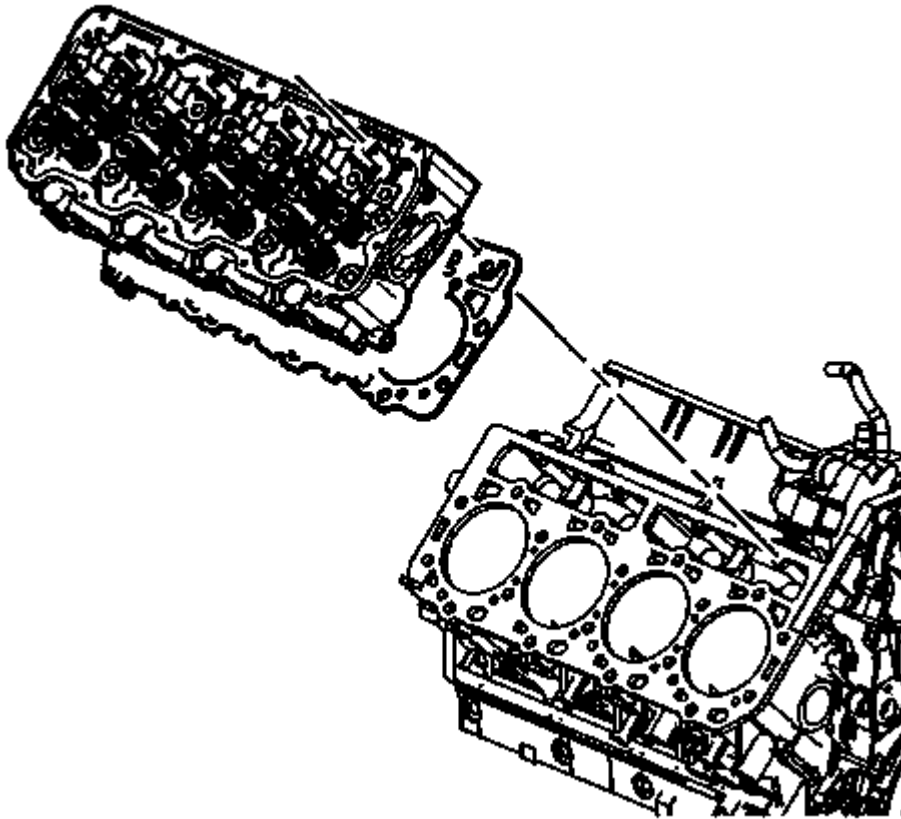


Fig. 86: View Of Cylinder Head & Gasket (Right)
Courtesy of GENERAL MOTORS COMPANY

13. Remove the cylinder head and discard the cylinder head gasket.
14. Clean the sealing surface of the engine block and the cylinder head.

CAUTION: 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.

15. Clean the cylinder head bolt holes in the engine block.
16. For service to the cylinder head, refer to the following:
 - **Cylinder Head Disassemble**
 - **Cylinder Head Cleaning and Inspection**
 1. Place clean rags in the cylinder bores and push rod openings in order to keep out debris.
 2. Use the J-28410 or equivalent to carefully clean the gasket sealing surface of large sealing or corrosion matter. When scraping, take care not to scratch or gouge the metal surfaces. Do not push the debris into oil, coolant, and combustion openings or bolt holes.
 3. Inspect the gasket sealing surfaces for corrosion, especially in the areas that were in contact

with the crimped tabs of the first generation head gasket. If corrosion is present, continue with the rest of the steps in this procedure for proper cleaning. If the sealing surface is sufficiently clean and smooth, then torque to specification.

4. For surfaces that have corrosion or pitting, wrap a piece of flat steel (4"x 2" or larger) with 600 grit wet grade sand paper. Using Moisture Displacing Lubricant, P/N 88862629 (in Canada, use 89020803) or equivalent, wet sand the block surface to remove any remaining gasket material or corrosion. Do not use any paper coarser than 600 grit.

NOTE: **Do not use any power type sanding devices. Do not use a wire brush or wheel to clean gasket surfaces. Do not use chemical cleaning agents on gasket surfaces.**

5. Take care to keep the sanding block parallel to the block surface and evenly sand the sealing surface. Some areas of corrosion will still show a stain. Do not attempt to wet sand these areas down to a shiny metal surface.
6. Change the sanding paper when it becomes clogged. Carefully and frequently wipe the surface, using a clean cloth each time, to prevent sanding debris from building up and contaminating the oil and coolant cavities.
7. Clean the bolt threads and holes and remove the rags from the bore cavities and pushrod openings.
8. Repeat the above cleaning procedure on the cylinder head gasket surface.
9. Clean the engine block and cylinder head gasket surfaces with Brake Parts Cleaner, P/N 88862650 (in Canada, use 88901247) or equivalent, to remove any traces of oil or debris.

- **Cylinder Head Assemble**

Installation Procedure

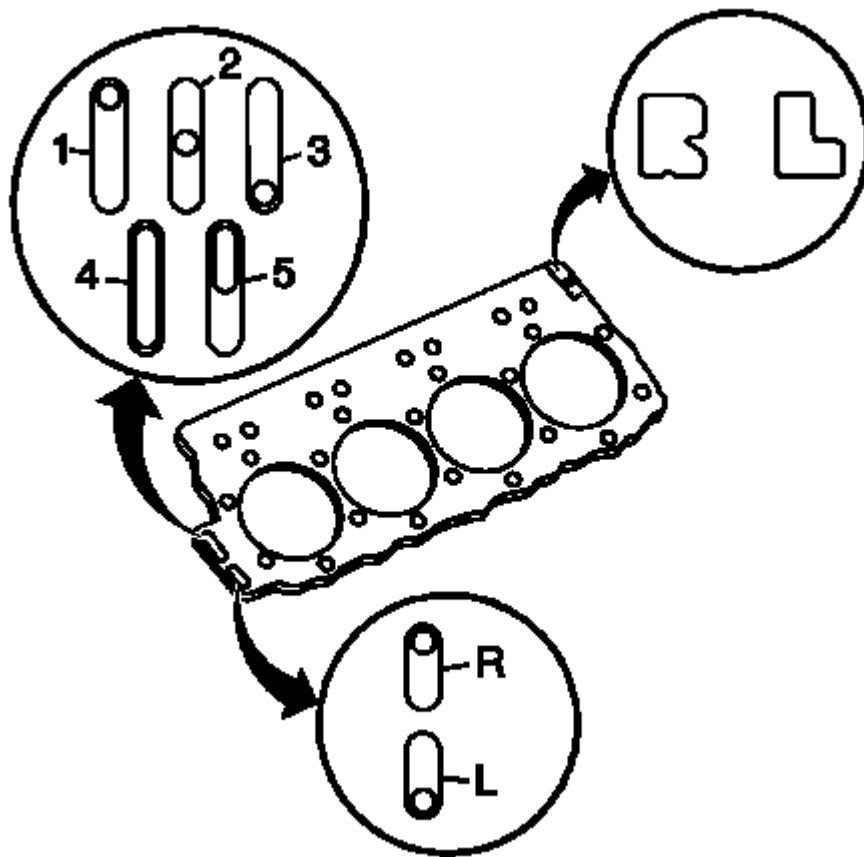


Fig. 87: View Of Cylinder Head Gasket Markings
Courtesy of GENERAL MOTORS COMPANY

CAUTION: The left and right cylinder head gaskets are not interchangeable. Improper placement of the cylinder head gasket will block coolant and oil passages. Blocked coolant and oil passages will cause severe engine damage.

NOTE: The stamped letter, R or L, must face up. R is the right bank, L is the left bank.

1. The markings on the gasket are as follows:
 - Grade A (1)
 - Grade B (2)
 - Grade C (3)
 - Block over-bored 0.010-0.030 in (0.254-0.762 mm) (4)
 - Block over-bored 0.010-0.030 in (0.254-0.762 mm) and deck milled 0.008 in (0.203 mm) (5)
2. Install the right cylinder head gasket of the correct grade. The left and right cylinder head gaskets are not interchangeable. Refer to Cylinder Head Gasket Selection .

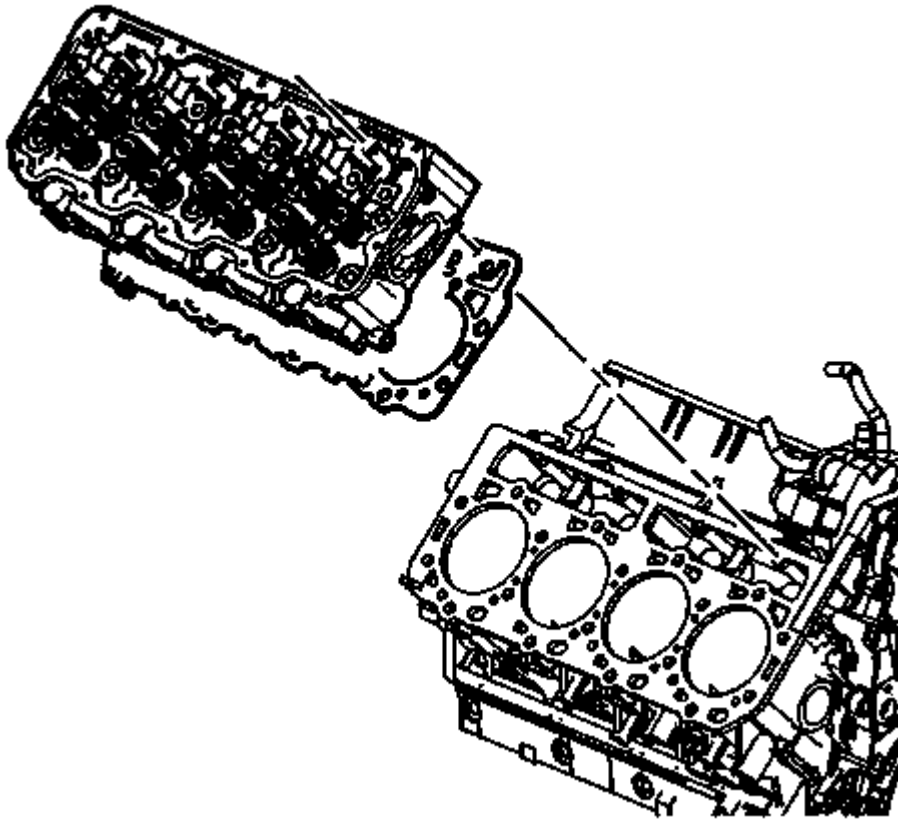


Fig. 88: View Of Cylinder Head & Gasket (Right)
Courtesy of GENERAL MOTORS COMPANY

3. Install the cylinder head.

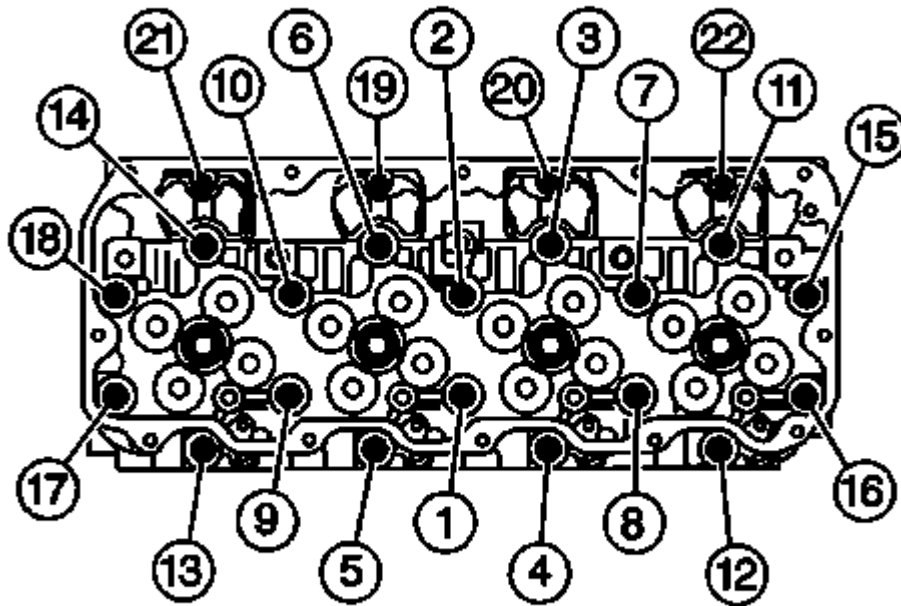


Fig. 89: Cylinder Head Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install NEW M12 cylinder head bolts. Reuse the M8 bolts.
5. Tighten the M12 cylinder head bolts in four steps:
 1. 1st step 50 N.m (37 lb ft).
 2. 2nd step 80 N.m (59 lb ft).
 3. 3rd step tighten 60 degrees using **J-45059** meter.
 4. Final step tighten 60 degrees using **J-45059** meter
6. Install the M8 bolts and tighten the M8 cylinder head bolts to 25 N.m (18 lb ft).

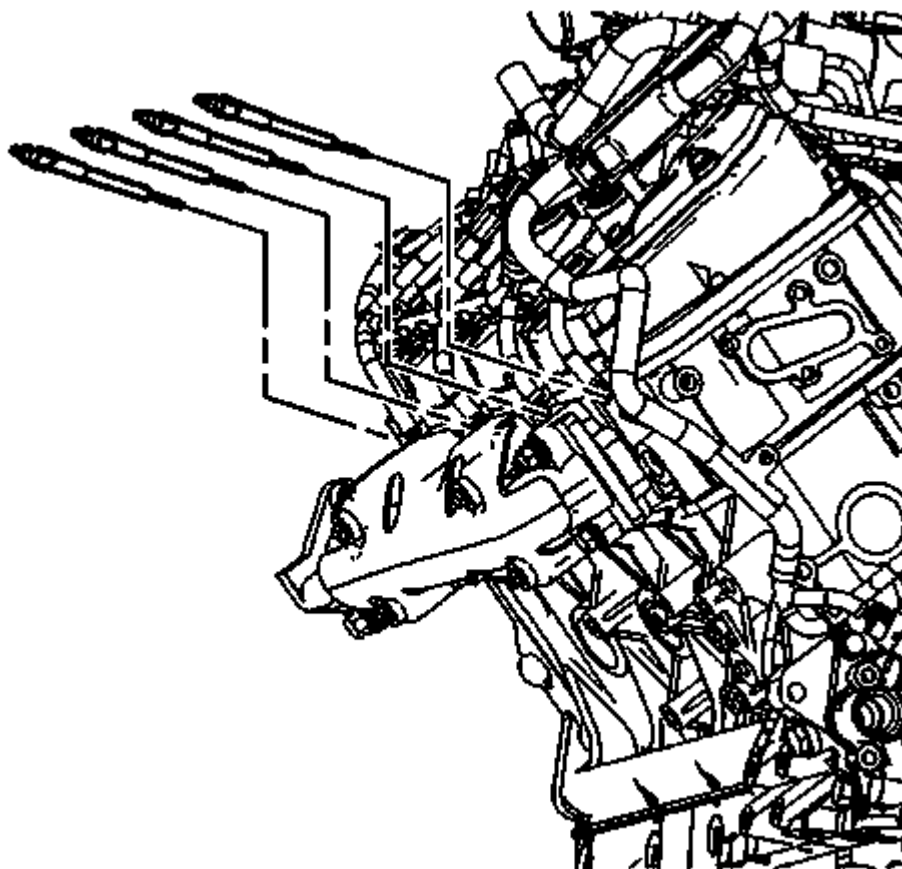


Fig. 90: View Of Right Glow Plugs
Courtesy of GENERAL MOTORS COMPANY

7. Install the glow plug(s) to the cylinder head and tighten to 18 N.m (13 lb ft).
8. Install the engine wiring harness lead(s) to the glow plug(s).
9. Install the engine wiring harness nut(s) to the glow plug(s) and tighten to 1.7 N.m (15 lb in).
10. Install the valve rocker arm shaft, pushrods, and valve bridges. Refer to **Valve Rocker Arm, Shaft, and Push Rod Replacement**.

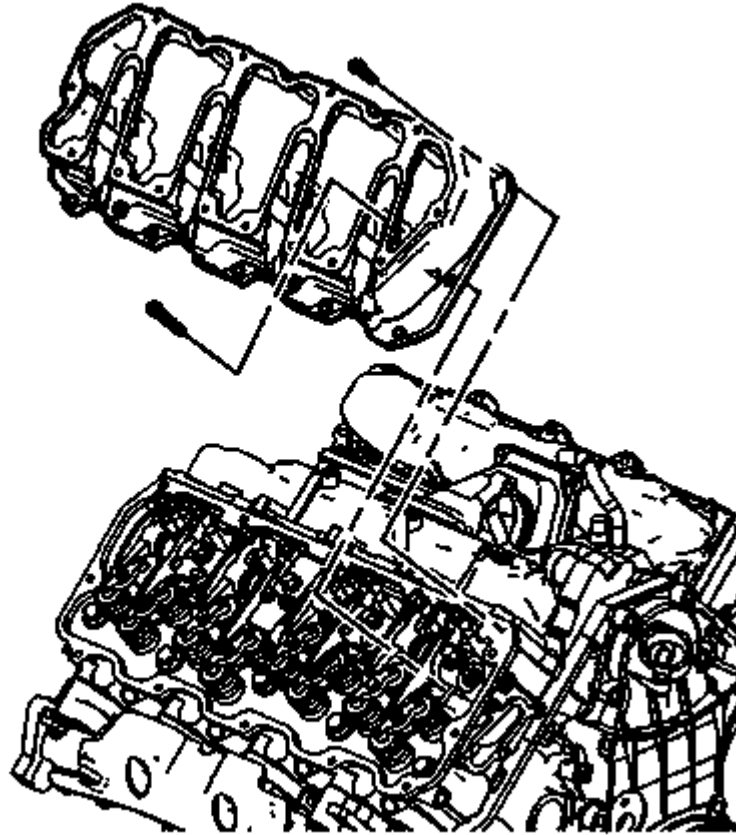


Fig. 91: View Of Lower Valve Rocker Arm Cover (Right)
Courtesy of GENERAL MOTORS COMPANY

11. Install the right lower valve rocker arm cover and cover bolts. Refer to **Valve Rocker Arm Lower Cover Replacement - Right Side**.
12. Install the exhaust manifold. Refer to **Exhaust Manifold Installation - Right Side**.
13. Install the exhaust pipe. Refer to **Exhaust Pipe Installation - Right Side (LML)**.
14. Install the intake manifold. Refer to **Intake Manifold Replacement - Right Side**.
15. Install the engine assembly. Refer to **Engine Replacement**.
16. Road test the vehicle for normal operation.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Special Tools

- **J-26999** Compression Gauge
- **J-26999-20** Compression Gauge Adapter
- **J-44640** Valve Stem Seal Installer
- **J-44646** Valve Spring Compressor

For equivalent regional tools, refer to Special Tools .

Removal Procedure

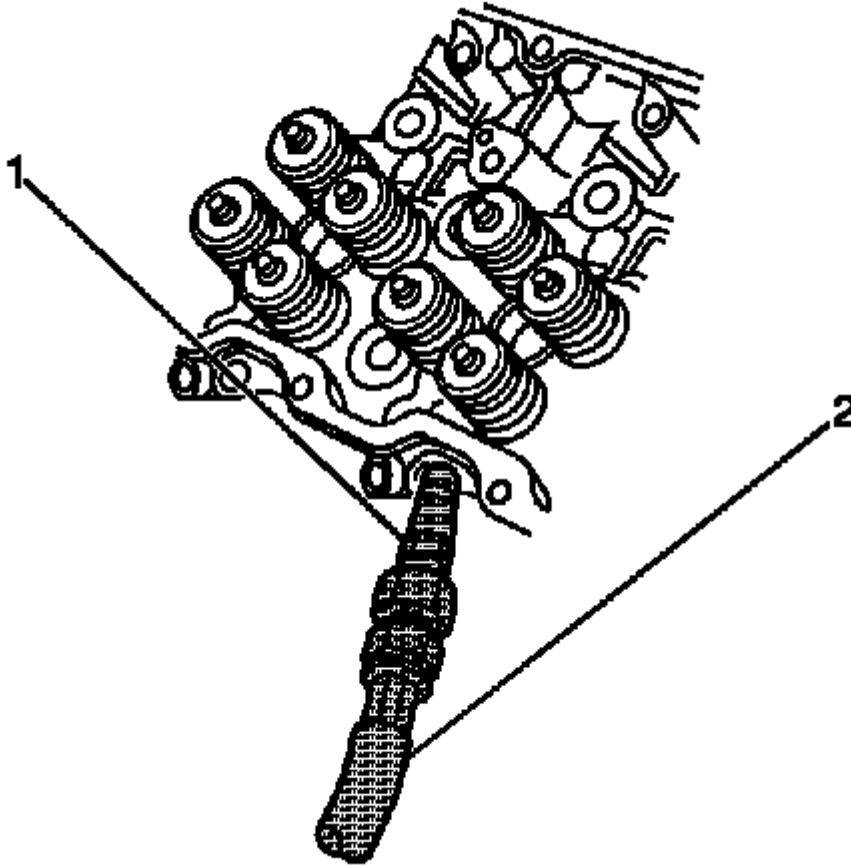


Fig. 92: View Of J 26999-20 & J 26999
Courtesy of GENERAL MOTORS COMPANY

1. Remove the upper fan shroud. Refer to Engine Coolant Fan Upper Shroud Replacement (Diesel) .
2. Remove the lower fan shroud. Refer to Engine Coolant Fan Lower Shroud Replacement (Mechanical) .
3. Remove the valve rocker arm shaft, valve bridges, and pushrods for the cylinder head being serviced. Refer to Valve Rocker Arm, Shaft, and Push Rod Replacement.
4. Remove the glow plug for the cylinder requiring service. Refer to Glow Plug Replacement - Bank 1 , or Glow Plug Replacement - Bank 2 .
5. In order to apply shop air to the cylinders, use the following procedures to modify **J-26999-20** adapter (1) and **J-26999** gauge (2):
 1. Remove the valve core from **J-26999-20** adapter to allow air to flow.
 2. Remove the quick connect fitting from **J-26999** gauge.
 3. Adapt the quick connect fitting in order to use for shop air.
 4. Connect the quick connect fitting to **J-26999-20** adapter.

NOTE: Rotate the cylinder to be serviced to the bottom of the stroke. This is to ensure that the engine does not rotate when the compressed air is applied to the cylinder being serviced.

6. Install **J-26999-20** adapter into the glow plug hole for the cylinder being serviced.
7. Apply compressed air to hold the valves in place. If the compressed air is released, the valves can drop into the cylinder.

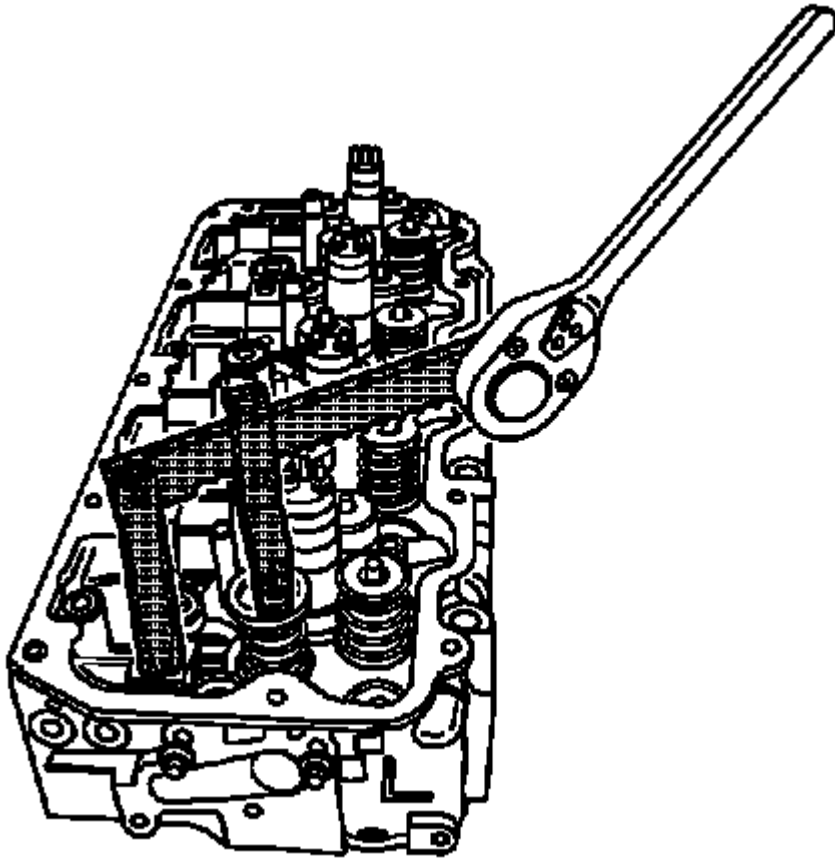


Fig. 93: Compressing Valve Spring Using J 44646
Courtesy of GENERAL MOTORS COMPANY

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

8. Install **J-44646** compressor to the rocker arm bosses on the cylinder head.

J-44646 compressor should be installed in the rocker arm boss next to the cylinder being serviced. The pivot pin can be removed from the stand to allow the stand to be installed. The lever has different locating holes for the pivot pin depending on available clearance. The lever is also notched for different locations of the compressor.

9. Using **J-44646** compressor compress the valve spring.

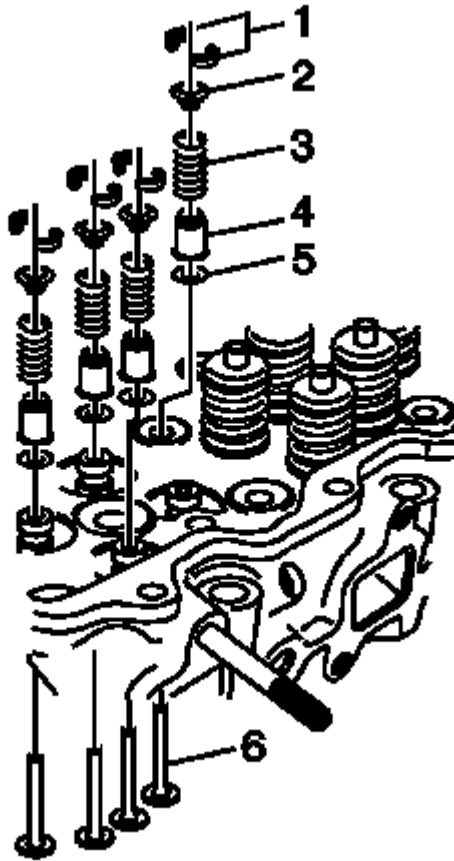


Fig. 94: View Of Valve Stem Oil Seal & Valve Spring
Courtesy of GENERAL MOTORS COMPANY

10. Remove the valve keys (1) from the valve stem.
11. Carefully release the valve spring tension.
12. Remove the valve spring upper seat (2) and the valve spring (3).
13. Remove the valve stem oil seal (4).
14. Remove the valve spring lower seat (5).
15. Continue removing the remaining valve stem seals for the cylinder using the above procedure.

Installation Procedure

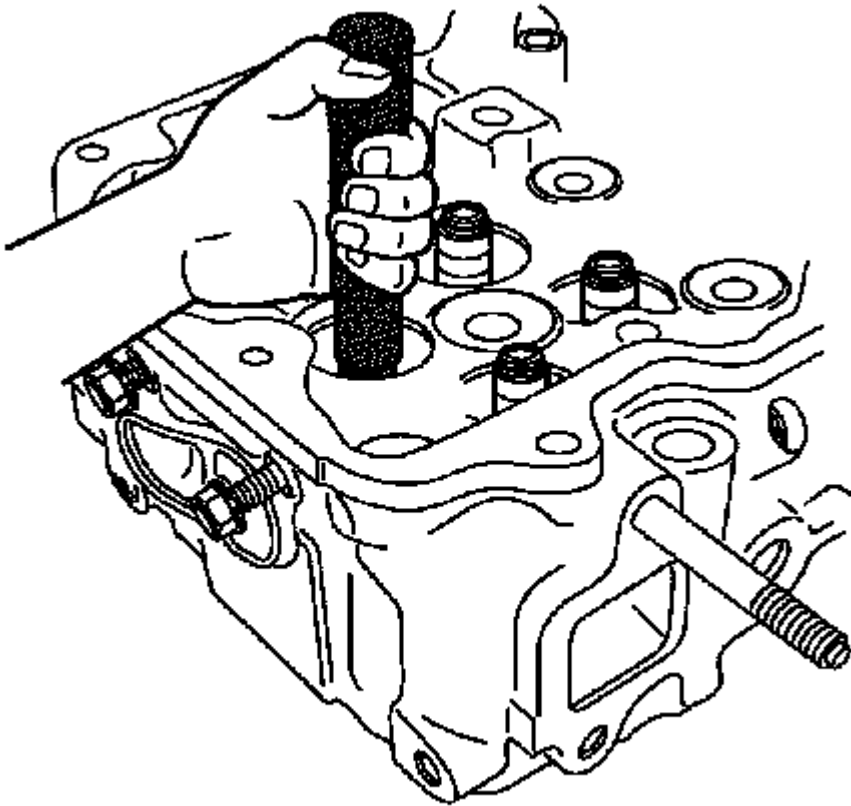


Fig. 95: Installing Valve Stem Using J 44640
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Air pressure should remain applied to the cylinder for installation.

1. Install the valve spring lower seat.
2. Install the valve stem seal using **J-44640** installer.

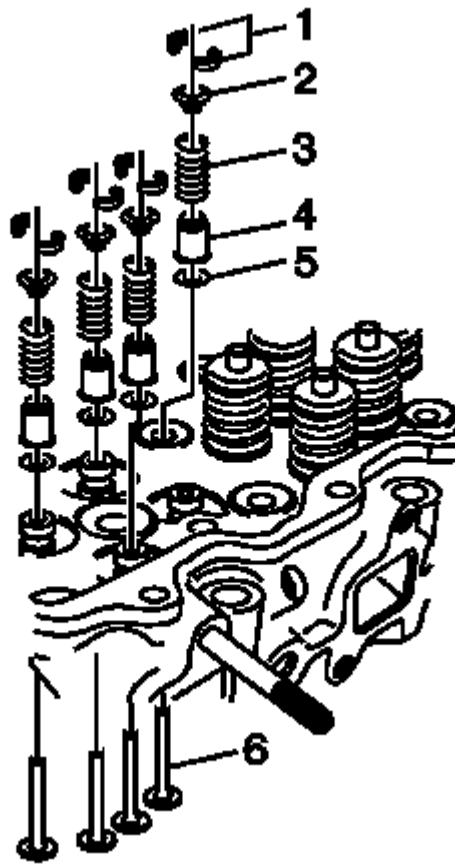


Fig. 96: View Of Valve Stem Oil Seal & Valve Spring
Courtesy of GENERAL MOTORS COMPANY

3. Install the valve spring (3), the painted end of the valve spring goes toward the cylinder head.
4. Install the valve spring upper seat (2).

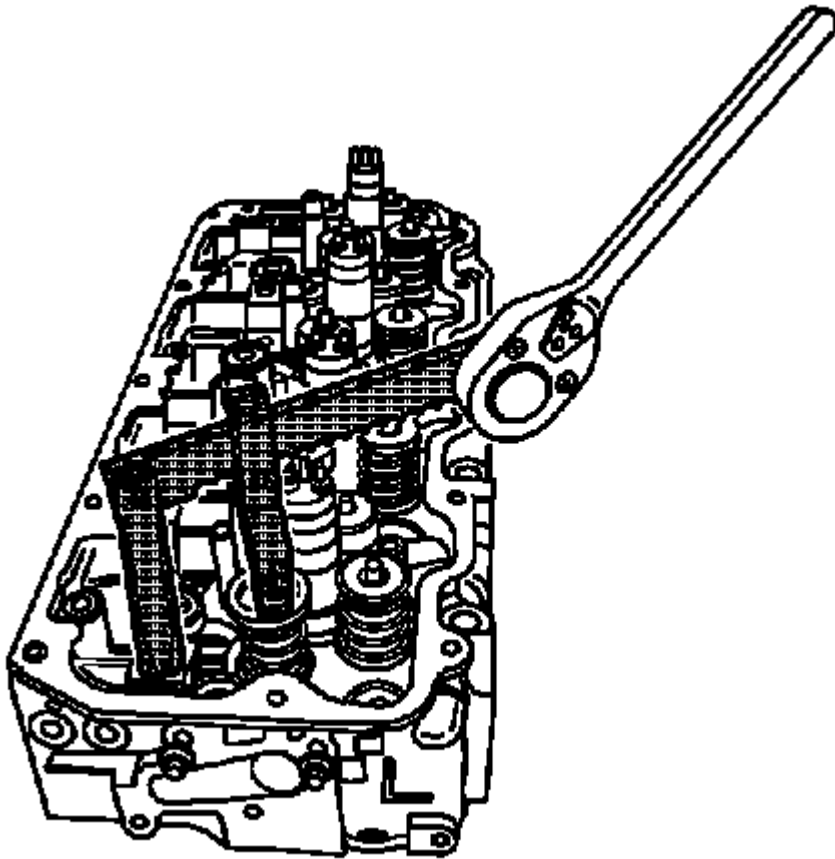


Fig. 97: Compressing Valve Spring Using J 44646
Courtesy of GENERAL MOTORS COMPANY

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

5. Using **J-44646** compressor compress the valve spring.
6. Install the valve keys to the valve stem.

CAUTION: The valve stem keys must correctly seat in the valve spring cap. Engine damage may occur by not installing properly.

7. Carefully release the valve spring pressure. Make sure the valve keys stay in place.
8. Continue to install the 3 remaining valve stem seals for the cylinder.

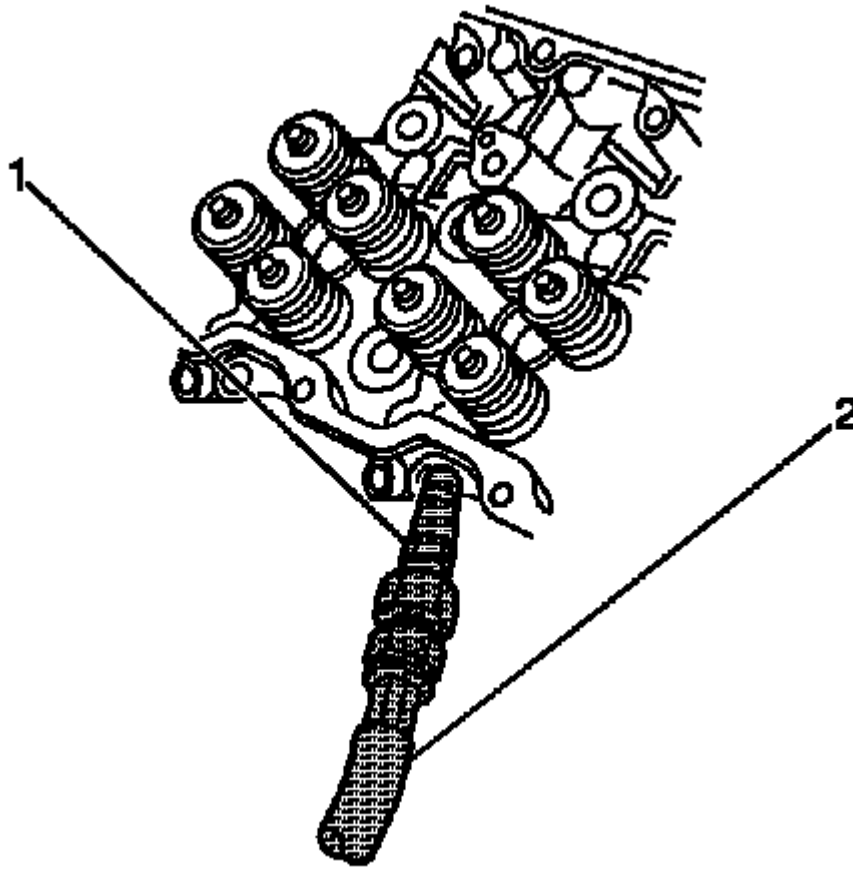


Fig. 98: View Of J 26999-20 & J 26999
 Courtesy of GENERAL MOTORS COMPANY

9. Release the compressed air holding the valves in place.
10. Remove **J-26999-20** adapter (1) from the glow plug hole.
11. Continue to replace the valve stem seals on the remaining cylinders using the above procedures.
12. Install the glow plug. Refer to **Glow Plug Replacement - Bank 1** , or **Glow Plug Replacement - Bank 2** .
13. Install the valve rocker arm shaft, the valve bridges, and the push rods. Refer to **Valve Rocker Arm, Shaft, and Push Rod Replacement**.
14. Install the lower fan shroud. Refer to **Engine Coolant Fan Lower Shroud Replacement (Mechanical)** .
15. Install the upper and lower fan shroud. Refer to **Engine Coolant Fan Upper Shroud Replacement (Diesel)** .

VALVE LIFTER REPLACEMENT

Removal Procedure

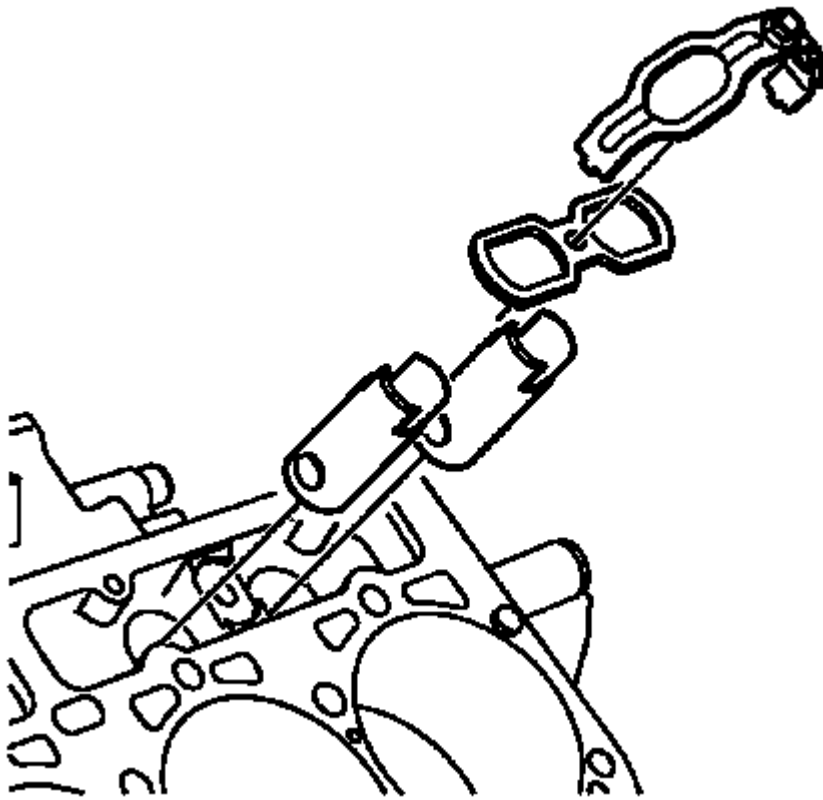


Fig. 99: View Of Valve Lifter, Guides, Retainers & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. If replacing the left side valve lifters remove the left side cylinder head. Refer to **Cylinder Head Replacement - Left Side**.
2. If replacing the right side valve lifters remove the right side cylinder head. Refer to **Cylinder Head Replacement - Right Side**.
3. Loosen the valve lifter guide retainer bolts.
4. Remove the valve lifter guide retainers.
5. Remove the valve lifter guides.
6. Remove the valve lifters.
7. If required, clean and inspect the lifters. Refer to **Valve Lifter Cleaning and Inspection** .

Installation Procedure

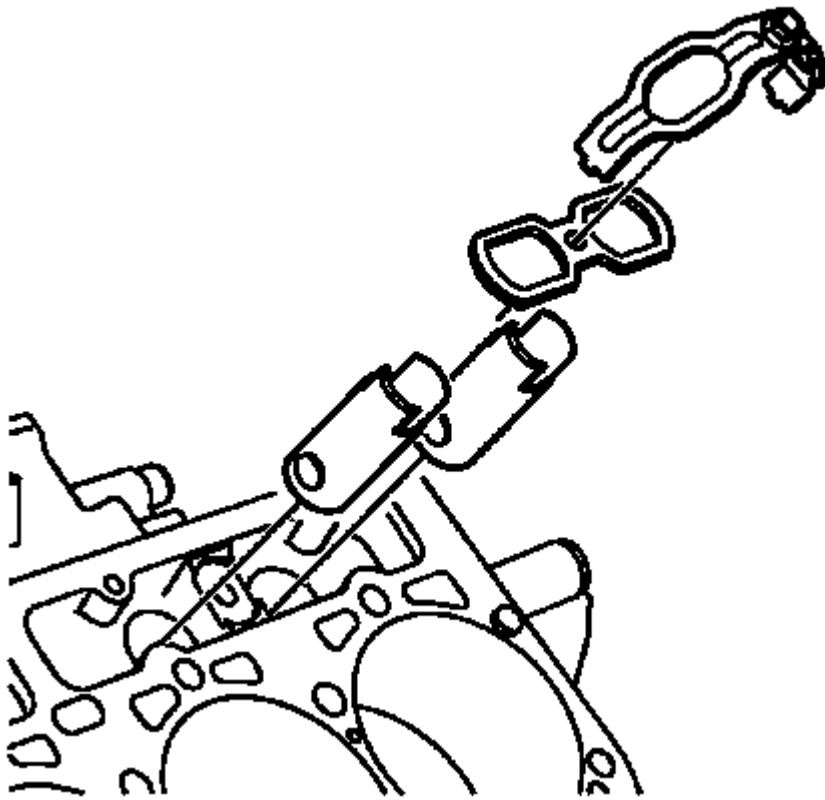


Fig. 100: View Of Valve Lifter, Guides, Retainers & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Apply clean engine oil to the roller and outside of the valve lifter.
2. Install the valve lifter.
3. Install the valve lifter guides.
4. Install the valve lifter guide retainer.

CAUTION: Refer to Fastener Caution .

5. Install the valve lifter guide retainer bolt and tighten to 11 N.m (97 lb in).
6. If left side cylinder head is removed, refer to **Cylinder Head Replacement - Left Side**.
7. If right side cylinder head is removed, refer to **Cylinder Head Replacement - Right Side**.

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

J-44643 Flywheel Holding Tool

For equivalent regional tools, refer to Special Tools .

Removal Procedure

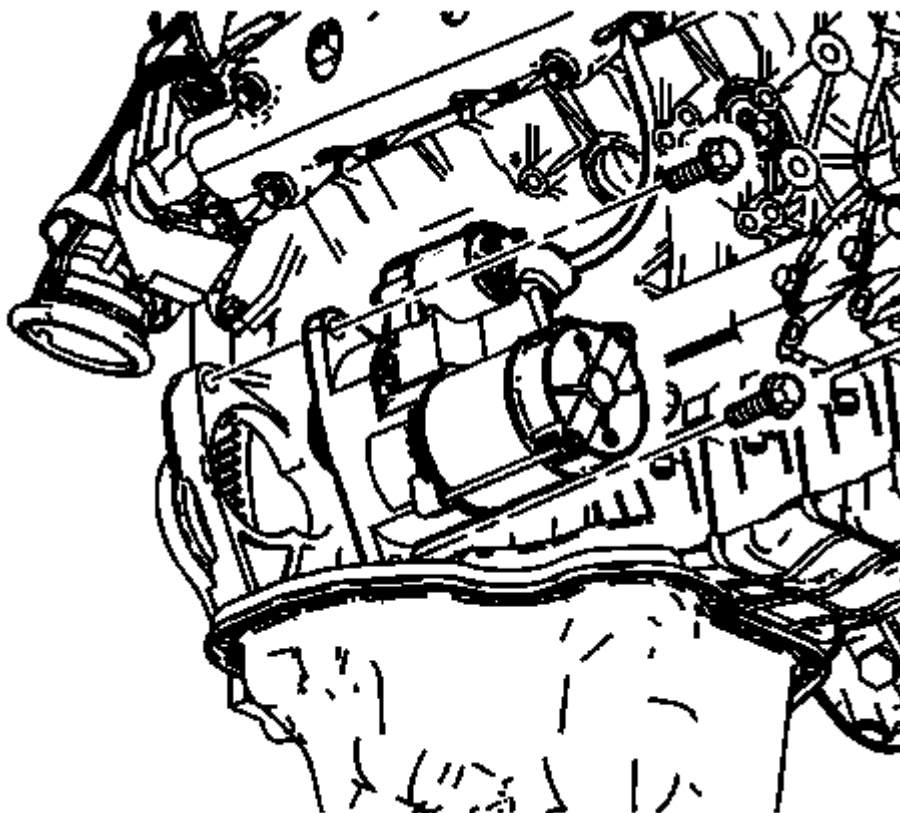


Fig. 101: View Of Starter

Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection (TP2) , Battery Negative Cable Disconnection and Connection (Single Battery) .
2. Remove the right wheelhouse panel. Refer to Front Wheelhouse Liner Replacement - Right Side (GMC) , Front Wheelhouse Liner Replacement - Right Side (Chevrolet) .
3. Remove the starter motor bolts. Reposition the starter aside. The wiring to the starter does not require removal.

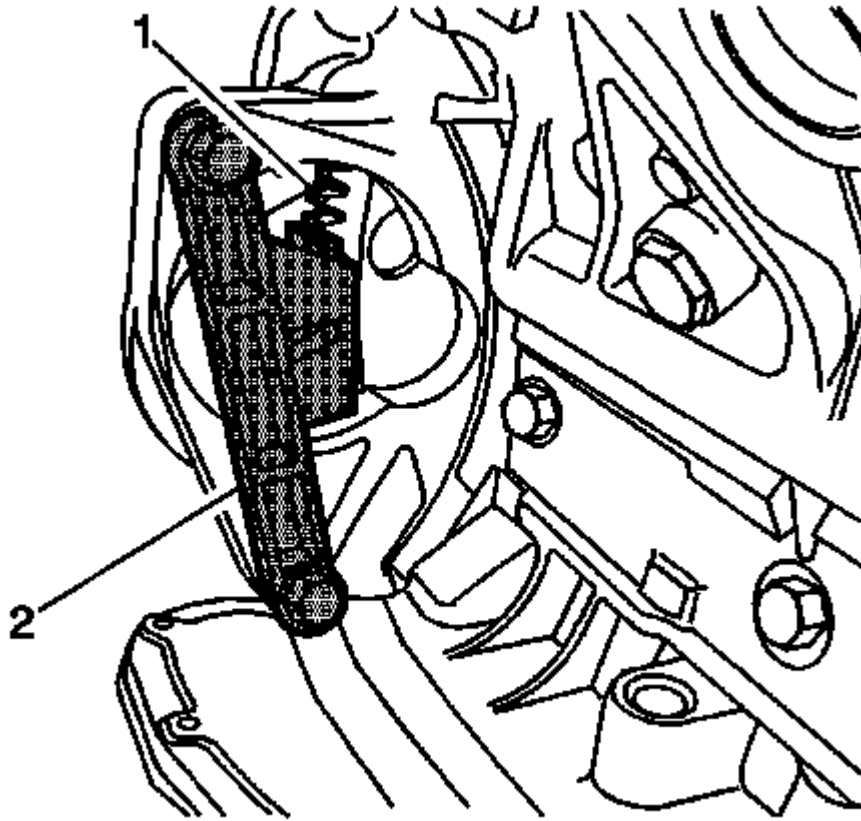


Fig. 102: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS COMPANY

4. Install the **J-44643** tool (2) in order to hold the flywheel (1).
5. Remove the drive belt. Refer to **Drive Belt Replacement**.

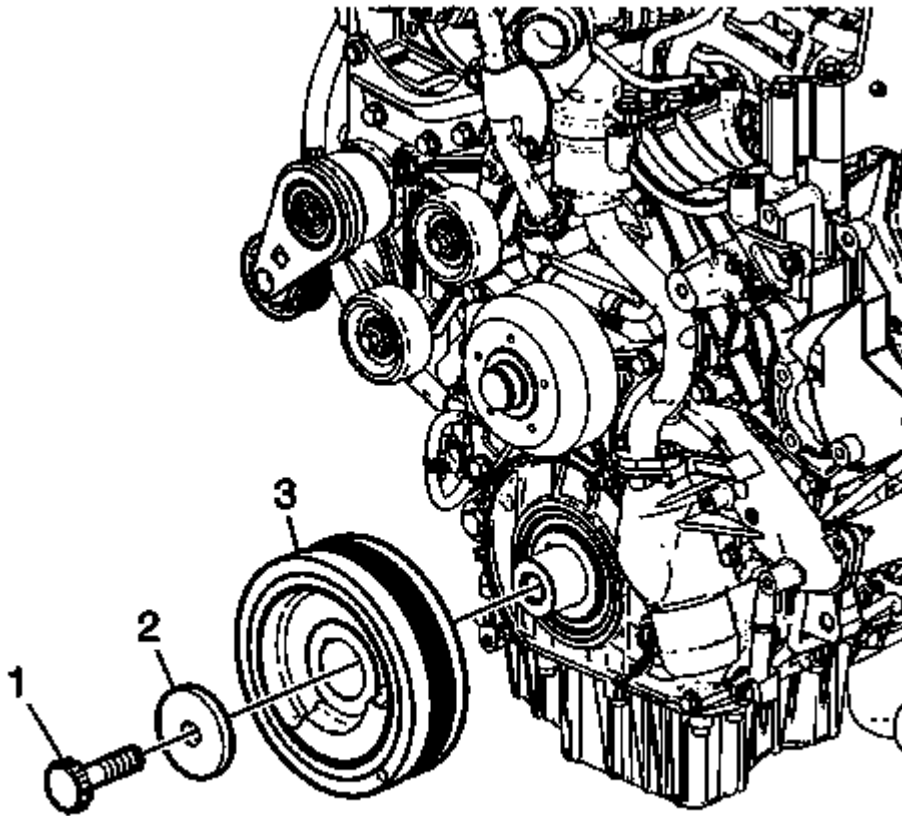


Fig. 103: Identifying Crankshaft Balancer, Washer And Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the crankshaft balancer bolt (1).
7. Remove the crankshaft balancer washer (2) and crankshaft balancer (3).

Installation Procedure

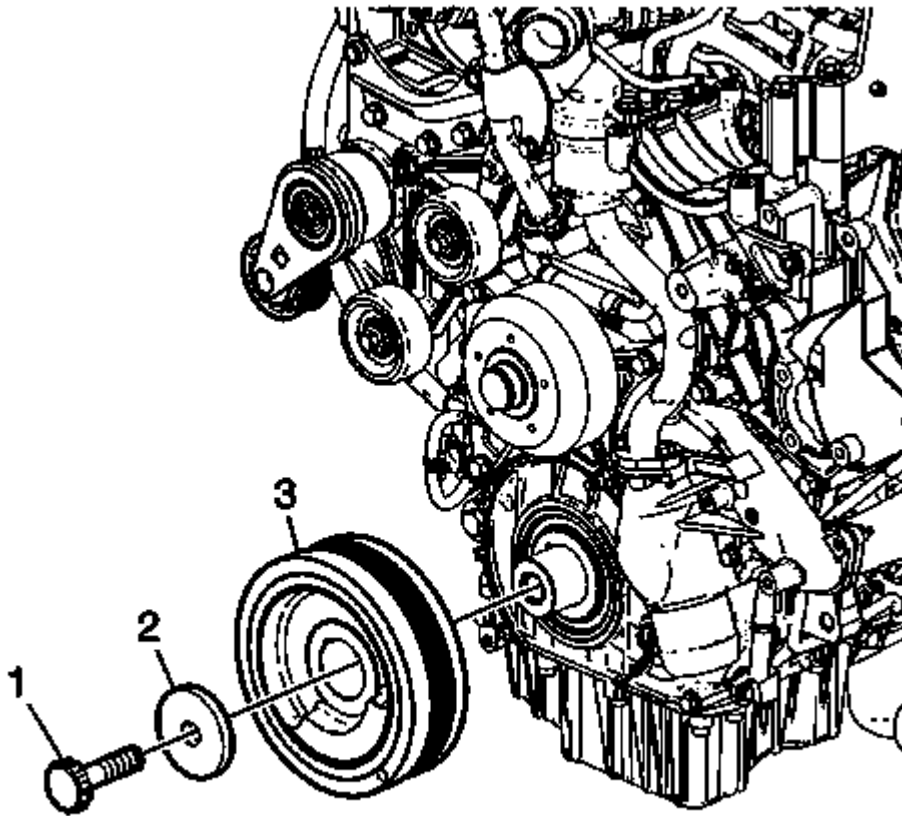


Fig. 104: Identifying Crankshaft Balancer, Washer And Bolt
 Courtesy of GENERAL MOTORS COMPANY

1. Lightly lubricate the crankshaft balancer internal hub with engine oil.
2. Install the crankshaft balancer (3) to the crankshaft.
3. Lightly lubricate the NEW crankshaft balancer bolt (1) with engine oil.

CAUTION: Refer to Fastener Caution .

4. Install the NEW crankshaft balancer bolt (1) and washer (2).
 1. Tighten the bolt a first pass to 100 N.m (74 lb ft).
 2. Tighten the bolt a second pass an additional 90 degrees.
5. Install the drive belt. Refer to **Drive Belt Replacement**.

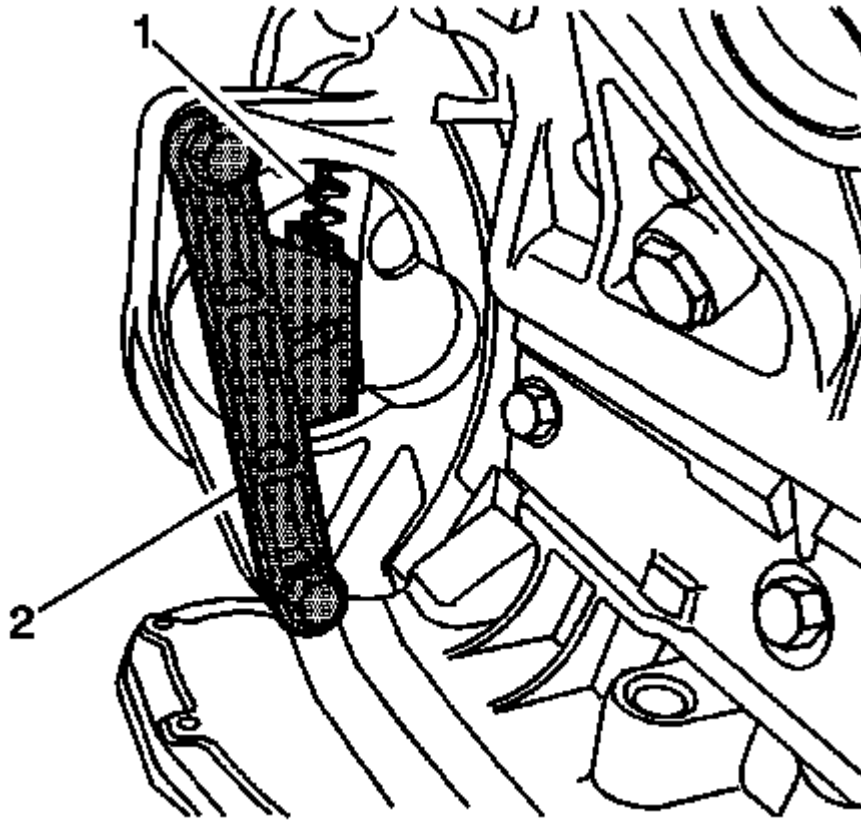


Fig. 105: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **J-44643** tool (2) .

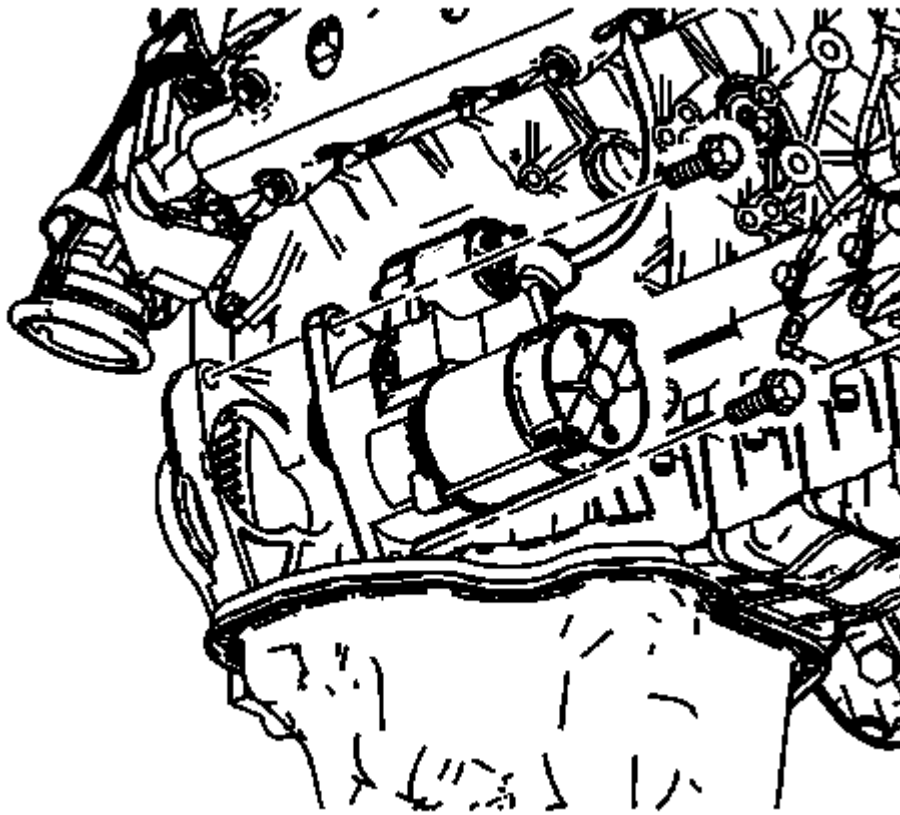


Fig. 106: View Of Starter

Courtesy of GENERAL MOTORS COMPANY

7. Position the starter motor.
8. Install the starter motor bolts and tighten to 85 N.m (63 lb ft).
9. Install the right wheelhouse panel. Refer to **Front Wheelhouse Liner Replacement - Right Side (GMC)** , **Front Wheelhouse Liner Replacement - Right Side (Chevrolet)** .
10. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (TP2)** , **Battery Negative Cable Disconnection and Connection (Single Battery)** .
11. Relearn the crankshaft position reluctor wheel. Refer to **Crankshaft Position Reluctor Wheel Learn** .

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

- **J-44644** Crankshaft Front Oil Seal Remover
- **J-44645** Crankshaft Front Oil Seal Installer

Removal Procedure

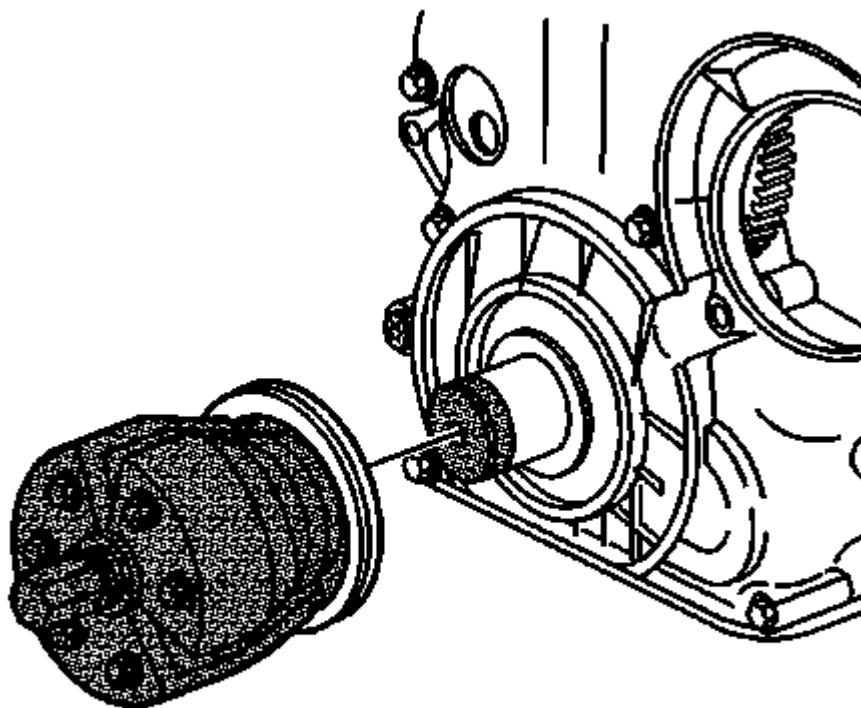


Fig. 107: Removing Crankshaft Front Oil Seal Using J 44644
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Install the button of **J-44644** oil seal remover into the crankshaft.
3. Press the jaws of **J-44644** oil seal remover into the felt portion of the seal far enough to engage the inner lip of the seal.
4. While holding the jaws of **J-44644** oil seal remover tightly to the seals inner sleeve, tighten the jaw bolts.
5. Using the **J-44644** oil seal remover , remove the crankshaft front oil seal.

Installation Procedure

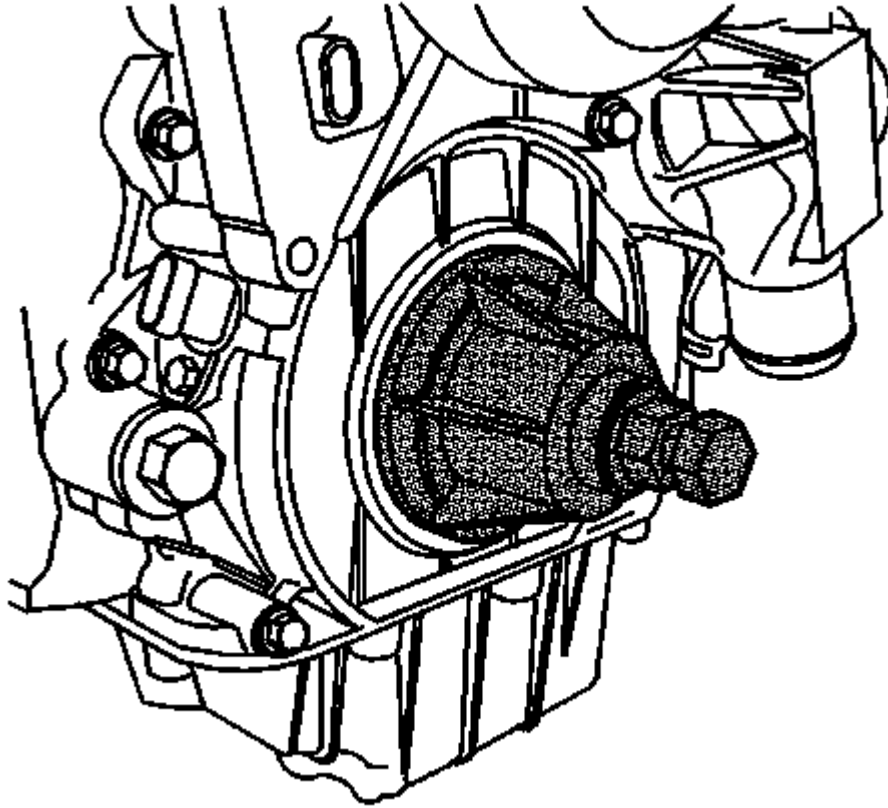


Fig. 108: Pressing Crankshaft Front Oil Seal On Using J 44645
Courtesy of GENERAL MOTORS COMPANY

1. Clean the front crankshaft seal bore and the crankshaft.
2. Lubricate the crankshaft sealing surface with clean engine oil.
3. Place the crankshaft front oil seal onto the crankshaft.
4. Install the **J-44645** oil seal installer to the crankshaft.
5. Press the crankshaft front oil seal onto the crankshaft using the **J-44645** oil seal installer until the tool bottoms out.
6. Remove the **J-44645** oil seal installer.
7. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
8. Relearn the crankshaft position reluctor wheel. Refer to **Crankshaft Position Reluctor Wheel Learn**.

ENGINE FRONT COVER REPLACEMENT

Special Tools

- **J-37228** Seal Cutter
- **EN-50956** Tamper Proof Drive Bit

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

Removal Procedure

1. Remove the water pump assembly. Refer to **Water Pump Replacement (Diesel)** .

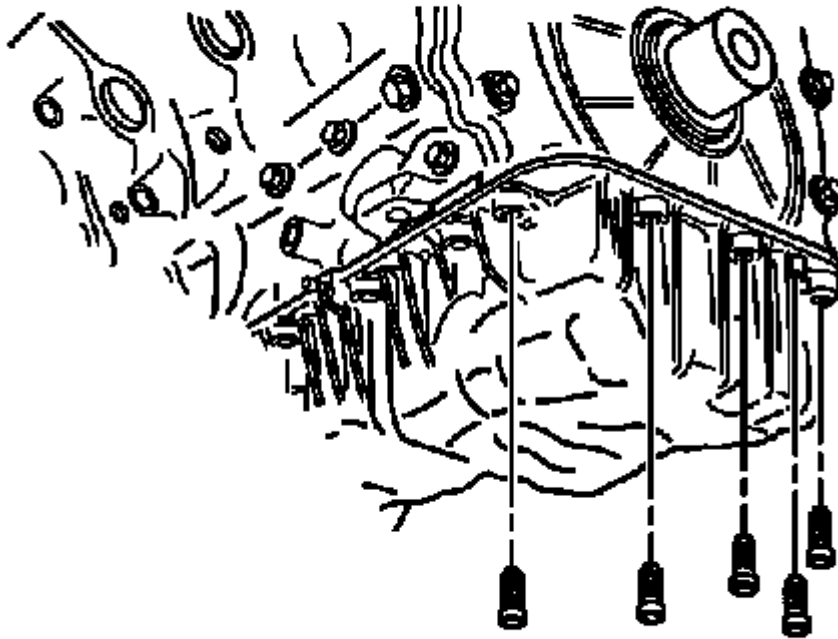


Fig. 109: View Of Upper Oil Pan To Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the upper oil pan to the engine front cover bolts ONLY.

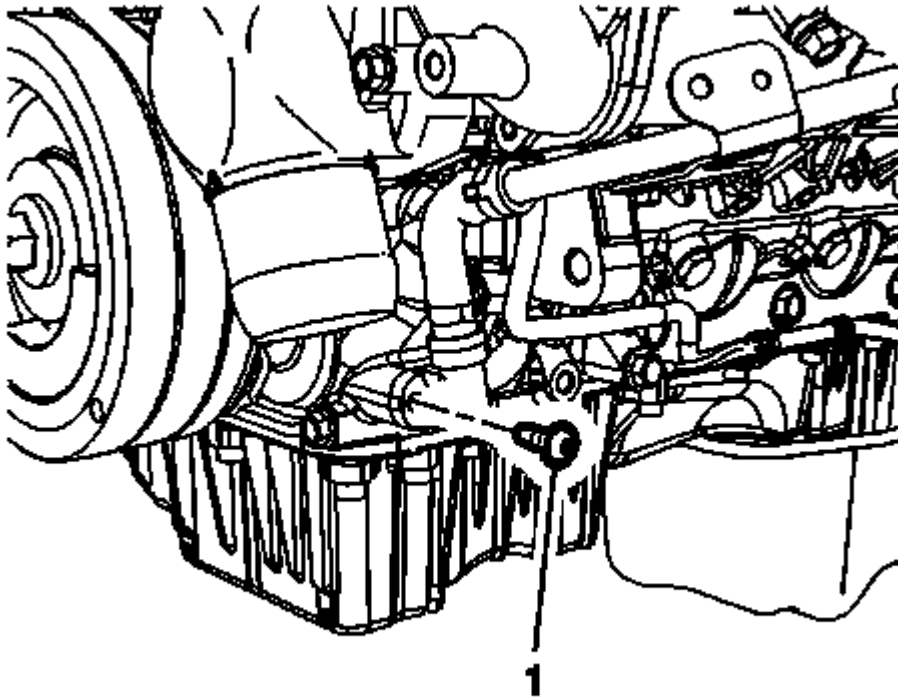


Fig. 110: PCV Bolt

Courtesy of GENERAL MOTORS COMPANY

NOTE: Using a suitable tool, cut a slot in the tamper-resistant positive crankcase ventilation (PCV) oil separator bolt heads and remove with a flat blade tool

3. Remove the PCV bolt (1).

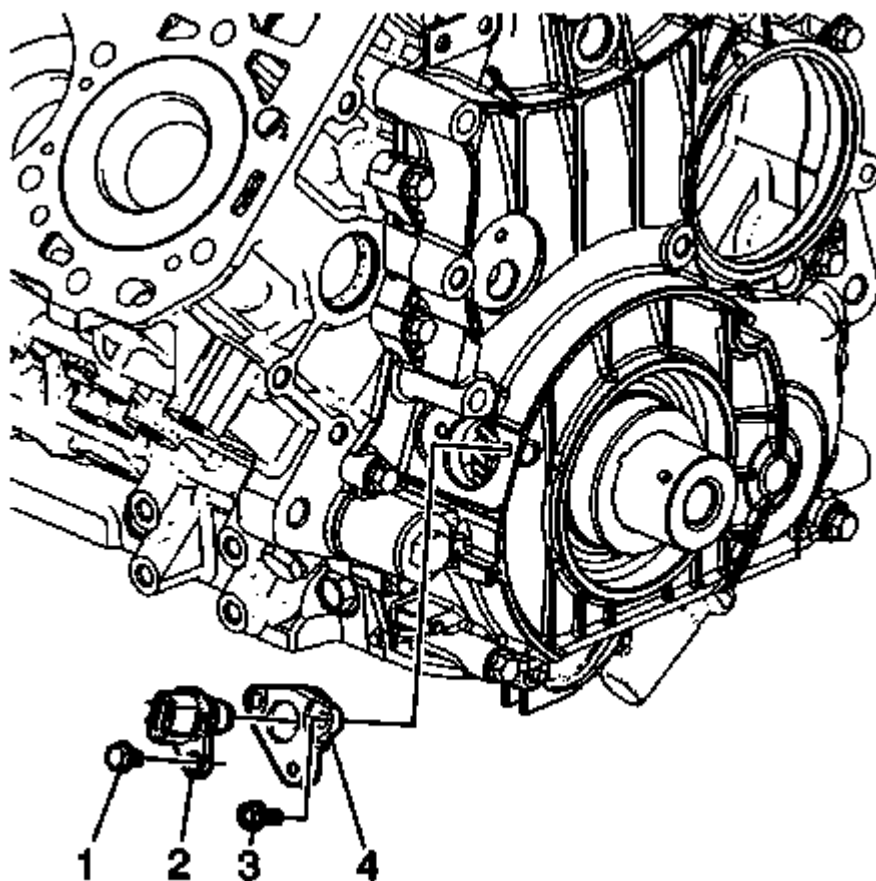


Fig. 111: Identifying Crankshaft Position Sensor, Bolts And Spacers
Courtesy of GENERAL MOTORS COMPANY

4. Remove the crankshaft position sensor bolt (1).
5. Remove the crankshaft position sensor (2).
6. Remove the crankshaft position sensor spacer bolts (3).
7. Remove the crankshaft position sensor spacer (4).
8. Remove the camshaft position sensor. Refer to **Camshaft Position Sensor Replacement** .

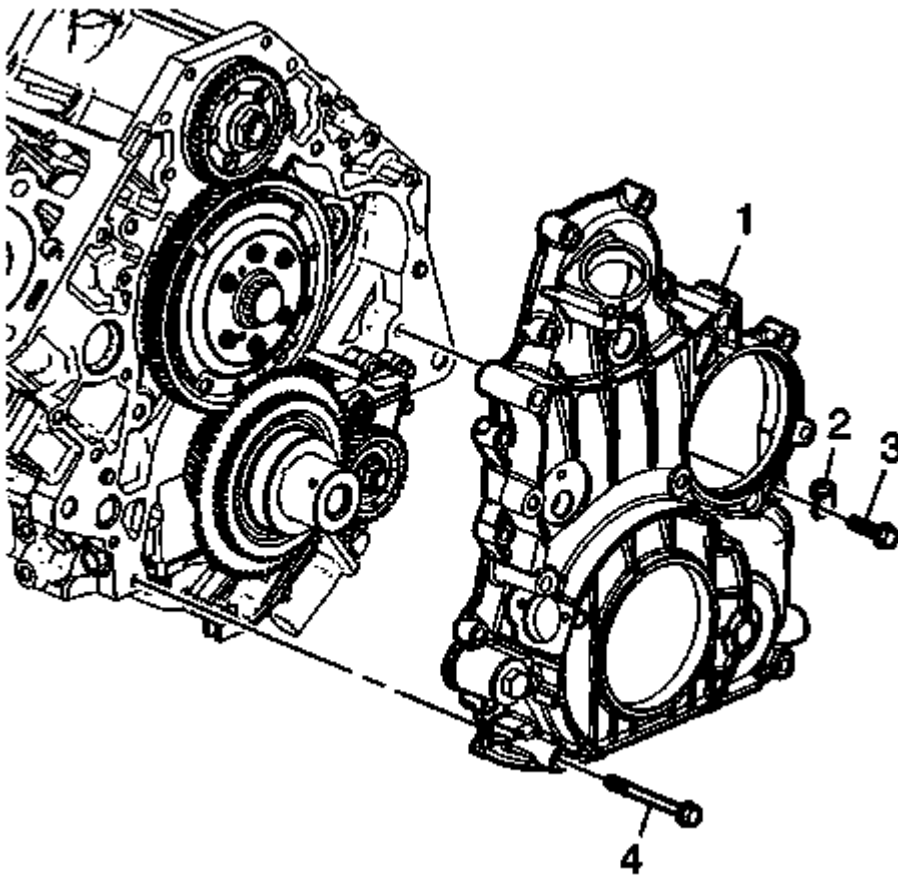


Fig. 112: View Of Engine Front Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the engine front cover bolts (3, 4).
10. Remove the engine wiring harness clip (2).
11. Separate the engine front cover from the cylinder block using **J-37228** cutter.
12. Remove the engine front cover (1).

Installation Procedure

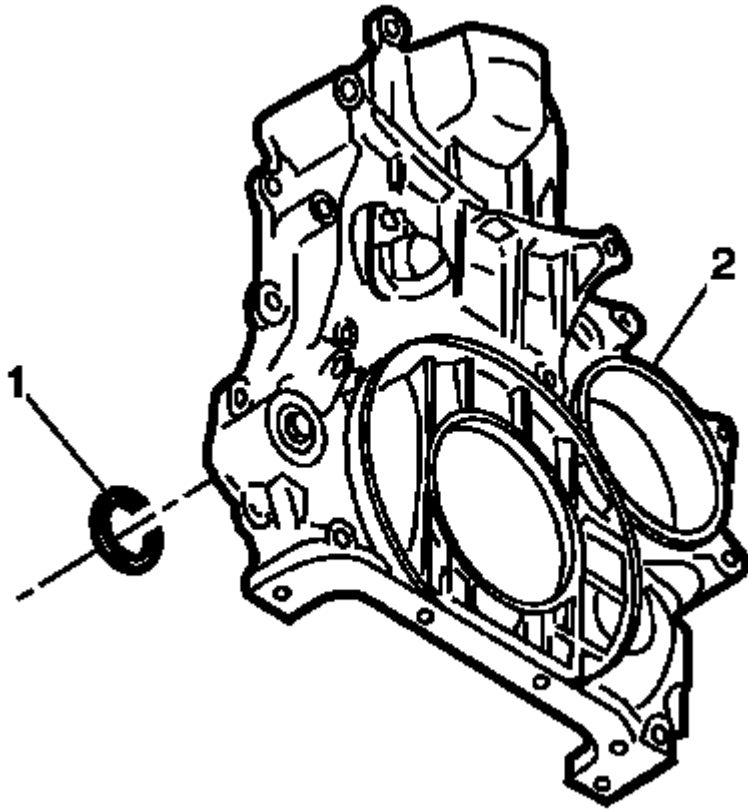


Fig. 113: View Of Pressure Relief Valve O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install the relief valve O-ring (1) to the engine front cover.
2. Lubricate the O-ring with engine oil.

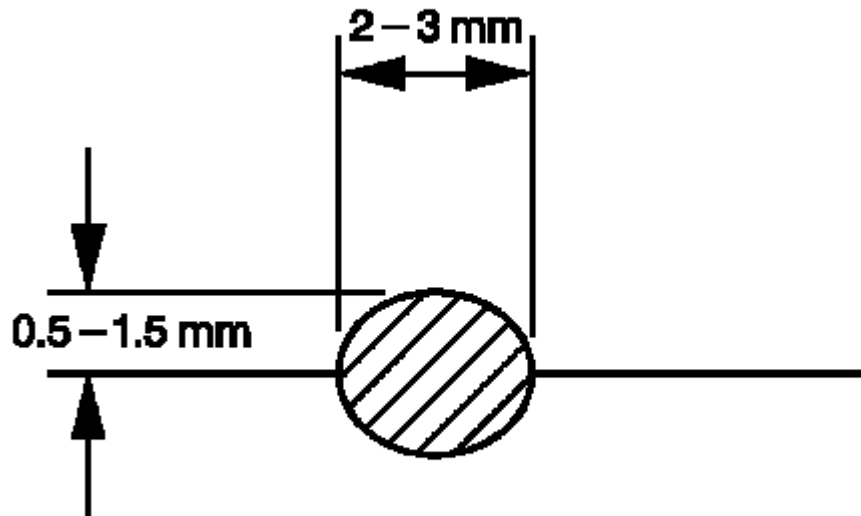


Fig. 114: Determining Sealant Bead Dimensions
Courtesy of GENERAL MOTORS COMPANY

3. Apply a 2-3 mm (0.079-0.118 in) wide and 0.5-1.5 mm (0.02-0.06 in) high bead of sealant to the mating surfaces of the engine front cover. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

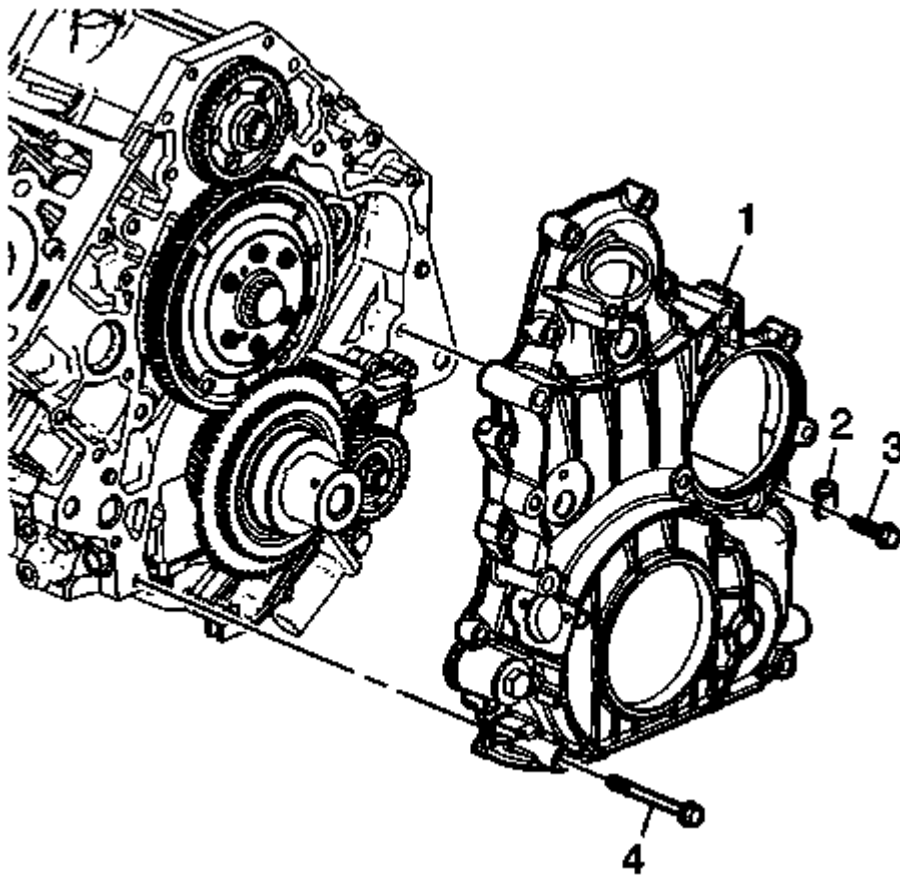


Fig. 115: View Of Engine Front Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the engine front cover (1).
5. Install the engine wiring harness clip (2).
6. Install the engine front cover bolts (3, 4).

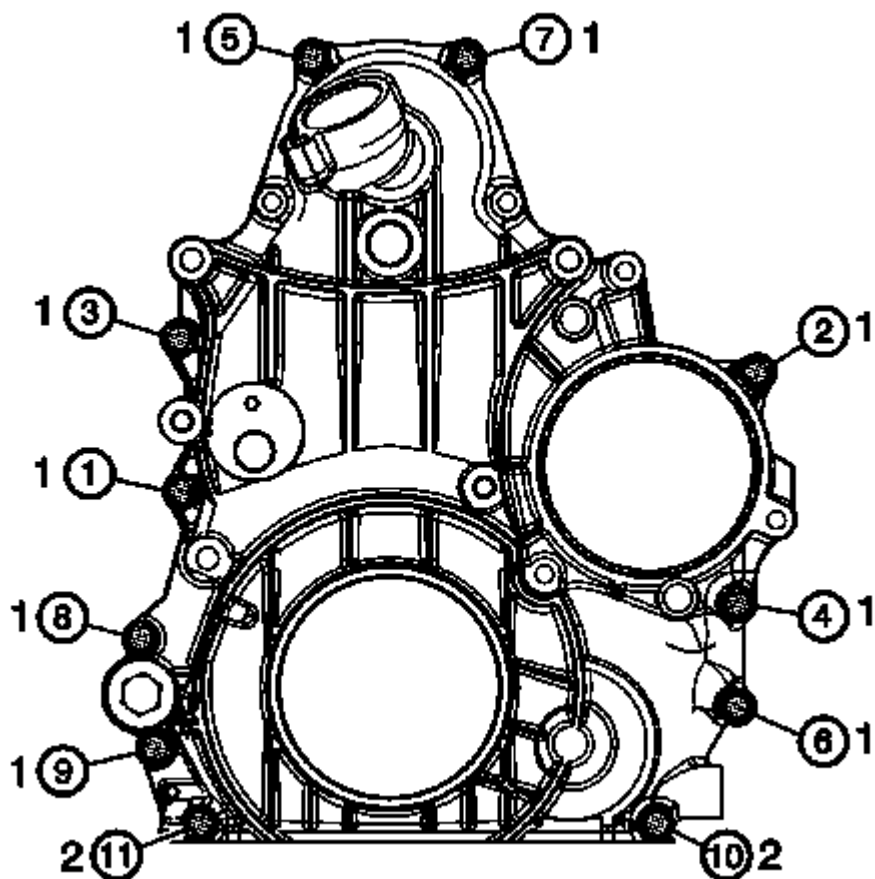


Fig. 116: Identifying Engine Front Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

7. Tighten the engine front cover bolts (1, 2) in sequence to 25 N.m (18 lb ft).

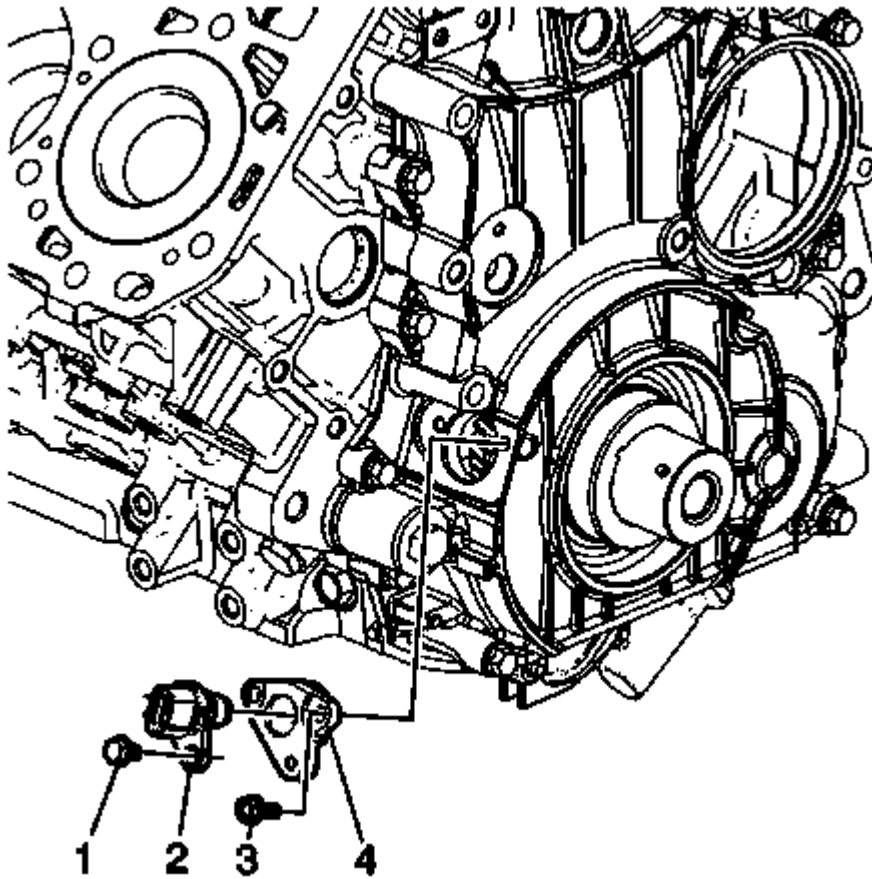


Fig. 117: Identifying Crankshaft Position Sensor, Bolts And Spacers
Courtesy of GENERAL MOTORS COMPANY

8. Install a NEW O-ring to the crankshaft position sensor spacer.
9. Lubricate the O-ring with engine oil.
10. Install the crankshaft position sensor spacer (4).
11. Install the crankshaft position sensor spacer bolts (3) and tighten to 10 N.m (89 lb in).
12. Install a NEW O-ring to the crankshaft position sensor.
13. Lubricate the O-ring with engine oil.
14. Install the crankshaft position sensor (2).
15. Install the crankshaft position sensor bolt (1) and tighten to 10 N.m (89 lb in).

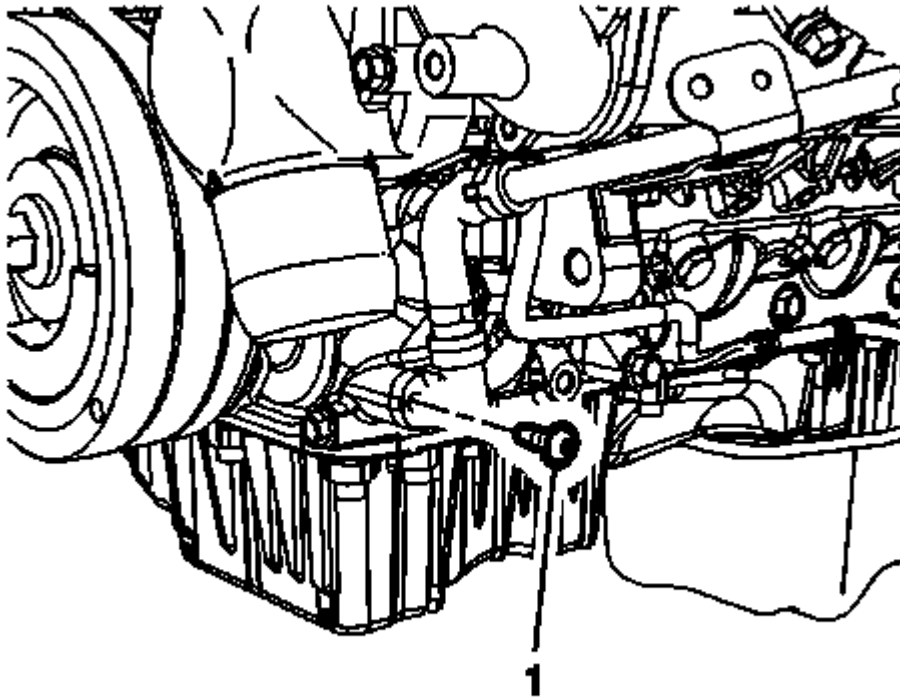


Fig. 118: PCV Bolt

Courtesy of GENERAL MOTORS COMPANY

16. Use **EN-50956** Tamper Proof Drive Bit to install the NEW bolts (1).
17. Install the camshaft position sensor. Refer to **Camshaft Position Sensor Replacement**

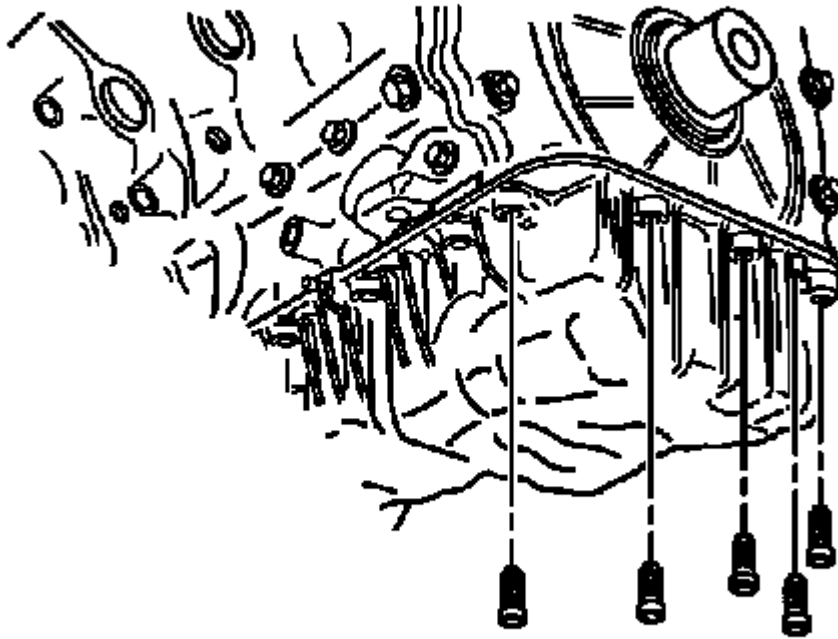


Fig. 119: View Of Upper Oil Pan To Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

18. Install the upper oil pan to the engine front cover bolts and tighten to 21 (15 lb ft).
19. Install the water pump assembly. Refer to **Water Pump Replacement (Diesel)** .
20. Relearn the crankshaft position reluctor wheel. Refer to **Crankshaft Position Reluctor Wheel Learn** .

CAMSHAFT GEAR REPLACEMENT

Special Tools

J-44643 Flywheel Holding Tool

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

Removal Procedure

1. Remove the starter. Refer to **Starter Replacement (Diesel)** .

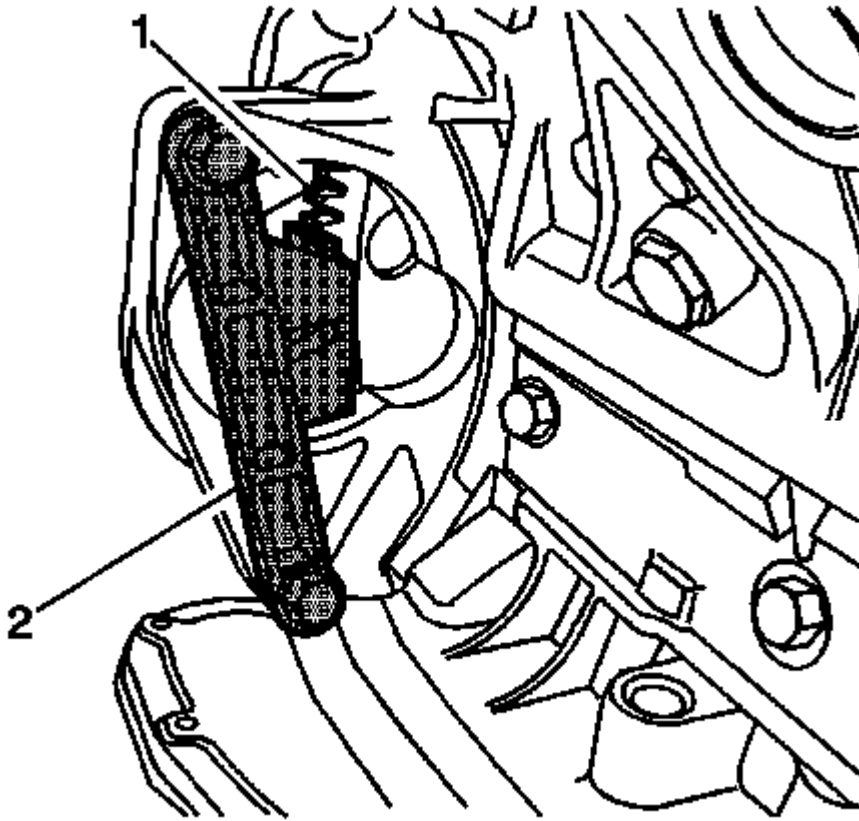


Fig. 120: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS COMPANY

2. Install the **J-44643** tool (2) in order to hold the flywheel (1).
3. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.

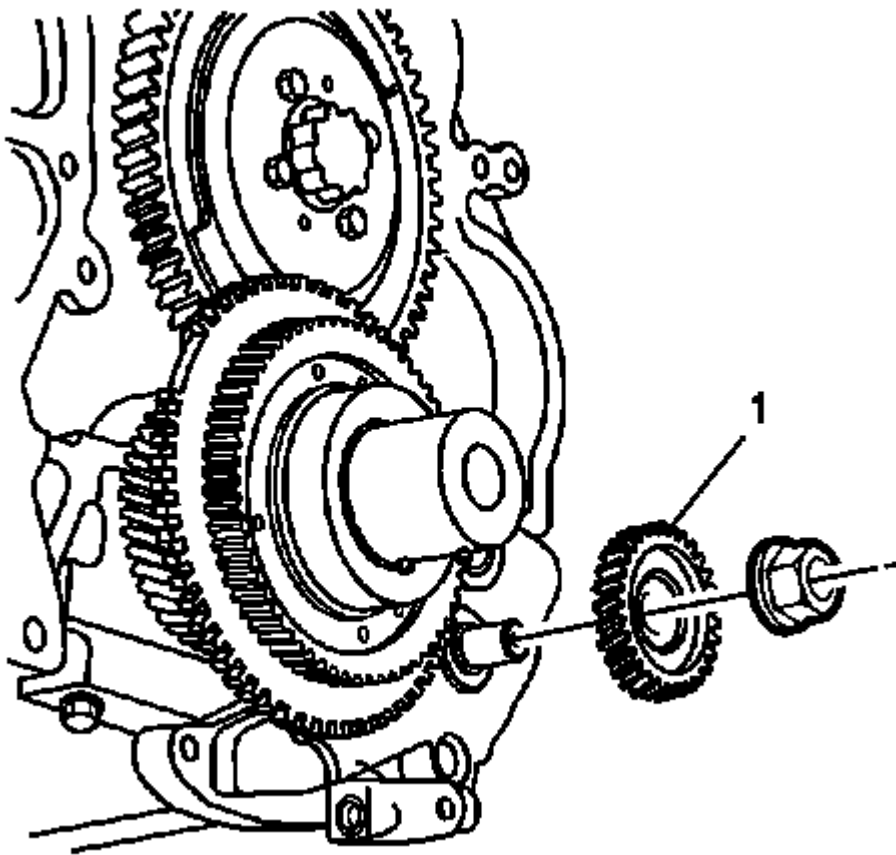


Fig. 121: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil pump driven gear fastener.
5. Remove the oil pump driven gear (1).

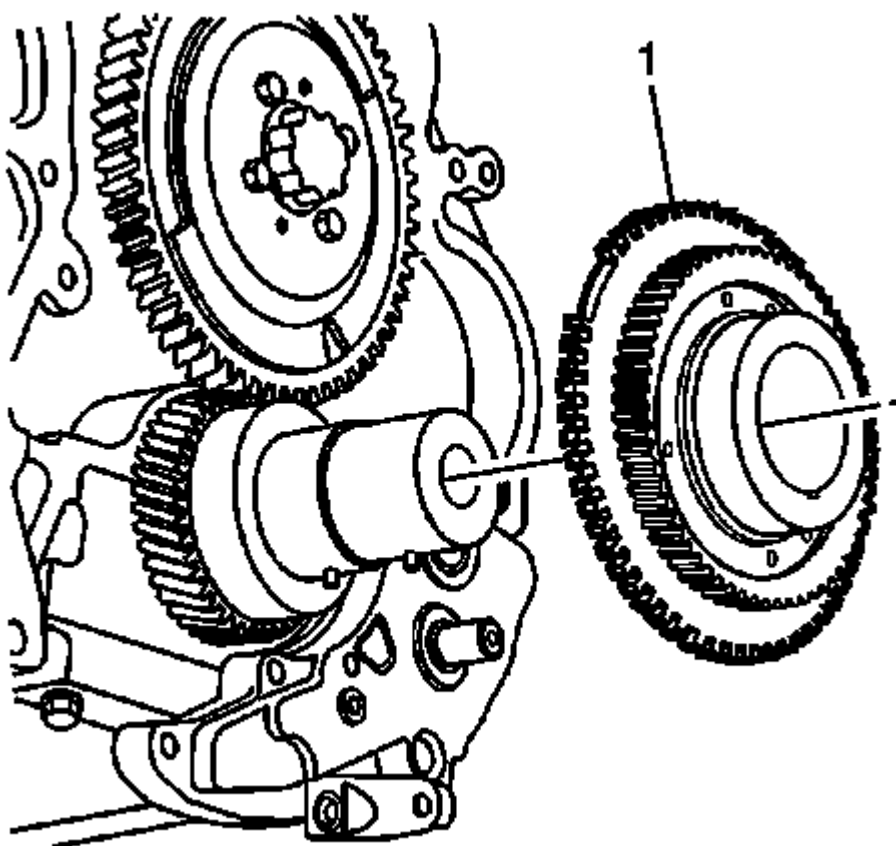


Fig. 122: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS COMPANY

NOTE: The crankshaft reluctor and the oil pump drive gear are timed together at the factory. Do not remove the crankshaft reluctor from the oil pump drive gear.

6. Remove the oil pump drive gear (1) and crankshaft reluctor.
 - Do not remove the crankshaft reluctor fasteners.
 - Do not damage the reluctor teeth.

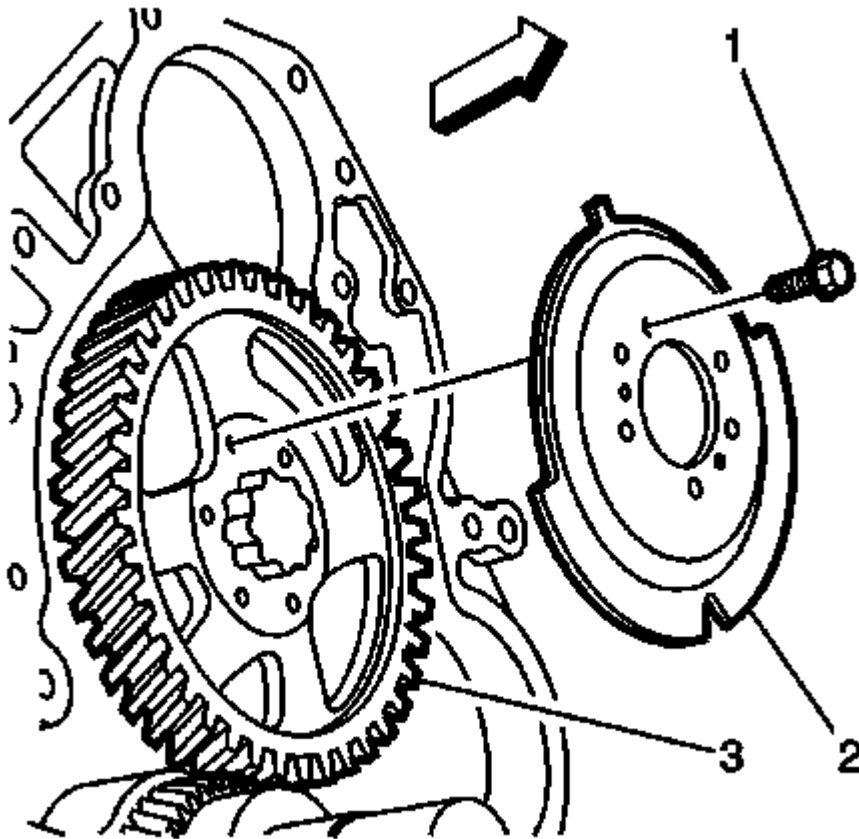


Fig. 123: View Of Camshaft Reluctor & Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the camshaft reluctor fasteners (1).
8. Remove the camshaft reluctor (2).

WARNING: The two piece cam gear must be bolted together to prevent the spring tension from unloading upon removal. Additionally, the two piece cam gear must remain bolted together until it is re-installed to the camshaft and fully engaged to the crankshaft gear. Failure to do so may result in personal injury.

9. Remove the camshaft exciter ring (3).

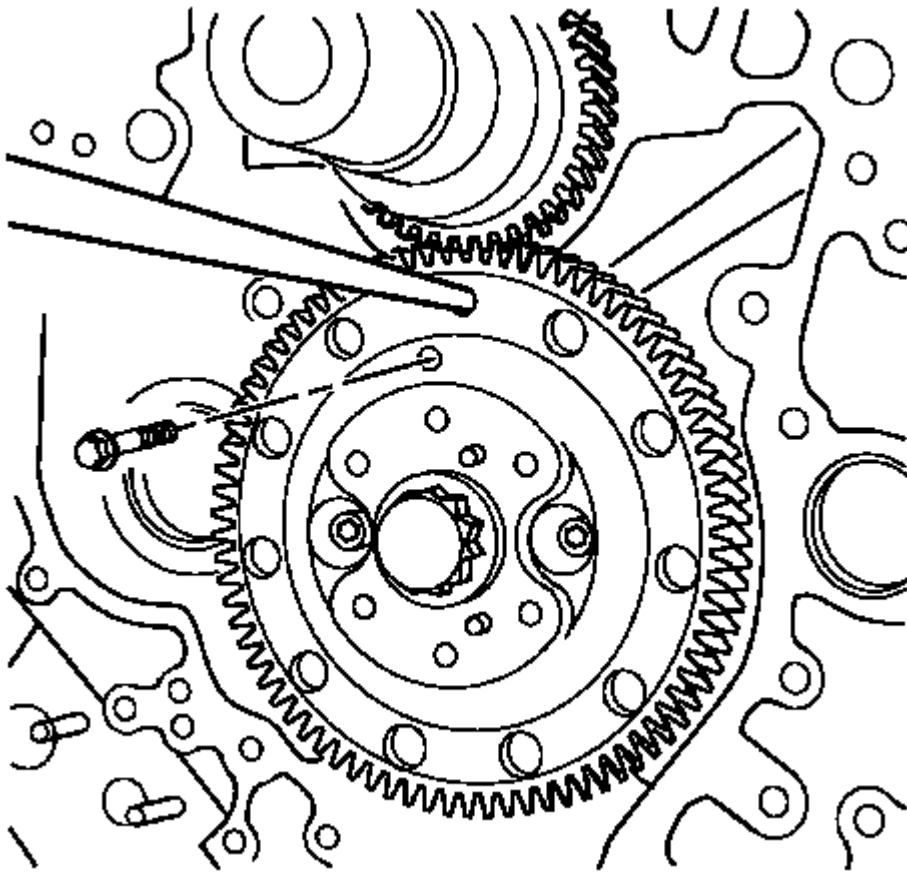


Fig. 124: Using Exciter Ring Bolt To Secure Spring Tension
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Graphic shown upside down for clarity.**

10. Align the threaded hole with a suitable tool and install an exciter ring fastener to secure the spring tension.

NOTE: **This will hold the spring tension of the two piece cam gear**

11. Loosen the camshaft gear fastener and leave the fastener finger tight.

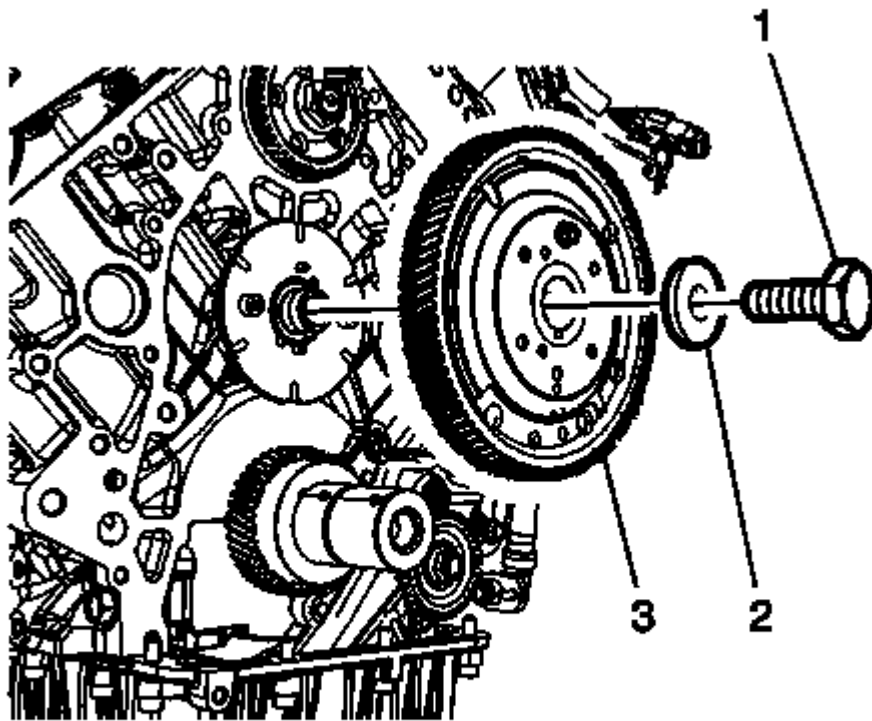


Fig. 125: Camshaft Gear

Courtesy of GENERAL MOTORS COMPANY

12. Remove the camshaft gear fastener (1) and discard. Save the washer (2) for reuse.
13. Remove the camshaft gear (3).

Installation Procedure

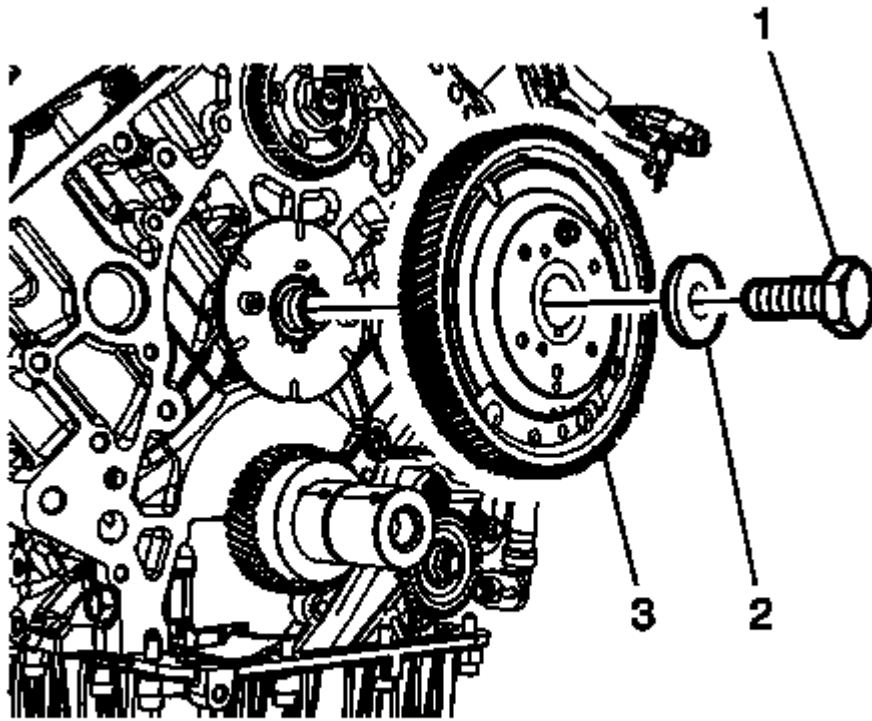


Fig. 126: Camshaft Gear

Courtesy of GENERAL MOTORS COMPANY

1. Install the camshaft driven gear (3).
2. Install a NEW camshaft driven gear fastener (1) and washer (2) finger tight only.

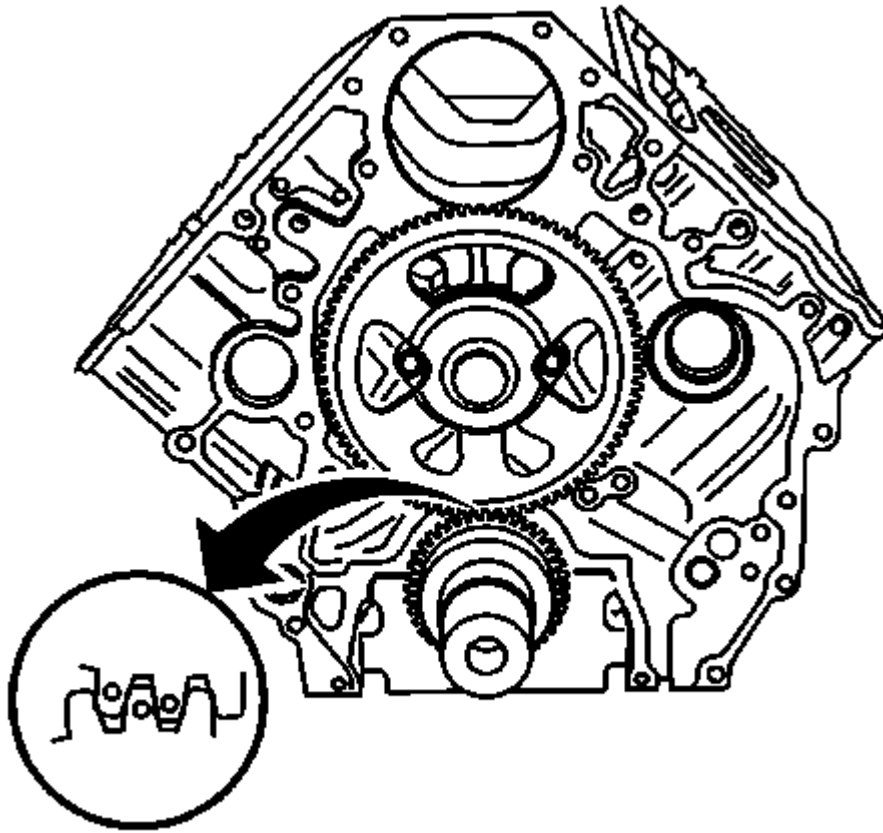


Fig. 127: View Of Camshaft Gear Aligned With Crankshaft Gear
Courtesy of GENERAL MOTORS COMPANY

3. Install the camshaft gear onto the camshaft and align the camshaft gear to the crankshaft gear as shown.

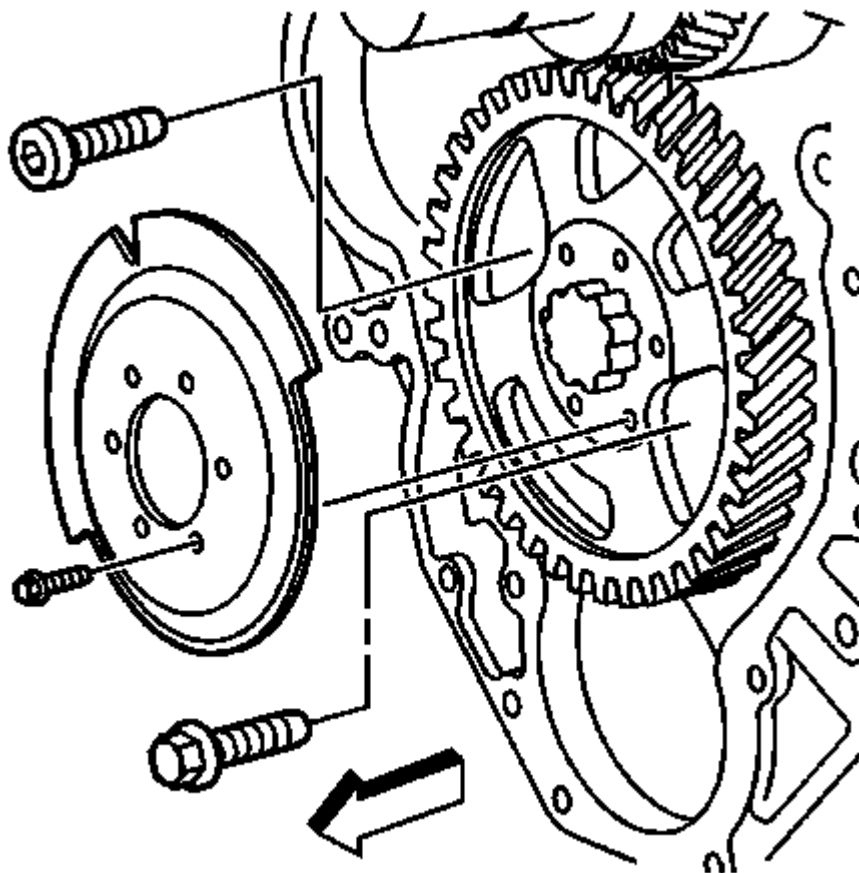


Fig. 128: View Of Camshaft Exciter Ring, Bolts & Thrust Plate Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a suitable tool to relieve the spring tension while removing the locking fastener.

4. Remove the exciter ring fastener that was installed to hold the spring tension of the two piece cam gear.

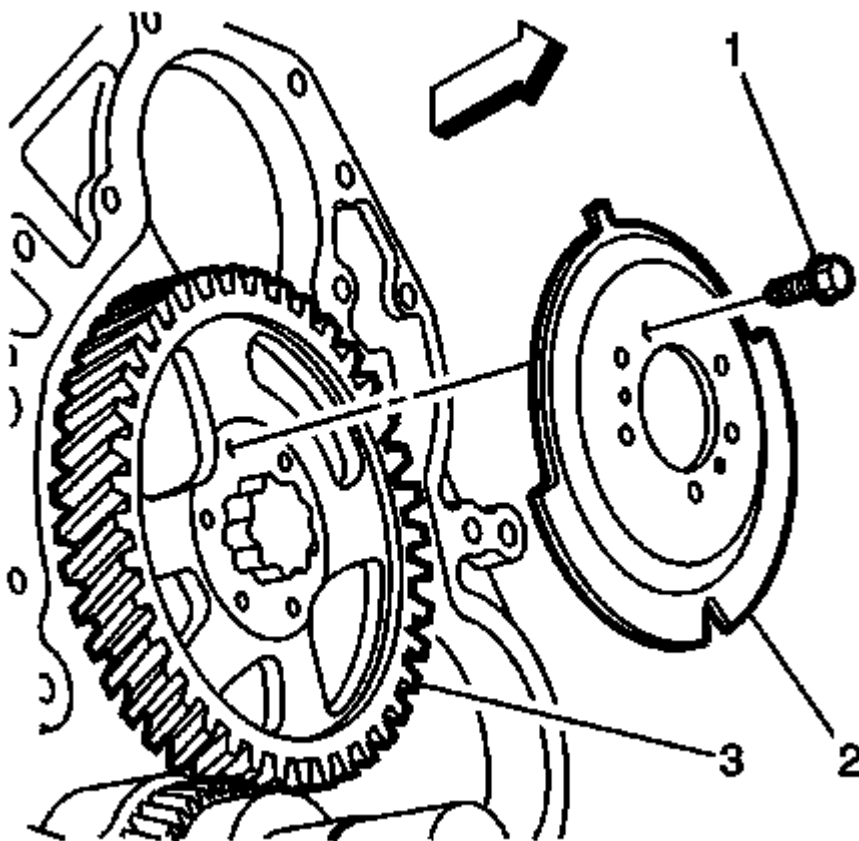


Fig. 129: View Of Camshaft Reluctor & Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the camshaft reluctor (2) to the camshaft gear (3).

CAUTION: Refer to Fastener Caution .

6. Install the camshaft reluctor fasteners and tighten in a cross-fastener pattern to 12 (106 lb in).
7. Tighten the NEW camshaft gear fastener to 234 (173 lb ft).

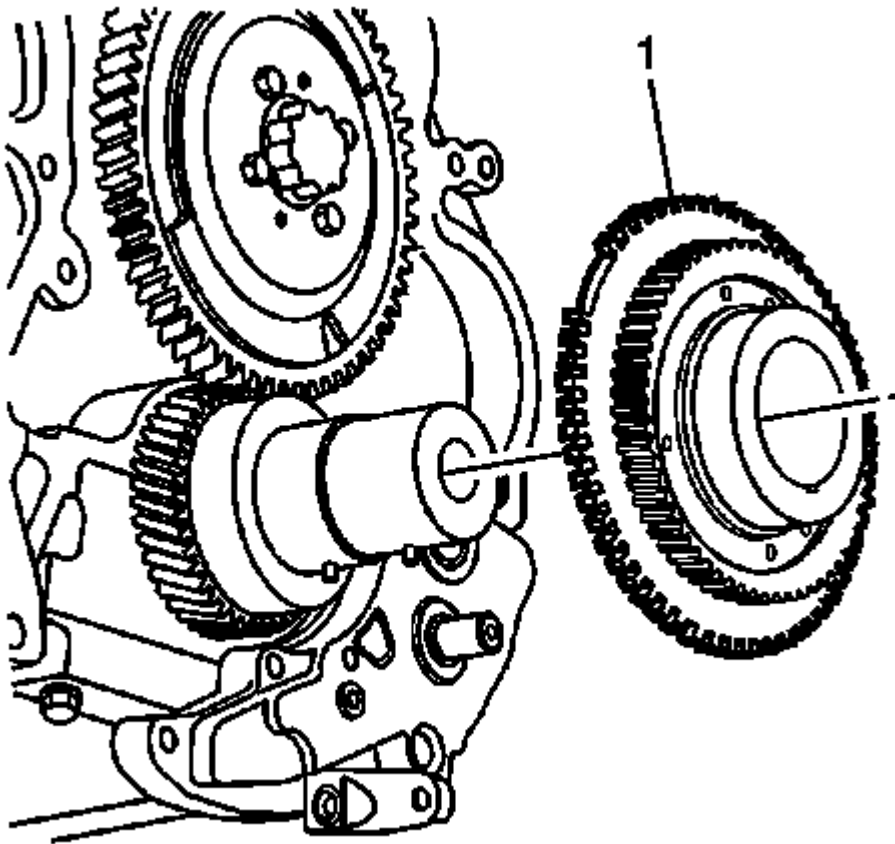


Fig. 130: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not damage the teeth on the crankshaft reluctor.

8. Install the oil pump drive gear (1) and reluctor to the crankshaft.

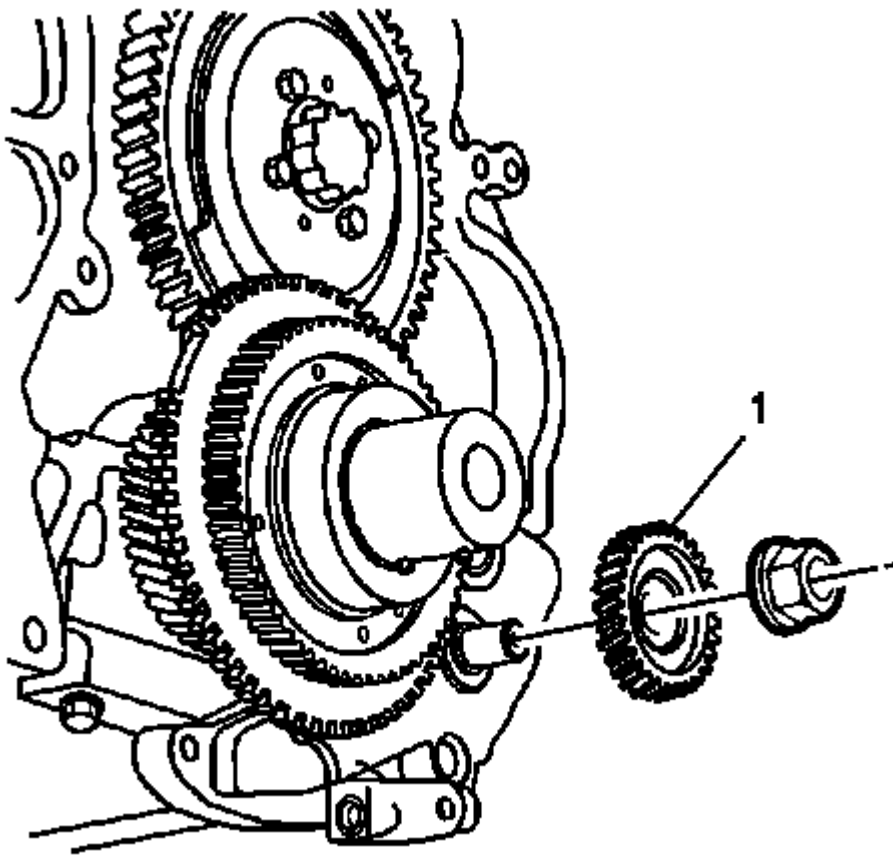


Fig. 131: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS COMPANY

9. Install the oil pump driven gear (1).
10. Install the oil pump driven gear fastener and tighten to 100 (74 lb ft).
11. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

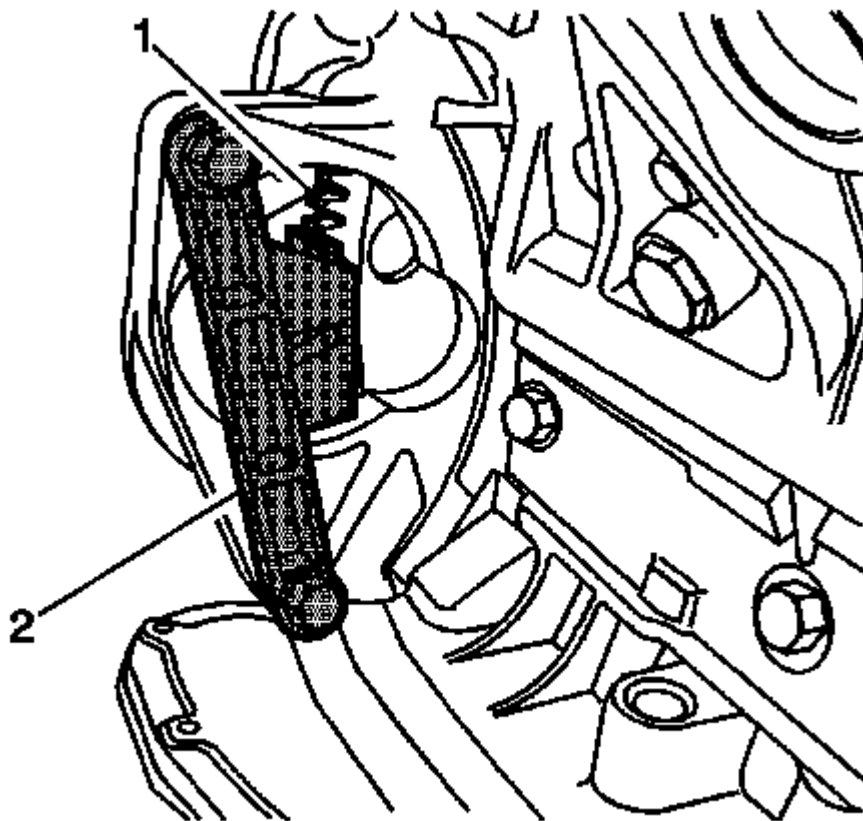


Fig. 132: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS COMPANY

12. Remove the **J-44643** tool (2).
13. Install the starter. Refer to **Starter Replacement (Diesel)** .
14. Relearn the crankshaft position reluctor wheel. Refer to **Crankshaft Position Reluctor Wheel Learn** .

CAMSHAFT POSITION SENSOR EXCITER RING REPLACEMENT

Removal Procedure

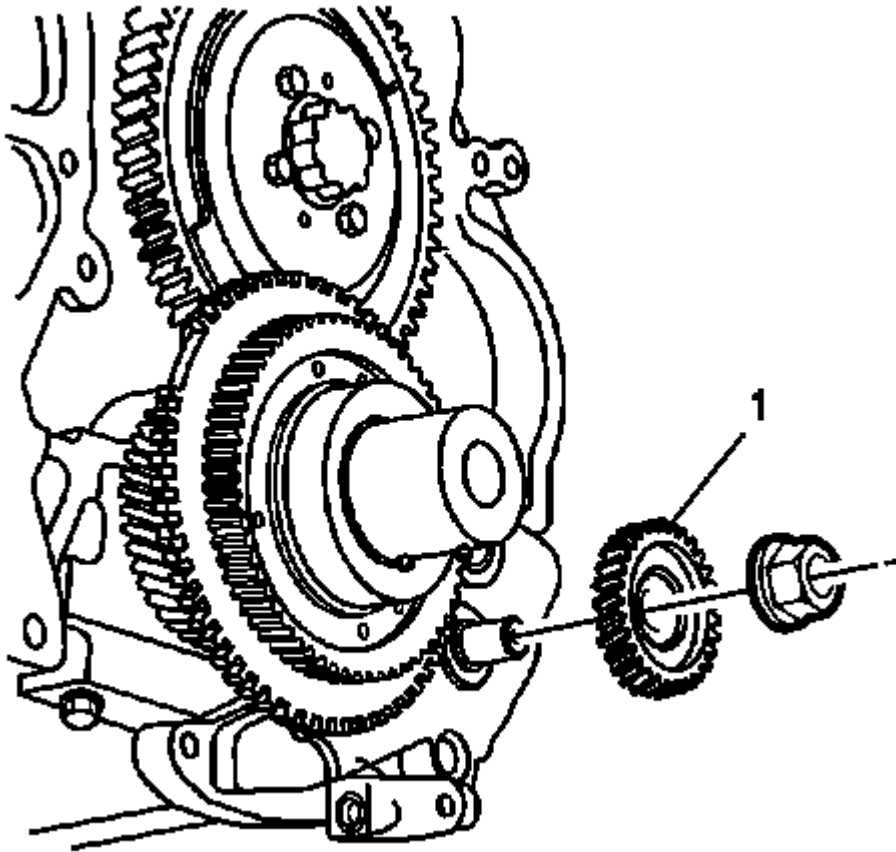


Fig. 133: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine front cover. Refer to Engine Front Cover Replacement.

CAUTION: Do not use an impact driver to remove or install the oil pump driven gear nut. Use of an impact driver may shear the oil pump drive gear pin in the crankshaft.

2. While holding the secondary oil pump shaft with a hex driver, remove the oil pump driven gear nut.
3. Remove the oil pump driven gear (1).

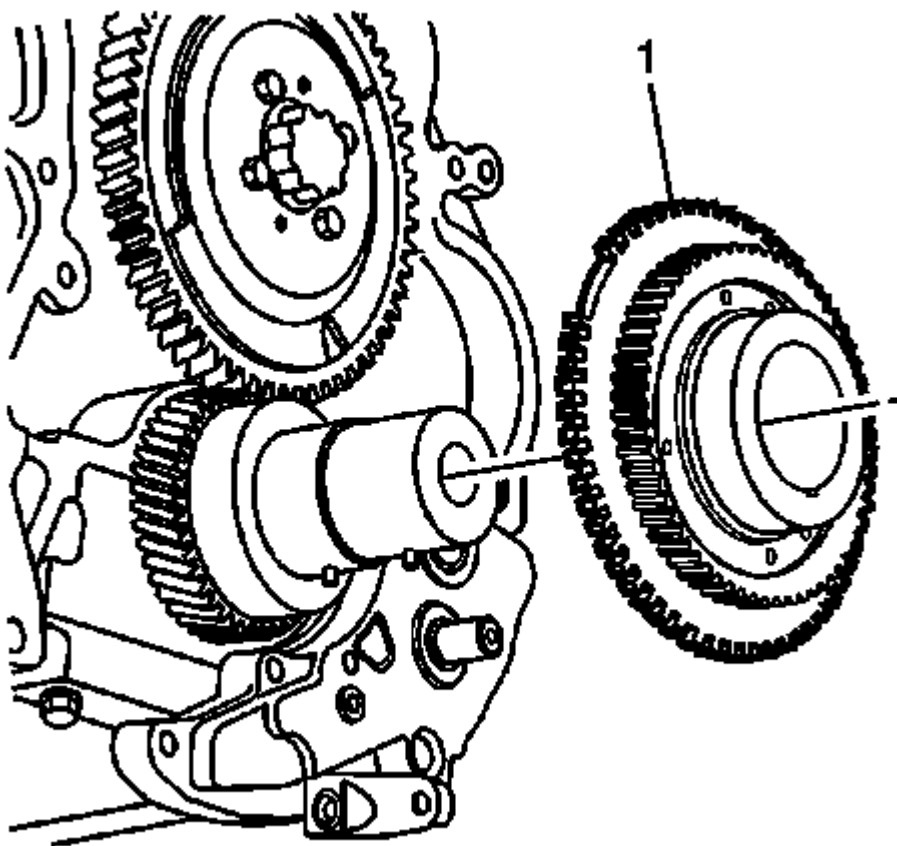


Fig. 134: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS COMPANY

NOTE: DO NOT remove the reluctor from the oil pump drive gear. The reluctor is timed to the gear and once removed the correct timing will be lost.

4. Remove the oil pump drive gear and crankshaft sensor reluctor (1).

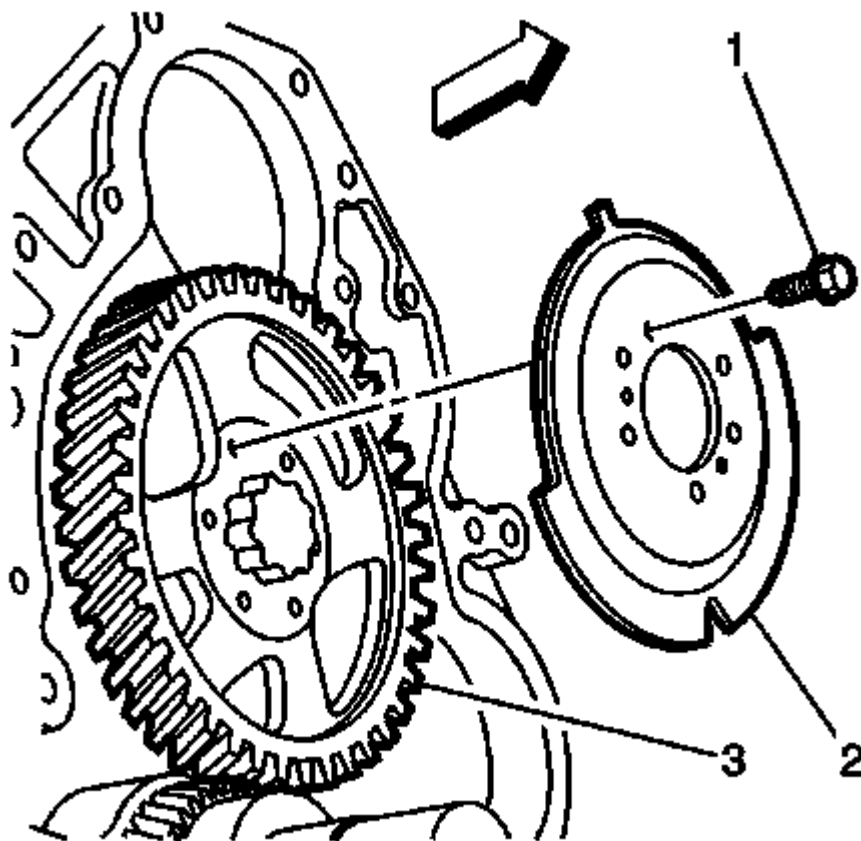


Fig. 135: View Of Camshaft Reluctor & Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the camshaft reluctor screws (1).
6. Remove the camshaft reluctor (2).

Installation Procedure

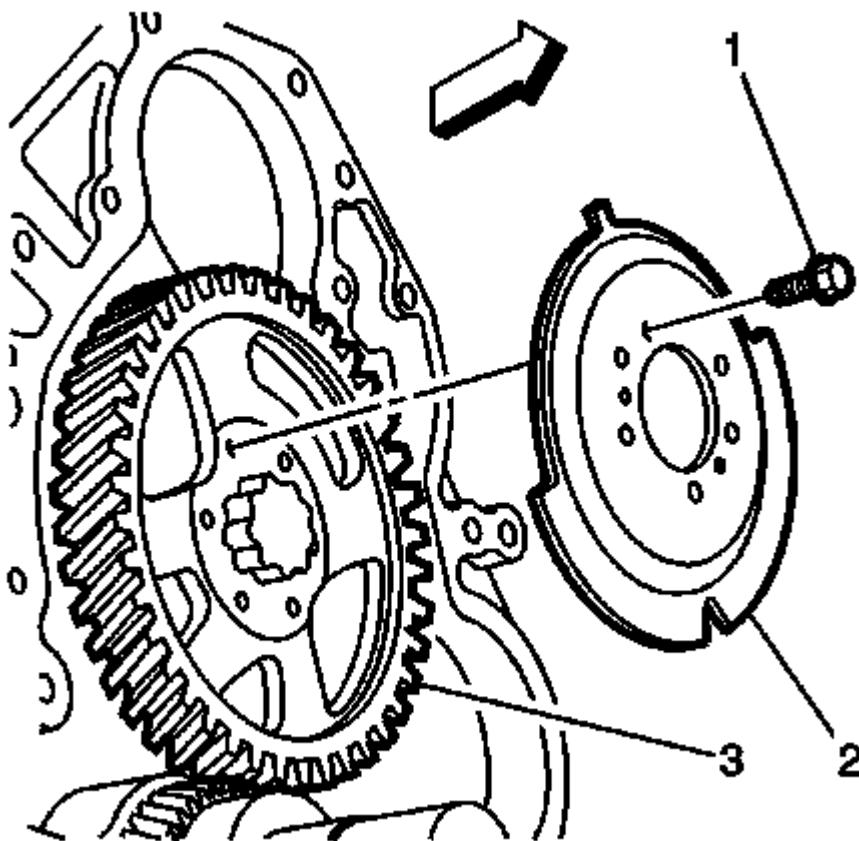


Fig. 136: View Of Camshaft Reluctor & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Position the camshaft reluctor (2) to the camshaft gear (3).

CAUTION: Refer to Fastener Caution .

2. Install the camshaft reluctor bolts and tighten to 12 N.m (106 lb in).

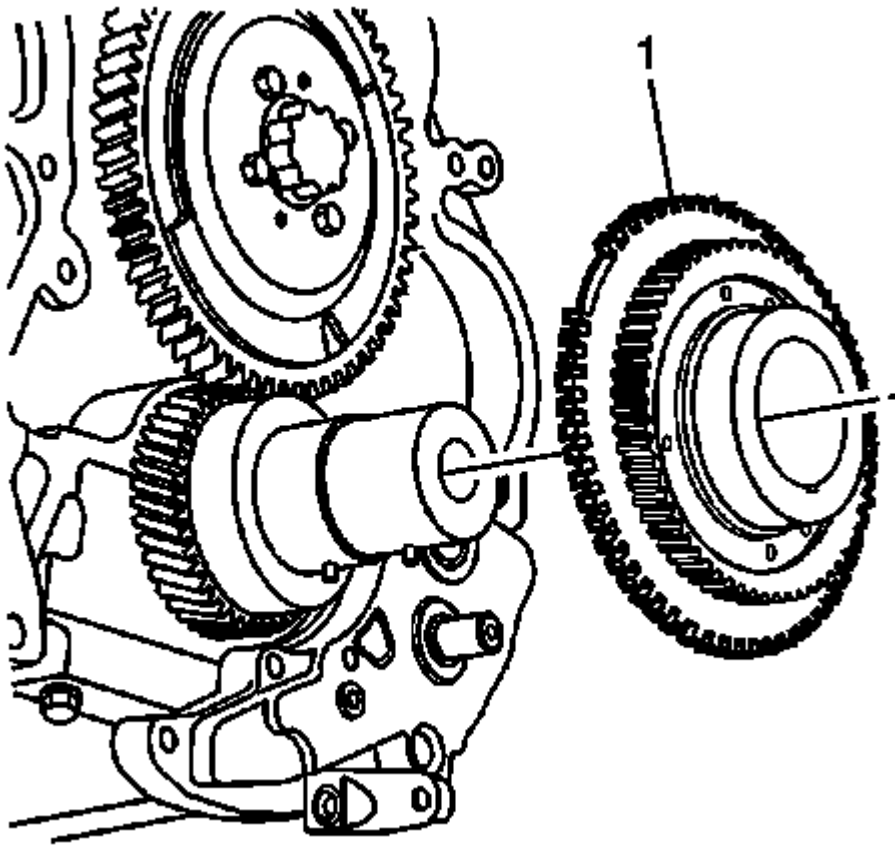


Fig. 137: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not damage the teeth on the reluctor.

3. Install the oil pump drive gear (1) and reluctor to the crankshaft.

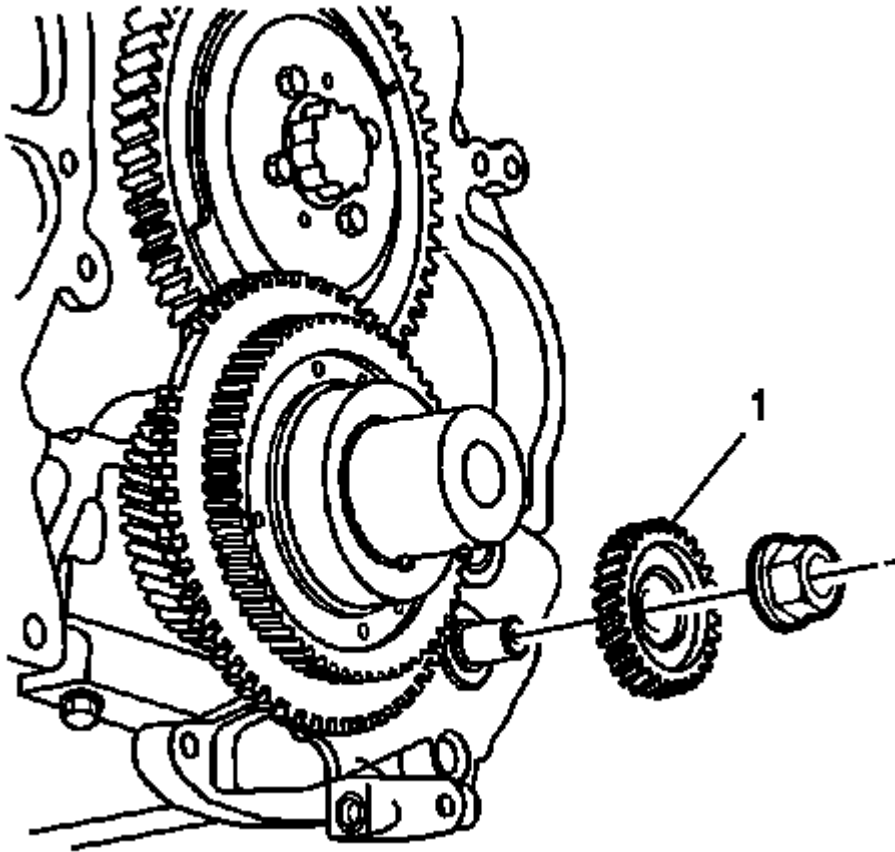


Fig. 138: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS COMPANY

4. Install the oil pump driven gear (1).

CAUTION: Do not use an impact driver to remove or install the oil pump driven gear nut. Use of an impact driver may shear the oil pump drive gear pin in the crankshaft.

5. While holding the secondary oil pump shaft with a hex driver, install the oil pump driven gear nut and tighten to 100 N.m (74 lb ft).
6. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).
7. Relearn the crankshaft position reluctor wheel. Refer to [Crankshaft Position Reluctor Wheel Learn](#).

CAMSHAFT REPLACEMENT

Special Tools

- J-26900-12 Dial Indicator
- J-26900-13 Magnetic Base

- **J-44643** Flywheel Holding Tool

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

Removal Procedure

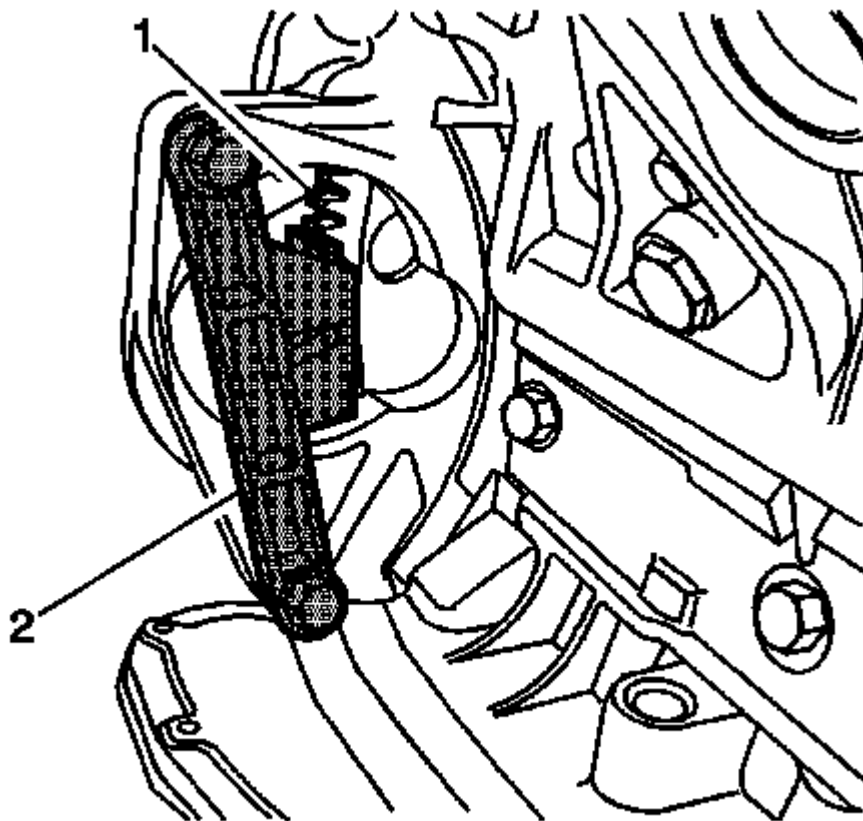


Fig. 139: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine assembly. Refer to **Engine Replacement**.
2. Remove the valve lifters. Refer to **Valve Lifter Replacement**.
3. Install **J-44643** tool (2) flush to the flywheel opening.
4. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.

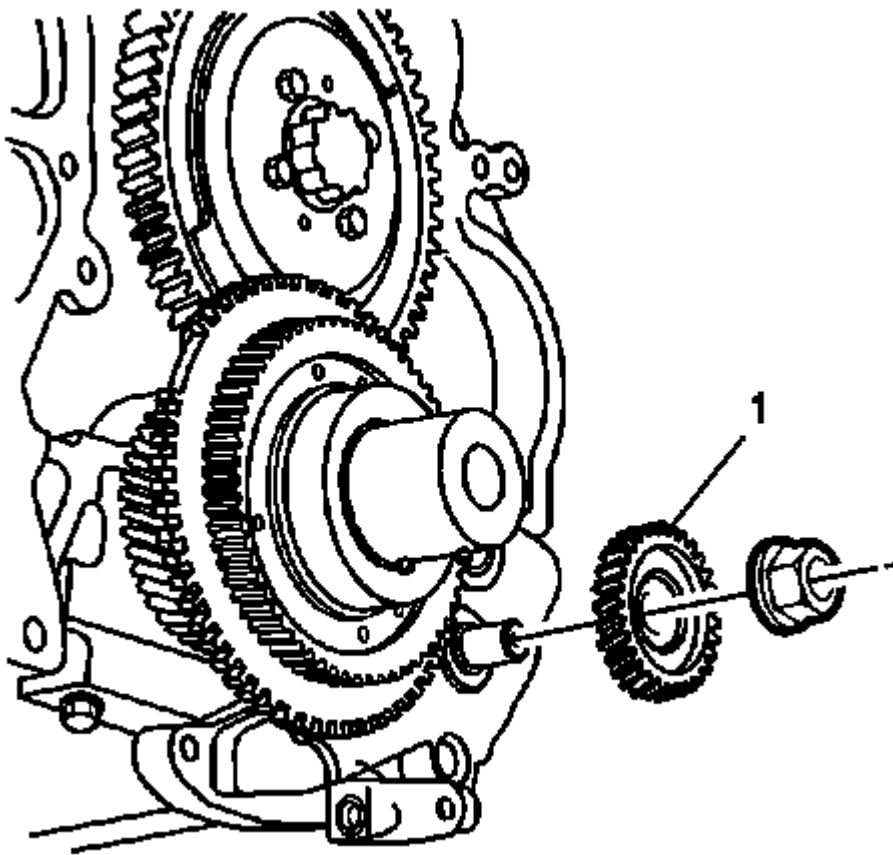


Fig. 140: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS COMPANY

5. Remove the oil pump driven gear nut (1).
6. Remove the oil pump driven gear.

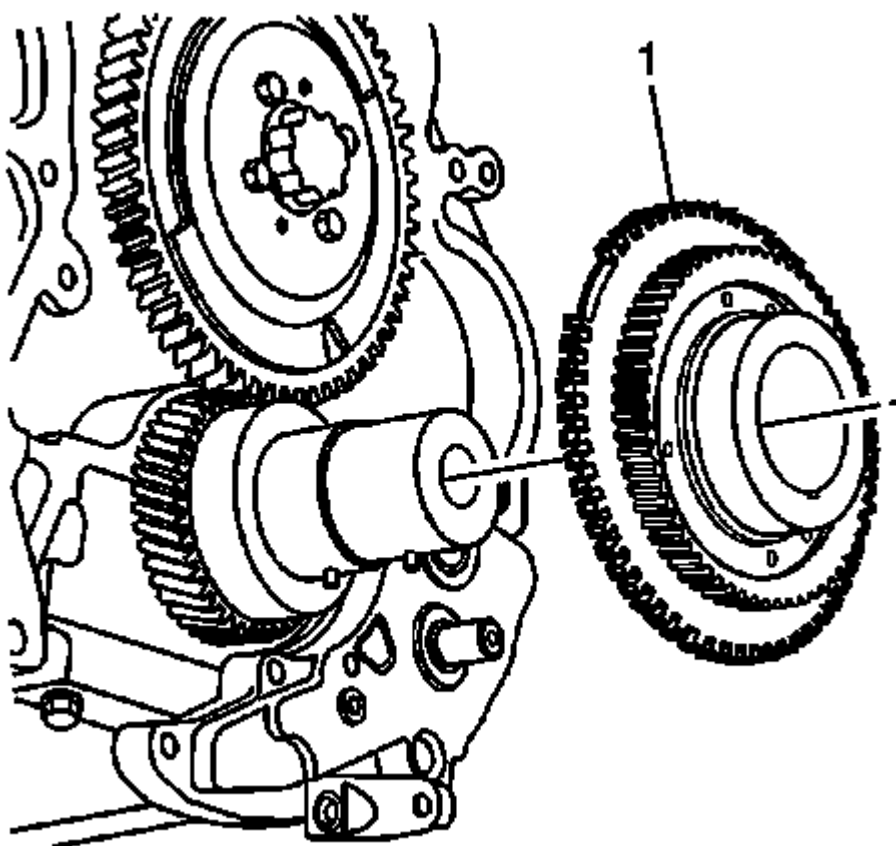


Fig. 141: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS COMPANY

NOTE: The crankshaft reluctor and the oil pump drive gear are timed together at the factory. Do not remove the crankshaft reluctor from the oil pump drive gear.

7. Remove the oil pump drive gear (1) and crankshaft reluctor.
 - Do not remove the crankshaft reluctor bolts.
 - Do not damage the reluctor teeth.

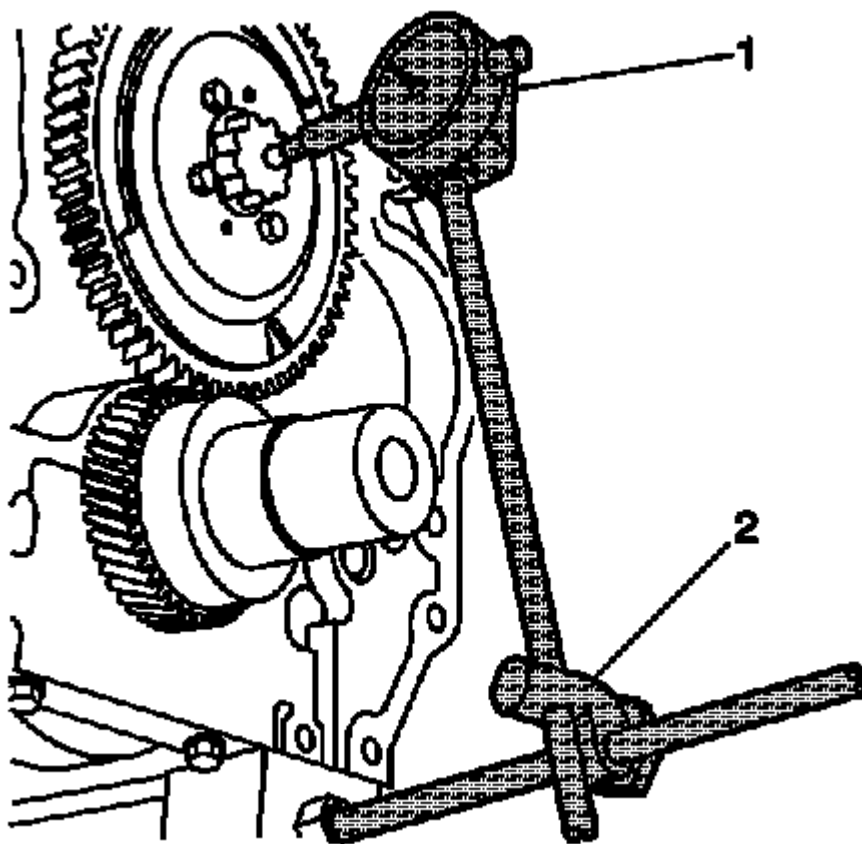


Fig. 142: Measuring Camshaft End Play Using J 26900-12 & J 26900-13
Courtesy of GENERAL MOTORS COMPANY

8. Using **J-26900-12** indicator (1) and **J-26900-13** base (2), measure the camshaft end play.
 - The production value is 0.050-0.114 mm (0.002-0.0045 in) and service limit is 0.20 mm (0.008 in).
 - Replace the camshaft gear or the camshaft thrust plate if measured value exceeds service limit.

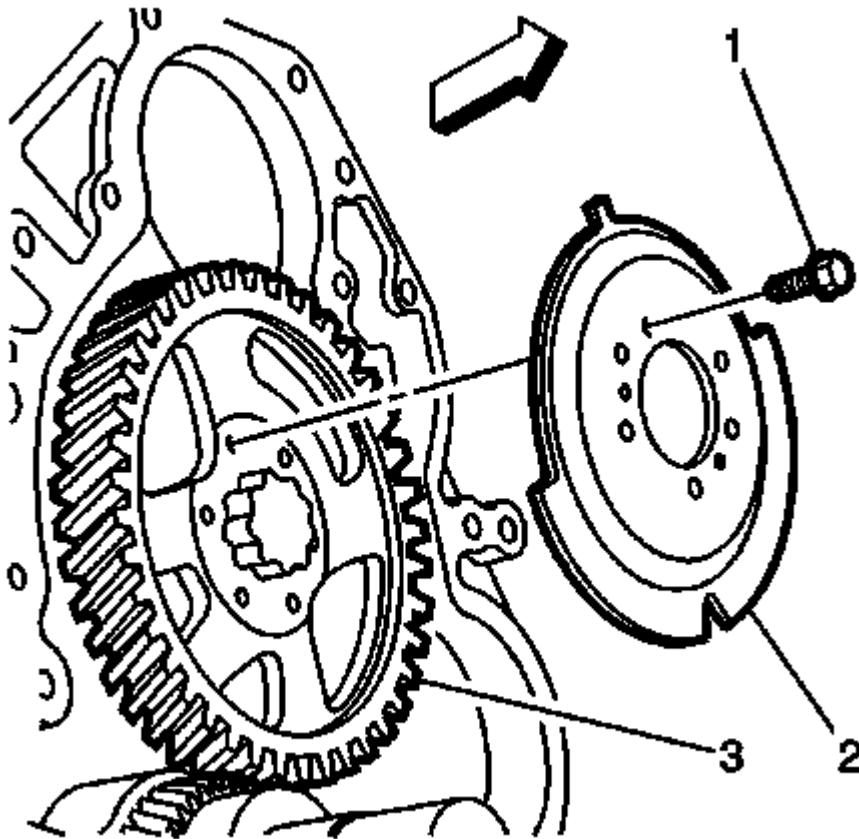


Fig. 143: View Of Camshaft Reluctor & Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the camshaft reluctor screws (1).
10. Remove the camshaft reluctor (2).

WARNING: The two piece cam gear must be bolted together to prevent the spring tension from unloading upon removal. Additionally, the two piece cam gear must remain bolted together until it is re-installed to the camshaft and fully engaged to the crankshaft gear. Failure to do so may result in personal injury.

11. Remove the camshaft exciter ring (3).

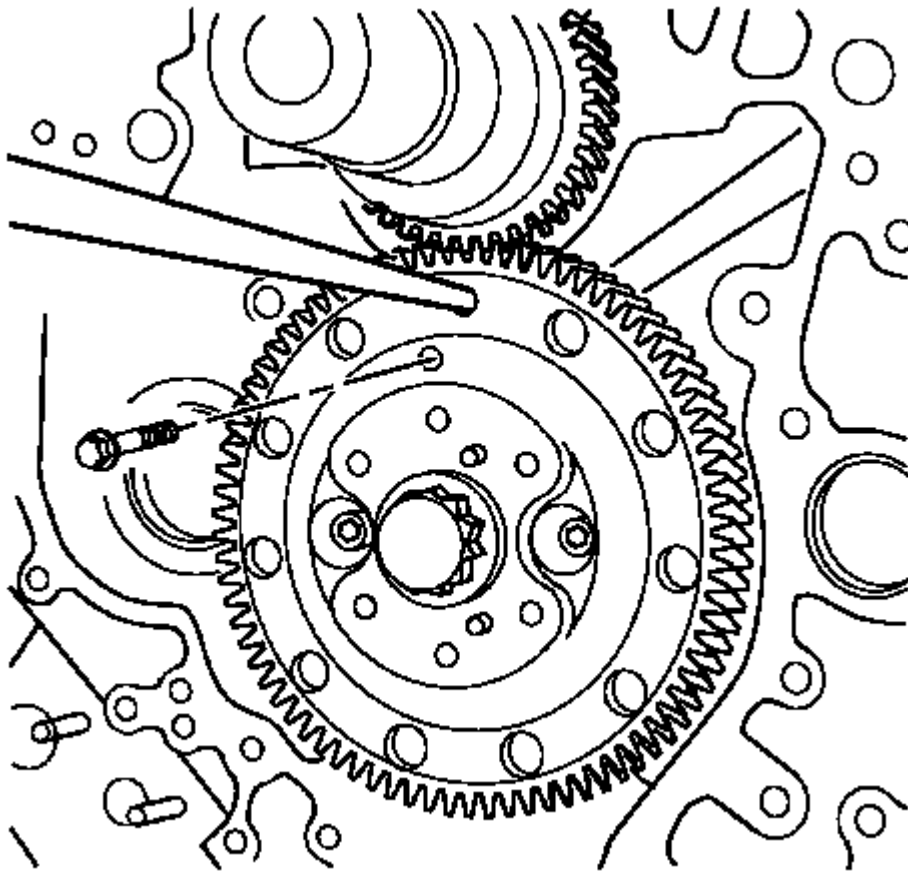


Fig. 144: Using Exciter Ring Bolt To Secure Spring Tension
Courtesy of GENERAL MOTORS COMPANY

12. Align the threaded hole with a suitable tool and install an exciter ring bolt to secure the spring tension.
13. Remove the camshaft thrust plate bolts through the holes in the camshaft gear.

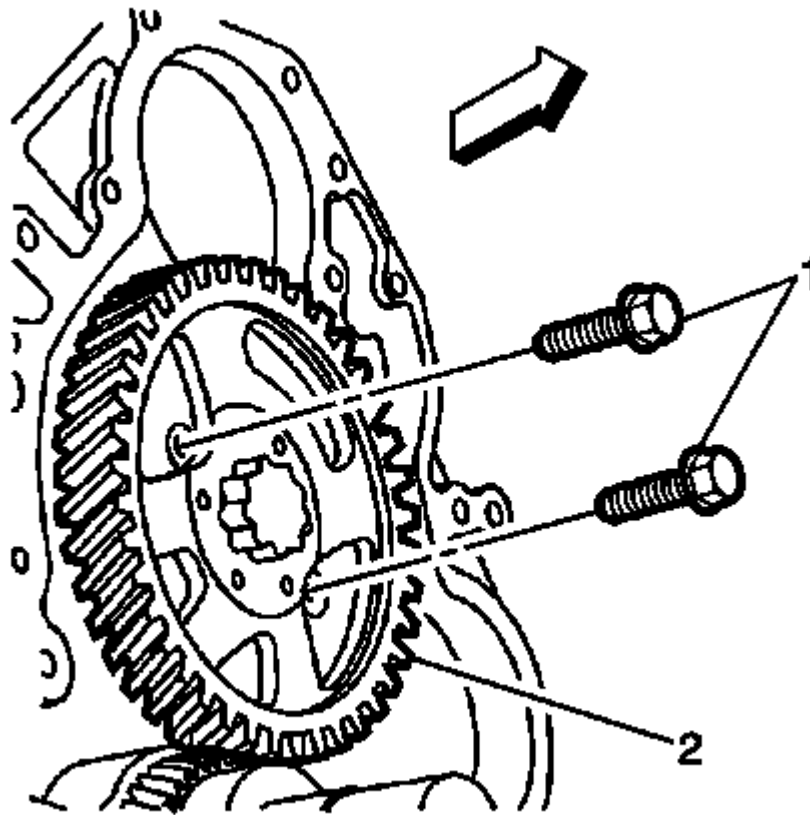


Fig. 145: View Of Camshaft Thrust Plate Bolts

Courtesy of GENERAL MOTORS COMPANY

14. In order to loosen the camshaft gear bolt, use **J-44643** tool in order to hold the engine from turning.
15. Loosen the camshaft gear bolt (1) and leave the bolt finger tight.
16. Remove the camshaft thrust plate bolts through the holes in the camshaft gear.

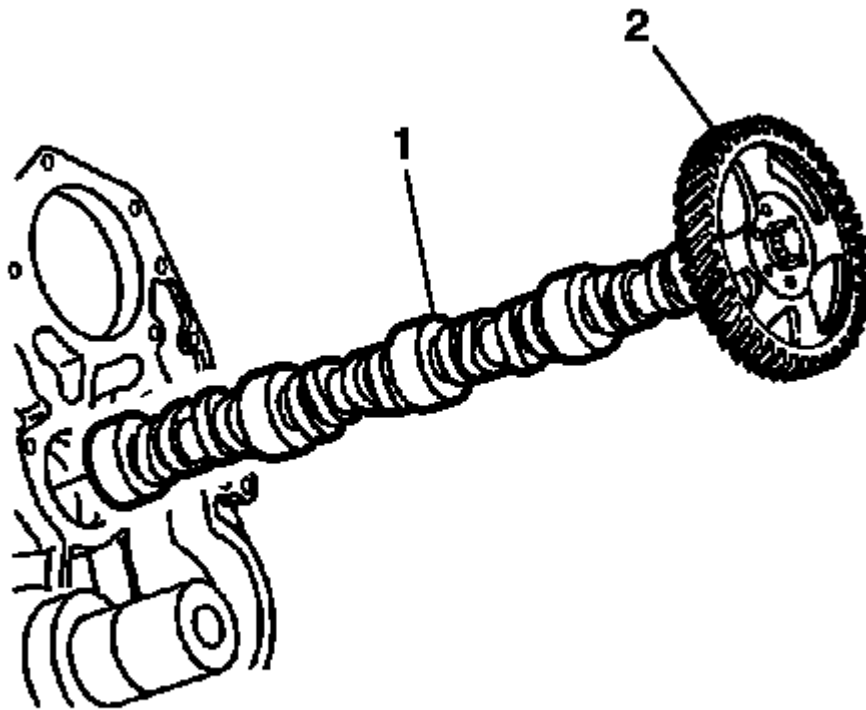


Fig. 146: View Of Camshaft & Camshaft Gear
Courtesy of GENERAL MOTORS COMPANY

17. Remove the camshaft (1) with the camshaft gear (2) attached.

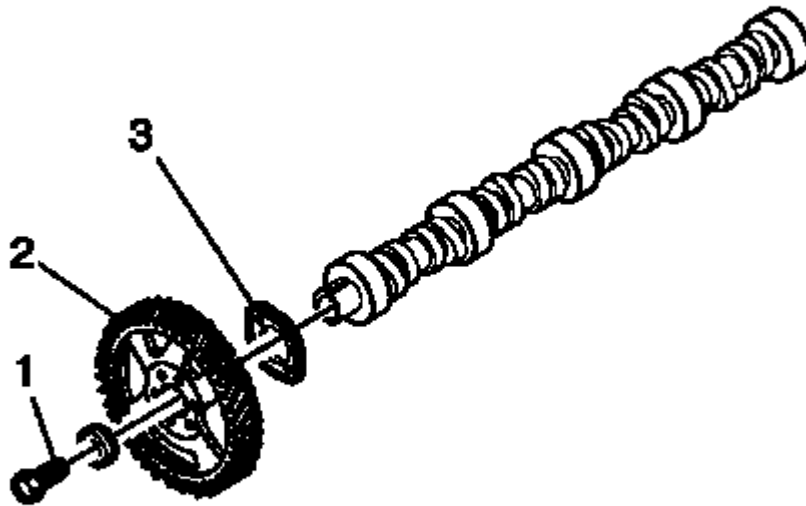


Fig. 147: View Of Camshaft, Camshaft Gear & Camshaft Thrust Plate
Courtesy of GENERAL MOTORS COMPANY

18. Remove the camshaft gear bolt (1) and discard.
19. Remove the camshaft gear (2).
20. Remove the camshaft thrust plate (3).
21. Clean and inspect the camshaft and bearings. Refer to **Camshaft and Bearings Cleaning and Inspection** .

Installation Procedure

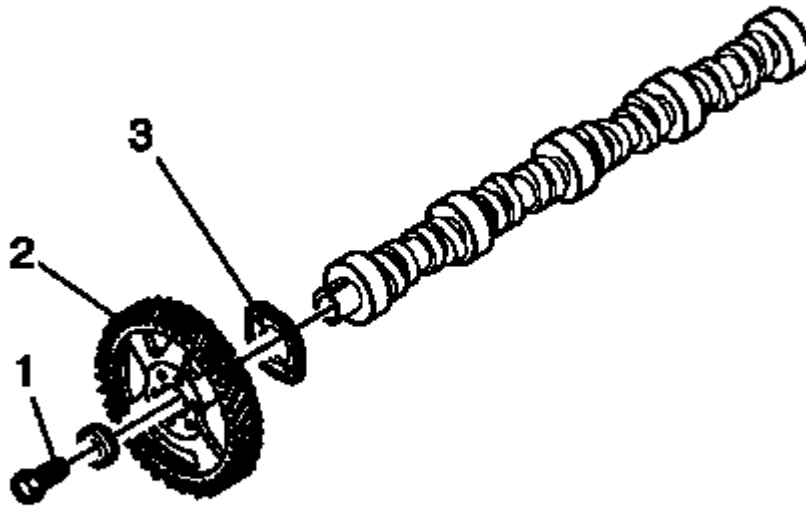


Fig. 148: View Of Camshaft, Camshaft Gear & Camshaft Thrust Plate
Courtesy of GENERAL MOTORS COMPANY

1. Install the camshaft thrust plate (3) to the camshaft.
2. Install the camshaft driven gear (2).

CAUTION: Refer to Fastener Caution .

3. Install a NEW camshaft driven gear bolt (1).

Leave the bolt finger tight.

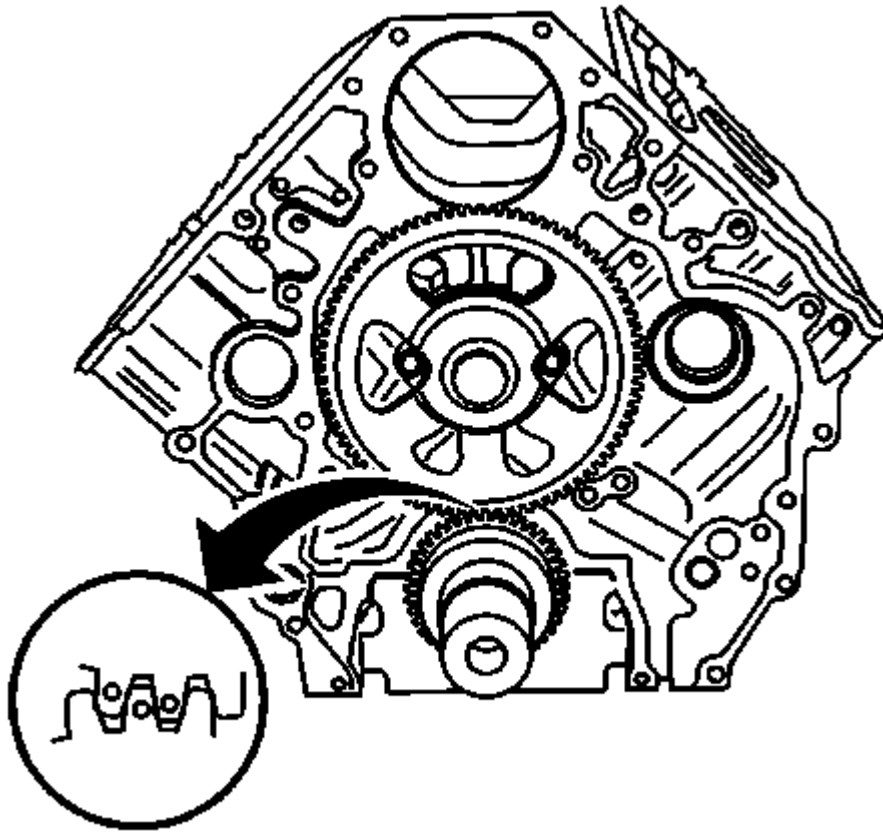


Fig. 149: View Of Camshaft Gear Aligned With Crankshaft Gear
Courtesy of GENERAL MOTORS COMPANY

4. Install the camshaft into the cylinder block, align the camshaft gear to the crankshaft gear as shown.

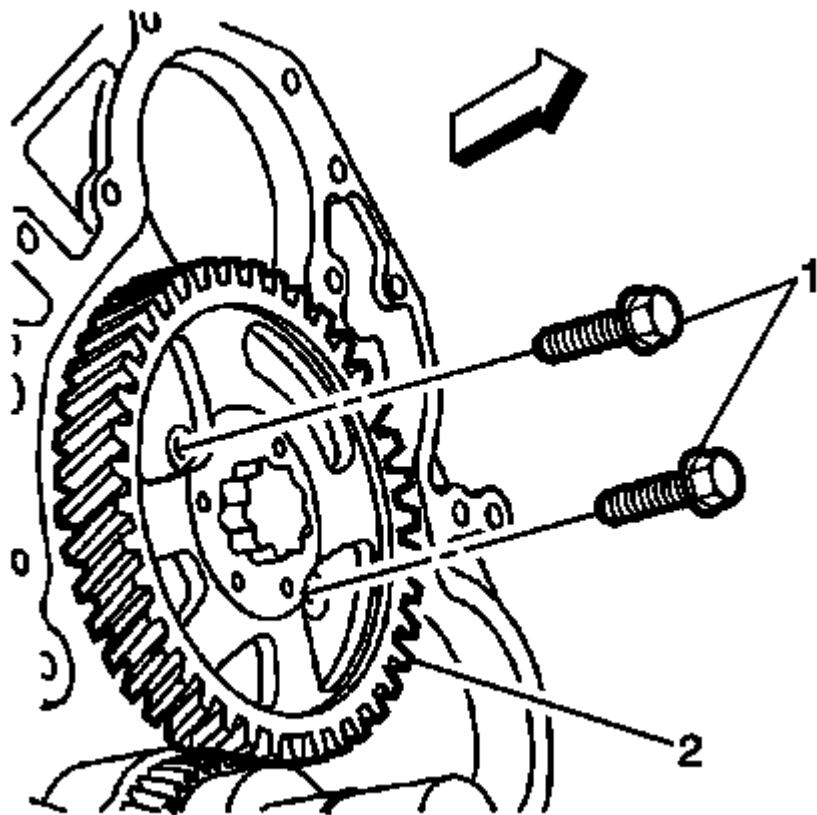


Fig. 150: View Of Camshaft Thrust Plate Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Apply threadlock to the threads of the camshaft thrust plate bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
6. Install the camshaft thrust plate bolts (1) and tighten to 22 N.m (16 lb ft).

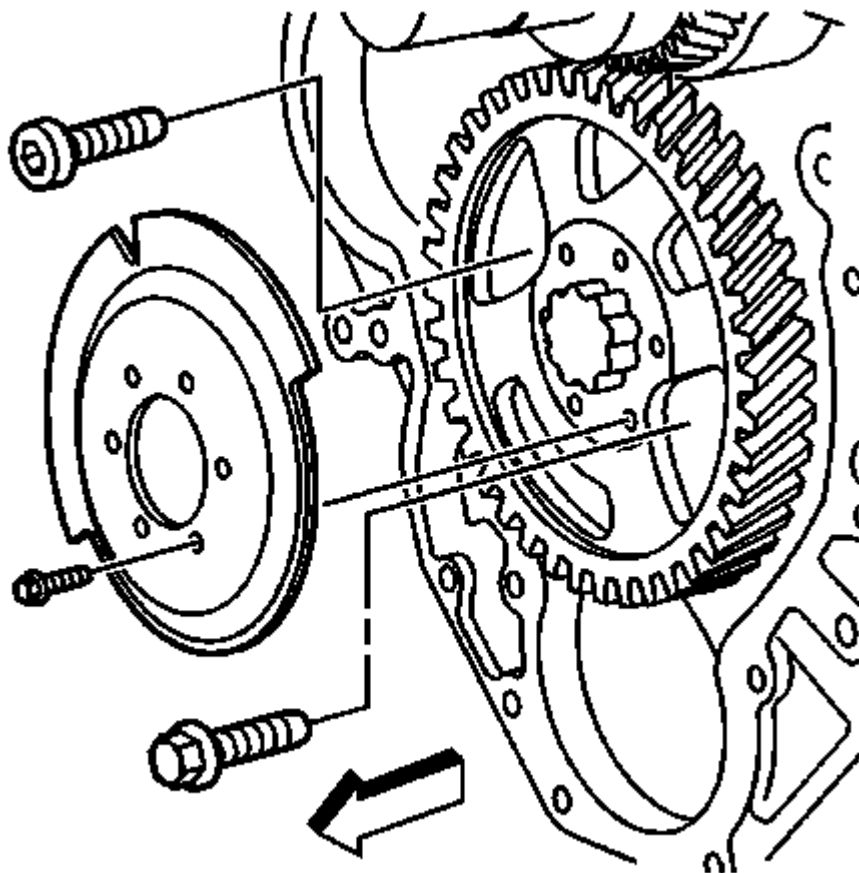


Fig. 151: View Of Camshaft Exciter Ring, Bolts & Thrust Plate Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a suitable tool to relieve the spring tension while removing the locking bolt.

7. Remove the exciter ring bolt that was installed to hold the spring tension of the two piece cam gear.

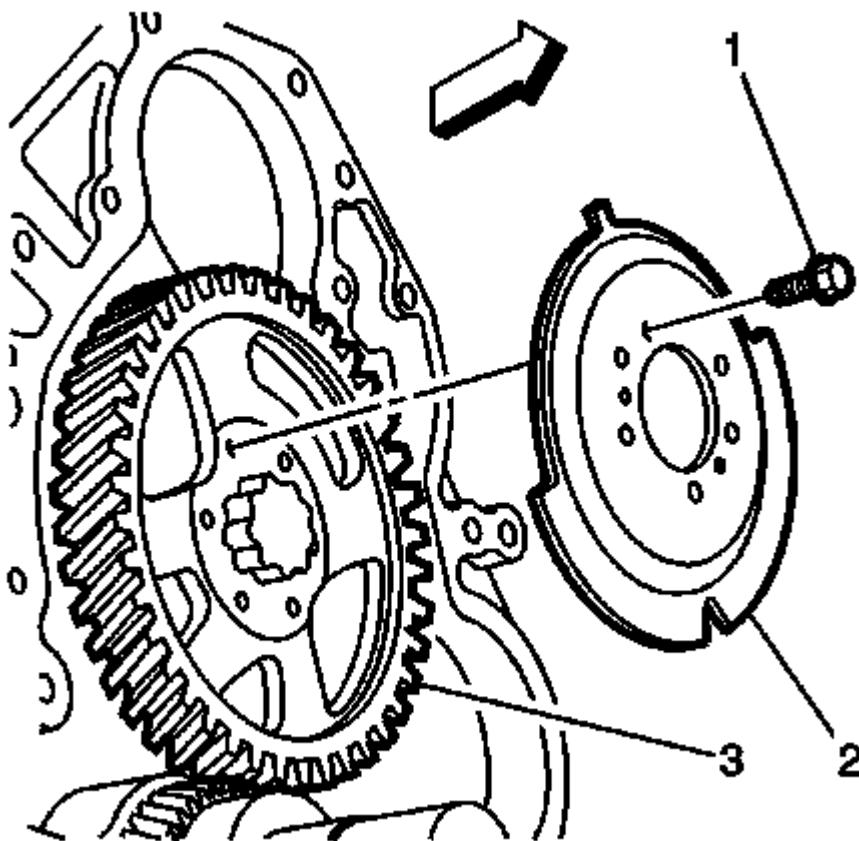


Fig. 152: View Of Camshaft Reluctor & Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft reluctor (2) to the camshaft gear (3).
9. Install the camshaft reluctor bolts. Tighten the bolts in a cross-bolt pattern to 12 N.m (106 lb in).

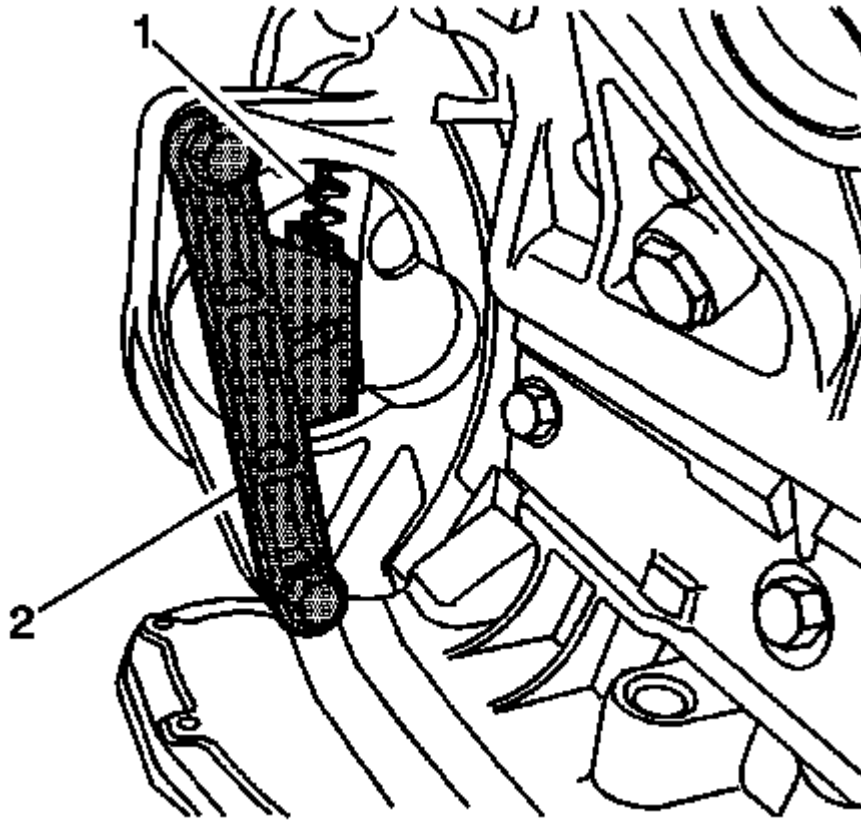


Fig. 153: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS COMPANY

10. Reinstall **J-44643** tool (2) in the starter opening, if removed.
11. Install a NEW camshaft gear bolt and tighten to 234 N.m (173 lb ft).

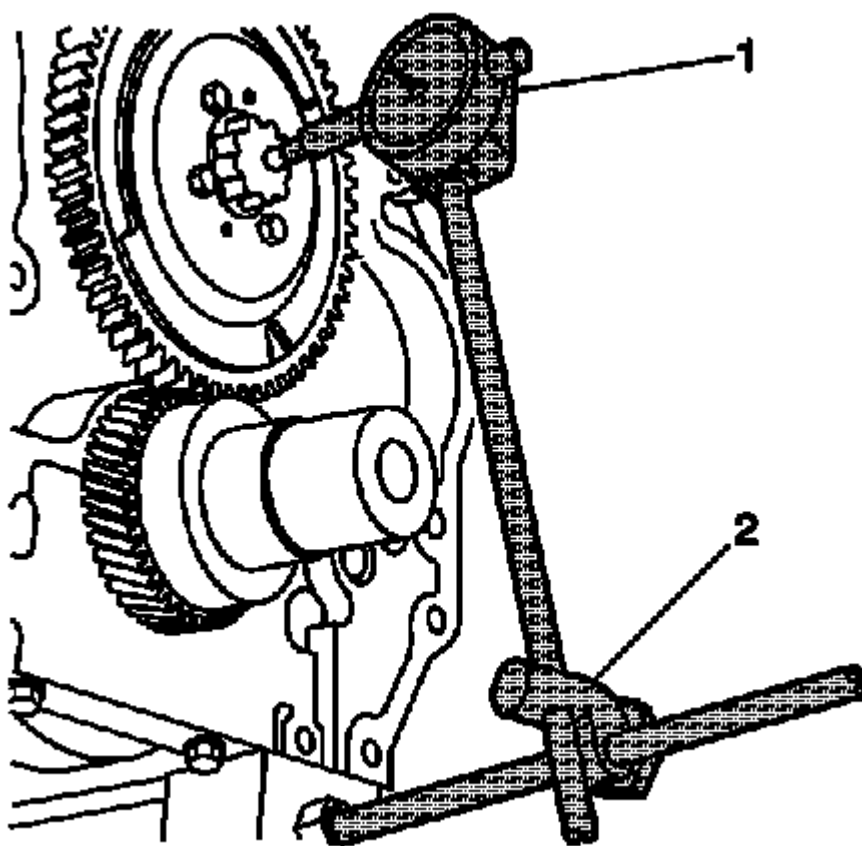


Fig. 154: Measuring Camshaft End Play Using J 26900-12 & J 26900-13
Courtesy of GENERAL MOTORS COMPANY

12. Using **J-26900-12** indicator (1) and **J-26900-13** base (2) measure the camshaft end play.
- The production value is 0.050-0.114 mm (0.002-0.0045 in) and service limit is 0.20 mm (0.008 in).
 - Replace the camshaft gear or the camshaft thrust plate if measured value exceeds the service limit.

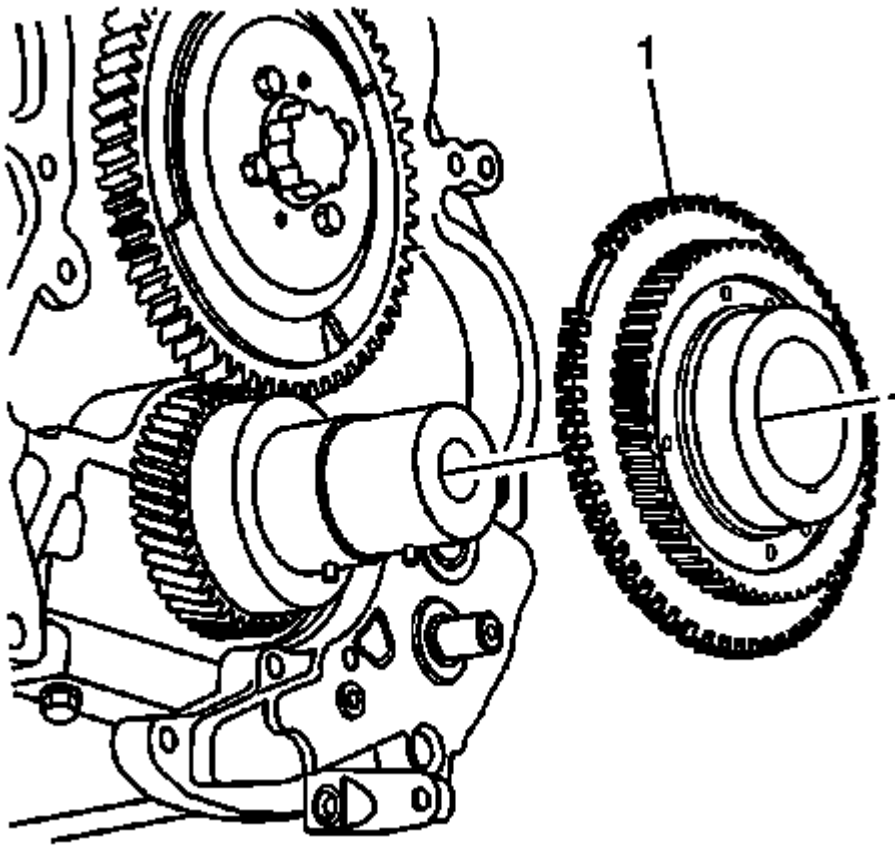


Fig. 155: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not damage the teeth on the crankshaft reluctor.

13. Install the oil pump drive gear (1) and reluctor to the crankshaft.

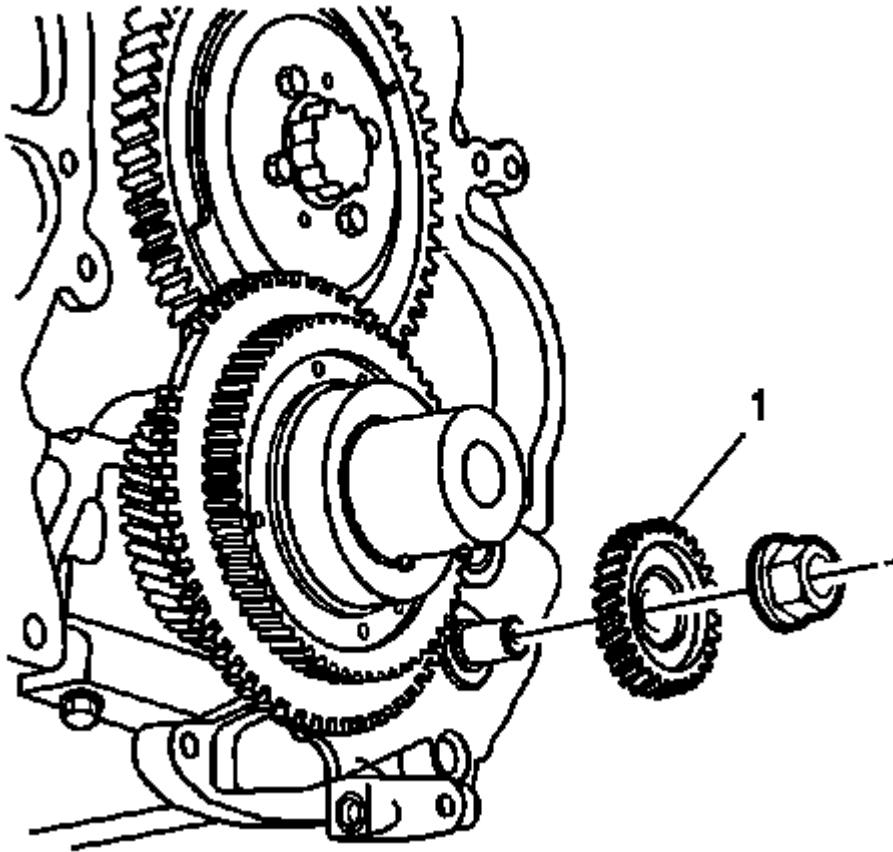


Fig. 156: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS COMPANY

14. Install the oil pump driven gear (1).
15. Install the oil pump driven gear nut and tighten to 100 N.m (74 lb ft).
16. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
17. Install the engine assembly. Refer to **Engine Replacement**.
18. Install the valve lifters. Refer to **Valve Lifter Replacement**.
19. Relearn the crankshaft position reluctor wheel. Refer to **Crankshaft Position Reluctor Wheel Learn** .

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

- **J-44641** Crankshaft Rear Oil Seal Remover.
- **J-44642** Crankshaft Rear Oil Seal Installer.

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

Removal Procedure

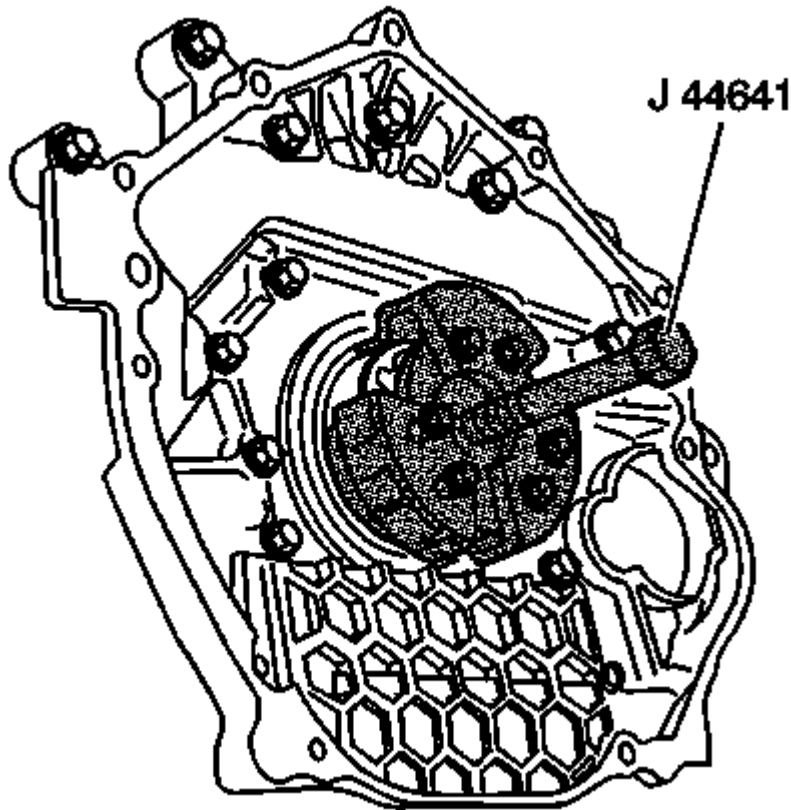


Fig. 157: Removing Crankshaft Rear Oil Seal Using J 44641
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine flywheel. Refer to **Engine Flywheel Replacement**
2. Install the button of **J-44641** oil seal remover into the crankshaft.
3. Press the jaws of **J-44641** oil seal remover into the felt portion of the seal far enough to engage the inner lip of the seal.
4. While holding the jaws of **J-44641** oil seal remover tightly to the seals inner sleeve, tighten the jaw bolts.
5. Remove the crankshaft rear oil seal using the **J-44641** oil seal remover.

Installation Procedure

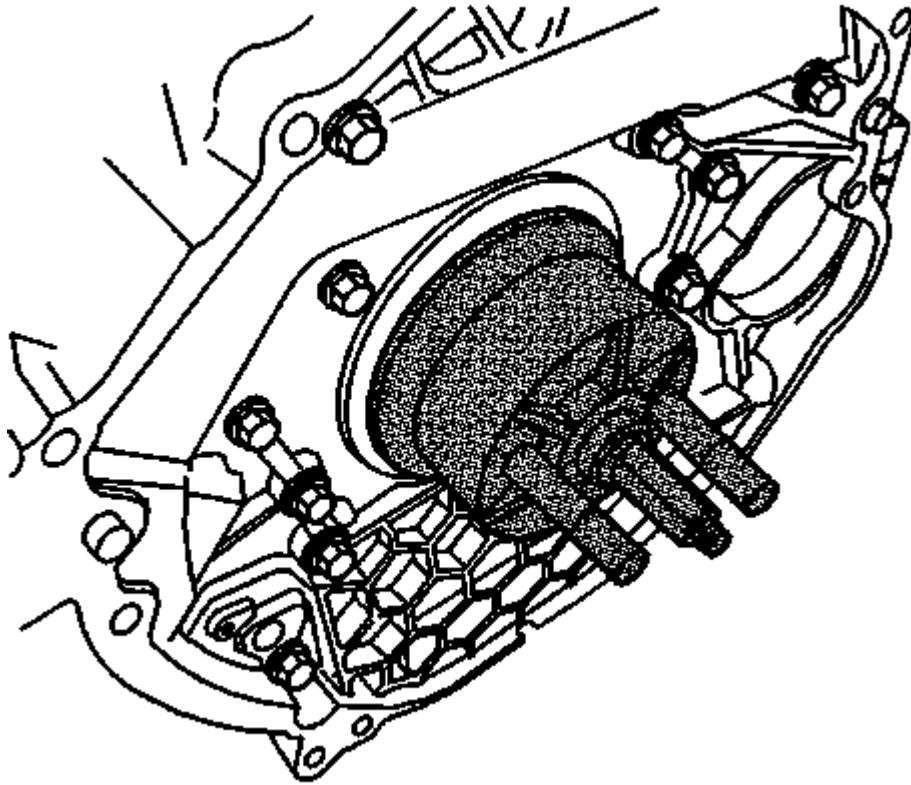


Fig. 158: Pressing Crankshaft Rear Oil Seal In Using J 44642
Courtesy of GENERAL MOTORS COMPANY

1. Place the crankshaft rear oil seal onto the crankshaft.

NOTE: The J-44642 oil seal installer must be fully secured to the crankshaft to ensure proper seal depth.

2. Install the J-44642 oil seal installer to the crankshaft.
3. Press the crankshaft rear oil seal into position using the J-44642 oil seal installer. The J-44642 oil seal installer will bottom out when the seal reaches the proper depth.
4. Remove the J-44642 oil seal installer.
5. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.
6. Relearn the crankshaft position reluctor wheel. Refer to **Crankshaft Position Reluctor Wheel Learn**.

FLYWHEEL HOUSING REPLACEMENT

Special Tools

J 37228 Seal Cutter

Removal Procedure

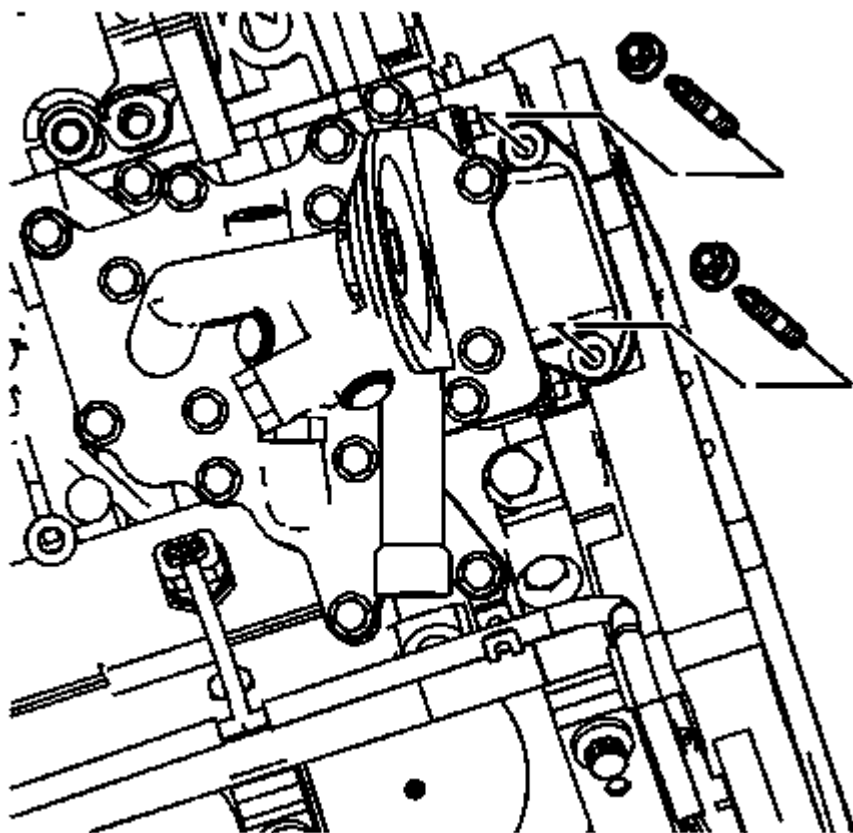


Fig. 159: View Of Turbocharger Oil Return Pipe Nuts
Courtesy of GENERAL MOTORS COMPANY

1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (Static Fill LGH, LML) , Cooling System Draining and Filling (Vac-N-Fill Diesel) .
2. Remove the crankshaft rear oil seal. Refer to Crankshaft Rear Oil Seal Removal .
3. Remove the turbocharger oil return pipe nuts from the top of the flywheel housing.
4. Remove the oil cooler adapter studs and nuts from the flywheel housing.

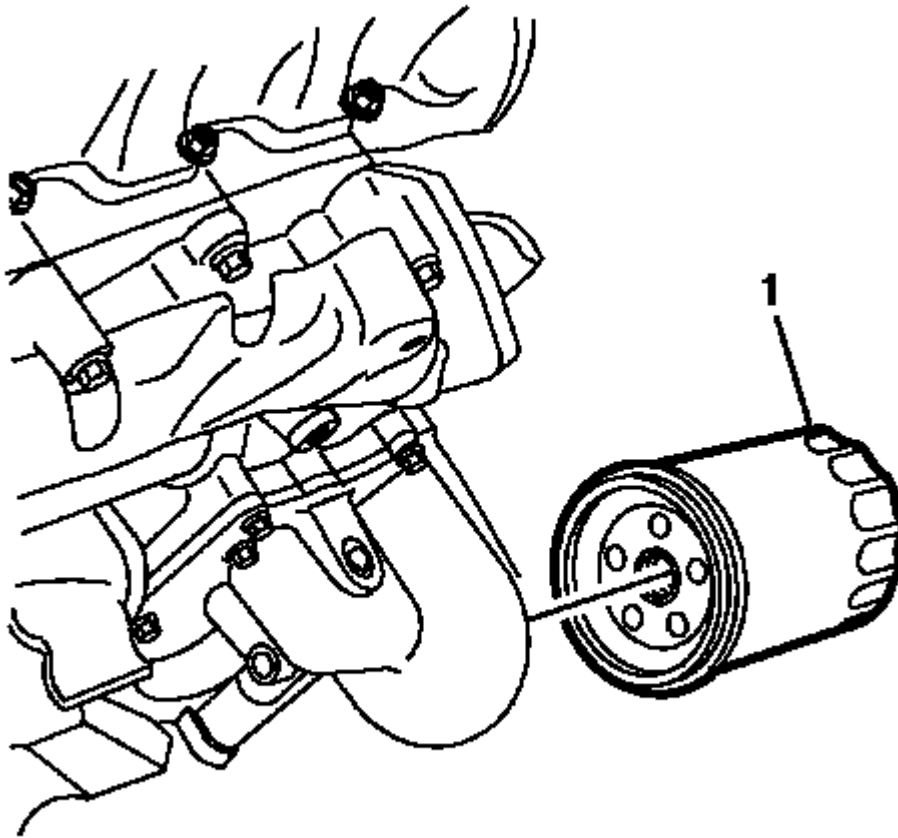


Fig. 160: View Of Oil Filter

Courtesy of GENERAL MOTORS COMPANY

5. Remove the upper oil pan. Refer to Upper Oil Pan Replacement.
6. Remove the oil filter (1).

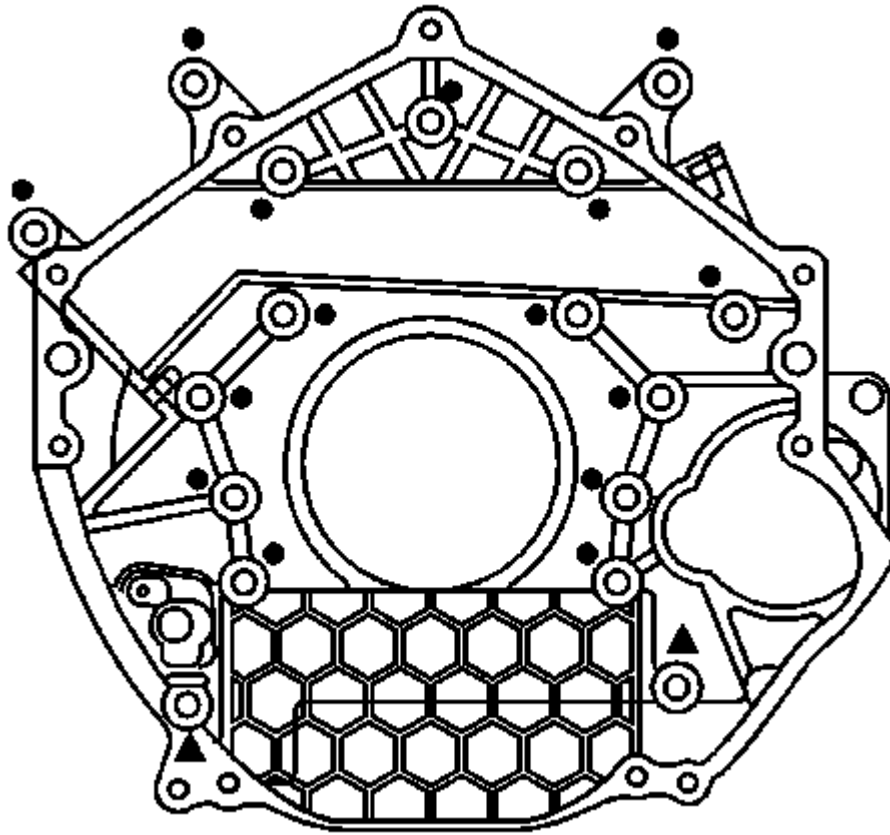


Fig. 161: View Of Engine Rear Cover Bolts & Flywheel Housing To Upper Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the flywheel housing bolts, denoted by the black circles.
8. Separate the flywheel from the cylinder block using **J 37228** Seal Cutter.
9. Remove the flywheel housing.

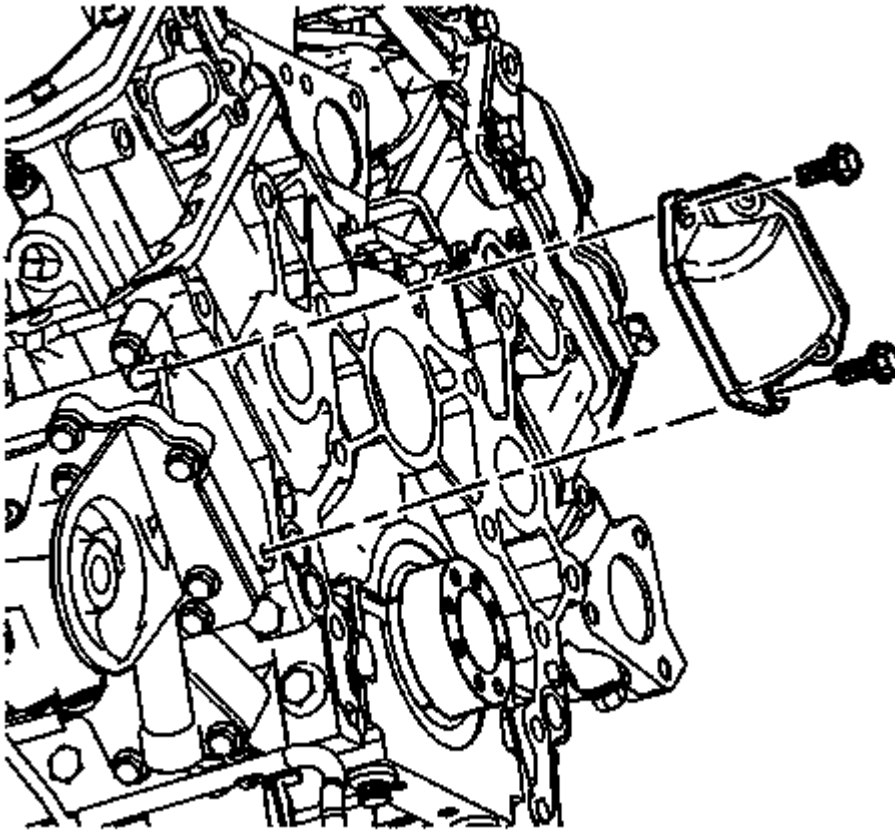


Fig. 162: View Of Oil Cooler Adapter
Courtesy of GENERAL MOTORS COMPANY

10. Remove the turbocharger oil return pipe gasket from the flywheel housing.
11. Remove the oil cooler adapter bolts.
12. Remove the oil cooler adapter and gaskets.
13. If required, clean and inspect the flywheel housing. Refer to **Engine Flywheel Cleaning and Inspection** .

Installation Procedure

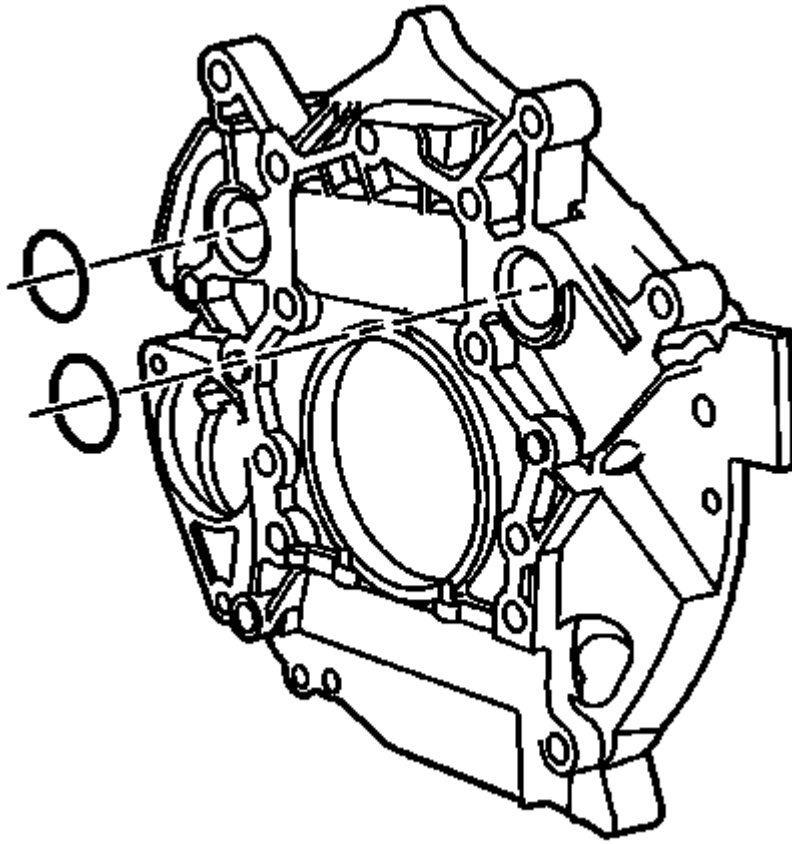


Fig. 163: View Of Flywheel Housing O-Ring Seals
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW O-ring seals to the flywheel housing, if necessary.

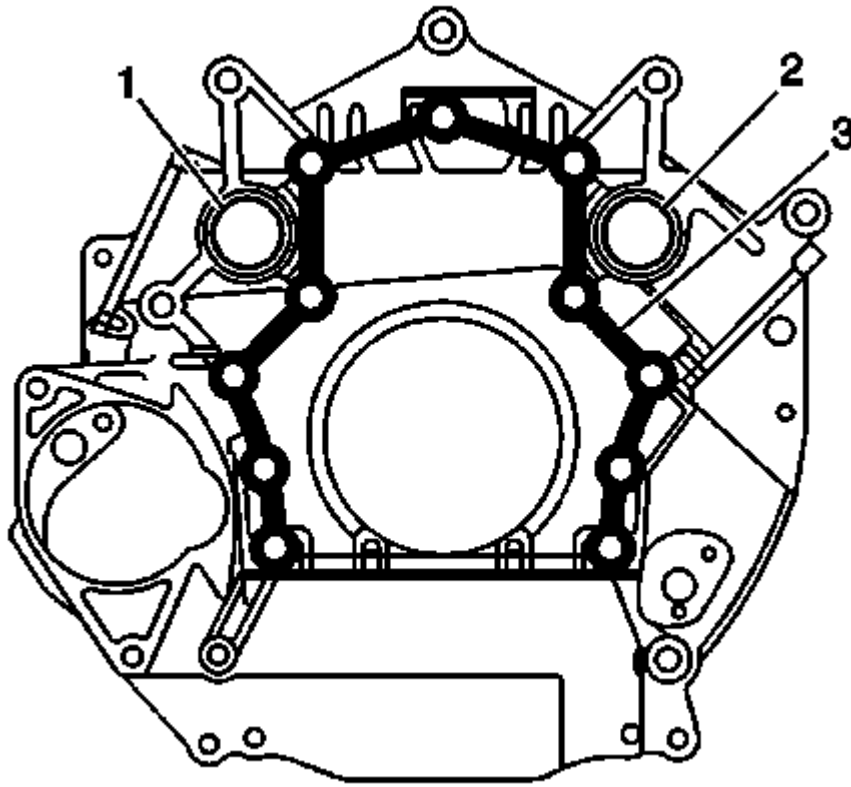


Fig. 164: View Of Engine Rear Cover Sealing Surfaces Sealant Application Area
Courtesy of GENERAL MOTORS COMPANY

2. Apply a 2 mm (1/8 in) wide bead of sealant (3) to the flywheel housing sealing surfaces. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

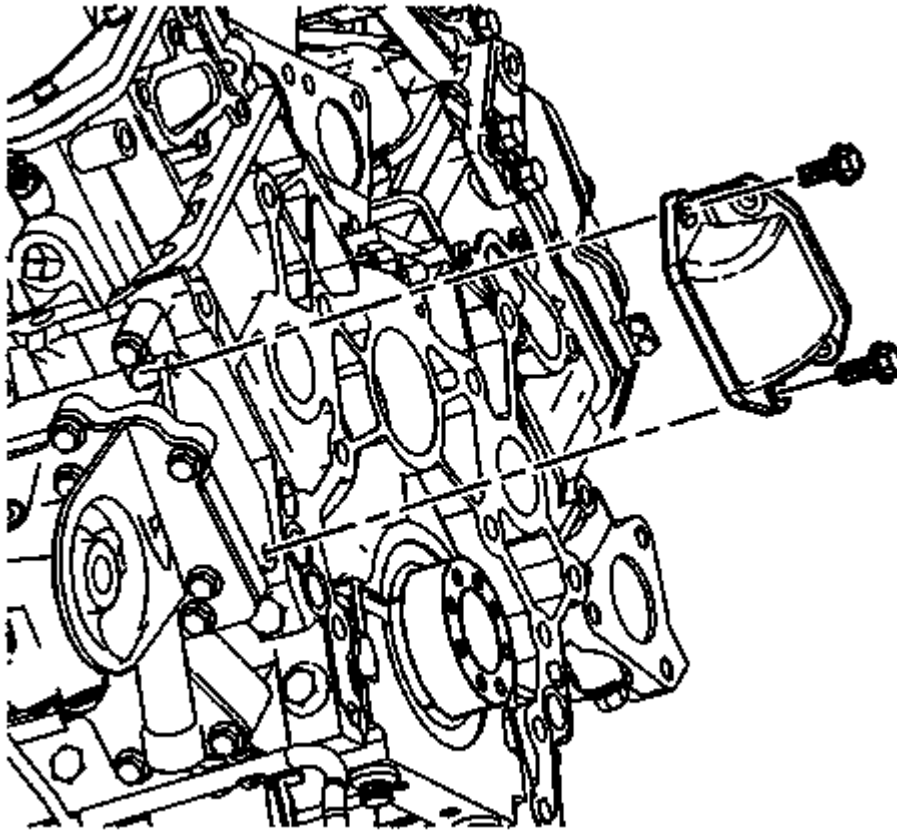


Fig. 165: View Of Oil Cooler Adapter
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW oil cooler adapter gasket .
4. Install a NEW oil cooler adapter to flywheel housing gasket.
5. Install the oil cooler adapter to the flywheel housing.
6. Install the oil cooler adapter bolts.

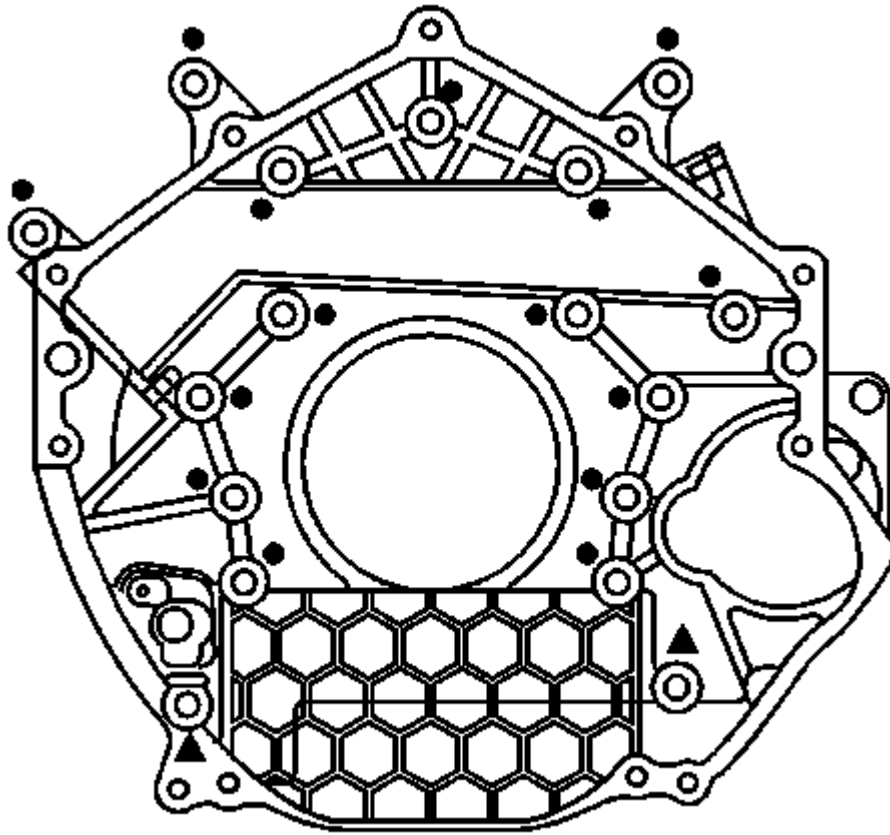


Fig. 166: View Of Engine Rear Cover Bolts & Flywheel Housing To Upper Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

7. Install the flywheel housing bolts, denoted by the black circles.

Tighten

Tighten the bolts to 90 N.m (67 lb ft).

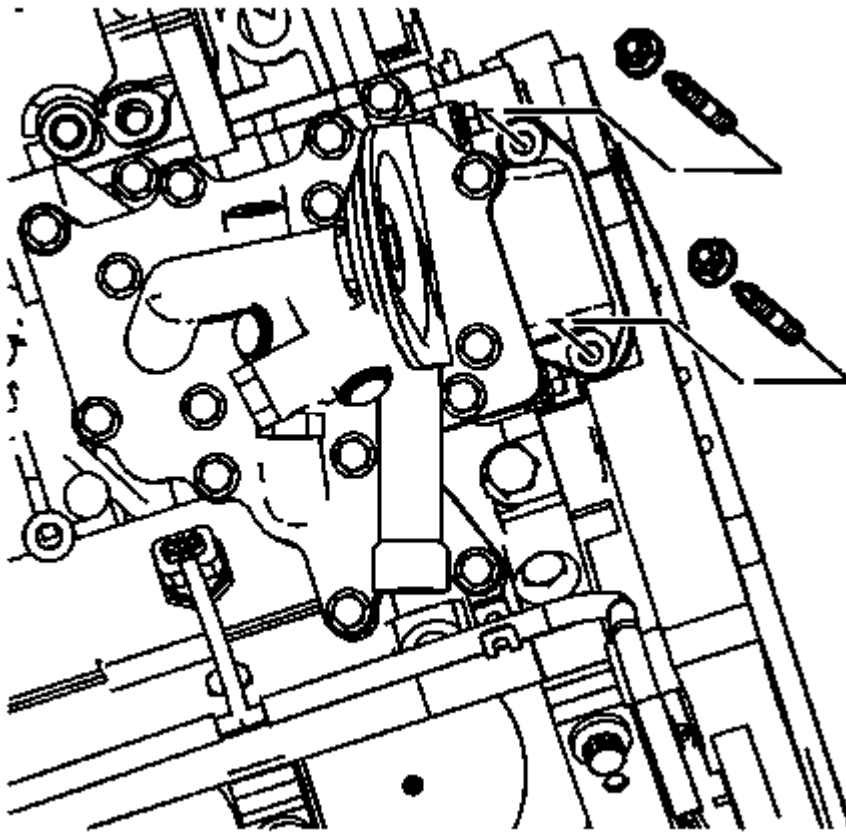


Fig. 167: View Of Turbocharger Oil Return Pipe Nuts
Courtesy of GENERAL MOTORS COMPANY

8. Install the oil cooler adapter studs and nuts to the flywheel housing.

Tighten

- Tighten the oil cooler adapter studs to 10 N.m (89 lb in).
- Tighten the oil cooler adapter nuts to 25 N.m (18 lb ft).
- Tighten the flywheel housing bolts/nuts to 21 N.m (15 lb ft).

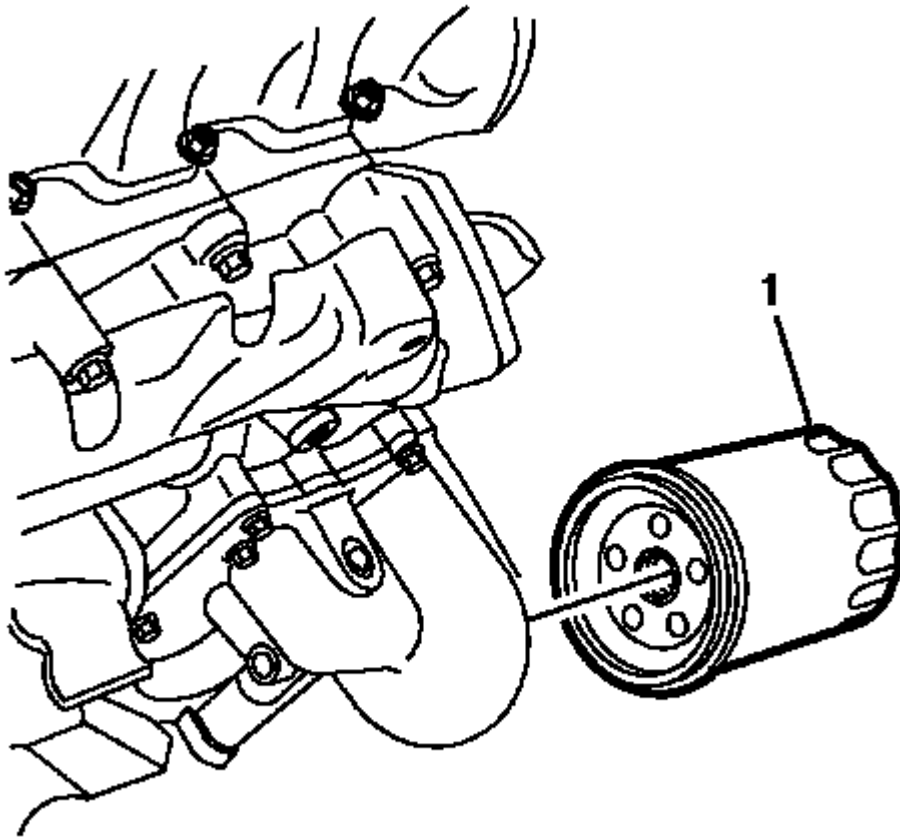


Fig. 168: View Of Oil Filter

Courtesy of GENERAL MOTORS COMPANY

9. Install the oil filter (1).
10. Install the upper oil pan. Refer to **Upper Oil Pan Replacement**.
11. Install a NEW gasket to the turbocharger oil return pipe.
12. Install the turbocharger oil return pipe to flywheel housing nuts.

Tighten

Tighten the nuts to 21 N.m (15 lb ft).

13. Install the crankshaft rear oil seal. Refer to **Crankshaft Rear Oil Seal Installation** .
14. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (Static Fill LGH, LML)** , **Cooling System Draining and Filling (Vac-N-Fill Diesel)** .
15. Relearn the crankshaft position reluctor wheel. Refer to **Crankshaft Position Reluctor Wheel Learn** .

ENGINE FLYWHEEL REPLACEMENT

Special Tools

- **J 44643** Flywheel Holding Tool.
- **J 45059** Angle Meter.

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

Removal Procedure

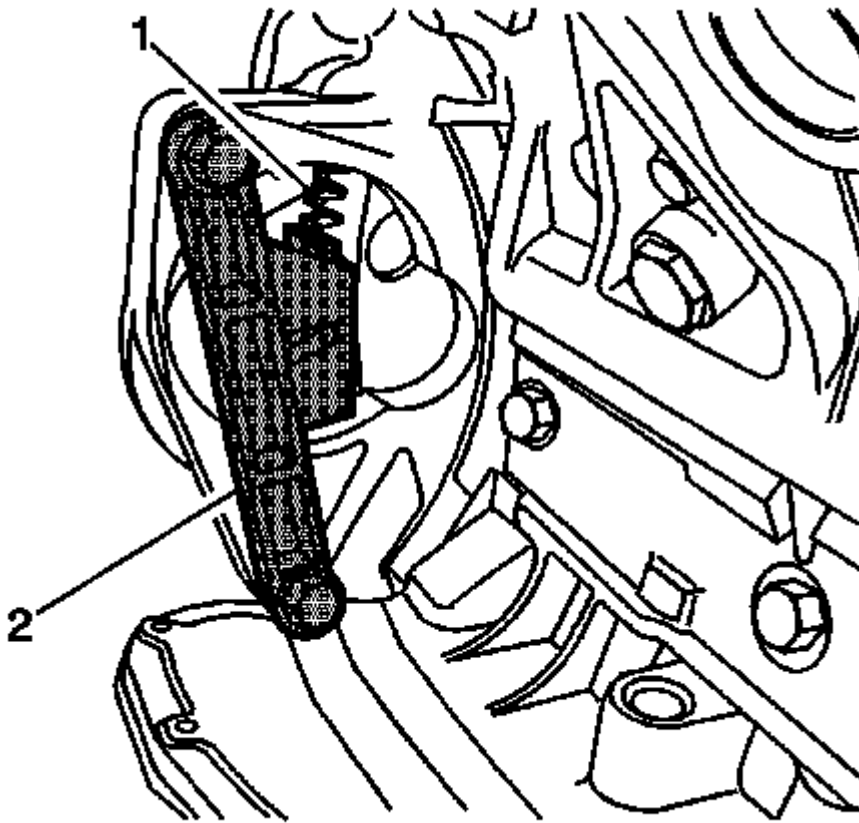


Fig. 169: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS COMPANY

1. Remove the transmission. Refer to **Transmission Replacement** .
2. Install the **J 44643** flywheel holding tool in order to lock the flywheel (1).

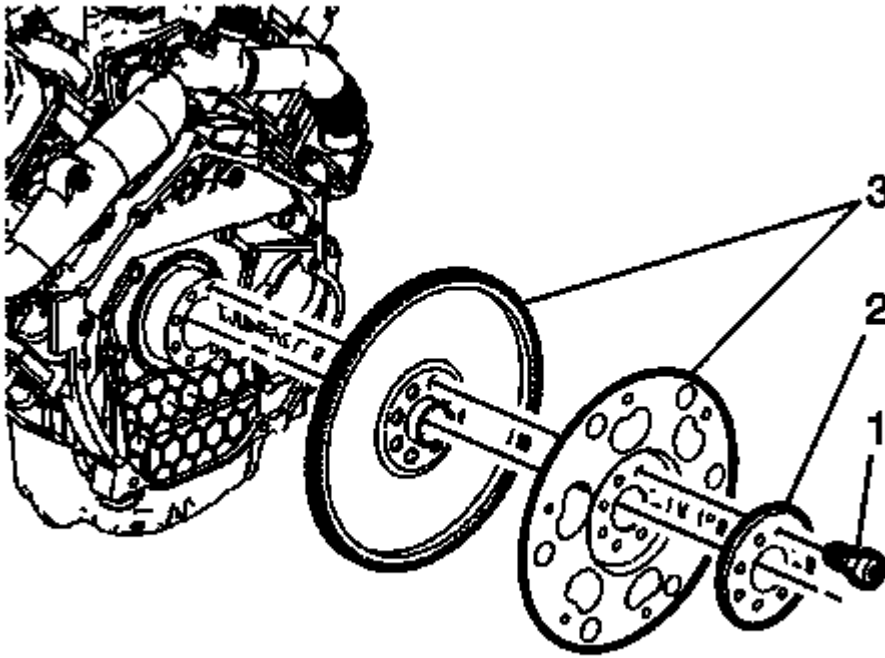


Fig. 170: View Of Flywheel & Washer (Automatic)
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the flywheel bolts (1).
4. Remove the flywheel washer (2).
5. Remove the flywheel assembly (3).
6. Remove the **J 44643** flywheel holding tool.

Installation Procedure

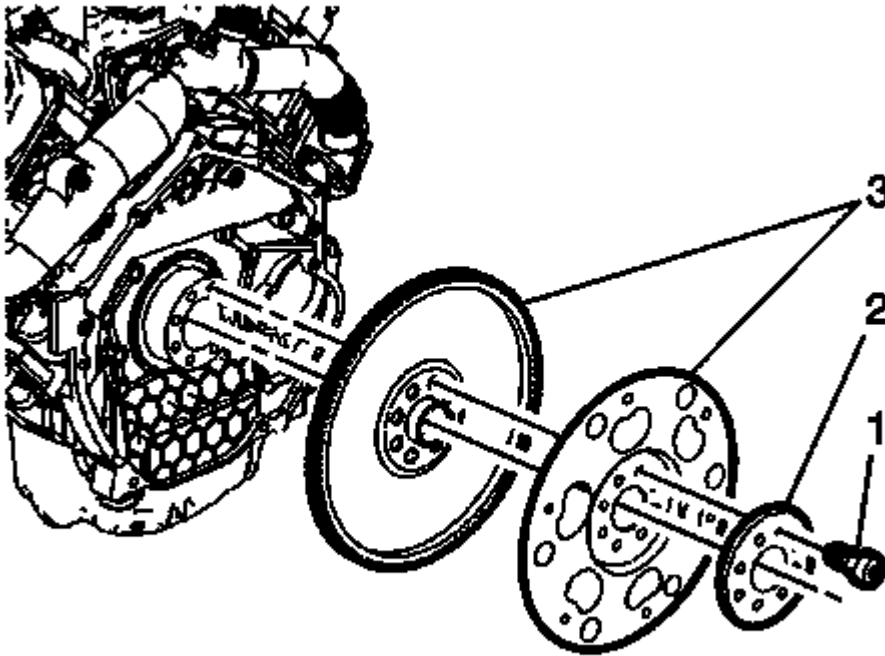


Fig. 171: View Of Flywheel & Washer (Automatic)
Courtesy of GENERAL MOTORS COMPANY

1. Install the flywheel (3) to the crankshaft.
2. Install the flywheel washer (2) to the flywheel with the beveled side facing the engine.

CAUTION: This component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine damage.

3. Install NEW flywheel bolts (1) until snug.

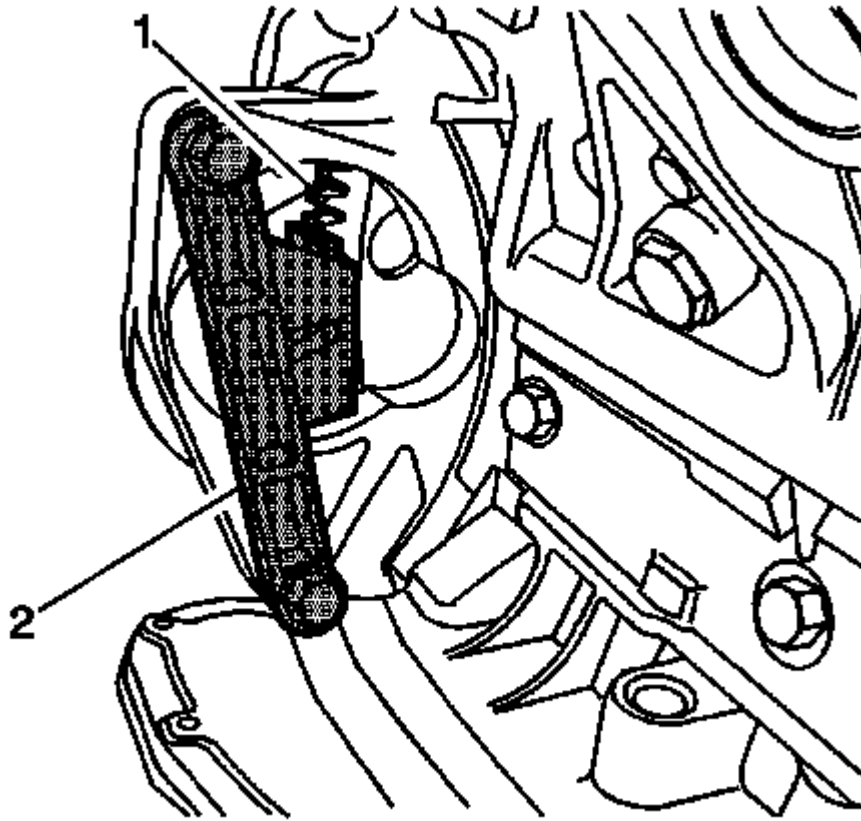


Fig. 172: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS COMPANY

4. Install the **J 44643** flywheel holding tool in order to lock the flywheel (1).

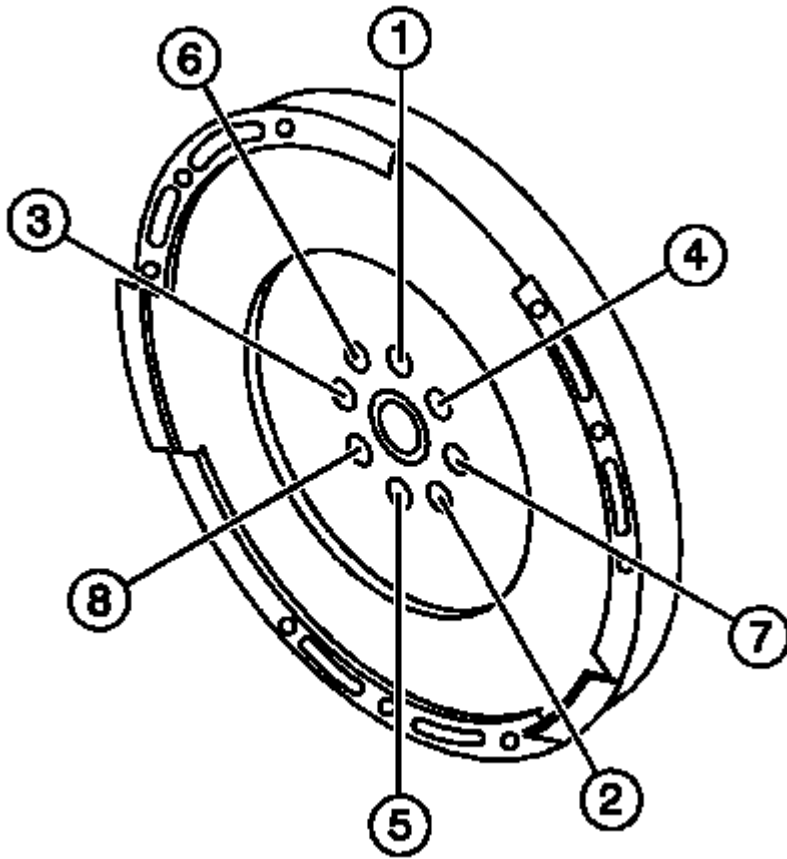


Fig. 173: Flywheel Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Tighten the flywheel bolts in the sequence shown.
 1. Tighten the bolts a first pass to 80 (59 lb ft).
 2. Tighten the bolts a second pass an additional 60 degrees using the **J 45059** angle meter.
 3. Tighten the bolts a final pass an additional 60 degrees using the **J 45059** angle meter.
6. Remove the **J 44643** flywheel holding tool.
7. Install the transmission. Refer to Transmission Replacement .
8. Relearn the crankshaft position reluctor wheel. Refer to Crankshaft Position Reluctor Wheel Learn .

LOWER OIL PAN REPLACEMENT

Special Tools

J-37228 Seal Cutter

For equivalent regional tools, refer to Special Tools .

Removal Procedure

1. Remove the drivetrain and front suspension crossmember. Refer to **Drivetrain and Front Suspension Frame Front Crossmember Replacement (2500/3500 Series)** .
2. If equipped, remove the oil pan skid plate. Refer to **Oil Pan Skid Plate Replacement (2500/3500 with RPO NZZ)** .
3. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

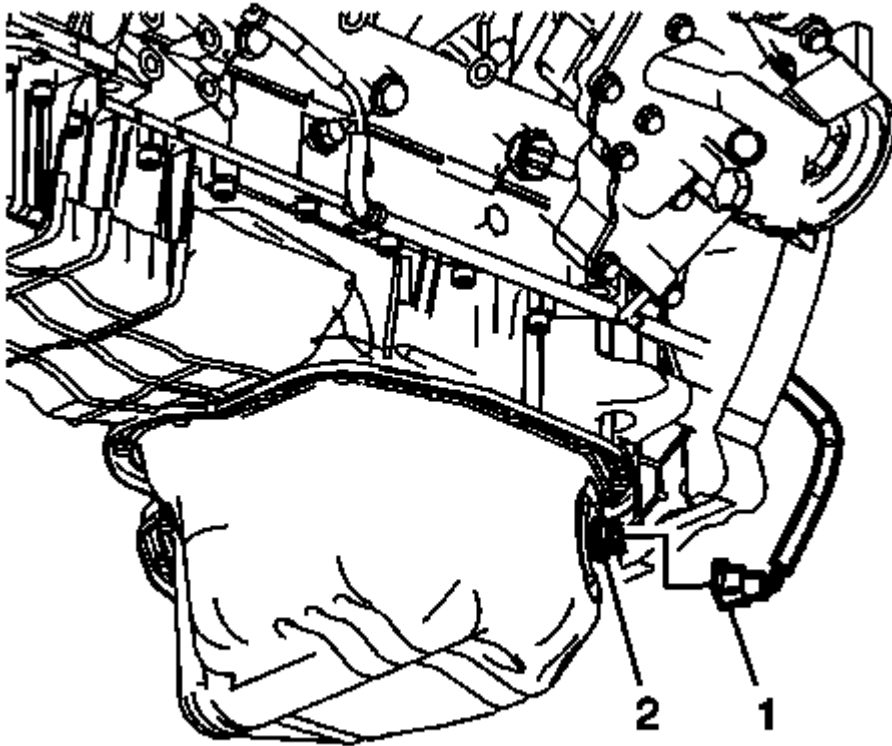


Fig. 174: View Of Oil Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the engine harness electrical connector (1) from the oil level sensor (2).

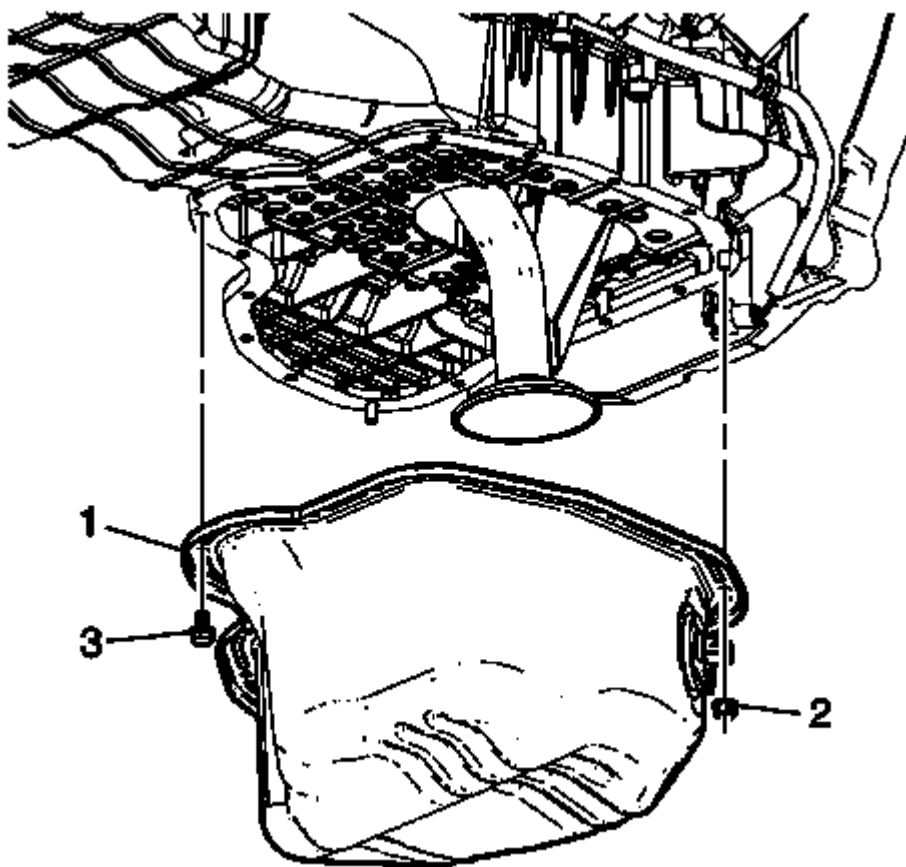


Fig. 175: View Of Lower Oil Pan

Courtesy of GENERAL MOTORS COMPANY

5. Remove the lower oil pan bolts (3) and nuts (2).

NOTE: Do not damage the sealing surfaces when separating the lower oil pan from the upper oil pan.

6. Separate the lower oil pan from the upper oil pan using **J-37228** cutter.
7. Remove the lower oil pan (1).
8. If necessary, clean and inspect the lower oil pan. Refer to **Lower Oil Pan Cleaning and Inspection**

Installation Procedure

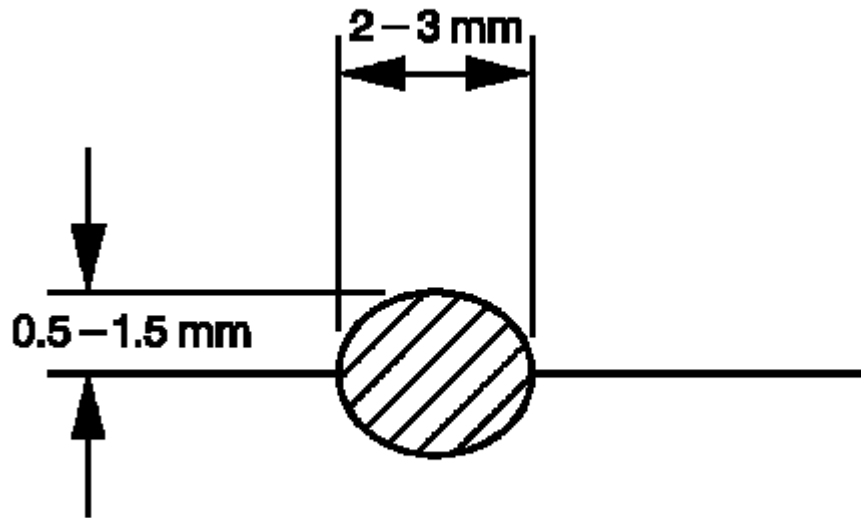


Fig. 176: Determining Sealant Bead Dimensions
Courtesy of GENERAL MOTORS COMPANY

1. Apply a 2-3 mm (0.079-0.118 in) wide by 0.5-1.5 mm (0.02-0.06 in) high bead of sealant to the lower oil pan mating surface. Refer to Adhesives, Fluids, Lubricants, and Sealers .

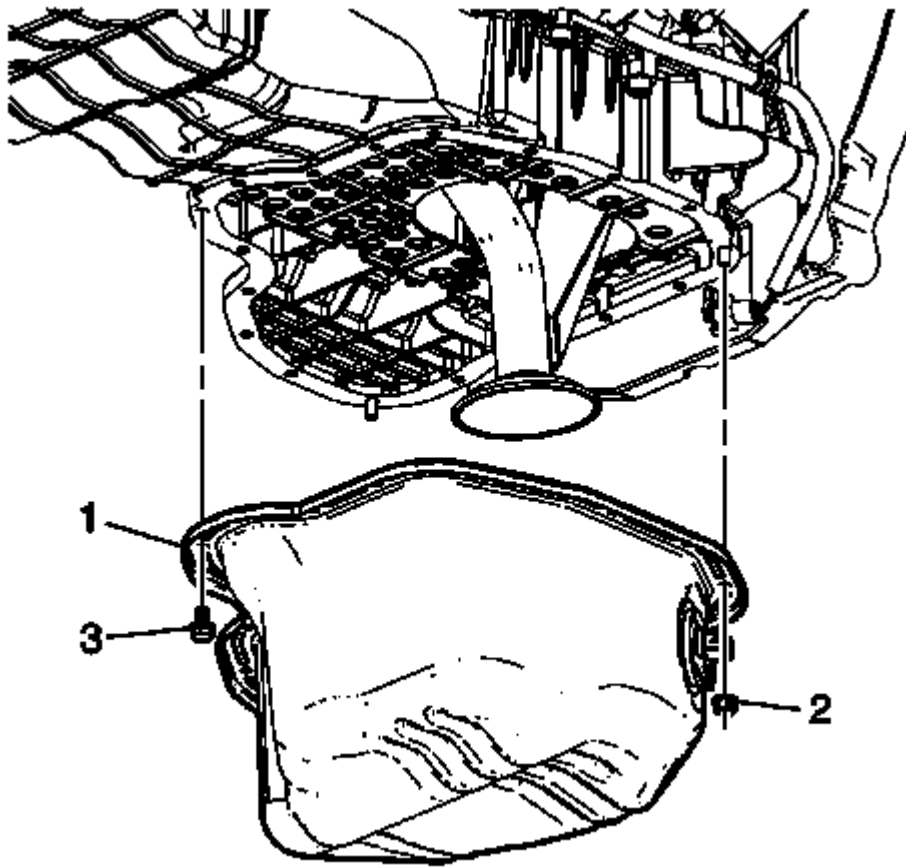


Fig. 177: View Of Lower Oil Pan

Courtesy of GENERAL MOTORS COMPANY

2. Install the lower oil pan (1).
3. Install the lower oil pan nuts (2) and bolts (3).

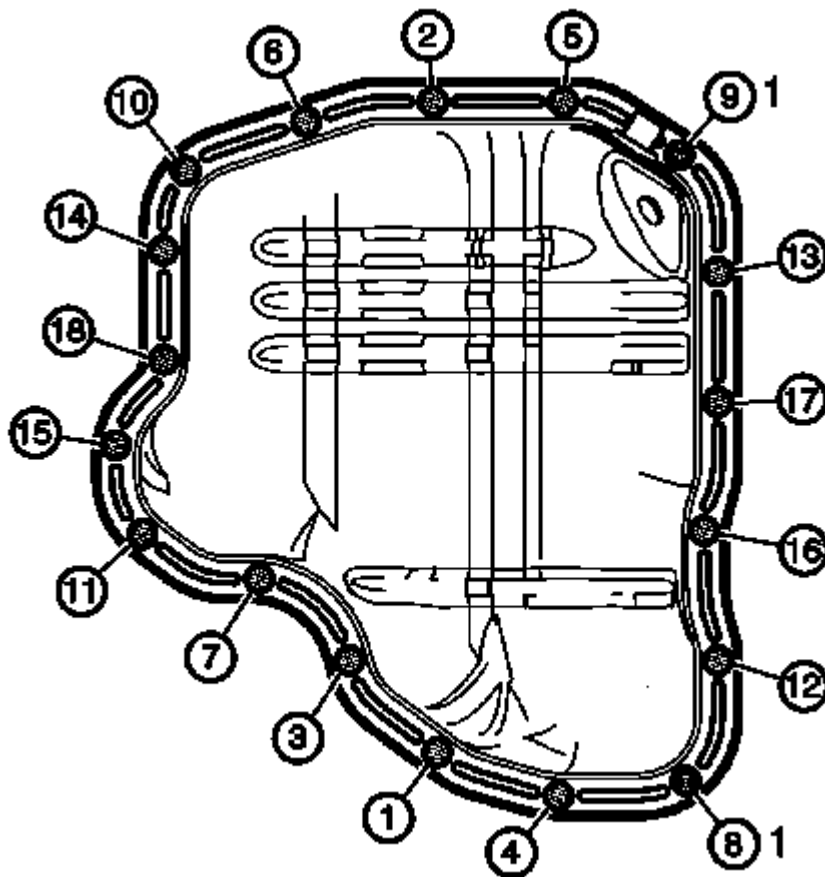


Fig. 178: Lower Oil Pan Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Tighten the lower oil pan bolts and nuts (1) in sequence to 10 N.m (89 lb in).

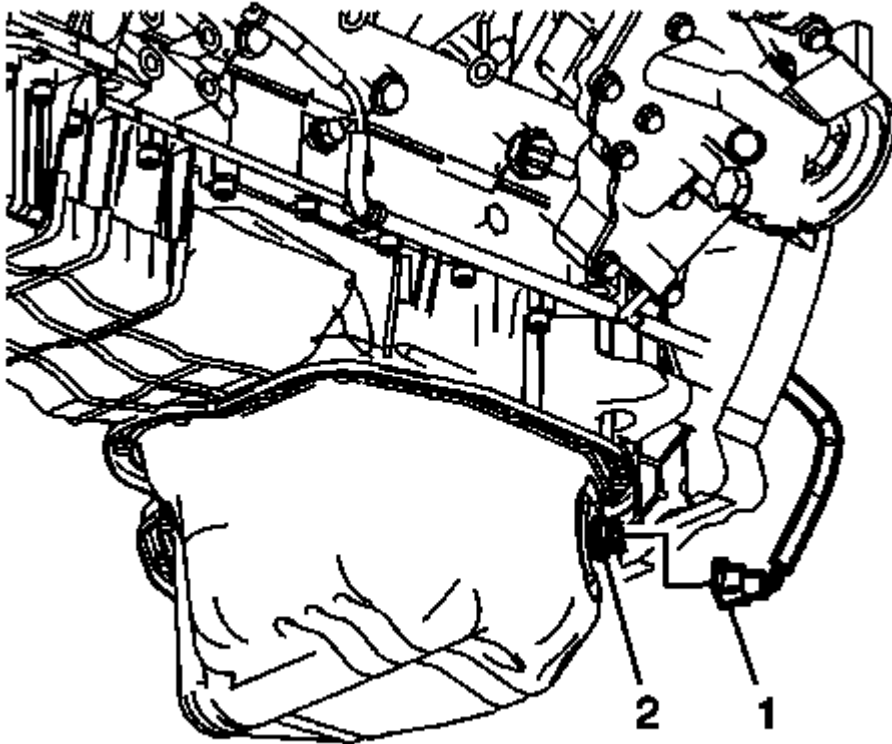


Fig. 179: View Of Oil Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Connect the oil level sensor (1).
6. Install the drivetrain and front suspension crossmember. Refer to **Drivetrain and Front Suspension Frame Front Crossmember Replacement (2500/3500 Series)** .
7. If equipped, install the oil pan skid plate. Refer to **Oil Pan Skid Plate Replacement (2500/3500 with RPO NZZ)** .
8. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

UPPER OIL PAN REPLACEMENT

Special Tools

J-37228 Seal Cutter

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

Removal Procedure

1. If vehicle is a 4-wheel drive (4WD), remove the front differential carrier. Refer to **Differential Carrier**

Assembly Replacement (2500 4WD) , Differential Carrier Assembly Replacement (9.25 Inch HD Axle) .

2. If vehicle is a 2-wheel drive (2WD), disconnect the relay rod from the pitman arm and idler arm. Refer to **Relay Rod Replacement (Dual Rear Wheels or Crew Cab With SRW) , Relay Rod Replacement (SRW Except Crew Cab With SRW) .**
3. Remove the lower oil pan. Refer to **Lower Oil Pan Replacement.**
4. Remove the engine flywheel. Refer to **Engine Flywheel Replacement.**

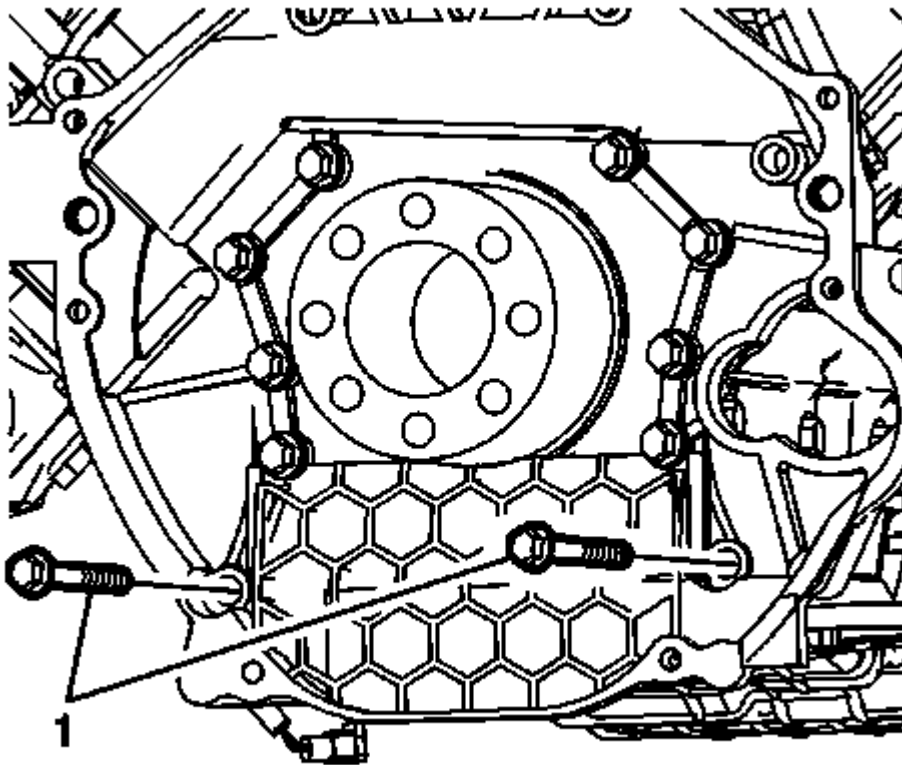


Fig. 180: View Of Flywheel Housing To Upper Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 2 flywheel housing to upper oil pan bolts (1).

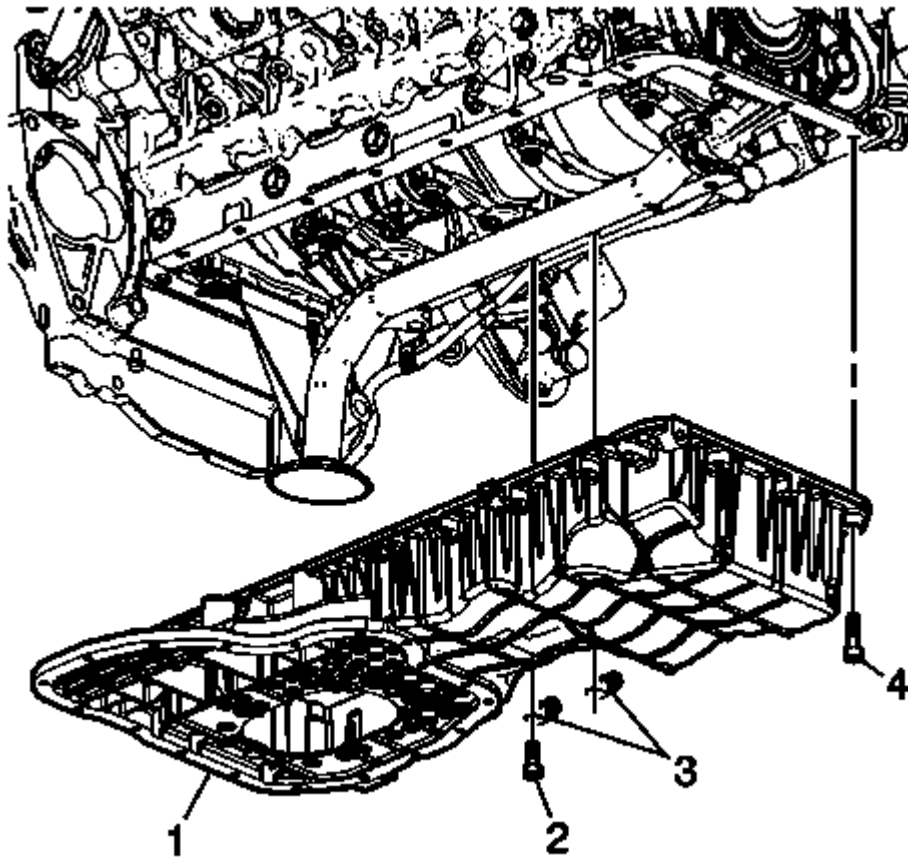


Fig. 181: View Of Upper Oil Pan & Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the upper oil pan bolts (2, 4).
7. Remove the wiring harness clips (3).
8. Separate the upper oil pan from the engine block using the **J-37228** cutter.
9. Remove the upper oil pan (1).

Installation Procedure

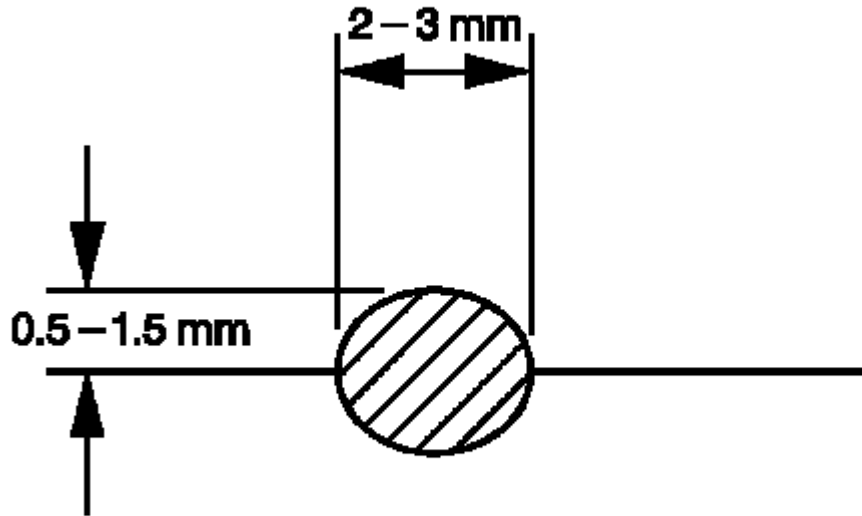


Fig. 182: Determining Sealant Bead Dimensions
Courtesy of GENERAL MOTORS COMPANY

1. Apply a 2-3 mm (0.079-0.118 in) wide by 0.5-1.5 mm (0.02-0.06 in) bead of sealant to the upper oil pan mating surfaces. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2. Apply a 2-3 mm (0.079-0.118 in) wide by 0.5-1.5 mm (0.02-0.06 in) bead of sealant to the flywheel housing sealing surface. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

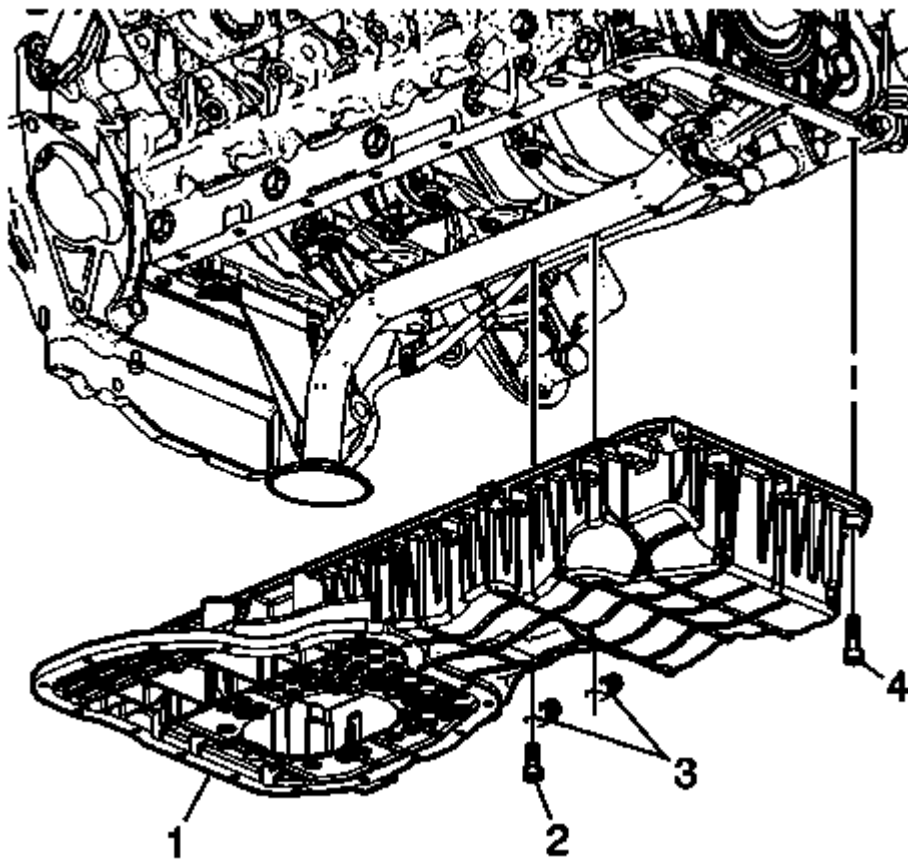


Fig. 183: View Of Upper Oil Pan & Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the upper oil pan to the engine block (1).
4. Install the wiring harness clips (3).
5. Install the upper oil pan bolts (2, 4).

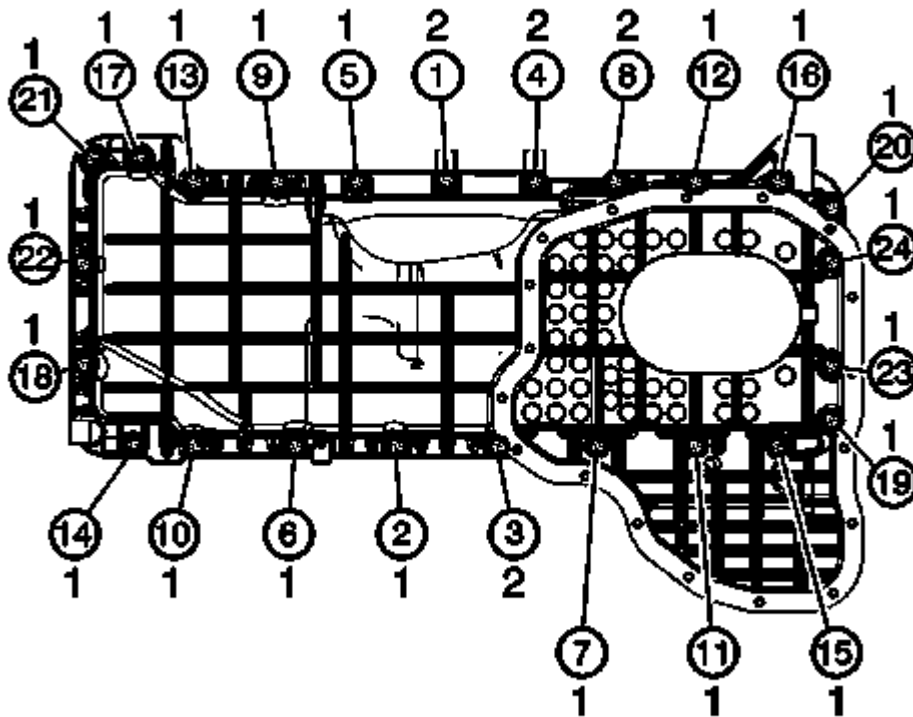


Fig. 184: Upper Oil Pan Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Tighten the upper oil pan bolts (1, 2) in sequence to 21 N.m (15 lb ft).

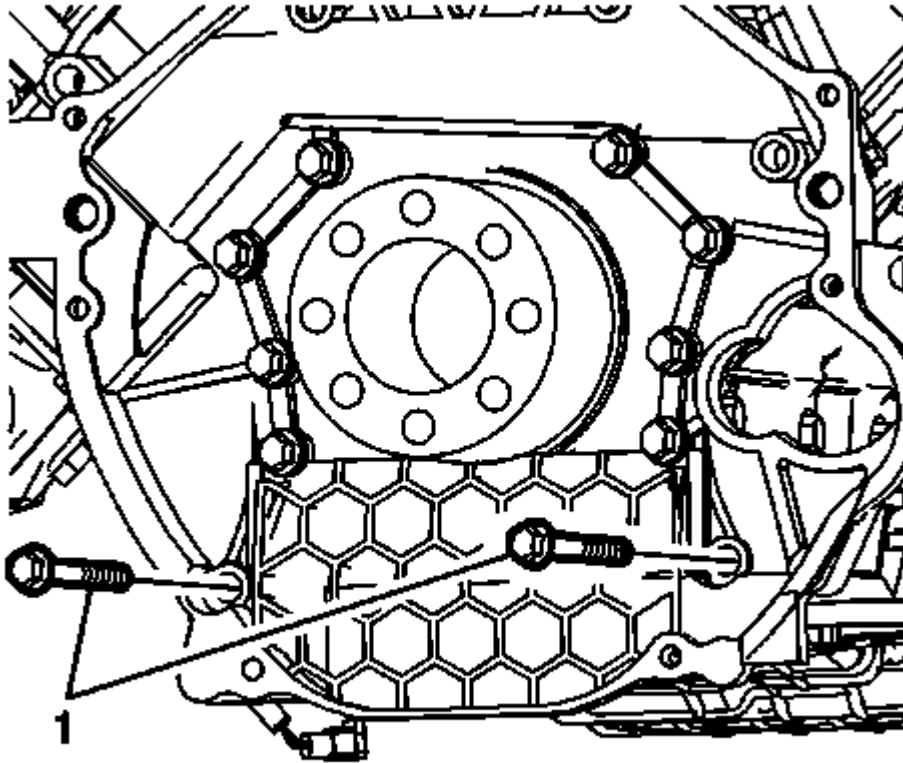


Fig. 185: View Of Flywheel Housing To Upper Oil Pan Bolts
 Courtesy of GENERAL MOTORS COMPANY

7. Install the 2 flywheel housing to upper oil pan bolts (1) and tighten to 50 N.m (37 lb ft).
8. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.
9. Install the lower oil pan. Refer to **Lower Oil Pan Replacement**.
10. If vehicle is a 4WD, install the front differential carrier. Refer to **Differential Carrier Assembly Replacement (2500 4WD)** , **Differential Carrier Assembly Replacement (9.25 Inch HD Axle)** .
11. If vehicle is a 2WD, connect the relay rod to the pitman arm and idler arm. Refer to **Relay Rod Replacement (Dual Rear Wheels or Crew Cab With SRW)** , **Relay Rod Replacement (SRW Except Crew Cab With SRW)** .
12. Relearn the crankshaft position reluctor wheel. Refer to **Crankshaft Position Reluctor Wheel Learn** .

OIL PUMP REPLACEMENT

Removal Procedure

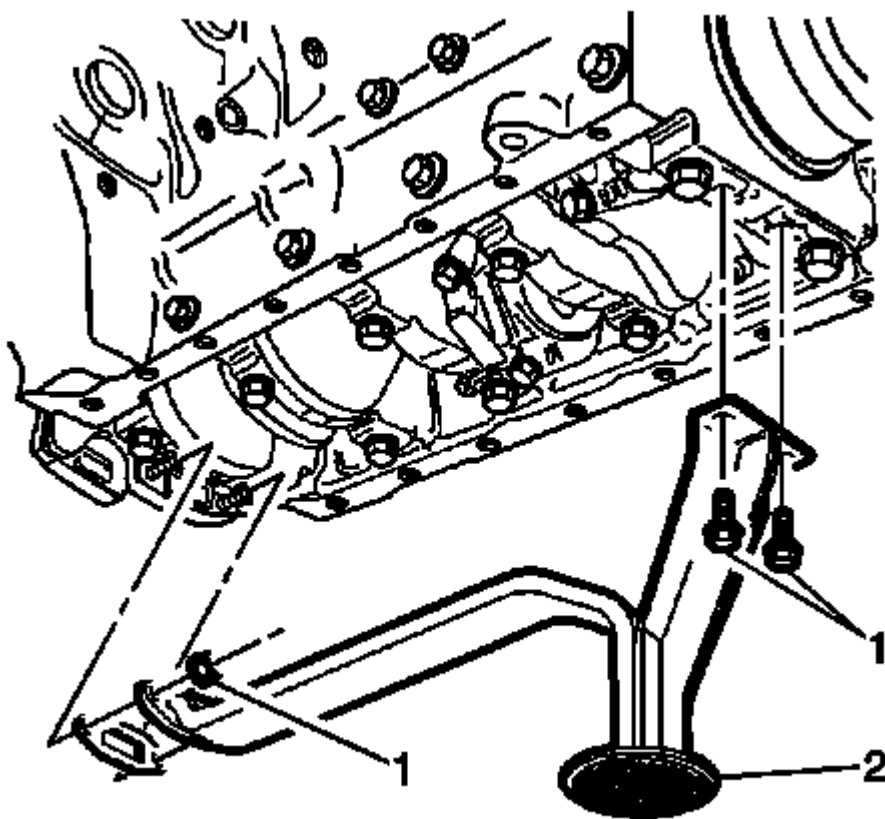


Fig. 186: View Of Oil Pump Screen, Bolts, Nuts & Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine front cover. Refer to Engine Front Cover Replacement.
2. Remove the upper oil pan. Refer to Upper Oil Pan Replacement.
3. Remove the oil pump screen bolts and nuts (1).
4. Remove the oil pump screen (2).
5. Remove and discard the oil pump screen gasket.

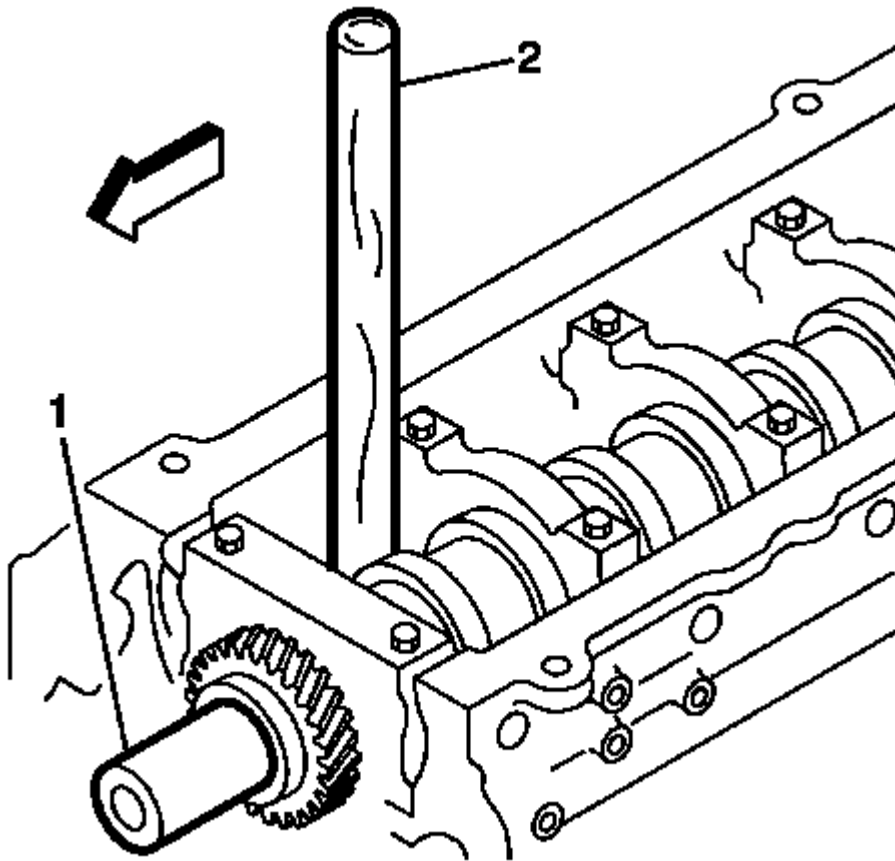


Fig. 187: Blocking Crankshaft From Turning Using Wooden Handle
Courtesy of GENERAL MOTORS COMPANY

6. Block the crankshaft (1) from turning with a wooden handle (2).

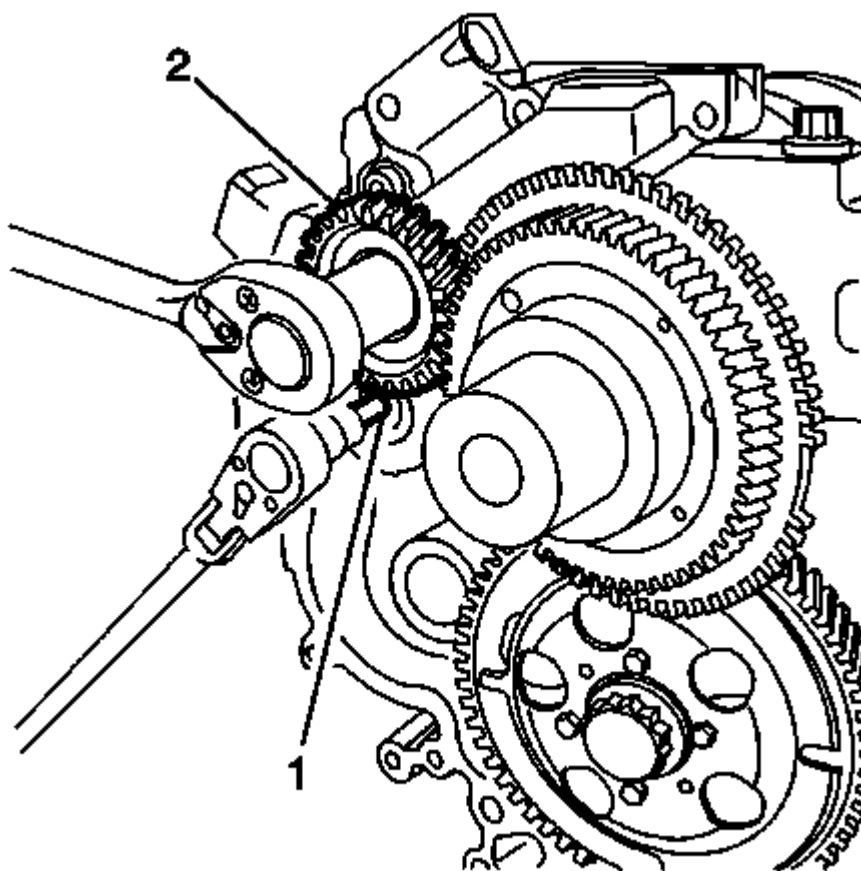


Fig. 188: Removing/Installing Secondary Oil Pump Driven Gear Nut While Holding Oil Pump Shaft

Courtesy of GENERAL MOTORS COMPANY

NOTE: Look for an "L" on the end of the oil pump shaft. If there is an "L" present, the nut and shaft have left hand threads. Service the nut accordingly.

7. While holding the secondary oil pump shaft with a hex driver (1), remove the oil pump driven gear (2) nut.

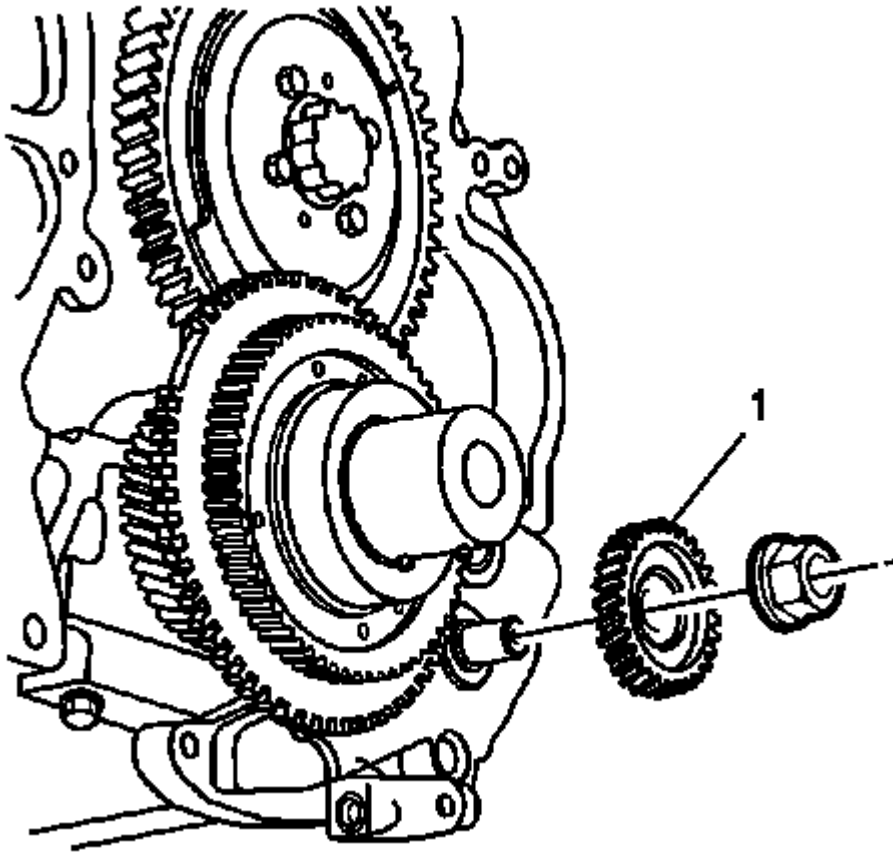


Fig. 189: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS COMPANY

8. Remove the oil pump driven gear (1).

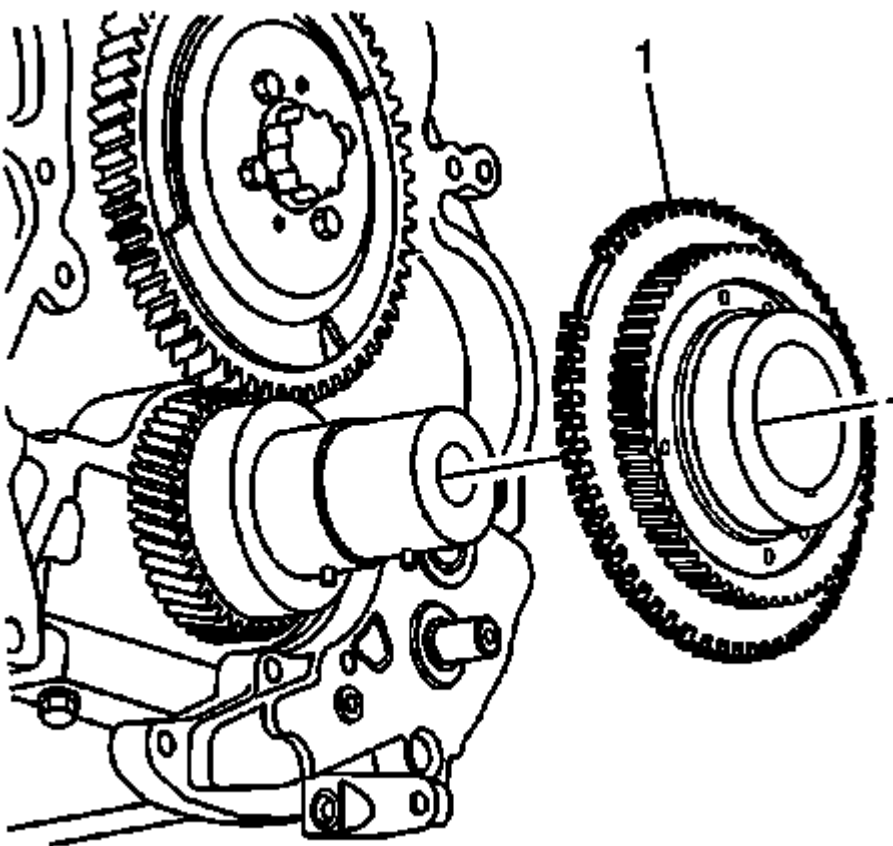


Fig. 190: View Of Oil Pump Drive Gear
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not damage the crankshaft reluctor. Do not remove the crankshaft reluctor to oil pump drive bolts.

9. Remove the oil pump drive gear (1) and crankshaft reluctor.
 - Use a brass drift.
 - Tap on the back as close to the center of the reluctor.

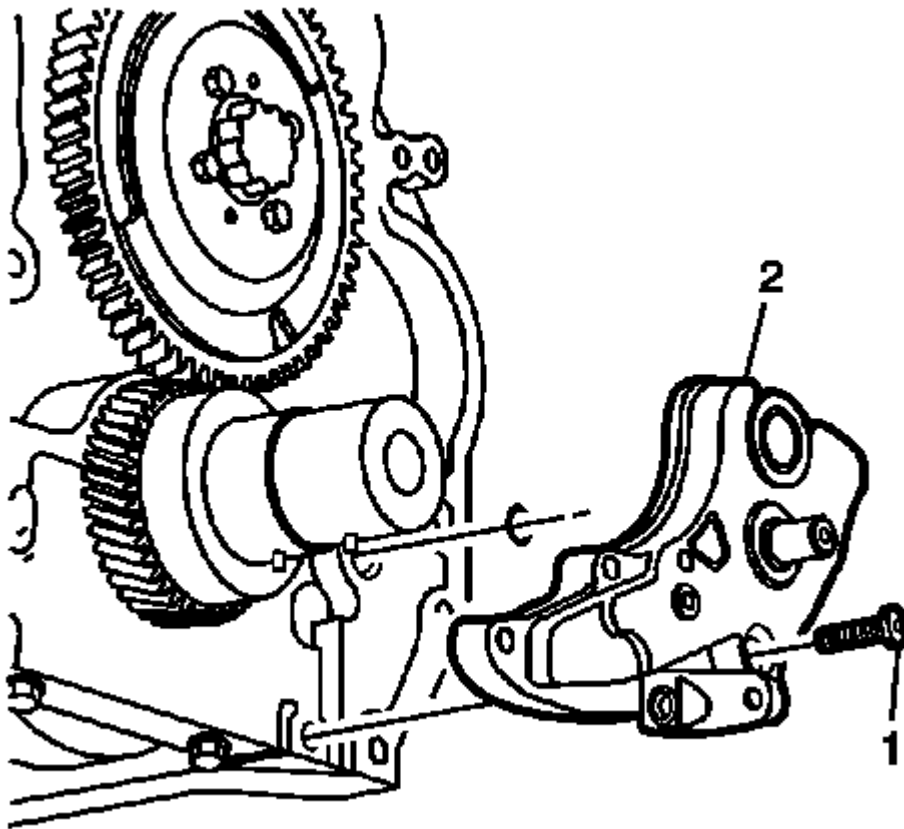


Fig. 191: View Of Oil Pump, O-Ring Seal & Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove the hex head (1) and the allen head bolt in order to remove the oil pump.
11. Remove the oil pump.
12. Remove the O-ring seal for the oil pump.
13. If required, clean and inspect the oil pump. Refer to **Oil Pump Cleaning and Inspection** .

Installation Procedure

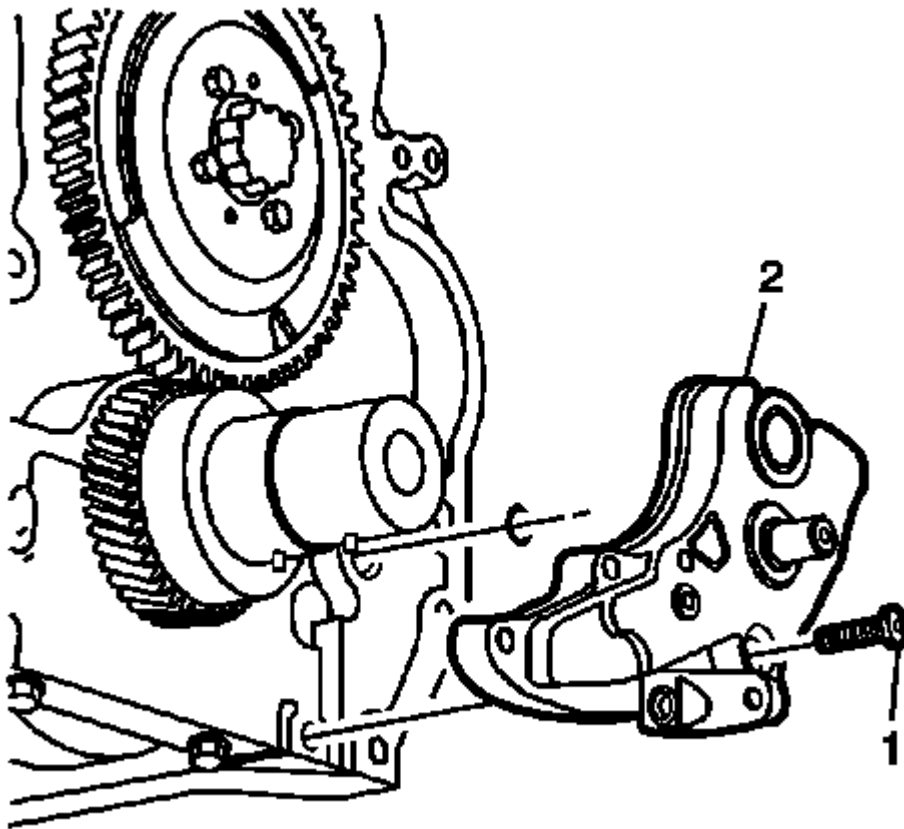


Fig. 192: View Of Oil Pump, O-Ring Seal & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW oil pump O-ring seal.
2. Install the oil pump (2).

CAUTION: Refer to Fastener Caution .

3. Install the oil pump bolts (1) and tighten to 25 N.m (18 lb ft).
4. Inspect the oil pump drive gear for wear.
5. Replace the oil pump drive gear pin if worn.

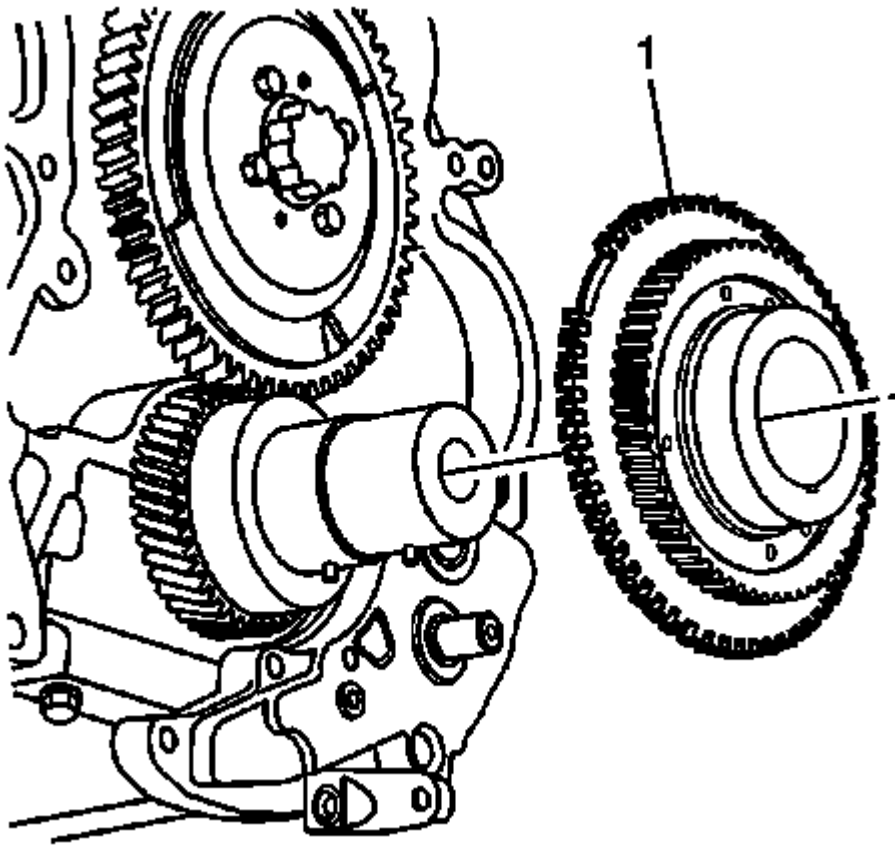


Fig. 193: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS COMPANY

6. Install the oil pump drive gear (1) and reluctor to the crankshaft.

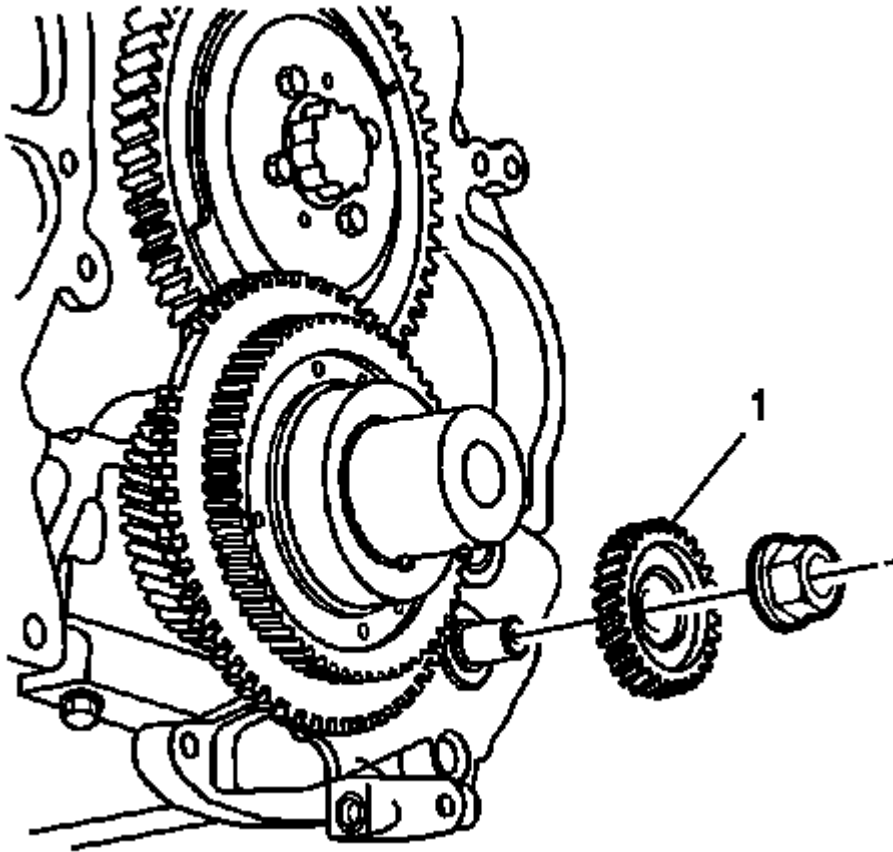


Fig. 194: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS COMPANY

7. Install the oil pump driven gear (1).

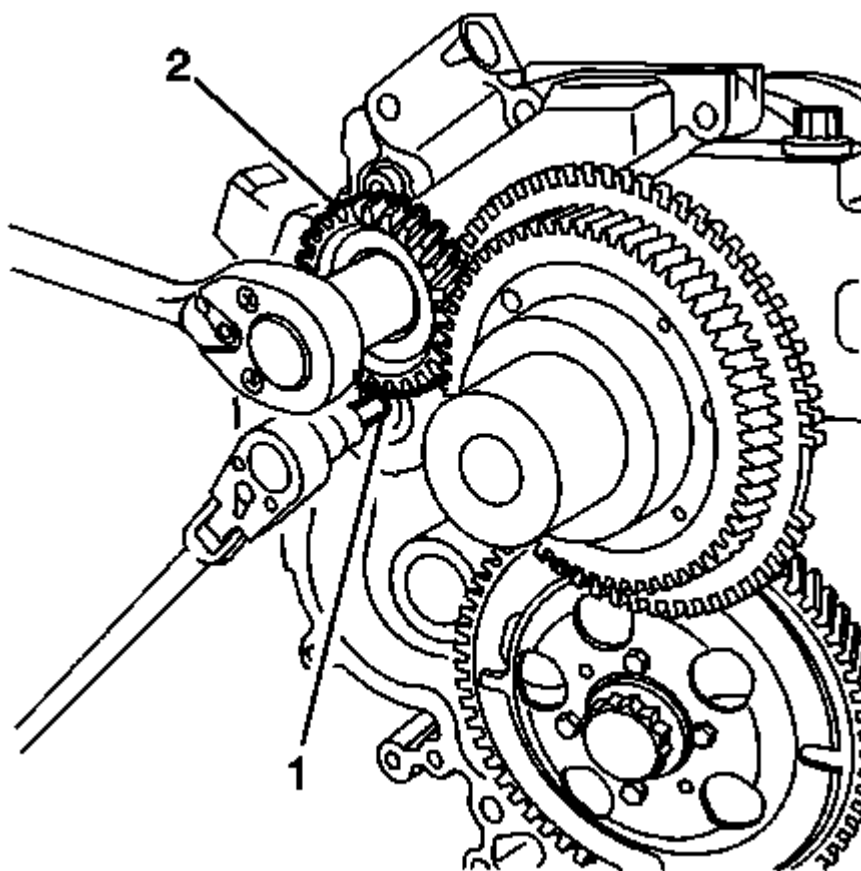


Fig. 195: Removing/Installing Secondary Oil Pump Driven Gear Nut While Holding Oil Pump Shaft

Courtesy of GENERAL MOTORS COMPANY

8. While holding the secondary oil pump shaft with a hex driver (1), install the oil pump driven gear nut. Tighten the nut to 100 N.m (74 lb ft).

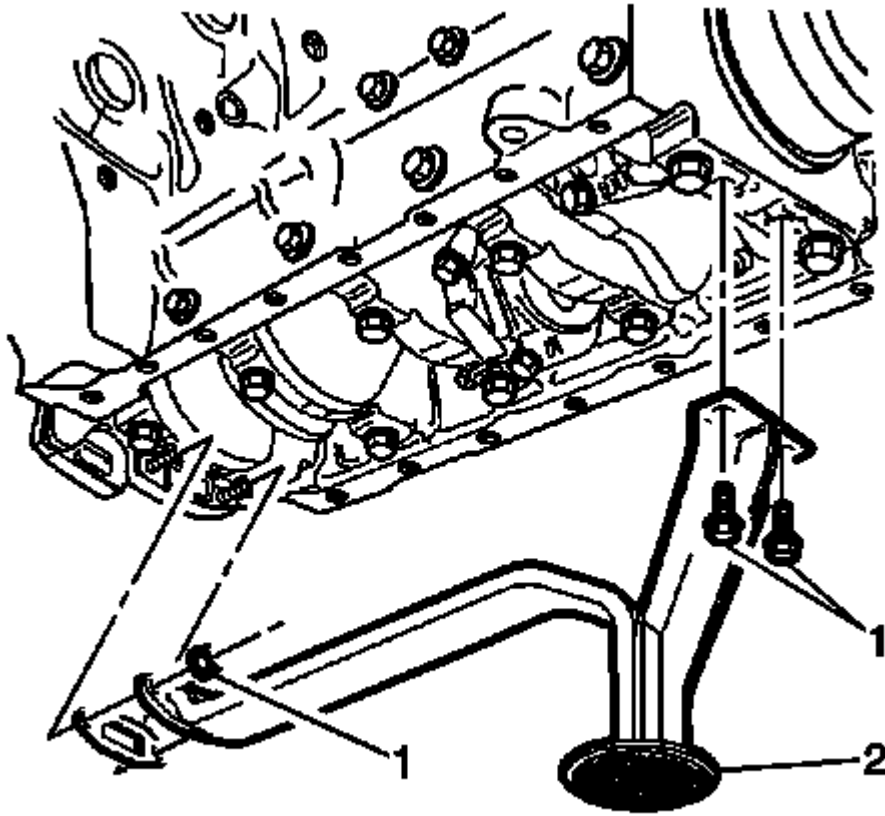


Fig. 196: View Of Oil Pump Screen, Bolts, Nuts & Gasket
 Courtesy of GENERAL MOTORS COMPANY

9. Install a NEW oil pump screen gasket to the oil pump.
10. Install the oil pump screen (2).
11. Install the oil pump screen bolts and nuts (1). Tighten the bolts/nuts to 25 N.m (18 lb ft).
12. Install the upper oil pan. Refer to **Upper Oil Pan Replacement**.
13. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
14. Relearn the crankshaft position reluctor wheel. Refer to **Crankshaft Position Reluctor Wheel Learn** .

OIL FILTER ADAPTER AND OIL COOLER ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the water pump outlet pipe bolts. Refer to **Water Pump Outlet Pipe Replacement (LML)** .
2. Remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.

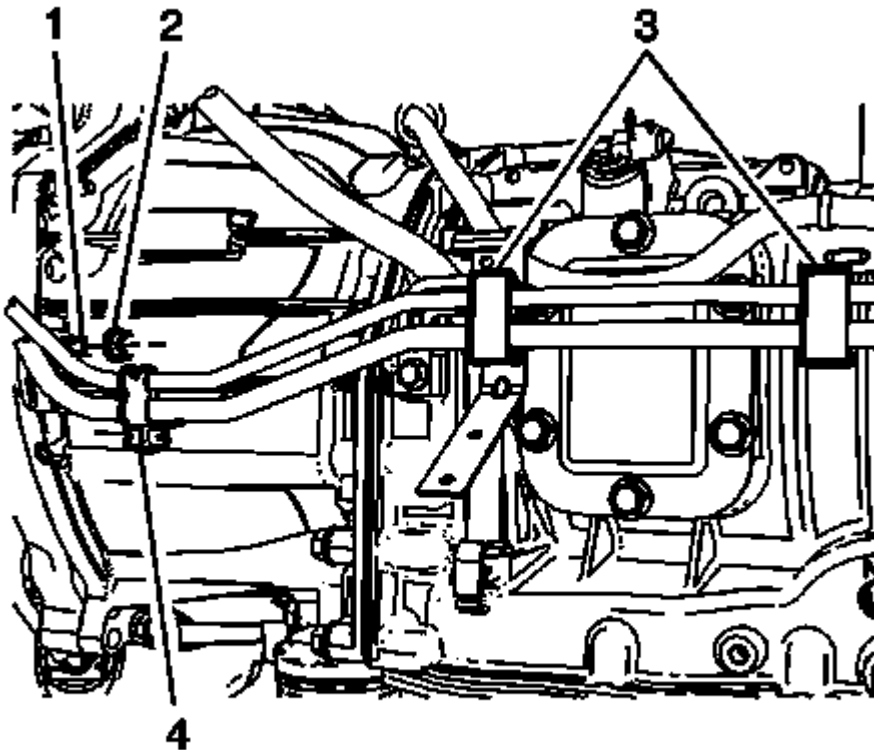


Fig. 197: Fuel Line Brackets And Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fuel line bracket retaining nut (2).
4. Remove fuel lines from the retainers (3) and slide the fuel line bracket (4) from the stud (1).
5. Remove the engine to transmission stud (1).

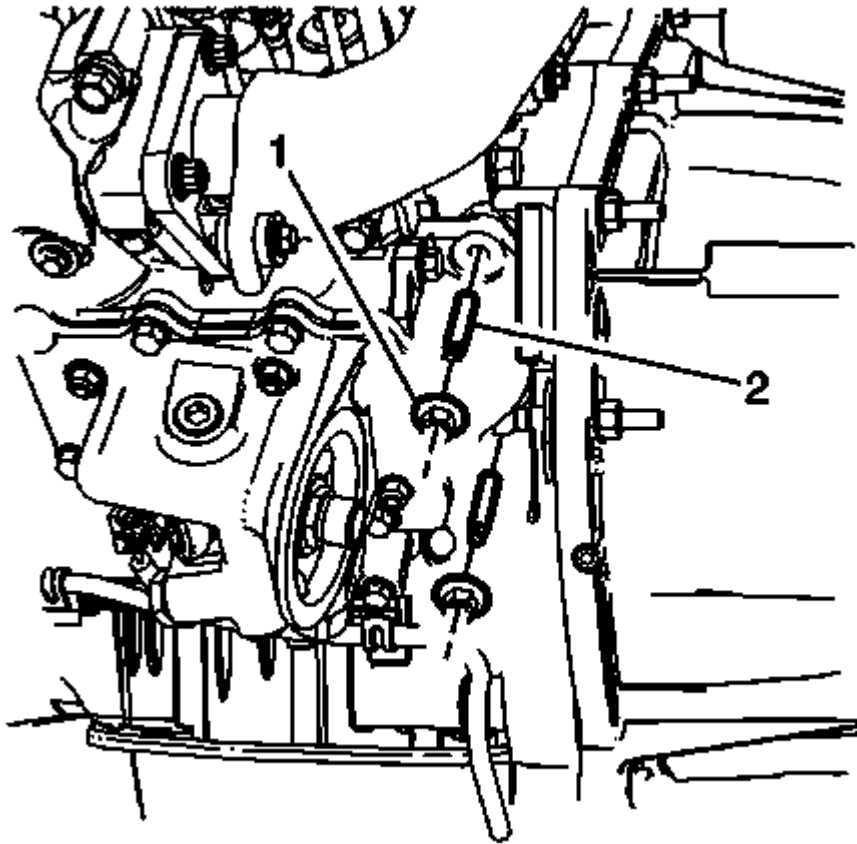


Fig. 198: Oil Cooler Adapter Nuts And Studs
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil cooler adapter nuts (1) and studs (2).

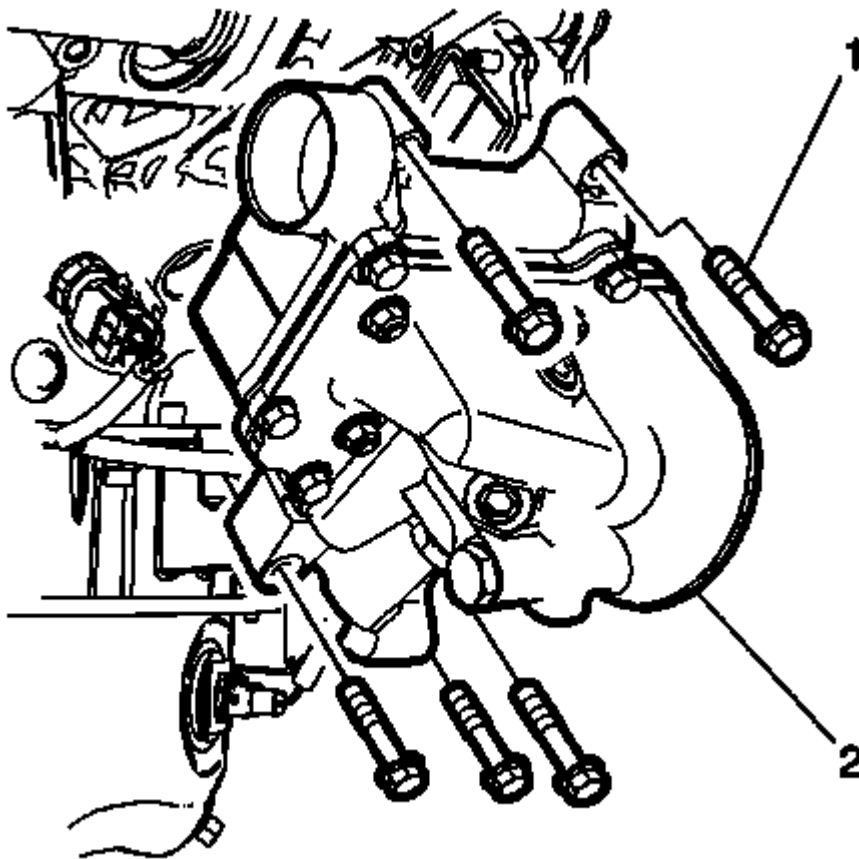


Fig. 199: Oil Cooler And Bolts

Courtesy of GENERAL MOTORS COMPANY

7. Remove the oil cooler bolts (1) and assembly (2).

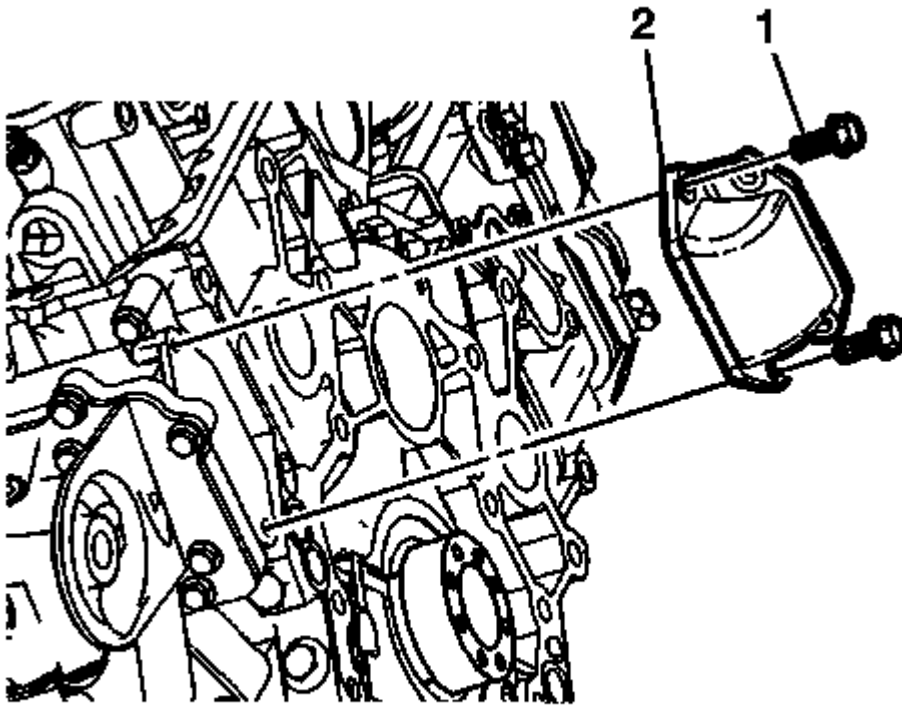


Fig. 200: Oil Cooler Adapter And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the oil cooler adapter bolts (1) and adapter (2).
9. If required, clean and inspect the oil filter adapter/oil cooler. Refer to **Oil Filter Adapter and Oil Cooler Assembly Cleaning and Inspection** .

Installation Procedure

CAUTION: Refer to **Fastener Caution** .

1. Install the oil cooler adapter bolts and adapter cover to oil filter adapter/oil cooler. Tighten the oil cooler adapter bolts to 25 N.m (18 lb ft).

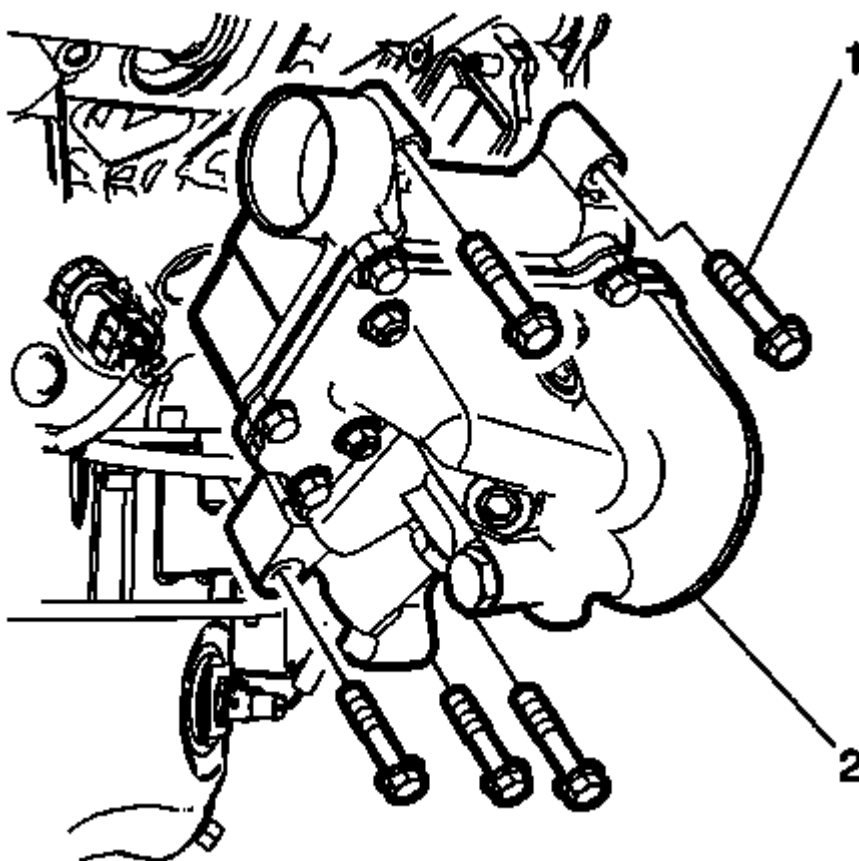


Fig. 201: Oil Cooler And Bolts

Courtesy of GENERAL MOTORS COMPANY

2. Install the oil cooler bolts (1) and oil cooler assembly (2). Tighten the oil cooler assembly bolts to 25 N.m (18 lb ft).
3. Install the oil cooler adapter studs (2) and nut (1) to the flywheel housing.
 - Tighten the oil cooler adapter nuts to 25 N.m (18 lb ft).
 - Tighten the oil cooler adapter studs to 8 N.m (71 lb in).
 - Tighten the oil cooler adapter nuts to 25 N.m (18 lb ft).

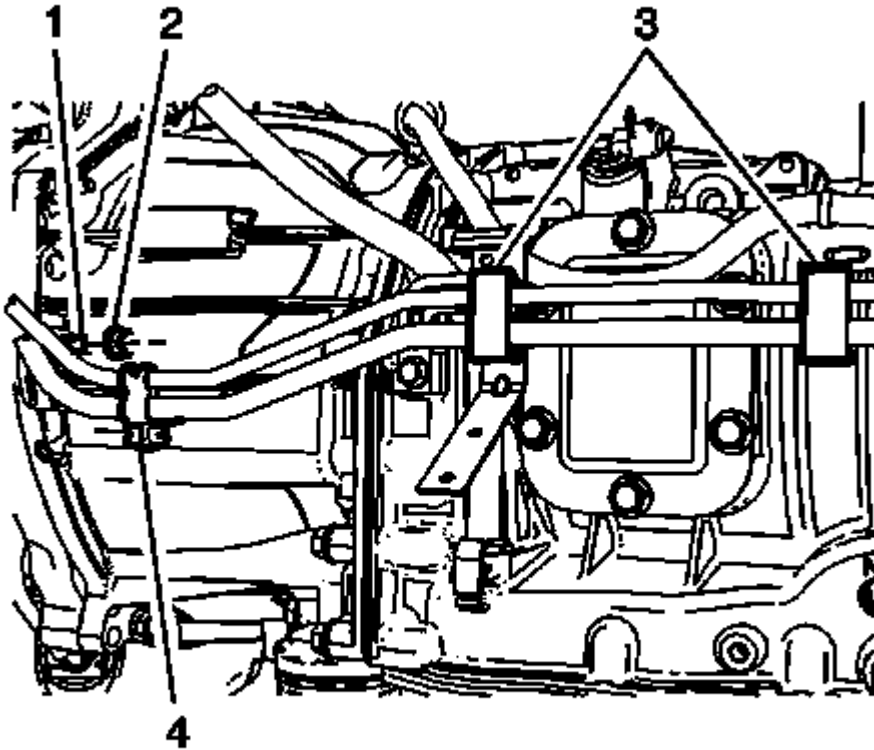


Fig. 202: Fuel Line Brackets And Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Install the engine to transmission stud (1) and tighten to 50 N.m (37 lb ft).
5. Position the fuel lines into the retainers (3) and slide the fuel line bracket (4) onto the stud (1).
6. Install the fuel line bracket retaining nut (2) and tighten to 18 N.m (13 lb ft).
7. Install the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
8. Install the water pump outlet pipe bolts. Refer to **Water Pump Outlet Pipe Replacement (LML)**.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

Special Tools

J-41712 Oil Pressure Sensor Socket

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

Removal Procedure

NOTE: Clean the area around the sensor. Do not allow debris to enter the engine.

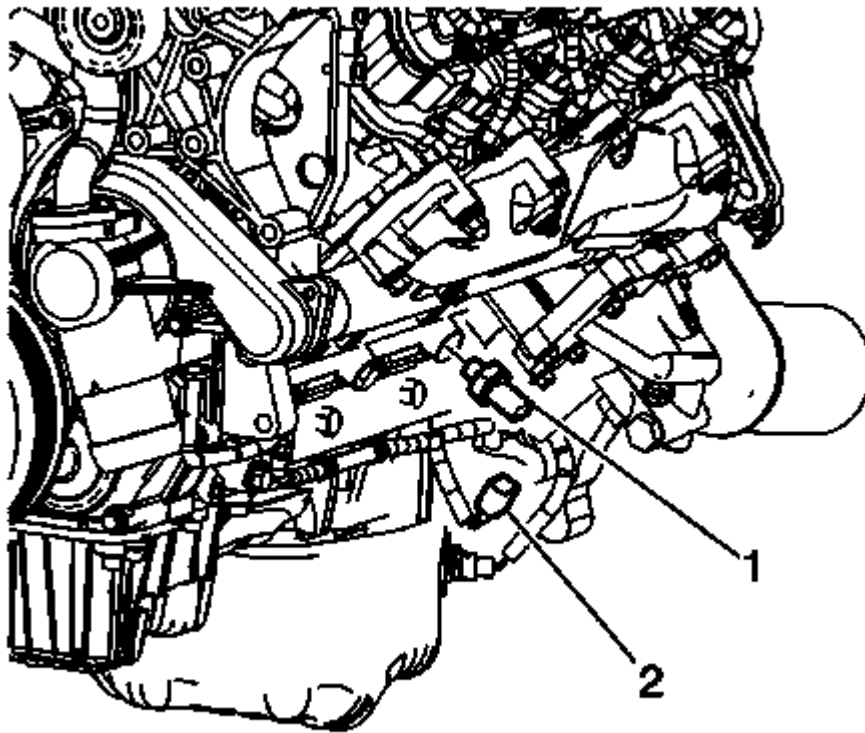


Fig. 203: View Of Engine Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Disconnect the engine harness electrical connector (2) from the oil pressure sensor.
3. Remove the oil pressure sensor (1) using **J-41712** socket.

Installation Procedure

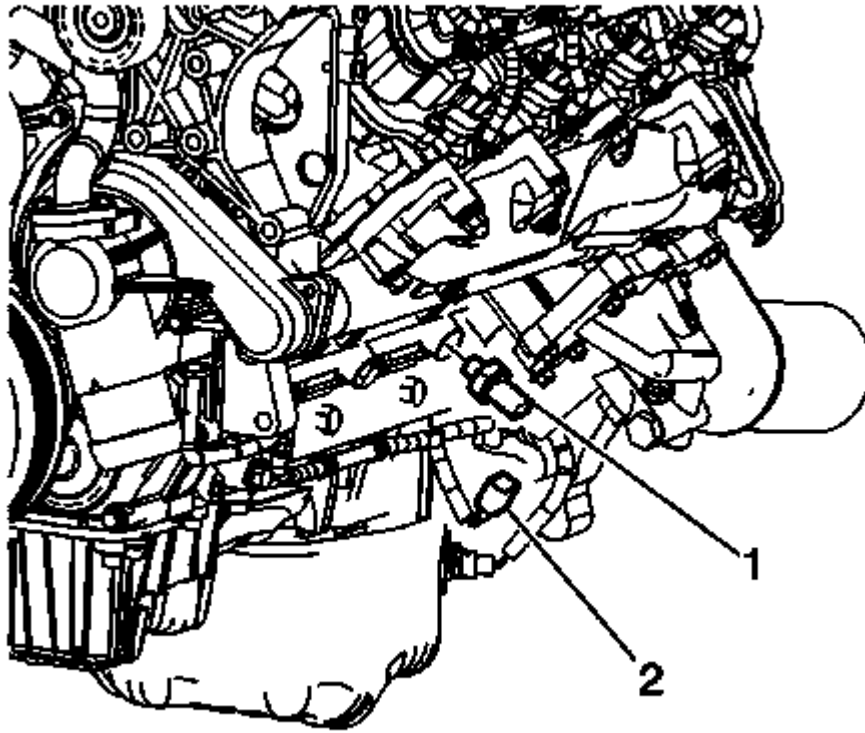


Fig. 204: View Of Engine Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Apply sealant to the threads of the oil pressure sensor, if necessary. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

CAUTION: Refer to Fastener Caution .

2. Install the oil pressure sensor (1) using **J-41712** socket and tighten to 49 N.m (36 lb ft).
3. Connect the engine harness electrical connector (2) to the oil pressure sensor.
4. Lower the vehicle.
5. Check and add engine oil, if necessary.

ENGINE OIL LEVEL SENSOR AND/OR SWITCH REPLACEMENT

Removal Procedure

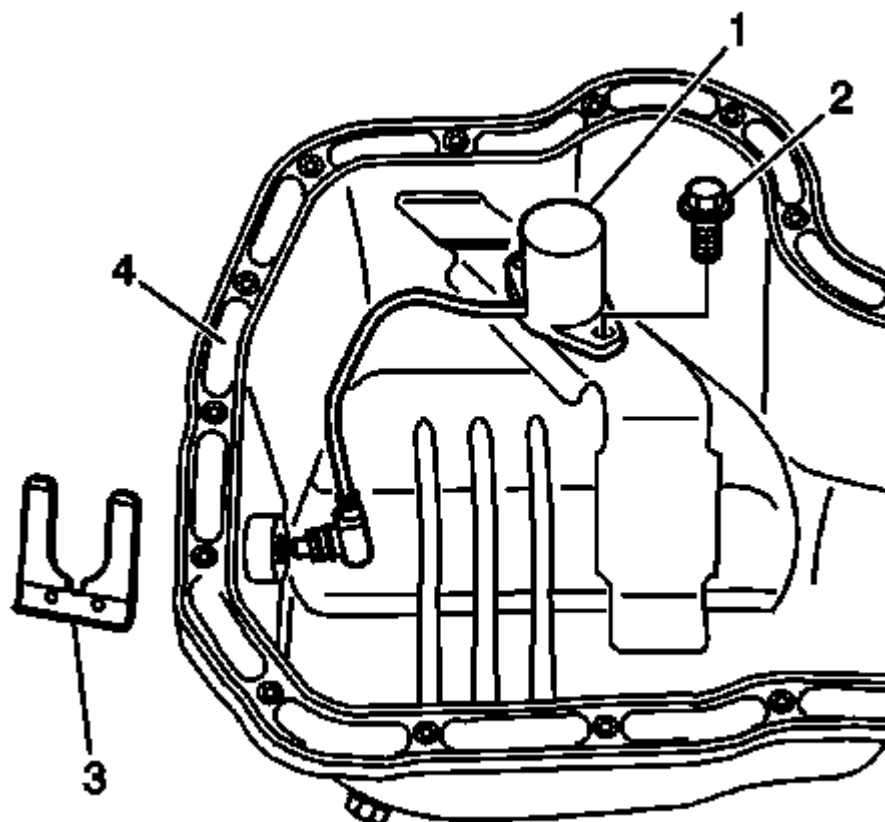


Fig. 205: View Of Oil Level Sensor, Clip, Bolt & Oil Pan Mating Surface
Courtesy of GENERAL MOTORS COMPANY

1. Remove the lower oil pan. Refer to **Lower Oil Pan Replacement**.
2. Remove the oil level sensor clip (3).
3. Remove the oil level sensor bolt (2) and sensor (1).

Installation Procedure

NOTE: When routing the oil level sensor wire, ensure that the wire is routed along the side of the oil pan.

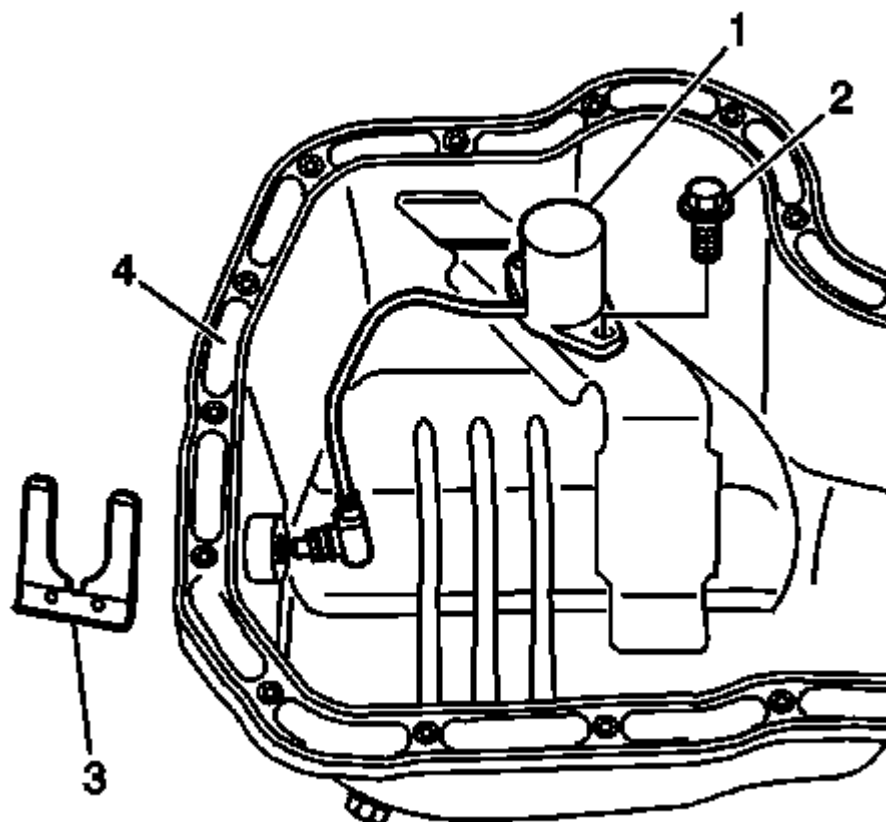


Fig. 206: View Of Oil Level Sensor, Clip, Bolt & Oil Pan Mating Surface
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the oil level sensor (1) and bolt (2) and tighten to 9 N.m (80 lb in).
2. Install the oil level sensor clip (3).
3. Install the lower oil pan. Refer to Lower Oil Pan Replacement.

ENGINE REPLACEMENT

Special Tools

- J 38185 Hose Clamp Pliers
- EN-49397 Lift Bracket

For equivalent regional tools, refer to Special Tools

Removal Procedure

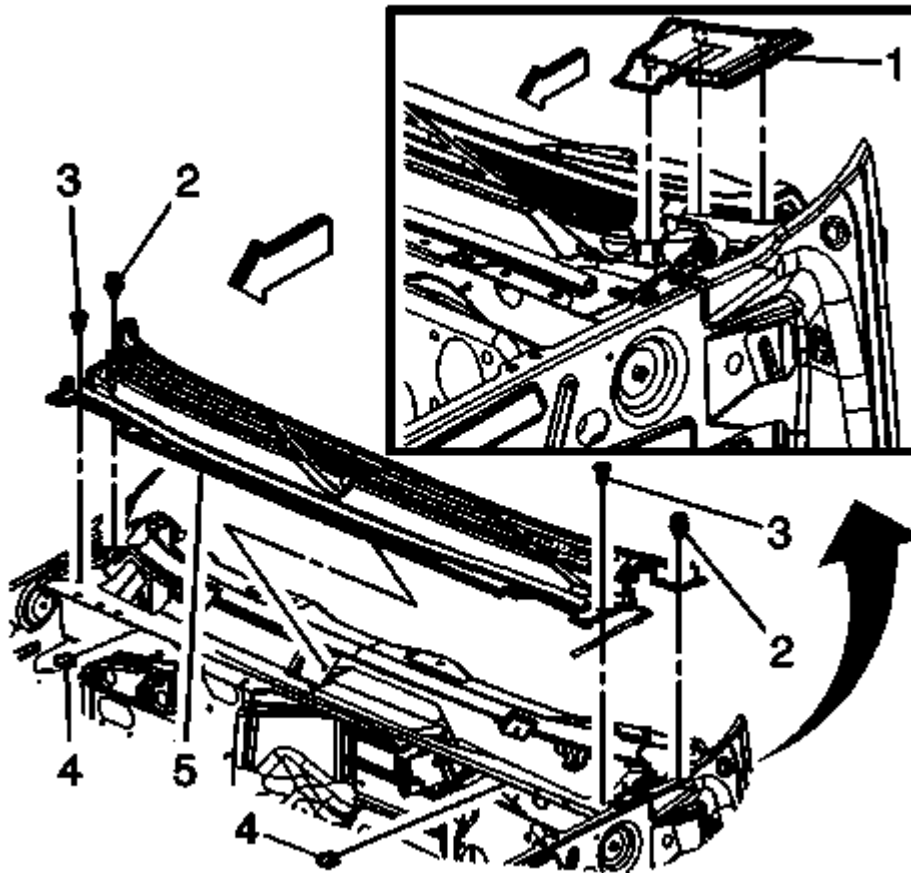


Fig. 207: Air Inlet Grille

Courtesy of GENERAL MOTORS COMPANY

1. Remove the air inlet grille (1). Refer to **Air Inlet Grille Panel Replacement** .
2. Place hood in service position.
3. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (TP2)** , **Battery Negative Cable Disconnection and Connection (Single Battery)** .
4. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (Static Fill LGH, LML)** , **Cooling System Draining and Filling (Vac-N-Fill Diesel)** .
5. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
6. Recover the A/C refrigerant. Refer to **Refrigerant Recovery and Recharging (Non-HP2)** .

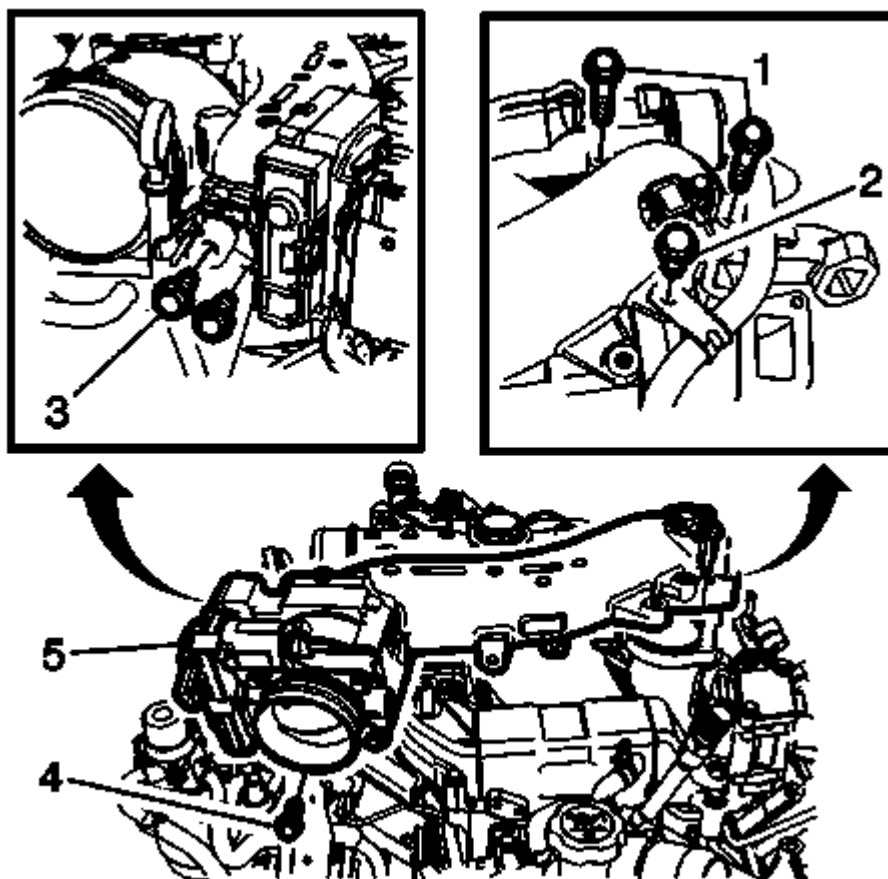


Fig. 208: Intake Manifold Tube

Courtesy of GENERAL MOTORS COMPANY

7. Remove the intake manifold tube (5). Refer to Intake Manifold Tube Replacement.
8. Remove the EGR cooler. Refer to Exhaust Gas Recirculation Valve Cooler Replacement (Rear) , Exhaust Gas Recirculation Valve Cooler Replacement (Front) .

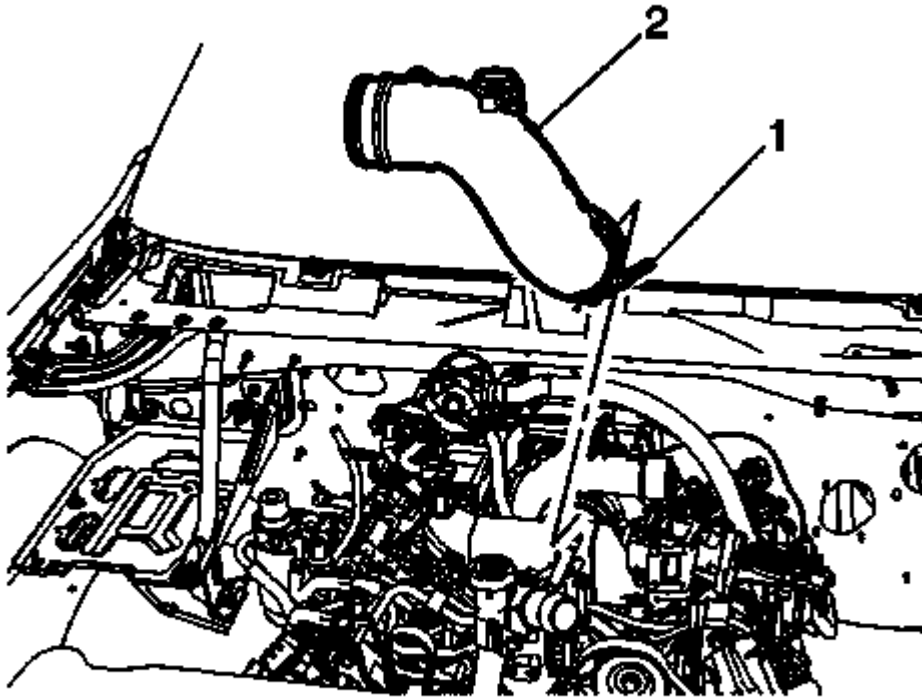


Fig. 209: Turbocharger Air Inlet Adapter
Courtesy of GENERAL MOTORS COMPANY

9. Remove the turbocharger air inlet adapter (2) . Refer to **Turbocharger Air Inlet Adapter Replacement** .
10. Remove the water pump outlet pipe bolts. Refer to **Water Pump Outlet Pipe Replacement (LML)** .

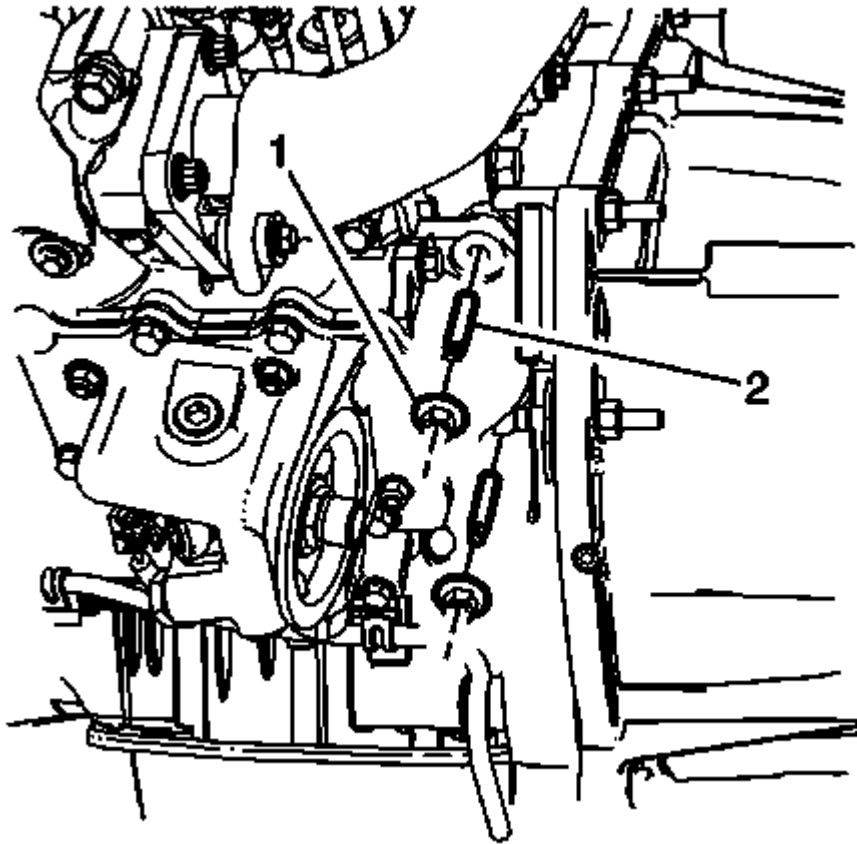


Fig. 210: Oil Cooler Adapter Nuts And Studs
Courtesy of GENERAL MOTORS COMPANY

11. Remove the oil cooler adapter nuts (1) and studs (2).

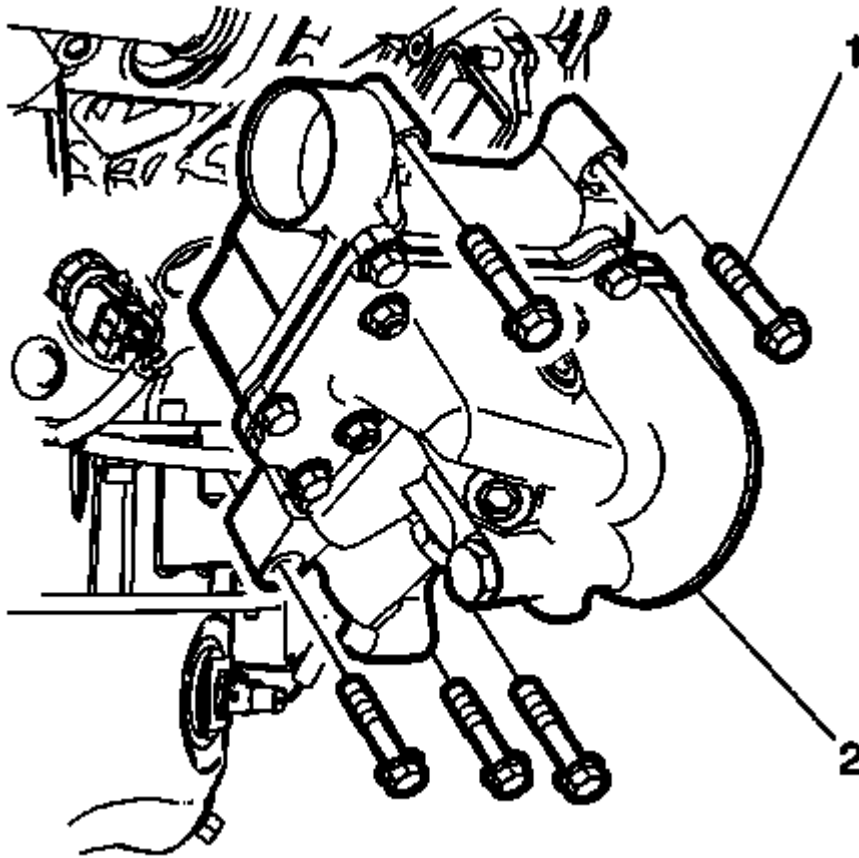


Fig. 211: Oil Cooler And Bolts

Courtesy of GENERAL MOTORS COMPANY

12. Remove the oil cooler bolts (1) and assembly (2).

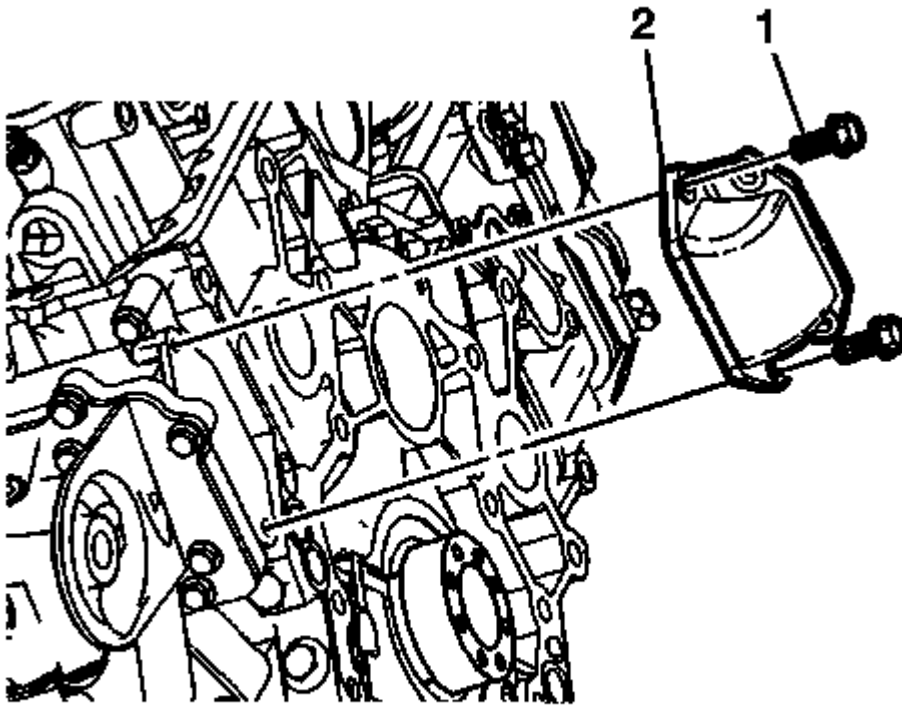


Fig. 212: Oil Cooler Adapter And Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the oil cooler adapter bolts (1) and adapter (2).

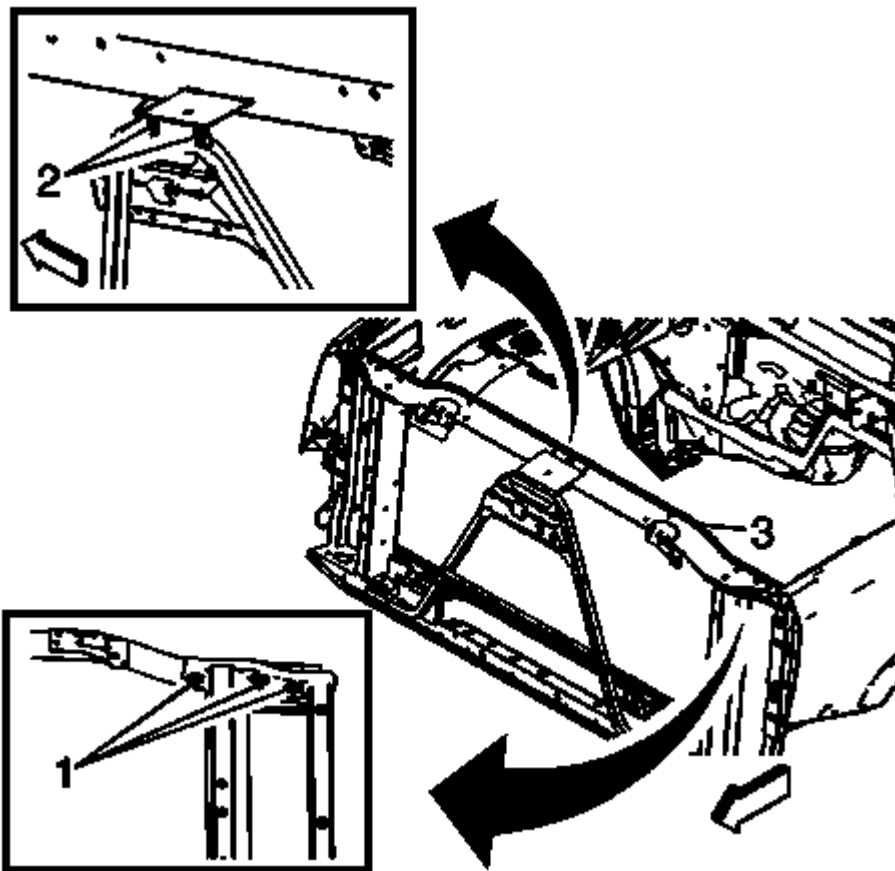


Fig. 213: Upper Tie Bar

Courtesy of GENERAL MOTORS COMPANY

14. Remove the upper tie bar (3). Refer to **Front End Upper Tie Bar Replacement** .

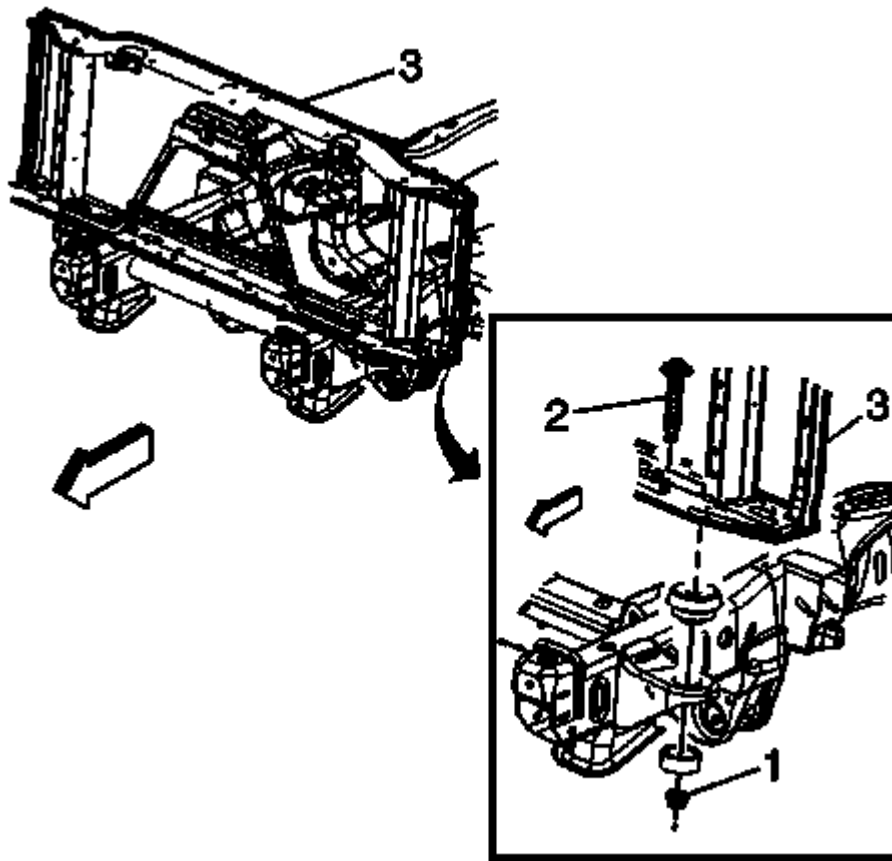


Fig. 214: Radiator Support And Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Remove radiator support bolts (3). Access the bolts from the rear of the upper radiator support.

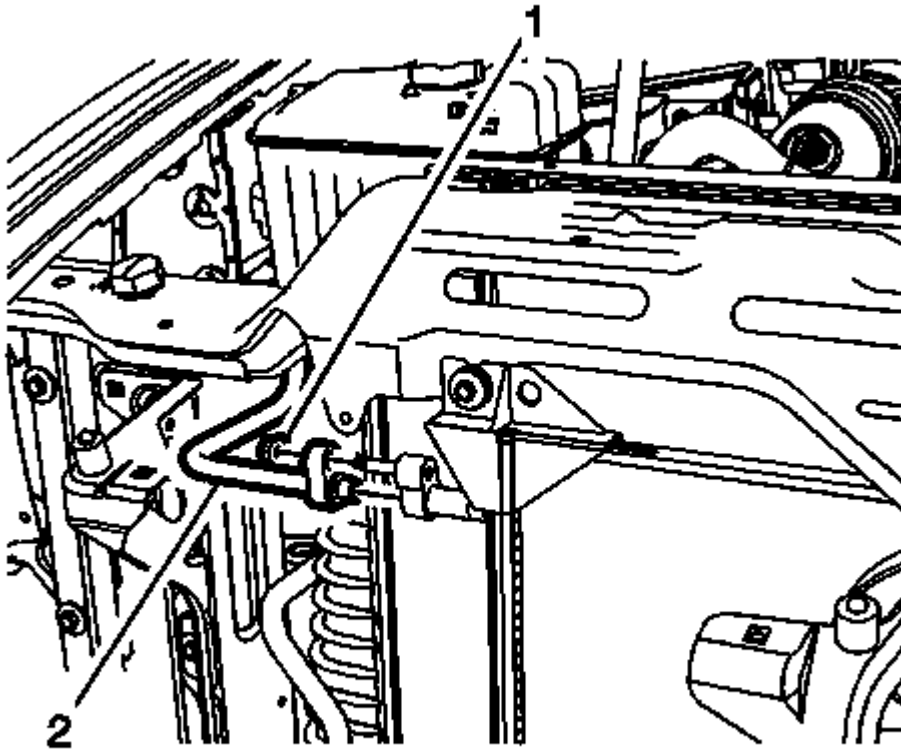


Fig. 215: Identifying Discharge Hose And Nut
Courtesy of GENERAL MOTORS COMPANY

16. Remove the compressor discharge hose nut (1) from the condenser.
17. Disconnect the compressor discharge hose (2) from the condenser.

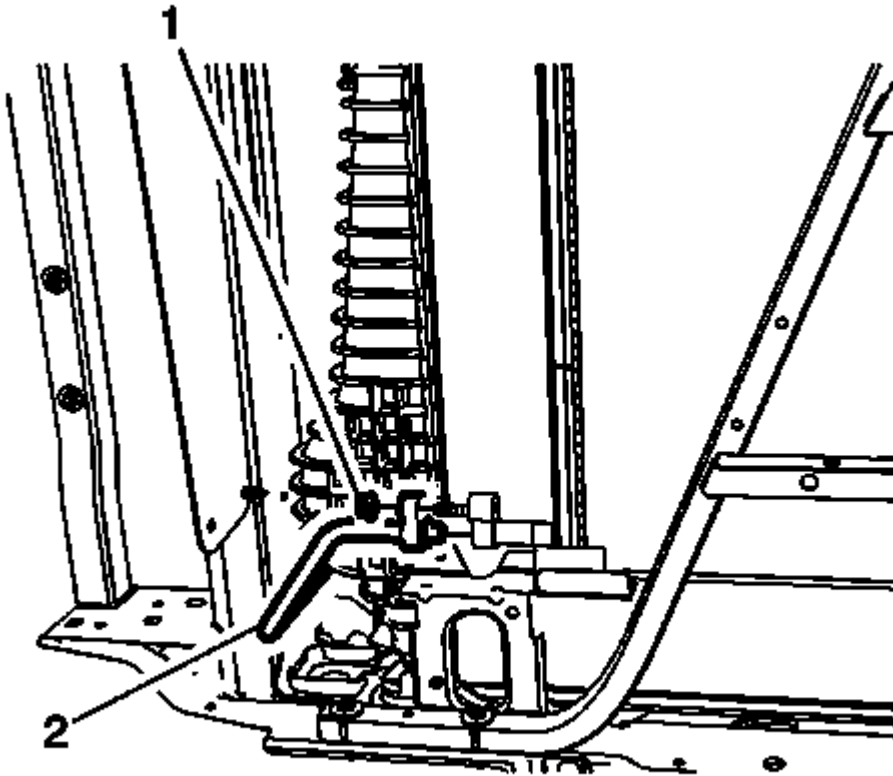


Fig. 216: Identifying Evaporator Tube And Nut
 Courtesy of GENERAL MOTORS COMPANY

18. Remove the evaporator tube nut (1) from the condenser.
19. Disconnect the evaporator tube (2) from the condenser.
20. Remove the insulator retainer bolts and the upper insulator retainers.
21. Remove the condenser from the vehicle.
22. Remove the transmission fluid auxiliary cooler. Refer to **Transmission Fluid Auxiliary Cooler Replacement (Diesel)** .
23. Remove the charge air cooler. Refer to **Charge Air Cooler Replacement** .
24. Remove the radiator. Refer to **Radiator Replacement (LGH, LML)** .

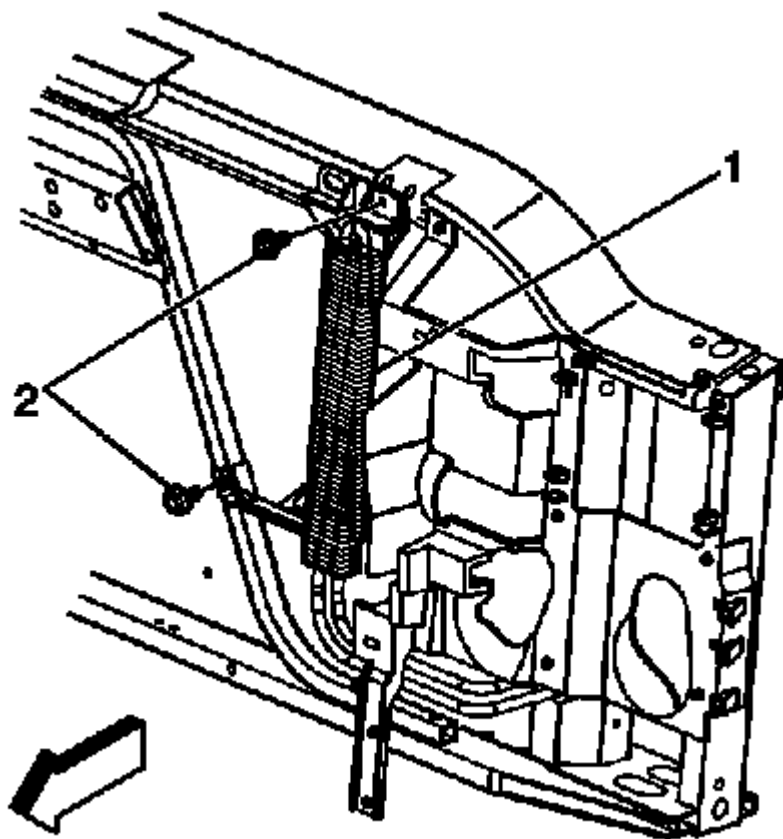


Fig. 217: Removing Power Steering Cooler From The Vehicle (Without Hydroboost)
Courtesy of GENERAL MOTORS COMPANY

25. Remove the power steering fluid cooler bolts (2).
26. Remove the power steering fluid cooler (1). Refer to **Power Steering Fluid Cooler Replacement (6.6L)** .
27. Remove the transmission control module. Refer **Transmission Control Module Replacement** .
28. Remove the ECM. Refer to **Engine Control Module Replacement** .

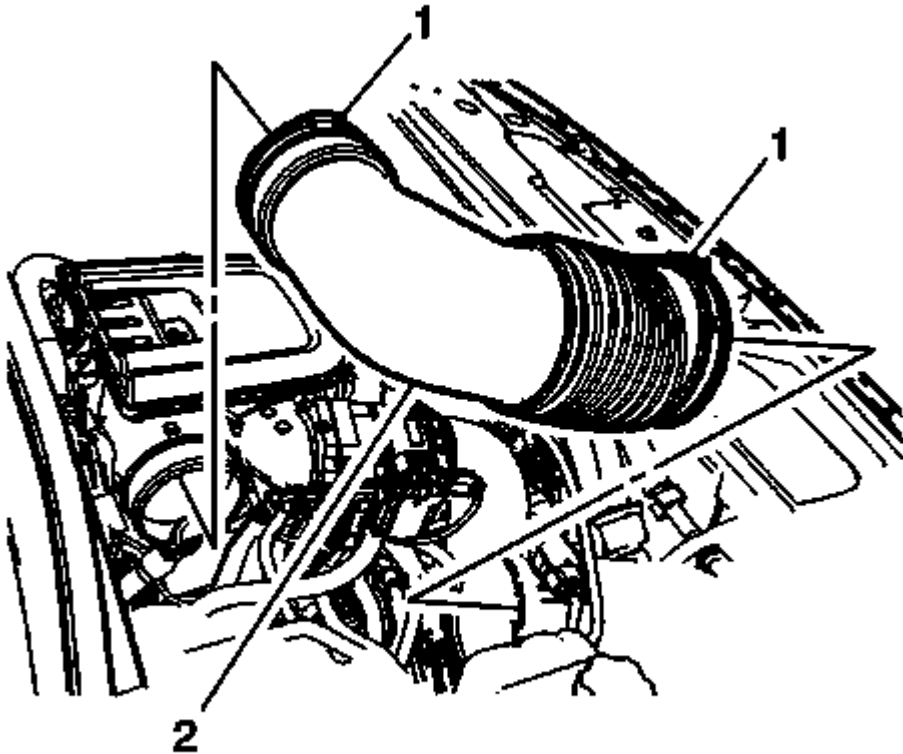


Fig. 218: Air Cleaner Outlet Duct

Courtesy of GENERAL MOTORS COMPANY

29. Remove the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement** .

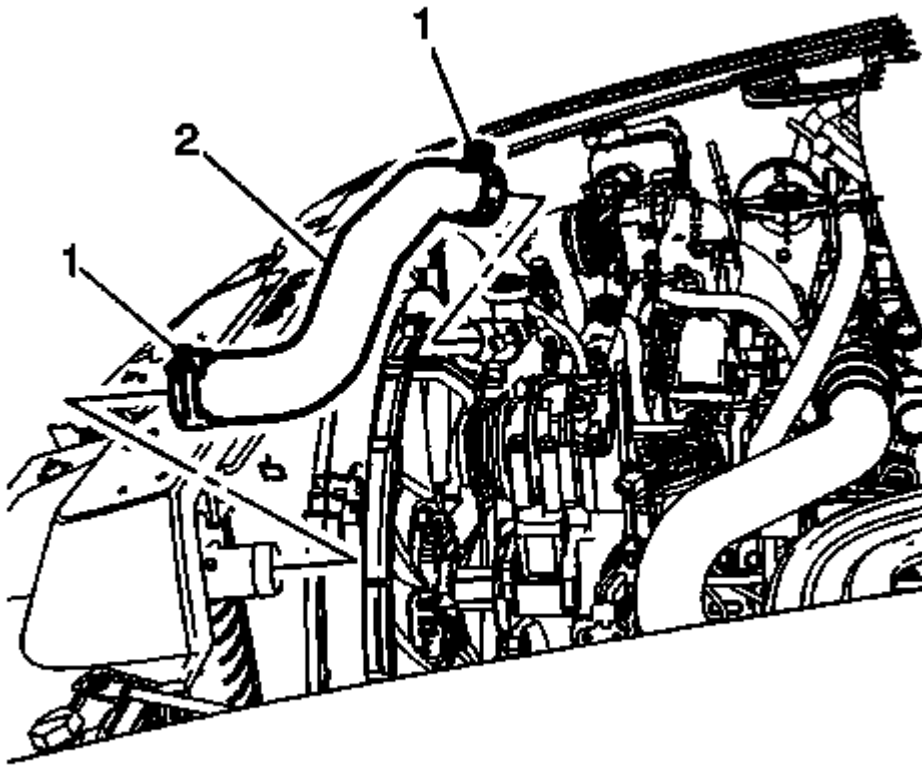


Fig. 219: Radiator Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

30. Remove the radiator inlet hose (2). Refer to **Radiator Inlet Hose Replacement (LGH, LML)** .

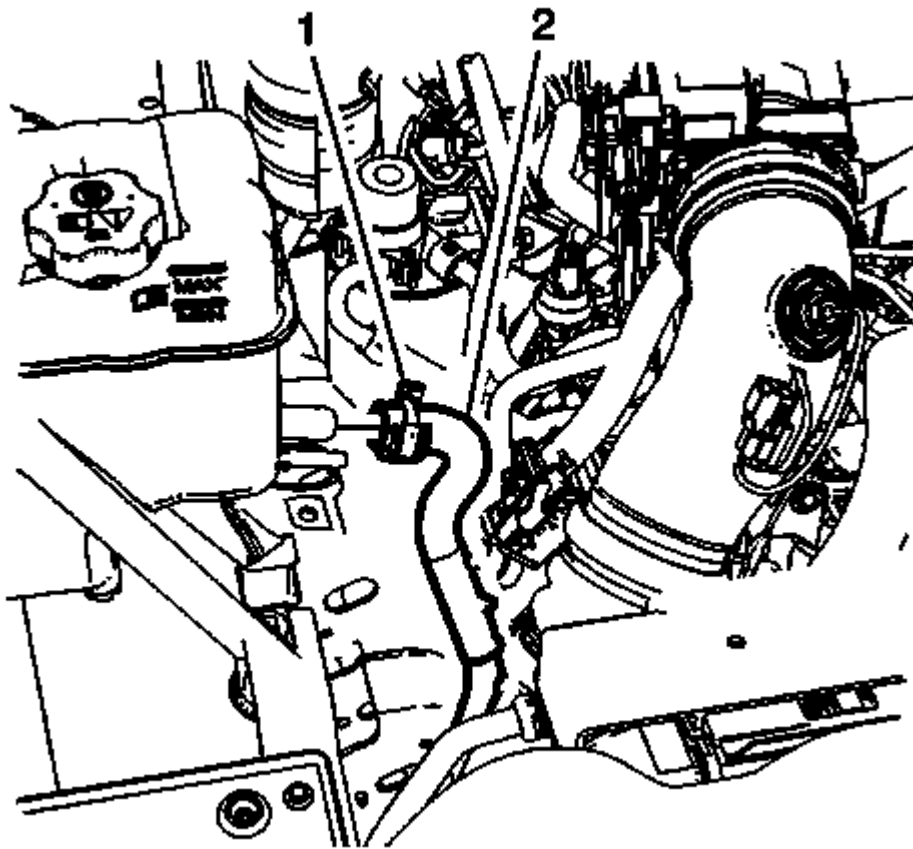


Fig. 220: Radiator Outlet Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

31. Reposition the radiator outlet hose clamp (1) at the surge tank using **J -8185** Hose Clamp Pliers.
32. Remove the radiator outlet hose (2) from the surge tank.

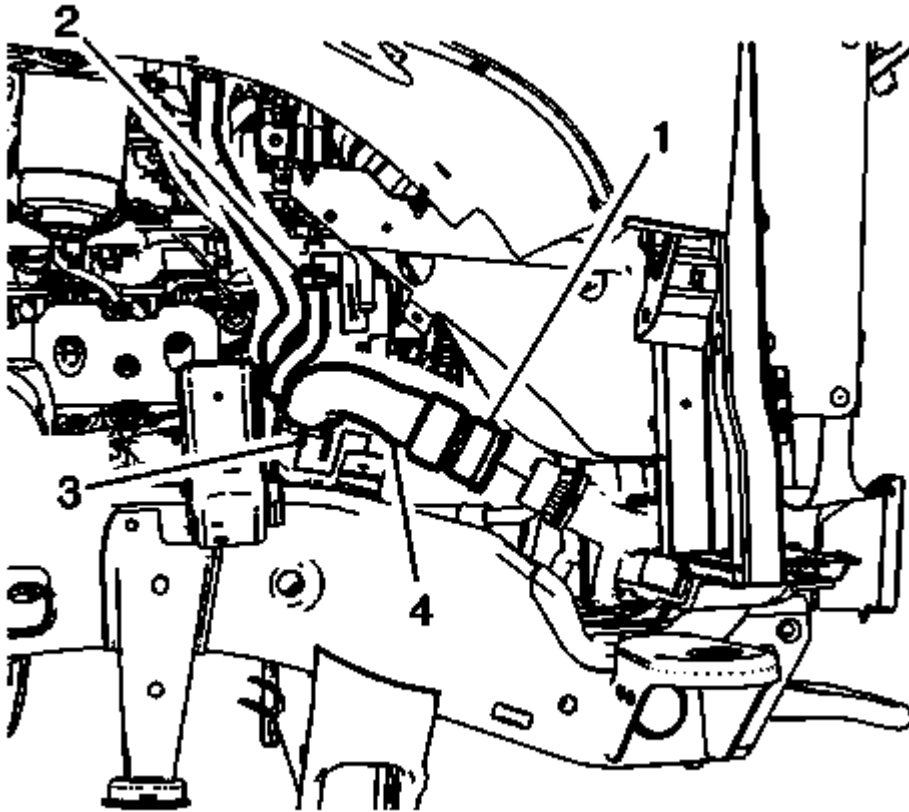


Fig. 221: Radiator Outlet Hose, Quick Connect, Outlet Hose Clamp And Clip Retainers
Courtesy of GENERAL MOTORS COMPANY

33. Disconnect the quick connect (1) at the radiator.
34. Reposition the radiator outlet hose clamp (2) at the heater outlet hose using **J 38185** Hose Clamp Pliers.
35. Remove the radiator outlet hose clip retainers (3) from the brackets.
36. Remove the radiator outlet hose (4) from the radiator.
37. Remove the radiator outlet hose clamp (1) from the engine.
38. Remove the radiator outlet hose clip retainers (2) from the engine shield.
39. Remove the radiator outlet hose (3). Refer to **Radiator Outlet Hose Replacement (LGH, LML)** .

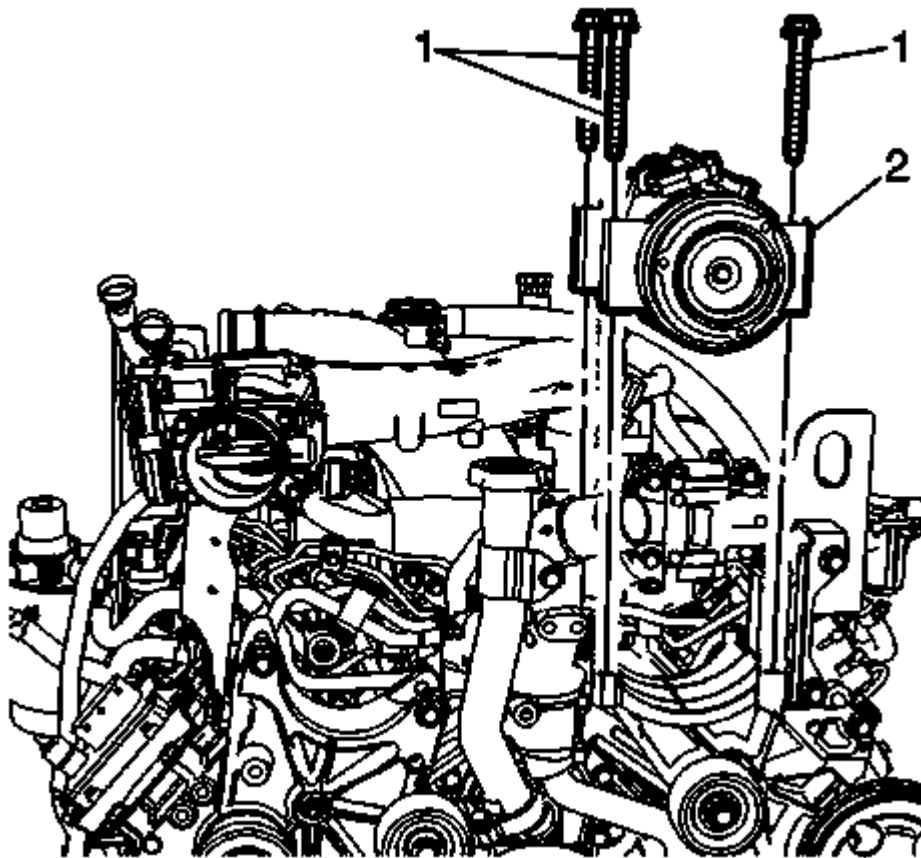


Fig. 222: Air Conditioning Compressor
Courtesy of GENERAL MOTORS COMPANY

40. Remove the air conditioning compressor (2). Refer to **Air Conditioning Compressor Replacement (LGH, LML)** .

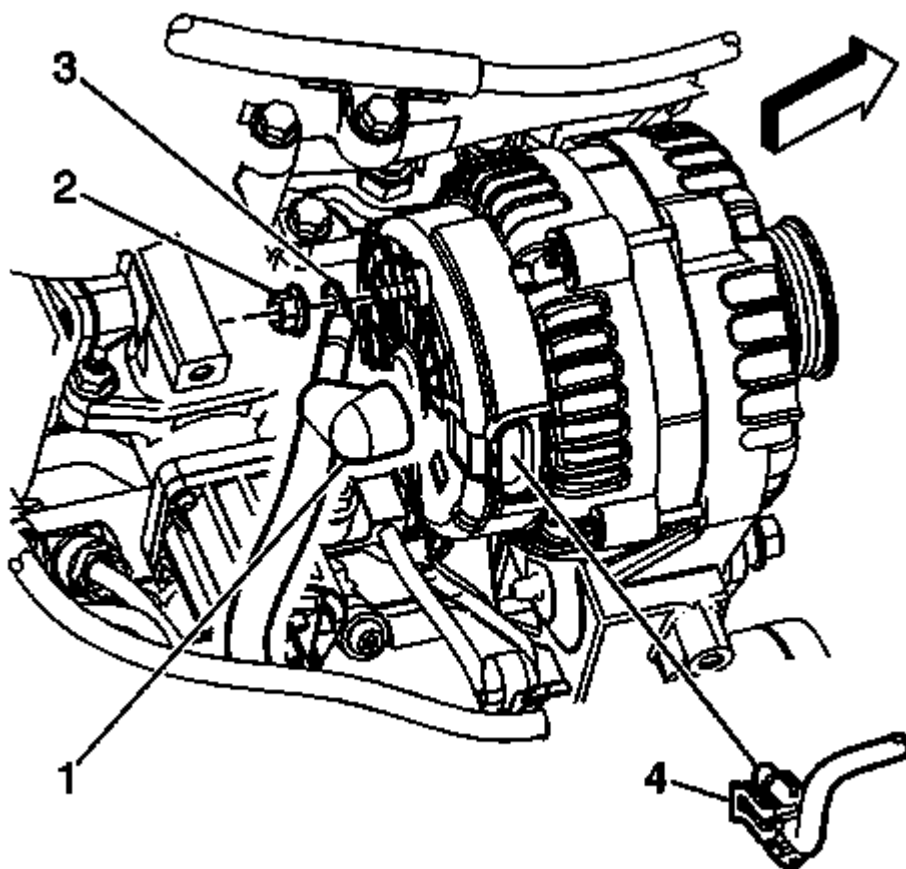


Fig. 223: View Of Generator Positive Terminal & Protective Boot
Courtesy of GENERAL MOTORS COMPANY

41. Uncover the B+ terminal (2) by sliding away the protective boot (1).
42. Remove the generator B+ terminal nut (2) and the electrical connector (4).

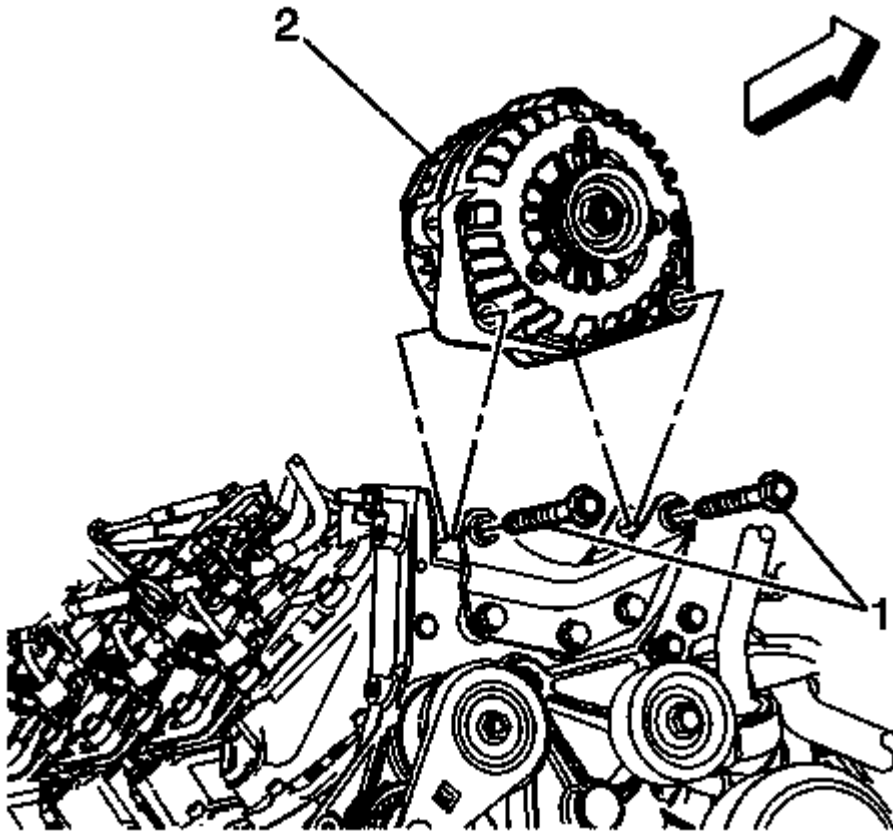


Fig. 224: View Of Generator

Courtesy of GENERAL MOTORS COMPANY

43. Remove the generator bolts (1) and generator (2) from the generator bracket.
44. If equipped remove the auxiliary generator. Refer to **Auxiliary Generator Replacement (KD9)** .
45. Reposition the power steering pump. Refer to **Power Steering Pump Replacement (6.6L)** .
46. Disconnect the heater inlet hose. Refer to **Heater Inlet Hose Replacement (LML)** .
47. Disconnect the heater outlet hose. Refer **Heater Outlet Hose Replacement (LGH and LML)** .
48. Disconnect all necessary electrical connections.
49. Remove all ground bolts and wires.
50. Remove the ground strap.

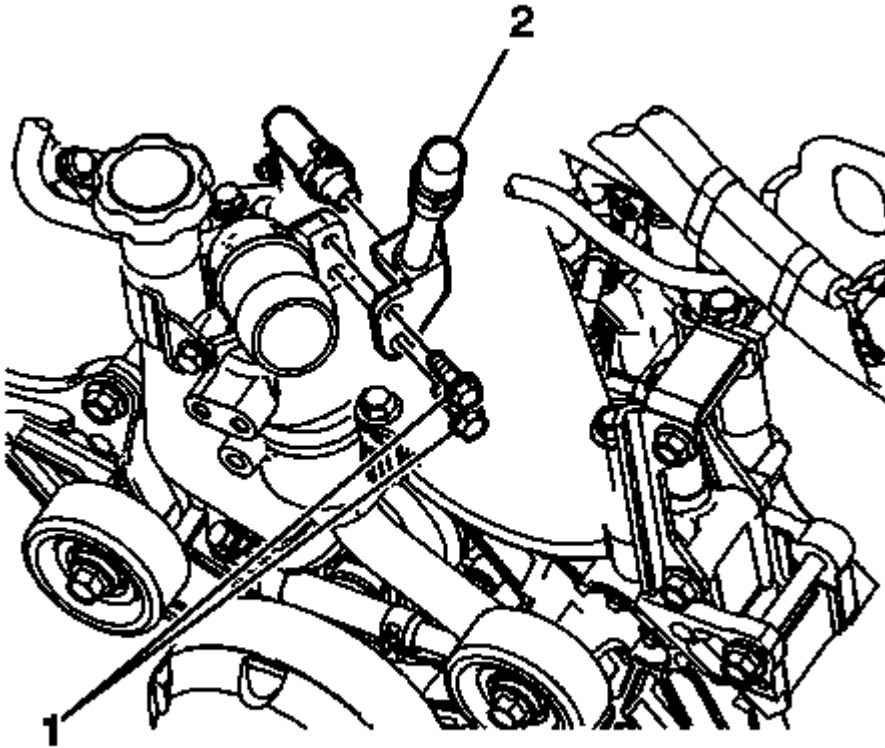


Fig. 225: Identifying Fuel Pressure Valve And Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

51. Remove the fuel pressure valve bracket bolts (1) and reposition the fuel pressure valve (2).

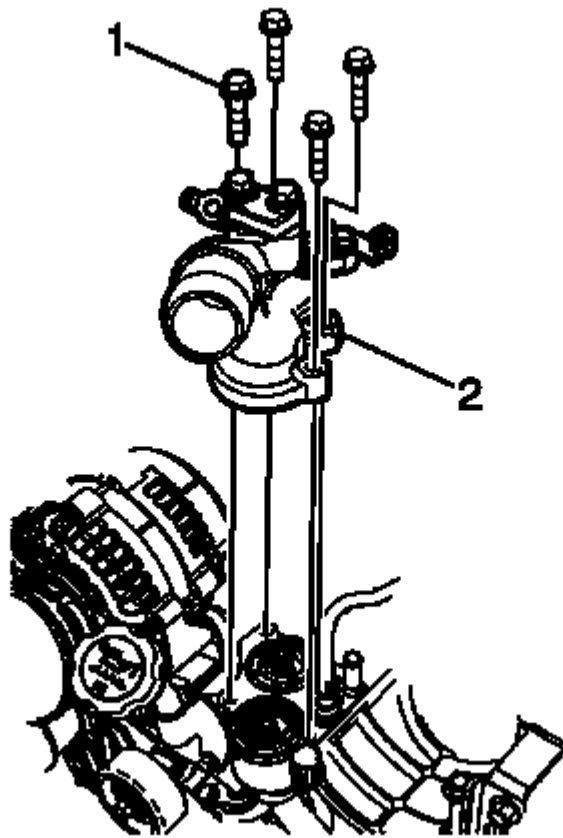


Fig. 226: Identifying Thermostat Bolts & Engine Coolant Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

52. Remove the thermostat bolts (1) from the engine coolant outlet pipe (2) and remove housing.
53. Remove the transmission cooler line retainer bracket on the right side of oil pan and reposition lines.
54. Disconnect fuel feed and return lines.
55. Remove the drivetrain and front suspension frame front crossmember. Refer **Drivetrain and Front Suspension Frame Front Crossmember Replacement (2500/3500 Series)** .
56. If equipped, remove the front differential carrier assembly. Refer to **Differential Carrier Assembly Replacement (2500 4WD) Differential Carrier Assembly Replacement (9.25 Inch HD Axle)** .
57. Remove the transmission. Refer to **Transmission Replacement** .

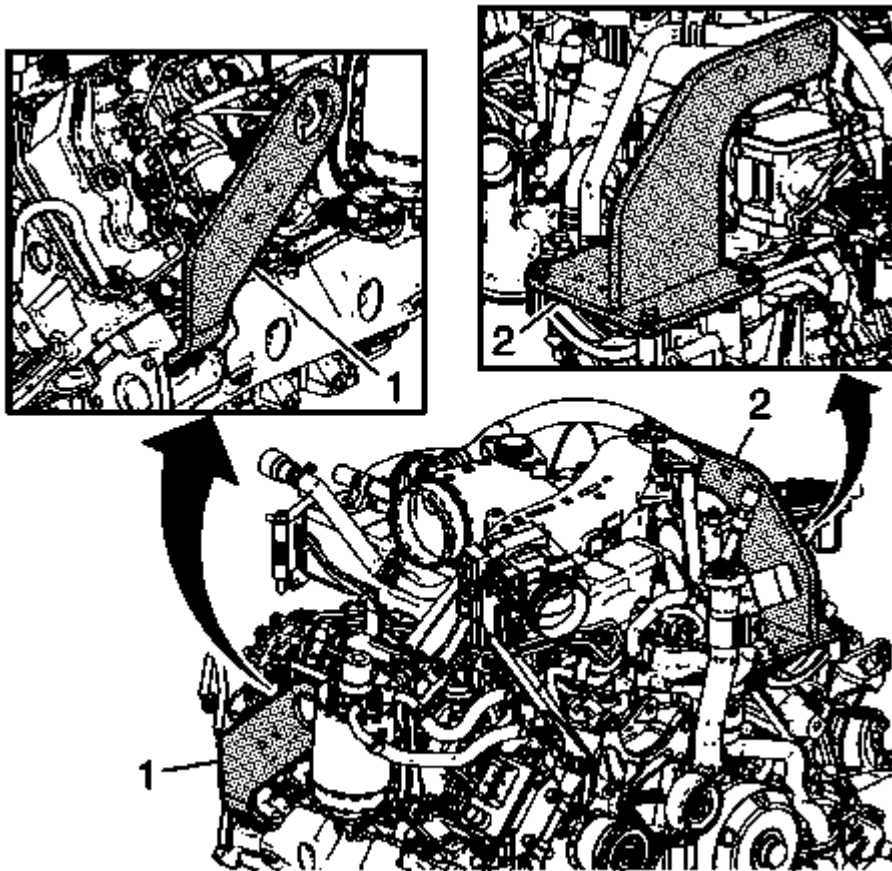


Fig. 227: Lift Brackets

Courtesy of GENERAL MOTORS COMPANY

58. Install EN-4939 bracket (1) to the right side exhaust manifold.
59. Install EN-49397 bracket (2) to the power steering pump mounting bracket.
60. Attach engine lift device with chains to the engine lift brackets.

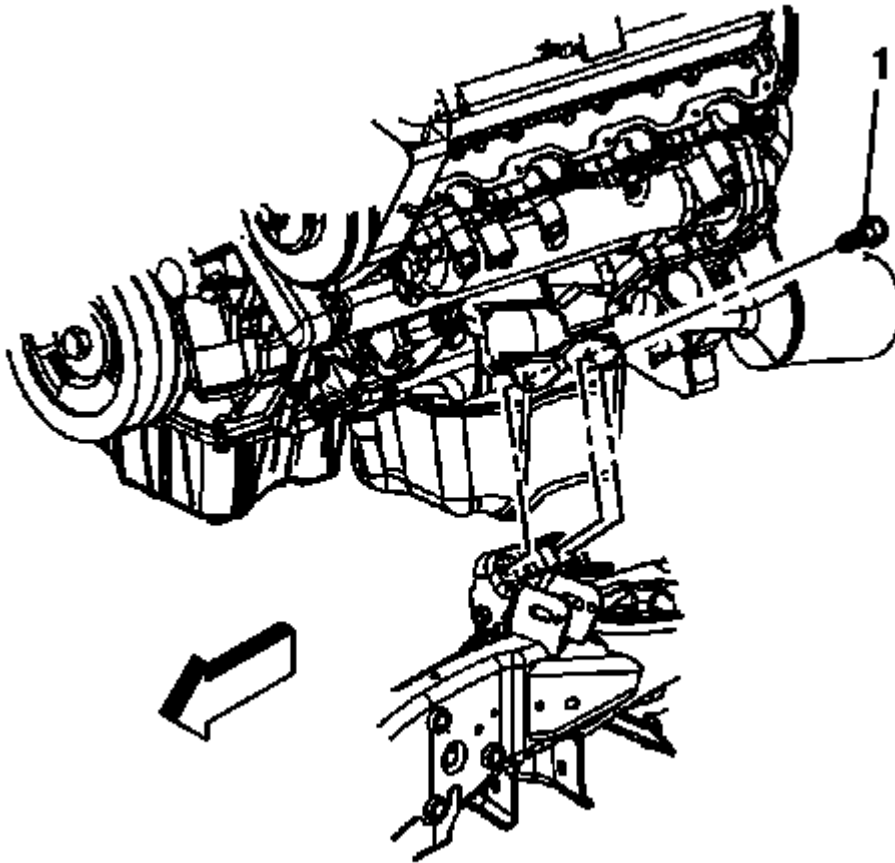


Fig. 228: Left Side Engine Mount And Bolt
Courtesy of GENERAL MOTORS COMPANY

61. Remove the left side engine mount bolt (1). Refer to **Engine Mount Replacement - Left Side**.

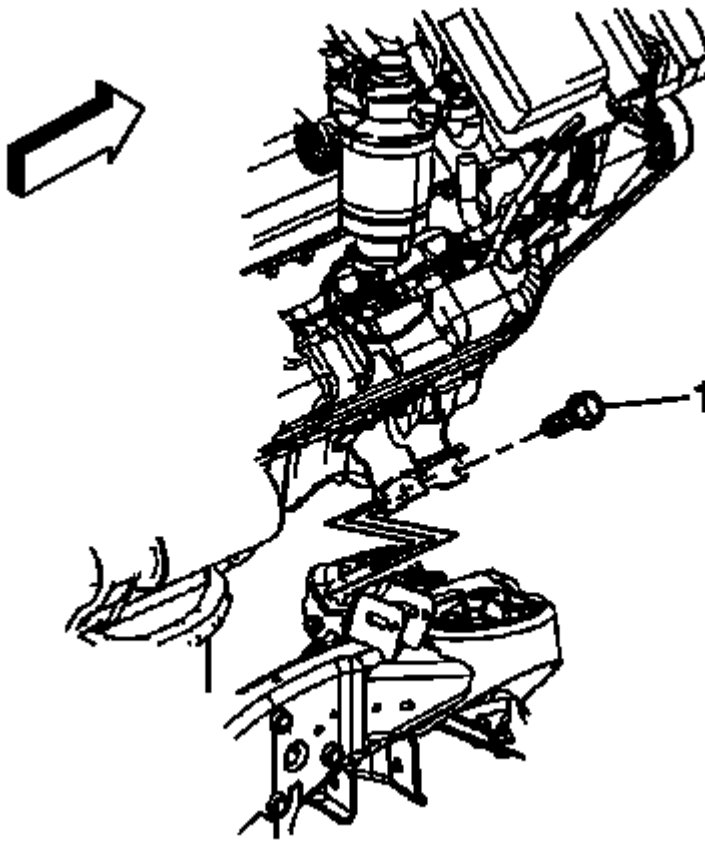


Fig. 229: Right Side Engine Mount And Bolt
Courtesy of GENERAL MOTORS COMPANY

62. Remove the right side engine mount bolt (1). Refer to Engine Mount Replacement - Right Side.
63. Remove the engine from vehicle.

CAUTION: When replacing a failed engine, clean any engine oil that may have collected in the charge air cooler before installing the new engine. The failure to clean excessive oil from the charge air cooler may cause an engine runaway condition on start up. Engine runaway may result in severe engine damage.

64. In order to secure the engine to an engine stand remove the following and follow the special procedures:
 - Refer to Engine Flywheel Removal (Automatic Transmission) .
 - Refer to Exhaust Turbocharger Outlet Pipe Adapter Removal .
 - Refer to Upper Oil Pan Removal .
 - Refer to Flywheel Housing Removal .
 - Refer to Engine Mounting to Stand .

Installation Procedure

1. Remove the engine from the stand. Refer to **Engine Removal from Stand** .
2. Install the following:
 - Refer to **Engine Flywheel Installation (Automatic Transmission)** .
 - Refer to **Exhaust Turbocharger Outlet Pipe Adapter Installation** .
 - Refer to **Upper Oil Pan Installation** .
 - Refer to **Flywheel Housing Installation** .
3. Install the engine in the vehicle.

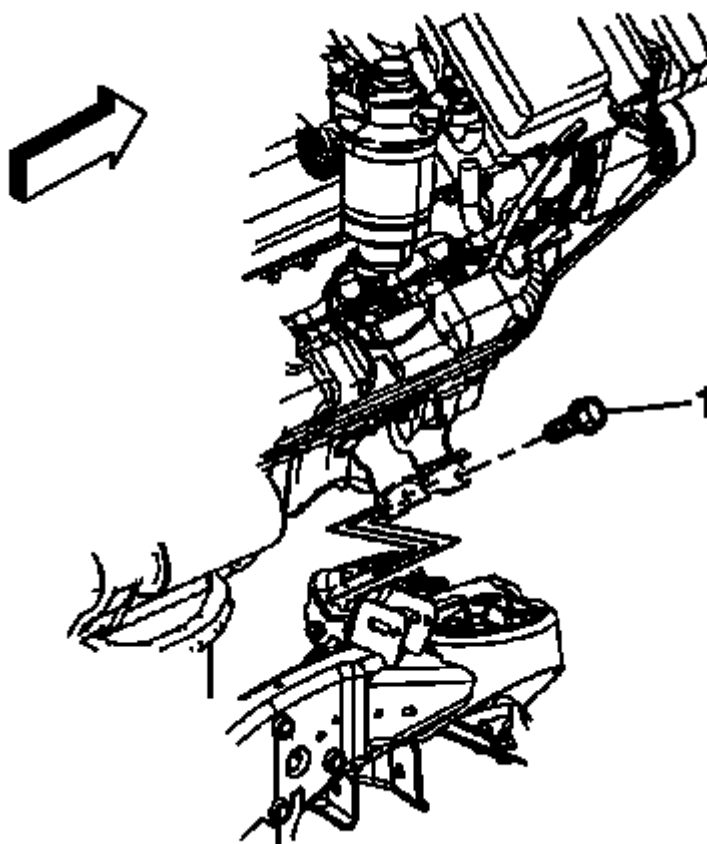


Fig. 230: Right Side Engine Mount And Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the right side engine mount bolt (1). Refer to **Engine Mount Replacement - Right Side**.

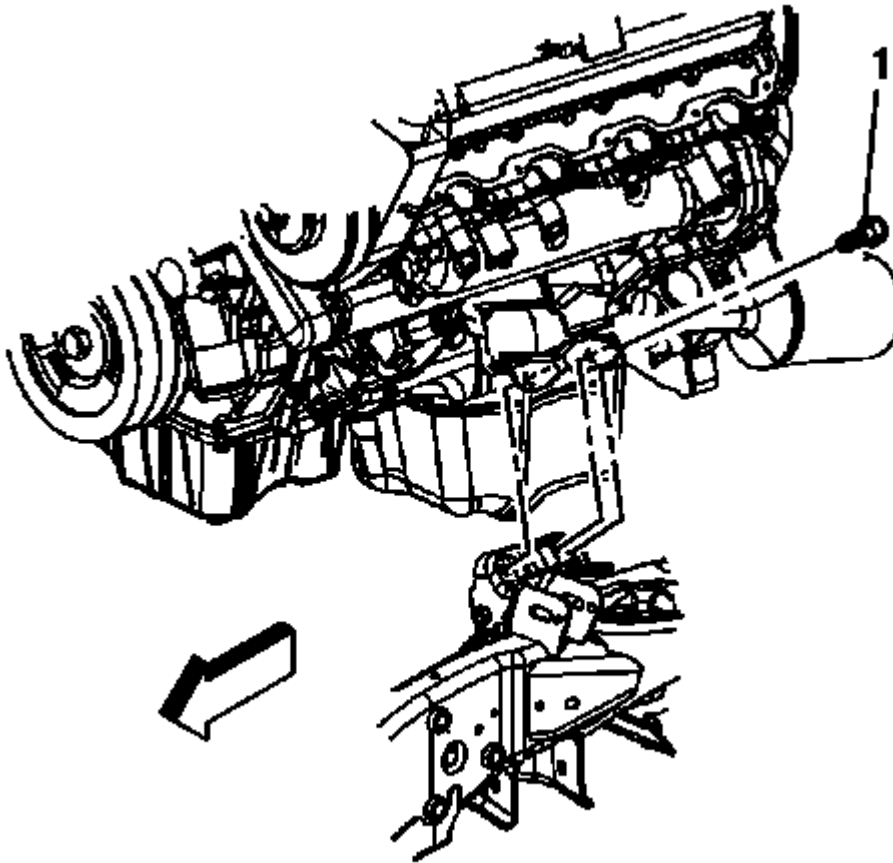


Fig. 231: Left Side Engine Mount And Bolt
 Courtesy of GENERAL MOTORS COMPANY

5. Install the left side engine mount bolt (1). Refer to **Engine Mount Replacement - Left Side**.
6. Remove the engine lift chain from the EN-49397 brackets and attach to an engine lift device.
7. Install the transmission. Refer to **Transmission Replacement** .
8. If equipped, install the front differential carrier assembly. Refer to **Differential Carrier Assembly Replacement (2500 4WD)** , **Differential Carrier Assembly Replacement (9.25 Inch HD Axle)** .
9. Install the drivetrain and front suspension frame front crossmember. Refer **Drivetrain and Front Suspension Frame Front Crossmember Replacement (2500/3500 Series)** .
10. Connect fuel feed and return lines.

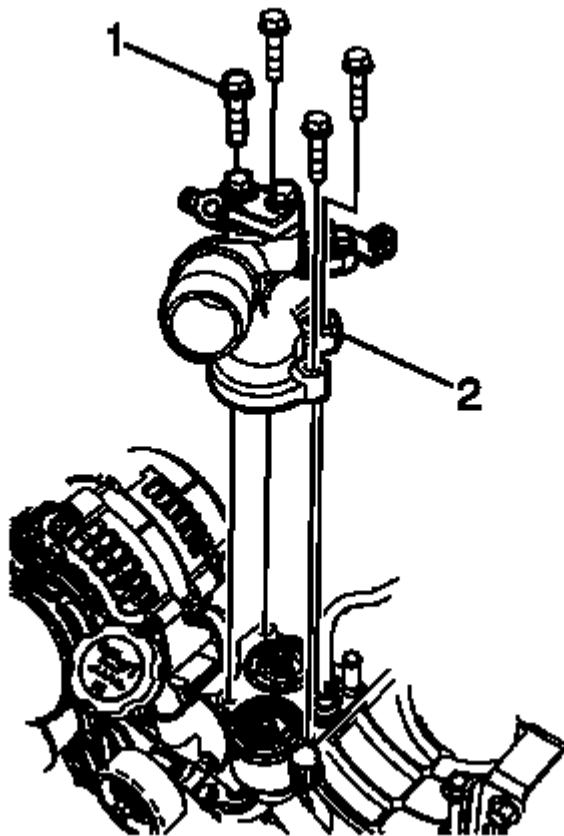


Fig. 232: Identifying Thermostat Bolts & Engine Coolant Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

11. Position the thermostat housing (2) and install the bolts (1) and tighten to 25 N.m (18 lb ft).
12. Connect the turbocharger coolant feed pipe retaining bracket bolt. Refer to **Turbocharger Coolant Hoses/Pipes Replacement (Return to Turbocharger-LML)** , **Turbocharger Coolant Hoses/Pipes Replacement (Return to Bypass Pipe-LML)** , **Turbocharger Coolant Hoses/Pipes Replacement (Feed-LGH/LML)** .

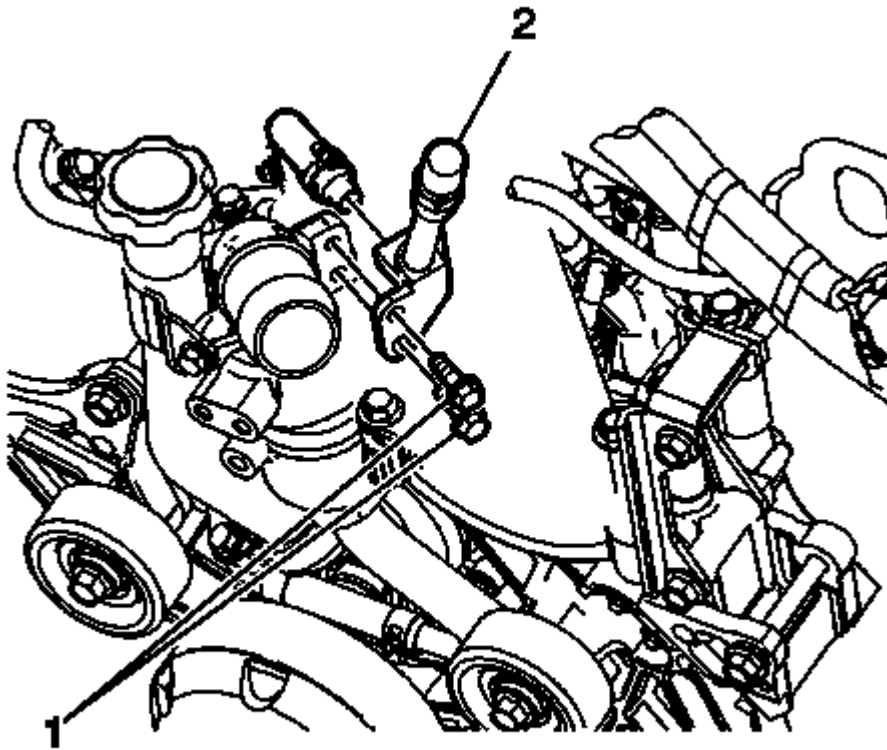


Fig. 233: Identifying Fuel Pressure Valve And Bracket Bolts
 Courtesy of GENERAL MOTORS COMPANY

13. Position the fuel pressure valve (2) to the thermostat housing and tighten the bolts (1) to 100 N.m (74 lb ft).
14. Connect all ground straps.
15. Connect the heater outlet hose. Refer to **Heater Outlet Hose Replacement (LGH and LML)** .
16. Connect the heater inlet hose. Refer to **Heater Inlet Hose Replacement (LML)** .
17. Reposition the power steering pump. Refer to **Power Steering Pump Replacement (6.6L)** .
18. If equipped, install the auxiliary generator. Refer to **Auxiliary Generator Replacement (KD9)** .

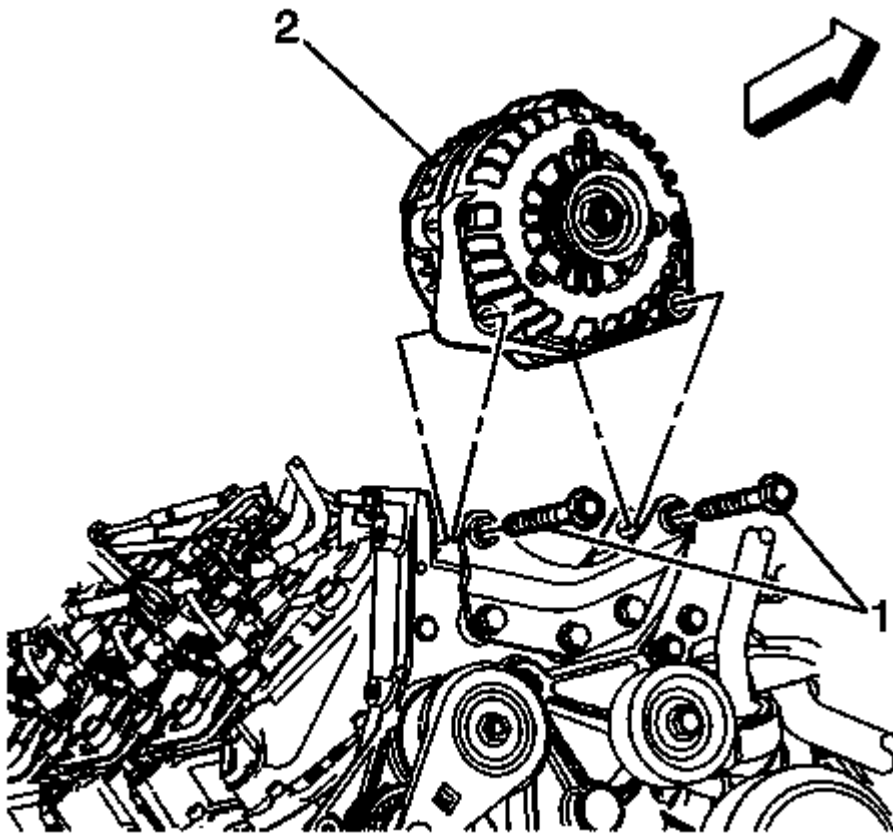


Fig. 234: View Of Generator

Courtesy of GENERAL MOTORS COMPANY

19. Install the generator (2) to the generator bracket and tighten the generator mounting bolts (1) to 50 N.m (37 lb ft).

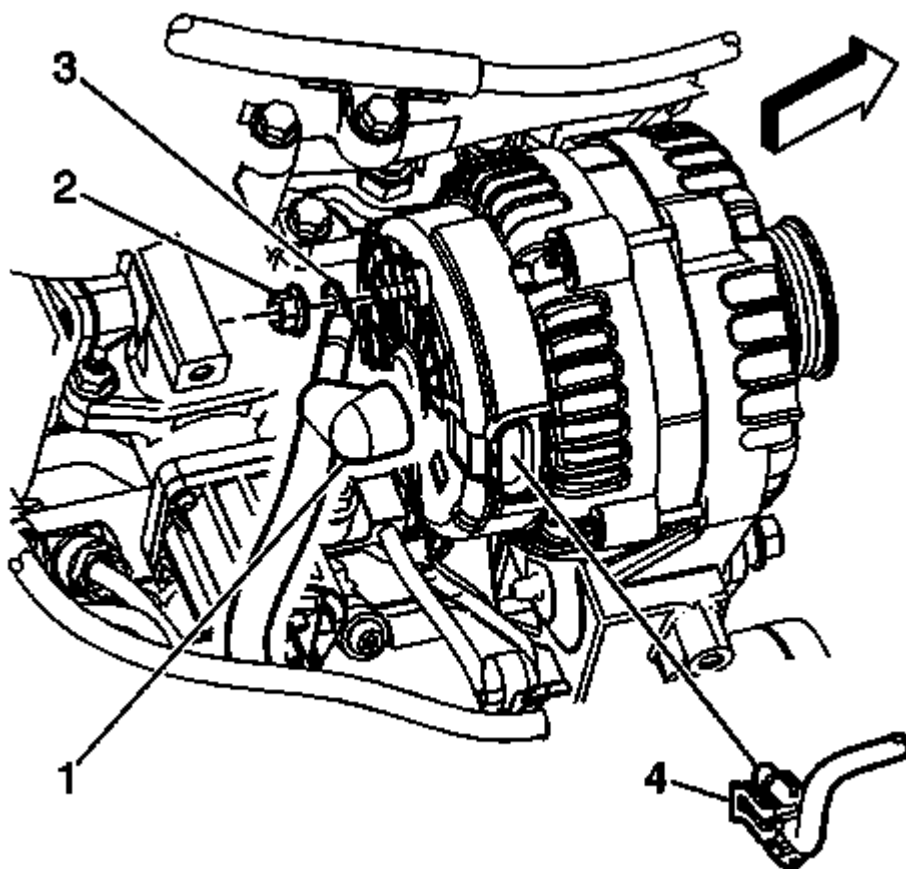


Fig. 235: View Of Generator Positive Terminal & Protective Boot
 Courtesy of GENERAL MOTORS COMPANY

20. Connect the generator electrical connector (4).
21. Install the battery positive B+ cable terminal (3) to the generator stud and tighten to 9 N.m (80 lb in).
22. Slide the protective boot (1) back onto the terminal stud.

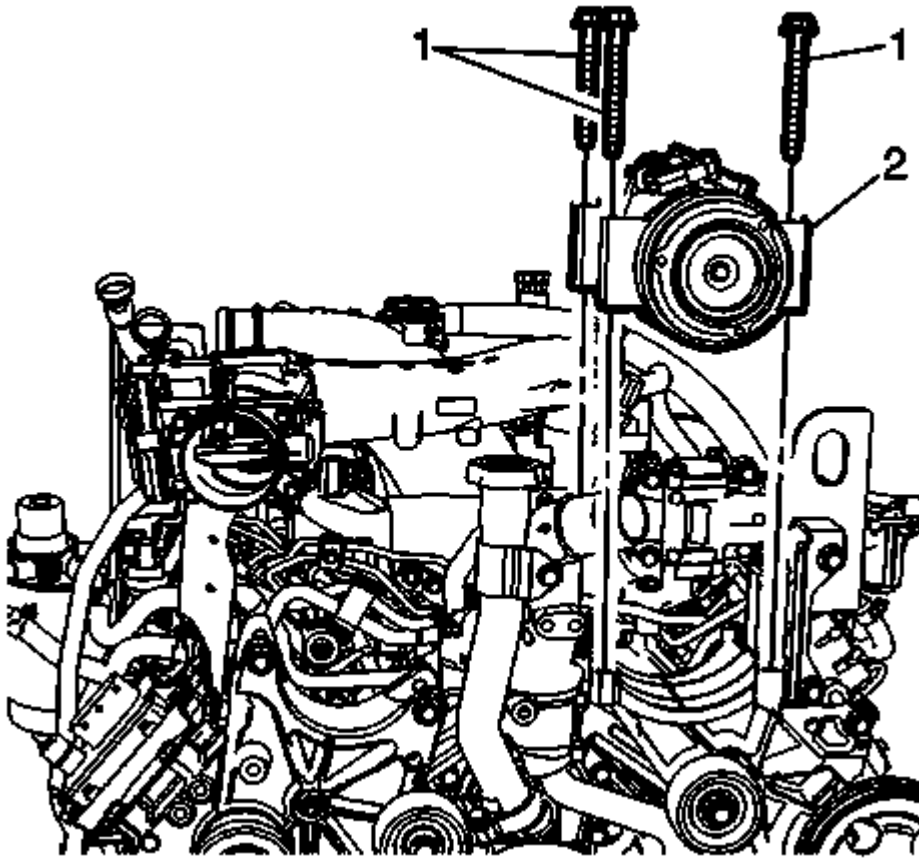


Fig. 236: Air Conditioning Compressor
Courtesy of GENERAL MOTORS COMPANY

23. Install the air conditioning compressor (2). Refer to **Air Conditioning Compressor Replacement (LGH, LML)** .

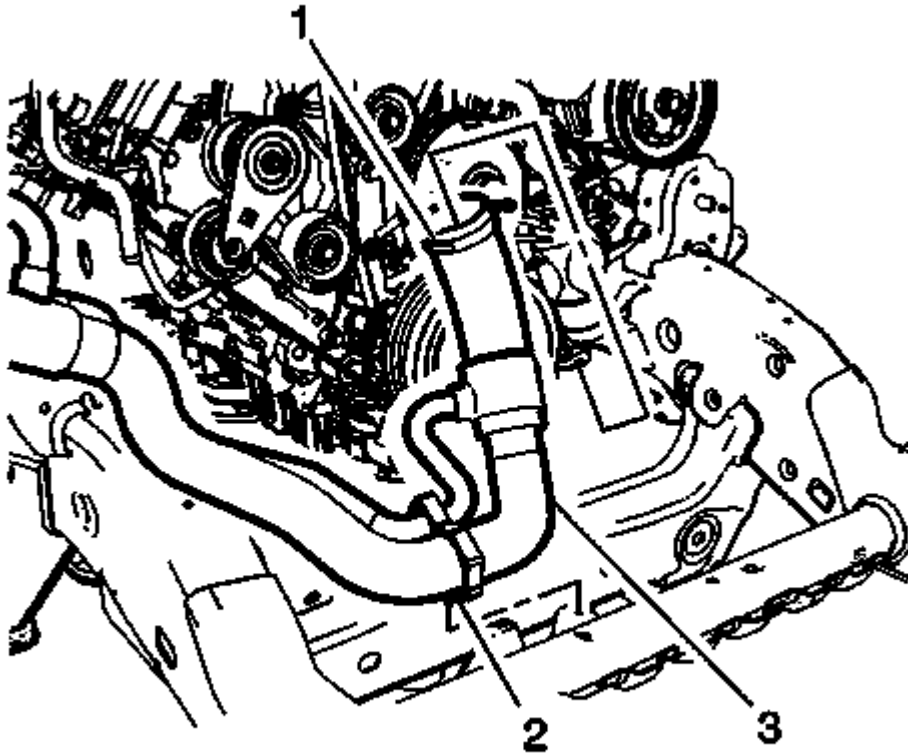


Fig. 237: Radiator Outlet Hose, Clamp And Clip Retainers
Courtesy of GENERAL MOTORS COMPANY

24. Install the radiator outlet hose (3) to the vehicle.
25. Install the radiator outlet hose clamp (1) to the engine.
26. Install the radiator outlet hose clip retainers (2) to the engine shield.

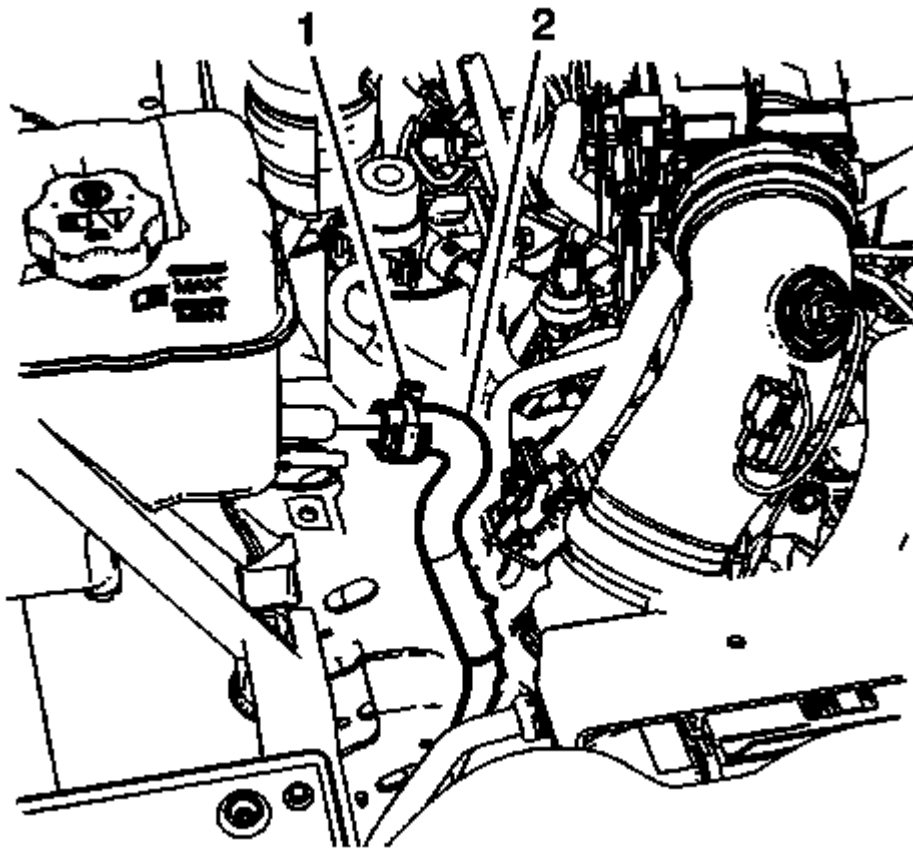


Fig. 238: Radiator Outlet Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

27. Install the radiator outlet hose (2) to the surge tank.
28. Reposition the radiator outlet hose clamp (1) at the surge tank using **J 38185** Hose Clamp Pliers.

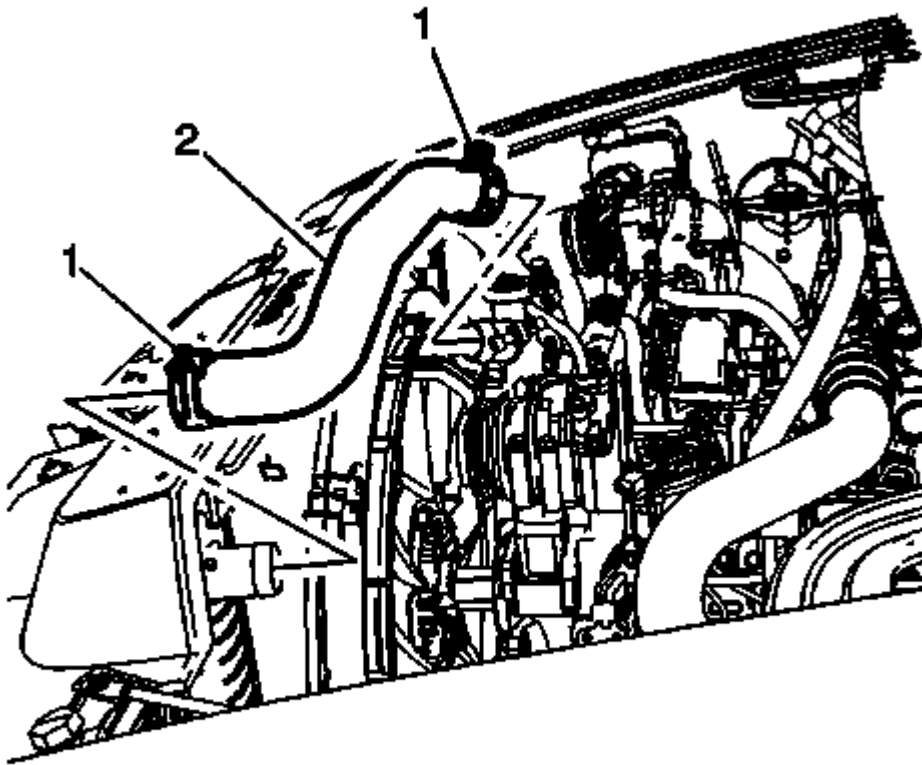


Fig. 239: Radiator Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

29. Install the radiator inlet hose (2). Refer to **Radiator Inlet Hose Replacement (LGH, LML)** .

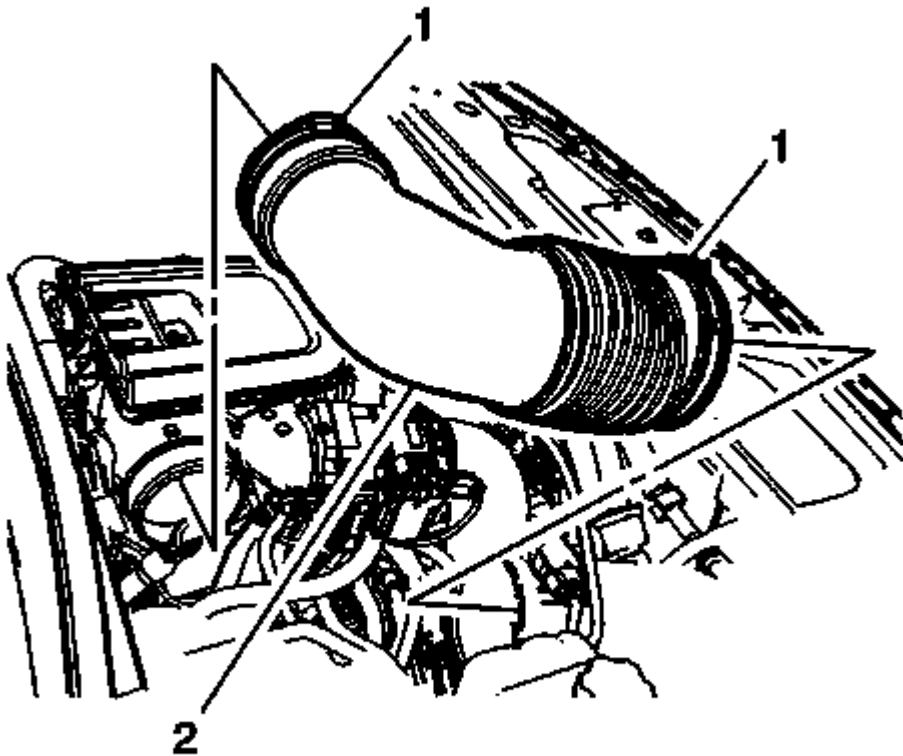


Fig. 240: Air Cleaner Outlet Duct

Courtesy of GENERAL MOTORS COMPANY

30. Install the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement** .
31. Install the ECM. Refer to **Engine Control Module Replacement** .
32. Install the transmission control module. Refer to **Transmission Control Module Replacement** .

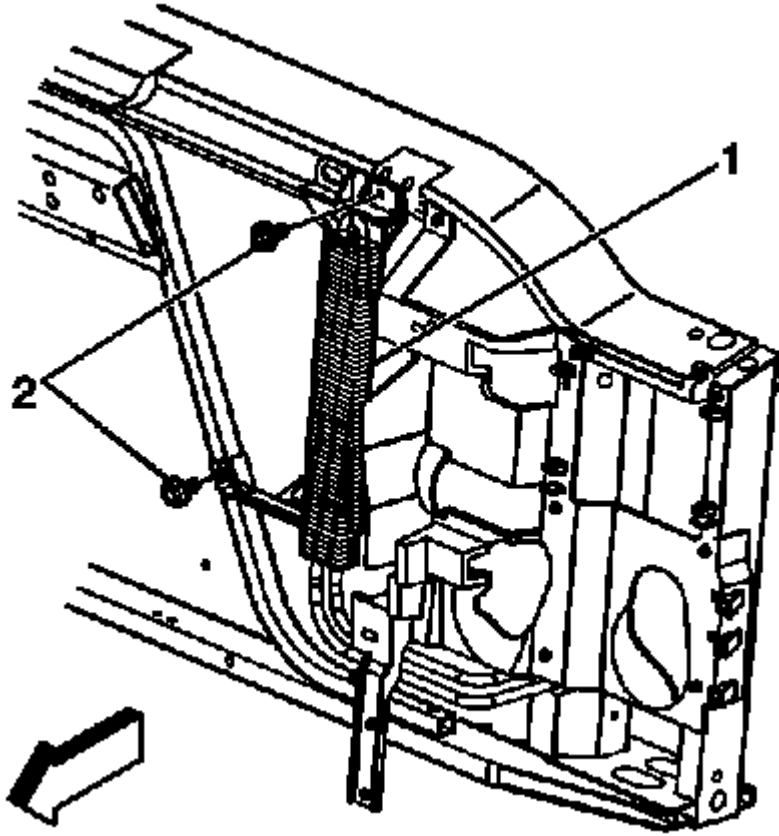


Fig. 241: Removing Power Steering Cooler From The Vehicle (Without Hydroboost)
 Courtesy of GENERAL MOTORS COMPANY

33. Position the power steering fluid cooler (1) in the vehicle.
34. Install the power steering fluid cooler bolts (2) and tighten to 9 N.m (80 lb in).
35. Install the radiator. Refer to **Radiator Replacement (LGH, LML)** .
36. Install the charge air cooler. Refer to **Charge Air Cooler Replacement** .
37. Install the transmission fluid auxiliary cooler. Refer to **Transmission Fluid Auxiliary Cooler Replacement (Diesel)** .

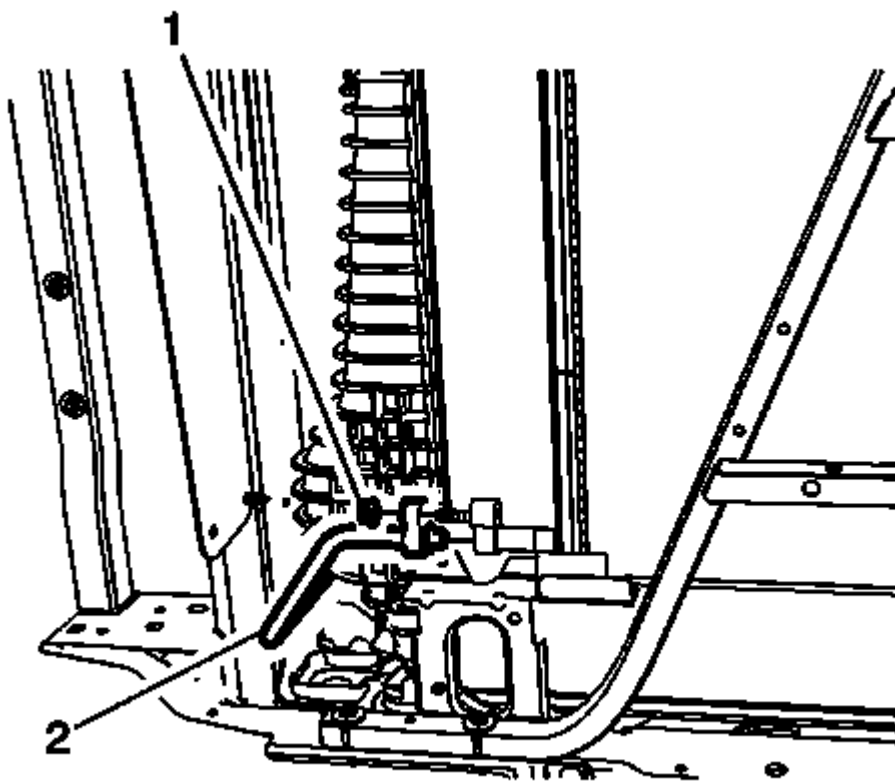


Fig. 242: Identifying Evaporator Tube And Nut
Courtesy of GENERAL MOTORS COMPANY

38. Connect the evaporator tube (2) to the condenser using new sealing washers. Refer to **Air Conditioning System Seal Replacement**.
39. Install the evaporator tube nut (1) to the condenser and tighten to 16 N.m (12 lb ft).

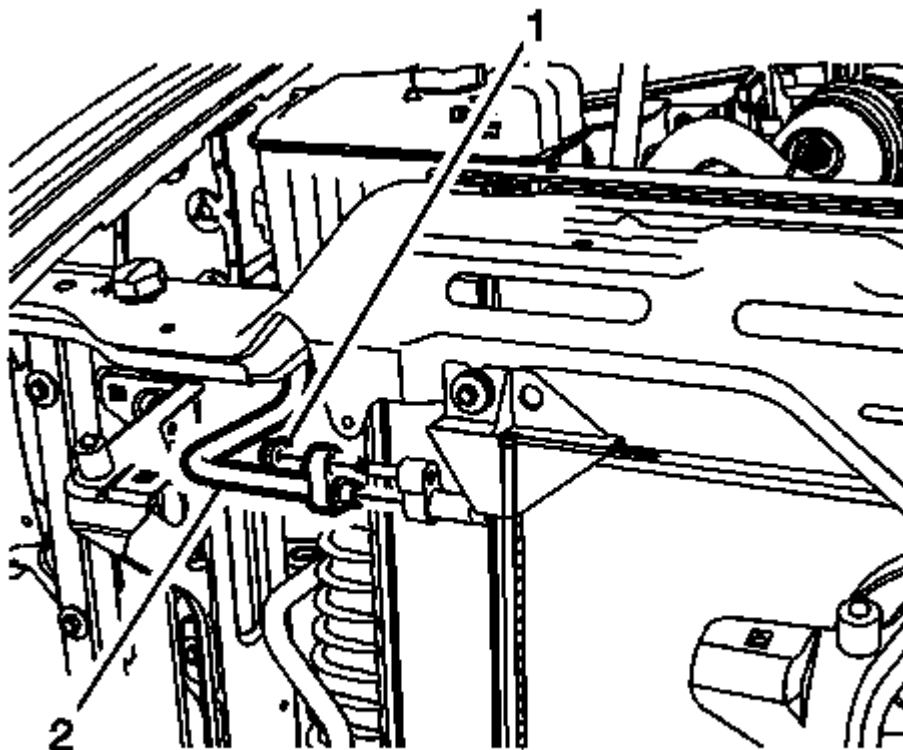


Fig. 243: Identifying Discharge Hose And Nut
Courtesy of GENERAL MOTORS COMPANY

40. Connect the compressor discharge hose (2) to the condenser using new sealing washers. Refer to **Air Conditioning System Seal Replacement**.
41. Install the compressor discharge hose nut (1) to the condenser and tighten to 16 N.m (12 lb ft).

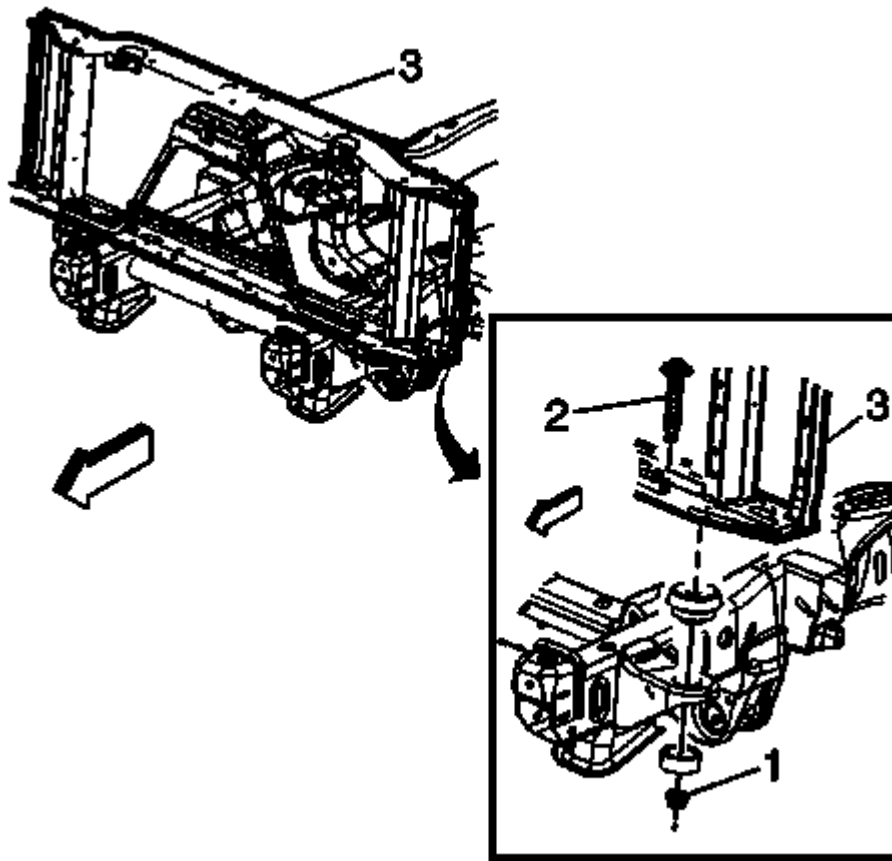


Fig. 244: Radiator Support And Bolts
Courtesy of GENERAL MOTORS COMPANY

42. Install radiator support bolts (3). Access the bolts from the rear of the upper radiator support.

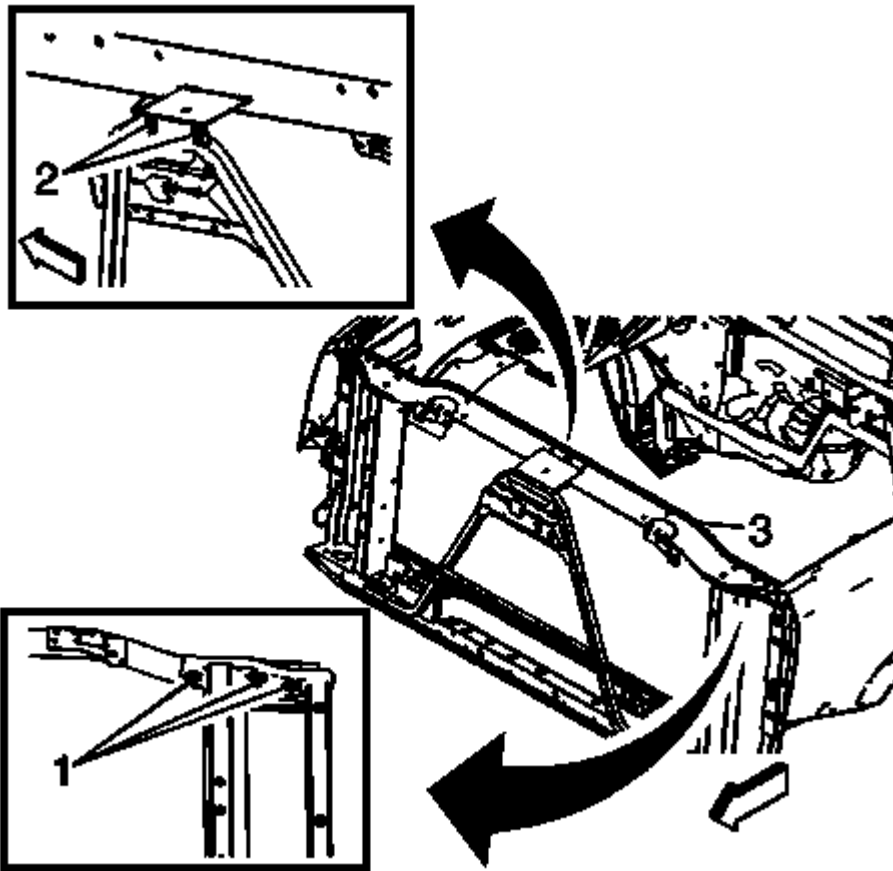


Fig. 245: Upper Tie Bar

Courtesy of GENERAL MOTORS COMPANY

43. Install the upper tie bar (3). Refer to **Front End Upper Tie Bar Replacement** .

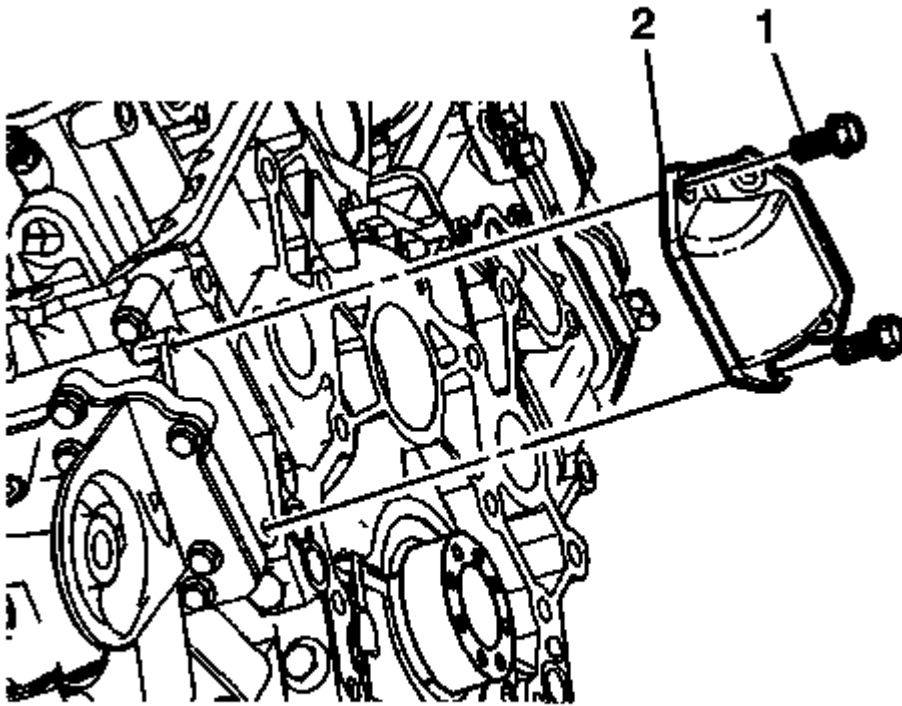


Fig. 246: Oil Cooler Adapter And Bolts
Courtesy of GENERAL MOTORS COMPANY

44. Install the oil cooler adapter bolts (1) and adapter (2) and tighten to 25 N.m (18 lb ft).

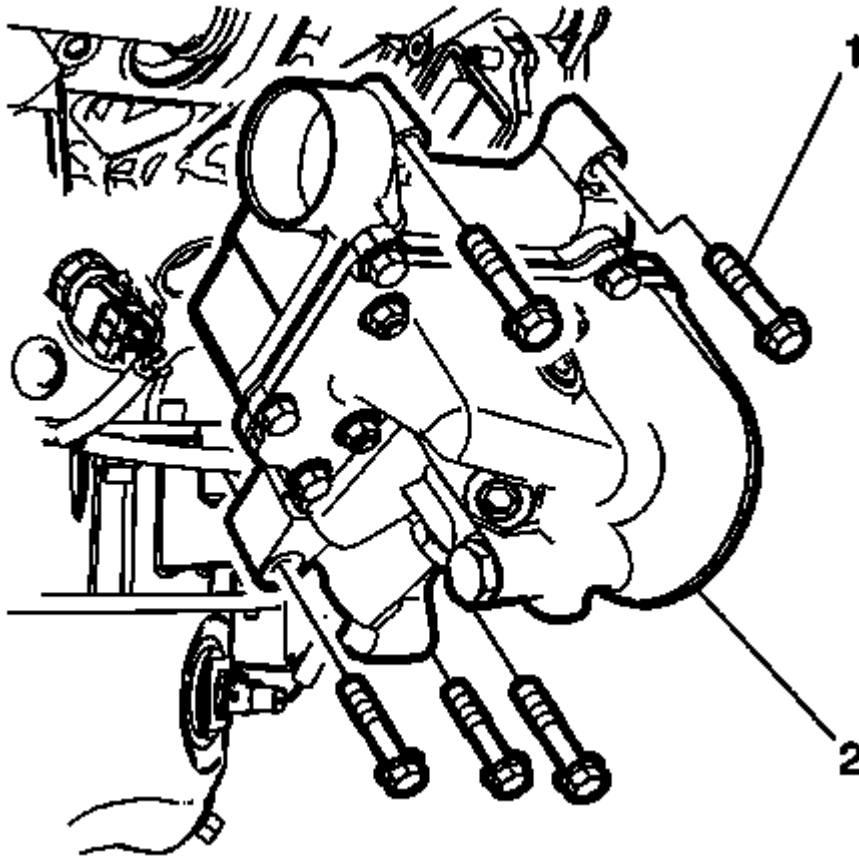


Fig. 247: Oil Cooler And Bolts

Courtesy of GENERAL MOTORS COMPANY

45. Install the oil cooler bolts (1) and oil cooler assembly (2). Tighten the oil cooler assembly bolts to 25 N.m (18 lb ft).

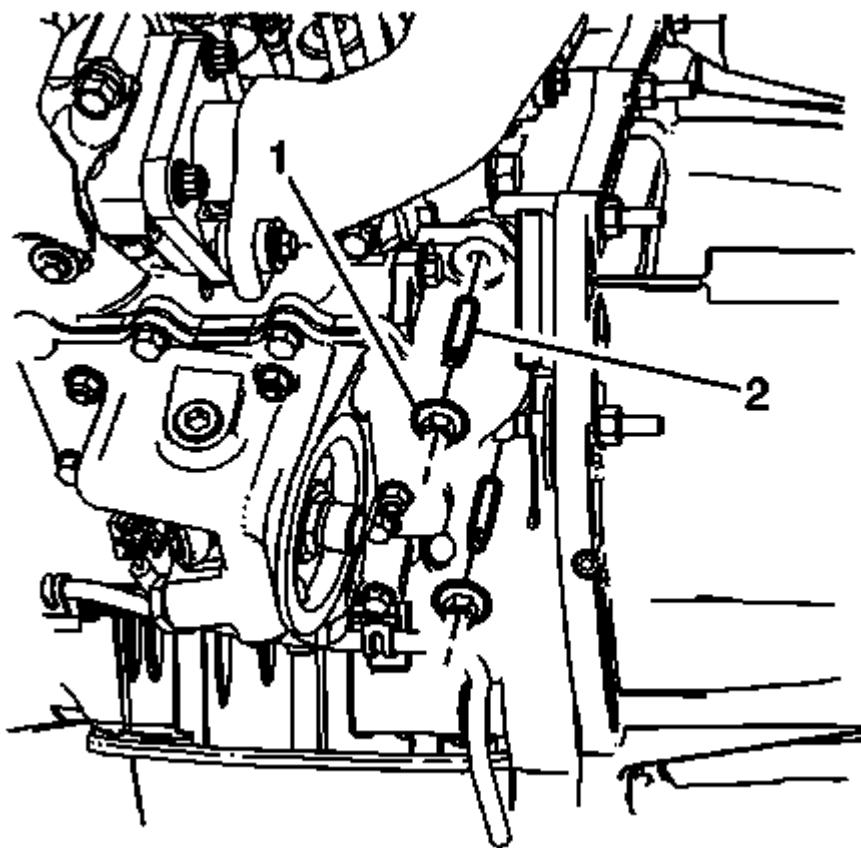


Fig. 248: Oil Cooler Adapter Nuts And Studs
Courtesy of GENERAL MOTORS COMPANY

46. Install the oil cooler adapter studs to 8 N.m (71 lb in).
47. Install the oil cooler adapter studs (2) and nut (1) to the flywheel housing and tighten to 25 N.m (18 lb ft).
48. Install the water pump outlet pipe bolts. Refer to **Water Pump Outlet Pipe Replacement (LML)** .

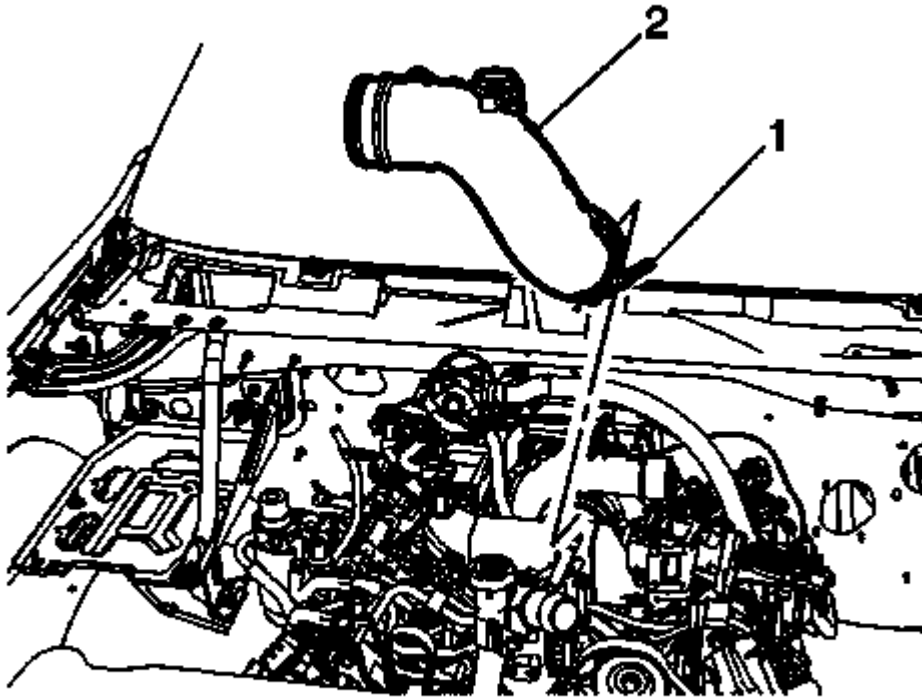


Fig. 249: Turbocharger Air Inlet Adapter
Courtesy of GENERAL MOTORS COMPANY

49. Install the turbocharger air inlet adapter (2) . Refer to **Turbocharger Air Inlet Adapter Replacement** .
50. Install the EGR cooler. Refer to **Exhaust Gas Recirculation Valve Cooler Replacement (Rear)** , **Exhaust Gas Recirculation Valve Cooler Replacement (Front)** .

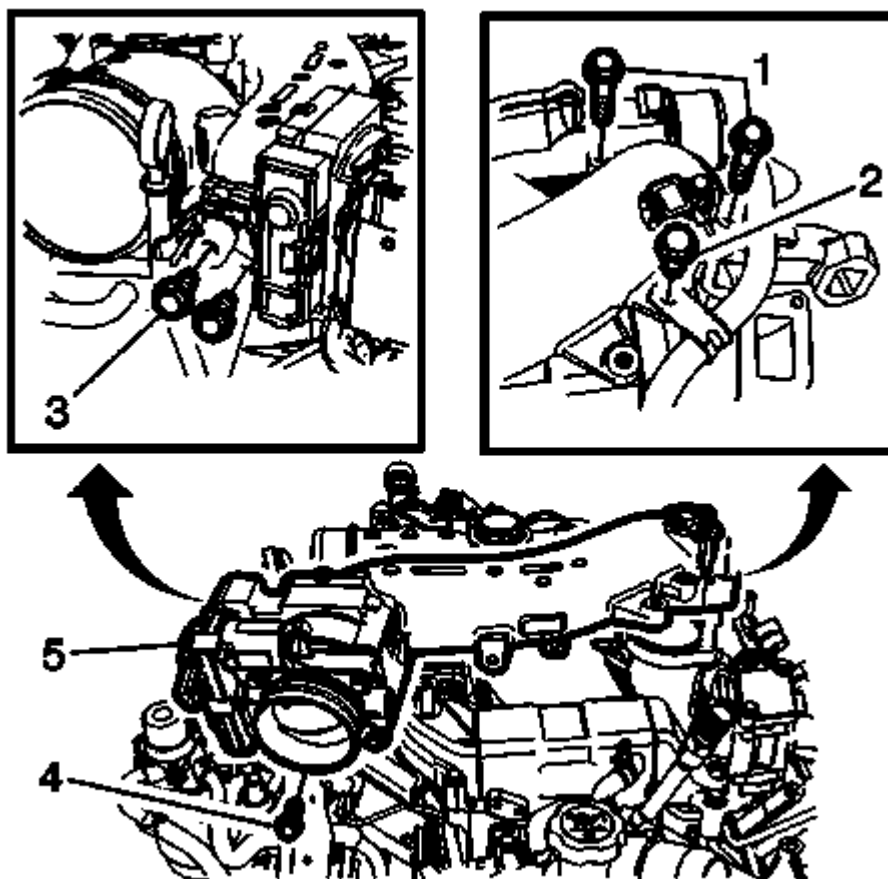


Fig. 250: Intake Manifold Tube

Courtesy of GENERAL MOTORS COMPANY

51. Install the intake manifold tube (5). Refer to **Intake Manifold Tube Replacement**.
52. Charge the A/C refrigerant. Refer to **Refrigerant Recovery and Recharging (Non-HP2)** .
53. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
54. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (Static Fill LGH, LML)** , **Cooling System Draining and Filling (Vac-N-Fill Diesel)** .

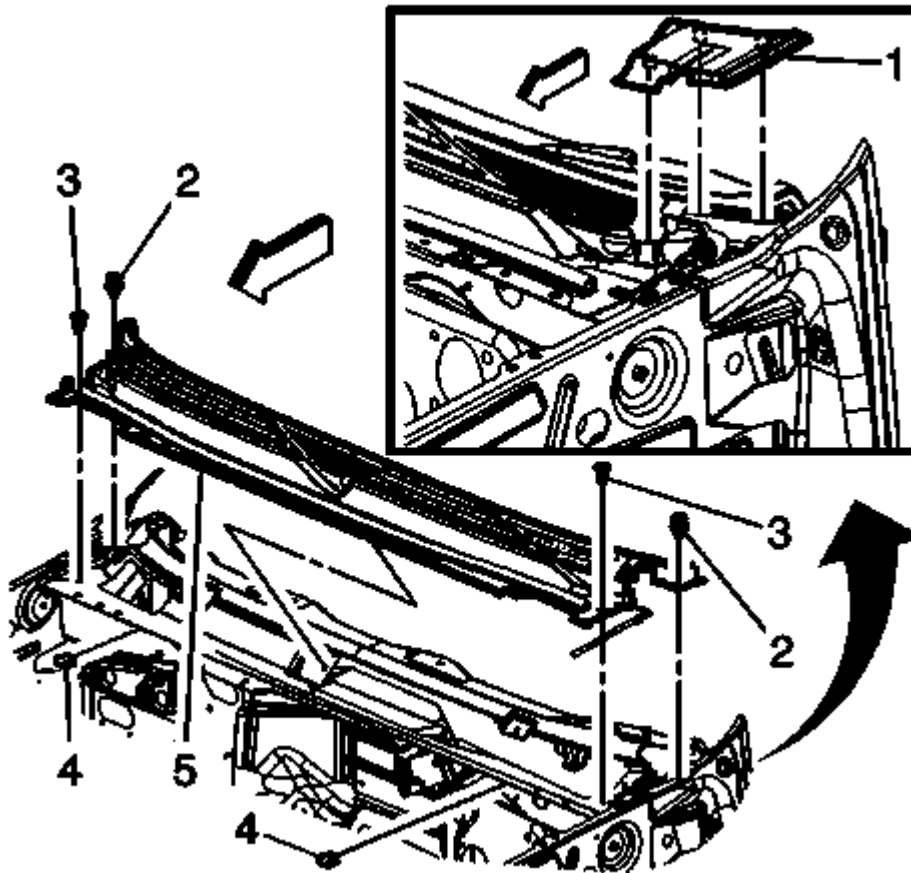


Fig. 251: Air Inlet Grille

Courtesy of GENERAL MOTORS COMPANY

55. Install the air inlet grille (1). Refer to [Air Inlet Grille Panel Replacement](#) .
56. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection \(TP2\)](#) , [Battery Negative Cable Disconnection and Connection \(Single Battery\)](#) .
57. Relearn the crankshaft position reluctor wheel. Refer to [Crankshaft Position Reluctor Wheel Learn](#) .
58. If over 14k GVW, program the engine serial number with the scan tool.
59. Test the vehicle using the following procedure:
 - Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
 - Start the engine and listen for unusual noises.
 - Check the vehicle oil pressure gauge or light and confirm that the engine has acceptable oil pressure.
 - Run the engine speed at about 1,000 RPM until the engine has reached normal operating temperature.
 - Listen for sticking lifter and other unusual noises.
 - Inspect for fuel, oil and/or coolant leaks while the engine is running.
 - Inspect for coolant, oil, gas or exhaust leaks.
 - Road test the vehicle for normal operation.

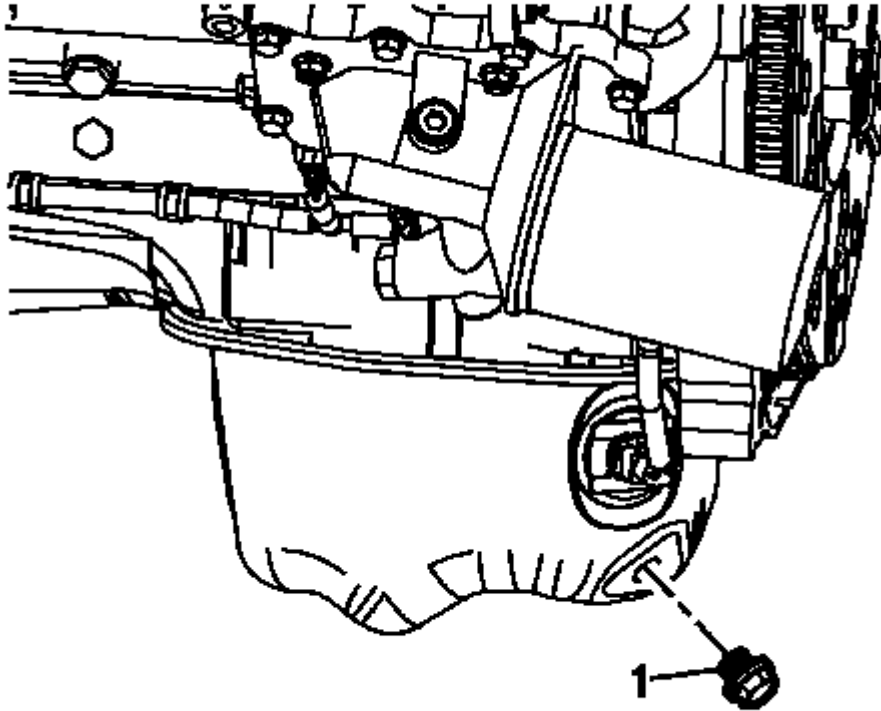
ENGINE OIL AND OIL FILTER REPLACEMENT**Removal Procedure**

Fig. 252: View Of oil drain plug

Courtesy of GENERAL MOTORS COMPANY

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Position a suitable drain pan under the oil pan drain plug.
3. Remove the oil drain plug (1).
4. Allow the oil to drain completely.
5. Clean and inspect the oil pan drain plug, replace if necessary.
6. Clean and inspect the oil pan drain plug sealing surface, replace the oil pan if necessary.
7. Wipe any remaining oil from the drain plug hole and reinstall the oil pan drain plug until snug.

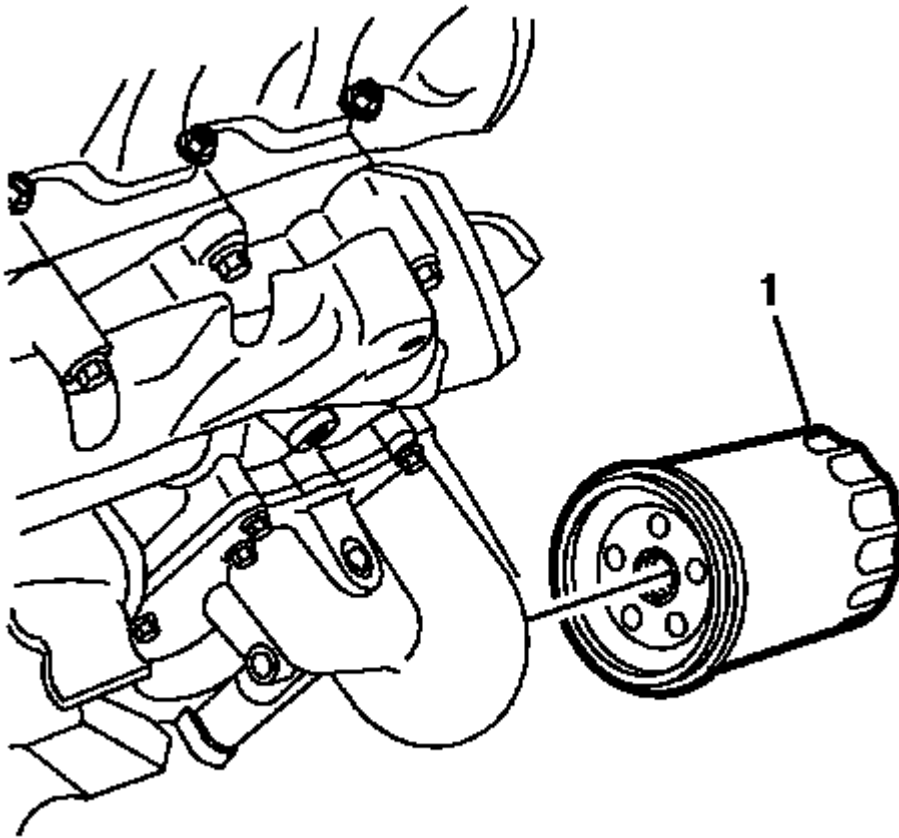


Fig. 253: View Of Oil Filter

Courtesy of GENERAL MOTORS COMPANY

8. Position a suitable drain pan under the oil filter (1).
9. Remove the oil filter (1).
10. Ensure that the oil filter gasket is still on the old oil filter, if not remove the oil filter gasket from the adapter.

Installation Procedure

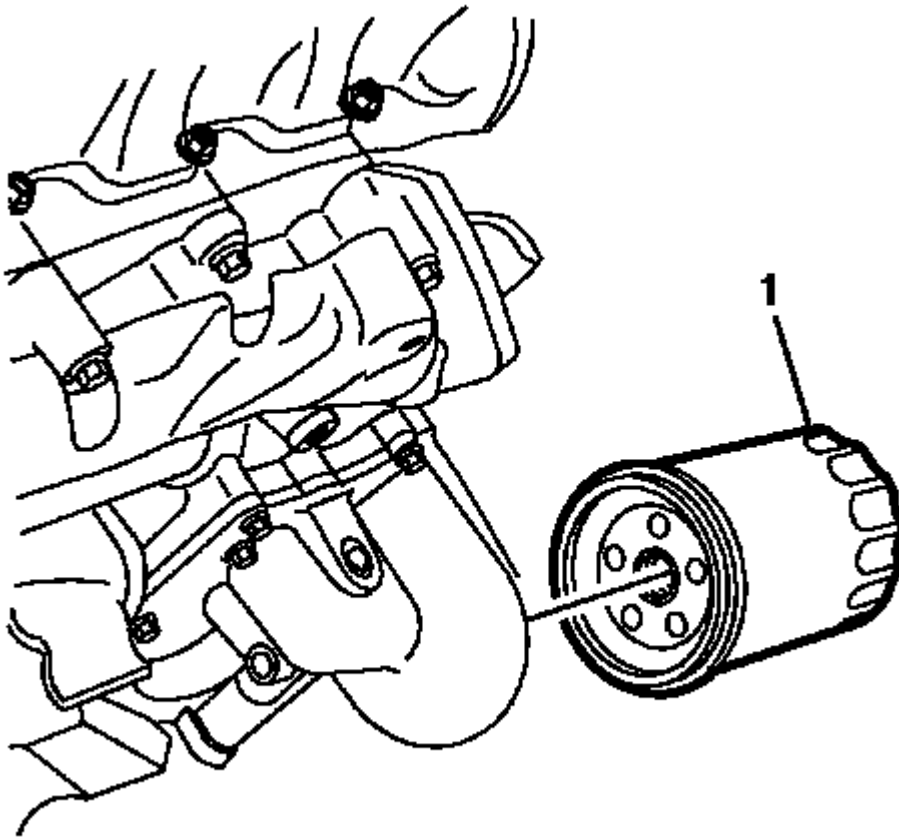


Fig. 254: View Of Oil Filter

Courtesy of GENERAL MOTORS COMPANY

1. Apply clean engine oil to the NEW oil filter gasket.

CAUTION: Refer to Fastener Caution .

2. Install the NEW oil filter (1) and tighten after contact plus 1 to 1 1/4 turn.

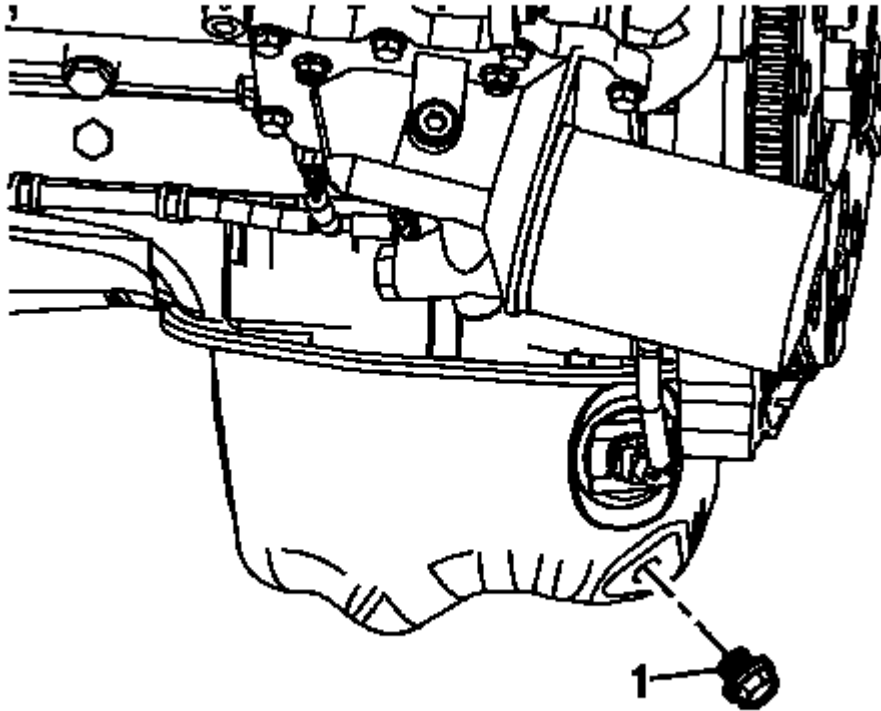


Fig. 255: View Of oil drain plug

Courtesy of GENERAL MOTORS COMPANY

3. Tighten the oil pan drain plug (1) to 25 N.m (18 lb ft).
4. Remove the oil drain pan from under the vehicle.
5. Lower the vehicle.
6. Fill the engine with new engine oil. Refer to **Approximate Fluid Capacities** , and **Fluid and Lubricant Recommendations** .
7. Start the engine.
8. Inspect for oil leaks after engine start up.
9. Turn off the engine and allow the oil a few minutes to drain back into the oil pan.
10. Remove the oil level indicator from the oil level indicator tube.
11. Clean off the indicator end of the oil level indicator with a clean paper towel or cloth.
12. Install the oil level indicator into the oil level indicator tube until the oil level indicator handle contacts the top of the oil level indicator tube.
13. Again, remove the oil level indicator from the oil level indicator tube keeping the tip of the oil level indicator down.
14. Check the level of the engine oil on the oil level indicator.
15. If necessary, adjust the oil level be adding or draining oil.

16. Check for oil leaks.
17. Reset the oil monitor.