

2010 ENGINE

Engine Mechanical - 2.2L or 2.4L - Repair Instructions - On Vehicle - G6

DRIVE BELT REPLACEMENT

SPECIAL TOOLS

J 44811 Accessory Belt Tensioner Unloader. See [Special Tools](#) .

REMOVAL PROCEDURE

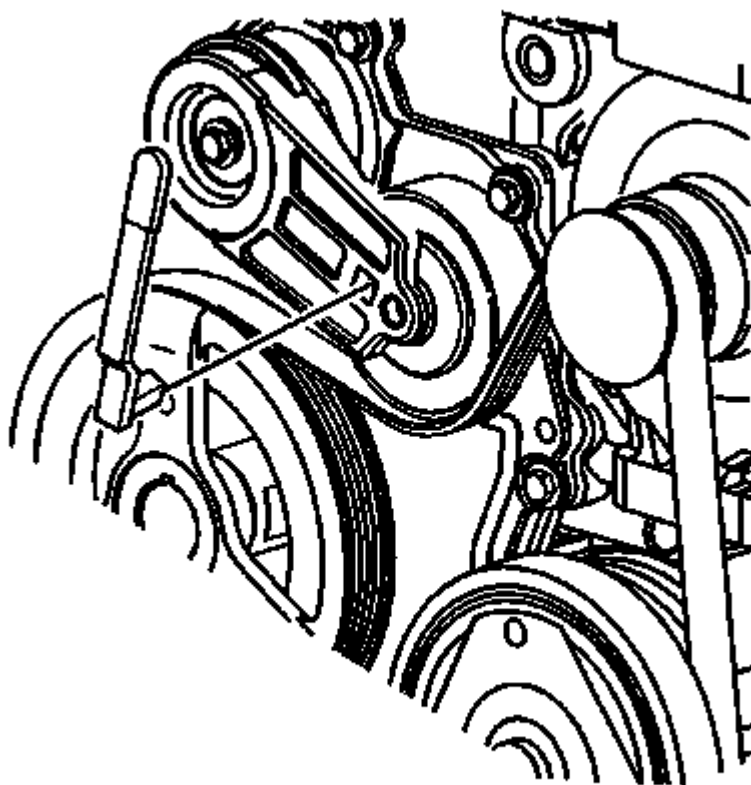


Fig. 1: View Of Drive Belt Tensioner & Special Tool
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
2. Remove the right front fender liner. Refer to [Front Fender Liner Replacement](#) .
3. Install the **J 44811** to the drive belt tensioner. See [Special Tools](#) .
4. Using the **J 44811** , rotate the tensioner counterclockwise in order to release the tensioner from the drive belt. See [Special Tools](#) .

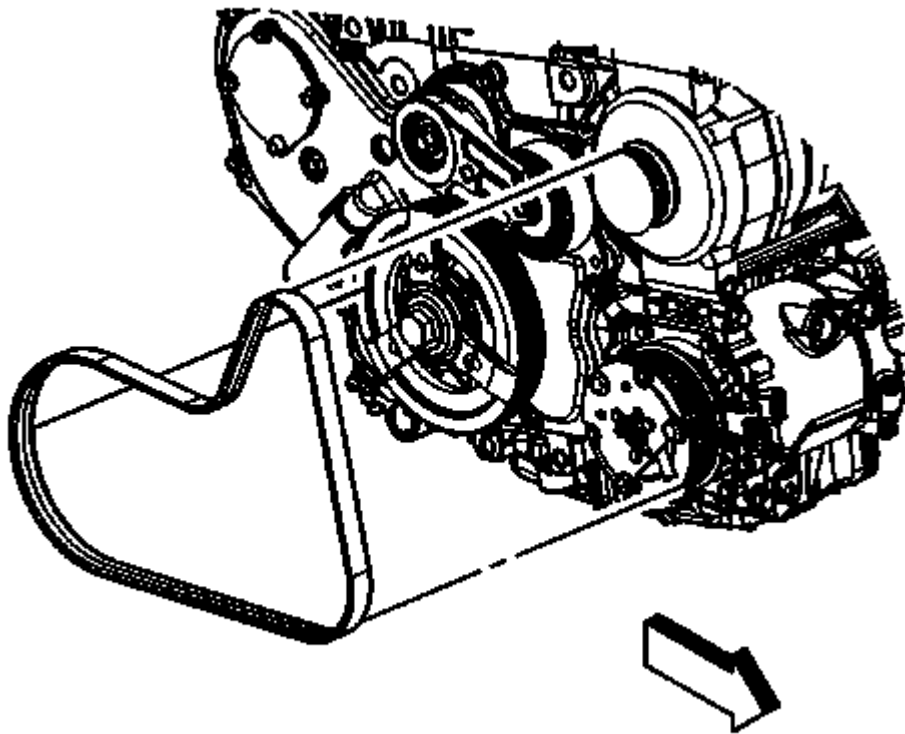


Fig. 2: View Of Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

5. Remove the drive belt.
6. Slowly rotate the **J 44811** and the tensioner clockwise in order to allow the tensioner to rest. See **Special Tools** .
7. Remove the **J 44811** from the drive belt tensioner. See **Special Tools** .

INSTALLATION PROCEDURE

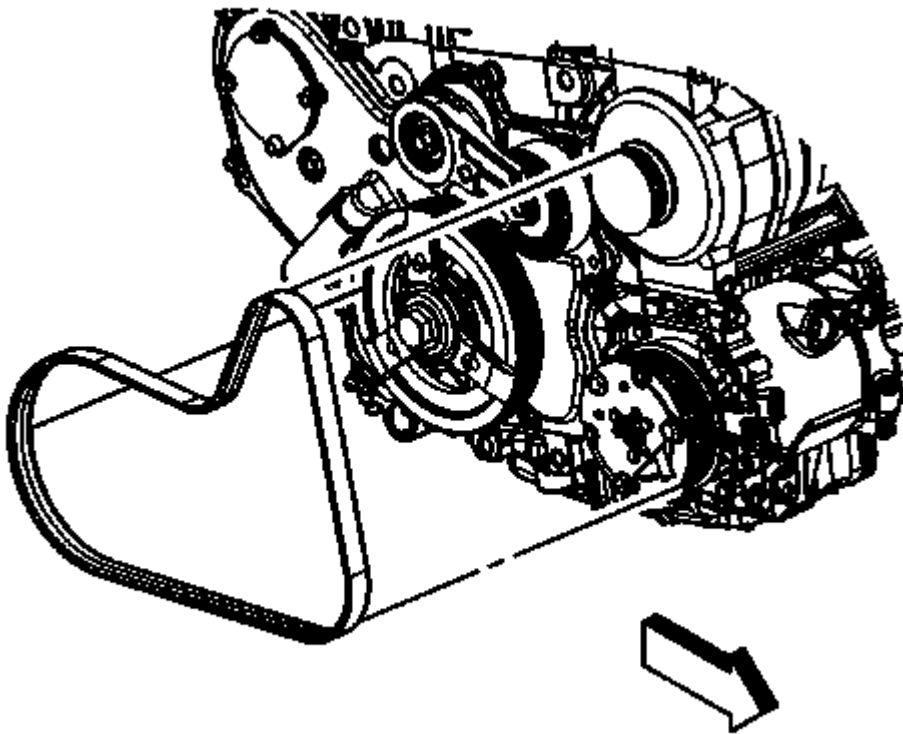


Fig. 3: View Of Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

1. Install and position the drive belt around all of the pulleys except for the drive belt tensioner.
2. Install the **J 44811** to the drive belt tensioner. See **Special Tools** .
3. Using the **J 44811** , rotate the tensioner counterclockwise. See **Special Tools** .
4. Position the drive belt under the tensioner pulley.

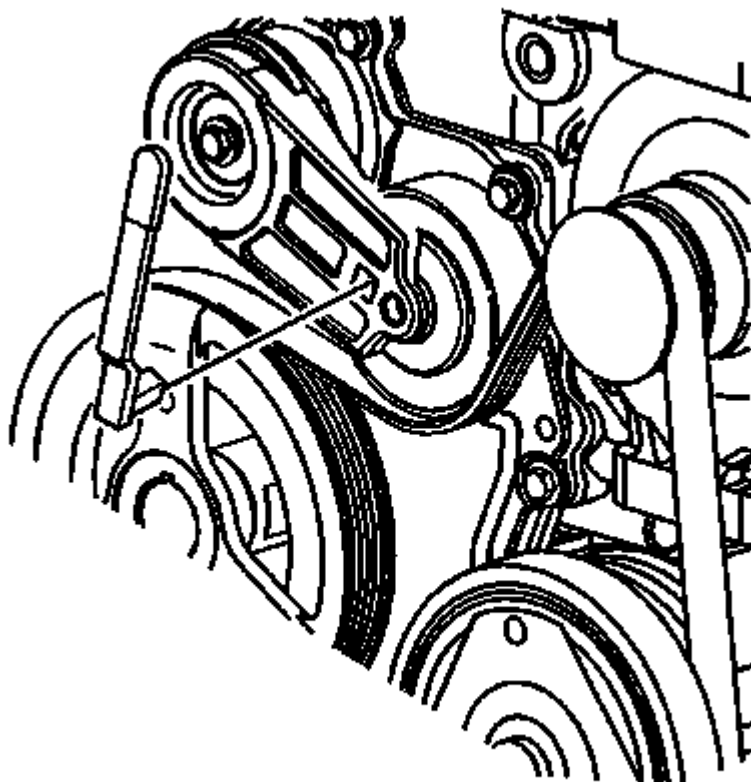


Fig. 4: View Of Drive Belt Tensioner & Special Tool
Courtesy of GENERAL MOTORS CORP.

5. Using the **J 44811** , rotate the tensioner clockwise in order to seat the tensioner pulley onto the drive belt. See **Special Tools** .
6. Install the right front fender liner. Refer to **Front Fender Liner Replacement** .
7. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .

DRIVE BELT TENSIONER REPLACEMENT

SPECIAL TOOLS

J 45025 Torque Wrench Adapter. See **Special Tools** .

REMOVAL PROCEDURE

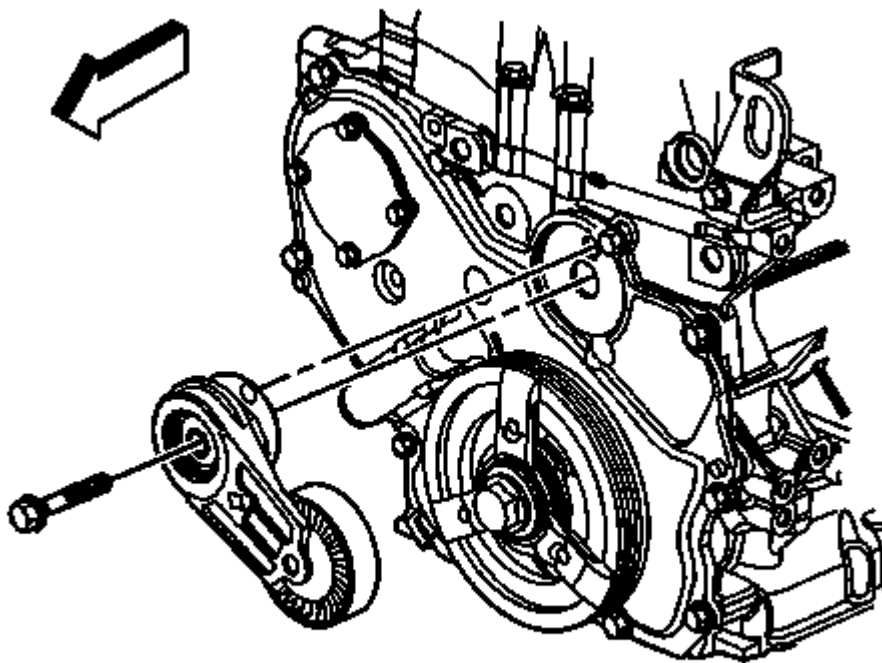


Fig. 5: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

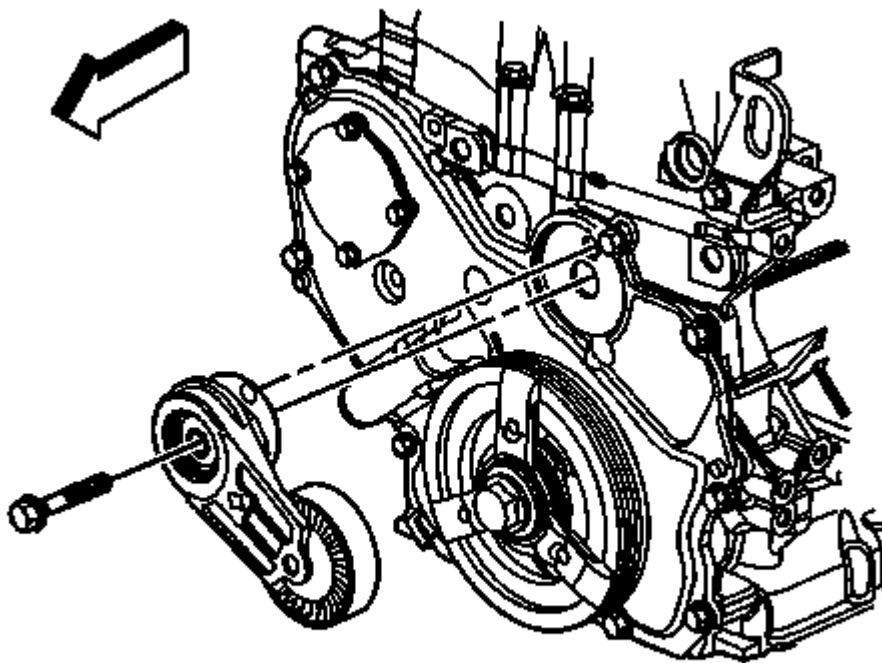


Fig. 6: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Position the drive belt tensioner. Ensure that the tensioner is flush with the front cover.

CAUTION: Refer to Fastener Caution .

NOTE: In order to obtain the proper torque when using any torque wrench adapter you must use the following formula: $\text{Pre-set Torque} = \frac{\text{Torque Wrench Length} \times \text{Torque Desired}}{\text{Torque Wrench Length} + \text{Extension Length}}$.

2. Install the drive belt tensioner bolt.

Using the **J 45025** tighten the drive belt tensioner bolt. See Special Tools .

Tighten: Tighten the bolt to 45 N.m (33 lb ft).

3. Install the drive belt. Refer to Drive Belt Replacement.

ENGINE OIL PRESSURE SWITCH REPLACEMENT

REMOVAL PROCEDURE

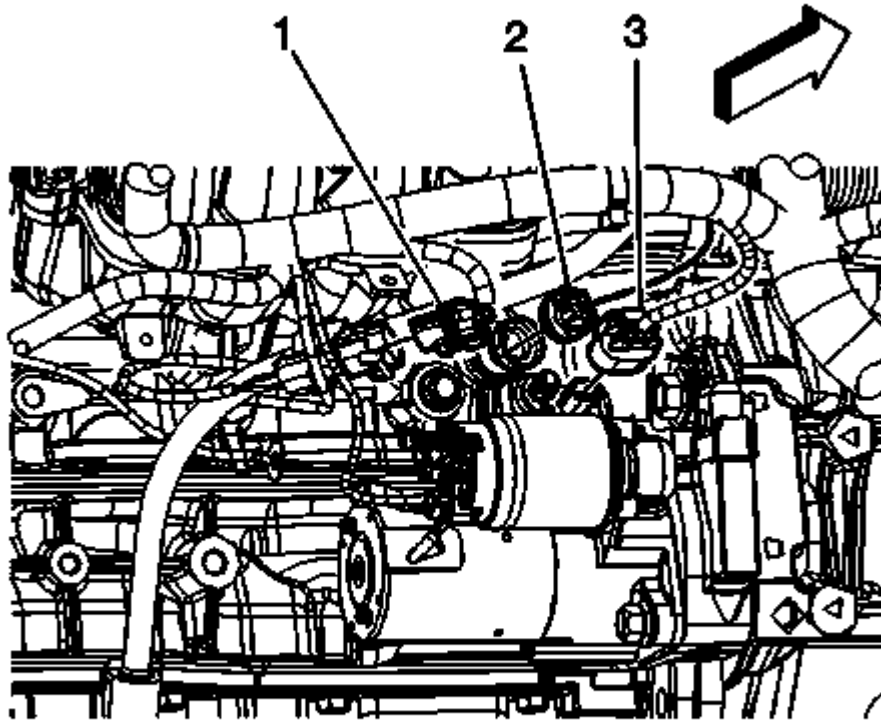


Fig. 7: Identifying Engine Oil Pressure Sensor, Knock Sensor & CKP Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement (LE5)**.
2. Disconnect the engine oil pressure sensor electrical connector (2).

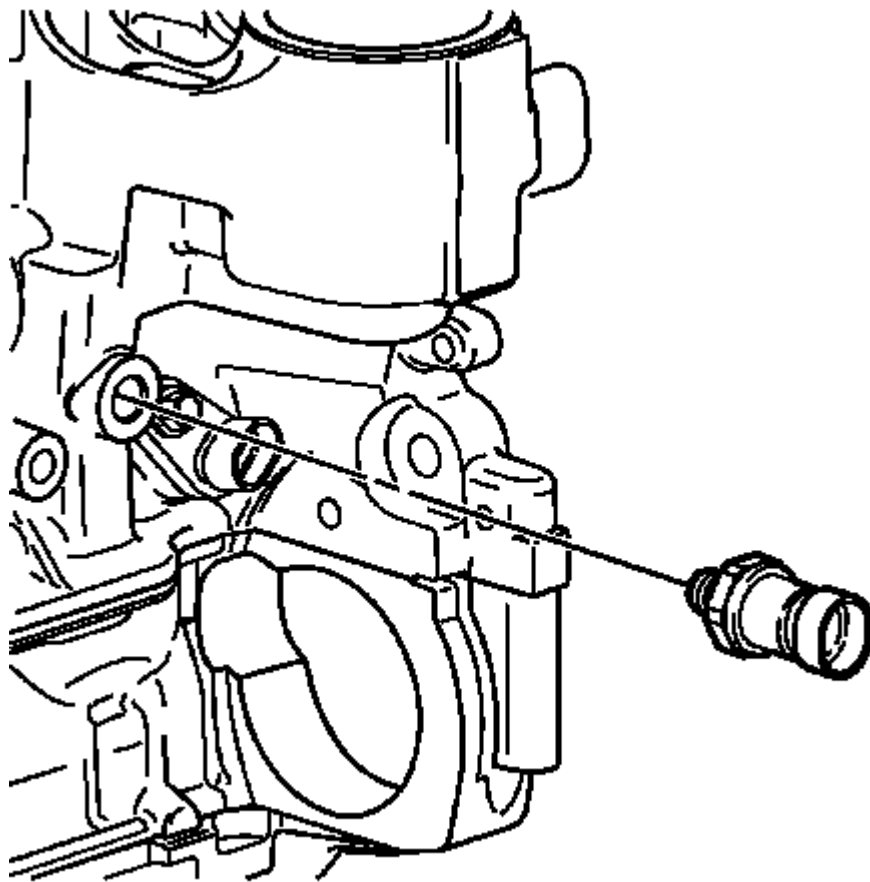


Fig. 8: View Of Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine oil pressure sensor.

INSTALLATION PROCEDURE

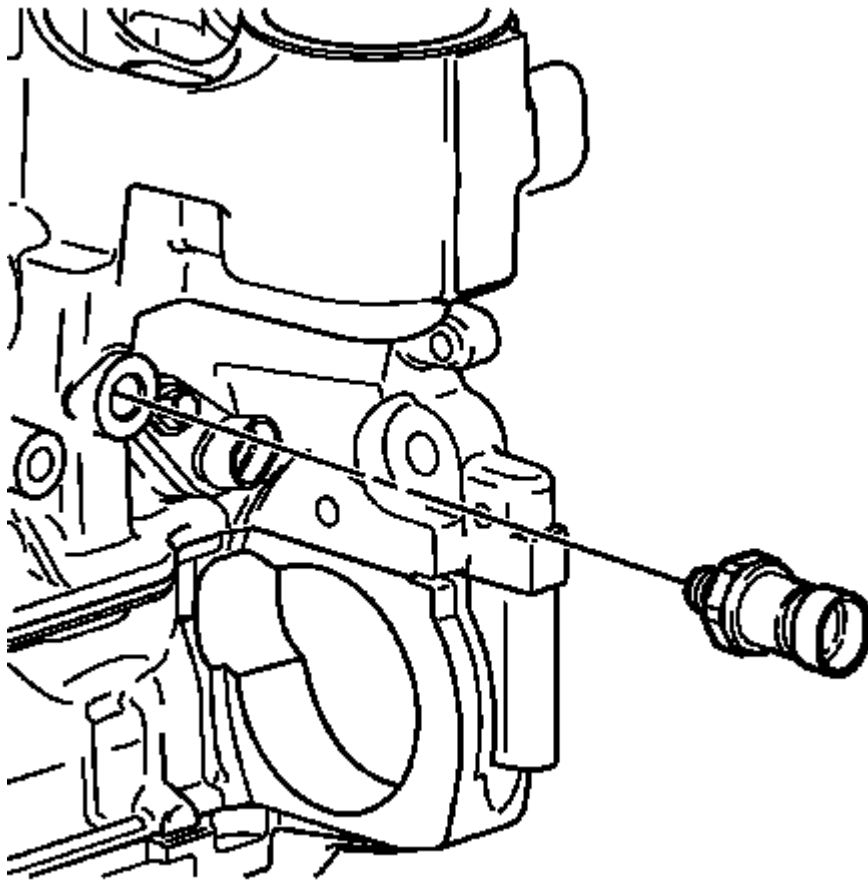


Fig. 9: View Of Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the engine oil pressure sensor.

Tighten: Tighten the sensor to 22 N.m (16 lb ft).

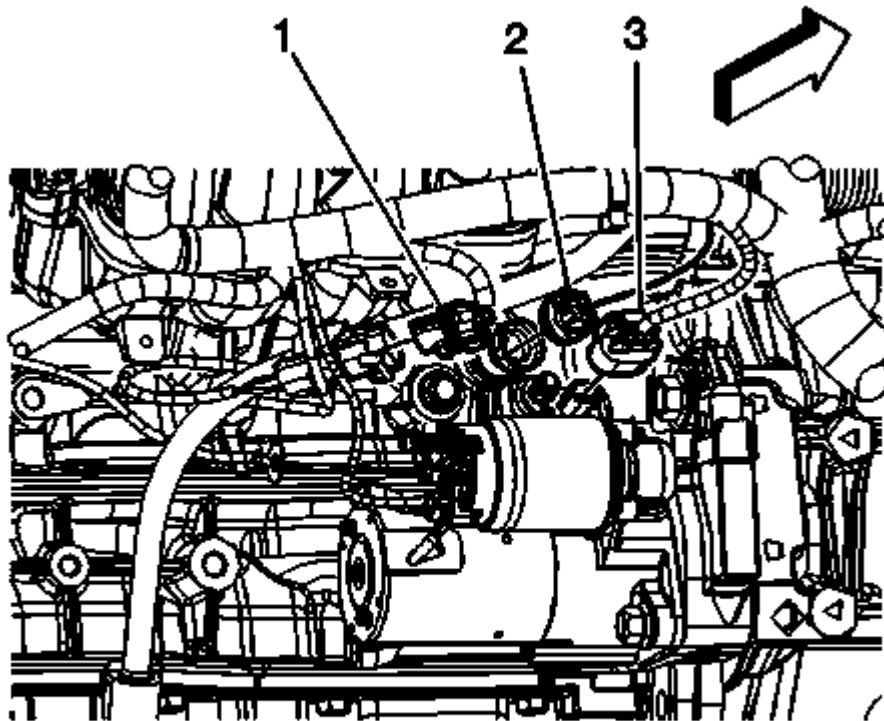


Fig. 10: Identifying Engine Oil Pressure Sensor, Knock Sensor & CKP Sensor Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

2. Connect the engine oil pressure sensor electrical connector (2).
3. Install the engine oil level indicator tube. Refer to Oil Level Indicator Tube Replacement (LE5).

ENGINE MOUNT INSPECTION

IMPORTANT: Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is the engine mount, not the engine or accessories.

1. Install the engine support fixture. Refer to Engine Support Fixture.
2. Raise the engine slightly and observe the engine mount. Raising the engine removes the weight from the engine mount and creates a slight tension on the rubber portion.
3. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber is covered with heat check cracks.
 - The rubber is separated from the metal plate of the engine mount.
 - The rubber is split through the center of the engine mount.

- The engine mount itself is leaking fluid.
4. For engine mount replacement. Refer to Engine Mount Replacement.

ENGINE MOUNT BRACKET REPLACEMENT

REMOVAL PROCEDURE

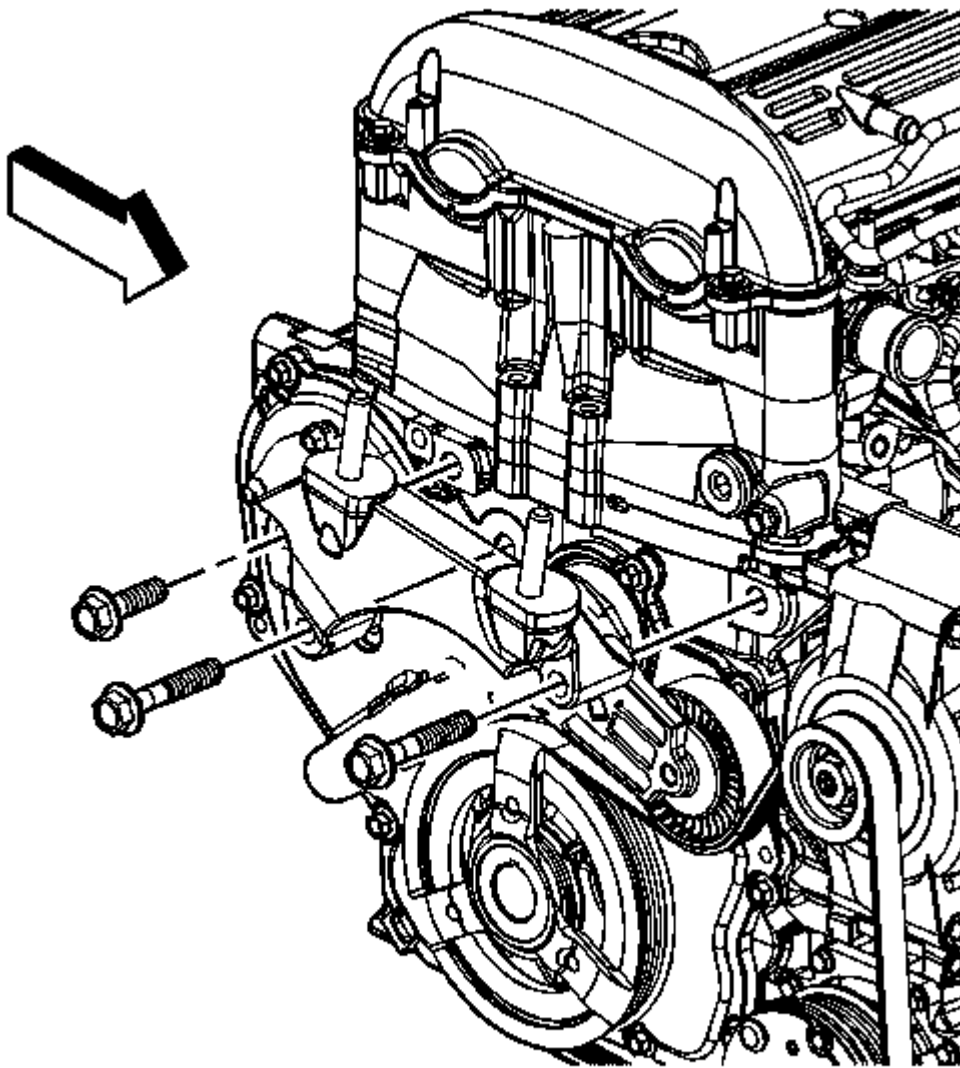


Fig. 11: Identifying Engine Mount Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

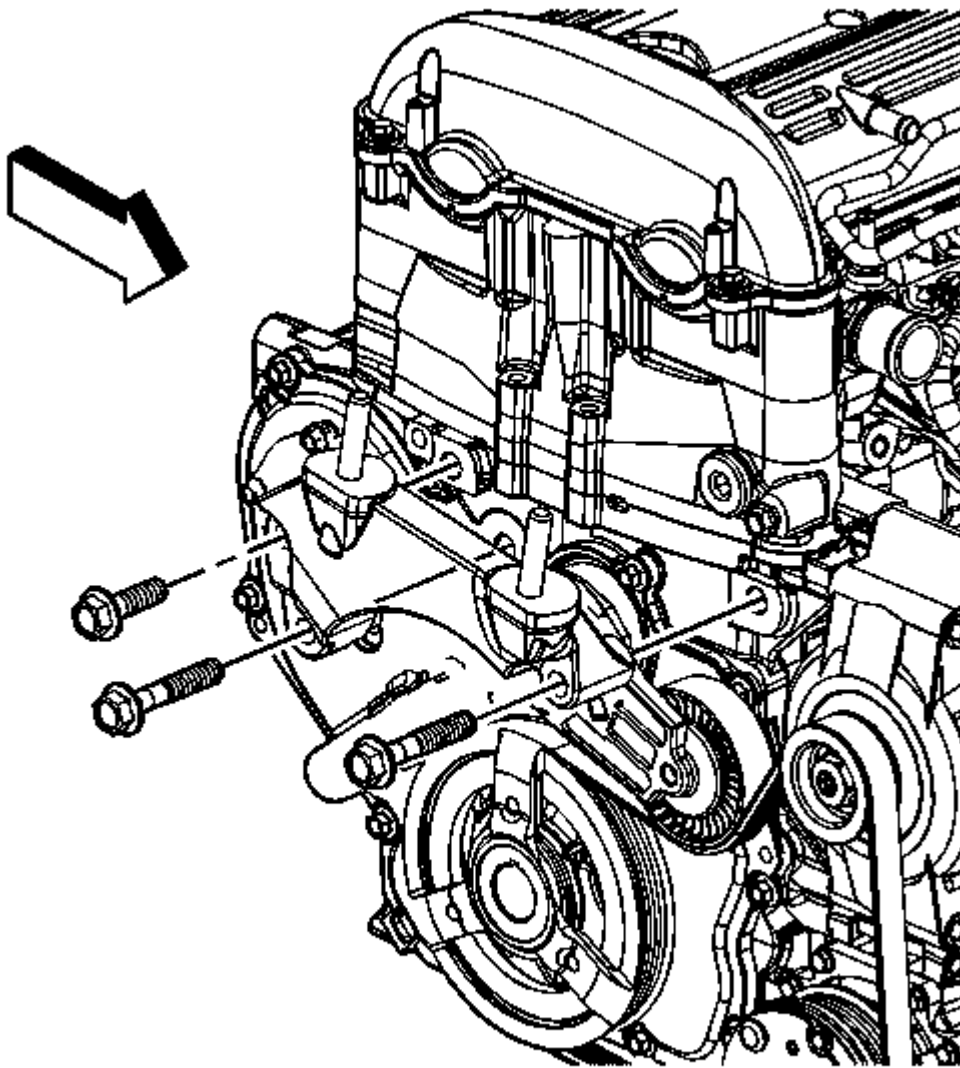


Fig. 12: Identifying Engine Mount Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount bracket to the engine.
2. Install until snug the engine mount bracket bolts in the following locations:
 - The long bolts in the forward and front lower holes
 - The short bolt in the rear upper hole

CAUTION: Refer to Fastener Caution .

3. Tighten the engine mount bracket bolts.

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

4. Install the engine mount. Refer to Engine Mount Replacement.

ENGINE AND TRANSMISSION MOUNT BALANCING - ALL MOUNTS

NOTE: Follow the balance procedure in the order listed in the following steps.
Powertrain mounts must be tightened in sequence.

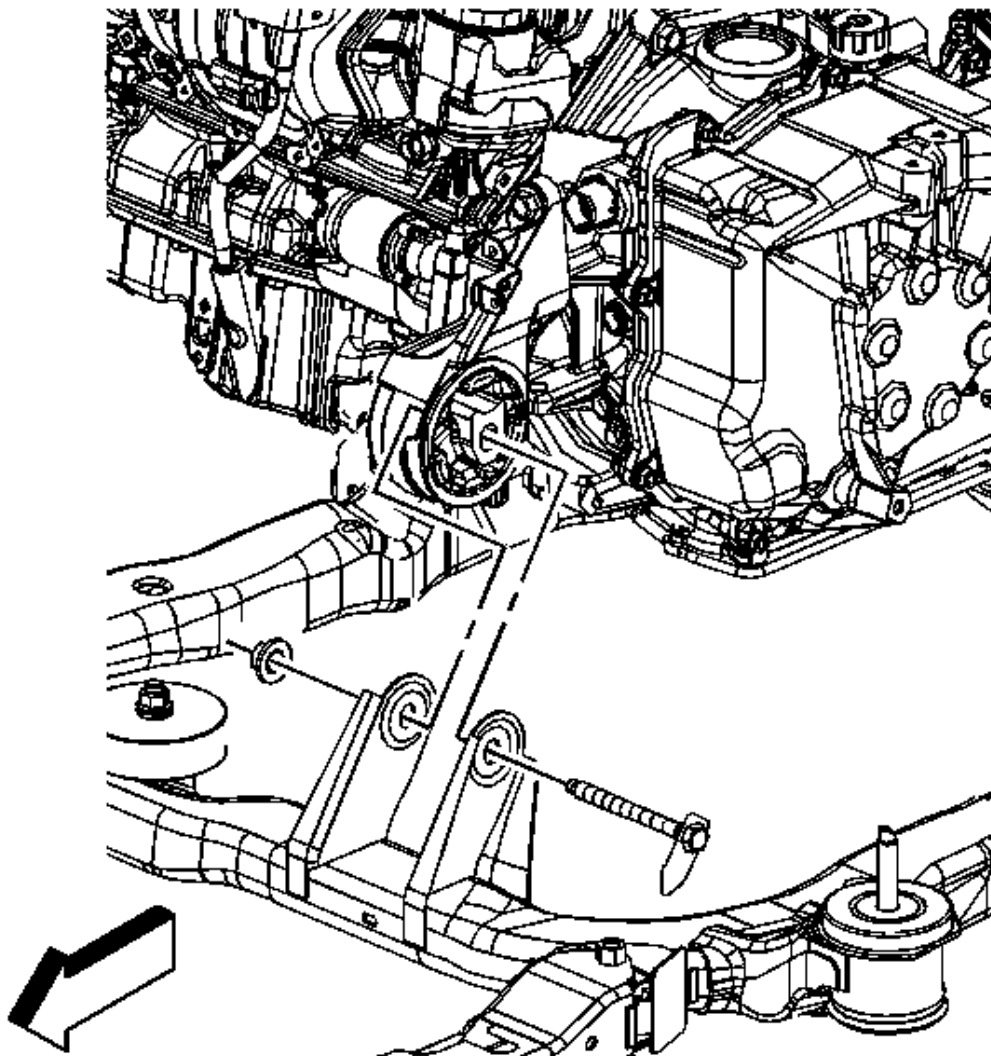


Fig. 13: Identifying Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Loosen, but DO NOT REMOVE the front transmission mount through bolt.

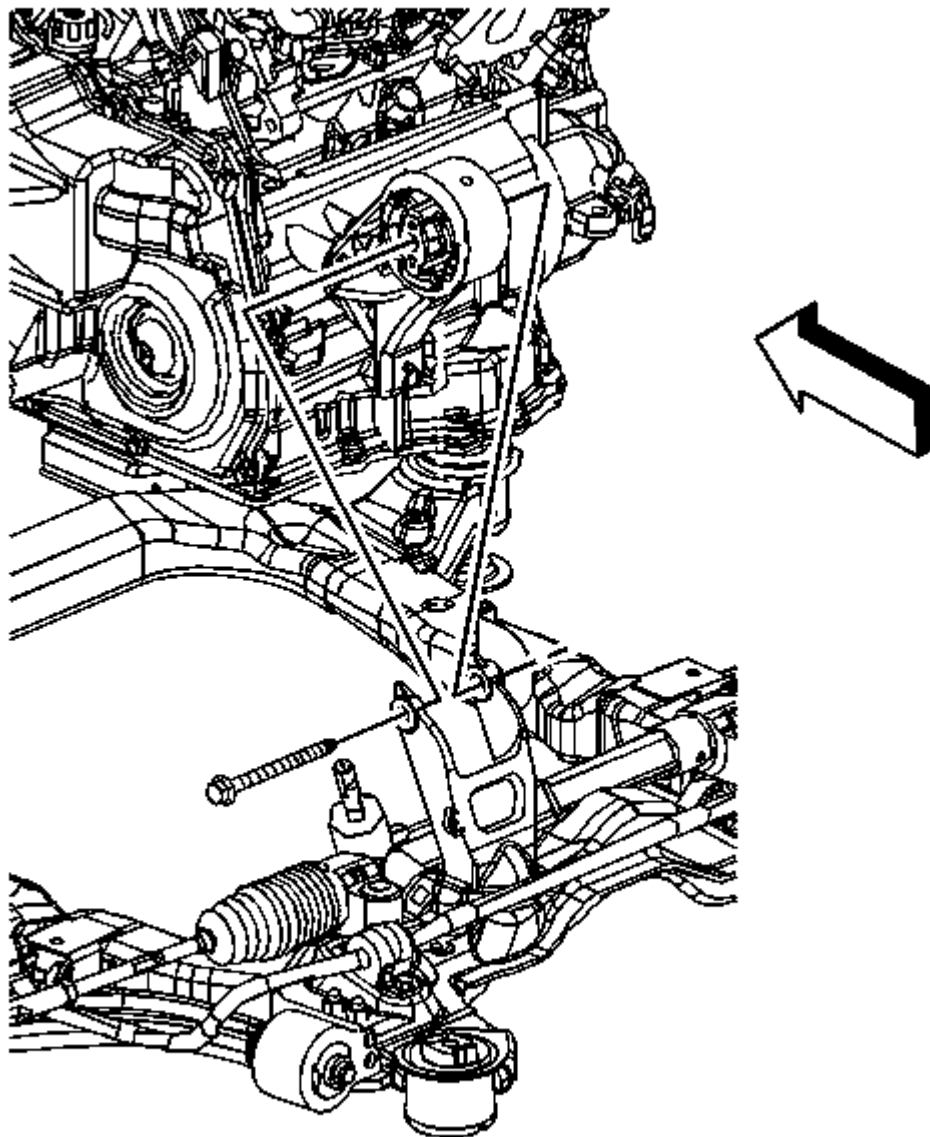


Fig. 14: Identifying Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS CORP.

3. Loosen, but DO NOT REMOVE the rear transmission mount through bolt.
4. Position 2 floor jacks with wood blocks under the engine and transmission to support the powertrain.

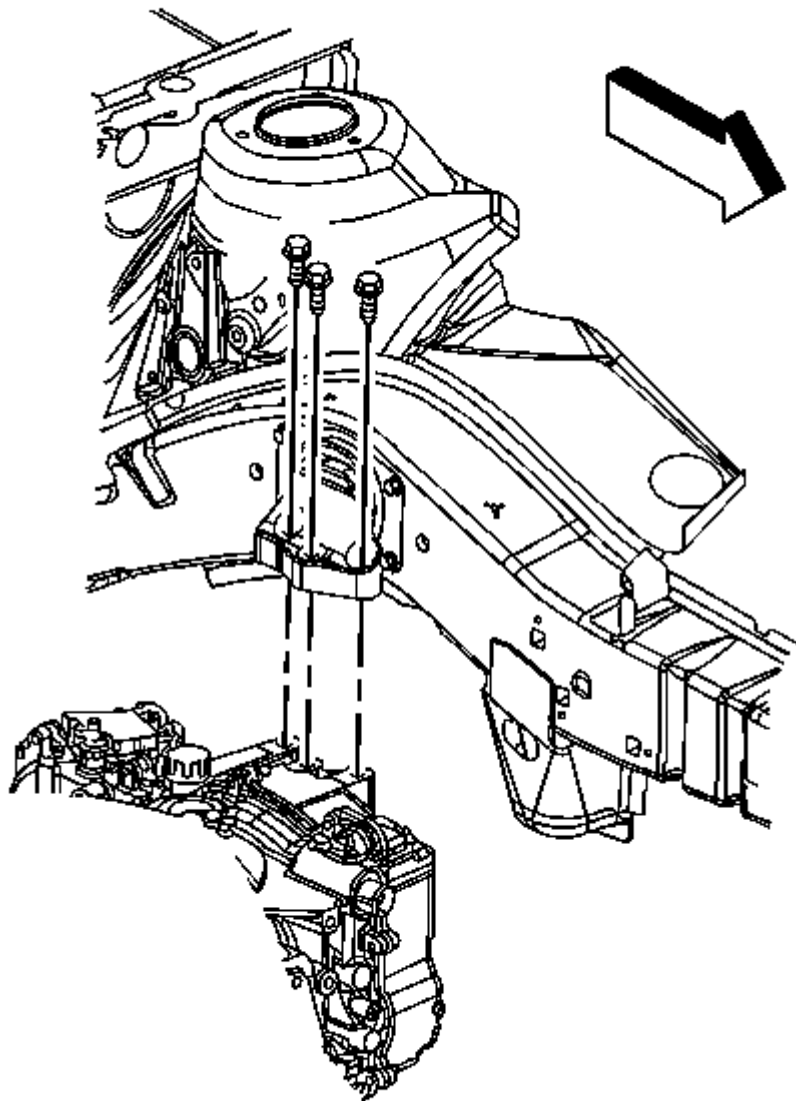


Fig. 15: Identifying Transmission Mount Bracket-To-Transmission Bolts
Courtesy of GENERAL MOTORS CORP.

5. From inside the engine compartment, loosen the transmission mount bracket to transmission bolts.

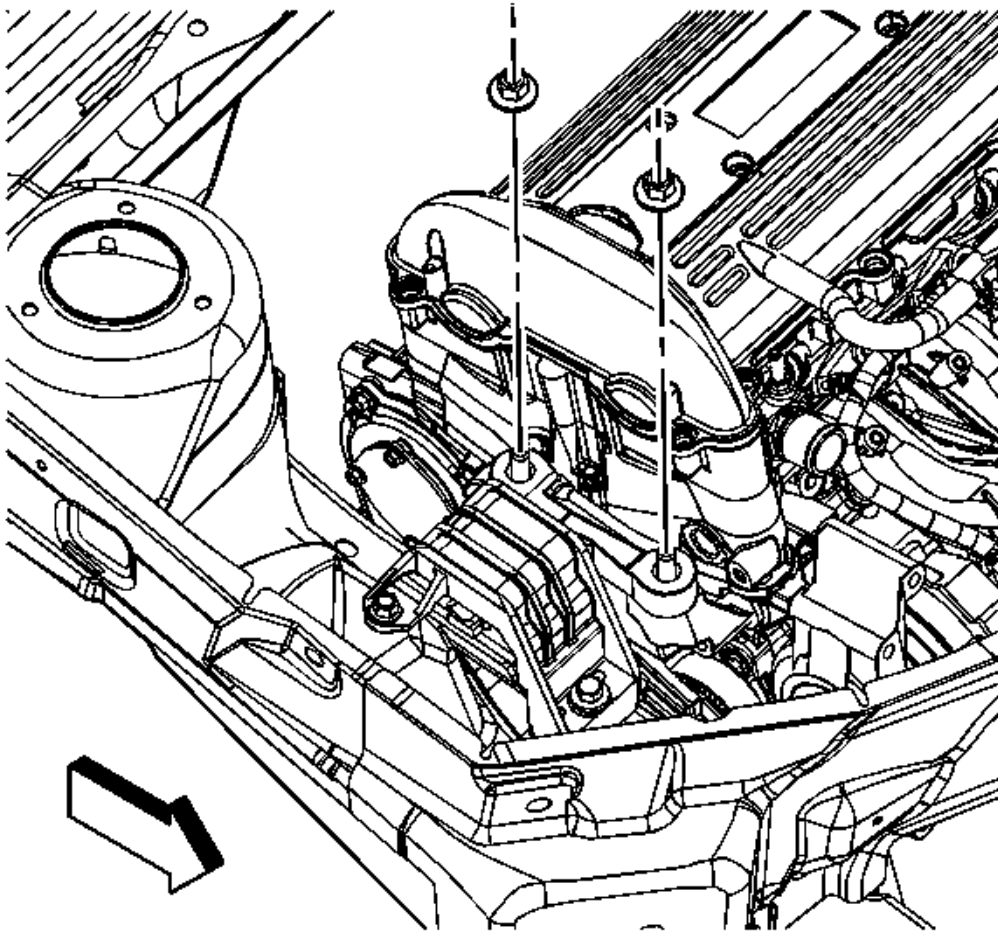


Fig. 16: Identifying Engine Mount & Engine Mount Bracket Nuts
Courtesy of GENERAL MOTORS CORP.

6. Loosen the engine mount bracket nuts.
7. Reposition the floor jacks to allow a 1/8 inch gap between the engine mount and engine mount bracket.

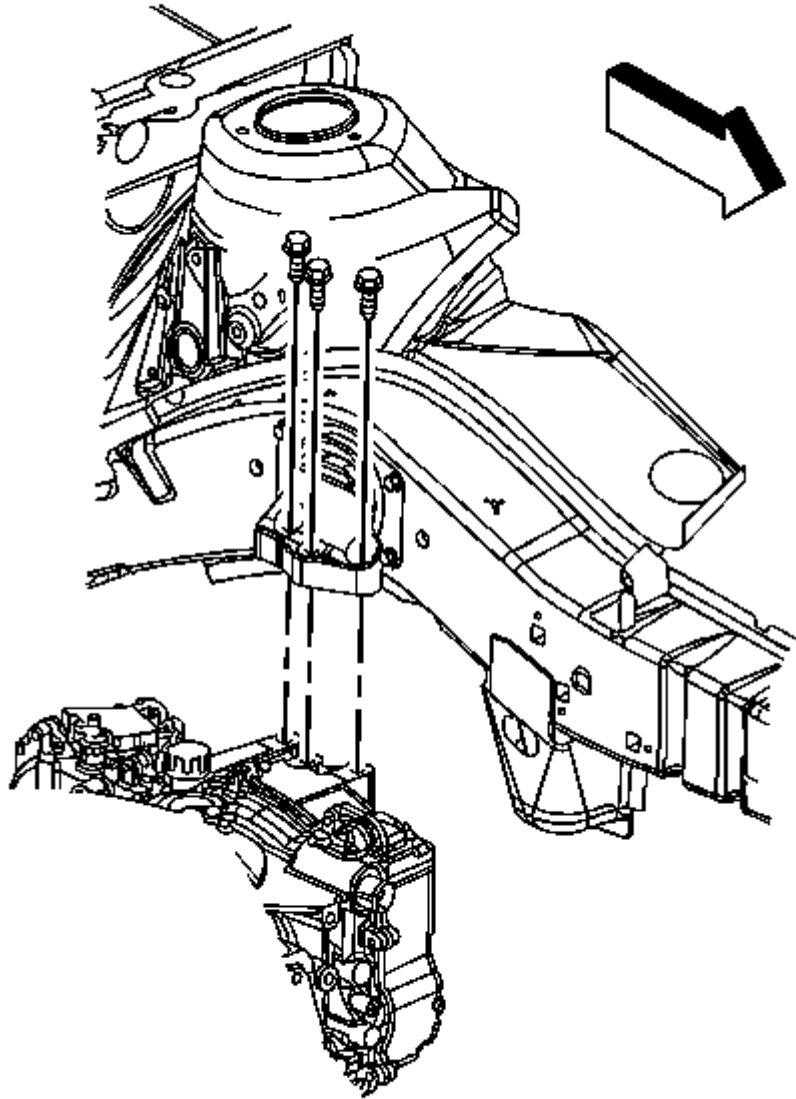


Fig. 17: Identifying Transmission Mount Bracket-To-Transmission Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

8. Tighten the transmission mount bracket to transmission bolts using the following sequence:
 1. Rear bolt

2. Middle bolt
3. Front bolt

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

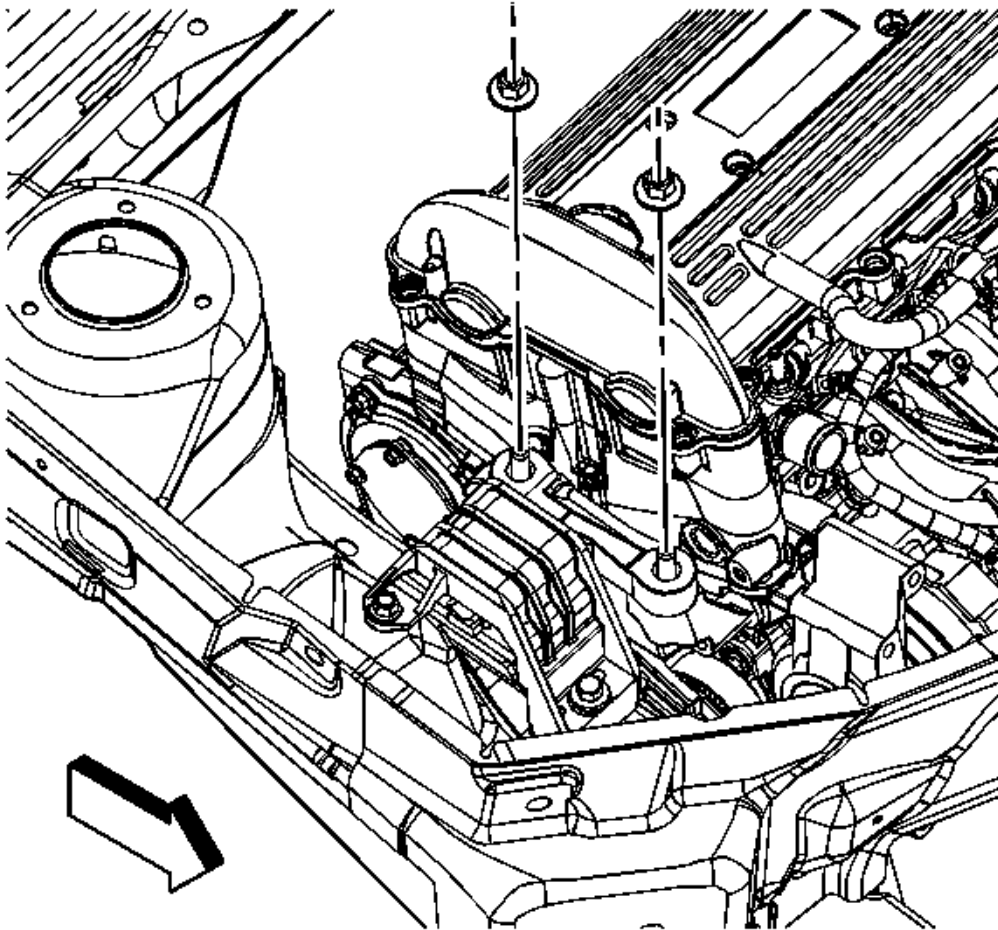


Fig. 18: Identifying Engine Mount & Engine Mount Bracket Nuts
Courtesy of GENERAL MOTORS CORP.

9. Tighten the engine mount bracket nuts.

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

10. Remove the floor jacks.

11. Rock the powertrain vigorously from front to rear and allow the powertrain to settle.

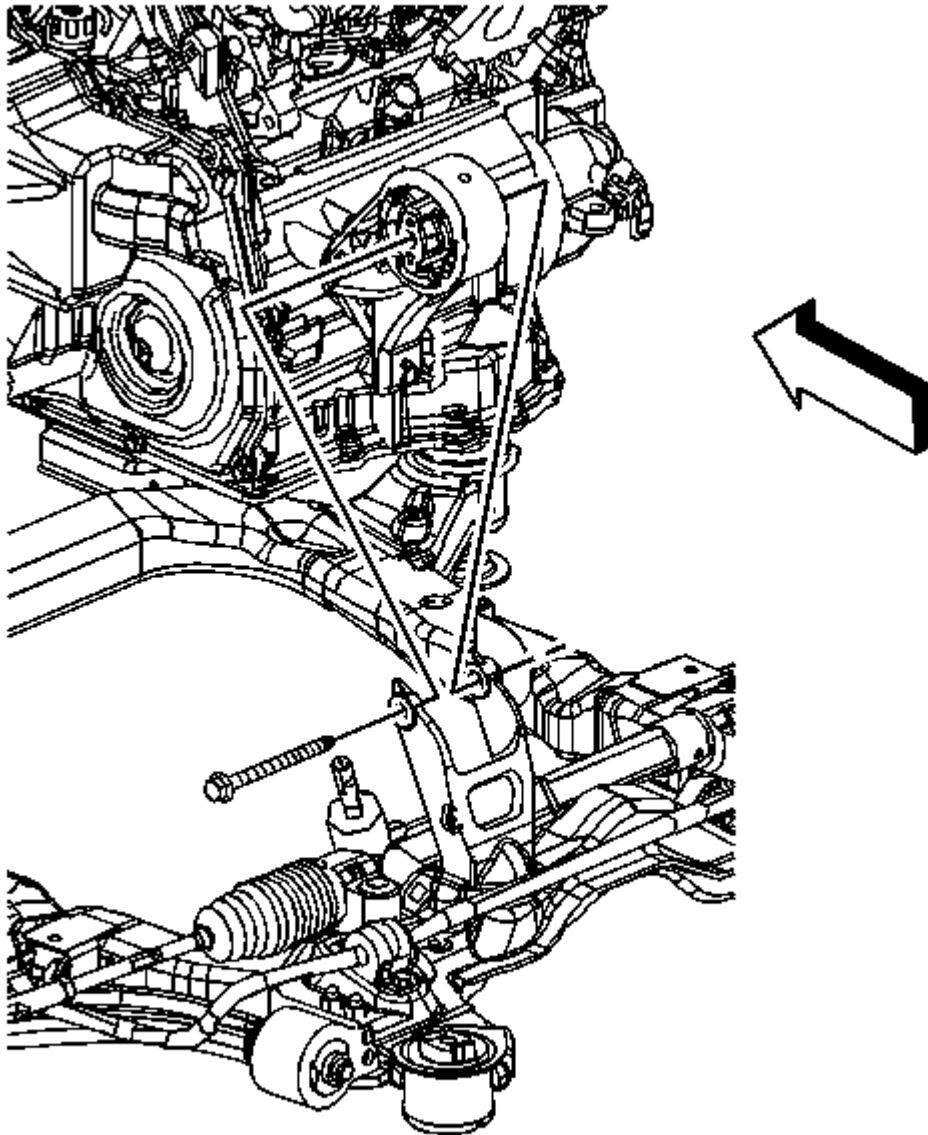


Fig. 19: Identifying Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS CORP.

12. Tighten the rear transmission mount through bolt.

Tighten: Tighten the bolt to 90 N.m (66 lb ft).

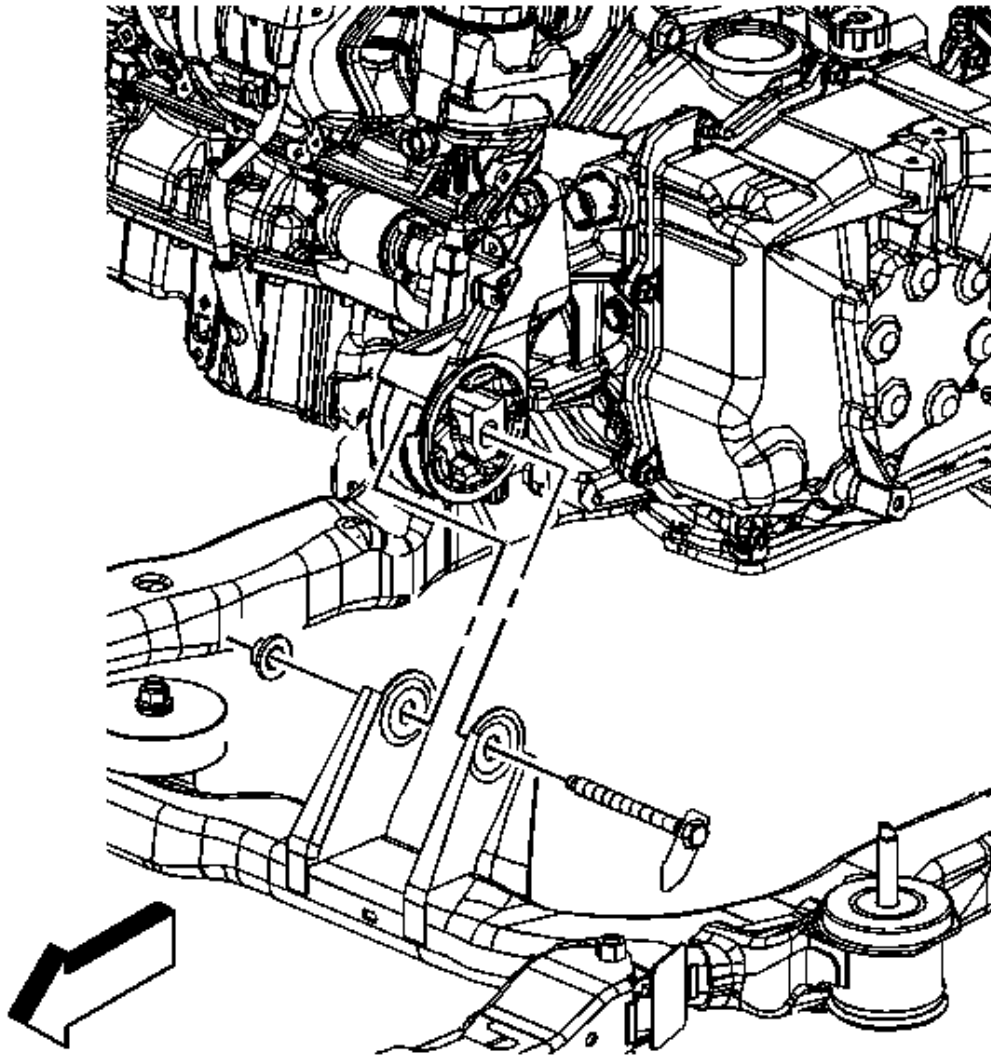


Fig. 20: Identifying Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS CORP.

13. Tighten the front transmission mount through bolt.

Tighten: Tighten the bolt to 90 N.m (66 lb ft).

14. Lower the vehicle.

POWERTRAIN MOUNT BALANCE - LOWER MOUNT

NOTE: Follow the balance procedure in the order listed in the following steps. Powertrain mounts must be tightened in sequence.

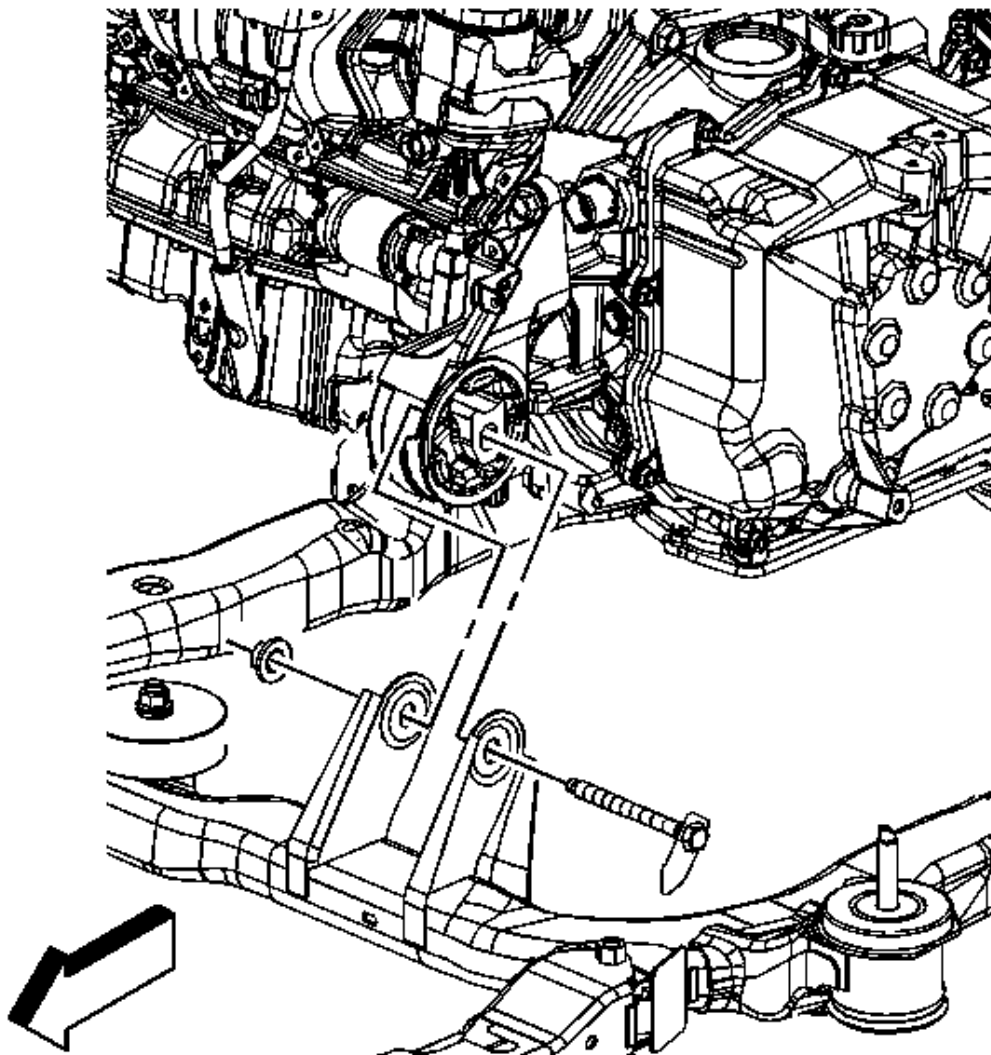


Fig. 21: Identifying Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Loosen, but DO NOT REMOVE the front transmission mount through bolt.

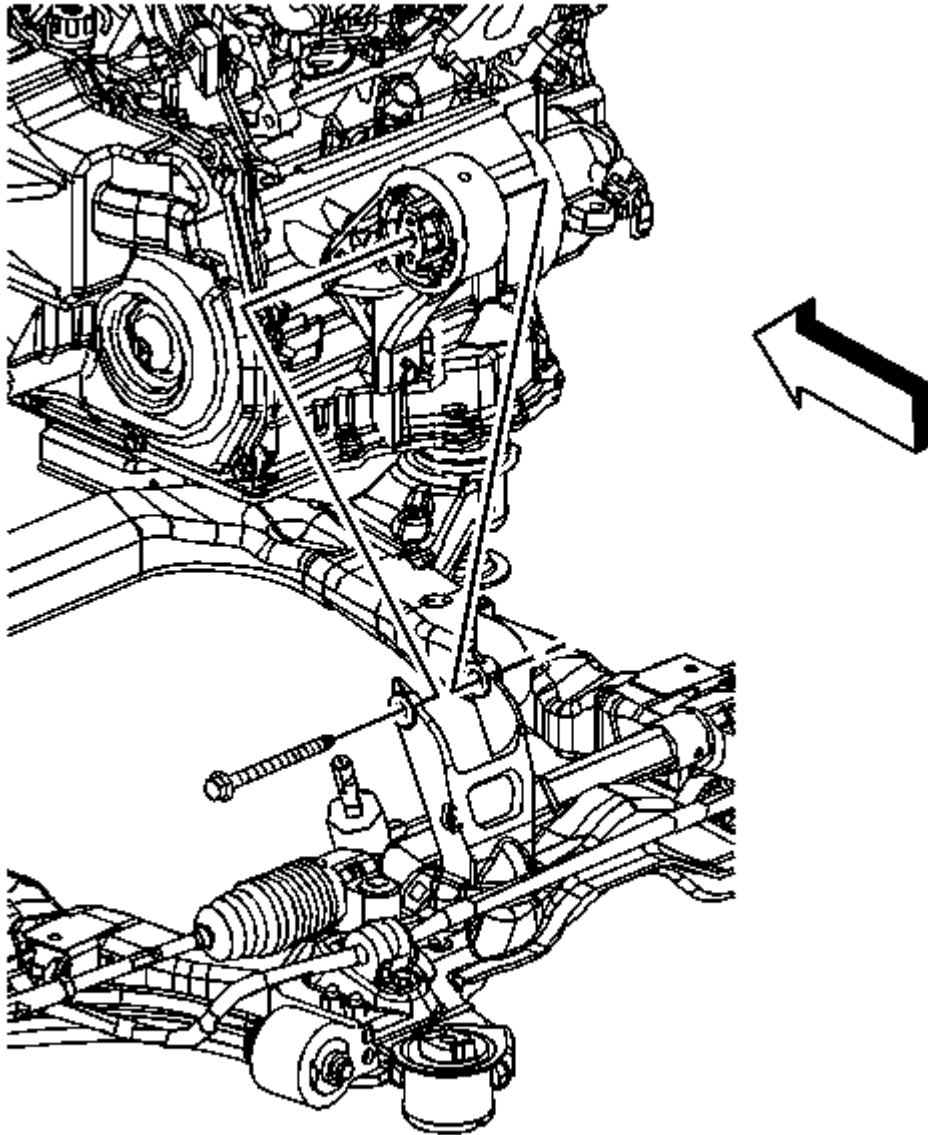


Fig. 22: Identifying Rear Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS CORP.

3. Loosen, but DO NOT REMOVE the rear transmission mount through bolt.
4. Rock the powertrain vigorously from front to rear and allow the powertrain to settle.

CAUTION: Refer to Fastener Caution .

5. Tighten the rear transmission mount through bolt.

Tighten: Tighten the bolt to 90 N.m (66 lb ft).

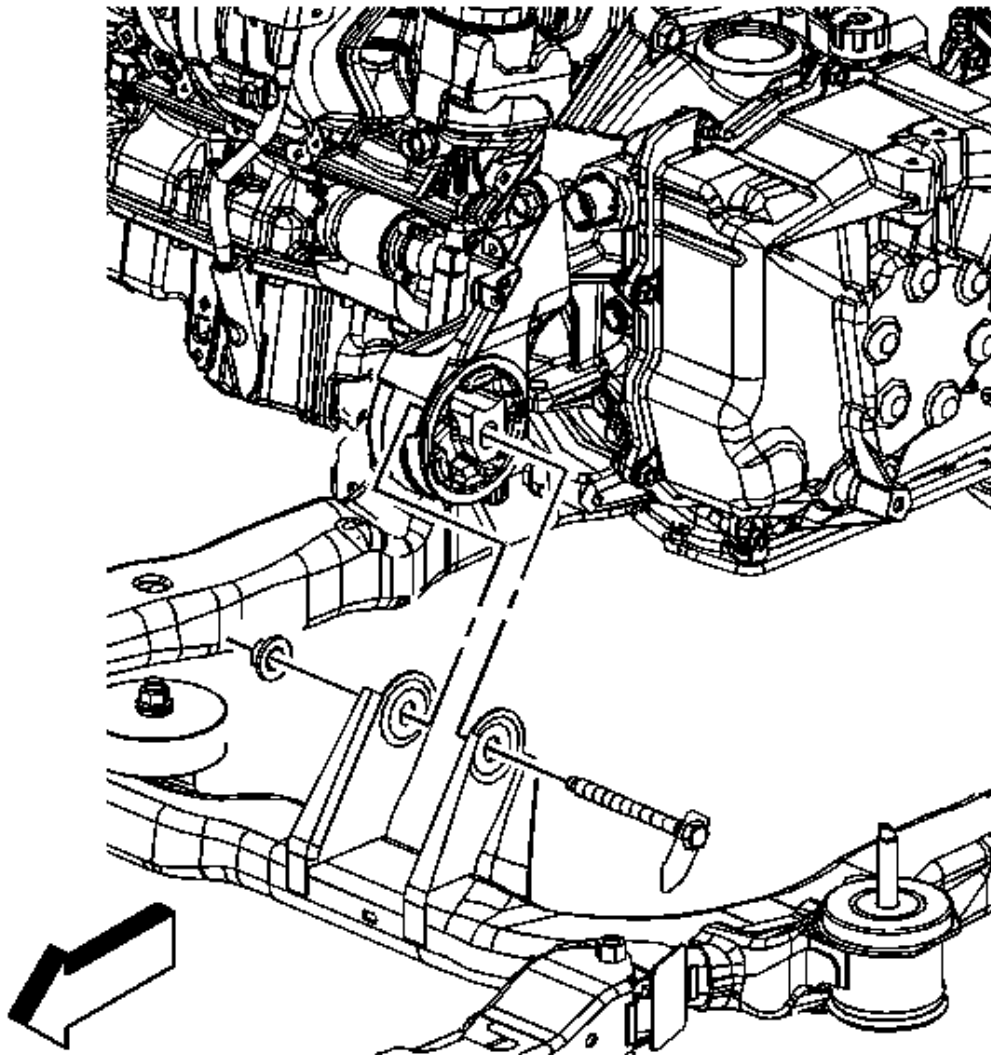


Fig. 23: Identifying Front Transmission Mount Through Bolt
Courtesy of GENERAL MOTORS CORP.

6. Tighten the front transmission mount through bolt.

Tighten: Tighten the bolt to 90 N.m (66 lb ft).

7. Lower the vehicle.

ENGINE MOUNT REPLACEMENT

REMOVAL PROCEDURE

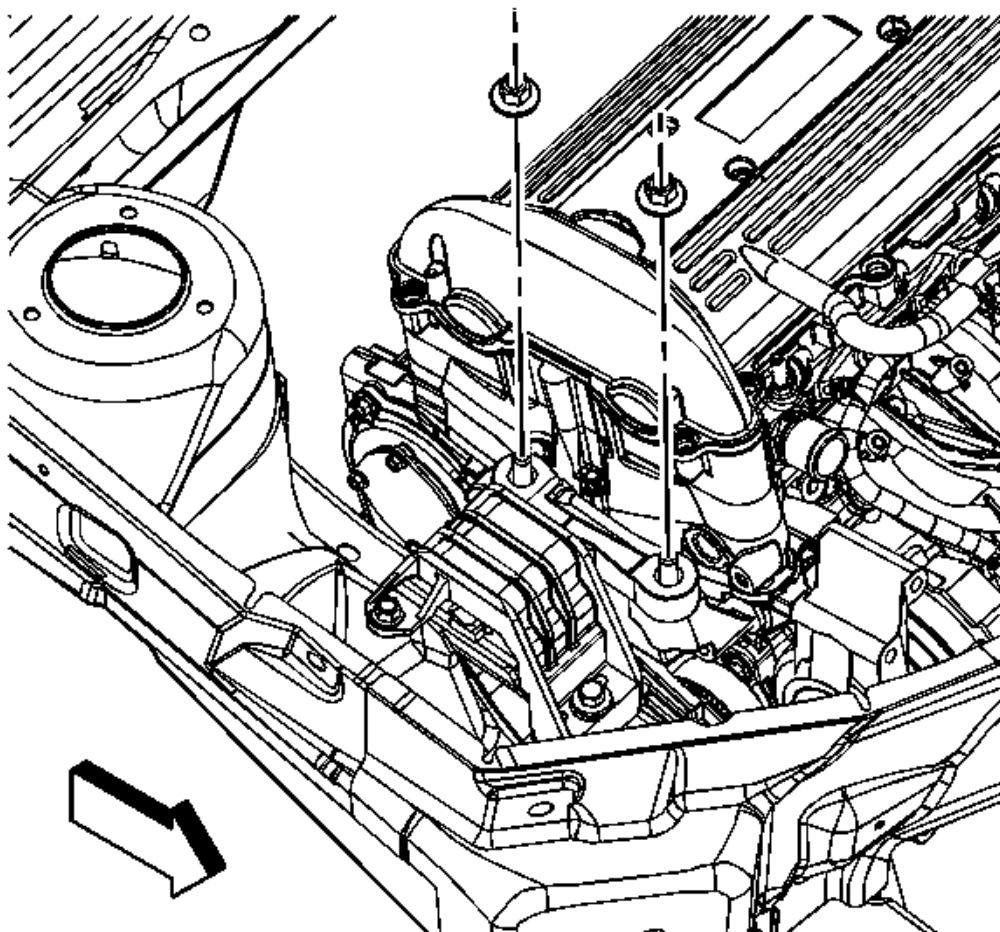


Fig. 24: Identifying Engine Mount & Engine Mount Bracket Nuts
Courtesy of GENERAL MOTORS CORP.

1. Use a floor jack and a block of wood to support the powertrain from under the oil pan.
2. Remove the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).

3. Remove the engine mount bracket nuts.

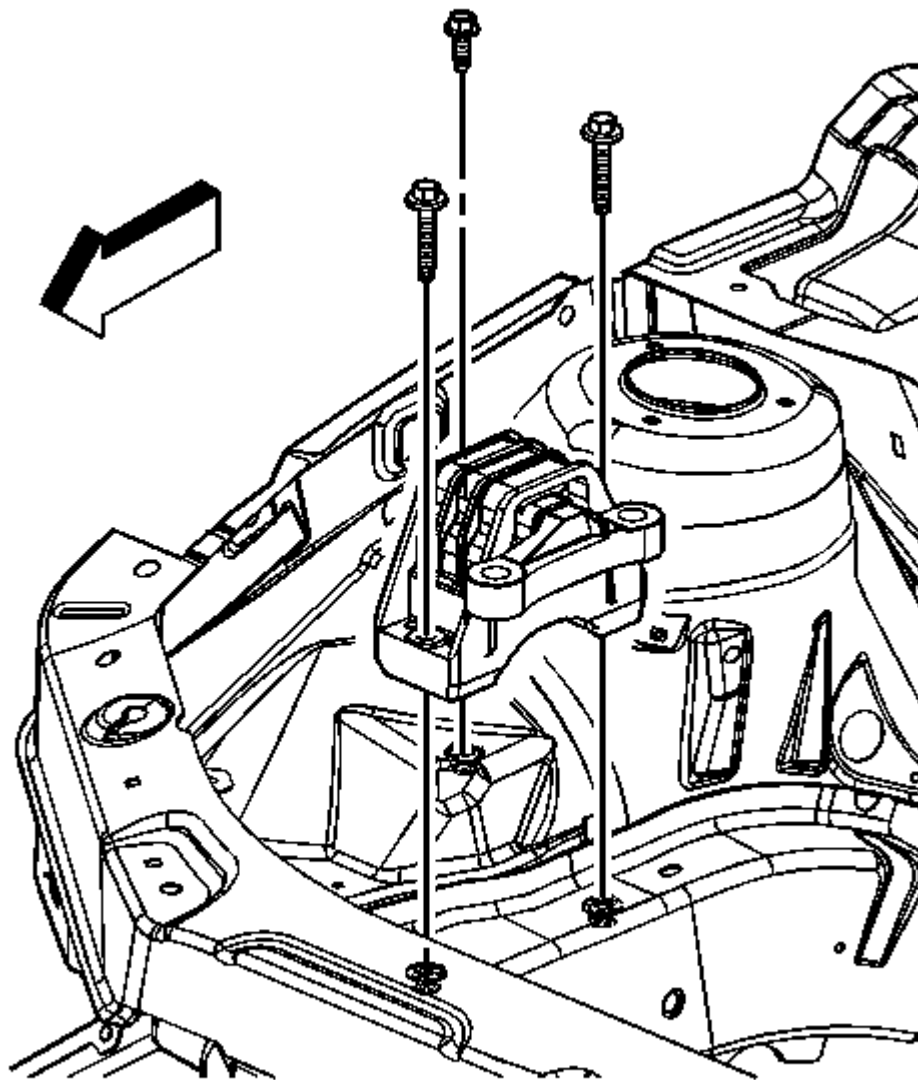


Fig. 25: Identifying Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine mount bolts.
5. Remove the engine mount.

INSTALLATION PROCEDURE

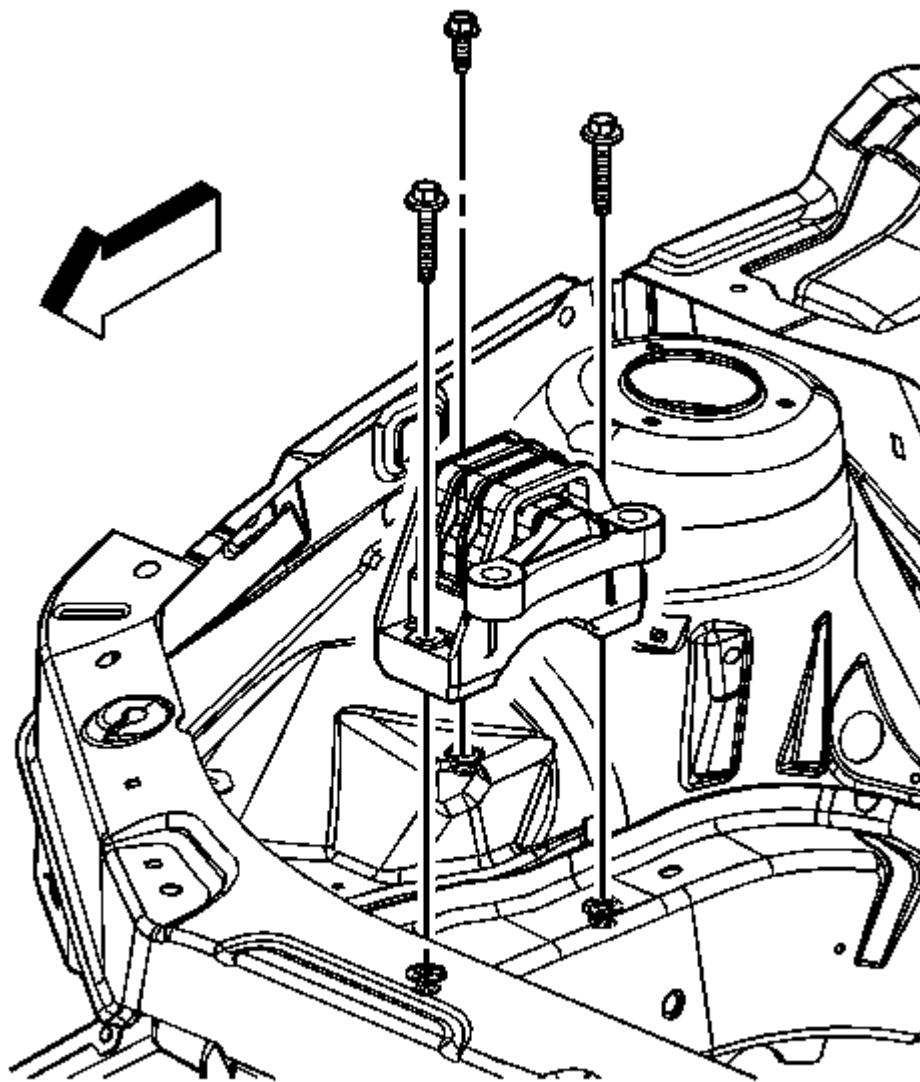


Fig. 26: Identifying Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount to the vehicle.
2. Install and finger tighten the engine mount bolts.

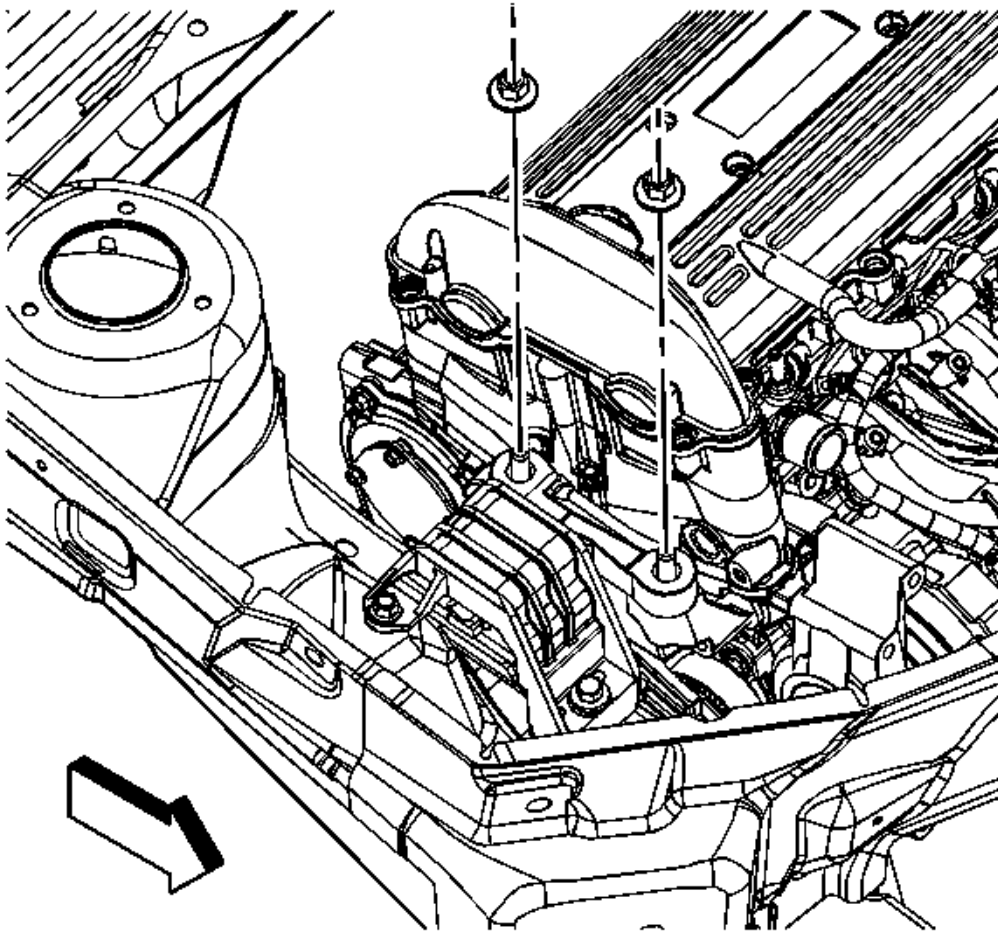


Fig. 27: Identifying Engine Mount & Engine Mount Bracket Nuts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the engine mount bracket nuts.

Tighten:

- Tighten the nuts to 50 N.m (37 lb ft).
- Tighten the bolts to 50 N.m (37 lb ft).

4. Remove the floor jack and the block of wood from under the oil pan.

5. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#) .

ENGINE SUPPORT FIXTURE

SPECIAL TOOLS

- **J 28467-B** Universal Engine Support Fixture. See [Special Tools](#) .
- **J 36462** Engine Support Adapter Leg. See [Special Tools](#) .

INSTALLATION PROCEDURE

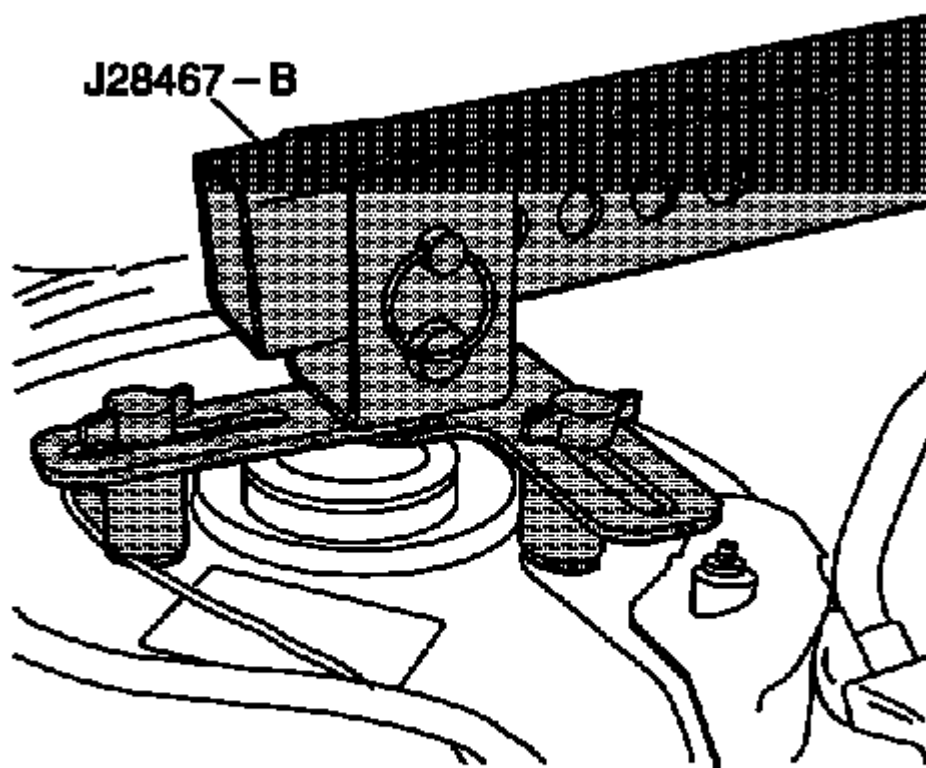


Fig. 28: Identifying Engine Support Fixture (J 28467-B)
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
2. Raise the hood.
3. Install the J 28467-33A thread support nuts onto the strut attaching studs.
4. Install the J 28467-5A strut tower support assemblies over the J 28467-33A thread support nuts.
5. Install the J 28467-53 T-bolts with 5/16 inch washers through the J 28467-5A strut tower support

assemblies into the J 28467-33A thread support nuts and hand tighten.

6. Install the J 28467-1A 2 cross bracket assemblies over the J 28467-3 strut tower tube.
7. Install the J 28467-3 strut tower tube into the J 28467-5A strut tower support assemblies.
8. Install the J 28467-10 1/2 inch x 2.5 inch quick release pin through the J 28467-5A strut tower support assemblies and the J 28467-3 strut tower tube on one side only.

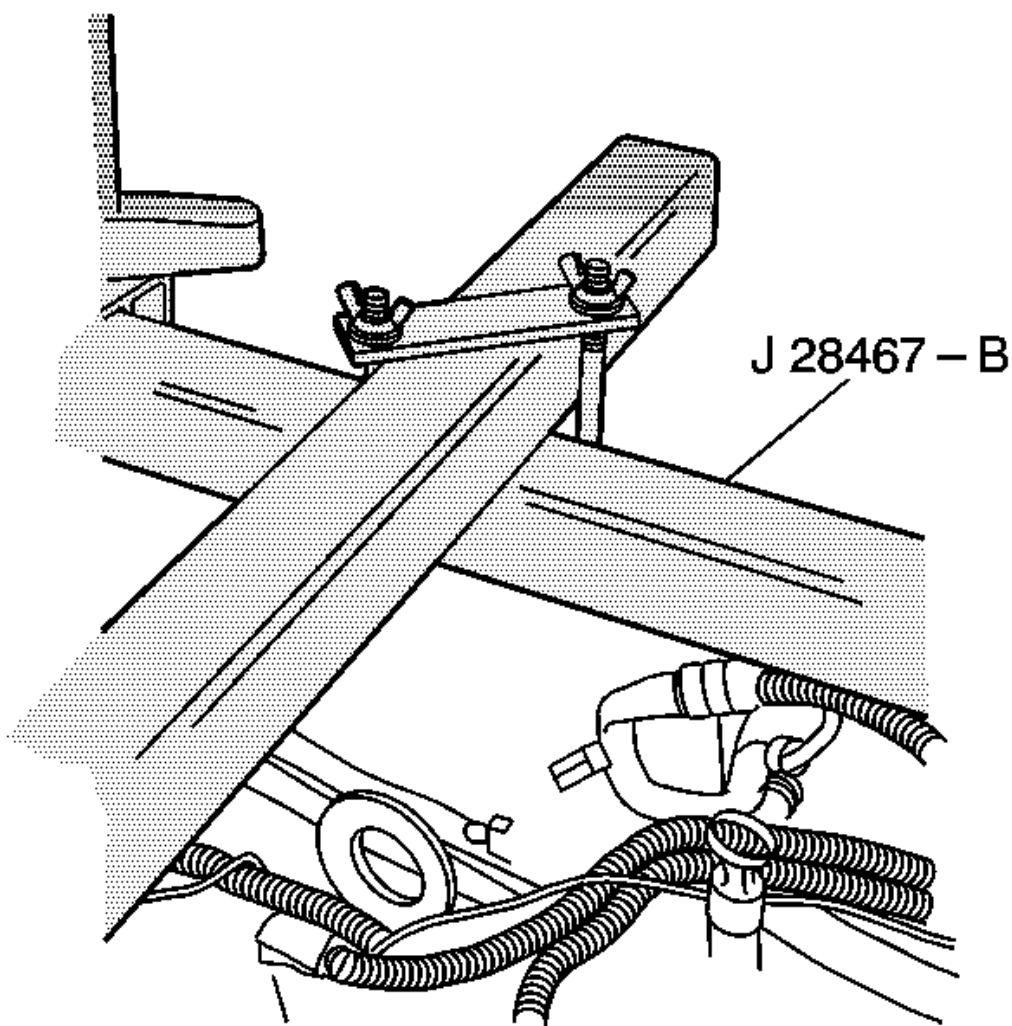


Fig. 29: View Of Engine Support Fixture (J 28467-B)
Courtesy of GENERAL MOTORS CORP.

9. Install the J 28467-2A radiator shelf tube through the J 28467-1A driver side cross bracket assembly on the top of the J 28467-3 strut tower tube.

10. Place the rubber padded foot of the J 28467-4A front support assembly on the vehicle radiator shelf. The foot position used in the J 28467-4A front support assembly depends on the vehicle application.
11. Install the J 28467-9 7/16 inch x 2.0 inch quick release pin through the hole in the J 28467-4A front support assembly in order to level the J 28467-2A radiator shelf tube. The hole used in the J 28467-4A front support assembly depends on the vehicle application.
12. Install the J 28467-7A lift hook through the J 28467-6A lift hook bracket.
13. Install the 1/2 inch lift hook washer and J 28467-34 lift hook wing nut onto the J 28467-7A lift hook.
14. Install the J 28467-6A assembled lift hook bracket over the J 28467-2A radiator shelf tube.
15. Adjust the J 28467-2A radiator shelf tube and the J 28467-6A assemblage lift hook bracket in order to align the hook with the left (front), rear of engine, lift hook bracket part of the left engine mount strut bracket.
16. Hand tighten the J 28467-1A driver side cross bracket assembly wing nuts.
17. Install the J 28467-2A second radiator shelf tube through the J 28467-1A passenger side cross bracket assembly on the top of the J 28467-3 strut tower tube.
18. Place the rubber padded foot of the J 28467-4A front support assembly on the vehicle radiator shelf. The foot position used in the J 28467-4A front support assembly depends on the vehicle application.
19. Install the J 28467-9 7/16 inch x 2.0 inch quick release pin through the hole in the J 28467-4A front support assembly in order to level the J 28467-2A radiator shelf tube. The hole used in the J 28467-4A front support assembly depends on the vehicle application.
20. Install the J 28467-7A lift hook through the J 28467-6A lift hook bracket.
21. Install the 1/2 inch lift hook washer and J 28467-34 lift hook wing nut onto the J 28467-7A lift hook.
22. Install the J 28467-6A assemblage lift hook bracket over the J 28467-2A radiator shelf tube.
23. Adjust the J 28467-2A radiator shelf tube and the J 28467-6A assemblage lift hook bracket in order to align the hook with the right (rear), front of engine, lift hook bracket located next to the generator.
24. Hand tighten the J 28467-1A passenger side cross bracket assembly wing nuts.
25. Hand tighten the J 28467-34 lift hook wing nuts securely to remove all slack from the engine support fixture assembly.

OIL LEVEL INDICATOR TUBE REPLACEMENT (LE5)

REMOVAL PROCEDURE

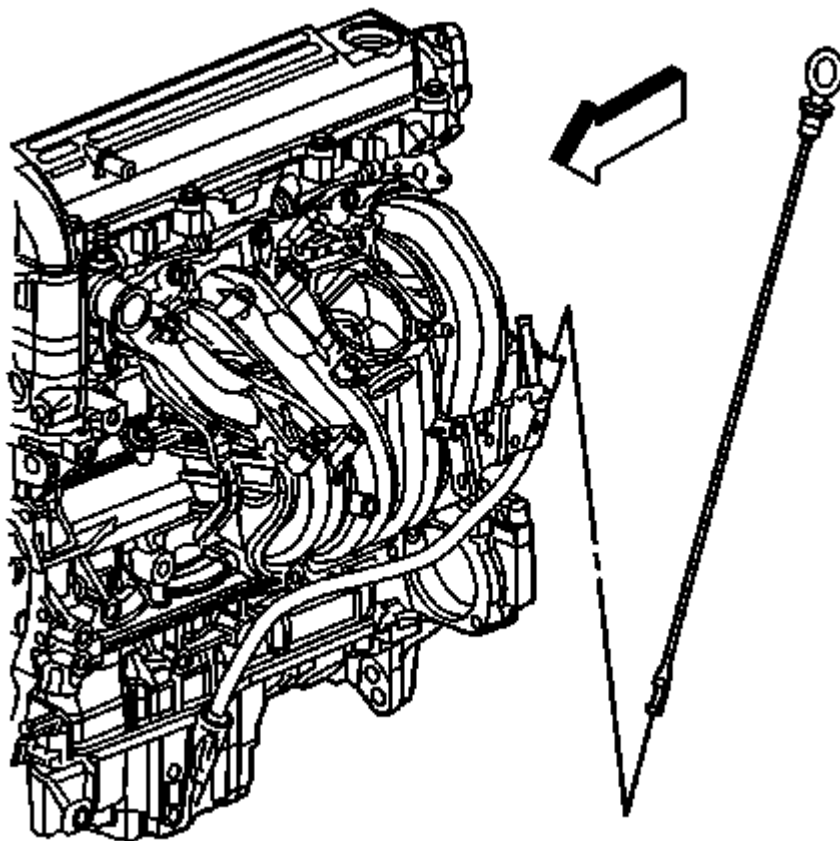


Fig. 30: Identifying Oil Level Indicator
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator.

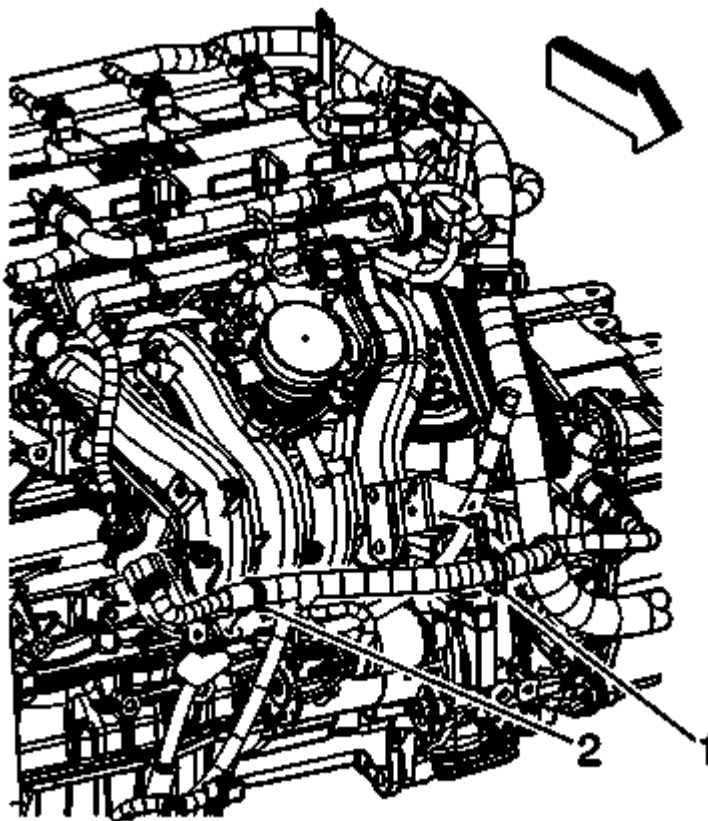


Fig. 31: Identifying Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

2. Remove the engine harness clip (1) from the oil level indicator tube.

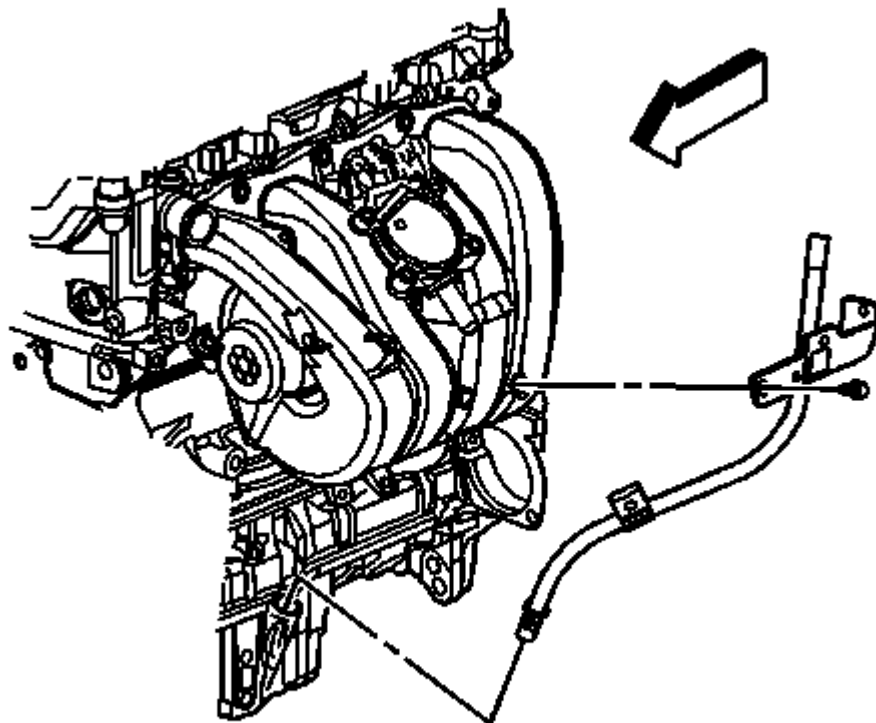


Fig. 32: View Of Oil Level Indicator Tube & Bolt
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

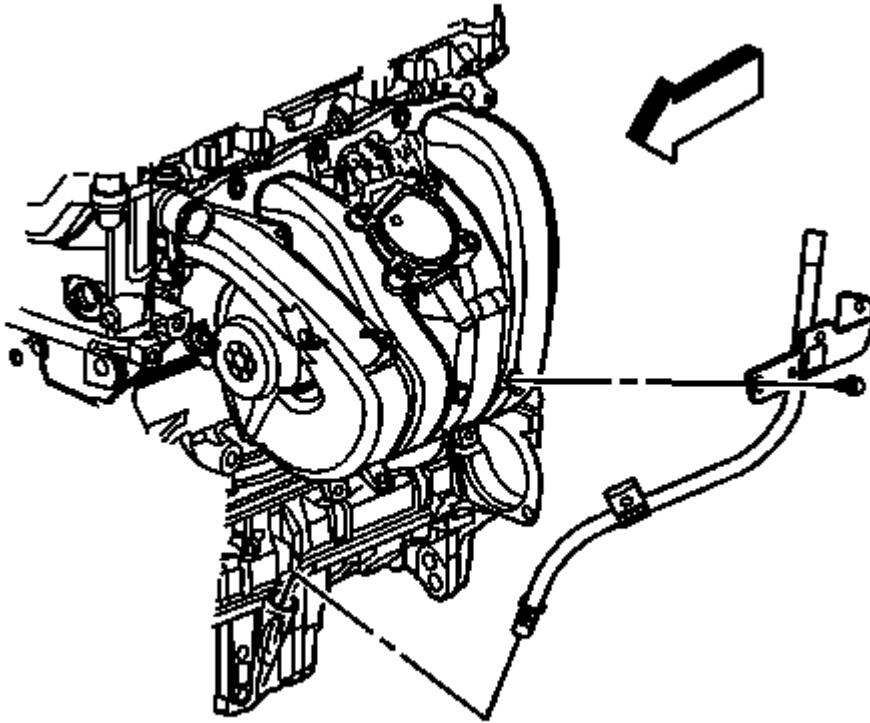


Fig. 33: View Of Oil Level Indicator Tube & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the oil level indicator tube O-ring seal with engine oil lubricant.
2. Install the oil level indicator tube.

CAUTION: Refer to Fastener Caution .

3. Install the oil level indicator tube bolt and tighten to 10 N.m (89 lb in).

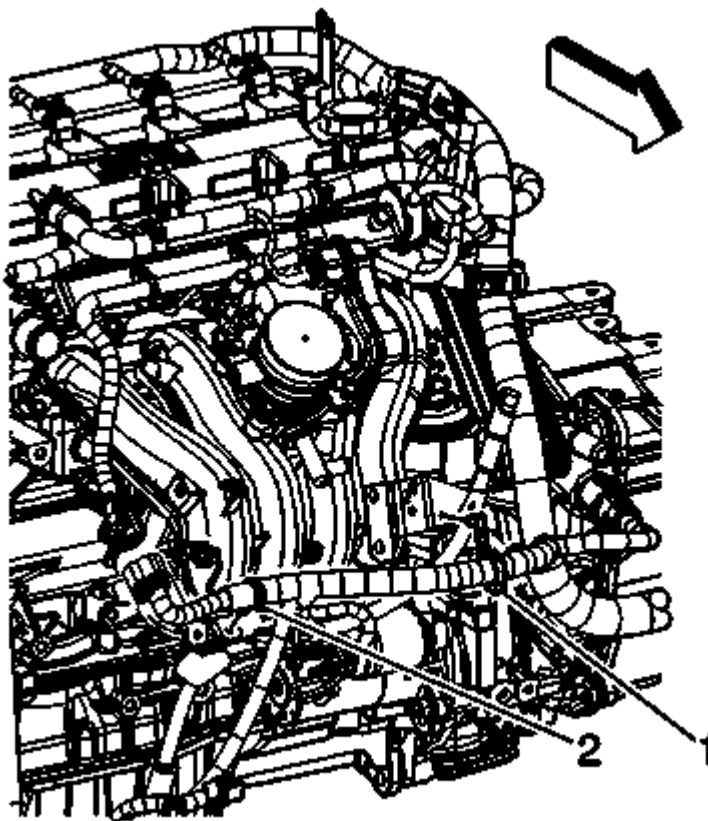


Fig. 34: Identifying Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

4. Install the engine harness clip (1) to the oil level indicator tube.

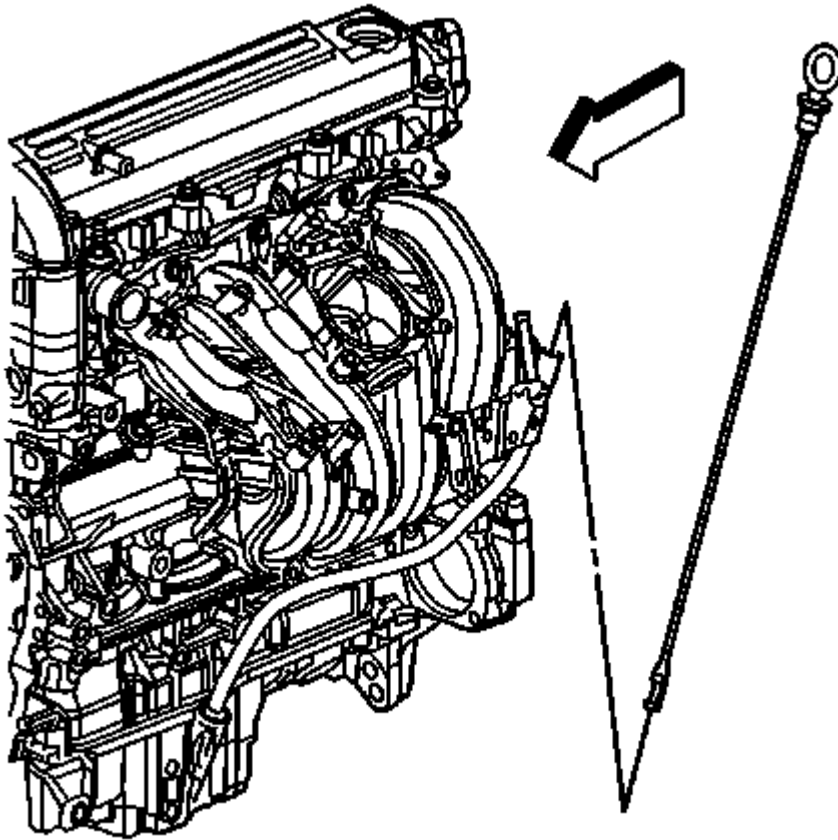


Fig. 35: Identifying Oil Level Indicator
Courtesy of GENERAL MOTORS CORP.

5. Install the oil level indicator.

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (LE5)

REMOVAL PROCEDURE

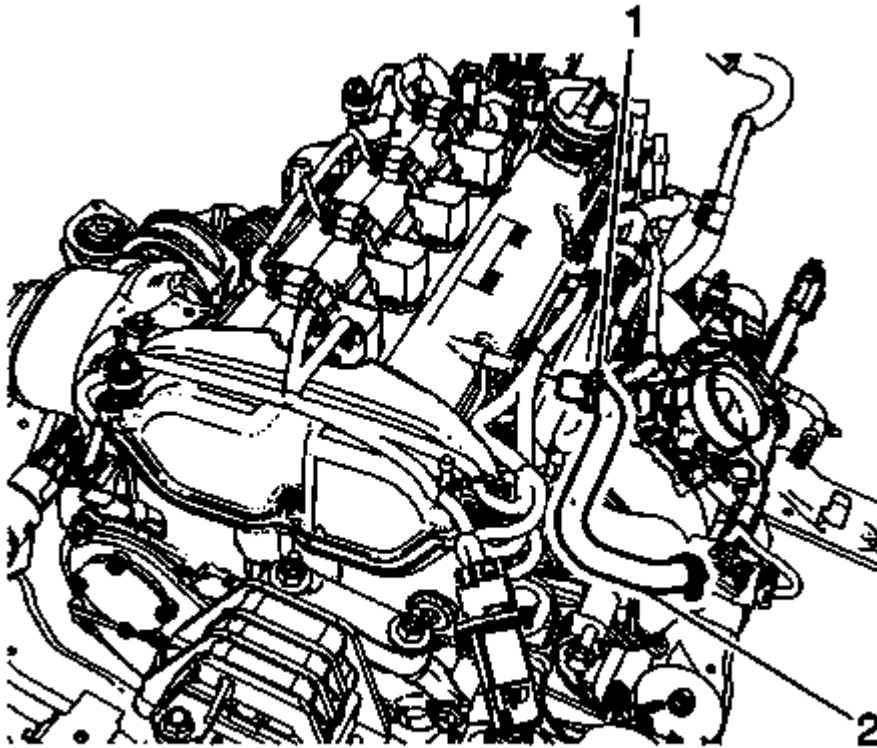


Fig. 36: Locating PCV Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
2. Reposition the positive crankcase ventilation (PCV) hose clamp (1) at the camshaft cover.
3. Remove the PCV hose (2) from the camshaft cover.

INSTALLATION PROCEDURE

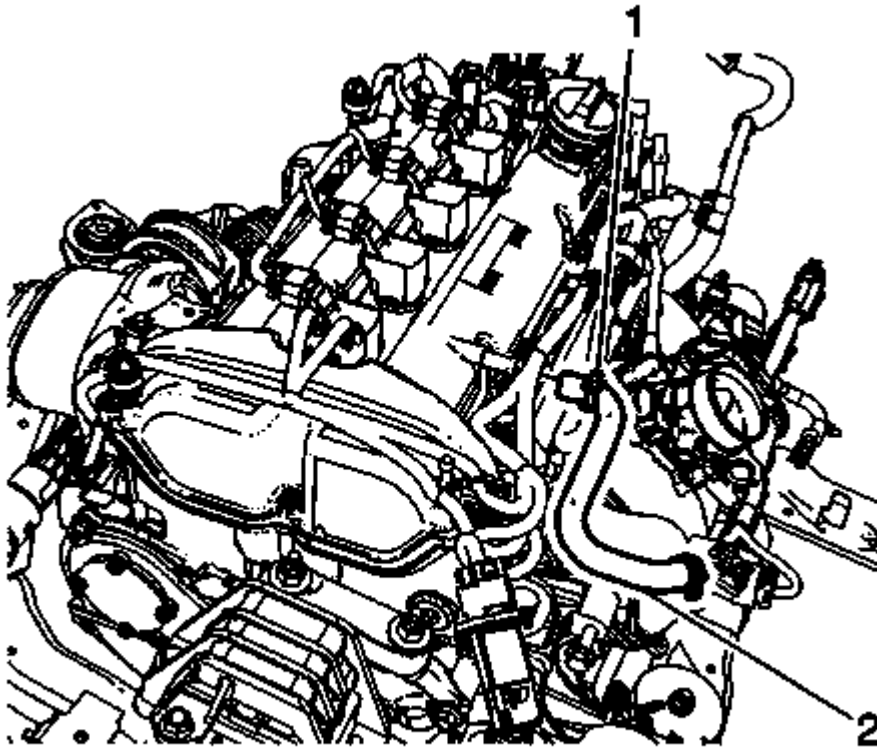


Fig. 37: Locating PCV Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

1. Install the PCV hose (2) to the camshaft cover.
2. Position the PCV hose clamp (1) at the camshaft cover.
3. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .

INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

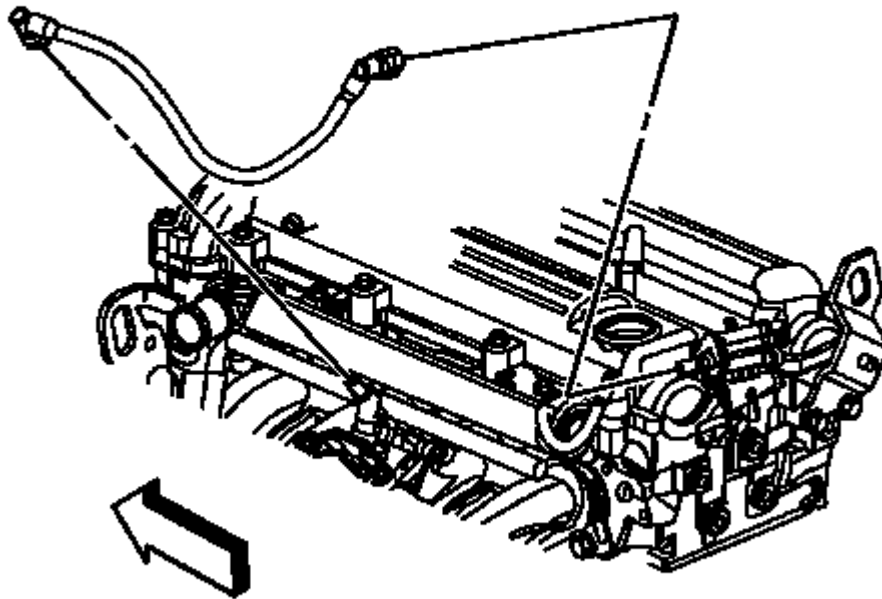


Fig. 38: Identifying EVAP Canister Purge Solenoid Valve Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the throttle body. Refer to **Throttle Body Assembly Replacement** .
2. Remove the fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement** .
3. Remove the evaporative emission (EVAP) canister purge solenoid valve tube. Refer to **Plastic Collar Quick Connect Fitting Service** .

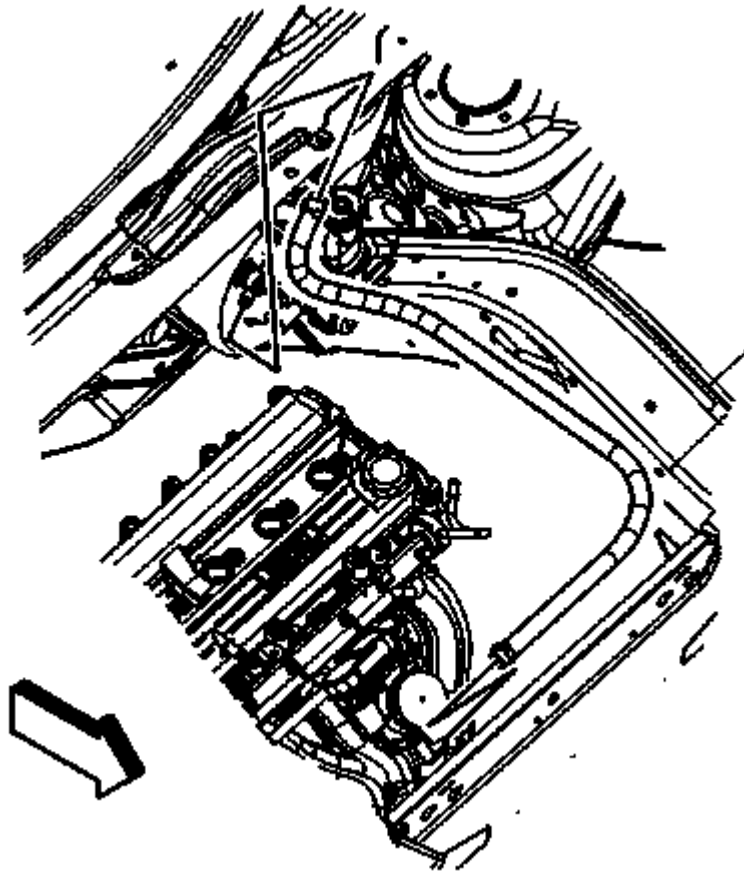


Fig. 39: Identifying Brake Booster Vacuum Hose & Clamps
Courtesy of GENERAL MOTORS CORP.

4. Reposition the brake booster vacuum hose clamp at the intake manifold.
5. Remove the brake booster hose from the intake manifold.
6. Remove the oil level indicator tube bolt.

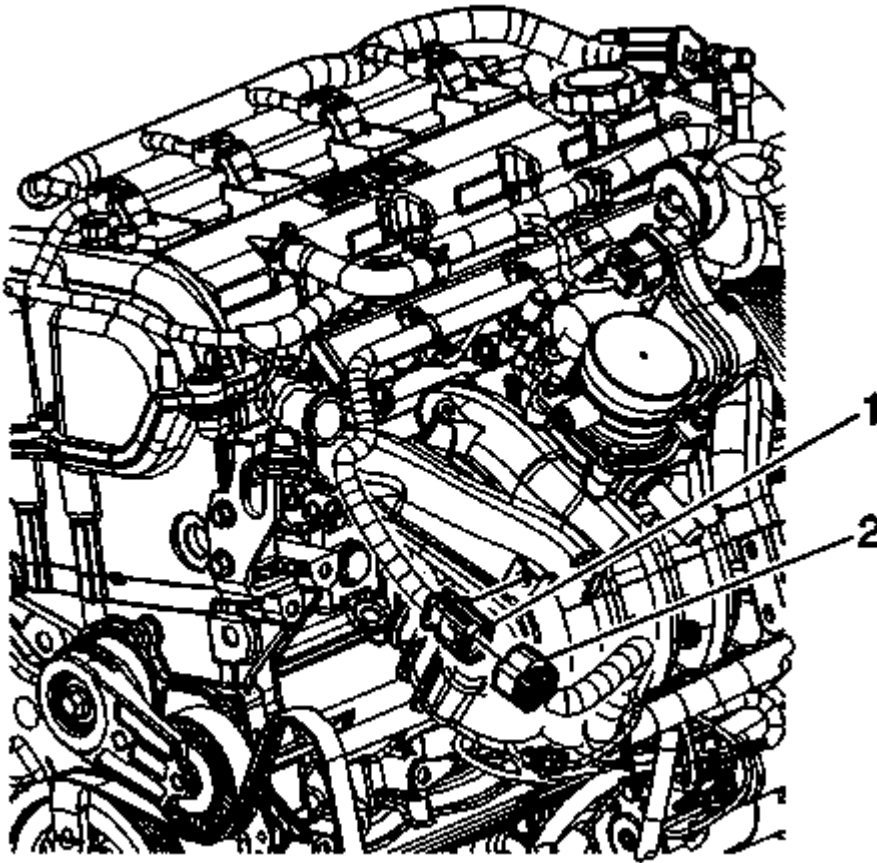


Fig. 40: Locating Fuel Injector Wiring Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the engine harness electrical connector (1) from the fuel injector inline electrical connector (2).
8. Remove the fuel injector inline connector clip from the intake manifold.

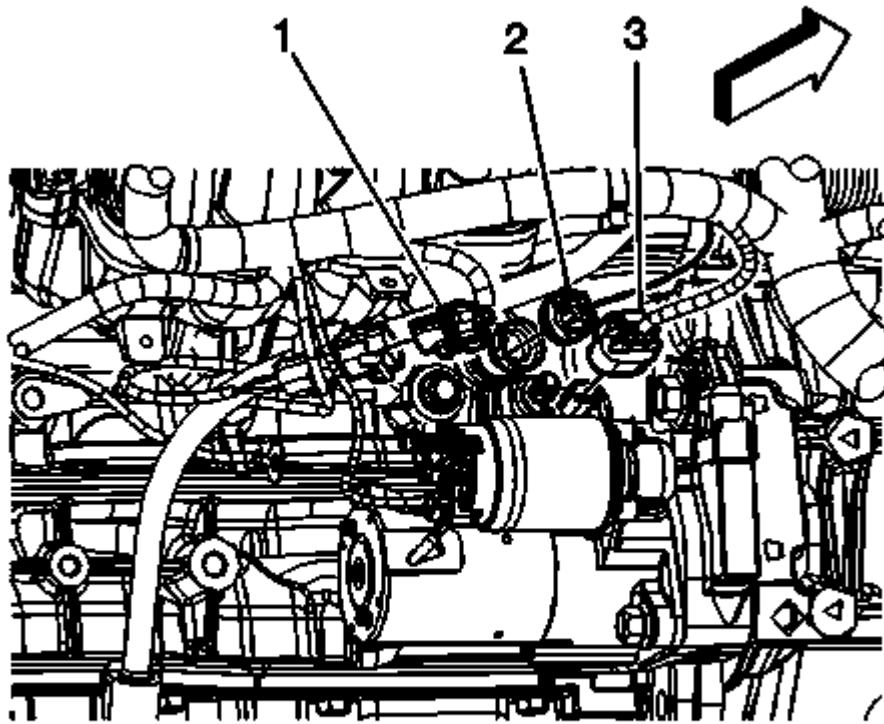


Fig. 41: Identifying Engine Oil Pressure Sensor, Knock Sensor & CKP Sensor Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

9. Disconnect the engine harness electrical connector (1) from the knock sensor harness.
10. Remove the knock sensor connector clip from the oil level indicator tube.

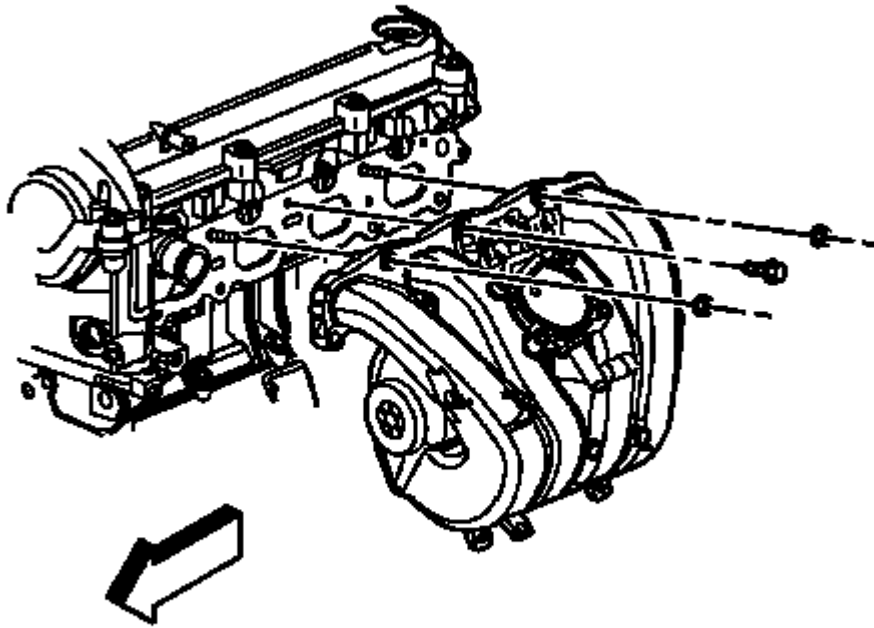


Fig. 42: Identifying Intake Manifold, Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

11. Remove the intake manifold bolts and nuts.
12. Remove the intake manifold.

NOTE: The intake manifold gasket is reusable. Only replace the gasket if damage has occurred.

13. Remove the intake manifold gasket, if necessary.

INSTALLATION PROCEDURE

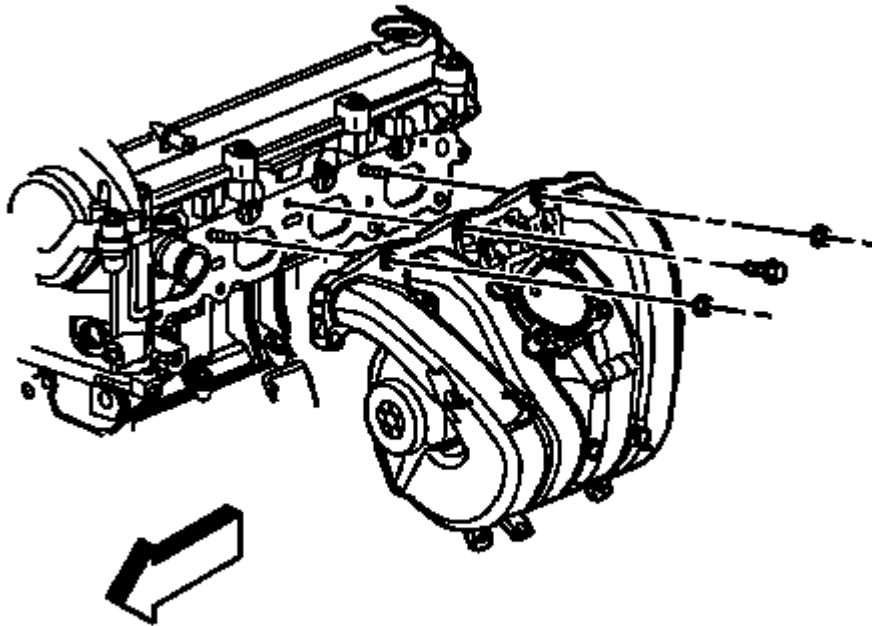


Fig. 43: Identifying Intake Manifold, Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

1. Install the intake manifold gasket, if necessary.
2. Install the intake manifold.

CAUTION: Refer to Fastener Caution .

3. Install the intake manifold bolts and nuts.

Tighten: Tighten the bolts and nuts to 10 N.m (89 lb in).

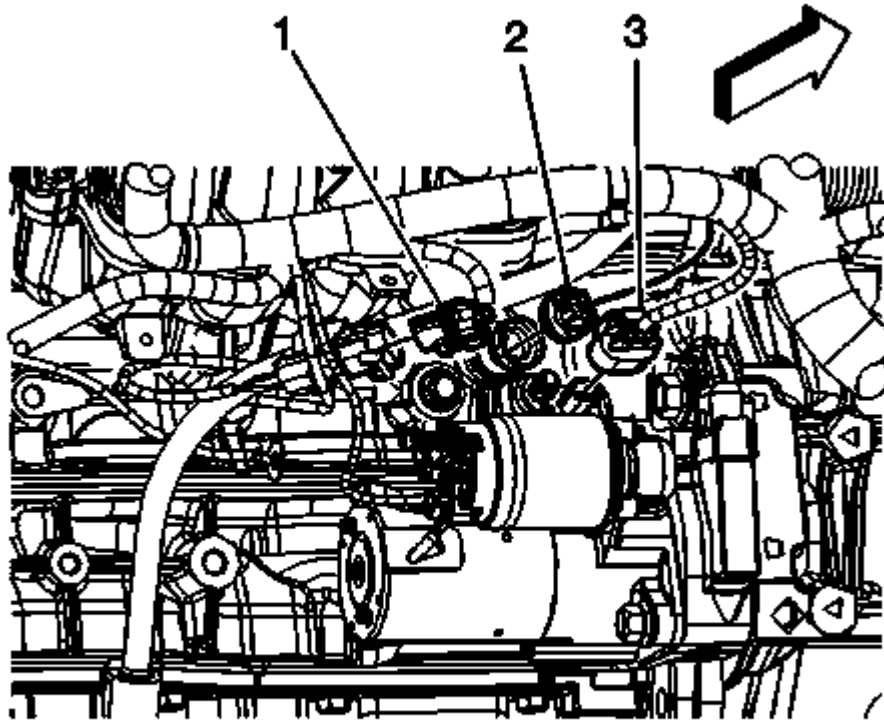


Fig. 44: Identifying Engine Oil Pressure Sensor, Knock Sensor & CKP Sensor Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

4. Connect the engine harness electrical connector (1) to the knock sensor harness.
5. Install the knock sensor connector clip to the oil level indicator tube.

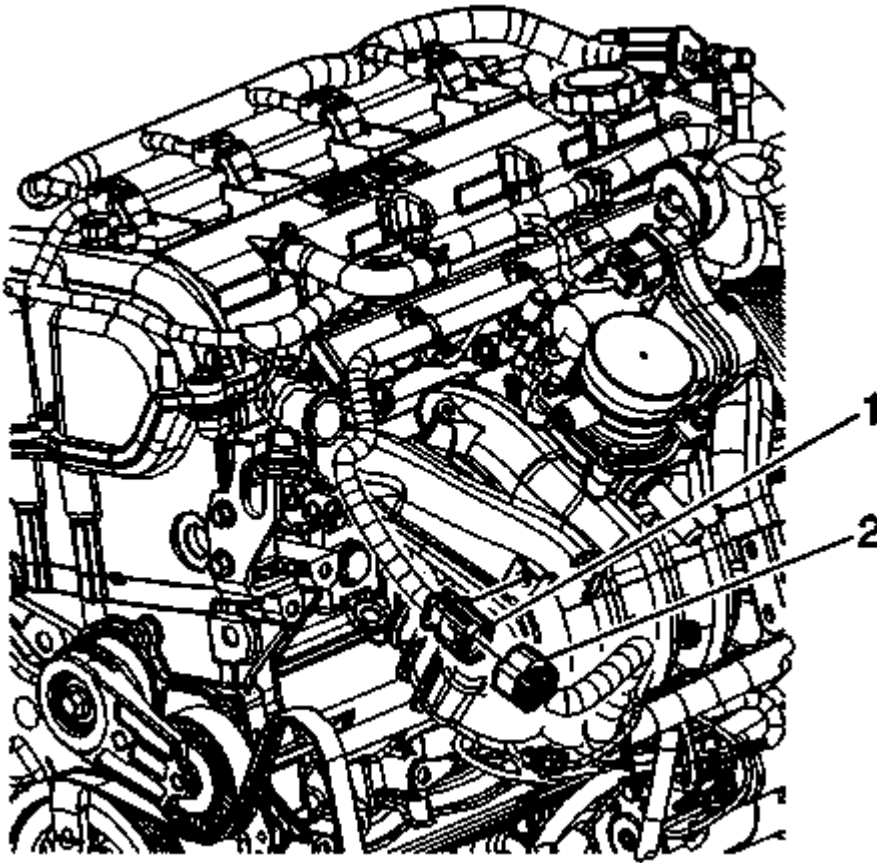


Fig. 45: Locating Fuel Injector Wiring Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

6. Connect the engine harness electrical connector (1) to the fuel injector inline electrical connector (2).
7. Install the fuel injector inline connector clip to the intake manifold.
8. Install the oil level indicator tube bolt.

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

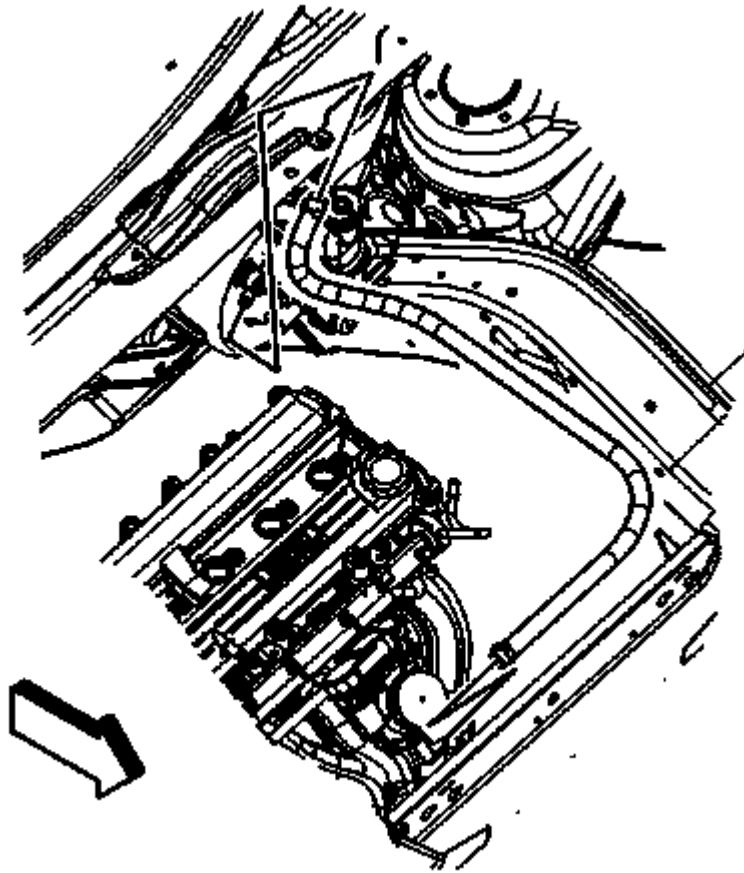


Fig. 46: Identifying Brake Booster Vacuum Hose & Clamps
Courtesy of GENERAL MOTORS CORP.

9. Install the brake booster hose to the intake manifold.
10. Position the brake booster vacuum hose clamp at the intake manifold.

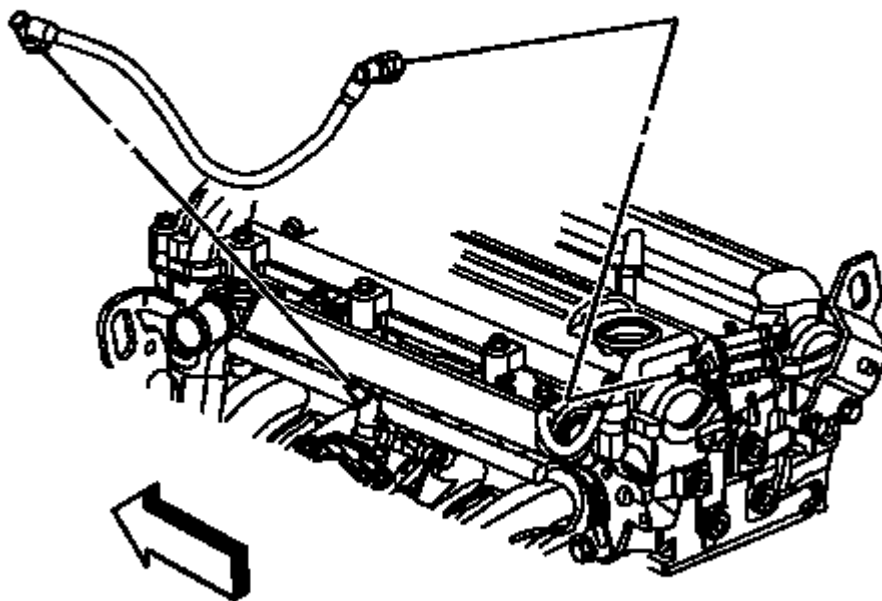


Fig. 47: Identifying EVAP Canister Purge Solenoid Valve Tube
Courtesy of GENERAL MOTORS CORP.

11. Install the EVAP canister purge solenoid valve tube. Refer to Plastic Collar Quick Connect Fitting Service .
12. Install the fuel rail. Refer to Fuel Injection Fuel Rail Assembly Replacement .
13. Install the throttle body. Refer to Throttle Body Assembly Replacement .

CRANKSHAFT BALANCER REPLACEMENT

SPECIAL TOOLS

- **J 38122-A** Harmonic Balancer Holder. See Special Tools .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

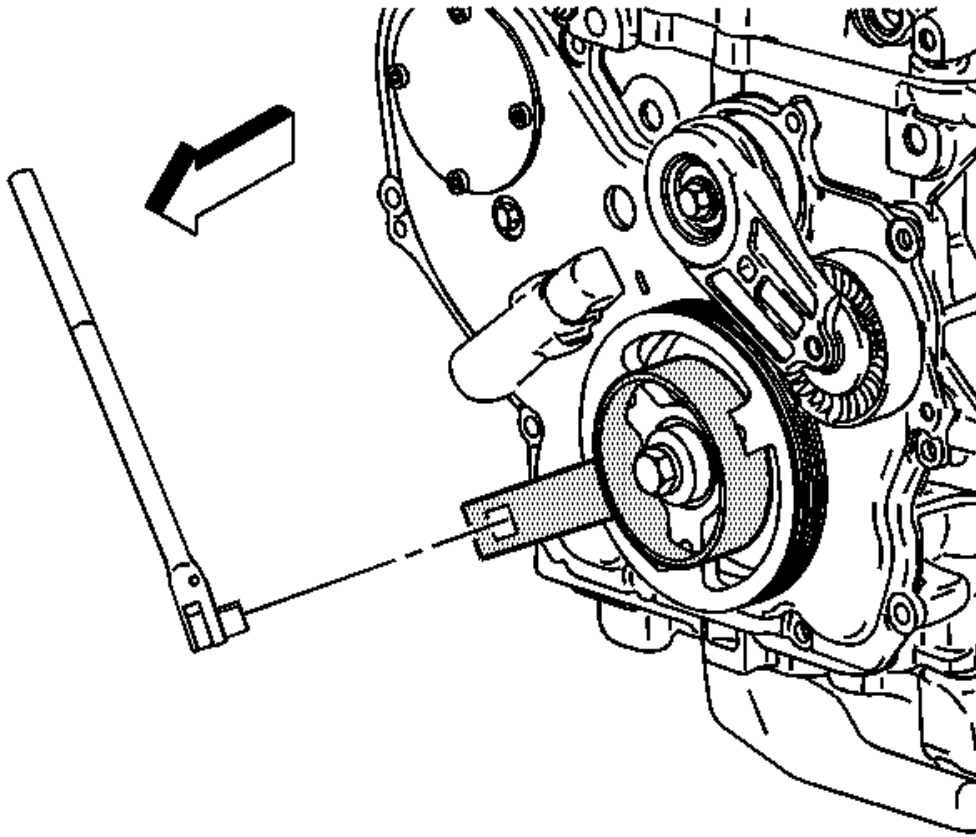


Fig. 48: View Of Harmonic Balancer Holder J38122-A
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine drive belt. Refer to **Drive Belt Replacement**.
2. Use the **J 38122-A** in order to prevent the crankshaft from rotating while loosening the crankshaft balancer bolt. See **Special Tools**.

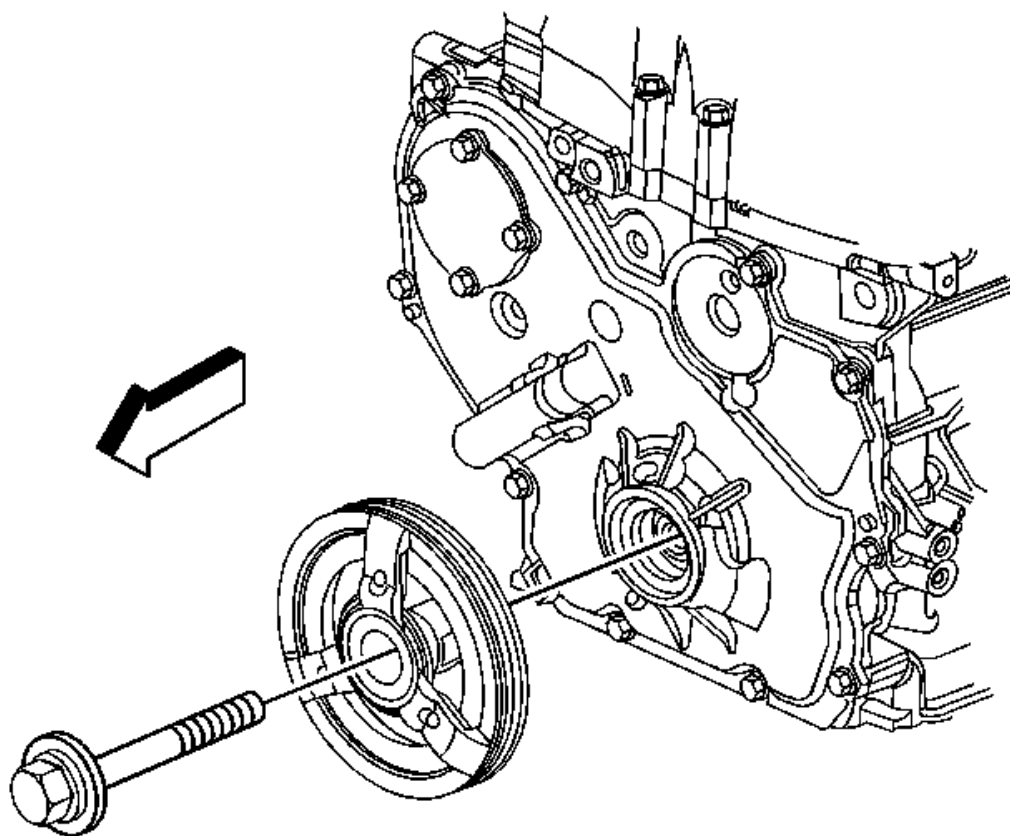


Fig. 49: Identifying Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the crankshaft balancer bolt.

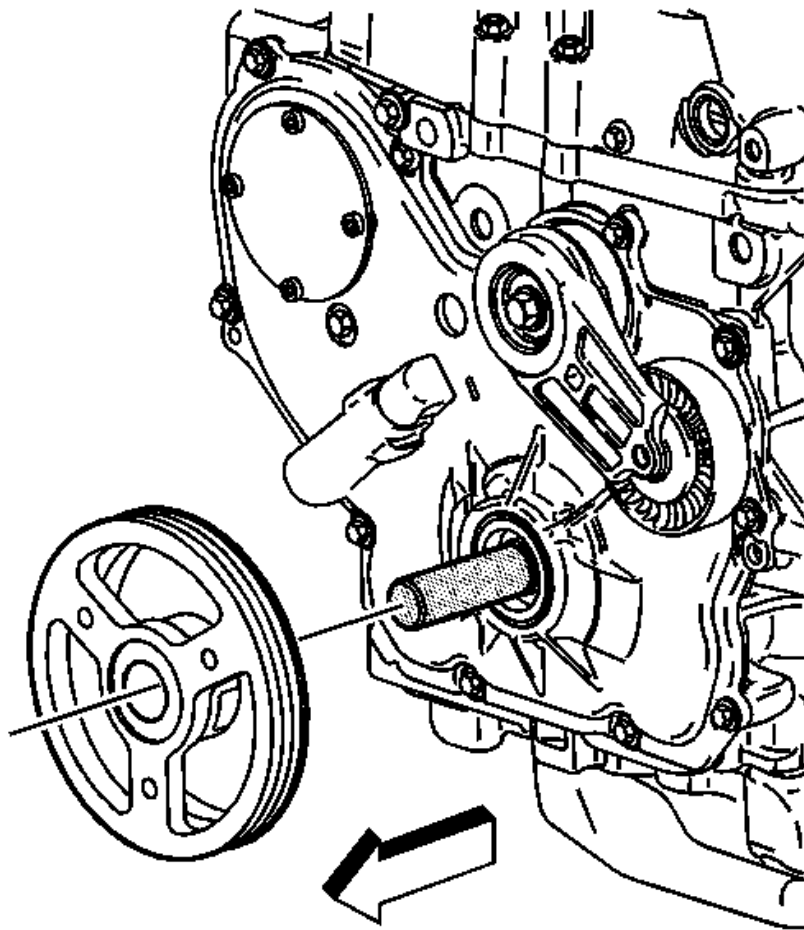


Fig. 50: View Of Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

4. Remove the crankshaft balancer.

INSTALLATION PROCEDURE

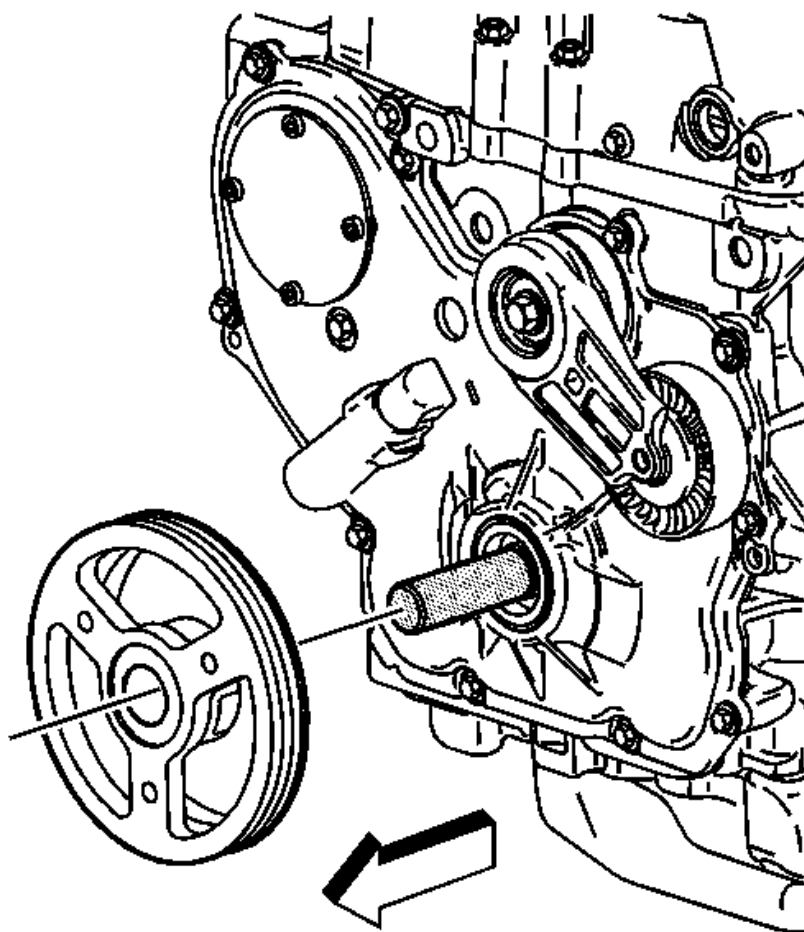


Fig. 51: View Of Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

1. Position the crankshaft balancer to the engine.

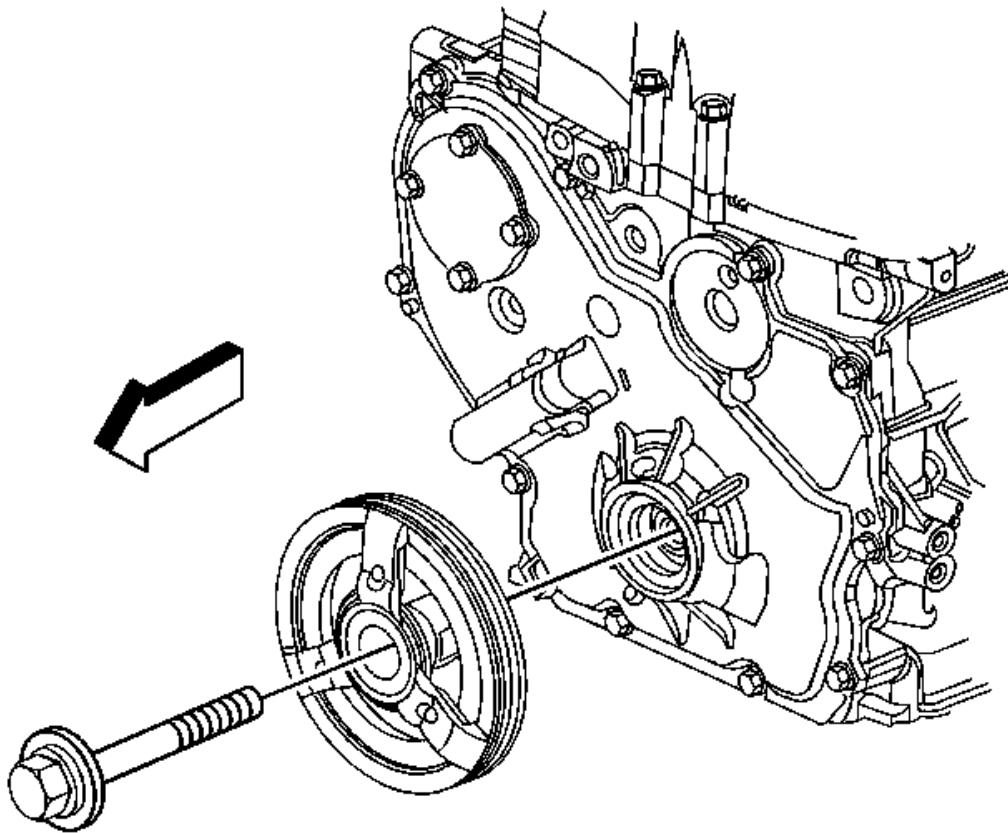


Fig. 52: Identifying Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

2. Install a NEW crankshaft balancer bolt.

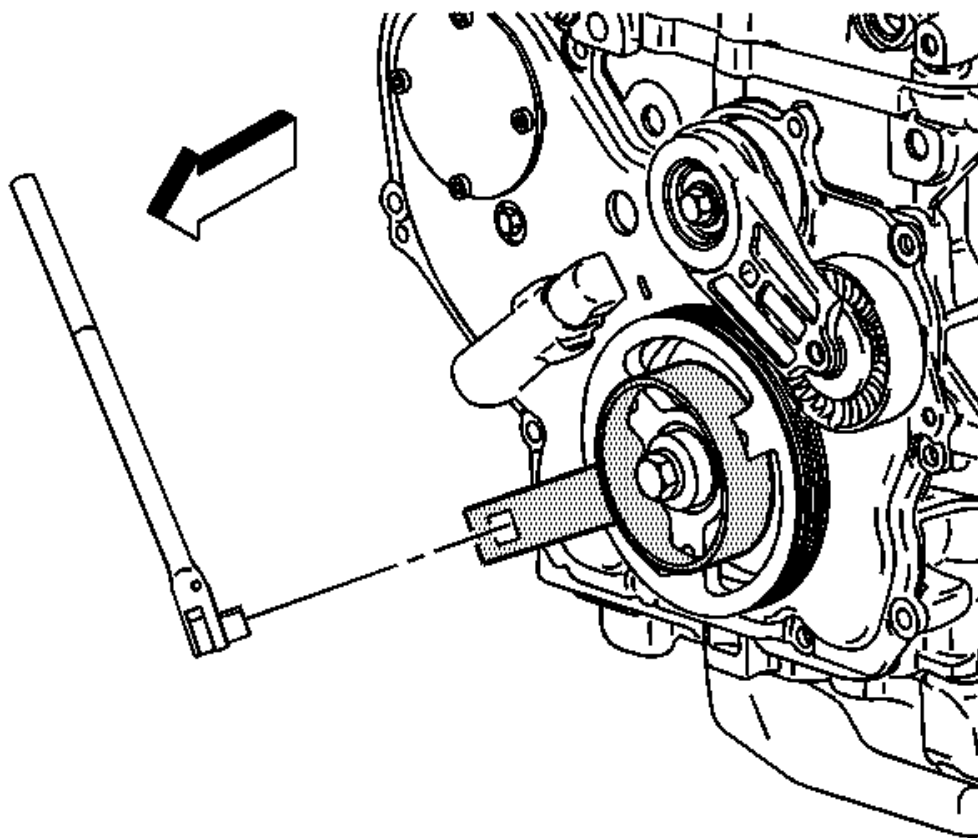


Fig. 53: View Of Harmonic Balancer Holder J38122-A
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Use the **J 38122-A** in order to prevent the crankshaft from rotating while tightening the crankshaft balancer bolt. See Special Tools .

Tighten: Tighten the bolt to 100 N.m (74 lb ft) plus an additional 125 degrees using the **J 45059** .

4. Install the engine drive belt. Refer to Drive Belt Replacement.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

SPECIAL TOOLS

J 35268-A Camshaft/Front Main Seal Installer. See Special Tools .

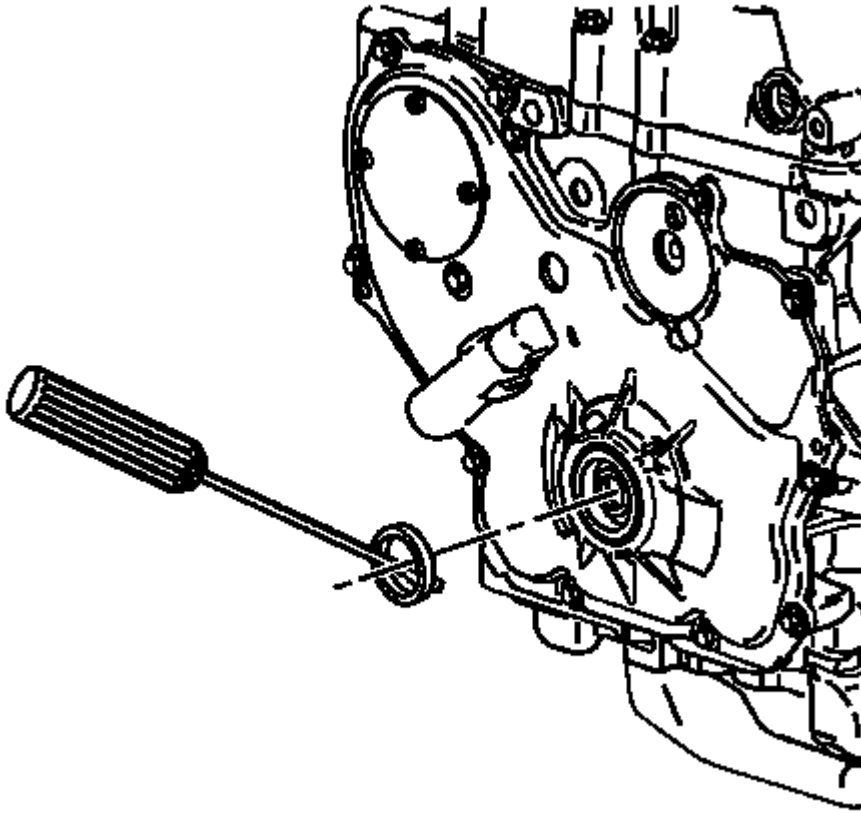
REMOVAL PROCEDURE

Fig. 54: View Of Crankshaft Front Oil Seal Removal
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Using a flat-bladed tool, remove the oil seal from the front cover.

INSTALLATION PROCEDURE

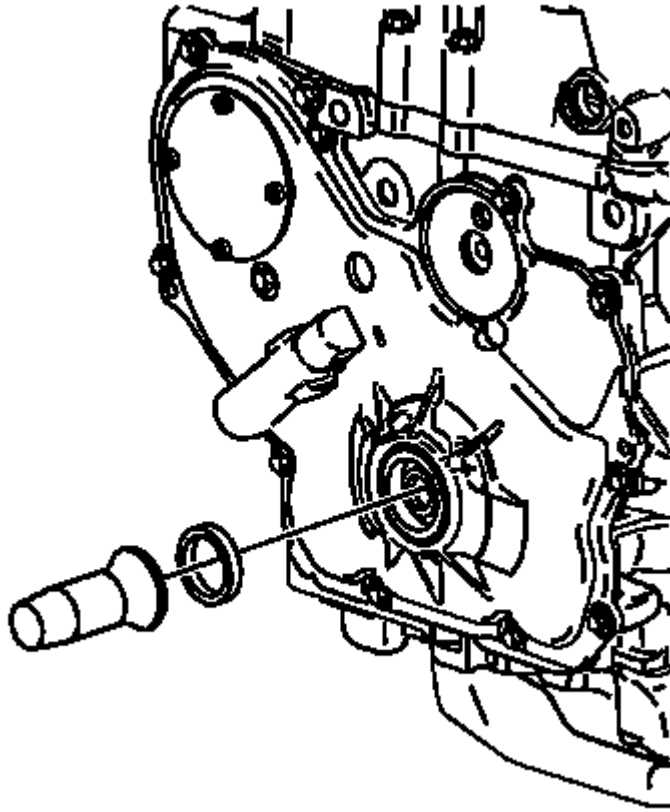


Fig. 55: Identifying Crankshaft Front Oil Seal & Special Tool J 35268-A
Courtesy of GENERAL MOTORS CORP.

1. Use the **J 35268-A** in order to install the oil seal to the front cover. See **Special Tools** .
2. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

ENGINE FRONT COVER REPLACEMENT

REMOVAL PROCEDURE

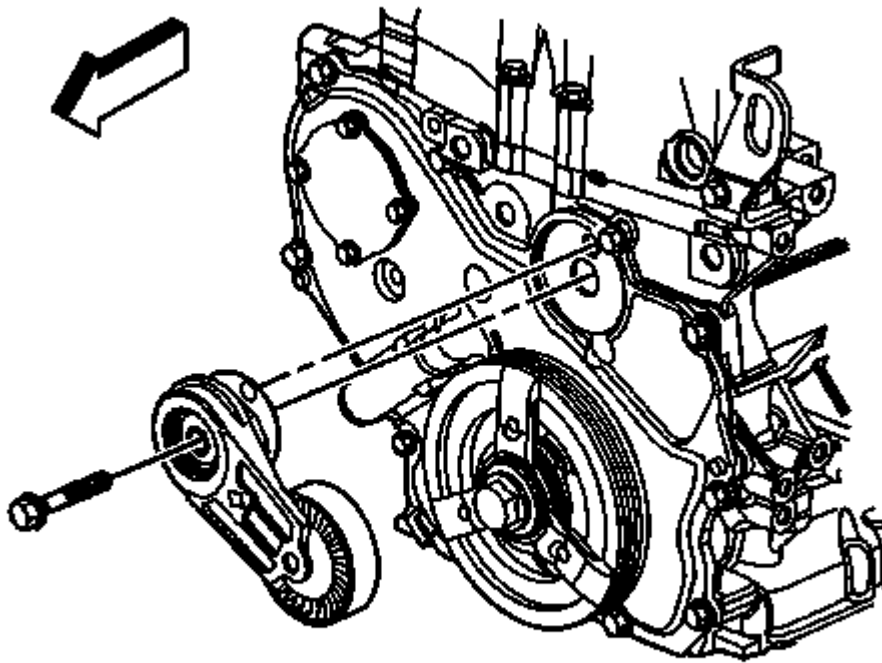


Fig. 56: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Remove the drive belt tensioner bolt.
3. Remove the drive belt tensioner.

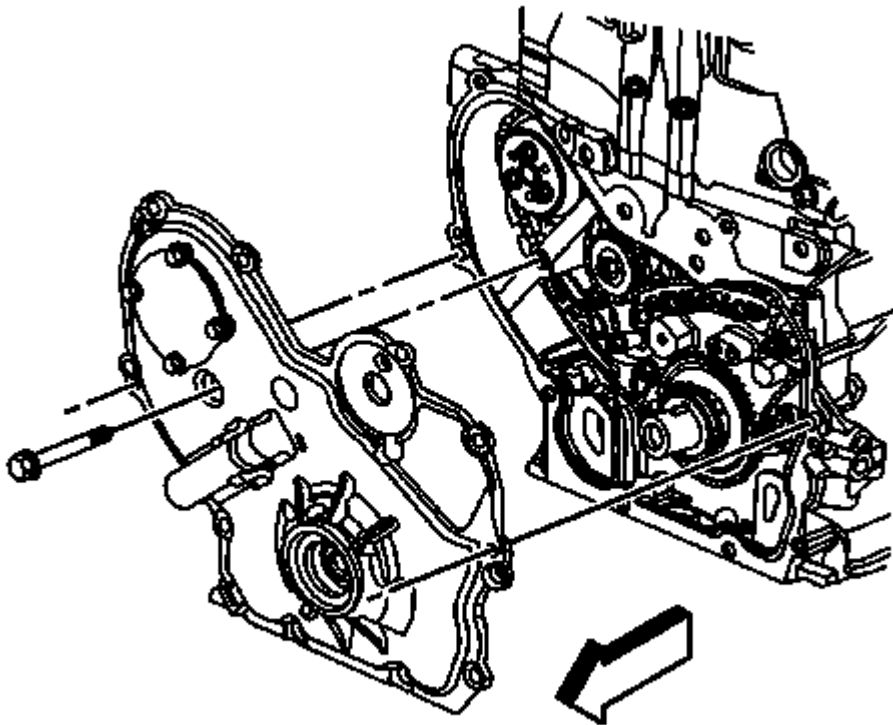


Fig. 57: View Of Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine front cover to water pump bolt.

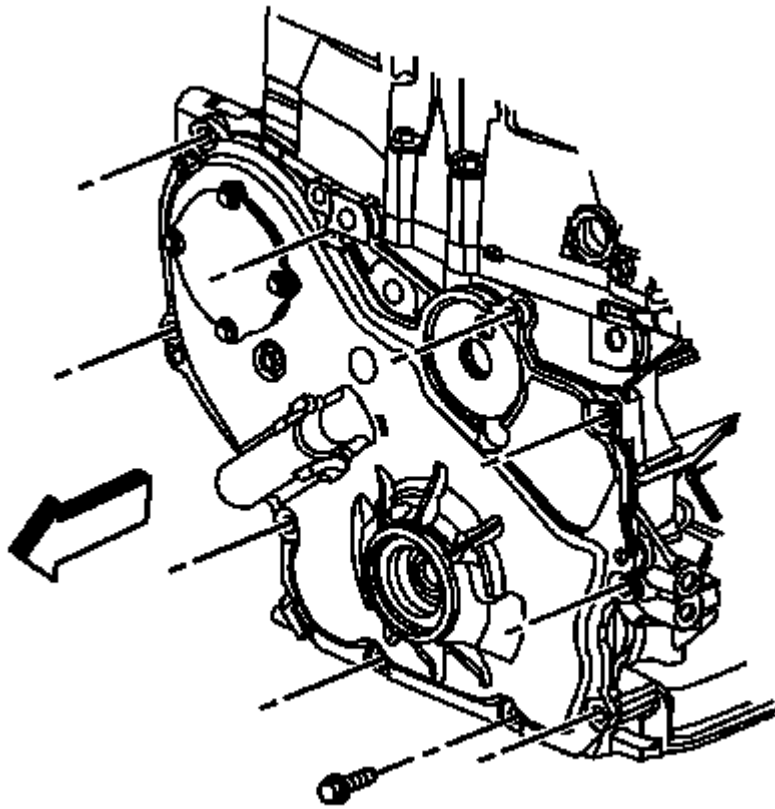


Fig. 58: Identifying Engine Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the remaining engine front cover bolts.
6. Remove the engine front cover.

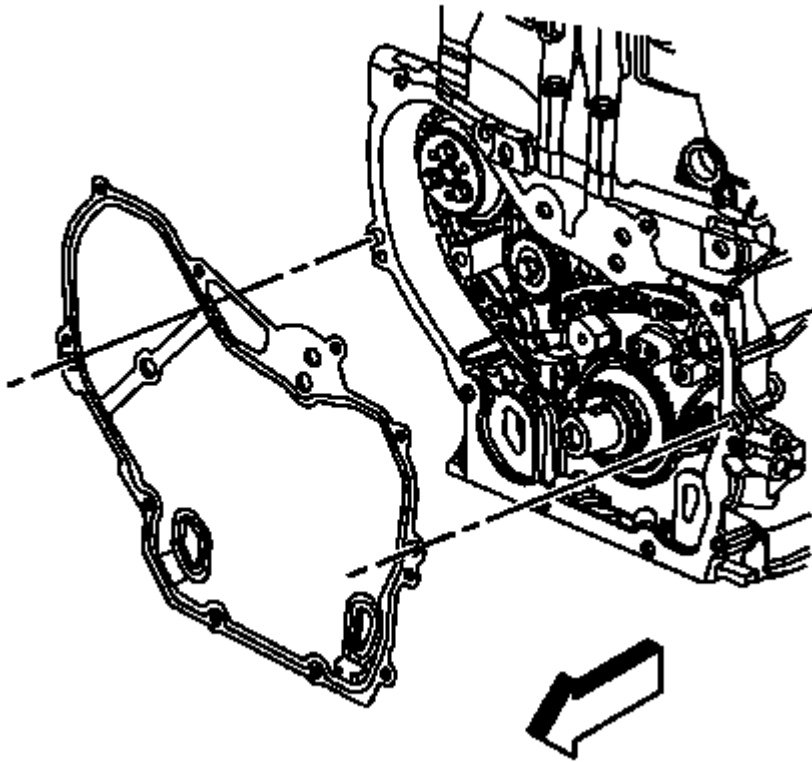


Fig. 59: View Of Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

7. If the engine front cover gasket is damaged perform the following steps:
8. Remove the engine mount. Refer to **Engine Mount Replacement**.
9. Remove and discard the engine front gasket.

INSTALLATION PROCEDURE

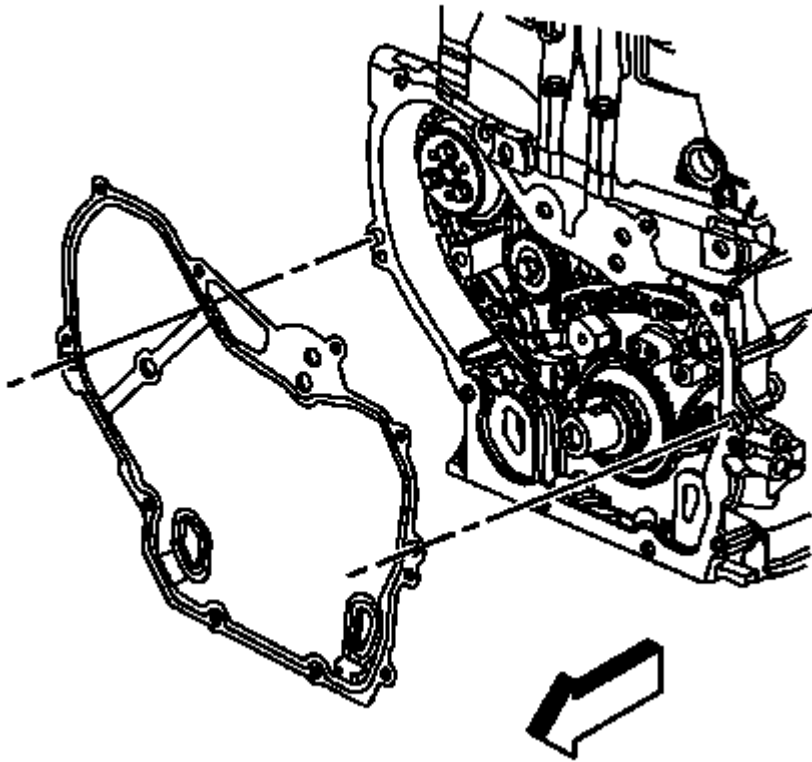


Fig. 60: View Of Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

1. If the engine front cover was damaged perform the following steps, otherwise proceed to step 4.
2. Position and install a NEW engine front cover gasket to the dowel pins.
3. Install the engine mount. Refer to **Engine Mount Replacement**.

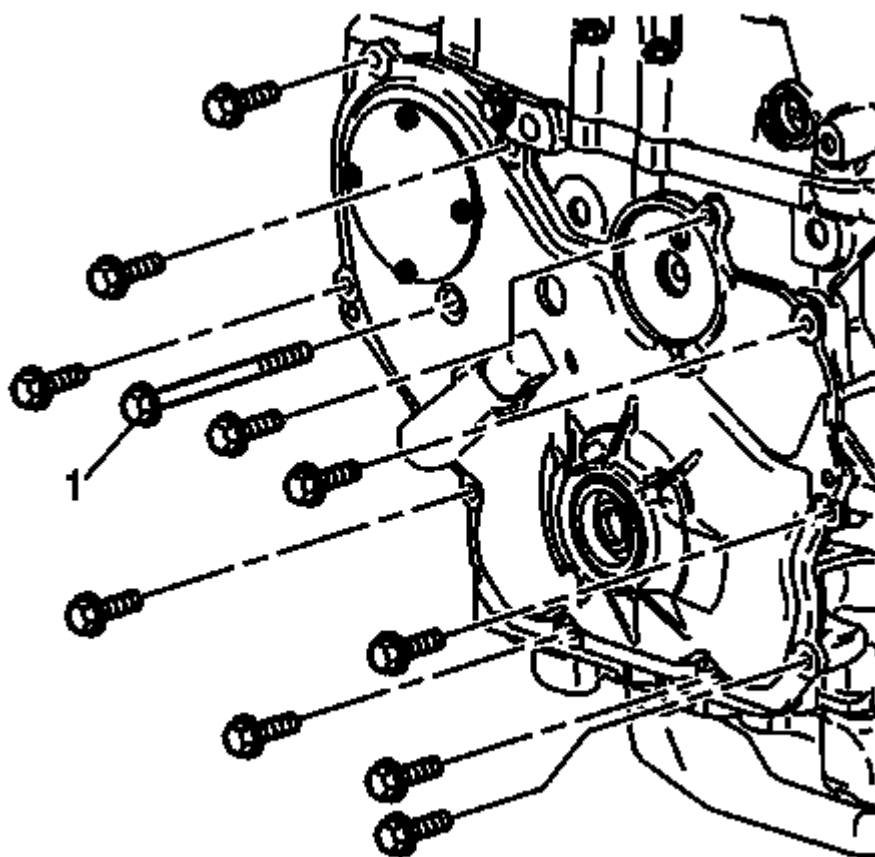


Fig. 61: Identifying Engine Front Cover Bolts & Long Water Pump Bolt
 Courtesy of GENERAL MOTORS CORP.

4. Position and install the engine front cover.

CAUTION: Refer to Fastener Caution .

5. Install the engine front cover bolts

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

6. Install the long water pump bolt (1) and tighten to 25 N.m (18 lb ft).

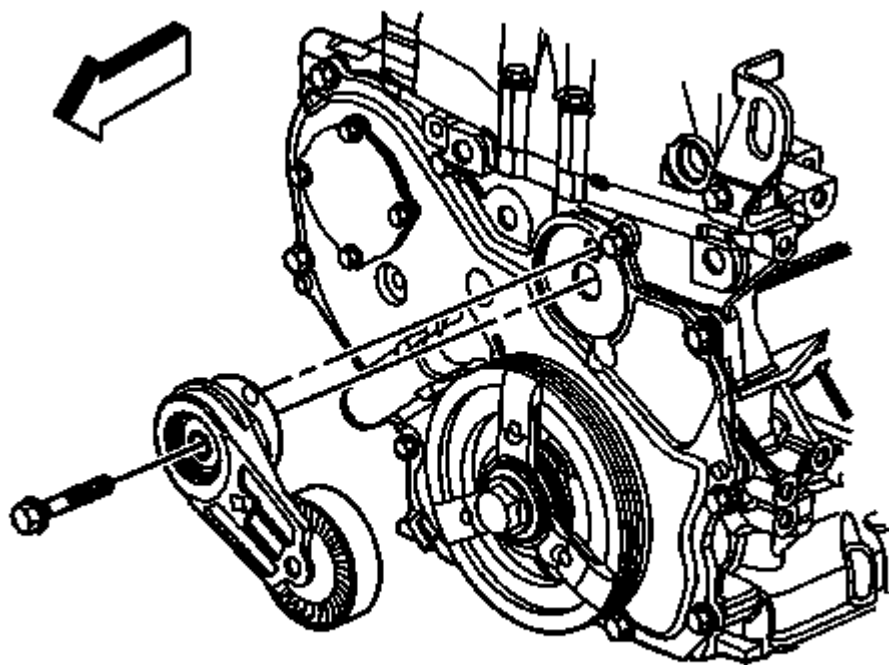


Fig. 62: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

7. Install the drive belt tensioner.
8. Install the drive belt tensioner bolt.

Tighten: Tighten the bolt to 45 N.m (33 lb ft).

9. Install the crankshaft balancer. Refer to Crankshaft Balancer Replacement.

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER REPLACEMENT

SPECIAL TOOLS

- J 45027 Tensioner Tool
- J 45059 Angle Meter

REMOVAL PROCEDURE

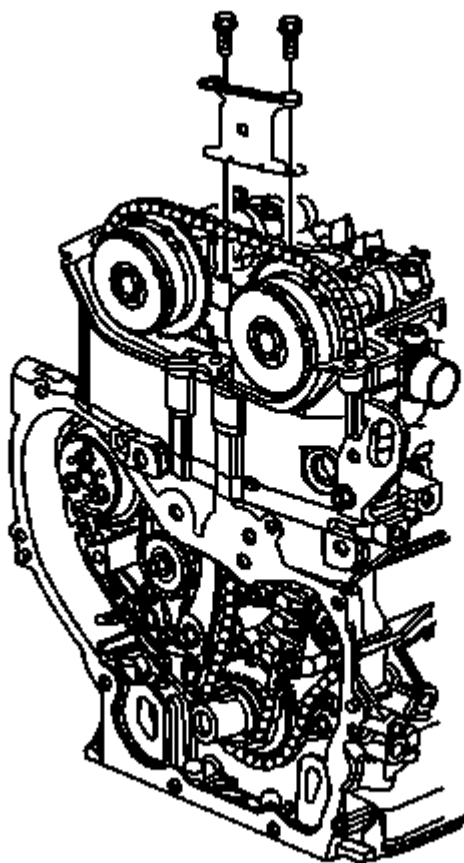


Fig. 63: View Of Upper Timing Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the number 1 cylinder spark plug. Refer to [Spark Plug Replacement](#) .
2. Rotate the crankshaft in the engine rotational direction clockwise, until the number 1 piston is at top dead center (TDC) on the exhaust stroke.
3. Remove the camshaft cover. Refer to [Camshaft Cover Replacement](#).
4. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
5. Remove the upper timing chain guide bolts and guide.

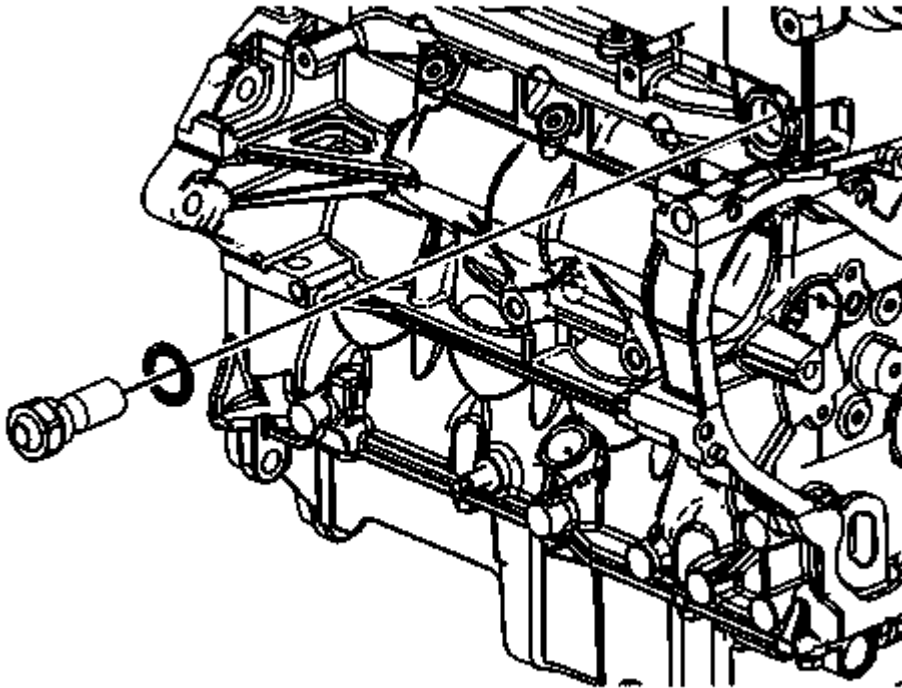


Fig. 64: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

NOTE: The timing chain tensioner must be removed to unload chain tension before the timing chain is removed. If it is not, the timing chain will become cocked and it will be difficult to remove.

6. Remove the timing chain tensioner.

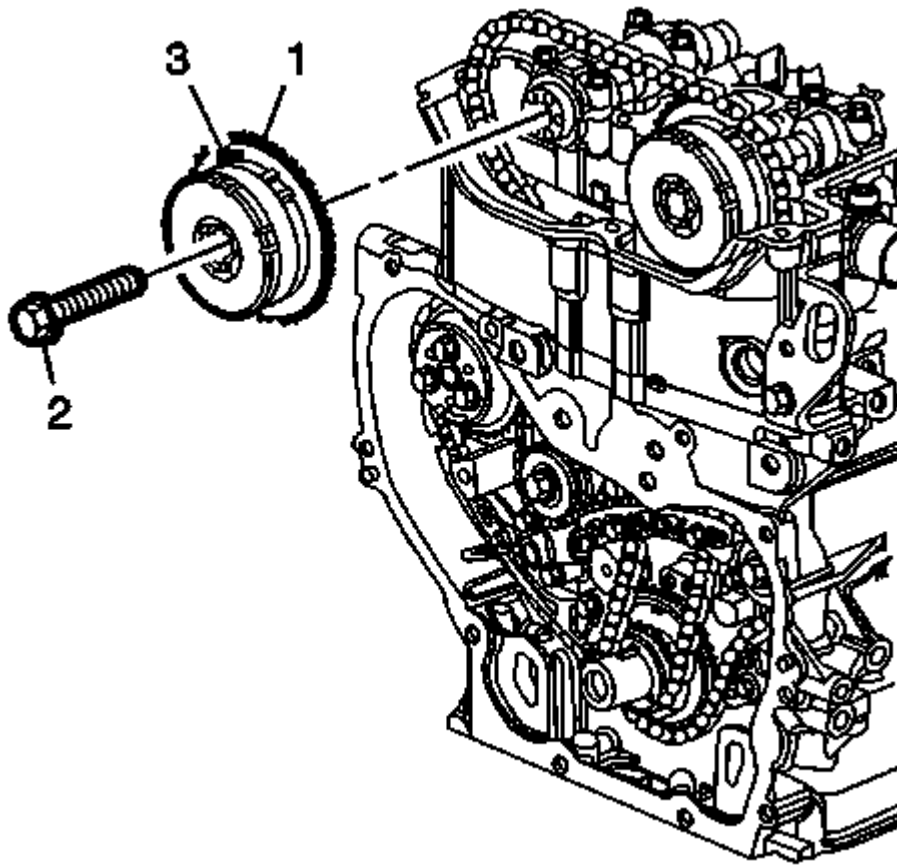


Fig. 65: Identifying Exhaust Camshaft Actuator & Bolt
Courtesy of GENERAL MOTORS CORP.

7. Install a 24 mm wrench on the hex on the exhaust camshaft in order to hold the camshaft.
8. Remove and discard the exhaust camshaft actuator bolt (2).
9. Remove the exhaust camshaft actuator (1, 3) from the camshaft and timing chain.

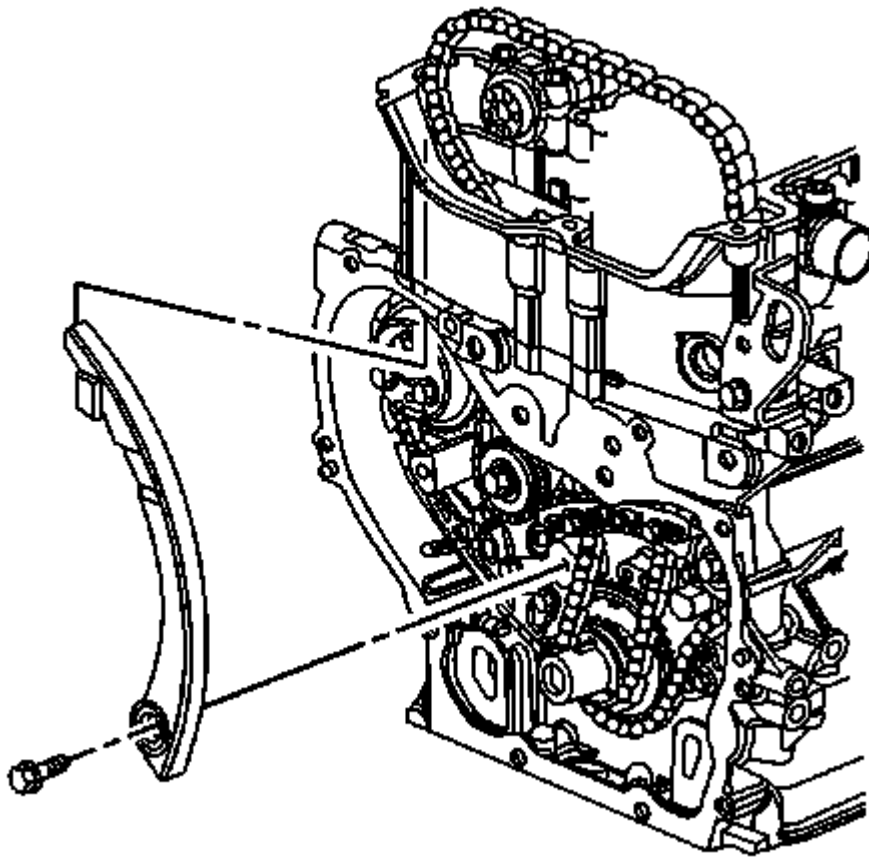


Fig. 66: View Of Timing Chain Tensioner Guide
Courtesy of GENERAL MOTORS CORP.

10. Remove the timing chain tensioner guide bolt and guide.

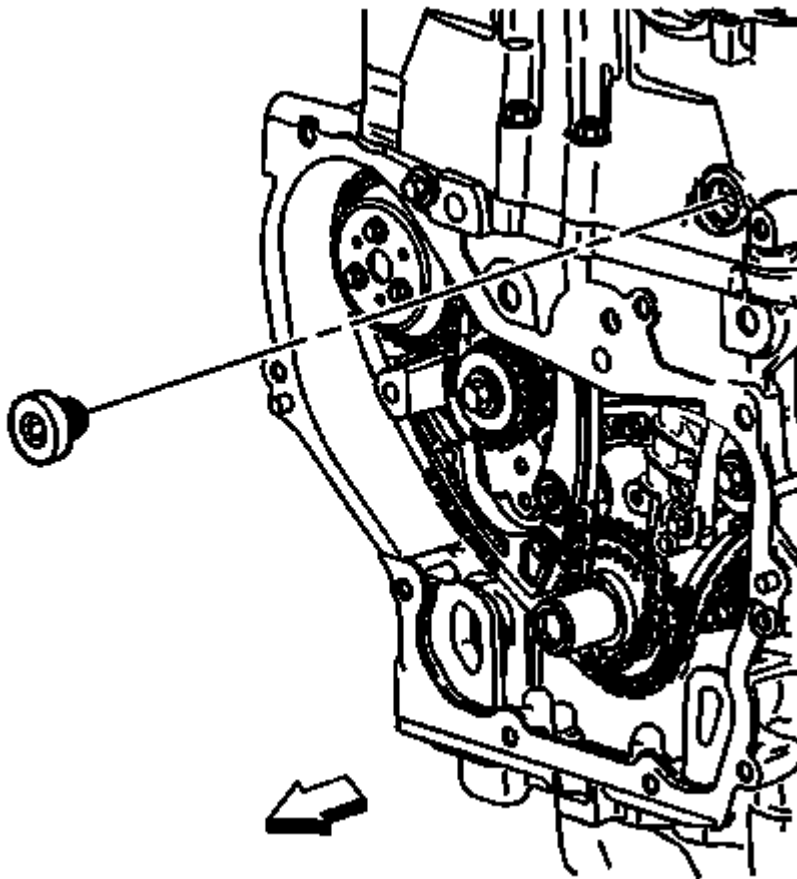


Fig. 67: View Of Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS CORP.

11. Remove the fixed timing chain guide access plug.

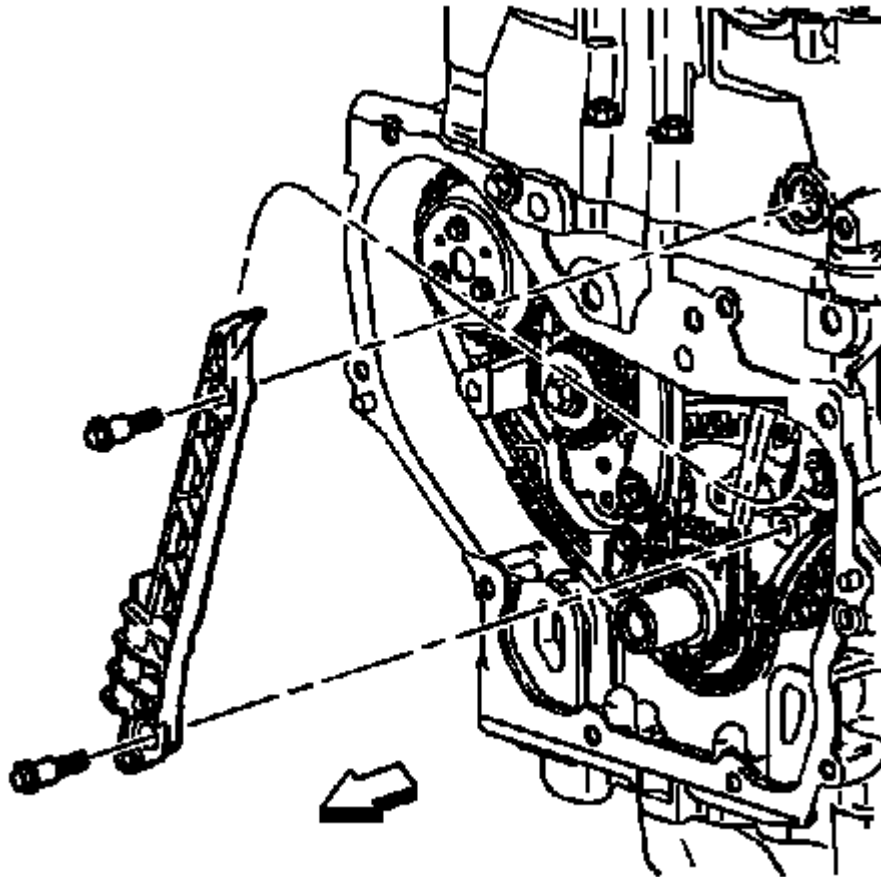


Fig. 68: View Of Fixed Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

12. Remove the fixed timing chain guide bolts and guide.

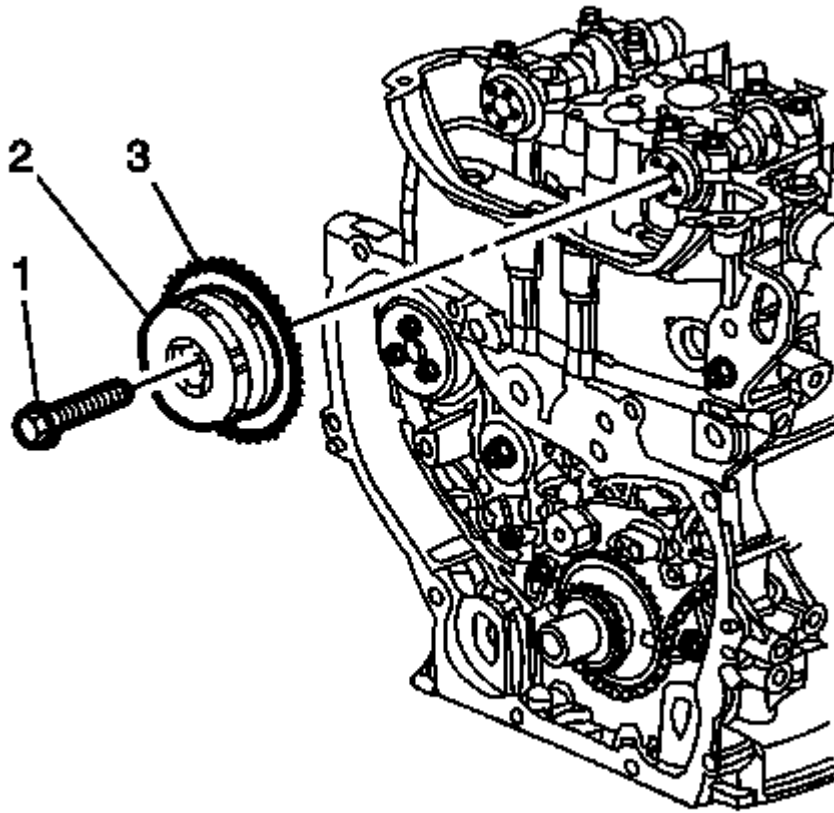


Fig. 69: Identifying Crankshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

13. Install a 24 mm wrench on the hex on the intake camshaft in order to hold the camshaft.
14. Remove and discard the intake camshaft actuator bolt (2).
15. Remove the intake camshaft actuator (3), and the timing chain through the top of the cylinder head.

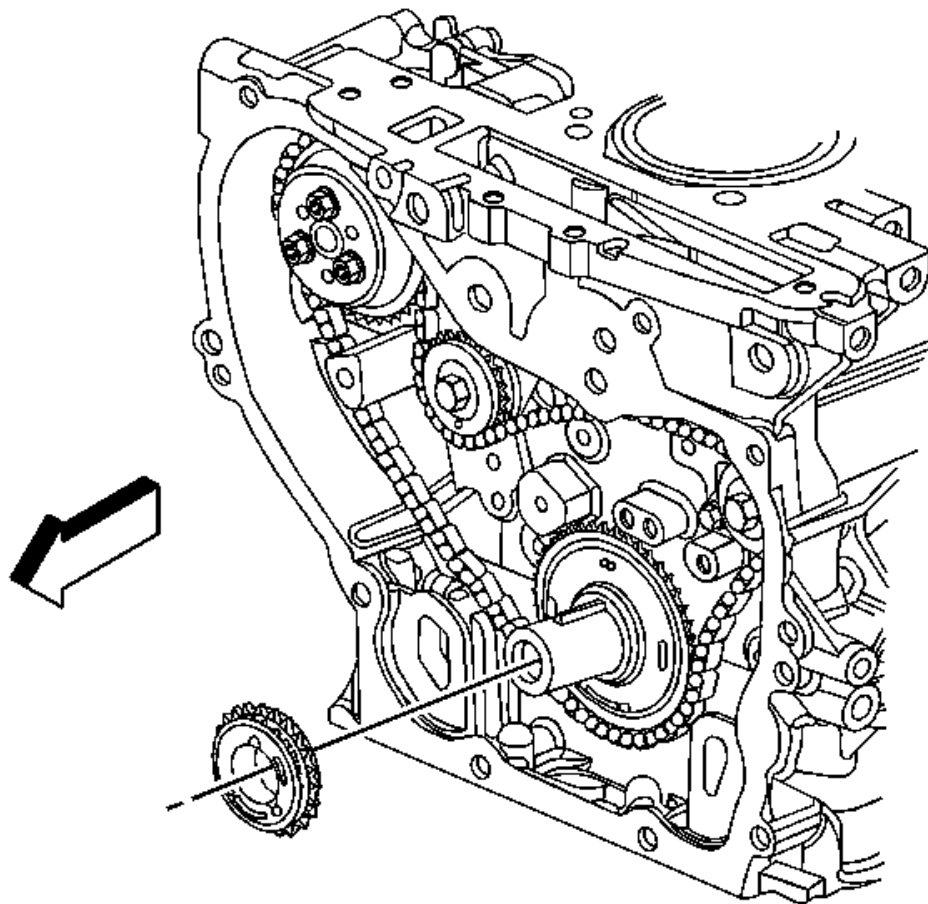


Fig. 70: View Of Timing Chain Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

16. Remove the timing chain crankshaft sprocket.

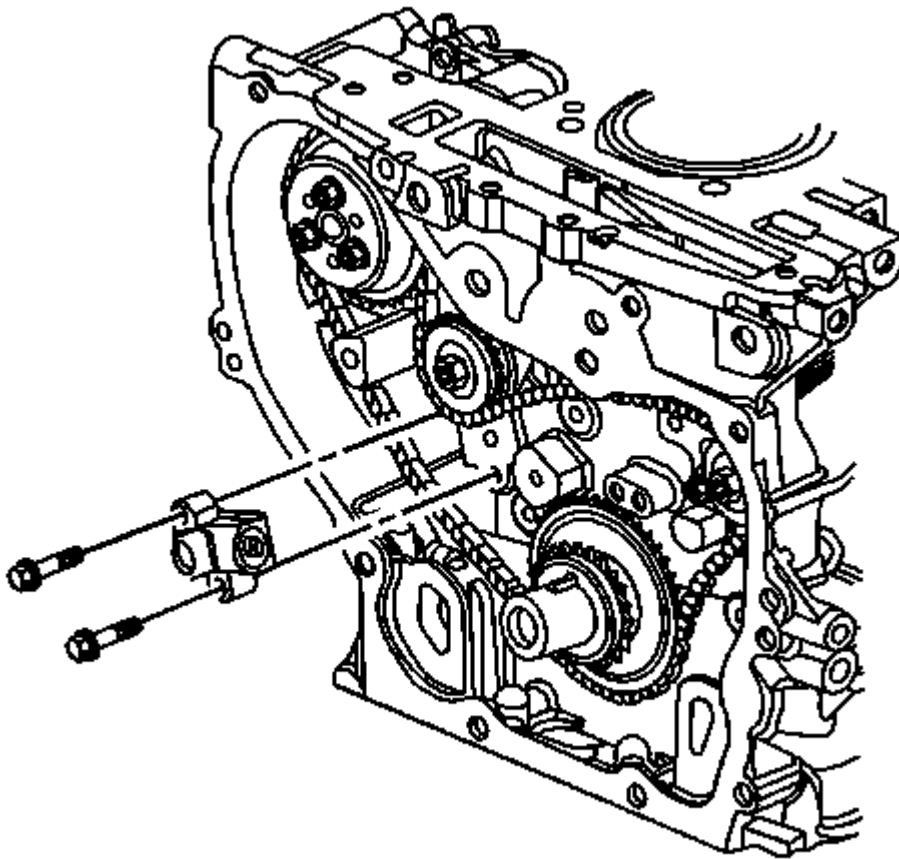


Fig. 71: View Of Balance Shaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

17. If replacing the balance shaft timing chain and sprocket, perform the following steps: if not proceed to step 10 in the installation procedure.
18. Remove the balance shaft drive chain tensioner bolts and tensioner.

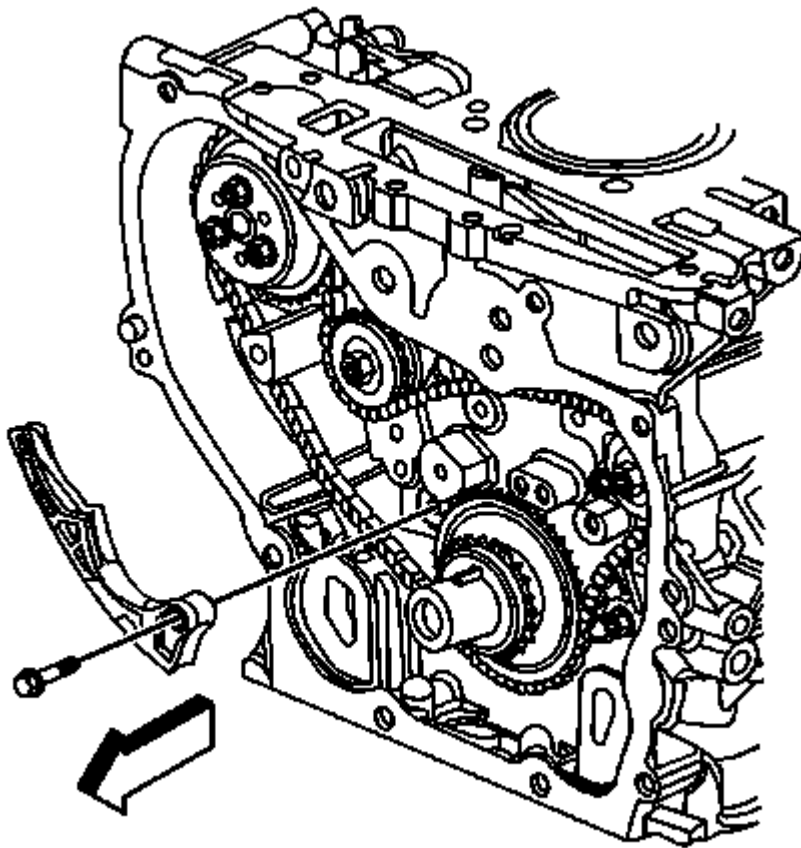


Fig. 72: View Of Adjustable Balance Shaft Chain Guide
Courtesy of GENERAL MOTORS CORP.

19. Remove the adjustable balance shaft chain guide bolt and guide.

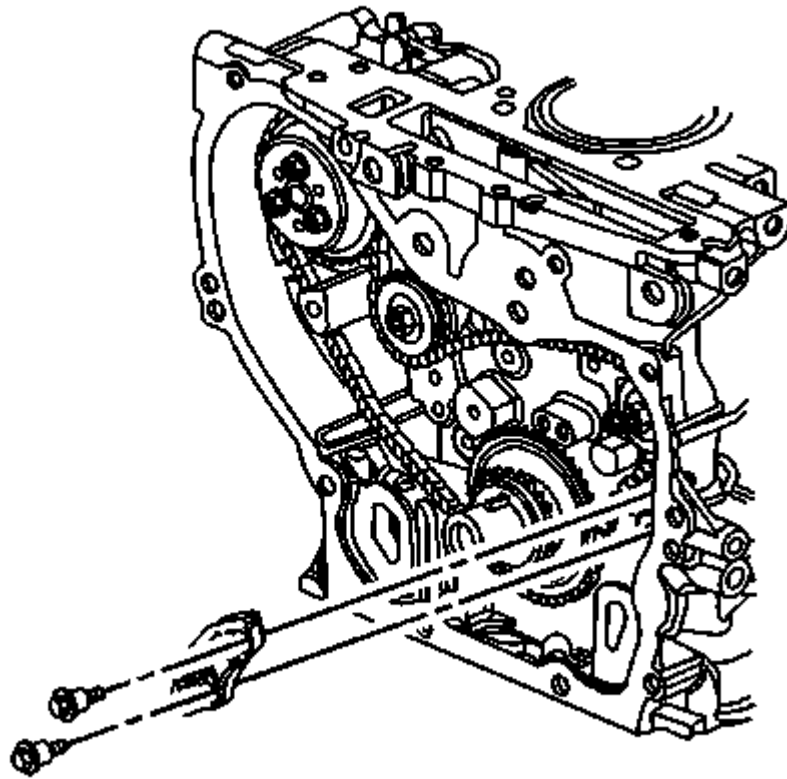


Fig. 73: Identifying Small Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

20. Remove the small balance shaft drive chain guide bolts and guide.

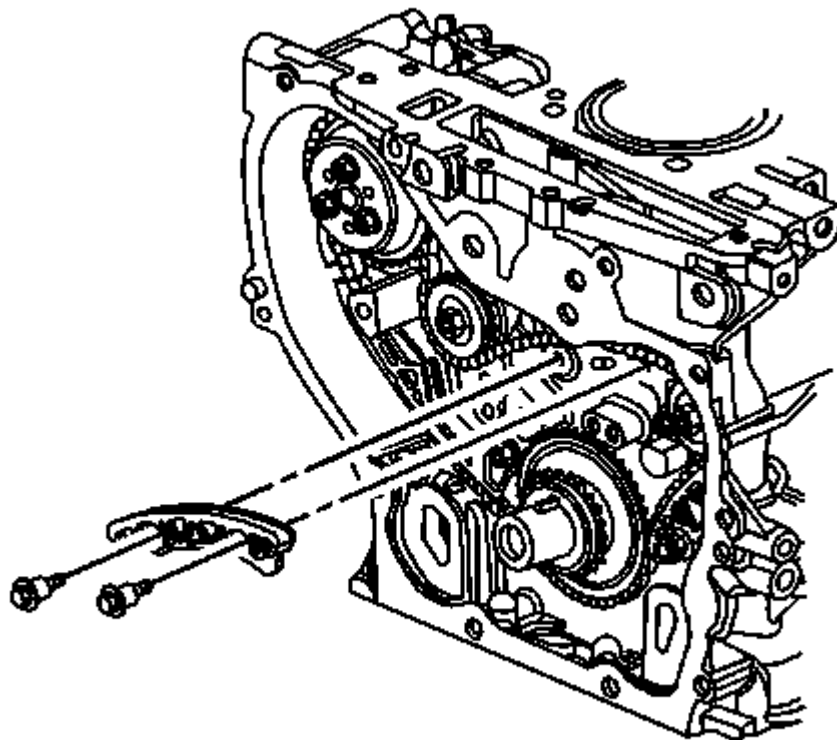


Fig. 74: Identifying Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

21. Remove the upper balance shaft drive chain guide bolts and guide.

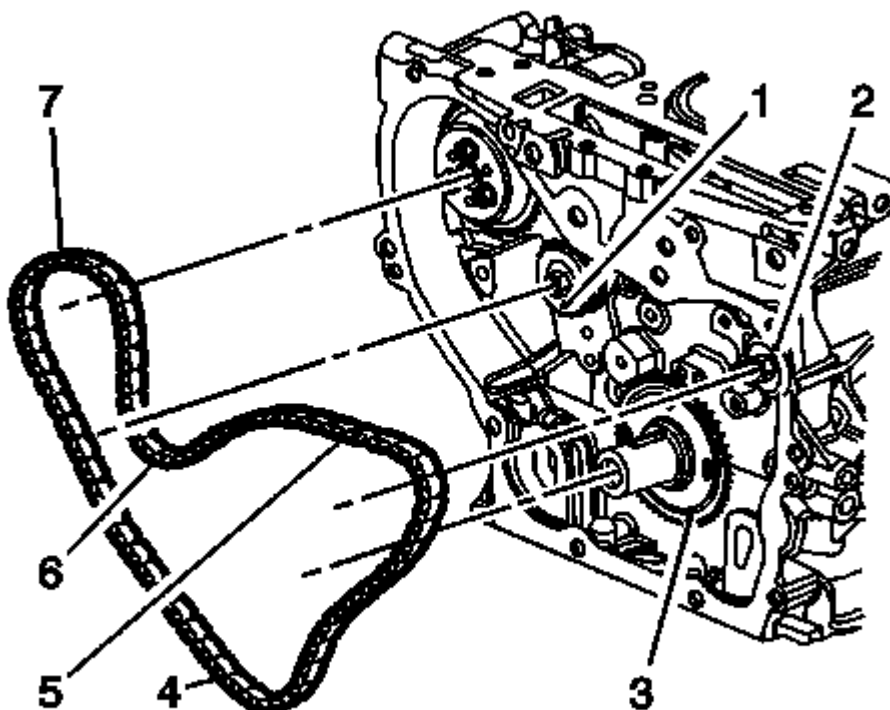


Fig. 75: Identifying Balance Shaft Drive Chain & Components
Courtesy of GENERAL MOTORS CORP.

NOTE: It may ease removal of the balance shaft drive chain to get all the slack in the chain between the crankshaft and water pump sprockets.

22. Remove the balance shaft drive chain (7).
23. Remove the balance shaft drive sprocket.

INSTALLATION PROCEDURE

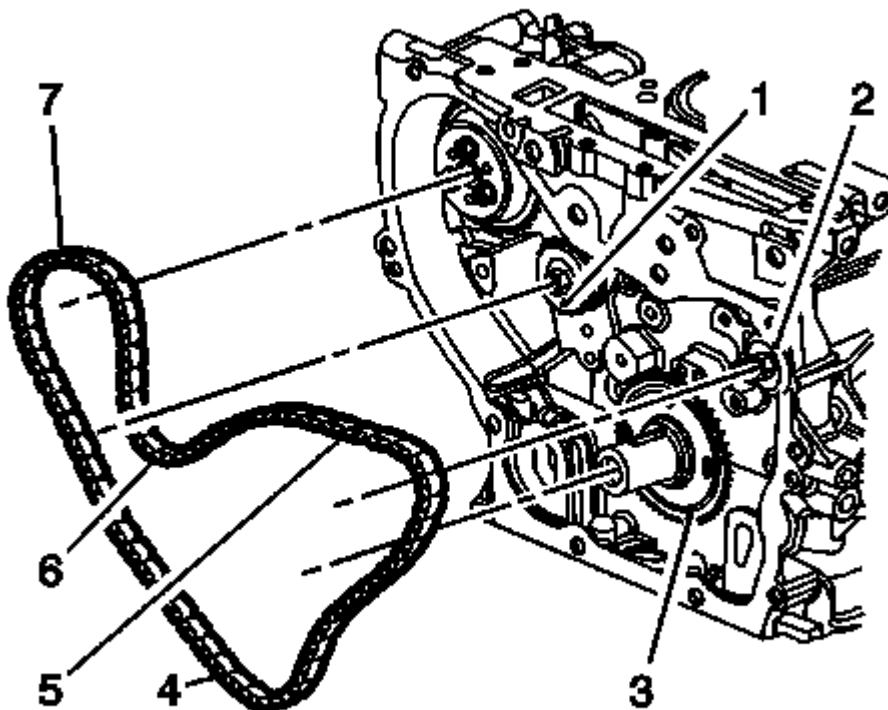


Fig. 76: Identifying Balance Shaft Drive Chain & Components
 Courtesy of GENERAL MOTORS CORP.

1. If replacing the balance shaft timing chain, perform the following steps, if not proceed to step 10.
2. Install the balance shaft drive sprocket.

NOTE: If the balance shafts are not properly timed to the engine, the engine may vibrate or make noise.

3. Install the balance shaft drive chain (1) with the colored link lined up with the marks on the balance shaft sprockets and the balance shaft drive sprocket. There are three colored links on the chain. Two are chrome and one is copper. Use the following steps in order to line up the links with the sprockets.
 - Place the copper link (5) so that it lines up with the timing mark (2) on the intake side balance shaft sprocket.
 - Working clockwise around the chain, place the chrome link (4) in line with the timing mark (3) on the balance shaft drive sprocket. (Approximately 6 o'clock position on the sprocket).
 - Place the chain (7) on the water pump drive sprocket. The alignment is not critical.
 - Align the last chrome link (6) with the timing mark (1) on the exhaust side balance shaft drive sprocket.

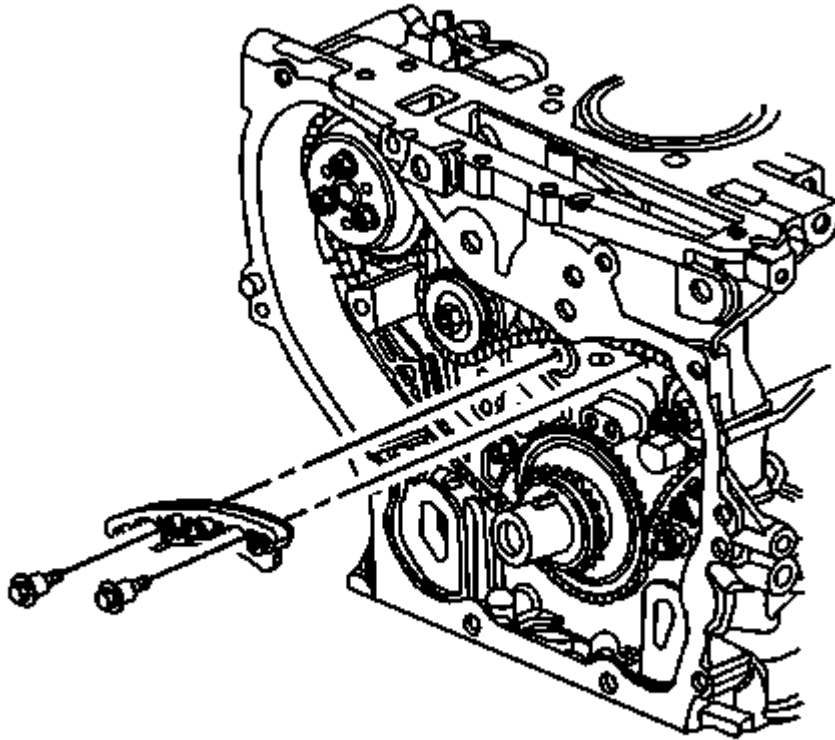


Fig. 77: Identifying Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install the upper balance shaft drive chain guide and bolts.

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

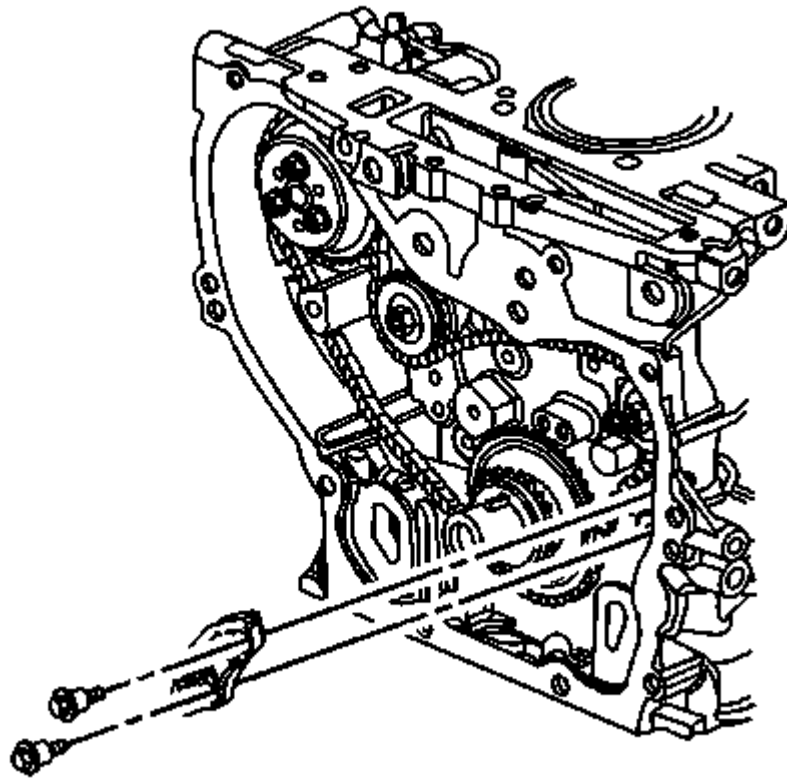


Fig. 78: Identifying Small Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

5. Install the small balance shaft drive chain guide and bolts.

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

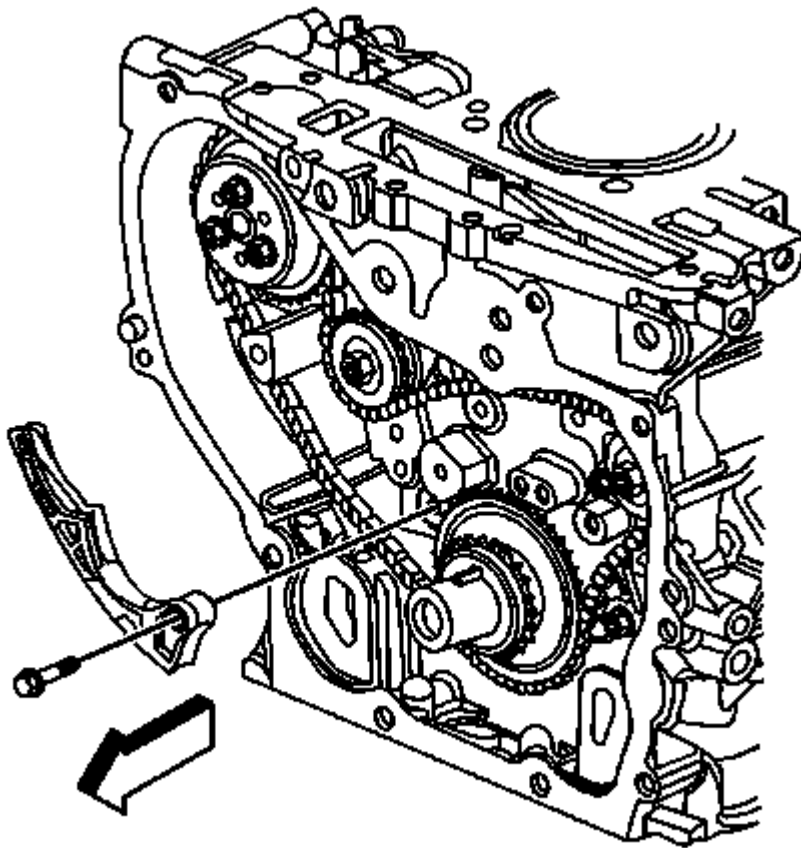


Fig. 79: View Of Adjustable Balance Shaft Chain Guide
Courtesy of GENERAL MOTORS CORP.

6. Install the adjustable balance shaft chain guide and bolt.

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

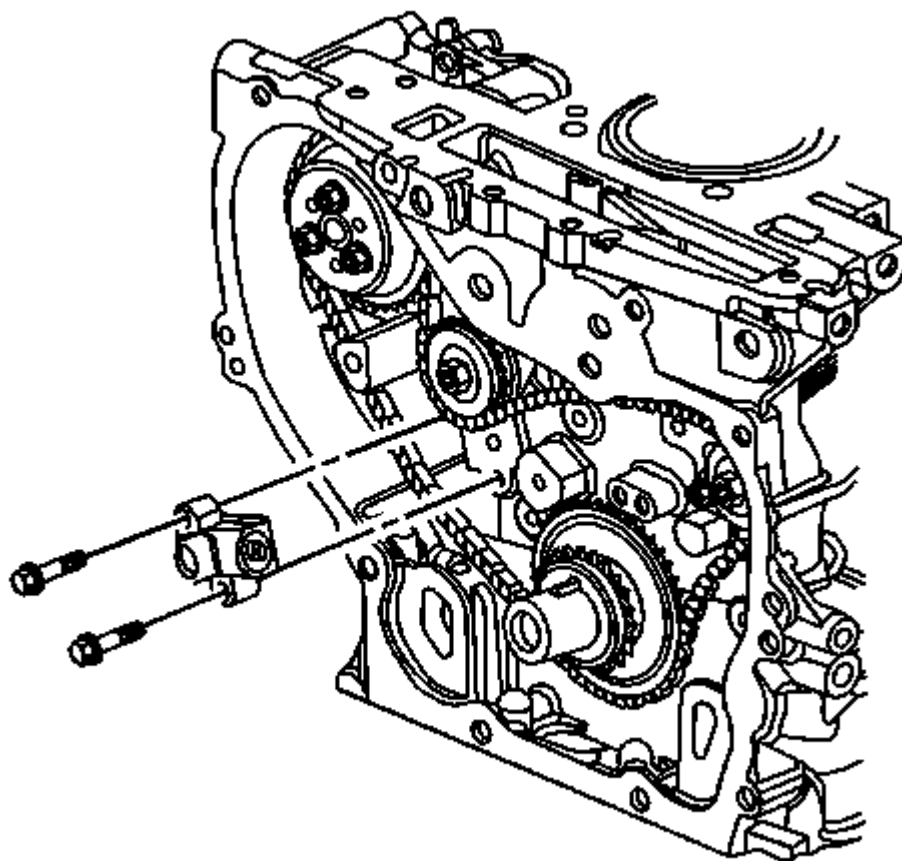


Fig. 80: View Of Balance Shaft Drive Chain Tensioner
 Courtesy of GENERAL MOTORS CORP.

7. Reset the timing chain tensioner by performing the following steps:
 - Rotate the tensioner plunger 90 degrees in its bore and compress the plunger.
 - Rotate the tensioner back to the original 12 o'clock position and insert a paper clip through the hole in the plunger body and into the hose in the tensioner plunger.
8. Install the balance shaft drive chain tensioner and bolts.

Tighten: Tighten the bolts to 10 N.m (89 lb in).

9. Remove the paper clip from the balance shaft drive chain tensioner.

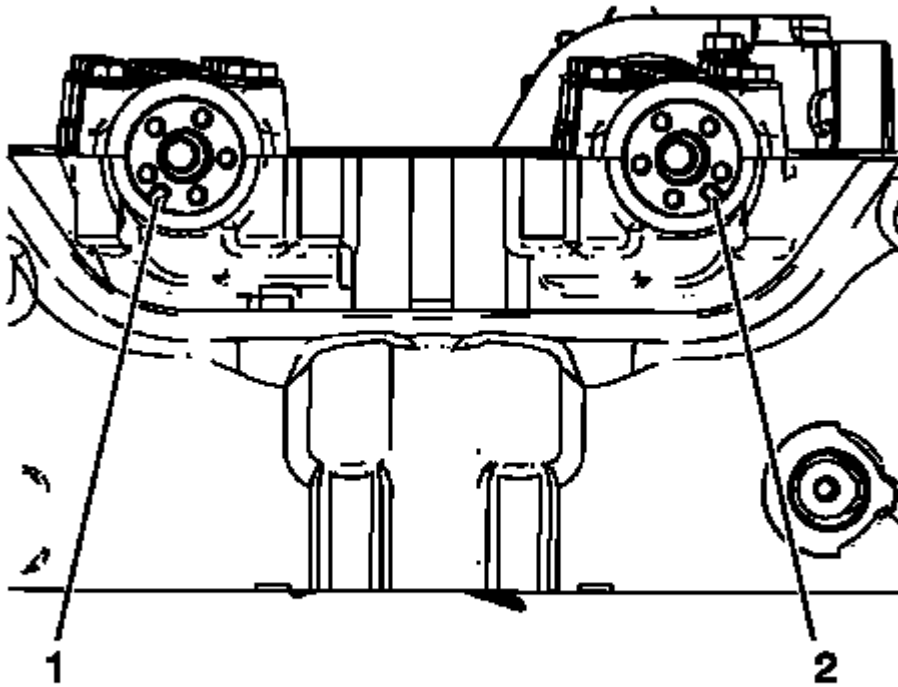


Fig. 81: Identifying Proper Exhaust/Intake Camshaft Alignment positions
Courtesy of GENERAL MOTORS CORP.

10. Ensure the intake camshaft notch is in the 5 o'clock position (2) and the exhaust camshaft notch is in the 7 o'clock position (1). The number 1 piston should be at TDC, crankshaft key at 12 o'clock.

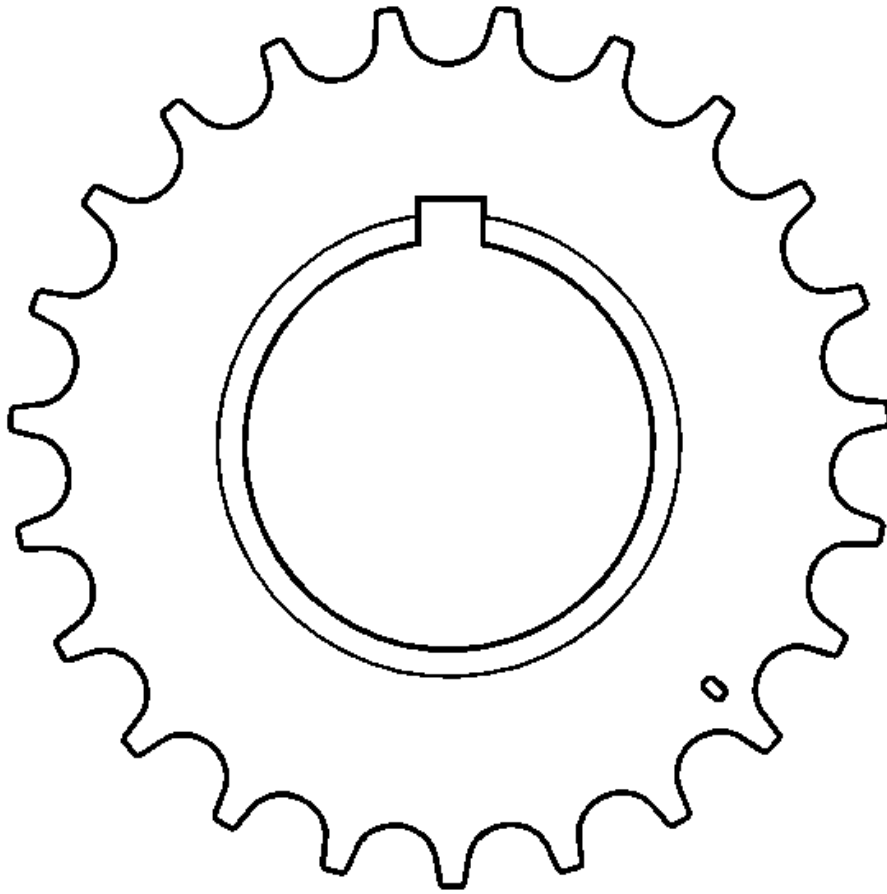


Fig. 82: View Of Crankshaft Sprocket Timing Mark
Courtesy of GENERAL MOTORS CORP.

11. Install the timing chain drive sprocket to the crankshaft with the timing mark in the 5 o'clock position and the front of the sprocket facing out.

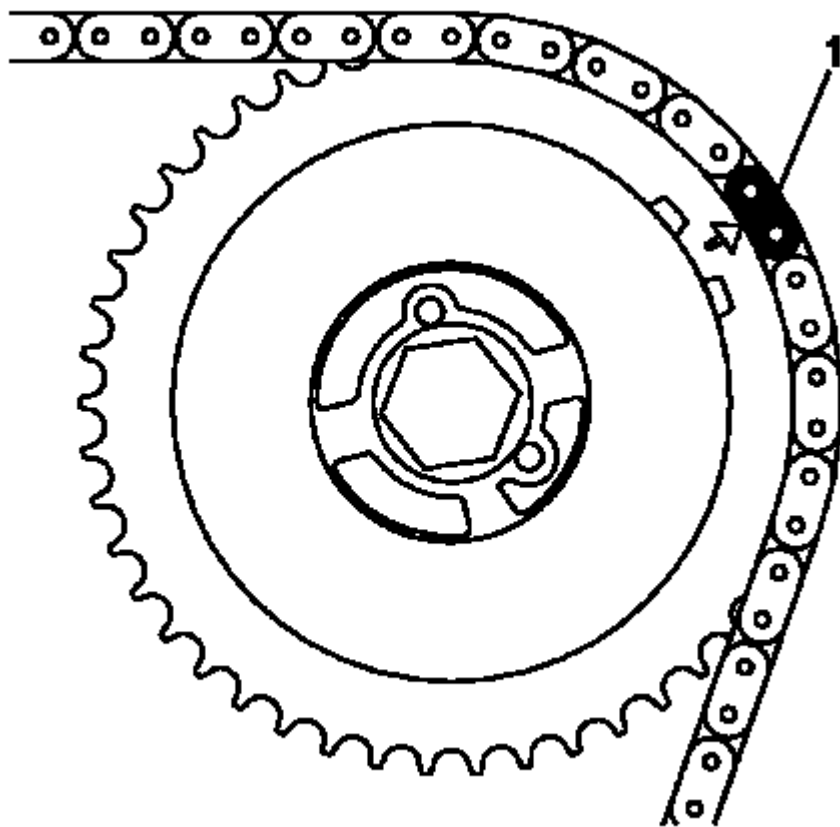


Fig. 83: Identifying Colored Links On Timing Chain
Courtesy of GENERAL MOTORS CORP.

NOTE:

- There are 3 colored links on the timing chain. 2 links are of matching color, and 1 link is of a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.
- Always use new actuator bolts.

12. Assemble the intake camshaft actuator into the timing chain with the timing mark lined up with the uniquely colored link (1).

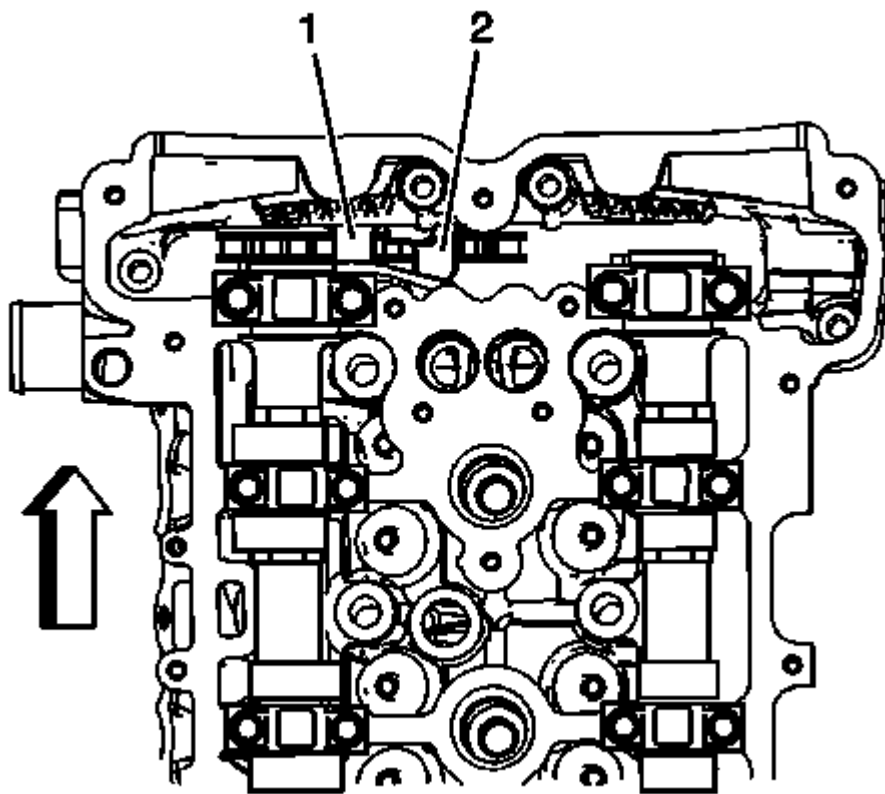


Fig. 84: Identifying Cylinder Head Opening
Courtesy of GENERAL MOTORS CORP.

13. Lower the timing chain through the opening in the cylinder head. Use care to ensure that the chain goes around both sides of the cylinder block bosses (1, 2).
14. Install the intake camshaft actuator onto the intake camshaft while aligning the dowel pin into the camshaft slot.
15. Hand tighten the new intake camshaft actuator bolt.

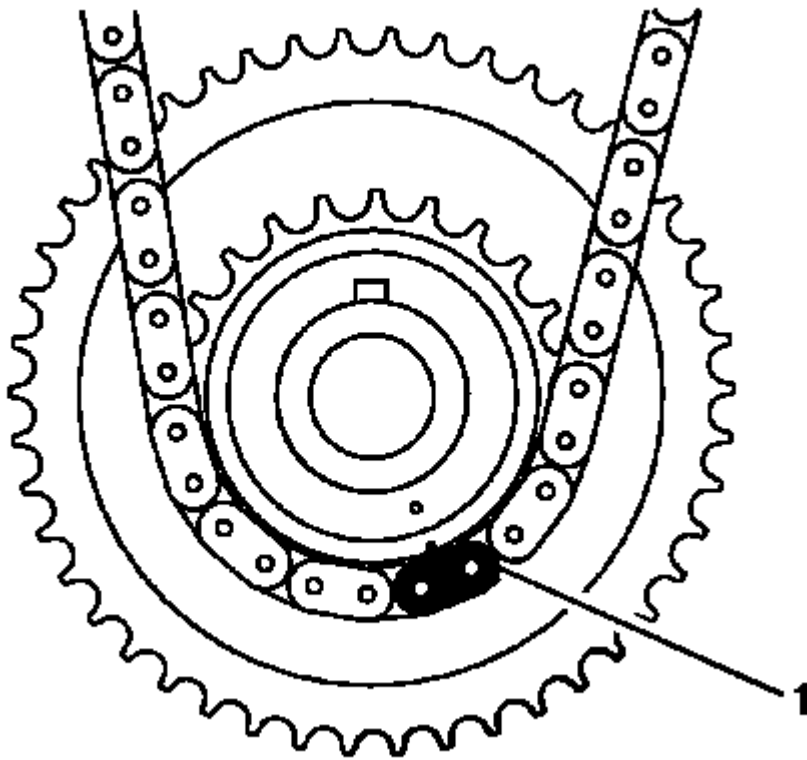


Fig. 85: Lining Up First Pink Link With Timing Mark On Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

16. Route the timing chain around the crankshaft sprocket and line up the first matching colored link with the timing mark on the crankshaft sprocket, in approximately the 5 o'clock position.

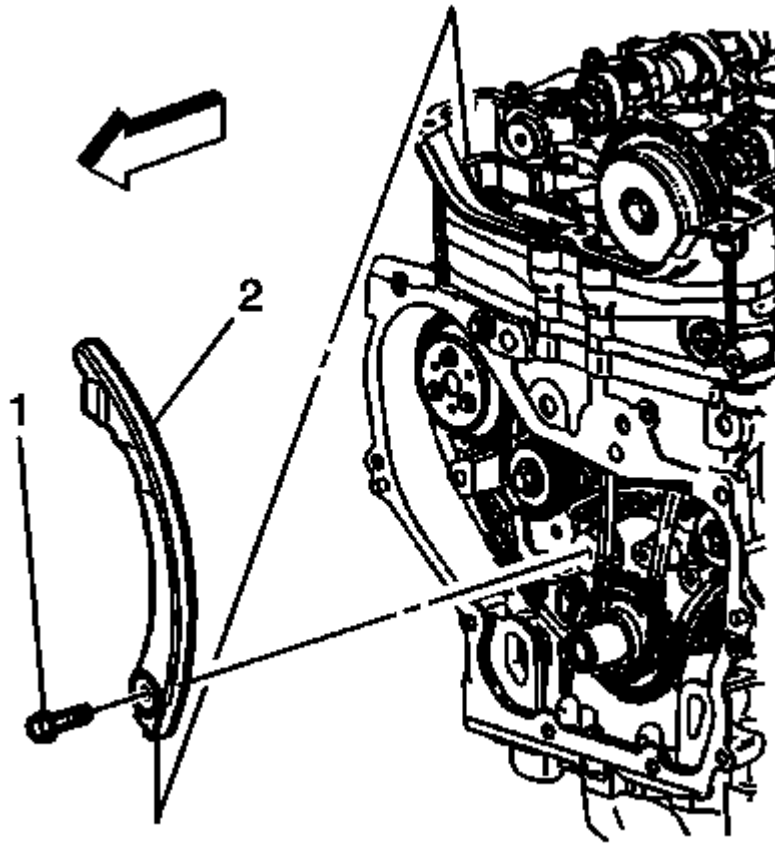


Fig. 86: View Of Adjustable Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

17. Rotate the crankshaft clockwise to remove all chain slack. Do not rotate the intake camshaft.
18. Install the adjustable timing chain guide down through the opening in the cylinder head and install the adjustable timing chain bolt.

Tighten: Tighten the adjustable timing chain guide bolt to 10 N.m (89 lb in).

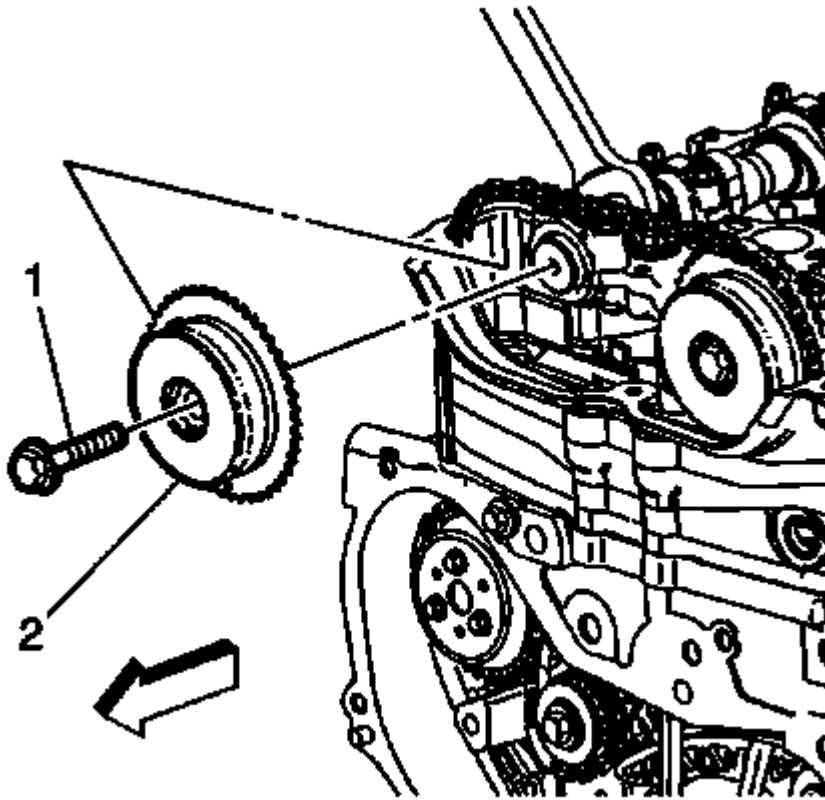


Fig. 87: View Of Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

NOTE: Always install NEW actuator bolts.

19. Install the exhaust camshaft actuator into the timing chain with the timing mark lined up with the second matching colored link.

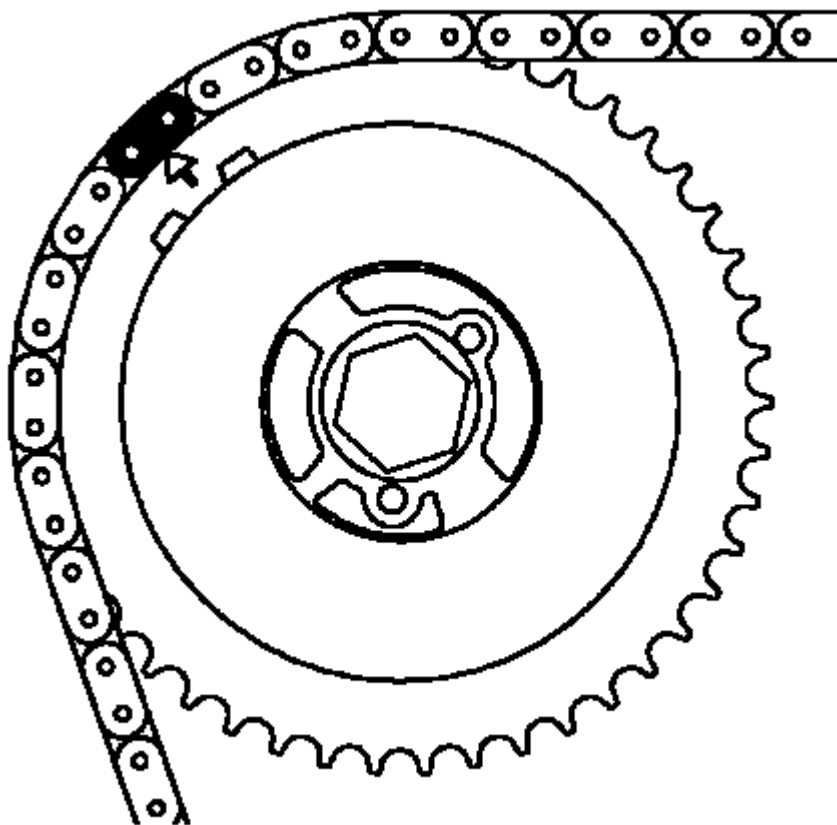


Fig. 88: Identifying Timing Mark On Actuator & Last Pink Colored Link
 Courtesy of GENERAL MOTORS CORP.

20. Install the exhaust camshaft actuator onto the exhaust camshaft, aligning the dowel pin into the camshaft slot.
21. Using a 23 mm open end wrench, rotate the exhaust camshaft approximately 45 degrees until the dowel pin in the camshaft actuator goes into the camshaft slot.

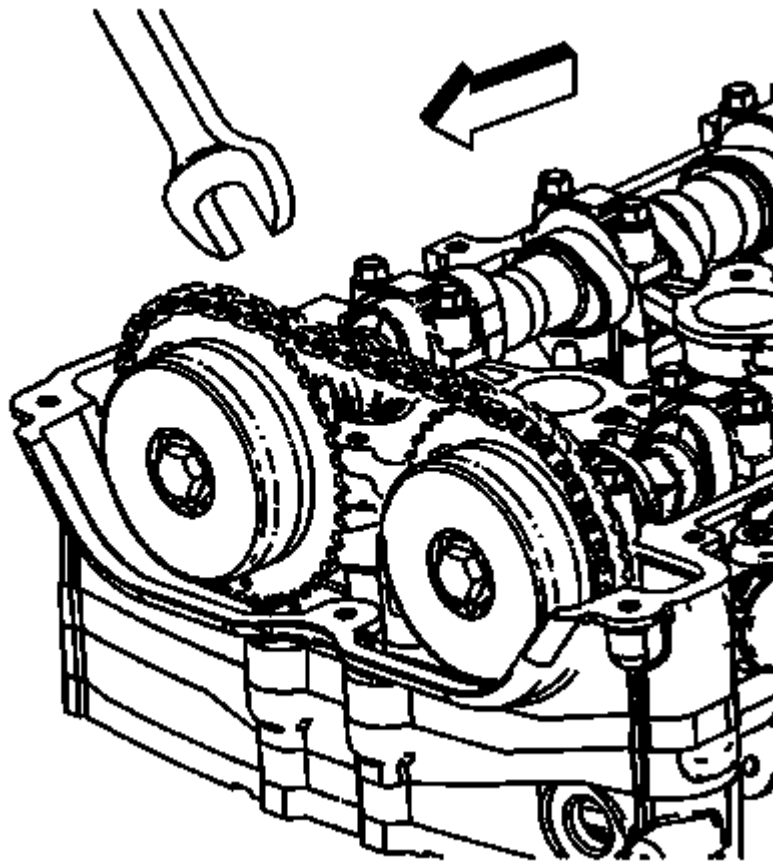


Fig. 89: Identifying Cam Actuator, Camshaft & Chain
Courtesy of GENERAL MOTORS CORP.

22. When the actuator seats on the cam, tighten the new exhaust camshaft actuator bolt hand tight.

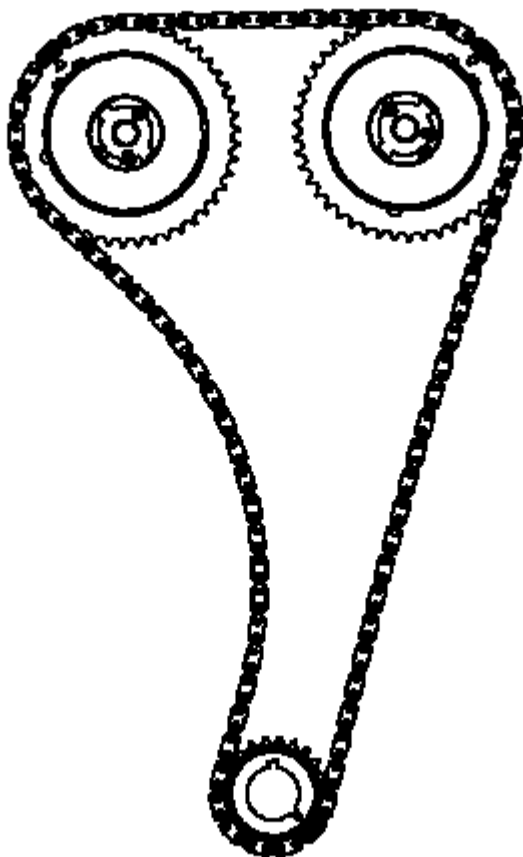


Fig. 90: Identifying Chain & Sprockets
Courtesy of GENERAL MOTORS CORP.

23. Verify that all of the colored links and the appropriate timing marks are still aligned. If they are not aligned, repeat the portion of the procedure necessary to align the timing marks.

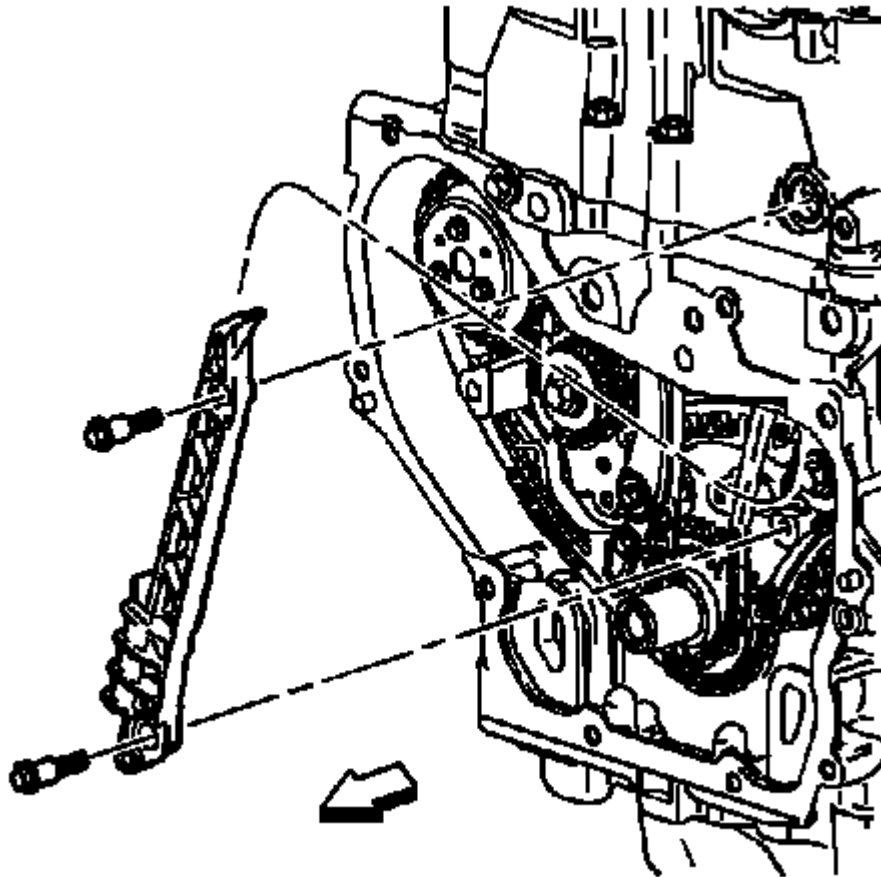


Fig. 91: View Of Fixed Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

24. Install the fixed timing chain guide and bolts.

Tighten: Tighten the fixed timing chain guide bolts to 12 N.m (106 lb in).

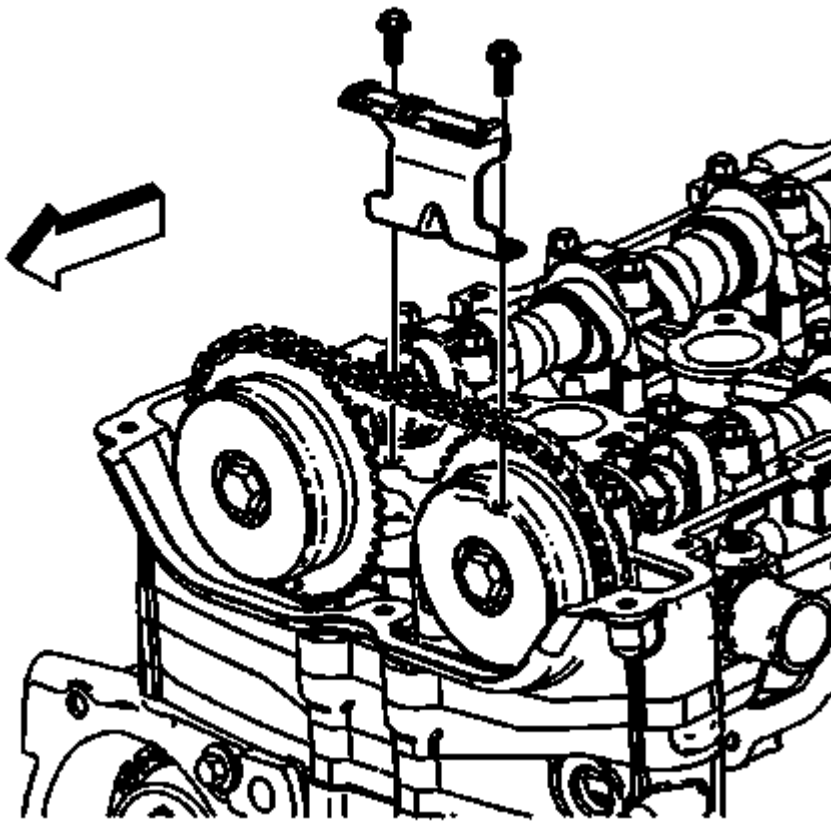


Fig. 92: View Of Upper Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

25. Install the upper timing chain guide and bolts.

Tighten: Tighten the upper timing chain guide bolts to 10 N.m (89 lb in).

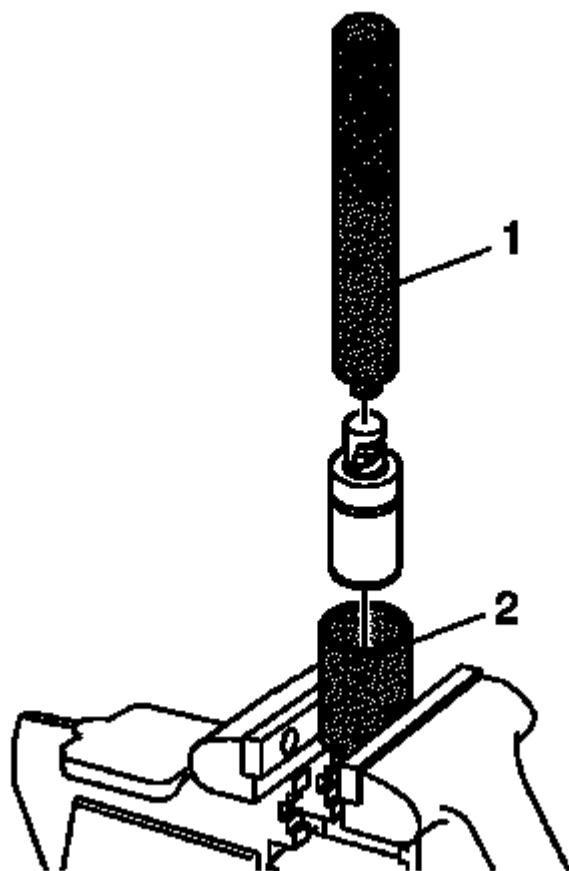


Fig. 93: View Of Compressing Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

26. Reset the timing chain tensioner by performing the following steps:
1. Remove the snap ring.
 2. Remove the piston assembly from the body of the timing chain tensioner.
 3. Install the J 45027-2 (2) into a vise.
 4. Install the notch end of the piston assembly into the J 45027-2 (2).
 5. Using the J 45027-1 (1), turn the ratchet cylinder into the piston.
 6. Reinstall the piston assembly into the body of the tensioner.
 7. Install the snap ring.

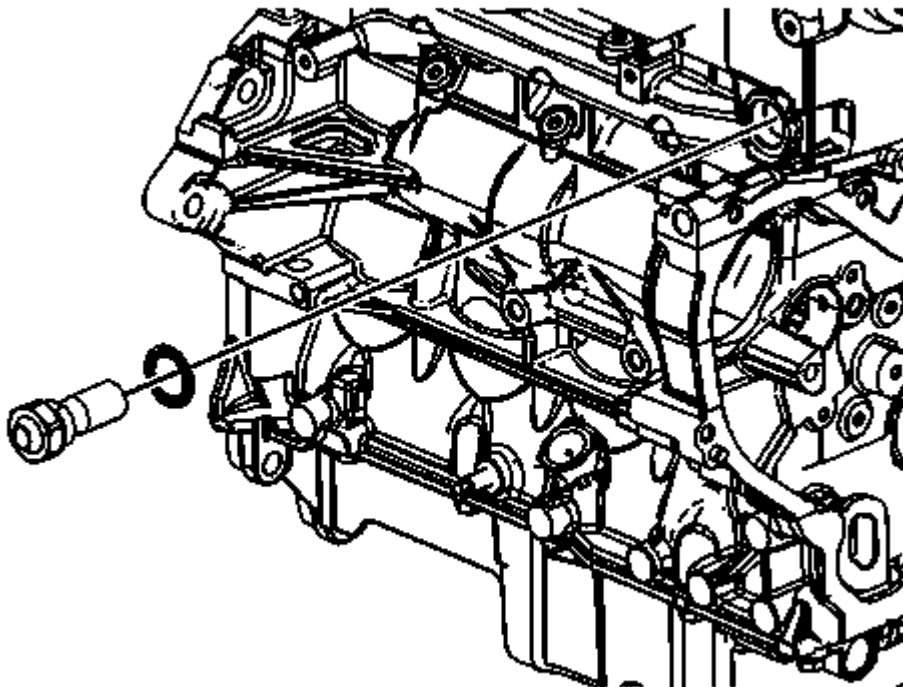


Fig. 94: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

27. Inspect the timing chain tensioner seal for damage. If damaged, replace the seal.
28. Inspect to ensure all dirt and debris is removed from the timing chain tensioner threaded hole in the cylinder head.

NOTE: Ensure the timing chain tensioner seal is centered throughout the torque procedure to eliminate the possibility of an oil leak.

29. Install the timing chain tensioner assembly.

Tighten: Tighten the timing chain tensioner to 75 N.m (55 lb ft).

30. The timing chain tensioner is released by compressing it 2 mm (0.079 in), which will release the locking mechanism in the ratchet. To release the timing chain tensioner, use a suitable tool with a rubber tip on the end. Feed the tool down through the cam drive chest to rest on the cam chain. Then give a sharp jolt diagonally downwards to release the tensioner.

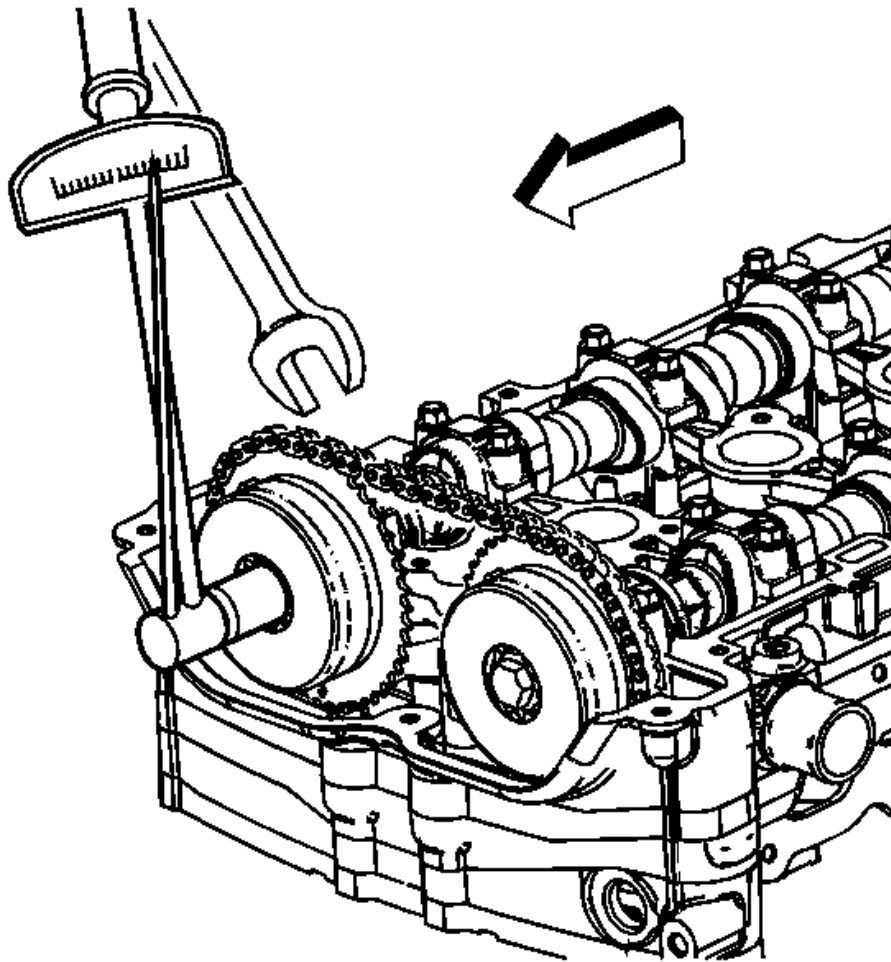


Fig. 95: View Of Tightening Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS CORP.

31. Using a 23 mm wrench, engage the hex on the intake camshaft, and using a torque wrench, tighten the camshaft actuator bolt.

Tighten: Tighten the intake camshaft position actuator bolt to 30 N.m (22 lb ft), plus 100 degrees.

32. Using a 23 mm wrench, engage the hex on the exhaust camshaft, and using a torque wrench, tighten the camshaft actuator bolt.

Tighten: Tighten the exhaust camshaft position actuator bolt to 30 N.m (22 lb ft), plus 100 degrees.

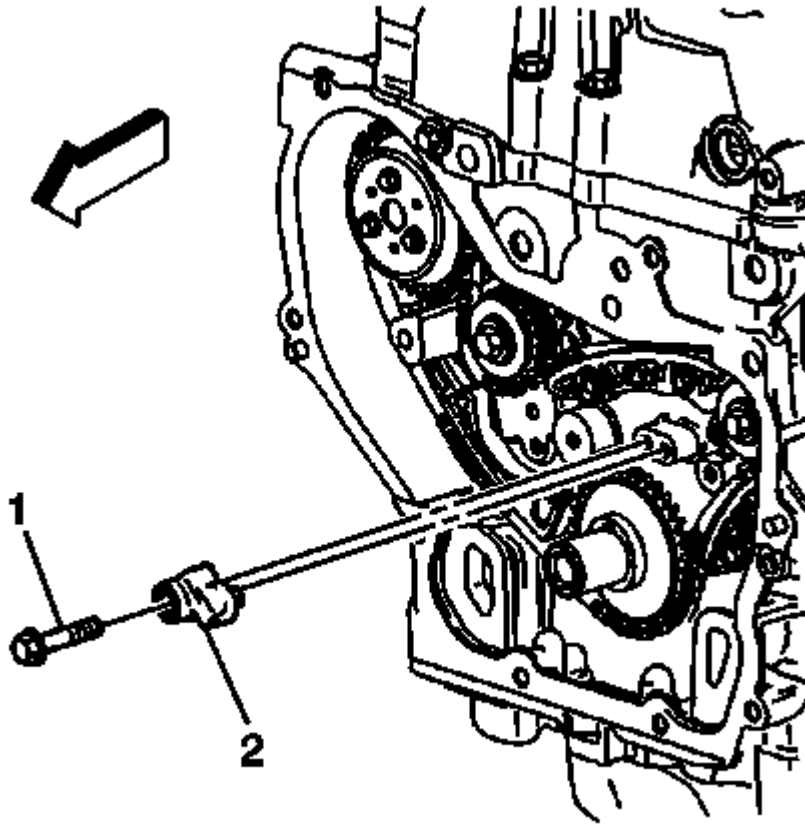


Fig. 96: View Of Oil Nozzle & Bolt
Courtesy of GENERAL MOTORS CORP.

33. Install the timing chain oiling nozzle.

Tighten: Tighten the timing chain oiling nozzle bolt to 10 N.m (89 lb in).

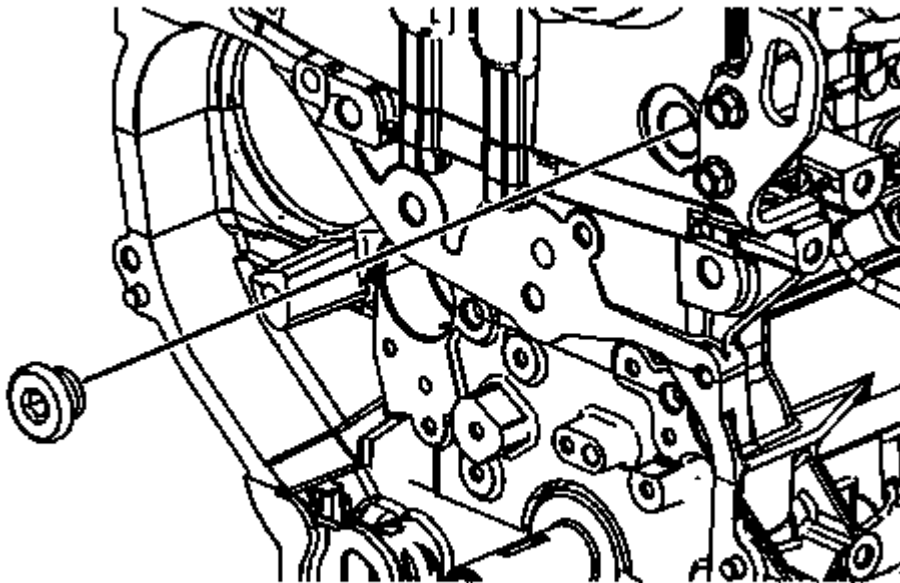


Fig. 97: View Of Timing Chain Guide Bolt Access Hole & Plug
Courtesy of GENERAL MOTORS CORP.

34. Apply sealant compound GM P/N 12345382 (Canadian P/N 10953489) to the thread of the timing chain guide bolt access hole plug.
35. Install the timing chain guide bolt access hole plug.

Tighten: Tighten the access hole plug to 90 N.m (66 lb ft).

36. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
37. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
38. Install the number 1 cylinder spark plug. Refer to **Spark Plug Replacement**.

CAMSHAFT COVER REPLACEMENT

REMOVAL PROCEDURE

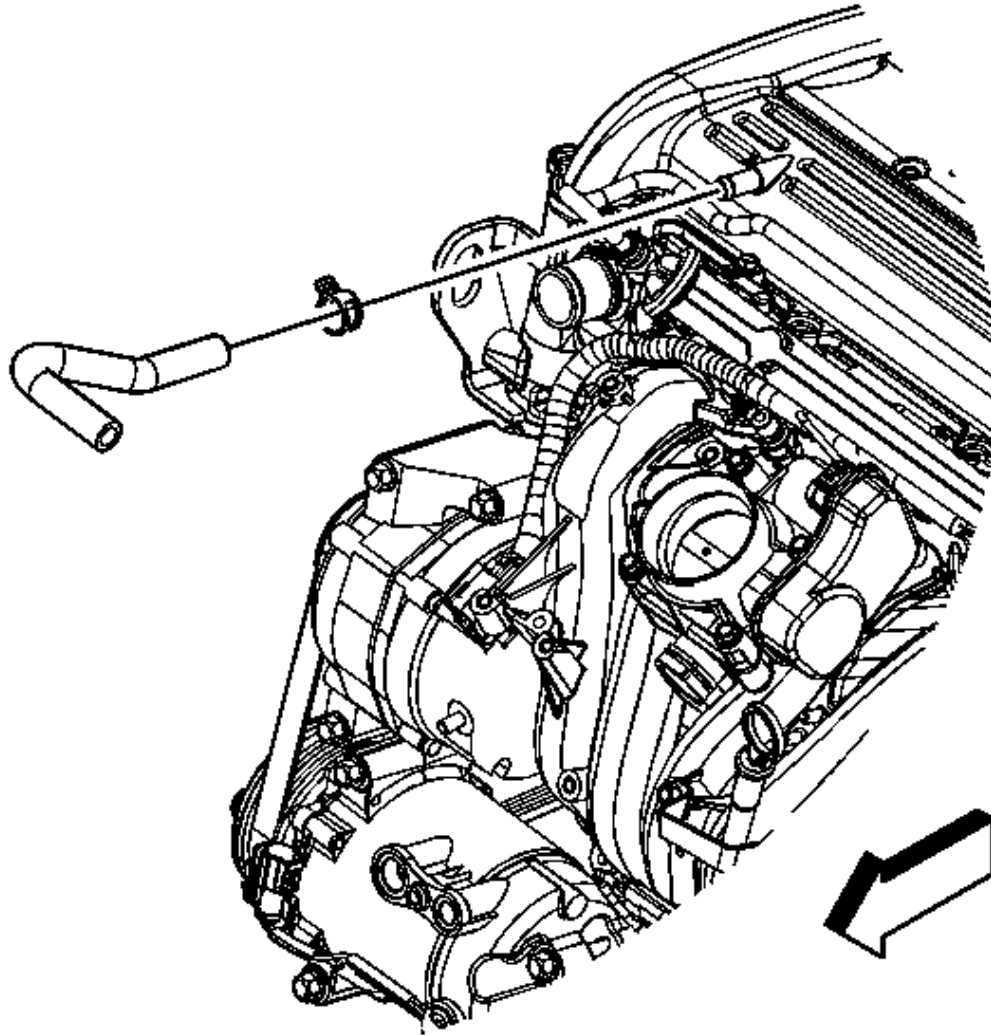


Fig. 98: Identifying PCV Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
2. Reposition the positive crankcase ventilation (PCV) hose clamp.
3. Remove the PCV hose from the cover.

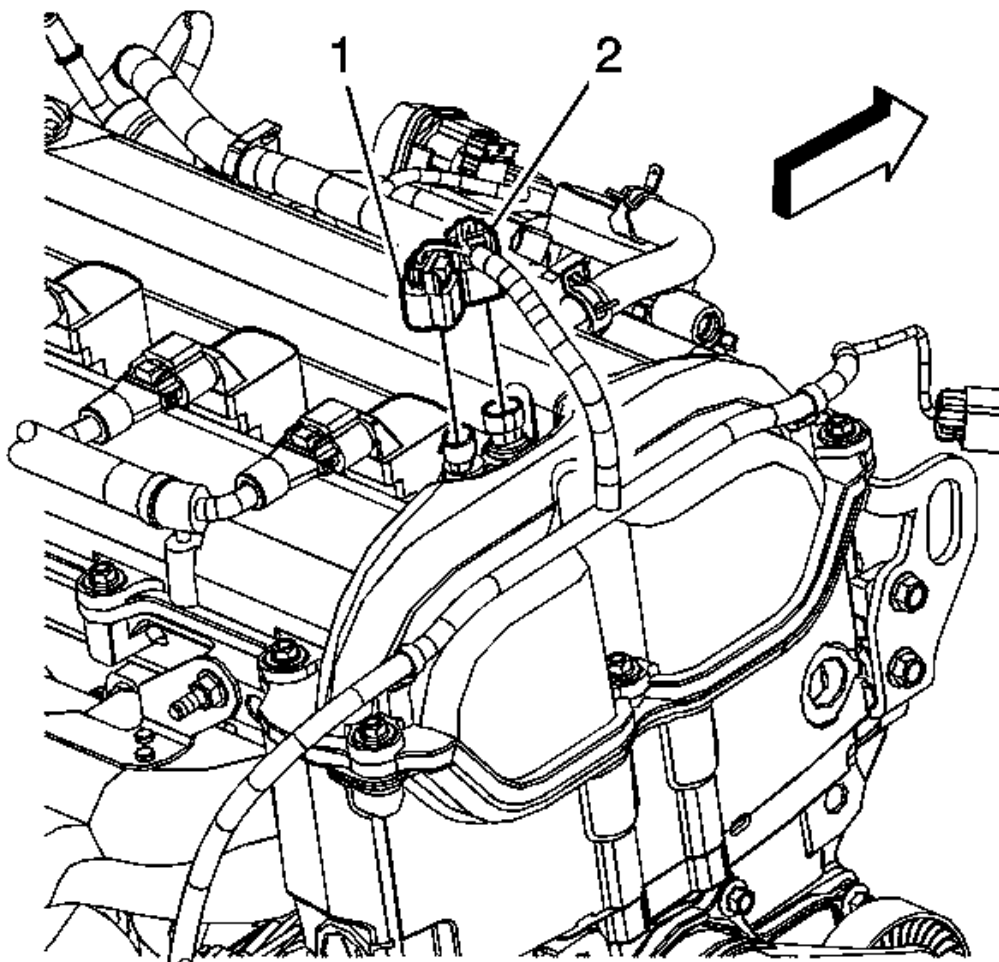


Fig. 99: View Of Camshaft Position (CMP) Actuator Solenoid Valve Harness Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the intake (2) and exhaust (1) camshaft position actuator solenoid valve electrical connectors.

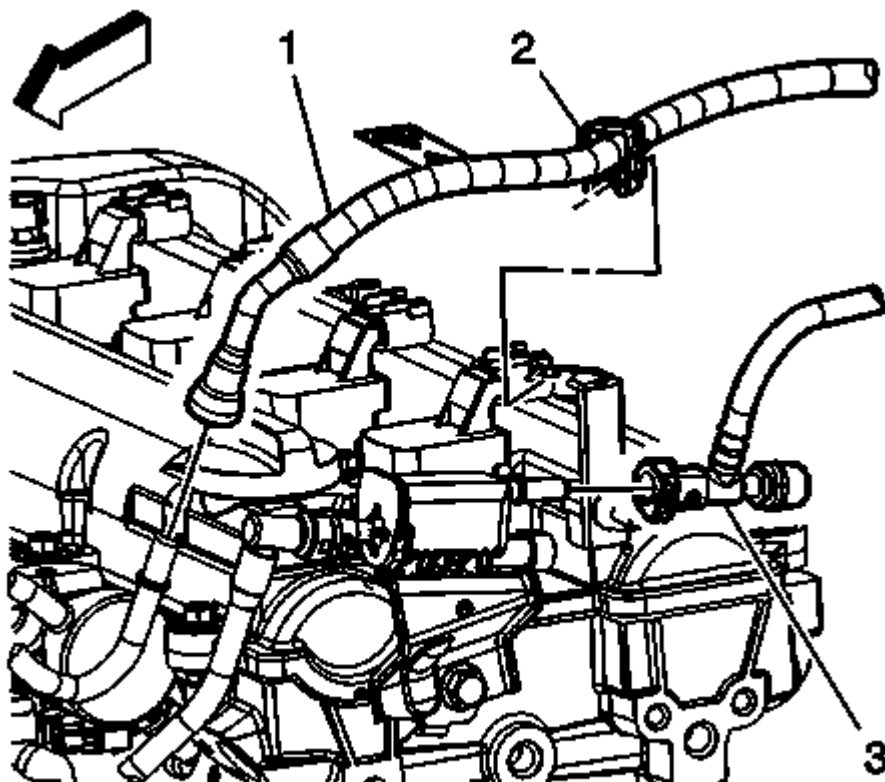


Fig. 100: View Of Fuel Feed Pipe Retainer & Fuel Pipe Bracket
Courtesy of GENERAL MOTORS CORP.

5. Remove the fuel feed pipe retainer (2) from the fuel pipe bracket.

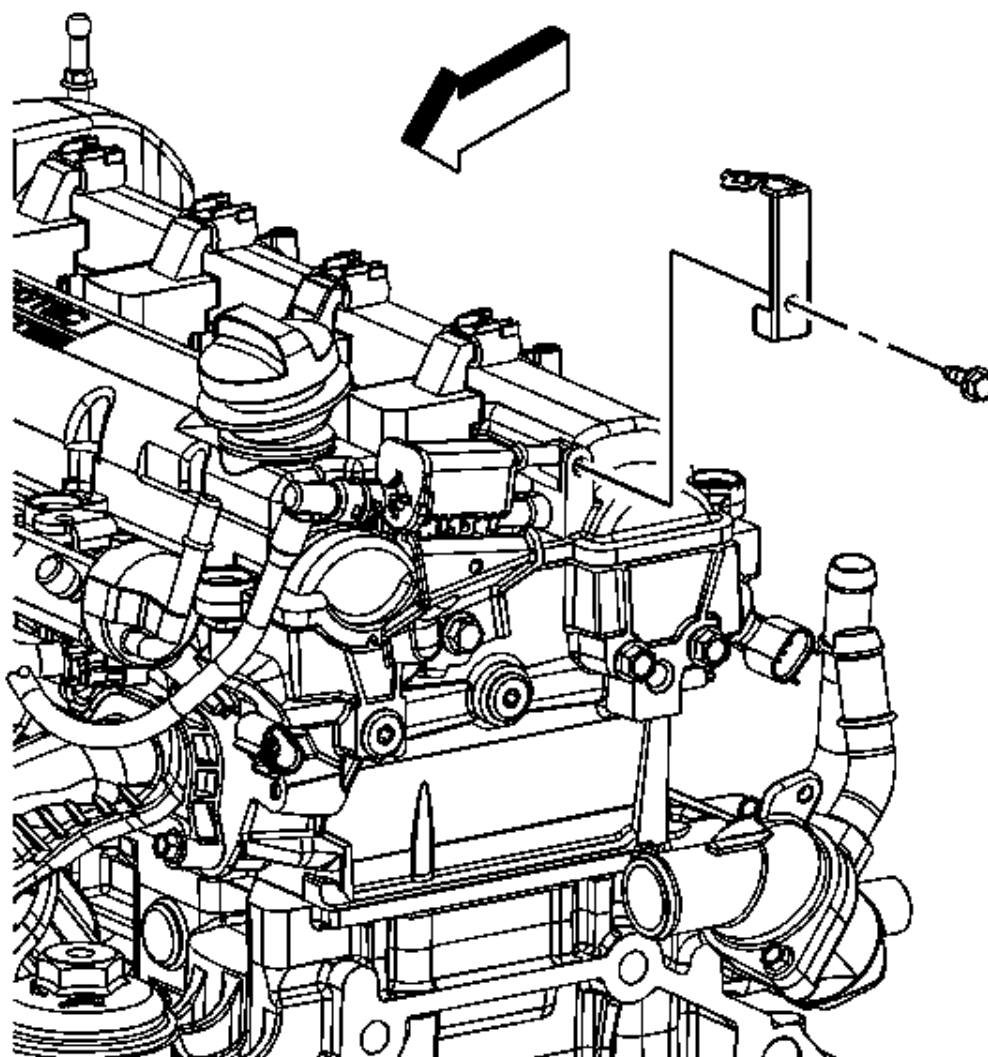


Fig. 101: Identifying Fuel Feed Pipe Bracket & Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the fuel feed pipe bracket bolt and bracket.

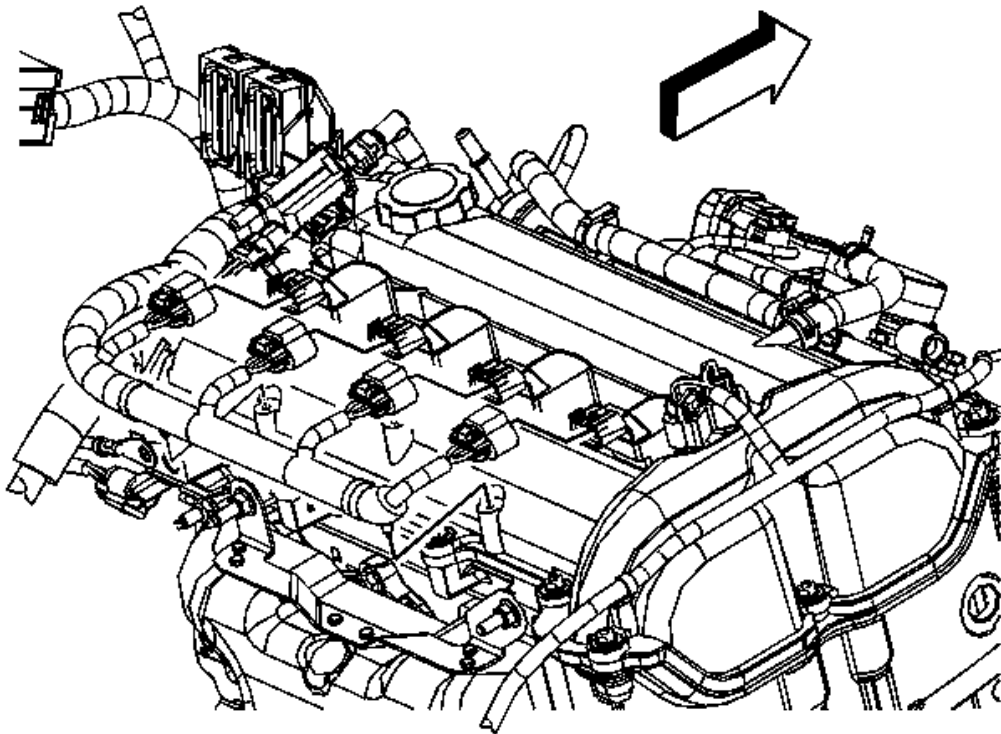


Fig. 102: Identifying Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

7. Disconnect and remove the ignition coil electrical connector harness clips from the cover.
8. Remove the ignition coils. Refer to **Ignition Coil Replacement** .

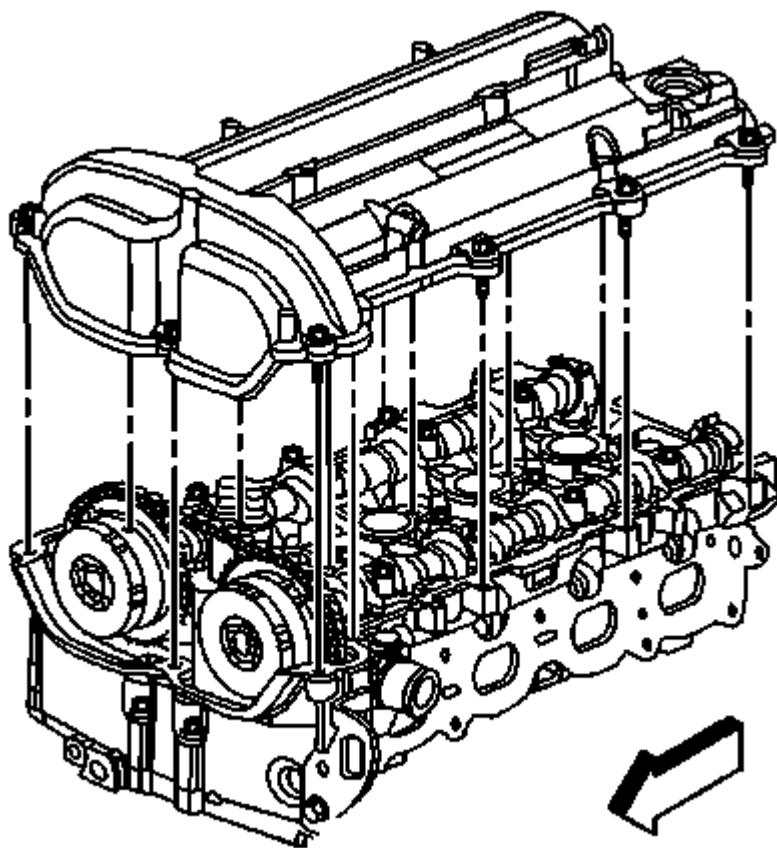


Fig. 103: View Of Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

9. Remove the camshaft cover bolts.
10. Remove the camshaft cover.

INSTALLATION PROCEDURE

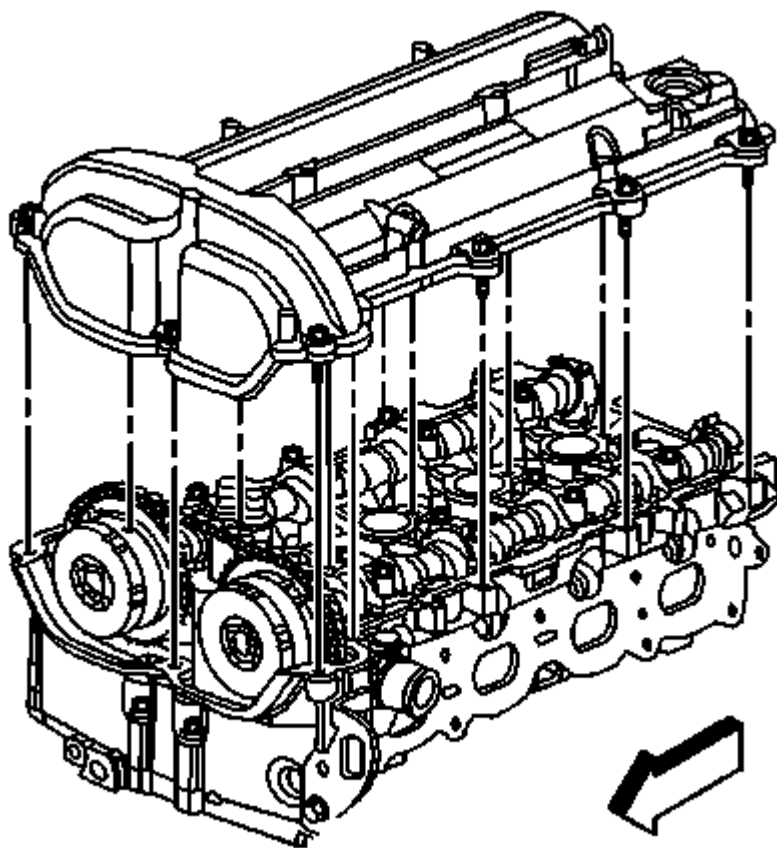


Fig. 104: View Of Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the camshaft cover and bolts and tighten to 10 N.m (89 lb in).

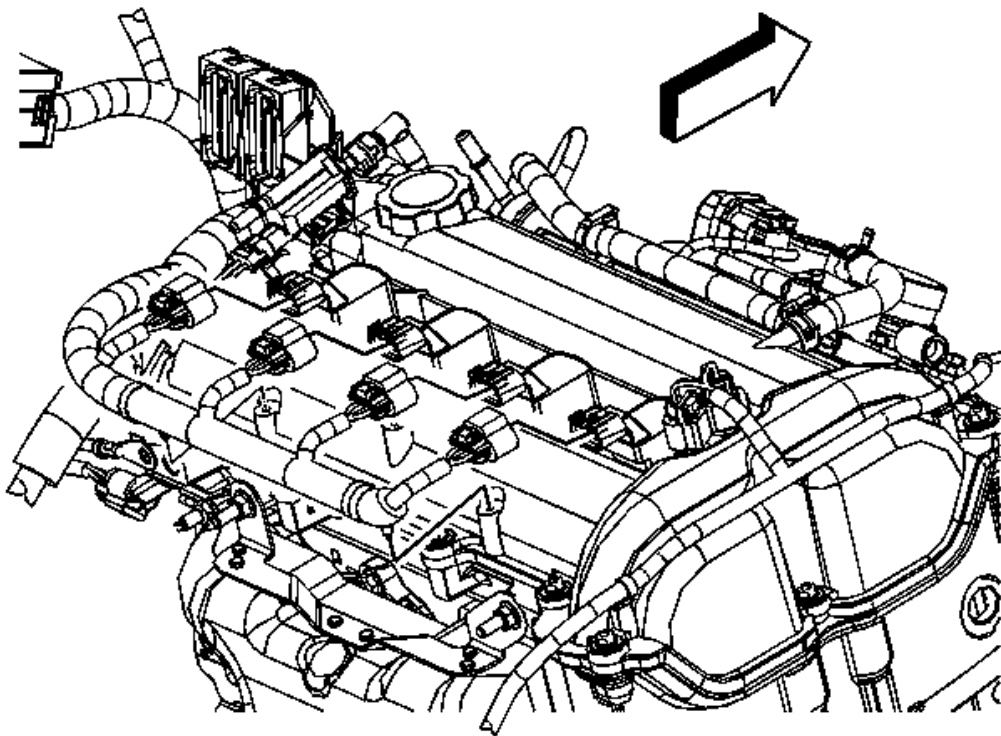


Fig. 105: Identifying Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

2. Install the ignition coils. Refer to **Ignition Coil Replacement** .
3. Install and connect the ignition coil electrical connector harness clips to the cover.

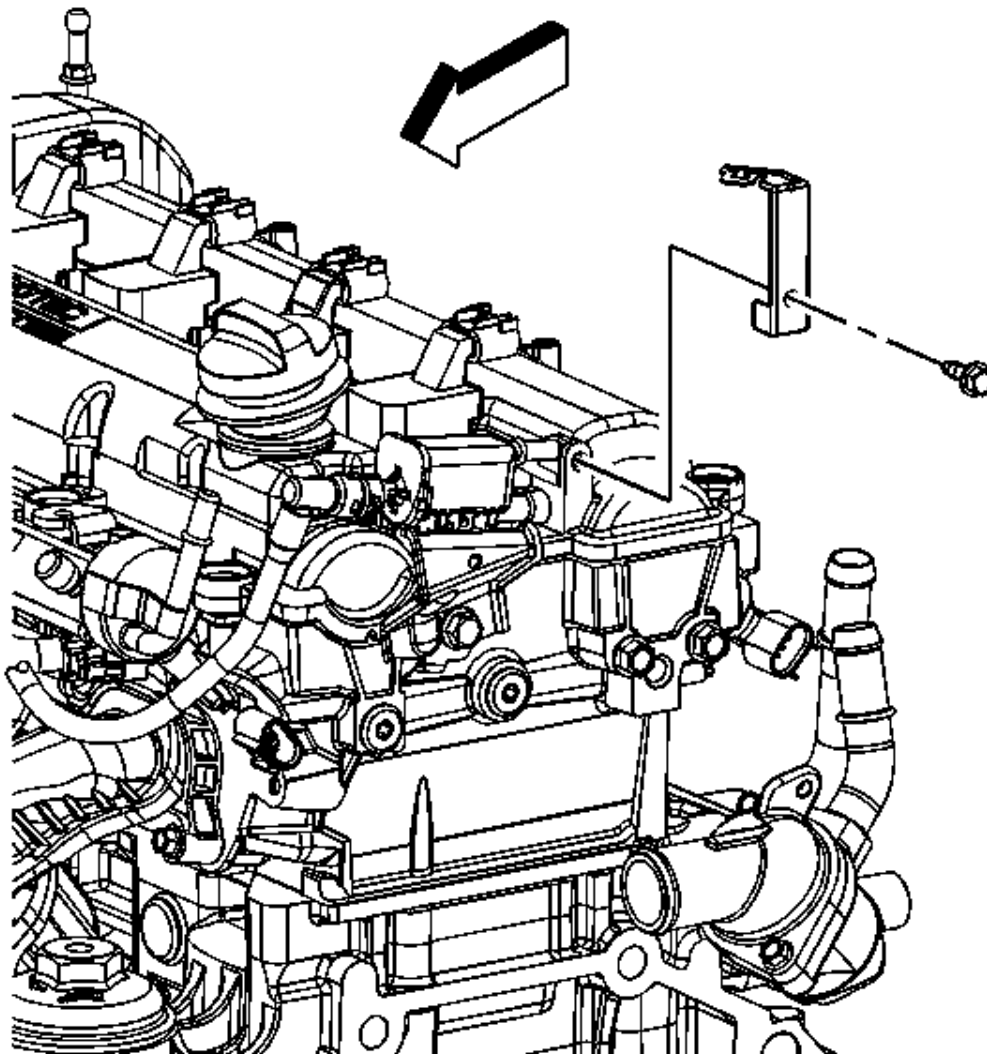


Fig. 106: Identifying Fuel Feed Pipe Bracket & Bolt
Courtesy of GENERAL MOTORS CORP.

4. Install the fuel feed pipe bracket and bolt and tighten the bolt to 10 N.m (89 lb in).

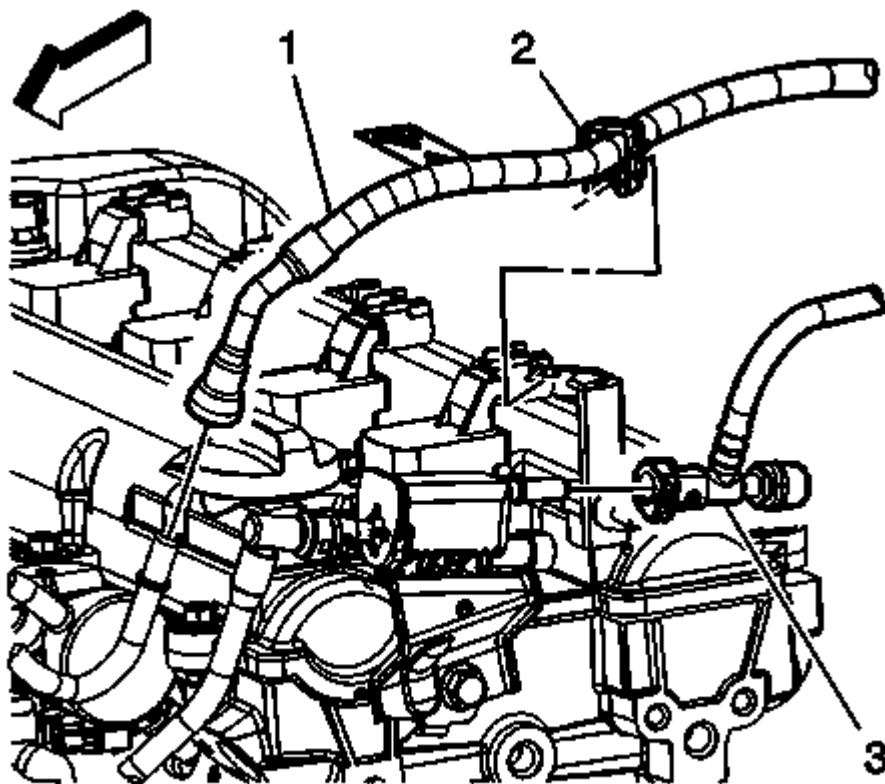


Fig. 107: View Of Fuel Feed Pipe Retainer & Fuel Pipe Bracket
Courtesy of GENERAL MOTORS CORP.

5. Install the fuel feed pipe retainer (2) to the fuel pipe bracket.

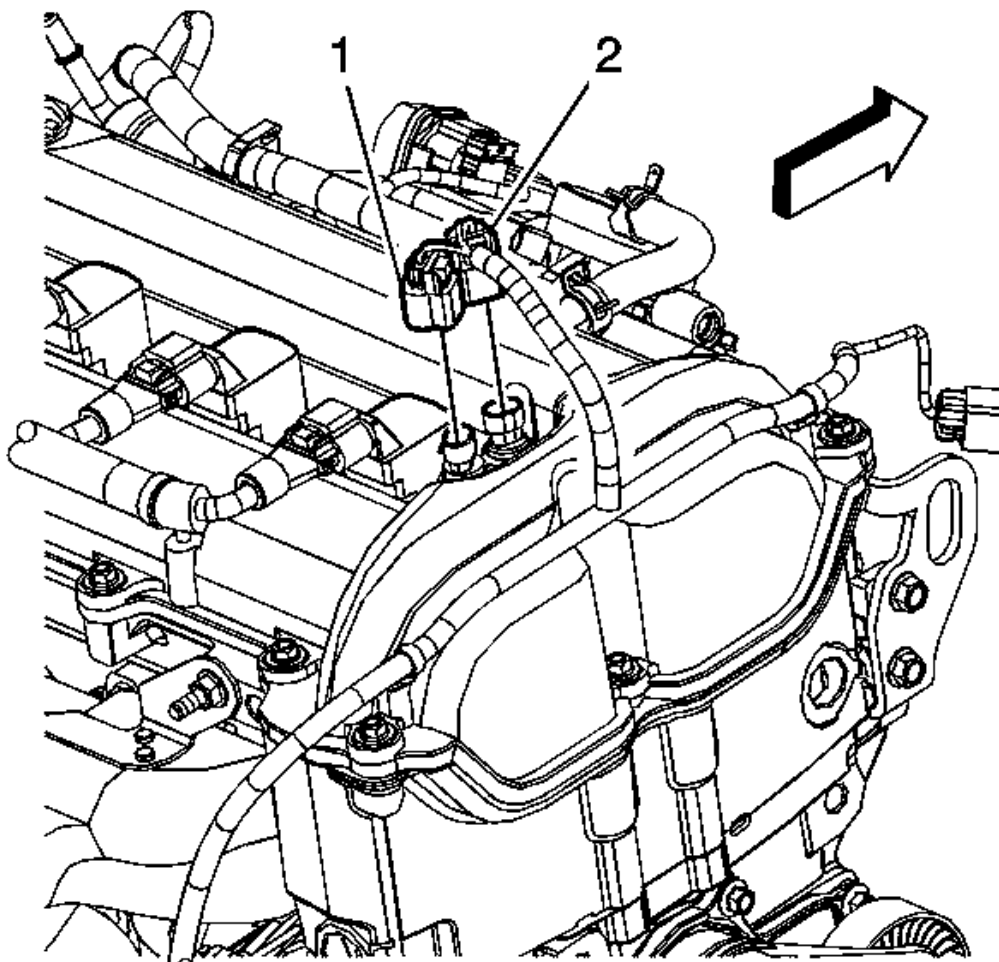


Fig. 108: View Of Camshaft Position (CMP) Actuator Solenoid Valve Harness Connector
Courtesy of GENERAL MOTORS CORP.

6. Connect the intake (2) and exhaust (1) camshaft position actuator solenoid valve electrical connectors.

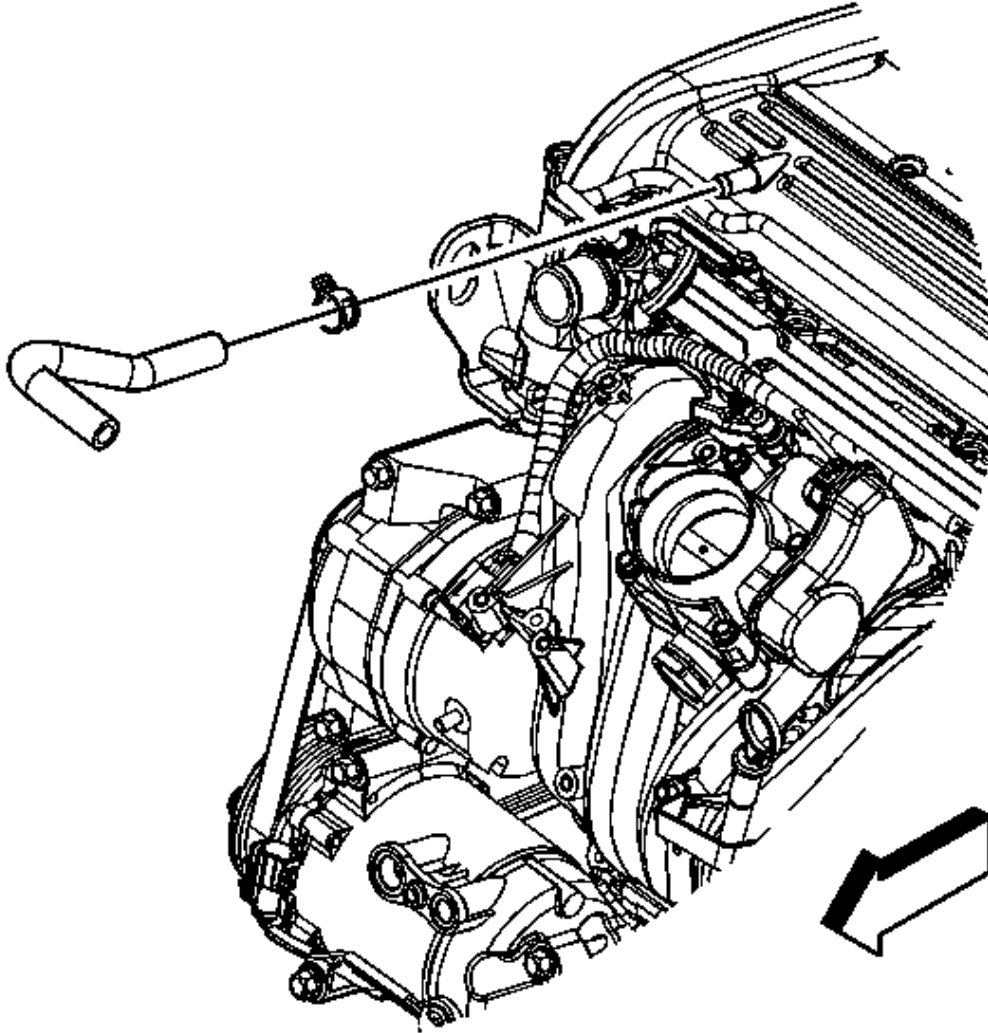


Fig. 109: Identifying PCV Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

7. Install the PCV hose to the cover.
8. Position the PCV hose clamp.
9. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .

TIMING CHAIN TENSIONER REPLACEMENT

SPECIAL TOOLS

J 45027 Tensioner Tool**REMOVAL PROCEDURE**

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

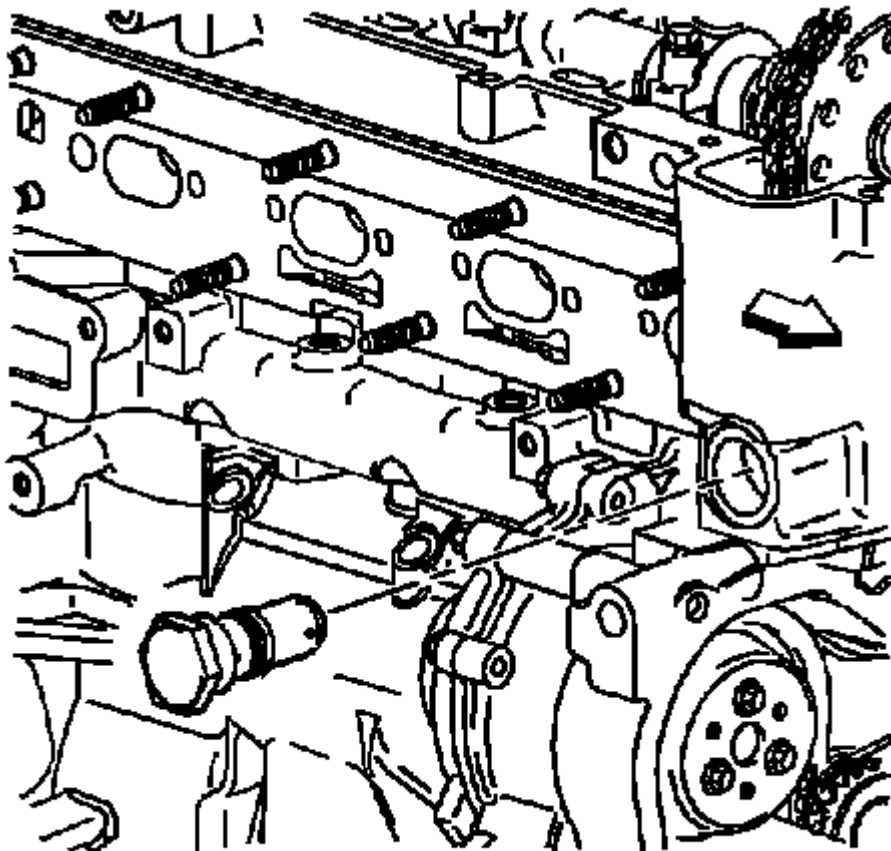


Fig. 110: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

3. Remove the timing chain tensioner.
4. Remove the seal from the tensioner.

INSTALLATION PROCEDURE

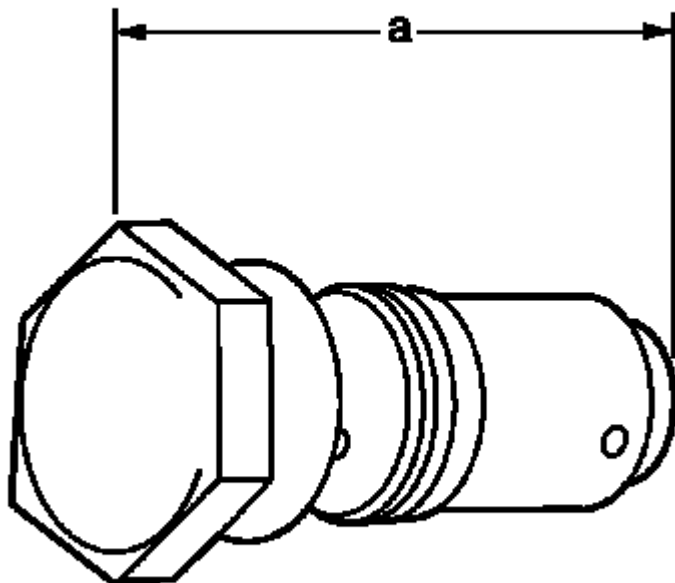


Fig. 111: Measuring Timing Chain Tensioner Assembly
Courtesy of GENERAL MOTORS CORP.

1. Inspect the timing chain tensioner. If the timing chain tensioner, O-ring seal, or washer is damaged, replace the timing chain tensioner or O-ring seal as applicable.
2. Measure the timing chain tensioner assembly from end to end. If the timing chain tensioner is to be replaced, a new tensioner should be supplied in the fully compressed non-active state. A tensioner in the compressed state will measure 72 mm (2.83 in) (a) from end to end. A tensioner in the active state will measure 85 mm (3.35 in) (a) from end to end.

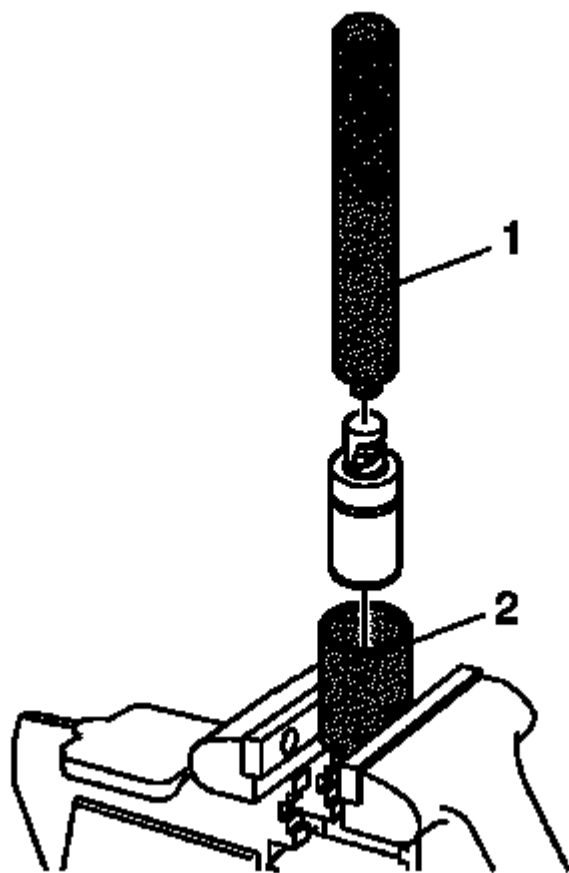


Fig. 112: View Of Compressing Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

3. If the timing chain tensioner is not in the compressed state, perform the following steps:
 1. Remove the piston assembly from the body of the timing chain tensioner by pulling it out.
 2. Install the J 45027-2 (2) into a vise.
 3. Install the notch end of the piston assembly into the J 45027-2 (2).
 4. Using the J 45027-1 (1), turn the ratchet cylinder into the piston.

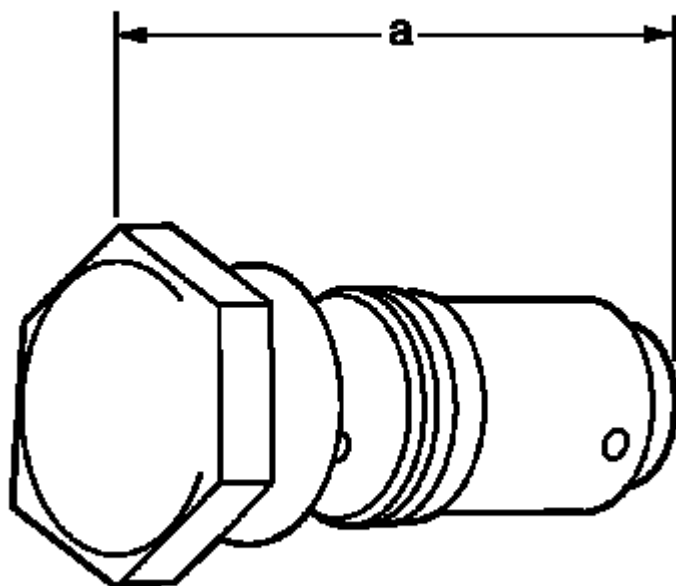


Fig. 113: Measuring Timing Chain Tensioner Assembly
 Courtesy of GENERAL MOTORS CORP.

4. Inspect the bore of the tensioner body for dirt, debris, and damage. If any damage appears, replace the tensioner. Clean dirt or debris out with a lint-free cloth.
5. Install the compressed piston assembly back into the timing chain tensioner body until it stops at the bottom of the bore. Do not compress the piston assembly against the bottom of the bore. If the piston assembly is compressed against the bottom of the bore, it will activate the tensioner, which will then need to be reset again.
6. At this point the tensioner should measure approximately 72 mm (2.83 in) (a) from end to end. If the tensioner does not read 72 mm (2.83 in) (a) from end to end, repeat steps 3-5.

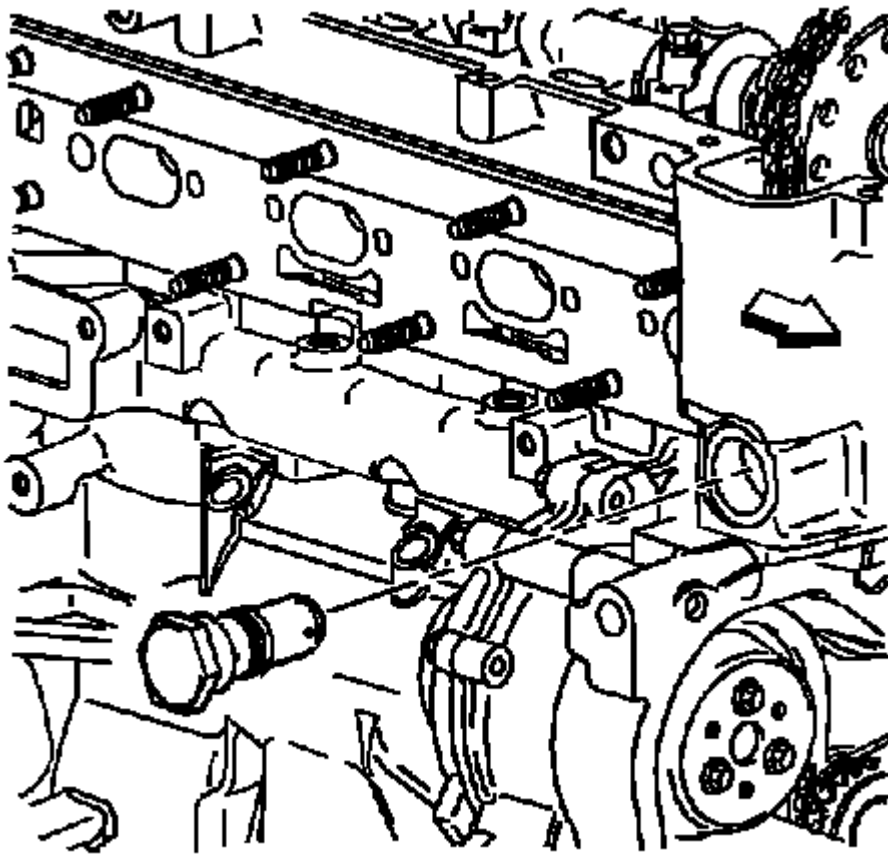


Fig. 114: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

7. Inspect to ensure all dirt and debris is removed from the timing chain tensioner threaded hole in the cylinder head.

CAUTION: Refer to Fastener Caution .

NOTE: Ensure the timing chain tensioner seal is centered throughout the torque procedure to eliminate the possibility of an oil leak.

8. Install the timing chain tensioner assembly. Tighten the timing chain tensioner to 75 N.m (55 lb ft).
9. The timing chain tensioner is released by compressing the tensioner 2 mm (0.079 in) which will release the locking mechanism in the ratchet. To release the timing chain tensioner, use a suitable tool with a rubber tip on the end. Feed the tool down through the cam drive chest to rest on the cam chain. Then give a sharp jolt diagonally downwards to release the tensioner.
10. Install the camshaft cover. Refer to Camshaft Cover Replacement.
11. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .

INTAKE CAMSHAFT AND VALVE LIFTER REPLACEMENT

REMOVAL PROCEDURE

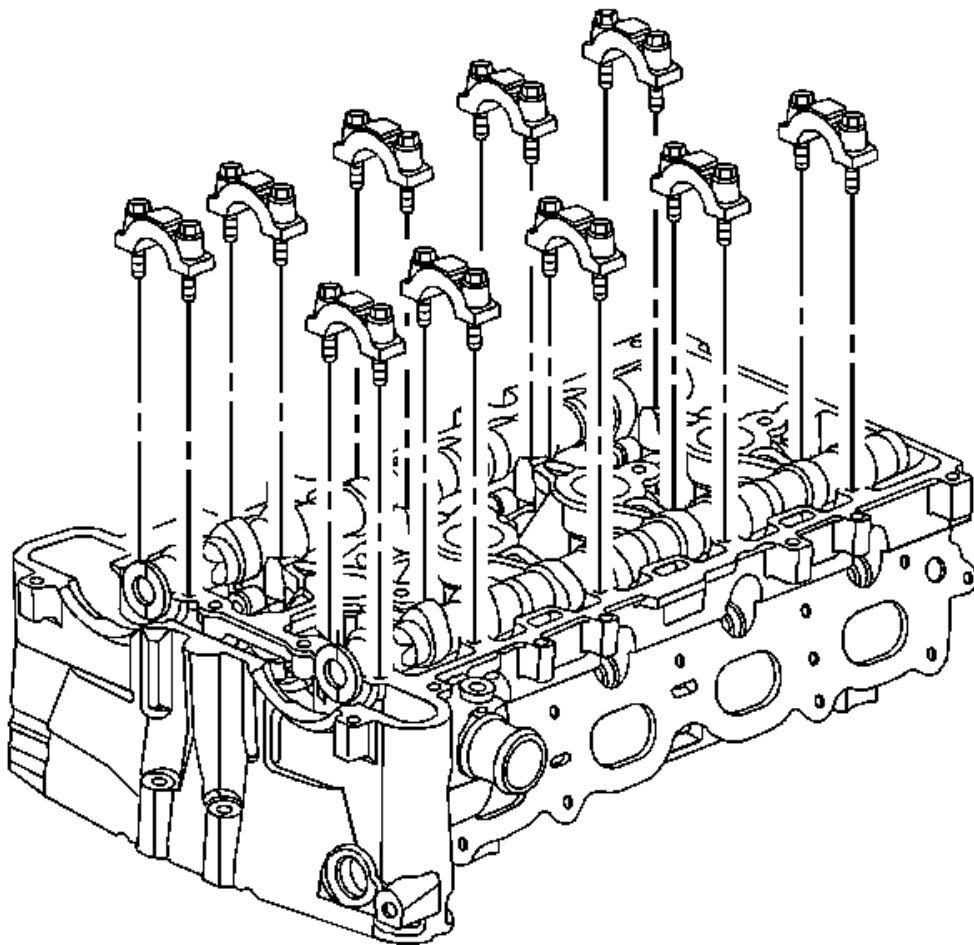


Fig. 115: View Of Camshaft Bearing Caps

Courtesy of GENERAL MOTORS CORP.

1. Remove the intake camshaft position actuator. Refer to [Camshaft Position Intake Actuator Replacement](#).

NOTE: Remove each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.

2. Mark the bearing caps to ensure they are installed in the original position.
3. Remove the bearing cap bolts.
4. Remove the bearing caps.

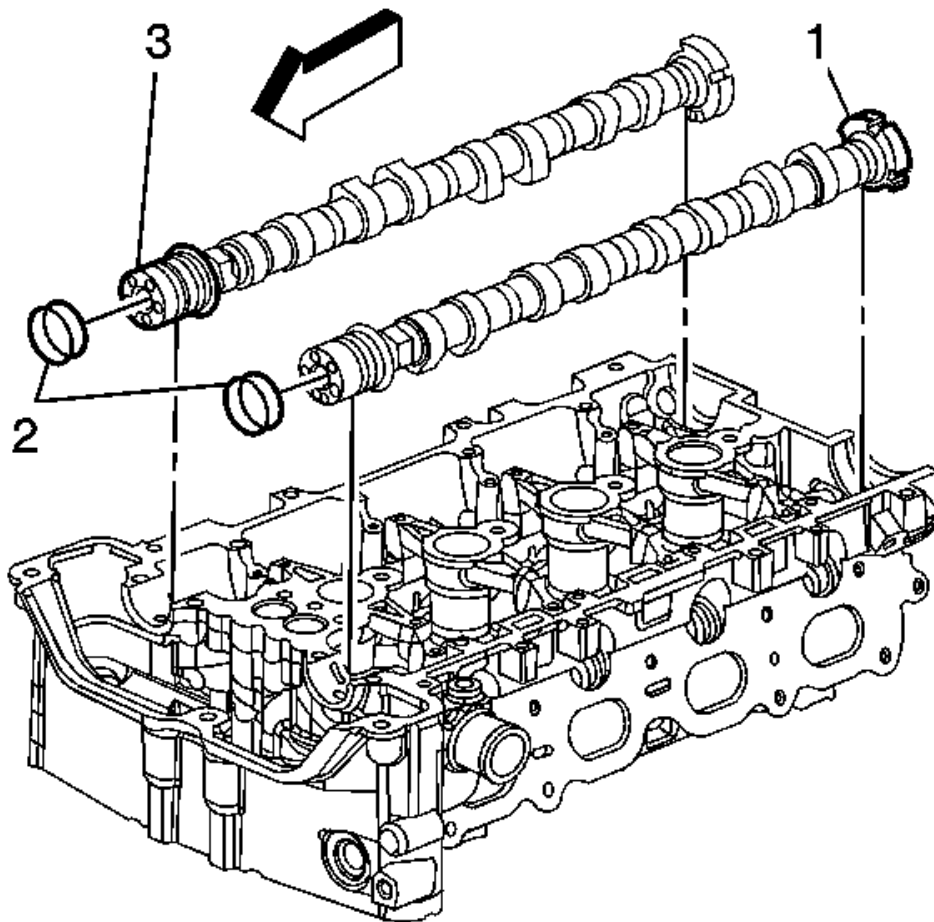


Fig. 116: View Of Intake & Exhaust Camshafts
Courtesy of GENERAL MOTORS CORP.

5. Remove the intake camshaft (1).

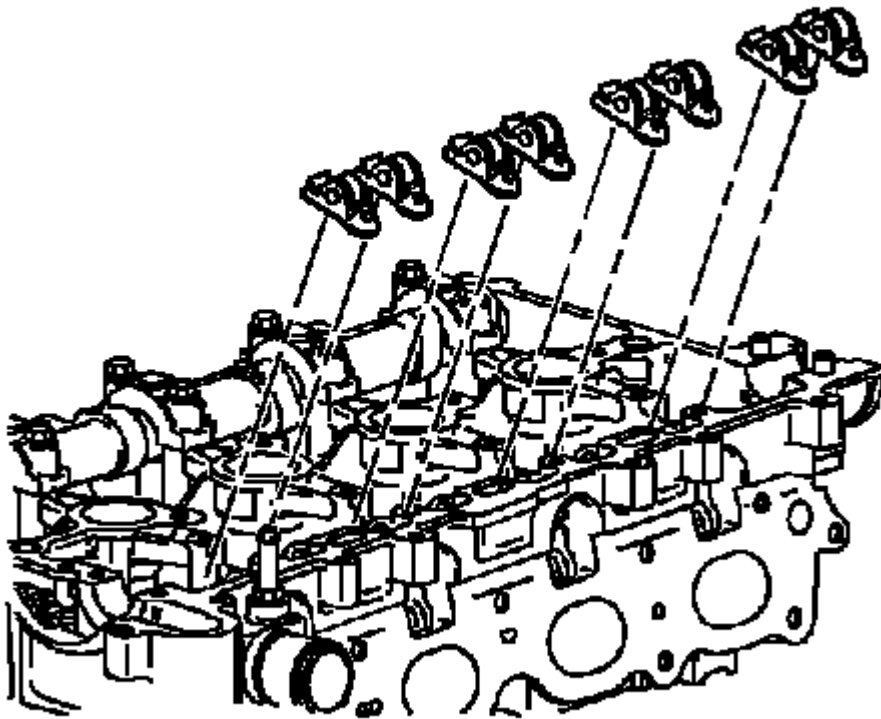


Fig. 117: View Of Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

NOTE: Keep all of the roller followers and hydraulic adjusters in order so that they can be reinstalled in their respective locations.

6. Remove the camshaft roller followers.

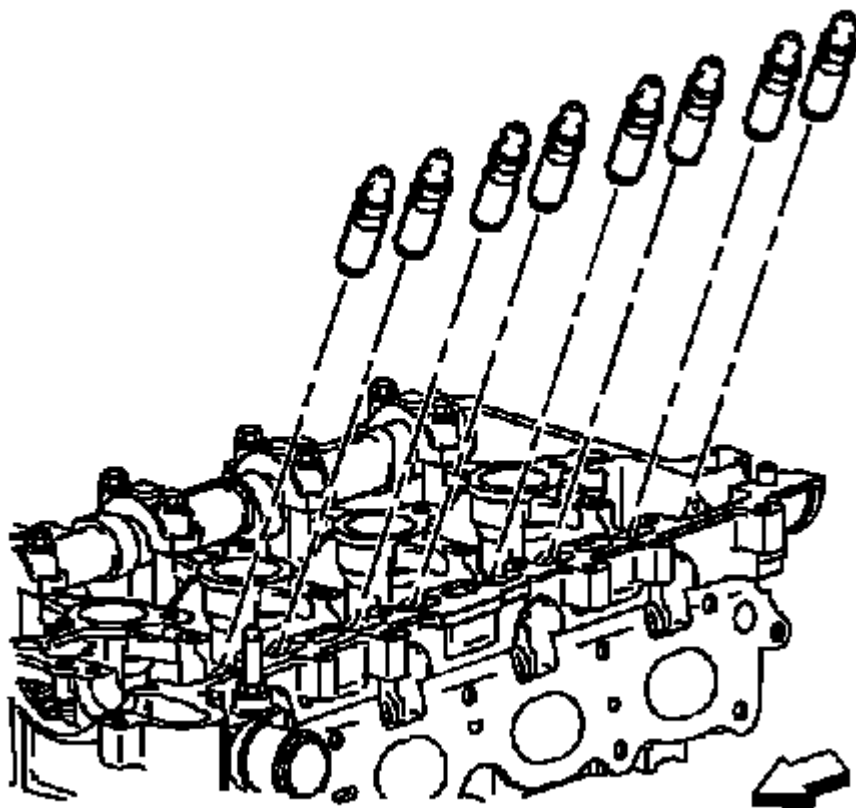


Fig. 118: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

7. Remove the hydraulic element adjusters.

INSTALLATION PROCEDURE

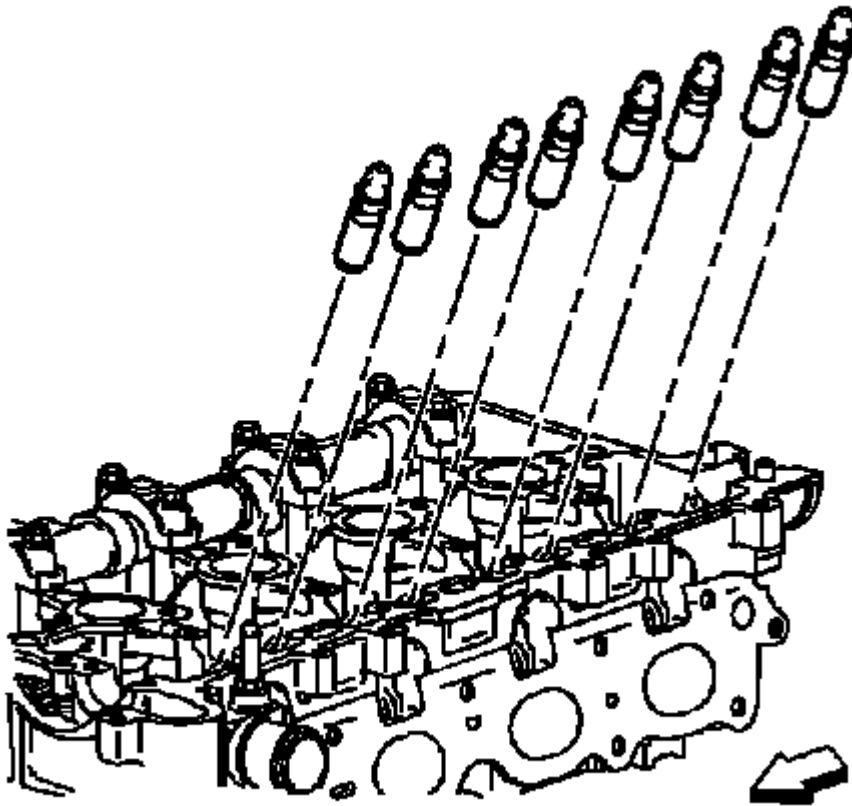


Fig. 119: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

1. Install the hydraulic element lash adjusters into their bores in the cylinder head.
2. Lubricate the hydraulic lash adjusters with GM PN 12345501 (Canadian PN 992704) or equivalent.

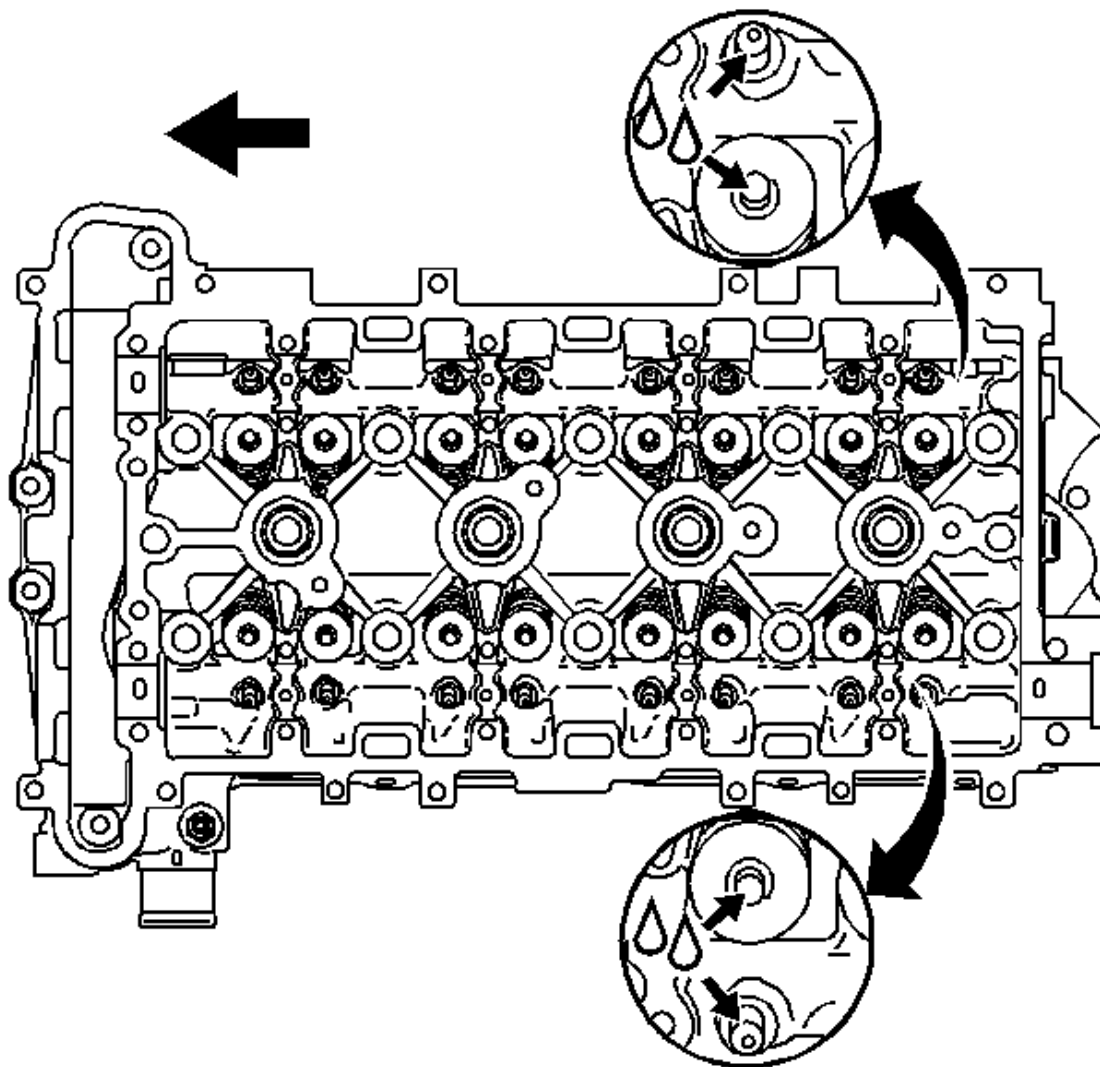


Fig. 120: Lubricating Valve Tips
Courtesy of GENERAL MOTORS CORP.

3. Lubricate the valve tips with GM PN 12345501 (Canadian PN 992704) or equivalent.

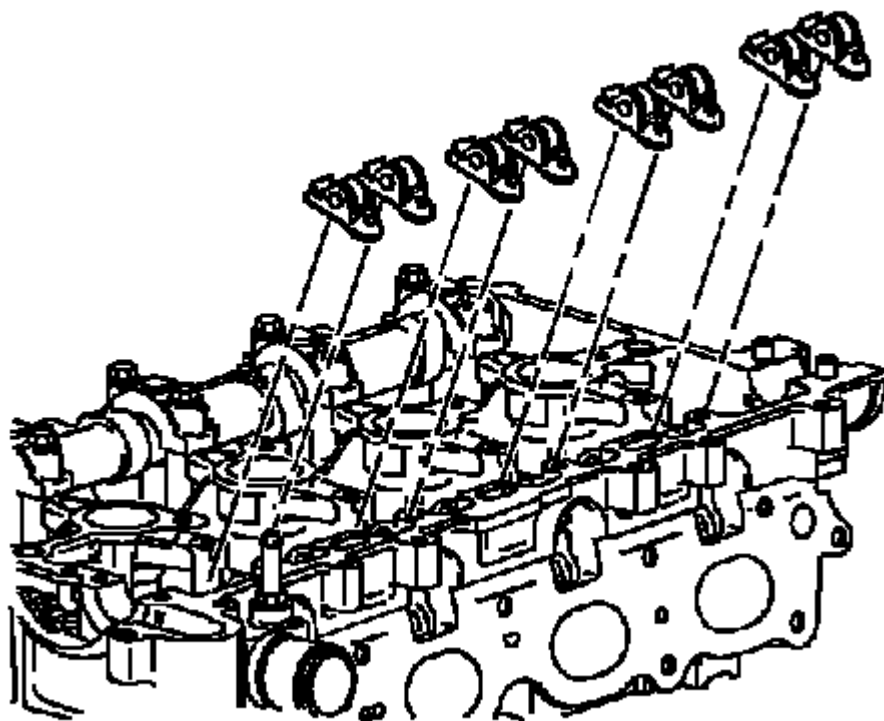


Fig. 121: View Of Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

NOTE: Used roller followers **MUST** be returned to their original position on the camshaft. If the camshaft is being replaced, the roller followers actuated by the camshaft must also be replaced.

4. Position the camshaft roller followers on the tip of the valve stem and on the lash adjuster. Lubricate the roller followers with GM PN 12345501 (Canadian PN 992704) or equivalent.

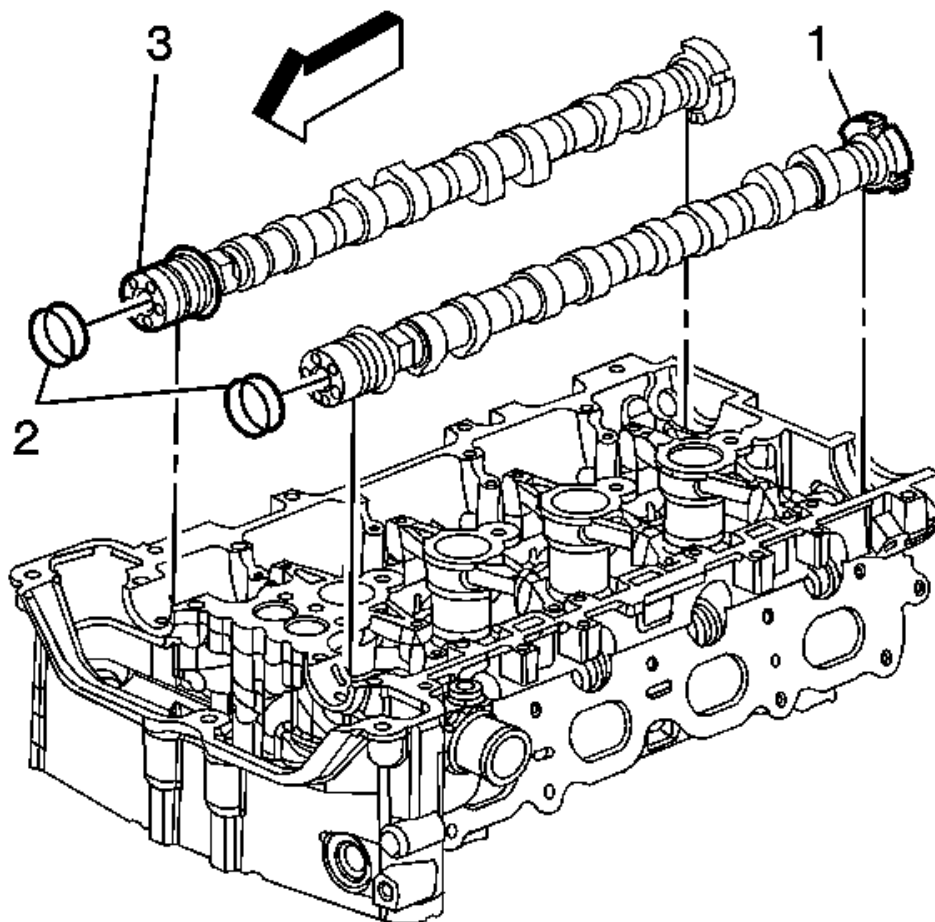


Fig. 122: View Of Intake & Exhaust Camshafts
Courtesy of GENERAL MOTORS CORP.

5. Install the intake camshaft (1). Lubricate with GM PN 12345501 (Canadian PN 992704) or equivalent.

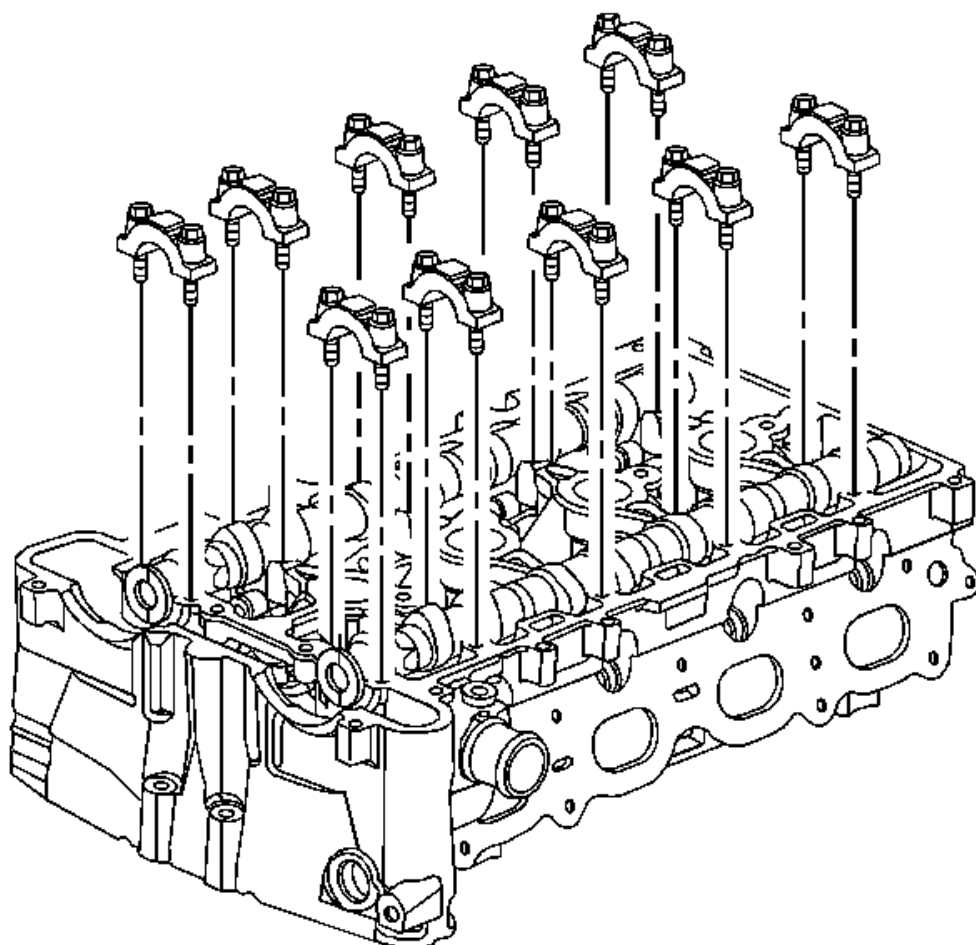


Fig. 123: View Of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

6. Install the camshaft bearing caps. Hand tighten the cap bolts.

CAUTION: Refer to Fastener Caution .

7. Tighten the bearing cap bolts in increments of 3 turns until they are seated.

Tighten: Tighten the bolts to 10 N.m (89 lb in).

8. Install the intake camshaft position actuator. Refer to Camshaft Position Intake Actuator Replacement.

EXHAUST CAMSHAFT AND VALVE LIFTER REPLACEMENT

REMOVAL PROCEDURE

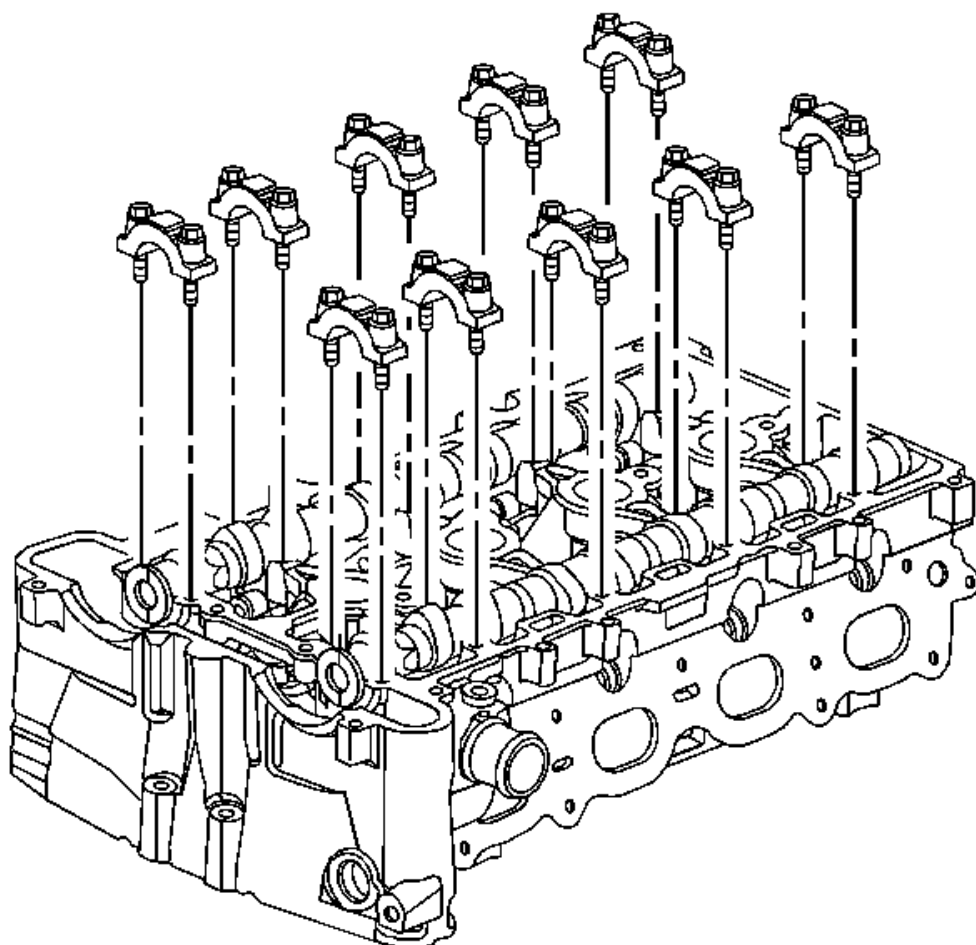


Fig. 124: View Of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

1. Remove the exhaust camshaft position actuator. Refer to [Camshaft Position Exhaust Actuator Replacement](#).

IMPORTANT: Remove each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.

2. Mark the bearing caps to ensure they are installed in the original position.
3. Remove the bearing cap bolts.
4. Remove the bearing caps.

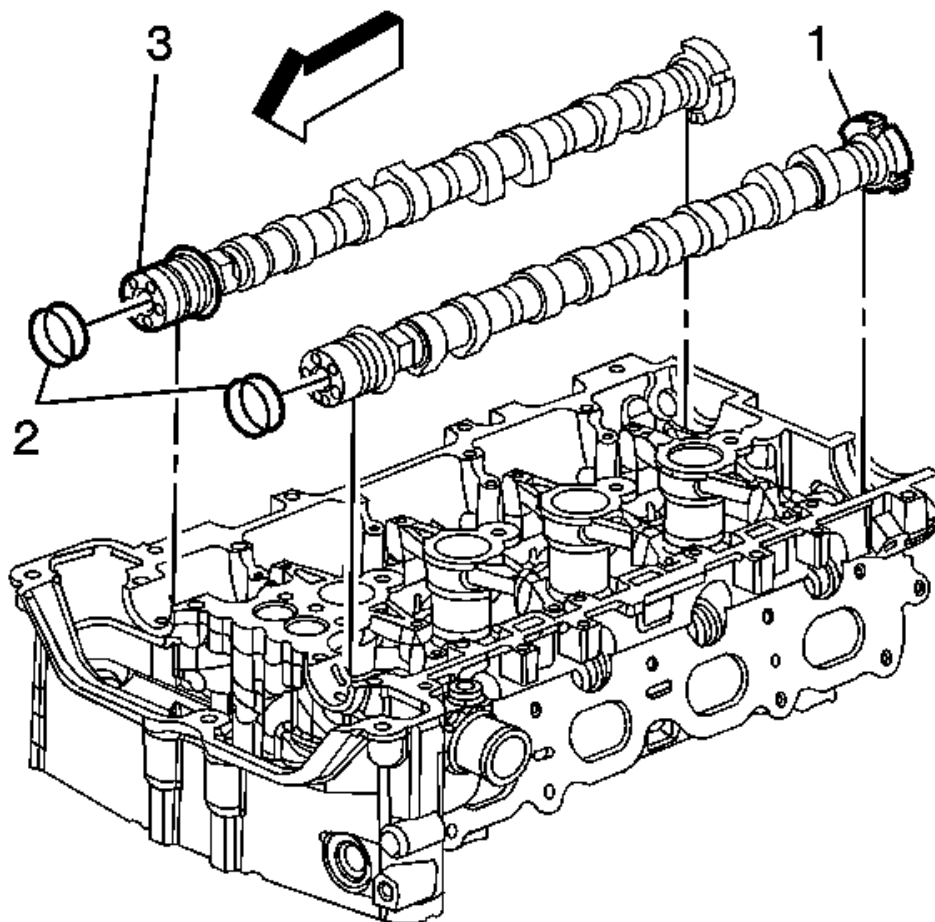


Fig. 125: View Of Intake & Exhaust Camshafts
Courtesy of GENERAL MOTORS CORP.

5. Remove the exhaust camshaft (3).

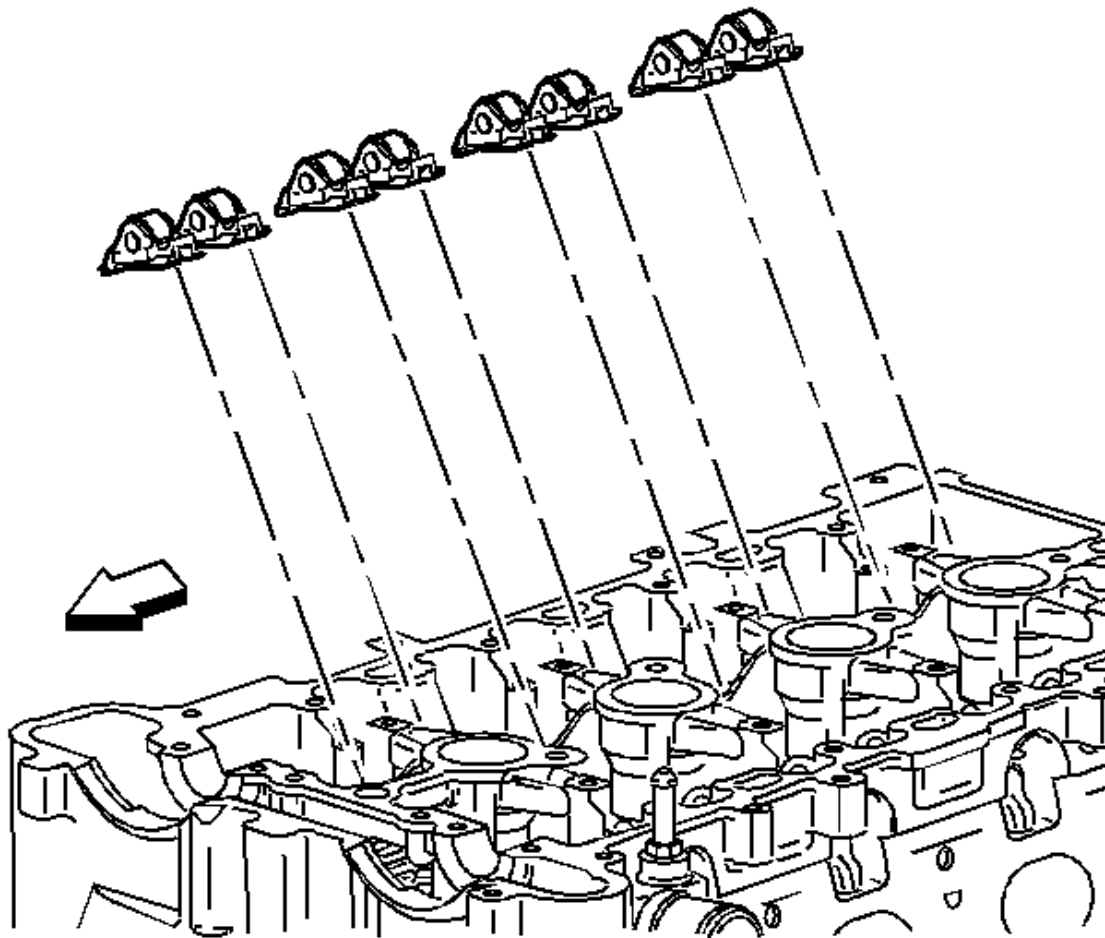


Fig. 126: Identifying Exhaust Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Keep all of the roller followers and hydraulic adjusters in order so that they can be reinstalled in their respective locations.

6. Remove the camshaft roller followers.

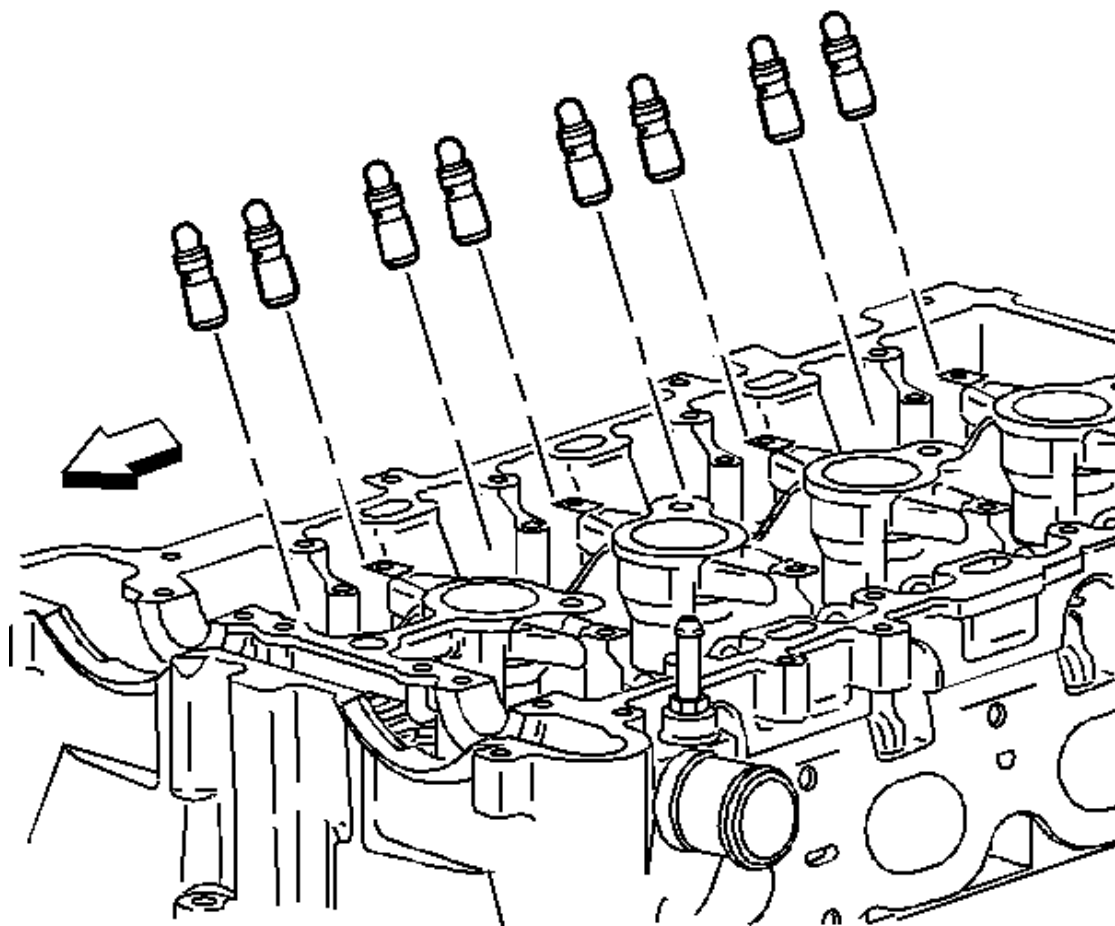


Fig. 127: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

7. Remove the hydraulic element adjusters.

INSTALLATION PROCEDURE

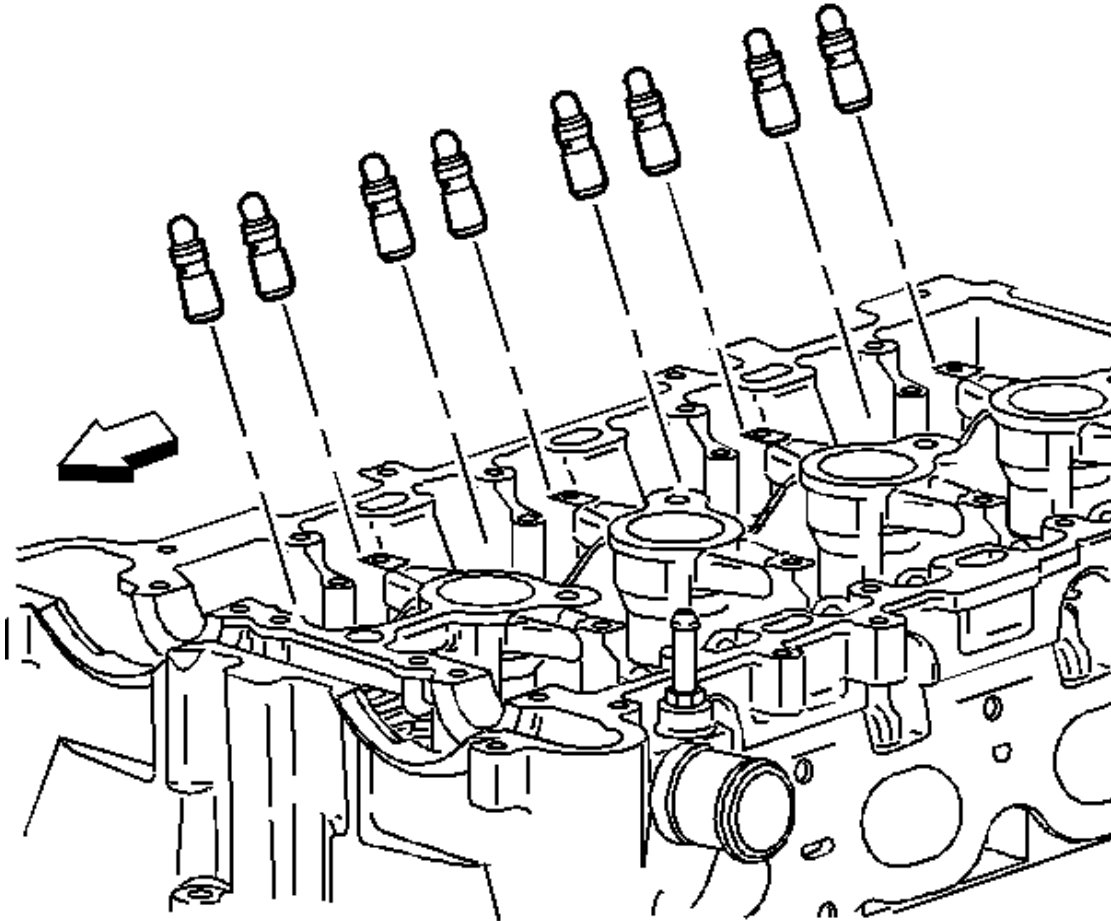


Fig. 128: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

1. Install the hydraulic element adjusters into their bores in the cylinder head.
2. Lubricate the hydraulic lash adjusters with GM PN 12345501 (Canadian PN 992704) or equivalent.

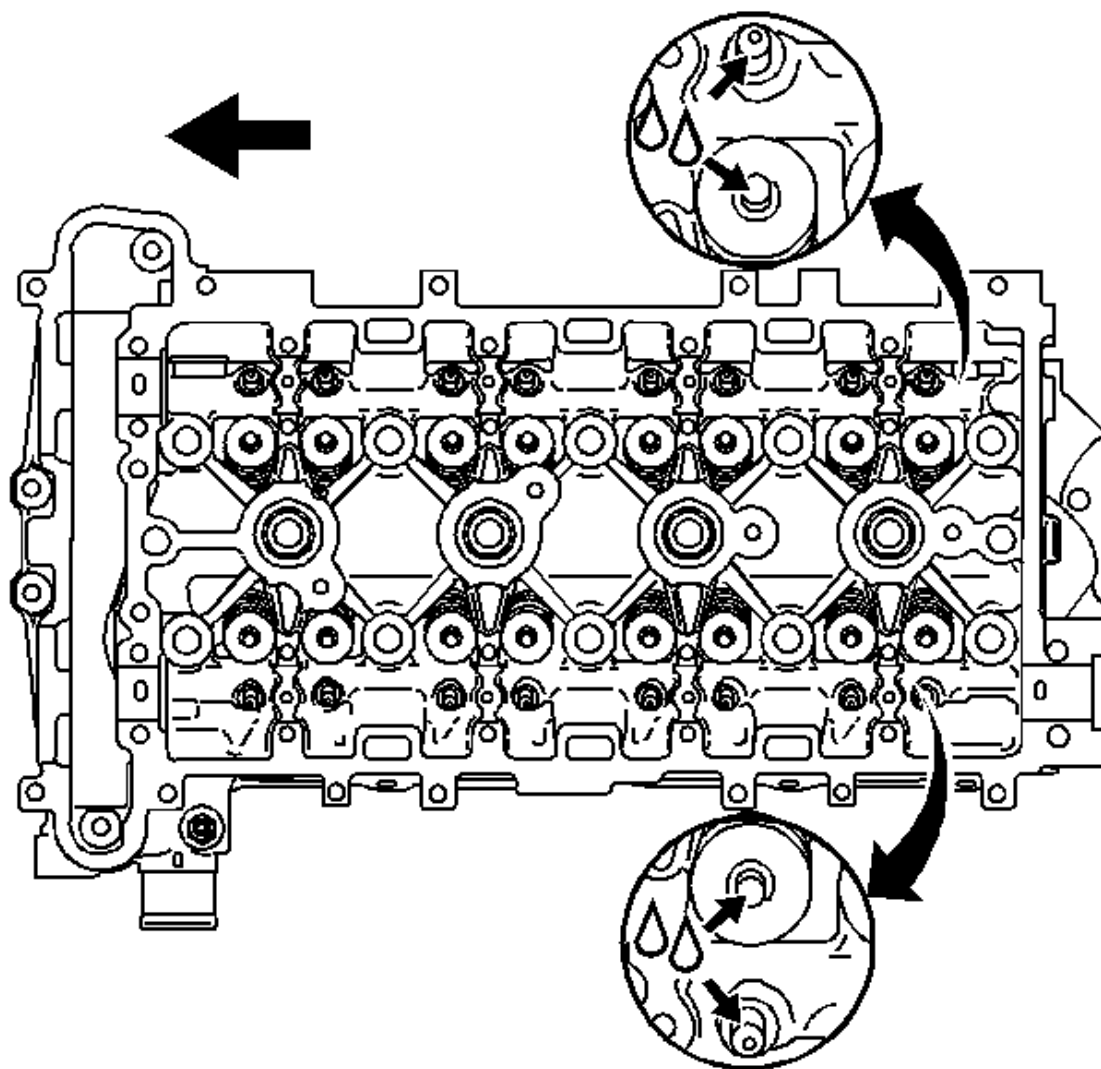


Fig. 129: Lubricating Valve Tips
Courtesy of GENERAL MOTORS CORP.

3. Lubricate the valve tips with GM PN 12345501 (Canadian PN 992704) or equivalent.

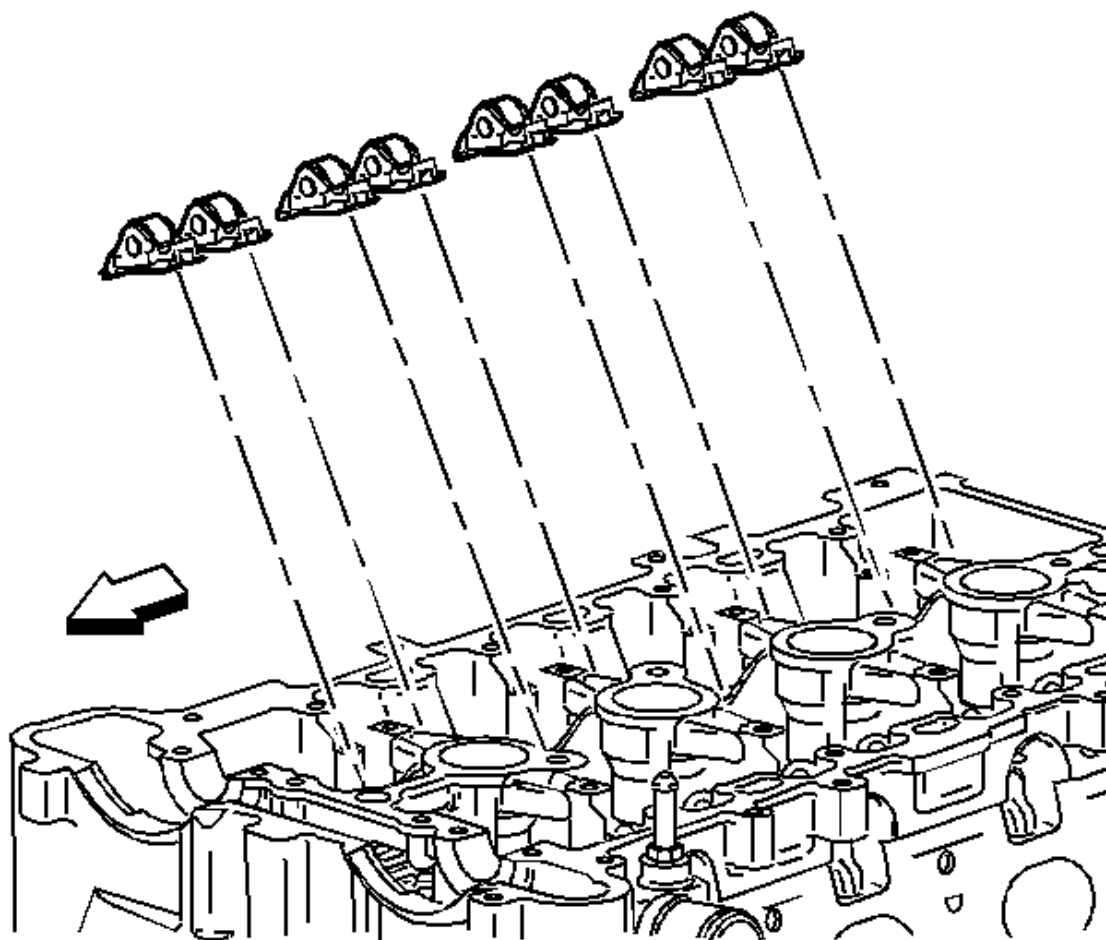


Fig. 130: Identifying Exhaust Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Used roller followers **MUST** be returned to the original position on the camshaft. If the camshaft is being replaced, the roller followers actuated by the camshaft must also be replaced.

4. Position the roller followers on the tip of the valve stem and on the lash adjuster, apply lubricate GM PN 12345501 (Canadian PN 992704) or equivalent.

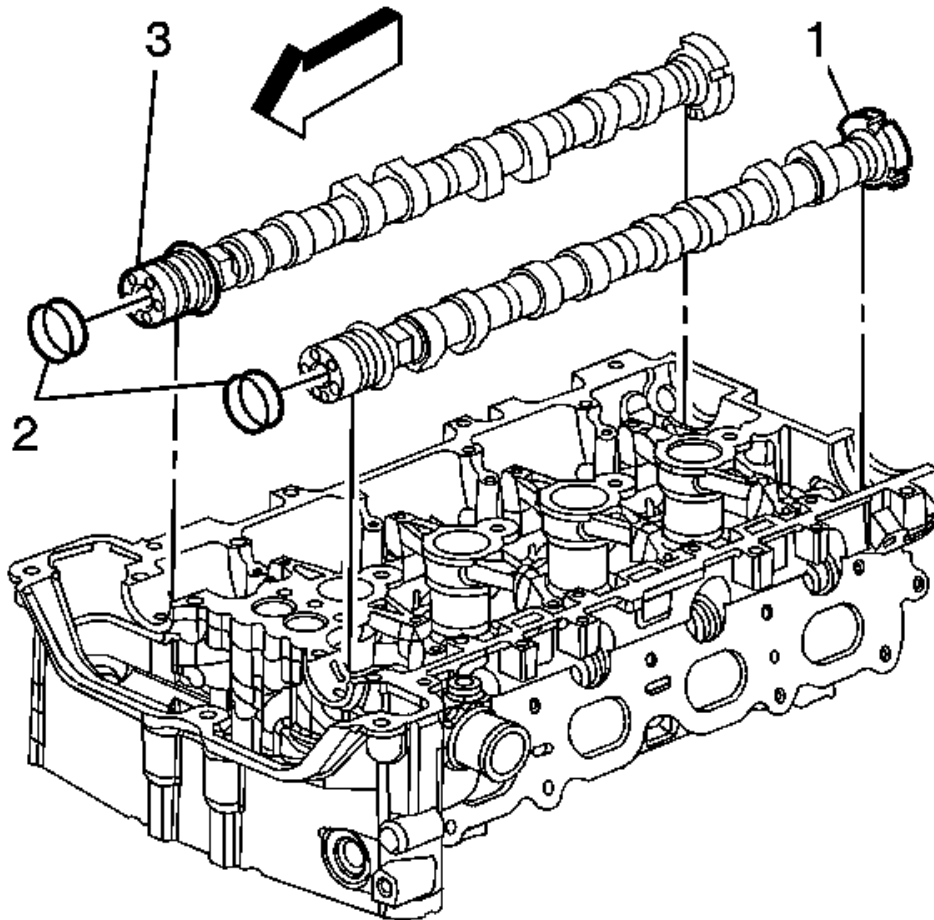


Fig. 131: View Of Intake & Exhaust Camshafts
Courtesy of GENERAL MOTORS CORP.

5. Install the exhaust camshaft (3). Lubricate with GM PN 12345501 (Canadian PN 992704) or equivalent.

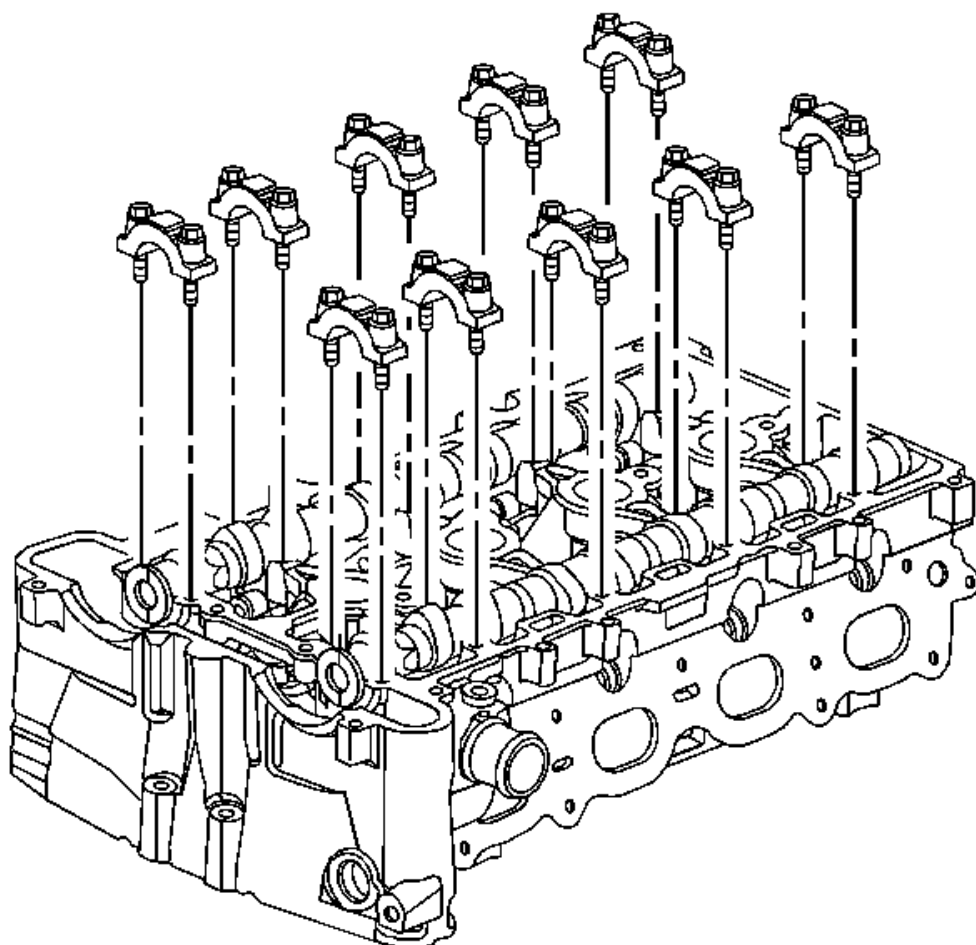


Fig. 132: View Of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

6. Install the camshaft bearing caps. Hand tighten the cap bolts.
7. Tighten the bearing cap bolts in increments of 3 turns until they are seated.

Tighten: Tighten the bolts to 10 N.m (89 lb in).

8. Install the exhaust camshaft position actuator. Refer to **Camshaft Position Exhaust Actuator Replacement**.

CAMSHAFT POSITION INTAKE ACTUATOR REPLACEMENT

SPECIAL TOOLS

- **EN-48749** Timing Chain Retention Tool Kit
- **EN-48953** Camshaft Actuator Locking Tool
- **J 45059** Angle Meter

REMOVAL PROCEDURE

1. Remove the camshaft cover. Refer to Camshaft Cover Replacement.
2. Remove the spark plugs. Refer to Spark Plug Replacement.

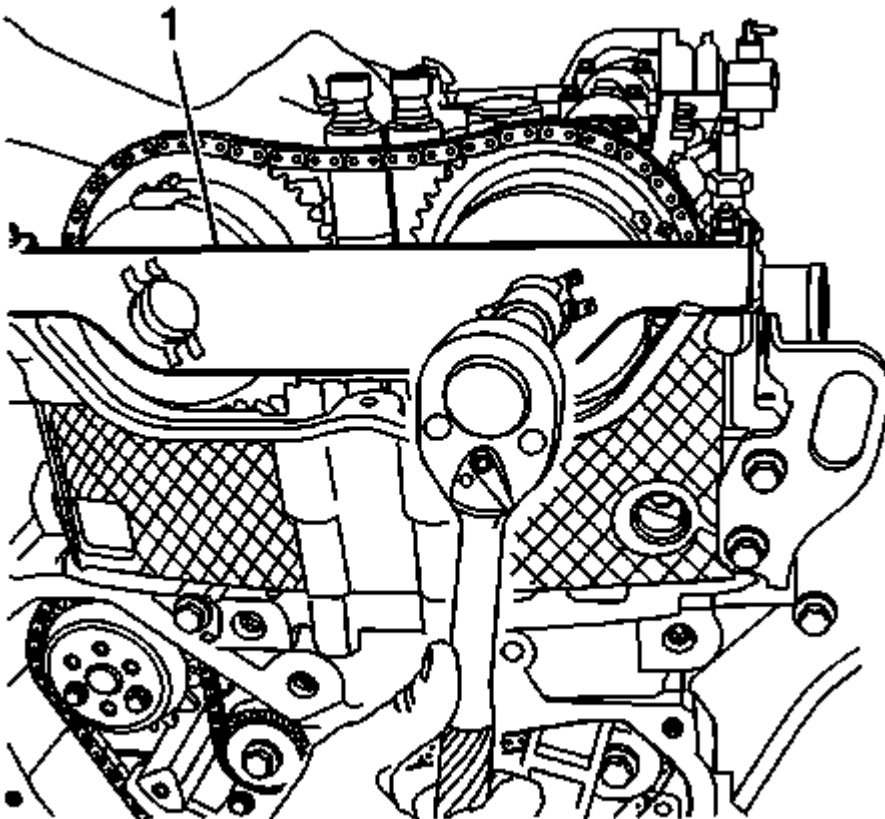


Fig. 133: View of Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

3. Rotate the crankshaft clockwise and install the camshaft actuator retainer **EN-48953** (1).

CAUTION: Refer to Fastener Caution.

4. Install the camshaft actuator retainer bolts and tighten to 10 N.m (89 lb in).
5. Loosen, but DO NOT remove the intake camshaft actuator bolt.
6. Remove the camshaft actuator locking tool, **EN-48953** (1).
7. Clean the timing chain and gears with solvent.

NOTE: Ensure the timing chain and the camshaft position actuators are marked for proper assembly.

8. Mark the intake and exhaust camshaft actuators and the respective locations on the timing chain.

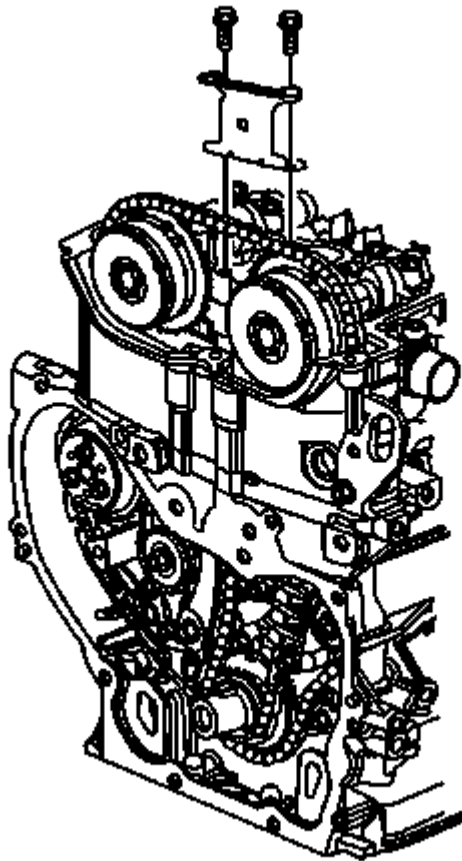


Fig. 134: View Of Upper Timing Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the upper timing chain guide bolts and guide.

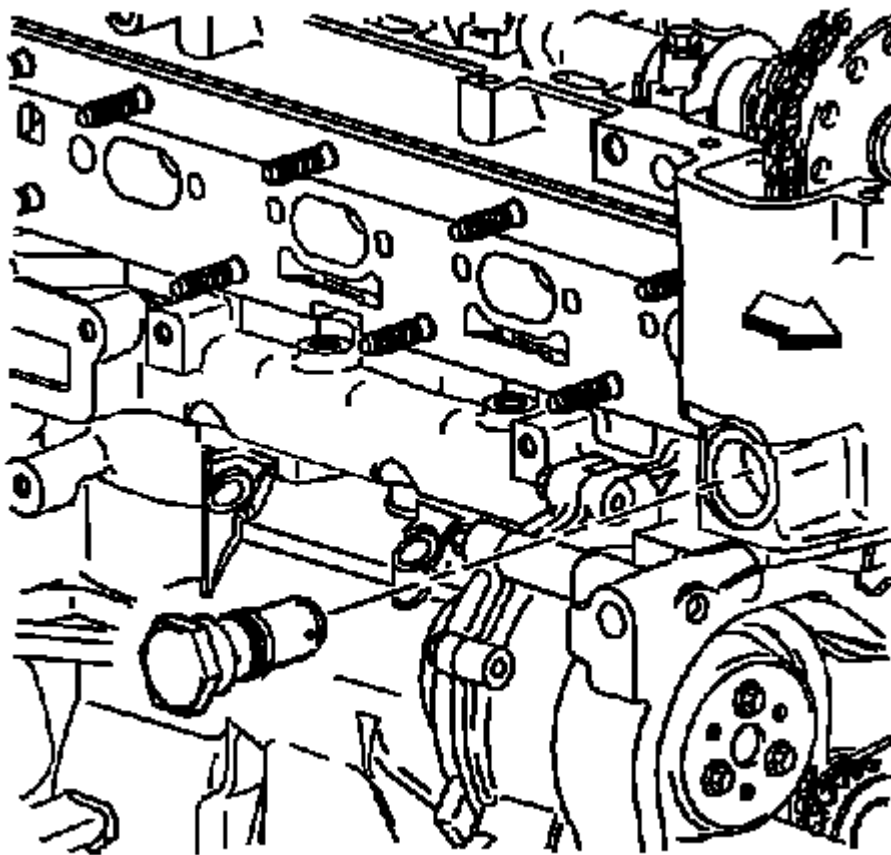


Fig. 135: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

10. Remove the timing chain tensioner.

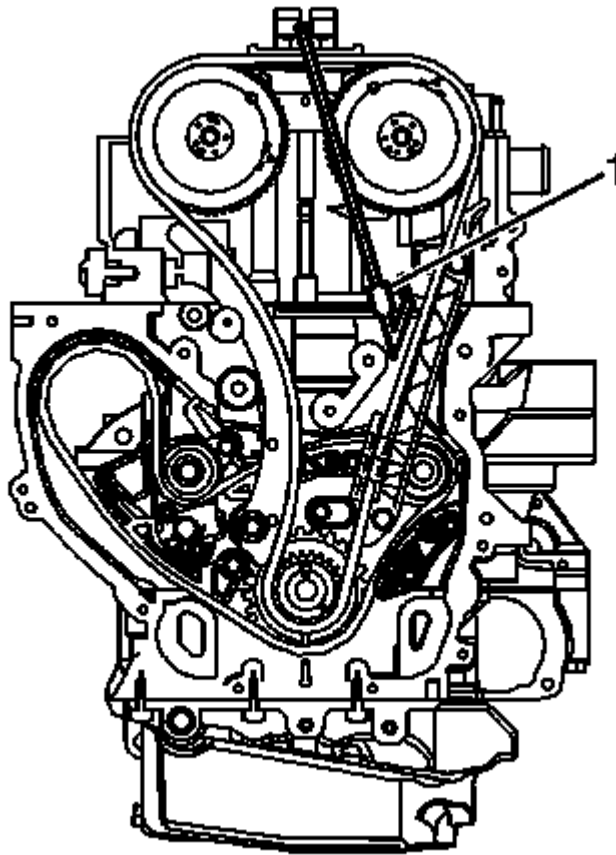


Fig. 136: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE:

- The intake camshaft actuator should not rotate during the removal or installation.
- Ensure the tips of the are fully engaged into the timing chain. The retention tool rod can be used on the back side of the chain to ensure the teeth from the retention tool are engaged.

11. Install the timing chain retention tool **EN-48749** (1) to the intake side of the timing chain.

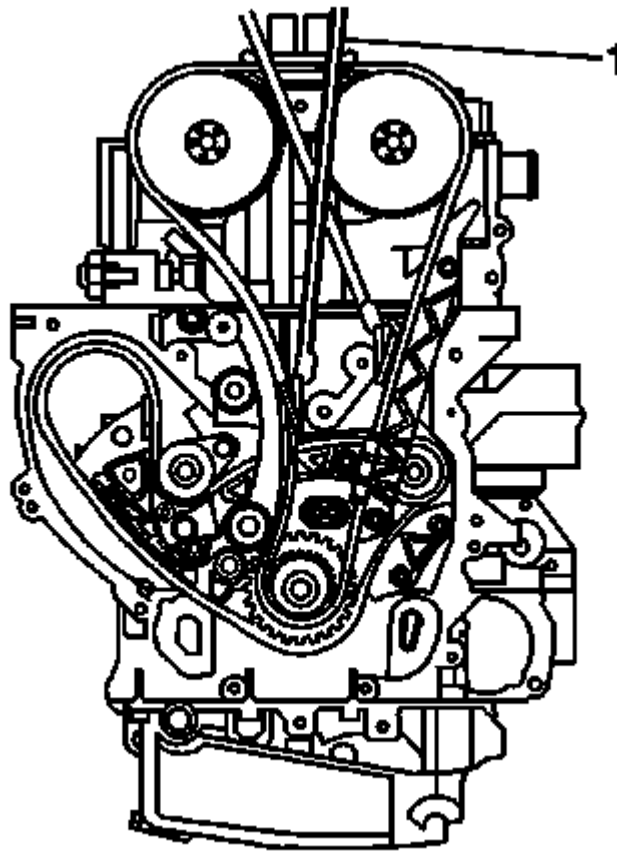


Fig. 137: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

12. Install the timing chain retention tool EN-48749 (1) to the exhaust side of the timing chain.

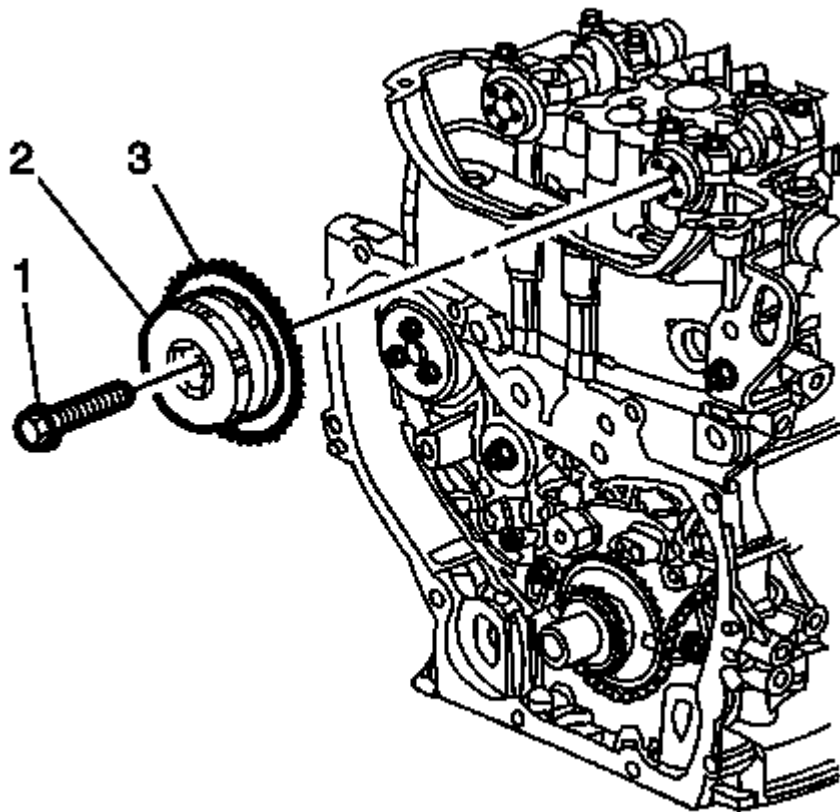


Fig. 138: Identifying Crankshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

13. Remove and discard the intake camshaft actuator bolt (2).
14. Rotate the exhaust camshaft clockwise slightly to take the tension off of the timing chain on the intake actuator.
15. Remove the intake camshaft actuator (3) from the camshaft while also removing the actuator from the timing chain.

INSTALLATION PROCEDURE

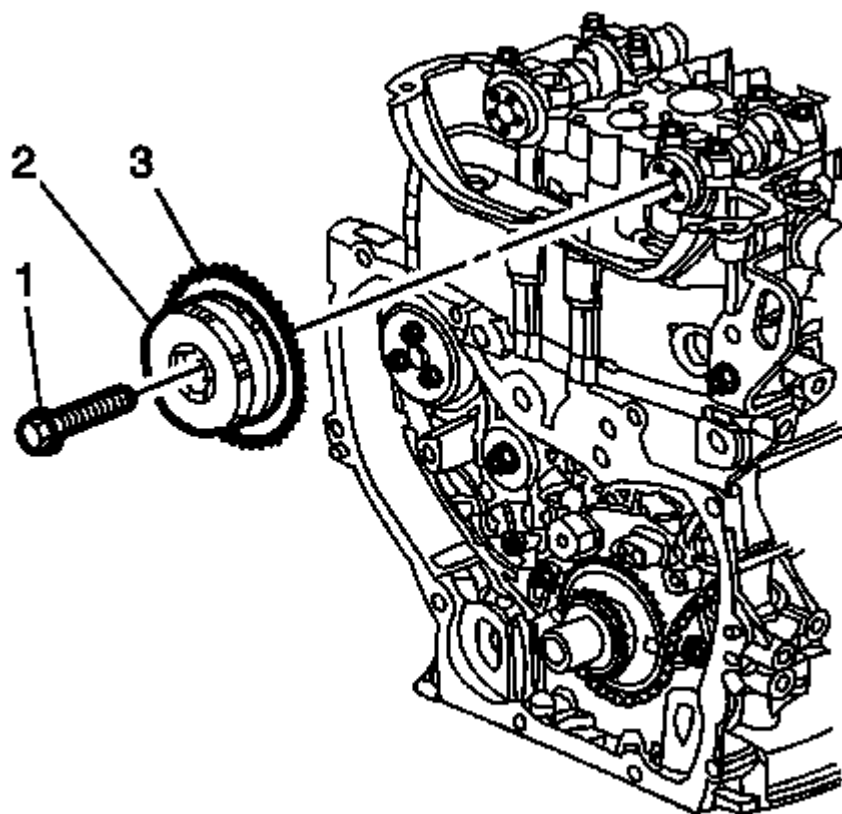


Fig. 139: Identifying Crankshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the alignment mark made previously on the intake camshaft actuator is still aligned properly with the mark on the timing chain.

1. Install the timing chain onto the intake camshaft actuator.
2. Align the intake camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft rotating the exhaust camshaft clockwise, if required.
3. Install a NEW intake camshaft actuator bolt (2) until snug.

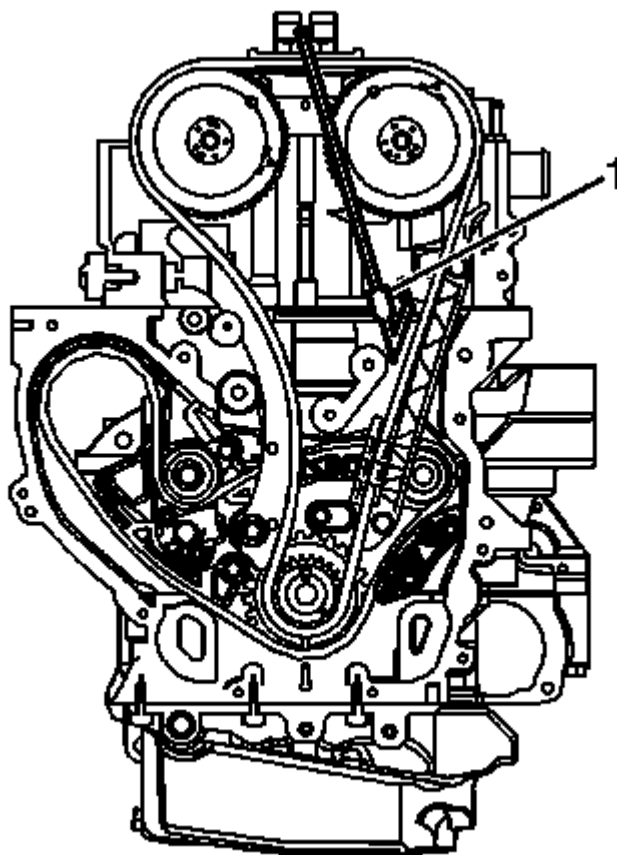


Fig. 140: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

4. Remove the timing chain retention tool (1) from the intake side of the timing chain.

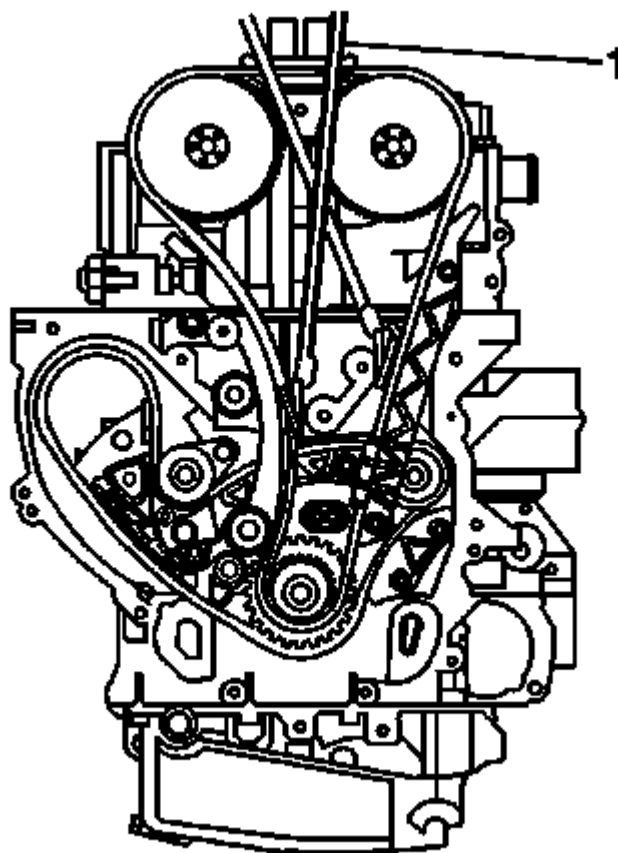


Fig. 141: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the alignment mark previously on the intake camshaft actuator is still aligned properly with the timing chain. If the mark made previously on the intake camshaft actuator is not aligned properly, refer to Camshaft Timing Chain, Sprocket, and Tensioner Replacement.

5. Remove the timing chain retention tool (1) from the exhaust side of the timing chain.

NOTE: Failure to reset the tensioner will allow the tensioner to over extend, limiting the timing chain life.

6. Reset and install the timing chain tensioner. Refer to Timing Chain Tensioner Replacement

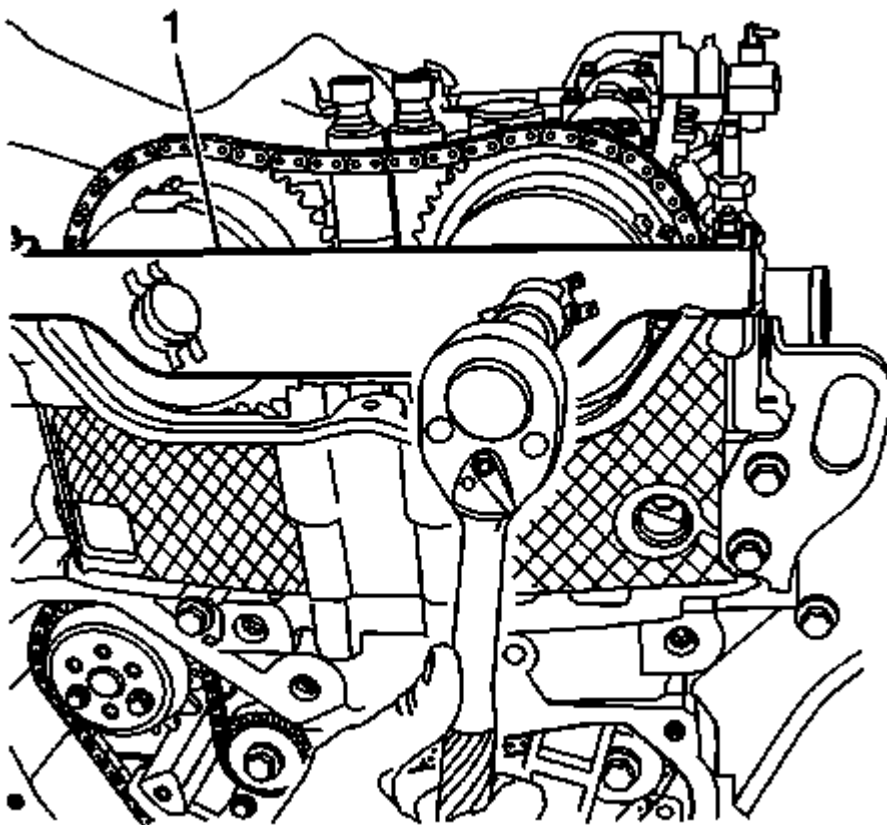


Fig. 142: View of Loosening/Tightening Camshaft Actuator Retainer Bolts
 Courtesy of GENERAL MOTORS CORP.

7. Install the camshaft actuator retainer (1) **EN-48953**: Camshaft Actuator Locking Tool.
8. Install the camshaft actuator retainer bolts and tighten to 10 N.m (89 lb in).
9. Tighten the NEW camshaft actuator bolt to 30 N.m (22 lb ft) plus an additional 100 degrees using the **J 45059**.

NOTE: You must have the **EN-48953** installed to perform this procedure.

10. To release the tensioner apply a counterclockwise rotational torque to the crankshaft balancer bolt of 45 N.m (33 lb ft).
11. Remove the camshaft actuator retainer **EN-48953** (1).

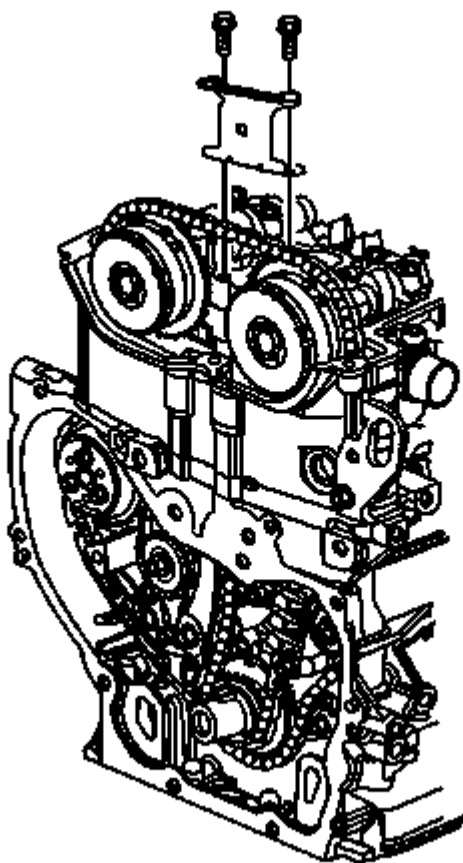


Fig. 143: View Of Upper Timing Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the upper timing chain guide and bolts and tighten to 10 N.m (89 lb in).
13. Install the spark plugs. Refer to **Spark Plug Replacement** .
14. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.

CAMSHAFT POSITION EXHAUST ACTUATOR REPLACEMENT

SPECIAL TOOLS

- **EN-48749** Timing Chain Retention Tool Kit
- **EN-48953** Camshaft Actuator Locking Tool
- **J 45059** Angle Meter

REMOVAL PROCEDURE

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.
2. Remove the spark plugs. Refer to **Spark Plug Replacement** .

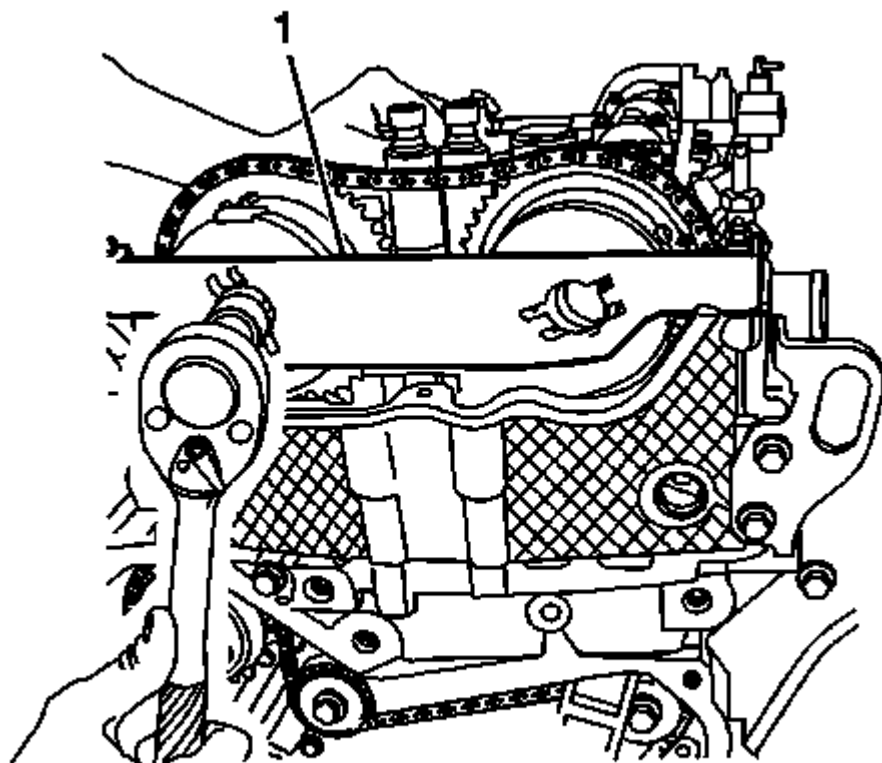


Fig. 144: View of Camshaft Actuator Retainer
Courtesy of GENERAL MOTORS CORP.

3. Rotate the crankshaft clockwise and install the camshaft actuator retainer **EN-48953** (1).

CAUTION: Refer to Fastener Caution .

4. Install the camshaft actuator retainer bolts and tighten to 10 N.m (89 lb in).
5. Loosen, but do not remove the exhaust camshaft actuator bolt.
6. Clean the timing chain and gears with solvent.

NOTE: Ensure the timing chain and the camshaft position actuators are marked for proper assembly.

7. Mark the intake and exhaust camshaft actuators and the respective locations on the timing chain.

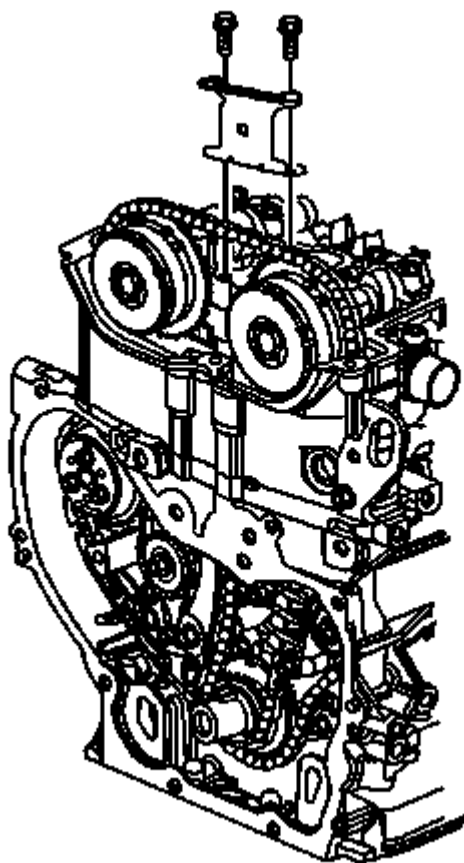


Fig. 145: View Of Upper Timing Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the upper timing chain guide bolts and guide.

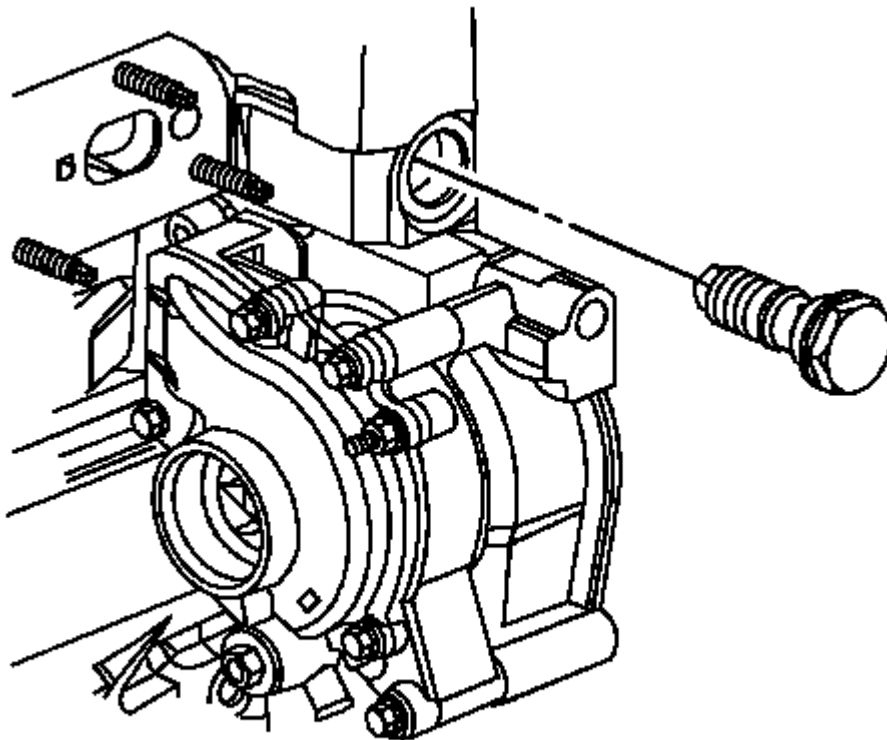


Fig. 146: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

9. Remove the timing chain tensioner.

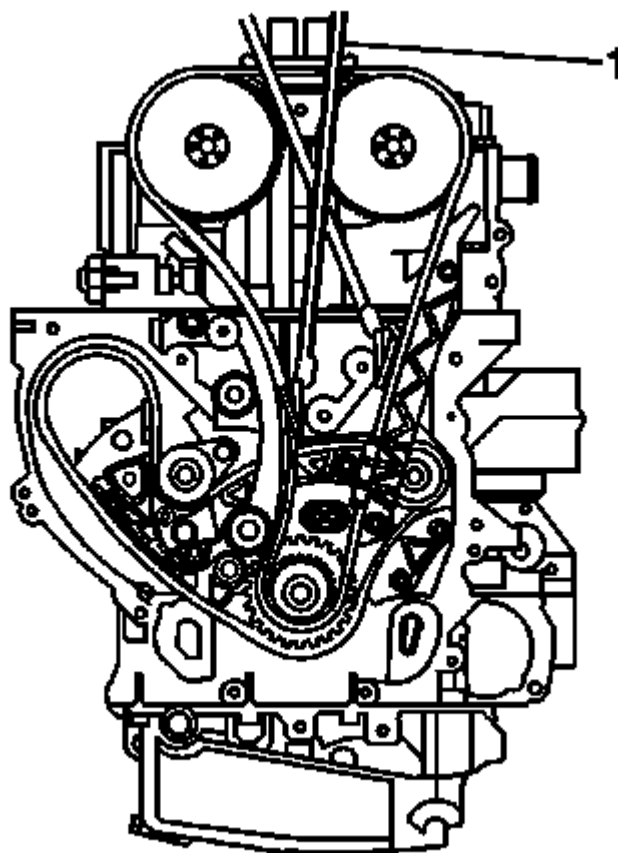


Fig. 147: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE:

- The camshaft actuators should not rotate during the removal or installation.
- Ensure the tips of the EN-48749 are fully engaged into the timing chain. The retention tool rod can be used on the back side of the chain to ensure the teeth from the retention tool are engaged.

10. Install the timing chain retention tool **EN-48749** (1) to the exhaust side of the timing chain.

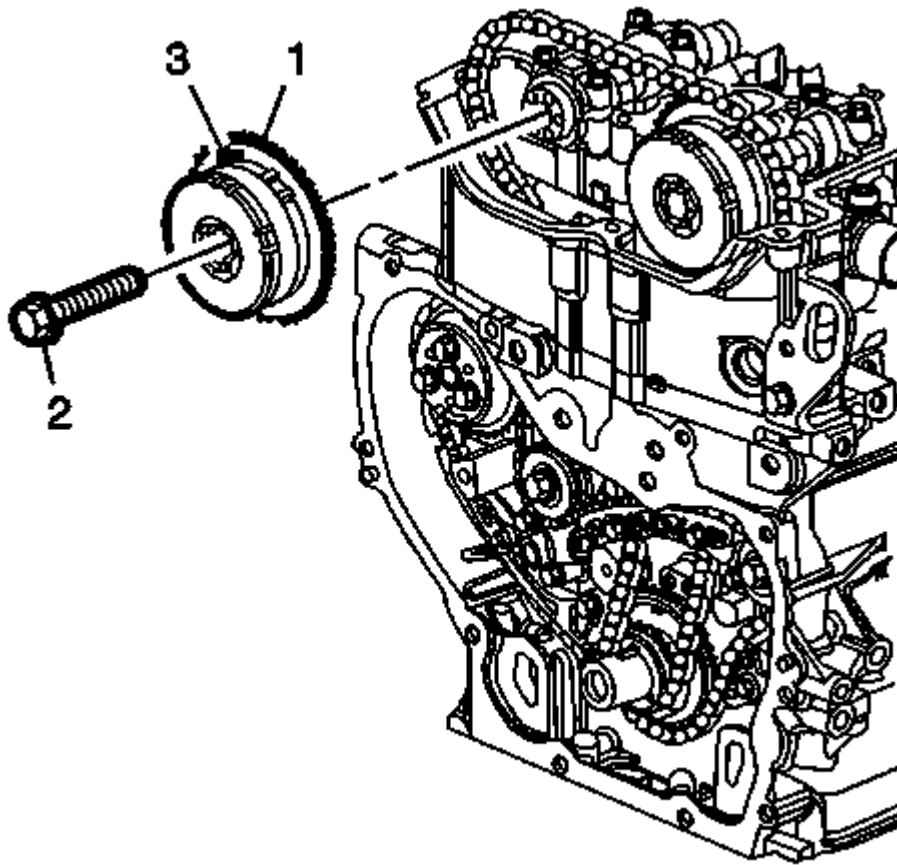


Fig. 148: Identifying Exhaust Camshaft Actuator & Bolt
Courtesy of GENERAL MOTORS CORP.

11. Remove and discard the exhaust camshaft actuator bolt (2).
12. Remove the exhaust camshaft actuator (3) from the camshaft while also removing the actuator from the timing chain.

INSTALLATION PROCEDURE

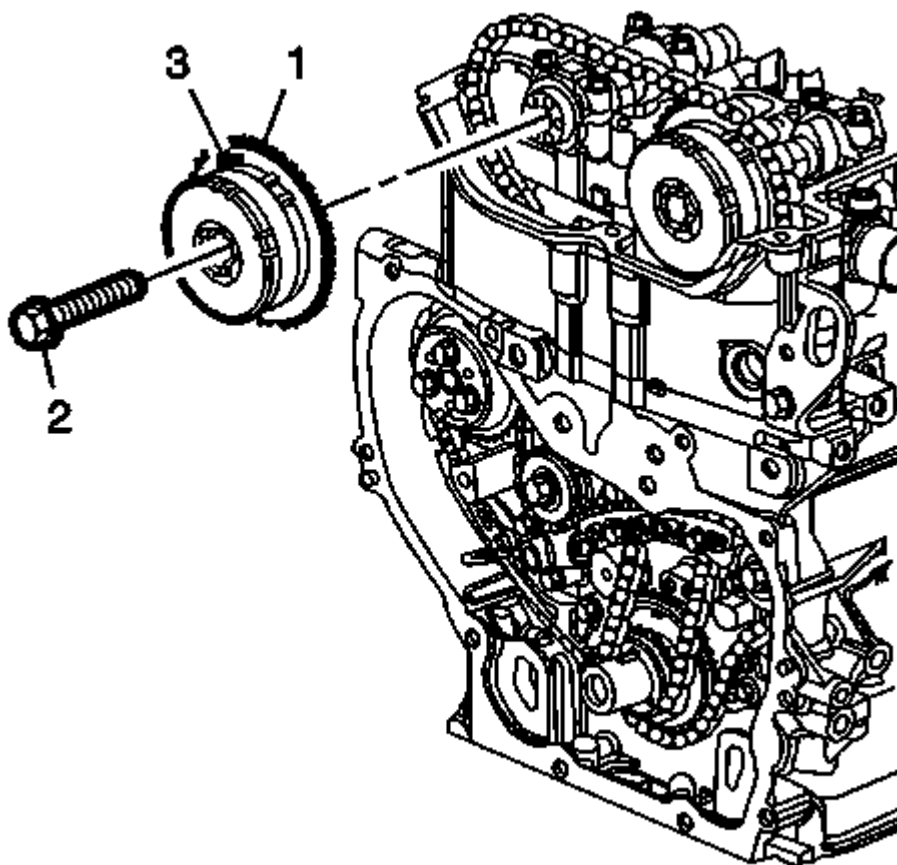


Fig. 149: Identifying Exhaust Camshaft Actuator & Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE:

- Ensure that the alignment mark made previously on the intake camshaft actuator is still aligned properly with the mark on the timing chain.
- The exhaust camshaft may need to be rotated clockwise to fully set the camshaft actuator.

1. Install the timing chain onto the exhaust camshaft actuator.
2. Align the exhaust camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft.
3. Install a NEW exhaust camshaft actuator bolt (2) until snug.

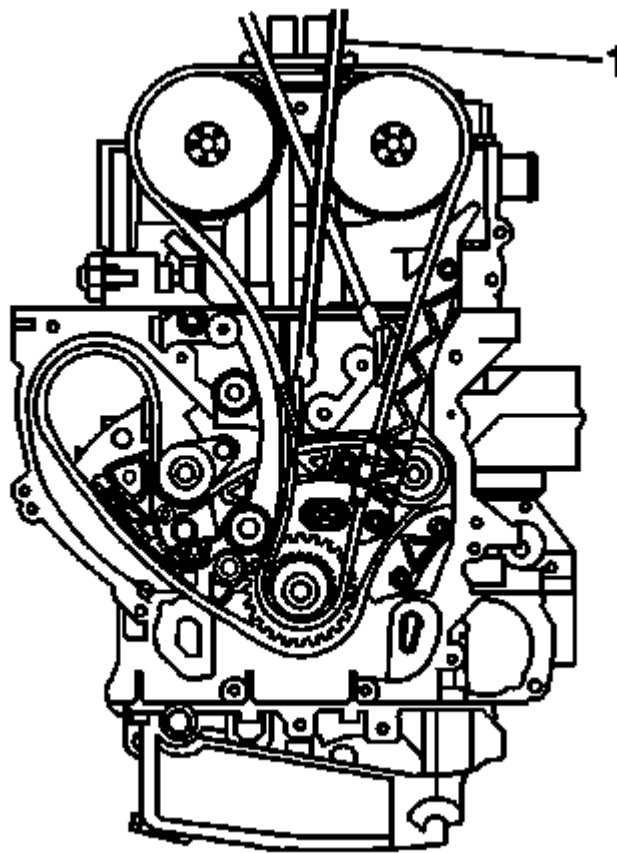


Fig. 150: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the alignment mark previously on the exhaust camshaft actuator is still aligned properly with the timing chain. If the mark made previously on the intake camshaft actuator is not aligned properly, refer to Camshaft Timing Chain, Sprocket, and Tensioner Replacement.

4. Remove the timing chain retention tool EN-48749 (1) from the exhaust side of the timing chain.

NOTE: Failure to reset the tensioner will allow the tensioner to over extend, limiting the timing chain life.

5. Reset and install the timing chain tensioner. Refer to Timing Chain Tensioner Replacement.

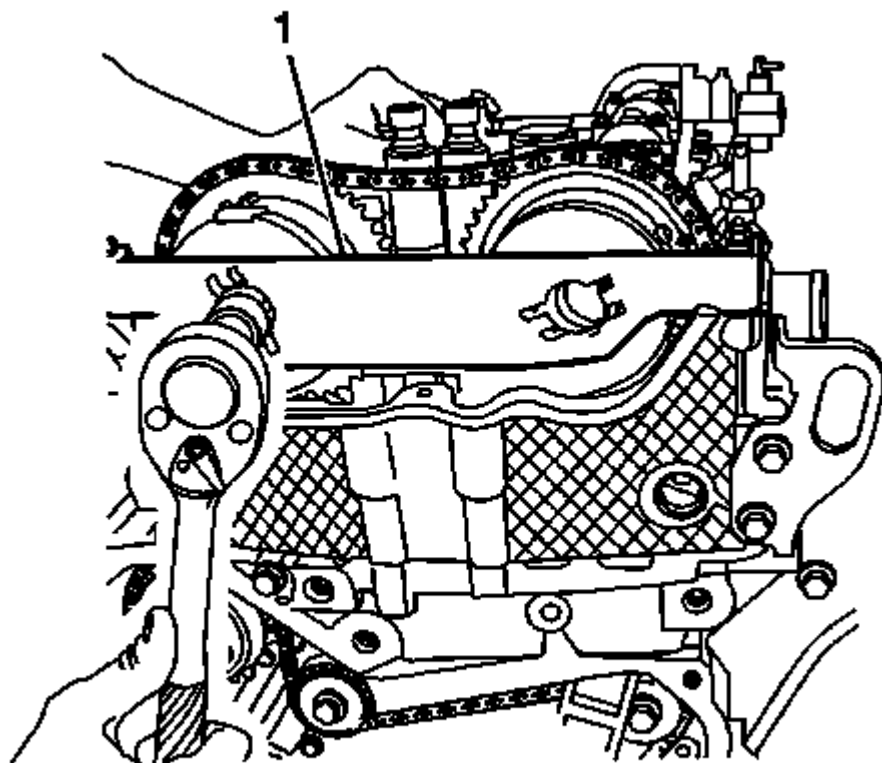


Fig. 151: View of Camshaft Actuator Retainer
Courtesy of GENERAL MOTORS CORP.

6. Install the intake camshaft actuator retainer (1).
7. Install the camshaft actuator retainer bolts and tighten 10 N.m (89 lb in).
8. Tighten the NEW camshaft actuator bolt to 30 N.m (22 lb ft) plus an additional 100 degrees using the **J 45059**.

NOTE: You must have the **EN-48953** installed to perform this procedure.

9. To release the tensioner apply a counterclockwise rotational torque to the crankshaft balancer bolt of 45 N.m (33 lb ft).

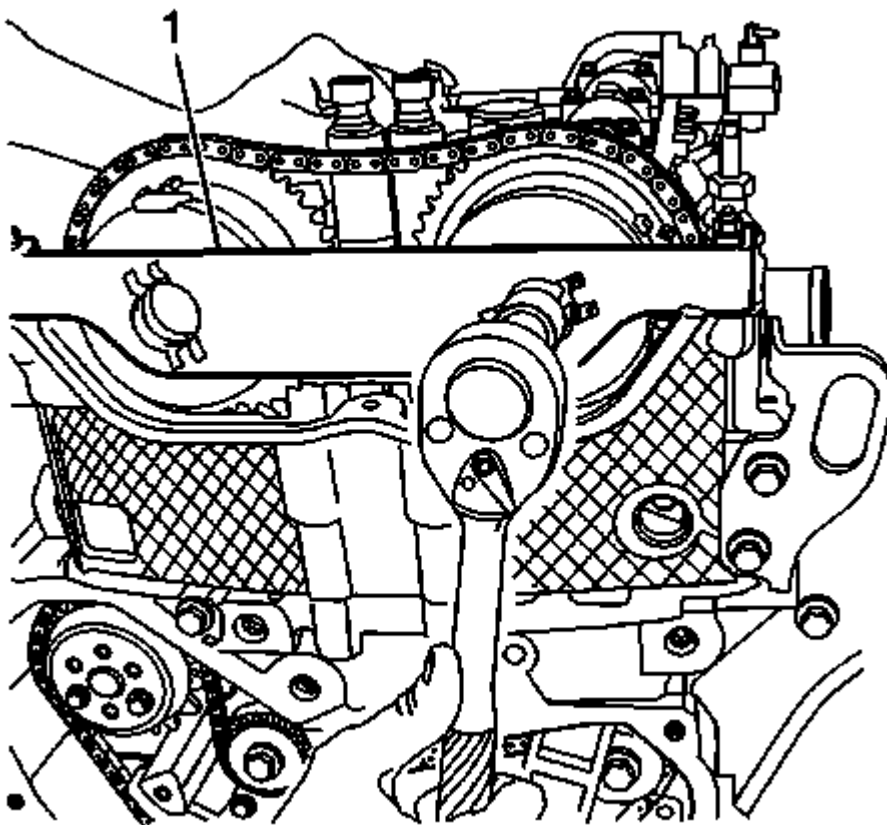


Fig. 152: View of Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the camshaft actuator retainer **EN-48953** (1).

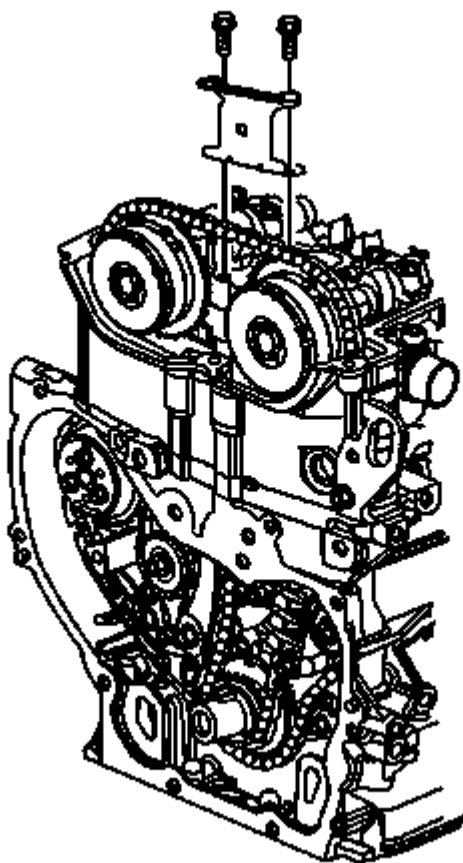


Fig. 153: View Of Upper Timing Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

11. Install the upper timing chain guide and bolts and tighten to 10 N.m (89 lb in).
12. Install the camshaft cover. Refer to Camshaft Cover Replacement.
13. Install the spark plugs. Refer to Spark Plug Replacement.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

SPECIAL TOOLS

- **J 43649** Valve Spring Compressor. See Special Tools.
- **J 36017** Valve Guide Seal Remover. See Special Tools.

REMOVAL PROCEDURE

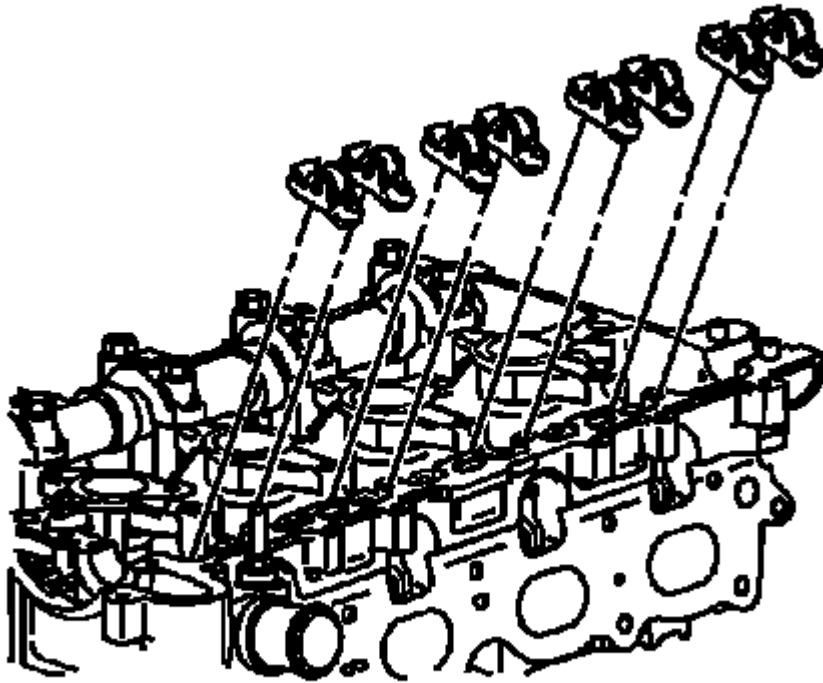


Fig. 154: Identifying Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft. Refer to **Intake Camshaft and Valve Lifter Replacement** or **Exhaust Camshaft and Valve Lifter Replacement**.
2. Remove the camshaft roller followers.

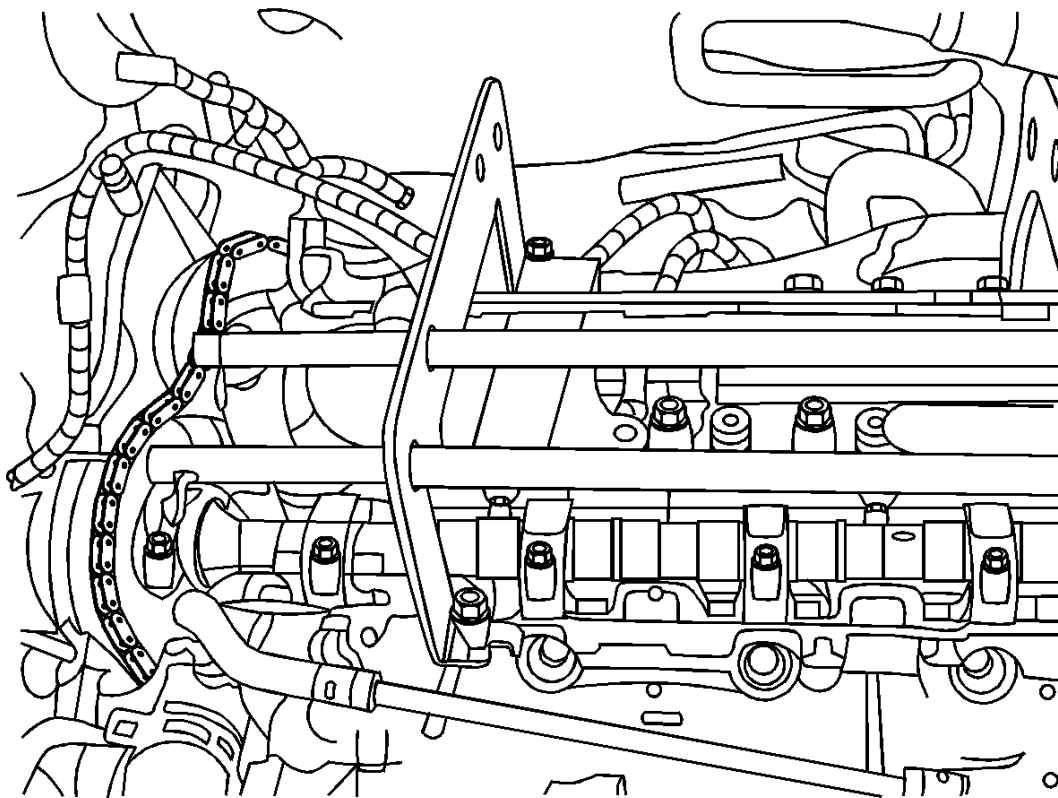


Fig. 155: View Of J 43649 Valve Spring Compressor (Second Camshaft Cover Bolt Hole)
Courtesy of GENERAL MOTORS CORP.

3. Install the front section of the **J 43649** to the second camshaft cover bolt hole. See **Special Tools** .

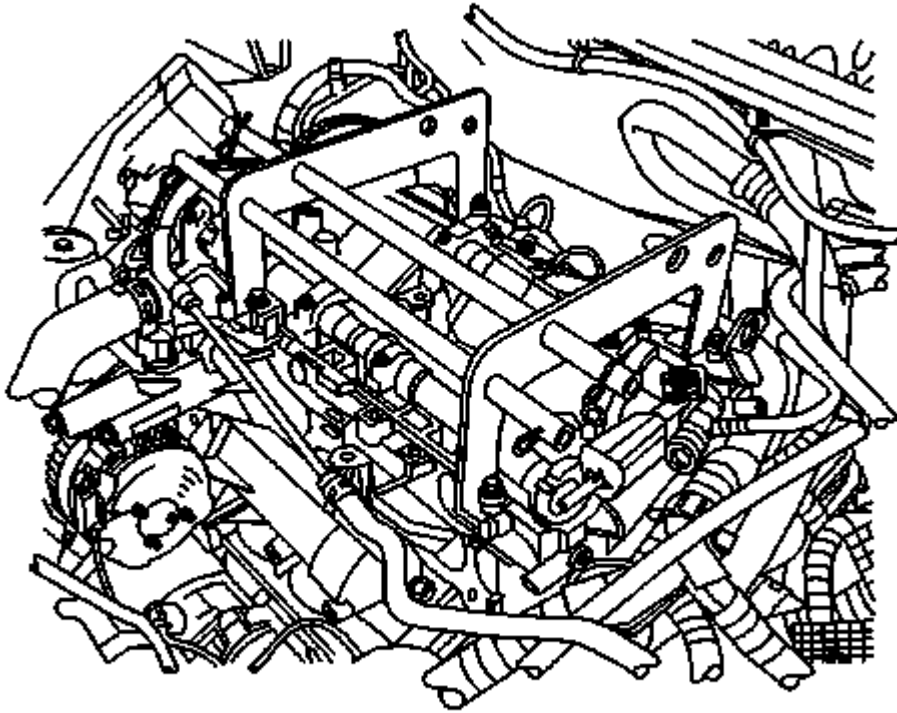


Fig. 156: View Of J 43649 Valve Spring Compressor (Cylinder Head)
Courtesy of GENERAL MOTORS CORP.

4. Install the remaining parts of the **J 43649** to the cylinder head. See **Special Tools** .
5. Remove the spark plugs. Refer to **Spark Plug Replacement** .

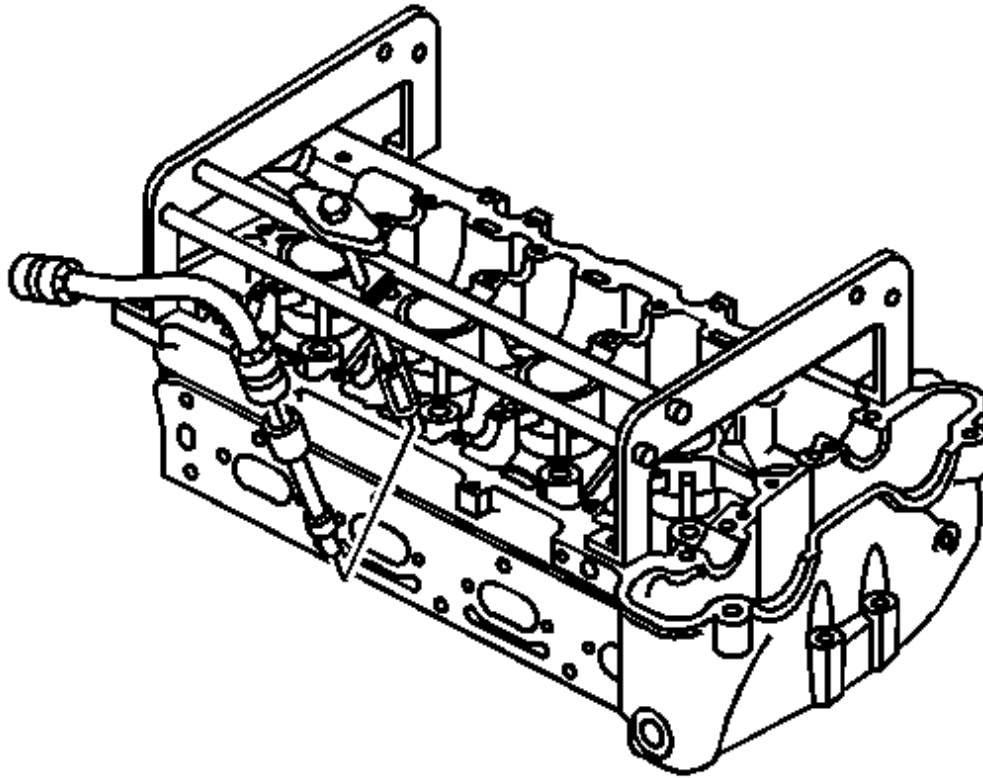


Fig. 157: View Of Air Hose Adaptor
Courtesy of GENERAL MOTORS CORP.

6. Install an air hose adapter into the spark plug hole.
7. Attach an air hose to the adapter
8. Using the compressed air, pressurize the cylinder to 690 kPa (100 psi).
9. Compress the valve spring using the **J 43649** . See **Special Tools** .

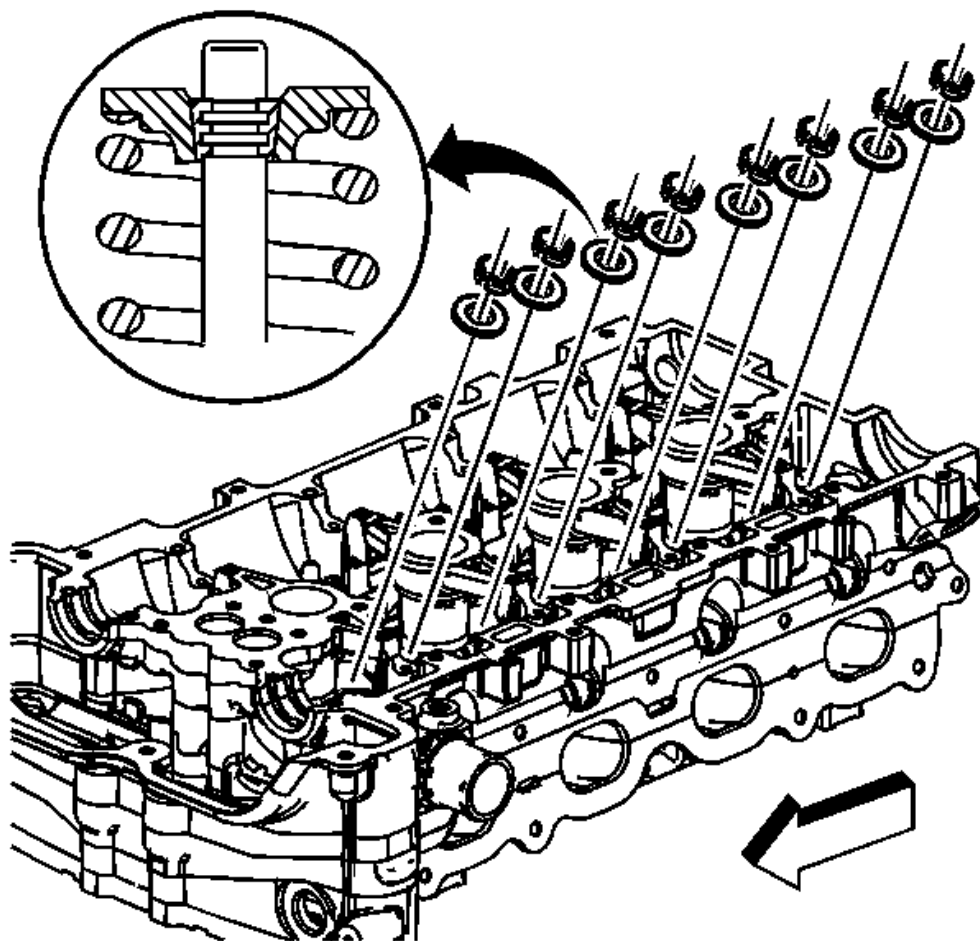


Fig. 158: View Of Valve Spring Keepers
 Courtesy of GENERAL MOTORS CORP.

10. Remove the valve spring keepers.
11. Remove the valve spring retainer.

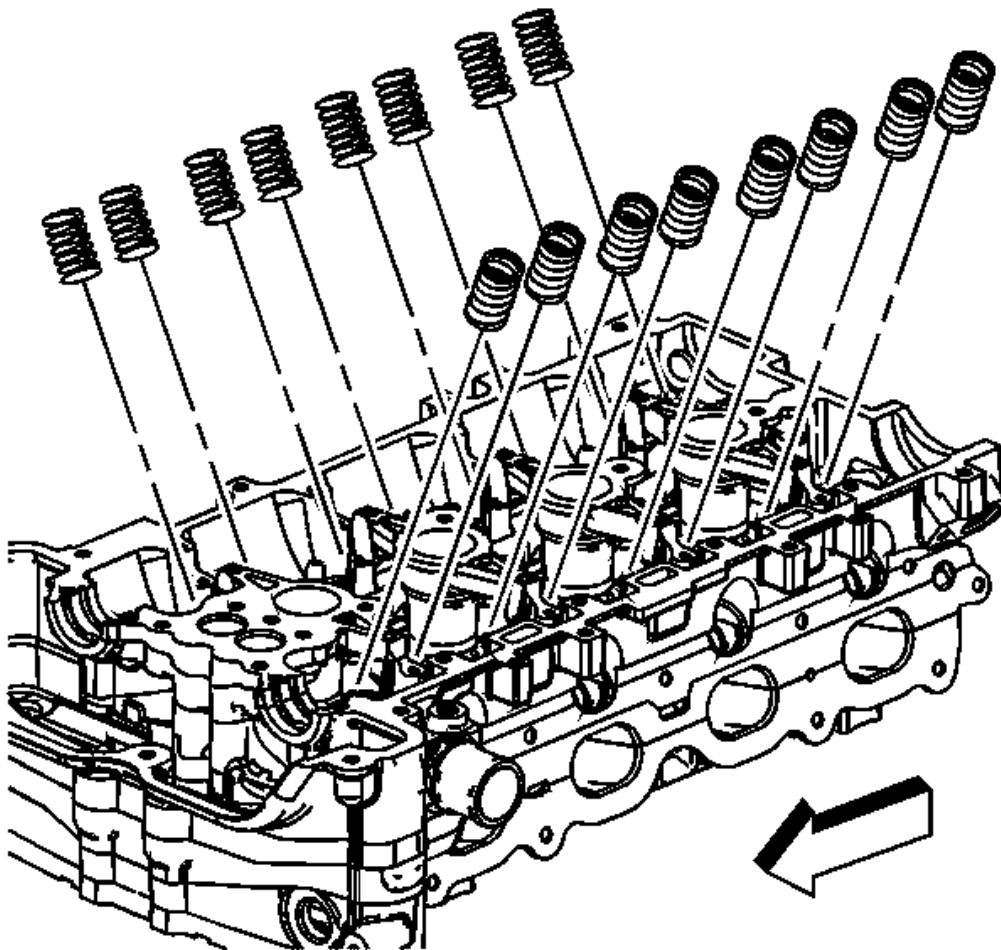


Fig. 159: Identifying Valve Springs
Courtesy of GENERAL MOTORS CORP.

12. Remove the valve spring.

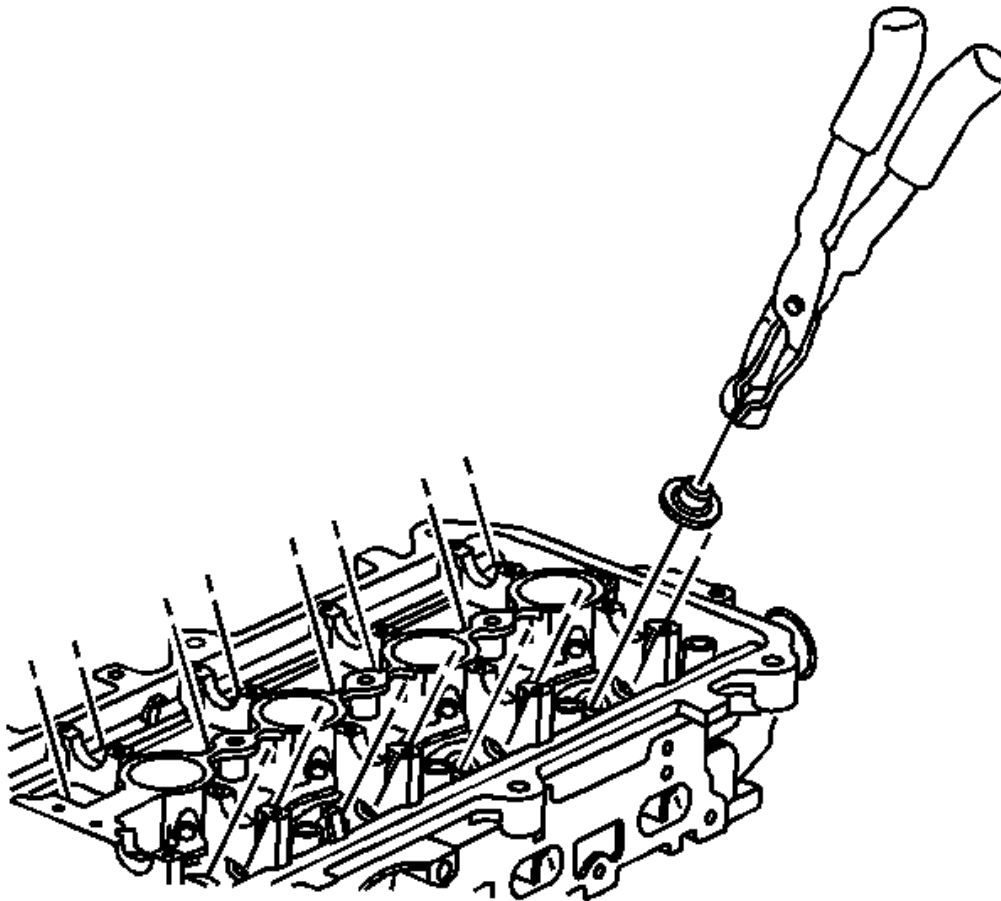


Fig. 160: View Of Special Tool J 36017 & Valve Seal
Courtesy of GENERAL MOTORS CORP.

13. Using the **J 36017** remove the valve seal. See **Special Tools** .

INSTALLATION PROCEDURE

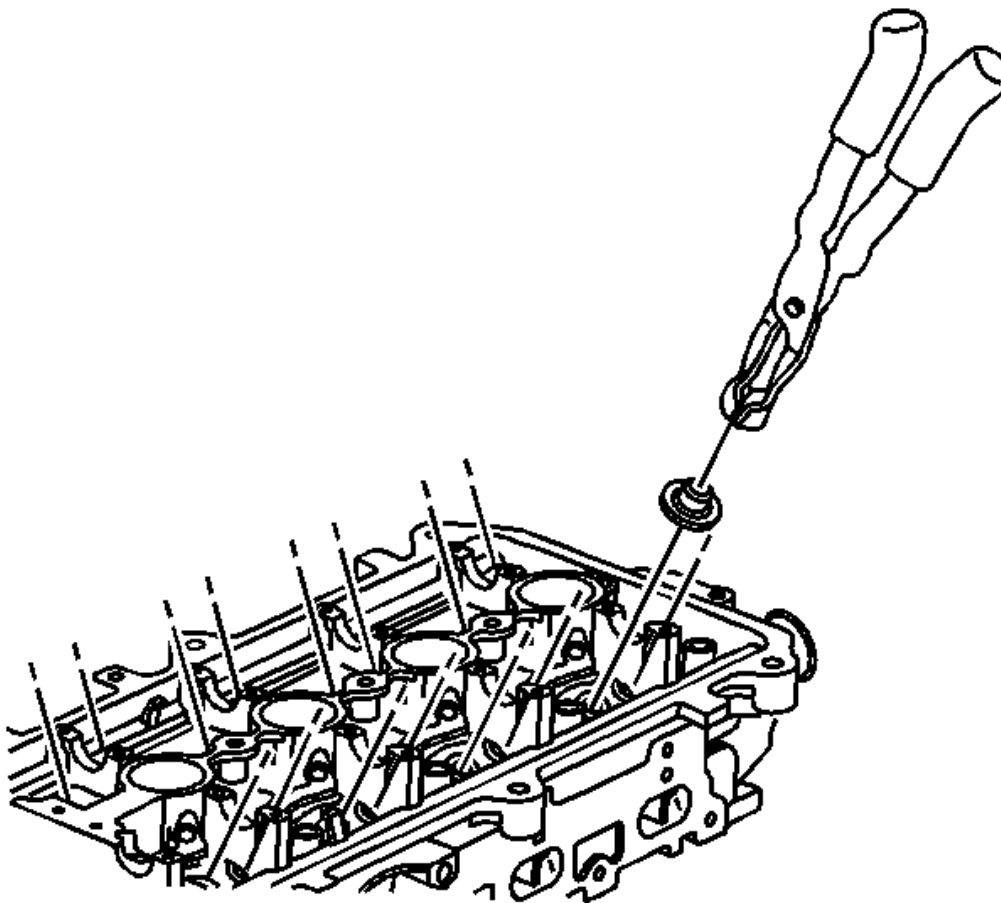


Fig. 161: View Of Special Tool J 36017 & Valve Seal
Courtesy of GENERAL MOTORS CORP.

1. Using the **J 36017** install the NEW valve seal. Fully seat the seal onto the valve guide. See **Special Tools** .

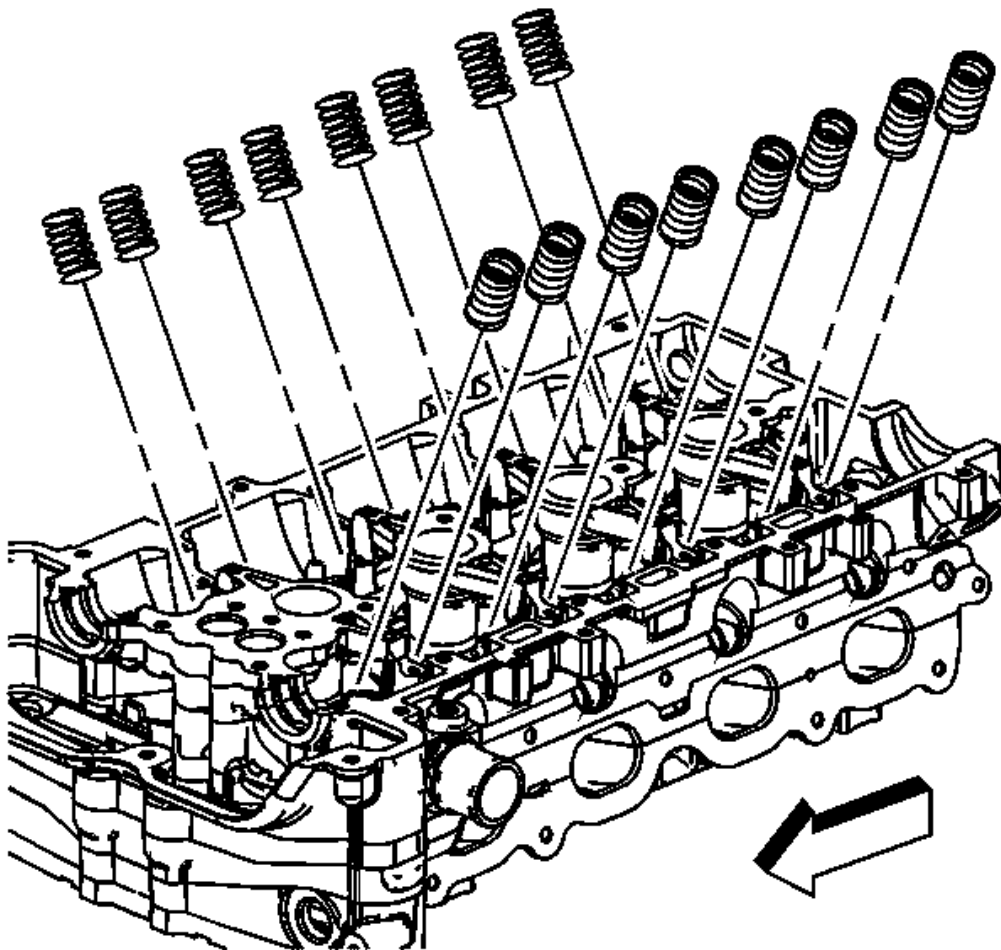


Fig. 162: Identifying Valve Springs
Courtesy of GENERAL MOTORS CORP.

2. Install the valve spring.

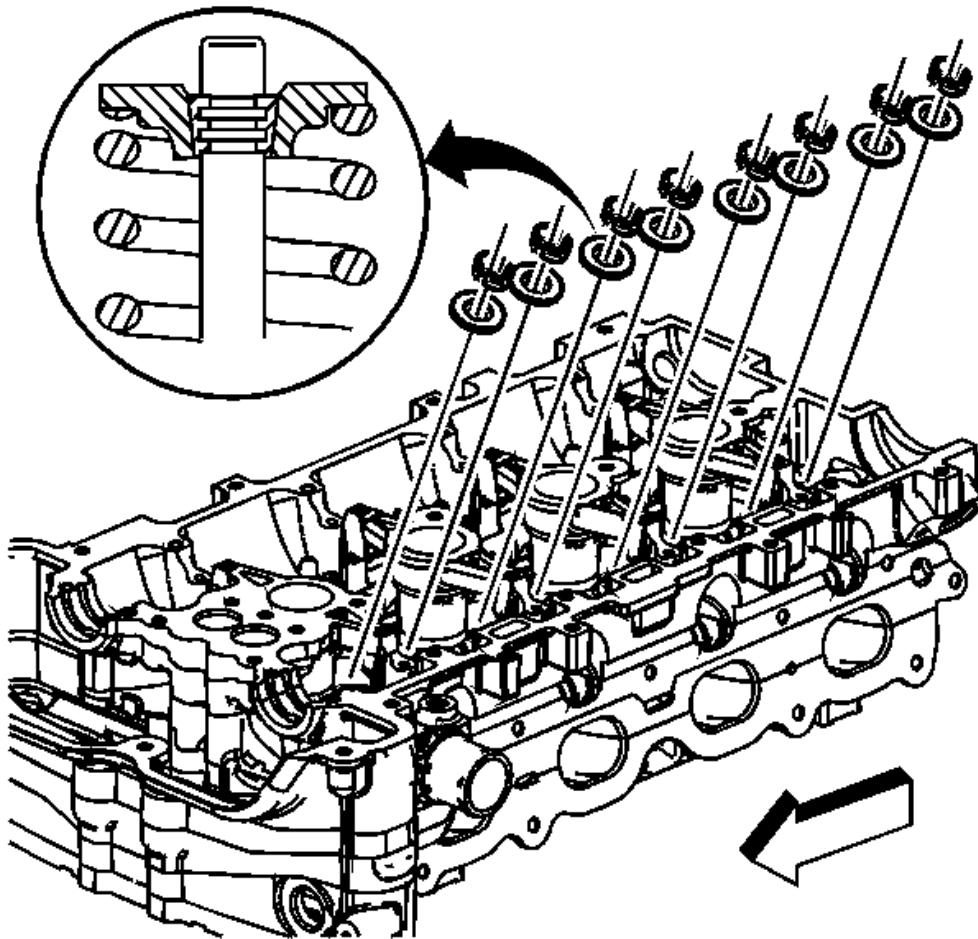


Fig. 163: View Of Valve Spring Keepers
 Courtesy of GENERAL MOTORS CORP.

3. Install the valve spring retainer.
4. Compress the valve spring using the **J 43649** . See **Special Tools** .
5. Install the valve spring keepers.

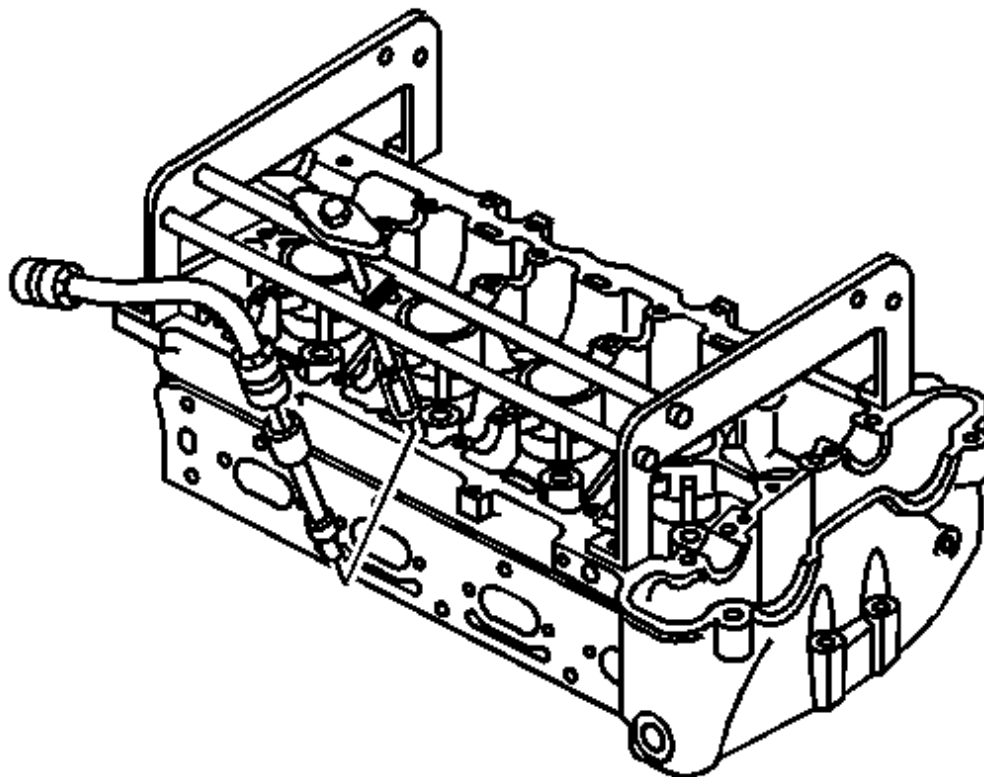


Fig. 164: View Of Air Hose Adaptor
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the air hose from the adaptor.
7. Remove the air hose adaptor from the spark plug hole.

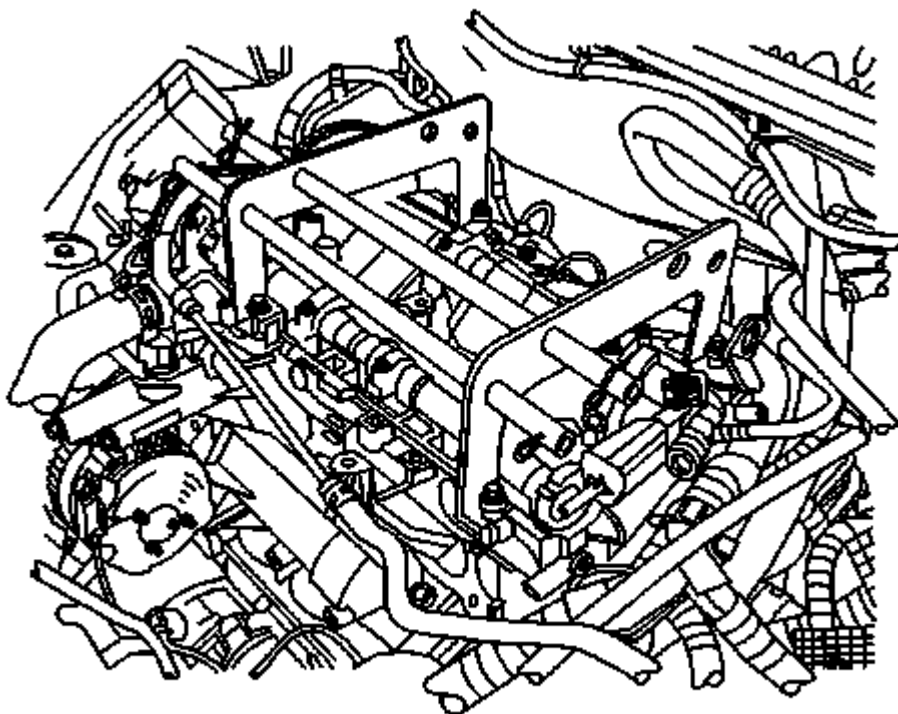


Fig. 165: View Of J 43649 Valve Spring Compressor (Cylinder Head)
Courtesy of GENERAL MOTORS CORP.

8. Remove the **J 43649** from the cylinder head. See Special Tools .
9. Install the spark plugs. Refer to Spark Plug Replacement .

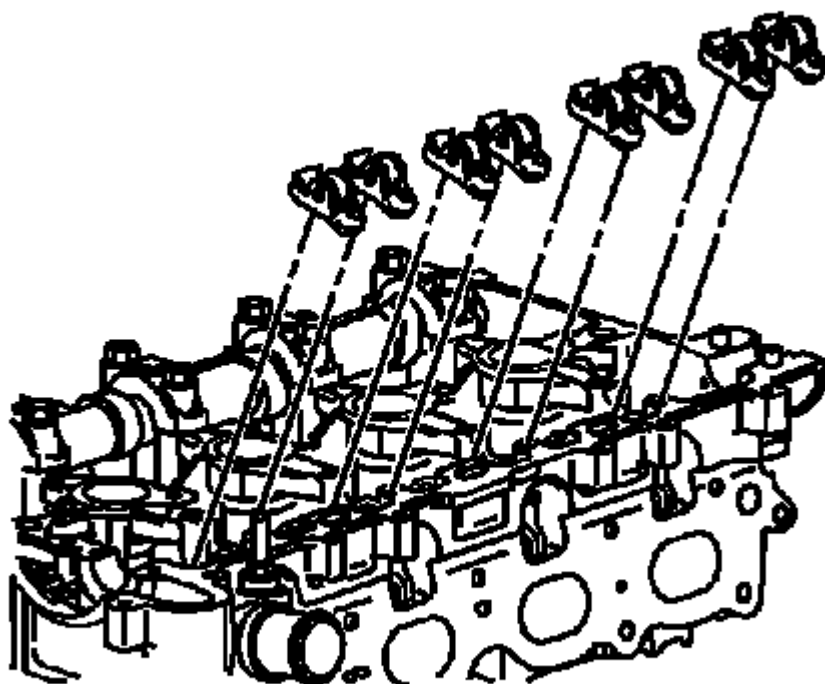


Fig. 166: Identifying Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

10. Install the camshaft roller followers.
11. Install the camshaft. Refer to Intake Camshaft and Valve Lifter Replacement or Exhaust Camshaft and Valve Lifter Replacement.

CYLINDER HEAD REPLACEMENT

SPECIAL TOOLS

- **J 38185** Hose Clamp Pliers
- **J 45059** Angle Meter
- **EN-48749** Timing Chain Retention Tool Kit
- **EN-48953** Camshaft Actuator Locking Tool

REMOVAL PROCEDURE

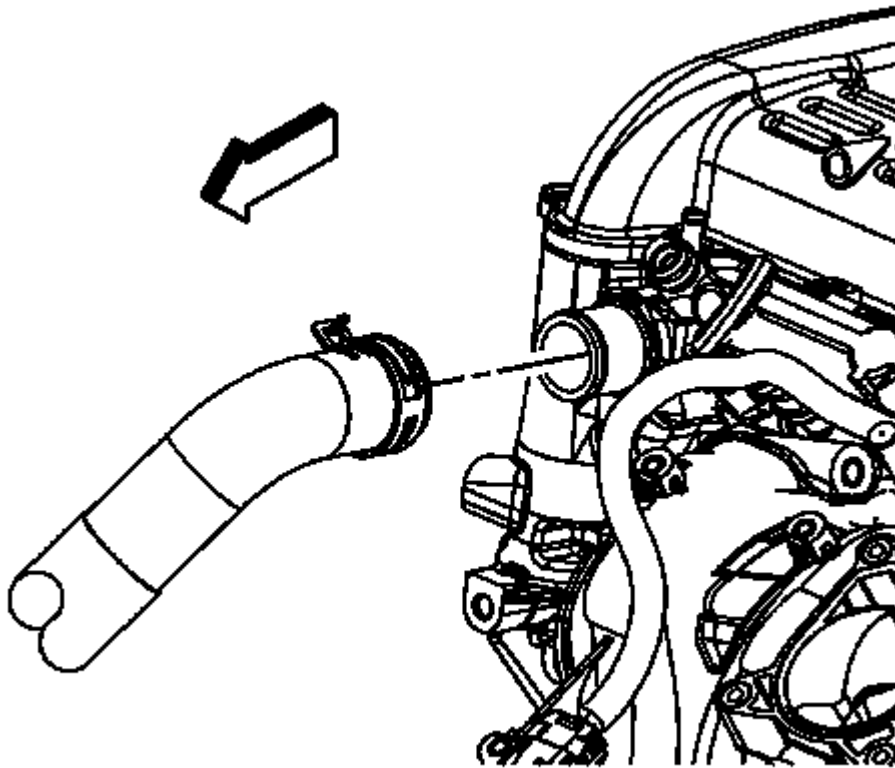


Fig. 167: View Of Radiator Inlet Hose To Engine
Courtesy of GENERAL MOTORS CORP.

1. Drain the cooling system. Refer to Cooling System Draining and Filling (GE 47716 Fill) .
2. Remove the exhaust manifold. Refer to Exhaust Manifold Replacement (LE5 or LE9 With MH8) or Exhaust Manifold Replacement (LE5) .
3. Remove the intake manifold. Refer to Intake Manifold Replacement.
4. Reposition the radiator surge tank air bleed hose clamp.
5. Remove the radiator surge tank air bleed hose from the cylinder head.
6. Reposition the radiator inlet hose clamp using the **J 38185** .
7. Remove the radiator inlet hose from the cylinder head.
8. Disconnect all electrical connectors as necessary.
9. Remove the spark plugs. Refer to Spark Plug Replacement
10. Remove the camshaft cover. Refer to Camshaft Cover Replacement.

NOTE: If the intake camshaft actuator is moving independently of the camshaft, this means the camshaft is not locked to the actuator. Rotate the camshaft counter-clockwise while the holding tool is installed and this will lock the camshaft to the actuator.

11. Rotate the crankshaft clockwise to install the camshaft actuator locking tool **EN-48953**: EGR Cooler Pressure Tester Adapter Set.

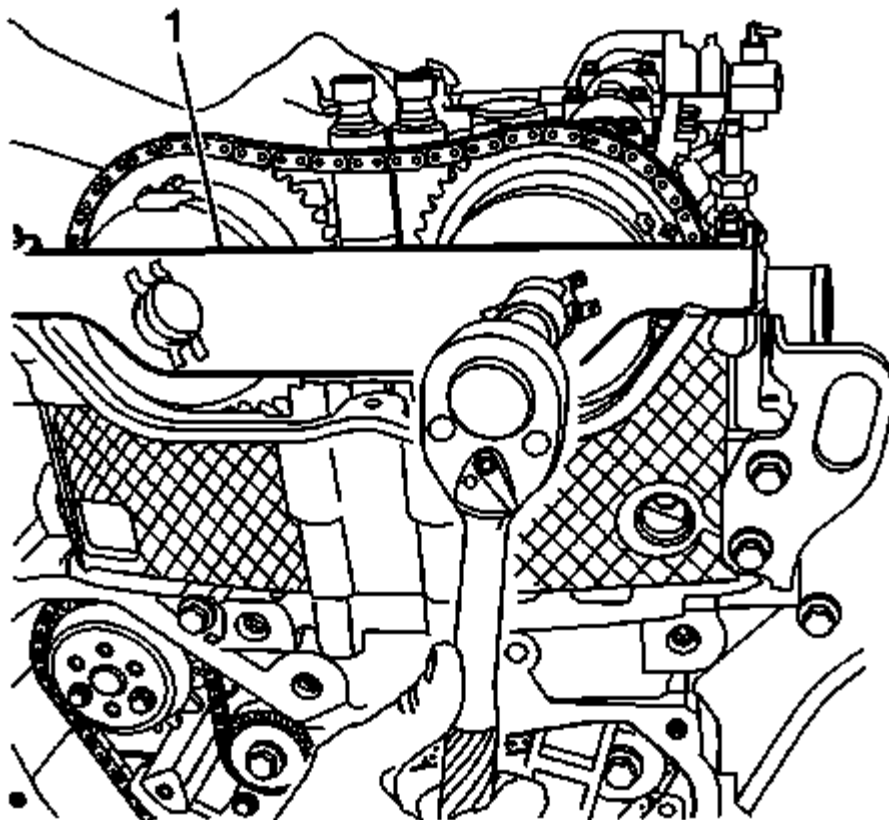


Fig. 168: View of Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the **EN-48953** (1).

CAUTION: Refer to Fastener Caution .

13. Install the camshaft actuator tool and bolts tighten to 10 N.m (89 lb in).

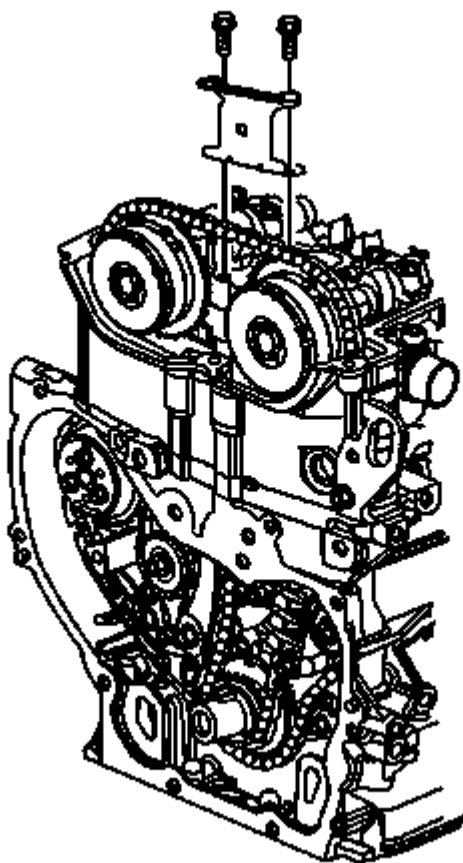


Fig. 169: View Of Upper Timing Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the upper timing chain guide bolts and guide.
15. Clean the timing chain and gears with solvent.

NOTE: **Ensure the timing chain and the camshaft position actuators are marked for proper assembly.**

16. Mark the timing gear sprockets and the timing chain. It is recommended that the paint marks are located in the 12 o'clock position.
17. Loosen, but do not remove the intake and exhaust camshaft actuator bolts.
18. Remove the camshaft actuator locking tool, **EN-48953** .

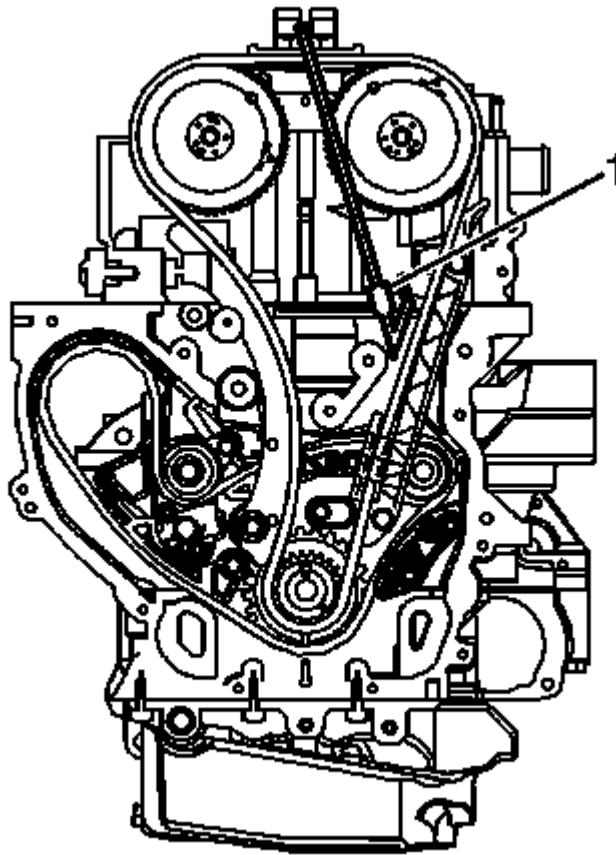


Fig. 170: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the tips of the EN-48749 are fully engaged into the timing chain. The retention tool rod can be used on the back side of the chain to ensure the teeth from the retention tool are engaged.

19. Install the timing chain retention tool **EN-48749** (1) to the intake side of the timing chain.

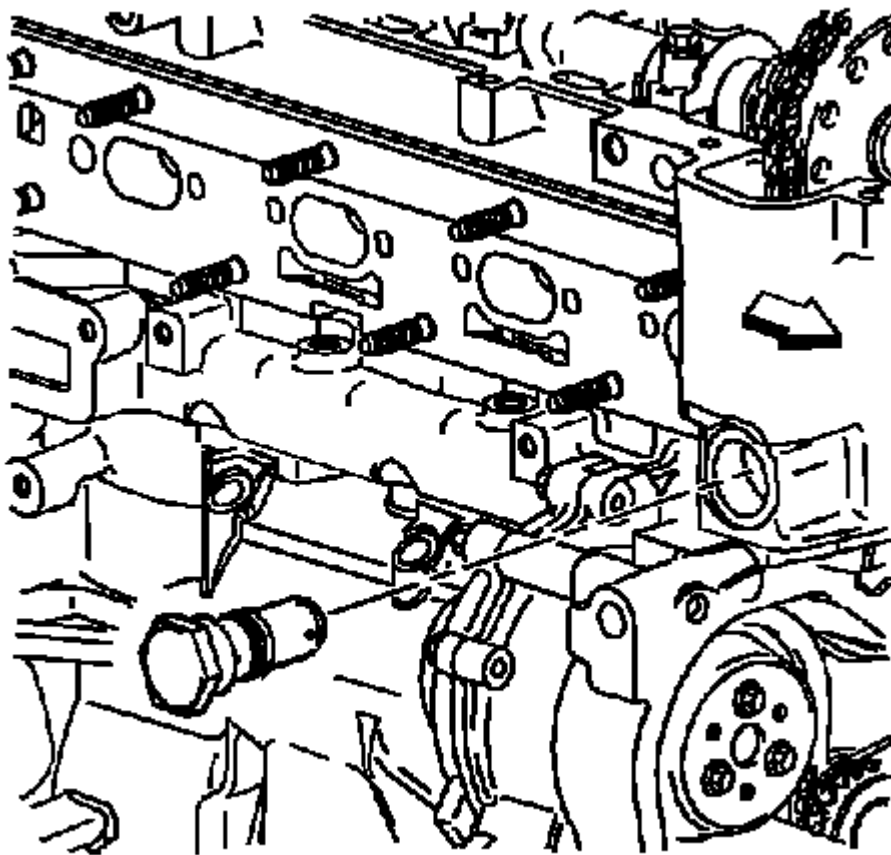


Fig. 171: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

20. Remove the timing chain tensioner.

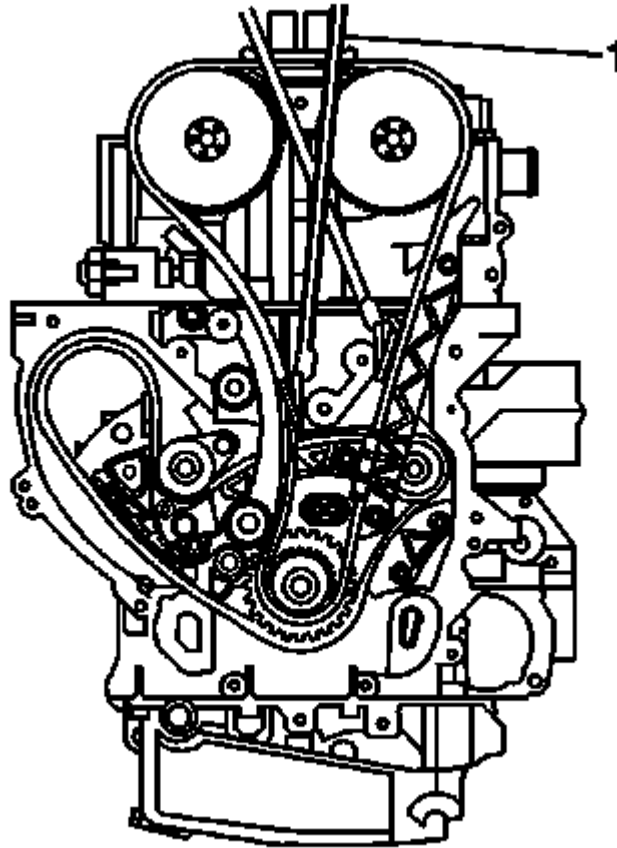


Fig. 172: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: The Intake camshaft and actuator should not rotate during the removal or installation.

21. Install the timing chain retention tool **EN-48749** (1) to the exhaust side of the timing chain.

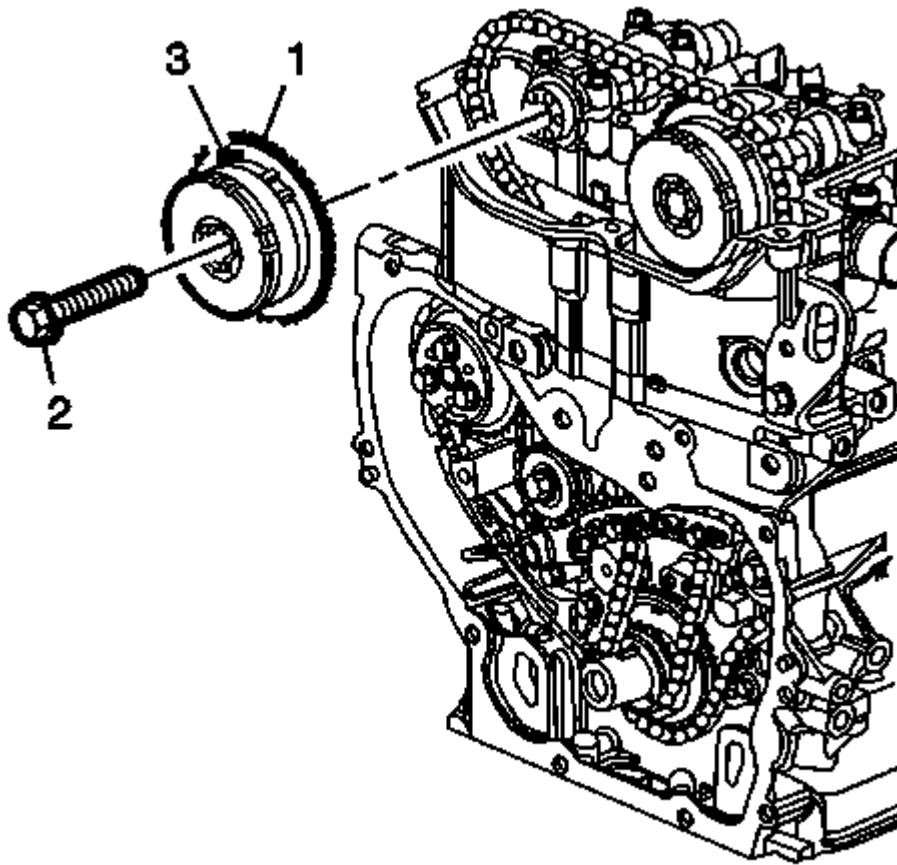


Fig. 173: Identifying Exhaust Camshaft Actuator & Bolt
Courtesy of GENERAL MOTORS CORP.

22. Remove and discard the exhaust camshaft actuator bolt (2).
23. Remove the exhaust cam actuator (3) from the exhaust camshaft while also removing the actuator from the chain.

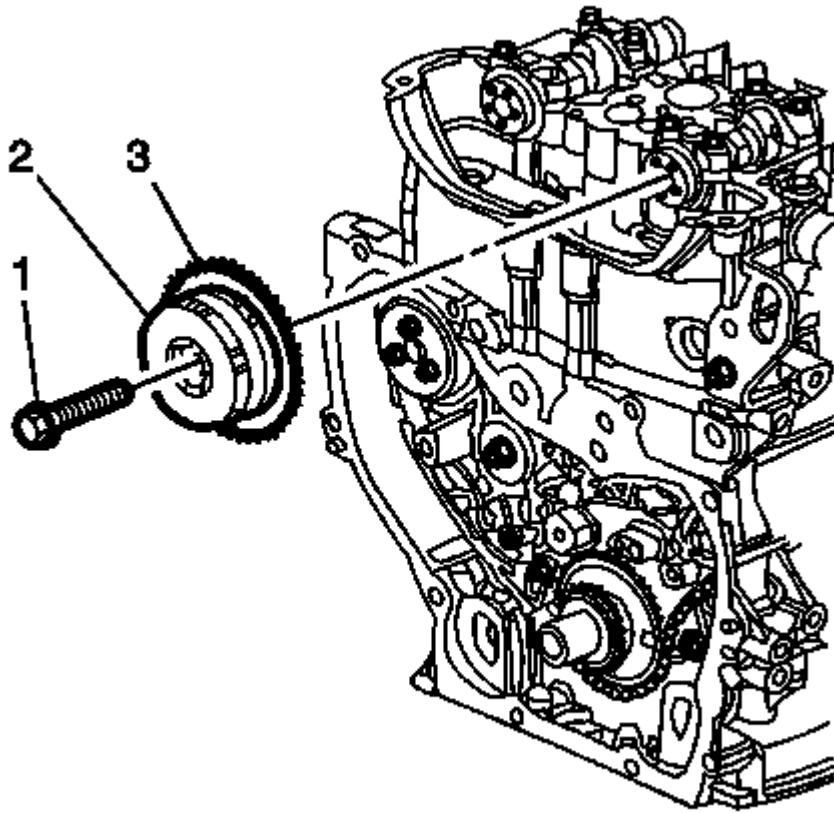


Fig. 174: Identifying Crankshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

24. Remove and discard the intake camshaft actuator bolt (2).
25. Remove the intake camshaft actuator (3) from the camshaft while also removing the actuator from the timing chain.

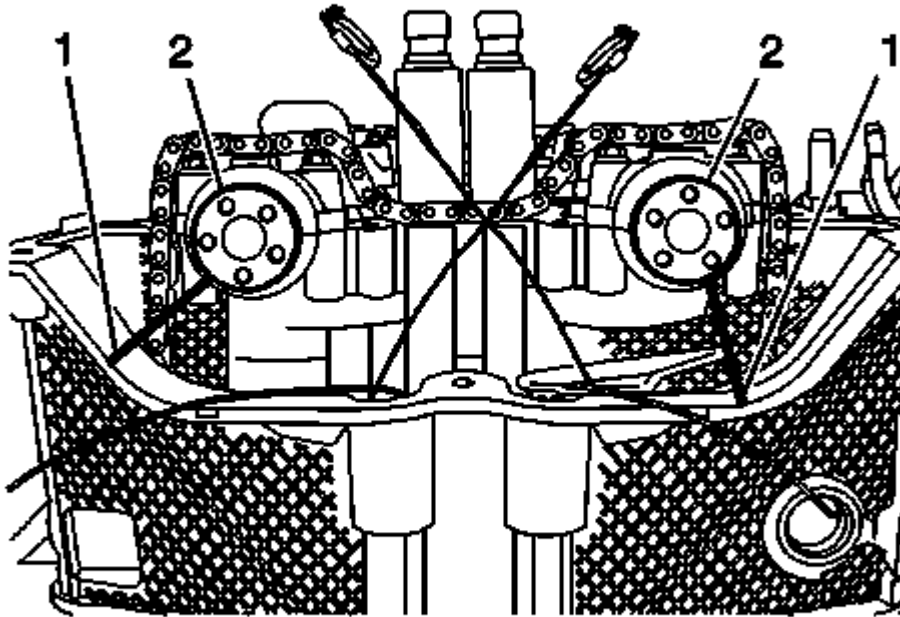


Fig. 175: Aligning Marks On Cylinder Head In Relationship To Camshaft Actuator Notches
Courtesy of GENERAL MOTORS CORP.

26. Mark the cylinder head (1) in relationship to the camshaft actuator notch is on the camshaft (2).

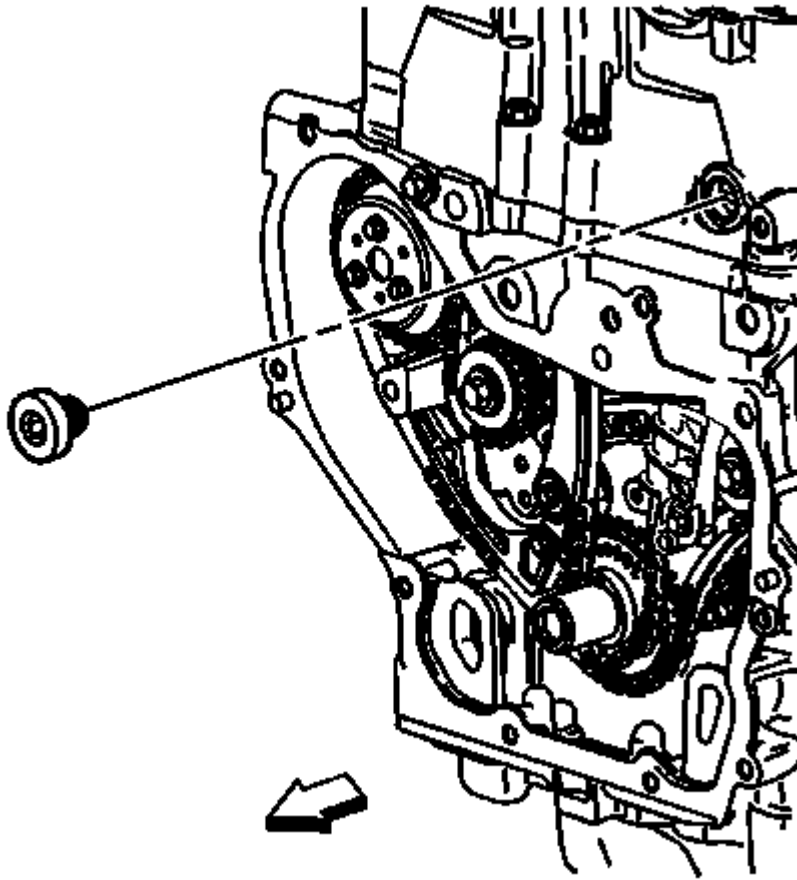


Fig. 176: View Of Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS CORP.

27. Remove the fixed timing chain guide access plug.
28. Remove the upper fixed timing chain guide bolt.

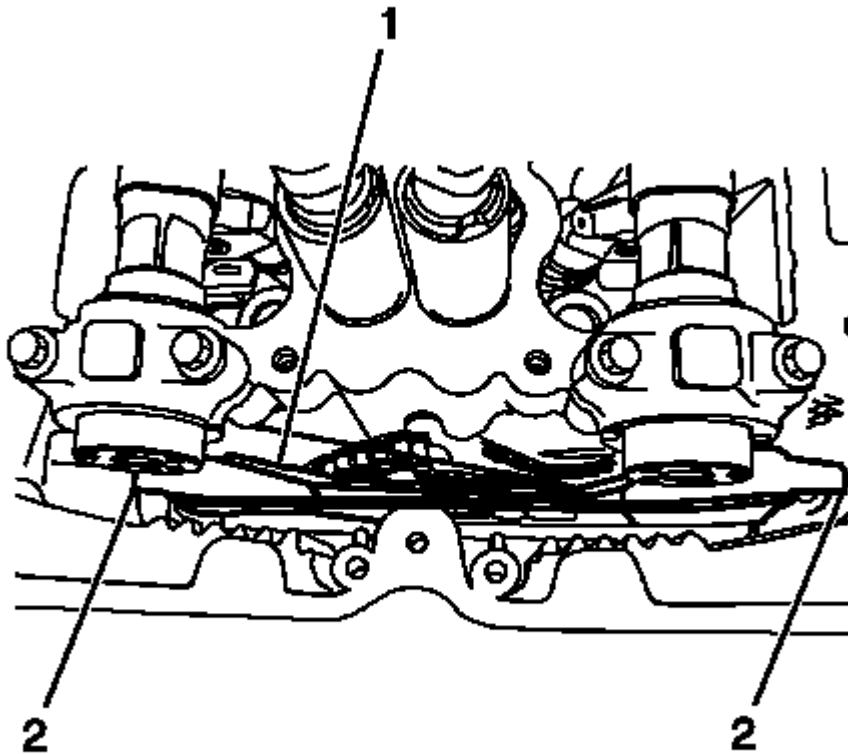


Fig. 177: View Of Rubber Band To Pull Guides Together
Courtesy of GENERAL MOTORS CORP.

NOTE: The threaded rod from the timing chain retention tool can be used to help feed the rubber band around the chain guides.

29. Install a rubber band (1) around the top of the upper timing chain guides (2) in order to pull the guides together.

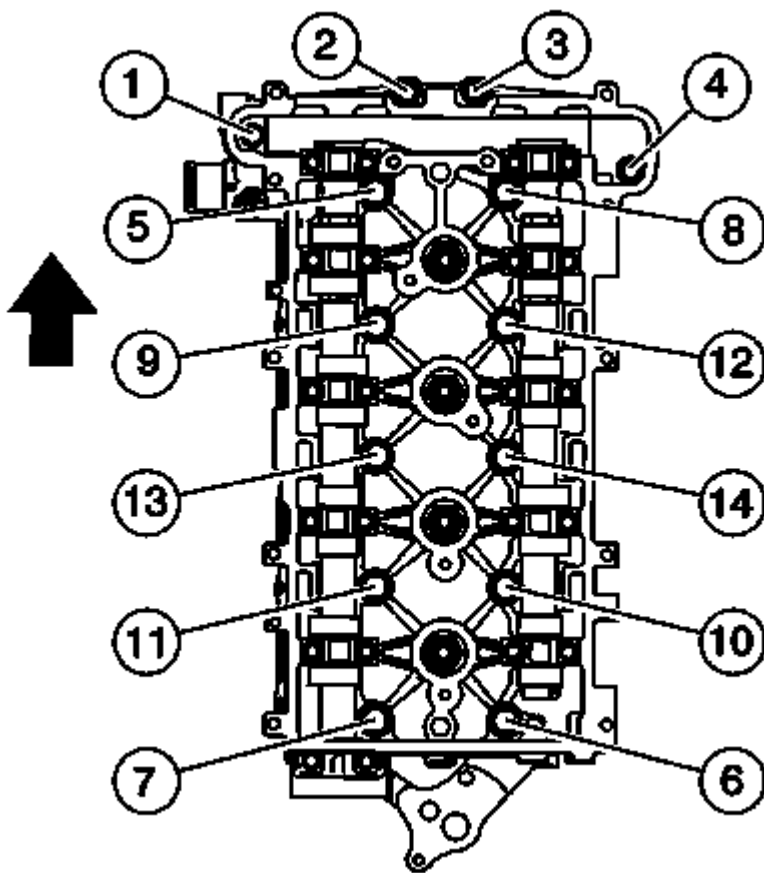


Fig. 178: Identifying Cylinder Head Bolt Removal Sequence
Courtesy of GENERAL MOTORS CORP.

30. Remove the cylinder head bolts in the sequence shown. Discard the bolts.

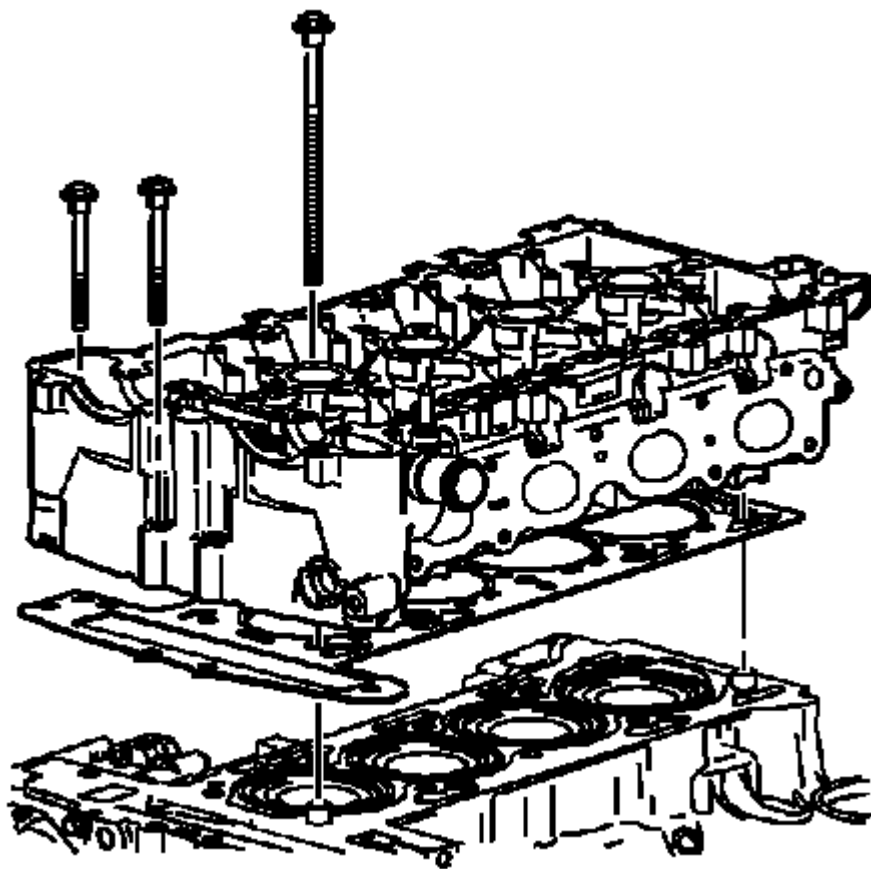


Fig. 179: View Of Cylinder Head And Gasket
Courtesy of GENERAL MOTORS CORP.

31. Remove the cylinder head.
32. Remove the cylinder head gasket.
33. Clean all of the gasket surfaces.
34. Use the following steps when cleaning the cylinder head and cylinder block surfaces:
 - Use a razor blade gasket scraper to clean the cylinder head and cylinder block gasket surfaces. Do not scratch or gouge either surface.

NOTE: **DO NOT use any other method or technique to clean these gasket surfaces.**

- Use a NEW razor blade on the cylinder head and a NEW blade on the cylinder block.

NOTE: **Be careful not to gouge or scratch the gasket surfaces. DO NOT gouge or scrape the combustion chamber surfaces. The feel of the gasket surface is important, not the appearance. There will be indentations from the gasket left in the cylinder head after all of the gasket material is removed. These small indentations will be filled in**

by the NEW gasket.

- Hold the razor blade as parallel to the gasket surface as possible.

35. Clean the old sealer/lube and any dirt from around the bolt holes.

NOTE: DO NOT use a tap to clean the cylinder head bolt holes.

36. Clean the bolts holes with a nylon bristle brush.

37. When cleaning the cylinder head bolt holes use suitable commercial spray liquid solvent and compressed air from an extended-tip blow gun in order to reach the bottom of the holes.

38. If replacing the cylinder head, transfer all parts as necessary.

INSTALLATION PROCEDURE

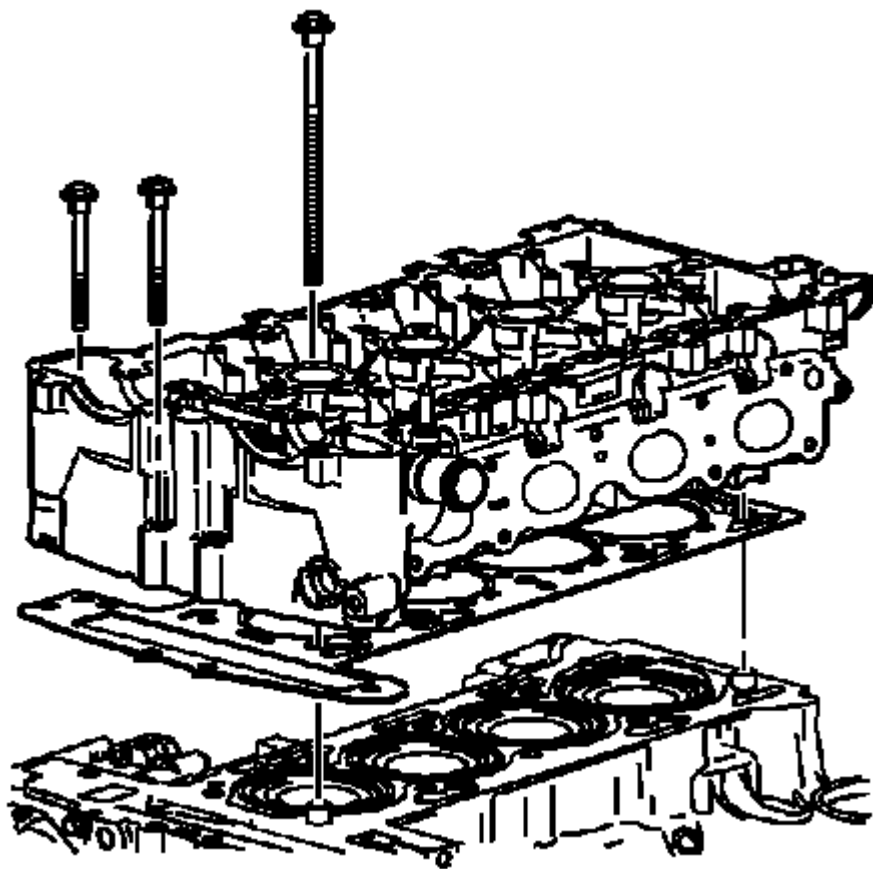


Fig. 180: View Of Cylinder Head And Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT use any sealing material.

1. Install the cylinder head gasket.

2. Install the cylinder head.
3. Install NEW cylinder head bolts.

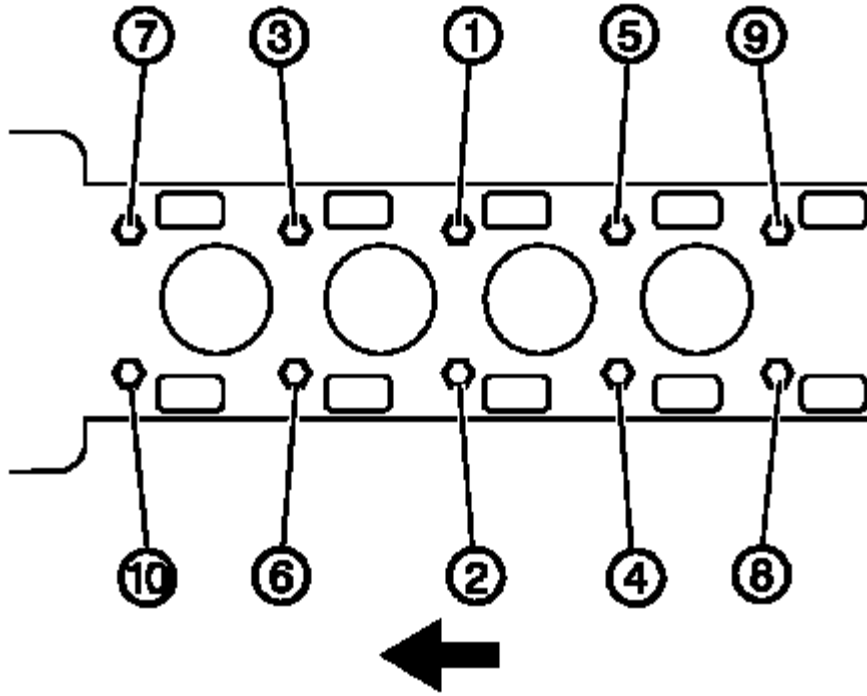


Fig. 181: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

4. Install and tighten the cylinder head bolts in the sequence shown to 30 N.m (22 lb ft) plus an additional 155 degrees using the **J 45059**.

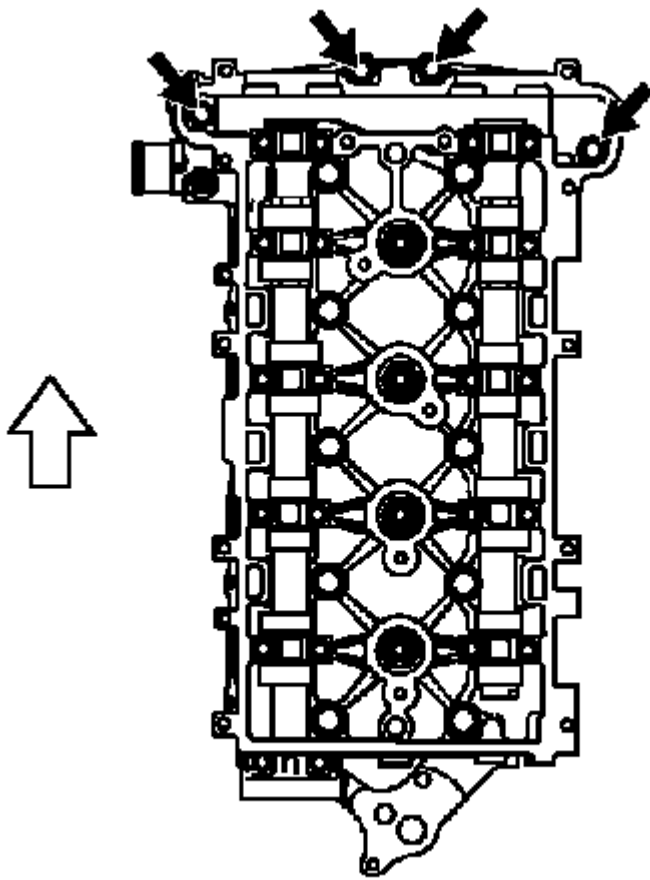


Fig. 182: Locating Front Cylinder Head Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the NEW front cylinder head bolts and tighten the bolts to 35 N.m (26 lb ft).

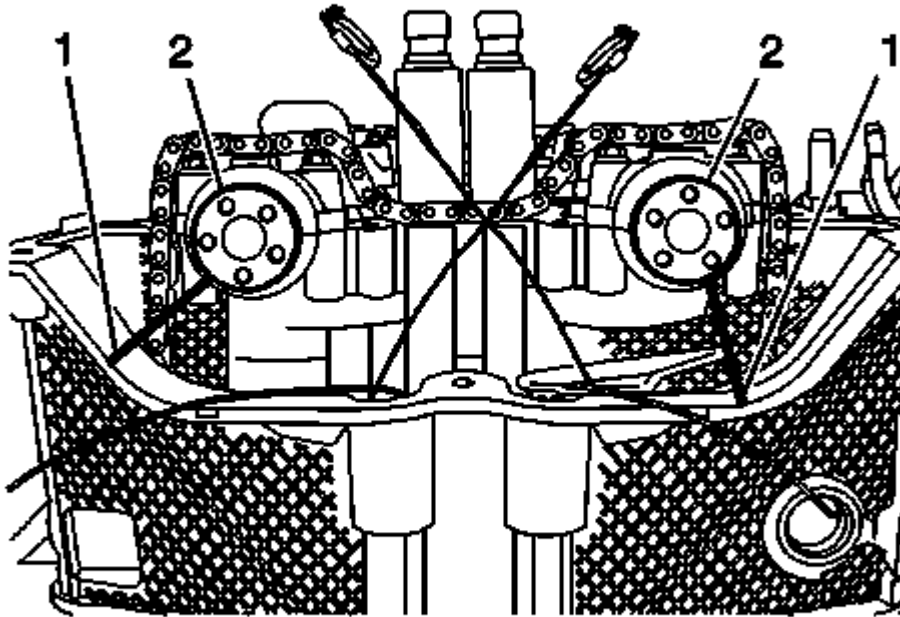


Fig. 183: Aligning Marks On Cylinder Head In Relationship To Camshaft Actuator Notches
Courtesy of GENERAL MOTORS CORP.

6. Ensure the cylinder head (1) and the camshaft (2) are correctly aligned.

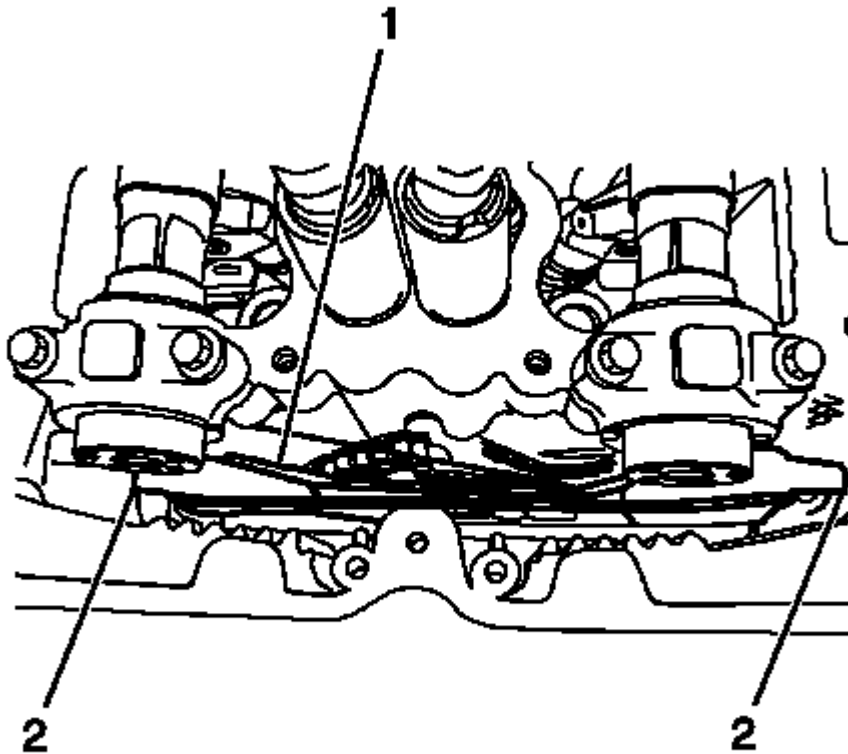


Fig. 184: View Of Rubber Band To Pull Guides Together
Courtesy of GENERAL MOTORS CORP.

7. Remove the rubber band (1) from around the top of the upper timing chain guides (2).
8. Install the fixed guide bolt into the cylinder head and tighten to 12 N.m (106 lb in).

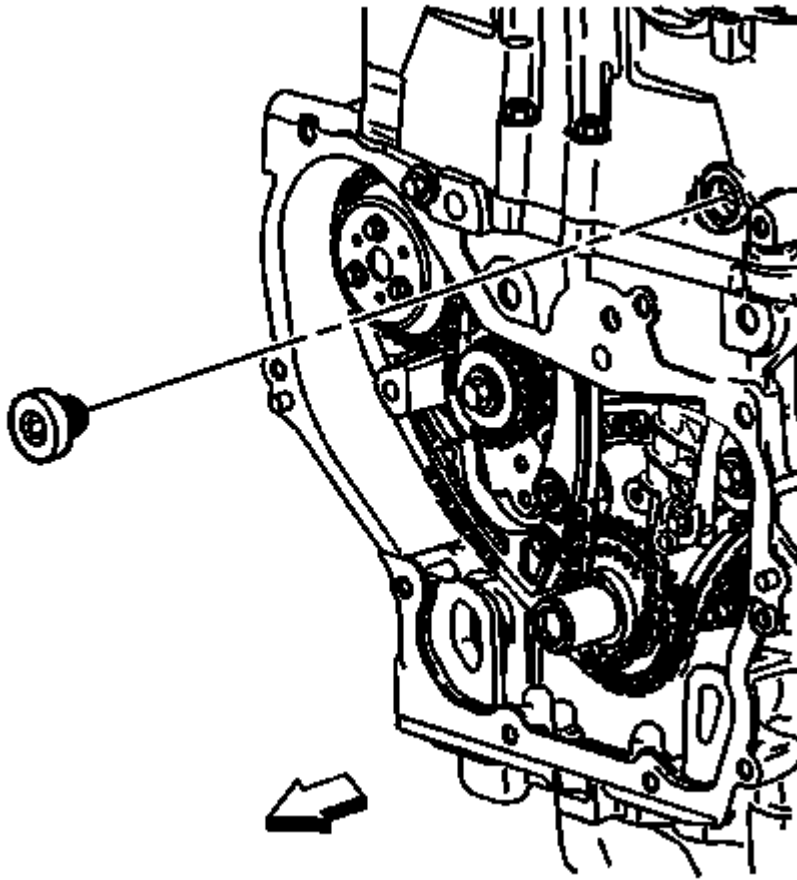


Fig. 185: View Of Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS CORP.

9. Apply sealant compound to thread and install the timing chain guide bolt access hole plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
10. Install the fixed timing chain guide access plug and tighten the plug to 90 N.m (59 lb ft).

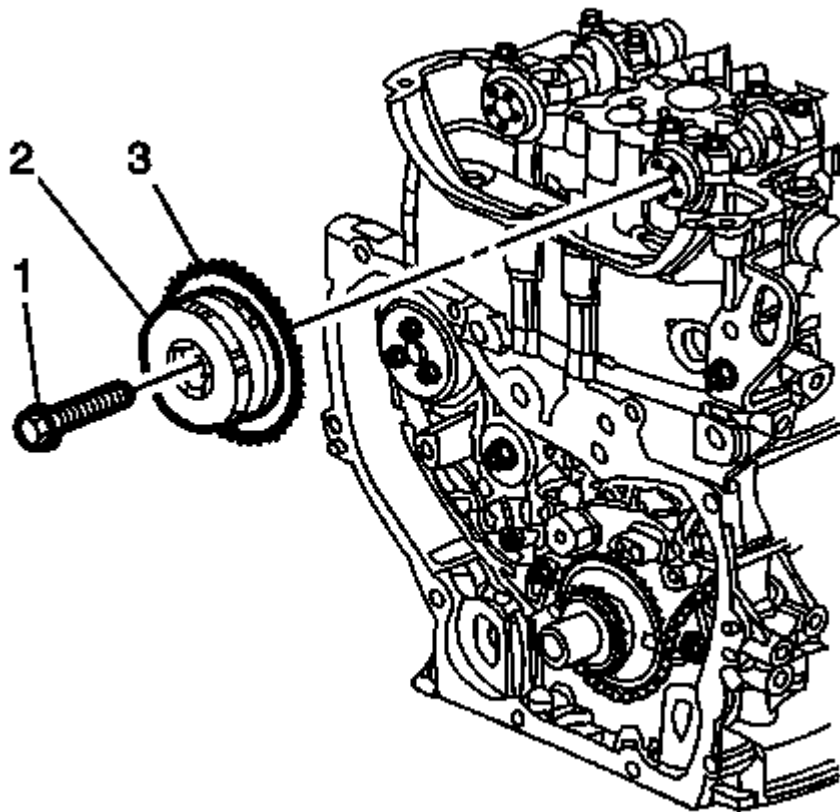


Fig. 186: Identifying Crankshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the alignment mark made previously on the intake camshaft actuator is still aligned properly with the mark on the timing chain. If the mark made previously on the intake camshaft actuator is not aligned properly, refer to Camshaft Timing Chain, Sprocket, and Tensioner Replacement.

11. Install the timing chain onto the intake camshaft actuator.
12. Align the intake camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft.
13. Install a NEW intake camshaft actuator bolt (2) until snug.

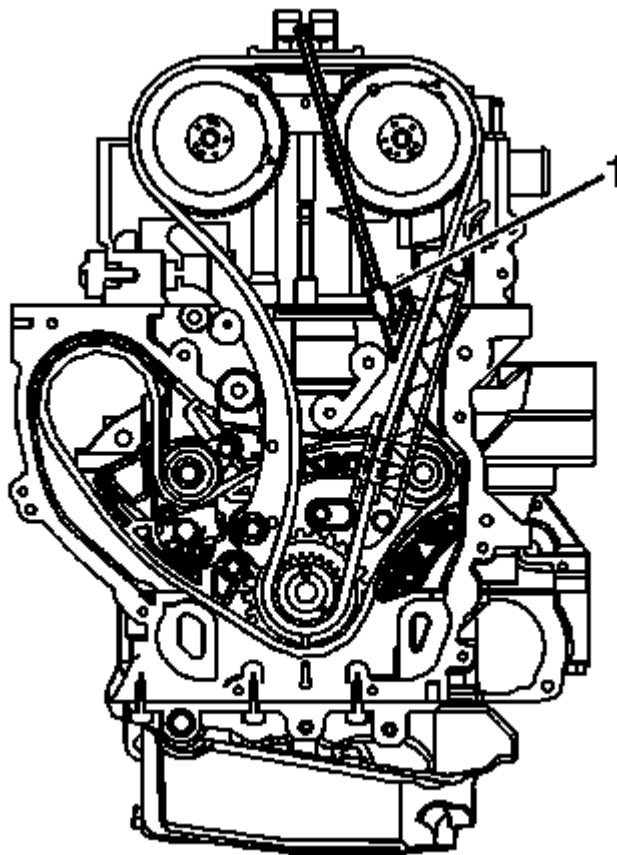


Fig. 187: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

14. Remove the timing chain retention tool EN-48749 (1) from the intake side of the timing chain.

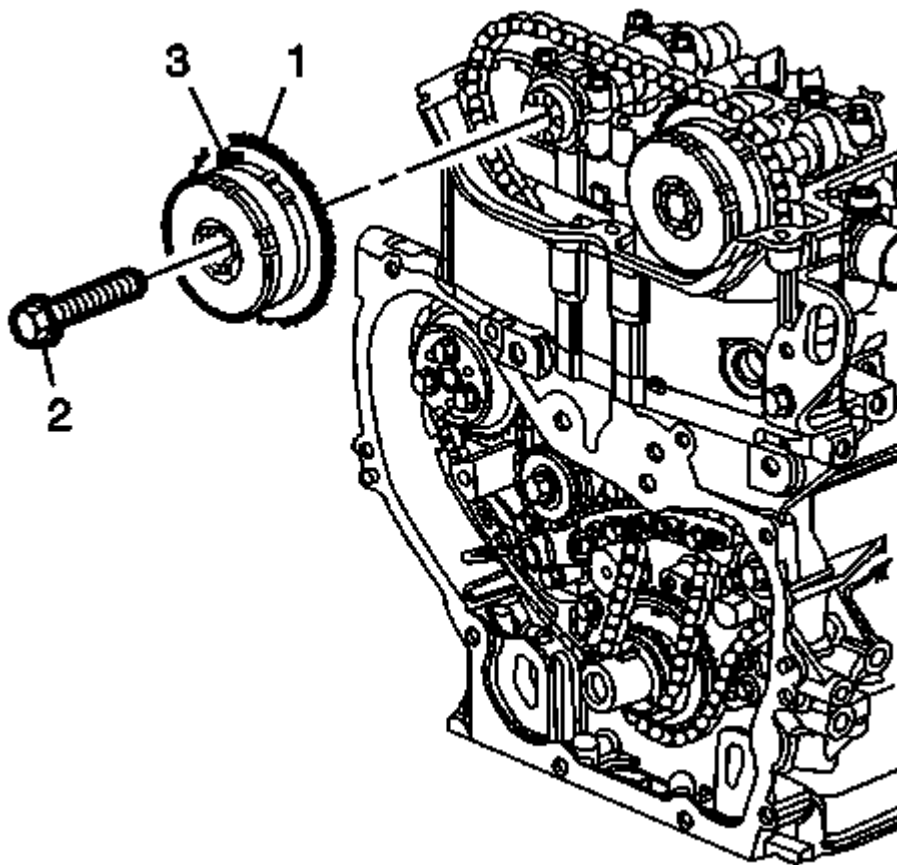


Fig. 188: Identifying Exhaust Camshaft Actuator & Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the alignment mark made previously on the exhaust camshaft actuator is still aligned properly with the mark on the timing chain. The exhaust cam may have to be rotated clockwise to install the exhaust actuator.

15. Install the timing chain onto the exhaust camshaft actuator.
16. Align the exhaust camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft.
17. Install a NEW exhaust camshaft actuator bolt (2) until snug.
18. Remove the timing chain retention tool **EN-48749** (1) from the exhaust side of the timing chain.

NOTE: Failure to reset the chain tensioner will put excess tension on the chain, limiting the chains life.

19. Reset and install the timing chain tensioner. Refer to Timing Chain Tensioner Replacement.

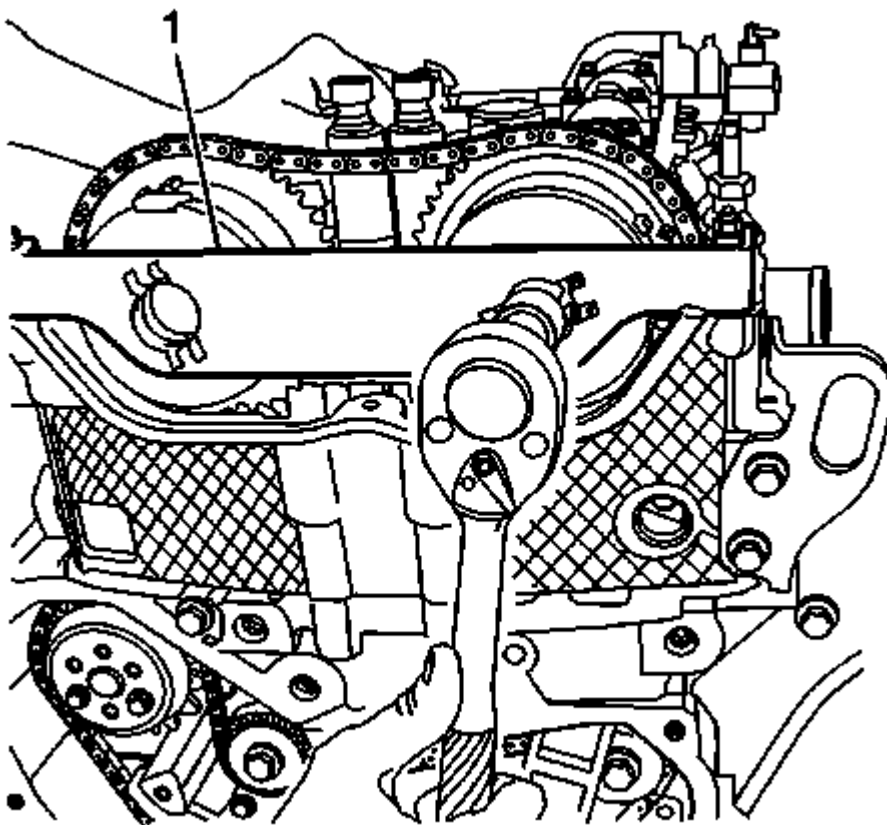


Fig. 189: View of Loosening/Tightening Camshaft Actuator Retainer Bolts
 Courtesy of GENERAL MOTORS CORP.

20. Install the **EN-48953** (1) to the actuators.
21. Install the camshaft actuator locking tool bolts and tighten to 10 N.m (89 lb in).
22. Tighten the NEW camshaft actuator bolt to 30 N.m (22 lb ft), plus an additional 100 degrees using the **J 45059**.
23. Release the tensioner by applying a counterclockwise rotational torque of 45 N.m (33 lb ft) to the harmonic balancer bolt.
24. Remove the camshaft actuator locking tool, **EN-48953**.

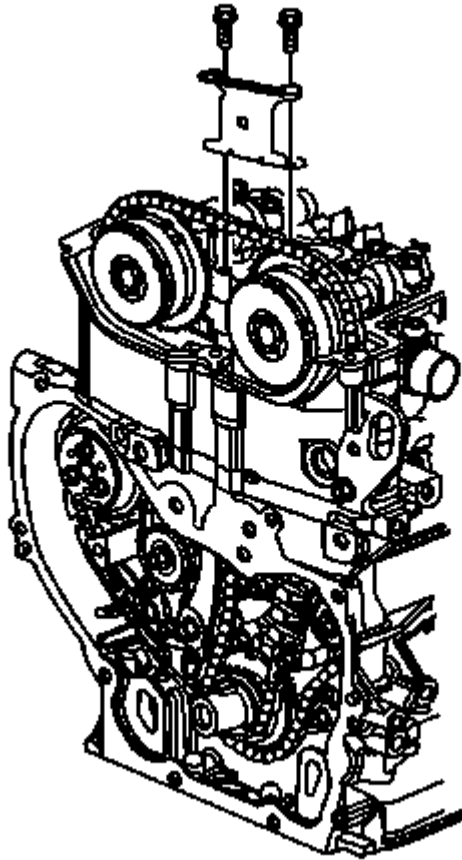


Fig. 190: View Of Upper Timing Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

25. Install the upper timing chain guide bolts and guide. Tighten the bolts to 10 N.m (89 lb in).
26. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
27. Install the spark plugs. Refer to **Spark Plug Replacement**.

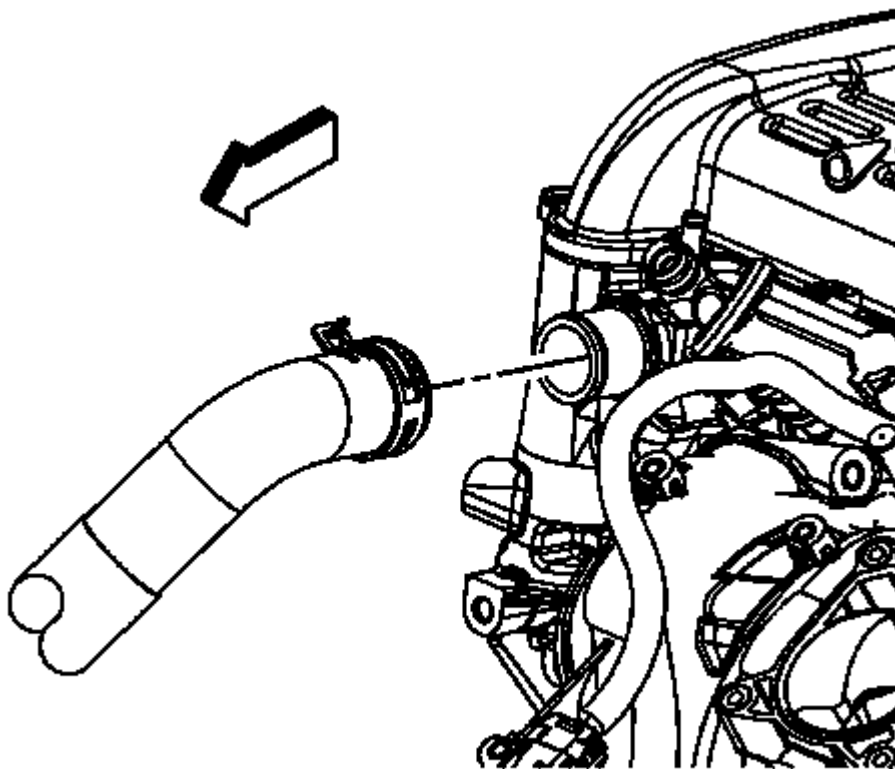


Fig. 191: View Of Radiator Inlet Hose To Engine
 Courtesy of GENERAL MOTORS CORP.

28. Connect all electrical connectors as necessary.
29. Install the radiator inlet hose to the cylinder head.
30. Position the radiator inlet hose clamp using the **J 38185**.
31. Install the radiator surge tank air bleed hose to the cylinder head.
32. Position the radiator surge tank air bleed hose clamp.
33. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement (LE5 or LE9 With MH8)** or **Exhaust Manifold Replacement (LE5)**.
34. Install the intake manifold. Refer to **Intake Manifold Replacement**.
35. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716 Fill)**.

ENGINE OIL COOLER REPLACEMENT

REMOVAL PROCEDURE

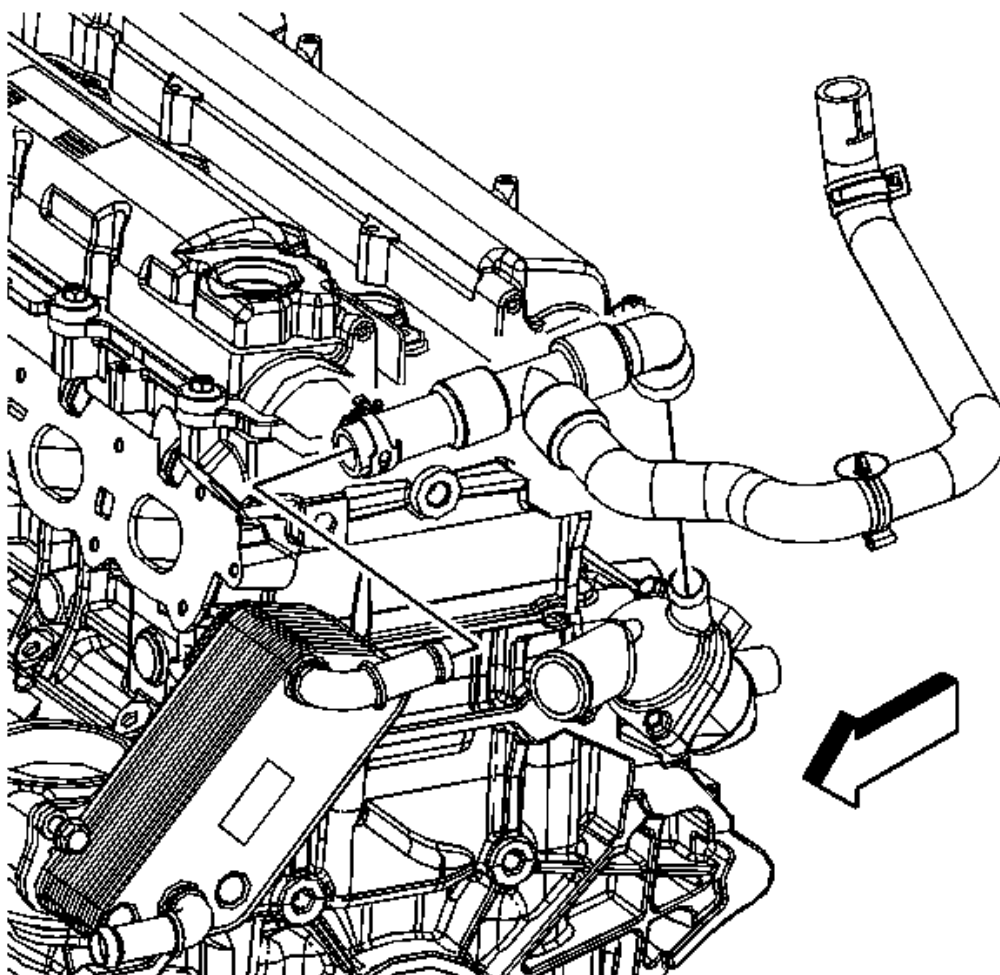


Fig. 192: Identifying Thermostat Housing & Oil Cooler
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716 Fill)** or **Cooling System Draining and Filling** .
3. Reposition the surge tank outlet hose clamps at the thermostat housing and oil cooler.
4. Remove the surge tank outlet hose from the thermostat housing and oil cooler.

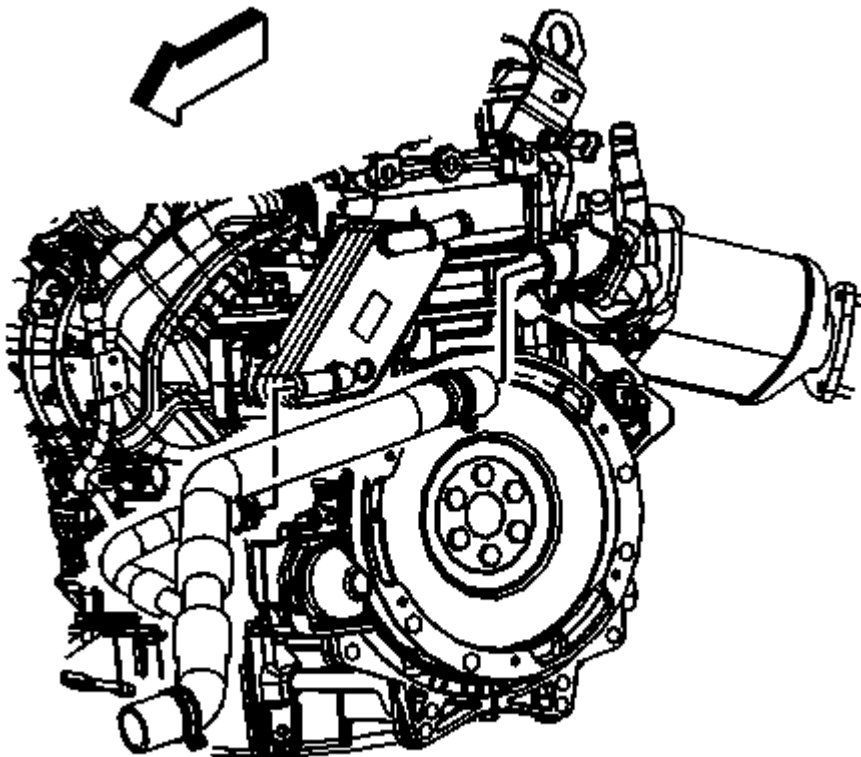


Fig. 193: View Of Radiator Outlet Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

5. Reposition the radiator outlet hose clamp at the oil cooler.
6. Remove the radiator outlet hose from the oil cooler.

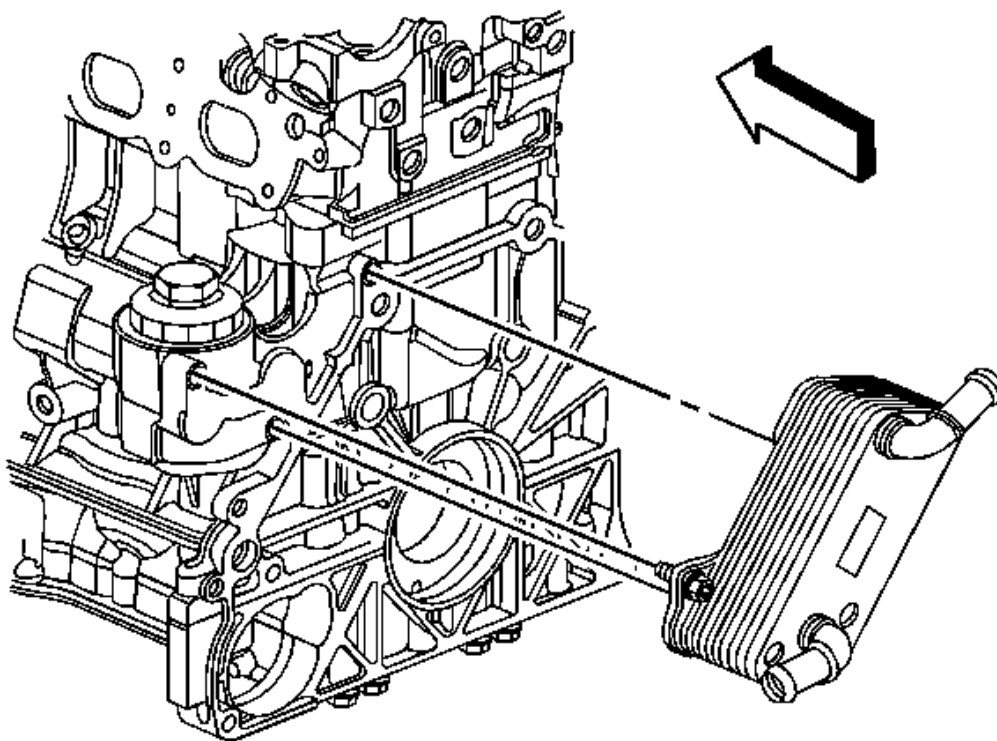


Fig. 194: Identifying Oil Cooler
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil cooler bolts.
8. Remove the oil cooler.

INSTALLATION PROCEDURE

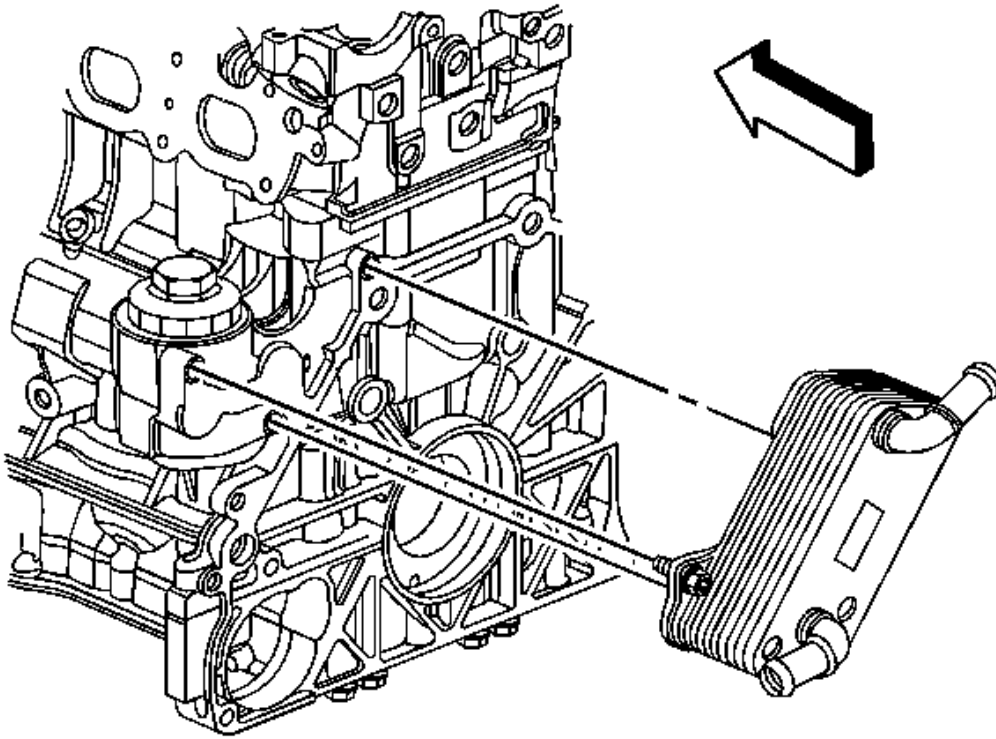


Fig. 195: Identifying Oil Cooler
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Position the oil cooler to the engine block.
2. Install the oil cooler bolts and tighten to 22 N.m (16 lb ft).

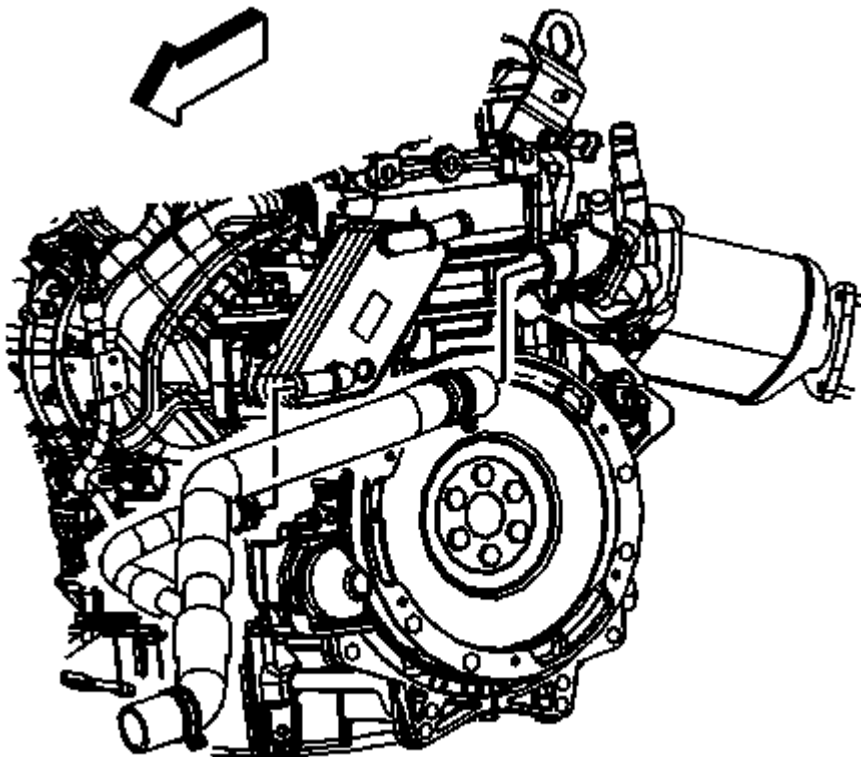


Fig. 196: View Of Radiator Outlet Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

3. Install the radiator outlet hose to the oil cooler.
4. Position the radiator outlet hose clamp at the oil cooler.

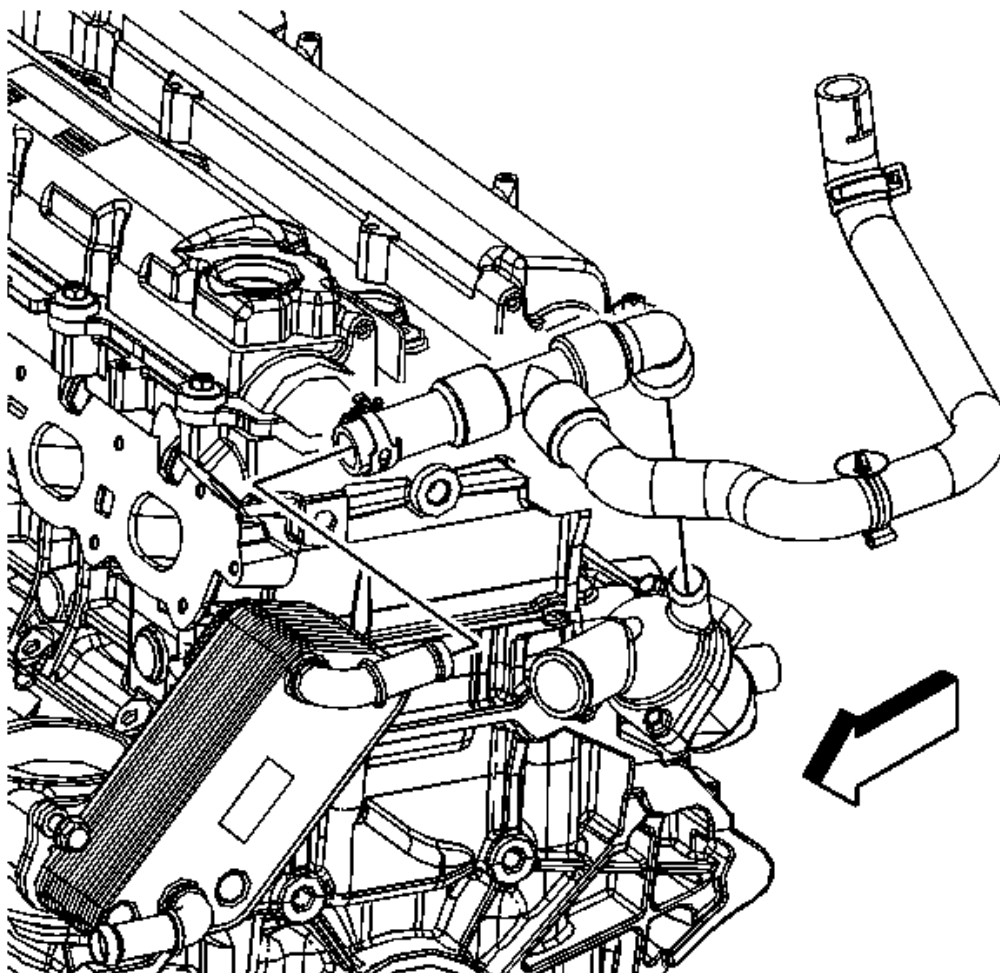


Fig. 197: Identifying Thermostat Housing & Oil Cooler
Courtesy of GENERAL MOTORS CORP.

5. Install the surge tank outlet hose to the thermostat housing and oil cooler.
6. Position the surge tank outlet hose clamps at the thermostat housing and oil cooler.
7. Fill the cooling system. Refer to Cooling System Draining and Filling (GE 47716 Fill) or Cooling System Draining and Filling .
8. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .

OIL PAN REPLACEMENT

REMOVAL PROCEDURE

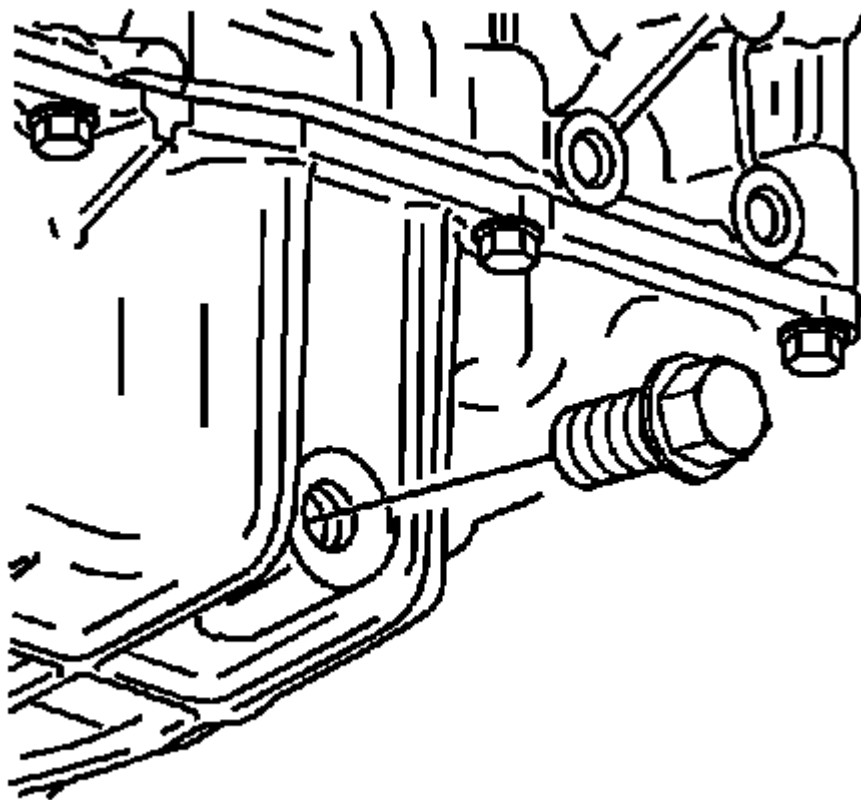


Fig. 198: View Of Oil Pan Drain Bolt
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Place a drain pan under the oil pan drain plug.
3. Remove the oil pan drain plug.
4. Drain the engine oil.
5. Remove the engine drive belt. Refer to **Drive Belt Replacement**.
6. Remove the lower AC compressor bolt.

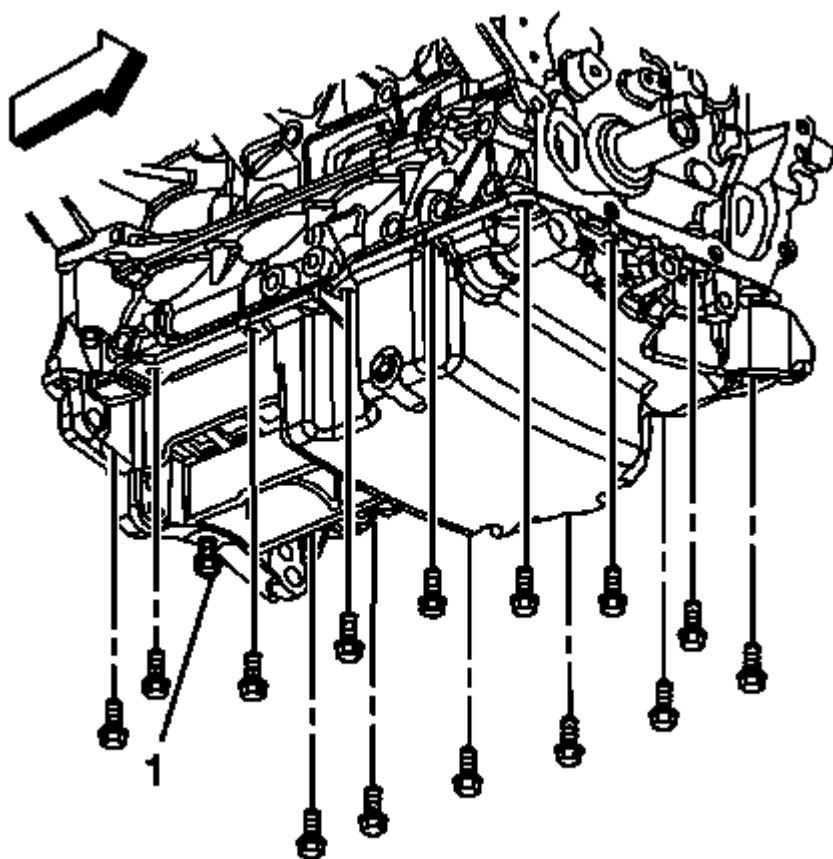


Fig. 199: Identifying Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil pan bolts (1).

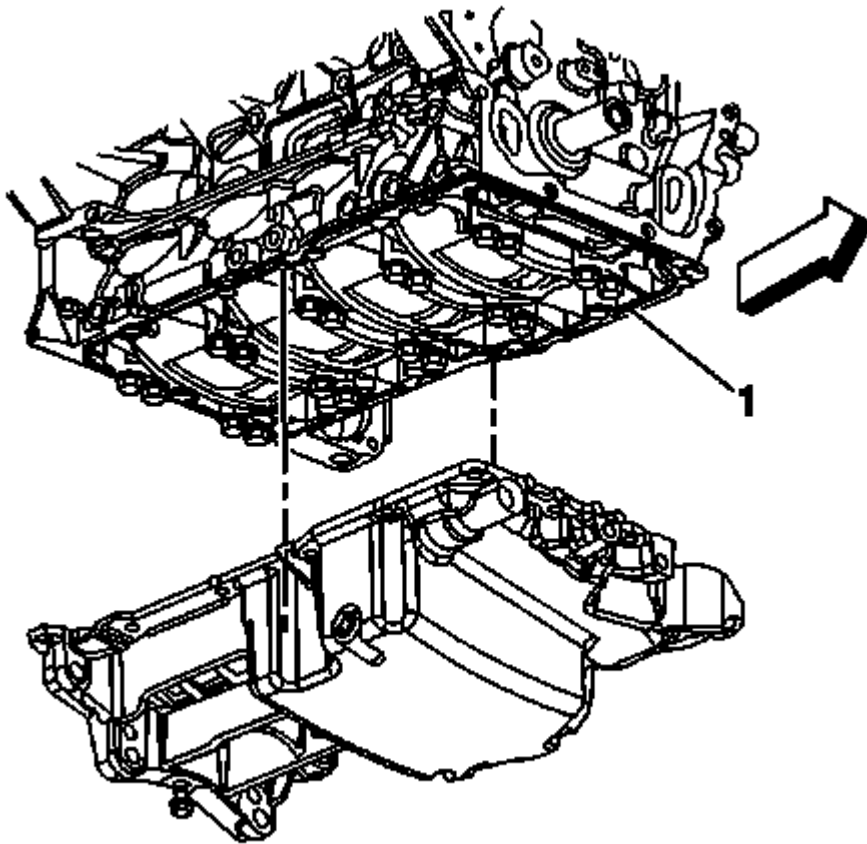


Fig. 200: Identifying Oil Pan

Courtesy of GENERAL MOTORS CORP.

8. Remove the oil pan
9. Remove any old oil pan sealant (1).

INSTALLATION PROCEDURE

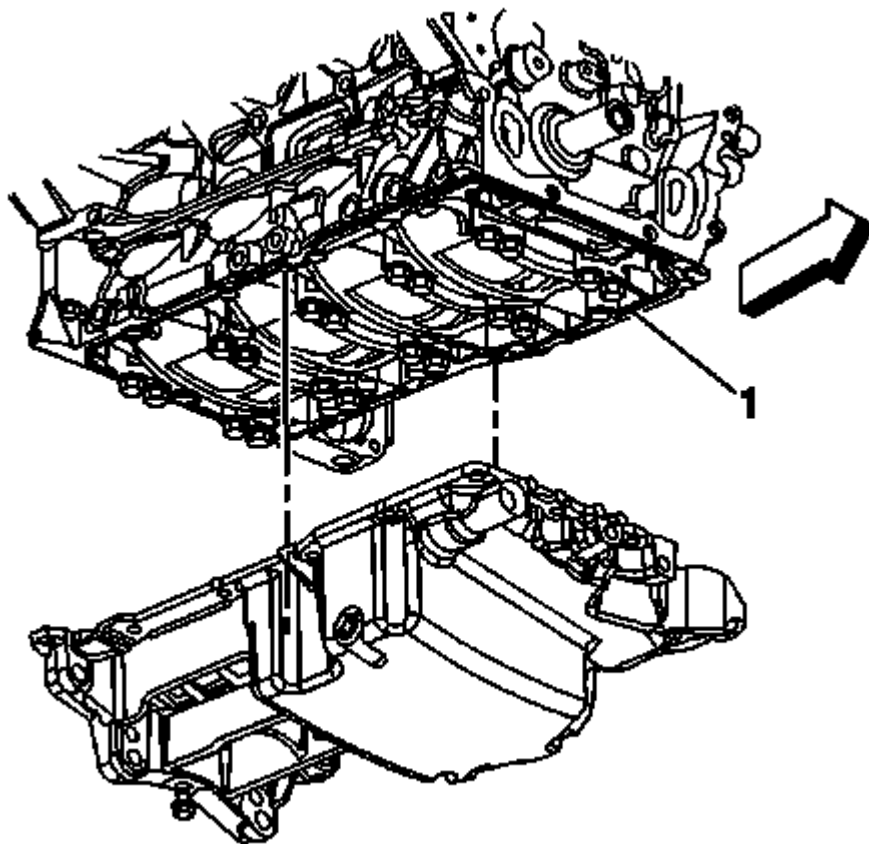


Fig. 201: Identifying Oil Pan

Courtesy of GENERAL MOTORS CORP.

1. Ensure that the oil pan and the sealing surface on the lower crankcase are free of all oil and debris.
2. Apply a 2 mm (0.079 in) bead of sealant (1) around the perimeter of the oil pan and the oil suction port opening. DO NOT over apply the sealant. More than a 2 mm (0.079 in) bead is not required. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
3. Install the oil pan.

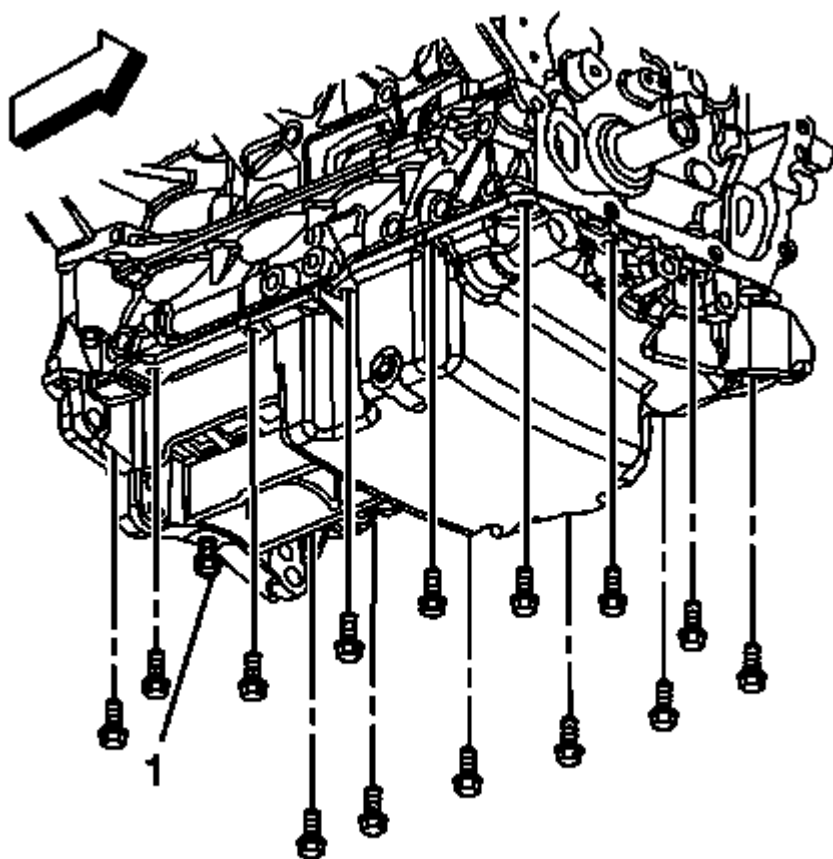


Fig. 202: Identifying Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the oil pan bolts (1).

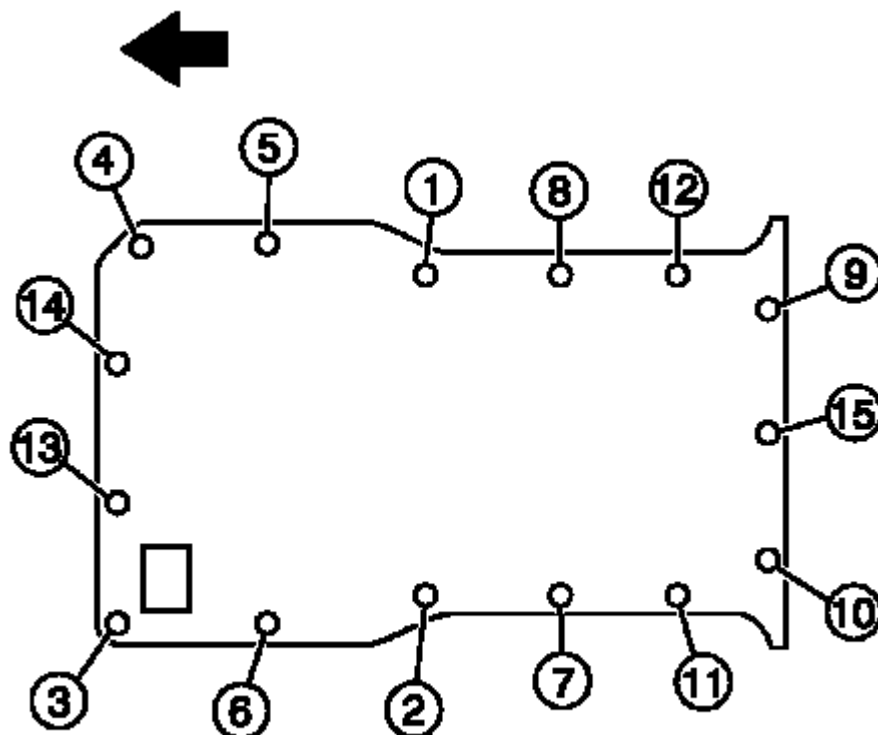


Fig. 203: Identifying Oil Pan Bolts Removal & Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

5. Tighten the oil pan bolts in the sequence shown.

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

6. Install the lower AC compressor bolt.

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

7. Ensure that the oil pan drain plug is tightened.

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

8. Install the engine drive belt. Refer to Drive Belt Replacement.

9. Lower the vehicle.

10. Fill the crankcase with oil.

PISTON, CONNECTING ROD, AND BEARING REPLACEMENT (LAF)

SPECIAL TOOLS

- **EN-47836** Piston Ring Compressor. See Special Tools .
- **J-43966-1** Connecting Rod Guides. See Special Tools .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

1. Remove the oil pan. Refer to Oil Pan Replacement.
2. Remove the cylinder head. Refer to Cylinder Head Replacement.

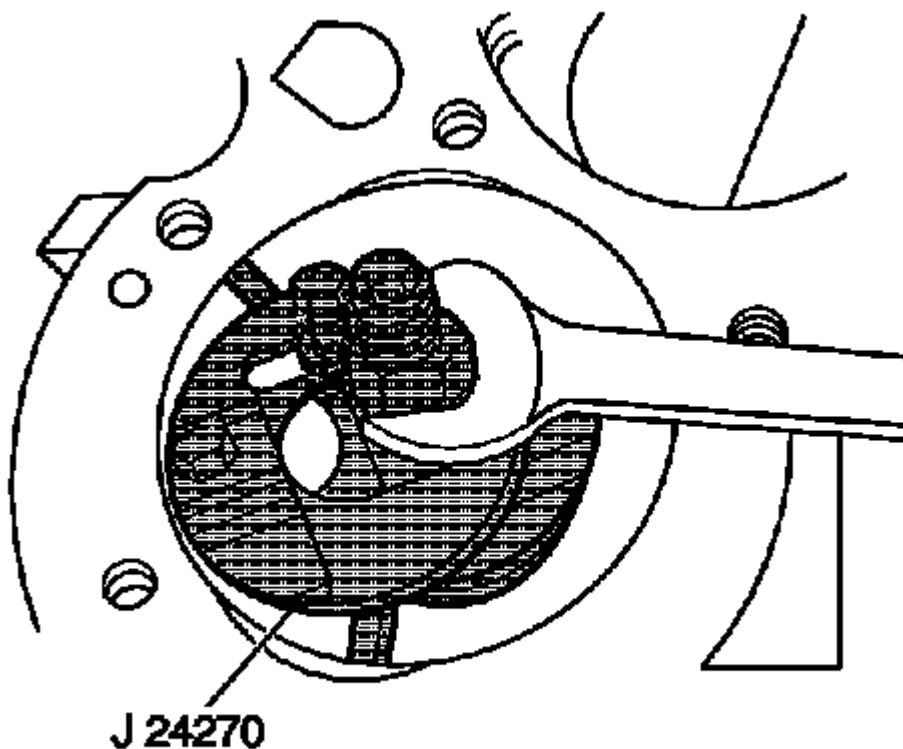


Fig. 204: View Of Removal Of Cylinder Bore Ring Ridge
Courtesy of GENERAL MOTORS CORP.

3. If a ring ridge is present, remove the ring ridge as follows:
 1. Turn the crankshaft until the piston is at the bottom of the stroke.
 2. Place a cloth on top of the piston.

3. Use a ridge reamer to remove the ring ridge.
4. Turn the crankshaft so the piston is at top of the stroke.
5. Remove the cloth and cutting debris.

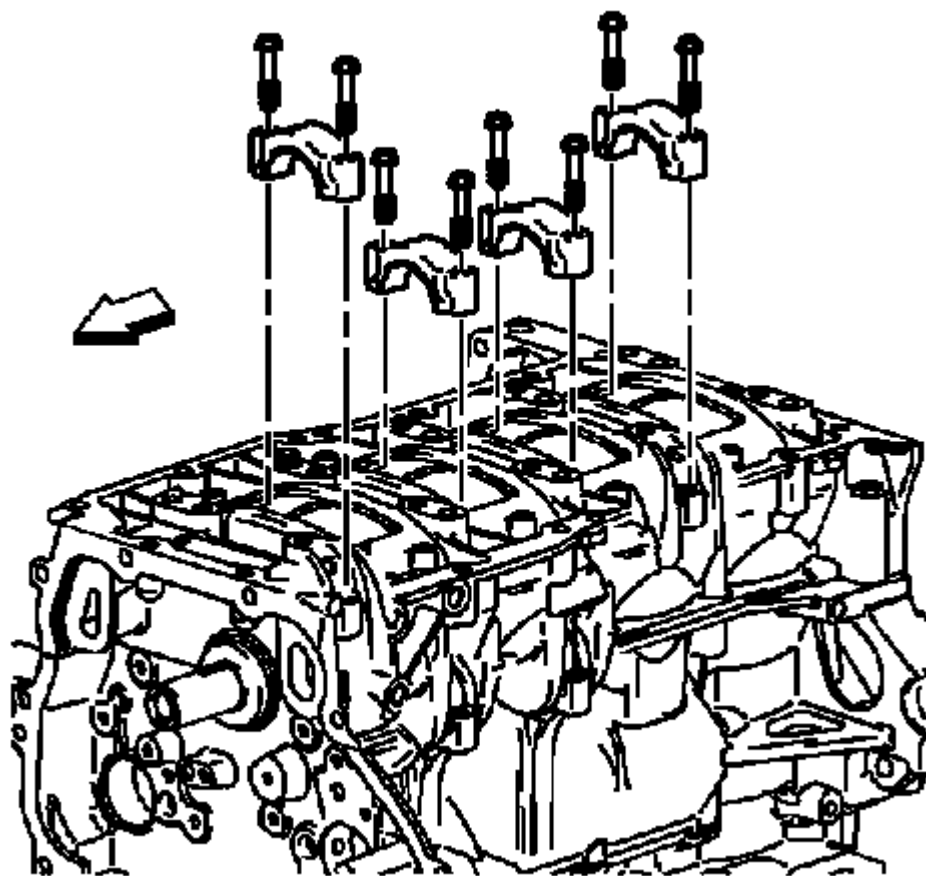


Fig. 205: View Of Connecting Rod Nuts & Caps
Courtesy of GENERAL MOTORS CORP.

NOTE: Place the numbers on connecting rods and the connecting rod caps. The connecting rod caps must be assembled to their original connecting rods.

4. Remove the connecting rod nuts and the connecting rod cap.

Discard the bolts and nuts.

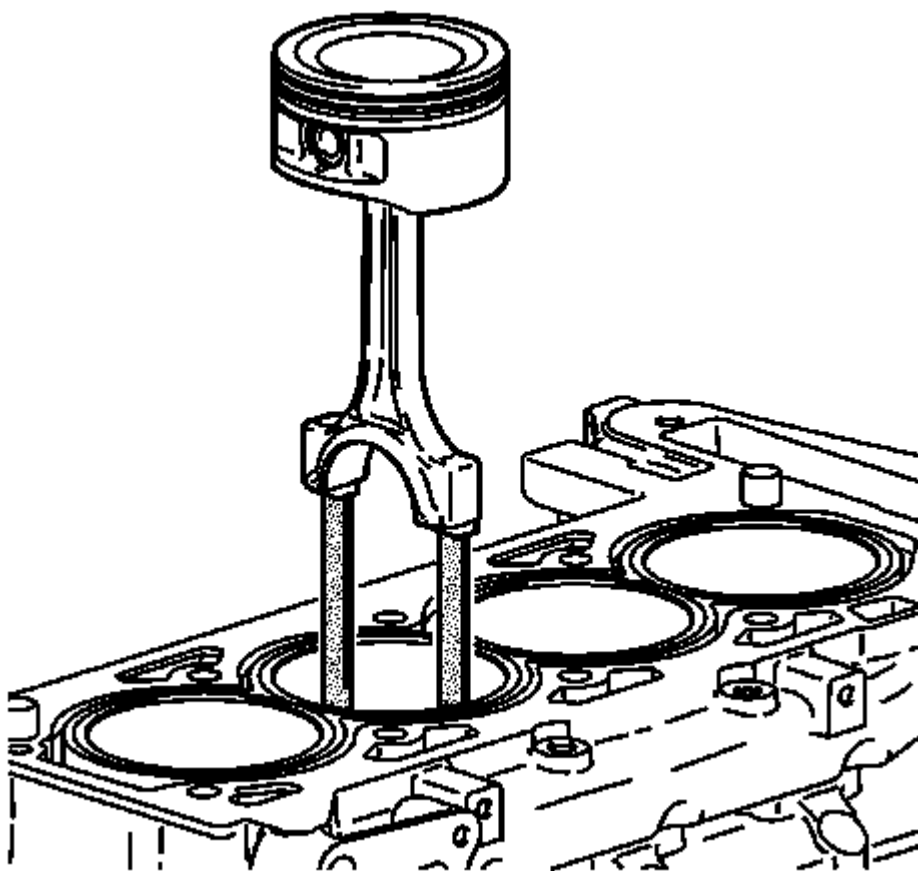


Fig. 206: View Of Special Tool J-43966-1 Installed In Connecting Rod Bolt Holes
 Courtesy of GENERAL MOTORS CORP.

5. Remove the connecting rod and the piston out of the top of the engine block using the **J-43966-1** . See **Special Tools** .
6. Clean the cylinder bores with hot water and detergent or with a light honing.
7. Swab the bores with the engine oil and a clean, dry cloth.

INSTALLATION PROCEDURE

1. Coat the following parts with engine oil:
 - The piston
 - The piston rings
 - The cylinder bore
 - The bearing surfaces

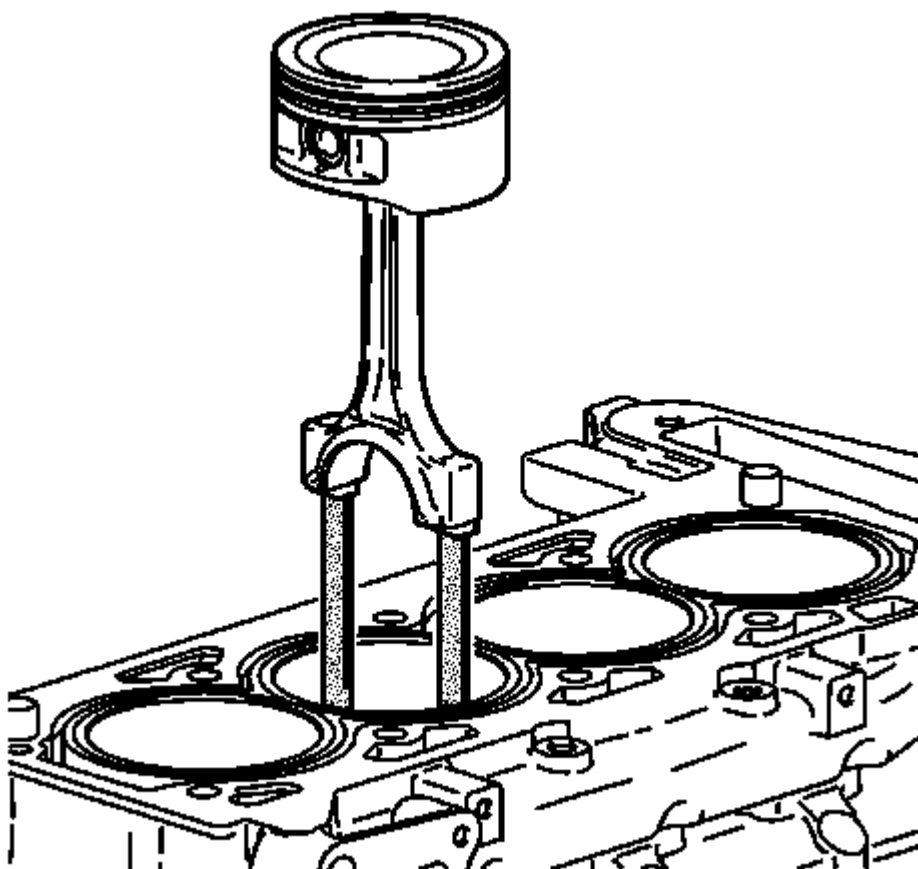


Fig. 207: View Of Special Tool J-43966-1 Installed In Connecting Rod Bolt Holes
Courtesy of GENERAL MOTORS CORP.

2. Install the piston into its original bore using the J-43966-1 . See Special Tools .

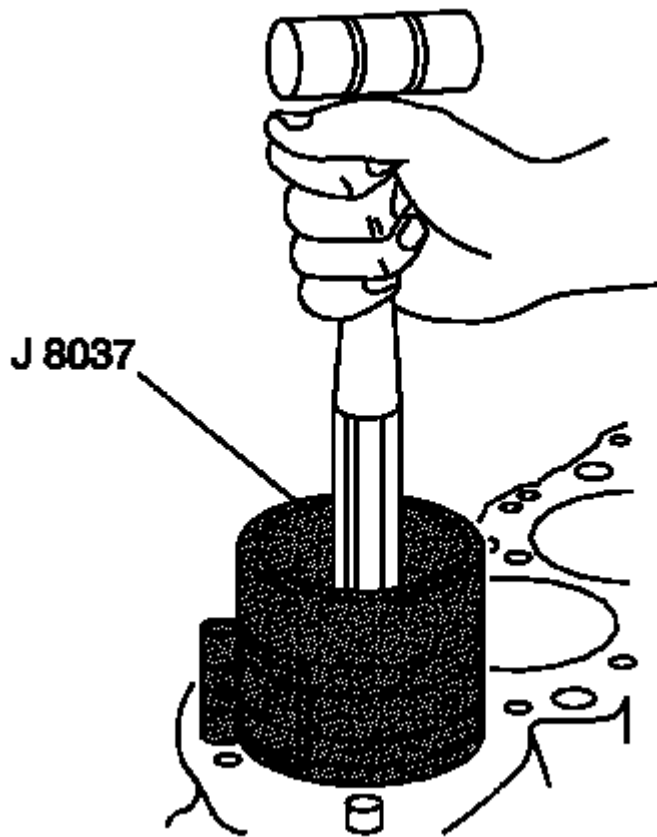


Fig. 208: View of Installing Piston & Connecting Rod Assembly Into Engine
Courtesy of GENERAL MOTORS CORP.

3. Lightly tap the top of the piston with a wooden hammer handle.
4. When installing the piston and the connecting rod, the stamped mark on the piston must point to the front of the engine.
5. Hold the **EN-47836** firmly against the engine block until all the piston rings have entered the cylinder bore. See **Special Tools**.
6. Install the connecting rod caps onto their original connecting rods.
7. Align the numbers placed on the connecting rod and the connecting rod cap during removal.

CAUTION: Refer to Fastener Caution.

8. Install the new connecting rod bolts and nuts.
 - On the first pass, tighten the nuts evenly to 25 N.m (18 lb ft).
 - On the final pass, use the **J 45059** in order to tighten the nuts an additional 100 degrees.

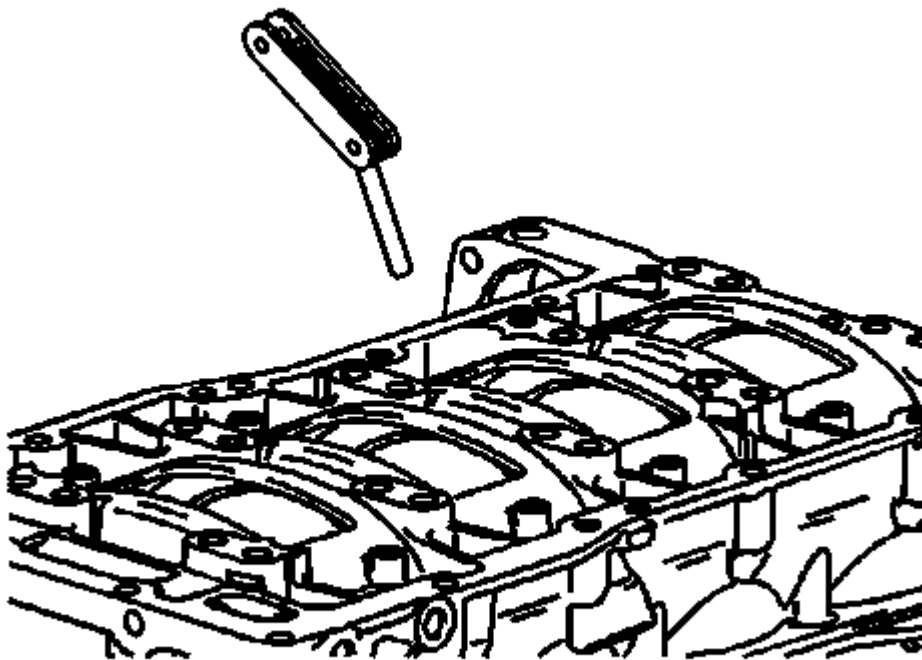


Fig. 209: Measuring Connecting Rod Side Clearance
Courtesy of GENERAL MOTORS CORP.

9. Measure the connecting rod side clearance with a feeler gauge.

The correct clearance is 0.070-0.370 mm (0.0027-0.0145 in).

10. Install the cylinder head. Refer to Cylinder Head Replacement.
11. Install the oil pan. Refer to Oil Pan Replacement.

CYLINDER SLEEVE REPLACEMENT

SPECIAL TOOLS

EN-45680-880 Cylinder Liner Removal and Installation Kit. See Special Tools .

REMOVAL PROCEDURE

CAUTION: Do not chill or heat the cylinder bore sleeve or the cylinder block when removing or installing a new cylinder bore sleeve. Chilling or heating the cylinder bore sleeve or the cylinder block will cause

engine damage and will not aid the removal or installation of the new cylinder bore sleeve.

CAUTION: Do not damage the crankshaft connecting rod journals or reluctor ring or engine damage will occur.

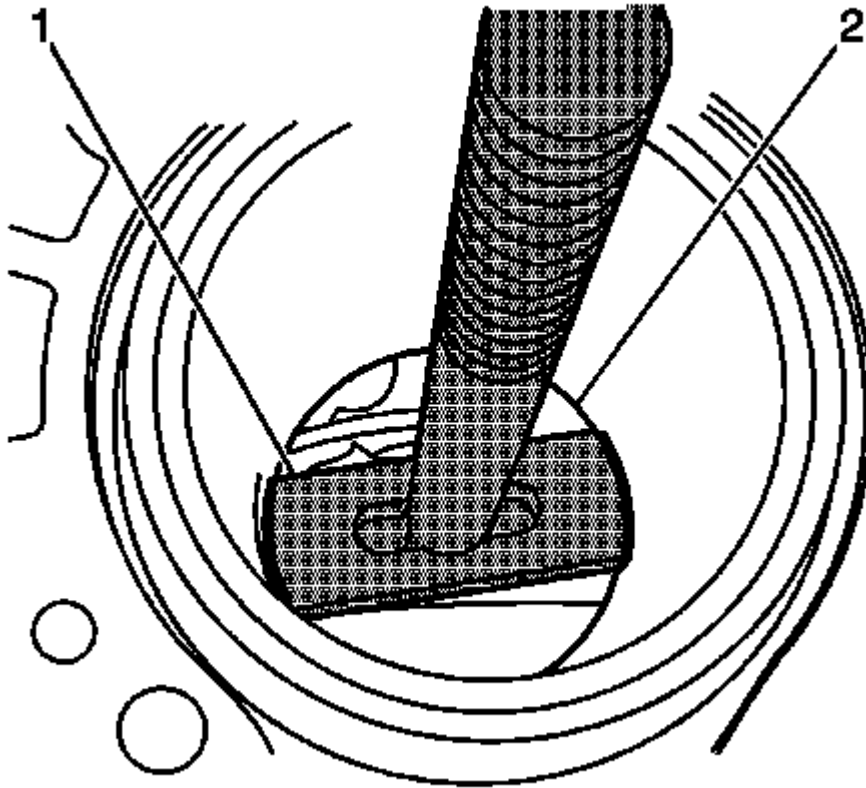


Fig. 210: View Of Cylinder Bore Sleeve Puller
Courtesy of GENERAL MOTORS CORP.

1. Remove the piston and connecting rod. Refer to **Piston, Connecting Rod, and Bearing Replacement (LAF)**.
2. Inspect the condition of the piston. Refer to **Piston, Connecting Rod, and Bearing Cleaning and Inspection**.
3. Rotate the crankshaft so that the counterweight is to the right side and the connecting rod journal is to the left side and not in alignment with the cylinder bore.
4. Install the EN 45680-882 cylinder bore sleeve puller (1) through the cylinder bore.

CAUTION: Ensure that the shoe is flat against the bottom of the cylinder bore sleeve or damage to the cylinder bore sleeve puller will occur.

5. Align the shoe (1) of the EN 45680-882 cylinder bore sleeve puller to the bottom of the cylinder bore sleeve (2).

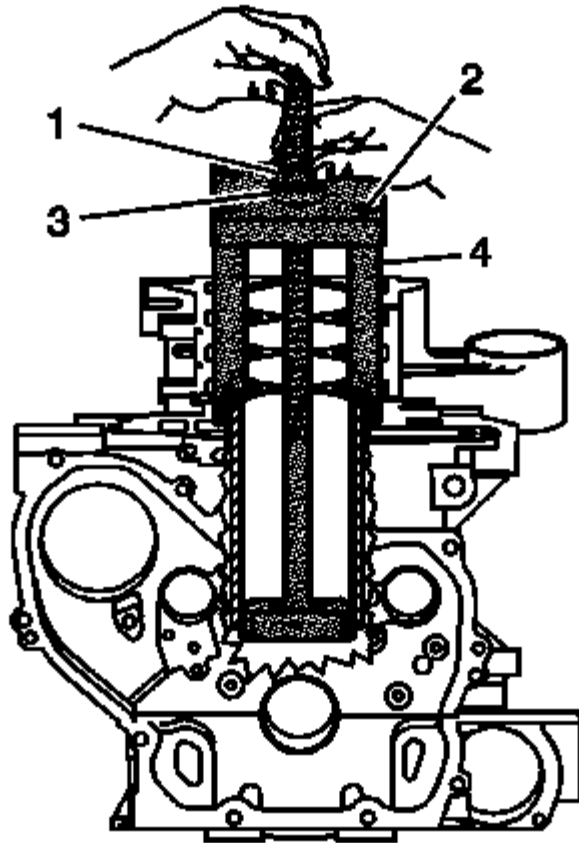


Fig. 211: Aligning Cylinder Bore Sleeve Puller
Courtesy of GENERAL MOTORS CORP.

6. Hold the threaded shaft of the EN 45680-882 cylinder bore sleeve puller upward in order to retain the shoe alignment to the bottom of the cylinder bore sleeve.
7. Install the EN 456850-881 fixture (4) onto the threaded shaft of the EN 456850-882 cylinder bore sleeve puller and the engine block.
8. Install the bearing (3) and the nut (1).
9. Tighten the nut (1) to the bearing (3).

CAUTION: Refer to Fastener Caution .

NOTE: Use 4 old cylinder head bolts for the attaching bolts.

10. Install the 4 attaching bolts (2) into the cylinder head bolt holes of the block and tighten to 15 N.m (11 lb ft).

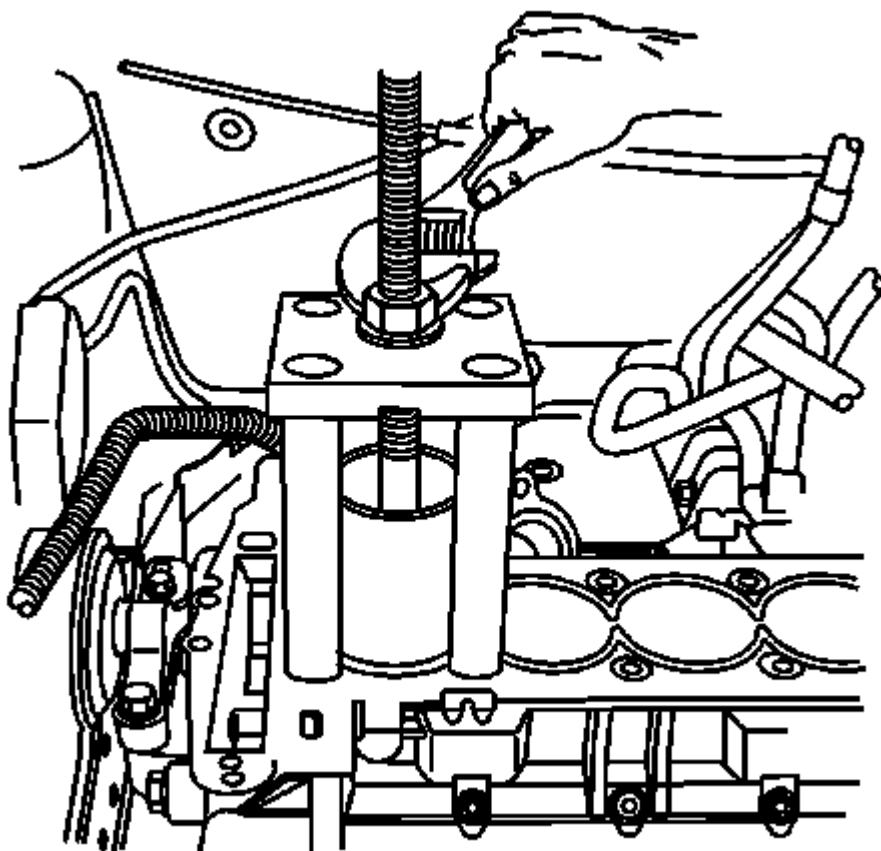


Fig. 212: Identifying Cylinder Bore Sleeve Puller Nut
Courtesy of GENERAL MOTORS CORP.

11. Rotate the nut clockwise in order to remove the cylinder bore liner.

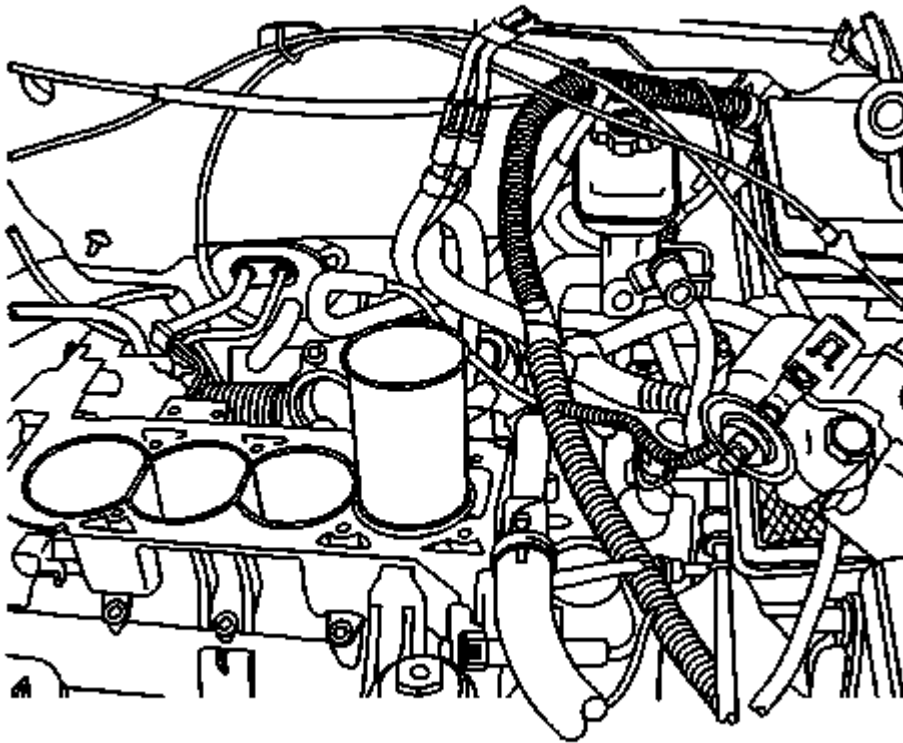


Fig. 213: View of Cylinder Bore Liner Sleeve
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not damage the cylinder block surface. Damage to the cylinder block surface can cause engine failure.

12. Remove EN 45680-881 fixture, EN 45680-882 cylinder bore sleeve puller, and the cylinder bore sleeve from the engine block.
13. Inspect the cylinder bore in the cylinder block for cracks or damage. If cracked or damaged, replace the cylinder block.

INSTALLATION PROCEDURE

CAUTION: Do not use assembly aids or lubricants on the cylinder bore sleeve or the cylinder bore block when installing a new cylinder bore sleeve, or engine damage will occur. These items will not aid in the installation of the new cylinder bore sleeve.

CAUTION: Do not chill or heat the cylinder bore sleeve or the cylinder block when removing or installing a new cylinder bore sleeve. Chilling or

heating the cylinder bore sleeve or the cylinder block will cause engine damage and will not aid the removal or installation of the new cylinder bore sleeve.

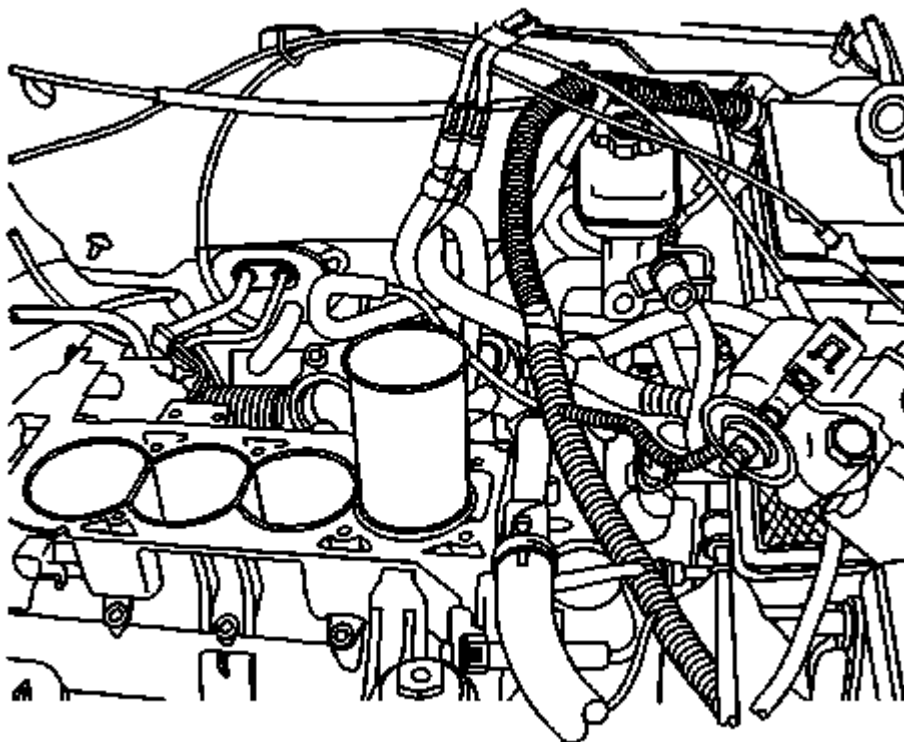


Fig. 214: View of Cylinder Bore Liner Sleeve
Courtesy of GENERAL MOTORS CORP.

1. Place the NEW cylinder bore sleeve onto the cylinder block.
2. Install EN 45680-881 fixture and EN 45680-883 cylinder bore sleeve installer assembly over the cylinder bore sleeve and onto the cylinder block. Do not apply downward pressure to the cylinder bore sleeve.

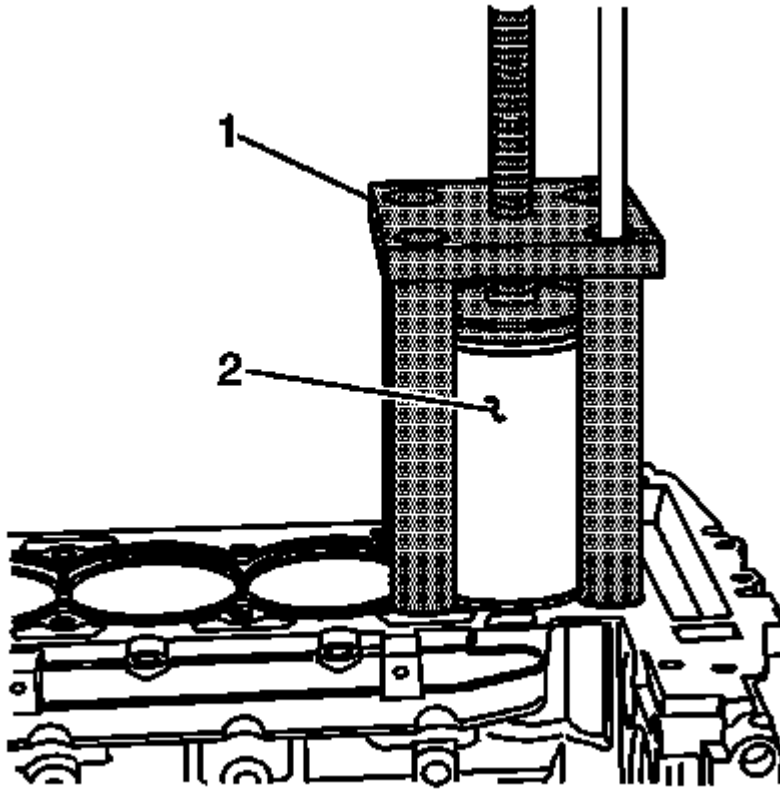


Fig. 215: View Of Cylinder Bore Sleeve Installer
Courtesy of GENERAL MOTORS CORP.

NOTE: Use 4 old cylinder head bolts for the attaching bolts.

3. Insert the 4 attachment bolts into the legs of the EN 45680-881 fixture (1). Do not apply downward pressure to the cylinder bore sleeve (2). Tighten the 4 attachment bolts to 15 N.m (11 lb ft).

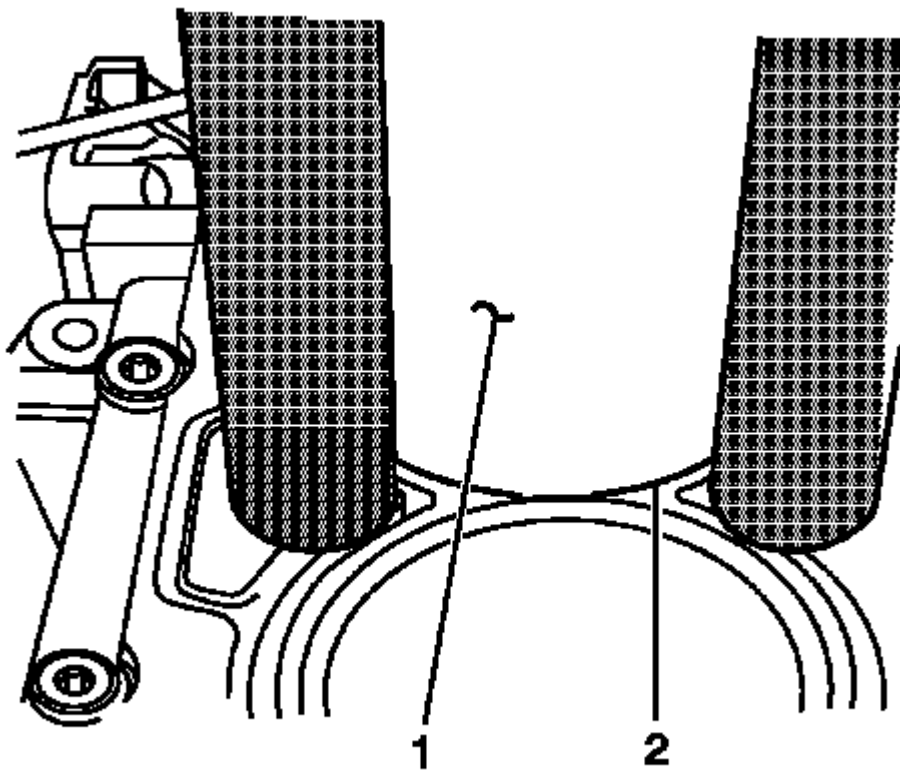


Fig. 216: View of Cylinder Bore Sleeve Alignment
Courtesy of GENERAL MOTORS CORP.

4. Align the bottom of the cylinder bore sleeve (1) with the cylinder bore of the block (2).

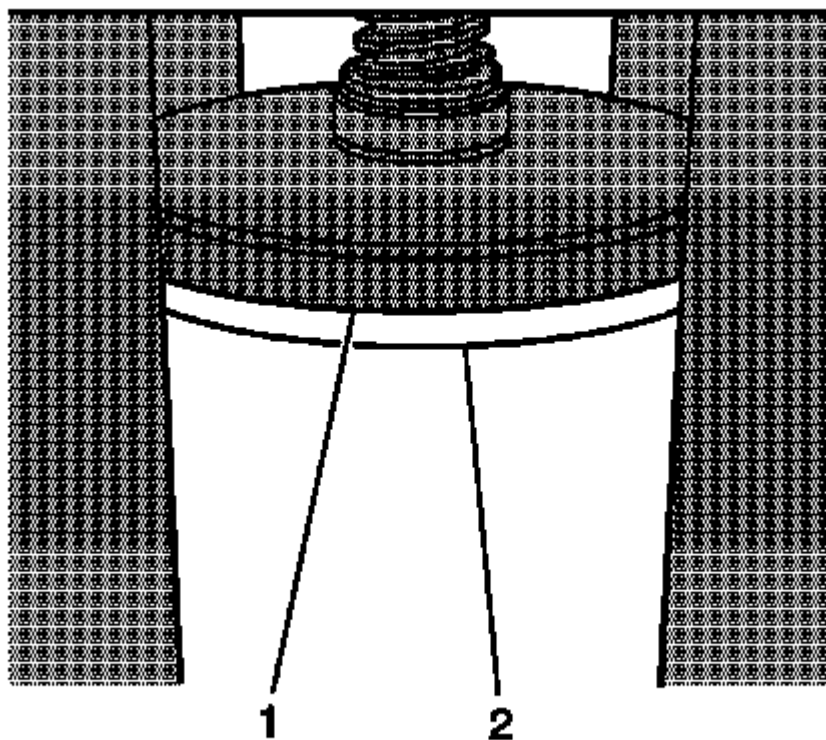


Fig. 217: View of Installation Arbor
Courtesy of GENERAL MOTORS CORP.

5. Align the installation arbor (1) onto the top of the cylinder bore sleeve (2).

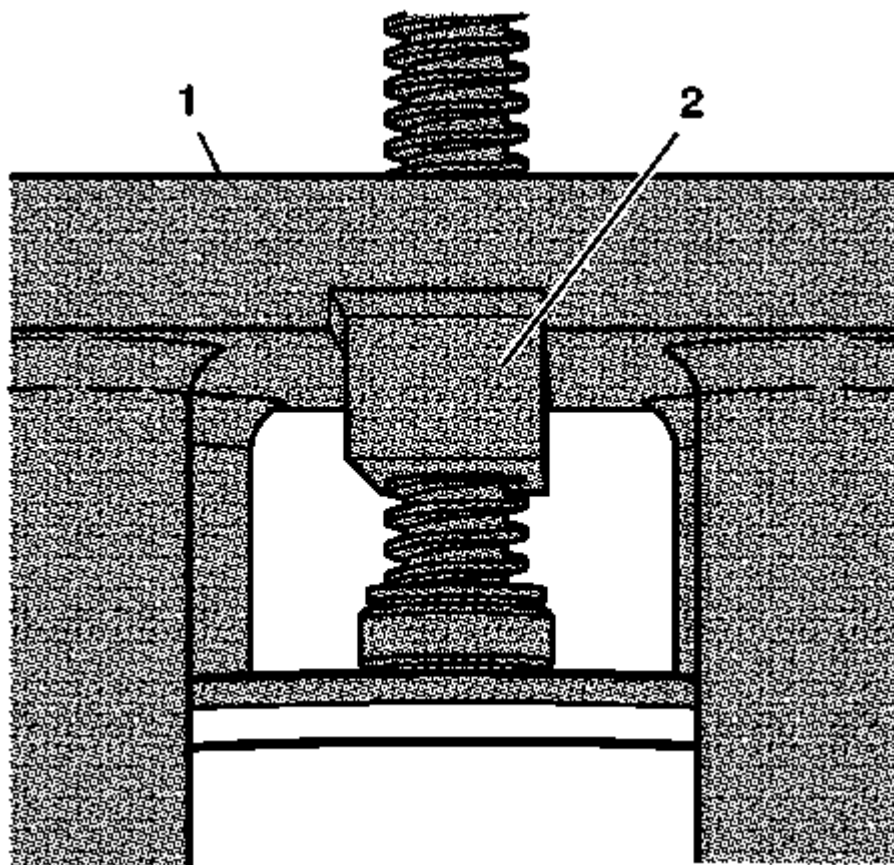


Fig. 218: View Of Pusher Block

Courtesy of GENERAL MOTORS CORP.

6. Align the pusher block (2) of EN 45680-883 cylinder bore sleeve installer into the groove of EN 45680-881 fixture (1).

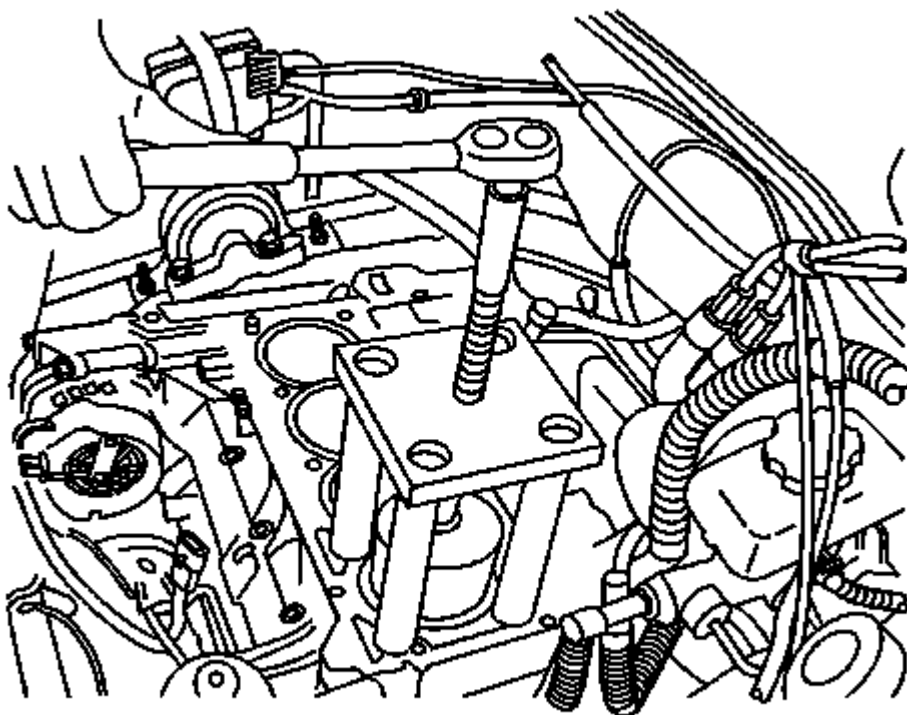


Fig. 219: View Of Cylinder Bore Sleeve Installer Assembly
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not use any air powered or electric tools to rotate the threaded shaft of the cylinder bore sleeve installer in the fixture assembly or damage to the cylinder bore sleeve will occur.

7. Using a ratchet, rotate the threaded shaft of EN 45680-88 fixture and EN 45680-883 cylinder bore sleeve installer assembly in order to install the cylinder bore sleeve into the engine block.
8. Do not completely seat the cylinder bore sleeve in the block. Leave approximately 1.60 mm (1/16 inch) of the cylinder bore sleeve above the surface of the cylinder block.

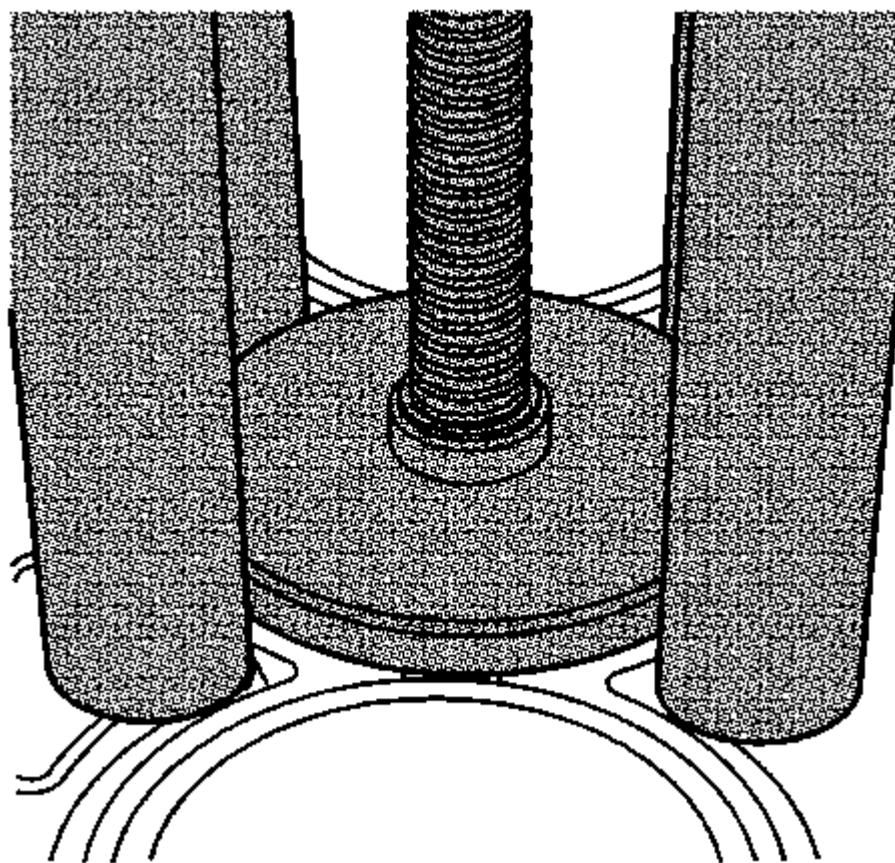


Fig. 220: Seating Cylinder Bore Sleeve Completely Using Tool
Courtesy of GENERAL MOTORS CORP.

9. Using a torque wrench, tighten the threaded shaft of the EN 45680-881 fixture and EN 45680-883 cylinder bore sleeve installer assembly to 102 N.m (75 lb ft) in order to completely seat the cylinder bore sleeve in the cylinder block. With the cylinder bore sleeve properly installed, a minimal portion of the cylinder bore liner flange will protrude above the block deck surface.

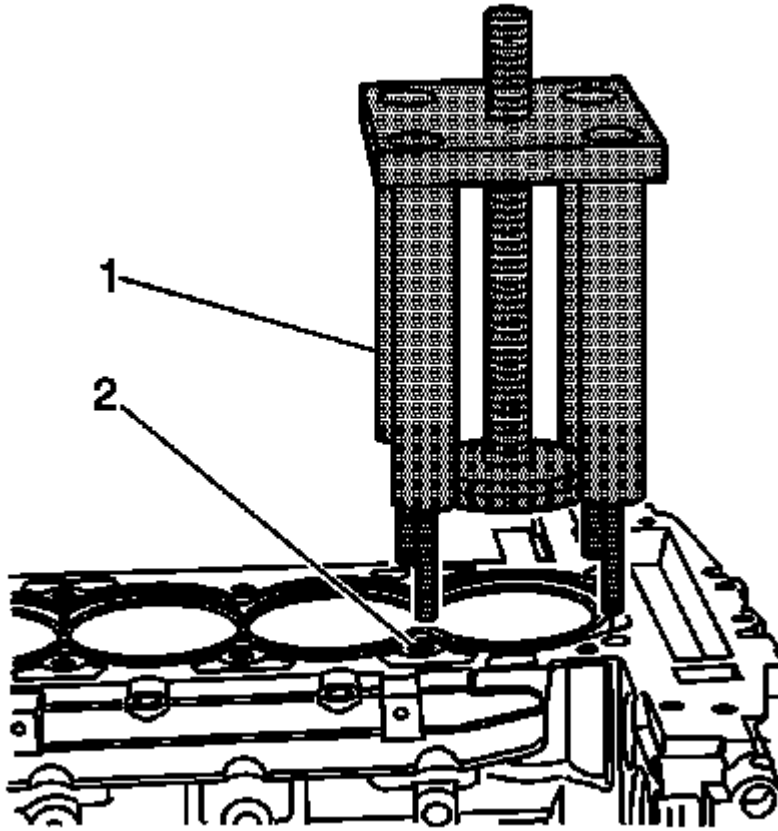


Fig. 221: Identifying Cylinder Bore Sleeve Installer Assembly
Courtesy of GENERAL MOTORS CORP.

10. Remove the EN 45680-881 fixture and EN 45680-883 cylinder bore sleeve installer assembly (1) from the cylinder block (2).

CYLINDER LINER TRIMMING

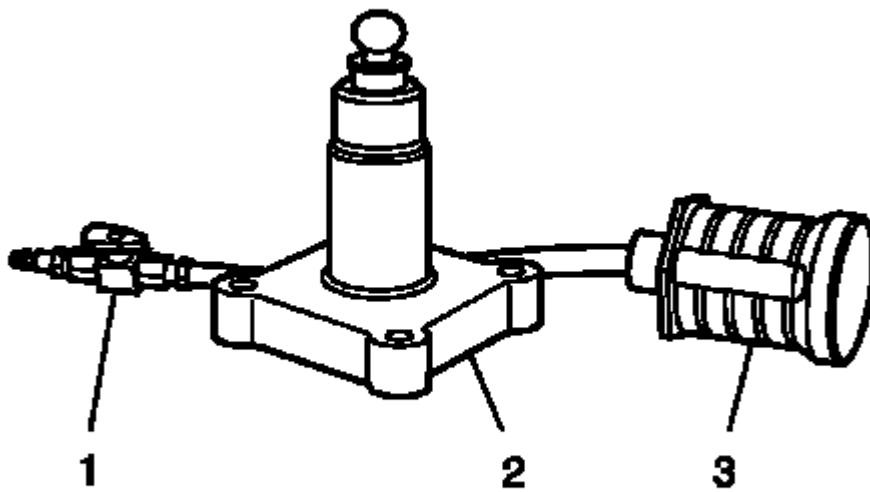


Fig. 222: Identifying Cylinder Liner Trimming Tool Components (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

- EN 45680-885 Debris Collector (3)
- EN 45680-881 Trim Tool Assembly (2)
- Air Control Valve (1)
- Drill Motor with 1/2 inch chuck, 1 1/8 hp, 7 amps, triple gear reduction, and a 450-600 RPM rotational speed in a clockwise direction

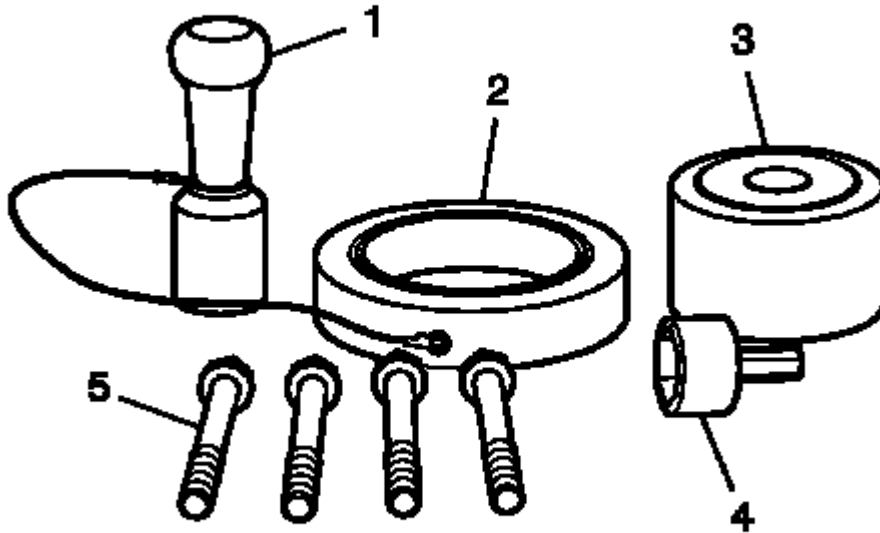


Fig. 223: Identifying Cylinder Liner Trimming Tool Components (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

- Trim Tool Preloader (1)
- EN 45680-882 Set Gauge Ring (2)
- EN 45680-883 Metal Shavings Catch Plug (3)
- EN 45680-886 Drive Adapter (4)
- EN 45680-884 Bolts (5)

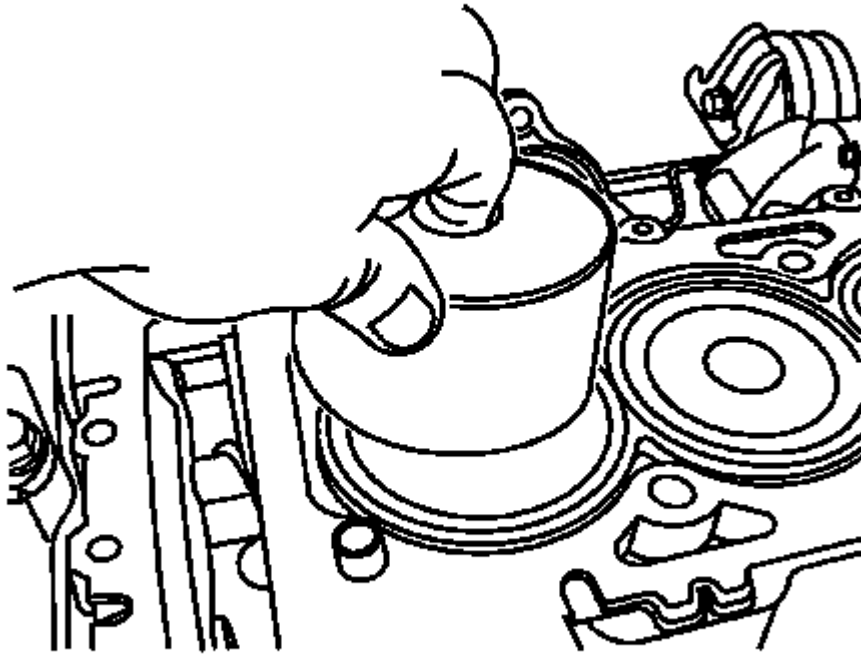


Fig. 224: View Of Metal Shaving Catch Plug
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not bore or hone the cylinder bore sleeve. The cylinder bore sleeve inside diameter (I.D) is fully machined and honed to size and is optimally finished as shipped. Any attempt to modify this factory-produced sizing and finish with additional boring and honing will lead to engine damage, excessive noise or abnormal oil consumption.

1. After installing the NEW cylinder bore sleeve(s) into the engine block, trim the excess material from the cylinder bore sleeve flange.

CAUTION: Ensure that all the metal particles are collected in order to prevent internal damage to the engine or bearings.

2. Place the EN 45680-883 metal shaving catch plug into the cylinder bore sleeve to be trimmed. Position the top of the EN 45680-883 approximately 3.0 mm (0.12 in) below the top surface of the cylinder bore sleeve.
3. Place additional EN 45680-883 metal shaving catch plugs into all remaining cylinder bore sleeves.

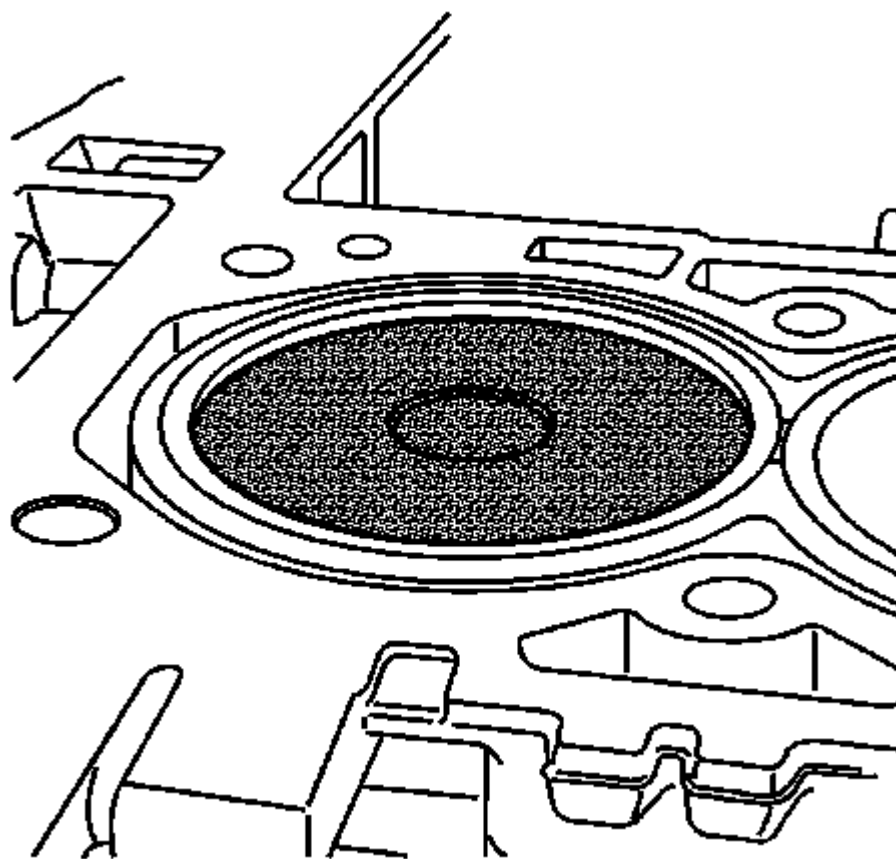


Fig. 225: Identifying Catch Plug Positioning
Courtesy of GENERAL MOTORS CORP.

CAUTION: Installing the metal shaving catch plug deeper than the recommended depth will create a decrease in vacuum system performance. A decrease in vacuum system performance will cause metal shavings to enter the engine and cause engine failure.

CAUTION: Installing the metal shaving catch plug above the recommended depth will cause damage to the metal shaving catch plug.

4. Ensure that the EN 45680-883 metal shaving catch plug is 3.0 mm (0.12 in) below the top surface of the cylinder bore sleeve.

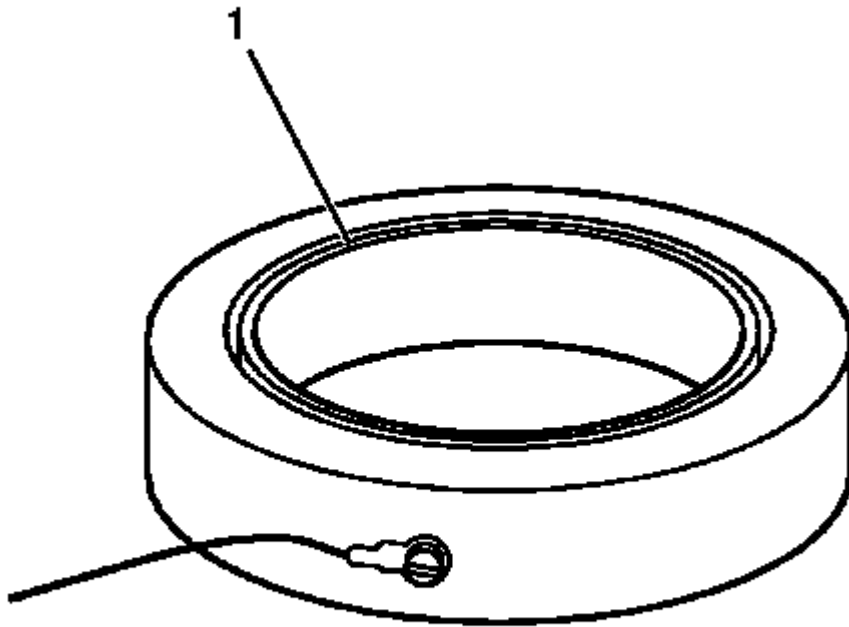


Fig. 226: Identifying Set Gauge Ring Groove
Courtesy of GENERAL MOTORS CORP.

NOTE: Before using EN 45680-881 trim tool assembly, the height of the cutting blades must be set to the proper specification. The proper specification is that the cylinder bore sleeve flange must be flush to $+0.02$ mm (0.0008 in) above the block deck surface.

5. The groove side of the EN 45680-882 set gauge ring (1) should be positioned upward on a flat surface.

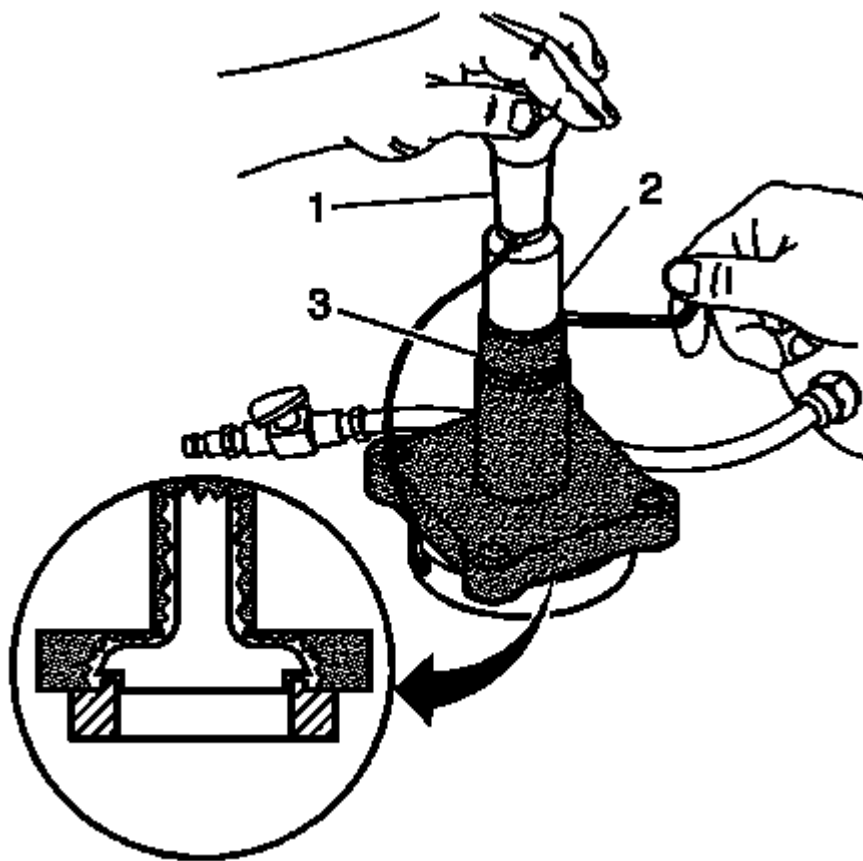


Fig. 227: View Of Trim Tool Assembly Components & Positioning
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the EN 45680-882 set gauge ring surfaces are clean.

6. Carefully position EN 45680-881 trim tool assembly onto the EN 45680-882 set gauge ring.
7. Loosen the shaft collar screw (2).
8. Push the shaft collar (2) downward using the trim tool preloader (1) until the shaft collar is positioned against the top of the flange bearing (3).

NOTE: Once this procedure is done, it is not necessary to reset the EN 45680-881 trim tool assembly height until the blades are worn or damaged.

9. Apply downward pressure on the collar and inner drive shaft using the trim tool preloader (1), then tighten the shaft collar screw to 19 N.m (14 lb ft).

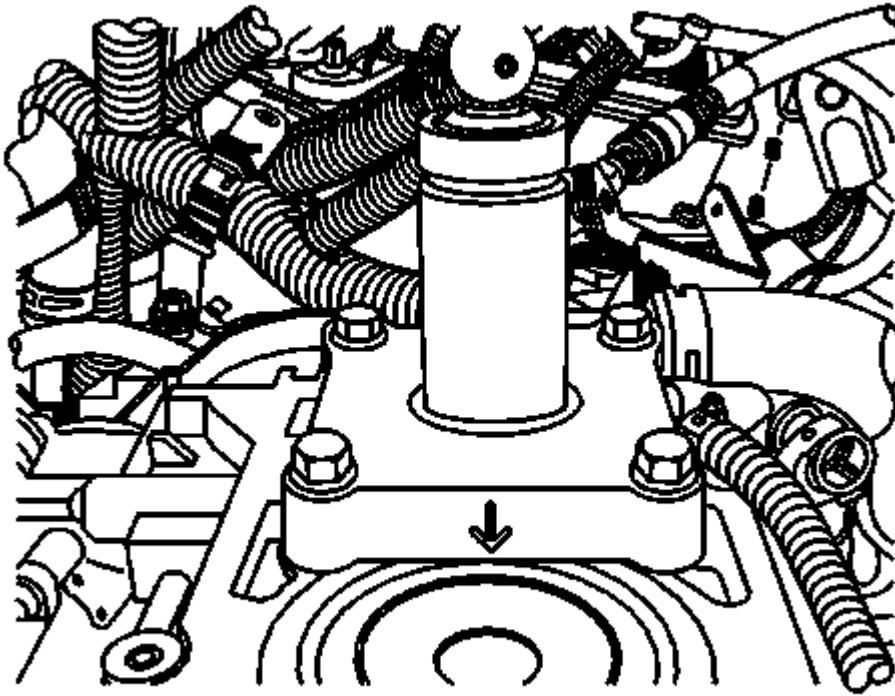


Fig. 228: Aligning Trim Tool Assembly
Courtesy of GENERAL MOTORS CORP.

10. Place the EN 45680-881 trim tool assembly onto the cylinder to be trimmed with the directional arrow pointing in line with the crankshaft centerline and the front of the block.
11. Install the EN 45680-884 4 bolts into the cylinder head bolt holes in the block and tighten to 20 N.m (15 lb ft).

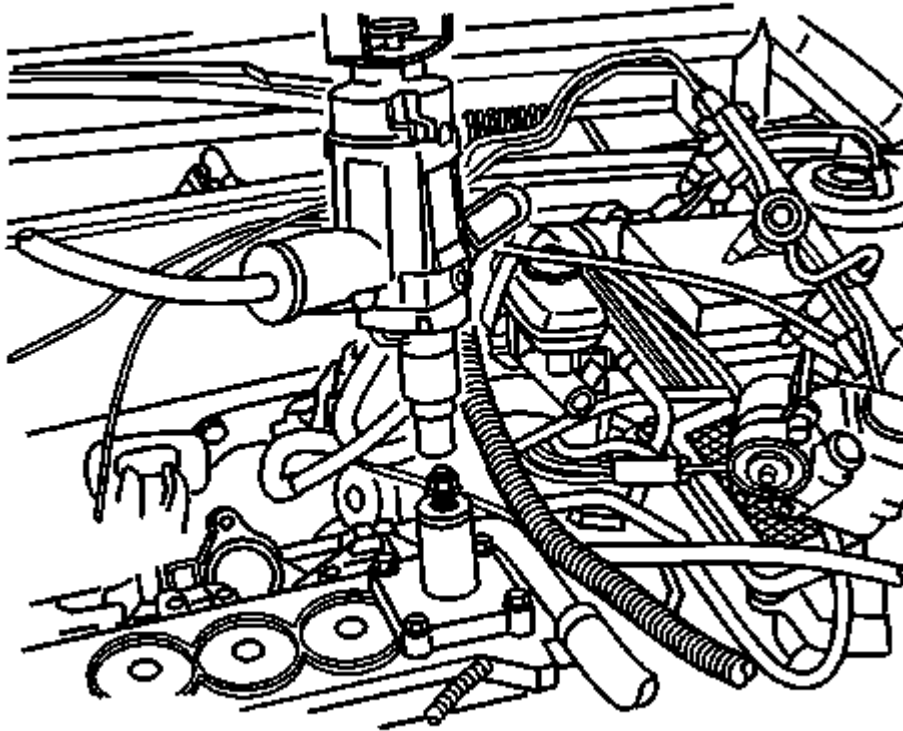


Fig. 229: Identifying Special Tool EN 45680-886
Courtesy of GENERAL MOTORS CORP.

CAUTION: For proper tool operation, a drill motor with a 1/2 inch chuck, 1 1/8 hp, 7 amps, triple gear reduction, and a 450-600 RPM rotational speed in a clockwise direction must be used. If the proper drill motor is not used, damage to the cylinder bore sleeve will occur.

12. Fasten the drive adapter EN 45680-886 into the drill chuck.

CAUTION: Ensure that there are no crimps in the air feed hose or the vacuum hose. Crimps in the hose may cause metal shavings to exit the cutting tool in any direction, causing engine damage.

13. Connect a compressed air supply (75-125 psi) to the male quick connect located on EN 45680-881 trim tool assembly. Turn the compressed air valve to the open position. This starts the venturi vacuum system that will catch the metal shavings.
14. Place the EN 45680-886 drive adapter and the drill assembly vertically onto the EN 45680-881 drive adapter end of trim tool assembly. Do not apply downward force on the drill until full rotational speed has been reached. After reaching full rotational speed, gradually apply downward force until the cutting action is complete in approximately 5 seconds.

15. Remove the EN 45680-886 drive adapter (1) and the drill assembly from the EN 45680-881 trim tool assembly.
16. Turn OFF the compressed air valve.
17. Remove the EN 45680-881 trim tool assembly from the engine block.
18. Wipe the cylinder bore sleeve and the surrounding areas of any powder residue. Remove the EN 45680-883 metal shaving catch plug.

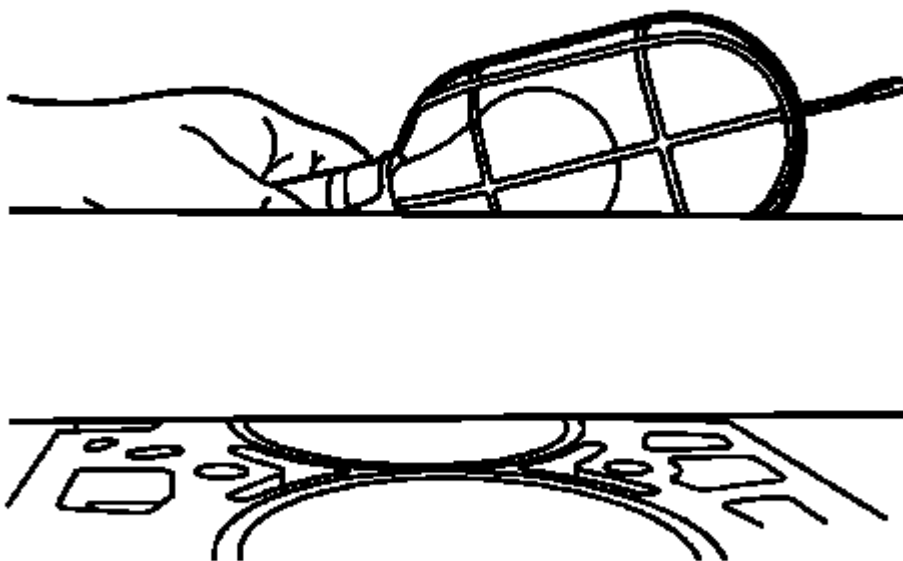


Fig. 230: Checking Cylinder Block Deck Surface With Straight Edge
Courtesy of GENERAL MOTORS CORP.

19. Install a straight edge on the cylinder block perpendicular to the crankshaft centerline.
20. Using a light, illuminate the backside of the straight edge.

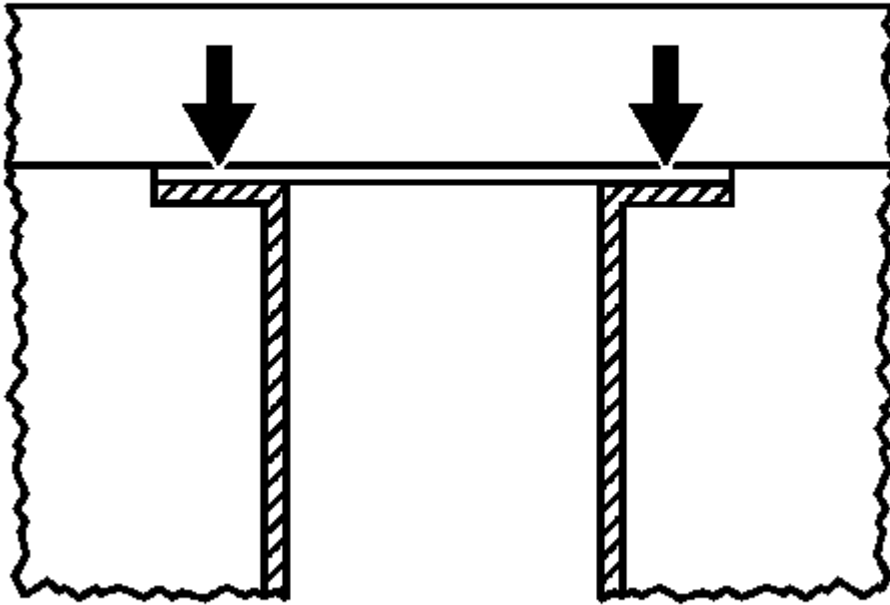


Fig. 231: View Of Improperly Cut Cylinder Bore Sleeve
Courtesy of GENERAL MOTORS CORP.

21. Looking at the front of the straight edge, inspect to see if light is protruding through the bottom of the straight edge and the top of the cylinder bore sleeve flange. If light is present on either side of both sides of the cylinder bore sleeve, the cylinder bore sleeve is cut incorrectly and a new cylinder bore sleeve needs to be installed.

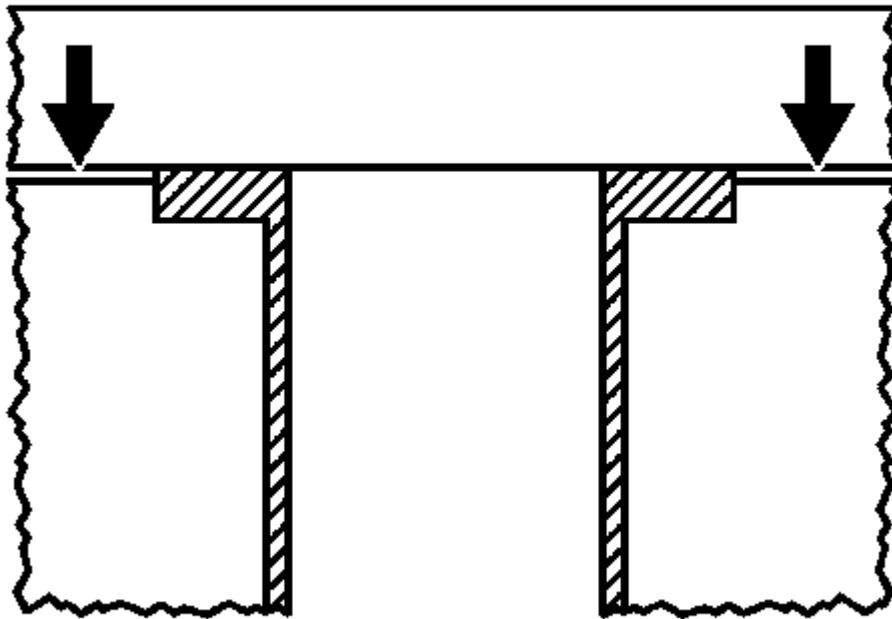


Fig. 232: View Of For Properly Cut Cylinder Bore Sleeve
Courtesy of GENERAL MOTORS CORP.

22. Looking at the front of the straight edge, inspect to see if light is protruding through the bottom of the straight edge and the top of the cylinder block deck surface. If light is present on both sides of the cylinder block, the cylinder bore sleeve is cut correctly.
23. Proceed to the next bore sleeve to be trimmed, repeating steps 10-19 if necessary.
24. Install the piston and the connecting rod. Refer to **Piston, Connecting Rod, and Bearing Replacement (LAF)**.

ENGINE FLYWHEEL REPLACEMENT

SPECIAL TOOLS

- **J 38122-A** Crankshaft Balancer Holder. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

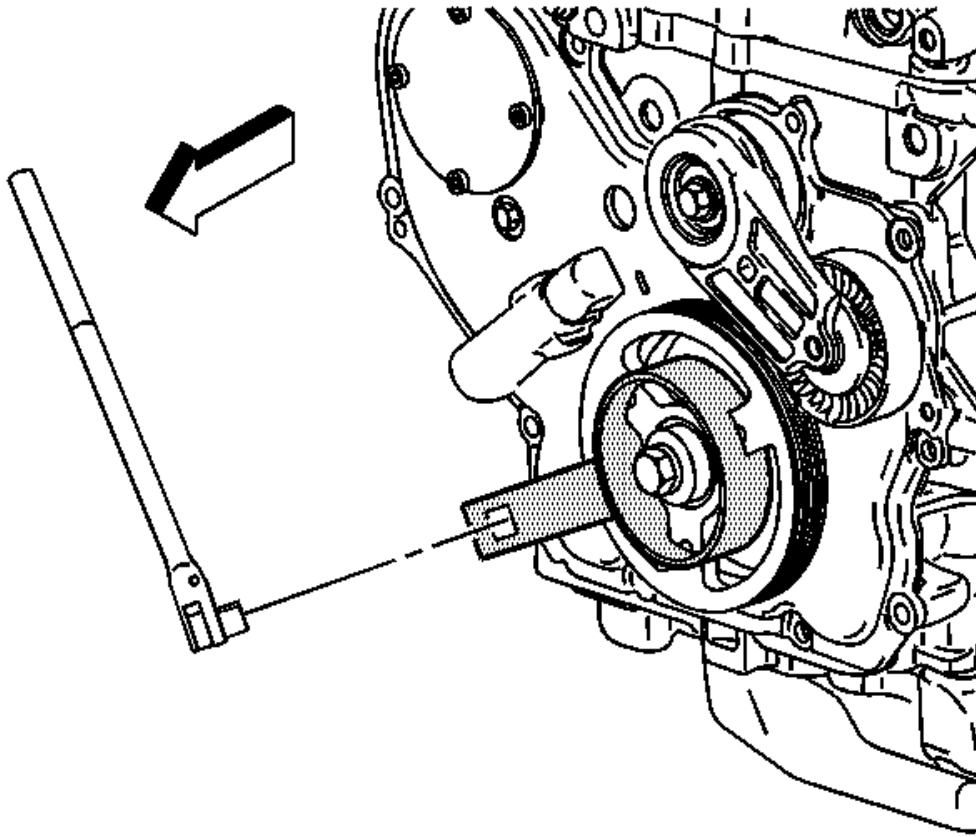


Fig. 233: View Of Harmonic Balancer Holder J38122-A
Courtesy of GENERAL MOTORS CORP.

1. Remove the transmission. Refer to **Transmission Replacement (2.4L (LE5) W/MN5)** .
2. Using the **J 38122-A** , hold the crankshaft balancer. See **Special Tools** .

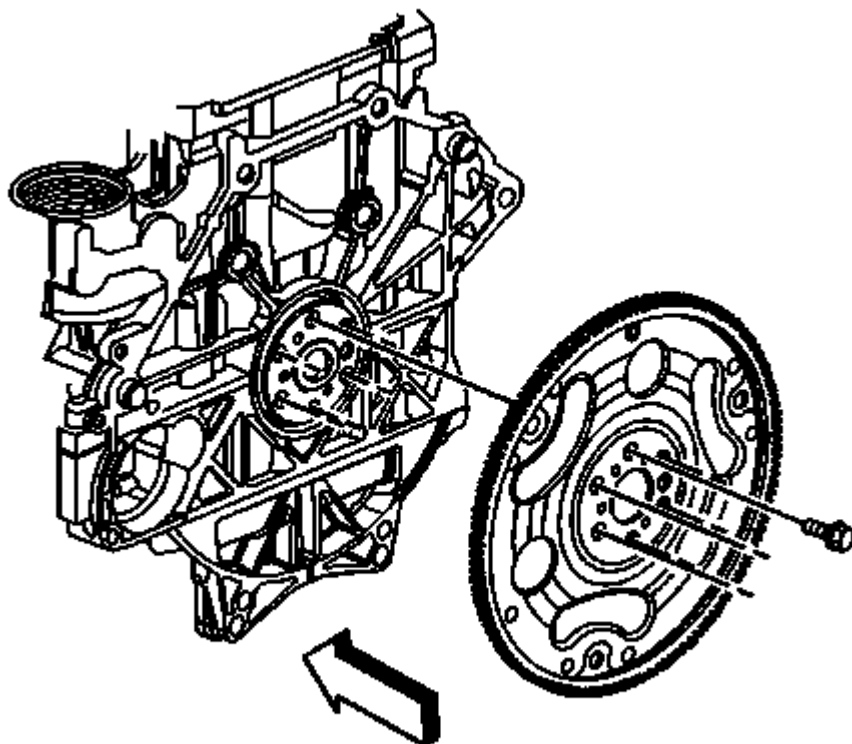


Fig. 234: View Of Flywheel (Automatic Transaxle)
Courtesy of GENERAL MOTORS CORP.

NOTE: It may be necessary to remove the chamfer (bevel) from the edge of an 18 mm socket in order to get full engagement on the thin-headed flywheel bolts.

3. Remove the flywheel bolts.

NOTE: Do not orientate the flywheel to the crankshaft. It is balanced separately from the engine.

4. Remove the flywheel.
5. Clean the thread adhesive from the flywheel bolt holes. Use a nylon bristle brush to clean the holes in the crankshaft.

INSTALLATION PROCEDURE

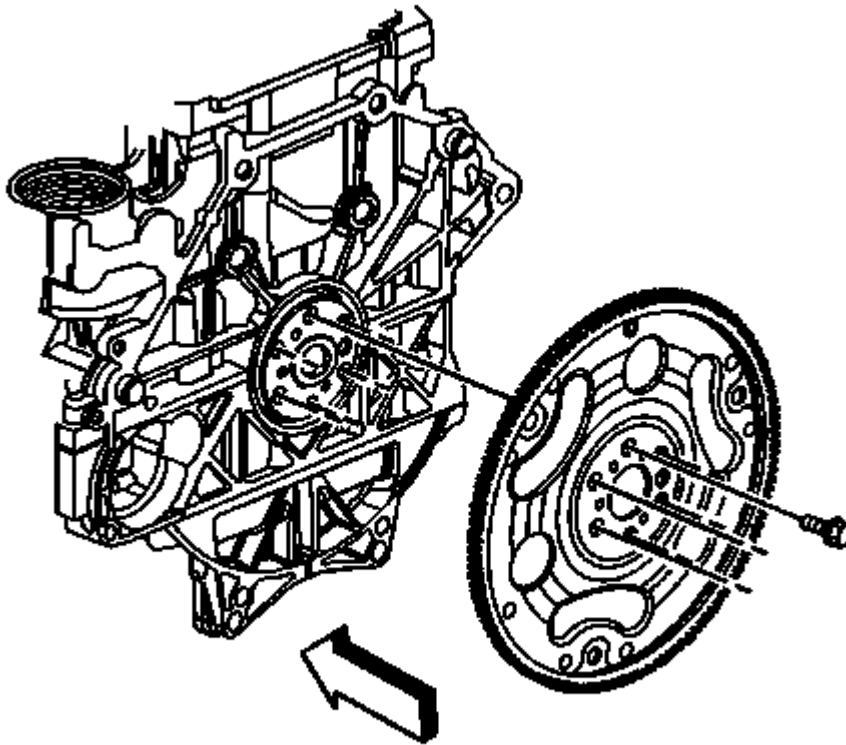


Fig. 235: View Of Flywheel (Automatic Transaxle)
Courtesy of GENERAL MOTORS CORP.

1. Install the flywheel.

CAUTION: Refer to Fastener Caution .

2. Install the flywheel bolts.

Tighten: Tighten the bolts to 53 N.m (39 lb ft) plus an additional 25 degrees using the **J 45059** .

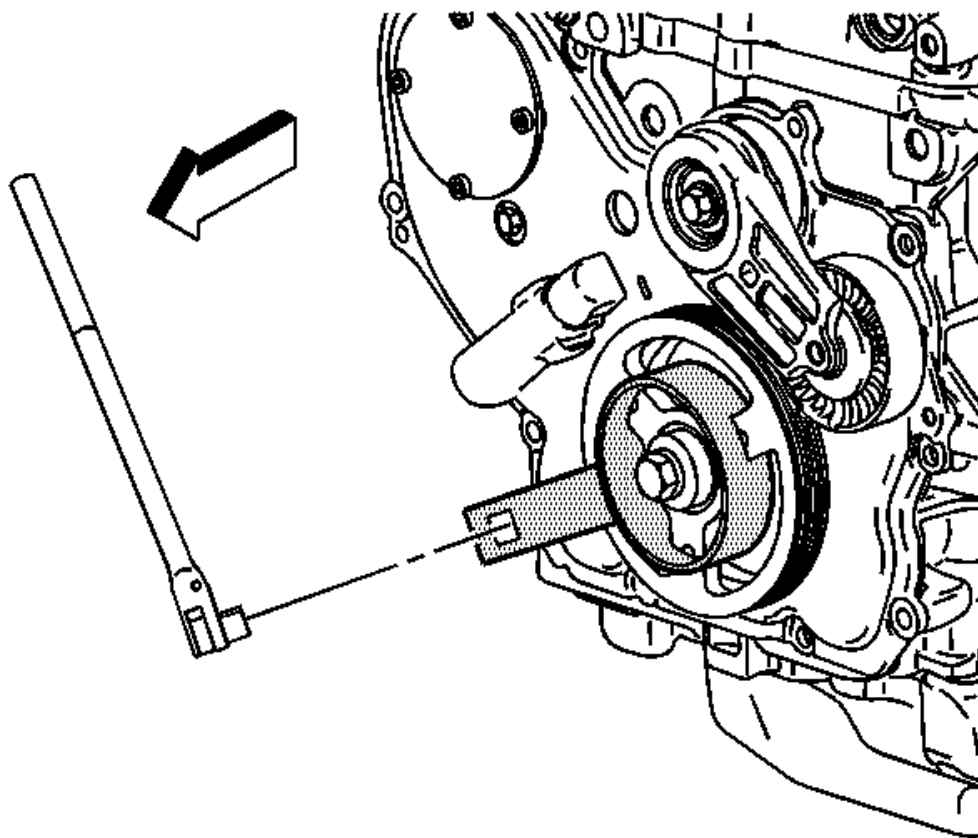


Fig. 236: View Of Harmonic Balancer Holder J38122-A
Courtesy of GENERAL MOTORS CORP.

3. Remove the **J 38122-A** . See Special Tools .
4. Install the transmission. Refer to Transmission Replacement (2.4L (LE5) W/MN5) .

CRANKSHAFT REAR OIL SEAL REPLACEMENT

SPECIAL TOOLS

J 42067 Rear Main Seal Installer. See Special Tools .

REMOVAL PROCEDURE

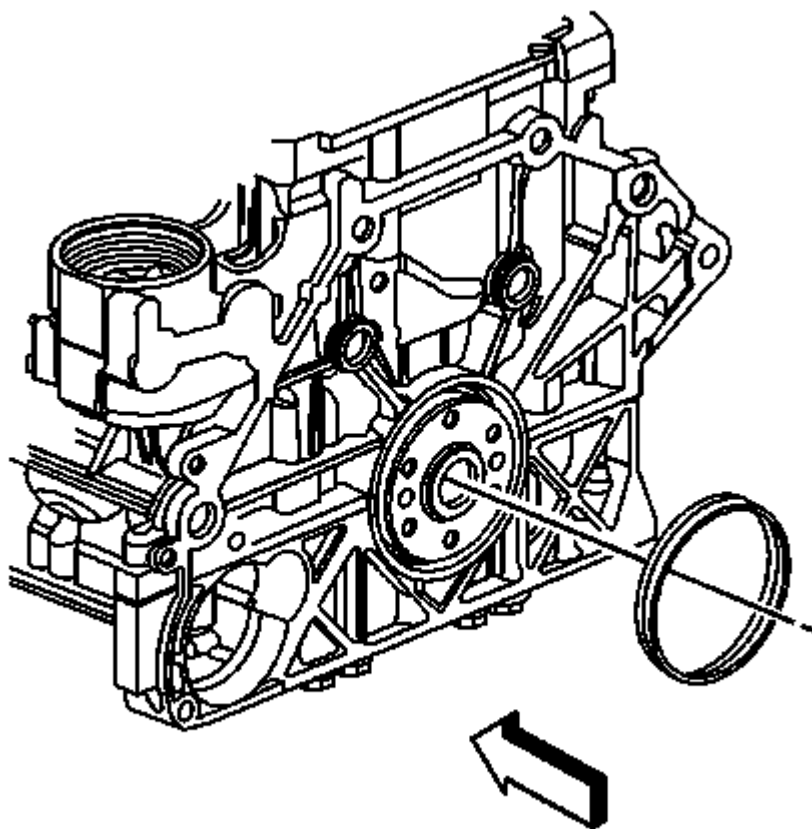


Fig. 237: Identifying Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the flywheel. Refer to **Engine Flywheel Replacement**.

IMPORTANT: Do not damage the outside diameter of the crankshaft or chamber with any tool.

2. Pry out the crankshaft rear oil seal using a flat-bladed tool.

INSTALLATION PROCEDURE

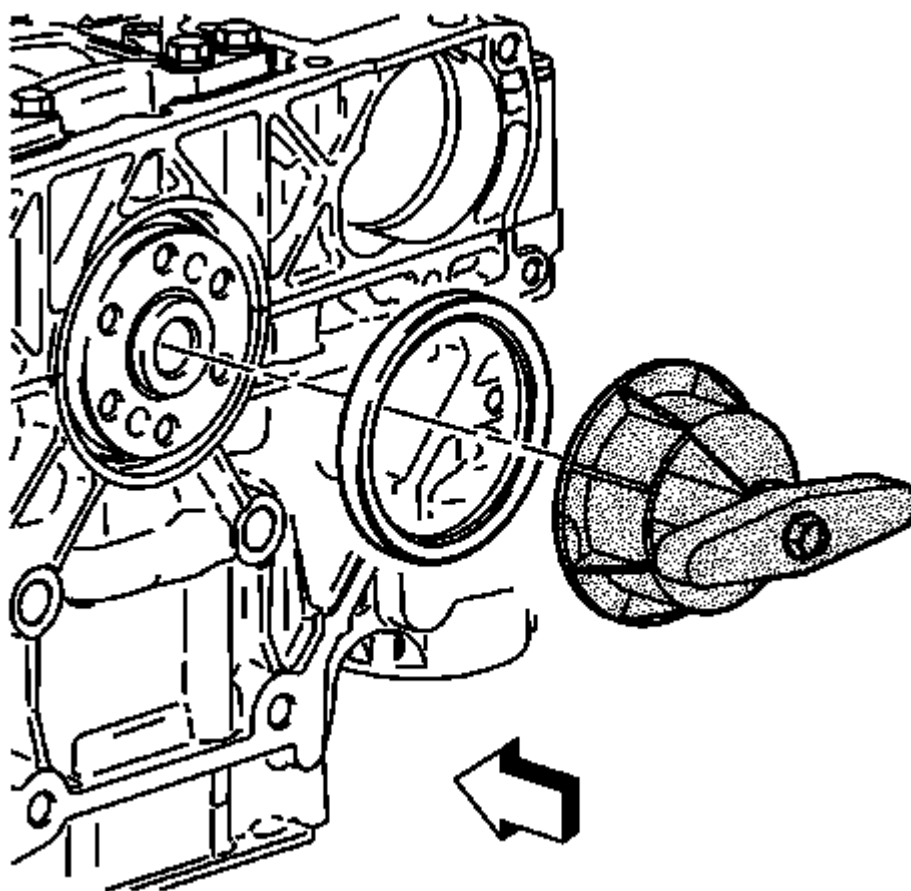


Fig. 238: View Of Crankshaft Rear Oil Seal & Special Tool J 42067
Courtesy of GENERAL MOTORS CORP.

1. Using the **J 42067** , install a NEW crankshaft rear oil seal. See **Special Tools** .
2. Install the flywheel. Refer to **Engine Flywheel Replacement**.

ENGINE REPLACEMENT

REMOVAL PROCEDURE

1. With the tires in the straight forward position, remove the key from the ignition.
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .

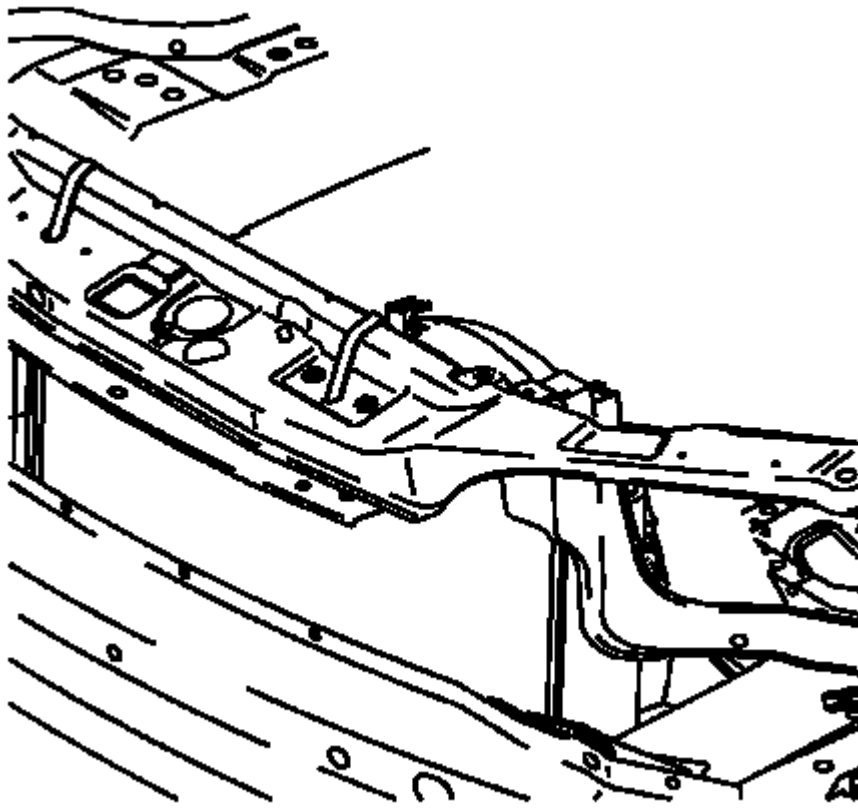


Fig. 239: View Of Cooling Module Secured To Upper Body Structure
 Courtesy of GENERAL MOTORS CORP.

4. Secure the cooling module to the upper body structure.
5. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (With CH 48027)** or **Fuel Pressure Relief (Without CH 48027)** .
6. Disconnect the fuel line from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
7. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716 Fill)** or **Cooling System Draining and Filling** .
8. Remove the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LZE, LZ4, LZ9)** .
9. Remove the surge tank to cylinder head hose. Refer to **Radiator Surge Tank Outlet Hose/Pipe Replacement** .
10. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement** .

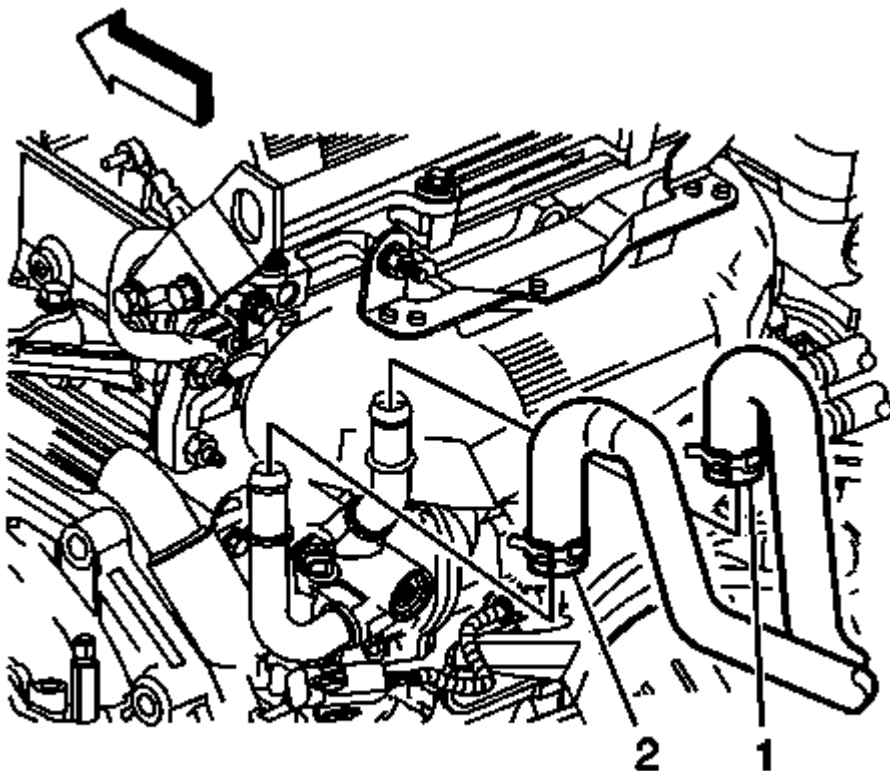


Fig. 240: View Of Inlet & Outlet Hose Clamps At Thermostat Housing Pipes
Courtesy of GENERAL MOTORS CORP.

11. Remove the inlet (1) and outlet (2) heater hoses. Refer to **Heater Inlet Hose Replacement** and **HEATER OUTLET HOSE REPLACEMENT - HEATER CORE TO CONNECTOR**.
12. Disconnect the following harness connectors:
 - The electronic throttle control
 - The manifold absolute pressure (MAP) sensor
 - The crankshaft sensor
 - The oil pressure sensor
 - The purge solenoid
 - The ignition coils
 - The heated oxygen sensor (HO2S) sensor
 - The vehicle speed sensor (VSS)
 - The engine temperature sensor
 - The back-up lamp switch only with automatic transmission.
 - The camshaft position actuator solenoid control valves
 - The fuel rail.

- Remove the ground wires from left side of cylinders head.
13. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
 14. Remove the engine drive belt. Refer to **Drive Belt Replacement**.
 15. Remove the AC compressor bolts and set the compressor aside.

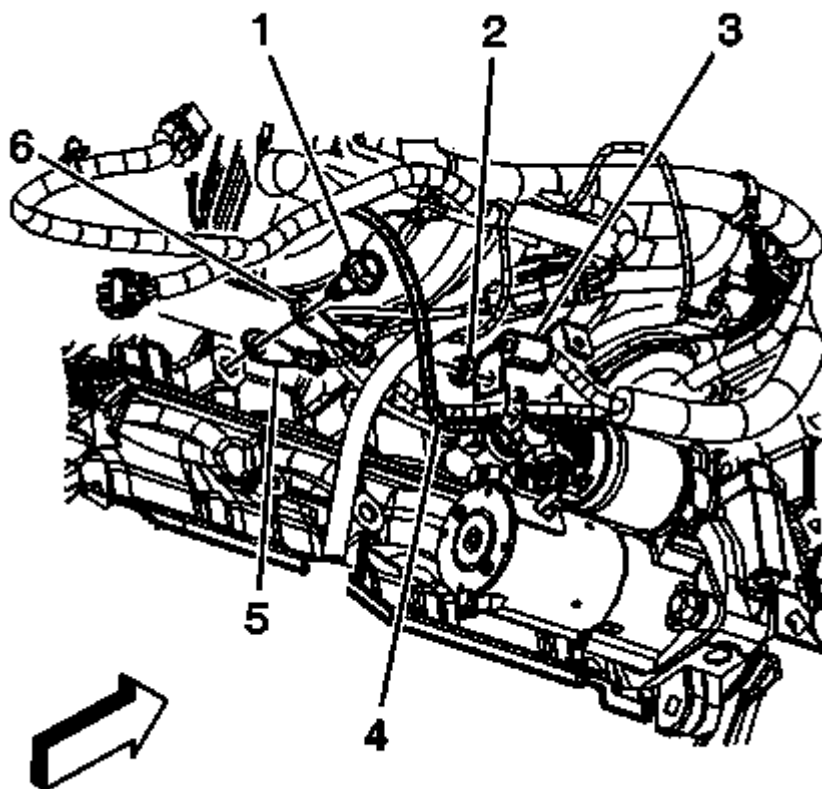


Fig. 241: View Of Negative Cable Ground Terminal Lead
Courtesy of GENERAL MOTORS CORP.

16. Remove the starter solenoid battery cable nut (2).
17. Remove the positive battery cable lead (3) from the starter solenoid.
18. Remove the engine harness lead (2) from the starter solenoid.

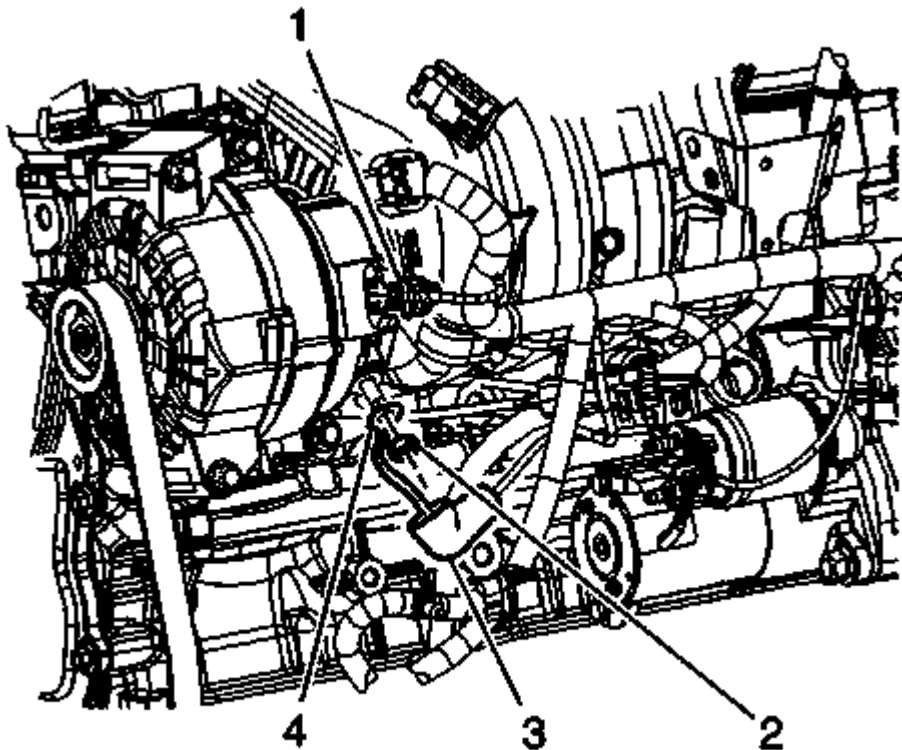


Fig. 242: View Of Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

19. Disconnect the generator electrical connector (1).
20. Reposition the engine harness rubber boot (3).
21. Remove the generator nut (2).
22. Remove the engine harness lead (4) from the generator.
23. Disconnect the front exhaust pipe from the exhaust manifold. Refer to **Exhaust Pipe Replacement (LE5 or LE9 With MH8)** and **Exhaust Manifold Pipe Replacement (LE5)** .
24. Lower the vehicle.
25. Disconnect the transmission harness connectors.
26. Disconnect the transmission shift cable from the transmission.
27. Use blocks of wood to support the powertrain assembly between the frame and the powertrain.
28. Remove the engine mount. Refer to **Engine Mount Replacement**.

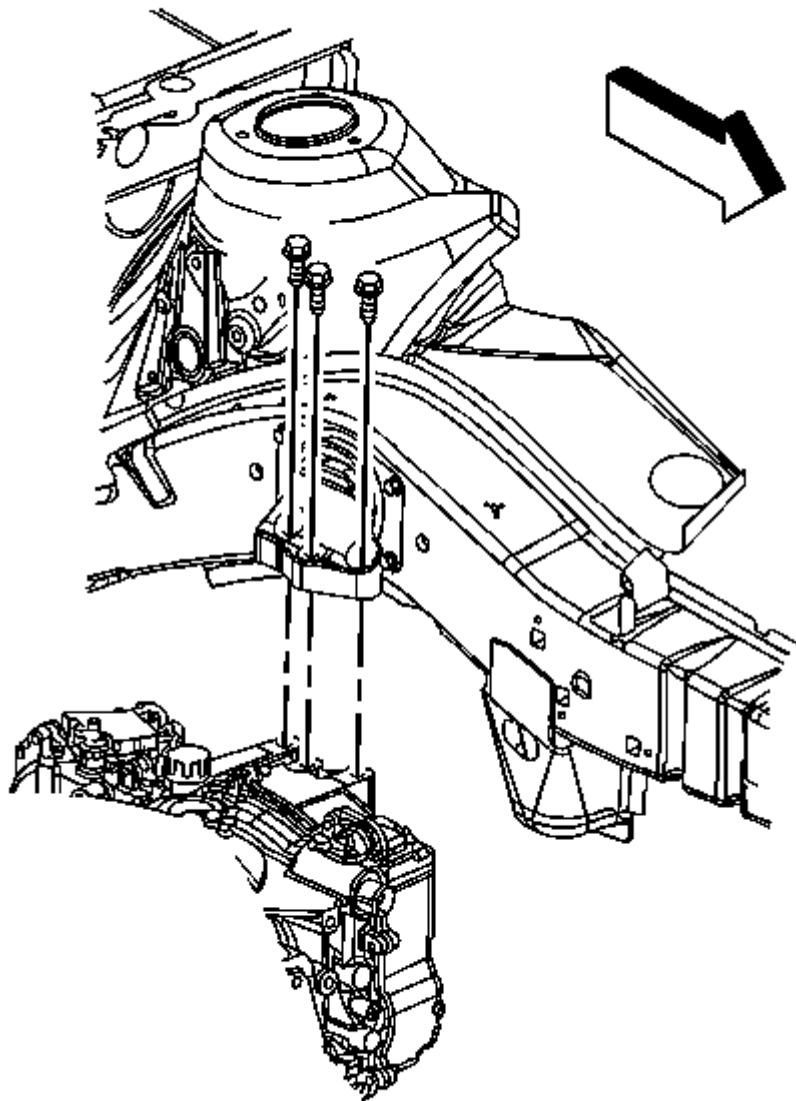


Fig. 243: Identifying Transmission Mount Bracket-To-Transmission Bolts
Courtesy of GENERAL MOTORS CORP.

29. Remove the side transmission mount bracket bolts.
30. Raise the vehicle.

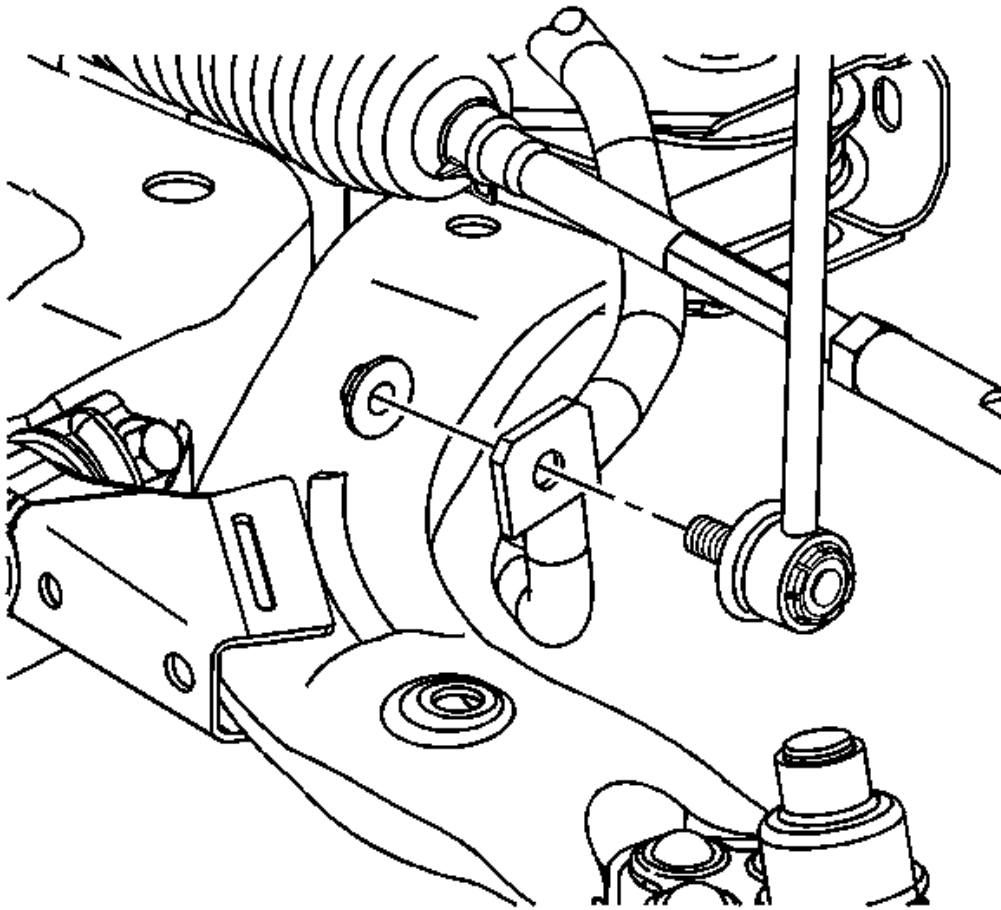


Fig. 244: View Of Stabilizer Link At Stabilizer Shaft
Courtesy of GENERAL MOTORS CORP.

31. Disconnect the stabilizer links from the stabilizer bar. Refer to **Stabilizer Shaft Link Replacement** .

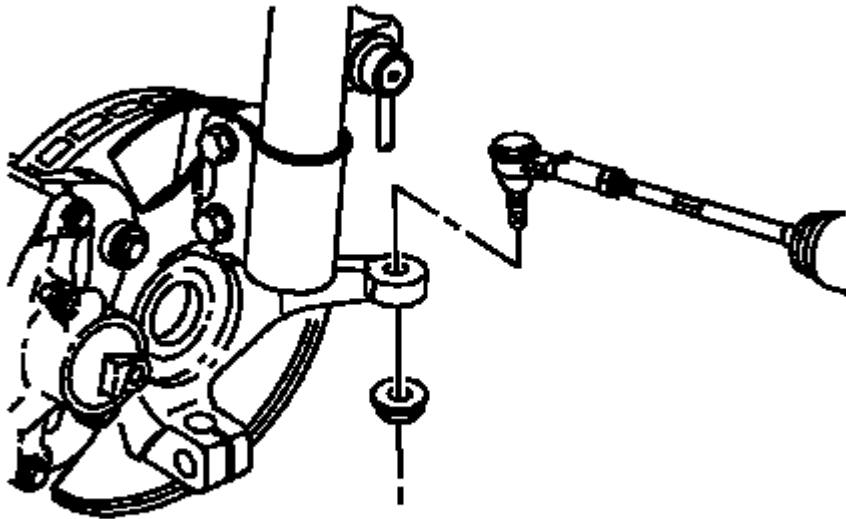


Fig. 245: View Of Tie Rod End To Steering Knuckle
Courtesy of GENERAL MOTORS CORP.

32. Disconnect the outer tie rod ends from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

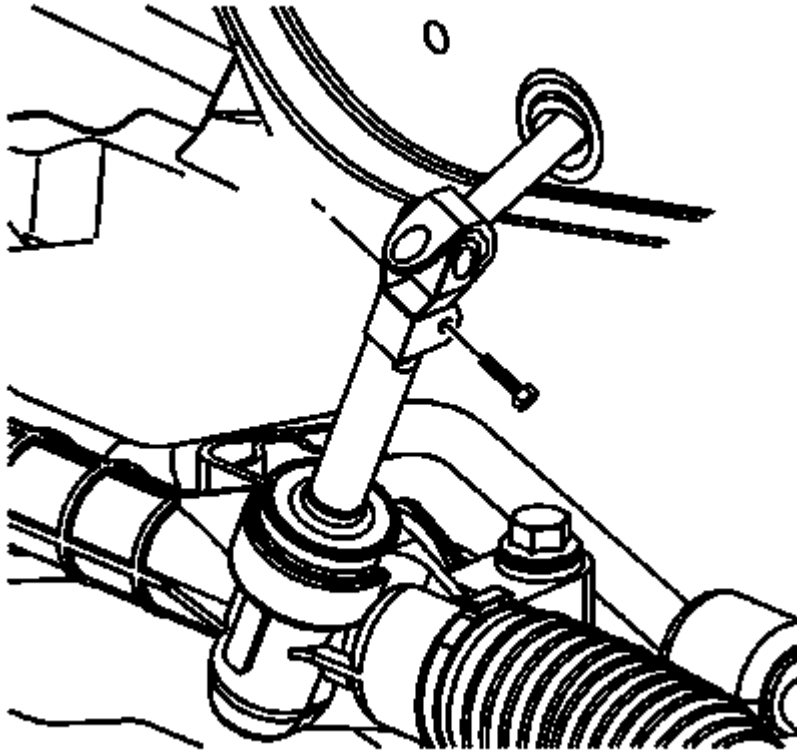


Fig. 246: View Of Intermediate Shaft-To-Steering Gear Pinch Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: In order to prevent possible supplemental inflatable restraint (SIR) system deployment, do not attempt to rotate the steering shaft.

33. Disconnect the intermediate shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement** .

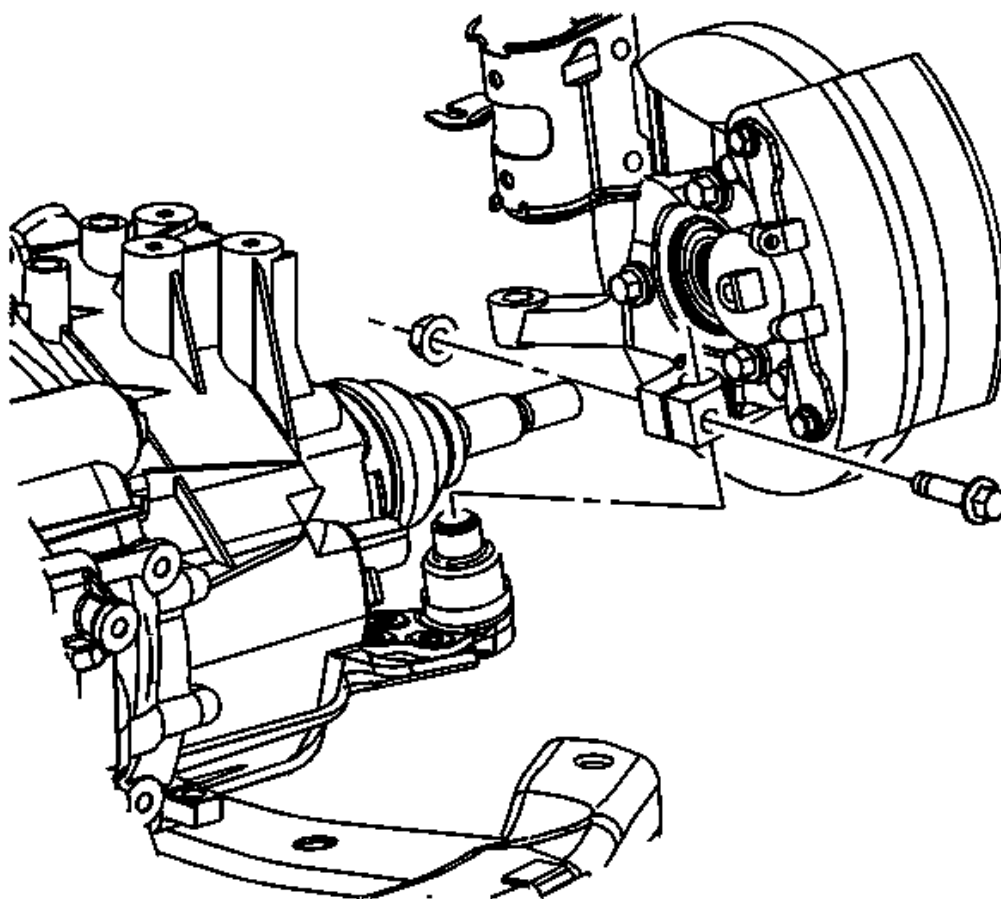


Fig. 247: Identifying Lower Control Arm Ball Stud-To-Steering Knuckle Pinch Bolt
Courtesy of GENERAL MOTORS CORP.

34. Disconnect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement**.
35. Disconnect the drive axles from the transaxle and support with wire or bungee cords.
36. Use a paint pen or magic marker in order to mark the frame to body position.

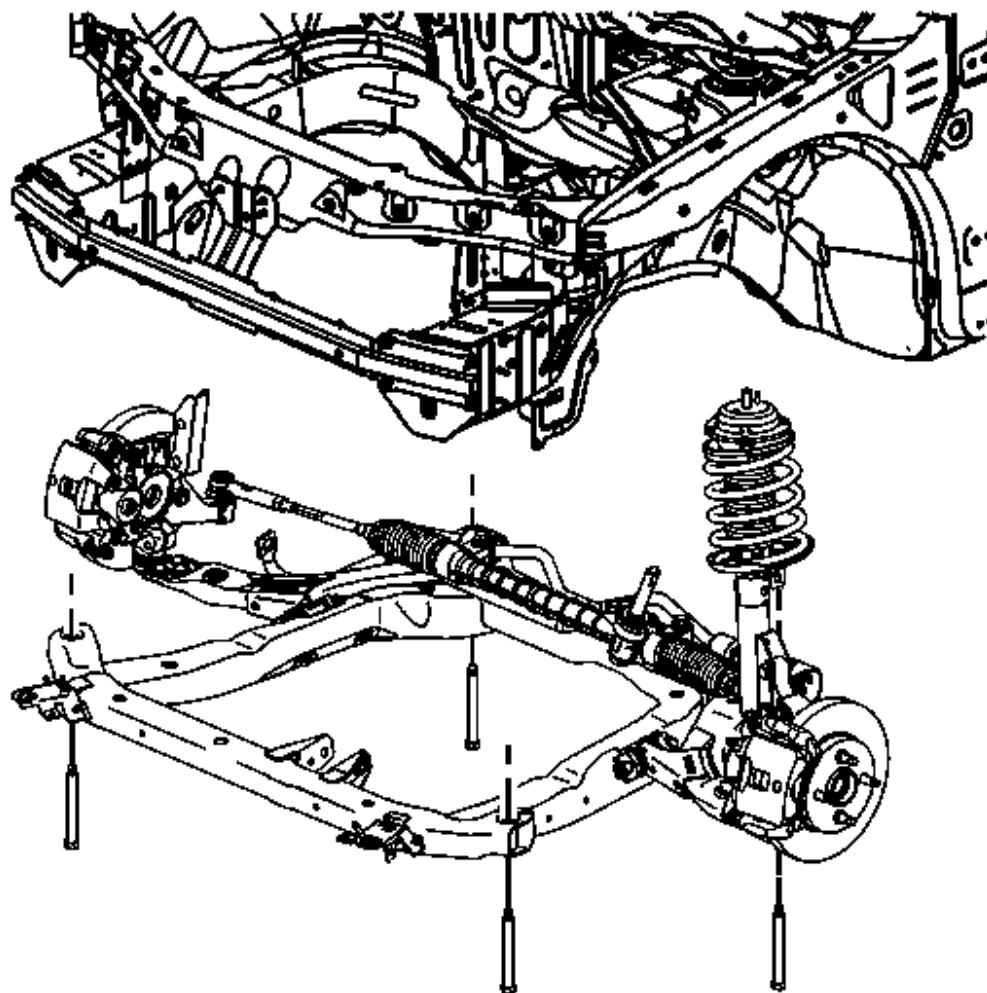


Fig. 248: View Of Frame Bolts

Courtesy of GENERAL MOTORS CORP.

37. Lower the vehicle to about 3 feet off the ground in order to position the lift table under the frame.
38. Use wood blocks as necessary between the lift table and the frame to support the assembly.
39. Remove the frame bolts using the following sequence:
 1. Remove the front frame bolts.
 2. Remove the frame support bracket and bolt.
 3. Remove the rear frame bolts.
40. Slowly raise the vehicle off of the frame and powertrain.

41. Attach the engine lift hoist to the engine lift hooks.

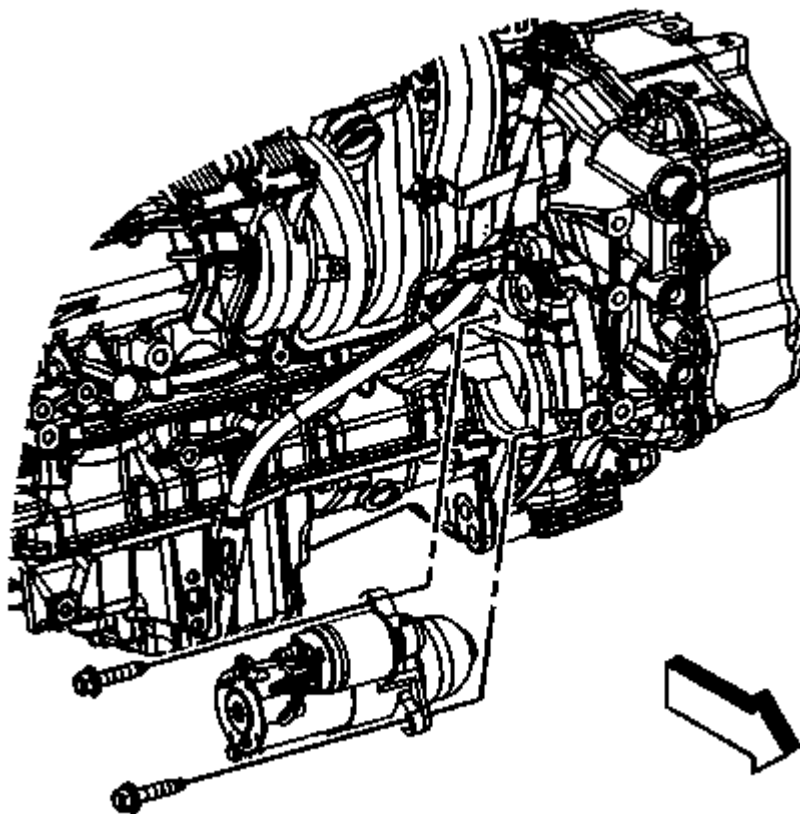


Fig. 249: View Of Starter Motor & Bolts
Courtesy of GENERAL MOTORS CORP.

42. Remove the starter bolts and starter.

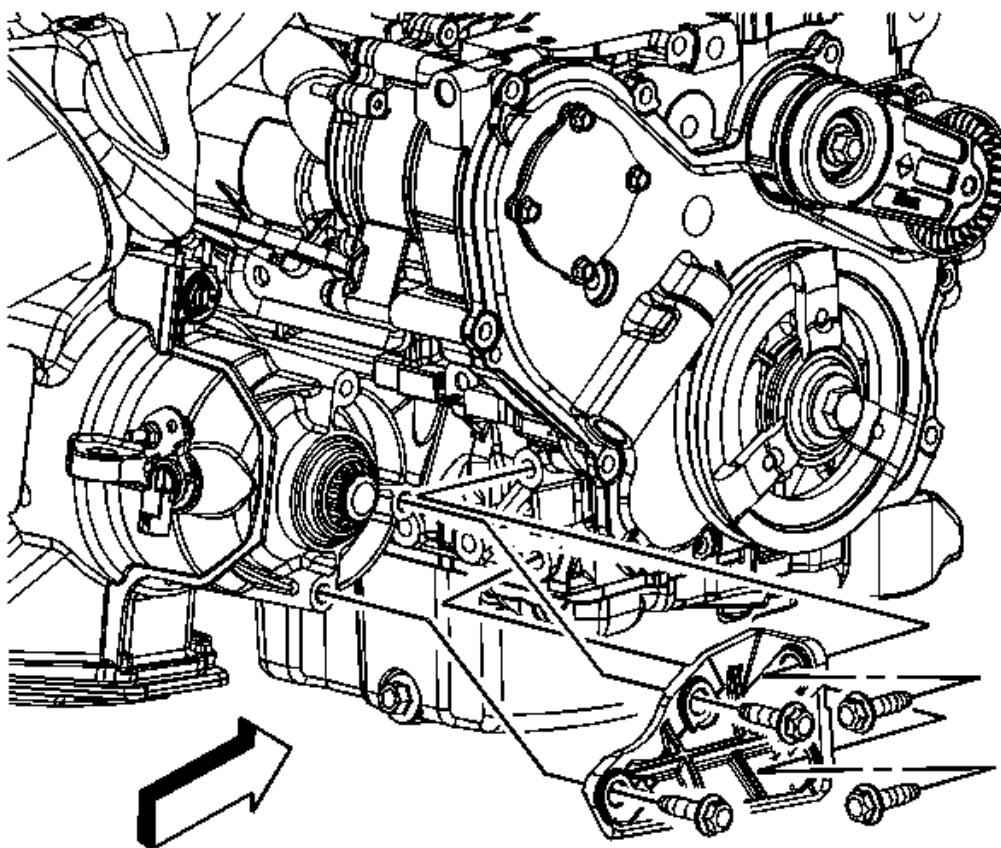


Fig. 250: View Of Transaxle Brace-To-Engine Bolts
Courtesy of GENERAL MOTORS CORP.

43. Remove the transaxle brace to engine bolts.
44. Remove the transaxle brace to transaxle bolts and brace.
45. Remove the torque converter to flywheel bolts.
46. Remove the transaxle to engine bolts.
47. Separate the engine from the transaxle.
48. Remove the following components:
 - The exhaust manifold
 - The engine mount bracket
 - The engine block heater
 - The thermostat housing and feed pipe
 - The generator

- The fuel rail
- The drive belt tensioner
- Engine Flywheel

49. Install the engine to a suitable engine stand.

INSTALLATION PROCEDURE

1. Attach the engine lift hoist to the engine lift hooks.
2. Install the following components:
 - The exhaust manifold-Refer to **Exhaust Manifold Replacement (LE5 or LE9 With MH8) or Exhaust Manifold Replacement (LE5)** .
 - The engine mount bracket-Refer to **Engine Mount Bracket Replacement**.
 - The fuel rail-Refer to **Fuel Injection Fuel Rail Assembly Replacement** .
 - The engine block heater, if equipped-Refer to **Coolant Heater Replacement (LE5 and LE9)** .
 - The drive belt tensioner-Refer to **Drive Belt Tensioner Replacement**.
 - The thermostat housing and feed pipe-Refer to **Engine Coolant Thermostat Replacement (LE5 and LE9)** .
 - The generator-Refer to **Generator Replacement (LE5 or LE9)** .
 - The flywheel-Refer to **Engine Flywheel Replacement**.
3. Align the engine to the transaxle.

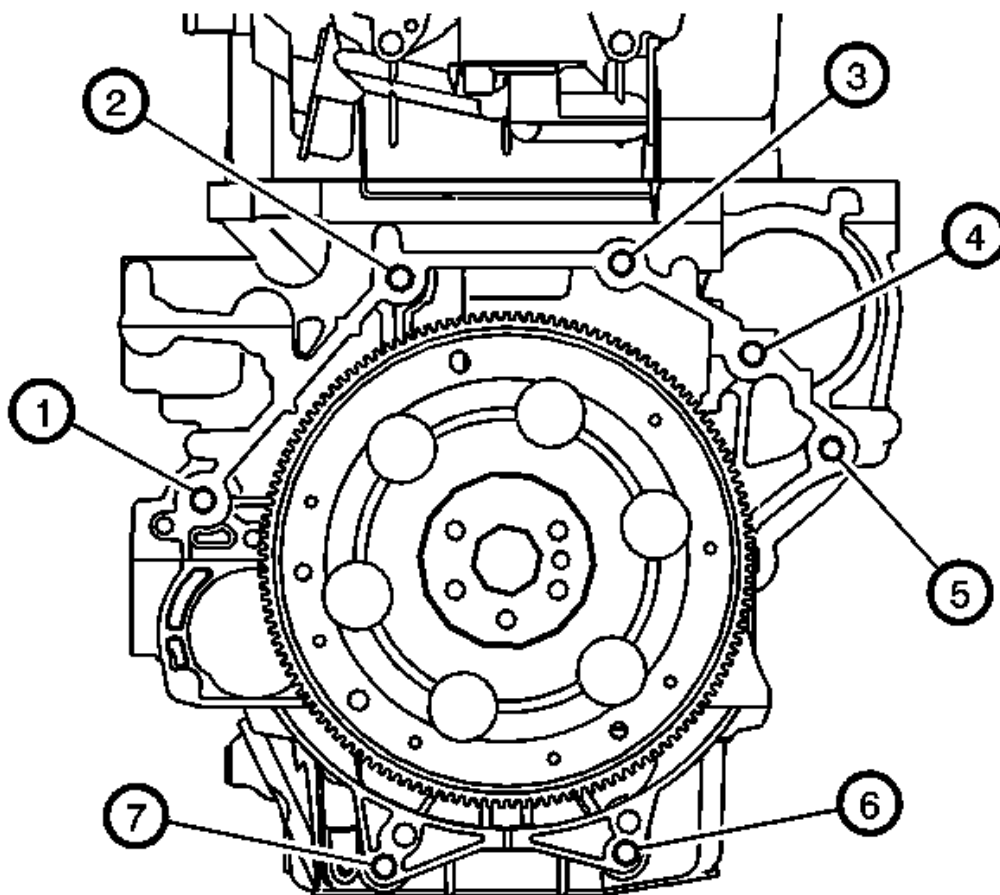


Fig. 251: Identifying Engine-To-Transmission Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: The number 3 bolt location is not used.

4. Install the engine to the transaxle bolts and tighten to 75 N.m (55 lb ft).
5. Install the torque converter bolts and tighten to 62 N.m (46 lb ft).

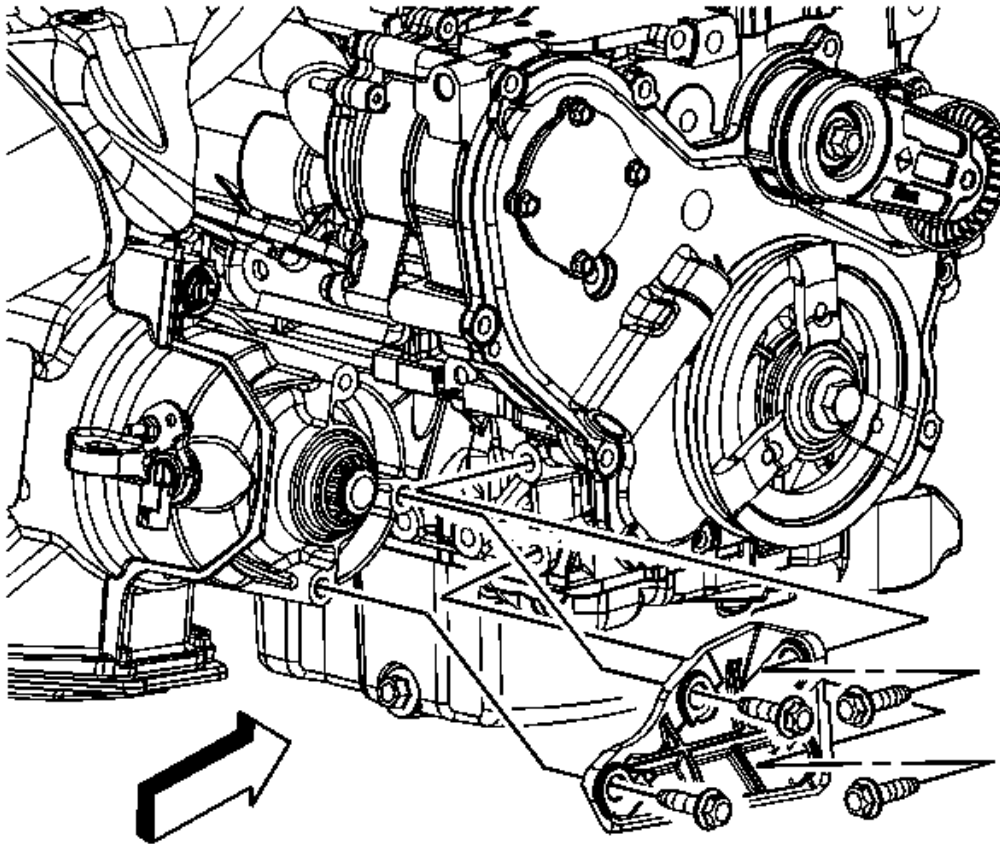


Fig. 252: View Of Transaxle Brace-To-Engine Bolts
Courtesy of GENERAL MOTORS CORP.

6. Position the transaxle brace to the engine and transaxle and install the brace to transaxle bolts.
7. Install the transaxle brace to engine block bolts and tighten to 50 N.m (37 lb ft).

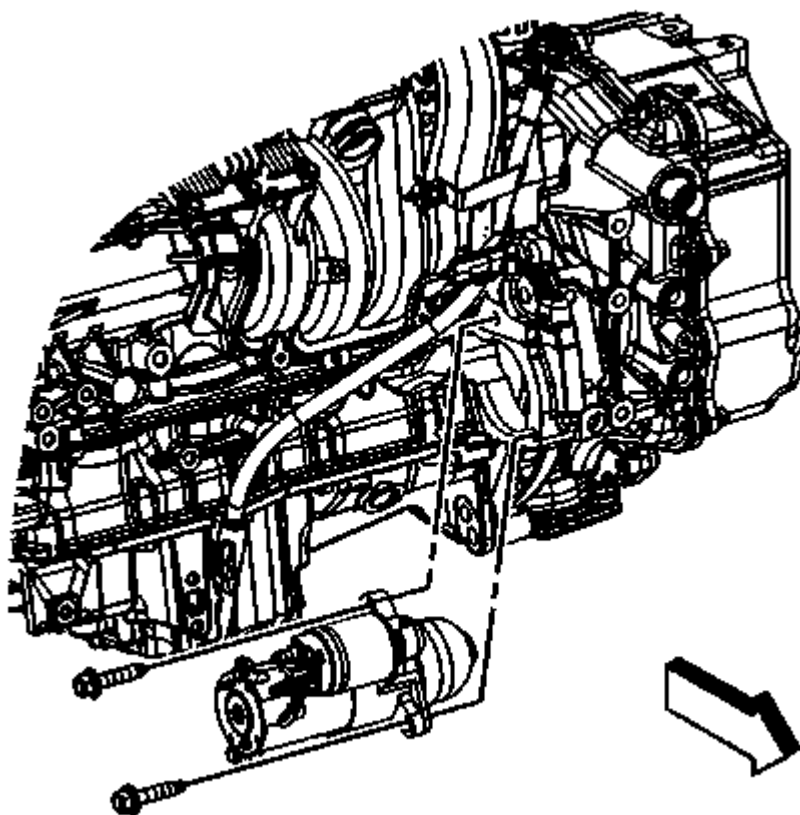


Fig. 253: View Of Starter Motor & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the starter. Refer to **Starter Replacement (LE5 or LE9)** .
9. Remove the engine lift from the engine.

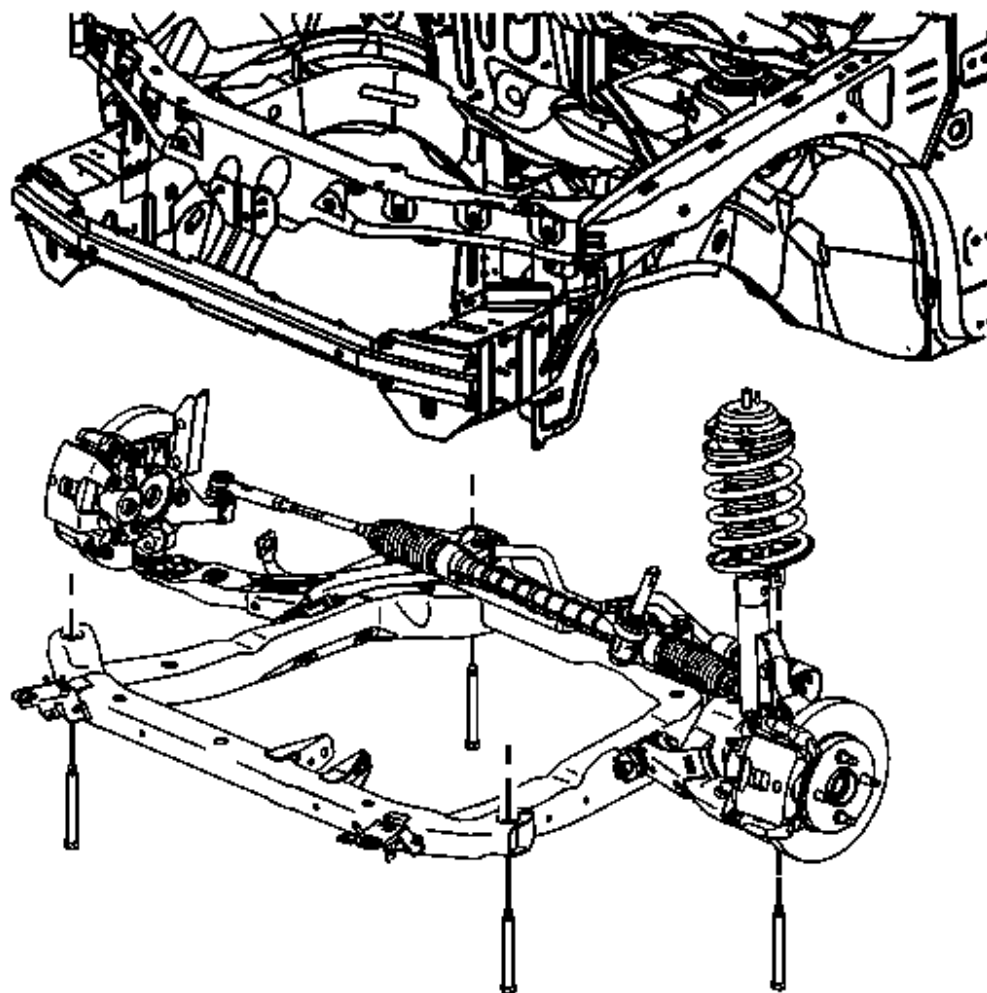


Fig. 254: View Of Frame Bolts
Courtesy of GENERAL MOTORS CORP.

10. Lower vehicle slowly over frame and powertrain.
11. Hand start all the frame bolts while aligning the frame to the paint marks.
12. Tighten the frame bolts to 100 N.m (74 lb ft) plus an additional 180 degrees.
13. Remove the lift table.
14. Connect the drive axles to the transaxle.

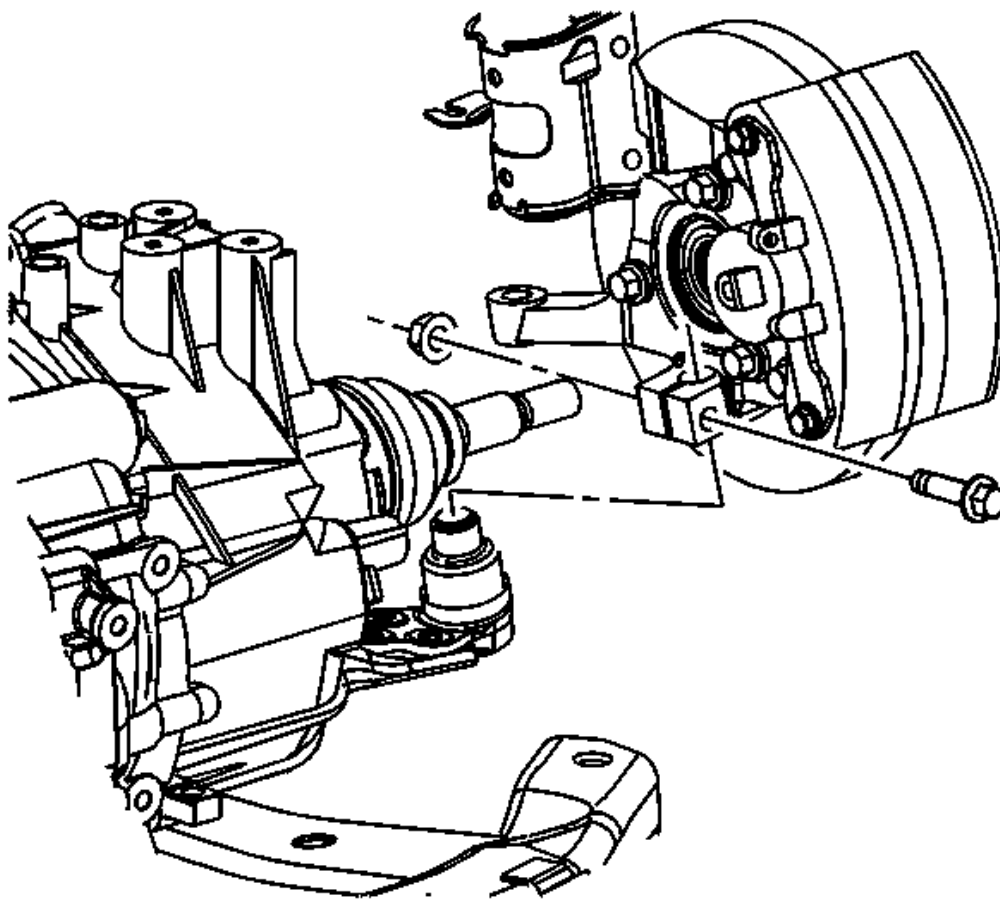


Fig. 255: Identifying Lower Control Arm Ball Stud-To-Steering Knuckle Pinch Bolt
Courtesy of GENERAL MOTORS CORP.

15. Connect the lower control arm to the steering knuckle. Refer to **Lower Control Arm Replacement** .

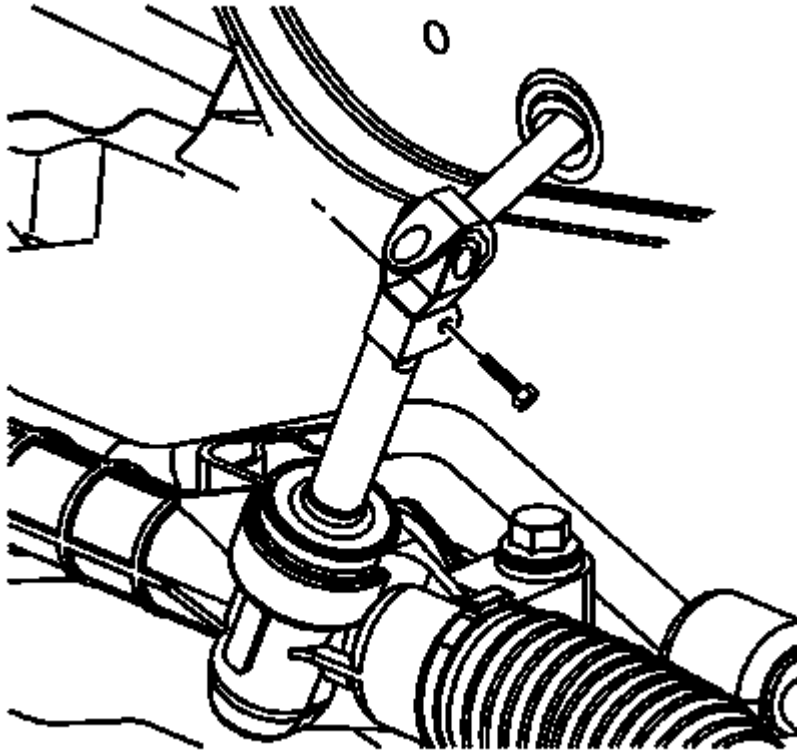


Fig. 256: View Of Intermediate Shaft-To-Steering Gear Pinch Bolt
Courtesy of GENERAL MOTORS CORP.

16. Connect the intermediate steering shaft to the steering gear. Refer to **Steering Gear Replacement (Electronic Power Steering)** or **Steering Gear Replacement (Hydraulic Power Steering LZ4, LZ9)** .

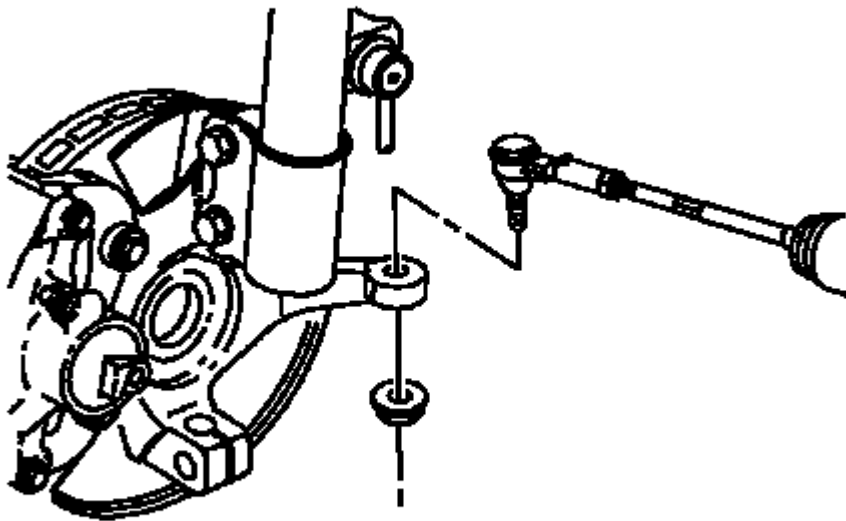


Fig. 257: View Of Tie Rod End To Steering Knuckle
Courtesy of GENERAL MOTORS CORP.

17. Connect the outer tie rod ends to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

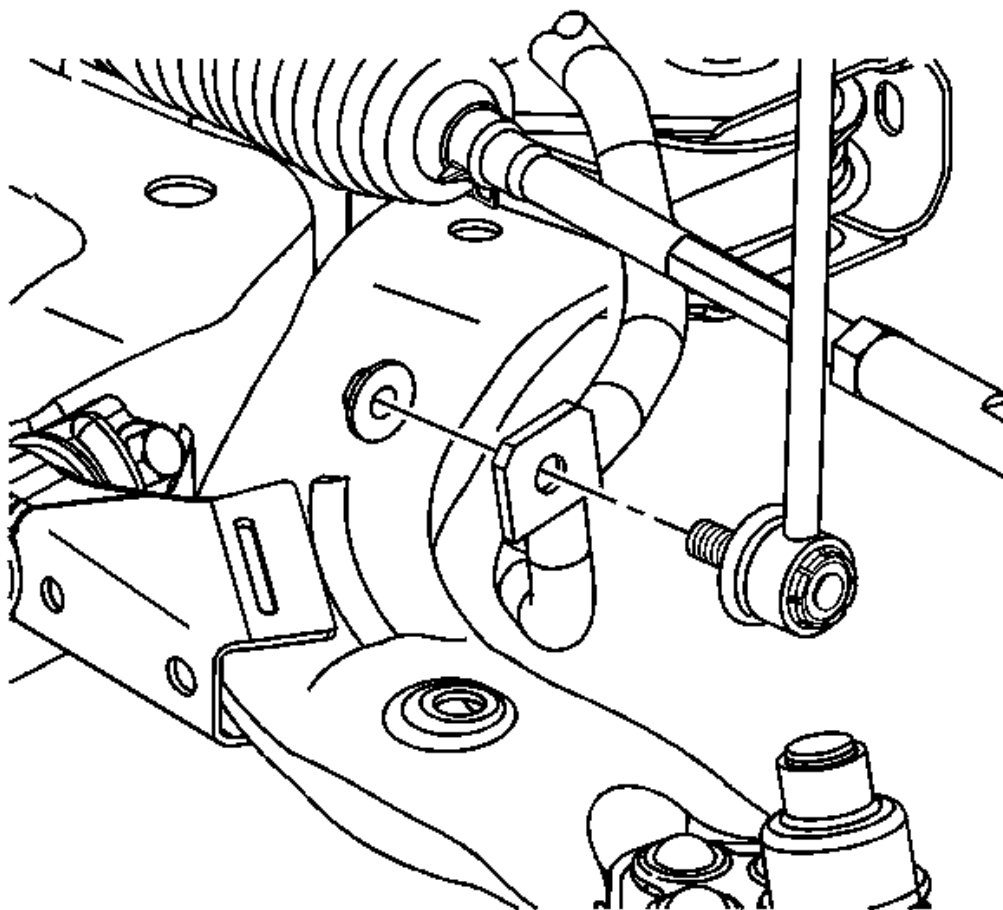


Fig. 258: View Of Stabilizer Link At Stabilizer Shaft
Courtesy of GENERAL MOTORS CORP.

18. Connect the stabilizer links to the stabilizer bar. Refer to **Stabilizer Shaft Link Replacement** .

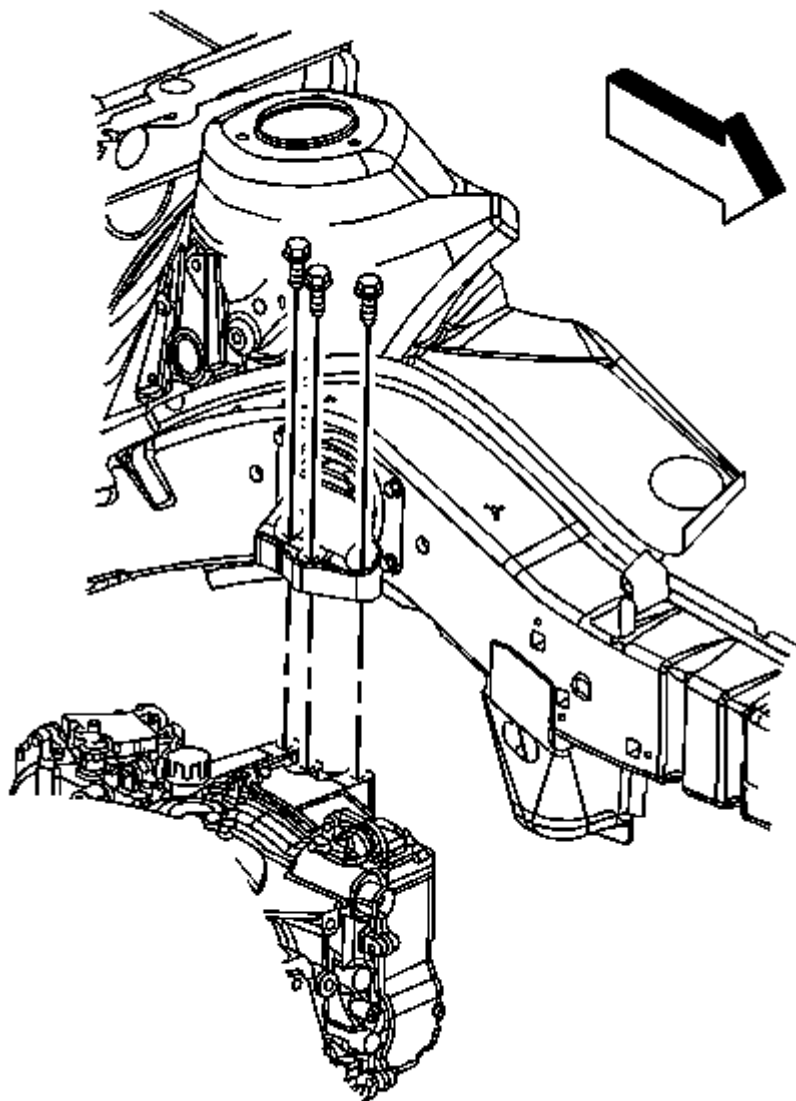


Fig. 259: Identifying Transmission Mount Bracket-To-Transmission Bolts
Courtesy of GENERAL MOTORS CORP.

19. Install the side transmission mount bracket bolts and tighten to 50 N.m (37 lb ft).
20. Install the engine mount. Refer to **Engine Mount Replacement**.
21. Remove the wood blocks between the powertrain and frame.
22. Connect the transmission shift cable to the transmission.
23. Connect the transmission harness connector.

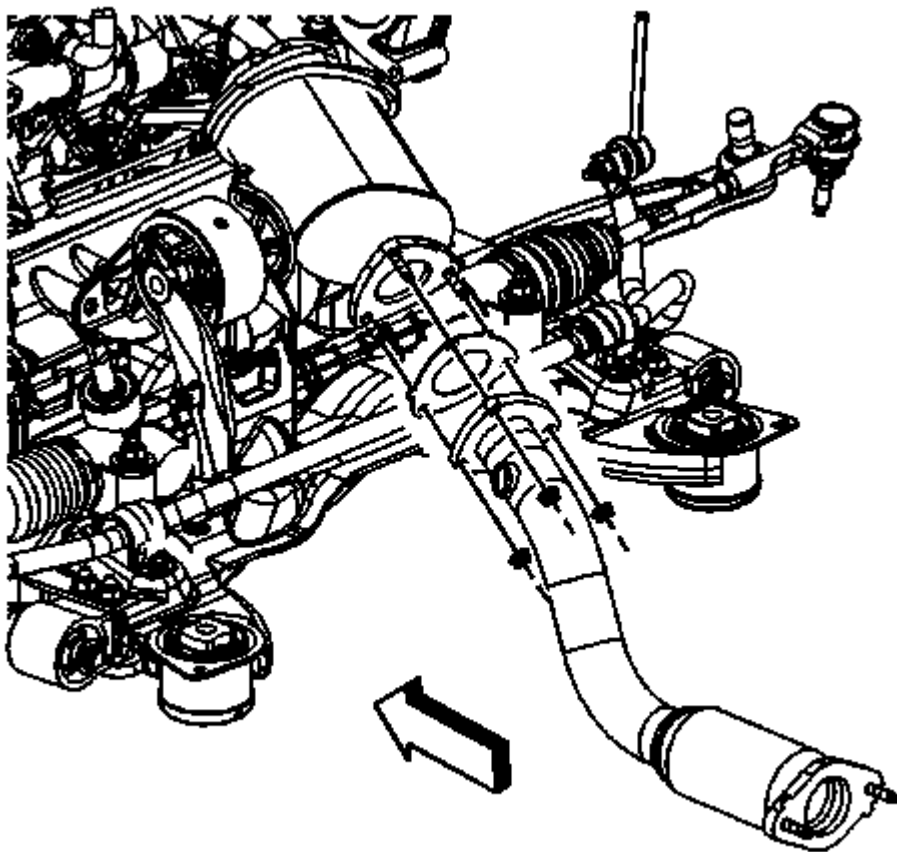


Fig. 260: Identifying Exhaust Manifold Pipe
Courtesy of GENERAL MOTORS CORP.

24. Install the catalytic converter to the exhaust manifold and tighten the nuts to 30 N.m (22 lb ft).
25. Lower the vehicle.

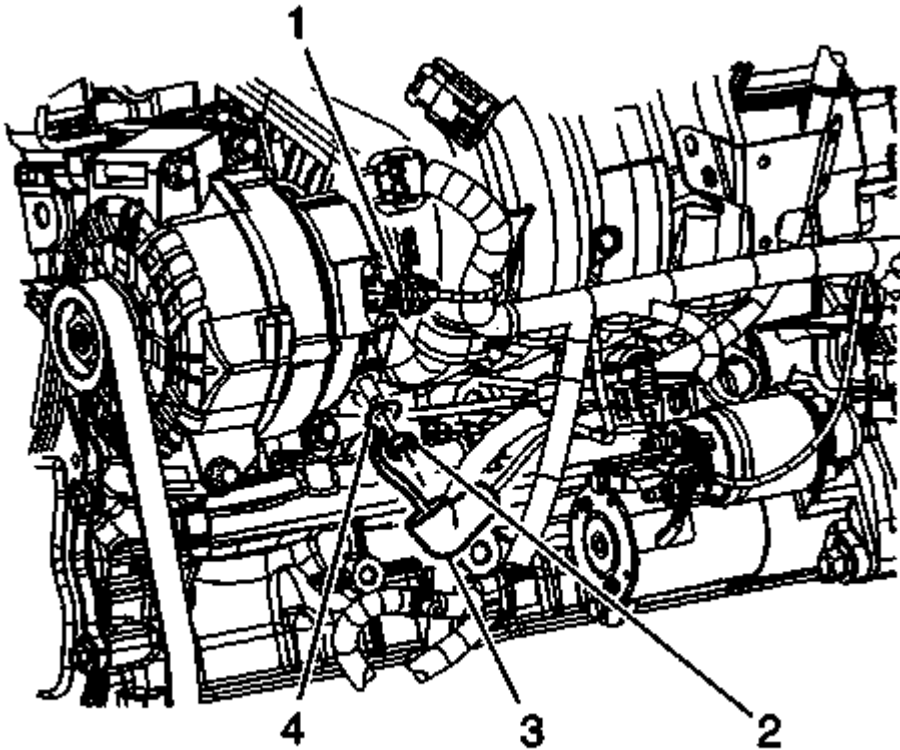


Fig. 261: View Of Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

26. Install the engine harness lead (4) to the generator.
27. Install the generator nut (2) and tighten to 20 N.m (15 lb ft).
28. Position the engine harness rubber boot (3).
29. Connect the generator electrical connector (1).
30. Raise the vehicle.

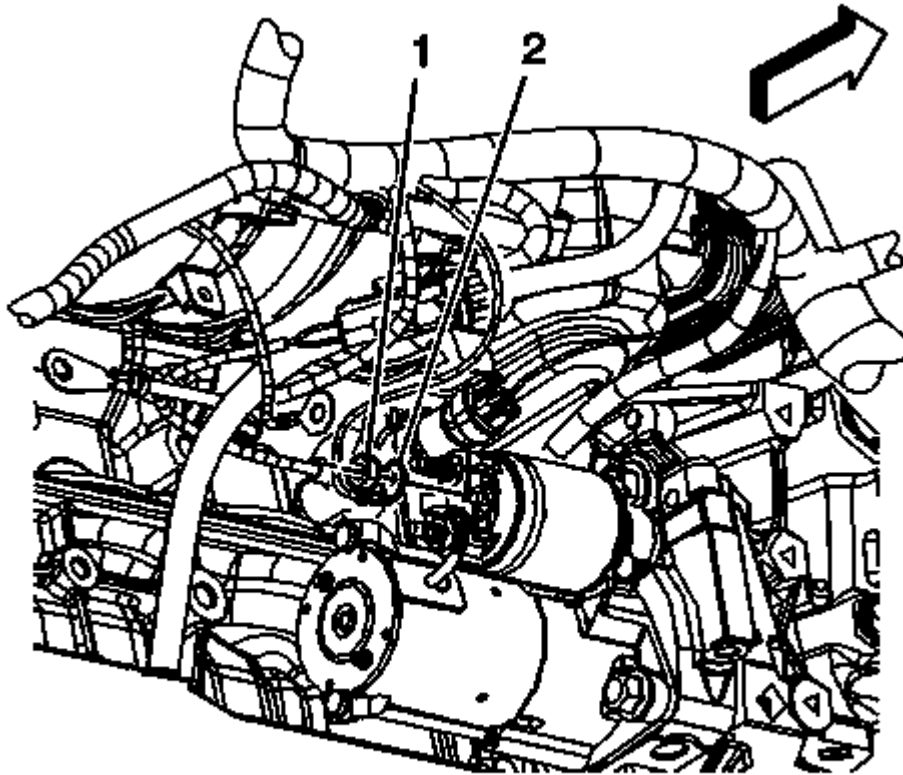


Fig. 262: Identifying Starter Solenoid Engine Harness & Nut
Courtesy of GENERAL MOTORS CORP.

31. Install the engine harness lead (2) to the starter solenoid.
32. Install the starter solenoid engine harness nut (1) and tighten to 3 N.m (27 lb in).

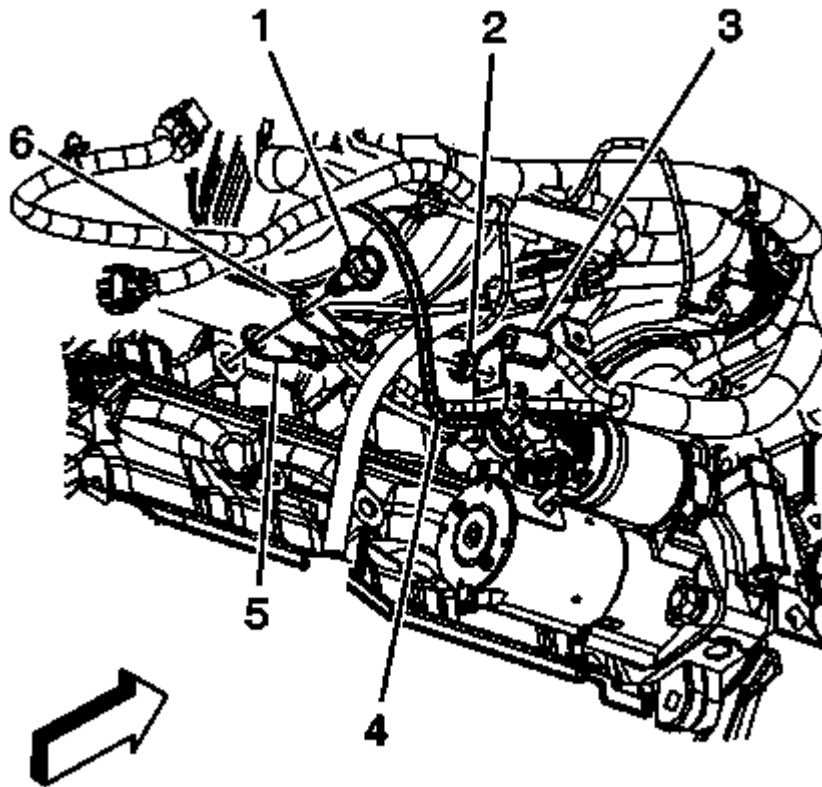


Fig. 263: View Of Negative Cable Ground Terminal Lead
Courtesy of GENERAL MOTORS CORP.

33. Install the positive battery cable lead (3) to the starter solenoid.
34. Install the starter solenoid battery cable nut (2) and tighten to 17 N.m (13 lb ft).
35. Install the AC compressor to the engine. Refer to **AIR CONDITIONING COMPRESSOR REPLACEMENT**.
36. Install the engine drive belt. Refer to **Drive Belt Replacement**.
37. Connect the following harness connectors:
 - The electronic throttle control
 - The MAP sensor
 - The crankshaft sensor
 - The oil pressure sensor
 - The purge solenoid
 - The ignition coils
 - The HO2S
 - The VSS
 - The engine temperature sensor

- The camshaft position actuator solenoid control valves
- The fuel rail

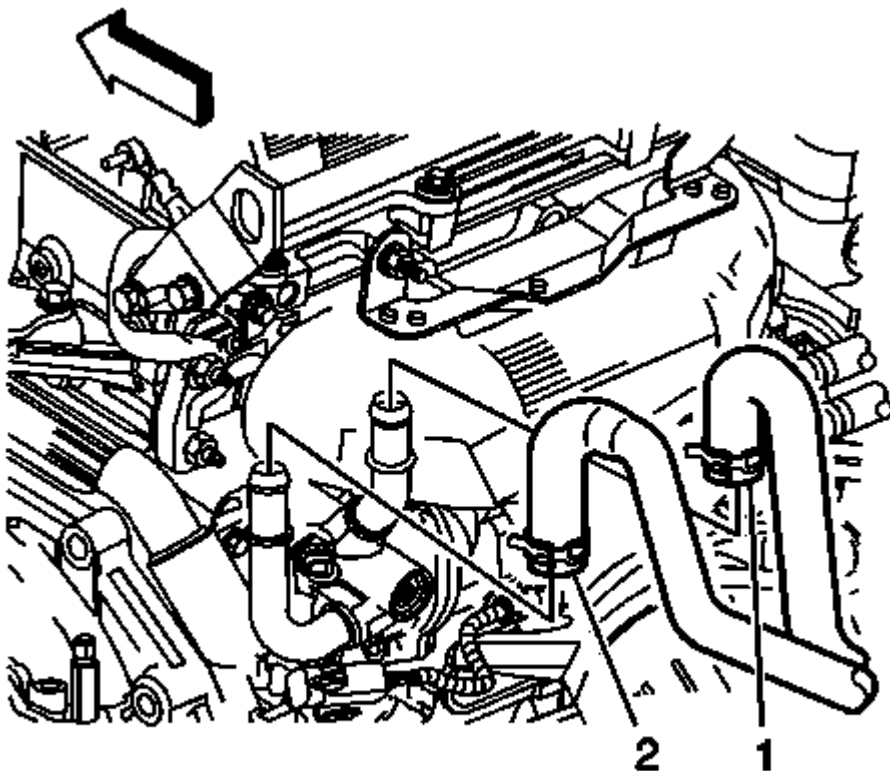


Fig. 264: View Of Inlet & Outlet Hose Clamps At Thermostat Housing Pipes
 Courtesy of GENERAL MOTORS CORP.

38. Install the inlet heater hose (1) and outlet heater hose (2). Refer to **Heater Inlet Hose Replacement** .
39. Install the radiator outlet hose. Refer to **Radiator Inlet Hose Replacement** .
40. Connect the fuel line to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .

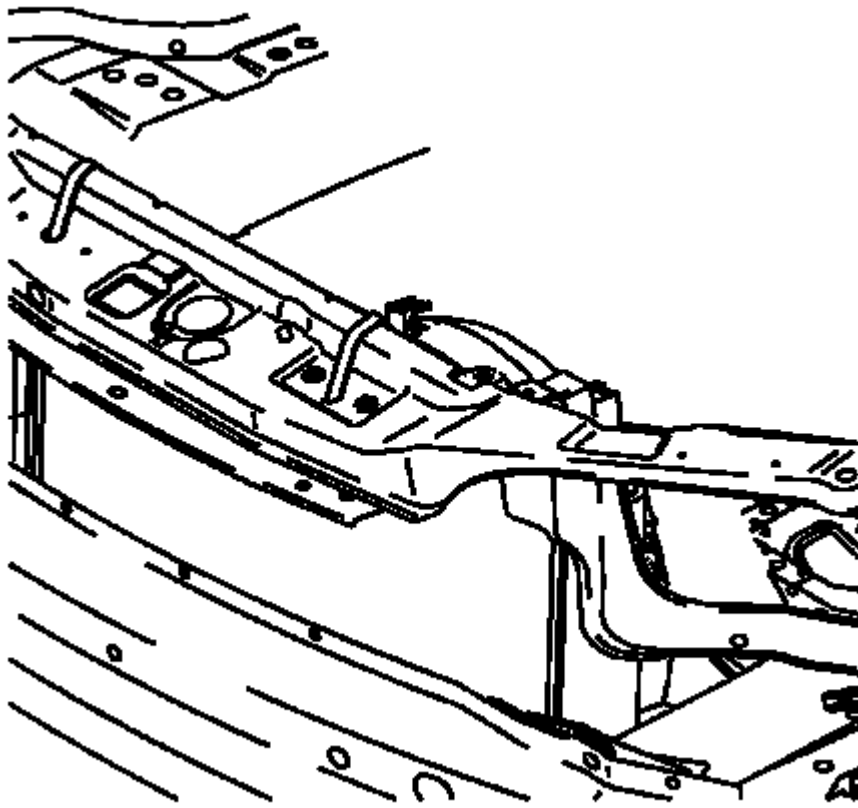


Fig. 265: View Of Cooling Module Secured To Upper Body Structure
 Courtesy of GENERAL MOTORS CORP.

41. Release the cooling module from the upper body structure.
42. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
43. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
44. Fill the engine with engine oil to the proper level. Refer to **Fluid and Lubricant Recommendations (USA and Canada)** .
45. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716 Fill)** or **Cooling System Draining and Filling** .
46. Perform Crankshaft Position System Variation Learn **Crankshaft Position System Variation Learn**
47. Road test the vehicle.

ENGINE OIL AND OIL FILTER REPLACEMENT (LAF)

REMOVAL PROCEDURE

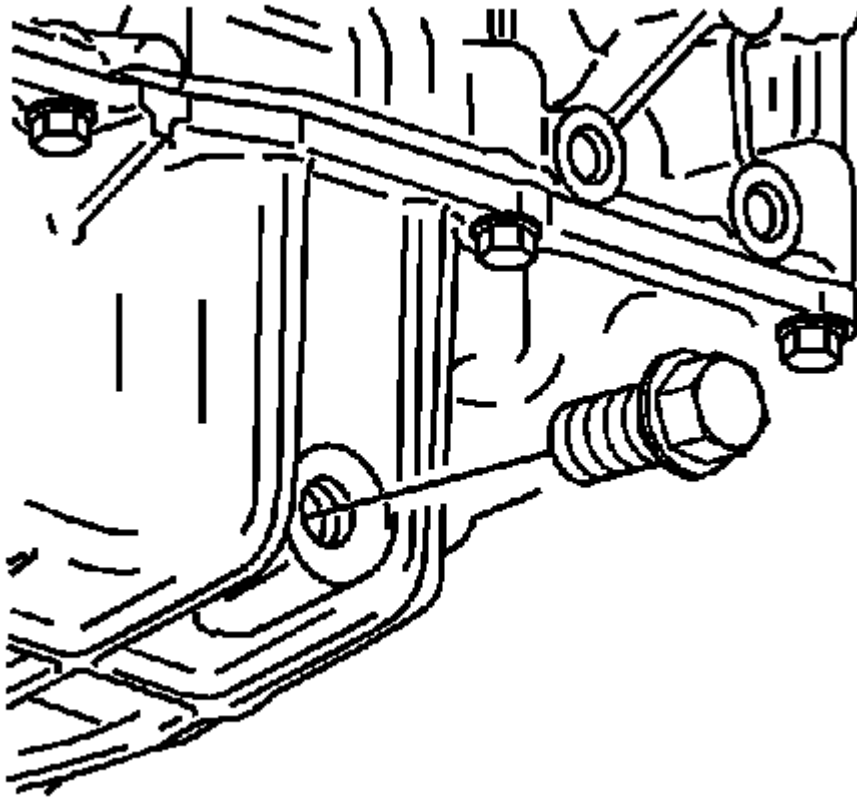


Fig. 266: View Of Oil Pan Drain Bolt
 Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Place a drain pan under the oil drain plug.
3. Remove the oil pan drain plug.
4. Allow the oil to drain completely.

CAUTION: Refer to Fastener Caution .

5. Install the oil pan drain plug and tighten to 25 N.m (18 lb ft).
6. Lower the vehicle.

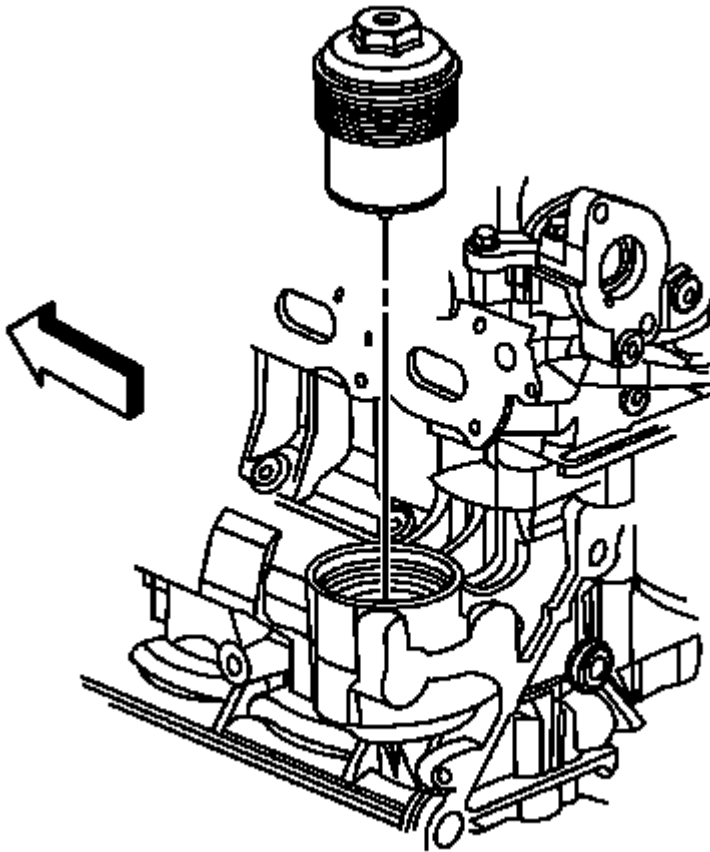


Fig. 267: Oil Filter Cap

Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT use an open end wrench on the hex on top of the oil filter cap.

7. use an oil filter wrench on the outside diameter of the oil filter cap.
8. Remove the oil filter cap and filter.
9. Remove the filter from the cap.

INSTALLATION PROCEDURE

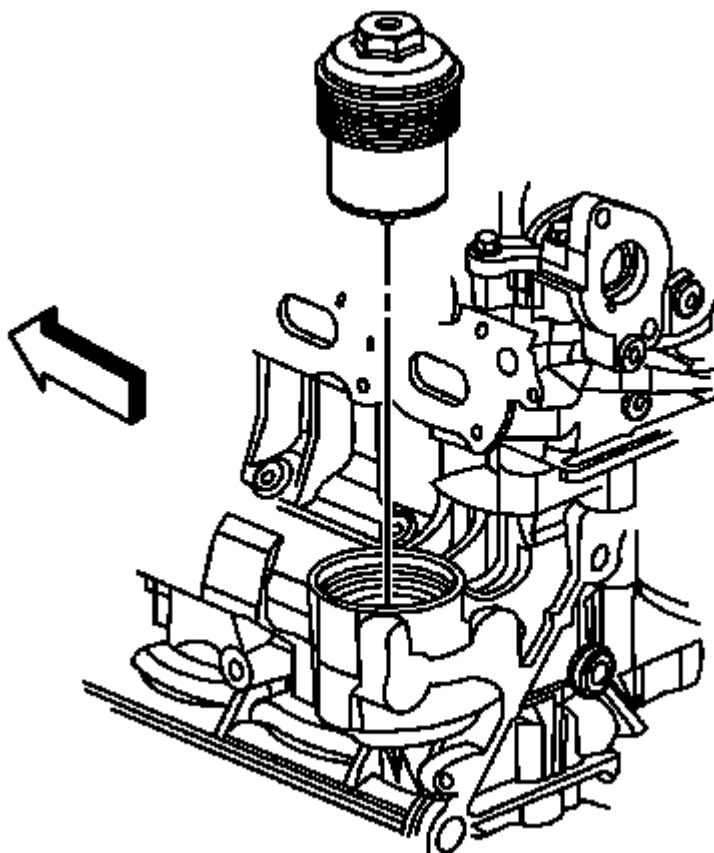


Fig. 268: Oil Filter Cap

Courtesy of GENERAL MOTORS CORP.

1. Install the NEW oil filter to the cap.
2. Install the oil filter cap and filter.

CAUTION: Over torquing the oil filter cap may cause damage to the oil filter cap resulting in an oil leak.

NOTE: DO NOT use an open end wrench on the hex on top of the oil filter cap.

3. use an oil filter wrench on the outside diameter of the oil filter cap. Tighten the oil filter cap until fully seated. DO NOT exceed 25 N.m (18 lb ft).
4. Fill the engine with oil. Refer to **Fluid and Lubricant Recommendations (USA and Canada)** .