

ENGINE

Engine Mechanical - 3.6L (LFX) - Repair Instructions - On Vehicle - Canyon, Colorado

REPAIR INSTRUCTIONS - ON VEHICLE

DRIVE BELT REPLACEMENT

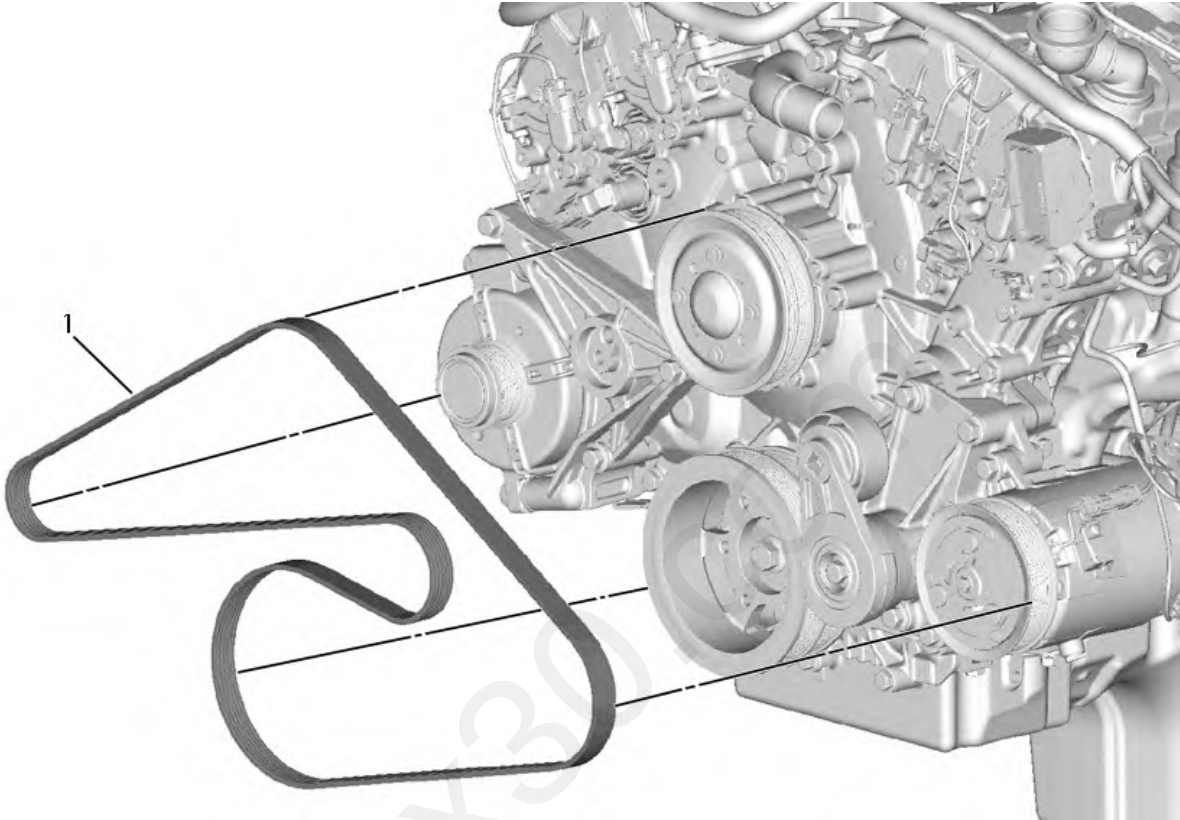
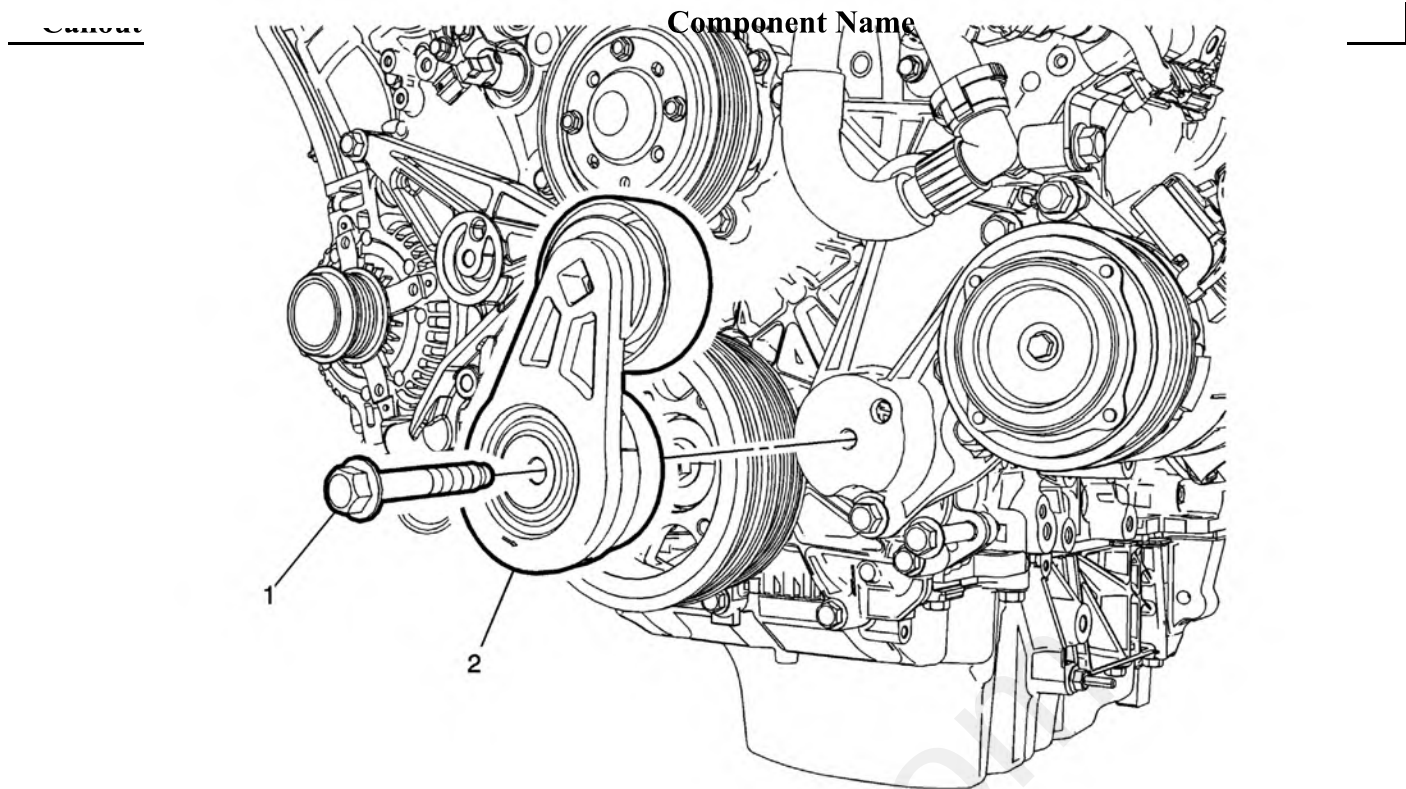


Fig. 1: Drive Belt Routing

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
1	Drive Belt Procedure 1. Rotate the drive belt tensioner counter clockwise to release the drive belt tension. 2. Slide the drive belt off of the water pump pulley. 3. Slowly release the drive belt tensioner.

DRIVE BELT TENSIONER REPLACEMENT



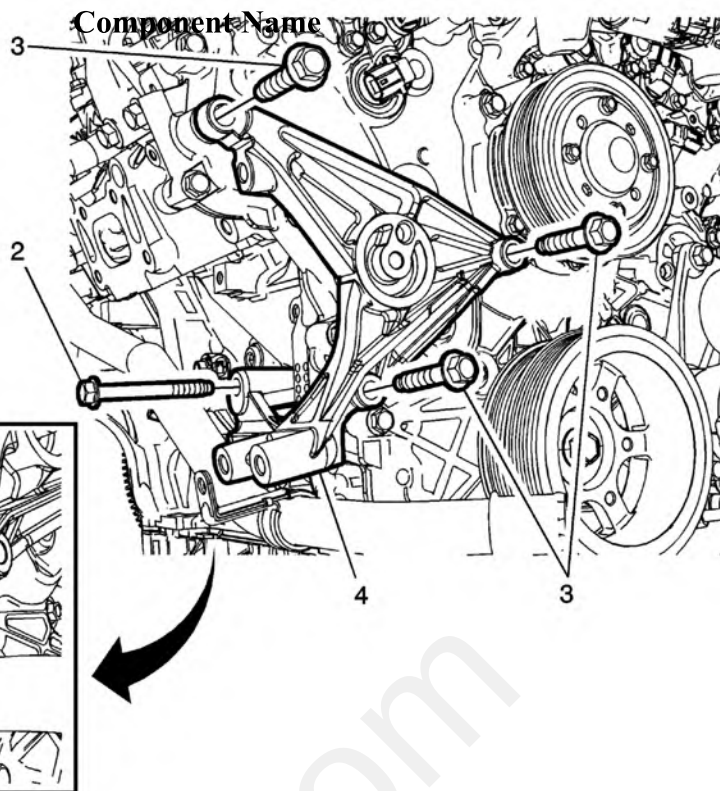


Fig. 3: Generator and Drive Belt Tensioner Bracket

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the generator. Refer to Generator Replacement (LFX) .	
1	Fastener CAUTION: Refer to Fastener Caution . Procedure Position the coolant hose clamp clear of the generator and drive belt tensioner bracket. Tighten 22 N.m (16 lb ft)
2	Fastener Tighten 50 N.m (37 lb ft)
3	Fastener (QTY:3) Tighten 50 N.m (37 lb ft)
4	Generator and Drive Belt Tensioner Bracket.

ENGINE SUPPORT FIXTURE

Special Tools

- EN-51007 Engine Support Fixture

Engine Lift Bracket

Installation Procedure

1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
2. Remove the front compartment front sight shield. Refer to [Front Compartment Front Sight Shield Replacement](#) .
3. Remove both front compartment side sight shield. Refer to [Front Compartment Side Sight Shield Replacement](#) .
4. Loosen the transmission mount nuts. Refer to [Transmission Mount Replacement \(4WD\)](#) [Transmission Mount Replacement \(2WD\)](#) .

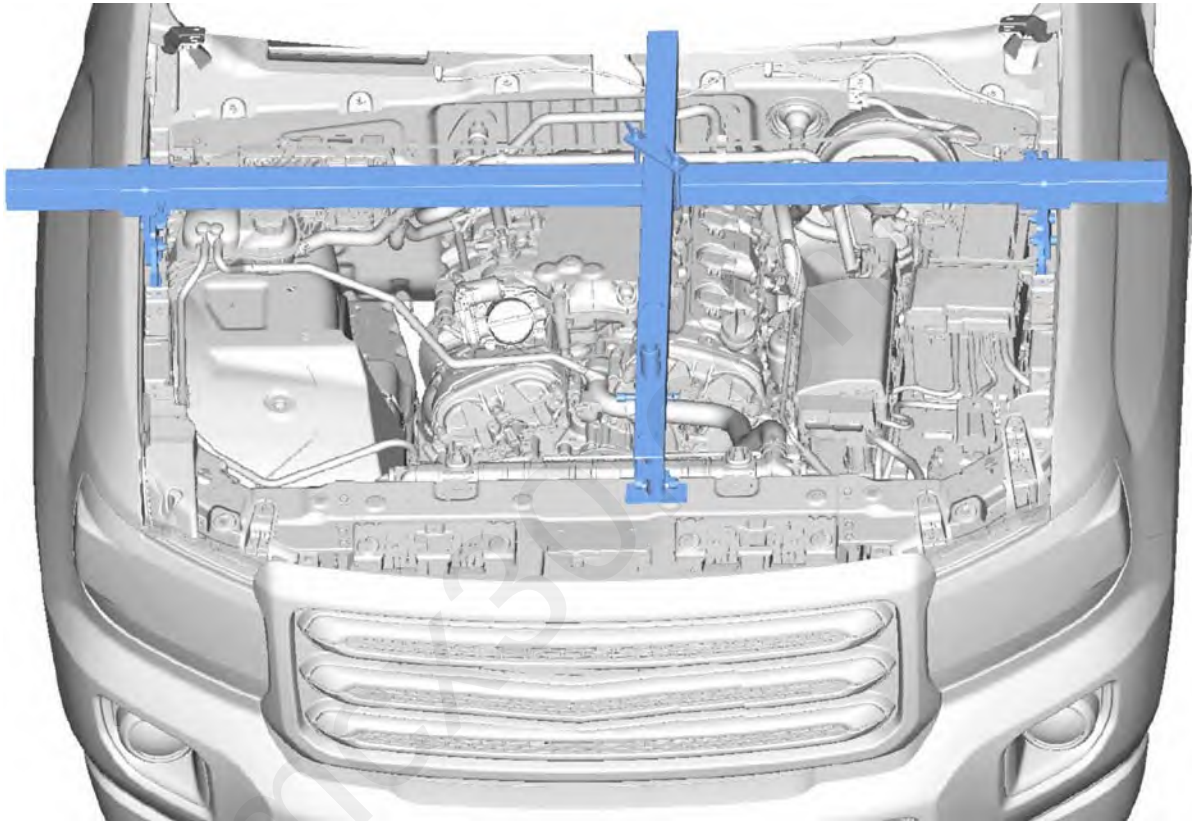


Fig. 4: Engine Support Fixture

Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-51007** Engine Support Fixture as shown.

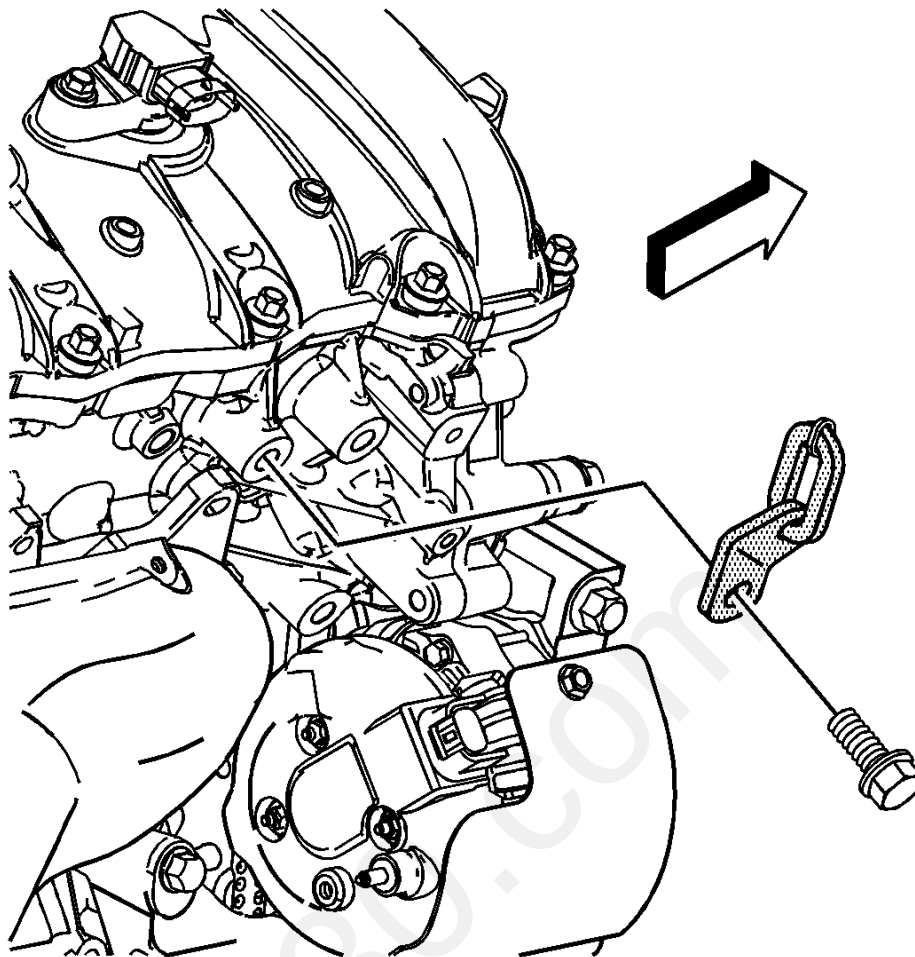


Fig. 5: View of Engine Lift Bracket Assembly
Courtesy of GENERAL MOTORS COMPANY

6. If servicing the right side engine mount, use a grade 10.9, M10 X 1.5 X 35 bolt, GM P/N 11519182, or equivalent, in order to install *J 36857* engine lift bracket, or equivalent, to the right cylinder head in the location shown. Tighten the bolt to 65 (48 lb ft)

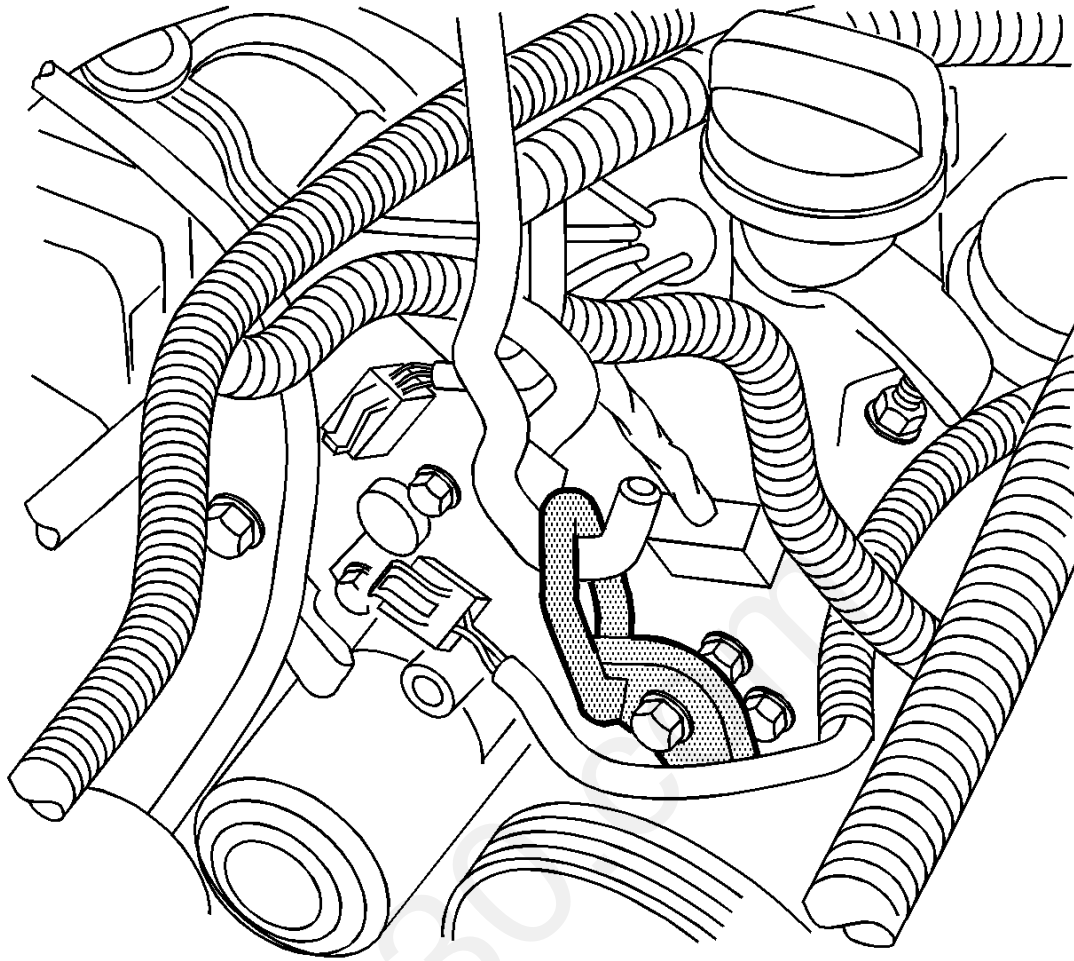


Fig. 6: Left Side Engine Lift Hook Assembly
Courtesy of GENERAL MOTORS COMPANY

7. If servicing the left side engine mount, use a grade 10.9, M10 X 1.5 X 35 bolt, GM P/N 11519182, or equivalent, in order to install *J 36857* engine lift bracket, or equivalent, to the right cylinder head in the location shown. Tighten the bolt to 65 (48 lb ft)

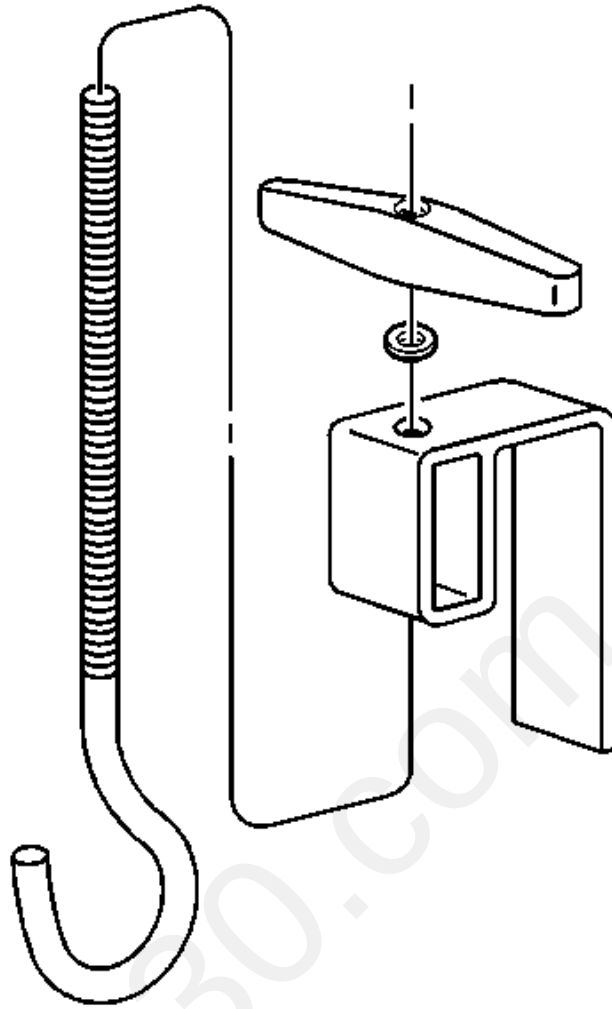


Fig. 7: View Of Lift Hook Assembly
Courtesy of GENERAL MOTORS COMPANY

8. Assemble the lift hook wing nut and the lift hook bracket to the lift hook.

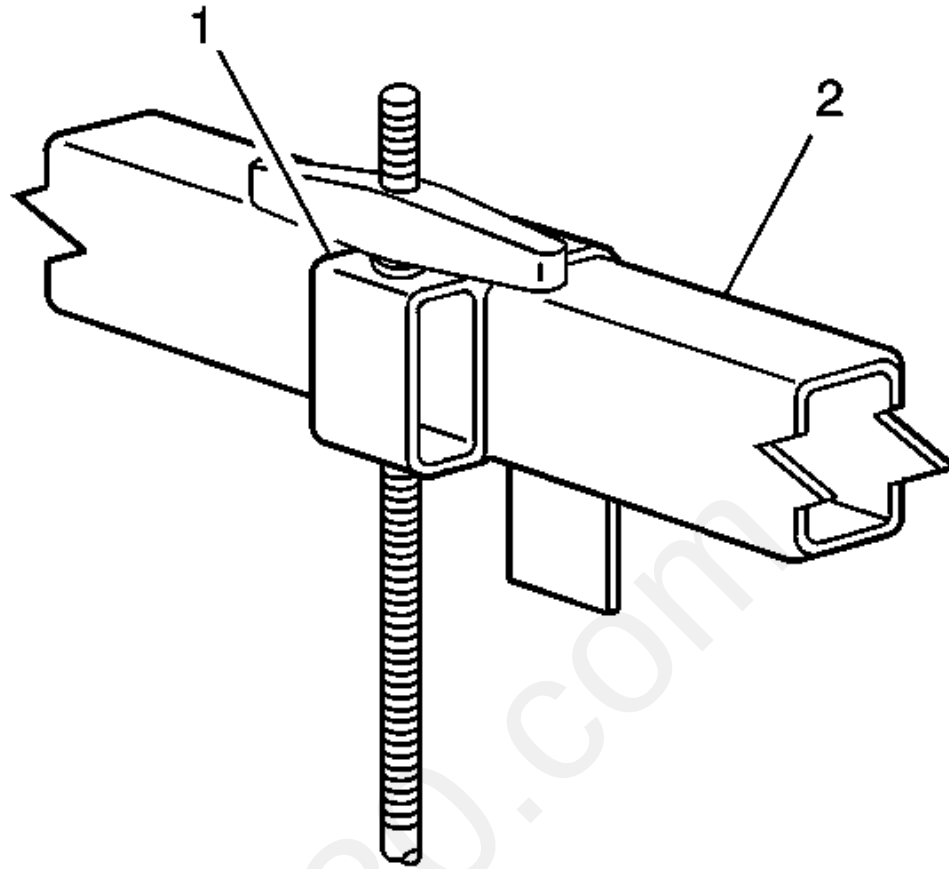


Fig. 8: View Of Lift Hook & Radiator Shelf Tube Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Install lift hook assembly (1) to the engine support fixture (2) engine lift bracket.
10. Tighten the wing nut until the engine weight is supported by the engine support fixture and no longer carried by the engine mounts.

ENGINE MOUNT INSPECTION

NOTE: 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. Observe the engine mount while raising the engine. Raising the engine removes the weight from the engine mount and creates slight tension on the rubber.
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.

Engine mount replacement. Refer to [Engine Mount Replacement - Left Side](#), or [Engine Mount Replacement - Right Side](#).

ENGINE MOUNT REPLACEMENT - LEFT SIDE

Removal Procedure

1. Install the engine support fixture. Refer to [Engine Support Fixture](#).
2. Remove the left front wheel. Refer to [Tire and Wheel Removal and Installation](#).
3. Remove the left front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#).
4. Remove the left side catalytic converter. Refer to [Catalytic Converter Replacement - Left Side \(LFX\)](#).

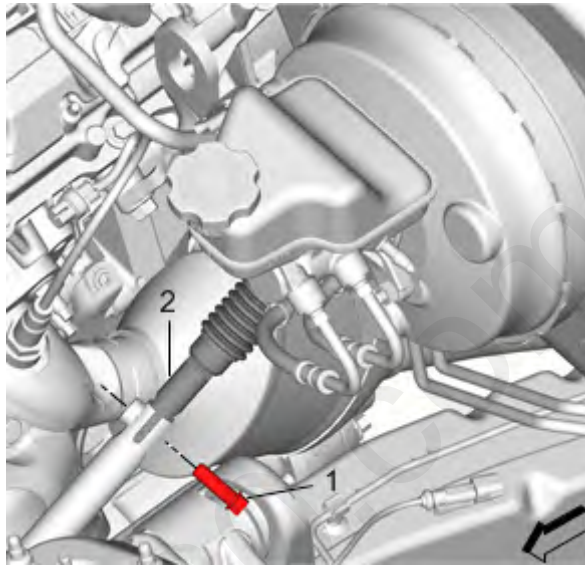


Fig. 9: Intermediate Steering Shaft Lower Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the intermediate steering shaft lower bolt (1) and disconnect the intermediate steering shaft (2) from the lower steering shaft assembly.

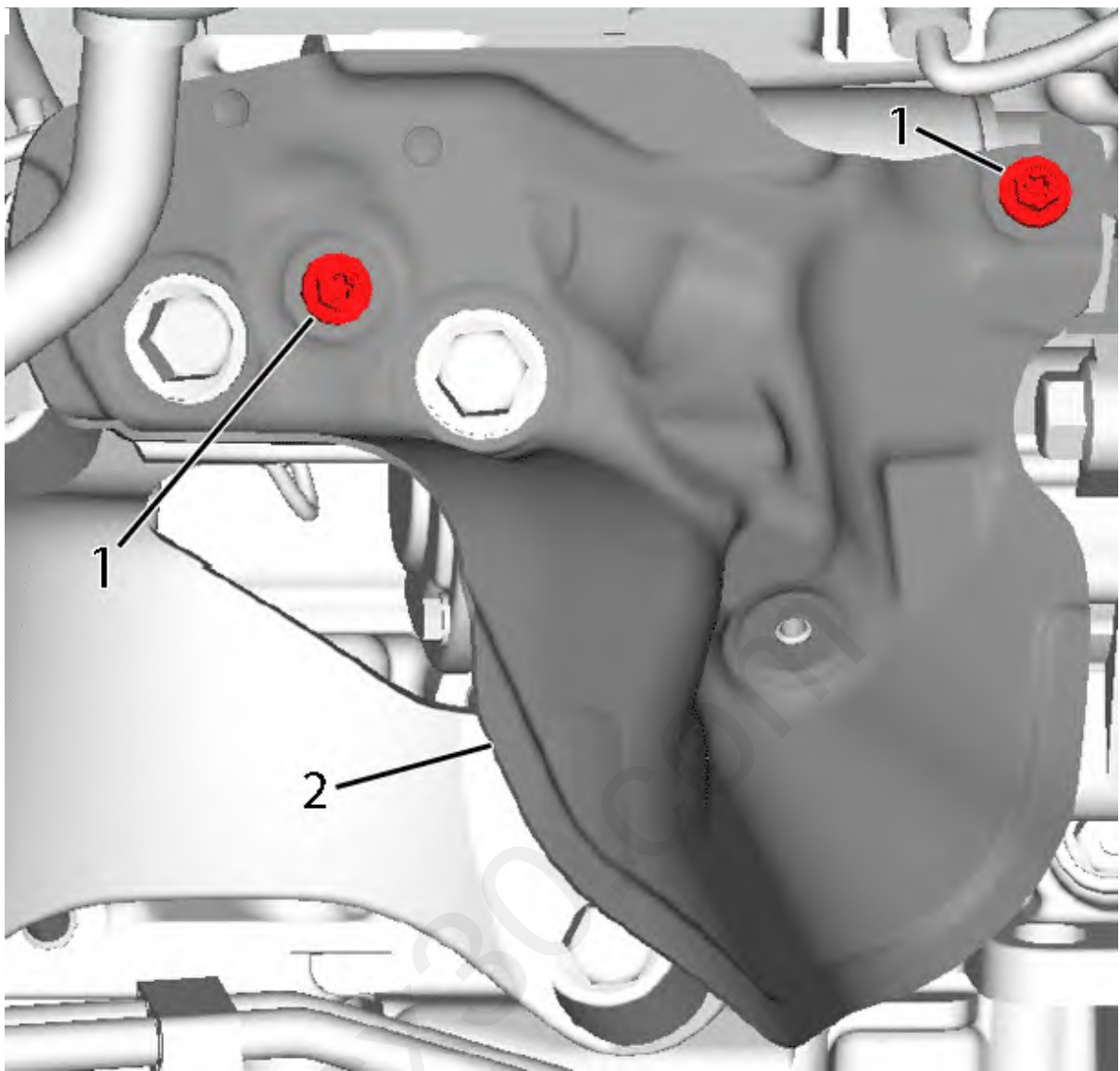


Fig. 10: Engine Mount Bracket Shield And Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine mount bracket shield bolts (1).
7. Remove the engine mount bracket shield (2)

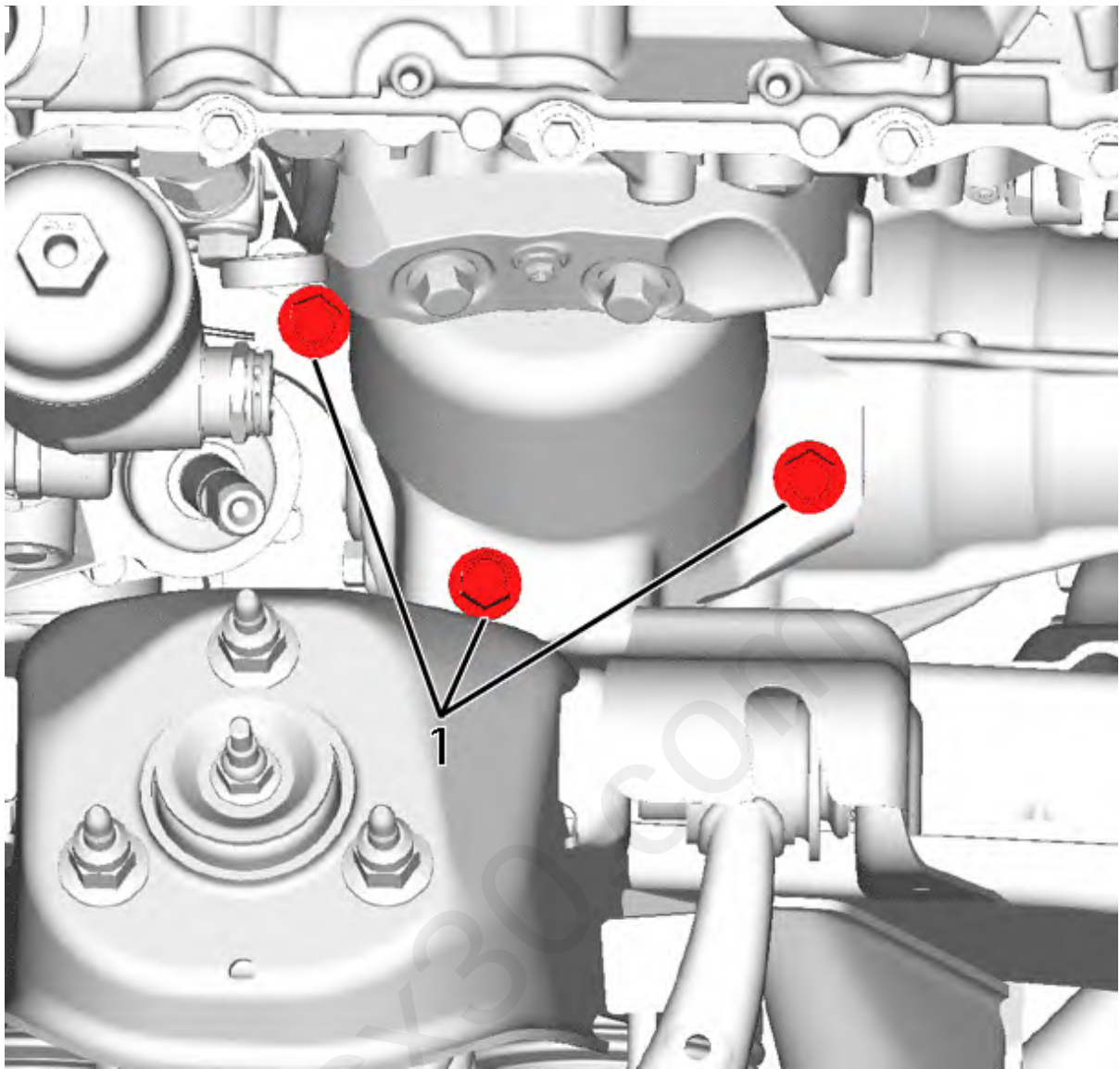


Fig. 11: Left Upper Engine Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

8. Remove the Left upper engine mount bolts (1).

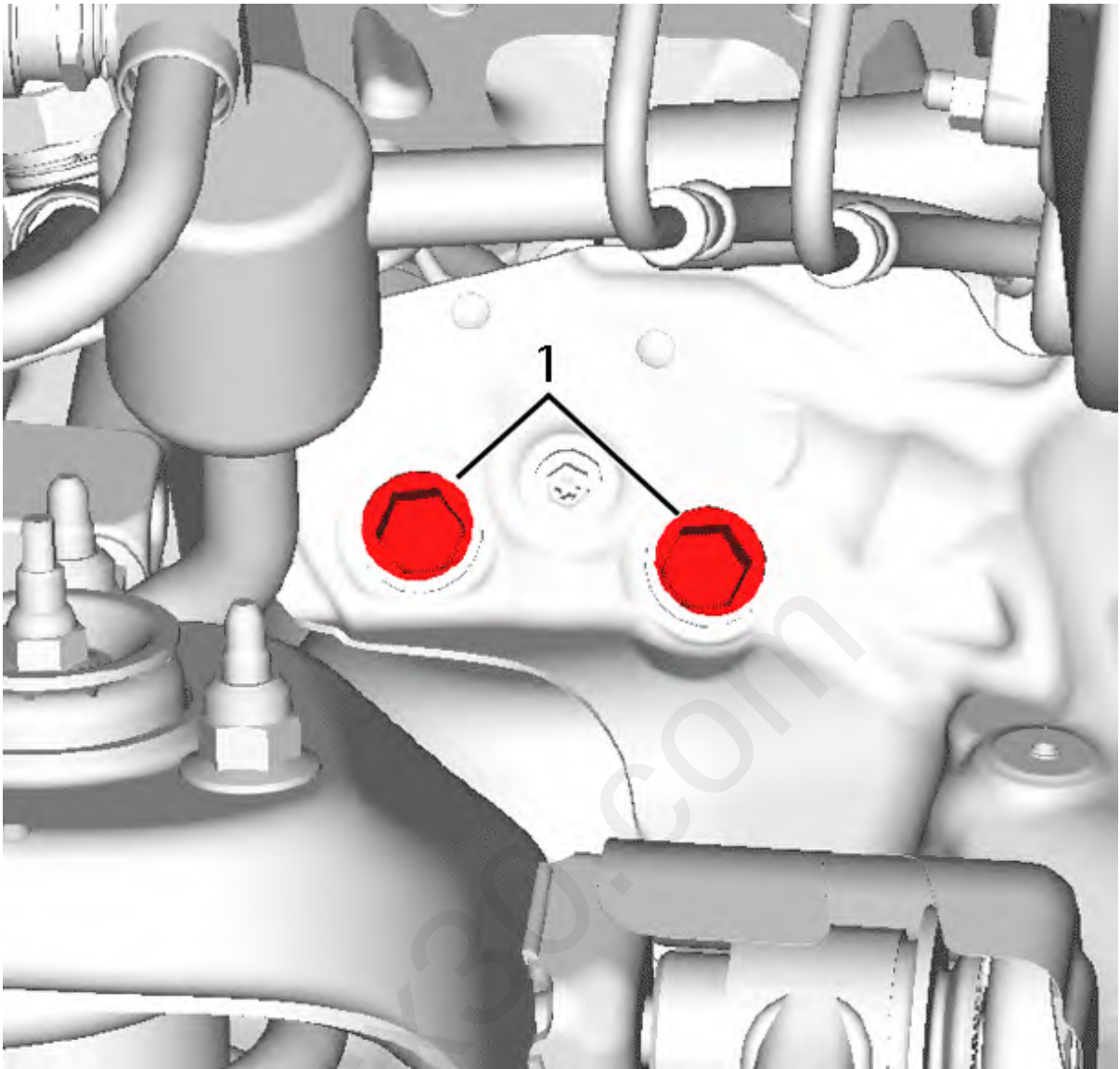


Fig. 12: Engine Mount Bracket Bolts

Courtesy of GENERAL MOTORS COMPANY

9. Remove the right engine mount to engine mount bracket bolts (1).
10. Adjust the support fixture as necessary to provide clearance to remove the engine mount.
11. Remove engine mount.

Installation Procedure

1. Install engine mount.

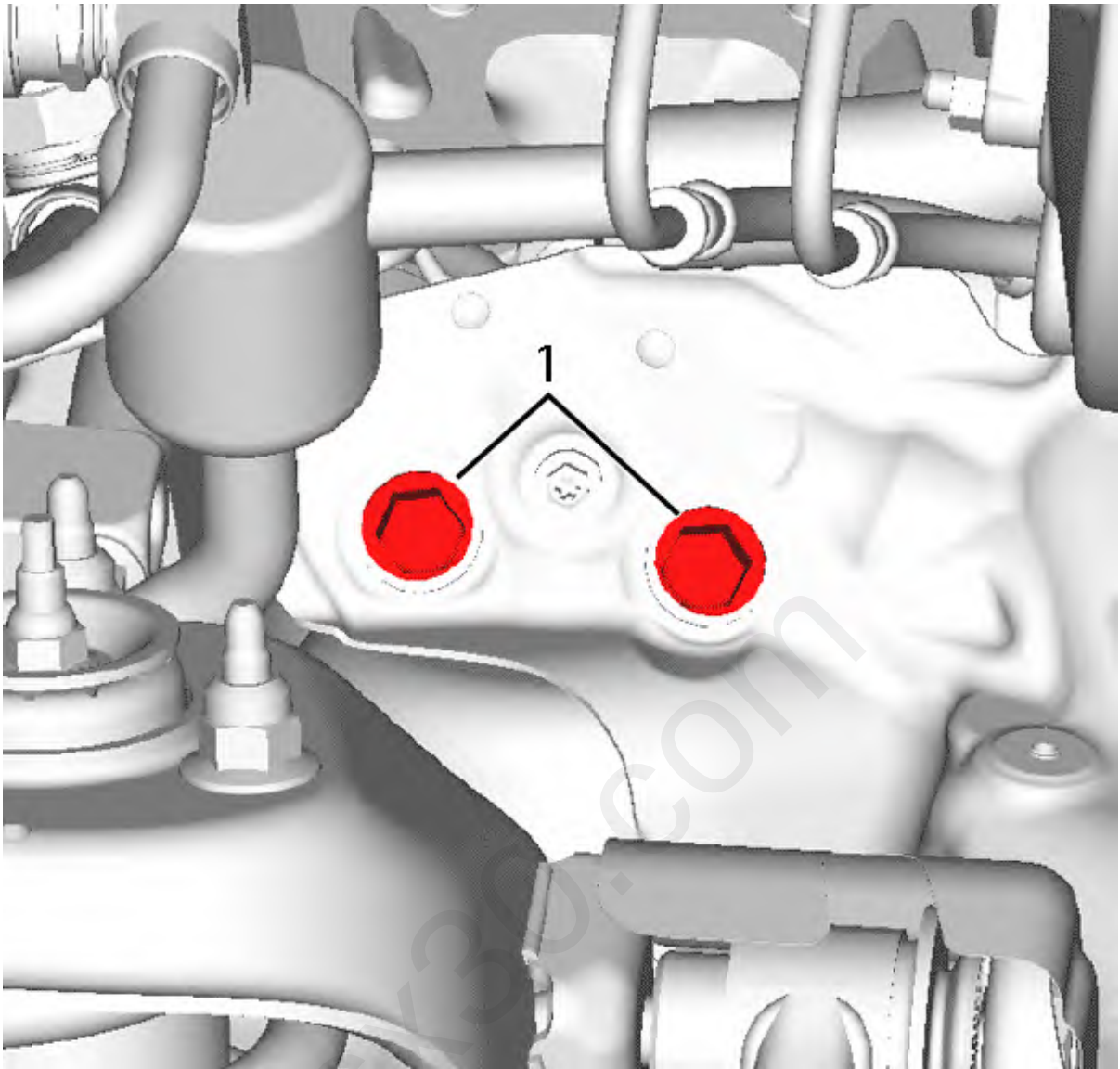


Fig. 13: Engine Mount Bracket Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution**

2. Install the right engine mount to engine mount bracket bolts (1) and tighten to 50 (37 lb ft) plus 60-75 degrees.

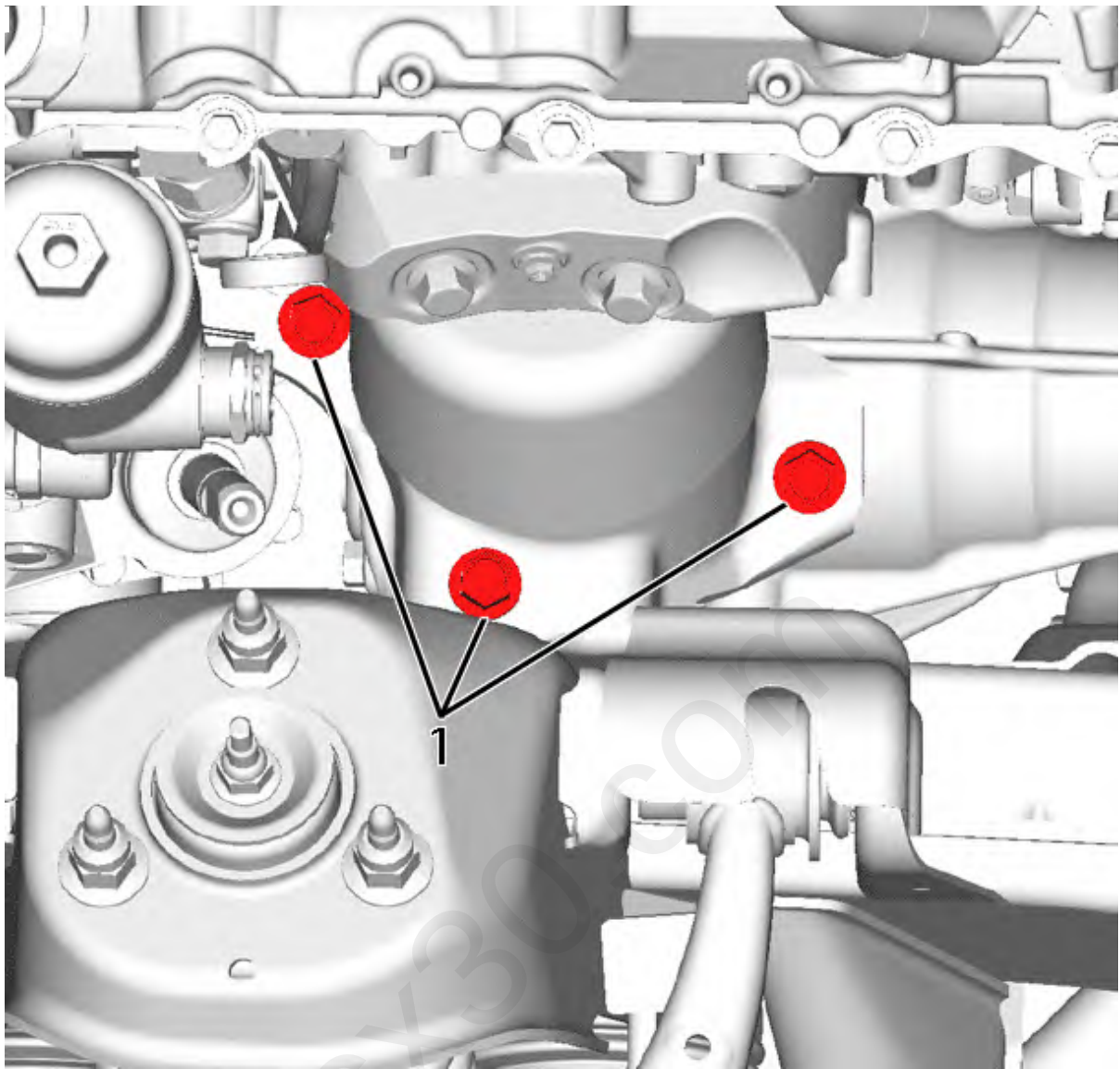


Fig. 14: Left Upper Engine Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

3. Install the right upper engine mount bolts (1) tighten to 50 (37 lb ft) plus 60-75 degrees..

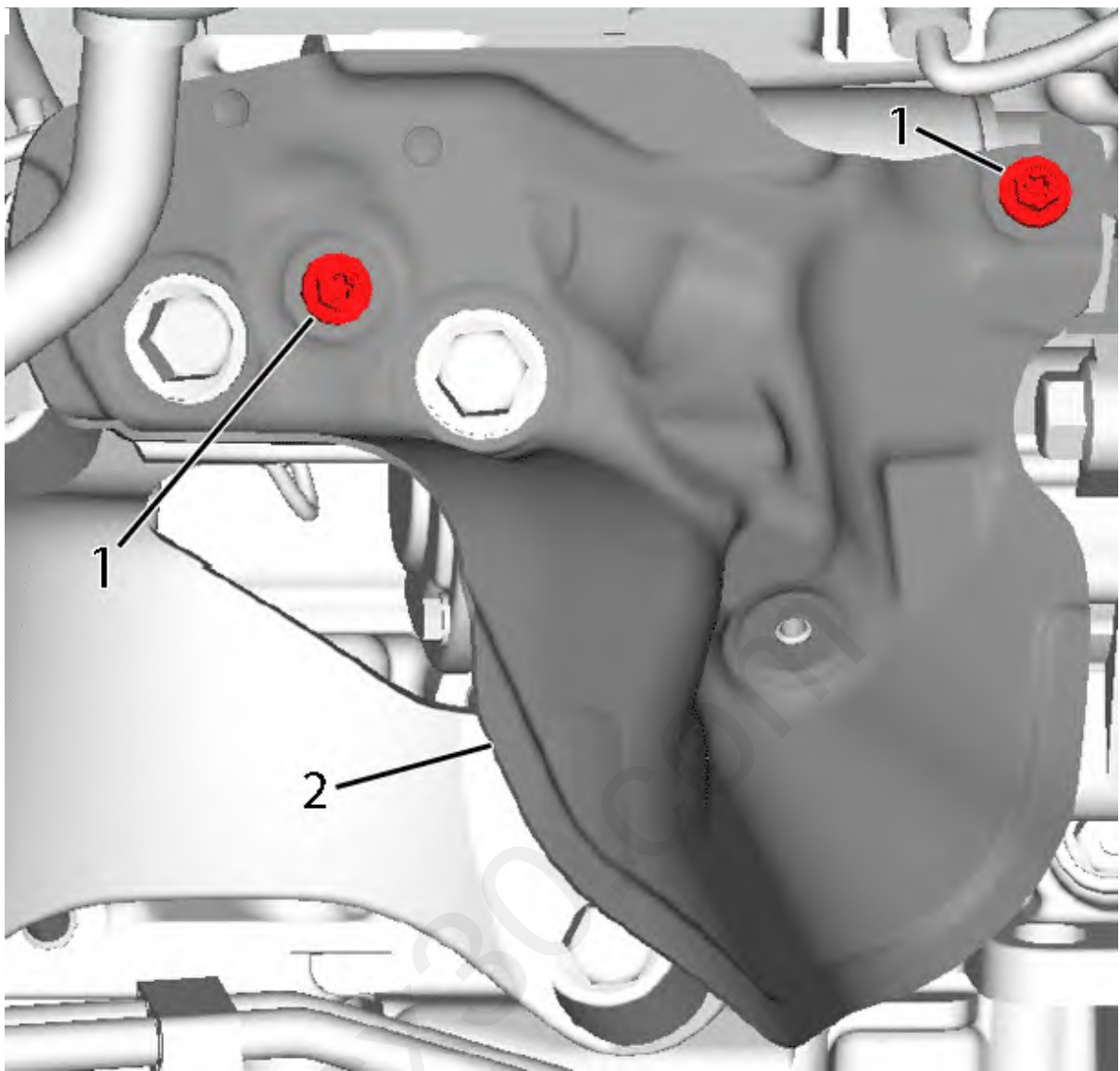
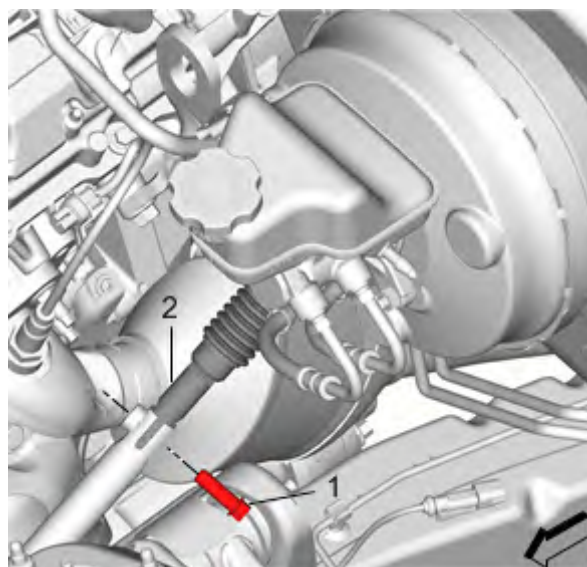


Fig. 15: Engine Mount Bracket Shield And Bolts
Courtesy of GENERAL MOTORS COMPANY

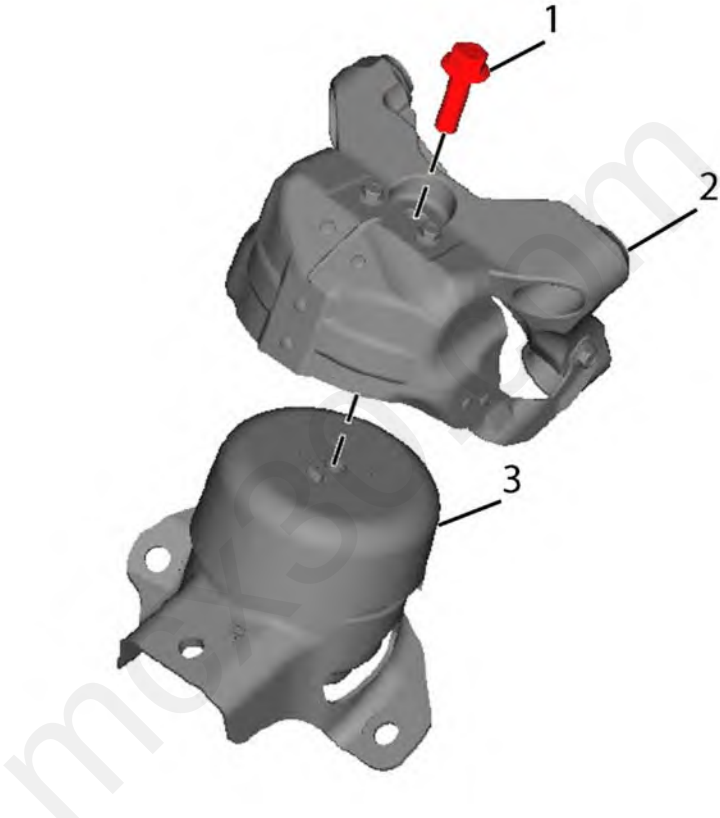
4. Install the engine mount bracket shield (2)
5. Install the engine mount bracket shield bolts (1) and tighten to 5 (44 lb in).



Callout	Component Name
1	Fig. 16: Intermediate Steering Shaft Lower Bolt Courtesy of GENERAL MOTORS COMPANY

6. Connect the intermediate steering shaft (2) to the lower steering shaft assembly.
7. Install the intermediate steering shaft lower bolt (1) and tighten to 45 (33 lb ft)
8. Install the left side catalytic converter. Refer to [Catalytic Converter Replacement - Left Side \(LFX\)](#) .
9. Install the left front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#) .
10. Install the left front wheel. Refer to [Tire and Wheel Removal and Installation](#) .
11. Remove the engine support fixture. Refer to [Engine Support Fixture](#).

ENGINE MOUNT REPLACEMENT - RIGHT SIDE



[Fig. 17: Engine Mount - Right Side](#)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove the right side engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side .	
1	Mount to bracket bolt CAUTION: Refer to Fastener Caution . Tighten 70 (52 lb ft)
2	Engine Mount Bracket

Chart	Component Name
3	Engine Mount

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the left side engine mount. Refer to [Engine Mount Replacement - Left Side](#).

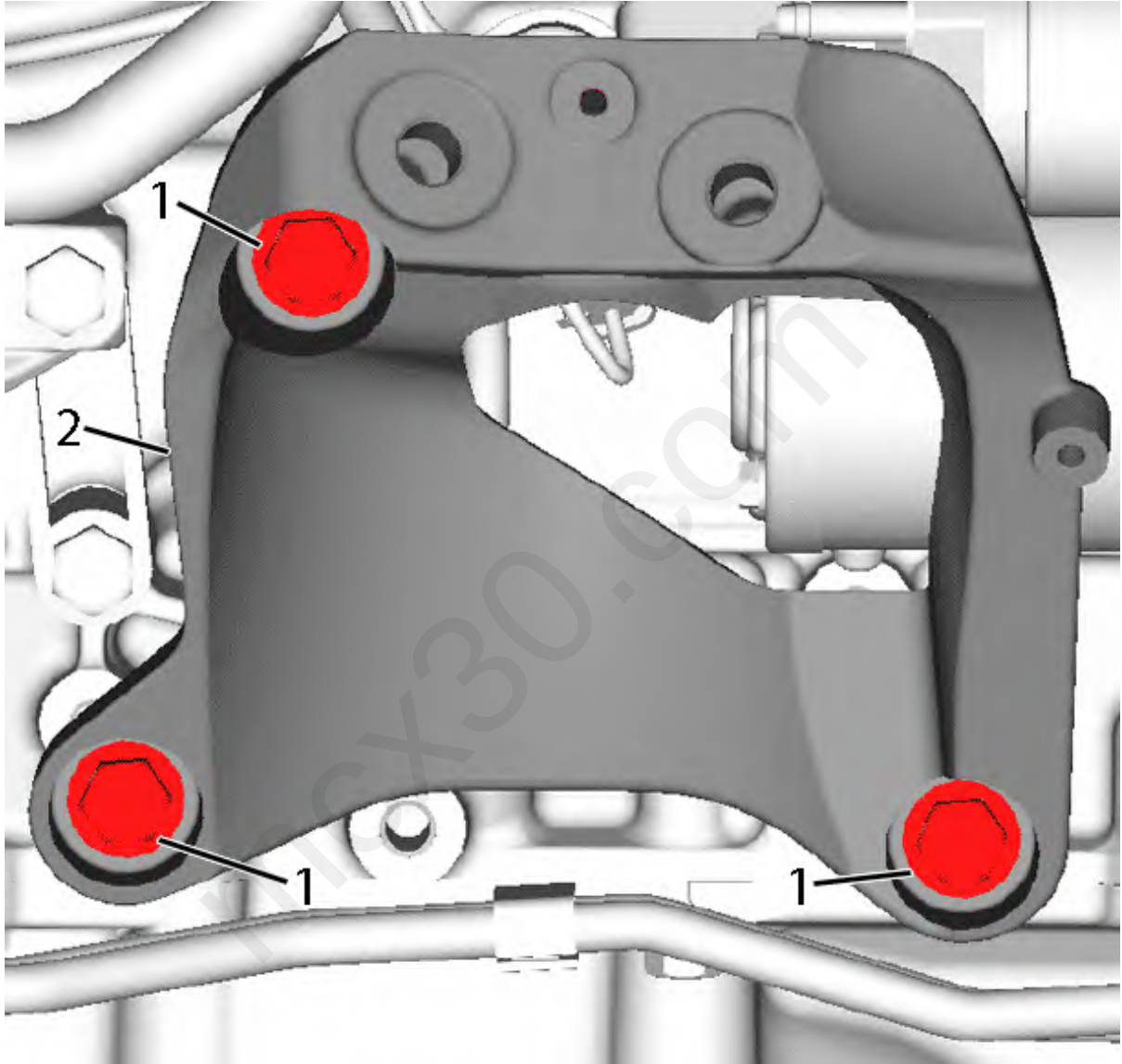


Fig. 18: Engine Mount Bracket And Bolts

Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine mount bracket bolts (1).
3. Remove the engine mount bracket (2).

Installation Procedure

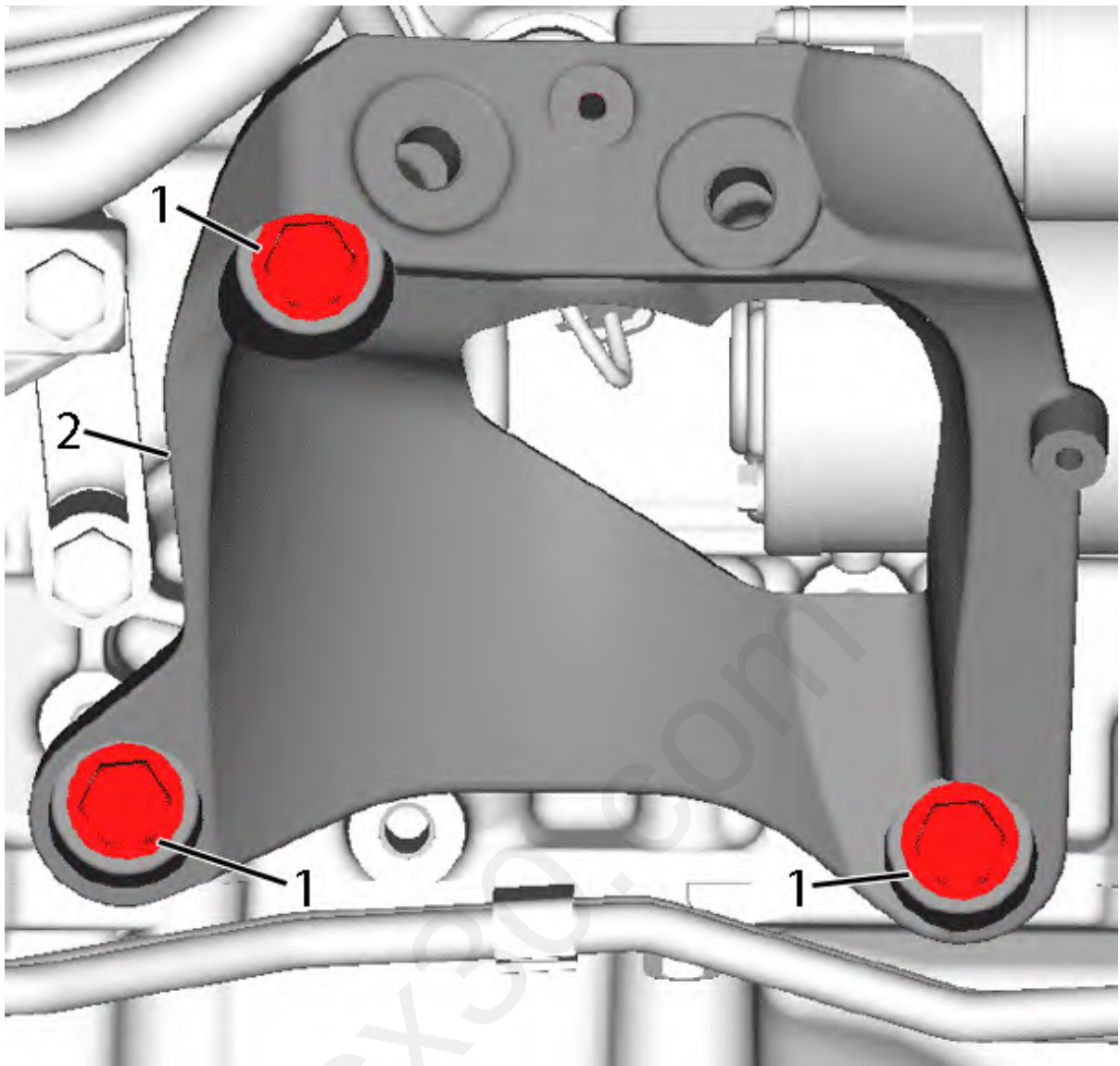


Fig. 19: Engine Mount Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine mount bracket (2).

CAUTION: Refer to [Fastener Caution](#) .

2. Install the engine mount bracket bolts (1) and tighten to 50 (37 lb ft) plus 60-75 degrees.
3. Install the left side engine mount. Refer to [Engine Mount Replacement - Left Side](#).

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

Special Tools

J 39580 Engine Support Stand

Removal Procedure

1. Install the engine support fixture. Refer to [Engine Support Fixture](#).
2. Remove the right front wheel. Refer to [Tire and Wheel Removal and Installation](#) .
3. Remove the right front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#) .

- the right side catalytic converter. Refer to [Catalytic Converter Replacement - Right Side \(LFX\)](#).
5. Remove the radiator outlet pipe. Refer to [Radiator Outlet Pipe Replacement](#).

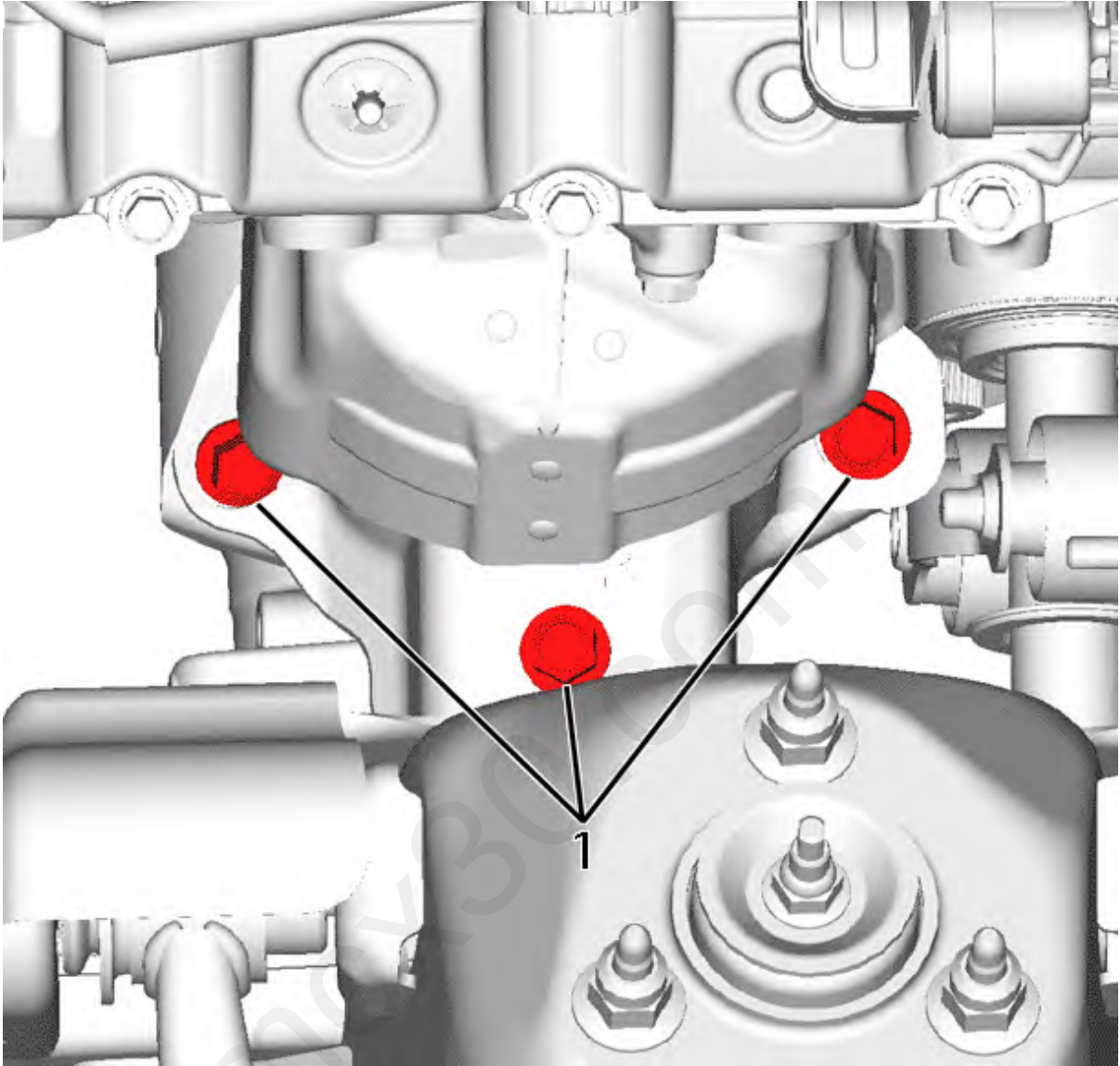


Fig. 20: Right Upper Engine Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the right upper engine mount bolts (1).

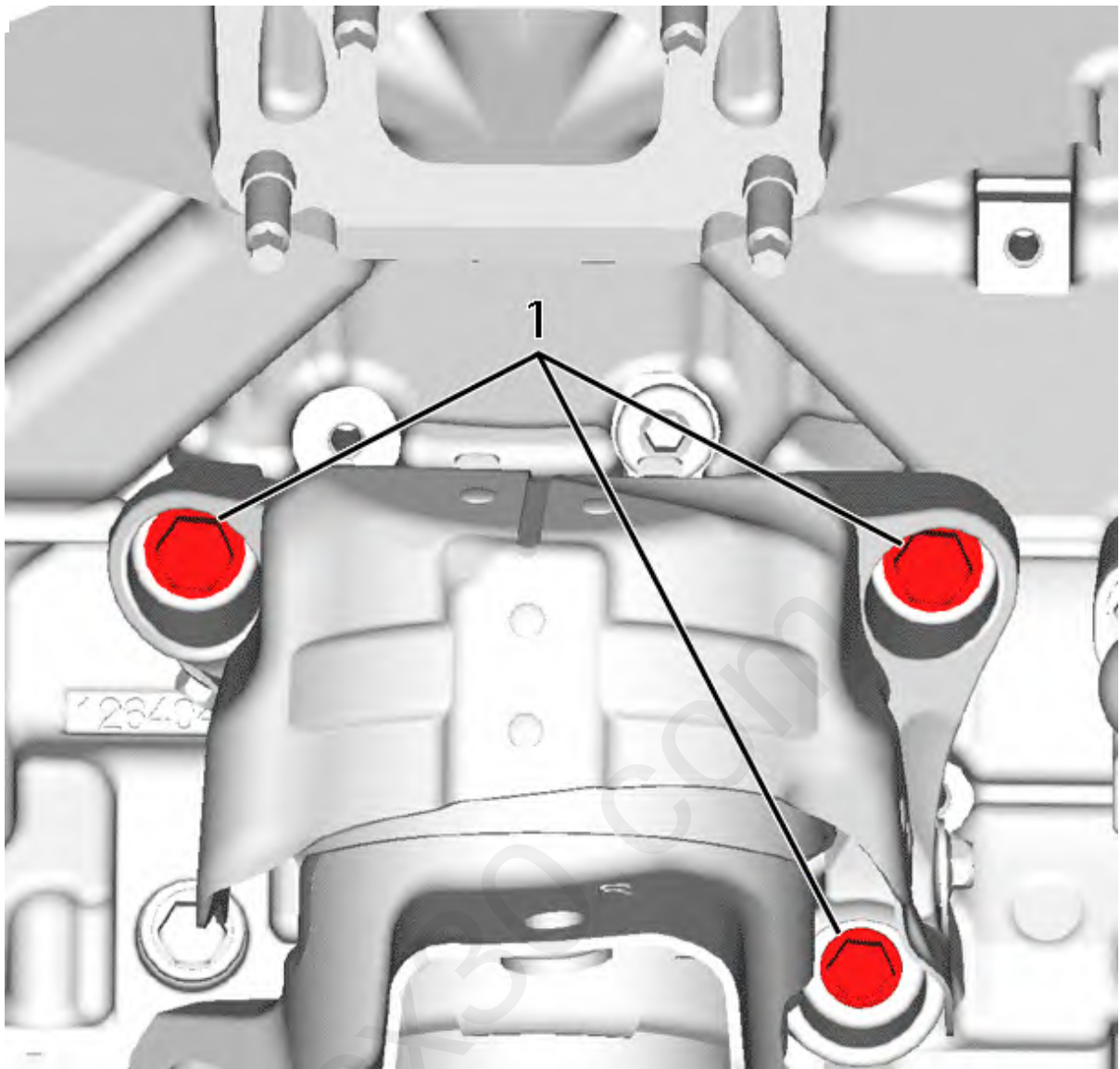


Fig. 21: Right Engine Mount To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the right engine mount to engine bolts (1).
8. Remove engine mount bracket and engine mount as an assembly.
9. Transfer parts as necessary.

Installation Procedure

1. Install engine mount bracket and engine mount as an assembly.

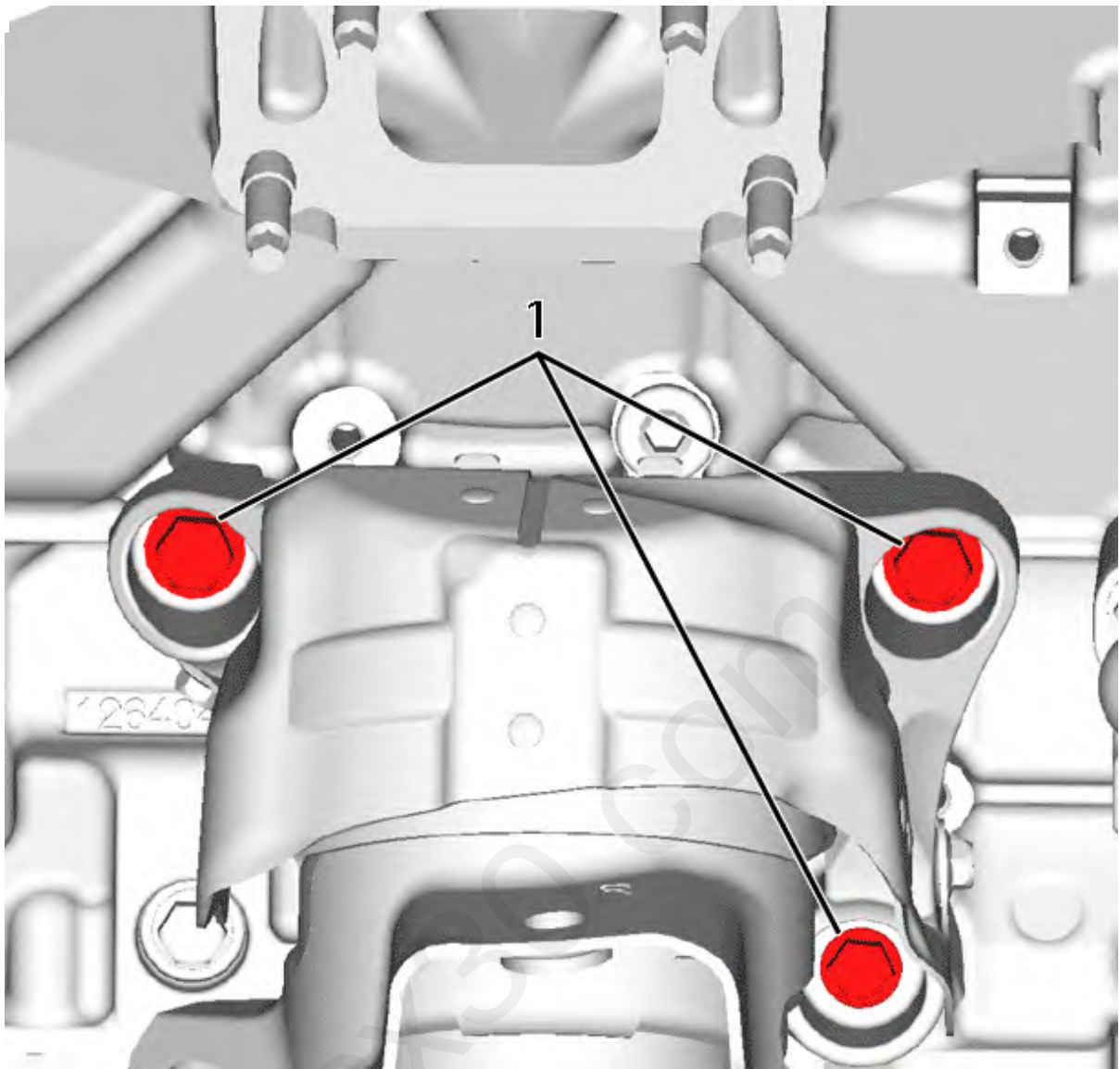


Fig. 22: Right Engine Mount To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution**

2. Install the right engine mount to engine bolts (1) and tighten to 50 N.m (37 lb ft) plus 60-75 degrees.

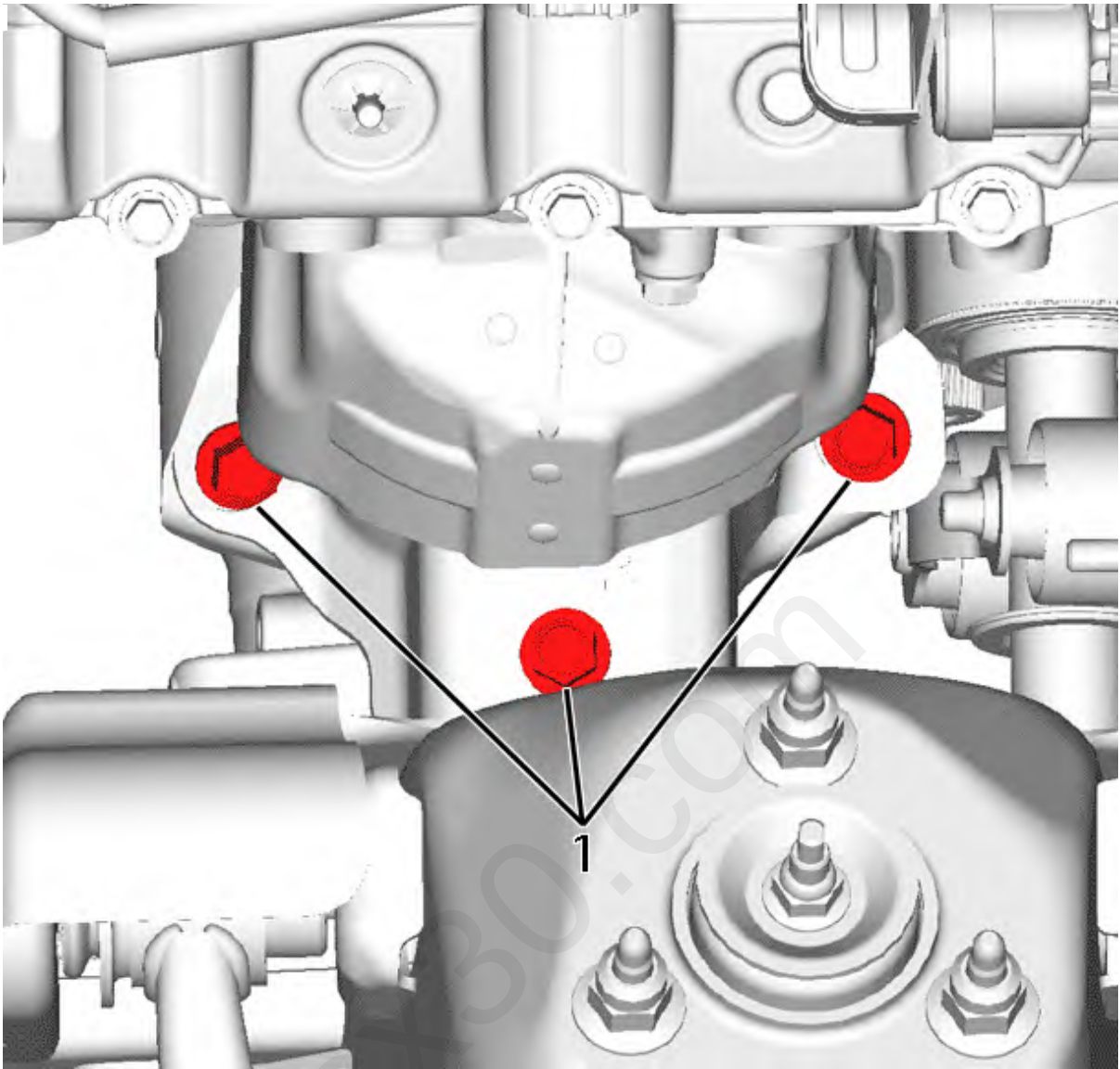


Fig. 23: Right Upper Engine Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

3. Install the right upper engine mount bolts (1) tighten to 50 N.m (37 lb ft) plus 60-75 degrees..
4. Install the radiator outlet pipe. Refer to [Radiator Outlet Pipe Replacement](#) .
5. Install the right side catalytic converter. Refer to [Catalytic Converter Replacement - Right Side \(LFX\)](#) .
6. Install the right front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#) .
7. Install the right front wheel. Refer to [Tire and Wheel Removal and Installation](#) .
8. Remove the engine support fixture. Refer to [Engine Support Fixture](#).

INTAKE MANIFOLD INSULATOR REPLACEMENT

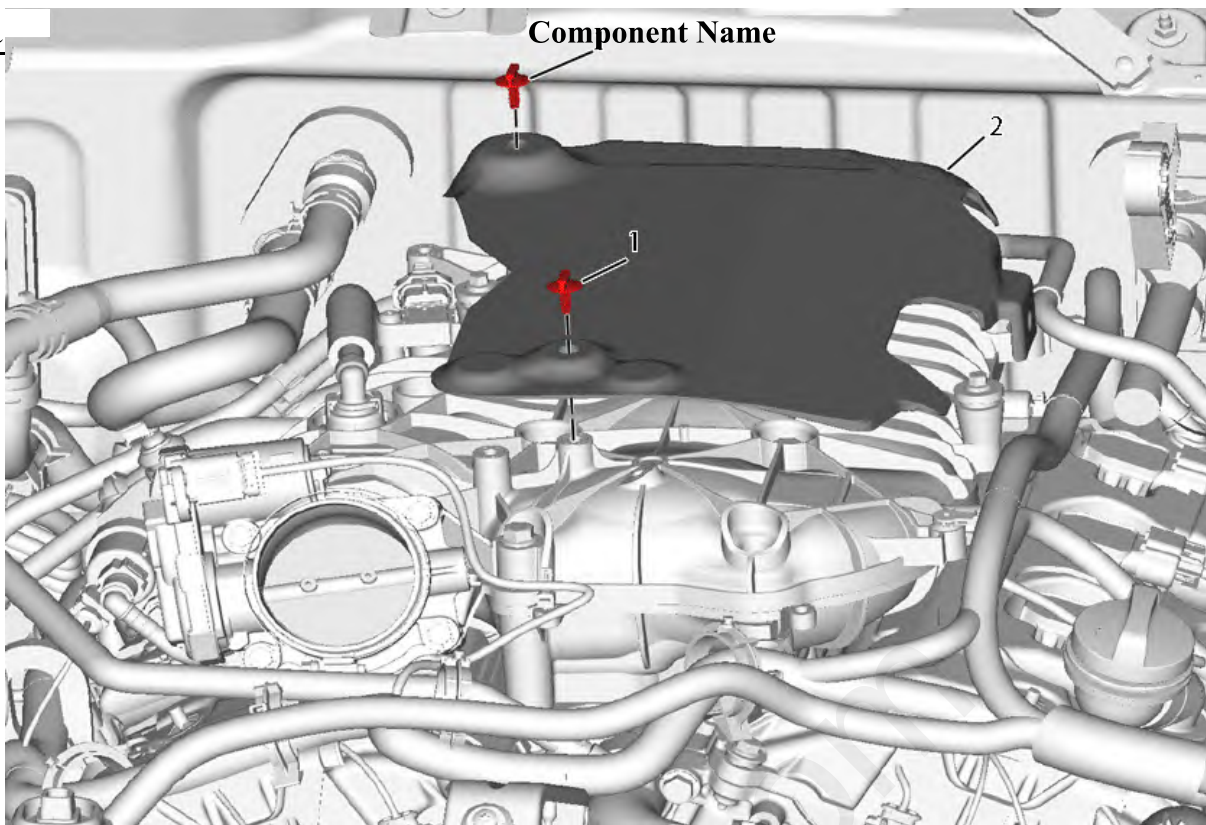


Fig. 24: Intake Manifold Insulator

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
1	Intake Manifold Insulator Retainers (Qty;2)
2	Intake Manifold Insulator

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

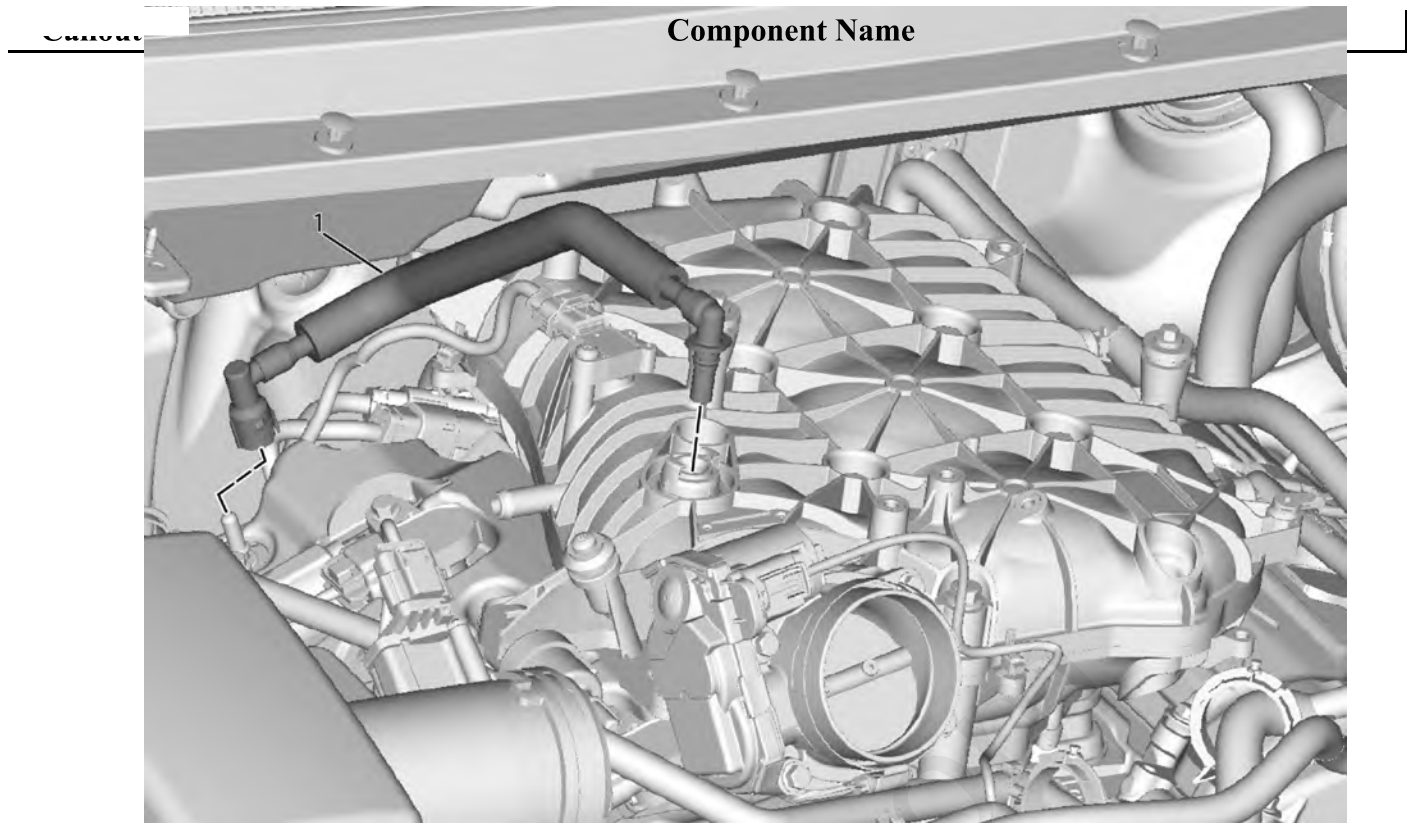


Fig. 25: Positive Crankcase Ventilation Hose/Pipe/Tube (Dirty Air)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
1	PCV Pipe Procedure 1. Disconnect the pipe at right side camshaft cover. Refer to Plastic Collar Quick Connect Fitting Service . 2. Turn the PCV air tube connector 90 degrees to detach the connector from the intake manifold

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

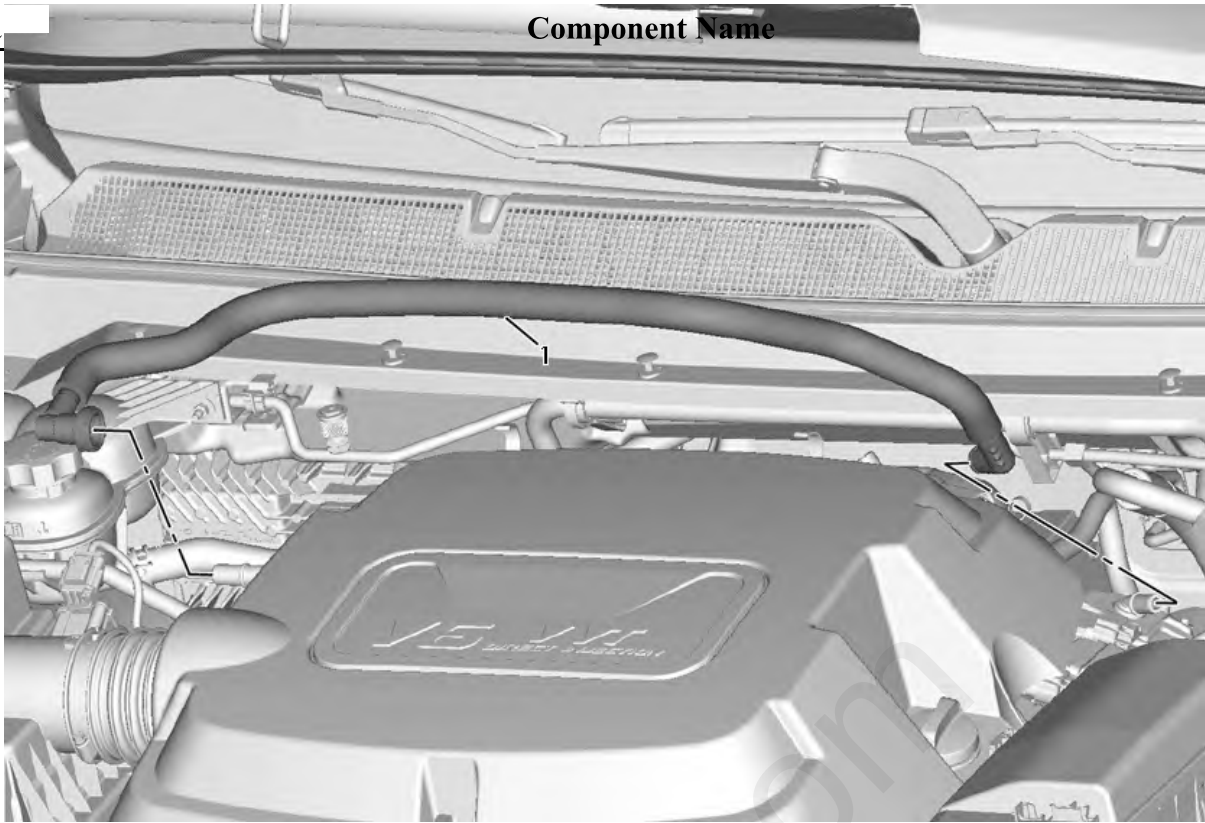


Fig. 26: Positive Crankcase Ventilation Hose/Pipe/Tube (Clean Air)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	PCV Pipe Procedure 1. Disconnect the pipe at the outlet duct. Refer to Plastic Collar Quick Connect Fitting Service . 2. Detach PCV air tube from the left side camshaft cover.

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

1. Remove the plenum front panel. Refer to [Plenum Front Panel Replacement](#) .
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
3. Remove the intake manifold insulator. Refer to [Intake Manifold Insulator Replacement](#)
4. Disconnect the power brake booster vacuum hose from the intake manifold. Refer to [Power Brake Booster Vacuum Hose Replacement \(LFX\)](#) .

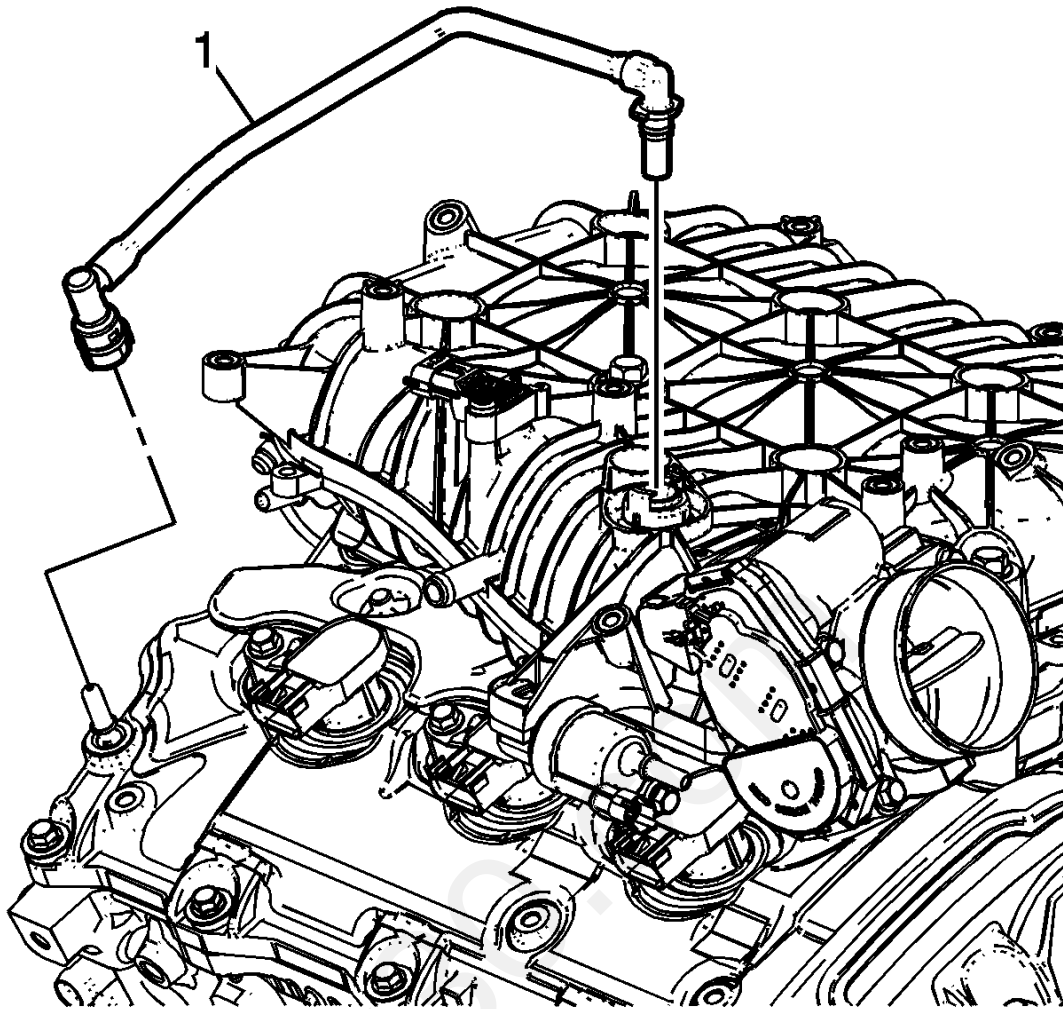


Fig. 27: View Of Positive Crankcase Ventilation Tube

Courtesy of GENERAL MOTORS COMPANY

5. Remove the positive crankcase ventilation (PCV) tube (1). Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement \(Dirty Air\)](#)[Positive Crankcase Ventilation Hose/Pipe/Tube Replacement \(Clean Air\)](#).

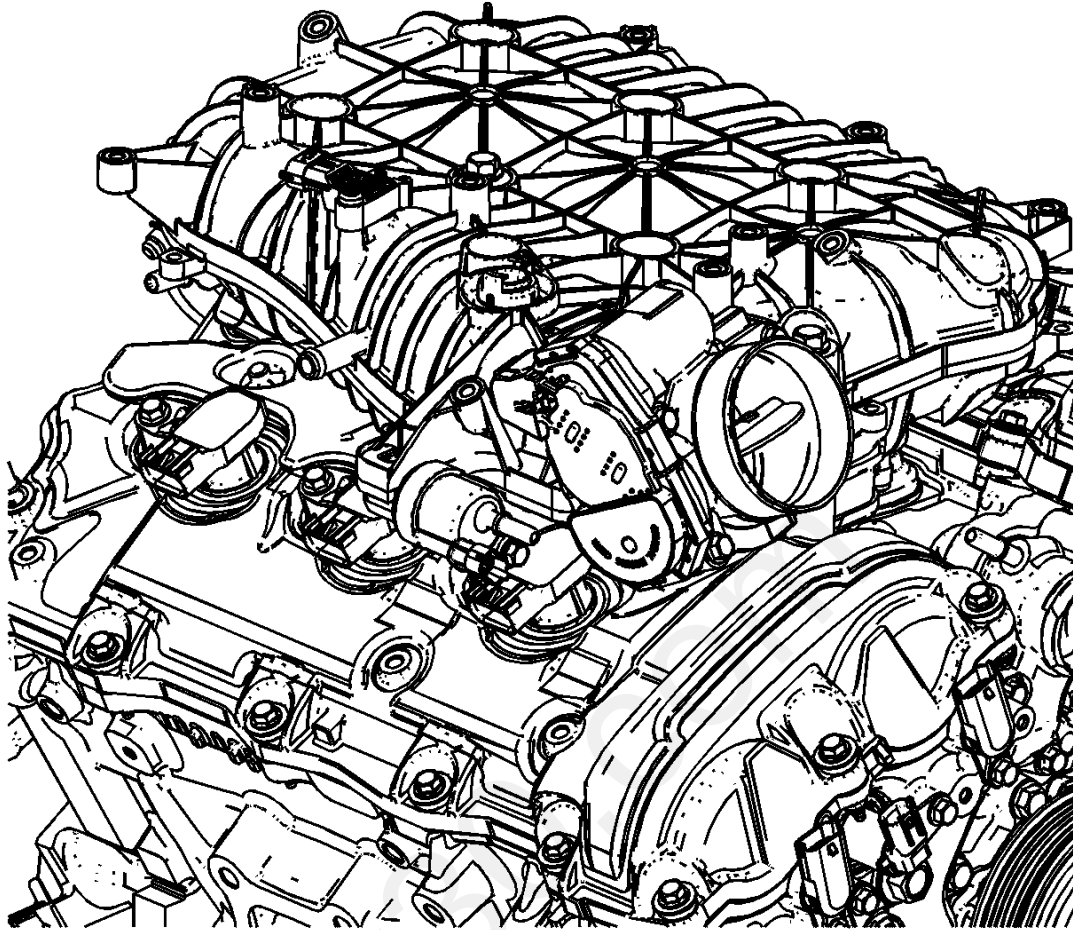


Fig. 28: Evaporative Emission Hose
Courtesy of GENERAL MOTORS COMPANY

6. Remove the evaporative emission (EVAP) pipe. Refer to [**Evaporative Emission Canister Purge Solenoid Valve Replacement**](#) .
7. Remove the fuel pipe shield. Refer to [**Fuel Pipe Shield Replacement**](#) .
8. Disconnect and reposition wire harnesses as necessary.

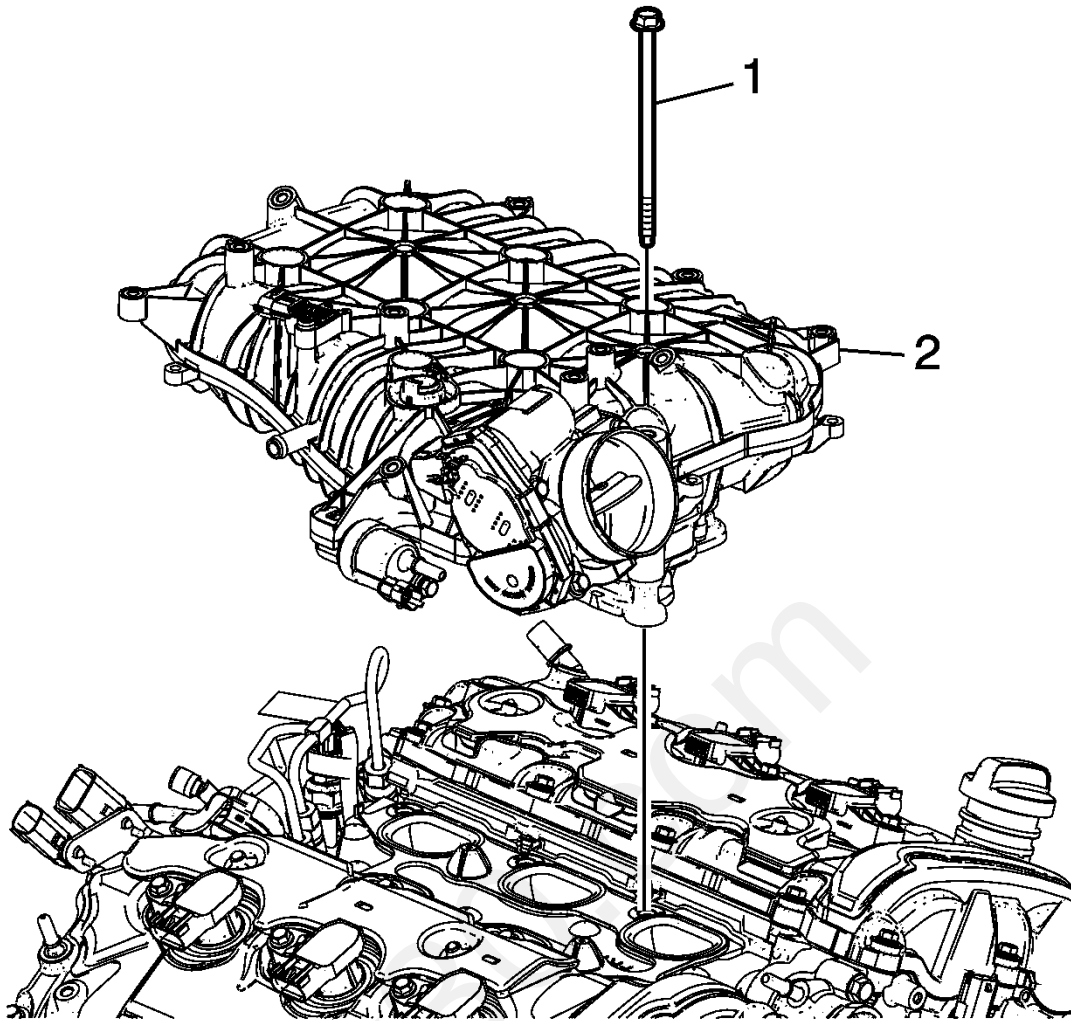


Fig. 29: Intake Manifold Assembly

Courtesy of GENERAL MOTORS COMPANY

9. Remove the intake manifold bolts (1).
10. Remove the intake manifold assembly (2).

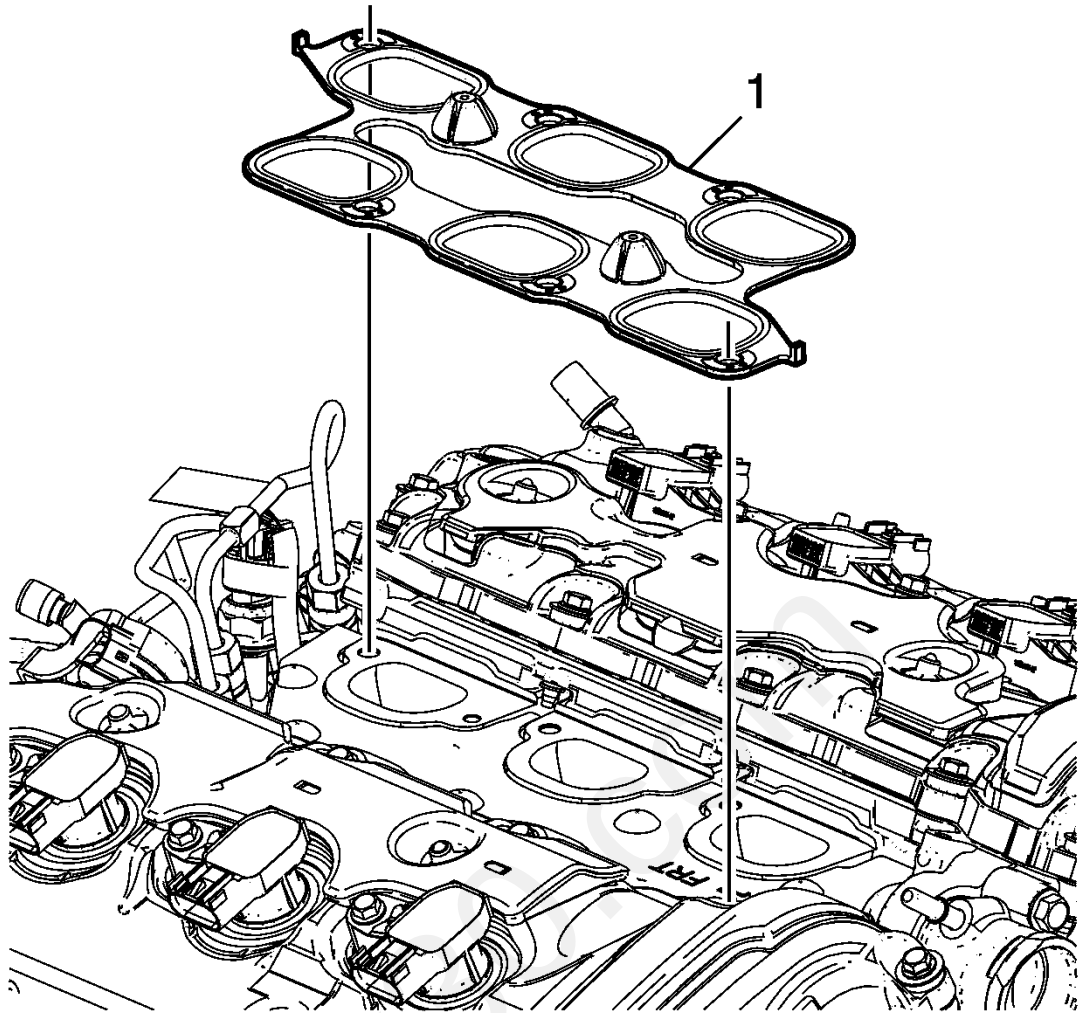


Fig. 30: Intake Manifold Gasket

Courtesy of GENERAL MOTORS COMPANY

11. Remove and discard the intake manifold gasket (1).
12. To clean the intake manifold, refer to [Intake Manifold Cleaning and Inspection](#) .
13. To disassemble the intake manifold, refer to [Intake Manifold Disassemble](#) .

Installation Procedure

1. Assemble the intake manifold if needed. Refer to [Intake Manifold Assemble](#) .

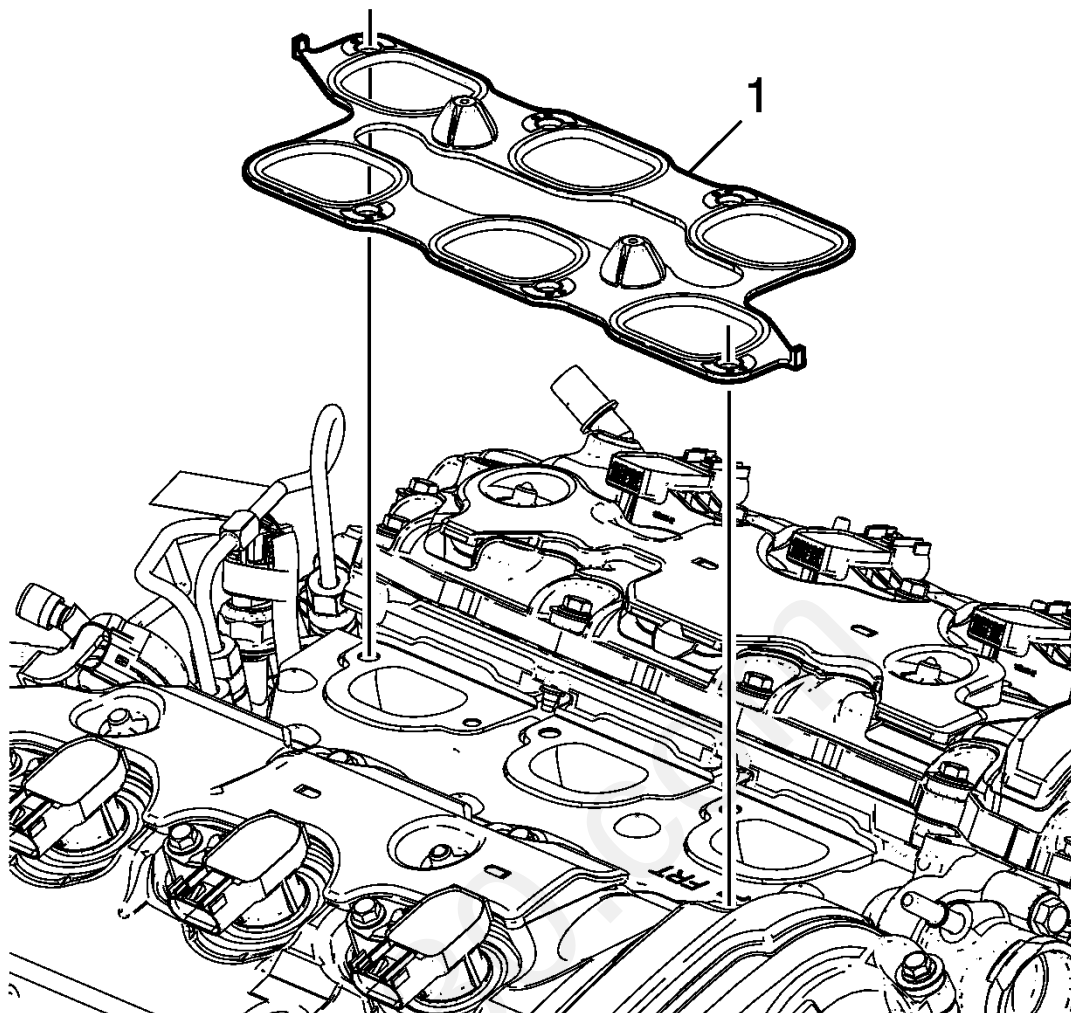


Fig. 31: Intake Manifold Gasket

Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW intake manifold gasket (1).

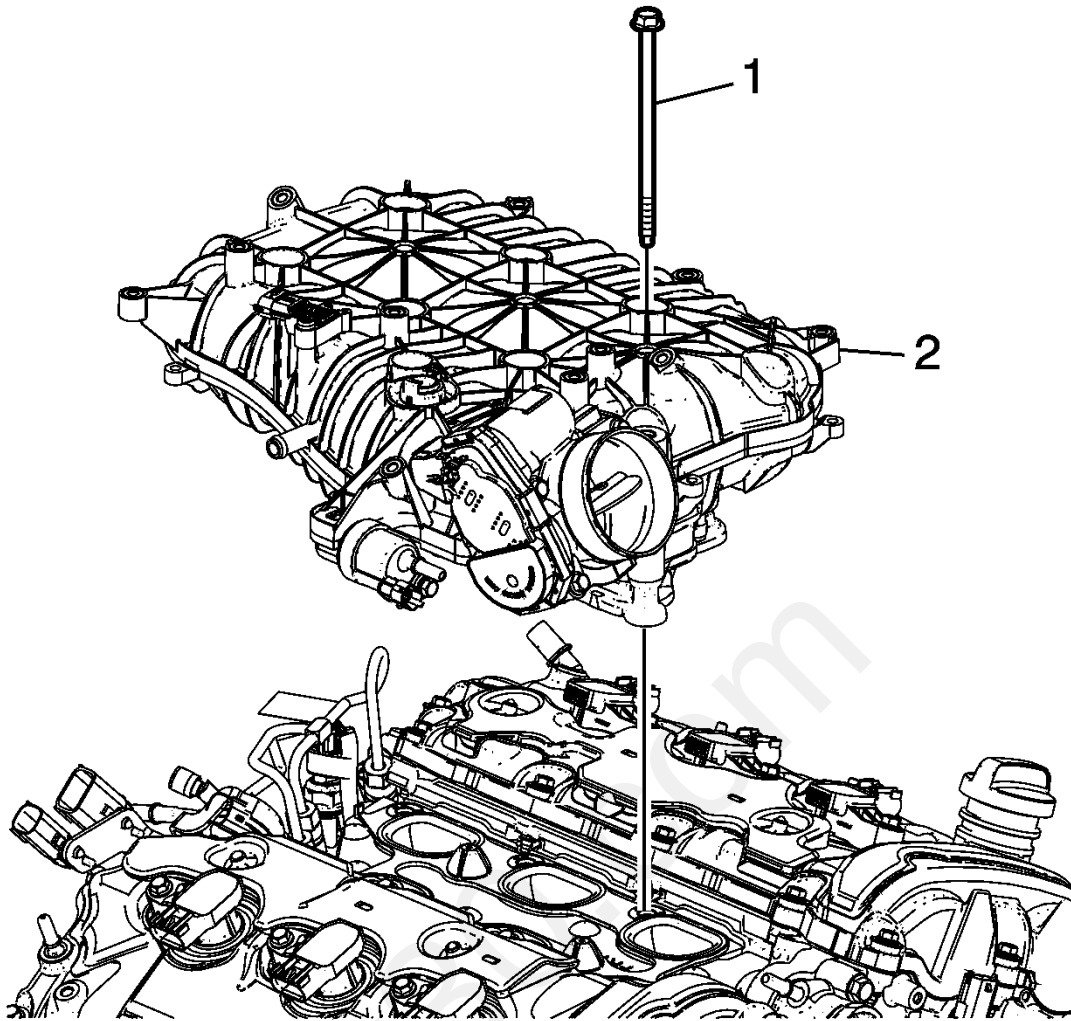


Fig. 32: Intake Manifold Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Install the intake manifold assembly (2).

CAUTION: Refer to **Fastener Caution** .

4. Install the intake manifold bolts (1).

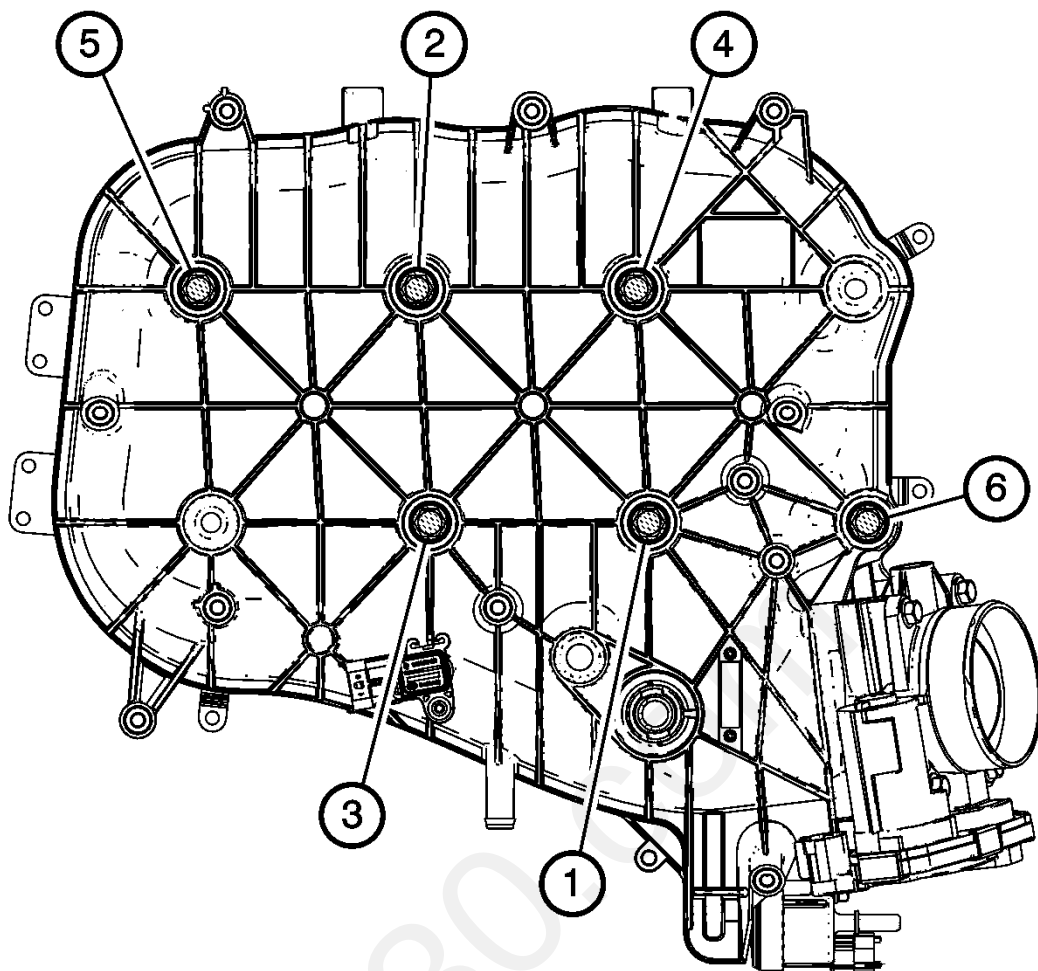


Fig. 33: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the intake manifold bolts in the sequence shown.
6. Tighten the intake manifold bolts in sequence to 25 N.m (18 lb ft).
7. Tighten the intake manifold bolts a second pass in sequence to 25 N.m (18 lb ft).
8. Install the fuel pipe shield. Refer to [Fuel Pipe Shield Replacement](#).
9. Position wire harnesses and connect as necessary.

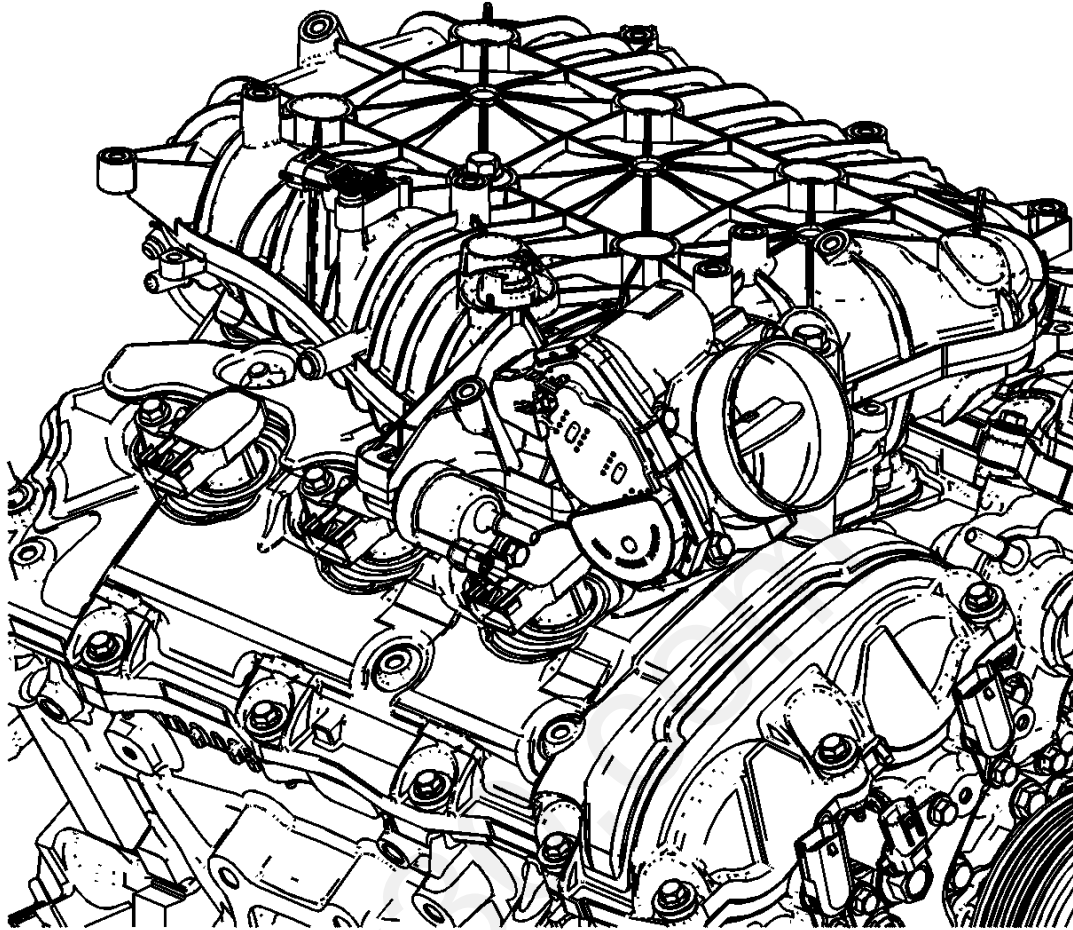


Fig. 34: Evaporative Emission Hose
Courtesy of GENERAL MOTORS COMPANY

10. Install the evaporative emission (EVAP) pipe. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .

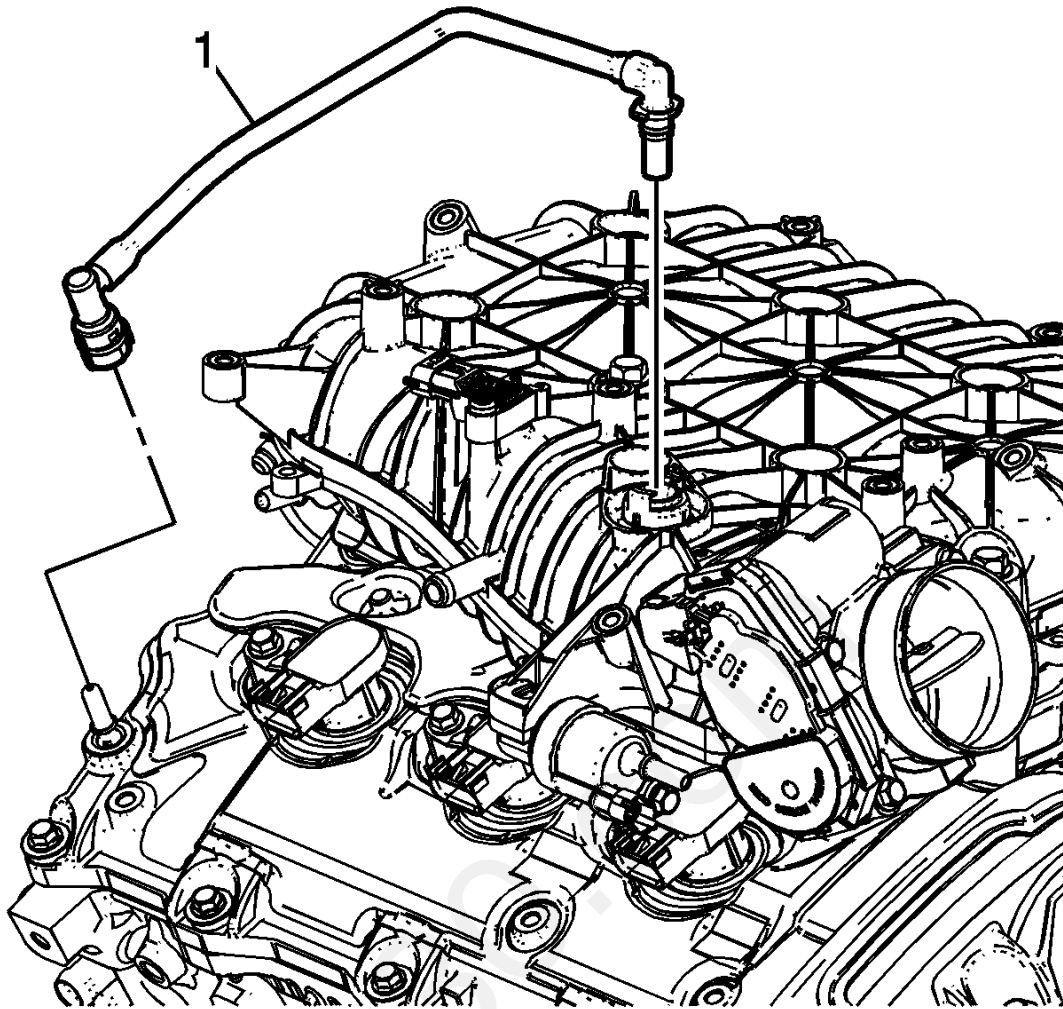


Fig. 35: View Of Positive Crankcase Ventilation Tube

Courtesy of GENERAL MOTORS COMPANY

11. Install the positive crankcase ventilation (PCV) tube (1). Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement \(Dirty Air\)](#)[Positive Crankcase Ventilation Hose/Pipe/Tube Replacement \(Clean Air\)](#).
12. Connect the power brake booster vacuum hose to the intake manifold. Refer to [Power Brake Booster Vacuum Hose Replacement \(LFX\)](#).
13. Install the intake manifold insulator. Refer to [Intake Manifold Insulator Replacement](#).
14. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
15. Install the plenum front panel. Refer to [Plenum Front Panel Replacement](#).

OIL LEVEL INDICATOR TUBE REPLACEMENT

Removal Procedure

1. Remove the oil level indicator.
2. Remove the left engine mount bracket. Refer to [Engine Mount Bracket Replacement - Left Side](#)
3. Detach the wiring harness retainer from the oil level indicator tube.

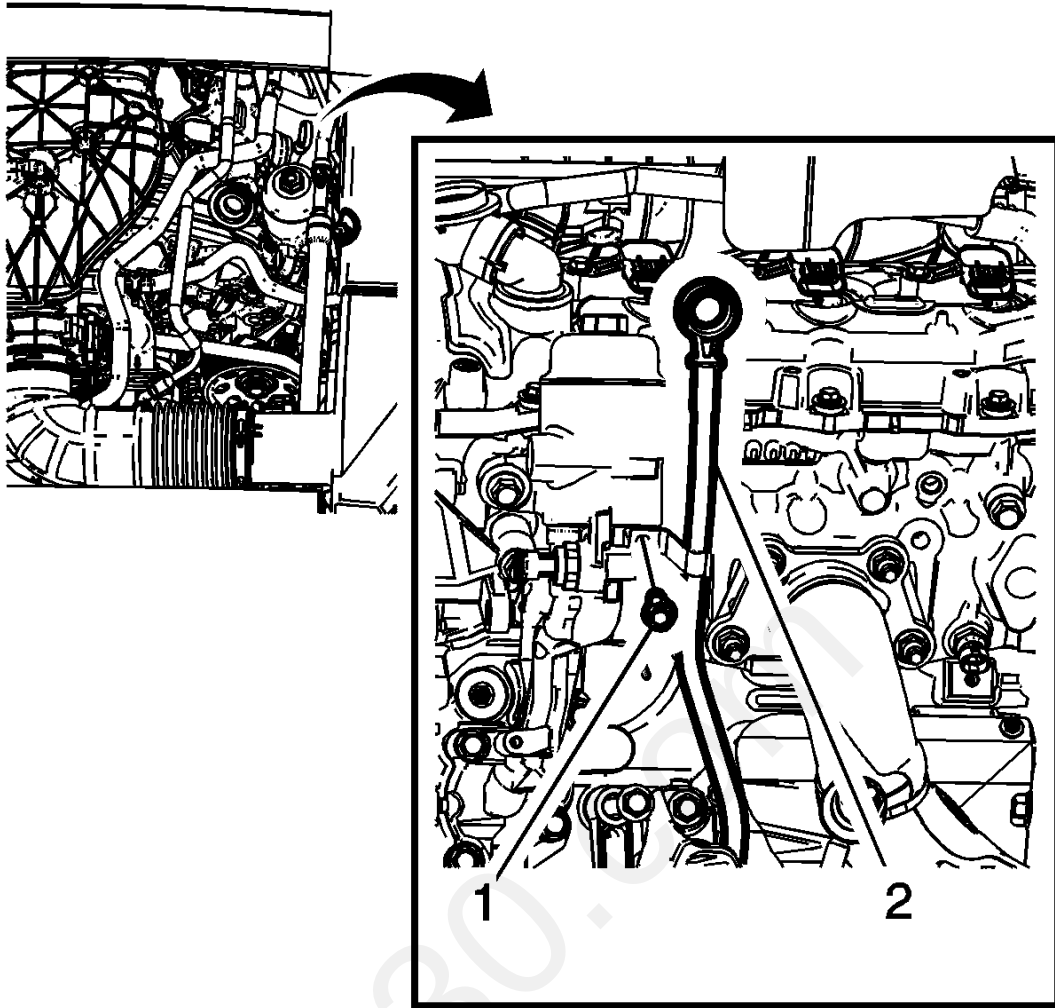


Fig. 36: Indicator Tube & Bracket Bolt

Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil level indicator tube bracket bolt (1).
5. Remove the oil level indicator and tube (2) by sliding the tube out from the lower crankcase hole.

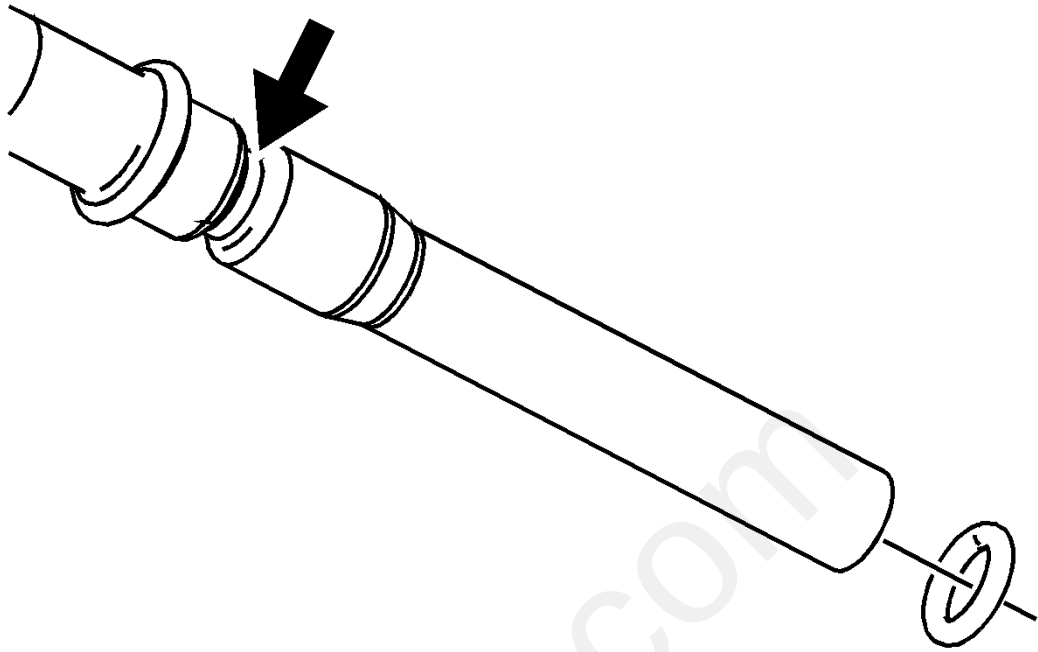


Fig. 37: View Of Oil Level Indicator Tube O-Ring

Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the O-ring from the oil level indicator tube if damaged.

Installation Procedure

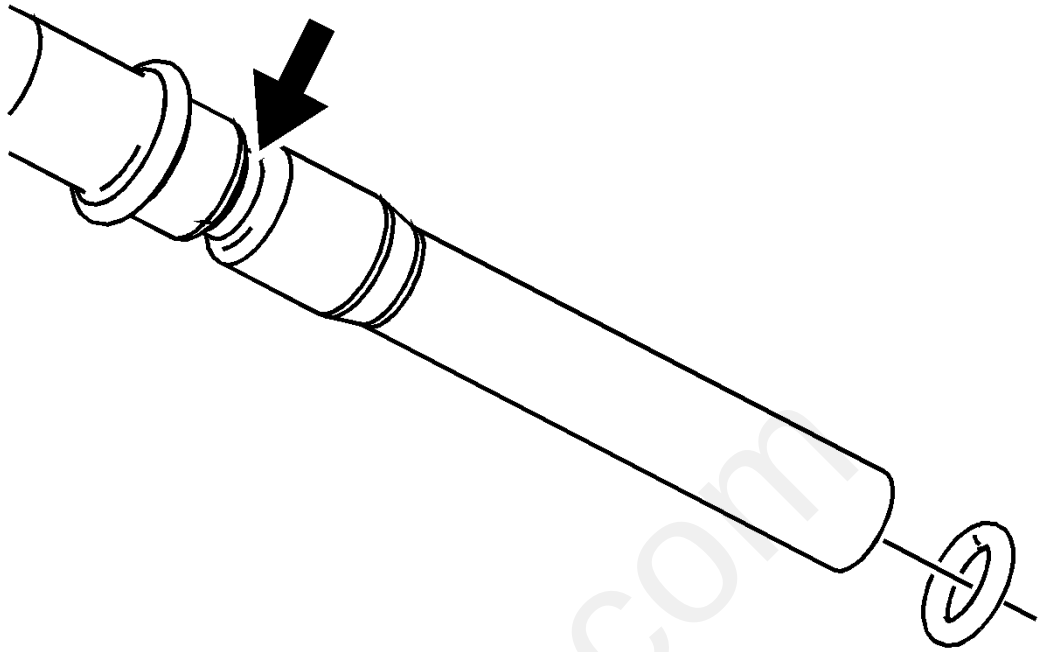


Fig. 38: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW O-ring on the oil level indicator tube

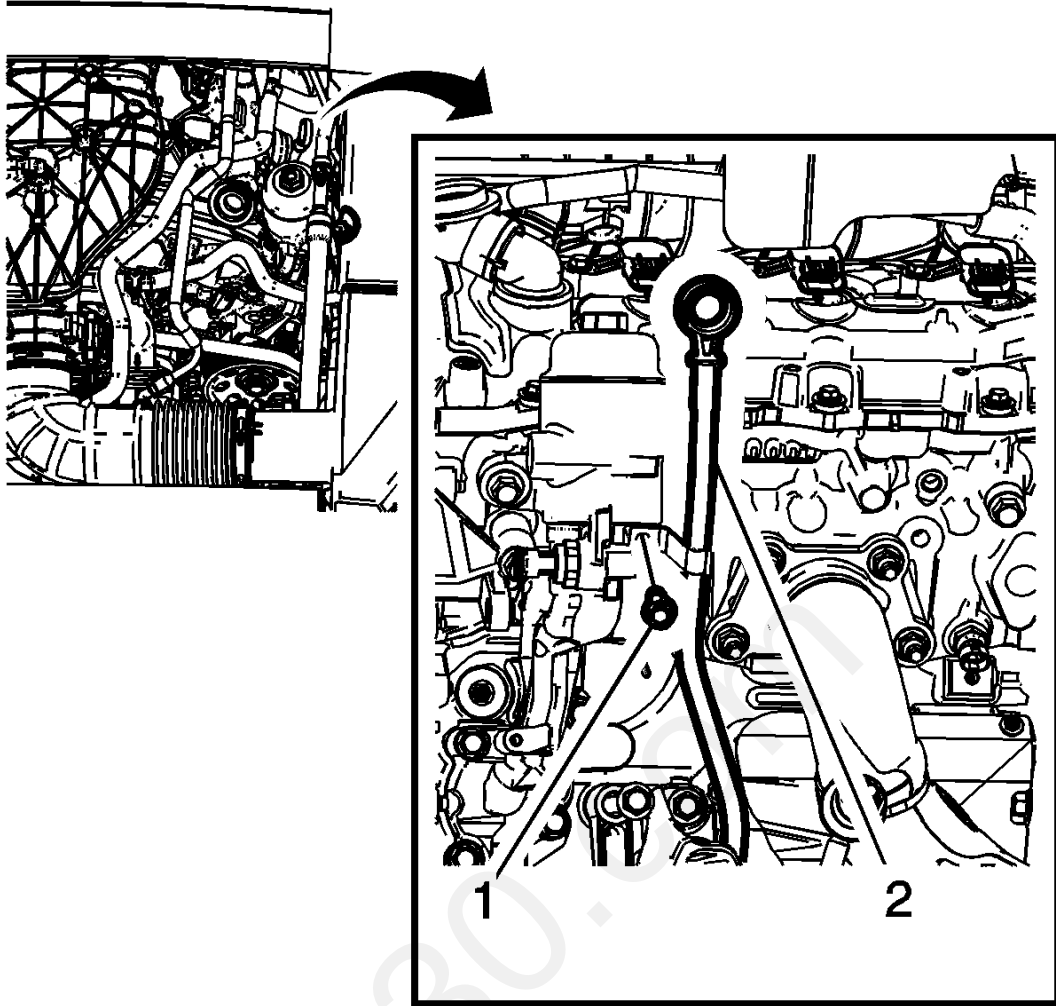


Fig. 39: Indicator Tube & Bracket Bolt

Courtesy of GENERAL MOTORS COMPANY

2. Position the oil level indicator and tube (2) by sliding the tube down and in to the approximate location of the lower crankcase hole.
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .
4. Guide the lower portion of the oil level indicator tube into the lower crankcase hole and seat the oil level indicator tube in place

CAUTION: Refer to [Fastener Caution](#) .

5. Install the oil level indicator tube bracket bolt (1) and tighten to 10 N.m (89 lb in).
6. Attach the wiring harness retainer to the oil level indicator tube.
7. Install the left engine mount bracket. Refer to [Engine Mount Bracket Replacement - Left Side](#)
8. Install the oil level indicator.

OIL FILTER ADAPTER REPLACEMENT

Removal Procedure

1. Disconnect the battery. [Battery Negative Cable Disconnection and Connection](#)
2. Remove the underbody splash shield. [Underbody Splash Shield Replacement](#)

- the air cleaner outlet duct. [Air Cleaner Outlet Duct Replacement](#)
4. Remove the drive belt. [Drive Belt Replacement](#)

NOTE: Do not disconnect the A/C pipes from the A/C compressor.

5. Remove the A/C compressor bolts. [Air Conditioning Compressor Replacement \(LFX\)](#)
6. Disconnect the oil pressure sensor electrical connector.
7. Remove the stabilizer shaft bushing clamp bolts and lower the stabilizer shaft. [Front Stabilizer Shaft Bushing Replacement](#)
8. Place a drain pan under the vehicle.
9. Drain engine oil. [Engine Oil and Oil Filter Replacement](#)

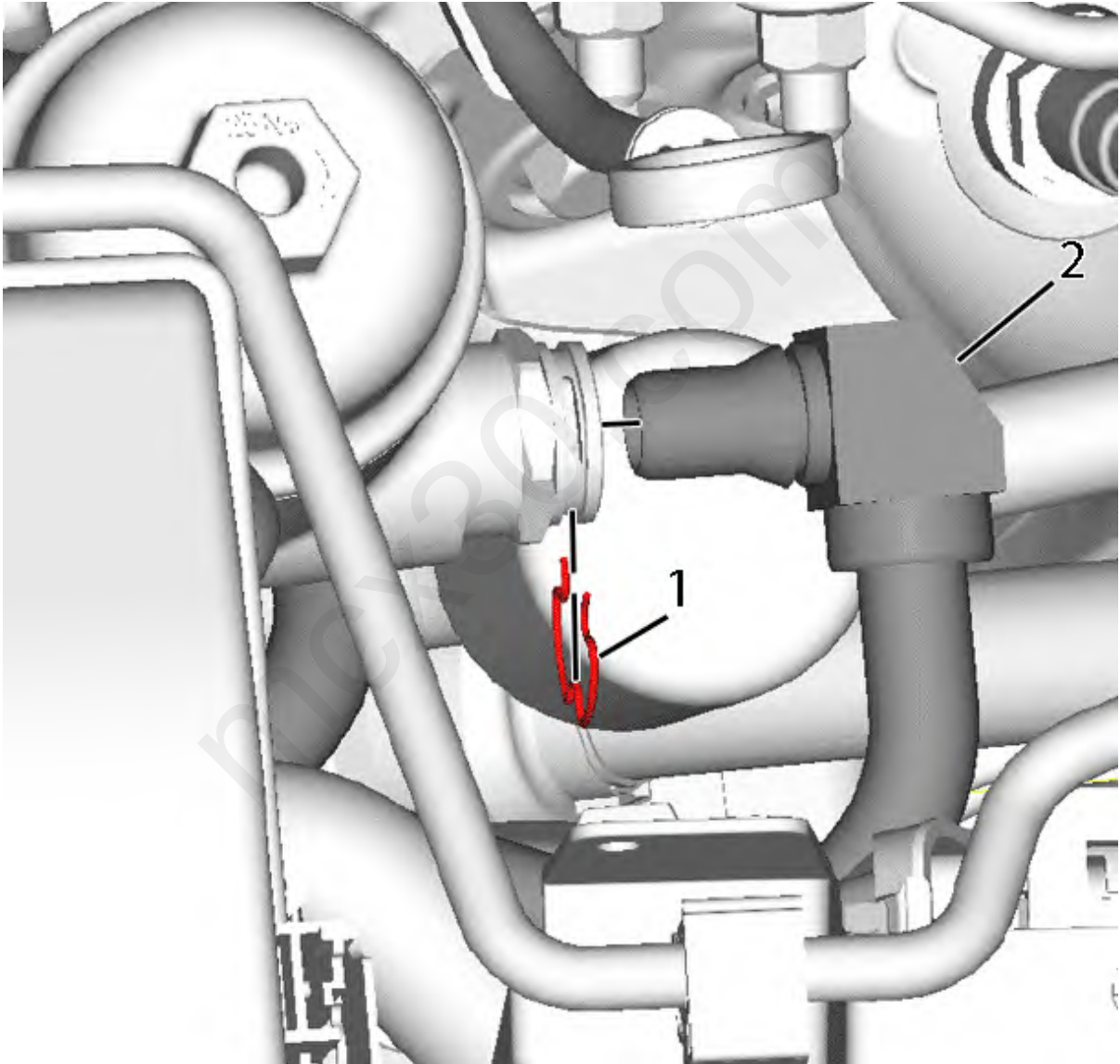


Fig. 40: Retaining Ring And Engine Oil Cooler Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

10. Remove the retaining ring (1) from the oil filter adaptor.
11. Disconnect the engine oil cooler inlet hose (2) from the oil filter adaptor.

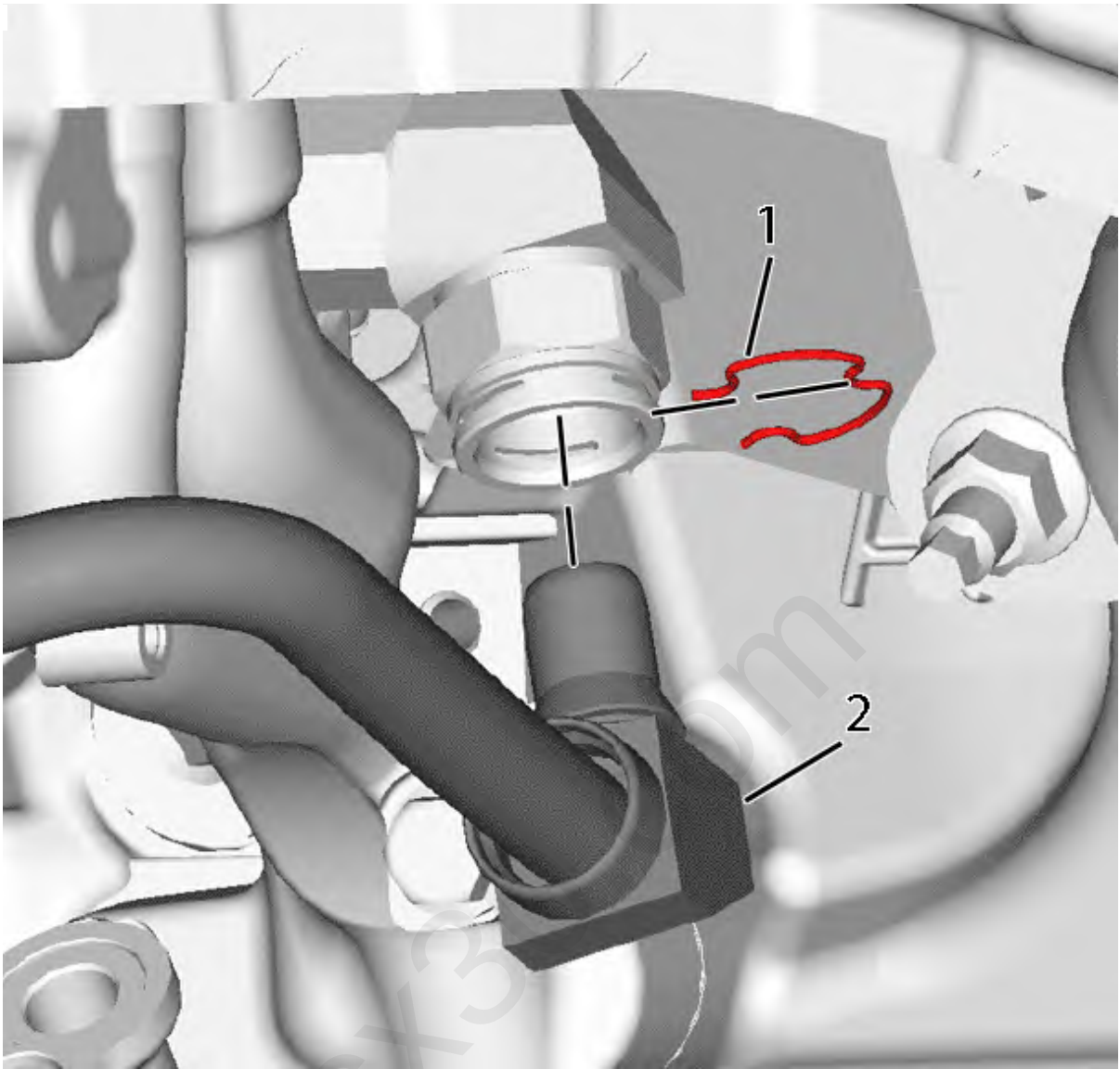


Fig. 41: Retaining Ring And Engine Oil Cooler Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

12. Remove the retaining ring (1) from the oil filter adaptor.
13. Disconnect the engine oil cooler outlet hose (2) from the oil filter adaptor.

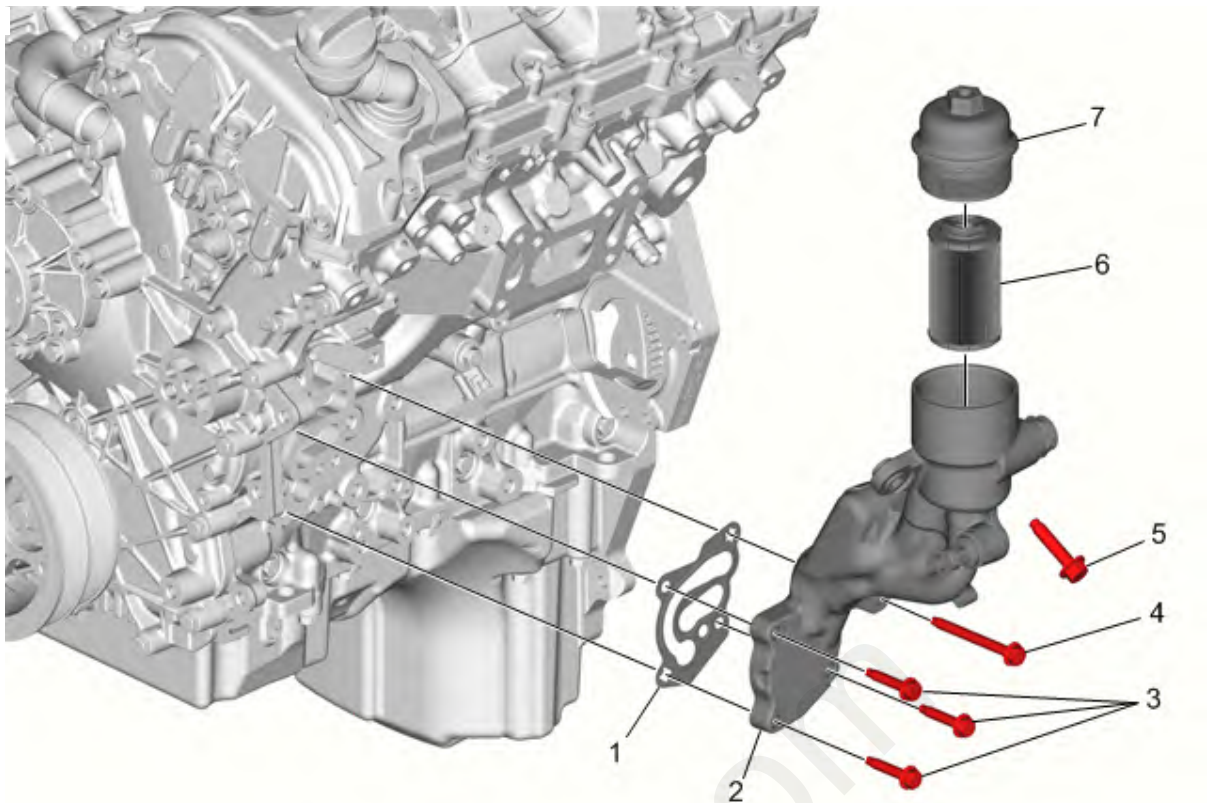


Fig. 42: Oil Filter Adaptor Cap And Oil Filter
Courtesy of GENERAL MOTORS COMPANY

14. Remove the oil filter adaptor cap (7) and oil filter (6), allow to drain.
15. Remove the oil filter adapter bolts (3, 4 and 5).
16. Remove the oil filter adapter (2).
17. Remove and discard the oil filter adapter gasket (1).

Installation Procedure

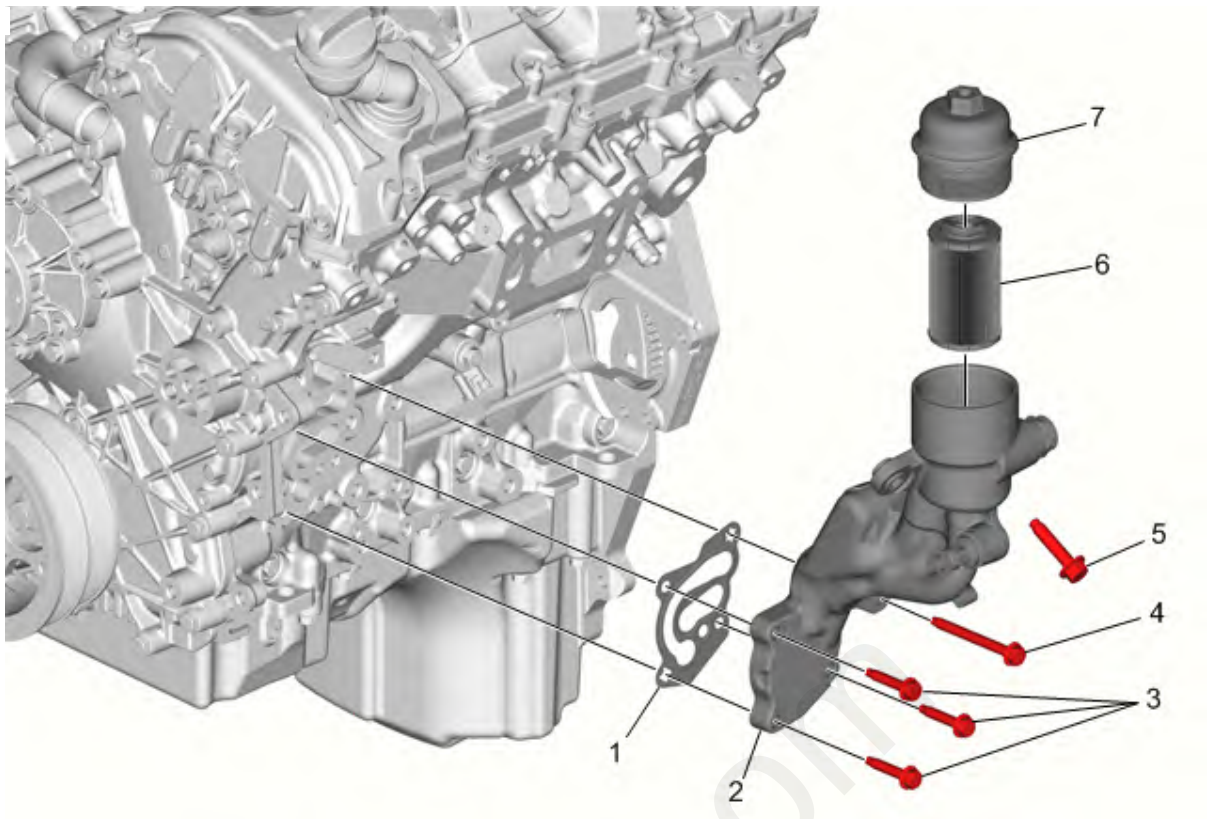


Fig. 43: Oil Filter Adaptor Cap And Oil Filter
Courtesy of GENERAL MOTORS COMPANY

1. Position a NEW oil filter adapter gasket (1) onto the oil filter adapter.
2. Install the oil filter adapter (2).
3. Install the oil filter adapter bolts (3, 4 and 5) into the oil filter adapter and hand tighten.

CAUTION: Refer to **Fastener Caution** .

4. Tighten the oil filter adapter bolts (3, 4 and 5) to 25 N.m (18 lb ft).

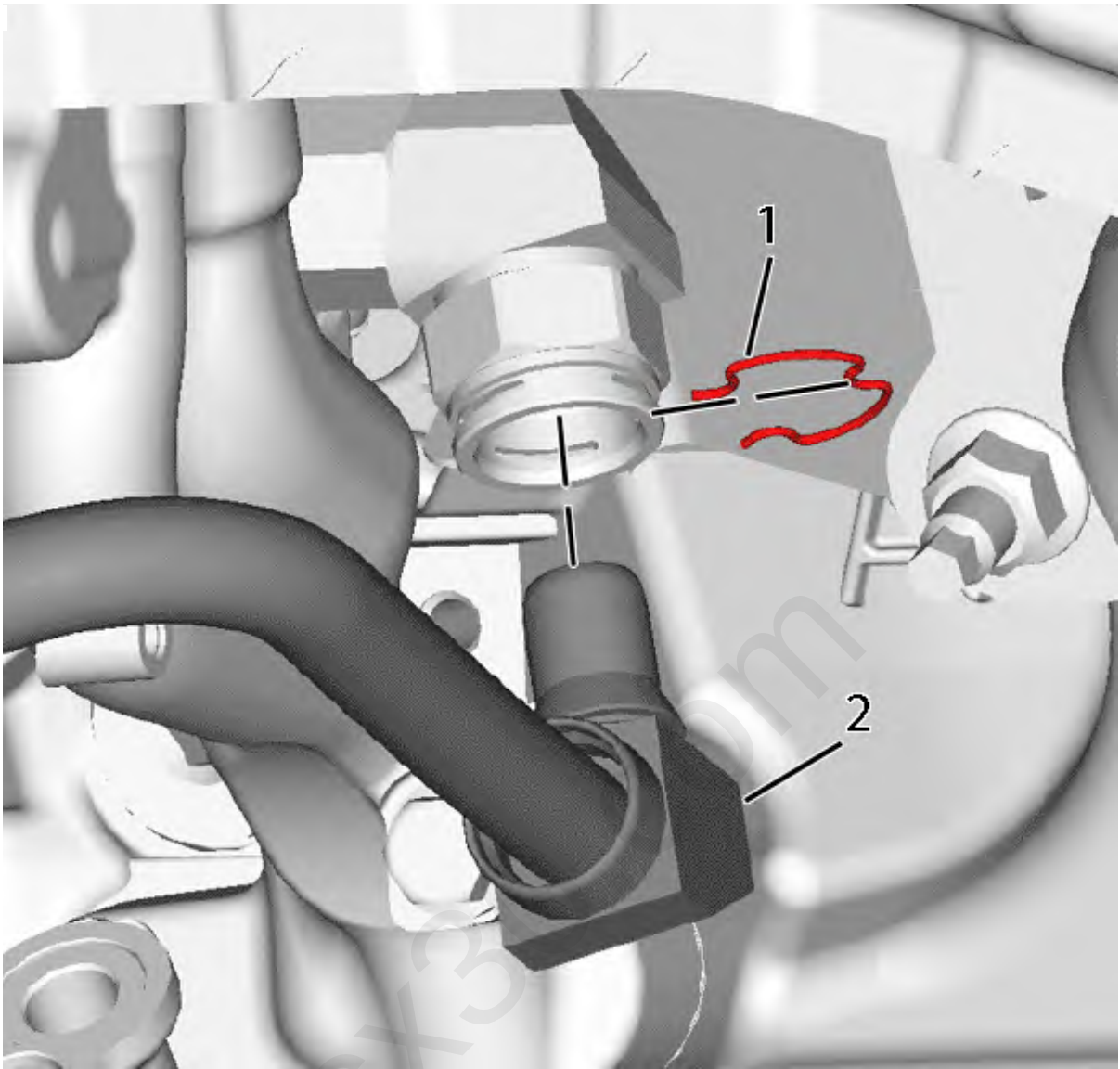


Fig. 44: Retaining Ring And Engine Oil Cooler Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

5. Connect the engine oil cooler outlet hose (2) to the oil filter adaptor.
6. Install the retaining ring (1) on the oil filter adaptor.

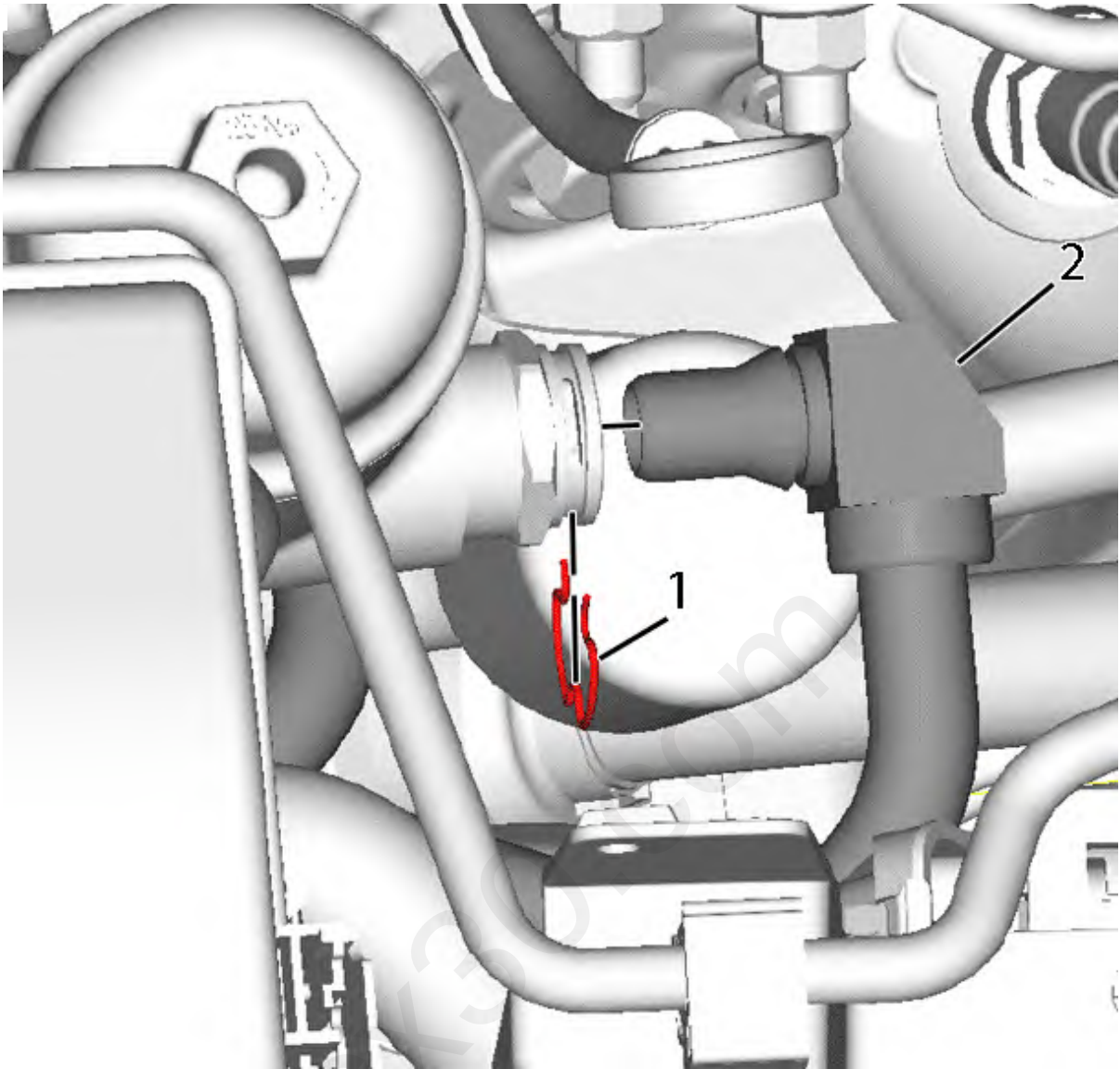


Fig. 45: Retaining Ring And Engine Oil Cooler Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

7. Connect the engine oil cooler inlet hose (2) to the oil filter adaptor.
8. Install the retaining ring (1) on the oil filter adaptor.
9. Connect the oil pressure sensor electrical connector.
10. Position the stabilizer shaft and install the stabilizer shaft bushing clamp bolts. [Front Stabilizer Shaft Bushing Replacement](#)
11. Install the A/C compressor with the A/C pipes to the engine. [Air Conditioning Compressor Replacement \(LFX\)](#)
12. Install the drive belt. [Drive Belt Replacement](#)
13. Install the air cleaner outlet duct. [Air Cleaner Outlet Duct Replacement](#)
14. Install the underbody splash shield. [Underbody Splash Shield Replacement](#)
15. Connect the battery. [Battery Negative Cable Disconnection and Connection](#)
16. Install the oil filter and oil filter adaptor cap and fill engine oil to proper level. Refer to [Engine Oil and Oil Filter Replacement](#)

CRANKSHAFT BALANCER REPLACEMENT

- **EN-38416-2** Crankshaft Button
- **EN-41816** Crankshaft Balancer Remover
- **EN-41998-B** Crankshaft Balancer Installer
- **EN-45059** Angle Meter
- **EN-46106** Flywheel Holding Tool

For equivalent regional tools, refer to [Special Tools](#) .

Removal Procedure

1. Remove the drive belt. Refer to [Drive Belt Replacement](#).
2. Remove the starter. Refer to [Starter Replacement \(LFX\)](#) .

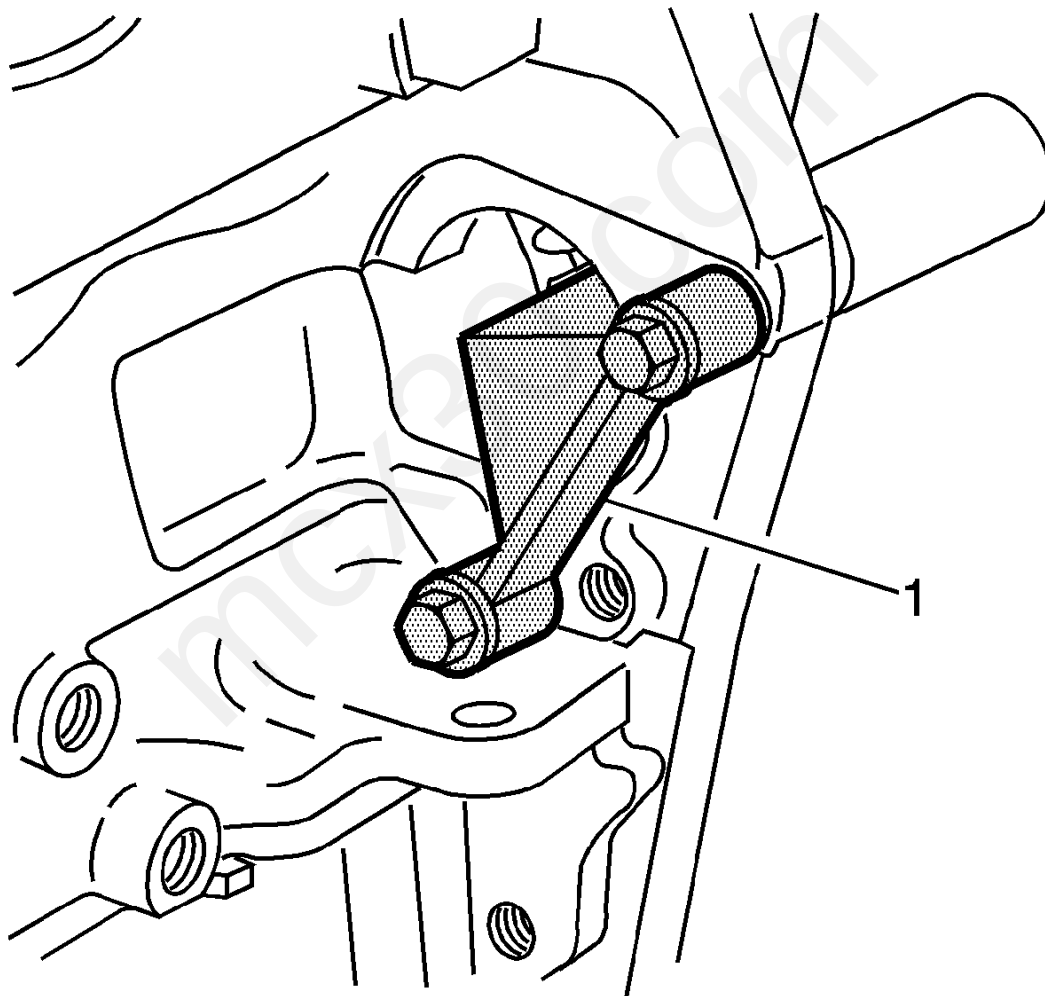


Fig. 46: Flywheel Holding Tool

Courtesy of GENERAL MOTORS COMPANY

3. Install the **EN-46106** tool (1) through the starter mounting hole.

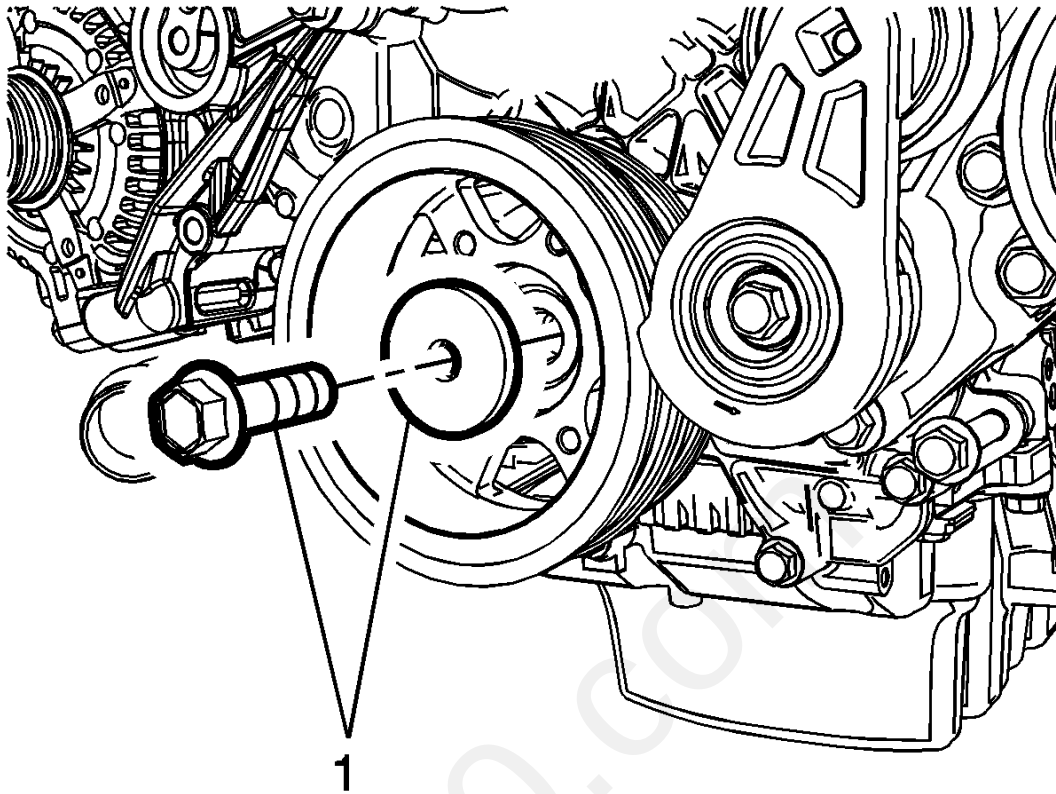


Fig. 47: Crankshaft Balancer Bolt And Washer

Courtesy of GENERAL MOTORS COMPANY

4. Remove the crankshaft balancer bolt and washer (1). Discard the bolt.

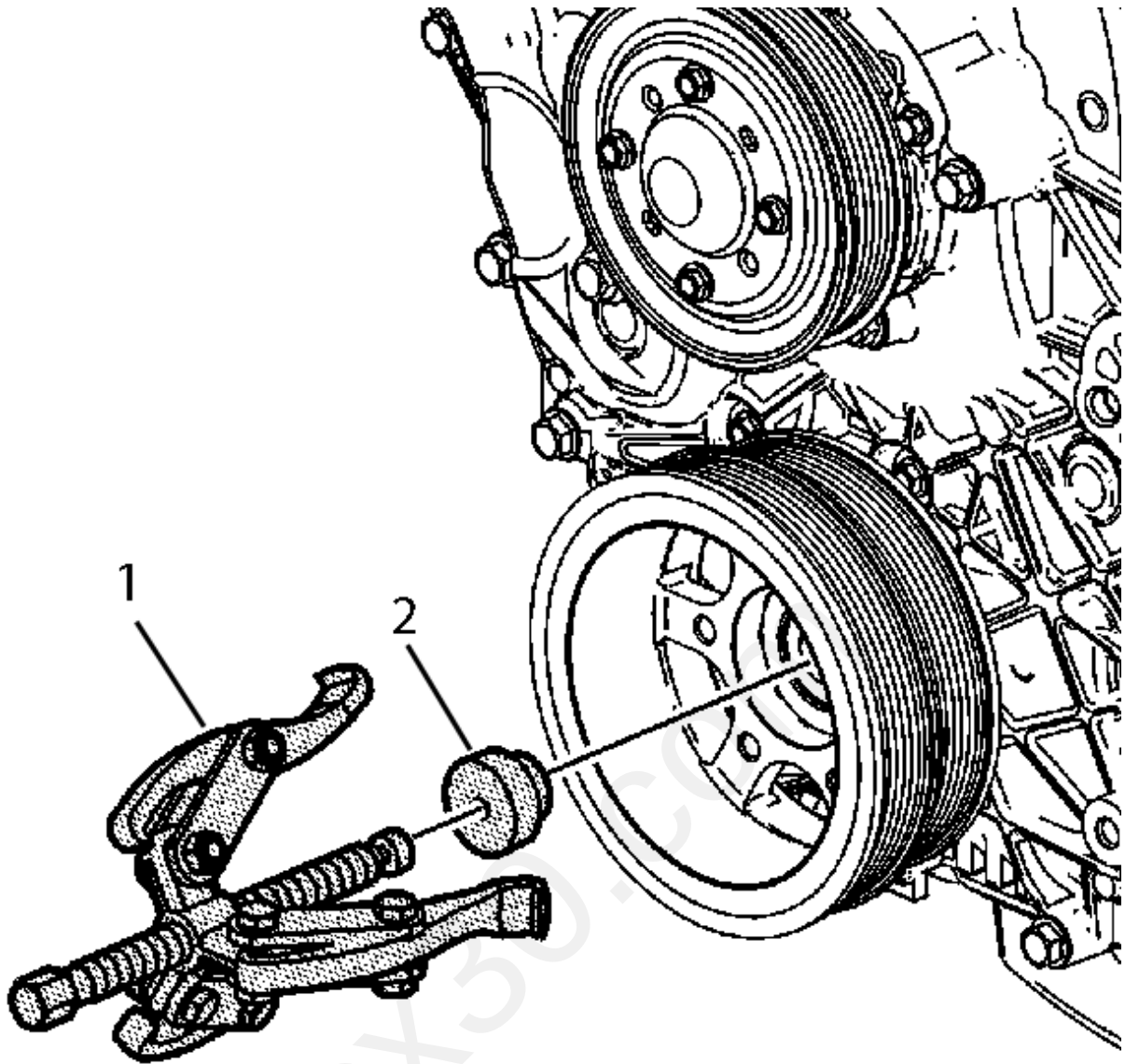


Fig. 48: Crankshaft Balancer Remover

Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-38416-2** button (2) in the nose of the crankshaft.
6. Install the **EN-41816** remover (1) in order to remove the crankshaft balancer (3).
7. Tighten the center bolt of the **EN-41816** remover (1) in order to pull the crankshaft balancer off of the crankshaft.
8. Remove the **EN-41816** remover and **EN-38416-2** button from the crankshaft balancer.

Installation Procedure

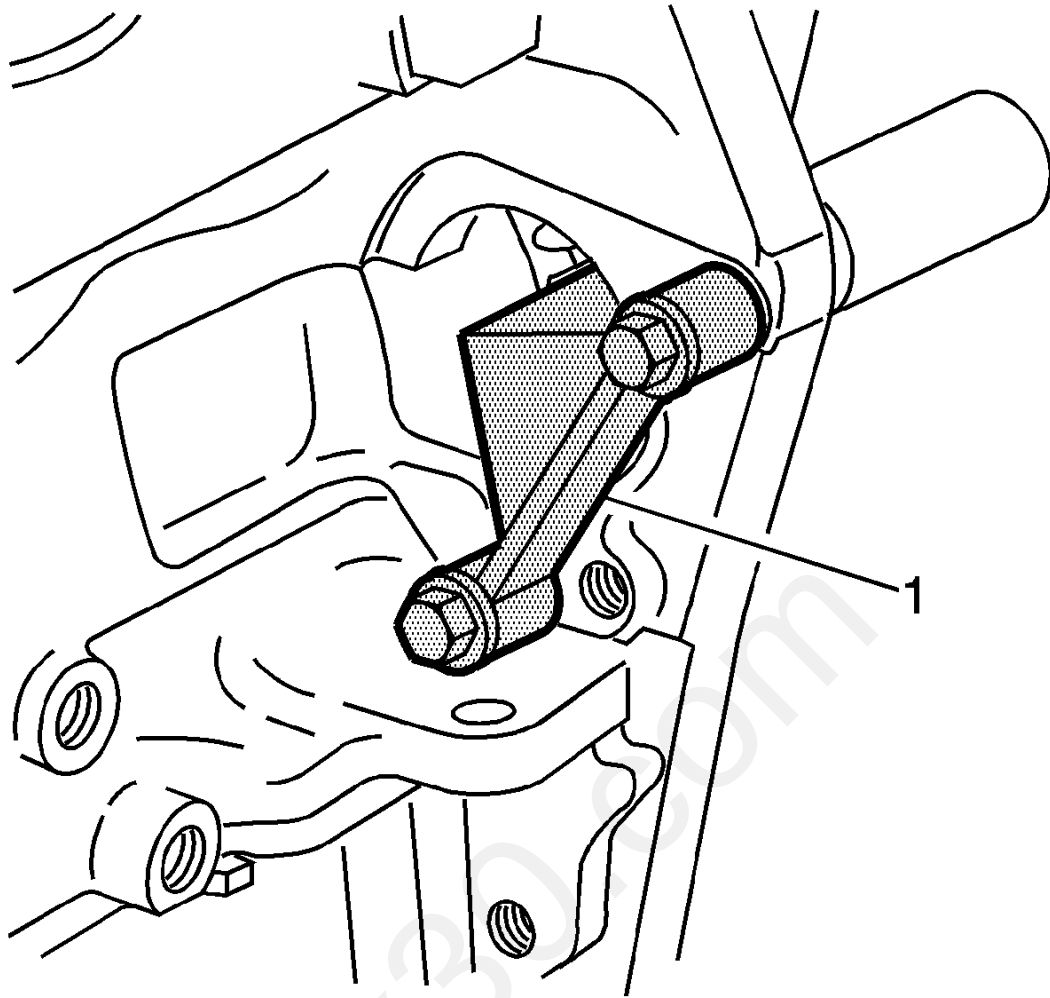


Fig. 49: Flywheel Holding Tool

Courtesy of GENERAL MOTORS COMPANY

1. The **EN-46106** tool (1) must be installed onto the flywheel.

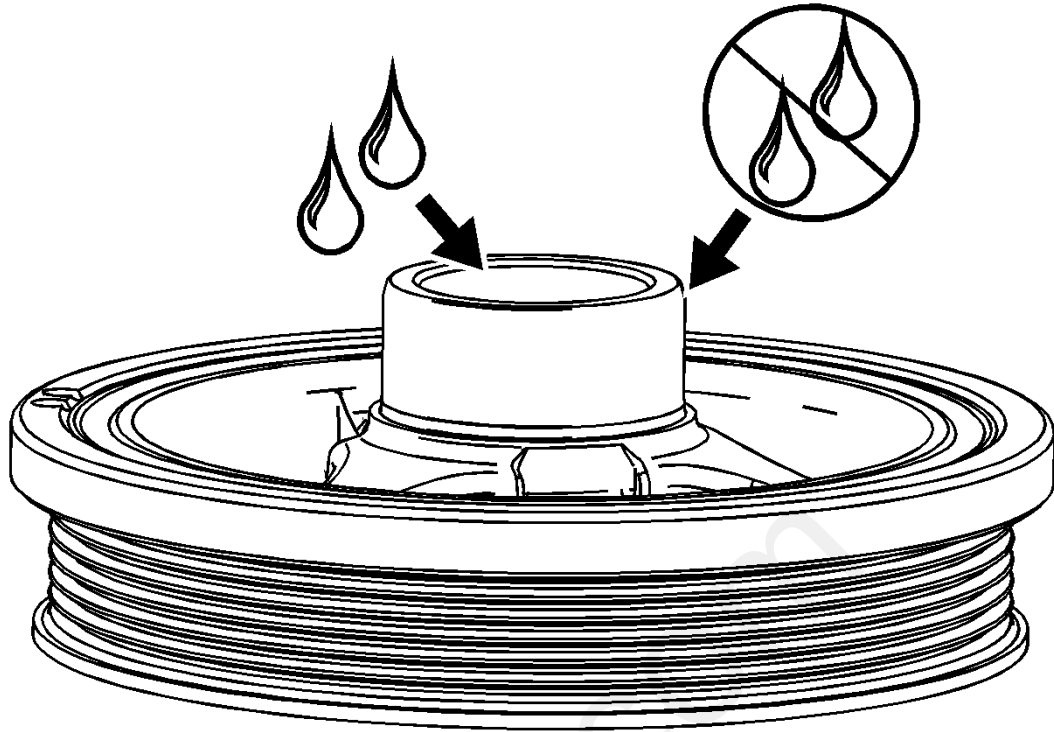


Fig. 50: Lubrication And Non-Lubrication Areas On Crankshaft Balancer

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

2. Apply lubricant to the inside of the crankshaft balancer hub bore.

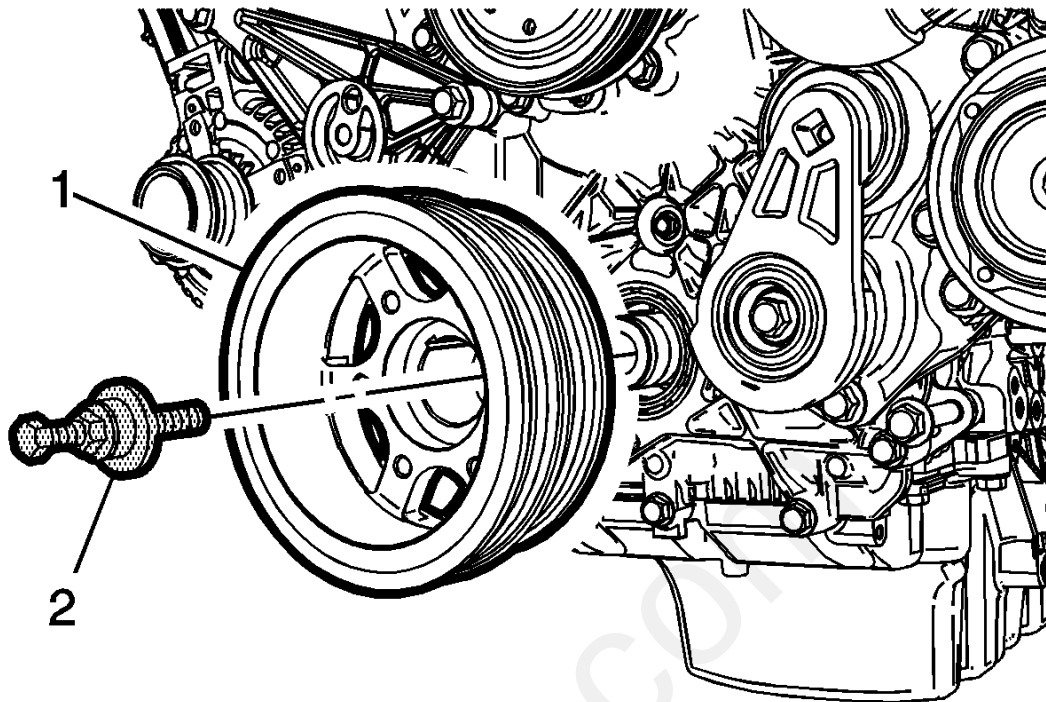


Fig. 51: Crankshaft Balancer

Courtesy of GENERAL MOTORS COMPANY

3. Place the crankshaft balancer (1) in position on the crankshaft.
4. Thread the **EN-41998-B** installer (2) in the crankshaft. Ensure you engage at least 10 threads of the **EN-41998-B** installer before pressing the crankshaft balancer in place.
5. Push the crankshaft balancer into position by tightening the nut on the **EN-41998-B** installer until the large washer bottoms out on the crankshaft end.
6. Remove the **EN-41998-B** installer.

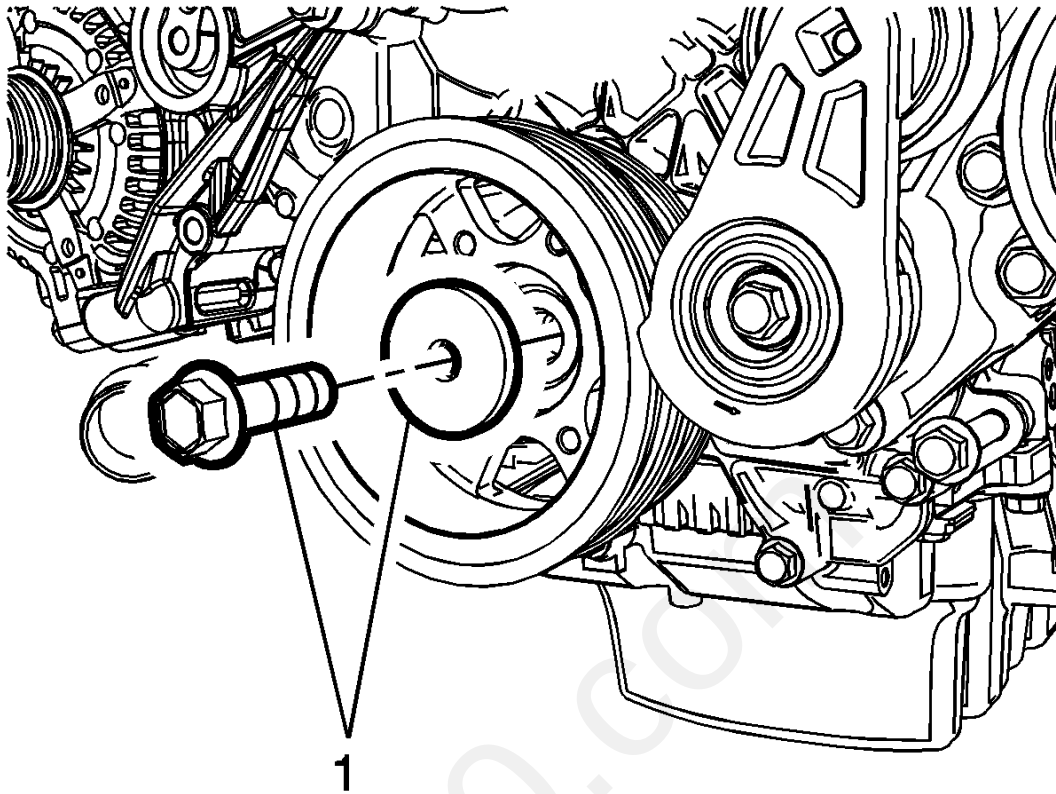


Fig. 52: Crankshaft Balancer Bolt And Washer

Courtesy of GENERAL MOTORS COMPANY

NOTE: Always install a new crankshaft balancer retaining bolt (1) and washer.

7. Install the NEW crankshaft balancer bolt (1).

CAUTION: Refer to **Fastener Caution** .

8. Tighten the crankshaft balancer bolt to 100 N.m (74 lb ft) and an additional 150 degrees using the **EN-45059** meter.

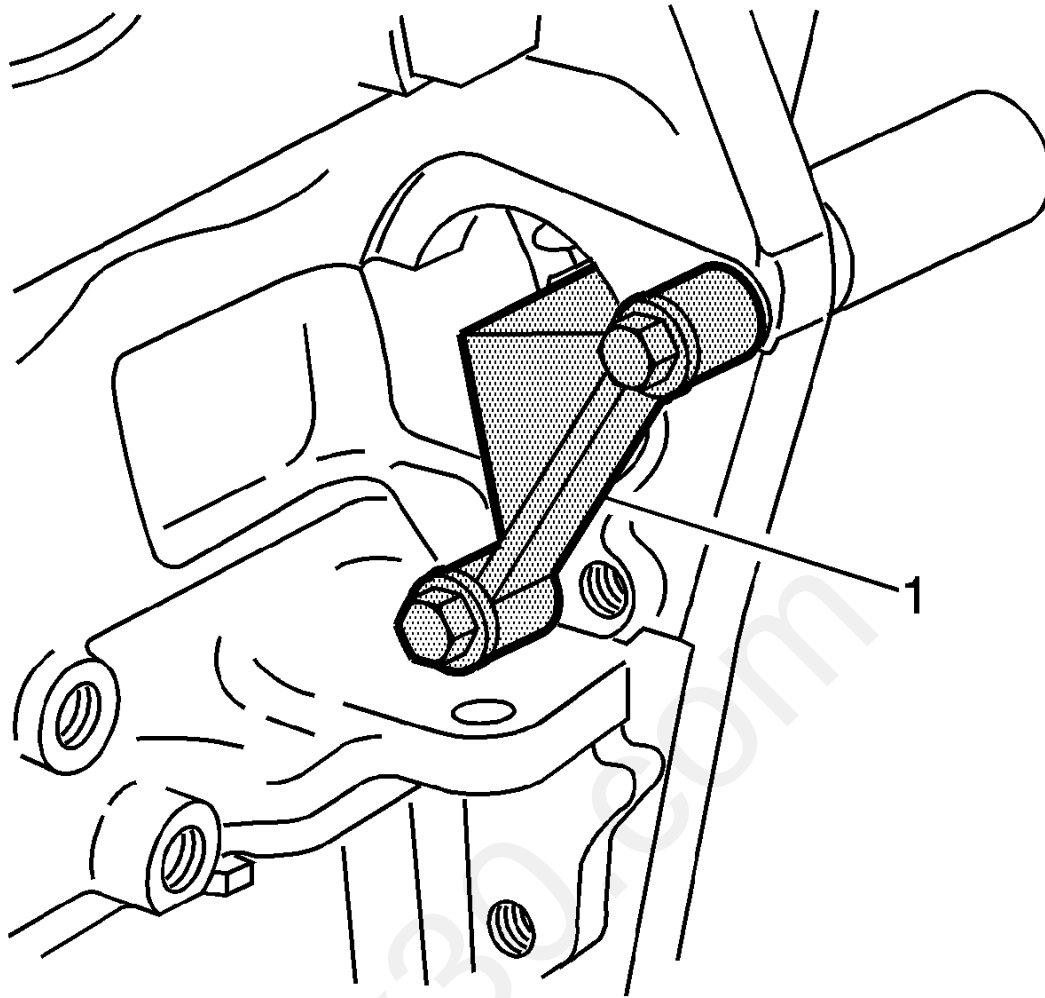


Fig. 53: Flywheel Holding Tool

Courtesy of GENERAL MOTORS COMPANY

9. Remove the **EN-46106** tool (1).
10. Install the starter. Refer to [Starter Replacement \(LFX\)](#).
11. Install the drive belt. Refer to [Drive Belt Replacement](#).

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

EN-29184 Oil Seal Installer

For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

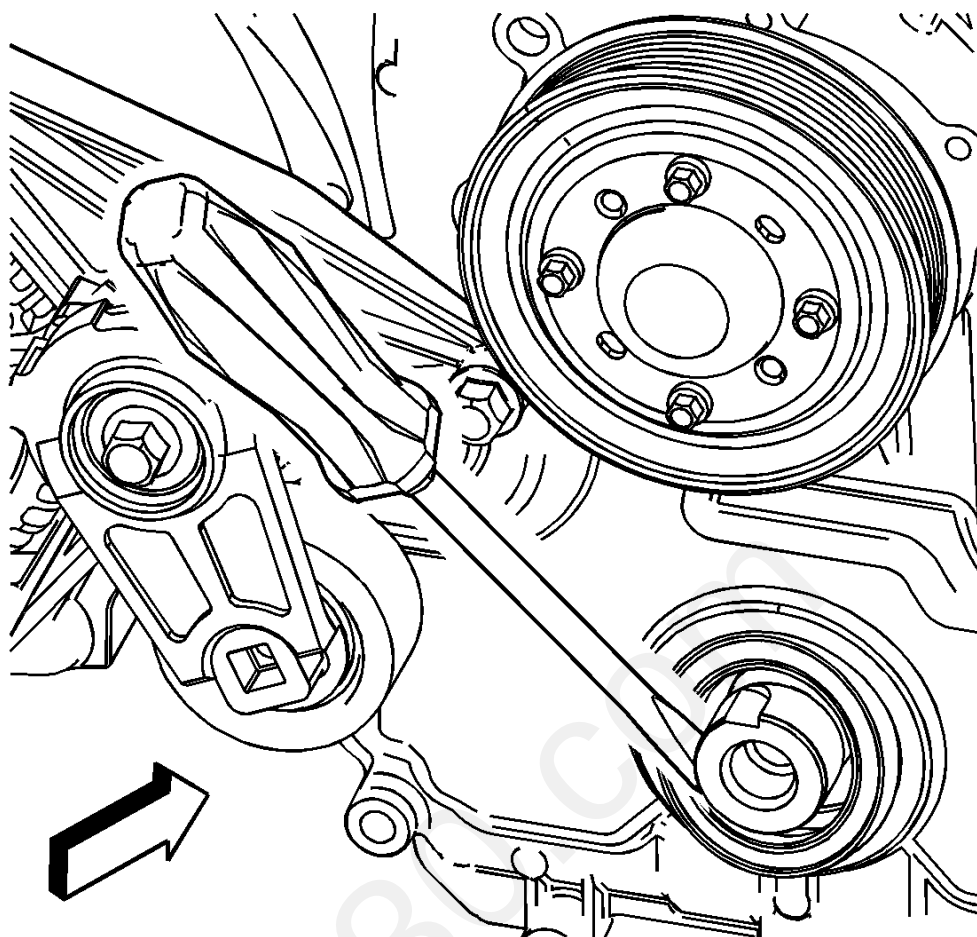


Fig. 54: Removing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).
2. Remove the crankshaft front oil seal using a suitable flat blade tool.

Installation Procedure

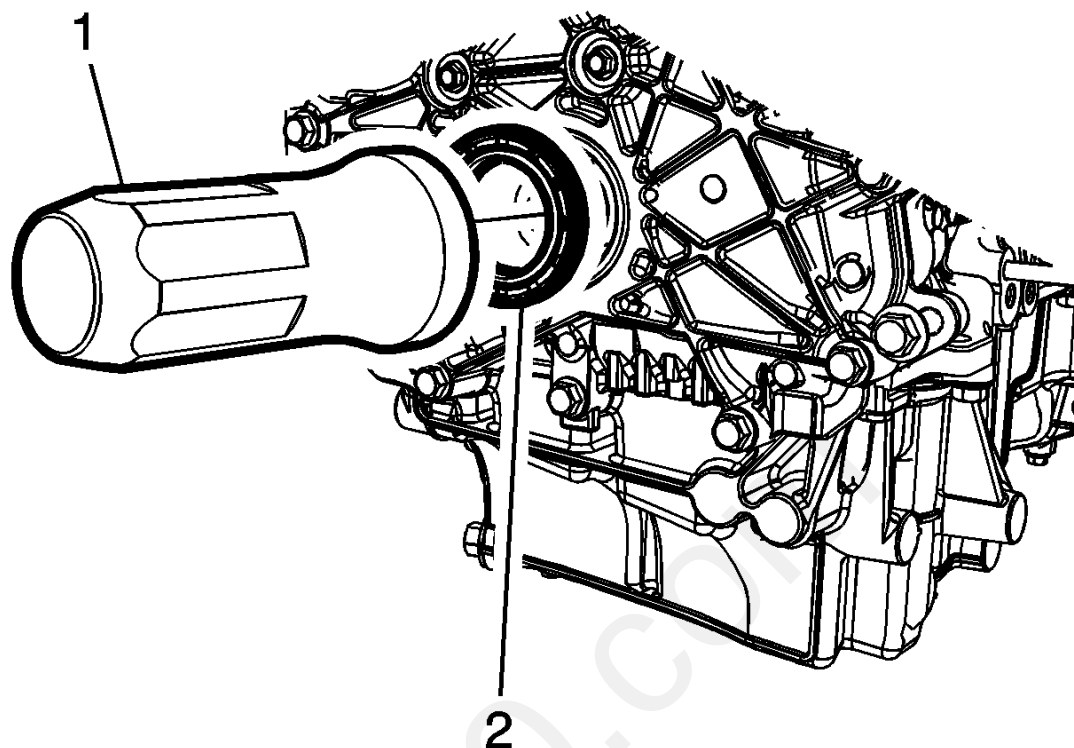


Fig. 55: Crankshaft Front Oil Seal And Installer
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not lubricate the crankshaft front oil seal or the crankshaft balancer sealing surfaces.

1. Use the **EN-29184** installer (1) or equivalent to install the crankshaft front oil seal (2).
2. Install the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).

CAMSHAFT COVER REPLACEMENT - LEFT SIDE

Special Tools

EN-46101 Spark Plug Tube Seal Guide

For equivalent regional tools, refer to [Special Tools](#) .

Removal Procedure

1. Remove the ignition coils. Refer to [Ignition Coil Replacement - Bank 2](#) .
2. Disconnect and remove the engine harness from the camshaft cover.
3. Remove the intake manifold. Refer to [Intake Manifold Replacement](#).

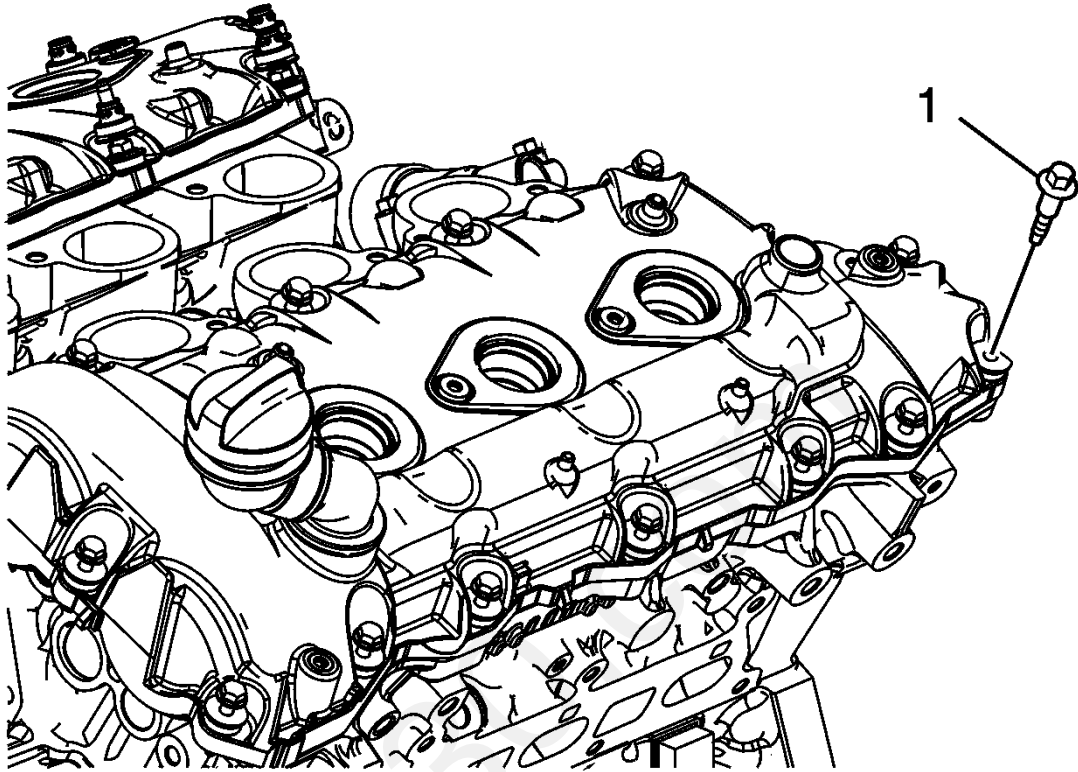


Fig. 56: View of Camshaft Cover and Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the left camshaft cover bolts (1).
5. Remove the left camshaft cover from the left cylinder head.
6. Disassemble the camshaft cover as needed. Refer to [Camshaft Cover Disassemble](#) .
7. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to [Camshaft Cover Cleaning and Inspection](#)

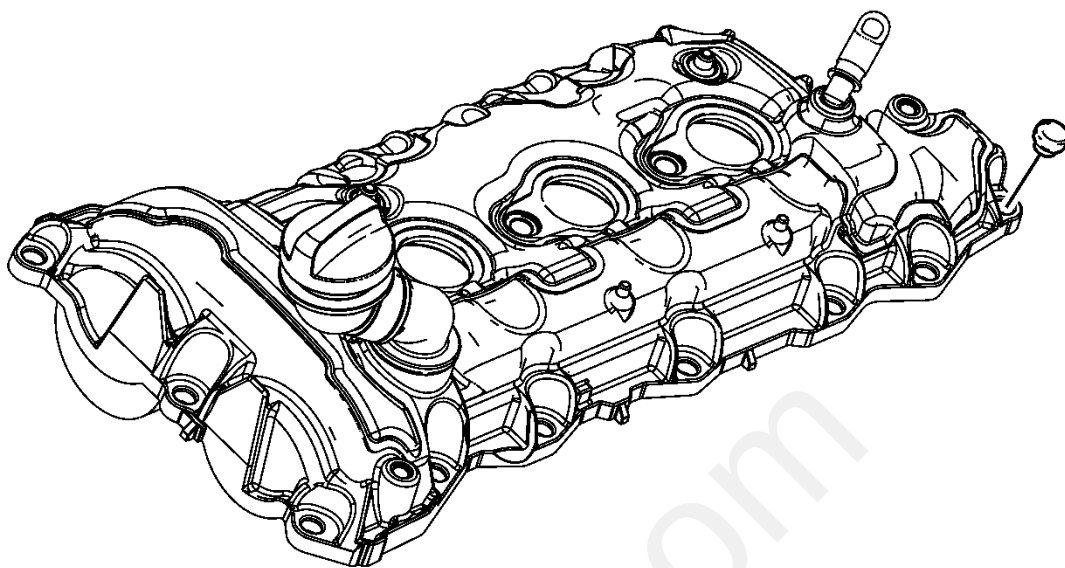


Fig. 57: View of Camshaft Cover

Courtesy of GENERAL MOTORS COMPANY

8. Install the **EN-46101** guide onto the spark plug tubes of the left cylinder head.

Installation Procedure

1. Assemble the camshaft cover as needed. Refer to **Camshaft Cover Assemble** .

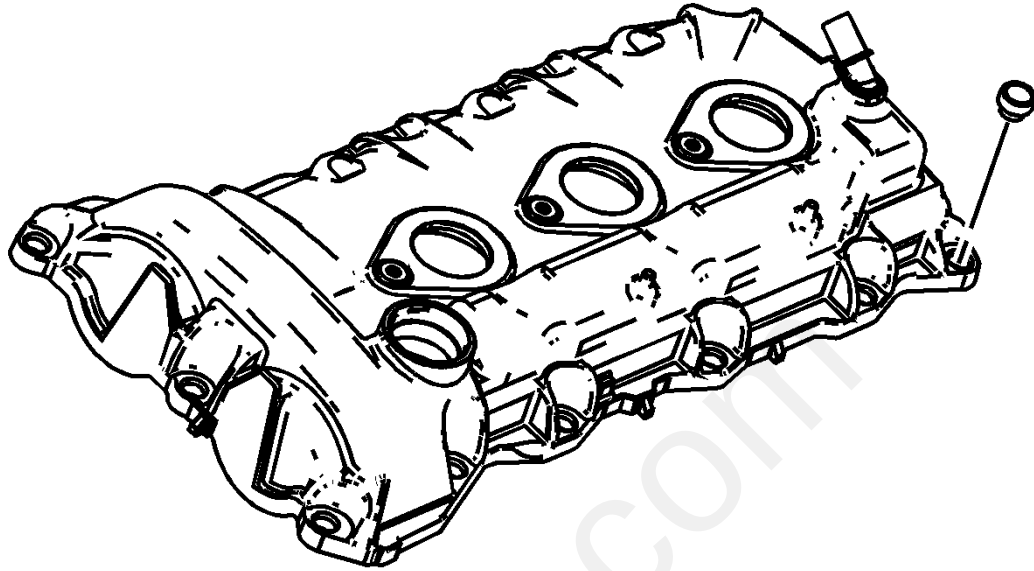


Fig. 58: Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

2. Install new camshaft cover bolt grommets prior to installing the camshaft cover bolts.

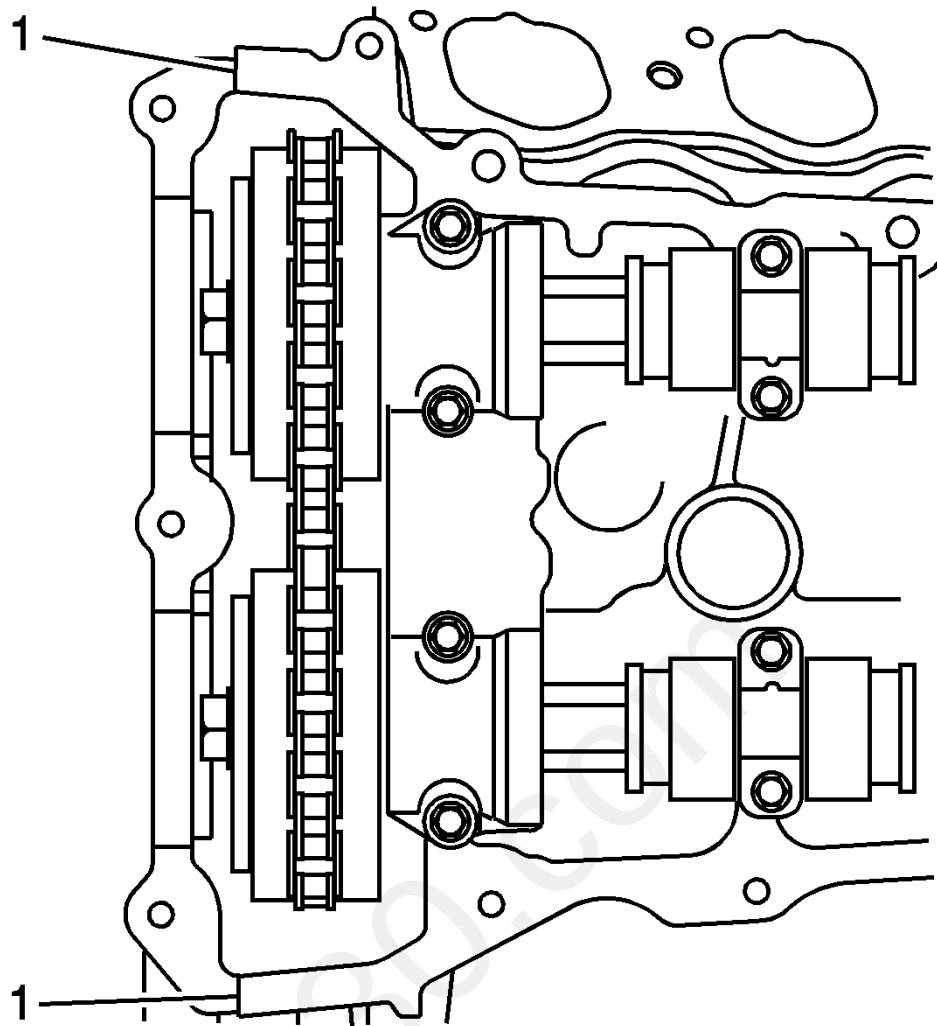


Fig. 59: Locating Engine Front Cover Split Lines

Courtesy of GENERAL MOTORS COMPANY

3. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant equivalent, on the engine front cover split lines (1). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.

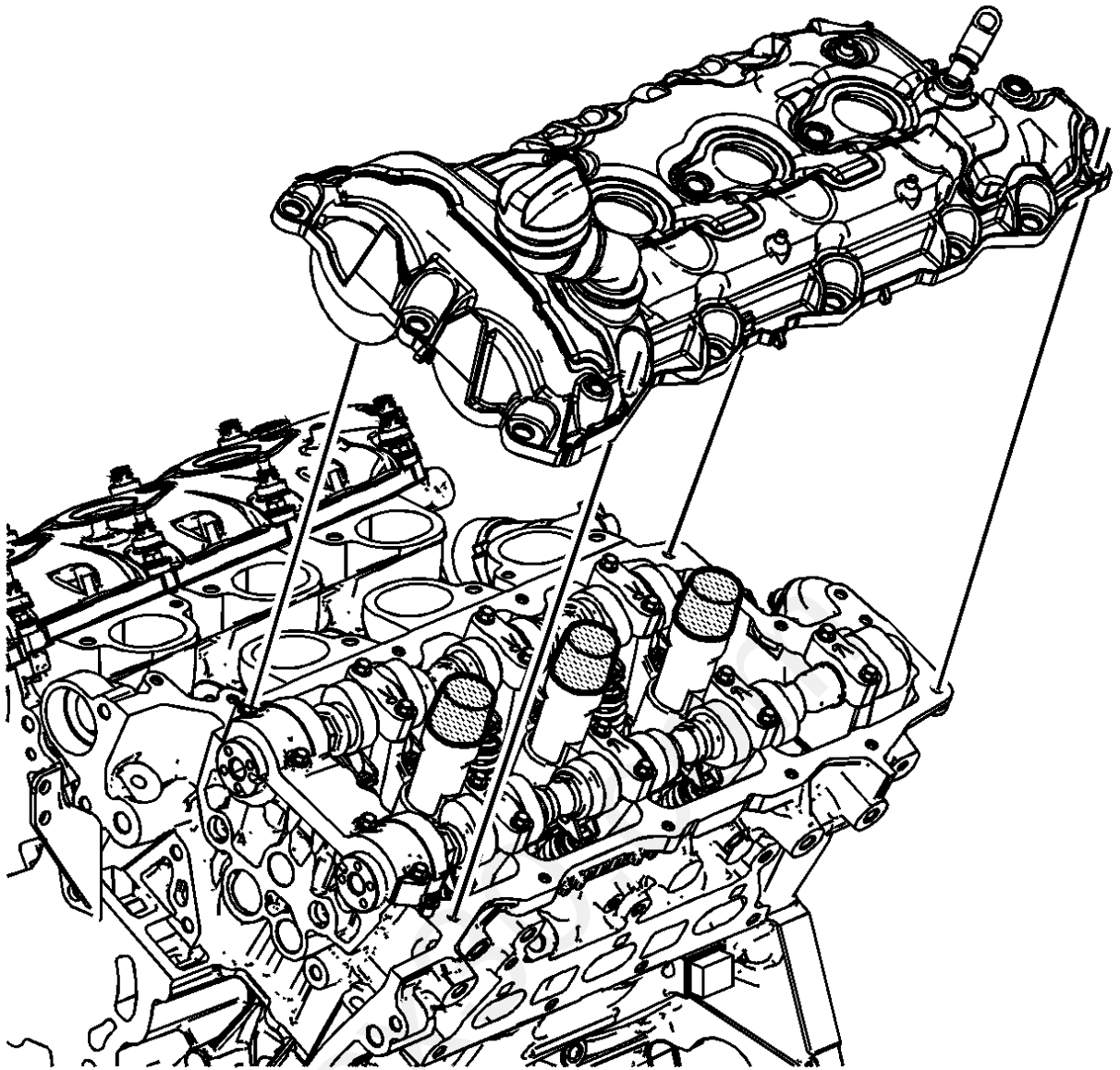


Fig. 60: View of Camshaft Cover & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

4. Place the left camshaft cover into position onto the left cylinder head.

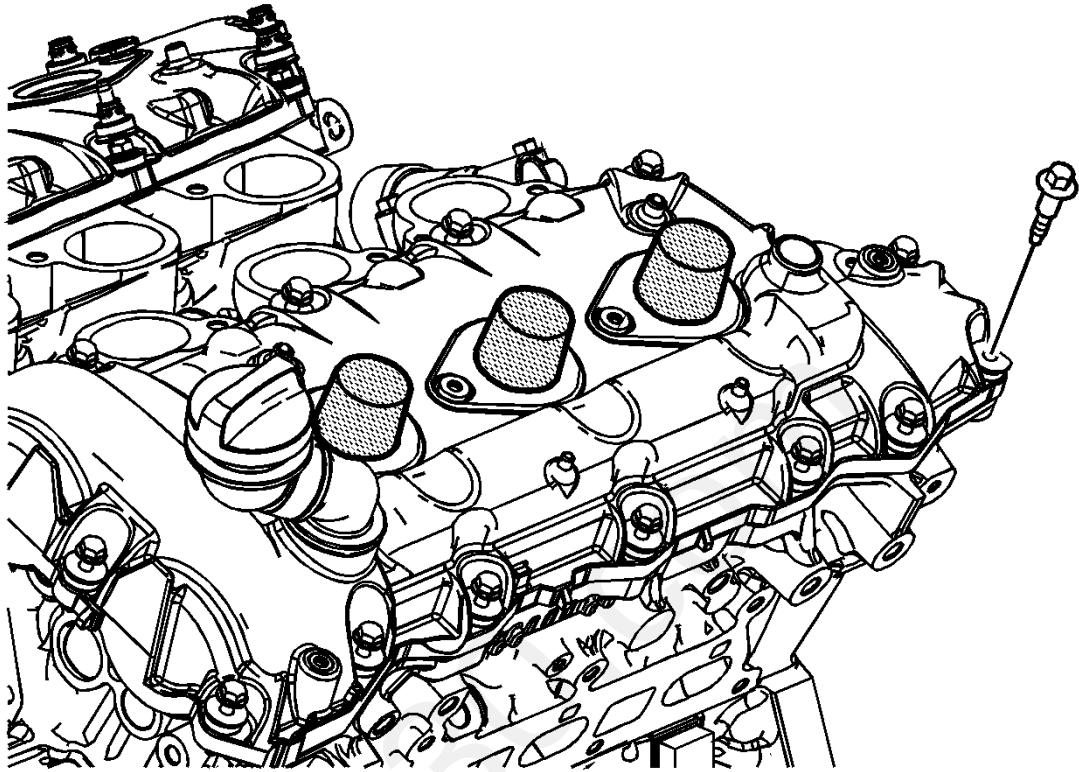


Fig. 61: View of Camshaft Cover & Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

5. Loosely install the left camshaft cover bolts.

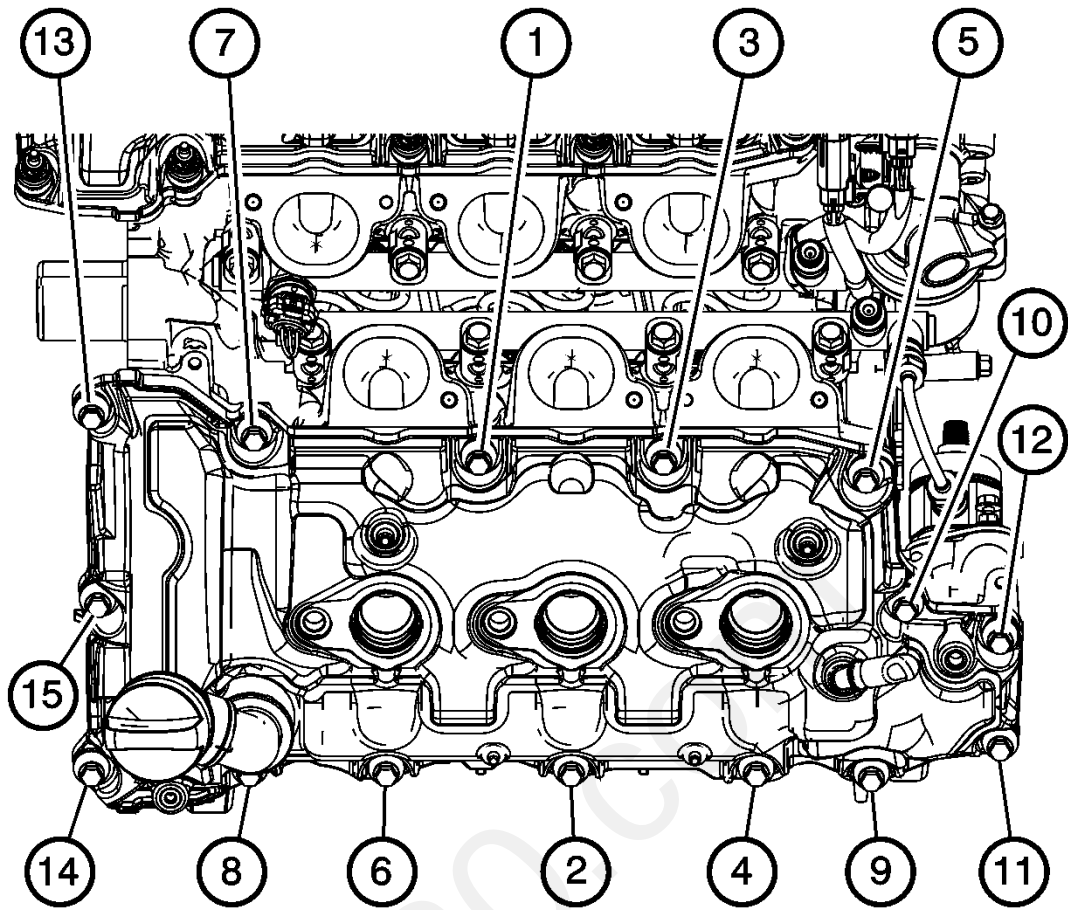


Fig. 62: Left Camshaft Cover Bolt Tightening Sequence

Courtesy of GENERAL MOTORS COMPANY

6. Tighten the left camshaft cover bolts in the sequence shown to 10 N.m (89 lb in).
7. Connect and install the engine harness to the camshaft cover.
8. Install the intake manifold. Refer to [Intake Manifold Replacement](#).

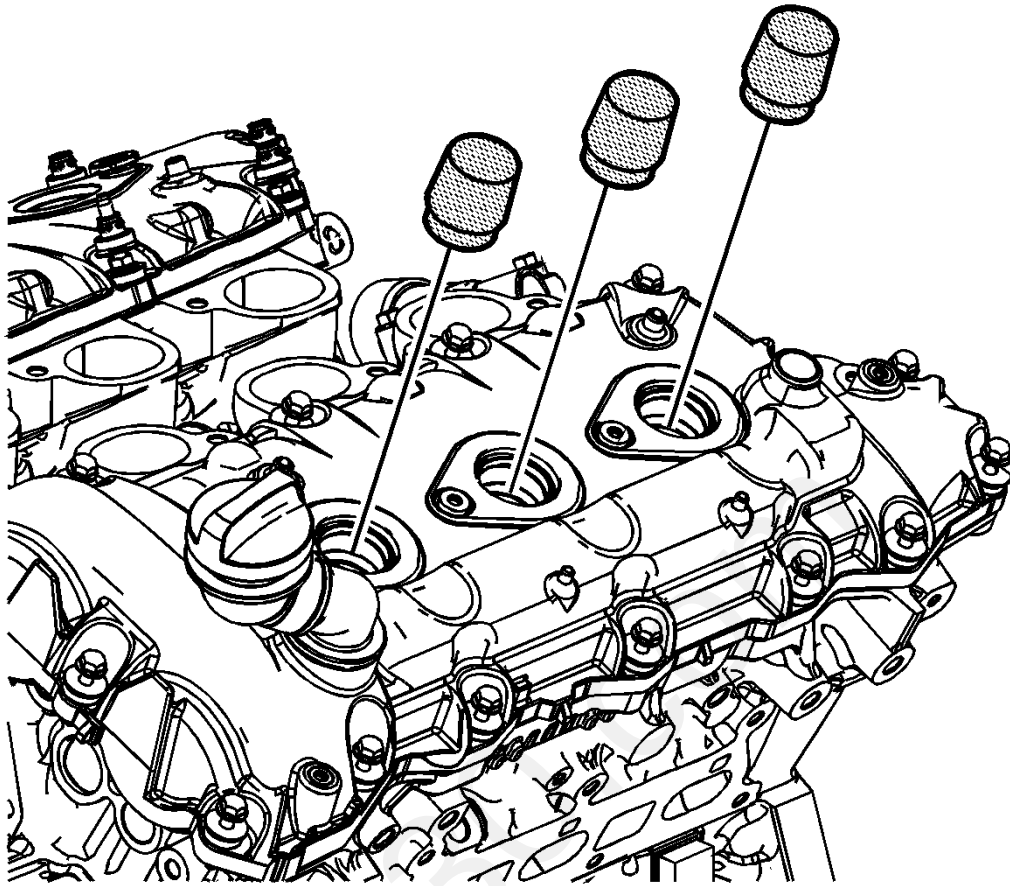


Fig. 63: View of Spark Plug Tubes & Cylinder Head

Courtesy of GENERAL MOTORS COMPANY

9. Remove the **EN-46101** guide from the spark plug tubes of the left cylinder head.
10. Install the ignition coils. Refer to [Ignition Coil Replacement - Bank 2](#) .

CAMSHAFT COVER REPLACEMENT - RIGHT SIDE

Special Tools

EN-46101 Spark Plug Tube Seal Guide

For equivalent regional tools, refer to [Special Tools](#)

Removal Procedure

1. Remove the intake manifold. Refer to [Intake Manifold Replacement](#).

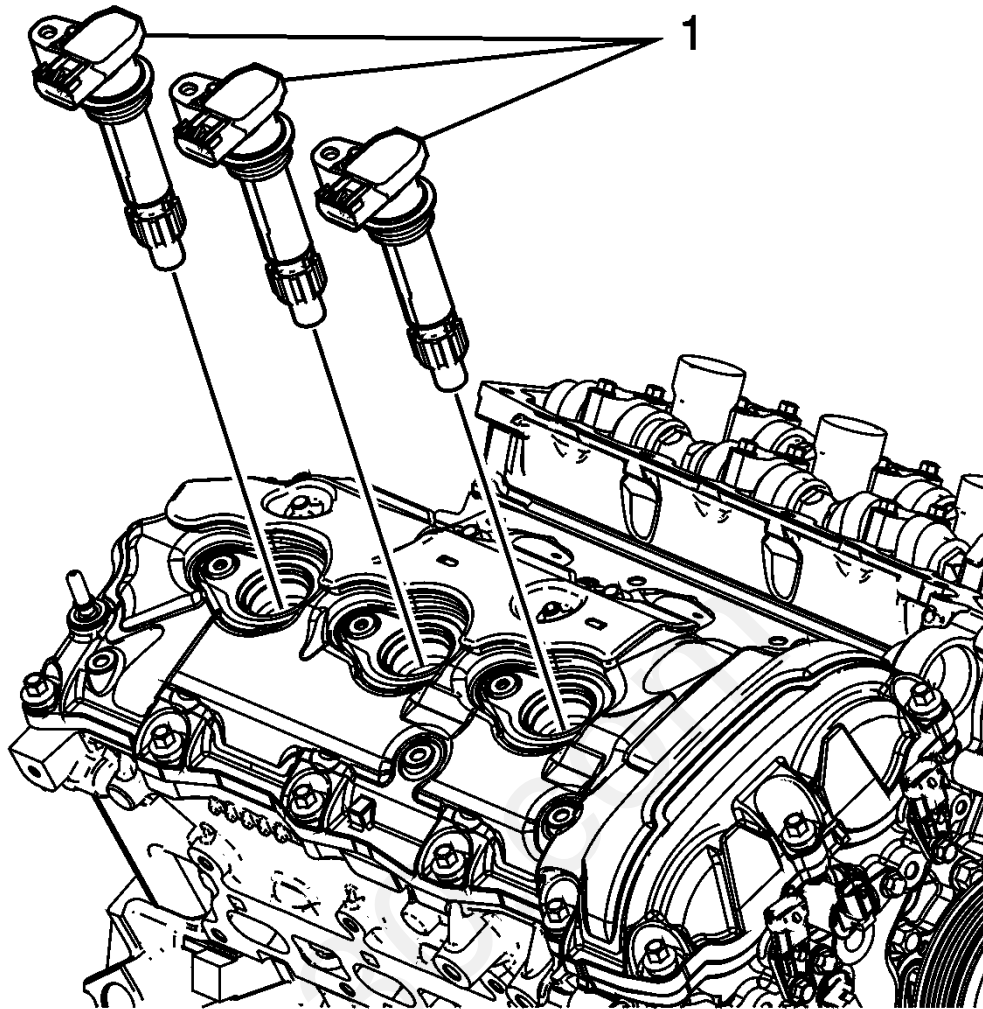


Fig. 64: View Of Ignition Coils

Courtesy of GENERAL MOTORS COMPANY

2. Remove the ignition coils (1). Refer to [**Ignition Coil Replacement - Bank 1**](#)
3. Disconnect and remove the engine harness from the camshaft cover.

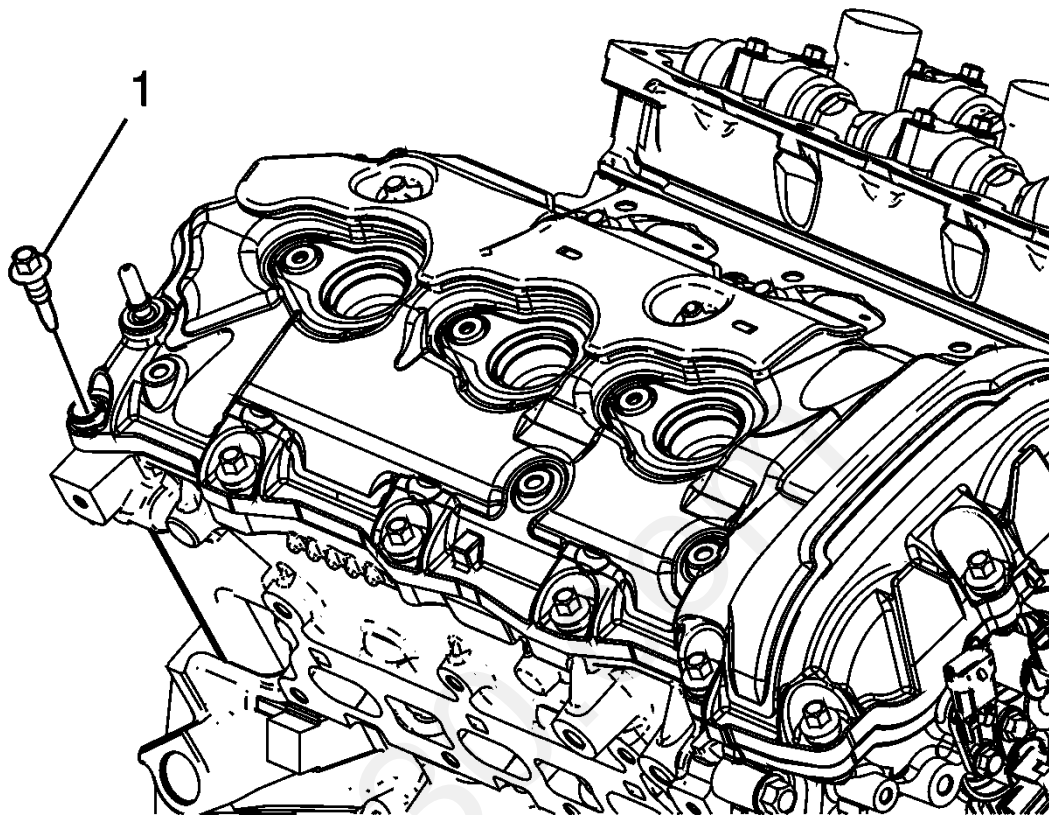


Fig. 65: View Of Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the right camshaft cover bolts (1).

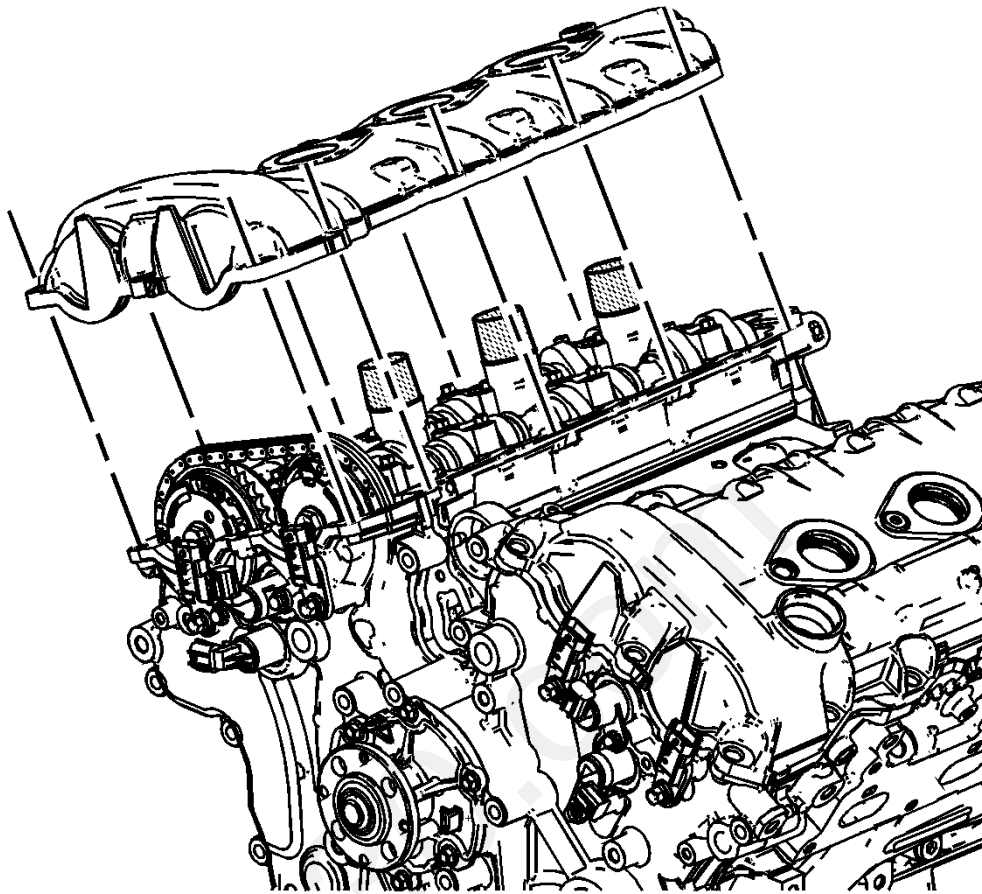


Fig. 66: View Of Right Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

5. Remove the right camshaft cover from the right cylinder head.
6. Install the **EN-46101** guide onto the spark plug tubes of the right cylinder head.
7. Disassemble the camshaft cover as needed. Refer to [Camshaft Cover Disassemble](#) .
8. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to [Camshaft Cover Cleaning and Inspection](#)

Installation Procedure

1. Assemble the camshaft cover as needed. Refer to [Camshaft Cover Assemble](#) .

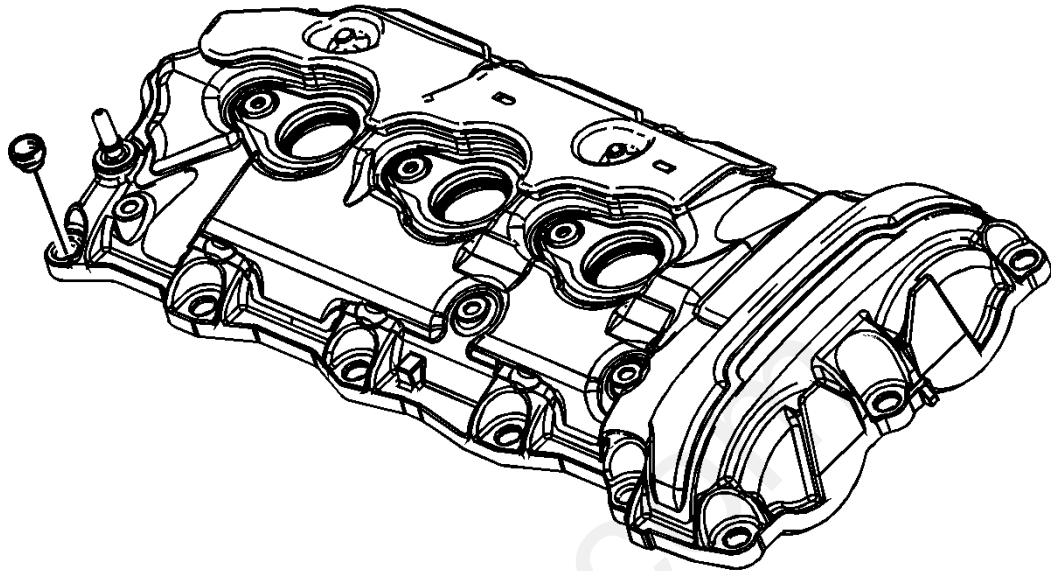


Fig. 67: View Of Right Camshaft Cover Bolt Grommets

Courtesy of GENERAL MOTORS COMPANY

2. Install new camshaft cover bolt grommets prior to installing the camshaft cover bolts.

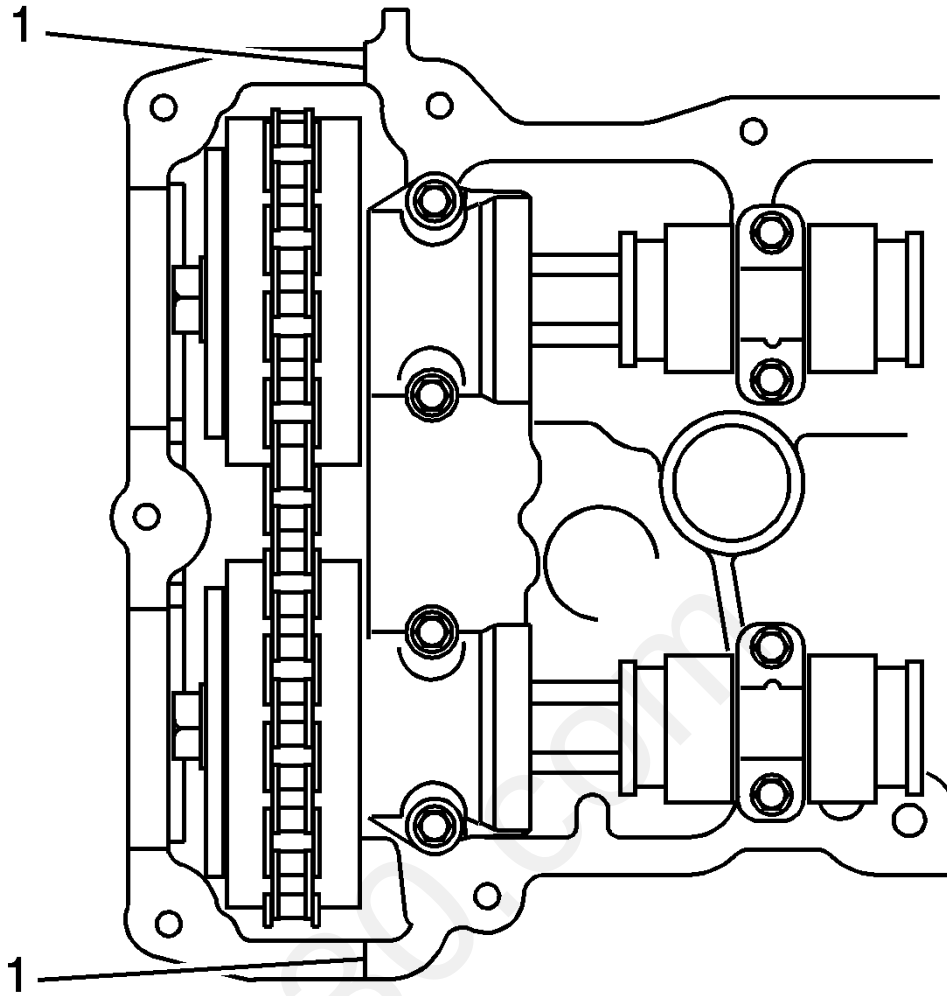


Fig. 68: Engine Front Cover Split Lines

Courtesy of GENERAL MOTORS COMPANY

3. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, on the engine front cover split lines (1). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.

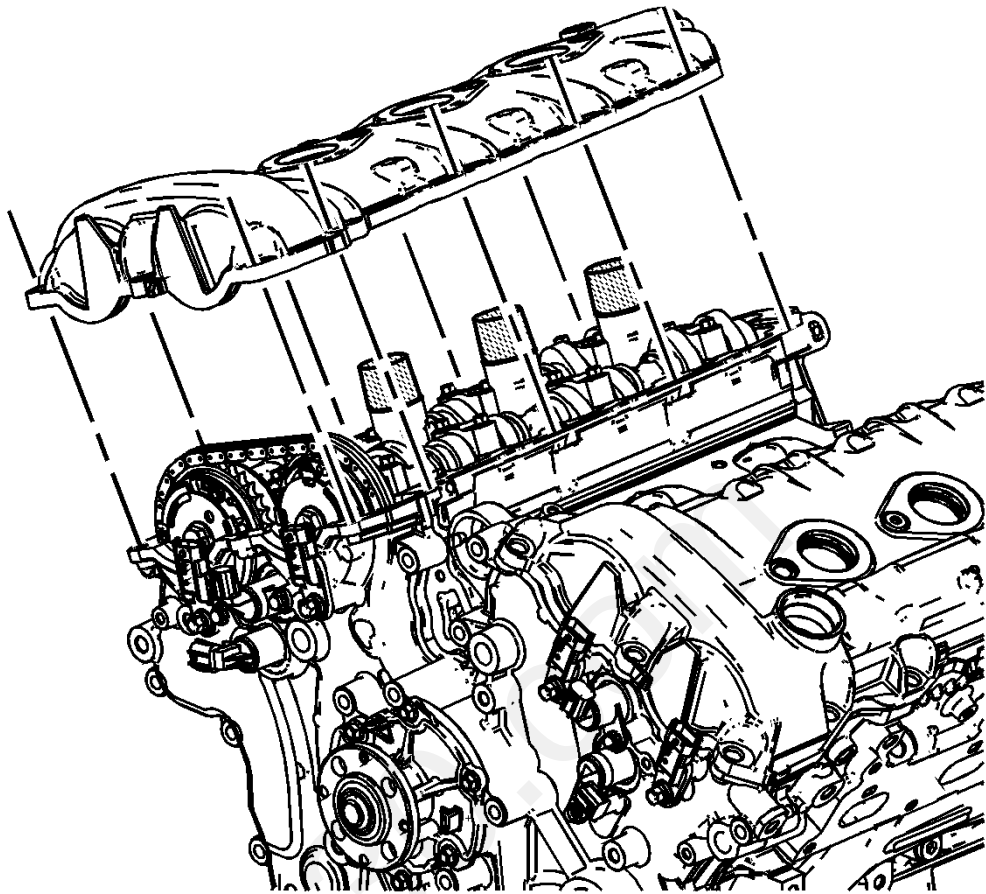


Fig. 69: View Of Right Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

4. Place the right camshaft cover into position onto the right cylinder head.

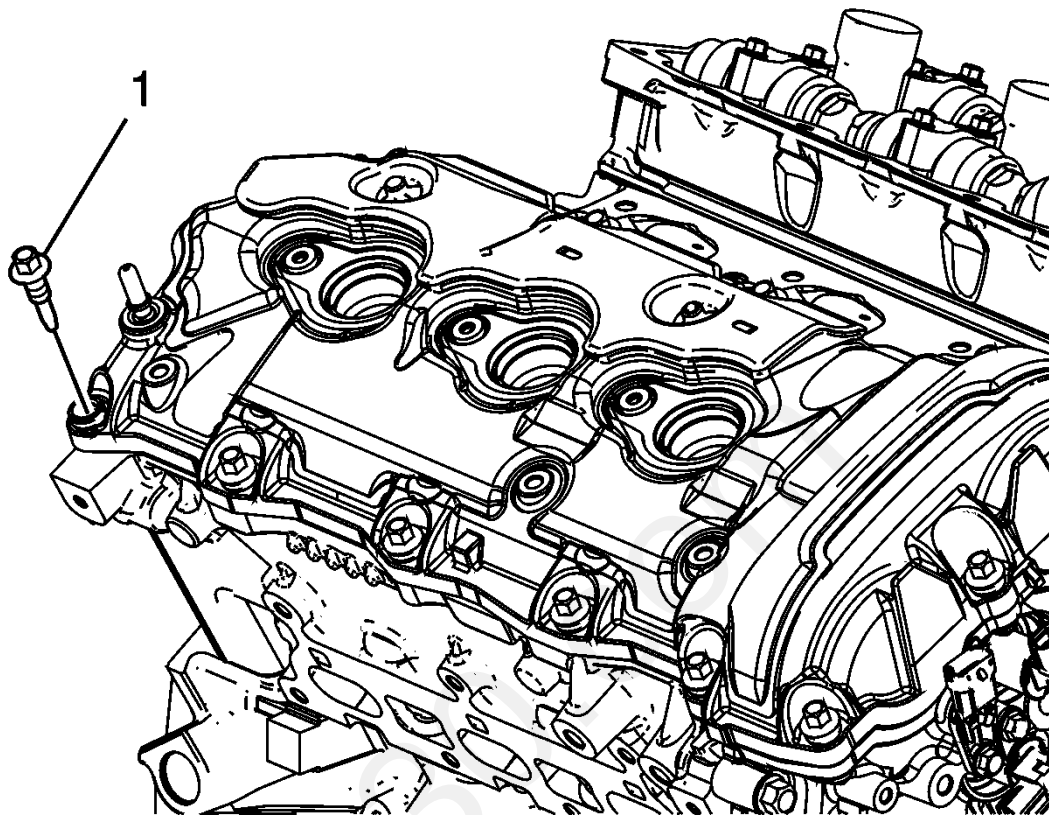


Fig. 70: View Of Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution**

5. Loosely install the right camshaft cover bolts (1).

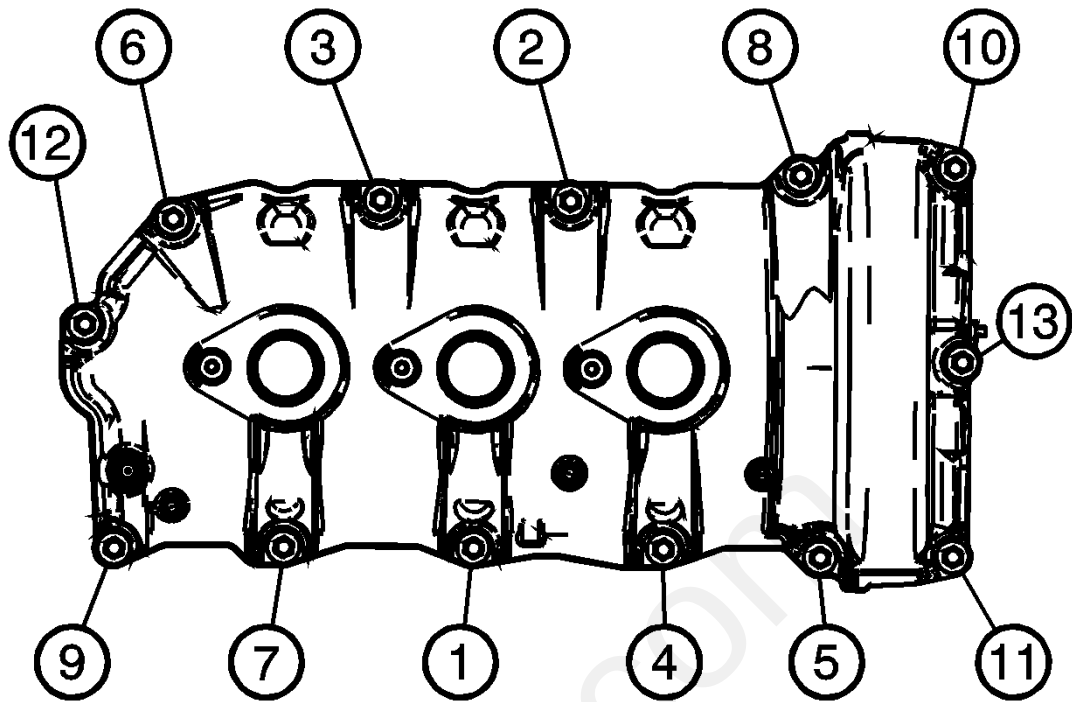


Fig. 71: Tightening Sequence for Right Camshaft Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

6. Tighten the right camshaft cover bolts in the sequence shown to 10 N.m (89 lb in).

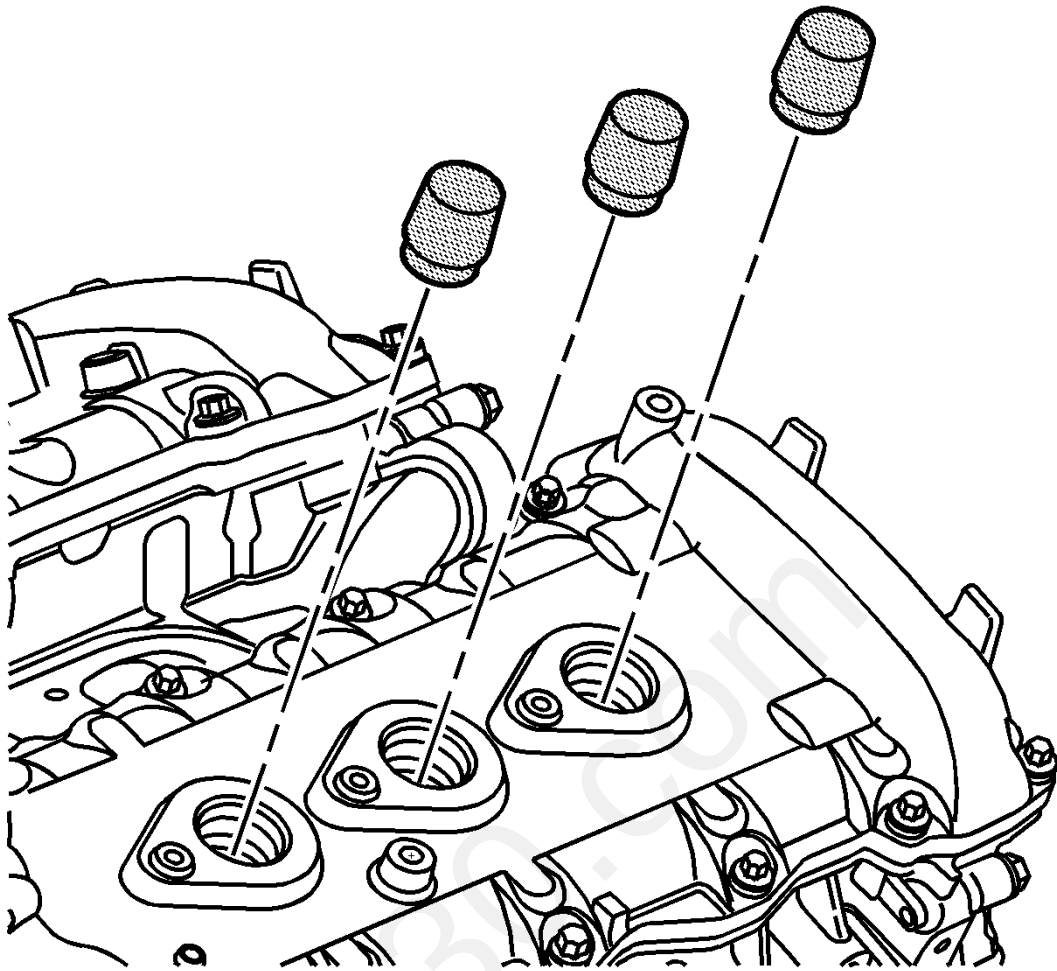


Fig. 72: Spark Plug Tube Seal Guides

Courtesy of GENERAL MOTORS COMPANY

7. Remove the **EN-46101** guide from the spark plug tubes of the right cylinder head.
8. Connect and install the engine harness to the camshaft cover.

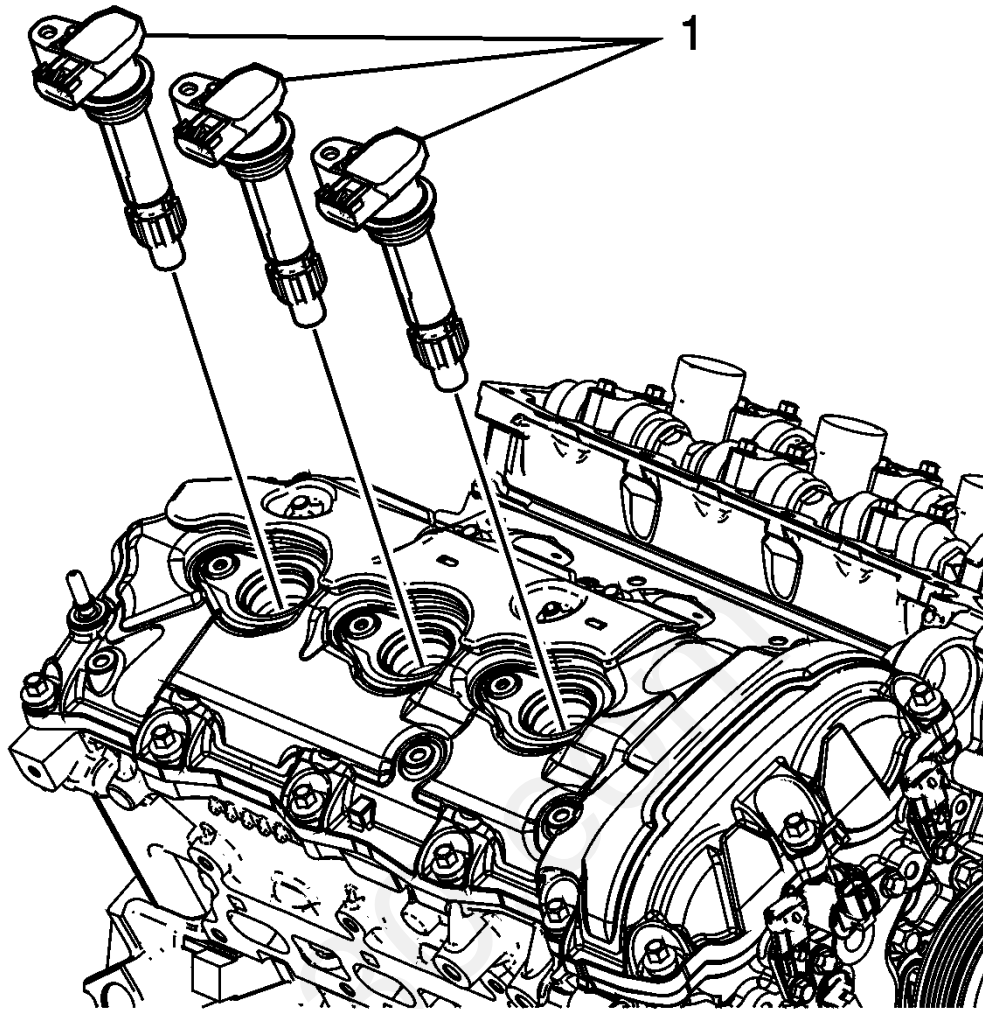


Fig. 73: View Of Ignition Coils

Courtesy of GENERAL MOTORS COMPANY

9. Install the ignition coils (1). Refer to [Ignition Coil Replacement - Bank 1](#)
10. Install the intake manifold. Refer to [Intake Manifold Replacement](#).

ENGINE FRONT COVER REPLACEMENT

Special Tools

EN-46109 Engine Front Cover Installation Guide Pins

For equivalent regional tools, refer to [Special Tools](#) .

Removal Procedure

1. Remove the intake manifold. Refer to [Intake Manifold Replacement](#).
2. Remove the water pump pulley. Refer to [Water Pump Replacement \(LFX\)](#) .
3. Remove the camshaft covers. Refer to [Camshaft Cover Replacement - Left Side](#), and [Camshaft Cover Replacement - Right Side](#).
4. Drain the engine coolant. Refer to [Cooling System Draining and Filling \(Static Fill\)](#) [Cooling System Draining and Filling \(Vac n Fill\)](#) .

- : the water outlet with the radiator hose and reposition aside. Refer to [Water Outlet Replacement \(LFX\)](#) .
6. Remove the generator and drive belt tensioner bracket. Refer to [Generator and Drive Belt Tensioner Bracket Replacement](#).
 7. Remove the air conditioner compressor bracket. Refer to [Air Conditioning Compressor Bracket Replacement \(LFX\)](#) .
 8. Remove Power Brake Booster Pump [Power Brake Booster Pump Replacement](#)
 9. Remove the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).

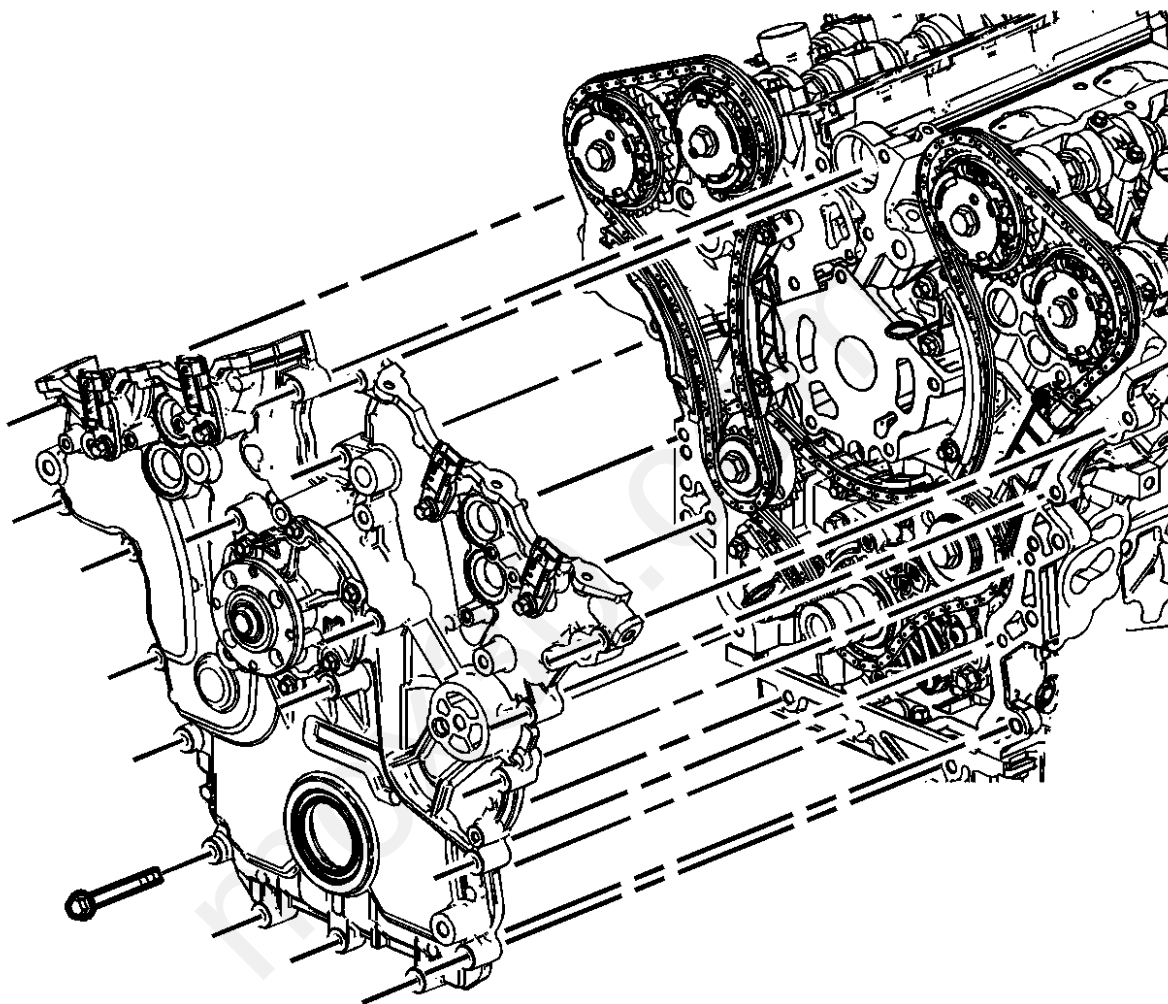


Fig. 74: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

10. Remove the engine front cover with the water pump. Refer to [Engine Front Cover Removal](#) .
11. Disassemble the engine front cover. Refer to [Engine Front Cover Disassemble](#) .

NOTE: Do NOT use sharp and/or metal gasket scrapers in order to clean the sealing surfaces.

12. Carefully clean the engine front cover sealing surfaces. Refer to [Engine Front Cover Cleaning and Inspection](#) .

NOTE:

Insert a piece of cardboard between the oil pan front and the oil pump in order to prevent any contaminants from falling into the oil pan.

13. Carefully clean the engine front cover sealing surfaces. Refer to [Engine Front Cover Cleaning and Inspection](#) .
14. Use compressed air in order to remove any engine coolant from the engine cooling passages and from the top of the oil pan scraper (windage tray).

Installation Procedure

1. Assemble the engine front cover. Refer to [Engine Front Cover Assemble](#) .

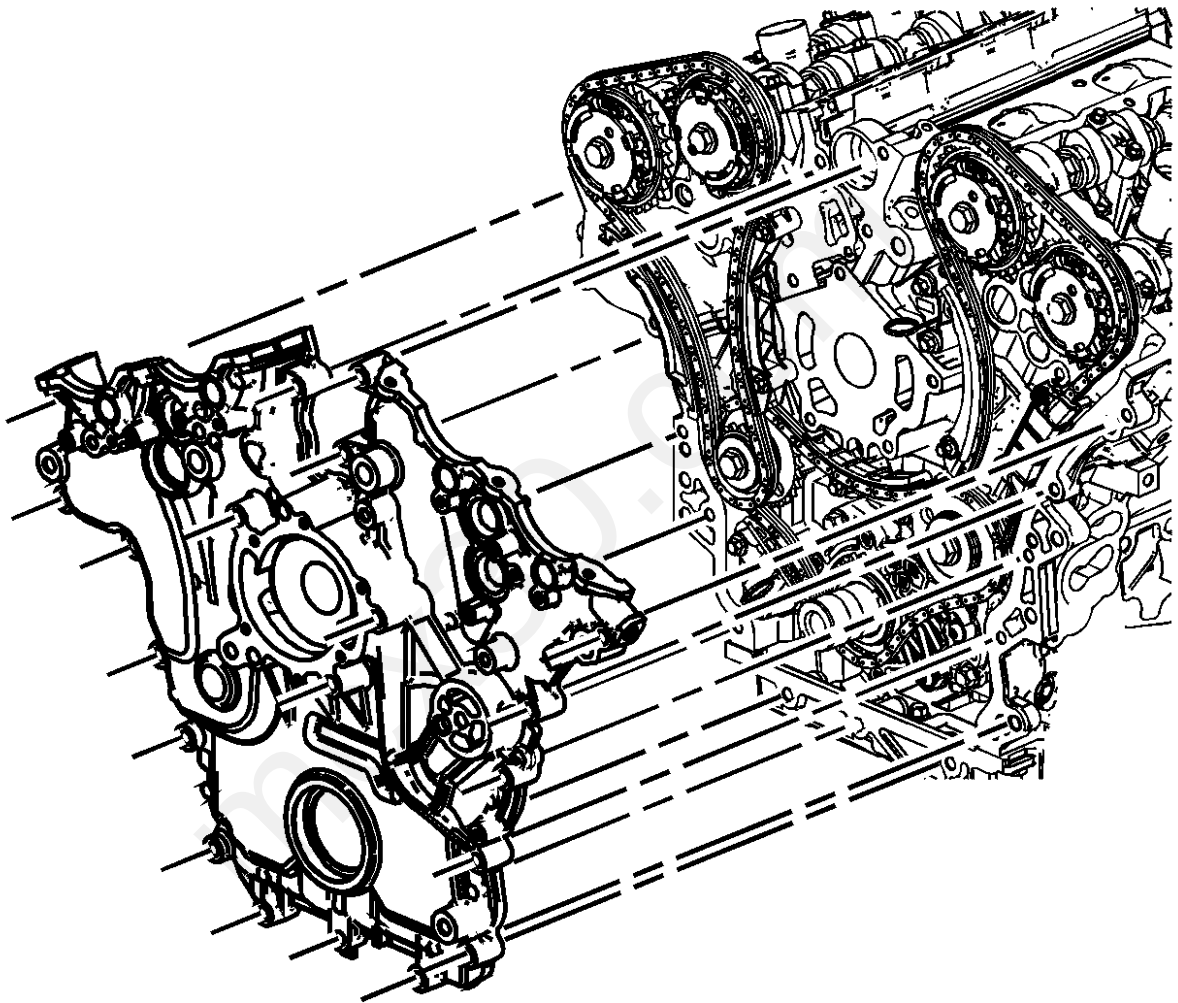


Fig. 75: View Of Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

2. Use the **EN-46109** pins in order to install the engine front cover. Refer to [Engine Front Cover Installation](#) .
3. Install the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).
4. Install Power Brake Booster Pump. Refer to [Power Brake Booster Pump Replacement](#)
5. Install the water outlet with radiator hose. Refer to [Water Outlet Replacement \(LFX\)](#) .

- ie camshaft covers. Refer to [Camshaft Cover Replacement - Left Side](#), and [Camshaft Cover Replacement - Right Side](#).
7. Install the air conditioner compressor bracket. Refer to [Air Conditioning Compressor Bracket Replacement \(LFX\)](#).
 8. Install the generator and drive belt tensioner bracket. Refer to [Generator and Drive Belt Tensioner Bracket Replacement](#).
 9. Install the water pump pulley. Refer to [Water Pump Replacement \(LFX\)](#).
 10. Install the intake manifold. Refer to [Intake Manifold Replacement](#).
 11. Fill the cooling system. Refer to [Cooling System Draining and Filling \(Static Fill\)](#) [Cooling System Draining and Filling \(Vac n Fill\)](#).

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the camshaft timing chain components. Refer to [Camshaft Timing Chain Components Removal](#).
3. Clean and inspect all of the camshaft timing drive components. Refer to [Camshaft Timing Drive Components Cleaning and Inspection](#). Replace components as necessary.

Installation Procedure

1. Install the camshaft timing chain components. Refer to [Camshaft Timing Chain Components Installation](#).
2. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the right side secondary camshaft drive chain components. Refer to [Camshaft Timing Chain Components Removal](#).
3. Clean and inspect all of the camshaft timing drive components. Refer to [Camshaft Timing Drive Components Cleaning and Inspection](#). Replace components as necessary.

Installation Procedure

1. Install the right side secondary camshaft drive chain components. Refer to [Camshaft Timing Chain Components Installation](#).
2. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the camshaft timing chain components. Refer to [Camshaft Timing Chain Components Removal](#).
3. Clean and inspect all of the camshaft timing drive components. Refer to [Camshaft Timing Drive Components Cleaning and Inspection](#).

Installation Procedure

ie camshaft timing chain components. Refer to [Camshaft Timing Chain Components Installation](#)

2. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the right side secondary camshaft drive chain tensioner. Refer to [Camshaft Timing Chain Components Removal](#).
3. Clean and inspect all of the camshaft timing drive components. Refer to [Camshaft Timing Drive Components Cleaning and Inspection](#). Replace components as necessary.

Installation Procedure

1. Install the right side secondary camshaft drive chain tensioner. Refer to [Camshaft Timing Chain Components Installation](#).
2. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the left side secondary camshaft drive chain tensioner, shoe, and guide. Refer to [Camshaft Timing Chain Components Removal](#).
3. Clean and inspect all of the camshaft timing drive components. Refer to [Camshaft Timing Drive Components Cleaning and Inspection](#). Replace components as necessary.

Installation Procedure

1. Install the left side secondary camshaft drive chain shoe, guide, and tensioner. Refer to [Camshaft Timing Chain Components Installation](#).
2. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the right side secondary camshaft drive chain tensioner, shoe, and guide. Refer to [Camshaft Timing Chain Components Removal](#).
3. Clean and inspect all of the camshaft timing drive components. Refer to [Camshaft Timing Drive Components Cleaning and Inspection](#). Replace components as necessary.

Installation Procedure

1. Install the right side secondary camshaft drive chain shoe, guide, and tensioner. Refer to [Camshaft Timing Chain Components Installation](#).
2. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - LEFT SIDE

dure

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the left side secondary camshaft drive chain tensioner, shoe, and guide. Refer to [Camshaft Timing Chain Components Removal](#).
3. Clean and inspect all of the camshaft timing drive components. Refer to [Camshaft Timing Drive Components Cleaning and Inspection](#). Replace components as necessary.

Installation Procedure

1. Install the left side secondary camshaft drive chain shoe, guide, and tensioner. Refer to [Camshaft Timing Chain Components Installation](#).
2. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the right side secondary camshaft drive chain tensioner, shoe, and guide. Refer to [Camshaft Timing Chain Components Removal](#).
3. Clean and inspect all of the camshaft timing drive components. Refer to [Camshaft Timing Drive Components Cleaning and Inspection](#). Replace components as necessary.

Installation Procedure

1. Install the right side secondary camshaft drive chain shoe, guide, and tensioner. Refer to [Camshaft Timing Chain Components Installation](#).
2. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

PRIMARY CAMSHAFT DRIVE CHAIN AND SPROCKETS REPLACEMENT

Removal Procedure

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the right side secondary camshaft drive chain components. Refer to [Camshaft Timing Chain Components Removal](#).
3. Remove the primary camshaft drive chain components. Refer to [Camshaft Timing Chain Components Removal](#).
4. Clean and inspect all of the camshaft timing drive components. Refer to [Camshaft Timing Drive Components Cleaning and Inspection](#).

Installation Procedure

1. Install the primary camshaft drive chain components. Refer to [Camshaft Timing Chain Components Installation](#).
2. Install the right side secondary camshaft drive chain components. Refer to [Camshaft Timing Chain Components Installation](#).
3. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

TIMING CHAIN IDLER SPROCKET REPLACEMENT - LEFT SIDE

Removal Procedure

- spark plugs. Refer to [Spark Plug Replacement](#) .
2. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
 3. Remove the camshaft timing chain components. Refer to [Camshaft Timing Chain Components Removal](#) .

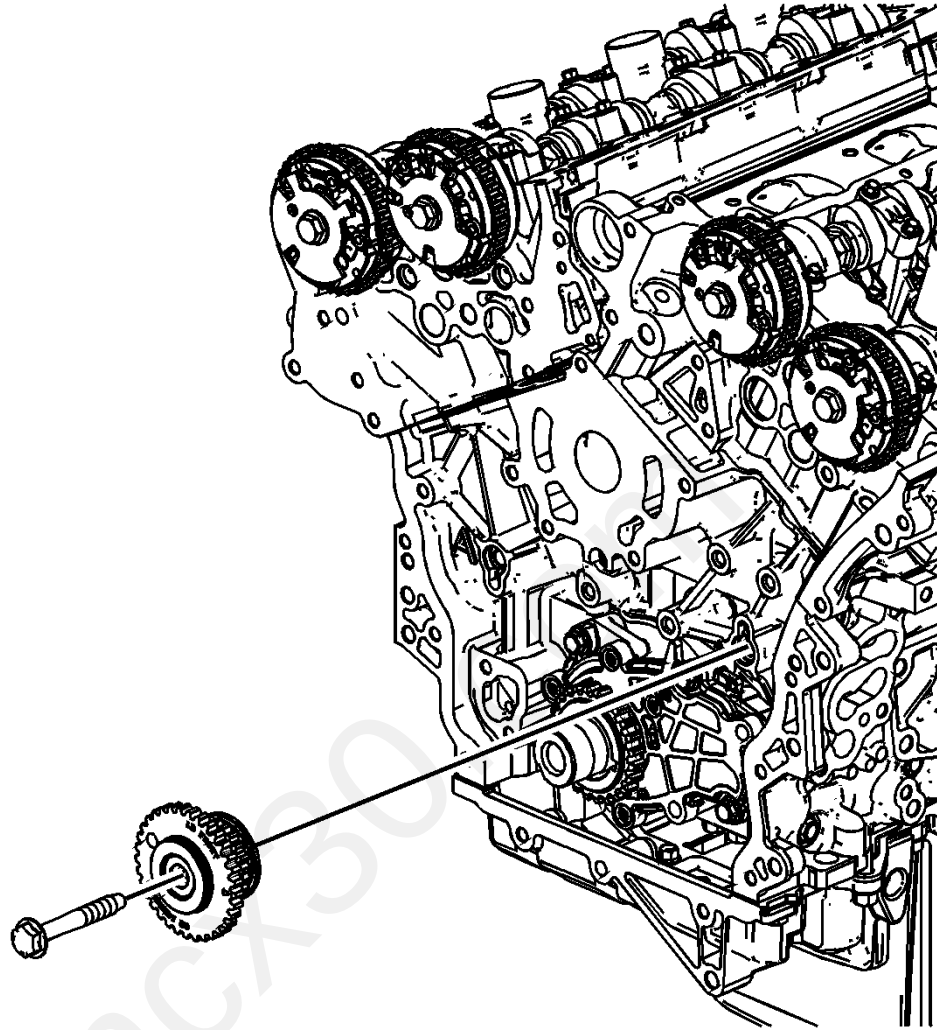


Fig. 76: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the left intermediate drive chain idler sprocket. Refer to [Timing Chain Idler Sprocket Removal - Left Side](#) .

Installation Procedure

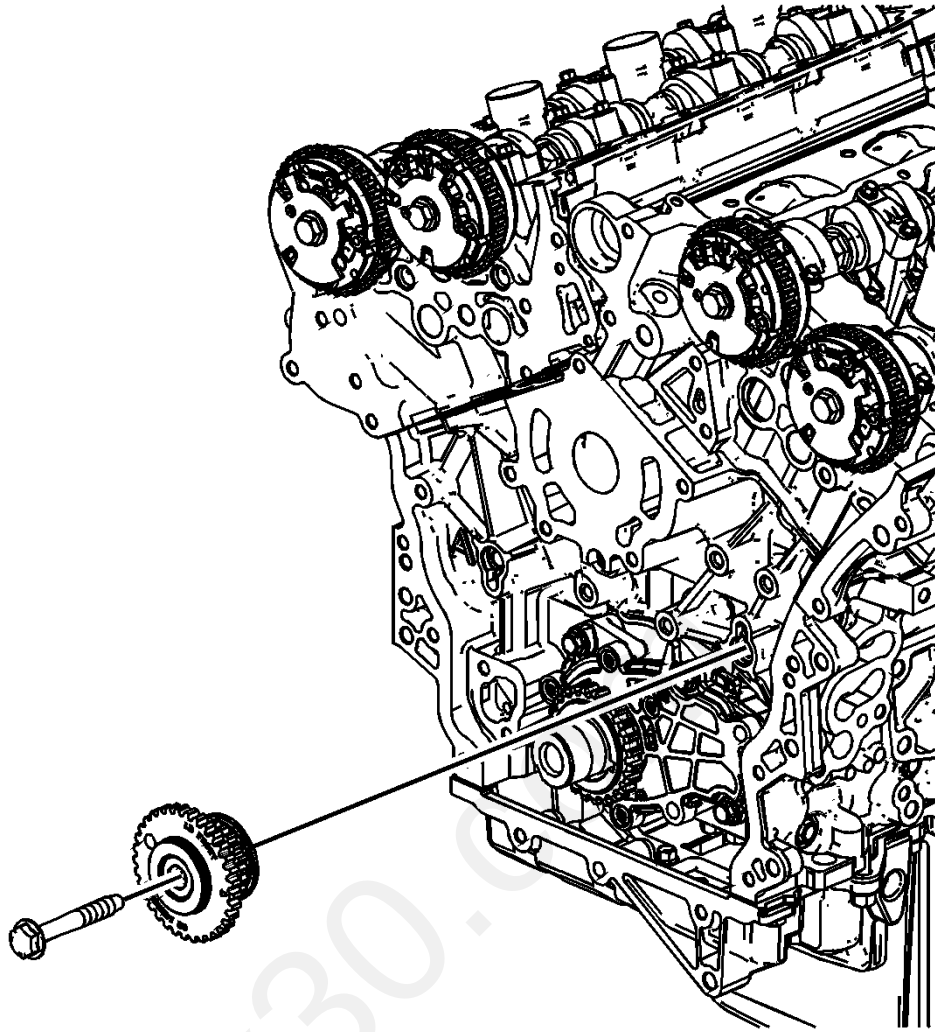


Fig. 77: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the left intermediate drive chain idler sprocket. Refer to [Timing Chain Idler Sprocket Installation - Left Side](#) .
2. Install the camshaft timing chain components. Refer to [Camshaft Timing Chain Components Installation](#) .
3. Install the engine front cover. Refer to [Engine Front Cover Replacement](#) .
4. Install spark plugs. Refer to [Spark Plug Replacement](#) .

TIMING CHAIN IDLER SPROCKET REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove spark plugs. Refer to [Spark Plug Replacement](#) .
2. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#) .
3. Remove the right side secondary camshaft drive chain components. Refer to [Camshaft Timing Chain Components Removal](#) .
4. Remove the primary camshaft drive chain components. Refer to [Camshaft Timing Chain Components Removal](#) .

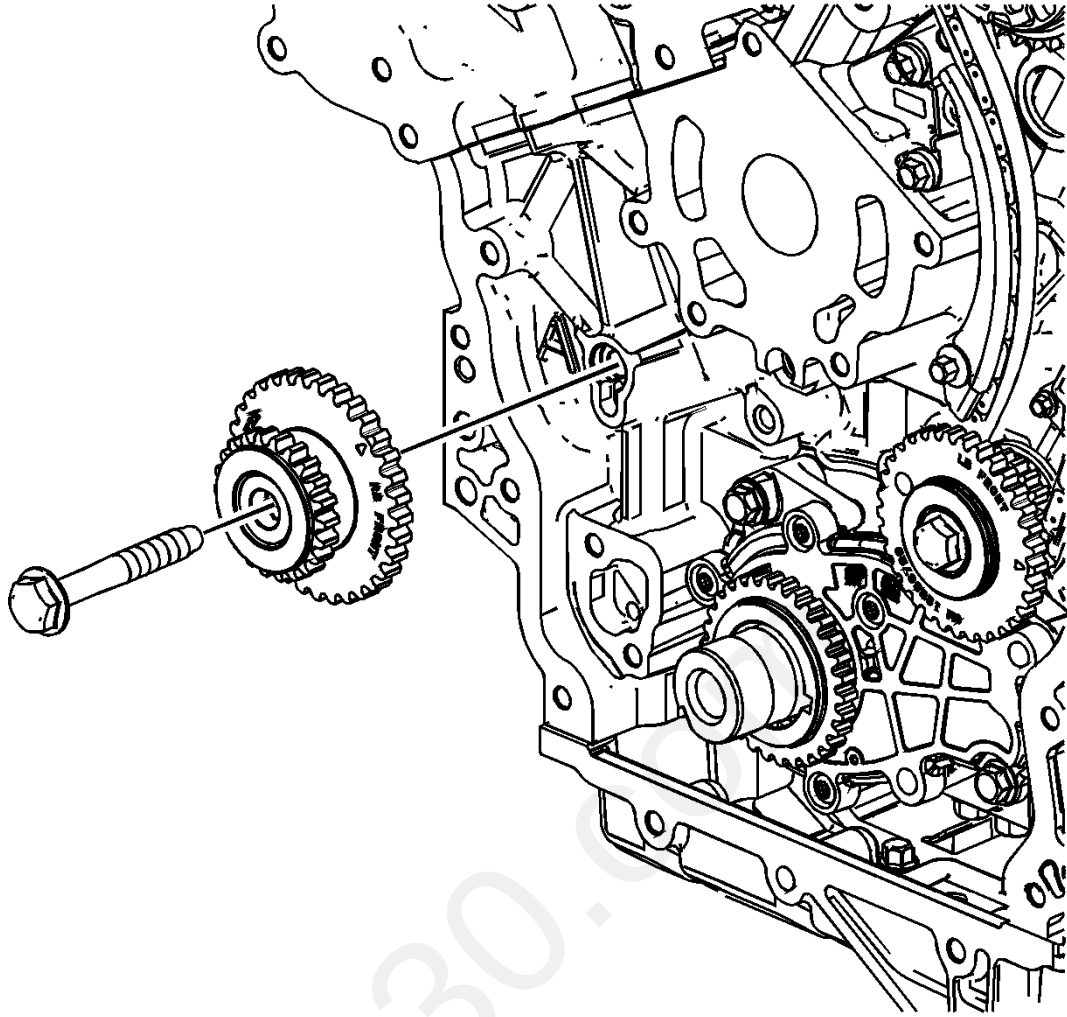


Fig. 78: Camshaft Intermediate Drive Chain Idler & Bolt

Courtesy of GENERAL MOTORS COMPANY

5. Remove the right intermediate drive chain idler sprocket. Refer to [Timing Chain Idler Sprocket Removal - Right Side](#) .

Installation Procedure

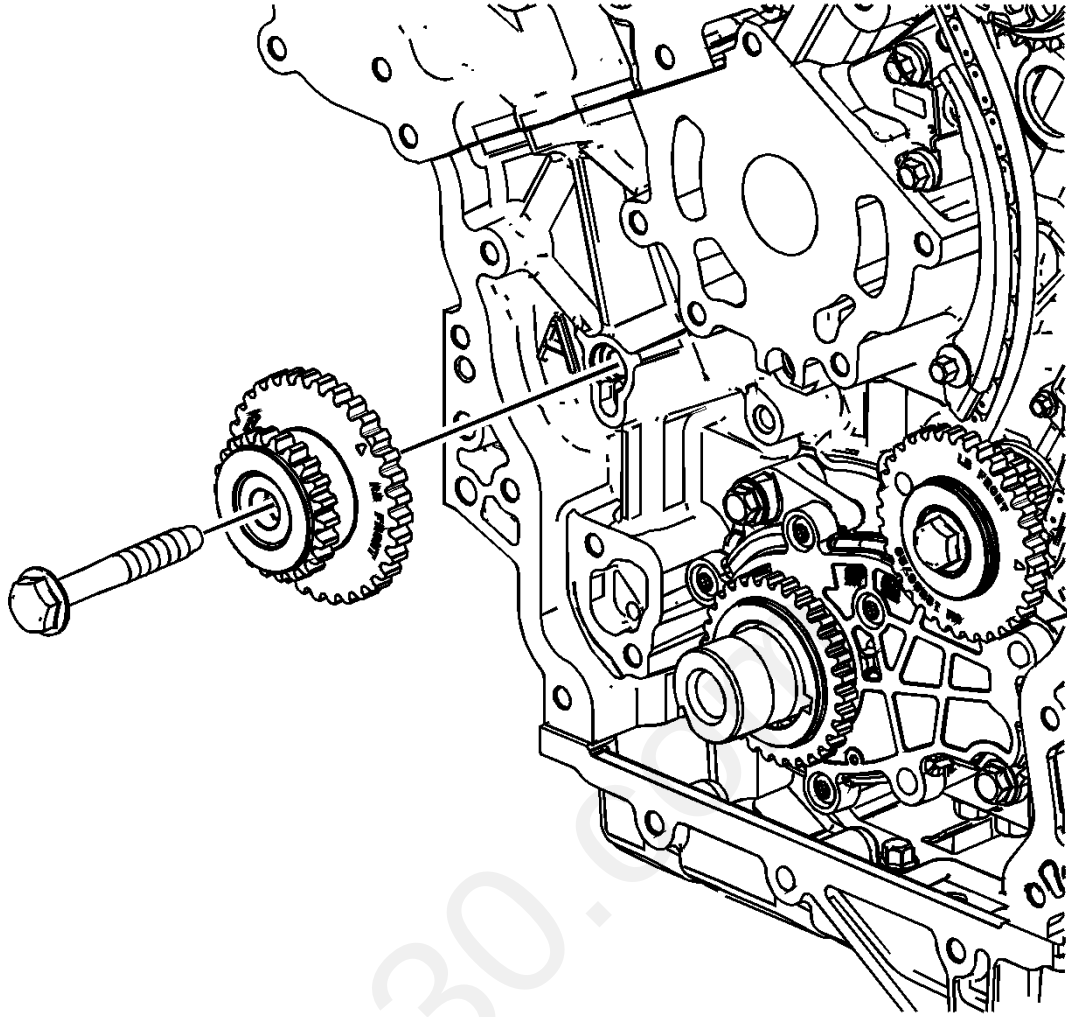


Fig. 79: Camshaft Intermediate Drive Chain Idler & Bolt

Courtesy of GENERAL MOTORS COMPANY

1. Install the left intermediate drive chain idler sprocket. Refer to [Timing Chain Idler Sprocket Installation - Right Side](#) .
2. Install the camshaft timing chain components. Refer to [Camshaft Timing Chain Components Installation](#) .
3. Install the engine front cover. Refer to [Engine Front Cover Replacement](#) .
4. Install spark plugs. Refer to [Spark Plug Replacement](#) .

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT

Removal Procedure

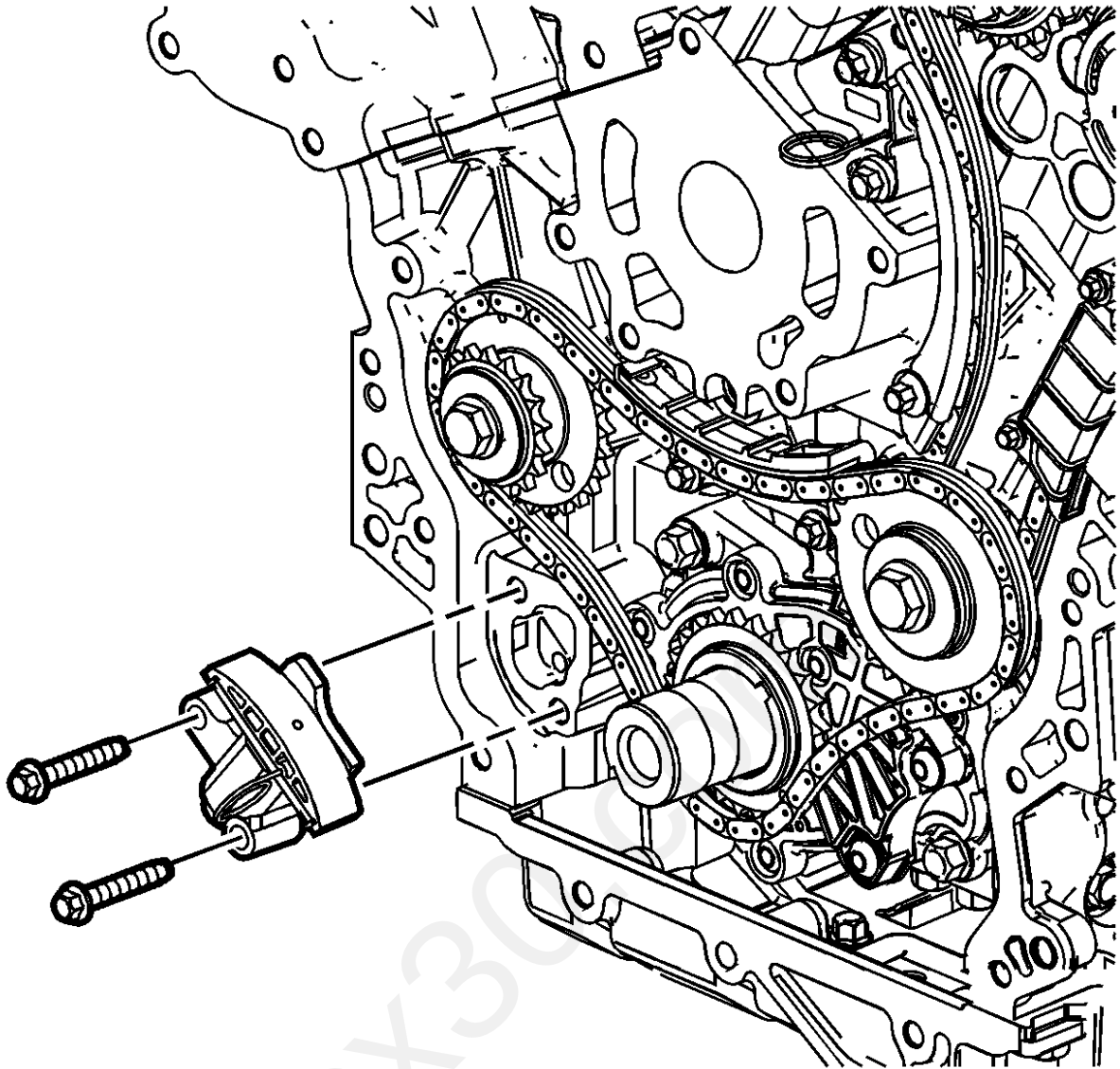


Fig. 80: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).

IMPORTANT: If the entire camshaft timing system is not in Stage 2, [Timing Chain Alignment Diagram](#) , mark the timing chain and sprockets in order to ensure proper reassembly.

2. Remove the primary camshaft drive chain tensioner. Refer to [Camshaft Timing Chain Components Removal](#) .

Installation Procedure

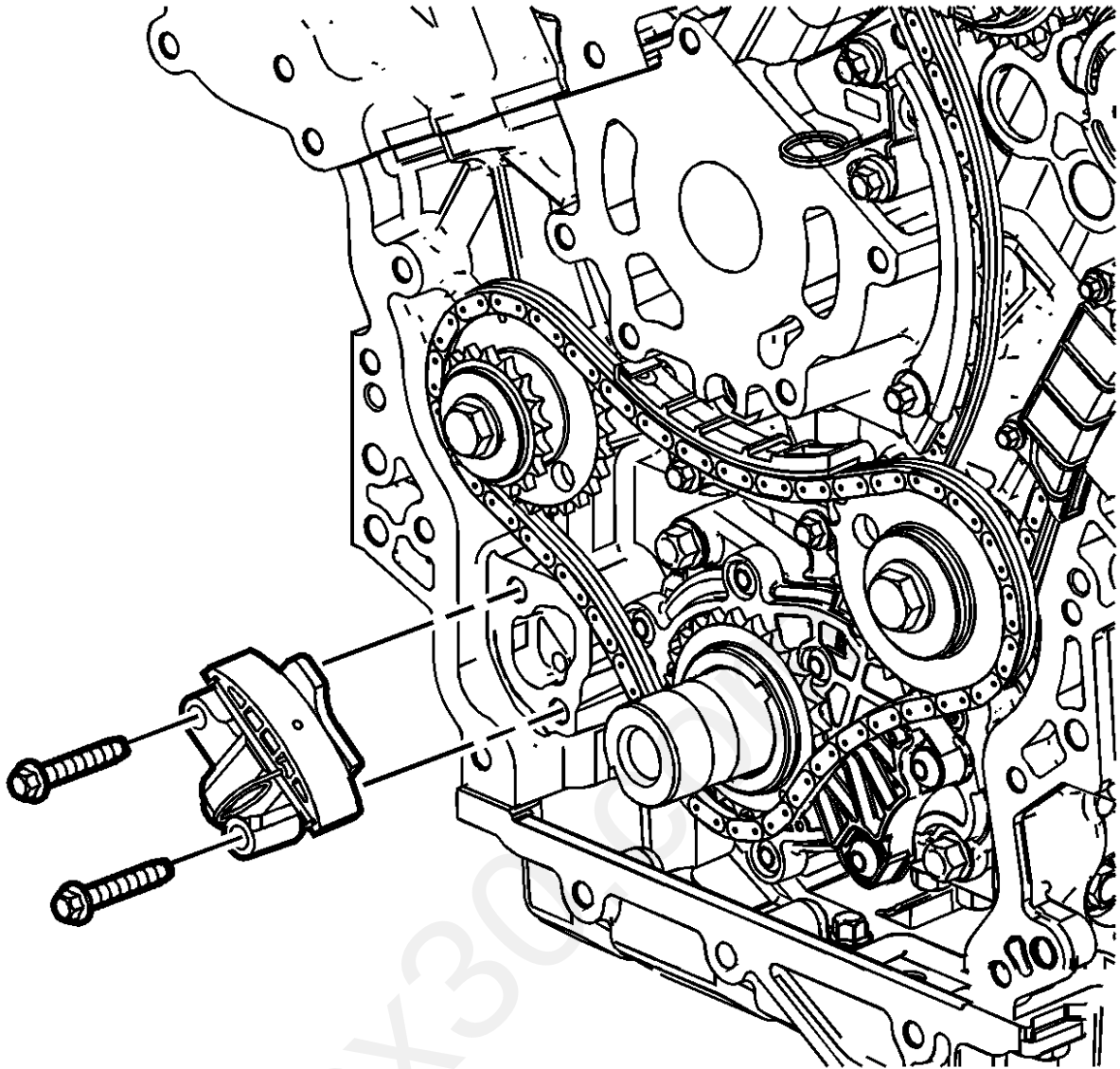


Fig. 81: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Install the primary camshaft drive chain tensioner. Refer to [Camshaft Timing Chain Components Installation](#) .
2. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

PRIMARY TIMING CHAIN GUIDE REPLACEMENT - LOWER

Removal Procedure

1. Remove the primary camshaft drive chain tensioner. Refer to [Primary Camshaft Intermediate Drive Chain Tensioner Replacement](#).

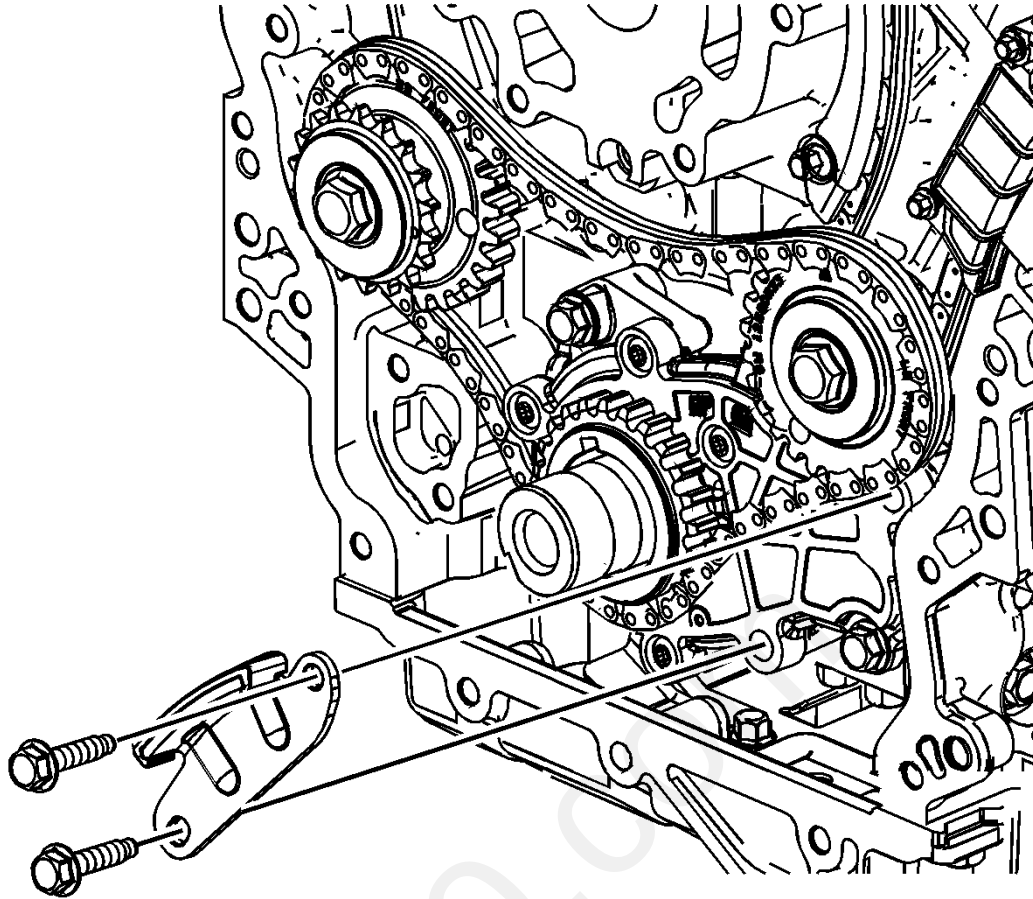


Fig. 82: View Of Primary Camshaft Drive Chain Lower Guide Bolts

Courtesy of GENERAL MOTORS COMPANY

2. Remove the primary camshaft drive chain lower guide bolts.
3. Remove the primary camshaft drive chain lower guide.

Installation Procedure

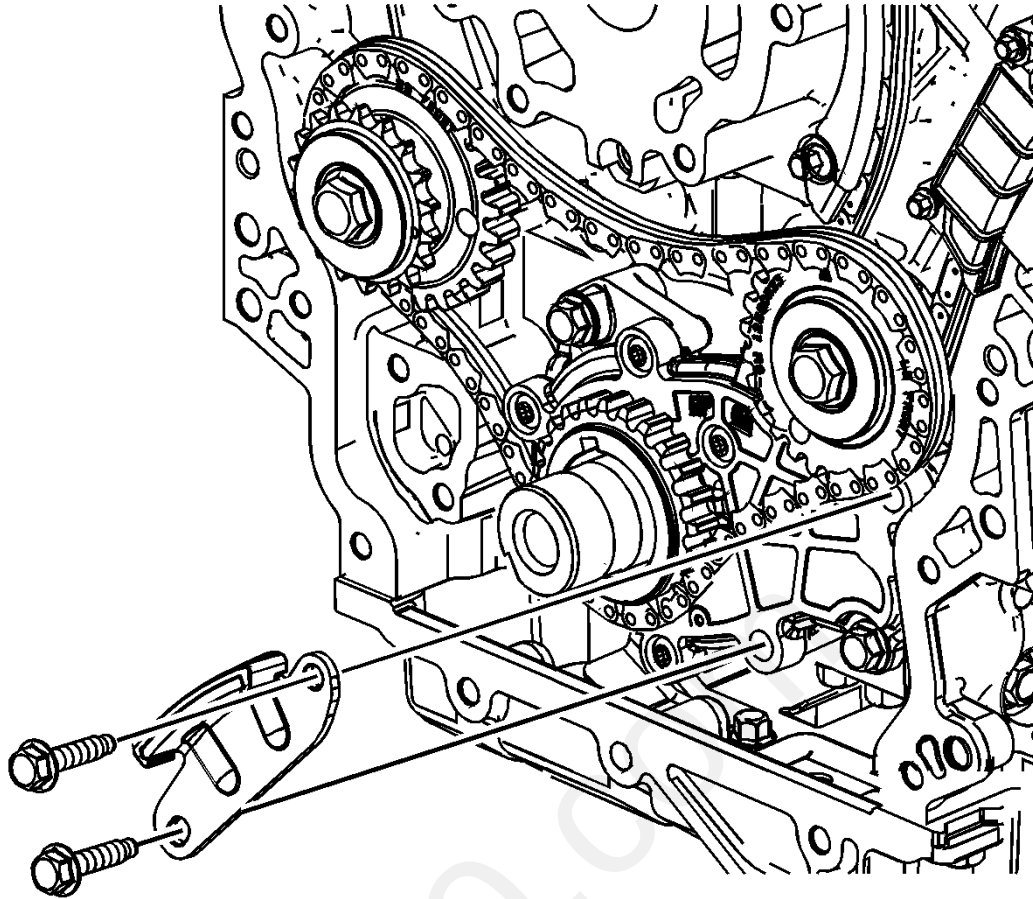


Fig. 83: View Of Primary Camshaft Drive Chain Lower Guide Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Position the primary camshaft drive chain lower guide to the oil pump.

CAUTION: Refer to [Fastener Caution](#) .

2. Install the primary camshaft drive chain lower guide bolts and tighten to 23 N.m (17 lb ft).
3. Install the primary camshaft drive chain tensioner. Refer to [Primary Camshaft Intermediate Drive Chain Tensioner Replacement](#).

PRIMARY TIMING CHAIN GUIDE REPLACEMENT - UPPER

Removal Procedure

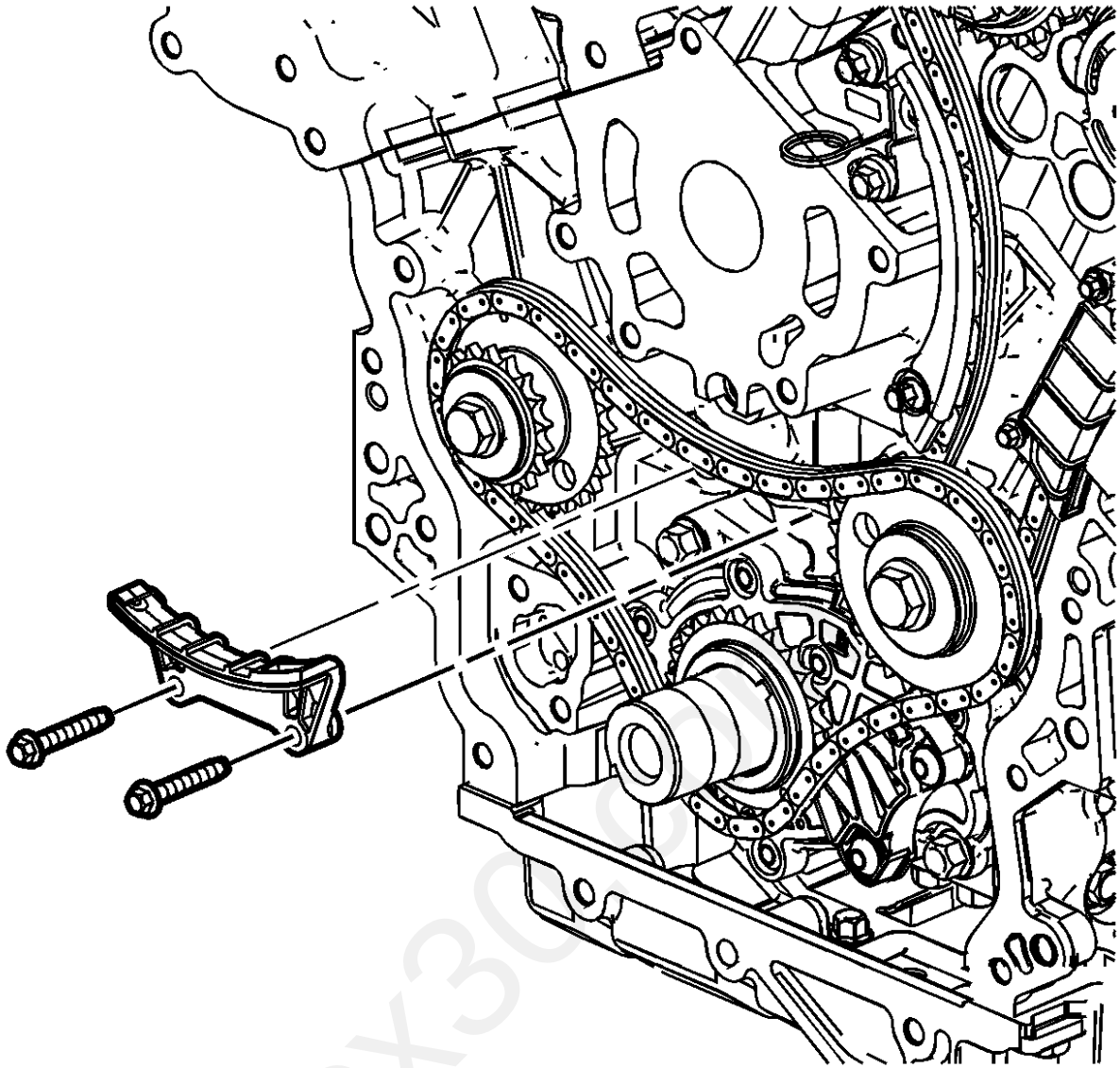


Fig. 84: View Of Upper Primary Camshaft Drive Chain Guide

Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the primary camshaft drive chain tensioner. Refer to [Camshaft Timing Chain Components Removal](#).
3. Remove the primary upper camshaft drive chain guide. Refer to [Camshaft Timing Chain Components Removal](#).

Installation Procedure

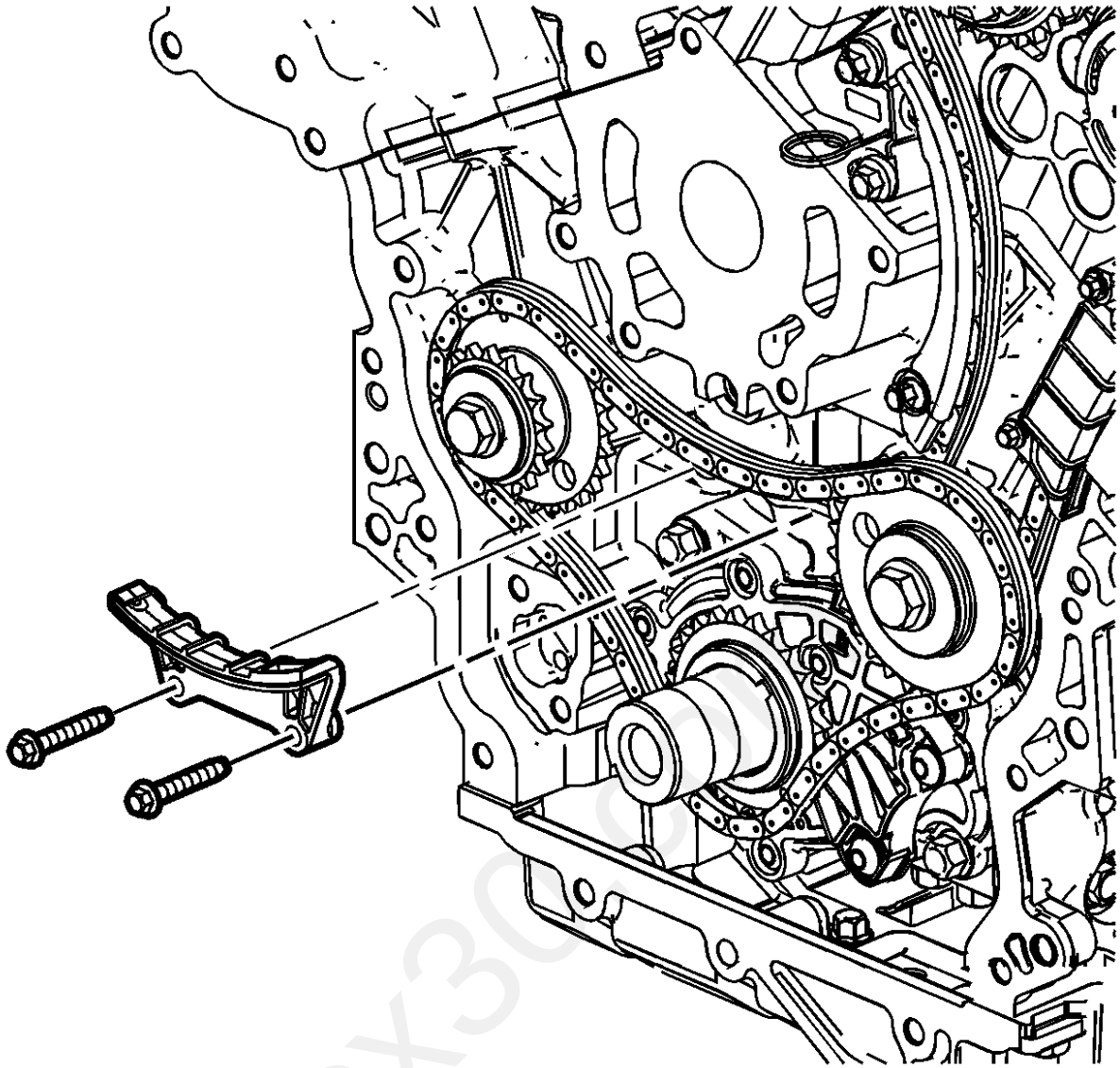


Fig. 85: View Of Upper Primary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

1. Install the primary upper camshaft drive chain guide. Refer to [Camshaft Timing Chain Components Installation](#) .
2. Install the primary camshaft drive chain tensioner. Refer to [Camshaft Timing Chain Components Installation](#) .
3. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 1

Special Tools

- EN49982-1 Timing Chain Retainer
- EN49982-2 Timing Chain Retainer

For equivalent regional tools, refer to [Special Tools](#) .

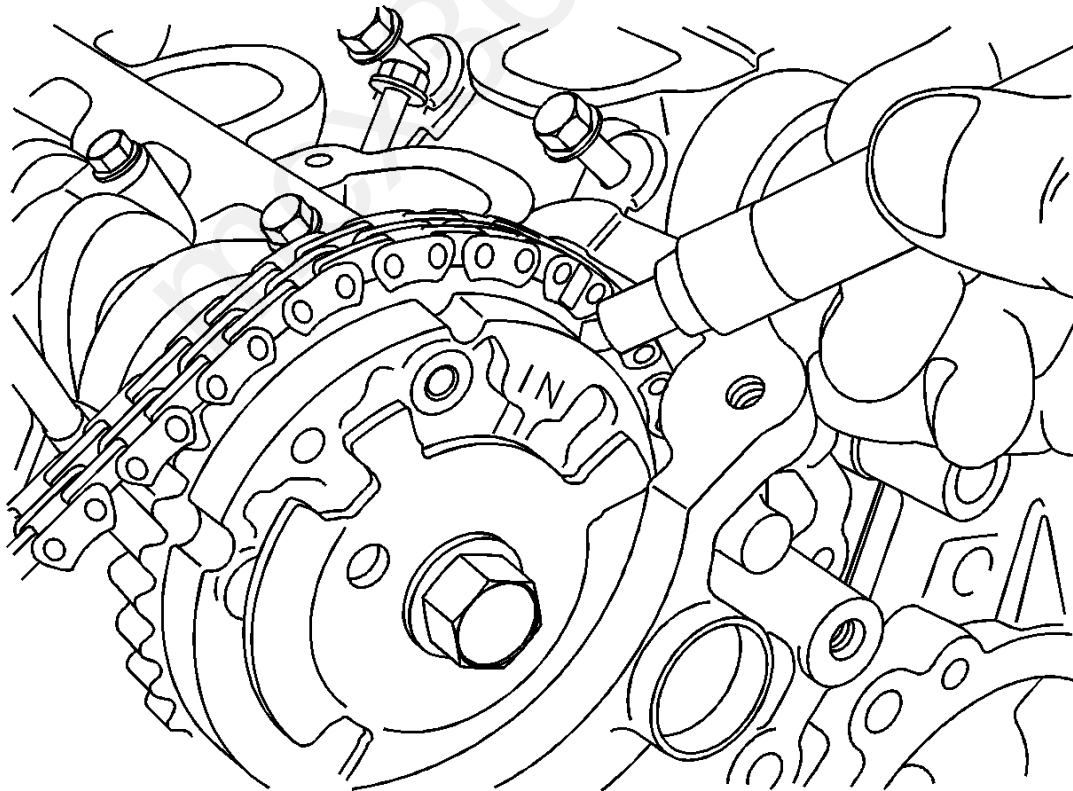
Removal Procedure

1. Remove the camshaft cover. Refer to [Camshaft Cover Replacement - Right Side](#).

- : the camshaft position actuator solenoid valve solenoid - intake. Refer to [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 \(Right Side\) Intake](#) .
3. Remove the intake camshaft position sensor. Refer to [Camshaft Position Sensor Replacement - Bank 1 \(Right Side\) Intake](#) .
 4. Remove the exhaust camshaft position sensor. Refer to [Camshaft Position Sensor Replacement - Bank 1 \(Right Side\) Exhaust](#) .
 5. Remove the camshaft position actuator solenoid valve solenoid - exhaust. Refer to [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 \(Right Side\) Exhaust](#) .
 6. Rotate engine clockwise using crankshaft dampener retaining bolt until the flats at the rear ends of the camshafts are pointing up. This puts the camshafts on "base circle" and will reduce their tendency to rotate from valve spring pressure when the camshaft position actuators/drive chains are removed.

NOTE: Do NOT remove or back out the camshaft position actuator bolt(s) significantly, simply break them loose from their fully-torqued position. The position actuators must stay firmly attached until the retaining tools are in place, but they should be broken loose while the chain is still tight and in position.

7. Loosen intake and/or exhaust camshaft position actuator retaining bolts, depending on which camshaft position actuator and/or camshaft you will be servicing. If servicing both camshaft position actuators and/or camshafts, loosen both bolts.



Marking Position Of Chain To Camshaft Position Actuator - Intake
Courtesy of GENERAL MOTORS COMPANY

NOTE: Be certain to clearly mark the position of the chain to the camshaft position actuator(s). Though the engine does not need to be set to a specific timing mark before starting the procedure, the relationship of the chain to the actuator(s) is critical and must be reestablished on assembly.

8. Mark the position of the chain to the camshaft position actuator - intake.

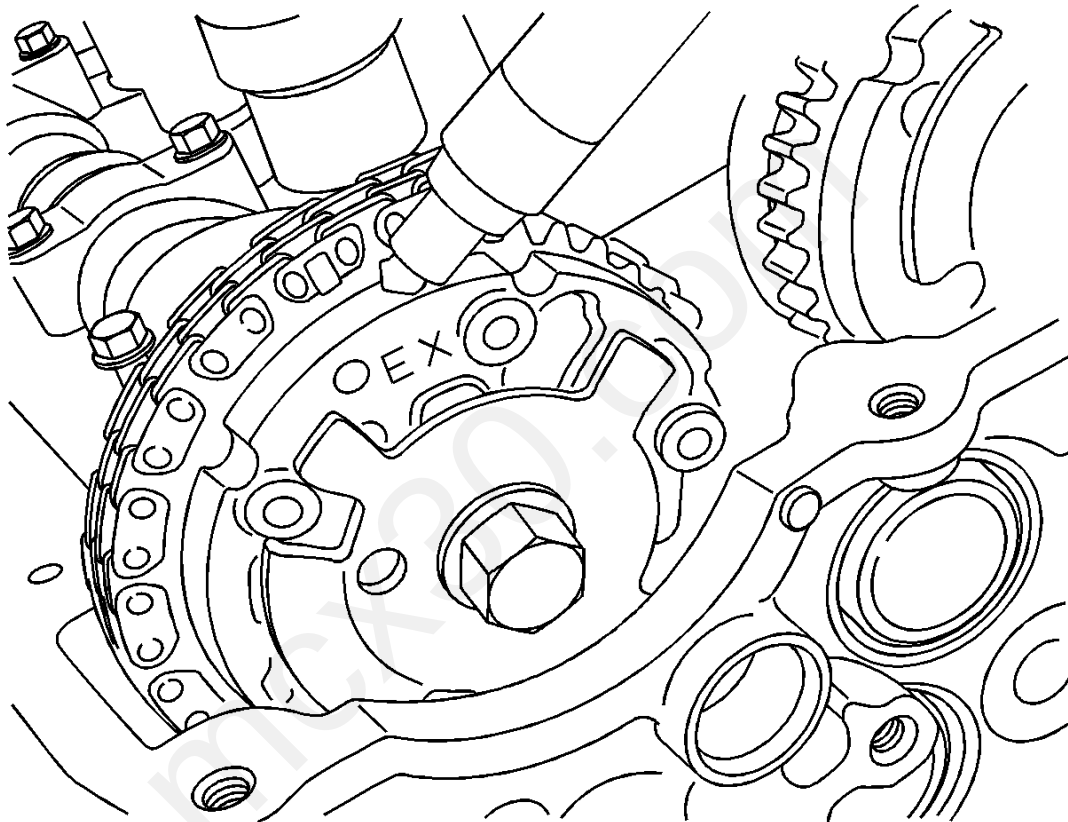


Fig. 87: Marking Position Of Chain To Camshaft Position Actuator - Exhaust
Courtesy of GENERAL MOTORS COMPANY

9. Mark the position of the chain to the camshaft position actuator - exhaust.

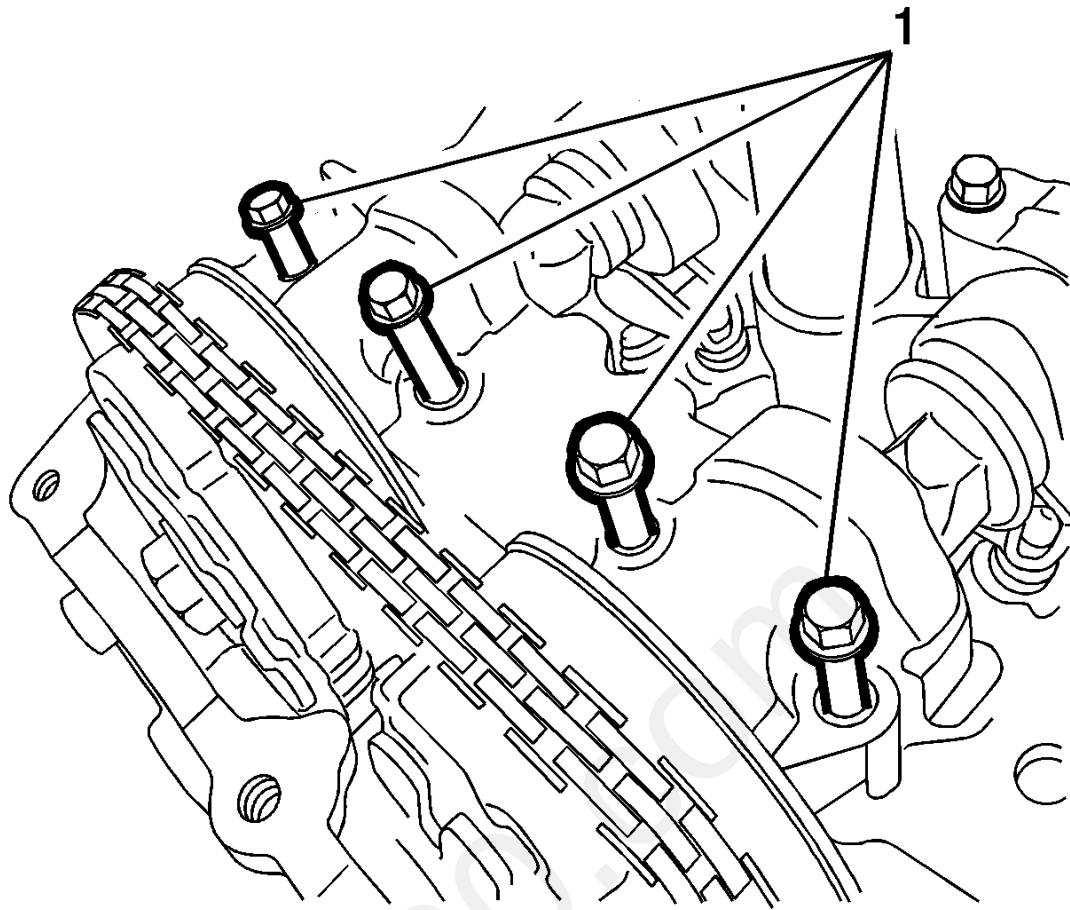


Fig. 88: Camshaft Front Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove camshaft front cap bolts (1).

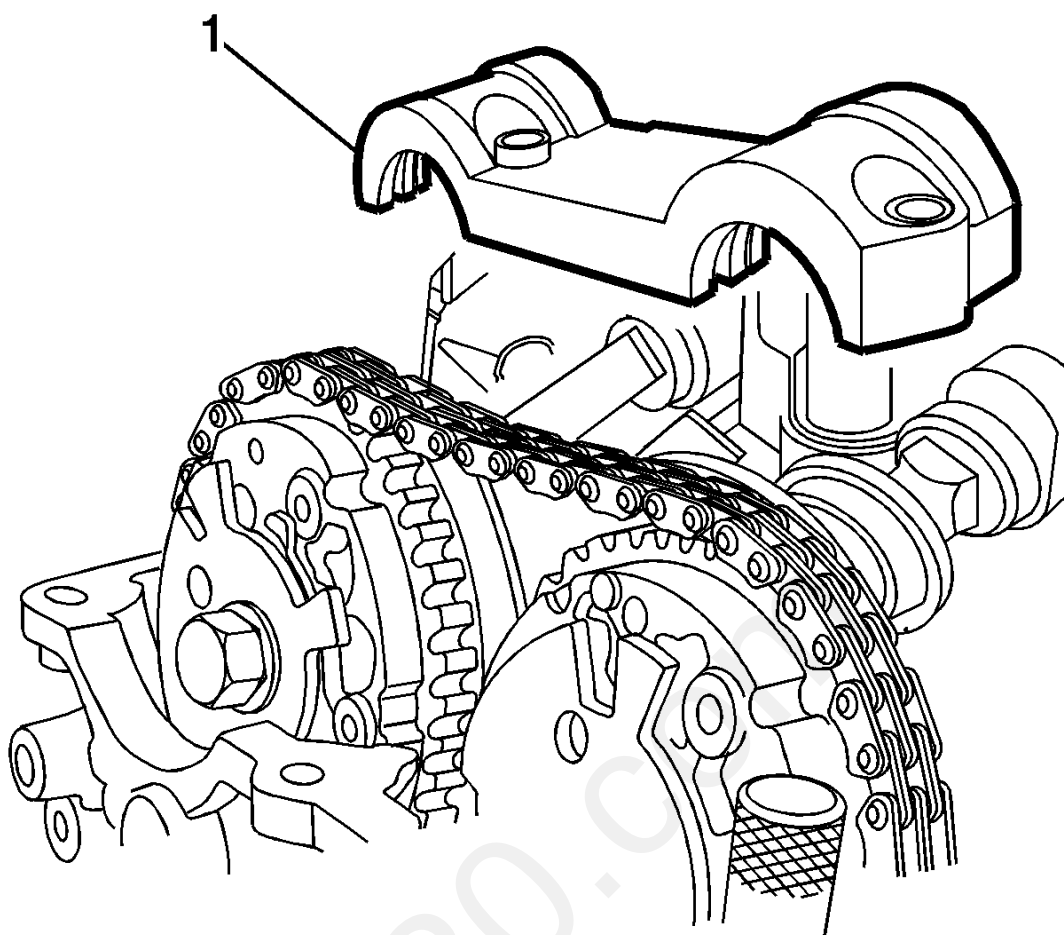


Fig. 89: Camshaft Front Cap

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT remove or loosen any other camshaft bearing caps at this time, even if you intend to eventually remove the camshaft.

11. Remove the camshaft front cap (1).

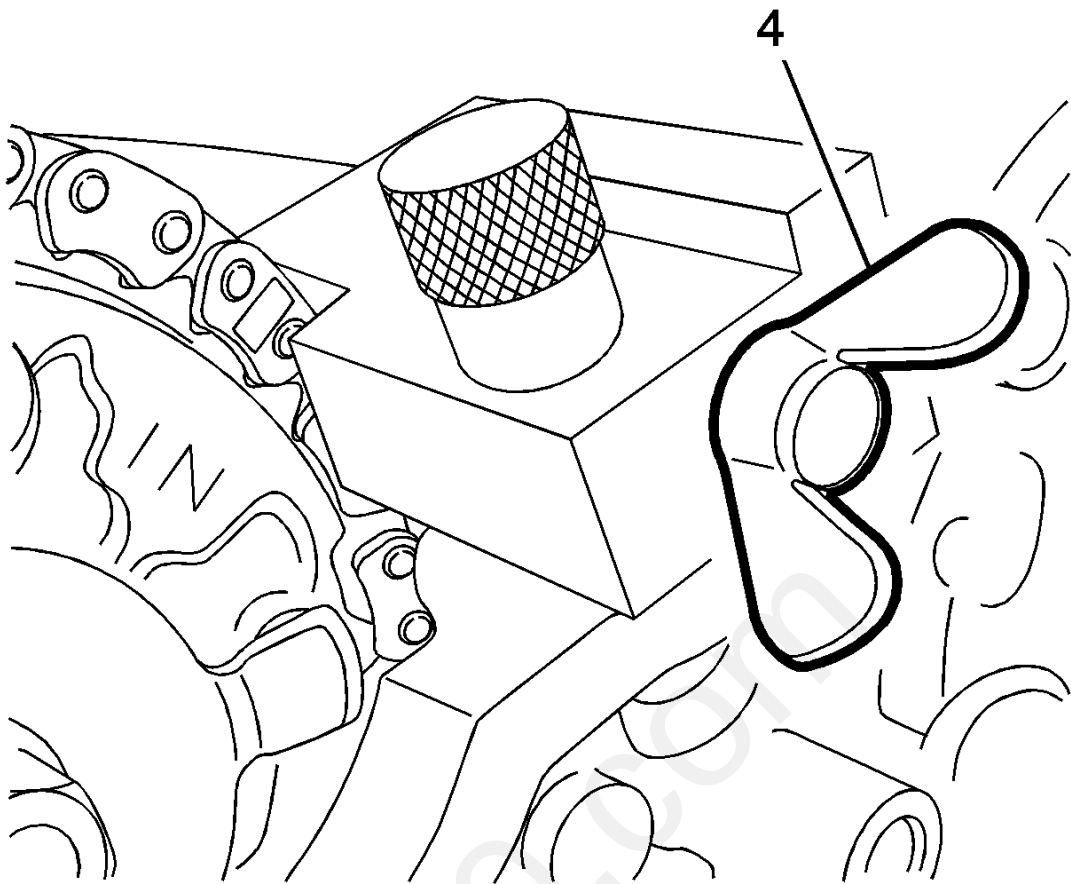


Fig. 90: Retainer Wingnut

Courtesy of **GENERAL MOTORS COMPANY**

12. Loosen wingnut (4) to open the clamping area of **EN49982-1** retainer.

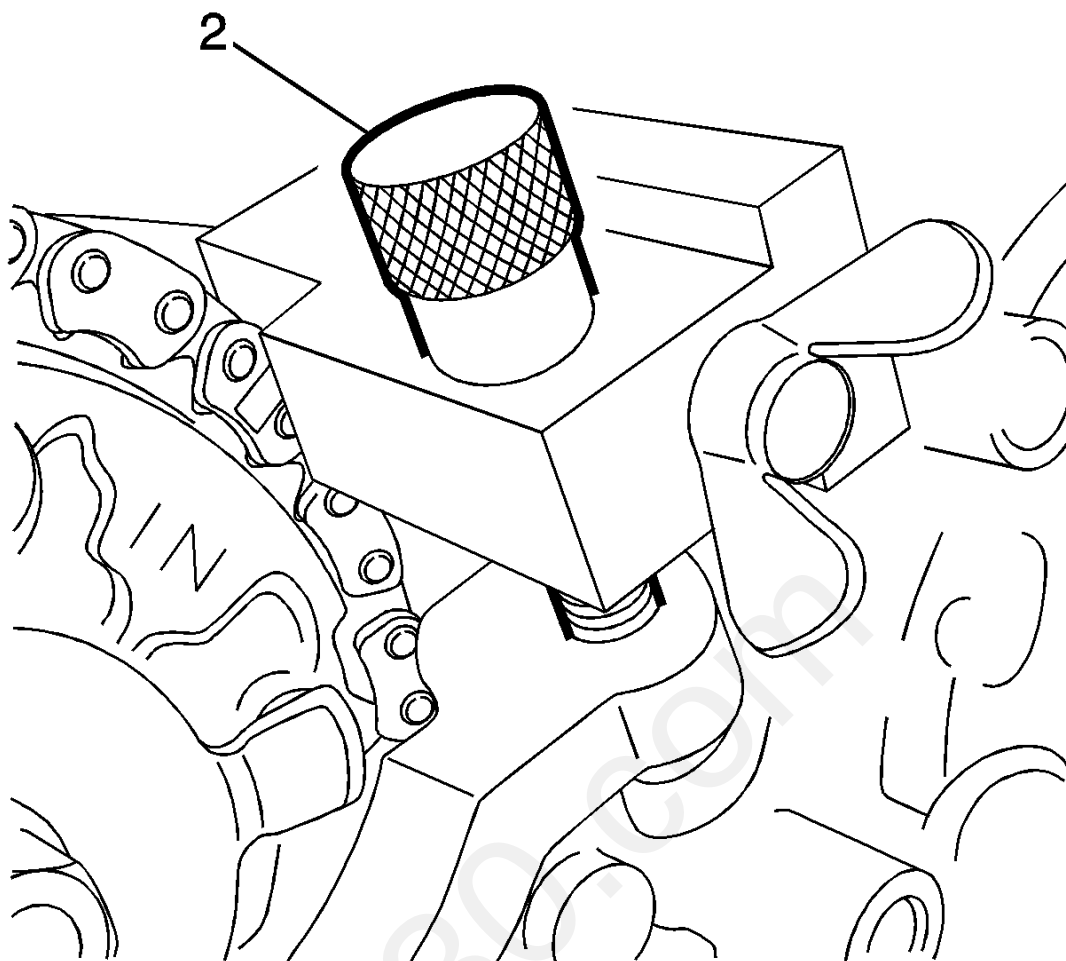


Fig. 91: Retainer Thumbscrew

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT overtighten the thumbscrew. The EN49982-1 retainer should be able to slide slightly via the slot the screw goes through. This fore/aft movement will allow easier removal and installation of the chain later.

13. Install **EN49982-1** retainer intake side chain holder onto front cover by screwing in the thumbscrew (2) on the **EN49982-1** retainer finger-tight.

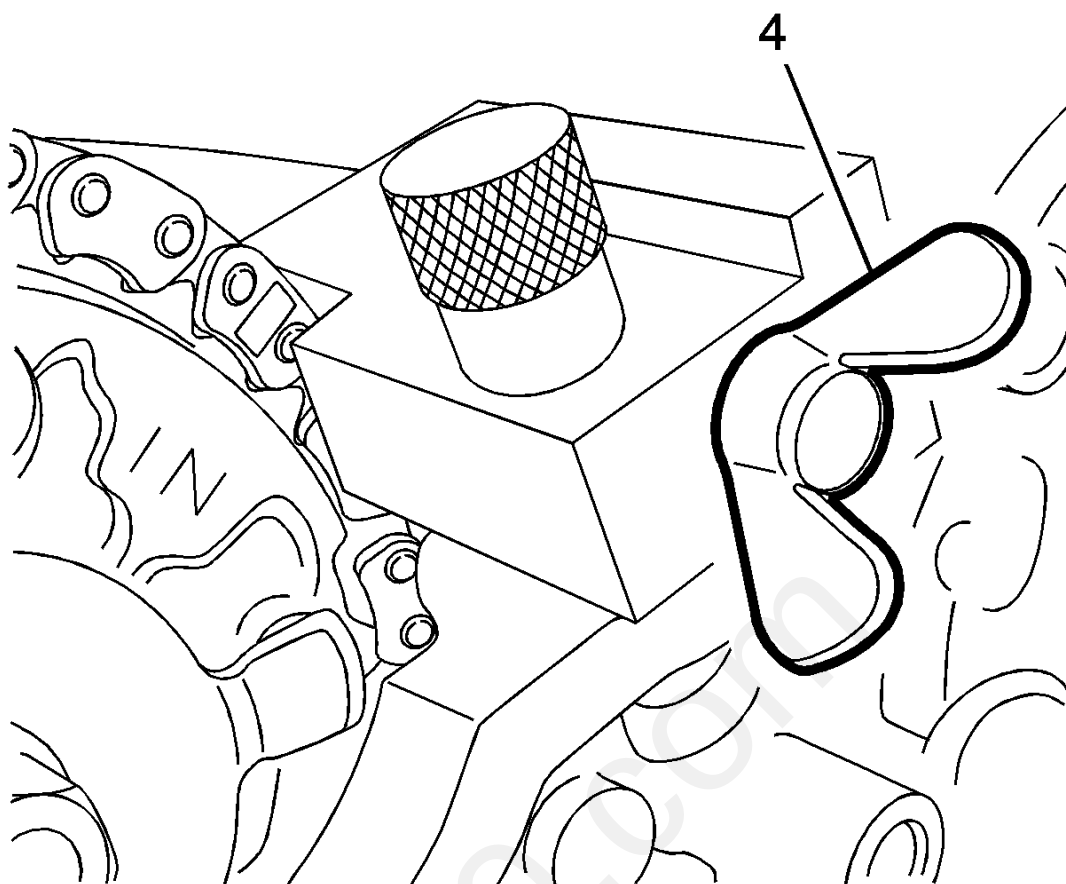


Fig. 92: Retainer Wingnut

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT tighten the wingnut with a tool of any kind. Firm finger-tightening is sufficient.

14. Tighten wingnut (4) so EN49982-1 retainer closes over and firmly grasps timing chain.

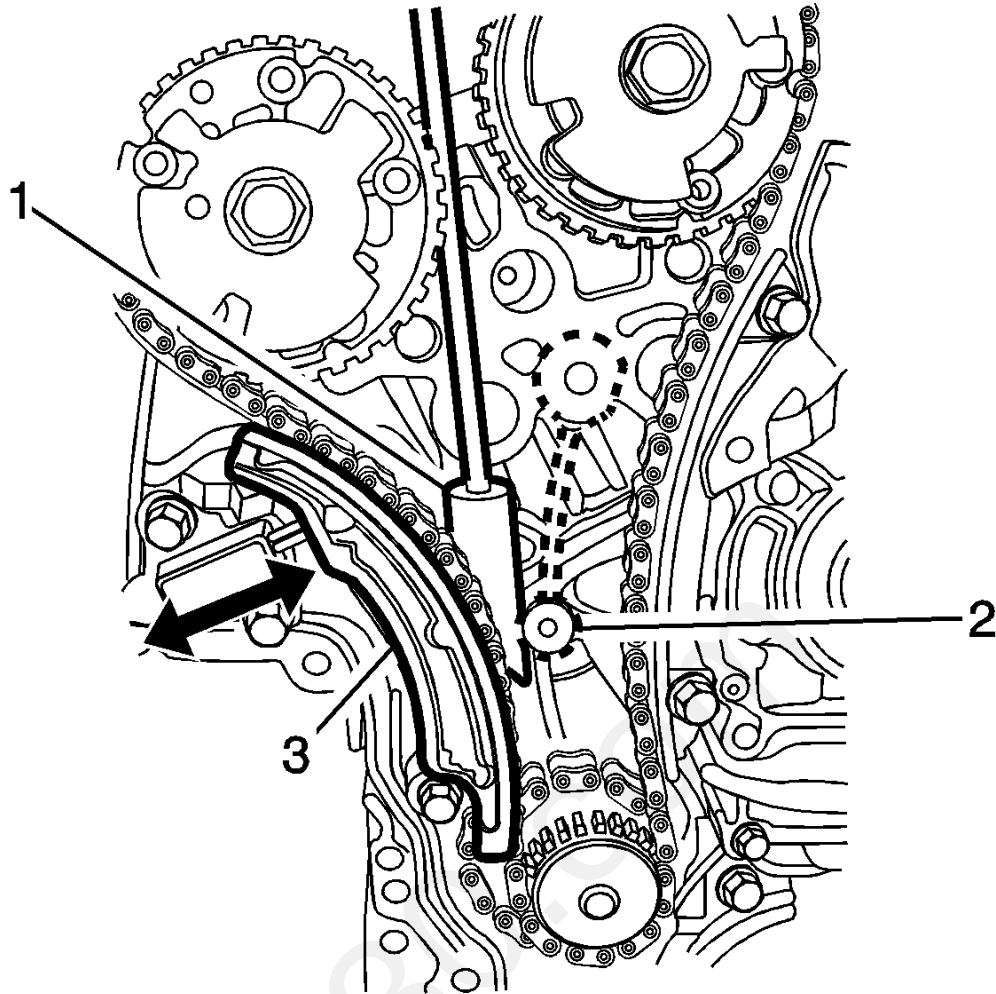


Fig. 93: Retainer Wedge

Courtesy of GENERAL MOTORS COMPANY

NOTE: The engine front cover is removed for clarity in the following graphics, but is **NOT** required to be removed to perform the procedure.

15. **EN49982-2** retainer (1) will be installed in the following steps such that it wedges between an internal rib (2) that is cast into the inside of the front cover (shown in dotted line above) and the timing chain and spring-loaded tensioner shoe (3), holding the chain in position. The wedge will be left in place during the cam position actuator and/or camshaft service.

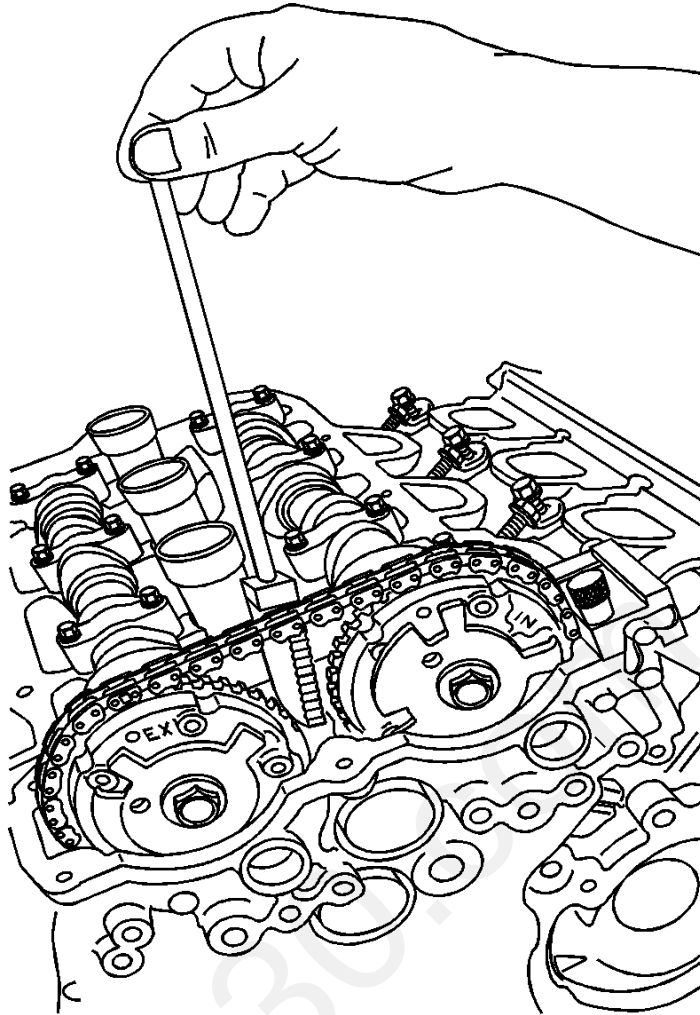


Fig. 94: Inserting Retainer

Courtesy of GENERAL MOTORS COMPANY

16. Insert the **EN49982-2** retainer between the two camshaft position actuators with the "teeth" on the **EN49982-2** retainer facing toward the front cover.

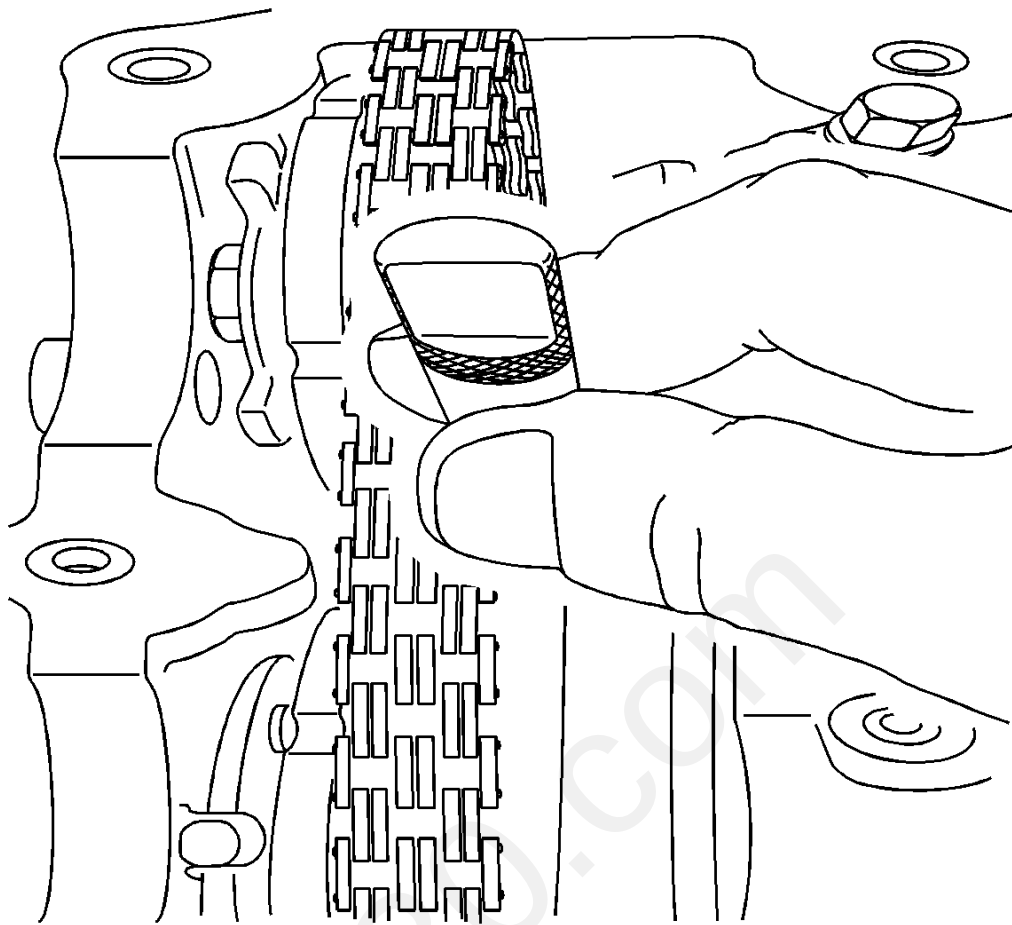


Fig. 95: Orienting Retainer Teeth

Courtesy of GENERAL MOTORS COMPANY

17. Once the wedge portion of **EN49982-2** retainer is below the camshaft position actuators, rotate the **EN49982-2** retainer until the flat in the handle faces toward the intake camshaft position actuator. This orients the "teeth" toward the chain.

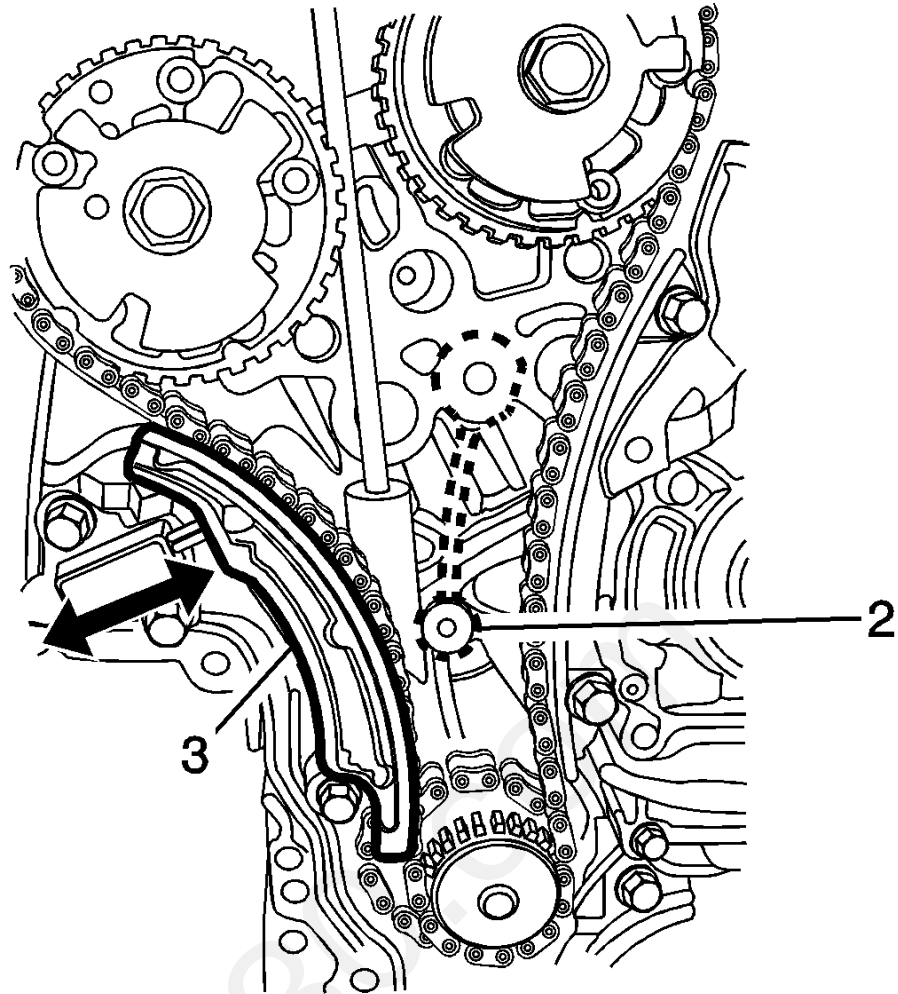


Fig. 96: Wedge, Timing Chain & Belt Casting
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not try to force the wedge into position, simply ensure it is loosely engaged in the timing chain and in the correct overall position.

18. Drop the wedge down until it begins to engage the timing chain and the belt casting (2).

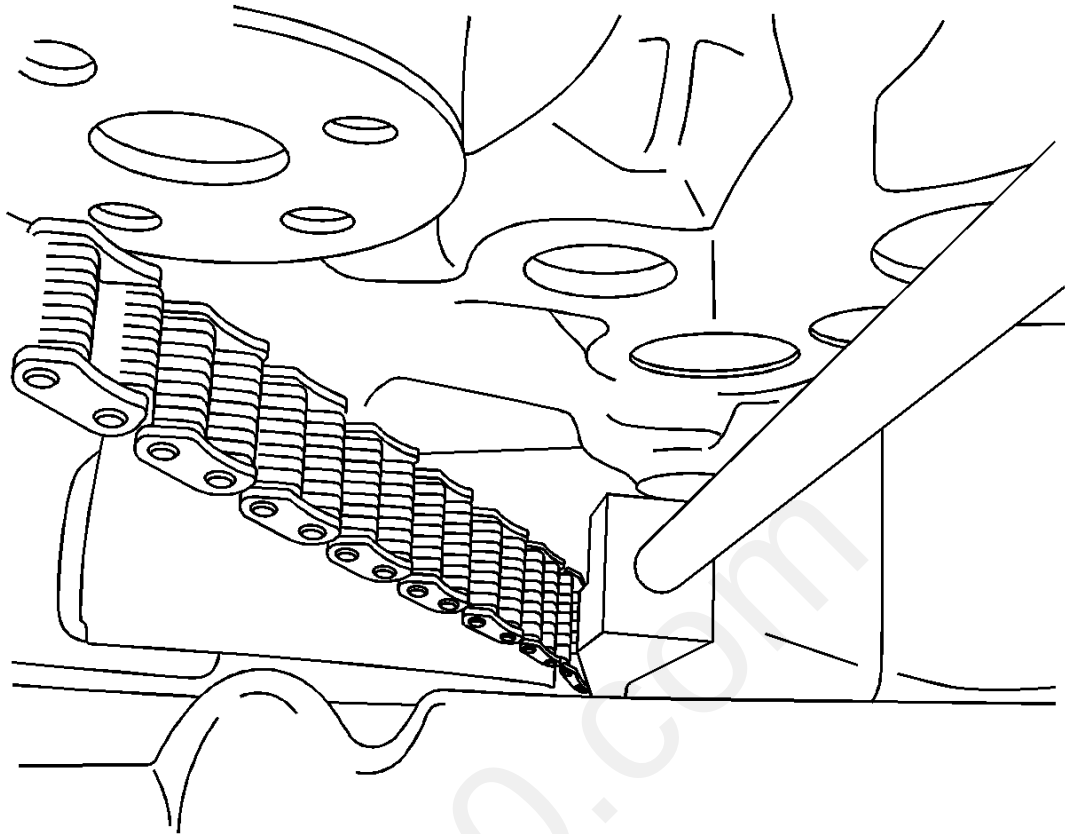


Fig. 97: Positioning Wedge

Courtesy of GENERAL MOTORS COMPANY

19. If possible shine a strong light down from above, between the camshaft position actuators, and see the wedge in overall position as shown in the above graphic.

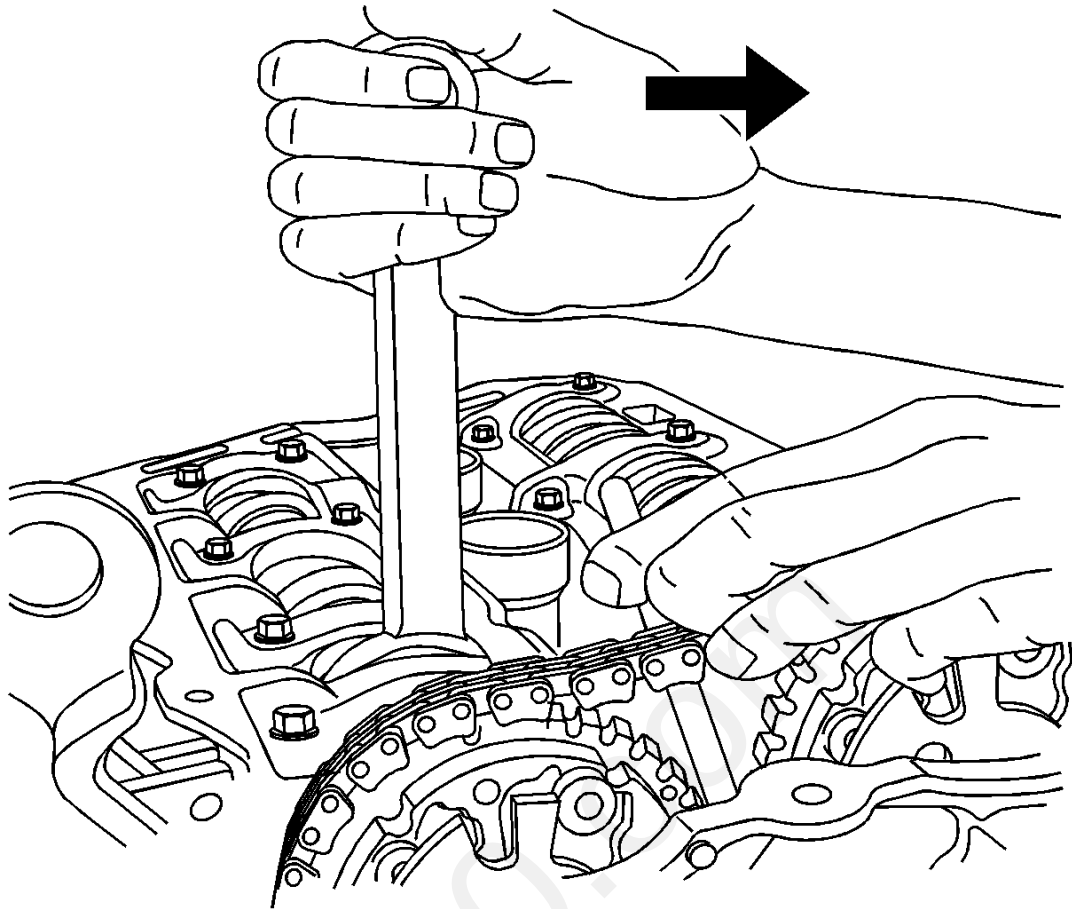


Fig. 98: Rotating Camshaft

Courtesy of GENERAL MOTORS COMPANY

20. Using a 20 mm wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft toward the intake camshaft while pushing down on the handle of the **EN49982-2** retainer.

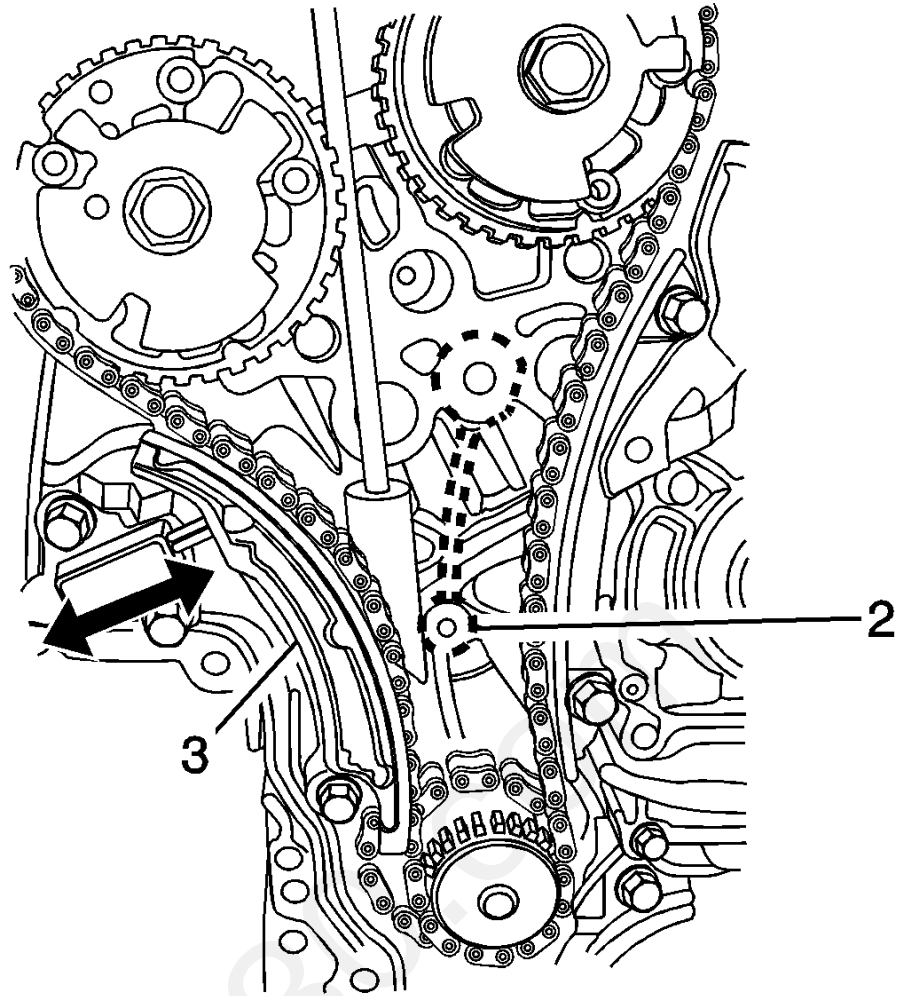


Fig. 99: Opening Gap Between Chain & Internal Rib In Front Cover

Courtesy of GENERAL MOTORS COMPANY

21. This rotation of the camshaft will compress the tensioner shoe (3) against the spring force of the tensioner, opening up a gap between the chain and the internal rib in the front cover. The wedge will then drop into this gap. You will feel a distinct click as the teeth engage the chain.

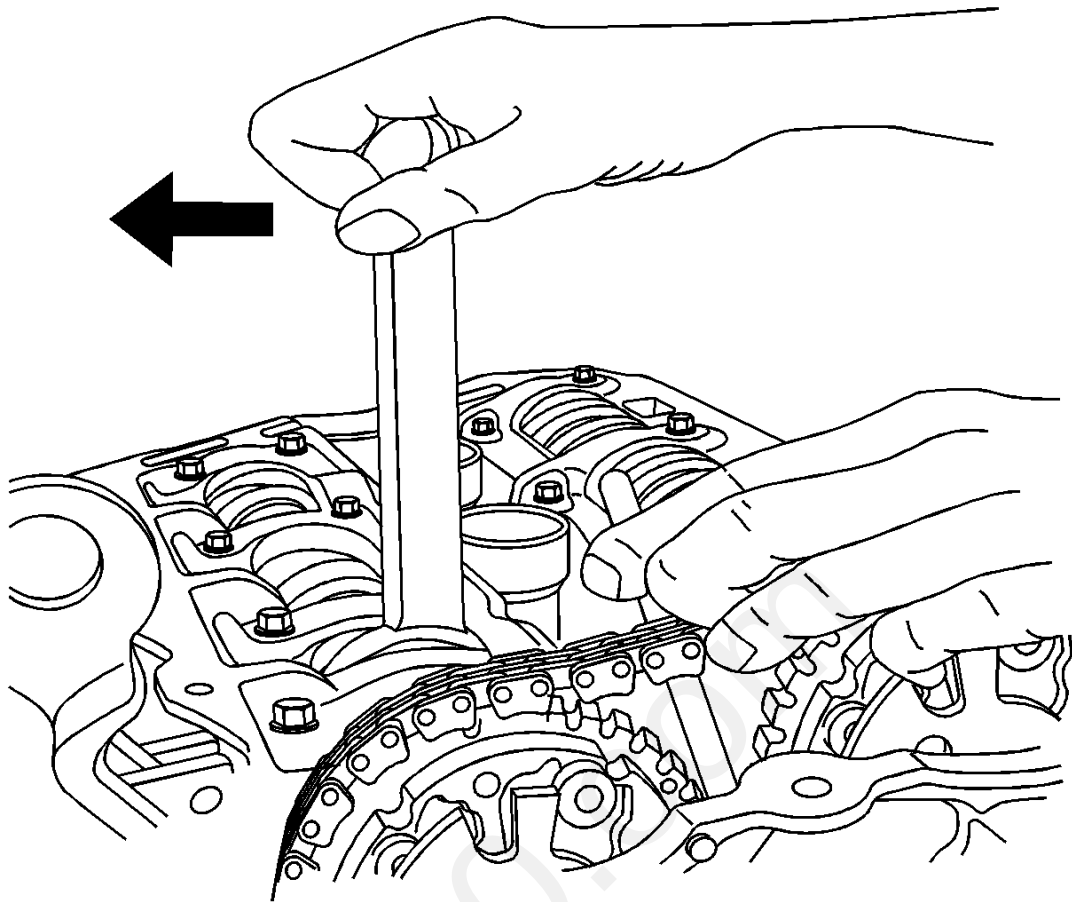


Fig. 100: Releasing Force On Wrench

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Be sure the EN49982-2 is captured firmly as described before continuing. This is critical to ensuring the camshaft drive chains stay properly timed.

22. Release the force on the wrench, allowing the spring tension to close the tensioner shoe against the wedge portion of **EN49982-2** retainer. You should be able to lightly tug on the **EN49982-2** retainer and it should stay in position. Repeat Steps 20 and 21 if necessary to re-insert the **EN49982-2** retainer until you are certain it is in position and will stay in position.

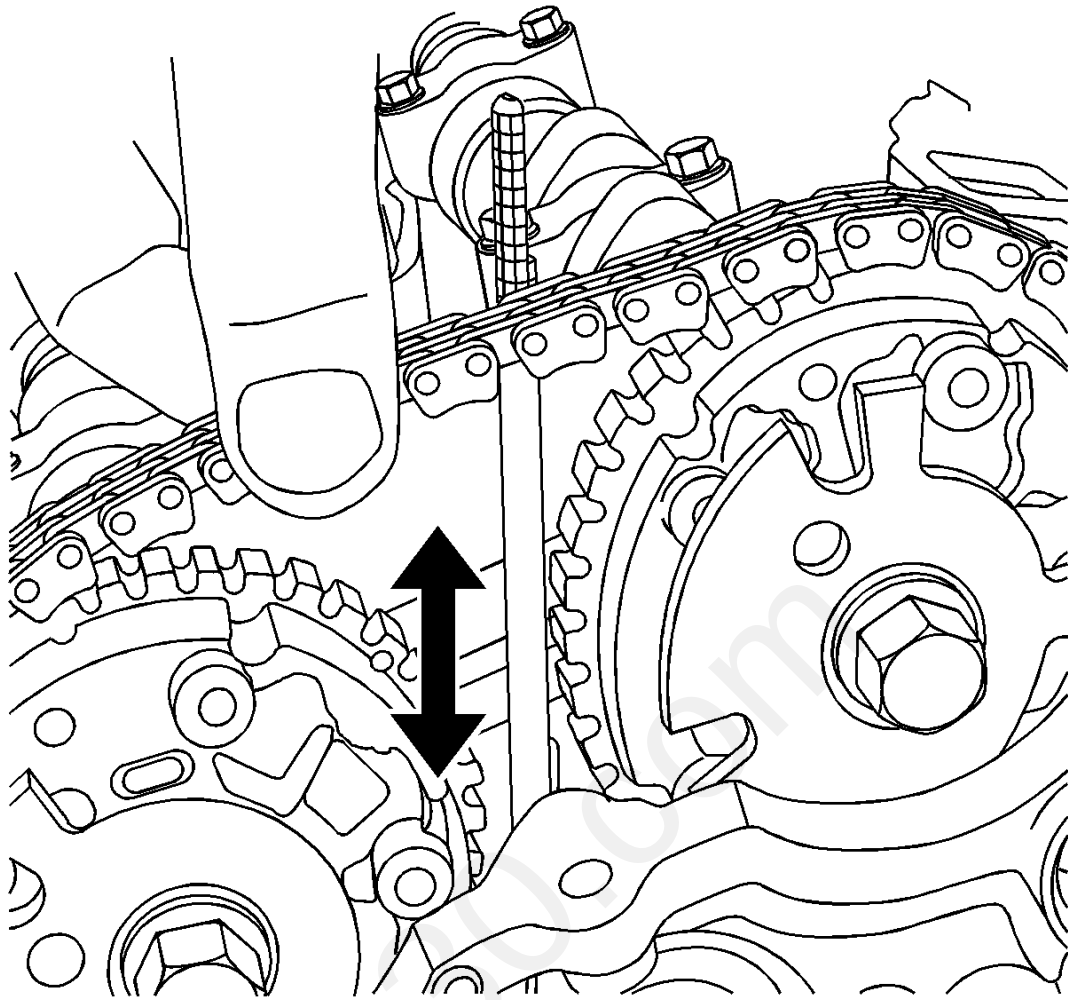


Fig. 101: Slack In Timing Drive Chain

Courtesy of **GENERAL MOTORS COMPANY**

23. With **EN49982-2** retainer in position and with the 20 mm wrench removed, there should now be some slack in the timing drive chain as indicated in the graphics shown.

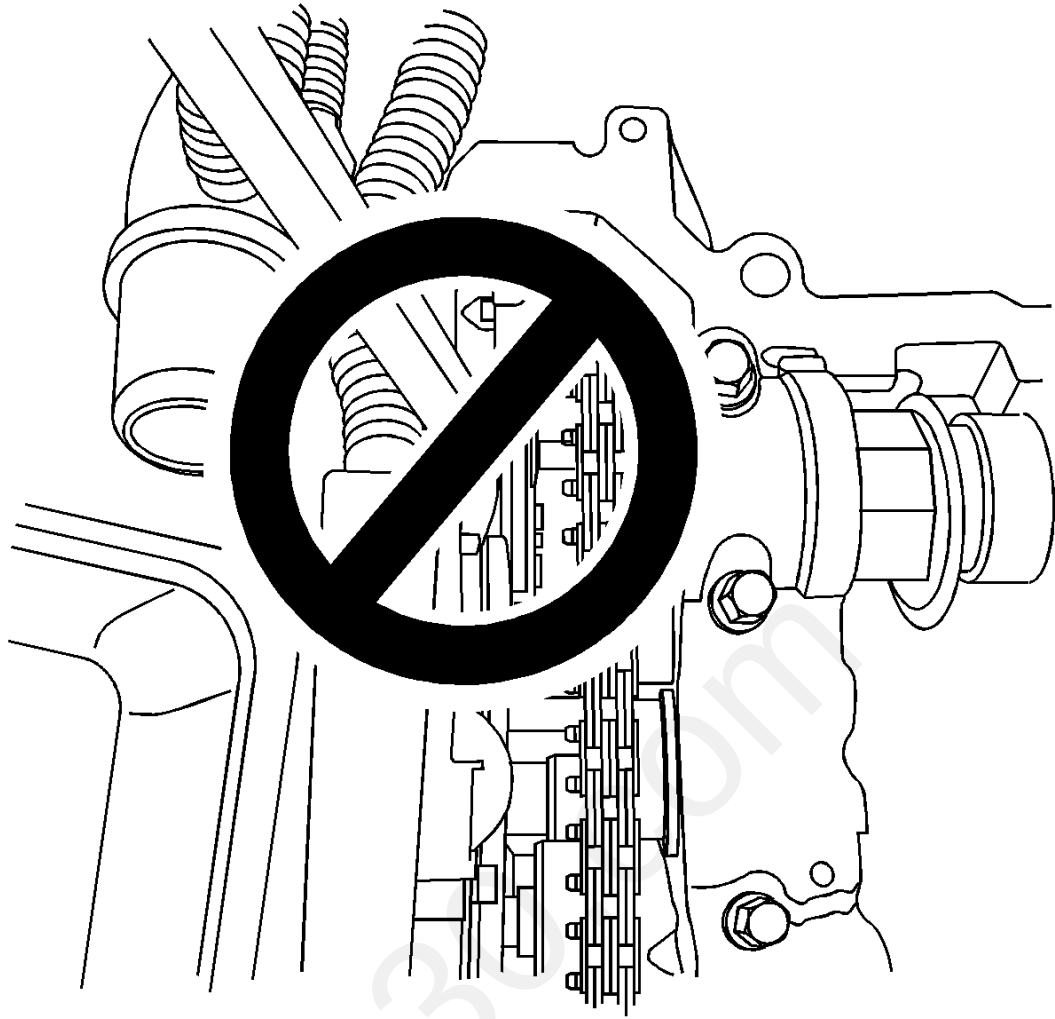


Fig. 102: Do Not Pry Warning

Courtesy of GENERAL MOTORS COMPANY

24. Do not pry against the face of the camshaft position actuators or the position actuator retaining bolt.

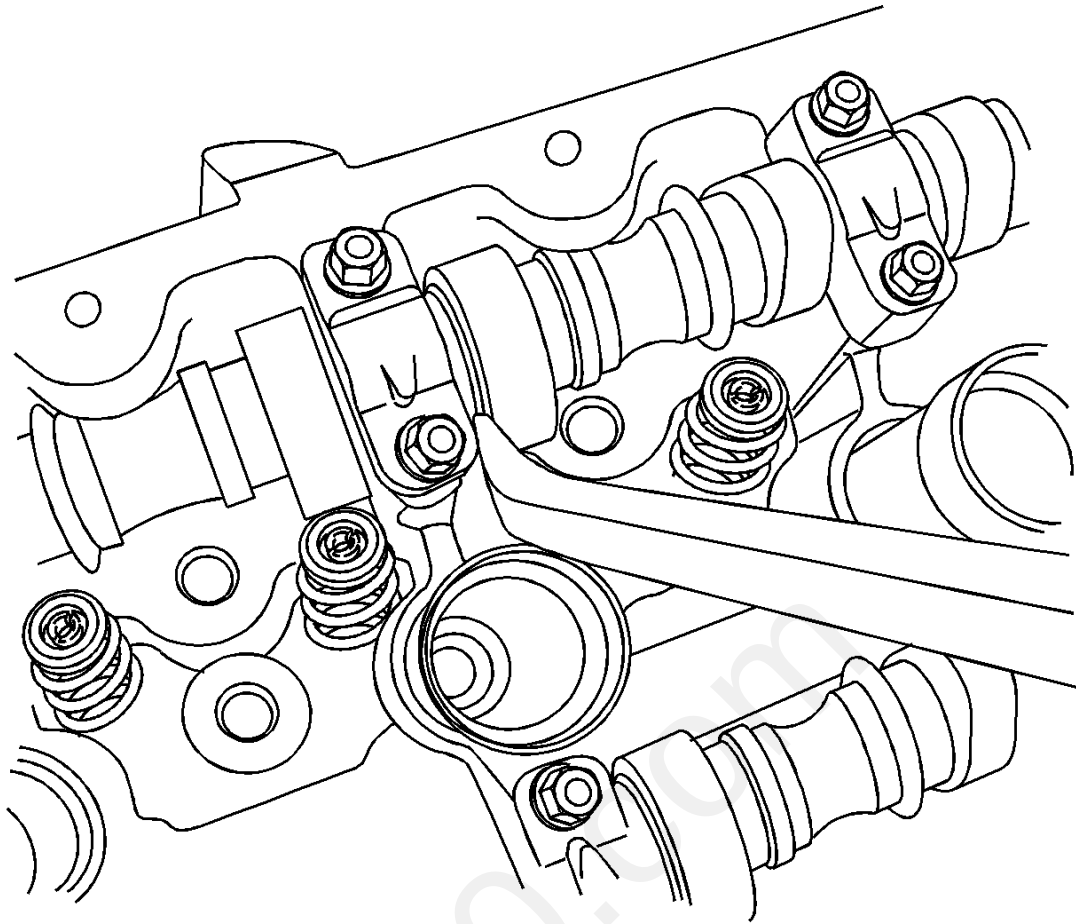


Fig. 103: Prying Camshaft Forward

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not pry against the face of the camshaft position actuators or the position actuator retaining bolts as the position actuators will be damaged.

25. Position a screwdriver or small pry bar between a camshaft cap and camshaft lobe. Carefully move/pry the camshafts as far as possible toward the rear/flywheel end of the engine.

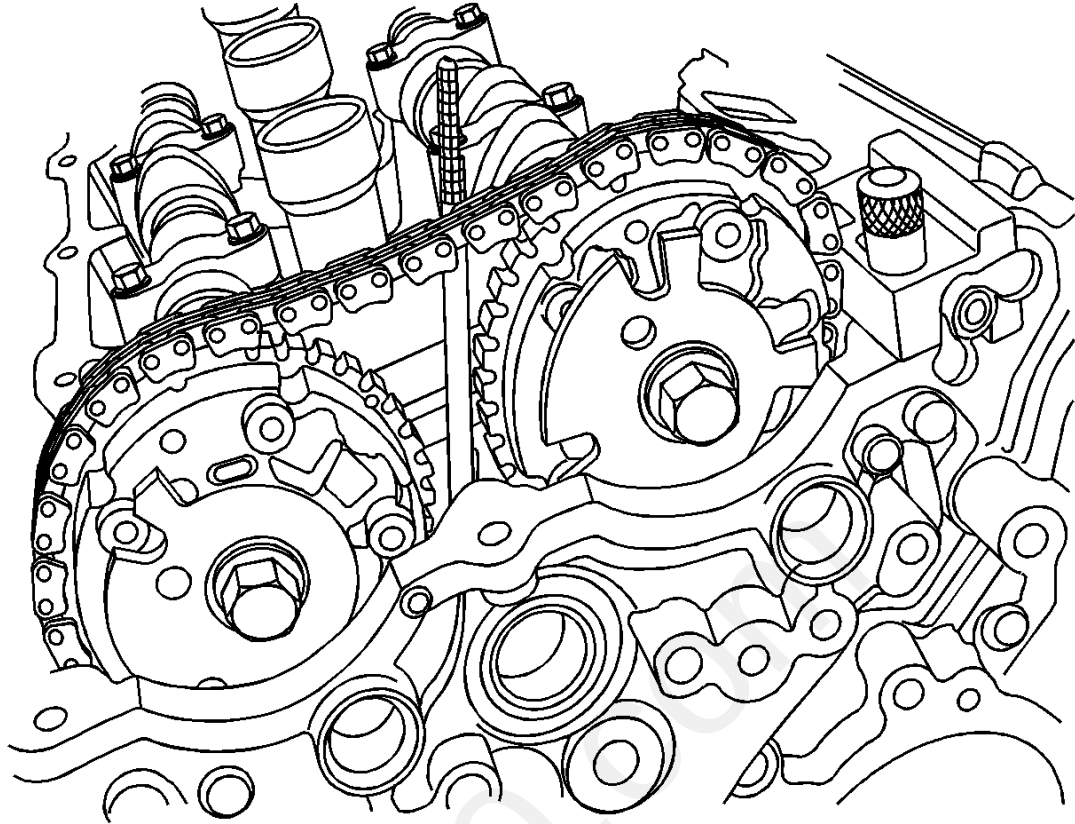


Fig. 104: Retainer Position

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not move or disturb the EN49982 retainer components after their installation or the timing chains may be lost inside the front cover.

26. The EN49982-1 retainer and EN49982-2 retainer should be in position as shown, they must be left in position during the servicing of the camshaft position actuator(s) and/or camshaft(s).

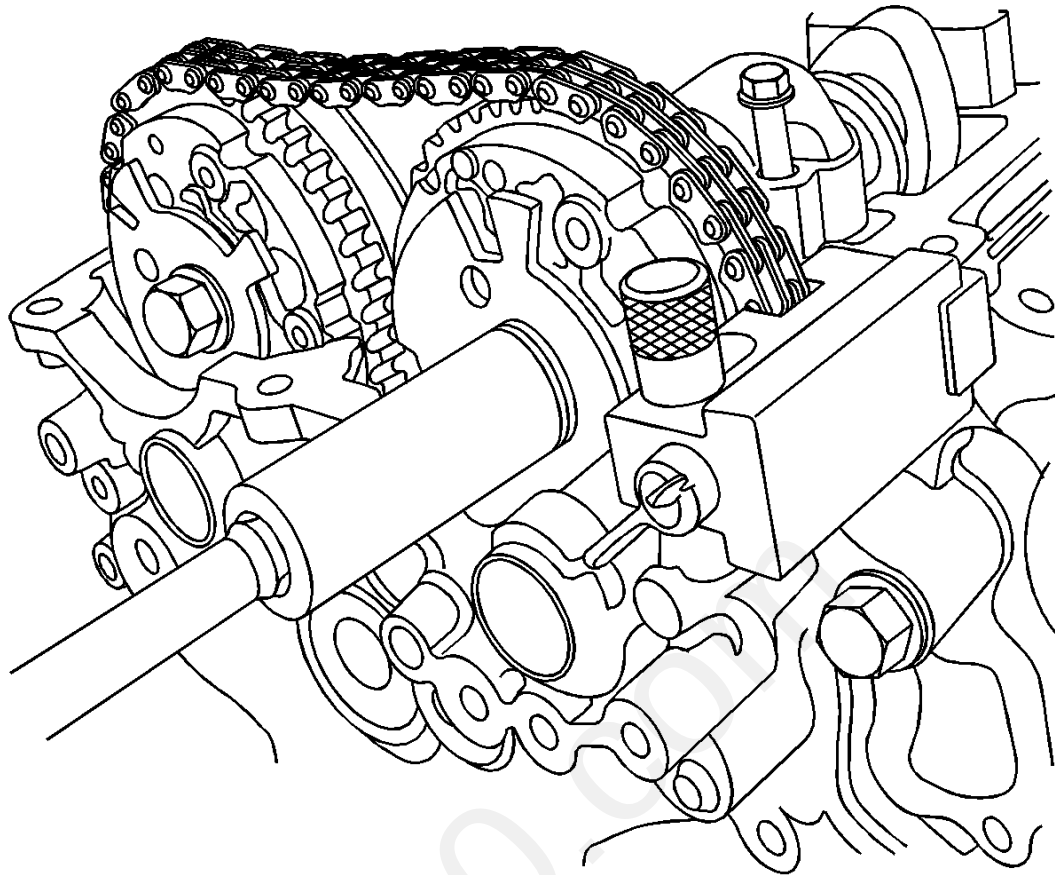


Fig. 105: Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

27. To remove the intake camshaft position actuator, remove the loosened retaining bolt. To remove only the exhaust camshaft position actuator, skip the steps for removing the intake camshaft position actuator. However, the **EN49982-1** retainer **MUST** be installed as discussed even if the intake side will not be serviced or the timing of the camshaft chains will be lost.

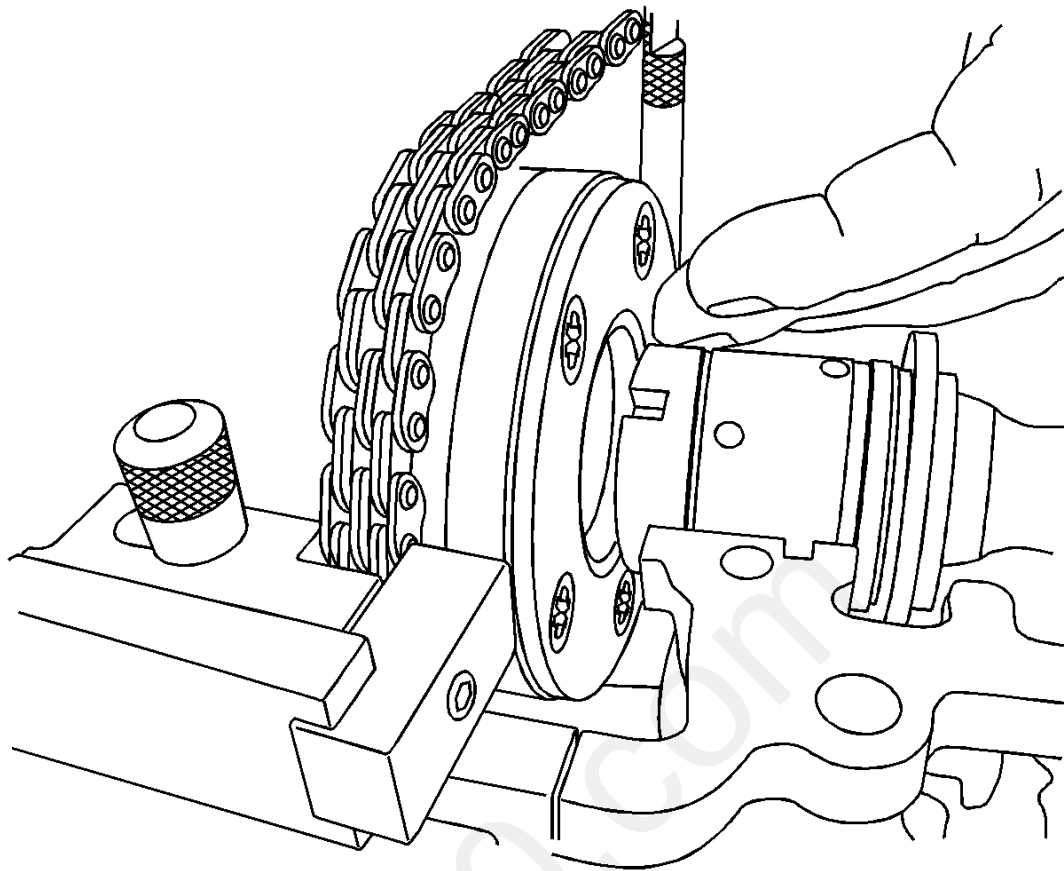


Fig. 106: Sliding Camshaft Position Actuator Off End Of Intake Camshaft

Courtesy of GENERAL MOTORS COMPANY

28. Slide the camshaft position actuator forward and off the end of the intake camshaft. The slot in the **EN49982-1** retainer will allow the tool to move forward enough to disengage the camshaft position actuator from the front of the camshaft. Remove the plastic thrust washer when removing the camshaft position actuator from the end of the camshaft.

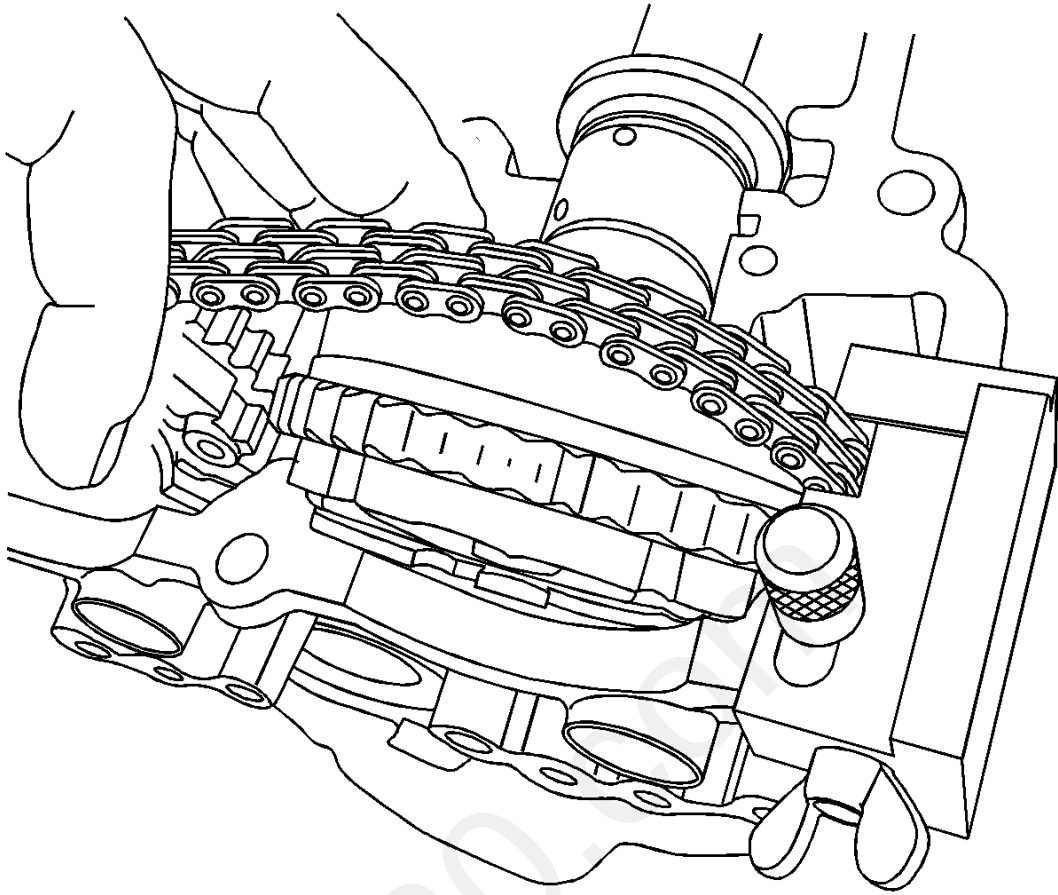


Fig. 107: Tilting Camshaft Position Actuator Forward

Courtesy of GENERAL MOTORS COMPANY

29. Tilt the camshaft position actuator forward and out/away from the engine.

NOTE: **DO NOT remove the EN49982 retainers. They are holding the cam chains to maintain their properly-timed positions.**

30. Allow the chain to rest on the EN49982-1 retainer and EN49982-2 retainer in position during service.

Installation Procedure

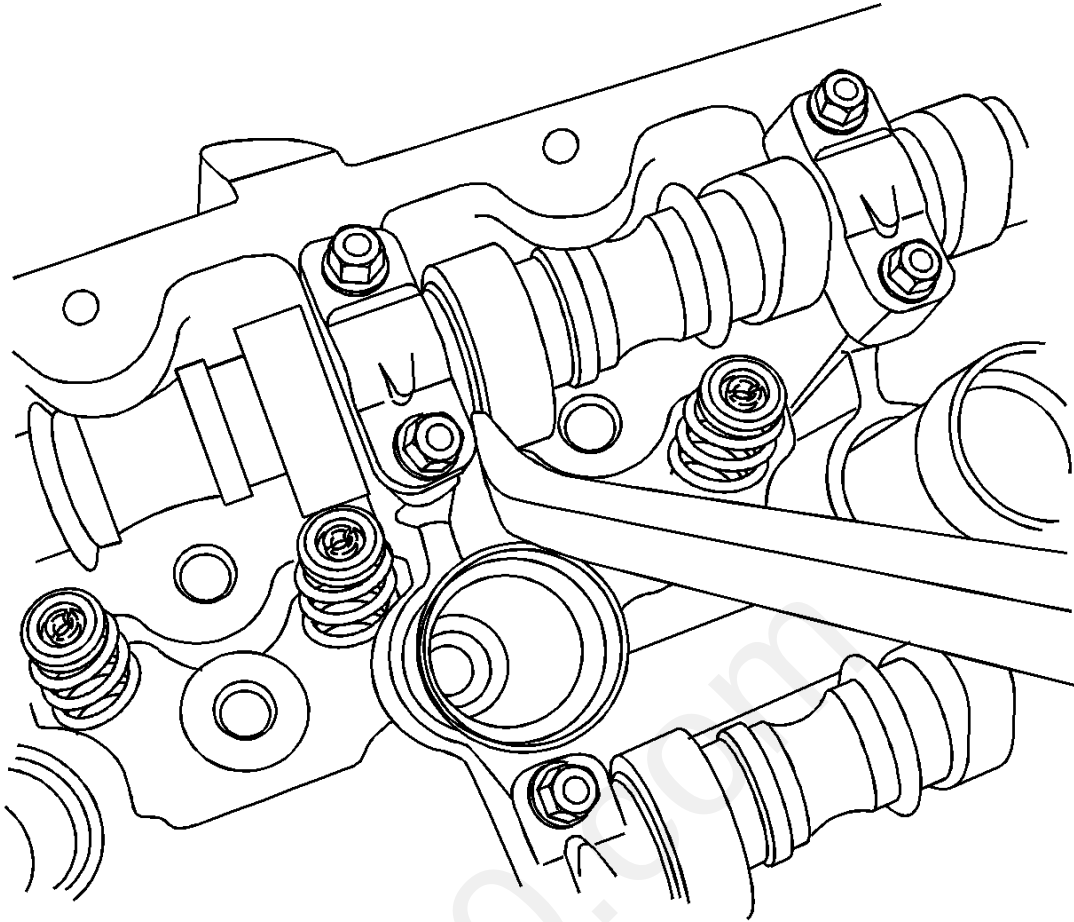


Fig. 108: Prying Camshaft Forward
Courtesy of GENERAL MOTORS COMPANY

1. It may help to carefully pry the camshaft forward and to move the **EN49982-1** retainer backward via the slot to reengage the position actuator to the camshaft. The dowel pin on the camshaft position actuator must be aligned with the slot in the camshaft nose for reassembly.

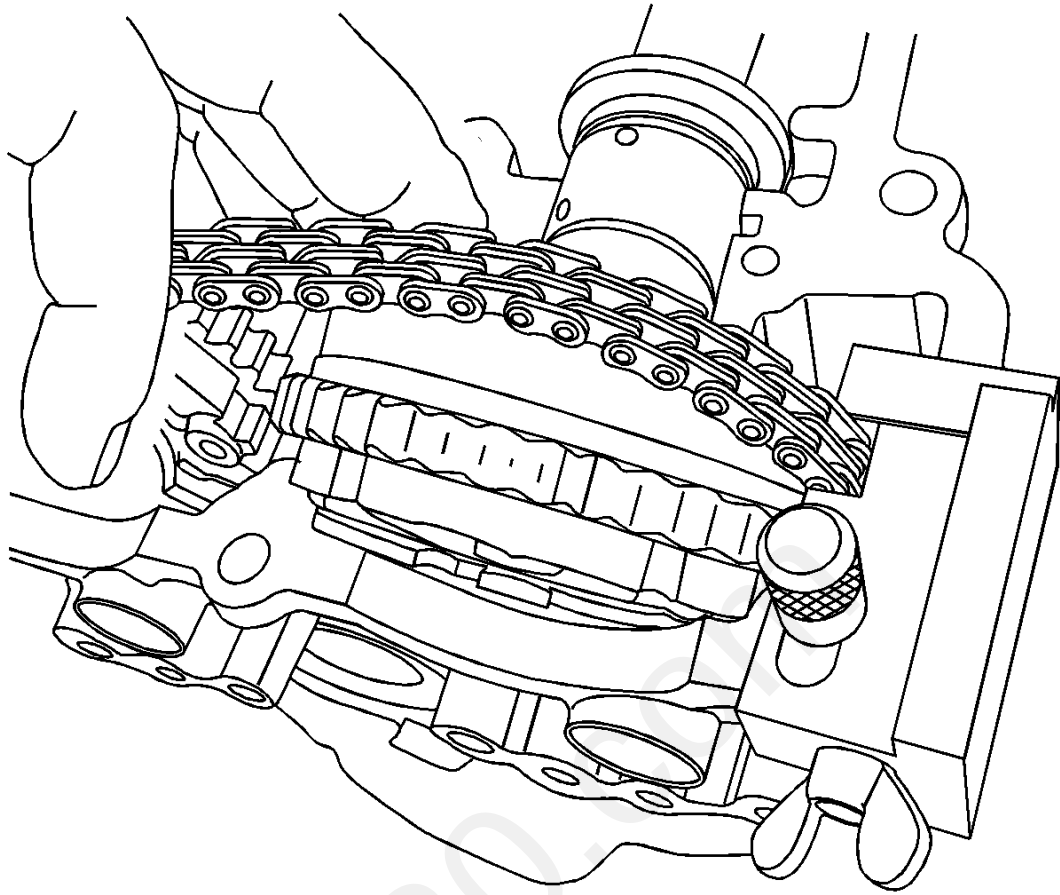


Fig. 109: Tilting Camshaft Position Actuator Forward

Courtesy of GENERAL MOTORS COMPANY

2. Install the intake camshaft position actuator first by inserting the actuator between the timing chain and front cover. Tilt the actuator in and engage the chain while aligning the marks you made on the chain and position actuator.

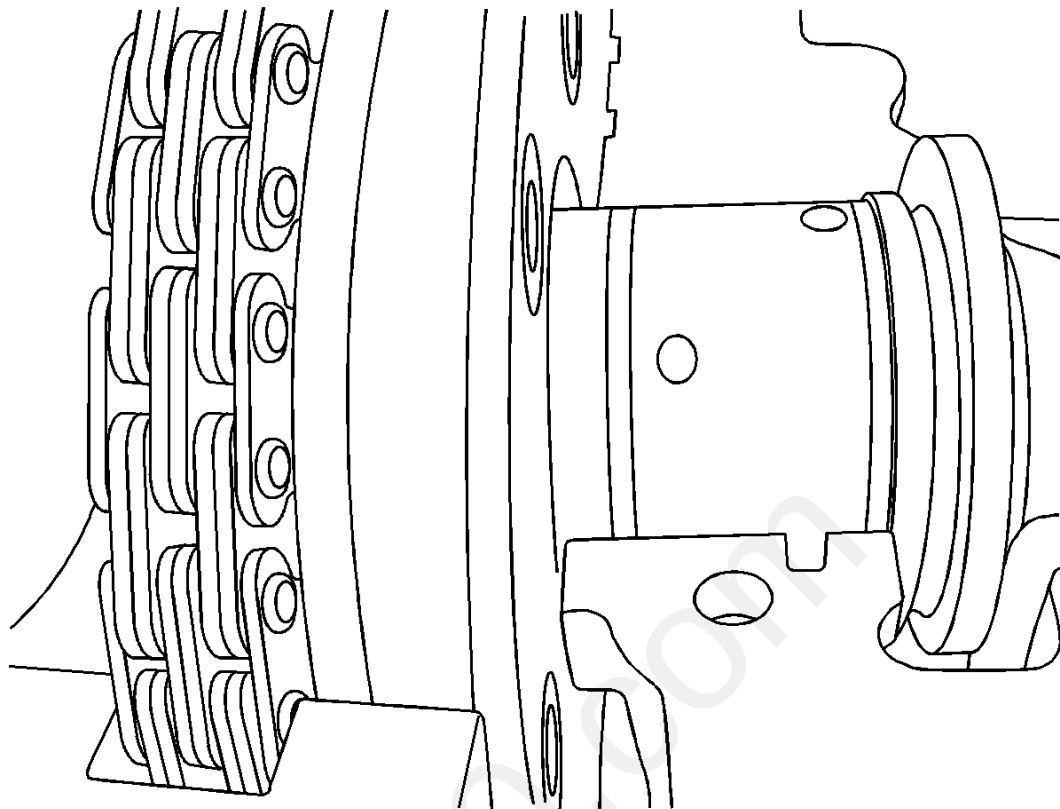


Fig. 110: Fitting Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

3. Ensure the camshaft position actuator fits snugly to the end of the camshaft.

CAUTION: Refer to **Fastener Caution** .

4. Install the intake camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
5. Install the exhaust camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
6. Double-check that the marks on both the intake and exhaust camshaft position actuators to ensure that they are aligned with their respective paint marks on the chain.

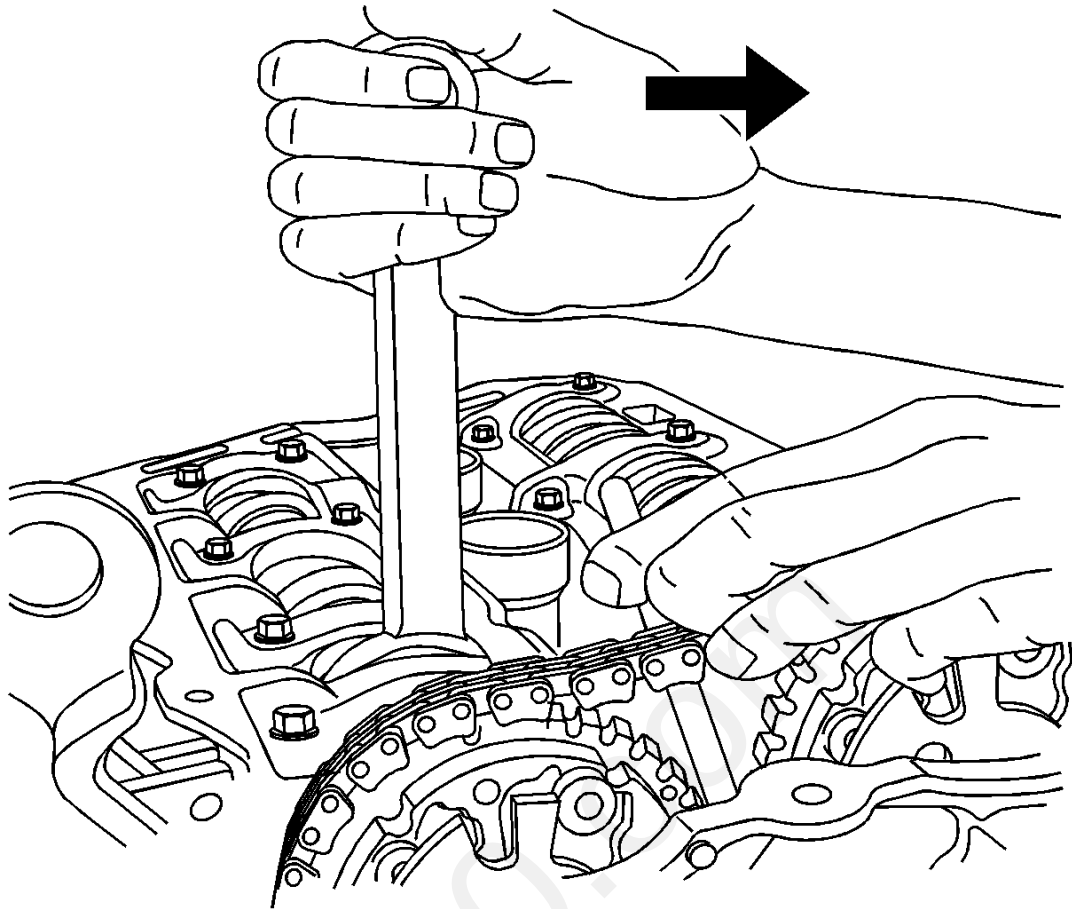


Fig. 111: Rotating Camshaft

Courtesy of GENERAL MOTORS COMPANY

7. Using a 20 mm wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft clockwise while pulling up on the handle of the **EN49982-2** retainer.
8. Remove EN49982-2 retainer.
9. Release the pressure on the wrench. The timing chain should now be tight and should lose the slack the wedge was providing.

NOTE: **Double-check the marks on the camshaft position actuators and chains to ensure they are correct.**

10. Torque one or both camshaft position actuator retaining bolts to 58 N.m (43 lb ft).

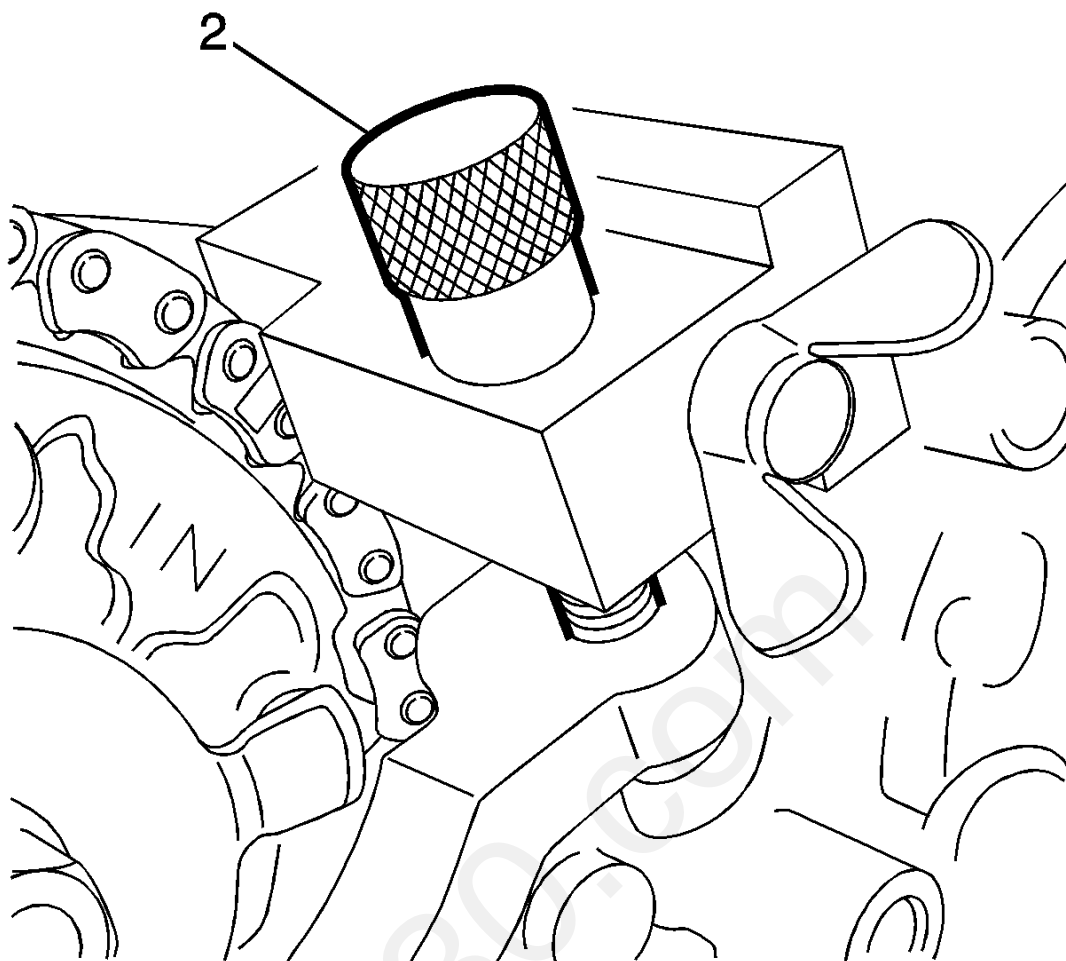


Fig. 112: Retainer Thumbscrew

Courtesy of **GENERAL MOTORS COMPANY**

11. Unscrew the wingnut on **EN49982-1** retainer to release timing chain, and then remove **EN49982-1** retainer from the front cover by unscrewing the thumbscrew (2).

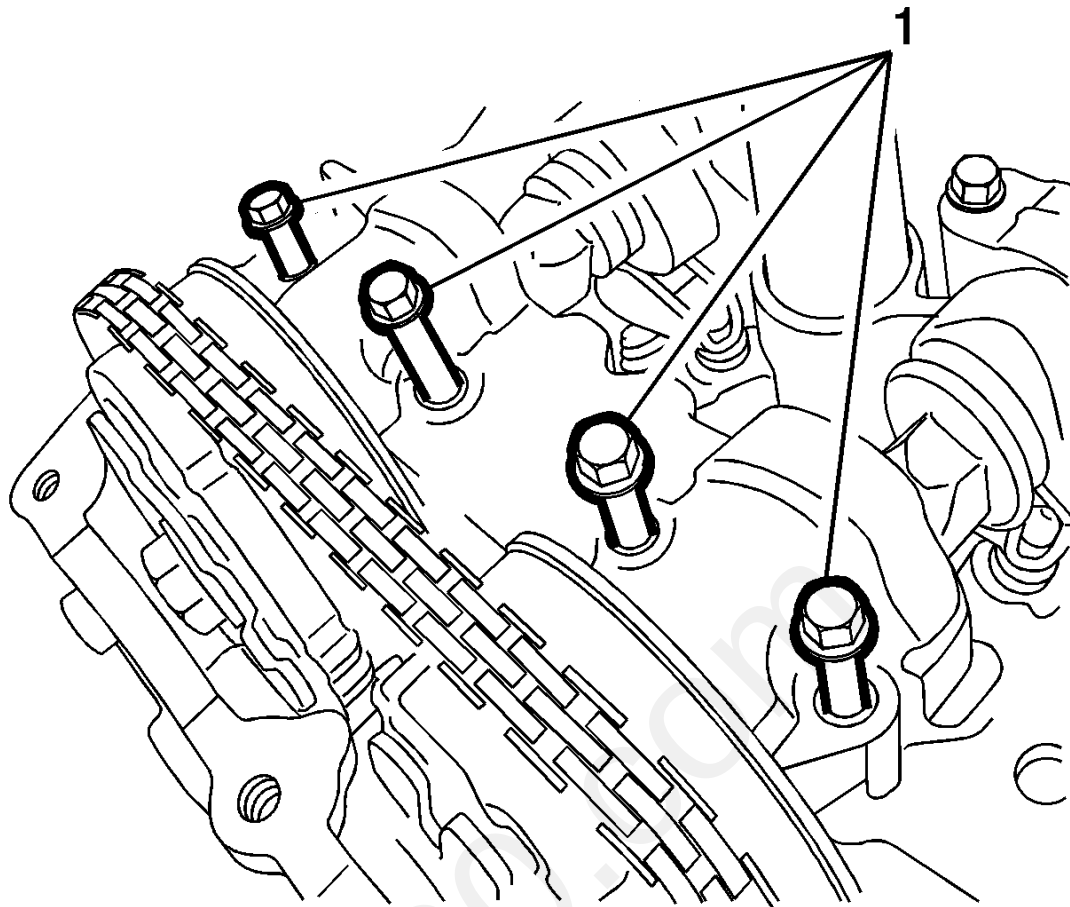


Fig. 113: Camshaft Front Cap And Bolts

Courtesy of GENERAL MOTORS COMPANY

12. Install camshaft front cap and bolts (1).
13. Tighten the camshaft front cap outer bolts to 10 N.m (89 lb in).
14. Tighten the camshaft front cap inner bolts to 10 N.m (89 lb in).
15. Install the camshaft position actuator solenoid valve solenoid - exhaust. Refer to [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 \(Right Side\) Exhaust](#) .
16. Install the camshaft position actuator solenoid valve solenoid-intake. Refer to [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 \(Right Side\) Intake](#) .
17. Install the intake camshaft position sensors. Refer to [Camshaft Position Sensor Replacement - Bank 1 \(Right Side\) Intake](#) .
18. Install the exhaust camshaft position sensor. Refer to [Camshaft Position Sensor Replacement - Bank 1 \(Right Side\) Exhaust](#) .
19. Install the camshaft cover. Refer to [Camshaft Cover Replacement - Right Side](#).

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2

Special Tools

EN-48313 Timing Chain Retention Tool

regional tools, refer to [Special Tools](#) .

Removal Procedure

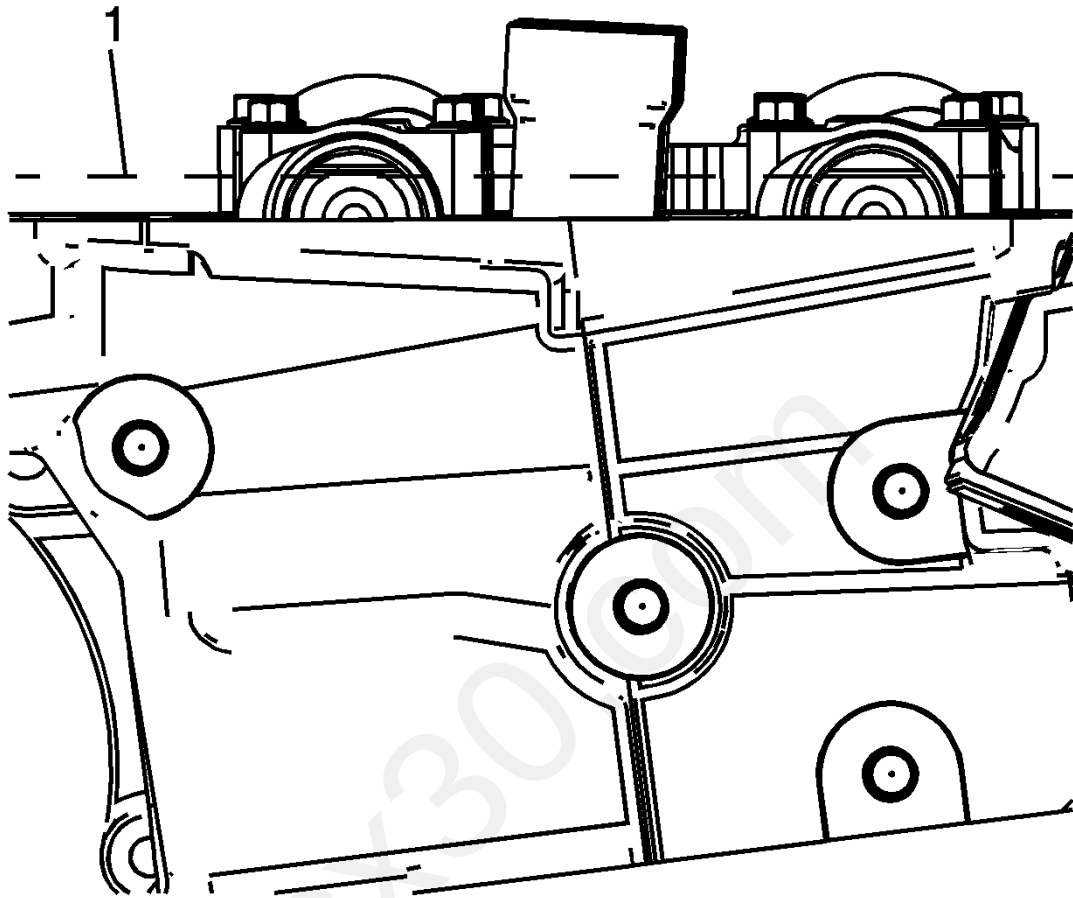


Fig. 114: View Of Camshaft Flats Parallel With Camshaft Cover Rail

Courtesy of GENERAL MOTORS COMPANY

1. Remove the left camshaft cover. Refer to [Camshaft Cover Replacement - Left Side](#).
2. Remove the left intake and exhaust camshaft position sensors. Refer to [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Intake](#) , and [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Exhaust](#) .
3. Remove the left intake and exhaust camshaft position actuator solenoids. Refer to [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 \(Left Side\) Intake](#) , and [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 \(Left Side\) Exhaust](#) .

NOTE: Rotate the crankshaft balancer bolt in a clockwise direction ONLY.

4. Rotate the crankshaft balancer using the balancer bolt until the camshafts are in a neutral (low tension) position. The camshafts will be parallel with the camshaft cover rail (1).

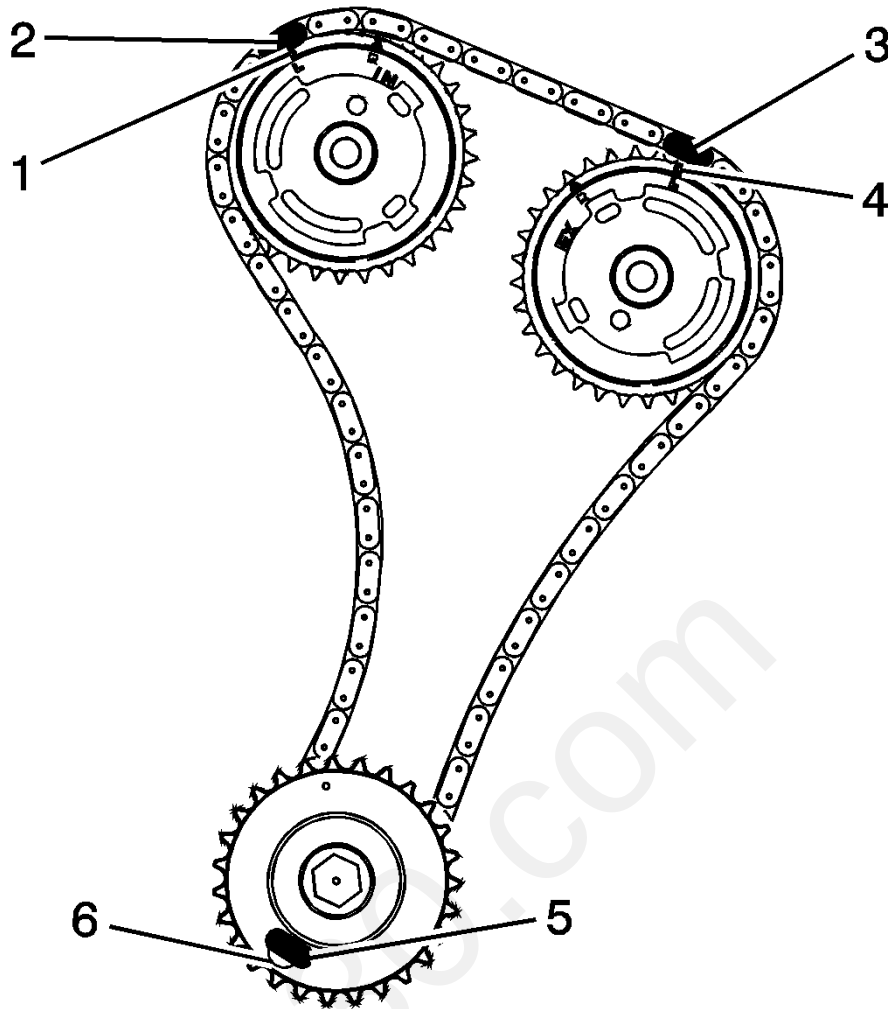


Fig. 115: Locating Left Secondary Camshaft Drive Chain Timing Marks

Courtesy of GENERAL MOTORS COMPANY

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

5. Use a paint stick to create an alignment mark on one of the timing chain links (2) and the adjacent tooth on the exhaust camshaft position actuator (1).
6. Use a paint stick to create an alignment mark on one of the timing chain links (3) and the adjacent tooth on the intake camshaft position actuator (4).

CAUTION: Refer to [Torque Reaction Against Timing Drive Chain Caution](#) .

7. Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.

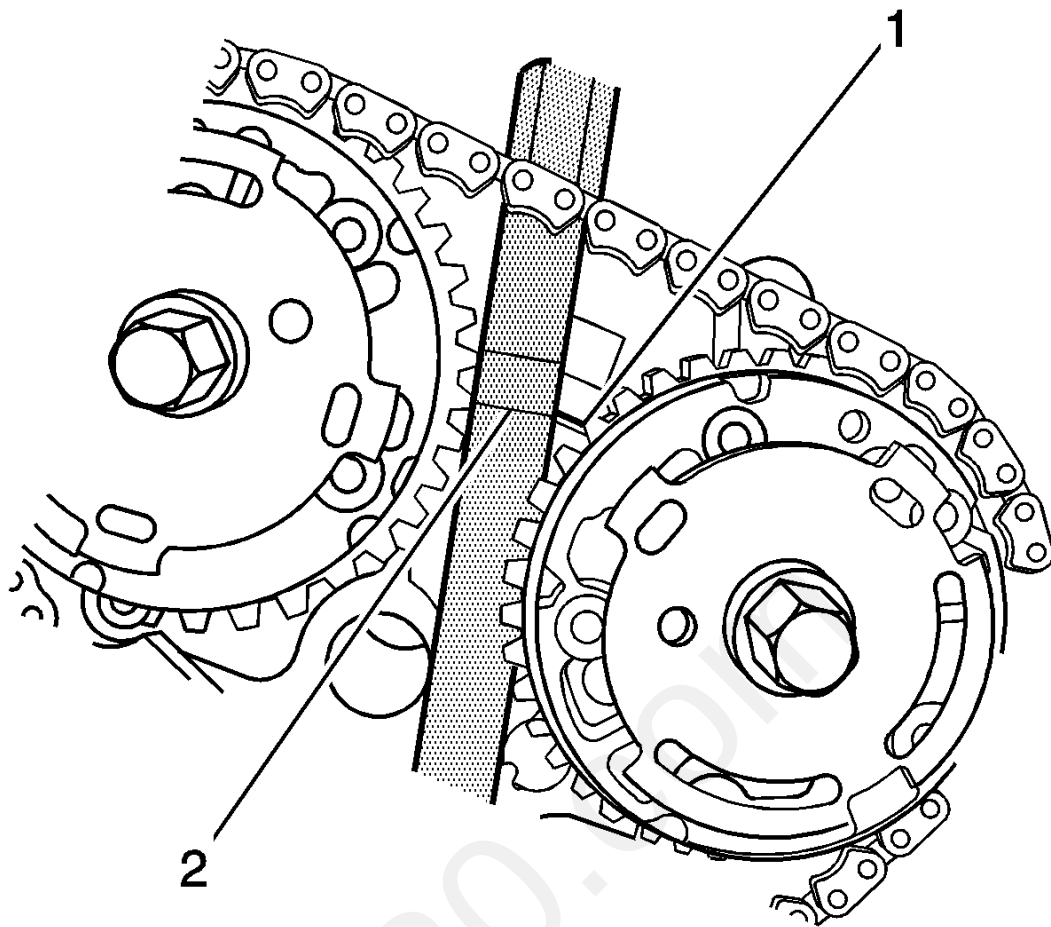


Fig. 116: Inserting Timing Chain Retention Tool

Courtesy of GENERAL MOTORS COMPANY

8. Unscrew the **EN-48313** tool so that the legs of the tool are retracted.
9. Insert the **EN-48313** tool between the camshaft actuators, rearward of the timing chain until the bottom line that is scribed in the body of the tool (2) is adjacent to the top surface of the cylinder head (1). This is the approximate installed position.

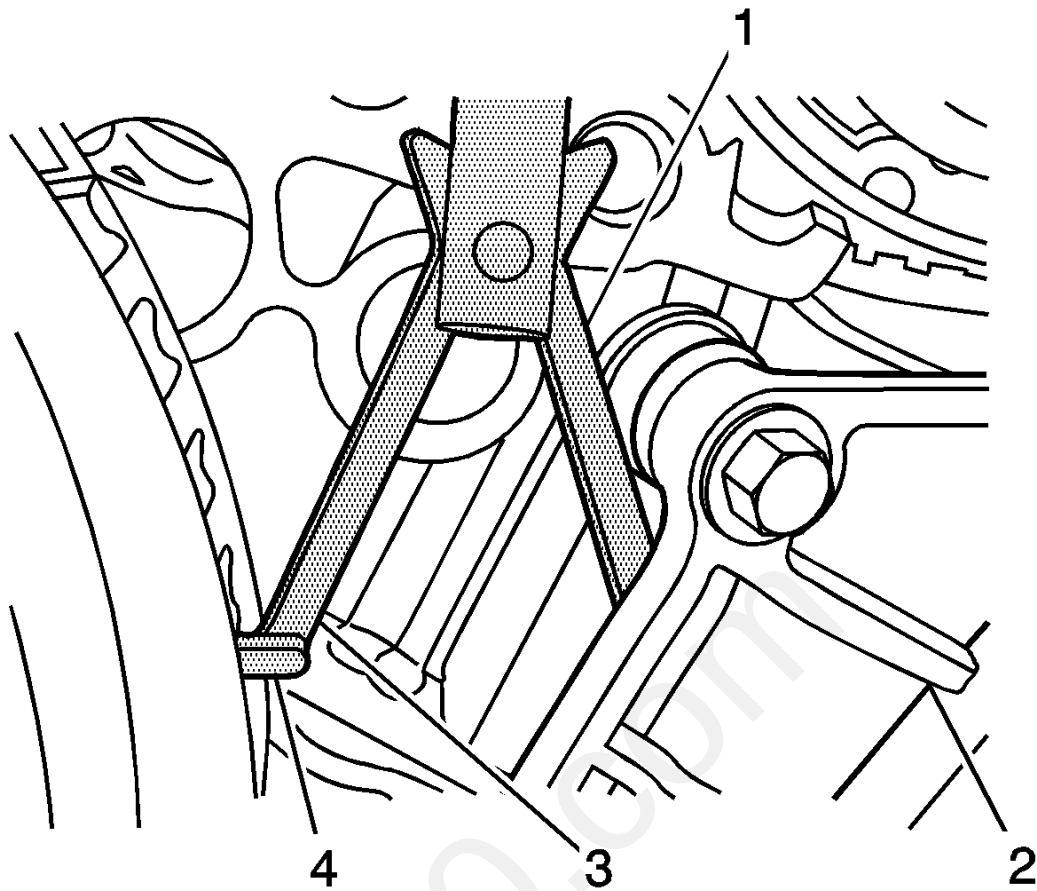


Fig. 117: View Of Feet, Legs & Timing Chain Guide

Courtesy of GENERAL MOTORS COMPANY

NOTE: The engine front cover is removed for clarity in the following graphics, but **NOT** required to perform the procedure.

10. Ensure that the feet (4) on the legs of the tool are facing the front of the engine.
11. Partially expand the legs (1, 3) of the **EN-48313** tool by turning the T-shaped handle clockwise.
12. Insert the leg of the tool (1) behind the timing chain guide (2).
13. Continue expanding the **EN-48313** tool until the legs (1, 3) contact the timing chain. Do not tighten at this time.

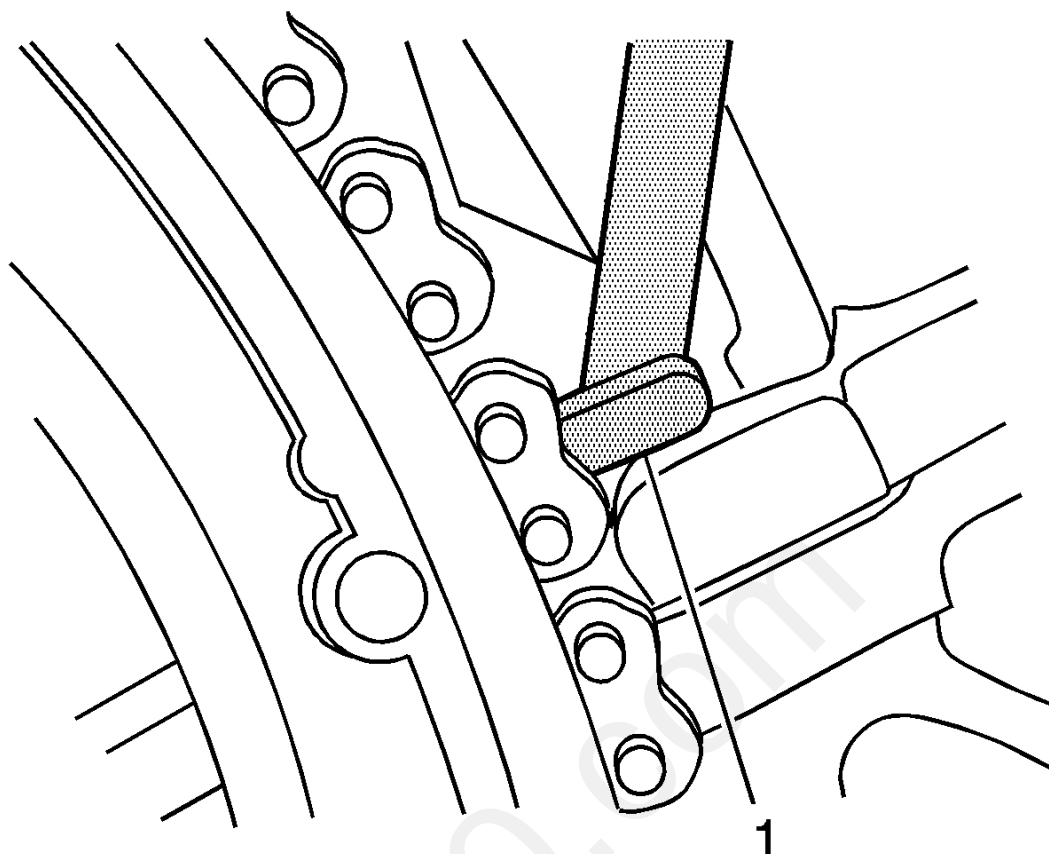


Fig. 118: Foot of Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the foot (1) of the EN-48313 tool is engaged into one of the link pockets to prevent tool slippage during tightening of the EN-48313 tool.

14. Hand tighten the EN-48313 tool.
15. Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.

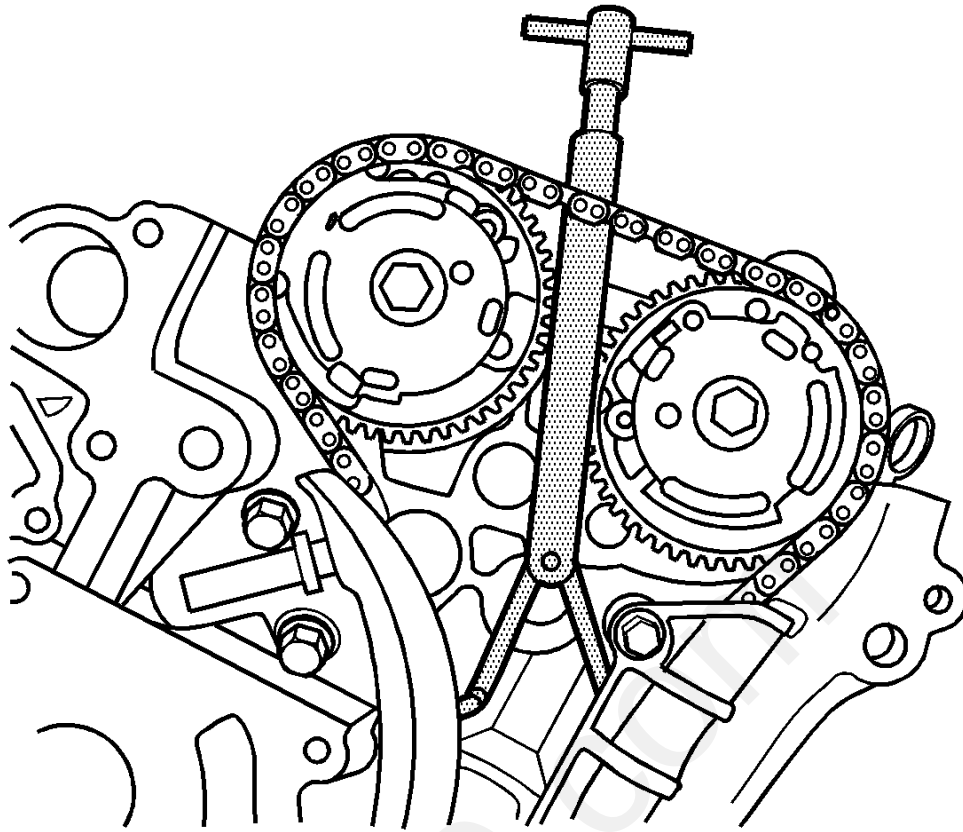


Fig. 119: Timing Chain Retention Tool

Courtesy of GENERAL MOTORS COMPANY

16. The **EN-48313** tool is now properly installed to hold the timing chain in position.

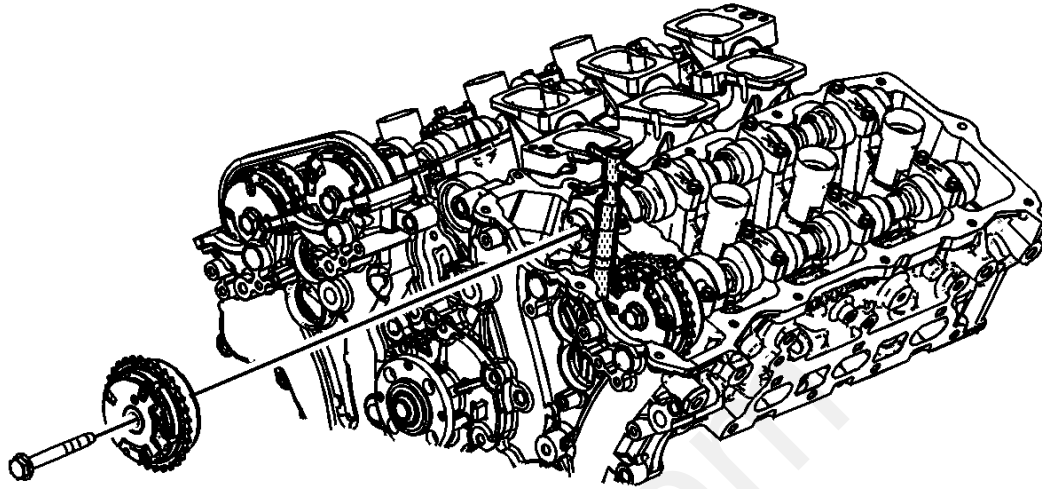


Fig. 120: View Of Exhaust Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

17. Use an open end wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
18. If replacing the exhaust camshaft position actuator, then remove the bolt and the actuator.
19. If replacing the intake camshaft position actuator, then remove the bolt and the actuator.
20. If removing both the exhaust and intake camshaft actuators, the timing chain can be draped over the **EN-48313** tool once the actuators have been removed.
21. Rotate the actuator in order to align the opening in the actuator reluctor wheel with the cam sensor boss in the front cover, to allow actuator removal.
22. Remove the camshaft thrust washer.

Installation Procedure

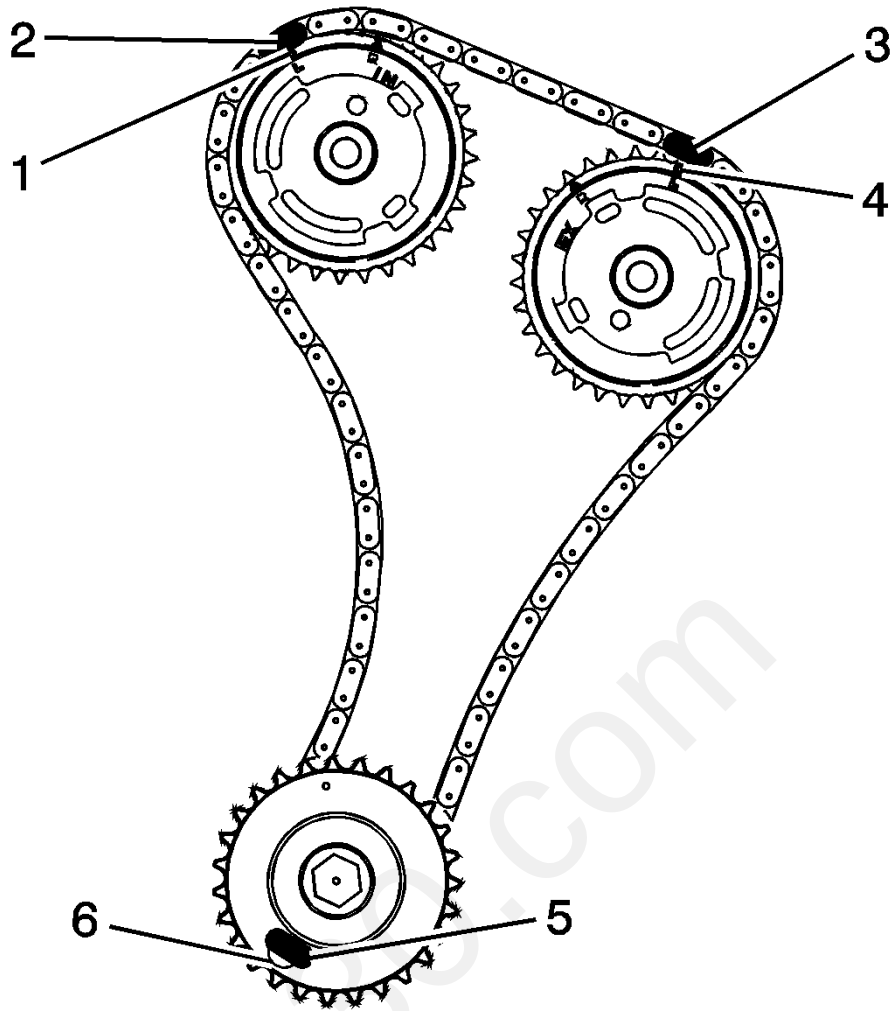


Fig. 121: Locating Left Secondary Camshaft Drive Chain Timing Marks

Courtesy of GENERAL MOTORS COMPANY

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

1. Align the exhaust camshaft actuator alignment mark (1) to the timing chain alignment mark (2) made during disassembly.
2. Ensure that the intake camshaft actuator alignment mark (4) and the timing chain alignment mark (3) are also aligned.
3. Position the exhaust camshaft actuator to the camshaft and install the actuator bolt hand tight.
4. Remove the EN-48313 tool.

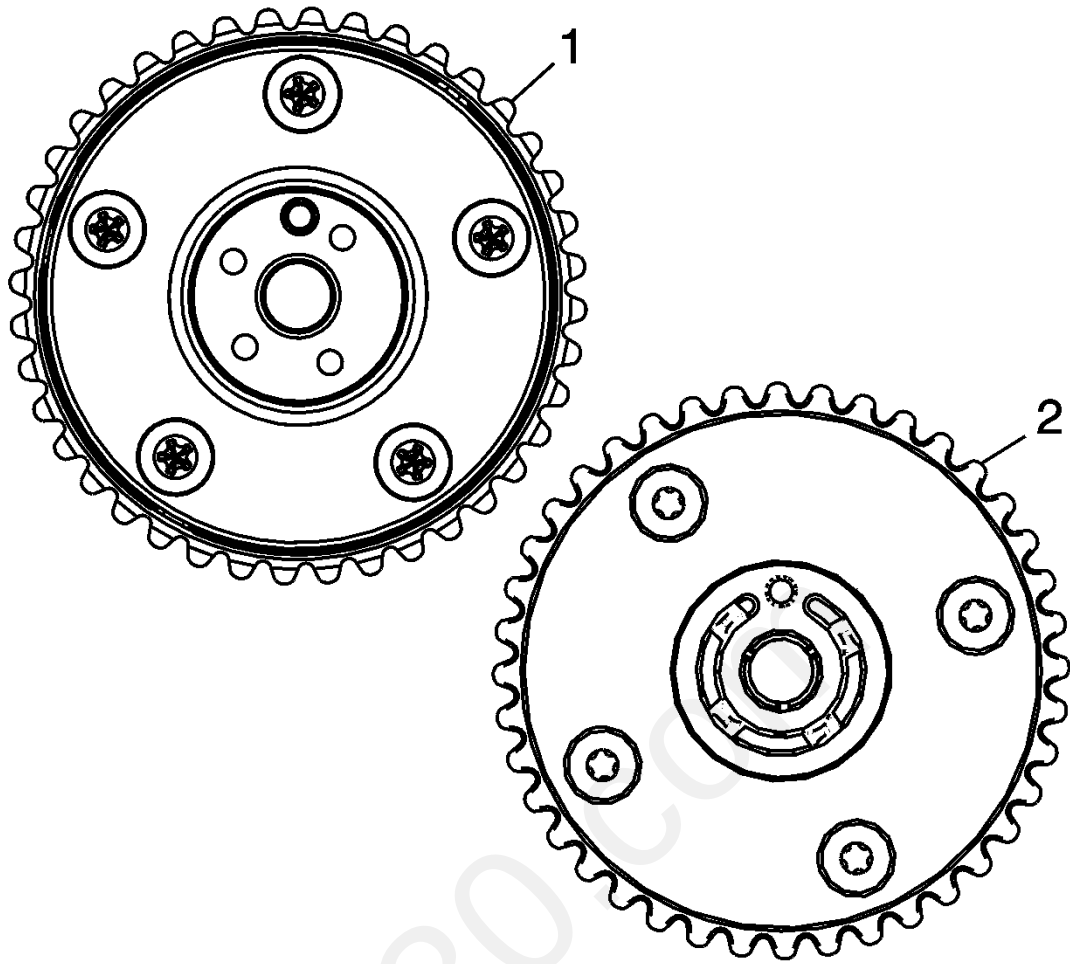


Fig. 122: Identifying Camshaft Position Actuators
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The camshaft position actuator will vary depending on application.
- Camshaft thrust washers must only be installed on applications that had thrust washers present during removal of the camshaft position actuators. Do not install washers on applications if they are not already present.

5. If equipped, ensure the proper camshaft thrust washer is used. Use a 1.6 mm (0.063 in) thrust washer on applications that have 5 attaching screws on the back side of the camshaft position actuator (1). Use a 1.1 mm (0.043 in) thick thrust washer with yellow speckles on applications that have 4 attaching screws on the back side of the camshaft position actuator (2).
6. Install the thrust washer, if applicable.

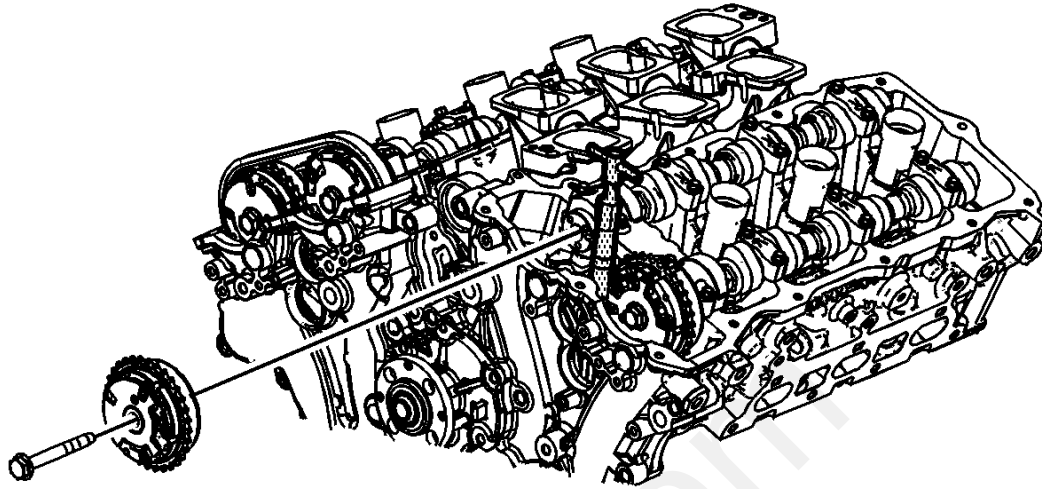


Fig. 123: View Of Exhaust Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

7. If the exhaust camshaft position actuator has been replaced, then tighten the bolt to 58 N.m (43 lb ft).
8. If the intake camshaft position actuator has been replaced, then tighten the bolt to 58 N.m (43 lb ft).
9. If both the exhaust and intake has been replaced, then tighten bolt to 58 N.m (43 lb ft).
10. Install the left intake and exhaust camshaft position actuator solenoids. Refer to [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 \(Left Side\) Intake](#) , and [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 \(Left Side\) Exhaust](#) .
11. Install the left intake and exhaust camshaft position sensors. Refer to [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Intake](#) , and [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Exhaust](#) .
12. Install the left camshaft cover. Refer to [Camshaft Cover Replacement - Left Side](#).
13. Install the intake manifold. Refer to [Intake Manifold Replacement](#).

SETTING CAMSHAFT TIMING

Setting the camshaft timing is necessary whenever the camshaft drive system has been disturbed such that the relationship between any chain and sprocket has been lost. Even when only one

: sprocket is involved, multiple crankshaft rotations will not produce conditions where correct timing can be confirmed.

Follow the left bank secondary camshaft drive chain replacement procedures to reset the camshaft timing. Refer to [Secondary Camshaft Intermediate Drive Chain Replacement - Left Side](#).

CAMSHAFT REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the fuel pump. Refer to [Fuel Pump Replacement](#).
2. Remove the camshaft position actuators. Refer to [Camshaft Position Actuator Replacement - Bank 2](#).

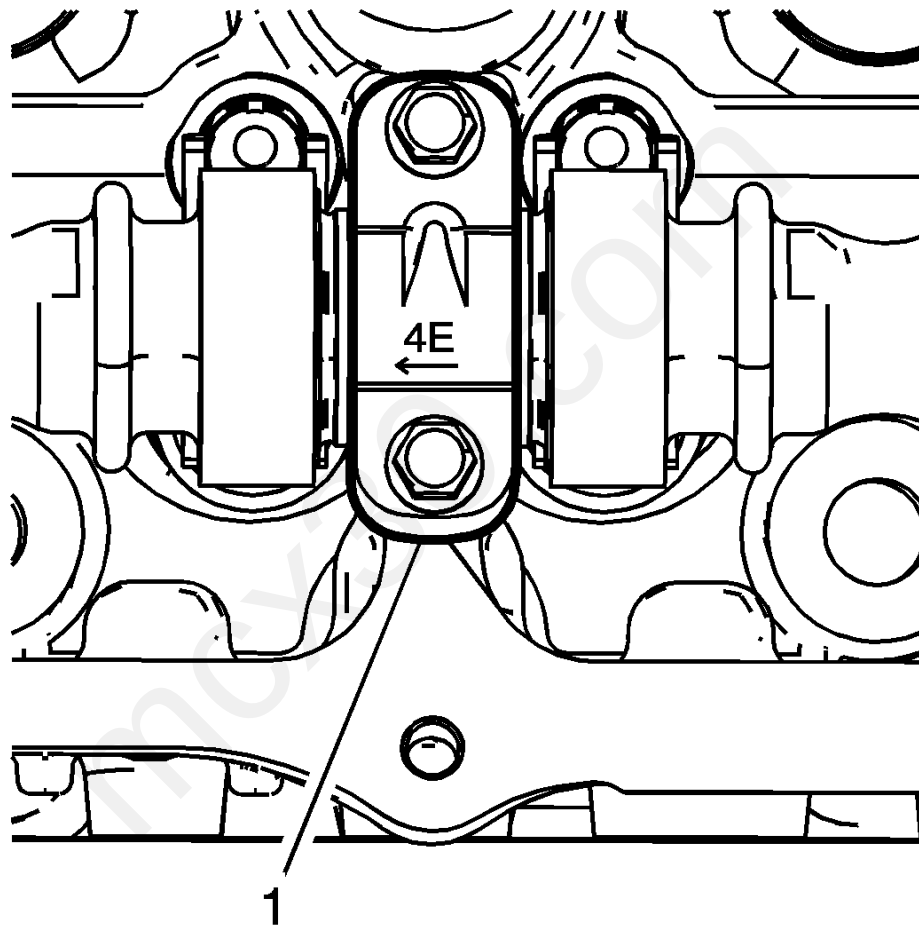


Fig. 124: Bearing Caps

Courtesy of GENERAL MOTORS COMPANY

3. Observe the markings on the bearing caps (1). Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The raised feature must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.

he number indicates the journal position from the front of the engine.

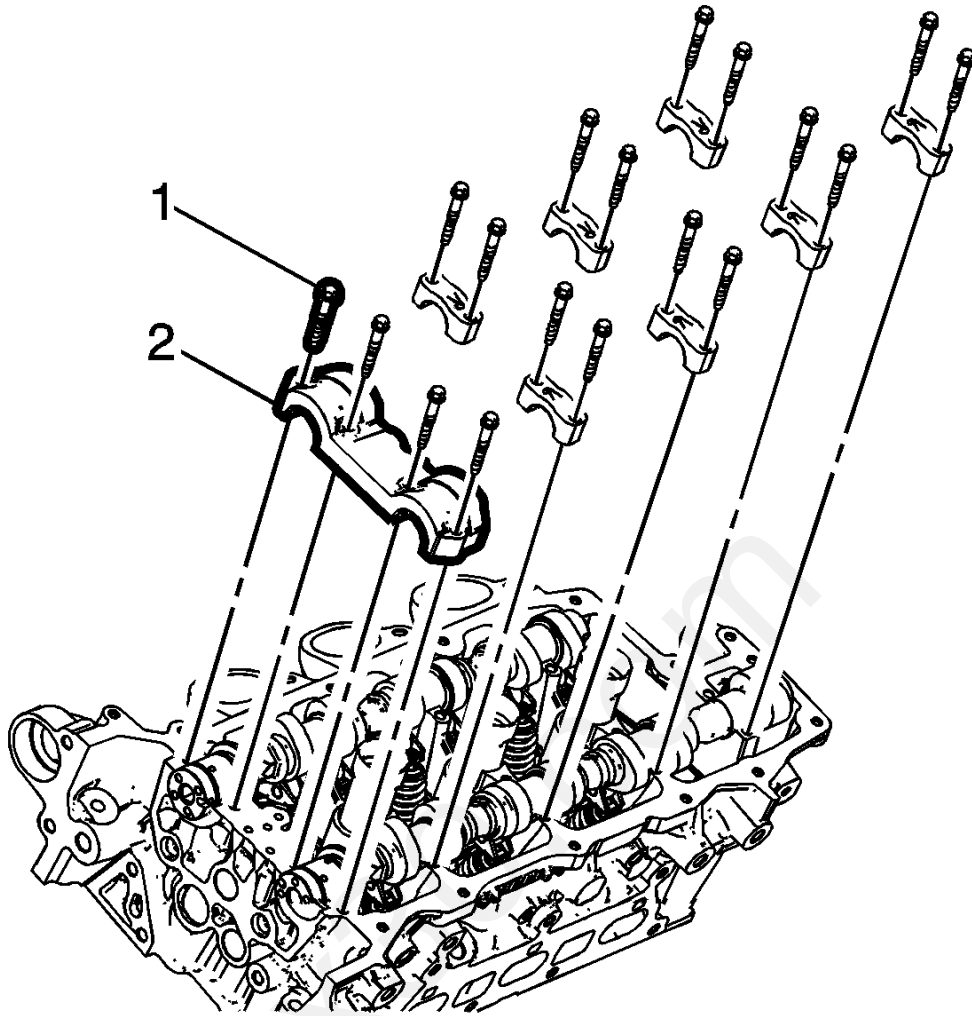


Fig. 125: Bearing Cap Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Remove the camshaft bearing cap bolts (1).
5. Remove the camshaft bearing caps (2).

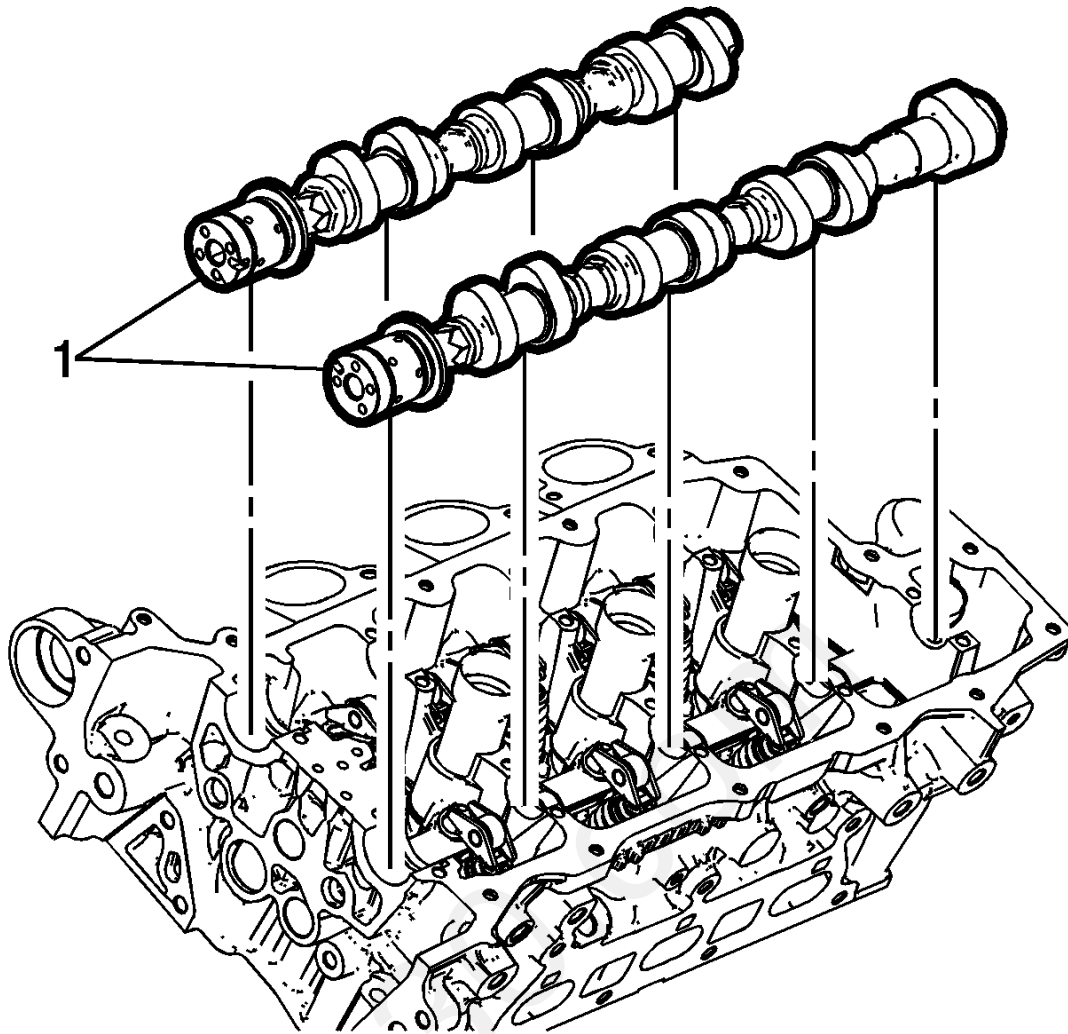


Fig. 126: Camshafts

Courtesy of GENERAL MOTORS COMPANY

NOTE: Mark the camshafts upon removal to ensure installation is in the correct position.

6. Remove the camshafts (1).

Installation Procedure

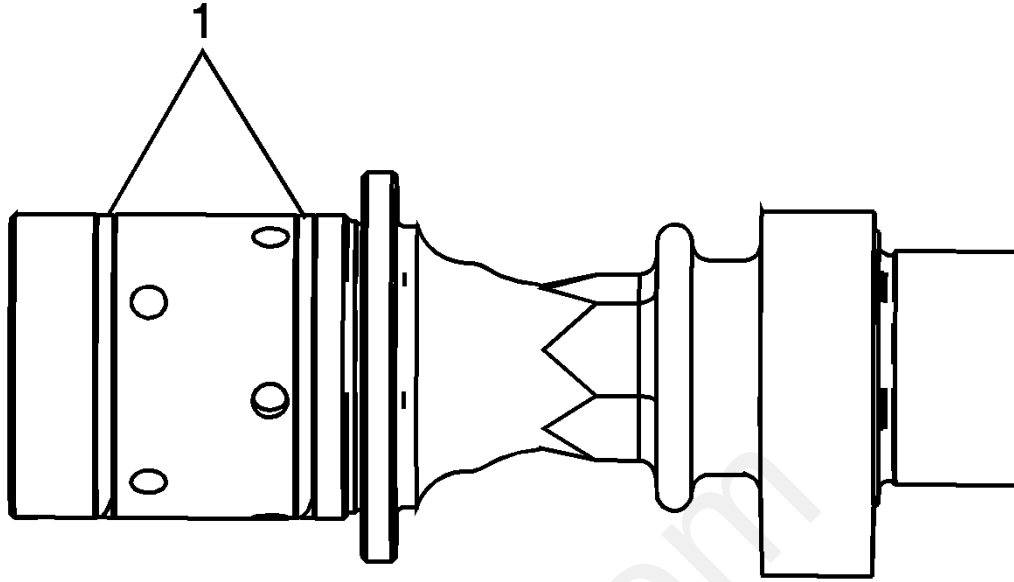


Fig. 127: Locating Camshaft Sealing Rings In Camshaft Grooves

Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

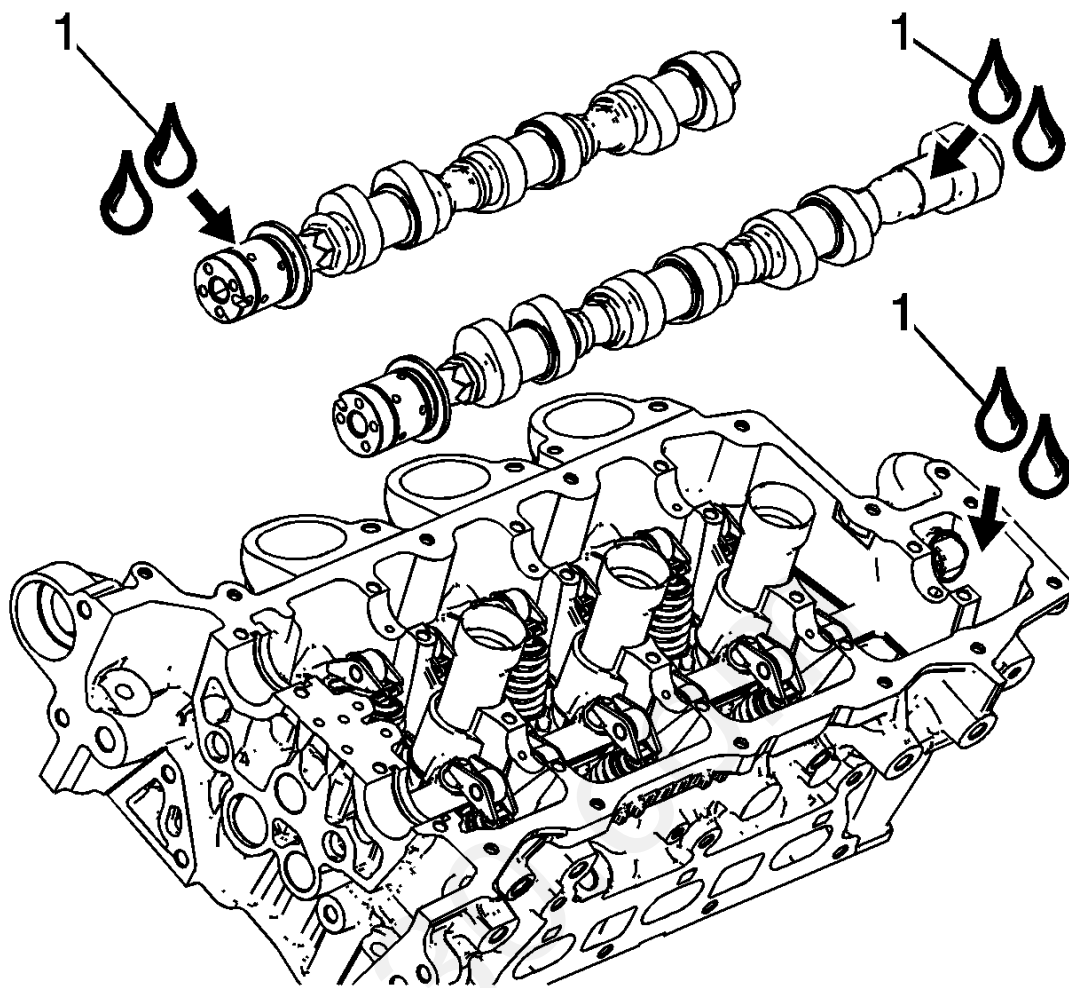


Fig. 128: Camshaft Journal Lubrication Points

Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant (1) to the camshaft journals and the left cylinder head camshaft carriers. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended lubricant.

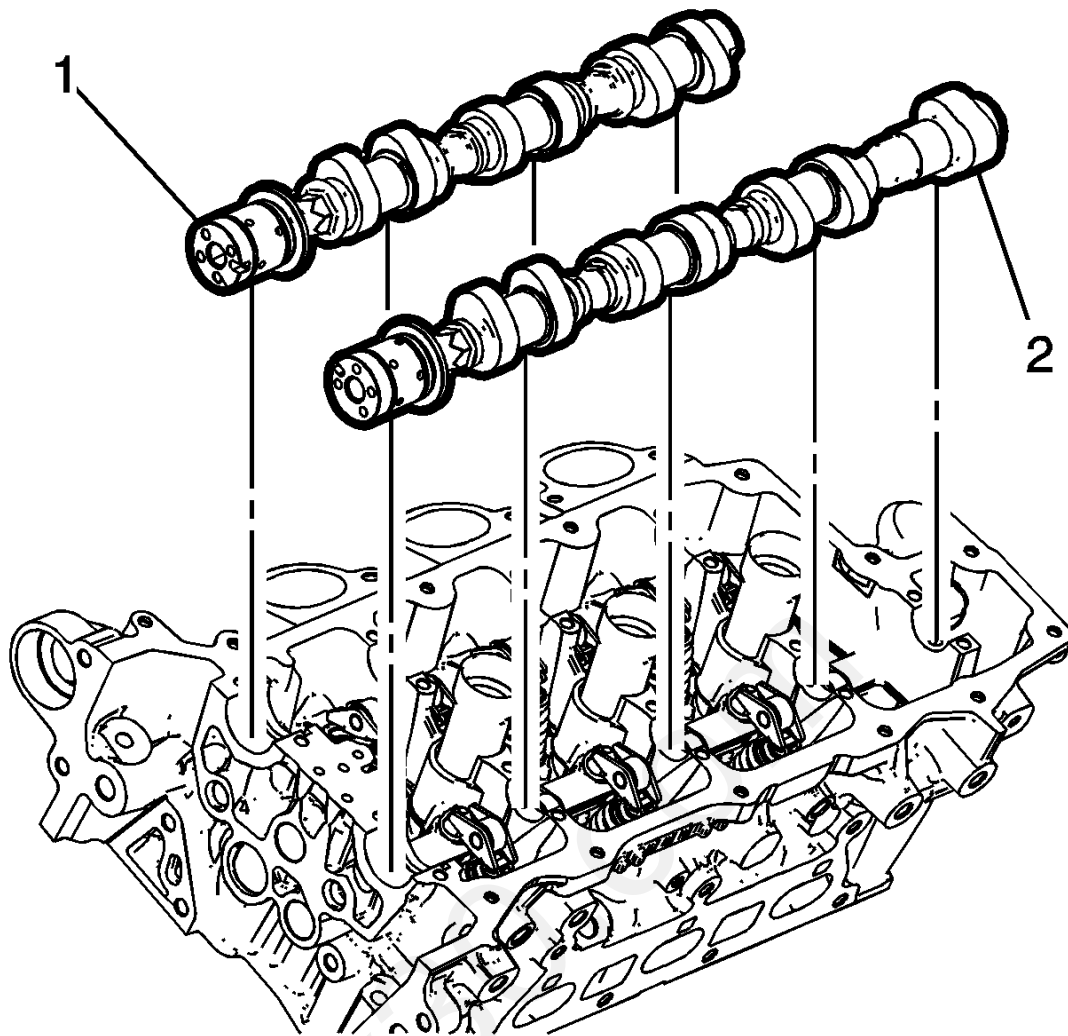


Fig. 129: Camshaft Intake And Exhaust Positioning Points

Courtesy of GENERAL MOTORS COMPANY

3. Place the left intake (1) and left exhaust (2) camshafts in position in the left cylinder head.

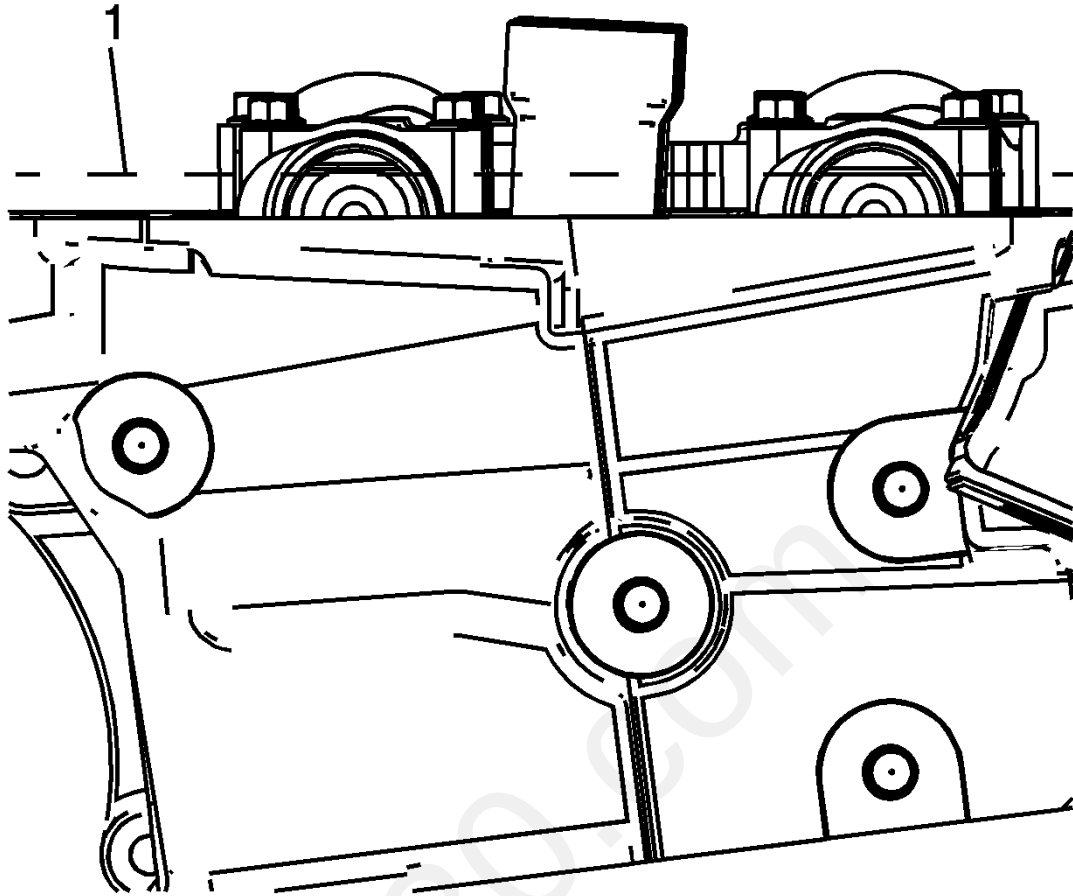


Fig. 130: View Of Camshaft Flats Parallel With Camshaft Cover Rail

Courtesy of GENERAL MOTORS COMPANY

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the left cylinder head camshaft cover rail.

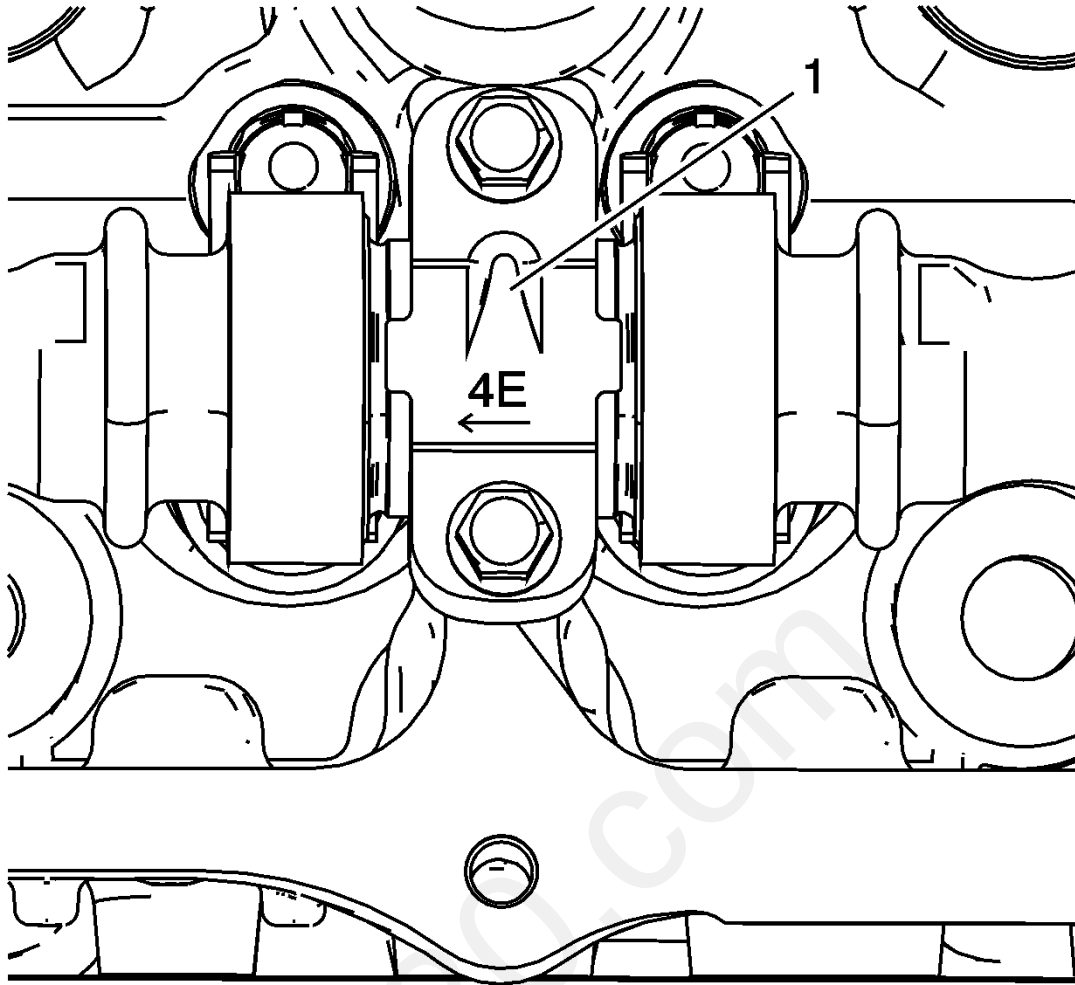


Fig. 131: Left Cylinder Head Camshaft Bearing Cap Markings

Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the left cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The raised feature (1) must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.
 - The number 2, 4, 6 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended lubricant.

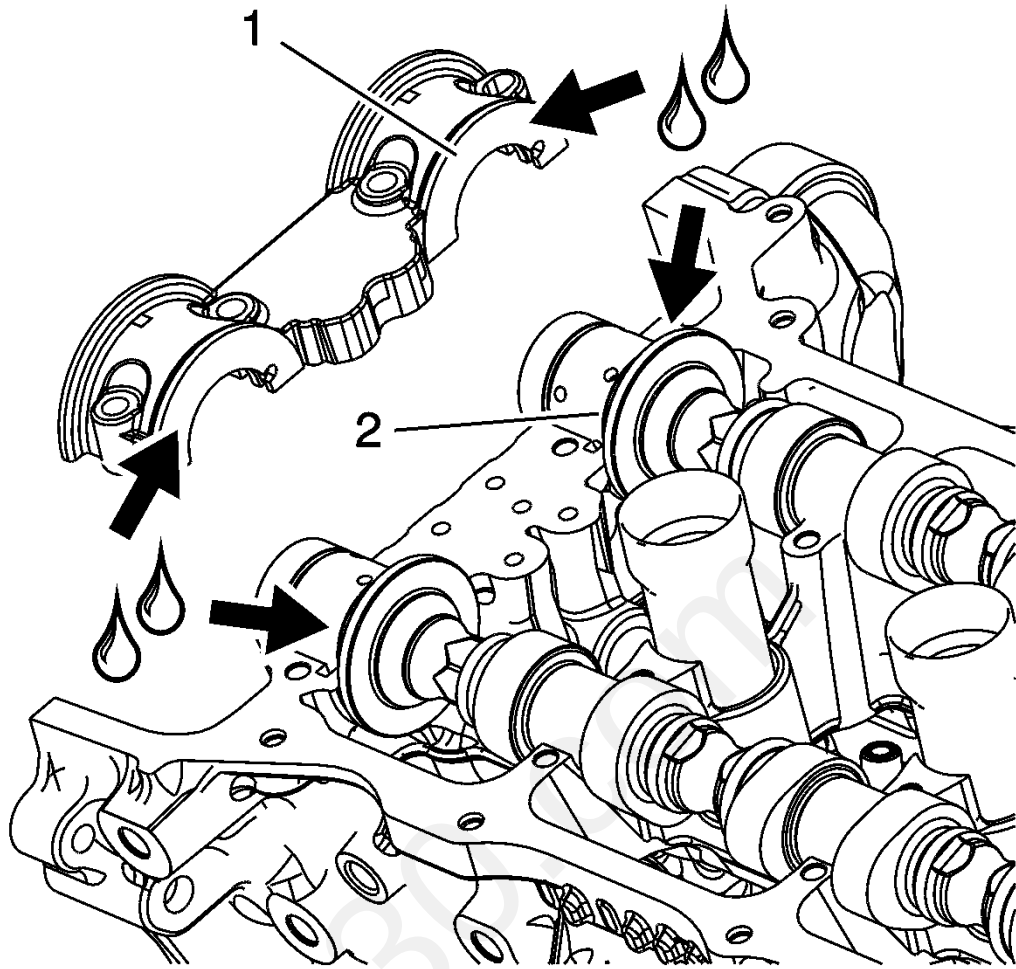


Fig. 132: Camshaft Bearing Cap And Camshaft Thrust Surface

Courtesy of GENERAL MOTORS COMPANY

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended lubricant.

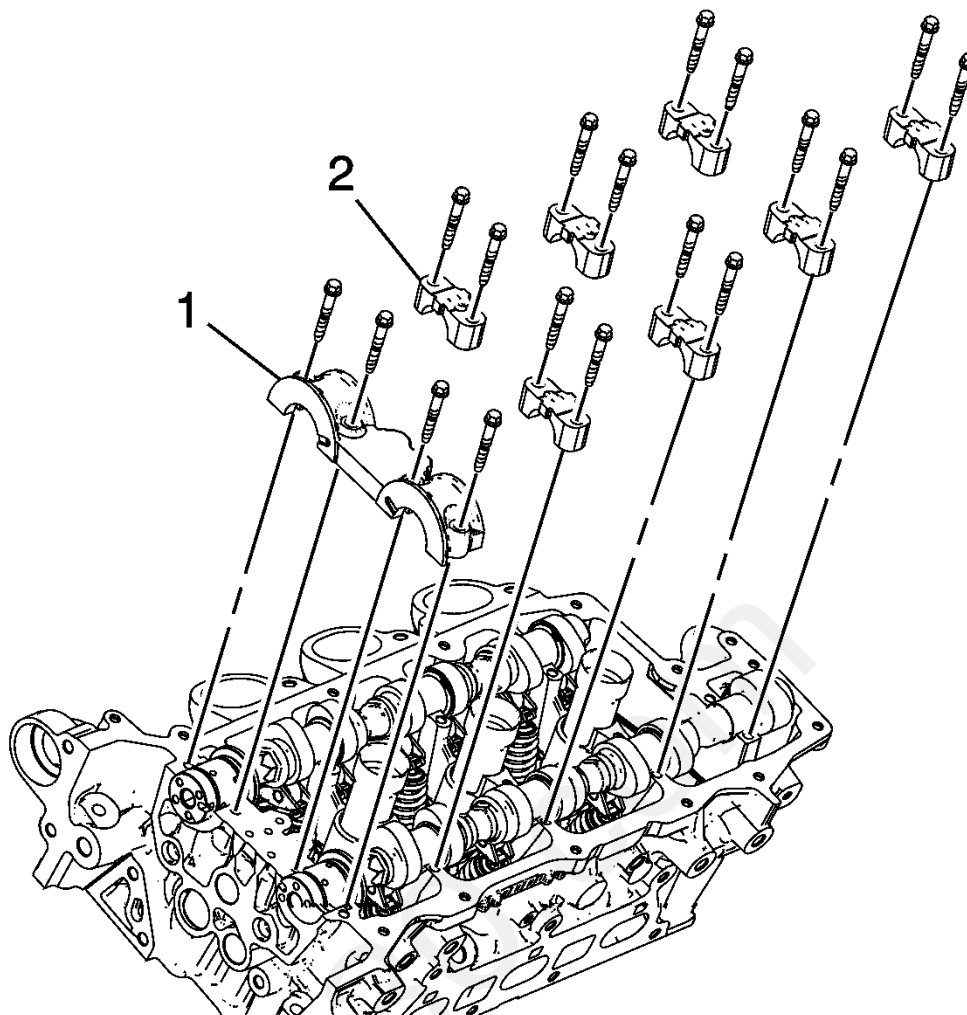


Fig. 133: Camshaft Bearing Caps And Bolts

Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust cap (1) in the first journal of the left cylinder head.
9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.

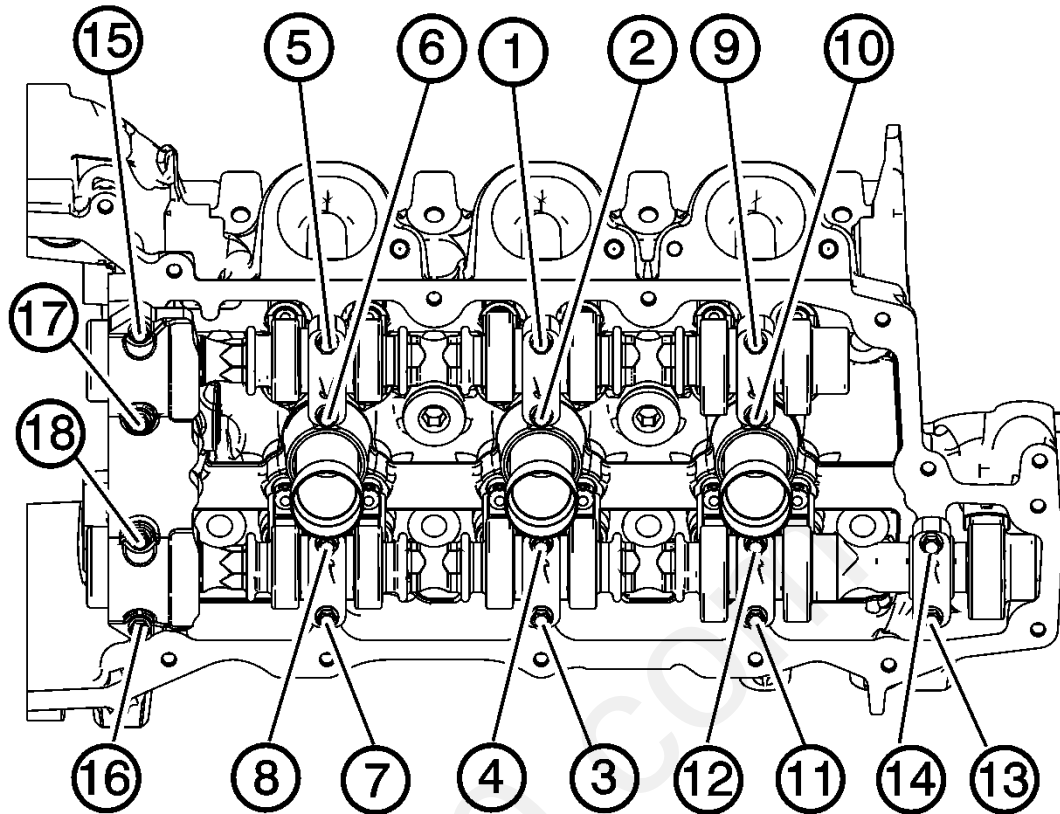


Fig. 134: Camshaft Bearing Cap Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).
12. Loosen the center intake camshaft bearing cap bolts 1, 2 and the center exhaust camshaft bearing cap bolts 3, 4.
13. Retighten the center camshaft bearing cap bolts 1, 2, 3, 4 and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).
14. Install the camshaft position actuators. Refer to [Camshaft Position Actuator Replacement - Bank 2](#).
15. Install the fuel pump. Refer to [Fuel Pump Replacement](#) .

CAMSHAFT REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the camshaft position actuators. Refer to [Camshaft Position Actuator Replacement - Bank 1](#).

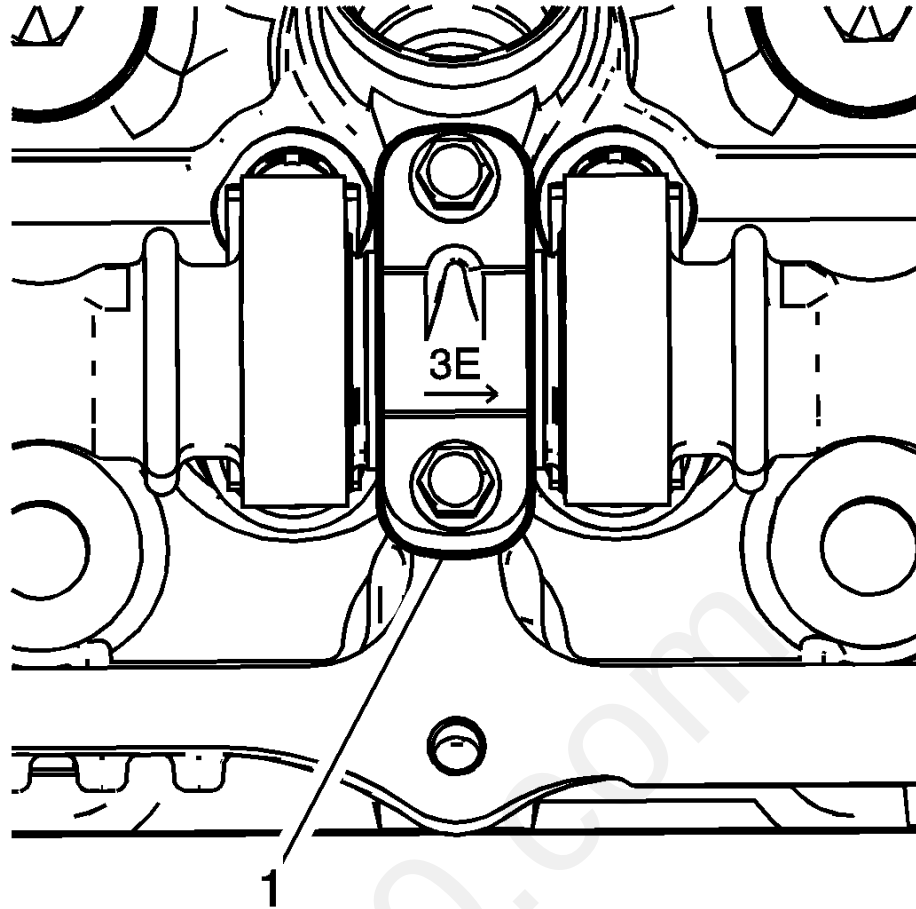


Fig. 135: Bearing Cap Markings

Courtesy of GENERAL MOTORS COMPANY

2. Observe the markings on the bearing caps (1). Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The raised feature must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.
 - The number indicates the journal position from the front of the engine.

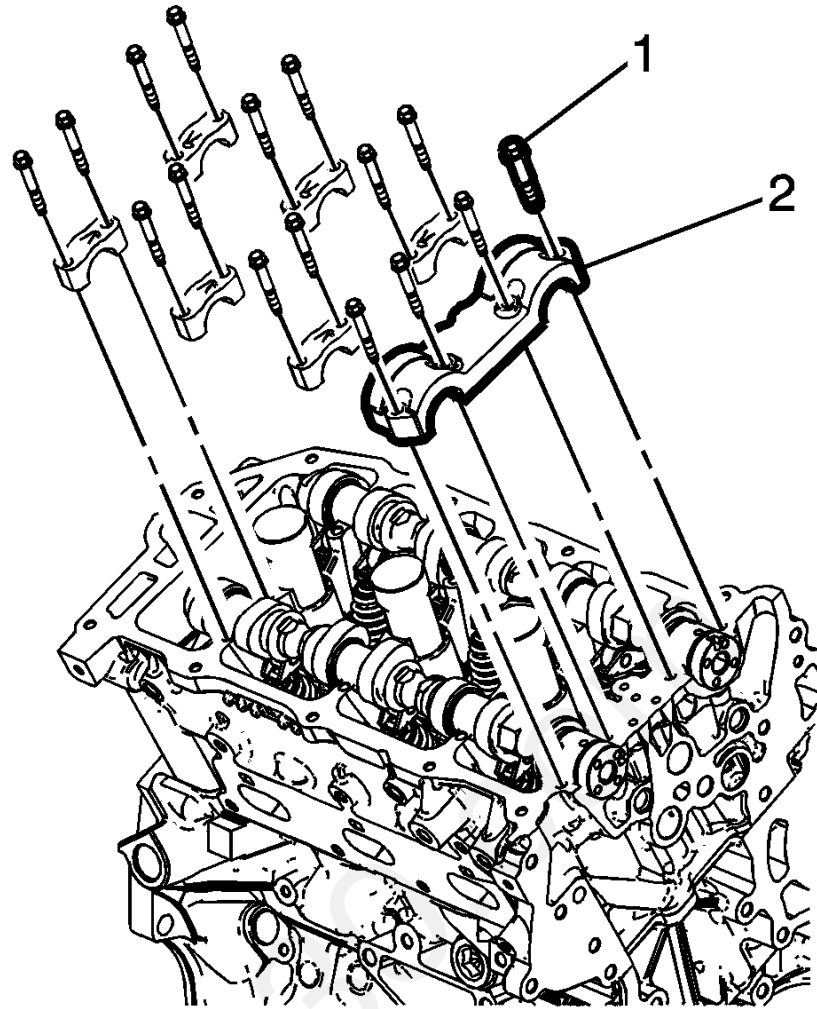


Fig. 136: Camshaft Bearing Caps & Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft bearing cap bolts (1).
4. Remove the camshaft bearing caps (2).

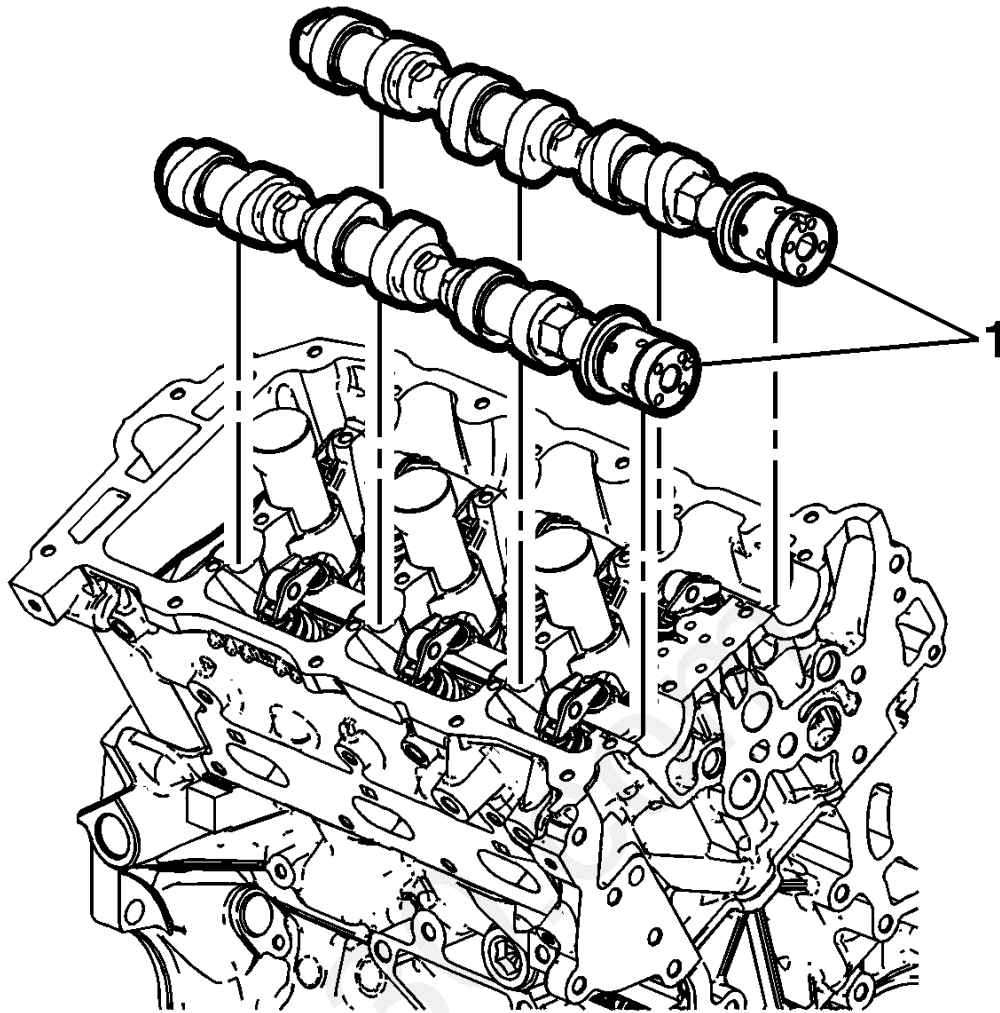


Fig. 137: Camshafts

Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Mark the camshafts upon removal to ensure installation is in the correct position.

5. Remove the camshafts (1).

Installation Procedure

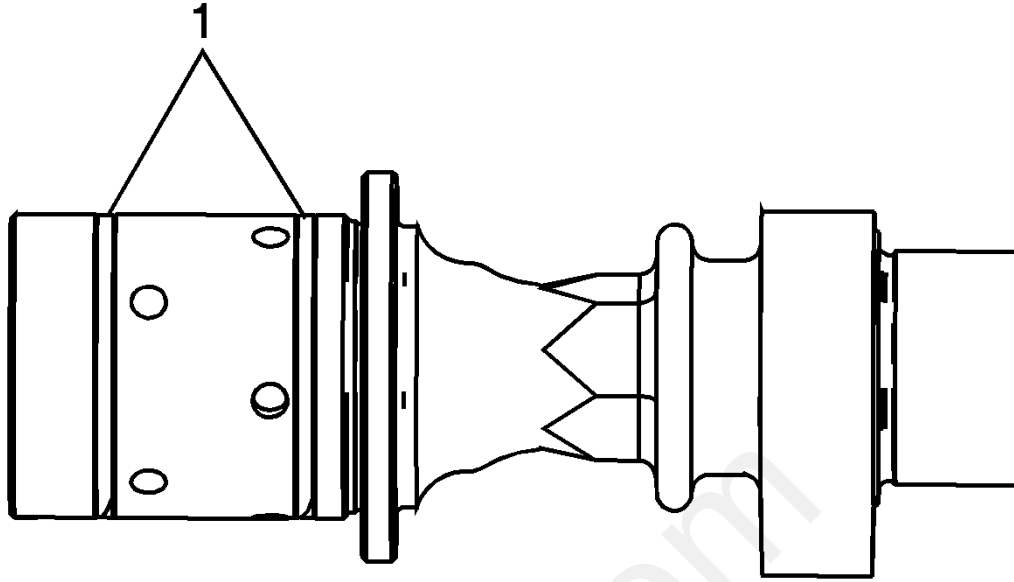


Fig. 138: Locating Camshaft Sealing Rings In Camshaft Grooves

Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

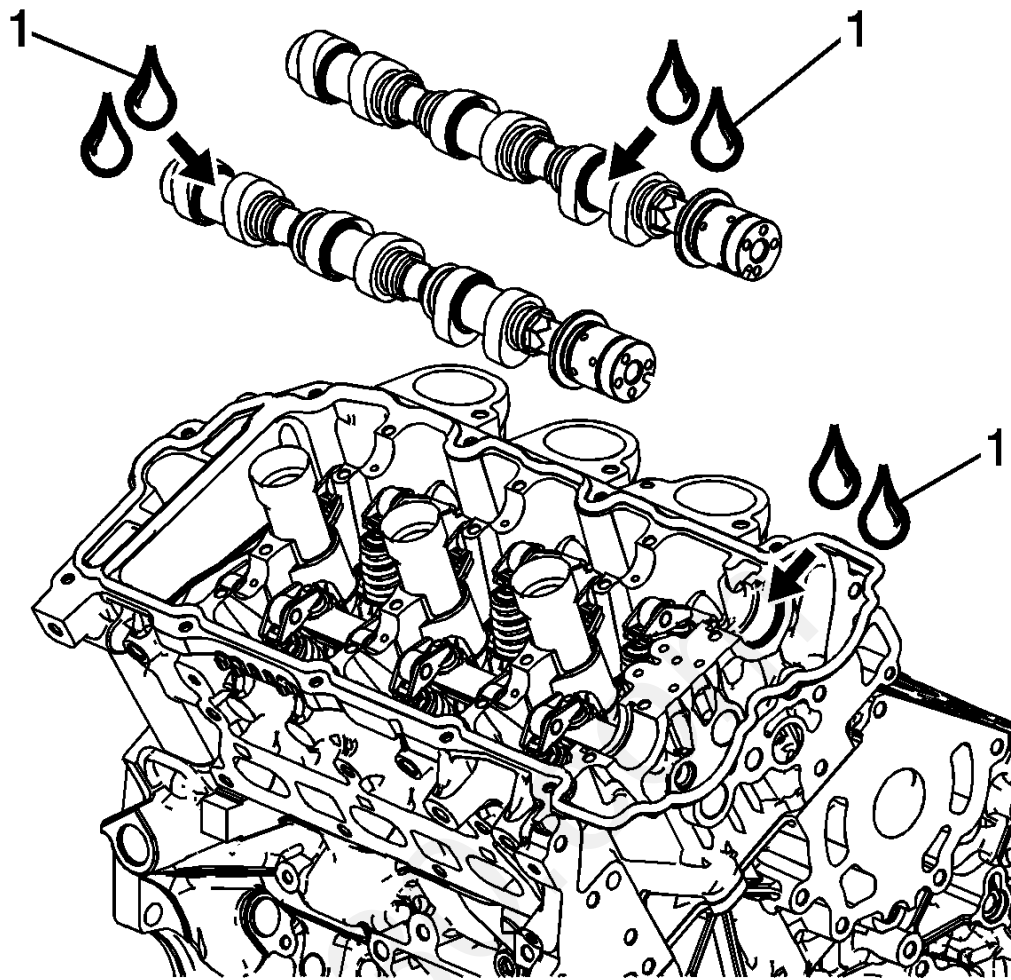


Fig. 139: Right Cylinder Head Camshaft Lubrication Points

Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant (1) to the camshaft journals and the right cylinder head camshaft carriers. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended lubricant.

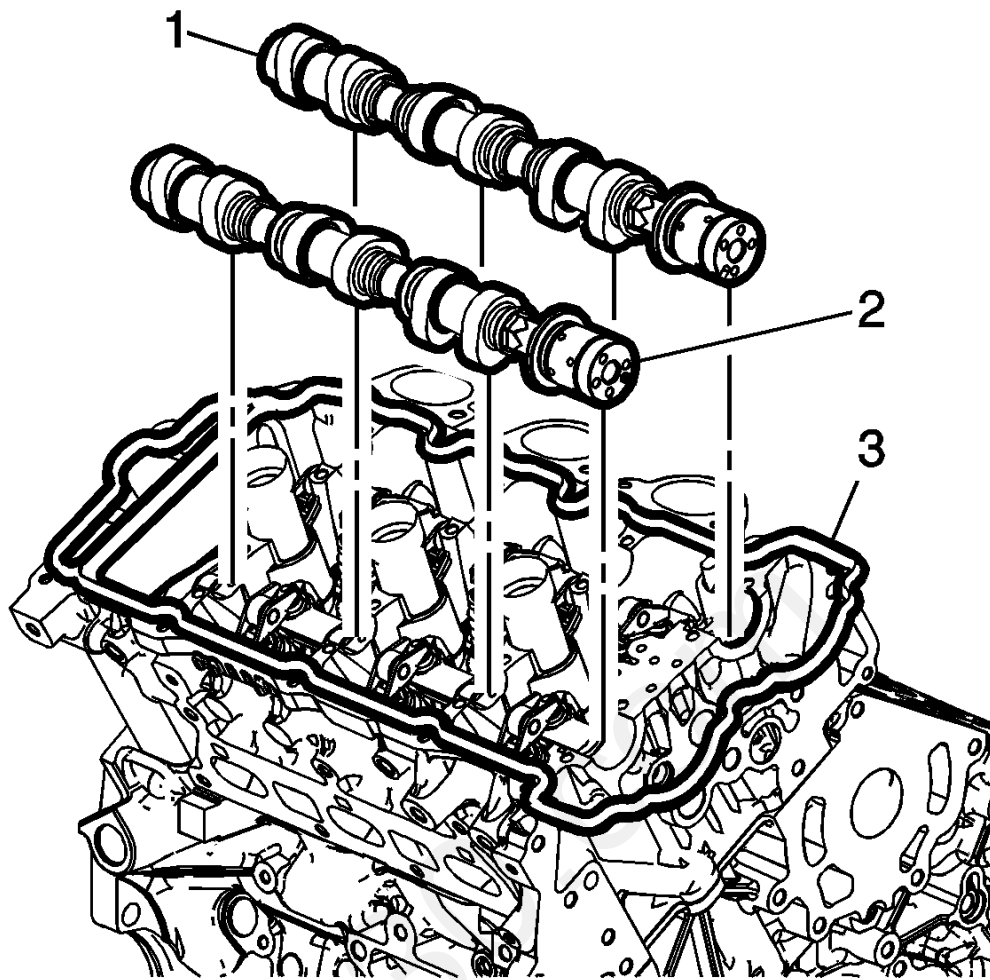


Fig. 140: Right Cylinder Head Camshaft Intake & Exhaust Points

Courtesy of GENERAL MOTORS COMPANY

3. Place the right intake (1) and right exhaust (2) camshafts in position in the right cylinder head (3).

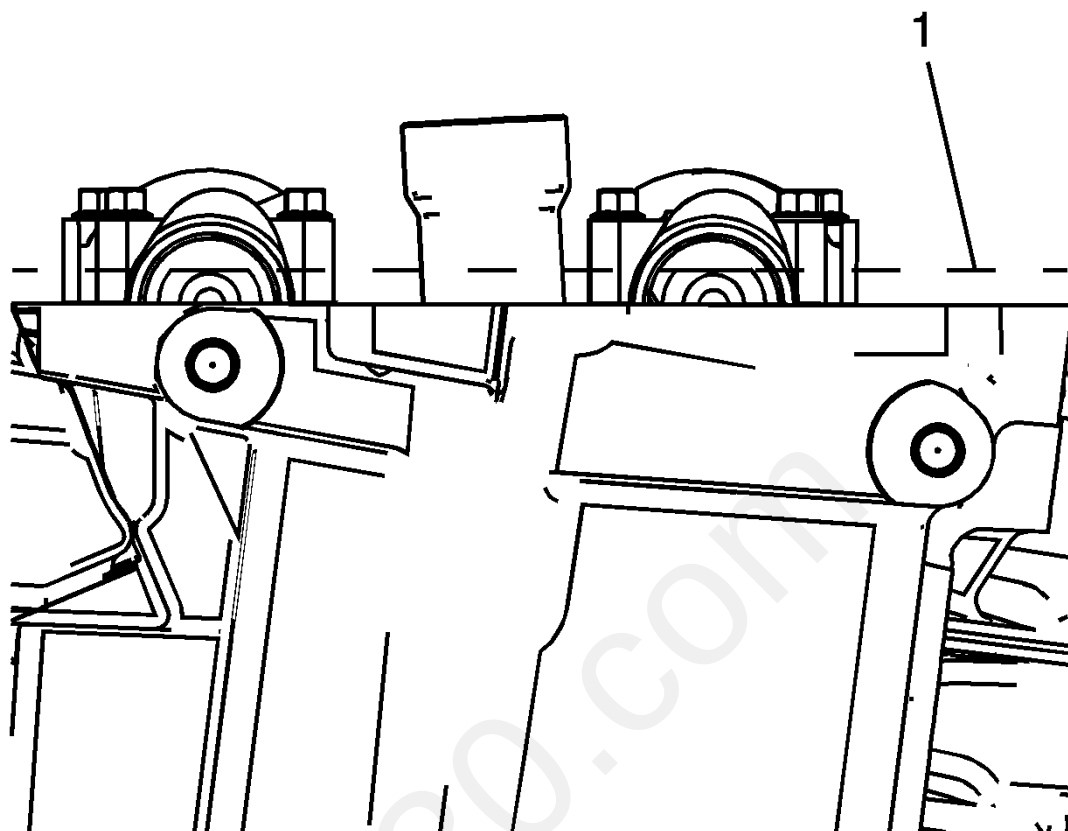


Fig. 141: Identifying Camshaft Neutral (Low Tension) Position

Courtesy of GENERAL MOTORS COMPANY

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the right cylinder head camshaft cover rail.

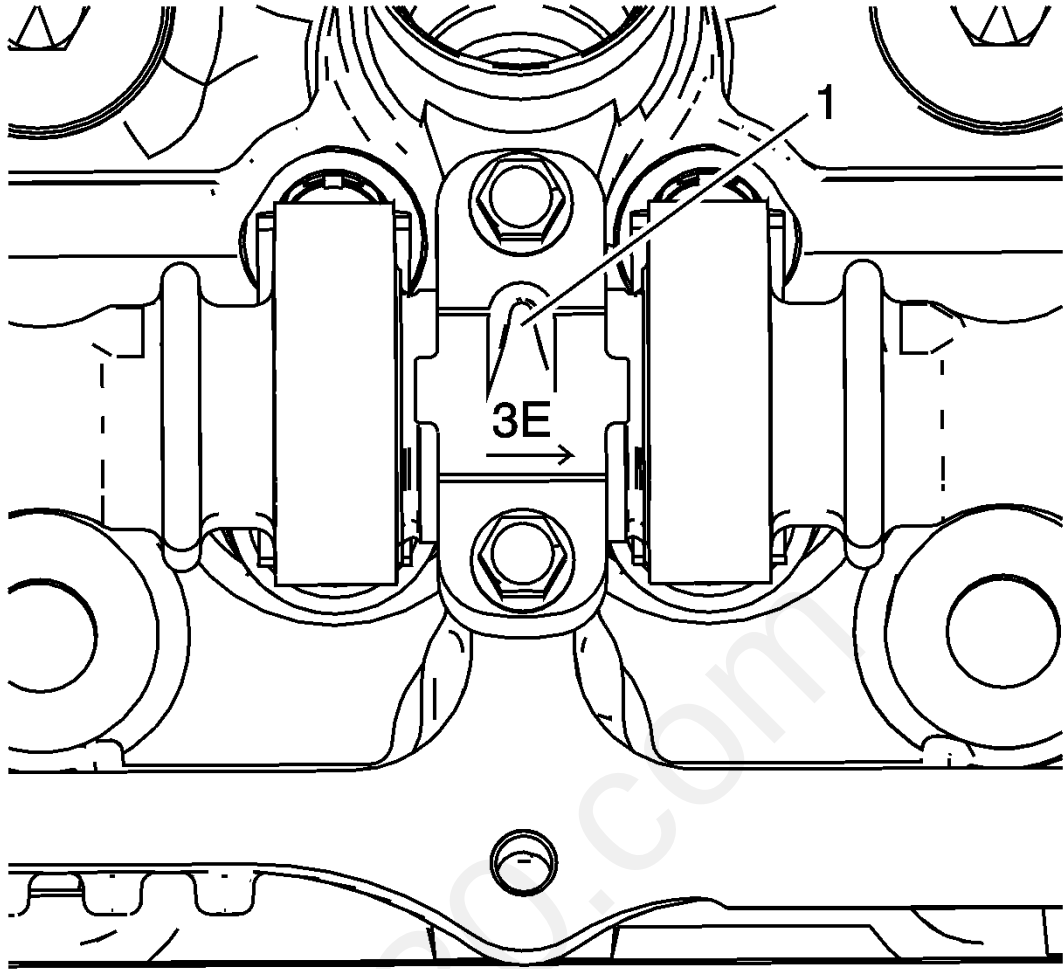


Fig. 142: Right Cylinder Head Camshaft Bearing Cap Markings

Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the right cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The raised feature (1) must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.
 - The number 1, 3, 5 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended lubricant.

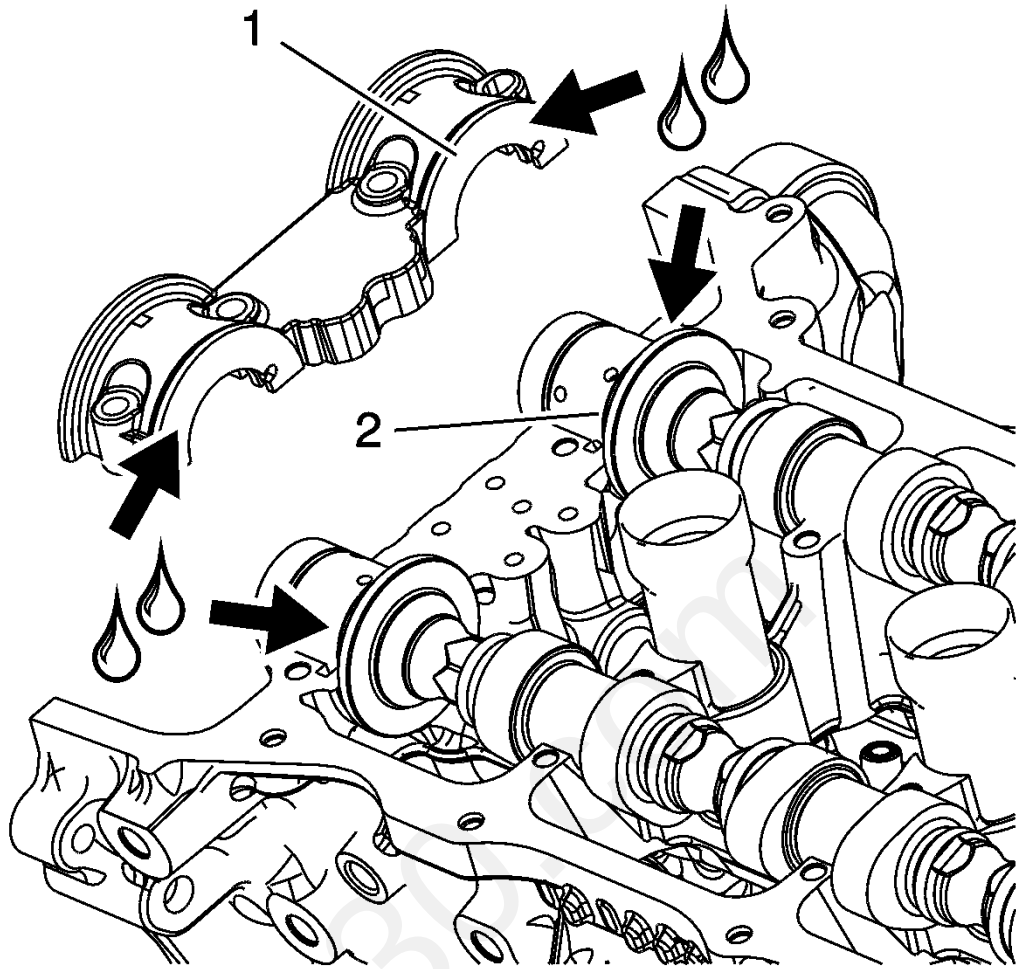


Fig. 143: Camshaft Bearing Cap And Camshaft Thrust Surface

Courtesy of GENERAL MOTORS COMPANY

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended lubricant.

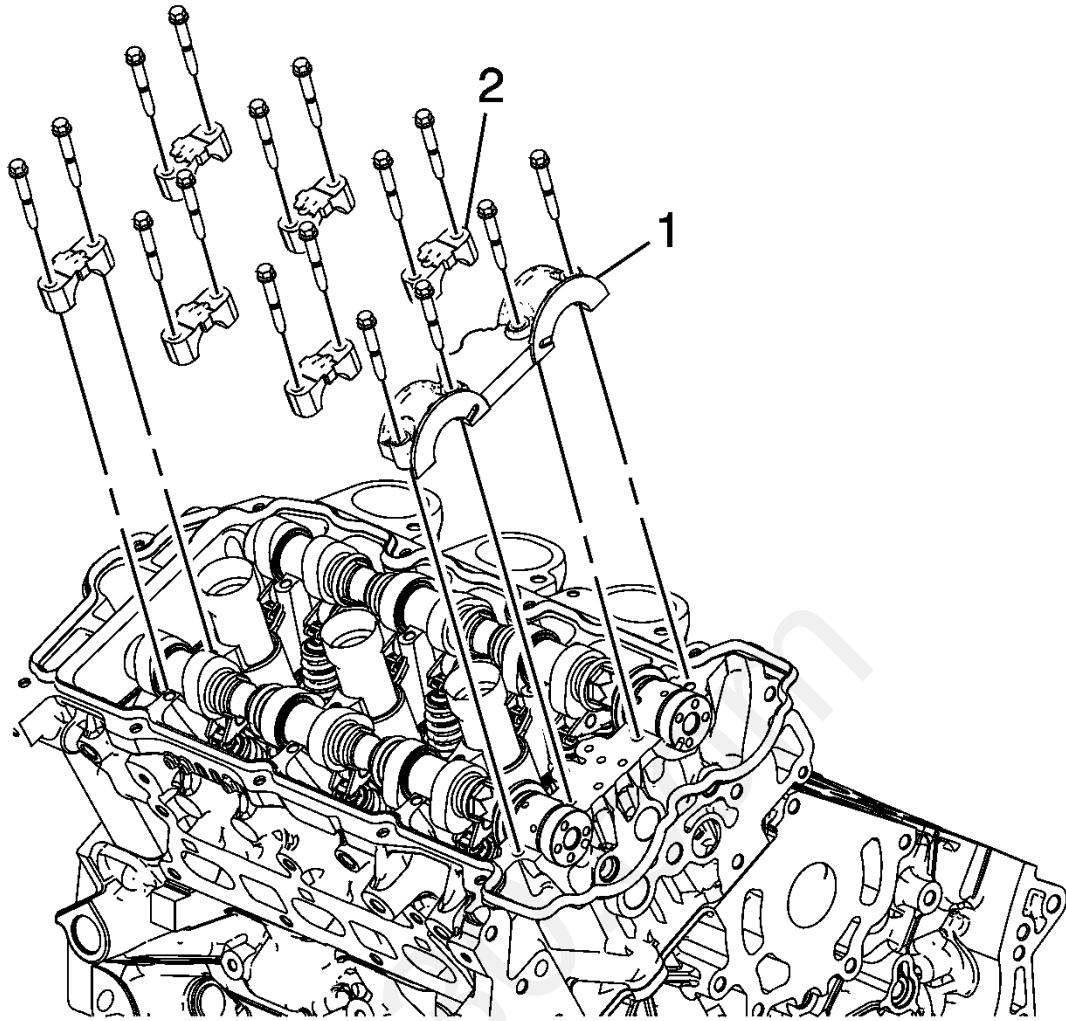


Fig. 144: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust caps (1) in the first journal of the right cylinder head.
9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.

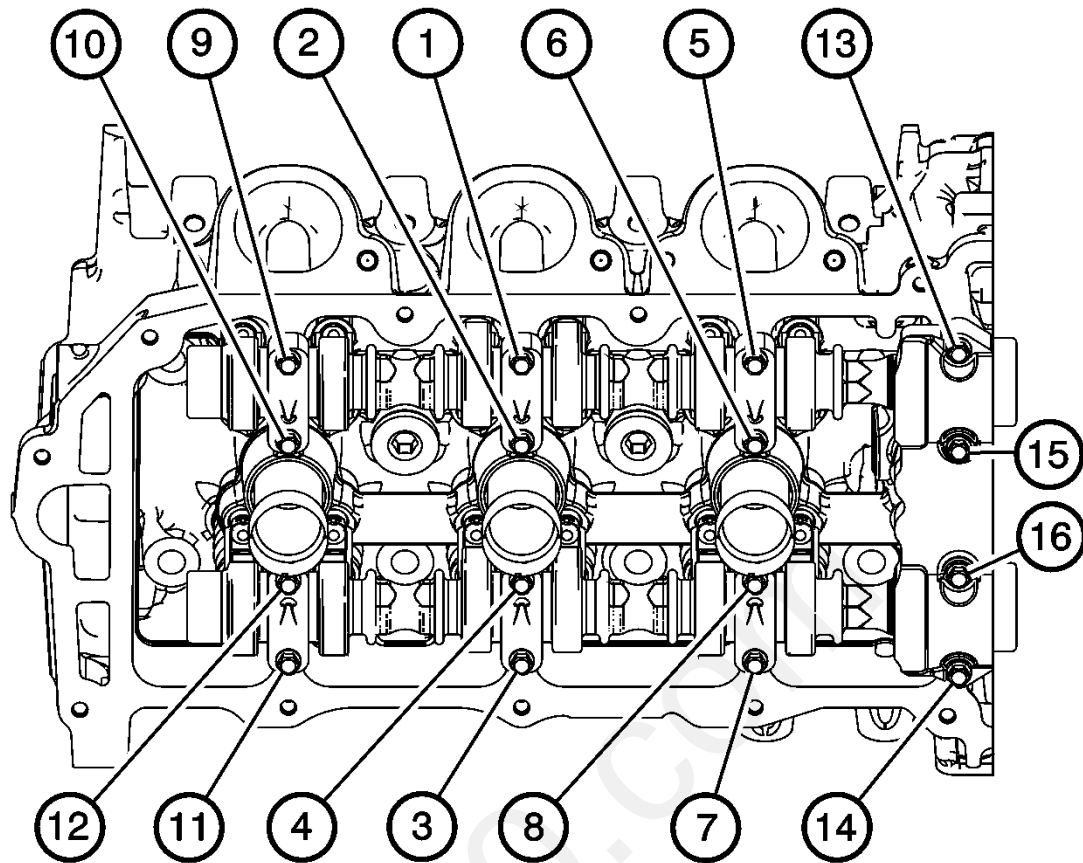


Fig. 145: Camshaft Bearing Cap Bolts Tighten Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a **NEW** torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).
12. Loosen the center intake camshaft bearing cap bolts (1, 2) and the center exhaust camshaft bearing cap bolts (3, 4).
13. Retighten the center camshaft bearing cap bolts (1, 2, 3, 4) and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).
14. Install the camshaft position actuators. Refer to [Camshaft Position Actuator Replacement - Bank 1](#).

VALVE ROCKER ARM REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the applicable camshaft(s). Refer to [Camshaft Replacement - Left Side](#).

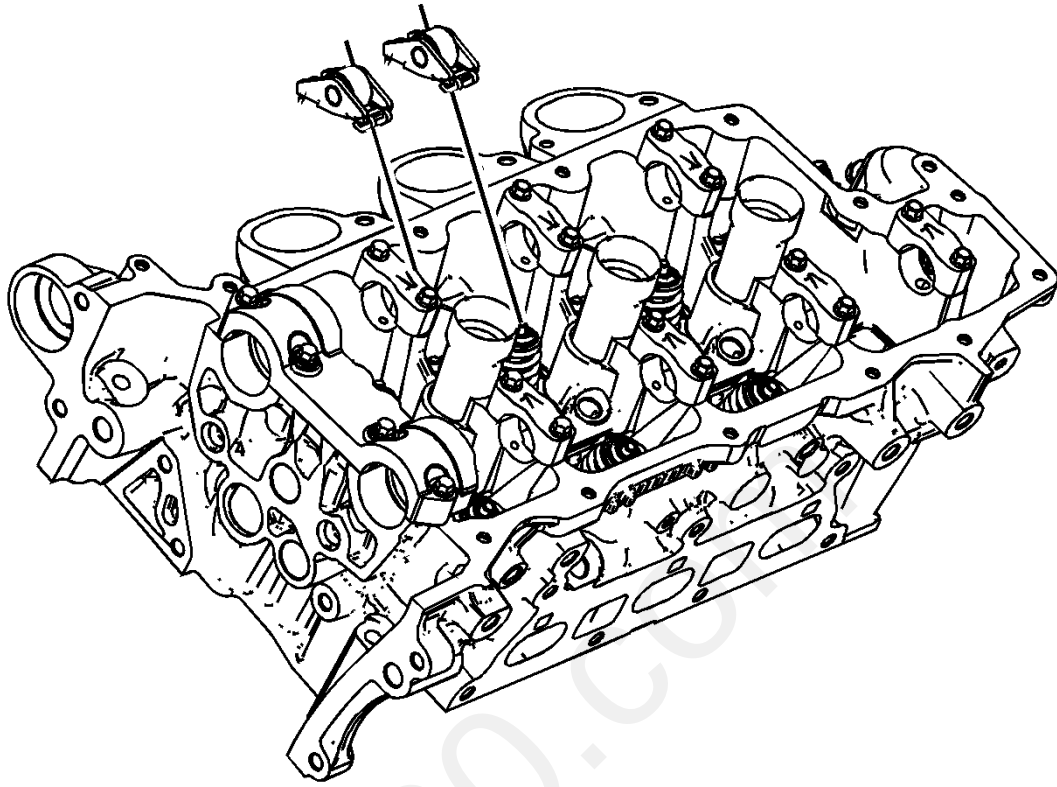


Fig. 146: View of Rocker Arm Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Remove the rocker arms.
3. Clean and inspect the camshaft(s) and the rocker arm(s). Replace as necessary. Refer to [Camshaft Cleaning and Inspection](#) , and [Valve Rocker Arm Cleaning and Inspection](#) .
4. Clean and inspect the valve lifters and replace as necessary. Refer to [Valve Lifter Cleaning and Inspection](#)

Installation Procedure

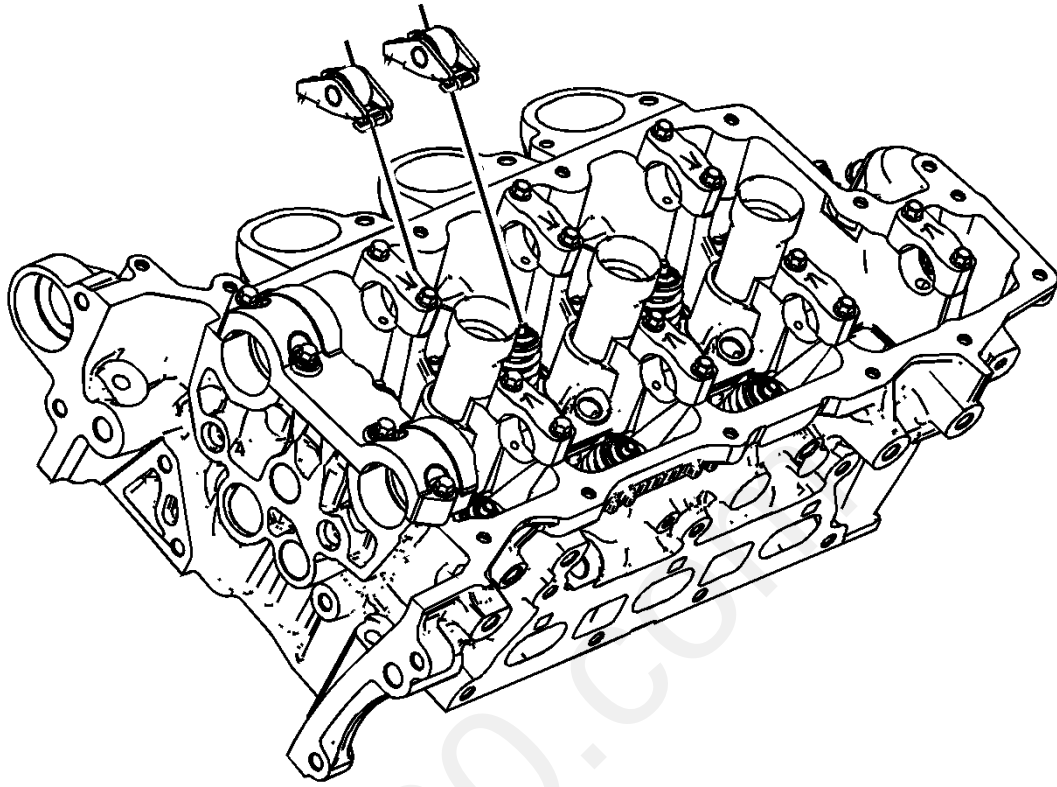


Fig. 147: View of Rocker Arm Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the rocker arms. Refer to [Valve Rocker Arm Installation - Left Side](#) .
2. Install the camshaft(s). Refer to [Camshaft Replacement - Left Side](#).

VALVE ROCKER ARM REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the applicable camshaft(s). Refer to [Camshaft Replacement - Right Side](#).

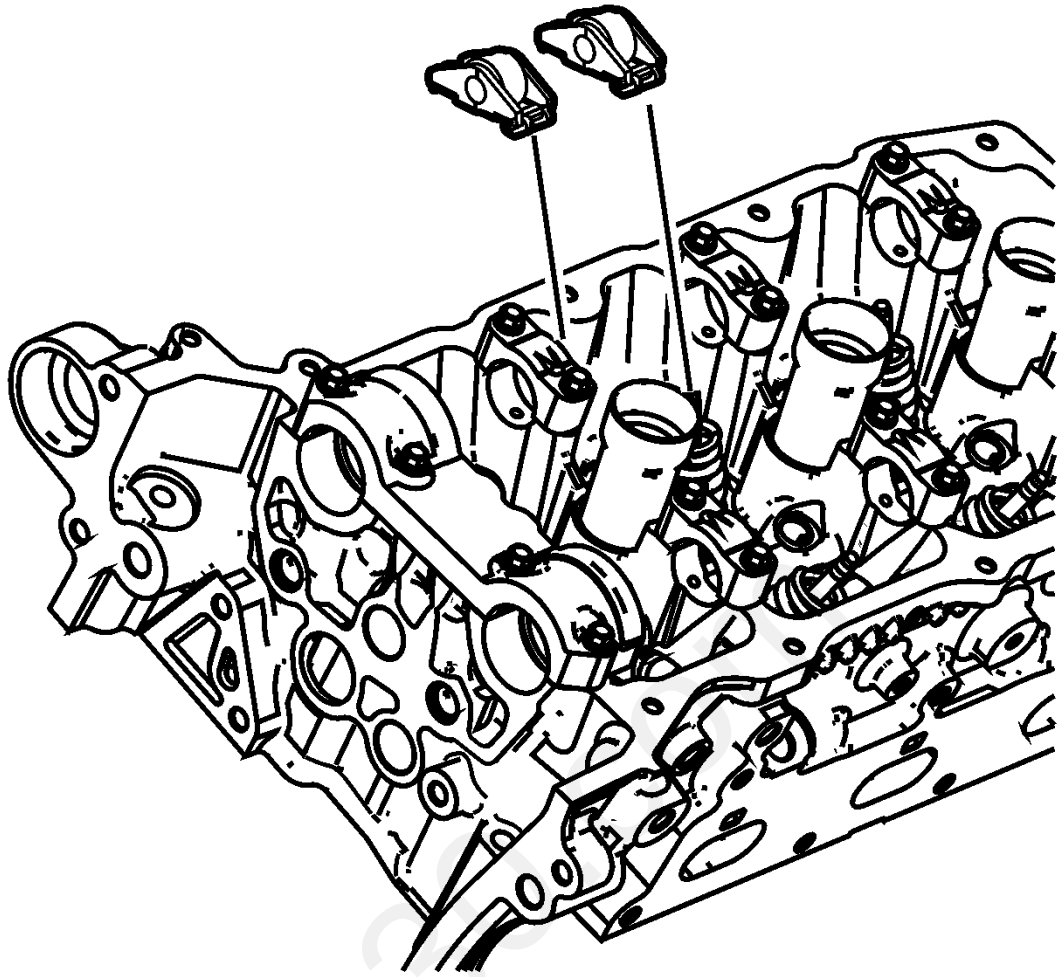


Fig. 148: View Of Valve Rocker Arm

Courtesy of GENERAL MOTORS COMPANY

2. Remove the rocker arms.
3. Clean and inspect the camshaft(s) and the rocker arm(s). Replace as necessary. Refer to [Camshaft Cleaning and Inspection](#) , and [Valve Rocker Arm Cleaning and Inspection](#) .
4. Clean and inspect the valve lifters and replace as necessary. Refer to [Valve Lifter Cleaning and Inspection](#)

Installation Procedure

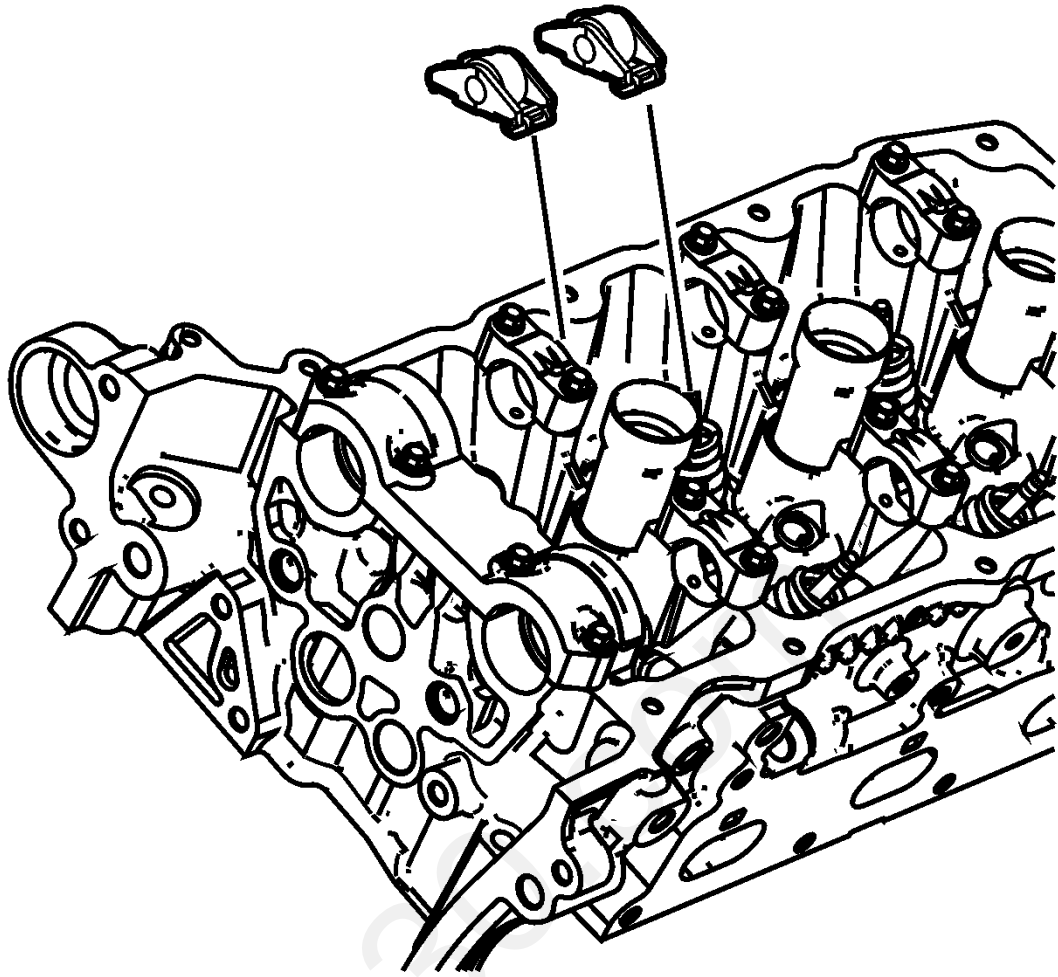


Fig. 149: View Of Valve Rocker Arm

Courtesy of GENERAL MOTORS COMPANY

1. Install the rocker arms. Refer to [Valve Rocker Arm Installation - Right Side](#) .
2. Install the camshaft(s). Refer to [Camshaft Replacement - Right Side](#).

VALVE LIFTER REPLACEMENT - LEFT SIDE

Removal Procedure

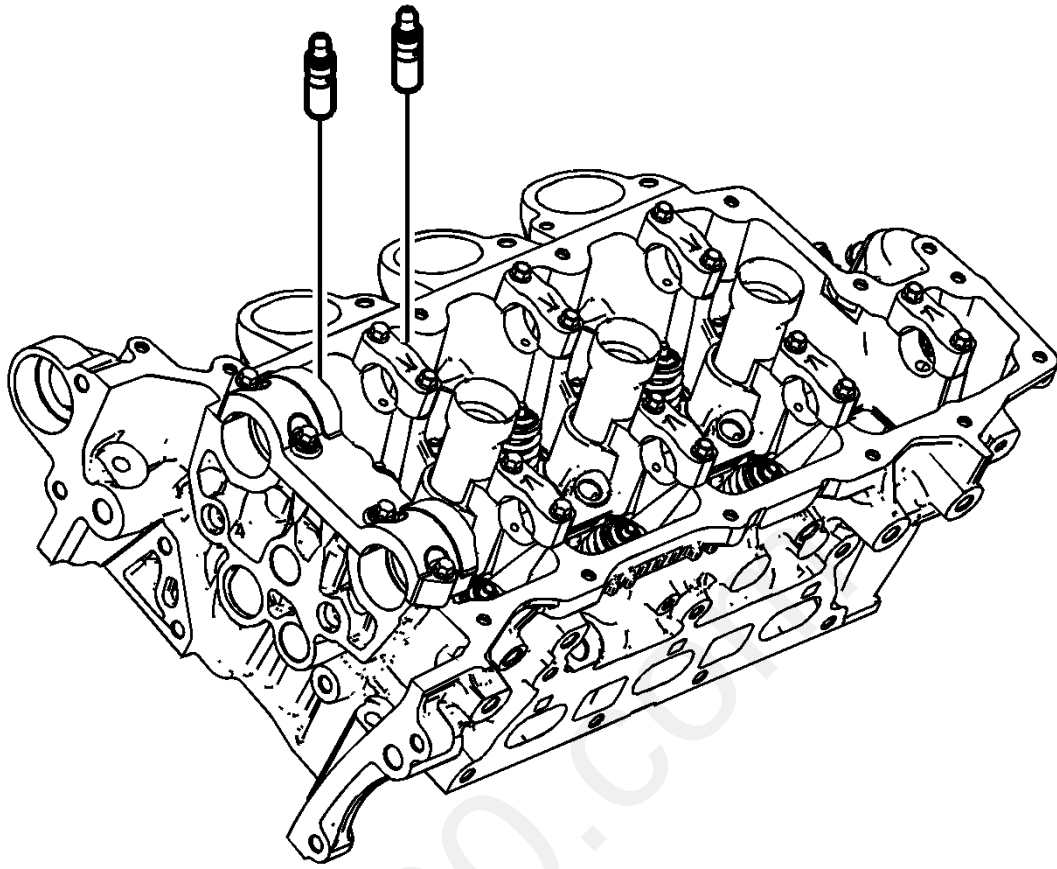


Fig. 150: Valve Lifter - Left Side

Courtesy of GENERAL MOTORS COMPANY

1. Remove the applicable camshafts. Refer to [Camshaft Replacement - Left Side](#).
2. Remove the rocker arms. Refer to [Valve Rocker Arm Replacement - Left Side](#).
3. Remove the lifters. Refer to [Valve Lifter Removal - Left Side](#)
4. Clean and inspect the camshafts, rocker arms and lifters. Repair or replace as necessary. Refer to [Camshaft Cleaning and Inspection](#) , and [Valve Lifter Cleaning and Inspection](#) .
5. Clean and inspect the rocker arm. Refer to [Valve Rocker Arm Cleaning and Inspection](#)

Installation Procedure

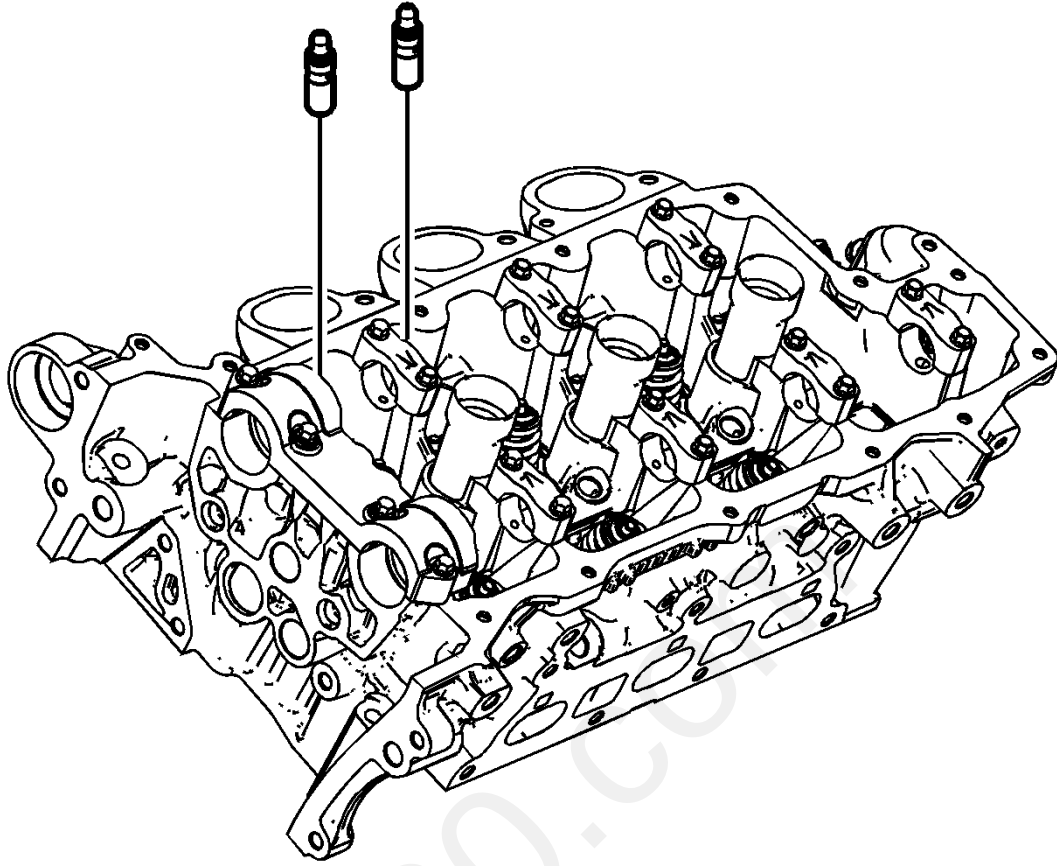


Fig. 151: Valve Lifter - Left Side

Courtesy of GENERAL MOTORS COMPANY

1. Install the lifters.
2. Install the rocker arms. Refer to [Valve Rocker Arm Replacement - Left Side](#).
3. Install the camshafts. Refer to [Camshaft Replacement - Left Side](#).

VALVE LIFTER REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the applicable camshaft(s). Refer to [Camshaft Replacement - Right Side](#).
2. Remove the rocker arms. Refer to [Valve Rocker Arm Removal - Right Side](#).

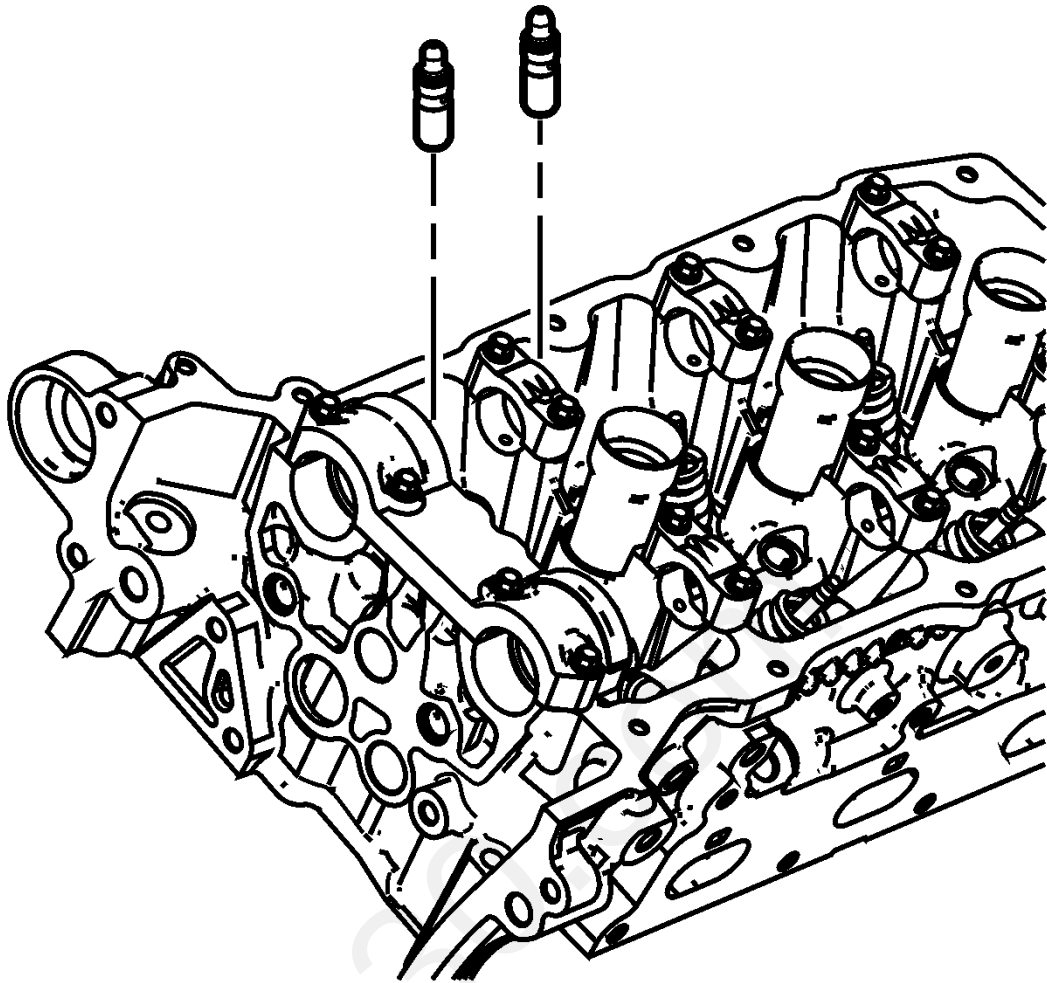


Fig. 152: Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

3. Remove the lifters. Refer to [Valve Lifter Removal - Right Side](#) .
4. Clean and inspect the camshaft(s) and the rocker arm(s) and lifter. Repair or replace as necessary. Refer to [Camshaft Cleaning and Inspection](#) , [Valve Lifter Cleaning and Inspection](#) , and [Valve Rocker Arm Cleaning and Inspection](#) .

Installation Procedure

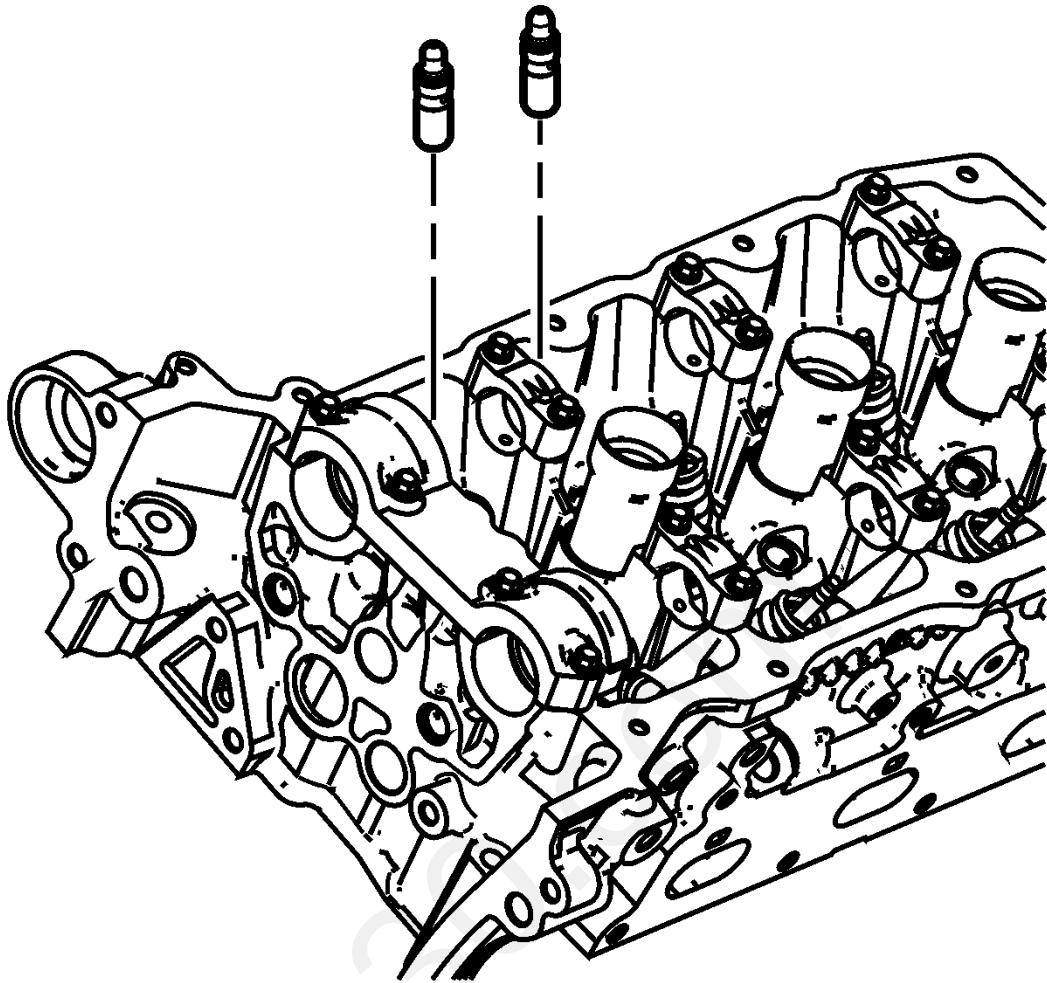


Fig. 153: Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

1. Install the lifters. Refer to [Valve Lifter Installation - Right Side](#) .
2. Install the rocker arms. Refer to [Valve Rocker Arm Installation - Right Side](#) .
3. Install the applicable camshaft(s). Refer to [Camshaft Replacement - Right Side](#).

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - LEFT SIDE

Special Tools

- EN-39313 Spark Plug Port Adapter
- EN-46106 Flywheel Holding Tool
- EN-46110 On-Vehicle Valve Spring Compressor
- EN-46116 Valve Stem Seal Remover/Installer

For equivalent regional tools, refer to [Special Tools](#) .

Removal Procedure

NOTE: This procedure is not used in Brazil.

- : the rocker arms. Refer to [Valve Rocker Arm Replacement - Left Side](#).
2. Remove the starter motor. Refer to [Starter Replacement \(LFX\)](#).

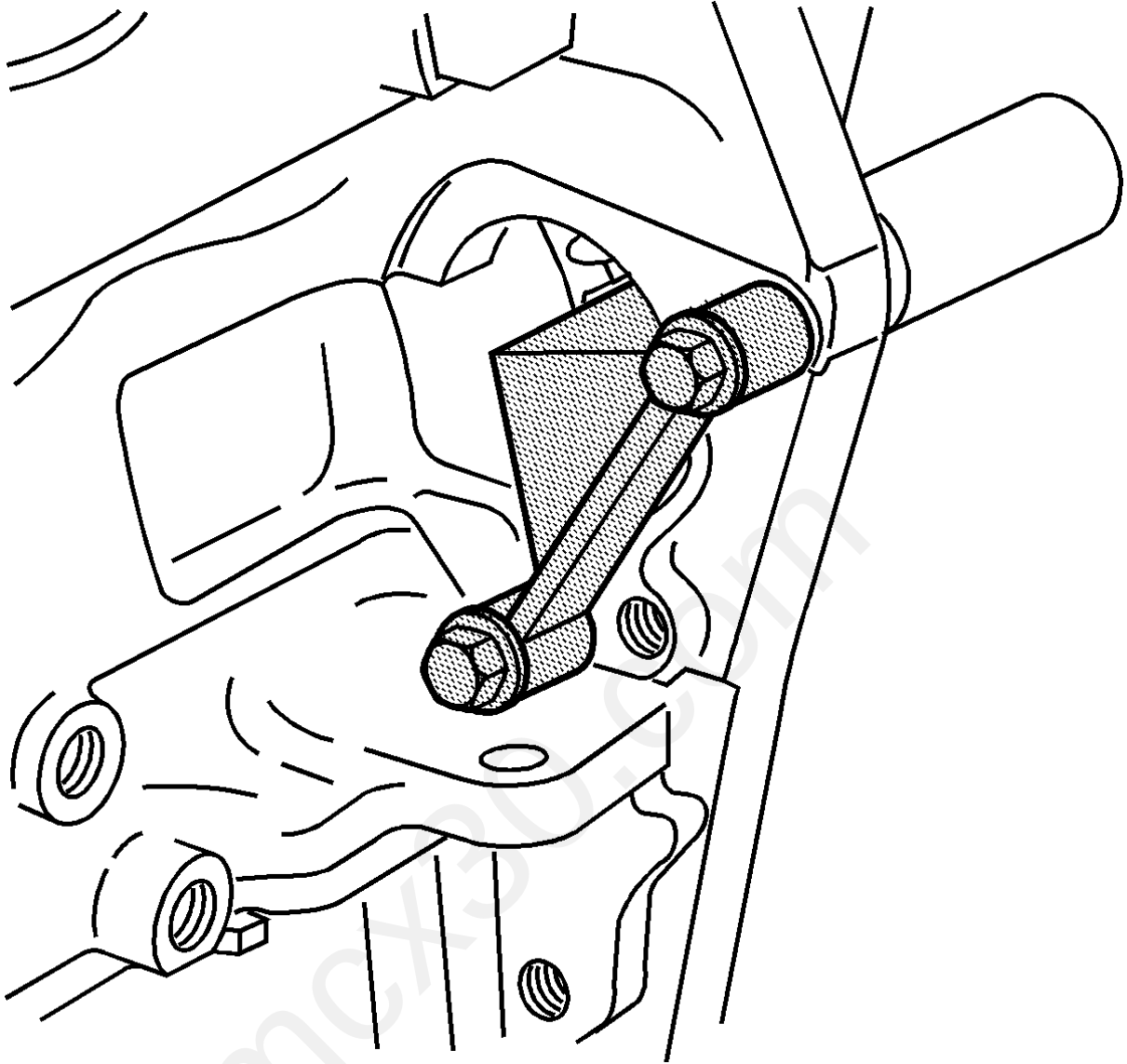


Fig. 154: Flywheel Holding Fixture

Courtesy of GENERAL MOTORS COMPANY

NOTE: If the EN-46106 tool is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required.

3. Install the **EN-46106** tool in order to prevent crankshaft rotation.
4. Remove the spark plug from the applicable cylinder. Refer to [Spark Plug Replacement](#).
5. Install the **EN-39313** adapter to the applicable cylinder.
6. Connect the **EN-39313** adapter to a compressed air source.

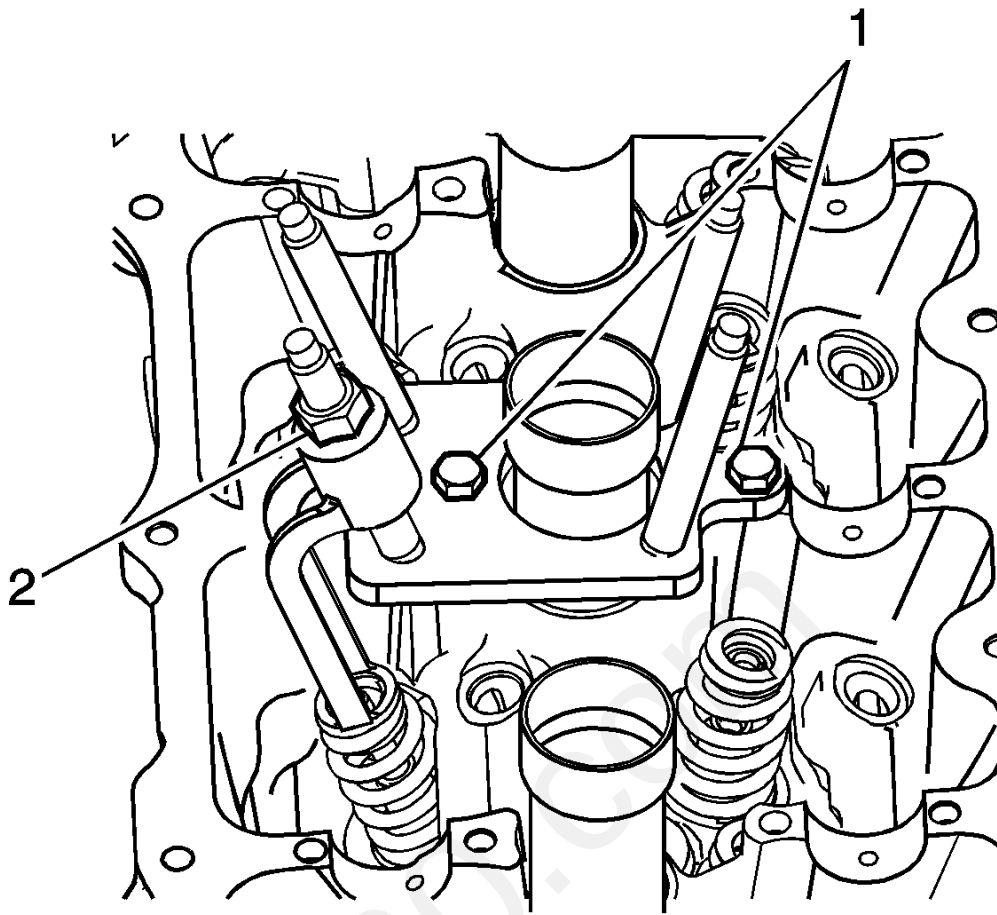


Fig. 155: View Of Installed Valve Spring Compressor Tool

Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-46110** compressor above the applicable cylinder as shown.
8. Tighten the **EN-46110** compressor nut (2).

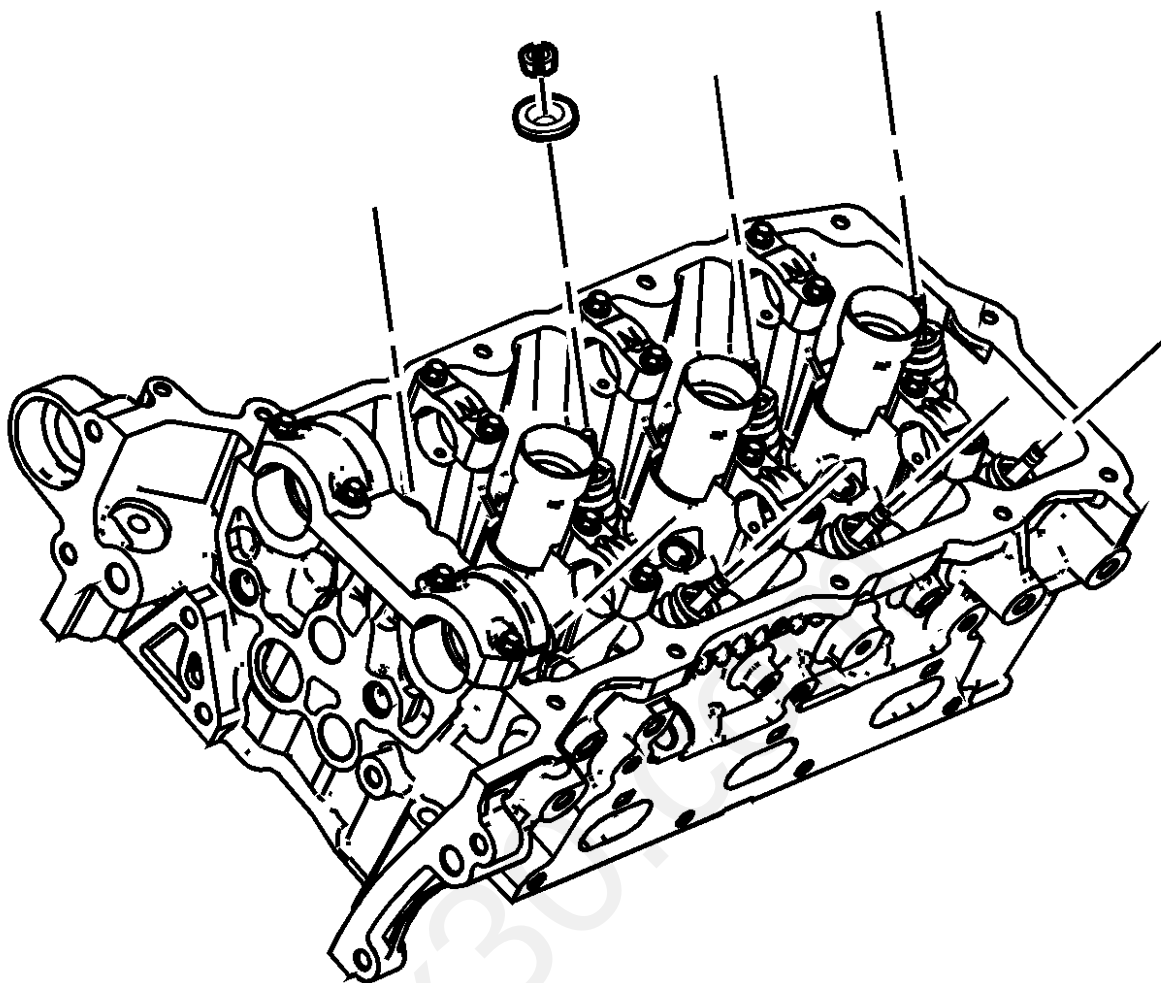


Fig. 156: View Of Valve Spring Keepers

Courtesy of GENERAL MOTORS COMPANY

9. Remove the valve keepers.
10. Loosen the **EN-46110** compressor nut.
11. Remove the valve spring retainer.

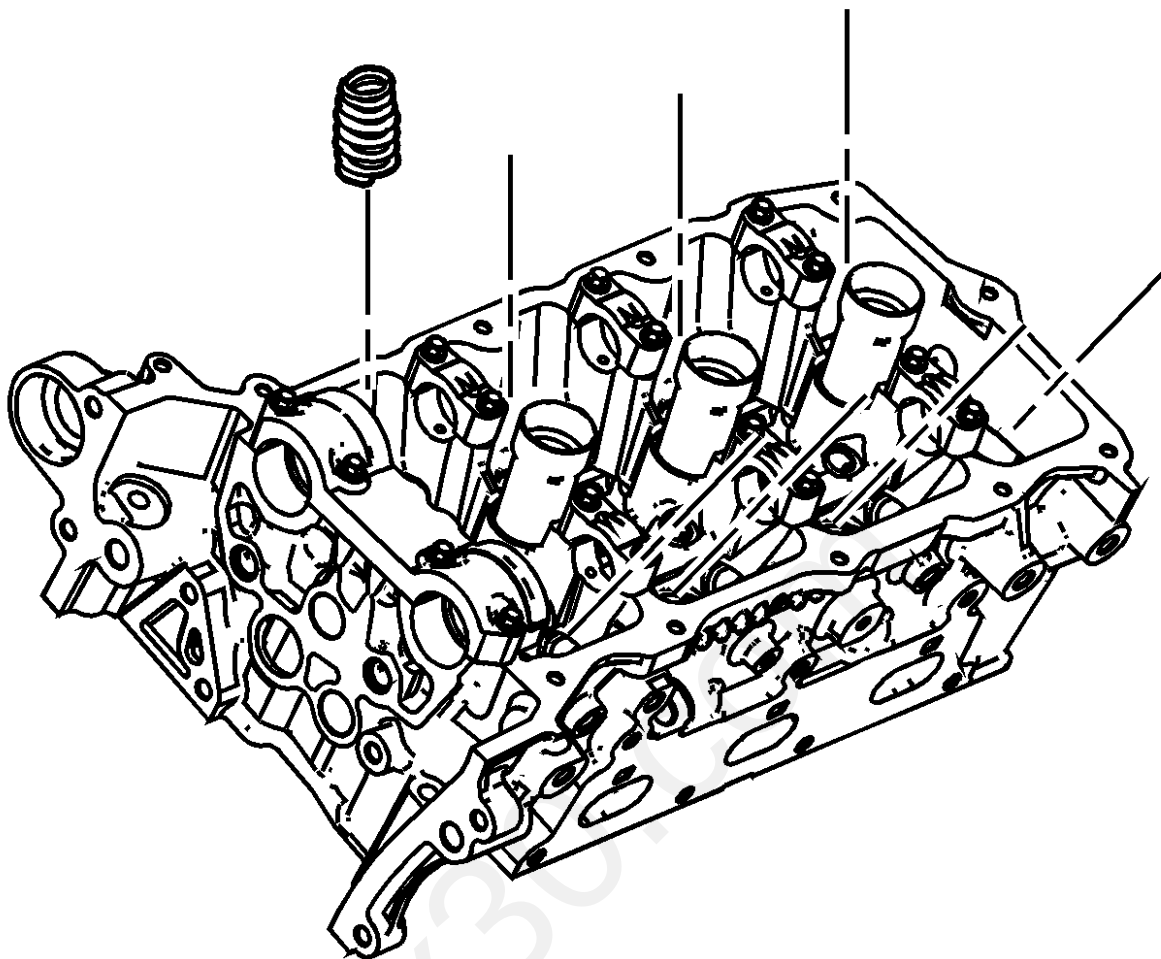


Fig. 157: View Of Valve Spring

Courtesy of GENERAL MOTORS COMPANY

12. Remove the valve spring.

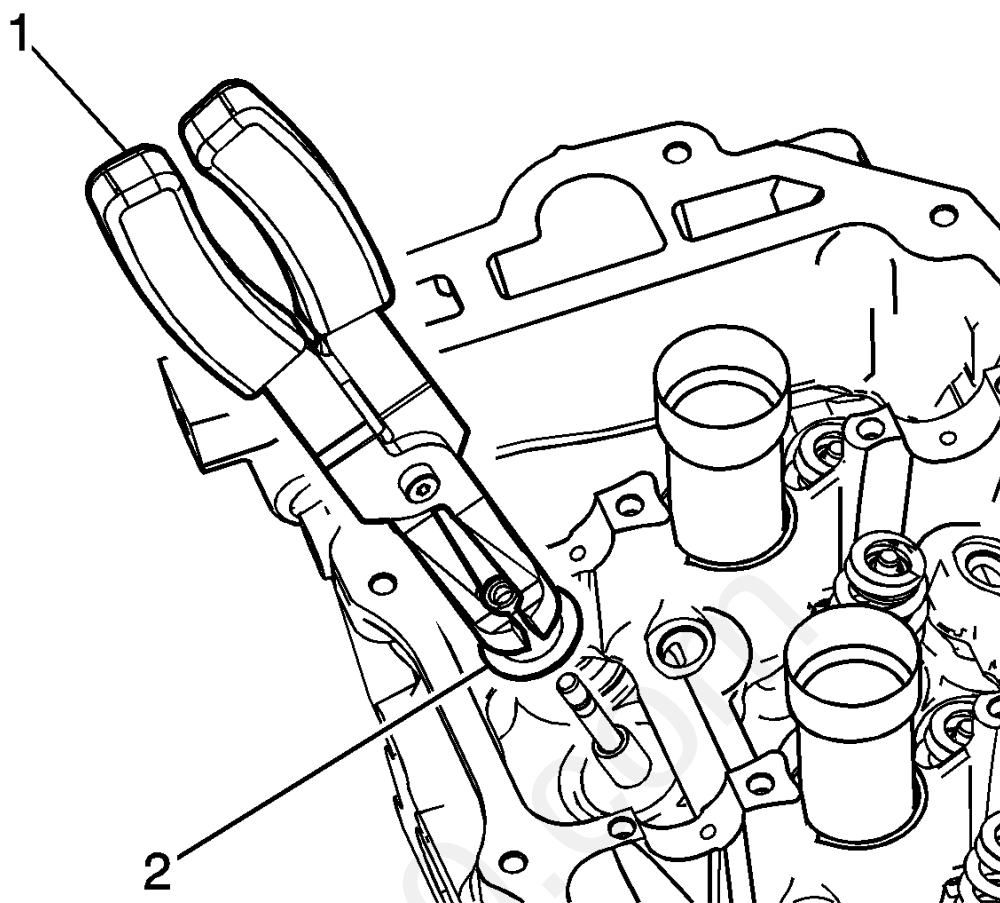


Fig. 158: Special Tool And Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

13. Use the **EN-46116** remover/installer (1) in order to remove the valve stem seal (2).

Installation Procedure

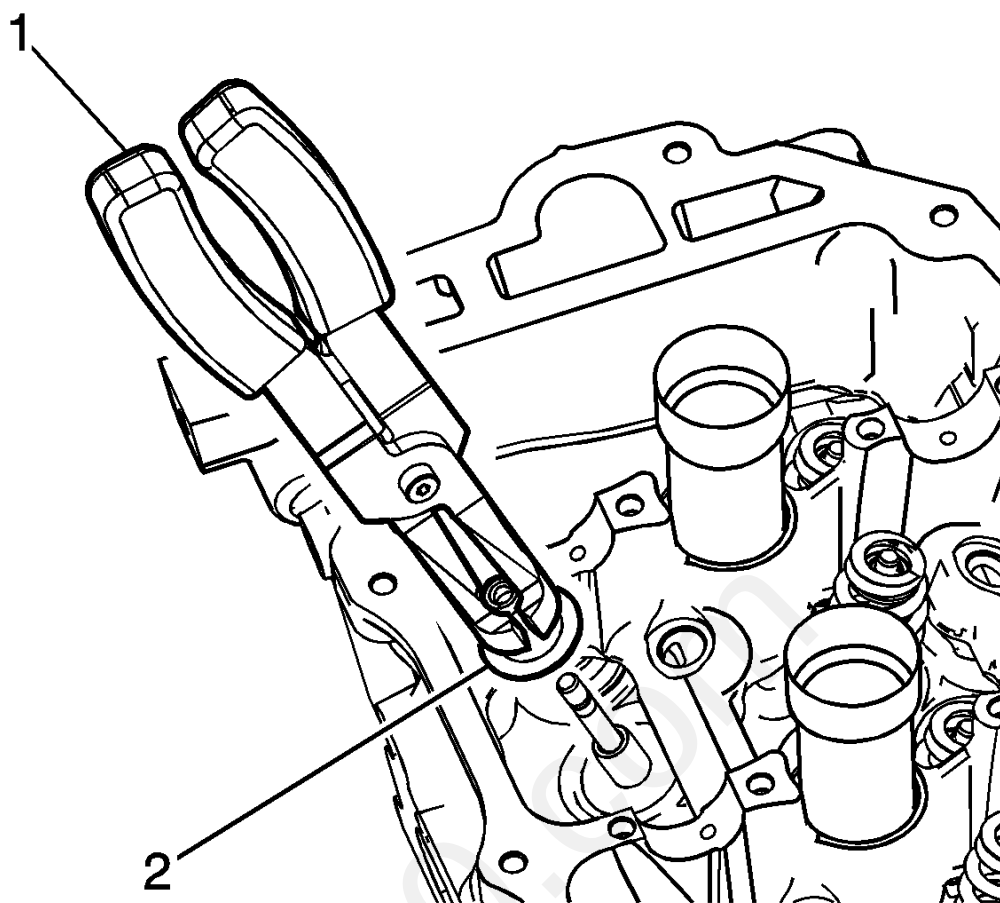


Fig. 159: Special Tool And Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

1. Use the **EN-46116** remover/installer (1) in order to install the valve stem seal (2).

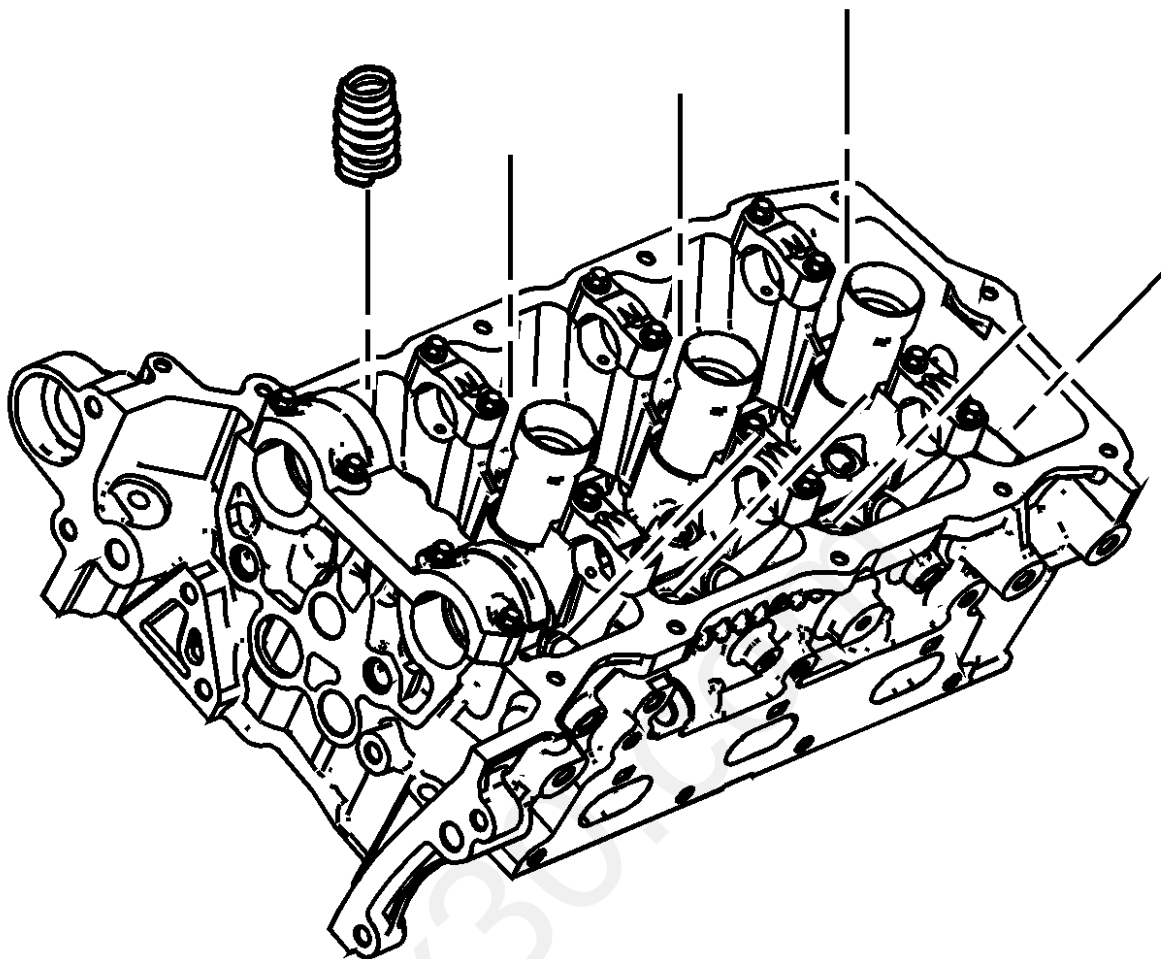


Fig. 160: View Of Valve Spring

Courtesy of GENERAL MOTORS COMPANY

2. Install the valve spring.
3. Install the valve spring retainer.

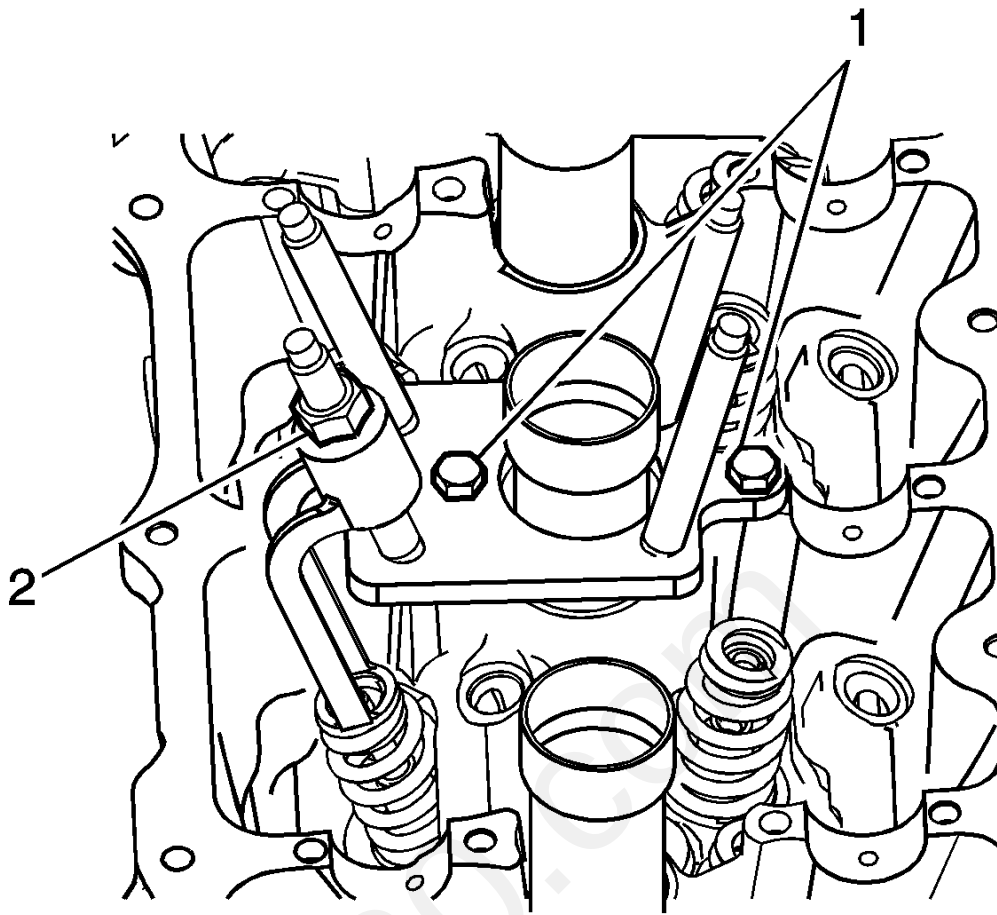


Fig. 161: View Of Installed Valve Spring Compressor Tool

Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-46110** compressor above the applicable valve spring as shown.

Tighten the **EN-46110** compressor nut (2).

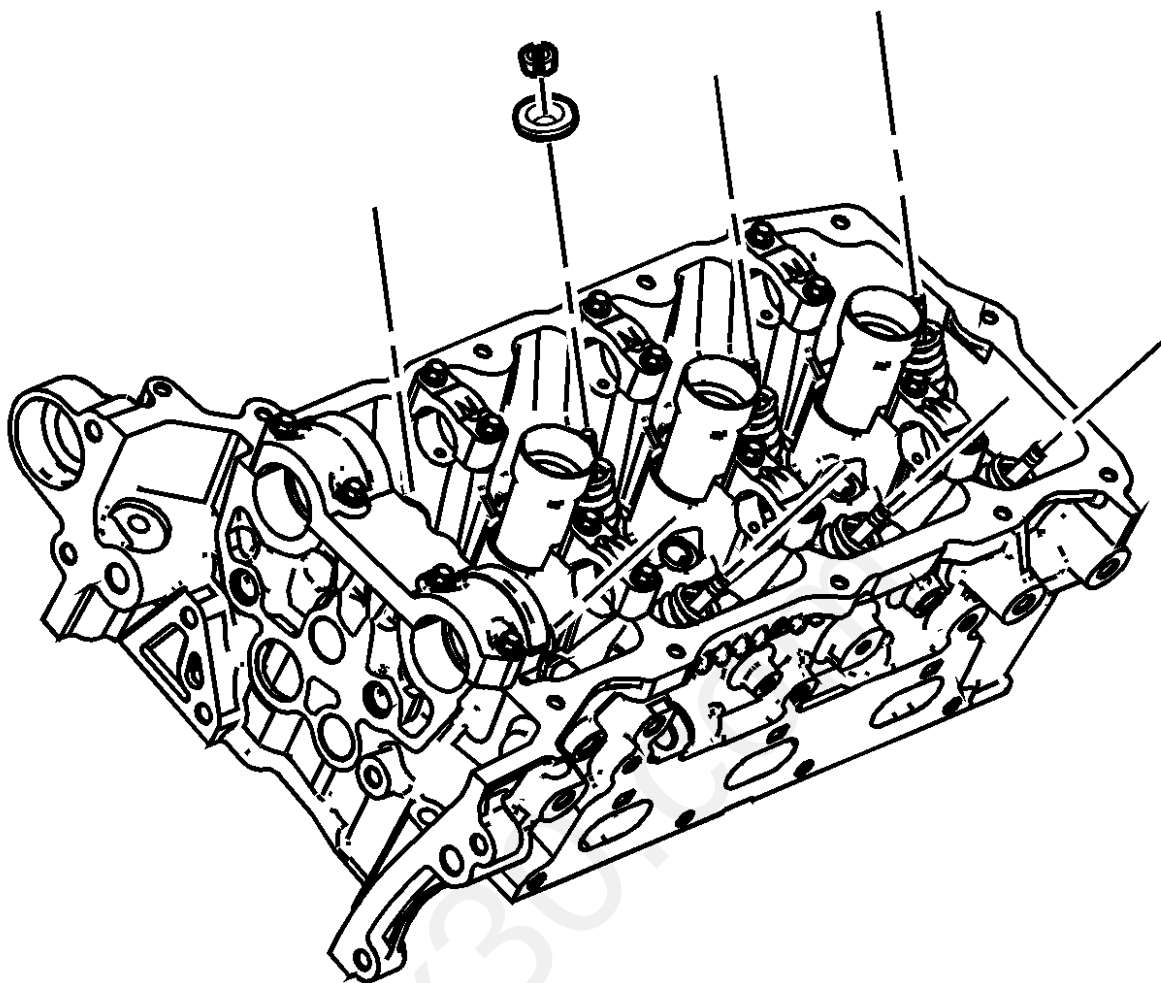


Fig. 162: View Of Valve Spring Keepers

Courtesy of GENERAL MOTORS COMPANY

5. Install the valve spring keepers.
6. Remove the **EN-46110** compressor.
7. Disconnect the **EN-39313** adapter from the compressed air source.
8. Remove the **EN-39313** adapter.
9. Install the spark plugs. Refer to [Spark Plug Replacement](#) .
10. Install the rocker arms. Refer to [Valve Rocker Arm Replacement - Left Side](#).
11. Remove the **EN-46106** tool in order to prevent crankshaft rotation.
12. Install the starter motor. Refer to [Starter Replacement \(LFX\)](#) .

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - RIGHT SIDE

Special Tools

- **EN-39313** Spark Plug Port Adapter
- **EN-46106** Flywheel Holding Tool
- **EN-46110** On-Vehicle Valve Spring Compressor

16 Valve Stem Seal Remover/Installer

For equivalent regional tools, refer to [Special Tools](#) .

Removal Procedure

NOTE: This procedure is not used in Brazil.

1. Remove the rocker arms. Refer to [Valve Rocker Arm Replacement - Right Side](#).
2. Remove the starter motor. Refer to [Starter Replacement \(LFX\)](#) .

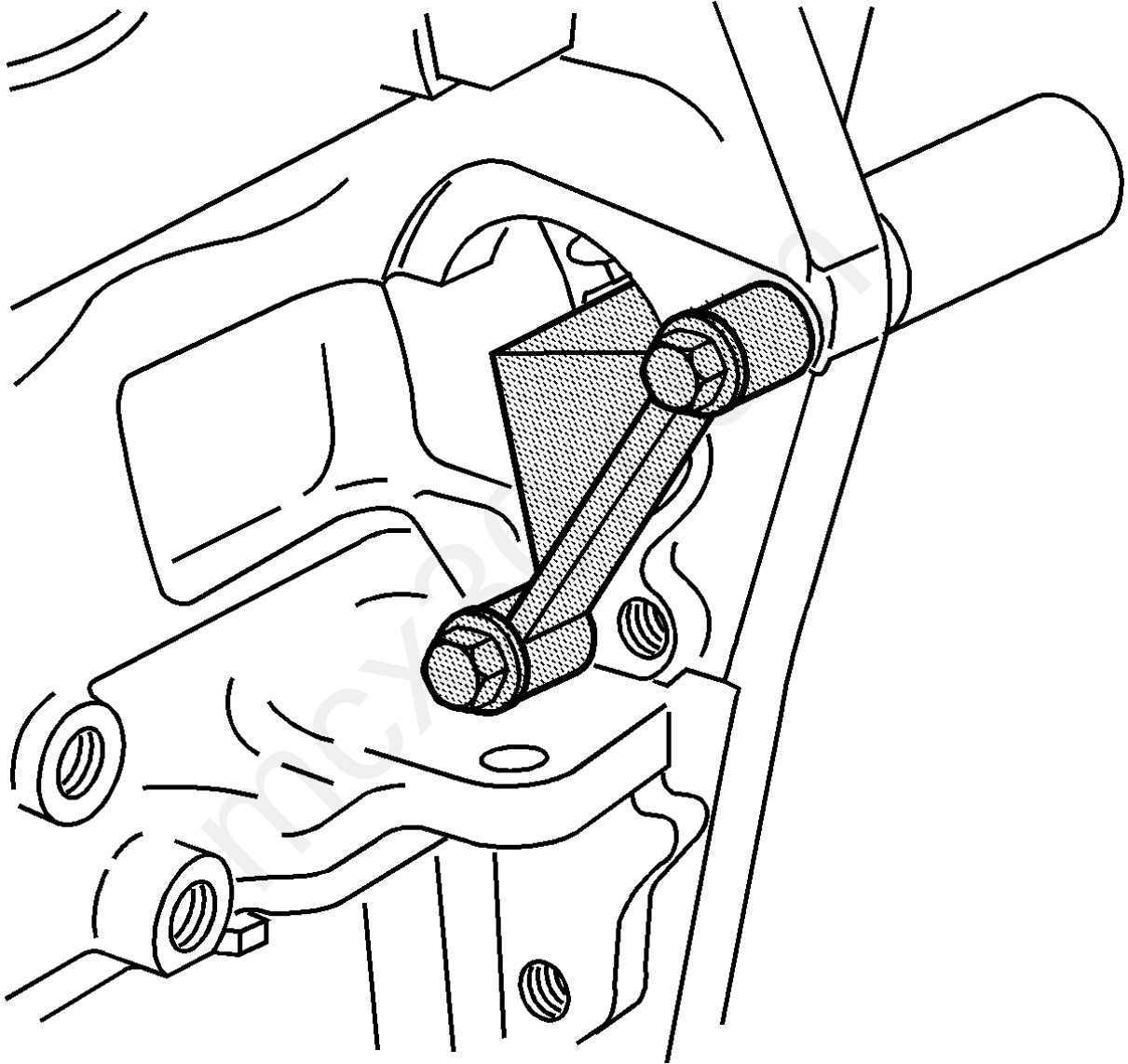


Fig. 163: Flywheel Holding Fixture

Courtesy of GENERAL MOTORS COMPANY

NOTE: If the EN-46106 tool is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required.

3. Install the **EN-46106** tool in order to prevent crankshaft rotation.
4. Remove the spark plug from the applicable cylinder. Refer to [Spark Plug Replacement](#) .
5. Install the **EN-39313** adapter to the applicable cylinder.

: the **EN-39313** adapter to a compressed air source.

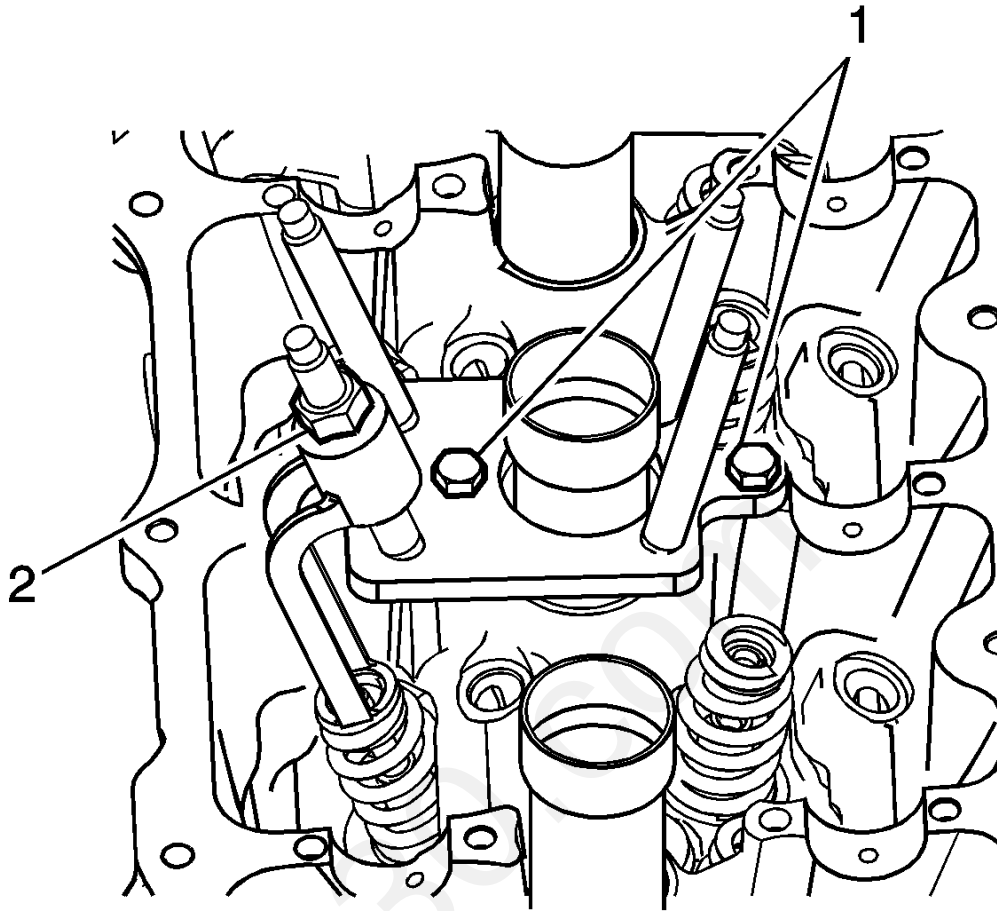


Fig. 164: View Of Installed Valve Spring Compressor Tool

Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-46110** compressor above the applicable cylinder as shown.
8. Tighten the **EN-46110** compressor nut (2).

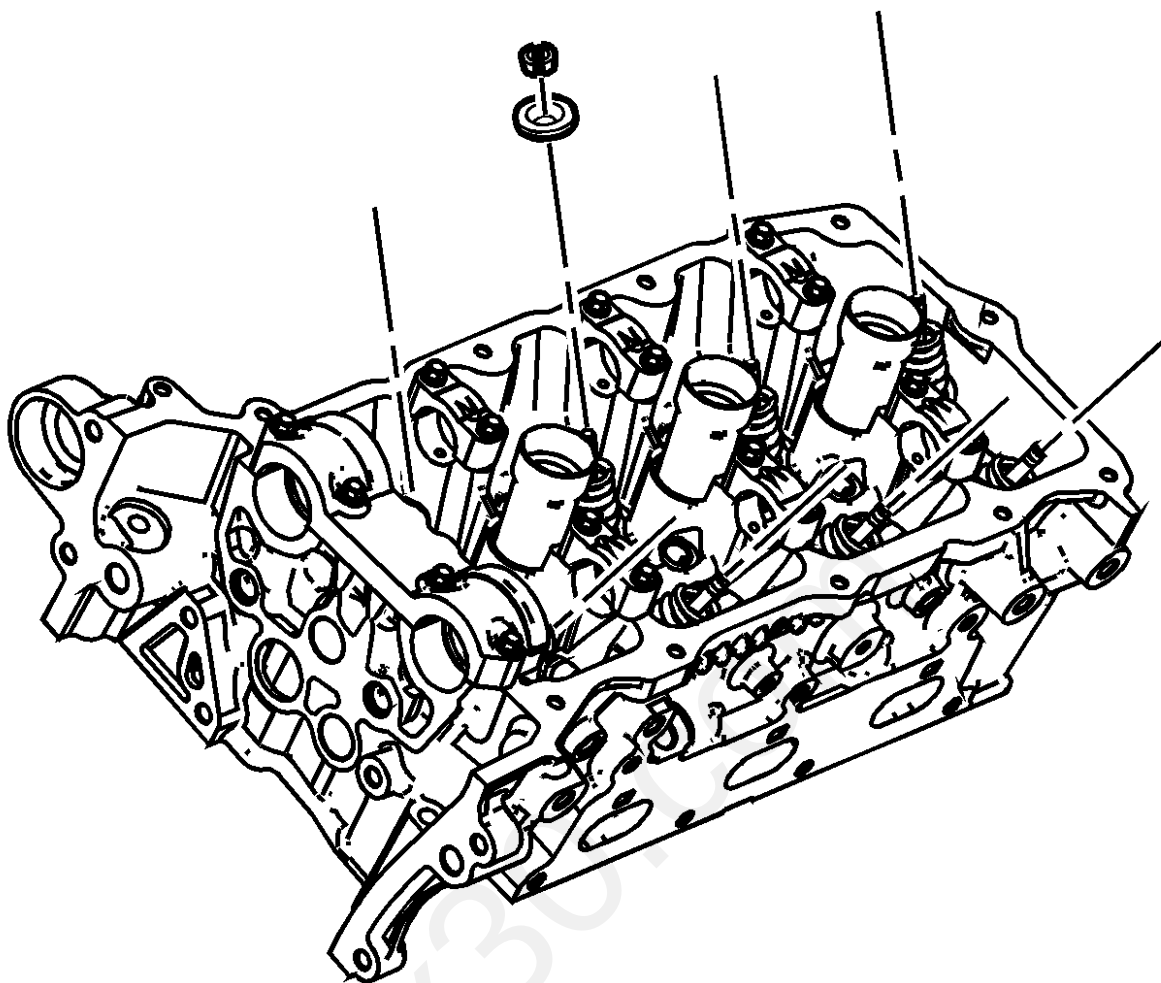


Fig. 165: View Of Valve Spring Keepers

Courtesy of GENERAL MOTORS COMPANY

9. Remove the valve keepers.
10. Loosen the **EN-46110** compressor nut.
11. Remove the valve spring retainer.

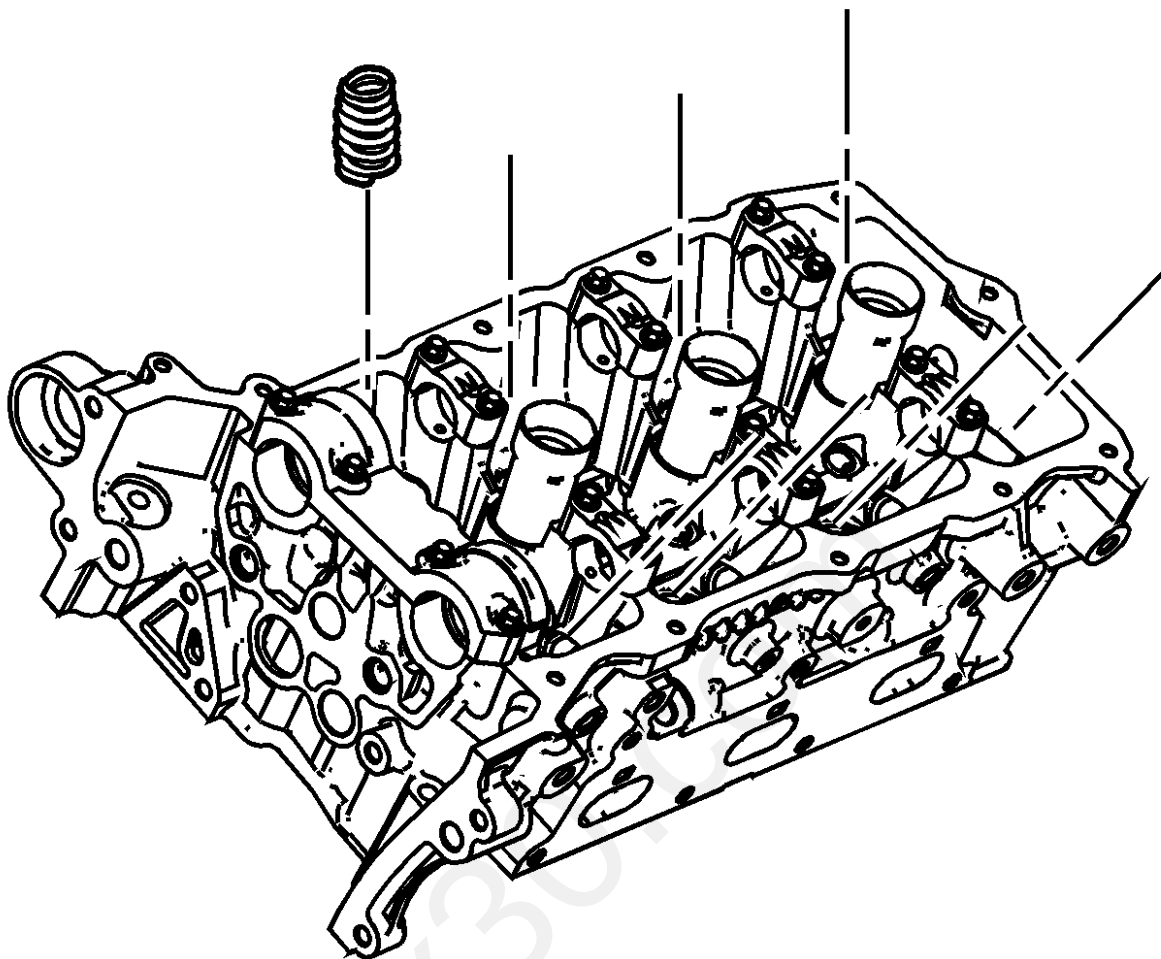


Fig. 166: View Of Valve Spring

Courtesy of GENERAL MOTORS COMPANY

12. Remove the valve spring.

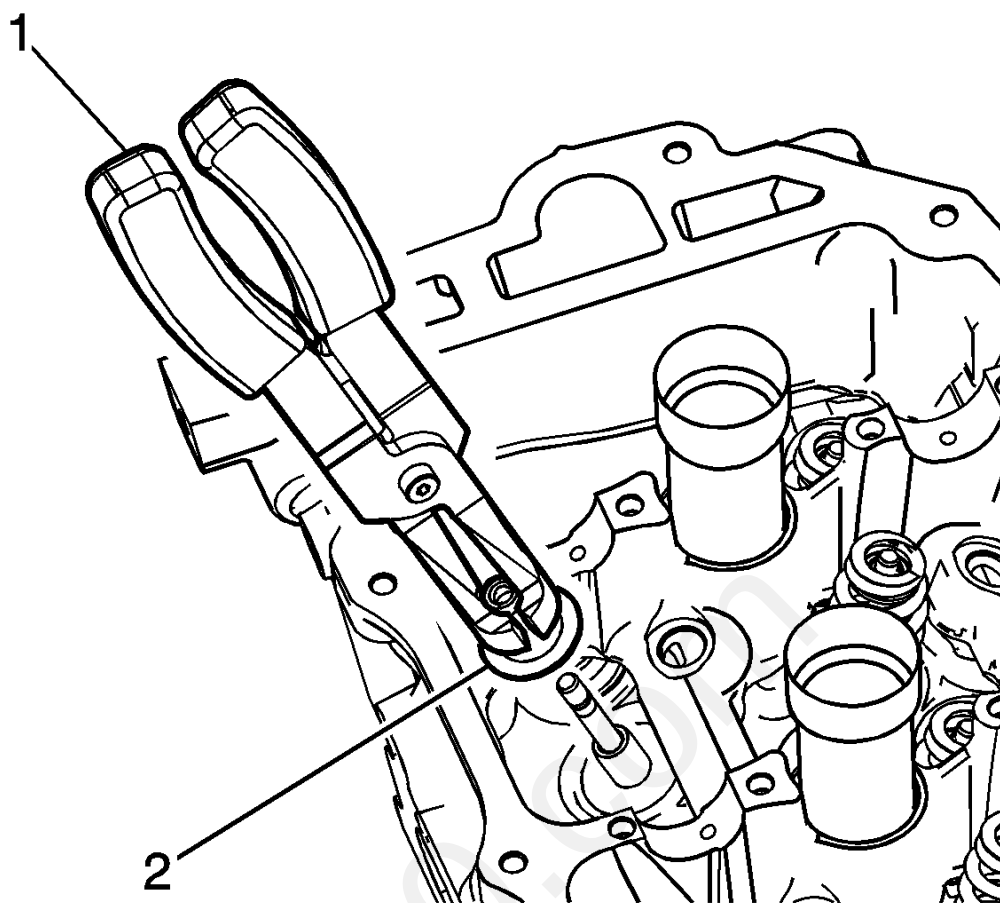


Fig. 167: Special Tool And Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

13. Use the **EN-46116** remover/installer (1) in order to remove the valve stem seal (2).

Installation Procedure

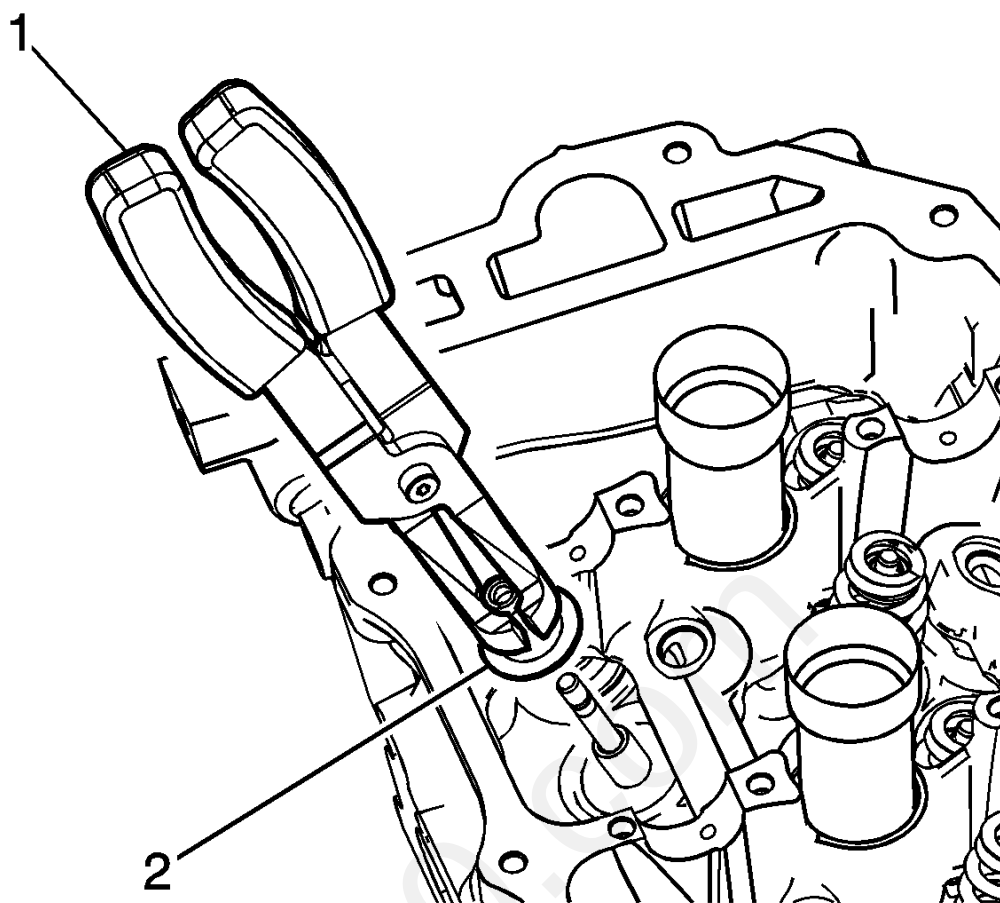


Fig. 168: Special Tool And Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

1. Use the **EN-46116** remover/installer (1) in order to install the valve stem seals (2).

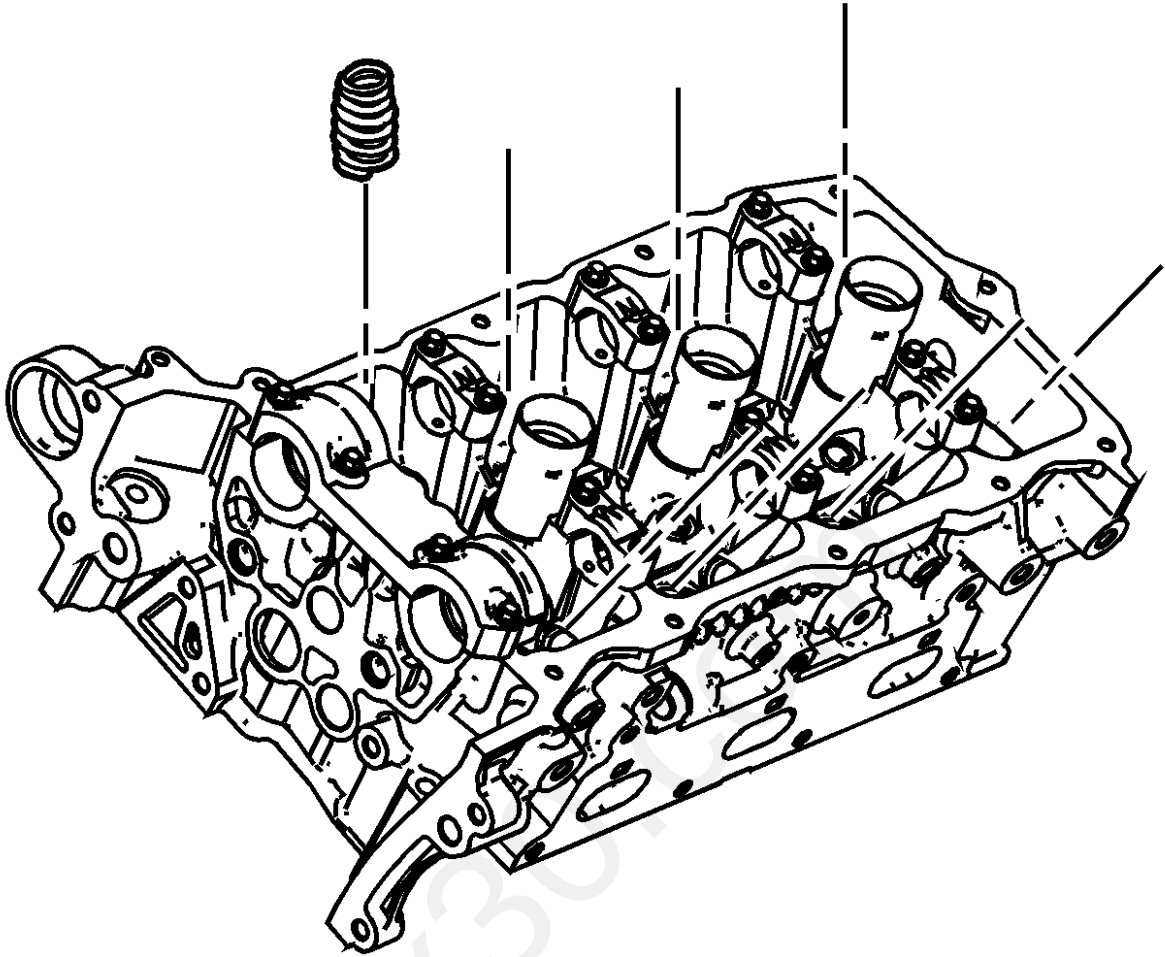


Fig. 169: View Of Valve Spring

Courtesy of GENERAL MOTORS COMPANY

2. Install the valve spring.
3. Install the valve spring retainer.

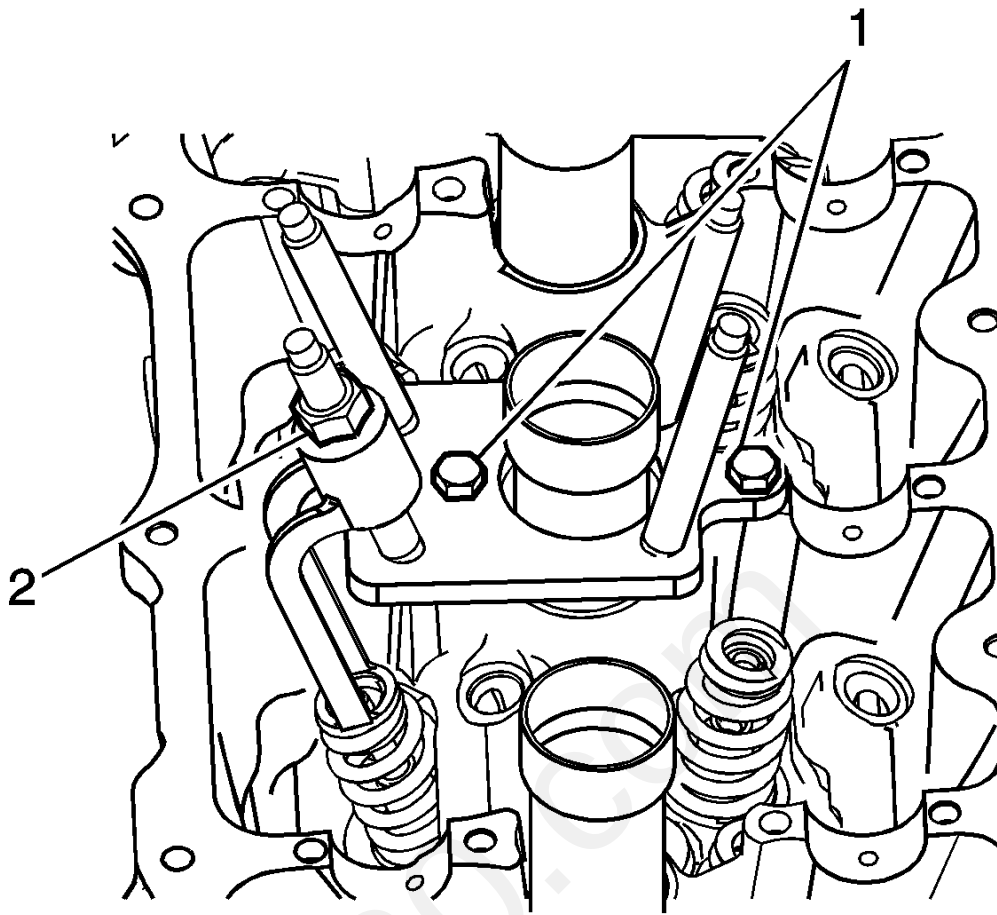


Fig. 170: View Of Installed Valve Spring Compressor Tool

Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-46110** compressor above the applicable valve spring as shown.

Tighten the **EN-46110** compressor nut (2).

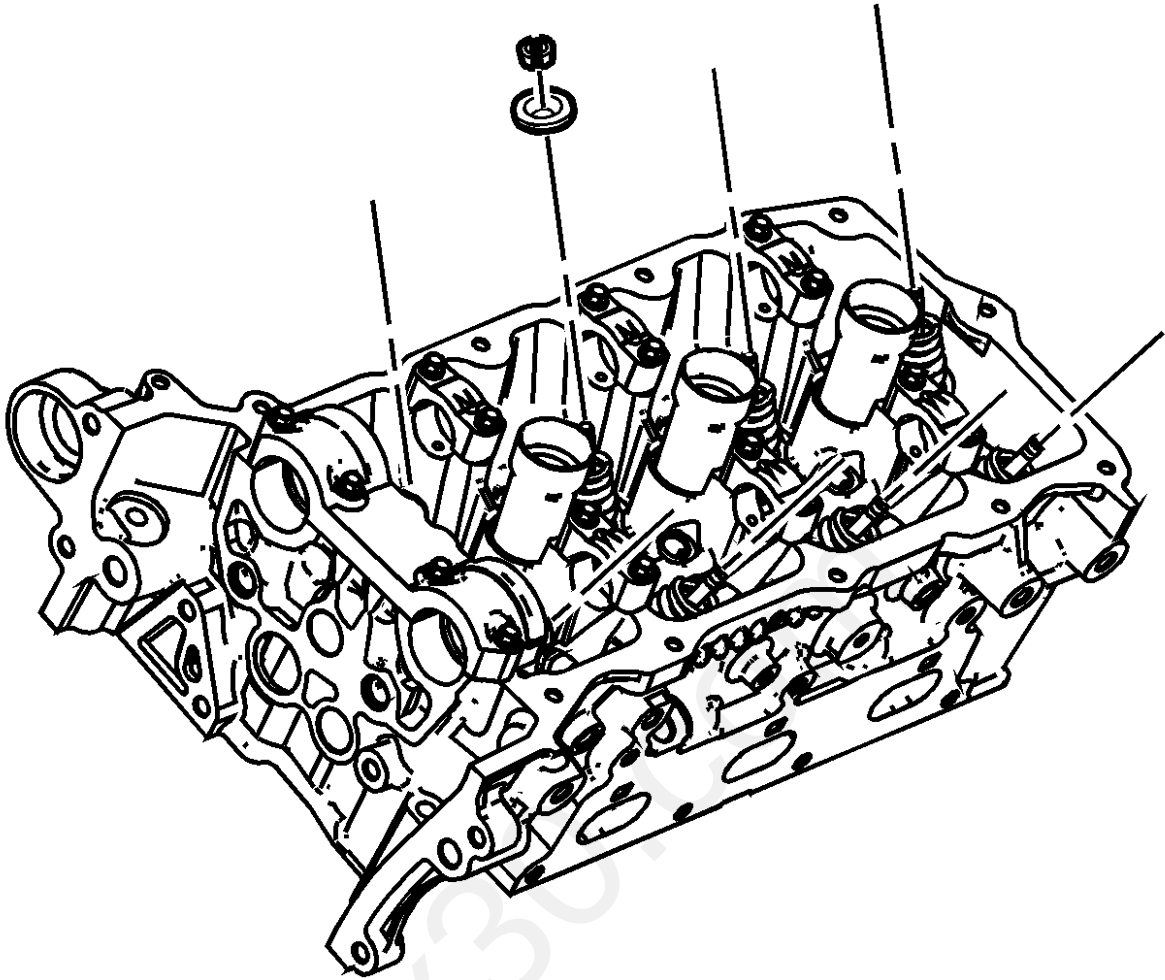


Fig. 171: View Of Valve Spring Keepers

Courtesy of GENERAL MOTORS COMPANY

5. Install the valve spring keepers.
6. Remove the **EN-46110** compressor.
7. Disconnect the **EN-39313** adapter from the compressed air source.
8. Remove the **EN-39313** adapter.
9. Install the spark plugs. Refer to [Spark Plug Replacement](#) .
10. Install the rocker arms. Refer to [Valve Rocker Arm Replacement - Right Side](#).
11. Remove the **EN-46106** tool.
12. Install the starter motor. Refer to [Starter Replacement \(LFX\)](#) .

CYLINDER HEAD REPLACEMENT - LEFT SIDE

Special Tools

EN-45059 Angle Meter

For equivalent regional tools, refer to [Special Tools](#) .

dure

1. Remove the left bank secondary timing chain. Refer to [Secondary Camshaft Intermediate Drive Chain Replacement - Left Side](#).
2. Remove the left bank camshaft position actuator. Refer to [Camshaft Position Actuator Replacement - Bank 2](#).
3. Remove the fuel pump. Refer to [Fuel Pump Replacement](#).
4. Remove the catalytic converter. Refer to [Catalytic Converter Replacement - Left Side \(LFX\)](#).
5. Remove the oil level indicator tube. Refer to [Oil Level Indicator Tube Replacement](#).
6. Remove the oil filter adapter. Refer to [Oil Filter Adapter Replacement](#).
7. Remove the ground wire bolt and ground wire.
8. Disconnect and reposition harness as necessary.
9. Disconnect the coolant temperature sensor.

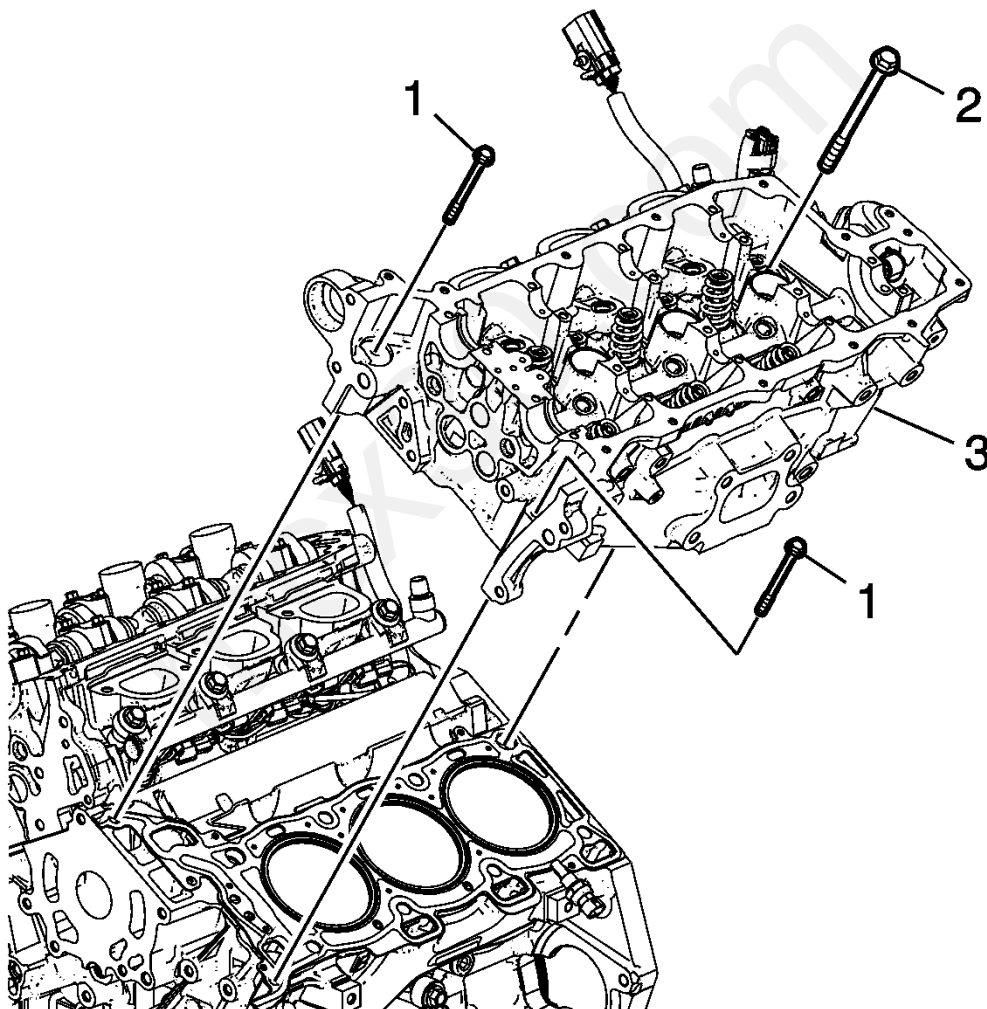


Fig. 172: View Of Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove the 2 front M8 left cylinder head bolts (1).
11. Remove the left cylinder head bolts (2).
12. Remove the left cylinder head (3).

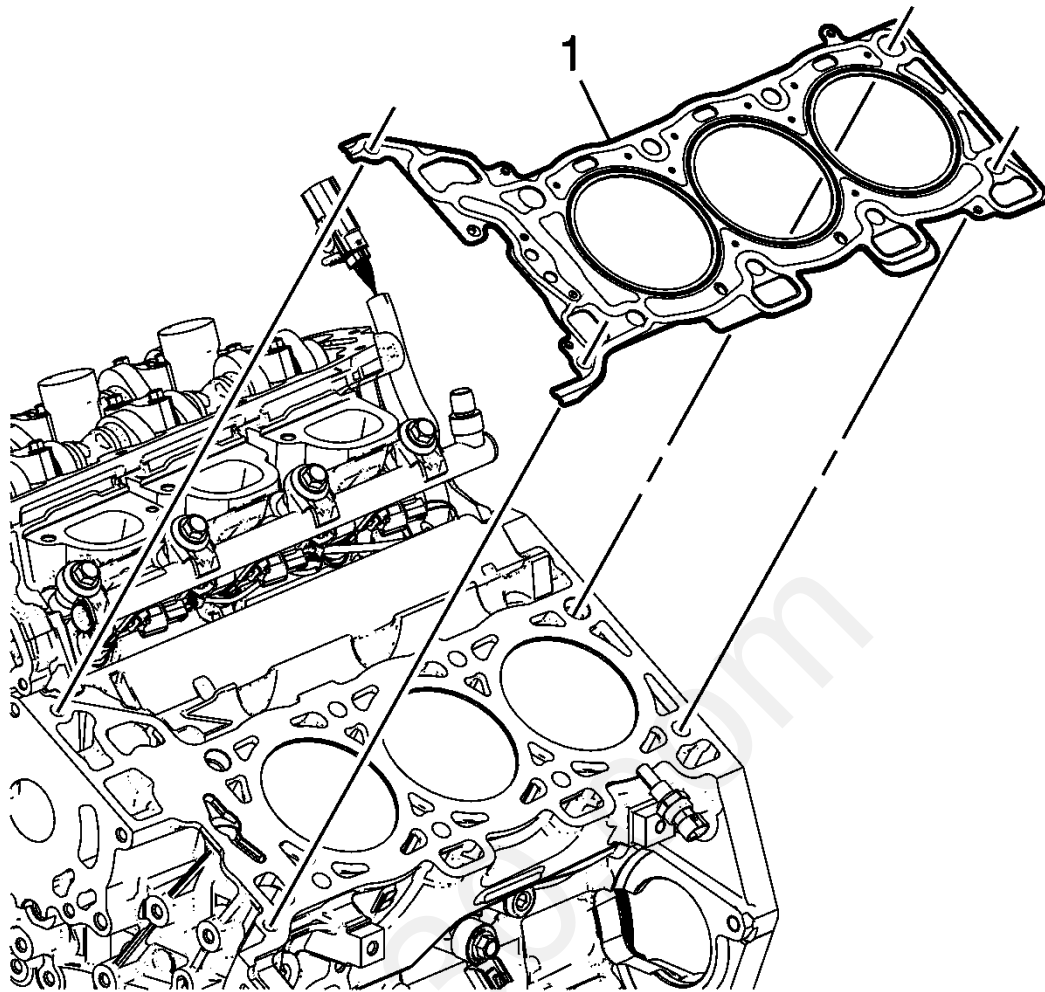


Fig. 173: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

13. Remove and discard the left cylinder head gasket (1).
14. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to [Cylinder Head Cleaning and Inspection](#) , and [Engine Block Cleaning and Inspection](#) .
15. If replacing the cylinder head, transfer parts as necessary.
16. Disassemble the cylinder head as necessary. Refer to [Cylinder Head Disassemble](#) .

Installation Procedure

1. Assemble the cylinder head as necessary. Refer to [Cylinder Head Assemble](#) .

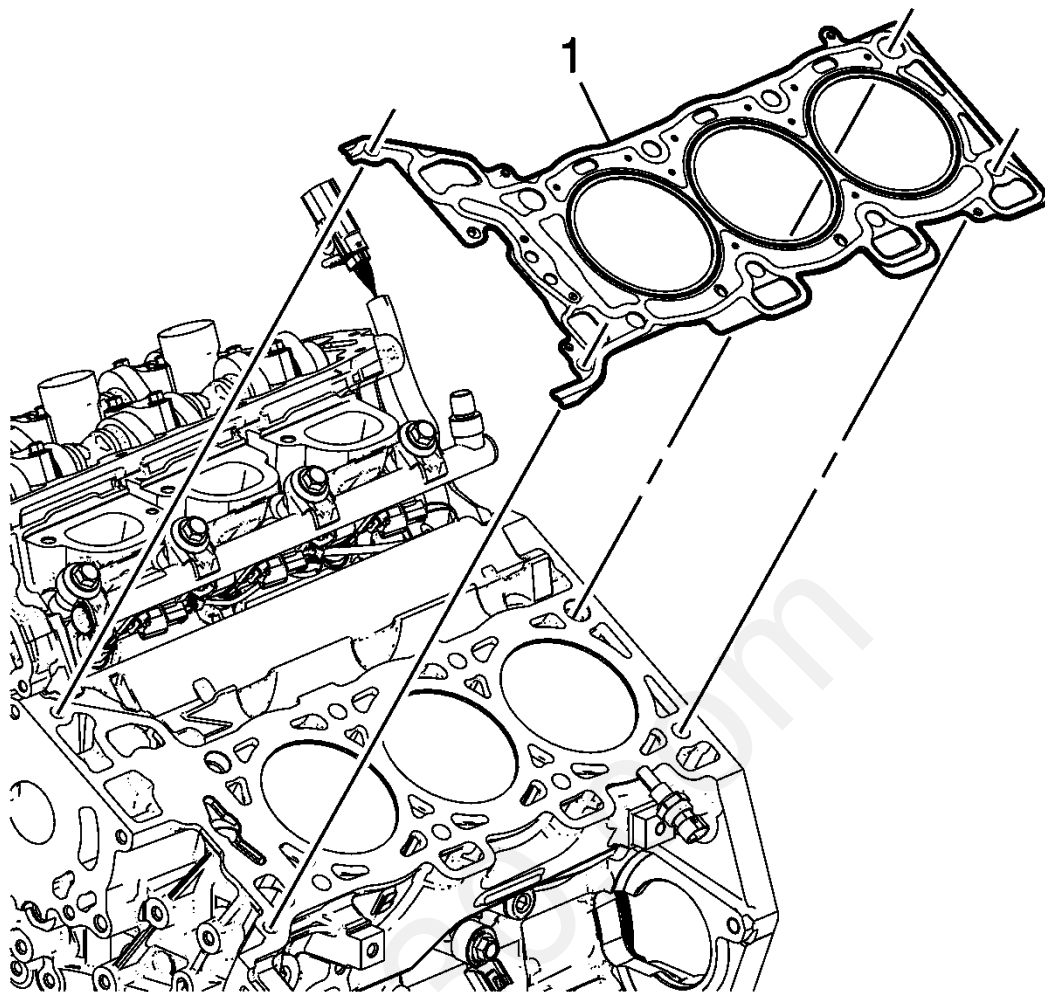


Fig. 174: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

2. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
3. Install a NEW left cylinder head gasket (1) using the deck face locating pins for retention.

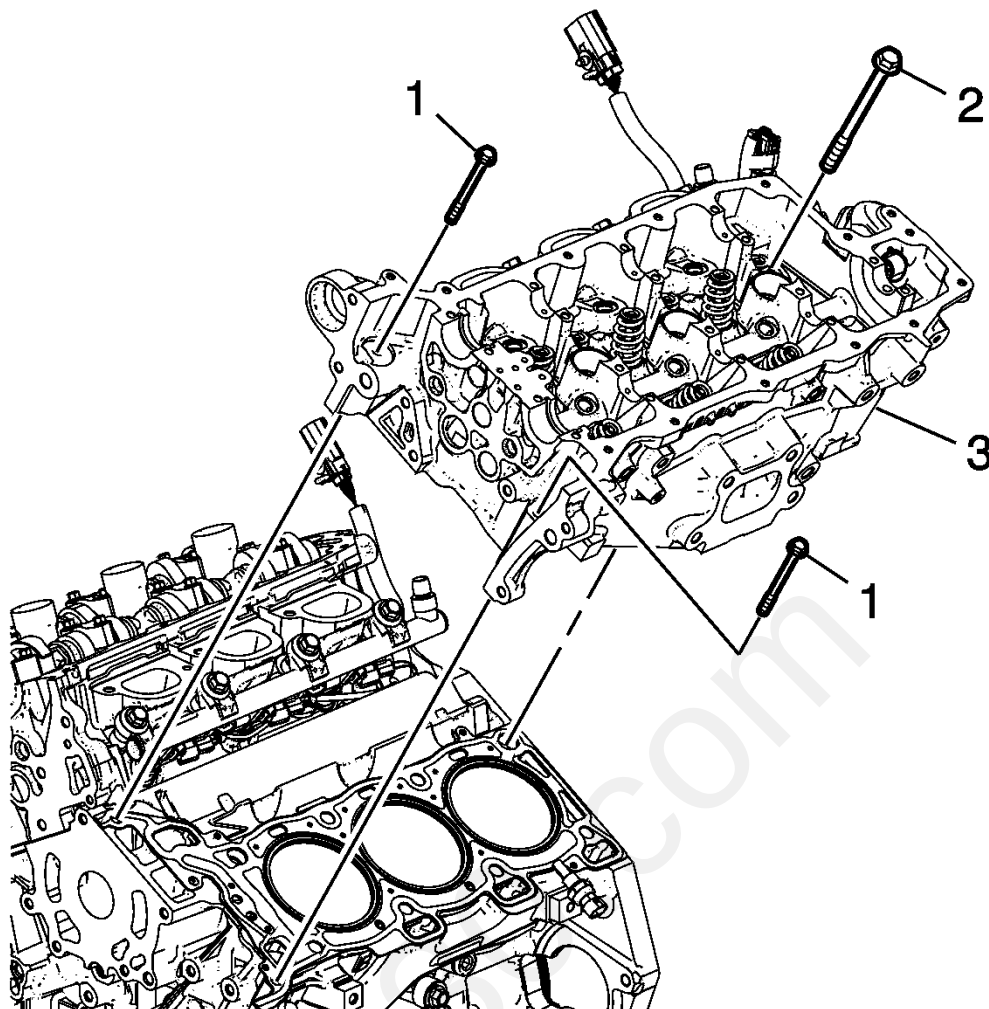


Fig. 175: View Of Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Align the left cylinder head (3) with the deck face locating pins.
5. Place the left cylinder head in position on the deck face.

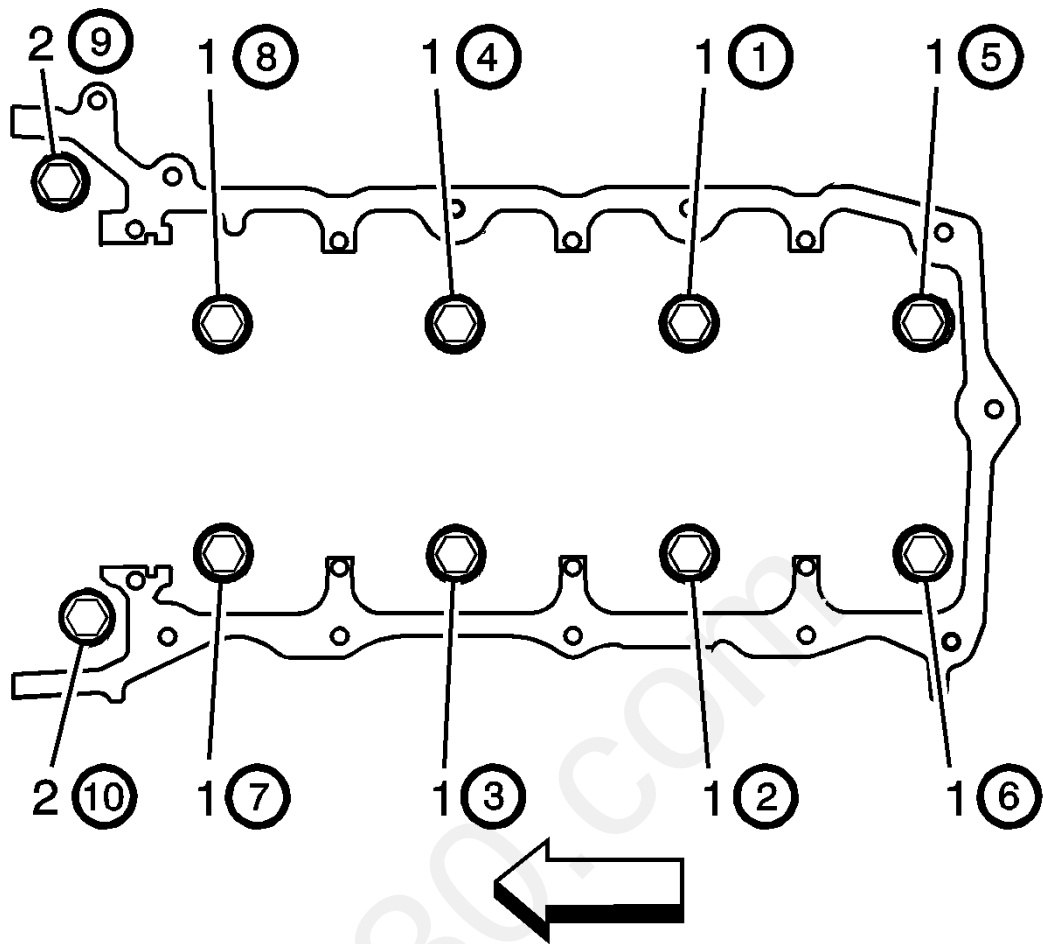


Fig. 176: Cylinder Head Bolt Tightening Sequence

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

NOTE:

- **DO NOT** allow oil on the cylinder head bolt bosses.
- **DO NOT** reuse the old cylinder head bolts.

6. Install the NEW M11 cylinder head bolts (1).

1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).
2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the **EN-45059** meter.

7. Install the 2 NEW front M8 left cylinder head bolts (2).

1. Tighten the M8 cylinder head bolts a first pass to 15 N.m (11 lb ft).
2. Tighten the M8 cylinder head bolts a second pass in sequence an additional 75 degrees using the **EN-45059** meter.

8. Connect the coolant temperature sensor.

9. Position and connect harness as necessary.

10. Install the ground wire bolt and ground wire. Tighten bolt to 40 N.m (30 lb ft)

ie oil level indicator tube. Refer to [Oil Level Indicator Tube Replacement](#).

12. Install the oil filter adapter. Refer to [Oil Filter Adapter Replacement](#).

13. Install the fuel pump. Refer to [Fuel Pump Replacement](#) .

14. Install the catalytic converter. Refer to [Catalytic Converter Replacement - Left Side \(LFX\)](#) .

15. Install the left bank camshaft position actuator. Refer to [Camshaft Position Actuator Replacement - Bank 2](#).

16. Install the left bank secondary timing chain. Refer to [Secondary Camshaft Intermediate Drive Chain Replacement - Left Side](#).

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

Special Tools

EN-45059 Angle Meter

For equivalent regional tools, refer to [Special Tools](#) .

Removal Procedure

1. Remove the right bank secondary timing chain. Refer to [Secondary Camshaft Intermediate Drive Chain Replacement - Right Side](#).
2. Remove the right bank camshaft position actuator. Refer to [Camshaft Position Actuator Replacement - Bank 1](#).
3. Remove the catalytic converter. Refer to [Catalytic Converter Replacement - Right Side \(LFX\)](#) .

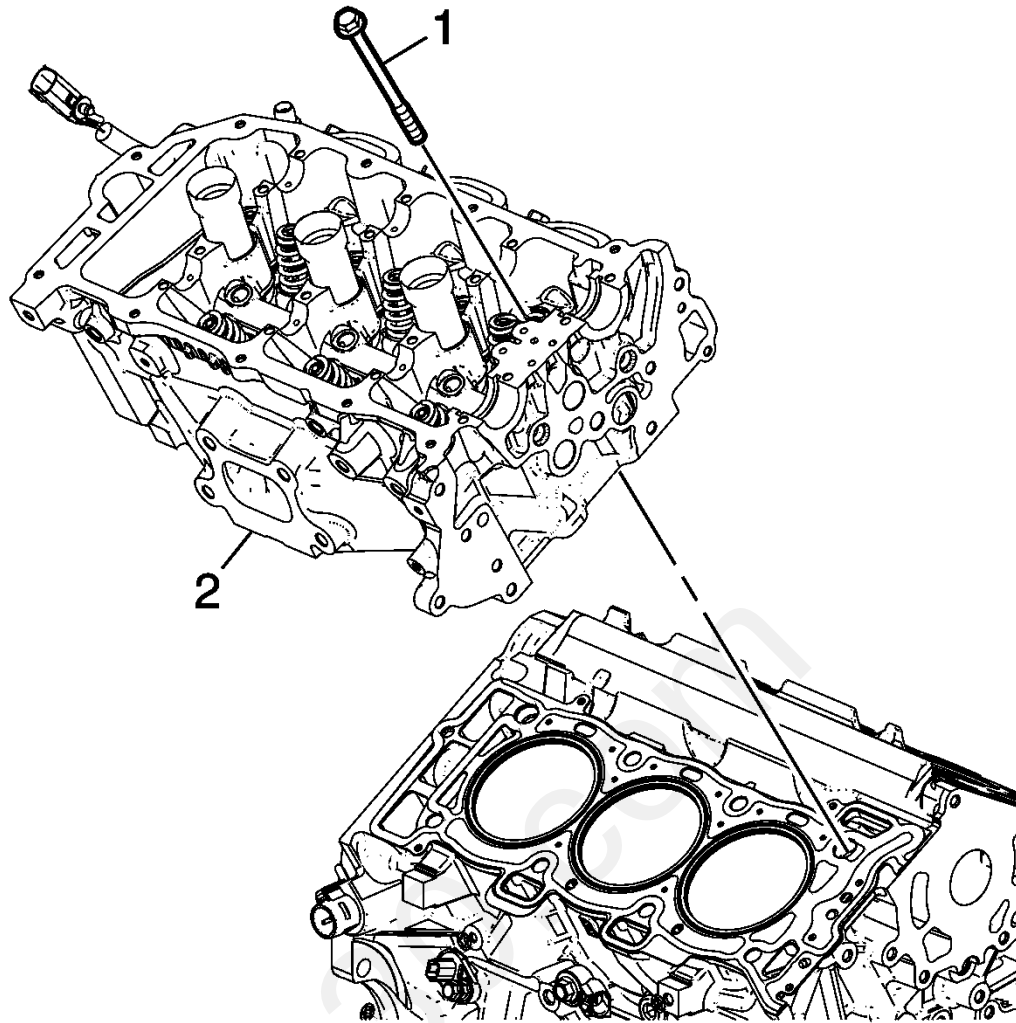


Fig. 177: View Of Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the right cylinder head bolts (1).
5. Remove the right cylinder head (2).
6. Remove Ground wire and harness and position aside.

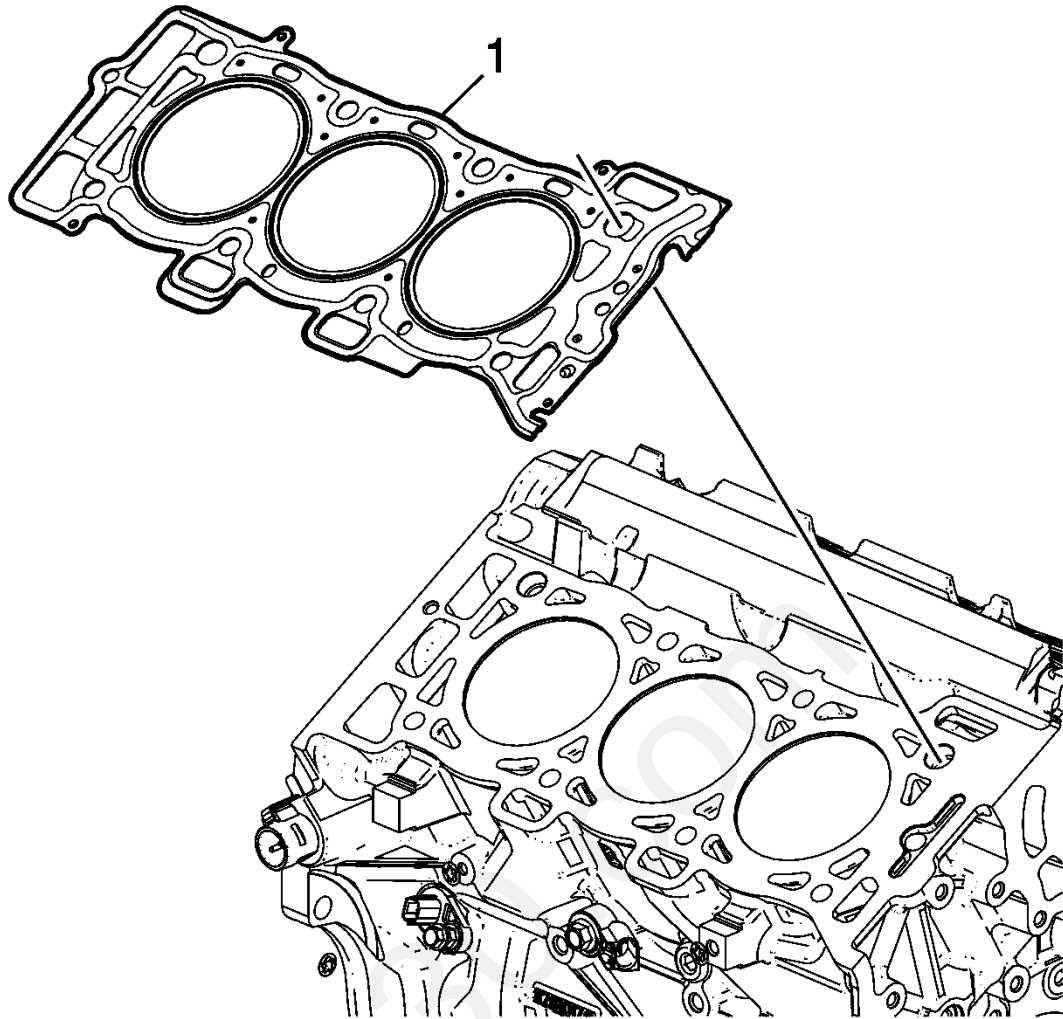


Fig. 178: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

7. Remove and discard the cylinder head gasket (1).
8. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to [Cylinder Head Cleaning and Inspection](#) , and [Engine Block Cleaning and Inspection](#) .
9. If replacing the cylinder head, transfer parts as necessary.
10. Disassemble the cylinder head as necessary. Refer to [Cylinder Head Disassemble](#) .

Installation Procedure

1. Assemble the cylinder head as necessary. Refer to [Cylinder Head Assemble](#) .

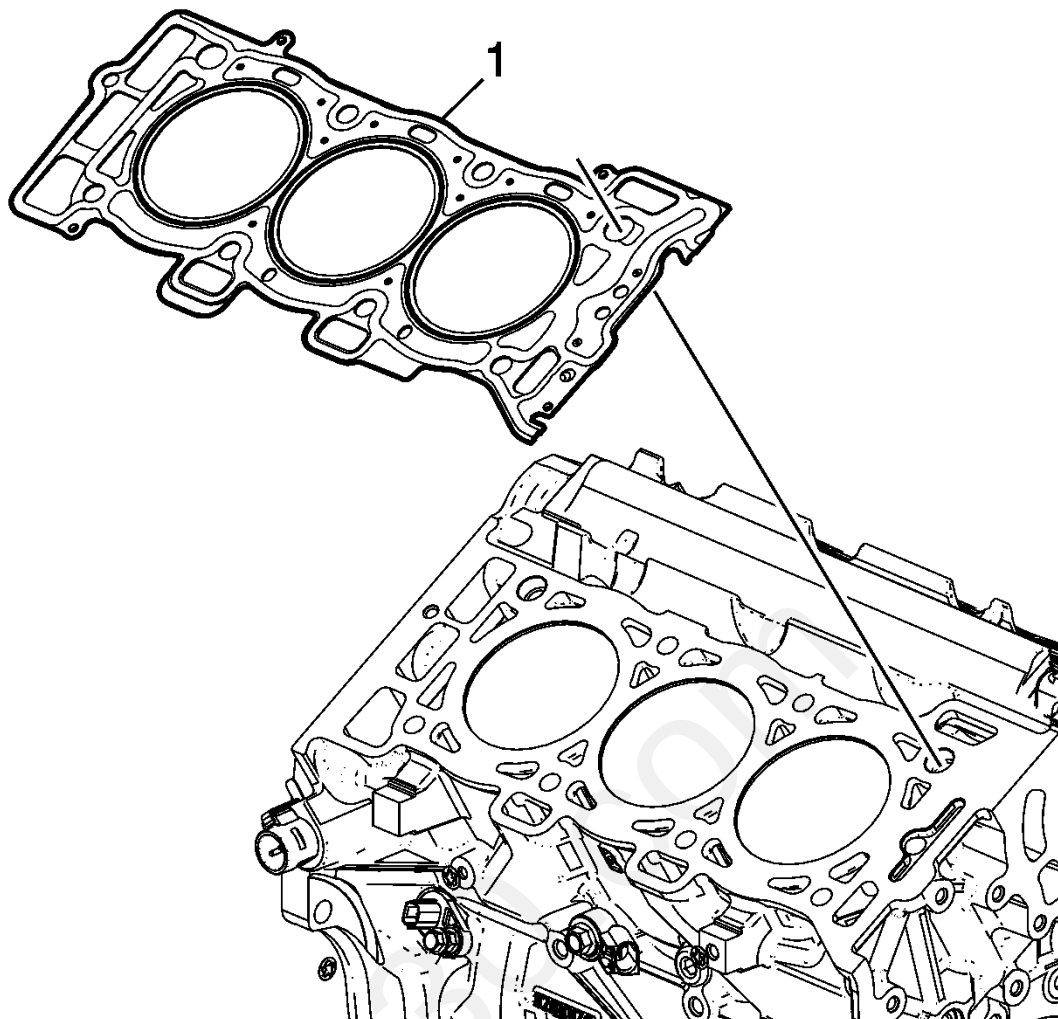


Fig. 179: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

2. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
3. Install a NEW right cylinder head gasket (1) using the deck face locating pins for retention.

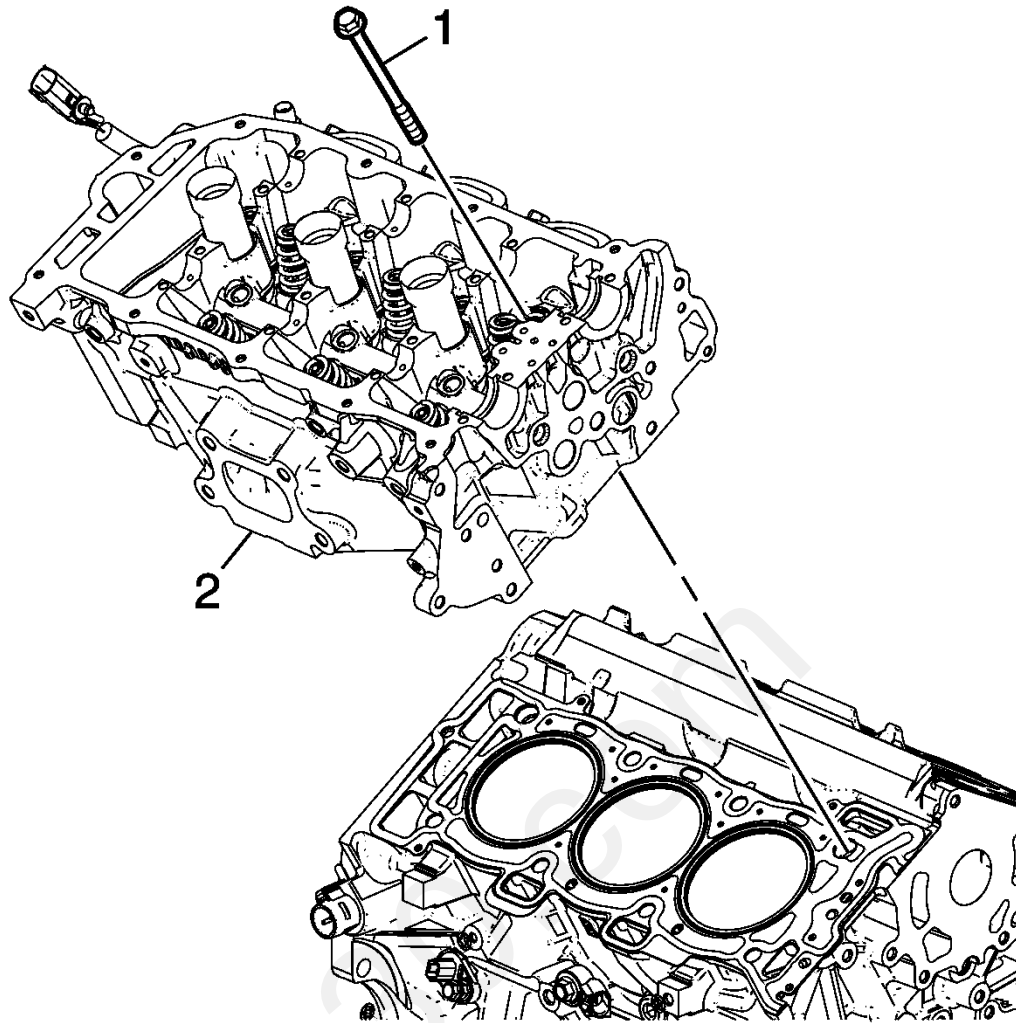


Fig. 180: View Of Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Align the right cylinder head (2) with the deck face locating pins.
5. Place the right cylinder head in position on the deck face.

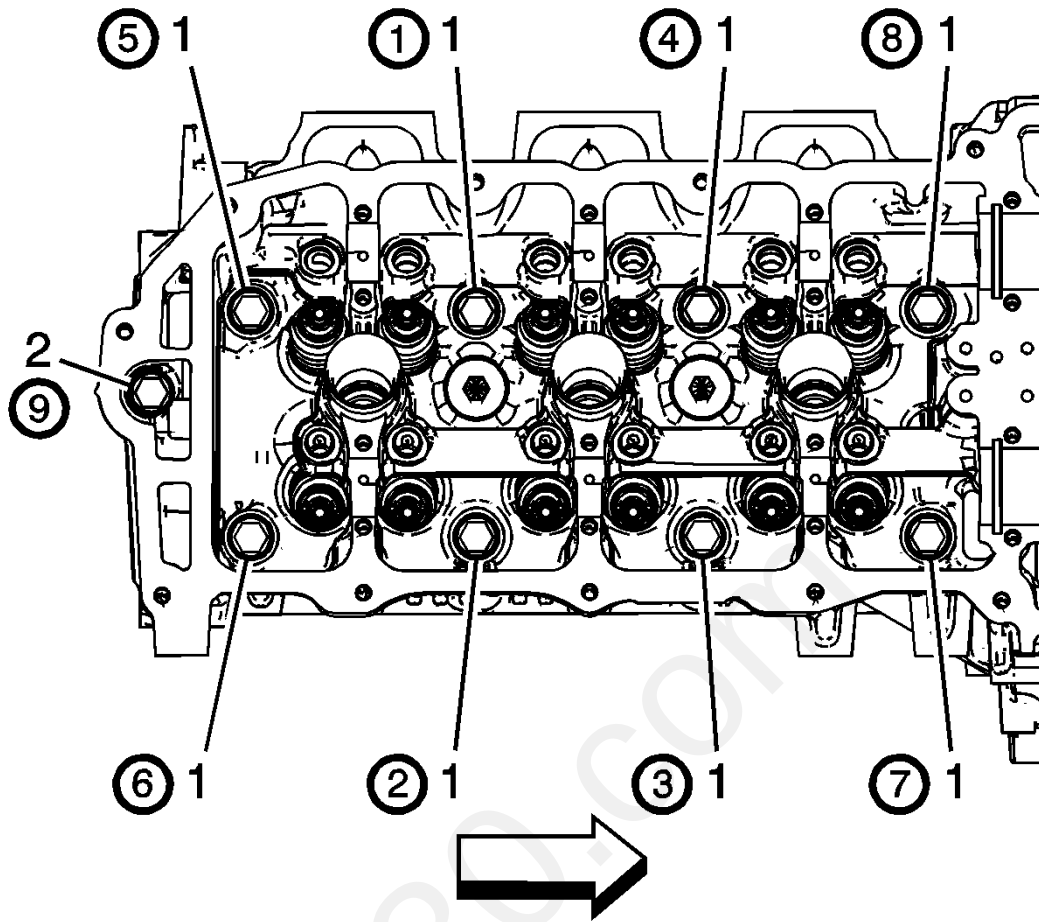


Fig. 181: Cylinder Head Bolt Tightening Sequence

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

NOTE:

- **DO NOT** allow oil on the cylinder head bolt bosses.
- **DO NOT** reuse the old cylinder head bolts.

6. Install the NEW M11 cylinder head bolts (1).

1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).
2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the **EN-45059** meter.

7. Install the NEW M8 cylinder head bolt (2).

1. Tighten the M8 cylinder head bolt a first pass to 15 N.m (11 lb ft).
2. Tighten the M8 cylinder head bolt a second pass an additional 75 degrees using the **EN-45059** meter.

8. Install the catalytic converter. Refer to [Catalytic Converter Replacement - Right Side \(LFX\)](#) .

9. Install the right bank camshaft position actuator. Refer to [Camshaft Position Actuator Replacement - Bank 1](#) .

10. Install the right bank secondary timing chain. Refer to [Secondary Camshaft Intermediate Drive Chain Replacement - Right Side](#) .

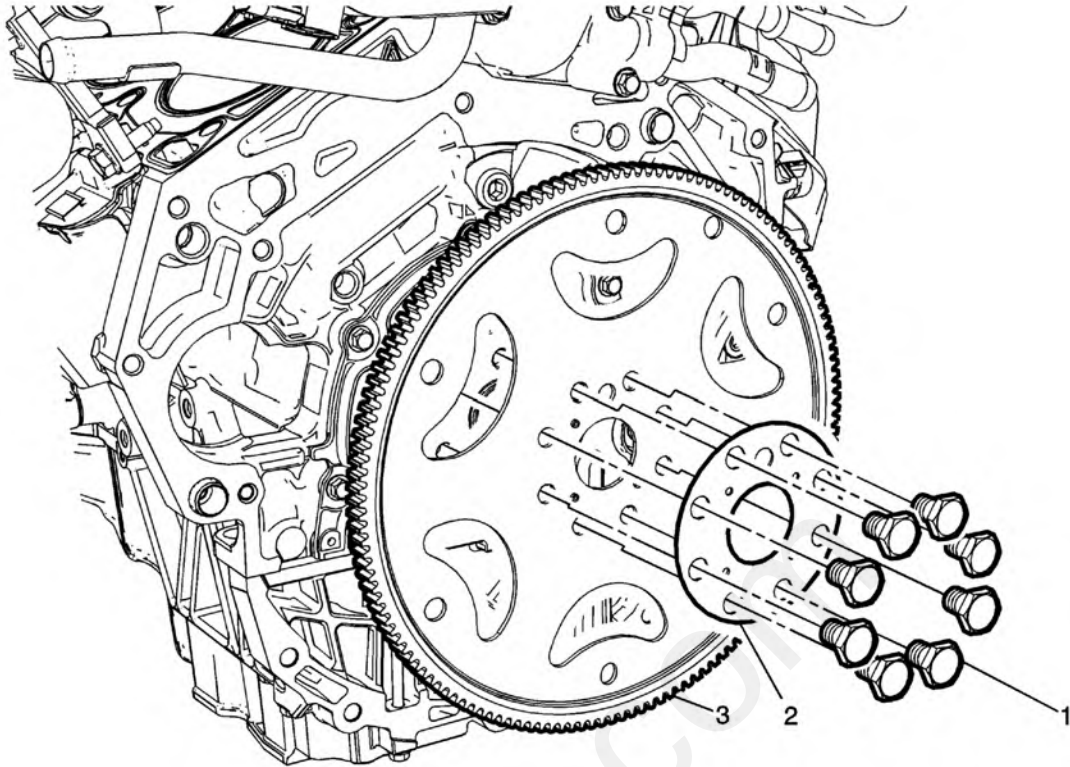


Fig. 182: Automatic Transmission Flex Plate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the transmission. Refer to Transmission Replacement (LFX Engine with Four Wheel Drive) Transmission Replacement (LFX Engine with Two Wheel Drive) .	
Special Tools • EN 45059 Angle Meter • EN 46106 Flywheel Holding Tool For equivalent regional tools. Refer to Special Tools .	
1	Automatic Transmission Flex Plate Fastener (Qty: 8) CAUTION: Refer to Fastener Caution . Procedure New bolts must be used whenever removing the automatic transmission flex plate. Tighten 30 N.m (22 lb ft) plus 45 degrees
2	Automatic Transmission Flex Plate Spacer

Chart	Component Name
3	Automatic Transmission Flex Plate Procedure Clean and inspect the automatic transmission flex plate. Refer to Automatic Transmission Flex Plate Cleaning and Inspection .

CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT

Special Tools

- EN-42183 Handle
- EN-46109 Guide Pin Set
- EN-47839 Crankshaft Rear Oil Seal Installation Tool

For equivalent regional tools, refer to [Special Tools](#) .

Removal Procedure

1. Remove the flex plate. Refer to [Automatic Transmission Flex Plate Replacement](#).
2. Remove the oil pan. Refer to [Oil Pan Replacement](#).

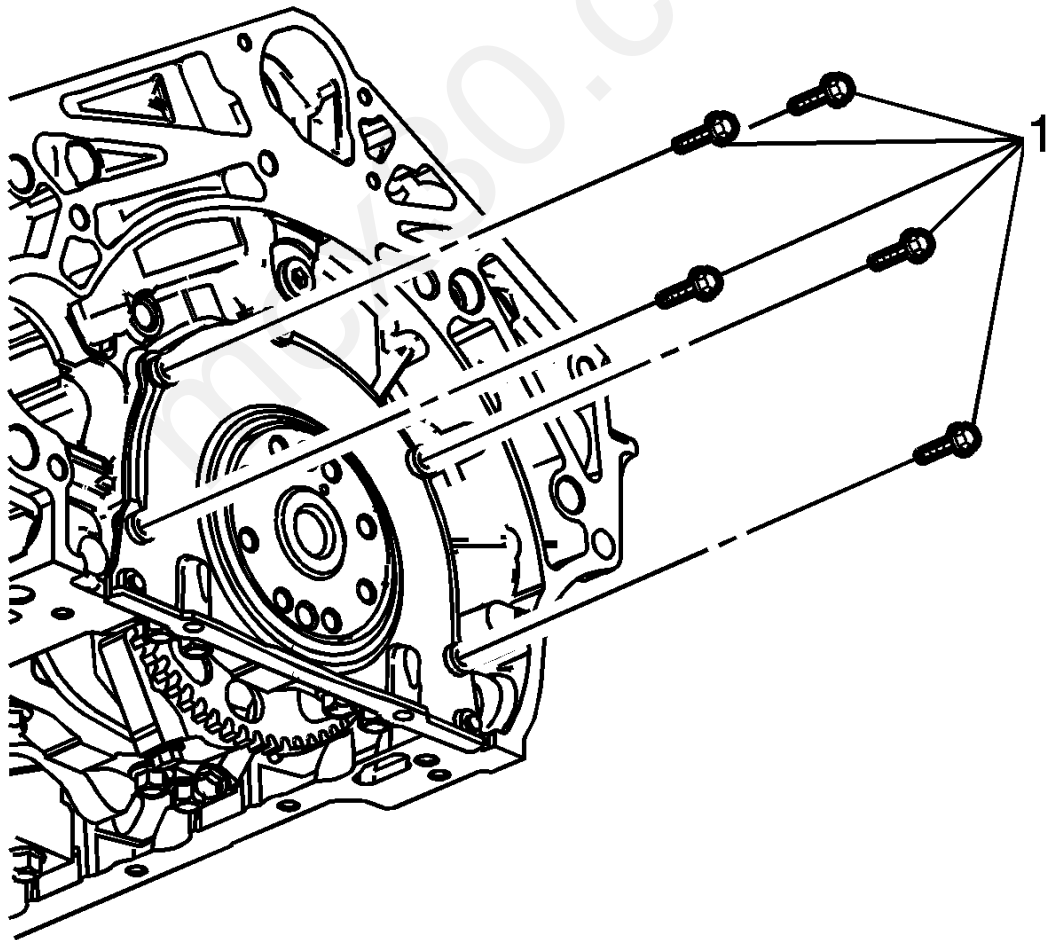


Fig. 183: Crankshaft Rear Oil Seal & Housing Bolts
 Courtesy of GENERAL MOTORS COMPANY

: the crankshaft rear oil seal and housing bolts (1).

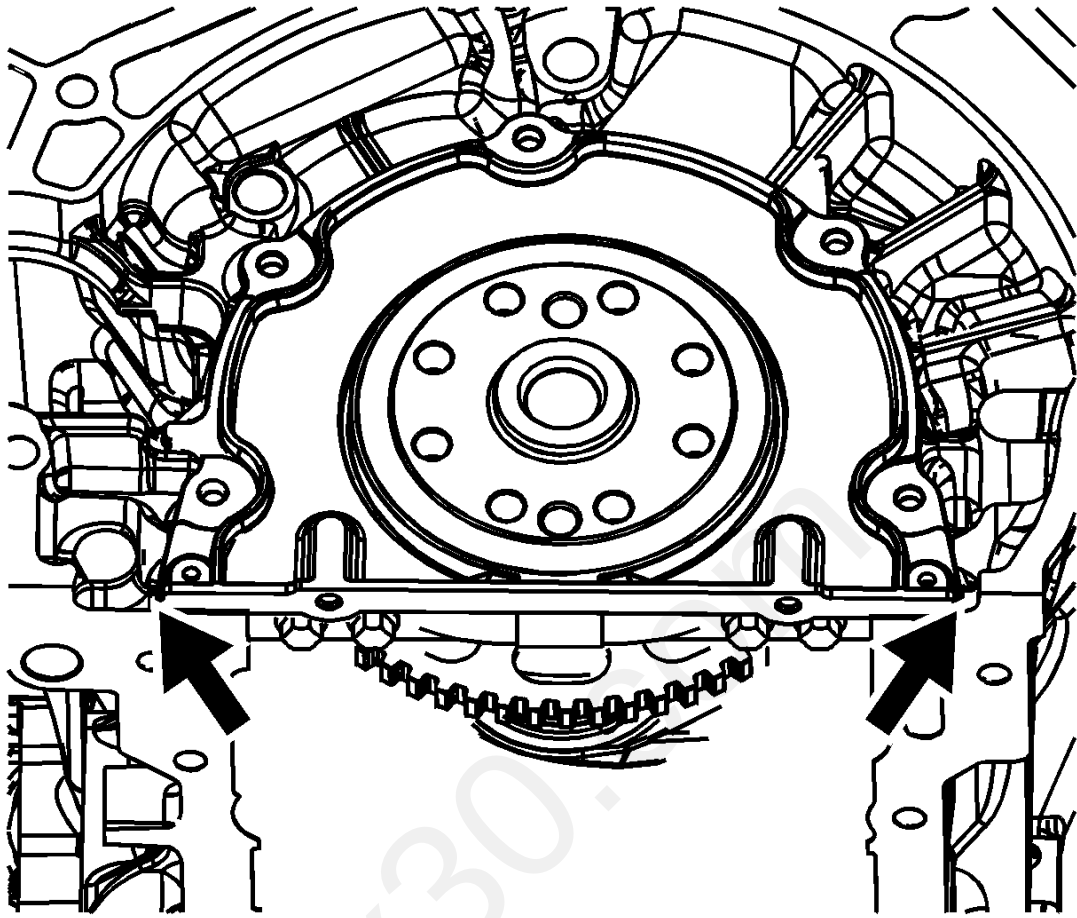


Fig. 184: Crankshaft Rear Oil Seal Housing Pry Points
Courtesy of GENERAL MOTORS COMPANY

4. Use the pry points located at the edge of the crankshaft rear oil seal housing to separate the RTV sealant.

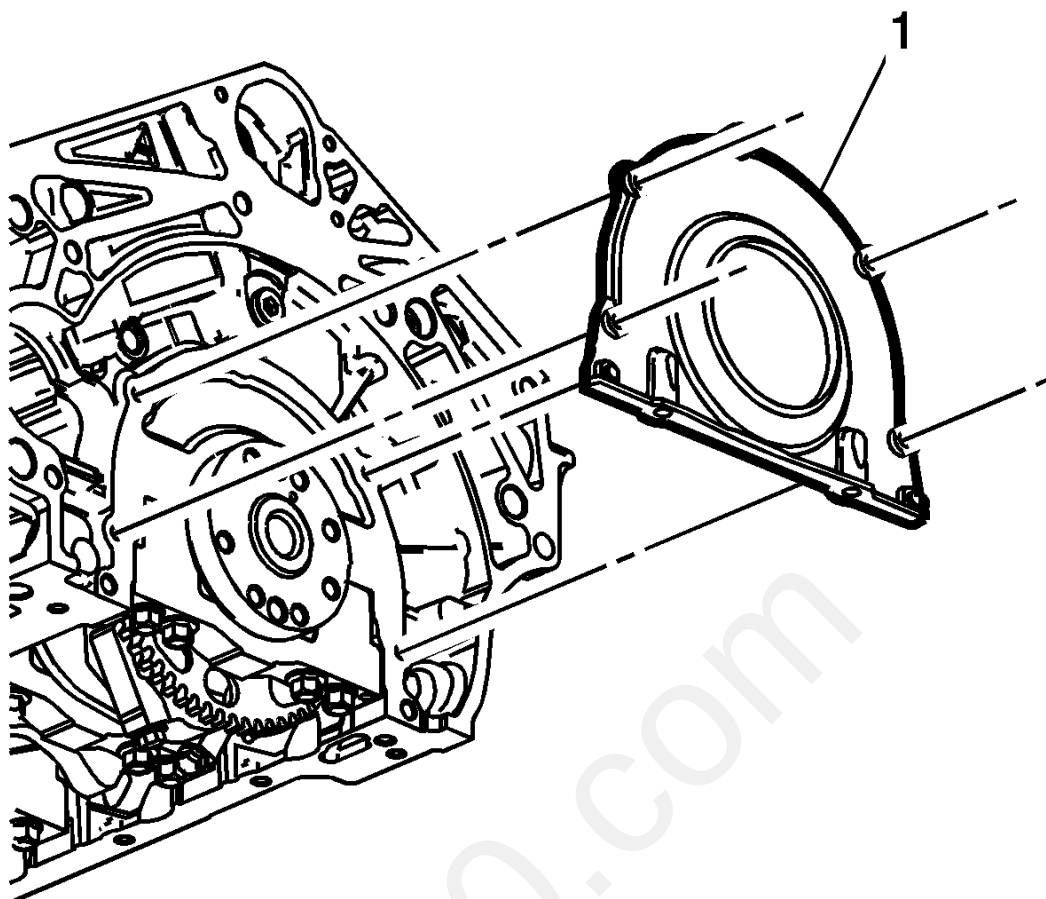


Fig. 185: Crankshaft Rear Oil Seal Housing

Courtesy of GENERAL MOTORS COMPANY

5. Remove and discard the crankshaft rear oil seal and housing (1). Refer to [Crankshaft Rear Oil Seal and Housing Removal](#) .

Installation Procedure

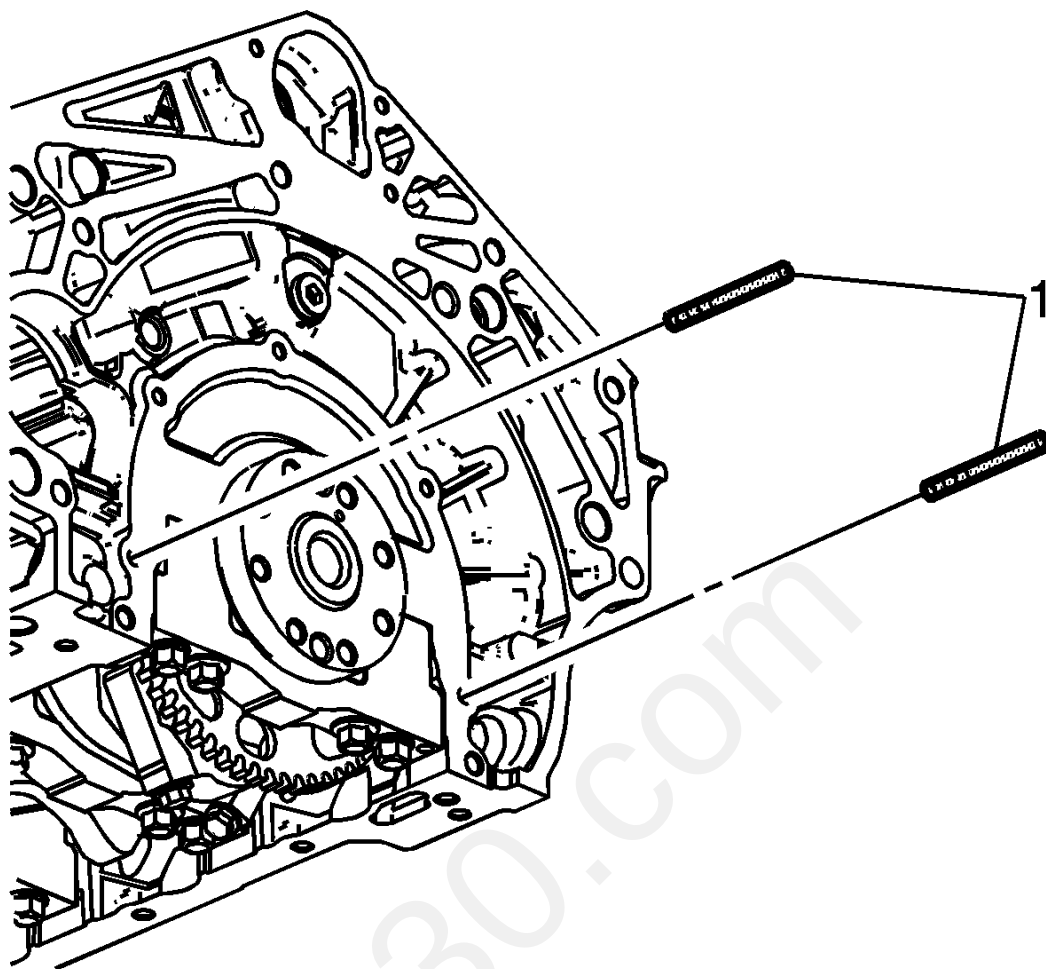


Fig. 186: Guide Pin Set

Courtesy of GENERAL MOTORS COMPANY

1. Install the 6 mm (0.236 in) guides from the EN-46109 pin set into the 2 crankshaft rear oil seal housing corner bolt holes of the engine block

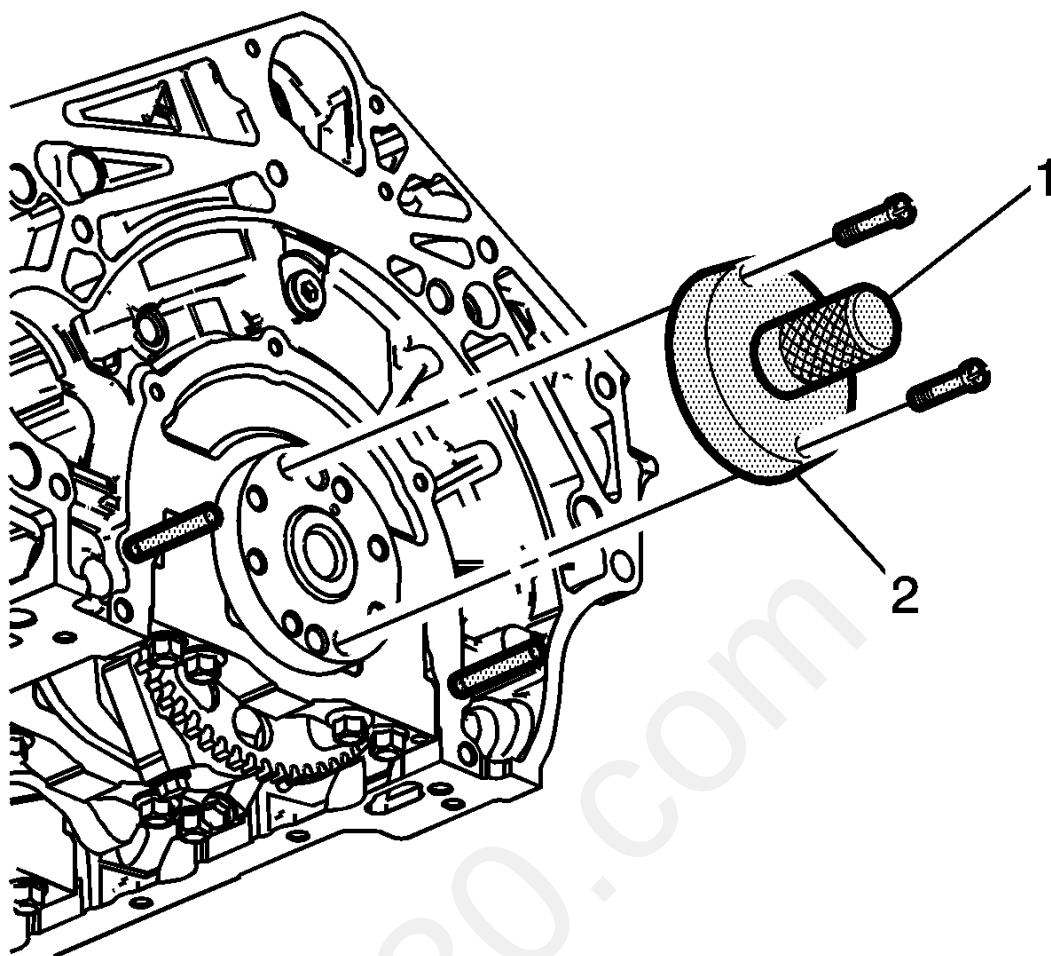


Fig. 187: Crankshaft Rear Oil Seal Installation Tool & Handle

Courtesy of GENERAL MOTORS COMPANY

2. Install the EN-47839 tool with the EN-42183 handle (1, 2) onto the rear of the crankshaft flange.

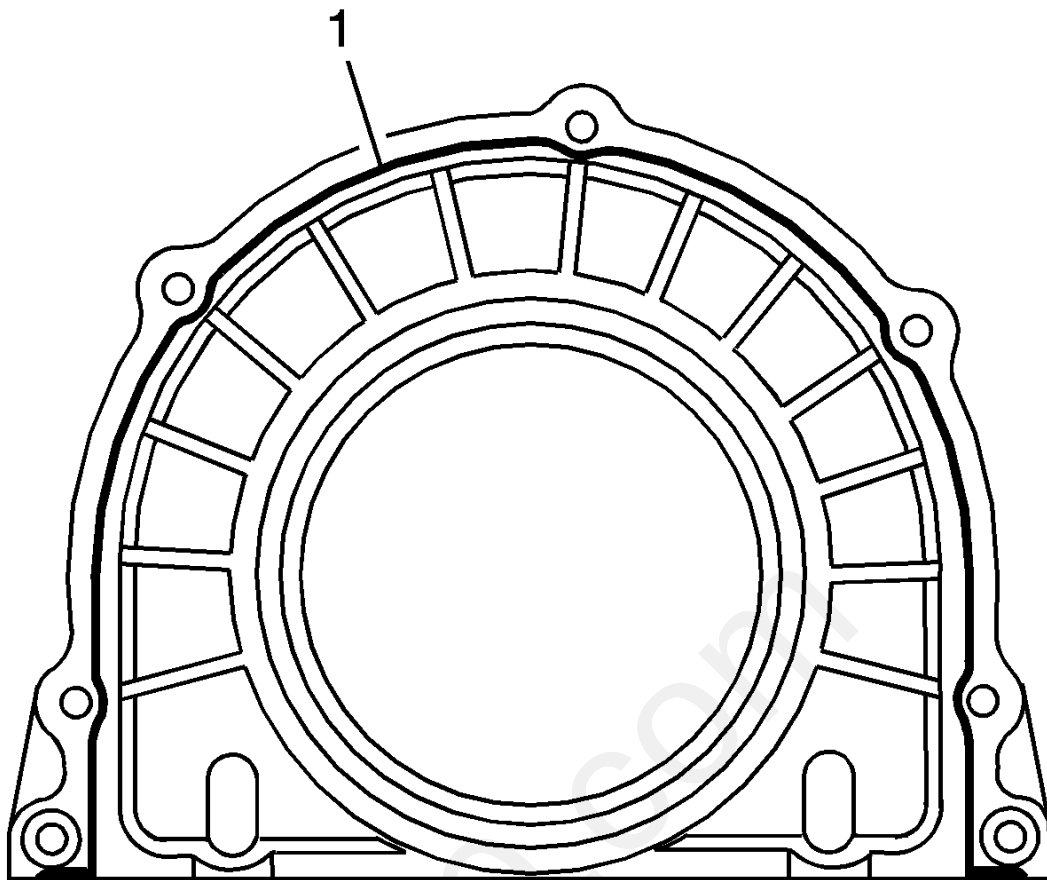


Fig. 188: RTV Sealant On Crankshaft Rear Oil Seal Housing

Courtesy of GENERAL MOTORS COMPANY

3. Place a 3 mm (0.118 in) bead of RTV sealant (1) to the NEW crankshaft rear oil seal housing as shown. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) , for recommended sealant.

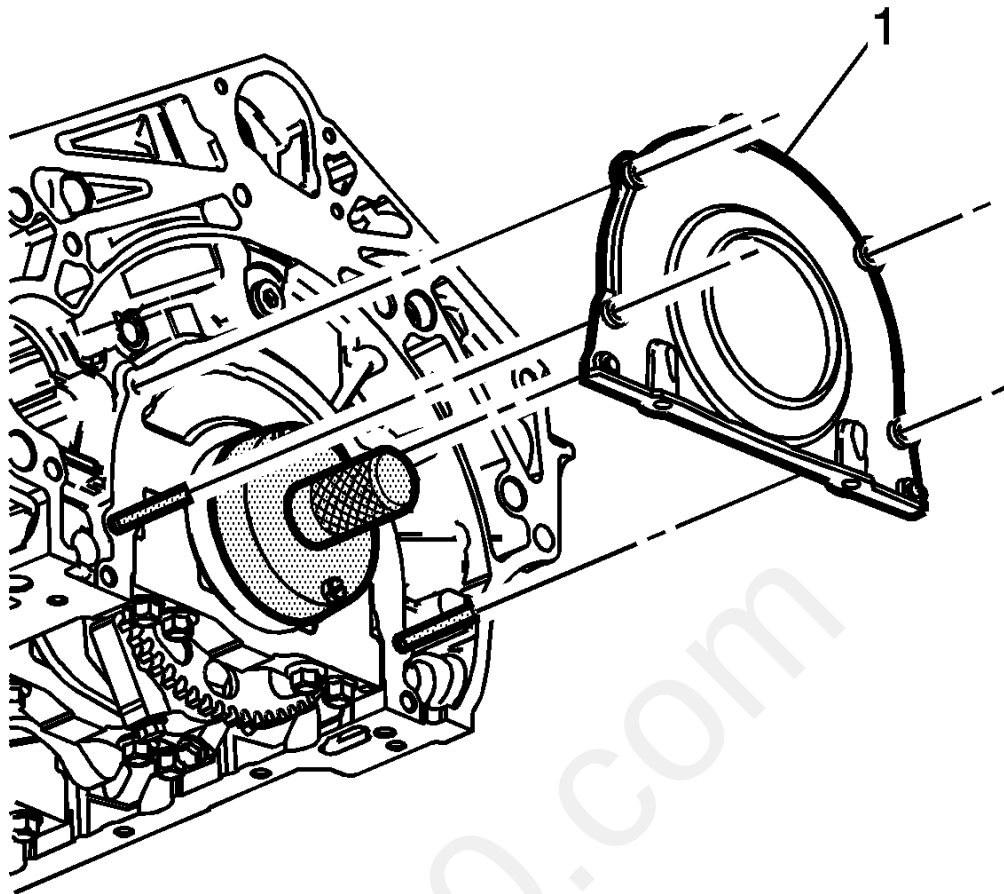


Fig. 189: Crankshaft Rear Oil Seal Housing

Courtesy of GENERAL MOTORS COMPANY

NOTE: DO NOT allow any engine oil on the area where the crankshaft rear oil seal housing is to be installed.

4. Install the crankshaft rear oil seal housing (1) to the engine block.

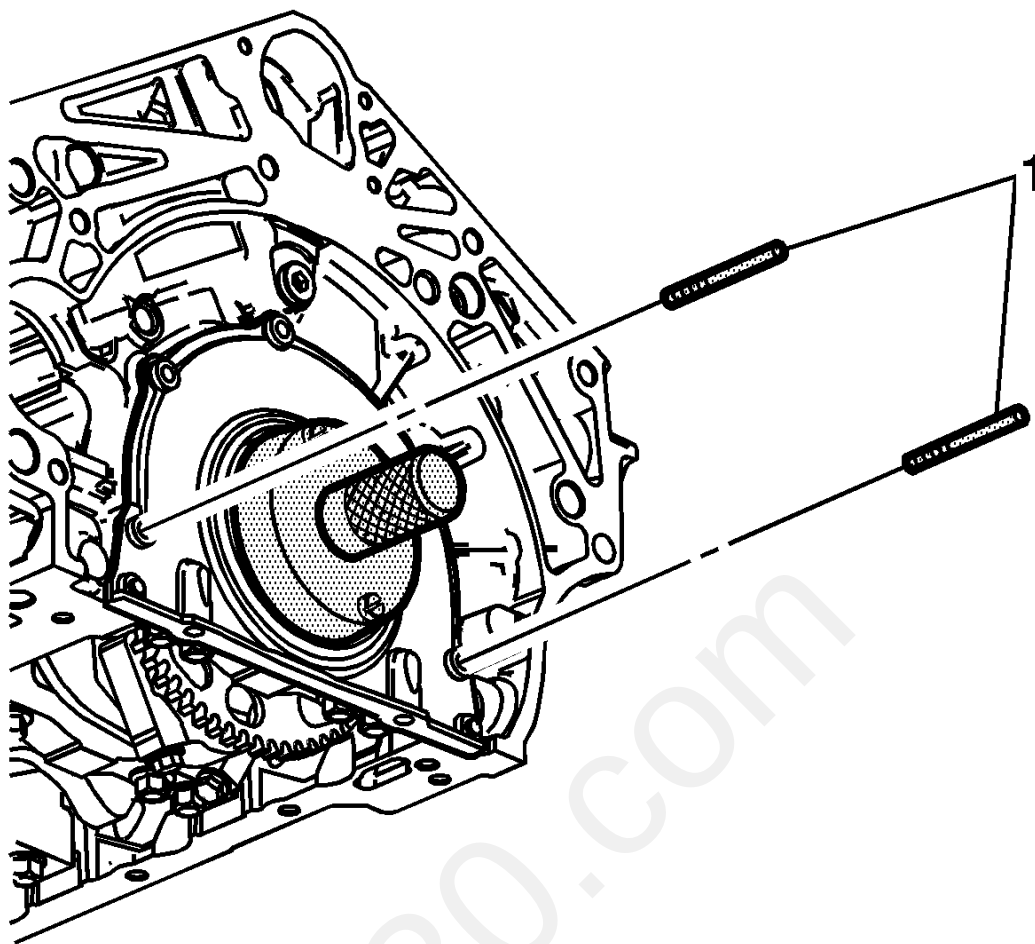


Fig. 190: Guide Pin Set

Courtesy of GENERAL MOTORS COMPANY

5. Remove the EN-46109 pin set 6 mm (0.236 in) guides (1) from the engine block.

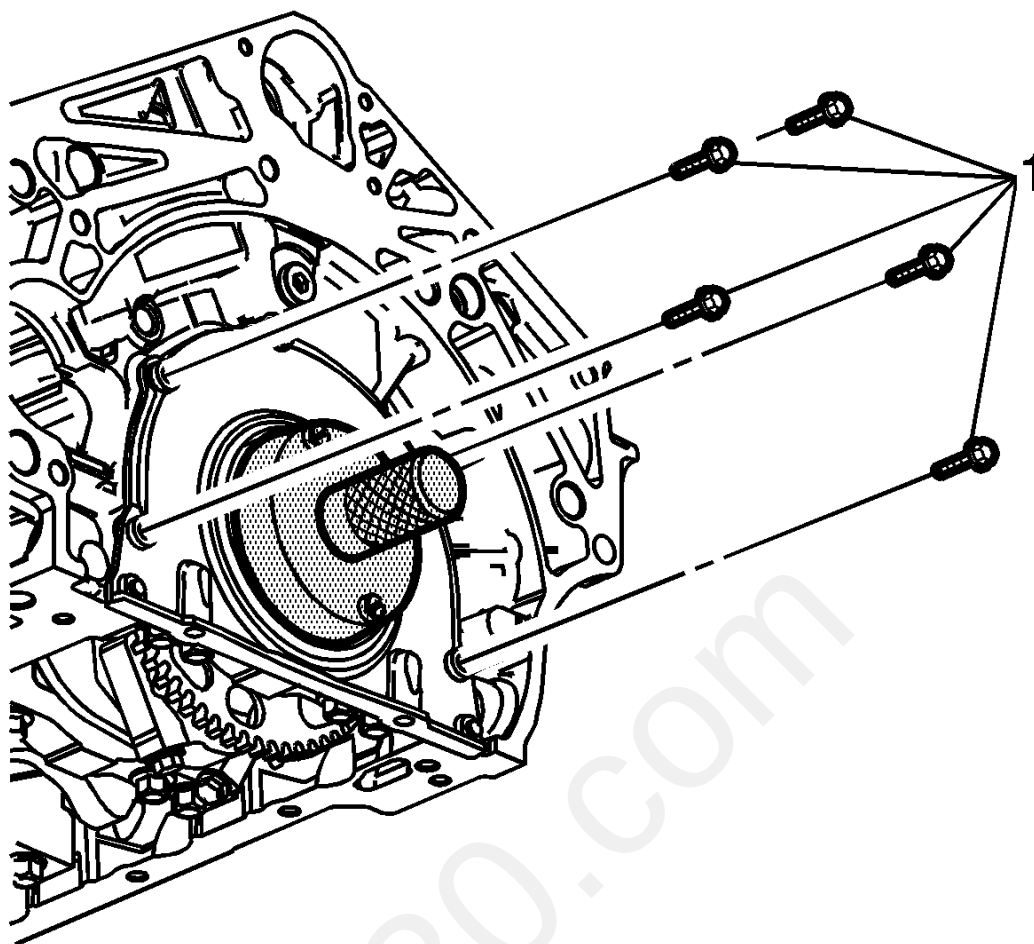


Fig. 191: Crankshaft Rear Oil Seal Housing Bolts

Courtesy of GENERAL MOTORS COMPANY

6. Install the crankshaft rear oil seal housing bolts (1).

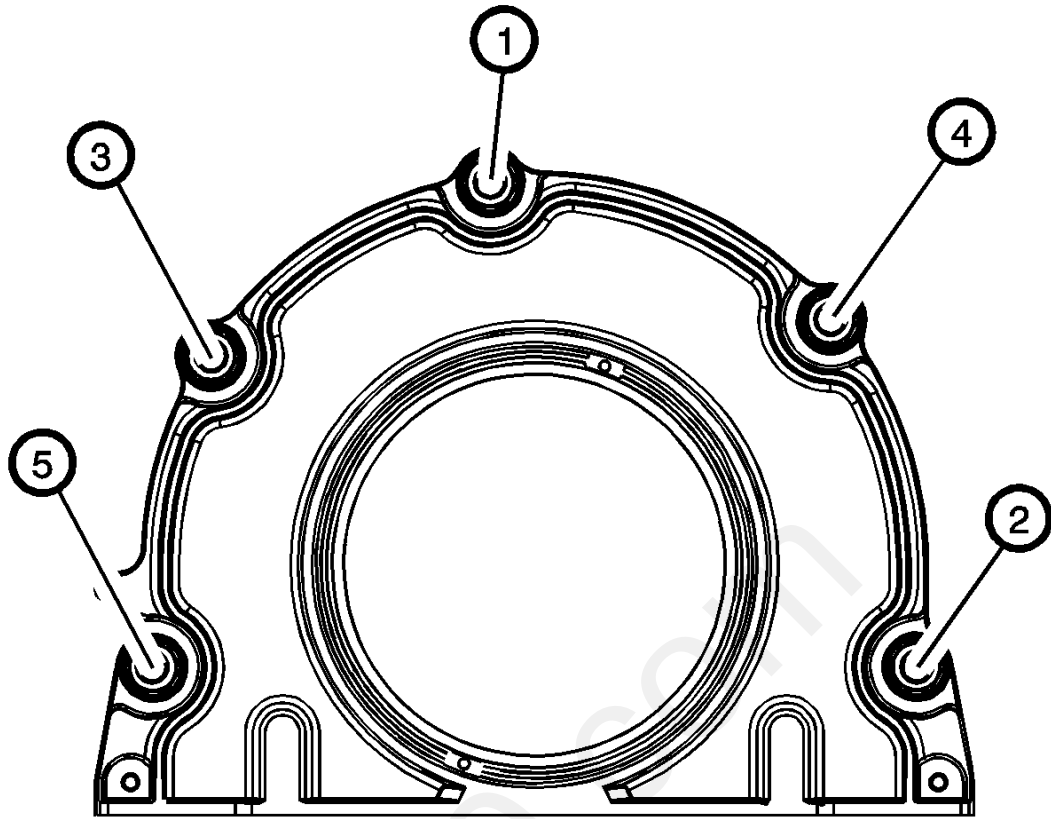


Fig. 192: Crankshaft Rear Oil Seal Housing Bolt Sequence

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

7. Tighten the crankshaft rear oil seal housing bolts in sequence and tighten to 10 N.m (89 lb in).

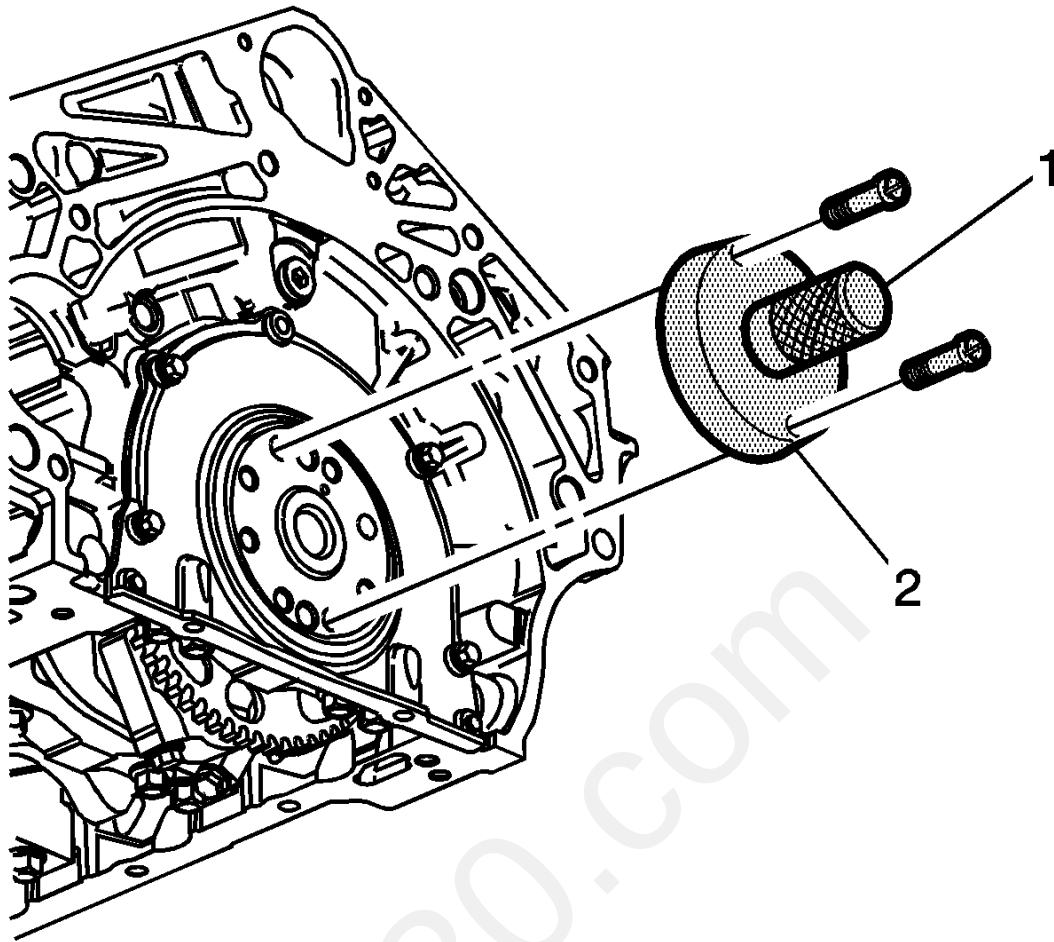


Fig. 193: Crankshaft Rear Oil Seal Installation Tool & Handle
Courtesy of GENERAL MOTORS COMPANY

8. Remove the EN-47839 tool and EN-42183 handle (1, 2) from the crankshaft flange.
9. Install the oil pan. Refer to [Oil Pan Replacement](#).
10. Install the flex plate. Refer to [Automatic Transmission Flex Plate Replacement](#).

ENGINE OIL COOLER INLET HOSE REPLACEMENT

Removal Procedure

1. Drain the engine oil. Refer to [Engine Oil and Oil Filter Replacement](#).
2. Remove the underbody splash shield. Refer to [Underbody Splash Shield Replacement](#).
3. Remove the left front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#).

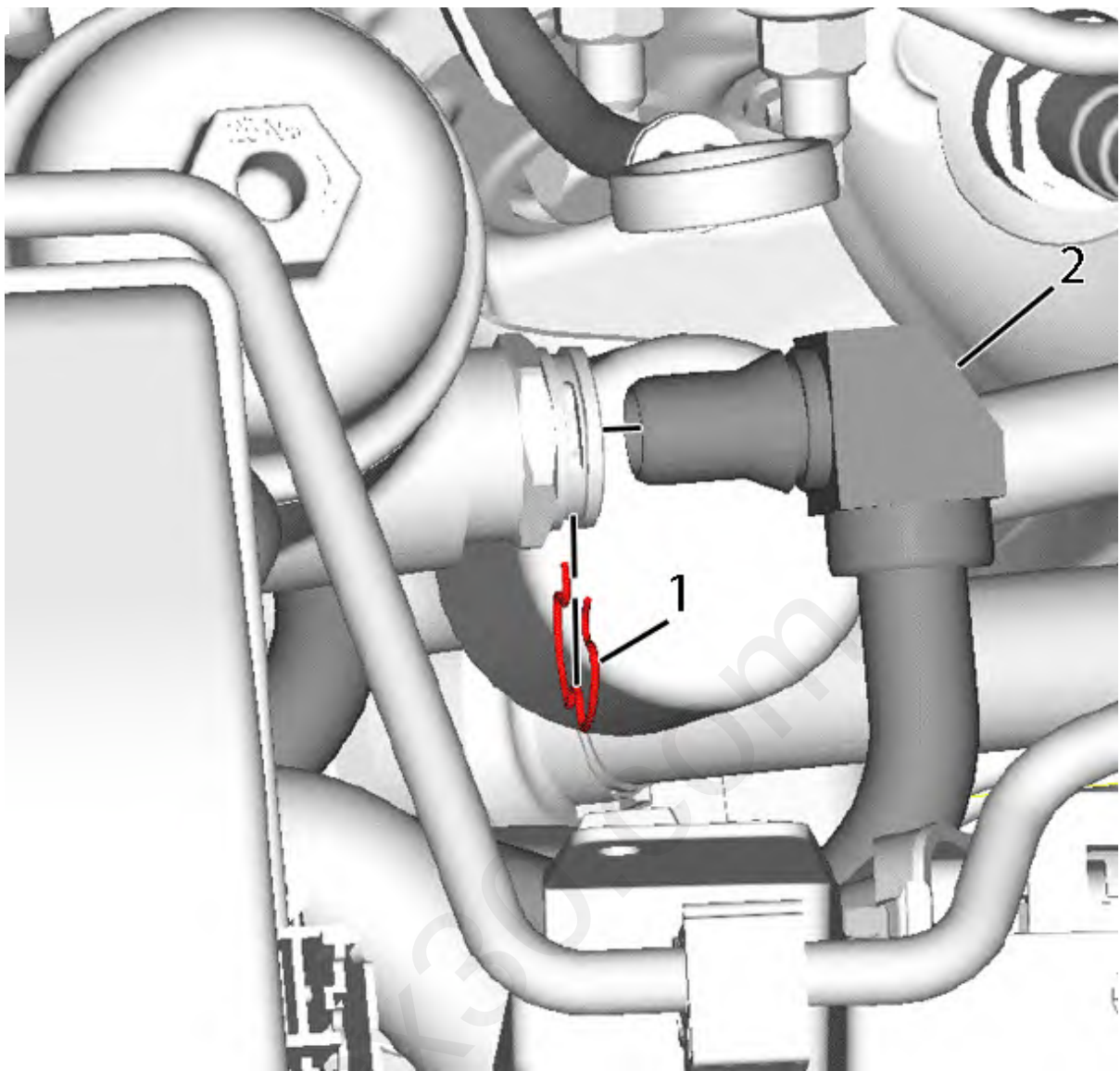


Fig. 194: Retaining Ring And Engine Oil Cooler Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

4. Remove the retaining ring (1) from the oil filter adaptor.
5. Remove the engine oil cooler inlet hose (2) from the oil filter adaptor.

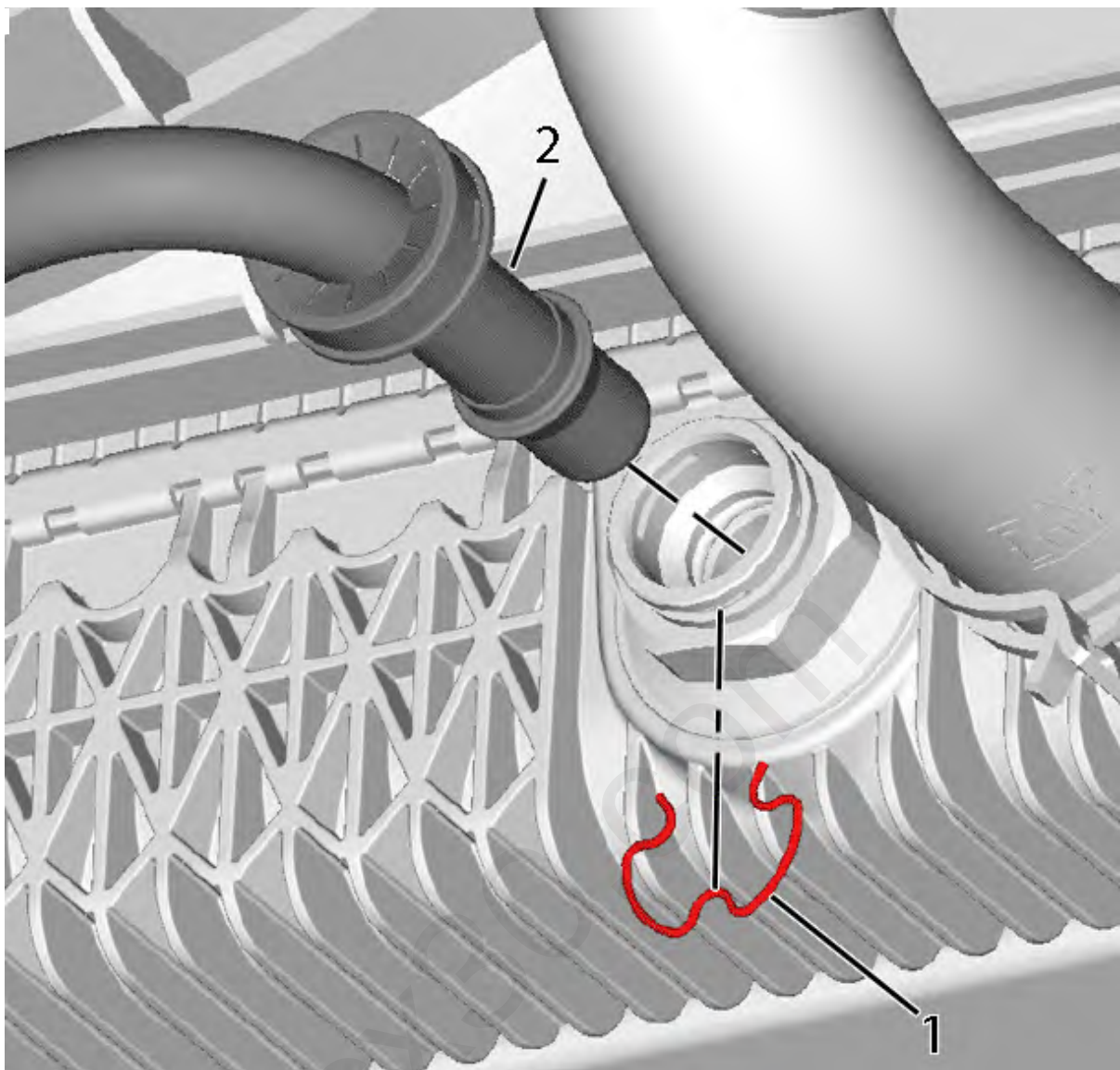


Fig. 195: Retaining Ring And Engine Oil Cooler Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

6. Remove the retaining ring (1) from the engine oil cooler coolant inlet hose connector at the radiator.
7. Remove the engine oil cooler inlet hose (2) from the radiator.
8. Detach the engine oil cooler inlet hose (2) from the retaining clip.
9. Remove the engine oil cooler inlet hose (2) from the vehicle.
10. Transfer parts as necessary.

Installation Procedure

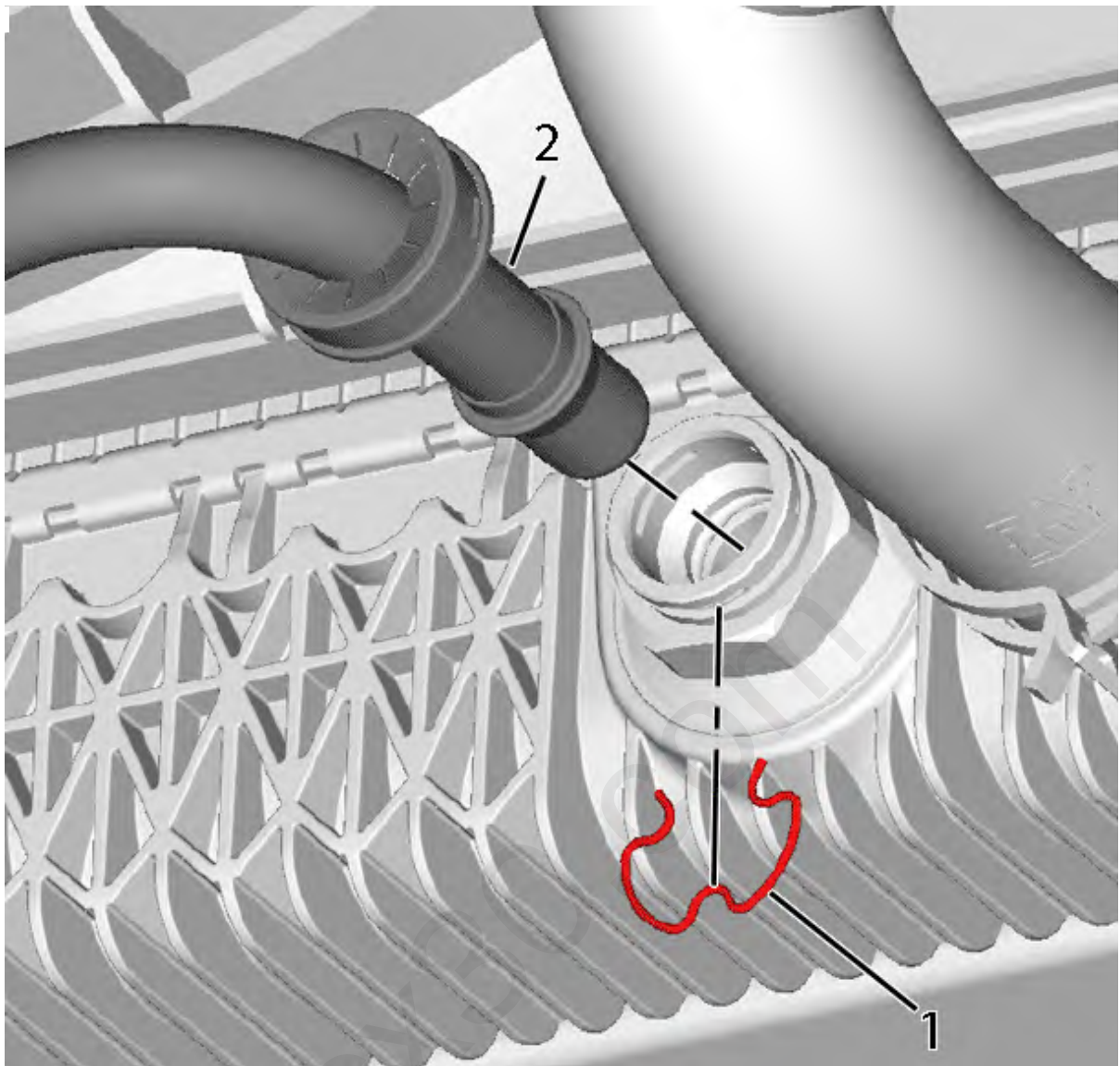


Fig. 196: Retaining Ring And Engine Oil Cooler Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine oil cooler inlet hose (2) to the vehicle.
2. Attach the engine oil cooler inlet hose (2) to the retaining clip.
3. Install the engine oil cooler inlet hose (2) to the radiator.
4. Install the retaining ring (1) to the engine oil cooler inlet hose connector at the radiator.

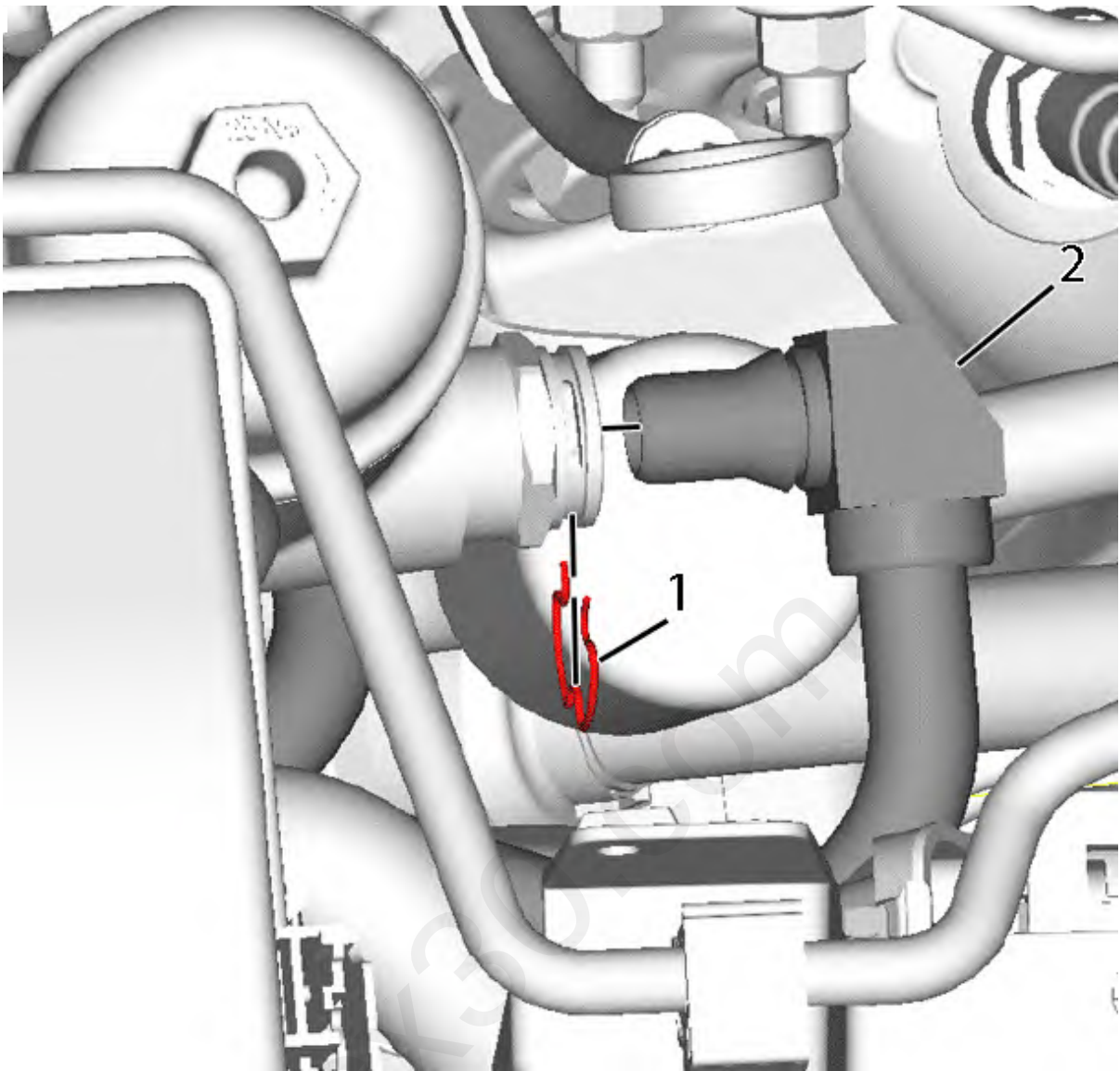


Fig. 197: Retaining Ring And Engine Oil Cooler Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

5. Install the engine oil cooler inlet hose (2) to the oil filter adaptor.
6. Install the retaining ring (1) to the oil filter adaptor.
7. Install the retaining ring (1) to the engine oil cooler coolant inlet hose connector at the oil filter adaptor.
8. Install the left front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#)
9. Install the underbody splash shield. Refer to [Underbody Splash Shield Replacement](#) .
10. refill the engine oil. Refer to [Engine Oil and Oil Filter Replacement](#).

ENGINE OIL COOLER OUTLET HOSE REPLACEMENT

Removal Procedure

1. Drain the engine oil. Refer to [Engine Oil and Oil Filter Replacement](#).
2. Remove the underbody splash shield. Refer to [Underbody Splash Shield Replacement](#) .
3. Remove the left front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#)

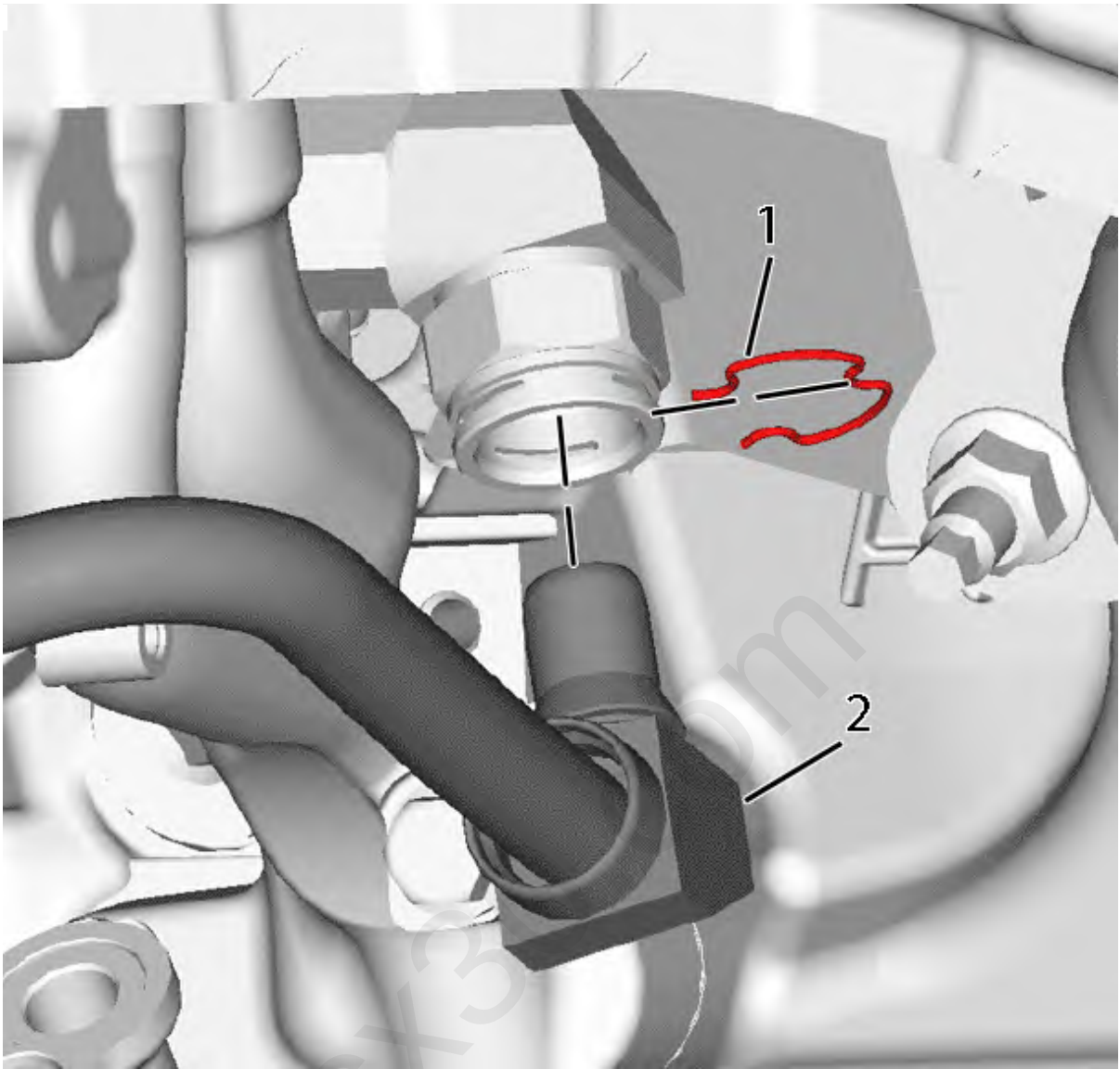


Fig. 198: Retaining Ring And Engine Oil Cooler Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Remove the retaining ring (1) from the oil filter adaptor.
5. Remove the engine oil cooler outlet hose (2) from the oil filter adaptor.

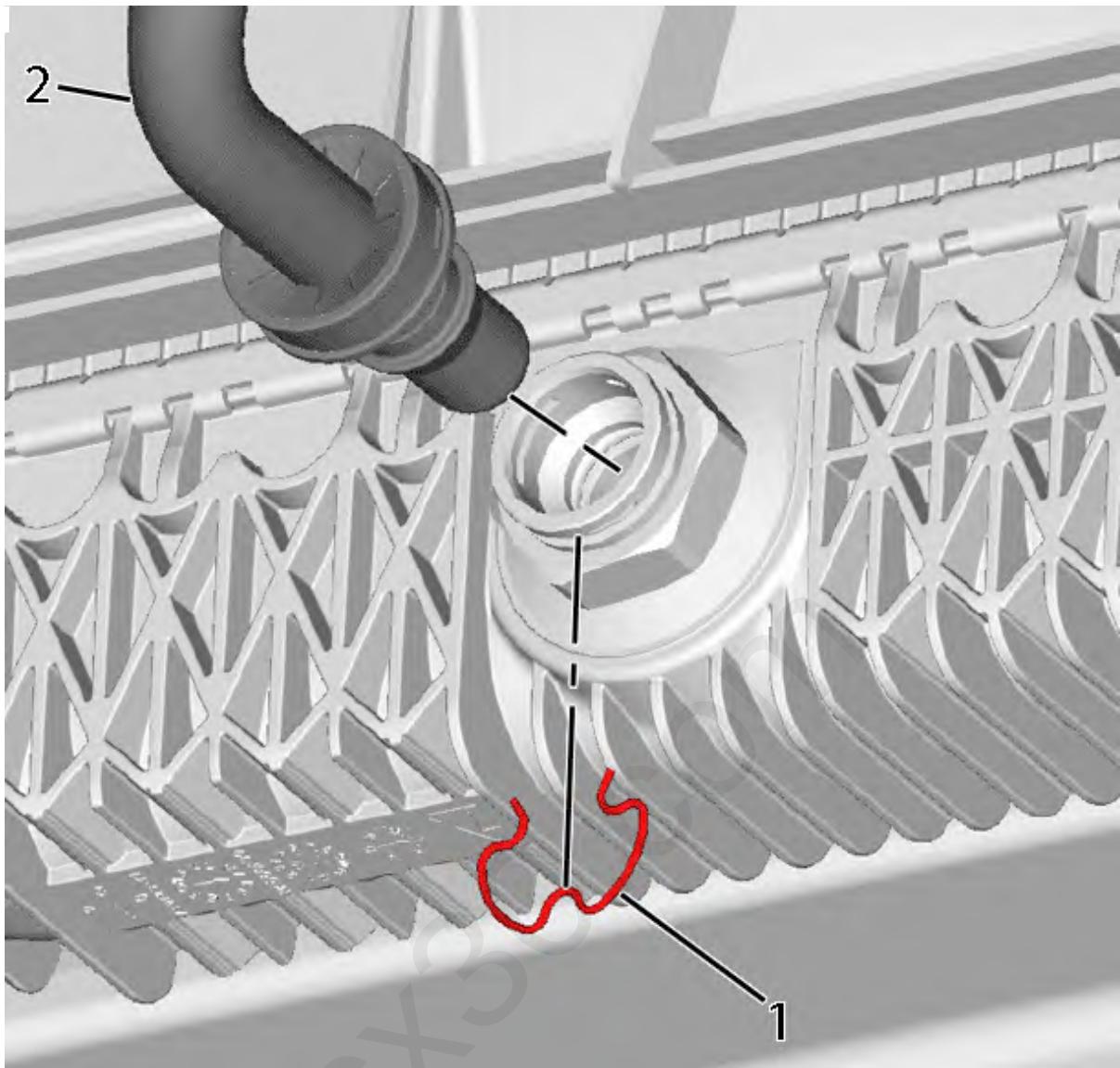


Fig. 199: Retaining Ring And Engine Oil Cooler Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

6. Remove the retaining ring (1) from the engine oil cooler coolant outlet hose connector at the radiator.
7. Remove the engine oil cooler outlet hose (2) from the radiator.
8. Detach the engine oil cooler outlet hose (2) from the retaining clip.
9. Remove the engine oil cooler outlet hose (2) from the vehicle.
10. Transfer parts as necessary.

Installation Procedure

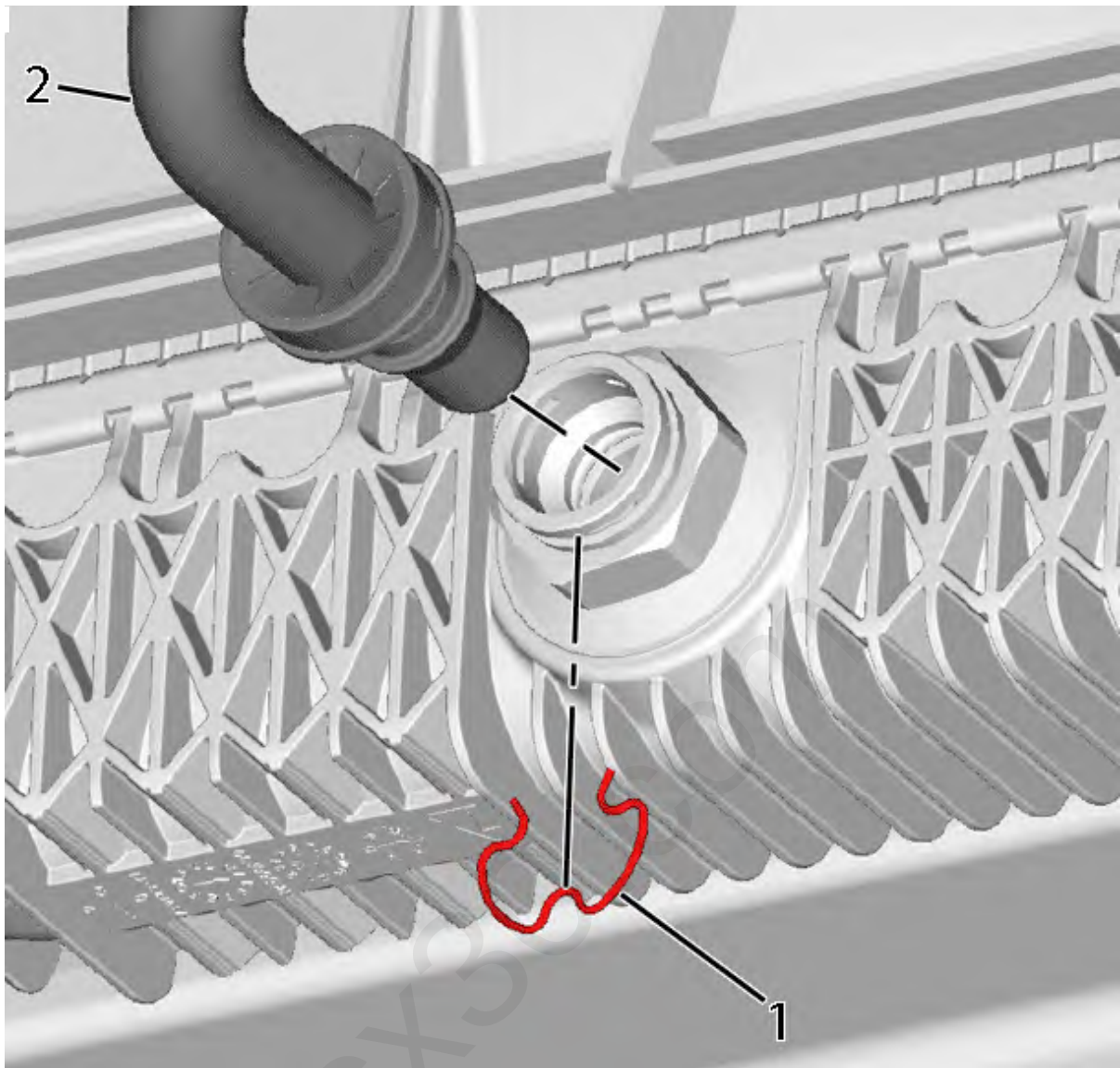


Fig. 200: Retaining Ring And Engine Oil Cooler Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine oil cooler outlet hose (2) to the vehicle.
2. Install the engine oil cooler outlet hose (2) to the radiator.
3. Attach the engine oil cooler outlet hose (2) to the retaining clip.
4. Install the retaining ring (1) to the engine oil cooler outlet hose connector at the radiator.

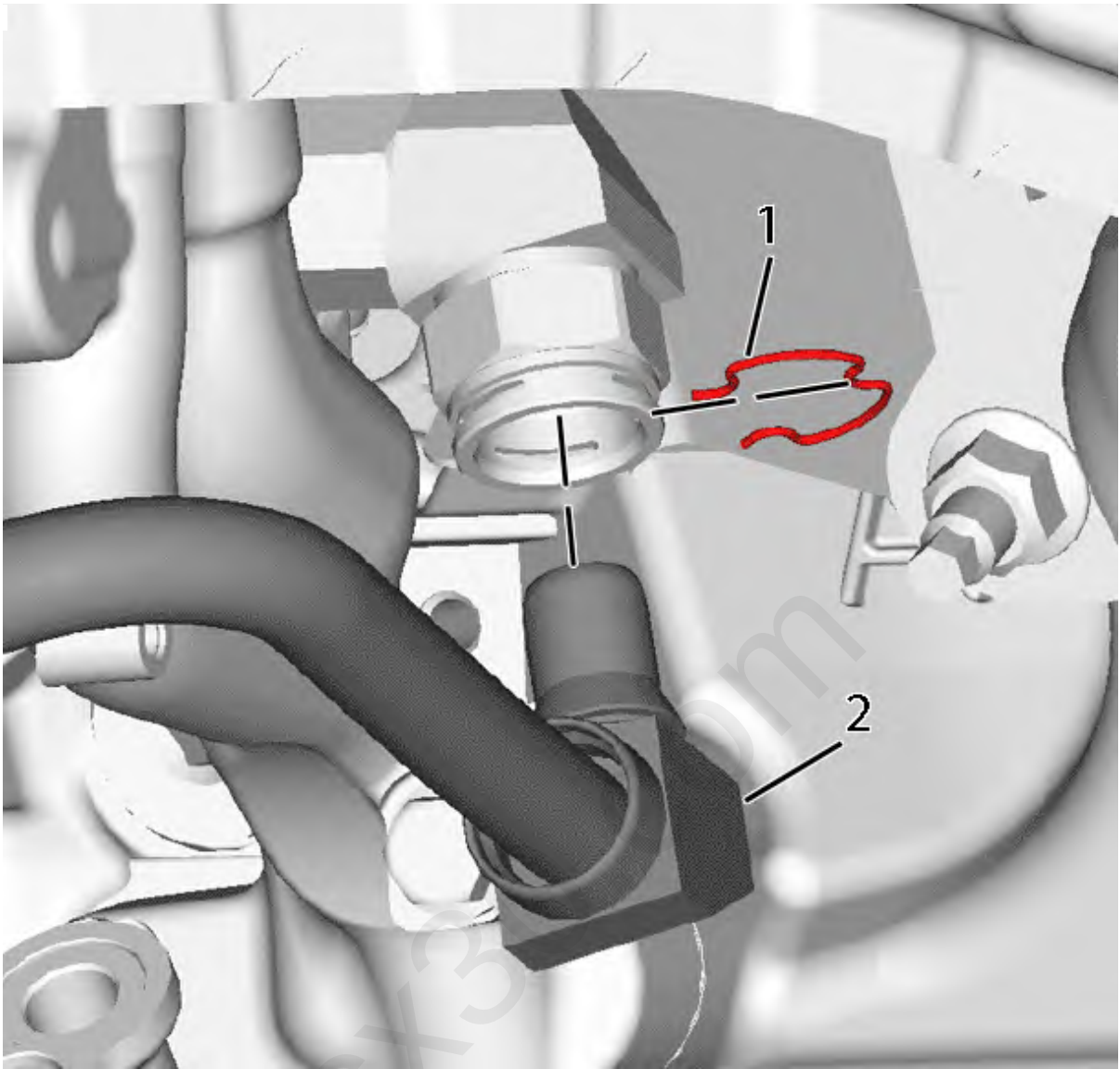


Fig. 201: Retaining Ring And Engine Oil Cooler Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

5. Install the engine oil cooler outlet hose (2) to the oil filter adaptor.
6. Install the retaining ring (1) to the oil filter adaptor.
7. Install the retaining ring (1) to the engine oil cooler coolant outlet hose connector at the oil filter adaptor.
8. Install the left front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#)
9. Install the underbody splash shield. Refer to [Underbody Splash Shield Replacement](#) .
10. refill the engine oil. Refer to [Engine Oil and Oil Filter Replacement](#).

ENGINE OIL COOLER INLET HOSE CONNECTOR FITTING REPLACEMENT

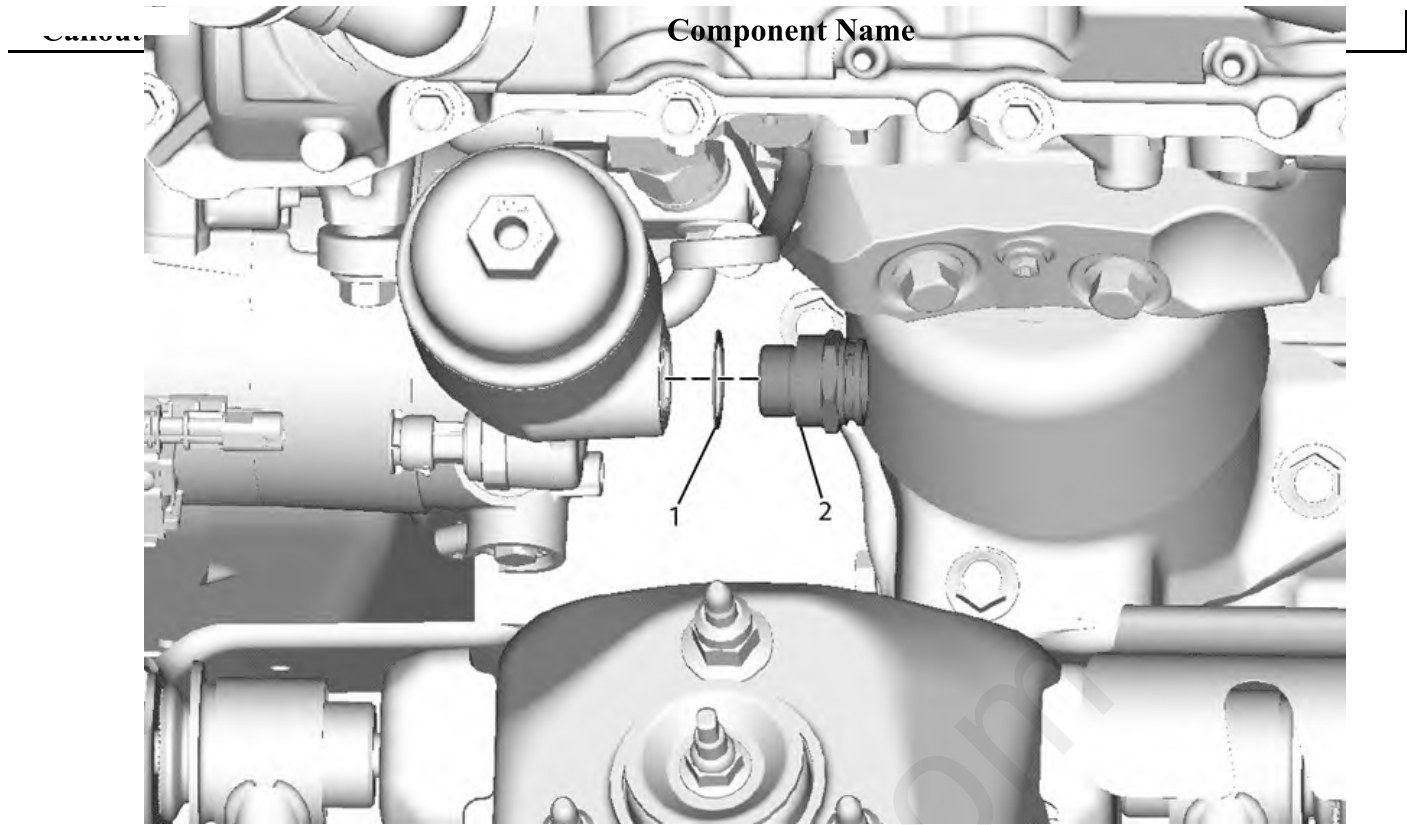


Fig. 202: Engine Oil Cooler Inlet Hose Connector Fitting
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Disconnect the engine oil cooler inlet hose. Refer to Engine Oil Cooler Inlet Hose Replacement .	
1	Inlet Hose Fitting Seal Ring NOTE: Replace the seal whenever fitting is removed.
2	Engine Oil Cooler Inlet Hose Fitting Fastener CAUTION: Refer to Component Fastener Tightening Caution . Tighten 35 N.m (26 lb ft)

ENGINE OIL COOLER OUTLET HOSE CONNECTOR FITTING REPLACEMENT

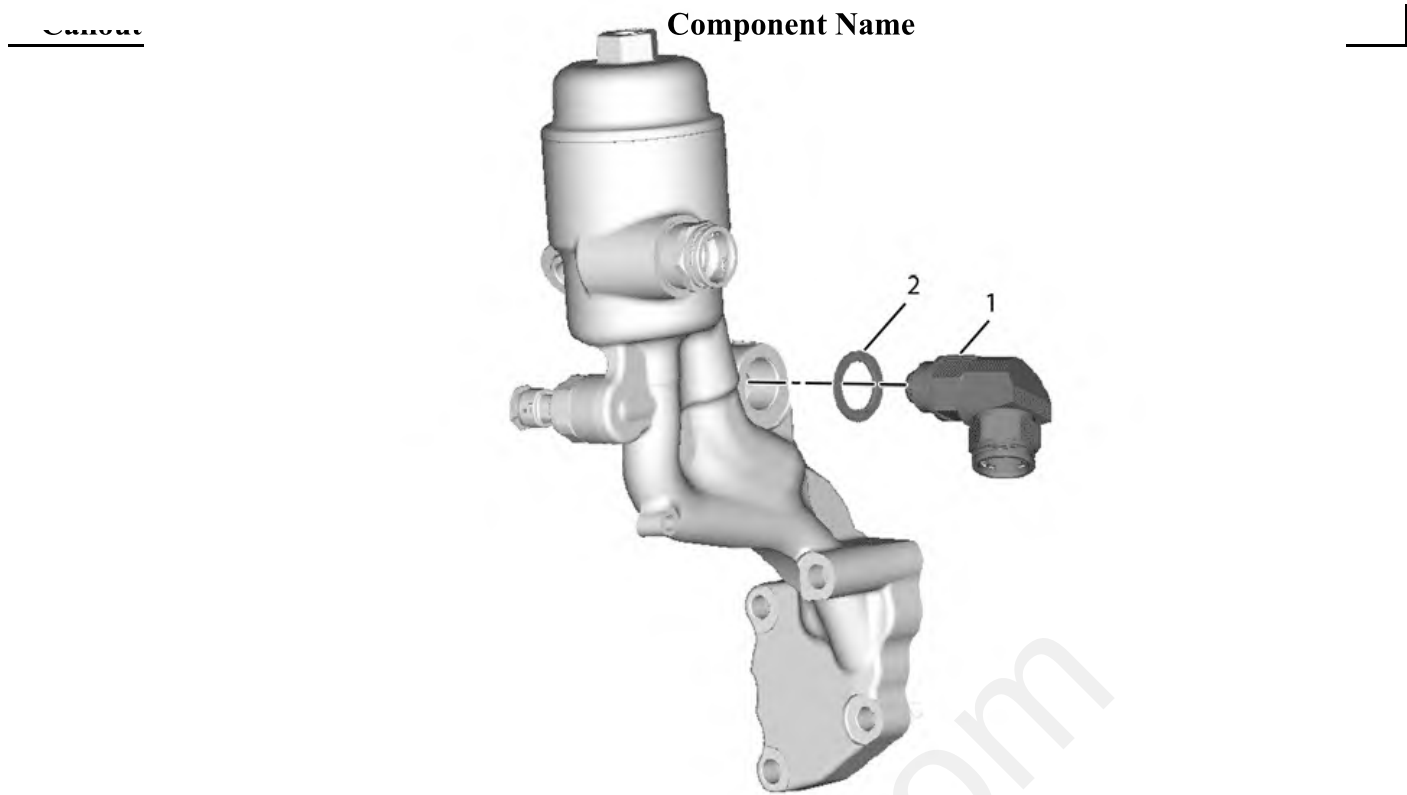


Fig. 203: Engine Oil Cooler Outlet Hose Connector Fitting
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the oil filter adaptor. Refer to Oil Filter Adapter Replacement .	
1	Engine Oil Cooler Outlet Hose Connector Fitting CAUTION: Refer to Component Fastener Tightening Caution . Tighten 35 N.m (26 lb ft)
2	Outlet Hose Fitting Seal Ring NOTE: Replace the seal whenever fitting is removed.

OIL PUMP REPLACEMENT

Removal Procedure

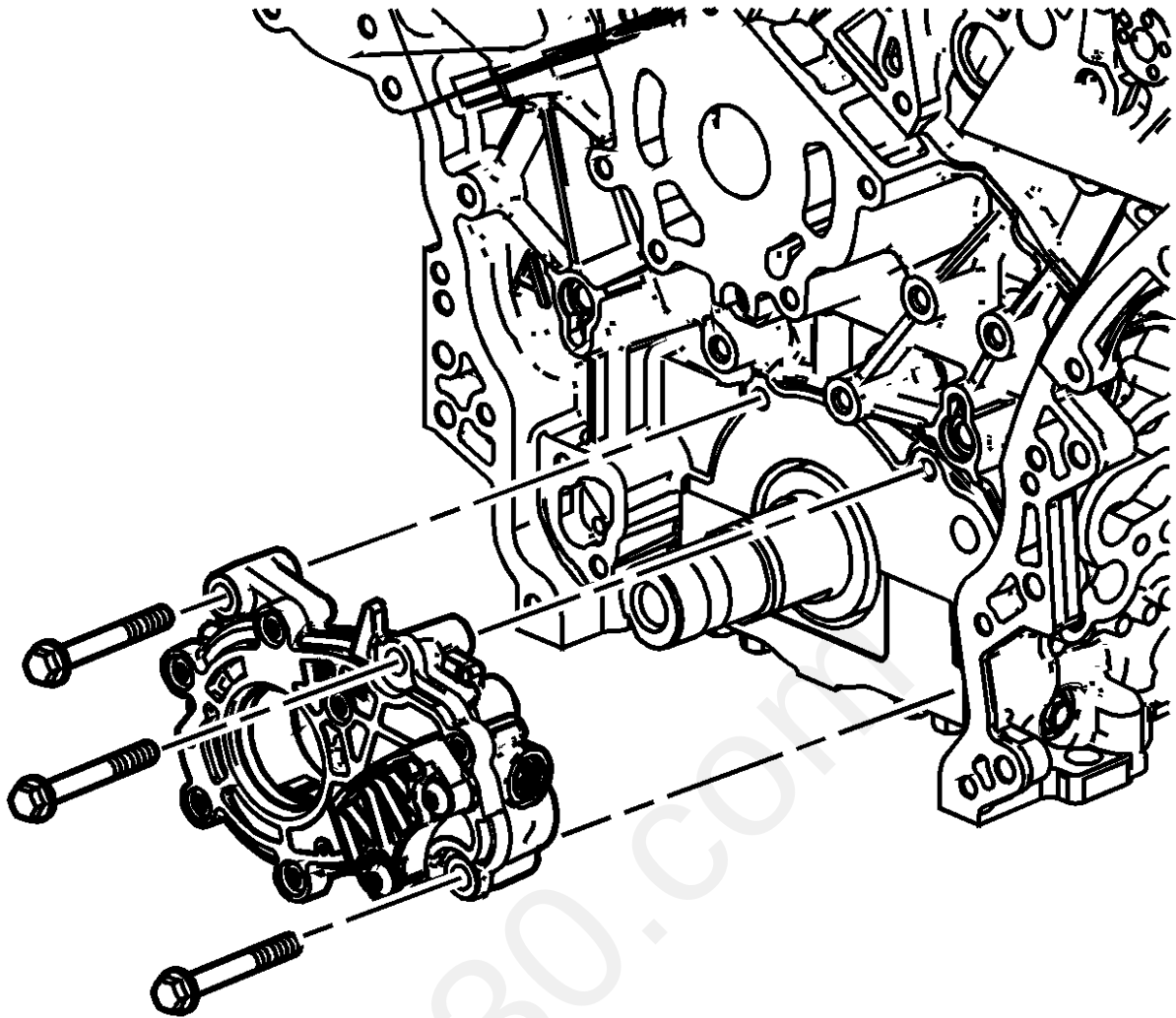


Fig. 204: View Of Oil Pump & Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not remove the left bank idler sprocket.

1. Remove the primary timing chain. Refer to [Primary Camshaft Drive Chain and Sprockets Replacement](#).
2. Remove the crankshaft sprocket. Refer to [Crankshaft Sprocket Removal](#).
3. Remove the oil pump bolts and the oil pump.

Installation Procedure

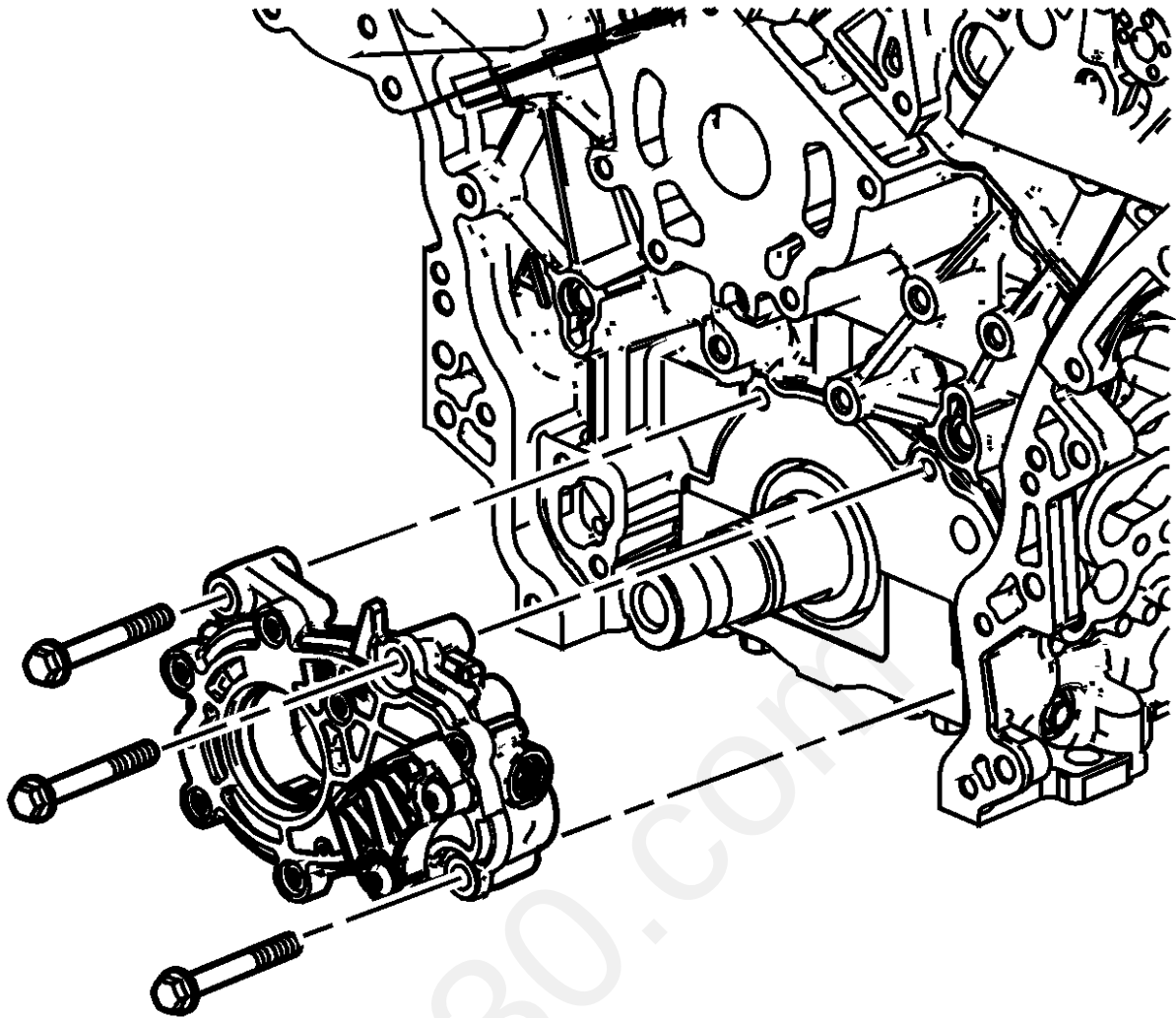


Fig. 205: View Of Oil Pump & Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the oil pump and bolts. Refer to [Oil Pump Installation](#)
2. Install the crankshaft sprocket. Refer to [Crankshaft Sprocket Installation](#) .
3. Install the primary timing chain. Refer to [Primary Camshaft Drive Chain and Sprockets Replacement](#).

OIL PAN REPLACEMENT

Special Tools

EN 46109 Guide Pin Set.

For equivalent regional tools, refer to [Special Tools](#) .

Removal Procedure

1. Drain the engine oil. Refer to [Engine Oil and Oil Filter Replacement](#).
2. If equipped with AWD remove the front axle. Refer to [Front Axle Replacement](#) .
3. Remove the steering gear skid plate. Refer to [Steering Gear Skid Shield Replacement](#) .

: the steering gear. Refer to [Electric Belt Drive Rack and Pinion Steering Gear Replacement \(4WD\)](#) [Electric Belt Drive Rack and Pinion Steering Gear Replacement \(2WD\)](#) .

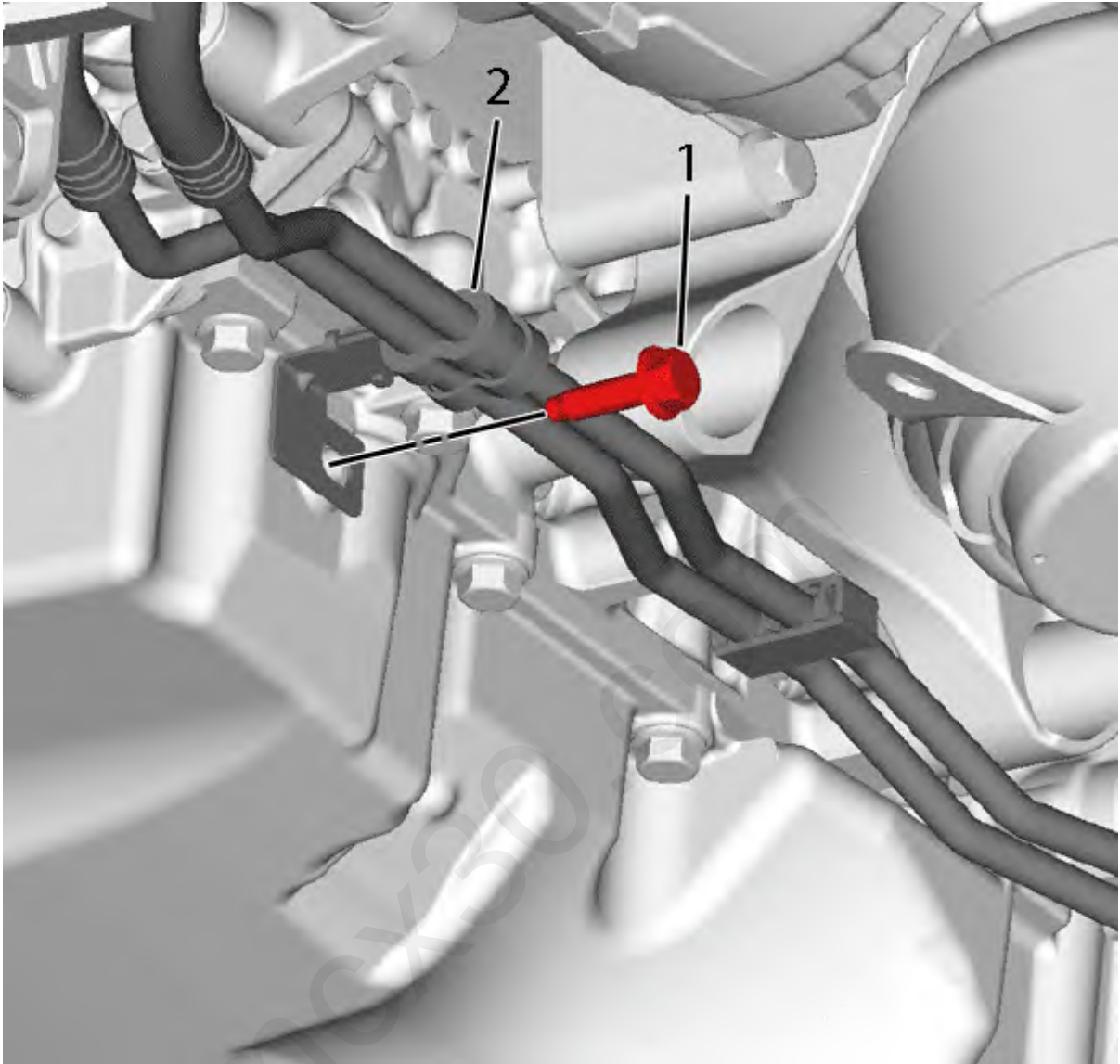


Fig. 206: Fastener

Courtesy of GENERAL MOTORS COMPANY

5. Remove the fastener (1) retaining the transmission lines (2) to the oil pan.
6. Position the transmission lines out of the way.
7. Disconnect the oil level sensor.
8. Remove the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).

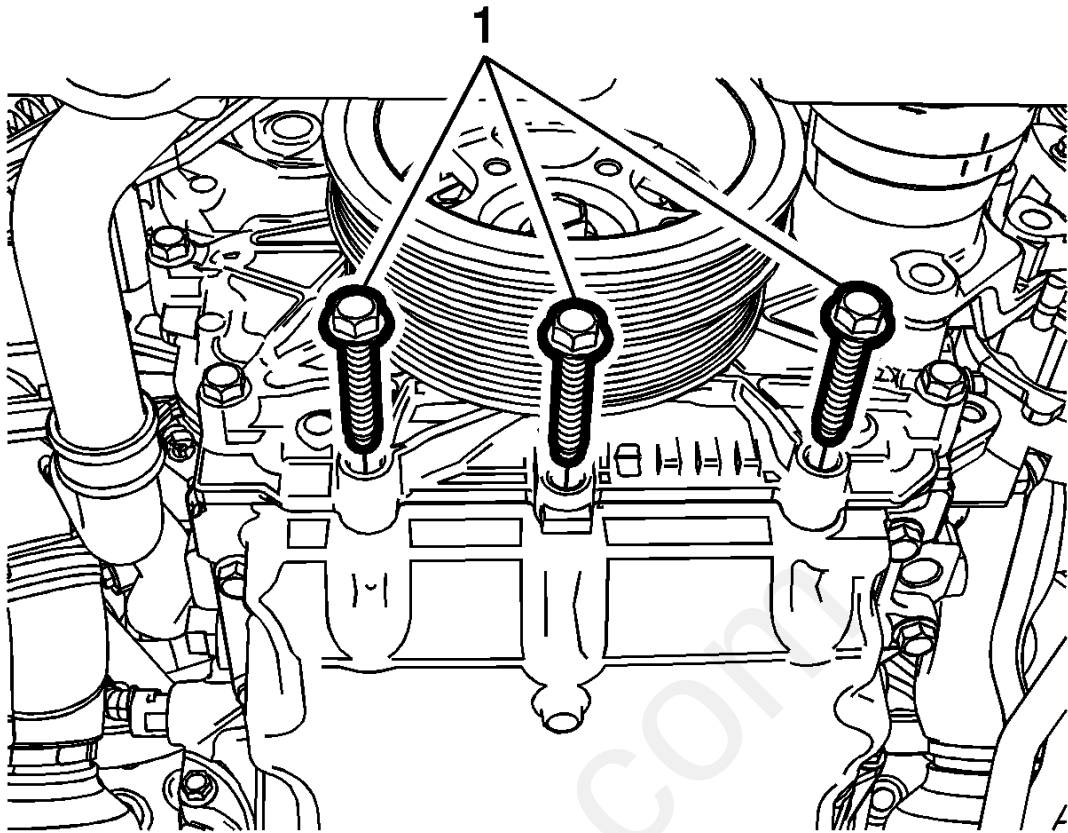


Fig. 207: Engine Front Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

9. Remove the front cover bolts (1).
10. Remove the transmission. Refer to [**Transmission Replacement \(LFX Engine with Four Wheel Drive\)**](#) , for automatic transmission, or [**Transmission Replacement \(LFX Engine with Two Wheel Drive\)**](#) , for manual transmission.

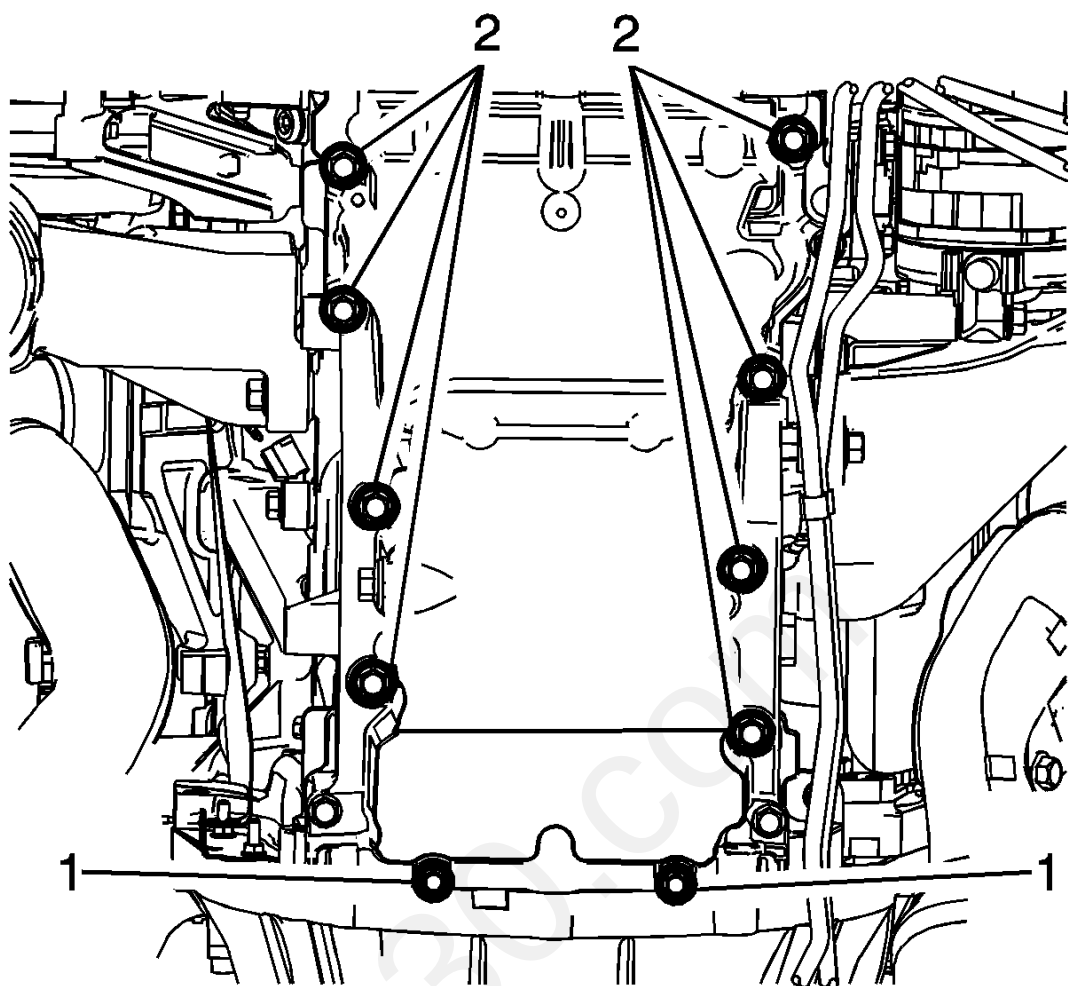


Fig. 208: Oil Pan Bolts

Courtesy of GENERAL MOTORS COMPANY

11. Remove the oil pan bolts (1) and (2).

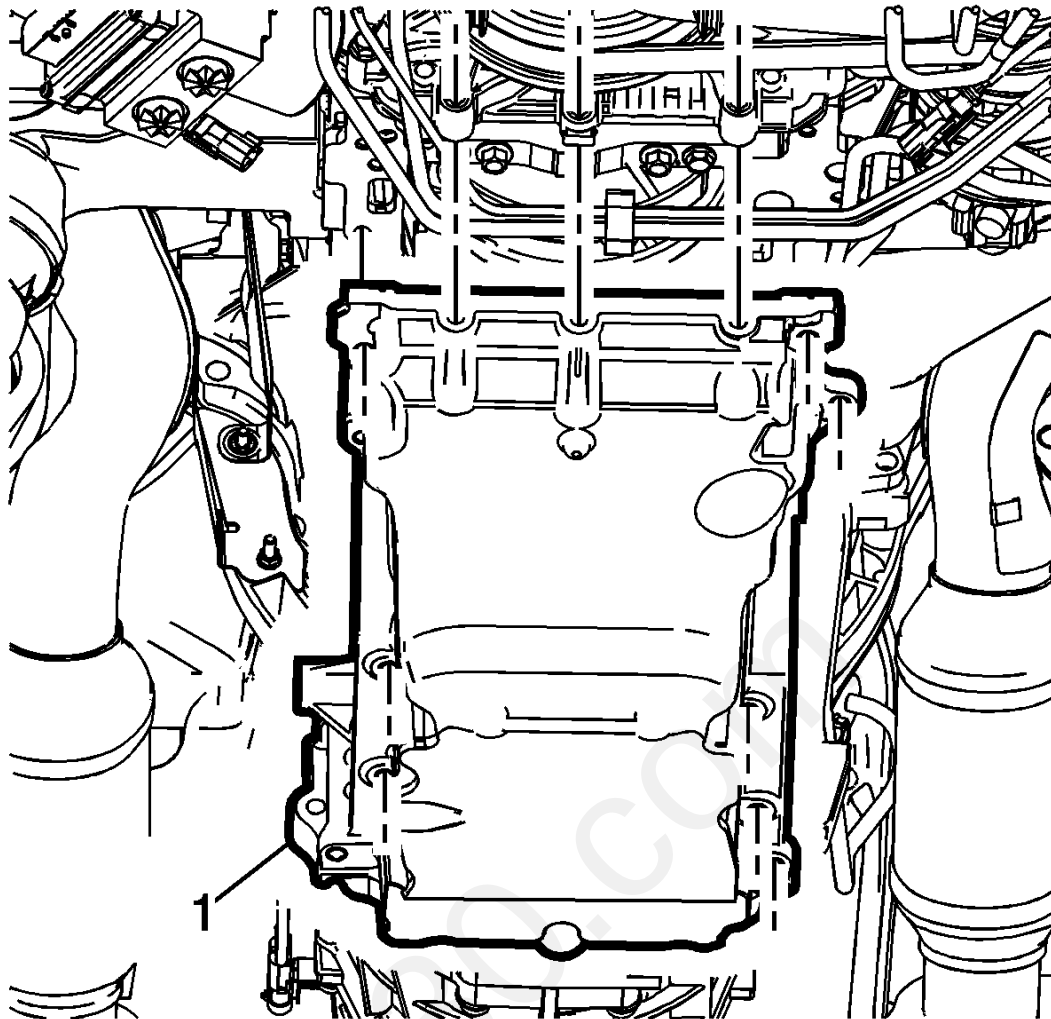


Fig. 209: Oil Pan

Courtesy of GENERAL MOTORS COMPANY

12. Remove the oil pan (1).
13. If necessary, disassemble the oil pan. Refer to [Oil Pan Disassemble](#) .
14. Clean and inspect the oil pan. Refer to [Oil Pan Cleaning and Inspection](#)

Installation Procedure

1. If the oil pan was disassembled, assemble the oil pan. Refer to [Oil Pan Assemble](#) .

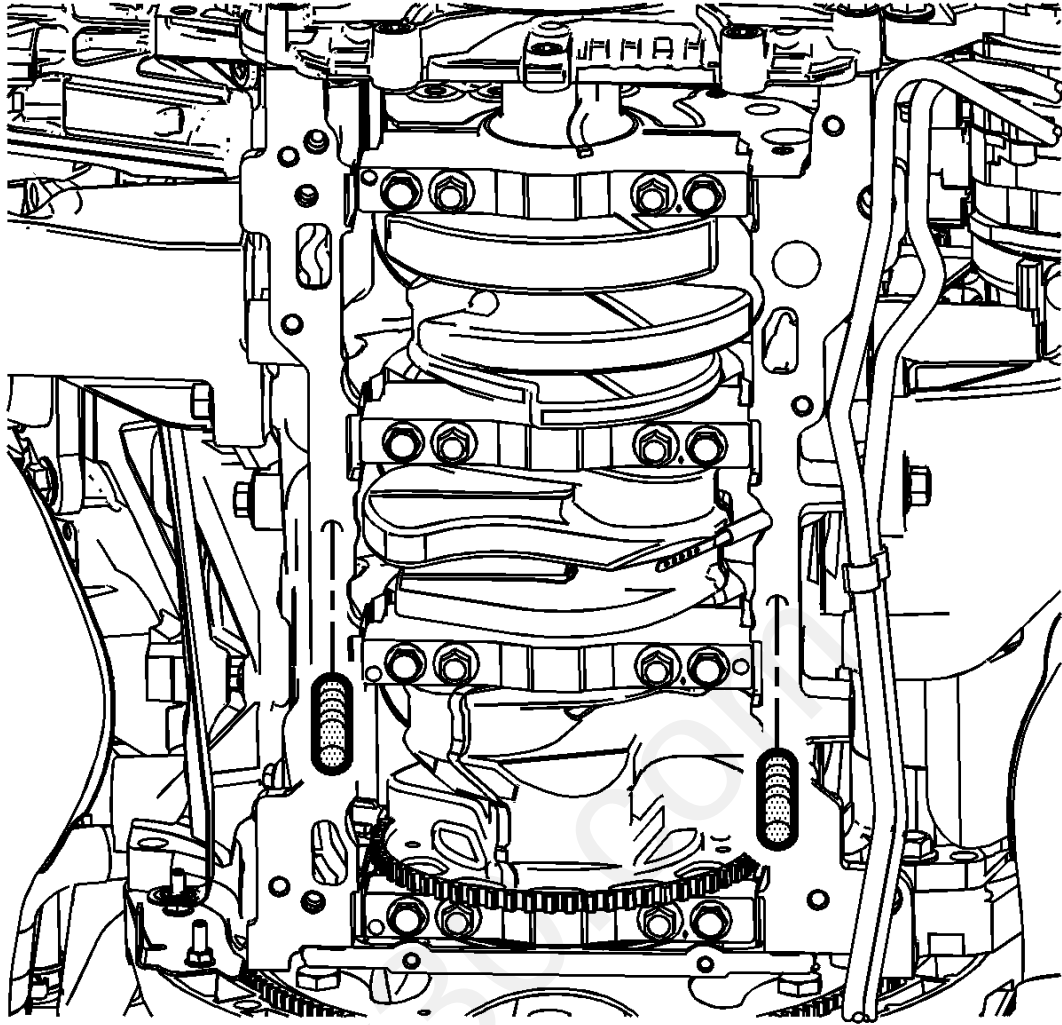


Fig. 210: Oil Pan Guide Pin Set

Courtesy of GENERAL MOTORS COMPANY

2. Install the 8 mm (0.315 in) guides from the EN 46109 set into the center oil pan rail bolt hole on each side of the engine block.

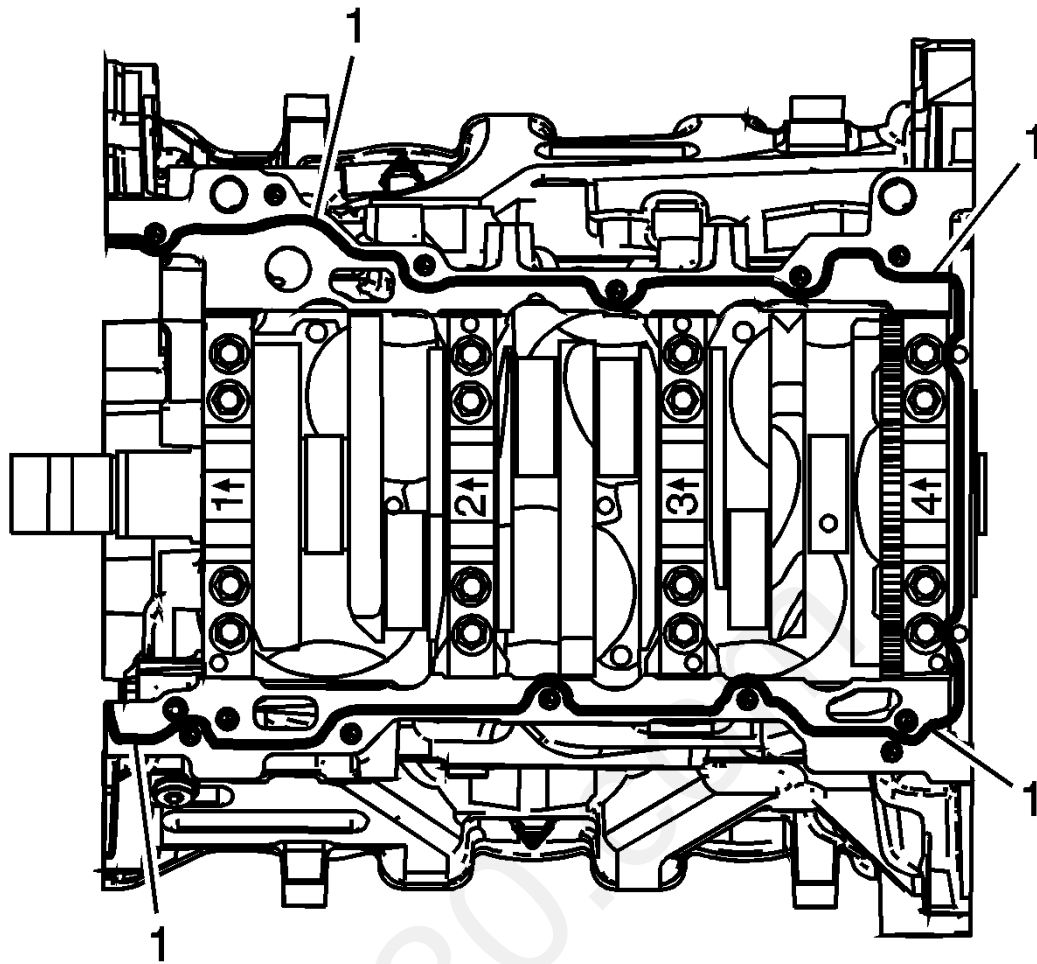


Fig. 211: Sealant Application Locations On Block Pan Rail And Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

3. Place a 3 mm (0.118 in) bead of RTV sealant, on the block pan rail and the crankshaft rear oil seal housing (1).

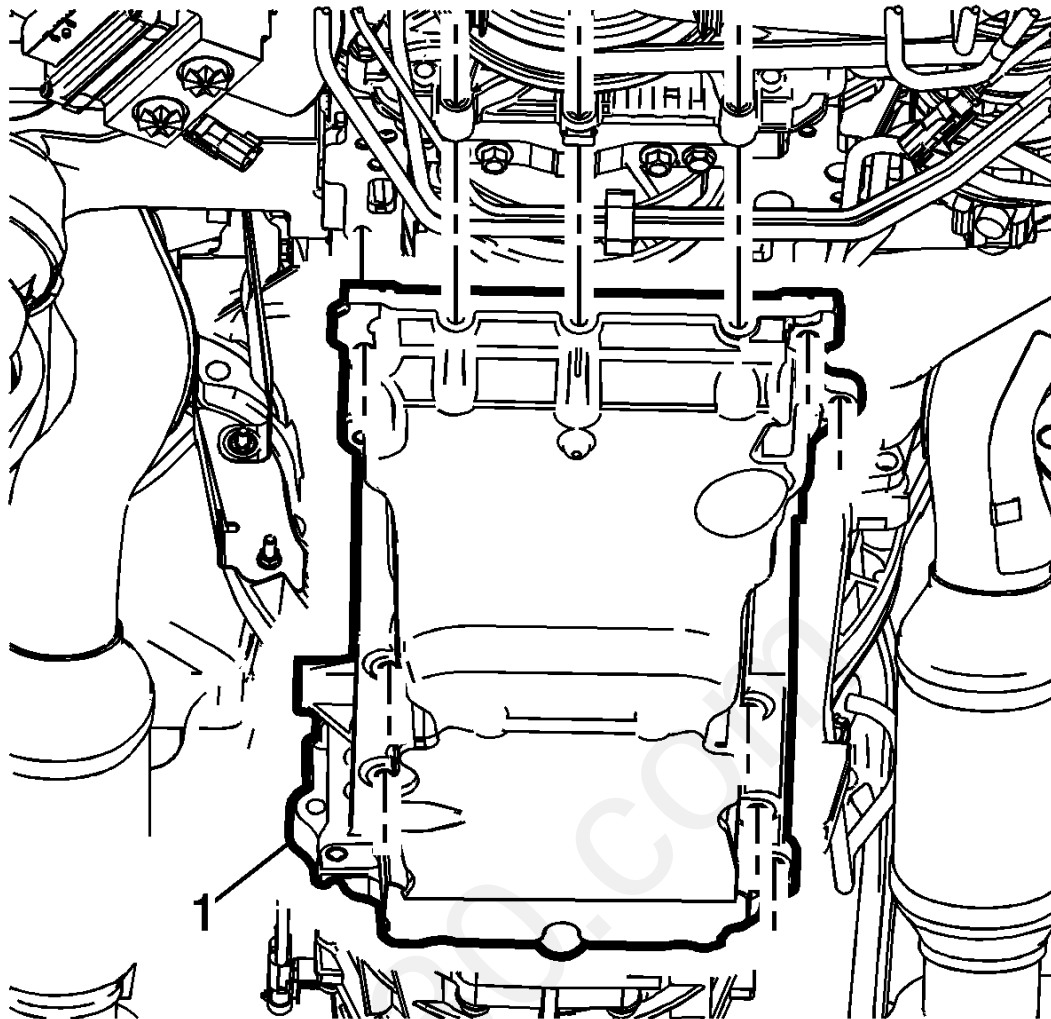


Fig. 212: Oil Pan

Courtesy of GENERAL MOTORS COMPANY

4. Install oil pan (1)
5. Remove the EN 46109 set 8 mm (0.315 in) guides from the engine block.

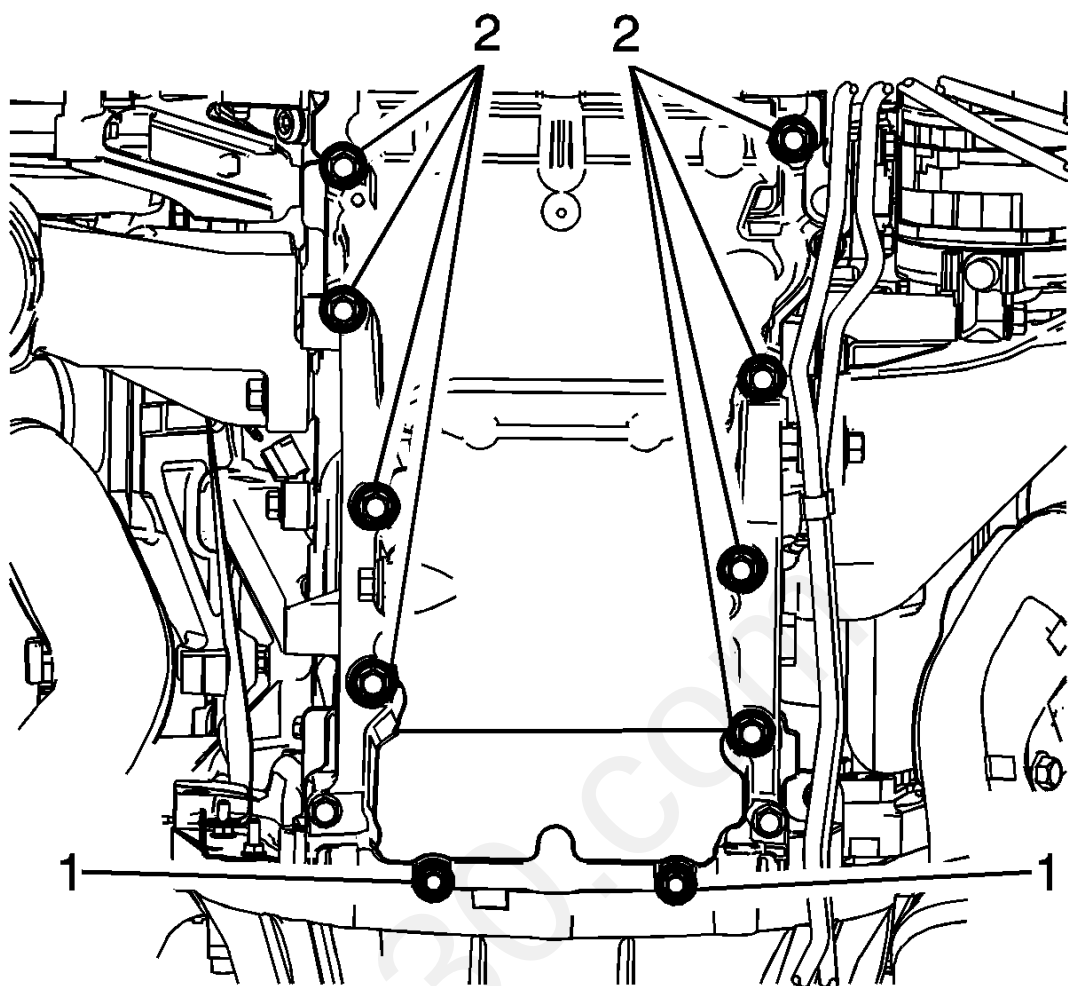


Fig. 213: Oil Pan Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

6. Loosely install the oil pan bolts (1) and (2).

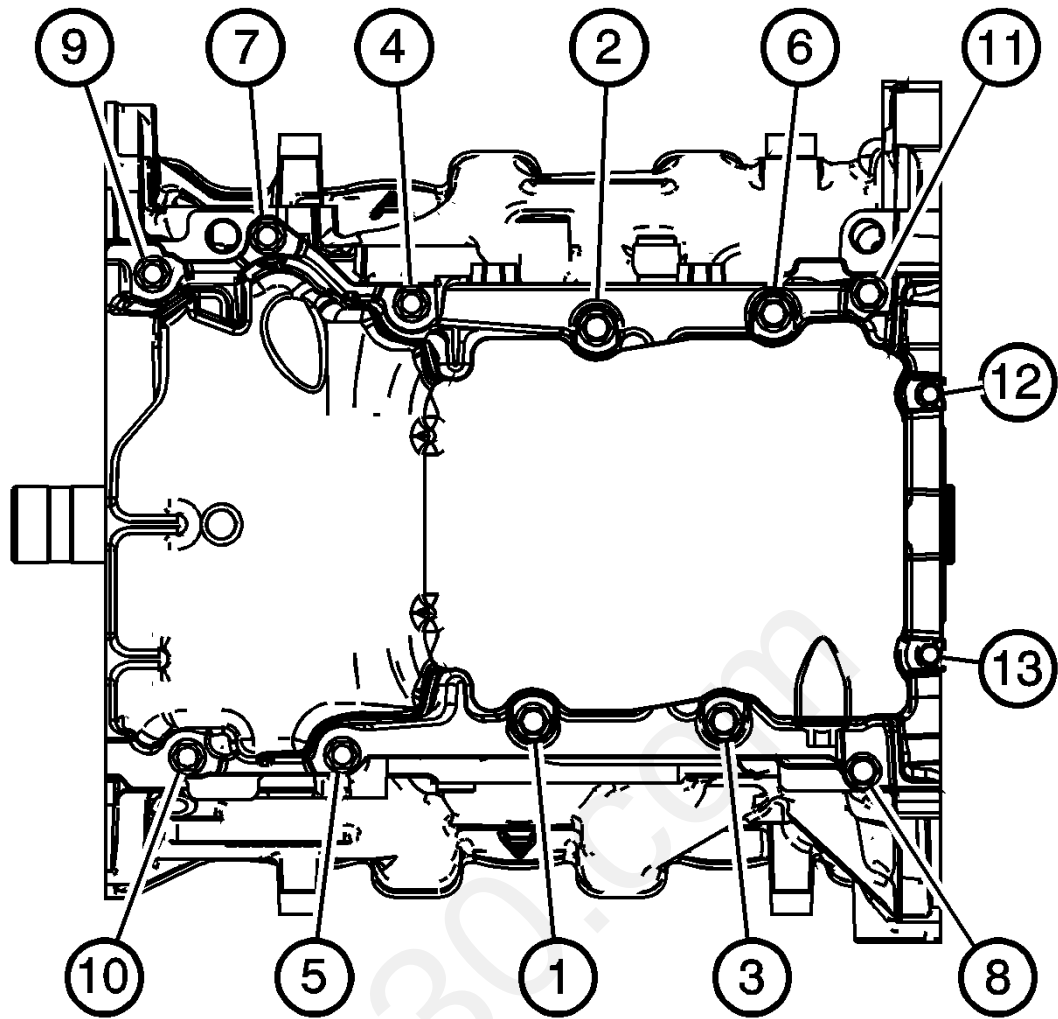


Fig. 214: View Of Engine Oil Pan Bolt Tightening Sequence

Courtesy of GENERAL MOTORS COMPANY

7. Tighten the oil pan bolts in sequence shown.

- Tighten the 8 mm bolts (1-11) to 25 N.m (18 lb ft).
- Tighten the 6 mm bolts (12, 13) to 10 N.m (89 lb in).

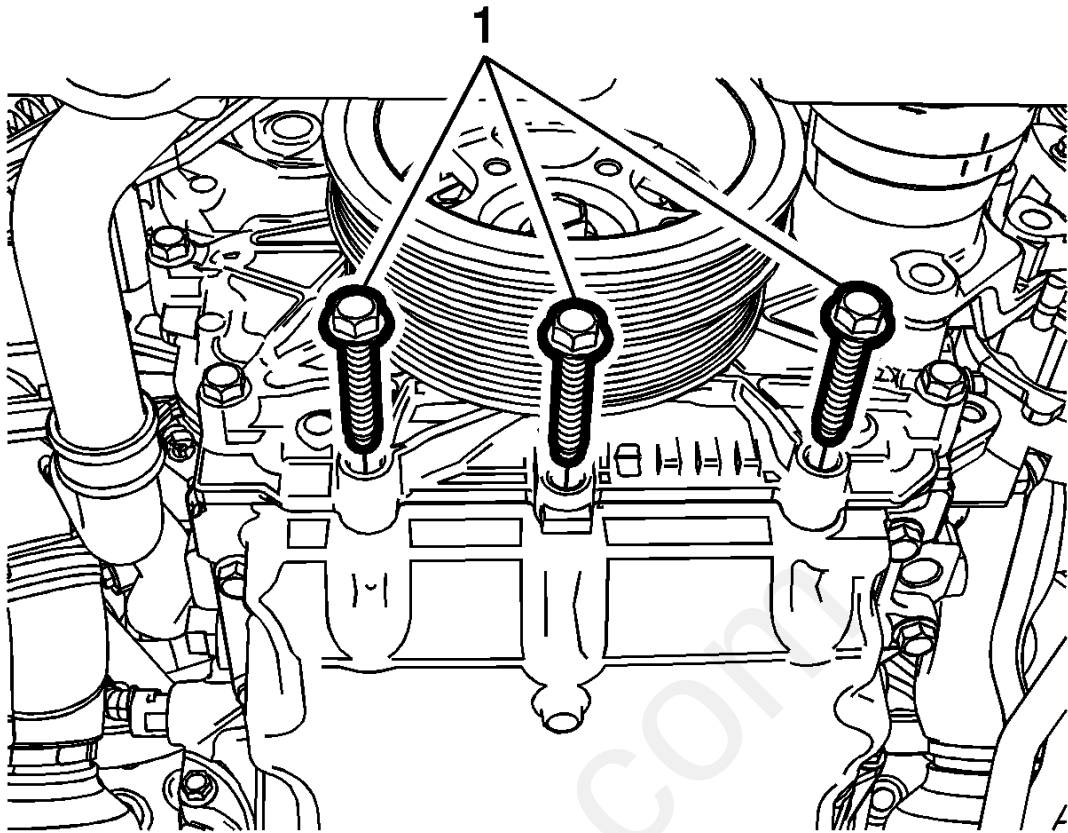


Fig. 215: Engine Front Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

8. Install NEW front cover bolts (1) and tighten the bolts to 20 N.m (14 lb ft) plus 60°.
9. Install the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).
10. Install the transmission. Refer to [Transmission Replacement \(LFX Engine with Four Wheel Drive\)](#) [Transmission Replacement \(LFX Engine with Two Wheel Drive\)](#) , for automatic transmission, or [Transmission Replacement](#) for manual transmission.
11. Connect the oil level sensor.

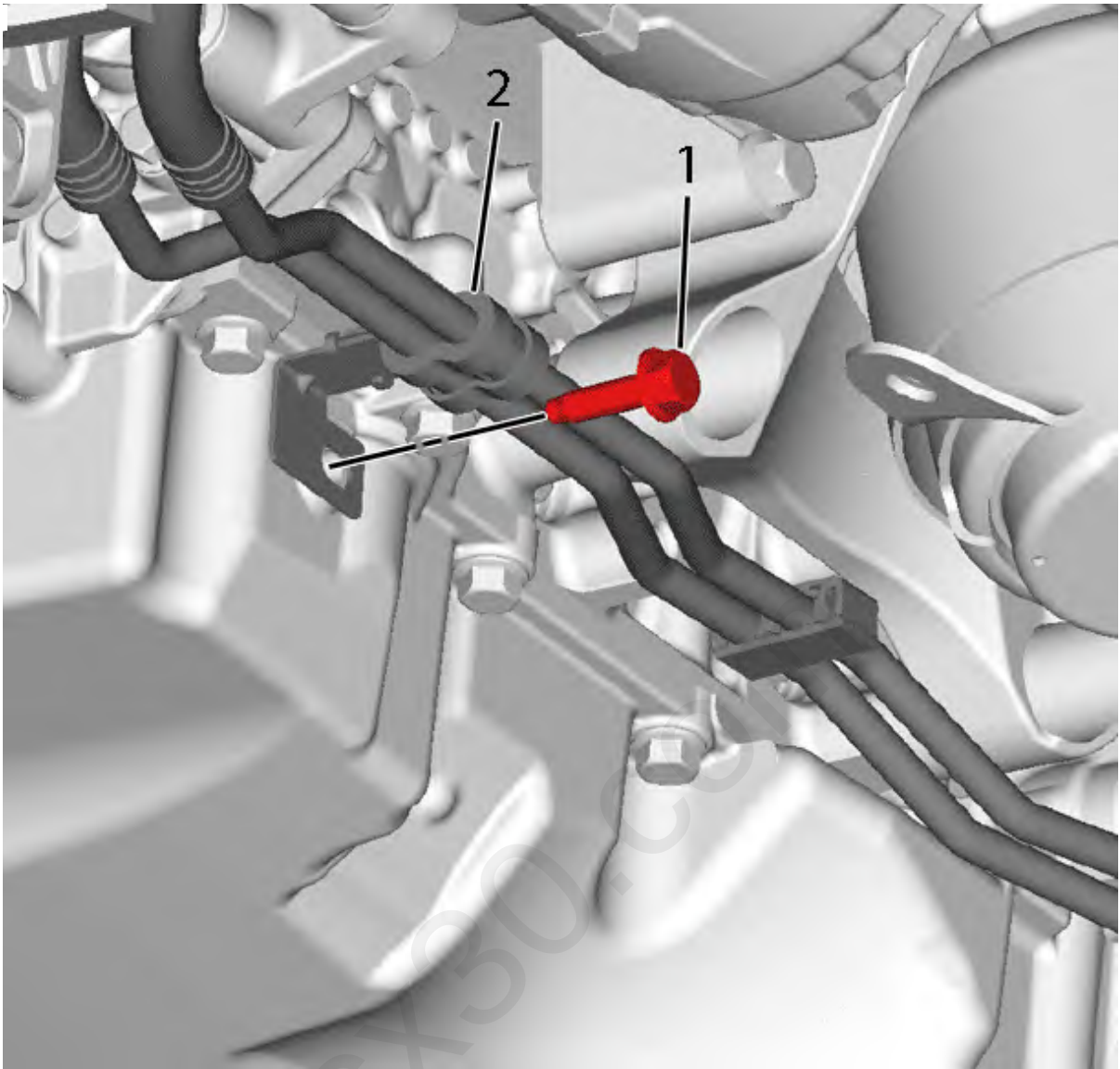


Fig. 216: Fastener

Courtesy of GENERAL MOTORS COMPANY

12. Reposition the transmission lines (2) to the oil pan.
13. Install the fastener (1) retaining the transmission lines (2) to the oil pan and tighten the fastener to 22 N.m (16 lb ft).
14. If equipped with AWD Install the front axle. Refer to [**Front Axle Replacement**](#) .
15. Install the steering gear. Refer to [**Electric Belt Drive Rack and Pinion Steering Gear Replacement \(4WD\)**](#) [**Electric Belt Drive Rack and Pinion Steering Gear Replacement \(2WD\)**](#) .
16. Install the steering gear skid plate. Refer to [**Steering Gear Skid Shield Replacement**](#) .
17. Fill the engine oil. Refer to [**Engine Oil and Oil Filter Replacement**](#).

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

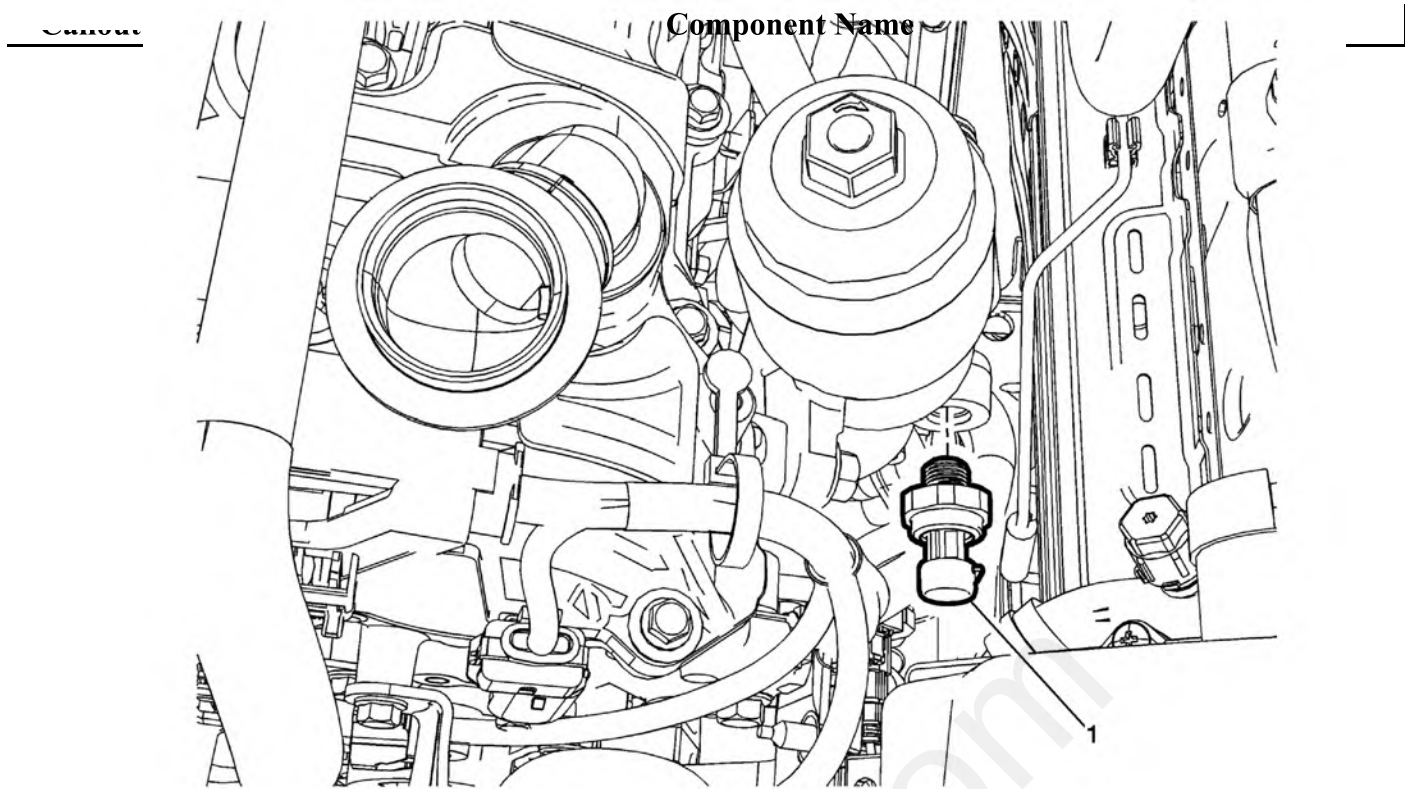


Fig. 217: Engine Oil Pressure Sensor and/or Switch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
1	Engine Oil Pressure Sensor and/or Switch CAUTION: Refer to Component Fastener Tightening Caution . Procedure Disconnect the oil pressure sensor electrical connector. Tighten 20 N.m (15 lb ft) Special Tools EN-41712 Oil Pressure Switch Socket For equivalent regional tools, refer to Special Tools .

ENGINE OIL LEVEL INDICATOR SWITCH REPLACEMENT

Removal Procedure

1. Remove the oil pan. Refer to [Oil Pan Replacement](#).

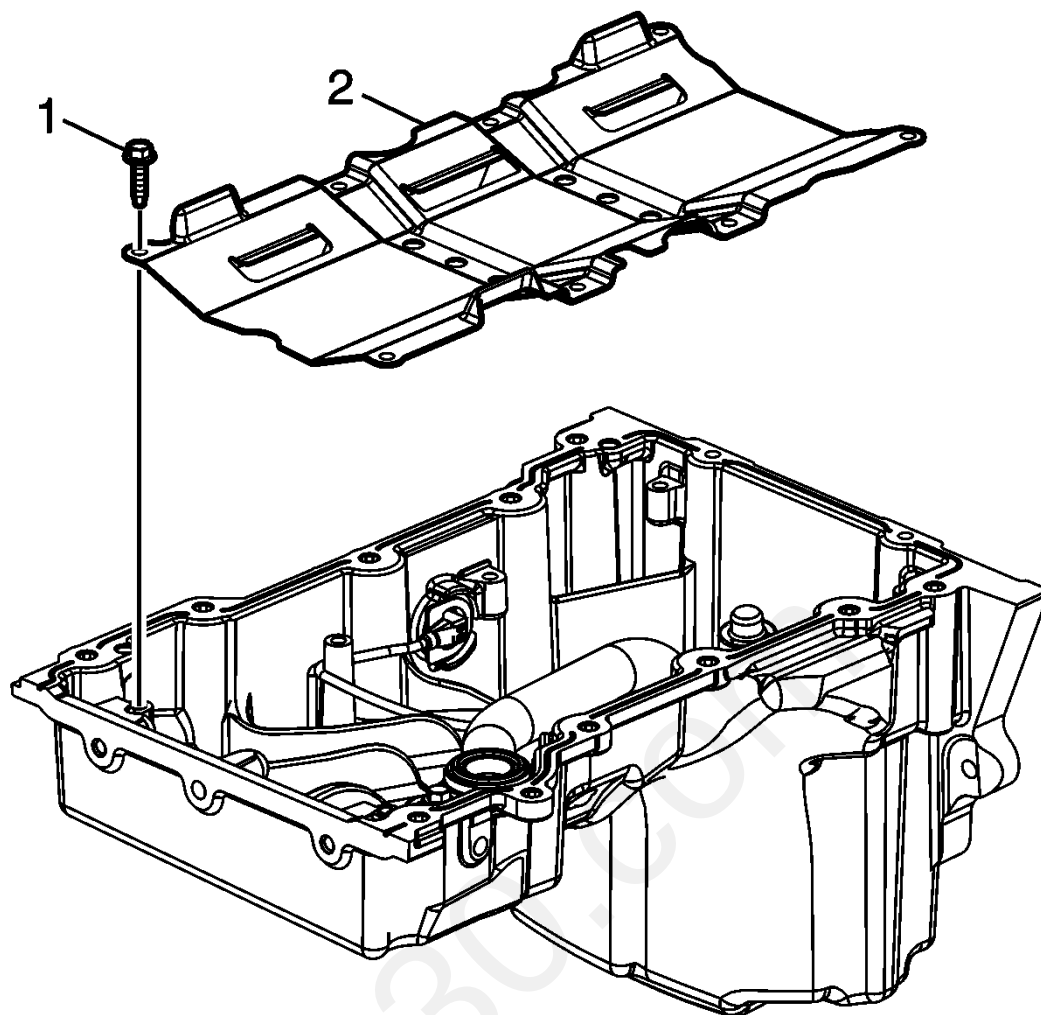


Fig. 218: Oil Pan Scraper Bolts

Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil pan scraper bolts (1).
3. Remove the oil pan scraper (2).

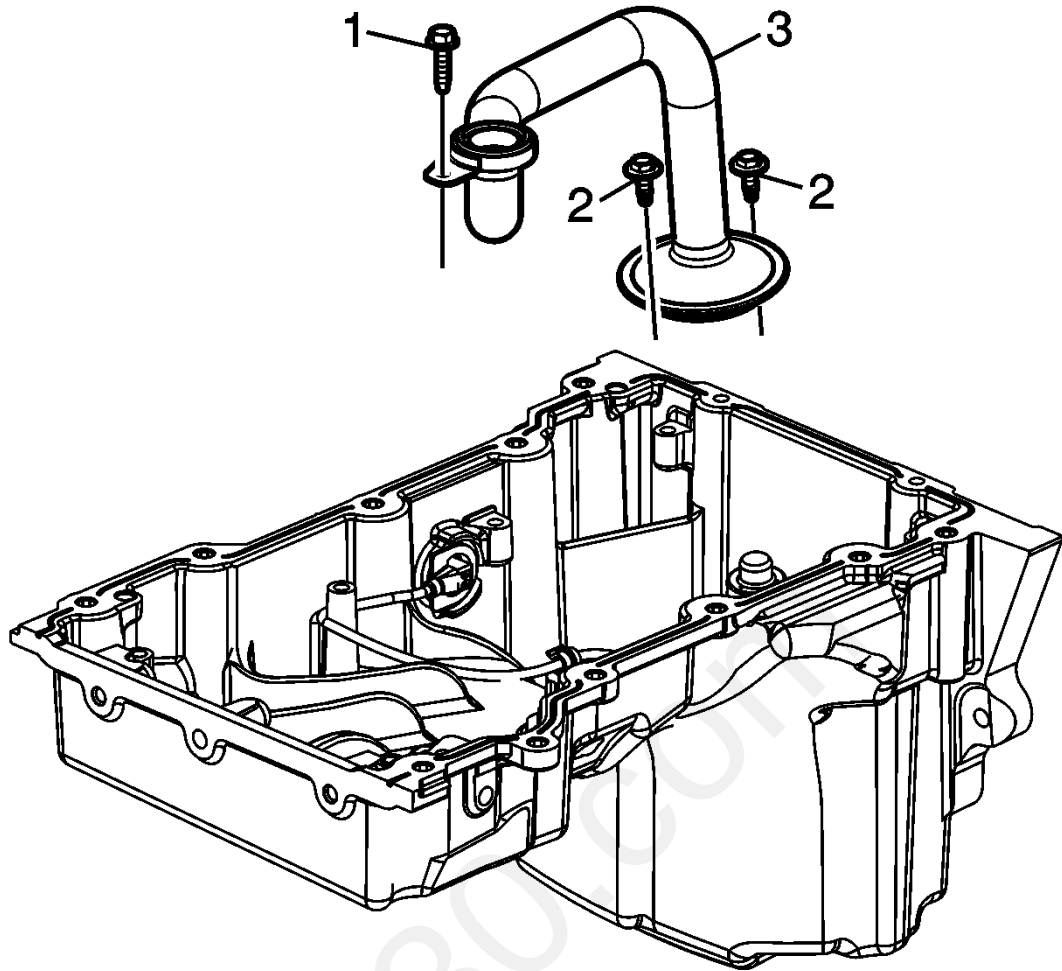


Fig. 219: Oil Suction Pipe Bolt

Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil suction pipe bolt (1).
5. Remove the oil suction pipe retaining bolts (2).
6. Remove the oil suction pipe (3).

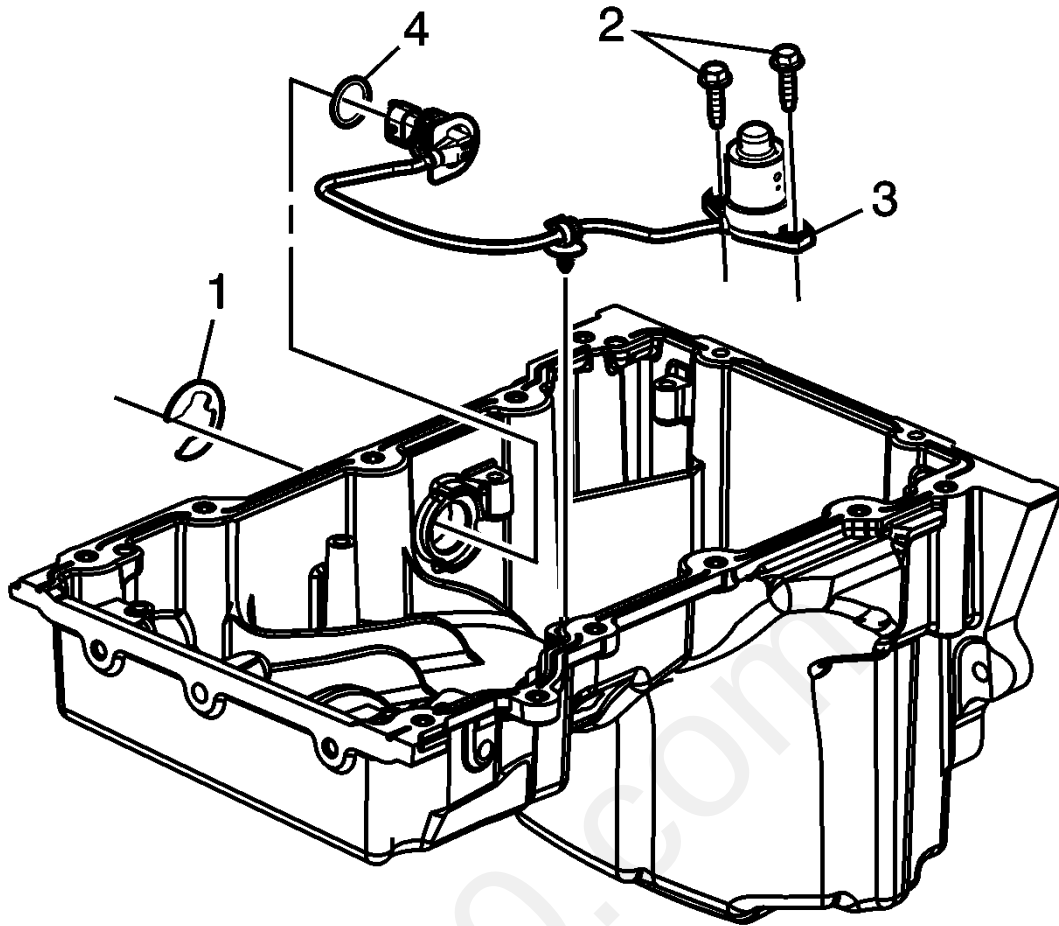


Fig. 220: Engine Oil Level Switch Clip

Courtesy of GENERAL MOTORS COMPANY

7. Remove the engine oil level switch clip (1).
8. Remove the engine oil level switch bolts (2).
9. Remove the engine oil level switch (3).
10. Remove the engine oil level switch seal (4).

Installation Procedure

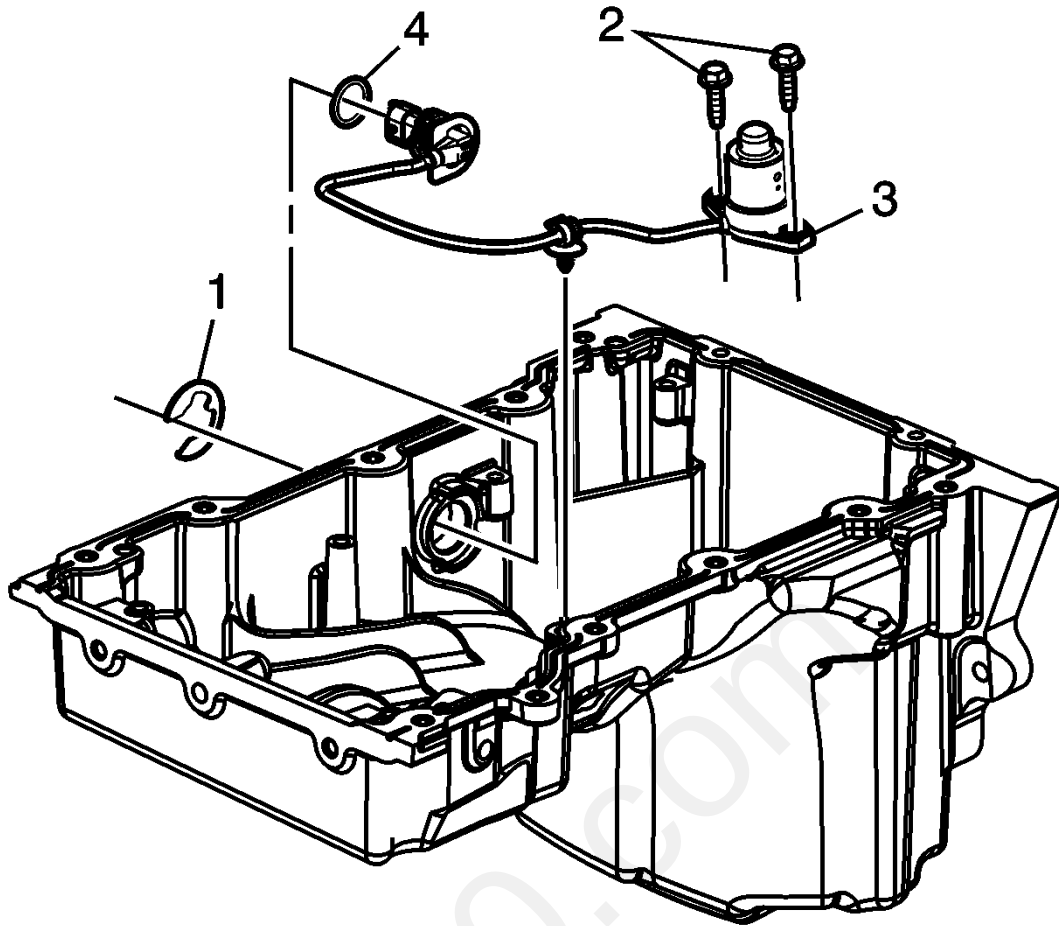


Fig. 221: Engine Oil Level Switch Clip
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

1. Install the NEW engine oil level switch seal (4).
2. Install the engine oil level switch (3).
3. Install the engine oil level switch bolts (2) and tighten to 10 N.m (89 lb in).
4. Install NEW engine oil level switch clip (1).

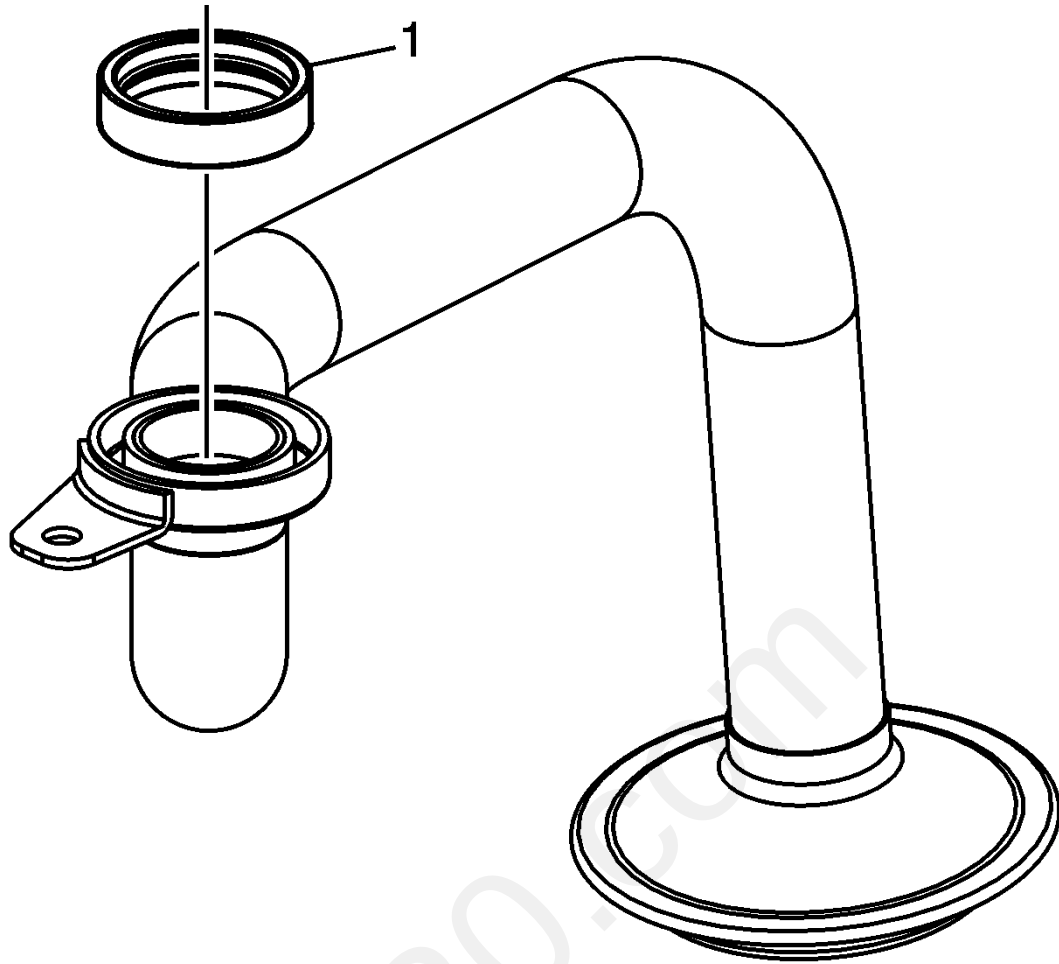


Fig. 222: Oil Suction Tube Seal

Courtesy of GENERAL MOTORS COMPANY

5. inspect the oil suction pipe seal (1) and replace if damaged.

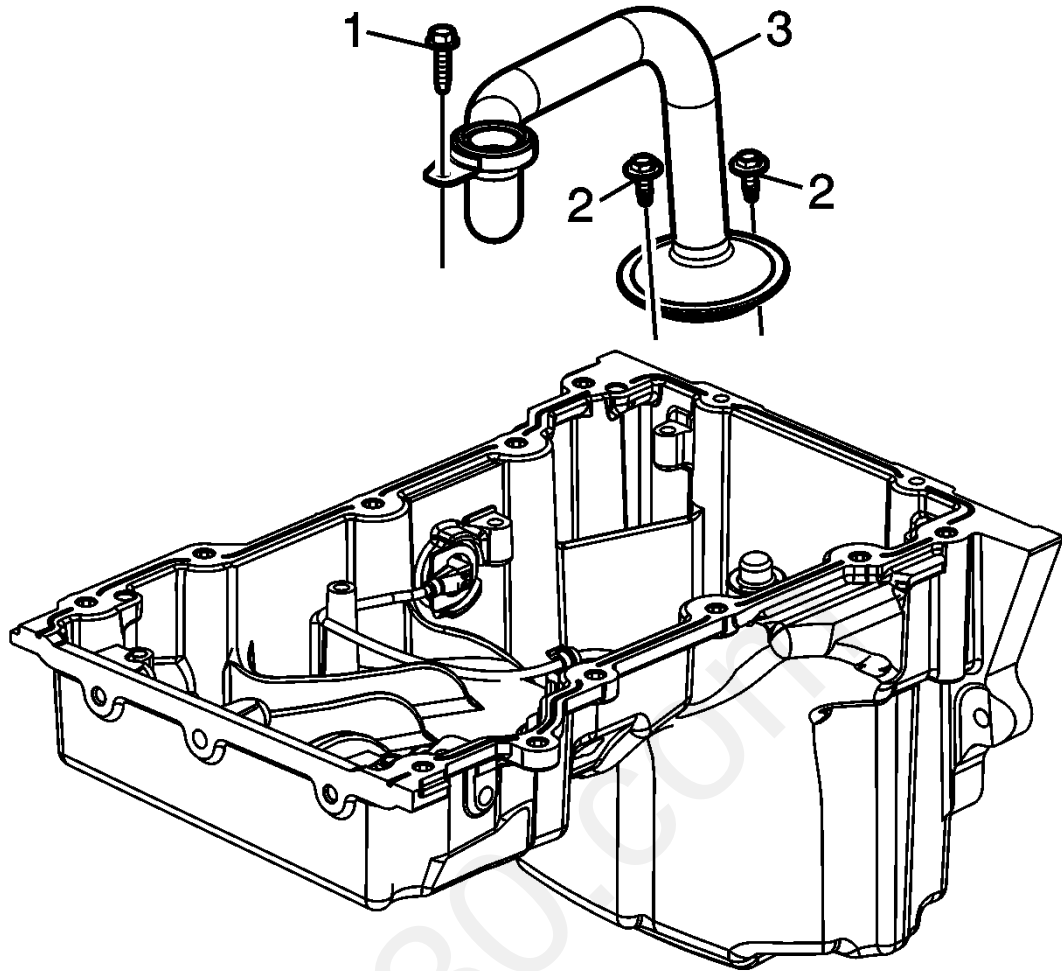


Fig. 223: Oil Suction Pipe Bolt

Courtesy of GENERAL MOTORS COMPANY

6. Install the oil suction pipe (2).
7. Install the oil suction pipe retaining bolts (2) and tighten to 10 N.m (89 lb in).
8. Install the oil suction pipe bolt (1) and tighten to 10 N.m (89 lb in).

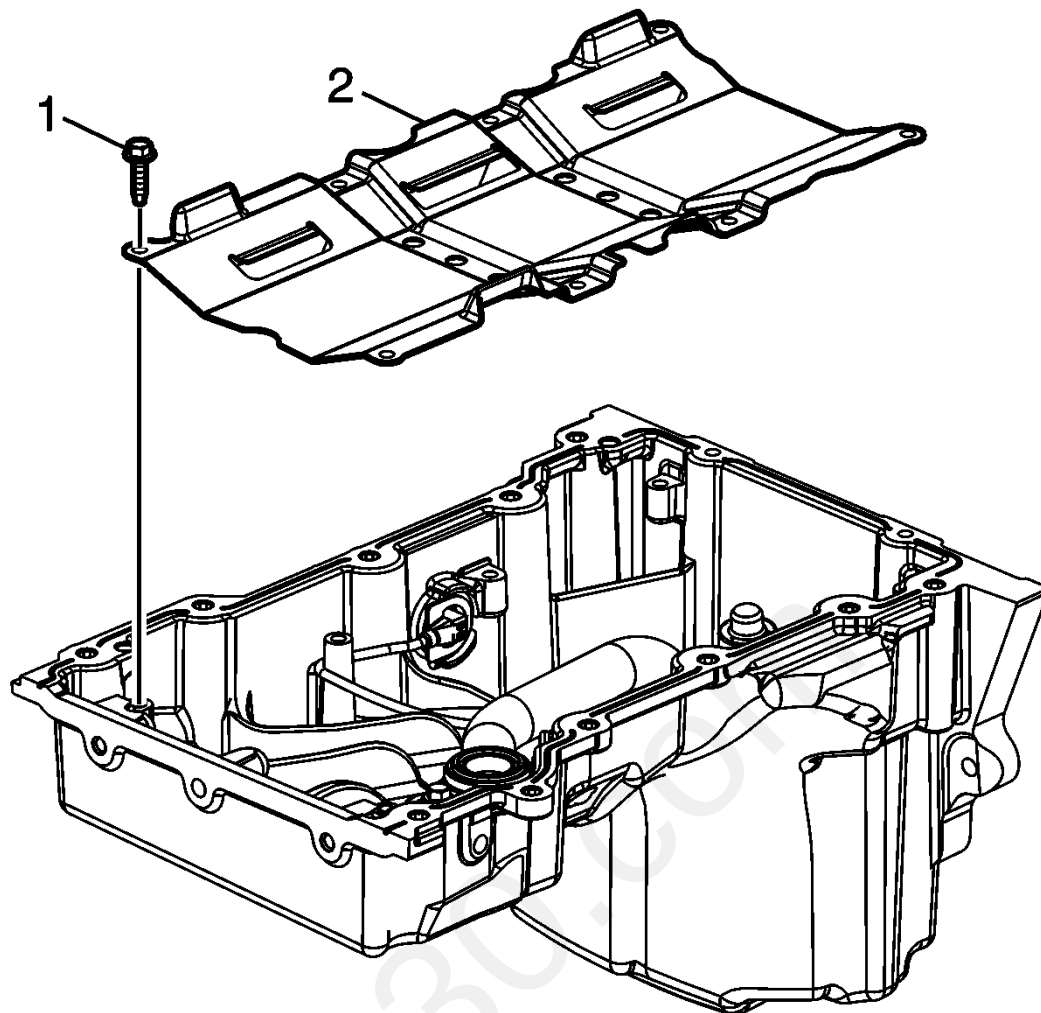


Fig. 224: Oil Pan Scraper Bolts

Courtesy of GENERAL MOTORS COMPANY

9. Install the oil pan scraper (2).
10. Install the oil pan scraper bolts (1) and tighten to 10 N.m (89 lb in).
11. Install the oil pan. Refer to [Oil Pan Replacement](#).

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the oil pan. Refer to [Oil Pan Replacement](#).

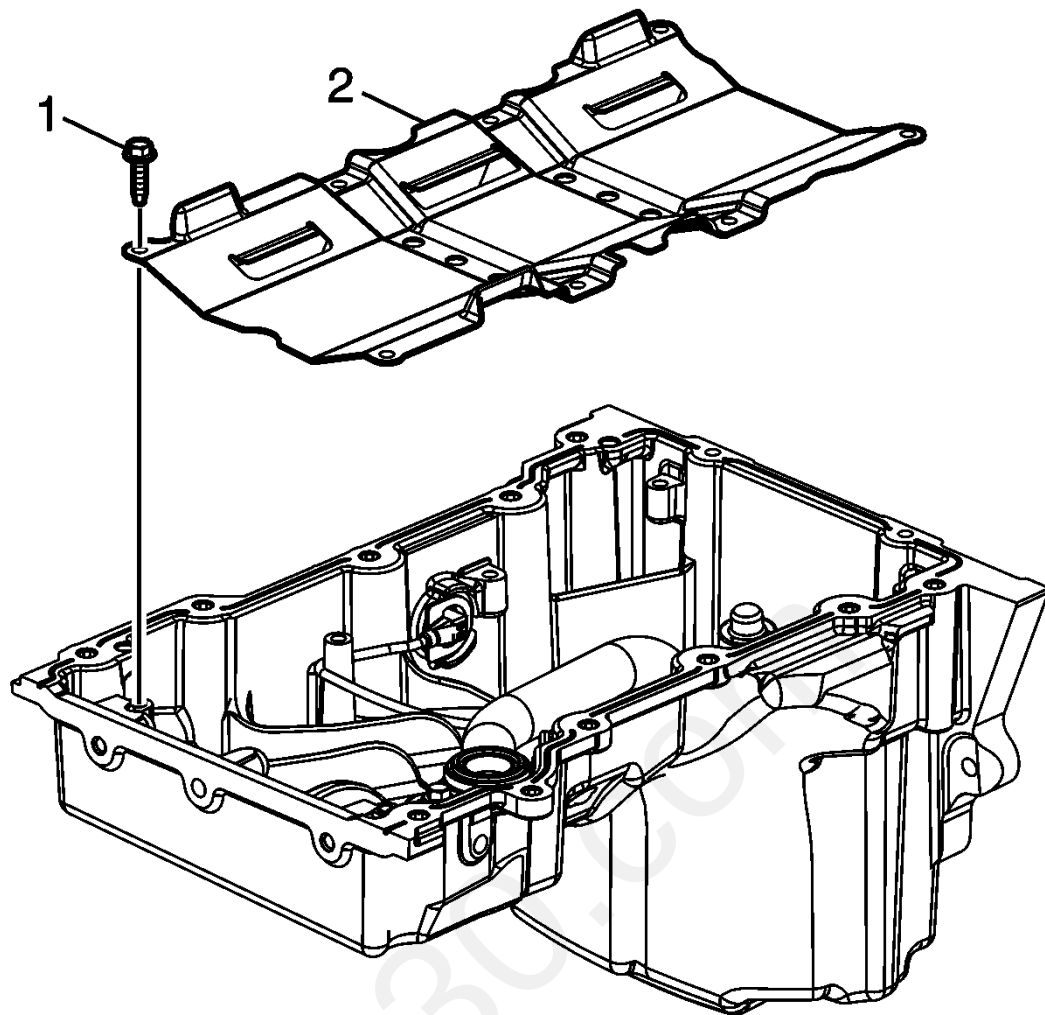


Fig. 225: Oil Pan Scraper Bolts

Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil pan scraper bolts (1).
3. Remove the oil pan scraper (2).

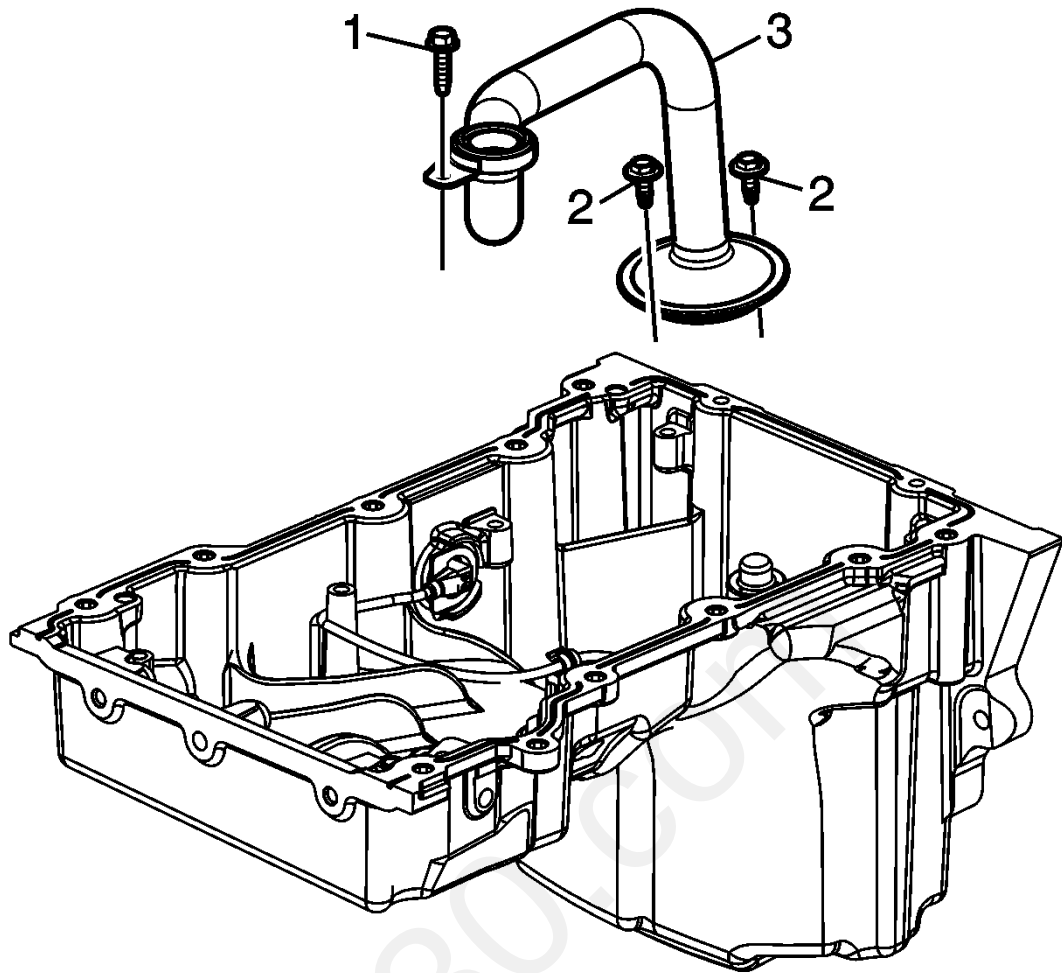


Fig. 226: Oil Suction Pipe Bolt

Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil suction pipe bolt (1).
5. Remove the oil suction pipe retaining bolts (2).
6. Remove the oil suction pipe (3).

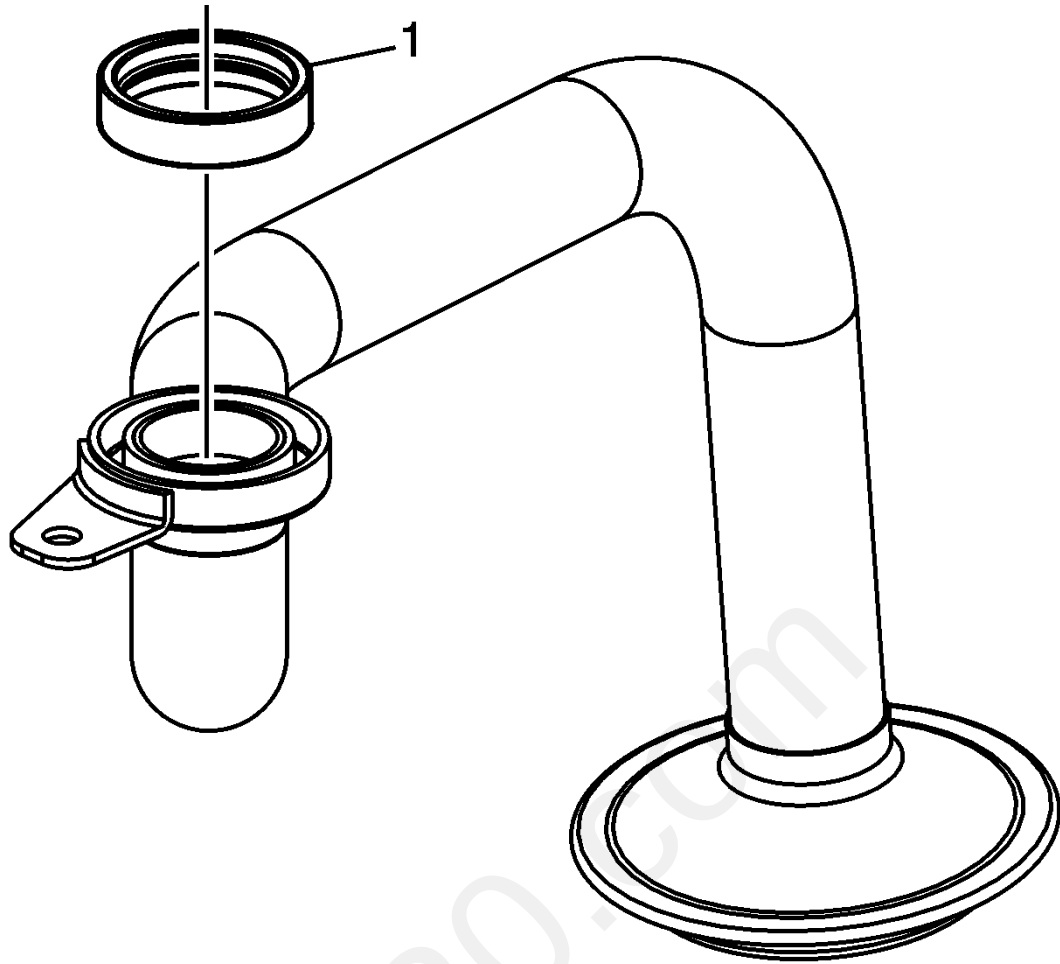


Fig. 227: Oil Suction Tube Seal

Courtesy of GENERAL MOTORS COMPANY

7. Remove and discard the oil suction pipe seal (1).

Installation Procedure

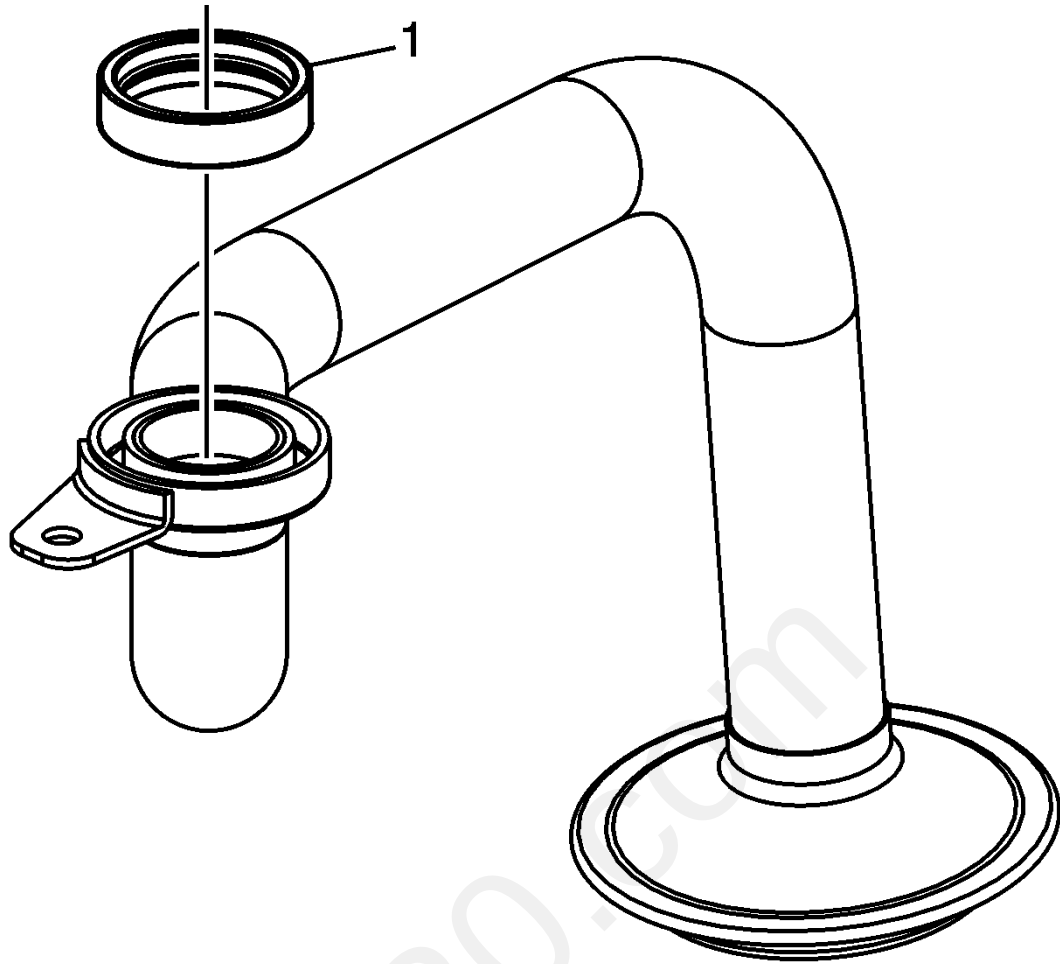


Fig. 228: Oil Suction Tube Seal

Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW oil suction pipe seal (1).

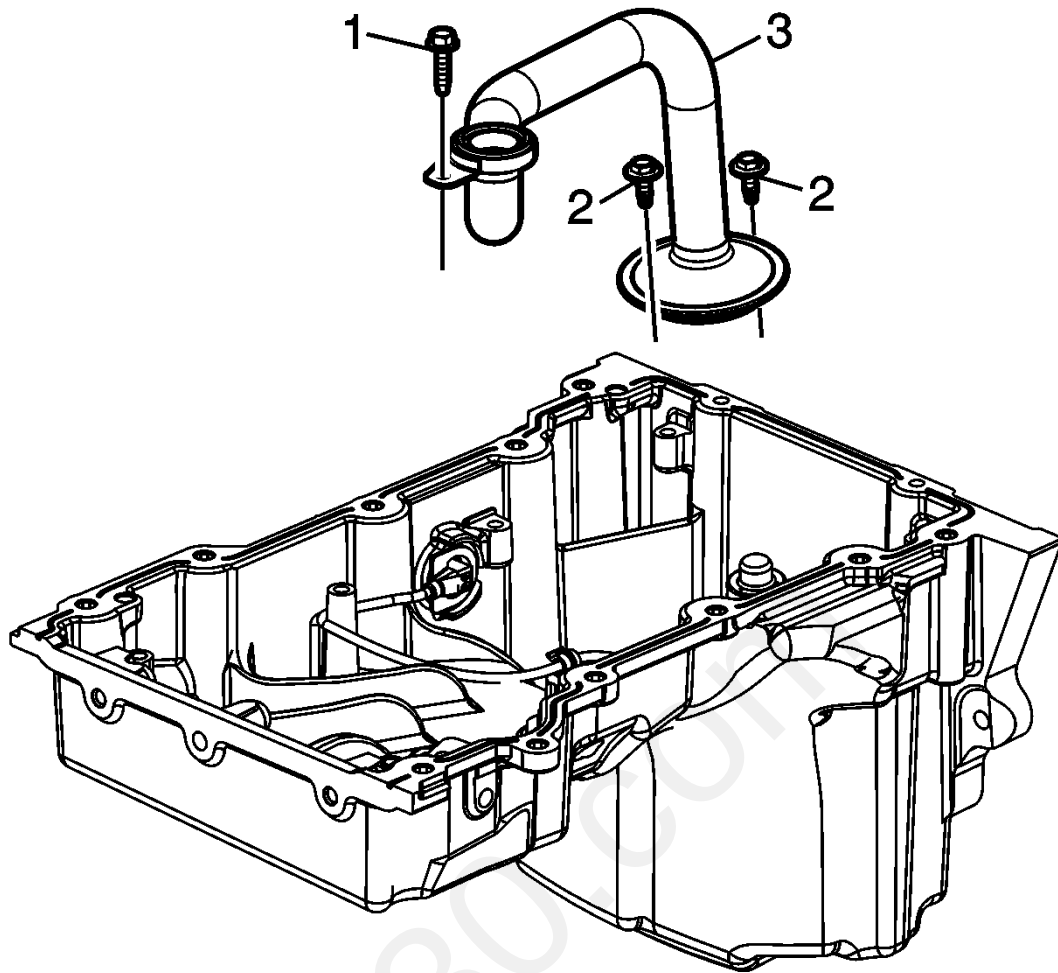


Fig. 229: Oil Suction Pipe Bolt

Courtesy of GENERAL MOTORS COMPANY

2. Install the oil suction pipe (2).

CAUTION: Refer to [Fastener Caution](#) .

3. Install the oil suction pipe retaining bolts (2) and tighten to 10 N.m (89 lb in).

4. Install the oil suction pipe bolt (1) and tighten to 10 N.m (89 lb in).

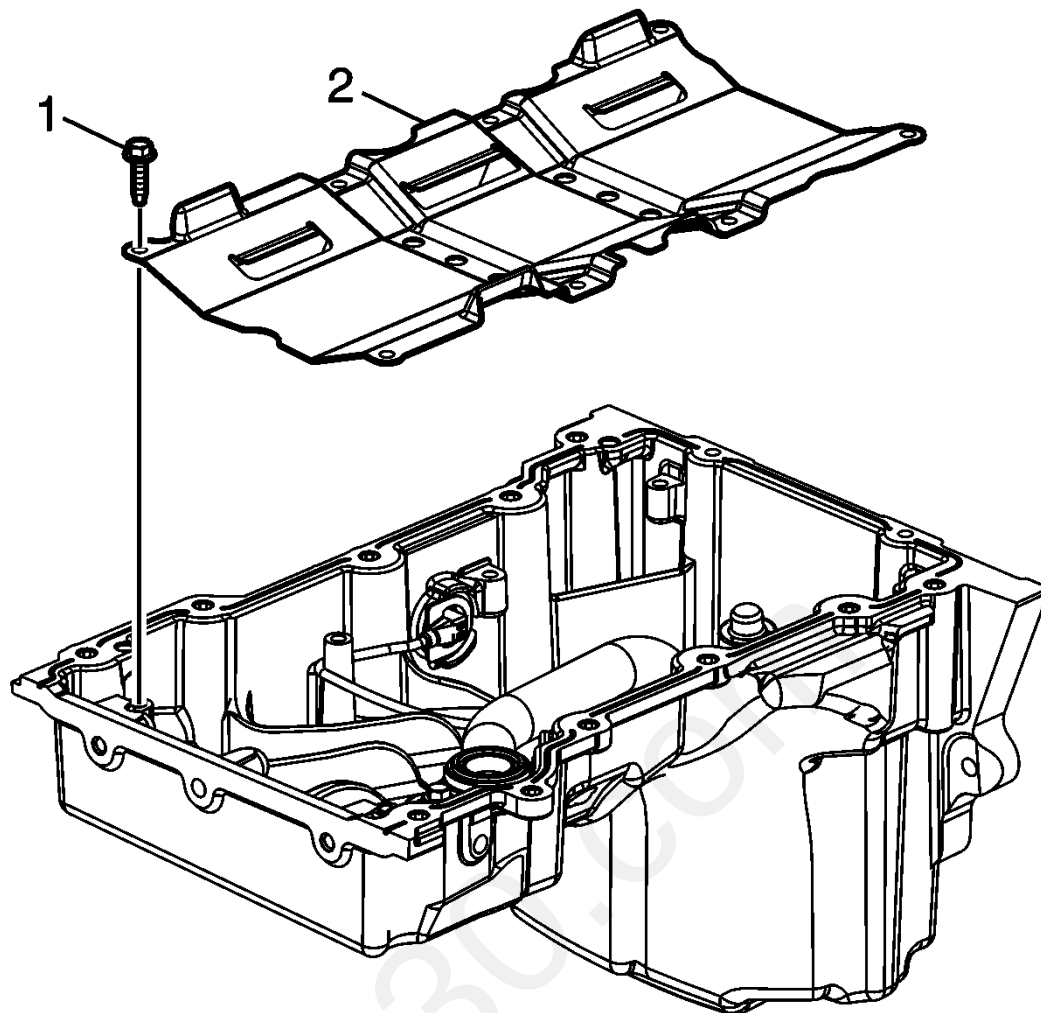


Fig. 230: Oil Pan Scraper Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Install the oil pan scraper (2).
6. Install the oil pan scraper bolts (1) and tighten to 10 N.m (89 lb in).
7. Install the oil pan. Refer to [Oil Pan Replacement](#).

ENGINE REPLACEMENT

Special Tools

- EN-36857 Engine Lift Hook

Equivalent regional tools: [Special Tools](#)

Removal Procedure

1. Remove the hood. [Hood Replacement](#)
2. Disconnect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)
3. Recover the refrigerant. [Refrigerant Recovery and Recharging](#)
4. Remove Radiator. [Radiator Replacement \(LFX\)](#)
5. Remove Front End Upper Tie Bar. [Front End Upper Tie Bar Replacement](#)

- the plenum front panel. [Plenum Front Panel Replacement](#)
- 7. Remove the air cleaner outlet duct. [Air Cleaner Outlet Duct Replacement](#)
- 8. Remove the intake air splash shield. [Intake Air Splash Shield Replacement](#)

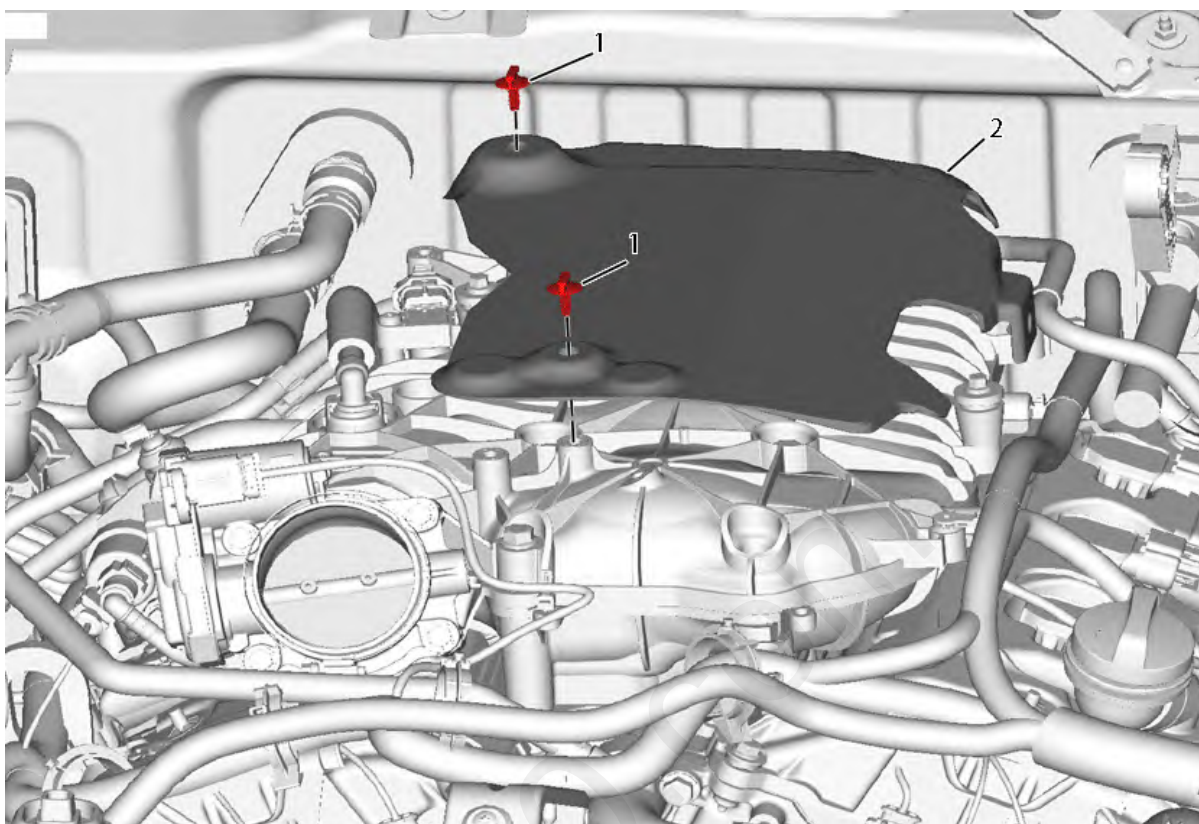


Fig. 231: Intake Manifold Insulator
Courtesy of GENERAL MOTORS COMPANY

- 9. Remove the intake manifold insulator (2). [Intake Manifold Insulator Replacement](#)
- 10. Disconnect the heater inlet hose from the heater core tube. [Heater Inlet Hose Replacement \(LFX\)](#)
- 11. Disconnect the heater outlet hose from the heater core tube. [Heater Outlet Hose Replacement \(Radiator Surge Tank to Outlet Heater Hose Tee\)](#) [Heater Outlet Hose Replacement \(Heater Outlet Hose Tee to Heater Core Tube LFX\)](#) [Heater Outlet Hose Replacement \(Heater Outlet Hose Tee to Heater Outlet Pipe LFX\)](#)
- 12. Remove the transmission. [Transmission Replacement \(LFX Engine with Four Wheel Drive\)](#) [Transmission Replacement \(LFX Engine with Two Wheel Drive\)](#)
- 13. Disconnect the coolant recovery reservoir hose (1) from the water outlet and position aside.
- 14. Disconnect the heater outlet pipe to surge tank hose. [Heater Outlet Hose Replacement \(Radiator Surge Tank to Outlet Heater Hose Tee\)](#) [Heater Outlet Hose Replacement \(Heater Outlet Hose Tee to Heater Core Tube LFX\)](#) [Heater Outlet Hose Replacement \(Heater Outlet Hose Tee to Heater Outlet Pipe LFX\)](#)
- 15. Disconnect the fuel feed pipe from the fuel pump. [Metal Collar Quick Connect Fitting Service](#)
- 16. Disconnect the evaporative emission purge solenoid hose.

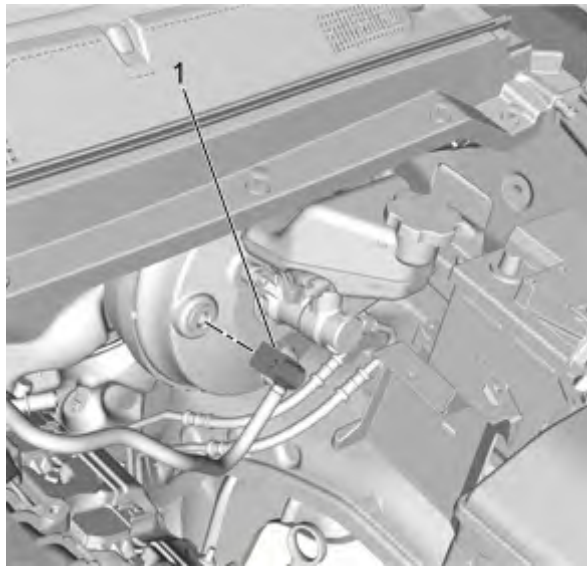


Fig. 232: Vacuum Sensor

Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the vacuum booster check valve (1) from the vacuum booster.
18. Remove the underbody splash shield. [**Underbody Splash Shield Replacement**](#)
19. Disconnect the A/C lines from the condenser. [**Air Conditioning Evaporative Connector Hose/Tube and Compressor and Condenser Hose Replacement \(LCV, LFX\)**](#)
20. Disconnect and reposition harnesses as necessary.
21. Disconnect the transmission fluid cooler lines from the radiator. [**Transmission Fluid Cooler Inlet and Outlet Pipe Replacement \(LFX\)**](#)
22. Disconnect the A/C lines from the compressor and position the lines aside. [**Air Conditioning Compressor Hose Replacement \(LFX\)**](#)
23. If equipped with an external engine oil cooler, disconnect the oil cooler inlet and oil cooler outlet hoses from the engine oil cooler. [**Engine Oil Cooler Inlet Hose Replacement**](#), and [**Engine Oil Cooler Outlet Hose Replacement**](#)
24. Install **EN-36857** Engine Lift Hook to the left cylinder head heavy duty bolt.
25. Install **EN-36857** Engine Lift Hook to the right cylinder head heavy duty bolt.

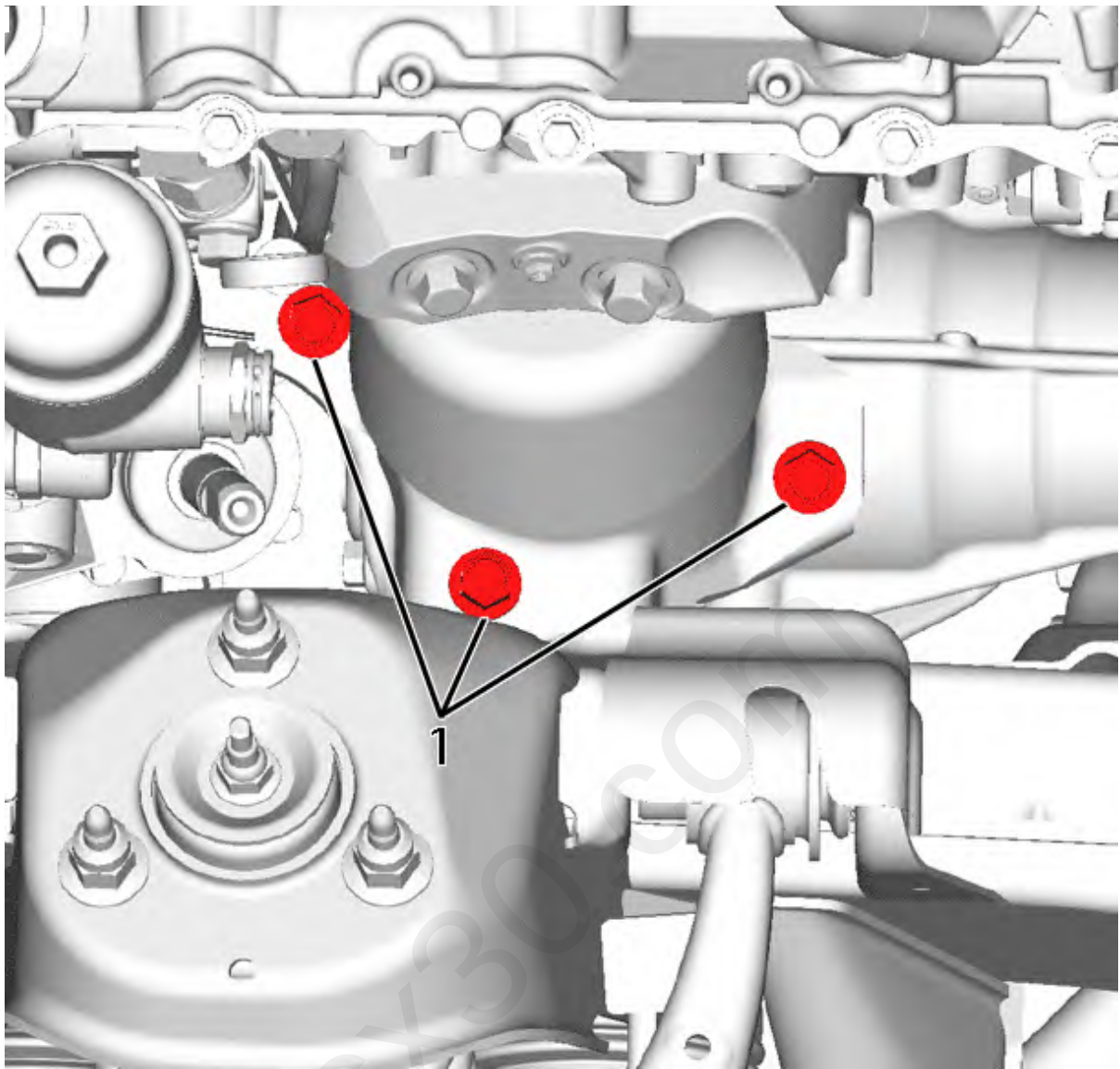


Fig. 233: Left Upper Engine Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

26. Remove the left upper engine mount bolts (1).

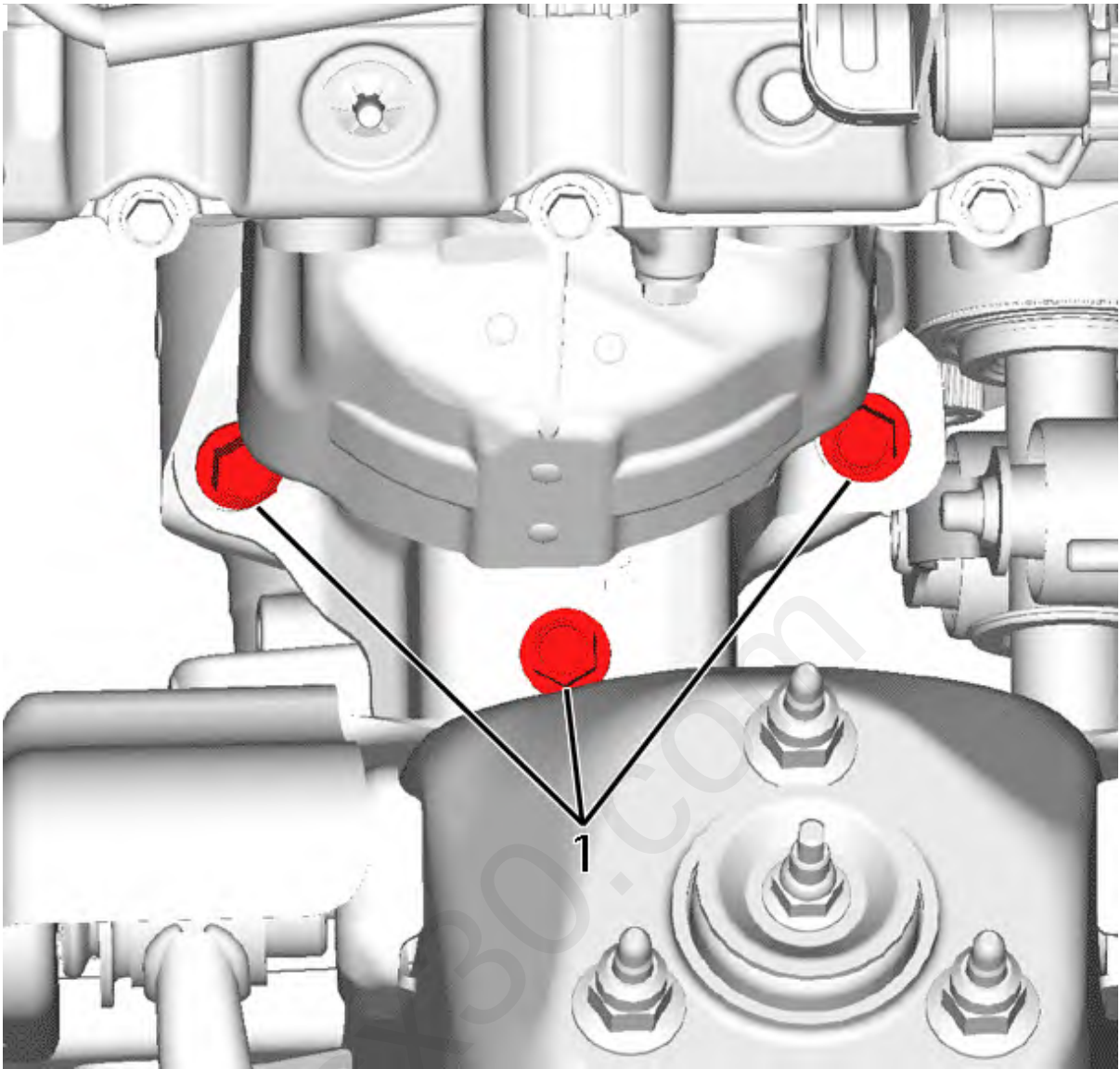


Fig. 234: Right Upper Engine Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

27. Remove the right upper engine mount bolts (1).
28. Ensure the following items are clear from the frame:
 - Vacuum lines
 - Steering knuckles
 - Electrical wiring harnesses
 - Oil cooler lines
29. Disconnect electrical connectors as necessary.
30. Using a suitable engine lifting device, remove the engine from the vehicle.
31. Transfer components as necessary.

Installation Procedure

1. With the aid of an assistant, carefully lower the engine into the vehicle.
2. Ensure when lowering the engine the following items are clear from the frame:
 - Vacuum lines
 - Steering knuckles

- Electrical wiring harnesses
- Oil cooler lines

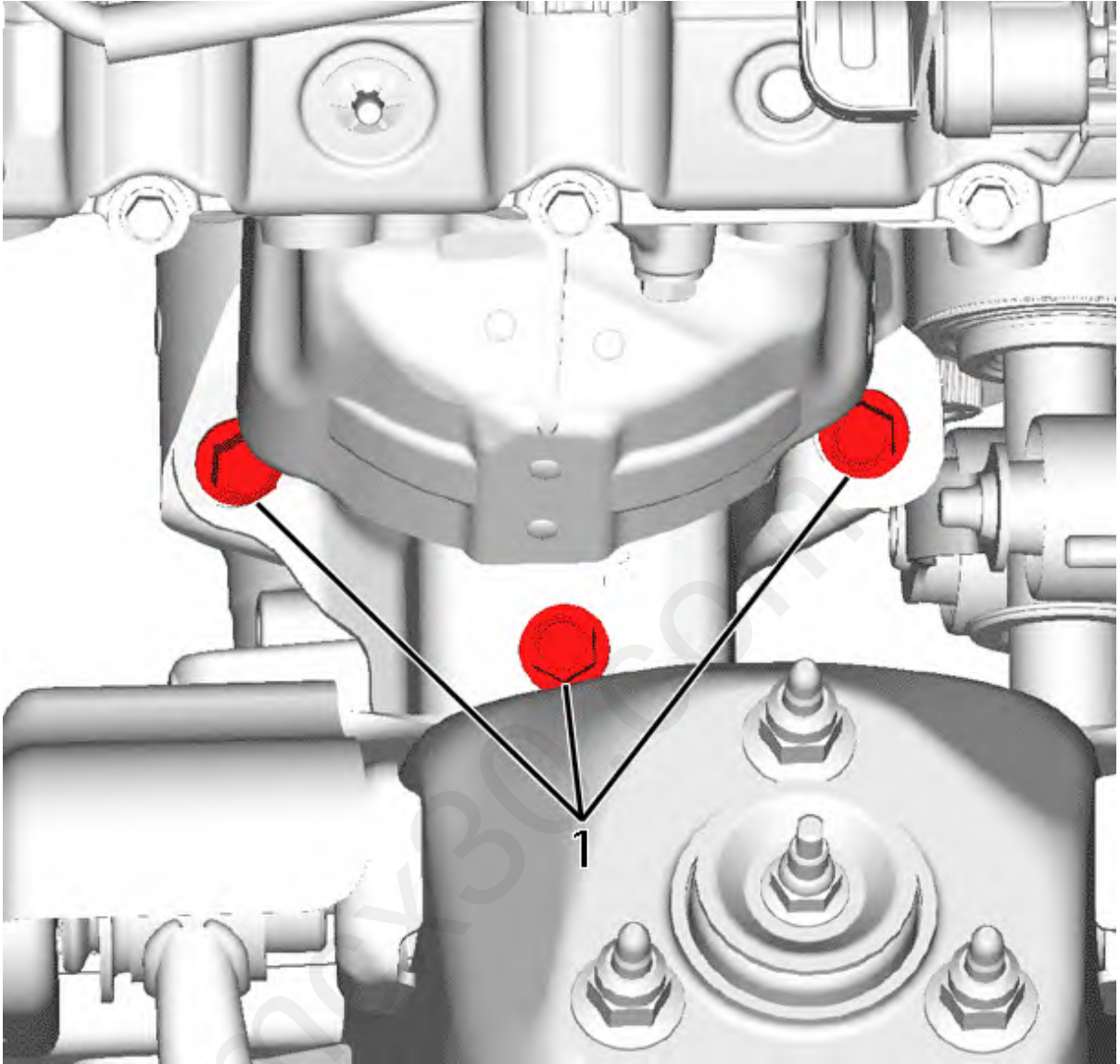


Fig. 235: Right Upper Engine Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the right upper engine mount bolts (1). **Engine Mount Replacement - Right Side**

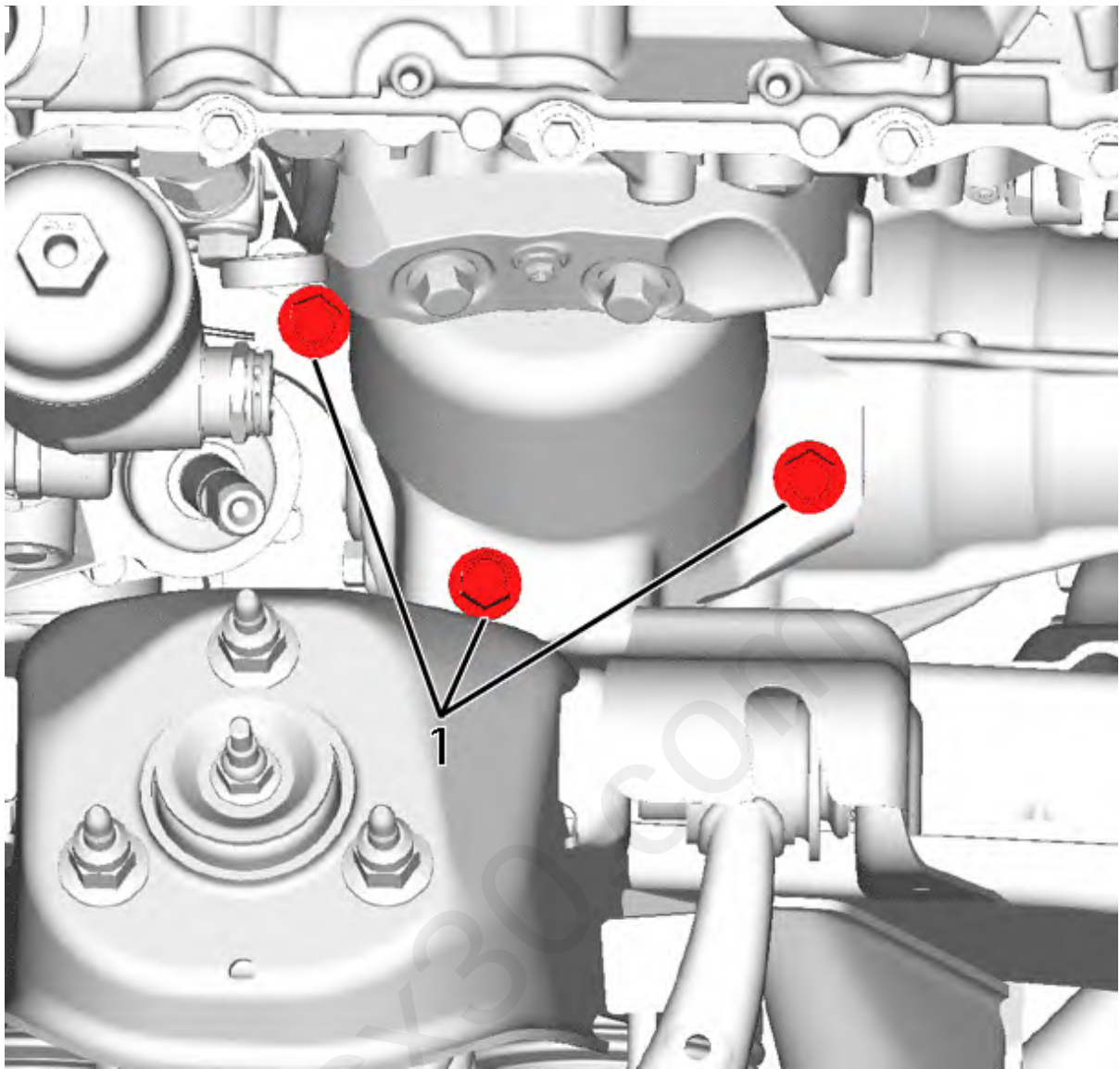


Fig. 236: Left Upper Engine Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Install the left upper engine mount bolts (1). [Engine Mount Replacement - Left Side](#)
5. Remove **EN-36857** Engine Lift Hook from the right cylinder head heavy duty bolt.
6. Remove **EN-36857** Engine Lift Hook from the left cylinder head heavy duty bolt.
7. If equipped with an external engine oil cooler, connect the oil cooler inlet and oil cooler outlet hoses to the engine oil cooler. [Engine Oil Cooler Inlet Hose Replacement](#), and [Engine Oil Cooler Outlet Hose Replacement](#)
8. Connect the A/C lines to the compressor. [Air Conditioning Compressor Hose Replacement \(LFX\)](#)
9. Connect the transmission fluid cooler lines to the radiator. [Transmission Fluid Cooler Inlet and Outlet Pipe Replacement \(LFX\)](#) .
10. Attach harnesses as necessary.
11. Connect the A/C lines to the condenser. [Air Conditioning Evaporative Connector Hose/Tube and Compressor and Condenser Hose Replacement \(LCV, LFX\)](#)
12. Install the underbody splash shield. [Underbody Splash Shield Replacement](#)

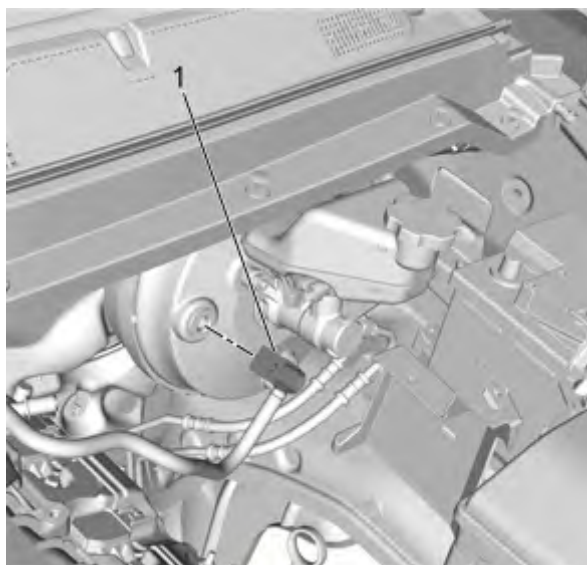


Fig. 237: Vacuum Sensor

Courtesy of GENERAL MOTORS COMPANY

13. Connect the vacuum booster check valve (1) to the vacuum booster.
14. Connect the evaporative emission purge solenoid hose.
15. Connect the fuel feed pipe to the fuel pump. [**Metal Collar Quick Connect Fitting Service**](#)
16. Connect the heater outlet pipe to surge tank hose. [**Heater Outlet Hose Replacement \(Radiator Surge Tank to Outlet Heater Hose Tee\)**](#) [**Heater Outlet Hose Replacement \(Heater Outlet Hose Tee to Heater Core Tube LFX\)**](#) [**Heater Outlet Hose Replacement \(Heater Outlet Hose Tee to Heater Outlet Pipe LFX\)**](#)
17. Connect the coolant recovery reservoir hose (1) from the water outlet and position aside.
18. Install the transmission. [**Transmission Replacement \(LFX Engine with Four Wheel Drive\)**](#) [**Transmission Replacement \(LFX Engine with Two Wheel Drive\)**](#)
19. Connect the heater outlet hose to the heater core tube. [**Heater Outlet Hose Replacement \(Radiator Surge Tank to Outlet Heater Hose Tee\)**](#) [**Heater Outlet Hose Replacement \(Heater Outlet Hose Tee to Heater Core Tube LFX\)**](#) [**Heater Outlet Hose Replacement \(Heater Outlet Hose Tee to Heater Outlet Pipe LFX\)**](#)
20. Connect the heater inlet hose to the heater core tube. [**Heater Inlet Hose Replacement \(LFX\)**](#)

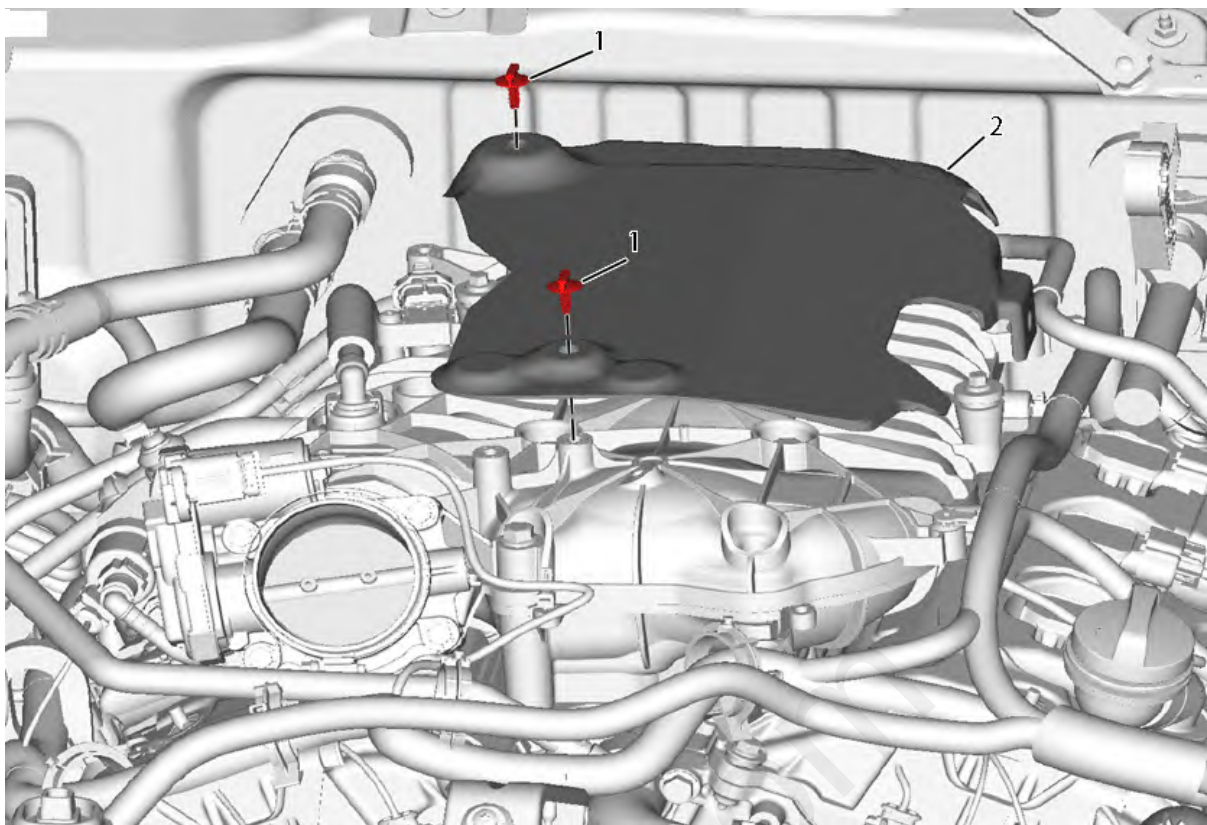


Fig. 238: Intake Manifold Insulator

Courtesy of GENERAL MOTORS COMPANY

21. Install the intake manifold insulator (2). [Intake Manifold Insulator Replacement](#)
22. Install the intake air splash shield. [Intake Air Splash Shield Replacement](#)
23. Install the air cleaner outlet duct. [Air Cleaner Outlet Duct Replacement](#)
24. Install the plenum front panel. [Plenum Front Panel Replacement](#)
25. Install the catalytic converter(s) and [Catalytic Converter Replacement - Right Side \(LFX\)](#)
26. Reposition and connect harnesses as necessary.
27. Install Front End Upper Tie Bar [Front End Upper Tie Bar Replacement](#)
28. Install Radiator [Radiator Replacement \(LFX\)](#)
29. Fill the cooling system. [Cooling System Draining and Filling \(Static Fill\)](#) [Cooling System Draining and Filling \(Vac n Fill\)](#)
30. Charge the A/C system. [Refrigerant Recovery and Recharging](#)
31. Connect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)
32. Install the hood. [Hood Replacement](#)

NOTE: **Prelube is necessary if the engine is replaced or overhauled.**

33. If the engine is replaced with a new engine or has been overhauled, perform the engine pre-lube procedure. [Engine Prelubing](#)
34. Perform the throttle learn procedure. [Q38 Throttle Body: Throttle/Idle Learn](#)

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

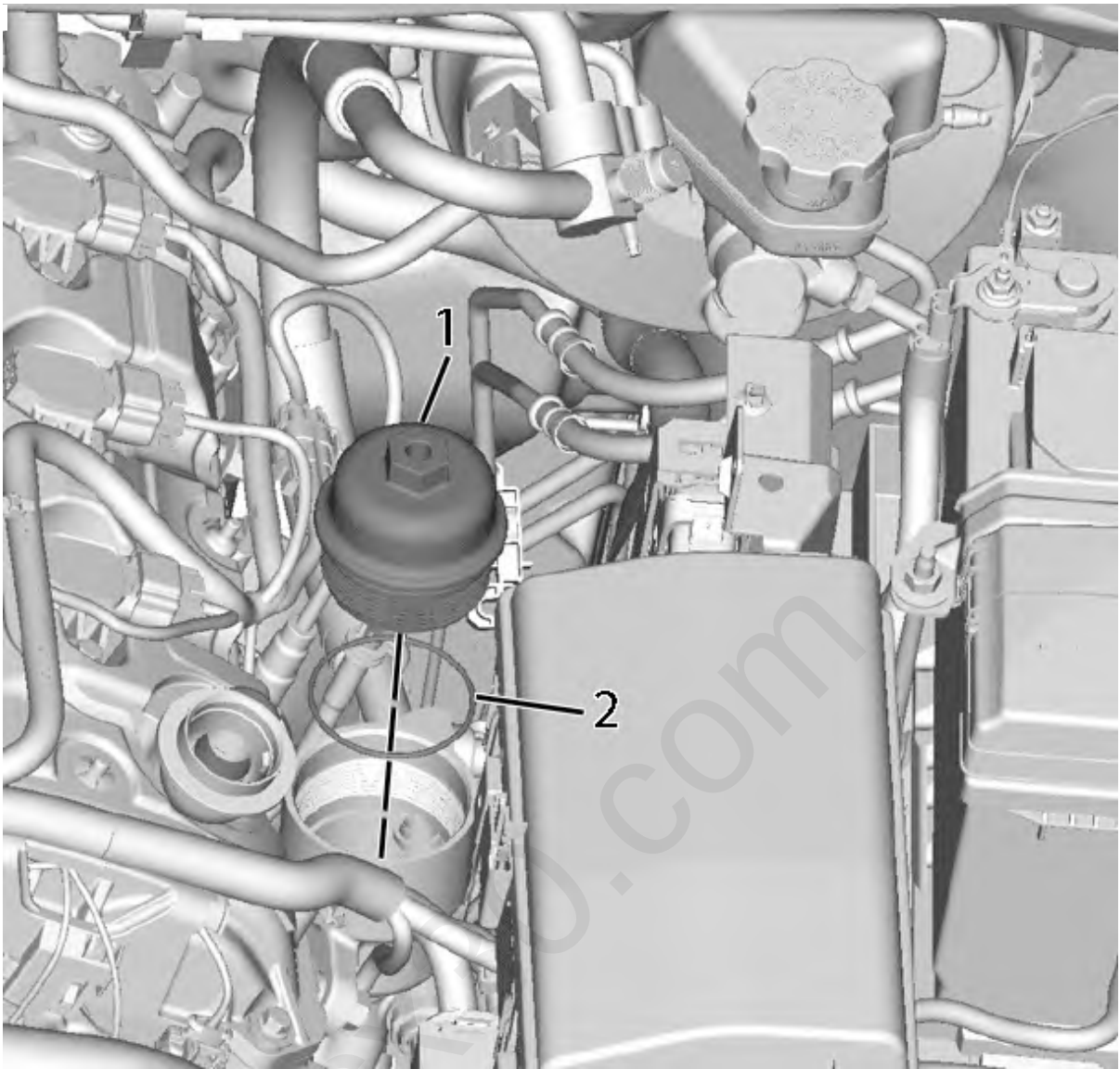


Fig. 239: Oil Filter Cap And Seal

Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil filter cap (1) and seal (2).
2. Remove and properly dispose of the oil filter insert.
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .

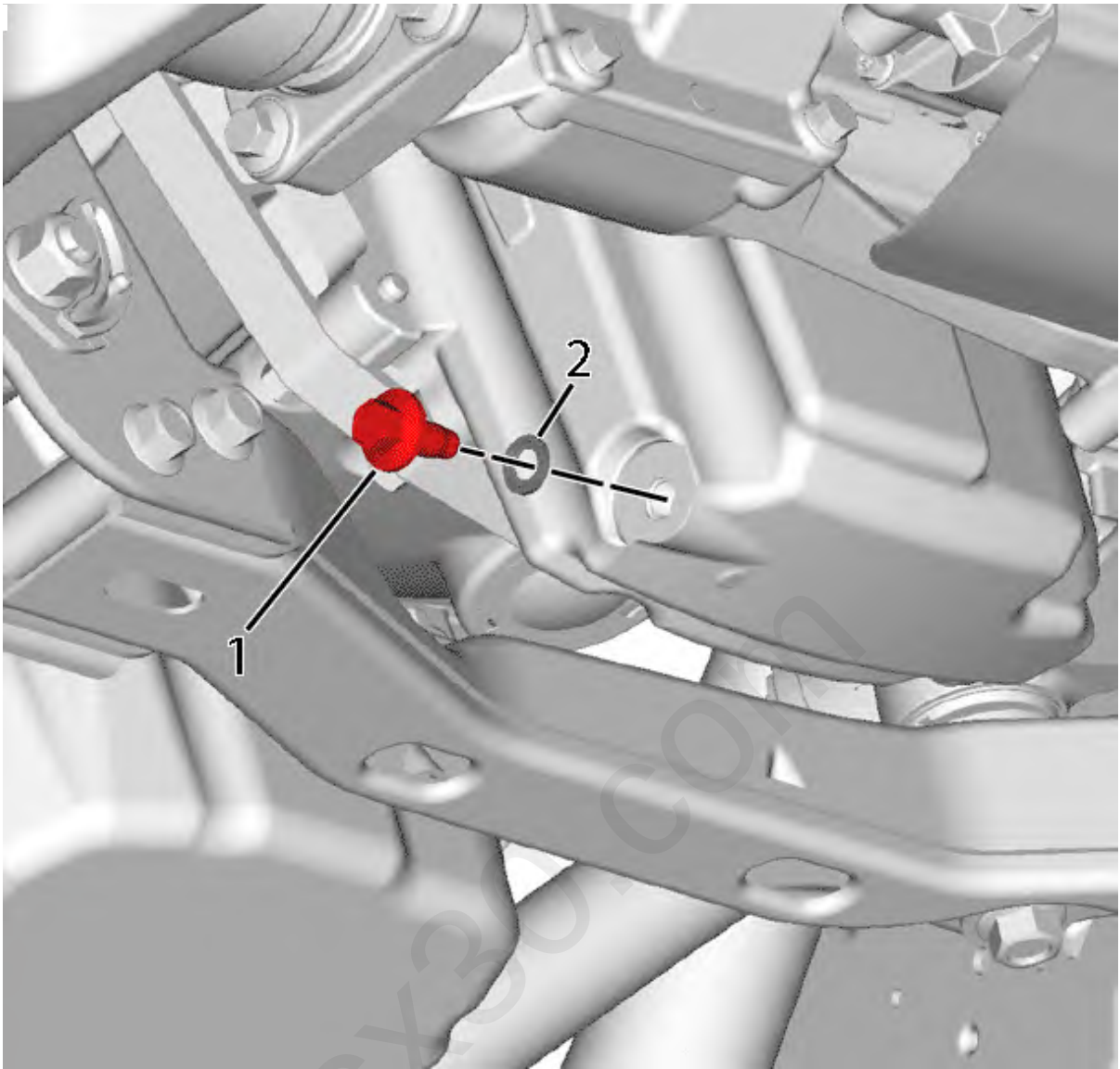


Fig. 240: Oil Pan Drain Plug And Seal

Courtesy of GENERAL MOTORS COMPANY

4. Place a suitable drain pan below the oil pan drain plug.
5. Remove the oil pan drain plug (1) and seal (2).
6. Allow the oil to drain completely.

Installation Procedure

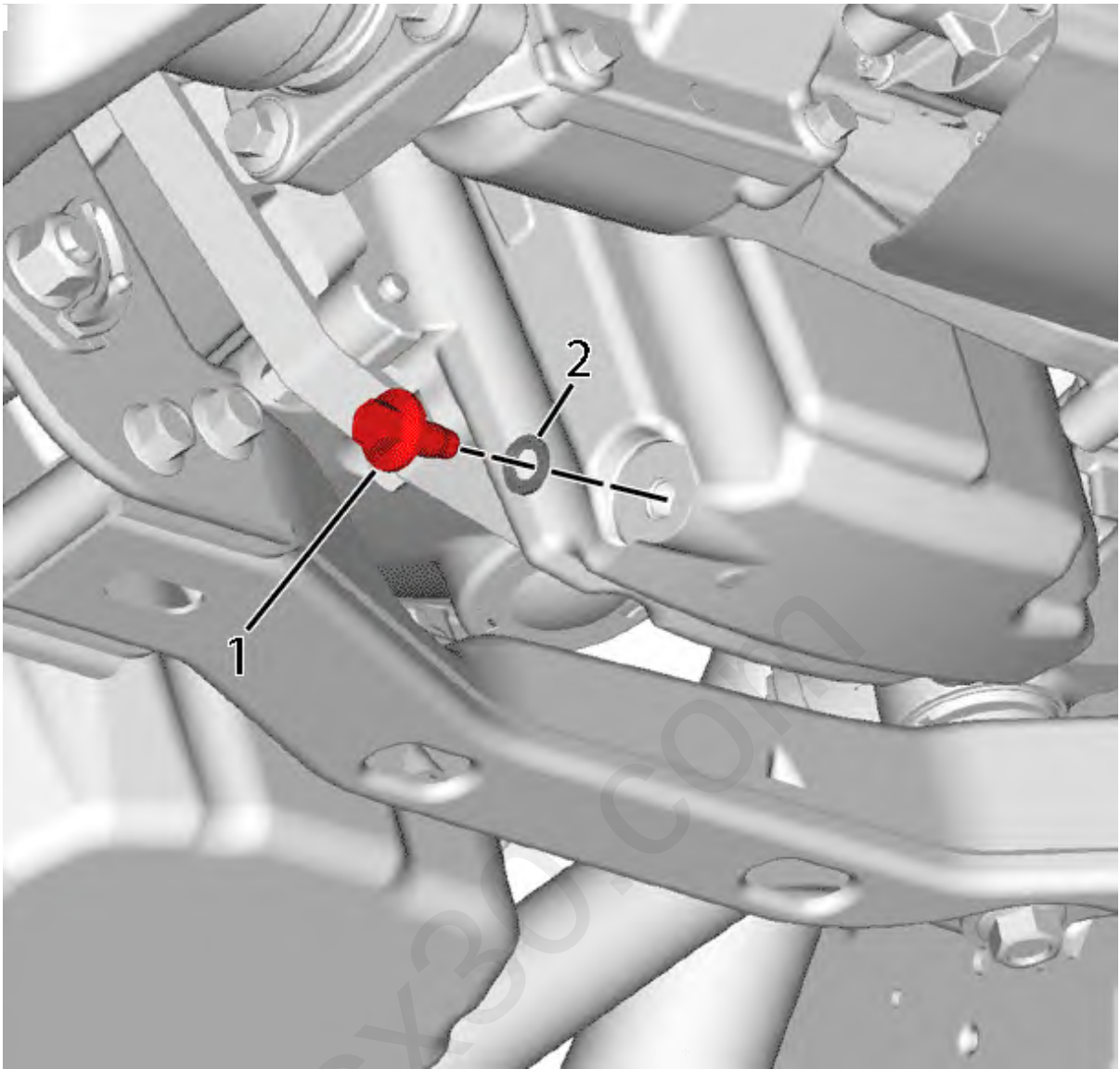


Fig. 241: Oil Pan Drain Plug And Seal

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Component Fastener Tightening Caution](#) .

NOTE: Inspect the oil drain plug seal for damage, replace if necessary.

1. Install seal (2) and oil pan drain plug (1) and tighten to 25 N.m (18 lb ft).
2. Remove the drain pan.
3. Lower the vehicle.

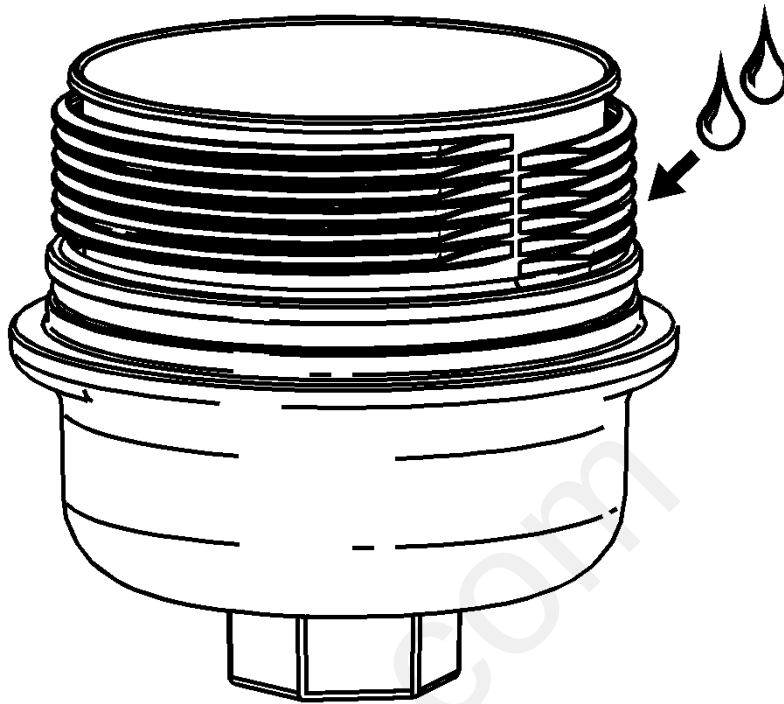


Fig. 242: Lubricating Threads Of Oil Filter Cap

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Lubrication must be applied to the threads of the oil filter cap prior to installation. Failure to lubricate the oil filter cap threads can hinder later removal and cause possible oil filter cap damage.

4. Lubricate the oil filter cap threads with clean engine oil.

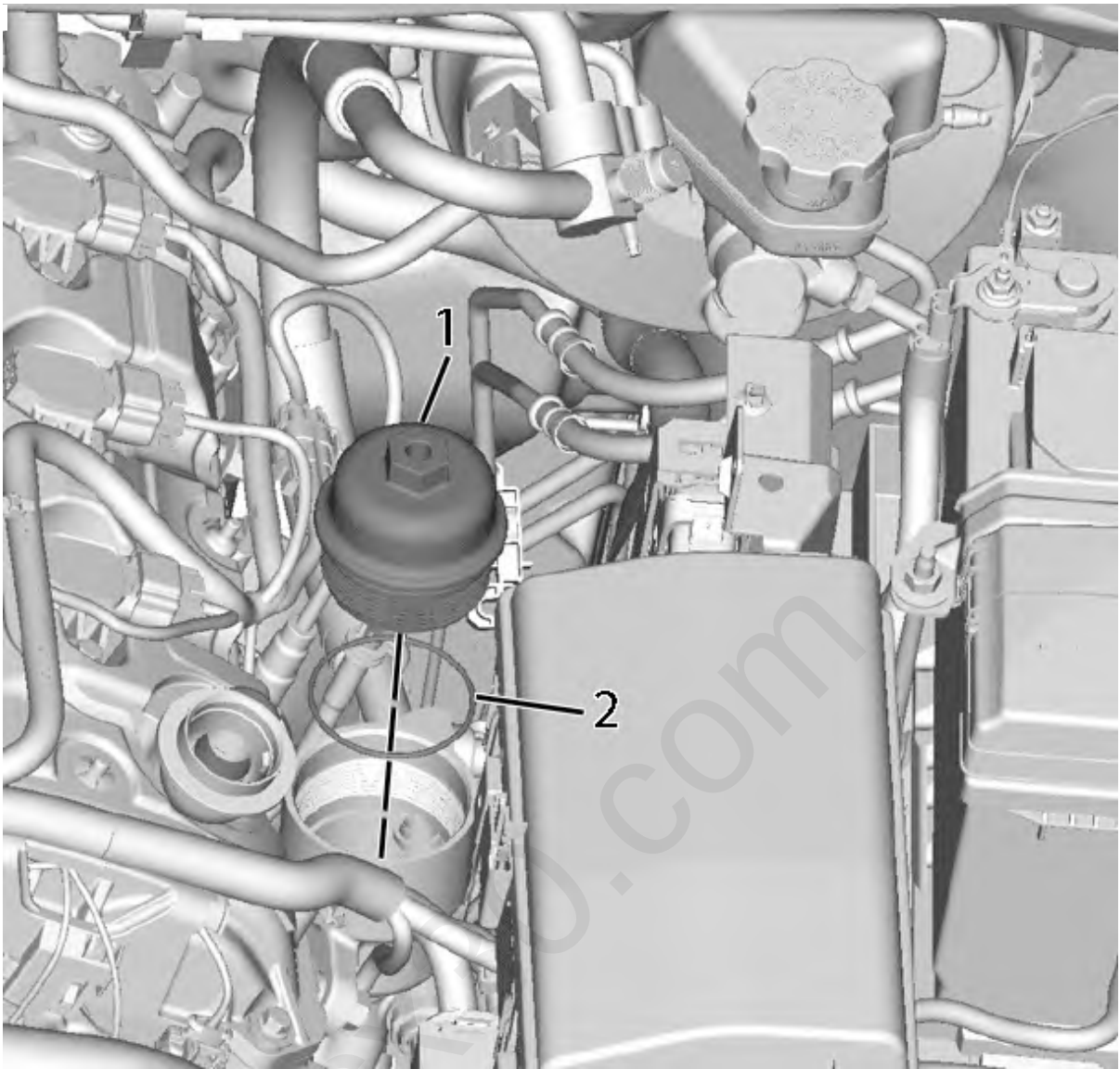


Fig. 243: Oil Filter Cap And Seal

Courtesy of GENERAL MOTORS COMPANY

5. Install a NEW oil filter (3).

CAUTION: Proper oil filter cap tightening is mandatory. Failure to tighten the oil filter cap to the proper specification can hinder later removal and cause possible oil filter cap damage.

NOTE: Inspect the oil filter seal for damage, replace if necessary.

6. Install seal (2) and tighten the oil filter cap (1) to 30 N.m (22 lb ft).
7. Fill the engine with the appropriate oil type and quantity. [Approximate Fluid Capacities](#) , and [Adhesives, Fluids, Lubricants, and Sealers](#)
8. Reset the oil life. Refer to [GM Oil Life System Resetting GM Oil Life System Resetting \(With Scan Tool\)](#)