2013 Engine

Engine Mechanical - 6.2L (L99, LS3, LSA) - Repair Instructions - On Vehicle - Camaro

REPAIR INSTRUCTIONS - ON VEHICLE

SUPERCHARGER BELT REPLACEMENT

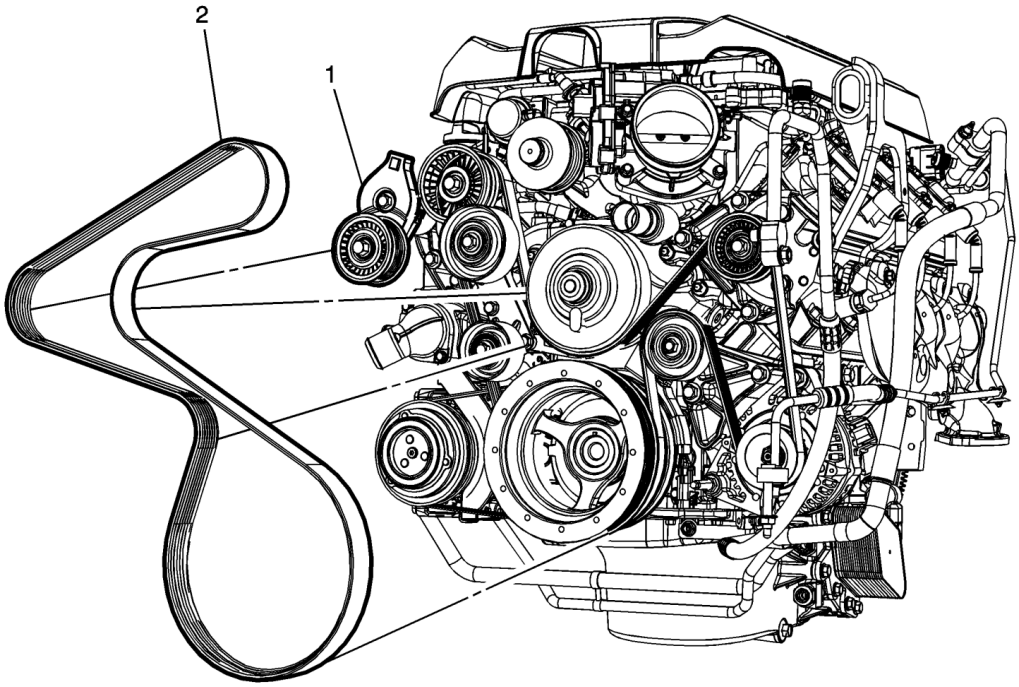


Fig. 1: Supercharger Drive Belt Routing
Courtesy of GENERAL MOTORS COMPANY

Supercharger Belt Replacement

Callout	Component Name
1	Supercharger Tensioner **Procedure** 1. Use a 1/2 inch breaker bar to rotate the supercharger belt tensioner counter clockwise. 2. Slide the belt off the upper supercharger idler pulley.
2	Supercharger Belt **Procedure** 1. Clean and inspect the supercharger belt surfaces of all the pulleys.

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	2. Inspect the supercharger belt for correct alignment.

SUPERCHARGER BELT IDLER PULLEY REPLACEMENT

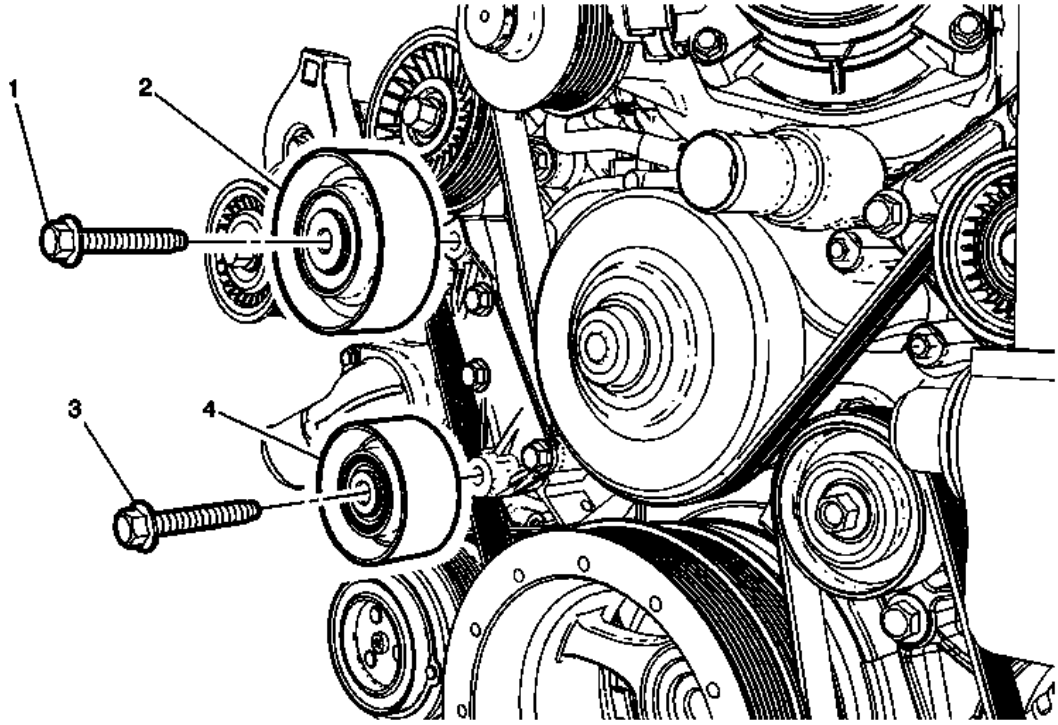


Fig. 2: Supercharger Belt Idler Pulleys & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Supercharger Belt Idler Pulley Replacement

Callout	Component Name
Preliminary Procedure Remove the supercharger belt. Refer to **Supercharger Belt Replacement**.	
1	Supercharger Belt Idler Pulley Fastener **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten** 58 N.m (43 lb ft)
2	Supercharger Belt Idler Pulley
3	Supercharger Belt Idler Pulley Fastener **Tighten** 58 N.m (43 lb ft)
4	Supercharger Belt Idler Pulley

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SUPERCHARGER BELT IDLER PULLEY BRACKET REPLACEMENT

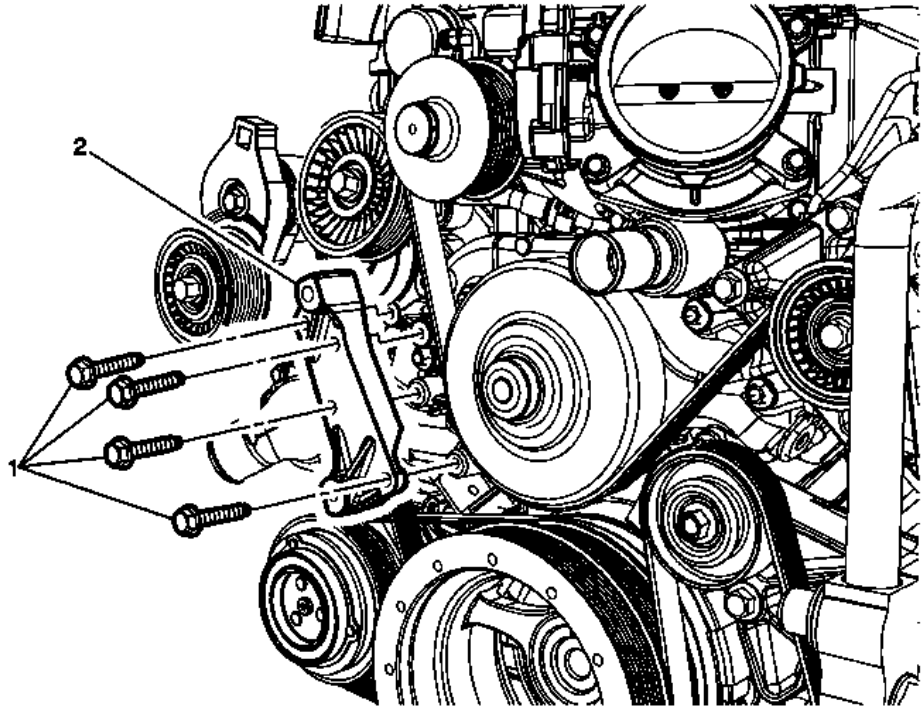


Fig. 3: Supercharger Belt Idler Pulley Bracket & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Supercharger Belt Idler Pulley Bracket Replacement

Callout	Component Name
Preliminary Procedure Remove the supercharger belt idler pulley. Refer to **Supercharger Belt Idler Pulley Replacement**.	
1	Supercharger Belt Idler Pulley Bracket Fastener (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 22 N.m (16 lb ft)
2	Supercharger Belt Idler Pulley Bracket

SUPERCHARGER BELT TENSIONER REPLACEMENT

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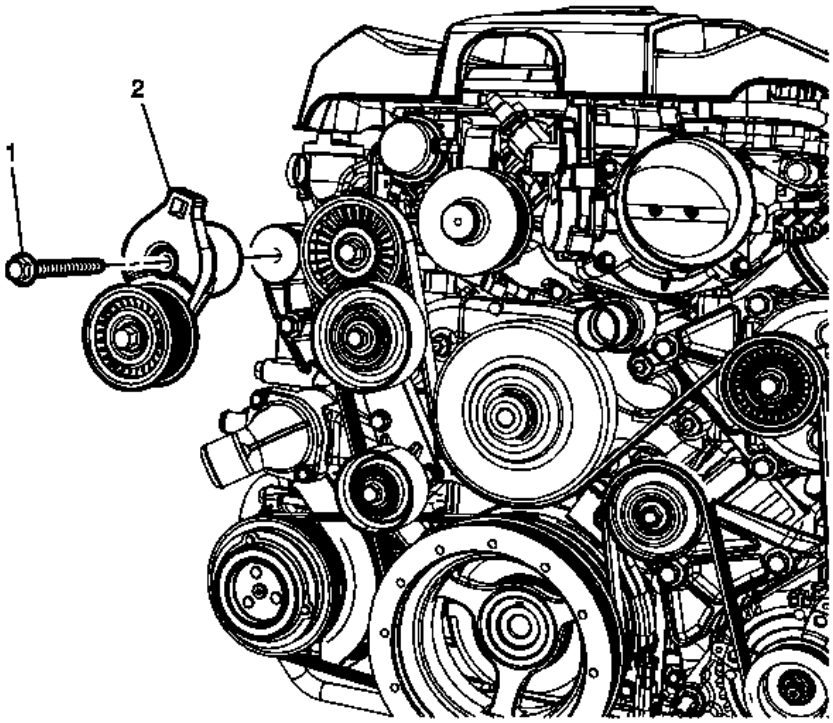


Fig. 4: Supercharger Belt Tensioner & Fastener
Courtesy of GENERAL MOTORS COMPANY

Supercharger Belt Tensioner Replacement

Callout	Component Name
Preliminary Procedure Remove the supercharger belt. Refer to **Supercharger Belt Replacement**.	
1	Supercharger Belt Tensioner Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 58 N.m (43 lb ft)
2	Supercharger Belt Tensioner

SUPERCHARGER BELT TENSIONER BRACKET REPLACEMENT

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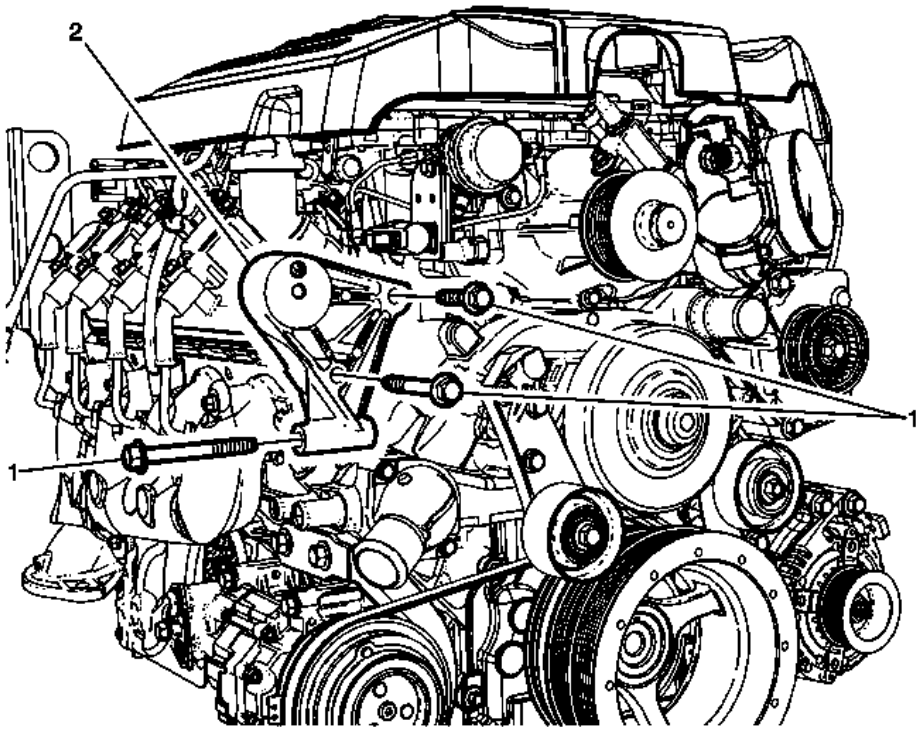


Fig. 5: Supercharger Belt Tensioner Bracket & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Supercharger Belt Tensioner Bracket Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the supercharger belt tensioner. Refer to **Supercharger Belt Tensioner Replacement**. 2. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement - Accessory (LS3 or L99)**, **Drive Belt Tensioner Replacement - Accessory (LSA)**.	
1	Supercharger Belt Tensioner Bracket Fastener (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 58 (43 lb ft)
2	Supercharger Belt Tensioner Bracket

DRIVE BELT REPLACEMENT - ACCESSORY (EXCEPT LSA)

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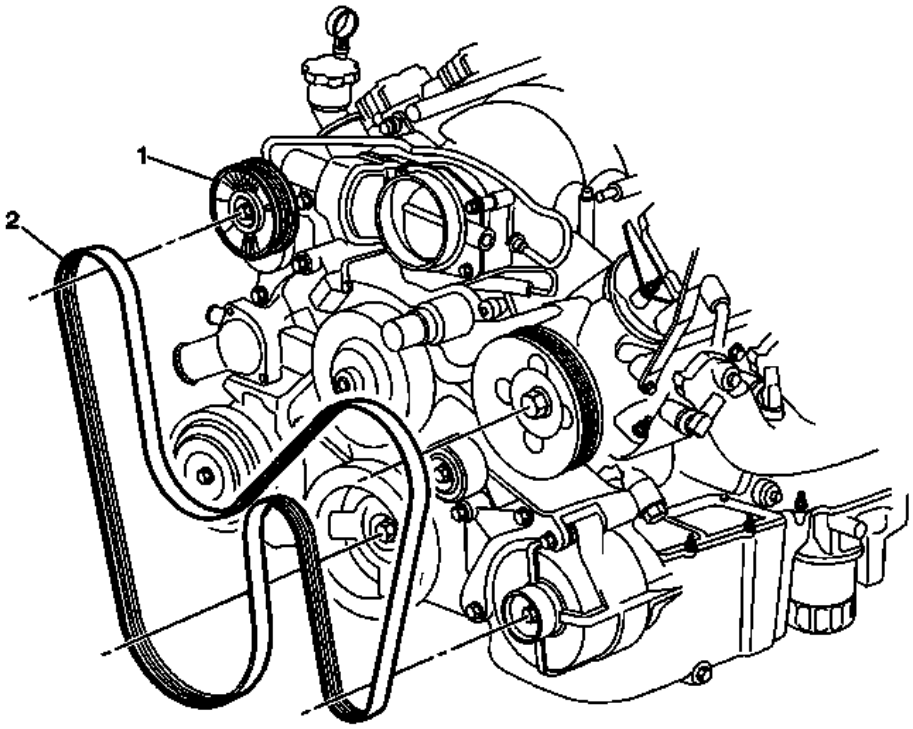


Fig. 6: Drive Belt Routing - Accessory (Except LSA)
Courtesy of GENERAL MOTORS COMPANY

Drive Belt Replacement - Accessory (Except LSA)

Callout	Component Name
1	Drive Belt **Procedure** 1. Use the proper tool to rotate the drive belt tensioner. 2. Remove the drive belt from the pulleys and tensioner.
2	Drive Belt Tensioner **Procedure** 1. Clean and inspect the drive belt surfaces of all the pulleys. 2. Inspect the drive belt for correct alignment.

DRIVE BELT REPLACEMENT - ACCESSORY (LSA)

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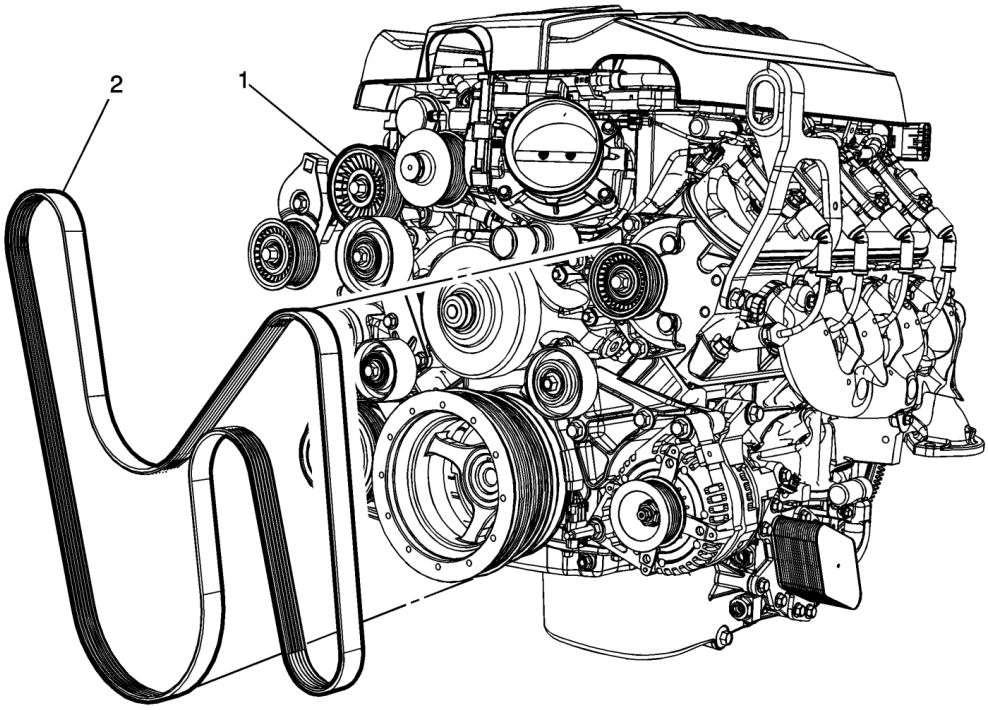


Fig. 7: Drive Belt Routing - Accessory (LSA)
Courtesy of GENERAL MOTORS COMPANY

Drive Belt Replacement - Accessory (LSA)

Callout	Component Name
Preliminary Procedure Remove the supercharger belt. Refer to **Supercharger Belt Replacement**.	
1	Drive Belt Tensioner **Procedure** 1. Use the proper tool to rotate the drive belt tensioner. 2. Remove the drive belt from the pulleys and tensioner.
2	Drive Belt **Procedure** 1. Clean and inspect the drive belt surfaces of all the pulleys. 2. Inspect the drive belt for correct alignment.

AIR CONDITIONING COMPRESSOR BELT REPLACEMENT (EXCEPT LSA)

Removal Procedure

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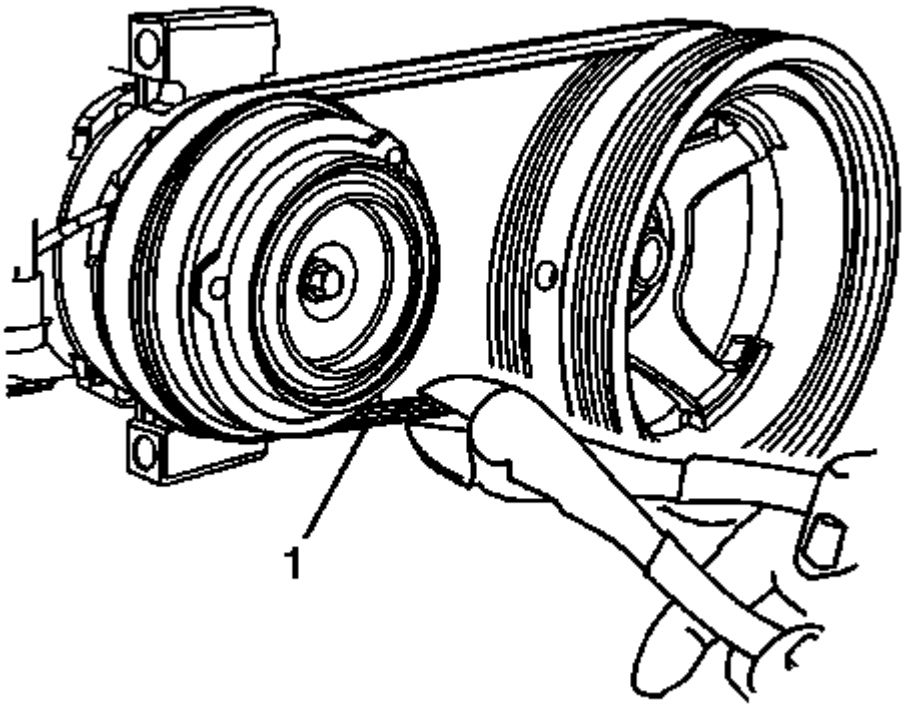


Fig. 8: Removing Belt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory (Except LSA)**.
2. Cut the belt (1) from air conditioning (A/C) and crankshaft pulleys.

Installation Procedure

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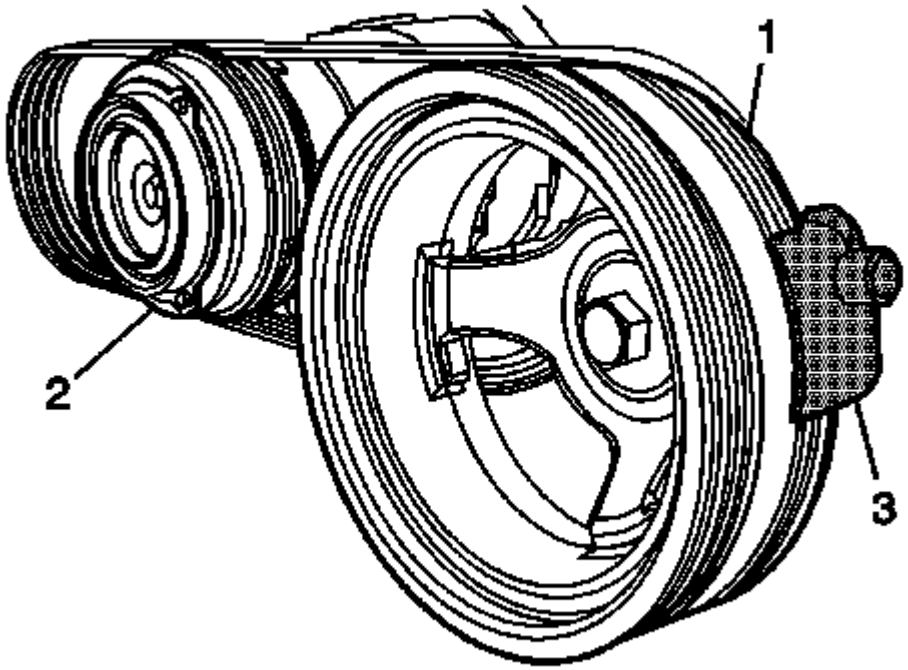


Fig. 9: InstallingBelt
Courtesy of GENERAL MOTORS COMPANY

NOTE: The OEM replacement stretchy belt is packaged with a disposable installation tool.

1. Position the belt behind the rear face of the balancer (1) and off of the A/C pulley (2).
2. Install the belt installation tool (3) onto the balancer.

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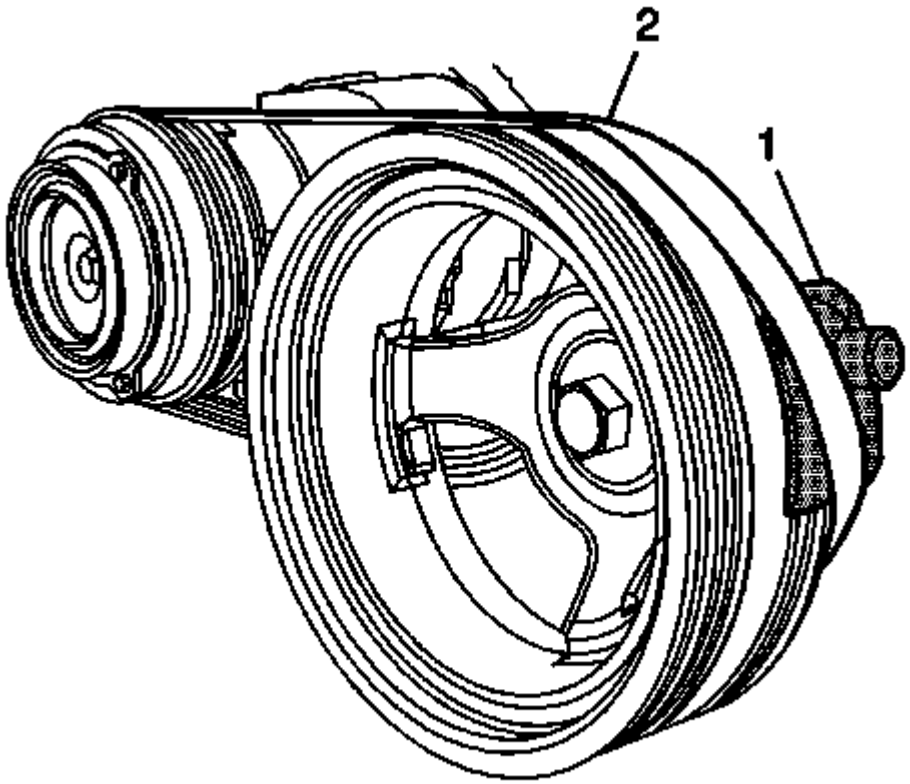


Fig. 10: Belt Installation Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: For RPO L99 applications, it may be necessary to loosen and reposition or remove the camshaft position sensor/actuator wire harness bracket for belt installation.

3. Slide the belt installation tool (1) upward, installing the belt (2) onto the belt installation tool.
4. Slide the belt installation tool downward, positioning the belt onto the A/C pulley, applying light tension to the belt.

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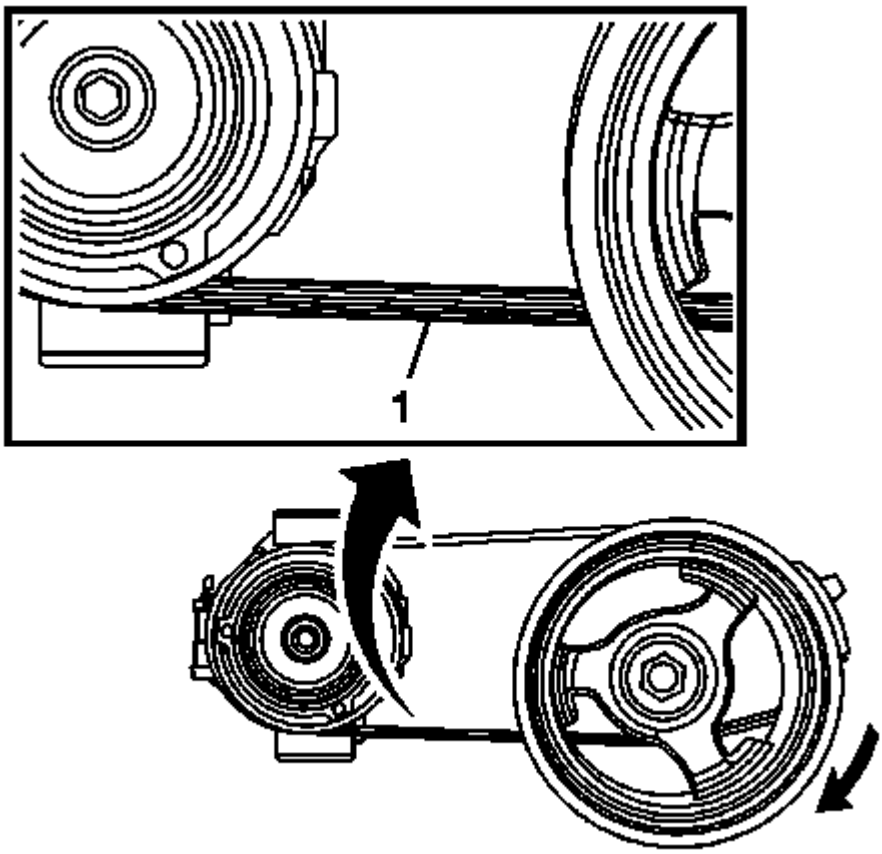


Fig. 11: Locating Lower Portion Of Belt & Ribbed Area Facing Forward
Courtesy of GENERAL MOTORS COMPANY

5. Position the lower portion of the belt (1) with the ribbed area facing forward.

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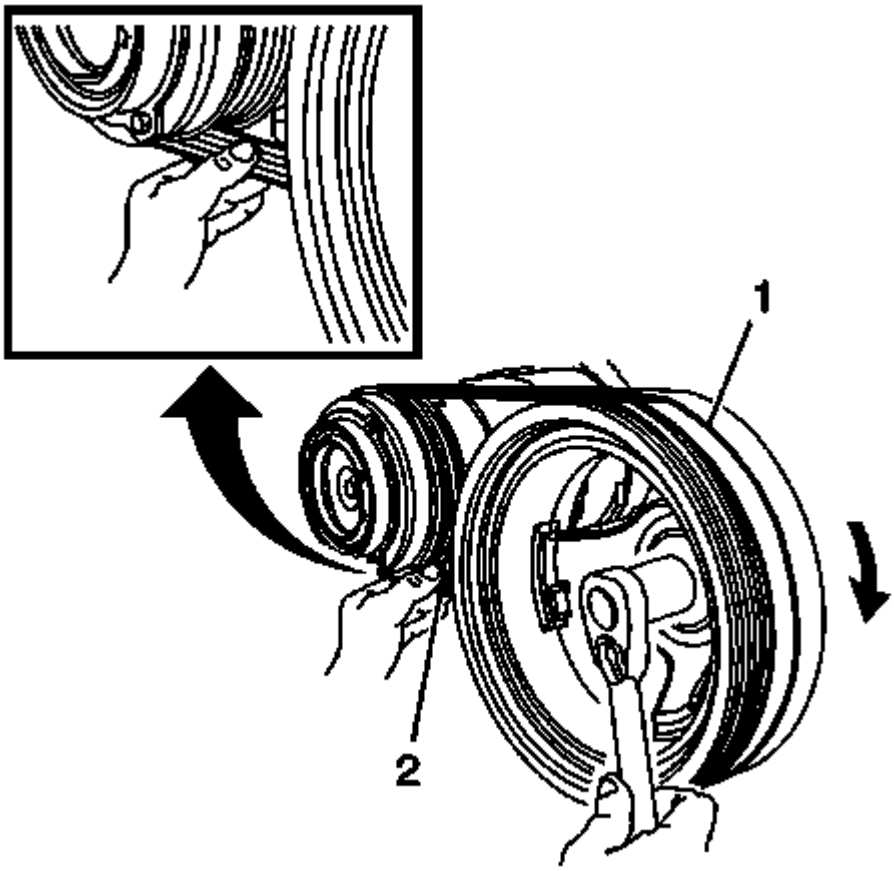


Fig. 12: Rotating Crankshaft Pulley
Courtesy of GENERAL MOTORS COMPANY

6. Slowly rotate the crankshaft pulley (1) in a clockwise direction while using finger pressure to pull the belt (2) forward. Ensure that the ribbed area of the belt remains facing forward and the belt aligns properly to the A/C pulley.

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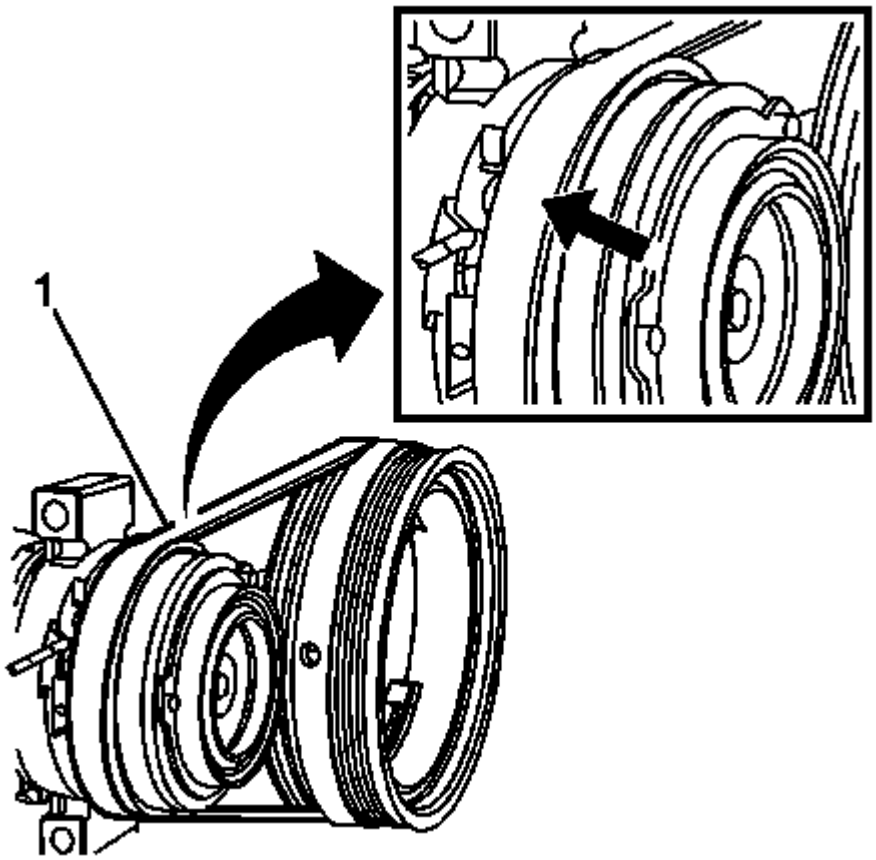


Fig. 13: Drive Belt Alignment
Courtesy of GENERAL MOTORS COMPANY

7. Inspect the drive belt (1) for proper installation and alignment.

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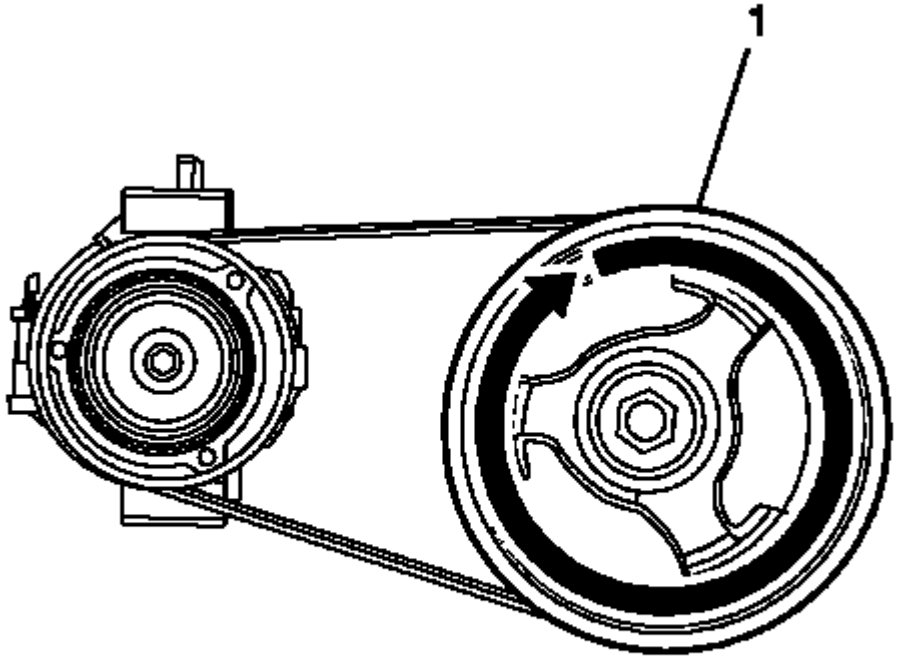


Fig. 14: A/C Compressor Drive Belt
Courtesy of GENERAL MOTORS COMPANY

8. Rotate the balancer (1) and additional 360 degrees to ensure proper belt installation.

CAUTION: Refer to Fastener Caution .

9. Reposition the camshaft position sensor/actuator wire harness bracket and tighten the bolts as required.

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

10. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory (Except LSA)**.

AIR CONDITIONING COMPRESSOR BELT REPLACEMENT (LSA)

Special Tools

EN-50721 Belt Installer

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

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Removal Procedure

1. Remove the supercharger drive belt. Refer to **Supercharger Belt Replacement**.
2. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory (LSA)**.

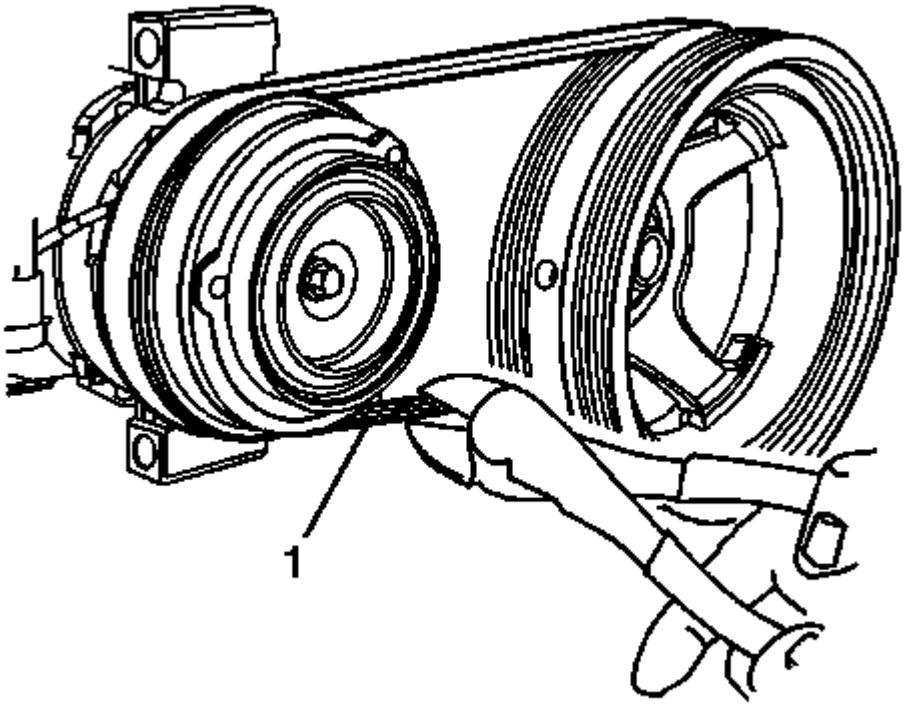


Fig. 15: Removing Belt
Courtesy of GENERAL MOTORS COMPANY

3. Cut the belt (1) from the air conditioning (A/C) and crankshaft pulleys and discard.

Installation Procedure

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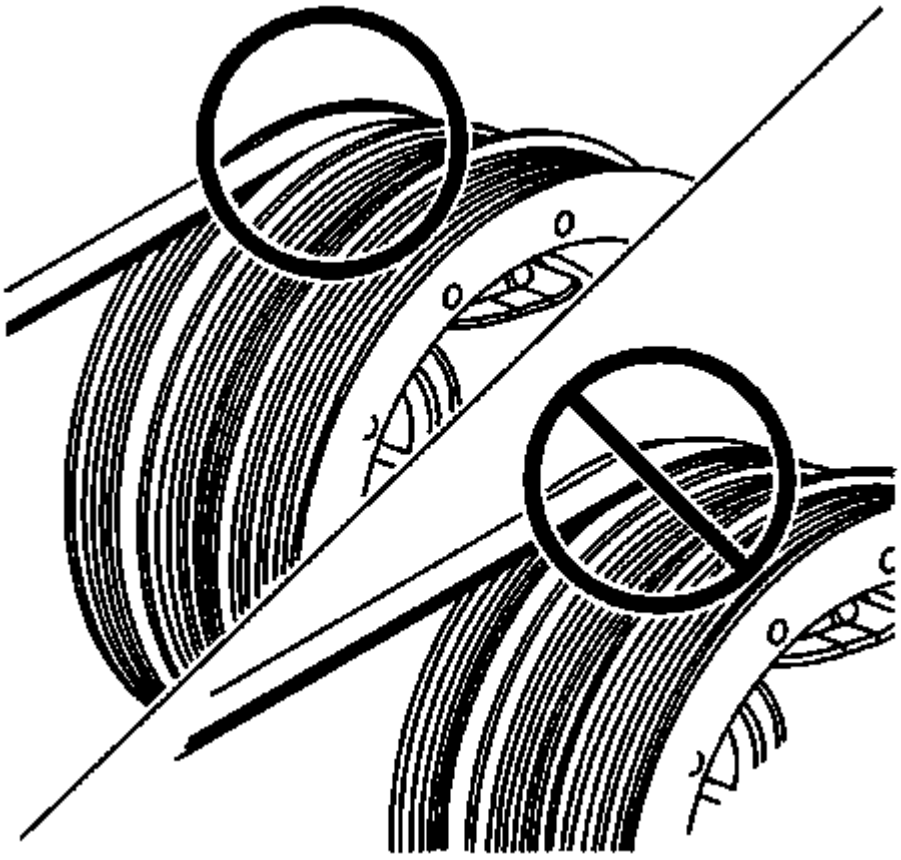


Fig. 16: Positioning Belt On Rear Of Crankshaft Pulley
Courtesy of GENERAL MOTORS COMPANY

1. Position the belt on the rear of the crankshaft pulley. Ensure the belt is properly seated around the crankshaft pulley.

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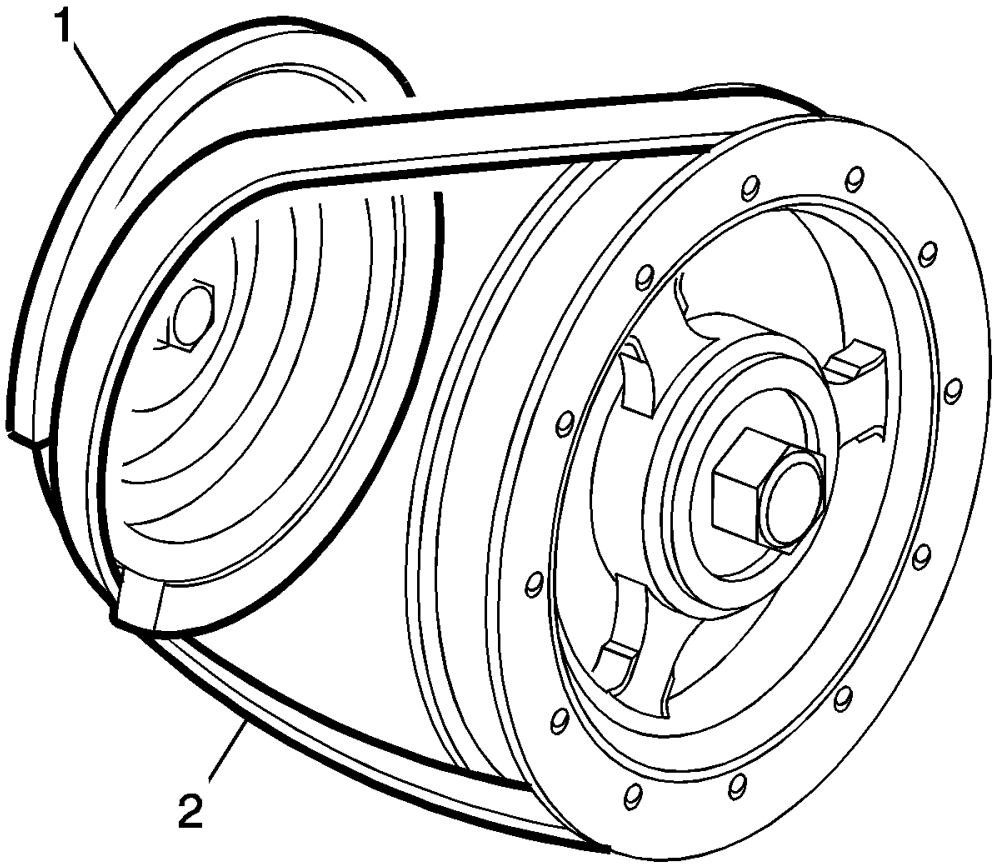


Fig. 17: Belt & Installer
Courtesy of GENERAL MOTORS COMPANY

2. Install the belt installer (1) onto the A/C compressor.
3. Position the belt (2) onto the installer as shown.

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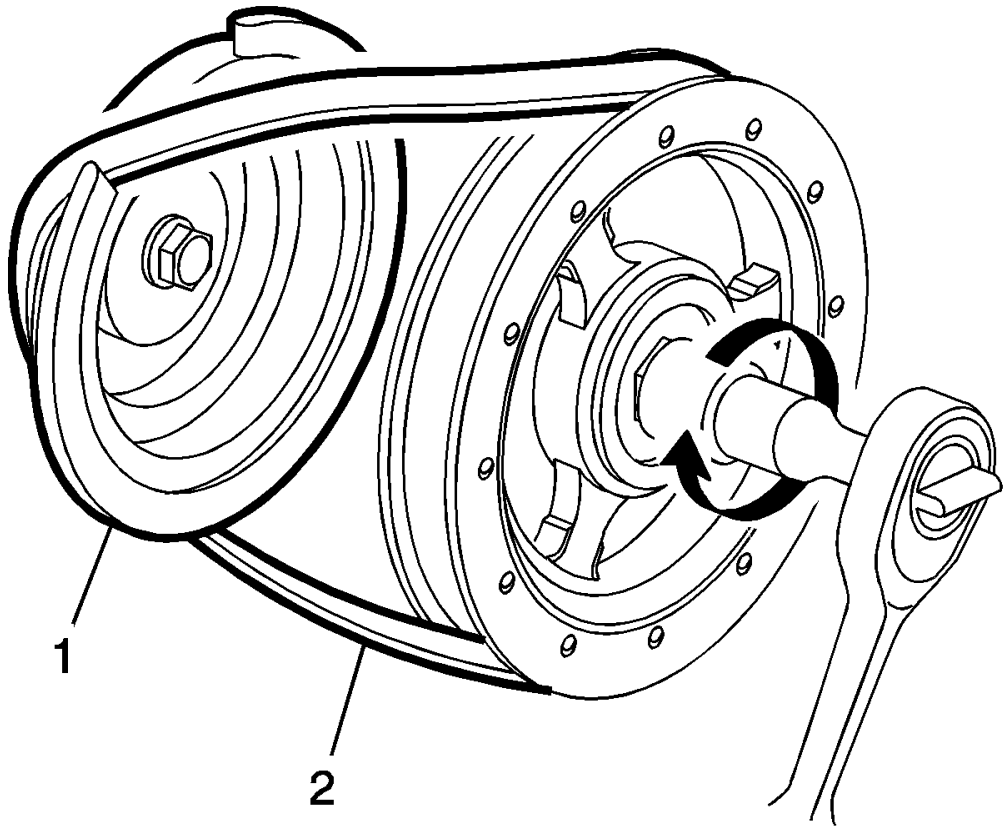


Fig. 18: Belt Tensioning Procedure
Courtesy of GENERAL MOTORS COMPANY

4. Rotate the belt installer (1) clockwise to load tension on the belt (2).

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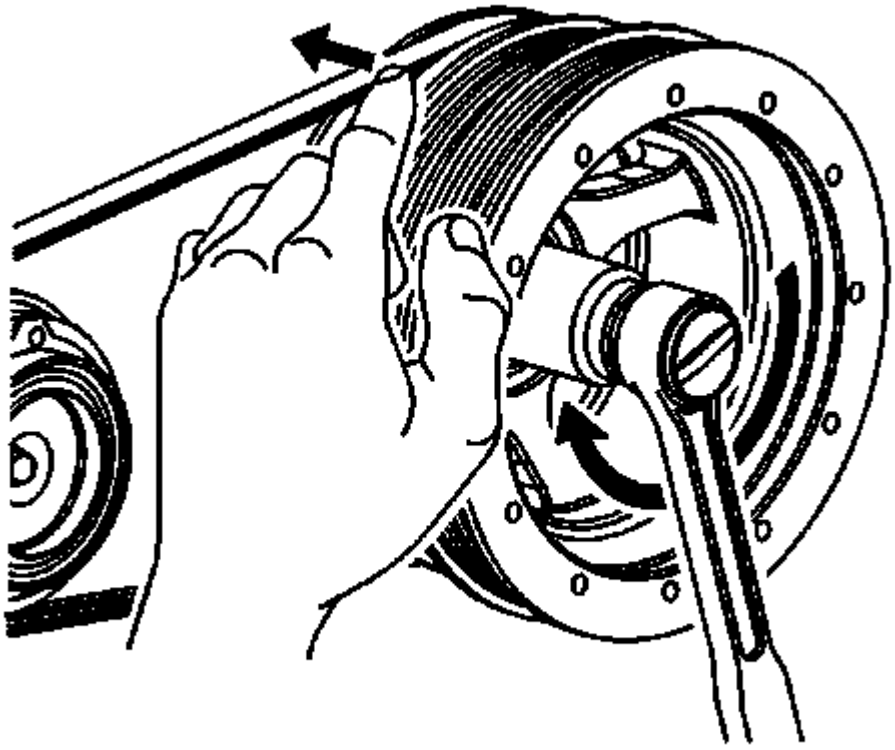


Fig. 19: Ensuring Top Of Belt Is Tight
Courtesy of GENERAL MOTORS COMPANY

NOTE: Before rotating the crankshaft pulley ensure the top of the belt is tight and all the slack in the belt is at the bottom.

5. Slowly rotate the crankshaft pulley in a clockwise direction while using finger pressure to ensure the belt remains on the crankshaft pulley and does not walk off.
6. Ensure the ribbed area of the belt remains facing rearward and the belt aligns properly to the A/C pulley.
7. Remove the belt installer.

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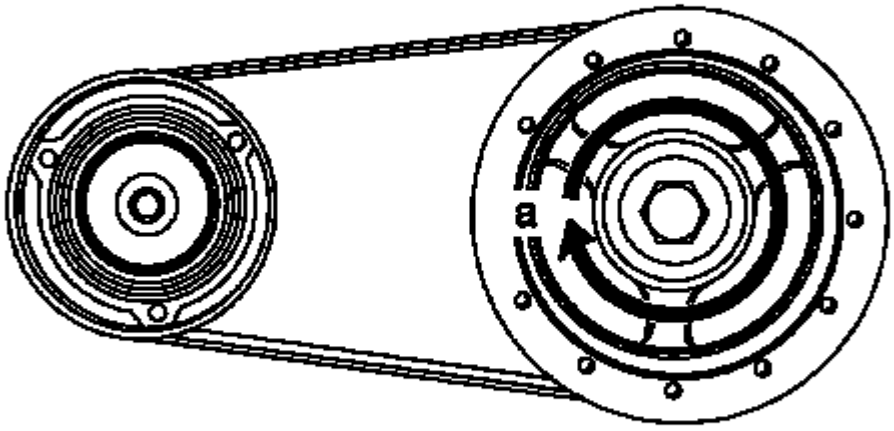


Fig. 20: Ensuring Proper Belt Installation
Courtesy of GENERAL MOTORS COMPANY

8. Rotate the balancer an additional 360 degrees to ensure proper belt installation.

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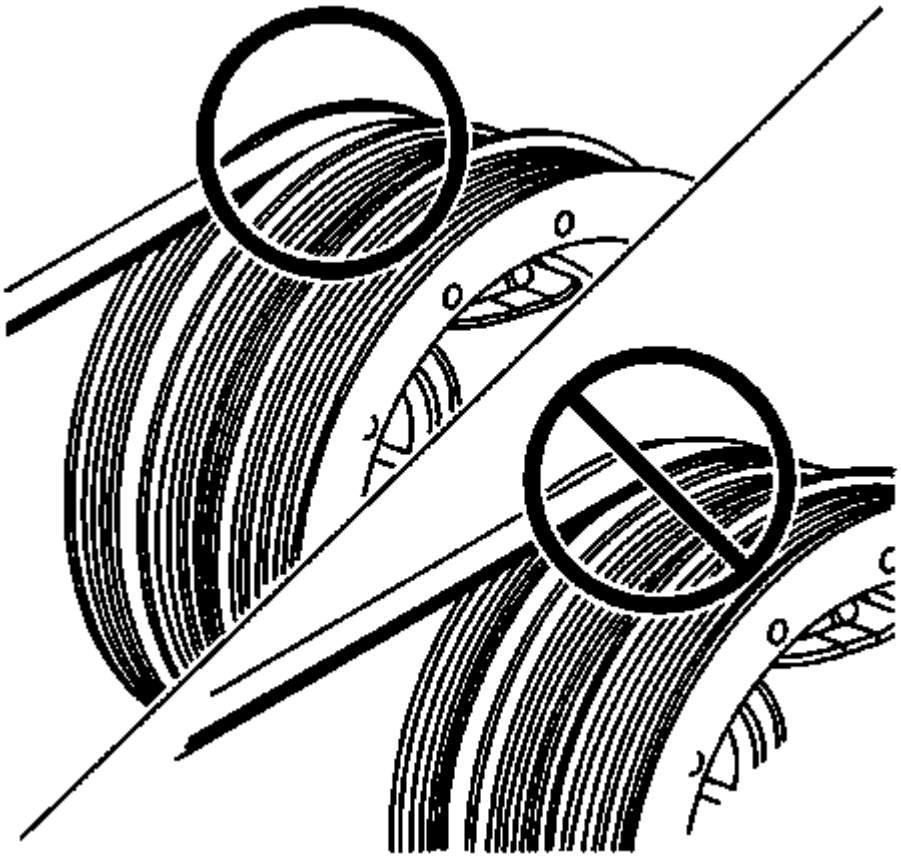


Fig. 21: Positioning Belt On Rear Of Crankshaft Pulley
Courtesy of GENERAL MOTORS COMPANY

9. Inspect the belt for proper installation.
10. Lower the vehicle.
11. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory (LSA)**.
12. Install the supercharger drive belt. Refer to **Supercharger Belt Replacement**.

DRIVE BELT IDLER PULLEY REPLACEMENT (L99 OR LS3)

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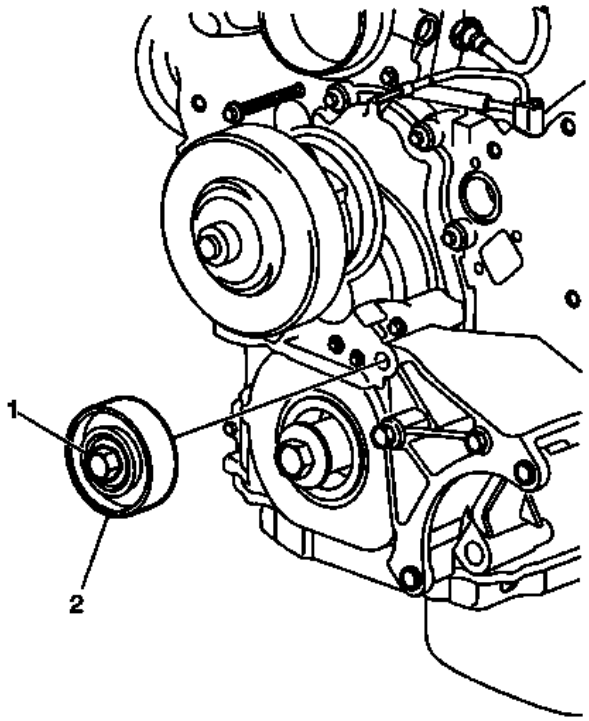


Fig. 22: Drive Belt Idler Pulley & Fastener (L99 or LS3)
Courtesy of GENERAL MOTORS COMPANY

Drive Belt Idler Pulley Replacement (L99 or LS3)

Callout	Component Name
Preliminary Procedure Remove the drive belt. Refer to **Drive Belt Replacement - Accessory (Except LSA)**.	
1	Drive Belt Idler Pulley Fastener **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten** 50 N.m (59 lb ft)
2	Drive Belt Idler Pulley **Procedure** Transfer components as necessary.

DRIVE BELT IDLER PULLEY REPLACEMENT (LSA UPPER)

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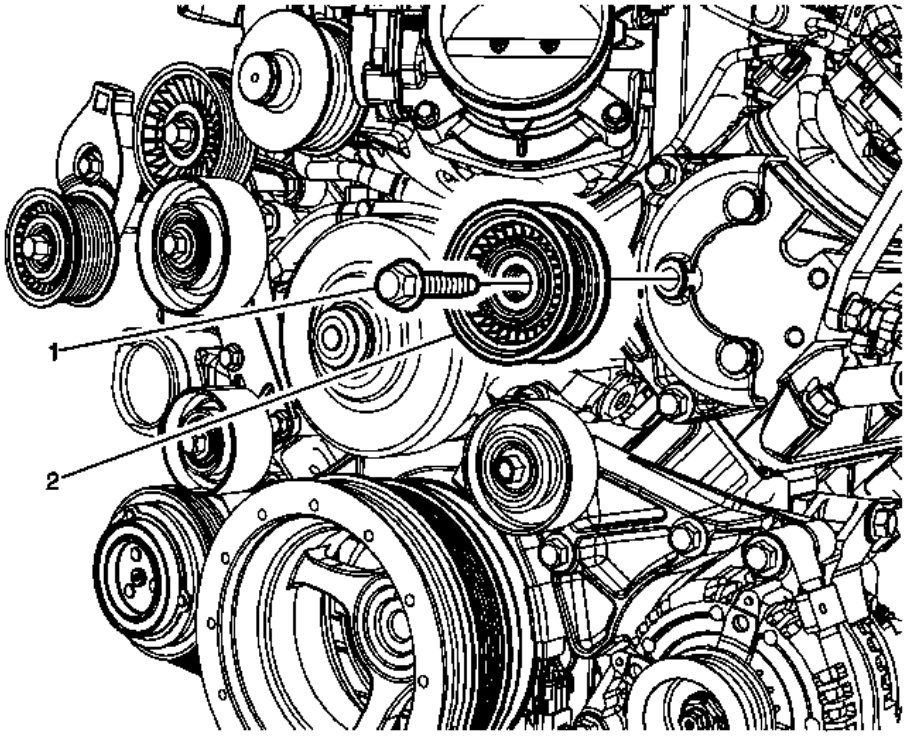


Fig. 23: Drive Belt Idler Pulley & Fastener (LSA Upper)
Courtesy of GENERAL MOTORS COMPANY

Drive Belt Idler Pulley Replacement (LSA Upper)

Callout	Component Name
Preliminary Procedure Remove the drive belt. Refer to **Drive Belt Replacement - Accessory (LSA)**.	
1	Upper Drive Belt Idler Pulley Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 58 N.m (43 lb ft)
2	Upper Drive Belt Idler Pulley

DRIVE BELT IDLER PULLEY REPLACEMENT (LSA LOWER)

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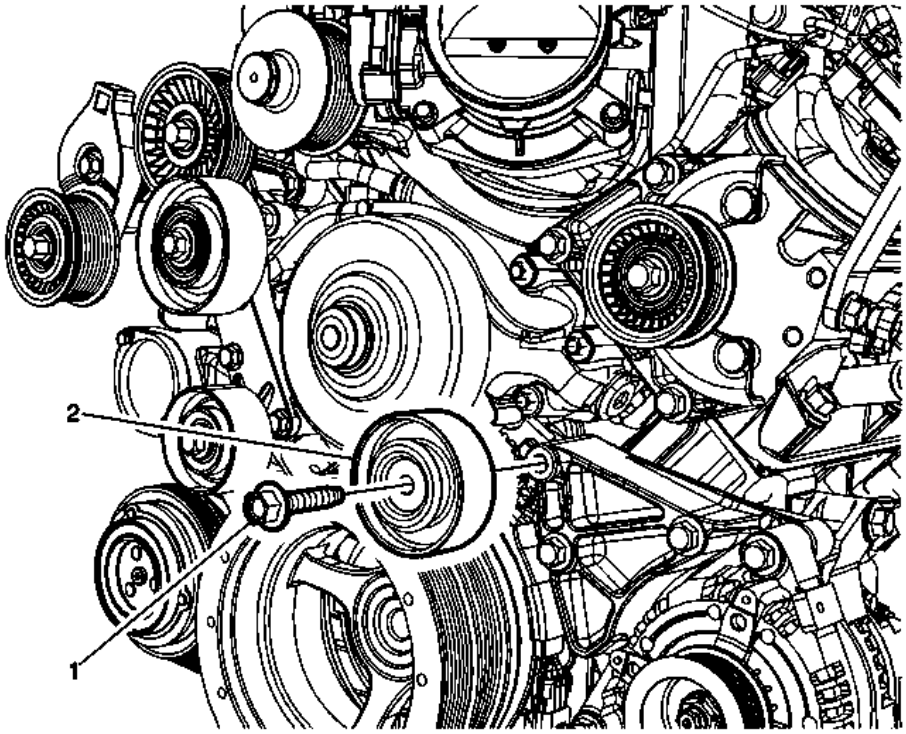


Fig. 24: Drive Belt Idler Pulley & Fastener (LSA Lower)
Courtesy of GENERAL MOTORS COMPANY

Drive Belt Idler Pulley Replacement (LSA Lower)

Callout	Component Name
Preliminary Procedure Remove the drive belt. Refer to **Drive Belt Replacement - Accessory (LSA)**.	
1	Lower Drive Belt Idler Pulley Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 45 N.m (33 lb ft)
2	Lower Drive Belt Idler Pulley

DRIVE BELT TENSIONER REPLACEMENT - ACCESSORY (LS3 OR L99)

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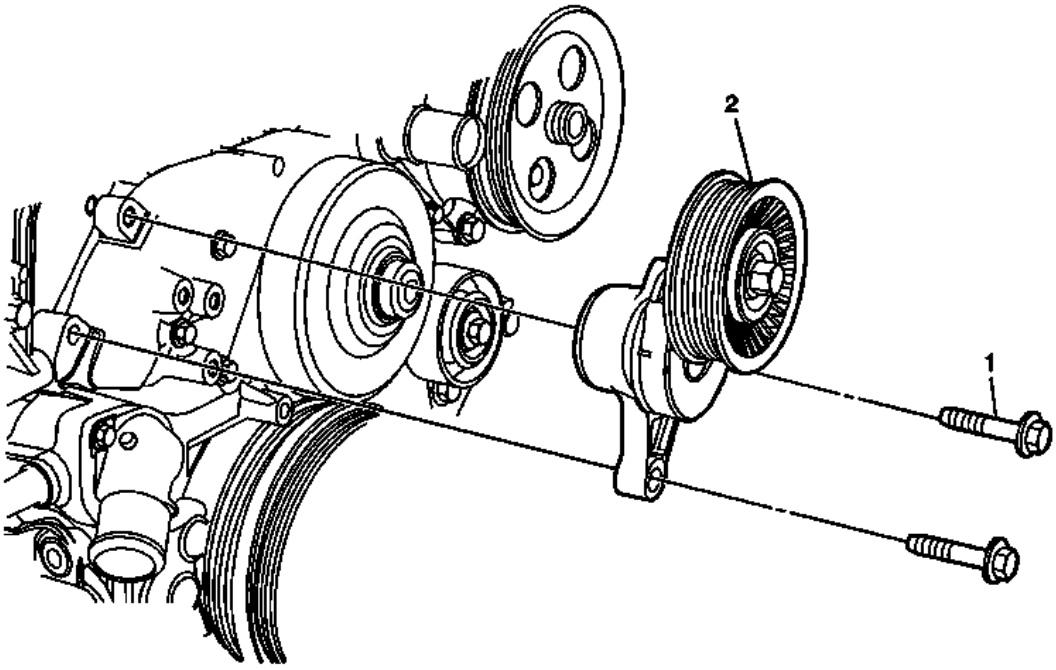


Fig. 25: Drive Belt Tensioner - Accessory
Courtesy of GENERAL MOTORS COMPANY

Drive Belt Tensioner Replacement - Accessory (LS3 or L99)

Callout	Component Name
Preliminary Procedure Remove the drive belt. Refer to **Drive Belt Replacement - Accessory (Except LSA)**.	
1	Drive Belt Tensioner Fastener (Qty: 2) **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten** 50 N.m (59 lb ft)
2	Drive Belt Tensioner **Procedure** Transfer components as necessary.

DRIVE BELT TENSIONER REPLACEMENT - ACCESSORY (LSA)

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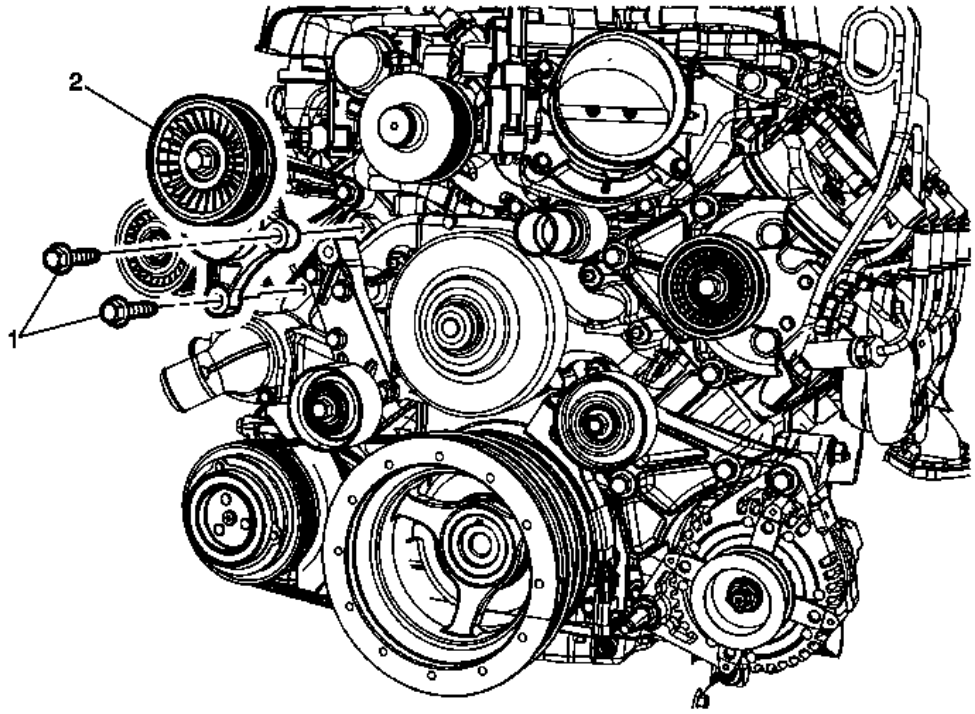


Fig. 26: Drive Belt Tensioner & Fasteners - Accessory (LSA)
Courtesy of GENERAL MOTORS COMPANY

Drive Belt Tensioner Replacement - Accessory (LSA)

Callout	Component Name
Preliminary Procedures 1. Remove the supercharger belt. Refer to **Supercharger Belt Replacement**. 2. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory (LSA)**. 3. Remove the upper supercharger belt idler pulley. Refer to **Supercharger Belt Idler Pulley Replacement**.	
1	Drive Belt Tensioner Fastener (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 58 N.m (43 lb ft)
2	Drive Belt Tensioner

ENGINE COVER REPLACEMENT

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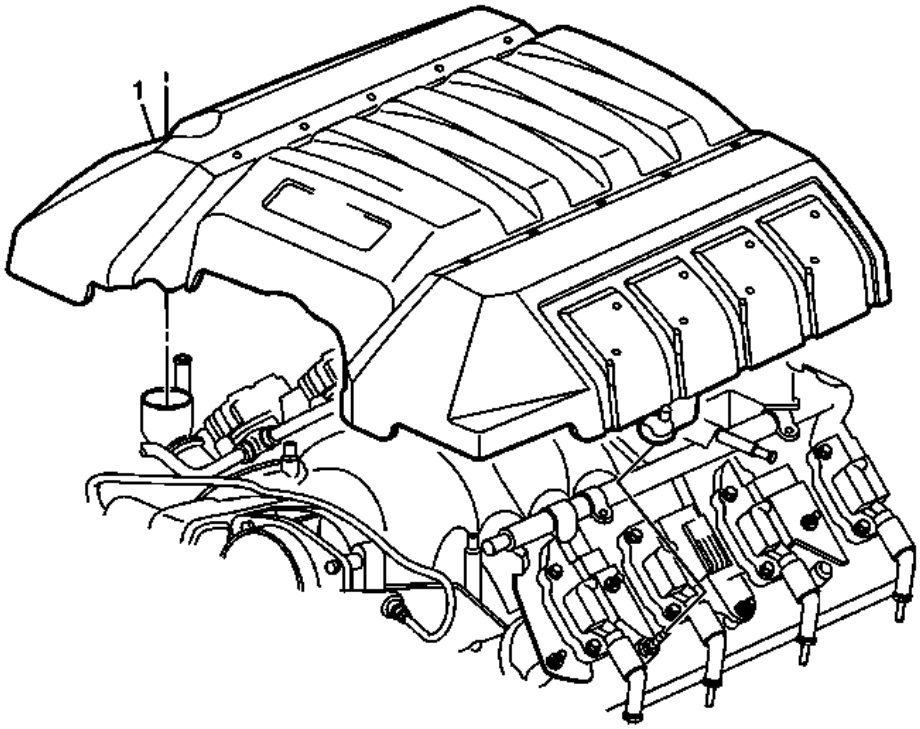


Fig. 27: Engine Cover
Courtesy of GENERAL MOTORS COMPANY

Engine Cover Replacement

Callout	Component Name
1	Engine Cover **Procedure** 1. Remove the oil cap before removing the cover. 2. Pull upward to remove the engine cover.

ENGINE SUPPORT FIXTURE

Special Tools

- **J 28467-81** Engine Support Fixture Kit
- **J 41798** Engine Lift Bracket

Installation Procedure

1. Remove the engine cover. Refer to **Engine Cover Replacement**.
2. Remove the two studs from the left valve cover ignition coil bracket.
3. Install **J 4179-2** engine bracket to the left cylinder head.

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4. Remove the #4 ignition coil from the right valve cover.
5. Remove the ground wire bolt from the right cylinder head.
6. Install **J 36857-1** Lifting Hook at the ground wire location.
7. Support the hood and remove the hood support strut. Refer to **Hood Strut Replacement**

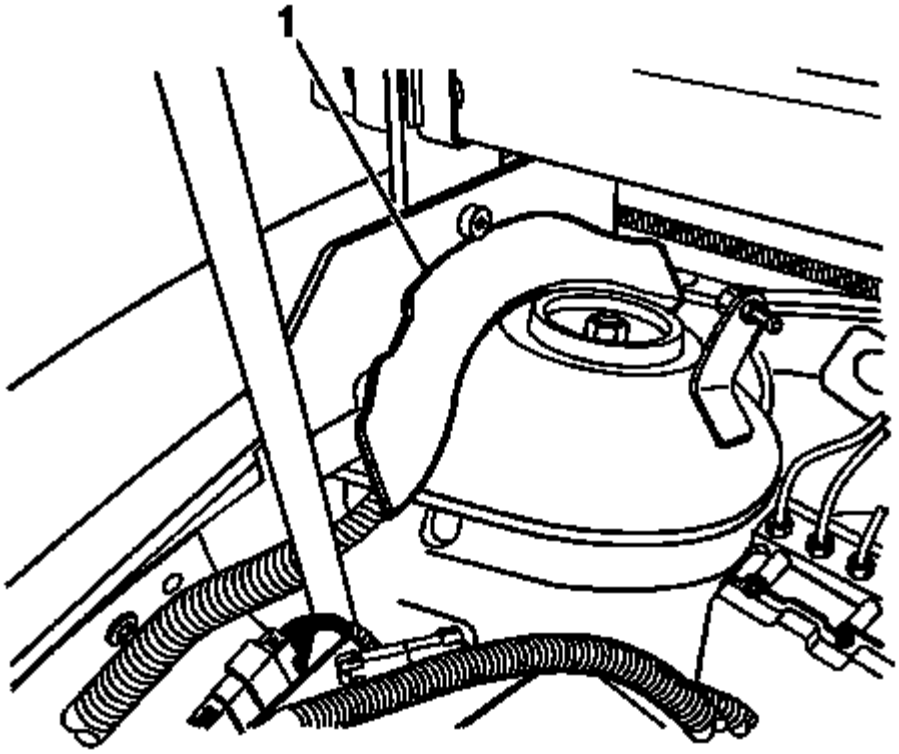


Fig. 28: Passenger Side Wire Harness
Courtesy of GENERAL MOTORS COMPANY

8. Reposition the passenger side wire harness (1) to provide clearance for support fixture leg.

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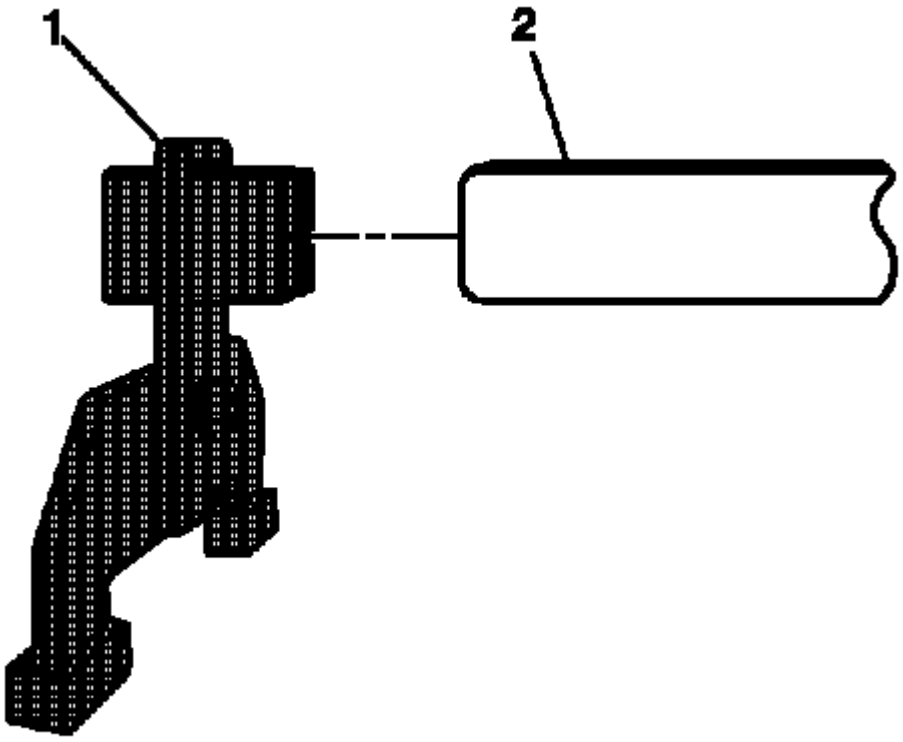


Fig. 29: Identifying Support Leg & Main Bar
Courtesy of GENERAL MOTORS COMPANY

9. Assemble a **J 28467-501** support leg (1) to each end of the **J 28467-518** main bar (2).

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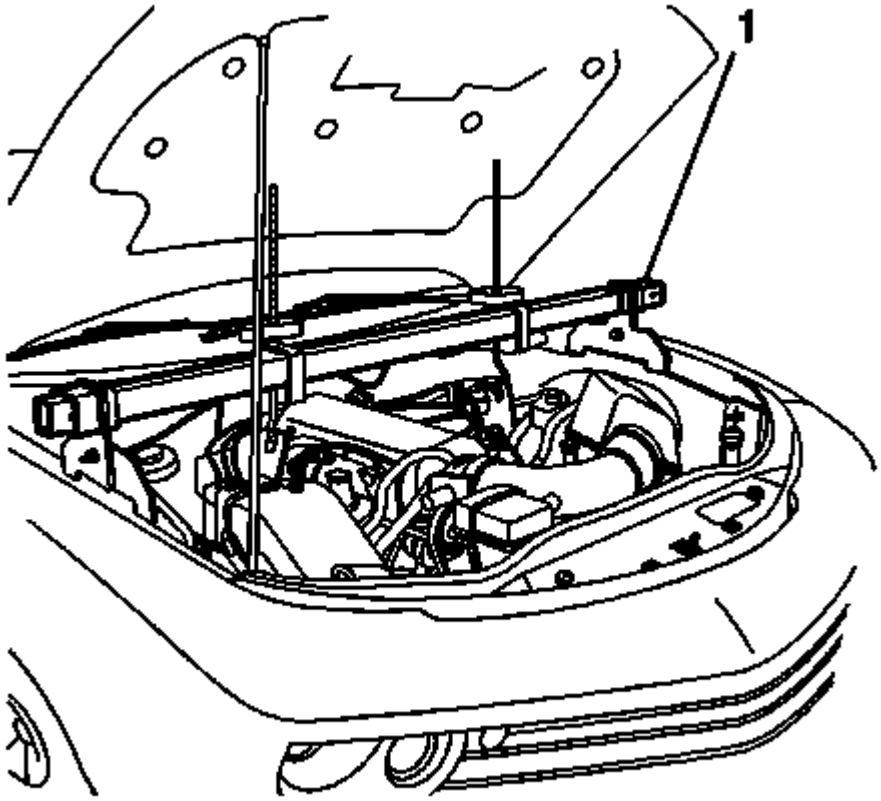


Fig. 30: Main Bar
Courtesy of GENERAL MOTORS COMPANY

10. Position the main bar (1) with the support legs over each shock tower. Ensure the rear support legs are located over the reinforced section of the shock tower.

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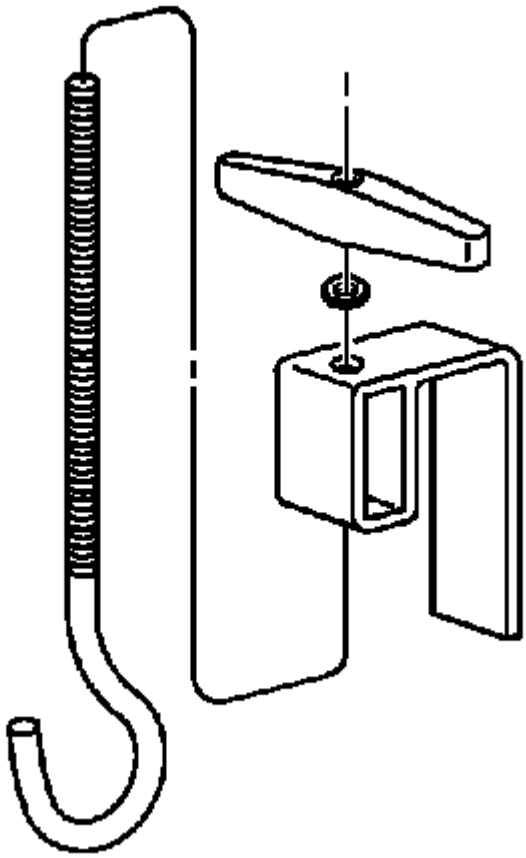


Fig. 31: View Of Lift Hook Assembly
Courtesy of GENERAL MOTORS COMPANY

11. Install the **J 28467-7A** lift hook through the **J 28467-6A** lift hook bracket.
12. Install the 1/2 inch lift hook washer and the **J 28467-34** handle onto the **J 28467-7A** lift hook.

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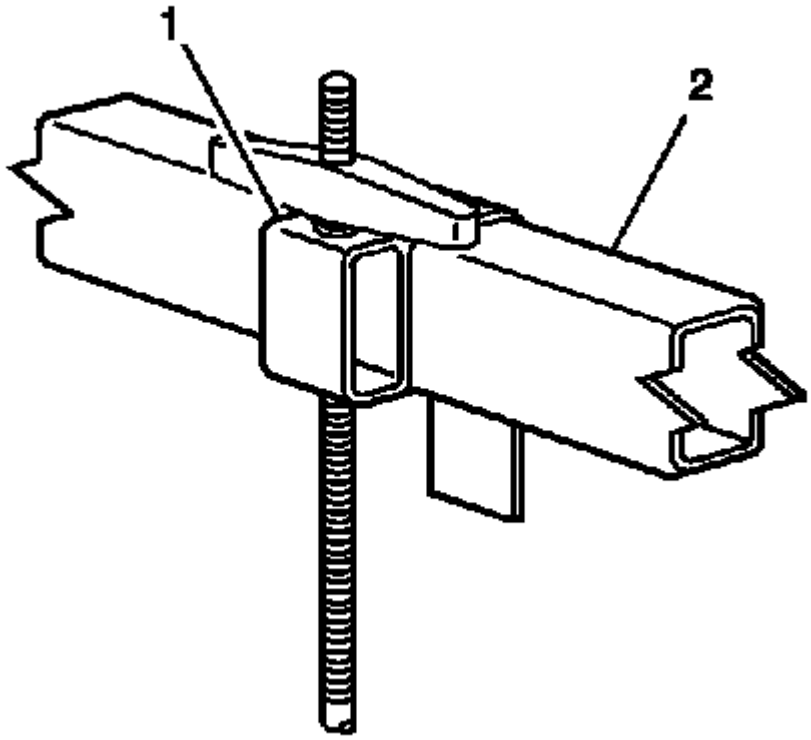


Fig. 32: View Of Lift Hook & radiator shelf tube Assembly
Courtesy of GENERAL MOTORS COMPANY

13. Install the **J 28467-6A** assembled lift hook bracket (1) over the **J 28467-16** main bar (2).
14. Adjust the **J 28467-6A** assembled lift hook bracket (1) in order to align the hook with the **J 41798** engine bracket.
15. Repeat steps 8-11 for the right lift hook.

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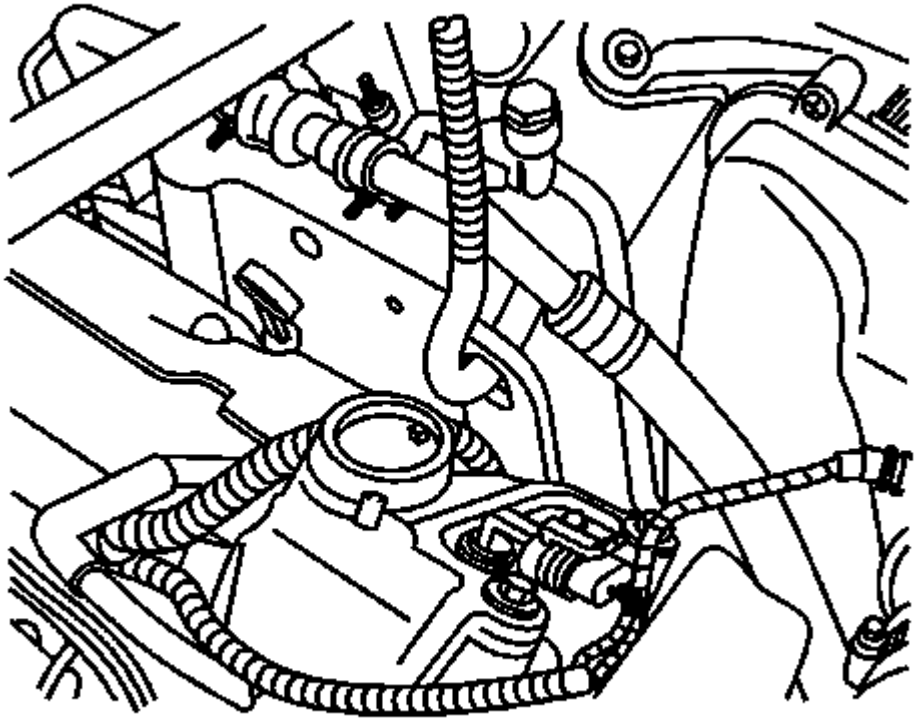


Fig. 33: Engine Lift Adapter
Courtesy of GENERAL MOTORS COMPANY

16. Install each **J 28467-7A** lift hook through each engine bracket. Ensure that the hooks do not damage the surrounding components.
17. Hand-tighten the lift hook wing nuts securely to remove all slack from the engine support fixture assembly.
18. The engine is now supported in the vehicle to perform repairs that require front frame removal.

Removal Procedure

1. Loosen and remove the **J 28467-7A** lift hooks.

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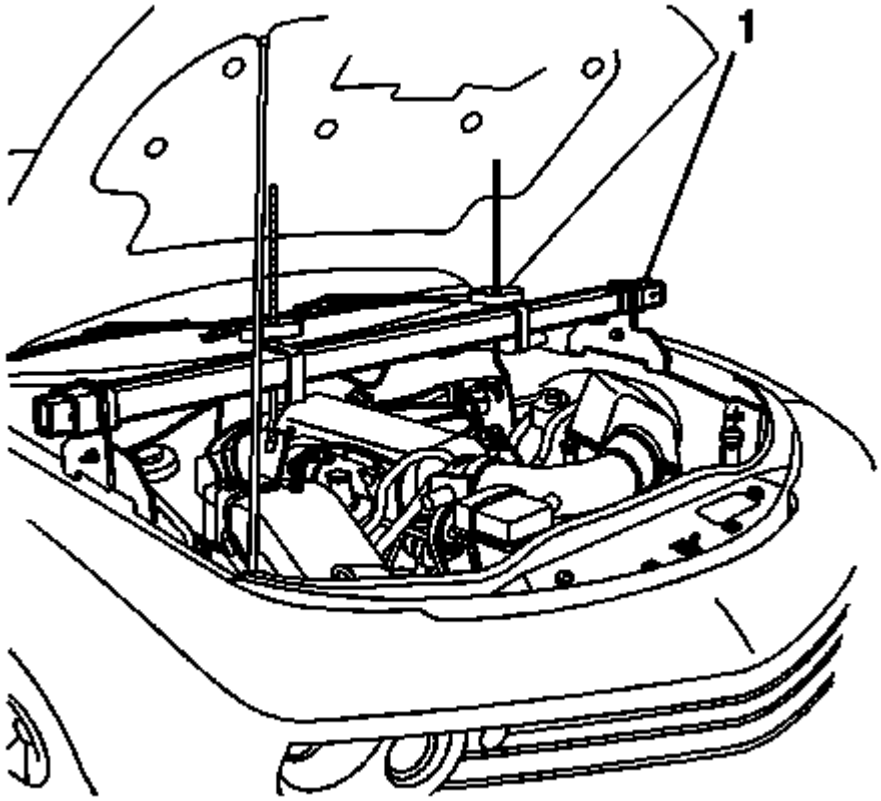


Fig. 34: Main Bar
Courtesy of GENERAL MOTORS COMPANY

2. Remove the **J 28467-81** kit (1).
3. Remove **J 36857-1** Lifting Hook from the right cylinder head.
4. Remove **J 4179-2** engine bracket from the left cylinder head.
5. Install the #4 ignition coil to the right valve cover.
6. Install the ground wire bolt to the right cylinder head.
7. Install the two studs to the left valve cover ignition coil bracket.
8. Install the hood support strut. Refer to **Hood Strut Replacement** .
9. Install the engine cover. Refer to **Engine Cover Replacement**.

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.

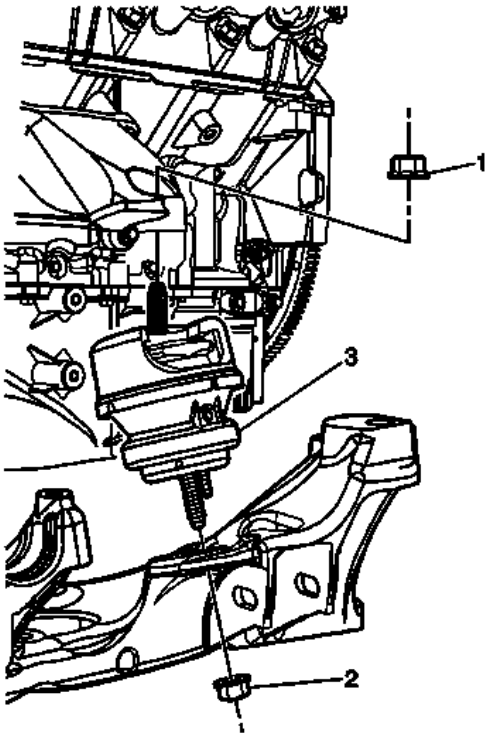
CAUTION: When raising or supporting the engine for any reason, do not use a jack

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under the oil pan, any sheet metal, or the crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause the pan to be bent against the pump screen. This will result in a damaged oil pickup unit.

1. Measure the engine movement at the engine mount in order to check for damage to the rubber portions of the mount.
    1. Apply the park brake.
    2. Start the engine.
    3. Firmly apply and hold the primary brakes.
    4. Have an assistant stand to the side of the vehicle in order to observe for engine movement.
    5. Slightly load the engine shifting from drive to reverse a few times.
    6. If the engine moves more than 24 mm (0.945 in) from the at rest position, in either direction, check for loose engine mount or engine mount bracket attachments.
2. If the engine mount and engine mount bracket bolt torque is at specifications, check the condition of the engine mount.
3. Replace the engine mount if any of the following conditions exist:
    - Heat check cracks cover the rubber cushion surface.
    - The rubber cushion is separated from the metal plate of the mount.
    - There is a split through the rubber cushion.

ENGINE MOUNT REPLACEMENT - LEFT SIDE



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Fig. 35: Identifying Engine Mount - Left Side (RWD)
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement - Left Side

Callout	Component Name
Preliminary Procedure Remove the front compartment air deflector. Refer to **Front Compartment Air Deflector Replacement** .	
1	Engine Mount Fastener **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** 1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Position a screw jack and a block of wood under the engine oil pan. **Tighten** 80 N.m (59 lb ft)
2	Engine Mount Fastener **Tighten** 80 N.m (59 lb ft)
3	Engine Mount **Procedure** 1. The drivetrain and front suspension frame fasteners will need to be loosened 3/4 of the way to allow the assembly to be lowered approximately 25 mm (1 in). Refer to **Drivetrain and Front Suspension Frame Replacement (V8)** . 2. Separate the left side engine mount bracket from the engine block. Refer to **Engine Mount Bracket Replacement - Left Side**. 3. Using the screw jack, raise the engine enough to remove the engine mount. 4. Install the lower engine mount nut first.

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE

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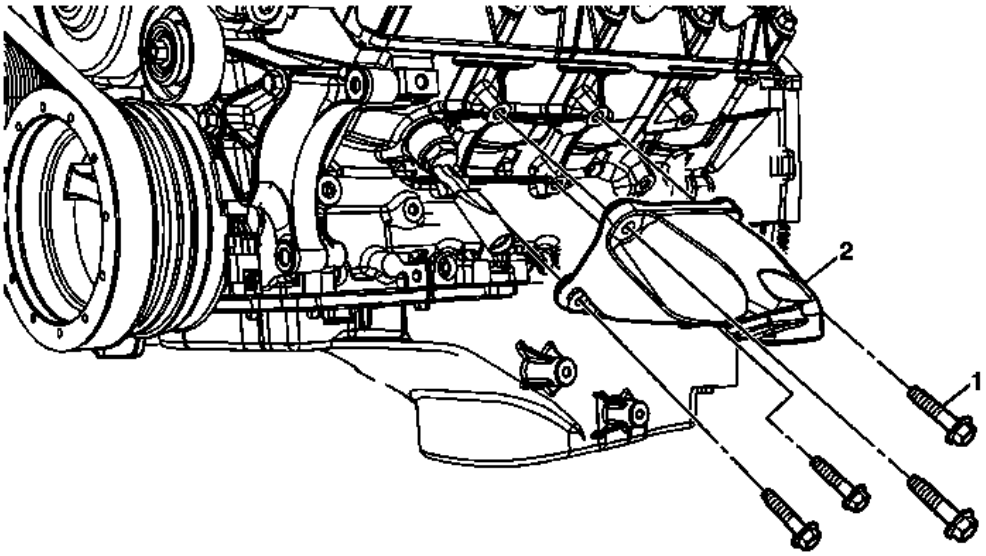


Fig. 36: Identifying Engine Mount Bracket - Left Side
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Bracket Replacement - Left Side

Callout	Component Name
Preliminary Procedure Remove the engine mount. Refer to **Engine Mount Replacement - Left Side**.	
1	Engine Mount Bracket Fastener (Qty: 4) **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten** 60 N.m (44 lb ft)
2	Engine Mount Bracket **Procedure** Transfer components as necessary.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

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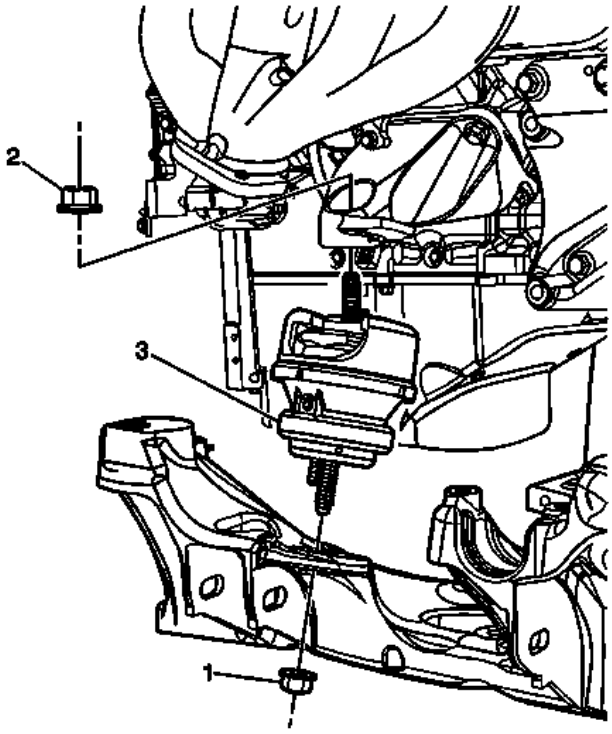


Fig. 37: Identifying Engine Mount - Right Side (RWD)
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement - Right Side

Callout	Component Name
Preliminary Procedure **Remove the front compartment air deflector. Refer to Front Compartment Air Deflector Replacement .**	
1	Engine Mount Fastener **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** 1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Position a screw jack and a block of wood under the engine oil pan. **Tighten** 80 N.m (59 lb ft)
2	Engine Mount Fastener **Tighten** 80 N.m (59 lb ft)
	Engine Mount

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3	**Procedure** 1. The drivetrain and front suspension frame fasteners will need to be loosened 3/4 of the way to allow the assembly to be lowered approximately 25 mm (1 in). Refer to **Drivetrain and Front Suspension Frame Replacement (V8)** . 2. Separate the right side engine mount bracket from the engine block. Refer to **Engine Mount Replacement - Right Side**. 3. Using the screw jack, raise the engine enough to remove the engine mount. 4. Install the lower engine mount nut first.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

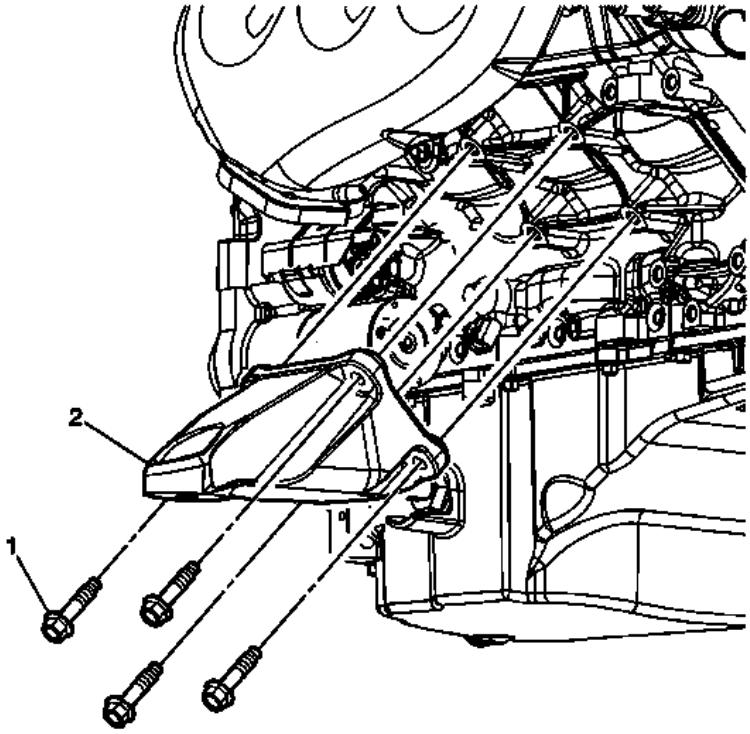


Fig. 38: Identifying Engine Mount Bracket - Right Side
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Bracket Replacement - Right Side

Callout	Component Name
Preliminary Procedure Remove the engine mount. Refer to **Engine Mount Replacement - Right Side**.	
	Engine Mount Bracket Fastener (Qty: 4)

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1	**CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten** 60 N.m (44 lb ft)
2	Engine Mount Bracket **Procedure** Transfer components as necessary.

INTAKE MANIFOLD COVER REPLACEMENT - FRONT

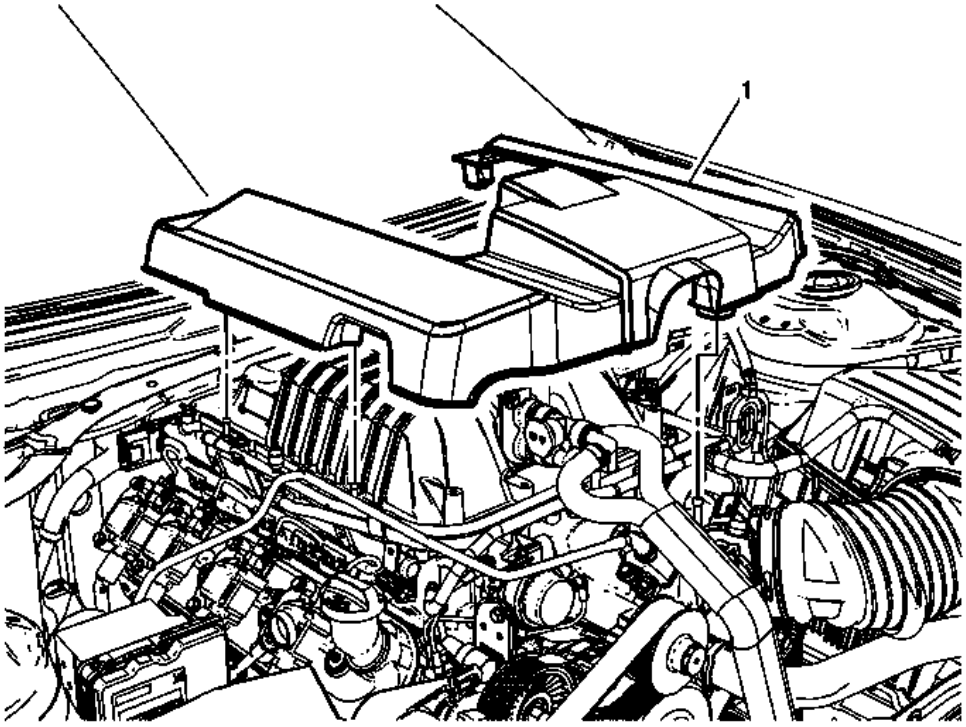


Fig. 39: Intake Manifold Cover - Front
Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Cover Replacement - Front

Callout	Component Name
Preliminary Procedure Remove the front end sheet metal cross brace. Refer to **Front End Sheet Metal Cross Brace Replacement** .	
1	Intake Manifold Cover - Front **Procedure** Grasp the outside edges and lift upward to remove cover grommets from the studs.

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POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (DIRTY AIR)

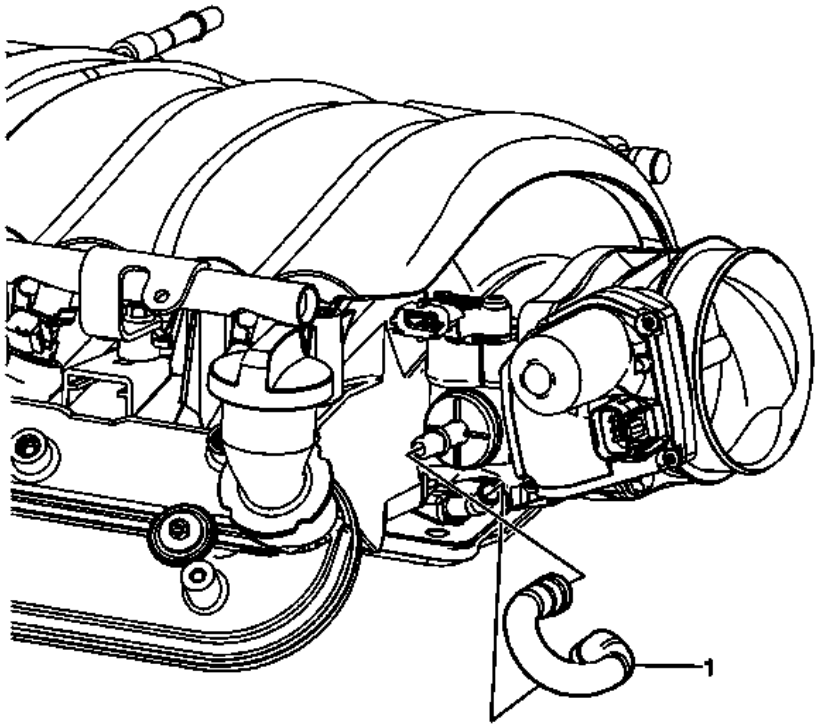


Fig. 40: Positive Crankcase Ventilation Hose/Pipe/Tube (Dirty Air)
Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Dirty Air)

Callout	Component Name
Preliminary Procedure Remove the engine cover. Refer to **Engine Cover Replacement**.	
1	Positive Crankcase Ventilation Hose/Pipe/Tube **Procedure** 1. Release the tabs on the end of the tube before removing. 2. Disconnect the electrical connectors, as needed. 3. Transfer components as necessary.

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (CLEAN AIR)

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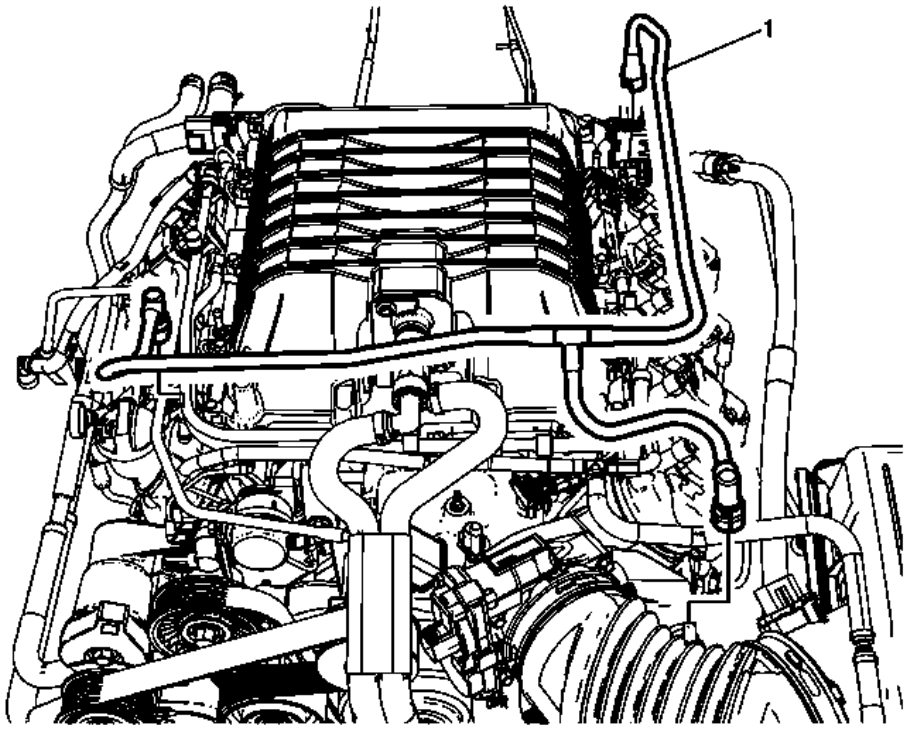


Fig. 41: Positive Crankcase Ventilation Hose/Pipe/Tube (Clean Air)
Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Clean Air)

Callout	Component Name
Preliminary Procedure Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front**.	
1	Positive Crankcase Ventilation Hose/Pipe/Tube **Procedure** 1. Disconnect the electrical connectors, as needed. 2. Route the PCV hose under the air charge cooler lines. **NOTE:** **It is not necessary to disconnect the air charge cooler lines from the air charge cooler.**

CHARGE AIR COOLER COVER REPLACEMENT

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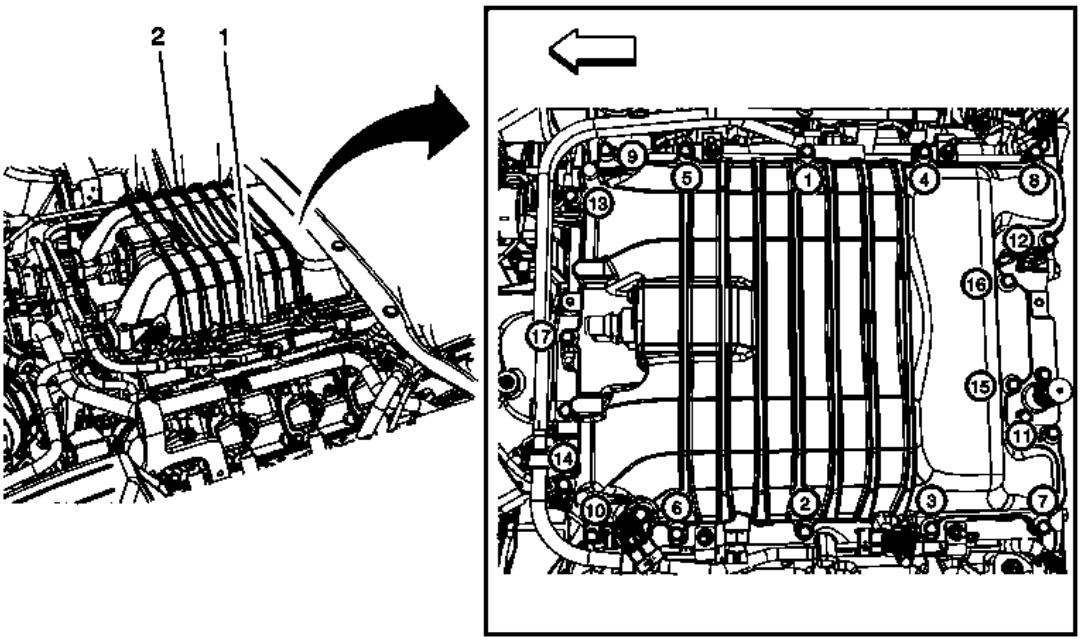


Fig. 42: Charge Air Cooler Cover & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Cover Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front**. 2. Remove the positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Dirty Air)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Clean Air)**. 3. Remove the charge air cooler coolant hoses from the cooler. Refer to **Charge Air Cooler Coolant Hose Replacement (LSA)** .	
1	Charge Air Cooler Cover Fastener (Qty: 16) **CAUTION:** **Refer to Fastener Caution .** **Procedure** To access the rear charge air cooler cover bolts the engine will need to be lowered. The front suspension crossmember fasteners will need to be loosened 3/4 of the way to allow the assembly to be lower approximately 25 mm (1 in). Refer to **Drivetrain and Front Suspension Frame Removal and Installation** .

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	Tighten 10 N.m (89 lb in)
2	Charge Air Cooler Cover **Procedure** 1. Do not reuse old gasket a NEW gasket must be used. 2. Disconnect any electrical connectors.

SUPERCHARGER REPLACEMENT

Special Tools

- **EN-48898** Supercharger Lift Fixture
- **J-37088-A** Fuel Line Disconnect Tool Set

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

Removal Procedure

1. Remove the supercharger belt. Refer to **Supercharger Belt Replacement**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front**.

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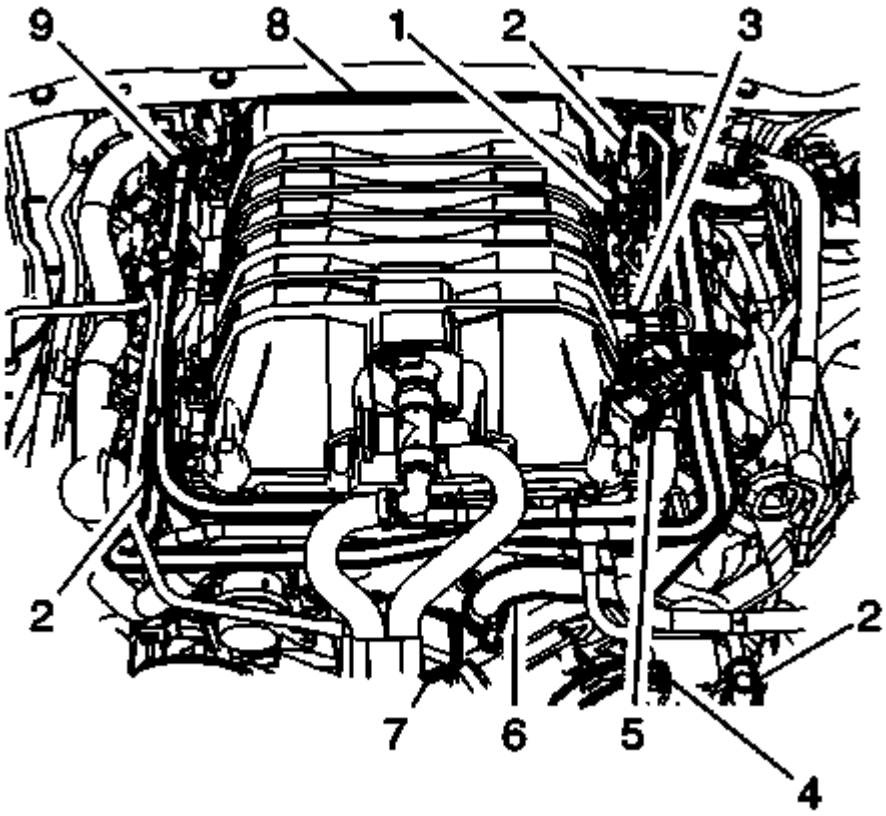


Fig. 43: Supercharger & Fuel System Components
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the supercharger pressure (1), intake air temperature (3) and barometric pressure (5) sensors.
4. Disconnect and remove the PCV fresh air tube (2).
5. Disconnect the brake booster vacuum hose (6).
6. Disconnect and remove the EVAP line from the canister purge solenoid (7).
7. Loosen the clamp (4) and remove the air cleaner outlet duct.
8. Remove the fuel injection fuel rail assembly (9). Refer to **Fuel Injection Fuel Rail Assembly Replacement (LSA)** .
9. Remove the charge air cooler cover (8). Refer to **Charge Air Cooler Cover Replacement**.

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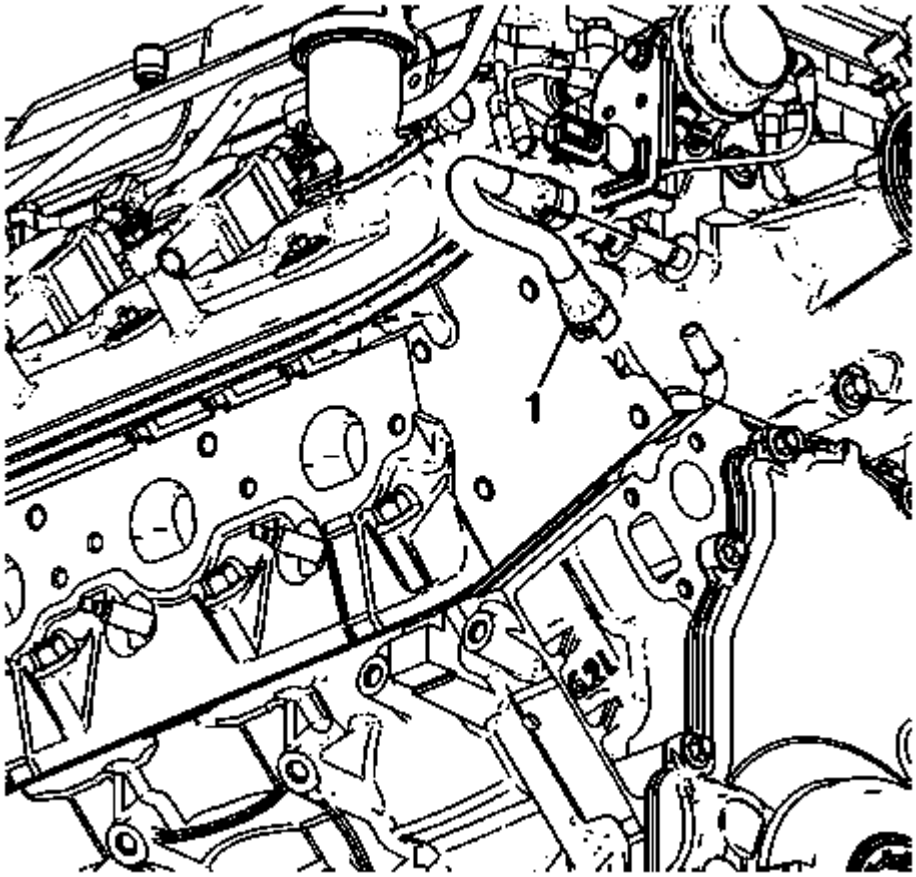


Fig. 44: Identifying Positive Crankcase Ventilation Dirty Air Hose
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The supercharger, throttle body and sensors may be removed as an assembly. If not servicing the individual components, remove the supercharger as an assembly.**
- **Cover the inlet area of the supercharger to prevent dirt or debris contamination onto the rotors.**

10. Remove the positive crankcase ventilation (PCV) dirty air hose (1) from the valley cover and supercharger.

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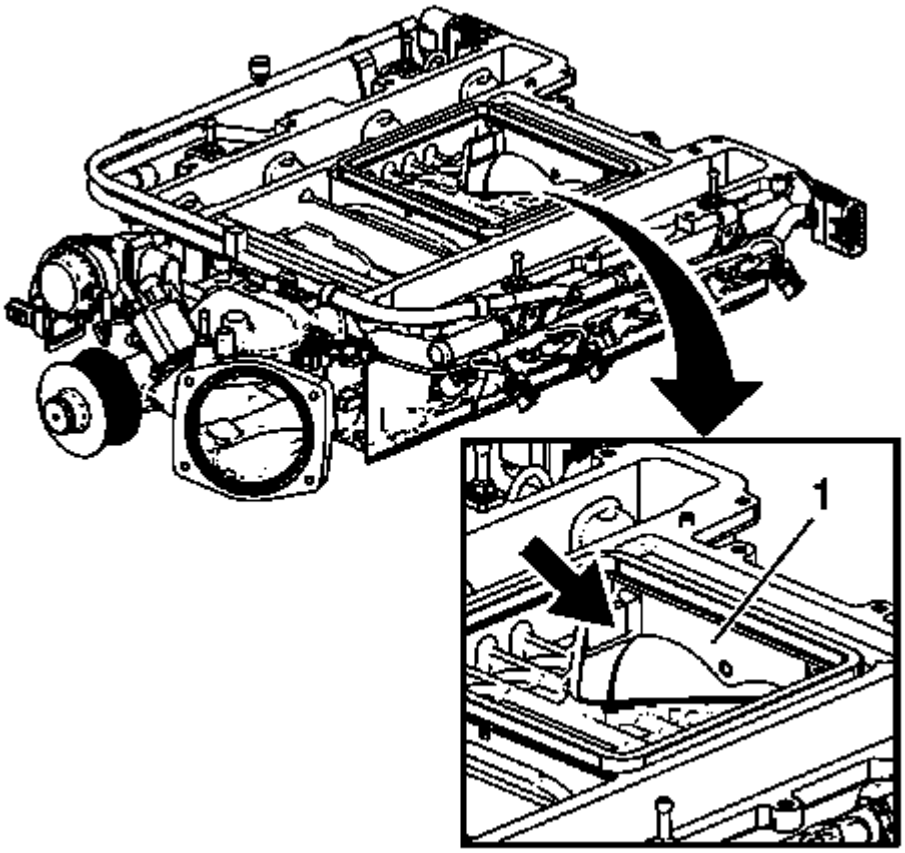


Fig. 45: Identifying Supercharger Rotors Area
Courtesy of GENERAL MOTORS COMPANY

11. Cover the supercharger rotors area (1) to prevent dirt or debris contamination onto the rotors.

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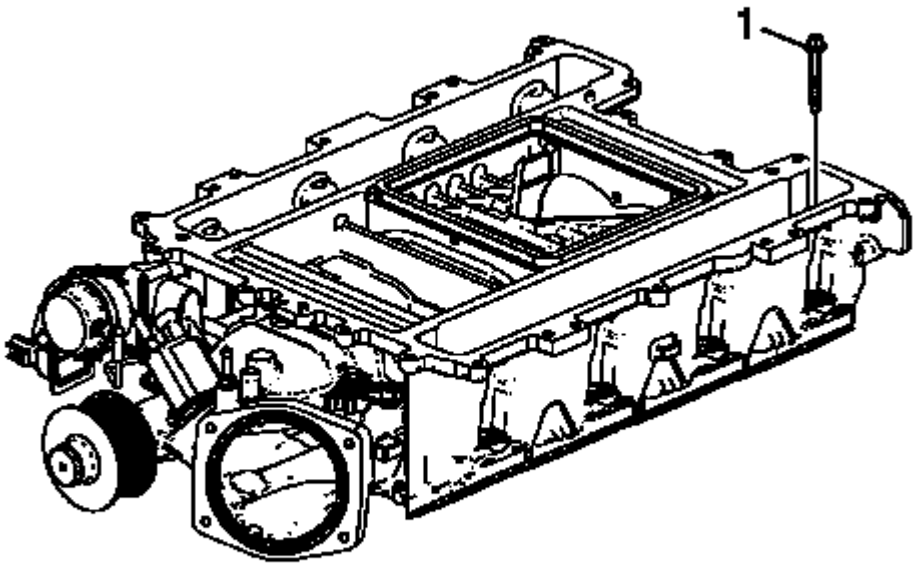


Fig. 46: Identifying Supercharger Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Remove the supercharger bolts (1).

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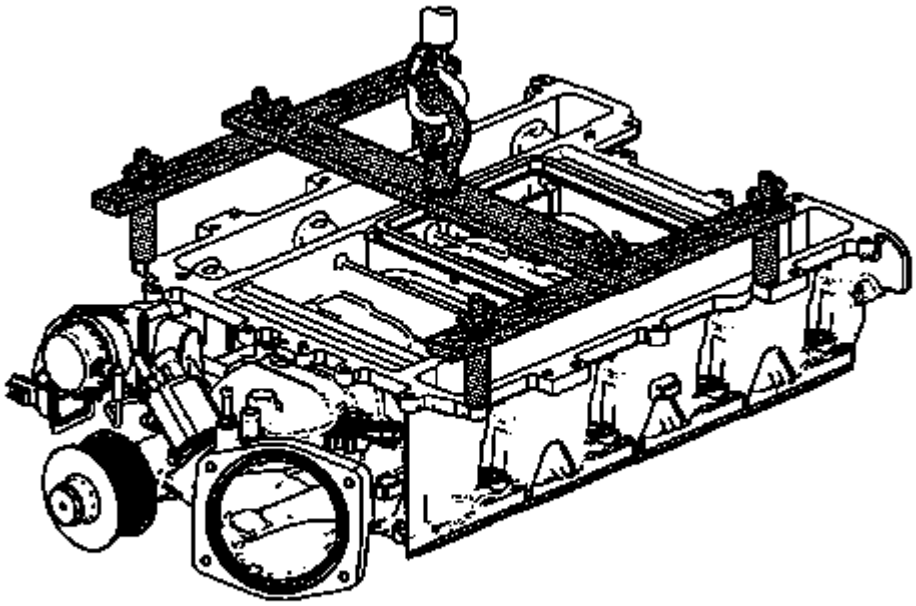


Fig. 47: View Of Supercharger Lift Fixture
Courtesy of GENERAL MOTORS COMPANY

13. Install the **EN-48898** fixture to the supercharger and tighten the **EN-48898** fixture studs and nuts until snug.
14. Using a lifting device, remove the supercharger from the engine.

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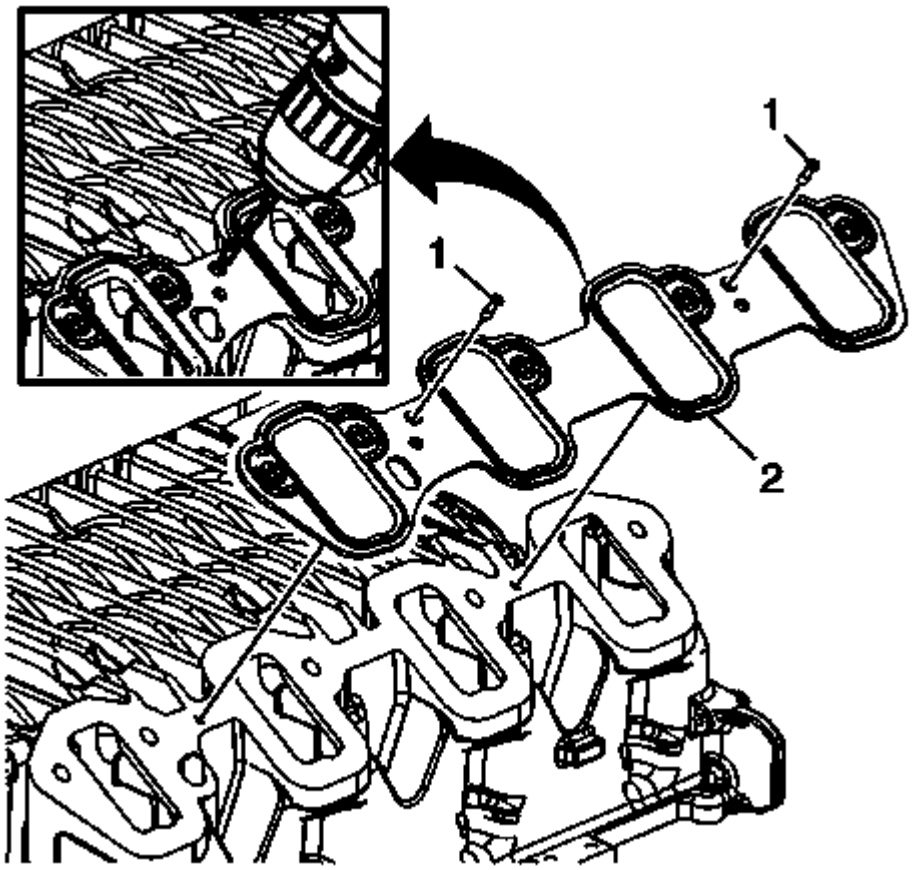


Fig. 48: Identifying Gasket & Rivets
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not allow dirt or debris to enter the passages of the supercharger. Cover the intake ports as required.**
- **With the manifold positioned upside down on a bench, the lower assembly may be positioned onto the intercooler cover dowel pins. Use care not to reposition or bend the dowel pins.**

15. Drill out the gasket rivets (1) using a drill bit with an outside diameter no larger than 3.2 mm (0.125 in). Remove the gasket (2).
16. For supercharger disassembly, refer to **Supercharger Disassemble** .
17. For supercharger cleaning and inspection, refer to **Supercharger Cleaning and Inspection** .

Installation Procedure

1. For supercharger assembly, refer to **Supercharger Assemble** .

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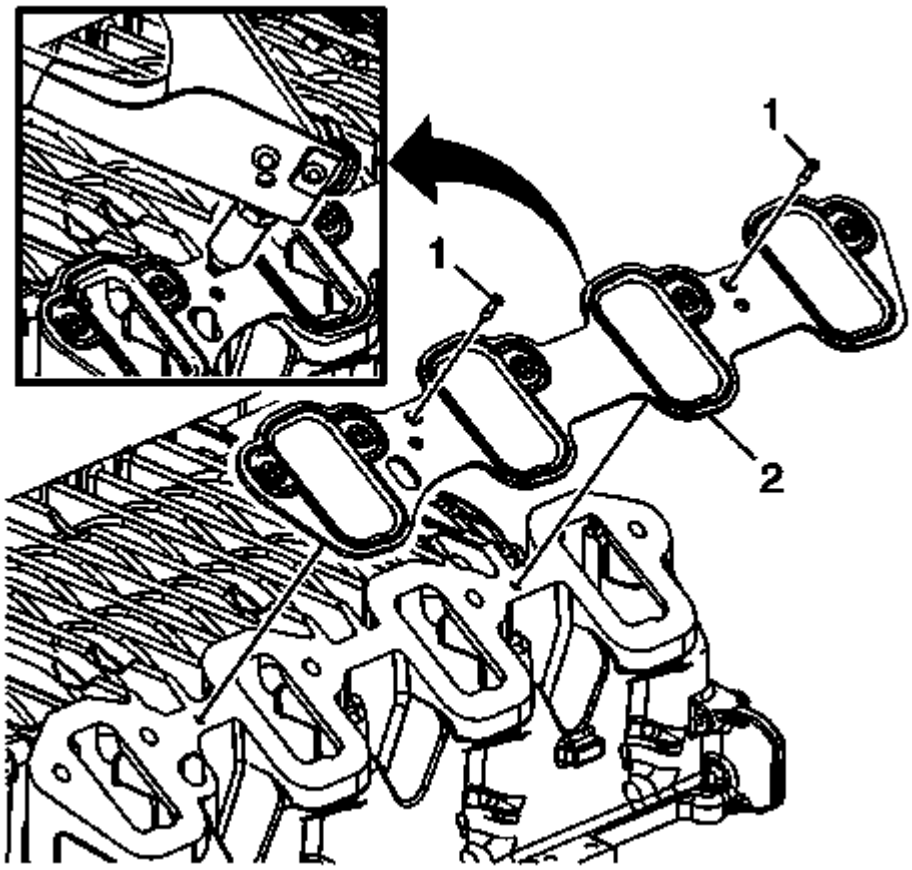


Fig. 49: Identifying Supercharger Gaskets & Rivets
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW gaskets (2).
3. Install NEW gasket rivets (1).

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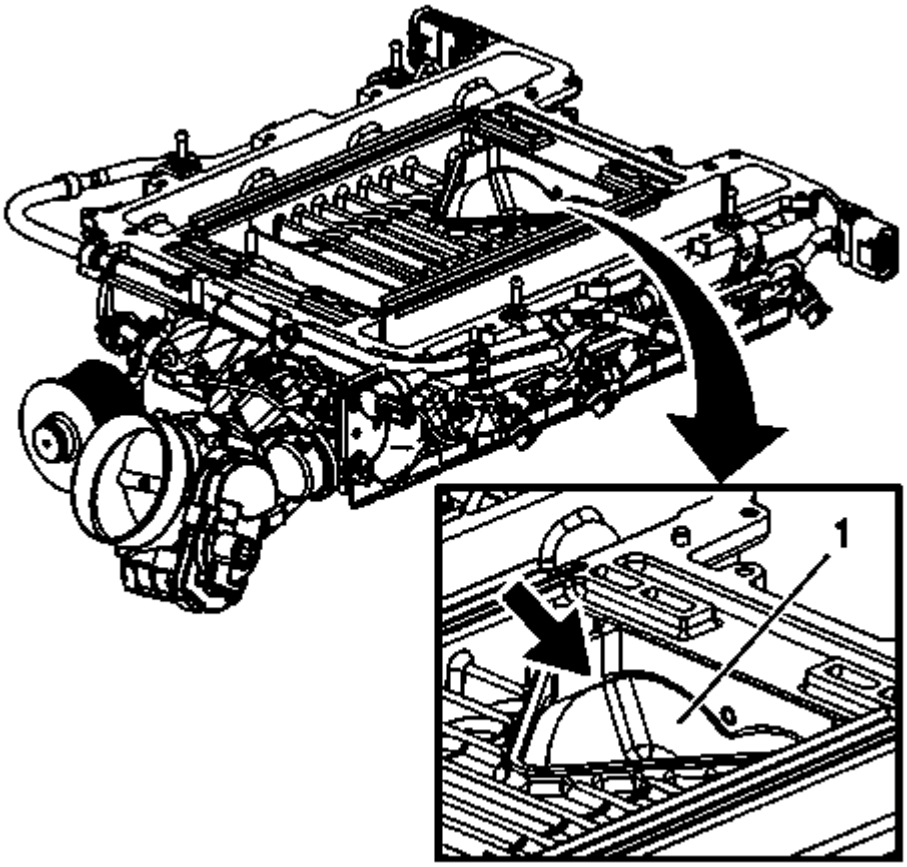


Fig. 50: Identifying Inlet Area Of Supercharger
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The supercharger, throttle body and sensors may be removed as an assembly. If not servicing the individual components, remove the supercharger as an assembly.**
- **Cover the inlet area of the supercharger to prevent dirt or debris contamination onto the rotors.**

4. Cover the supercharger rotors area (1) to prevent dirt or debris contamination onto the rotors.

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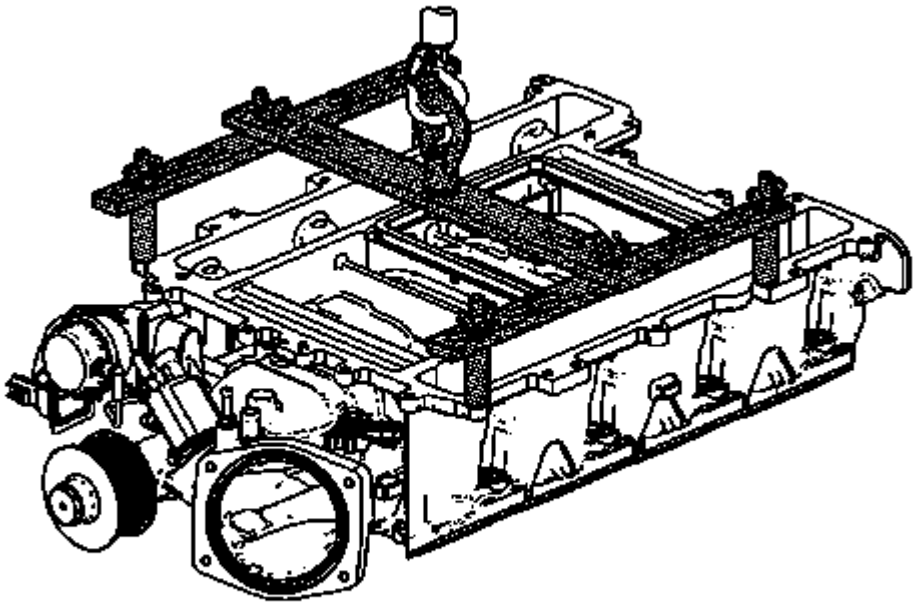


Fig. 51: View Of Supercharger Lift Fixture
Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-48898** fixture to the supercharger.
6. Tighten the **EN-48898** fixture bolts and nuts until snug.
7. Using a lifting device, install the supercharger onto the engine. Align the dowel pin at the right front of the supercharger to the cylinder head.

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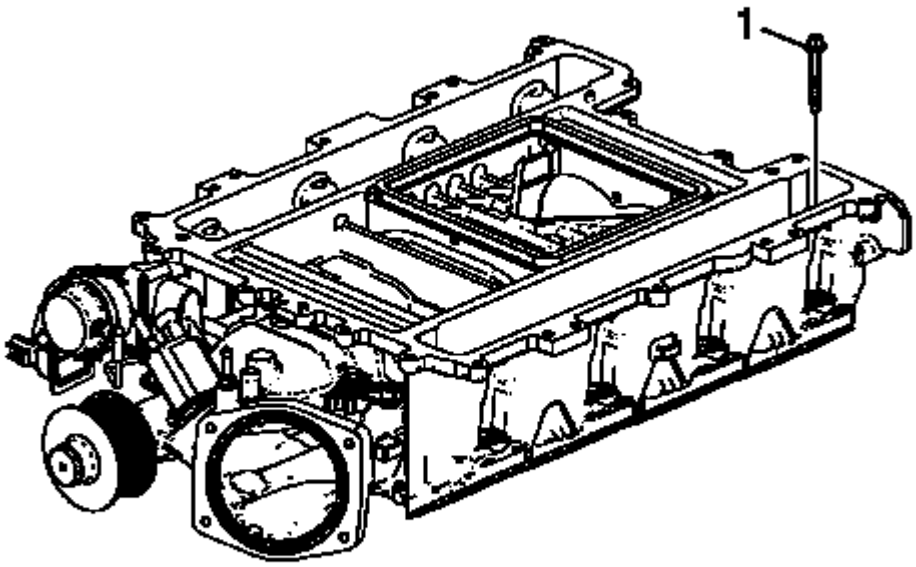


Fig. 52: Identifying Supercharger Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Apply a 5 mm (0.2 in) band of threadlocker to the threads of the bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
9. Install the supercharger bolts (1).

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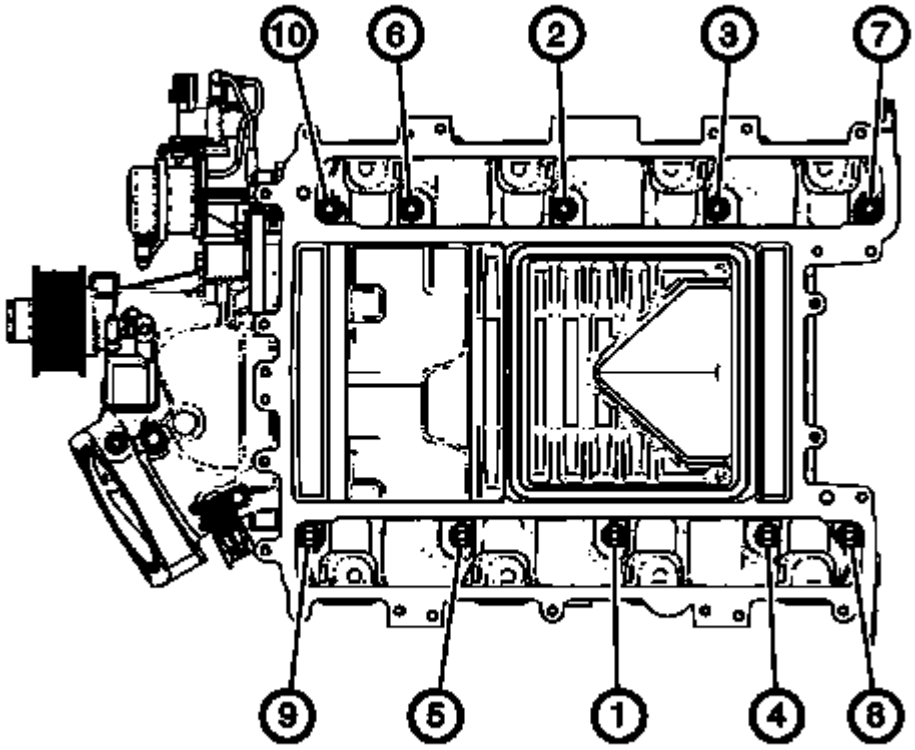


Fig. 53: Identifying Supercharger Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

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

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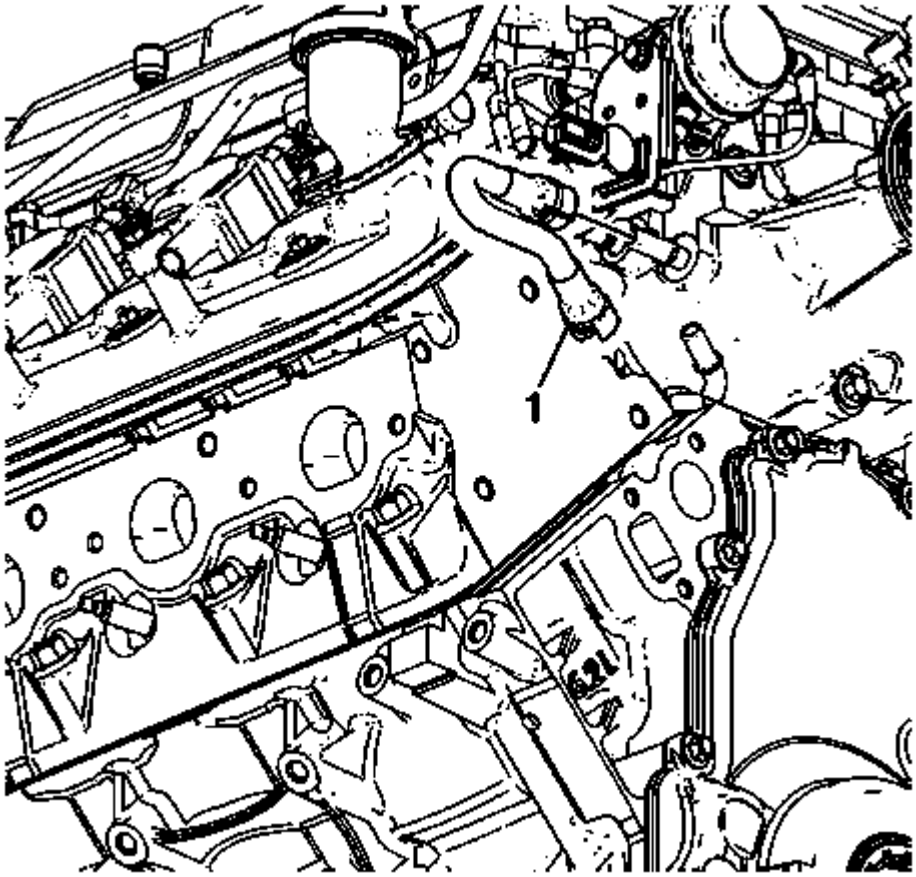


Fig. 54: Identifying Positive Crankcase Ventilation Dirty Air Hose
Courtesy of GENERAL MOTORS COMPANY

11. Install the PCV dirty air hose (1) to the valley cover and supercharger.

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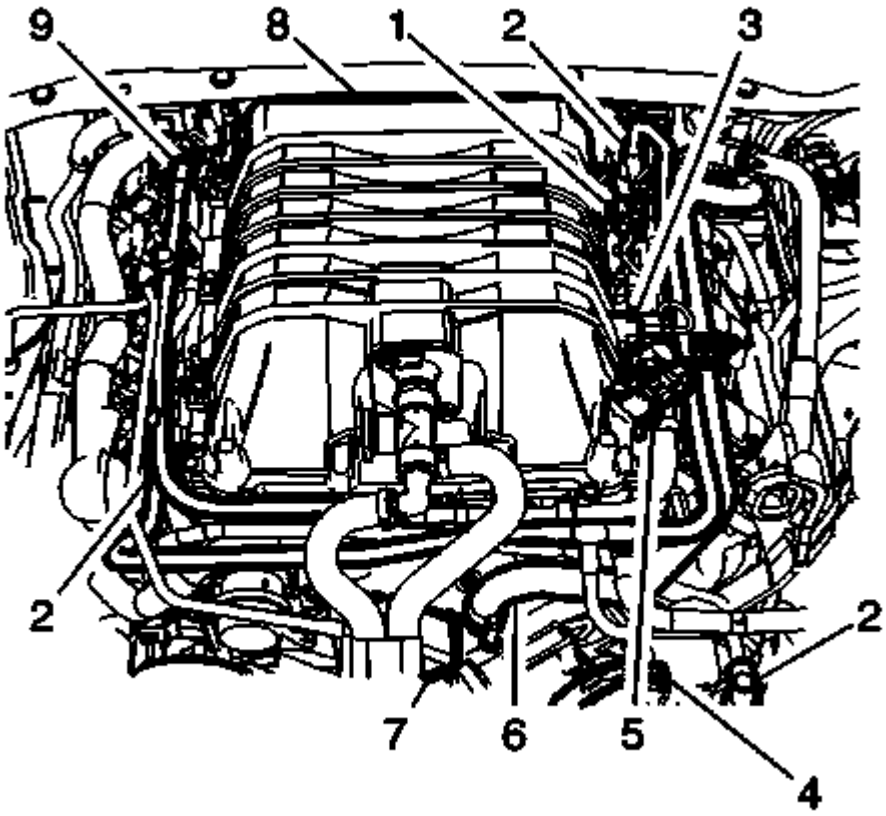


Fig. 55: Supercharger & Fuel System Components
Courtesy of GENERAL MOTORS COMPANY

12. Install the charge air cooler cover. Refer to **Charge Air Cooler Cover Replacement**.
13. Install the fuel injection fuel rail assembly (9). Refer to **Fuel Injection Fuel Rail Assembly Replacement (LSA)** .
14. Connect the brake booster vacuum hose (6).
15. Connect the connector and the EVAP line to the canister purge solenoid (7).
16. Connect the air cleaner outlet duct and tighten the clamp (4).
17. Connect the supercharger pressure (1), intake air temperature (3) and barometric pressure (5) sensors.
18. Install and connect the PCV fresh air tube (2).
19. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front**.
20. Install the supercharger belt. Refer to **Supercharger Belt Replacement**.

CHARGE AIR COOLER REPLACEMENT

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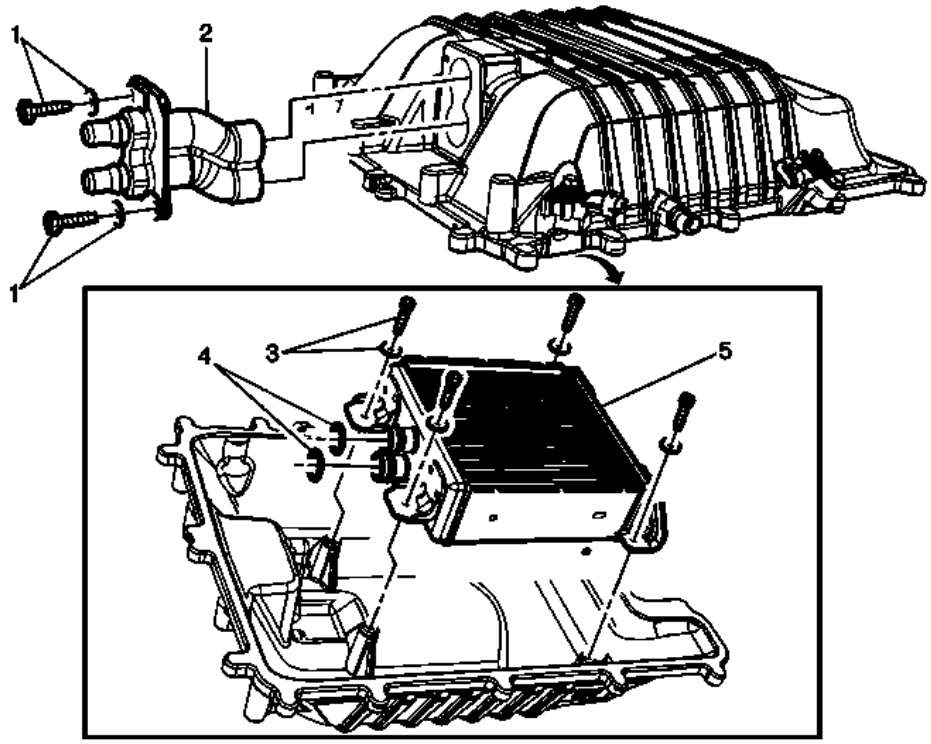


Fig. 56: Charge Air Cooler & Components
Courtesy of GENERAL MOTORS COMPANY

Charge Air Cooler Replacement

Callout	Component Name
Preliminary Procedure 1. Remove the charge air cooler coolant hoses from the cooler. Refer to **Charge Air Cooler Coolant Hose Replacement (LSA)** . 2. Remove the charge air cooler cover. Refer to **Charge Air Cooler Cover Replacement**.	
1	Charge Air Cooler Outlet Fastener (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 (89 lb in)
2	Charge Air Cooler Outlet
3	Charge Air Cooler Fastener (Qty: 4) **NOTE:** **Apply threadlocker before installing the fastener.**

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	Tighten 5 (44 lb in)
4	Charge Air Cooler Outlet Seals **NOTE:** **Do not reuse seals.**
5	Charge Air Cooler

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

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

1. Remove the engine covers. Refer to **Engine Cover Replacement**.
2. Remove the air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement (LSA)** , **Air Cleaner Resonator and Outlet Duct Replacement (L99 or LS3)** .
3. Disconnect the electrical connector for the fuel injectors.
4. Disconnect the electrical connectors from the throttle body.
5. Disconnect the fuel feed for the fuel injectors. Refer to **Fuel Line Replacement - Engine (L99 or LS3)** .
6. Remove positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Dirty Air)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Clean Air)**.

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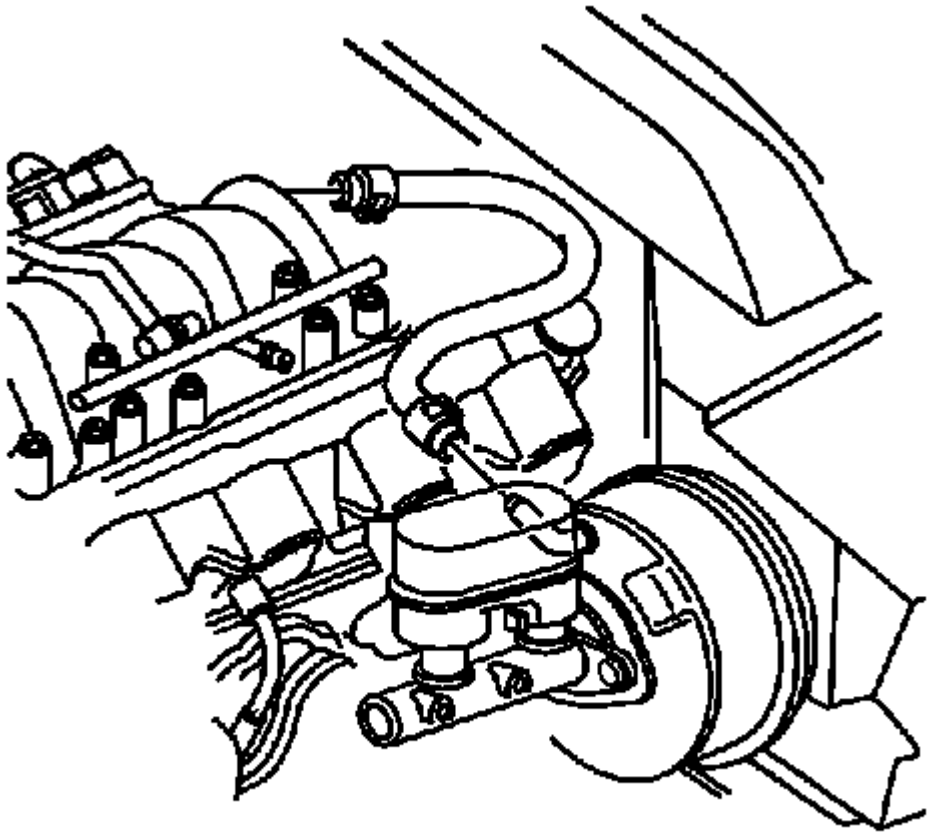


Fig. 57: Identifying Vacuum Booster Hose
Courtesy of GENERAL MOTORS COMPANY

7. Remove the vacuum hose from the brake booster.
8. Disconnect the electrical connector from the manifold absolute pressure (MAP) sensor.

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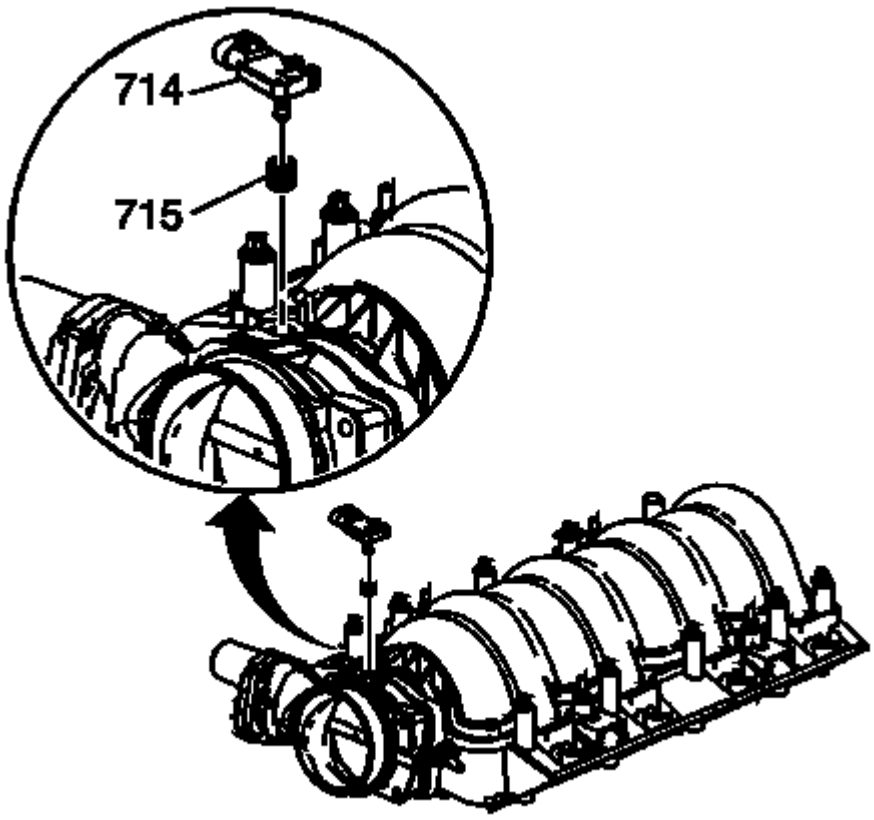


Fig. 58: MAP Sensor & Grommet
Courtesy of GENERAL MOTORS COMPANY

9. Remove the MAP sensor (714).
10. Remove the grommet (715) from the sensor, as required.

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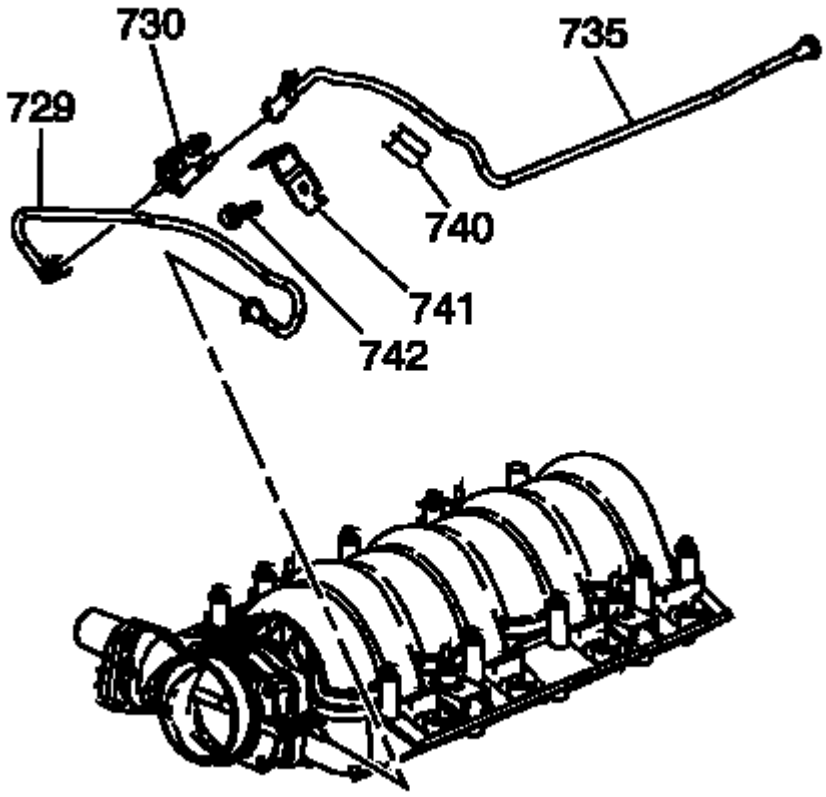


Fig. 59: EVAP Clip, Bolt, Bracket, Valve & Tubes
Courtesy of GENERAL MOTORS COMPANY

11. Remove the evaporative emission (EVAP) clip (740), bolt (742), bracket (741), valve (730) and tubes (729, 735).

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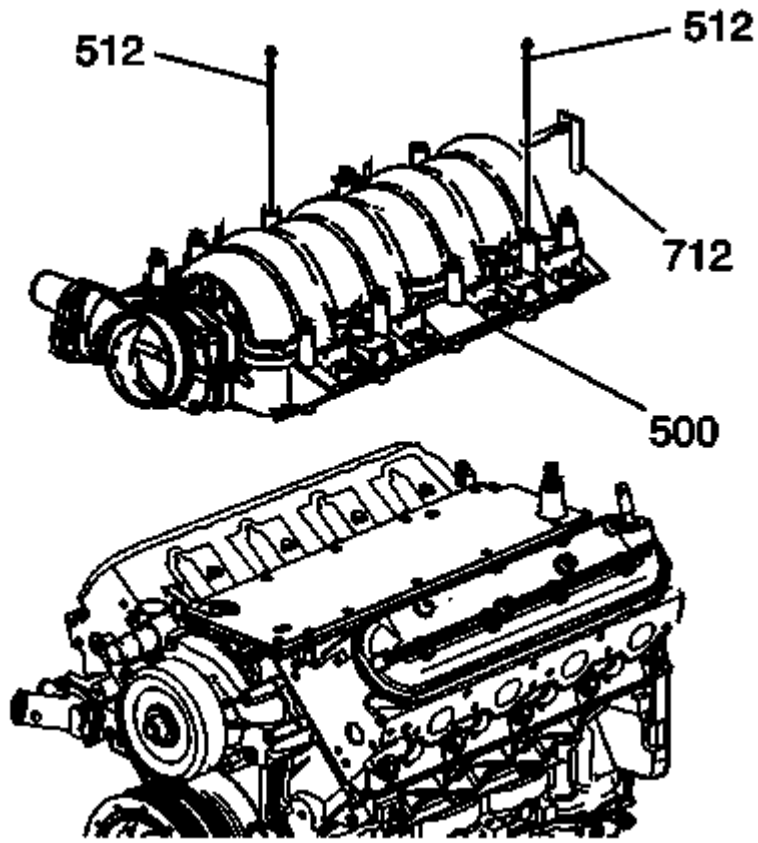


Fig. 60: Intake Manifold, Bolts & Fuel Rail Stop Bracket
Courtesy of GENERAL MOTORS COMPANY

12. Remove the intake manifold bolts (512) and the fuel rail stop bracket (712).
13. Remove the intake manifold (500).

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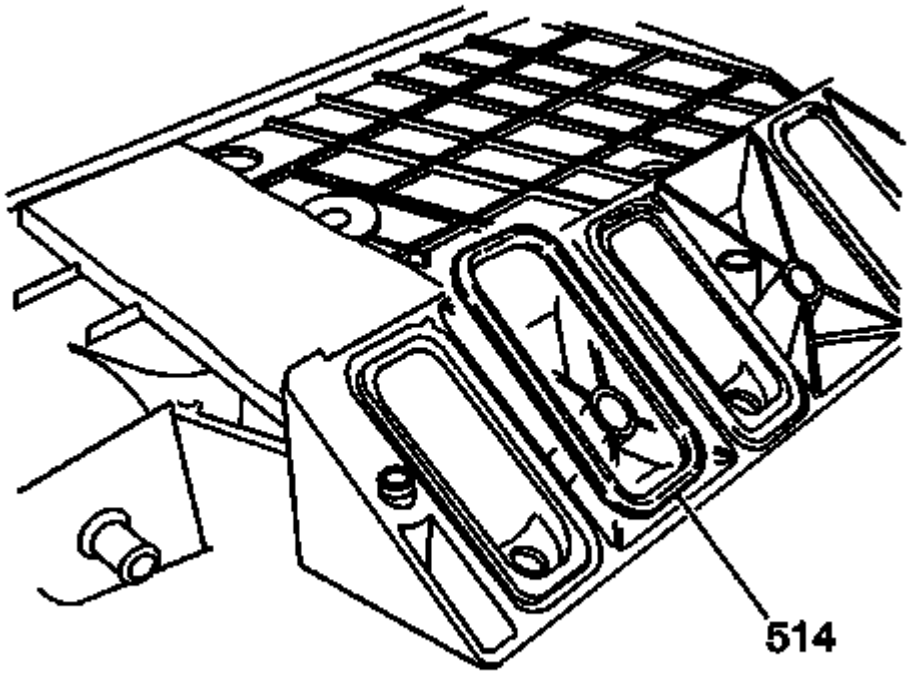


Fig. 61: View Of Intake Manifold-To-Cylinder Head Gaskets
Courtesy of GENERAL MOTORS COMPANY

14. Remove the intake manifold gaskets (514).
15. Discard the intake manifold gaskets.
16. If necessary clean and inspect intake manifold. Refer to **Intake Manifold Cleaning and Inspection** .

Installation Procedure

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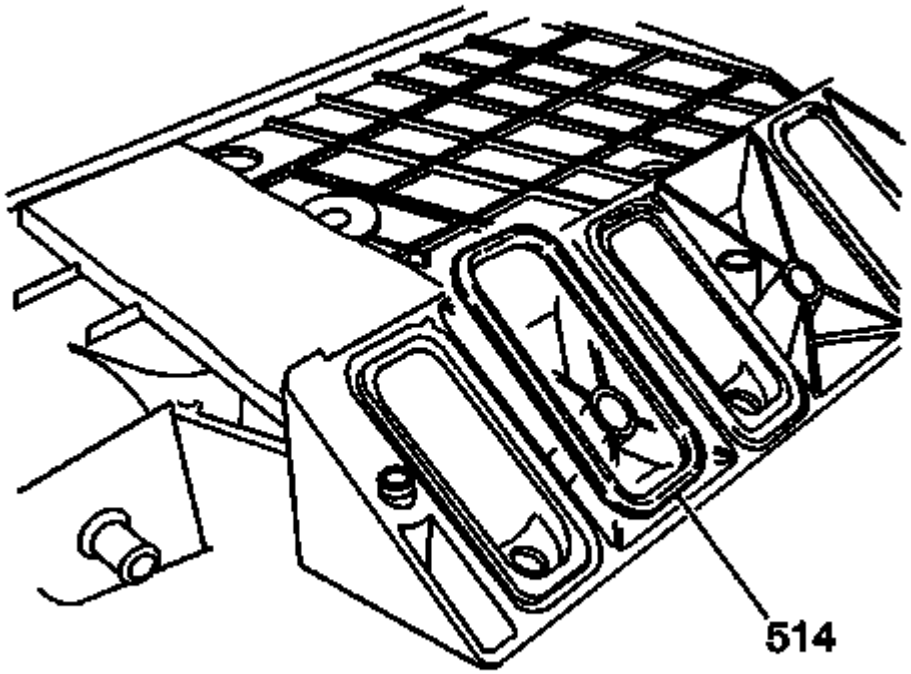


Fig. 62: View Of Intake Manifold-To-Cylinder Head Gaskets
Courtesy of GENERAL MOTORS COMPANY

NOTE: DO NOT reuse the intake manifold gaskets. Install NEW intake manifold gaskets.

NOTE:

- **The intake manifold, throttle body, fuel injection rail and injectors may be removed as an assembly. If not servicing the individual components, install the intake manifold as a complete assembly.**
- **DO NOT use the intake manifold gaskets again. Install NEW intake manifold-to-cylinder head gaskets.**

1. Install NEW intake manifold-to-cylinder head gaskets (514).

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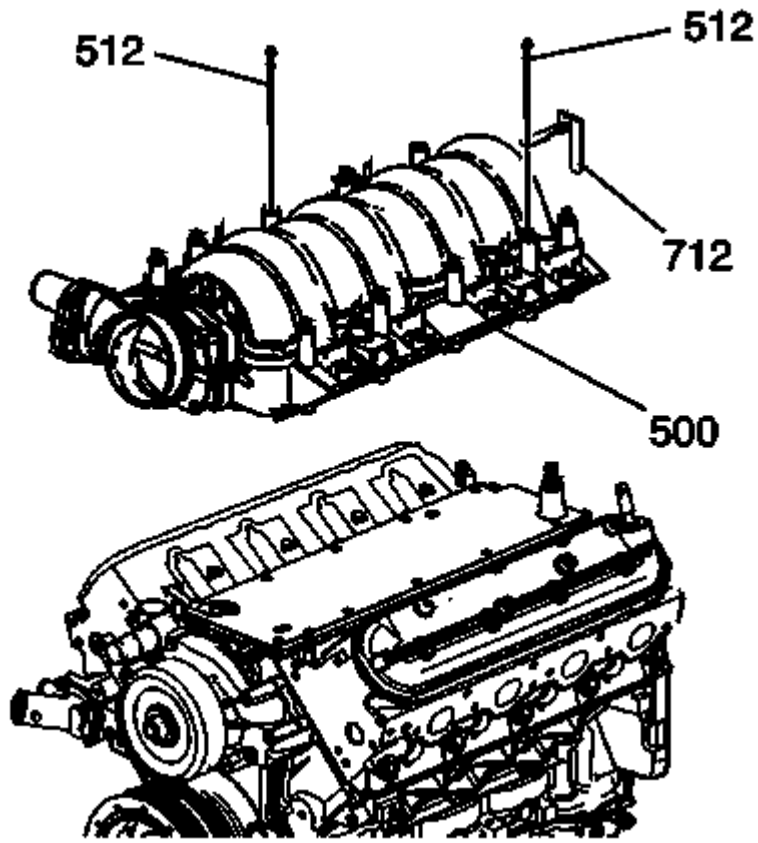


Fig. 63: Intake Manifold, Bolts & Fuel Rail Stop Bracket
Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold (500).
3. Apply a 5 mm (0.20 in) band of threadlocker to the threads of the intake manifold bolts (512). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
4. Install the fuel rail stop bracket (712).
5. Install the intake manifold bolts (512).

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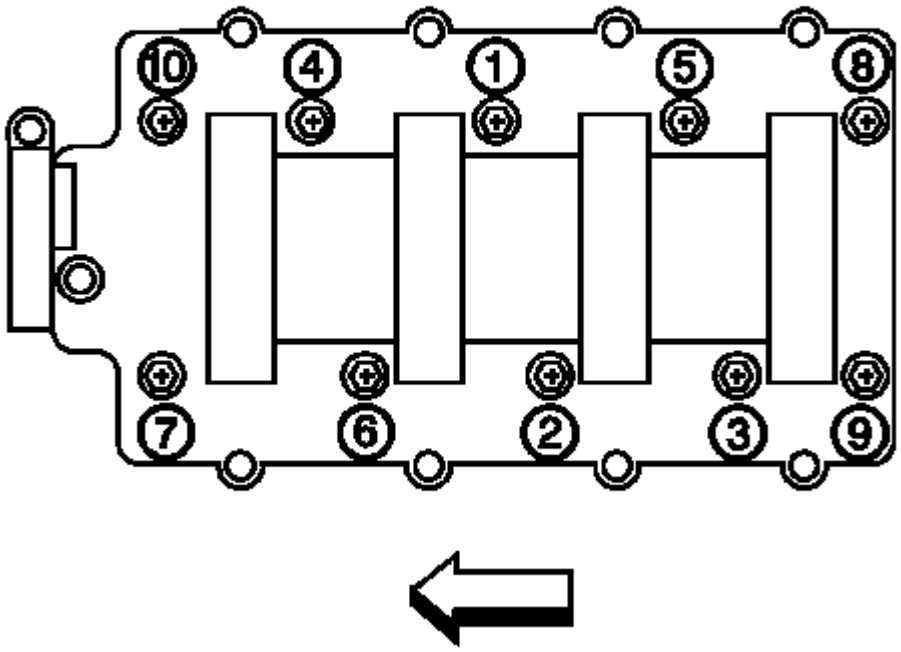


Fig. 64: Identifying Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Tighten the intake manifold bolts to the sequence below:
   - First Pass: Tighten the intake manifold bolts in sequence to 5 N.m (44 lb in).
   - Second Pass: Tighten the intake manifold bolts in sequence to 10 N.m (89 lb in).

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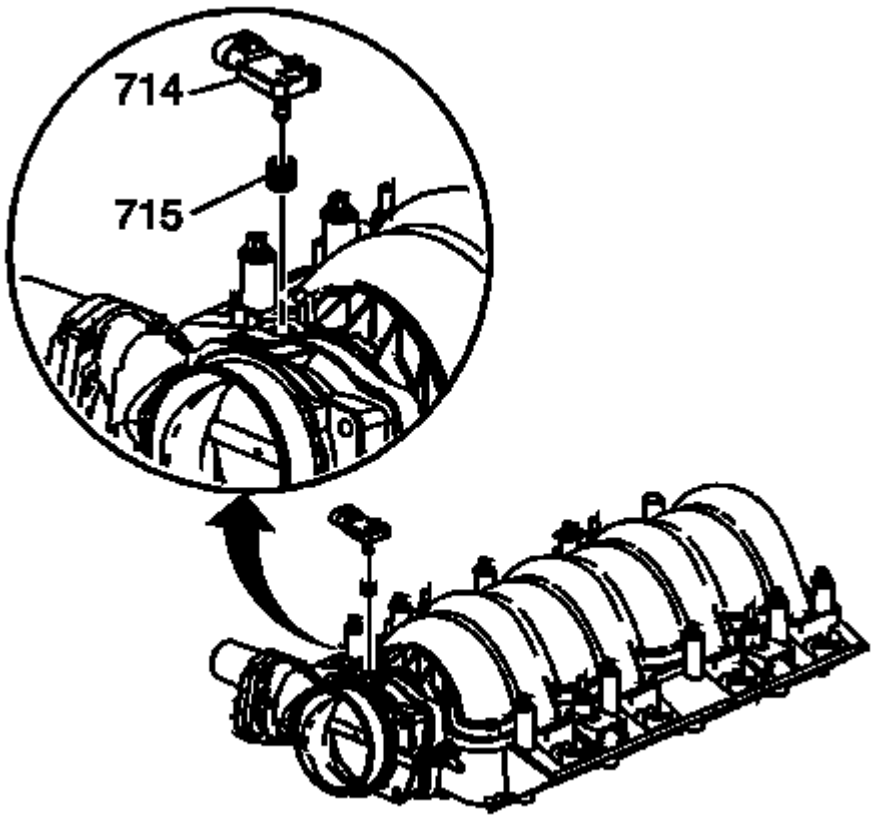


Fig. 65: MAP Sensor & Grommet
Courtesy of GENERAL MOTORS COMPANY

7. Lubricate the MAP sensor grommet (715) with clan engine oil.
8. Install the MAP sensor (714) and grommet (715).

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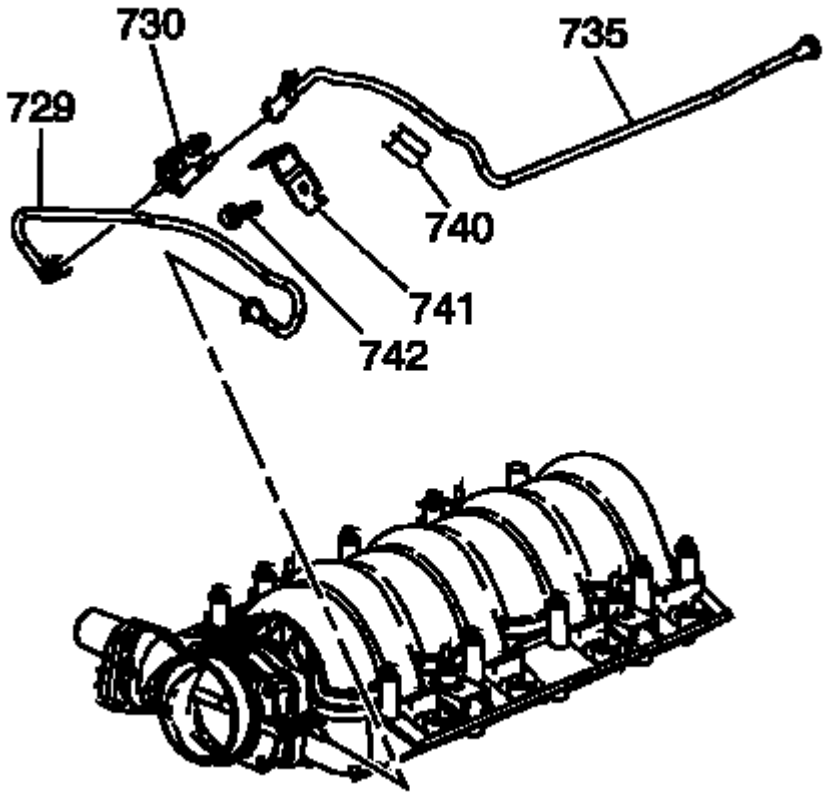


Fig. 66: EVAP Clip, Bolt, Bracket, Valve & Tubes
Courtesy of GENERAL MOTORS COMPANY

9. Install the EVAP valve (730), bracket (741) and bolt (742).

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

10. Install the EVAP tubes (729, 735).
11. Install the fuel rail. Refer to **Fuel Rail and Injectors Installation** .
12. Connect the electrical connector for the MAP sensor.

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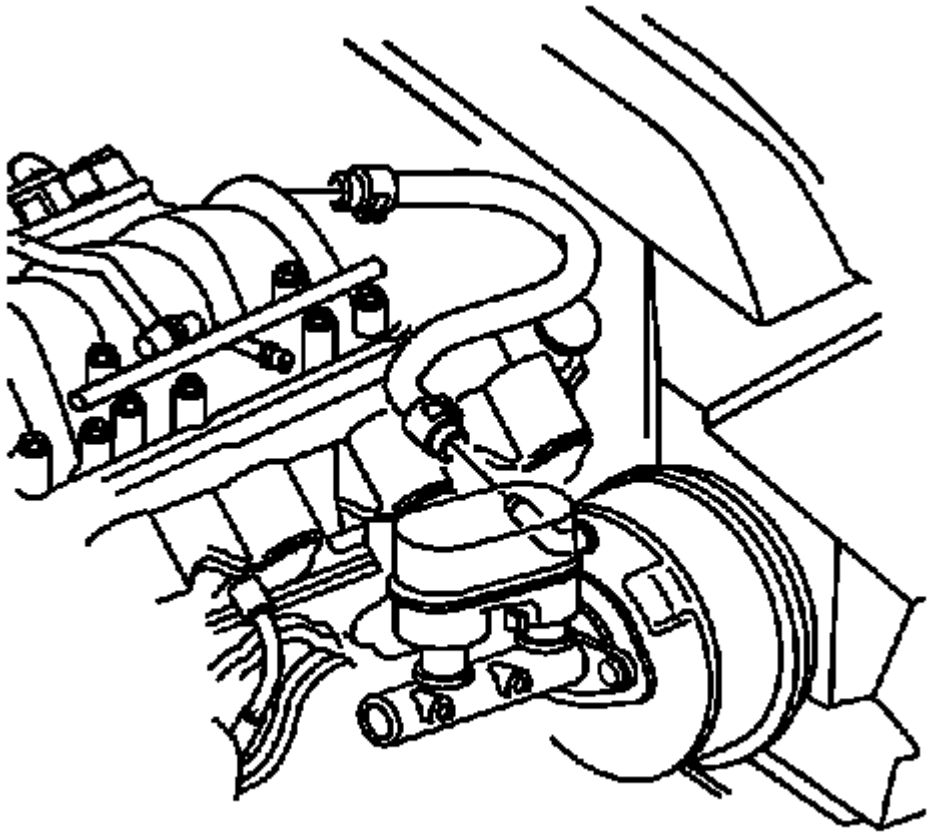


Fig. 67: Identifying Vacuum Booster Hose
Courtesy of GENERAL MOTORS COMPANY

13. Install the vacuum hose for the brake booster.
14. Connect the electrical connectors (3) for the throttle body.
15. Connect the electrical connector (1) for the fuel injectors.
16. Refill the cooling system. Refer to **Cooling System Draining and Filling (LFX, Static Fill)** , **Cooling System Draining and Filling (LSA, LS3, L99 Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
17. Install the engine covers. Refer to **Engine Cover Replacement**.

ENGINE BLOCK VALLEY COVER REPLACEMENT

Removal Procedure

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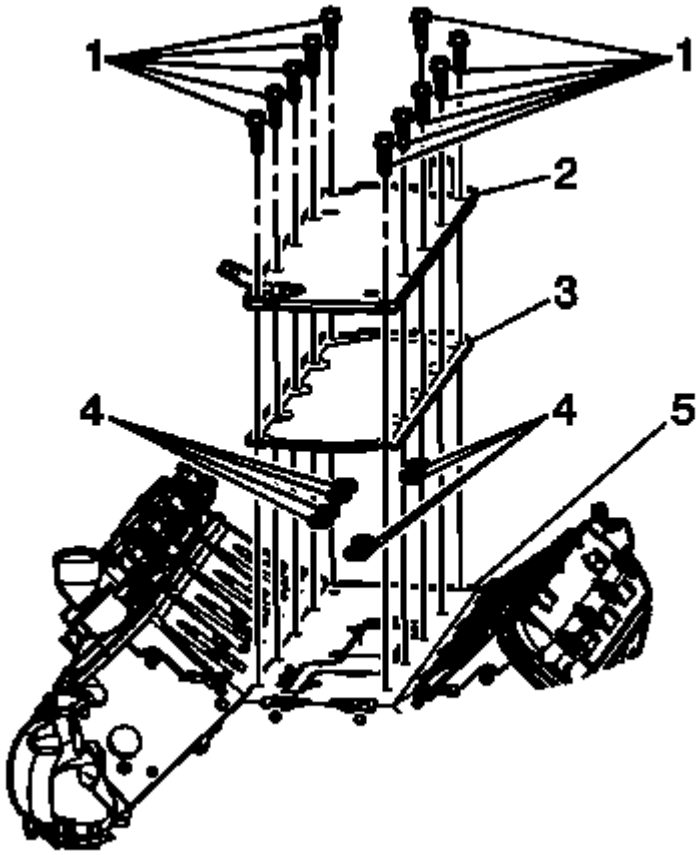


Fig. 68: Engine Valley Cover, Retaining Bolts, Gasket & O-Rings
Courtesy of GENERAL MOTORS COMPANY

1. Remove the supercharger. Refer to **Supercharger Replacement**.
2. Remove the oil pressure switch. Refer to **Engine Oil Pressure Sensor and/or Switch Replacement (L99/LS3)**, **Engine Oil Pressure Sensor and/or Switch Replacement (LSA)**.
3. Remove the engine valley retaining bolts (1).
4. Remove the engine valley cover (2).
5. Remove the engine valley gasket (3).
6. Remove the O-rings (4) from the engine valley cover (2).

Installation Procedure

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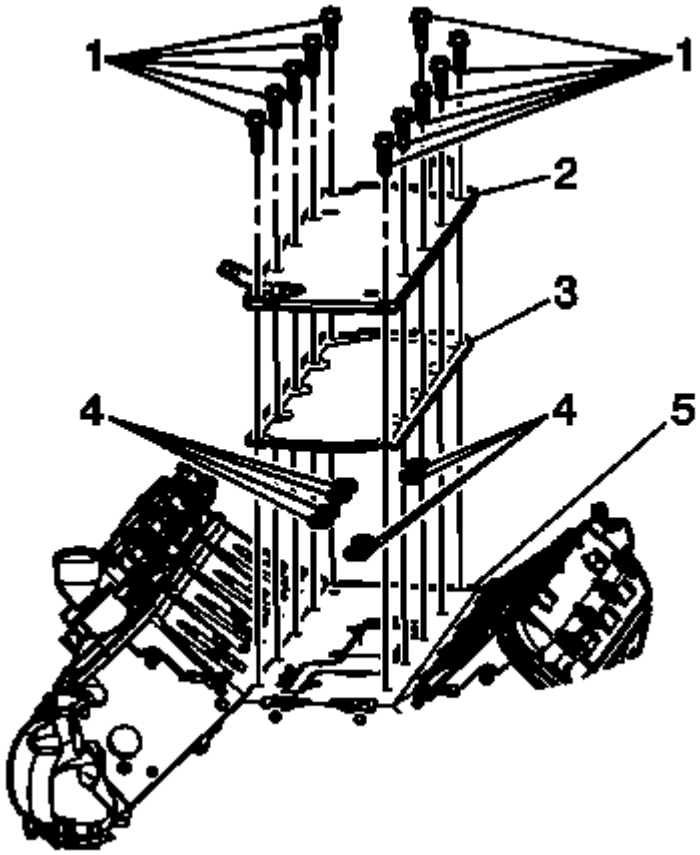


Fig. 69: Engine Valley Cover, Retaining Bolts, Gasket & O-Rings
Courtesy of GENERAL MOTORS COMPANY

1. Install the O-rings (4) to the engine valley cover (2).
2. Install the engine valley gasket (3).
3. Install the engine valley cover (2).
4. Install the retaining bolts (1).

CAUTION: Refer to Fastener Caution .

5. Tighten the engine valley retaining bolts to 25 N.m (18 lb ft).
6. Install the supercharger. Refer to **Supercharger Replacement**.
7. Install the oil pressure switch. Refer to **Engine Oil Pressure Sensor and/or Switch Replacement (L99/LS3)**, **Engine Oil Pressure Sensor and/or Switch Replacement (LSA)**.

VALVE LIFTER OIL MANIFOLD REPLACEMENT

Removal Procedure

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1. Remove the intake manifold. Refer to **Intake Manifold Replacement**
2. Disconnect the engine harness electrical connector from the oil pressure sensor and oil manifold..

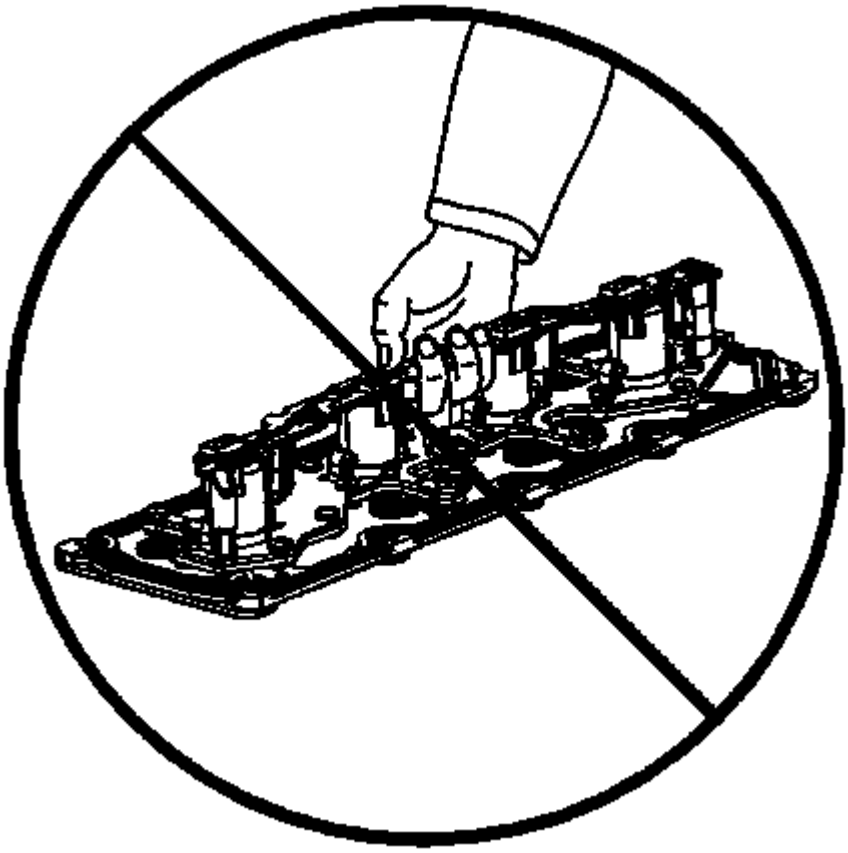


Fig. 70: Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS COMPANY

3. DO NOT lift the valve lifter oil manifold by the electrical lead frame.

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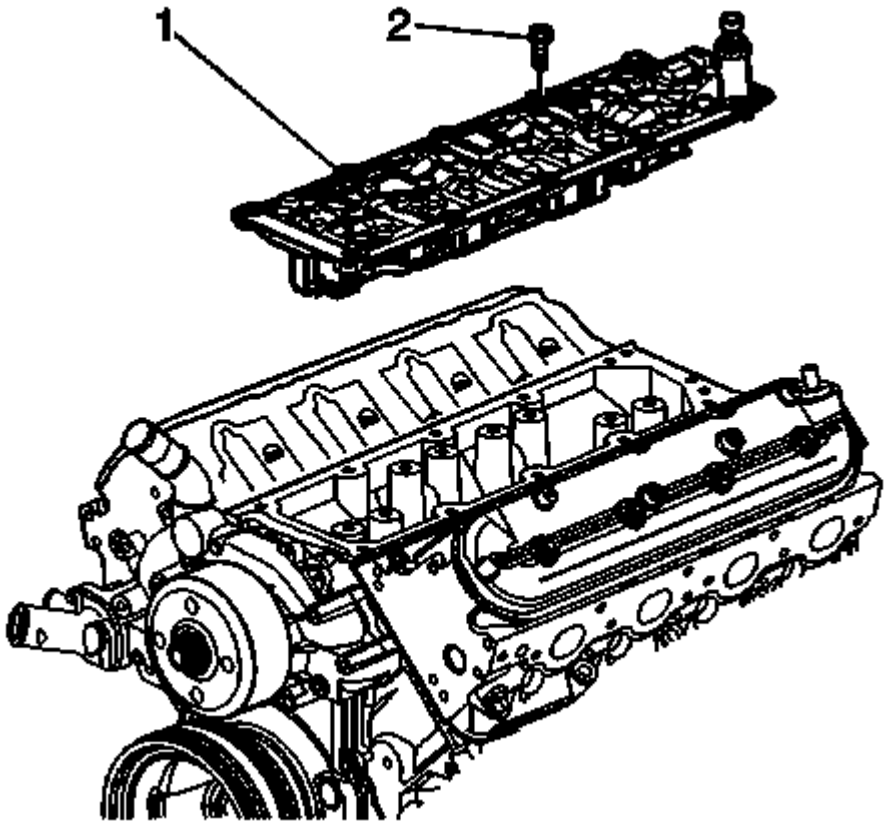


Fig. 71: Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS COMPANY

4. Remove the valve lifter oil manifold bolts (2).
5. Remove the valve lifter oil manifold (1).

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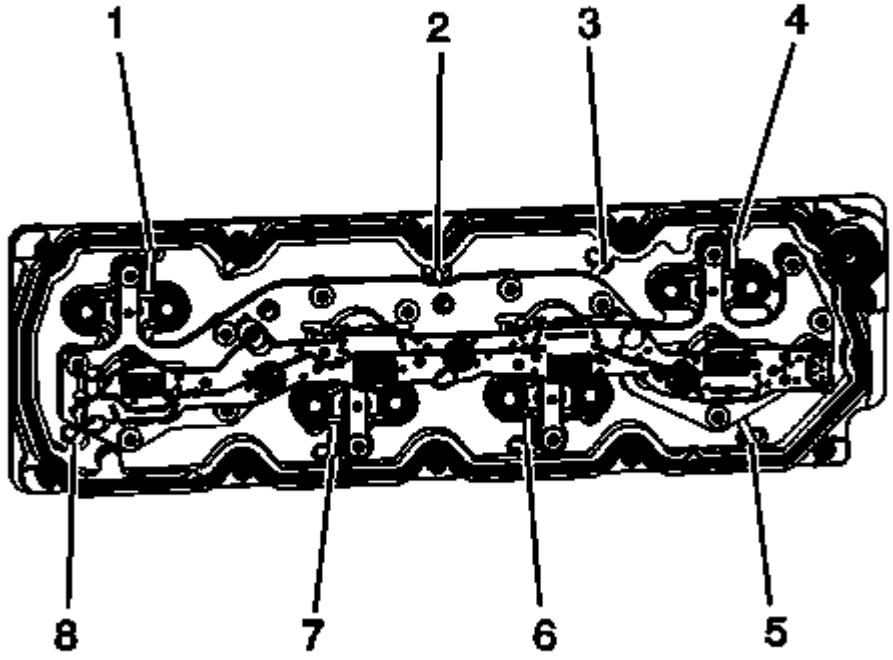


Fig. 72: Gasket Retaining Strap Locations
Courtesy of GENERAL MOTORS COMPANY

NOTE: Remove only the outer gasket from the manifold. Do not disassemble any of the internal components of the manifold in an attempt to remove the 8 inner sealing gaskets. If the inner gaskets are cut or damaged, replace the manifold as an assembly. Only use a wire-cutter type tool in order to minimize the amount of debris. Do not use a rotary-type cutting tool on the retaining straps.

6. Identify the 8 gasket retaining strap locations (1-8).

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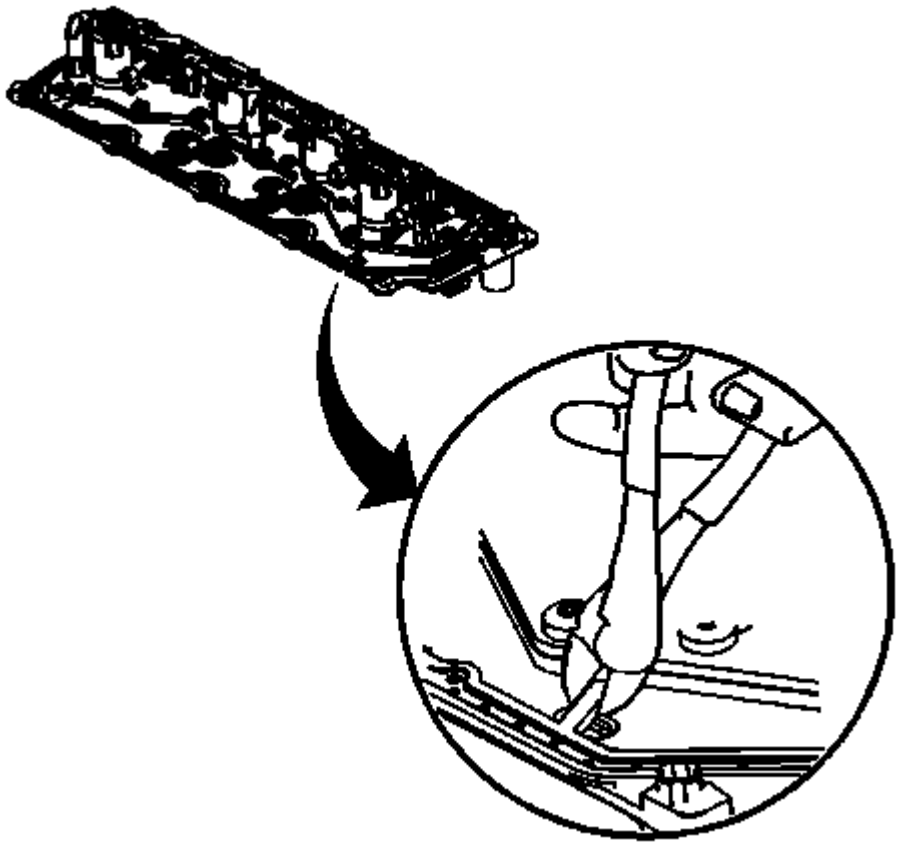


Fig. 73: Retaining Strap
Courtesy of GENERAL MOTORS COMPANY

7. Using a cutter type tool, cut the 8 retaining straps.

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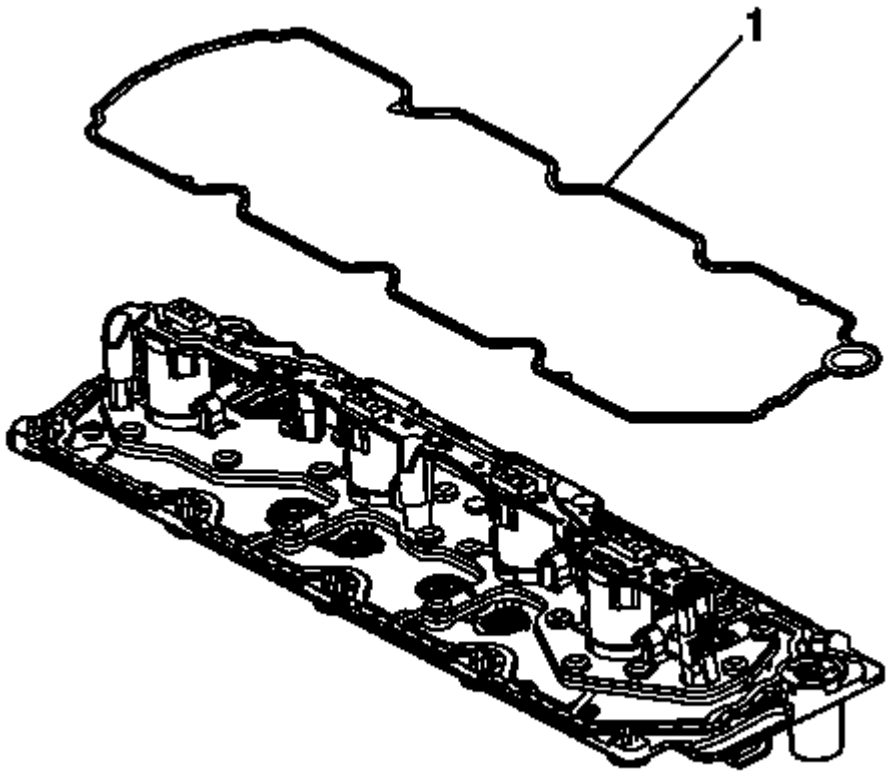


Fig. 74: Identifying Valve Cover Outer Gasket
Courtesy of GENERAL MOTORS COMPANY

8. Remove the outer gasket (1) from the valve lifter oil manifold.

Installation Procedure

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

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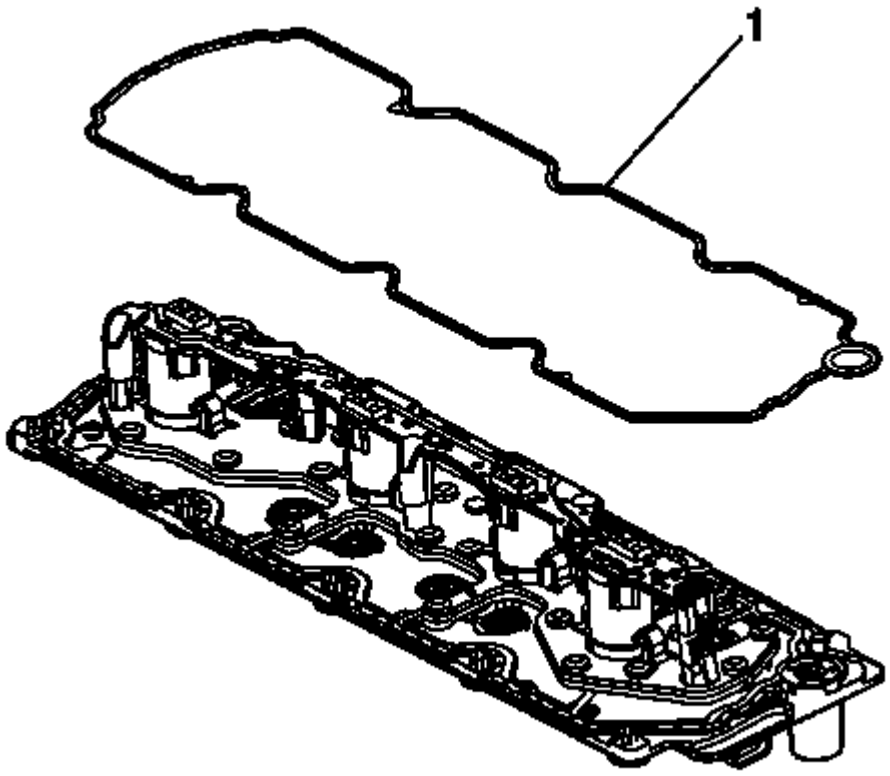


Fig. 75: Identifying Valve Cover Outer Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Place the service gasket (1) onto the valve lifter oil manifold.

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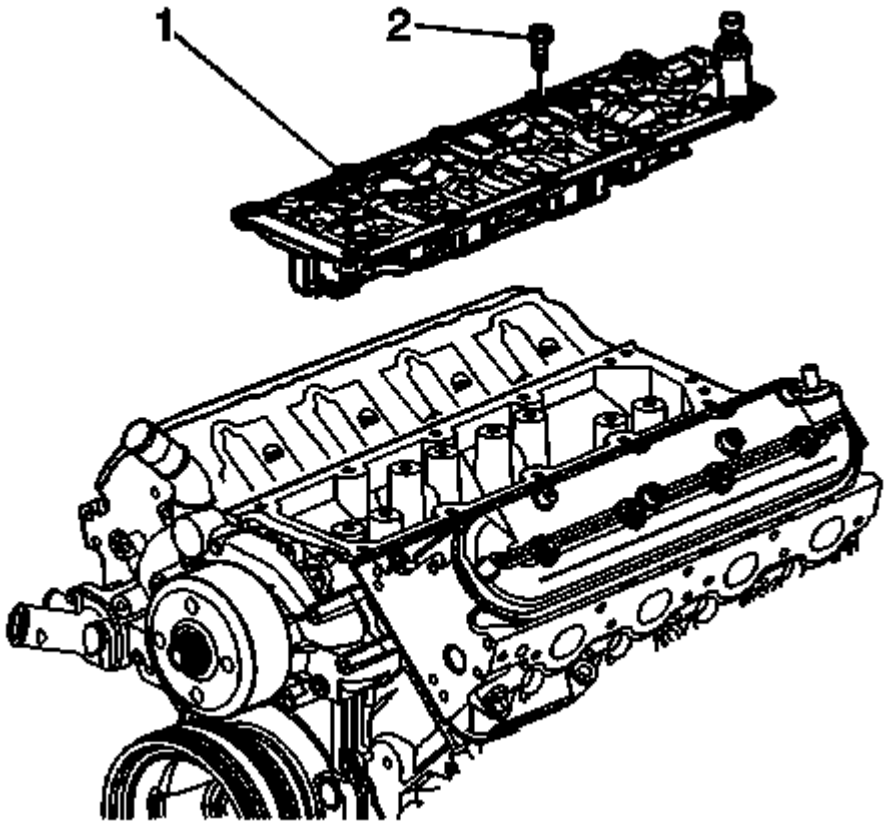


Fig. 76: Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS COMPANY

2. Install the valve lifter oil manifold (1) to the engine.

CAUTION: Refer to Fastener Caution

3. Install the valve lifter oil manifold bolts (2) and tighten to 25 N.m (18 lb ft).
4. Connect the engine harness electrical connector (1) to the oil pressure sensor.
5. Install the intake manifold. Refer to **Intake Manifold Replacement**

VALVE LIFTER OIL FILTER REPLACEMENT

Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Disconnect the engine harness electrical connector (1) from the oil pressure sensor.

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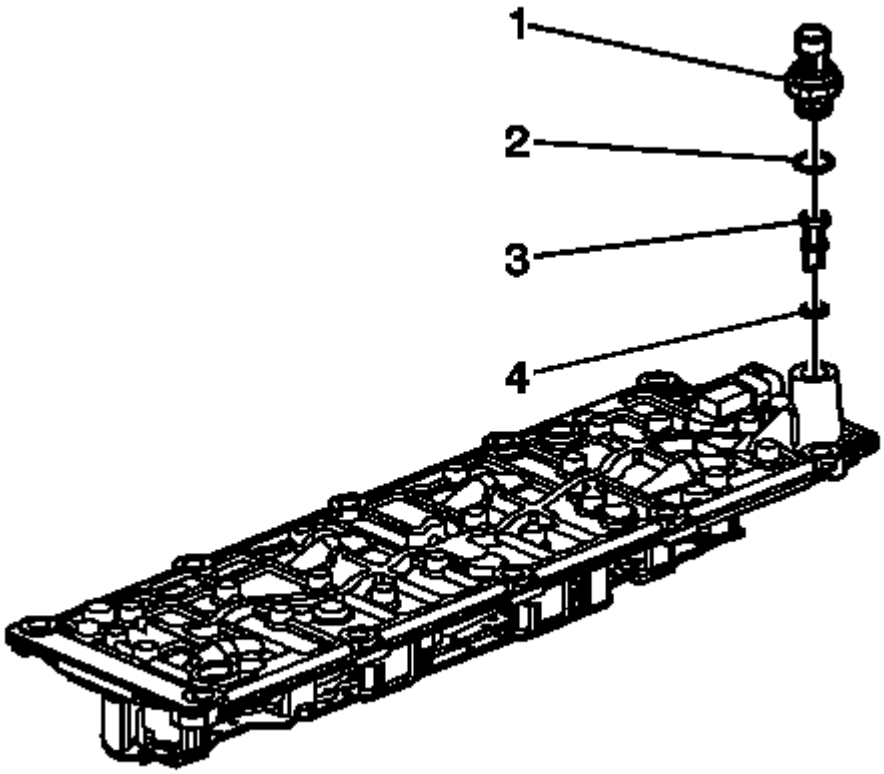


Fig. 77: View Of Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pressure sensor (1) and washer (2).
4. Remove and discard the valve lifter oil filter (3).
5. Remove and discard the valve lifter oil filter O-ring seal (4).

Installation Procedure

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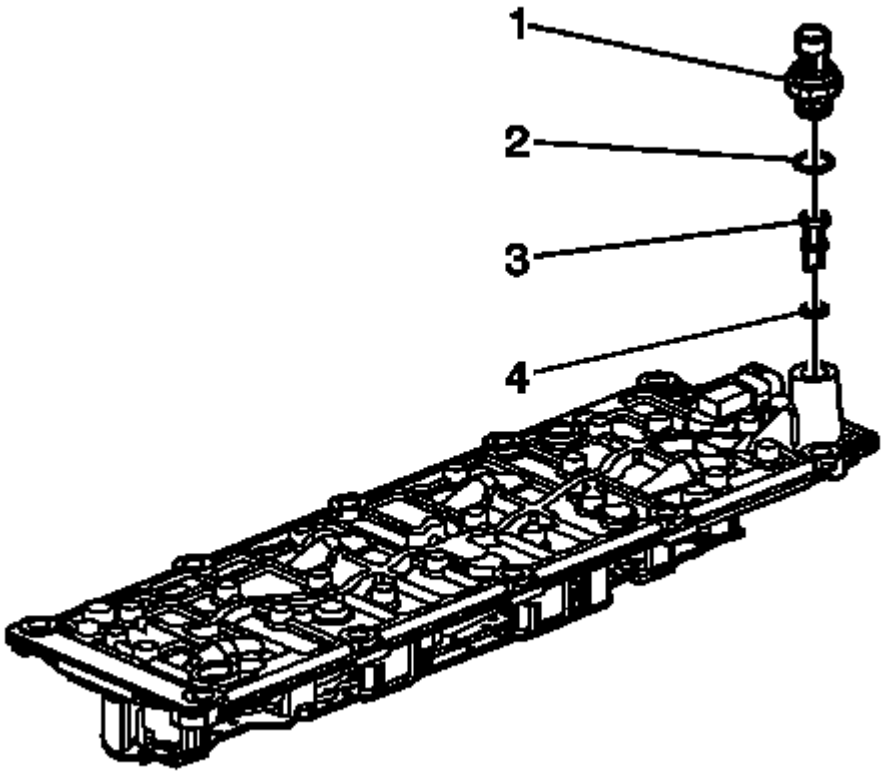


Fig. 78: View Of Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW valve lifter oil filter O-ring seal (4) into the valve lifter oil manifold.
2. Install the NEW valve lifter oil filter (3).
3. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent to the threads of the oil pressure sensor.

CAUTION: Refer to Fastener Caution .

4. Install the oil pressure sensor washer (2) and sensor (1) and tighten the sensor to 35 N.m (26 lb ft).
5. Connect the engine harness electrical connector (1) to the oil pressure sensor.
6. Install the intake manifold. Refer to **Intake Manifold Replacement**.

VALVE ROCKER ARM COVER REPLACEMENT - LEFT SIDE

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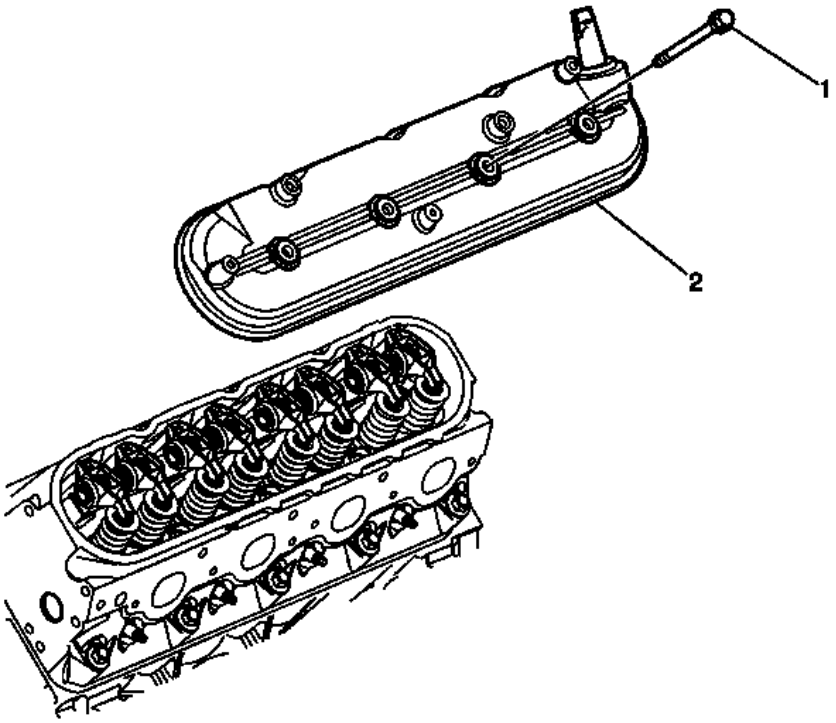


Fig. 79: Valve Rocker Arm Cover - Left Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Replacement - Left Side

Callout	Component Name
Preliminary Procedures 1. Remove the crankcase ventilation hoses/pipes. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Dirty Air)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Clean Air)**. 2. Remove the ignition coil. Refer to **Ignition Coil Replacement (L99 or LS3)** , **Ignition Coil Replacement (LSA)** .	
1	Valve Rocker Arm Cover Fastener (Qty: 4) **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** If valve rocker arm cover grommets are cracked, or damaged, replace the valve rocker arm cover bolts. The grommet is serviced with the rocker arm cover bolt. **Tighten** 12 N.m (106 lb in)
	Valve Rocker Arm Cover

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2	**Procedure** 1. Disconnect any electrical connectors. 2. Transfer components as necessary.

VALVE ROCKER ARM COVER REPLACEMENT - RIGHT SIDE

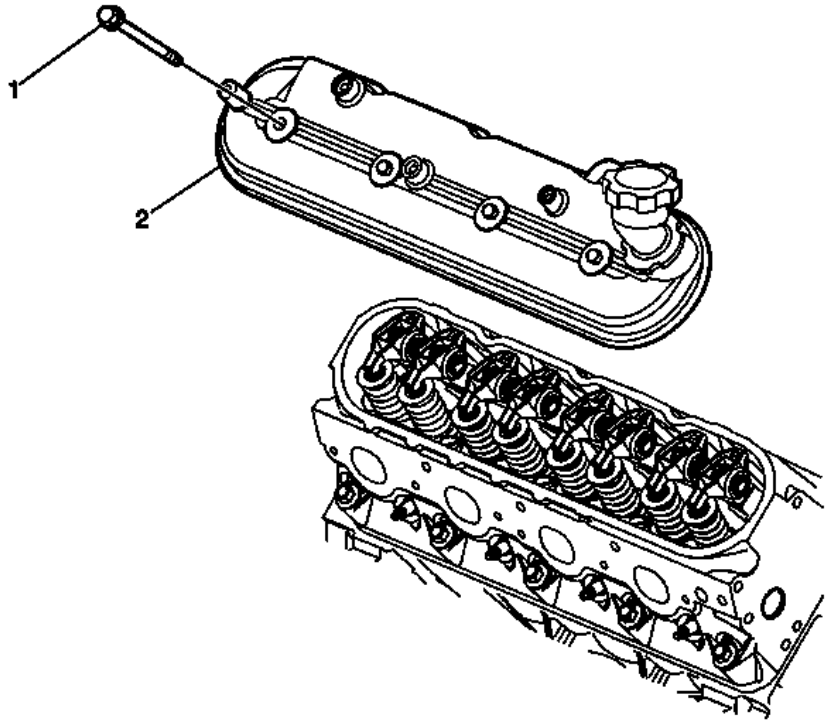


Fig. 80: Valve Rocker Arm Cover - Right Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Replacement - Right Side

Callout	Component Name
Preliminary Procedures 1. Remove the crankcase ventilation hoses/pipes. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Dirty Air)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Clean Air)**. 2. Remove the ignition coil. Refer to **Ignition Coil Replacement (L99 or LS3)** , **Ignition Coil Replacement (LSA)** .	
	Valve Rocker Arm Cover Fastener (Qty: 4) **CAUTION:** **Refer to Component Fastener Tightening Caution .**

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1	**Procedure** If valve rocker arm cover grommets are cracked, or damaged, replace the valve rocker arm cover bolts. The grommet is serviced with the rocker arm cover bolt. **Tighten** 12 N.m (106 lb in)
2	Valve Rocker Arm Cover **Procedure** 1. Disconnect any electrical connectors. 2. Transfer components as necessary.

VALVE ROCKER ARM AND PUSH ROD REPLACEMENT

Removal Procedure

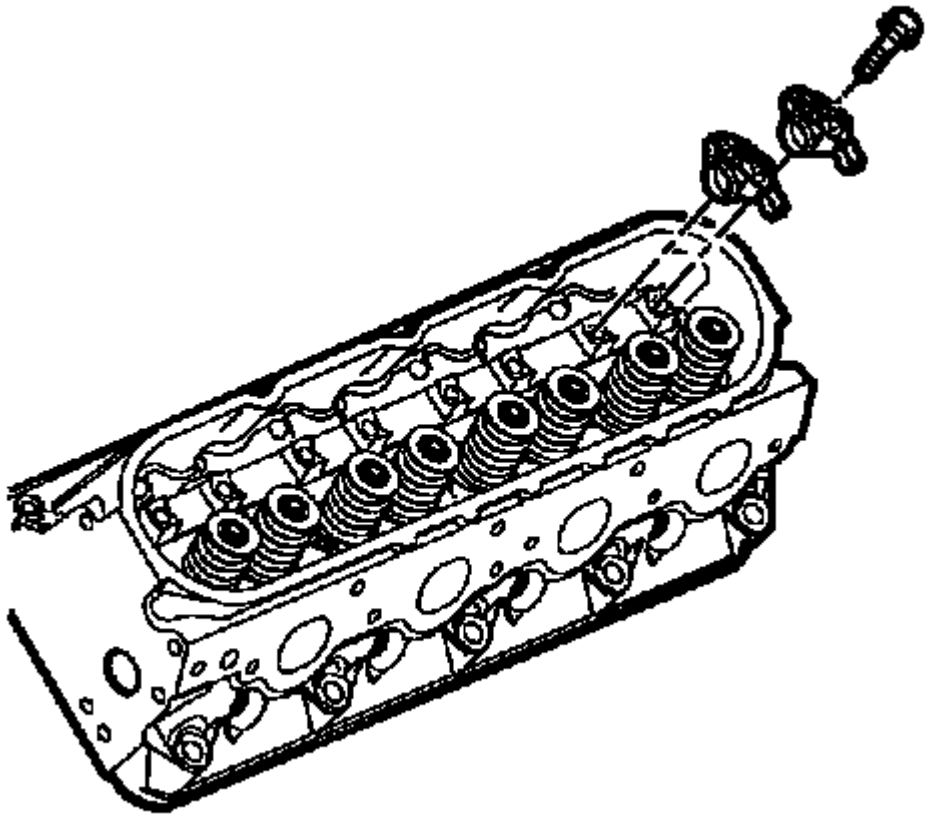


Fig. 81: View Of Rocker Arms & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

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

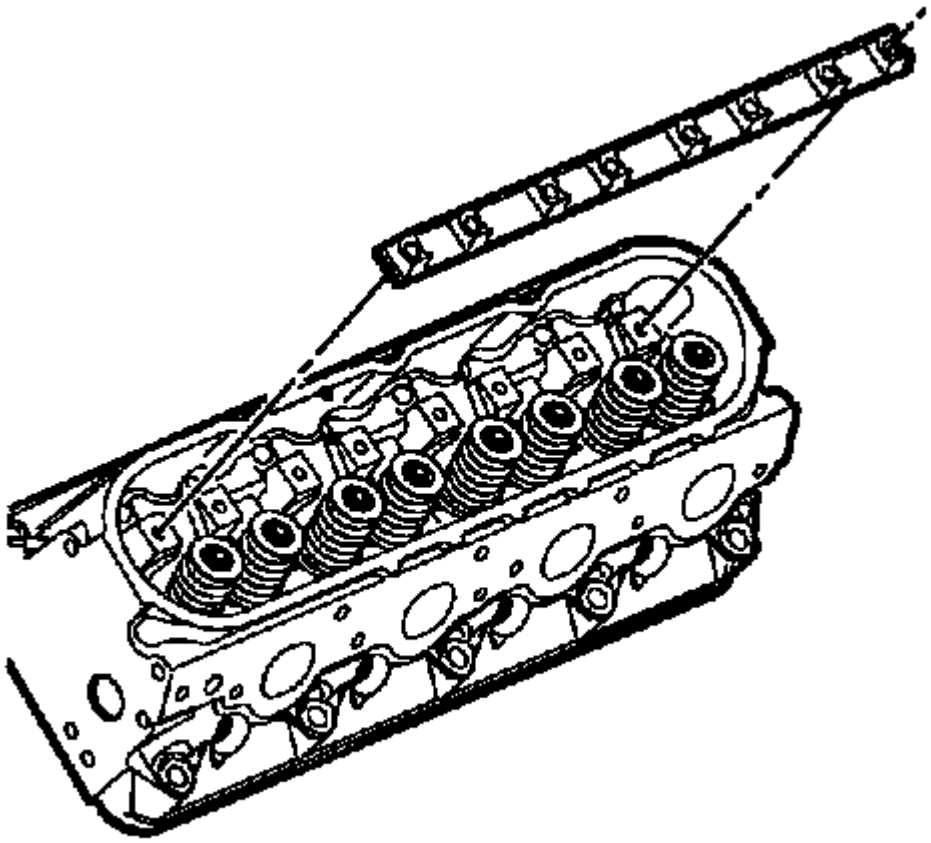


Fig. 82: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS COMPANY

4. Remove the valve rocker arm pivot support.

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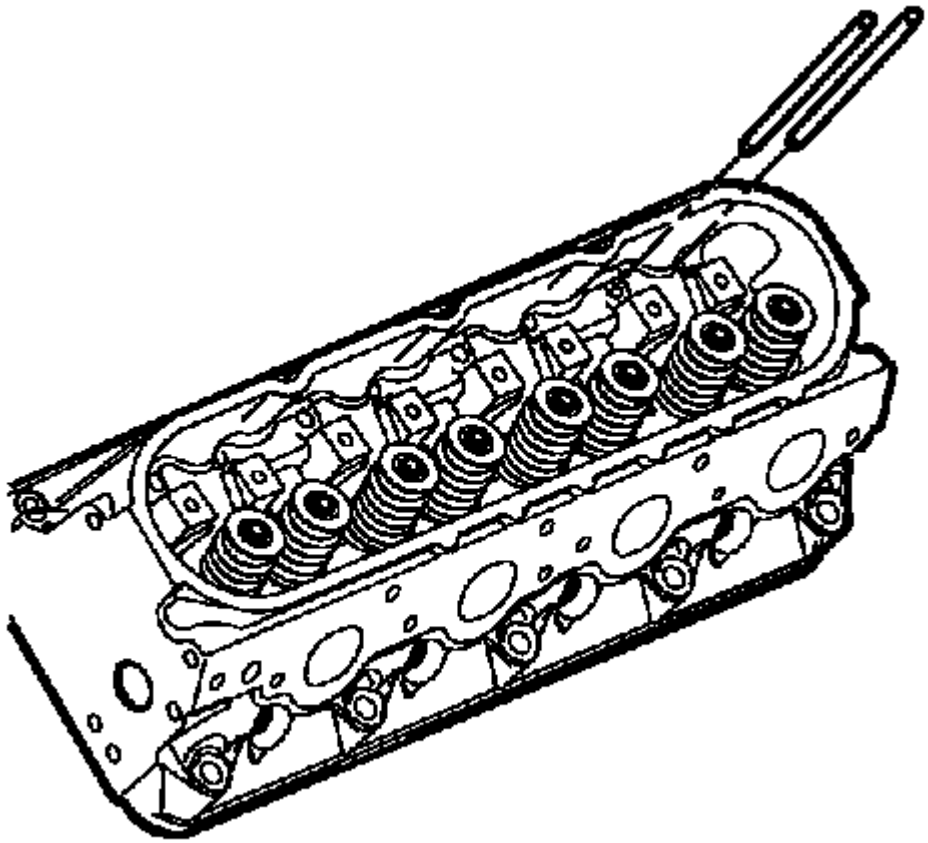


Fig. 83: View Of Pushrods
Courtesy of GENERAL MOTORS COMPANY

5. Remove the pushrods.
6. Clean and inspect the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Cleaning and Inspection** .

Installation Procedure

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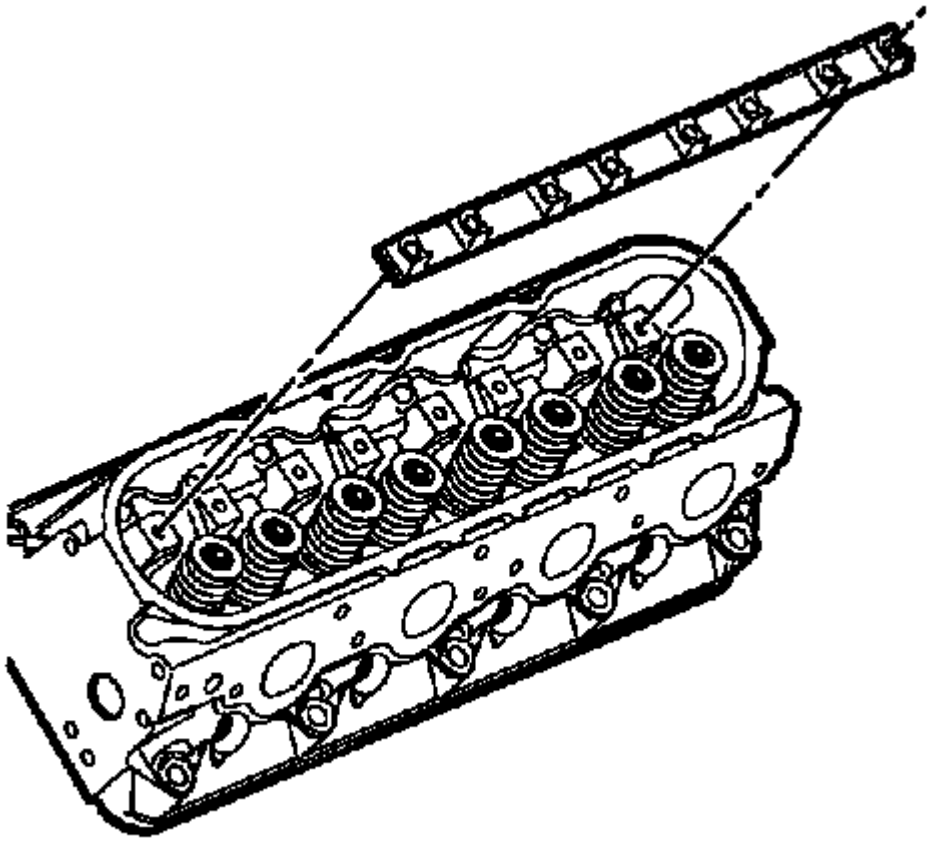


Fig. 84: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **When using the valve train components again, always install the components to the original location and position.**
- **Valve lash is net build, no valve adjustment is required.**

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

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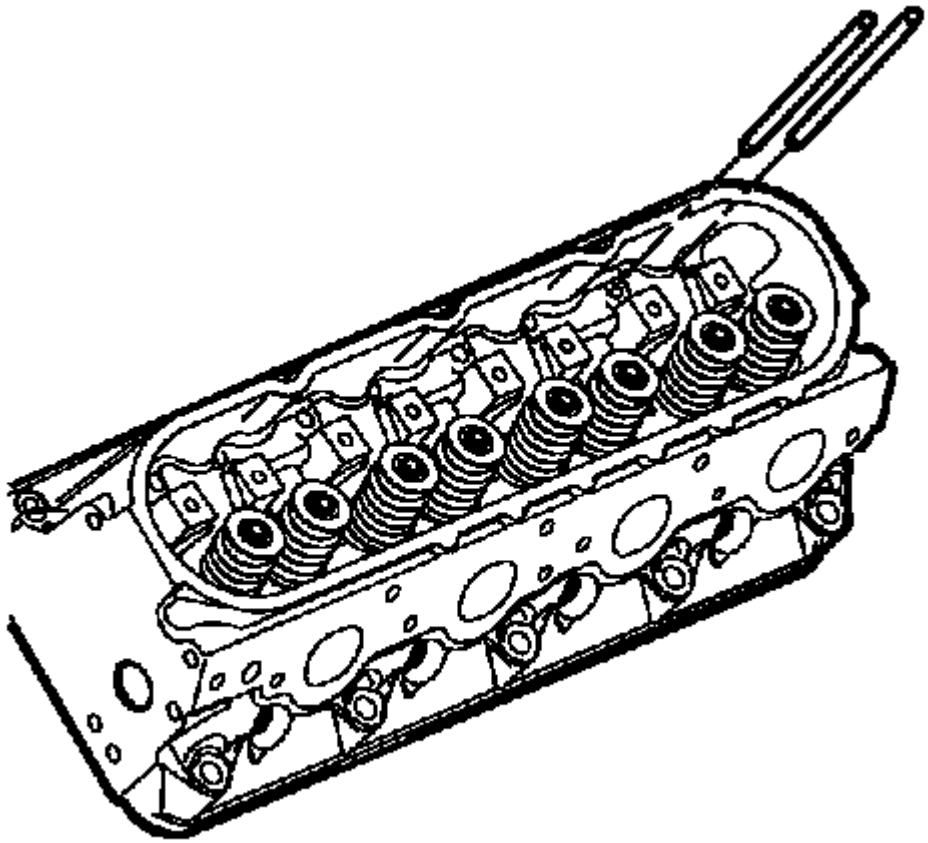


Fig. 85: View Of Pushrods
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the pushrods seat properly to the valve lifter sockets.

4. Install the pushrods.

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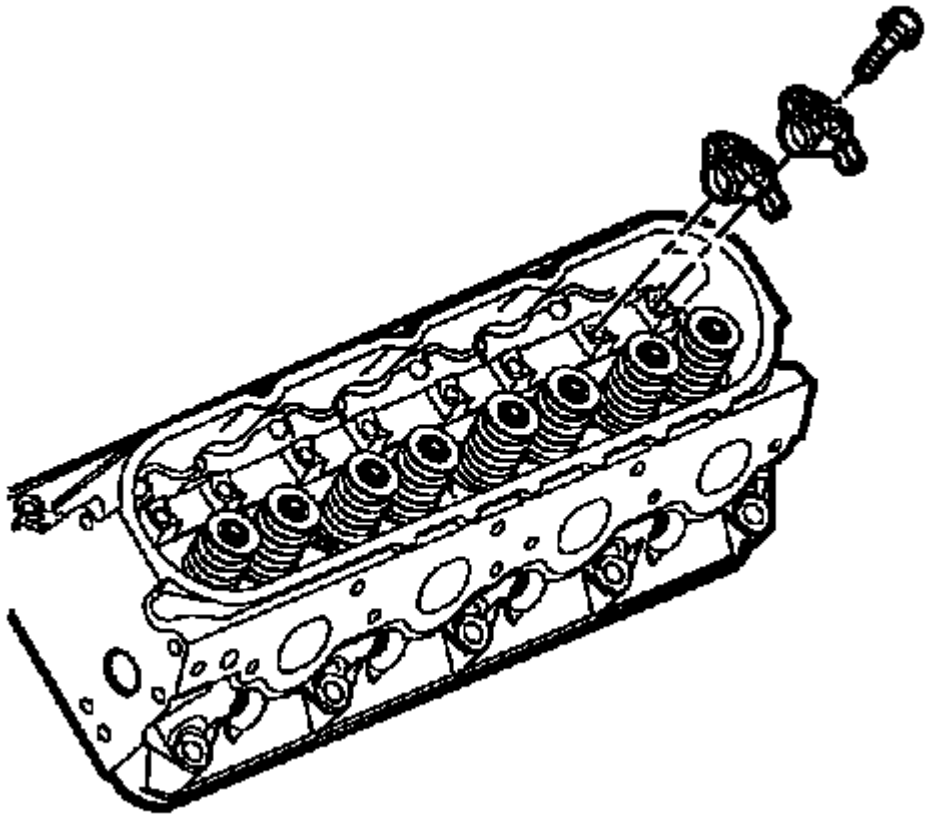


Fig. 86: View Of Rocker Arms & Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Ensure the pushrods seat properly to the ends of the rocker arms.**
- **DO NOT tighten the rocker arm bolts at this time.**

5. Install the rocker arms and bolts.

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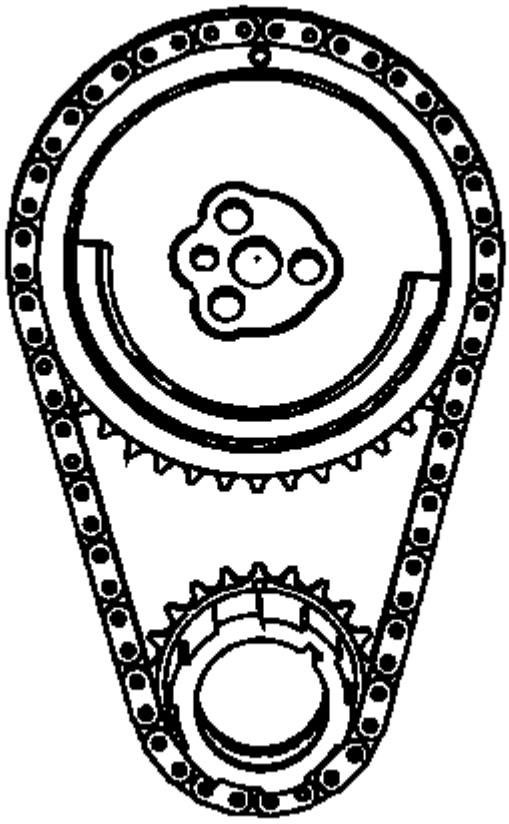


Fig. 87: Camshaft And Crankshaft Sprocket Alignment Marks
Courtesy of GENERAL MOTORS COMPANY

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

   In this position, cylinder number one rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. The camshaft and crankshaft sprocket alignment marks will be in the 12 o'clock positions. If viewing from the rear of the engine, the additional crankshaft pilot hole, non-threaded, will be in the 10:30 position.

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

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

   Cylinders 2, 4, 6, and 8 are right bank.

   CAUTION: Refer to Fastener Caution .

7. With the engine in the number one firing position, tighten the following valve rocker arm bolts:
   - Tighten exhaust valve rocker arm bolts 1, 2, 7, and 8 to 30 N.m (22 lb ft).

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- Tighten intake valve rocker arm bolts 1, 3, 4, and 5 to 30 N.m (22 lb ft).

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

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Special Tools

- **J 22794** Spark Plug Port Adapter
- **J 38606** Valve Spring Compressor (Head-on)

Removal Procedure

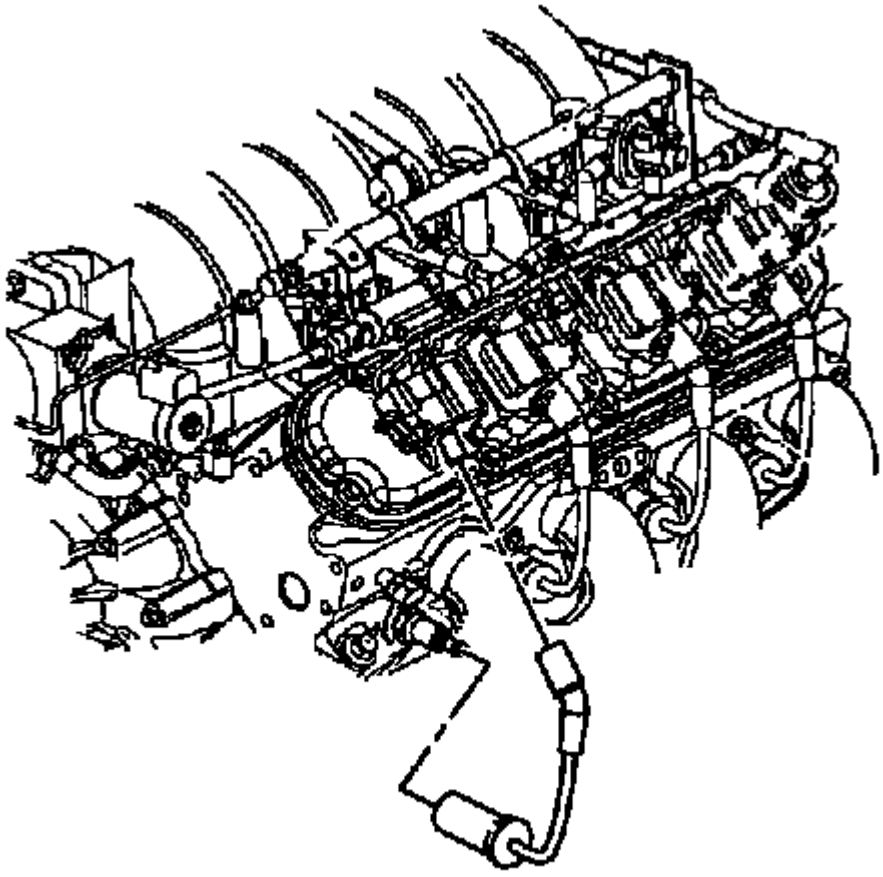


Fig. 88: Spark Plug Wire Routing
Courtesy of GENERAL MOTORS COMPANY

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1. Remove the valve rocker arms. Refer to **Valve Rocker Arm and Push Rod Replacement**.
2. Remove the spark plug. Refer to **Spark Plug Replacement** .

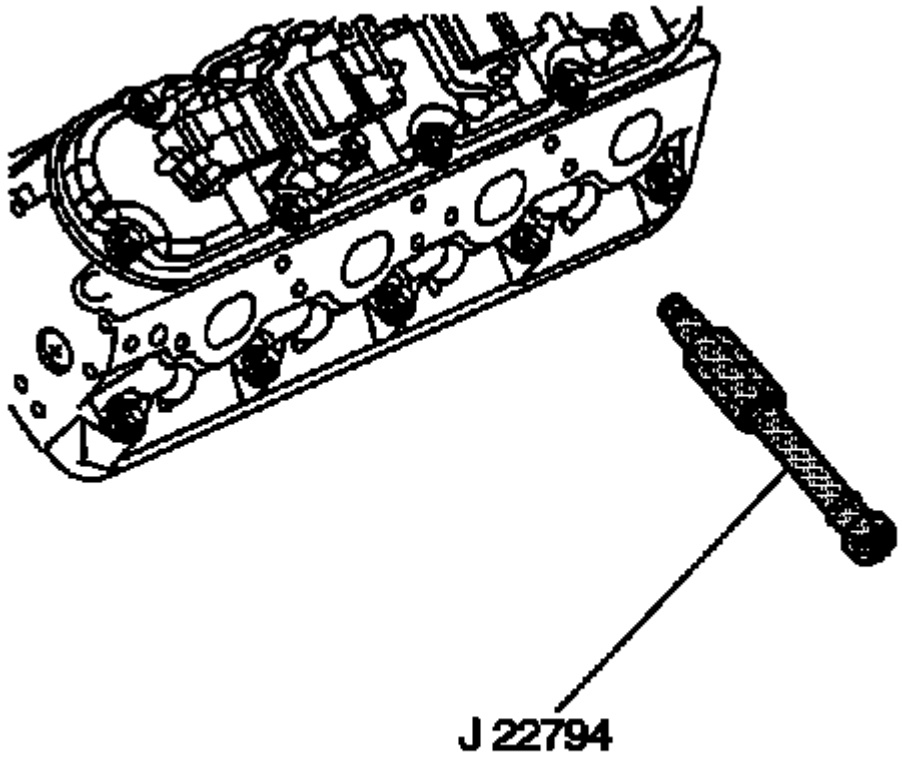


Fig. 89: Spark Plug Port Adapter
Courtesy of GENERAL MOTORS COMPANY

3. Install the **J 22794** spark plug port adapter into the spark plug hole.
4. Attach an air hose to **J 22794** spark plug port adapter.
5. Tap the end of the valve stem with a plastic face hammer in order to loosen any varnish on the valve stem keys.

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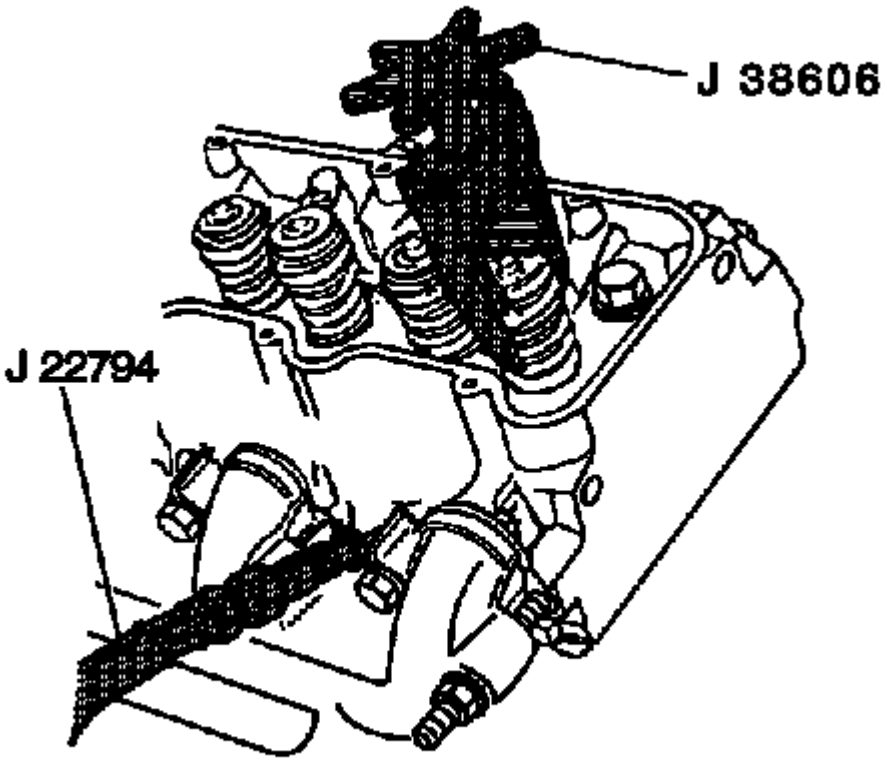


Fig. 90: Compressing Valve Spring (Cylinder Head Installed) Using Special Tools
Courtesy of GENERAL MOTORS COMPANY

6. Use the **J 38606** valve spring compressor in order to compress the valve spring.

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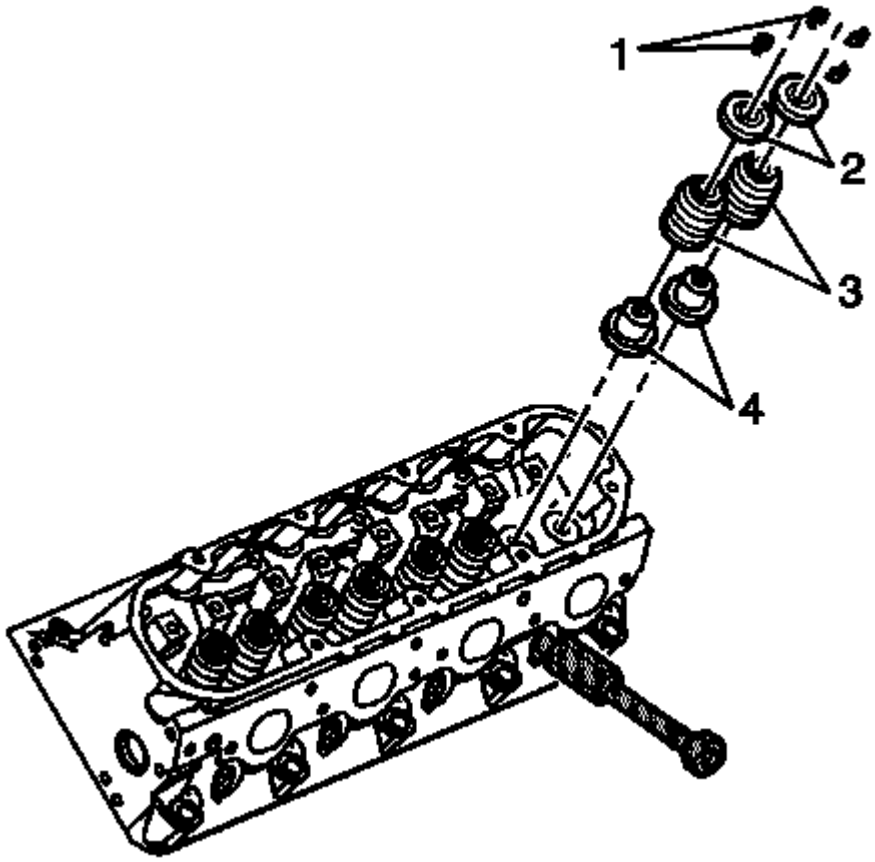


Fig. 91: Valve Stem Keys, Spring, Cap & Shim
Courtesy of GENERAL MOTORS COMPANY

7. Remove the valve stem keys (1).
8. Carefully release the valve spring tension.
9. Remove the **J 38606** valve spring compressor.
10. Remove the valve spring cap (2).
11. Remove the valve spring (3).
12. Remove the valve stem oil seal and shim (4).

Installation Procedure

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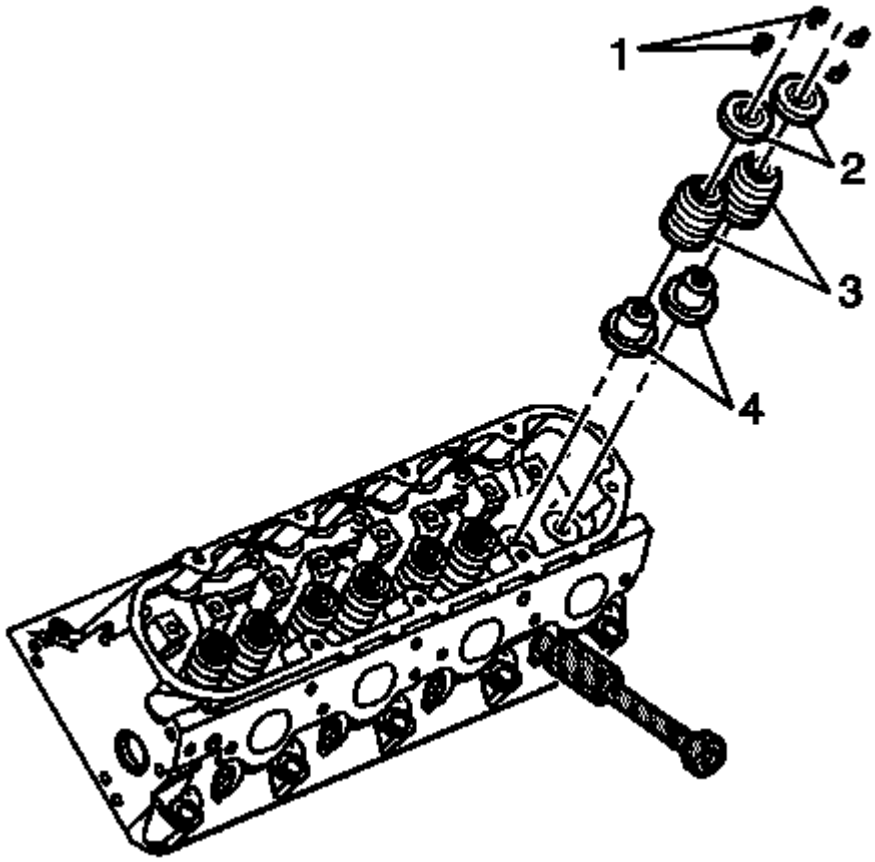


Fig. 92: Valve Stem Keys, Spring, Cap & Shim
Courtesy of GENERAL MOTORS COMPANY

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

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

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

3. Install the valve stem oil seal onto the guide.
    1. Lubricate the valve guide and valve stem oil seal with clean engine oil.
    2. Install the valve stem oil seal onto the valve stem. Push the seal down until the seal contacts the valve guide.

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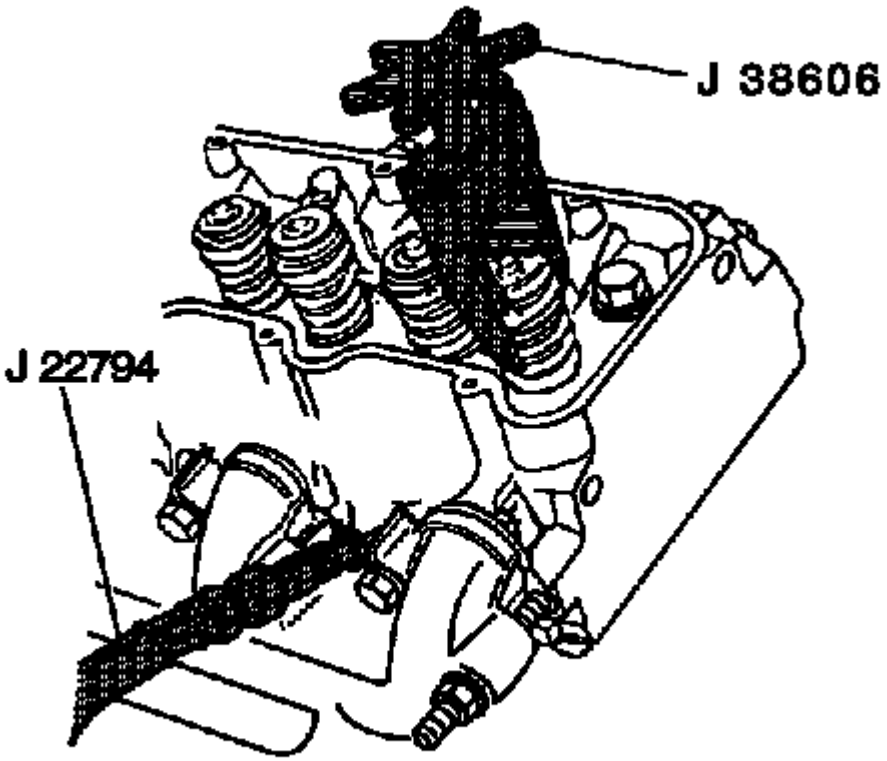


Fig. 93: Compressing Valve Spring (Cylinder Head Installed) Using Special Tools
Courtesy of GENERAL MOTORS COMPANY

4. Install the valve spring to the **J 38606** valve spring compressor.
5. Compress the valve spring using the **J 38606** valve spring compressor.
6. Install the valve spring to the cylinder head.

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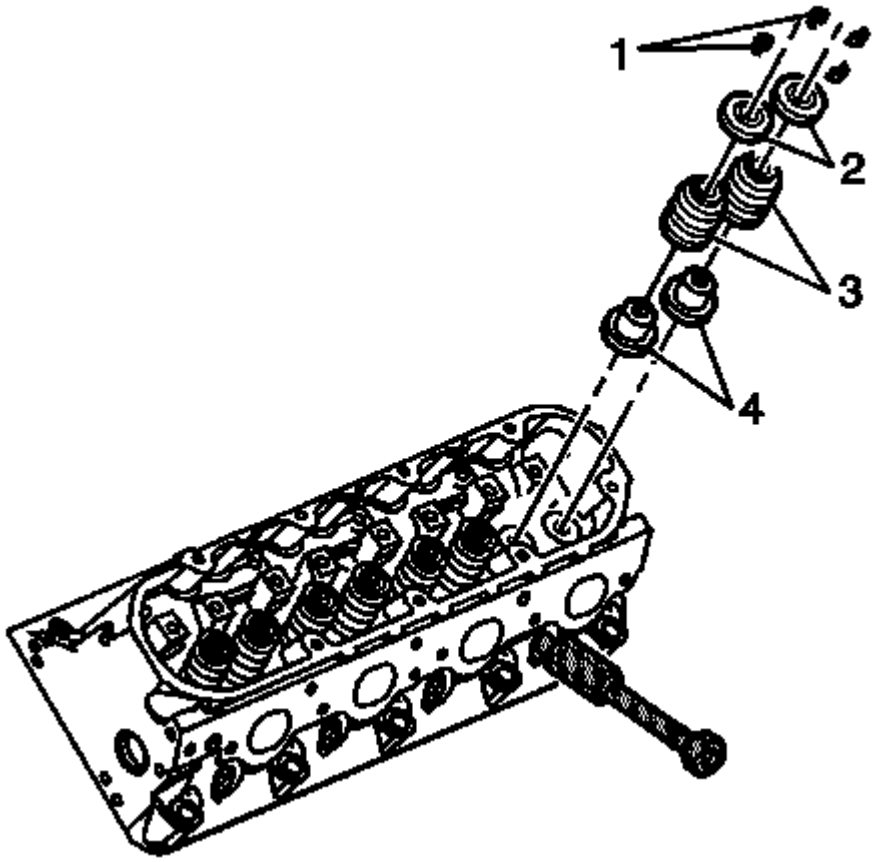


Fig. 94: Valve Stem Keys, Spring, Cap & Shim
Courtesy of GENERAL MOTORS COMPANY

7. Install the valve spring cap (2).
8. Install the valve stem keys (1).
    1. Use grease to hold the keys (2) in place and remove **J 38606** valve spring compressor.
    2. Make sure the keys (2) seat properly in the groove of the valve stem.
    3. Carefully release the valve spring pressure, making sure the valve keys stay in place.
    4. Remove the **J 38606** valve spring compressor.
    5. Tap the end to the valve stem with a plastic faced hammer to seat the keys, if necessary.

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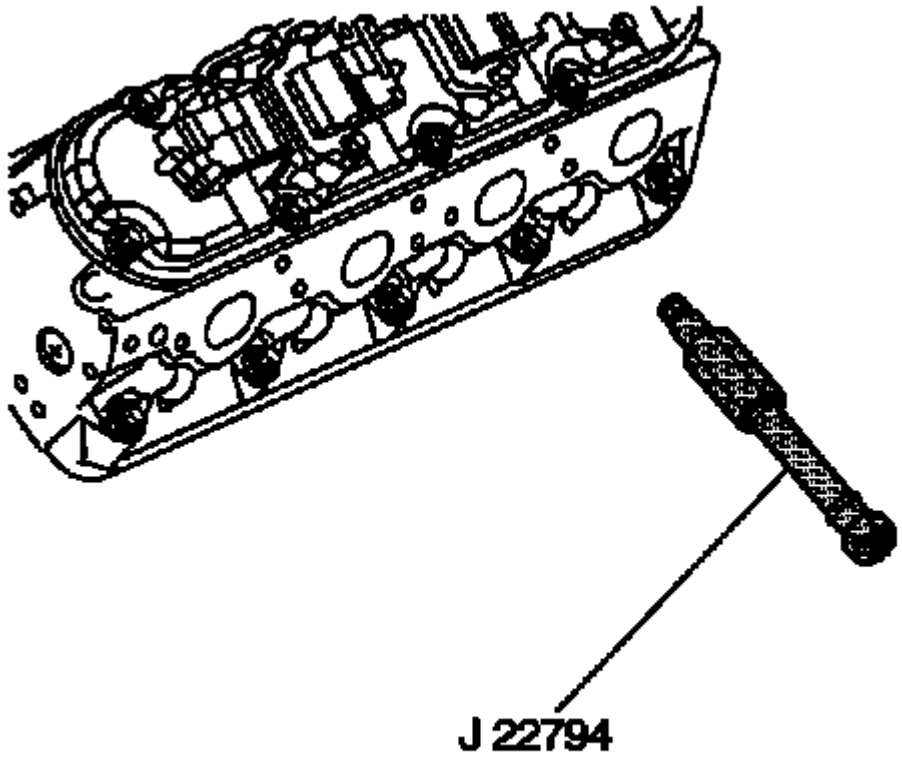


Fig. 95: Spark Plug Port Adapter
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect and remove the air supply from the **J 22794** spark plug port adapter.
10. Remove the **J 22794** spark plug port adapter from the spark plug hole.

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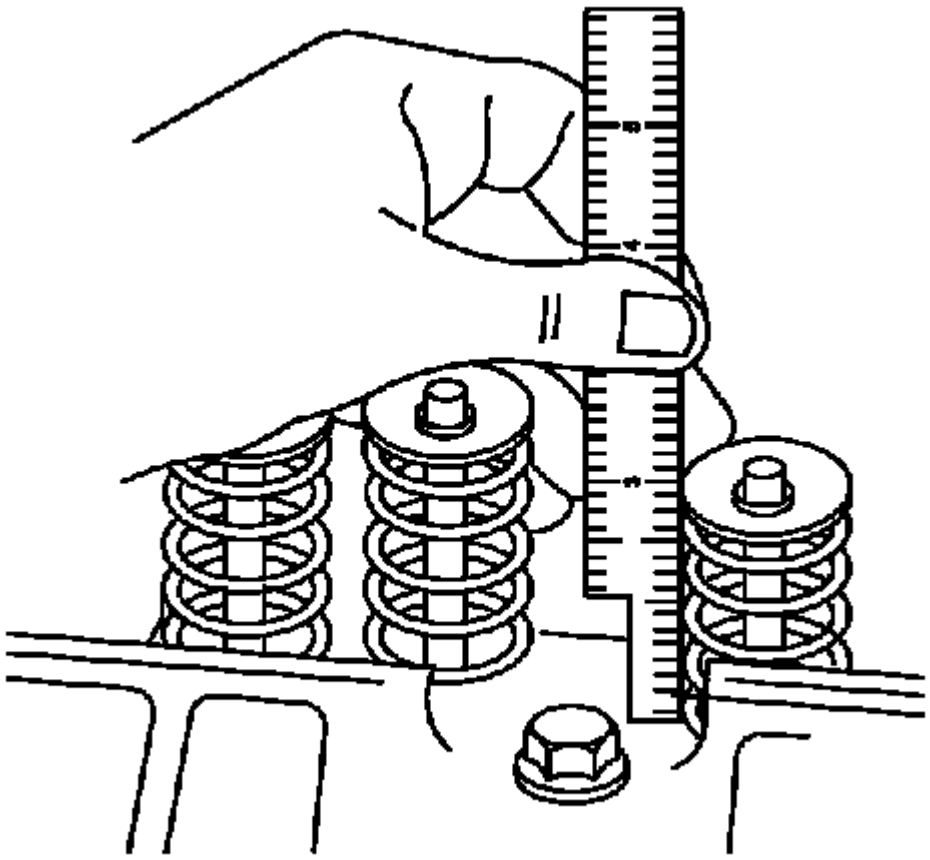


Fig. 96: Measuring Valve Spring Installed Height
Courtesy of GENERAL MOTORS COMPANY

11. Measure the valve spring installed height using a ruler.

    Measure from the base of the valve spring to the top of the valve spring.

    - If the installed height exceeds 46.25 mm (1.82 in), install a valve spring shim of approximately 0.5 mm (0.02 in) thick.
    - Do not shim the valve spring to obtain less than the specified height.

      Do not assemble the components without a spring shim on the cylinder head.

12. Remove the air hose from the **J 22794** spark plug port adapter.

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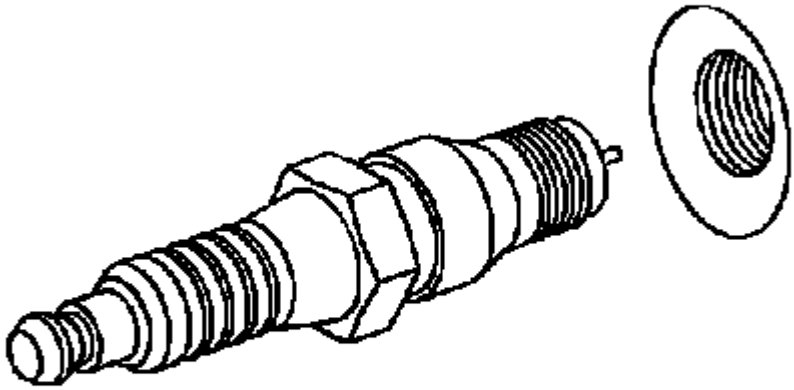


Fig. 97: View Of Spark Plug And Sparkplug Seat
Courtesy of GENERAL MOTORS COMPANY

13. Install the spark plug. Refer to **Spark Plug Replacement** .
14. Install the valve rocker arms. Refer to **Valve Rocker Arm and Push Rod Replacement**.

OIL LEVEL INDICATOR TUBE REPLACEMENT

Removal Procedure

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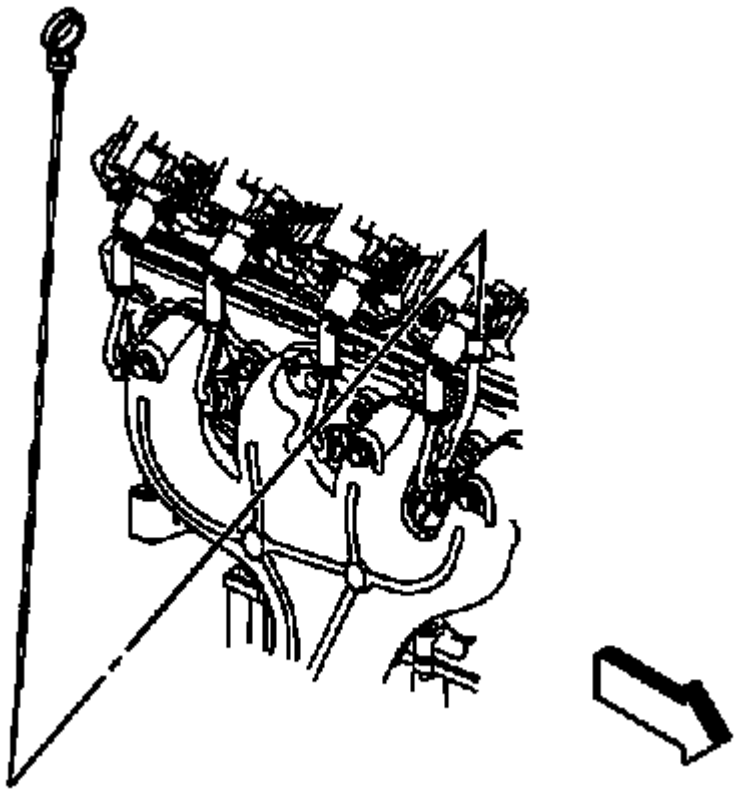


Fig. 98: Oil Level Indicator
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil level indicator.

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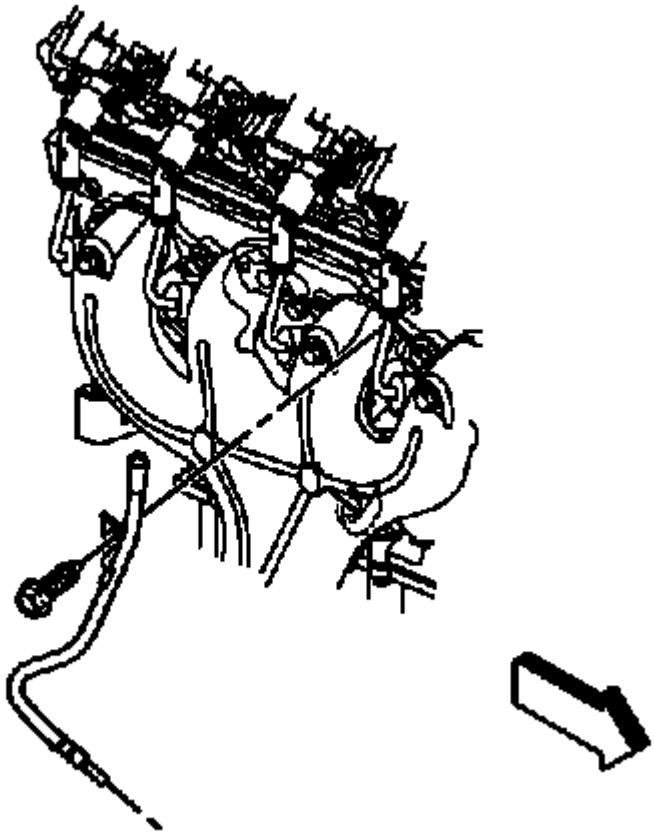


Fig. 99: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil level indicator tube bolt.
3. Remove the oil level indicator tube.

NOTE: Inspect the O-ring seal for cuts or damage. The O-ring seal may be reused if not cut or damaged.

4. Remove the O-ring from the oil level indicator tube, if required.

Installation Procedure

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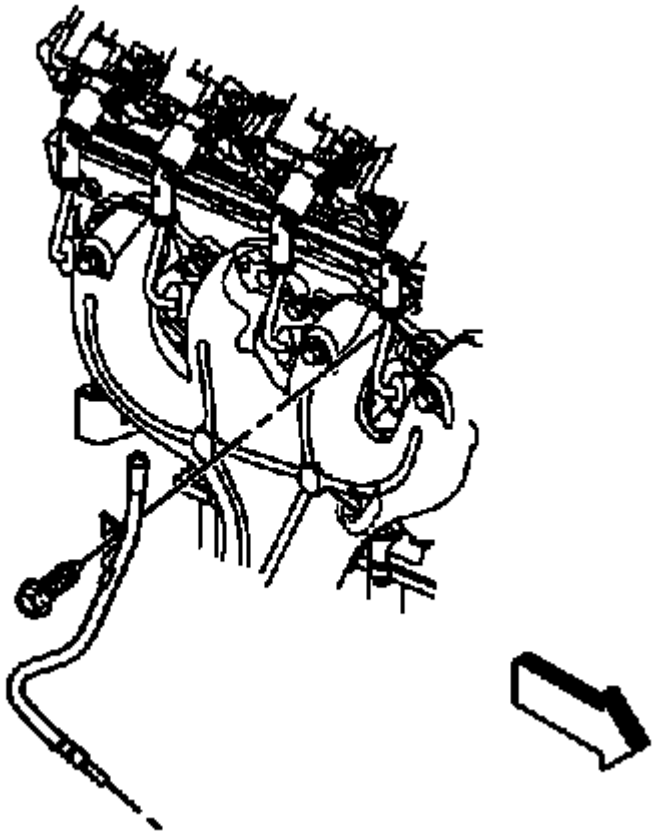


Fig. 100: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the O-ring seal with clean engine oil.
2. Install the oil level indicator tube into position.
3. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Insert the oil level indicator tube into the engine block until the collar is flush with the block.
5. Lower the vehicle.

CAUTION: Refer to Fastener Caution .

6. Install the oil level indicator tube bolt and tighten to 25 N.m (18 lb ft).

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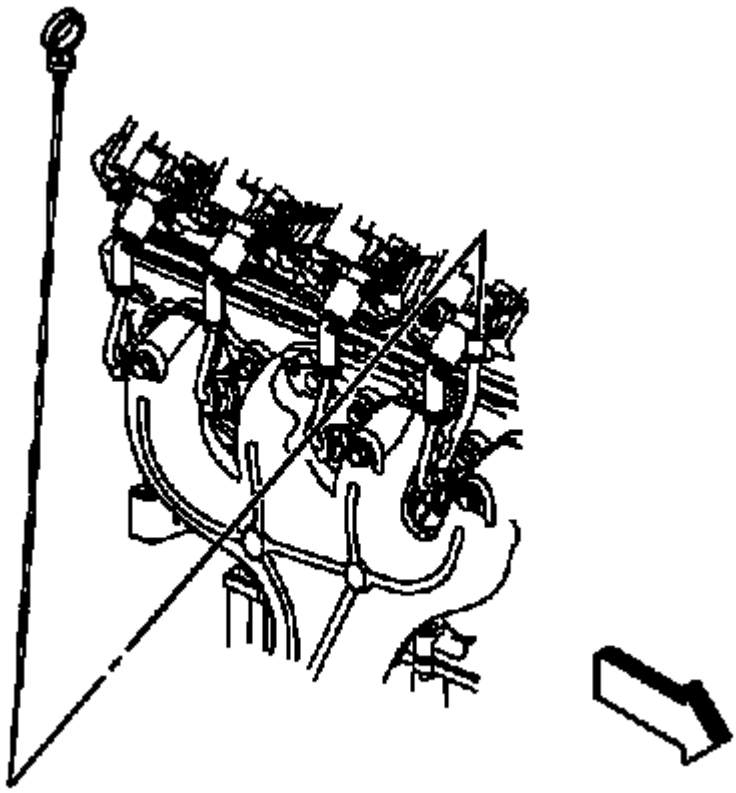


Fig. 101: Oil Level Indicator
Courtesy of GENERAL MOTORS COMPANY

7. Install the oil level indicator.
8. Check the oil level and add if necessary.

CYLINDER HEAD REPLACEMENT - LEFT SIDE

Special Tools

- **J 42385-100** Head/Main Bolt Thread Repair Kit
- **J 45059** Angle Meter

Removal Procedure

1. Drain the coolant. Refer to **Cooling System Draining and Filling (LSA, LS3, L99 Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
2. Remove the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
3. Remove the engine coolant air bleed hose.
4. Remove the power steering pump bracket. Refer to **Power Steering Pump Replacement** .

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5. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (V8)** .
6. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
7. Remove the Engine Coolant Air Bleed Pipe and Hole Cover. Refer to **Engine Coolant Air Bleed Pipe and Hole Cover Removal (LS3 or L99)** , **Engine Coolant Air Bleed Pipe and Hole Cover Removal (LSA)** .
8. Remove the engine wiring harness ground bolt from the rear of the left cylinder head.
9. Reposition the engine wire harness ground strap away from the cylinder head.
10. Disconnect and unclip electrical as necessary.

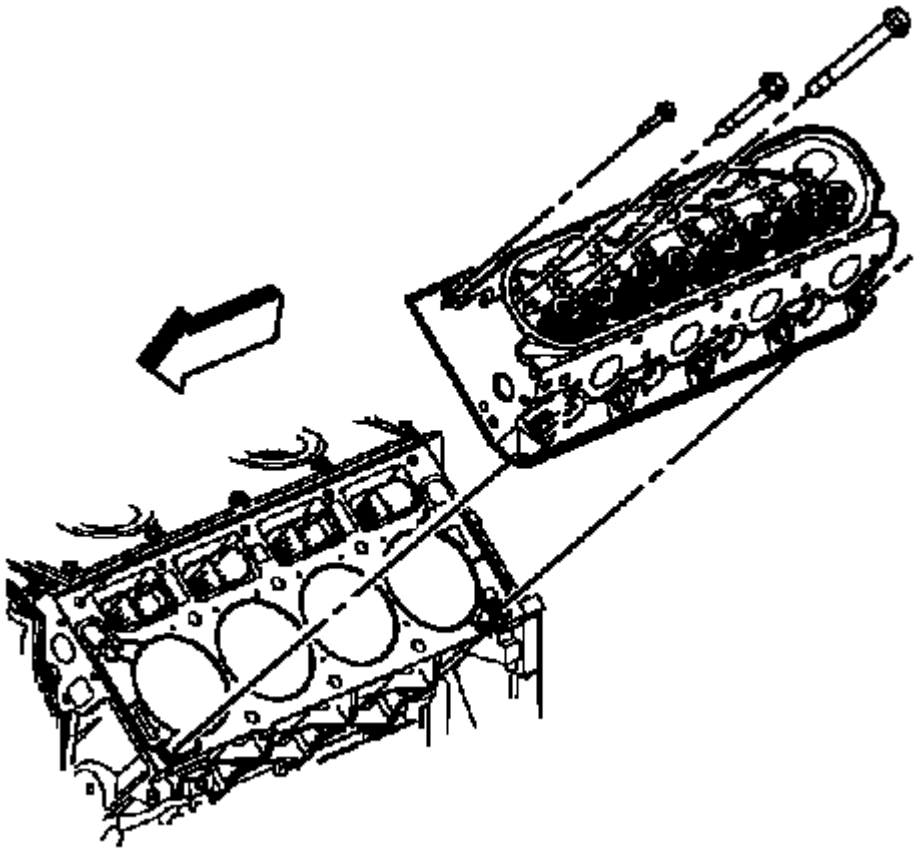


Fig. 102: View Of Cylinder Head & Bolts (Left)
Courtesy of GENERAL MOTORS COMPANY

NOTE: The cylinder head bolts are NOT reusable.

CAUTION: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

11. Remove the cylinder head bolts.

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12. Remove the cylinder head.

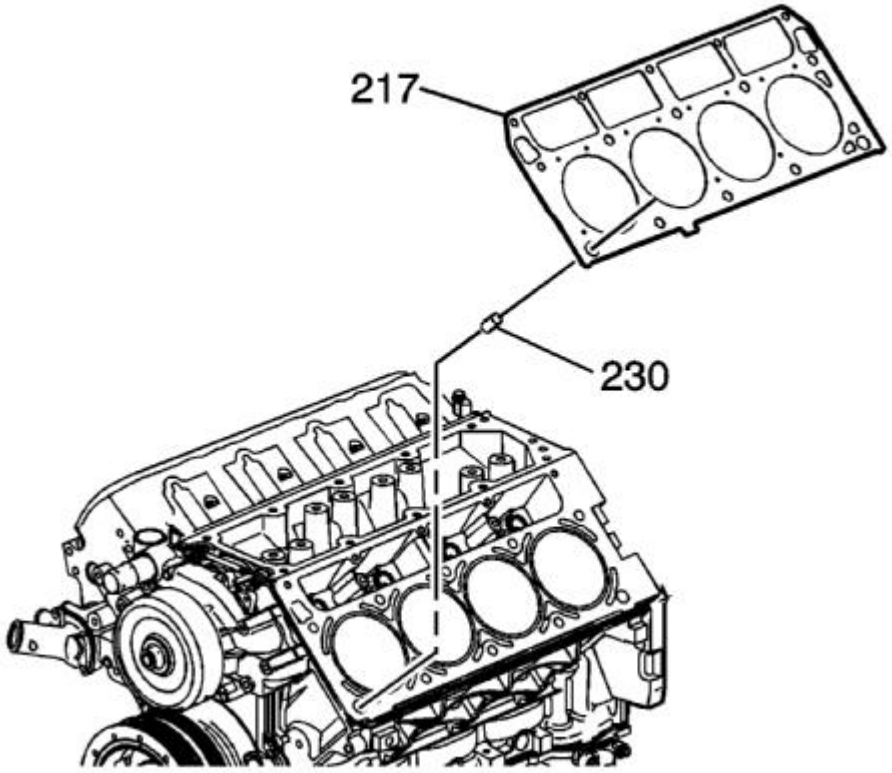


Fig. 103: View Of Cylinder Head Gasket And Alignment Pin - Left
Courtesy of GENERAL MOTORS COMPANY

13. Remove the cylinder head gasket (217).
14. Discard the gasket.
15. Discard all M8 and M11 cylinder head bolts.
16. Clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection** .

Installation Procedure

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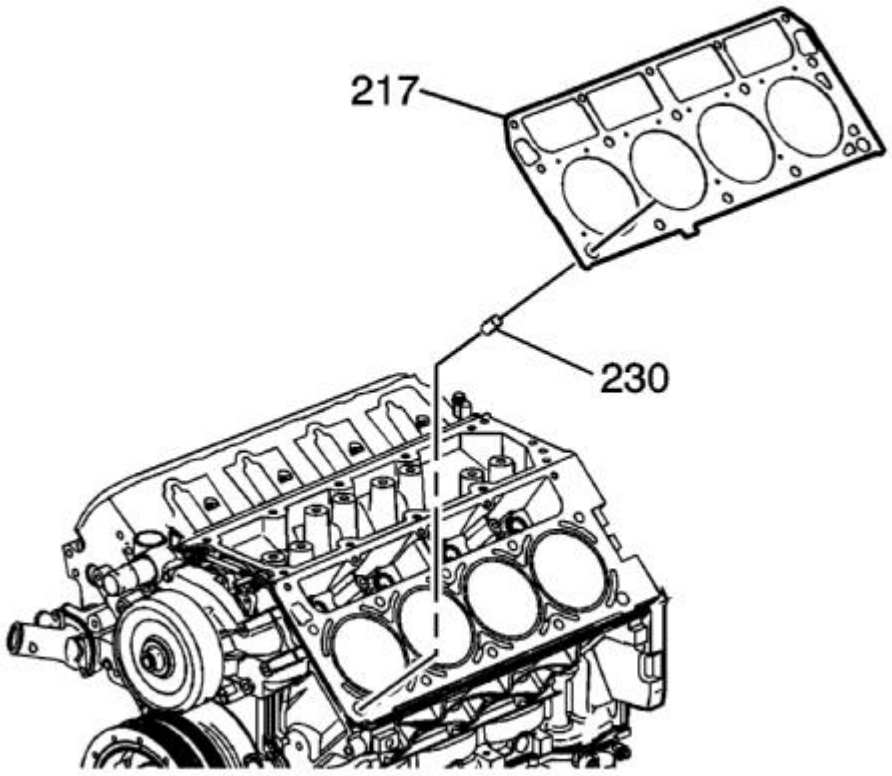


Fig. 104: View Of Cylinder Head Gasket And Alignment Pin - Left
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

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.

NOTE: If installing a new cylinder head it is necessary to install a new engine coolant air bleed plug into the rear coolant passage of the cylinder head. Refer to Cylinder Head Assemble .

NOTE:

- **Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.**
- **Do not use any type of sealant on the cylinder head gasket, unless specified.**

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- **The cylinder head gaskets must be installed in the proper direction and position.**

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

   Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.

2. Spray cleaner into the hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).

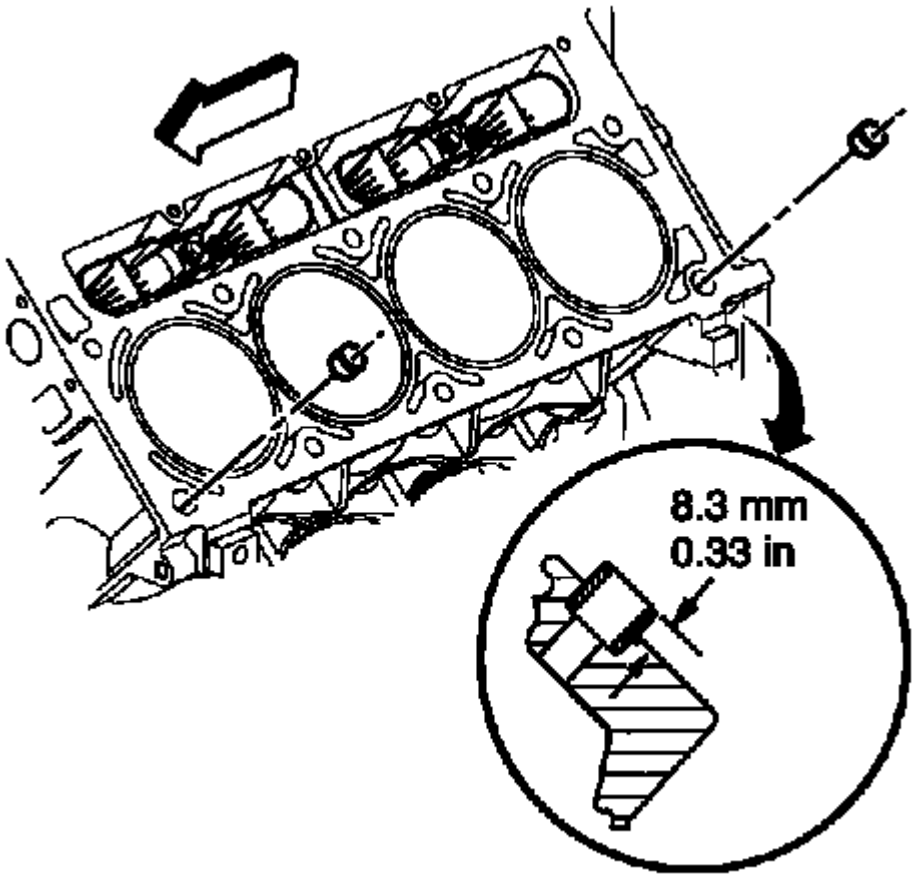


Fig. 105: Cylinder Head Locating Pins
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the locating pins for proper installation.

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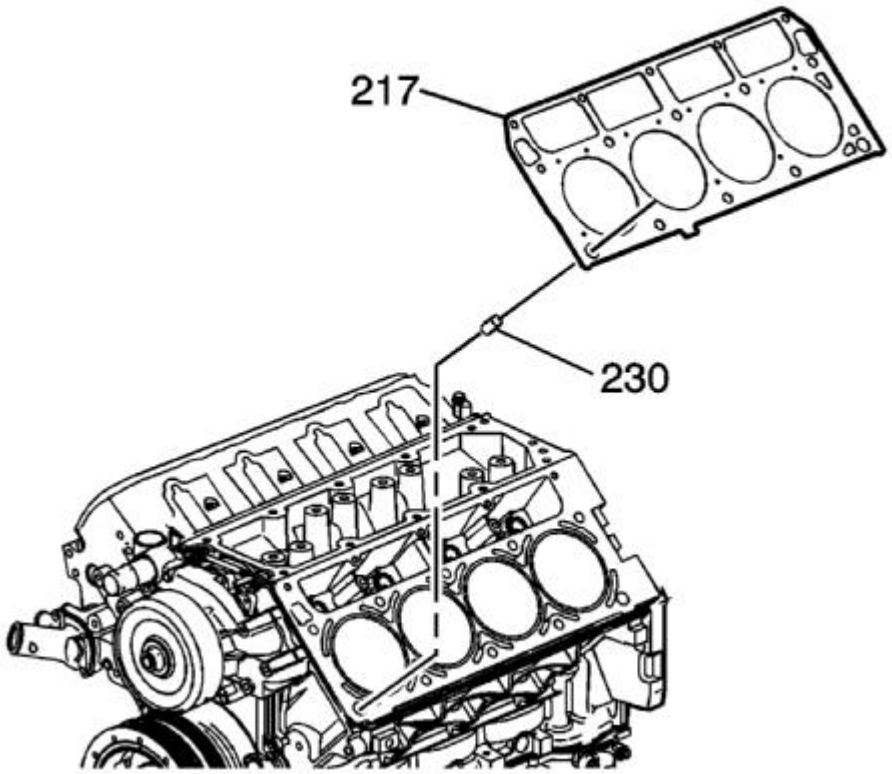


Fig. 106: View Of Cylinder Head Gasket And Alignment Pin - Left
Courtesy of GENERAL MOTORS COMPANY

6. Install the NEW cylinder head gasket (217) onto the locating pins.

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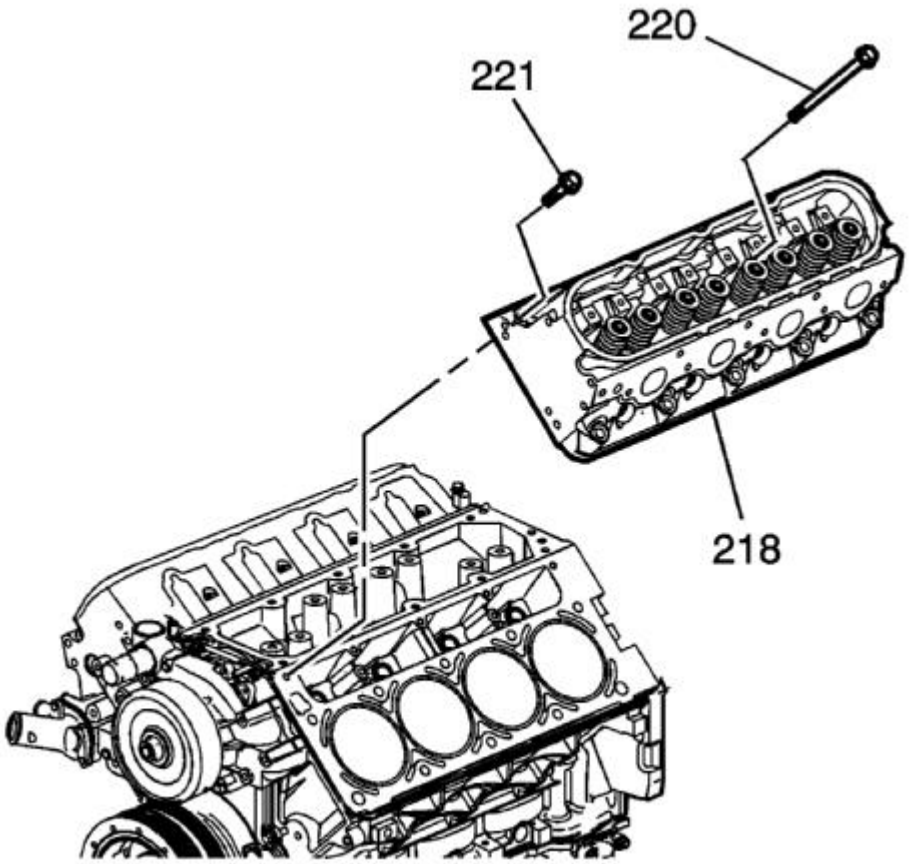


Fig. 107: Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the cylinder head (218) onto the locating pins and the gasket.
8. Install the NEW cylinder head bolts (200, 221).

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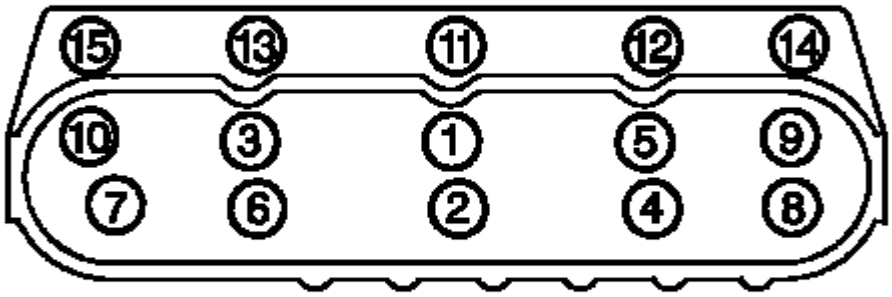


Fig. 108: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

9. Tighten the cylinder head bolts.
    1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to 30 (22 lb ft).
    2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to 90 degrees using the **J 45059** angle meter.
    3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to 70 degrees using the **J 45059** angle meter.
    4. Tighten the M8 cylinder head bolts (11-15) to 30 (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.
10. Install the intake manifold. Refer to **Intake Manifold Replacement**.
11. Position the engine wire harness ground strap against the cylinder head.
12. Install the engine wiring harness ground bolt to the rear of the left cylinder head. Tighten the bolt to 32 (24 lb ft).
13. Install Engine Coolant Air Bleed Pipe and Hole Cover. Refer to **Engine Coolant Air Bleed Pipe and Hole Cover Installation (LS3 or L99)** , **Engine Coolant Air Bleed Pipe and Hole Cover Installation**

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(LSA)

14. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (V8)** .
15. Install the power steering pump bracket. Refer to **Power Steering Pump Replacement** .
16. Install the engine coolant air bleed hose.
17. Install the valve rocker arms and push rods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
18. Fill the cooling system. Refer to **Cooling System Draining and Filling (LSA, LS3, L99 Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .

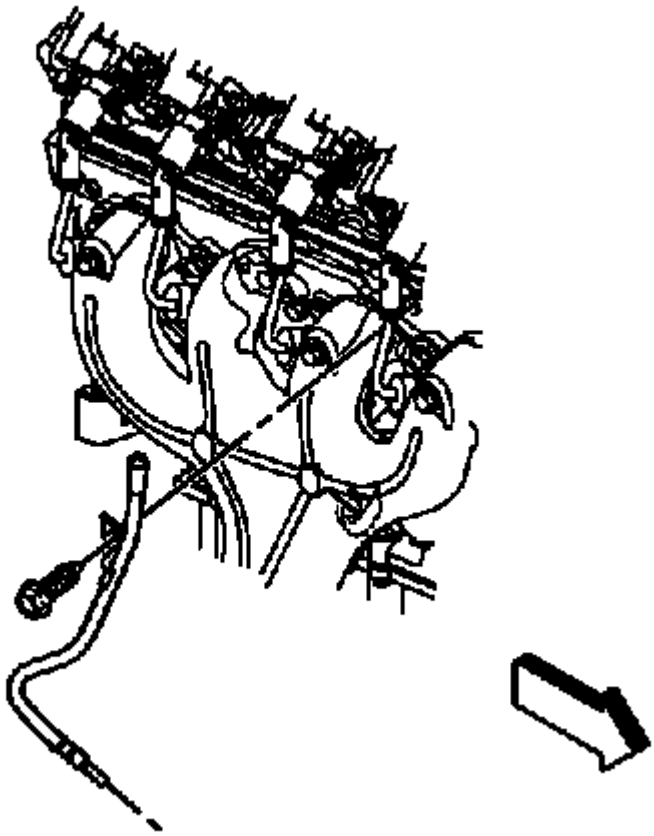
CYLINDER HEAD REPLACEMENT - RIGHT SIDE

Special Tools

- **J 42385-100** Head/Main Bolt Thread Repair Kit
- **J 45059** Angle Meter

Removal Procedure

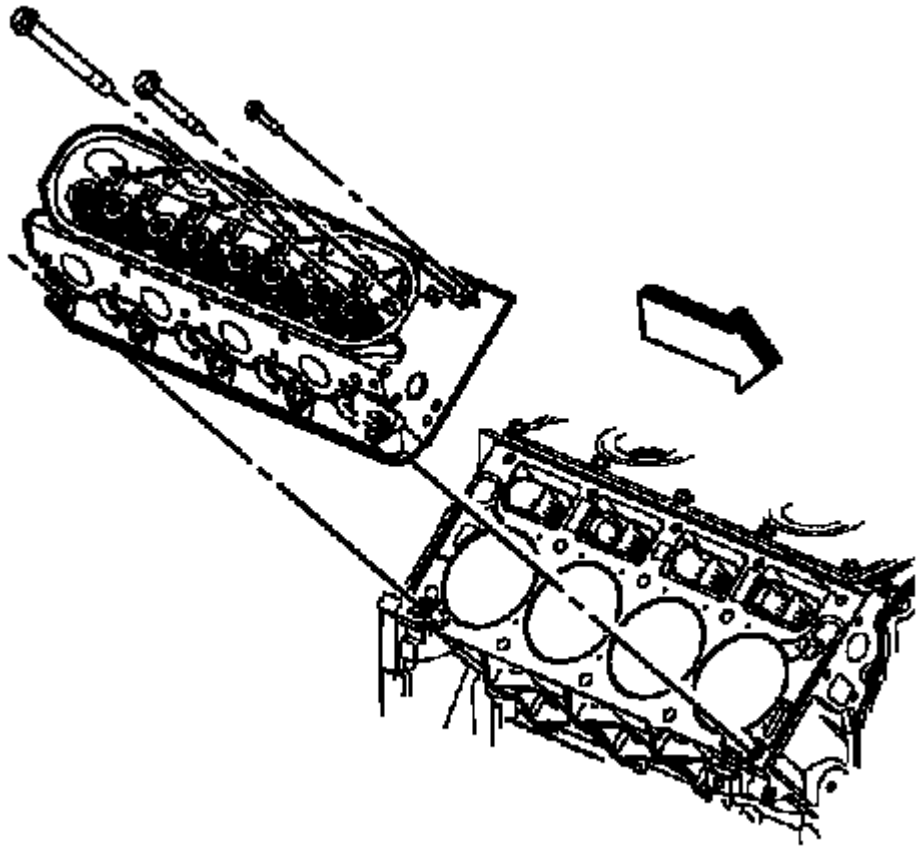
1. Drain the coolant. Refer to **Cooling System Draining and Filling (LSA, LS3, L99 Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .



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Fig. 109: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS COMPANY

2. Remove the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
3. Remove the engine coolant air bleed hose.
4. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (V8)** .
5. Remove the oil level indicator tube bolt.
6. Reposition the oil level indicator tube, if necessary.
7. Remove the Engine Coolant Air Bleed Pipe and Hole Cover. Refer to **Engine Coolant Air Bleed Pipe and Hole Cover Removal (LS3 or L99)** , **Engine Coolant Air Bleed Pipe and Hole Cover Removal (LSA)**
8. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
9. Remove the wiring harness from the clip at the rear of the cylinder head.
10. Remove the ground wire bolts/studs from the rear, center, and front of the cylinder head.
11. Remove the canister purge solenoid. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .
12. Reposition the harnesses as necessary.



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Fig. 110: View Of Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: The cylinder head bolts are NOT reusable.

CAUTION: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

13. Remove the cylinder head bolts.
14. Remove the cylinder head.

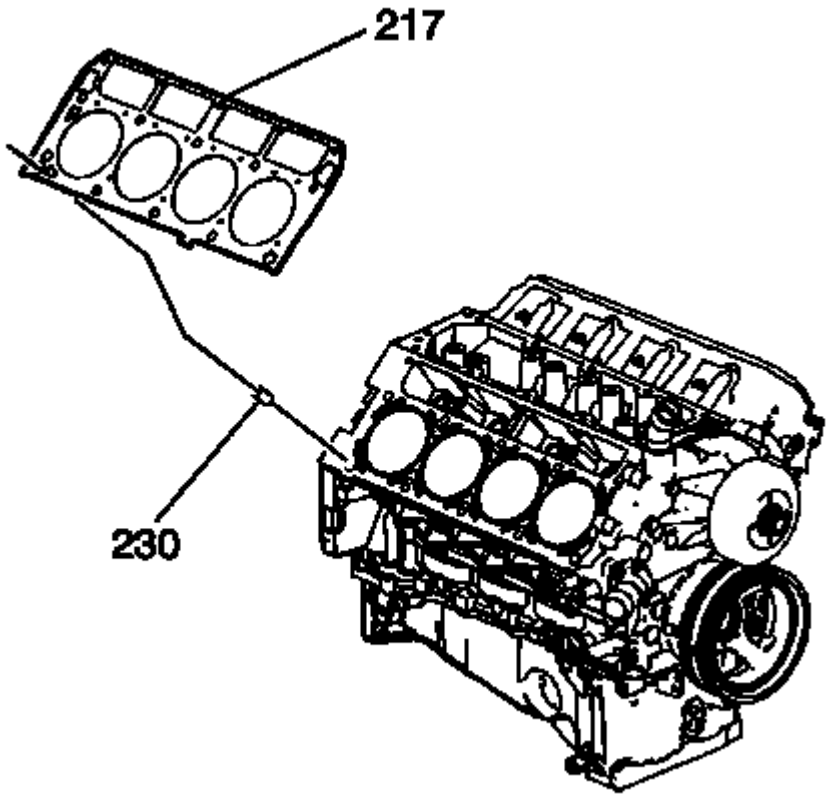


Fig. 111: Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

15. Remove the cylinder head gasket (217).
16. Discard the gasket.
17. Discard the cylinder head bolts.
18. Clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection** .

Installation Procedure

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

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.

NOTE: If installing a new cylinder head it is necessary to install a new engine coolant air bleed plug into the rear coolant passage of the cylinder head. Refer to Cylinder Head Assemble .

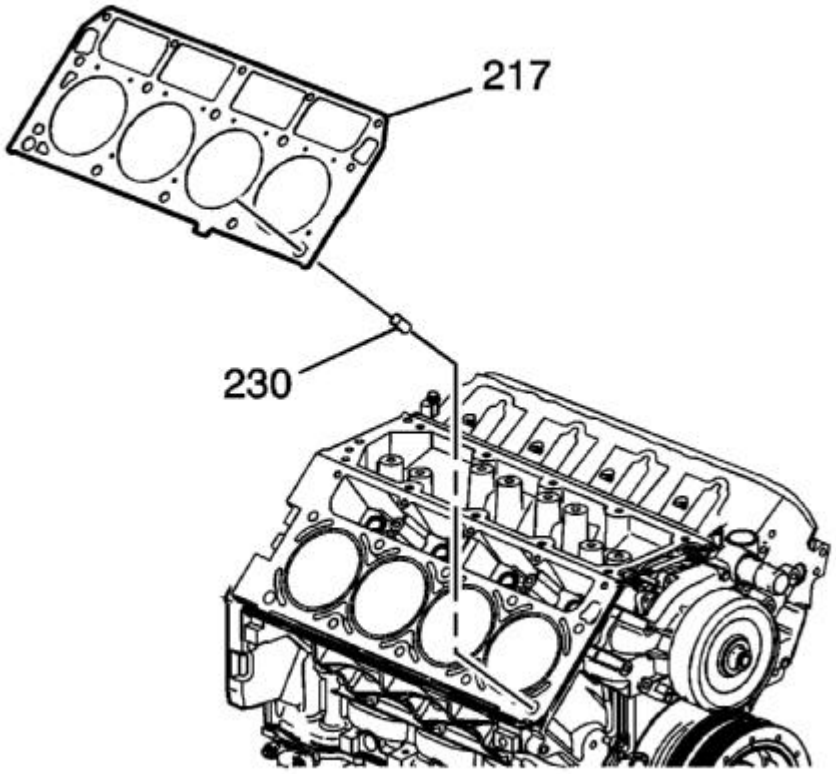


Fig. 112: Cylinder Head Gasket & Locating Pins - Right
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.**
- **Do not use any type of sealant on the cylinder head gasket, unless specified.**
- **The cylinder head gaskets (217) must be installed in the proper**

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direction and position.

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

   Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.

2. Spray cleaner into the hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).

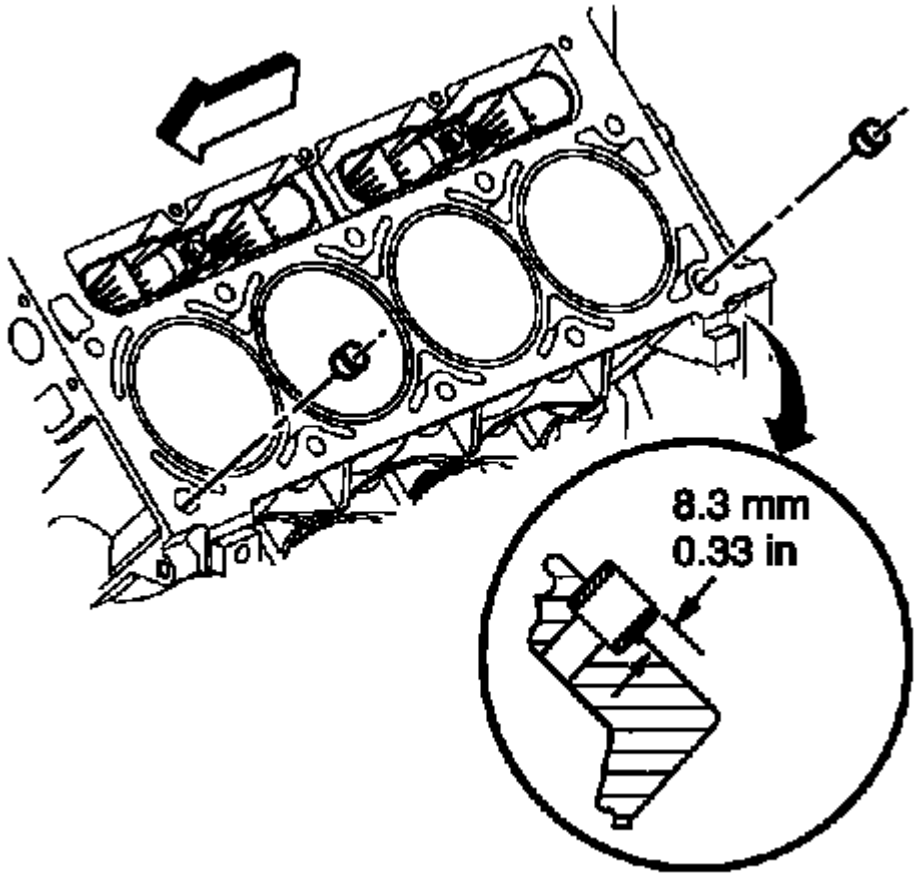


Fig. 113: Cylinder Head Locating Pins
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the locating pins for proper installation.

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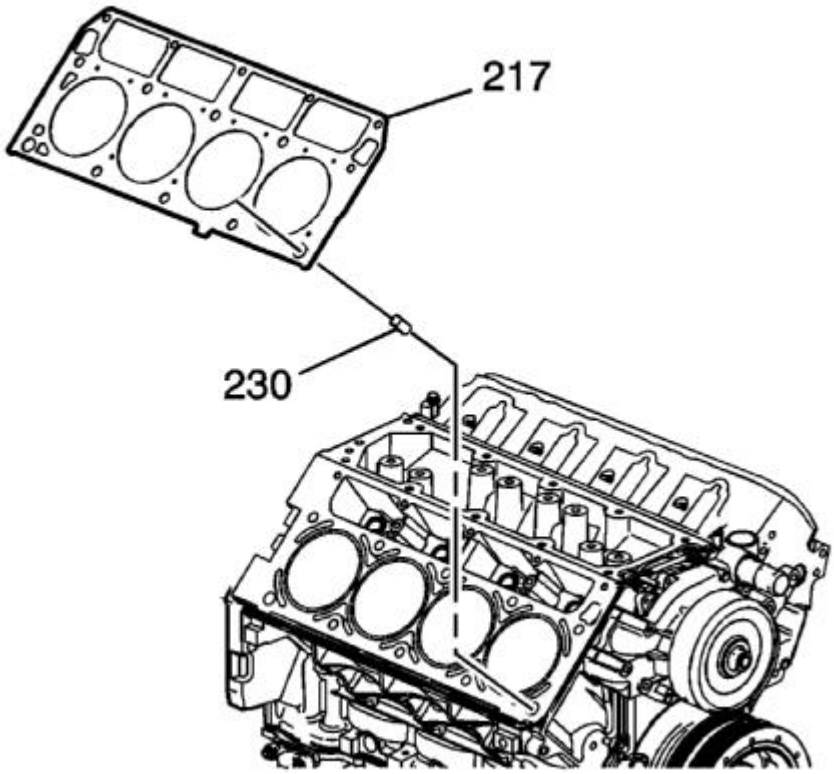


Fig. 114: Cylinder Head Gasket & Locating Pins - Right
Courtesy of GENERAL MOTORS COMPANY

6. Install the NEW cylinder head gasket (217) onto the locating pins.

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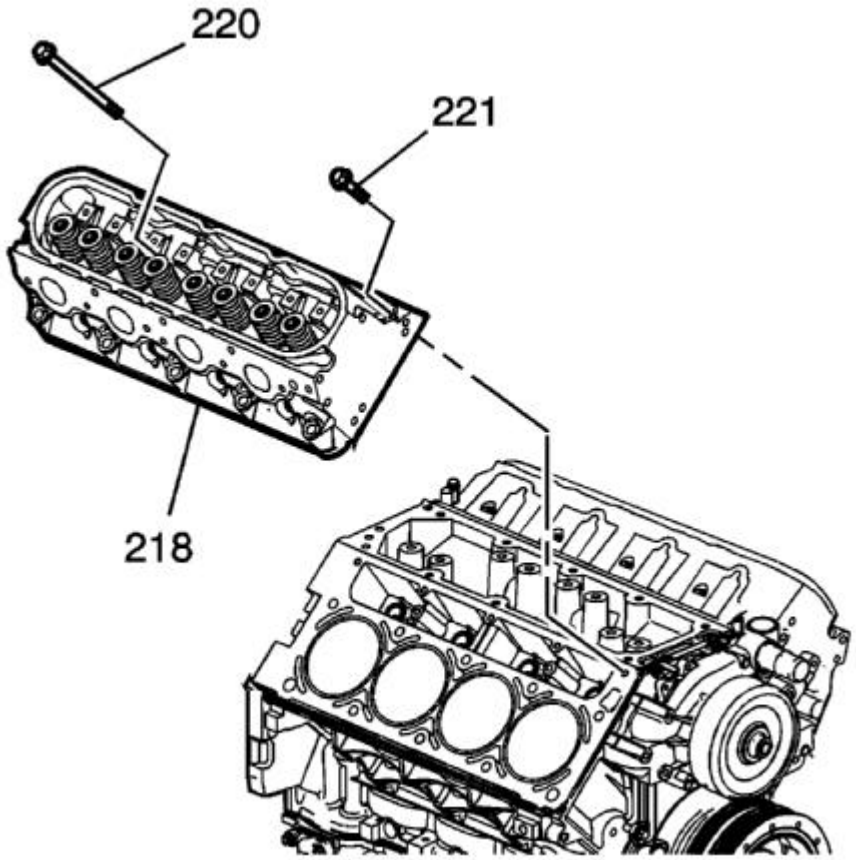


Fig. 115: Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the cylinder head (218) onto the locating pins and the gasket.
8. Install the NEW cylinder head bolts (220, 221).

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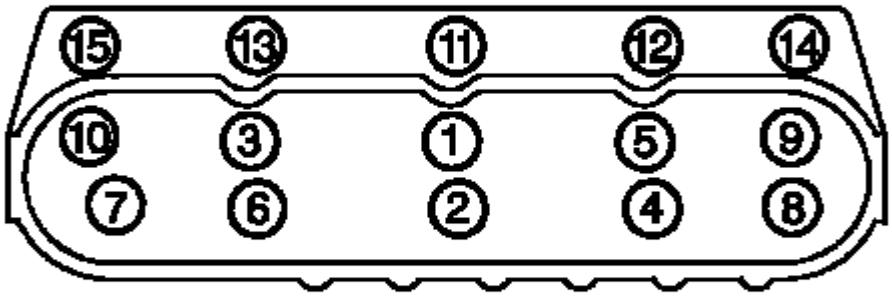


Fig. 116: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

9. Tighten the cylinder head bolts.
    1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to 30 (22 lb ft).
    2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to 90 degrees using the **J 45059** angle meter.
    3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to 70 degrees using the **J 45059** angle meter.
    4. Tighten the M8 cylinder head bolts (11-15) to 30 (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.
10. Install the wiring harness to the clip at the rear of the cylinder head.
11. Install the intake manifold. Refer to **Intake Manifold Replacement**.
12. Install the canister purge solenoid. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .

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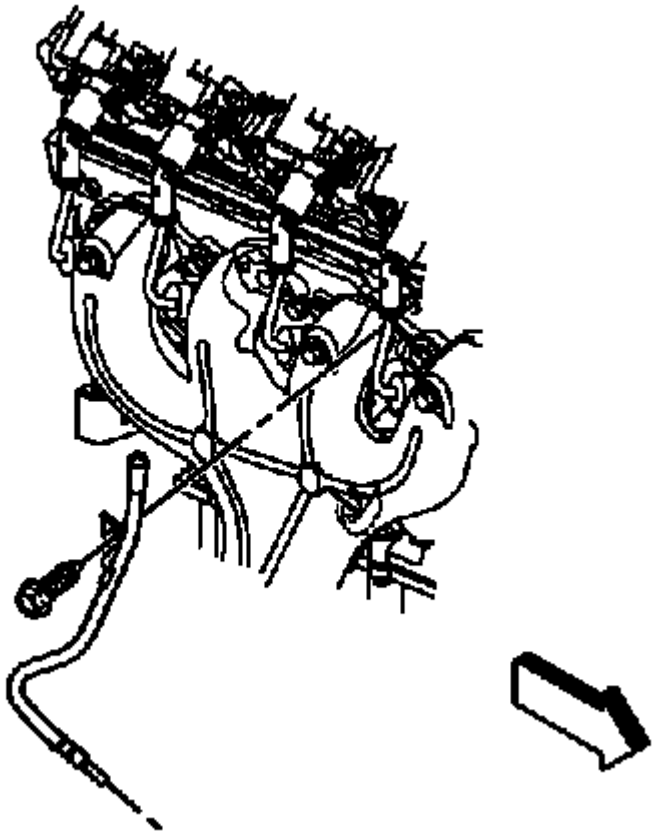


Fig. 117: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS COMPANY

13. Install the ground wire bolts/studs to the rear, center, and front of the cylinder head.
14. Install Engine Coolant Air Bleed Pipe and Hole Cover. Refer to **Engine Coolant Air Bleed Pipe and Hole Cover Installation (LS3 or L99)** , **Engine Coolant Air Bleed Pipe and Hole Cover Installation (LSA)**
15. Position the oil level indicator tube into place.
16. Install the oil level indicator tube bolt and tighten to 25 (18 lb ft).
17. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (V8)** .
18. Install the engine coolant air bleed hose.
19. Install the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
20. Fill the cooling system. Refer to **Cooling System Draining and Filling (LSA, LS3, L99 Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .

VALVE LIFTER REPLACEMENT (WITHOUT AFM)

Removal Procedure

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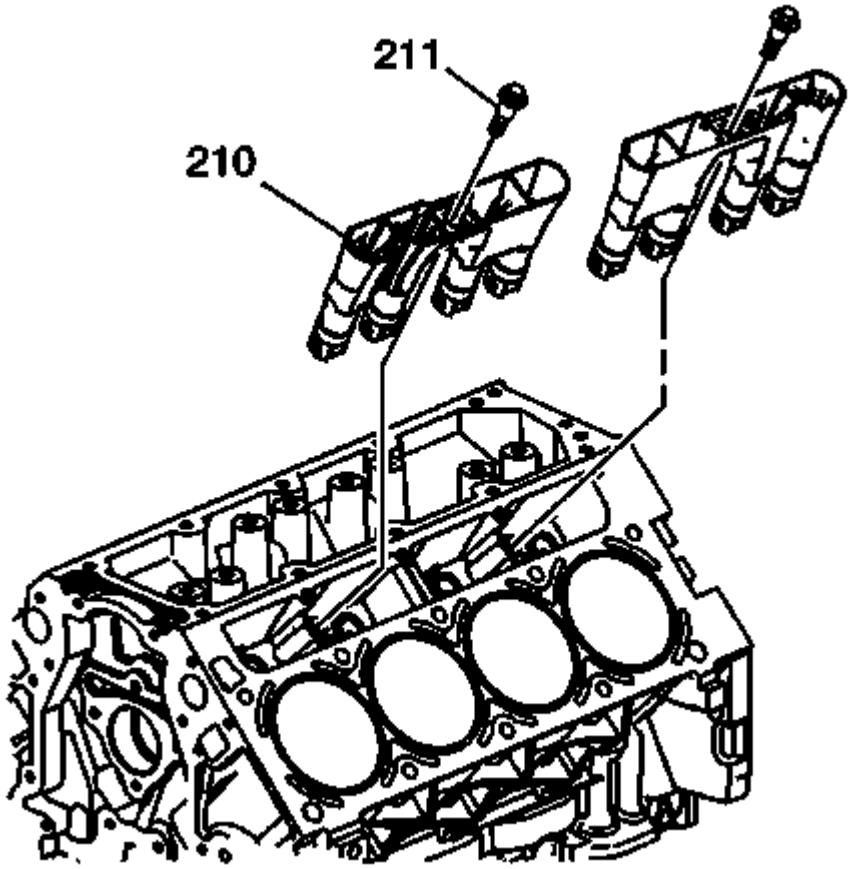


Fig. 118: Valve Lifter Guides, Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the cylinder head and gasket. Refer to **Cylinder Head Replacement - Left Side**, or **Cylinder Head Replacement - Right Side**.
2. Remove the valve lifter guide bolts (211).
3. Remove the valve lifter guides (210) with the lifters. Note the installed position of the guides. The notched area of the guides is to align with the locating tab on the engine block.

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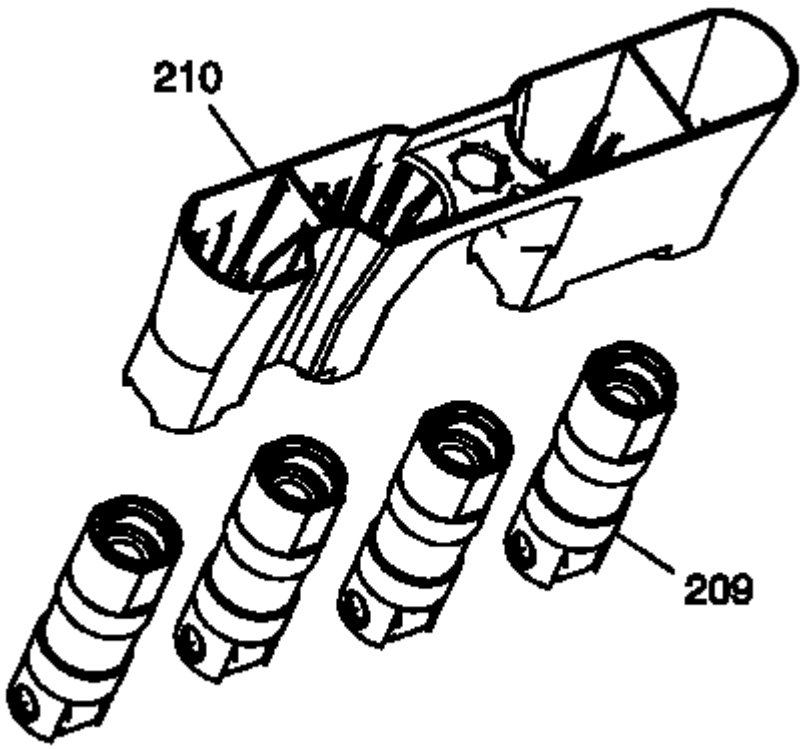


Fig. 119: Valve Lifter Guides & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the valve lifters (209) from the guide (210).
5. Organize or mark the components so that they can be installed in the same location from which they were removed, if required.
6. Clean and inspect the valve lifters, if required. Refer to **Valve Lifter and Guide Cleaning and Inspection** .

Installation Procedure

Note:

- If camshaft replacement is required, the valve lifters must also be replaced.
- When reusing valve lifters, install the lifters to their original locations

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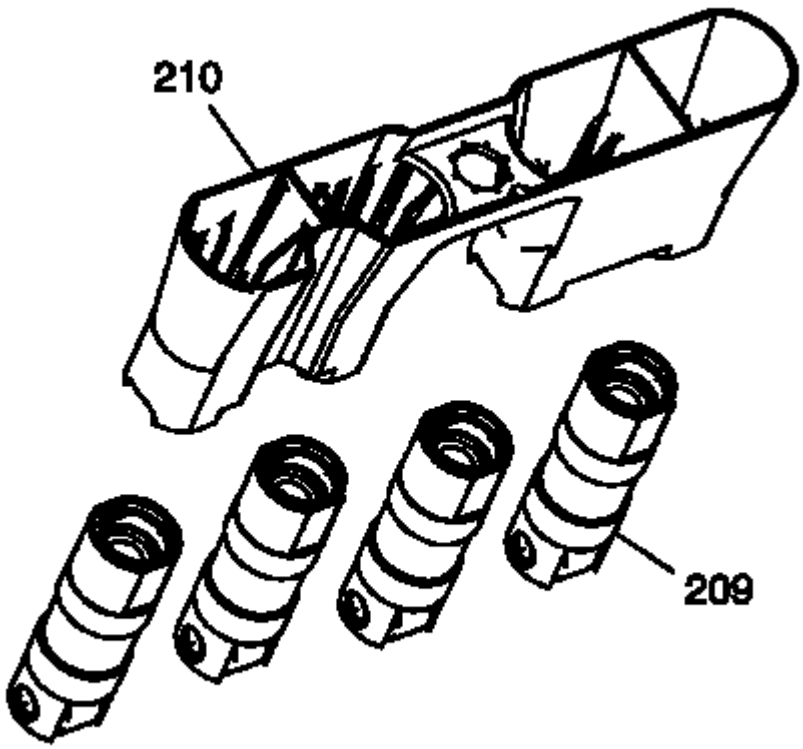


Fig. 120: Valve Lifter Guides & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve lifters (209) and engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters into the lifter guides (210). Align the flat area on the top of the lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.

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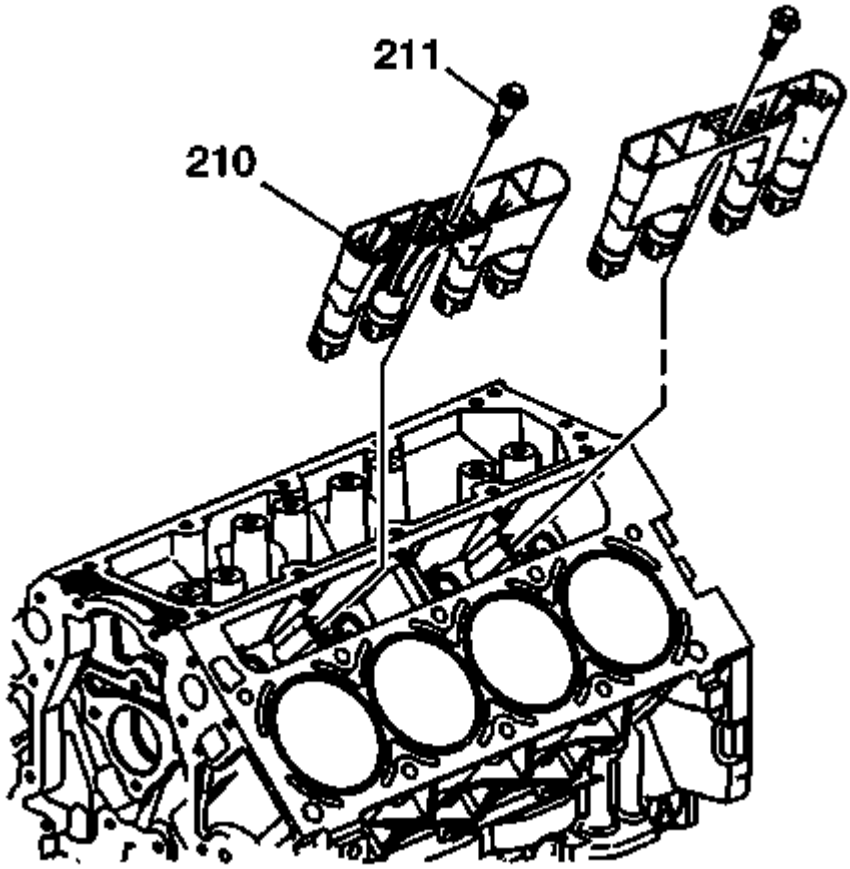


Fig. 121: Valve Lifter Guides, Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the valve lifters and guide (210) to the engine block.

CAUTION: Refer to Fastener Caution .

4. Install the valve lifter guide bolts.

Tighten

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

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

VALVE LIFTER REPLACEMENT (WITH AFM)

Removal Procedure

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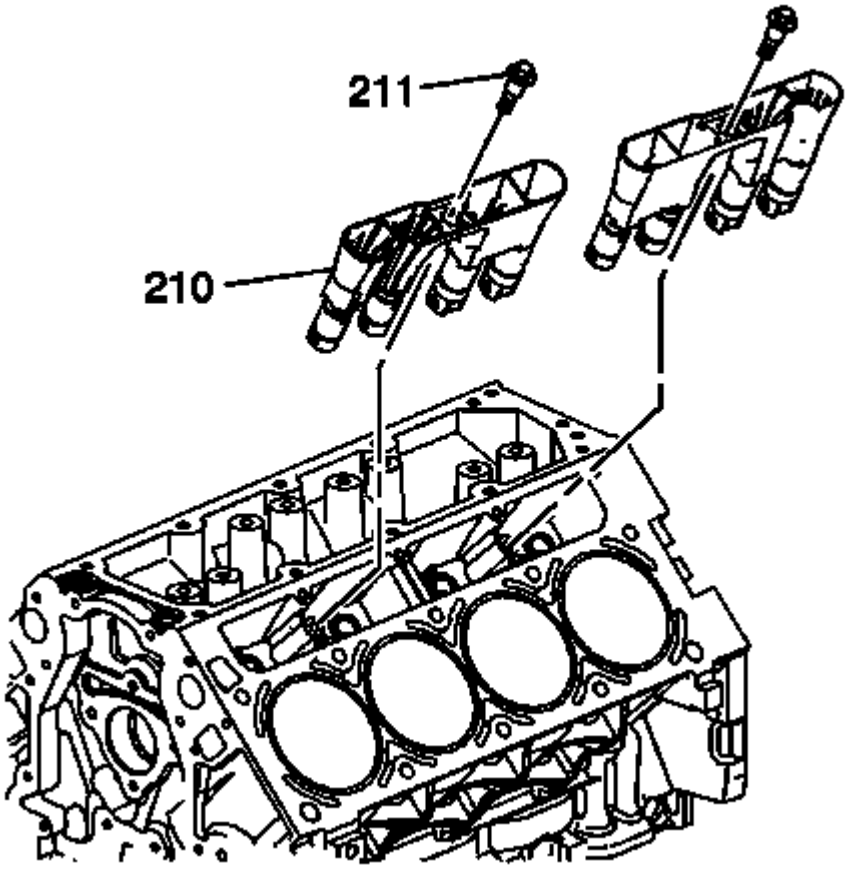


Fig. 122: View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS COMPANY

1. Remove the cylinder head and gasket. Refer to **Cylinder Head Replacement - Left Side**
2. Remove the cylinder head and gasket. Refer to **Cylinder Head Replacement - Right Side**.
3. Remove the valve lifter guide bolts (211).
4. Remove the valve lifter guides (210) with the lifters. Note the installed position of the guides. The notched area of the guides is to align with the locating tab on the engine block.

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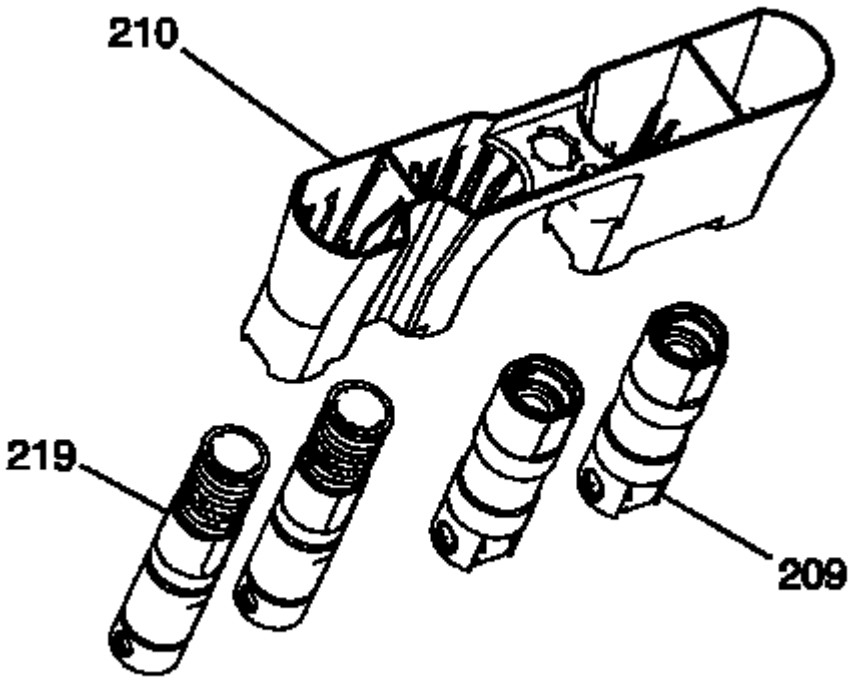


Fig. 123: Exploded View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS COMPANY

5. Remove the valve lifters (209, 219) from the guide (210).

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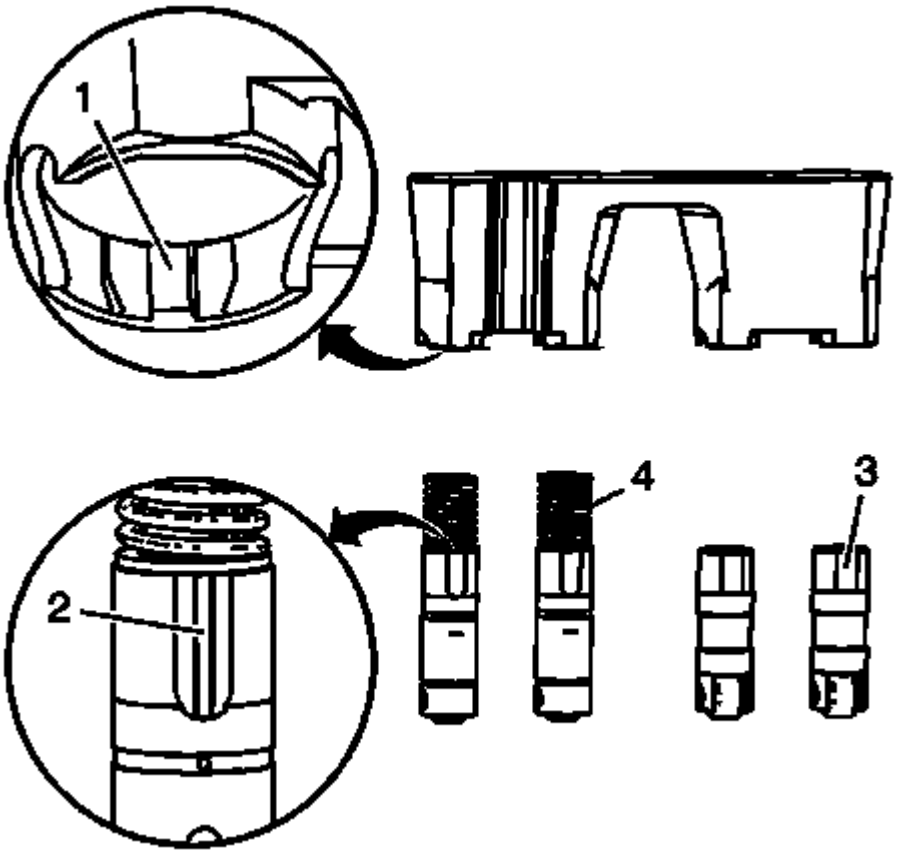


Fig. 124: Inserting Valve Lifters Into Lifter Guides
Courtesy of GENERAL MOTORS COMPANY

NOTE: The active fuel management lifters are installed into the guide by aligning the notched area of the guide (1) with the raised surface on the side of the lifter (2).

6. Organize or mark the components so that they can be installed in the same location from which they were removed, if required.
7. Clean and inspect the valve lifters, if required. Refer to **Valve Lifter and Guide Cleaning and Inspection**

Installation Procedure

NOTE:

- **If camshaft replacement is required, the valve lifters must also be replaced.**
- **When reusing valve lifters, install the lifters to their original locations.**
- **Each of the 4 valve guide assemblies will contain 2 active fuel management valve lifters and 2 non active fuel management valve lifters.**
- **With the lifters and guides properly installed, cylinders 1, 4, 6, and 7 lifter**

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bores will each contain 2 active fuel management valve lifters.

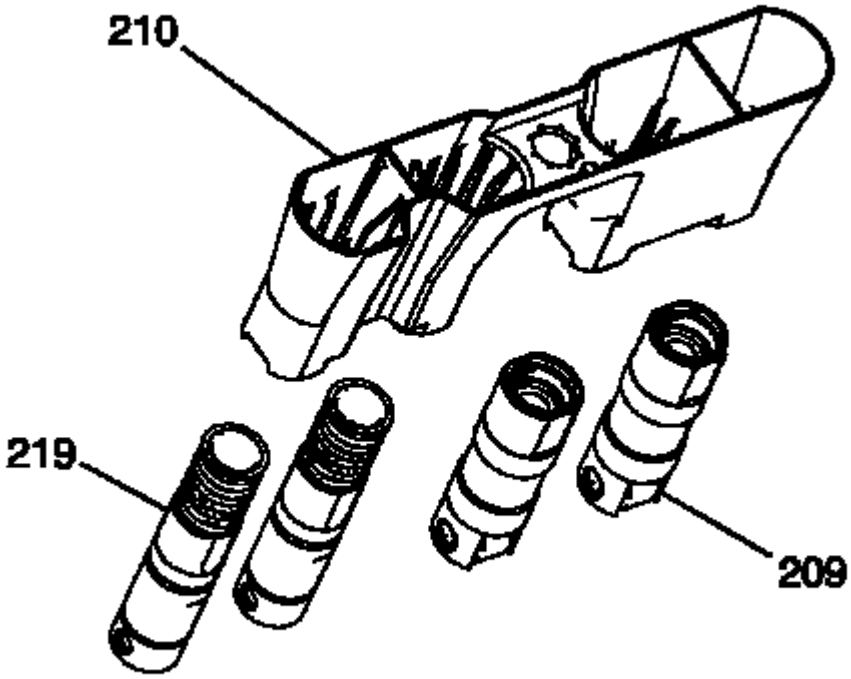


Fig. 125: Exploded View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve lifters (209, 219) and engine block valve lifter bores with clean engine oil.

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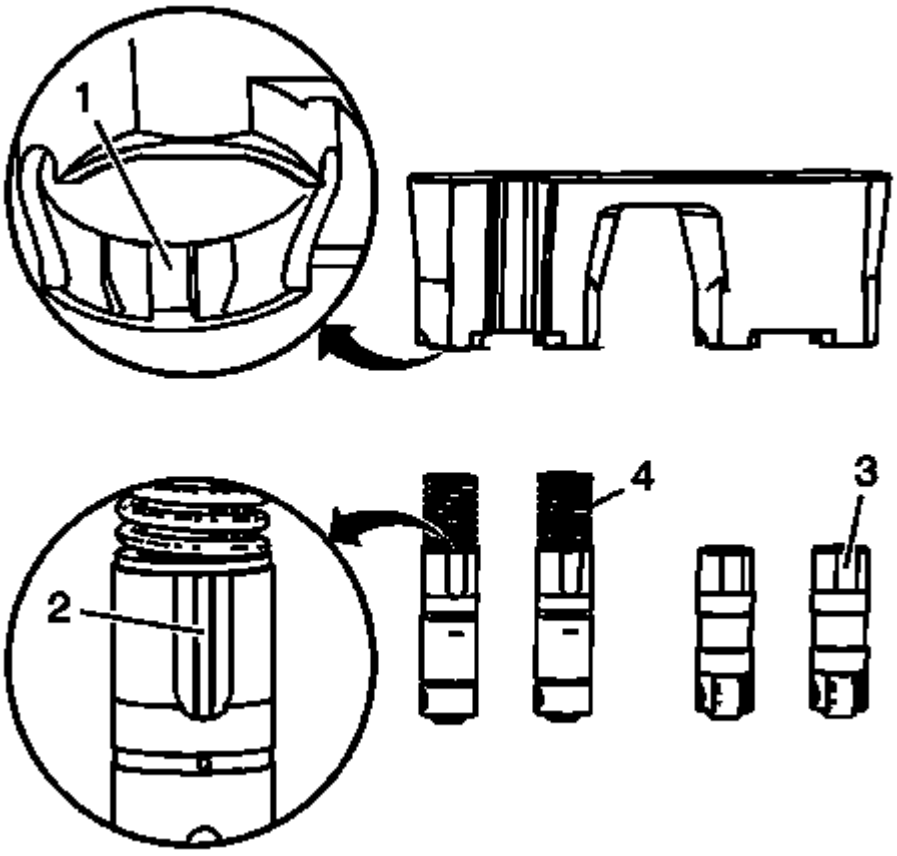


Fig. 126: Inserting Valve Lifters Into Lifter Guides
Courtesy of GENERAL MOTORS COMPANY

2. Insert the valve lifters into the lifter guides.
    - Align the flat area (3) on the top of the non active fuel management lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.
    - The active fuel management lifters are to be installed into the guide, with the notch in the guide (1) aligned with the raised area (2) of the lifter.

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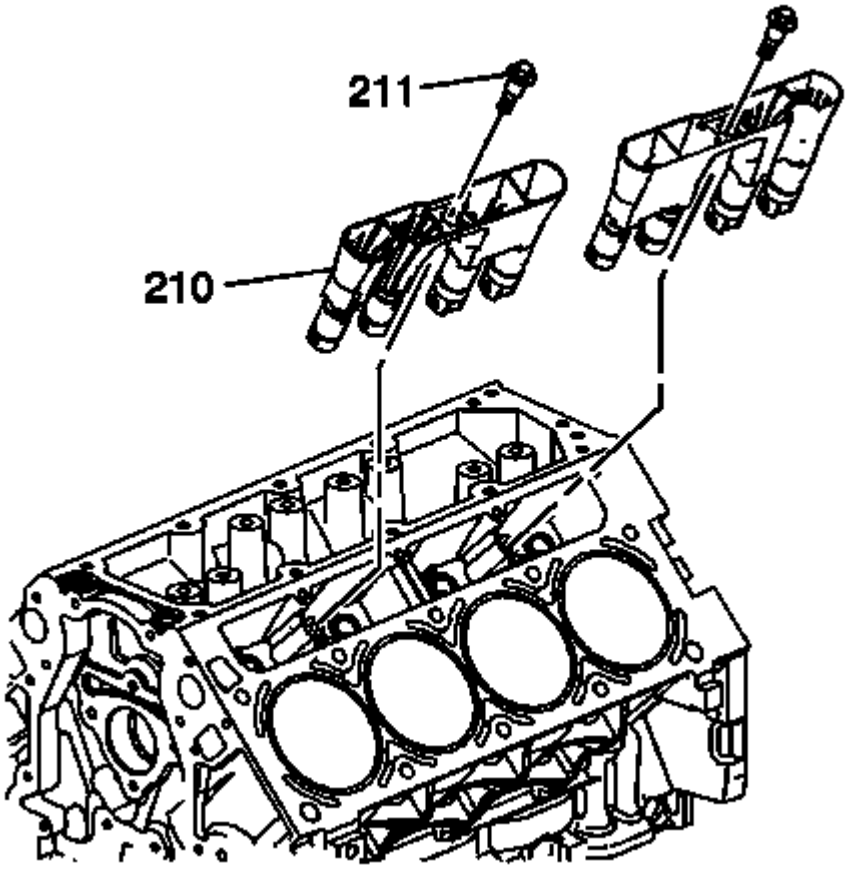


Fig. 127: View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS COMPANY

3. Install the valve lifters and guide (210) to the engine block.

CAUTION: Refer to Fastener Caution

4. Install the valve lifter guide bolts (211).

Tighten

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

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

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

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- **J 41665** Crankshaft Balancer and Sprocket Installer
- **J 41816** Crankshaft Balancer Remover
- **J 41816-2** Crankshaft End Protector
- **J 42386-A** Flywheel Holding Tool
- **J 45059** Angle Meter

Removal Procedure

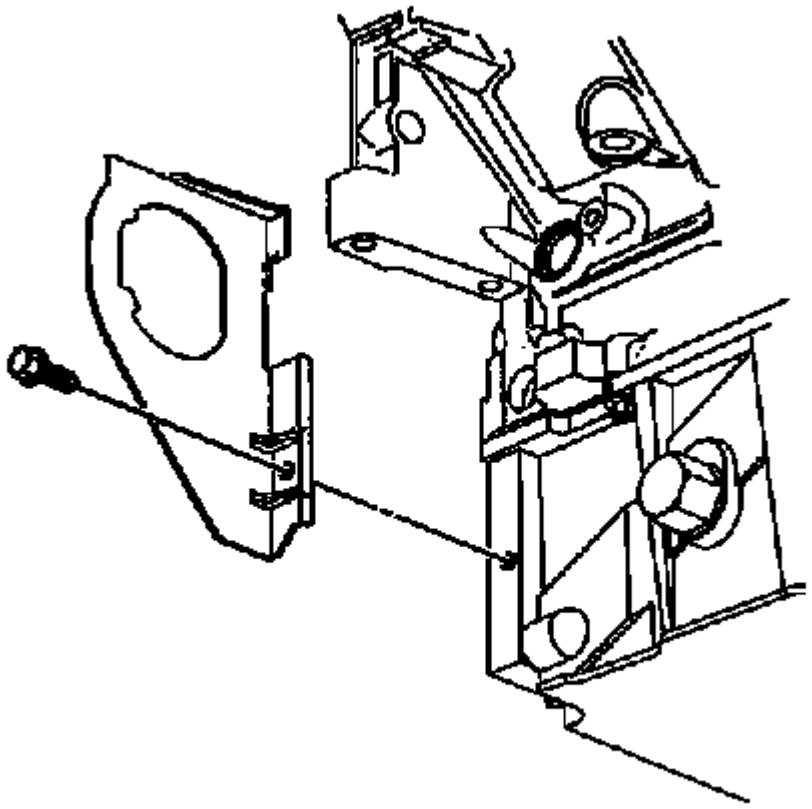


Fig. 128: View Of Right Transmission Cover & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the air conditioning (A/C) drive belt. Refer to **Air Conditioning Compressor Belt Replacement (Except LSA)**, **Air Conditioning Compressor Belt Replacement (LSA)**.
2. Remove the power steering gear. Refer to **Steering Gear Replacement (N41)** , **Steering Gear Replacement (NV9)** .
3. Remove the starter motor. Refer to **Starter Replacement (LSA,LS3,L99)** .
4. Remove the right transmission cover and bolt.

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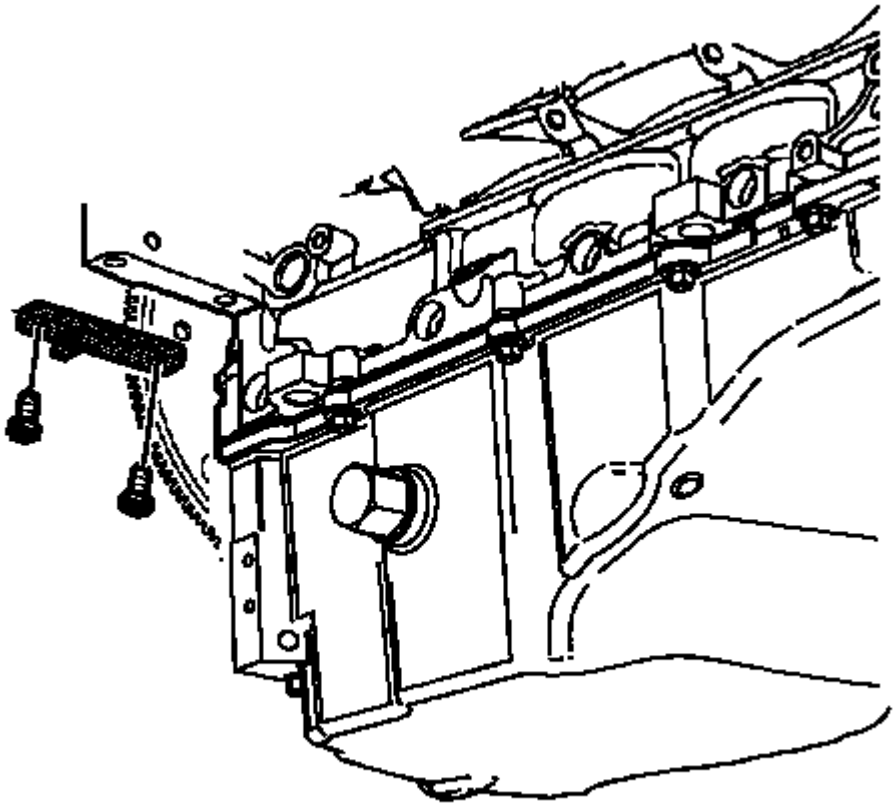


Fig. 129: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE:

- **For manual transmission applications, note the position of the crankshaft balancer before removal. The balancer does not use a key or keyway for positioning. Mark or scribe the end of the crankshaft and the balancer before component removal. The crankshaft balancer must be installed to the original position. If replacing the crankshaft balancer, note the location of any existing balance weights, if applicable. Crankshaft balance weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight will be either flush or below flush with the face of the balancer.**
- **Do not use the crankshaft balancer bolt again. Install a NEW crankshaft balancer bolt during final assembly.**

5. Install the **J 42386-A** flywheel holding tool and bolts.

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Use one M10 - 1.5 x 120 mm and one M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A** flywheel holding tool bolts to 50 (37 lb ft).

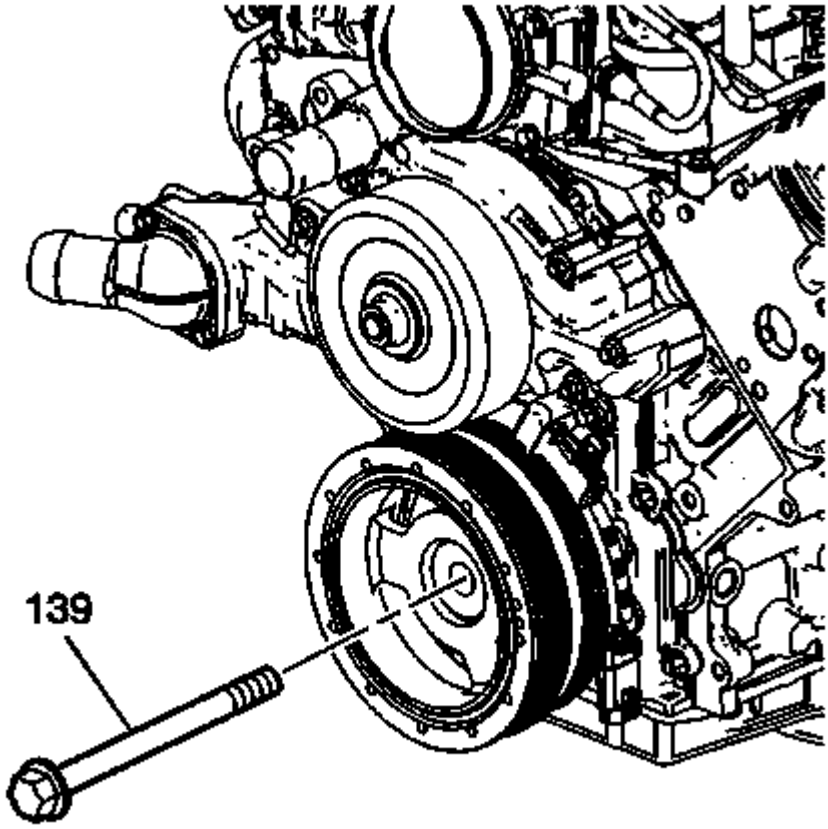


Fig. 130: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the crankshaft balancer bolt (139).

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

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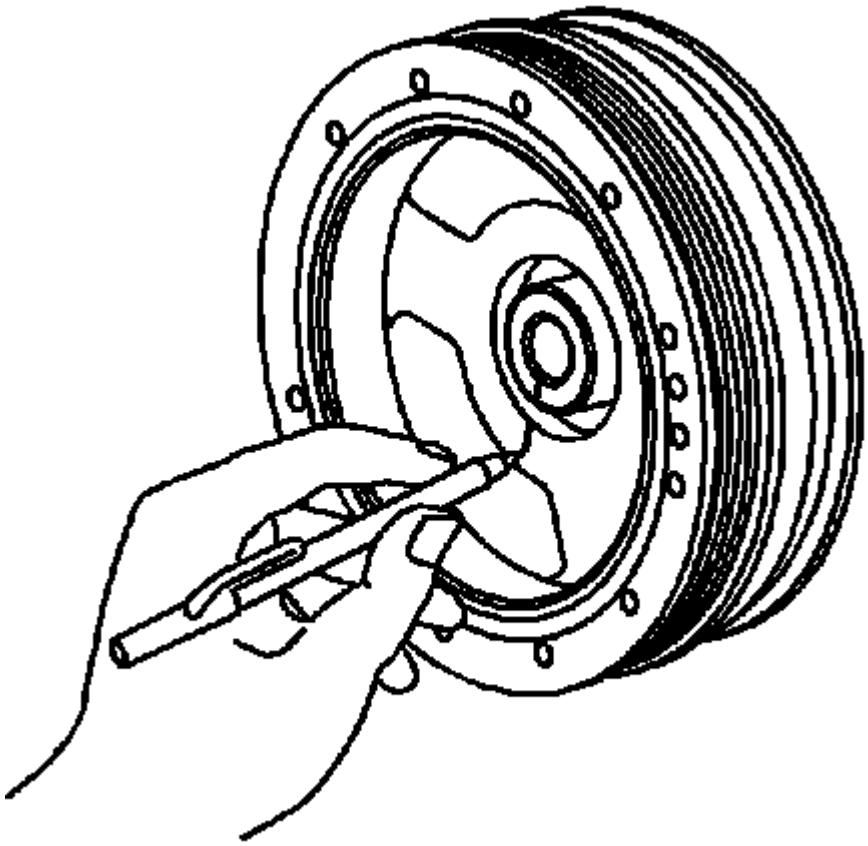


Fig. 131: Marking Crankshaft Balancer & End Of Crankshaft
Courtesy of GENERAL MOTORS COMPANY

7. Mark or scribe the crankshaft balancer and the end of the crankshaft.

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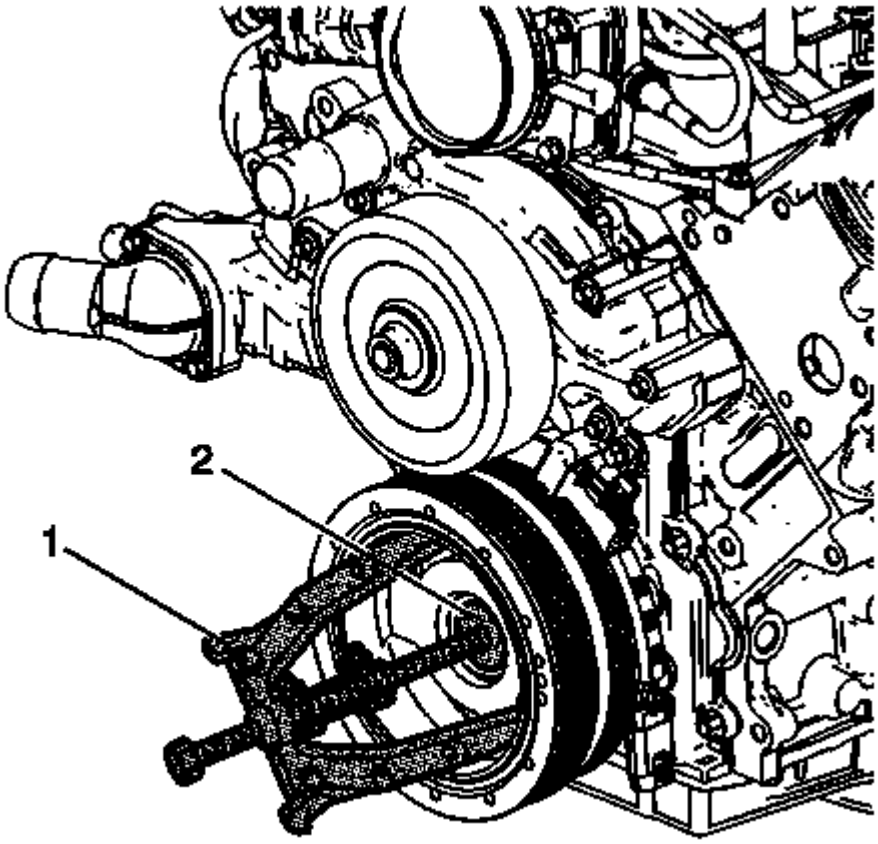


Fig. 132: Crankshaft Balancer Remover And Protector Tools
Courtesy of GENERAL MOTORS COMPANY

8. Use the **J 41816** crankshaft balancer remover (1) and the **J 41816-2** crankshaft end protector (2) in order to remove the crankshaft balancer.

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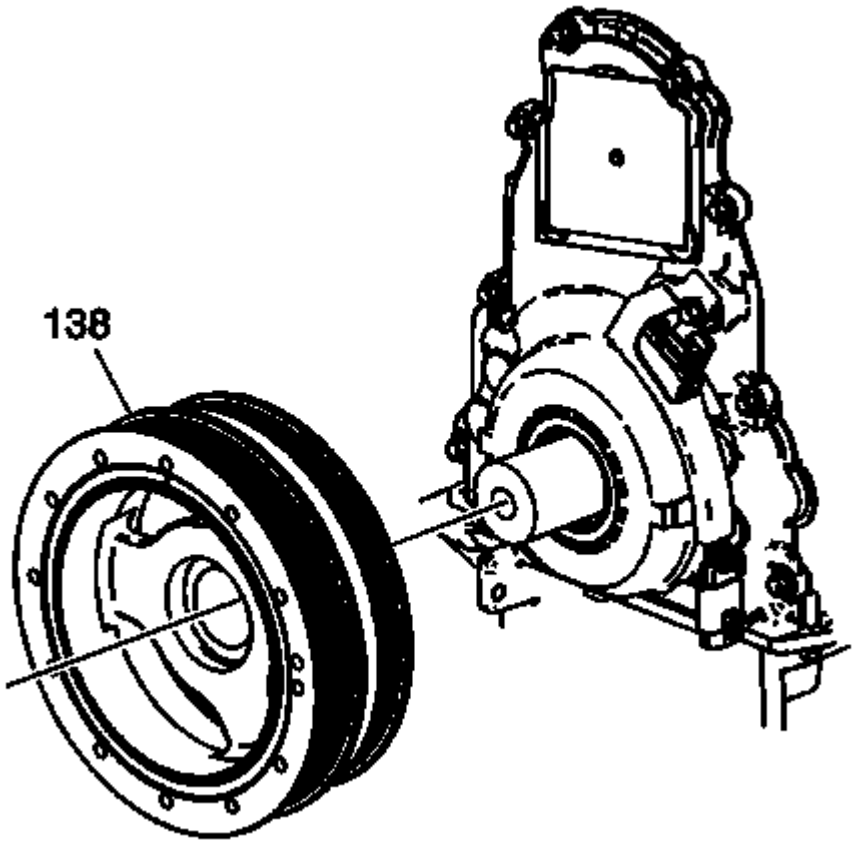


Fig. 133: Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

9. Remove the crankshaft balancer (138).

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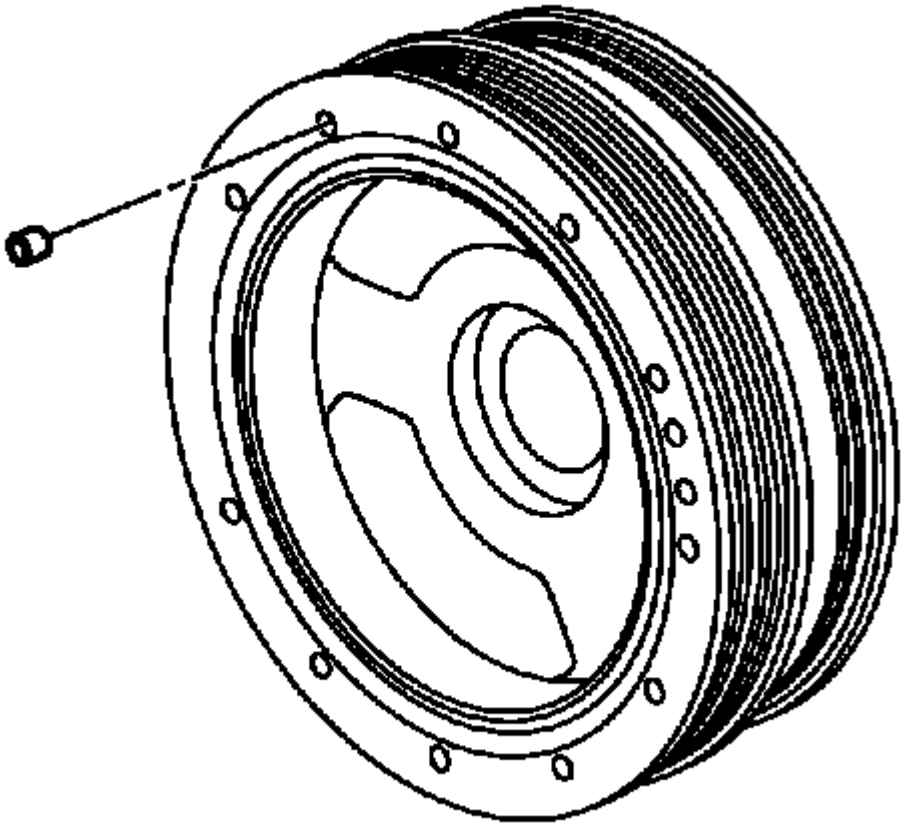


Fig. 134: View Of Balancer Weights In Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

10. Note the position of the crankshaft balance weights, if applicable. Refer to **Crankshaft Balancer Cleaning and Inspection** .

Installation Procedure

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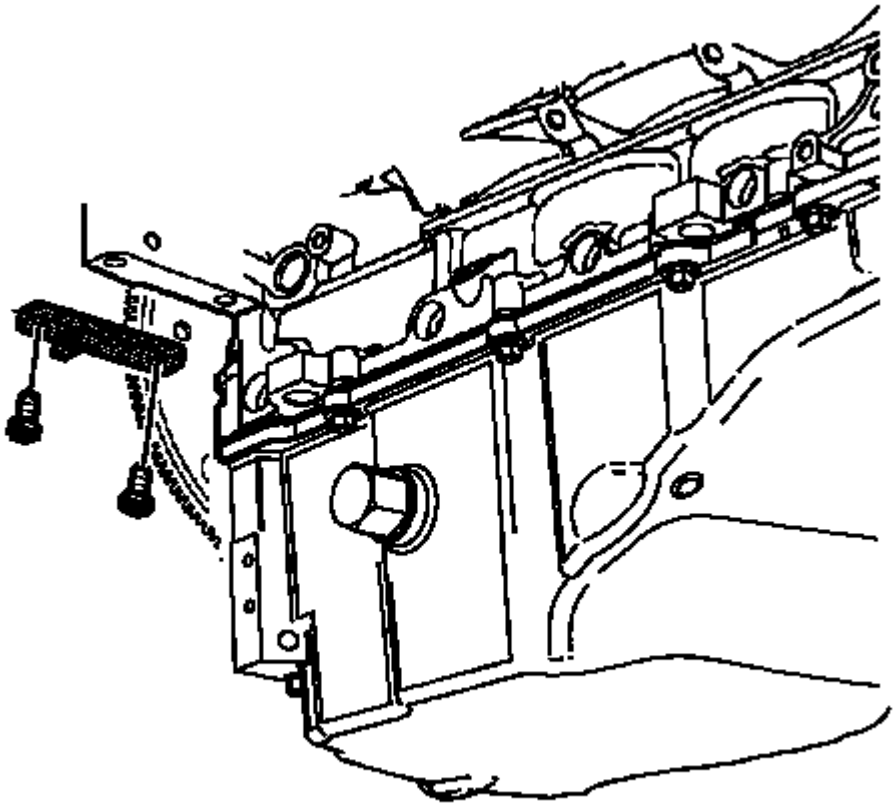


Fig. 135: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **For manual transmission applications, note the position of the crankshaft balancer before removal. The balancer does not use a key or keyway for positioning. Mark or scribe the end of the crankshaft and the balancer before removal. The crankshaft balancer must be installed to the original position. If replacing the crankshaft balancer, note the location of any existing balance weights, if applicable. Install new balance weights into the new crankshaft balancer, if applicable. Crankshaft balance weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight will be either flush or below flush with the face of the balancer.**
- **The crankshaft balancer installation and bolt tightening involves a four stage tightening process. The first pass ensures that the balancer is installed completely onto the crankshaft. The second, third and fourth passes tighten the NEW bolt to the proper torque.**
- **The used crankshaft balancer bolt is used only during the first pass of the balancer installation procedure. Install a NEW crankshaft**

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balancer bolt and tighten as described in the second, third and fourth passes of the balancer bolt tightening procedure.

1. Install the **J 42386-A** flywheel holding tool and bolts.

   Use one M10 - 1.5 x 120 mm and one M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A** flywheel holding tool bolts to 50 (37 lb ft).

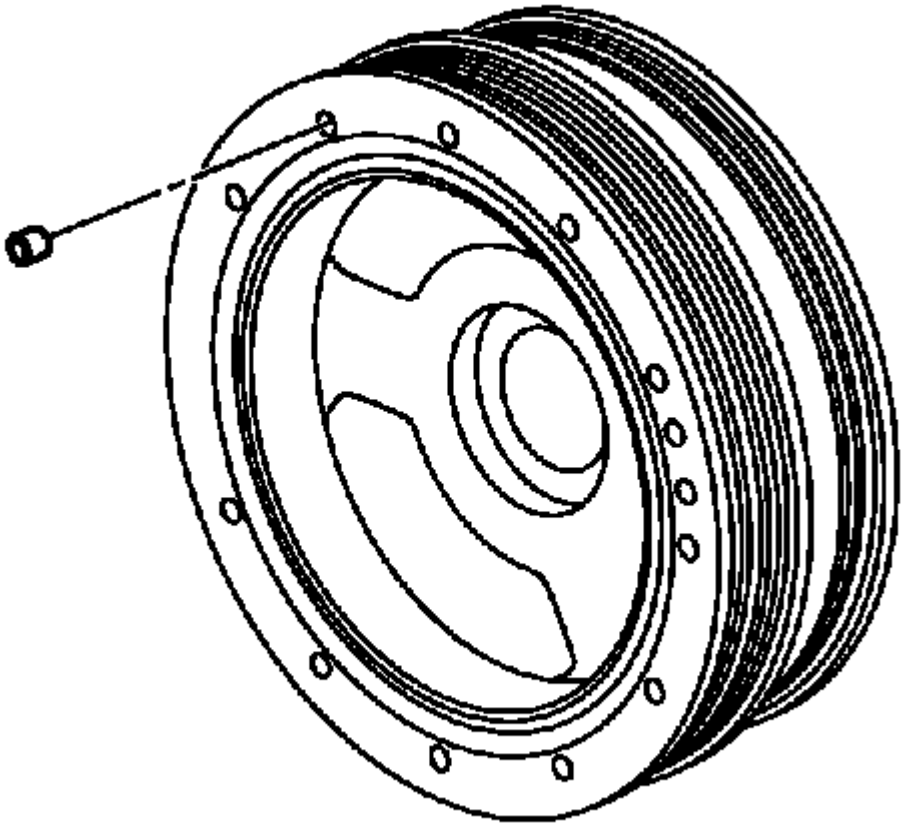


Fig. 136: View Of Balancer Weights In Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

2. Using the old balancer as a reference, mark or scribe the new balancer in the same location, if applicable.
3. Install balance weights into the new balancer, if applicable. Refer to **Crankshaft Balancer Cleaning and Inspection** .

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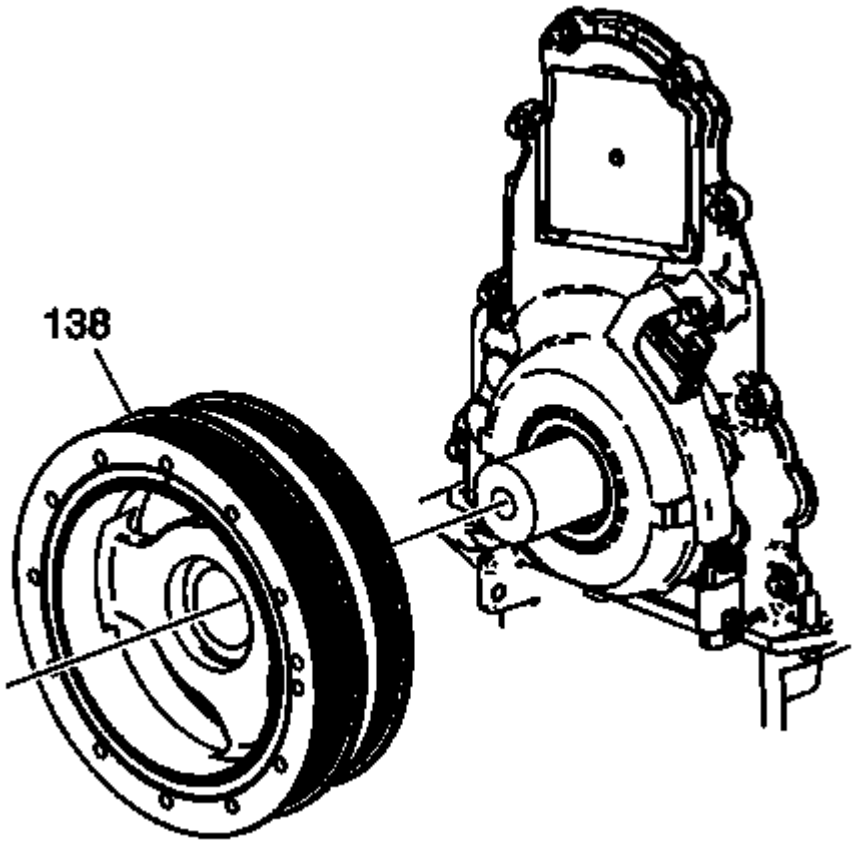


Fig. 137: Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.**
- **A thin washer has been added to the LS2 engine. If the washer is present it does not need to be replaced. If no washer is present, one should be added. (P/N 12598247).**

4. Position the balancer (138) onto the end of the crankshaft.

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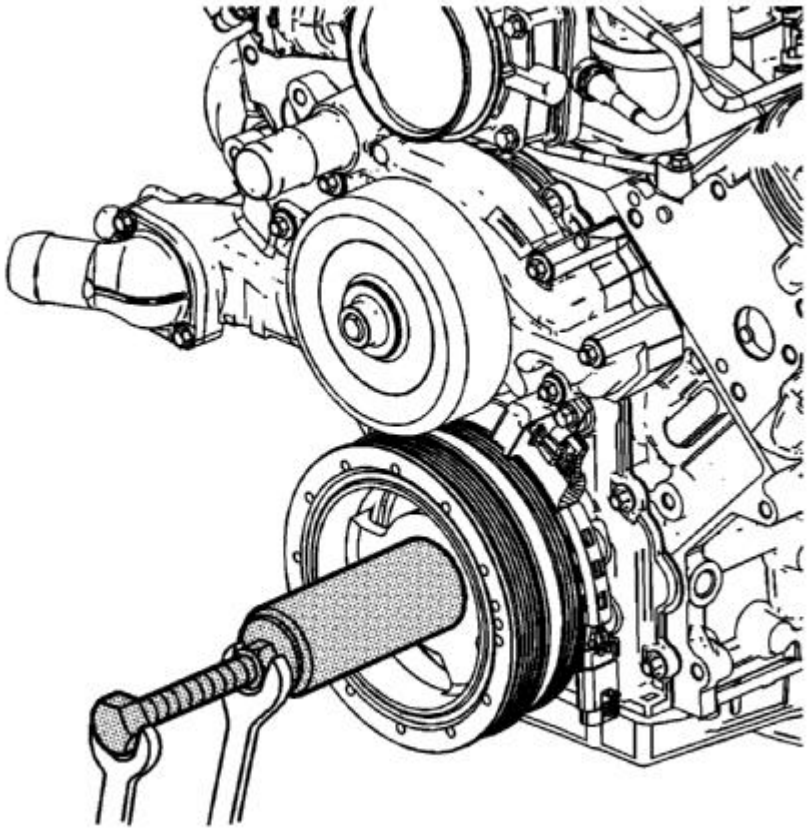


Fig. 138: Installing Balancer
Courtesy of GENERAL MOTORS COMPANY

5. Use the **J 41665** crankshaft balancer and sprocket installer in order to install the balancer.
    1. Assemble the threaded rod, nut, washer and installer.

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

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

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

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

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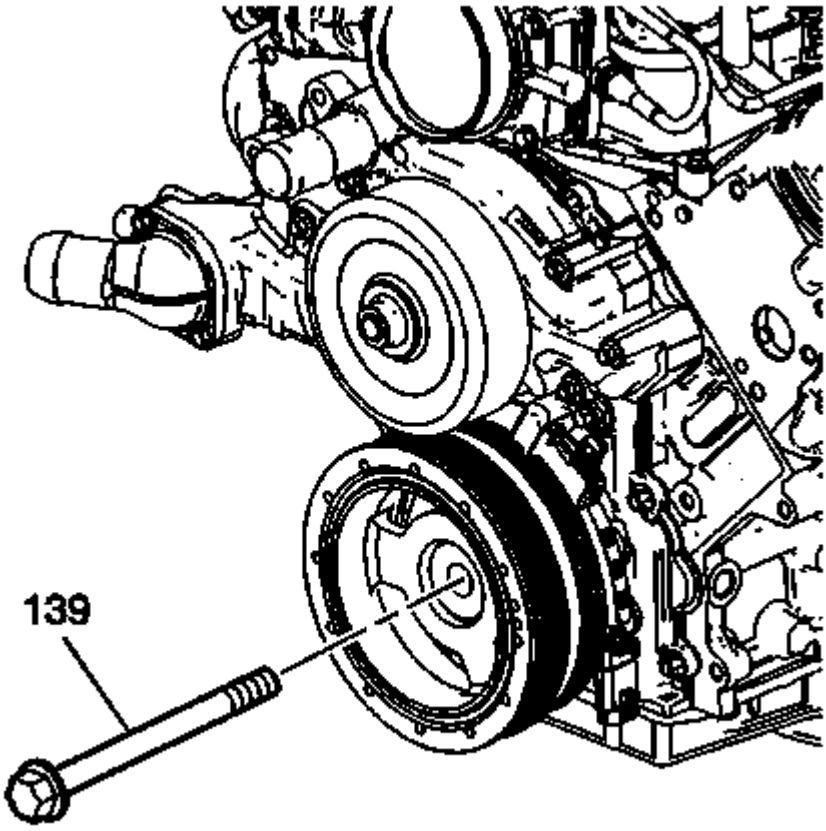


Fig. 139: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Install the used crankshaft balancer bolt (139) and tighten to 330 (240 lb ft).
7. Remove the used crankshaft balancer bolt.

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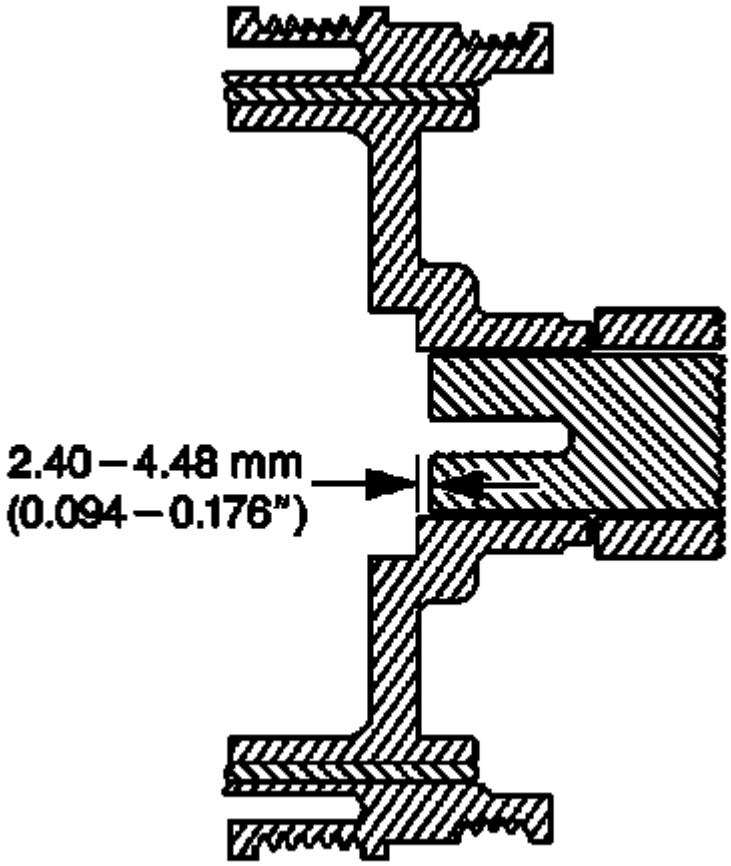


Fig. 140: Identifying Hub To Crankshaft Distance
Courtesy of GENERAL MOTORS COMPANY

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

8. Measure for a correctly installed balancer.

   If the balancer is not installed to the proper dimensions, install the **J 41665** crankshaft balancer and sprocket installer and repeat the installation procedure.

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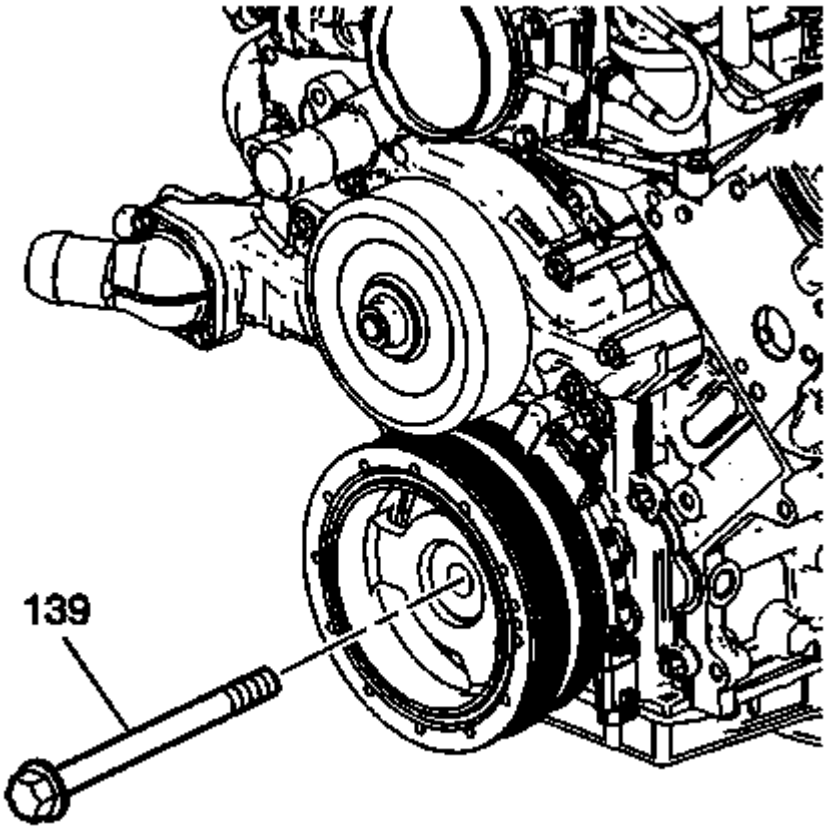


Fig. 141: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Install the NEW crankshaft balancer bolt (139).
    1. Tighten the crankshaft balancer bolt to 80 (59 lb ft).
    2. Tighten the crankshaft balancer bolt a final pass to 125 degrees using the **J 45059** angle meter.
10. Remove the **J 42386-A** flywheel holding tool.
11. Install the starter motor. Refer to **Starter Replacement (LSA,LS3,L99)** .
12. Install the power steering gear. Refer to **Steering Gear Replacement (N41)** , **Steering Gear Replacement (NV9)** .
13. Install the A/C drive belt. Refer to **Air Conditioning Compressor Belt Replacement (Except LSA)**, **Air Conditioning Compressor Belt Replacement (LSA)**.
14. Perform the crankshaft position (CKP) system variation learn procedure. Refer to **Crankshaft Position System Variation Learn** .

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

J 41478 Crankshaft Front Oil Seal Installer

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Removal Procedure

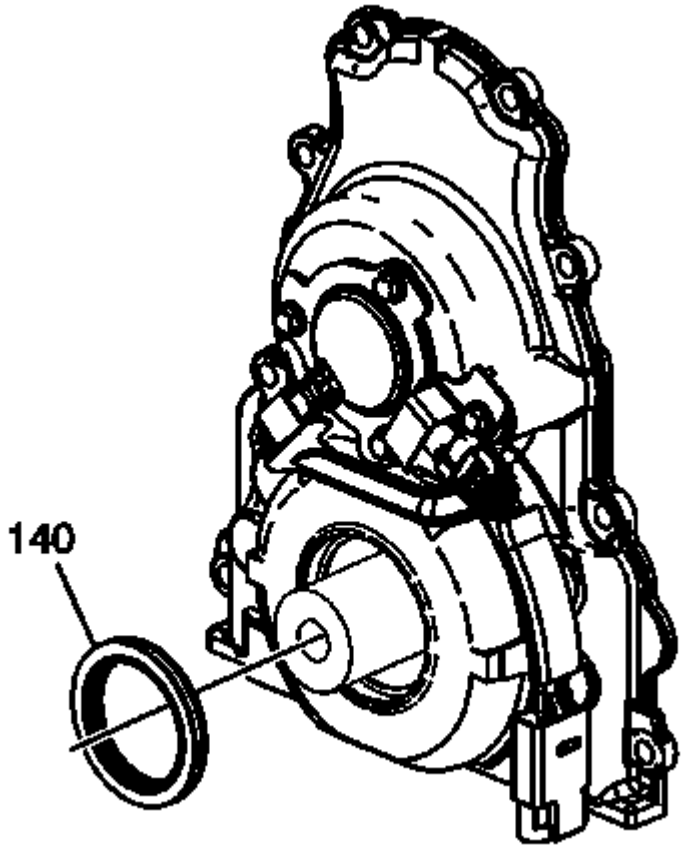


Fig. 142: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Remove the crankshaft front oil seal (140) from the front cover.

Installation Procedure

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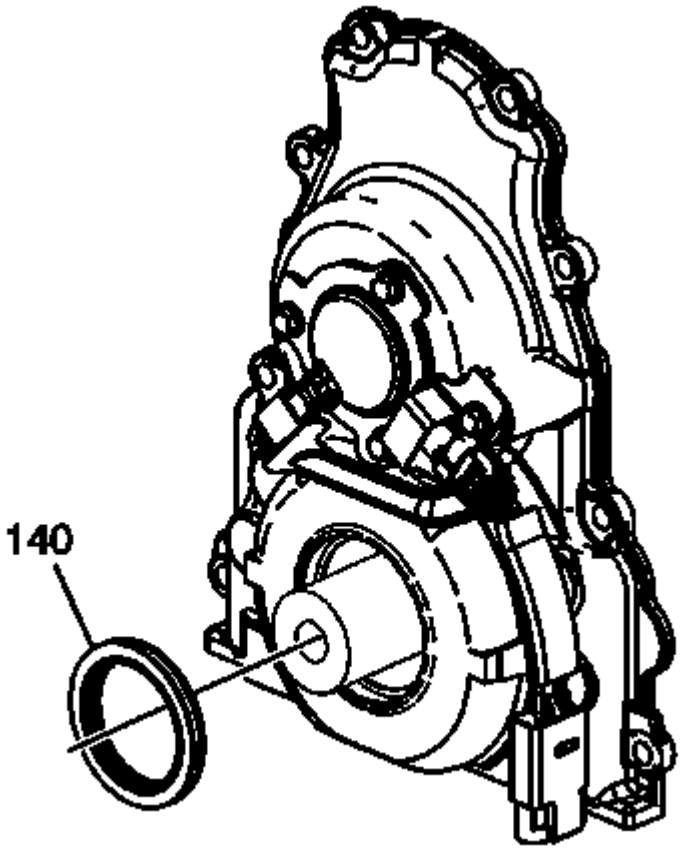


Fig. 143: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

1. Lubricate the outer edge of the oil seal (140) with clean engine oil.
2. Lubricate the front cover oil seal bore with clean engine oil.

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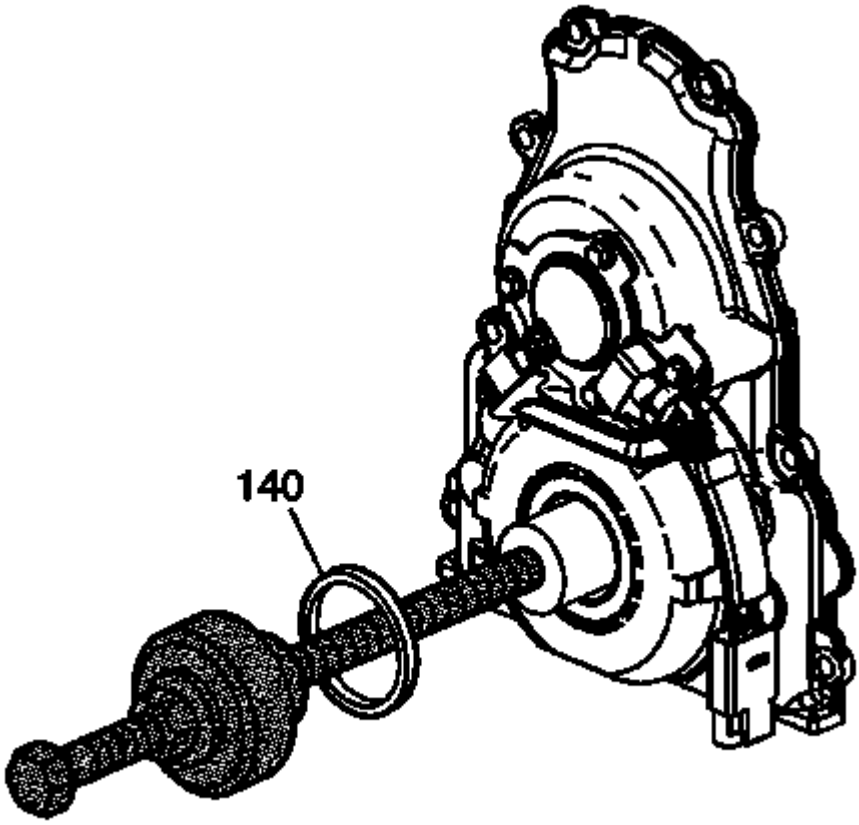


Fig. 144: View Of Front Oil Seal & Special Tool
Courtesy of GENERAL MOTORS COMPANY

3. Install the crankshaft front oil seal (140) onto the **J 41478** crankshaft front oil seal installer guide.
4. Install the **J 41478** crankshaft front oil seal installer threaded rod (with nut, washer, guide, and oil seal) into the end of the crankshaft.
5. Use the **J 41478** crankshaft front oil seal installer in order to install the oil seal into the cover bore.
    1. Use a wrench and hold the hex on the installer bolt.
    2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.
    3. Remove the **J 41478** crankshaft front oil seal installer.
    4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.
6. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

CAMSHAFT POSITION ACTUATOR MAGNET REPLACEMENT

Removal Procedure

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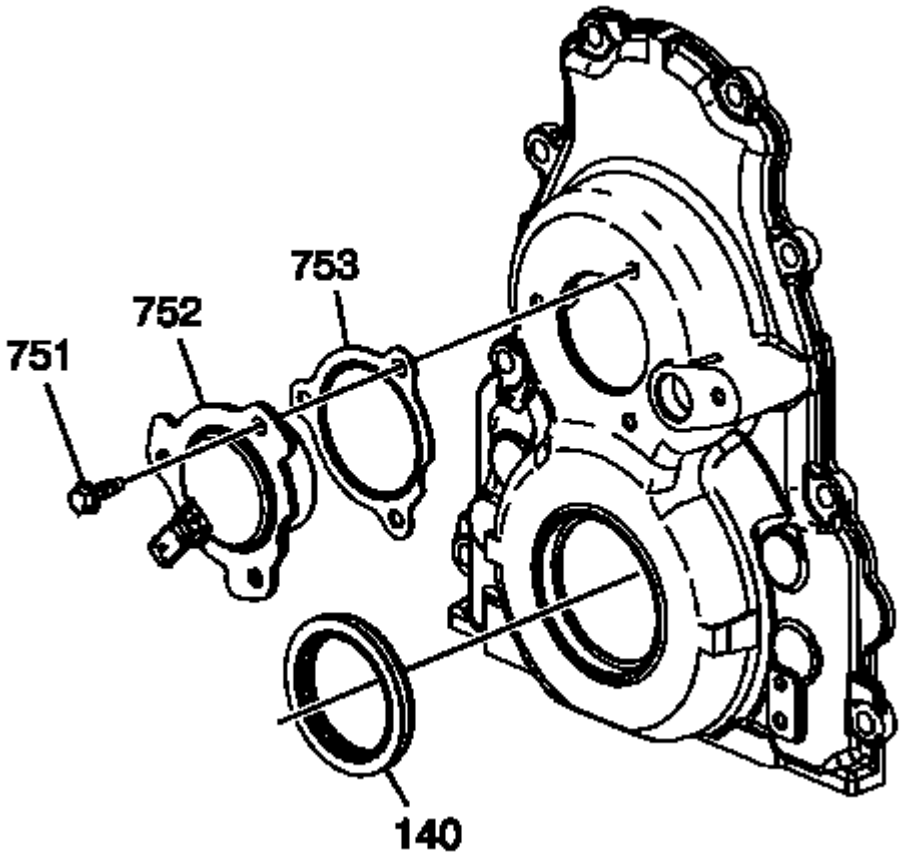


Fig. 145: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS COMPANY

1. Remove the water pump. Refer to **Water Pump Replacement (LS3/L99)** , **Water Pump Replacement (LSA)** .
2. Disconnect the engine harness electrical connector from the camshaft position (CMP) actuator magnet.
3. Remove the CMP actuator magnet bolts (751) and magnet (752).
4. Remove and discard the CMP actuator magnet gasket (753).

Installation Procedure

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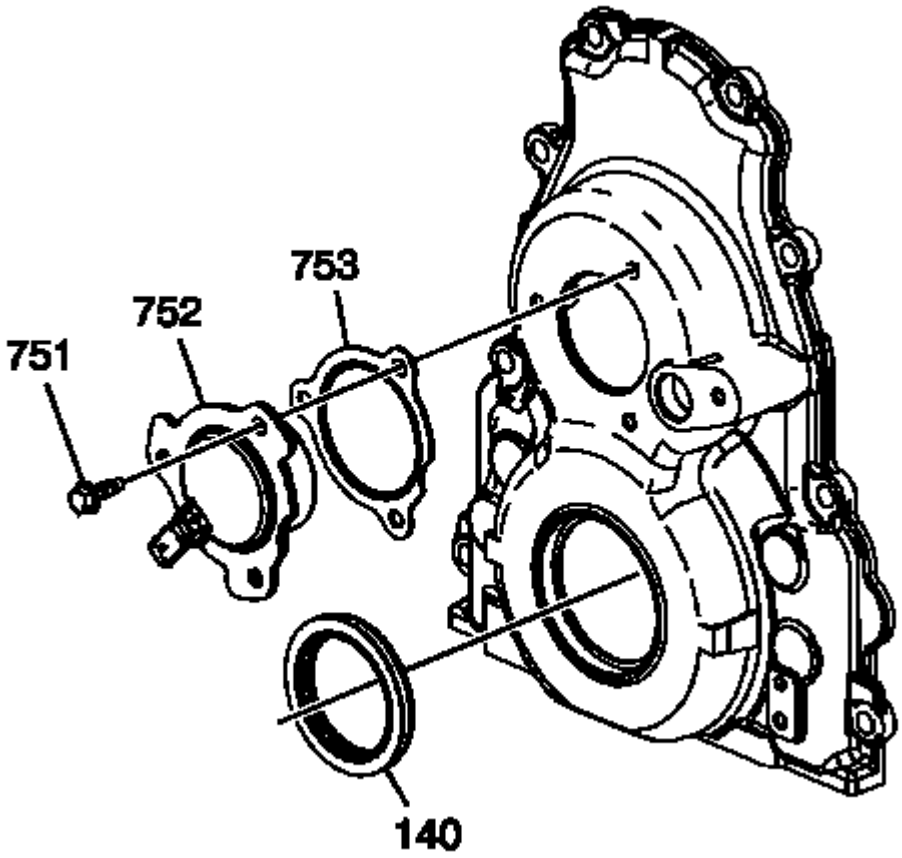


Fig. 146: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: The gasket surface should be free of oil or other foreign material during assembly.

1. Install a NEW CMP actuator magnet gasket (753) onto the CMP actuator magnet.
2. Install the CMP actuator magnet (752) to the front cover.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator magnet bolts (751) and tighten to 12 N.m (106 lb in).
4. Connect the engine harness electrical connector to the CMP actuator magnet.
5. Install the water pump. Refer to **Water Pump Replacement (LS3/L99)** , **Water Pump Replacement (LSA)** .

ENGINE FRONT COVER REPLACEMENT (L99)

Special Tools

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J 41476 Front and Rear Cover Alignment Tool

Removal Procedure

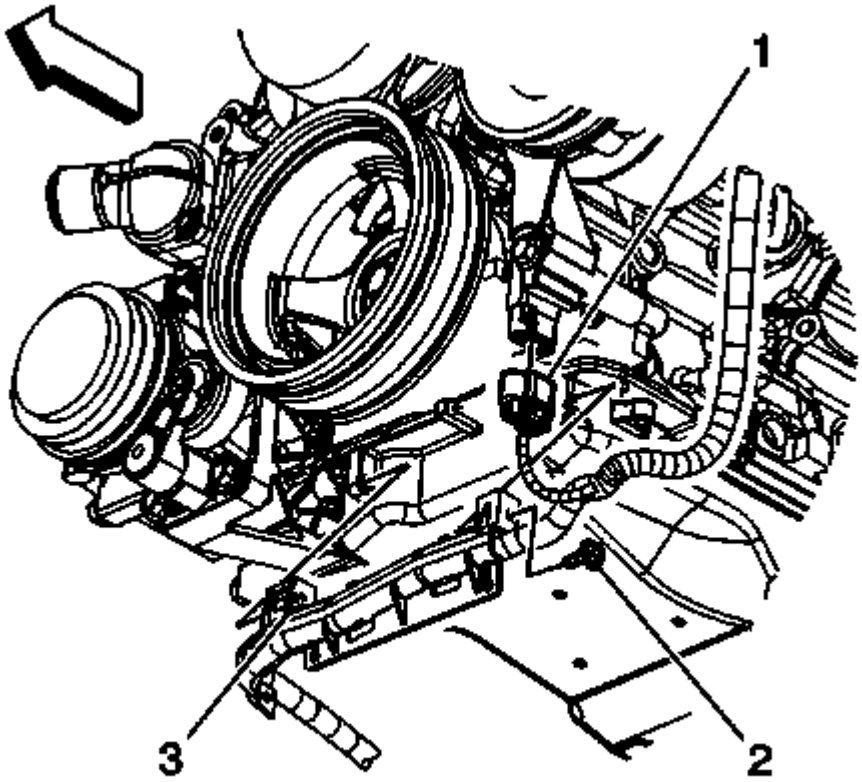


Fig. 147: View Of Electrical Connector, Cable Channel Bolt & Pin
Courtesy of GENERAL MOTORS COMPANY

1. Remove the water pump. Refer to **Water Pump Replacement (LS3/L99)** , **Water Pump Replacement (LSA)** .
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
3. Disconnect the engine harness electrical connector (1) from the camshaft position (CMP) sensor wire harness electrical connector.

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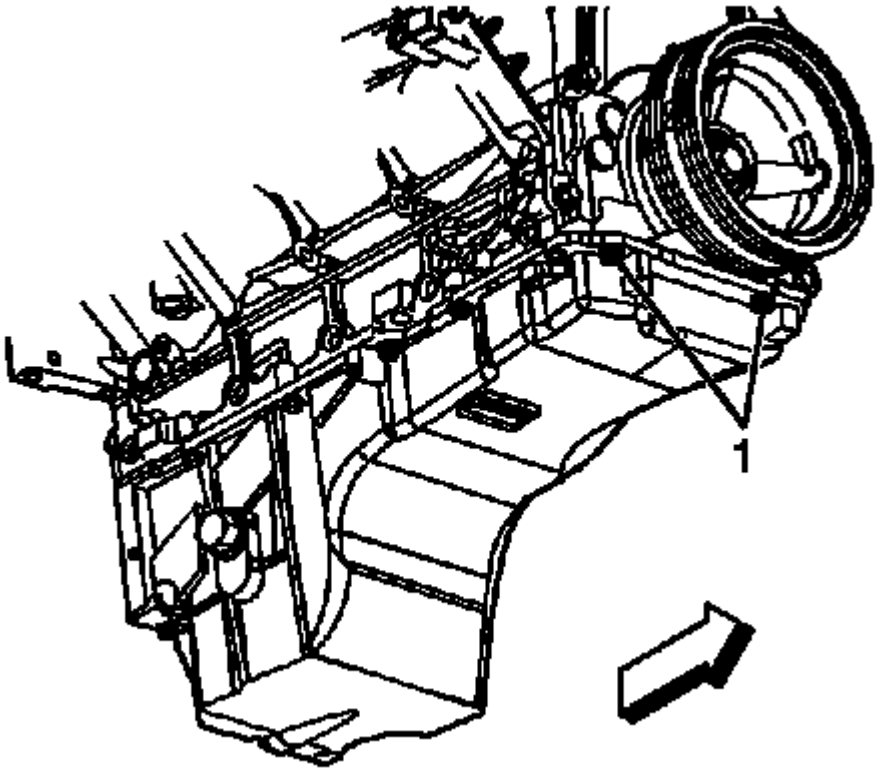


Fig. 148: View Of Oil Pan-To-Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil pan-to-front cover bolts (1).

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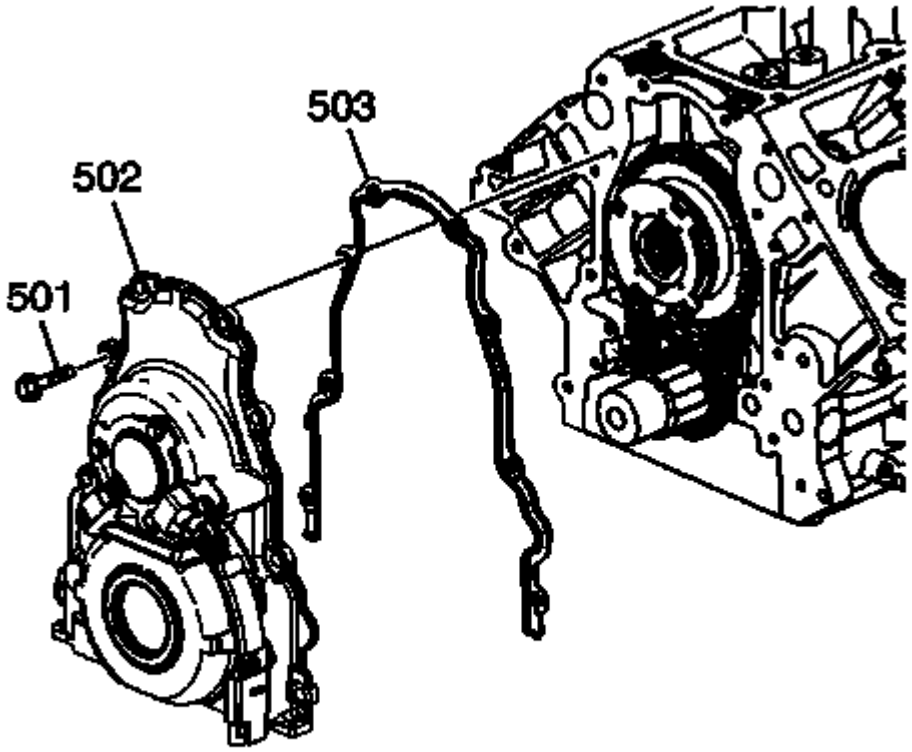


Fig. 149: View Of Front Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS COMPANY

5. Remove the front cover bolts (501).
6. Remove the front cover (502) and gasket (503).
7. Discard the front cover gasket.
8. Remove the crankshaft front oil seal.

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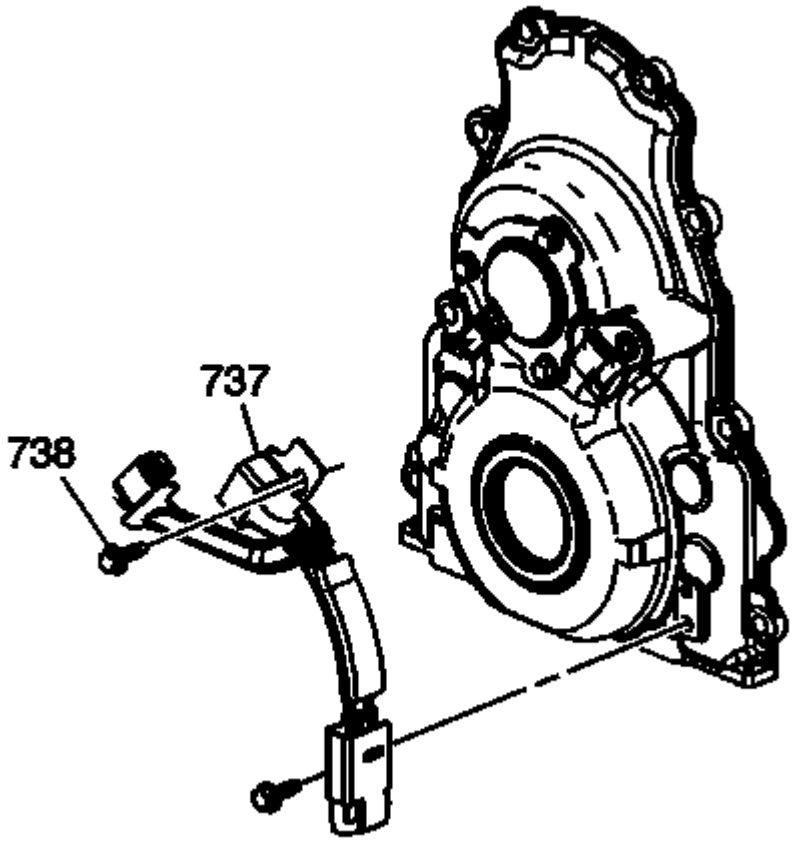


Fig. 150: View Of CMP Sensor Wire Harness & Bolts
Courtesy of GENERAL MOTORS COMPANY

9. If replacing the engine front cover perform the following steps, otherwise proceed to step 10 of the installation procedure.
10. Remove the CMP sensor wire harness bolts (738).
11. Disconnect the CMP sensor wire harness from the CMP sensor.
12. Remove the CMP sensor wire harness (737).

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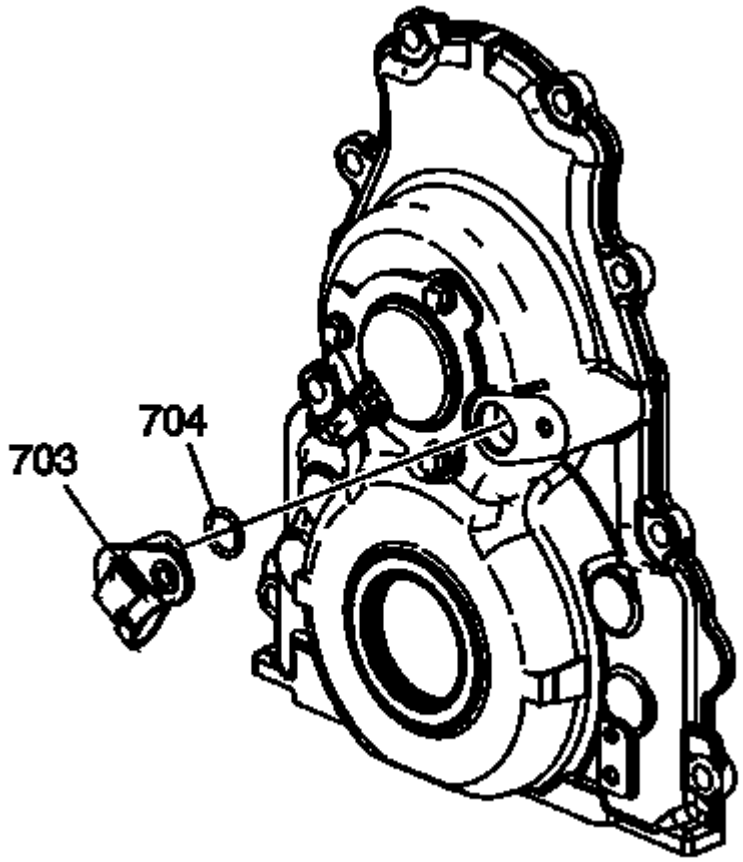


Fig. 151: View Of CMP Sensor & O-Ring
Courtesy of GENERAL MOTORS COMPANY

13. Remove the CMP sensor (703).

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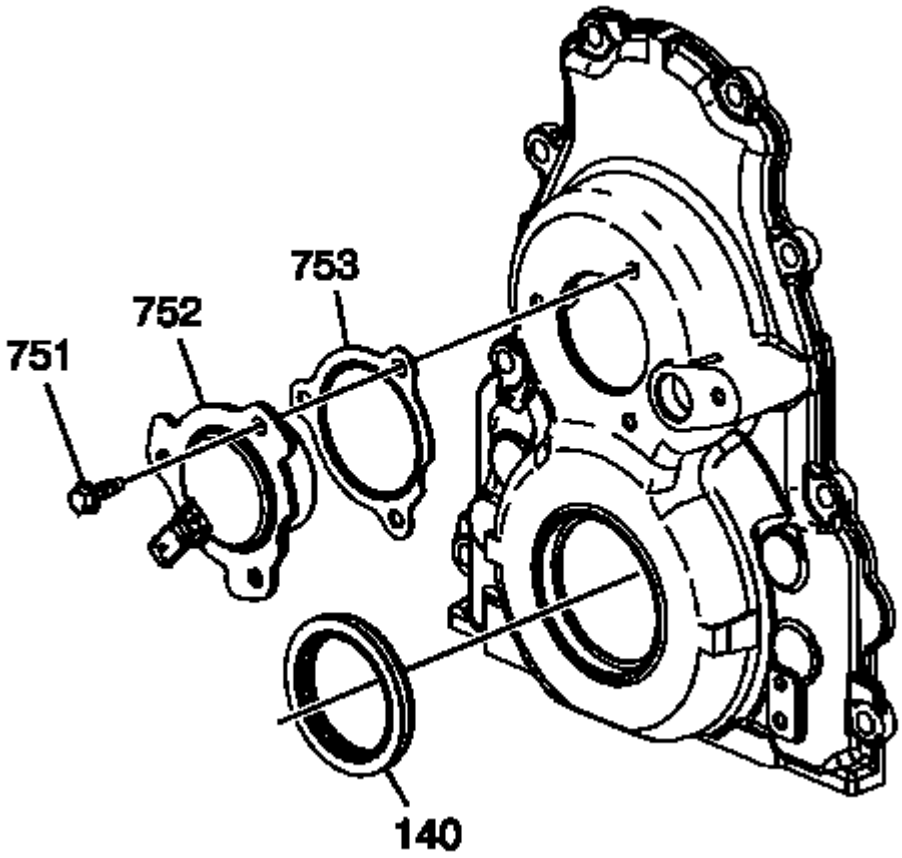


Fig. 152: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS COMPANY

14. Remove the CMP actuator magnet bolts (751), and magnet (752).
15. Remove and discard the CMP actuator magnet gasket (753).

Installation Procedure

NOTE:

- **Do not reuse the crankshaft oil seal or front cover gasket.**
- **Do not apply any type of sealant to the front cover gasket, unless specified.**
- **The special tool in this procedure is used to properly center the front crankshaft front oil seal.**
  - **All gasket surfaces should be free of oil or other foreign material during assembly.**
  - **The crankshaft front oil seal MUST be centered in relation to the crankshaft.**
  - **An improperly aligned front cover may cause premature front oil seal wear and/or engine oil leaks.**

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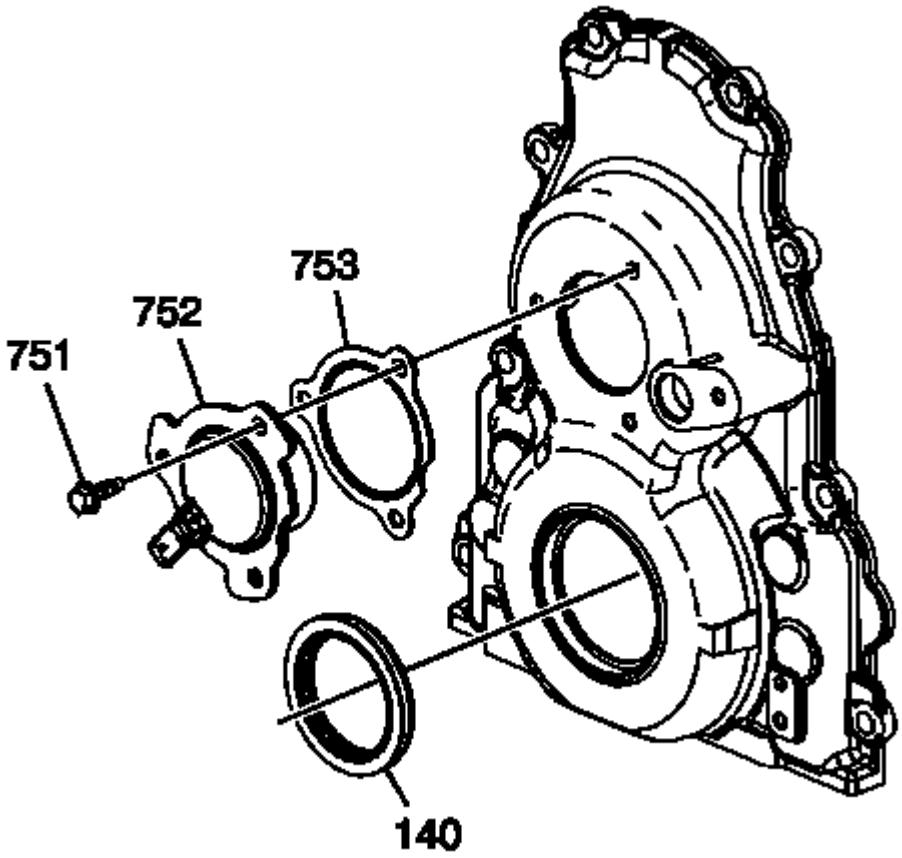


Fig. 153: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS COMPANY

1. If replacing the front cover perform the following steps, otherwise proceed to step 10.
2. Install a NEW CMP actuator magnet gasket (753) onto the magnet.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator magnet (752) and bolts (751) and tighten to 12 (106 lb in).

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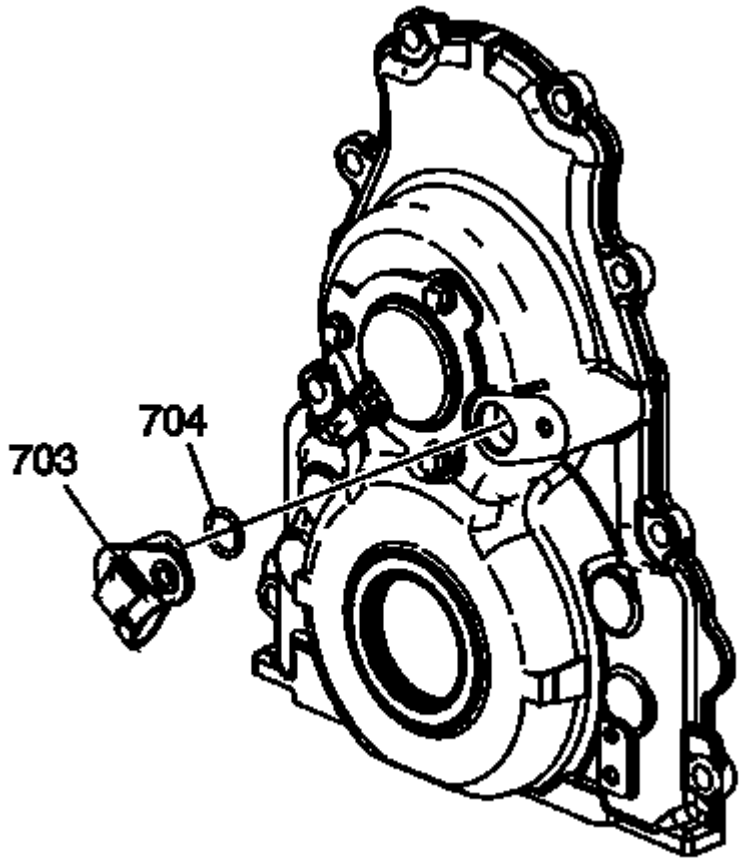


Fig. 154: View Of CMP Sensor & O-Ring
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the CMP sensor O-ring seal for cuts or damage. If the seal is not cut or damaged, it may be reused.
5. Lubricate the O-ring seal (704) with clean engine oil.
6. Install the CMP sensor (703).

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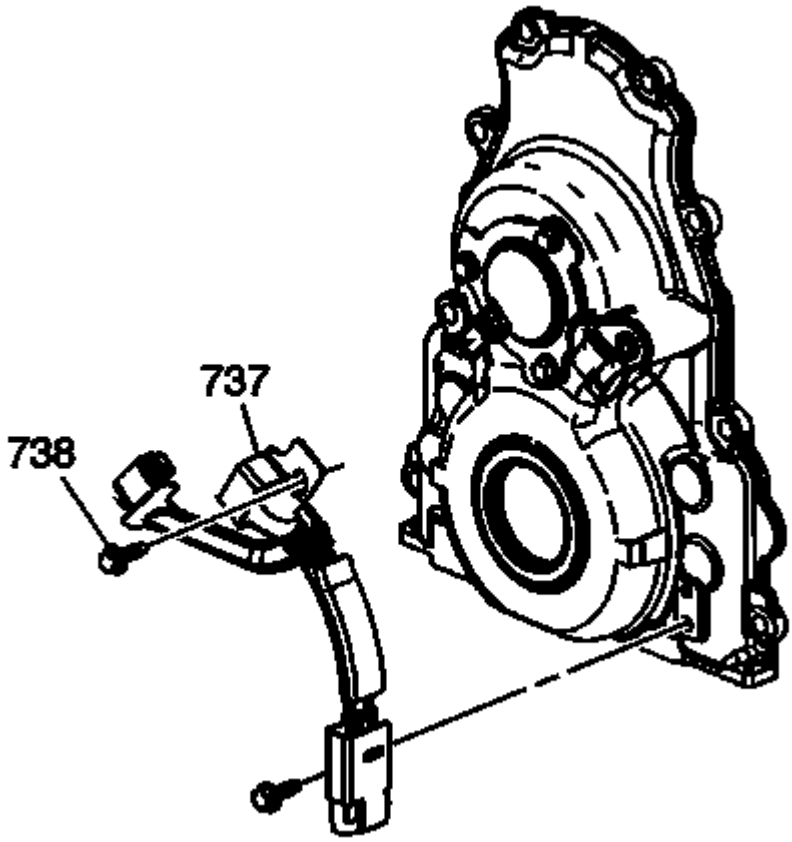


Fig. 155: View Of CMP Sensor Wire Harness & Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Position the CMP sensor wire harness (737) to the front cover
8. Connect the CMP sensor wire harness to the CMP sensor.
9. Install the CMP sensor wire harness bolts (738) and tighten to 12 (106 lb in).

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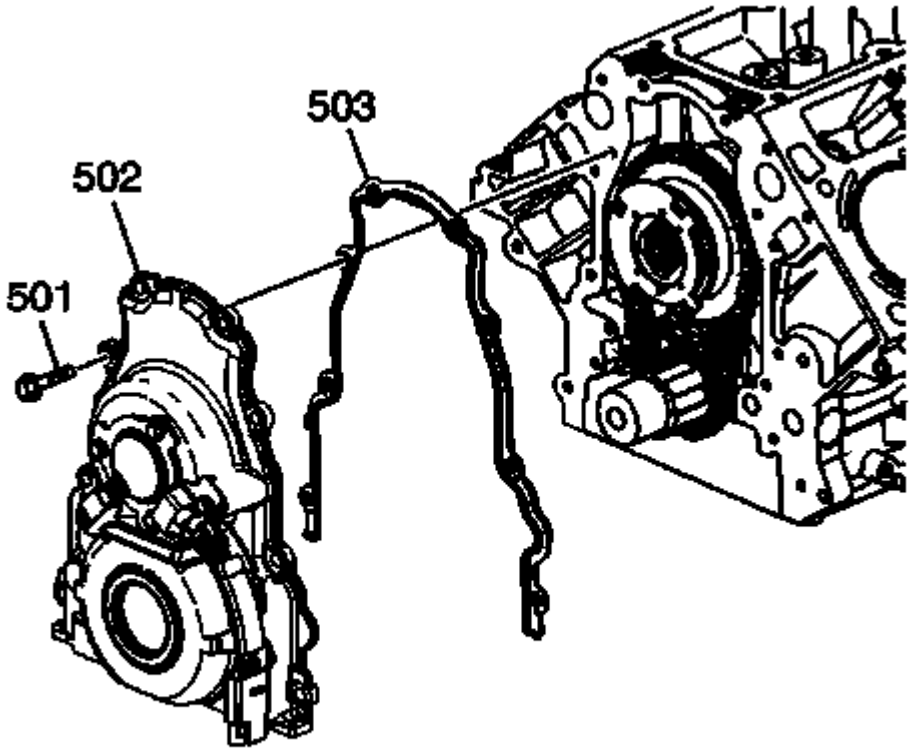


Fig. 156: View Of Front Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS COMPANY

10. Apply a 5 mm (0.20 in) bead of sealant, 20 mm (0.80 in) long to the oil pan to engine block junction. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
11. Position the NEW engine front cover gasket (503) and front cover (502) to the engine.
12. Install the front cover bolts (501) until snug. Do not overtighten.

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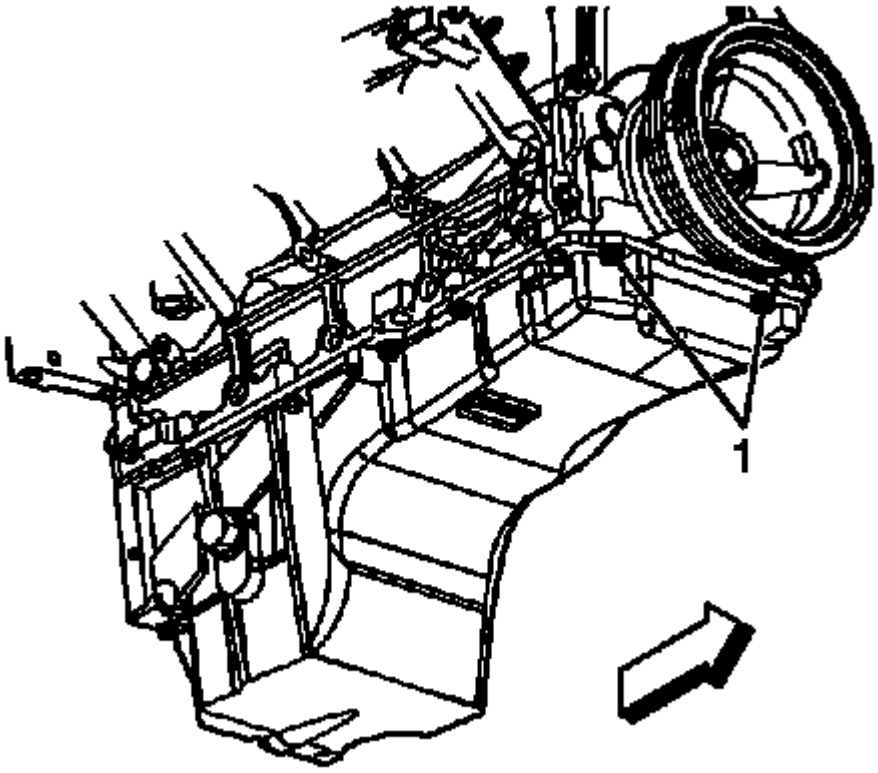


Fig. 157: View Of Oil Pan-To-Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Install the oil pan-to-front cover bolts (1) until snug. Do not over tighten.

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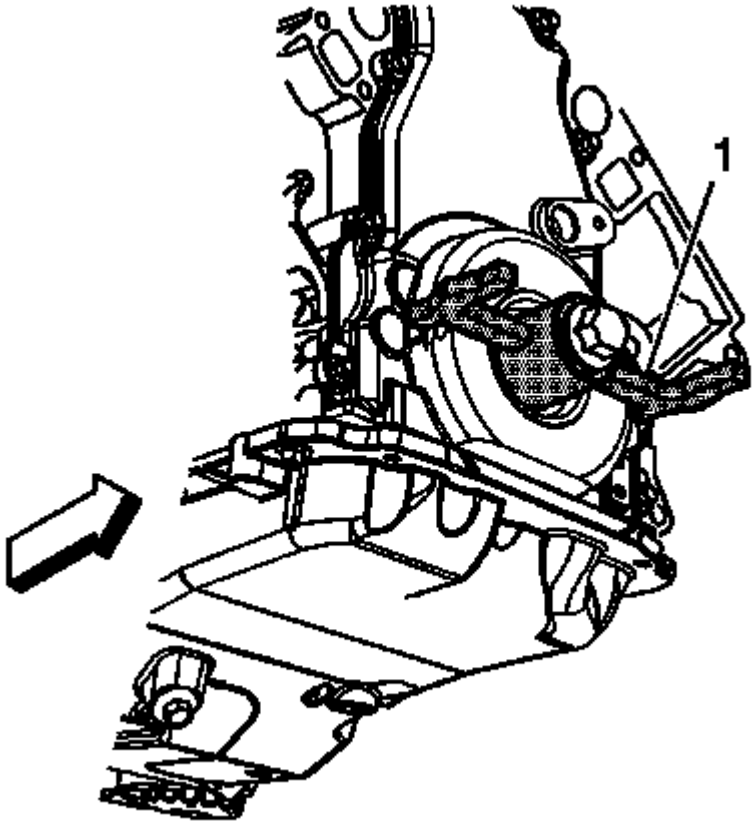


Fig. 158: Front Cover Alignment Tool
Courtesy of GENERAL MOTORS COMPANY

14. Install **J 41476** front and rear cover alignment tool to the crankshaft.
15. Align the tapered legs of the **J 41476** front and rear cover alignment tool with the machined alignment surfaces on the front cover.
16. Install the crankshaft balancer bolt until snug. Do not overtighten.
    1. Tighten the oil pan to front cover bolts to 25 (18 lb ft).
    2. Tighten the engine front cover bolts to 25 (18 lb ft).
17. Remove the **J 41476** front and rear cover alignment tool.

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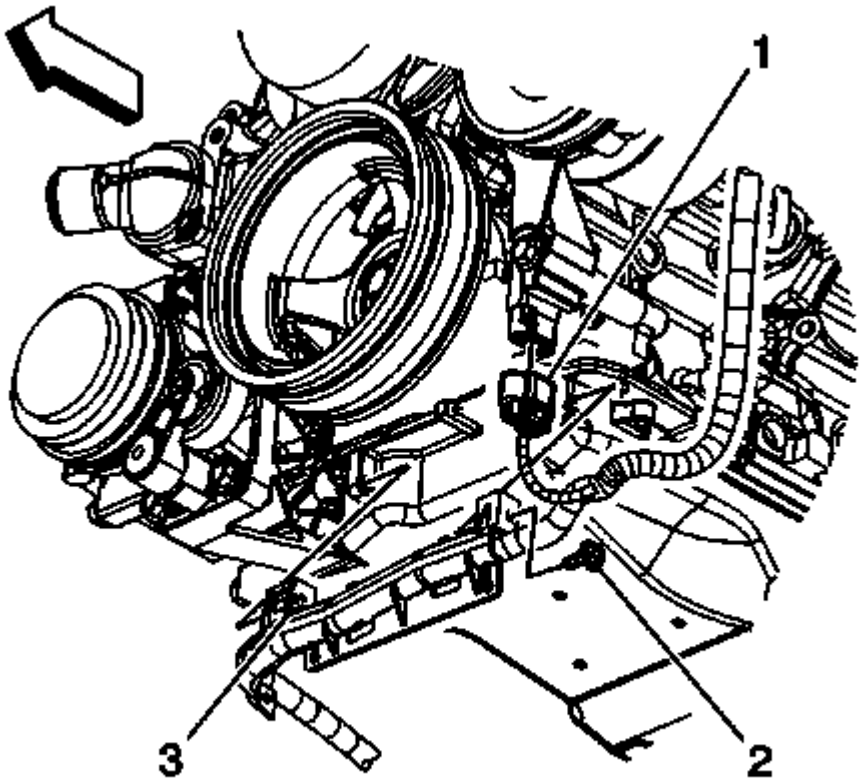


Fig. 159: View Of Electrical Connector, Cable Channel Bolt & Pin
Courtesy of GENERAL MOTORS COMPANY

18. Connect the engine harness electrical connector (1) to the CMP sensor wire harness electrical connector.
19. Install a NEW crankshaft front oil seal. Refer to **Crankshaft Front Oil Seal Replacement**.
20. Install the water pump. Refer to **Water Pump Replacement (LS3/L99)** , **Water Pump Replacement (LSA)** .

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REPLACEMENT

Special Tools

- **J 42386-A** Flywheel Holding Tool
- **J 45059** Angle Meter

Removal Procedure

1. Remove the starter. Refer to **Starter Replacement (LSA,LS3,L99)** .

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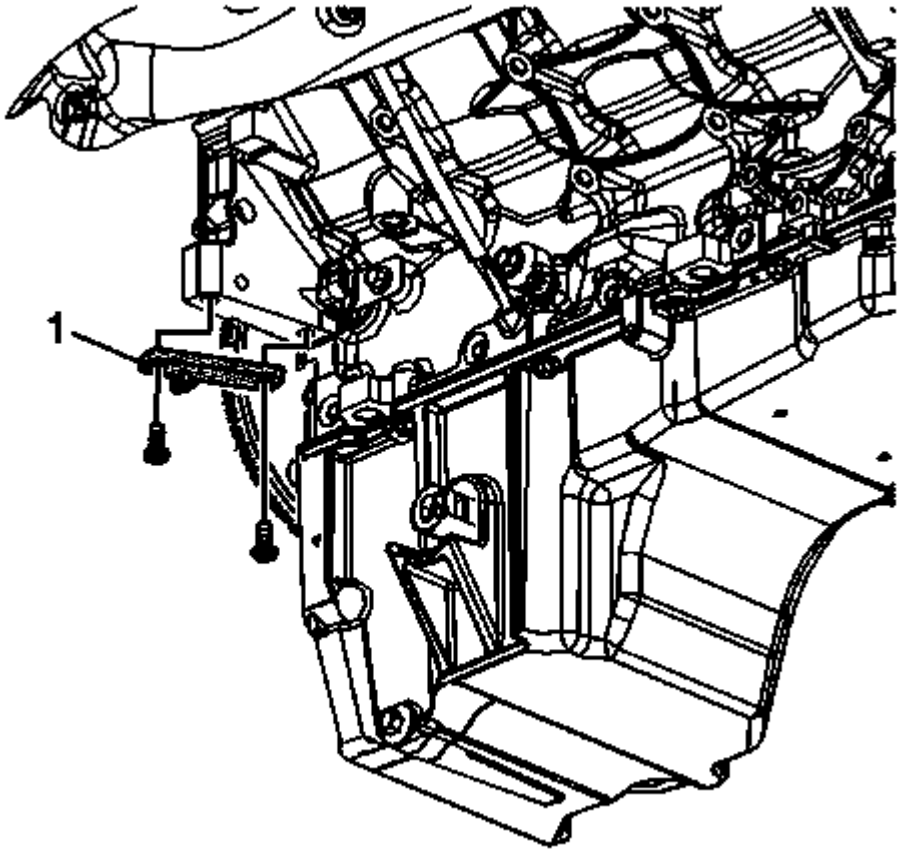


Fig. 160: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the **J 42386-A** flywheel holding tool (1) and bolts. Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A** flywheel holding tool bolts to 50 (37 lb ft).
3. Remove the camshaft position (CMP) actuator magnet. Refer to **Camshaft Position Actuator Magnet Replacement**.

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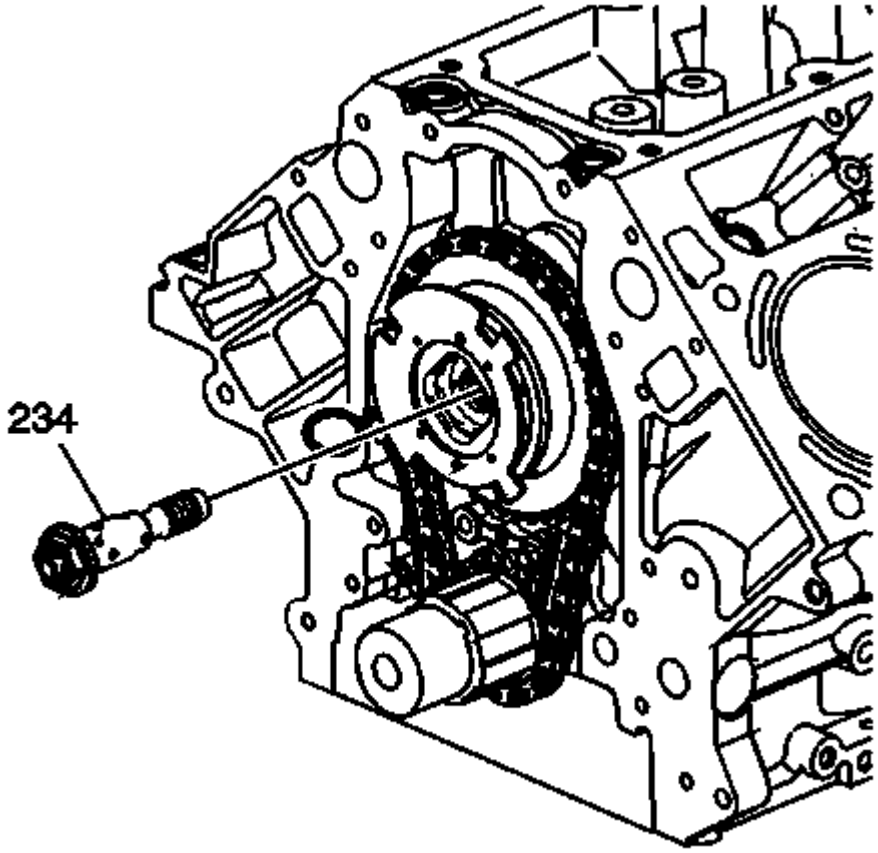


Fig. 161: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Camshaft Position Actuator Removal and Installation Warning .

4. Remove the CMP actuator solenoid valve (234).
5. Discard the solenoid valve.

Installation Procedure

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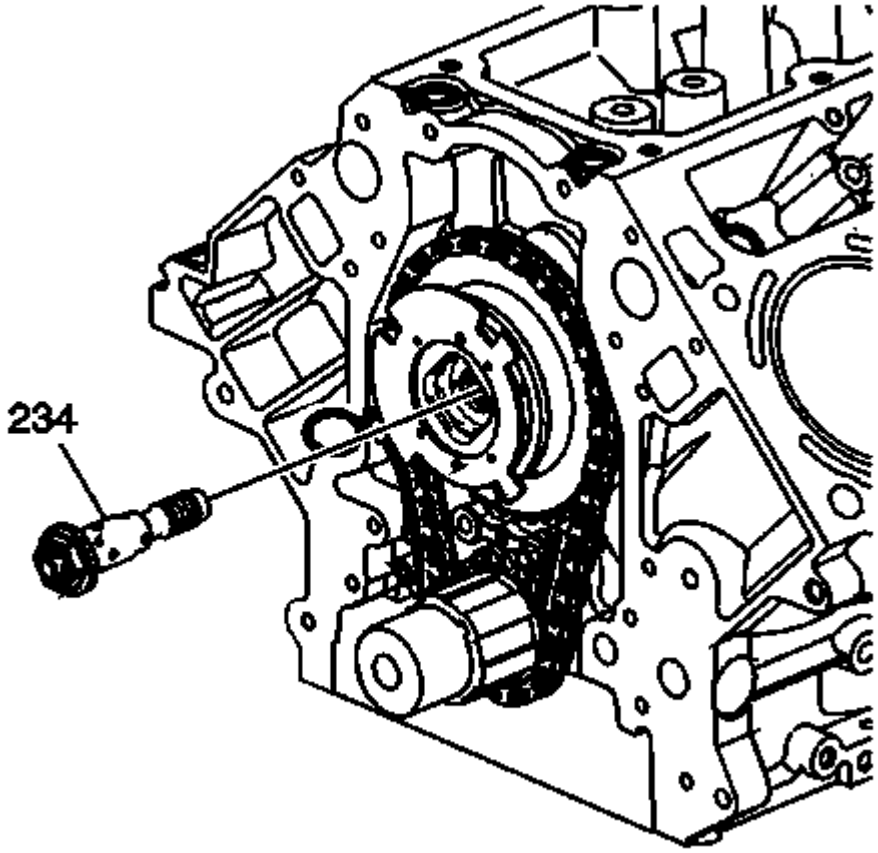


Fig. 162: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW CMP actuator solenoid valve (234).

   With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.

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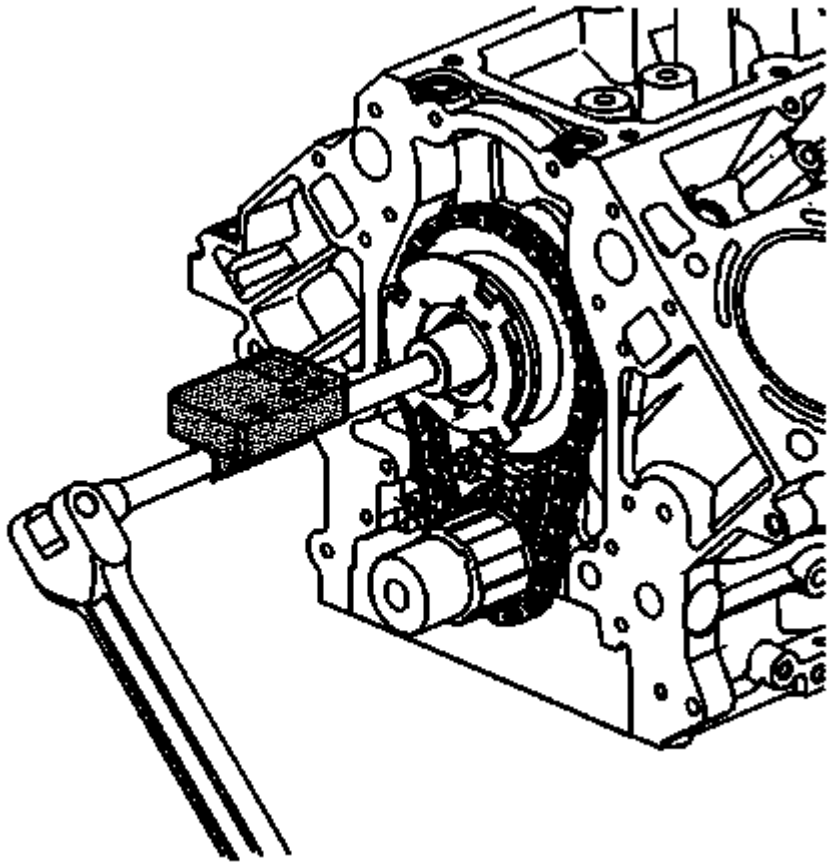


Fig. 163: Tightening CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Component Fastener Tightening Caution .

2. Tighten the CMP actuator solenoid valve.
    1. Tighten the CMP actuator solenoid valve a first pass to 65 (48 lb ft).
    2. Tighten the CMP actuator solenoid valve a final pass an additional 90 degrees using the **J 45059** angle meter.

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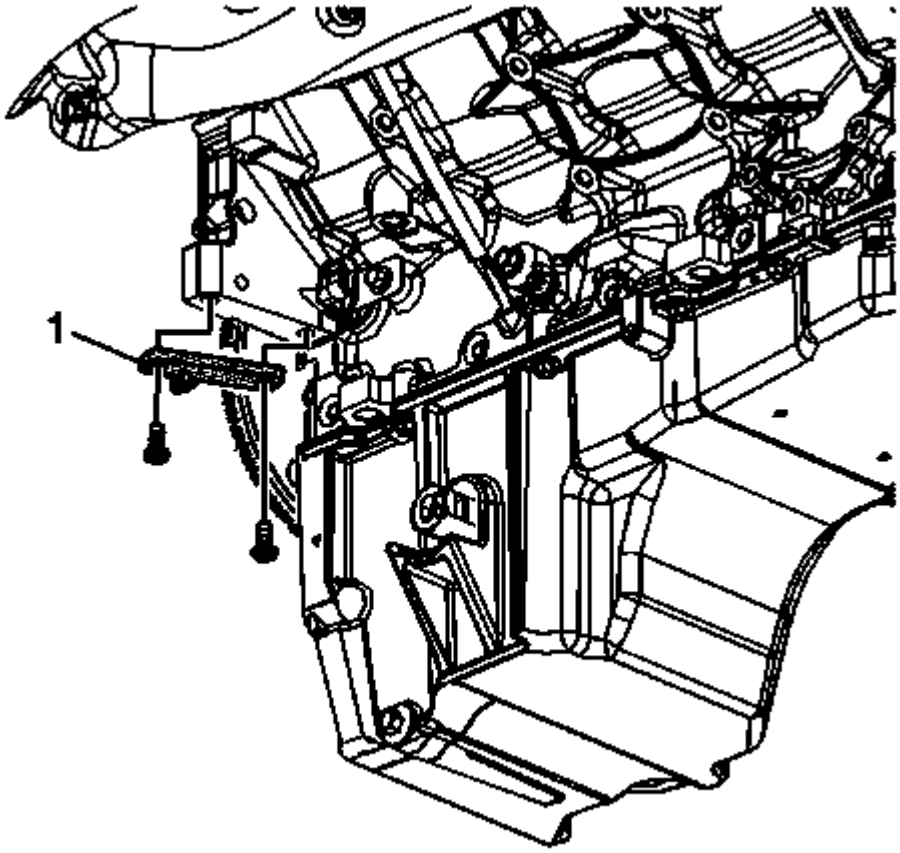


Fig. 164: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the **J 42386-A** flywheel holding tool (1).
4. Install the CMP actuator magnet. Refer to **Camshaft Position Actuator Magnet Replacement**.
5. Install the starter. Refer to **Starter Replacement (LSA,LS3,L99)** .

CAMSHAFT POSITION ACTUATOR REPLACEMENT

Special Tools

- **EN 46330** Timing Belt Tensioner Retaining Pin
- **J 42386-A** Flywheel Holding Tool
- **J 45059** Angle Meter

Removal Procedure

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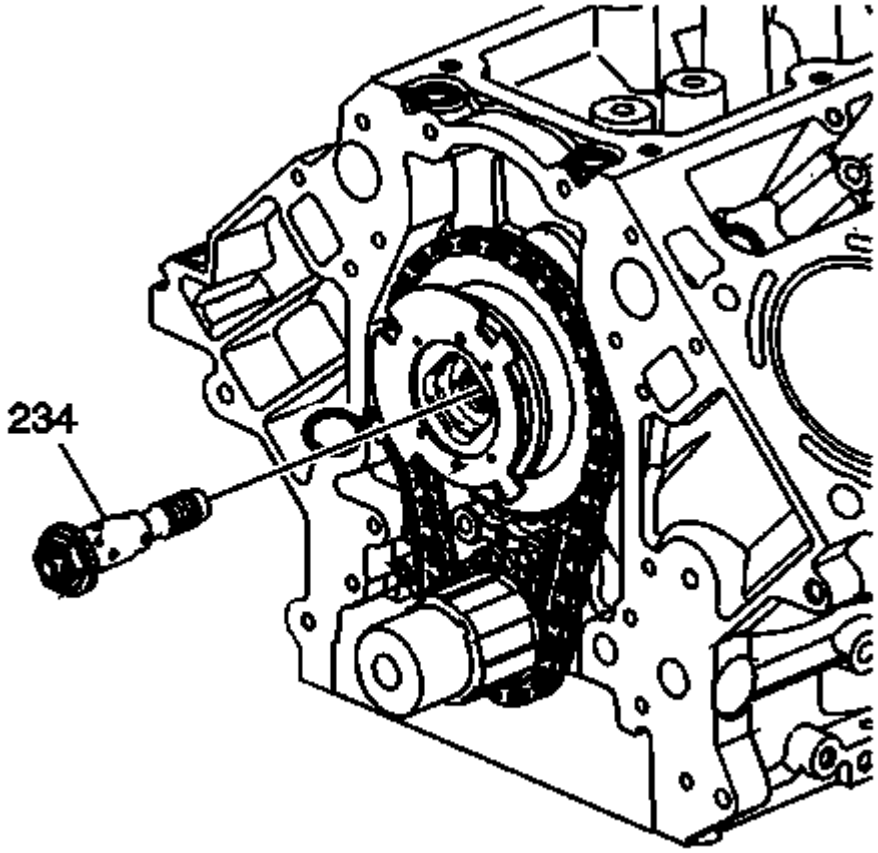


Fig. 165: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.
2. Align the timing marks.
3. Install the **J 42386-A** flywheel holding tool.
4. Remove and discard the camshaft position (CMP) actuator solenoid valve (234).

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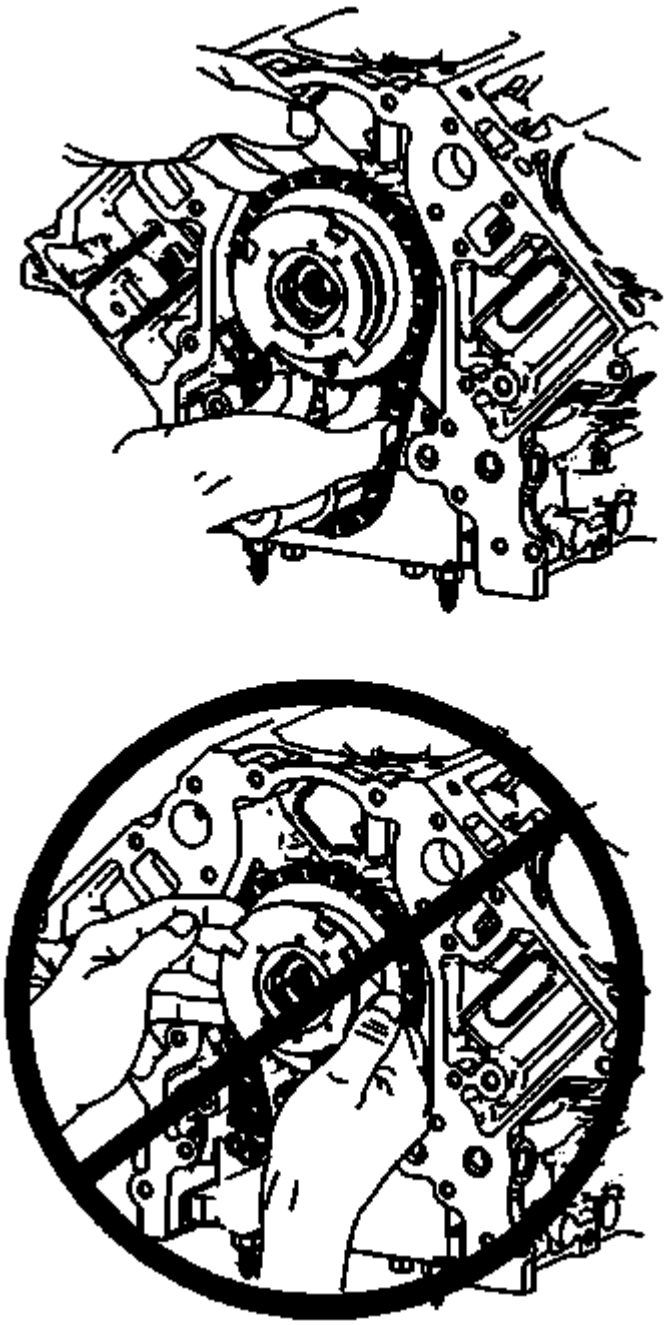


Fig. 166: View Of Proper CMP Actuator Removal
Courtesy of GENERAL MOTORS COMPANY

WARNING: Do not push or pull on the reluctor wheel of the camshaft position (CMP) actuator during removal or installation. The reluctor wheel is retained to the front of the CMP actuator by 3 roll pins. Pushing or pulling on the wheel may dislodge the wheel from the front of the actuator. The actuator return spring is under tension and may rotate the dislodged reluctor wheel, causing personal injury.

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5. Loosen and separate the CMP actuator and timing chain from the camshaft. Position your fingers behind the actuator sprocket and pull the actuator away from the front of the camshaft. Never pull on the reluctor wheel when attempting to remove the actuator.

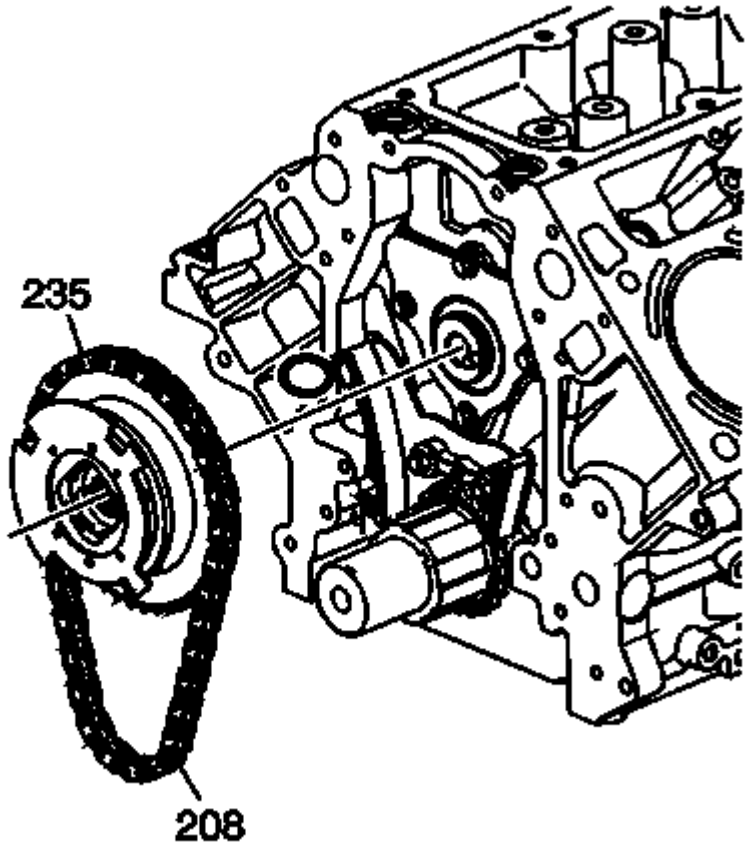


Fig. 167: View Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS COMPANY

6. Remove the CMP actuator (235) and timing chain (208).

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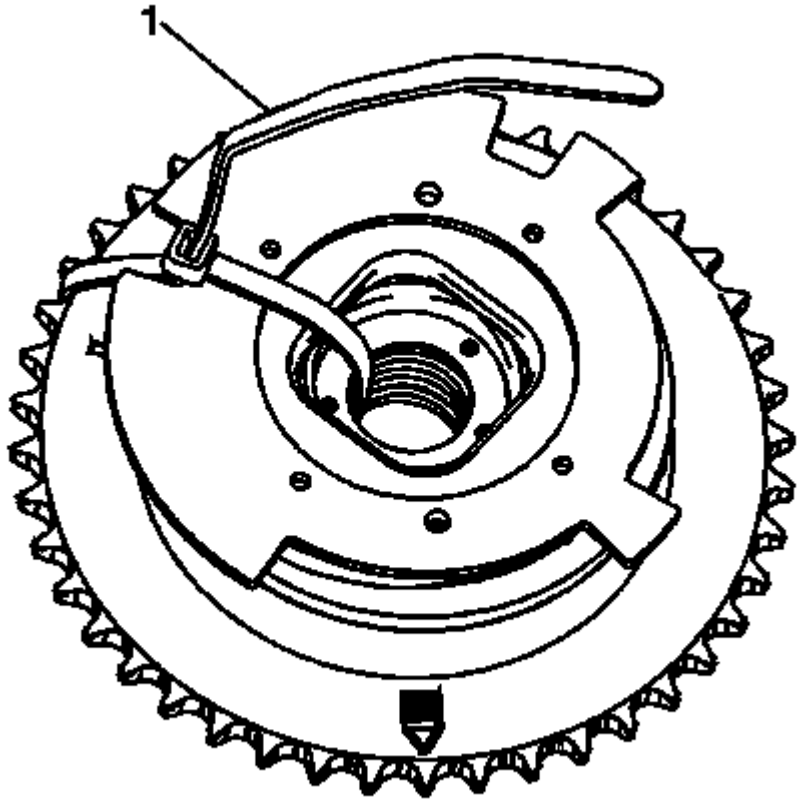


Fig. 168: View Of Tie Strap Through Center Of Actuator
Courtesy of GENERAL MOTORS COMPANY

7. Insert and secure a tie strap (1) through the center of the actuator and over the reluctor wheel.

Installation Procedure

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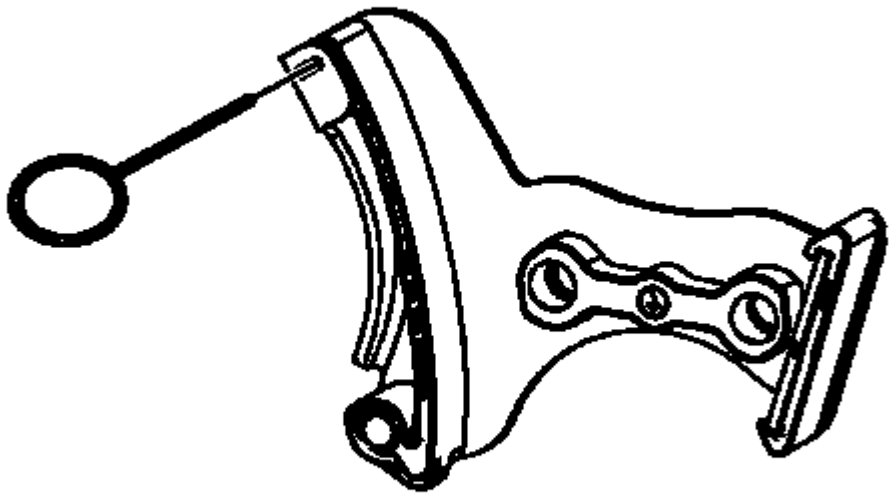


Fig. 169: View Of Compressed Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Compress the timing chain tensioner guide and install the **EN 46330** timing belt tensioner retaining pin.

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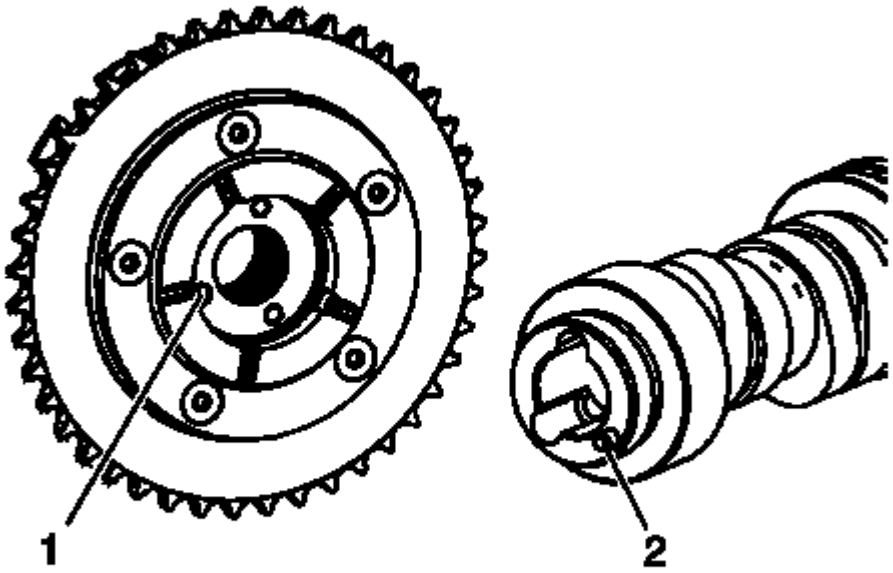


Fig. 170: Identifying Alignment Hole & Locating Pin
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Properly locate the CMP actuator on the locating pin of the camshaft.**
- **The sprocket teeth and timing chain must mesh.**
- **The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.**
- **DO NOT use the CMP solenoid valve again. Install a NEW valve during assembly.**

2. Identify the alignment hole (1) in the rear face of the CMP actuator and the locating pin (2) on the front face of the camshaft.

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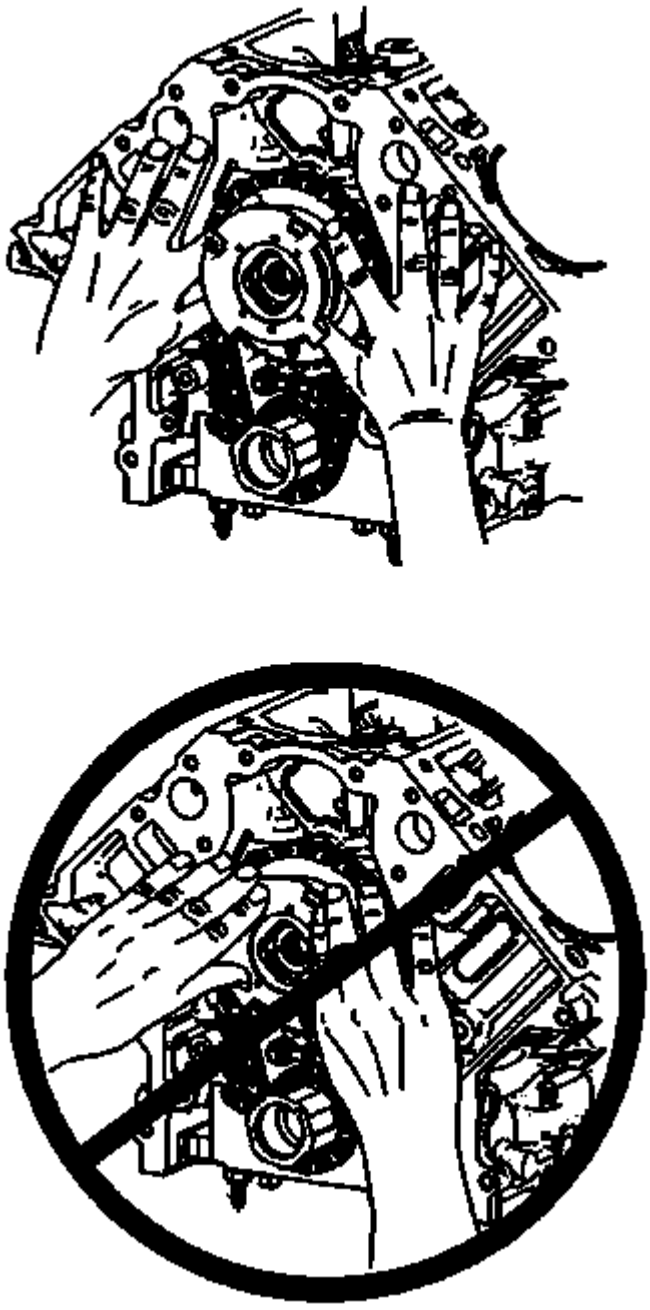


Fig. 171: Proper Installation Of CMP Actuator
Courtesy of GENERAL MOTORS COMPANY

WARNING: Do not push or pull on the reluctor wheel of the camshaft position (CMP) actuator during removal or installation. The reluctor wheel is retained to the front of the CMP actuator by 3 roll pins. Pushing or pulling on the wheel may dislodge the wheel from the front of the actuator. The actuator return spring is under tension and may rotate the dislodged reluctor wheel, causing personal injury.

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3. Install the CMP actuator and timing chain. Align the hole in the rear face of the CMP actuator with the locating pin on the front face of the camshaft. If necessary, rotate the camshaft or crankshaft sprockets in order to align the timing marks. Use care to install the actuator completely onto the front of the camshaft. Position your fingers onto the face of the actuator sprocket and push the actuator onto the front of the camshaft. Never push on the reluctor wheel when attempting to install the actuator.

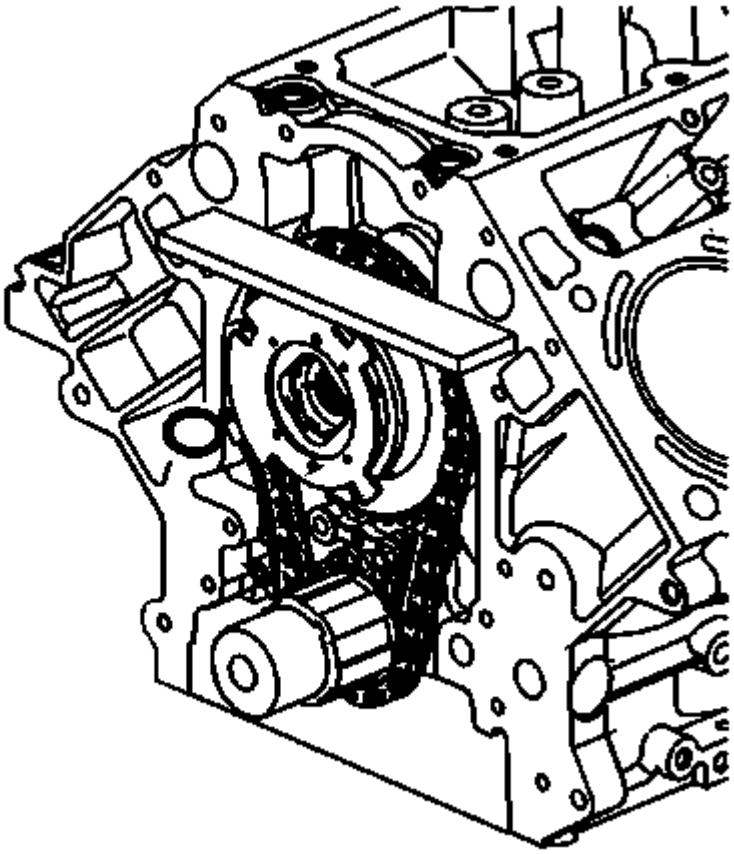


Fig. 172: Inspecting For Proper Installation Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS COMPANY

4. Place a straight edge across the front face of the engine block and inspect for proper installation of the CMP actuator and timing chain. With the CMP actuator properly and completely installed onto the front of the camshaft, the timing chain will not protrude beyond the front face of the engine block.

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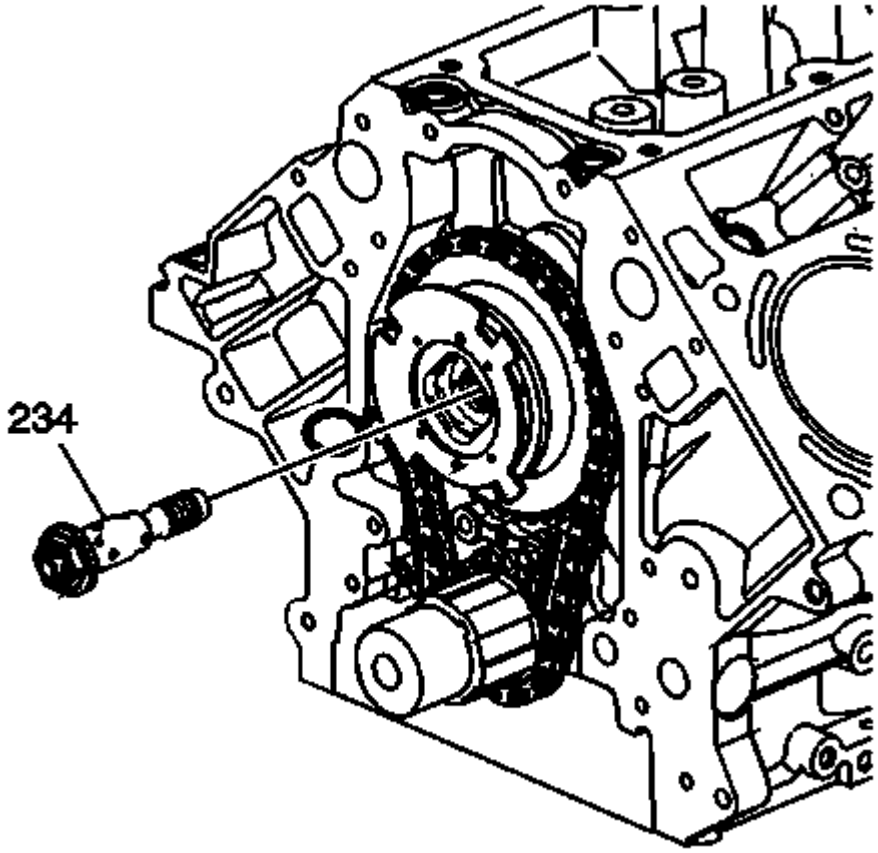


Fig. 173: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

5. Install a NEW CMP actuator solenoid valve (234). With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.

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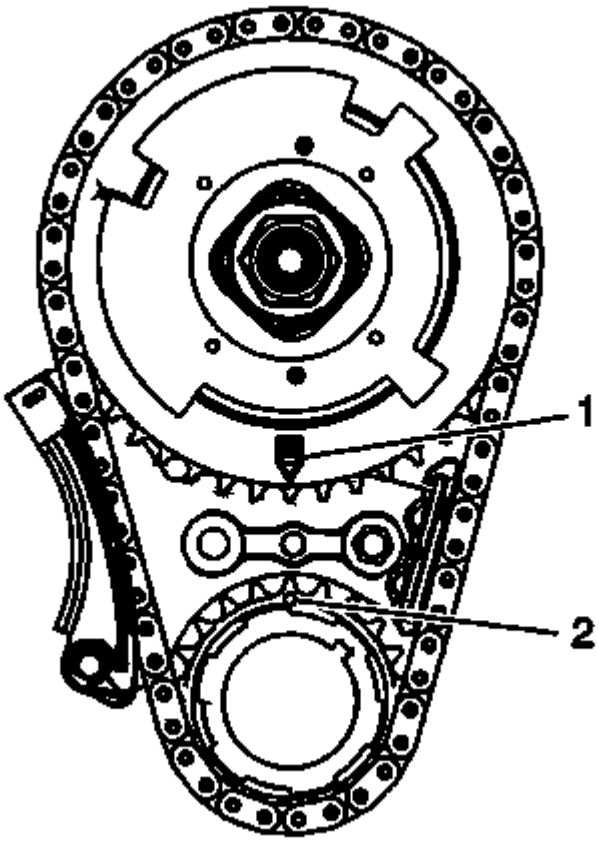


Fig. 174: View Of CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark
Courtesy of GENERAL MOTORS COMPANY

6. Inspect the sprockets for proper alignment. The mark on the CMP actuator sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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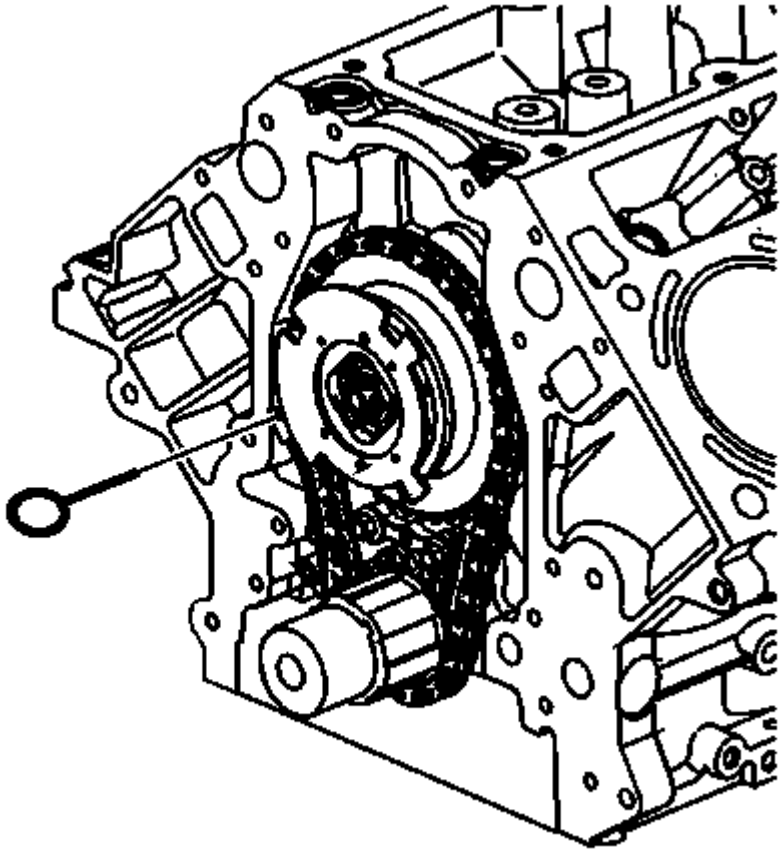


Fig. 175: View Of Special Tool EN 46330
Courtesy of GENERAL MOTORS COMPANY

7. Remove the **EN 46330** timing belt tensioner retaining pin.

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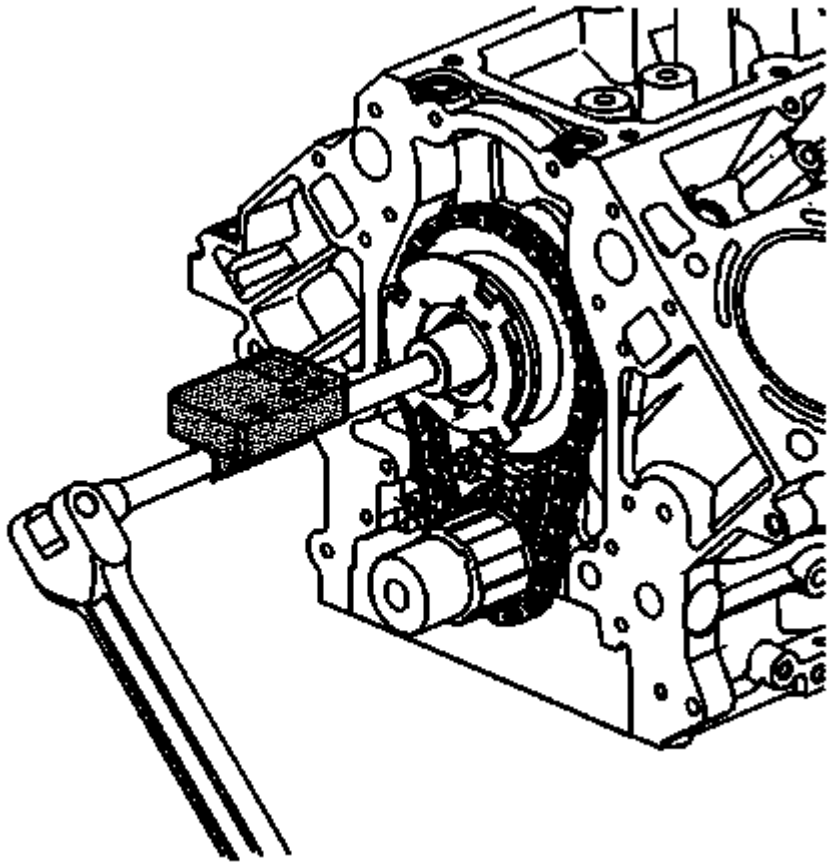


Fig. 176: Tightening CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

8. Tighten the CMP actuator solenoid valve.
    1. Tighten the valve a first pass to 65 (48 lb ft).
    2. Tighten the valve a final pass and additional 90 degrees using **J 45059** angle meter.
9. Remove the **J 42386-A** flywheel holding tool.
10. Install the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

J 41479 Crankshaft Rear Oil Seal Installer

Removal Procedure

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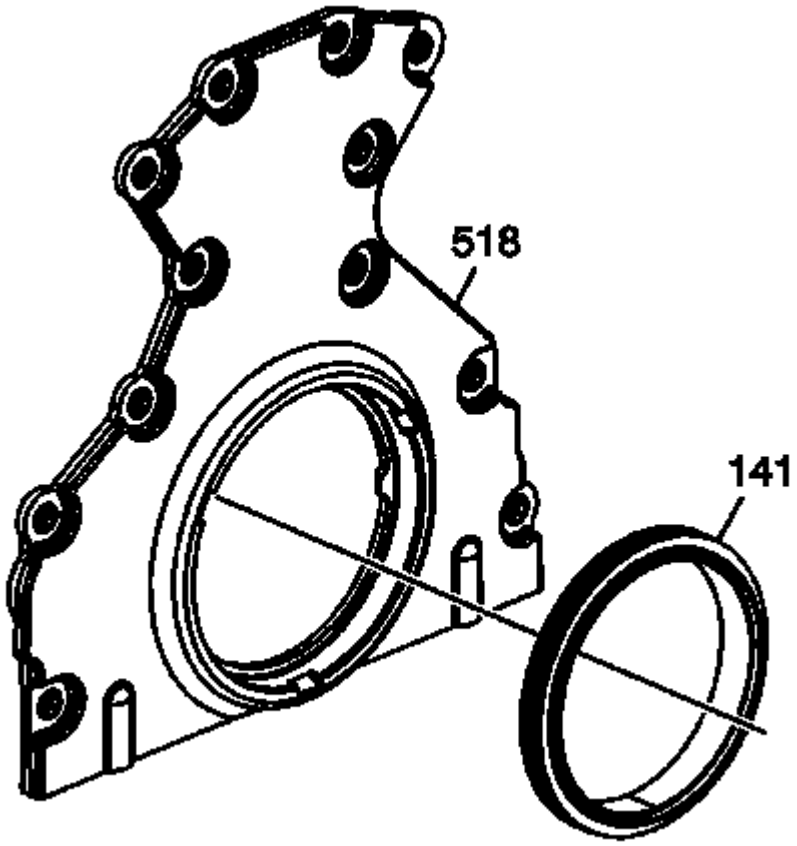


Fig. 177: Crankshaft Rear Oil Seal & Housing
Courtesy of GENERAL MOTORS COMPANY

1. If equipped with an automatic transmission, remove the automatic transmission flexplate. Refer to **Automatic Transmission Flex Plate Replacement**.
2. If equipped with a manual transmission, remove the flywheel. Refer to **Engine Flywheel Replacement**.
3. Remove and discard the crankshaft rear oil seal (141).

Installation Procedure

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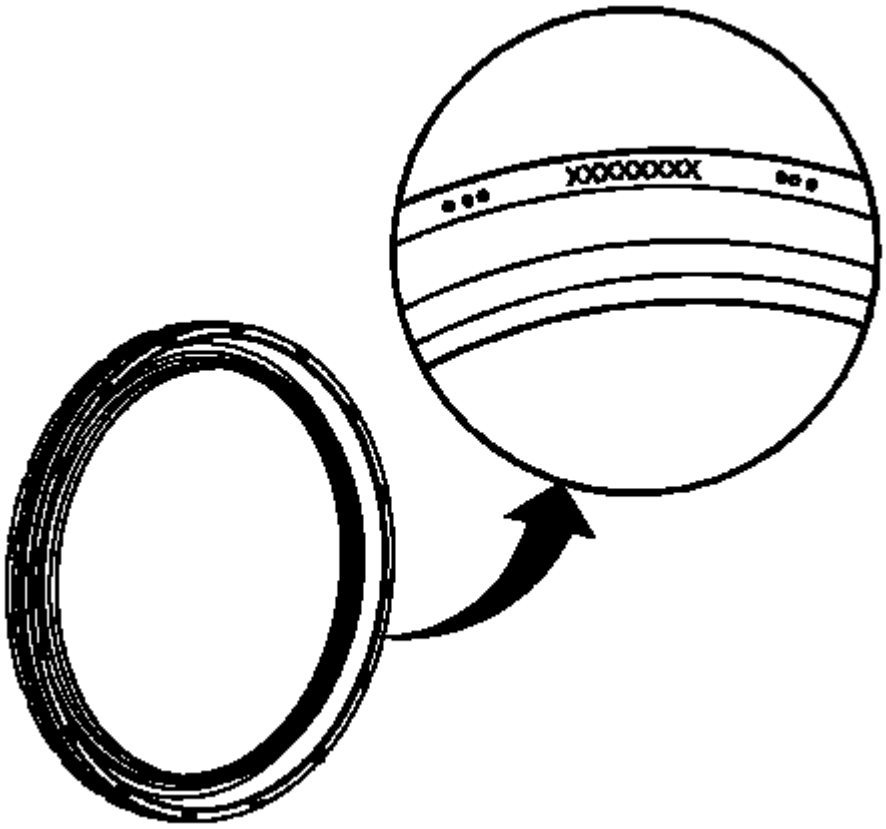


Fig. 178: Identifying Oil Seal
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. The part number is applied to the outside face of the seal, as shown.

1. Inspect the seal and identify the part number markings for proper orientation.

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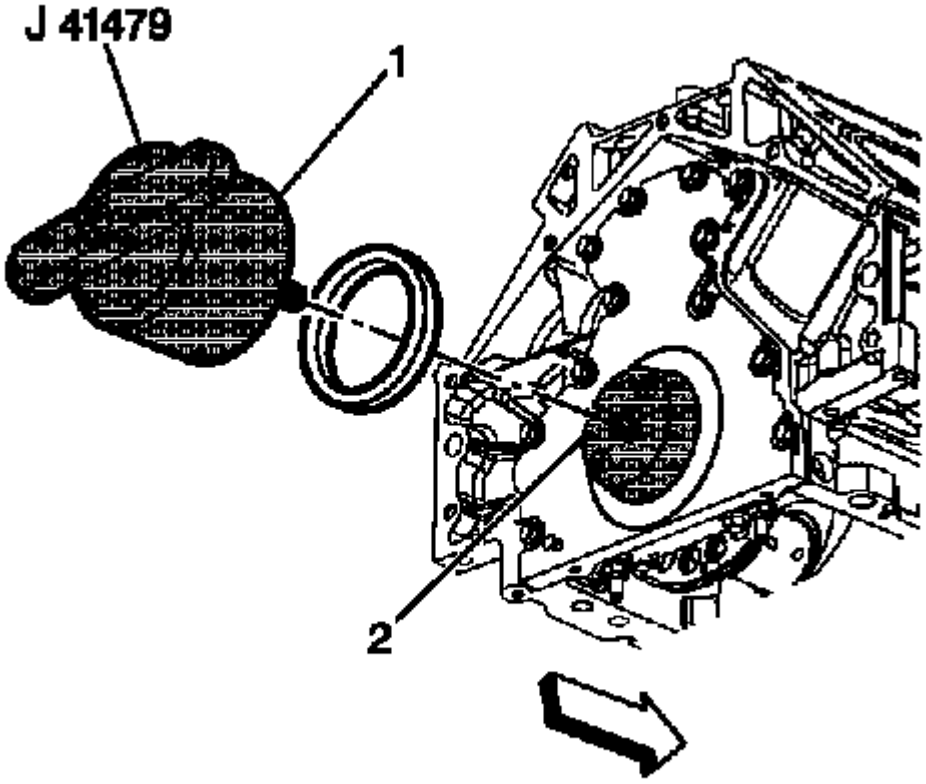


Fig. 179: Installing Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

2. Install the **J 41479** crankshaft rear oil seal installer cone (2) and bolts onto the rear of the crankshaft.
3. Tighten the bolts until snug. Do not overtighten.
4. Install the rear oil seal onto the tapered cone (2) and push the seal to the rear seal bore. Install the oil seal with the part number markings facing away from the engine.
5. Thread the **J 41479** crankshaft rear oil seal installer threaded rod into the tapered cone until the tool (1) contacts the oil seal.
6. Align the oil seal into the tool (1).
7. Rotate the handle of the tool (1) clockwise until the seal enters the rear cover and bottoms into the cover bore.
8. Remove the **J 41479** crankshaft rear oil seal installer.
9. If equipped with a manual transmission, install the flywheel. Refer to **Engine Flywheel Replacement**.
10. If equipped with an automatic transmission, install the automatic transmission flexplate. Refer to **Automatic Transmission Flex Plate Replacement**.

CRANKSHAFT REAR OIL SEAL HOUSING REPLACEMENT

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Special Tools

- **J 41476** Front and Rear Cover Alignment Tool
- **J 41479-2A** Crankshaft Rear Oil Seal Installation Guide

Removal Procedure

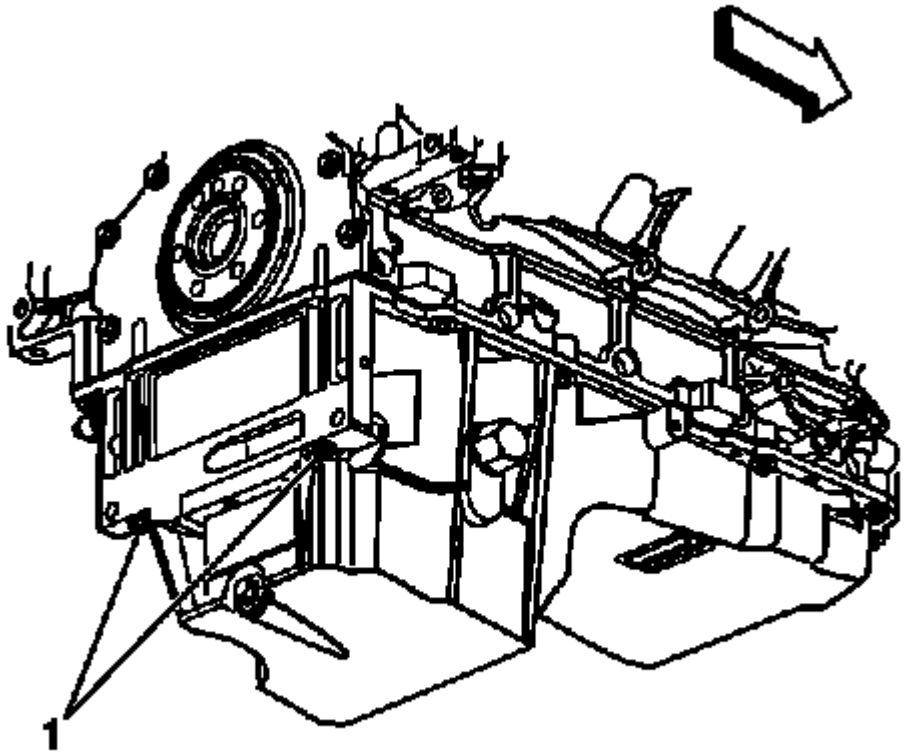


Fig. 180: View Of Oil Pan-To-Rear Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

1. If equipped with manual transmission, remove the flywheel. Refer to **Transmission Replacement** .
2. If equipped with automatic transmission, remove the automatic transmission flexplate, refer to **Automatic Transmission Flex Plate Replacement**.
3. Remove the oil pan-to-rear oil seal housing bolts (1).

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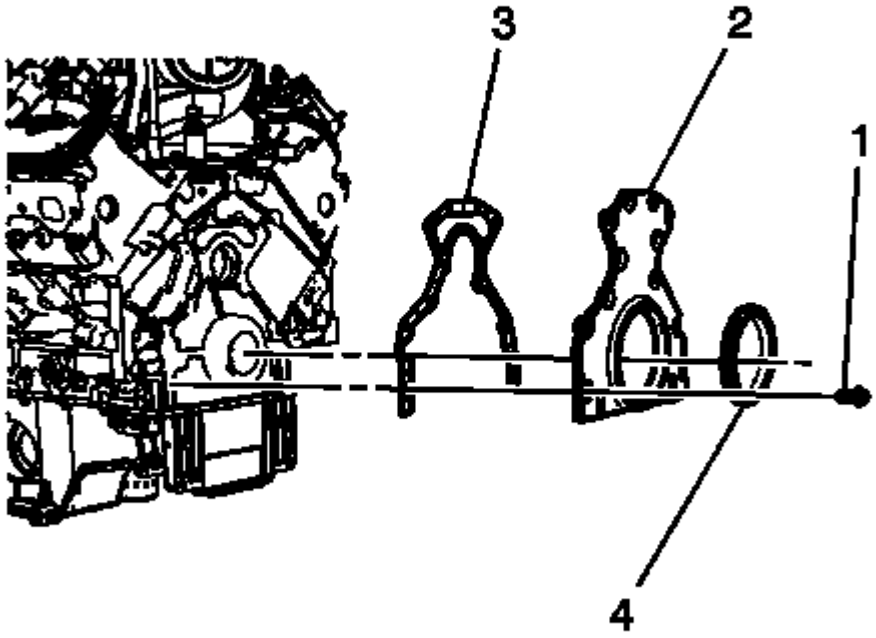


Fig. 181: Identifying Rear Oil Seal Housing Components
Courtesy of GENERAL MOTORS COMPANY

4. Remove the rear oil seal housing bolts (1).
5. Remove the rear oil seal housing (2) and gasket (3). Discard the gasket.
6. Remove and discard the rear oil seal (4).

Installation Procedure

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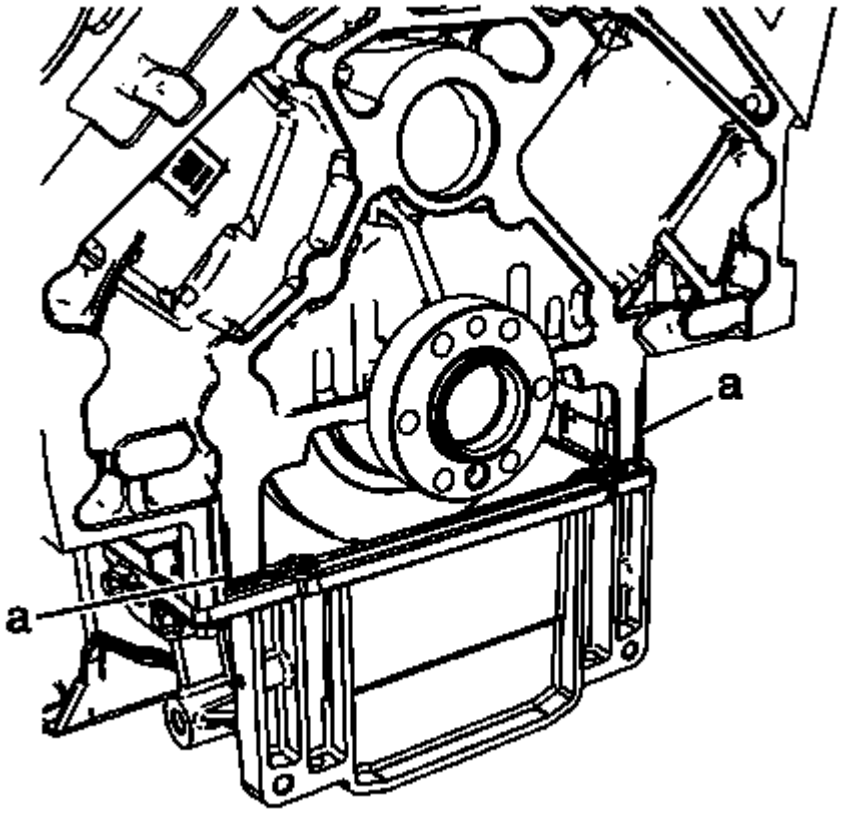


Fig. 182: Locating Joints At Rear Of Block/Pan
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not reuse the crankshaft oil seal or rear cover gasket.**
- **Do not apply any type of sealant to the rear cover gasket, unless specified.**
- **The special tool in this procedure is used to properly center the crankshaft rear oil seal.**
- **All gasket surfaces should be free of oil or other foreign material during assembly.**
- **The crankshaft rear oil seal MUST be centered in relation to the crankshaft.**
- **An improperly aligned rear cover may cause premature rear oil seal wear and/or engine assembly oil leaks.**

1. Apply a 5 mm (0.2 in) bead of sealant, 20 mm (0.8 in) to the 2 joints (a) at the rear of the block/pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

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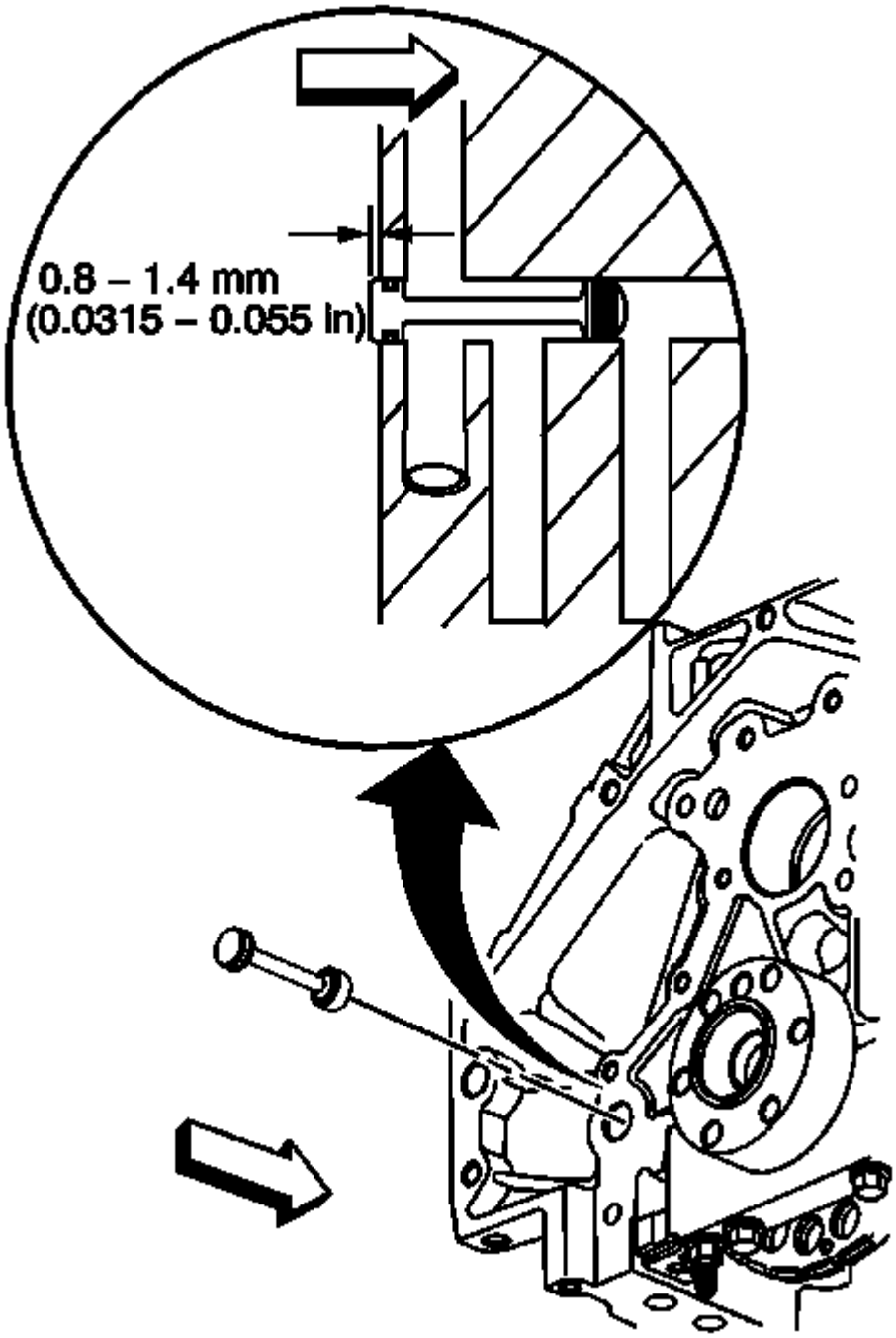


Fig. 183: View Of Engine Block Rear Oil Gallery Plug
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the rear oil gallery plug for proper installation.

Installation Procedure - Cover with Seal

1. Install the **J 41479-2A** crankshaft rear oil seal installation guide cone and bolts onto the rear of the crankshaft.

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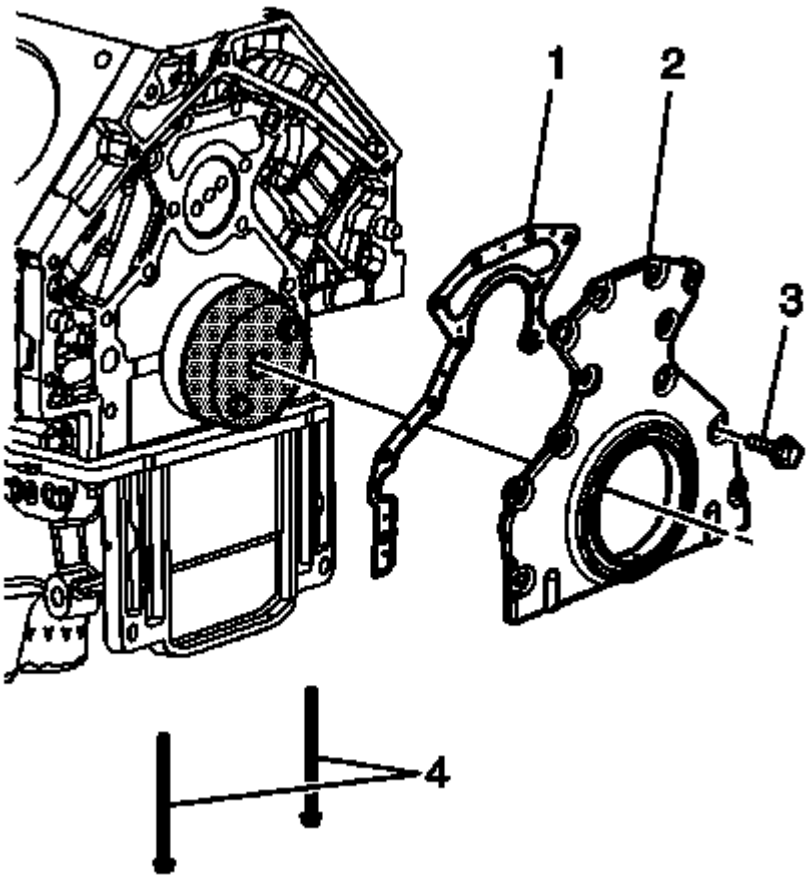


Fig. 184: Identifying Rear Housing Components
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW rear housing gasket (1), rear housing with seal (2), rear housing to engine bolts (3) and oil pan to rear housing bolts (4).

CAUTION: Refer to Fastener Caution .

3. Tighten the rear housing to engine bolts (3) until snug. Do not overtighten. Tighten the oil pan-to-rear housing bolts (4) to 12 (106 lb in).
4. Tighten the rear housing to engine bolts (3) to 30 (22 lb ft).
5. Remove the **J 41479-2A** crankshaft rear oil seal installation guide.
6. If equipped with automatic transmission, install the automatic transmission flexplate. refer to **Automatic Transmission Flex Plate Replacement**.
7. If equipped with manual transmission, install the flywheel. Refer to **Transmission Replacement** .

Installation Procedure - Cover without Seal

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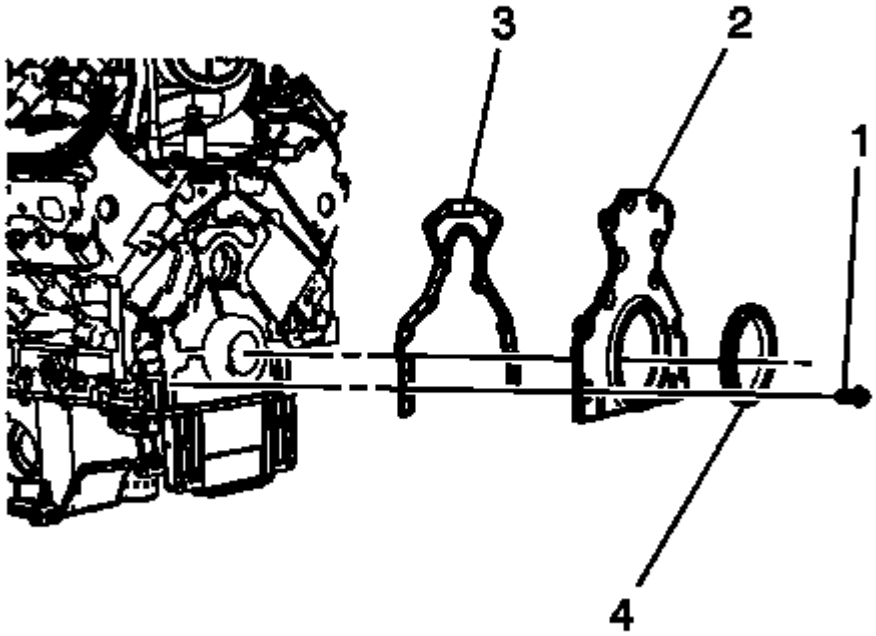


Fig. 185: Identifying Rear Oil Seal Housing Components
Courtesy of GENERAL MOTORS COMPANY

1. Position a NEW rear oil seal housing gasket (3) and the housing (2) to the engine.
2. Install the rear oil seal housing bolts (1) until snug. Do not overtighten.
3. Rotate the crankshaft until 2 opposing flywheel bolts holes are parallel to the oil pan surface.

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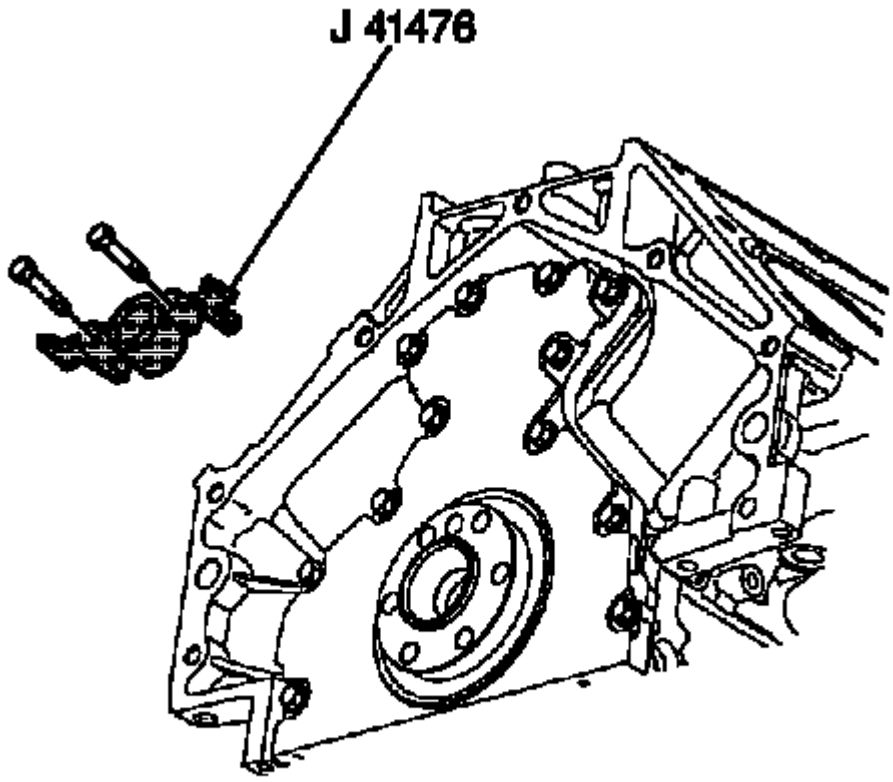


Fig. 186: Housing Alignment Tool
Courtesy of GENERAL MOTORS COMPANY

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

4. Install the **J 41476** front and rear cover alignment tool and bolts onto the rear of the crankshaft.
5. Tighten the **J 41476** front and rear cover alignment tool bolts until snug. Do not overtighten.

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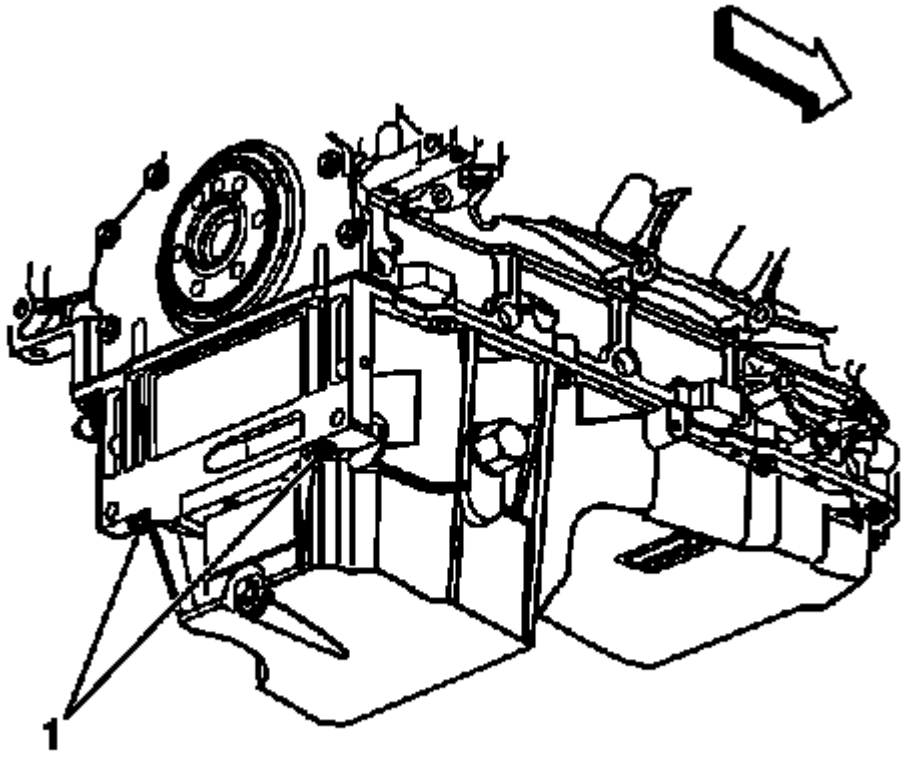


Fig. 187: View Of Oil Pan-To-Rear Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install the oil pan to rear oil seal housing bolts (1).
    1. Tighten the oil pan to rear cover bolts to 12 (106 lb in).
    2. Tighten the rear oil seal housing to engine bolts to 30 (22 lb ft).
7. Remove the **J 41476** front and rear cover alignment tool.
8. Install a NEW crankshaft rear oil seal. Refer to **Crankshaft Rear Oil Seal Replacement**.
9. If equipped with automatic transmission, install the automatic transmission flexplate. refer to **Automatic Transmission Flex Plate Replacement**.
10. If equipped with manual transmission, install the flywheel. Refer to **Camshaft Replacement (LS3)**, **Camshaft Replacement (L99)**.

OIL FILTER ADAPTER REPLACEMENT

Removal Procedure

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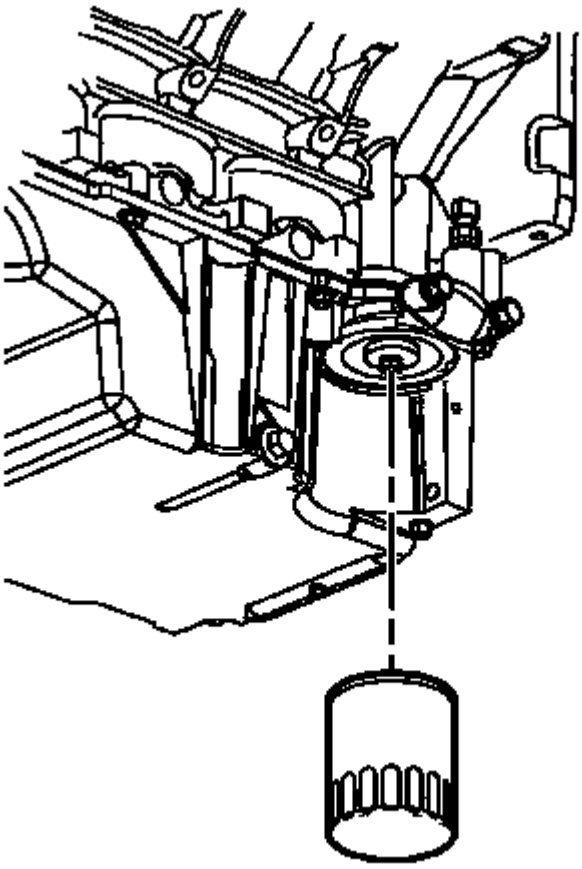


Fig. 188: View Of Oil Filter
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil filter.

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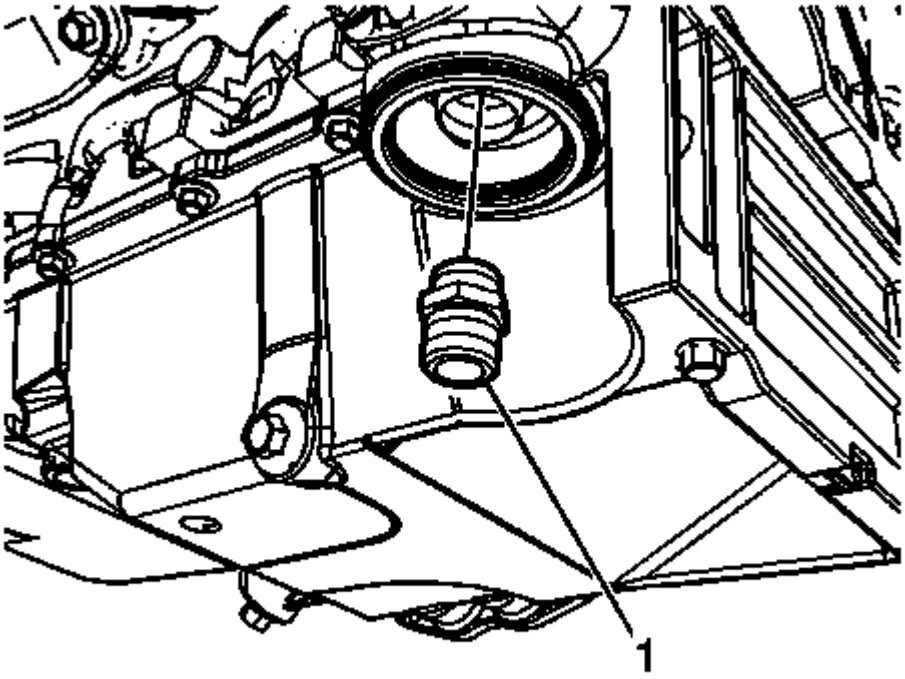


Fig. 189: Oil Filter Adapter
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil filter adapter (1).

Installation Procedure

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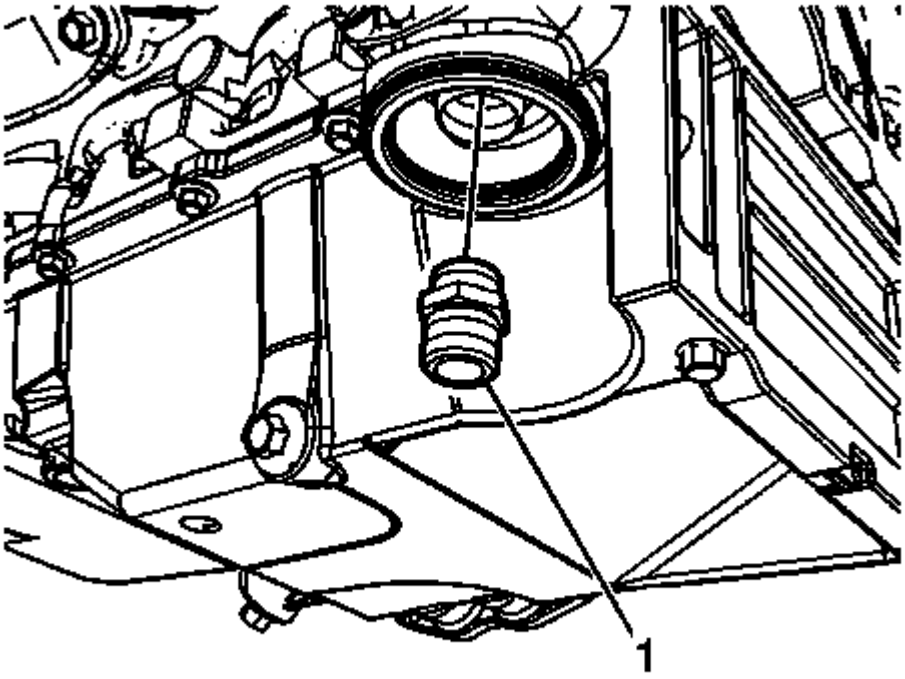


Fig. 190: Oil Filter Adapter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the oil filter adapter (1).

   Tighten

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

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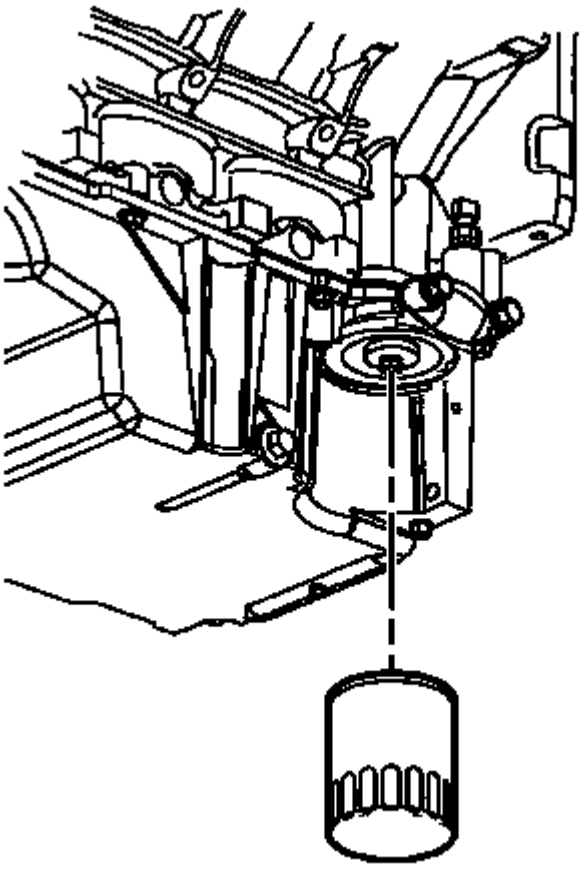


Fig. 191: View Of Oil Filter
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil filter.

   Tighten

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

ENGINE OIL PAN REPLACEMENT

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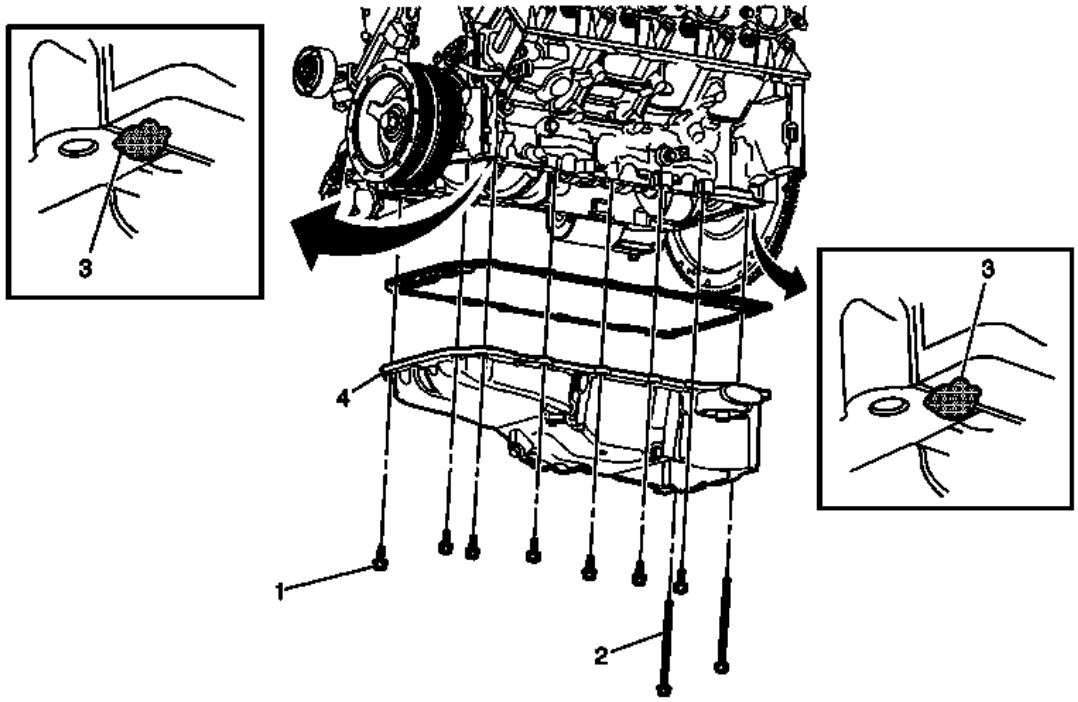


Fig. 192: Identifying Engine Oil Pan
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Pan Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the front frame. Refer to **Drivetrain and Front Suspension Frame Replacement (V8)** . 2. Remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement**. 3. Remove the starter assembly. Refer to , **Starter Replacement (LSA,LS3,L99)** . 4. Remove the engine oil cooler. Refer to **Engine Oil Cooler Replacement** . 5. Remove the A/C lines from the compressor and reposition to access the harness and bolts. Refer to **Air Conditioning Compressor Hose Replacement (LS3, L99)** , **Air Conditioning Compressor Hose Replacement (LSA)** . 6. Reposition the engine wiring harness. 7. Reposition the oil cooler lines as necessary. 8. Reposition transmission cooler lines away from the oil pan as necessary.	
1	Oil Pan Fastener (Qty: 12) **CAUTION:** **Refer to Fastener Caution .**

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	Tighten 25 N.m (18 lb ft)
2	Oil Pan Fastener (Qty: 2) **Tighten** 12 N.m (106 lb in)
3	Oil Pan Sealant **Procedure** 1. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . 2. Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. • The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush or even. The rear of the oil pan must NEVER protrude beyond the engine block and the transmission housing plane. • A new oil pan gasket should be used whenever the oil pan is removed from the engine assembly.
4	Oil Pan **Procedure** 1. Disconnect any electrical connectors. 2. Transfer components as necessary.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT (L99/LS3)

Special Tools

J 41712 Oil Pressure Sensor Socket

Removal Procedure

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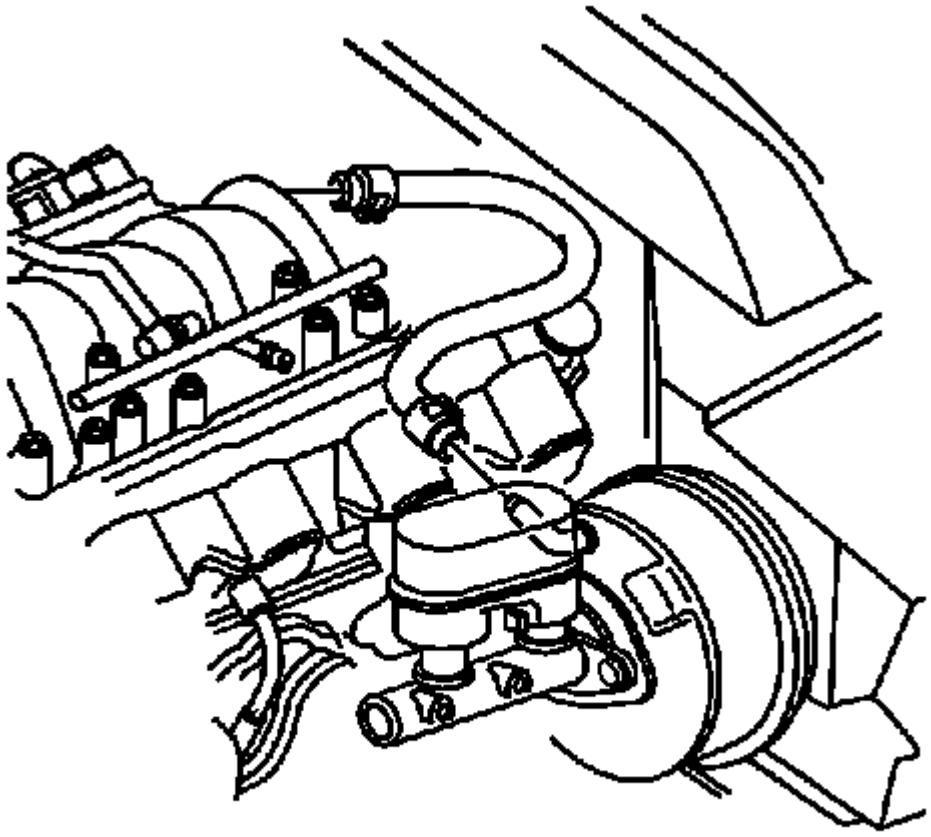


Fig. 193: Identifying Vacuum Booster Hose
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine cover. Refer to **Engine Cover Replacement**.
2. Clean area around the oil sensor/switch before removing it.
3. Remove the positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Dirty Air)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Clean Air)**.

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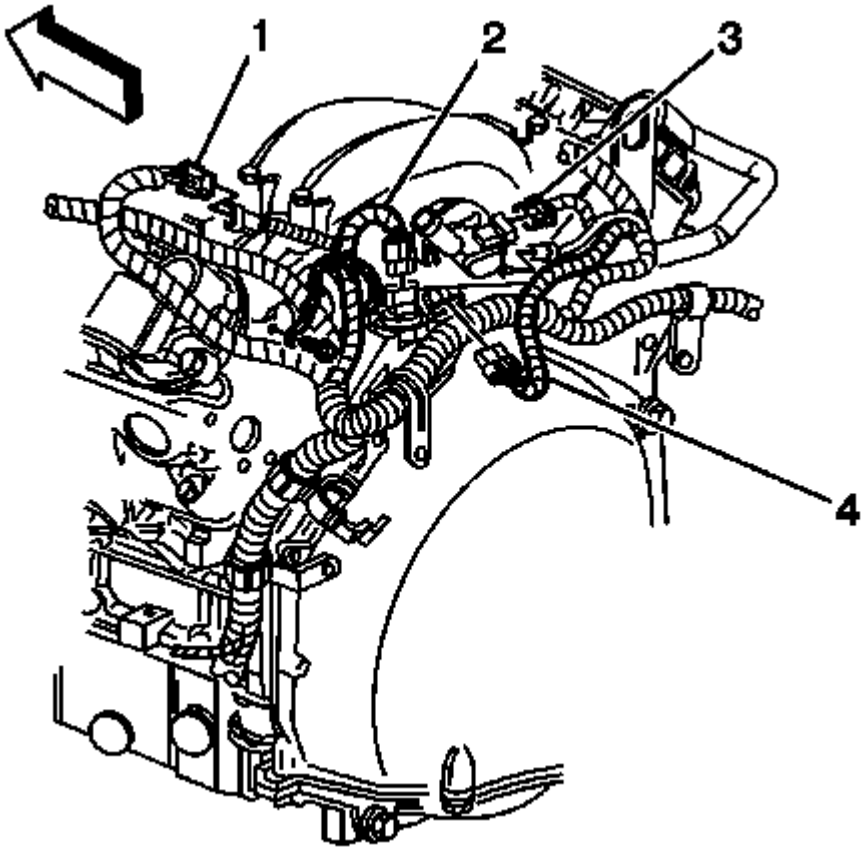


Fig. 194: Oil Pressure Sensor/Switch Electrical Connector & Engine Wiring Harness Ground Strap
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connector for the oil pressure sensor/switch (2).

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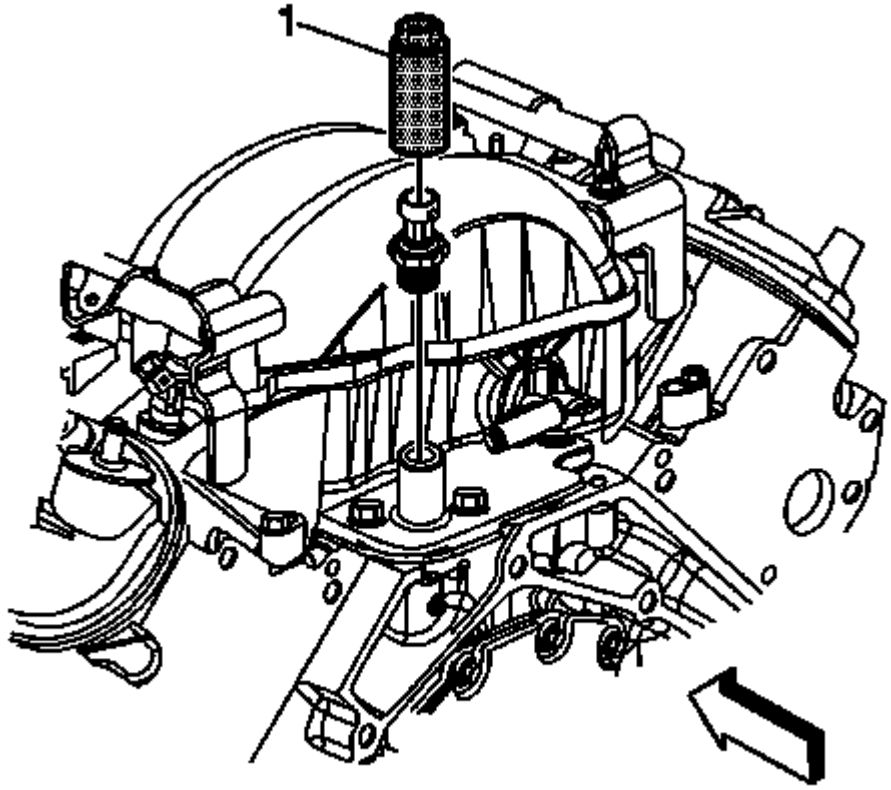


Fig. 195: Servicing Oil Pressure Sensor/Switch
Courtesy of GENERAL MOTORS COMPANY

5. Using the **J 41712** oil pressure sensor socket (1) , remove the oil pressure sensor/switch.

Installation Procedure

1. Replace the valve lifter oil filter. Refer to **Valve Lifter Oil Filter Replacement**.

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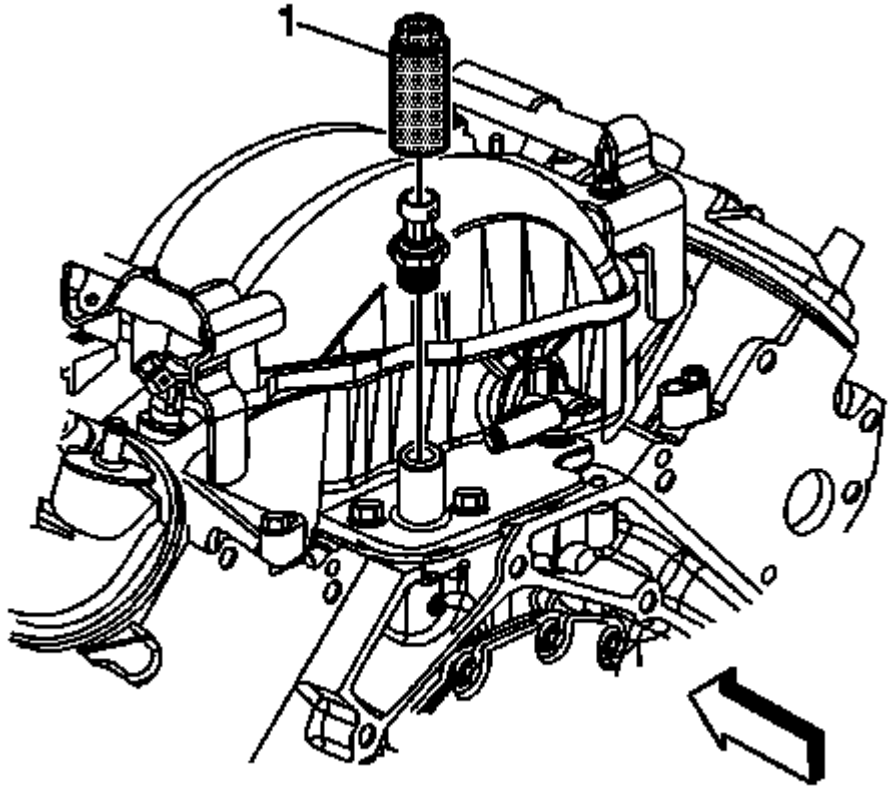


Fig. 196: Servicing Oil Pressure Sensor/Switch
Courtesy of GENERAL MOTORS COMPANY

2. If installing the old sensor, apply threadlocker sealant. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

CAUTION: Refer to Fastener Caution .

3. Using the **J 41712** oil pressure sensor socket (1), install the oil pressure sensor/switch. Tighten the engine oil pressure sensor to 20 (15 lb ft).

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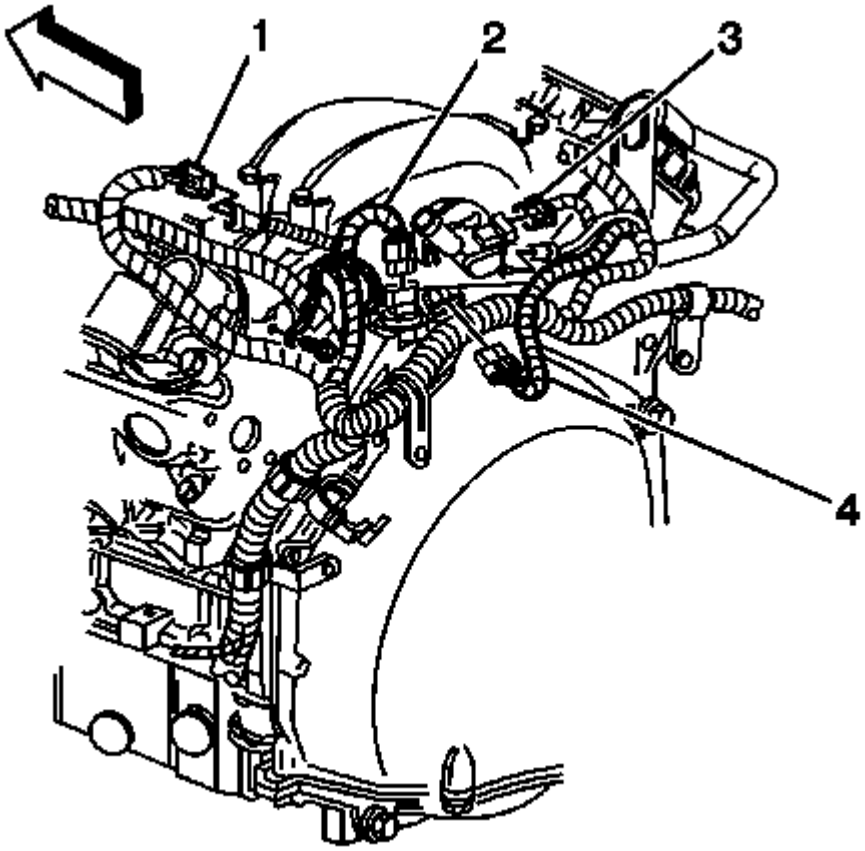


Fig. 197: Oil Pressure Sensor/Switch Electrical Connector & Engine Wiring Harness Ground Strap
Courtesy of GENERAL MOTORS COMPANY

4. Reconnect the oil pressure sensor/switch electrical connector (2).

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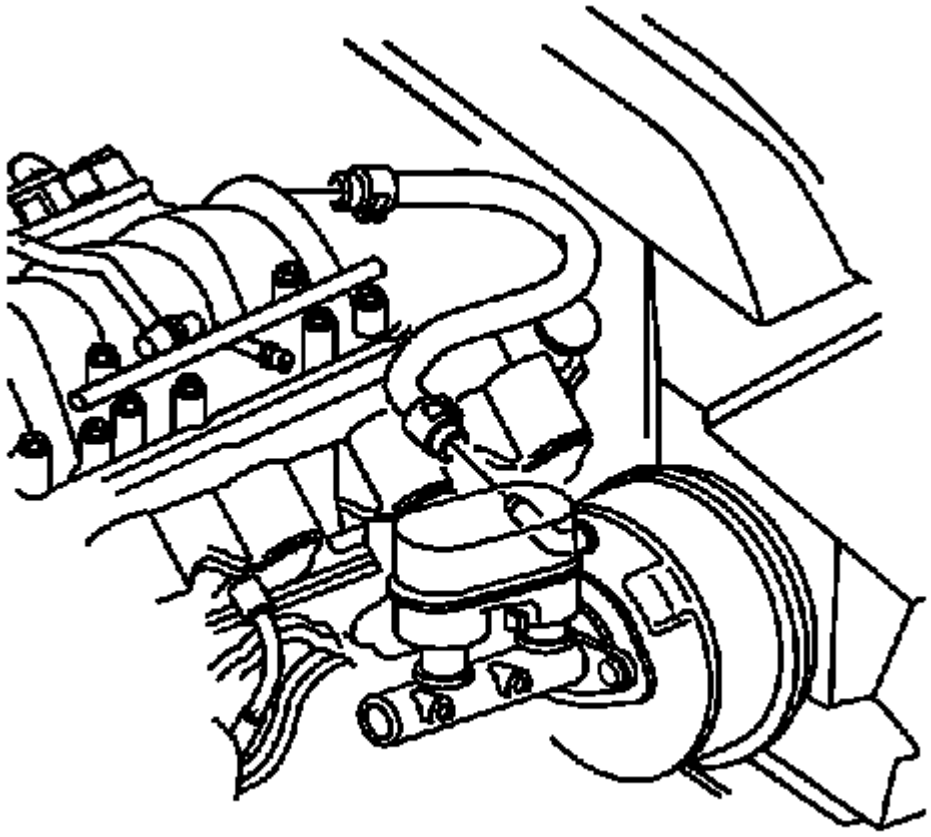


Fig. 198: Identifying Vacuum Booster Hose
Courtesy of GENERAL MOTORS COMPANY

5. Install the vacuum hose for the power brake booster.
6. Install the left engine sight cover.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT (LSA)

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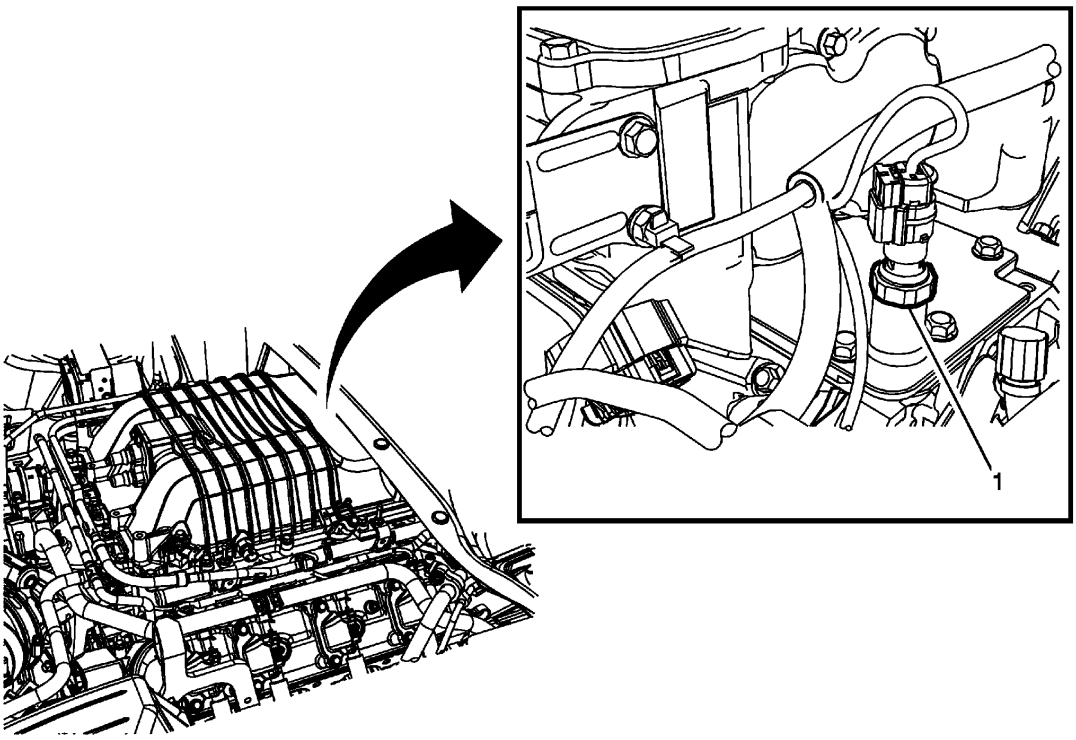


Fig. 199: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Pressure Sensor and/or Switch Replacement (LSA)

Callout	Component Name
Preliminary Procedure Remove the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front**. **Special Tools** **J 41712** Oil Pressure Sensor Socket For equivalent regional tools, refer to **Special Tools** .	
1	Engine Oil Pressure Sensor **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** 1. To access the oil pressure sensor the engine will need to be lowered. The front suspension crossmember fasteners will need to be loosened 3/4 of the way to allow the assembly to be lower approximately 25 mm (1 in). Refer to **Drivetrain and Front Suspension Frame Removal and Installation** . 2. Disconnect the electrical connector. 3. Using the **J 41712** oil pressure sensor socket (1) , remove the oil pressure sensor.

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	Tighten 35 (26 lb ft)

ENGINE OIL LEVEL SENSOR AND/OR OIL LEVEL SWITCH REPLACEMENT

Removal Procedure

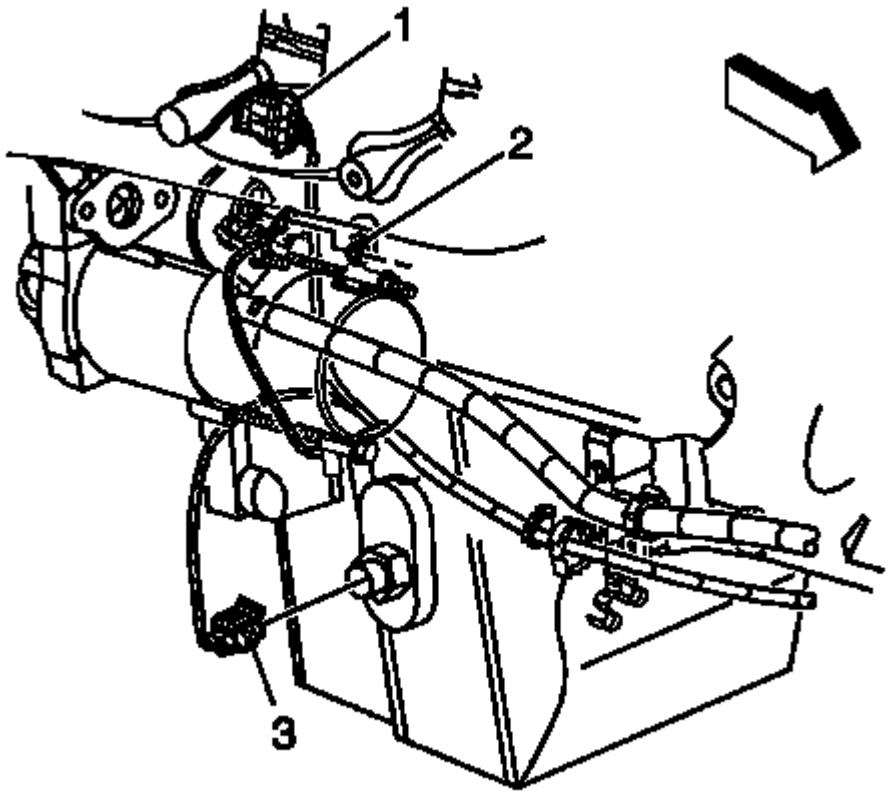


Fig. 200: View Of Oil Level Sensor & CKP Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Drain the engine of oil.
3. Disconnect the electrical connector (3).

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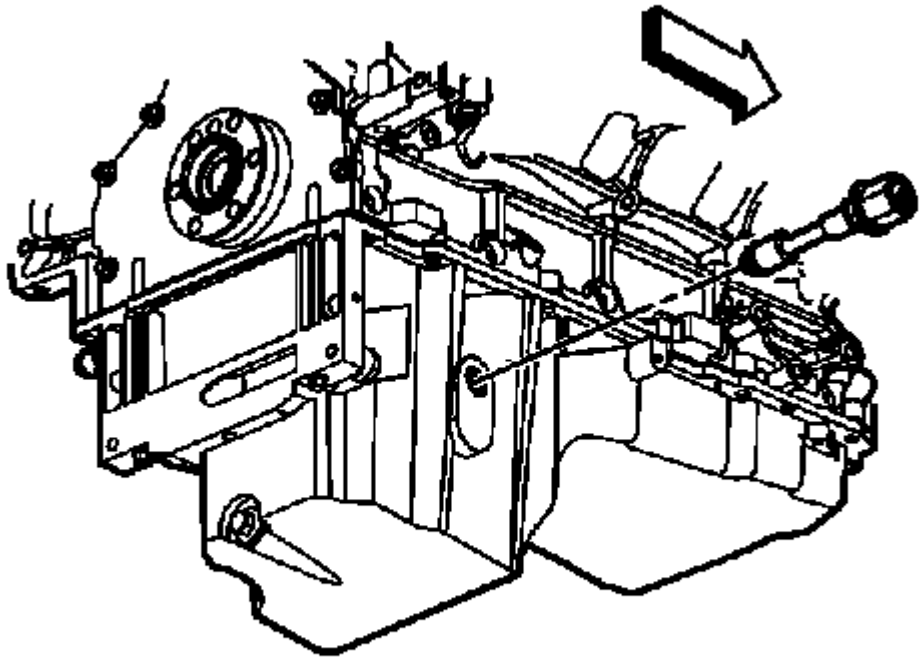


Fig. 201: View Of Oil Level Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine oil lever sensor.

Installation Procedure

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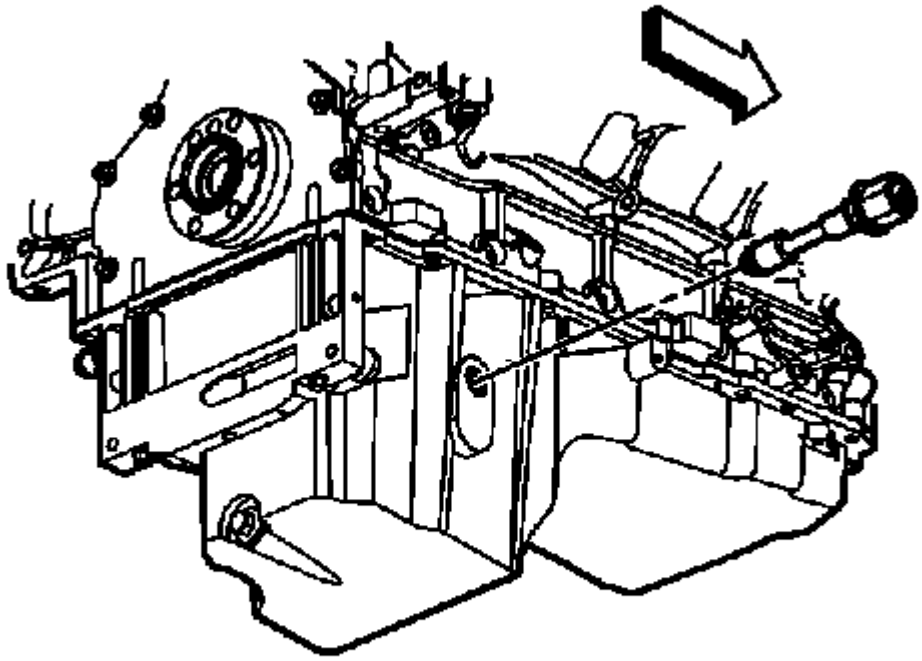


Fig. 202: View Of Oil Level Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the drain plug and tighten to 25 N.m (18 lb ft).
2. Install the engine oil level sensor. Tighten the sensor to 20 N.m (15 lb ft).

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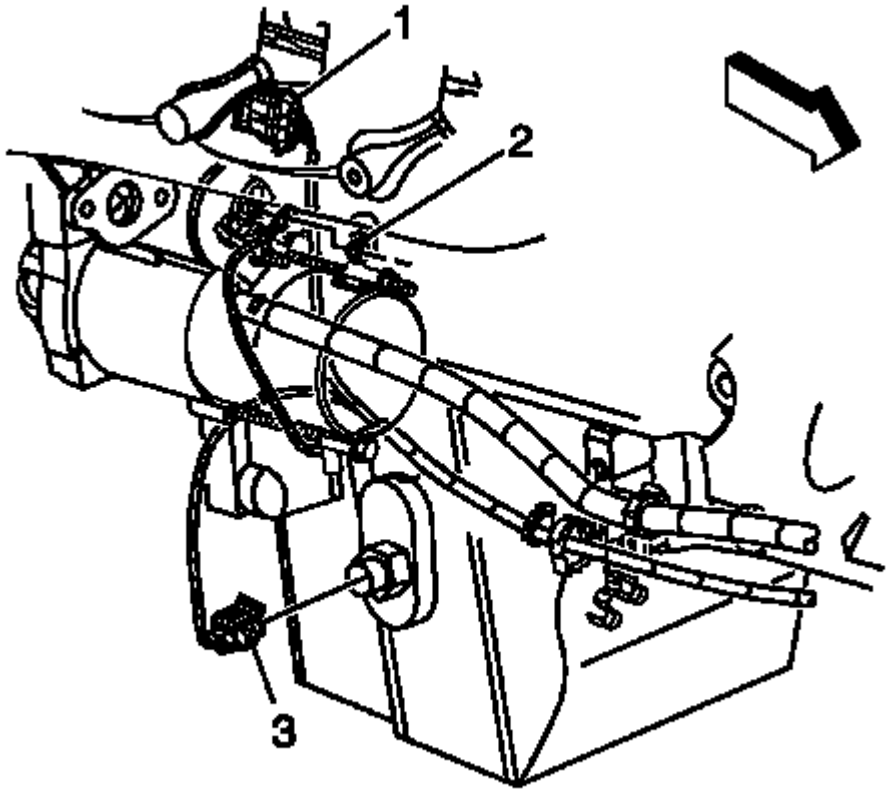


Fig. 203: View Of Oil Level Sensor & CKP Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Reconnect the electrical connector (3).
4. Lower the vehicle.
5. Refill the engine. Refer to **Approximate Fluid Capacities** .

OIL PUMP, SCREEN, AND CRANKSHAFT OIL DEFLECTOR REPLACEMENT

Removal Procedure

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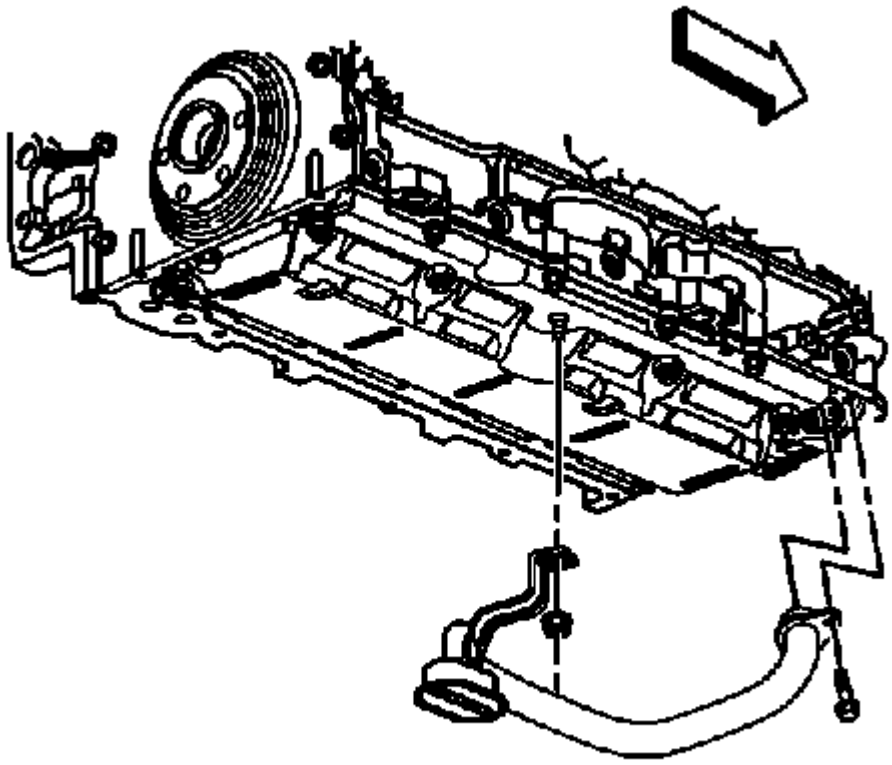


Fig. 204: Identifying Oil Pump Screen, Bolt & Nut
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement (L99)**.
2. Remove the engine oil pan. Refer to **Oil Pan Replacement**.
3. Remove the oil pump screen bolt and nut.
4. Remove the oil pump screen and O-ring seal.
5. Remove the O-ring seal from the pump screen.
6. Discard the O-ring seal.

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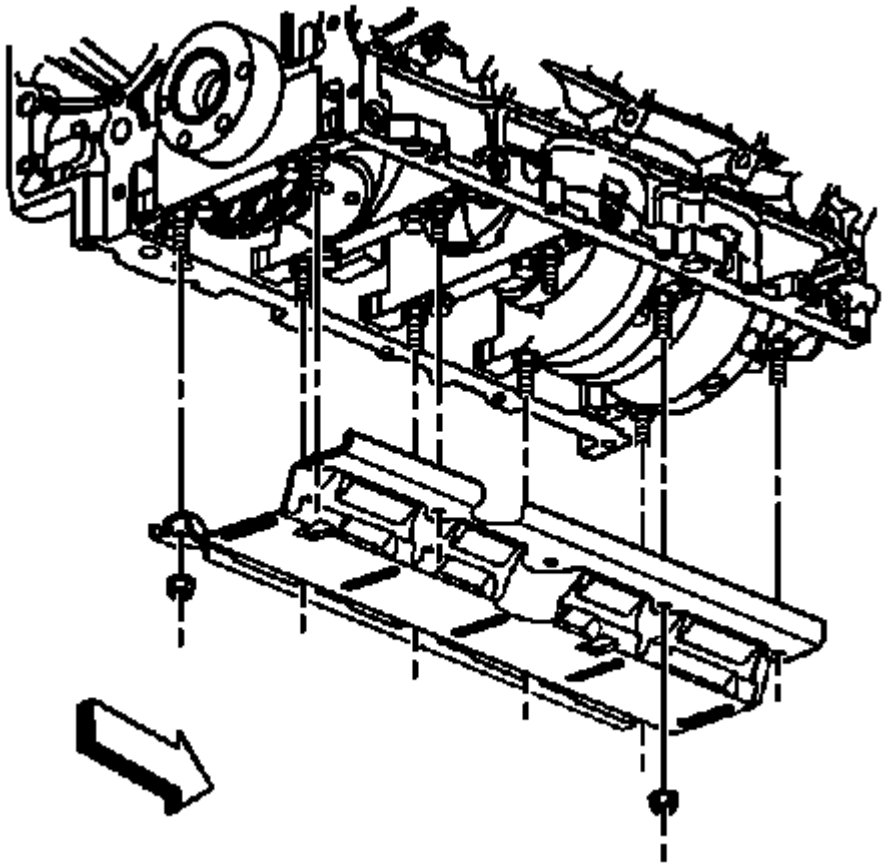


Fig. 205: View Of Crankshaft Oil Deflector & Nuts
Courtesy of GENERAL MOTORS COMPANY

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

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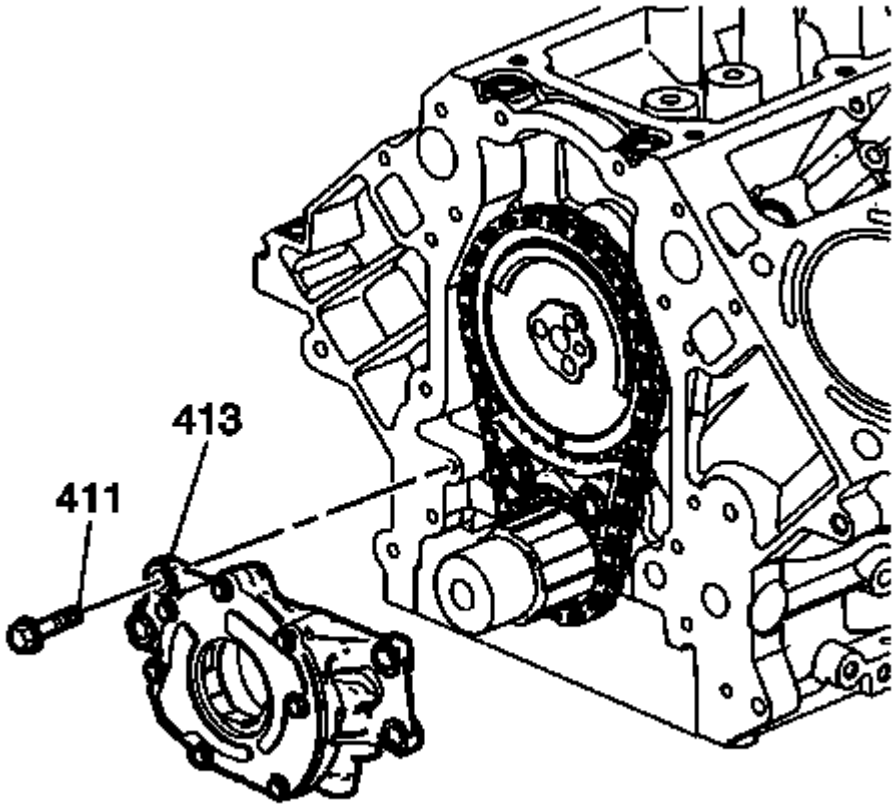


Fig. 206: View Of Oil Pump & Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not allow dirt or debris to enter the oil pump, cap the ends as necessary.

9. Remove the oil pump (413) and bolts (411).
10. Remove the oil pump.
11. Clean and inspect the oil pump. Refer to **Oil Pump Cleaning and Inspection (LS3 or L99)** , **Oil Pump Cleaning and Inspection (LSA)** .

Installation Procedure

NOTE: Inspect the engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

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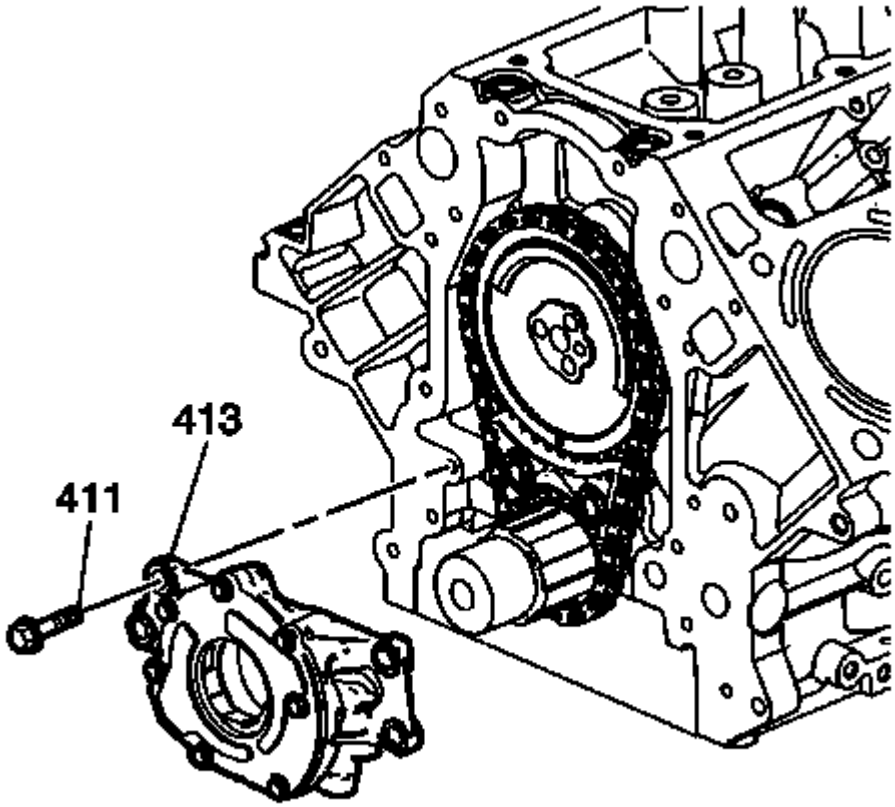


Fig. 207: View Of Oil Pump & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (413).
2. Install the oil pump (413) onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

CAUTION: Refer to Fastener Caution .

3. Install the oil pump bolts (411).

Tighten

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

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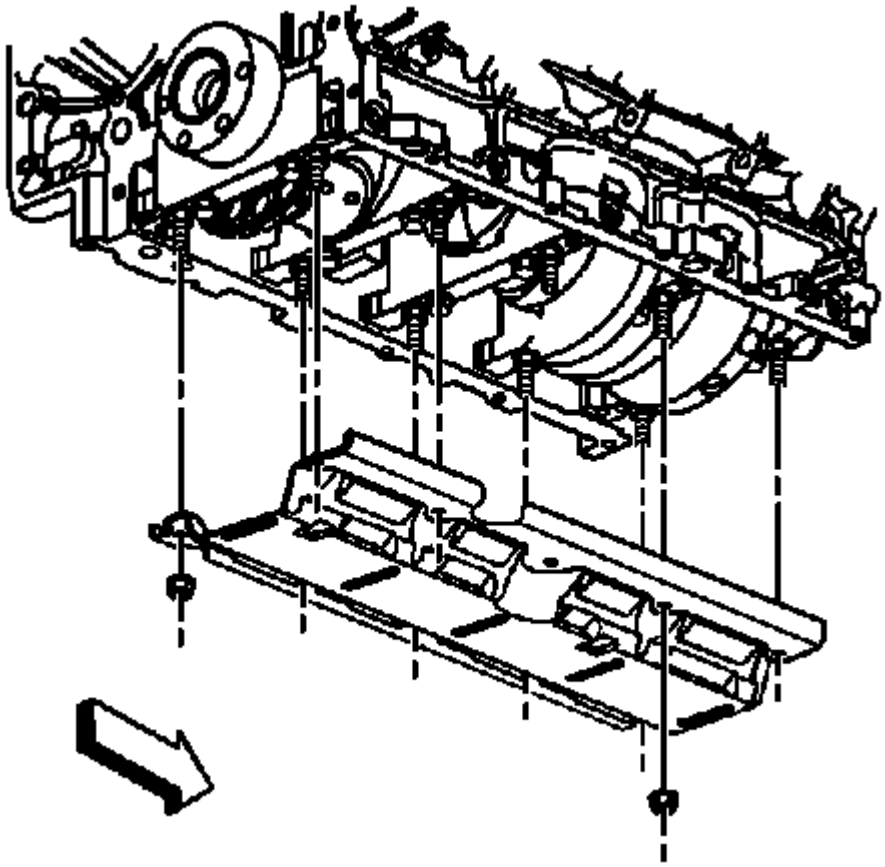


Fig. 208: View Of Crankshaft Oil Deflector & Nuts
Courtesy of GENERAL MOTORS COMPANY

4. Install the crankshaft oil deflector.
5. Install the crankshaft oil deflector nuts.

Tighten

Tighten the crankshaft oil deflector nuts to 25 N.m (18 lb ft).

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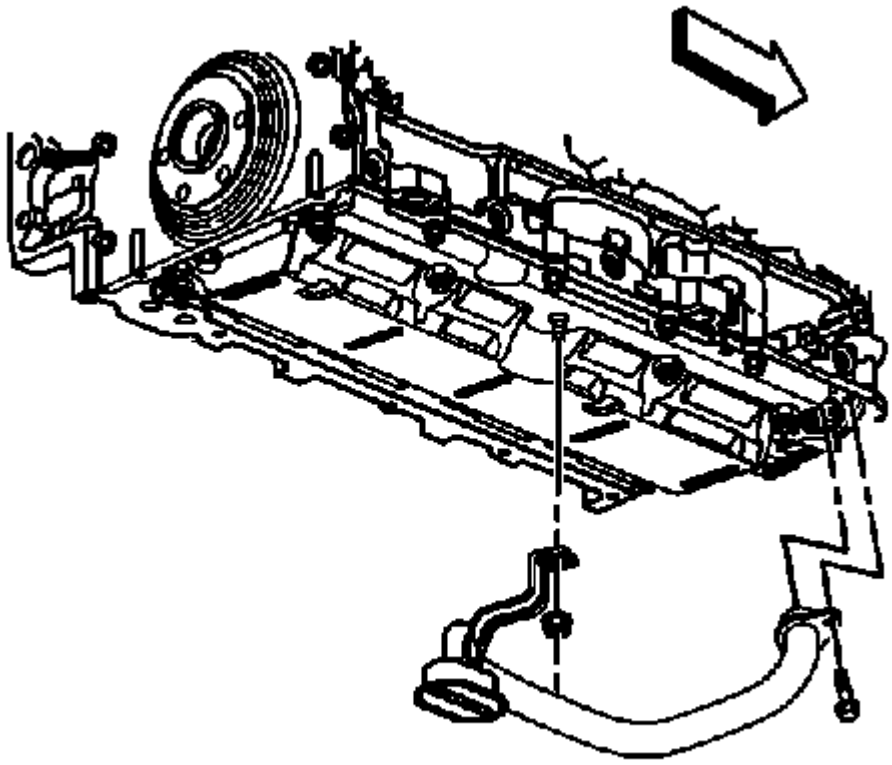


Fig. 209: Identifying Oil Pump Screen, Bolt & Nut
Courtesy of GENERAL MOTORS COMPANY

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

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

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

8. Install the oil pump screen.
9. Install the oil pump screen bolt and nut.

Tighten

- Tighten the oil pump screen bolt to 12 N.m (106 lb in).
- Tighten the oil pump screen nut to 25 N.m (18 lb ft).

10. Install the engine oil pan. Refer to **Oil Pan Replacement**.

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11. Install the engine front cover. Refer to **Engine Front Cover Replacement (L99)**.

TIMING CHAIN, CRANKSHAFT SPROCKET, CAMSHAFT POSITION ACTUATOR, AND SOLENOID VALVE REPLACEMENT (L99)

Special Tools

- **EN 46330** Timing Chain Tensioner Retaining Pin
- **J 8433** Puller Bar
- **J 41478** Crankshaft Front Oil Seal Installer
- **J 41558** Crankshaft Sprocket Remover
- **J 41665** Crankshaft Balancer and Sprocket Installer
- **J 41816-2** Crankshaft End Protector
- **J 42386-A** Flywheel Holding Tool

Removal Procedure

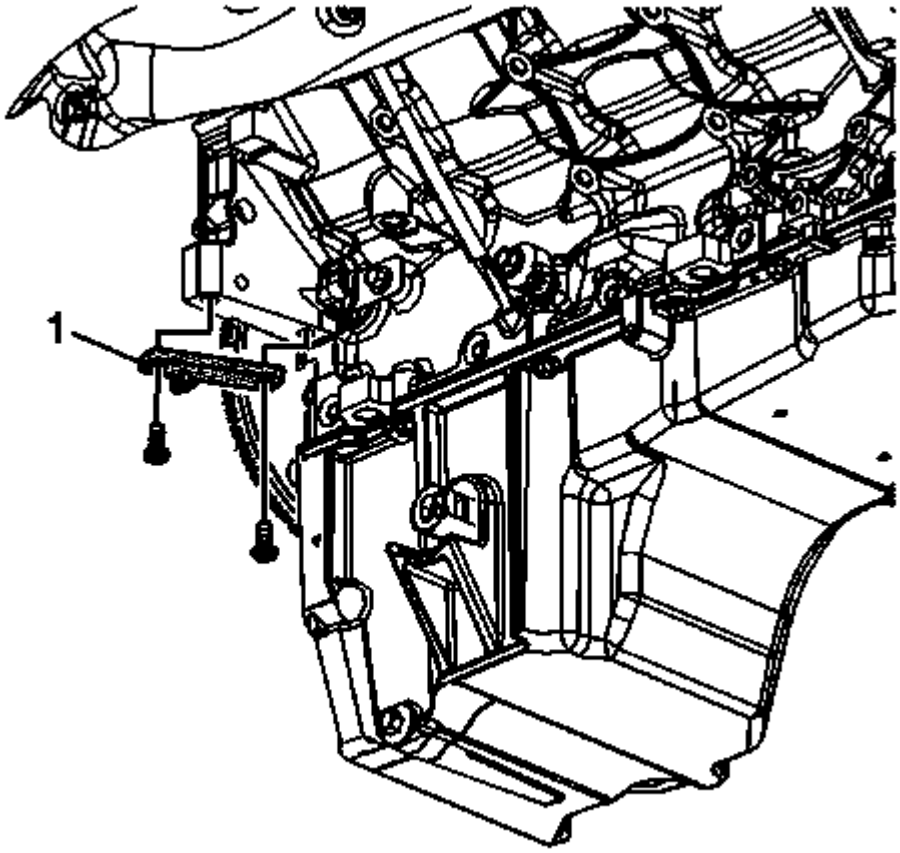


Fig. 210: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS COMPANY

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1. Remove the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.
2. Remove the starter motor. Refer to **Starter Replacement (LSA,LS3,L99)** .

CAUTION: Refer to Fastener Caution .

NOTE: Ensure that the teeth of the J 42386-A flywheel holding tool mesh with the teeth of the engine flywheel.

3. Install the **J 42386-A** flywheel holding tool (1) and bolts. Use one M10-1.5 x 120 mm and one M10-1.5 x 45 mm bolt for proper tool operation.

   Tighten

   Tighten the **J 42386-A** flywheel holding tool bolts to 50 (37 lb ft).

4. Remove the camshaft position actuator. Refer to **Camshaft Position Actuator Replacement**.

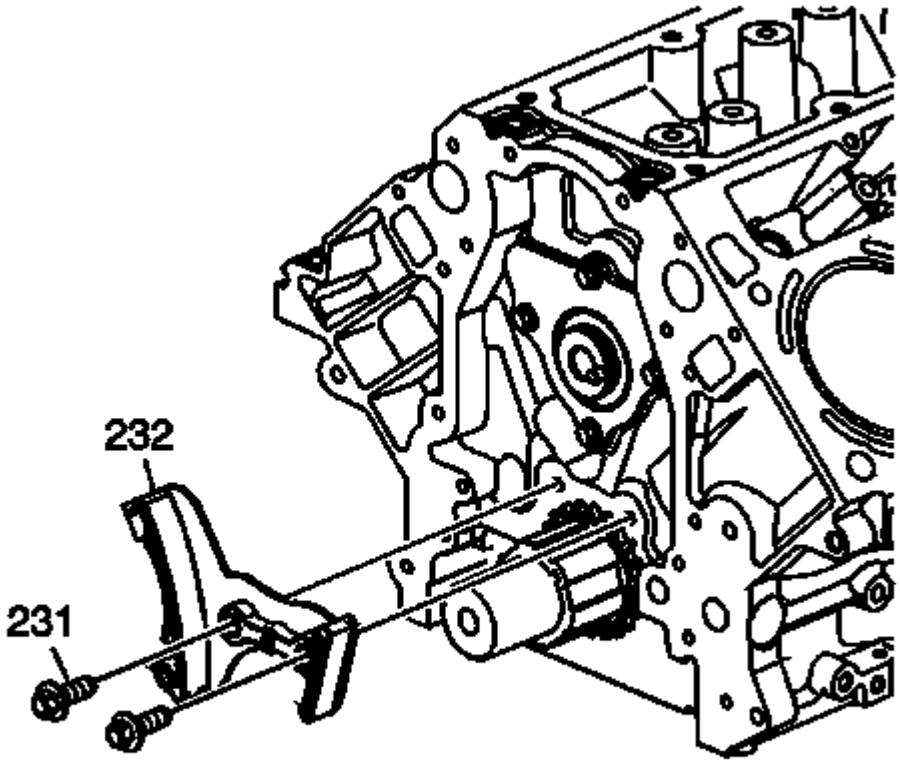


Fig. 211: View Of Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS COMPANY

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5. Remove the timing chain tension bolts (231) and tensioner (232).

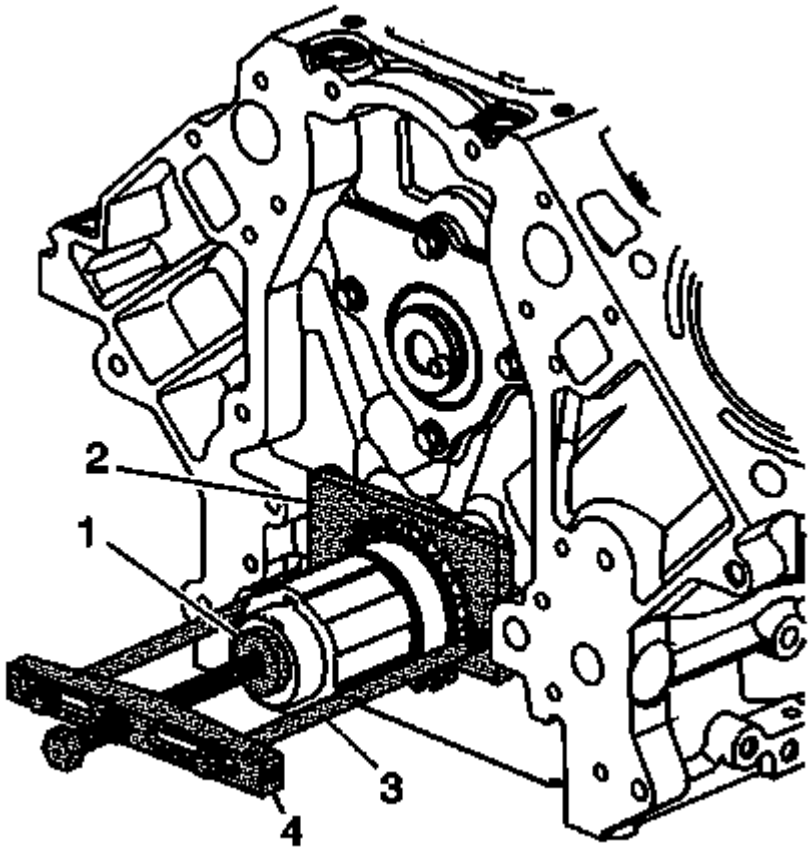


Fig. 212: View Of Crankshaft Sprocket Special Tools
Courtesy of GENERAL MOTORS COMPANY

6. Using the **J 41816-2** crankshaft end protector (1), the **J 41558** crankshaft sprocket remover (2), bolts (3) and the **J 8433** puller bar (4) in order to remove the crankshaft sprocket.

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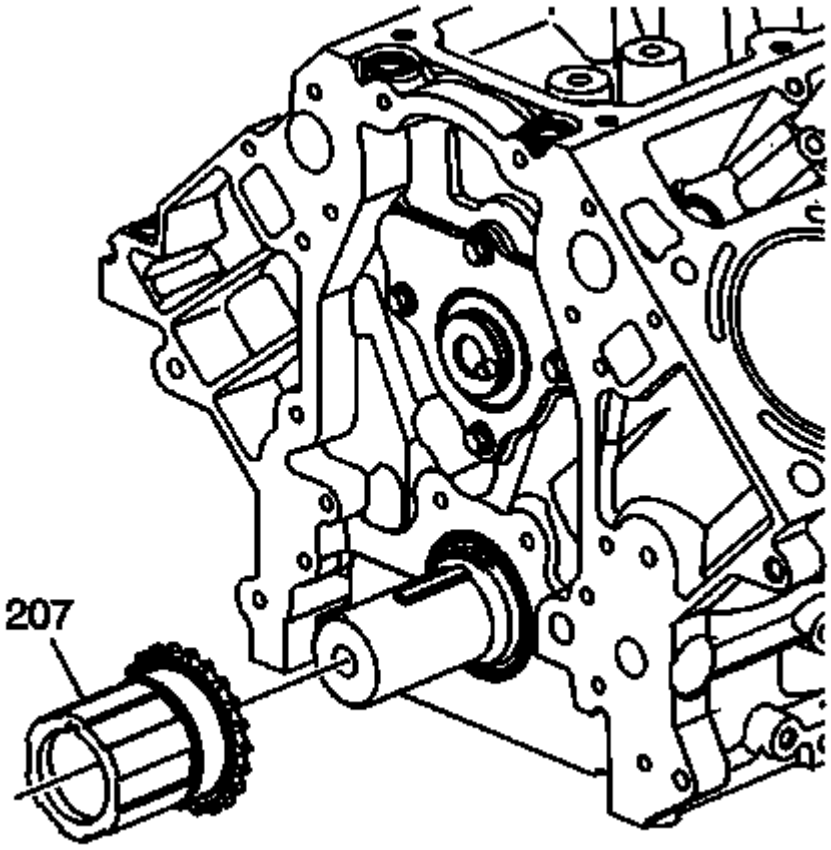


Fig. 213: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

7. Remove the crankshaft sprocket (207).

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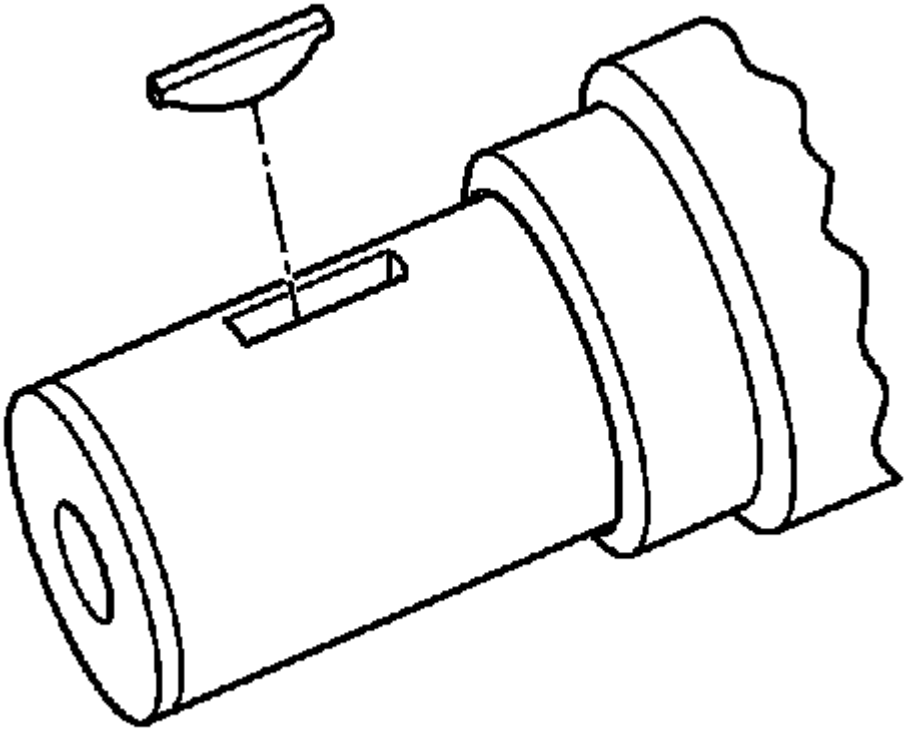


Fig. 214: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS COMPANY

8. Remove the crankshaft sprocket key, if required.

Installation Procedure

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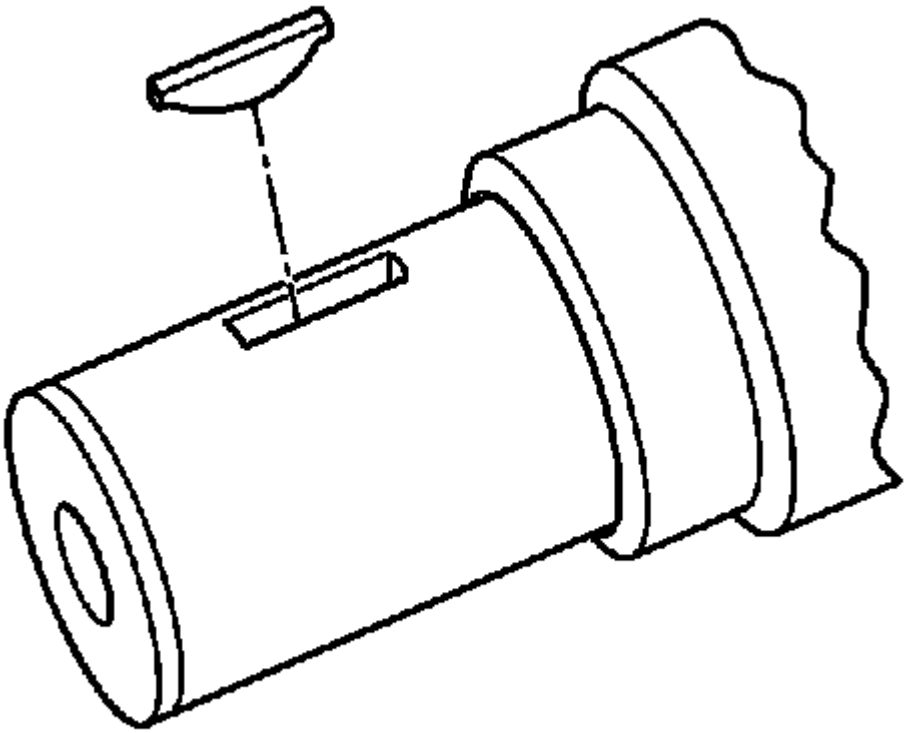


Fig. 215: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS COMPANY

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

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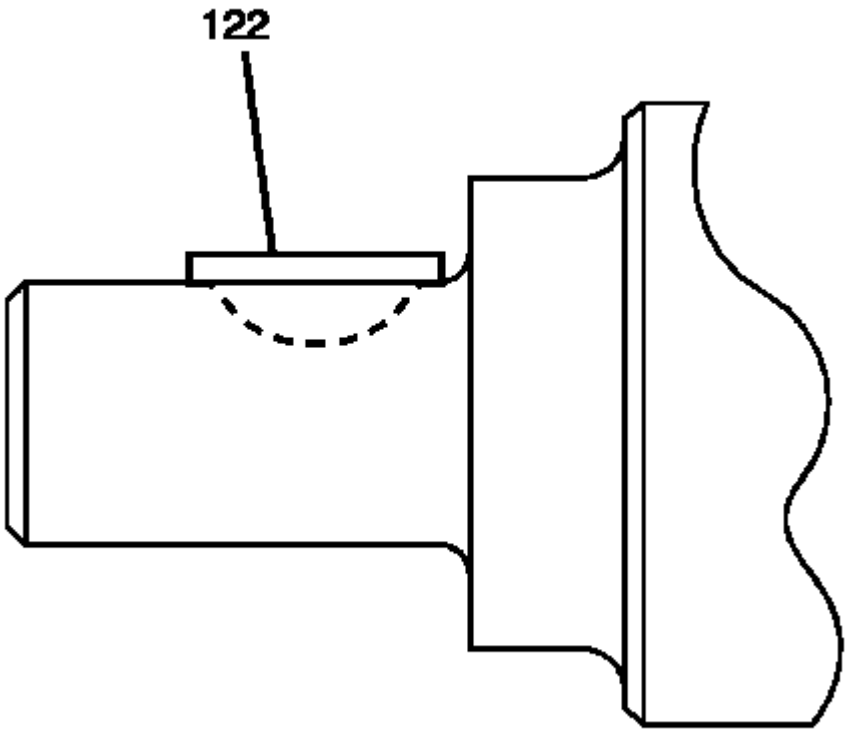


Fig. 216: View Of Installed Crankshaft Key
Courtesy of GENERAL MOTORS COMPANY

2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.

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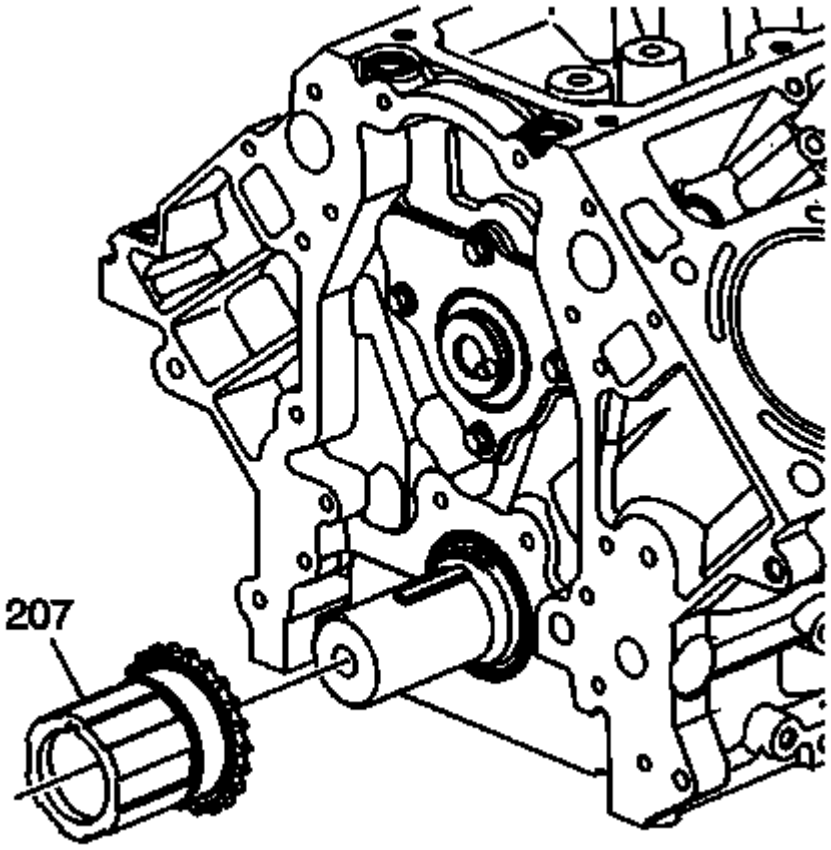


Fig. 217: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

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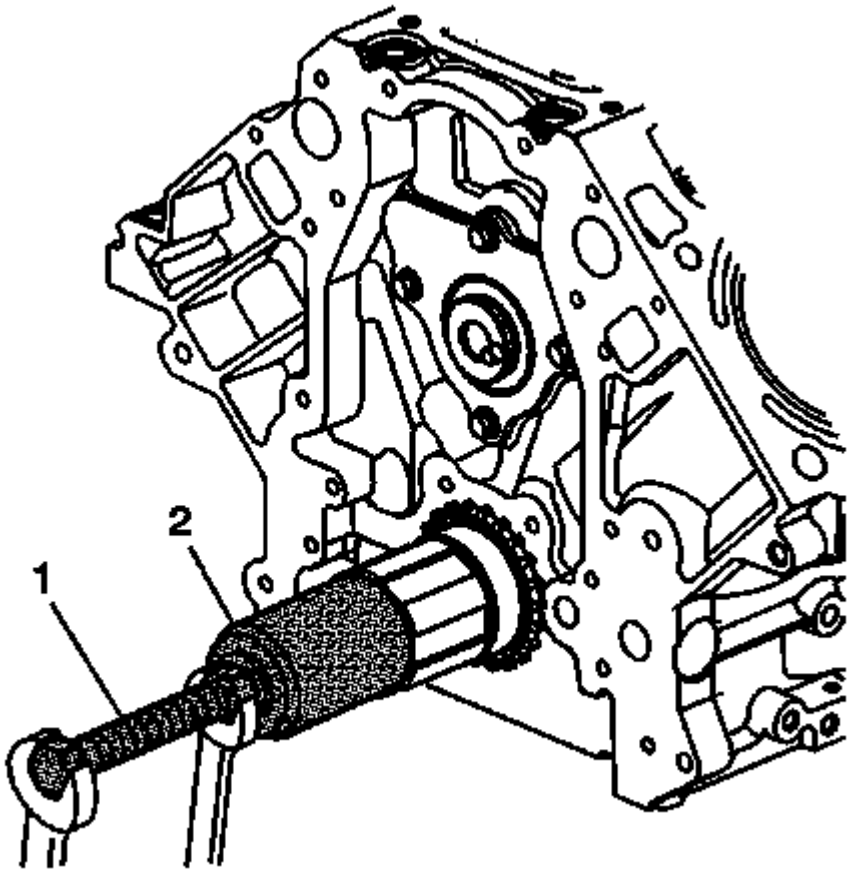


Fig. 218: View Of Crankshaft Sprocket & Installer
Courtesy of GENERAL MOTORS COMPANY

4. Use the **J 41478** crankshaft front oil seal installer (1) and the **J 41665** crankshaft balancer and sprocket installer (2) in order to install the crankshaft sprocket. Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.

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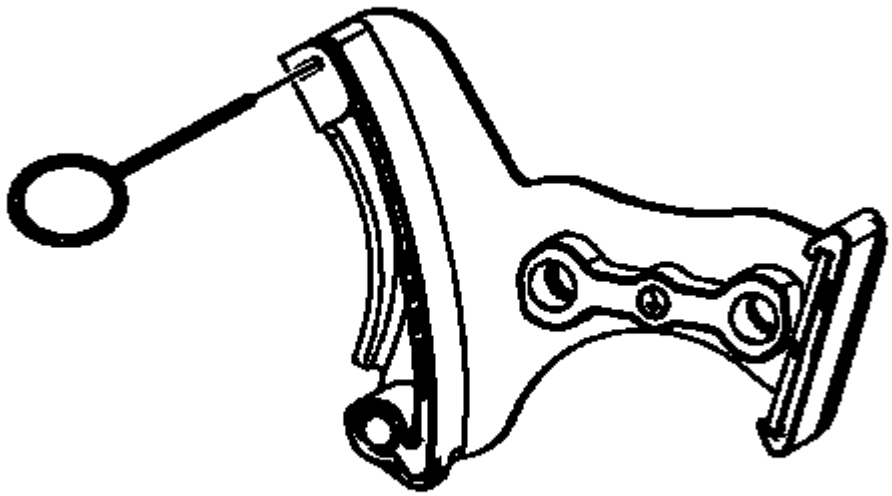


Fig. 219: View Of Compressed Tensioner
Courtesy of GENERAL MOTORS COMPANY

5. Compress the timing chain tensioner guide and install the **EN 46330** timing belt tensioner retaining pin.

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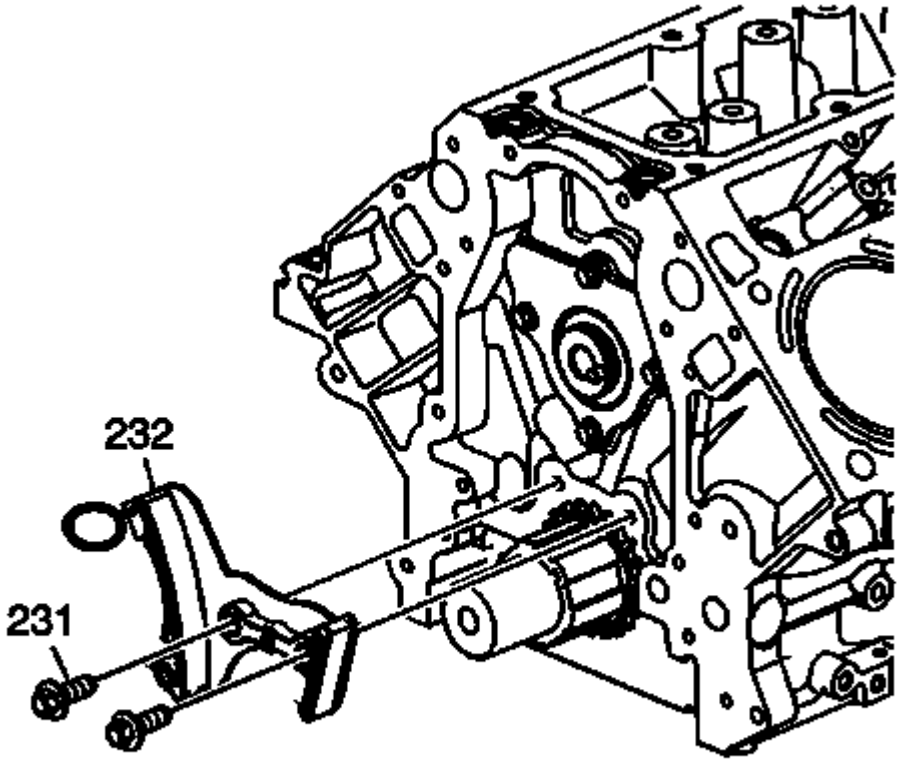


Fig. 220: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

6. Install the timing chain tensioner (232) and bolts (231).

   Tighten

   Tighten the bolts to 25 (18 lb ft).

7. Install the camshaft position actuator. Refer to **Camshaft Position Actuator Replacement**.

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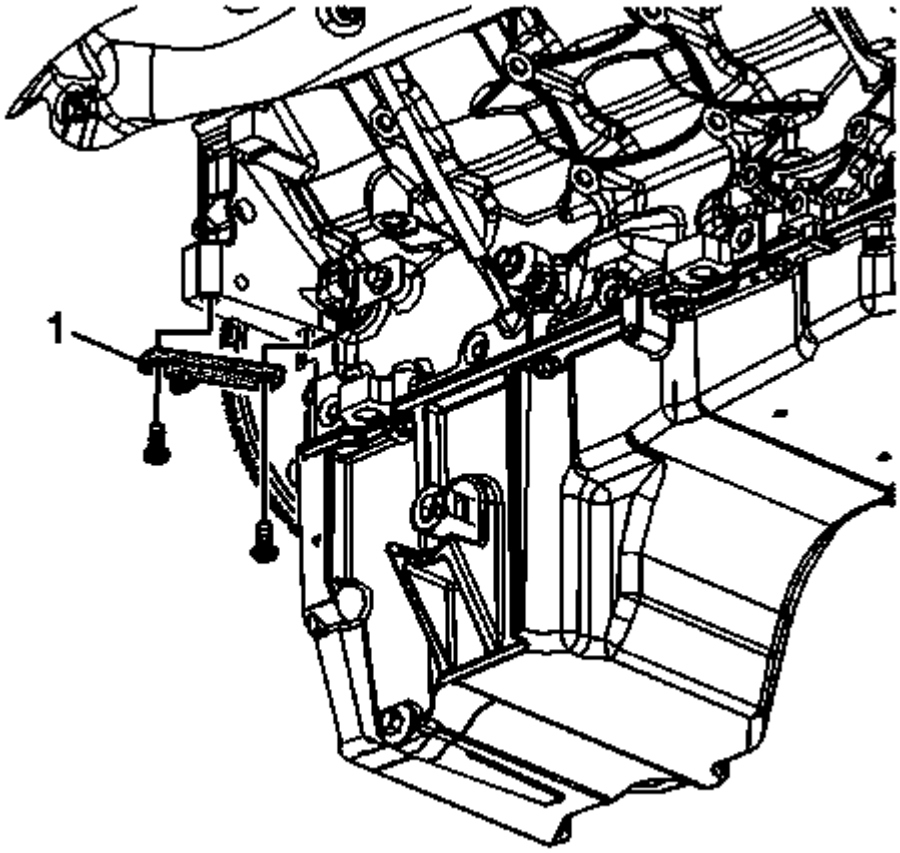


Fig. 221: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the **J 42386-A** flywheel holding tool (1) and bolts.
9. Install the starter motor. Refer to **Starter Replacement (LSA,LS3,L99)** .
10. Install the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.

CAMSHAFT TIMING CHAIN AND SPROCKET REPLACEMENT (LS3)

Special Tools

- **EN 46330** Timing Chain Tensioner Retaining Pin
- **J 8433** Puller Bar
- **J 41478** Crankshaft Front Oil Seal Installer
- **J 41558** Crankshaft Sprocket Remover
- **J 41665** Crankshaft Balancer and Sprocket Installer
- **J 41816-2** Crankshaft End Protector
- **J 45059** Angle Meter

Removal Procedure

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1. Remove the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.

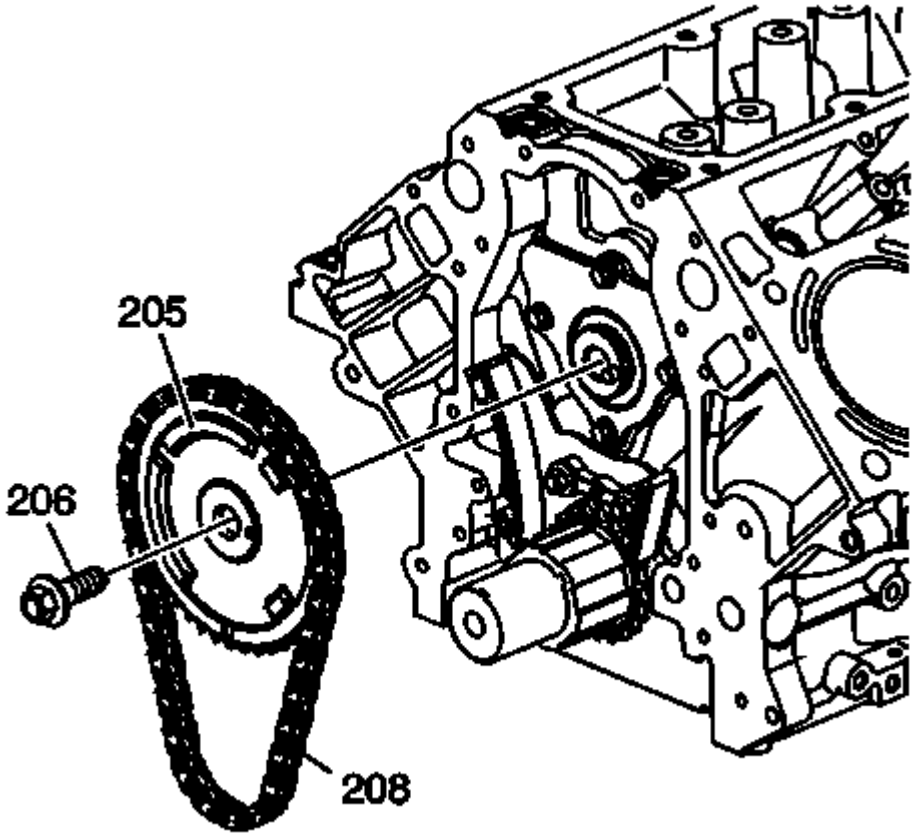


Fig. 222: View Of Camshaft Sprocket, Timing Chain & Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

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

2. Rotate the crankshaft until the timing marks on the crankshaft and the camshaft sprockets are aligned.
3. Remove the camshaft sprocket bolt (206) and discard sprocket bolt.
4. Remove the camshaft sprocket (205) and timing chain (208).

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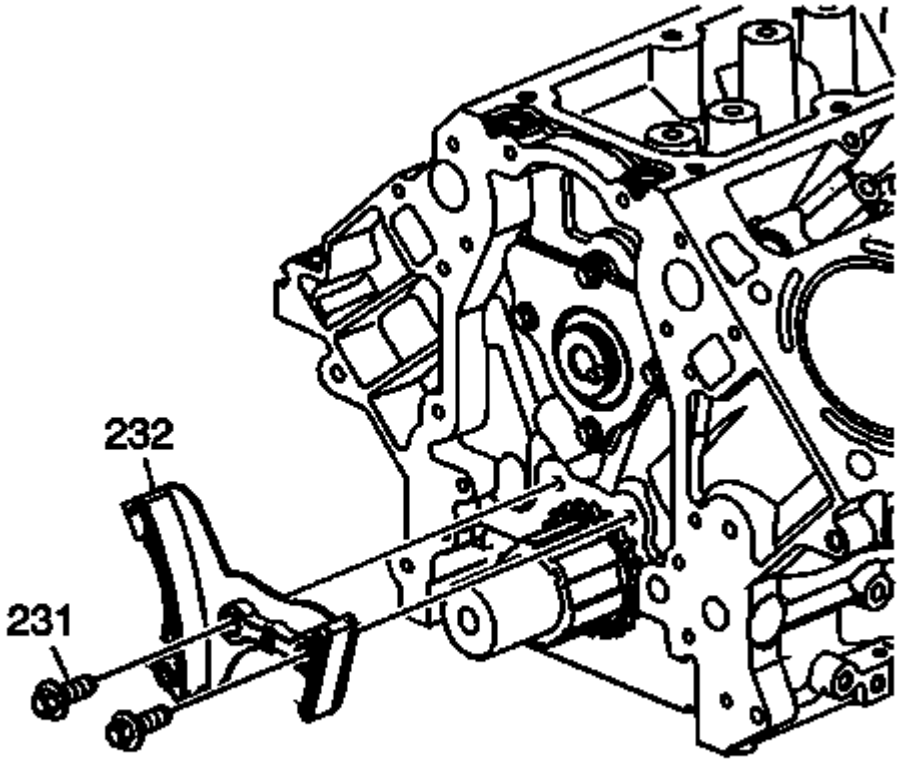


Fig. 223: View Of Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the timing chain tension bolts (231) and tensioner (232).

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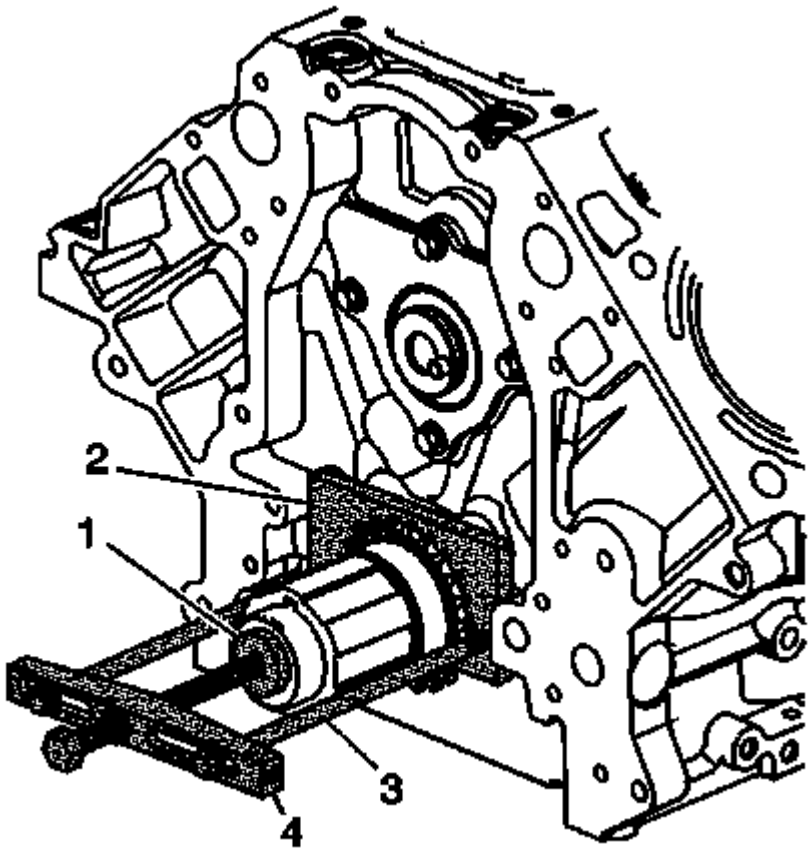


Fig. 224: View Of Crankshaft Sprocket Special Tools
Courtesy of GENERAL MOTORS COMPANY

6. Using the **J 41816-2** crankshaft end protector (1), the **J 41558** crankshaft sprocket remover (2), bolts (3) and the **J 8433** puller bar (4) in order to remove the crankshaft sprocket.

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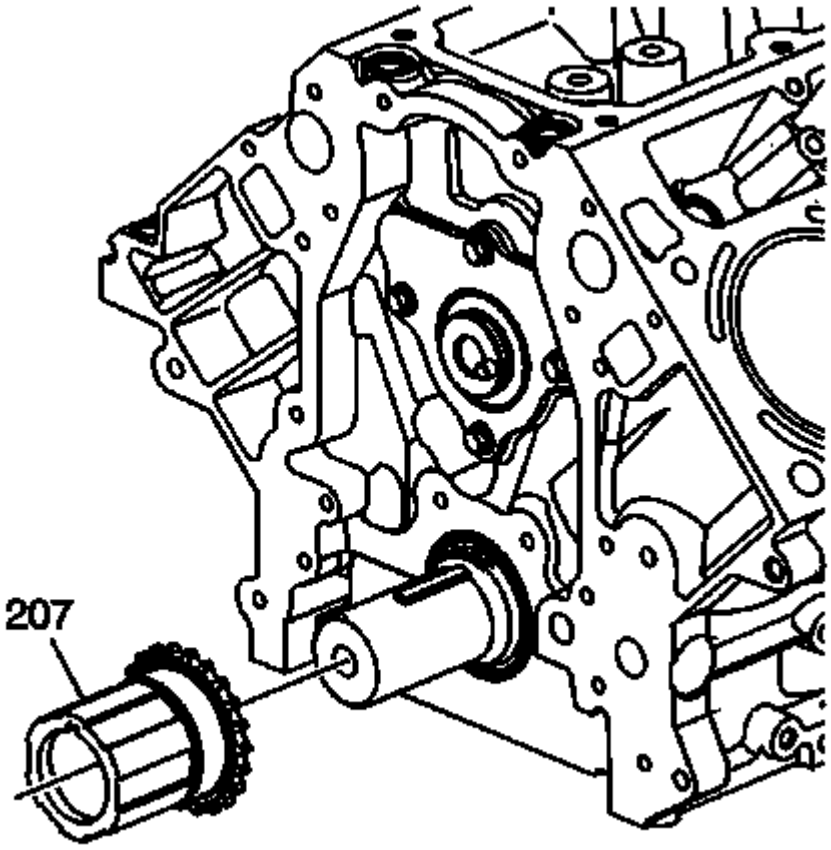


Fig. 225: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

7. Remove the crankshaft sprocket (207).

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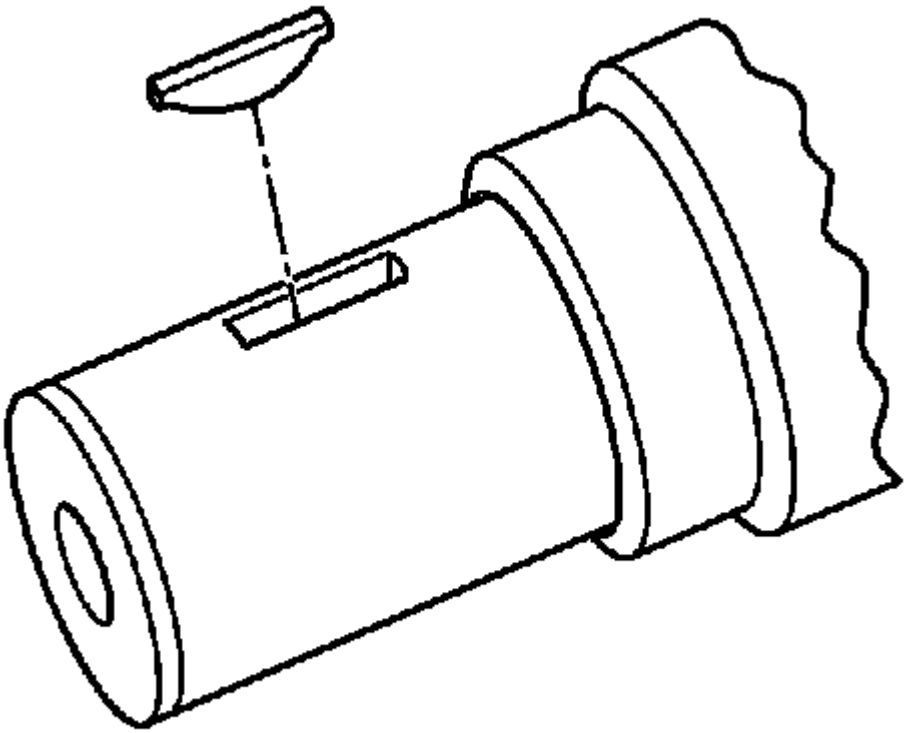


Fig. 226: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS COMPANY

8. Remove the crankshaft sprocket key, if required.

Installation Procedure

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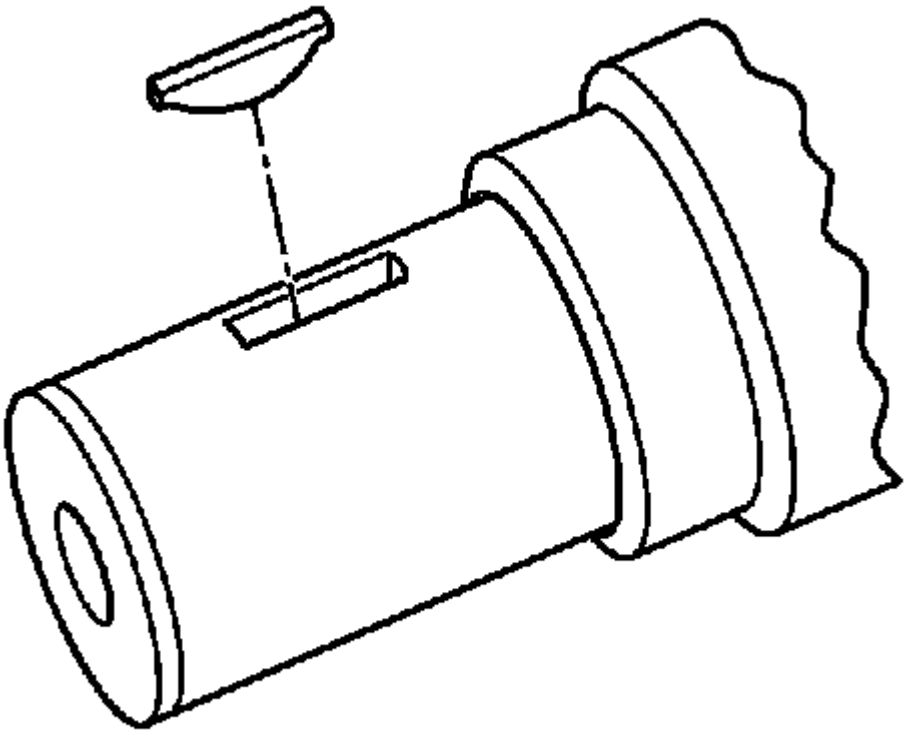


Fig. 227: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS COMPANY

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

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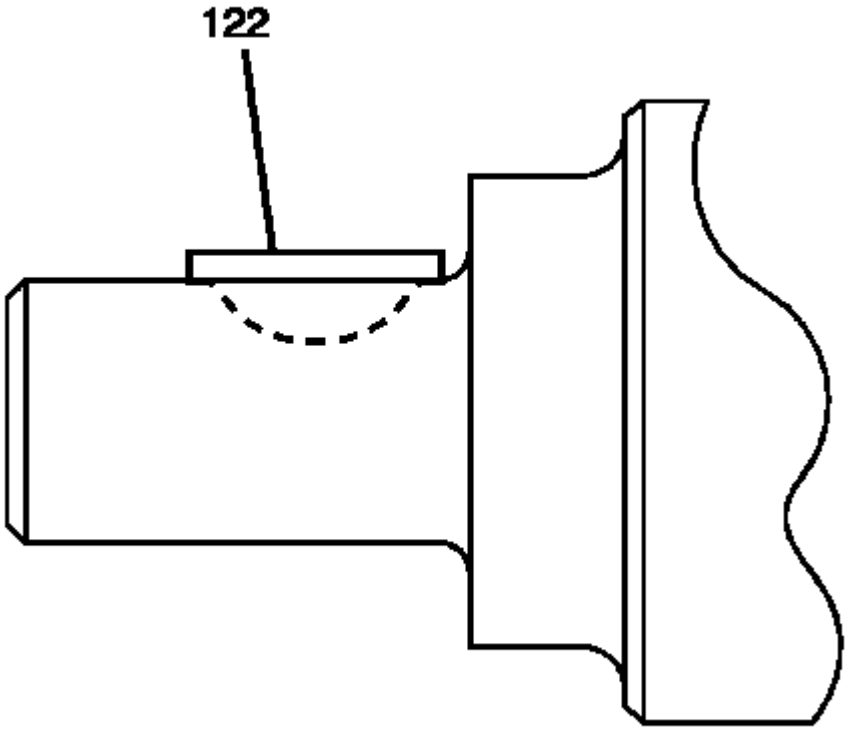


Fig. 228: View Of Installed Crankshaft Key
Courtesy of GENERAL MOTORS COMPANY

2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.

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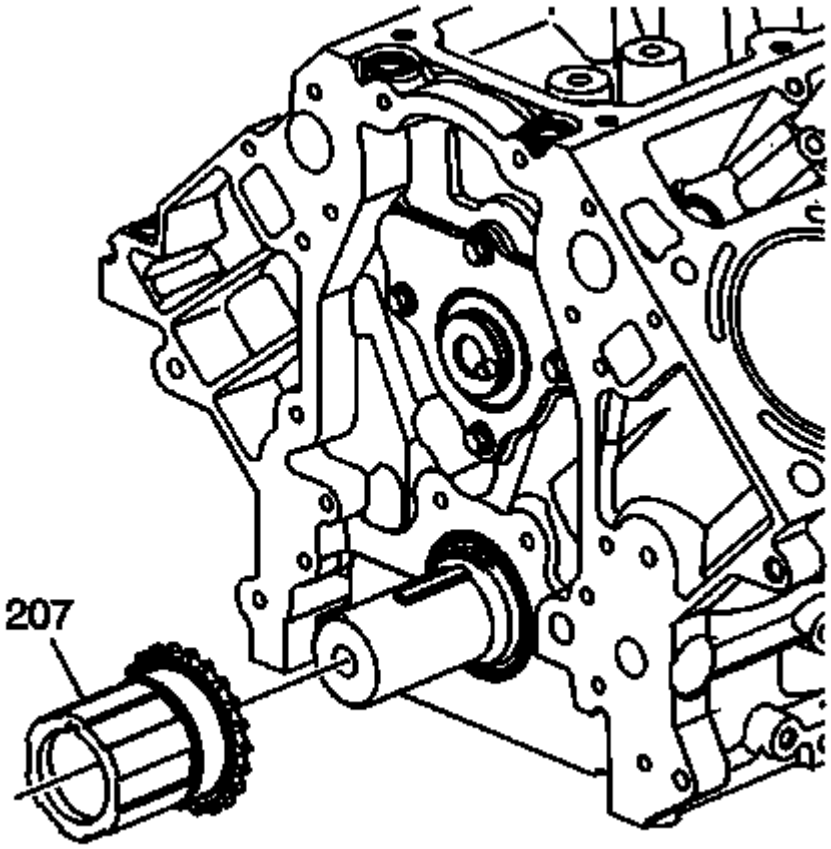


Fig. 229: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

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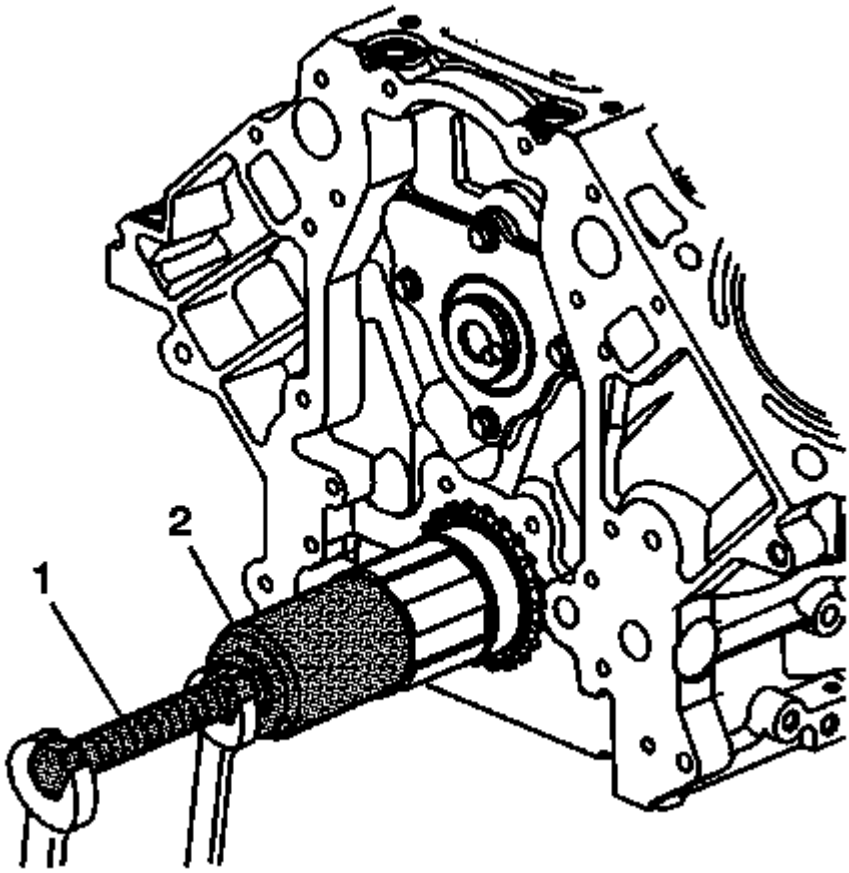


Fig. 230: View Of Crankshaft Sprocket & Installer
Courtesy of GENERAL MOTORS COMPANY

4. Use the **J 41478** crankshaft front oil seal installer (1) and the **J 41665** crankshaft balancer and sprocket installer (2) in order to install the crankshaft sprocket. Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.

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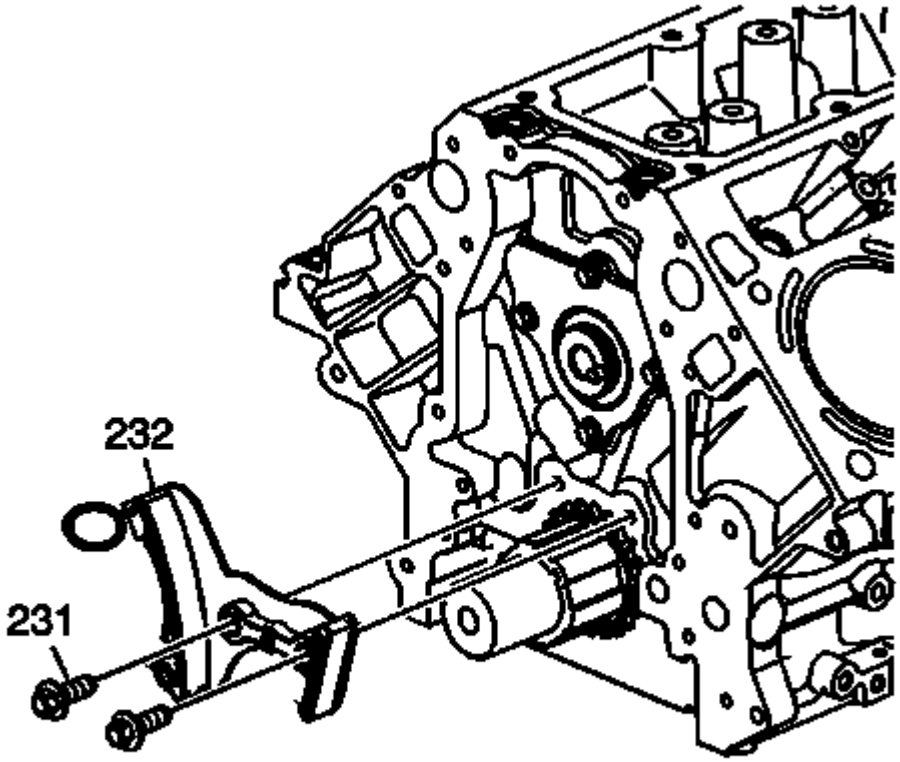


Fig. 231: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

5. Install the timing chain tensioner (232) and bolts (231).

   Tighten

   Tighten the bolts to 30 (22 lb ft).

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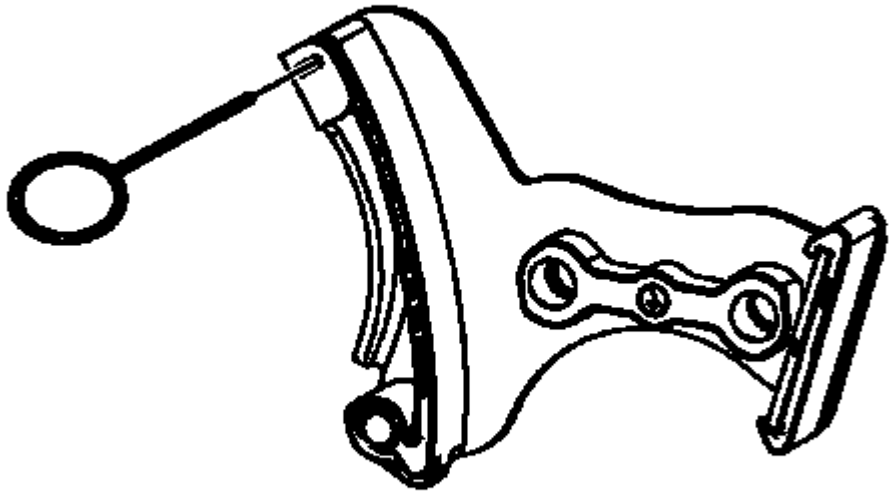


Fig. 232: View Of Compressed Tensioner
Courtesy of GENERAL MOTORS COMPANY

6. Compress the timing chain tensioner guide and install the **EN 46330** timing belt tensioner retaining pin.

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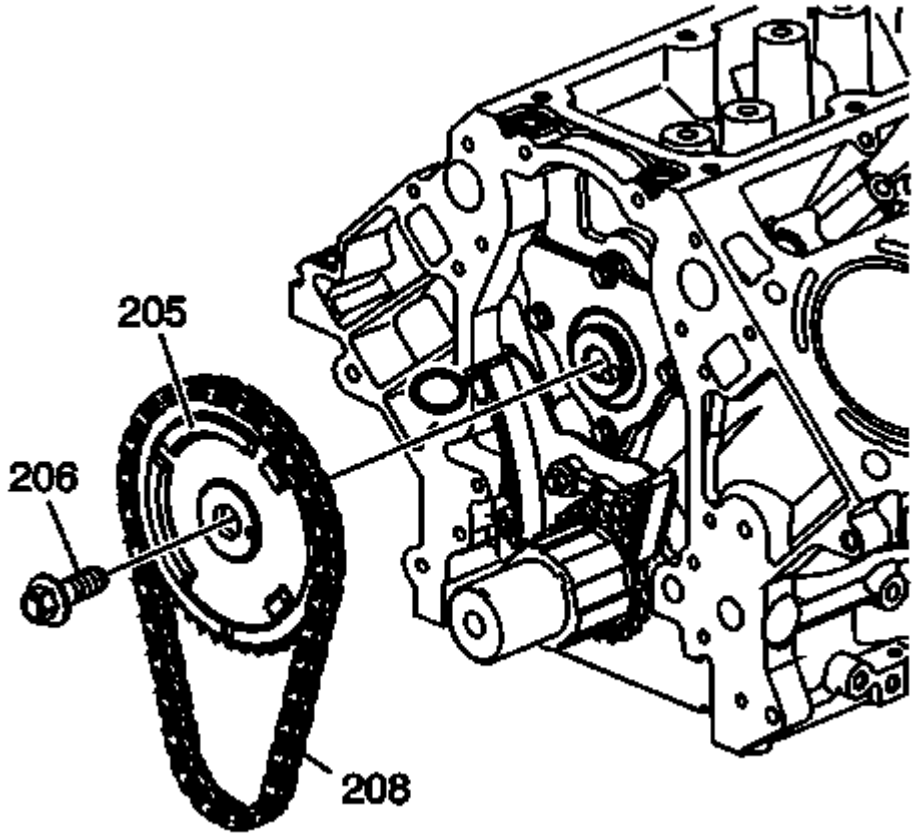


Fig. 233: View Of Camshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The sprocket teeth and timing chain must mesh.**
- **The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.**

7. Position the camshaft sprocket (205) so the timing mark is in the 6 o'clock position.
8. Install the camshaft sprocket (205), timing chain (208), and bolt (206).

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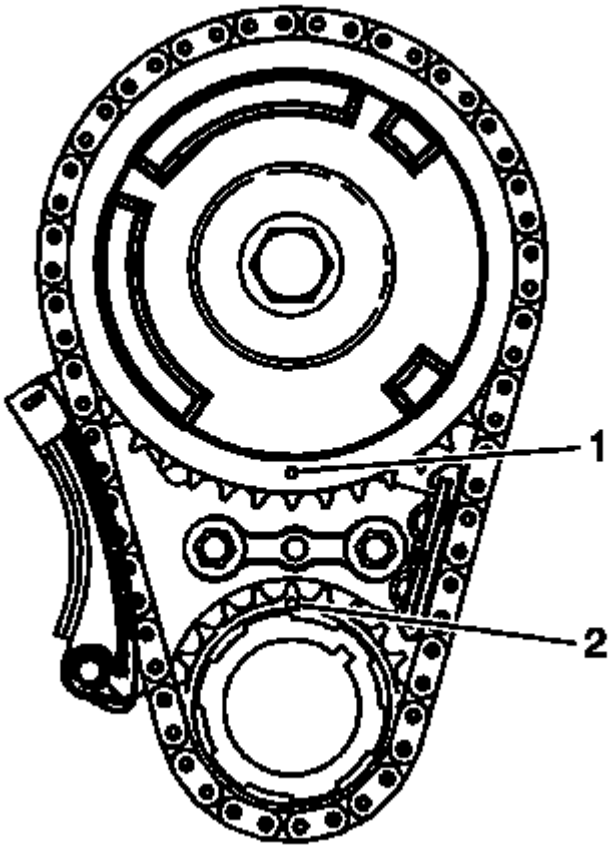


Fig. 234: Identifying Camshaft & Crankshaft Marks
Courtesy of GENERAL MOTORS COMPANY

9. Inspect the sprockets for proper alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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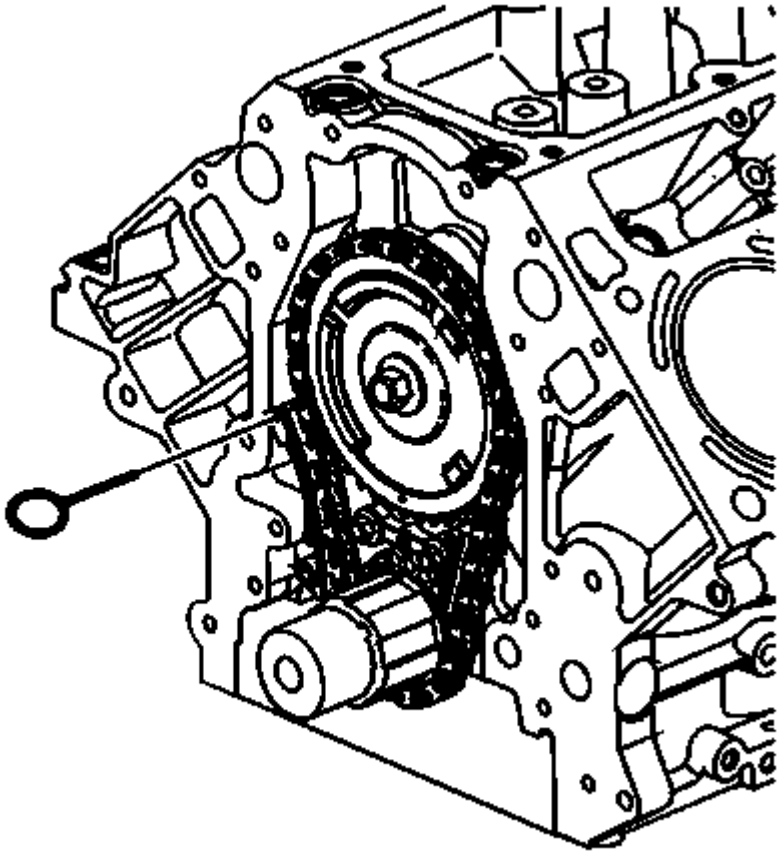


Fig. 235: Locating Tensioner Pin
Courtesy of GENERAL MOTORS COMPANY

10. Remove the **EN 46330** timing belt tensioner retaining pin.

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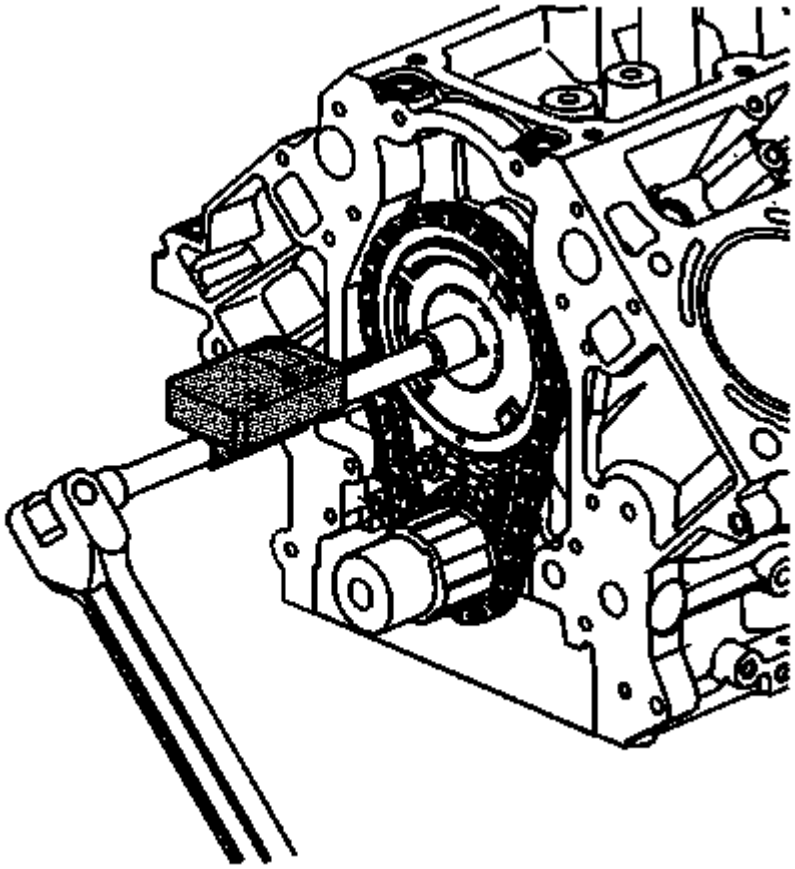


Fig. 236: Tightening Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do Not re-use camshaft sprocket bolt. New sprocket bolt must be used.

11. Tighten the camshaft sprocket bolt

    Tighten

    1. Tighten the bolt a first pass to 75 (55 lb ft).
    2. Tighten the bolt a final pass an additional 50 degrees using **J 45059** angle meter.
12. Remove the **J 42386-A** flywheel holding tool (1) and bolts.
13. Install the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.

CAMSHAFT REPLACEMENT (LS3)

Special Tools

- **EN 46330** Timing Belt Tensioner Retaining Pin
- **J 42386-A** Flywheel Holding Tool

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- **J 45059** Angle Meter

Removal Procedure

1. Remove the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LSA LS3, L99)** .
2. Remove the valve lifters. Refer to **Valve Lifter Replacement (Without AFM)**.
3. Remove the oil pump, screen, and crankshaft oil deflector. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.
4. Remove the starter motor. Refer to **Starter Replacement (LSA,LS3,L99)** .

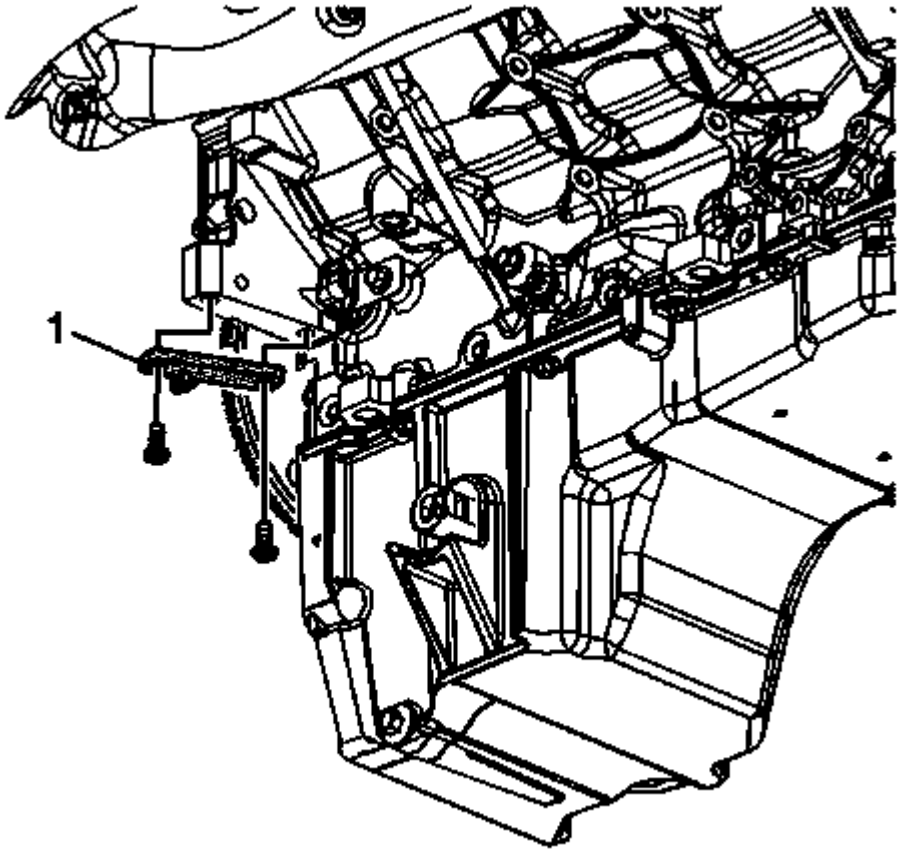


Fig. 237: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Ensure that the teeth of the J 42386-A flywheel holding tool mesh with the teeth of the engine flywheel.

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5. Install the **J 42386-A** flywheel holding tool (1) and bolts. Use one M10 - 1.5 x 120 mm and one M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A** flywheel holding tool bolts to 50 (37 lb ft).

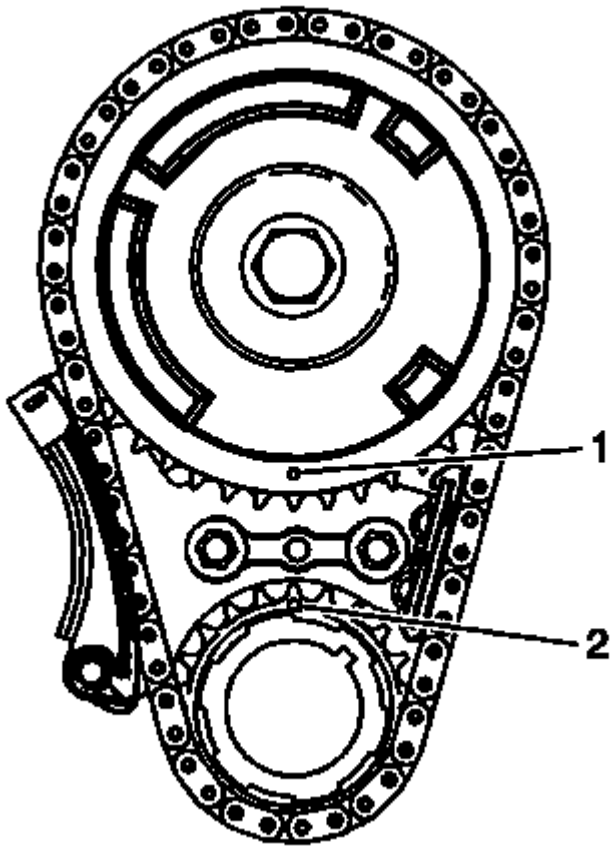


Fig. 238: Identifying Camshaft & Crankshaft Marks
Courtesy of GENERAL MOTORS COMPANY

6. Rotate the crankshaft sprocket until the camshaft sprocket alignment mark (1) and the crankshaft sprocket alignment mark (2) are aligned.

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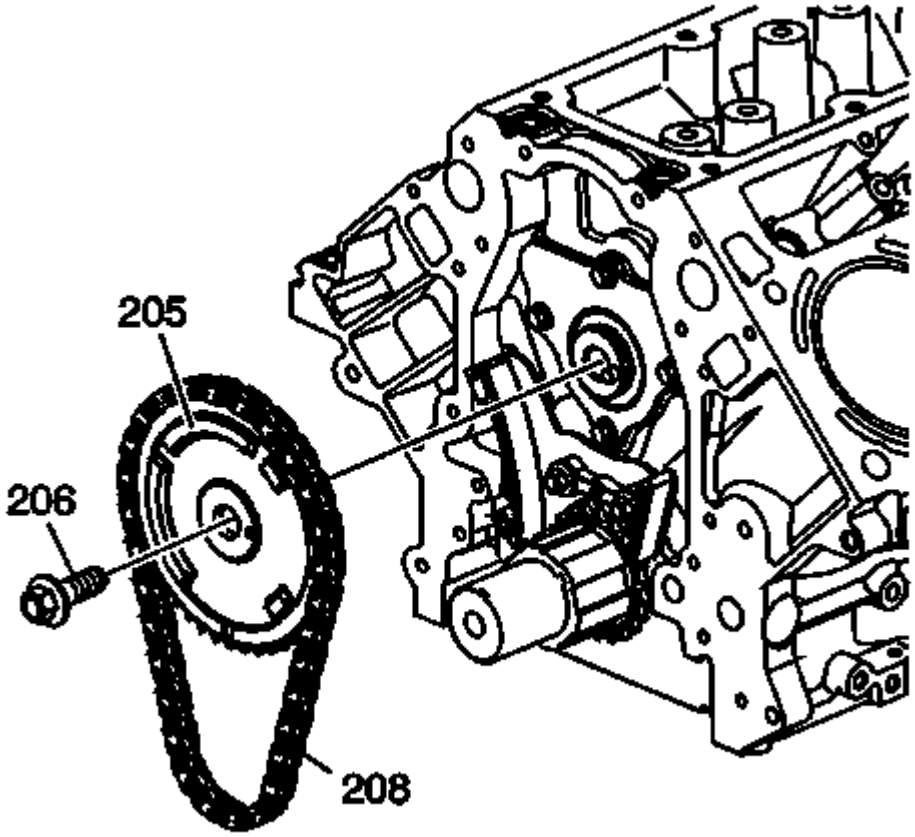


Fig. 239: View Of Camshaft Sprocket, Timing Chain & Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

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

7. Remove the camshaft sprocket bolt (206).
8. Remove the camshaft sprocket (205) and timing chain (208).

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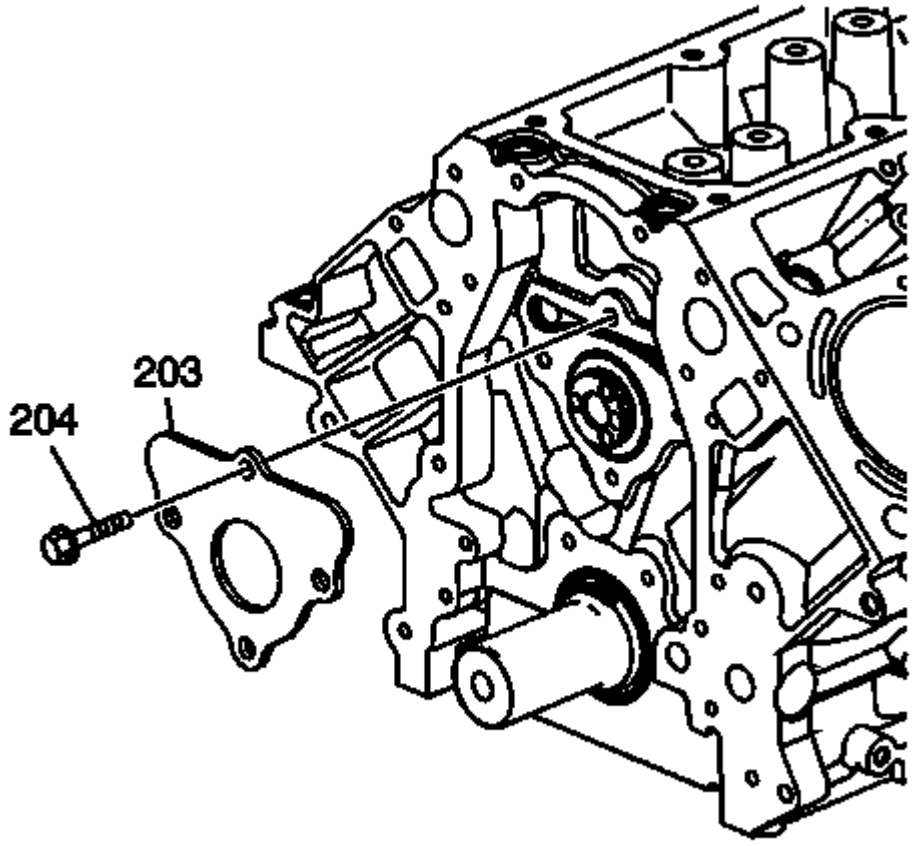


Fig. 240: Camshaft Retainer & Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the camshaft retainer bolts (204) and retainer (203).

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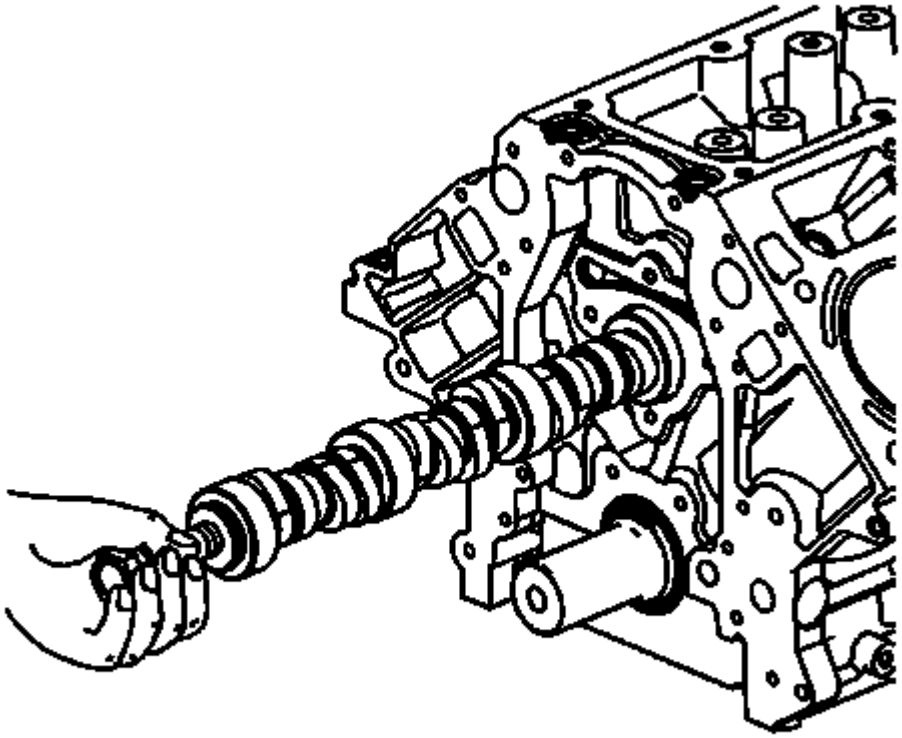


Fig. 241: View Of Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

10. Install the camshaft sprocket bolt into the camshaft front bolt hole.
11. Using the bolt as a handle, carefully rotate and remove the camshaft from the engine block.
12. Remove the bolt from the camshaft.

Installation Procedure

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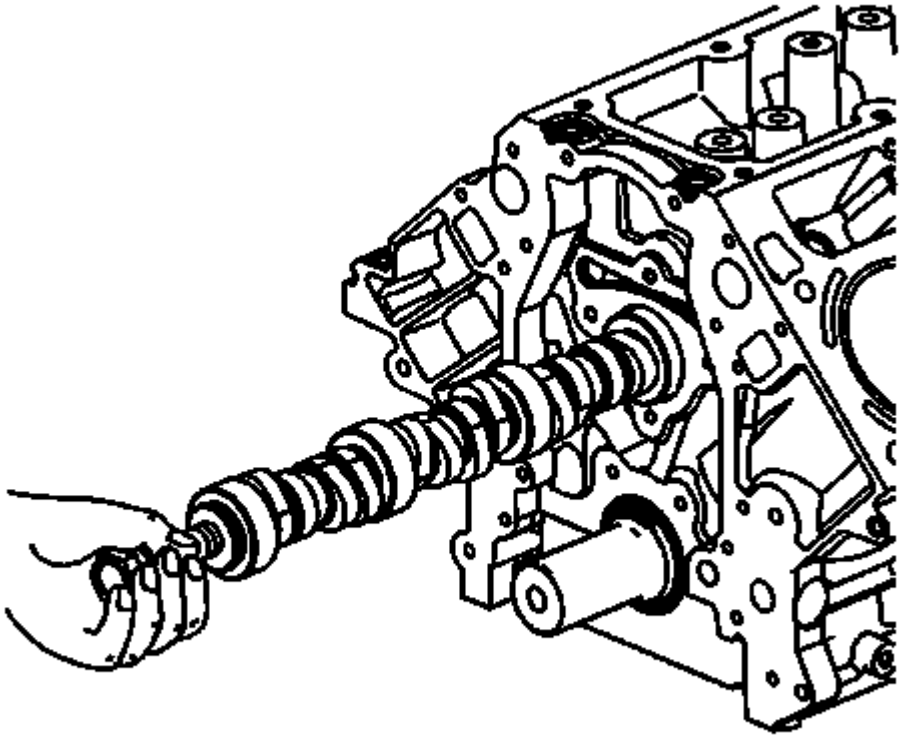


Fig. 242: View Of Camshaft
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the camshaft journals and the bearings with clean engine oil.
2. Install the camshaft sprocket bolt into the camshaft front bolt hole.

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

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

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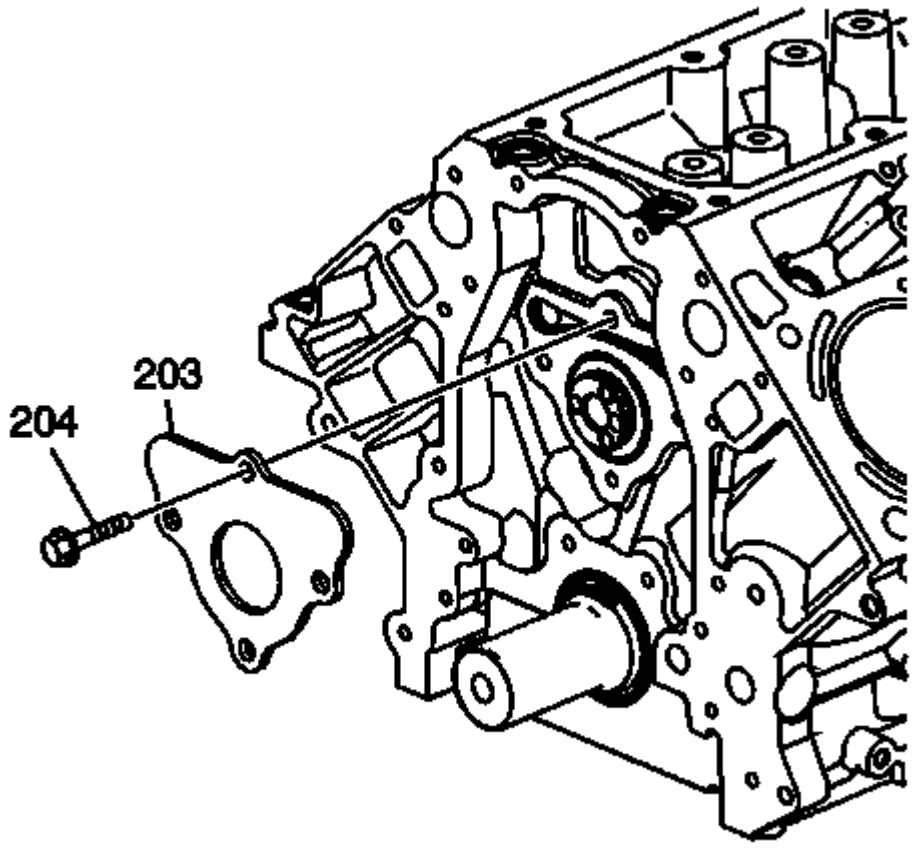


Fig. 243: Camshaft Retainer & Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: The gasket surface on the engine block should be clean and free of dirt and/or debris.

5. Install the camshaft retainer (203) and bolts (204). Install the retainer with the sealing gasket facing the engine block.

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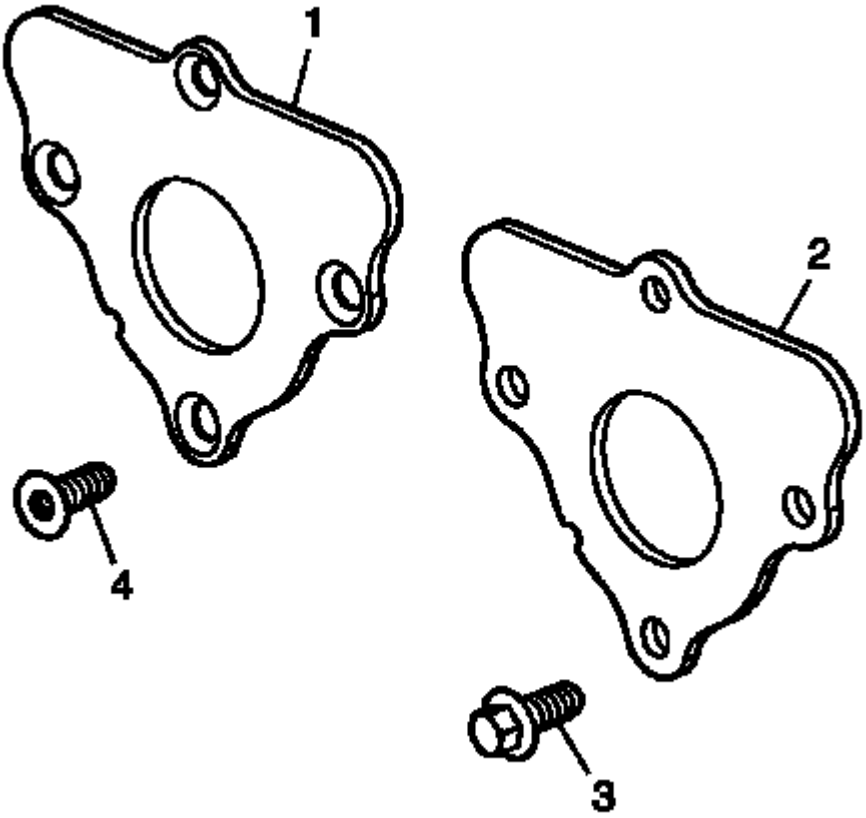


Fig. 244: Identifying Camshaft Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Tighten the camshaft retainer bolts.
    - Tighten the first design hex head bolts (3) to 25 (18 lb ft).
    - Tighten the second design TORX® head bolts (4) to 15 (11 lb ft).

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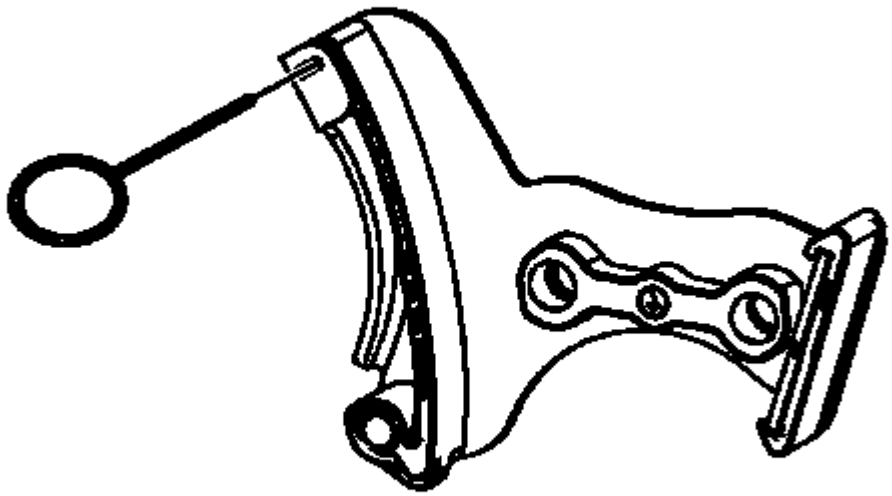


Fig. 245: View Of Compressed Tensioner
Courtesy of GENERAL MOTORS COMPANY

7. Compress the timing chain tensioner guide and install the **EN 46330** timing belt tensioner retaining pin.

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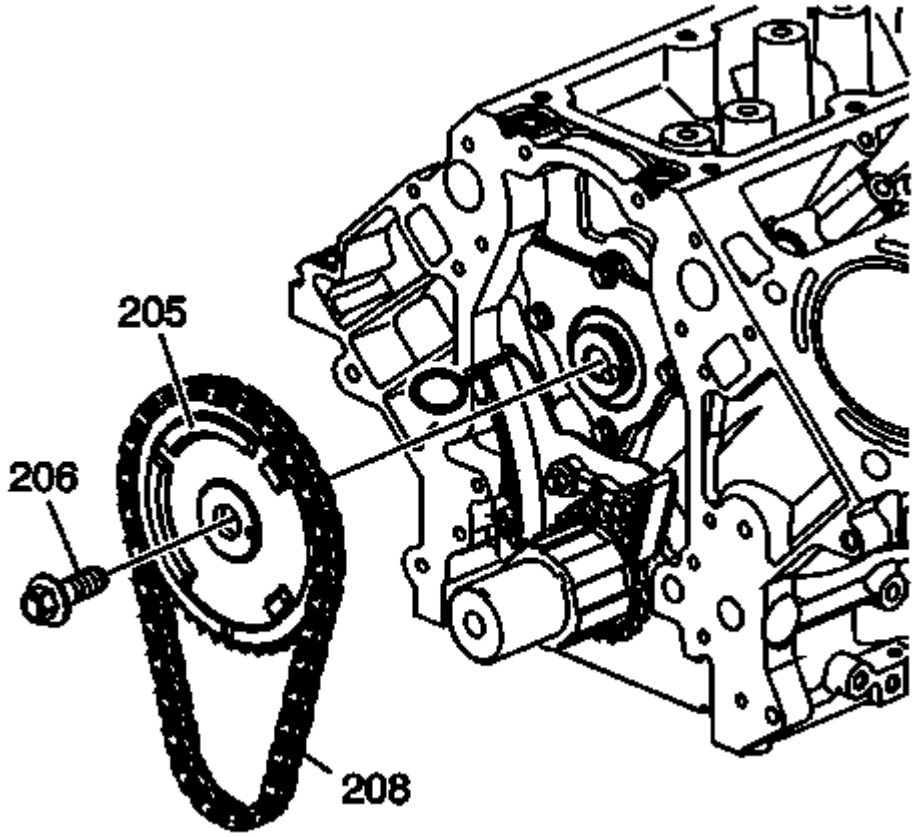


Fig. 246: View Of Camshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS COMPANY

8. Align the camshaft sprocket so the timing mark is in the 6 o'clock position.
9. Install the camshaft sprocket (205), timing chain (208), and bolt (206).

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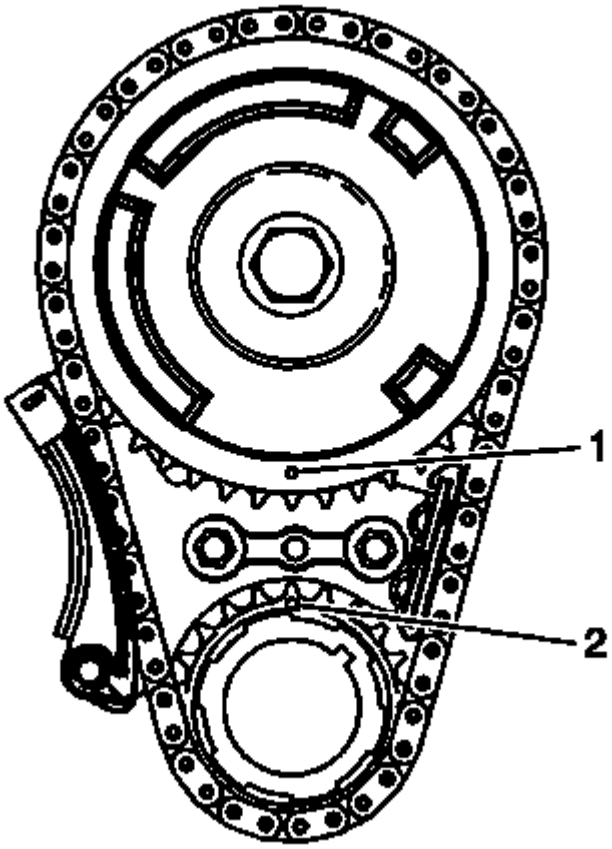


Fig. 247: Identifying Camshaft & Crankshaft Marks
Courtesy of GENERAL MOTORS COMPANY

10. Inspect the sprockets for proper alignment. The marks on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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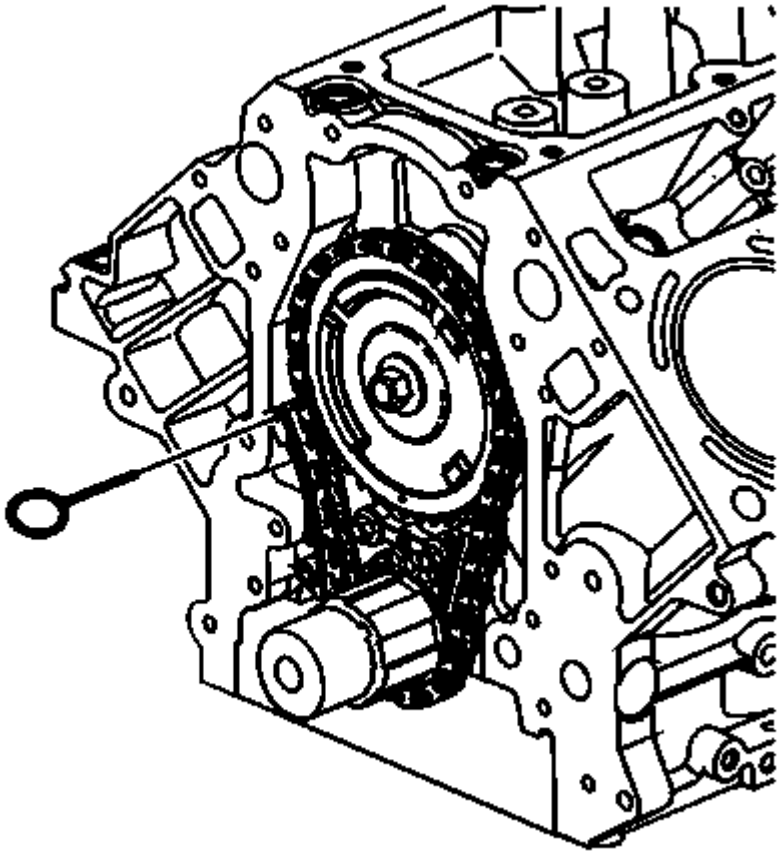


Fig. 248: Locating Tensioner Pin
Courtesy of GENERAL MOTORS COMPANY

11. Remove the **EN 46330** timing belt tensioner retaining pin.

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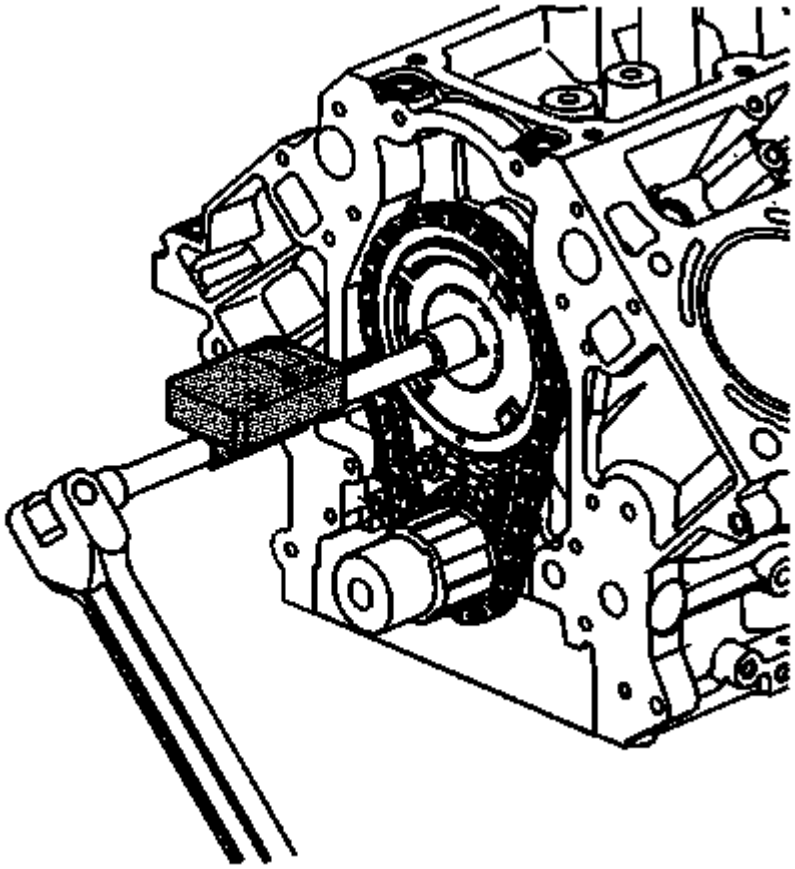


Fig. 249: Tightening Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Tighten the camshaft sprocket bolt.
    1. Tighten the bolt a first pass to 90 (66 lb ft).
    2. Tighten the bolt a final pass to 40 degrees using **J 45059** angle meter.

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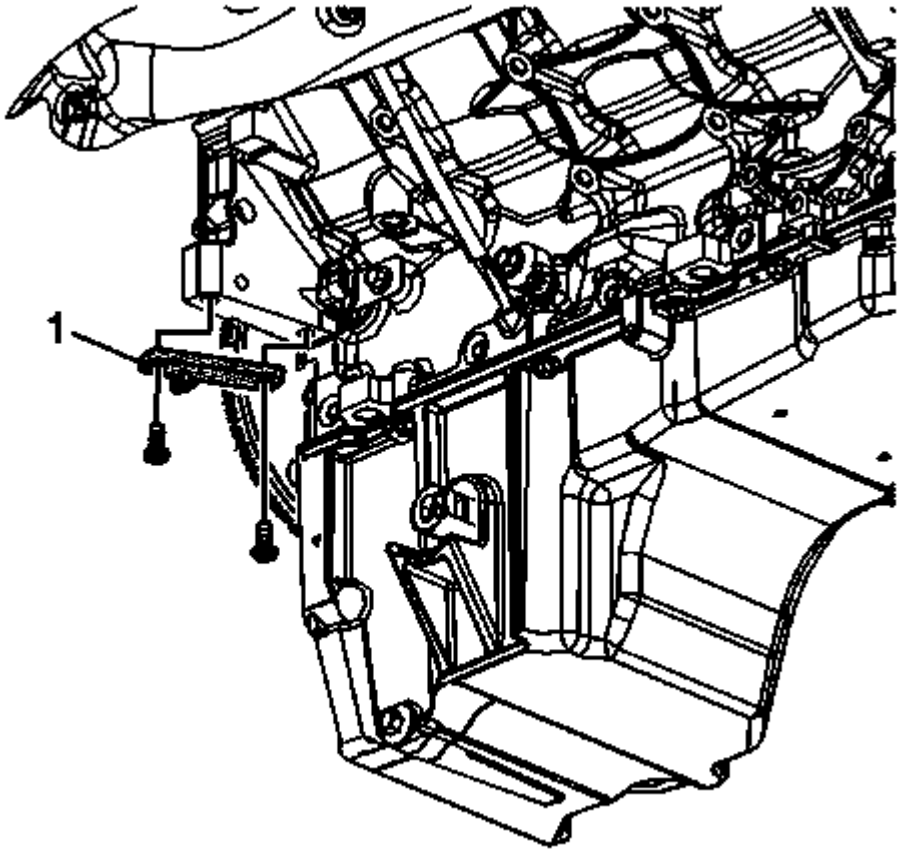


Fig. 250: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the **J 42386-A** flywheel holding tool (1) and bolts.
14. Install the starter motor. Refer to **Starter Replacement (LSA,LS3,L99)** .
15. Install the oil pump, screen, and crankshaft oil deflector. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.
16. Install the valve lifters. Refer to **Valve Lifter Replacement (Without AFM)**, **Valve Lifter Replacement (With AFM)**.
17. Remove the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LSA LS3, L99)** .

CAMSHAFT REPLACEMENT (L99)

Special Tools

- **EN 46330** Timing Belt Tensioner Retaining Pin
- **J 42386-A** Flywheel Holding Tool
- **J 45059** Angle Meter

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Removal Procedure

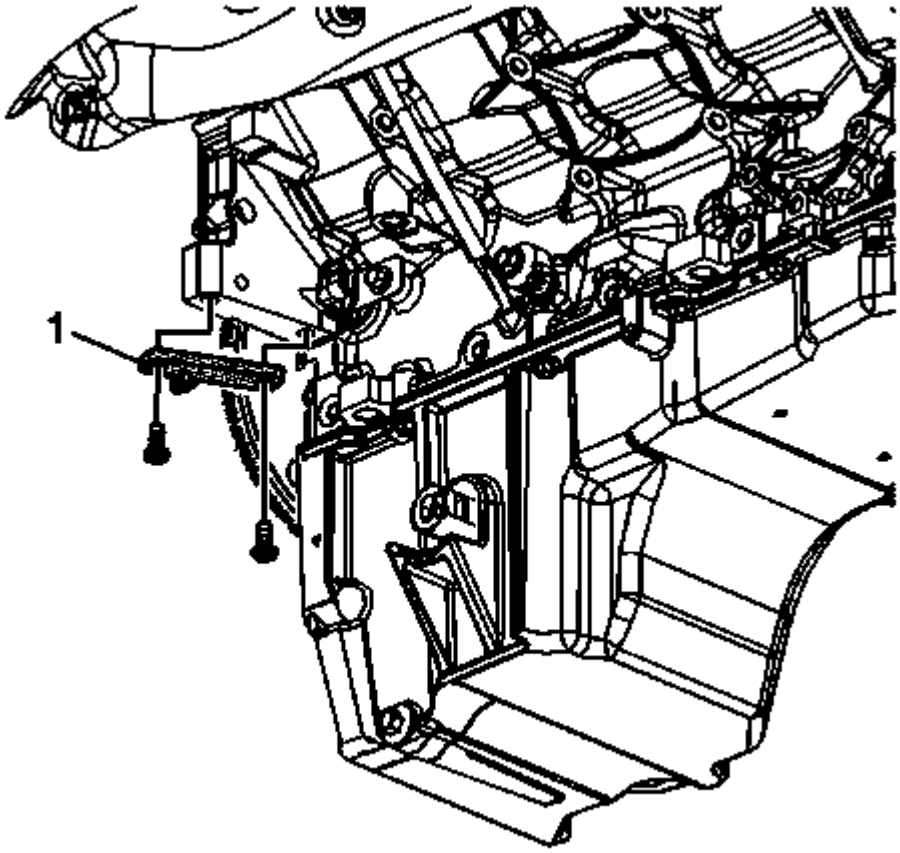


Fig. 251: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

1. Remove the radiator support. Refer to **Air Conditioning Condenser Replacement (LSA LS3, L99)** .
2. Remove the valve lifters. Refer to **Valve Lifter Replacement (Without AFM)**.
3. Remove the oil pump, screen, and crankshaft oil deflector. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.
4. Remove the camshaft position actuator. Refer to **Camshaft Position Actuator Replacement**.

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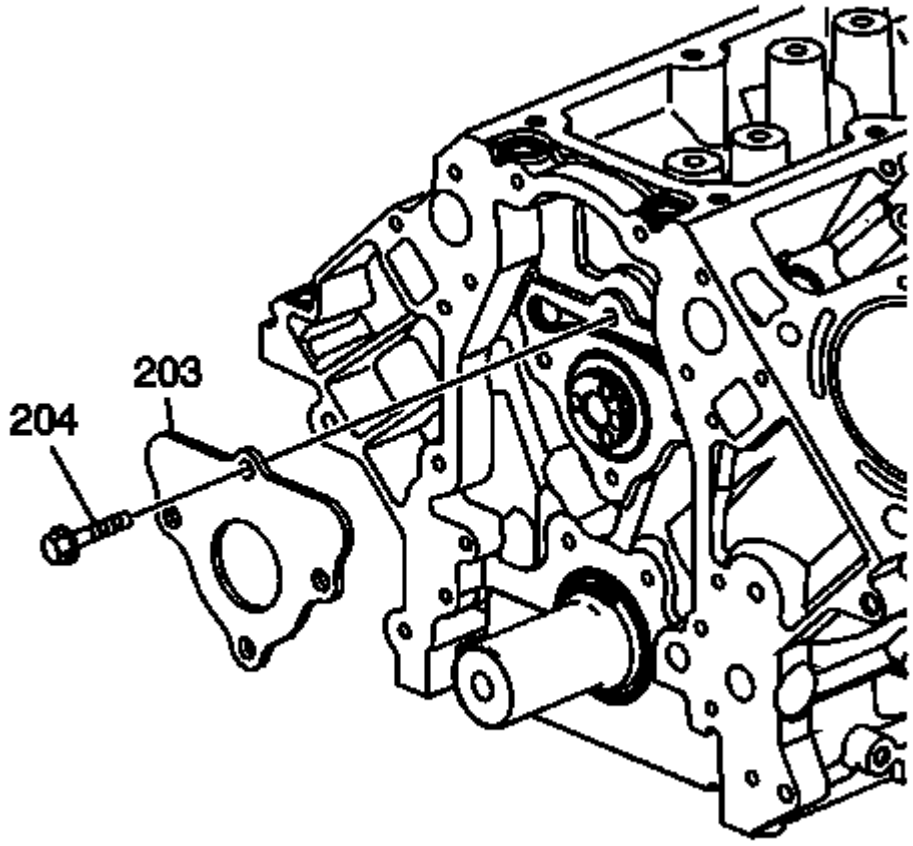


Fig. 252: Camshaft Retainer & Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the camshaft retainer bolts (204) and retainer (203).
6. Install the camshaft sprocket bolt into the camshaft front bolt hole
7. Using the bolt as a handle, carefully rotate and remove the camshaft from the engine block.
8. Remove the bolt from the camshaft.

Installation Procedure

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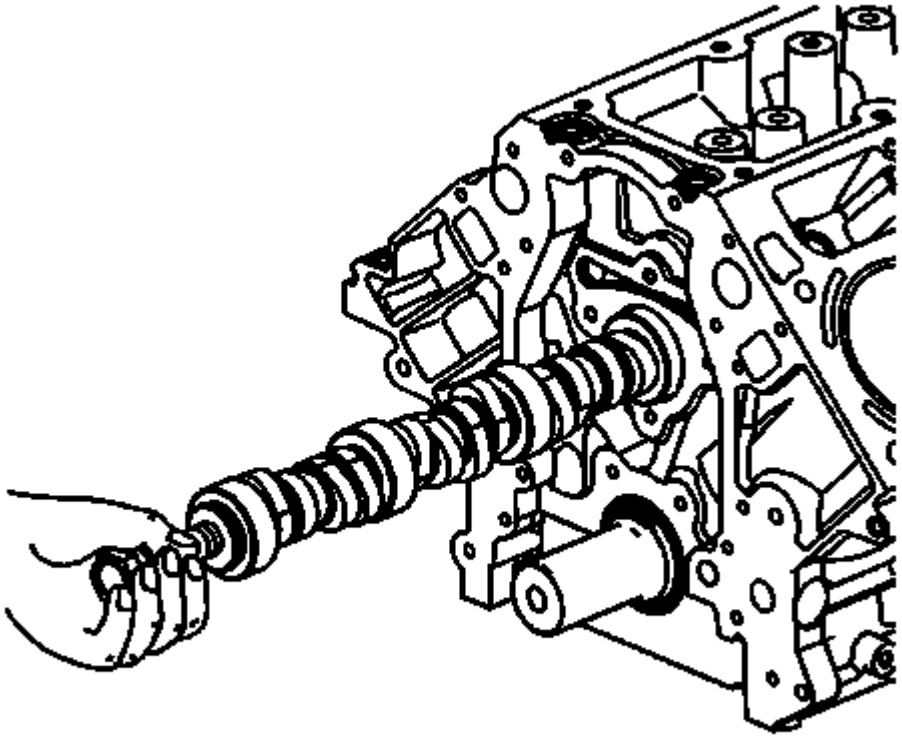


Fig. 253: View Of Camshaft
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the camshaft journals and the bearings with clean engine oil.
2. Install the camshaft sprocket bolt into the camshaft front bolt hole.

NOTE: Using the bolt as a handle, carefully install the camshaft into the engine block.

3. Remove the bolt from the front of the camshaft.

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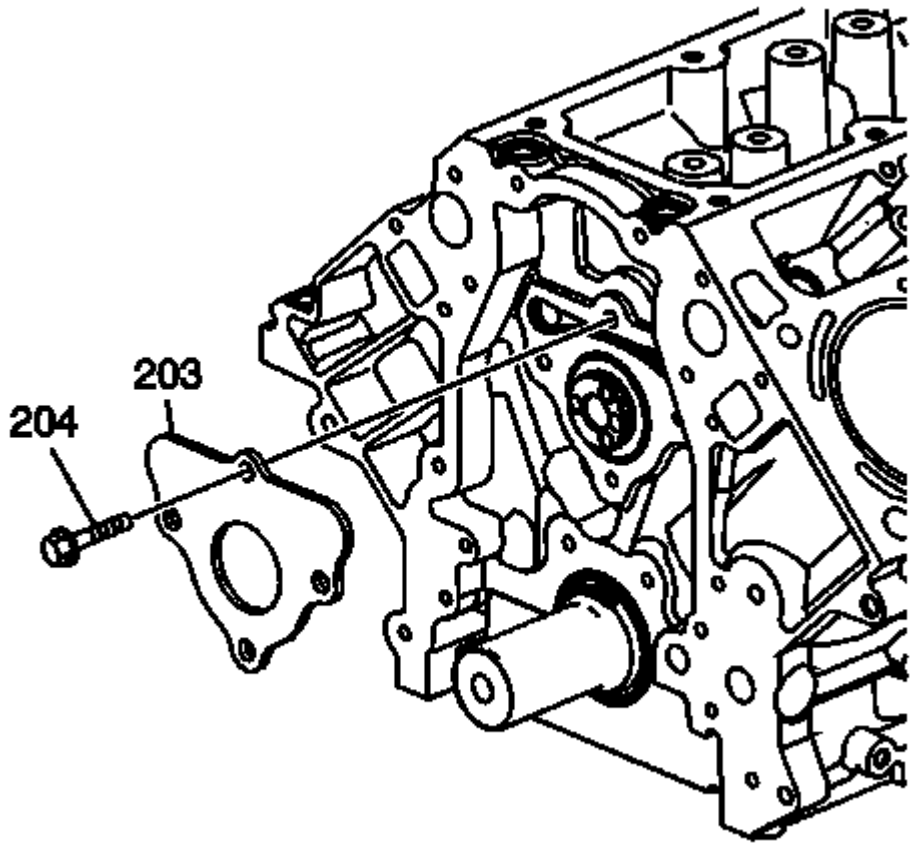


Fig. 254: Camshaft Retainer & Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: The gasket surface on the engine block should be clean and free of dirt and/or debris.

4. Install the camshaft retainer (203) and bolts (204). Install the retainer with the sealing gasket facing the engine block.

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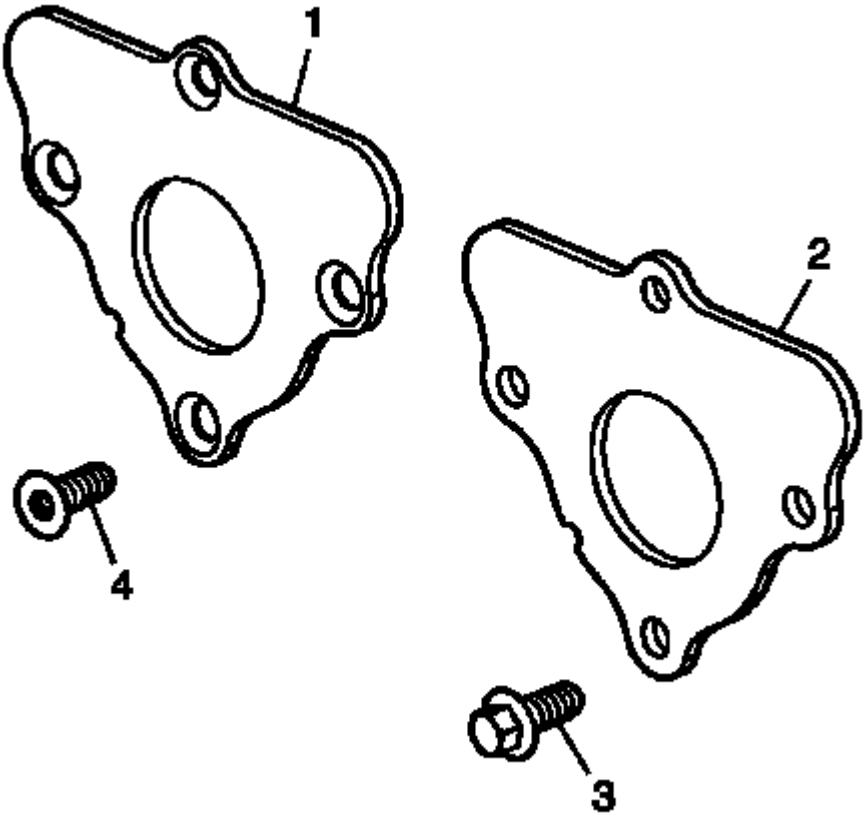


Fig. 255: Identifying Camshaft Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the camshaft retainer bolts.
    - Tighten the first design hex head bolts (3) to 25 (18 lb ft).
    - Tighten the second design TORX® head bolts (4) to 15 (11 lb ft).

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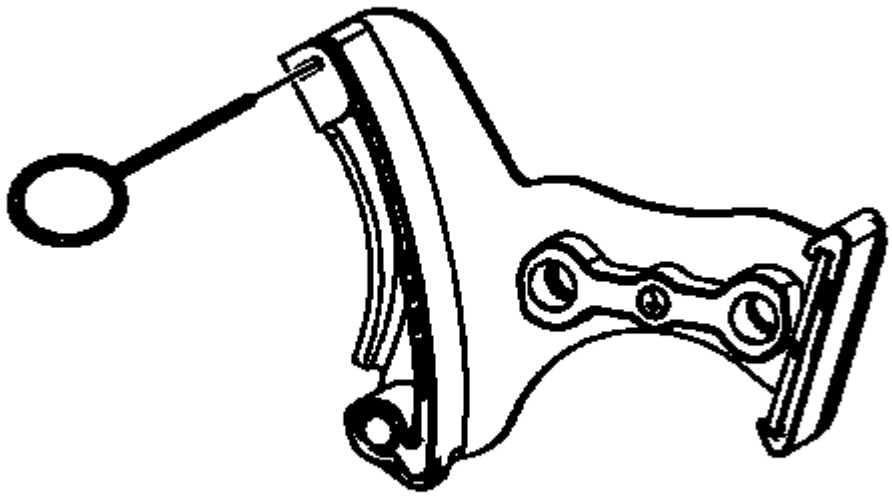


Fig. 256: View Of Compressed Tensioner
Courtesy of GENERAL MOTORS COMPANY

6. Compress the timing chain tensioner guide and install the **EN 46330** timing belt tensioner retaining pin.

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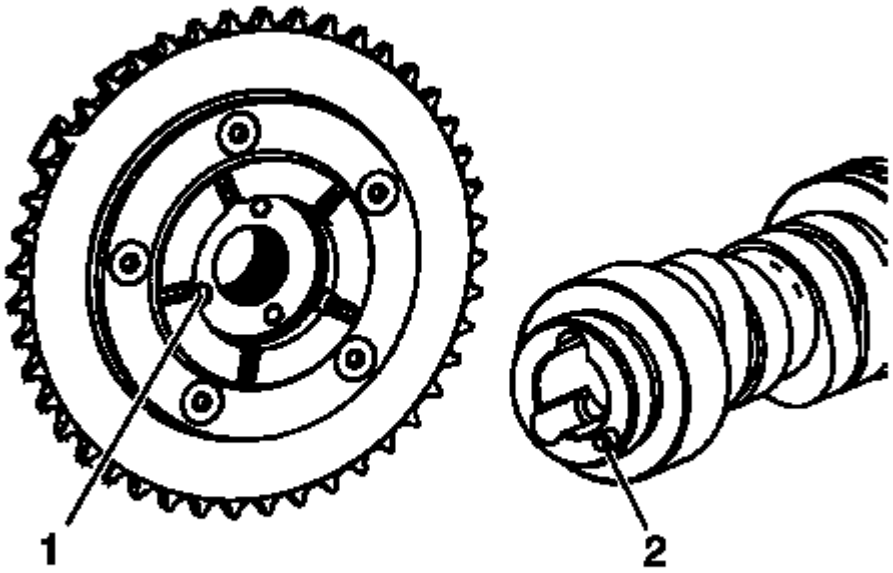


Fig. 257: Identifying Alignment Hole & Locating Pin
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Properly locate the CMP actuator onto the locating pin of the camshaft.**
- **The sprocket teeth and timing chain teeth must mesh.**
- **The camshaft and the crankshaft sprocket alignment mark MUST be aligned properly.**
- **Do not use the CMP solenoid valve again. Install a NEW valve during assembly.**

7. Identify the alignment hole (1) in the rear face of the CMP actuator and the locating pin (2) on the front face of the camshaft.

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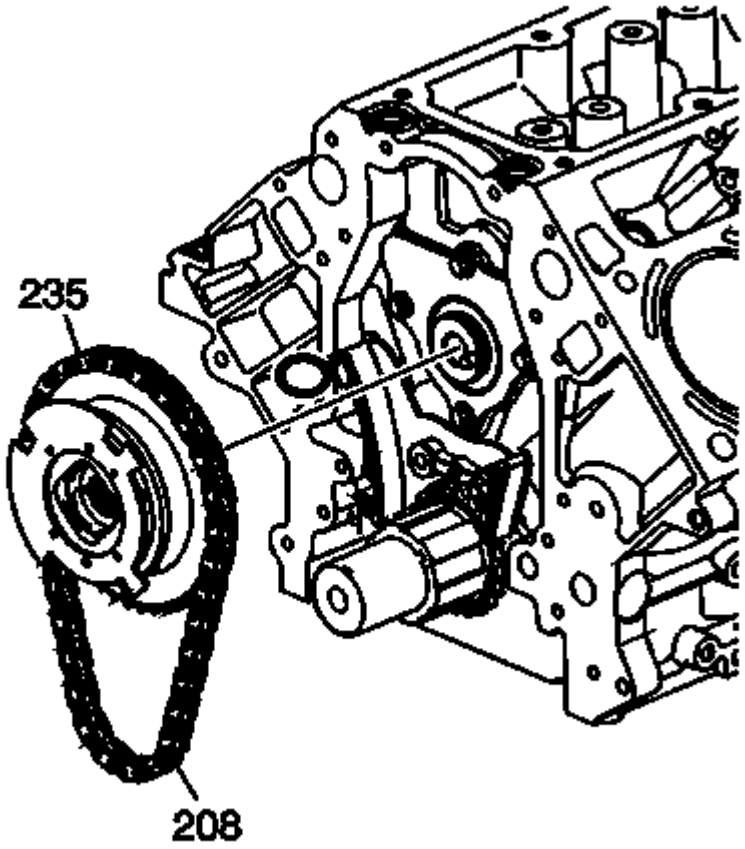


Fig. 258: View Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS COMPANY

8. Align the CMP actuator so the timing mark is in the 6 o'clock position.
9. Install the CMP actuator (235) and timing chain (208). Align the hole in the face of the CMP actuator with the locating pin on the front face of the camshaft.

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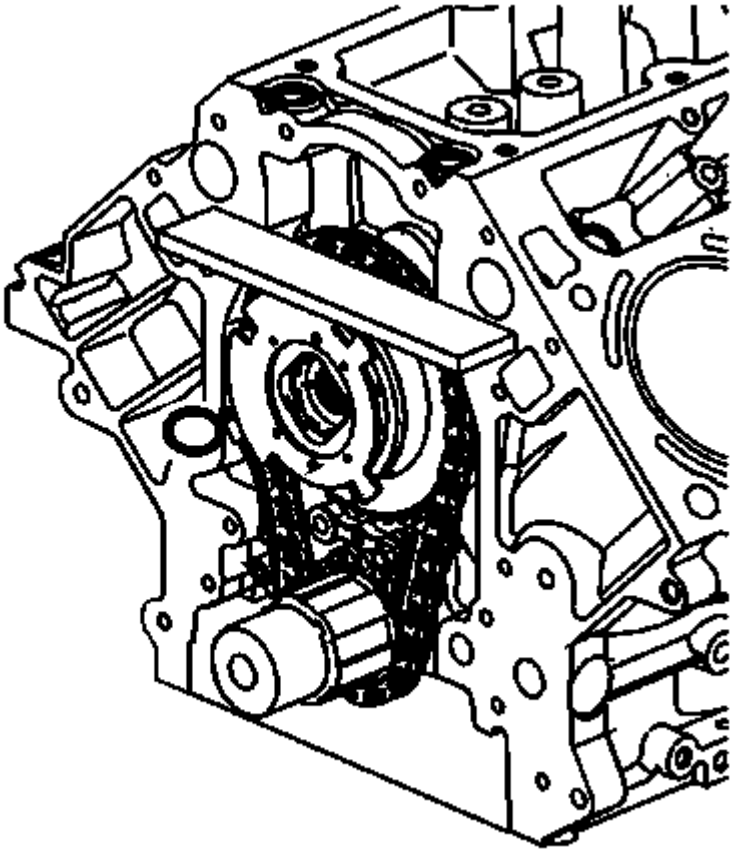


Fig. 259: Inspecting For Proper Installation Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS COMPANY

10. Place a straight edge across the front face of the engine block and inspect for proper installation of the CMP actuator and timing chain. With the CMP actuator properly and completely installed onto the front of the camshaft, the timing chain will not protrude beyond the front face of the engine block.

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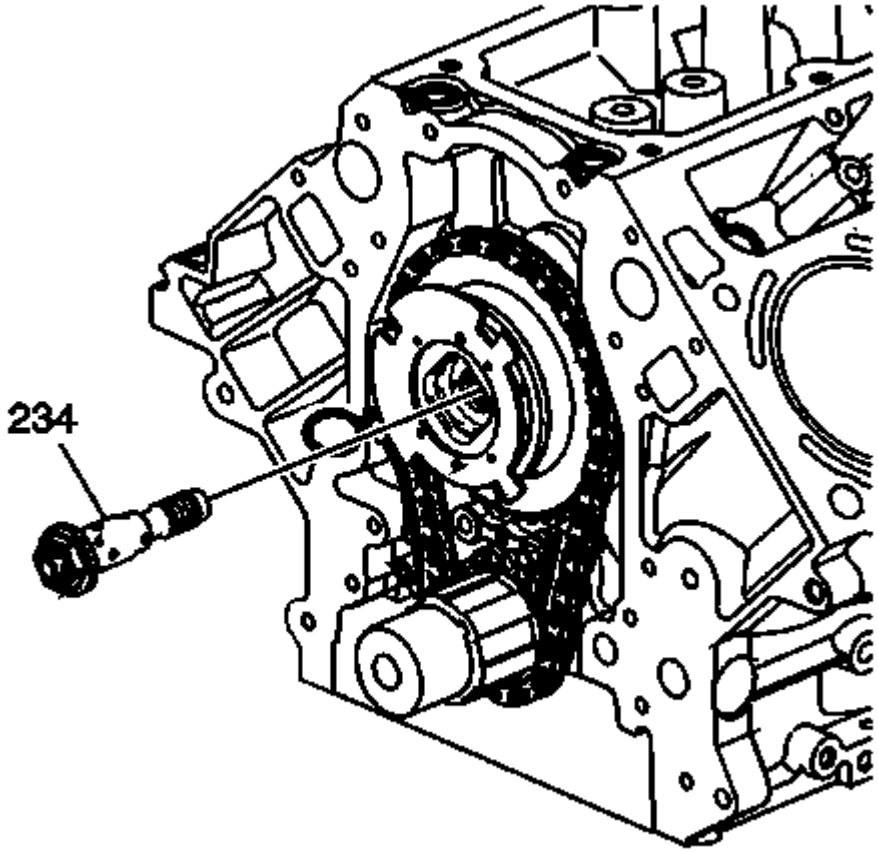


Fig. 260: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

11. Install a NEW CMP actuator solenoid valve (234). With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.

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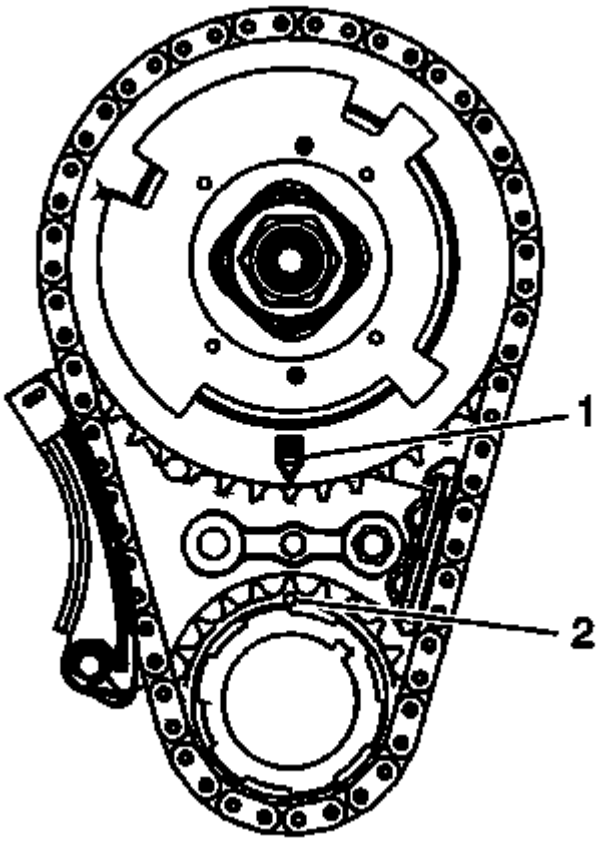


Fig. 261: View Of CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark
Courtesy of GENERAL MOTORS COMPANY

12. Inspect the sprockets for proper alignment. The mark on the CMP actuator sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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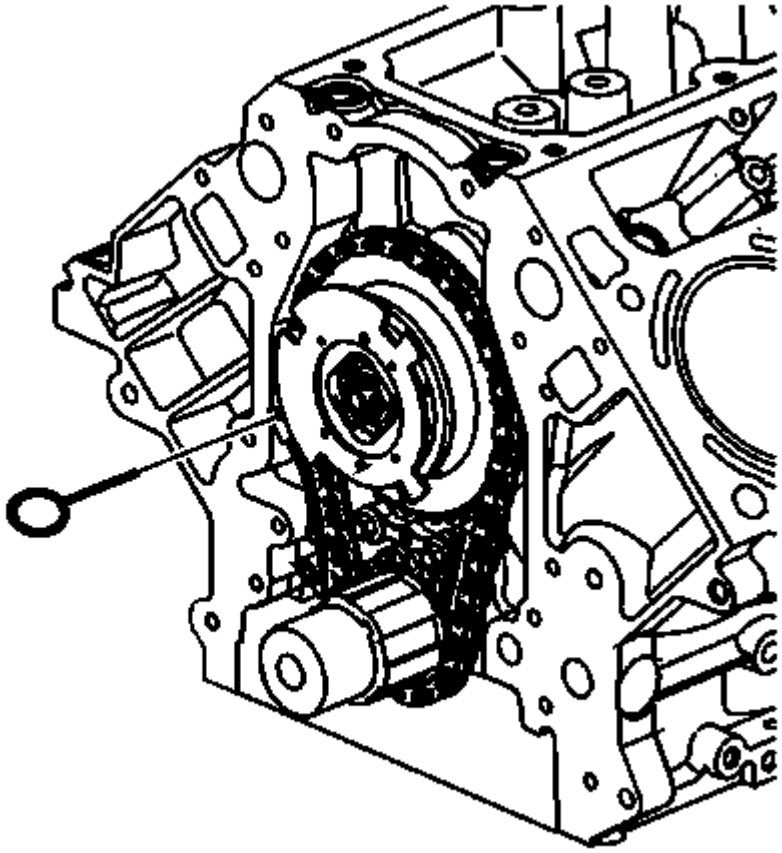


Fig. 262: View Of Special Tool EN 46330
Courtesy of GENERAL MOTORS COMPANY

13. Remove the **EN 46330** timing belt tensioner retaining pin.

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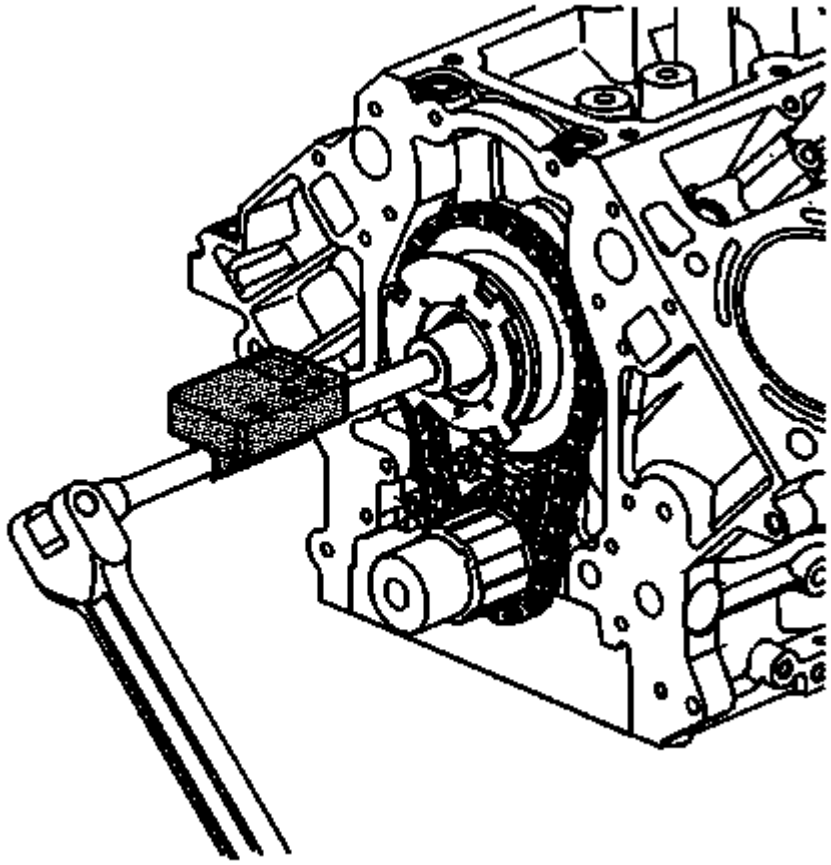


Fig. 263: Tightening CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

14. Tighten the CMP actuator solenoid valve.
    1. Tighten the valve a first pass to 65 (48 lb ft).
    2. Tighten the valve a final pass to 90 degrees using **J 45059** angle meter.

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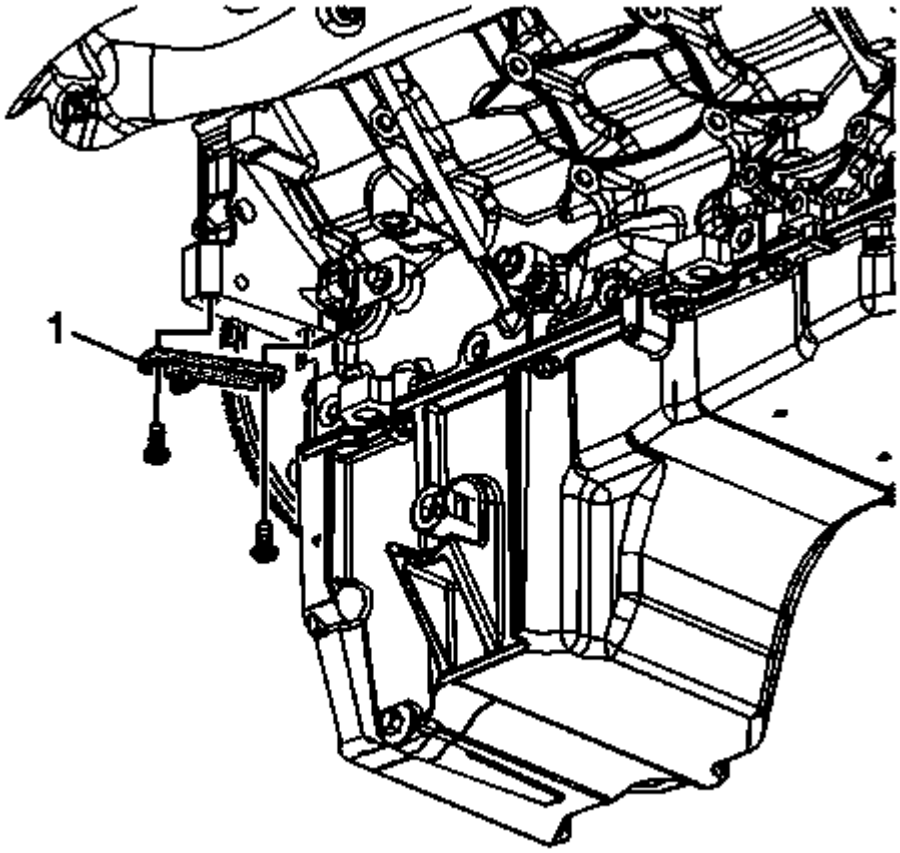


Fig. 264: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Remove the **J 42386-A** flywheel holding tool.
16. Install the starter motor. Refer to **Starter Replacement (LSA,LS3,L99)**
17. Install the oil pump, screen, and crankshaft oil deflector. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.
18. Install the valve lifters. Refer to **Valve Lifter Replacement (Without AFM)**.
19. Install the radiator support.

ENGINE FLYWHEEL REPLACEMENT

Removal Procedure

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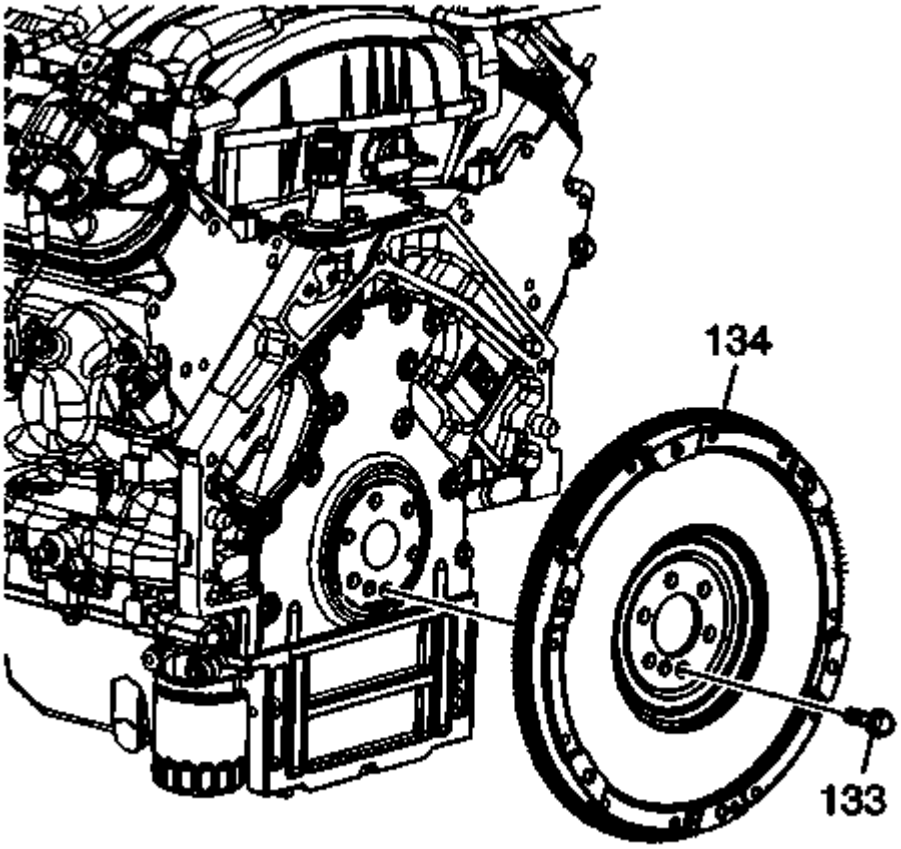


Fig. 265: View Of Flywheel & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the Clutch Assembly. Refer to **Clutch Assembly Replacement** .
2. Remove the engine flywheel bolts (133) and the flywheel (134).
3. Clean and inspect the flywheel. Refer to **Engine Flywheel Cleaning and Inspection** , . If the flywheel teeth are damaged, inspect the starter for proper operation. Replace the starter if you find excessive wear or damage to the starter drive. Refer to **Starter Replacement (LSA, LS3, L99)** .

Installation Procedure

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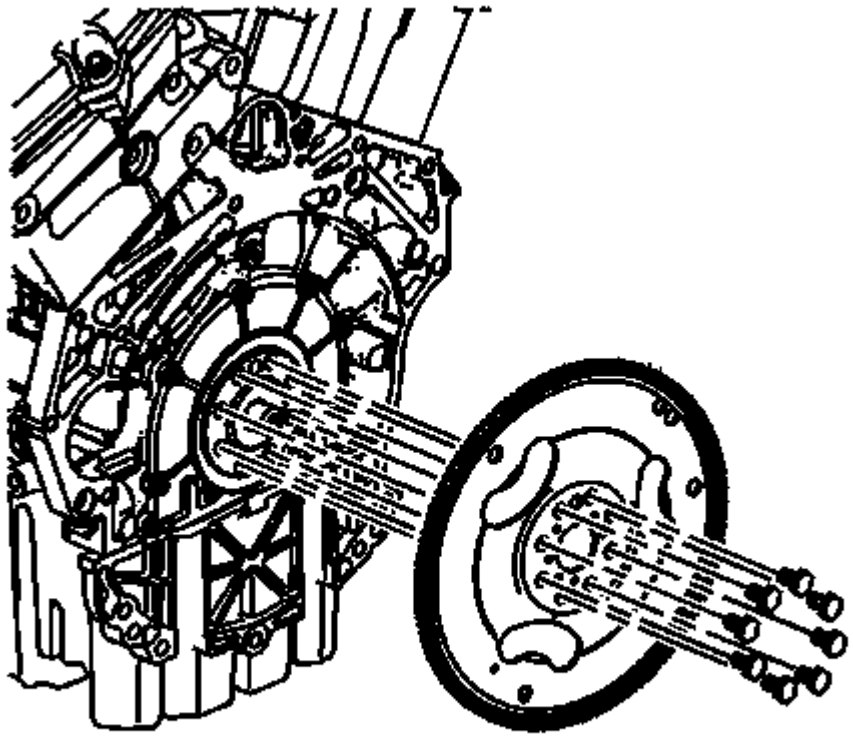


Fig. 266: View Of Engine Flywheel
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine flywheel bolts (133) and the flywheel (134). Refer to **Engine Flywheel Installation (LS3 or L99)** , **Engine Flywheel Installation (LSA)** .
2. Install the Clutch Assembly. Refer to **Clutch Assembly Replacement** .

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Removal Procedure

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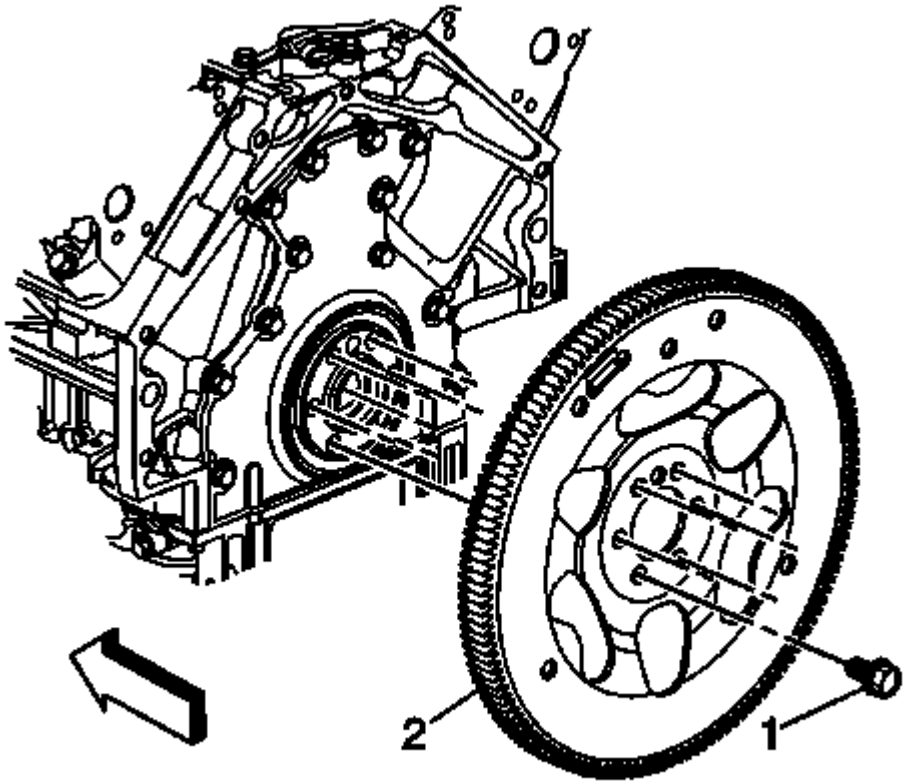


Fig. 267: View Of Engine Flywheel & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the automatic transmission. Refer to **Transmission Replacement** .

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

2. Remove the flywheel bolts.
3. Remove the flywheel.

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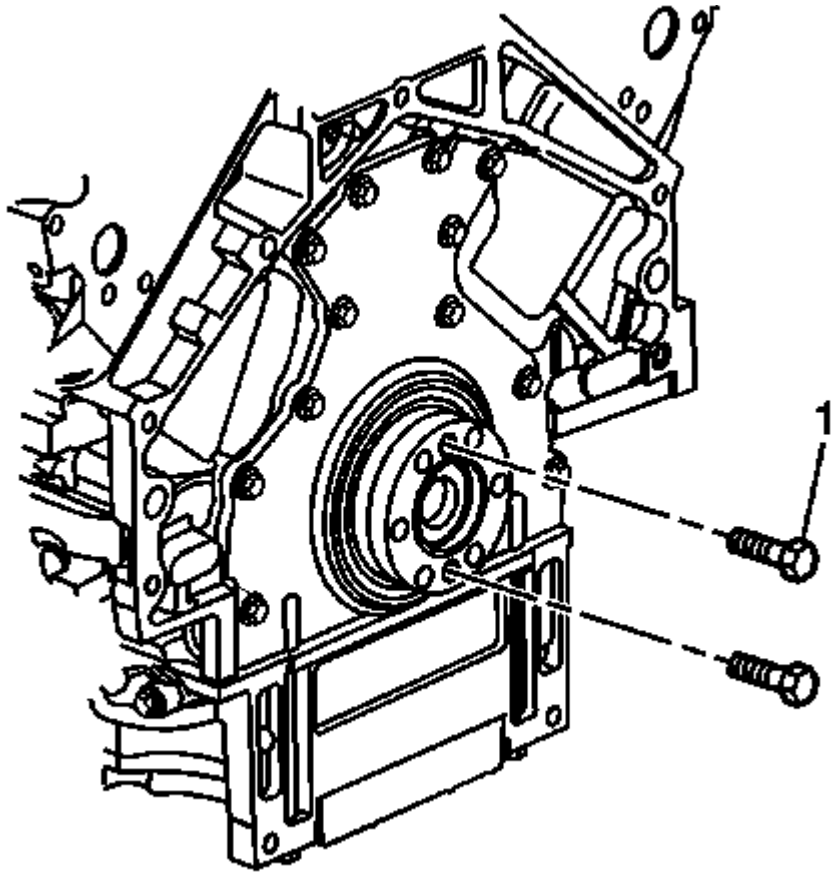


Fig. 268: View Of Bolts & Spacer
Courtesy of GENERAL MOTORS COMPANY

4. Install two M11x1.5 mm bolts (1) to the threaded holes of the spacer, if applicable.
5. Rotate the bolts clockwise to remove the spacer.

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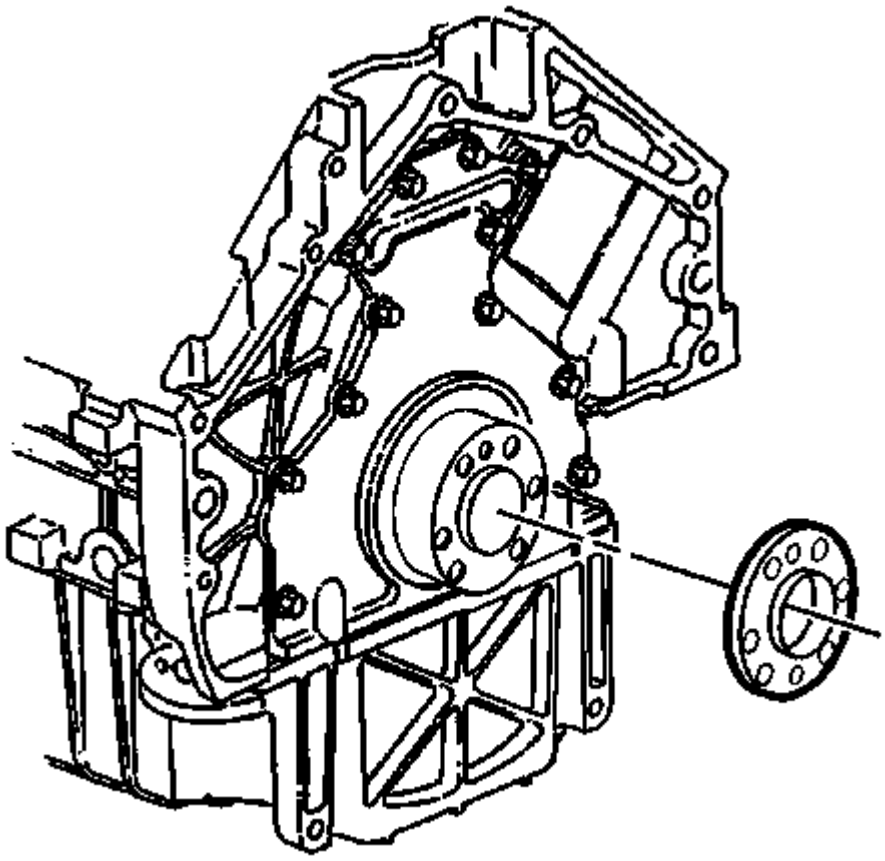


Fig. 269: View Of Spacer & Crankshaft Rear
Courtesy of GENERAL MOTORS COMPANY

6. Remove the spacer from the rear of the crankshaft, if applicable.

Installation Procedure

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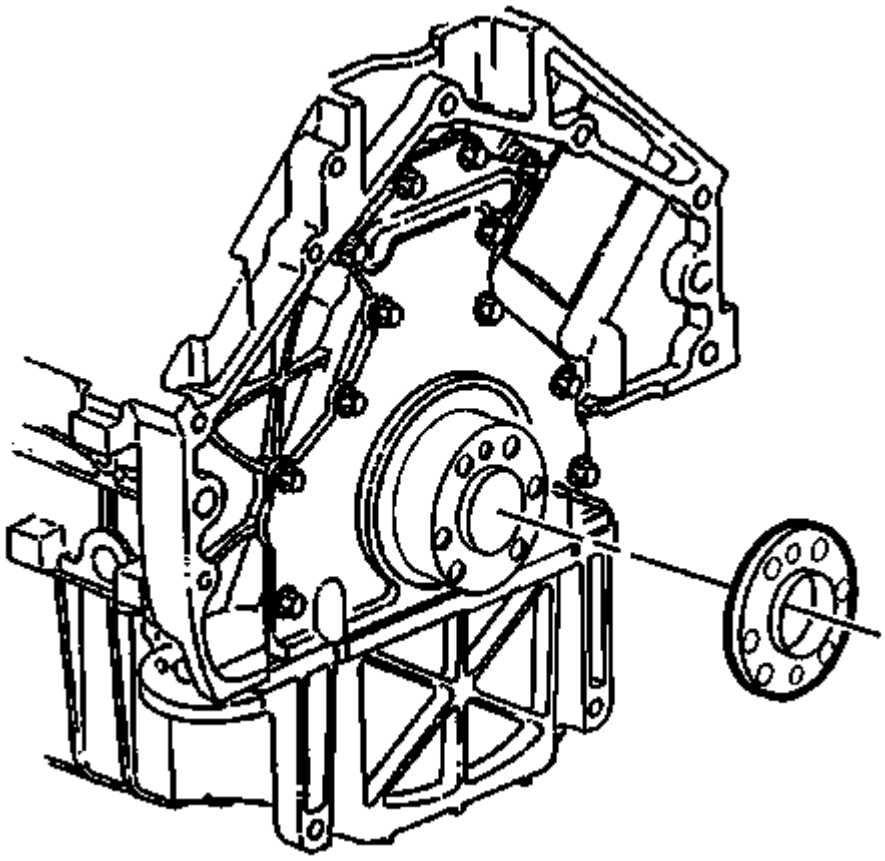


Fig. 270: View Of Spacer & Crankshaft Rear
Courtesy of GENERAL MOTORS COMPANY

NOTE: The flywheel does not use a locating pin for alignment and will not initially seat against the crankshaft flange or spacer, if applicable, but will be pulled onto the crankshaft by the engine flywheel bolts. This procedure requires a three stage tightening process.

1. Install the spacer, if applicable, onto the rear of the crankshaft.

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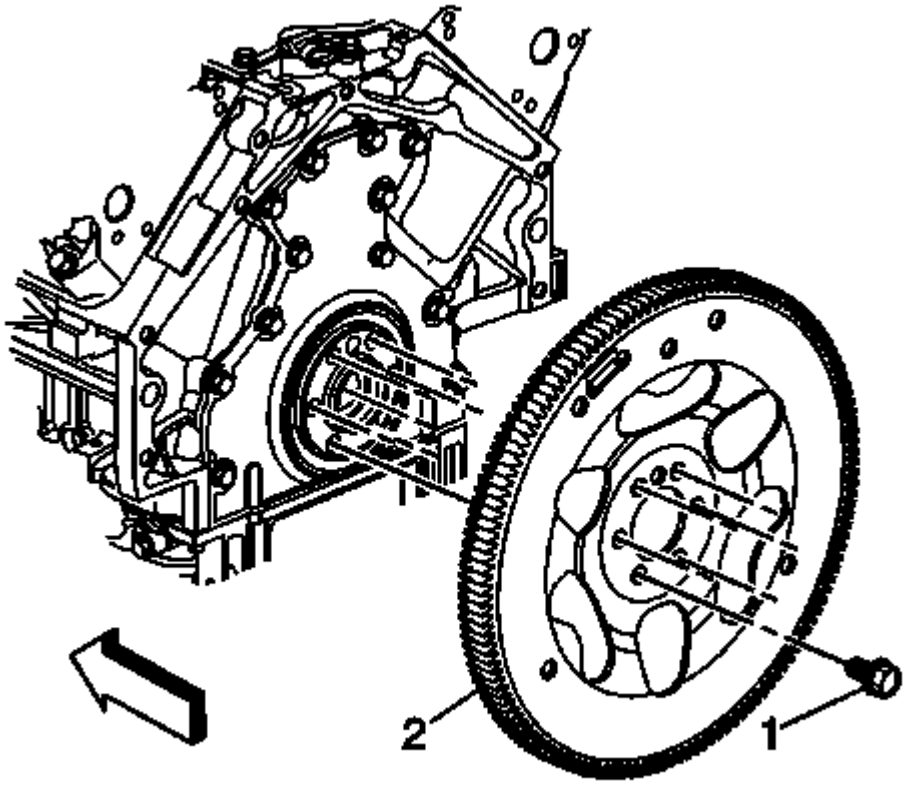


Fig. 271: View Of Engine Flywheel & Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Longer flywheel bolts must be used on applications using a flywheel spacer.

2. Install the flywheel and bolts to the crankshaft.
3. Apply threadlock to the threads of the flywheel bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

CAUTION: Refer to Fastener Caution .

4. Tighten the flywheel bolts.
    1. Tighten the bolts (1-6) a first pass in sequence to 20 N.m (15 lb ft).
    2. Tighten the bolts (1-6) a second pass in sequence to 50 N.m (37 lb ft).
    3. Tighten the bolts (1-6) a final pass in sequence to 100 N.m (74 lb ft).
5. Install the automatic transmission. Refer to **Transmission Replacement** .

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ENGINE REPLACEMENT

Special Tools

J-38185 Hose Clamp Pliers

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

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the engine cover. Refer to **Engine Cover Replacement**.

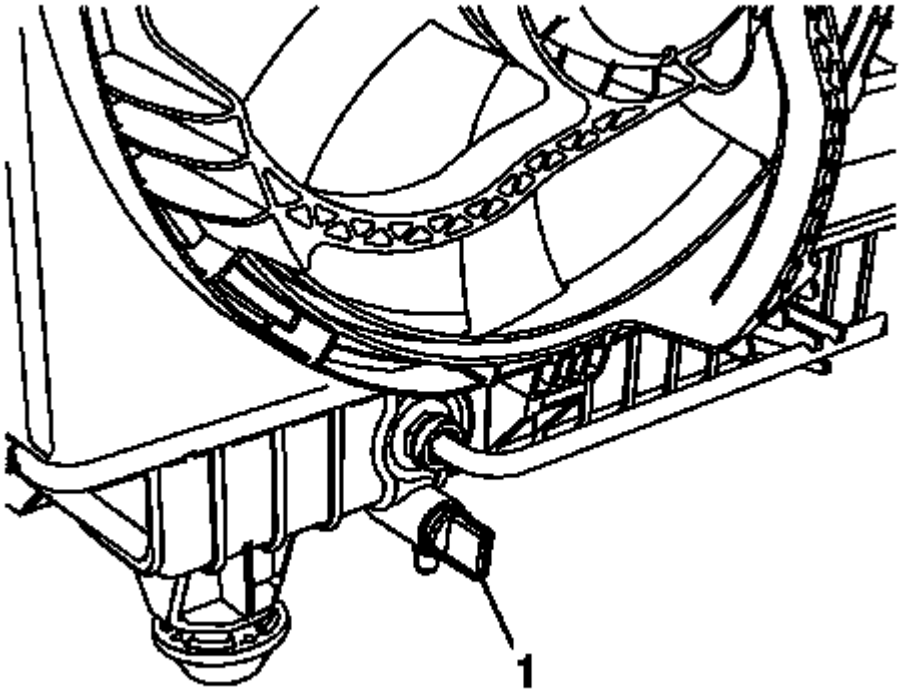


Fig. 272: Radiator Drain Cock
Courtesy of GENERAL MOTORS COMPANY

3. Place a clean drain pan under the radiator drain cock.
4. Loosen the radiator drain cock (1).
5. Drain the cooling system. Refer to **Cooling System Draining and Filling (LSA, LS3, L99 Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .

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6. Tighten the radiator drain cock (1).
7. Relieve the high side fuel system pressure. Refer to **Fuel Pressure Relief** .
8. Discharge the air conditioning (A/C) system. Refer to **Refrigerant Recovery and Recharging (Belt Driven Compressor)** .
9. Remove the front tires. Refer to **Tire and Wheel Removal and Installation (Without RT2)** , **Tire and Wheel Removal and Installation (With RT2)** .
10. Remove the transmission. Refer to the appropriate procedure:
    - **Transmission Replacement** for the 6L45/6L50/6L80/6L90 transmission
    - **Transmission Replacement** for the Aisin AY6 transmission
    - **Transmission Replacement** for the Tremec 6-speed transmission

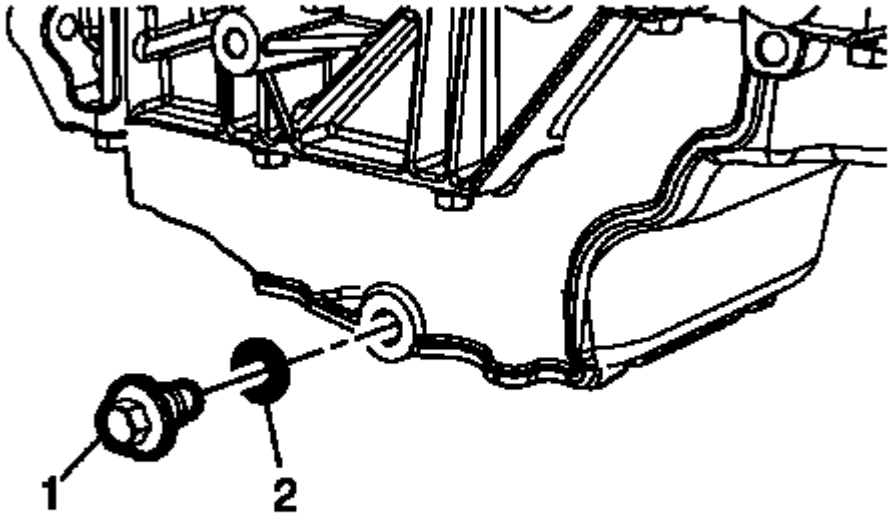


Fig. 273: Oil Drain Plug & O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

11. Remove the oil pan drain plug (1) from the oil pan allow the oil to drain completely. Refer to **Engine Oil and Oil Filter Replacement**.

CAUTION: Refer to Fastener Caution .

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12. Install the oil pan drain plug (1) and NEW O-ring seal (2) and tighten to 20 N.m (15 lb ft).
13. Remove the air cleaner outlet duct hose. Refer to **Air Cleaner Resonator and Outlet Duct Replacement (LSA)** , **Air Cleaner Resonator and Outlet Duct Replacement (L99 or LS3)** .
14. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement (LSA)** , **Air Cleaner Assembly Replacement (L99 or LS3)** .

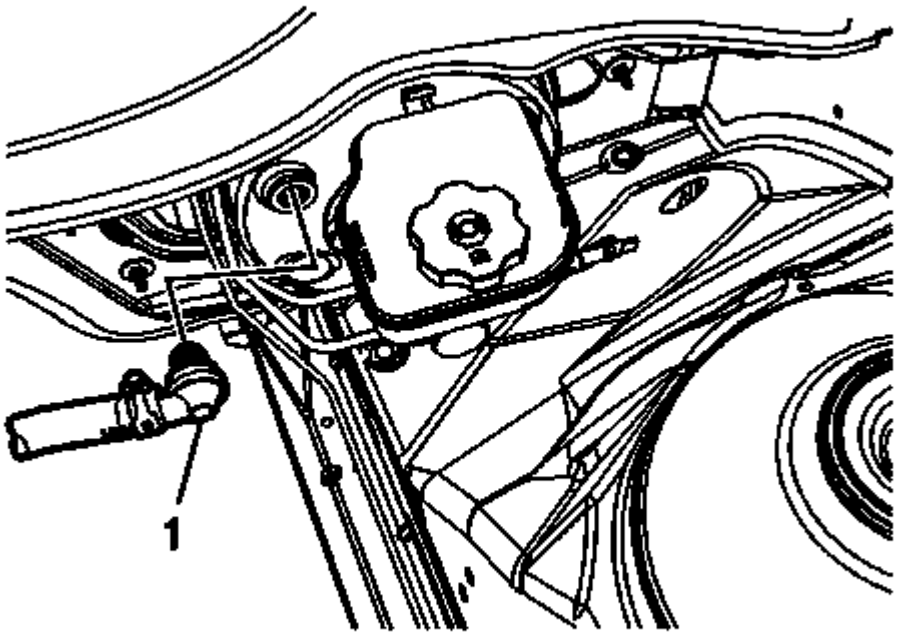


Fig. 274: Power Vacuum Brake Booster Check Valve & Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

15. Remove the check valve (1) from the vacuum brake booster.

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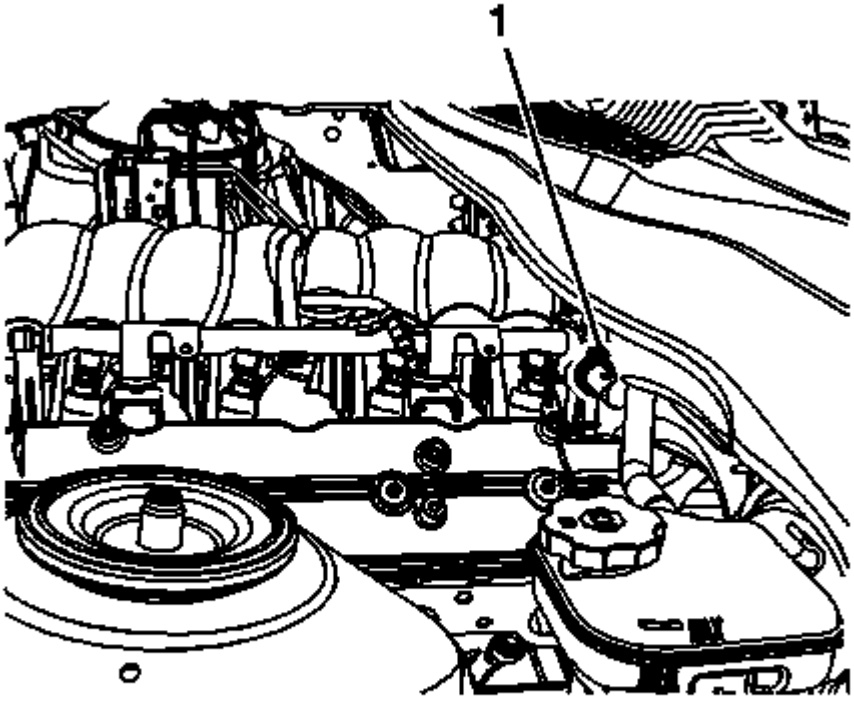


Fig. 275: Power Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS COMPANY

16. Release the clamp and remove the power brake booster vacuum hose (1) from the vacuum port on the left side of the intake manifold.

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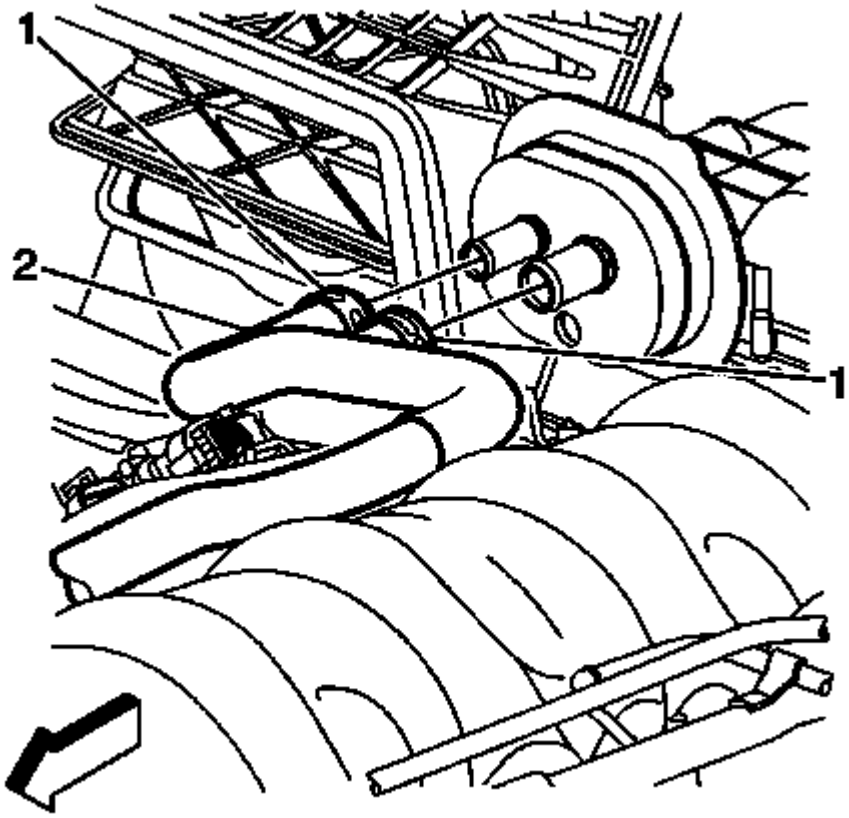


Fig. 276: Heater Inlet & Outlet Hoses & Clamps At Heater Core
Courtesy of GENERAL MOTORS COMPANY

17. Disengage tension on the heater inlet rear and outlet hose clamps (1) at the heater core using **J-38185** pliers.
18. Remove the heater inlet rear and outlet hose (2) from the heater core.

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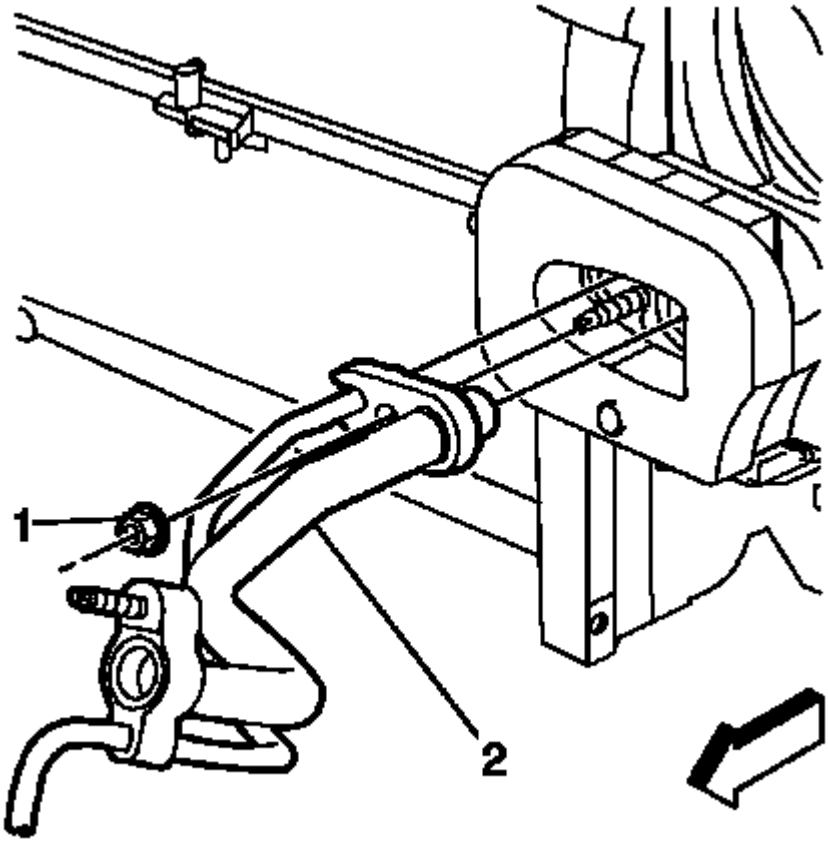


Fig. 277: A/C Evaporator Thermal Expansion Valve Tube & Nut At HVAC Module
Courtesy of GENERAL MOTORS COMPANY

NOTE: Cap or tape off the open A/C components immediately to prevent system contamination.

19. Remove A/C evaporator thermal expansion valve tube nut (1).
20. Remove A/C evaporator thermal expansion valve tube (2) from HVAC module reposition.

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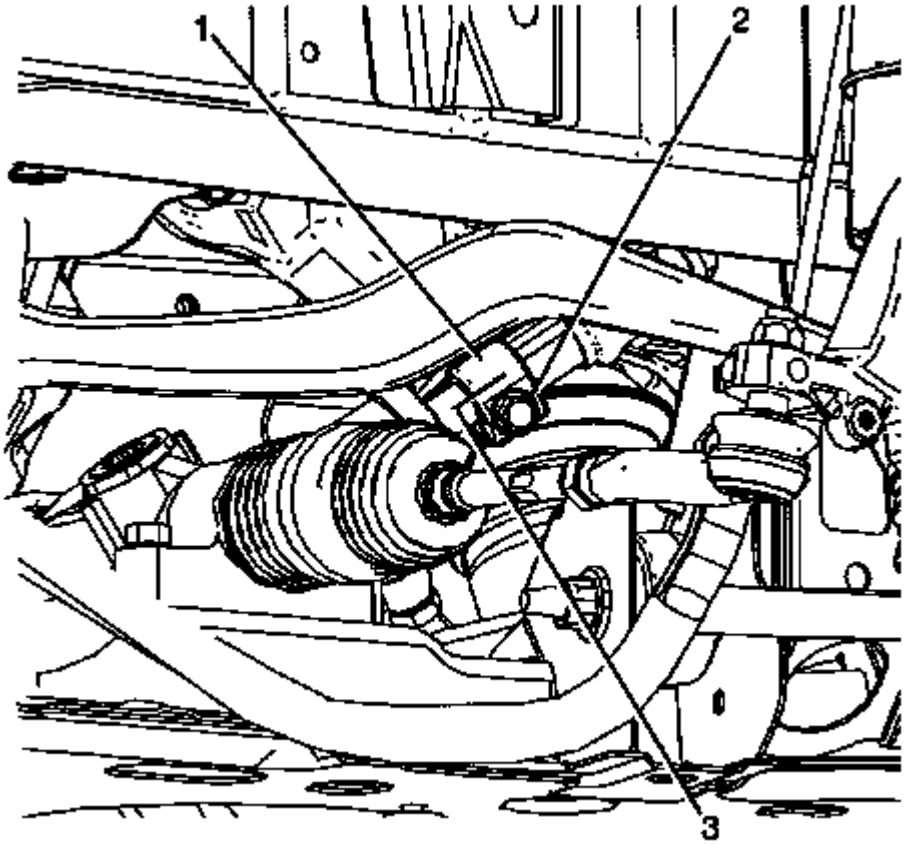


Fig. 278: Identifying Intermediate Steering Shaft To Pinion Shaft Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

21. Working under the vehicle, use paint in order to place match marks on the intermediate steering shaft (1) and on the steering gear pinion shaft (3).
22. Remove the steering gear pinion bolt (2).
23. Remove the thread locking patch and clean the threads on the steering gear pinion bolt.
24. Disconnect the intermediate steering shaft from the steering gear pinion shaft.
25. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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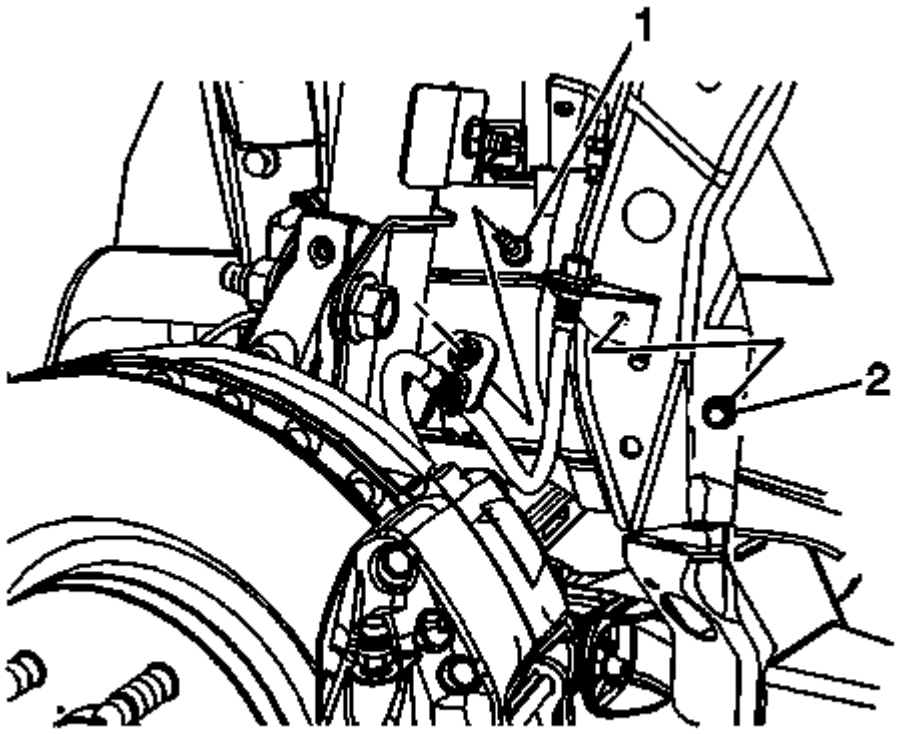


Fig. 279: Brake Hose Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

26. Remove the brake hose bracket bolt (1) from the front suspension strut.
27. Remove the brake hose bracket bolt (2) from the wheelhouse panel.

NOTE: The brake caliper bolts must be replaced any time they are removed. Do not reuse the brake caliper bolts.

28. Remove and discard the brake caliper bolts (1).

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

29. Remove the disc brake caliper and bracket assembly and support with heavy mechanics wire or equivalent.

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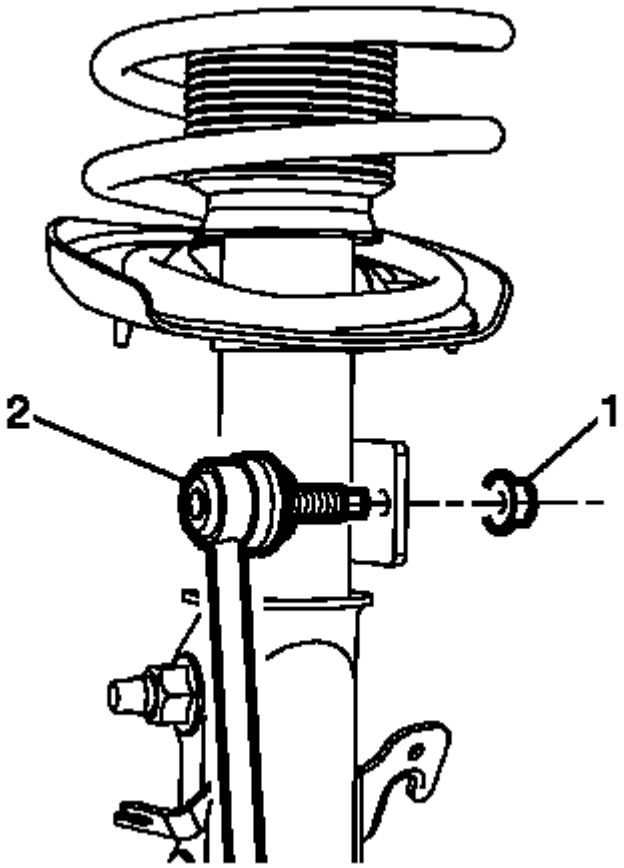


Fig. 280: Stabilizer Link & Front Stabilizer Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: After the nut has been removed, discard and replace with NEW.

30. Remove the front stabilizer shaft nut (1) and discard the old nut.
31. Reposition the stabilizer link (2).

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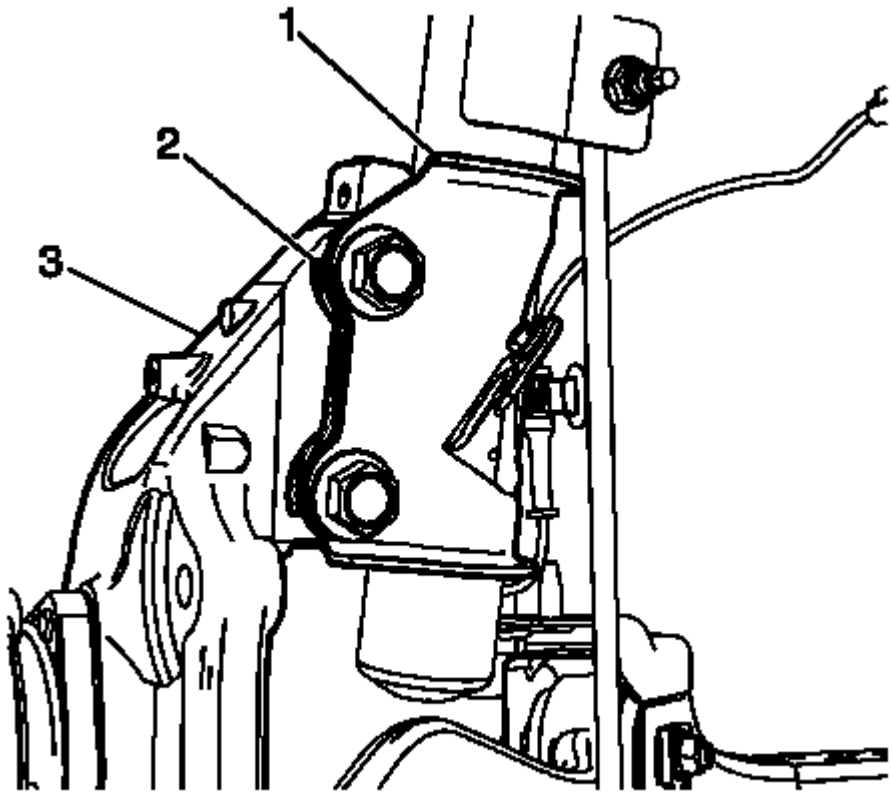


Fig. 281: Mark On Steering Knuckle & Strut Assembly
Courtesy of GENERAL MOTORS COMPANY

32. Paint a reference mark (2) of the strut (1) to the steering knuckle (3).

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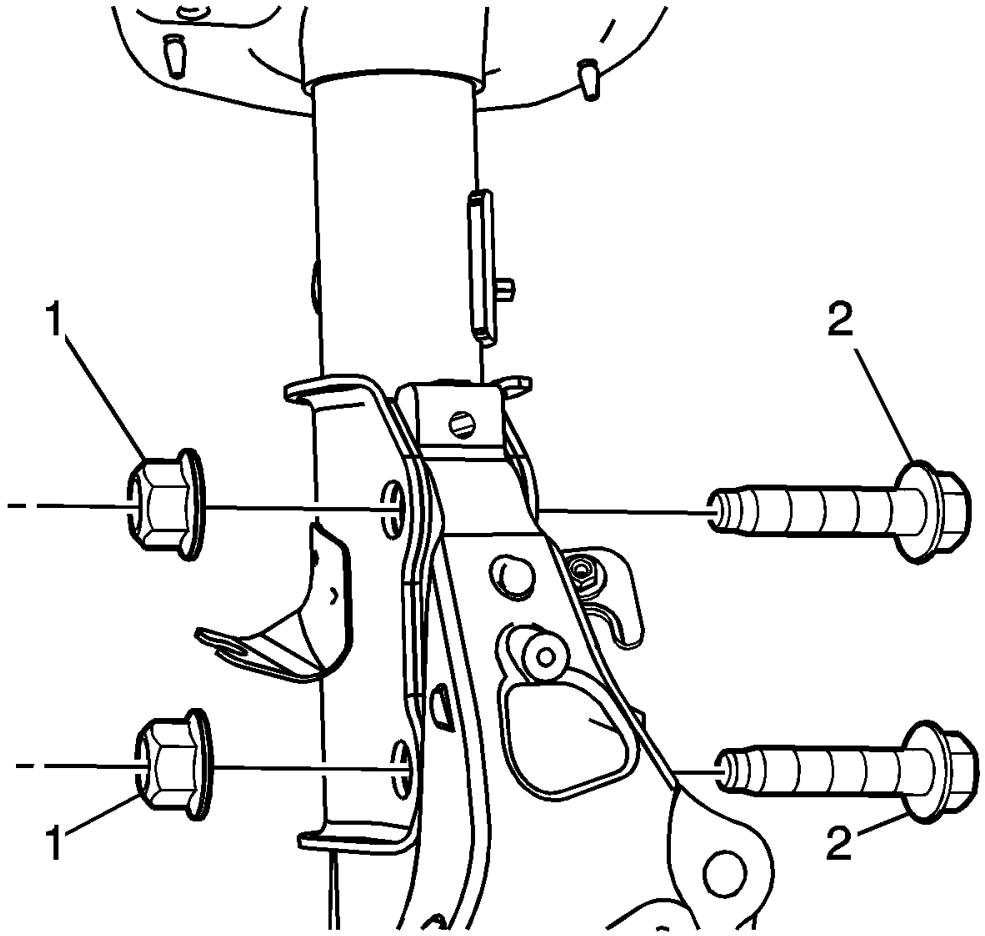


Fig. 282: Front Strut Nuts & Bolts
Courtesy of GENERAL MOTORS COMPANY

33. Remove the front strut nuts (1) and the bolts (2).

NOTE: Adjust the hydraulic floor jack so that the front strut has a small amount of pressure on it.

34. Using a hydraulic floor jack, support the steering knuckle.
35. Disconnect all necessary engine harness electrical connectors. Refer to **Powertrain Component Views** .
36. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement (Base, RS, SS)** , **Front Bumper Fascia Replacement (ZL1)** .
37. Convertible vehicle, remove the front end lower structure brace.

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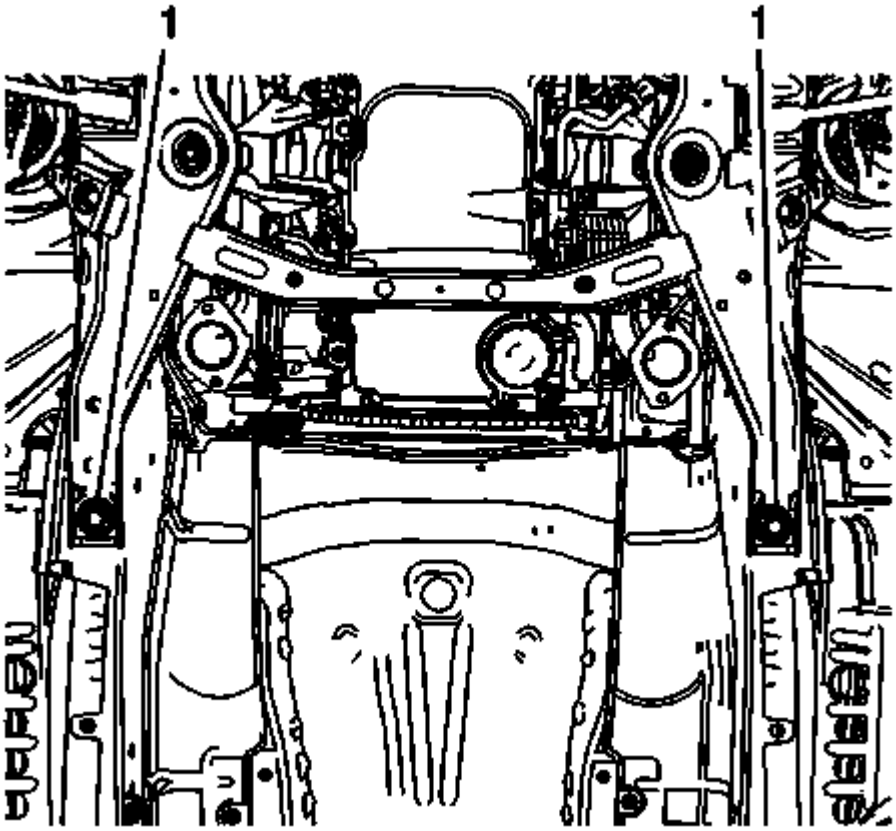


Fig. 283: Rear Frame Bolts
Courtesy of GENERAL MOTORS COMPANY

38. Remove the rear frame bolts (1).
39. Using a suitable engine support table or equivalent, lower the vehicle until the drivetrain and front suspension frame contacts the engine support table.

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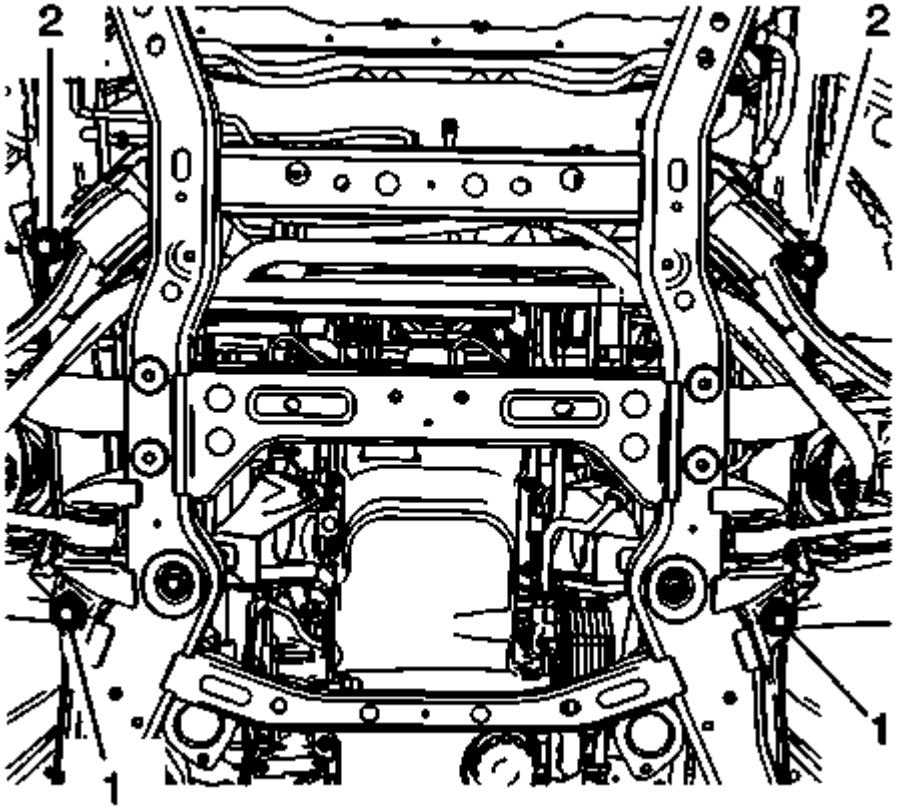


Fig. 284: Front & Rear Frame Bolts
Courtesy of GENERAL MOTORS COMPANY

40. Remove the front (2) and rear (1) frame bolts.
41. Lower the frame with the engine until clear the body and raise the vehicle at full height.
42. Remove the engine mount nuts and remove the engine from the crossmember.
43. Transfer components as required. Refer to the appropriate procedures.

Installation Procedure

1. Install the engine to the crossmember.
2. Tighten both the engine mount nuts to 80 N.m (59 lb ft).

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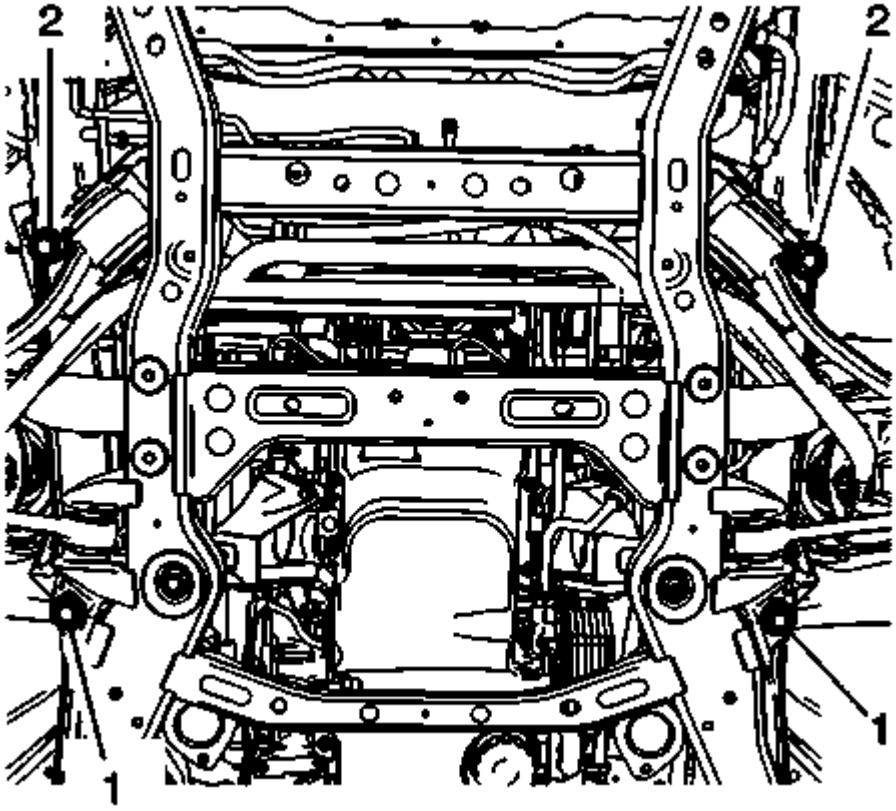


Fig. 285: Front & Rear Frame Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the front frame (2) mountings bolts and tighten to 160 N.m (118 lb ft).
4. Install the front frame (1) mountings bolts and tighten to 160 N.m (118 lb ft).

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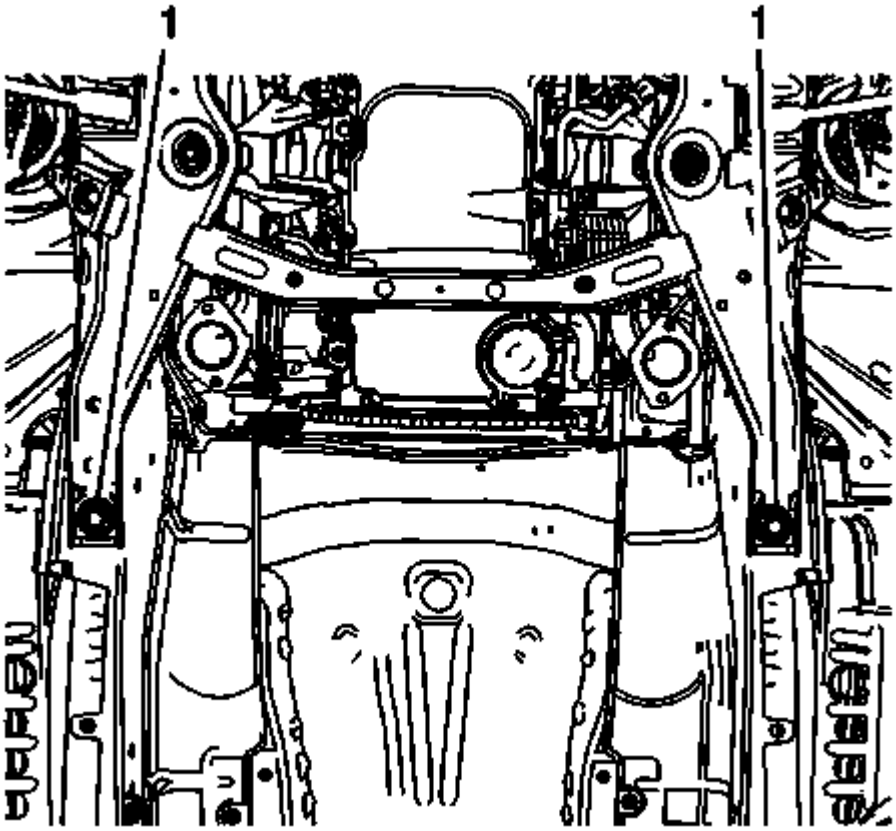


Fig. 286: Rear Frame Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the rear frame (1) mountings bolts and tighten to 240 N.m (177 lb ft).
6. Convertible vehicle, install the front end lower structure brace.
7. Install the front bumper fascia. Refer to **Front Bumper Fascia Replacement (Base, RS, SS)** , **Front Bumper Fascia Replacement (ZL1)** .
8. Connect all necessary engine harness electrical connectors. Refer to **Powertrain Component Views** , and **Harness Routing Views** .

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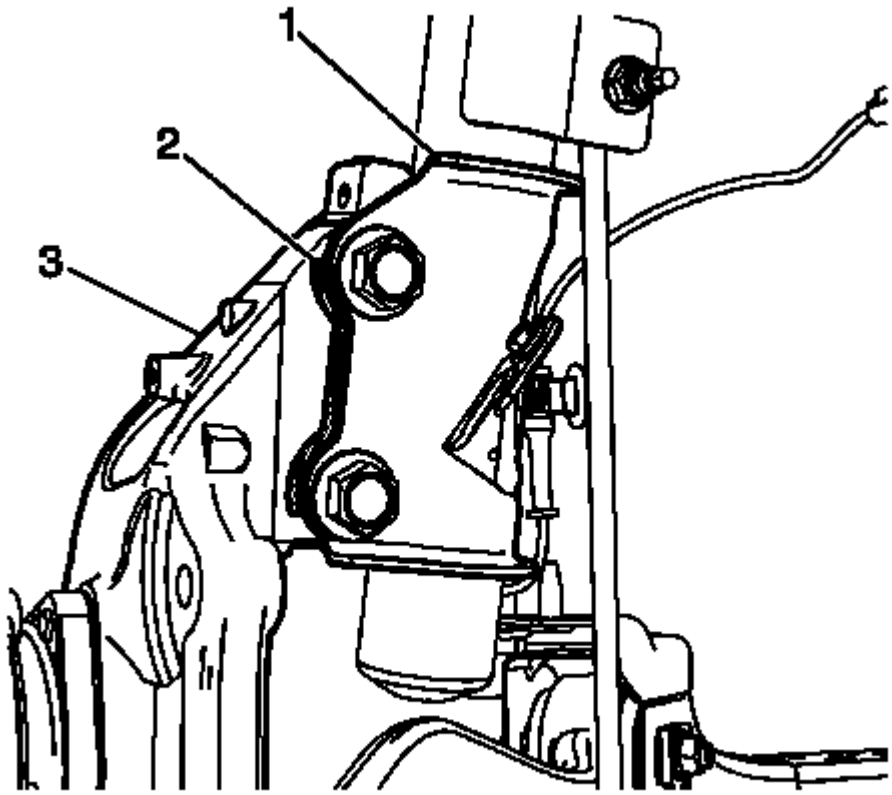


Fig. 287: Mark On Steering Knuckle & Strut Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Align the front strut (1) with the alignment mark (2).

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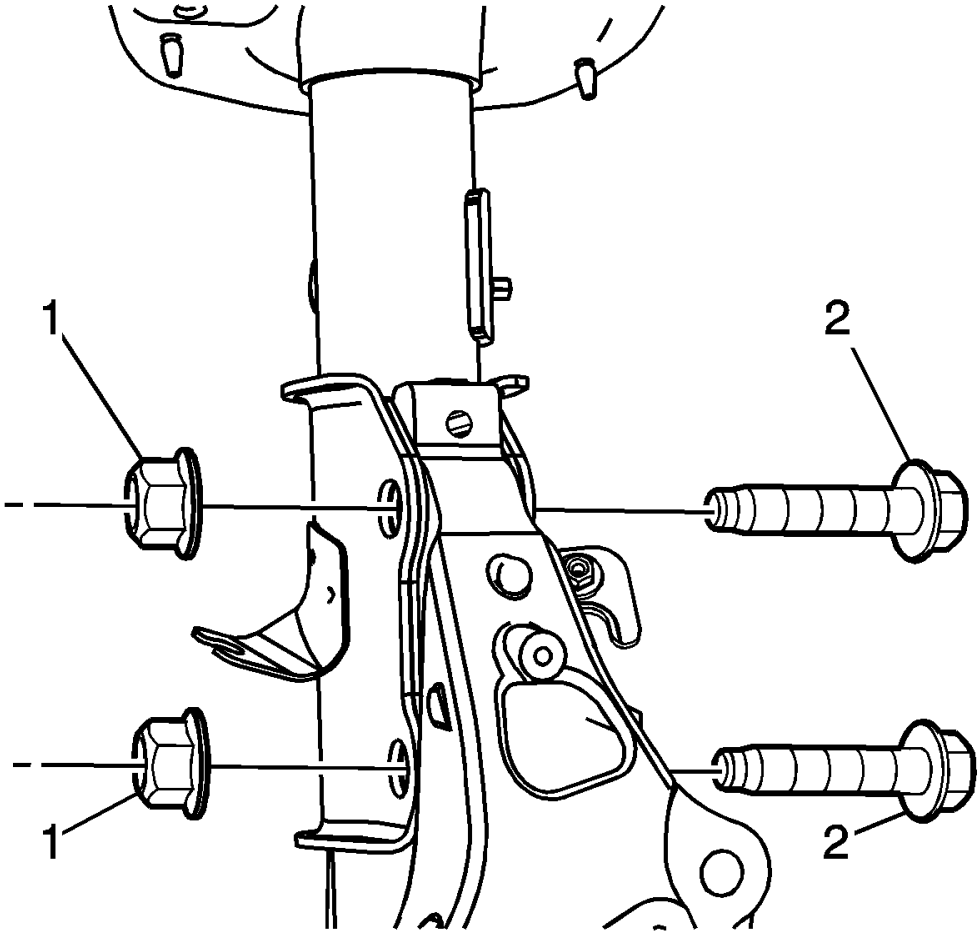


Fig. 288: Front Strut Nuts & Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Install the front strut bolts (2).
11. Install the nuts (1) and tighten to 80 N.m (59 lb ft) plus an additional 180 degrees.

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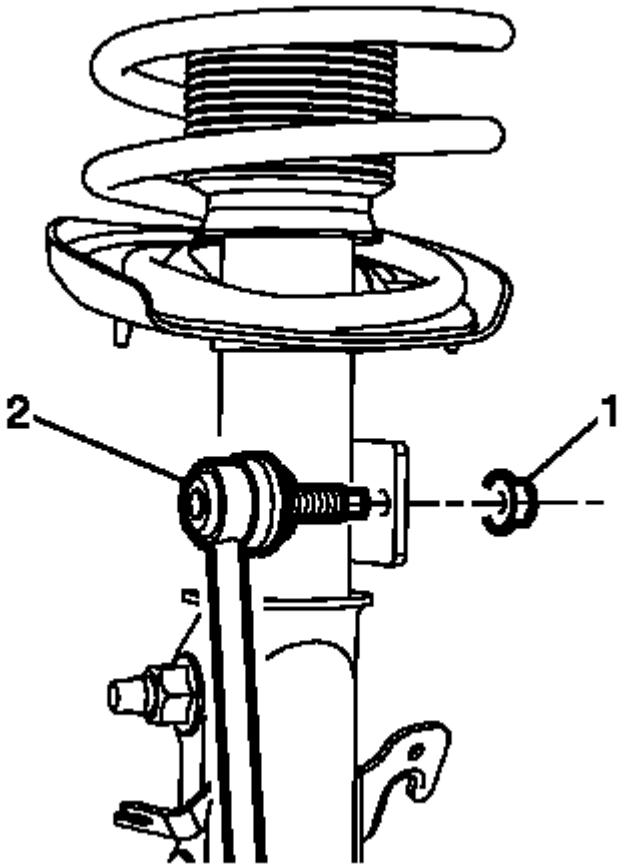


Fig. 289: Stabilizer Link & Front Stabilizer Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

12. Install the front stabilizer shaft nut (1) and tighten to 49 N.m (36 lb ft).

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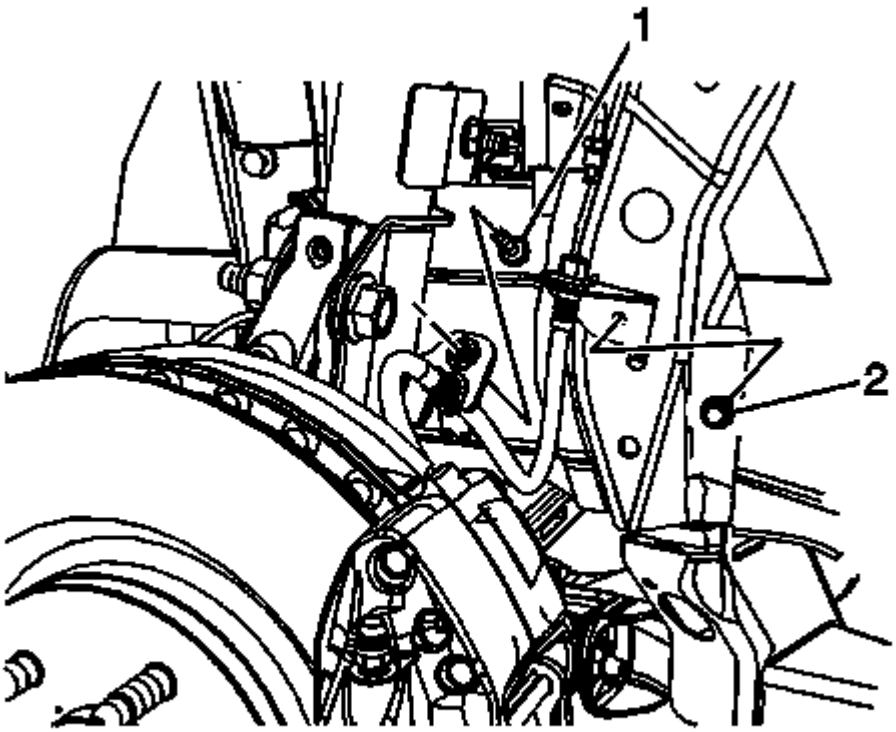


Fig. 290: Brake Hose Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Install the brake hose bracket bolt (1) to the front suspension strut and tighten to 9 N.m (80 lb in).
14. Install the brake hose bracket bolt (2) to the wheelhouse panel and tighten to 9 N.m (80 lb in).

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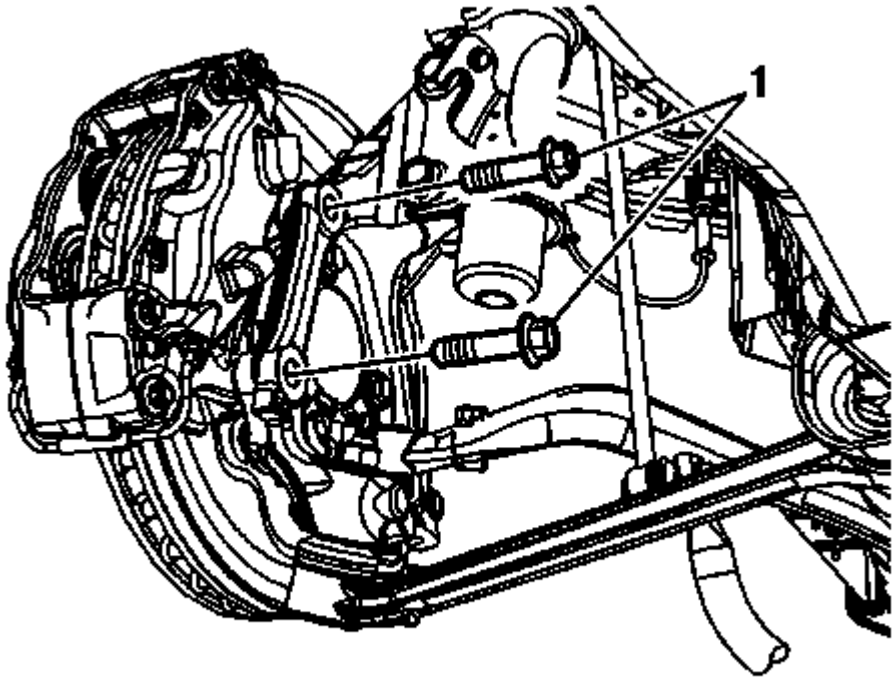


Fig. 291: Brake Caliper Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: The brake bolts must be replaced any time they are removed.

15. Install 2 new brake caliper bolts (1) and tighten to 40 N.m (33 lb ft) plus 90 degrees.

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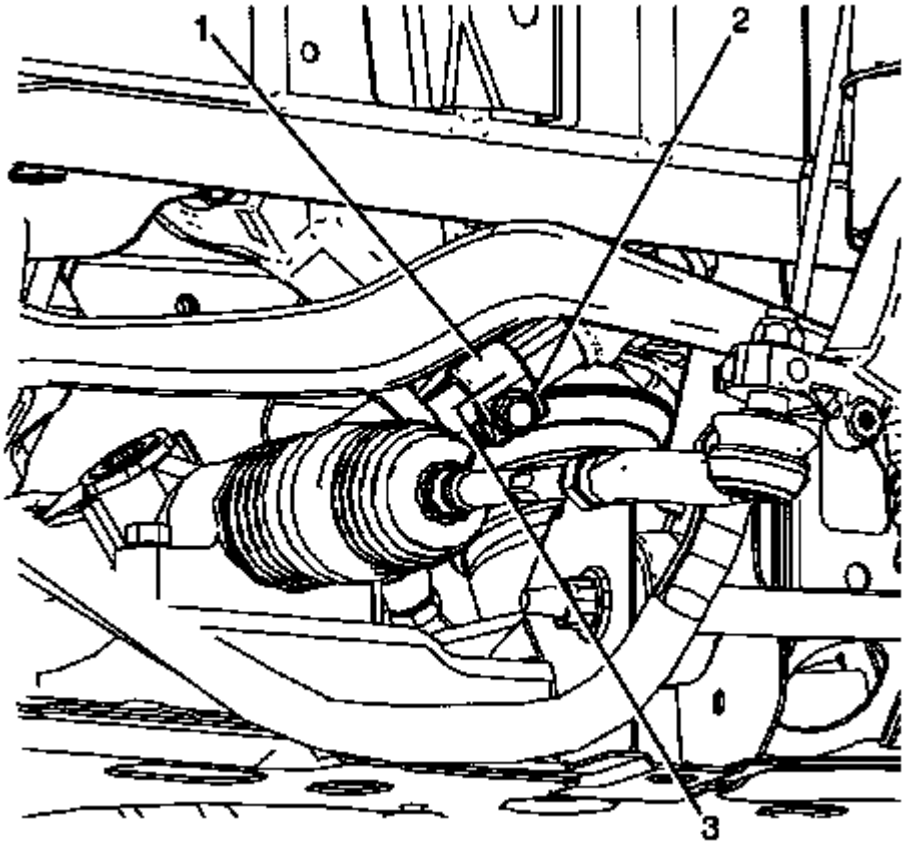


Fig. 292: Identifying Intermediate Steering Shaft To Pinion Shaft Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

16. Working under the vehicle, align the match marks and connect the intermediate steering shaft (1) to the steering gear pinion shaft (3).
17. Apply thread locking adhesive to the steering gear pinion bolt (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
18. Install the steering gear pinion bolt and tighten to 50 N.m (37 lb ft).

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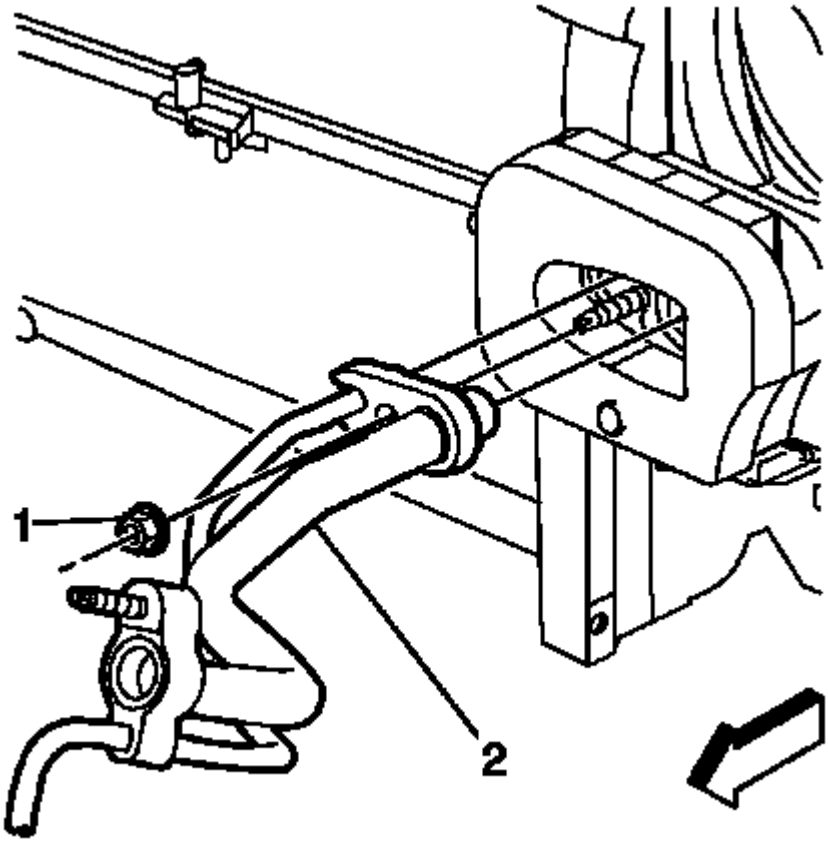


Fig. 293: A/C Evaporator Thermal Expansion Valve Tube & Nut At HVAC Module
Courtesy of GENERAL MOTORS COMPANY

19. Install A/C evaporator thermal expansion valve tube (2) to thermal expansion valve tube.
20. Install A/C evaporator thermal expansion valve tube nut (1) and tighten to 19 N.m (14 lb ft).

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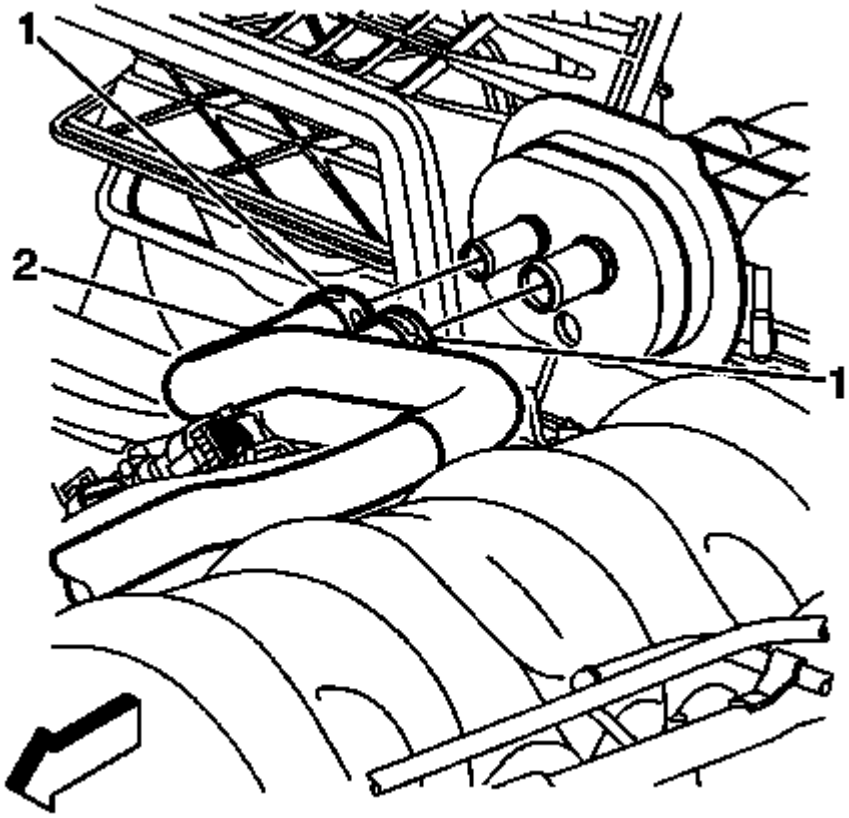


Fig. 294: Heater Inlet & Outlet Hoses & Clamps At Heater Core
Courtesy of GENERAL MOTORS COMPANY

NOTE: Lubricate the inside diameters of the hose with clean coolant prior to installation.

21. Install the heater inlet rear and outlet hose (2) to the heater core.
22. Engage tension on the heater inlet rear and outlet hose clamps (1) at the heater core using **J-38185** pliers.

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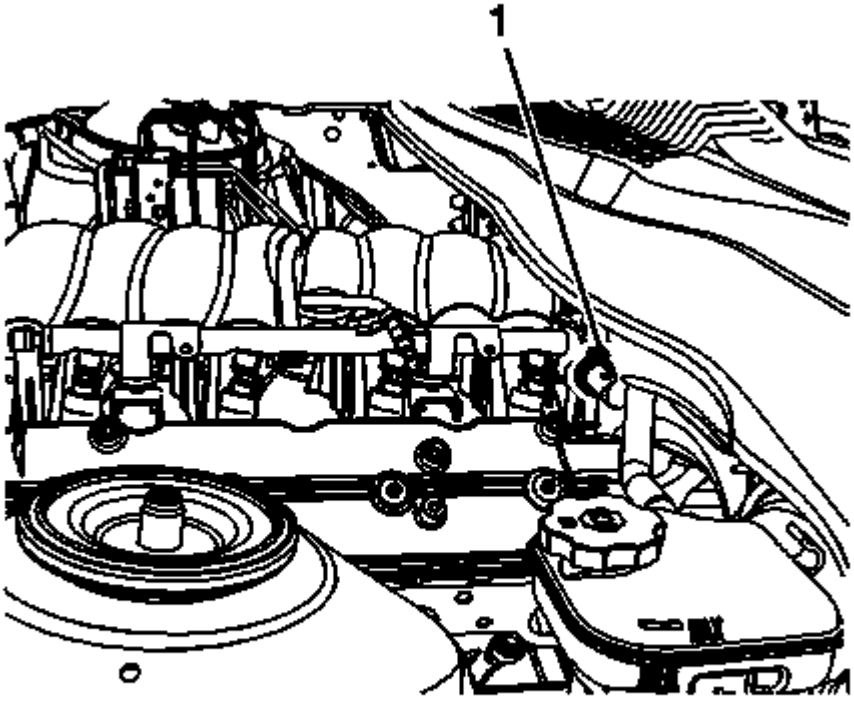


Fig. 295: Power Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS COMPANY

23. Install the power brake booster vacuum hose (1) to the vacuum port on the left side of the intake manifold.

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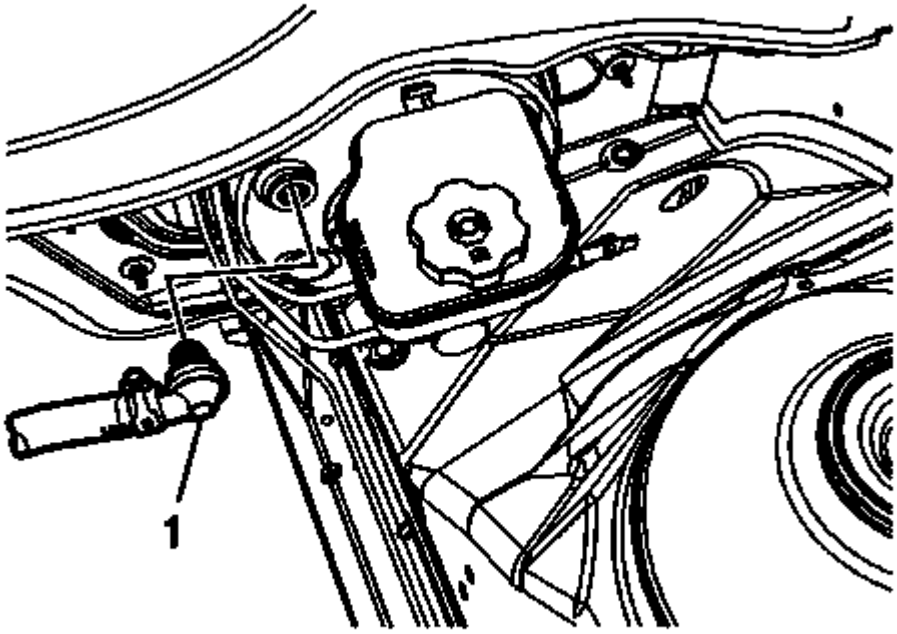


Fig. 296: Power Vacuum Brake Booster Check Valve & Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

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

24. Install the check valve to the vacuum brake booster.
25. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement (LSA)** , **Air Cleaner Assembly Replacement (L99 or LS3)** .
26. Install the air cleaner outlet duct hose. Refer to **Air Cleaner Resonator and Outlet Duct Replacement (LSA)** , **Air Cleaner Resonator and Outlet Duct Replacement (L99 or LS3)** .
27. Install the transmission. Refer to the appropriate procedure:
    - **Transmission Replacement** for the 6L45/6L50/6L80/6L90 transmission
    - **Transmission Replacement** for the Aisin AY6 transmission
    - **Transmission Replacement** for the Tremec 6-speed transmission
28. Charge the A/C system. Refer to **Refrigerant Recovery and Recharging (Belt Driven Compressor)** .
29. Fill the engine cooling system. Refer to **Cooling System Draining and Filling (LSA, LS3, L99 Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
30. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

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31. Install the engine cover. Refer to **Engine Cover Replacement**.
32. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

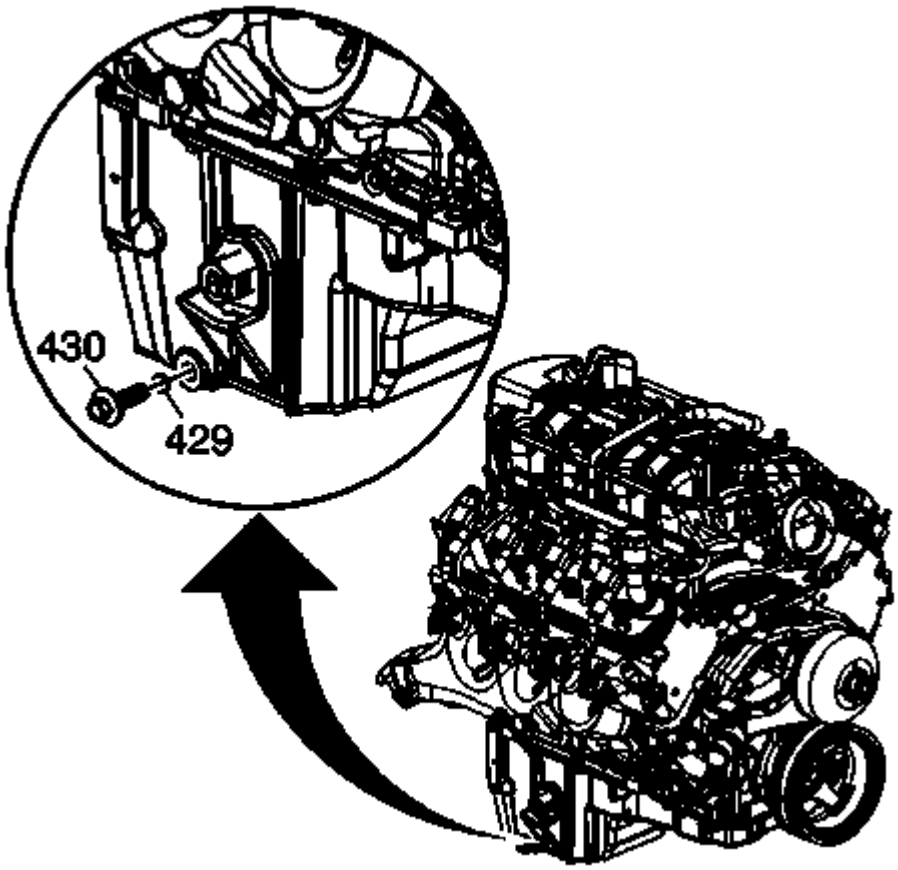


Fig. 297: View Of Oil Pan Drain Plug & Seal
Courtesy of GENERAL MOTORS COMPANY

1. Open the hood.
2. Remove the oil fill cap.
3. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Place a oil drain pan under the oil pan drain plug.
5. Remove the oil pan drain plug (430).
6. Allow the oil to drain completely.
7. Clean and inspect the oil pan drain plug, replace if necessary.
8. Clean and inspect the oil pan sealing surface, replace the oil pan if necessary.
9. Wipe any remaining oil from the drain plug hole and reinstall the oil pan drain plug until snug.

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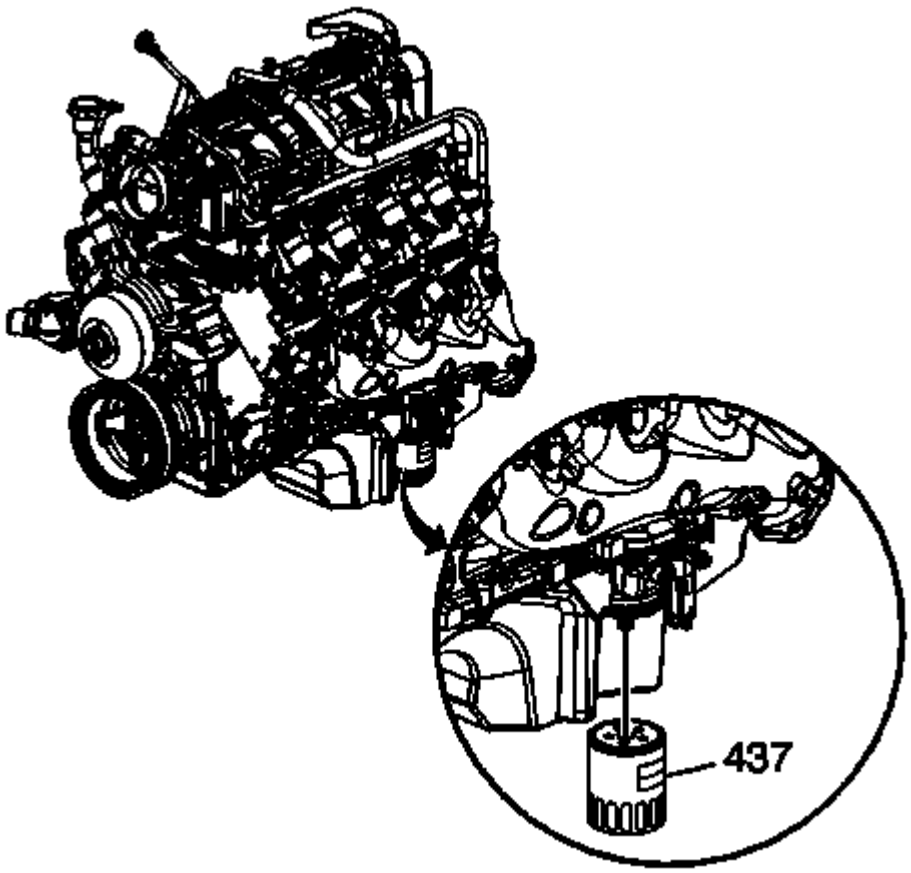


Fig. 298: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS COMPANY

10. Position the drain pan under the oil filter (437).
11. Remove the oil filter.
12. Ensure that the oil filter gasket is still on the old filter if not, remove the oil filter gasket from the oil pan.

Installation Procedure

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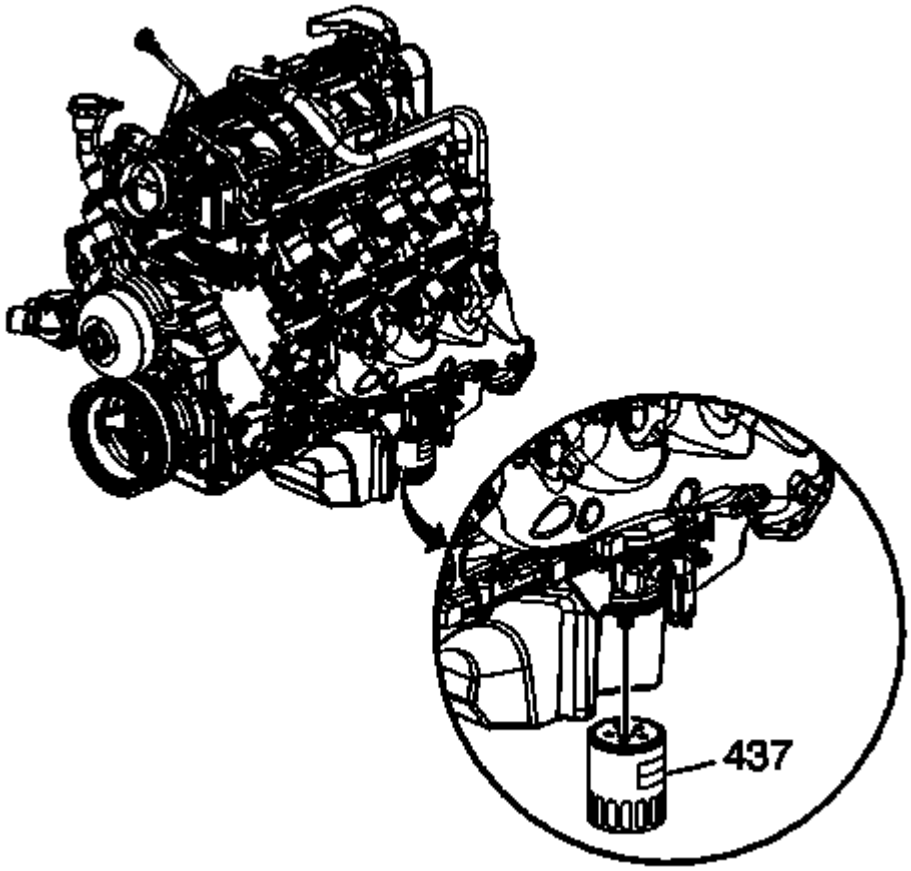


Fig. 299: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS COMPANY

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

   CAUTION: Refer to Fastener Caution .

2. Install the NEW oil filter (437) and tighten to 30 N.m (22 lb ft).

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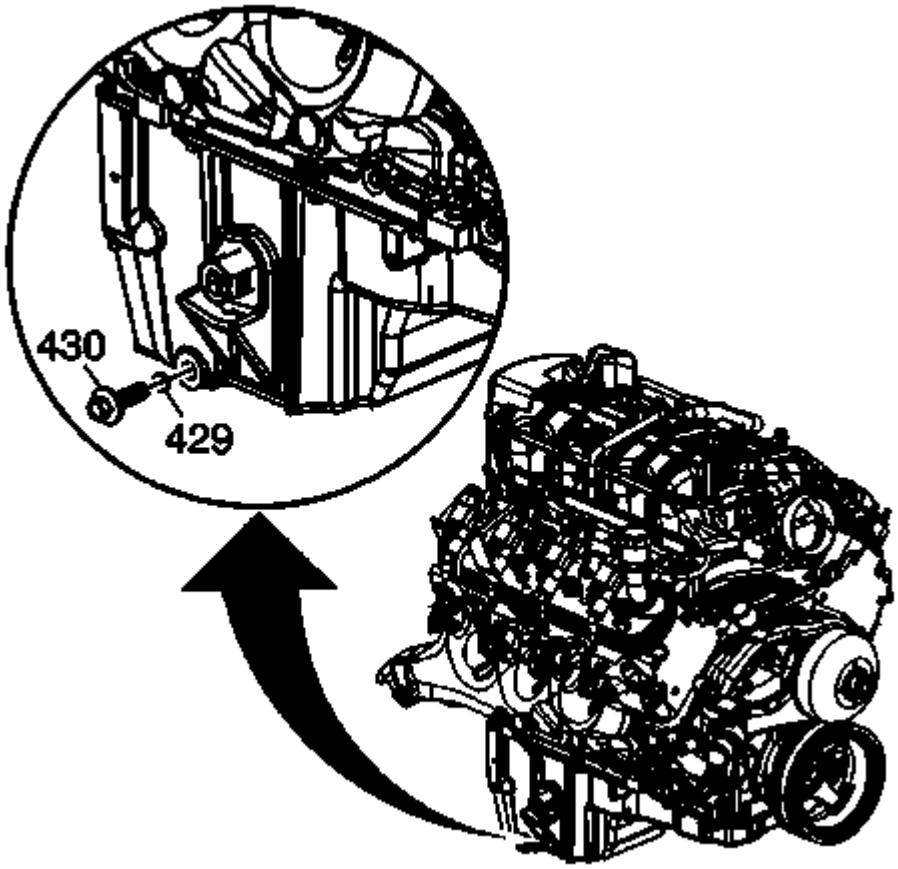


Fig. 300: View Of Oil Pan Drain Plug & Seal
Courtesy of GENERAL MOTORS COMPANY

3. Tighten the oil pan drain plug (430) 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 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 by adding or draining oil.

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16. Check for oil leaks.
17. Close the hood.

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