

2014 Engine

Engine Mechanical - 2.0L (LTG) - Repair Instructions - On Vehicle - Regal

REPAIR INSTRUCTIONS - ON VEHICLE

INTAKE MANIFOLD COVER REPLACEMENT

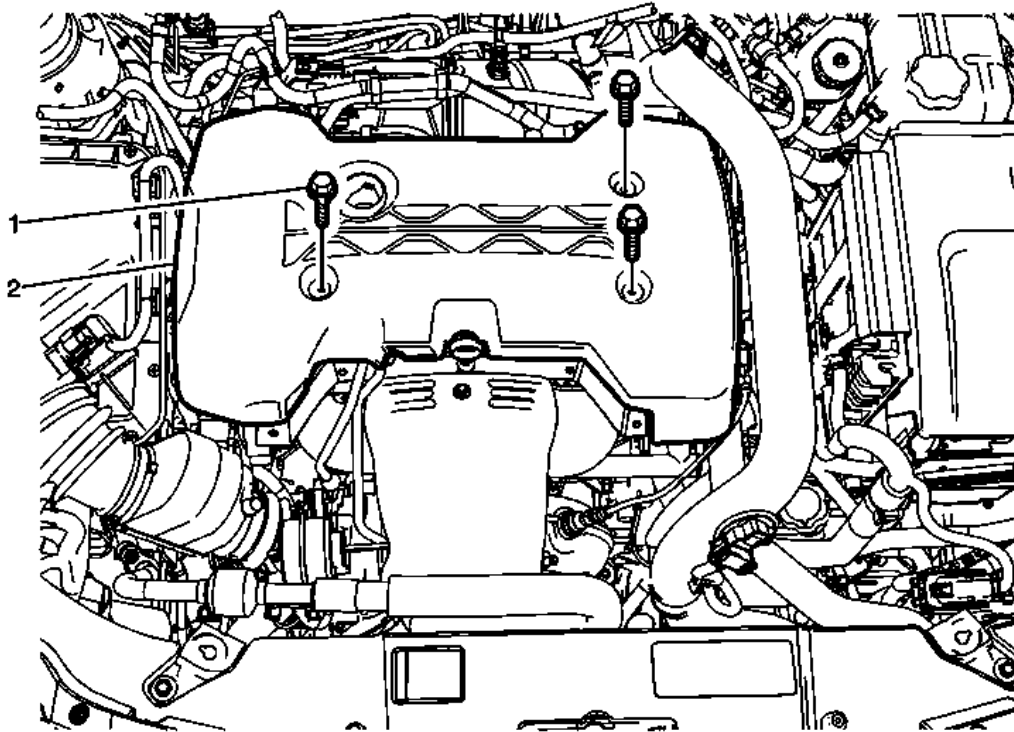
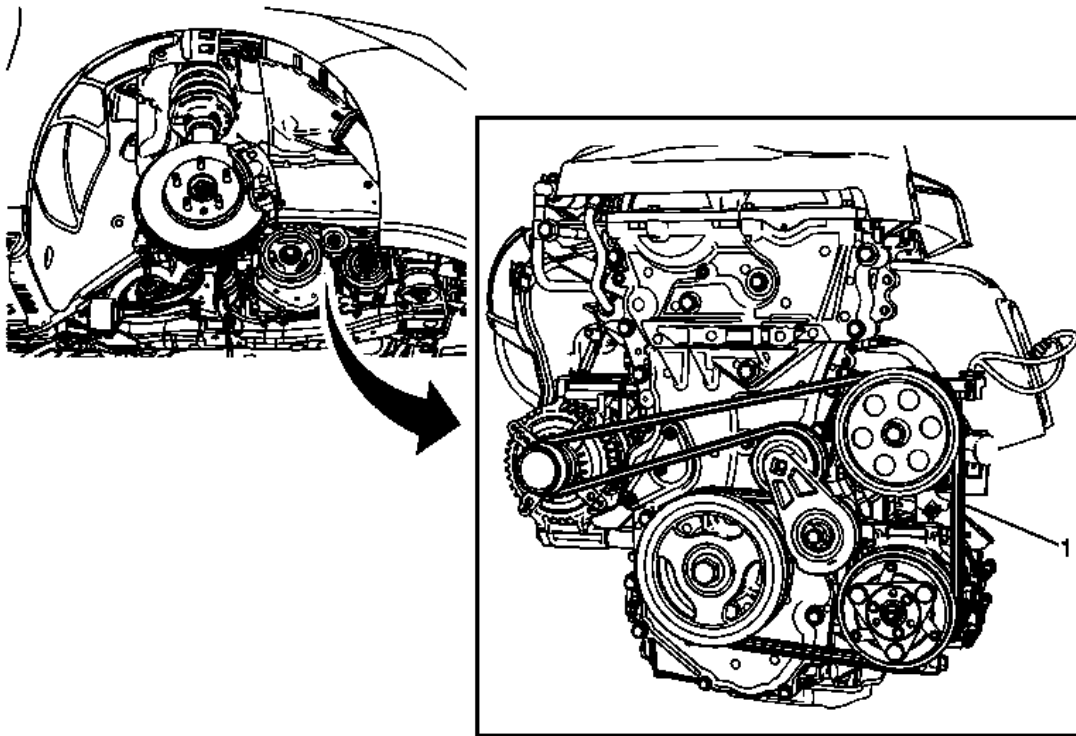


Fig. 1: Intake Manifold Cover (LTG)
Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Cover Replacement

Callout	Component Name
1	Intake Manifold Cover Fastener (Qty,3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Intake Manifold Cover Procedure Remove the oil cap before removing the intake manifold cover.

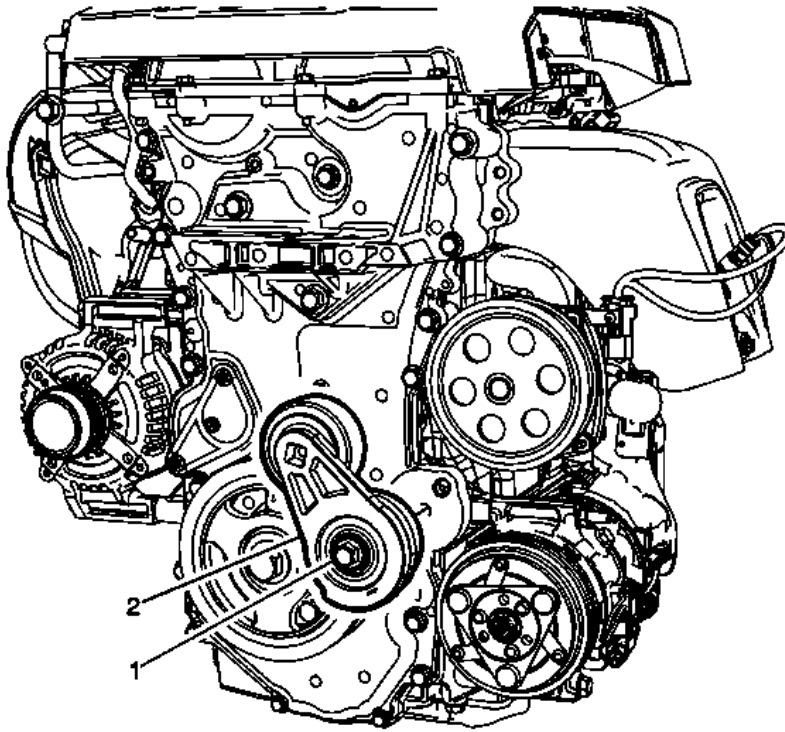
DRIVE BELT REPLACEMENT**Fig. 2: Drive Belt Routing (LTG)**

Courtesy of GENERAL MOTORS COMPANY

Drive Belt Replacement

Callout	Component Name
Preliminary Procedure	
Remove the front wheelhouse front liner. Refer to Front Wheelhouse Front Liner Replacement .	
1	Drive Belt Procedure 1. Use the proper tool to rotate the drive belt tensioner. 2. Remove the drive belt from the pulleys and tensioner.

DRIVE BELT TENSIONER REPLACEMENT

**Fig. 3: Drive Belt Tensioner**

Courtesy of GENERAL MOTORS COMPANY

Drive Belt Tensioner Replacement

Callout	Component Name
Preliminary Procedures	
Remove the drive belt. Refer to <u>Drive Belt Replacement</u> .	
1	Drive belt tensioner fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 (43 lb ft)
2	Drive belt tensioner

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**. Raising the engine removes the weight from the engine mount and creates slight tension in the rubber.

2. Observe the engine mount while raising the engine. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber surface is covered with heat check cracks.
 - The rubber is split through the center of the engine mount.
 - The GLYCOL™ fluid is leaking from the engine mount.
3. Inspect the system for loose vacuum hose connections or vacuum leaks. Refer to Vacuum Operated Engine Mounts Description and Operation.
4. Inspect the engine mount valve assemblies for loose electrical connections. Inspect the electrical system connected to the engine mount valve assemblies. Refer to **Diagnostic System Check - Vehicle** .
5. Inspect for the presence of glycol fluid in the vacuum system. Remove the hose assembly connections at the engine mounts. If fluid is present in the engine mount vacuum system, the entire vacuum system should be replaced.

POWERTRAIN MOUNT BALANCING

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

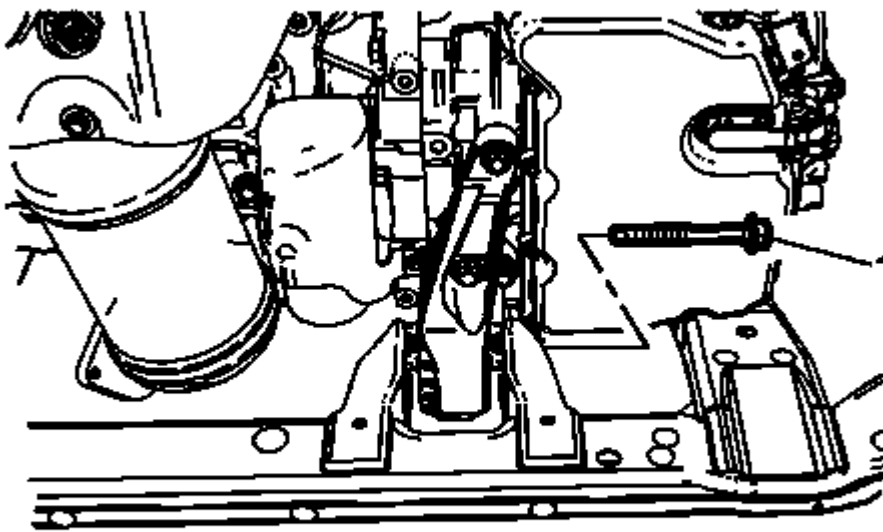


Fig. 4: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the battery tray. Refer to **Battery Tray Replacement** .
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Loosen the front transaxle mount through bolt (1).
5. Loosen the rear transaxle mount through bolt.
6. Lower the vehicle.
7. Position two floor jacks with wood blocks under the engine and transaxle in order to support the powertrain assembly.

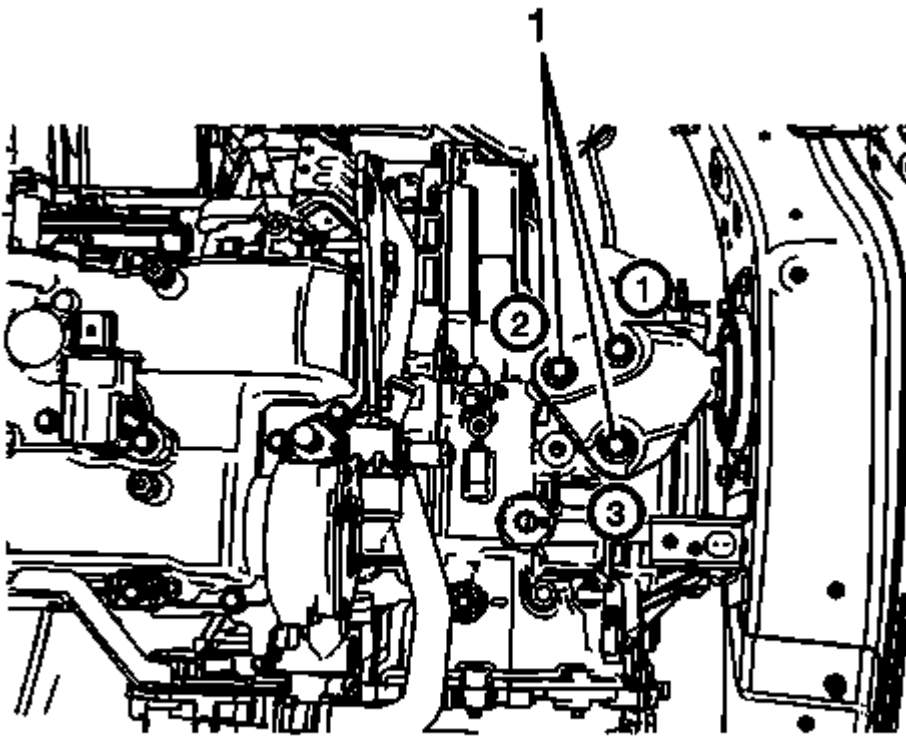


Fig. 5: Transaxle Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

8. Loosen the transaxle mount bolts (1).

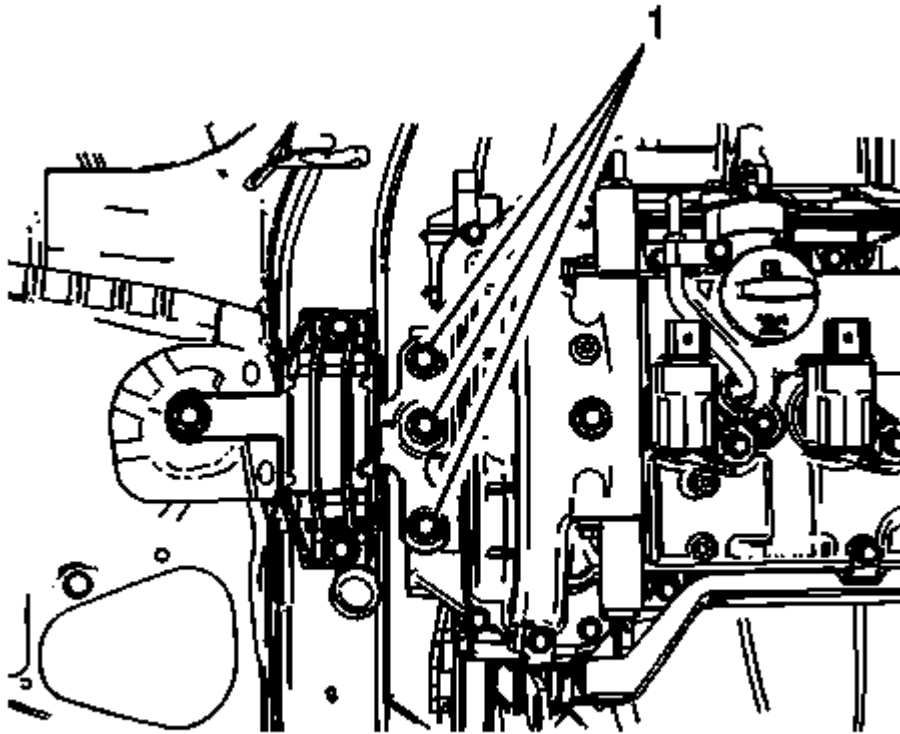


Fig. 6: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

9. Loosen the engine mount to bracket bolts (1).
10. Reposition both floor jacks in order to allow a 1/8 inch gap between the mount and bracket.

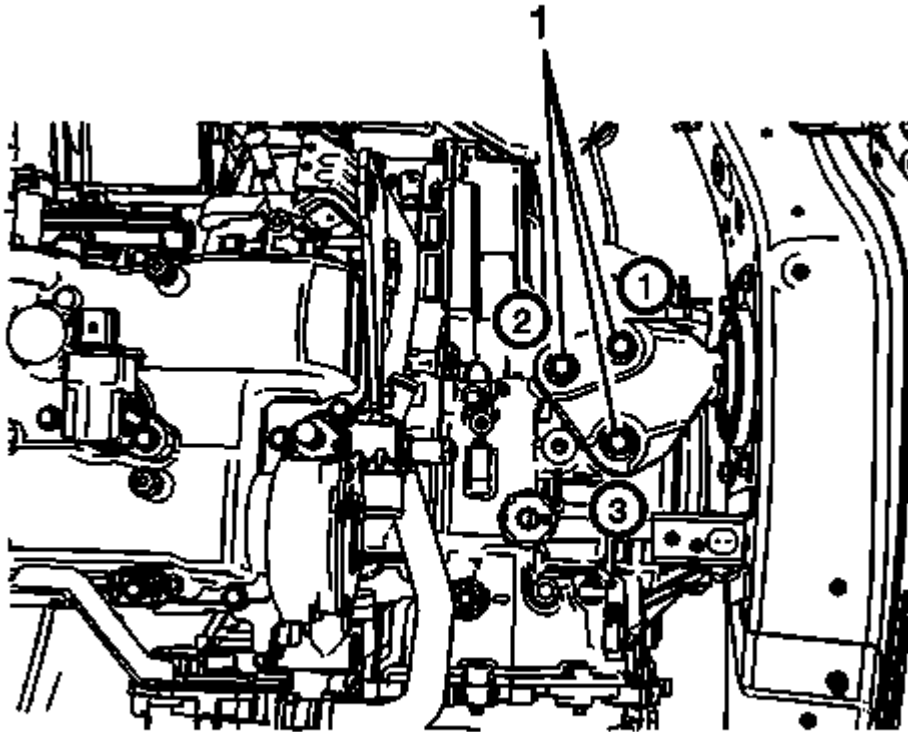


Fig. 7: Transaxle Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

11. Tighten the transaxle mount bolts (1) to 50 (37 lb ft) in sequence.

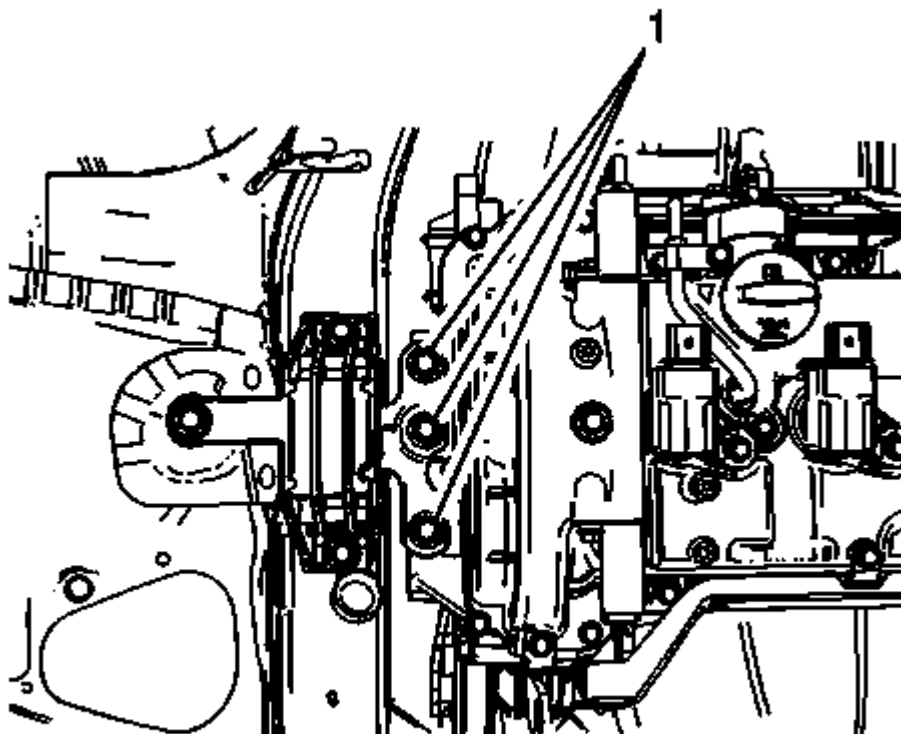


Fig. 8: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

12. Tighten the engine mount to bracket bolts (1) to 62 (46 lb ft) in the following sequence.
13. Remove the floor jacks from under the oil pan.
14. Shake the powertrain vigorously from front to rear and allow the powertrain to settle.
15. Raise the vehicle.
16. Tighten the rear transaxle mount through bolt to 100 (74 lb ft).

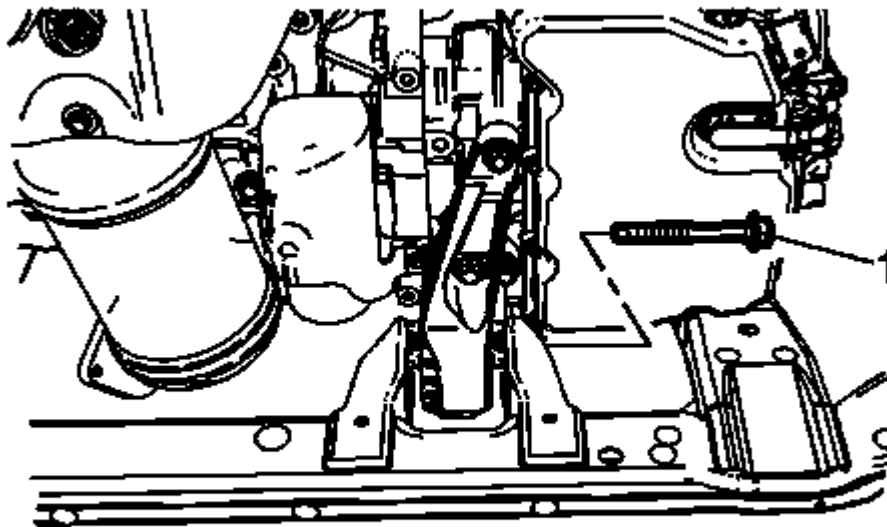


Fig. 9: Front Transaxle Mount Through Bolt
 Courtesy of GENERAL MOTORS COMPANY

17. Tighten the front transaxle mount through bolt (1) to 100 (74 lb ft).
18. Lower the vehicle.
19. Install the battery tray. Refer to **Battery Tray Replacement** .
20. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

POWERTRAIN MOUNT BALANCING - LOWER

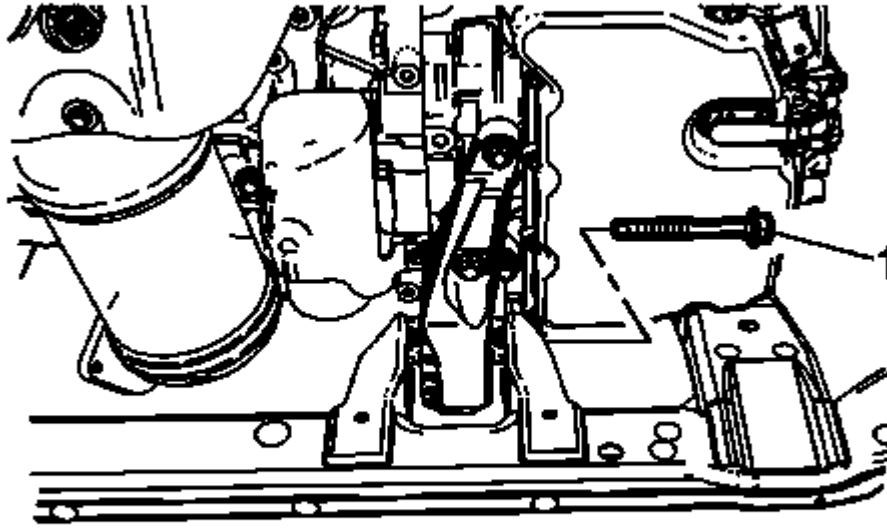


Fig. 10: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

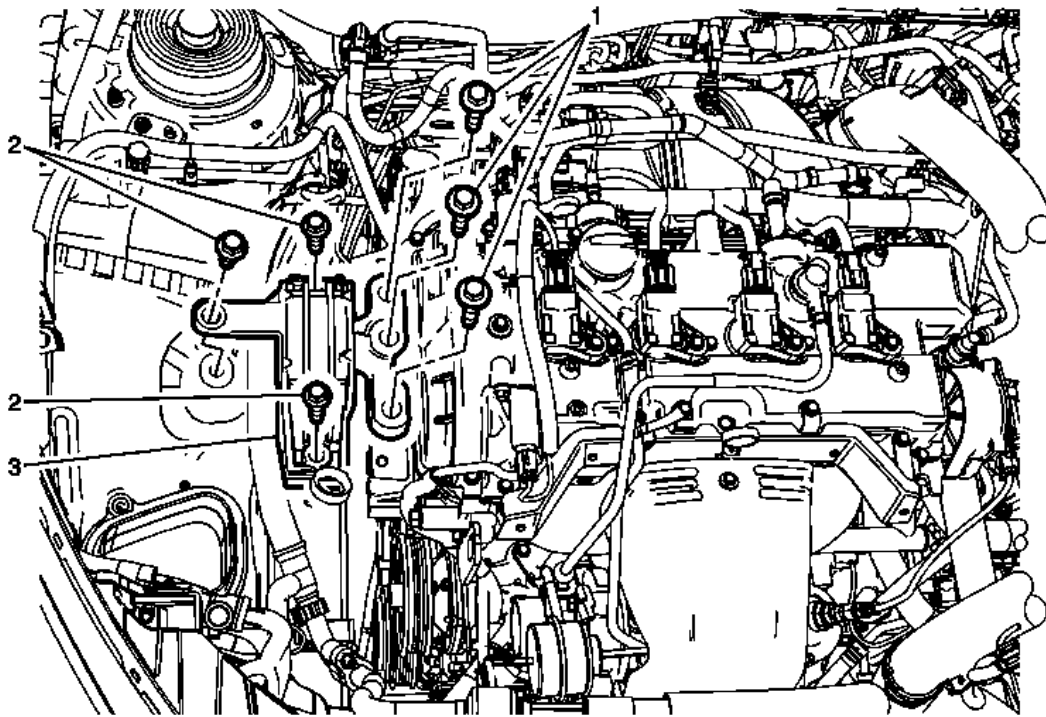
NOTE: Follow the balance procedure steps listed below. Powertrain mounts must be tightened in sequence.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Loosen the front transaxle mount through bolt (1).
3. Loosen the rear transaxle mount through bolt.
4. Shake the powertrain vigorously from front to rear and allow the powertrain to settle.

CAUTION: Refer to Fastener Caution .

5. Tighten the rear transaxle mount through bolt to 100 (74 lb ft).
6. Tighten the front transaxle mount through bolt (1) to 100 (74 lb ft).
7. Lower the vehicle.

ENGINE MOUNT REPLACEMENT

**Fig. 11: Engine Mount (LTG)**

Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u> . 3. Install the engine support fixture. Refer to <u>Engine Support Fixture</u> .	
1	Engine Mount Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 62 N.m (46 lb ft)
2	Engine Mount Bolt (Qty: 3) Tighten 62 N.m (46 lb ft)
3	Engine Mount

ENGINE SUPPORT FIXTURE

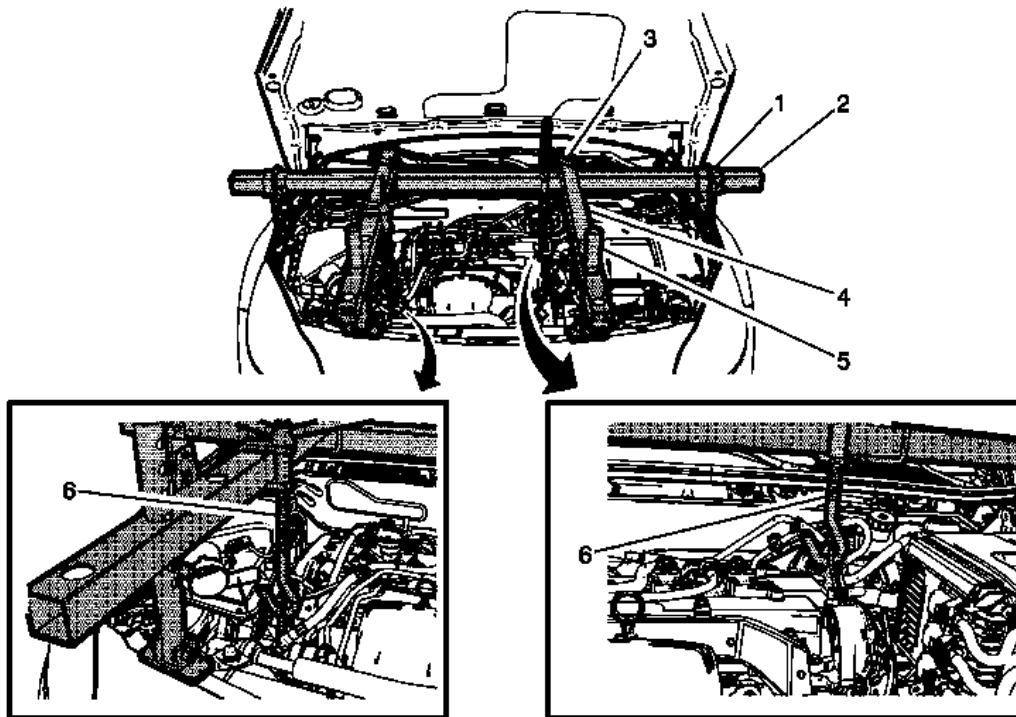


Fig. 12: Engine Support Fixture
Courtesy of GENERAL MOTORS COMPANY

Engine Support Fixture

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>. 2. Remove the hood strut. Refer to <u>Hood Strut Replacement</u>. 3. Remove the charge air cooler outlet air tube. Refer to <u>Charge Air Cooler Outlet Air Tube Replacement</u>.	
Special Tools EN-51007 Engine Support Fixture. For equivalent regional tools. Refer to <u>Special Tools</u> .	
1	Engine Support Fixture Adapter Leg (Qty: 2) Procedure Install the bracket to fender frame. Do not install on top of the fender lip.
2	Main Support Beam
3	Cross Bracket (Qty: 2)
4	Strut Tower Support Assembly (Qty: 2) Procedure Adjust the length of the strut tower support assembly.
5	Radiator Tube Shelf Assembly (Qty: 2)
	Hook Assembly (Qty: 2)

Procedure

- 6
1. If the engine is not equipped with engine lift brackets, install **J-36857** engine lift bracket in place.
 2. Use a grade 10.9 bolt to install the engine lift bracket.

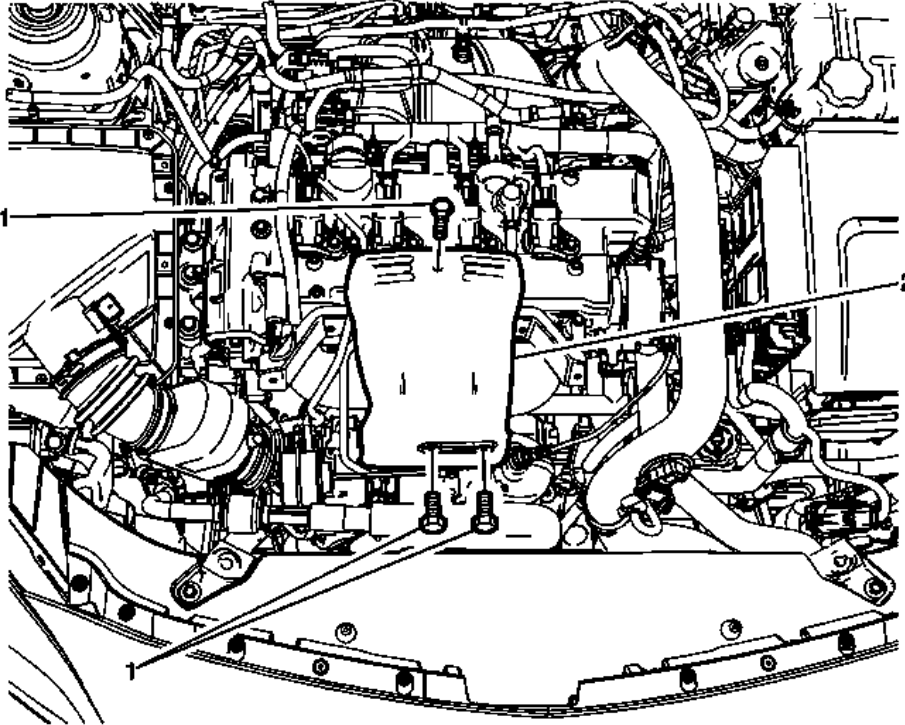
TURBOCHARGER HEAT SHIELD REPLACEMENT

Fig. 13: Turbocharger Heat Shield
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Heat Shield Replacement

Callout	Component Name
1	Turbocharger Heat Shield Fastener (Qty;3) CAUTION: Refer to Fastener Caution . Tighten 14 (10 lb ft)
2	Turbocharger Heat Shield

TURBOCHARGER REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

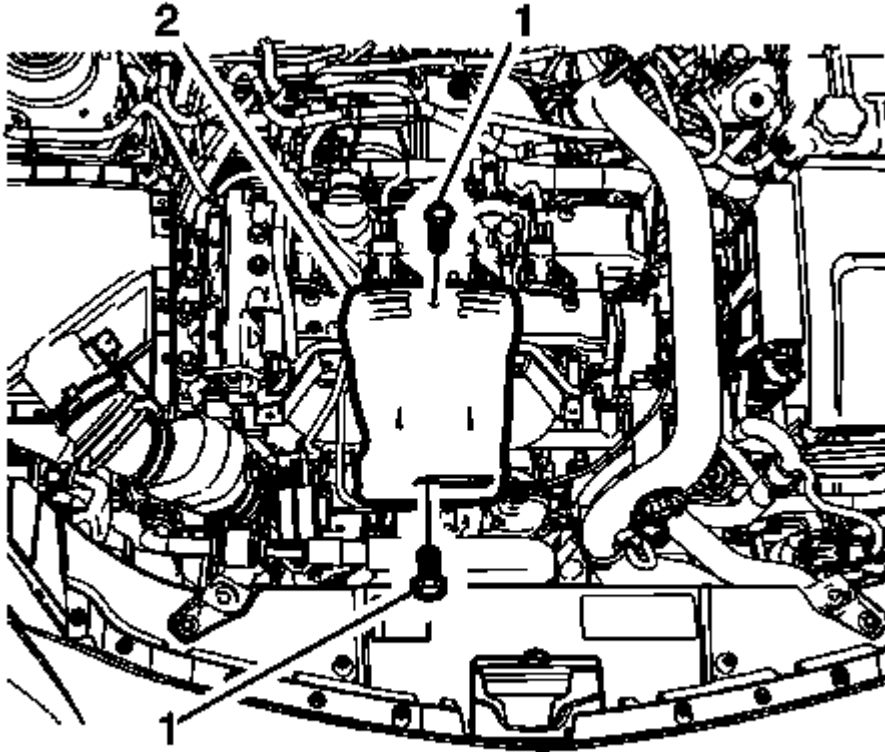


Fig. 14: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

3. Remove the turbocharger heat shield (2). Refer to **Turbocharger Heat Shield Replacement**.
4. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)**.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
6. Remove the PCV hose. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

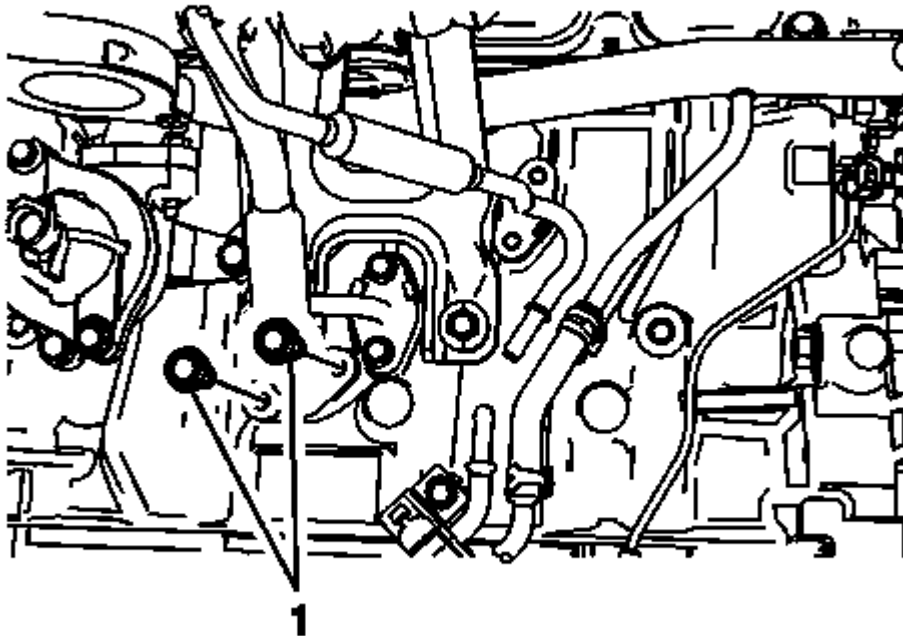


Fig. 15: Turbocharger Oil Return Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the turbocharger oil return pipe bolts (1).

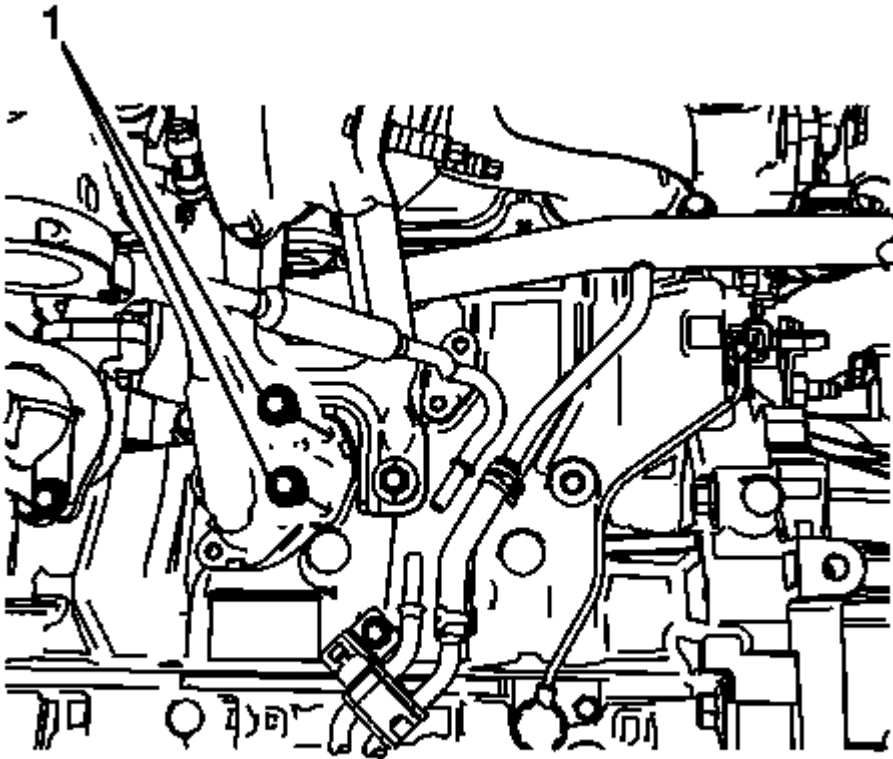


Fig. 16: Turbocharger Oil Feed Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the turbocharger oil feed pipe bolts (1).

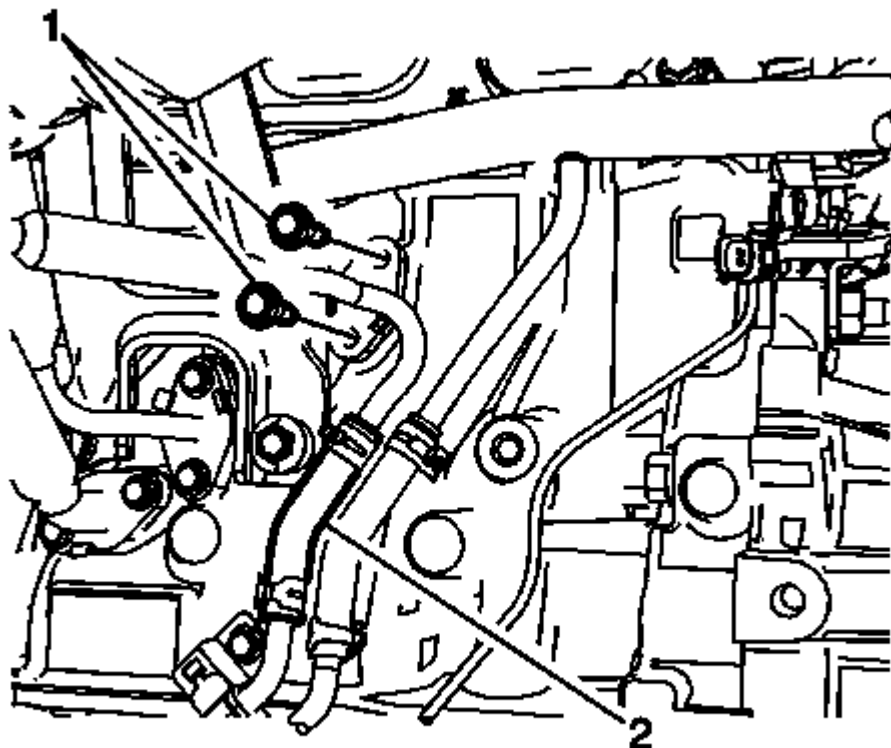


Fig. 17: Turbocharger Coolant Feed Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the turbocharger coolant feed pipe bolts (1). Refer to **Turbocharger Coolant Feed Pipe Replacement (LTG)** .
10. Remove the turbocharger coolant return pipe. Refer to **Turbocharger Coolant Return Pipe Replacement (LTG)** .

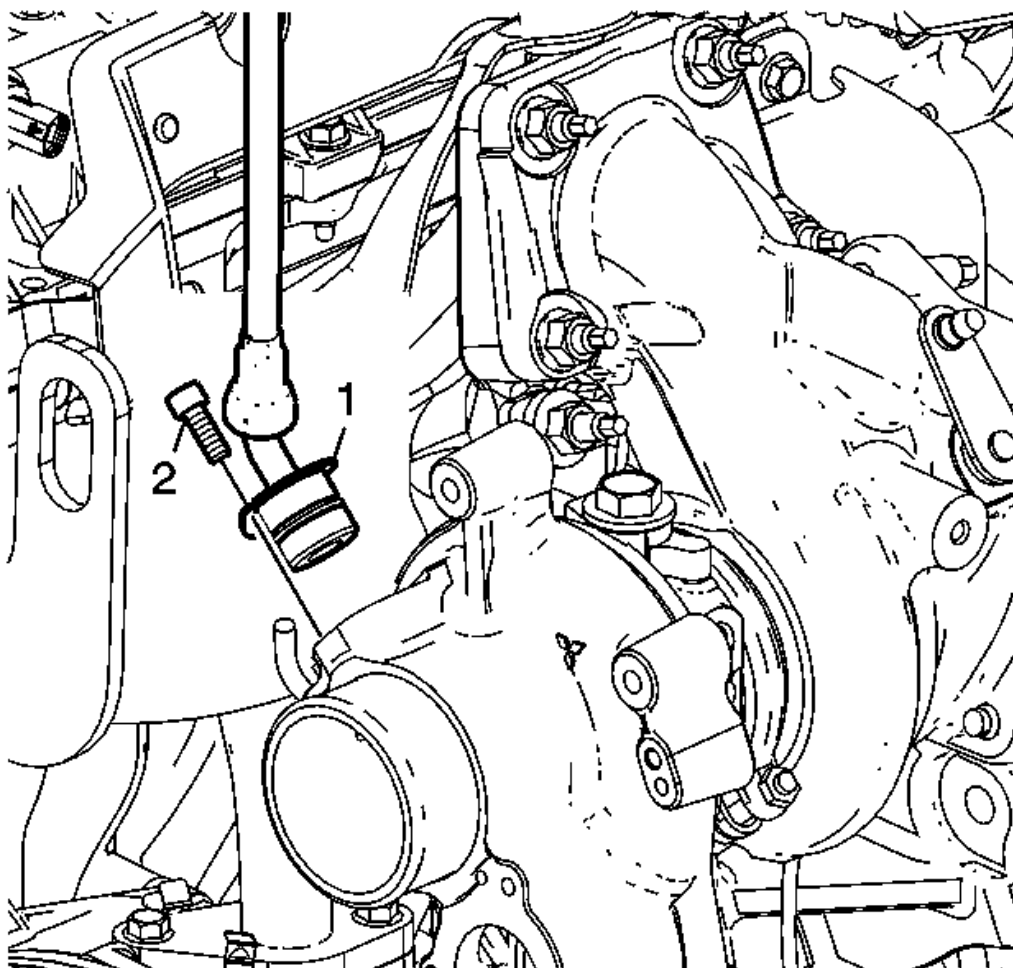


Fig. 18: PCV Hose Fitting Bolt

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not disturb the joint between the PCV hose and PCV hose fitting at the turbocharger. This is a permanent connection.

11. Remove the PCV hose fitting bolt (2). Disconnect the PCV hose fitting (1) with the PCV hose attached from the turbocharger.

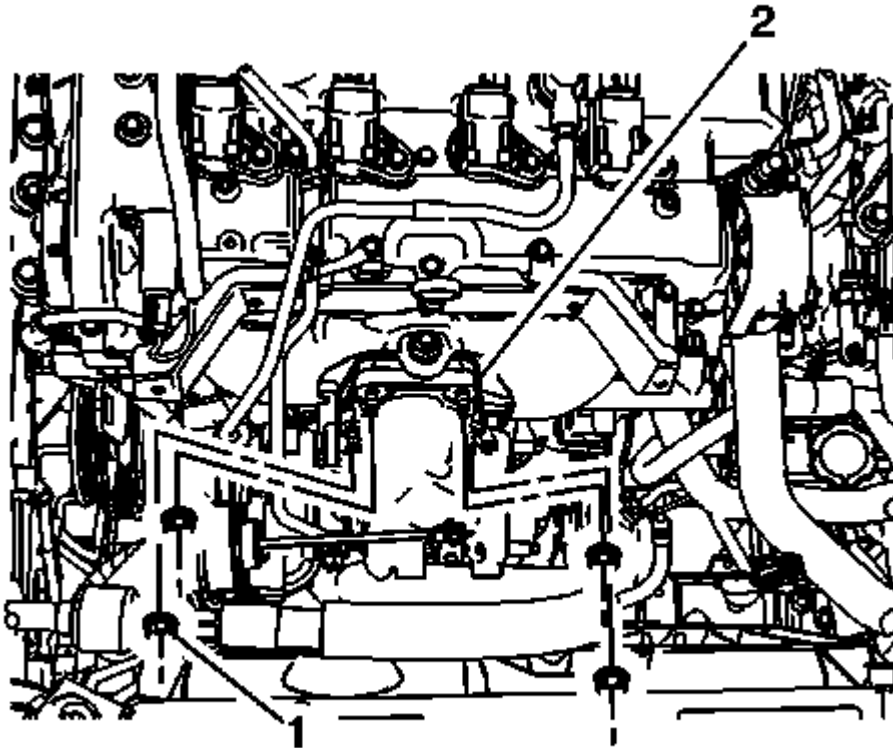


Fig. 19: Turbocharger Nuts And Turbocharger
Courtesy of GENERAL MOTORS COMPANY

12. Remove the turbocharger nuts (1) and turbocharger (2).
13. For turbocharger cleaning and inspection, refer to **Turbocharger Cleaning and Inspection** .

Installation Procedure

NOTE: The exhaust pipe studs do not come installed on new turbochargers. If the turbocharger is being replaced, new studs will need to be installed.

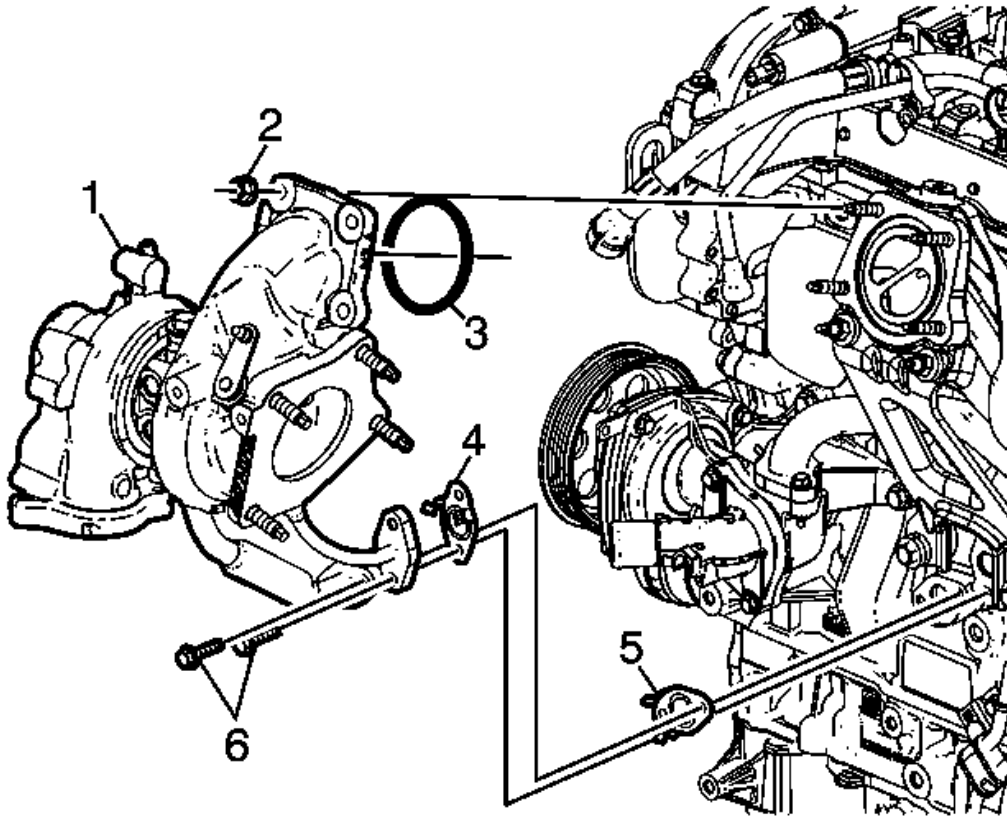


Fig. 20: Turbocharger Nuts

Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW turbocharger gasket (3) on the turbocharger.
2. Install NEW turbocharger oil feed and oil return pipe gaskets (4, 5).
3. Install the turbocharger (1).
4. Install NEW turbocharger nuts (2) finger tighten.

CAUTION: Refer to Fastener Caution .

5. Install the turbocharger oil feed and return pipe bolts (6) at the engine block. Tighten the bolts to 10 (89 lb in).

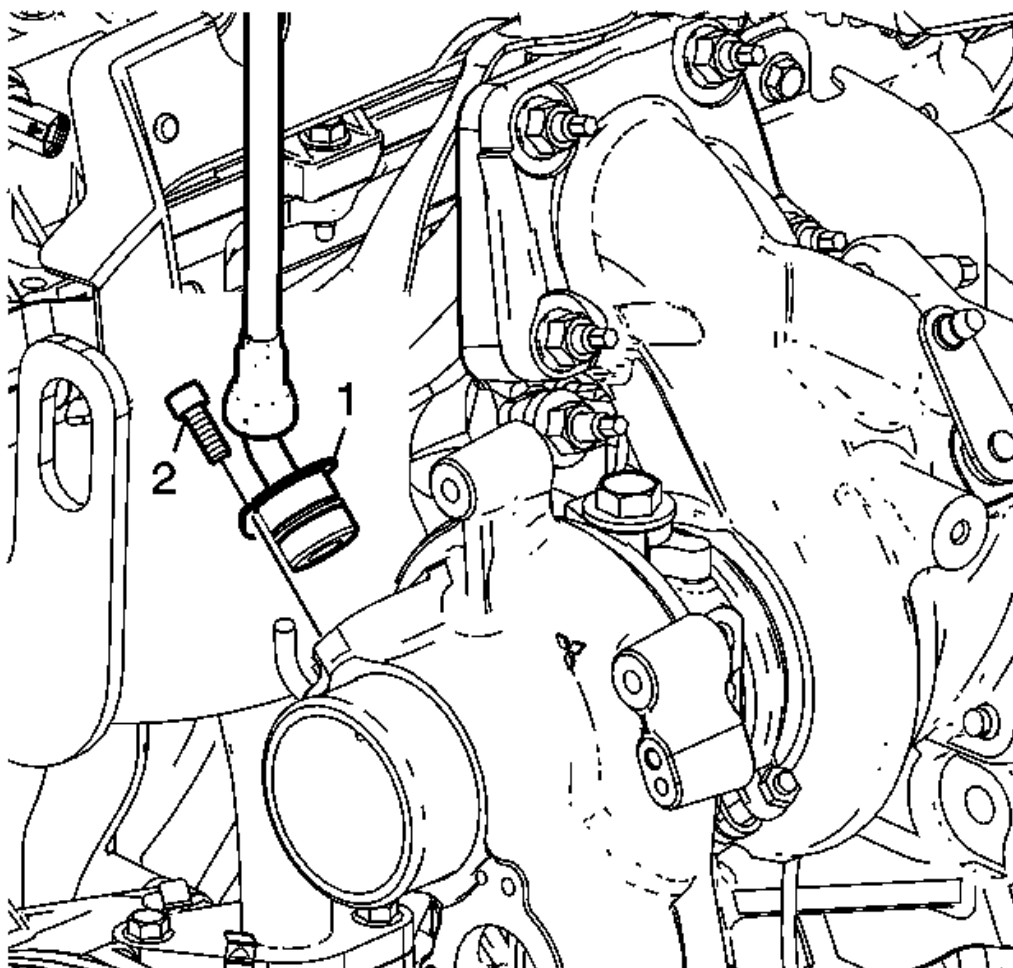


Fig. 21: PCV Hose Fitting Bolt

Courtesy of GENERAL MOTORS COMPANY

NOTE: The PCV hose and fitting assembly connection is permanent. Reinstall these components as an assembly unless new components are being used.

6. Install the PCV hose and fitting assembly (1) to the turbocharger. Install the PCV hose fitting assembly bolt (2) and tighten to 8 (6 lb ft)

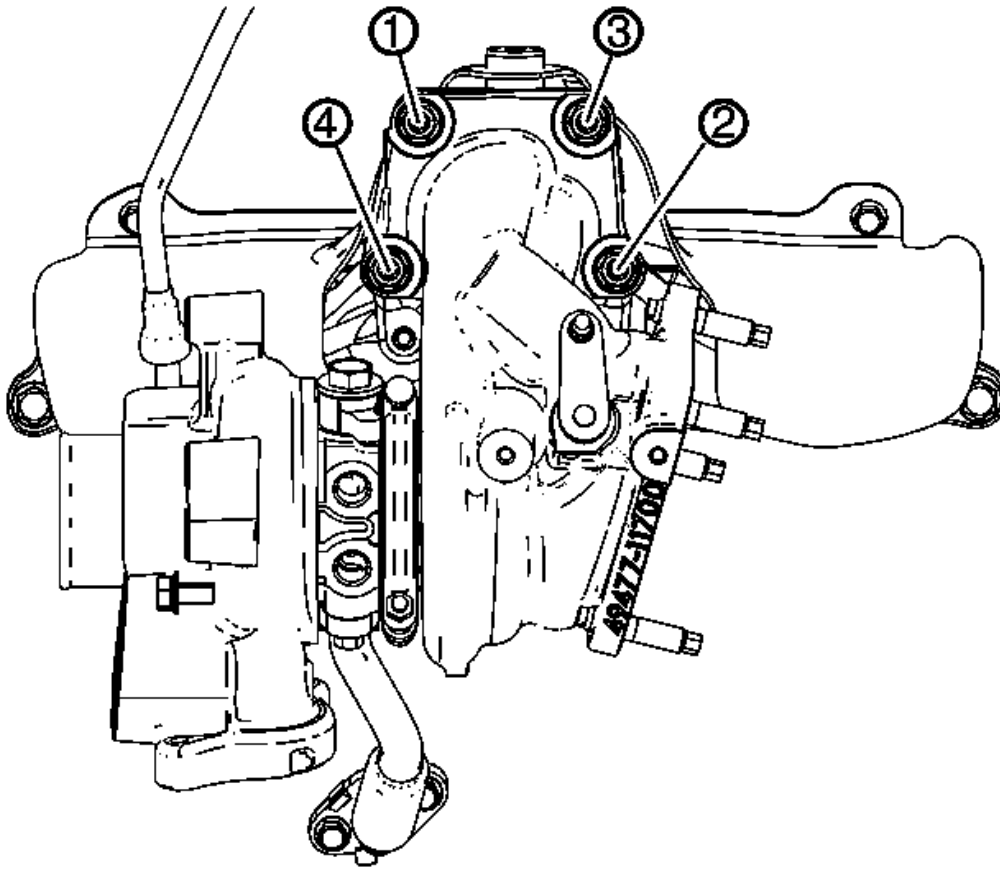


Fig. 22: Turbocharger Nut Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

7. Tighten the turbocharger nuts in sequence:
 1. First pass 30 (22 lb ft).
 2. Final pass plus 90 degrees.

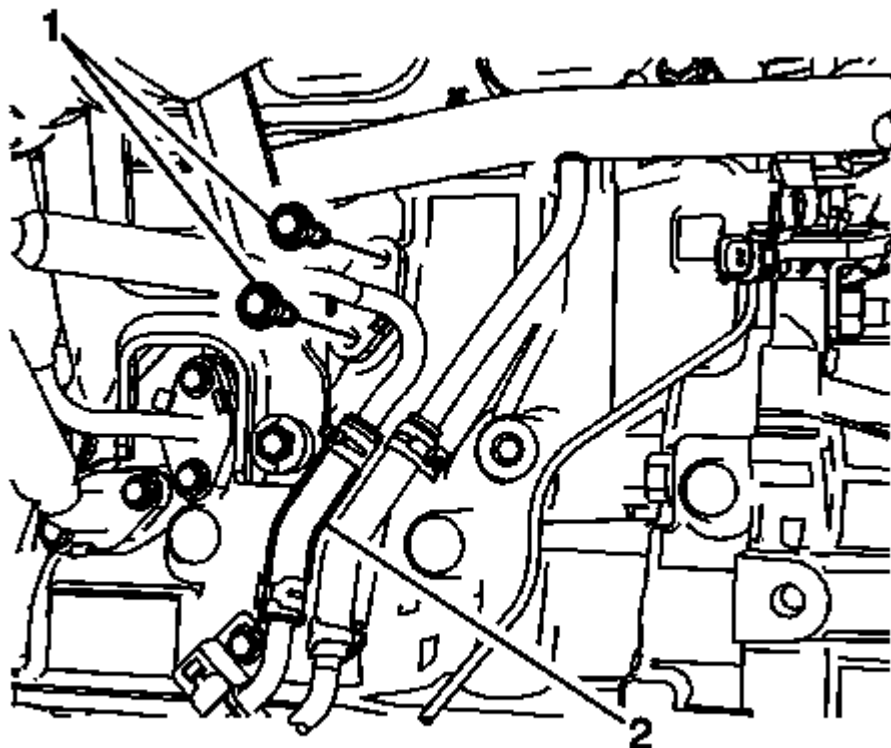


Fig. 23: Turbocharger Coolant Feed Pipe Bolts

Courtesy of GENERAL MOTORS COMPANY

8. Install the turbocharger coolant feed pipe bolts (1) and tighten to 10 (89 lb in).
9. Install the turbocharger coolant return pipe. Refer to **Turbocharger Coolant Return Pipe Replacement (LTG)** .
10. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)** .

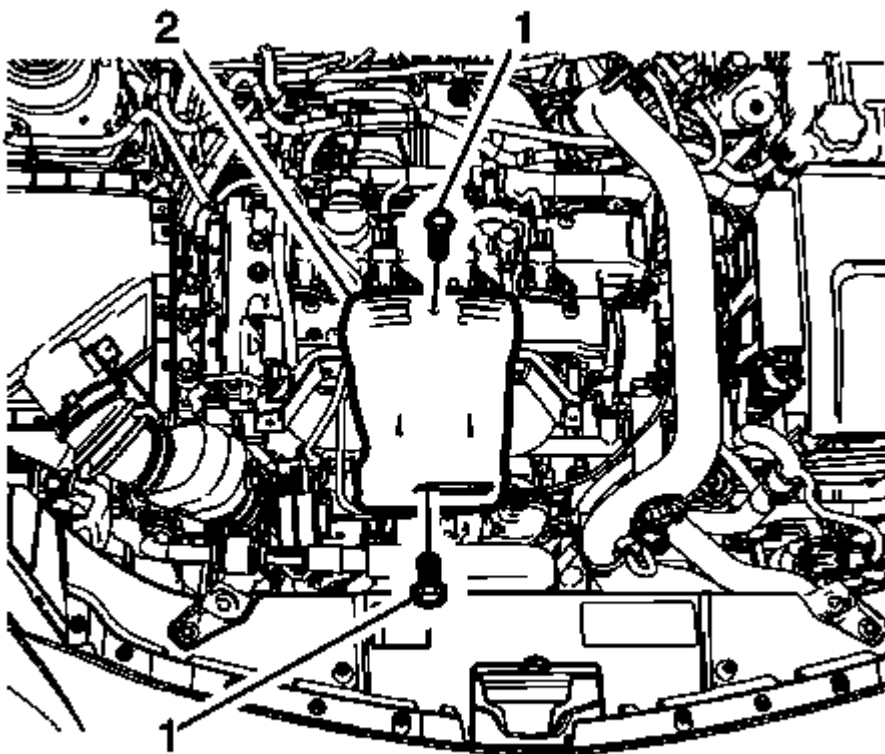


Fig. 24: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

11. Install the turbocharger heat shield (2). Refer to **Turbocharger Heat Shield Replacement**.
12. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
13. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

TURBOCHARGER OIL RETURN PIPE REPLACEMENT

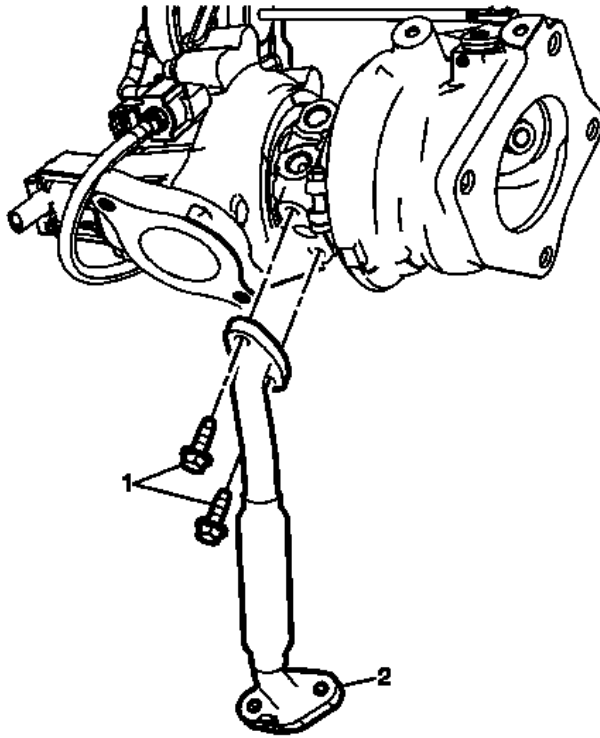
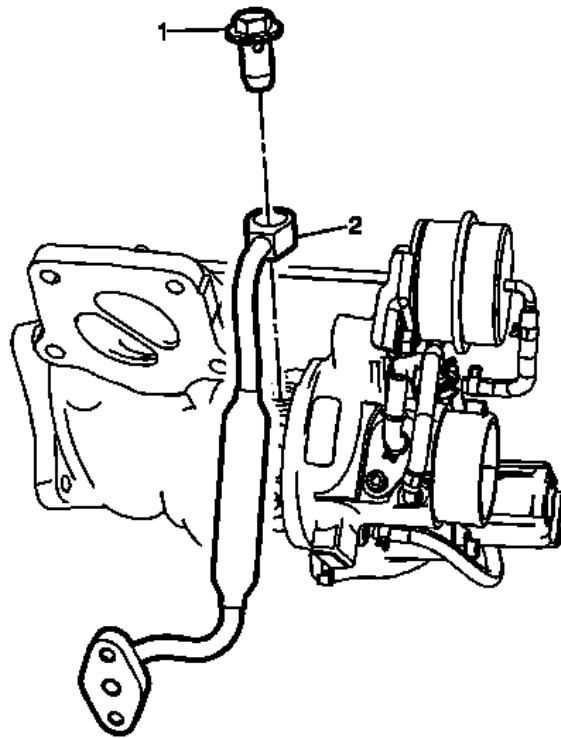


Fig. 25: Turbocharger Oil Return Pipe
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Oil Return Pipe Replacement

Callout	Component Name
Preliminary Procedure Remove the turbocharger. Refer to <u>Turbocharger Replacement</u> .	
1	Turbocharger Oil Return Pipe Fastener (Qty; 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Turbocharger Oil Return Pipe Procedure A NEW turbocharger oil return gasket should be used whenever installing the pipe.

TURBOCHARGER OIL FEED PIPE REPLACEMENT

**Fig. 26: Turbocharger Oil Feed Pipe**

Courtesy of GENERAL MOTORS COMPANY

Turbocharger Oil Feed Pipe Replacement

Callout	Component Name
Preliminary Procedure Remove the turbocharge. Refer to <u>Turbocharger Replacement</u> .	
1	Turbocharger Oil Feed Pipe Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 35 (26 lb ft)
2	Turbocharger Oil Feed Pipe NOTE: A NEW turbocharger oil feed gasket should be used whenever the pipe is installed.

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (CAMSHAFT COVER TO AIR CLEANER RESONATOR TO OUTLET DUCT)

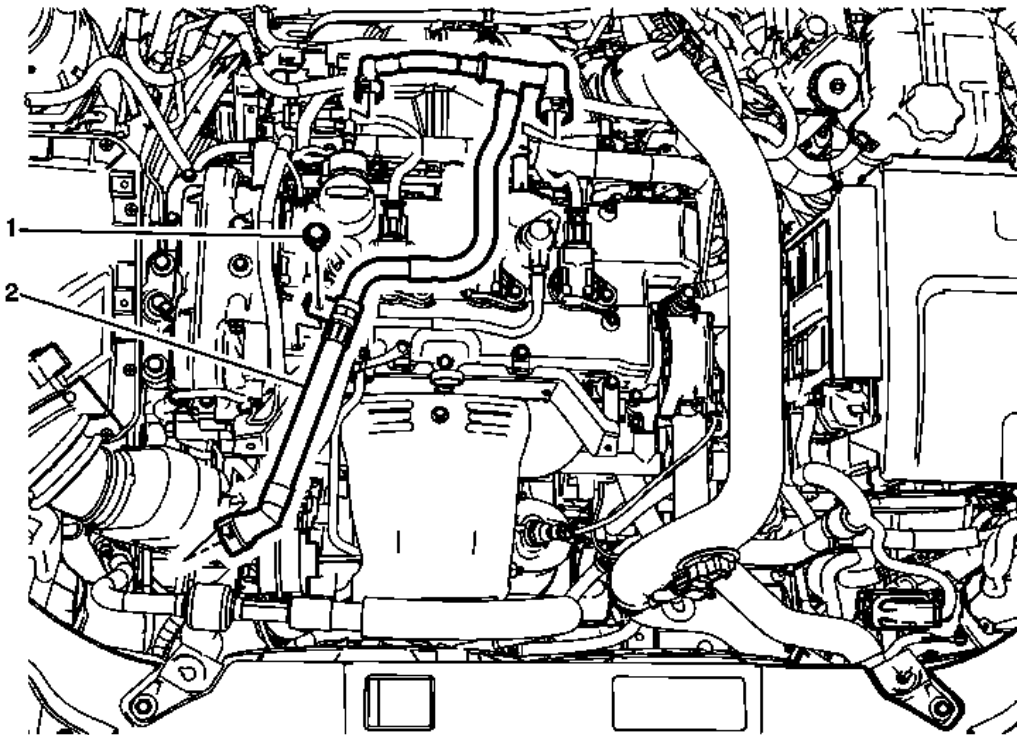


Fig. 27: Positive Crankcase Ventilation Hose/Pipe/Tube (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)

Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Positive Crankcase Ventilation Hose Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Positive Crankcase Ventilation Hose

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Remove the charge air cooler outlet tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement** .

3. Disconnect the fuel feed pipe. Refer to **Fuel Feed Front Pipe Replacement** .

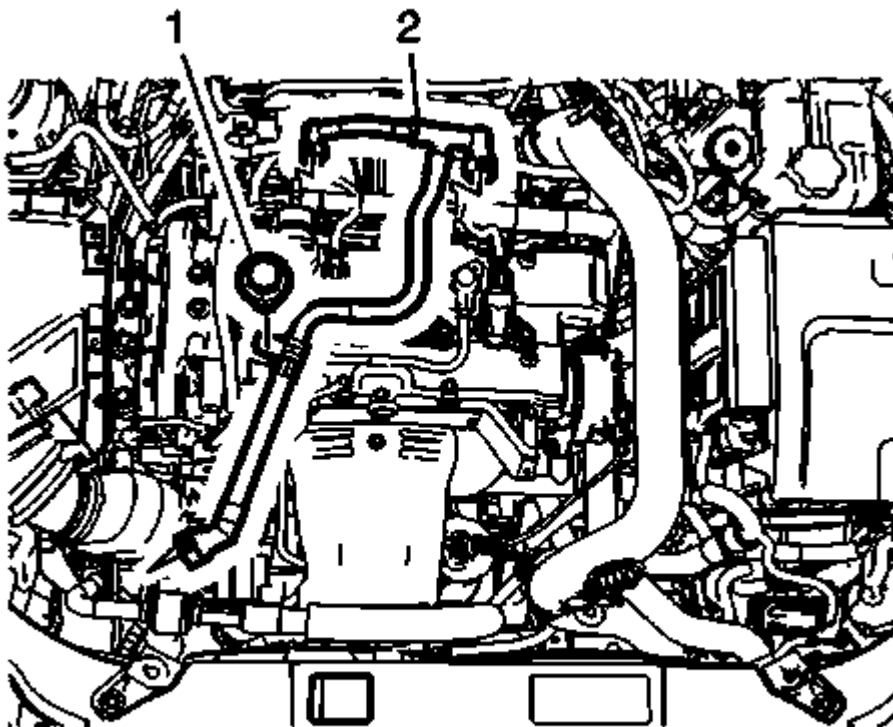


Fig. 28: PCV Pipe

Courtesy of GENERAL MOTORS COMPANY

4. Remove the PCV pipe (2). Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

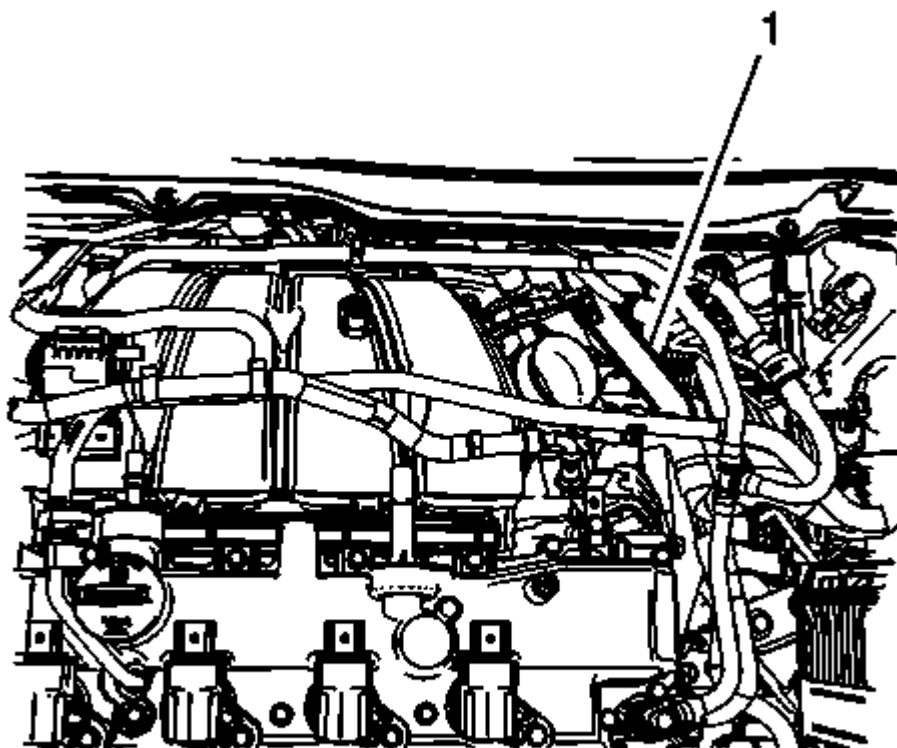


Fig. 29: Brake Vacuum Pipe

Courtesy of GENERAL MOTORS COMPANY

5. Remove the brake vacuum pipe (1). Refer to **Power Brake Booster Vacuum Pipe Replacement (LTG)**.

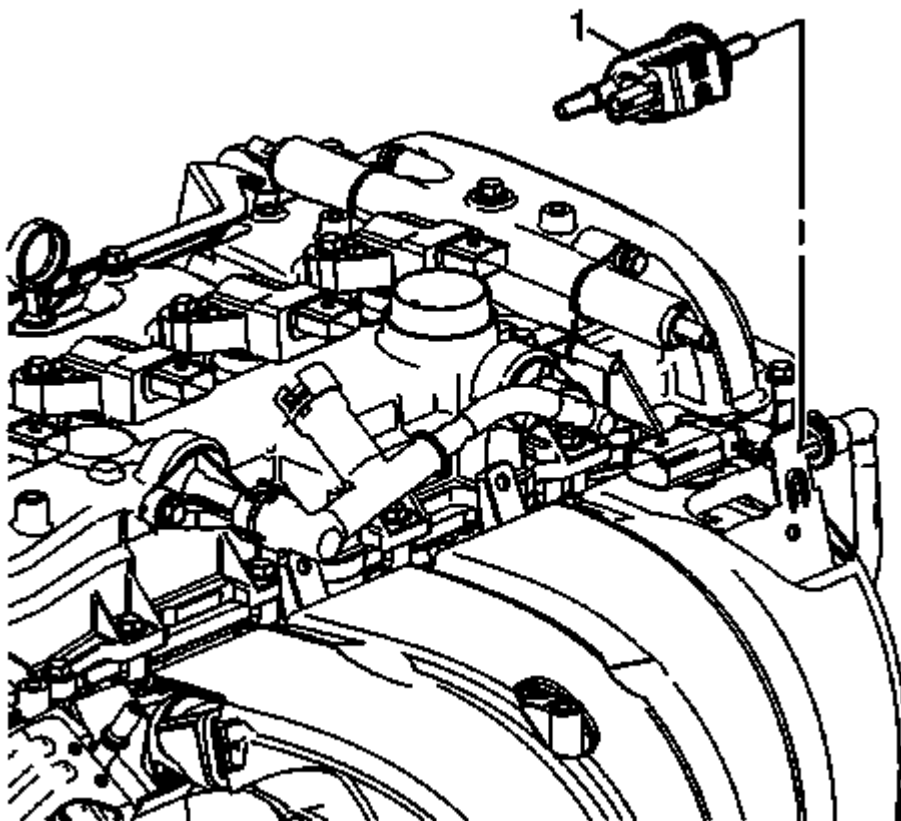


Fig. 30: EVAP Canister Valve

Courtesy of GENERAL MOTORS COMPANY

6. Remove the EVAP Canister Purge Solenoid Valve. (1).
7. Remove the throttle body. Refer to **Throttle Body Assembly Replacement** .
8. Remove the fuel pump. Refer to **Fuel Pump Replacement** .

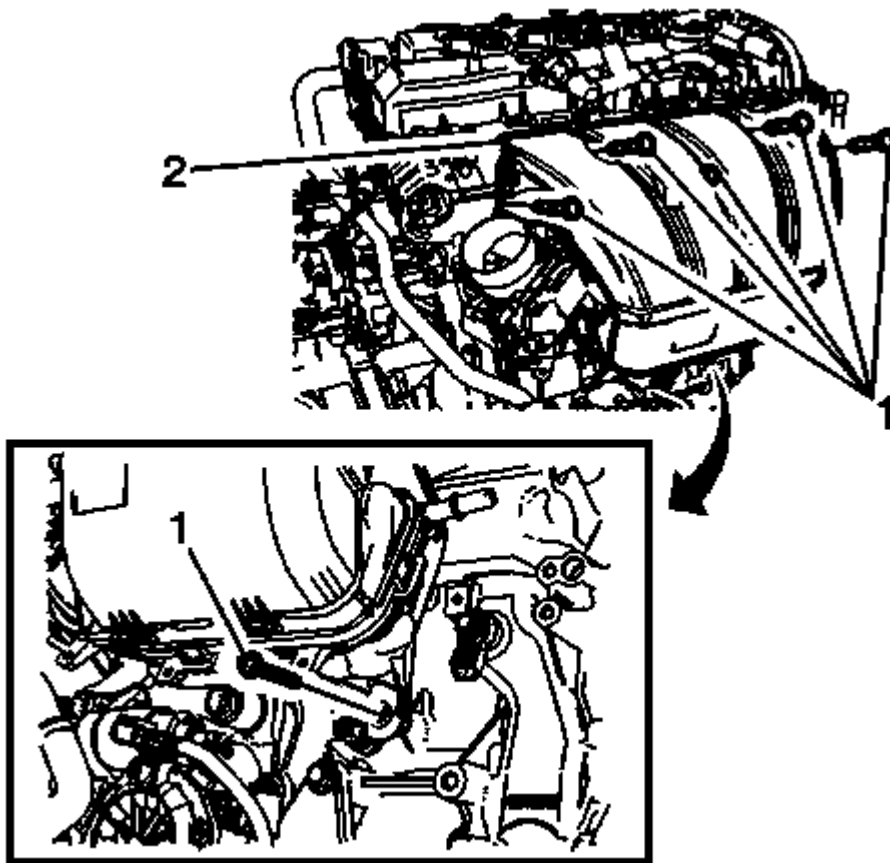


Fig. 31: Intake Bolts

Courtesy of GENERAL MOTORS COMPANY

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

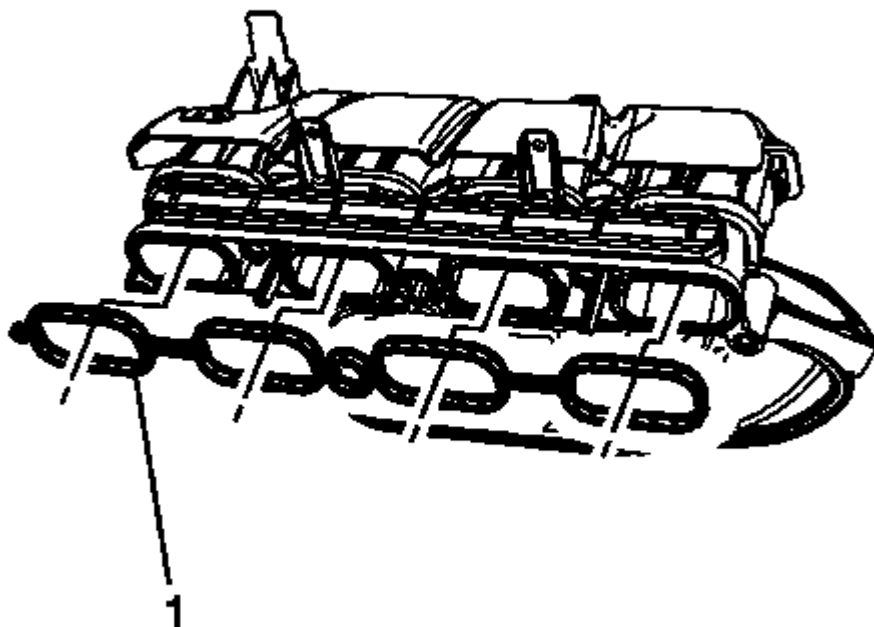


Fig. 32: Intake Manifold Gasket

Courtesy of GENERAL MOTORS COMPANY

11. Remove the intake manifold gasket (1) and DISCARD.
12. For intake manifold cleaning and inspection. Refer to **Intake Manifold Cleaning and Inspection** .

Installation Procedure

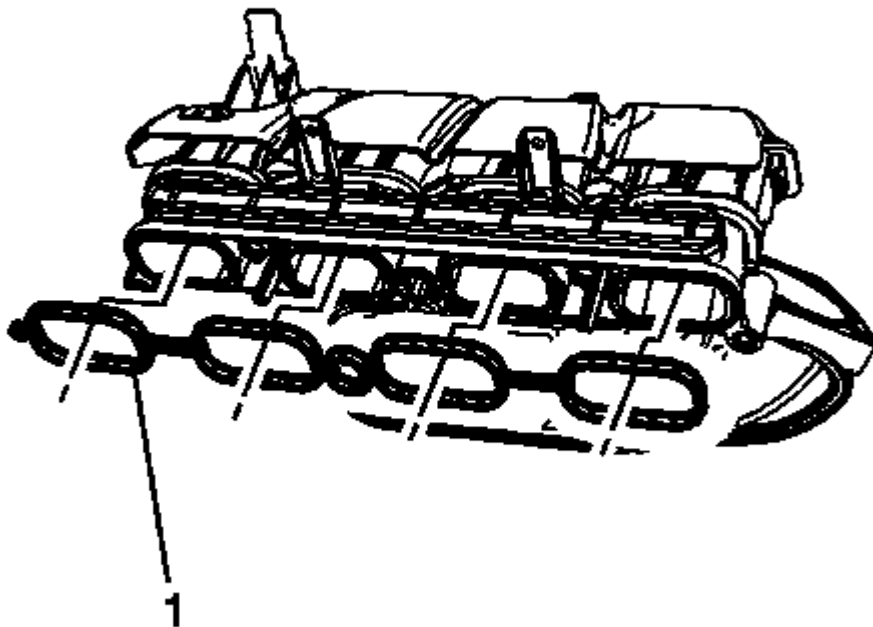


Fig. 33: Intake Manifold Gasket

Courtesy of GENERAL MOTORS COMPANY

1. Install the intake manifold gasket (1).

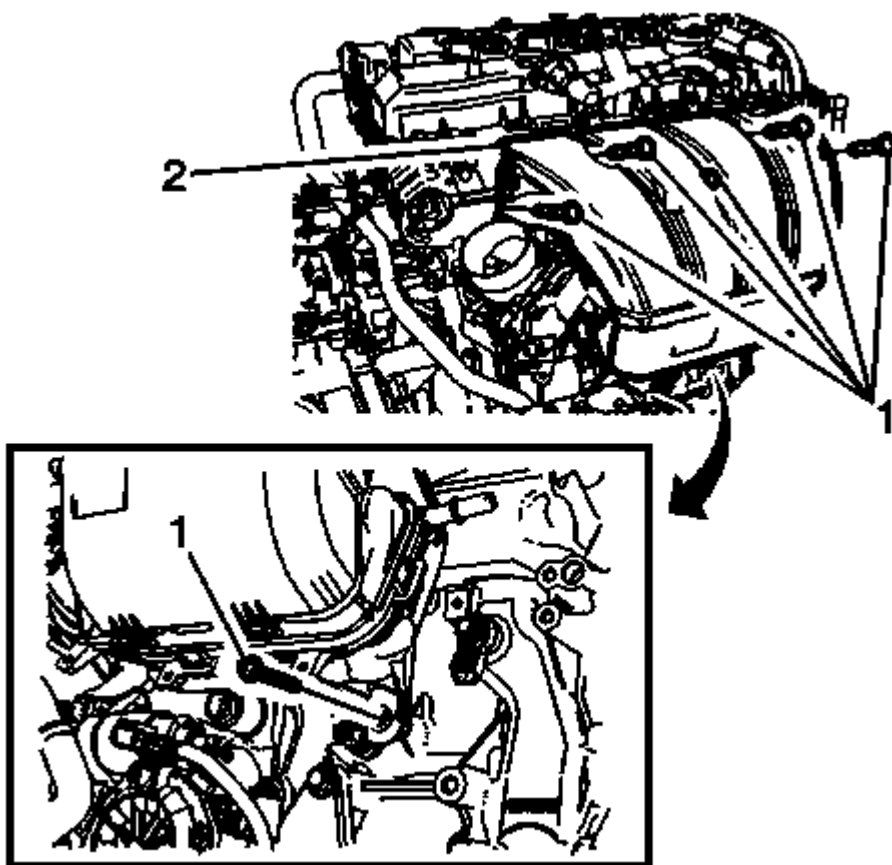


Fig. 34: Intake Bolts

Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold (2).
3. Hand start the intake manifold bolts (1).

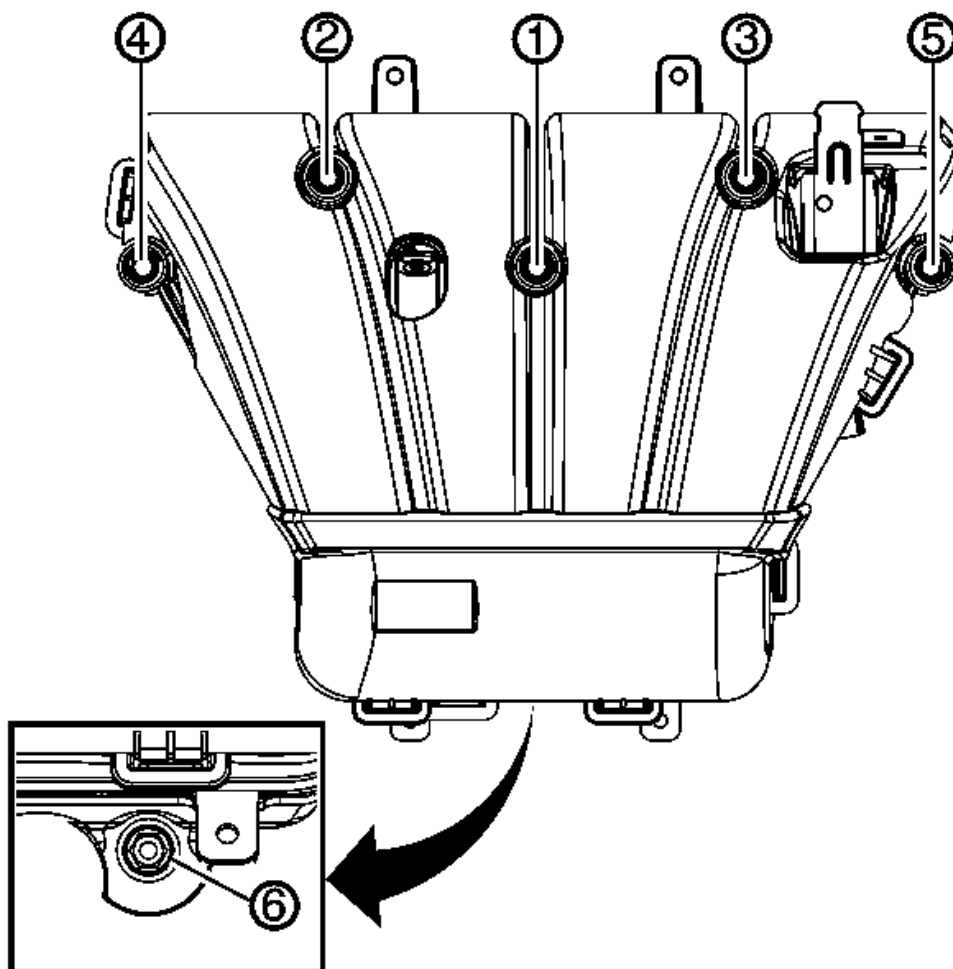


Fig. 35: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Tighten the fastener in sequence twice to 12 (106 lb in).
5. Install the fuel pump. Refer to Fuel Pump Replacement .
6. Install the throttle body. Refer to Throttle Body Assembly Replacement .

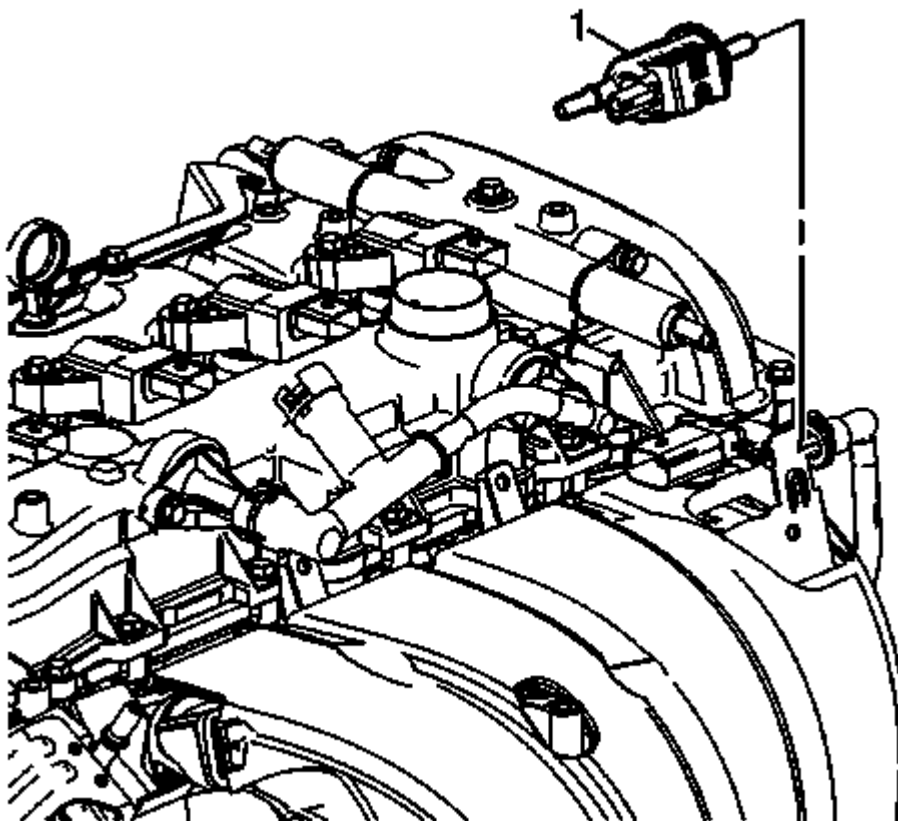


Fig. 36: EVAP Canister Valve

Courtesy of GENERAL MOTORS COMPANY

7. Install the EVAP Canister Purge Solenoid Valve (1).

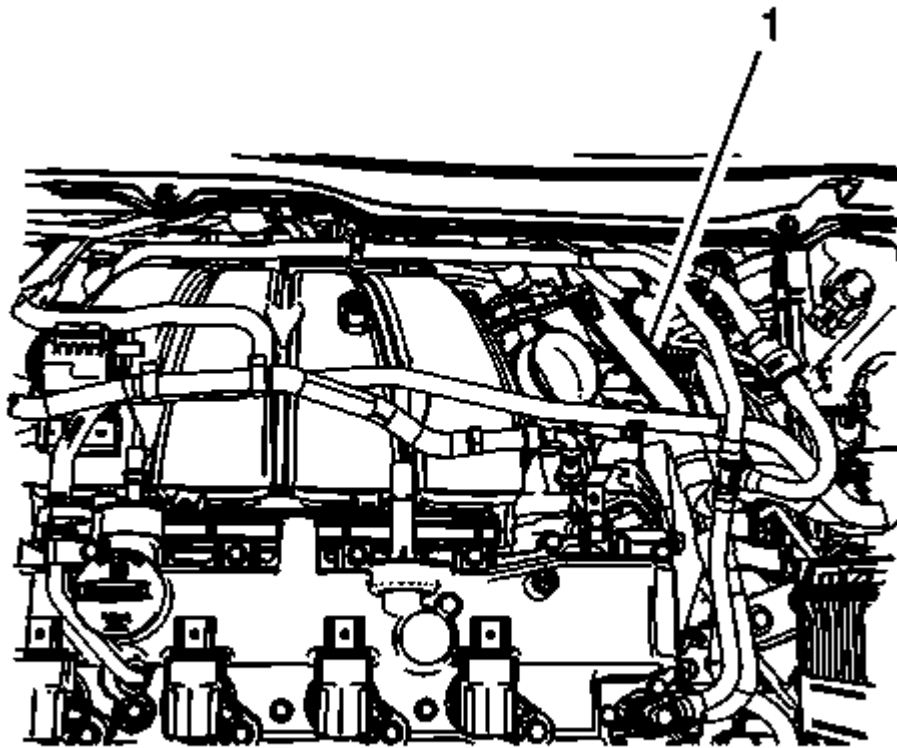


Fig. 37: Brake Vacuum Pipe

Courtesy of GENERAL MOTORS COMPANY

8. Install the brake vacuum pipe (1). Refer to **Power Brake Booster Vacuum Pipe Replacement (LTG)** .

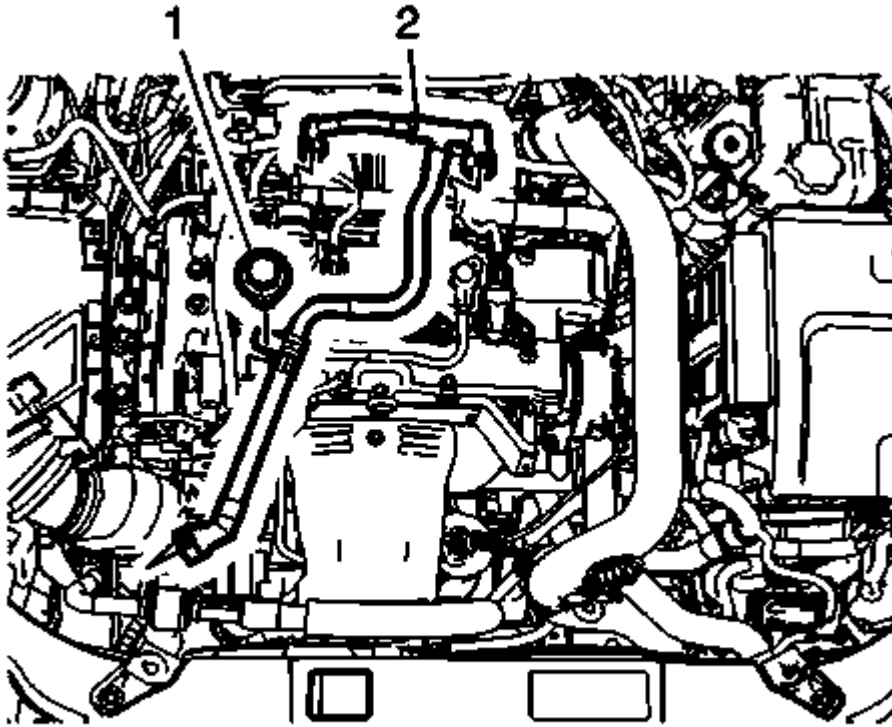
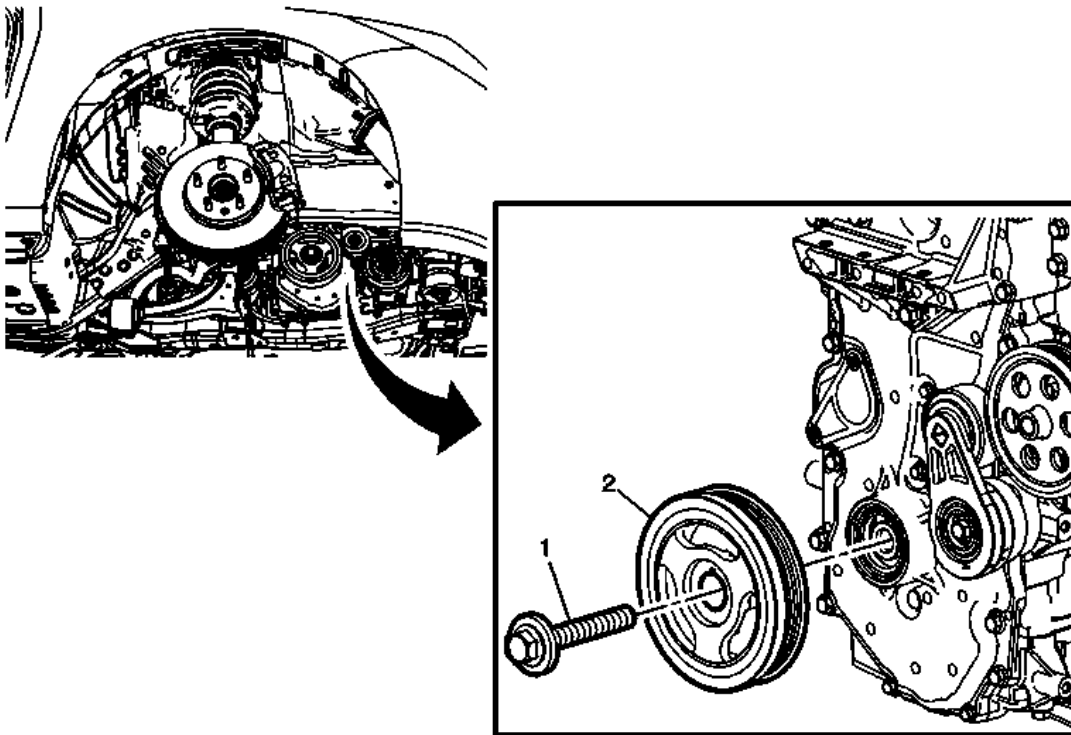


Fig. 38: PCV Pipe

Courtesy of GENERAL MOTORS COMPANY

9. Install the PCV pipe (2). Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.
10. Install the charge air cooler outlet tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement**.
11. Connect the fuel feed pipe. Refer to **Fuel Feed Front Pipe Replacement**.
12. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

CRANKSHAFT BALANCER REPLACEMENT

**Fig. 39: Crankshaft Balancer**

Courtesy of GENERAL MOTORS COMPANY

Crankshaft Balancer Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the starter . Refer to <u>Starter Replacement (LTG)</u> . 2. Install the EN-46106 flywheel holder. 3. Remove the drive belt. Refer to <u>Drive Belt Replacement</u>.	
Special Tools • EN-41816 Crankshaft Balancer Remover • EN-45059 Angle Meter • EN-46106 Flywheel Holder	
For equivalent regional tools, refer to <u>Special Tools</u> .	
1	Crankshaft Balancer Bolt CAUTION: Refer to <u>Fastener Caution</u> .

	Procedure Install a NEW crankshaft bolt and washer. Tighten 150 (111 lb ft) plus 180 degrees.
2	Crankshaft Balancer

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

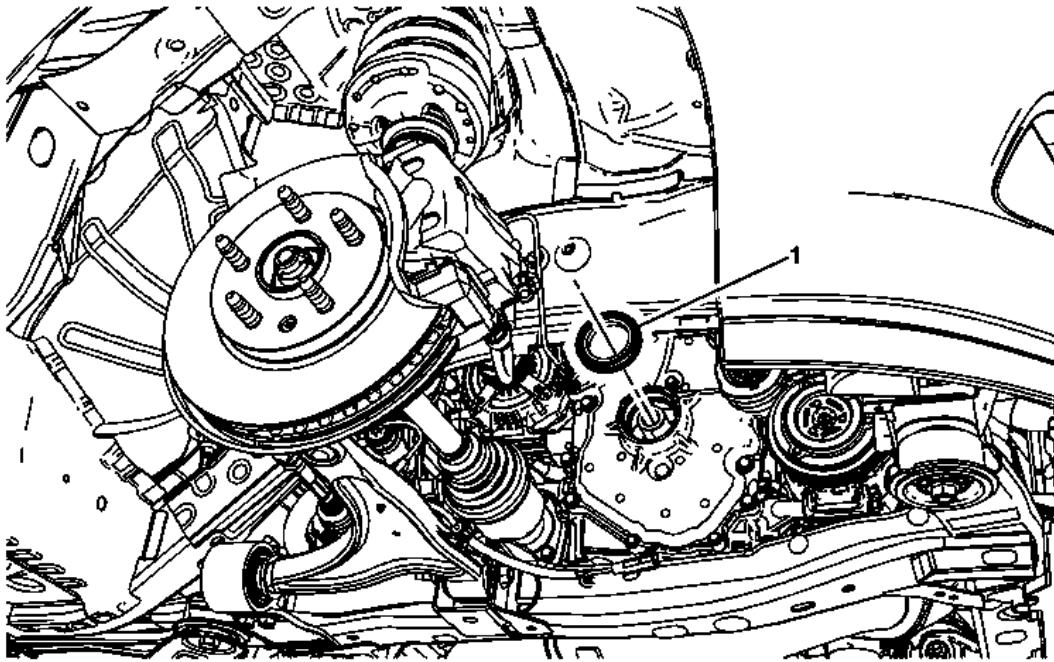


Fig. 40: Crankshaft Front Oil Seal

Courtesy of GENERAL MOTORS COMPANY

Crankshaft Front Oil Seal Replacement

Callout	Component Name
Preliminary Procedure Remove the crankshaft balancer. Refer to Crankshaft Balancer Replacement .	
1	Front Crankshaft Seal Procedure 1. Use a suitable tool to remove the front cover oil seal. 2. Use the EN 50820 Front Crankshaft Seal Installer to install the seal. Special Tools EN 50820 Front Crankshaft Seal Installer

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

ENGINE FRONT COVER REPLACEMENT

Removal Procedure

Special Tools

EN-50820 Front Crankshaft Seal Installer

KM-470-B Angular Torque Gauge

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

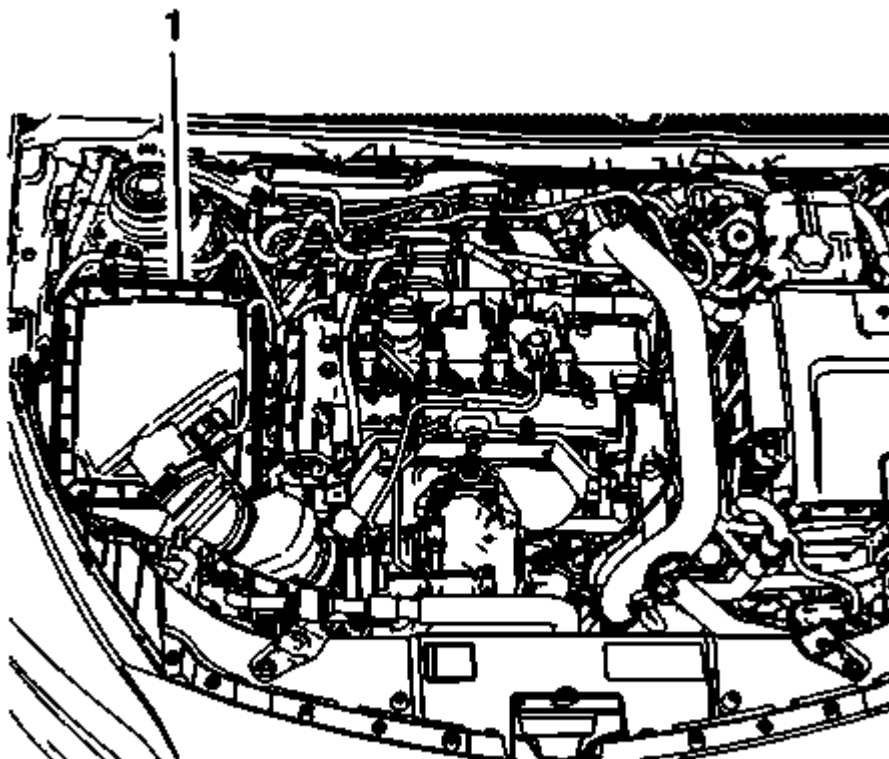


Fig. 41: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Remove the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.

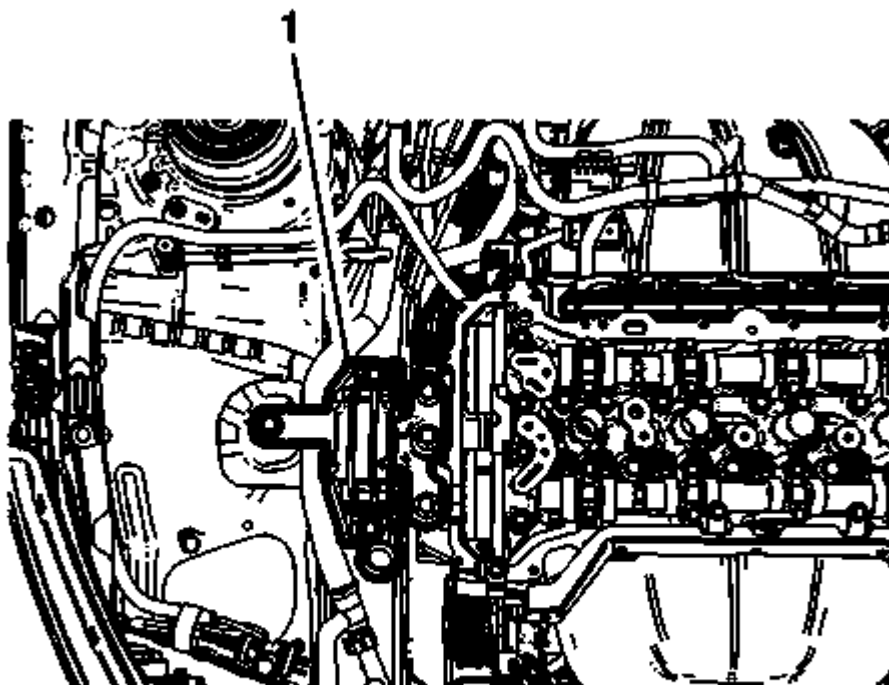


Fig. 42: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine mount (1). Refer to **Engine Mount Replacement**.
4. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
5. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.

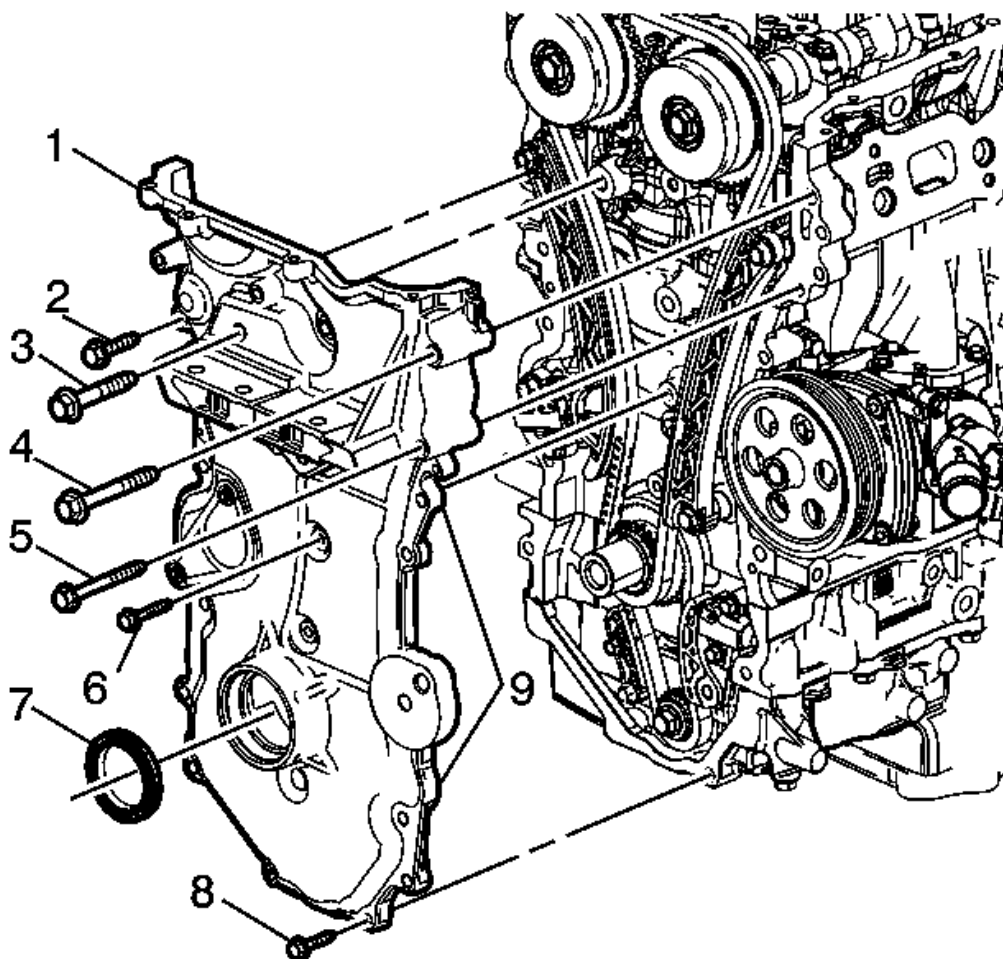


Fig. 43: Front Oil Seal

Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine front cover bolts (2-6, 8).
7. Remove the engine front cover (1).
8. Remove the front oil seal (7) with an appropriate tool.

Installation Procedure

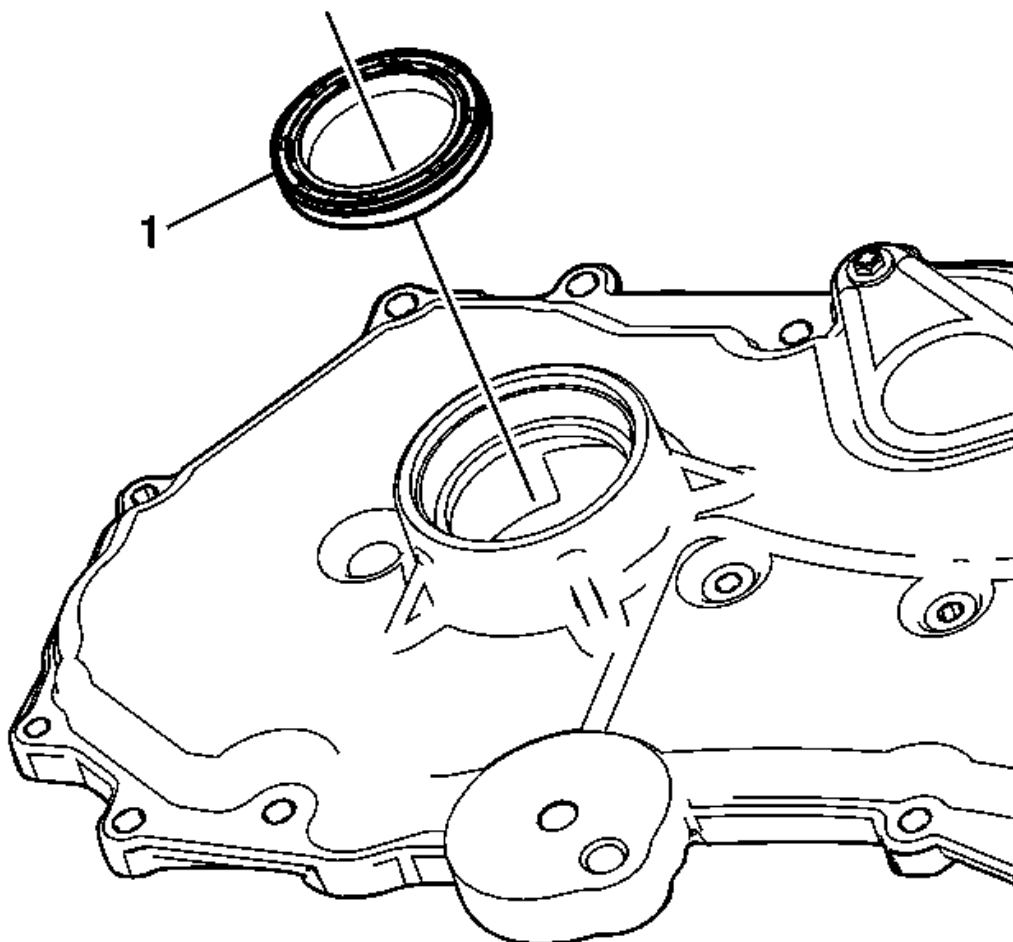


Fig. 44: Front Crankshaft Seal

Courtesy of GENERAL MOTORS COMPANY

1. Using **EN-50820** installer , install the front crankshaft seal (1) into the engine front cover.

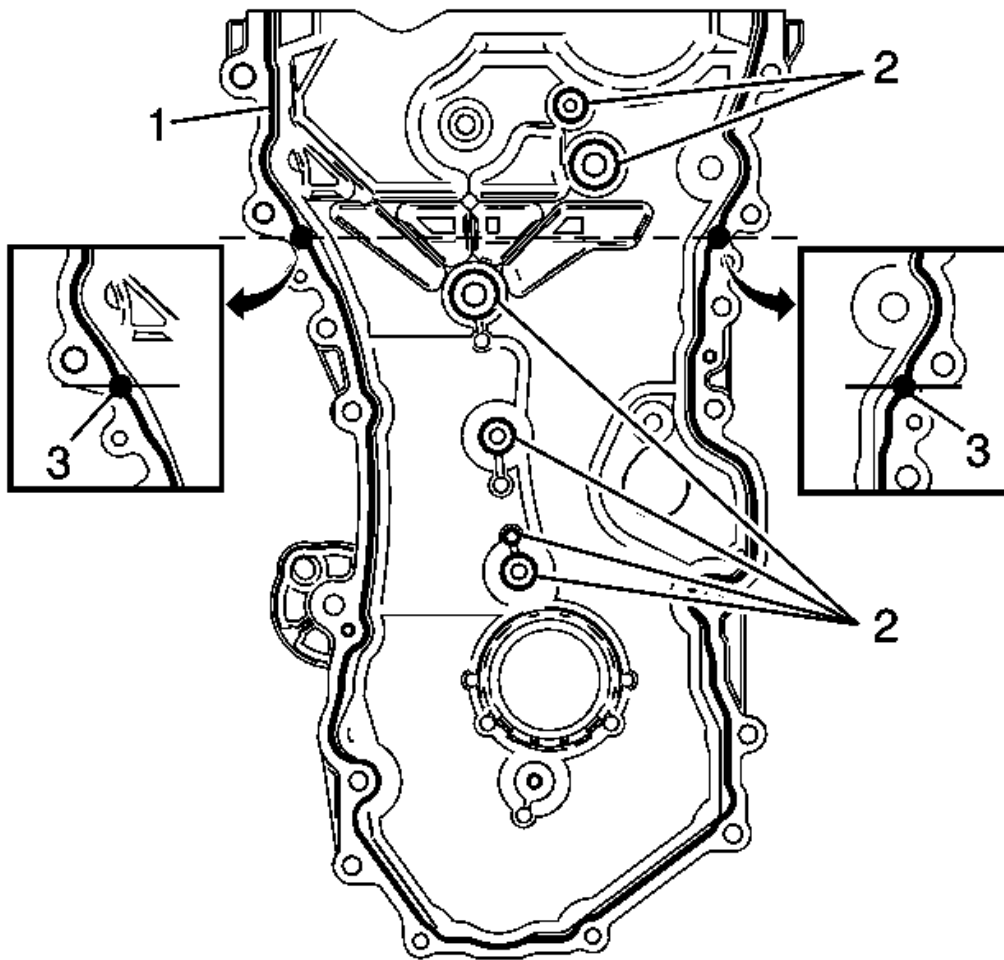


Fig. 45: Applying Bead Of Sealer Directly In Flange
 Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The engine front cover surface must be free of contamination prior to applying the sealer.
- Install and align the cover within 20 minutes of applying the sealer.
- The cover must be fastened to final torque specification within 60 minutes of applying the sealer.
- Additional sealant is necessary to reduce the possibility of leakage where the cylinder head to engine block interface along the bead path flange on the front cover.

2. Apply a 5 mm bead of sealer directly in the flange (1) of the engine front cover perimeter mating surface. Also apply a 5 mm bead of sealer directly to the locations indicated (2). Finally, apply a 14 mm dab of sealant at the locations indicated (3). Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

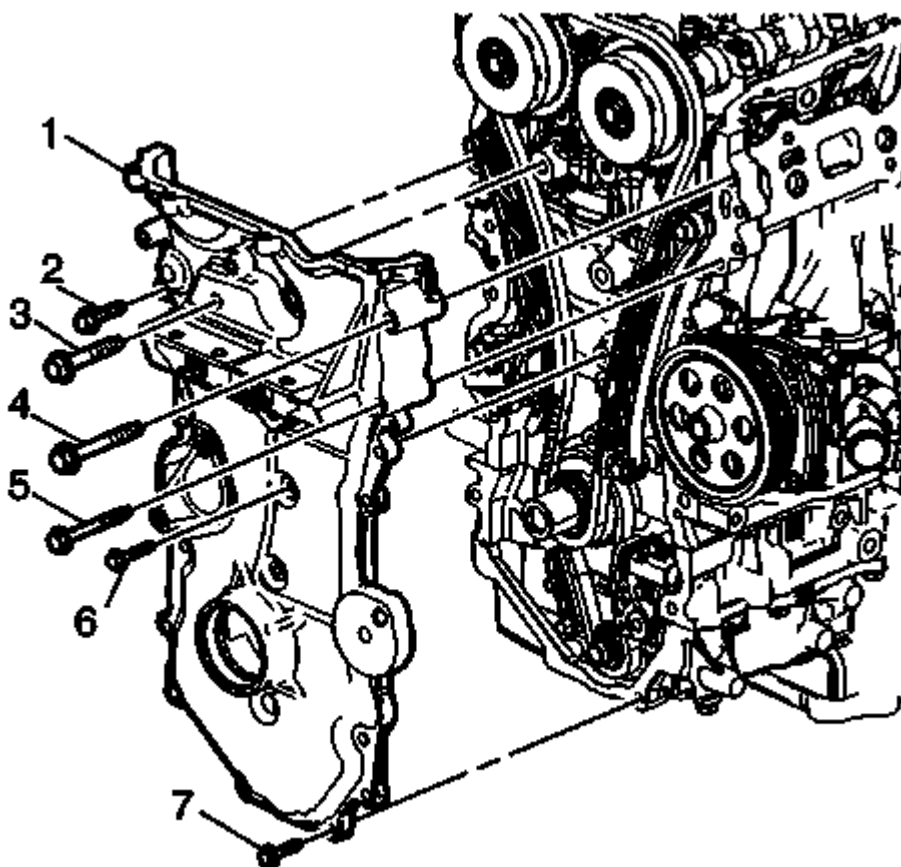


Fig. 46: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

3. Install the engine front cover (1).
4. Hand start the engine front cover bolts (2-6, 7).

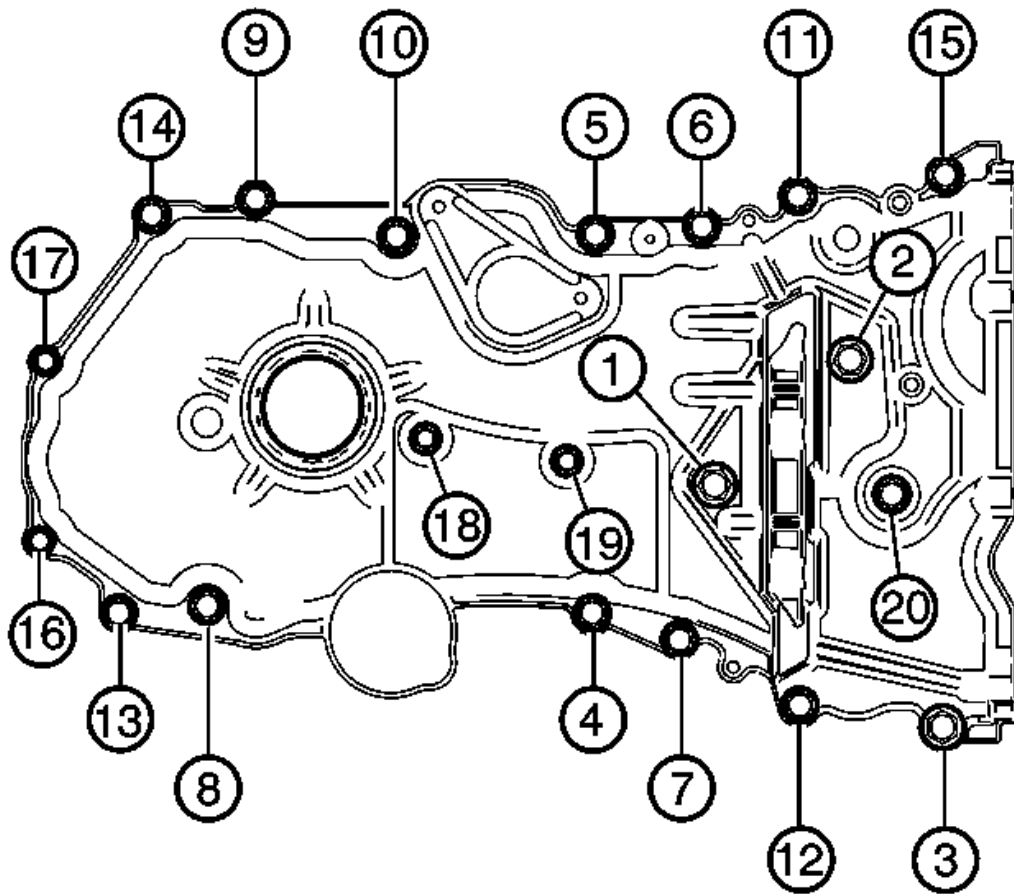


Fig. 47: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Tighten the engine front cover bolts in sequence to final torque twice:
 1. Using **KM-470-B** Angular Torque Gauge tighten sequence 1-2 bolts to 15 (11 lb ft) + 130 degrees.
 2. Tighten sequence 3 bolt to 58 (43 lb ft).
 3. Tighten sequence 4-11 bolts to 25 (18 lb ft).
 4. Tighten sequence 12 bolt to 25 (18 lb ft).
 5. Tighten sequence 13-15 bolts to 25 (18 lb ft).
 6. Tighten sequence 16-17 bolts to 10 (89 lb in).
 7. Tighten sequence 18-19 bolts to 10 (89 lb in).
 8. Using **KM-470-B** Angular Torque Gauge tighten sequence 20 bolt to 15 (11 lb ft) + 130 degrees.
6. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.

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

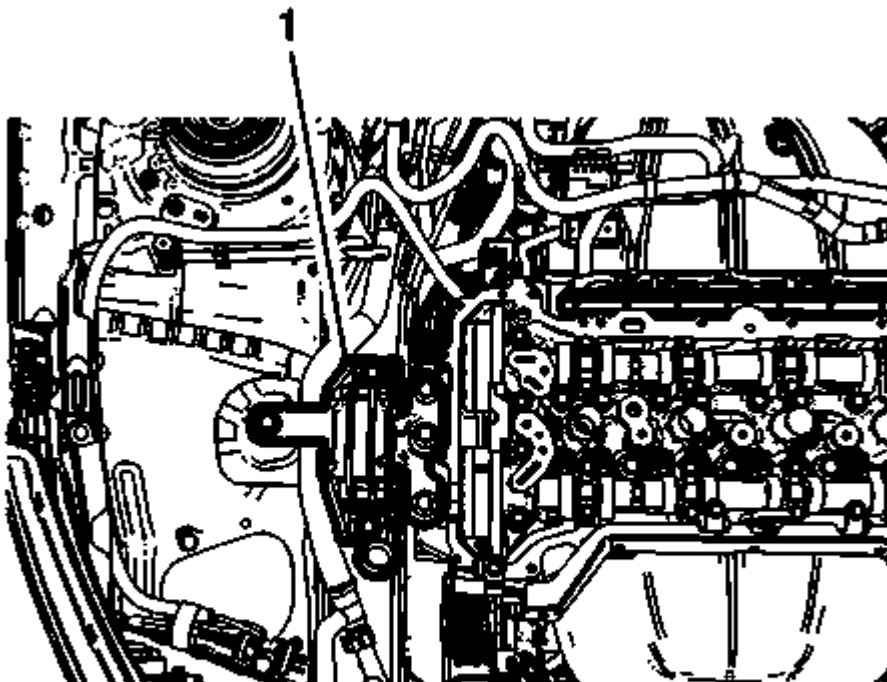


Fig. 48: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

8. Install the engine mount (1). Refer to **Engine Mount Replacement**.
9. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.

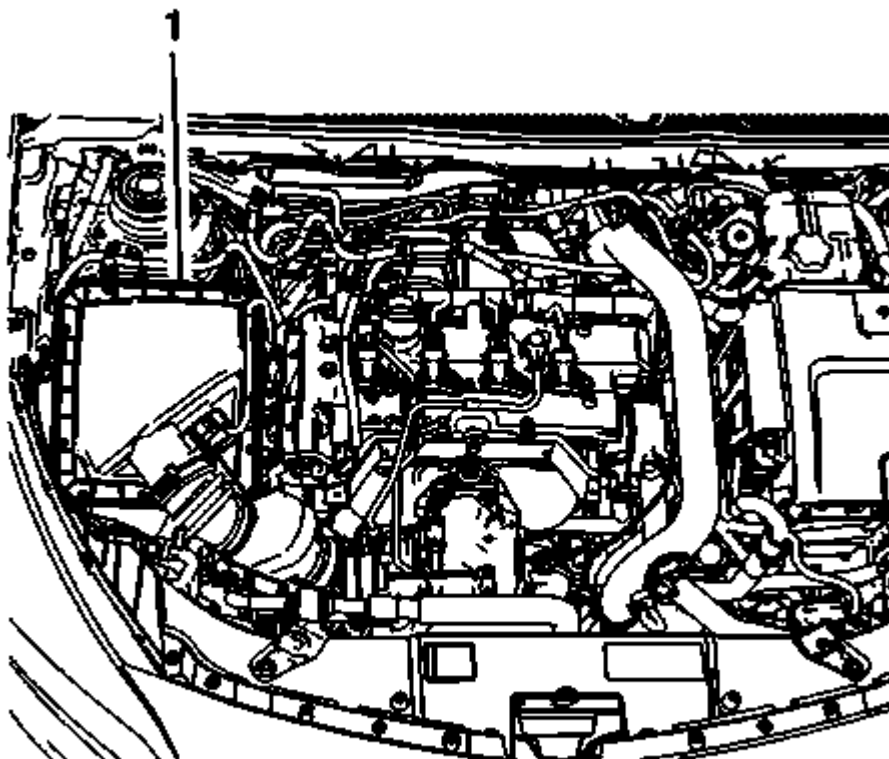


Fig. 49: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

10. Install the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .

INTAKE VALVE ROCKER ARM REPLACEMENT

Removal Procedure

1. Remove the camshaft position actuator and camshaft - intake. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake**.

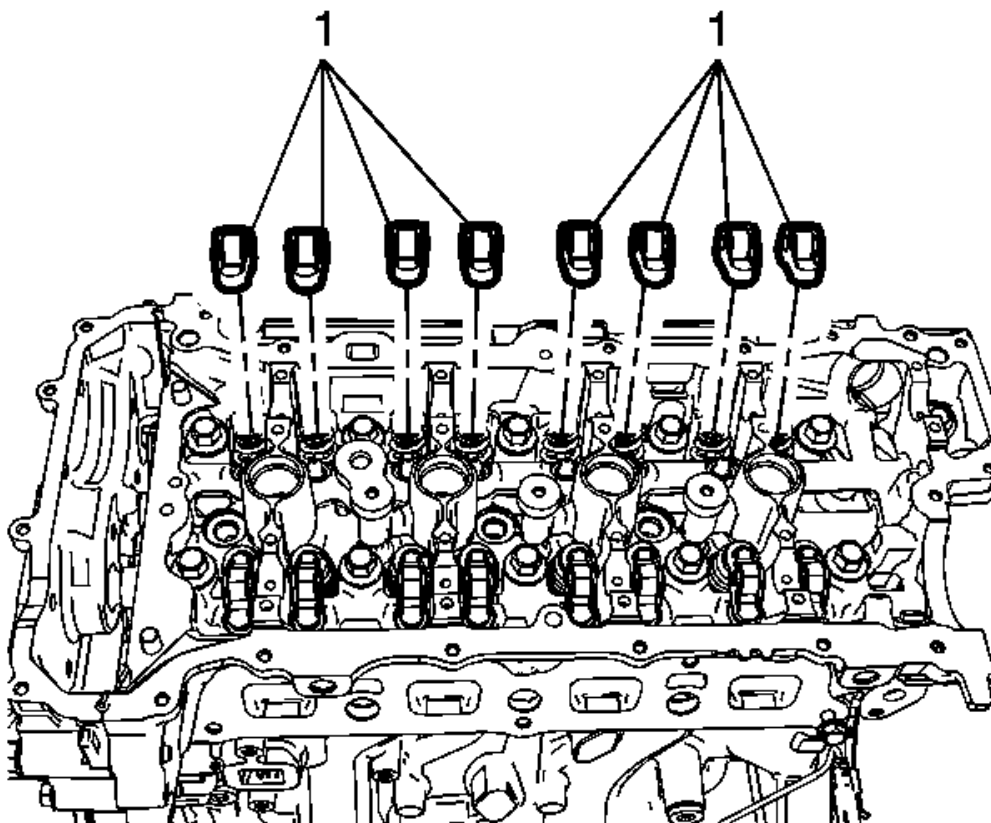


Fig. 50: Intake Rocker Arm

Courtesy of GENERAL MOTORS COMPANY

NOTE: Keep all of the valve rocker arms and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.

2. Remove the intake rocker arm (1).

Installation Procedure

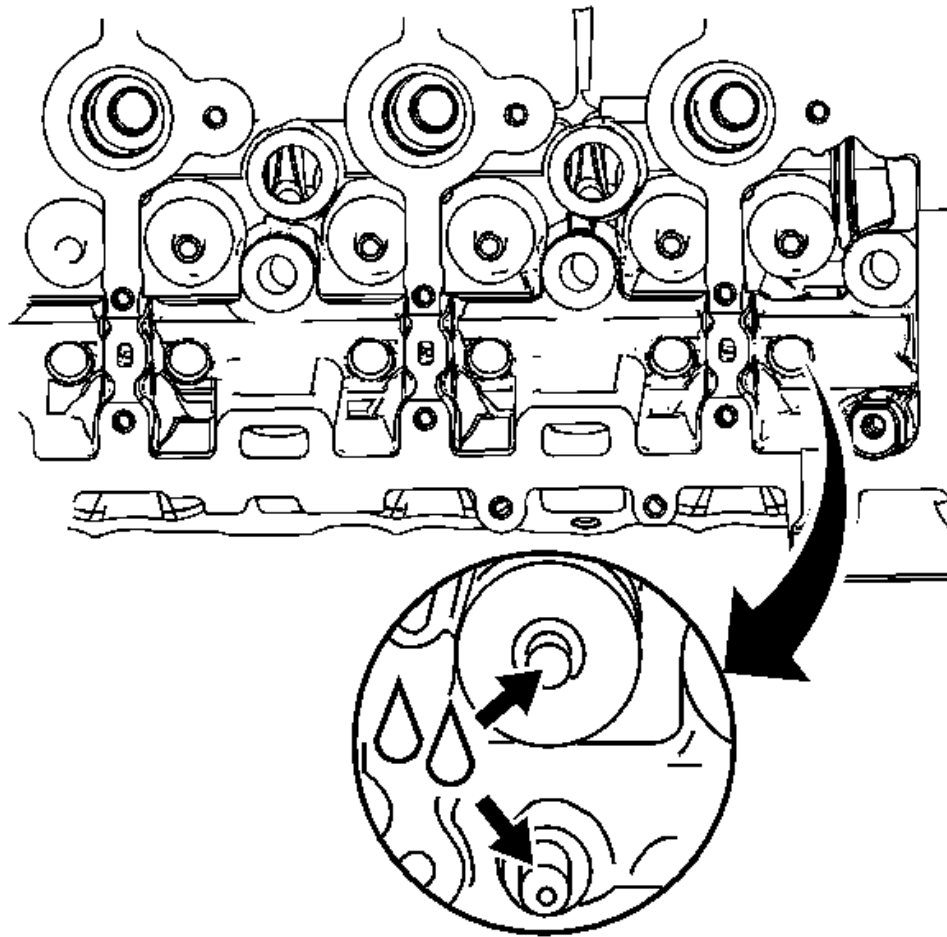


Fig. 51: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve tips. Refer to Adhesives, Fluids, Lubricants, and Sealers .

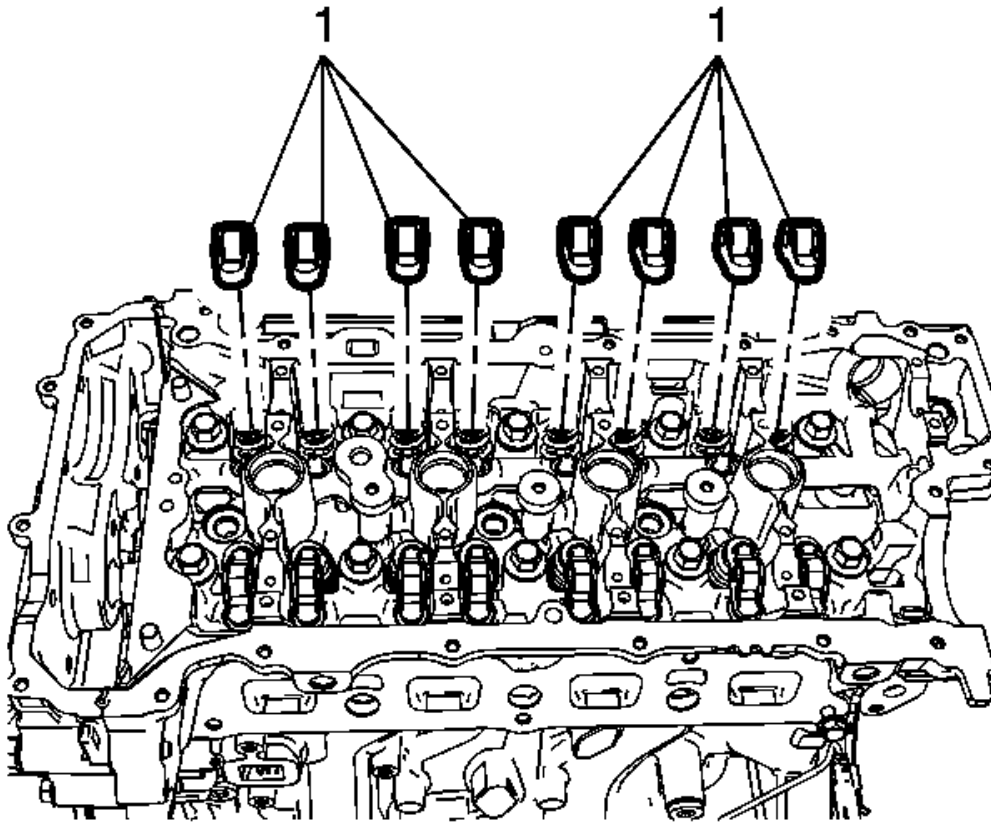


Fig. 52: Intake Rocker Arm

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Used rocker arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms actuated by the camshaft must also be replaced.
- Pre-oil roller bearings before installation.

2. Lubricate the roller bearings with valve rocker arm lubricant. Refer to Adhesives, Fluids, Lubricants, and Sealers .
3. Position the valve rocker arm (1) on the tip of the valve stem and on the lash adjuster and lubricate. Refer to Adhesives, Fluids, Lubricants, and Sealers .
4. Install the camshaft position actuator and camshaft - intake. Refer to Camshaft Position Actuator and Camshaft Replacement - Intake.

EXHAUST VALVE ROCKER ARM REPLACEMENT

Removal Procedure

1. Remove the camshaft position actuator and camshaft - exhaust. Refer to **Camshaft Position Actuator and Camshaft Replacement - Exhaust**.

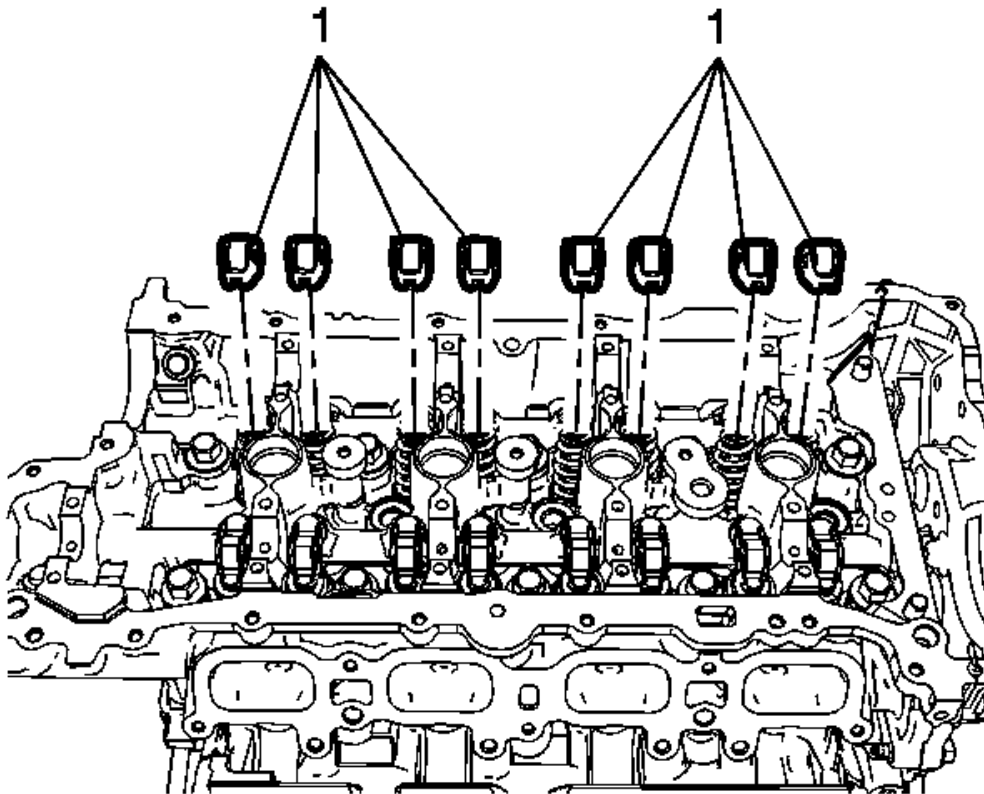


Fig. 53: Exhaust Rocker Arm

Courtesy of GENERAL MOTORS COMPANY

NOTE: Keep all of the Valve Rocker Arms and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.

2. Remove the exhaust rocker arm (1).

Installation Procedure

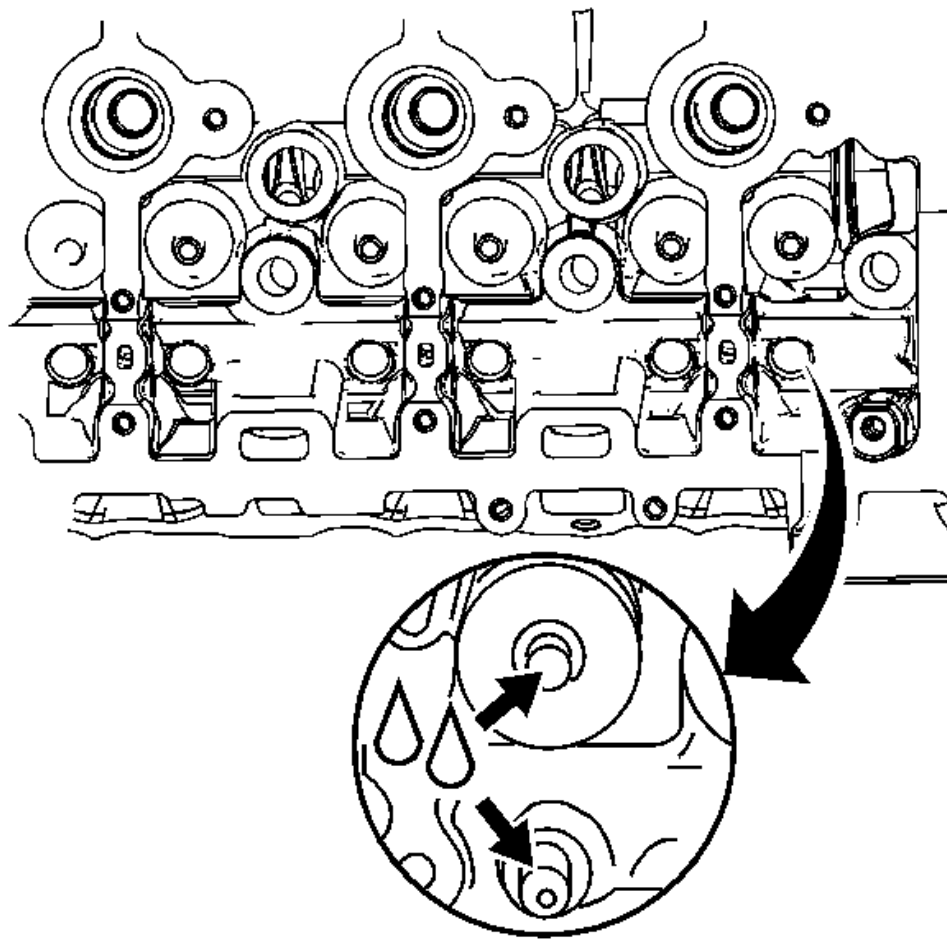


Fig. 54: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve tips. Refer to Adhesives, Fluids, Lubricants, and Sealers .

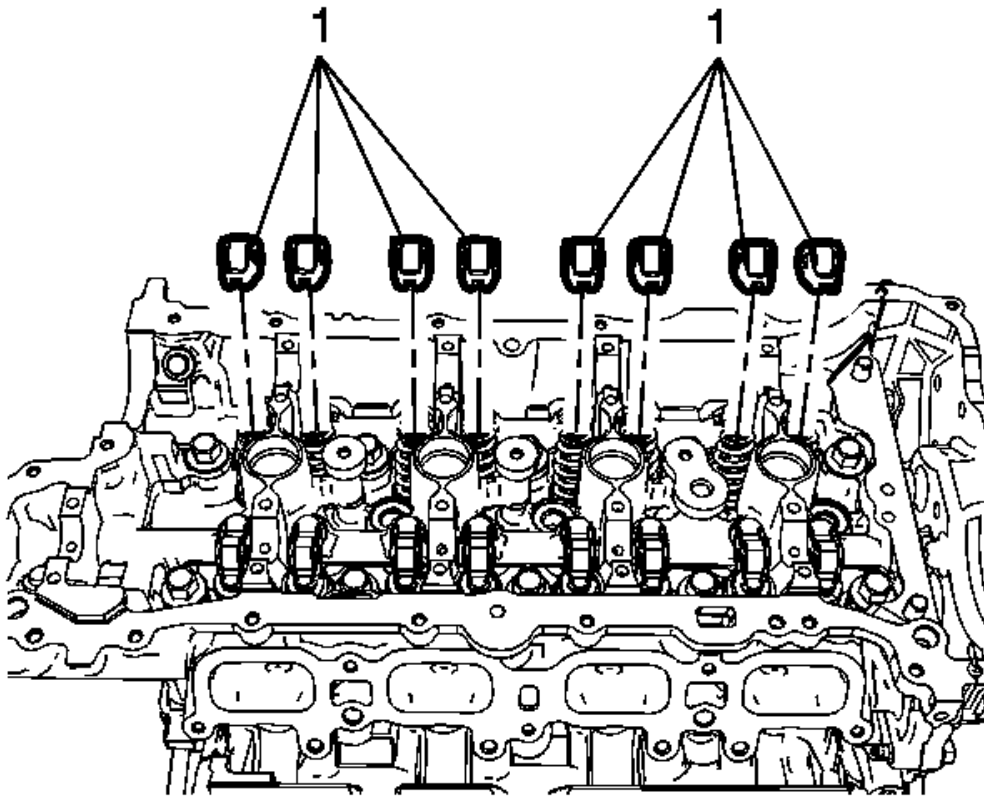


Fig. 55: Exhaust Rocker Arm

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Used rocker arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms actuated by the camshaft must also be replaced.
- Pre-oil roller bearings before installation.

2. Lubricate the roller bearings with valve rocker arm lubricant. Refer to Adhesives, Fluids, Lubricants, and Sealers .
3. Position the valve rocker arm (1) on the tip of the valve stem and on the lash adjuster and lubricate. Refer to Adhesives, Fluids, Lubricants, and Sealers .
4. Install the camshaft position actuator and camshaft - exhaust. Refer to Camshaft Position Actuator and Camshaft Replacement - Exhaust.

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER REPLACEMENT

Removal Procedure

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

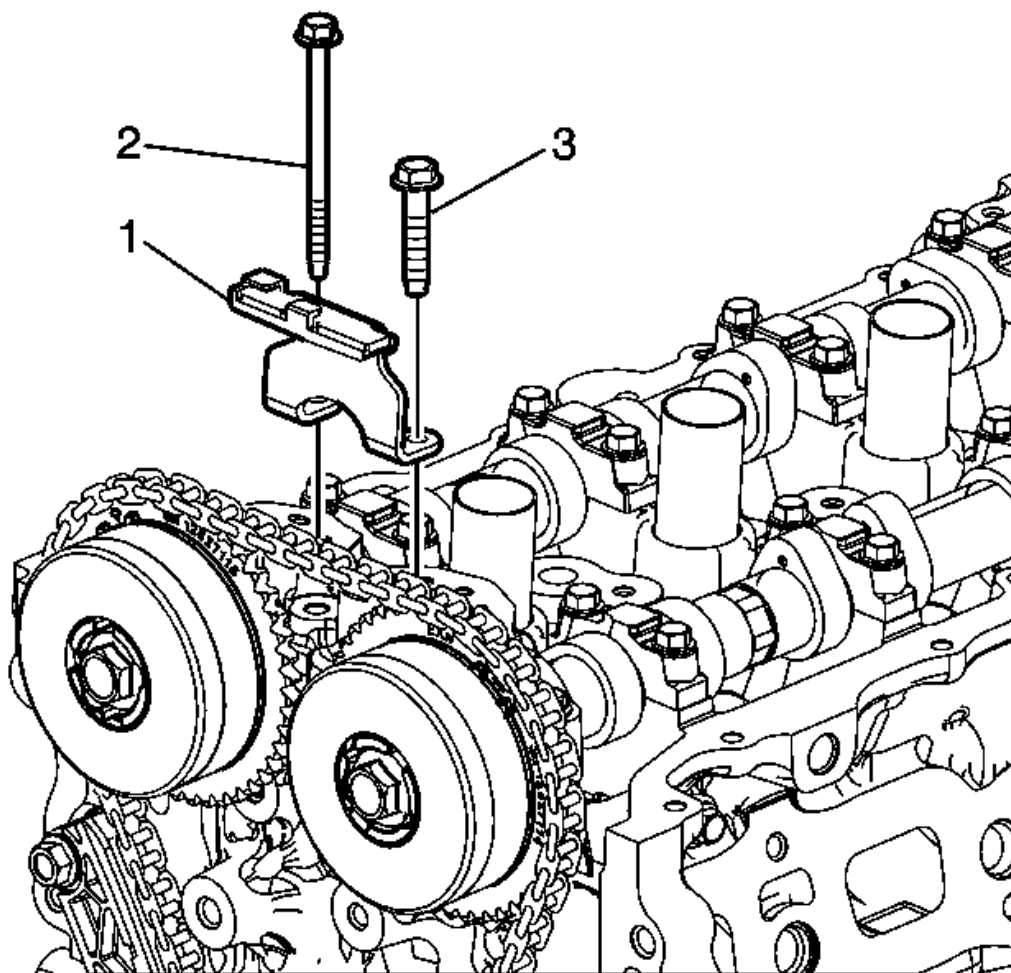


Fig. 56: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the upper timing chain guide bolts (2, 3).
3. Remove the upper timing chain guide (1).

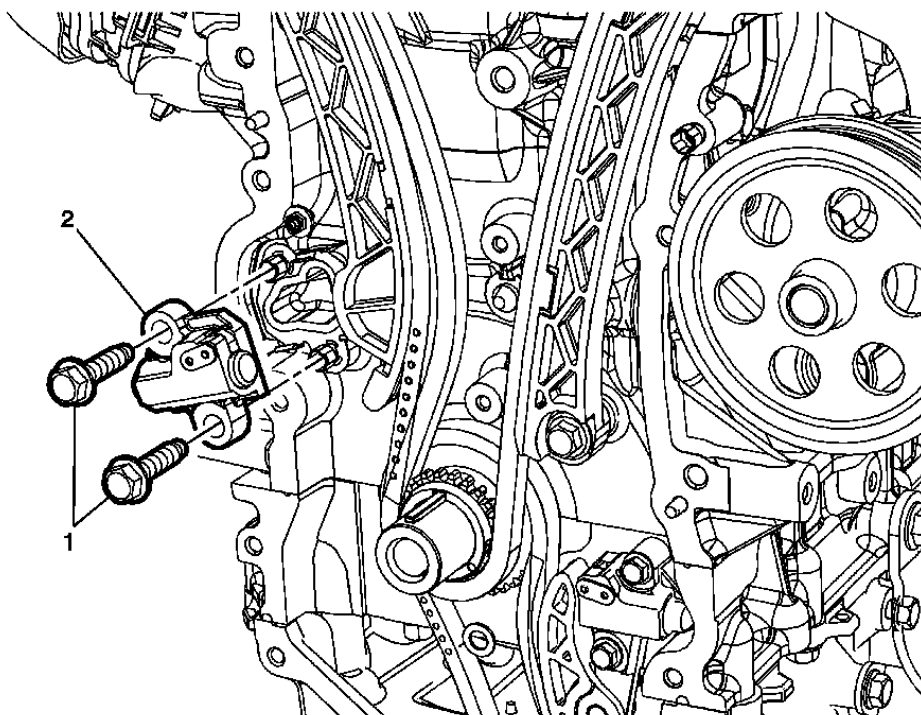


Fig. 57: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

4. Remove the timing chain tensioner bolts (1) and timing chain tensioner (2).

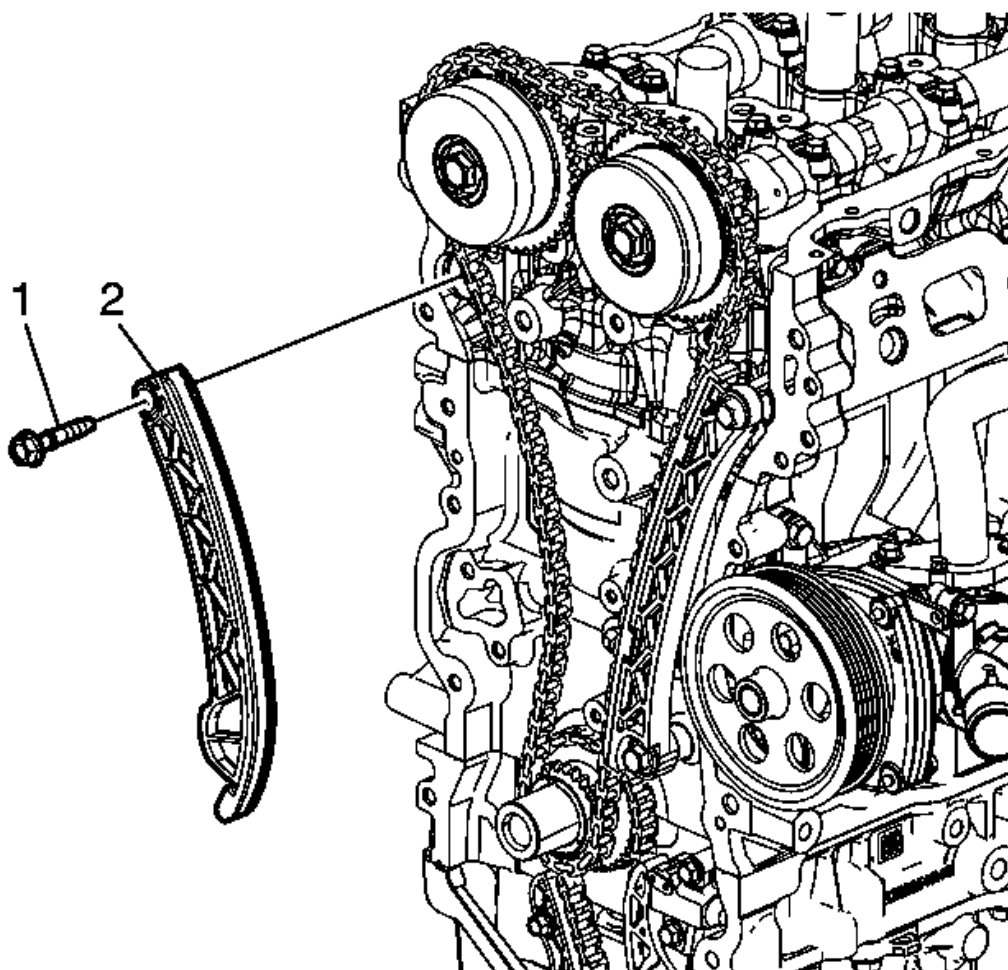


Fig. 58: Timing Chain Tensioner Pivot Arm Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the timing chain tensioner pivot arm bolt (1).
6. Remove the timing chain tensioner pivot arm (2).

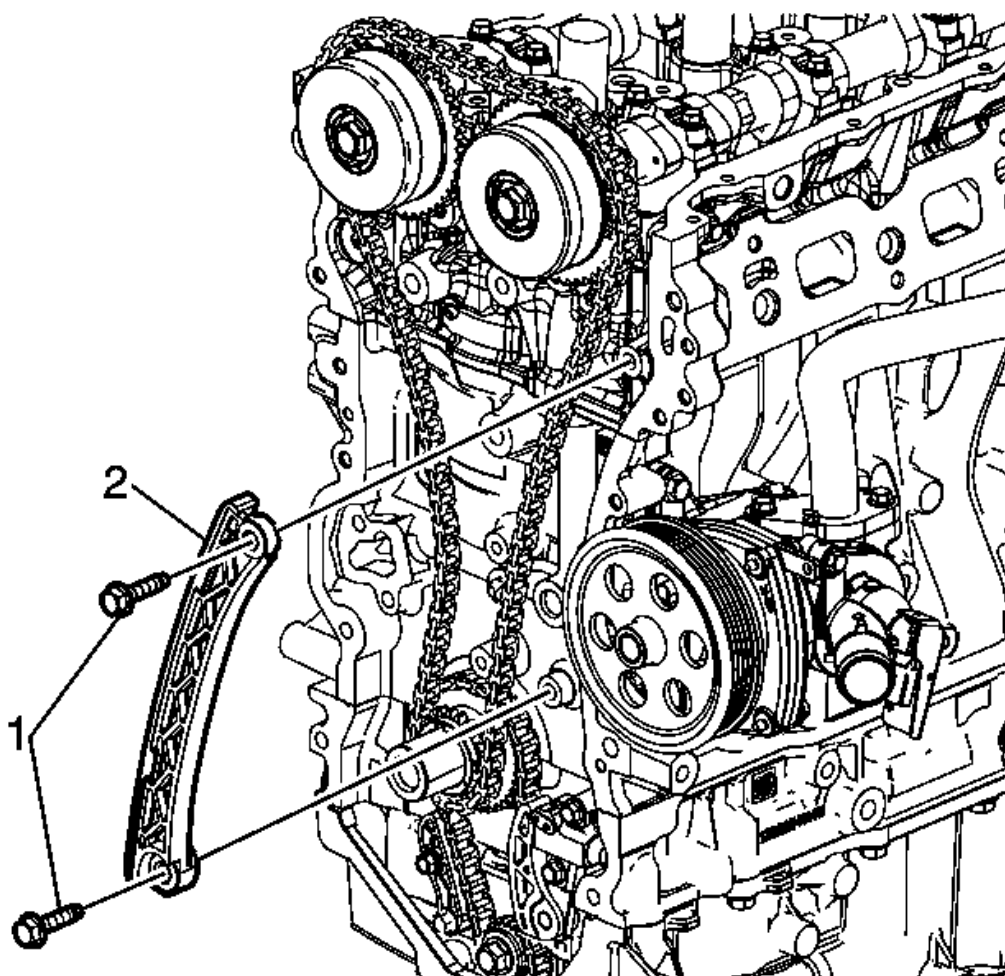


Fig. 59: Timing Chain Guide Bolts
 Courtesy of GENERAL MOTORS COMPANY

7. Remove the timing chain guide bolts (1).
8. Remove the timing chain guide (2).

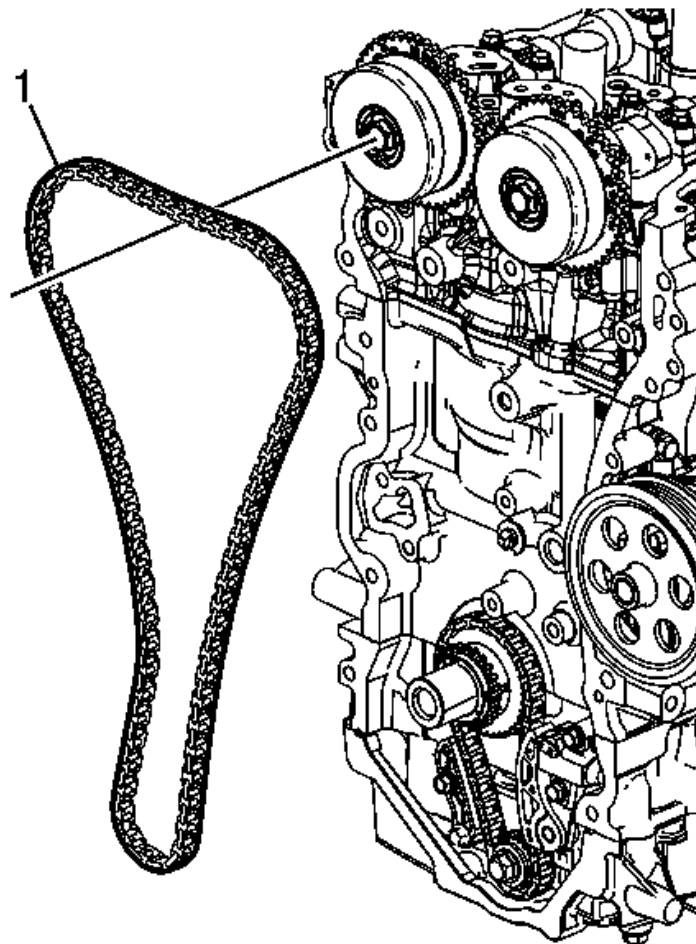


Fig. 60: Timing Chain

Courtesy of GENERAL MOTORS COMPANY

9. Remove the timing chain (1).

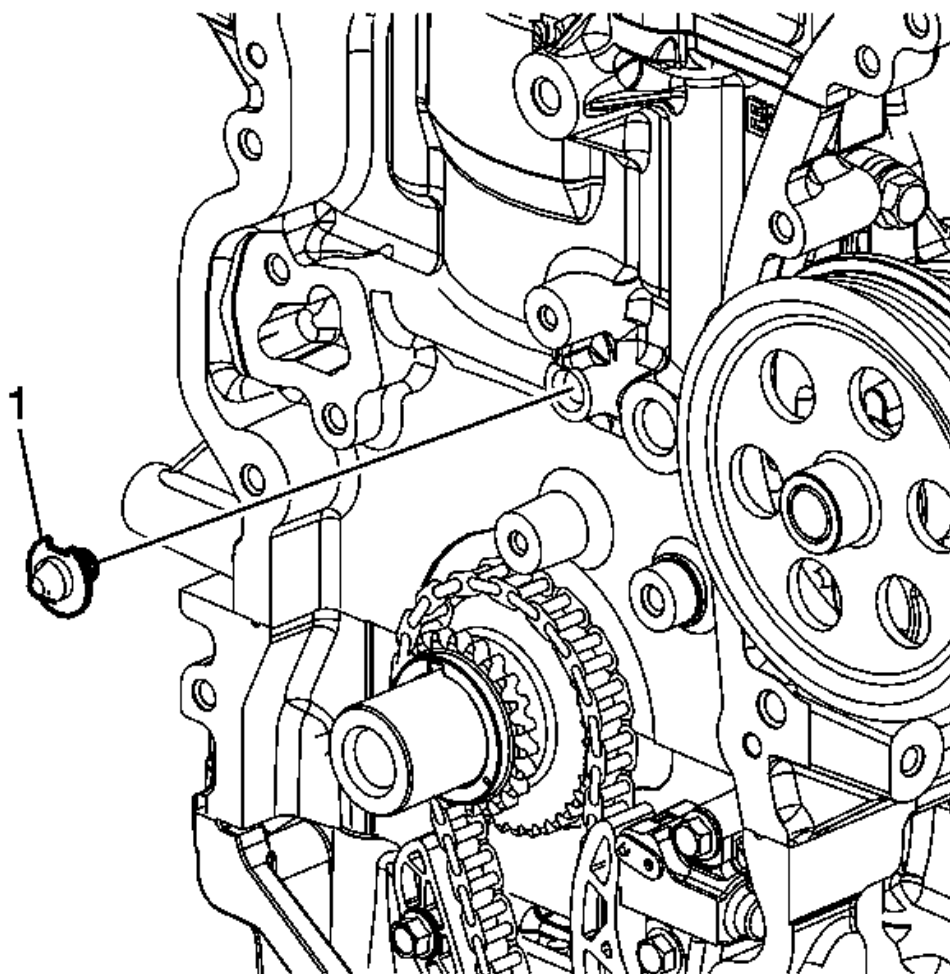


Fig. 61: Timing Chain Oil Nozzle

Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain oil nozzle (1).
11. For camshaft timing chain, sprocket, and tensioner cleaning and inspection. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Cleaning and Inspection** .

Installation Procedure

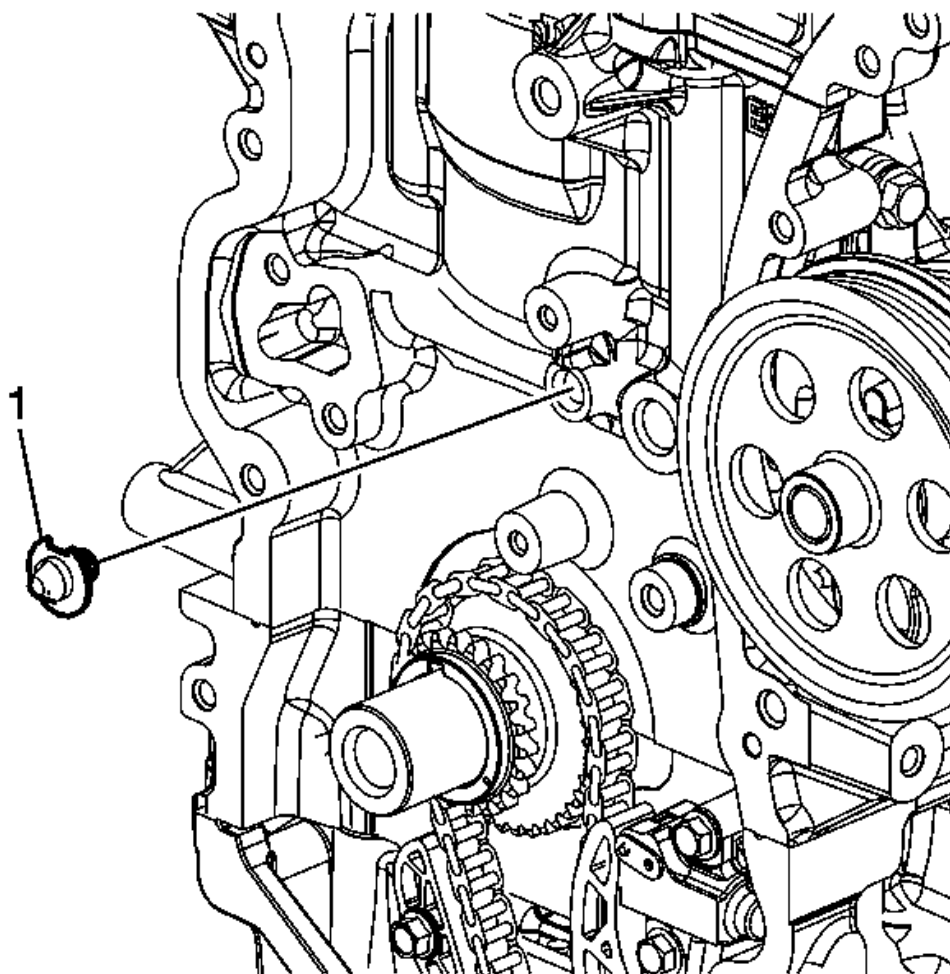


Fig. 62: Timing Chain Oil Nozzle

Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the timing chain oil nozzle is rotated with the notch facing upward, and aligned with the tab on the engine block.

1. Install the timing chain oil nozzle (1).

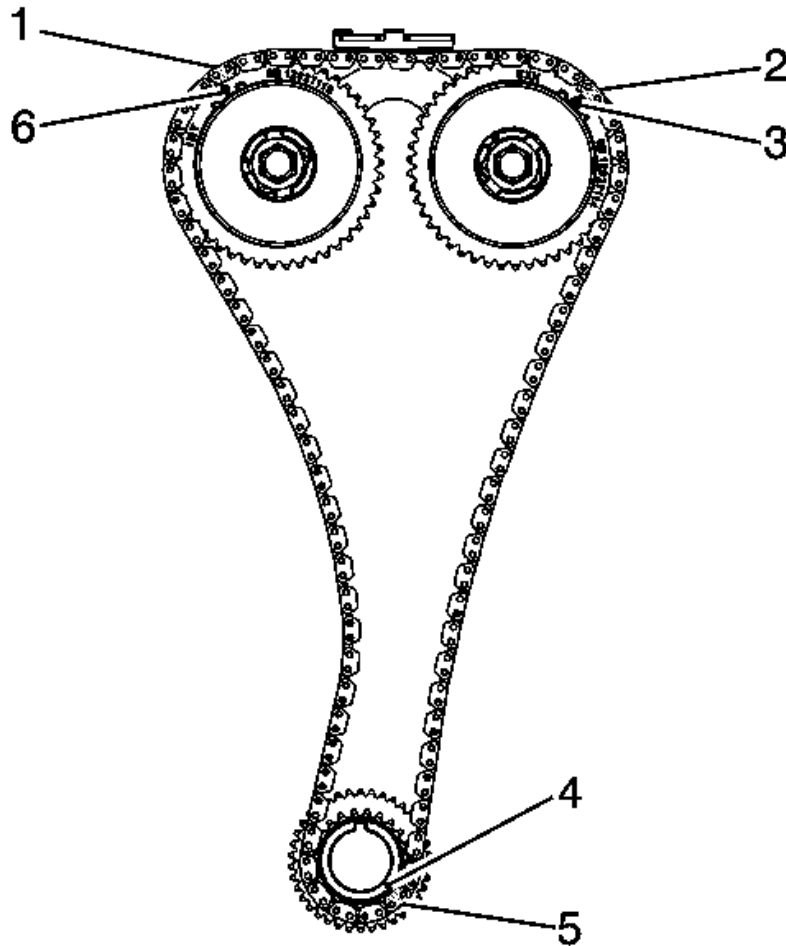


Fig. 63: Timing Chain Oil Nozzle

Courtesy of GENERAL MOTORS COMPANY

NOTE: There are three colored links on the timing chain. The two links that align to the timing marks on the actuators are the same color. The timing link that aligns with the timing mark on the crankshaft sprocket is a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.

2. Loop the timing chain over the intake and exhaust camshaft actuators, aligning the unique colored link (2) with the timing mark on the exhaust camshaft actuator (3).

NOTE: The unique colored links will not initially align with the intake actuator timing mark or the crankshaft sprocket timing mark.

3. Ensure the crankshaft key is in the 12 O'clock position. Loop the timing chain onto the crankshaft sprocket.

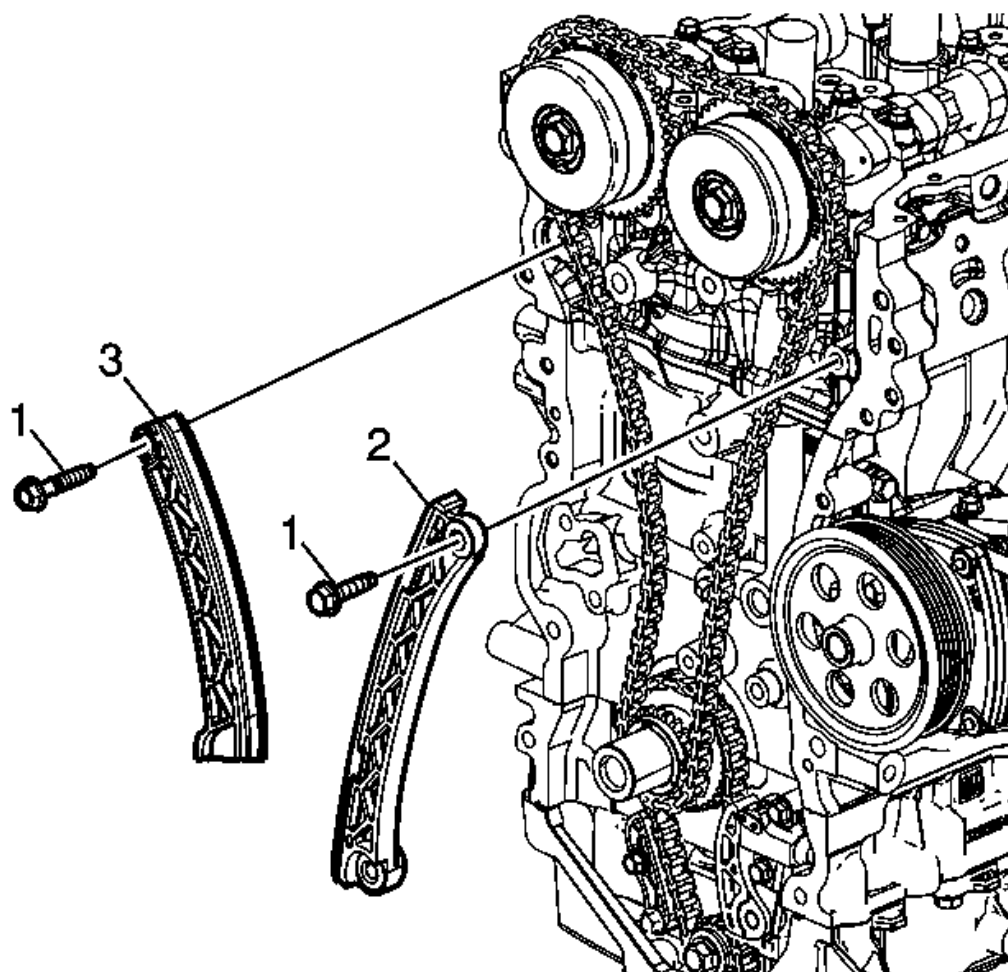


Fig. 64: Timing Chain Guide And Upper Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Timing will be established before the final install and torque of the guide bolts.

4. Install the timing chain guide (2) and upper bolt (1) only, finger tight.
5. Install the timing chain tensioner pivot arm (3).
6. Install the pivot arm bolt (1) finger tight.

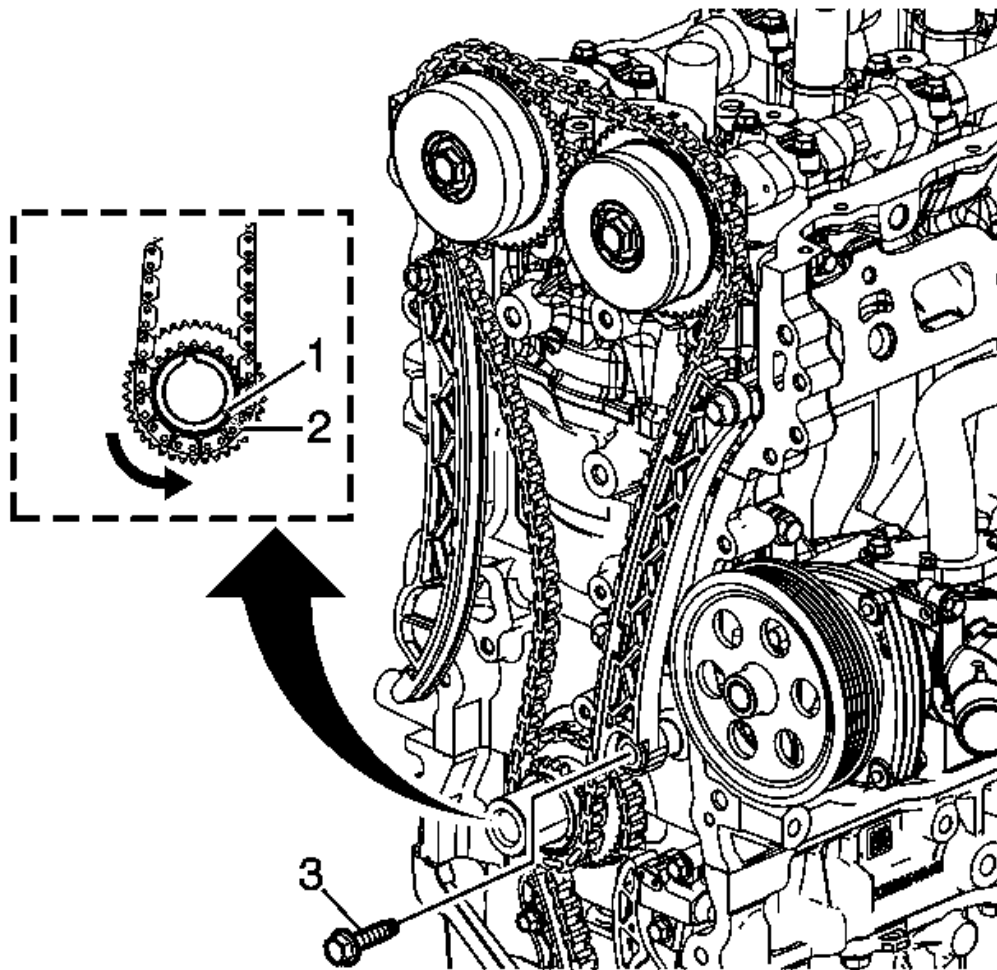


Fig. 65: Crankshaft Sprocket

Courtesy of GENERAL MOTORS COMPANY

7. With a suitable tool, rotate the crankshaft counterclockwise to align the timing mark on the crankshaft sprocket (1) with the timing link (2).

NOTE:

- Continue to rotate the crankshaft counterclockwise as necessary to maintain timing alignment.
- Ensure that the alignment mark on the exhaust camshaft actuator remains aligned with the timing link.

8. Rotate the lower end of the fixed timing chain guide into installation position and install the lower bolt (3).

CAUTION: Refer to Fastener Caution .

9. Tighten the timing chain guide upper and lower bolts to 25 N.m (18 lb ft).

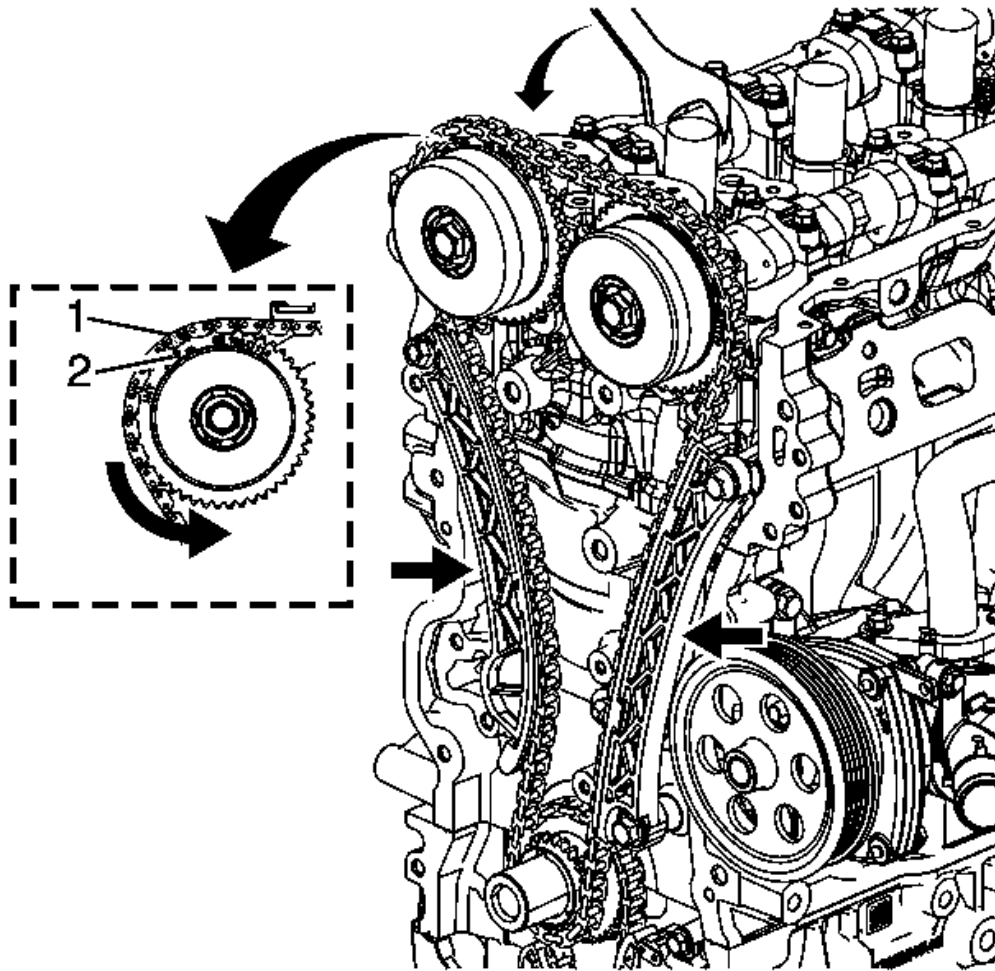


Fig. 66: Timing Mark On Intake Actuator
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The timing for the exhaust camshaft actuator and the crankshaft sprocket has been established.
- Applying or loosening pressure by hand between the timing chain guides will allow the chain to slip or bind during counterclockwise rotation of the camshaft.

10. Using a suitable tool, rotate the intake camshaft counterclockwise until the timing mark on the intake actuator (2) is aligned with the timing link (1). Maintain tension on intake camshaft until the timing chain tensioner can be installed and activated.

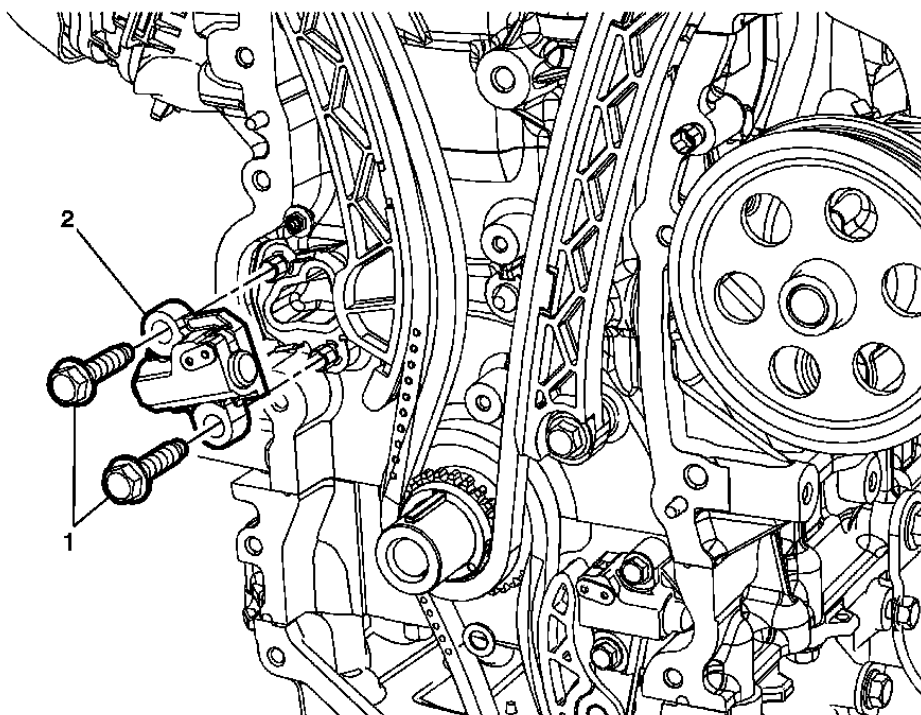


Fig. 67: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

11. Install the timing chain tensioner (2) and tighten timing chain tensioner bolts (1) to 25 (18 lb ft)

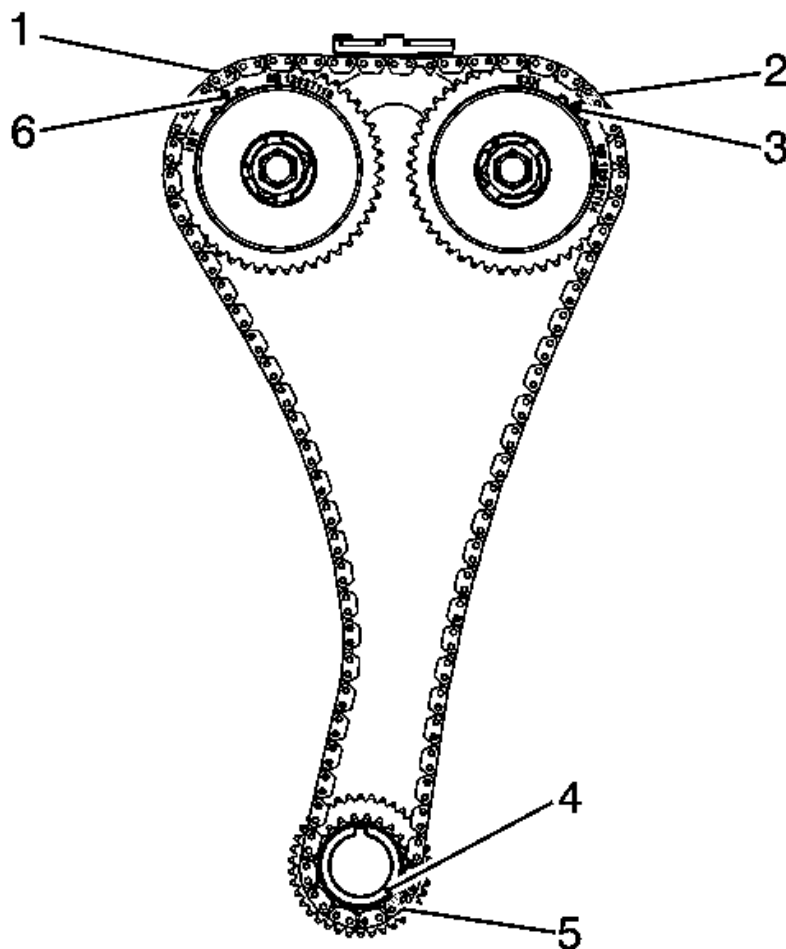


Fig. 68: Timing Chain Oil Nozzle

Courtesy of GENERAL MOTORS COMPANY

12. Verify the timing links on the timing chain are properly aligned to the timing marks:
 1. The timing links (1, 2) are aligned to the appropriate timing marks on the camshaft actuators (6, 3).
 2. The unique colored link (5) is aligned to the timing mark on the crankshaft sprocket (4).
13. If they are not, repeat the portion of the procedure necessary to align the timing marks.

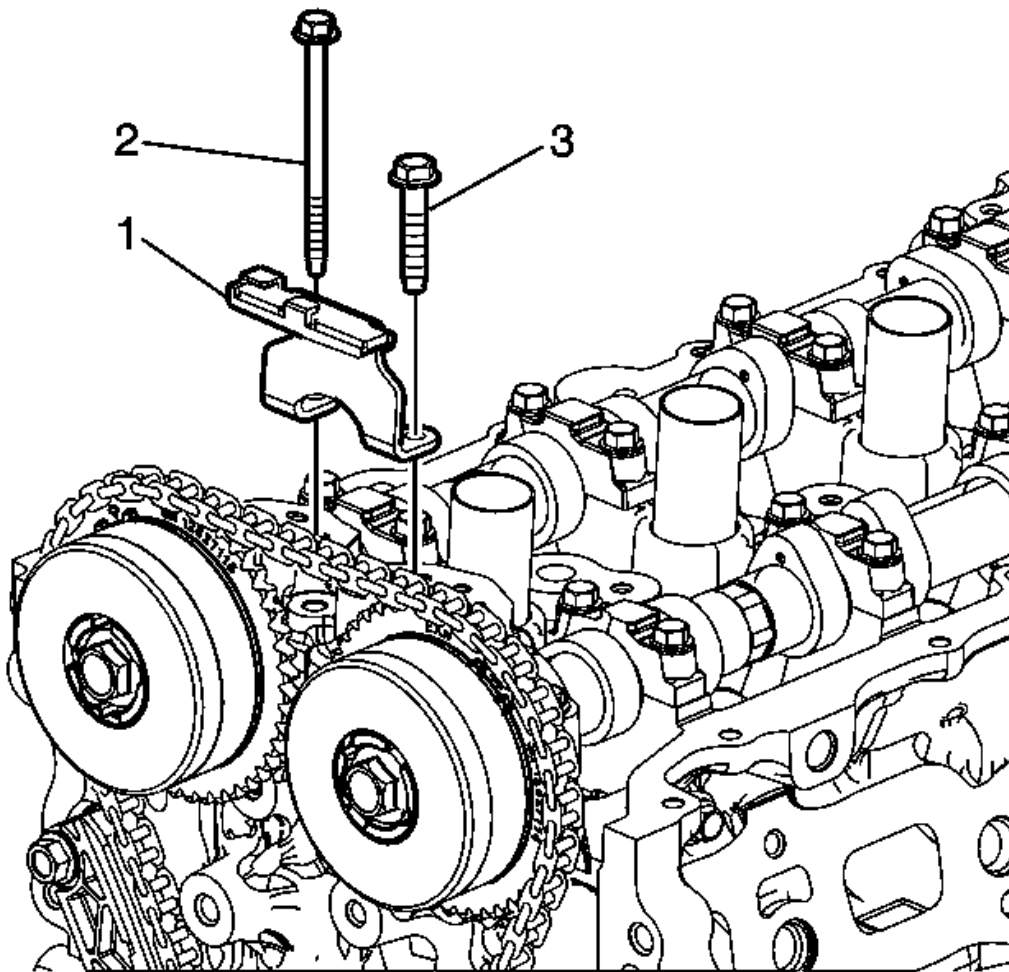


Fig. 69: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Install the timing chain guide (1) and bolts (2, 3) finger tight.

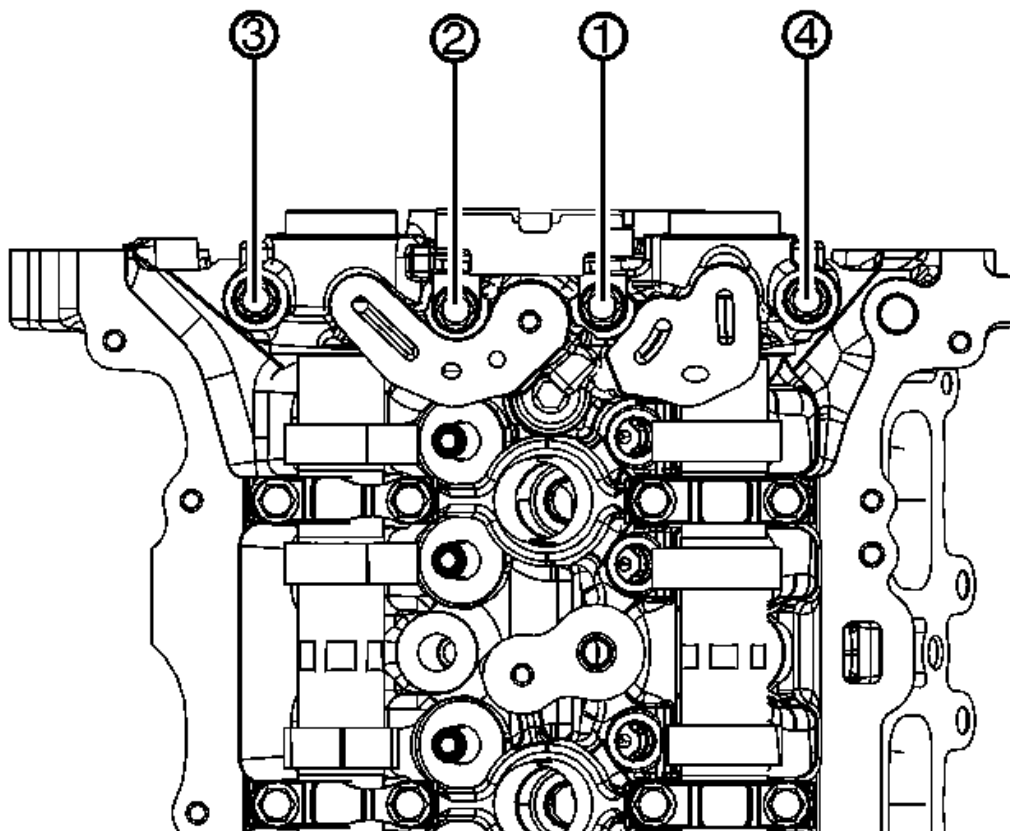


Fig. 70: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

15. Tighten the front camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.
16. Rotate the crankshaft clockwise to see if either of the actuators or the crankshaft sprocket jump timing chain teeth. If this occurs, repeat procedure to align the timing marks.

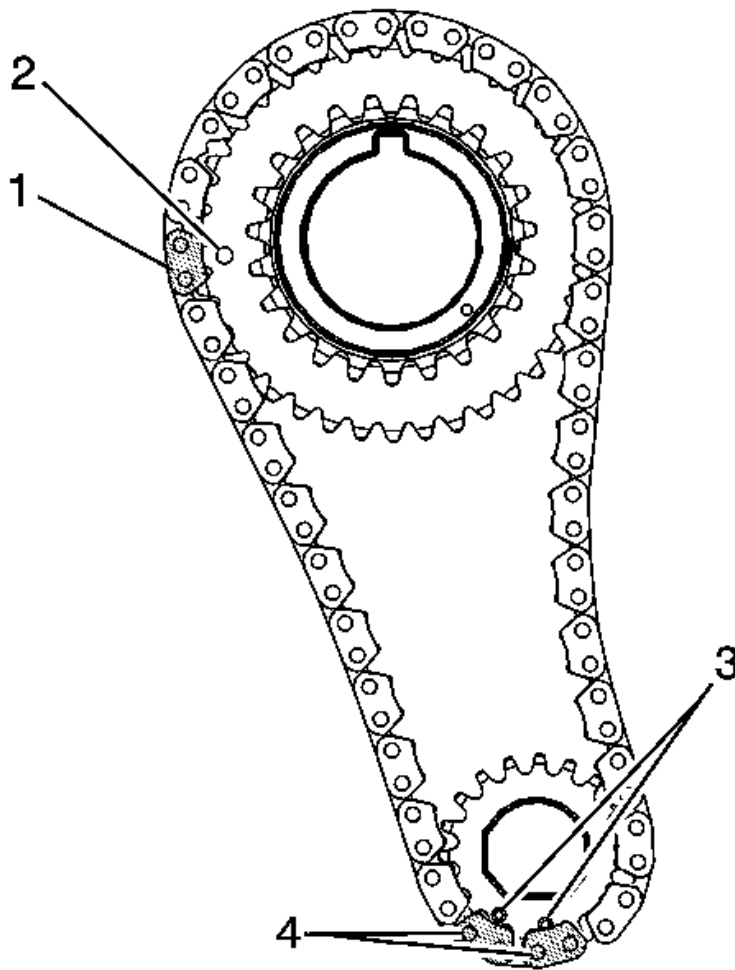


Fig. 71: Timing Link Lines Up And Timing Mark
Courtesy of GENERAL MOTORS COMPANY

17. Verify the timing links on the balance chain are properly aligned to the timing marks:
 1. The timing link (1) is aligned to the timing mark on the crankshaft sprocket (2).
 2. The adjacent timing links (4) are aligned with both timing marks (3) on the balancer shaft driven sprocket.
18. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

CAMSHAFT TIMING CHAIN AND TENSIONER REPLACEMENT

Removal Procedure

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

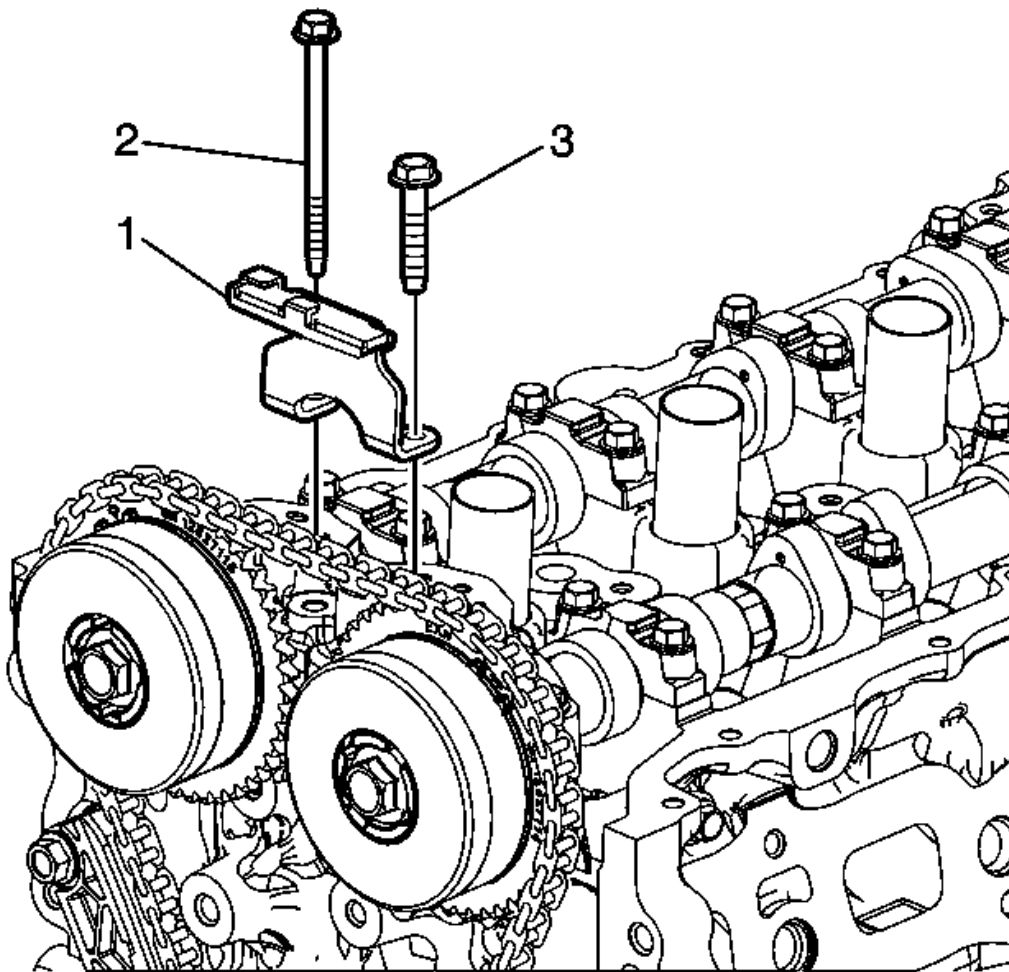


Fig. 72: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the upper timing chain guide bolts (2, 3).
3. Remove the upper timing chain guide (1).

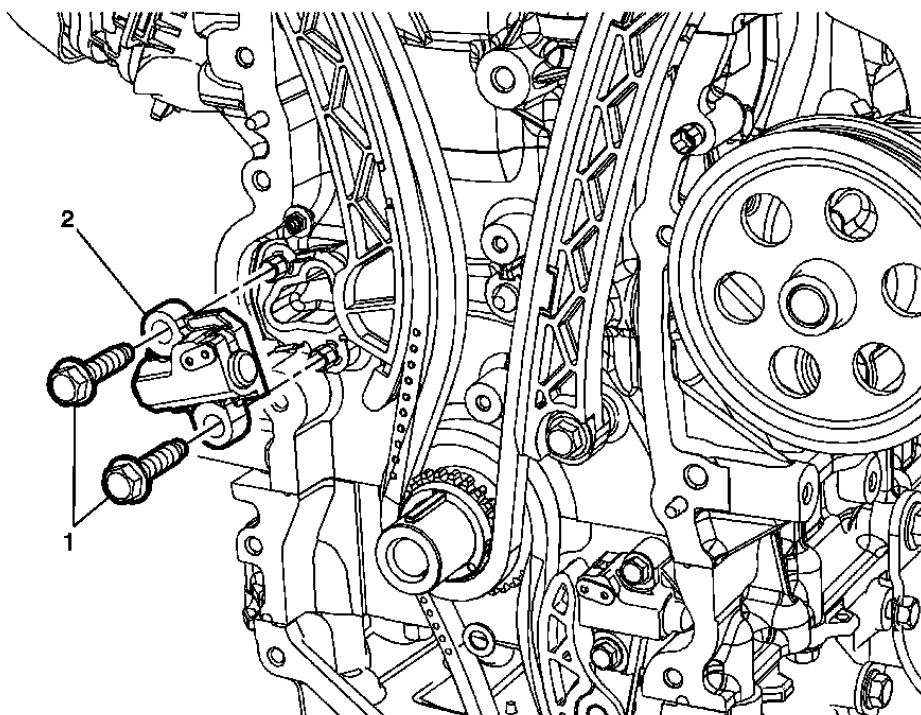


Fig. 73: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

4. Remove the timing chain tensioner bolts (1) and timing chain tensioner (2).

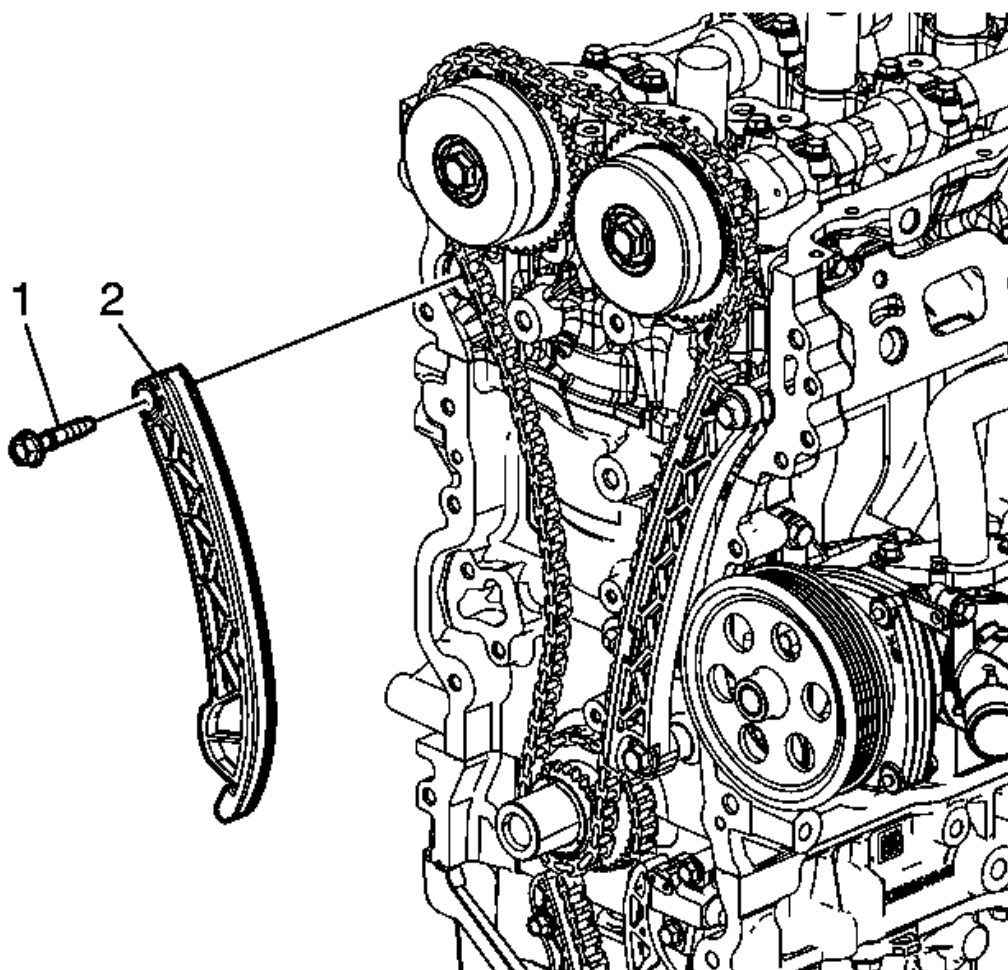


Fig. 74: Timing Chain Tensioner Pivot Arm Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the timing chain tensioner pivot arm bolt (1).
6. Remove the timing chain tensioner pivot arm (2).

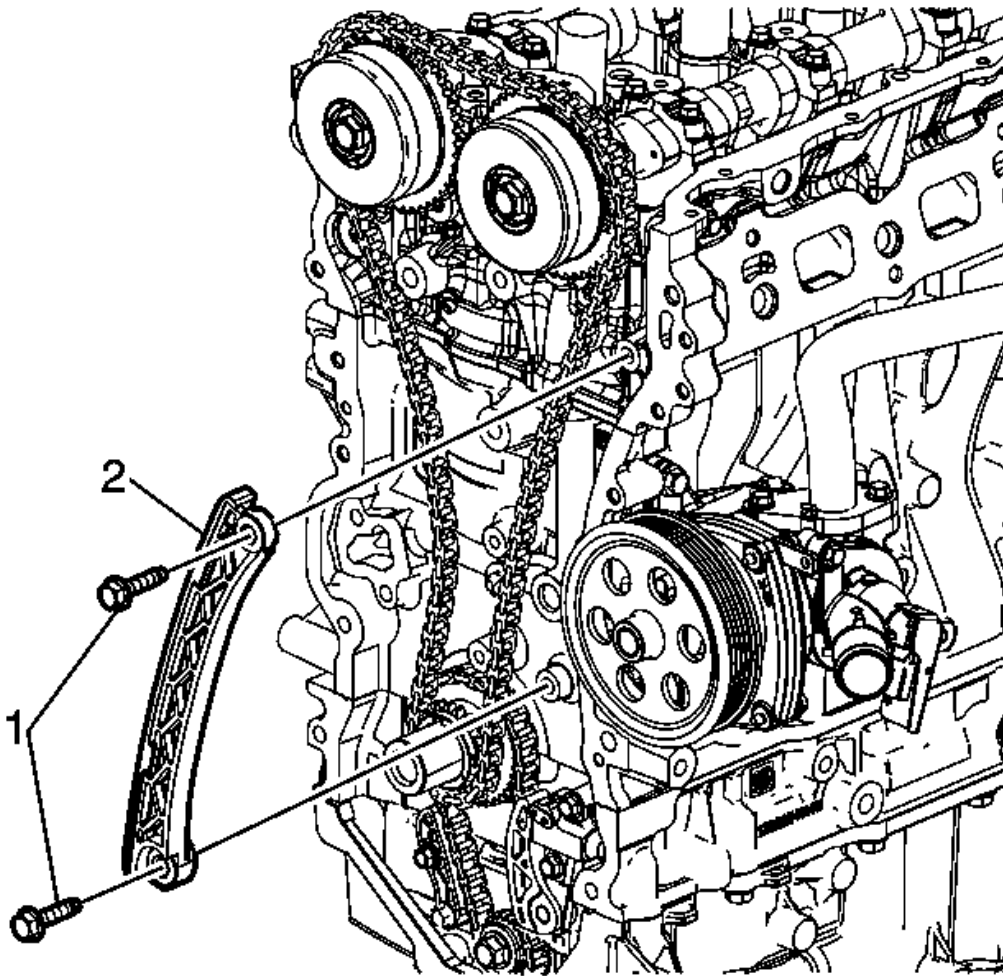


Fig. 75: Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the timing chain guide bolts (1).
8. Remove the timing chain guide (2).

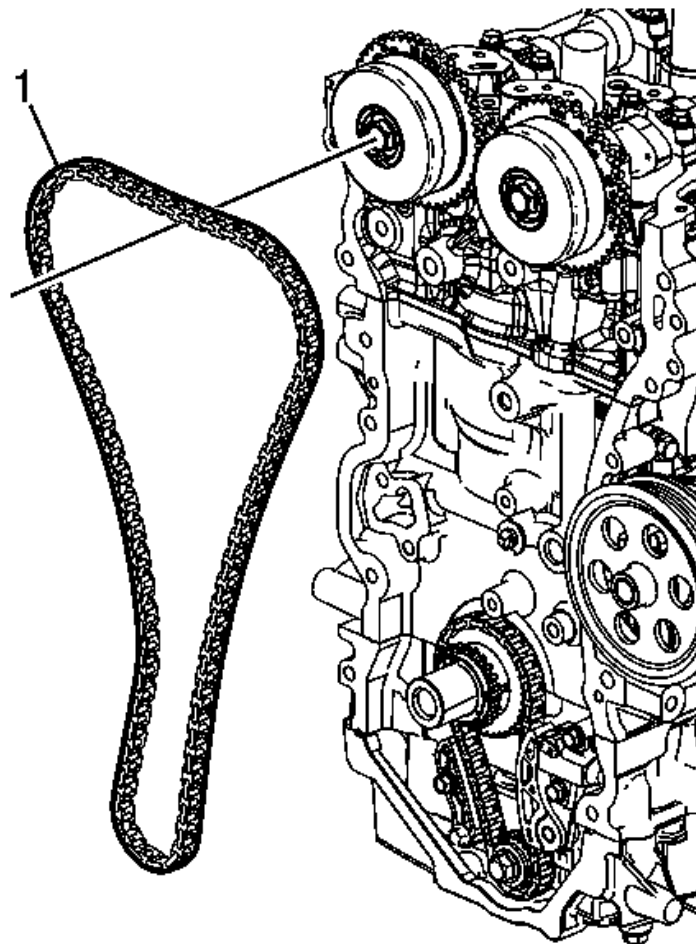


Fig. 76: Timing Chain

Courtesy of GENERAL MOTORS COMPANY

9. Remove the timing chain (1).

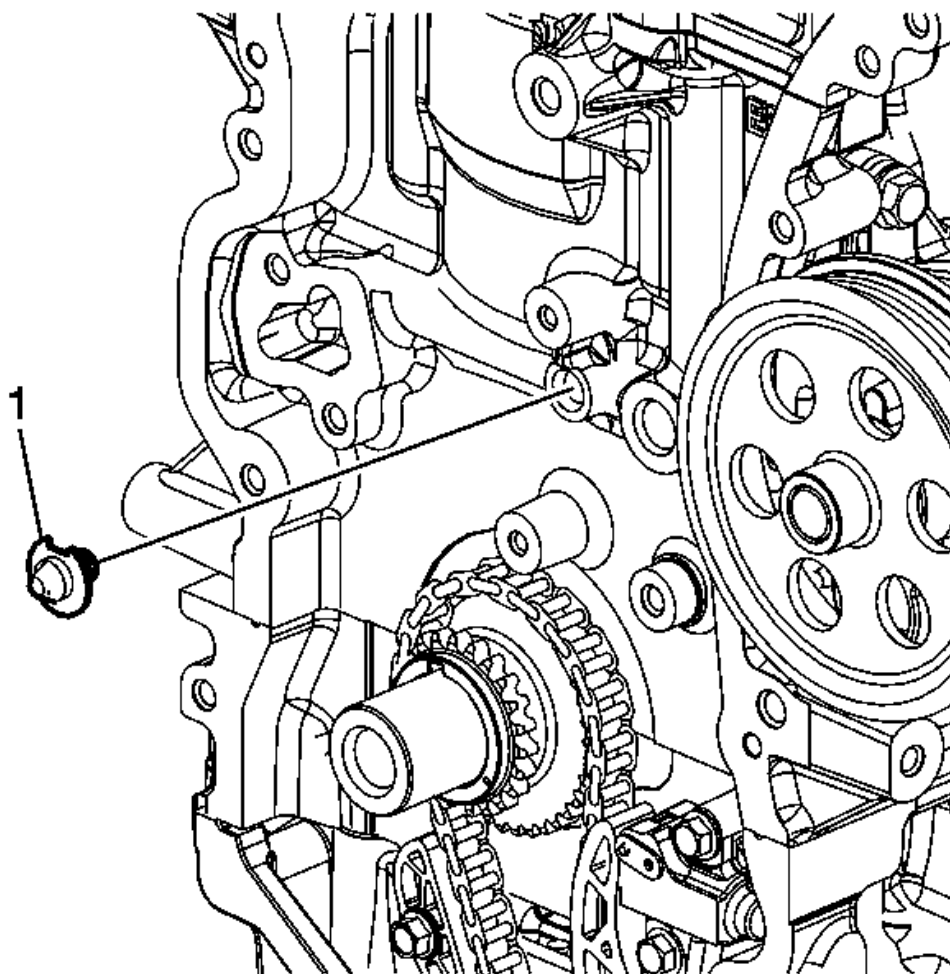


Fig. 77: Timing Chain Oil Nozzle

Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain oil nozzle (1).
11. For camshaft timing chain, sprocket, and tensioner cleaning and inspection. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Cleaning and Inspection** .

Installation Procedure

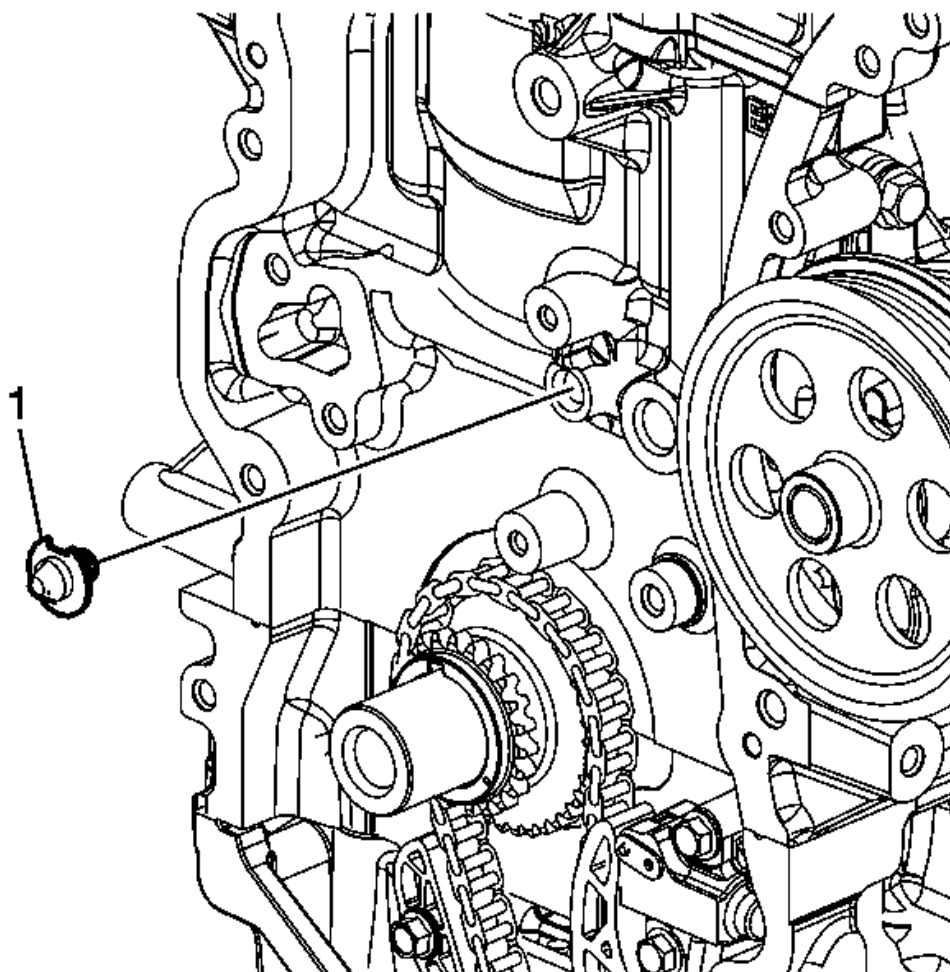


Fig. 78: Timing Chain Oil Nozzle

Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the timing chain oil nozzle is rotated with the notch facing upward, and aligned with the tab on the engine block.

1. Install the timing chain oil nozzle (1).

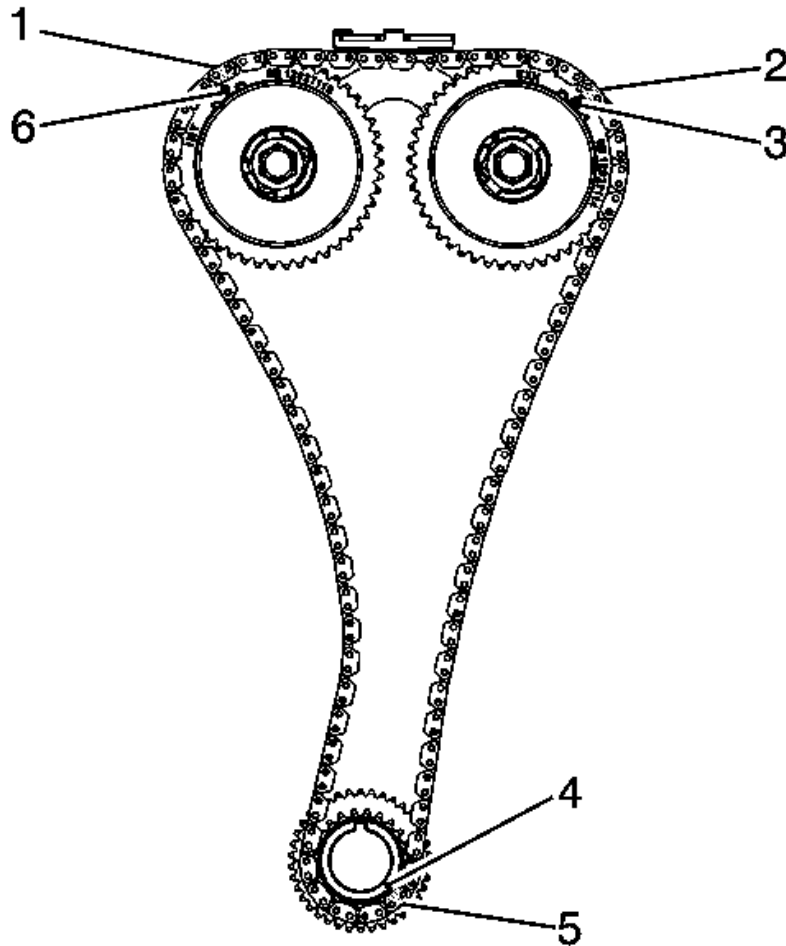


Fig. 79: Timing Chain Oil Nozzle

Courtesy of GENERAL MOTORS COMPANY

NOTE: There are three colored links on the timing chain. The two links that align to the timing marks on the actuators are the same color. The timing link that aligns with the timing mark on the crankshaft sprocket is a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.

2. Loop the timing chain over the intake and exhaust camshaft actuators, aligning the unique colored link (2) with the timing mark on the exhaust camshaft actuator (3).

NOTE: The unique colored links will not initially align with the intake actuator timing mark or the crankshaft sprocket timing mark.

3. Ensure the crankshaft key is in the 12 O'clock position. Loop the timing chain onto the crankshaft sprocket.

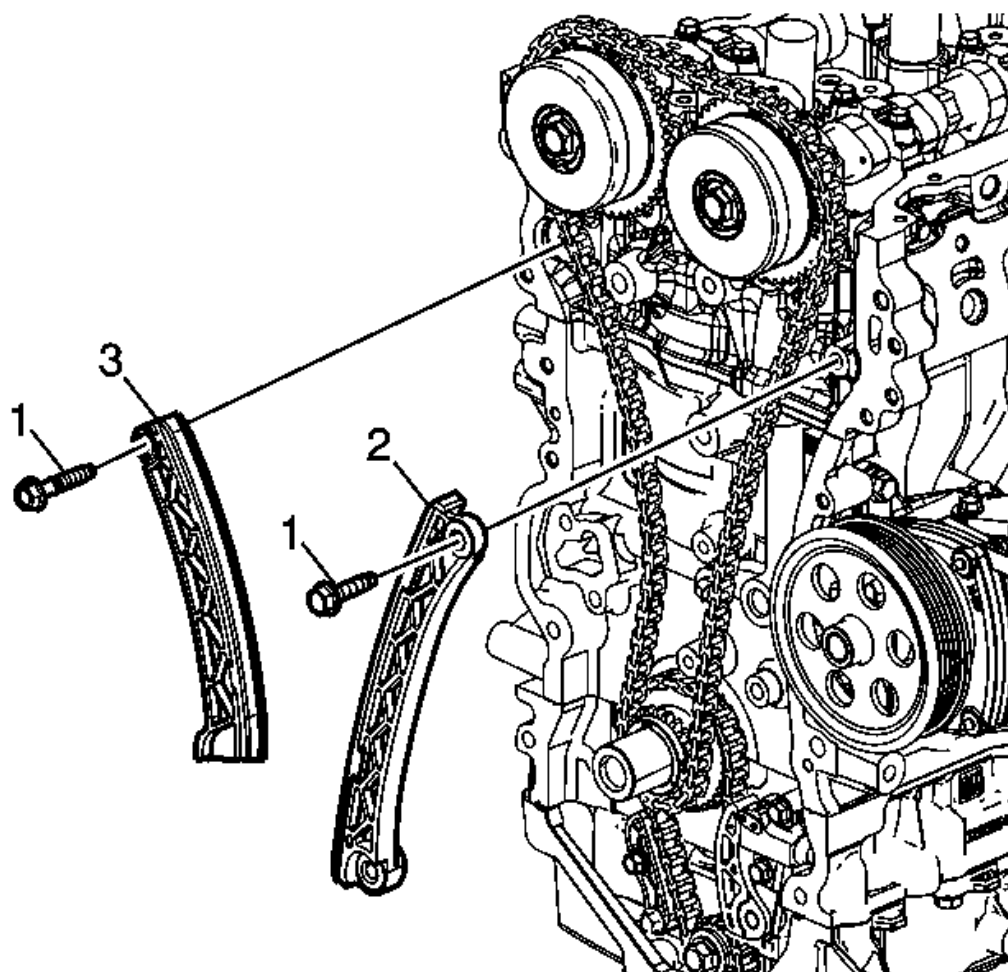


Fig. 80: Timing Chain Guide And Upper Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Timing will be established before the final install and torque of the guide bolts.

4. Install the timing chain guide (2) and upper bolt (1) only, finger tight.
5. Install the timing chain tensioner pivot arm (3).
6. Install the pivot arm bolt (1) finger tight.

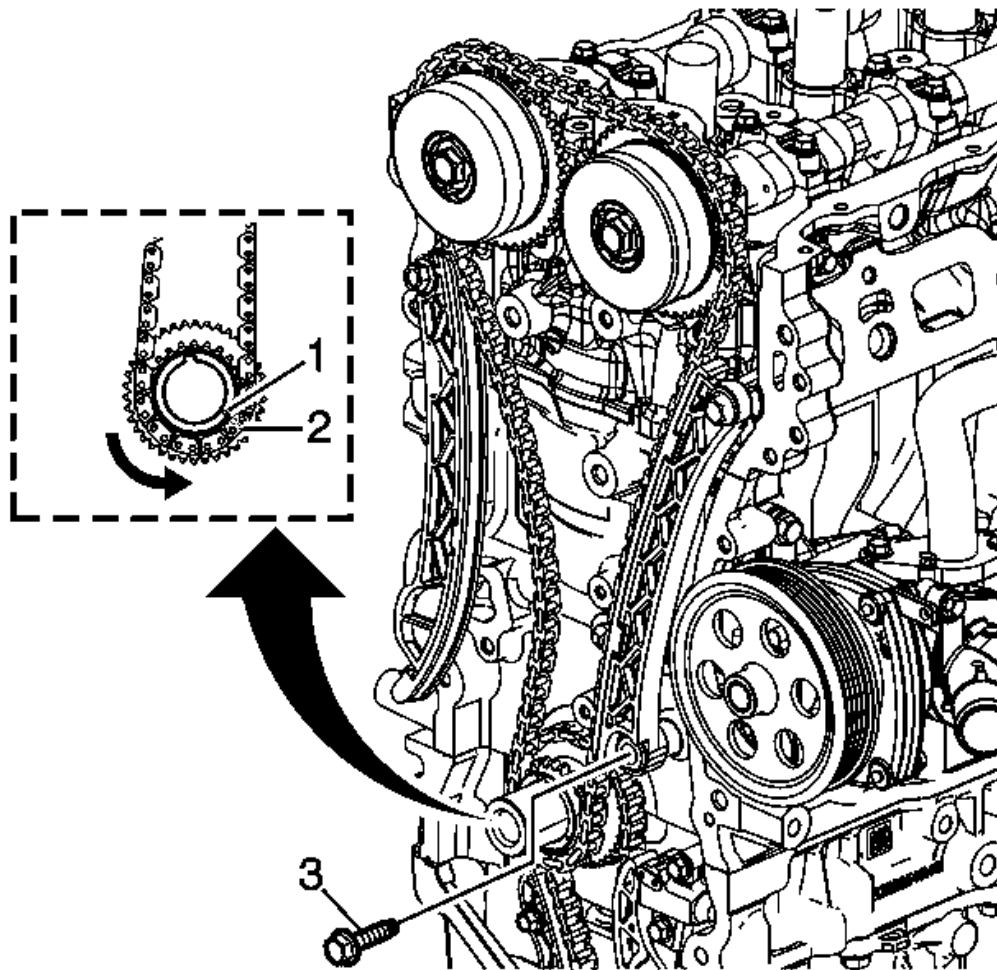


Fig. 81: Crankshaft Sprocket

Courtesy of GENERAL MOTORS COMPANY

7. With a suitable tool, rotate the crankshaft counterclockwise to align the timing mark on the crankshaft sprocket (1) with the timing link (2).

NOTE:

- Continue to rotate the crankshaft counterclockwise as necessary to maintain timing alignment.
- Ensure that the alignment mark on the exhaust camshaft actuator remains aligned with the timing link.

8. Rotate the lower end of the fixed timing chain guide into installation position and install the lower bolt (3).

CAUTION: Refer to Fastener Caution .

9. Tighten the timing chain guide upper and lower bolts to 25 N.m (18 lb ft).

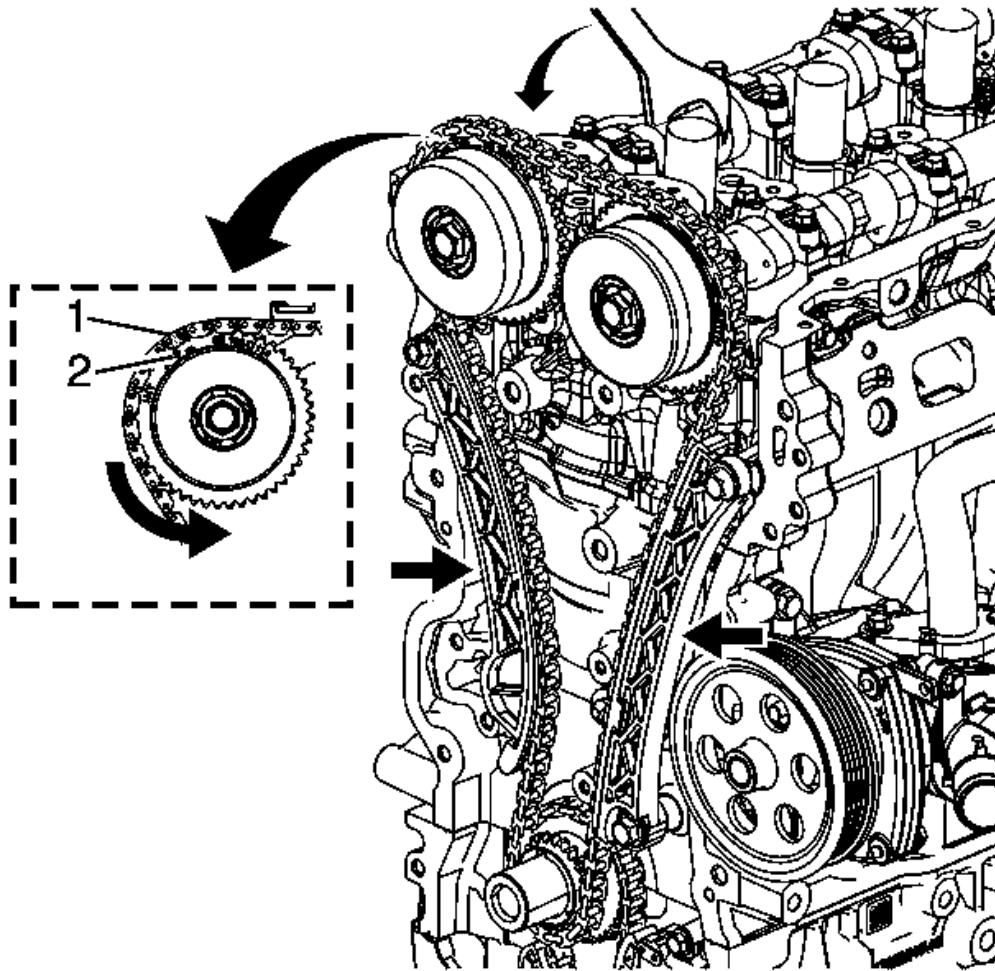


Fig. 82: Timing Mark On Intake Actuator
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The timing for the exhaust camshaft actuator and the crankshaft sprocket has been established.
- Applying or loosening pressure by hand between the timing chain guides will allow the chain to slip or bind during counterclockwise rotation of the camshaft.

10. Using a suitable tool, rotate the intake camshaft counterclockwise until the timing mark on the intake actuator (2) is aligned with the timing link (1). Maintain tension on intake camshaft until the timing chain tensioner can be installed and activated.

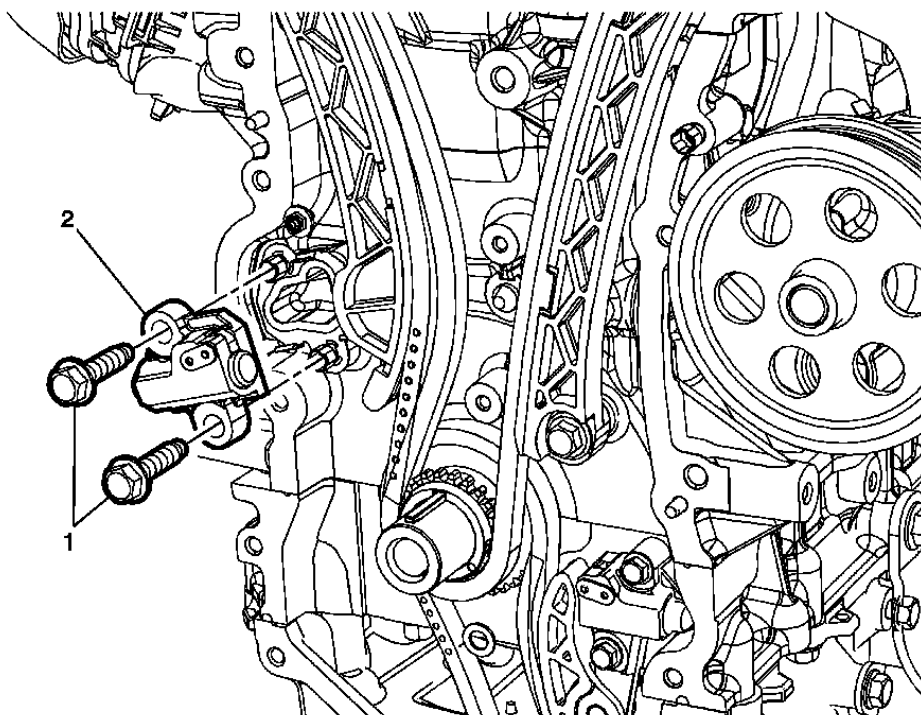


Fig. 83: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

11. Install the timing chain tensioner (2) and tighten timing chain tensioner bolts (1) to 25 (18 lb ft)

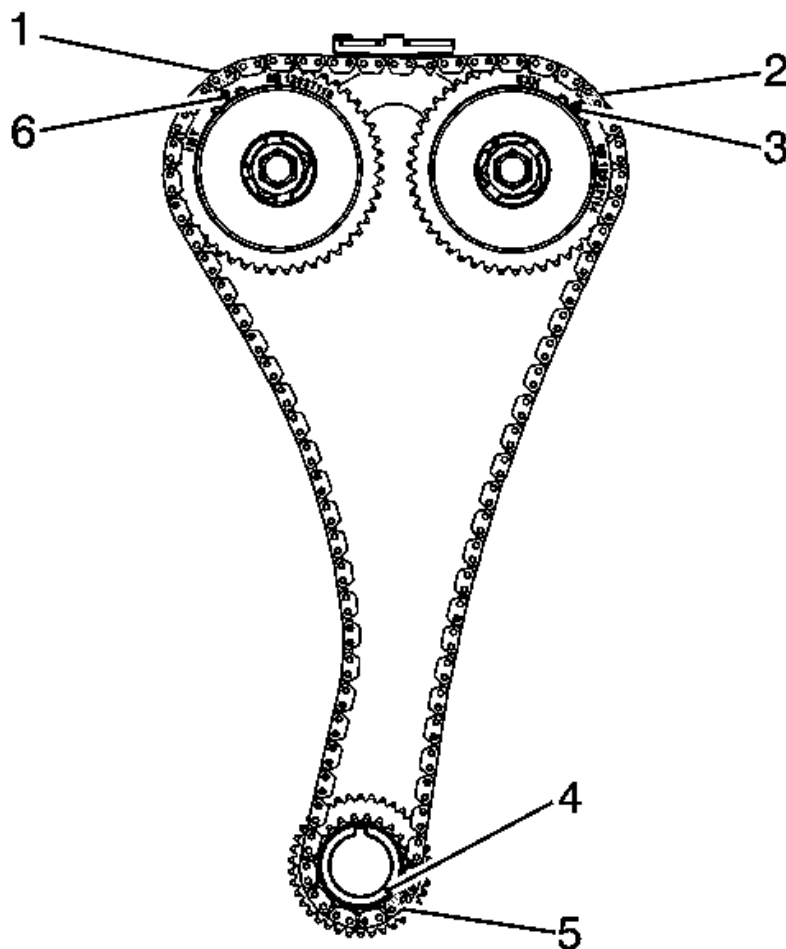


Fig. 84: Timing Chain Oil Nozzle

Courtesy of GENERAL MOTORS COMPANY

12. Verify the timing links on the timing chain are properly aligned to the timing marks:
 1. The timing links (1, 2) are aligned to the appropriate timing marks on the camshaft actuators (6, 3).
 2. The unique colored link (5) is aligned to the timing mark on the crankshaft sprocket (4).
13. If they are not, repeat the portion of the procedure necessary to align the timing marks.

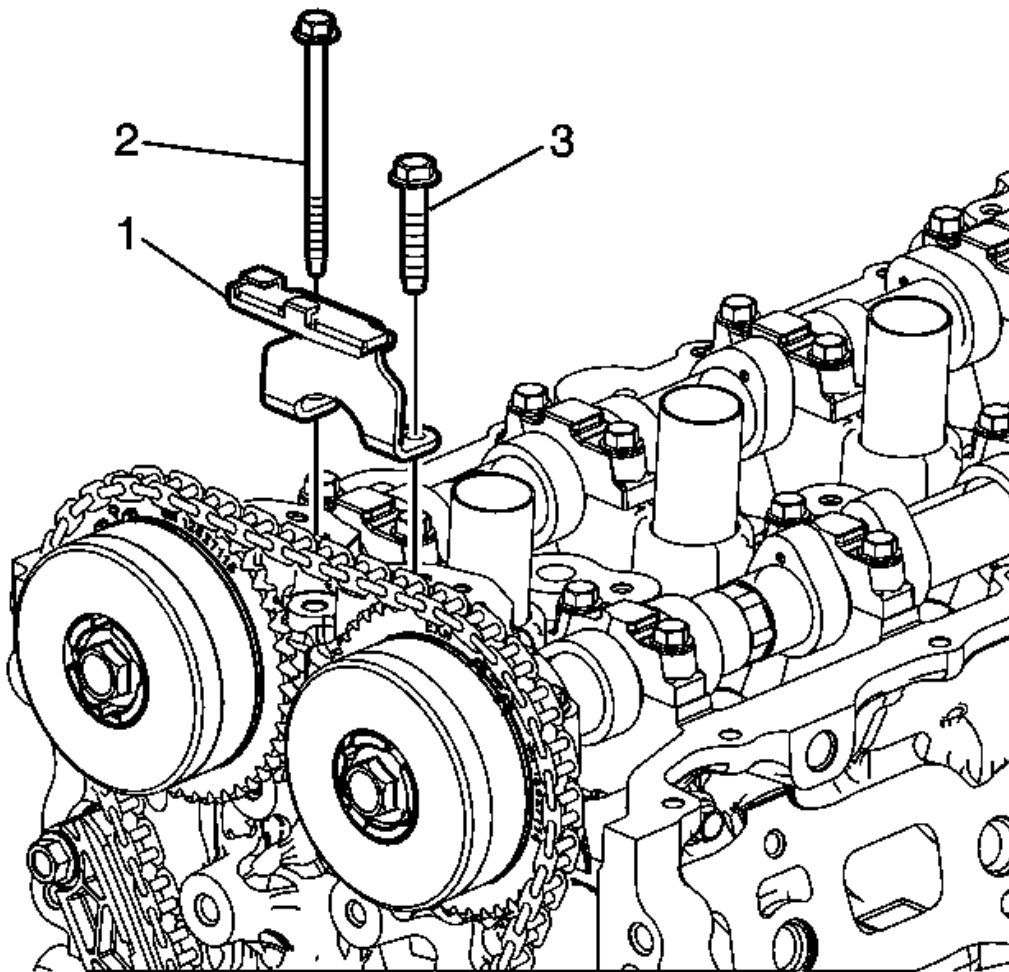


Fig. 85: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Install the timing chain guide (1) and bolts (2, 3) finger tight.

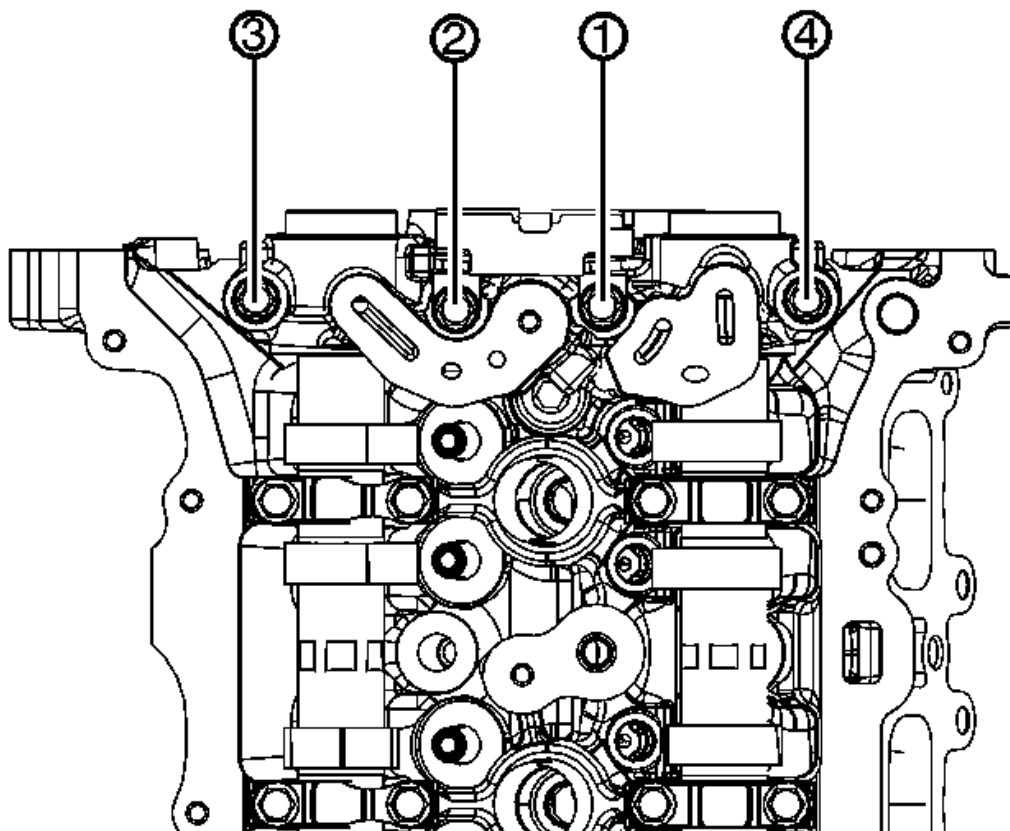


Fig. 86: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

15. Tighten the front camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.
16. Rotate the crankshaft clockwise to see if either of the actuators or the crankshaft sprocket jump timing chain teeth. If this occurs, repeat procedure to align the timing marks.

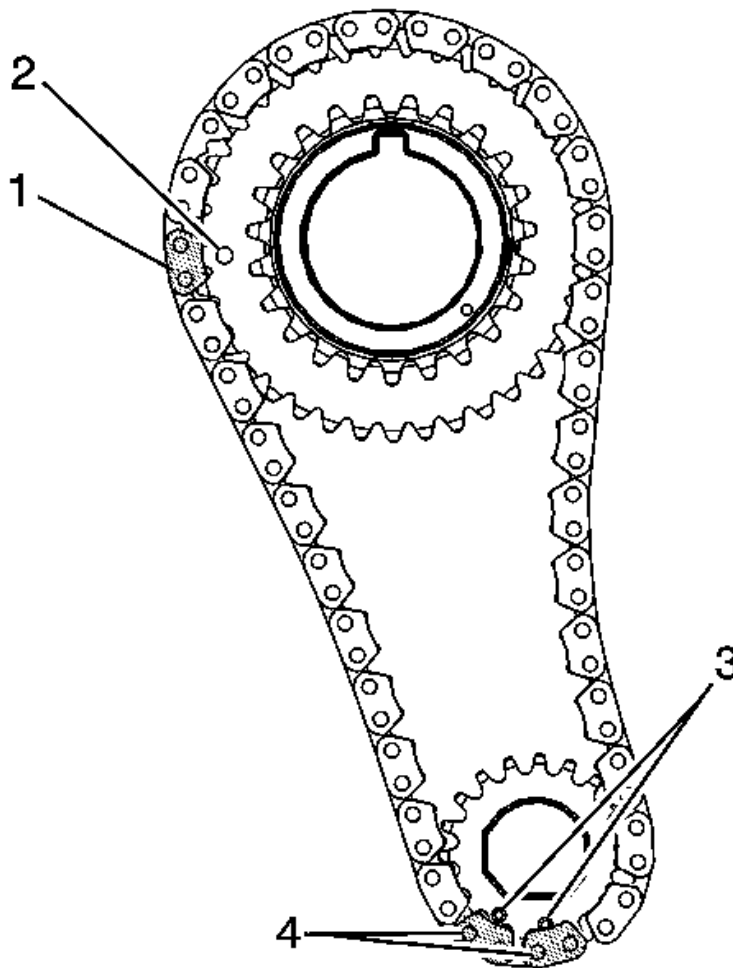


Fig. 87: Timing Link Lines Up And Timing Mark
Courtesy of GENERAL MOTORS COMPANY

17. Verify the timing links on the balance chain are properly aligned to the timing marks:
 1. The timing link (1) is aligned to the timing mark on the crankshaft sprocket (2).
 2. The adjacent timing links (4) are aligned with both timing marks (3) on the balancer shaft driven sprocket.
18. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

CAMSHAFT COVER REPLACEMENT

Removal Procedure

1. Remove the positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

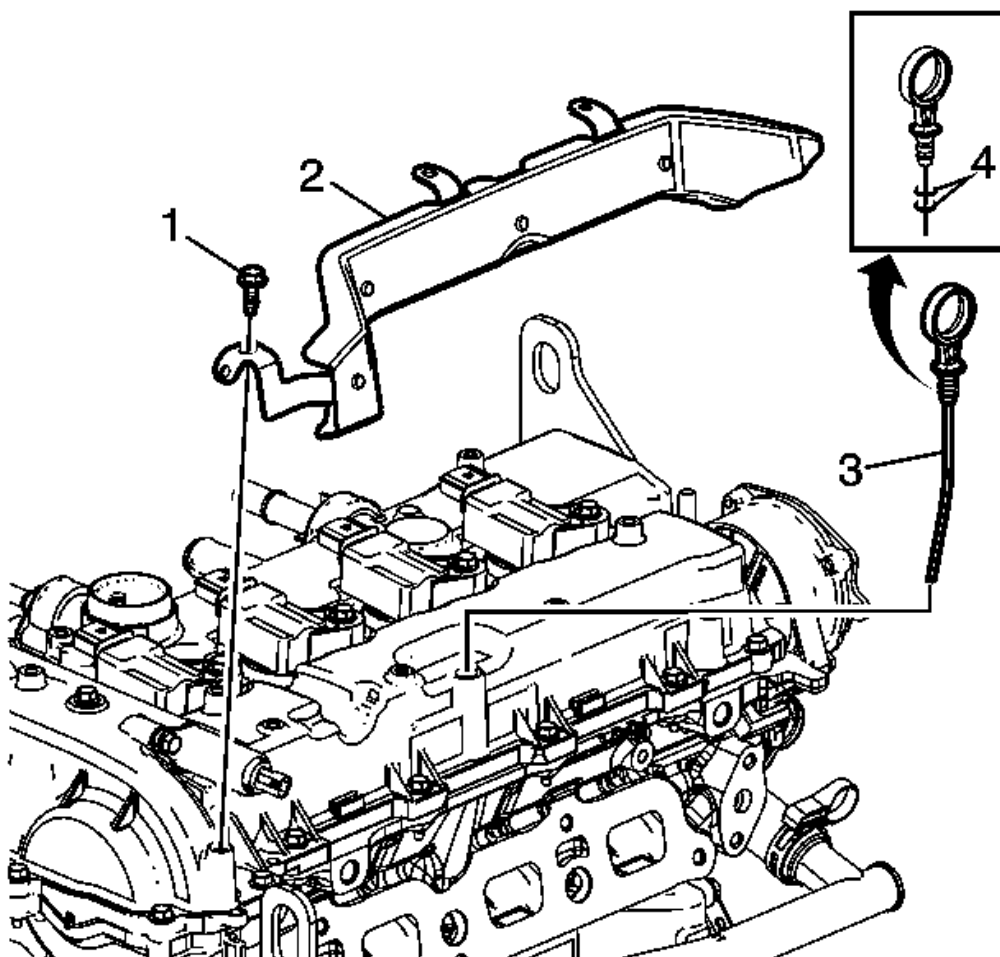


Fig. 88: Oil Level Indicator

Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil level indicator (3). Inspect and replace the oil indicator O-ring seals (4), if necessary.
3. Remove the camshaft cover heat shield (2) and bolts (1).

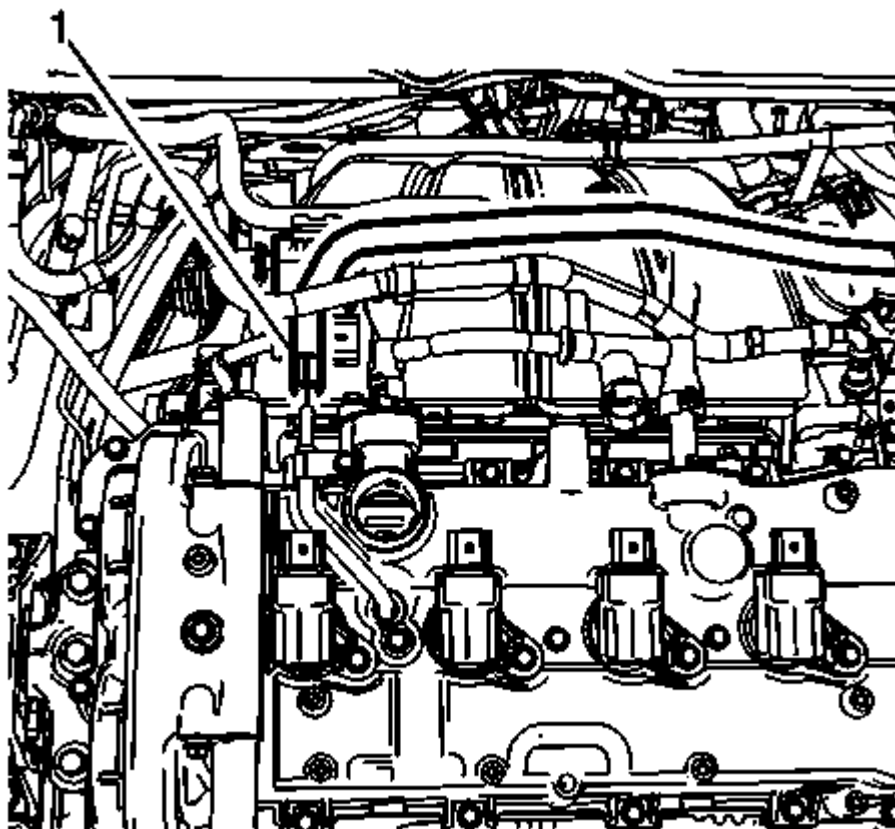


Fig. 89: Surge Tank Hose

Courtesy of GENERAL MOTORS COMPANY

4. Remove the surge tank hose (1).
5. Remove the engine coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (LTG)**.

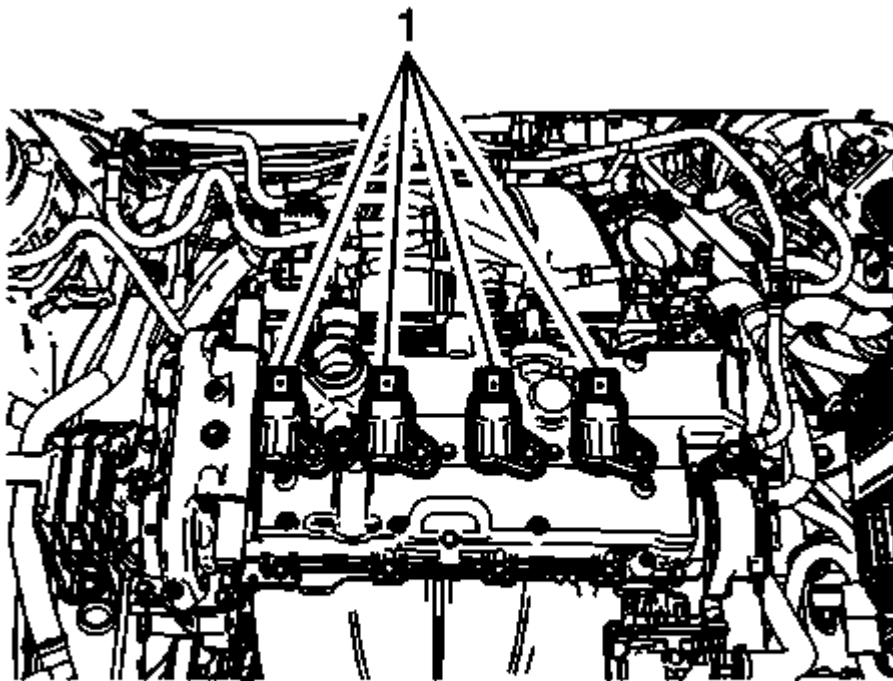


Fig. 90: Ignition Coils

Courtesy of GENERAL MOTORS COMPANY

6. Remove the ignition coils (1). Refer to **Ignition Coil Replacement** .

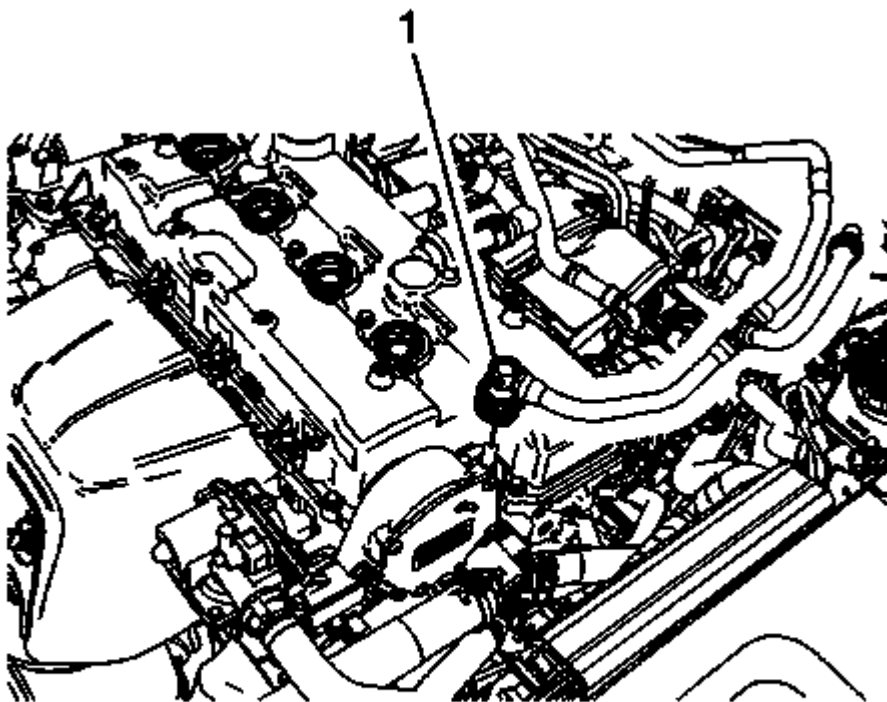


Fig. 91: Vacuum Booster Pipe

Courtesy of GENERAL MOTORS COMPANY

7. Disconnect vacuum booster pipe (1).

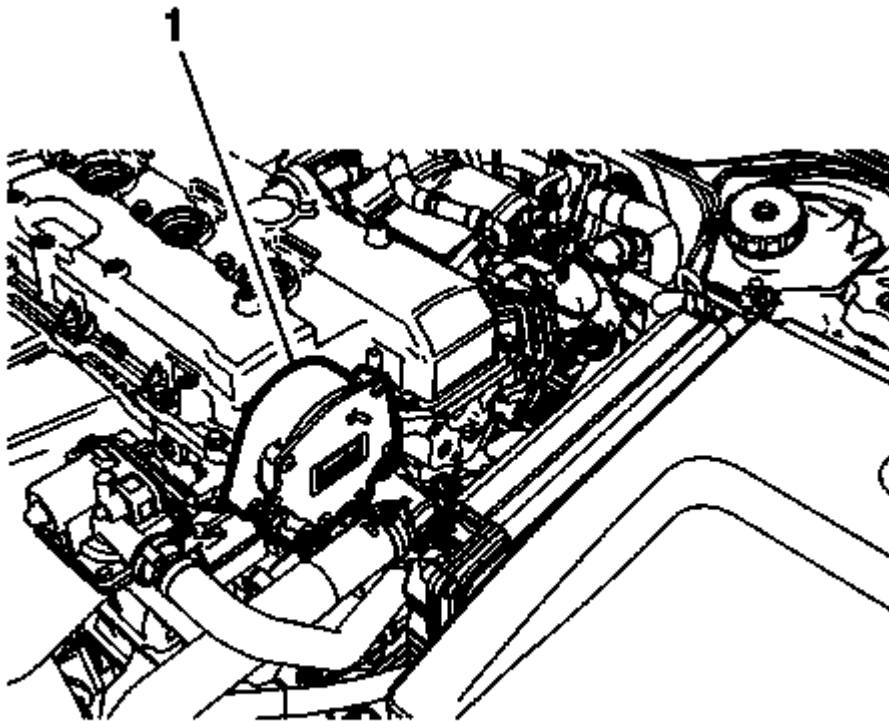


Fig. 92: Vacuum Assembly

Courtesy of GENERAL MOTORS COMPANY

8. Remove the vacuum assembly (1). Refer to **Vacuum Pump Replacement** .

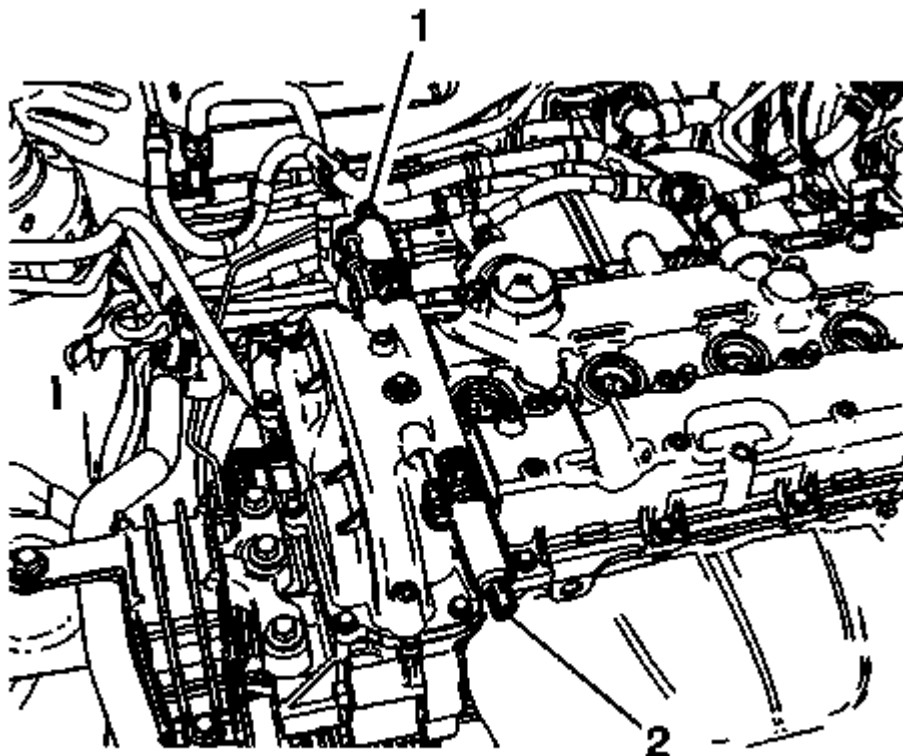


Fig. 93: Camshaft Position Actuator Intake Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

9. Remove the camshaft position actuator intake (1) solenoid valve. Refer to **Camshaft Position Actuator Intake Solenoid Valve Replacement**
10. Remove the camshaft position actuator exhaust (2) solenoid valve. Refer to **Camshaft Position Actuator Exhaust Solenoid Valve Replacement**

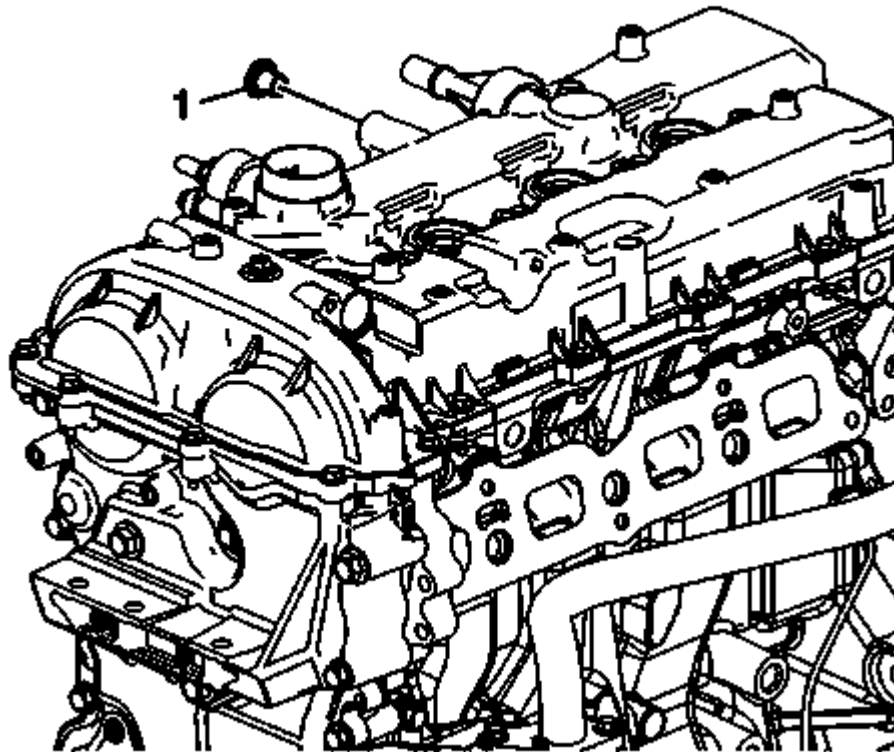


Fig. 94: Camshaft Cover Plug

Courtesy of GENERAL MOTORS COMPANY

11. Remove the camshaft cover plug (1).

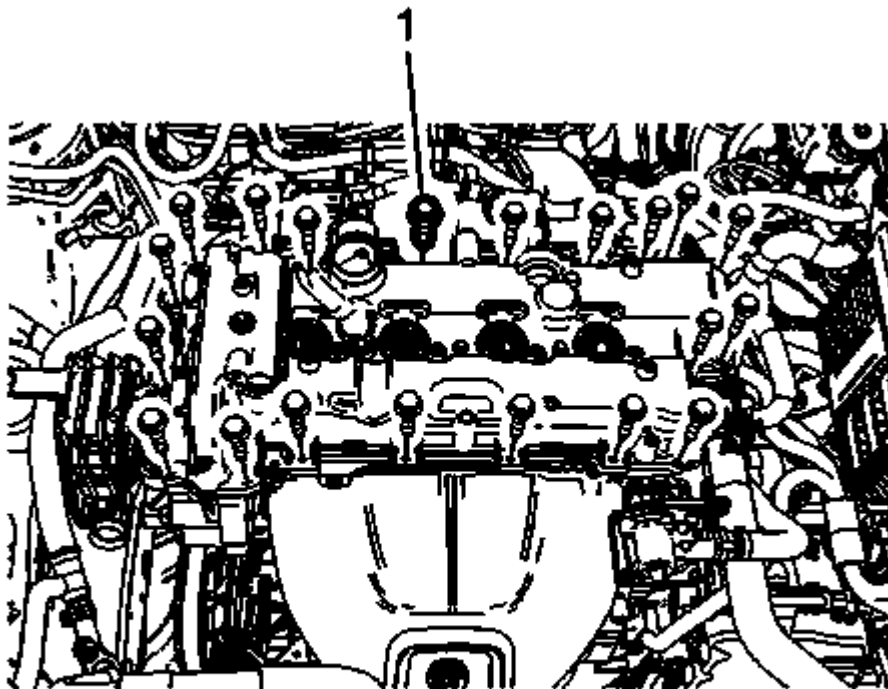


Fig. 95: Camshaft Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

12. Remove the camshaft cover fasteners (1).

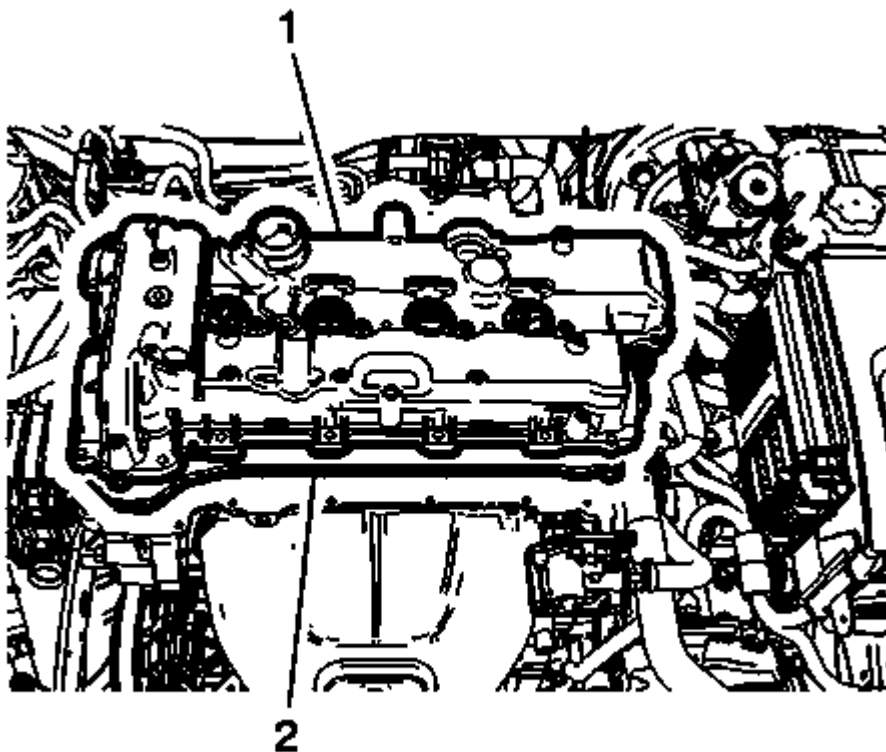


Fig. 96: Camshaft Cover And Gasket
Courtesy of GENERAL MOTORS COMPANY

13. Remove the camshaft cover (1) and gasket (2).
14. For cleaning and inspection. Refer to Camshaft Cover Cleaning and Inspection .

Installation Procedure

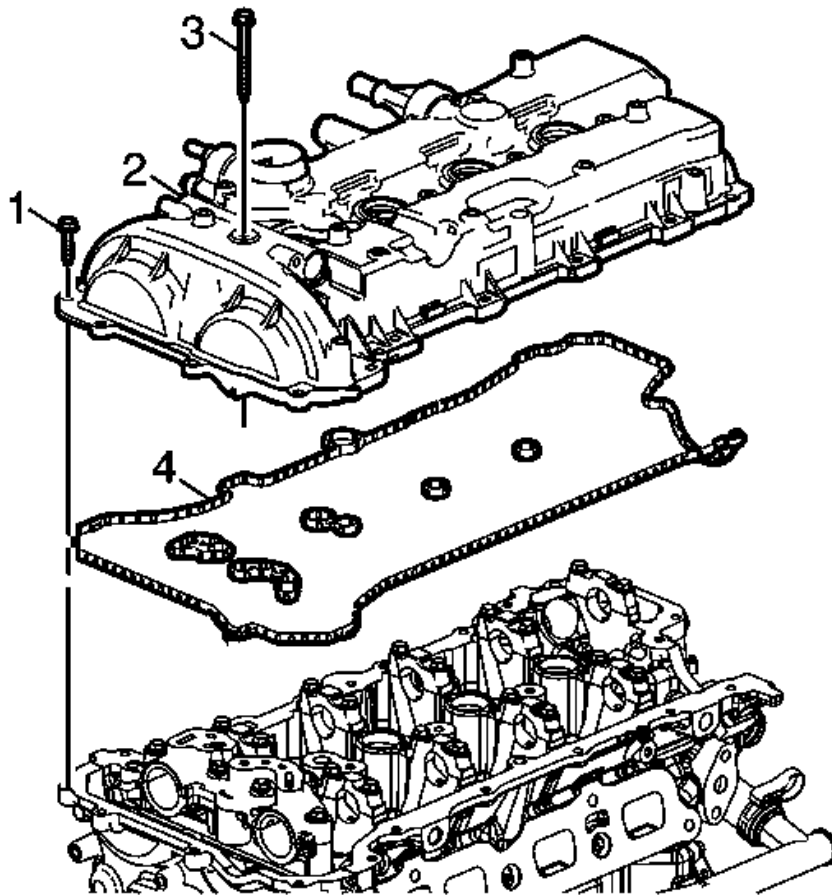


Fig. 97: Camshaft Cover Assembly

Courtesy of GENERAL MOTORS COMPANY

NOTE: Add 14mm bead of sealant part # 12378521 at right and left T-Joint where front cover meets head and at rear of camshaft cover right and left T-Joint where vacuum pump bolts on.

1. Assemble the camshaft cover (2) and a NEW gasket (4). Ensure that the gasket is located in the retaining groove in the camshaft cover.
2. Install the cover on the cylinder head and hand start the bolts (1, 3).

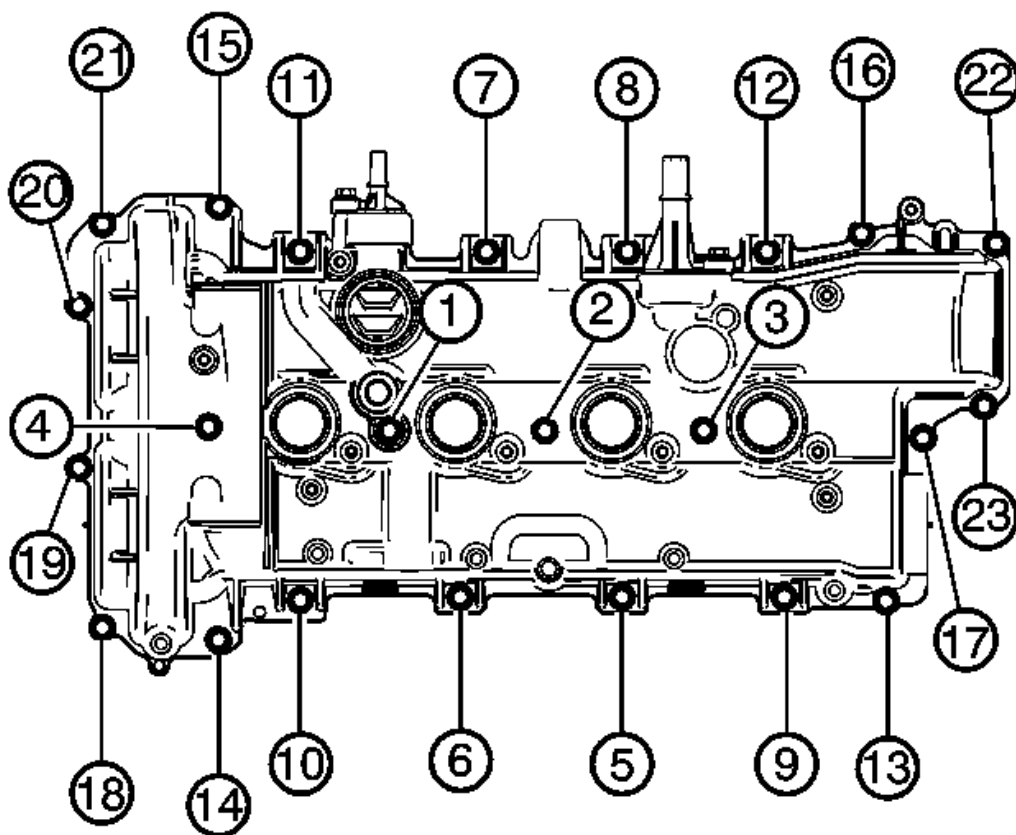


Fig. 98: Camshaft Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Tighten the camshaft cover bolts in sequence to 10 (89 lb in).

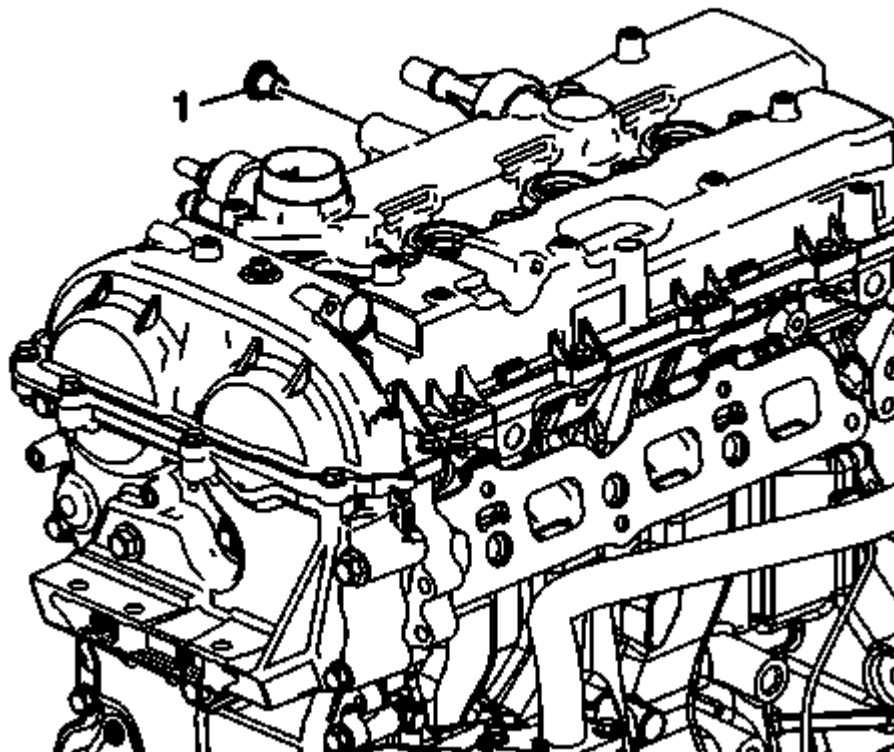


Fig. 99: Camshaft Cover Plug

Courtesy of GENERAL MOTORS COMPANY

4. Install the camshaft cover plug (1). Tighten the plug to 35 (26 lb ft).
5. Install the engine coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (LTG)** .

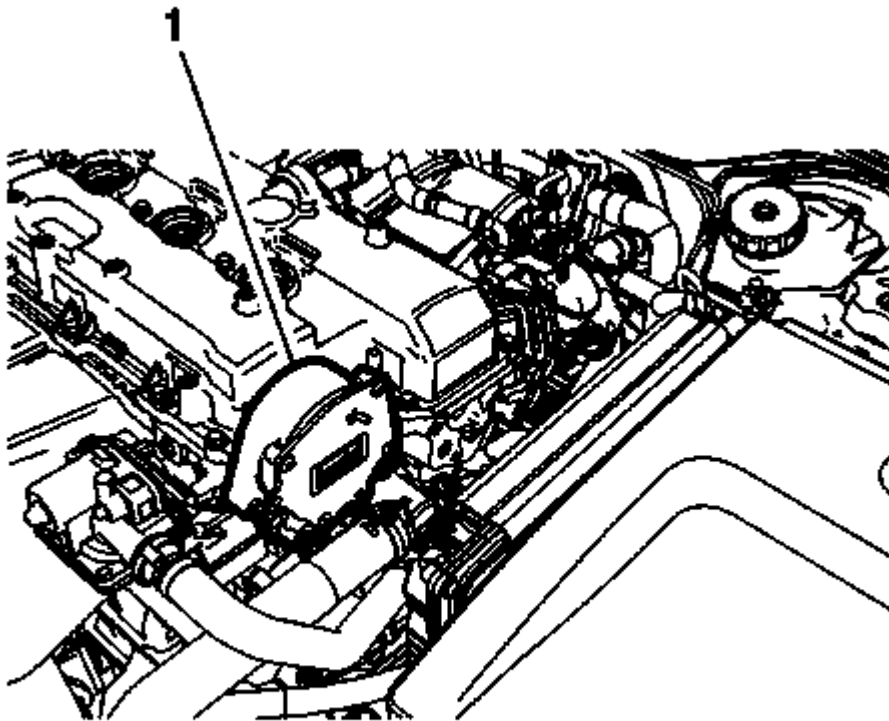


Fig. 100: Vacuum Assembly

Courtesy of GENERAL MOTORS COMPANY

6. Install the vacuum assembly (1). Refer to **Vacuum Pump Replacement** .

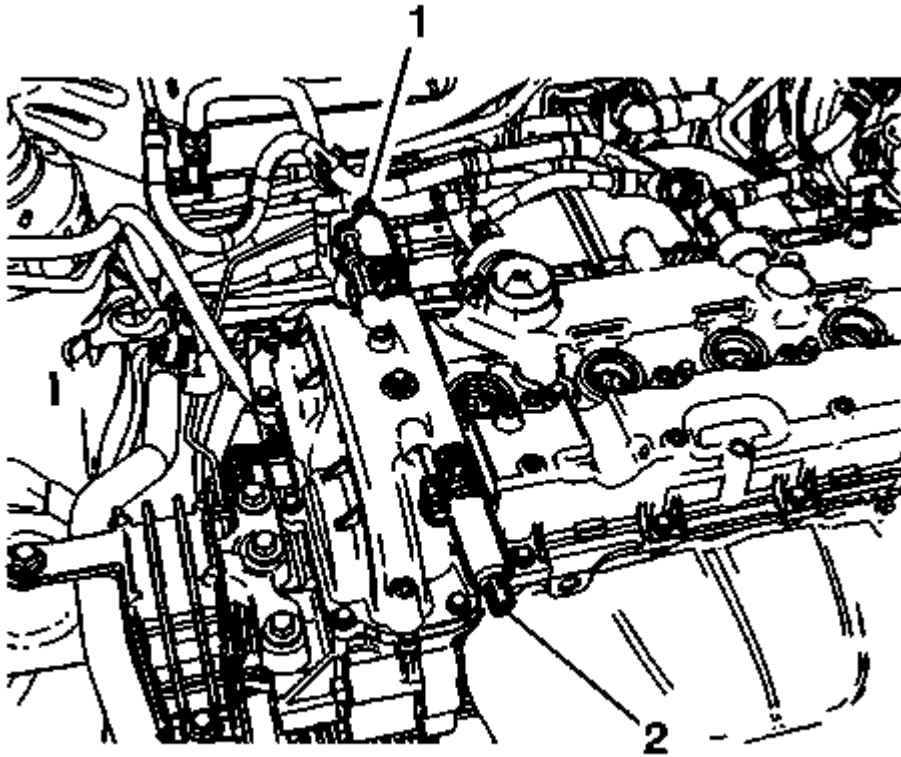


Fig. 101: Camshaft Position Actuator Intake Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

7. Install the camshaft position actuator intake (1) solenoid valve. Refer to **Camshaft Position Actuator Intake Solenoid Valve Replacement** .
8. Install the camshaft position actuator exhaust (2) solenoid valve. Refer to **Camshaft Position Actuator Exhaust Solenoid Valve Replacement** .

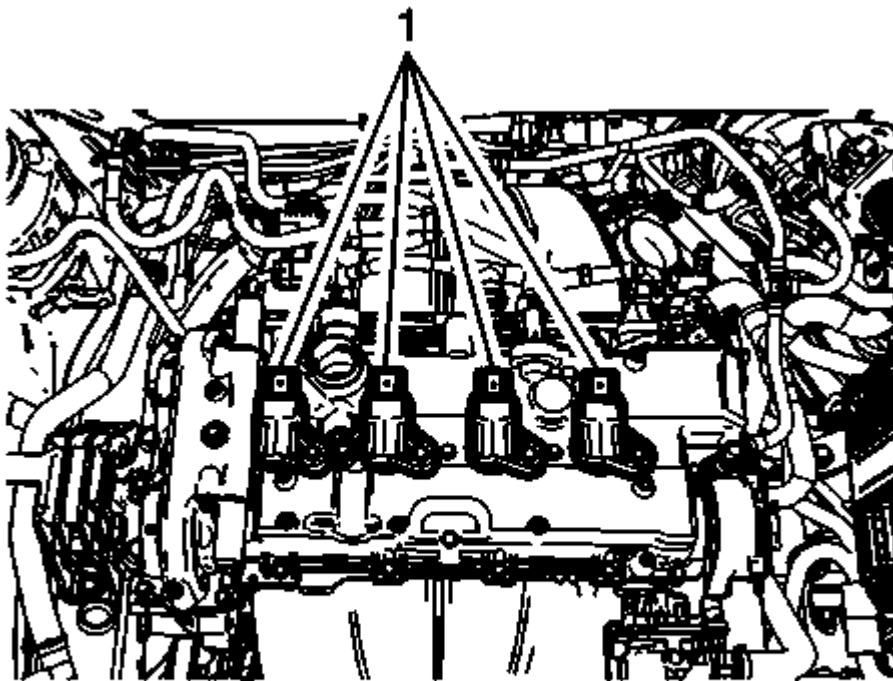


Fig. 102: Ignition Coils

Courtesy of GENERAL MOTORS COMPANY

9. Install the ignition coils (1). Refer to **Ignition Coil Replacement** .

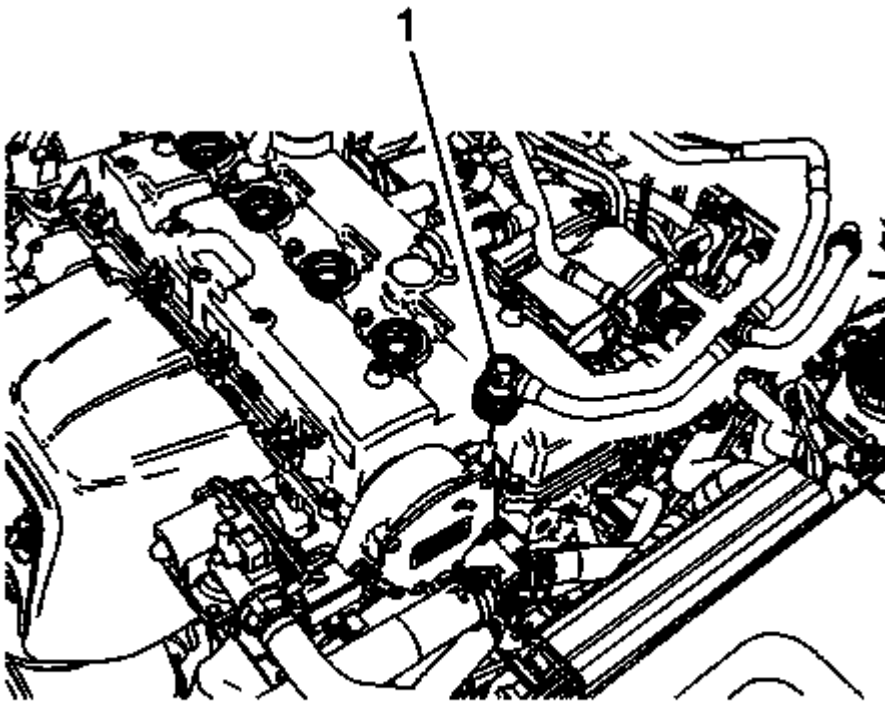


Fig. 103: Vacuum Booster Pipe

Courtesy of GENERAL MOTORS COMPANY

10. Connect vacuum booster pipe (1).

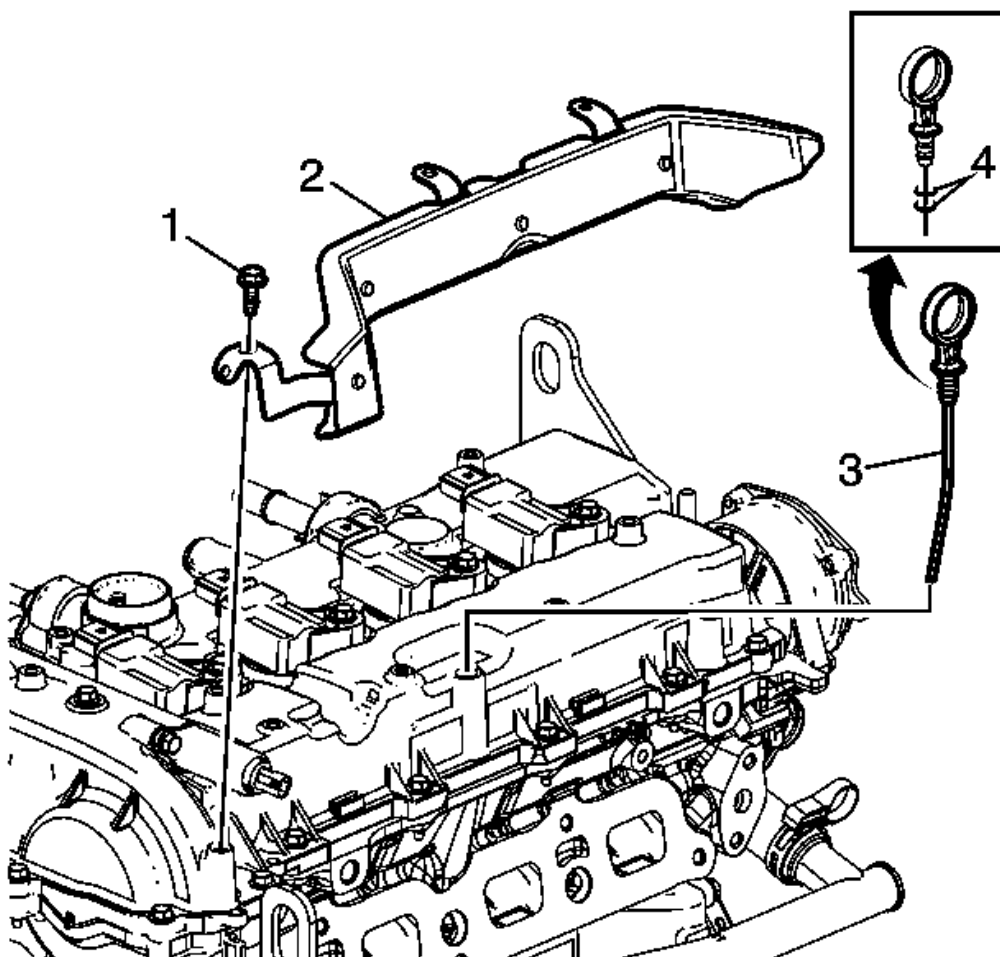


Fig. 104: Oil Level Indicator

Courtesy of GENERAL MOTORS COMPANY

11. Install the camshaft cover heat shield (2) and bolts (1). Tighten the bolts to 10 (89 lb in).
12. Inspect the oil level indicator O-ring seals (4) and replace if necessary. Install the oil level indicator (3).

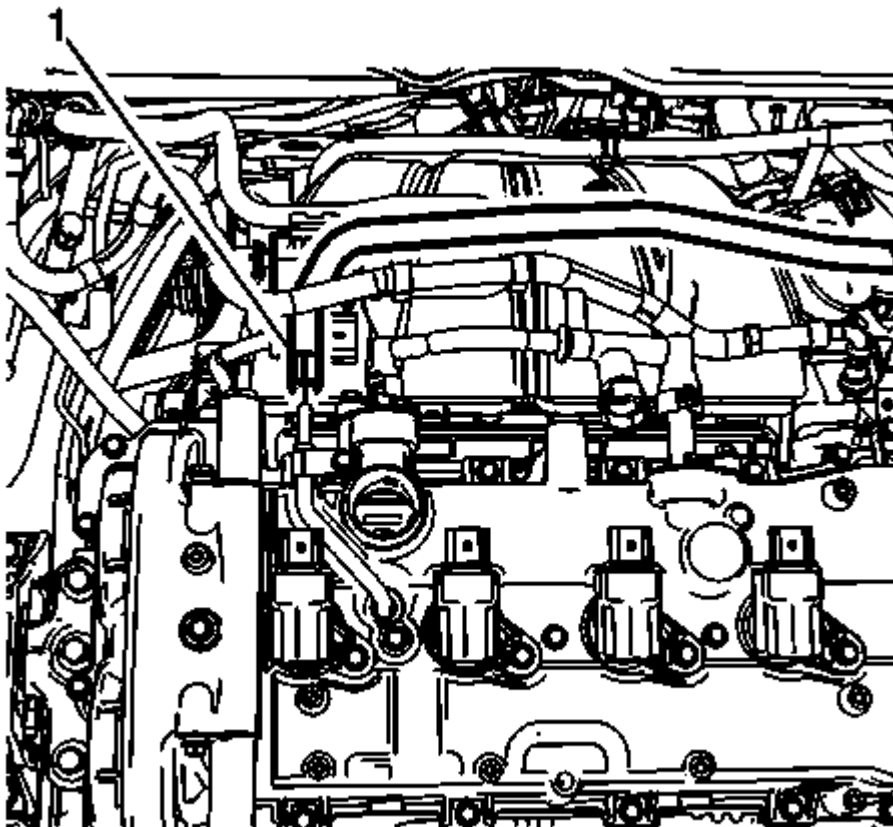


Fig. 105: Surge Tank Hose

Courtesy of GENERAL MOTORS COMPANY

13. Install the surge tank hose (1).
14. Install the positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

TIMING CHAIN TENSIONER REPLACEMENT

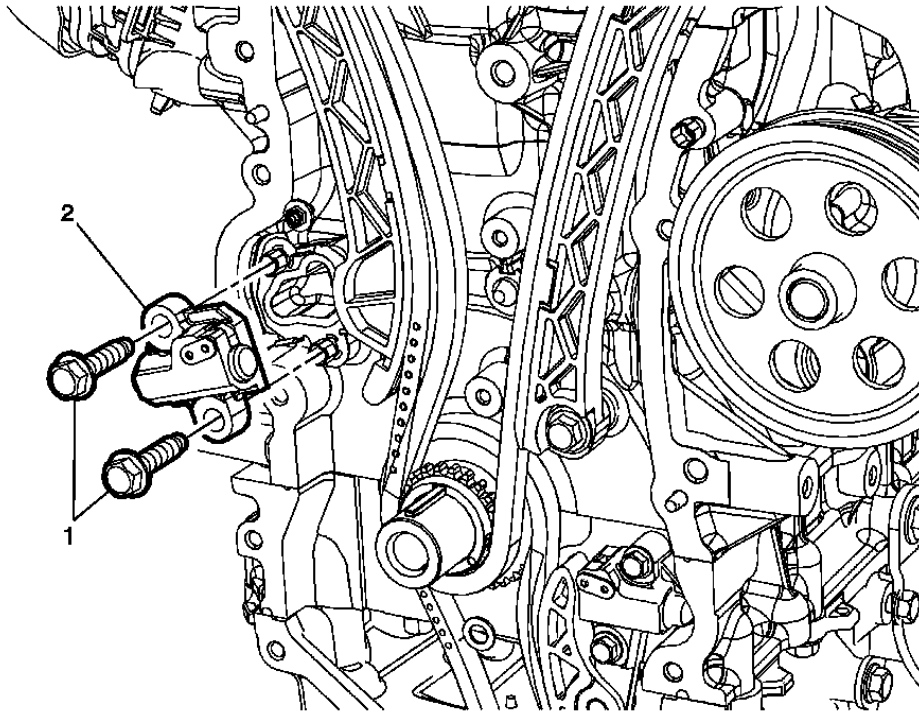


Fig. 106: Timing Chain Tensioner Bolts And Timing Chain Tensioner
 Courtesy of GENERAL MOTORS COMPANY

Timing Chain Tensioner Replacement

Callout	Component Name
Preliminary Procedure Remove the engine front cover. Refer to <u>Engine Front Cover Replacement</u> .	
1	Timing Chain Tensioner Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft) Special Tool EN-50837 Timing Chain Tensioner Retraction Tool . For equivalent regional tools, refer to <u>Special Tools</u> .
2	Timing Chain Tensioner

HYDRAULIC VALVE LASH ADJUSTER REPLACEMENT - EXHAUST

Removal Procedure

1. Remove the exhaust valve rocker arm. Refer to **Exhaust Valve Rocker Arm Replacement**.

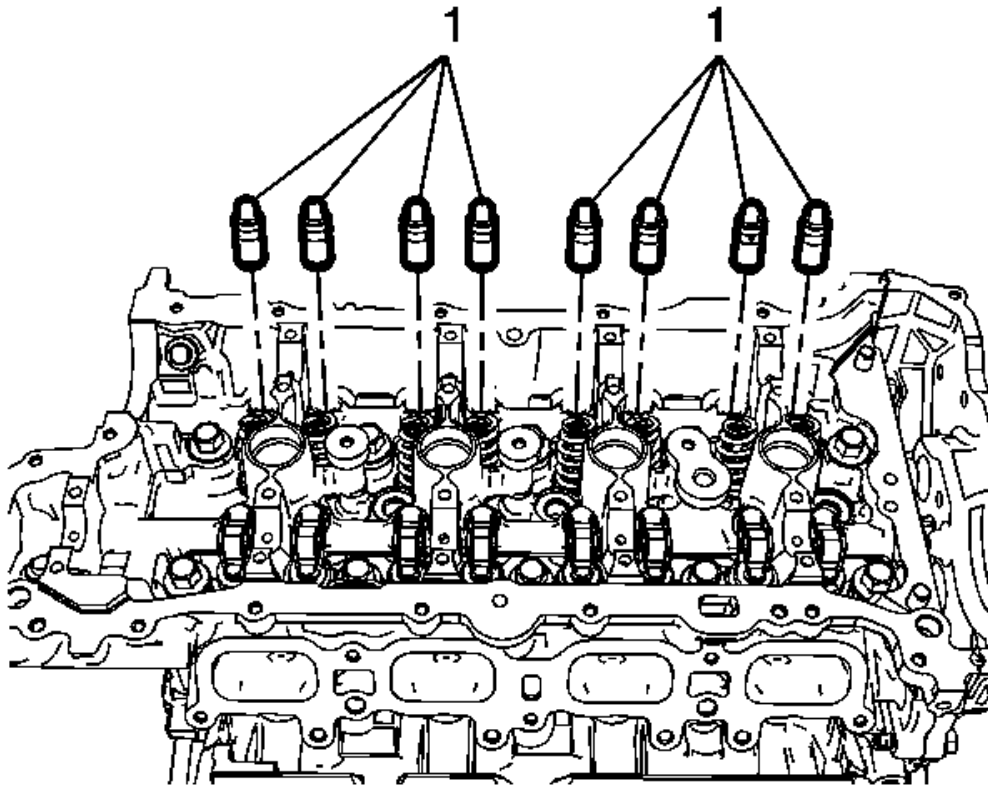


Fig. 107: Hydraulic Lash Adjusters - Exhaust
Courtesy of GENERAL MOTORS COMPANY

2. Remove the hydraulic lash adjusters (1).

Installation Procedure

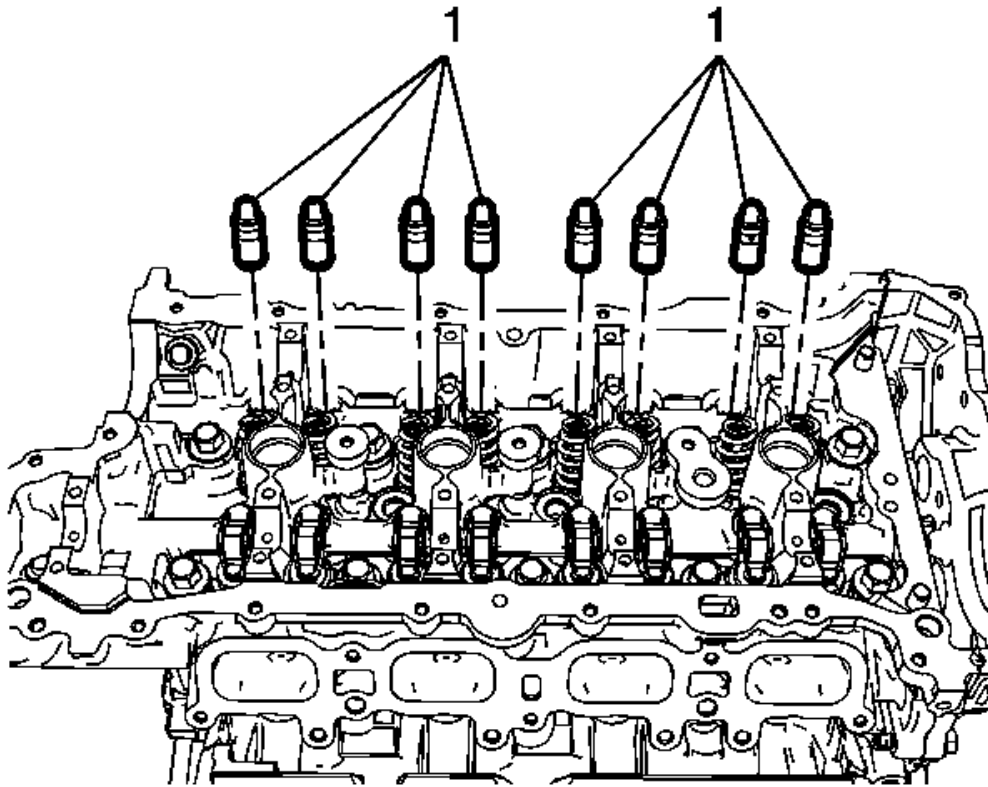


Fig. 108: Hydraulic Lash Adjusters - Exhaust
Courtesy of GENERAL MOTORS COMPANY

NOTE: Pre-fill the low pressure chamber with engine oil. Maintain a vertical orientation of the assembly to retain the oil in the reservoir and high pressure chamber. Do not install the lash adjusters without pre-filling the low pressure chamber. Apply engine oil to the outer diameter surface of all adjusters.

1. Lubricate and install the hydraulic valve lash adjusters (1) into their bores in the cylinder head. Refer to Adhesives, Fluids, Lubricants, and Sealers .
2. Install the exhaust valve rocker arm. Refer to Exhaust Valve Rocker Arm Replacement.

HYDRAULIC VALVE LASH ADJUSTER REPLACEMENT - INTAKE

Removal Procedure

1. Remove the intake valve rocker arm. Refer to Intake Valve Rocker Arm Replacement.

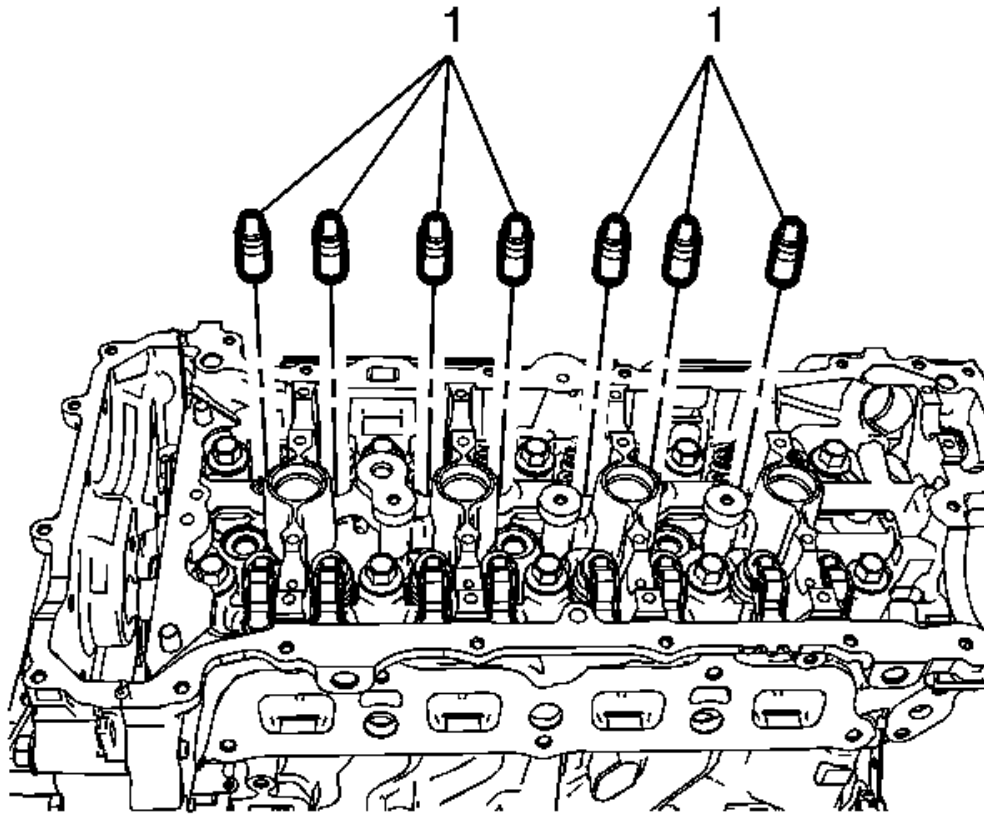


Fig. 109: Hydraulic Lash Adjusters - Intake
Courtesy of GENERAL MOTORS COMPANY

2. Remove the hydraulic lash adjusters (1).

Installation Procedure

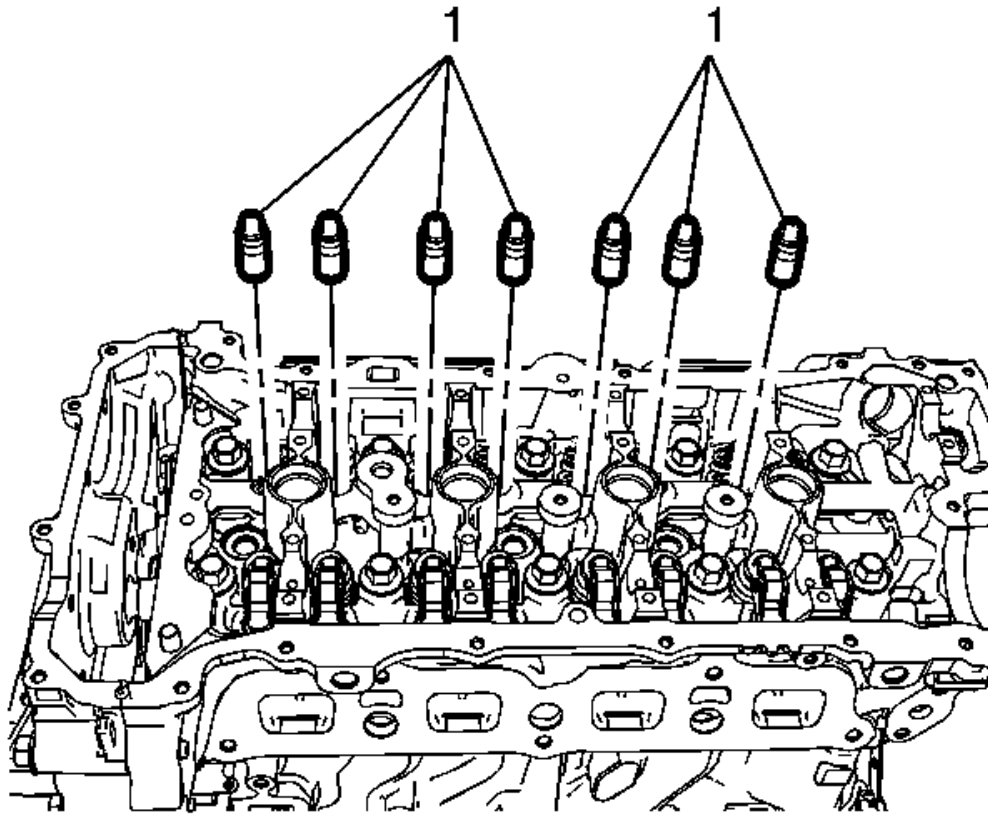


Fig. 110: Hydraulic Lash Adjusters - Intake
Courtesy of GENERAL MOTORS COMPANY

NOTE: Pre-fill the low pressure chamber with engine oil. Maintain a vertical orientation of the assembly to retain the oil in the reservoir and high pressure chamber. Do not install the lash adjusters without pre-filling the low pressure chamber. Apply engine oil to the outer diameter surface of all adjusters.

1. Lubricate and install the hydraulic valve lash adjusters (1) into their bores in the cylinder head. Refer to Adhesives, Fluids, Lubricants, and Sealers .
2. Install the intake valve rocker arm. Refer to Intake Valve Rocker Arm Replacement.

CAMSHAFT POSITION ACTUATOR AND CAMSHAFT REPLACEMENT - INTAKE

Special Tools

- EN-50656 Holding Tool

- **EN 50793** Locking Tool

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

Removal Procedure

NOTE: Ensure the engine is properly timed to Top Dead Center (TDC), prior to performing repairs.

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.
2. Remove the high pressure fuel pump. Refer to **Fuel Pump Replacement** .

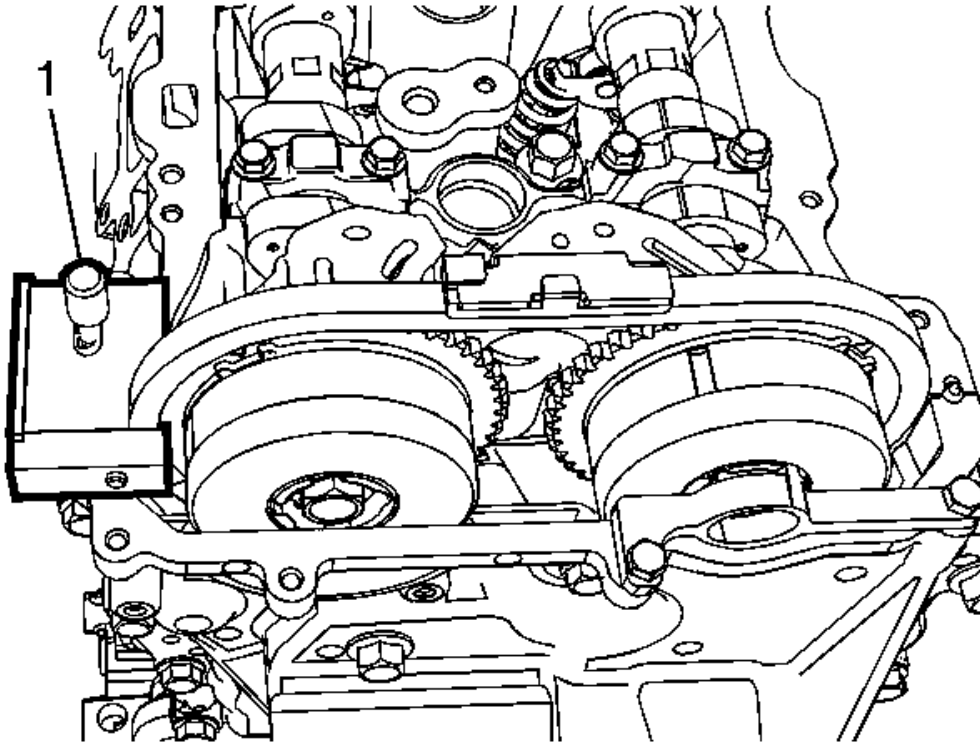


Fig. 111: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the EN-50656 holding tool is installed and securely tightened to prevent the camshaft chain from dropping into the front engine cover during camshaft actuator replacement.

3. Install **EN-50656** timing chain holding tool (1) and tighten to 8 (71 lb in).

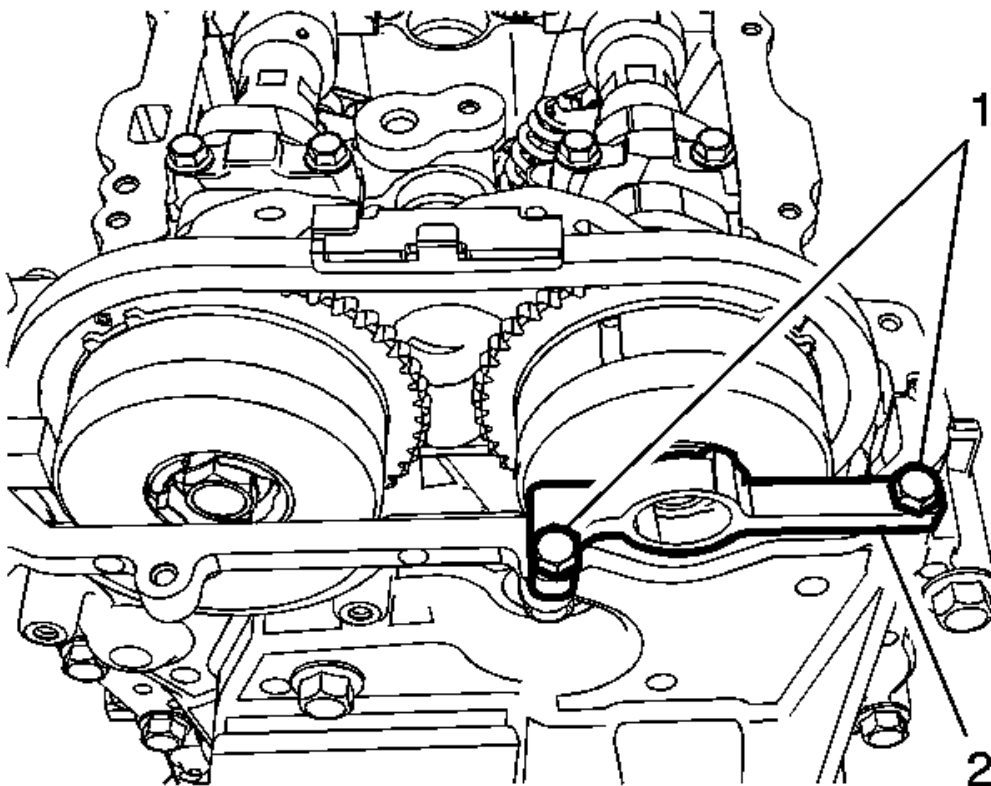


Fig. 112: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Ensure to mark actuator sprocket and chain before removal.

4. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the exhaust camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

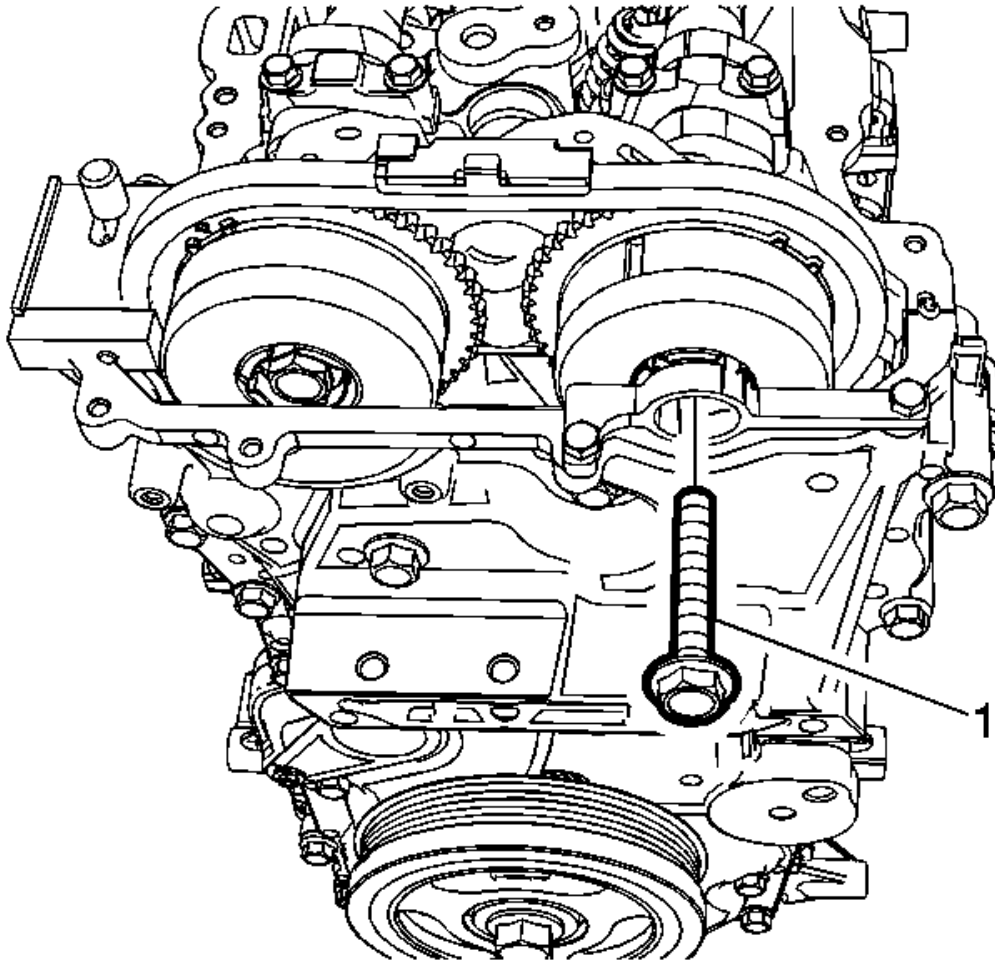


Fig. 113: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove and DISCARD the camshaft actuator bolt (1).

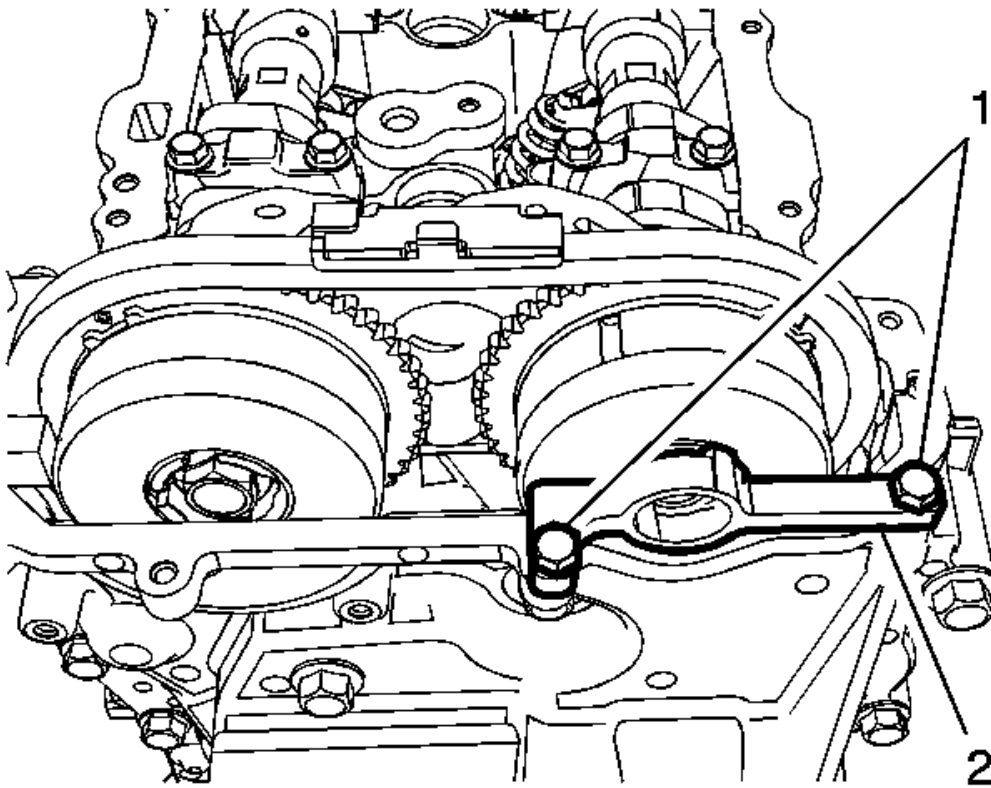


Fig. 114: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-50793** holding tool (2).

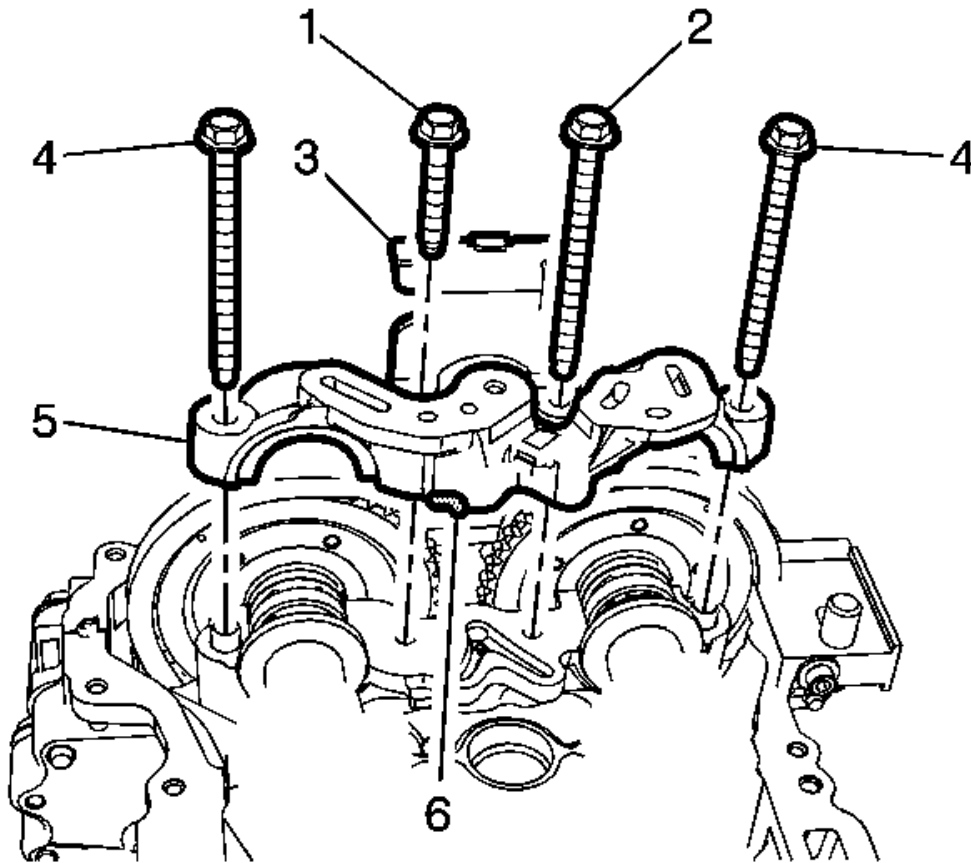


Fig. 115: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the upper timing chain guide bolts (1, 2).
8. Remove the upper timing chain guide (3).
9. Remove the camshaft front bearing cap bolts (4).

NOTE: Locate the pry points (6) in the camshaft front bearing cap. When using the 3 pry points to remove the front bearing cap evenly, use a protective material between the camshaft lobes, the cylinder head flange, and pry tool.

10. Remove the camshaft front bearing cap (5).

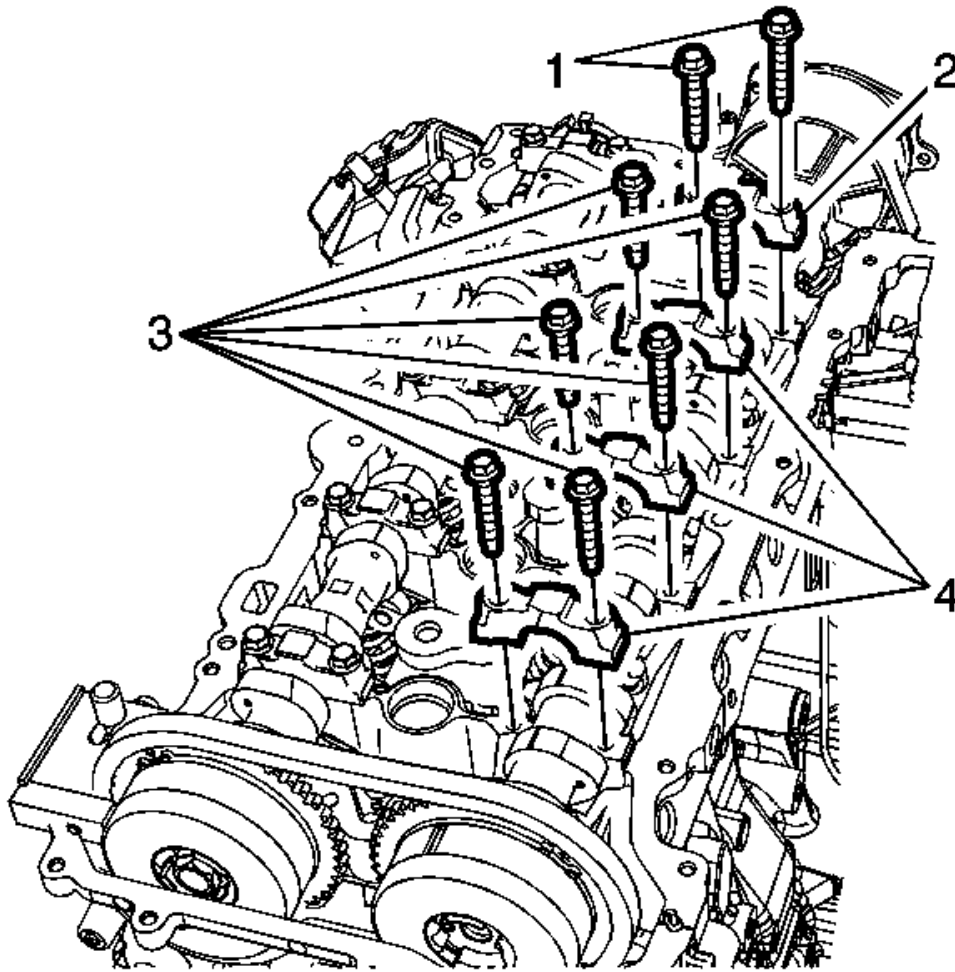


Fig. 116: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

11. Mark the exhaust camshaft rear cap to ensure it is installed in the same position. Remove the exhaust camshaft bearing rear cap bolts (1) and cap (2).

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

12. Mark the camshaft caps (4) to ensure they are installed in the same position.
13. Remove the exhaust camshaft cap bolts (3).
14. Remove the camshaft caps (4).

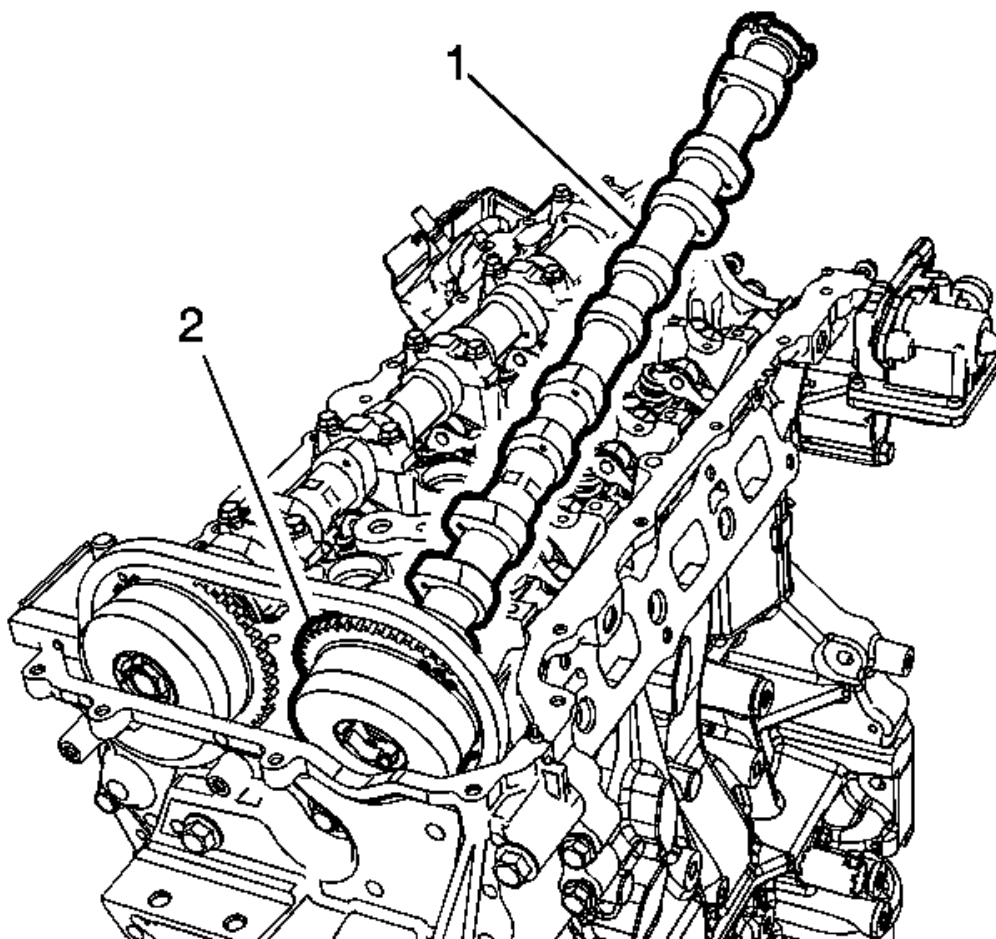


Fig. 117: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

15. Pull exhaust camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of exhaust camshaft assembly to a tilt and pull free from exhaust camshaft actuator assembly (2).

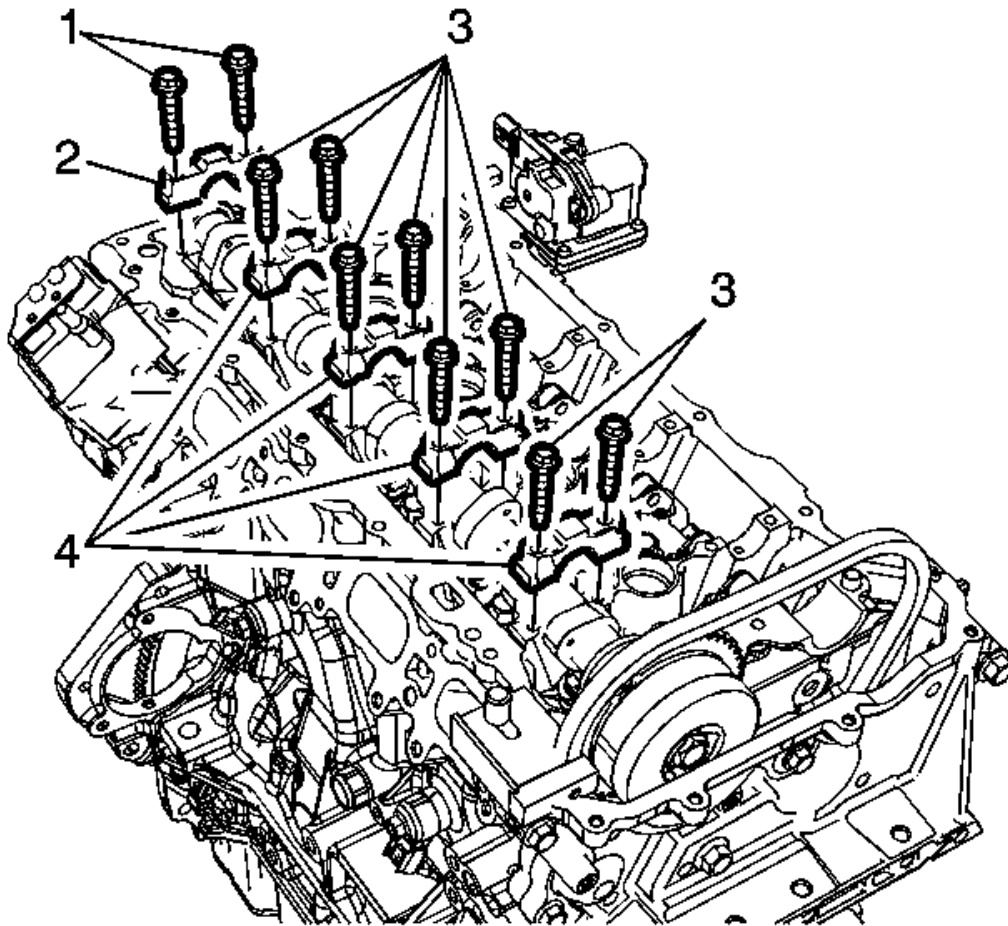


Fig. 118: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

16. Mark the intake camshaft rear cap to ensure it is installed in the same position. Remove the intake camshaft bearing rear cap bolts (1) and cap (2).

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

17. Mark the camshaft caps (4) to ensure they are installed in the same position.
18. Remove the intake camshaft cap bolts (3).
19. Remove the camshaft caps (4).
20. Lift and roll intake camshaft assembly from original position over into exhaust camshaft position within engine head assembly.

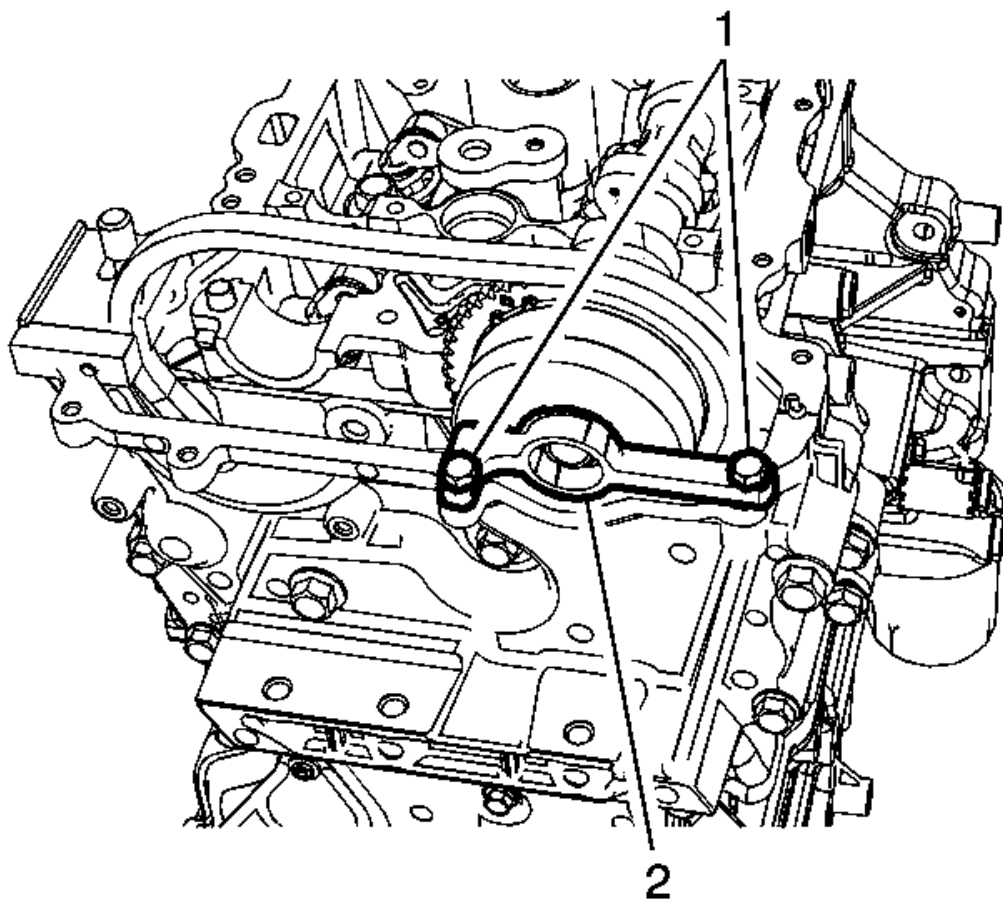


Fig. 119: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

21. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

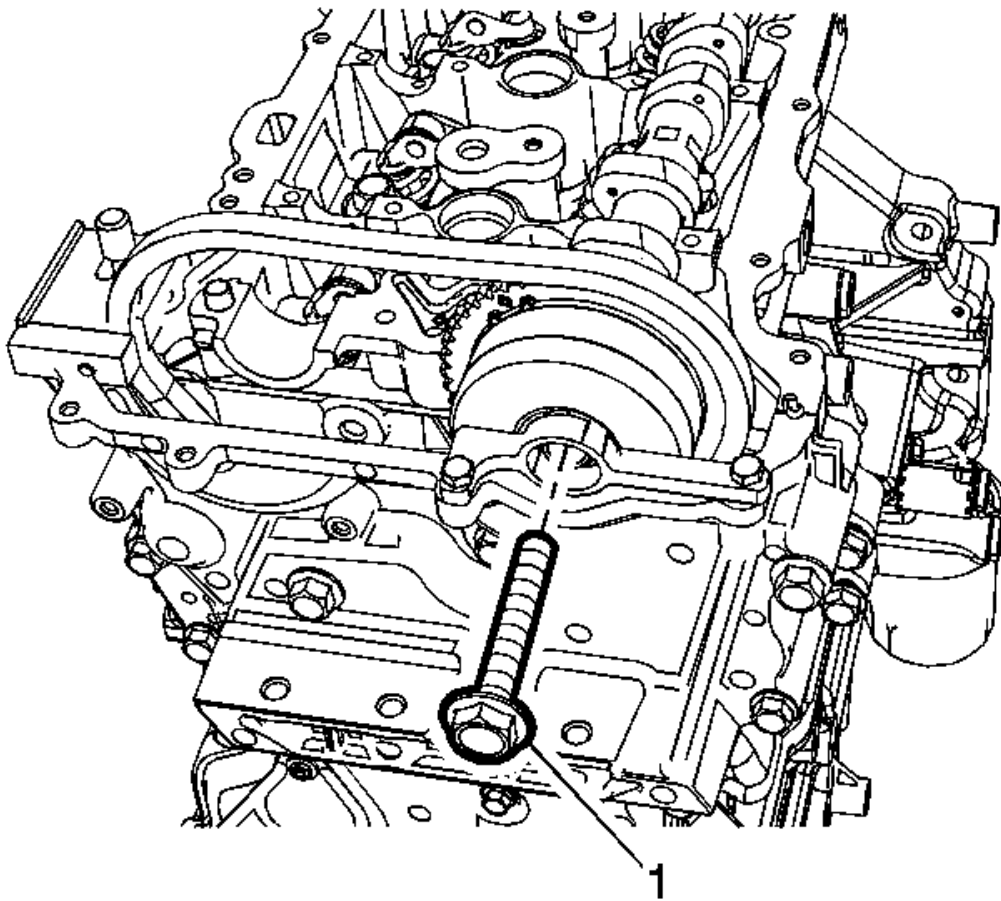


Fig. 120: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

22. Remove the camshaft actuator bolt (1).

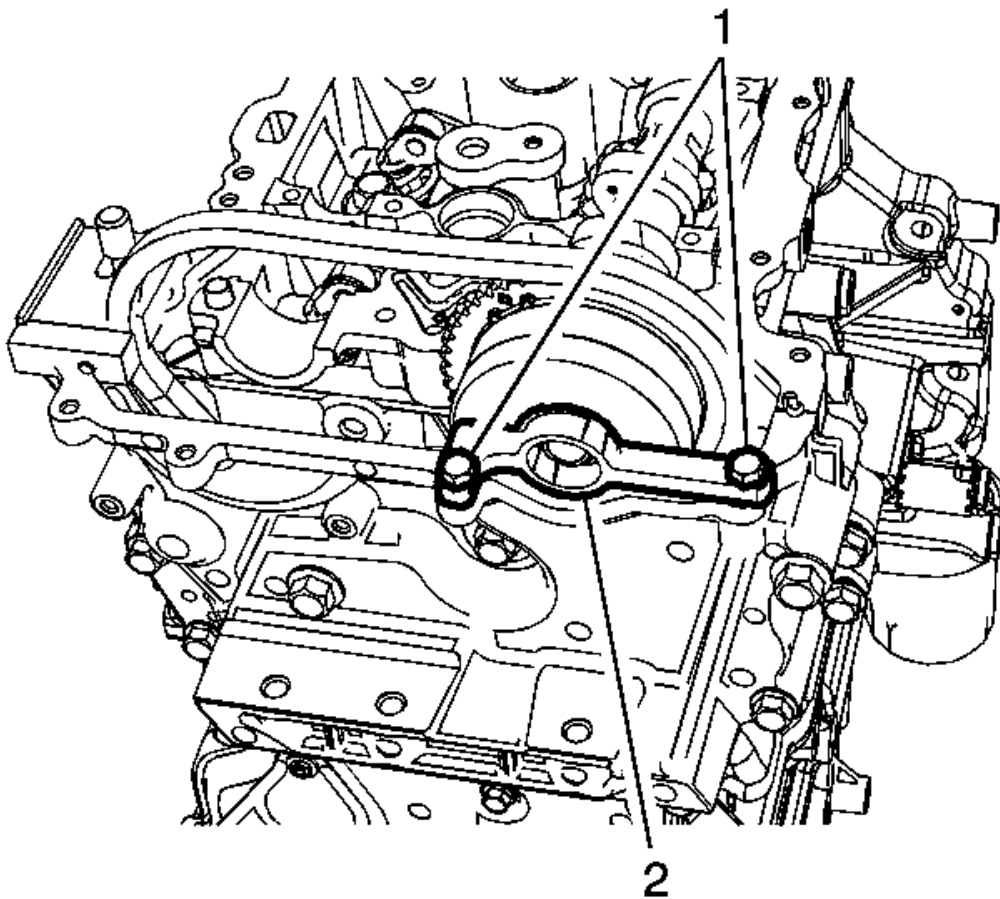


Fig. 121: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

23. Remove the **EN-50793** holding tool (2).

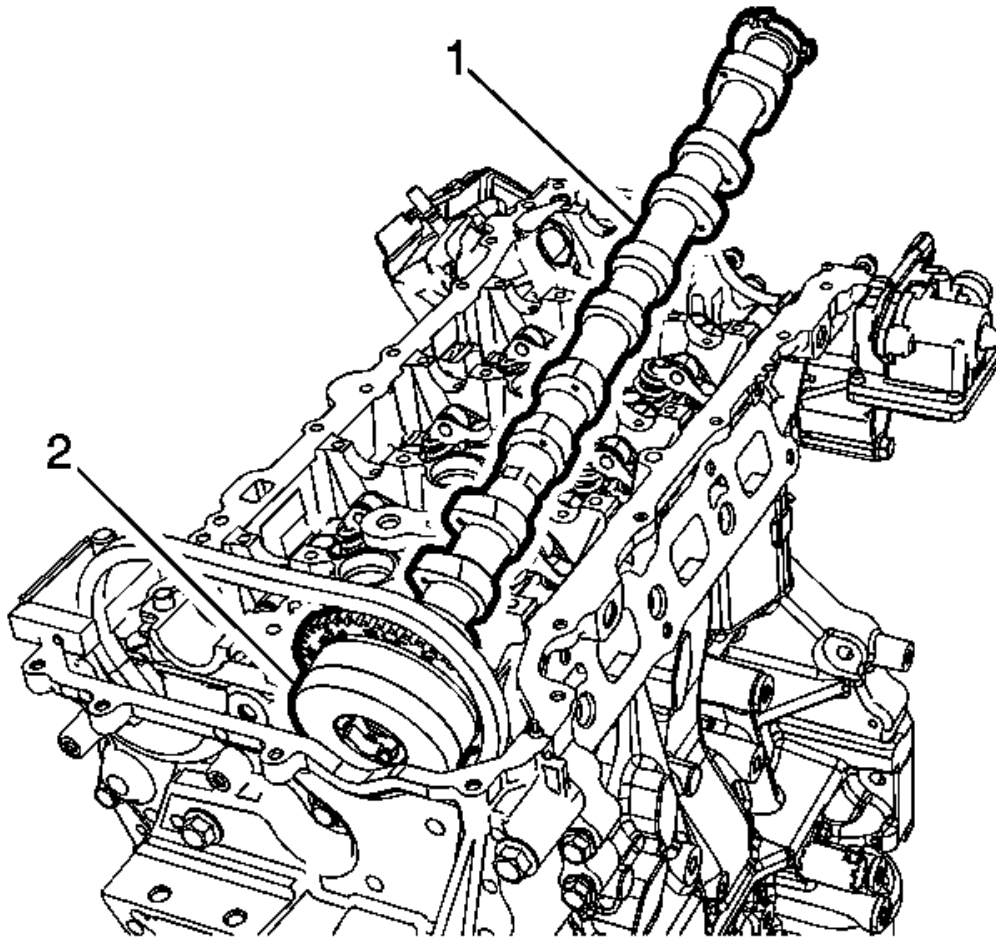


Fig. 122: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

24. Pull intake camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of intake camshaft assembly to a tilt and pull free from intake camshaft actuator assembly (2).

NOTE: If replacing the camshaft, ensure to transfer any marking from the old camshaft to the new one.

25. Replace the camshaft if necessary.

Installation Procedure

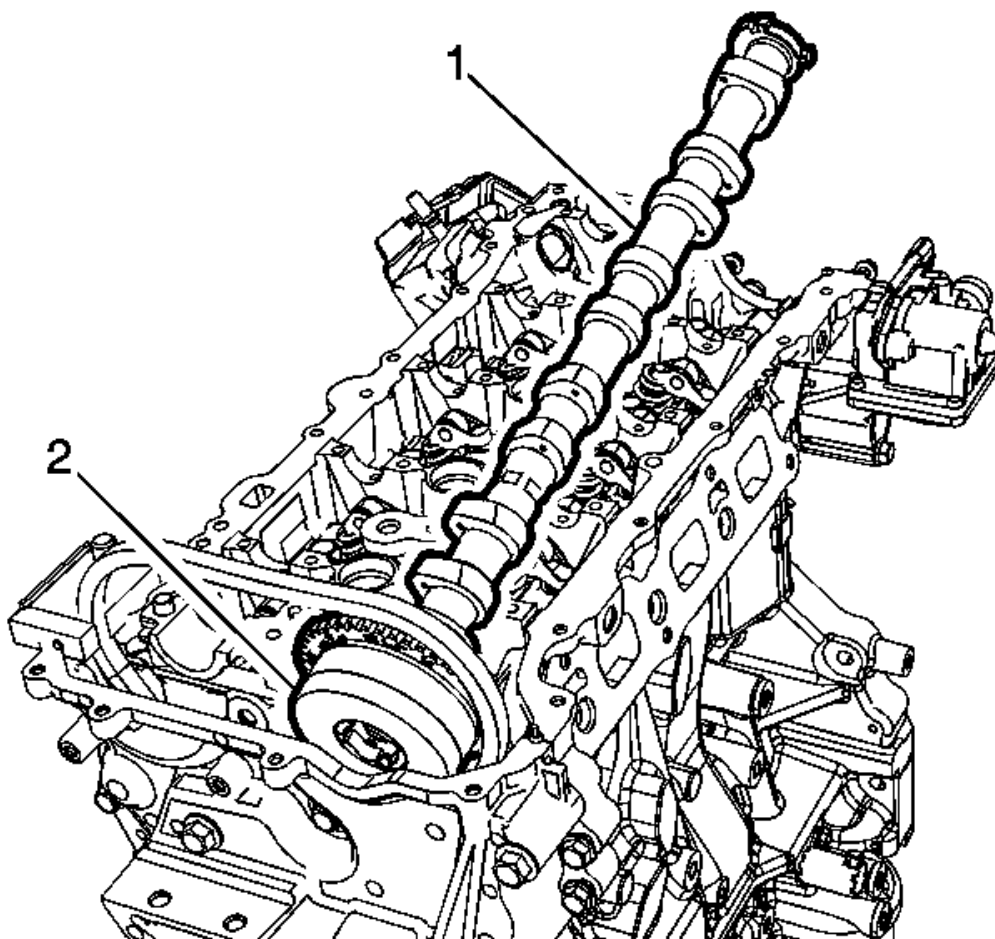


Fig. 123: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Install the intake camshaft (1) and camshaft actuator (2).

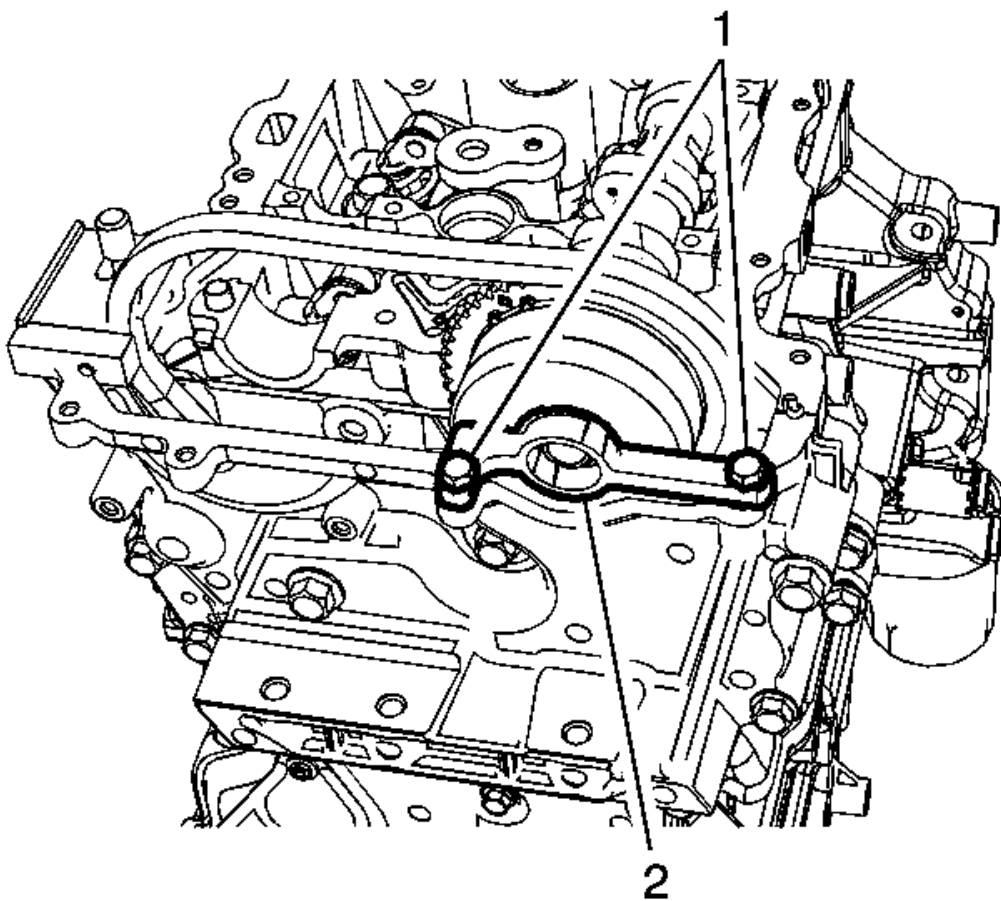


Fig. 124: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

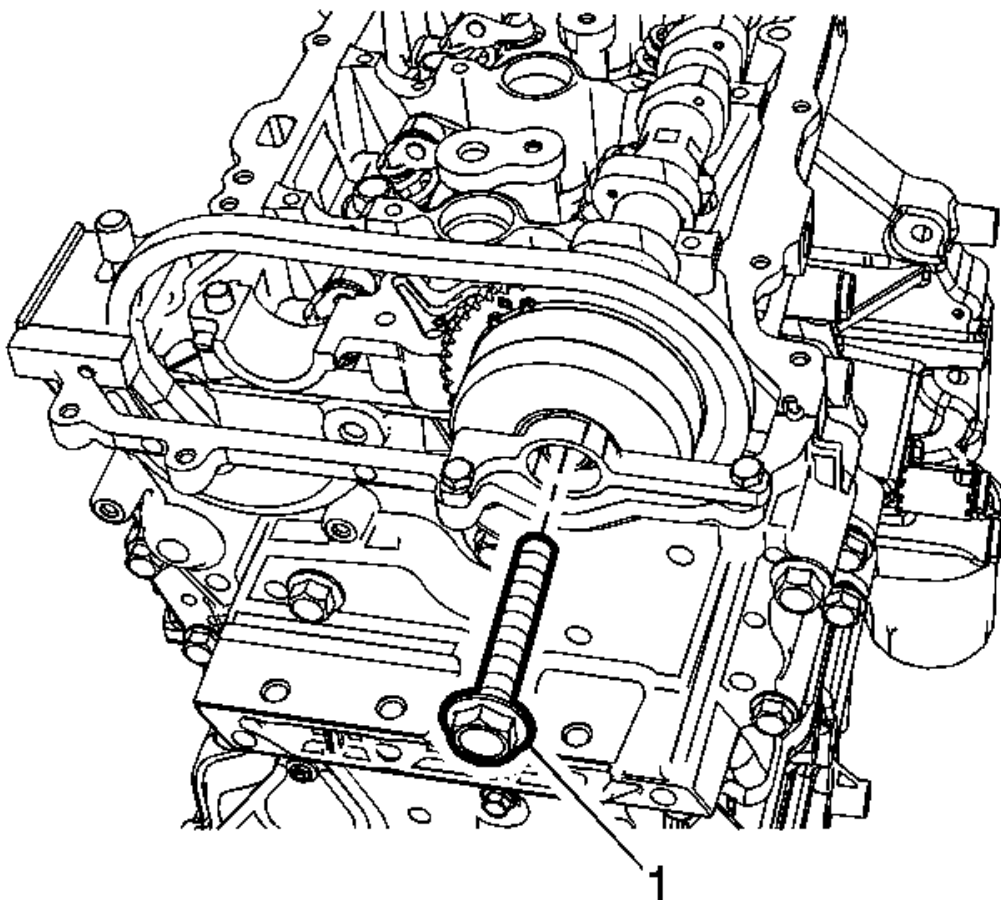


Fig. 125: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW camshaft actuator bolt (1) and tighten to 30 (22 lb ft) plus 100 degrees.
4. Lift and roll intake camshaft assembly from exhaust camshaft position over into original position.

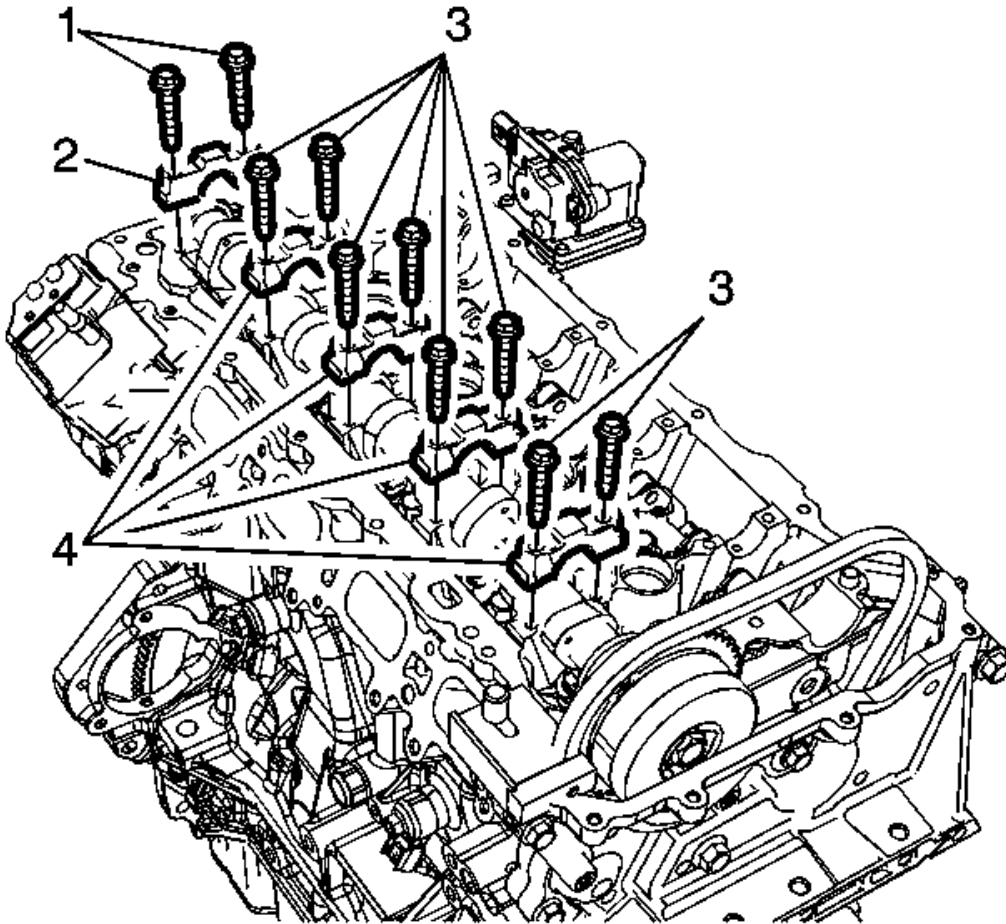


Fig. 126: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

5. Set the intake camshaft on top of the roller followers in the camshaft bearing journals with the intake actuator timing mark at approximately the 11 O'clock position.

NOTE: To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

6. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
7. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

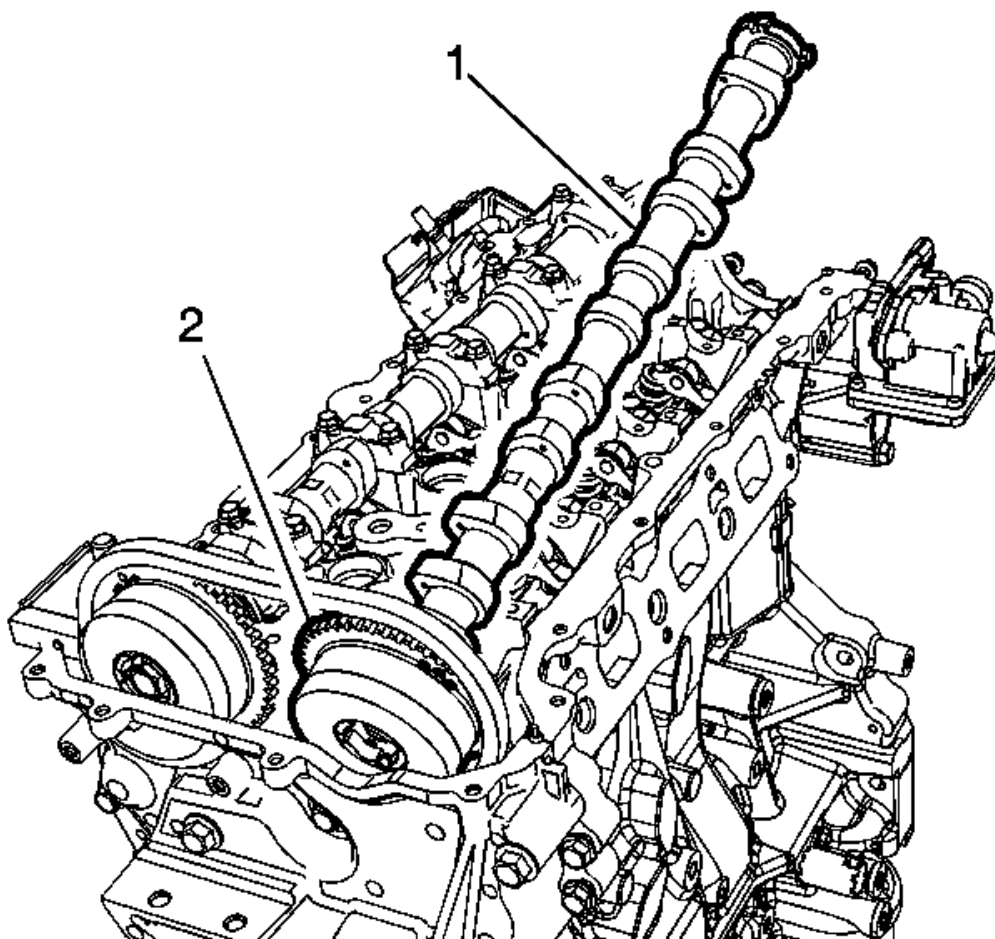


Fig. 127: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

8. Install the exhaust camshaft (1) and camshaft actuator (2).

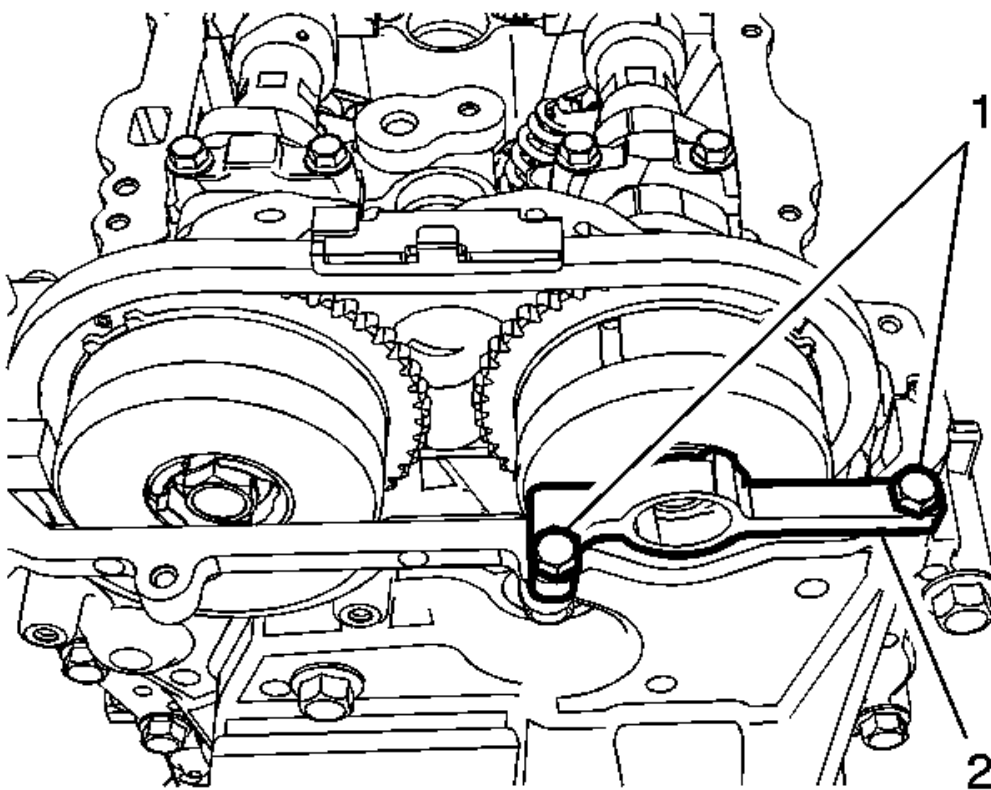


Fig. 128: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

9. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

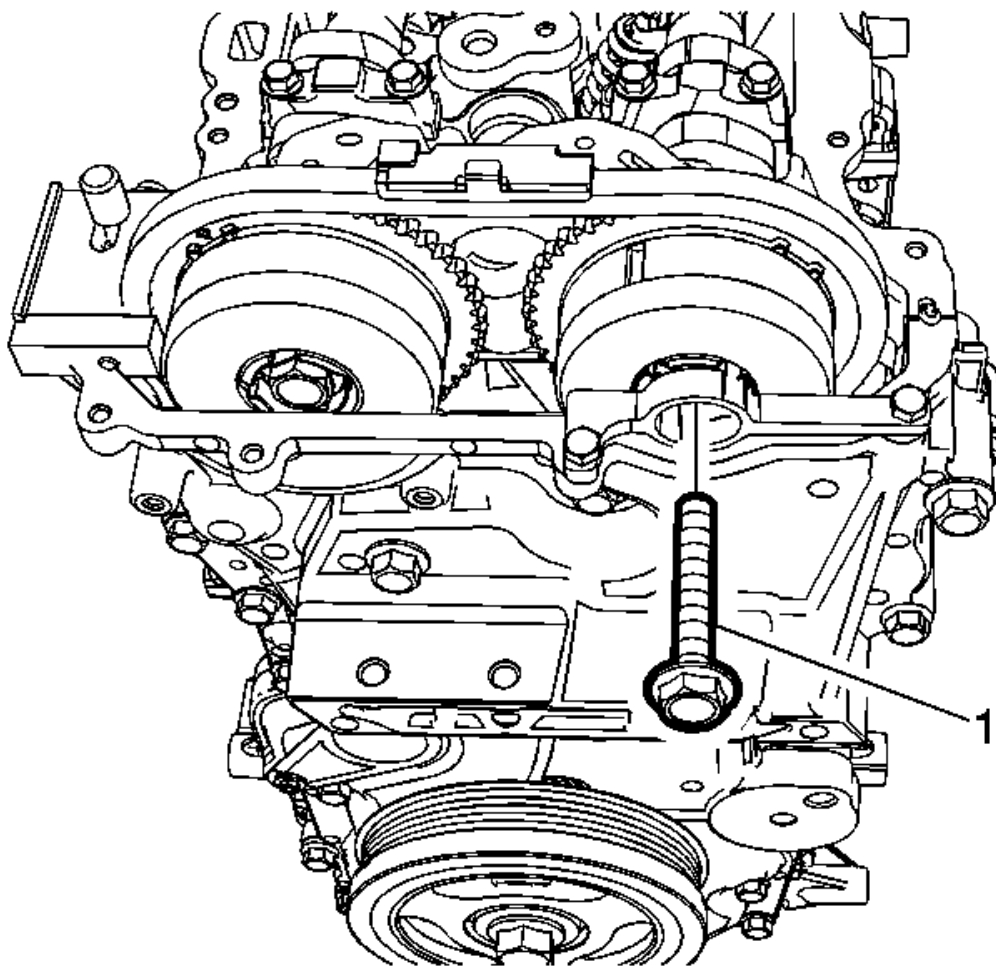


Fig. 129: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Install a NEW camshaft actuator bolt (1) and tighten to 30 (22 lb ft) plus 100 degrees.

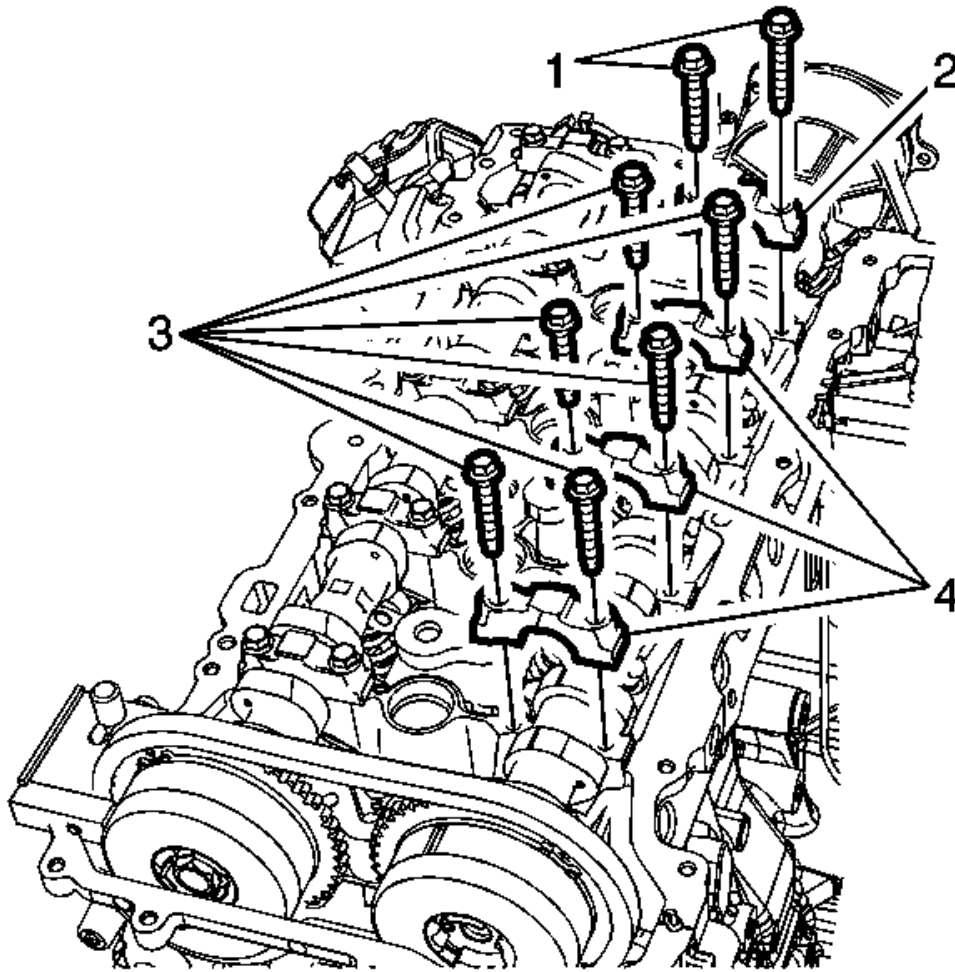


Fig. 130: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

11. Set the exhaust camshaft on top of the roller followers in the camshaft bearing journals with the exhaust actuator timing mark at approximately the one O'clock position.

NOTE: To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

12. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
13. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

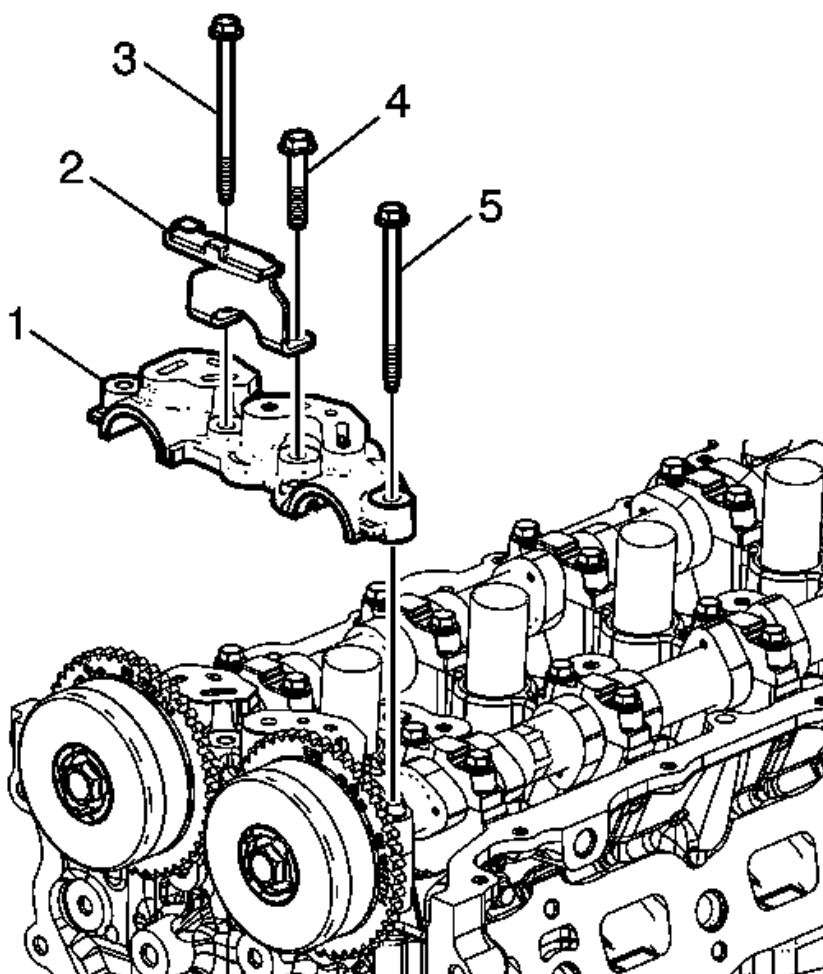


Fig. 131: Front Camshaft Bearing Cap

Courtesy of GENERAL MOTORS COMPANY

14. Install the front camshaft bearing cap (1). Install the timing chain guide (2) onto the front camshaft bearing cap, then hand start the camshaft cap bolts (3-5).

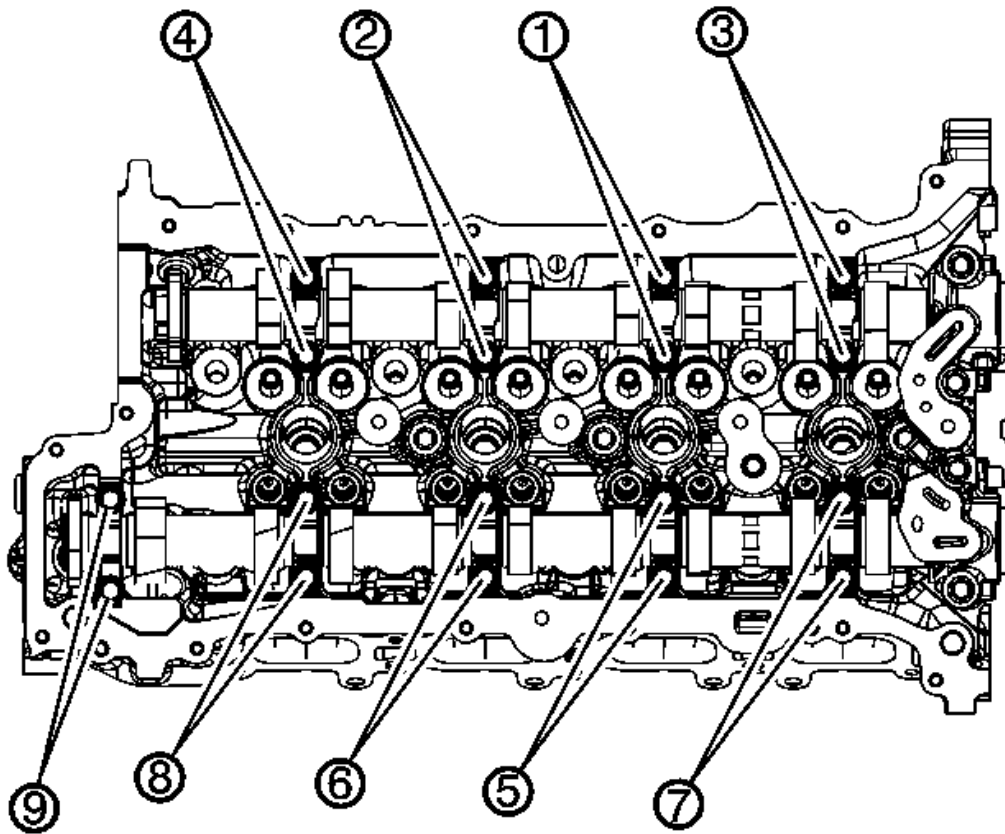


Fig. 132: Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: During the tightening sequence, locate and tighten each camshaft cap bolt installed into the circular hole first. Then, tighten the bolt installed into the slotted hole.

15. Tighten the camshaft cap bolts in sequence using the following procedure:
 1. Tighten the camshaft cap bolts in sequence to 8 (71 lb in).
 2. Loosen both bolts in each cap in sequence to 180 degrees.
 3. Tighten the camshaft cap bolts in sequence to 10 (89 lb in) twice.

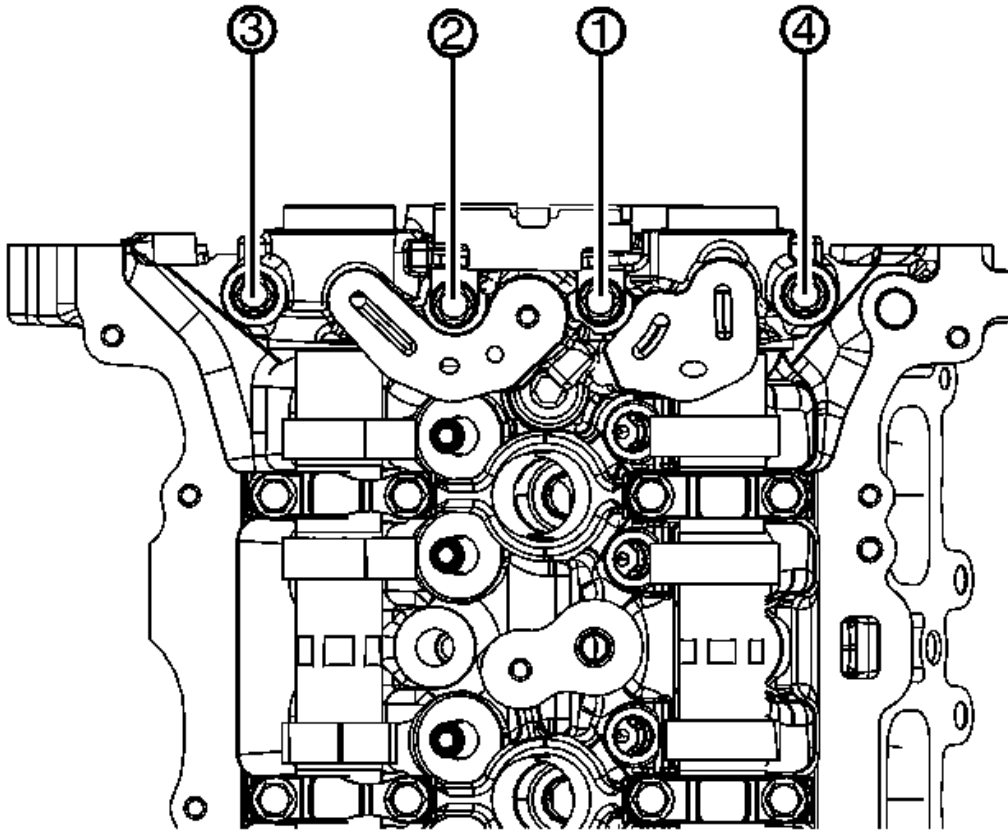


Fig. 133: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

16. Tighten the front camshaft cap bolts in sequence to 10 (89 lb in) twice.

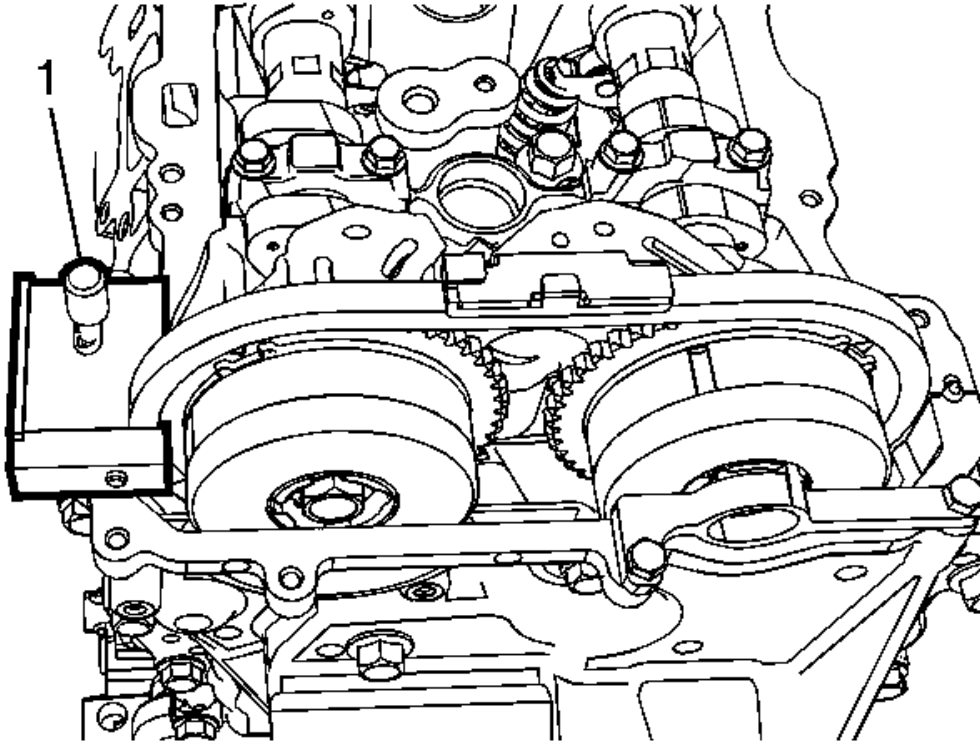


Fig. 134: Identifying Timing Chain Holding Tool
 Courtesy of GENERAL MOTORS COMPANY

17. Remove **EN-50656** timing chain holding tool (1).
18. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
19. Install the high pressure fuel pump. Refer to **Fuel Pump Replacement** .

CAMSHAFT POSITION ACTUATOR AND CAMSHAFT REPLACEMENT - EXHAUST

Special Tools

- **EN-50656** Holding Tool
- **EN 50793** Locking Tool

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

Removal Procedure

NOTE: Ensure the engine is properly timed to Top Dead Center (TDC), prior to performing repairs.

1. Remove the camshaft cover. Refer to Camshaft Cover Replacement.

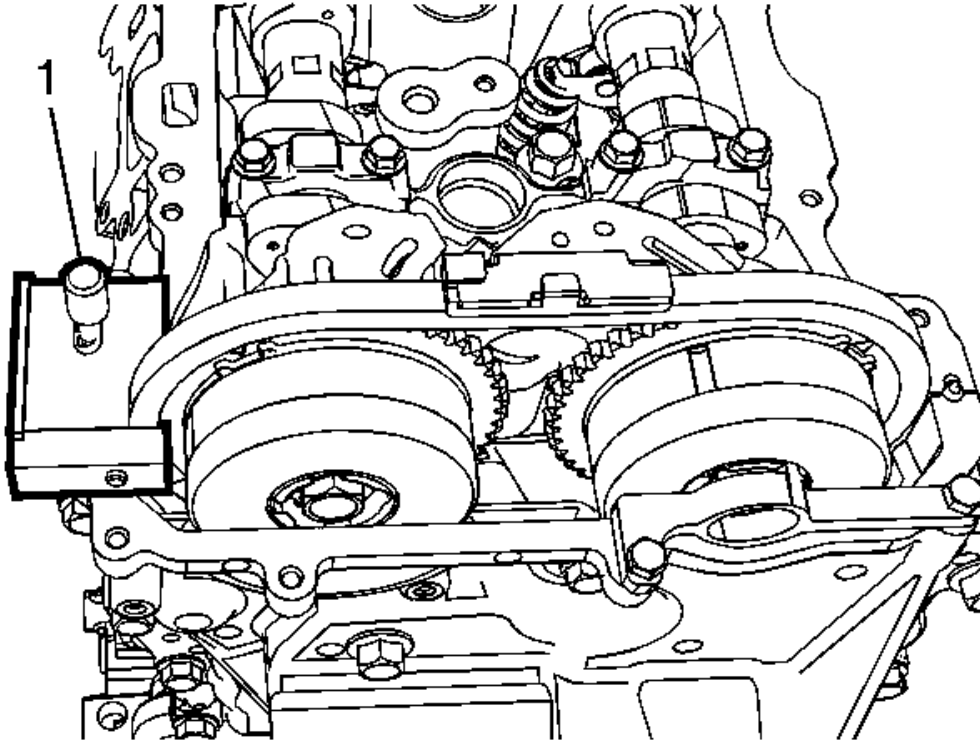


Fig. 135: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the EN-50656 Holding tool is installed and securely tightened to prevent the camshaft chain from dropping into the front engine cover during camshaft actuator replacement.

2. Install **EN-50656** timing chain holding tool (1) and tighten to 8 (71 lb in).

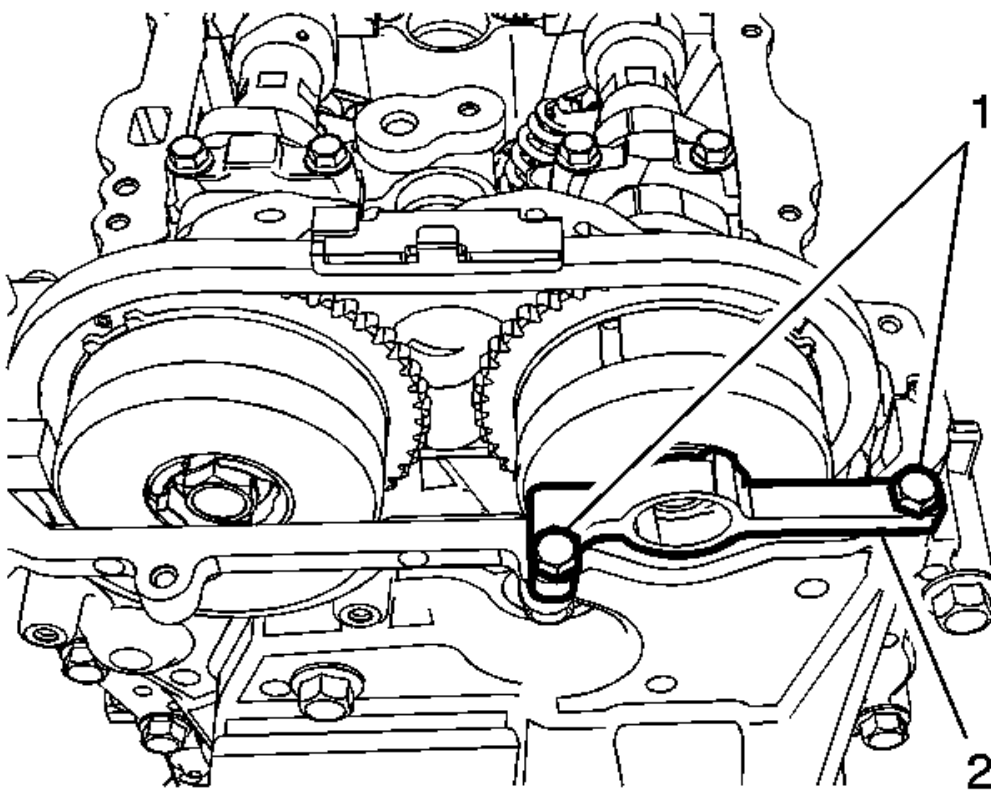


Fig. 136: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: **Ensure to mark actuator sprocket and chain before removal.**

3. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the exhaust camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

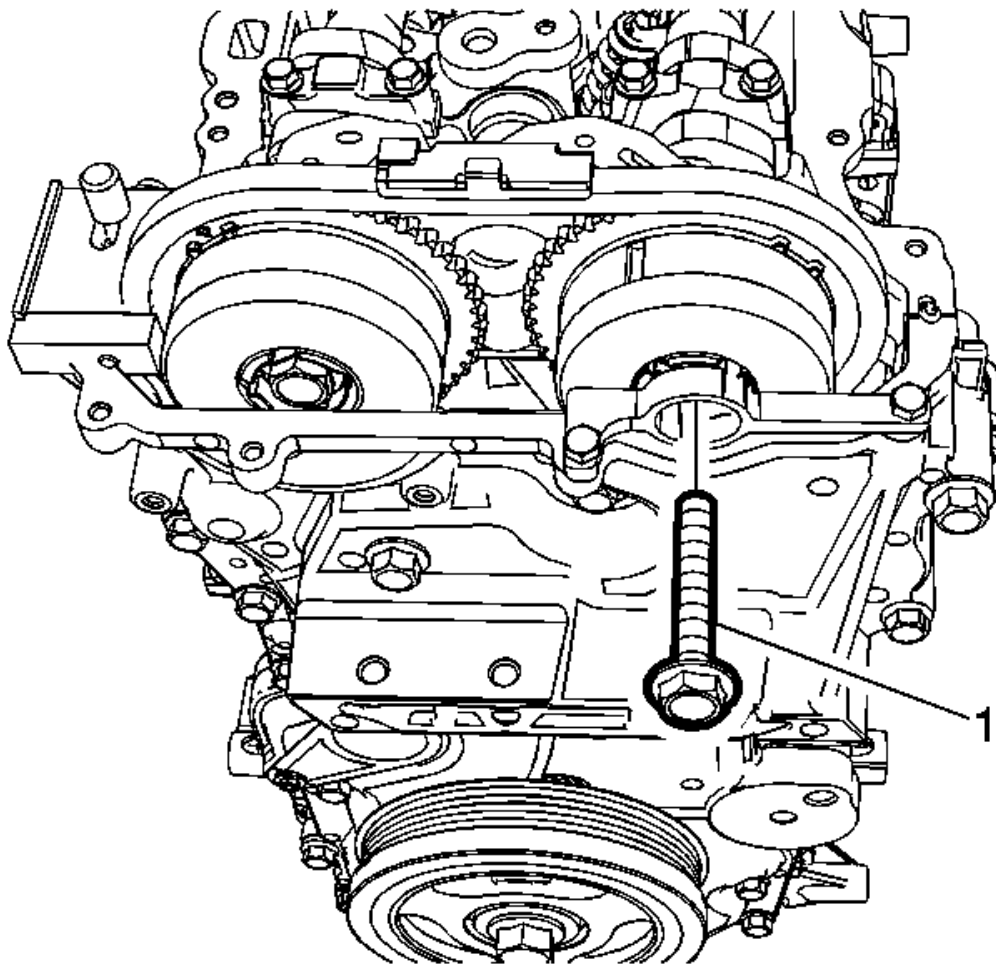


Fig. 137: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD the camshaft actuator bolt (1).

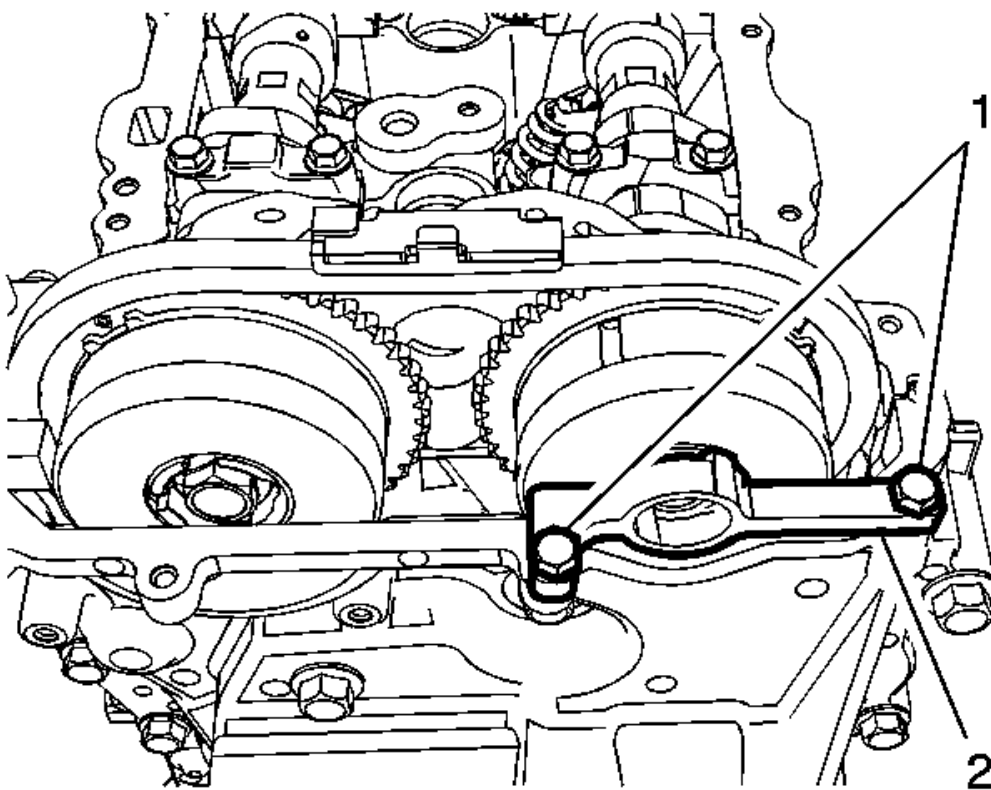


Fig. 138: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN-50793** holding tool (2).

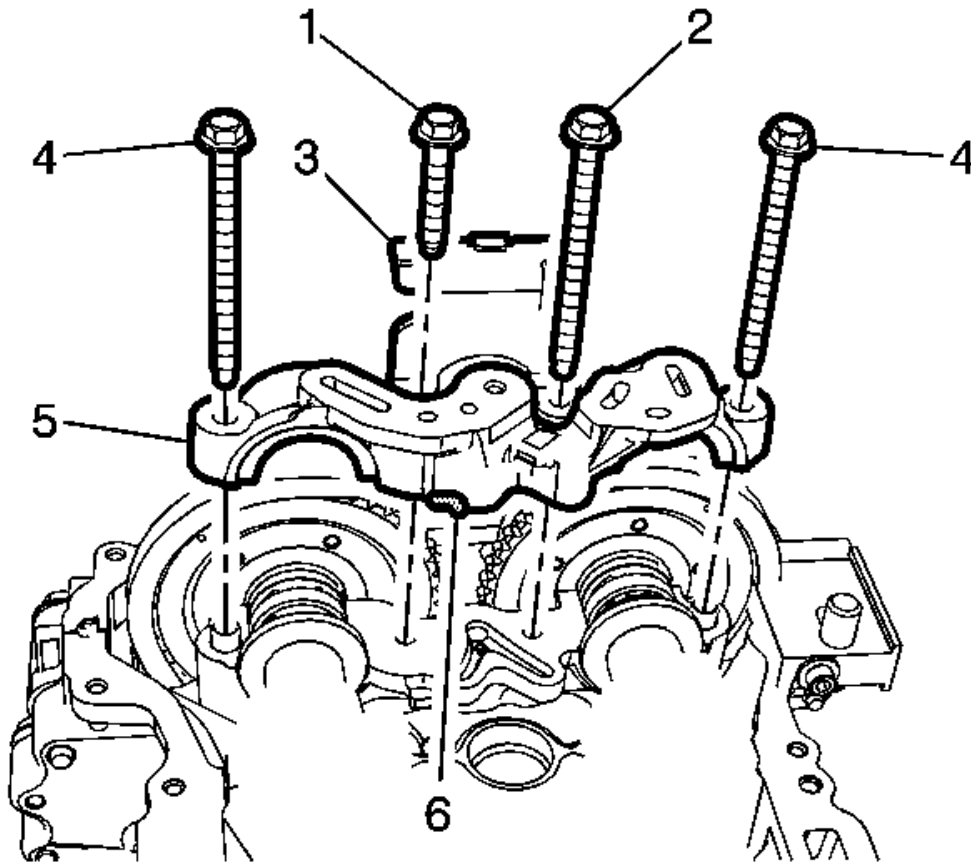


Fig. 139: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the upper timing chain guide bolts (1, 2).
7. Remove the upper timing chain guide (3).
8. Remove the camshaft front bearing cap bolts (4).

NOTE: Locate the pry points (6) in the camshaft front bearing cap. When using the 3 pry points to remove the front bearing cap evenly, use a protective material between the camshaft lobes, the cylinder head flange, and pry tool.

9. Remove the camshaft front bearing cap (5).

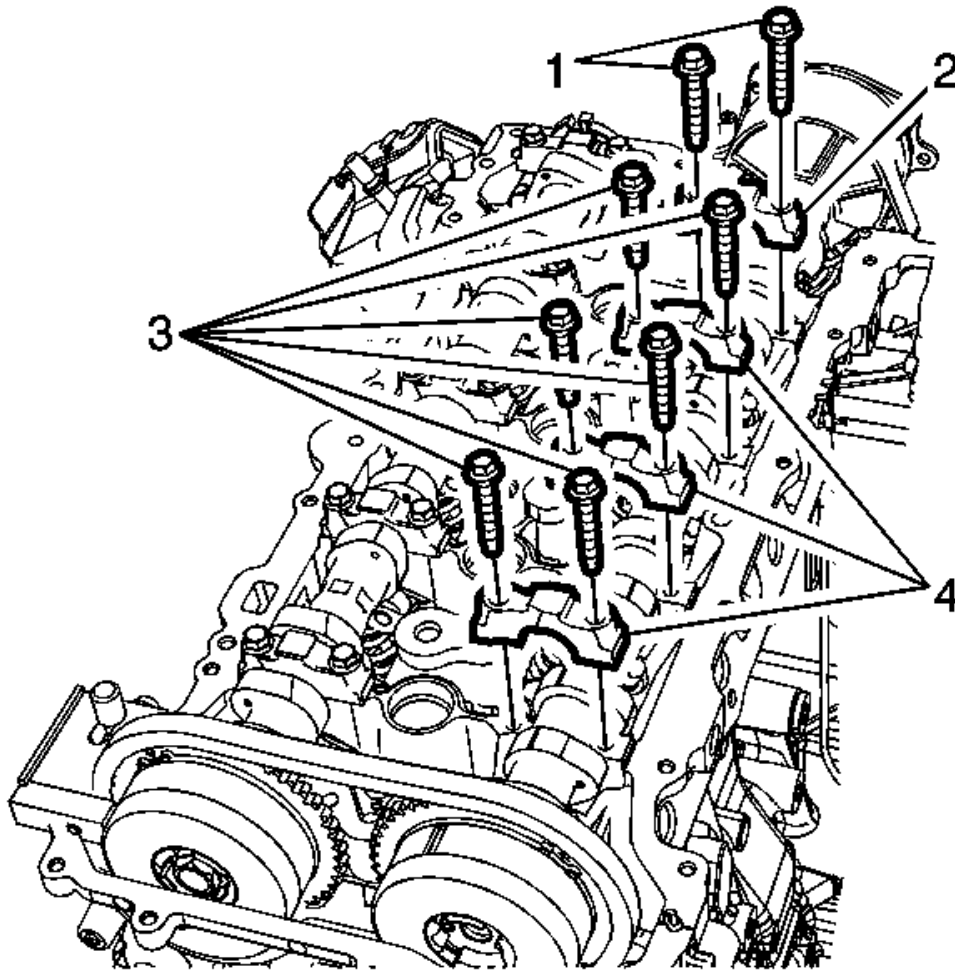


Fig. 140: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

10. Mark the exhaust camshaft rear cap to ensure it is installed in the same position. Remove the exhaust camshaft bearing rear cap bolts (1) and cap (2).

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

11. Mark the camshaft caps (4) to ensure they are installed in the same position.
12. Remove the exhaust camshaft cap bolts (3).
13. Remove the camshaft caps (4).

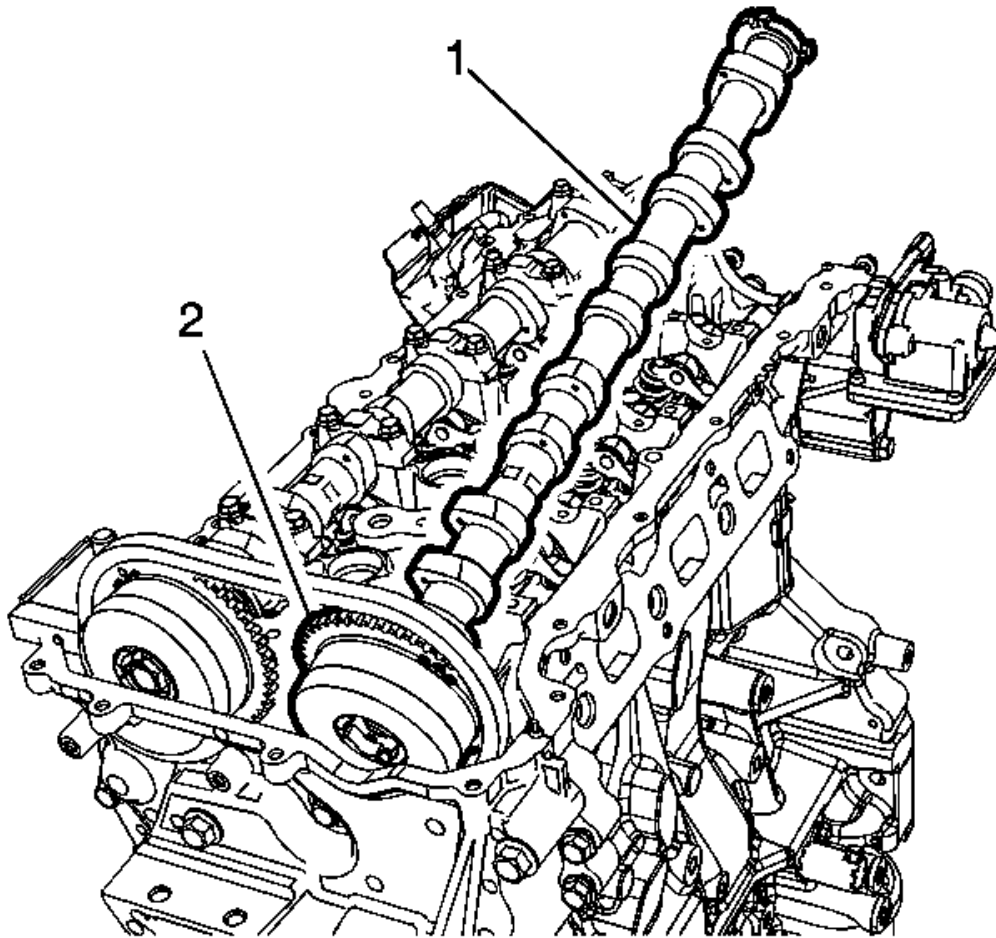


Fig. 141: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

14. Pull exhaust camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of exhaust camshaft assembly to a tilt and pull free from exhaust camshaft actuator assembly (2).

NOTE: If replacing the camshaft, ensure to transfer any marking from the old camshaft to the new one.

15. Replace the camshaft if necessary.

Installation Procedure

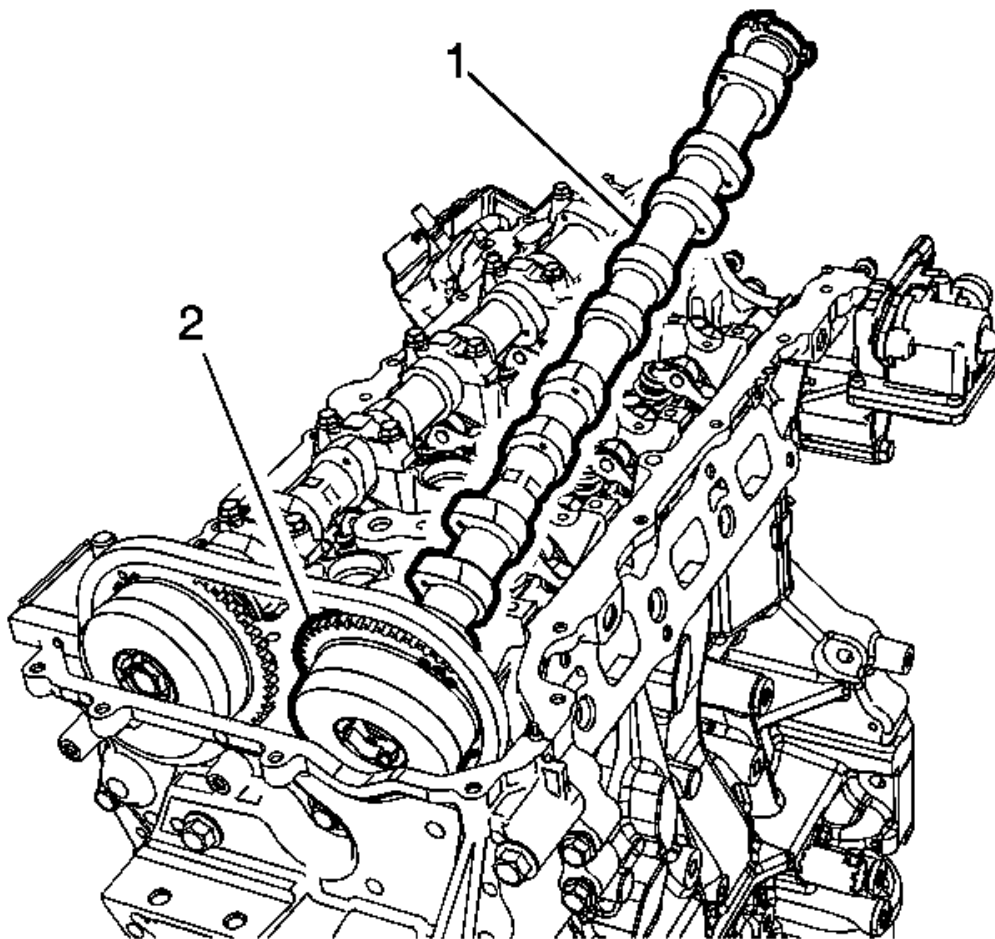


Fig. 142: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Install the exhaust camshaft (1) and camshaft actuator (2).

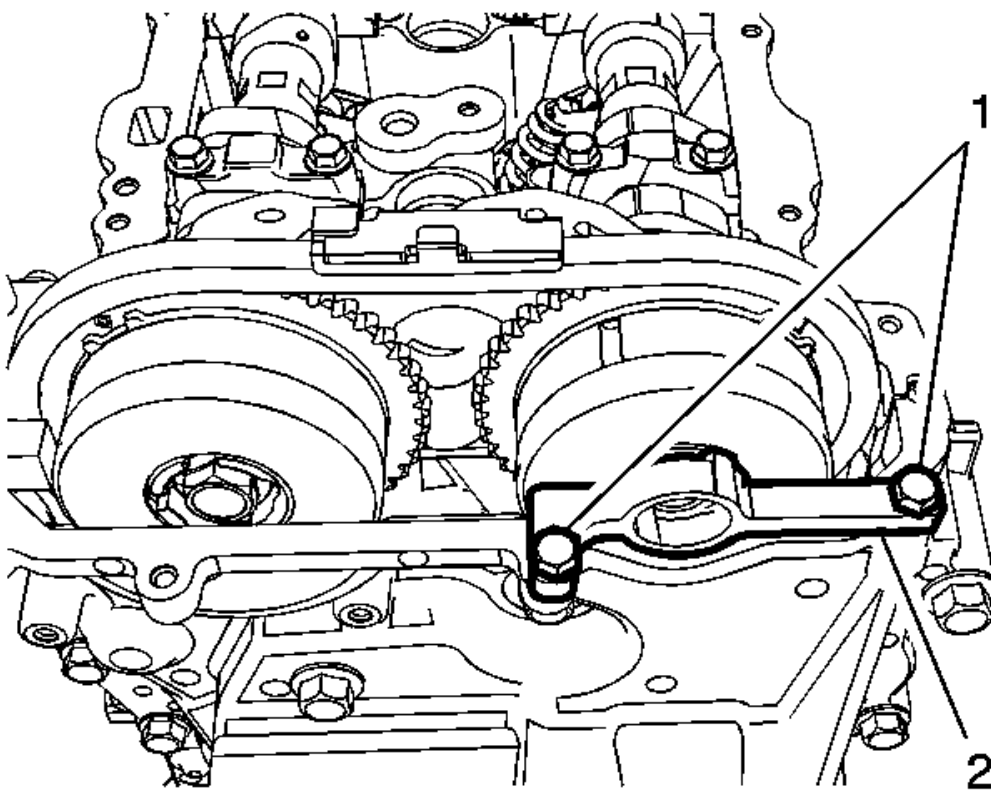


Fig. 143: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

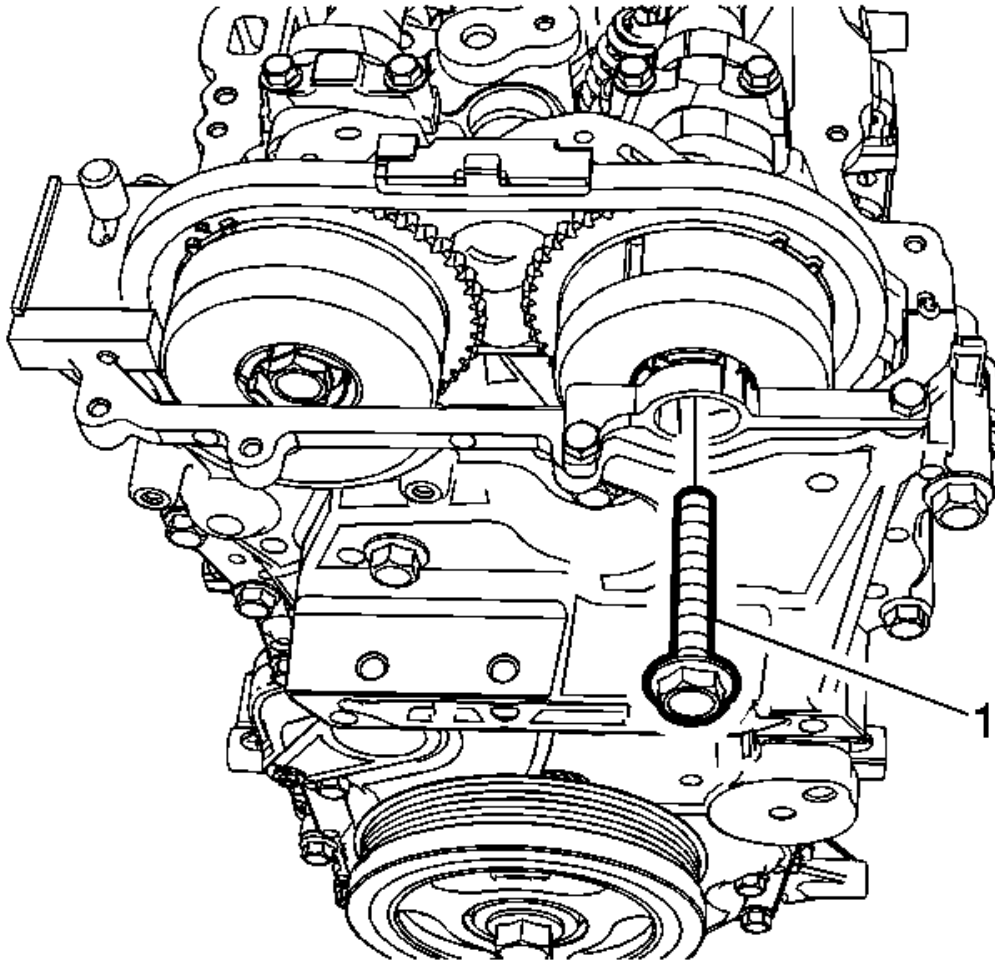


Fig. 144: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW camshaft actuator bolt (1) and tighten to 30 (22 lb ft) plus 100 degrees.

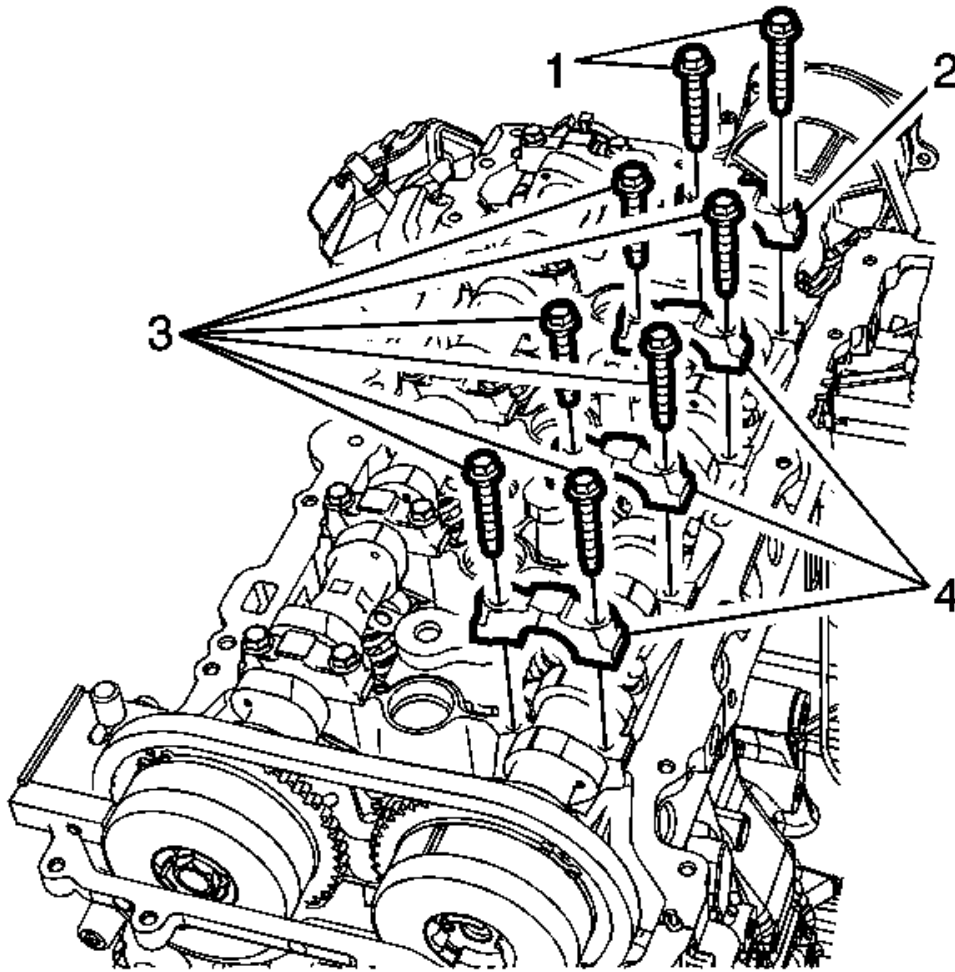


Fig. 145: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

4. Set the exhaust camshaft on top of the roller followers in the camshaft bearing journals with the exhaust actuator timing mark at approximately the one O'clock position.

NOTE: To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

5. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
6. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

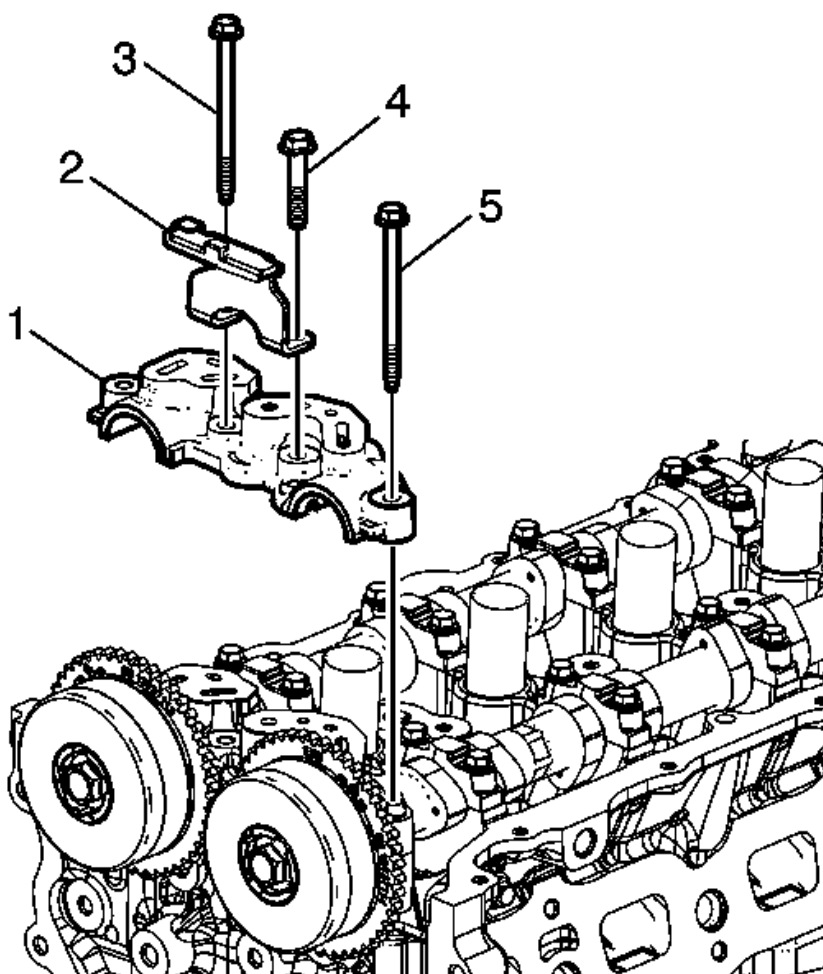


Fig. 146: Front Camshaft Bearing Cap

Courtesy of GENERAL MOTORS COMPANY

7. Install the front camshaft bearing cap (1). Install the timing chain guide (2) onto the front camshaft bearing cap, then hand start the camshaft cap bolts (3-5).

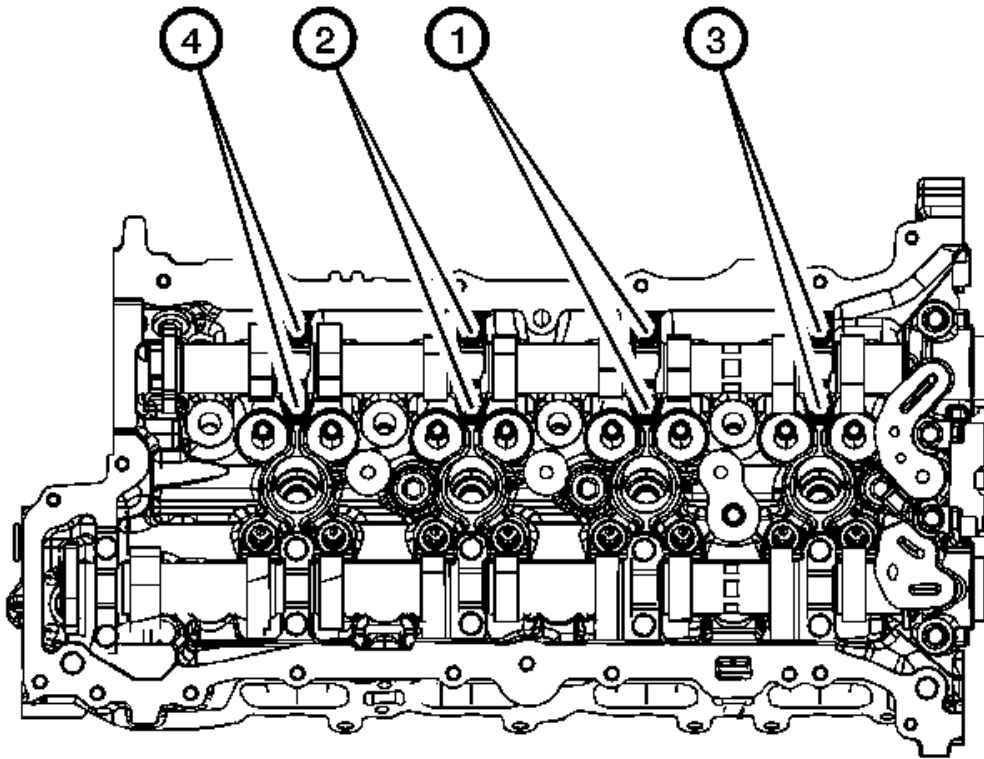


Fig. 147: Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: During the tightening sequence, locate and tighten each camshaft cap bolt installed into the circular hole first. Then, tighten the bolt installed into the slotted hole.

8. Install the camshaft cap bolts in sequence using the following procedure:
 1. Tighten the camshaft cap bolts in sequence to 8 (71 lb in).
 2. Loosen both bolts in each cap in sequence to 180 degrees.
 3. Tighten the camshaft cap bolts in sequence to 10 (89 lb in) twice.

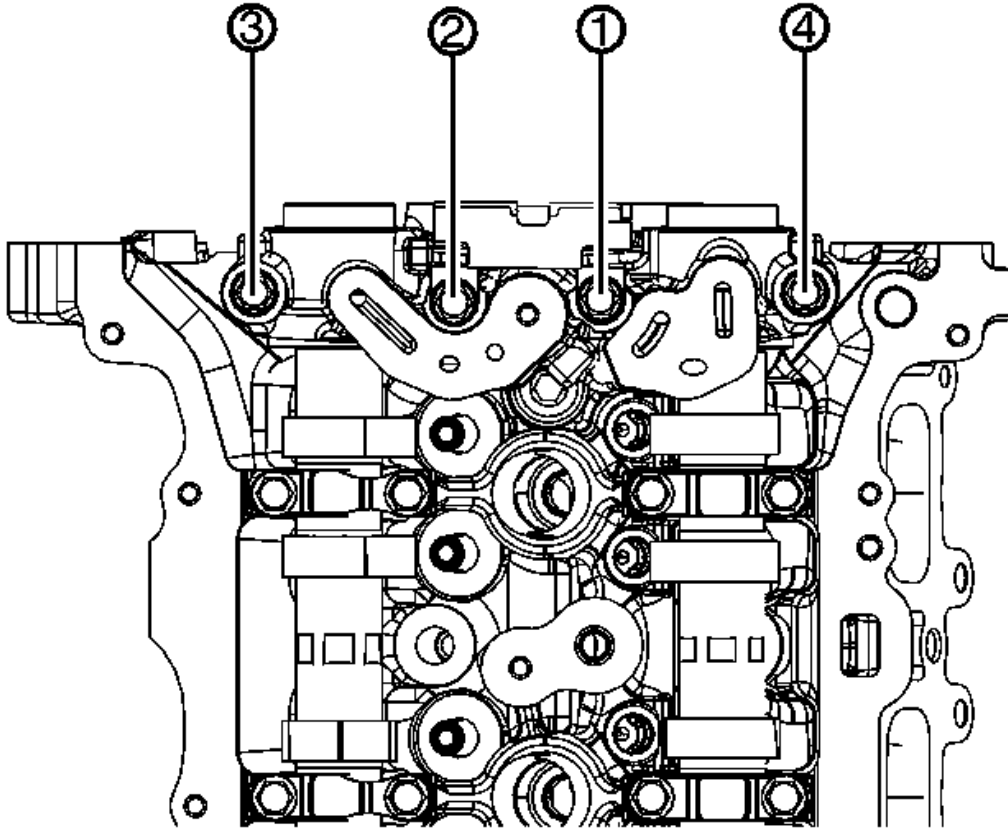


Fig. 148: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

9. Tighten the front camshaft cap bolts in sequence to 10 (89 lb in) twice.

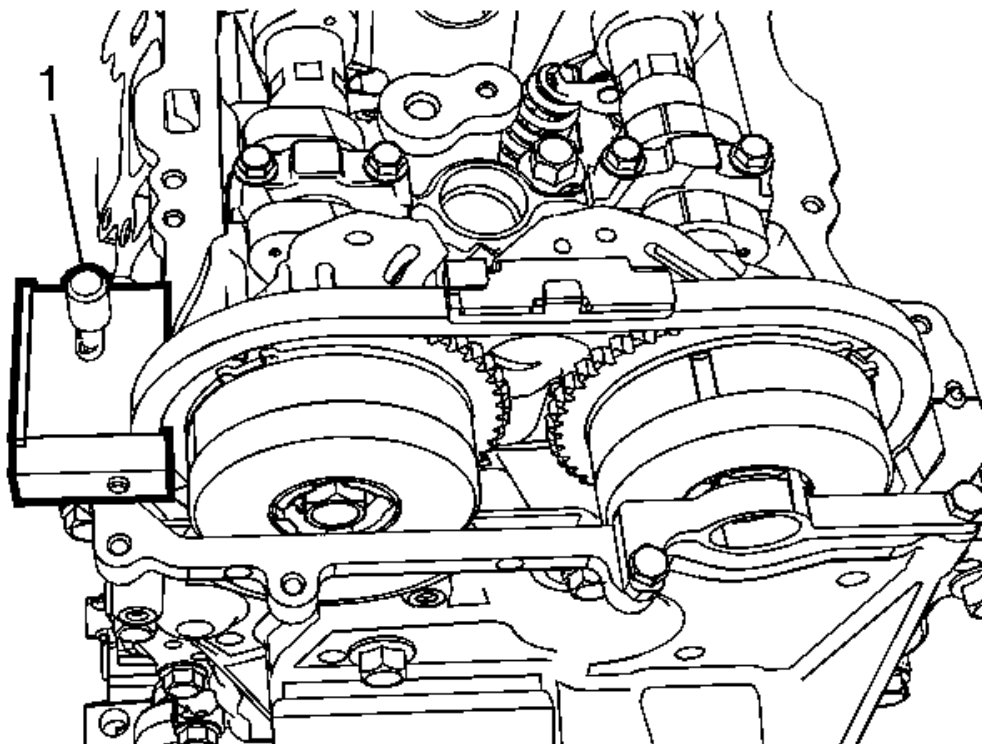


Fig. 149: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

10. Remove **EN-50656** timing chain holding tool (1).
11. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.

CAMSHAFT COVER HEAT SHIELD REPLACEMENT

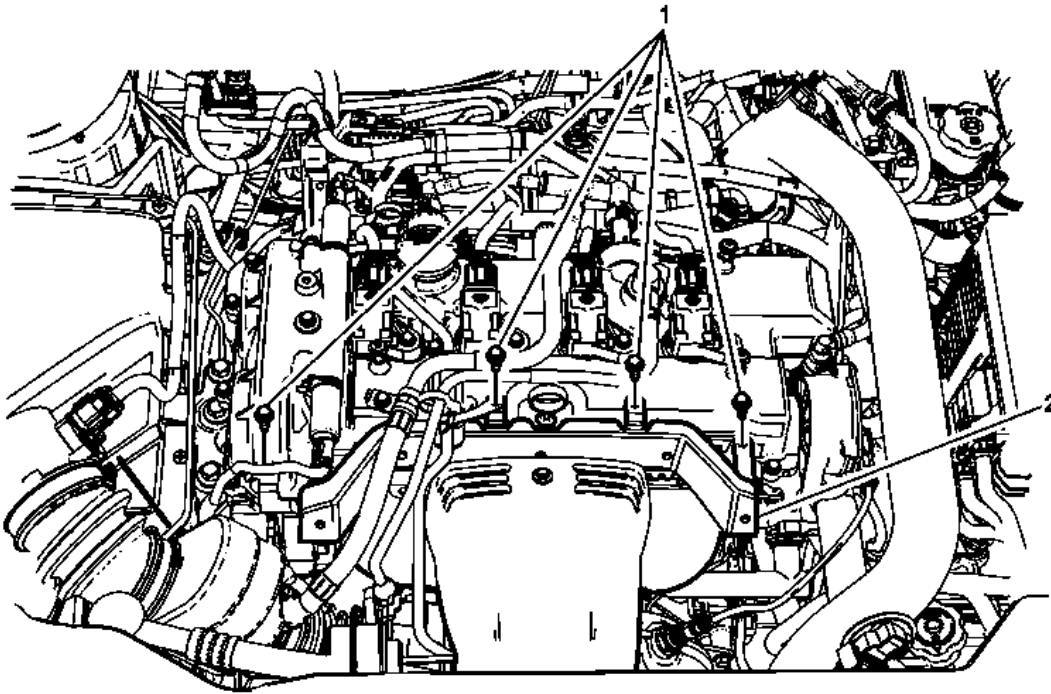


Fig. 150: Camshaft Cover Heat Shield
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Heat Shield Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Camshaft Heat Shield Cover Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Camshaft Heat Shield Cover

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Special Tools

- EN-36017 Valve Guide Seal Remover
- EN-43649 Valve Spring Compressor
- EN-43649-10 Valve Spring Compressor Adaptor Set

- **EN-46106** Flywheel Holder

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

Removal Procedure

NOTE: Prevent the crankshaft from rotating clockwise or counterclockwise before using compressed air in the cylinder. Rotation of the crankshaft may cause damage to EN-46106 flywheel holding.

1. If equipped with a manual transmission, leave the transmission in first gear with the vehicle on the ground and the parking brake set.
2. If equipped with an automatic transmission, remove the starter. Refer to **Starter Replacement (LTG)** .
3. Install EN-46106 flywheel holding.
4. Remove the camshaft. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake**, or **Camshaft Position Actuator and Camshaft Replacement - Exhaust**.

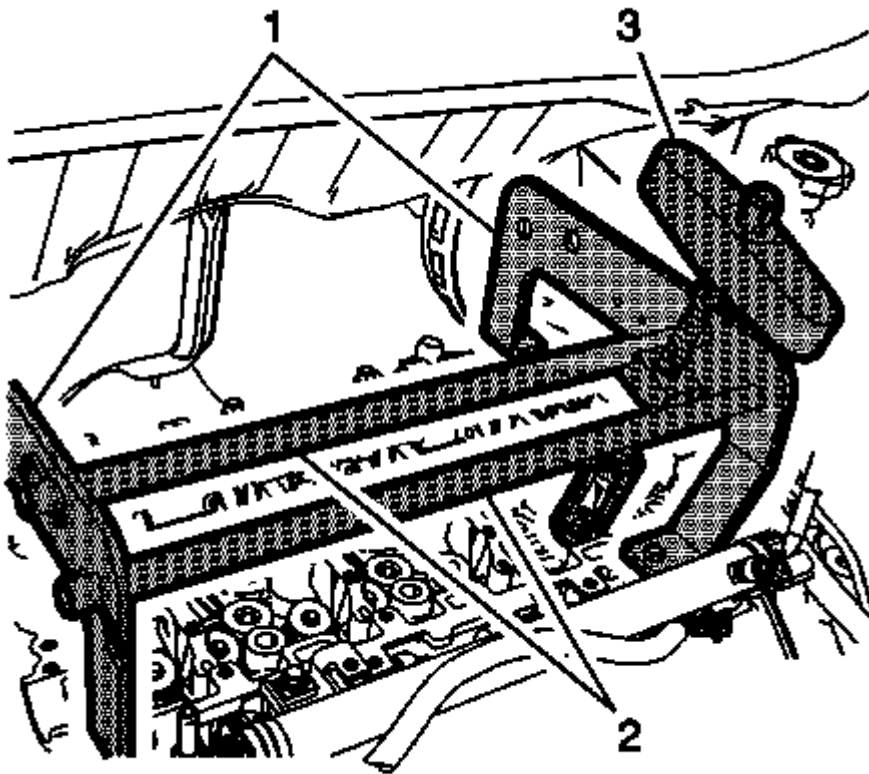


Fig. 151: View Of Valve Spring Compressor Adaptor Set
Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-43649-10** adaptor set (1) to the front and rear of the cylinder head.

6. Install the cross bars and locks (2) of the **EN-43649** compressor to the valve spring compressor adaptors.
7. Remove the spark plugs. Refer to **Spark Plug Replacement** .
8. Install an air hose adapter into the spark plug hole.
9. Attach an air hose to the adapter and pressurize the cylinder to 690 kPa (100 psi).
10. Compress the valve spring using the valve spring compressor (3).

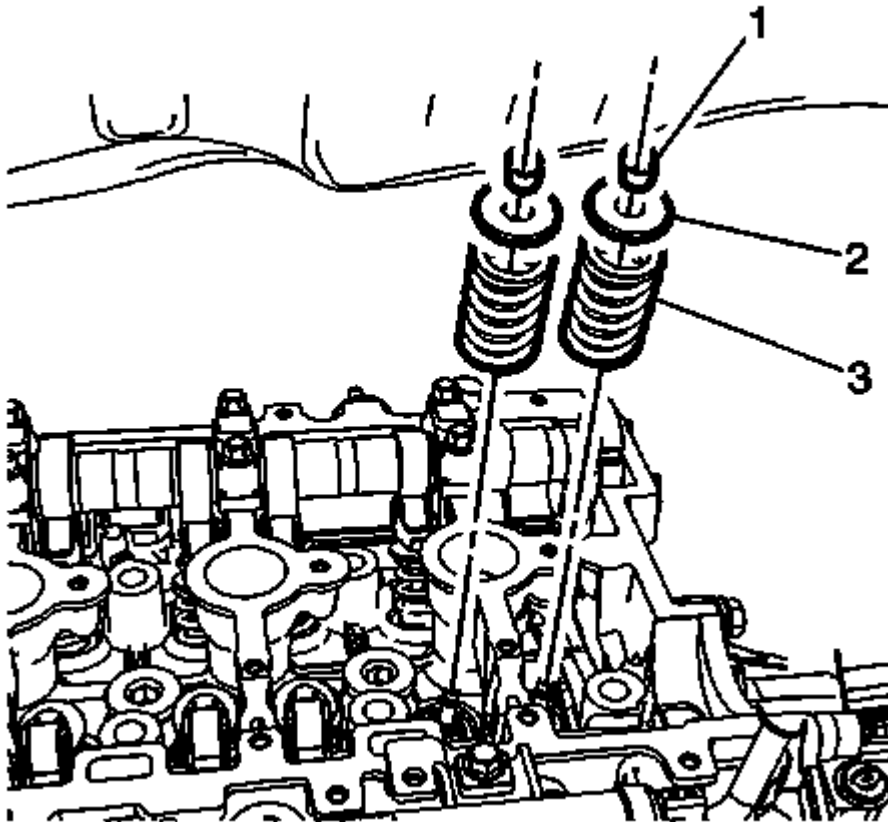


Fig. 152: View Of Valve Spring, Keepers & Retainer
Courtesy of GENERAL MOTORS COMPANY

11. Remove the valve spring keepers (1).
12. Remove the valve spring (3) and retainer (2).

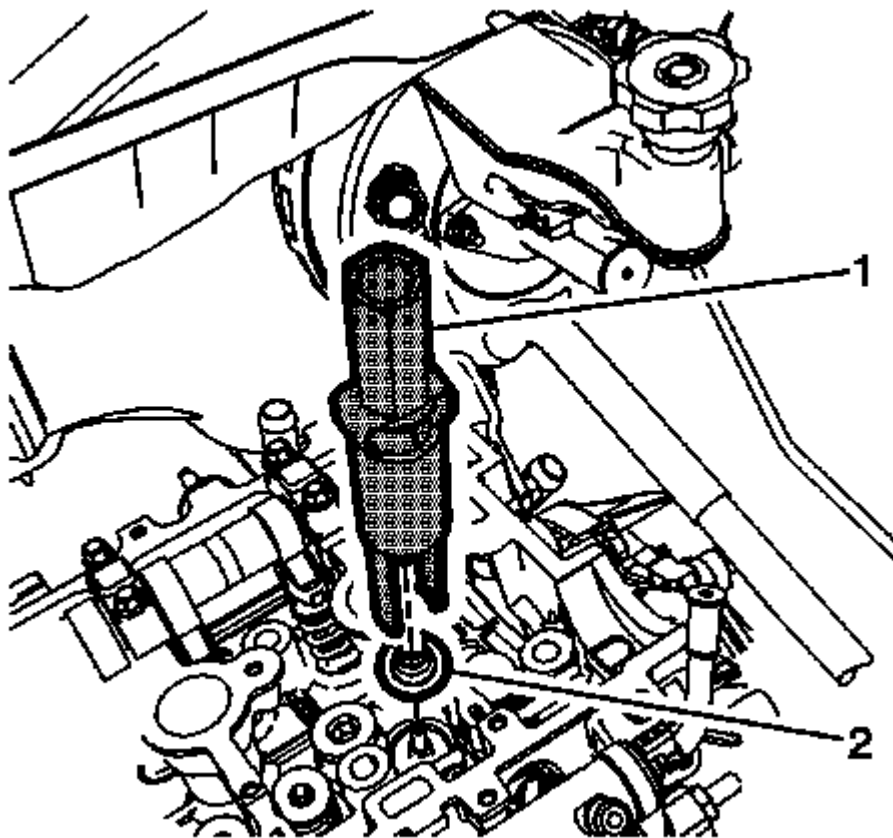


Fig. 153: View Of Valve Guide Seal Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

13. Use the **EN-36017** seal remover (1) to remove the valve seal.

Installation Procedure

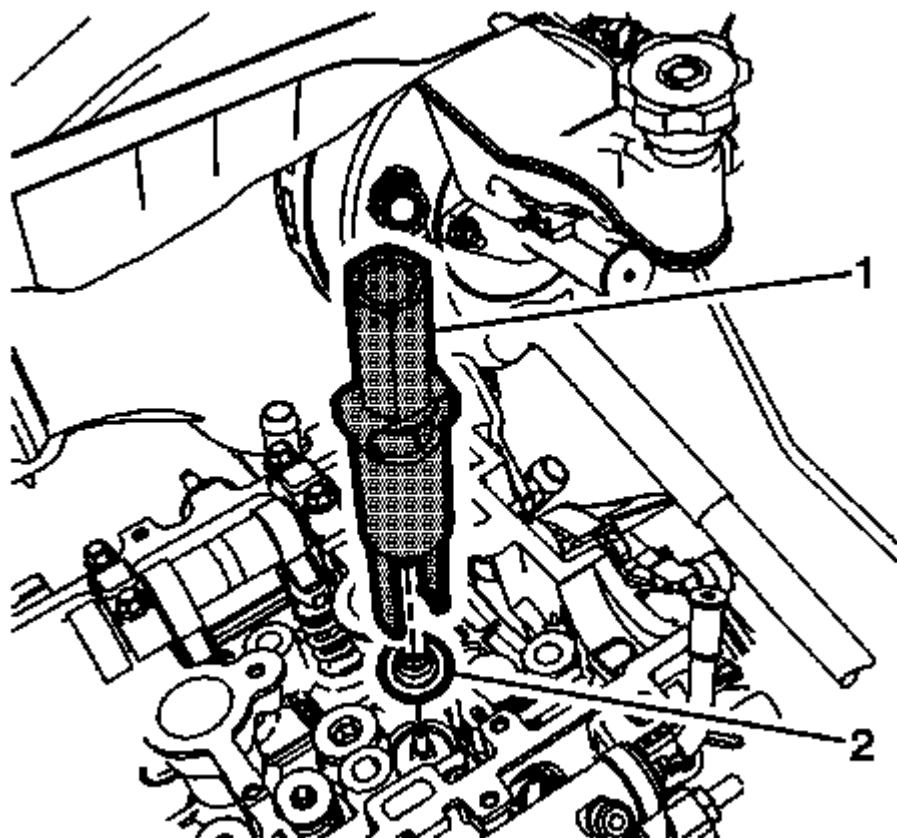


Fig. 154: View Of Valve Guide Seal Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

1. Using the **EN-36017** seal remover (1) install the NEW valve seal. Fully seat the seal onto the valve guide.

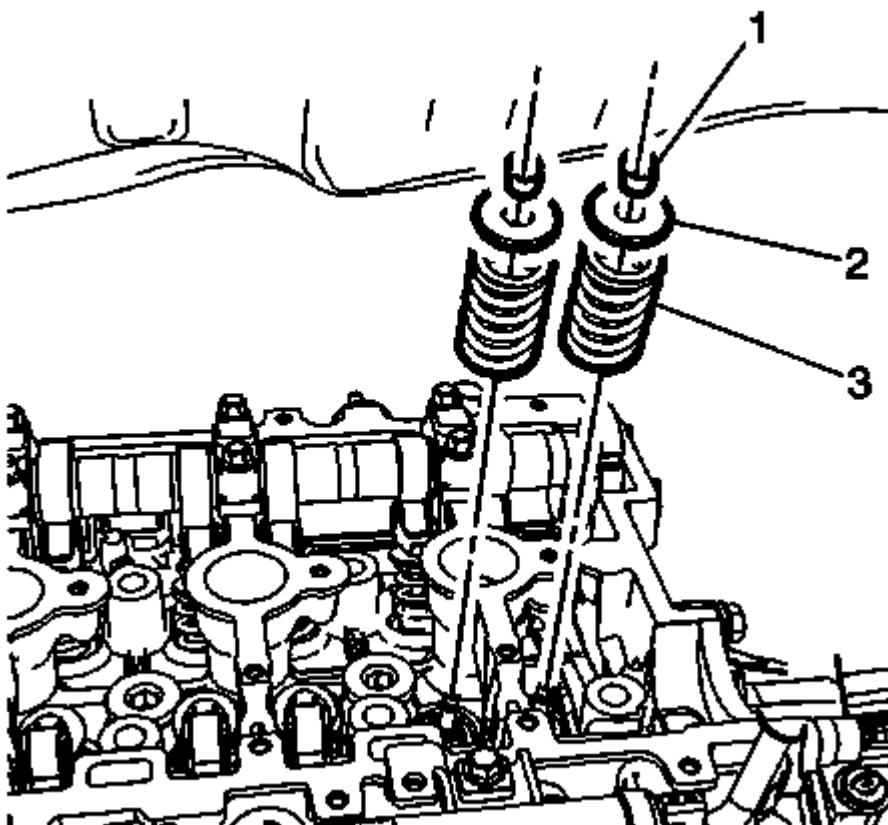


Fig. 155: View Of Valve Spring, Keepers & Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Install the valve spring (3) and retainer (2).
3. Compress the valve spring using the valve spring compressor.
4. Install the valve spring keepers (1).
5. Disconnect the air hose and air hose adapter.

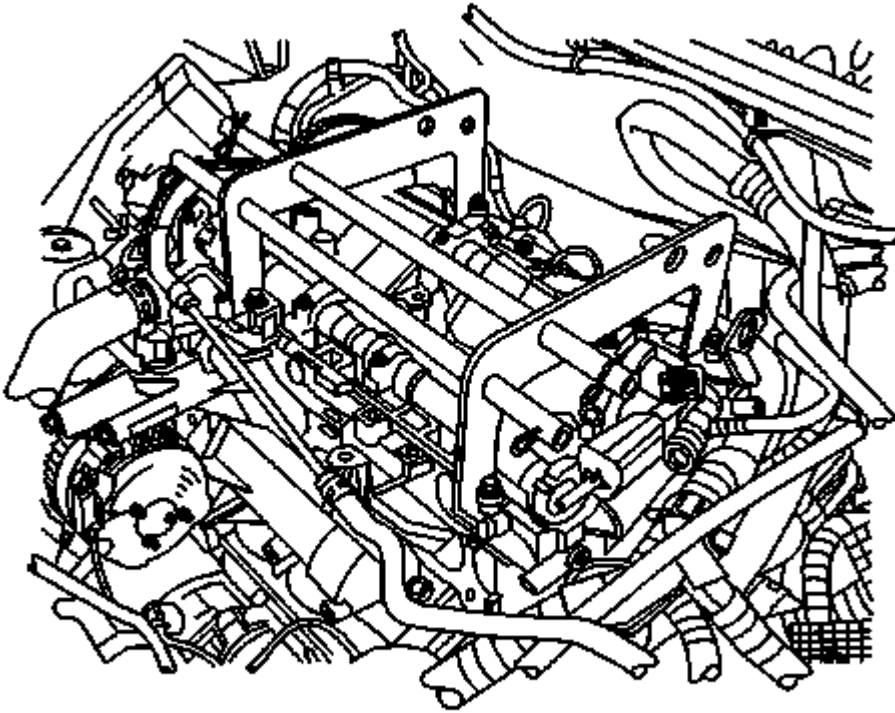


Fig. 156: Cylinder Head Valve Spring Compressor
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-43649** compressor and **EN-43649-10** adaptor set from the cylinder head.
7. Install the spark plugs. Refer to **Spark Plug Replacement** .
8. Install the camshaft. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake**, or **Camshaft Position Actuator and Camshaft Replacement - Exhaust**.
9. Remove the **EN-46106** flywheel holding.
10. If equipped with an automatic transmission, install the starter. Refer to **Spark Plug Replacement** .

CYLINDER HEAD REPLACEMENT

Removal Procedure

Special Tools

- **EN 38188** Cylinder Head Broken Bolt Extractor Kit
- **EN 45059** Angle Meter

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

1. Drain the coolant system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .
2. Drain the engine oil. Refer to Engine Oil and Oil Filter Replacement.
3. Remove the camshaft cover. Refer to Camshaft Cover Replacement.
4. Remove the intake manifold. Refer to Intake Manifold Replacement.
5. Remove the exhaust manifold. Refer to Exhaust Manifold Replacement (LTG) .
6. Remove the engine front cover. Refer to Engine Front Cover Replacement.
7. Remove the camshaft position actuator and camshaft - Intake. Refer to Camshaft Position Actuator and Camshaft Replacement - Intake.

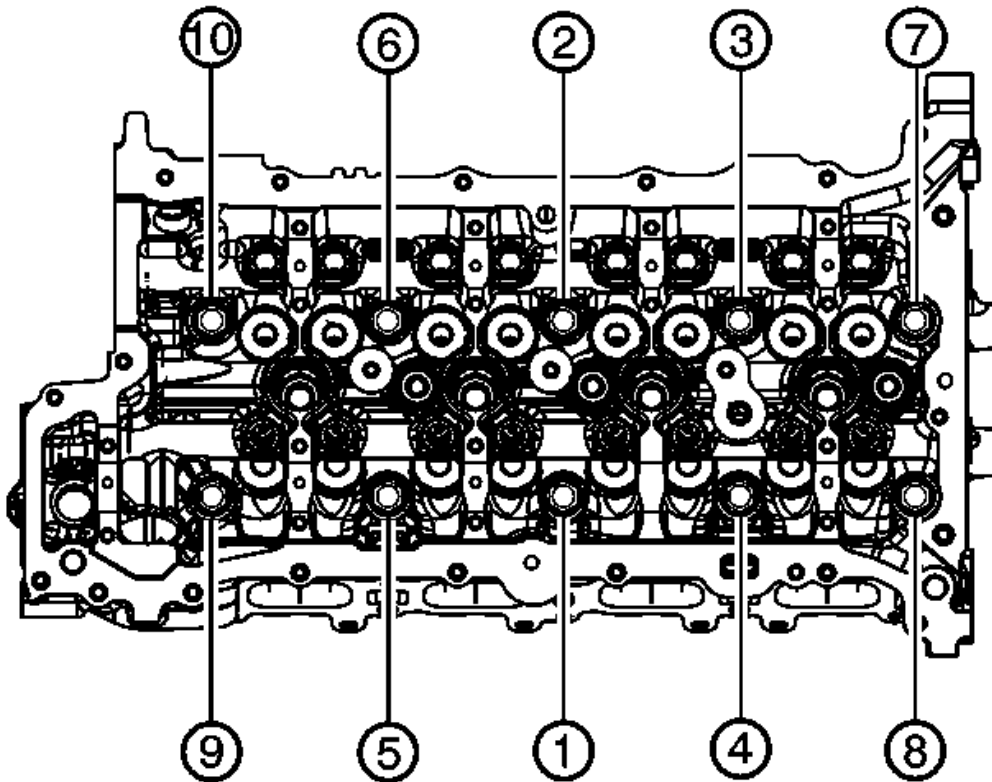


Fig. 157: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

8. Remove the cylinder head to the block bolts in sequence.

Discard the bolts.

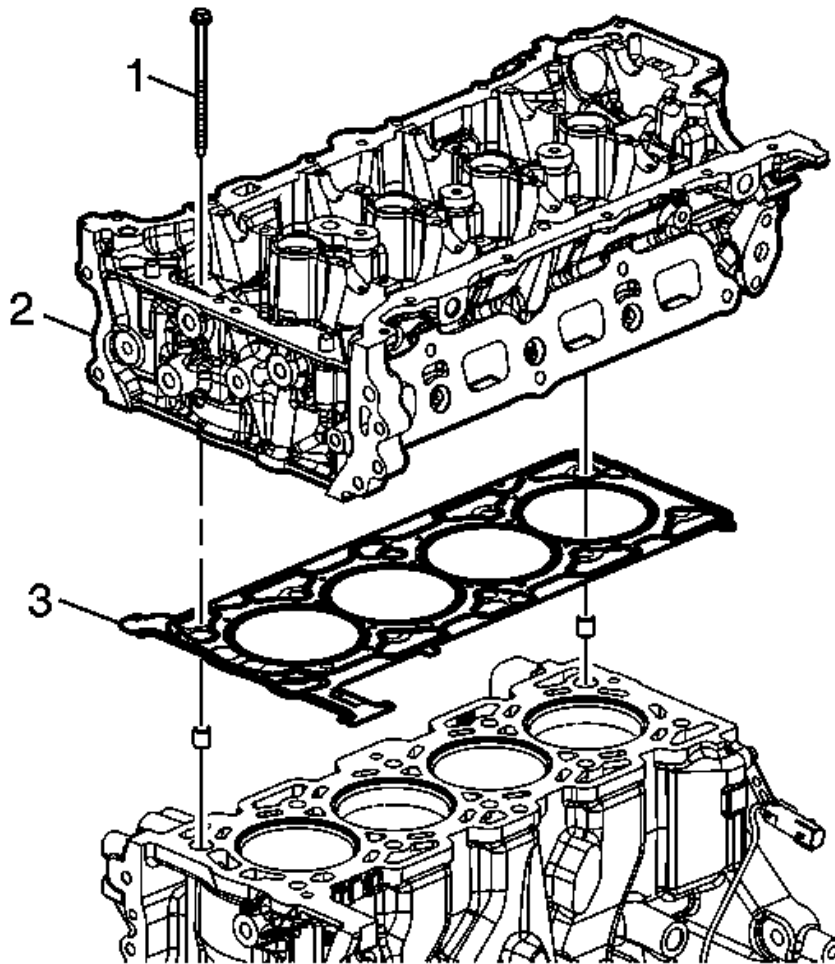


Fig. 158: Cylinder Head Gasket

Courtesy of GENERAL MOTORS COMPANY

CAUTION: In order to prevent damage to the valves and injectors during cylinder head removal, set the cylinder head on blocks.

9. Remove the cylinder head (2).
10. Remove the cylinder head gasket (3).
11. Clean all of the gasket surfaces.
12. Use the following procedures when cleaning the cylinder head and cylinder block surfaces:
 - Use a gasket scraper to clean the cylinder head and cylinder block gasket surfaces. Do not scratch or gouge any surface.

NOTE: Do not use any other method or technique to clean these gasket surfaces.

NOTE: Be careful not to gouge or scratch the gasket surfaces. Do not gouge

or scrape the combustion chamber surfaces. The feel of the gasket surface is important, not the appearance. There will be indentations from the gasket left in the cylinder head after all of the gasket material is removed. These small indentations will be filled in by the new gasket.

•

NOTE: Do not use a tap to clean the cylinder head bolt holes.

13. Clean the old sealer/lube and dirt from the bolt holes.
14. Clean the bolt holes with a nylon bristle brush.

WARNING: Wear safety glasses to avoid injury when using compressed air or any cleaning solvent. Bodily injury may occur if fumes are inhaled or if skin is exposed to chemicals.

15. When cleaning the cylinder head bolt holes use a suitable commercial spray liquid solvent and compressed air from an extended-tip blow gun to reach the bottom of the holes.
16. Remove any broken long cylinder head bolts using the **EN 38188** kit.
17. For cylinder head disassemble. Refer to **Cylinder Head Disassemble** .
18. For cylinder head cleaning and inspection. Refer to **Cylinder Head Cleaning and Inspection**

Installation Procedure

1. For cylinder head assemble. Refer to **Cylinder Head Assemble** .

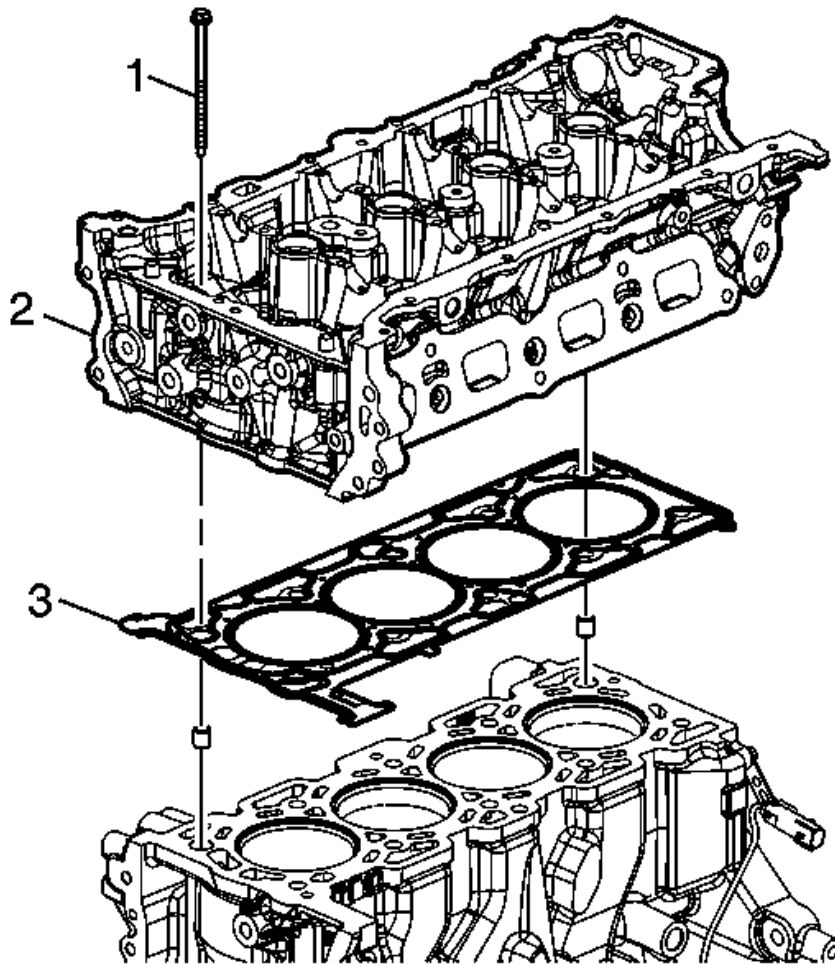


Fig. 159: Cylinder Head Gasket

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use any sealing material.

2. Install the cylinder head gasket (3) to the block.
3. Install the cylinder head (2). Ensure the number 1 cylinder is at top dead center (TDC). The key on the crankshaft should be on top in the 12 o'clock position.

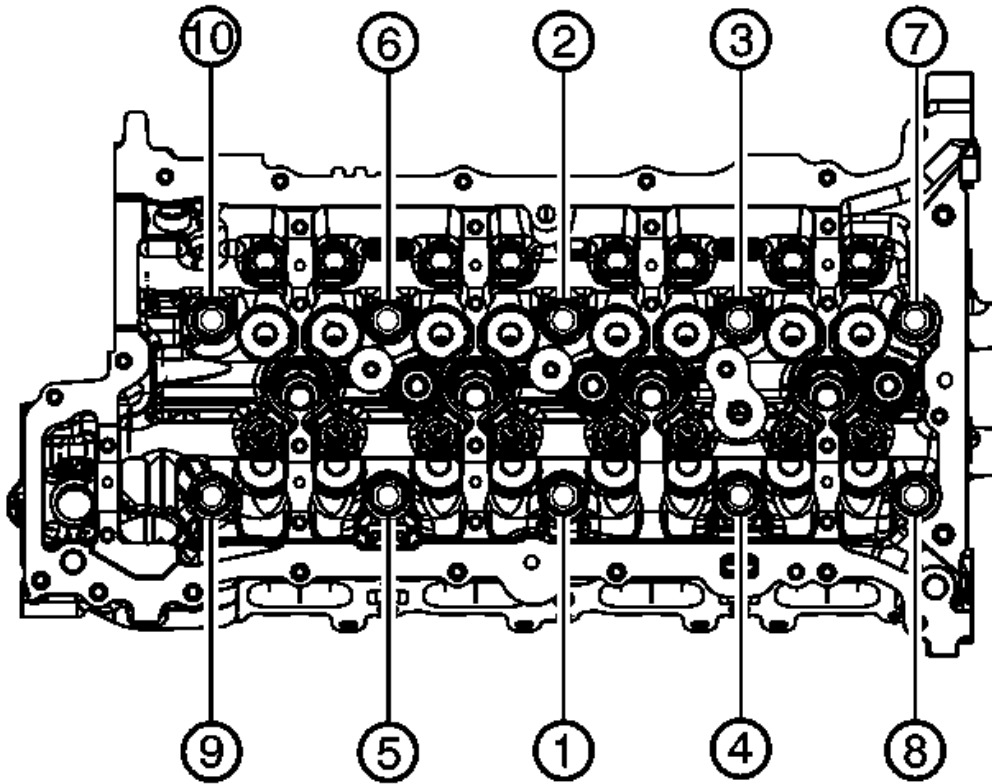


Fig. 160: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Always use NEW cylinder head bolts.

4. Install the cylinder head bolts.
 1. Tighten the bolts in sequence to 30 N.m (22 lb ft).
 2. Tighten the bolts an additional 190 degrees in sequence using the **EN 45059** meter.
5. Install the camshaft position actuator and camshaft - Intake. Refer to Camshaft Position Actuator and Camshaft Replacement - Intake.
6. Install the engine front cover. Refer to Engine Front Cover Replacement.
7. Install the exhaust manifold. Refer to Exhaust Manifold Replacement (LTG) .
8. Install the intake manifold. Refer to Intake Manifold Replacement.

9. Install the camshaft cover. Refer to Camshaft Cover Replacement.
10. Refill the engine with NEW oil. Refer to Engine Oil and Oil Filter Replacement.
11. Refill the coolant system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .

ENGINE OIL COOLER REPLACEMENT (AWD)

Removal Procedure

1. Remove the engine oil filter. Refer to Engine Oil and Oil Filter Replacement.

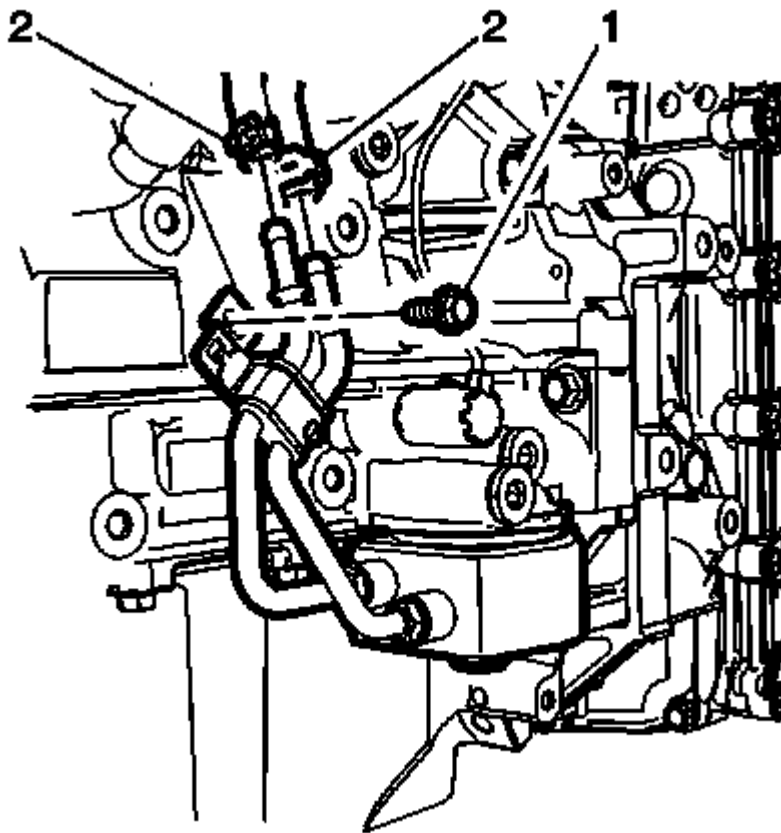


Fig. 161: Engine Oil Cooler Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil cooler fastener (1).
3. Remove the engine oil cooler hoses (2).

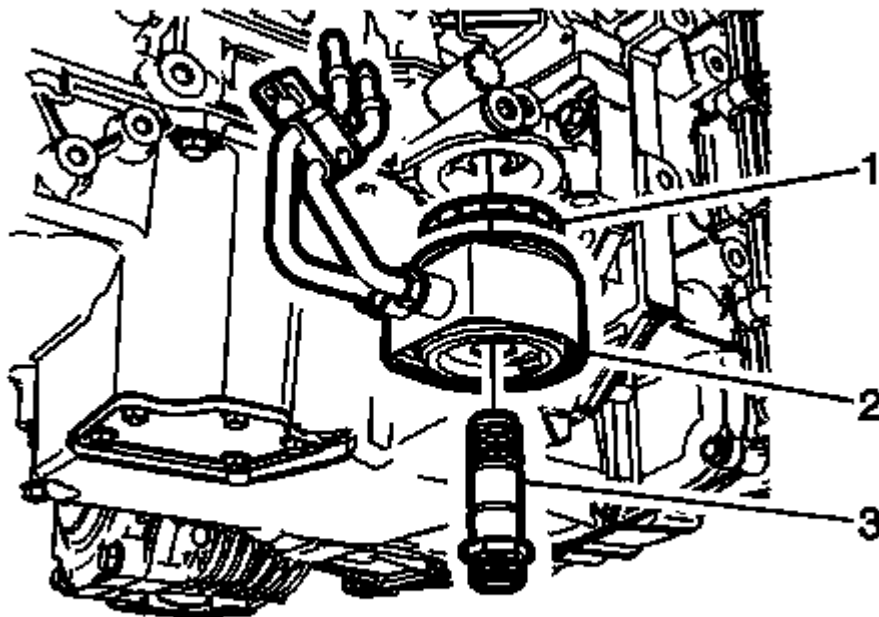


Fig. 162: Engine Oil Cooler Connector
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine oil cooler connector (3).

NOTE: **DISCARD** the old engine oil cooler seal (1).

5. Remove the engine oil cooler (2).

Installation Procedure

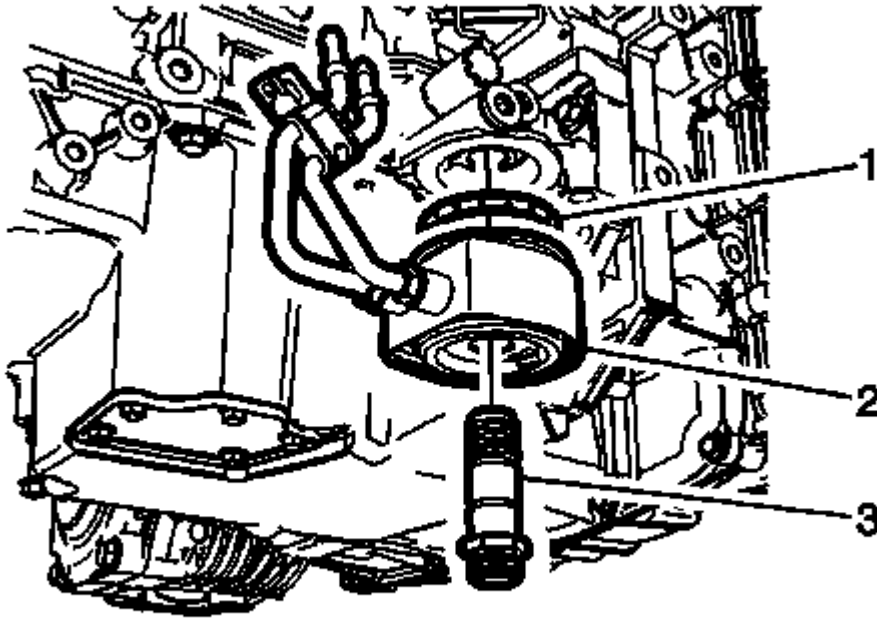


Fig. 163: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

NOTE: A NEW engine oil cooler seal must be used whenever reinstalling the engine oil cooler.

1. Install the engine oil cooler (2) with a NEW seal.

CAUTION: Refer to Component Fastener Tightening Caution .

2. Install the engine oil cooler connector (3) and tighten to 50 (37 lb ft).

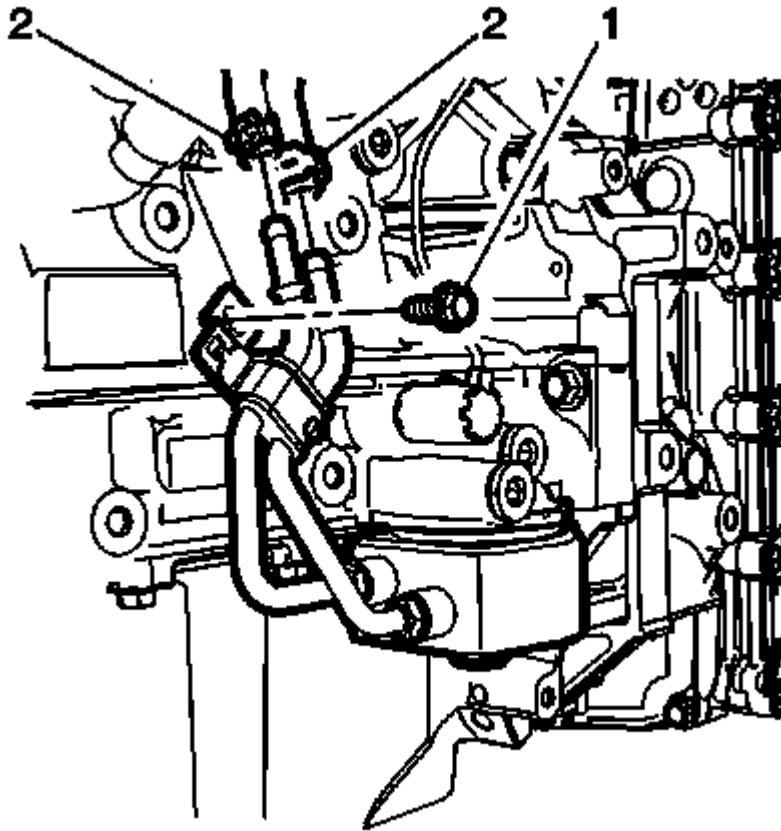


Fig. 164: Oil Cooler Hoses

Courtesy of GENERAL MOTORS COMPANY

3. Install the oil cooler hoses (2).

CAUTION: Refer to Fastener Caution .

4. Install the oil cooler fastener (1) and tighten to 10 (89 lb in)
5. Install the engine oil filter. Refer to Engine Oil and Oil Filter Replacement.

ENGINE OIL COOLER REPLACEMENT (FWD)

Removal Procedure

1. Remove the engine oil filter. Refer to Engine Oil and Oil Filter Replacement.

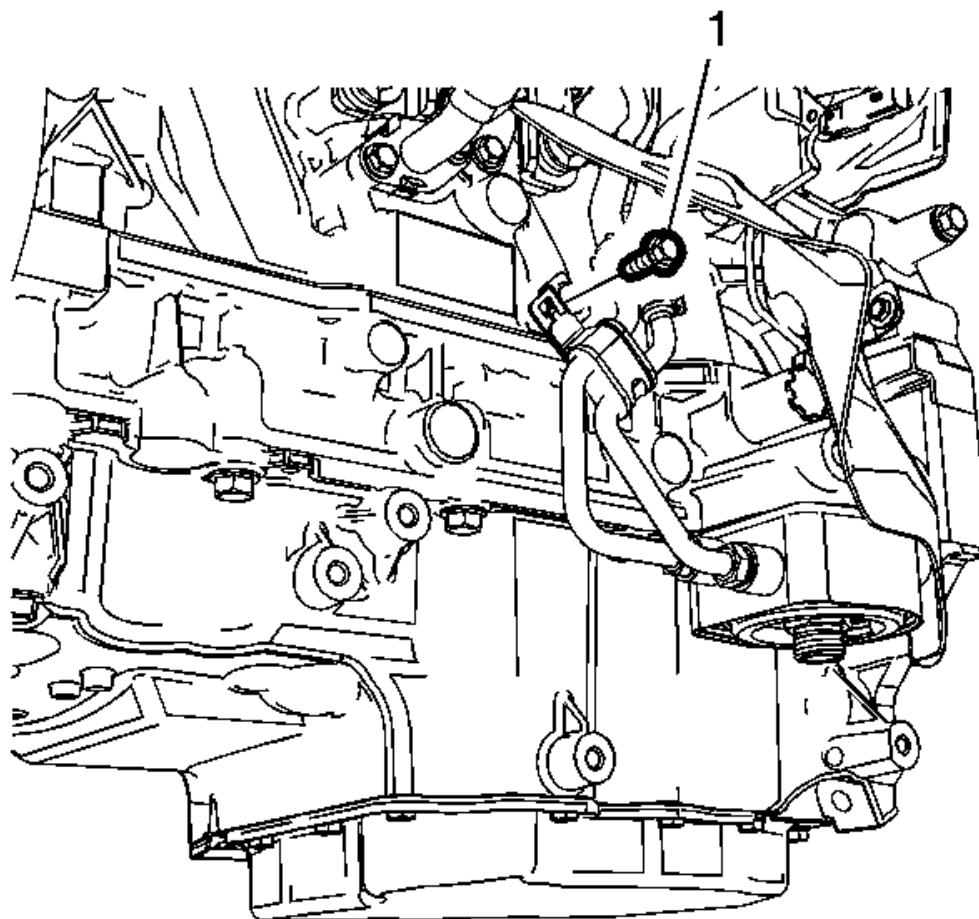


Fig. 165: Engine Oil Cooler Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil cooler fastener (1).

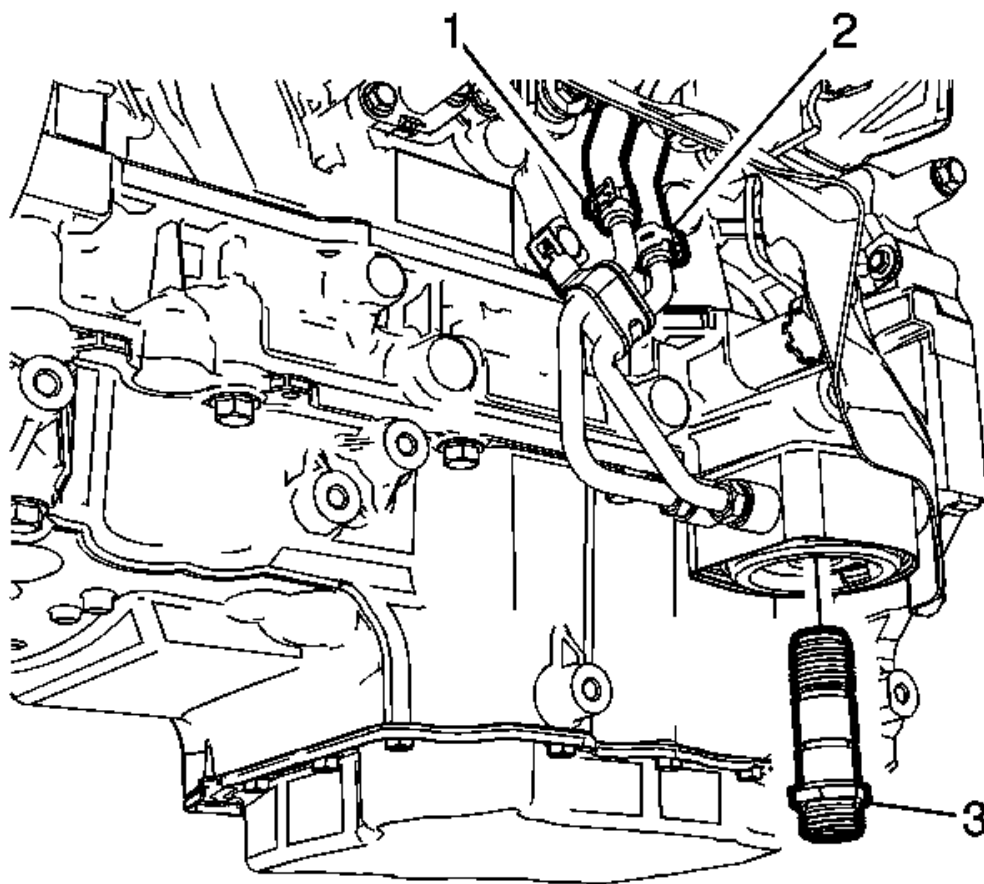


Fig. 166: Engine Oil Cooler Connector
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine oil cooler hose (1) and (2).
4. Remove the engine oil cooler connector (3).

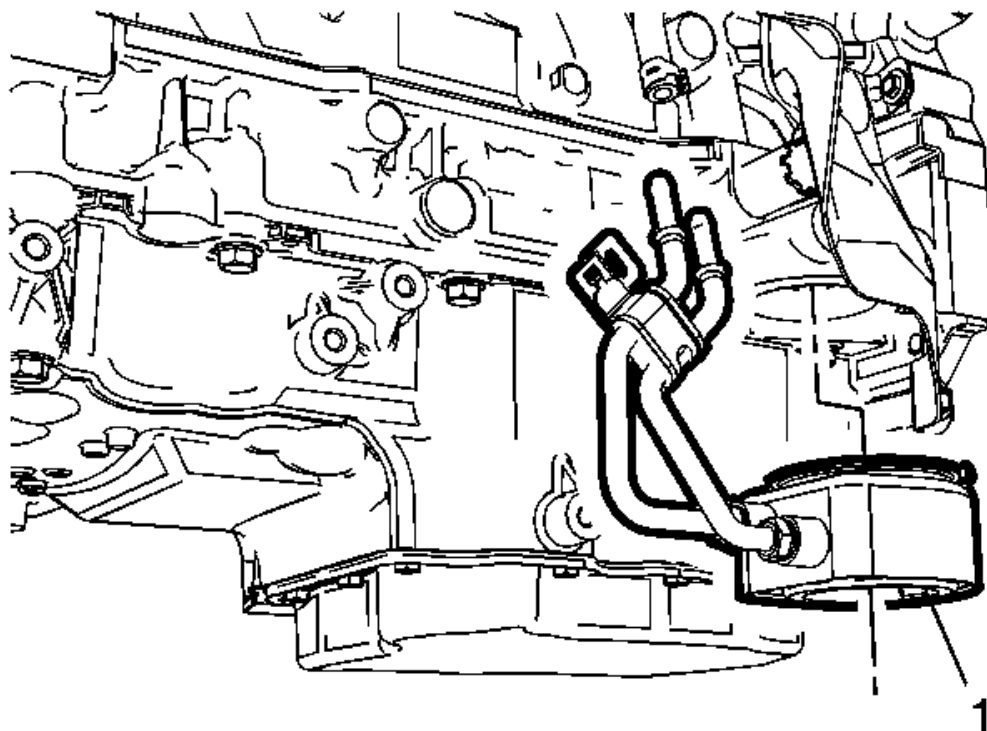


Fig. 167: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

NOTE: DISCARD the old engine oil cooler seal.

5. Remove the engine oil cooler (1).

Installation Procedure

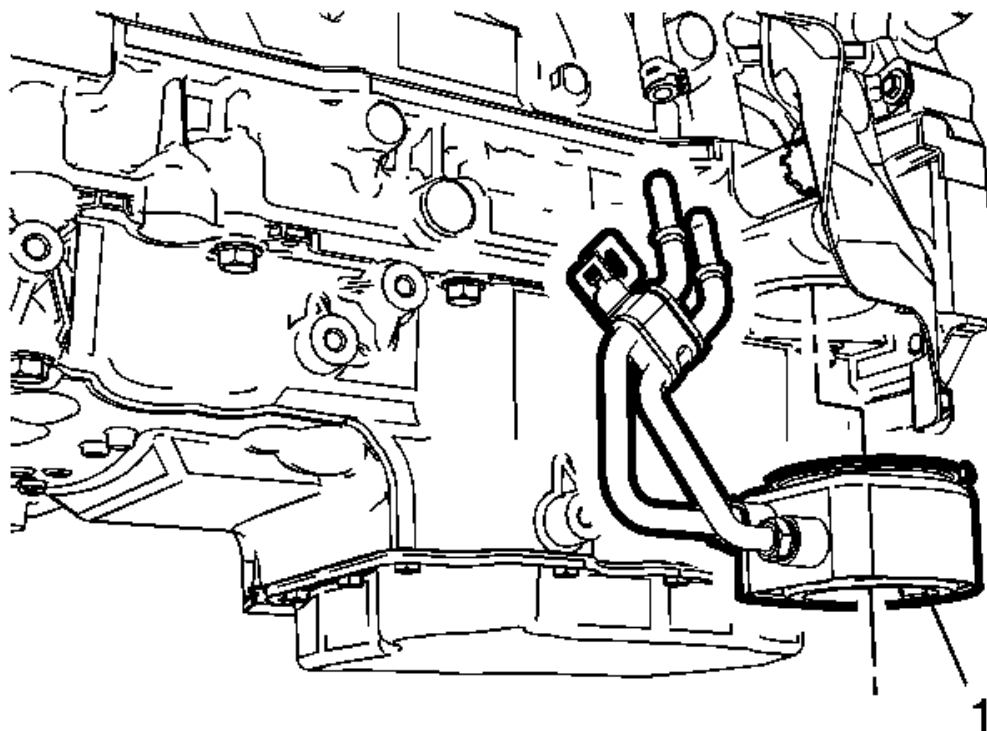


Fig. 168: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

NOTE: A NEW engine oil cooler seal must be used whenever reinstalling the engine oil cooler.

1. Install the engine oil cooler (1).

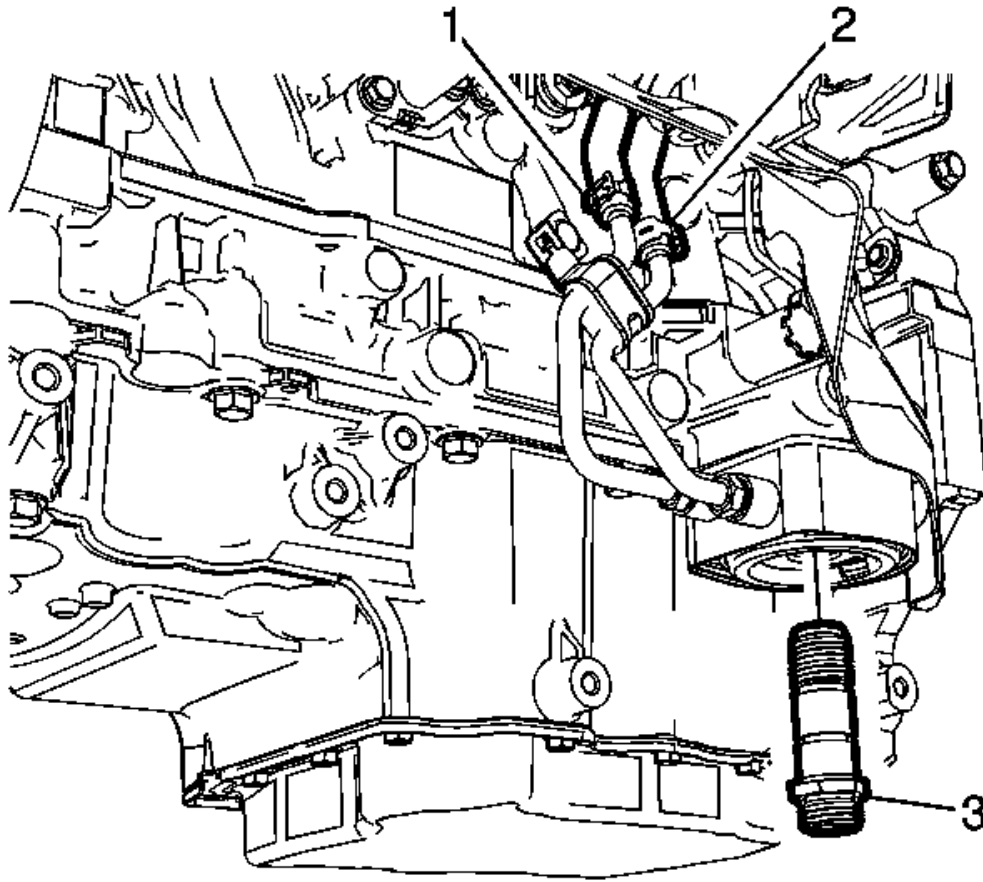


Fig. 169: Engine Oil Cooler Connector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Component Fastener Tightening Caution .

2. Install the engine oil cooler connector (3) and tighten to 50 (37 lb ft).
3. Install the oil cooler hose (1) and (2).

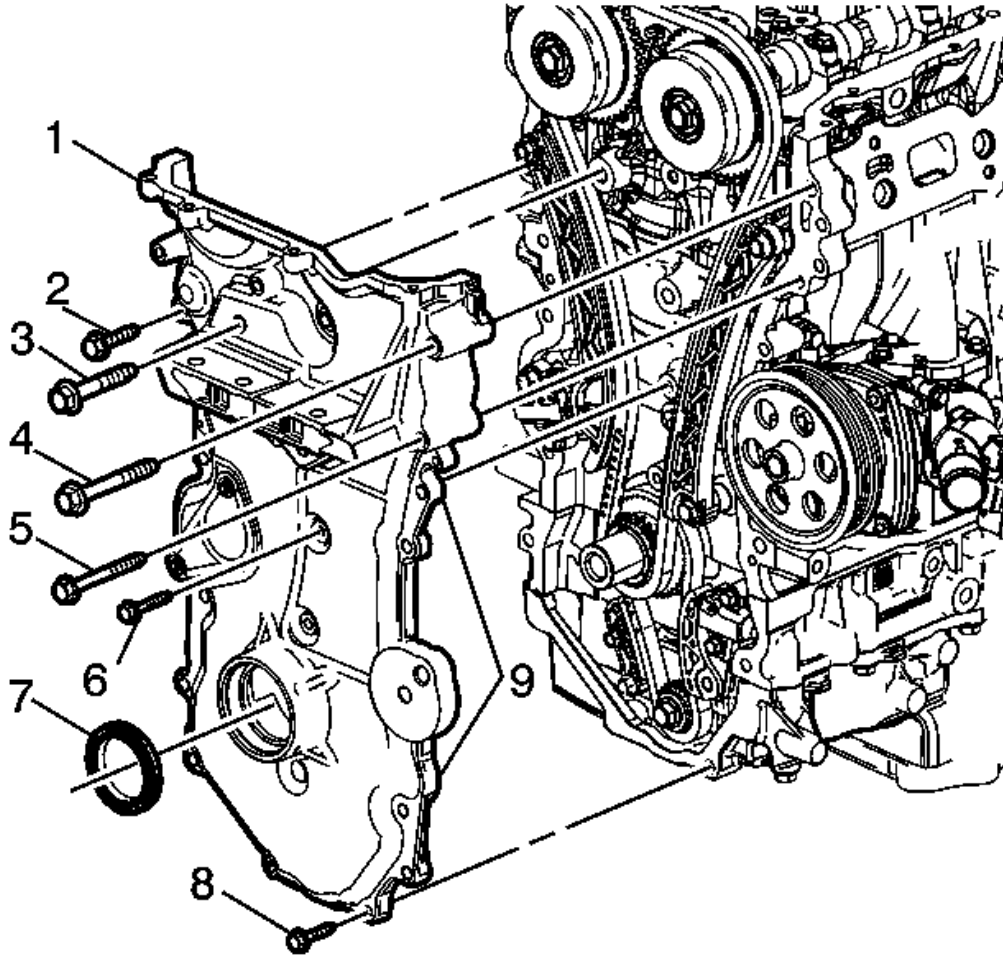
CAUTION: Refer to Fastener Caution .

4. Install the oil cooler fastener (1) and tighten to 10 (89 lb in)
5. Install the engine oil filter. Refer to Engine Oil and Oil Filter Replacement.

OIL PAN REPLACEMENT (AWD)

Removal Procedure

1. Drain the engine oil and remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
2. Support the engine using the engine support fixture. Refer to **Engine Support Fixture**.
3. Remove the drivetrain and front suspension frame front crossmember. Refer to **Drivetrain and Front Suspension Frame Replacement**.
4. Remove the transfer case. Refer **Transfer Case Replacement**.

**Fig. 170: Front Oil Seal**

Courtesy of GENERAL MOTORS COMPANY

5. Remove the front engine cover. Refer to **Engine Front Cover Replacement**.
6. Remove the front exhaust pipe. Refer to **Exhaust Front Pipe Replacement (LTG AWD)**.

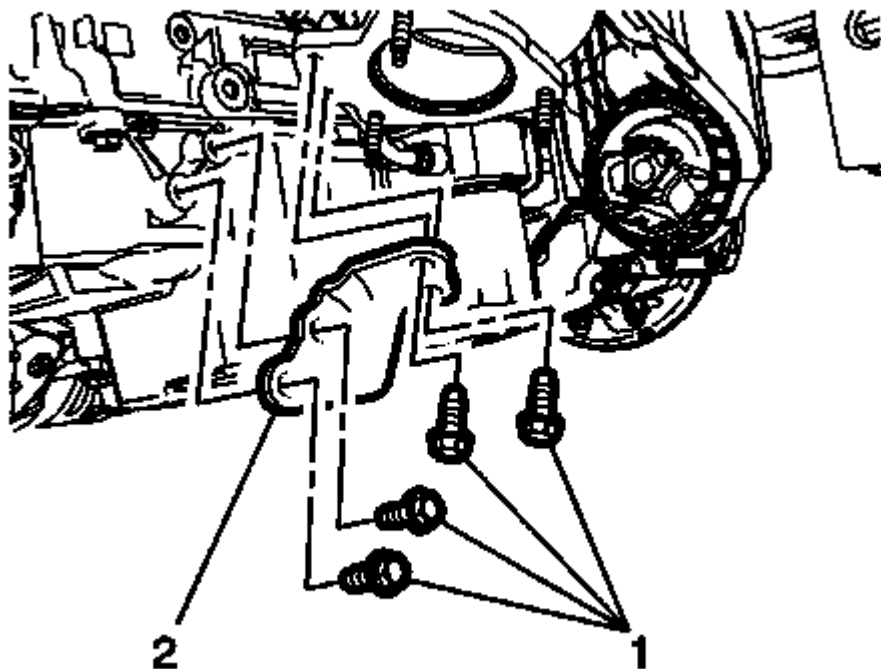


Fig. 171: Catalytic Converter Lower Brace & Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Remove the catalytic converter to oil pan brace fasteners (1).
8. Remove the catalytic lower brace (2).
9. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)** .

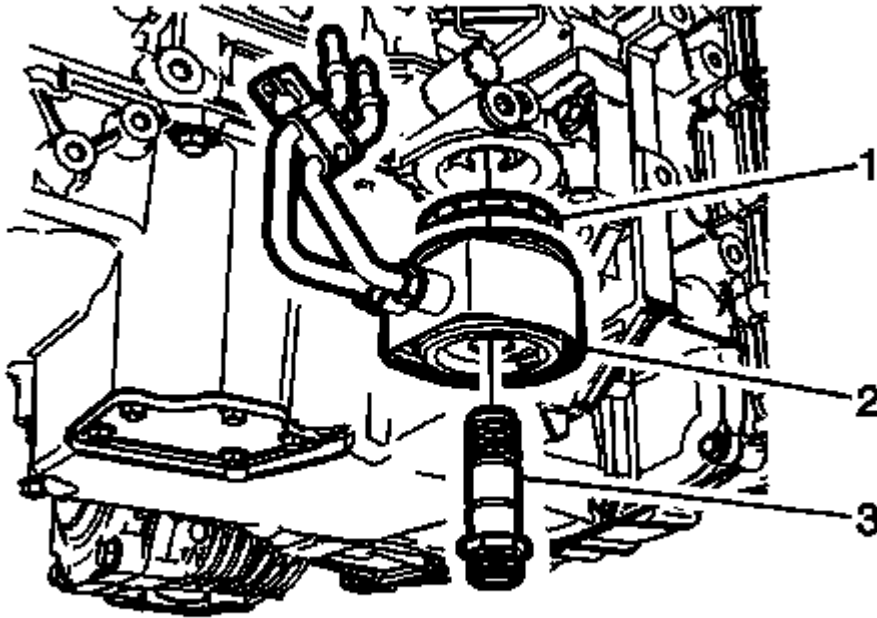


Fig. 172: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

10. Remove the engine oil cooler (2). Refer to **Engine Oil Cooler Replacement (AWD)**.

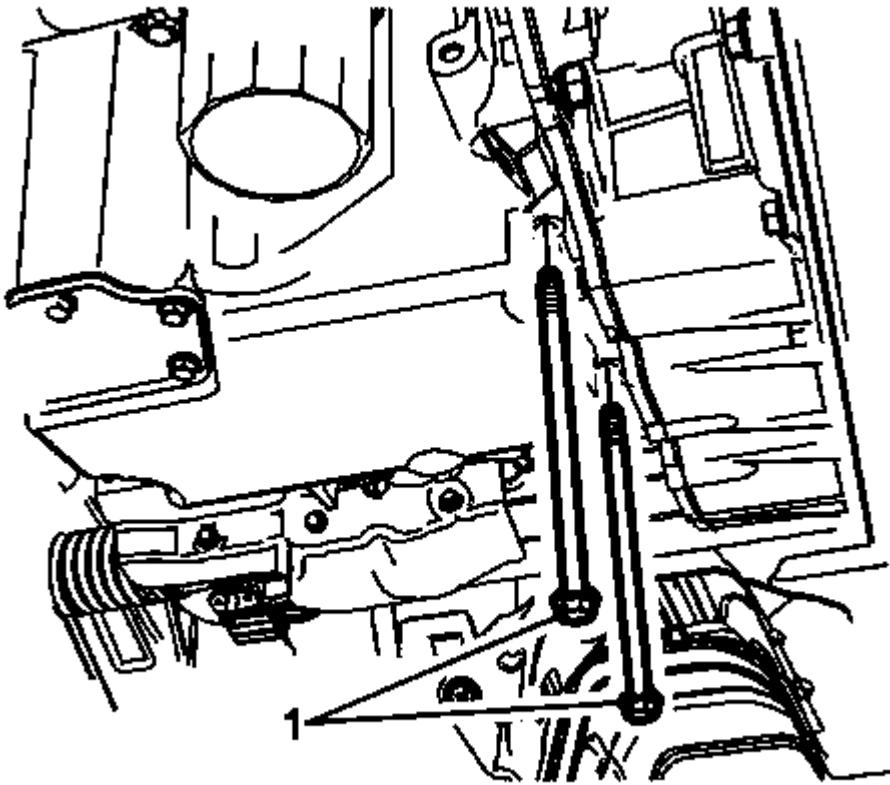


Fig. 173: Rear Oil Pan to Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

11. Remove the rear oil pan to engine block fasteners (1).

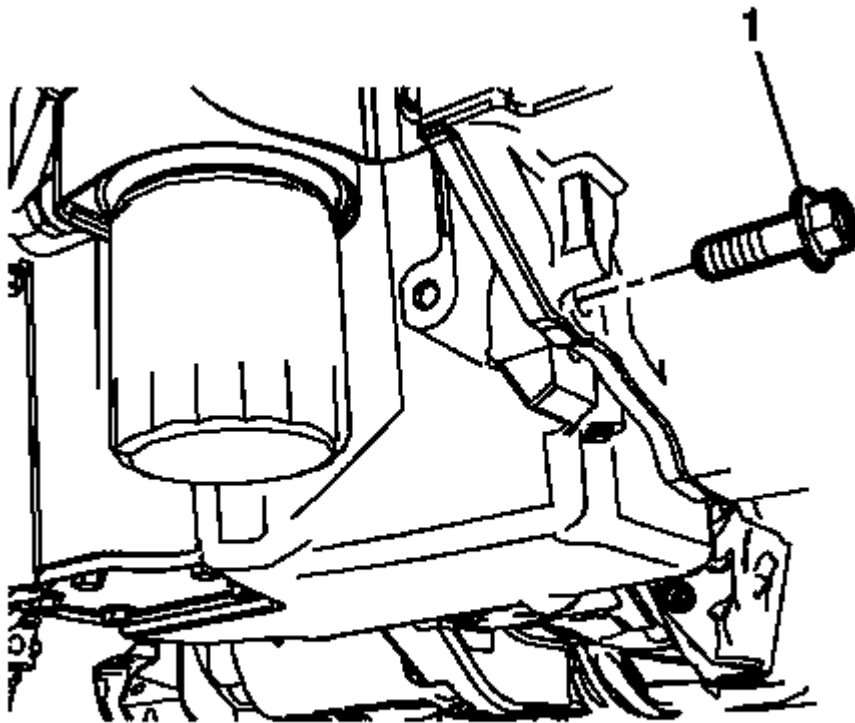


Fig. 174: Transmission To Oil Pan Fastener
Courtesy of GENERAL MOTORS COMPANY

12. Remove the transmission to oil pan fastener (1).

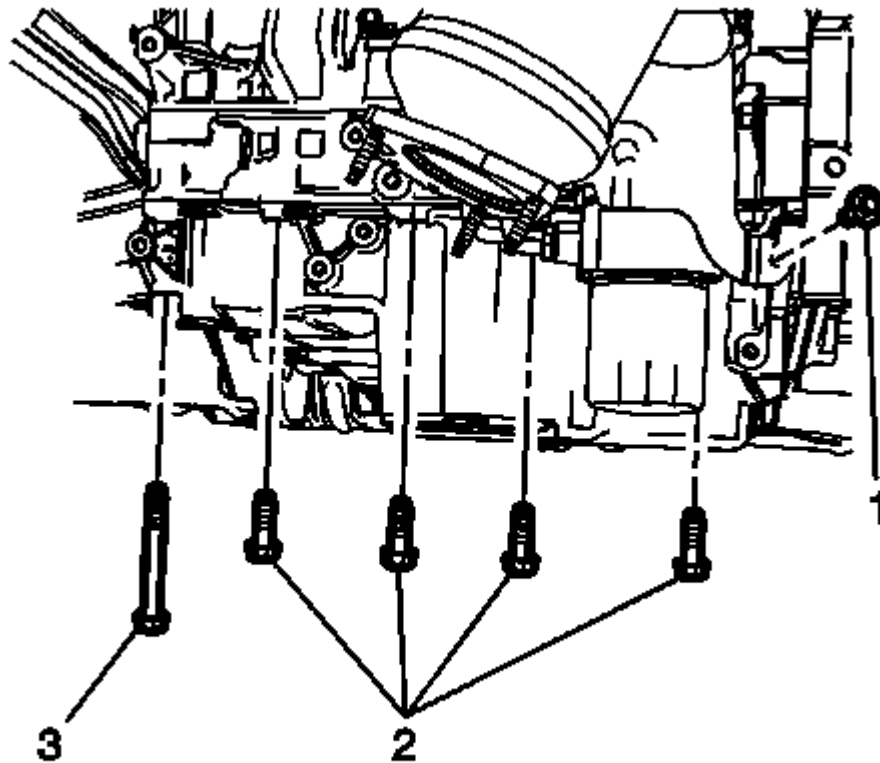


Fig. 175: Left Oil Pan To Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

13. Remove the left oil pan to engine block fasteners (2, 3).

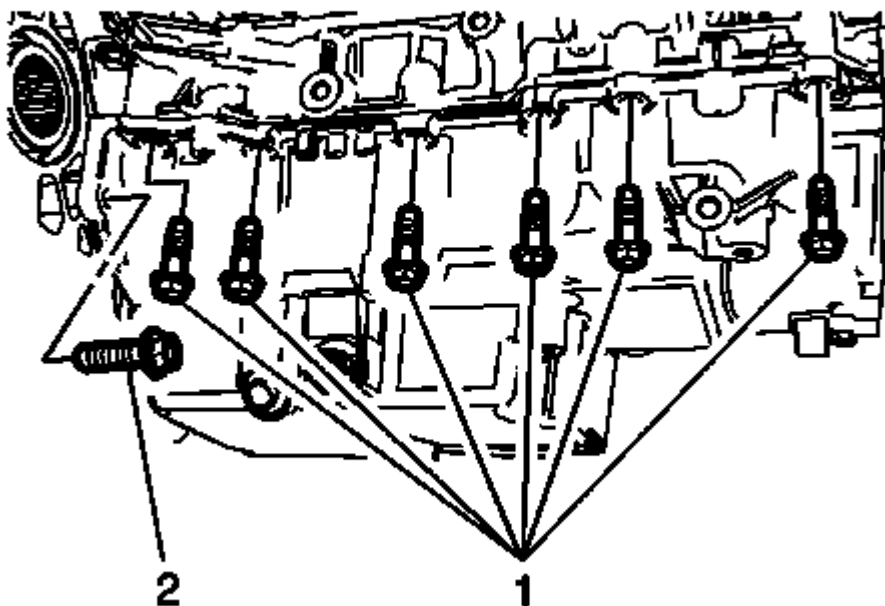


Fig. 176: Oil Pan To Transmission Fasteners
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect the oil level sensor harness connector.
15. Remove the oil pan to transmission fastener (2).
16. Remove the right oil pan to engine block fasteners (1).

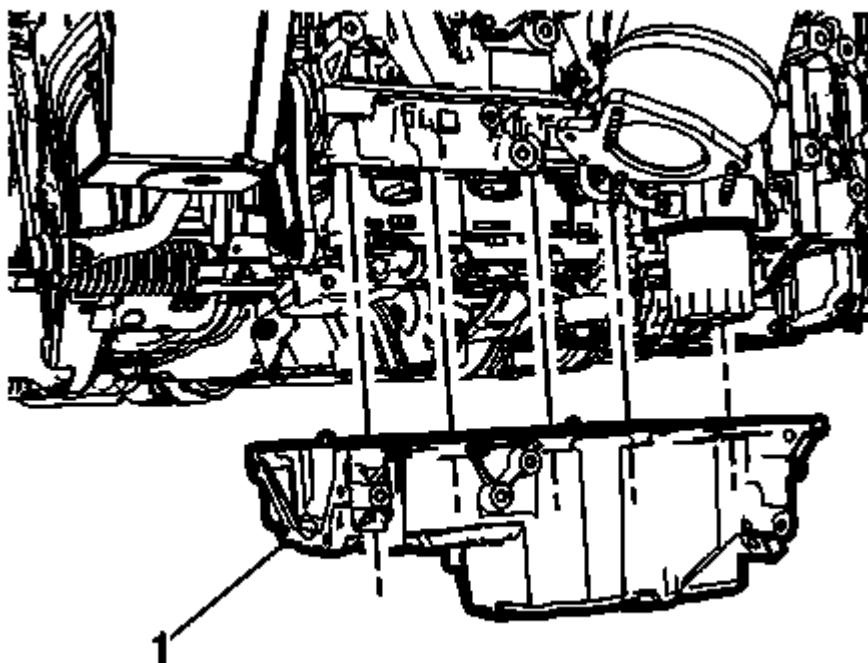


Fig. 177: Engine Oil Pan

Courtesy of GENERAL MOTORS COMPANY

17. Remove the oil pan (1) from the engine.

Installation Procedure

1. Clean and inspect the surfaces of the oil pan and engine block. Refer to **Oil Pan Cleaning and Inspection** .

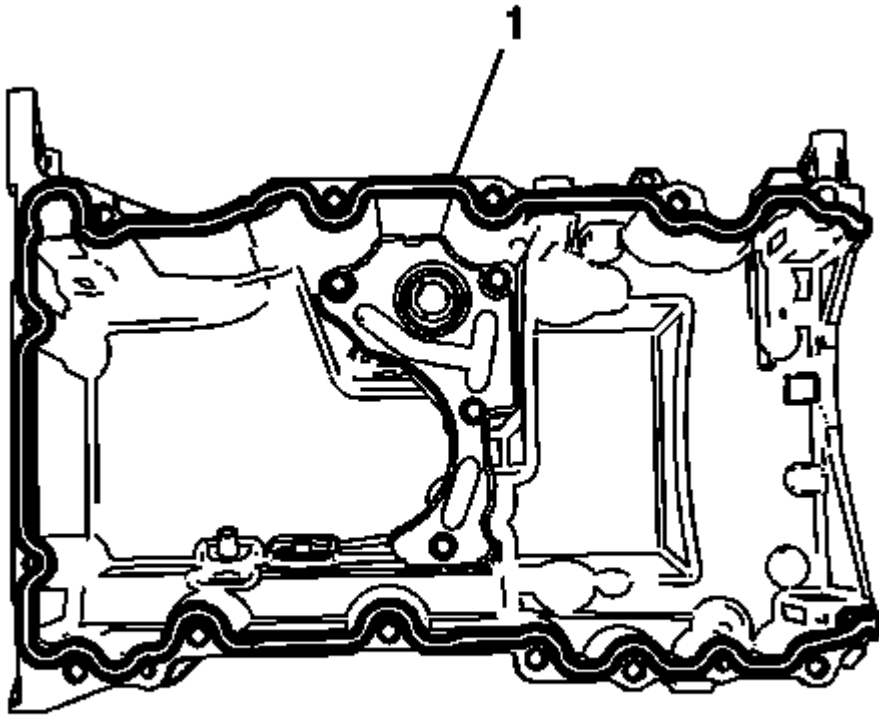


Fig. 178: Engine Oil Pan Sealing Surface
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The oil pan sealing surfaces must be free of contamination prior to applying the sealer.
- Install and align the oil pans within 20 minutes of applying the sealer.
- The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.

2. Apply a 4.25 mm bead of sealer (1) on the level part of the flange around the perimeter of the oil pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
3. Place the oil pan to the engine and loosely installing fasteners at the four corners of the oil pan.

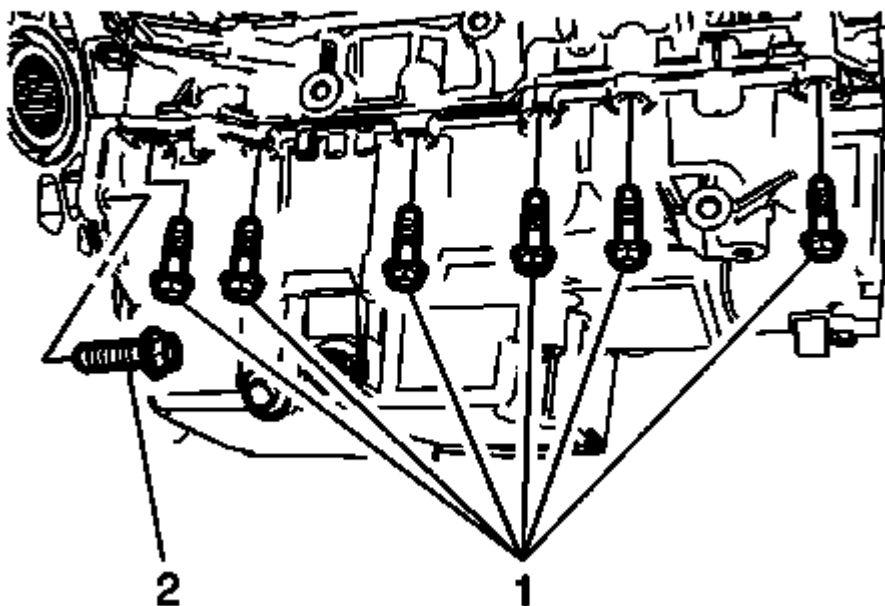


Fig. 179: Oil Pan To Transmission Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Install the right oil pan to engine block fasteners (1) hand tight.
5. Install the oil pan to transmission fastener (2) hand tight.
6. Connect the oil level sensor harness connector.

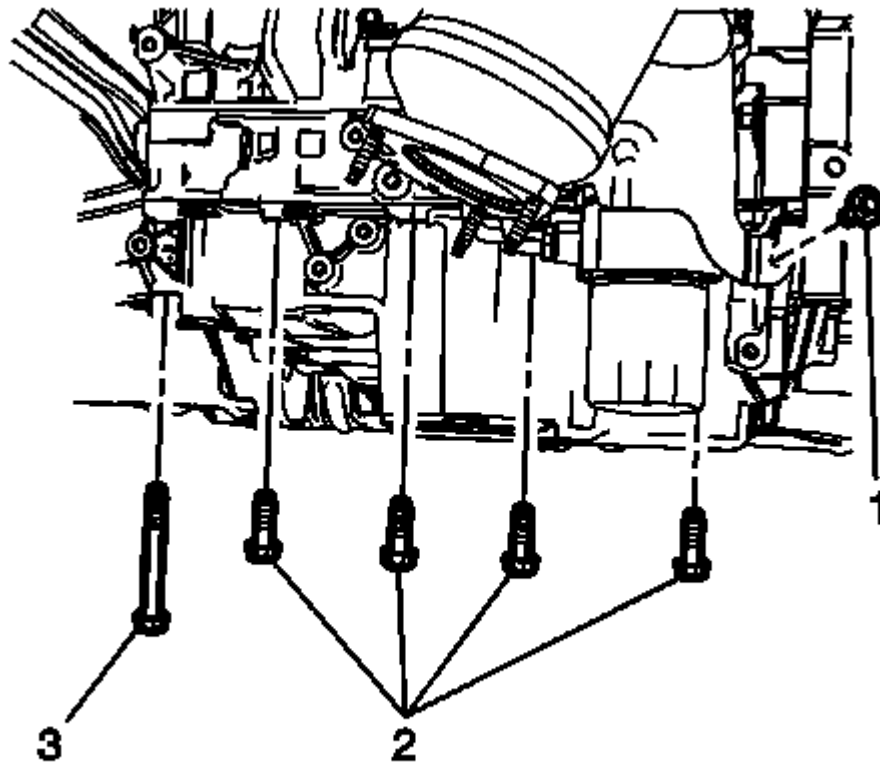


Fig. 180: Left Oil Pan To Engine Block Fasteners
 Courtesy of GENERAL MOTORS COMPANY

7. Install the left oil pan to engine block fasteners (2, 3) hand tight.

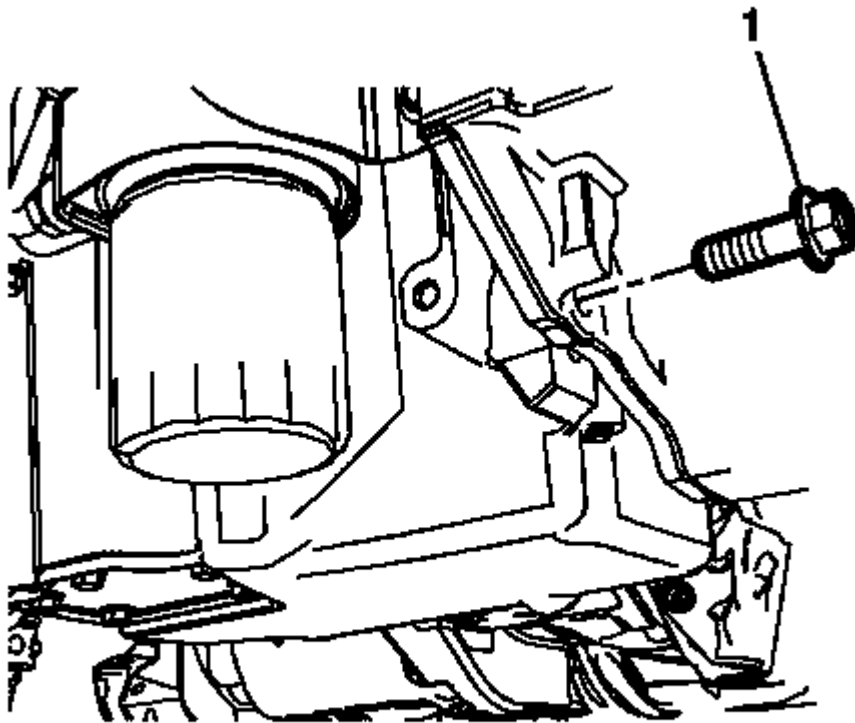


Fig. 181: Transmission To Oil Pan Fastener
Courtesy of GENERAL MOTORS COMPANY

8. Install the transmission to oil pan fastener (1) hand tight.

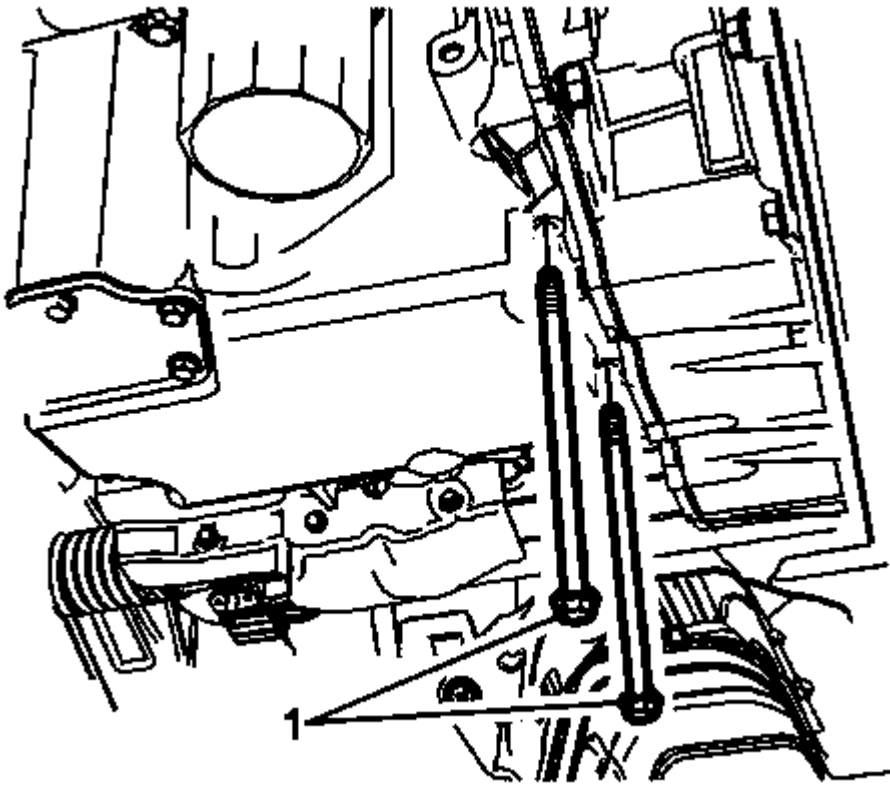


Fig. 182: Rear Oil Pan to Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

9. Install the rear oil pan to engine block fasteners (1) hand tight.

CAUTION: Refer to Fastener Caution .

10. Tighten the oil pan bolts in sequence to final torque twice using the following procedure:
 1. Tighten the fasteners in sequence (1-11) to 25 (18 lb ft).
 2. Tighten the fasteners in sequence (12-13) to 10 (89 lb in).
11. Tighten the oil pan to engine bolts to 60 (44 lb ft).

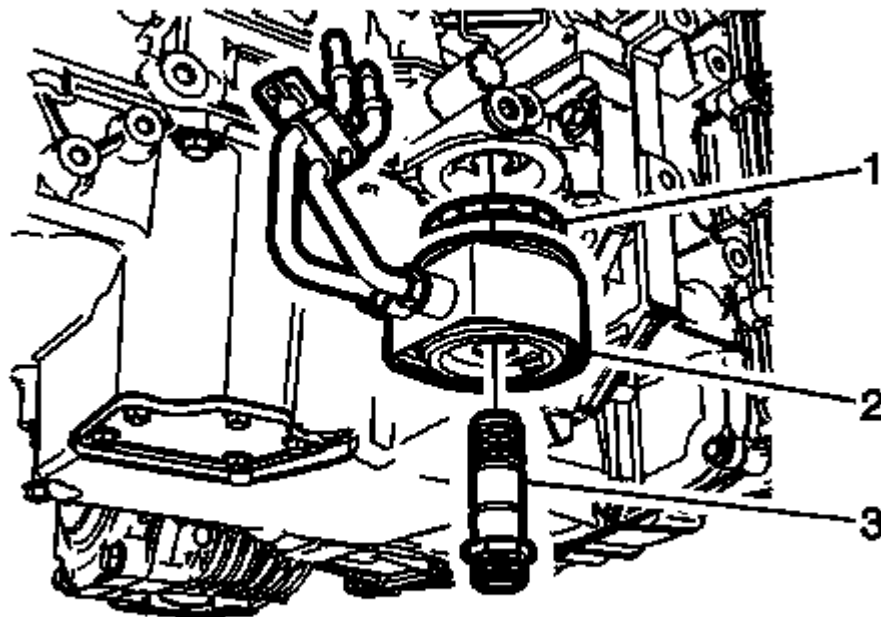


Fig. 183: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

12. Install the engine oil cooler (2). Refer to **Engine Oil Cooler Replacement (AWD)**.
13. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)**.

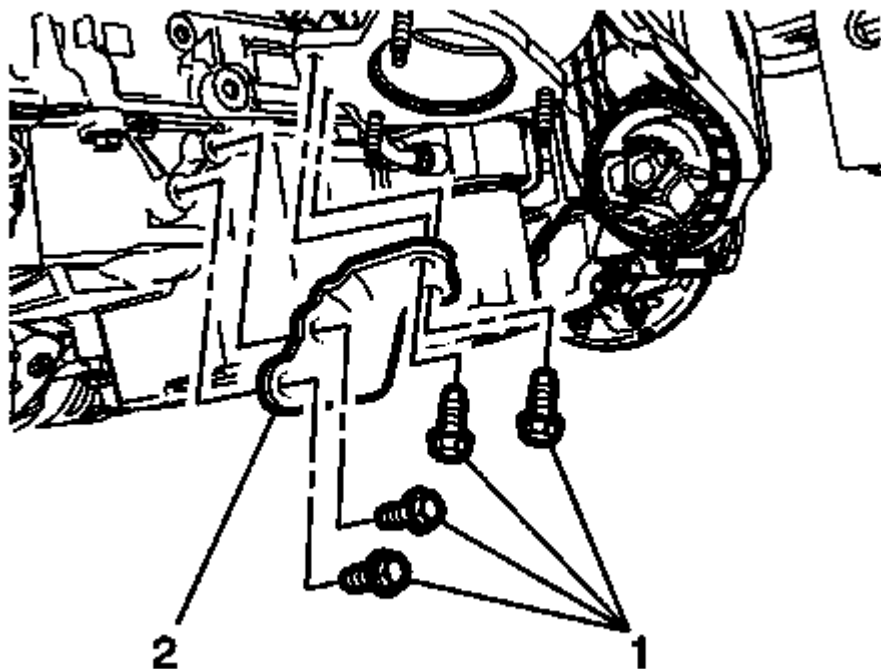
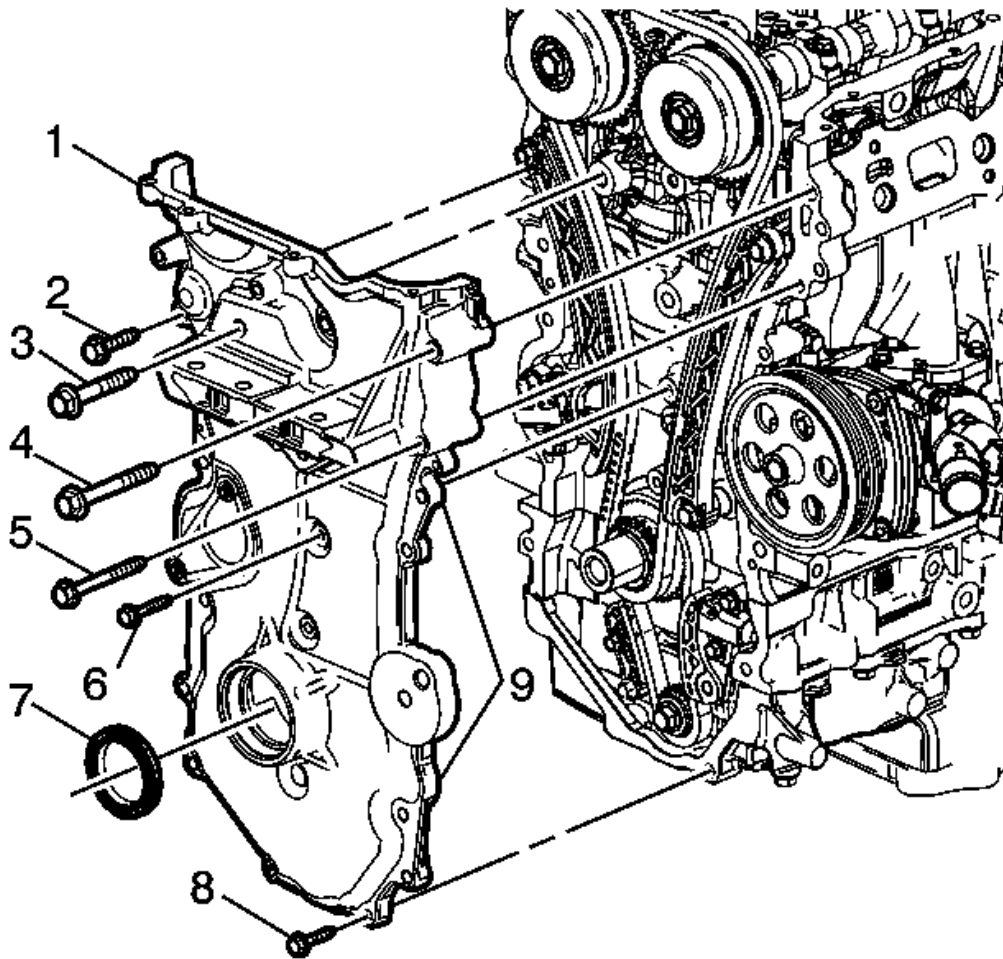


Fig. 184: Catalytic Converter Lower Brace & Fasteners
Courtesy of GENERAL MOTORS COMPANY

14. Position the catalytic lower brace (2).
15. Install the catalytic converter to oil pan brace fasteners (1) and tighten to 25 (18 lb ft).
16. Install the front exhaust pipe. Refer to **Exhaust Front Pipe Replacement (LTG AWD)** .

**Fig. 185: Front Oil Seal**

Courtesy of GENERAL MOTORS COMPANY

17. Install the front engine cover. Refer to **Engine Front Cover Replacement**.
18. Install the transfer case. Refer **Transfer Case Replacement** .
19. Install the drivetrain and front suspension frame front crossmember. Refer to **Drivetrain and Front Suspension Frame Replacement** .
20. Remove the engine support fixture. Refer to **Engine Support Fixture**.
21. Refill the engine oil and install a NEW oil filter. Refer to **Engine Oil and Oil Filter Replacement**.

OIL PAN REPLACEMENT (FWD)

Removal Procedure

1. Drain the engine oil and remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
2. Support the engine. Refer to **Engine Support Fixture**.
3. Remove the drivetrain and front suspension frame front crossmember. Refer to **Drivetrain and Front Suspension Frame Replacement** .

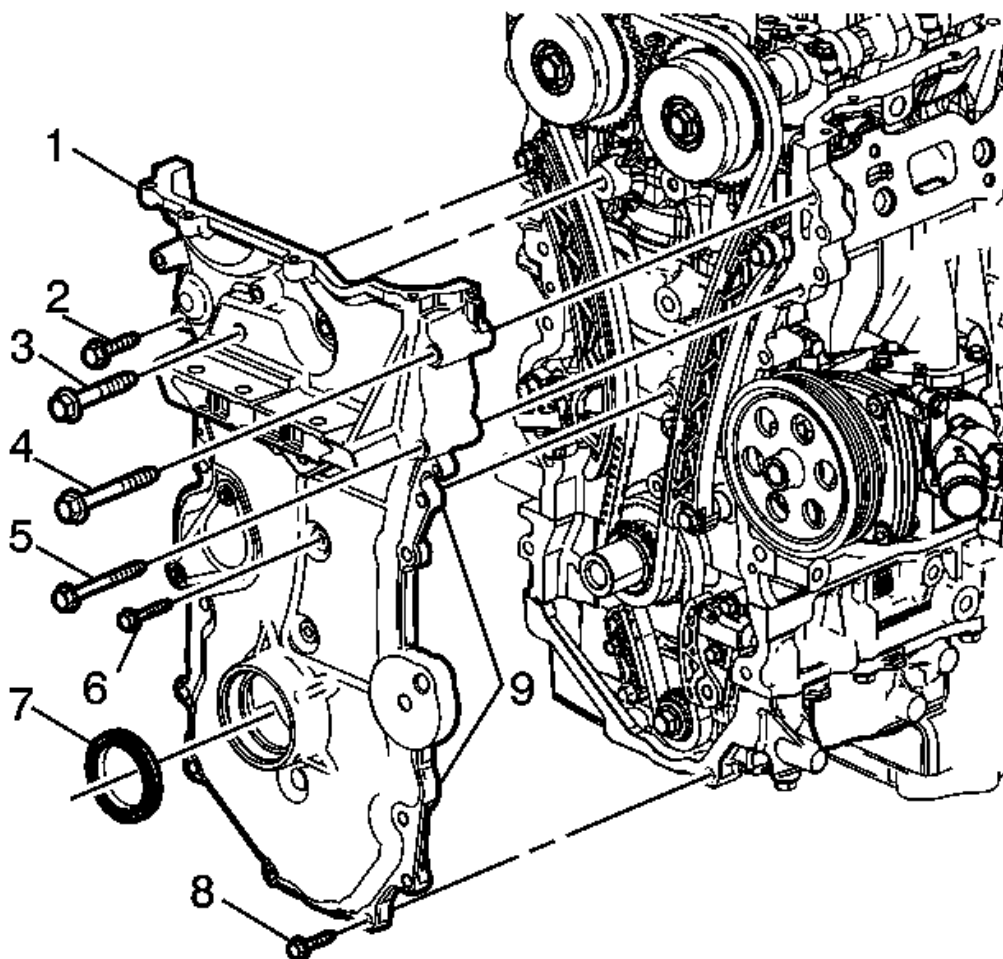


Fig. 186: Front Oil Seal

Courtesy of GENERAL MOTORS COMPANY

4. Remove the front engine cover (1). Refer to **Engine Front Cover Replacement**.
5. Remove the front exhaust pipe. Refer to **Exhaust Front Pipe Replacement (LTG)**.

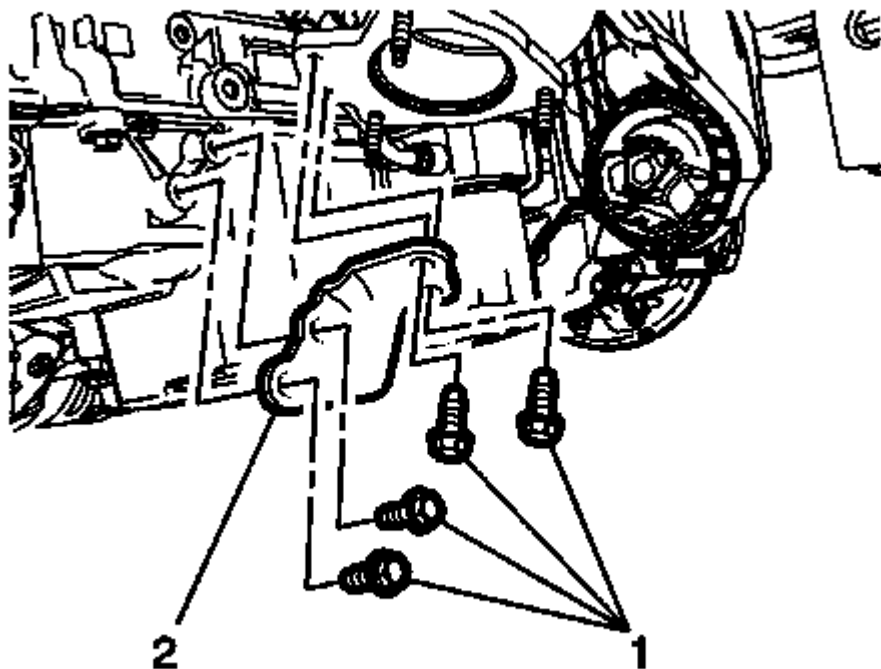


Fig. 187: Catalytic Converter Lower Brace & Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the catalytic converter to oil pan brace fasteners (1).
7. Remove the catalytic lower brace (2).
8. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)** .

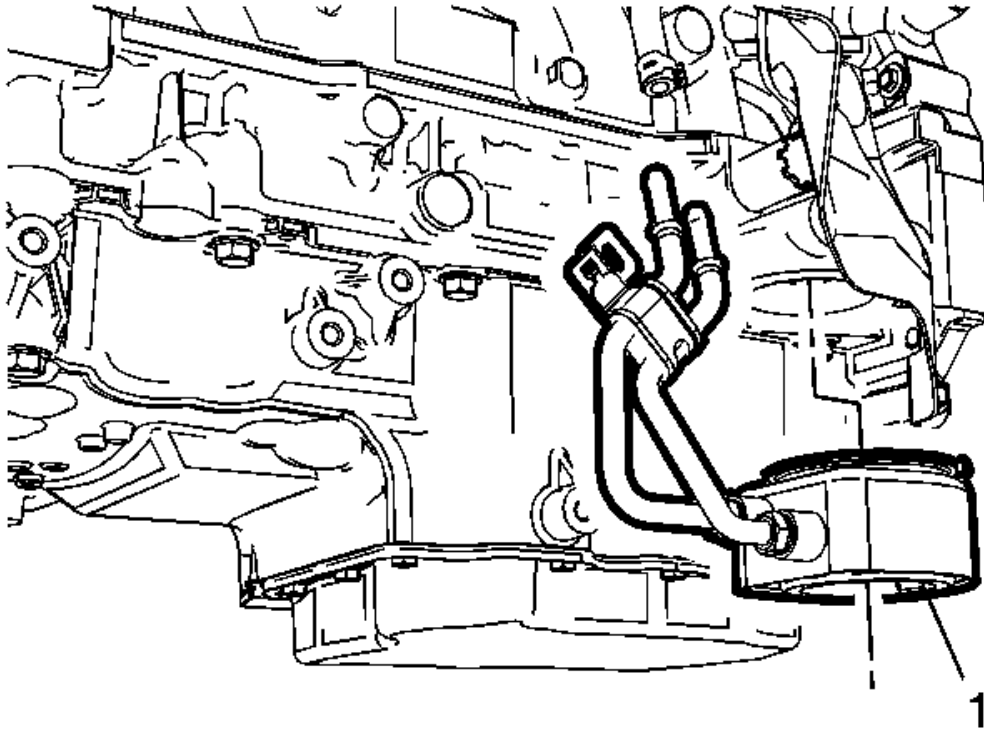


Fig. 188: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

9. Remove the engine oil cooler (1). Refer to **Engine Oil Cooler Replacement (FWD)**.

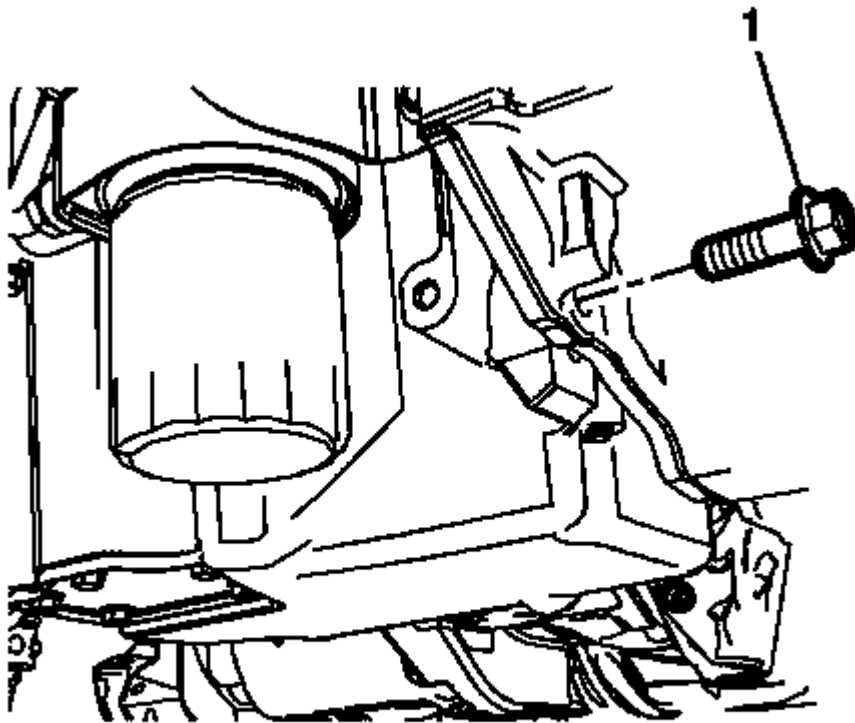


Fig. 189: Transmission To Oil Pan Fastener
Courtesy of GENERAL MOTORS COMPANY

10. Remove the transmission to oil pan fastener (1).

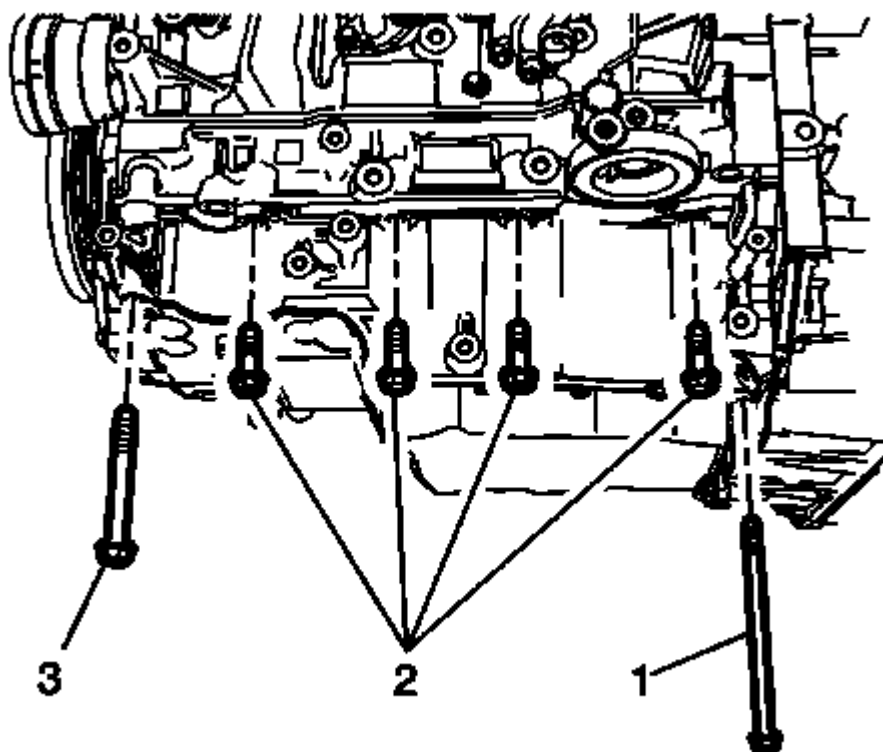


Fig. 190: Left Oil Pan to Engine Block Fasteners
 Courtesy of GENERAL MOTORS COMPANY

11. Remove the left oil pan to engine block fasteners (1, 2, 3).

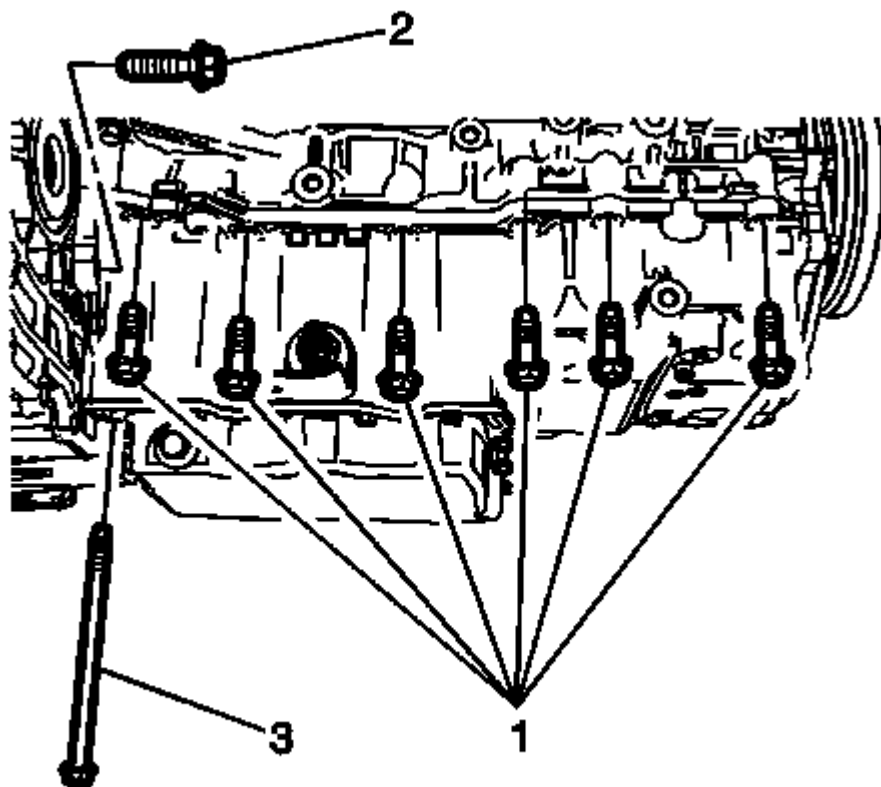


Fig. 191: Right Oil Pan to Transmission & Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the oil level sensor harness connector.
13. Remove the oil pan to transmission fastener (2).
14. Remove the right oil pan to engine block fasteners (1, 3).

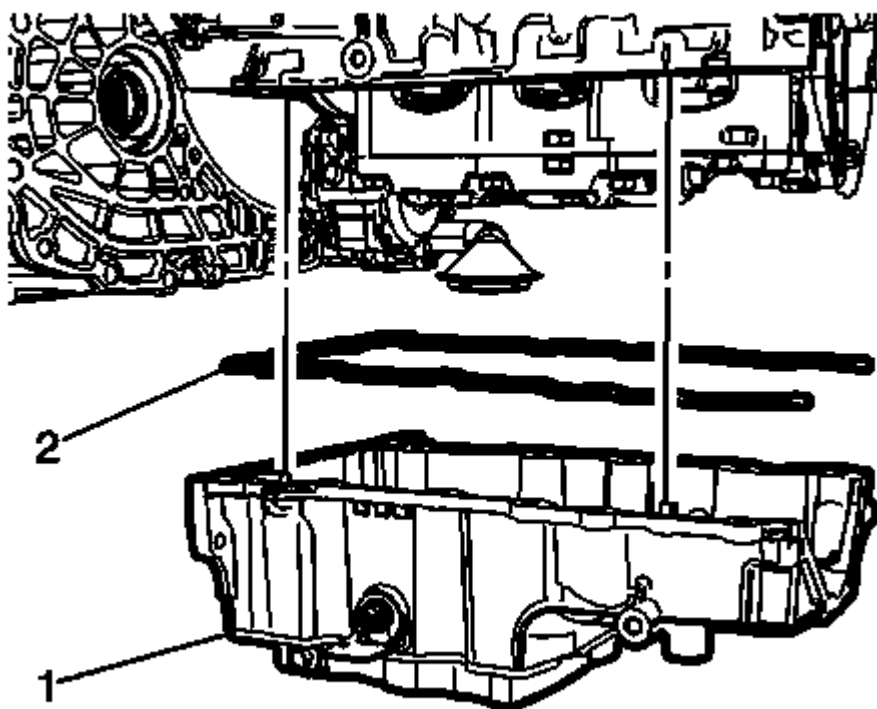


Fig. 192: Oil Pan & Gasket

Courtesy of GENERAL MOTORS COMPANY

15. Remove the oil pan (1) from the engine.

Installation Procedure

1. Clean and inspect the surfaces of the oil pan and engine block. Refer to **Oil Pan Cleaning and Inspection** .

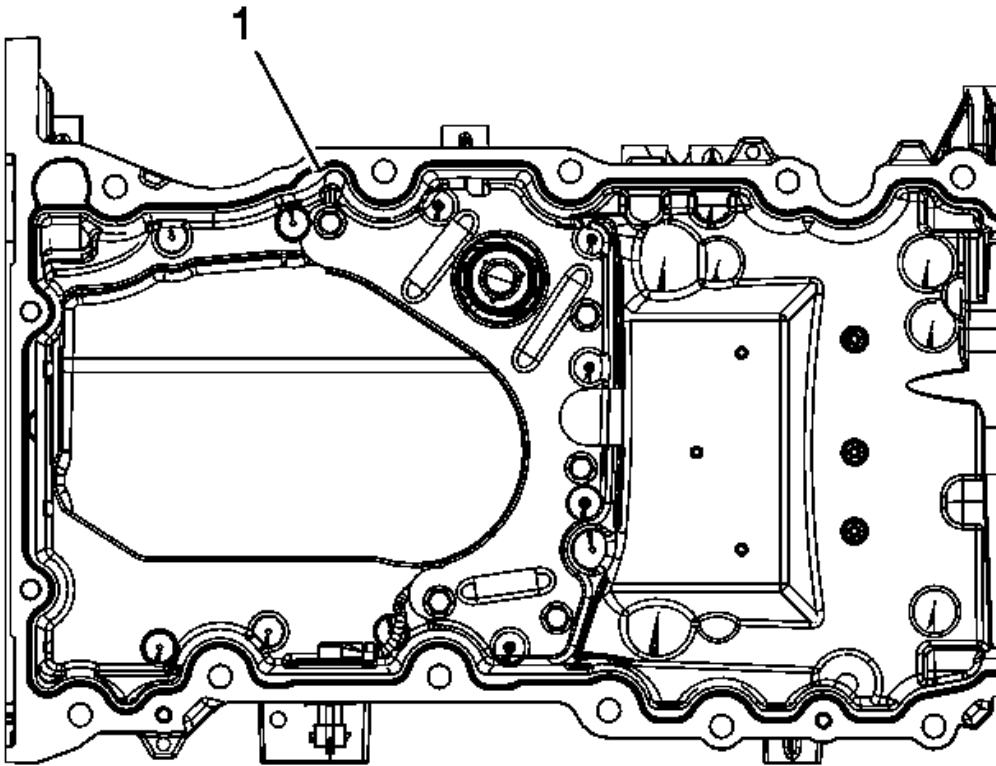


Fig. 193: Short Lower Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The oil pan sealing surfaces must be free of contamination prior to applying the sealer.
- Install and align the oil pans within 20 minutes of applying the sealer.
- The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.

2. Apply a 4.25 mm bead of sealer (1) on the level part of the flange around the perimeter of the oil pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
3. Place the oil pan to the engine and loosely installing fasteners at the four corners of the oil pan.

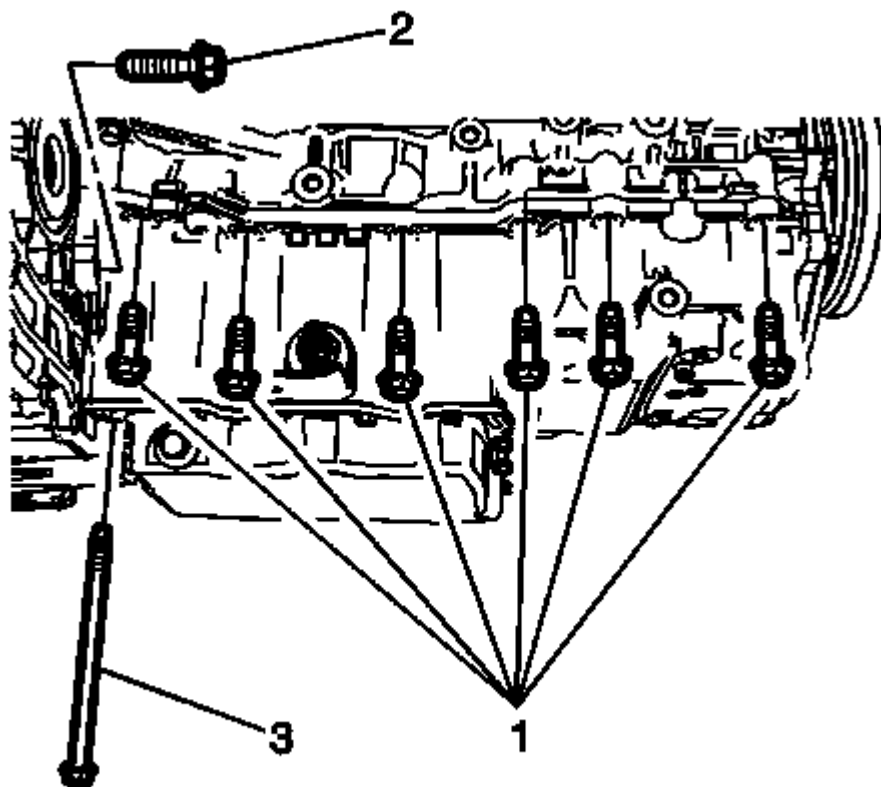


Fig. 194: Right Oil Pan to Transmission & Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Install the right oil pan to engine block fasteners (1, 3) hand tight.
5. Install the oil pan to transmission fastener (2) hand tight.
6. Connect the oil level sensor harness connector.

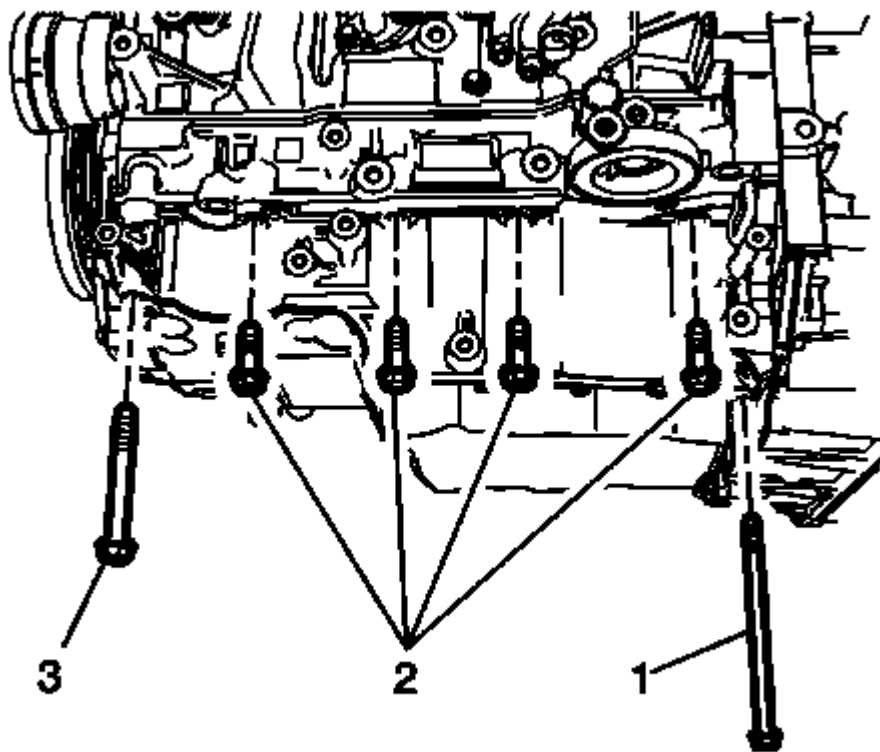


Fig. 195: Left Oil Pan to Engine Block Fasteners
 Courtesy of GENERAL MOTORS COMPANY

7. Install the left oil pan to engine block fasteners (1, 2, 3) hand tight.

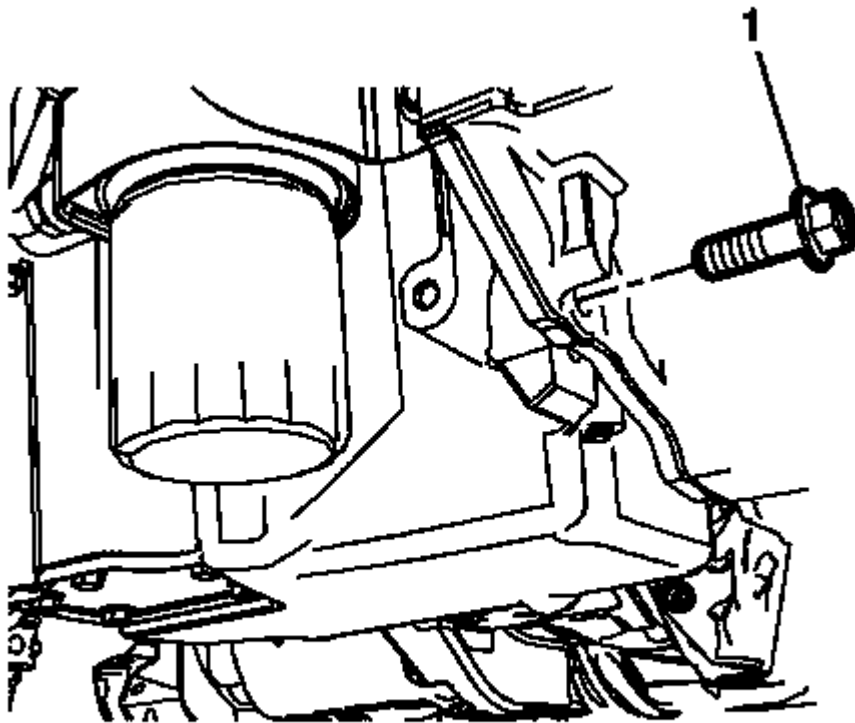


Fig. 196: Transmission To Oil Pan Fastener
Courtesy of GENERAL MOTORS COMPANY

8. Install the transmission to oil pan fastener (1) hand tight.

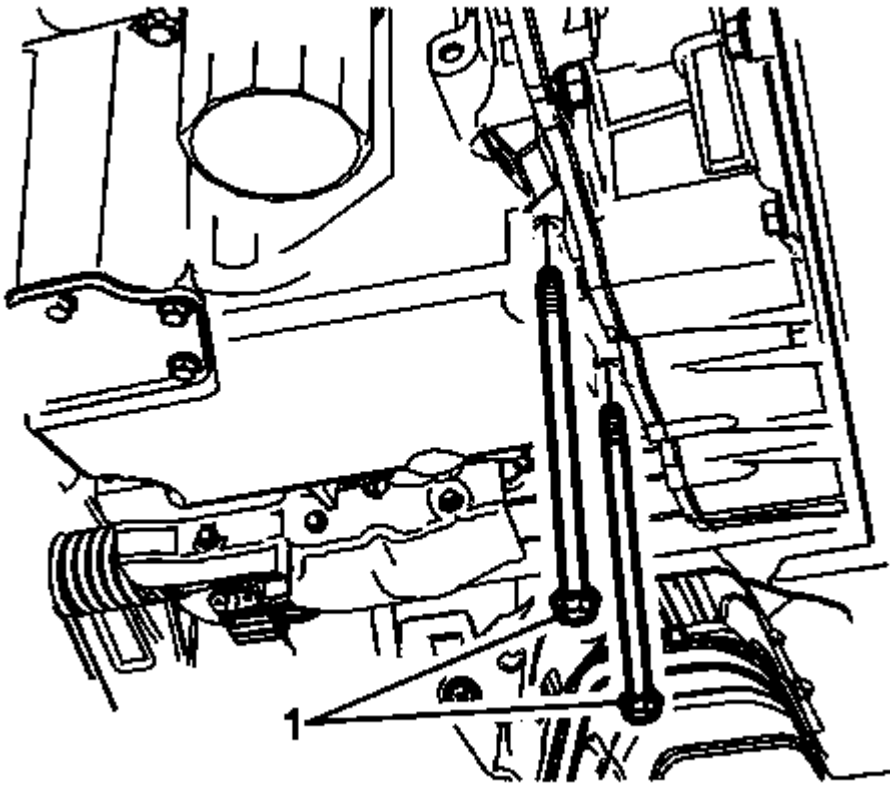


Fig. 197: Rear Oil Pan to Engine Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

9. Install the rear oil pan to engine block fasteners (1) hand tight.

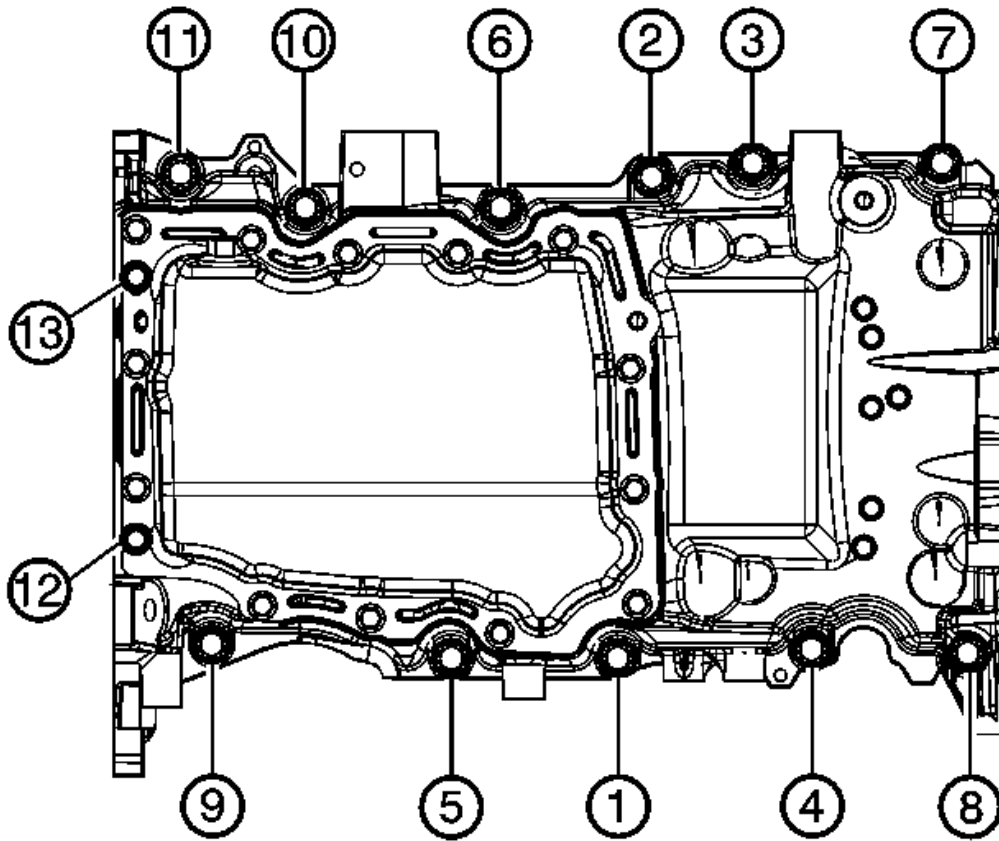


Fig. 198: Oil Pan Bolts In Sequence

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

10. Tighten the oil pan bolts in sequence to final torque twice using the following procedure:
 1. Tighten the fasteners in sequence (1-11) to 25 (18 lb ft).
 2. Tighten the fasteners in sequence (12-13) to 10 (89 lb in).
11. Tighten the oil pan to transmission bolts to 60 (44 lb ft).

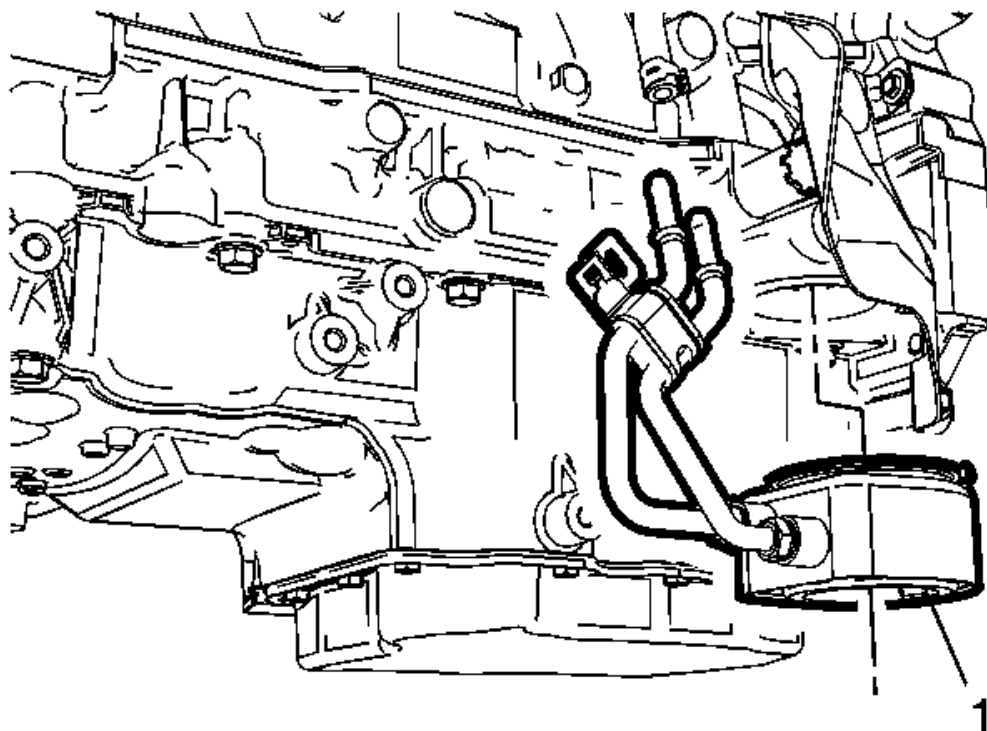


Fig. 199: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

12. Install the engine oil cooler (1). Refer to **Engine Oil Cooler Replacement (FWD)**.
13. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)**.

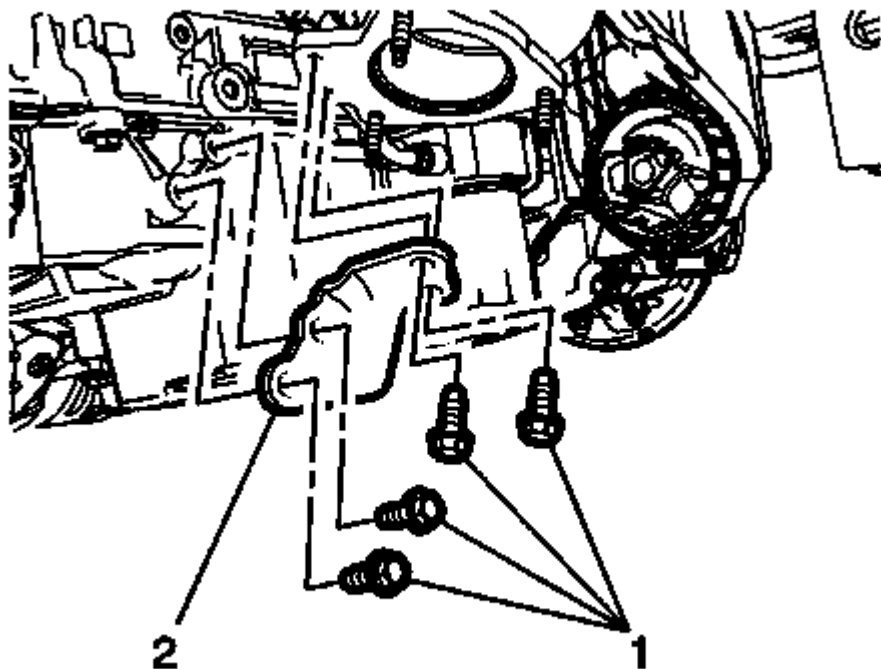


Fig. 200: Catalytic Converter Lower Brace & Fasteners
Courtesy of GENERAL MOTORS COMPANY

14. Position the catalytic lower brace (2).
15. Install the catalytic converter to oil pan brace fasteners (1) and tighten to 25 (18 lb ft).
16. Install the front exhaust pipe. Refer to **Exhaust Front Pipe Replacement (LTG)** .

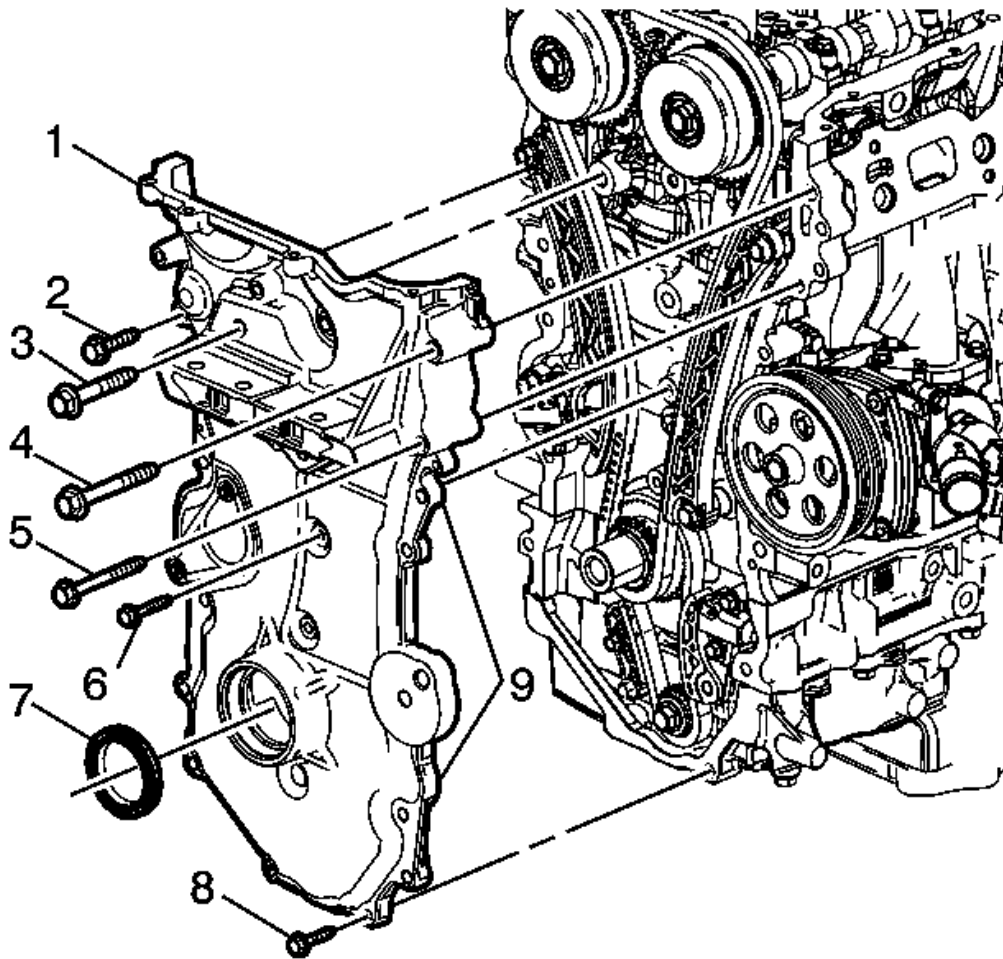
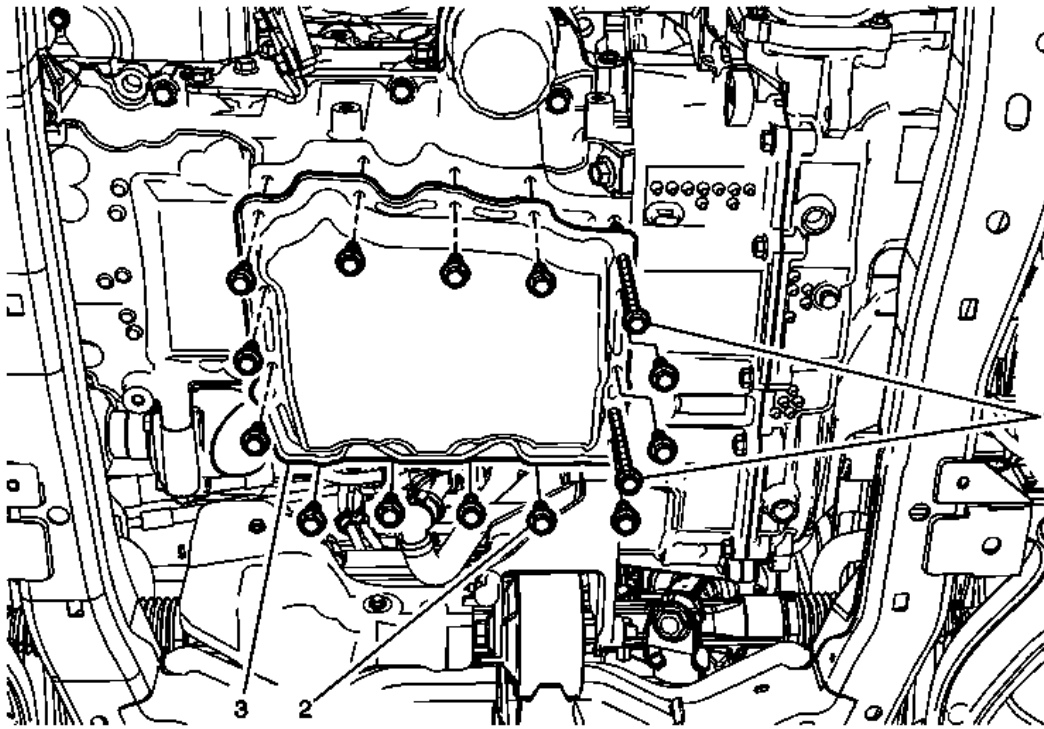


Fig. 201: Front Oil Seal

Courtesy of GENERAL MOTORS COMPANY

17. Install the front engine cover (1). Refer to [Engine Front Cover Replacement](#).
18. Install the drivetrain and front suspension frame front crossmember. Refer to [Drivetrain and Front Suspension Frame Replacement](#).
19. Remove the engine support fixture. Refer to [Engine Support Fixture](#).
20. Refill the engine oil and install a NEW oil filter. Refer to [Engine Oil and Oil Filter Replacement](#).

LOWER OIL PAN REPLACEMENT

**Fig. 202: Oil Pan & Fasteners**

Courtesy of GENERAL MOTORS COMPANY

Lower Oil Pan Replacement

Callout	Component Name
Preliminary Procedures	
1. Drain engine oil. Refer to <u>Engine Oil and Oil Filter Replacement</u> 2. Remove the exhaust front pipe. Refer to <u>Exhaust Front Pipe Replacement (LTG)</u> , <u>Exhaust Front Pipe Replacement (LTG AWD)</u> .	
1	Oil Pan Bolts (Qty 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Oil Pan Bolts (Qty; 13) Tighten 10 (89 lb in)
	Oil Pan Procedure Apply a 2.25 mm bead of sealer on the level part of the flange around the perimeter of the oil pan. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> .

3

NOTE:

- The lower crankcase surface must be free of contamination prior to applying the sealer.
- Install and align the oil pan to block within 20 minutes of applying the sealer.
- The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.

ENGINE OIL LEVEL INDICATOR SWITCH REPLACEMENT (FWD)**Removal Procedure**

1. Remove the lower oil pan. Refer to . **Lower Oil Pan Replacement.**
2. Disconnect the oil level sensor electrical connector.

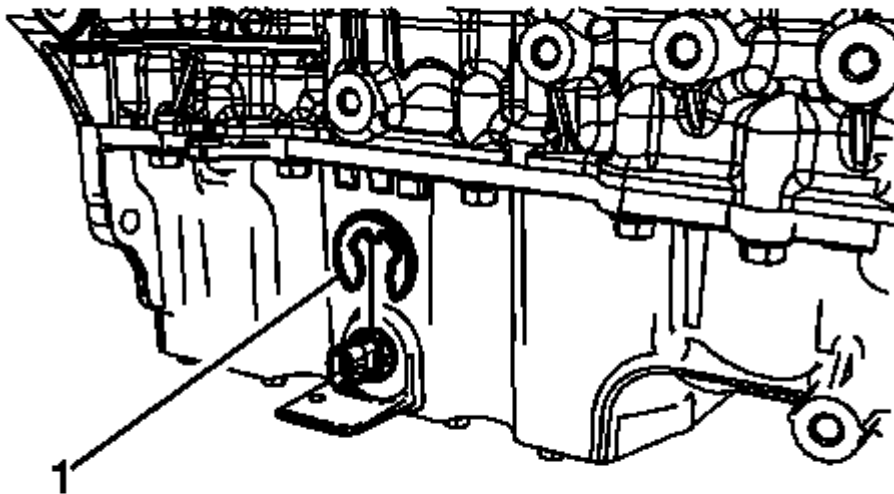


Fig. 203: Engine Oil Level Sensor C-clip
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine oil level sensor retainer (1).

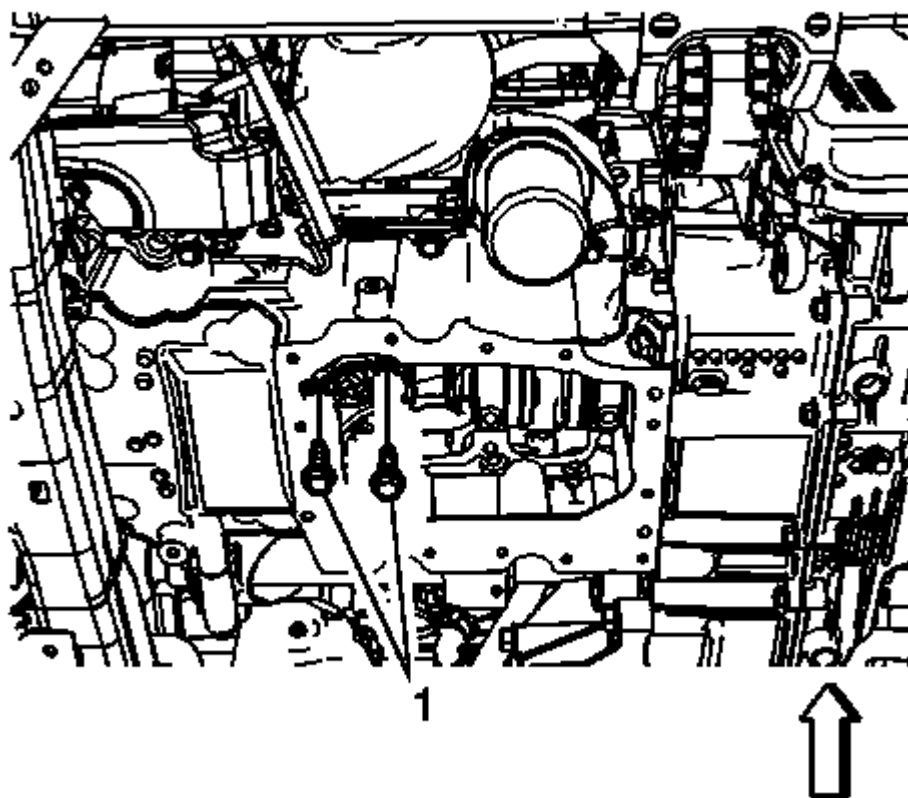


Fig. 204: Engine Oil Level Sensor Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine oil level sensor fasteners (1).

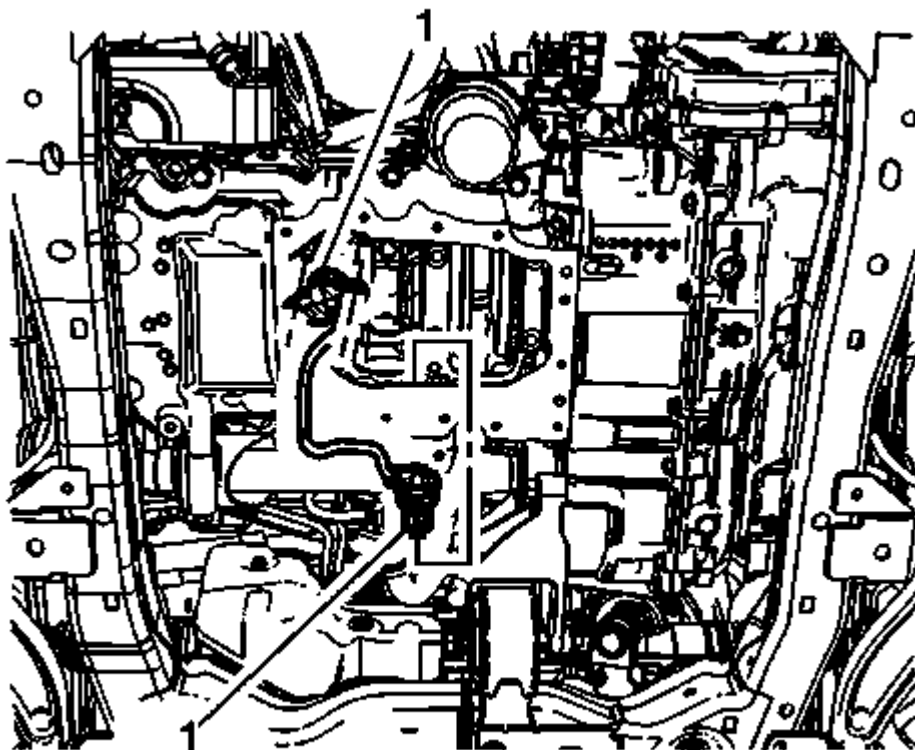


Fig. 205: O-ring Around Level Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: Replace the O-ring around the level sensor.

5. Remove the engine oil level sensor (1) from the oil pan.

Installation Procedure

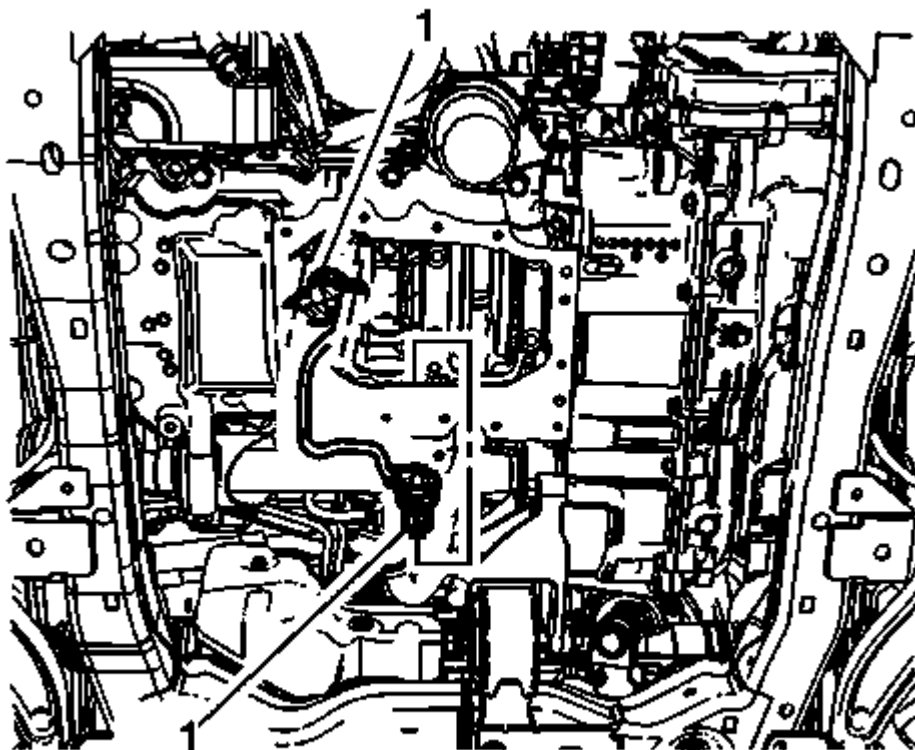


Fig. 206: O-ring Around Level Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine oil level sensor (1).

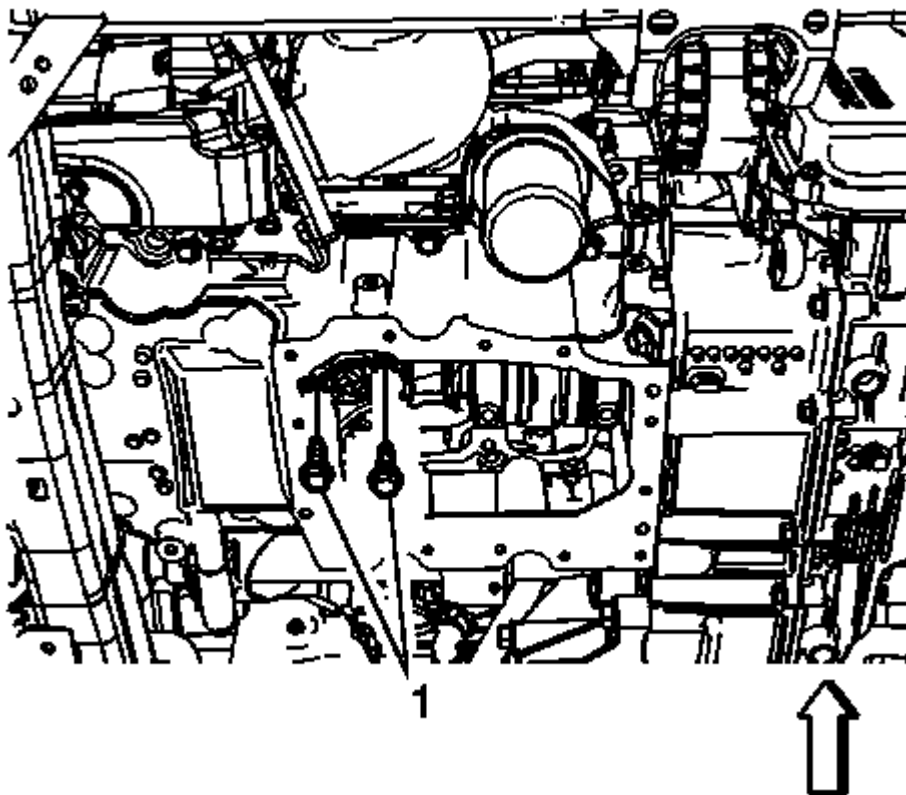


Fig. 207: Engine Oil Level Sensor Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the engine oil level sensor fastener (1) and tight to 10 (89 lb in).

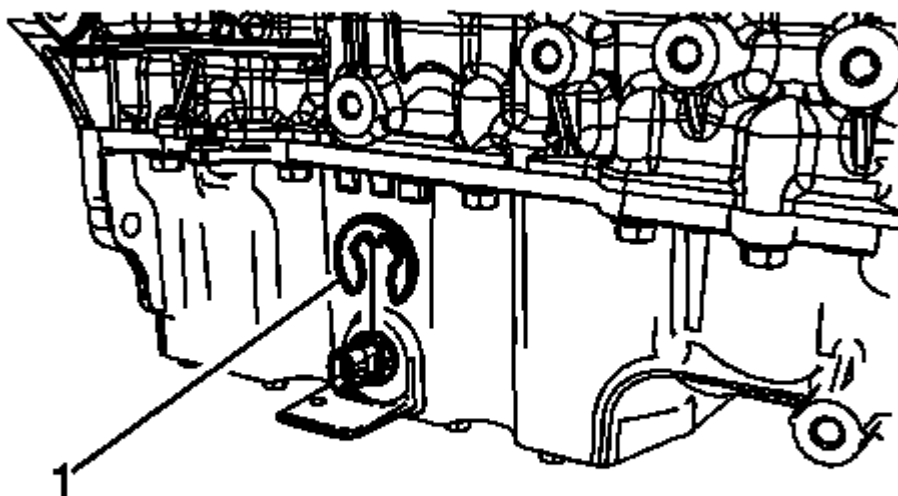


Fig. 208: Engine Oil Level Sensor C-clip
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine oil level sensor retainer (1).
4. Connect the oil level sensor electrical connector.
5. Install the lower oil pan. Refer to **Lower Oil Pan Replacement**.

ENGINE OIL LEVEL INDICATOR SWITCH REPLACEMENT (AWD)

Removal Procedure

1. Remove the oil pan. Refer to . **Oil Pan Replacement (AWD)**.

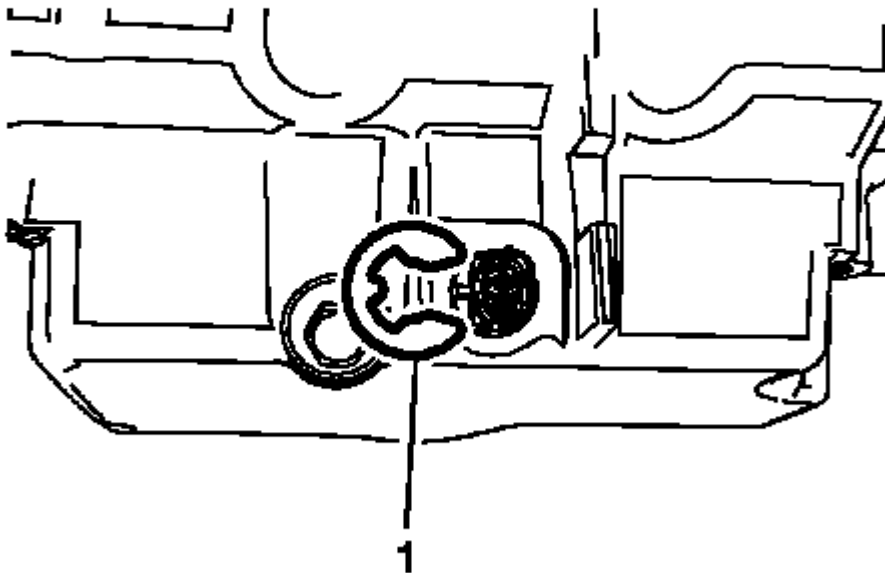


Fig. 209: Engine Oil Level Sensor

Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil level sensor retainer (1).

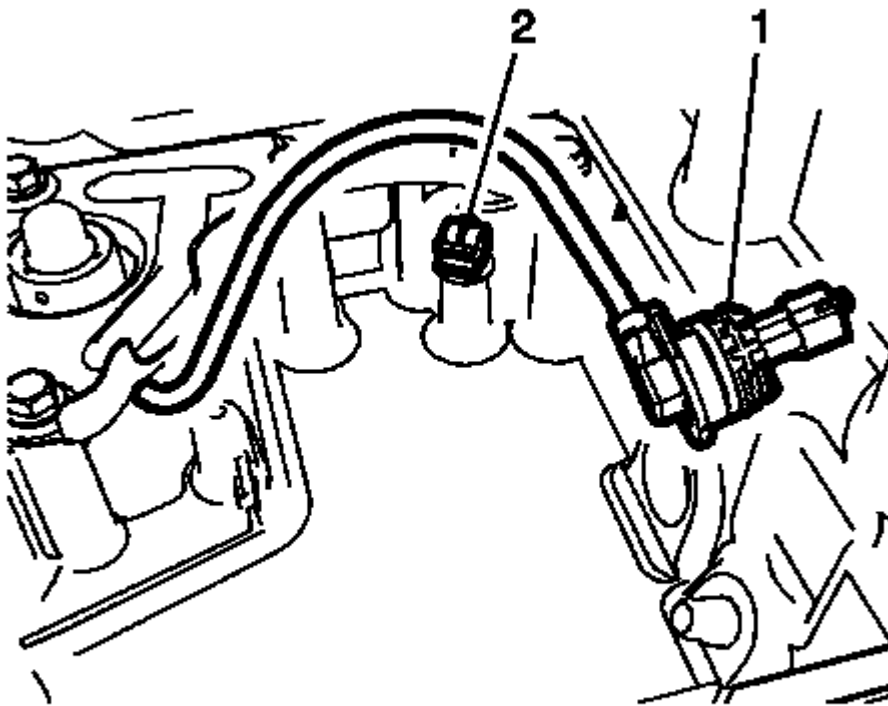


Fig. 210: Engine Oil Level Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the engine oil level sensor connector (1) from the oil pan and the retainer (2). Discard the O-ring.

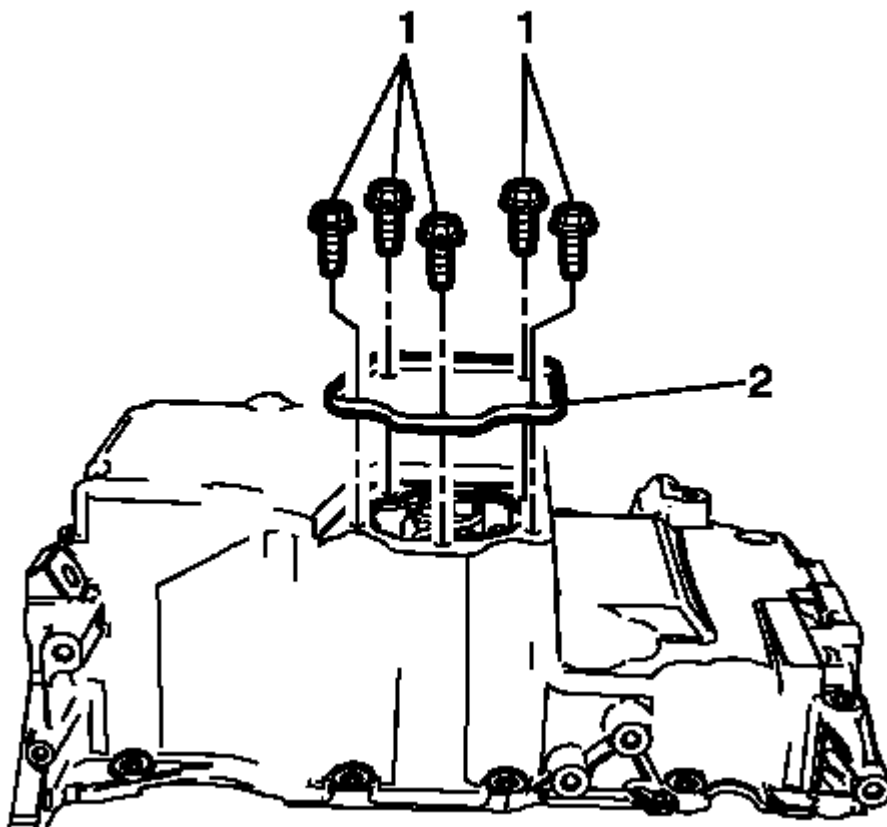


Fig. 211: Lower Oil Pan

Courtesy of GENERAL MOTORS COMPANY

4. Remove the lower oil pan (2) and fasteners (1).

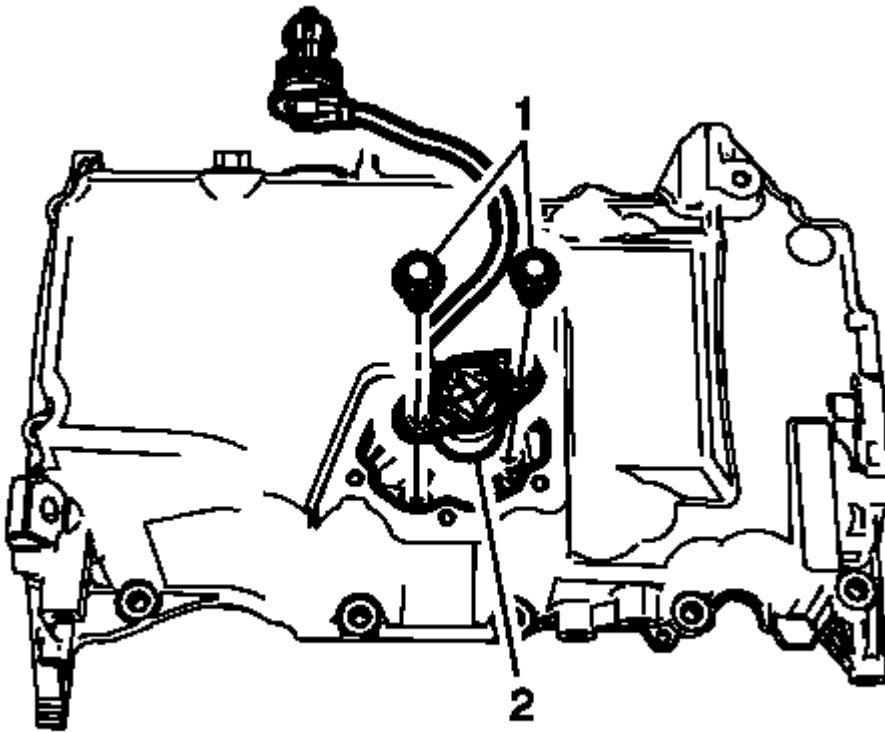


Fig. 212: Engine Oil Level Sensor

Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine oil level sensor fasteners (1).
6. Remove the engine oil level sensor (2) from the oil pan.

Installation Procedure

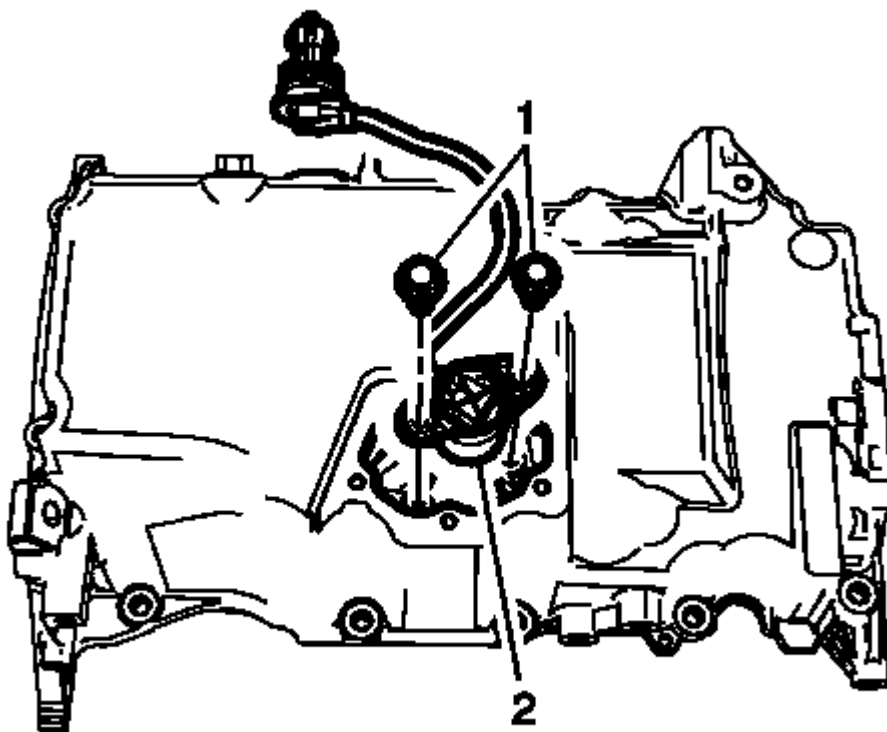


Fig. 213: Engine Oil Level Sensor

Courtesy of GENERAL MOTORS COMPANY

1. Install the engine oil level sensor (1) into the oil pan

CAUTION: Refer to Fastener Caution .

2. Install the engine oil level sensor fastener (1) and tighten to 10 (89 lb in).

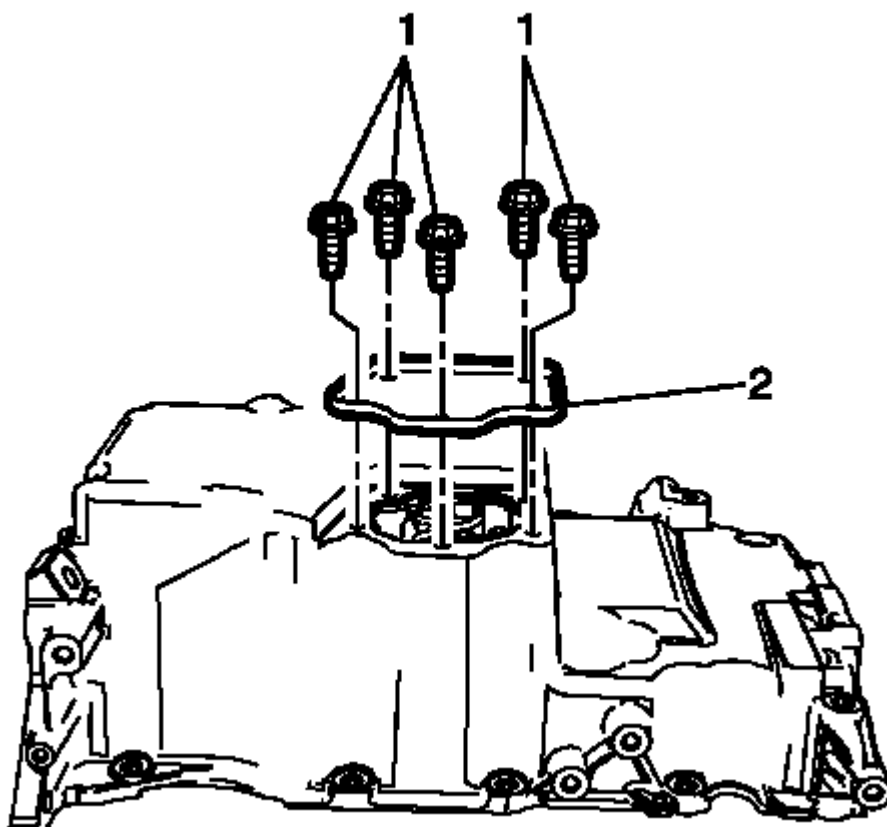


Fig. 214: Lower Oil Pan

Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply a 4.25 mm bead of sealer (1) on the level part of the flange around the perimeter of the lower oil pan. Refer to Adhesives, Fluids, Lubricants, and Sealers .

3. Install the lower oil pan (2) and fasteners (1) and tighten to 10 (89 lb in).

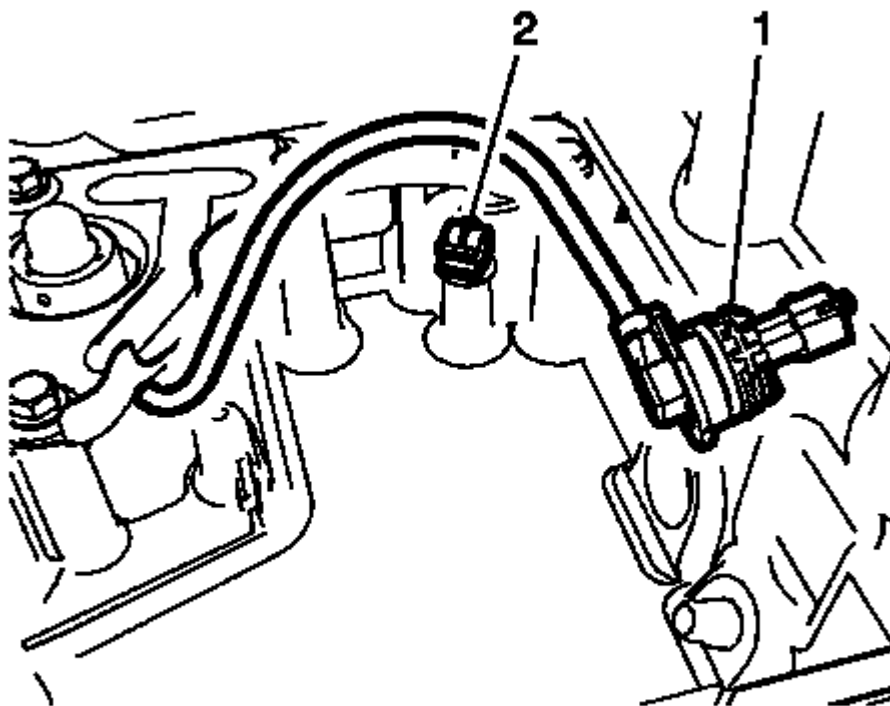


Fig. 215: Engine Oil Level Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Always install a NEW O-ring when installing the engine oil level sensor.

4. Connect the engine oil level sensor connector (1) to the oil pan with a NEW O-ring.
5. Connect the engine oil level sensor pigtail wire to the retainer (2).

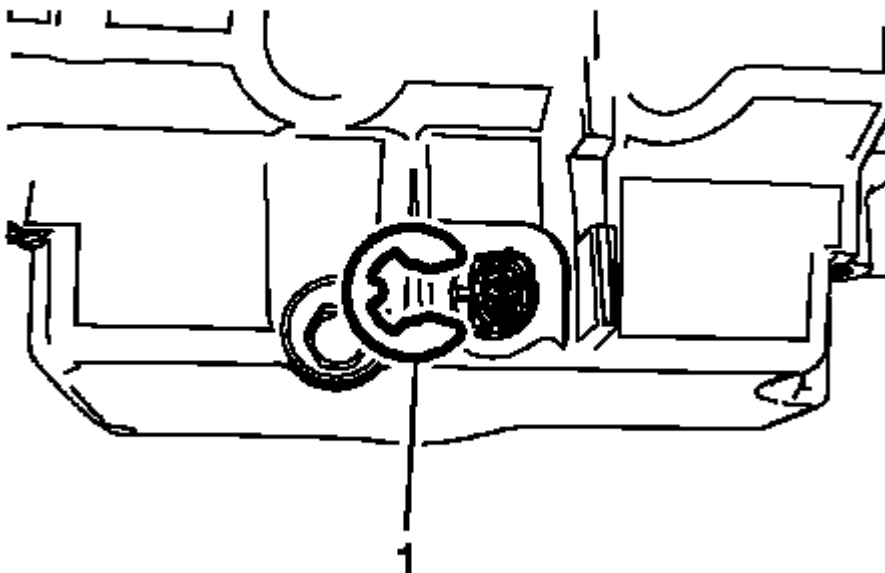


Fig. 216: Engine Oil Level Sensor

Courtesy of GENERAL MOTORS COMPANY

6. Install the engine oil level sensor retainer (1).
7. Install the oil pan. Refer to Oil Pan Replacement (AWD), Oil Pan Replacement (FWD).

ENGINE FLYWHEEL REPLACEMENT

Special Tools

- EN 50792 Flywheel Holding Tool
- EN-45059 Angle Meter

For equivalent regional tools, refer to Special Tools .

Removal Procedure

1. Remove the clutch assembly. Refer to Clutch Assembly Replacement (With DT-6263) .

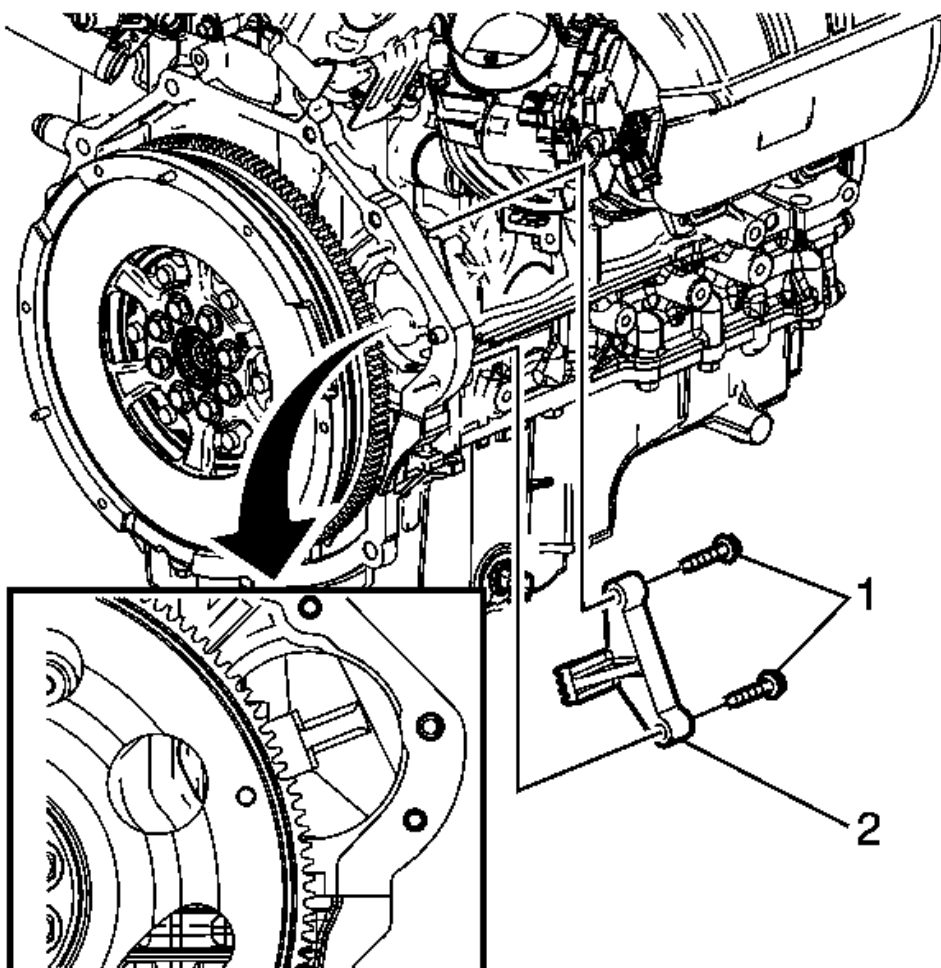


Fig. 217: Flywheel Holding Tool & Starter Motor Bolts
Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install EN-50792 holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flywheel.

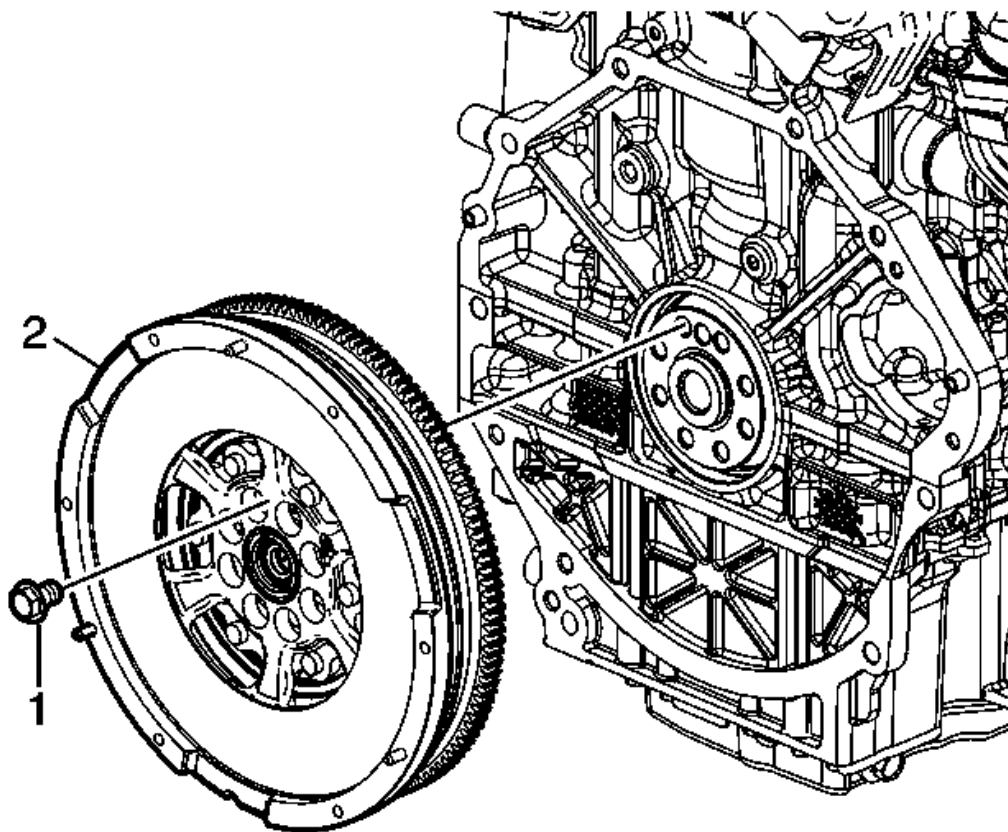


Fig. 218: Flywheel & Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the flywheel attaching bolts (1).
4. Remove the flywheel (2).
5. Remove **EN 50792** holding tool.

Installation Procedure

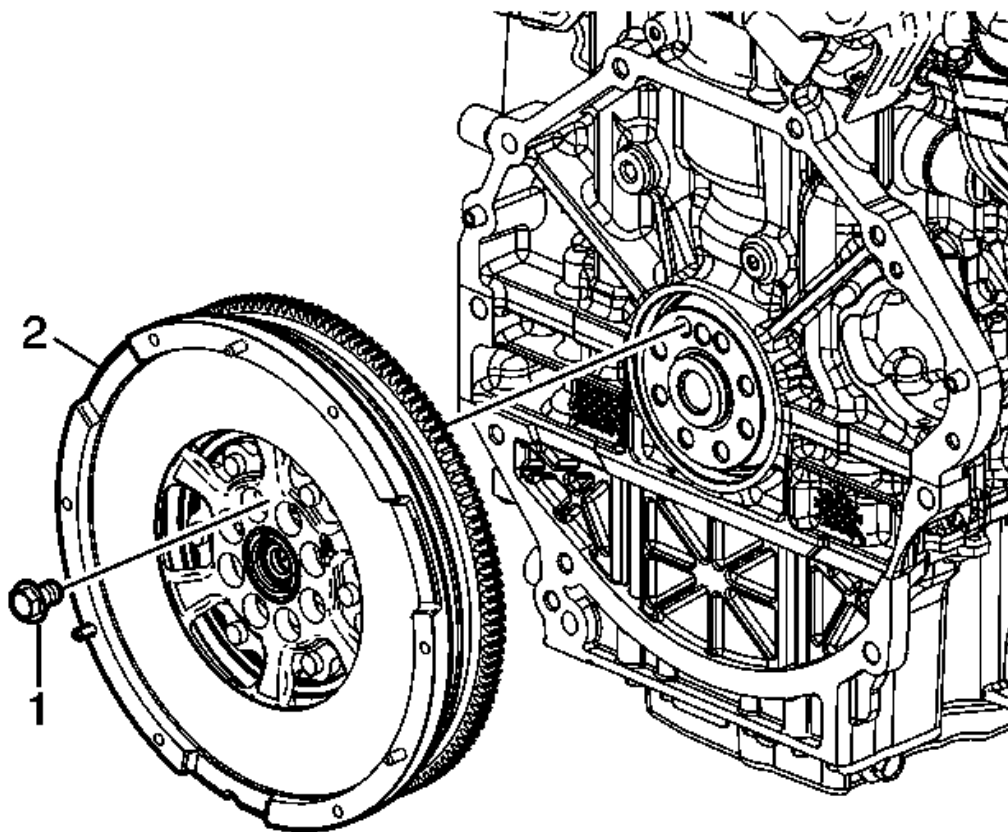


Fig. 219: Flywheel & Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Fasteners have adhesive patch and must be tightened to final torque within 5 minutes.

1. Install the flywheel (2) and hand start NEW bolts (1).

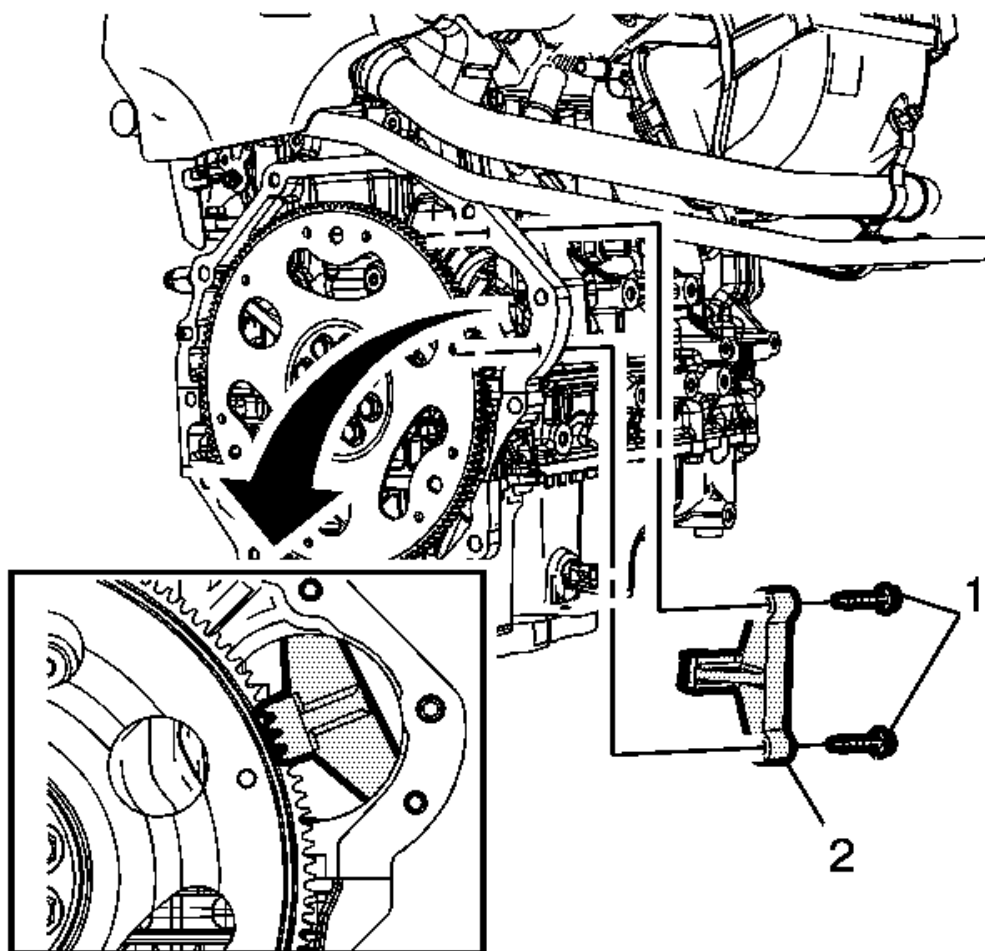


Fig. 220: Flywheel Holding Tool

Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install EN-50792 holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flywheel.

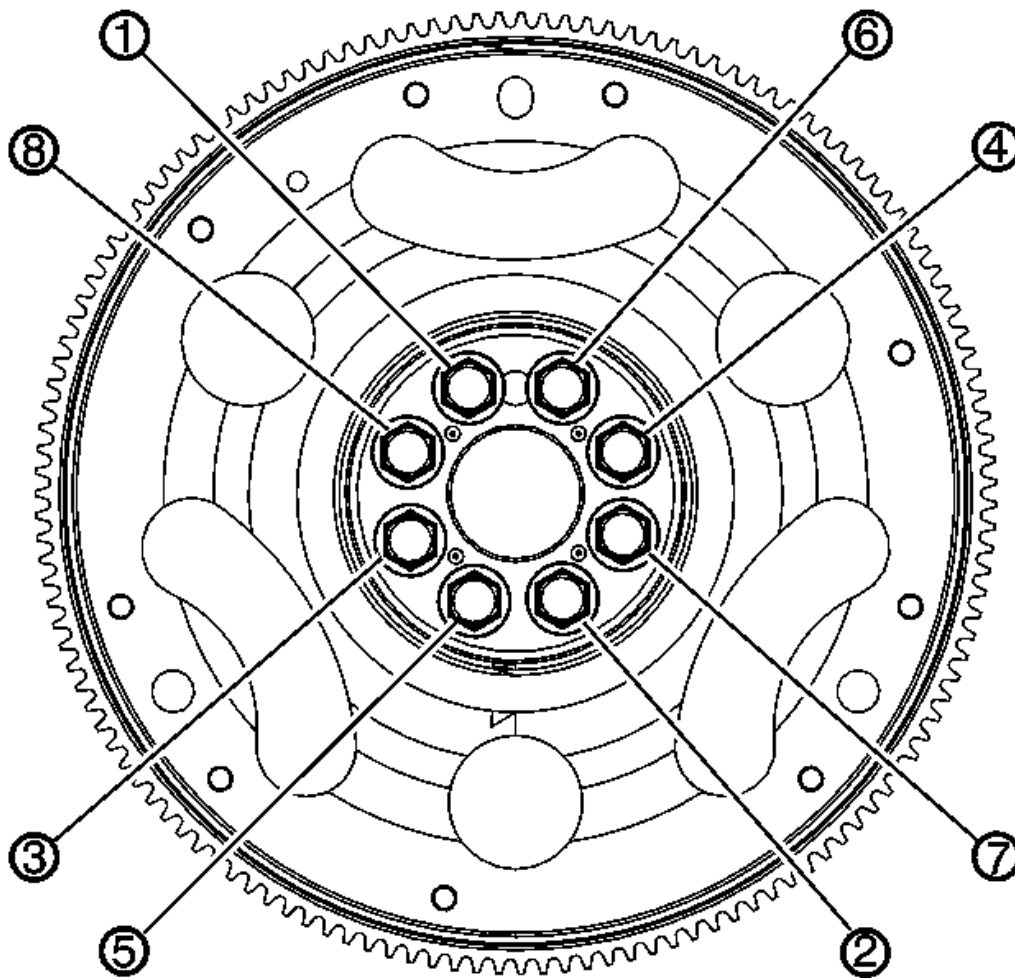


Fig. 221: Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Tighten the bolts evenly using the following procedure:
 1. Tighten the bolts a first pass in sequence to 20 (15 lb ft).
 2. Tighten the bolts a second pass in sequence to 30 (22 lb ft).
 3. Tighten the bolts a final pass in sequence 40 degrees using the **EN-45059** angle meter.
4. Remove **EN-50792** holding tool.
5. Install the clutch assembly. Refer to Clutch Assembly Replacement (With DT-6263) .

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Removal Procedure

Special Tools

- EN 45059 Angle Meter
- EN 46106 Holding Tool

For equivalent regional tools, refer to Special Tools .

1. Remove the transmission. Refer to Transmission Replacement .

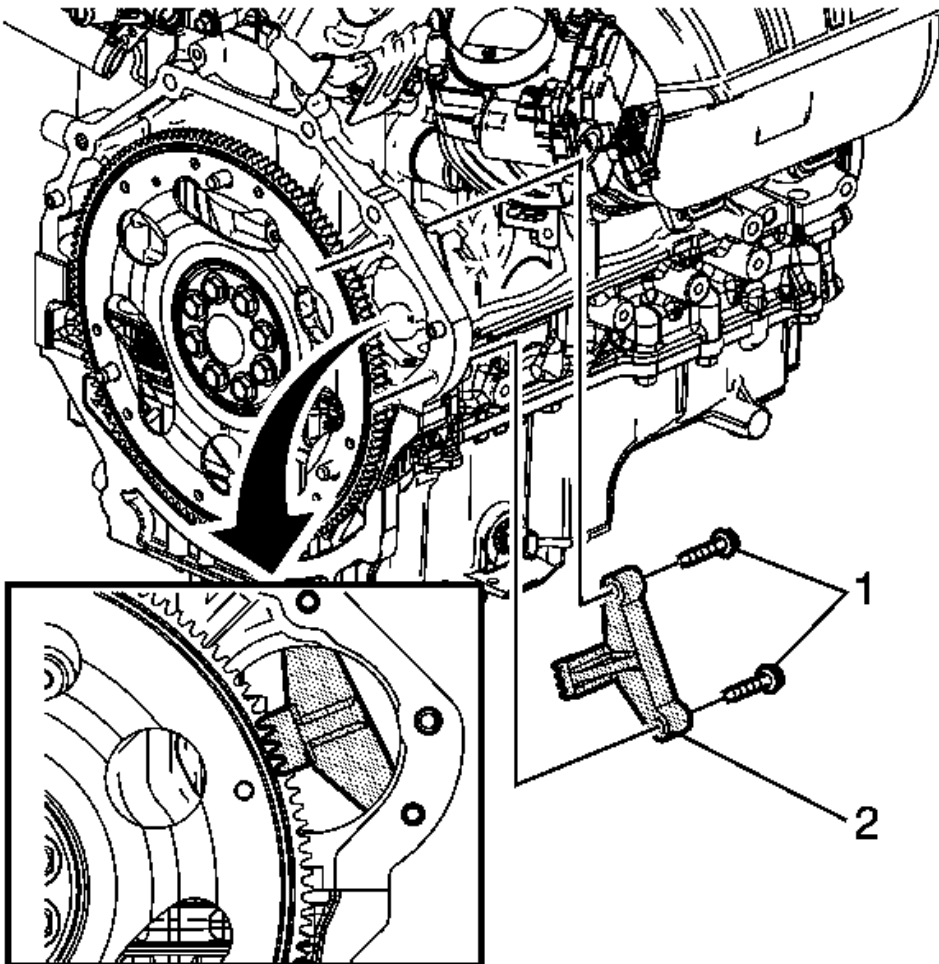


Fig. 222: Starter Motor Bolts

Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install EN 46106 holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the automatic flex plate.

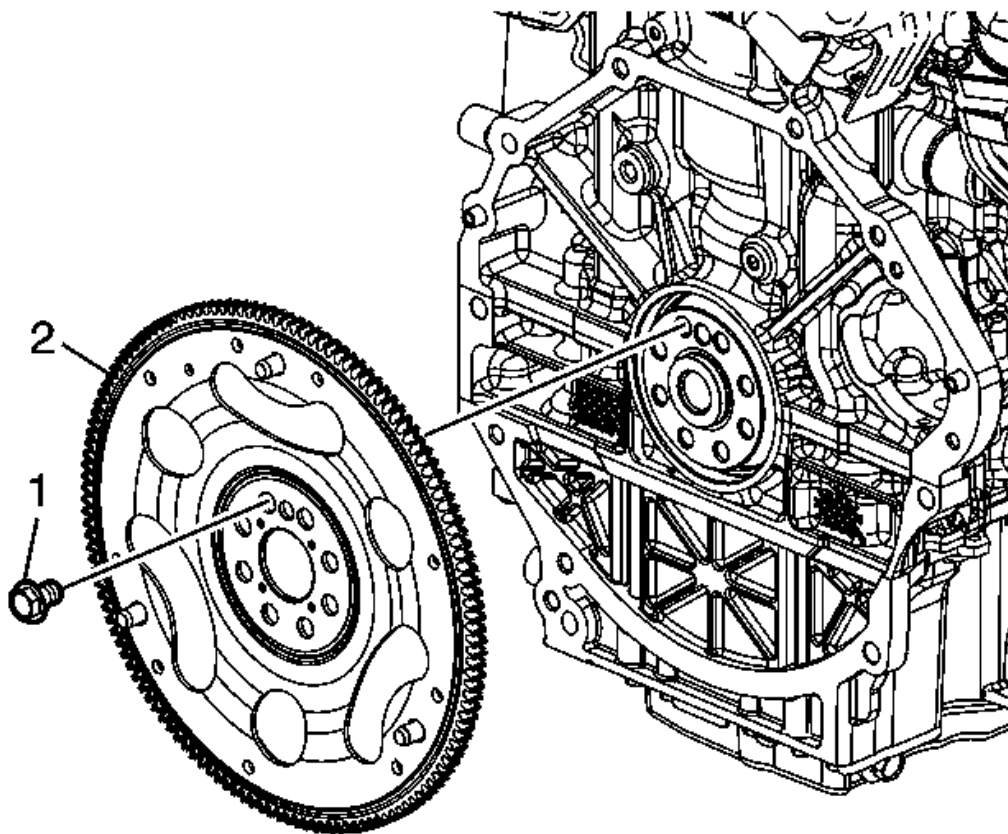


Fig. 223: Flywheel Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the automatic flex plate attaching bolts (1).
4. Remove the automatic flex plate (2).
5. Remove **EN 46106** holding tool.
6. For automatic flex plate cleaning and inspection, Refer to **Automatic Transmission Flex Plate Cleaning and Inspection** .

Installation Procedure

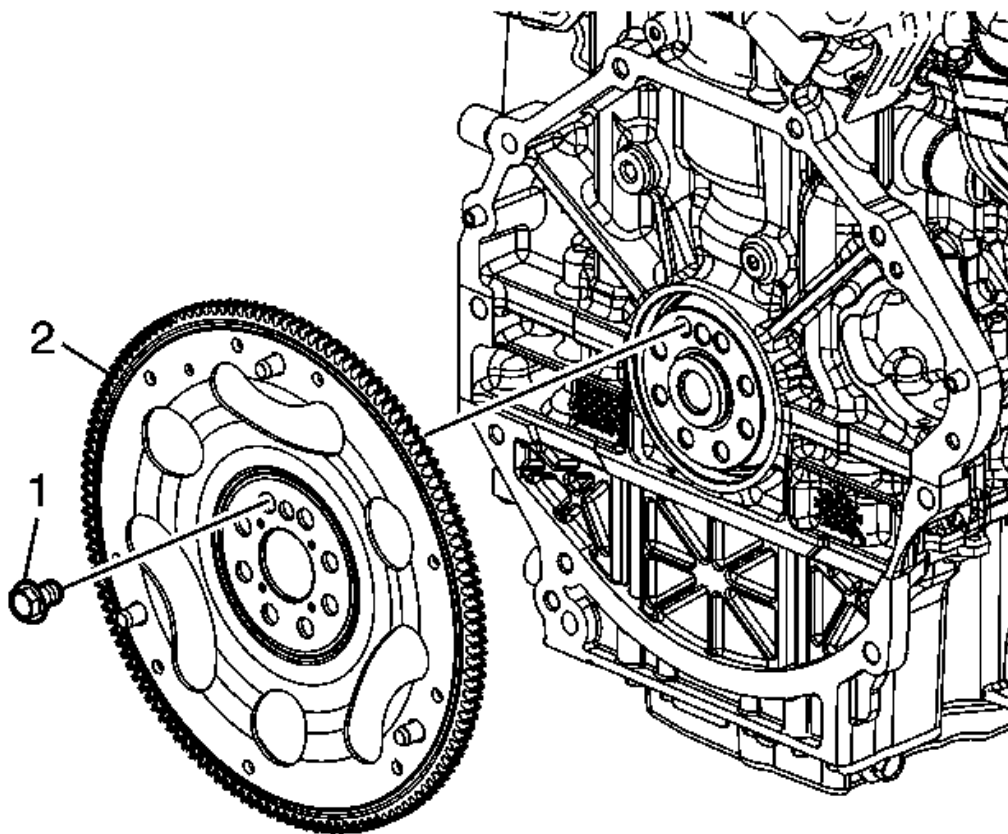


Fig. 224: Flywheel Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Fasteners have adhesive patch and must be tightened to final torque within 5 minutes.

1. Install the automatic flex plate (2) and hand start NEW bolts (1).

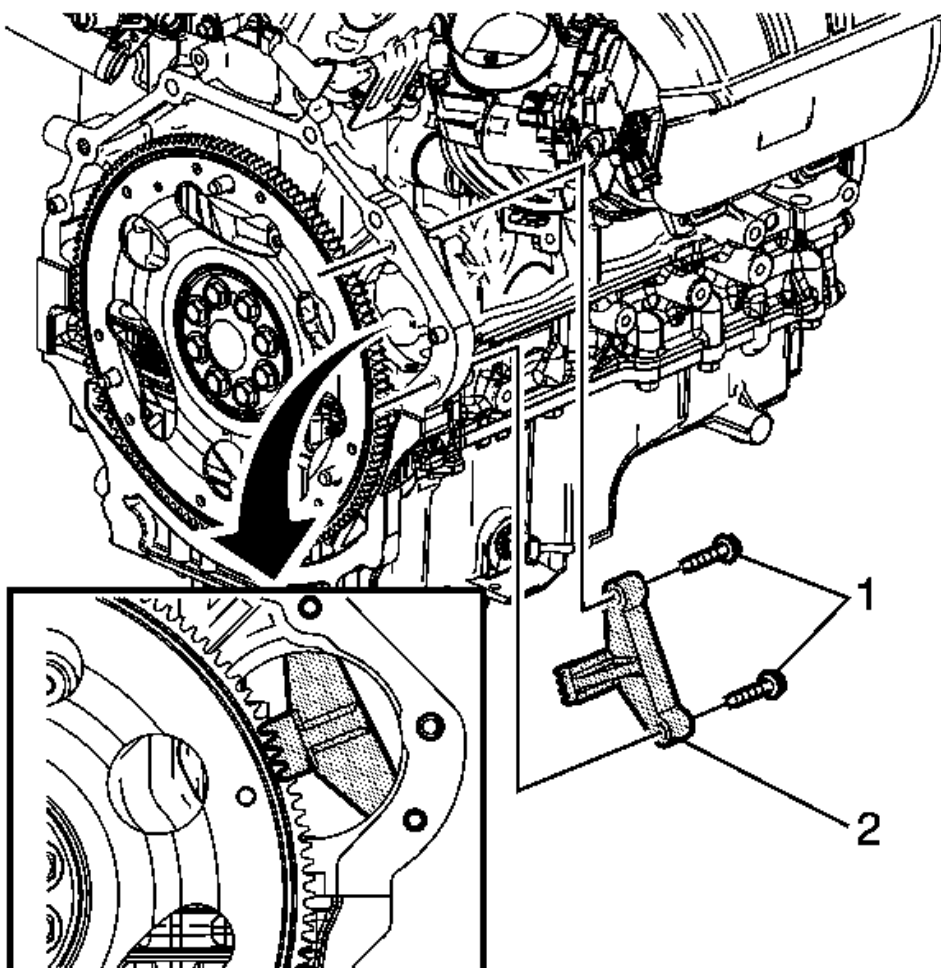


Fig. 225: Starter Motor Bolts

Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install **EN 46106** holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flex plate.

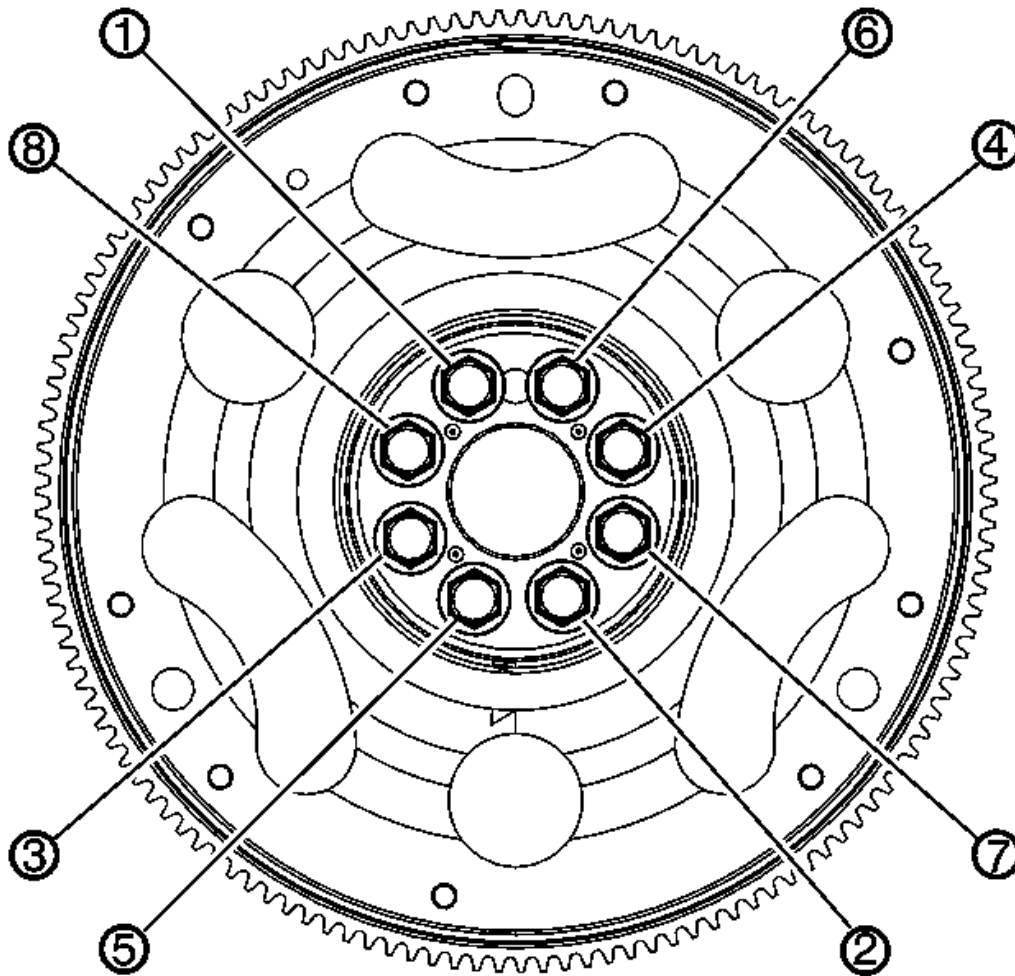


Fig. 226: Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Tighten the bolts evenly using the following procedure:
 1. Tighten the bolts a first pass in sequence to 20 (15 lb ft).
 2. Tighten the bolts a second pass in sequence to 30 (22 lb ft).
 3. Tighten the bolts a final pass in sequence 40 degrees using the **EN 45059** meter.
4. Remove **EN 46106** holding tool.
5. Install the transmission. Refer to Transmission Replacement .

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

EN-51380 Rear Main Seal Installer

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

Removal Procedure

1. If equipped with an automatic transmission, remove the flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.
2. If equipped with a manual transmission, remove the flywheel. Refer to **Engine Flywheel Replacement**.

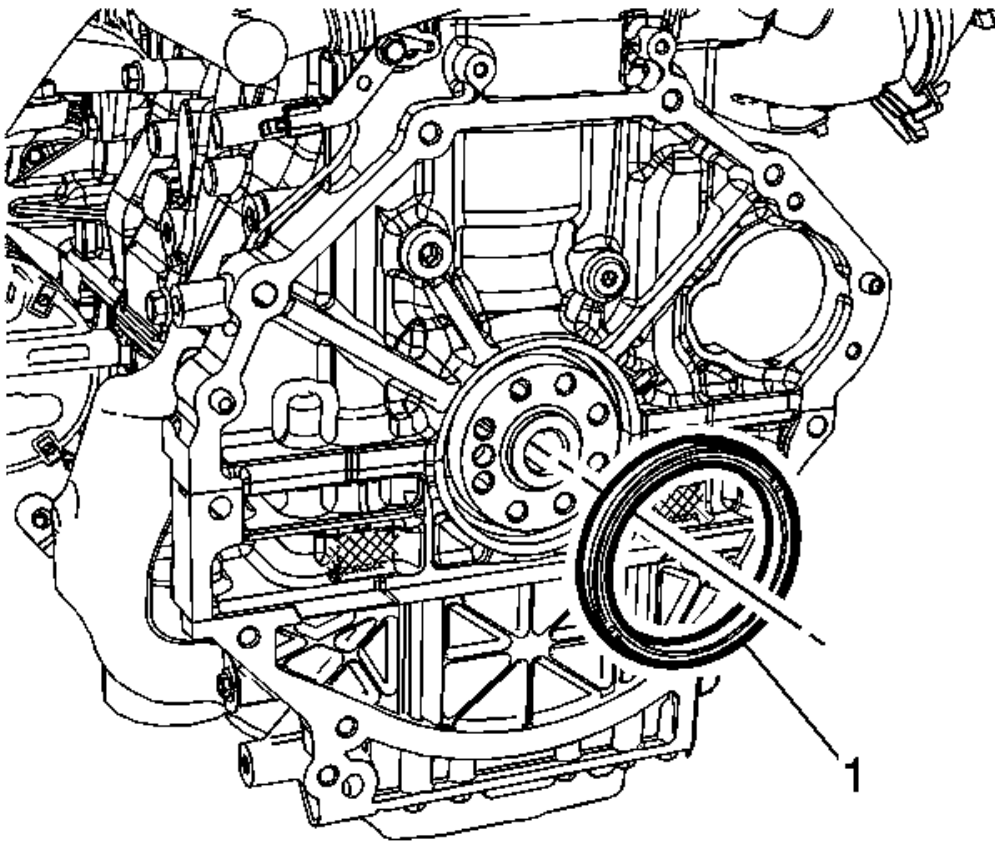


Fig. 227: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

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

3. Use a suitable tool to remove the crankshaft rear oil seal (1).

Installation Procedure

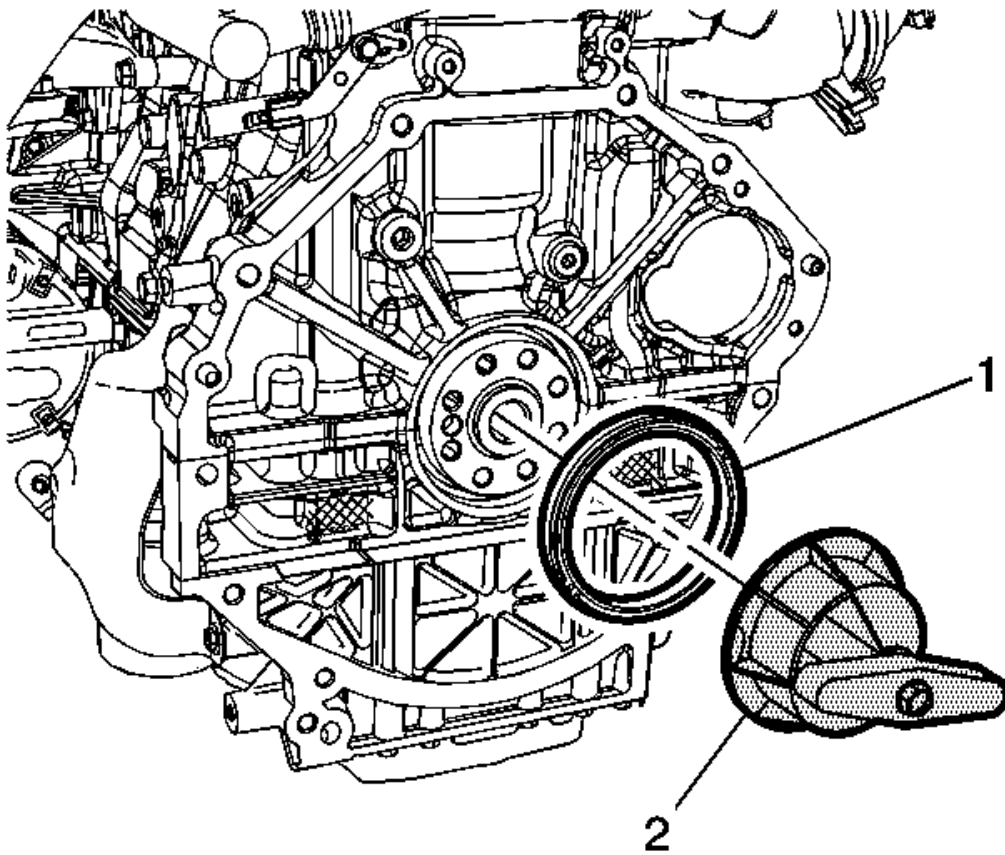


Fig. 228: Crankshaft Rear Oil Seal

Courtesy of GENERAL MOTORS COMPANY

1. Using the (2) **EN-51380** seal installer , install a NEW crankshaft rear oil seal (1).
2. If equipped with a manual transmission, install the flywheel and transmission. Refer to **Engine Flywheel Replacement**.
3. If equipped with an automatic transmission, install the automatic transmission flex plate and transmission. Refer to **Automatic Transmission Flex Plate Replacement**.

ENGINE REPLACEMENT (FWD)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
3. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

4. Evacuate the A/C system. Refer to **Refrigerant Recovery and Recharging** .
5. Remove the battery tray. Refer to **Battery Tray Replacement** .
6. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .

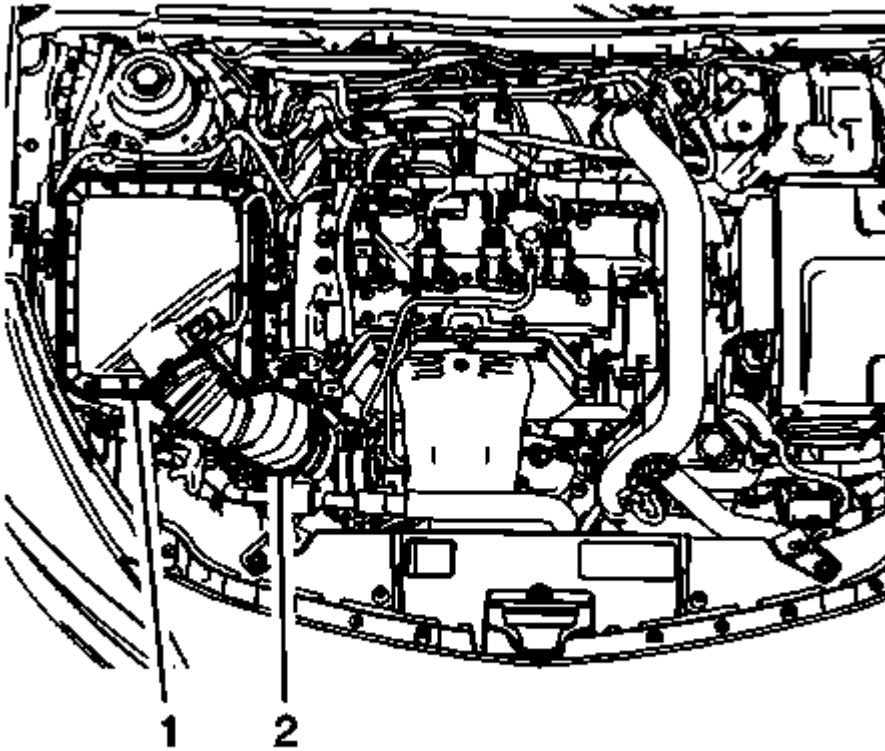


Fig. 229: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

7. Remove the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .
8. Remove the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement** .

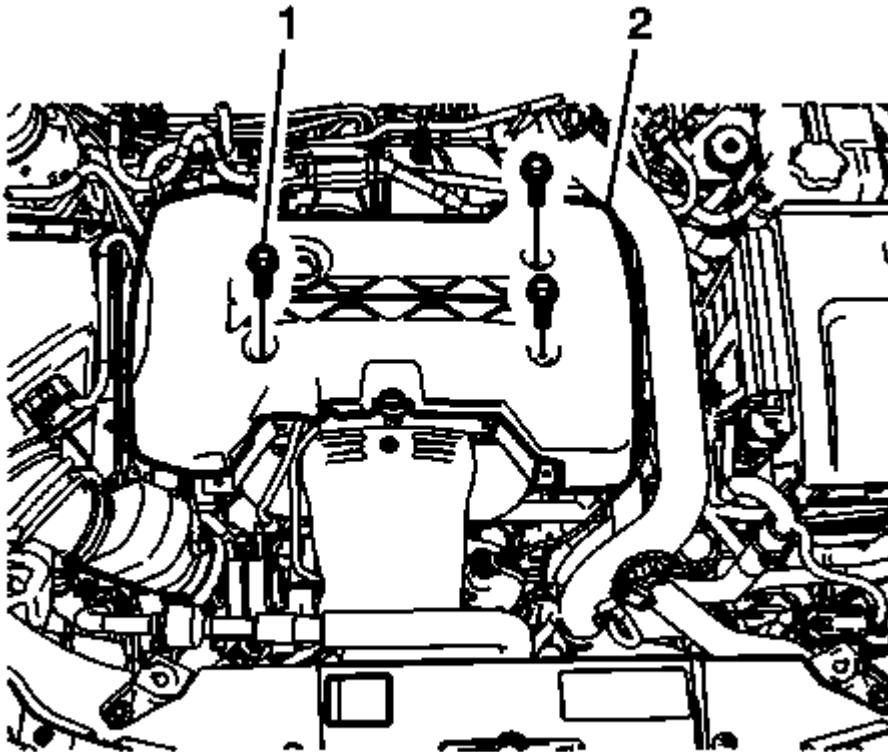


Fig. 230: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

9. Remove the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.

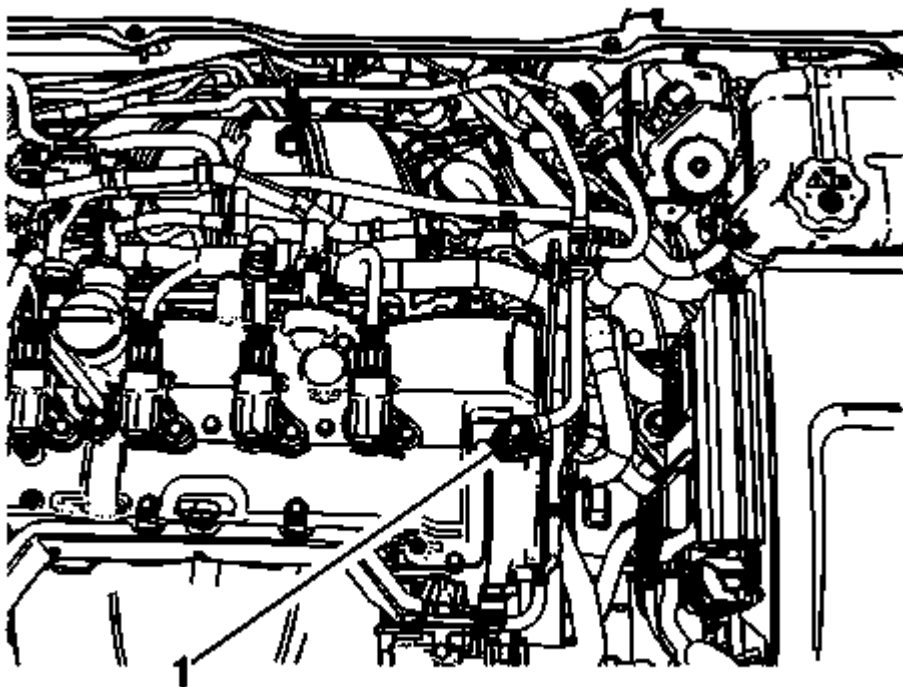


Fig. 231: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

10. Disconnect the vacuum hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
11. Disconnect the fuel line (1). Refer to **Metal Collar Quick Connect Fitting Service** .

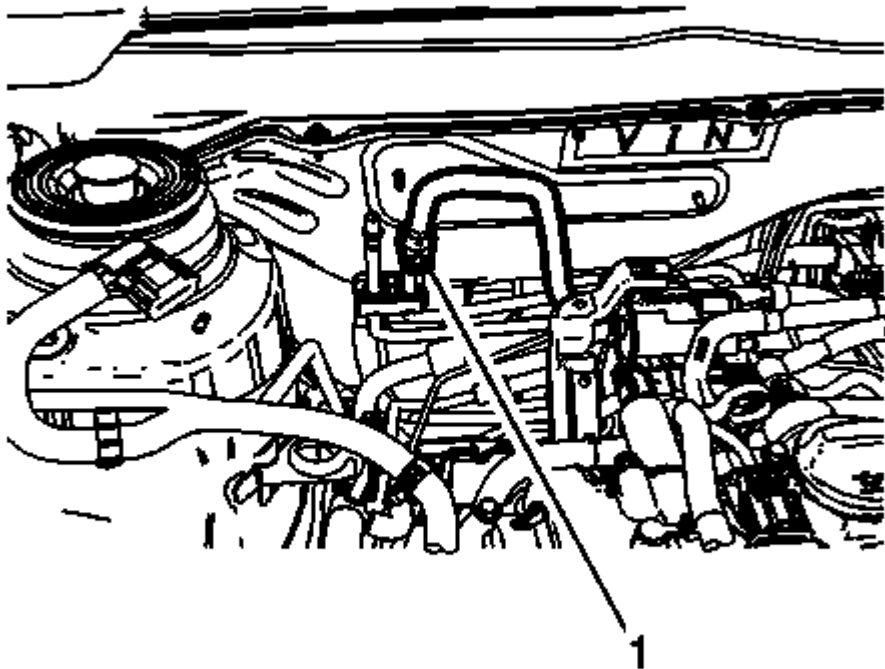


Fig. 232: EVAP Hose

Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the EVAP hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

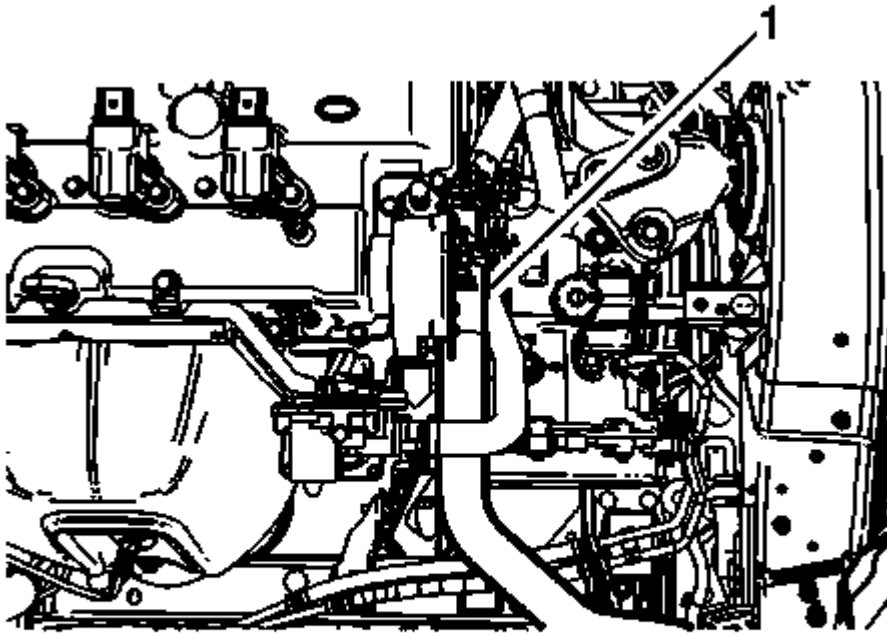


Fig. 233: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the radiator outlet hose (1). Refer to **Radiator Outlet Hose Replacement (LTG)** .

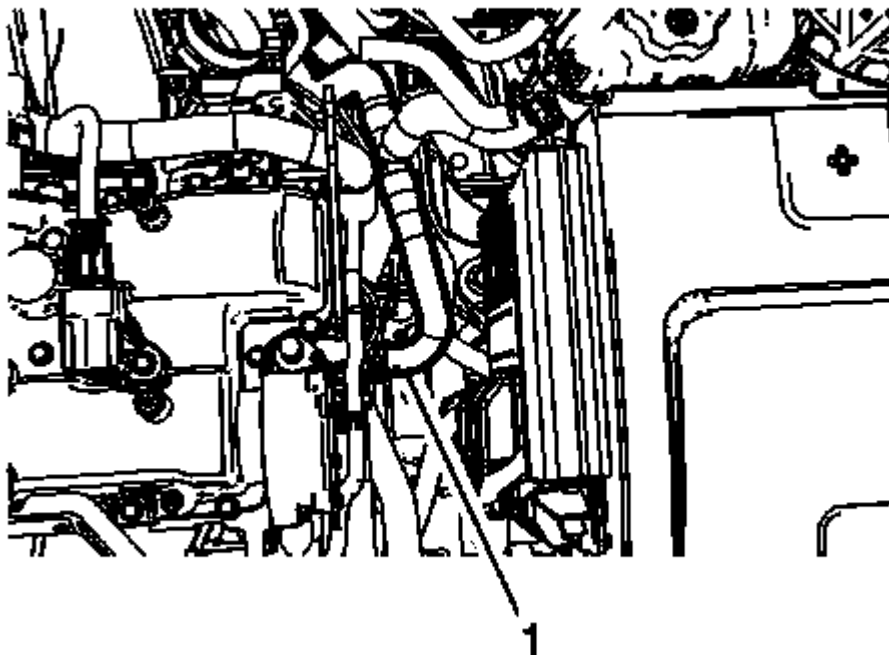


Fig. 234: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

14. Remove the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LTG)** .
15. Remove the heater outlet hose (2). Refer to **Heater Outlet Hose Replacement (LTG)** .

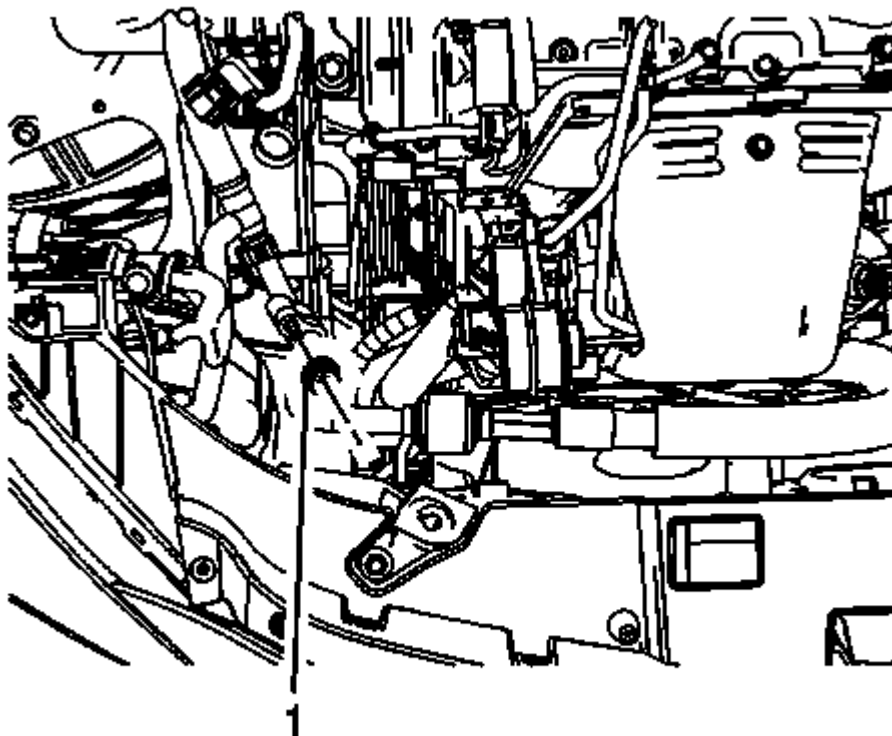


Fig. 235: Air Conditioning Compressor And Condenser Hose
Courtesy of GENERAL MOTORS COMPANY

16. Remove the air conditioning compressor and condenser hose (1). Refer to **Air Conditioning Compressor and Condenser Hose Replacement (LUK)** .

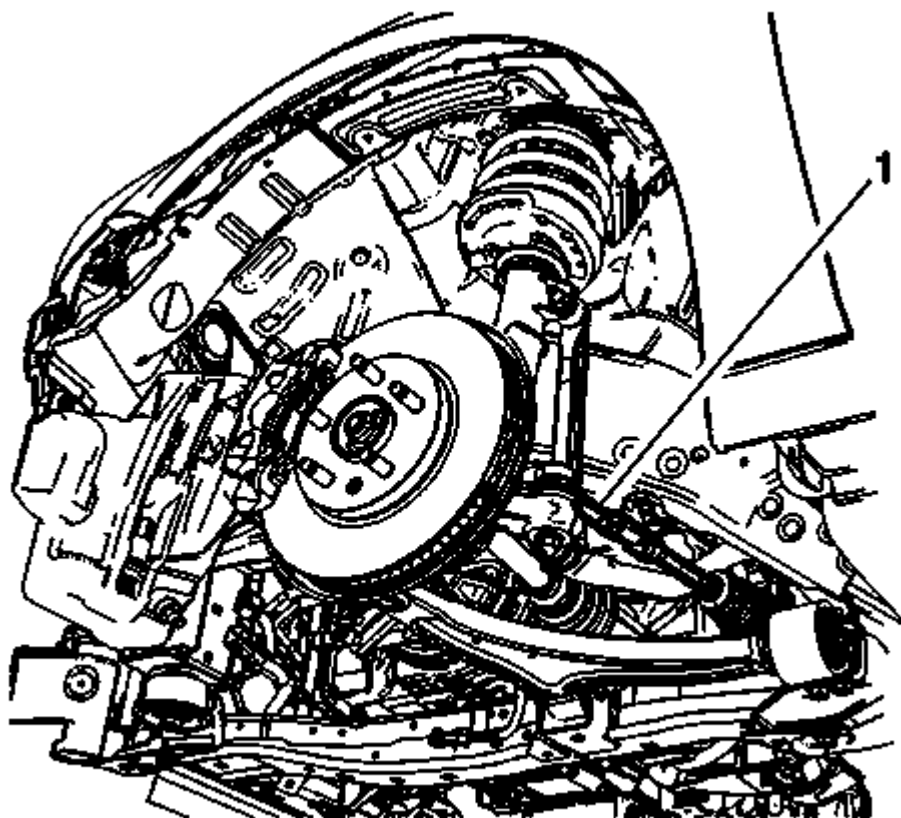


Fig. 236: Tie Rods And Steering Knuckles

Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the tie rods (1) from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

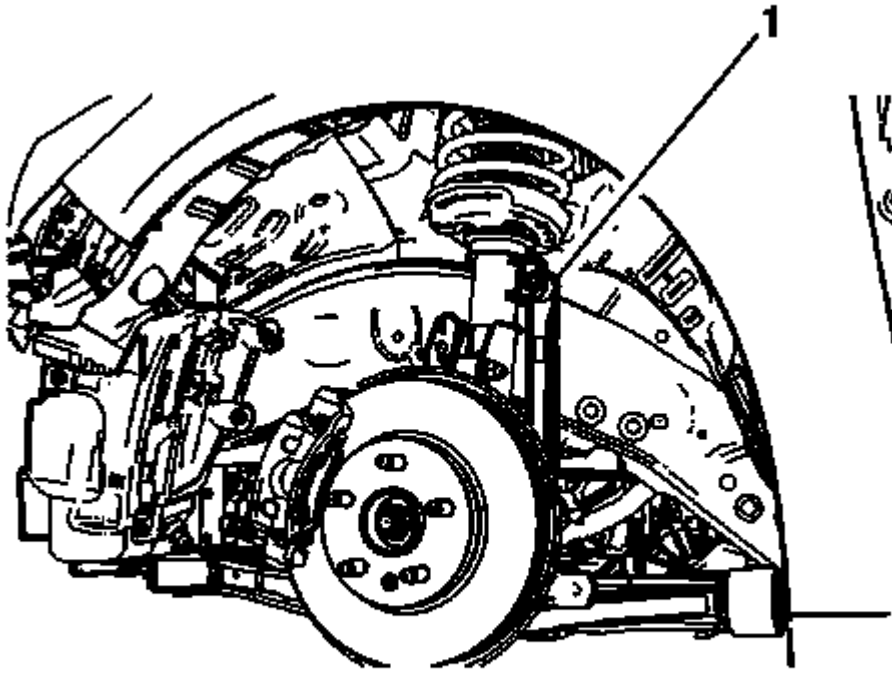


Fig. 237: Stabilizer Links

Courtesy of GENERAL MOTORS COMPANY

18. Disconnect the stabilizer links (1) from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)** .
19. Disconnect the intermediate shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
20. Remove the exhaust system. Refer to **Exhaust Front Pipe Replacement (LTG)** .
21. Disconnect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB)** .
22. Remove the left wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side** .
23. Remove the intermediate drive shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement (with MR6)** , **Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)** .

NOTE: During the powertrain removal support the vehicle body by placing a jack at the rear of the vehicle.

24. Position an engine support table under the powertrain assembly.
25. Blocks of wood can be used between the front of the frame and the oil pan to table in order to level the powertrain during the removal.

26. With the table positioned, fully raise the table to contact with the powertrain assembly.

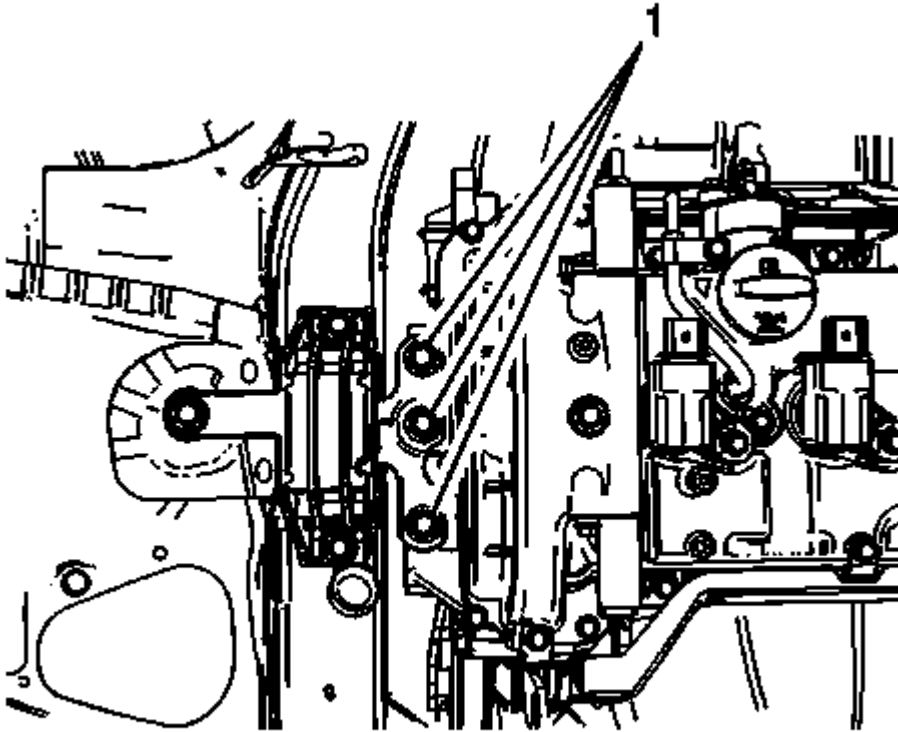


Fig. 238: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

27. Remove the engine mount (1). Refer to **Engine Mount Replacement**.
28. Remove the transmission mount . Refer to **Transmission Mount Replacement - Left Side** .
29. Remove the frame to body bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .
30. Disconnect electrical connectors as necessary.
31. Carefully lower the engine table and raise the body on the hoist until the engine/transaxle and frame are separated from the vehicle.
32. Separate the engine from the transaxle. Refer to **Transmission Replacement** .
33. Install the engine to a suitable engine stand.

Installation Procedure

1. Install the engine and transaxle back together. Refer to **Transmission Replacement** .
2. Position the powertrain support table under the vehicle.
3. Raise the powertrain into position under the vehicle.

4. With the table positioned, if required, lower the vehicle over the powertrain.
5. Install the NEW frame to body bolts. Refer to **Drivetrain and Front Suspension Frame Replacement**.
6. Lower the vehicle.
7. Install the transmission mount. Refer to **Transmission Mount Replacement - Left Side**.

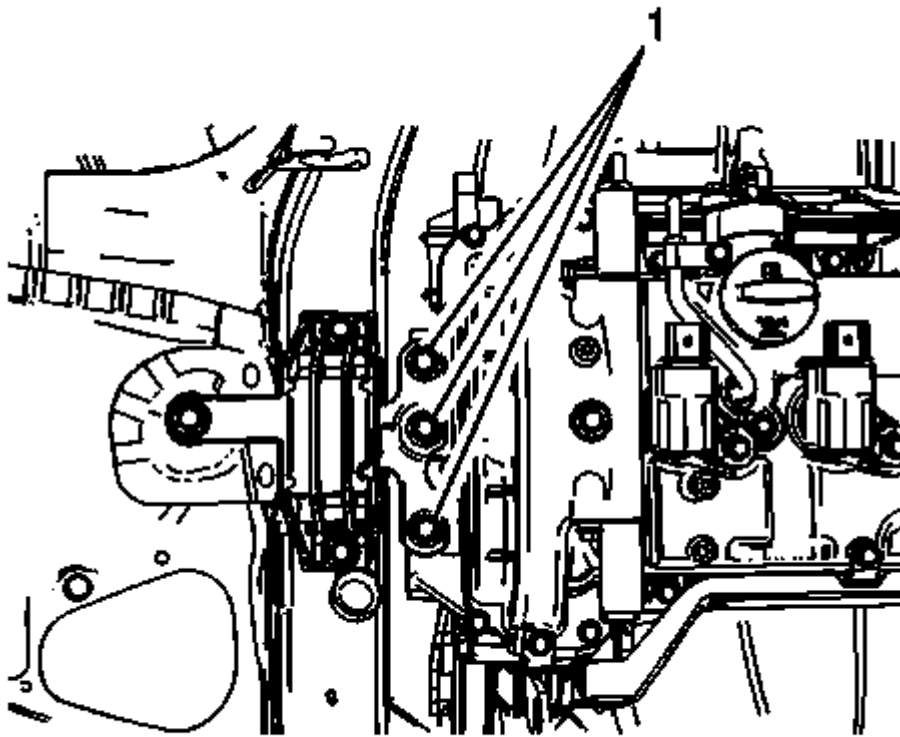


Fig. 239: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

8. Install the engine mount (1). Refer to **Engine Mount Replacement**.
9. Install the intermediate drive shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement (with MR6)**, **Front Wheel Drive Intermediate Shaft Replacement (with MHH, MHK or MDK)**.
10. Install the left wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side**.
11. Connect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (GNA)**, **Lower Control Arm Replacement (GNB)**.
12. Install the exhaust system. Refer to **Exhaust Front Pipe Replacement (LTG)**.
13. Connect the intermediate shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement**.

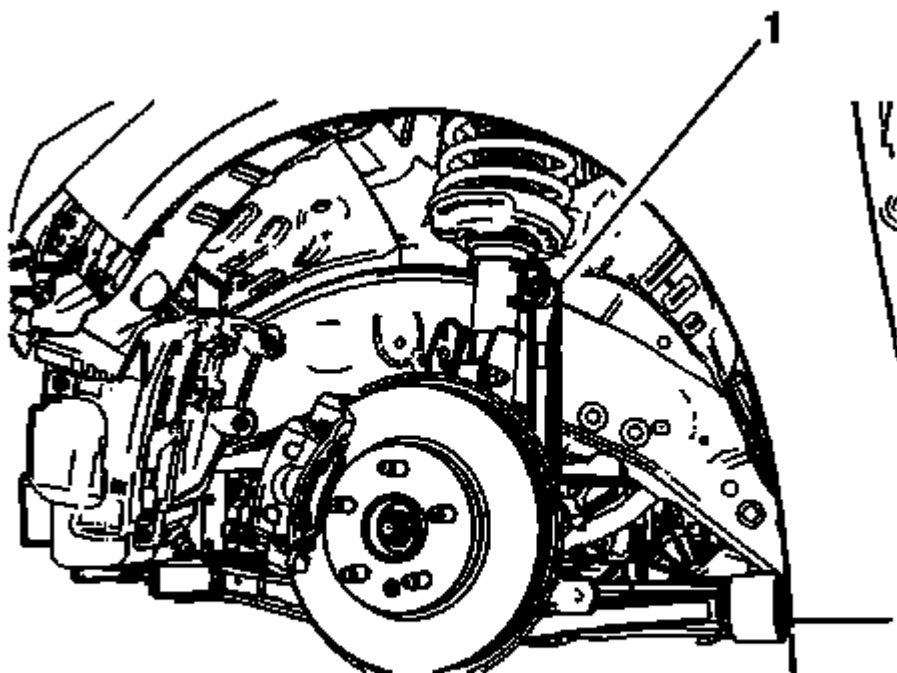


Fig. 240: Stabilizer Links

Courtesy of GENERAL MOTORS COMPANY

14. Connect the stabilizer links (1) from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)** .

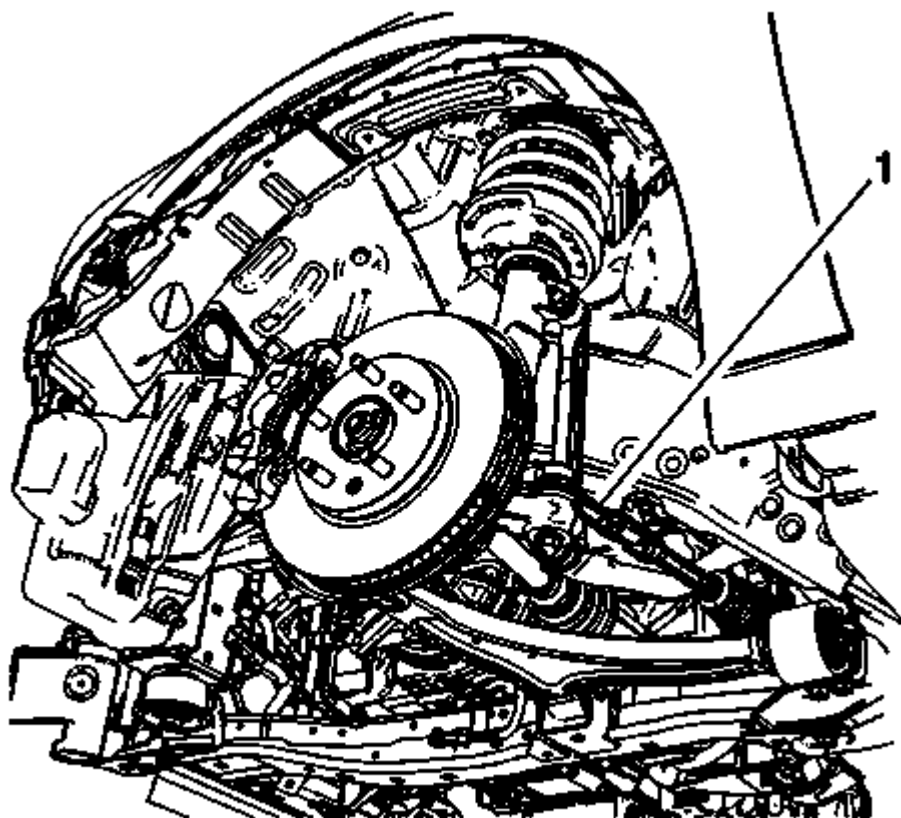


Fig. 241: Tie Rods And Steering Knuckles

Courtesy of GENERAL MOTORS COMPANY

15. Connect the tie rods (1) from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

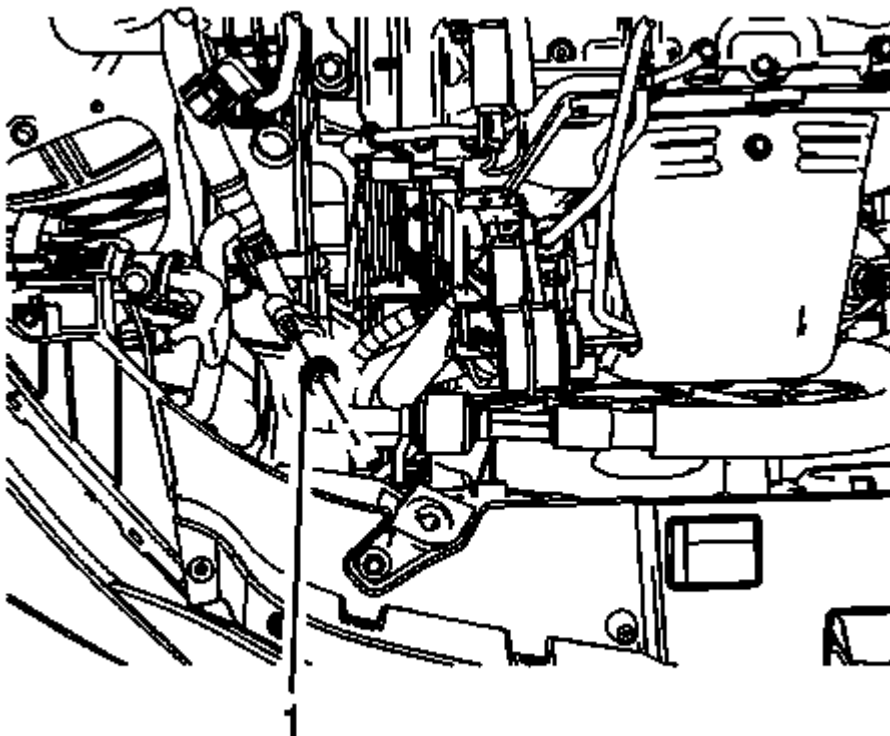


Fig. 242: Air Conditioning Compressor And Condenser Hose
Courtesy of GENERAL MOTORS COMPANY

16. Install the air conditioning compressor and condenser hose (1). Refer to **Air Conditioning Compressor and Condenser Hose Replacement (LUK)** .

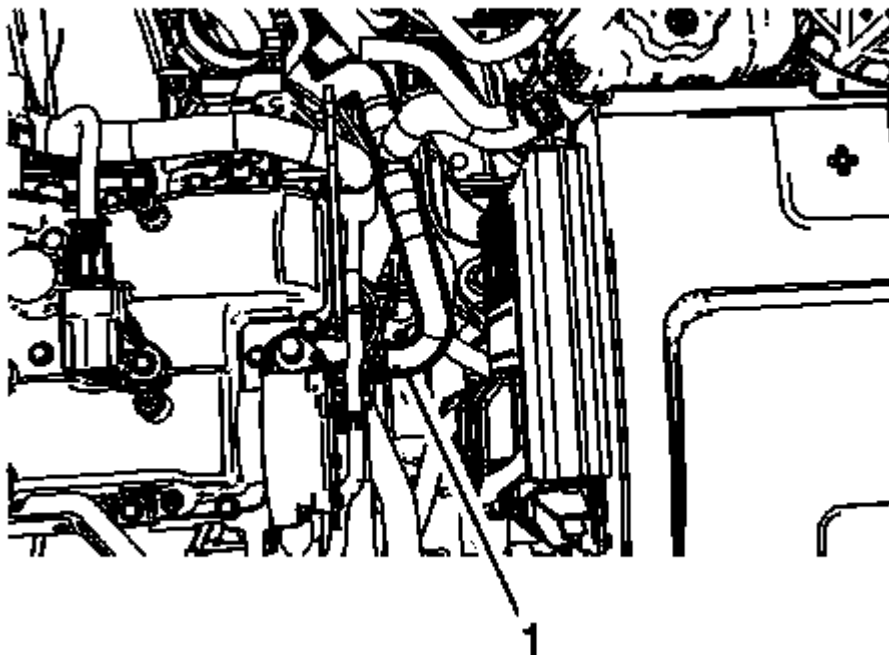


Fig. 243: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

17. Install the heater outlet hose (2). Refer to **Heater Outlet Hose Replacement (LTG)** .
18. Install the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LTG)** .

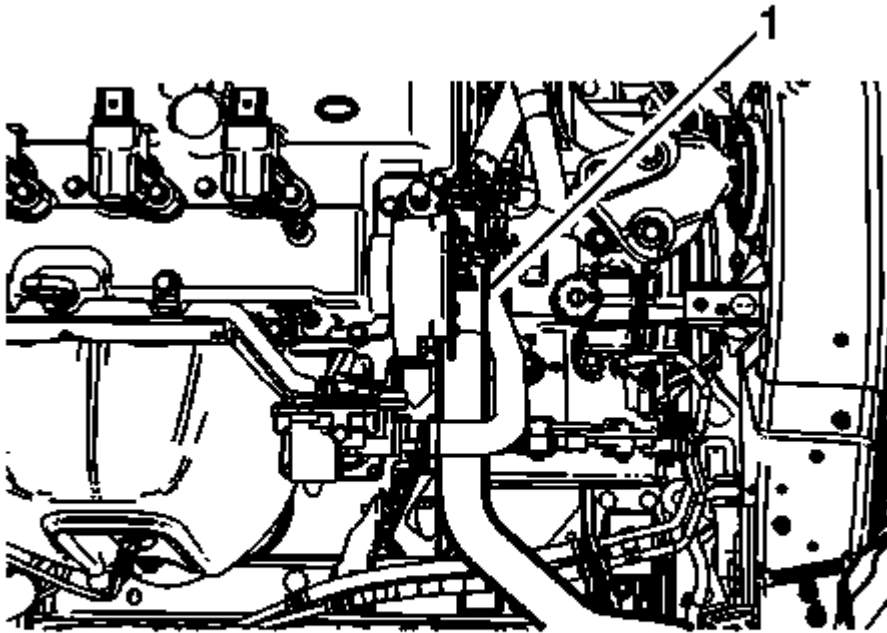


Fig. 244: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

19. Connect the radiator outlet hose (1). Refer to **Radiator Outlet Hose Replacement (LTG)** .

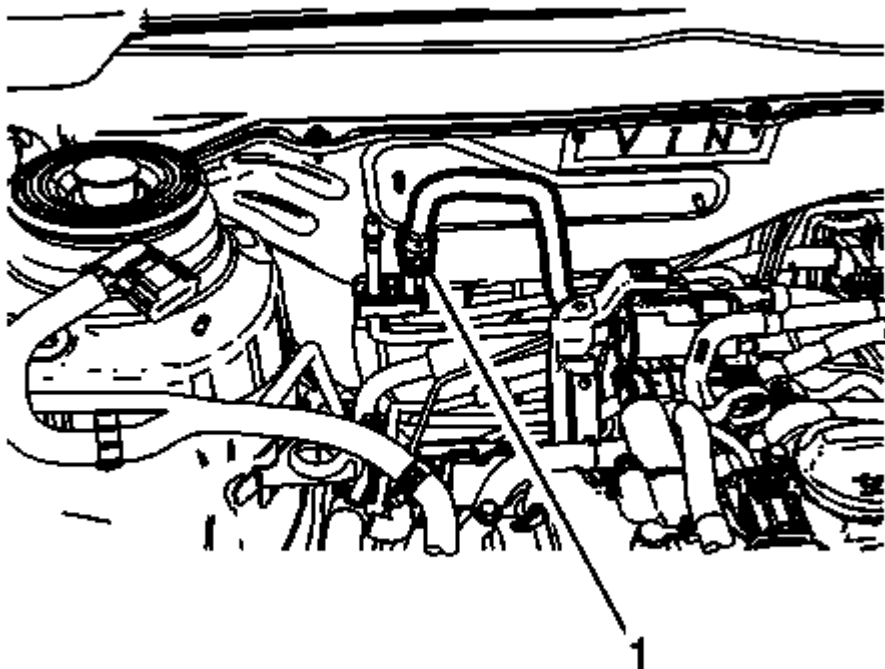


Fig. 245: EVAP Hose

Courtesy of GENERAL MOTORS COMPANY

20. Connect the EVAP hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
21. Connect the fuel line (1). Refer to **Metal Collar Quick Connect Fitting Service** .

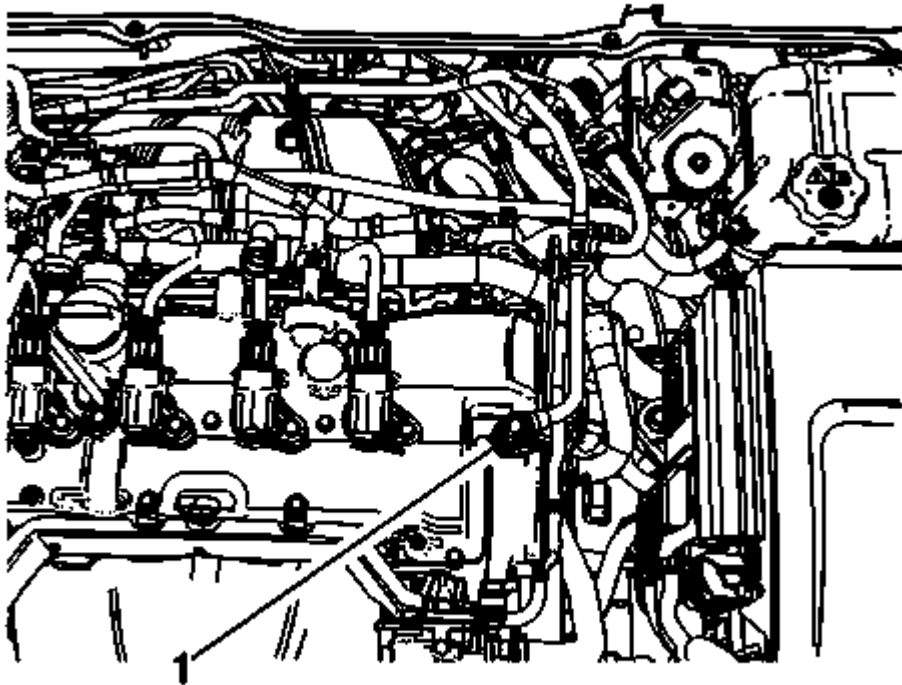


Fig. 246: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

22. Connect the vacuum hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

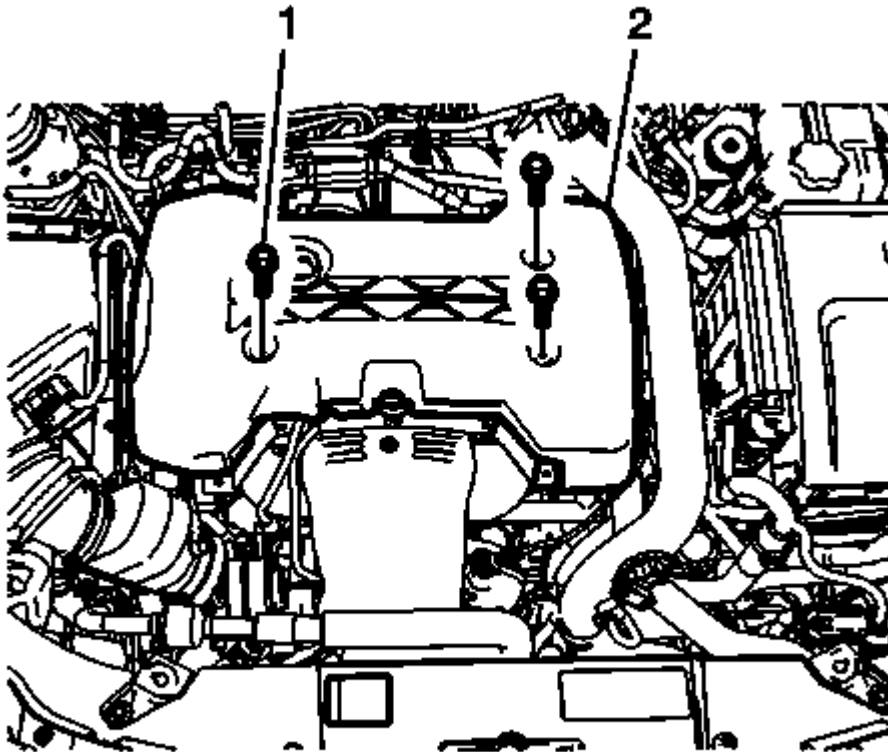


Fig. 247: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

23. Install the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.

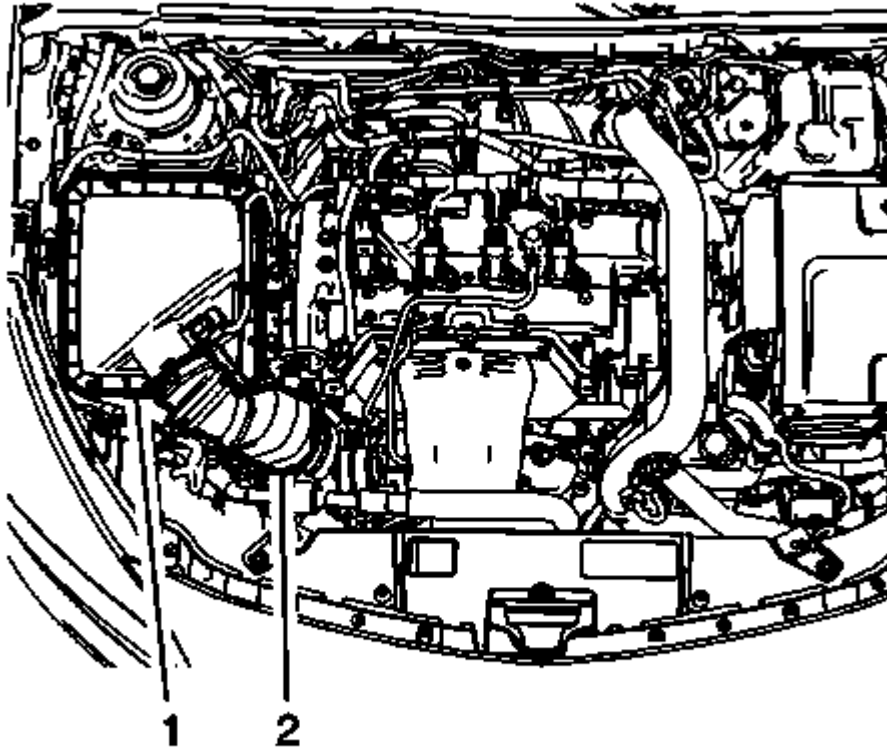


Fig. 248: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

24. Install the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .
25. Install the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement** .
26. Install the battery tray. Refer to **Battery Tray Replacement** .
27. Recharge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
28. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
29. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
30. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

ENGINE REPLACEMENT (AWD)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .

3. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
4. Evacuate the A/C system. Refer to **Refrigerant Recovery and Recharging**.
5. Remove the battery tray. Refer to **Battery Tray Replacement**.
6. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

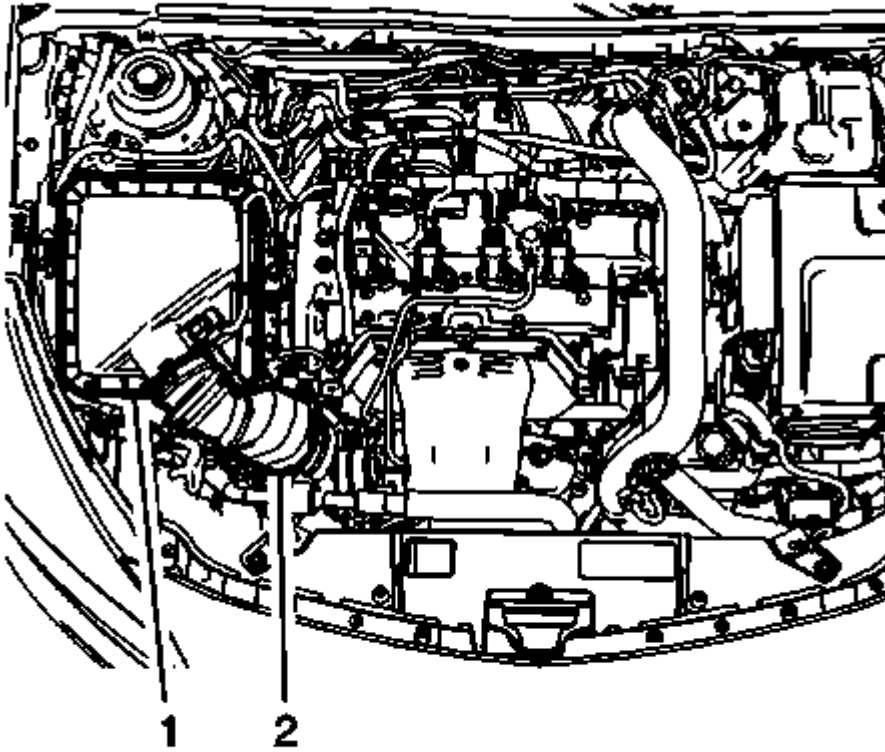


Fig. 249: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

7. Remove the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement**.
8. Remove the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement**.

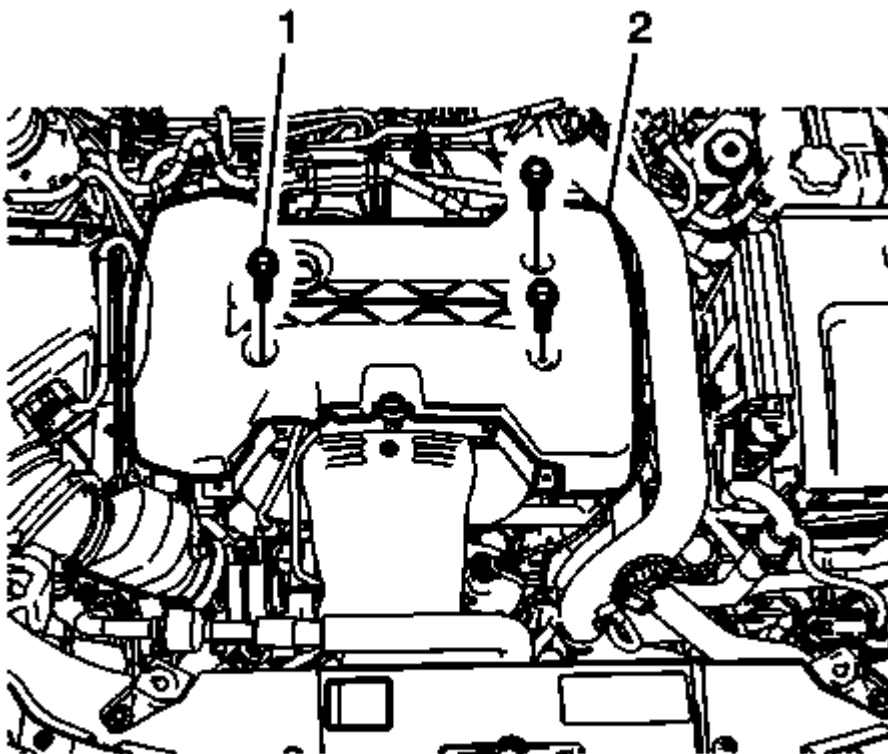


Fig. 250: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

9. Remove the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.

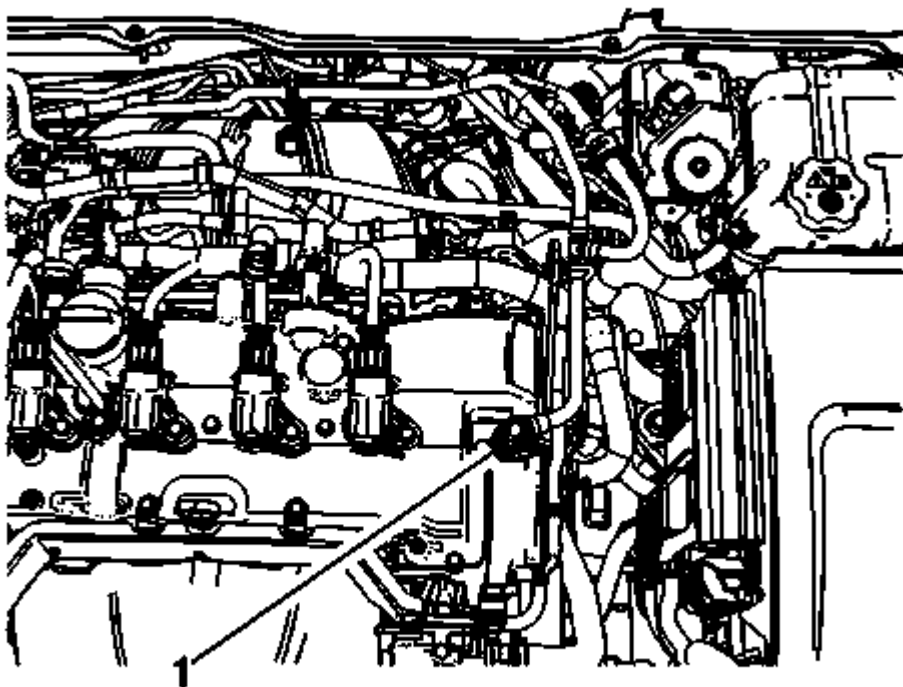


Fig. 251: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

10. Disconnect the vacuum hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
11. Disconnect the fuel line. Refer to **Metal Collar Quick Connect Fitting Service** .

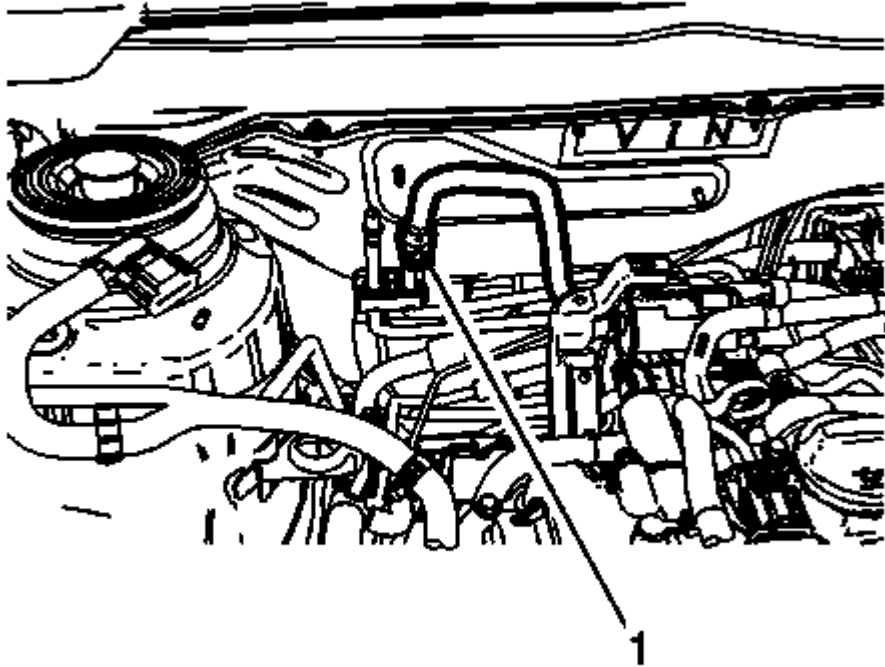


Fig. 252: EVAP Hose

Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the EVAP hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

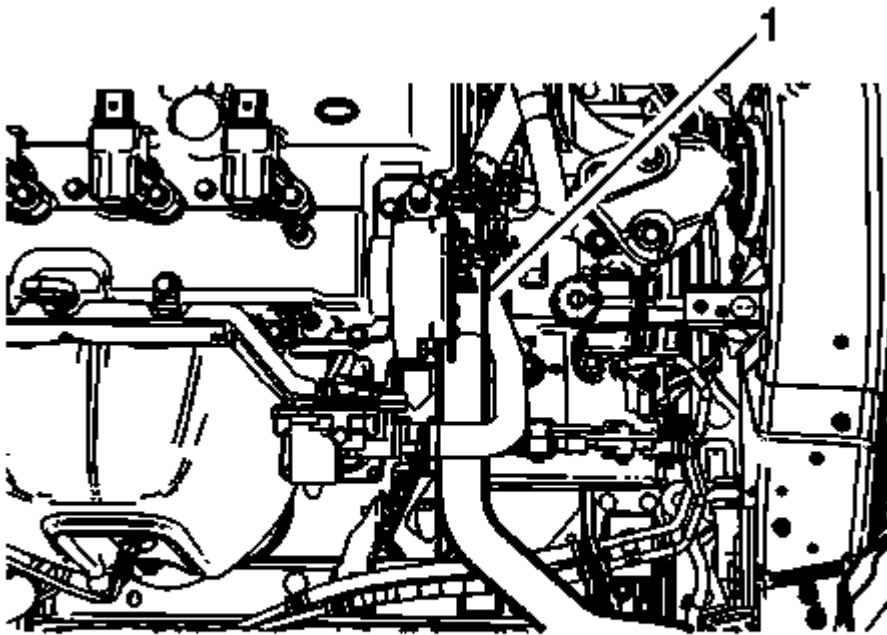


Fig. 253: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the radiator outlet hose (1). Refer to **Radiator Outlet Hose Replacement (LTG)** .

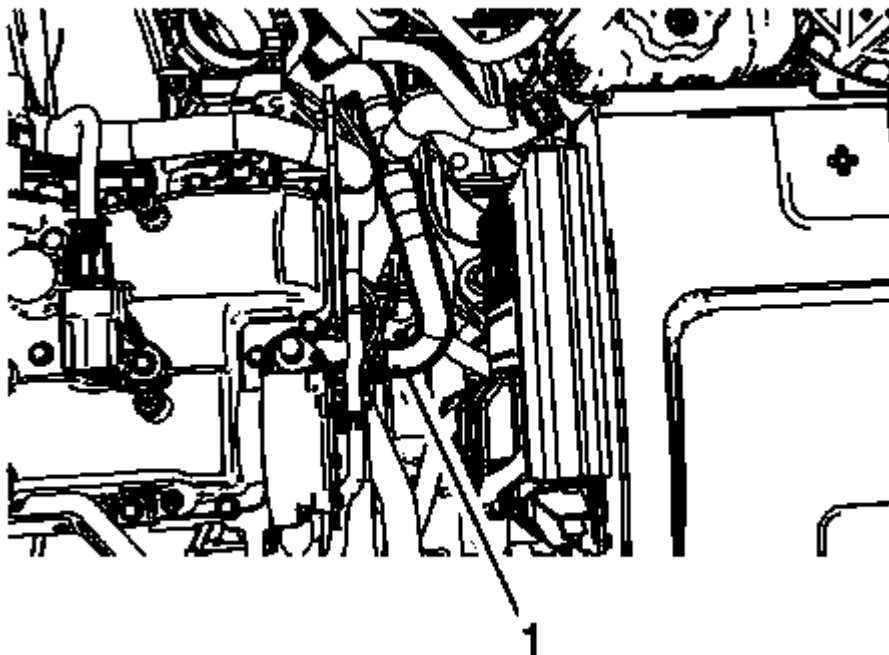


Fig. 254: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

14. Remove the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LTG)** .
15. Remove the heater outlet hose. Refer to **Heater Outlet Hose Replacement (LTG)** .

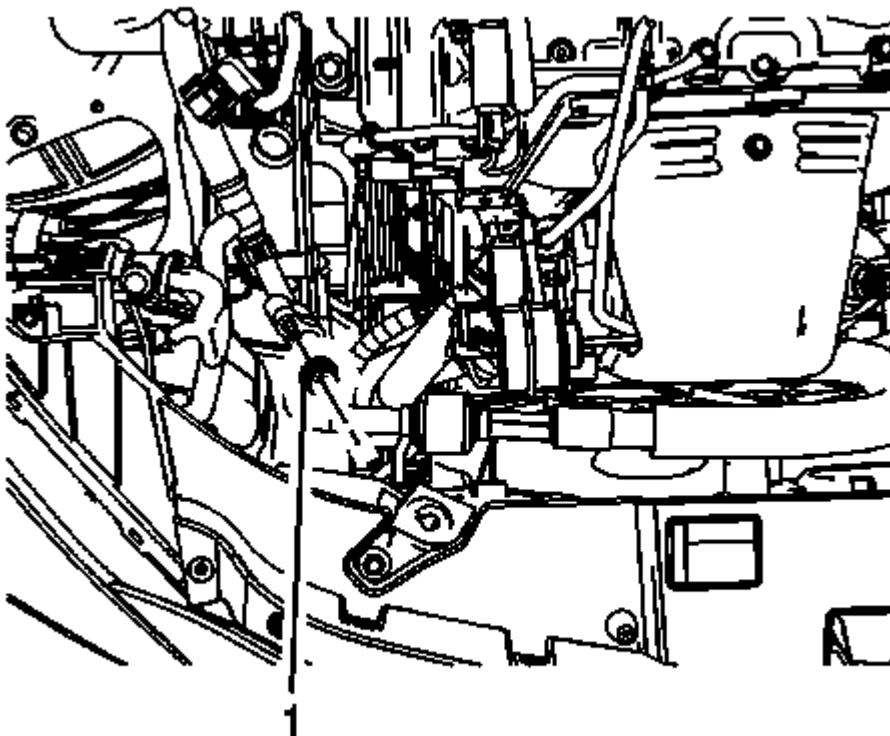


Fig. 255: Air Conditioning Compressor And Condenser Hose
Courtesy of GENERAL MOTORS COMPANY

16. Remove the air conditioning compressor and condenser hose (1).

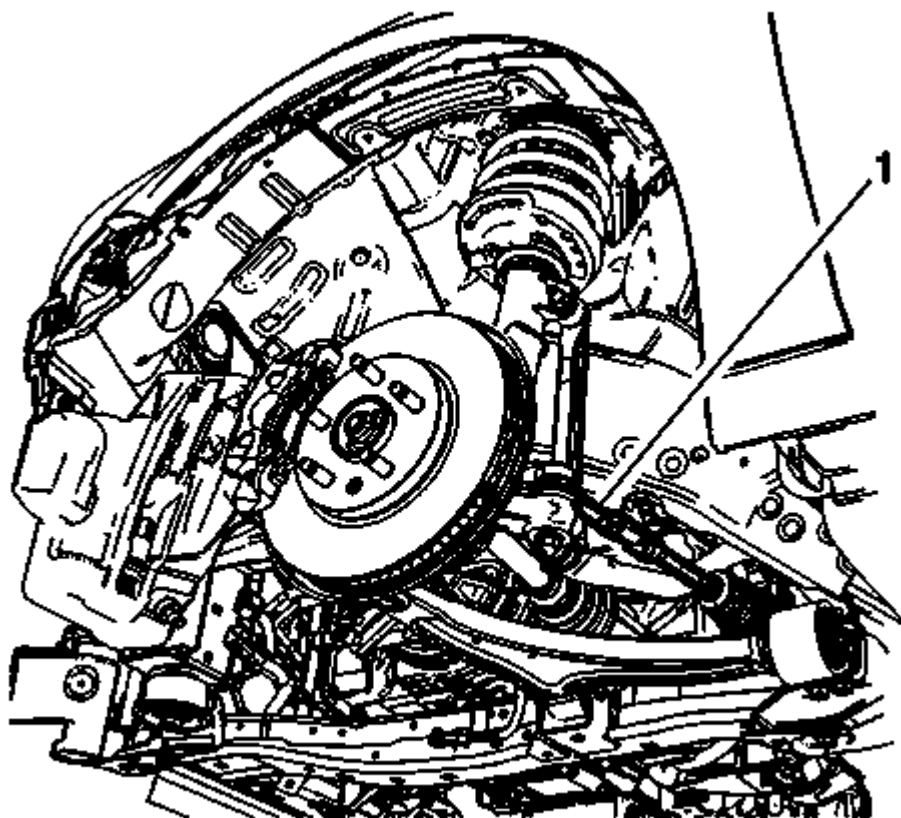


Fig. 256: Tie Rods And Steering Knuckles

Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the tie rods (1) from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

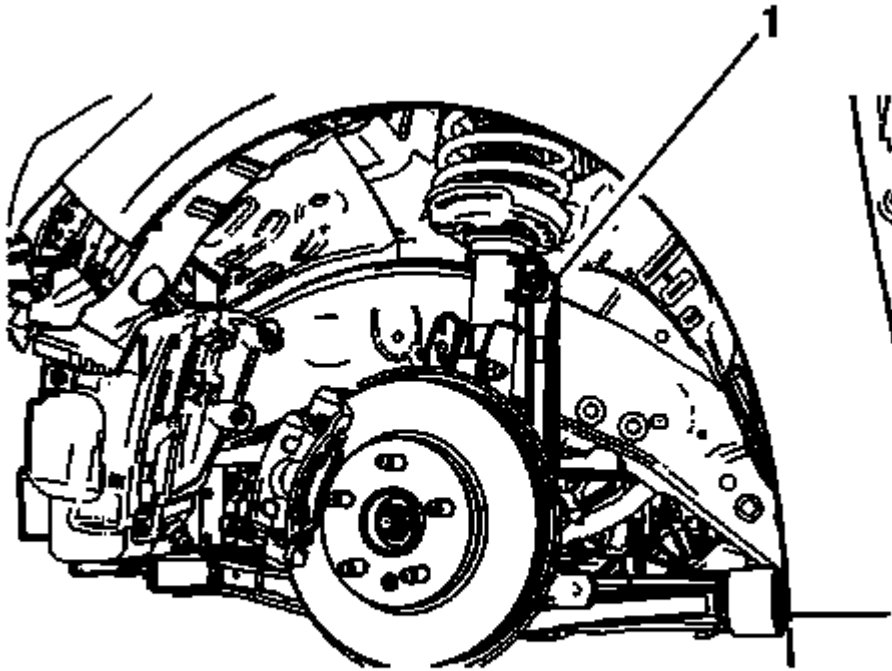


Fig. 257: Stabilizer Links

Courtesy of GENERAL MOTORS COMPANY

18. Disconnect the stabilizer links (1) from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)** .
19. Disconnect the intermediate shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
20. Remove the exhaust system. Refer to **Exhaust Front Pipe Replacement (LTG AWD)** .
21. Disconnect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (GNA)** , **Lower Control Arm Replacement (GNB)** .
22. Remove the left wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side** .
23. Remove the transfer case. Refer to **Transfer Case Replacement** .

NOTE: During the powertrain removal support the vehicle body by placing a jack at the rear of the vehicle.

24. Position an engine support table under the powertrain assembly.
25. Blocks of wood can be used between the front of the frame and the oil pan to table in order to level the powertrain during the removal.
26. With the table positioned, fully raise the table to contact with the powertrain assembly.

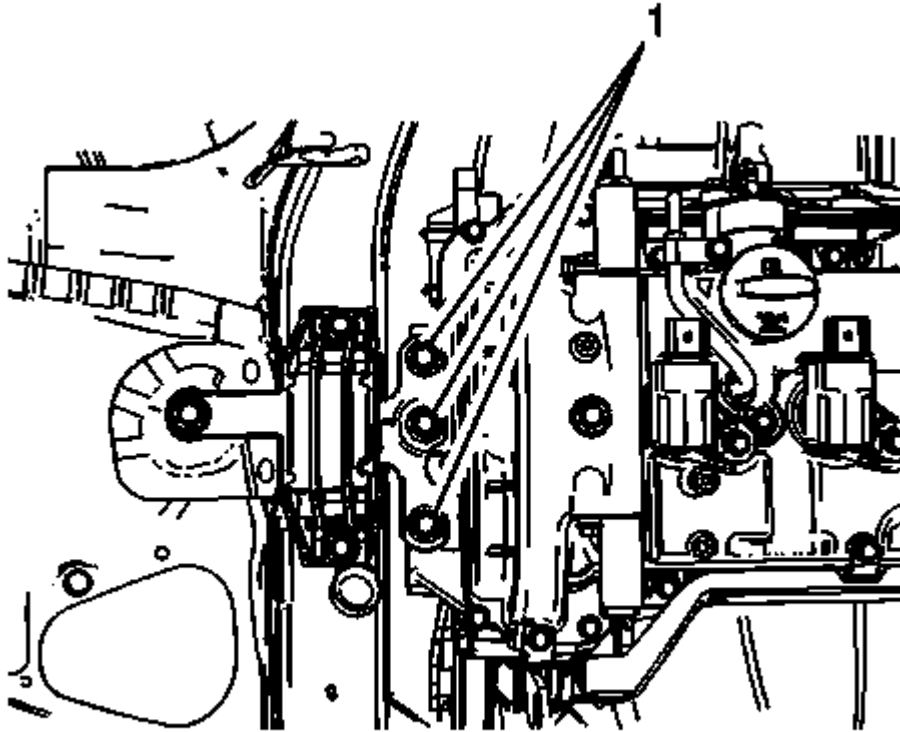


Fig. 258: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

27. Remove the engine mount (1). Refer to **Engine Mount Replacement**.
28. Remove the transmission mount . Refer to **Transmission Mount Replacement - Left Side** .
29. Remove the frame to body bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .
30. Disconnect electrical connectors as necessary.
31. Carefully lower the engine table and raise the body on the hoist until the engine/transaxle and frame are separated from the vehicle.
32. Separate the engine from the transaxle. Refer to **Transmission Replacement** .
33. Install the engine to a suitable engine stand.

Installation Procedure

1. Install the engine and transaxle back together. Refer to **Transmission Replacement** .
2. Position the powertrain support table under the vehicle.
3. Raise the powertrain into position under the vehicle.
4. With the table positioned, if required, lower the vehicle over the powertrain.
5. Install the NEW frame to body bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .

6. Lower the vehicle.
7. Install the transmission mount. Refer to **Transmission Mount Replacement - Left Side**.

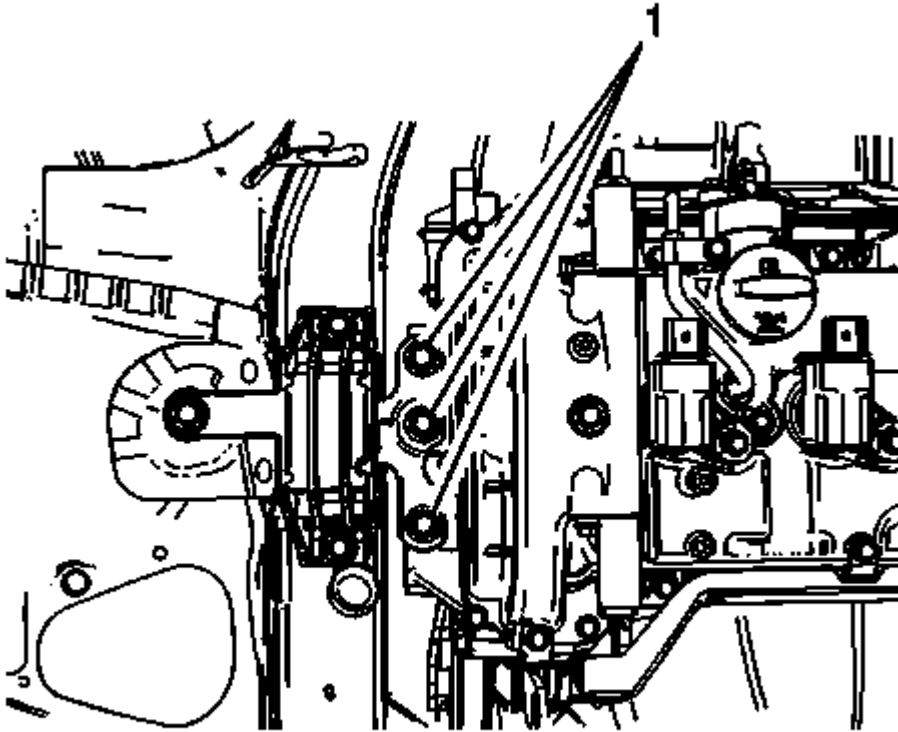


Fig. 259: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

8. Install the engine mount (1). Refer to **Engine Mount Replacement**.
9. Install the transfer case. Refer to **Transfer Case Replacement**.
10. Install the left wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side**.
11. Connect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement (GNA)**, **Lower Control Arm Replacement (GNB)**.
12. Install the exhaust system. Refer to **Exhaust Front Pipe Replacement (LTG AWD)**.
13. Connect the intermediate shaft to the steering gear. Refer to **Intermediate Steering Shaft Replacement**.

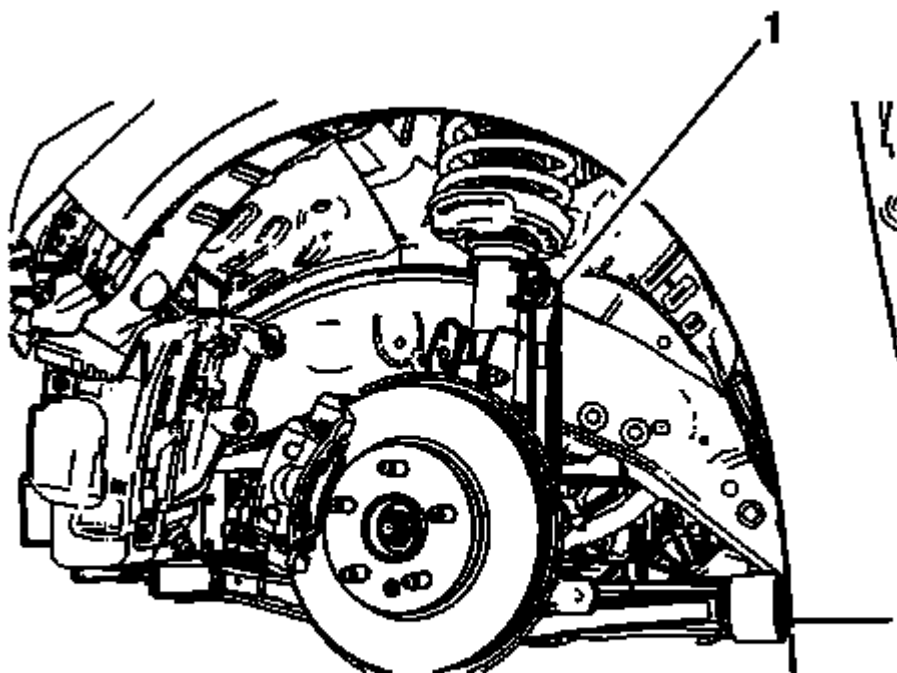


Fig. 260: Stabilizer Links

Courtesy of GENERAL MOTORS COMPANY

14. Connect the stabilizer links (1) from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement (GNA, GNB)** .

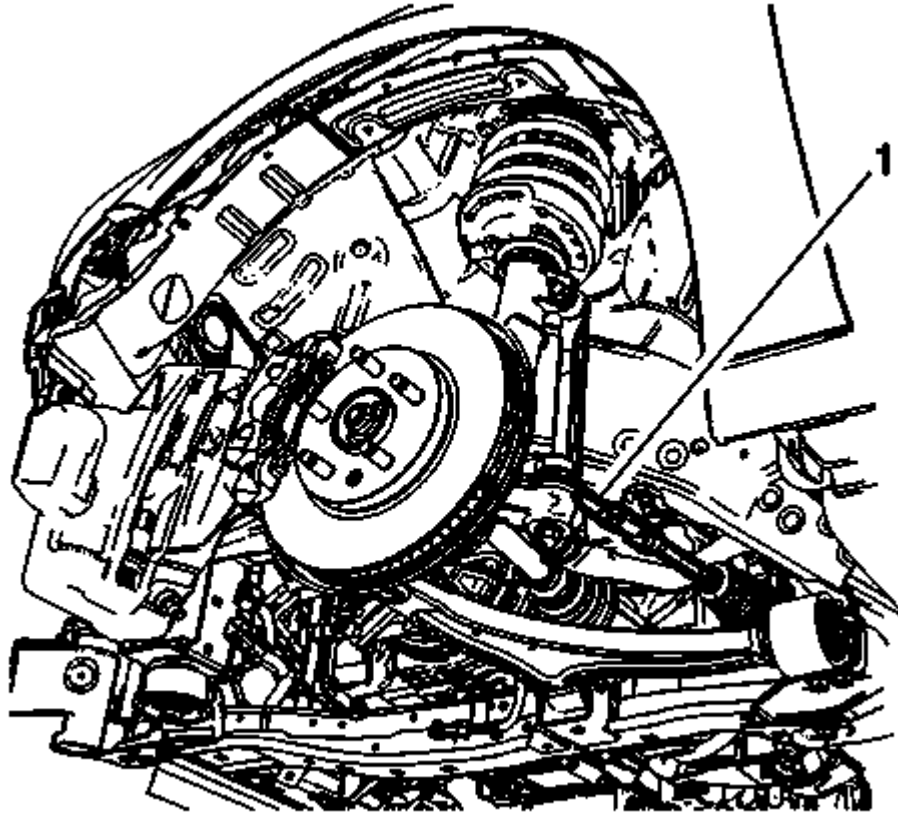


Fig. 261: Tie Rods And Steering Knuckles

Courtesy of GENERAL MOTORS COMPANY

15. Connect the tie rods (1) from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

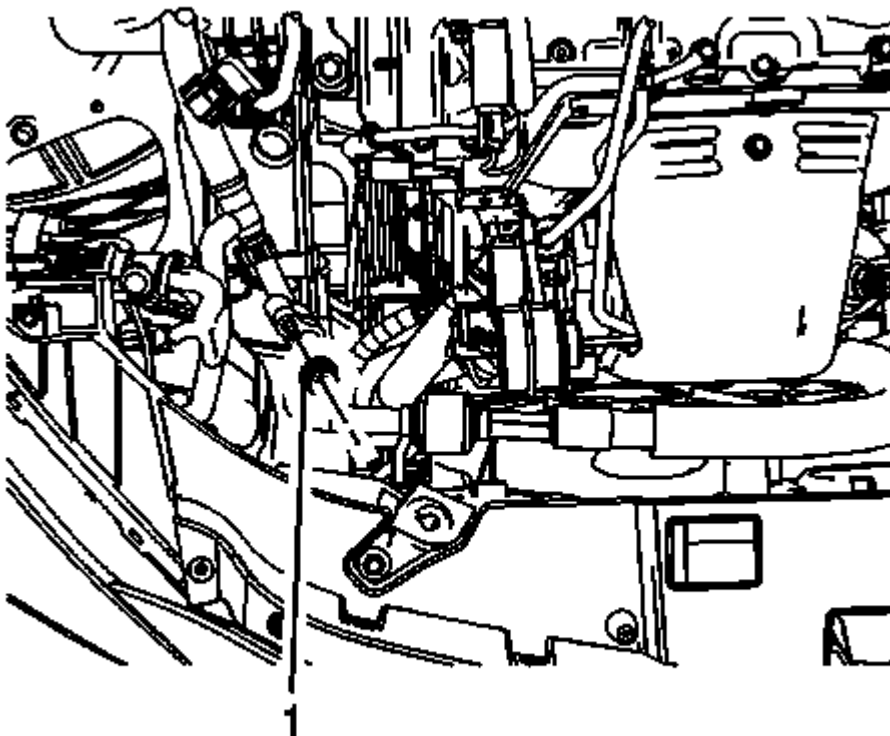


Fig. 262: Air Conditioning Compressor And Condenser Hose
Courtesy of GENERAL MOTORS COMPANY

16. Install the air conditioning compressor and condenser hose (1). Refer to **Air Conditioning Compressor and Condenser Hose Replacement (LUK)** .

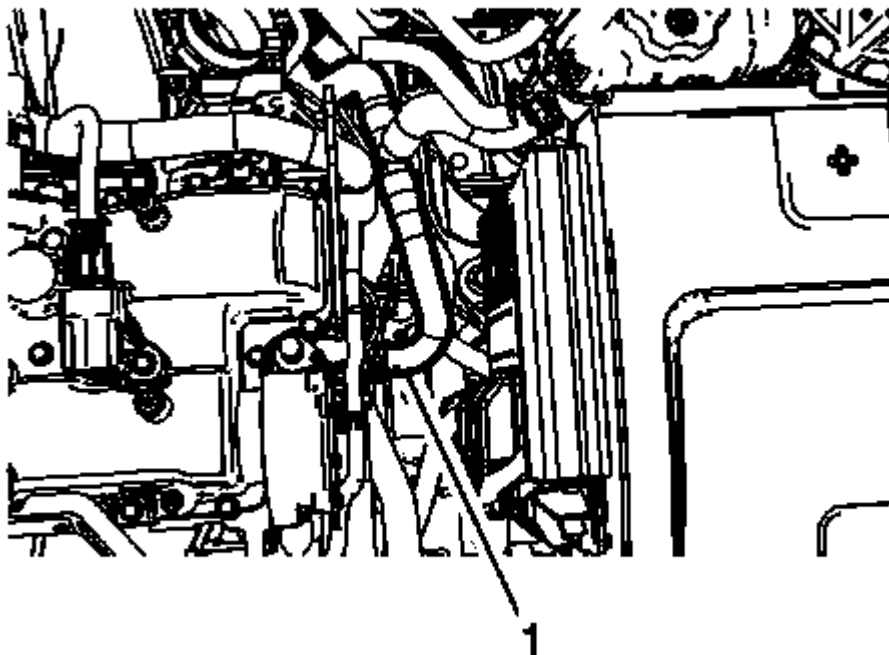


Fig. 263: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

17. Install the heater outlet hose. Refer to **Heater Outlet Hose Replacement (LTG)** .
18. Install the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LTG)** .

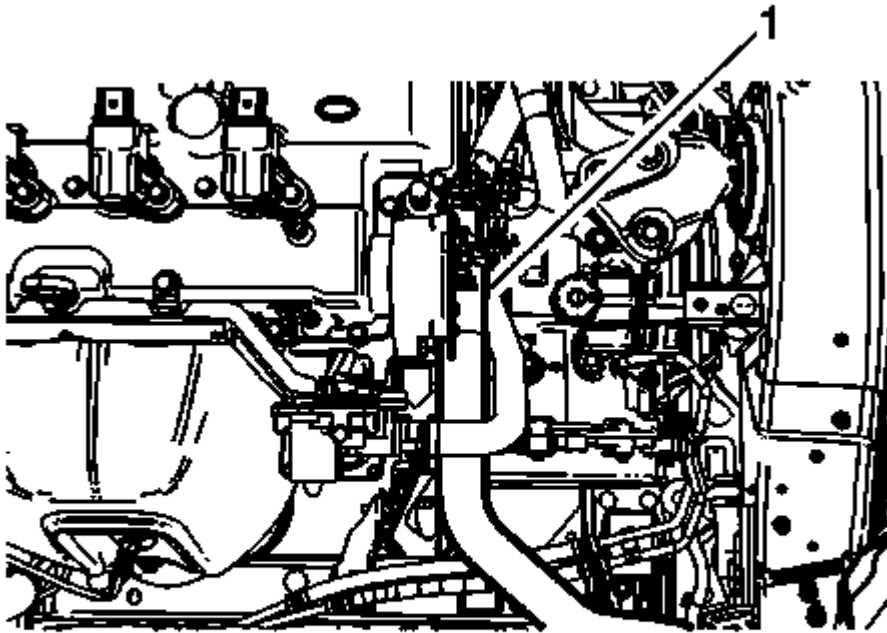


Fig. 264: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

19. Connect the radiator outlet hose (1). Refer to **Radiator Outlet Hose Replacement (LTG)** .

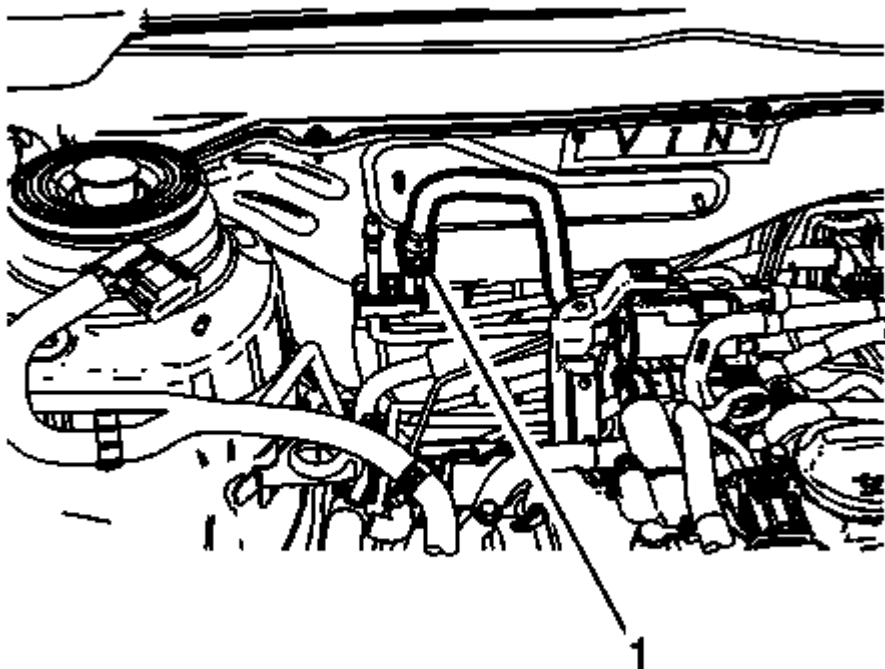


Fig. 265: EVAP Hose

Courtesy of GENERAL MOTORS COMPANY

20. Connect the EVAP hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
21. Connect the fuel line. Refer to **Metal Collar Quick Connect Fitting Service** .

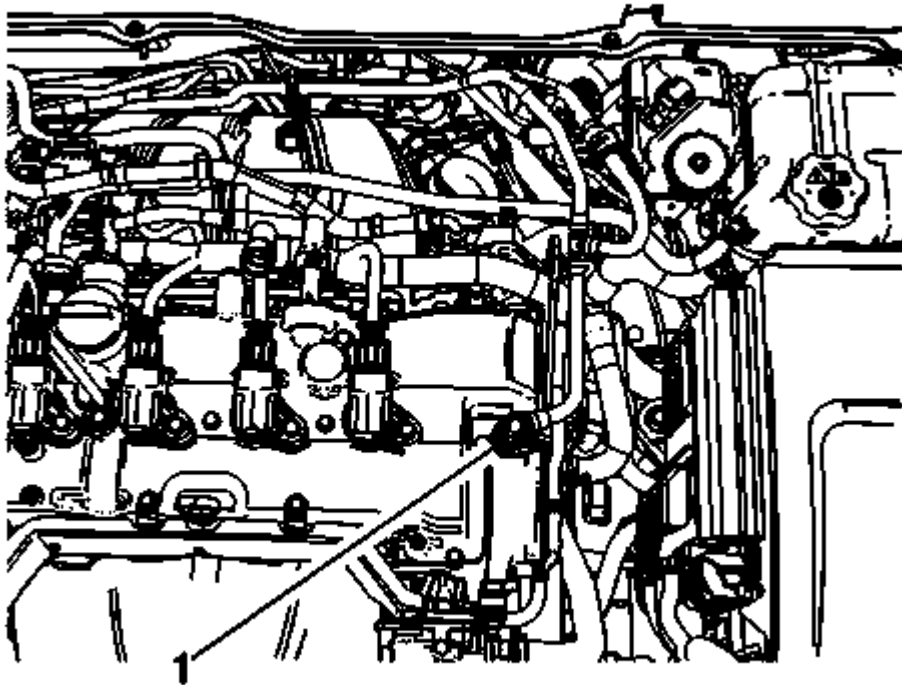


Fig. 266: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

22. Connect the vacuum hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

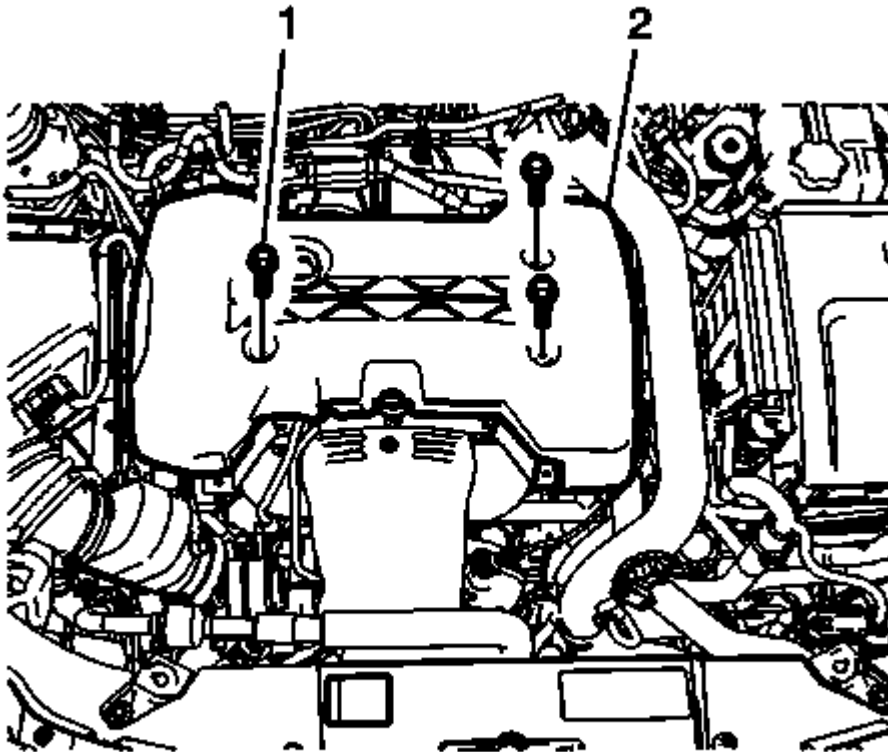


Fig. 267: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

23. Install the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.

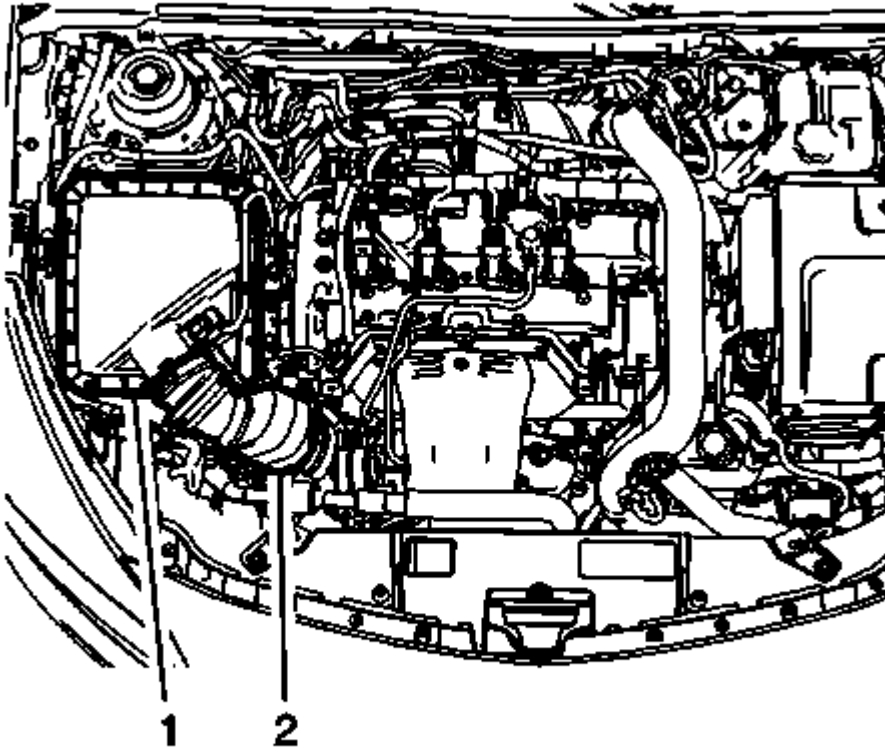


Fig. 268: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

24. Install the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .
25. Install the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement** .
26. Install the battery tray. Refer to **Battery Tray Replacement** .
27. Recharge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
28. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
29. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
30. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle**
2. Place a drain pan under the oil drain plug.

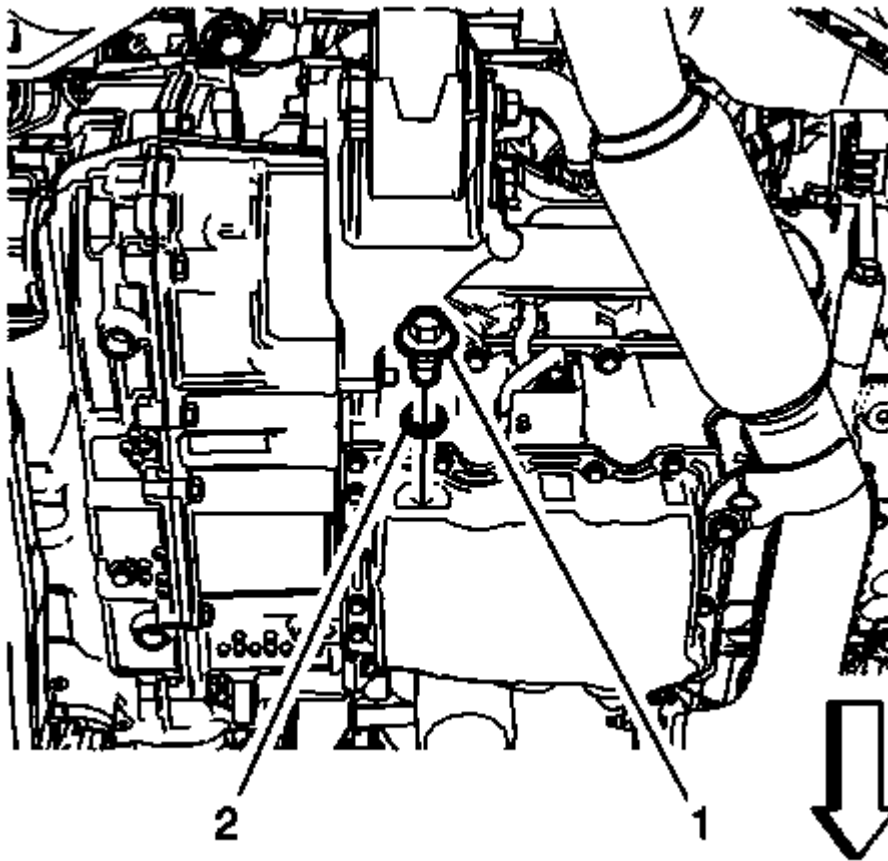


Fig. 269: Oil Pan Drain Plug

Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pan drain plug (1).
4. Allow the oil to drain completely.
5. Clean and inspect the oil pan drain plug, replace if necessary.
6. Clean and inspect the oil pan drain plug sealing surface (2), replace the oil pan drain plug sealing surface if necessary.

CAUTION: Refer to Component Fastener Tightening Caution .

7. Reinstall oil pan drain plug (1) and tighten to 25 (18 lb ft).

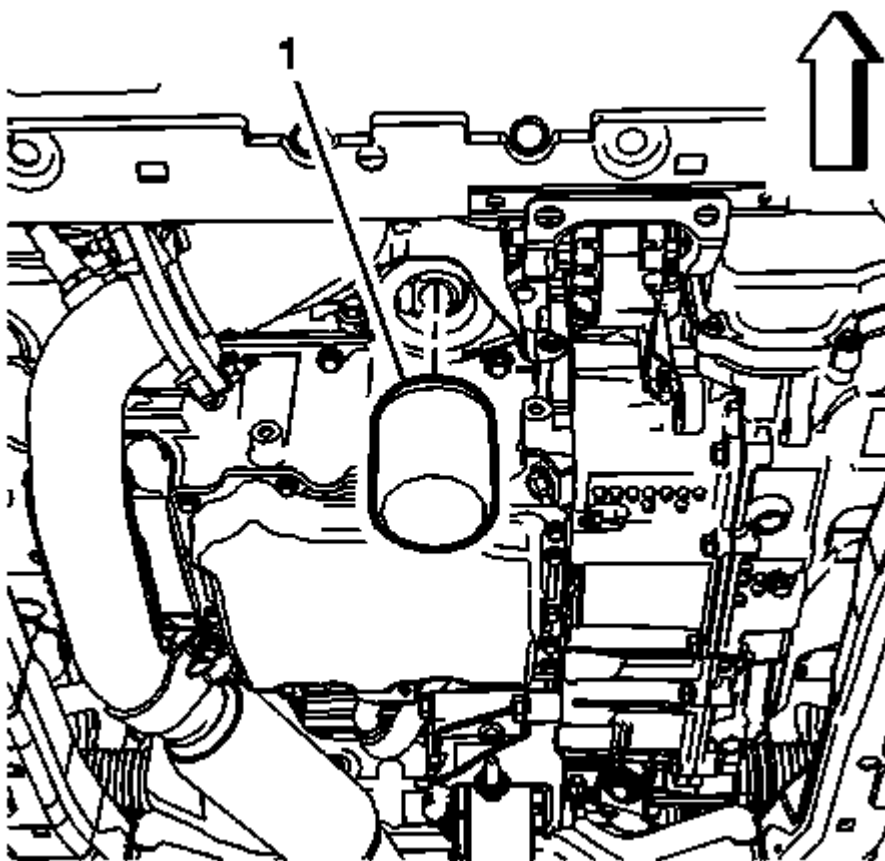


Fig. 270: Oil Filter

Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

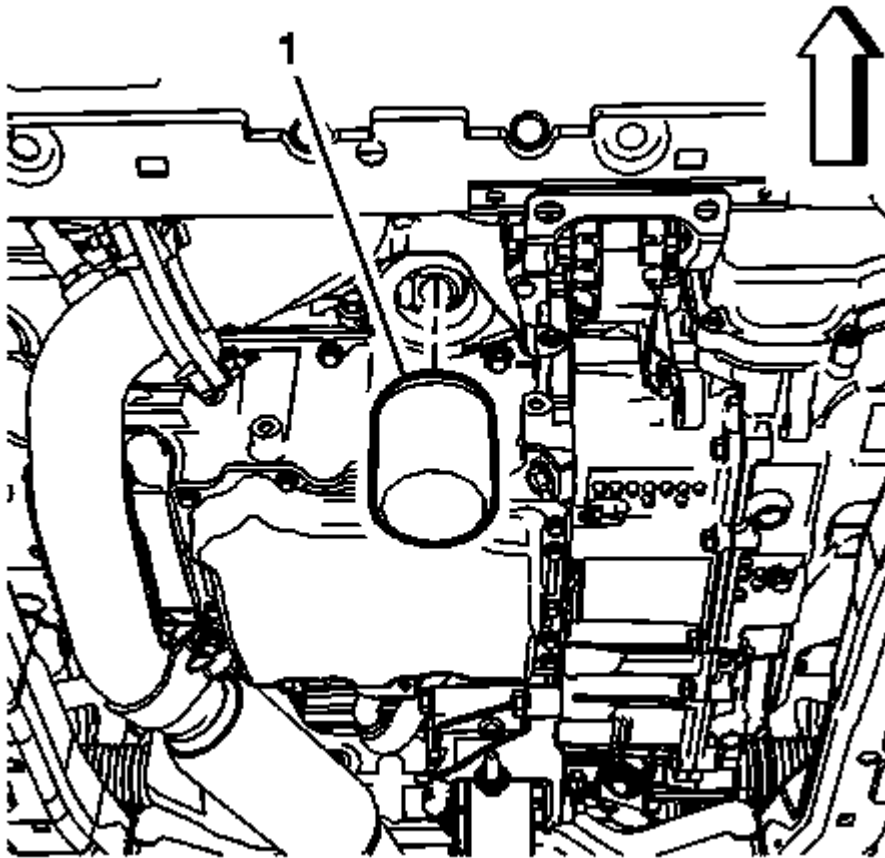


Fig. 271: Oil Filter

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Component Fastener Tightening Caution .

1. Install the oil filter and tighten to 30 (22 lb ft)
2. Remove the oil drain pan from under the vehicle
3. Lower the vehicle.
4. Fill the engine with new engine oil.
5. Start the engine.
6. Inspect for oil leaks after engine start up.