

2013 ENGINE

Engine Mechanical - 2.4L (LUK) - Repair Instructions - On Vehicle - Regal

REPAIR INSTRUCTIONS - ON VEHICLE

INTAKE MANIFOLD COVER REPLACEMENT

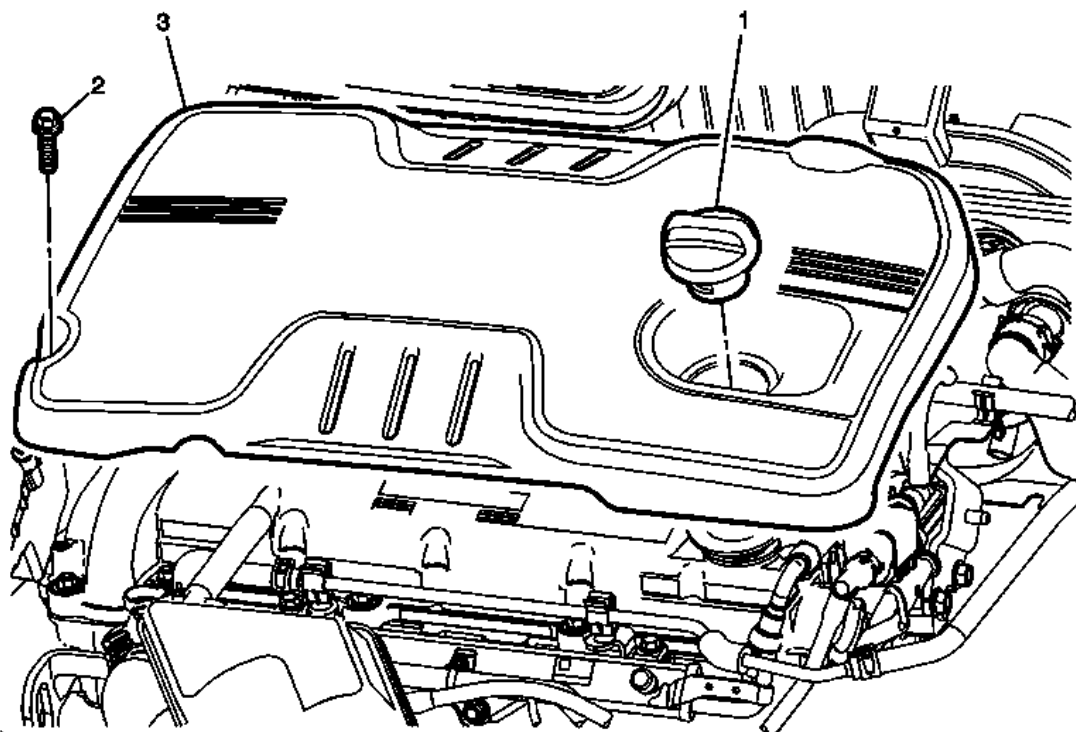
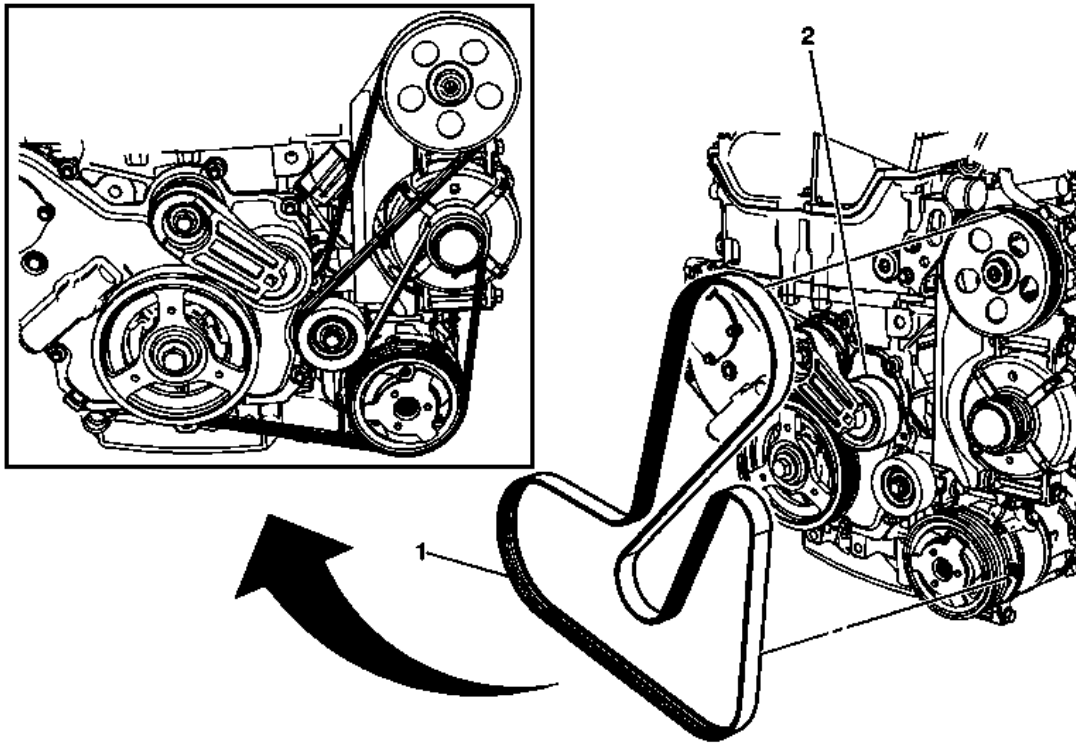


Fig. 1: Intake Manifold Cover, Fastener & Oil Cap
Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Cover Replacement

Callout	Component Name
1	Oil Cap
2	Intake Manifold Cover Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m (80 lb in)
3	Intake Manifold Cover Procedure Transfer components as necessary.

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

Courtesy of GENERAL MOTORS COMPANY

Drive Belt Replacement (LEA)

Callout	Component Name
Preliminary Procedure Remove the Engine Mount. Refer to <u>Engine Mount Replacement</u>	
1	Drive Belt Procedure 1. Use the proper tool to rotate the drive belt tensioner. 2. Remove the drive belt from the pulleys and tensioner.
2	Drive Belt Tensioner Procedure 1. Clean and inspect the drive belt surfaces of all the pulleys. 2. Inspect the drive belt for correct alignment.

DRIVE BELT REPLACEMENT (LUK)**Special Tools**

EN-48932 Hydraulic Belt Tensioner Compressor

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

Removal Procedure

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

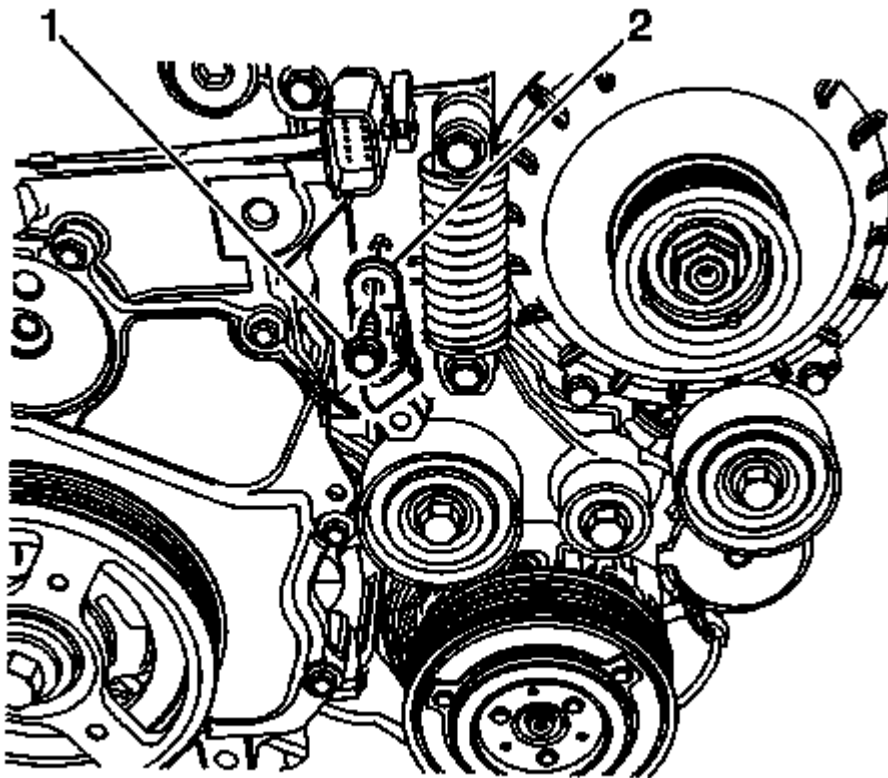


Fig. 3: View Of Tensioner Stop & Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: The tensioner stop is critical and must be removed prior to compressing the drive belt tensioner spring.

2. Remove the tensioner stop fastener (1) and stop (2).

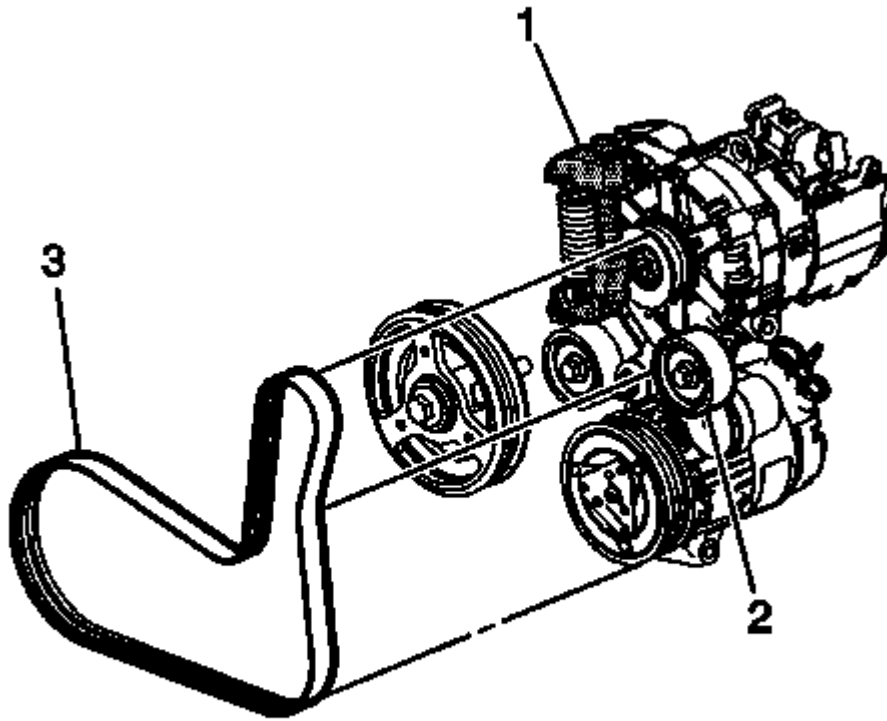


Fig. 4: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the EN- 48932 compressor tool is not on the generator bracket and A/C compressor bracket.

3. Install the **EN-48932** compressor (1) to the drive belt tensioner spring.
4. Compress the drive belt tensioner spring fully using the **EN-48932** compressor.
5. Reposition the idler pulley (2) to release tension off the drive belt.
6. Remove the drive belt from under the middle idler pulley.
7. Remove the drive belt (3) from the vehicle.

Installation Procedure

1. With the **EN-48932** compressor still compressing the tensioner spring Install and position the drive belt around all of the pulleys except for the middle idler pulley.

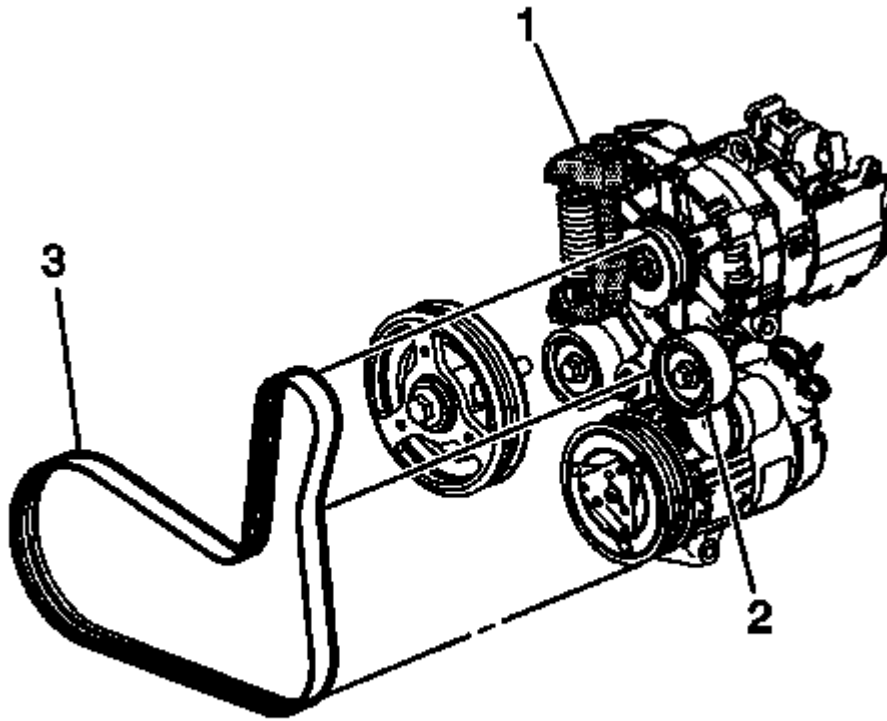


Fig. 5: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

2. Rotate pulley (2) clockwise and install the drive belt under the middle idler pulley.
3. Ensure the drive belt tensioner idler pulley is fully seated against the drive belt (3).
4. Loosen the forcing bolt on the EN-48932 compressor (1) and remove from the drive belt tensioner spring.

NOTE: If tensioner assembly is new, use a 6 point socket on the drive belt tensioner hex boss (1) and rotate hex boss clockwise to release the tension and remove the shipping retainer by hand. Discard the shipping retainer.

5. Ensure that the drive belt tensioner idler is fully seated against the drive belt.

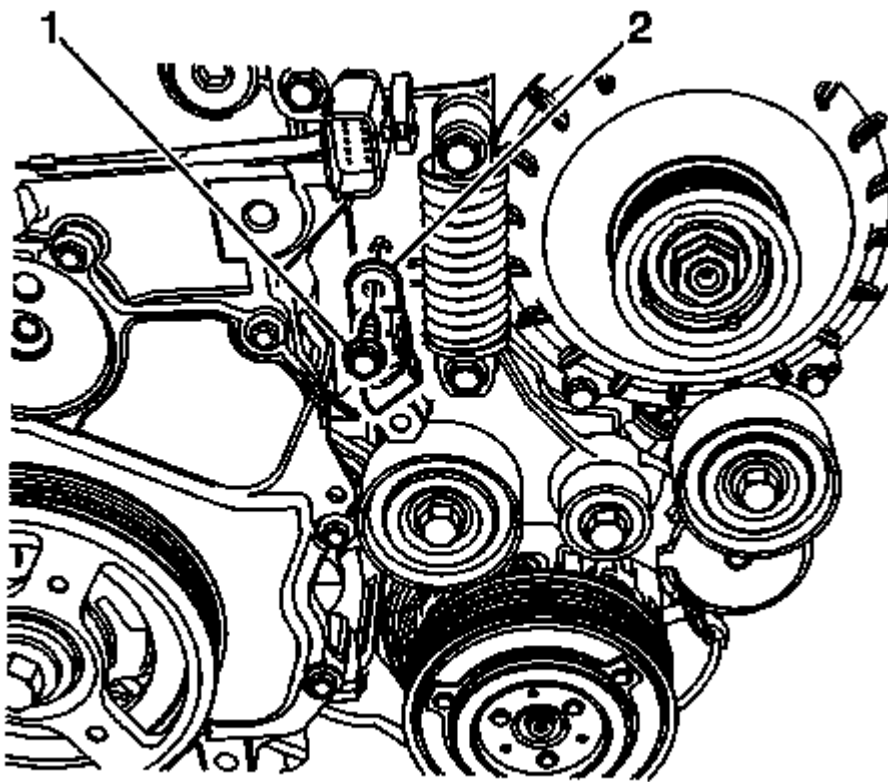


Fig. 6: View Of Tensioner Stop & Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: *Make sure the Tensioner Stop locator pin is in the guide hole of the bracket.*

6. Install the tension stop (2) and fastener (1), then tighten to 10 (89 lb in).
7. Install the air cleaner assembly. Refer to Air Cleaner Assembly Replacement .

DRIVE BELT TENSIONER REPLACEMENT (LUK)

Special Tools

J-45025 Torque Wrench Adapter

For equivalent regional tools, refer to Special Tools .

Removal Procedure

1. Remove the drive belt. **Drive Belt Replacement (LUK)**.
2. Remove the right side engine mount. Refer to **Engine Mount Replacement**.

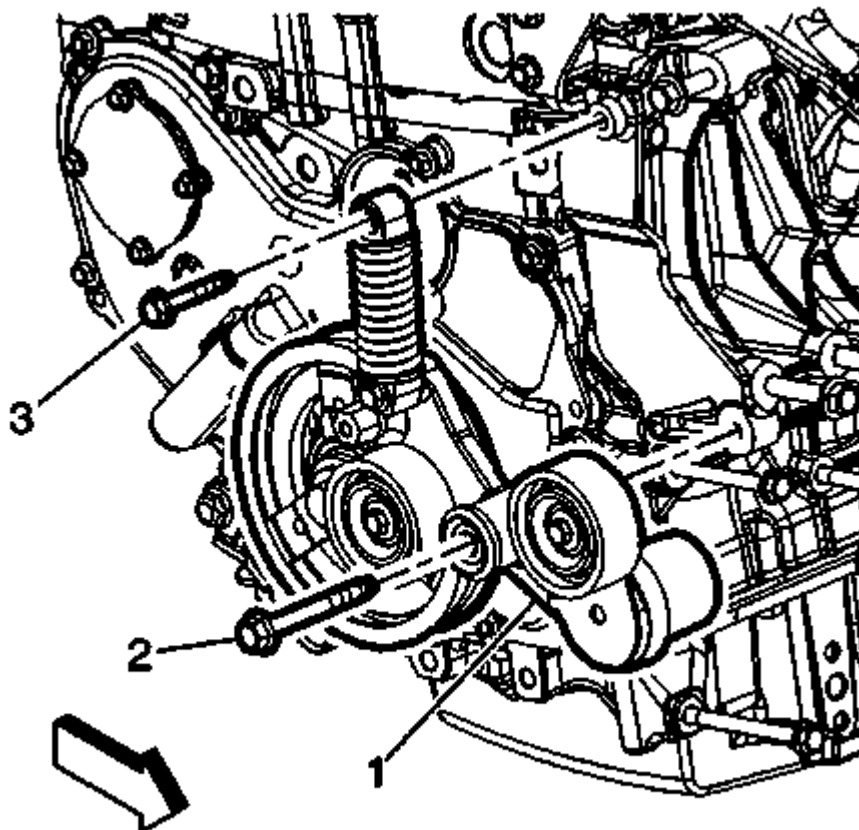


Fig. 7: Drive Belt Tensioner, Spring And Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the drive belt tensioner bolts (2, 3).
4. Remove the drive belt tensioner (1) with drive belt tensioner bolt (3) from top of vehicle.

Installation Procedure

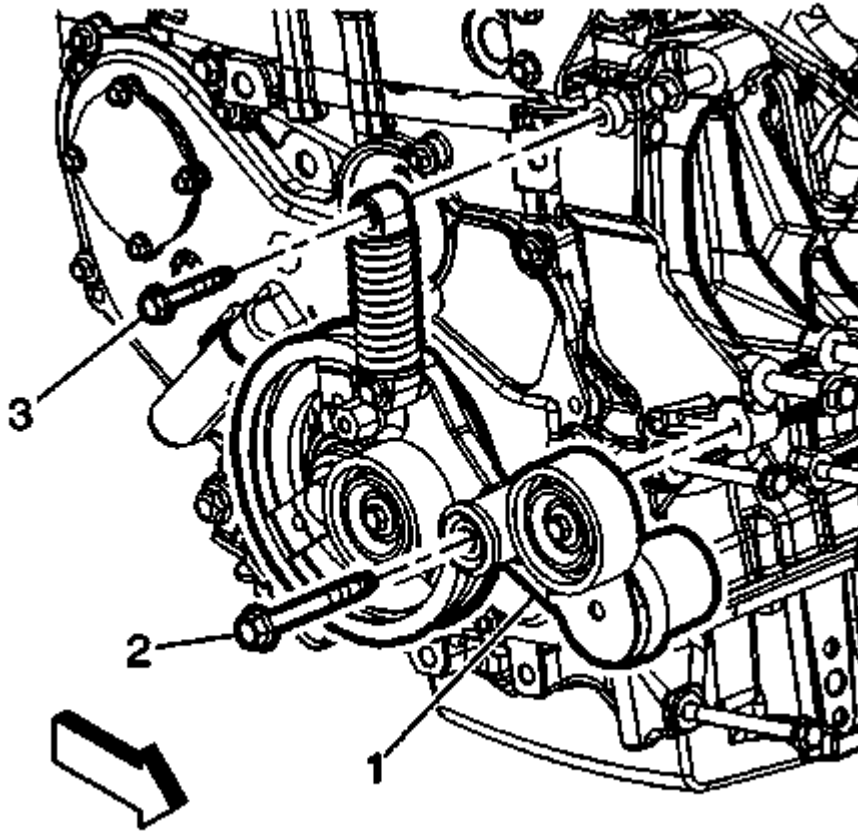


Fig. 8: Drive Belt Tensioner, Spring And Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Install the accessory drive belt tensioner and bolt as an assembly.

1. Install the lower tensioner pivot bolt (2) into the tensioner (1).
2. Position the tensioner assembly in place.

WARNING: To avoid personal injury, only remove the tensioner shipping clip when the tensioner is properly mounted to the engine and the accessory drive belt is in place and properly routed.

CAUTION: Refer to Fastener Caution .

3. Install the drive belt tensioner bolts (2, 3).

CAUTION: Refer to Drive Belt Tensioner Pivot Bolt Caution .

NOTE: Use J-45025 adapter in combination with a 3/8 drive torque wrench to reach & achieve proper torque on tensioner pivot bolt. Make sure that the torque wrench and the J-45025 adapter are in a straight line to ensure proper torque at the bolt.

4. Tighten the bolts (2, 3) in sequence. Make sure that the torque wrench and J-45025 are in a straight line to ensure proper torque at the bolt.
 1. Tighten the top bolt to 22 N.m (16 lb ft).
 2. Use the **J-45025** adapter , to tighten the tensioner pivot bolt to 42 N.m (31 lb ft).
5. Install the drive belt. **Drive Belt Replacement (LUK)**.
6. Install the right side engine mount. Refer to **Engine Mount Replacement**.

DRIVE BELT TENSIONER REPLACEMENT (LEA)

Removal Procedure

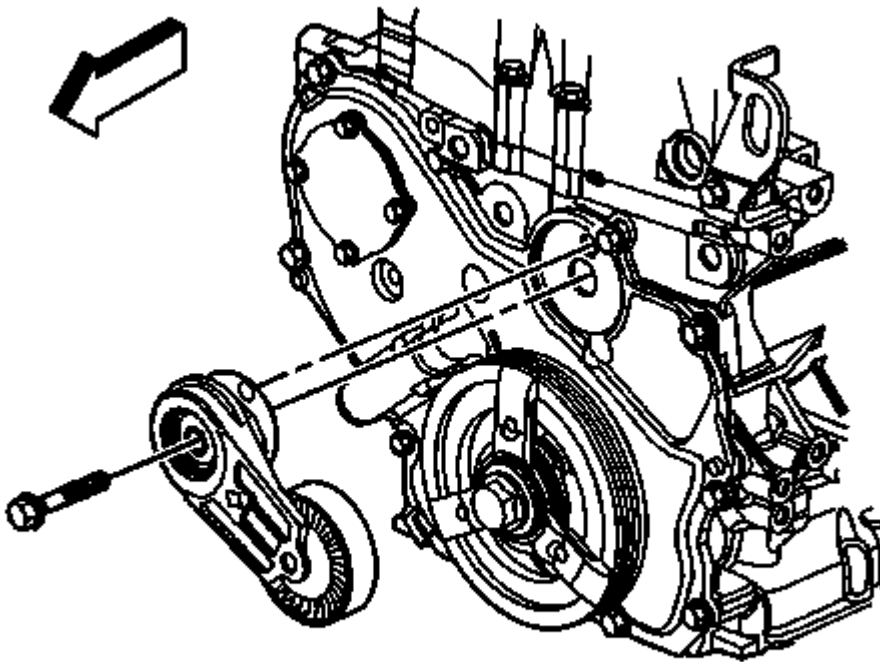


Fig. 9: Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt. Refer to **Drive Belt Replacement (LUK)**

2. Remove the drive belt tensioner bolt.
3. Remove the drive belt tensioner.

Installation Procedure

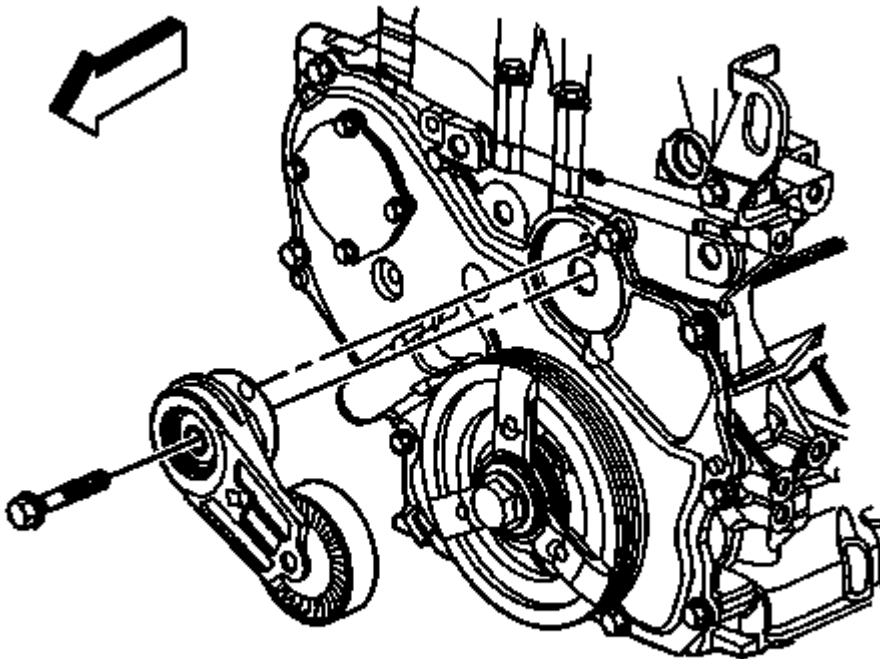


Fig. 10: Drive Belt Tensioner

Courtesy of GENERAL MOTORS COMPANY

1. Position the drive belt tensioner.

CAUTION: Refer to Fastener Caution .

2. Install the drive belt tensioner bolt and tighten to 45 N.m (33 lb ft).
3. Install the drive belt. Refer to Drive Belt Replacement (LUK).

ENGINE OIL PRESSURE SWITCH REPLACEMENT

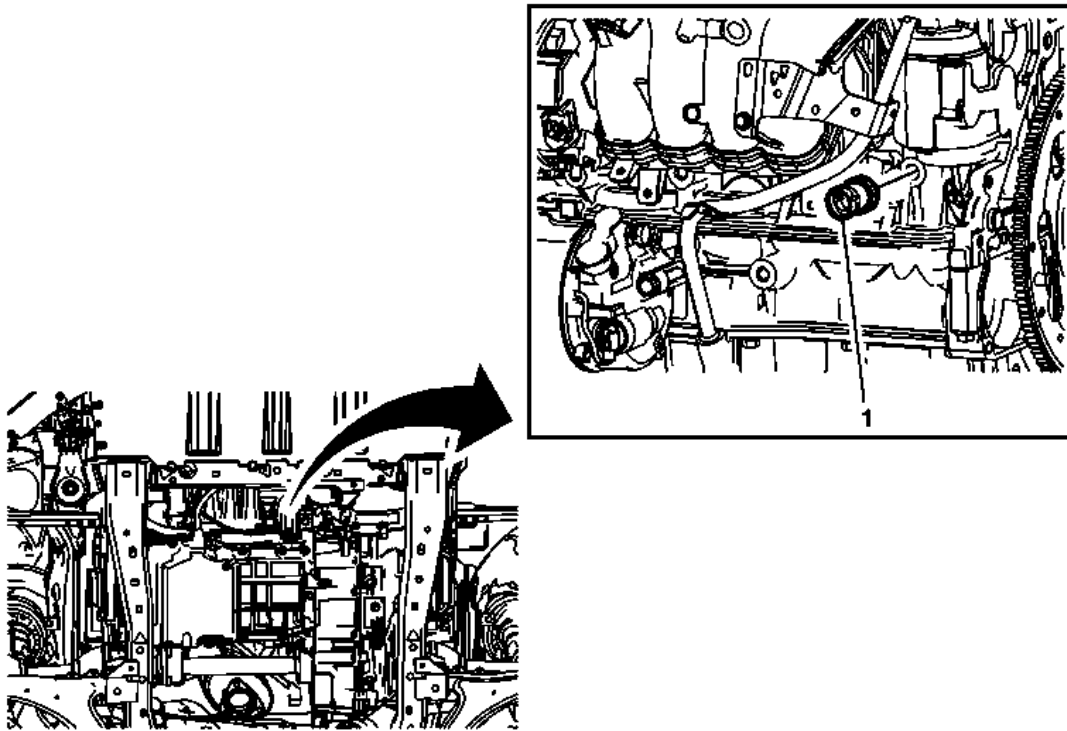


Fig. 11: Engine Oil Pressure Switch
 Courtesy of GENERAL MOTORS COMPANY

Engine Oil Pressure Switch Replacement

Callout	Component Name
Preliminary Procedure Remove the starter.	
1	Oil Pressure Switch CAUTION: Refer to <u>Fastener Caution</u> . Procedure Disconnect the engine wiring harness electrical connector as necessary. Tighten 22 N.m (16 lb ft)

ENGINE MOUNT INSPECTION

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

1. Install the engine support fixture. Refer to Engine Support Fixture.

2. Raise the engine slightly and observe the engine mount. Raising the engine removes the weight from the engine mount and creates a slight tension on the rubber portion.
3. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber is covered with heat check cracks.
 - The rubber is separated from the metal plate of the engine mount.
 - The rubber is split through the center of the engine mount.
 - The engine mount itself is leaking fluid.
4. For engine mount replacement. Refer to **Engine Mount Replacement**.

ENGINE MOUNT BRACKET REPLACEMENT (LUK)

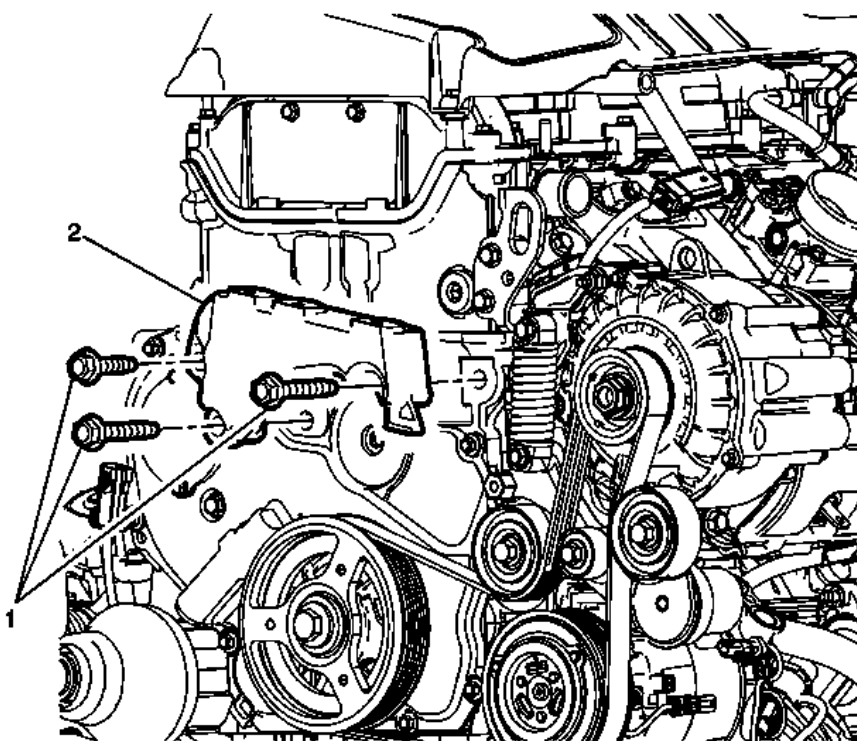


Fig. 12: Engine Mount Bracket & Bolts (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Engine Mount Bracket Replacement (LUK)

Callout	Component Name
Preliminary Procedure Remove the engine mount. Refer to <u>Engine Mount Replacement</u> .	
1	Engine Mount Bracket Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 100 N.m (73 lb ft)
2	Engine Mount Bracket

POWERTRAIN MOUNT BALANCING

NOTE: Follow the balance procedure steps listed below when no starting point has been established such as in a collision repair.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

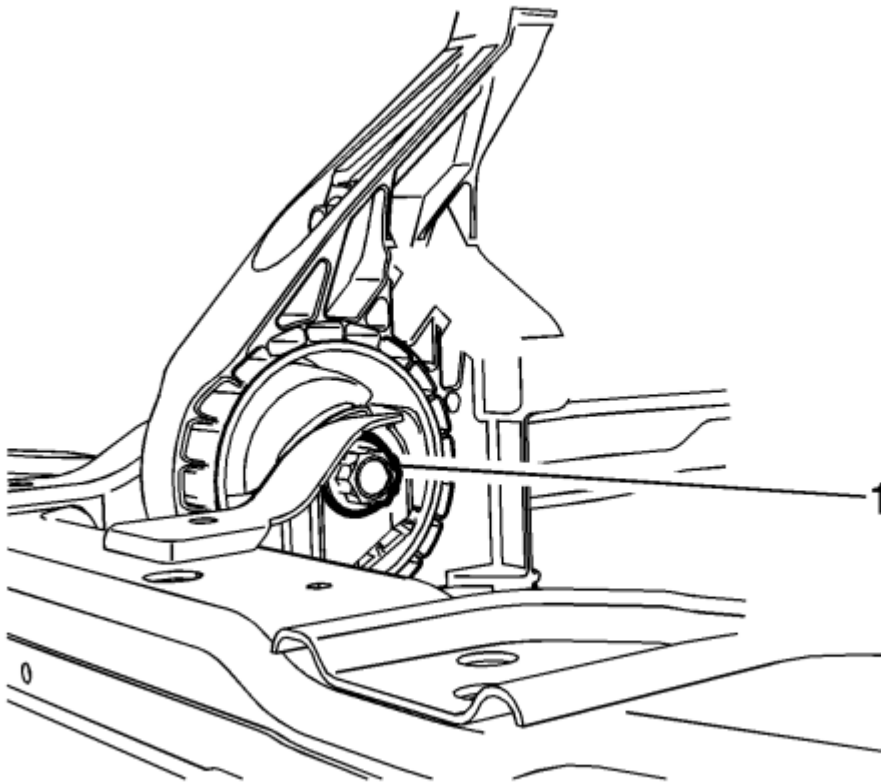


Fig. 13: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Loosen the front transaxle mount through bolt (1) until it is finger tight.

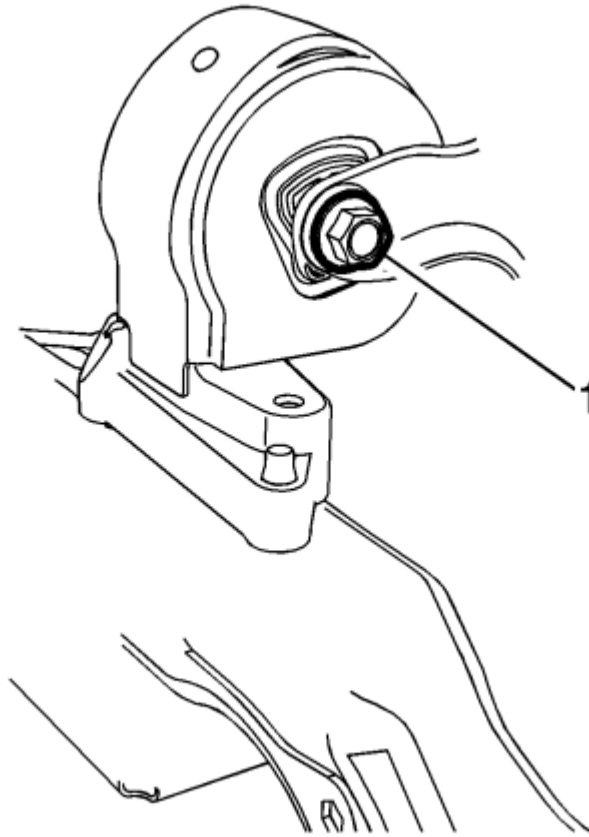


Fig. 14: Rear Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Loosen the rear transaxle mount (1) through bolt until it is finger tight.
4. Lower the vehicle.

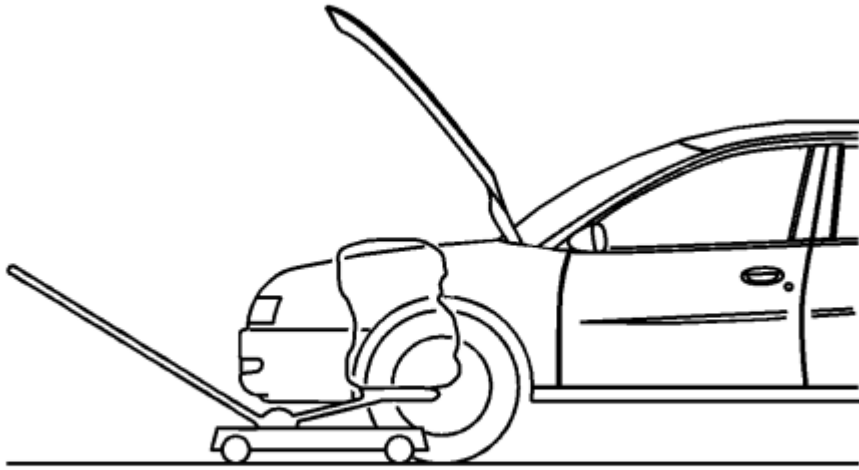


Fig. 15: Supporting Engine/Transmission With Hydraulic Floor Jack
Courtesy of GENERAL MOTORS COMPANY

5. Position two floor jacks with wood blocks under the engine and transaxle in order to support the powertrain assembly.

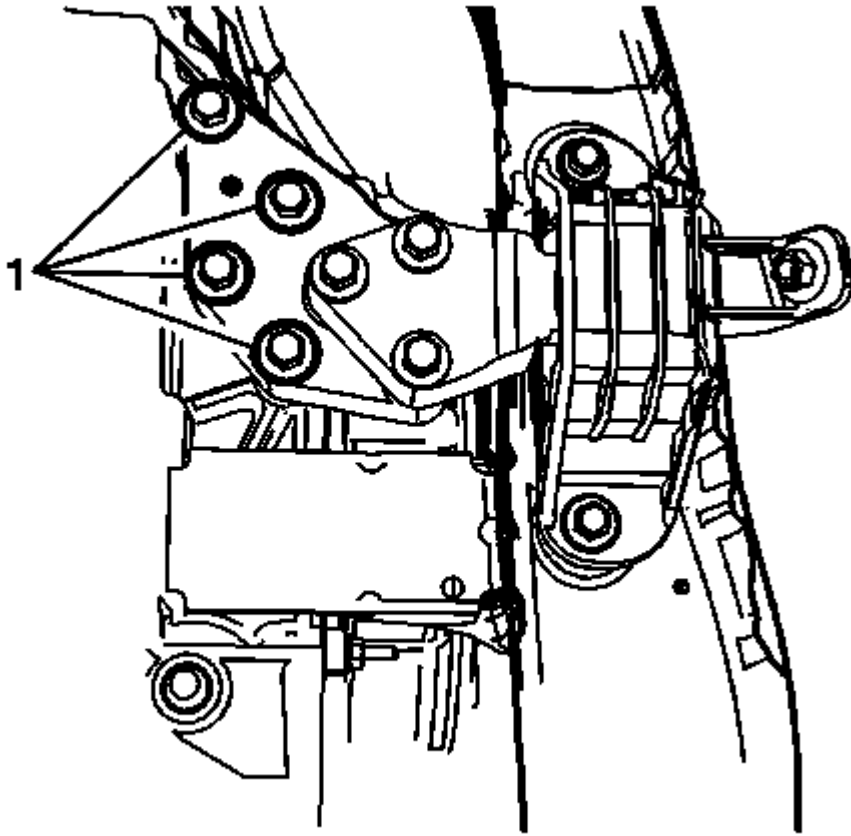


Fig. 16: Transaxle Bolts

Courtesy of GENERAL MOTORS COMPANY

6. Loosen the transaxle adapter to transaxle bolts (1).

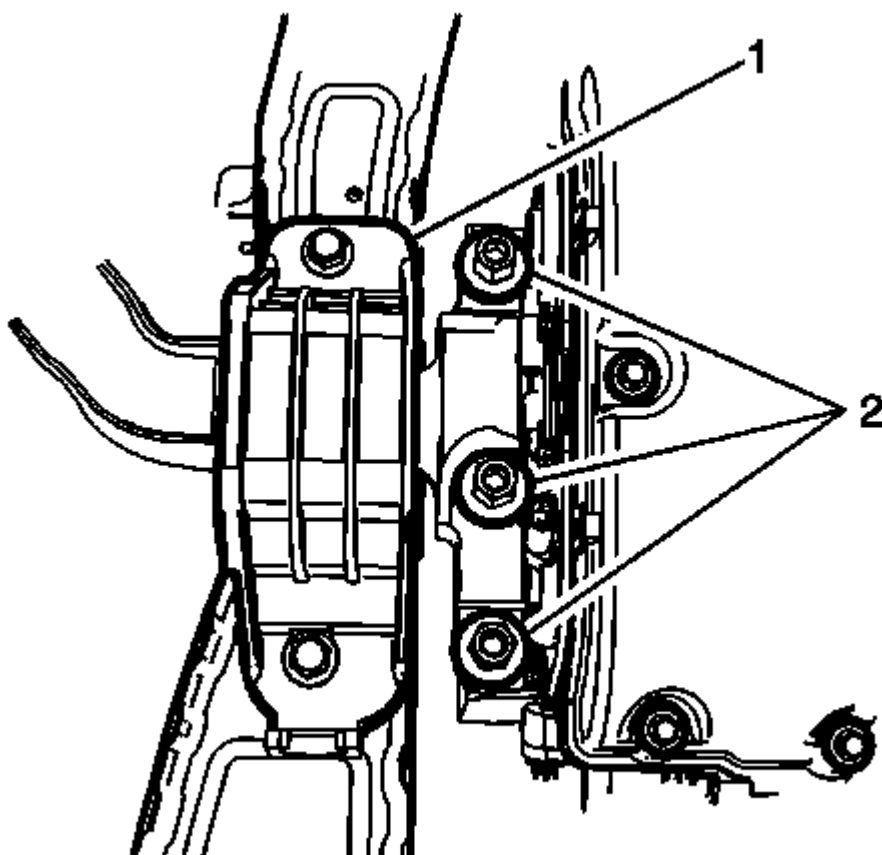


Fig. 17: Engine Mount And Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Loosen the engine mount (1) to bracket bolts (2).
8. Lower the floor jacks in order to allow a 1/4 inch (6 mm) gap between the upper engine mount and engine mount bracket, and also between the transmission and left transmission mount.

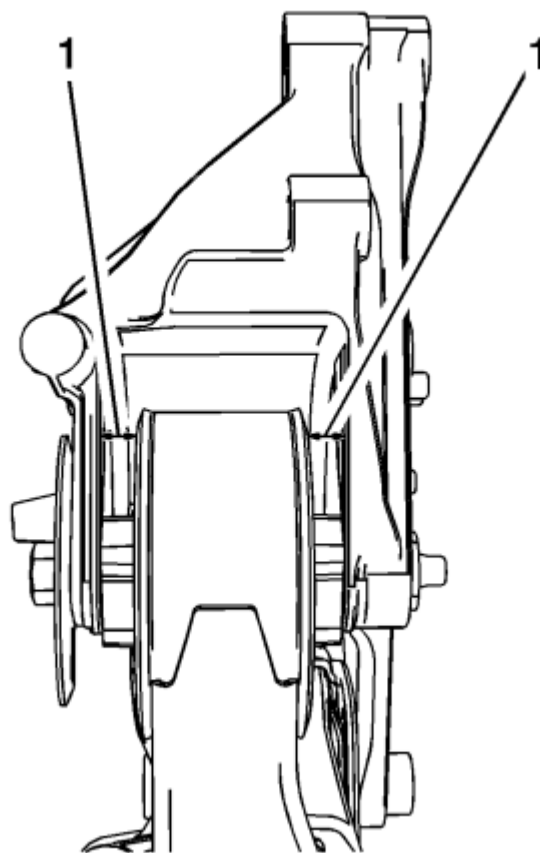


Fig. 18: Front And Rear Powertrain Mounts
Courtesy of GENERAL MOTORS COMPANY

9. Check that the front and rear mounts are centered (1) in the mount brackets, adjust if necessary.
10. Tighten the left hand (transaxle side) mount bolts, starting with the bolt nearest to the center of the mount. See the appropriate transmission mount replacement procedure for the fastener tightening specifications.

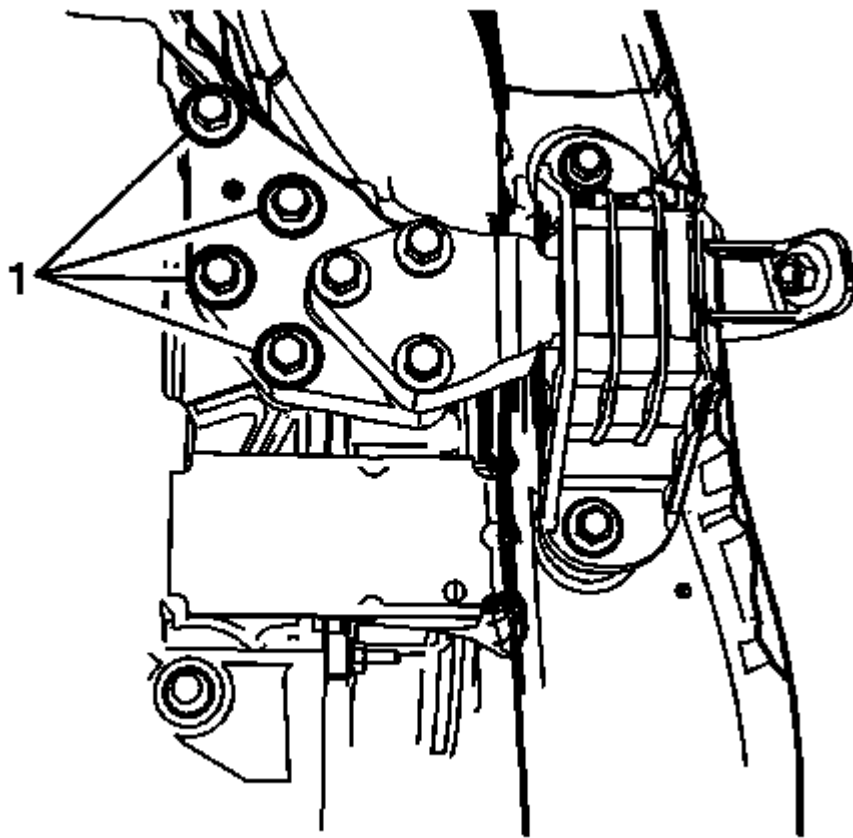


Fig. 19: Transaxle Bolts

Courtesy of GENERAL MOTORS COMPANY

11. Tighten the right hand (engine side) mount bolts (1), starting with the bolt nearest to the center of the mount. See the appropriate engine mount replacement procedure for the fastener tightening specifications.
12. Remove the floor jacks from under the oil pan and transmission.
13. Raise the vehicle.
14. Shake the powertrain from front to rear and allow the powertrain to settle.

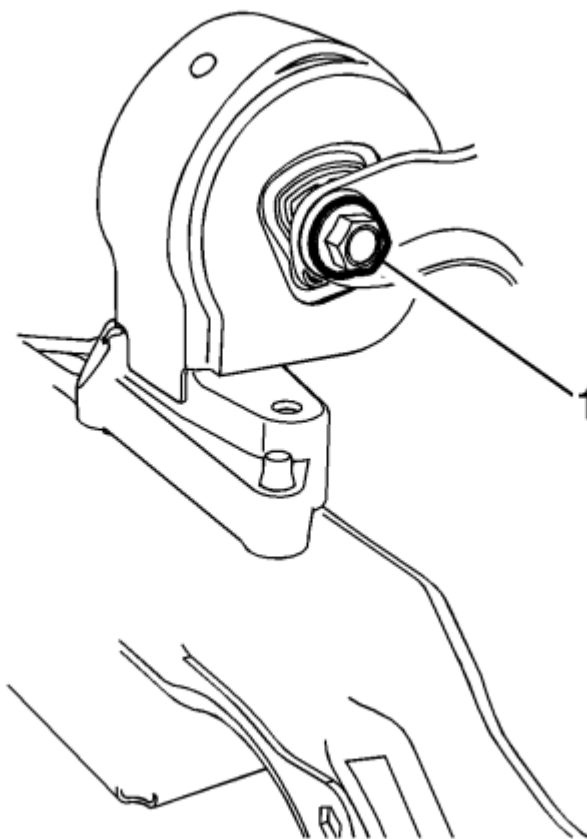


Fig. 20: Rear Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: It is essential that the lower mount through bolts should be as close to centered as possible in the oversized mount insert holes before tightening to specification.

15. Tighten the rear transaxle mount through bolt (1). See the appropriate transmission mount replacement procedure for the fastener tightening specifications.

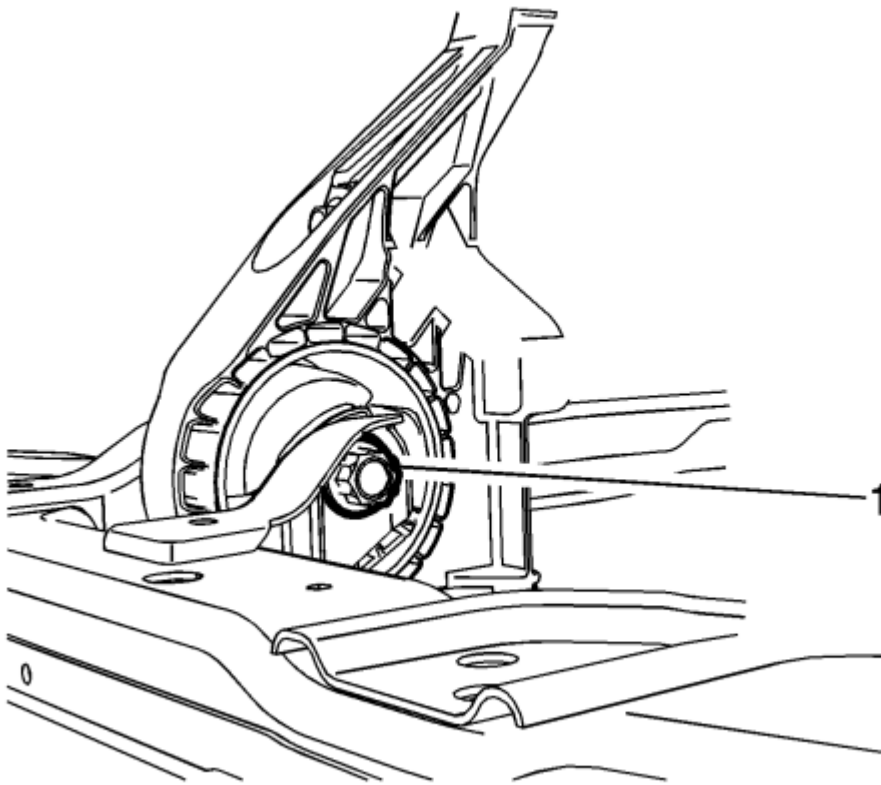


Fig. 21: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

16. Tighten the front transaxle mount through bolt (1). See the appropriate transmission mount replacement procedure for the fastener tightening specifications.
17. Lower the vehicle.

POWERTRAIN MOUNT BALANCING - LOWER

NOTE: Follow the balance procedure steps listed below when front or rear mounts through bolts are loosened or removed during a repair procedure.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

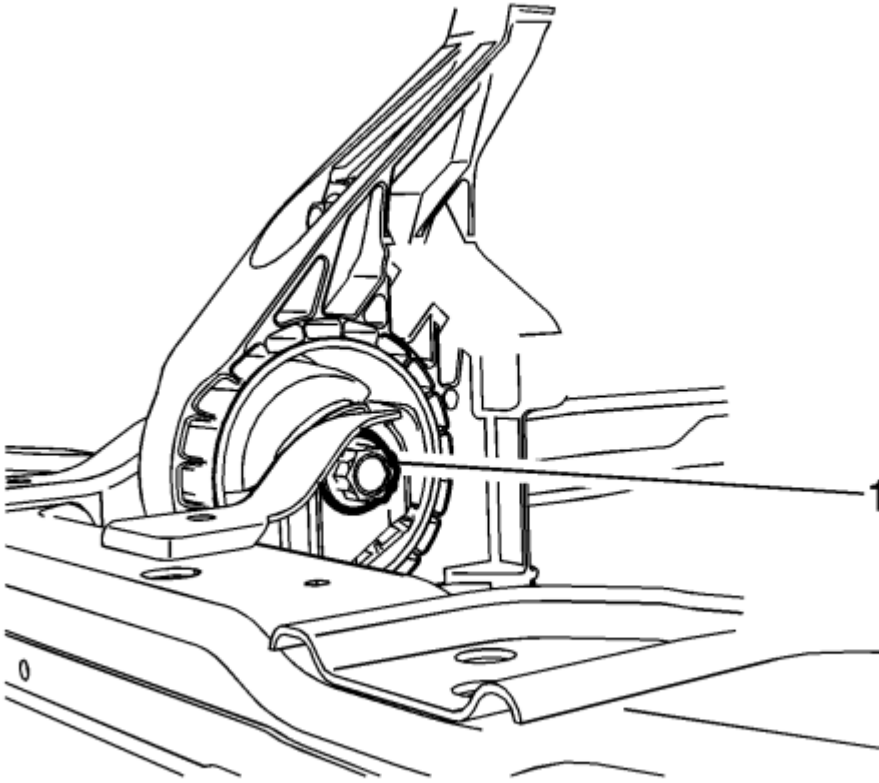


Fig. 22: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Loosen the front transaxle mount through bolt (1).

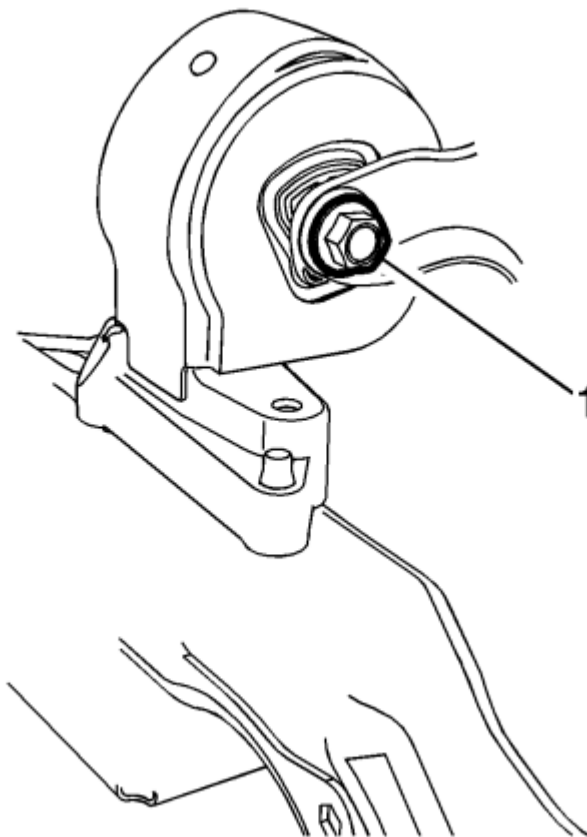


Fig. 23: Rear Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Loosen the rear transaxle mount through bolt (1).
4. Shake the powertrain from front to rear and allow the powertrain to settle.

NOTE: **It is essential that the through bolts are as close to centered as possible in the oversized mount insert holes before tightening to specification.**

5. Tighten the rear transaxle mount through bolt (1). See the appropriate transmission mount replacement procedure for the fastener tightening specifications.

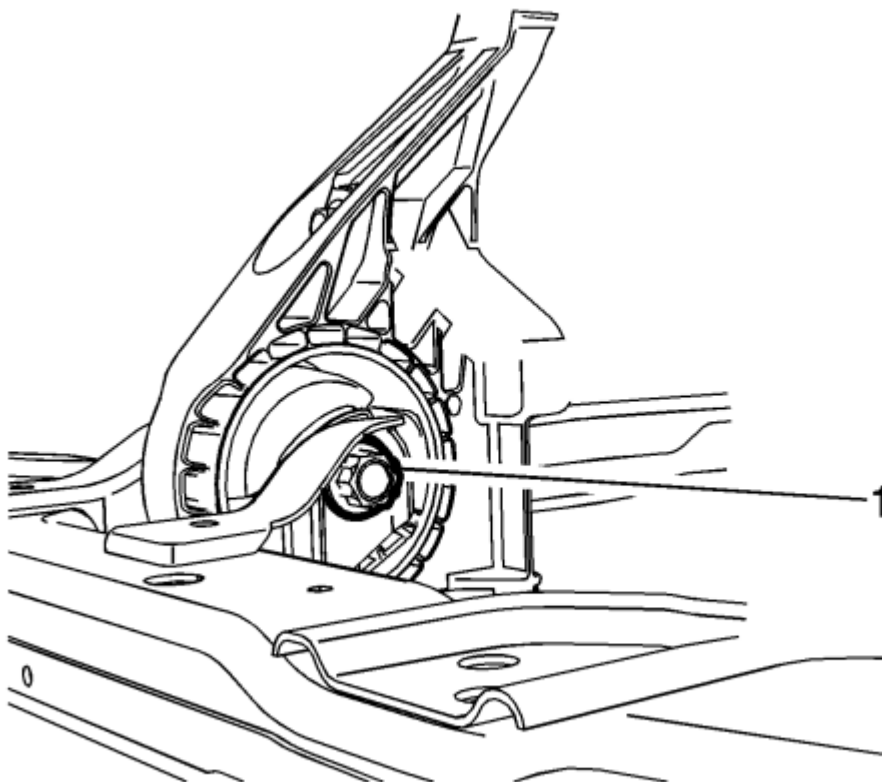
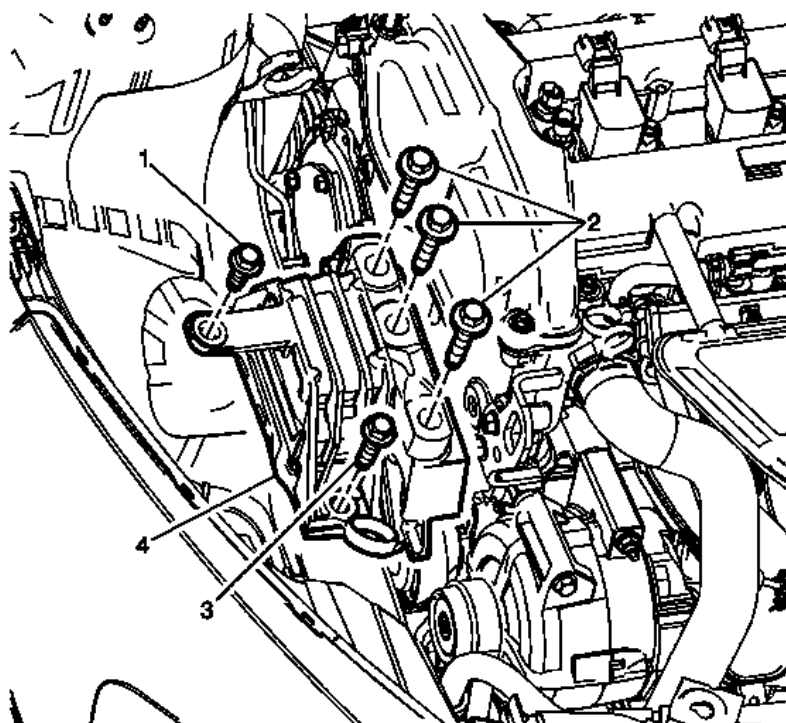


Fig. 24: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Tighten the front transaxle mount through bolt (1). See the appropriate transmission mount replacement procedure for the fastener tightening specifications.
7. Lower the vehicle.

ENGINE MOUNT REPLACEMENT

**Fig. 25: Engine Mount & Fasteners**

Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement . 2. Install engine support fixture. Refer to Engine Support Fixture. 3. Prior to removing the mount, mark mount to bracket, mount to body interfaces and fasteners to mount interfaces using a marker for correct positioning during installation.	
1	Engine Mount Fastener CAUTION: Refer to Fastener Caution . Tighten 62 N.m (46 lb ft)
2	Engine Mount Fastener (Qty: 3) Tighten 62 N.m (46 lb ft)
3	Engine Mount Fastener (Qty: 2) Tighten

	62 N.m (46 lb ft)
4	Engine Mount Procedure Transfer components as necessary.

ENGINE SUPPORT FIXTURE

Special Tools

- **EN-28467-B** Universal Engine Support Fixture
- **EN-28467-500B** Engine Support Fixture
- **EN-43405-10** Engine Support Fixture Adaptor

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

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

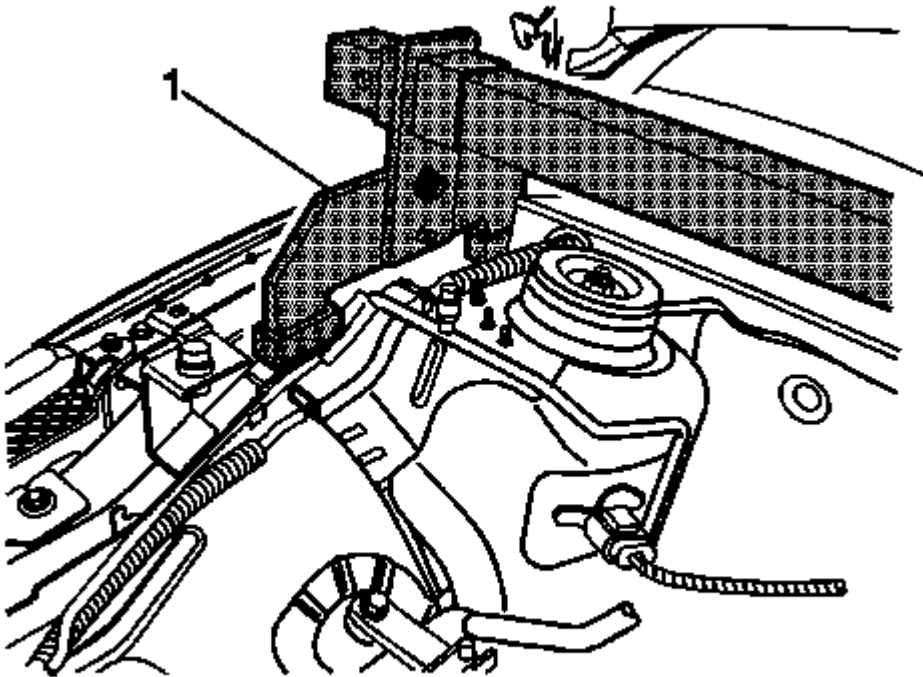


Fig. 26: Engine Support Special Tool
Courtesy of GENERAL MOTORS COMPANY

2. Assemble the **EN-28467-B** universal engine support fixture to the **EN-43405-1** engine support feet

(passenger side) and **EN-43405-2** engine support feet (drivers side) (1) and place across the engine compartment.

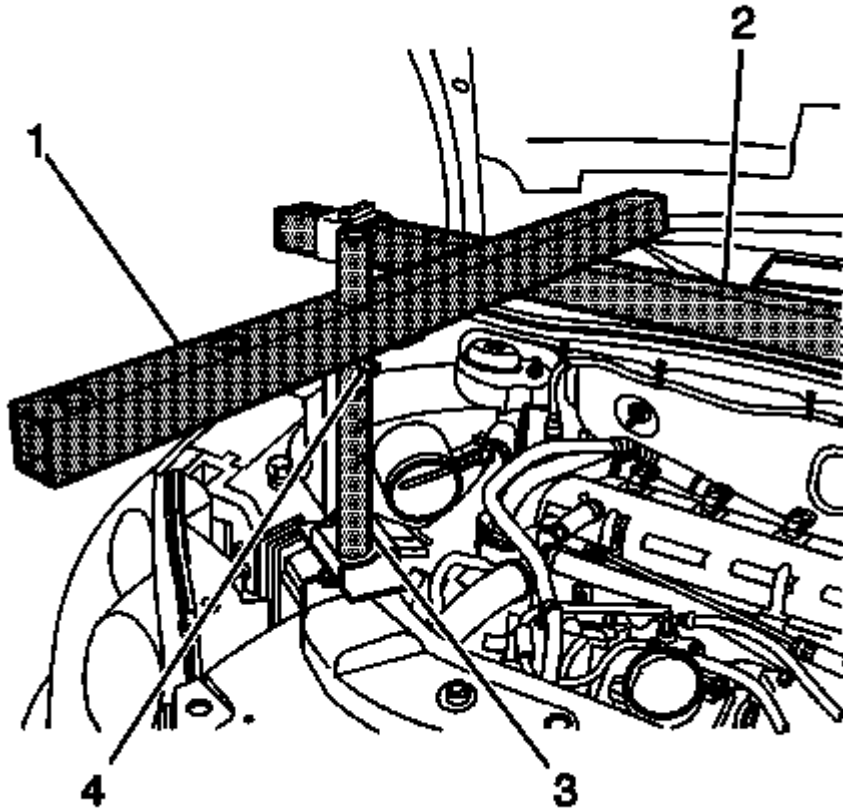


Fig. 27: View Of Engine Support Fixture
Courtesy of GENERAL MOTORS COMPANY

3. From the **EN-28467-500B** universal engine support fixture , install the radiator shelf tube J-28467-2A (1) on top of the strut tower tube J-28467-3 (2) above the engine front (right back) lift hook bracket.
4. Install the round tube of the front support assembly J-28467-4A (3) through the large hole in the radiator shelf tube J-28467-2A.
5. Locate the J-28467-4A front support assembly to the upper tie bar.
6. Install the J-28467-9 7/16 inch x 2.0 inch quick-release pin (4) through the top hole in the J-28467-4A front support assembly.

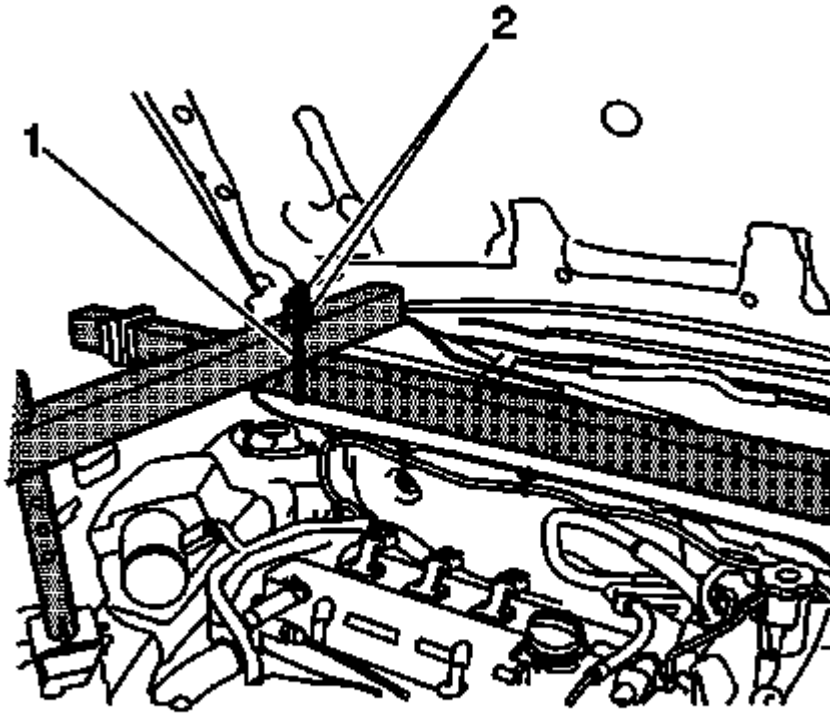


Fig. 28: View Of Engine Support Fixture & Cross Bracket
Courtesy of GENERAL MOTORS COMPANY

7. Install the J-28467-1A cross bracket assembly (1).
8. Hand tighten the J-28467-1A cross bracket wing nuts (2).

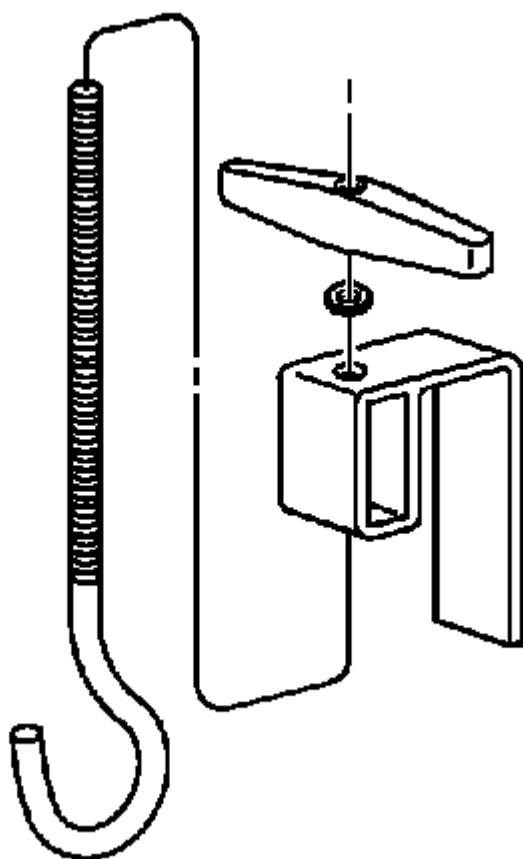


Fig. 29: View Of Lift Hook Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Install the J-28467-7A bolt hook through the J-28467-6A bracket.
10. Install the J-28467-34 lift hook wing nut and washer to the J-28467-7A lift hook.
11. Repeat the previous 2 steps in order to assemble 2 lift hooks and brackets.

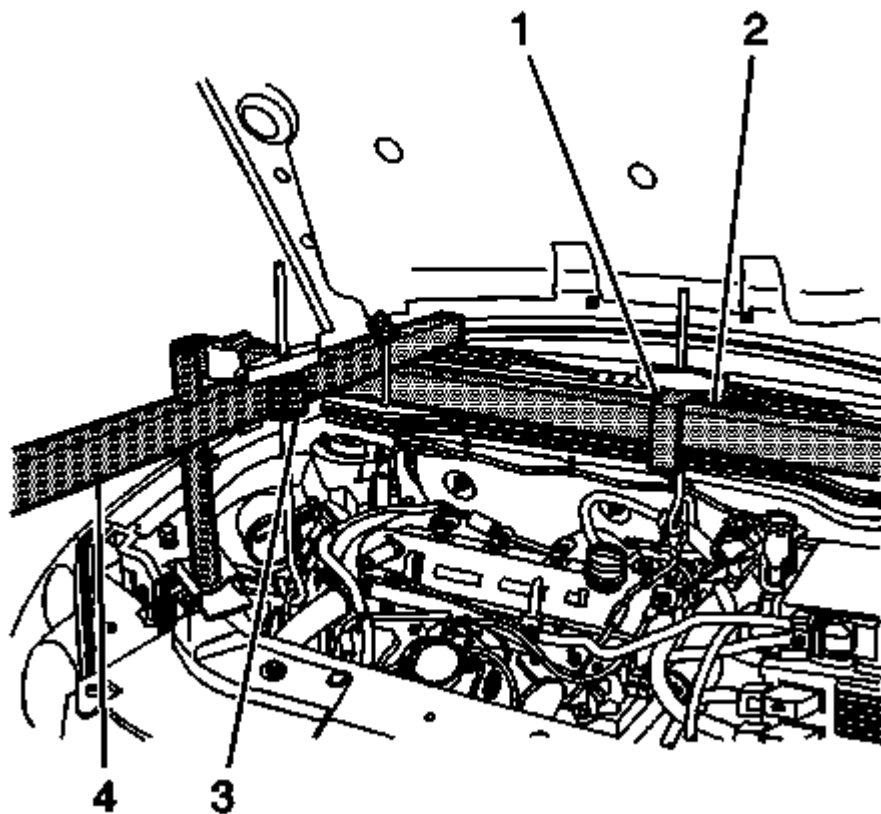


Fig. 30: Identifying Engine Support Fixture & Cross Bracket
Courtesy of GENERAL MOTORS COMPANY

12. Install one of the lift hook and bracket assemblies (1) to the engine support fixture long bar (2).
13. Install the other lift hook and bracket assembly (3) to the J-28467-2A radiator shelf tube (4) above the engine front lift bracket.

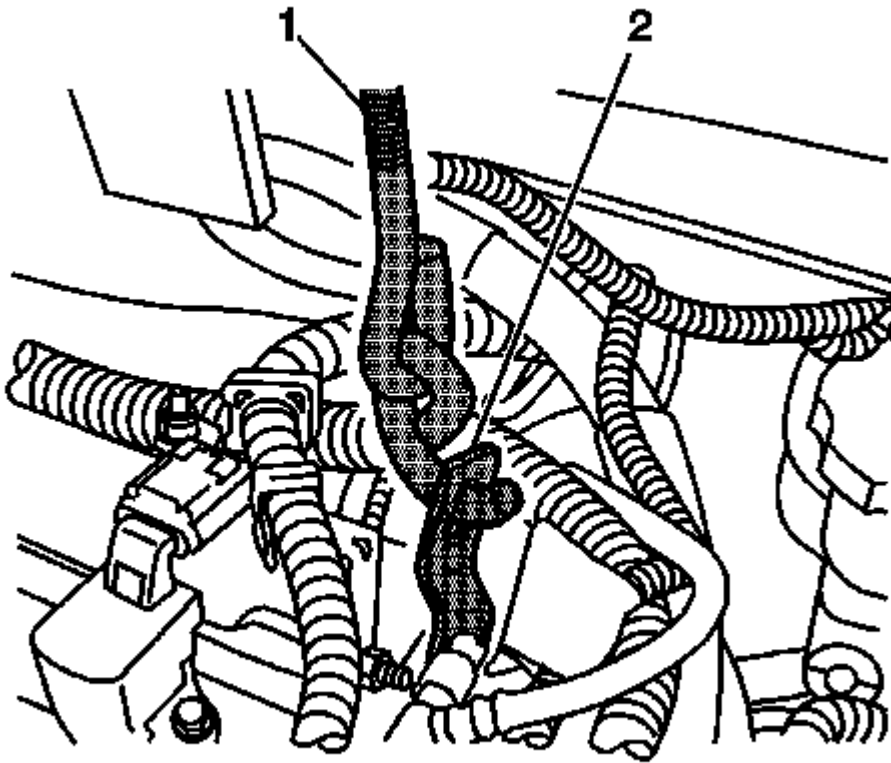


Fig. 31: Inserting Lift Hook Through Engine Rear Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

14. Install the lift hook J-28467-7A through the engine rear lift bracket (2).

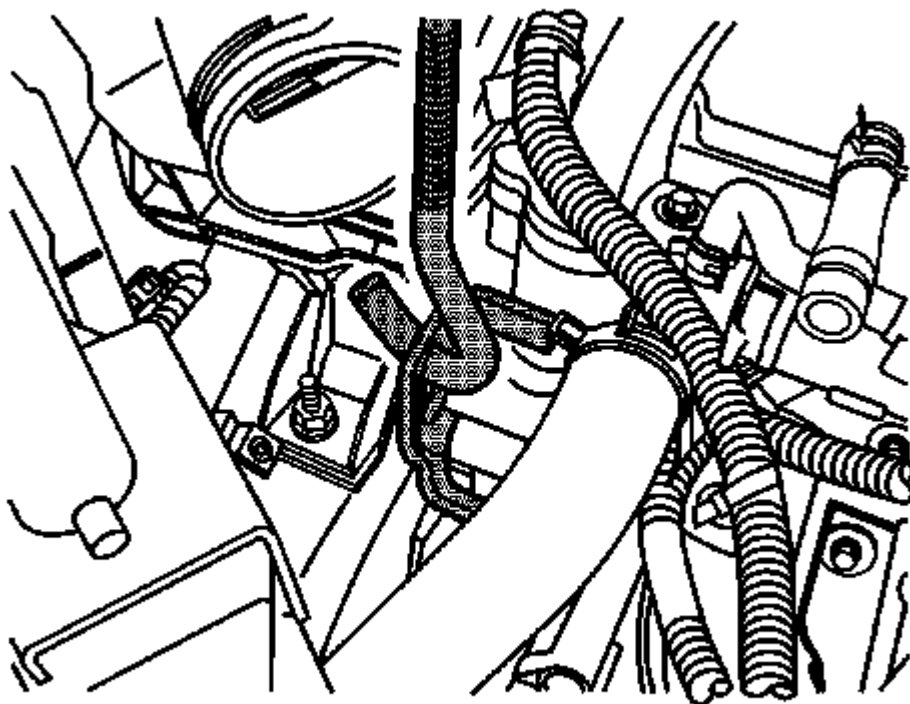


Fig. 32: Lift Hook Inserted Through Engine Front Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

15. Install the lift hook J-28467-7A through the engine front lift bracket.
16. Hand tighten the lift hook wing nuts J-28467-34 in order to remove all slack from the engine support fixture assembly.

OIL LEVEL INDICATOR TUBE REPLACEMENT

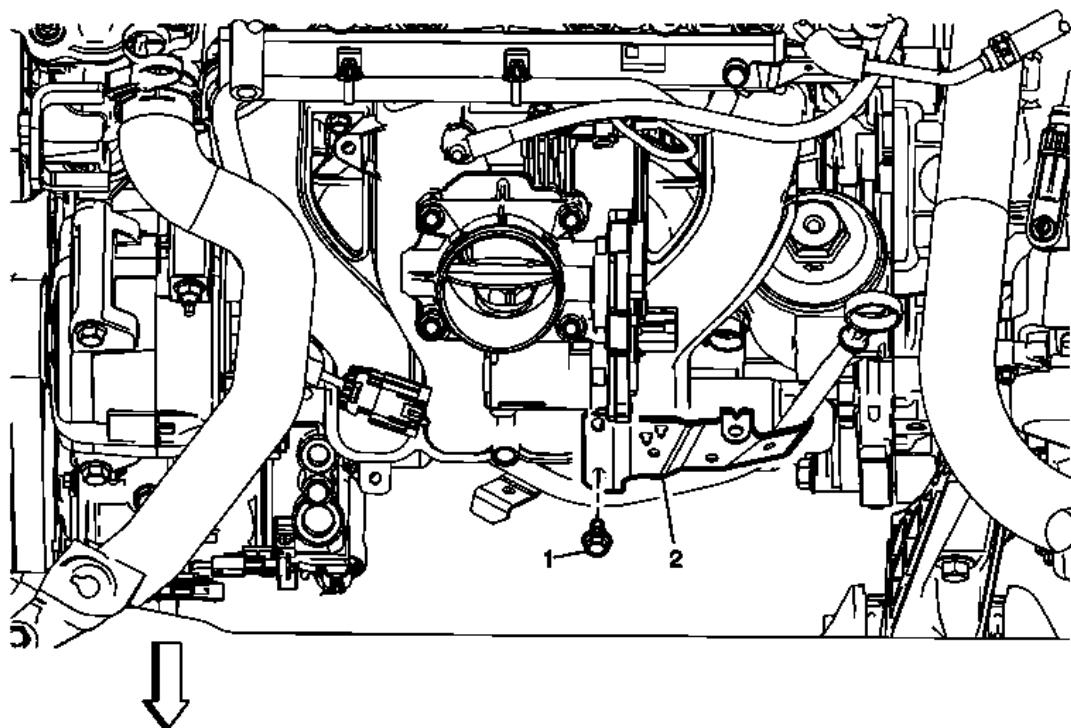


Fig. 33: Oil Level Indicator Tube & Bolt
 Courtesy of GENERAL MOTORS COMPANY

Oil Level Indicator Tube Replacement

Callout	Component Name
Preliminary Procedure Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
1	Oil Level Indicator Tube Bolt CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Oil Level Indicator Tube Procedure 1. Transfer over the oil level indicator. 2. Install NEW oil level indicator tube O-ring seals. 3. Disconnect electrical connector

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT

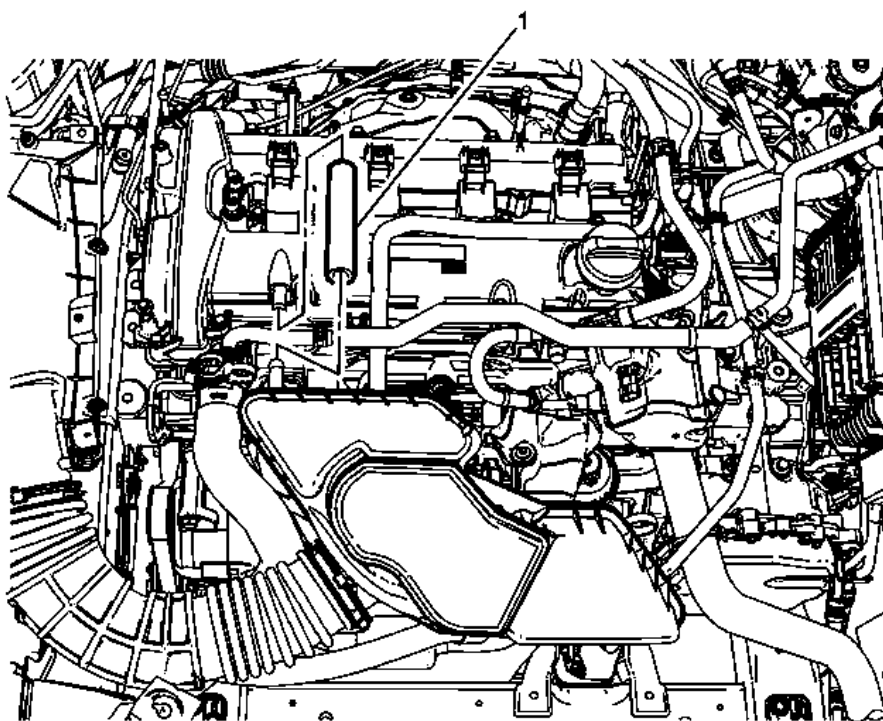


Fig. 34: Positive Crankcase Ventilation Hose/Pipe/Tube

Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement

Callout	Component Name
Preliminary Procedure	
Remove intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>	
1	Positive Crankcase Ventilation Hose/Pipe/Tube

INTAKE MANIFOLD REPLACEMENT (LEA)

Removal Procedure

1. Recover the A/C system. Refer to [Refrigerant Recovery and Recharging](#) .
2. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#) .
3. Remove the air cleaner outlet duct. Refer to [Air Cleaner Assembly Replacement](#) .

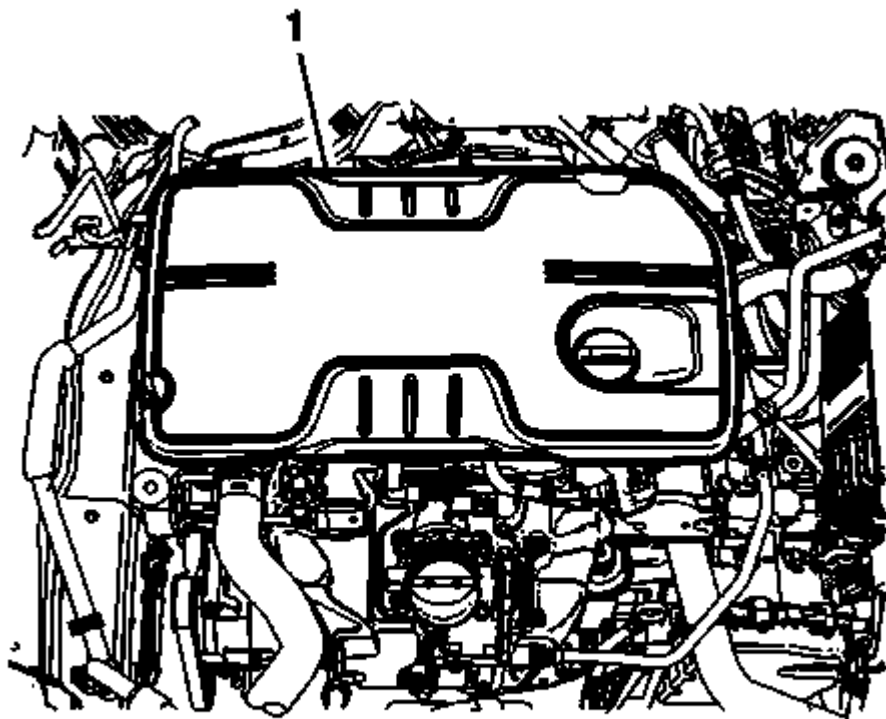


Fig. 35: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Never attempt to remove the intake manifold from a hot engine, allow the engine to cool to ambient temperature. The intake manifold can be damaged if it is removed when the engine is hot.

4. Remove the intake manifold cover (1). Refer to **Intake Manifold Cover Replacement**

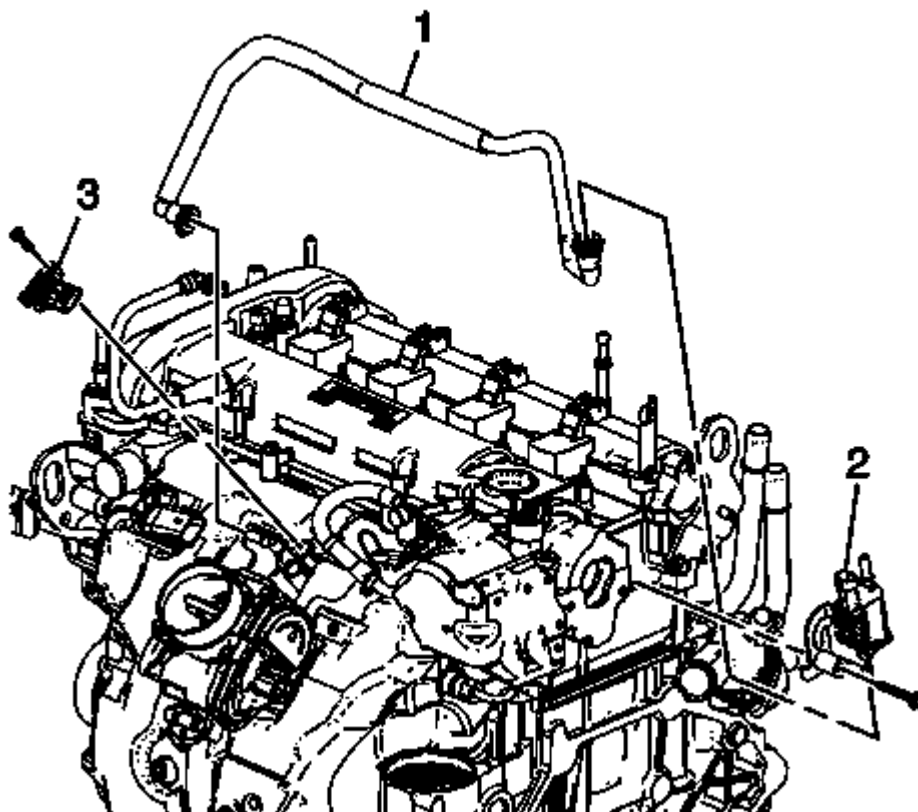


Fig. 36: EVAP Canister Valve, Tube & MAP Sensor
Courtesy of GENERAL MOTORS COMPANY

5. Remove the evaporative (EVAP) emission canister valve tube (1) from the intake manifold and reposition.
6. Remove the MAP sensor (3) electrical connector.

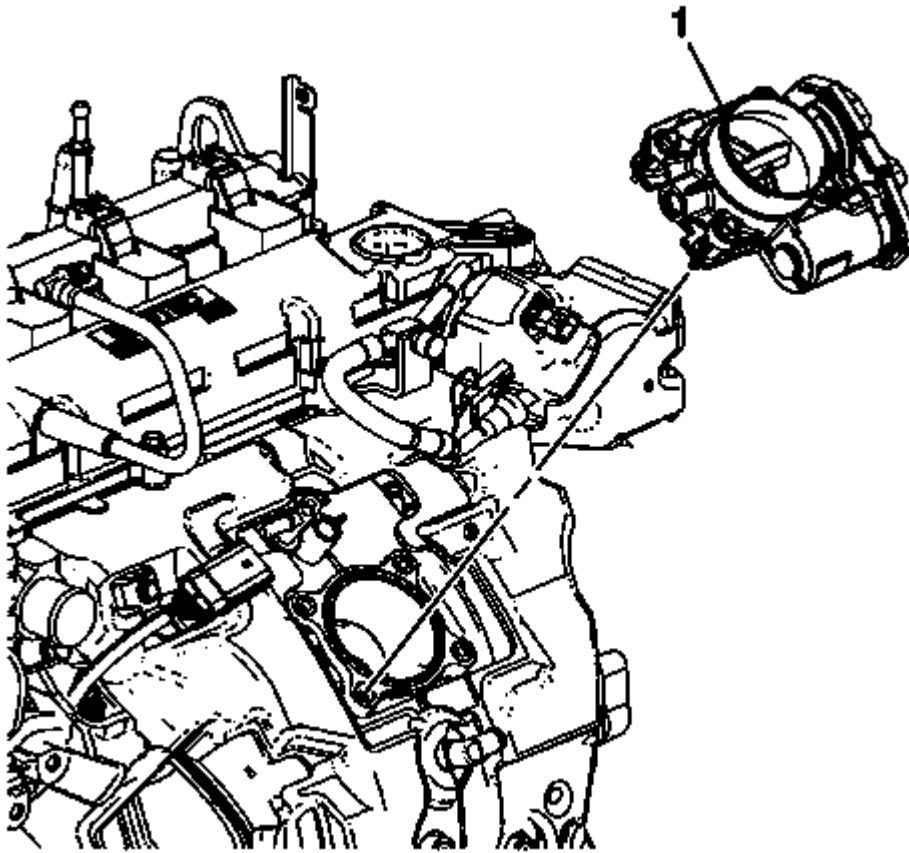


Fig. 37: Throttle Body

Courtesy of GENERAL MOTORS COMPANY

7. Remove the throttle body (1). Refer to **Throttle Body Assembly Replacement** .

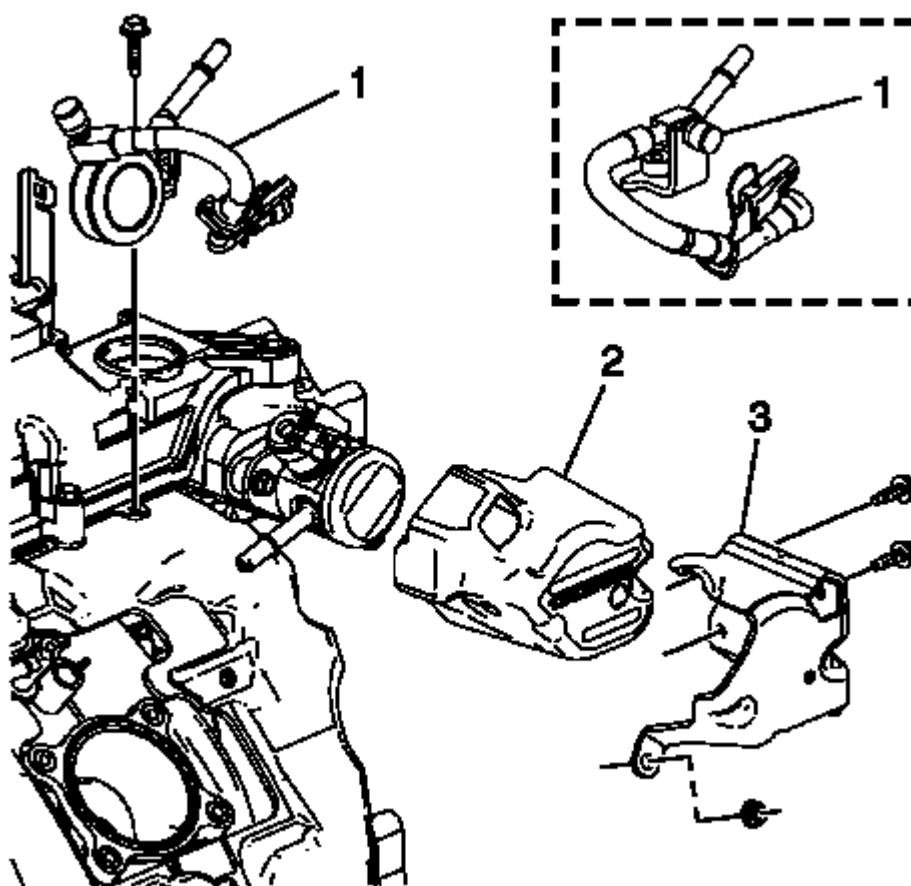


Fig. 38: Fuel Pump Components

Courtesy of GENERAL MOTORS COMPANY

8. Remove the fuel pump cover (3) and insulator (2). Refer to **Fuel Pump Cover Replacement** .

NOTE: The low pressure fuel pipe used is model dependent.

9. Disconnect and reposition the low pressure fuel feed pipe from the fuel pump. Refer to **Metal Collar Quick Connect Fitting Service** .

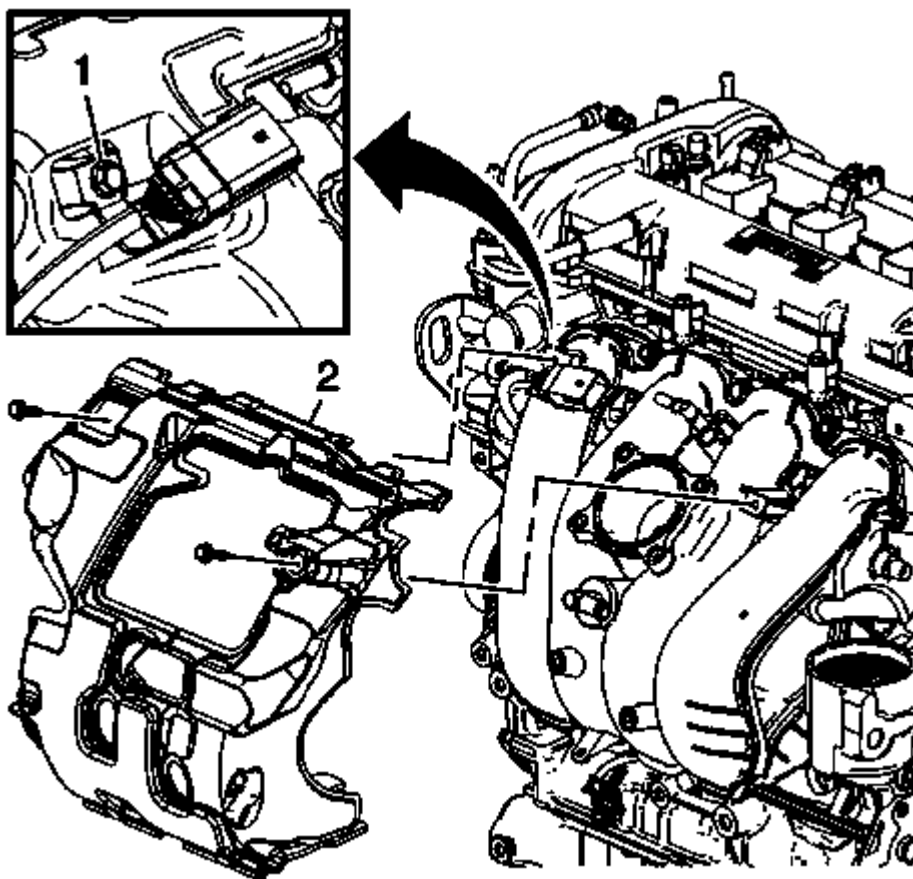


Fig. 39: Fuel Rail Harness Connector Bracket And Intake Manifold Insulator
 Courtesy of GENERAL MOTORS COMPANY

10. Remove the fuel rail harness connector bracket bolt (1) and intake manifold insulator bolt.
11. Remove the intake manifold insulator (2).

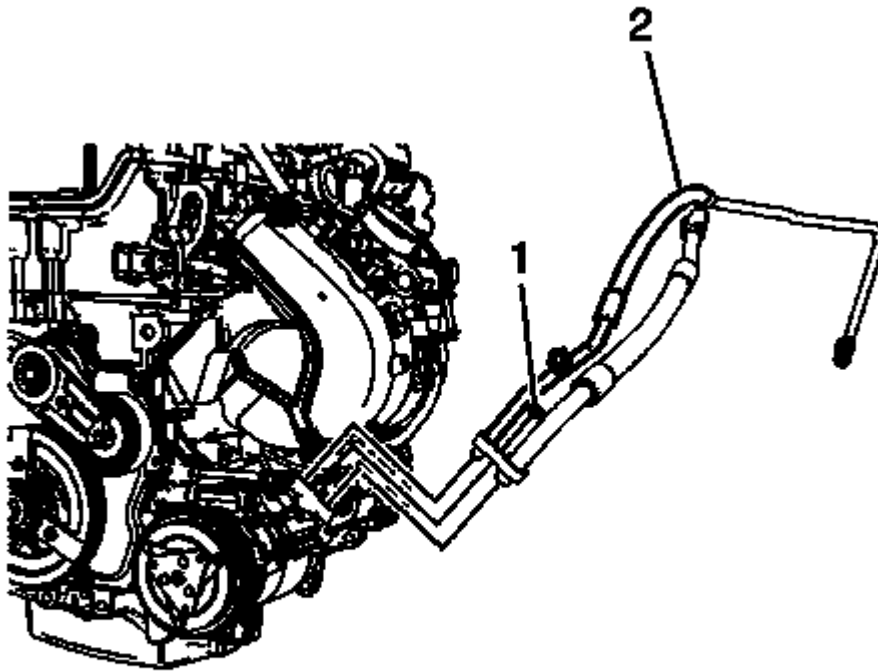


Fig. 40: Compressor Hose At Compressor
Courtesy of GENERAL MOTORS COMPANY

12. Remove the A/C line nut (1) and line (2) from the compressor and reposition the line to the side.

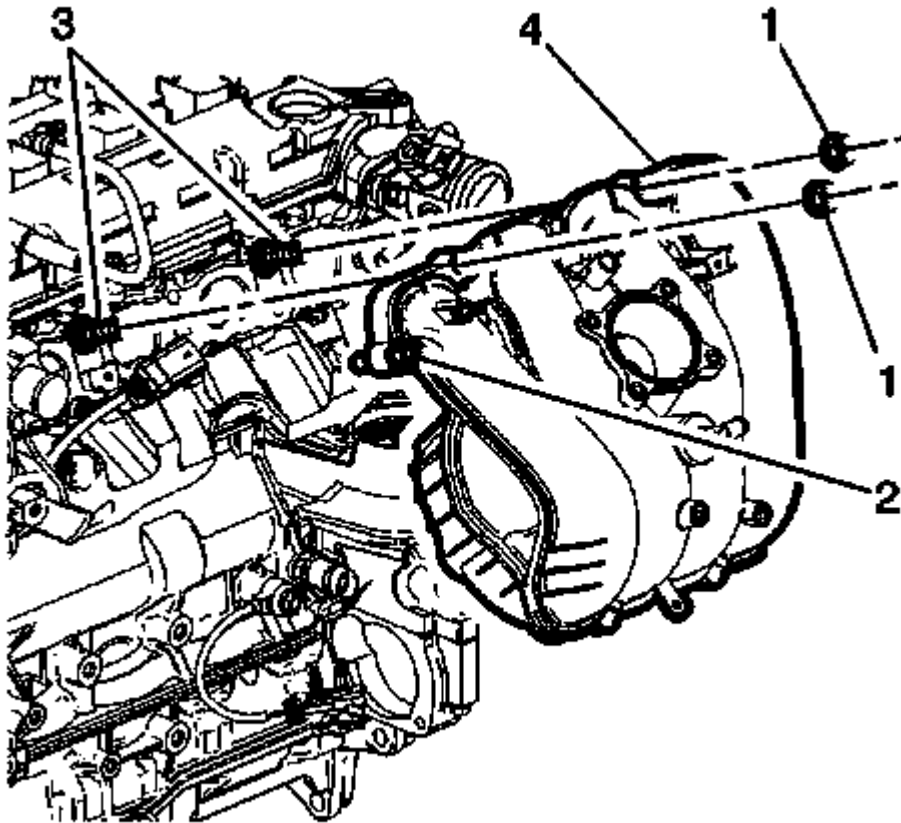


Fig. 41: Intake Manifold Retaining Nuts And Studs
Courtesy of GENERAL MOTORS COMPANY

NOTE: Removing studs allows the intake manifold to be removed without removing the fuel pump.

13. Remove the intake manifold retaining nuts (1), studs (3), and bolts (2).
14. Remove the intake manifold (1).
15. Disconnect electrical connectors as necessary.
16. Transfer parts as necessary.
17. If reusing the intake manifold, clean and inspect as necessary. Refer to **Intake Manifold Cleaning and Inspection (LAF, LEA, or LUK)** .

Installation Procedure

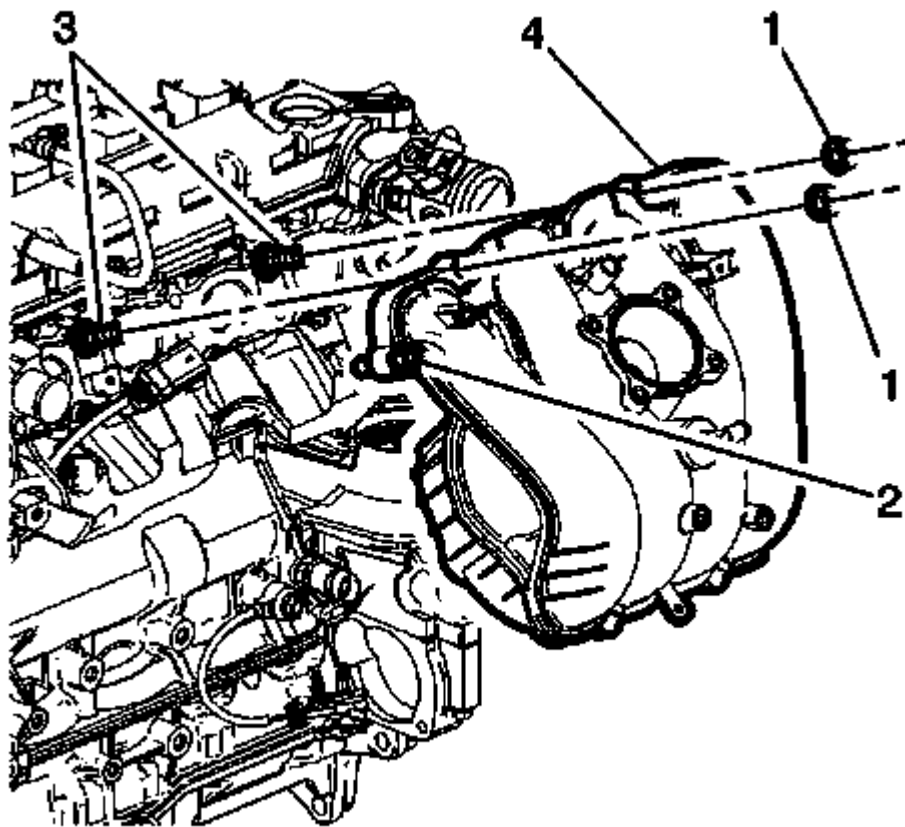


Fig. 42: Intake Manifold Retaining Nuts And Studs
Courtesy of GENERAL MOTORS COMPANY

1. Position the intake manifold (4) and hand start the bolts (2).

CAUTION: Refer to Fastener Caution .

2. Install the intake manifold studs (3) and tighten to 6 N.m (53 lb in).

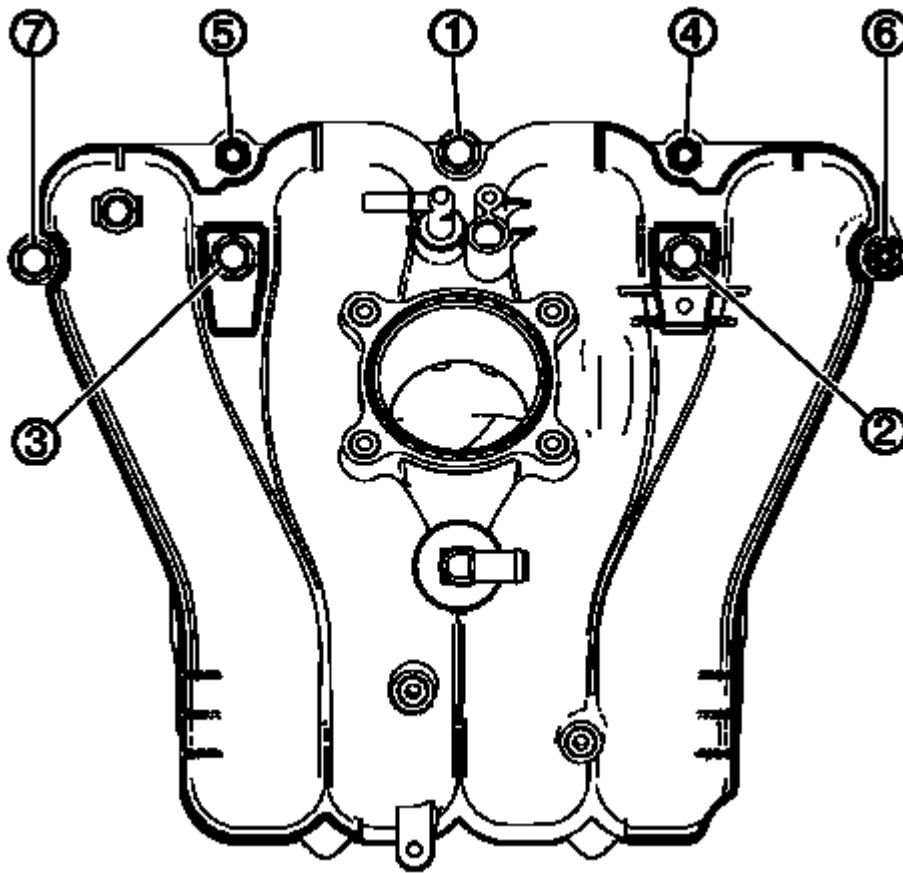


Fig. 43: Identifying Intake Manifold Bolts And Nuts
Courtesy of GENERAL MOTORS COMPANY

3. Tighten the bolts (2) and nuts (1) in sequence to 10 N.m (89 lb in).

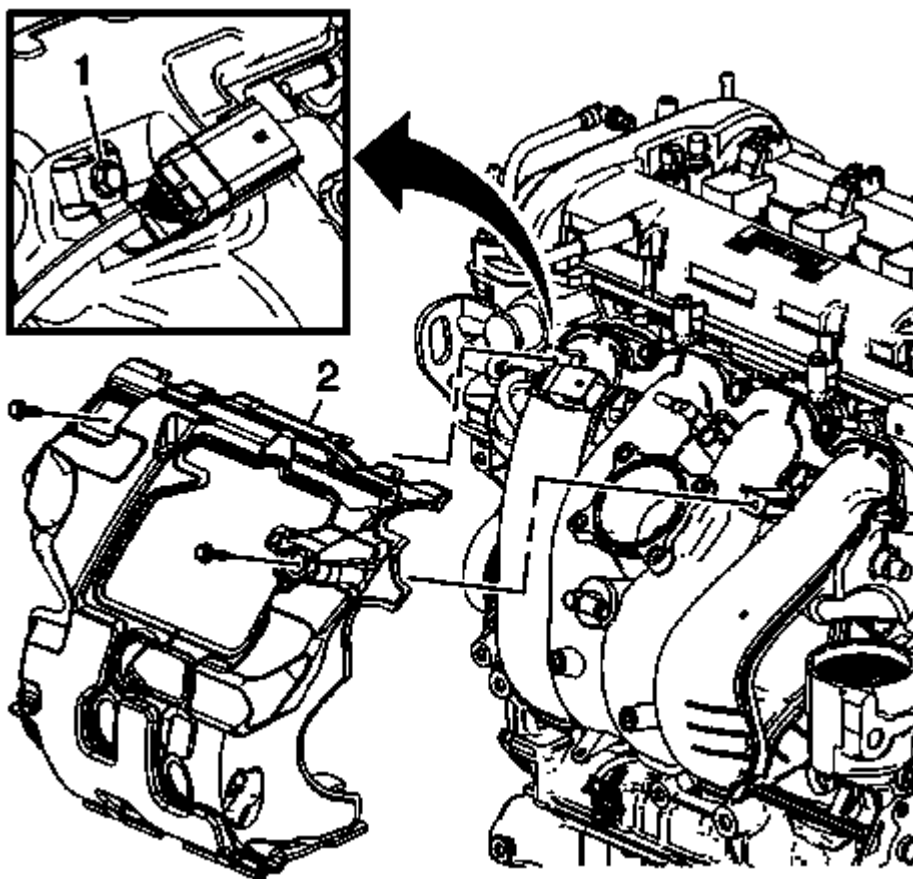


Fig. 44: Fuel Rail Harness Connector Bracket And Intake Manifold Insulator
Courtesy of GENERAL MOTORS COMPANY

4. Install the intake manifold insulator (2).
5. Install the insulator bolt and tighten to 10 N.m (89 lb in).
6. Install the fuel rail harness connector bracket (1) to the intake manifold. Tighten the bracket bolt to 10 N.m (89 lb in).

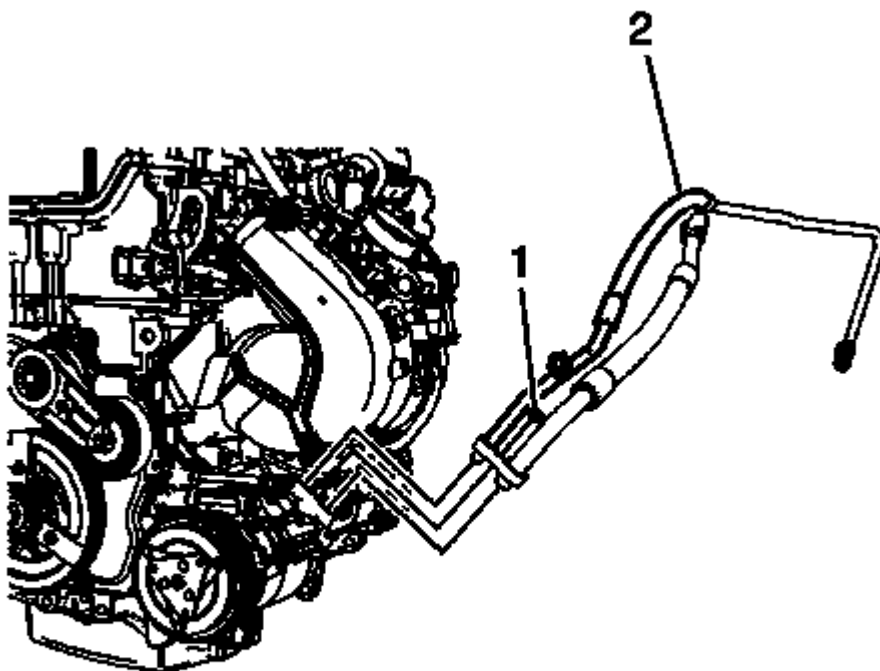


Fig. 45: Compressor Hose At Compressor

Courtesy of GENERAL MOTORS COMPANY

7. Install new seal washers to the compressor hose. Refer to [Air Conditioning System Seal Replacement](#) .
8. Install the compressor hose (2) to the compressor.
9. Install the compressor hose nut (1) to the compressor and tighten the nut to 22 N.m (16 lb ft).
10. Connect the engine harness electrical connector as necessary.

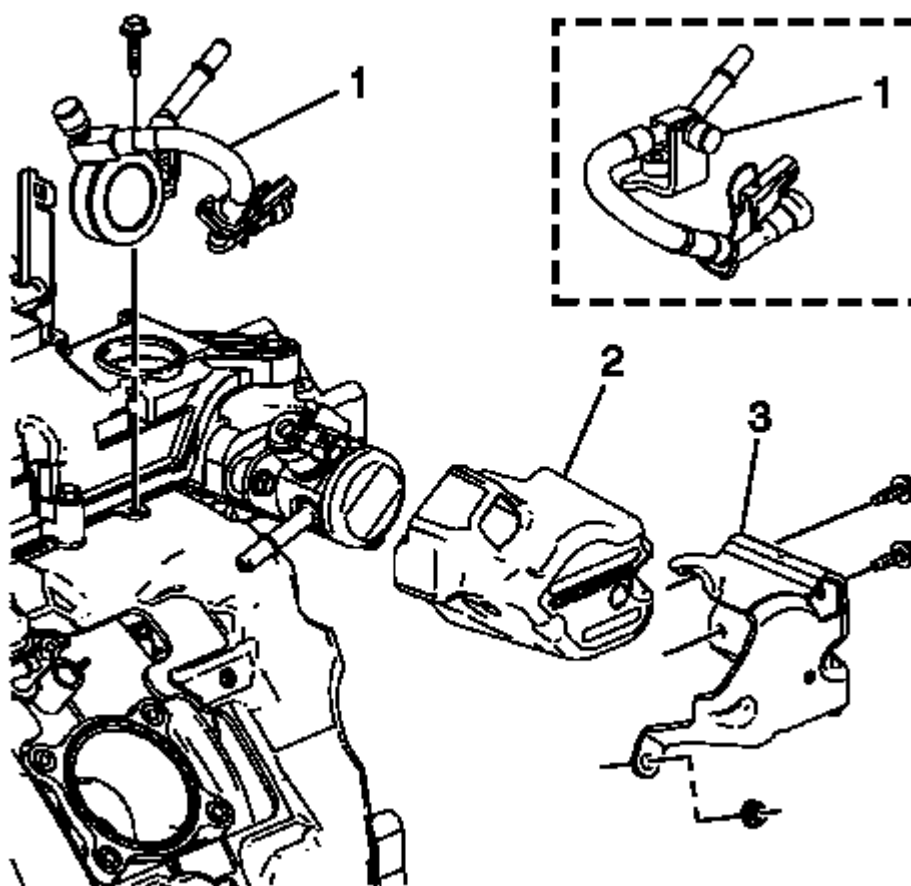


Fig. 46: Fuel Pump Components

Courtesy of GENERAL MOTORS COMPANY

11. Install the fuel pump insulator (2) and cover (3). Refer to **Fuel Pump Cover Replacement** .

NOTE: The low pressure fuel pipe used is model dependent.

12. Install the low pressure fuel pipe assembly (1).

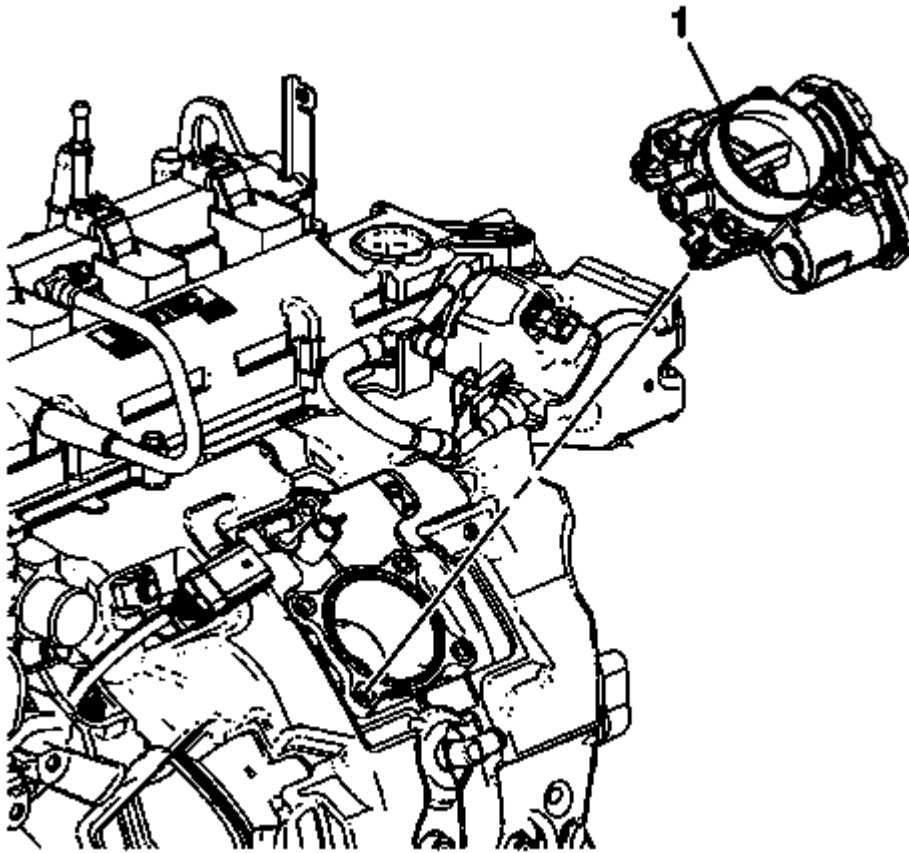


Fig. 47: Throttle Body

Courtesy of GENERAL MOTORS COMPANY

13. Install a new throttle body gasket.
14. Install the throttle body (1). Refer to Throttle Body Assembly Replacement .

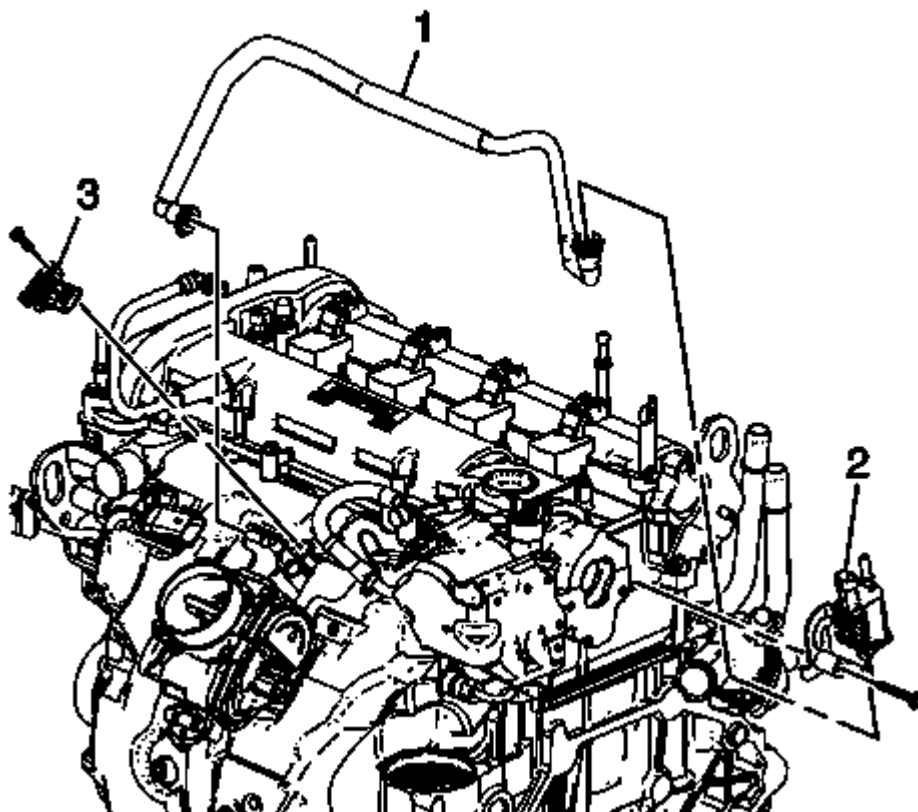


Fig. 48: EVAP Canister Valve, Tube & MAP Sensor
Courtesy of GENERAL MOTORS COMPANY

15. Install the EVAP canister valve tube (1).
16. Connect the MAP sensor electrical connector.

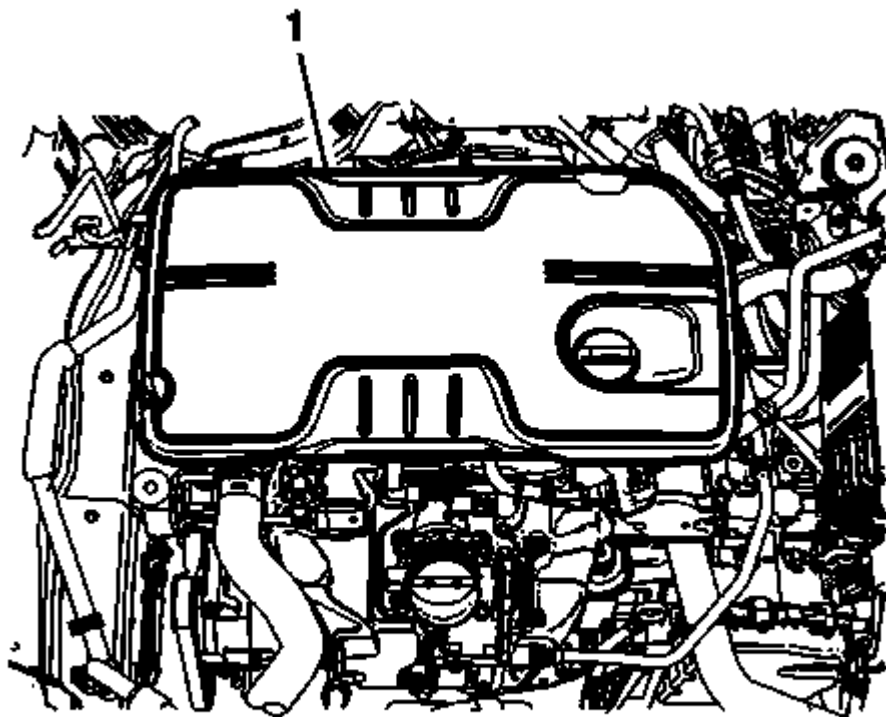


Fig. 49: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Never attempt to remove the intake manifold from a hot engine, allow the engine to cool to ambient temperature. The intake manifold can be damaged if it is removed when the engine is hot.

17. Install the intake manifold cover (1). Refer to [Intake Manifold Cover Replacement](#)
18. Recharge the A/C system. Refer to [Refrigerant Recovery and Recharging](#) .
19. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#) .

INTAKE MANIFOLD REPLACEMENT (LUK)

Removal Procedure

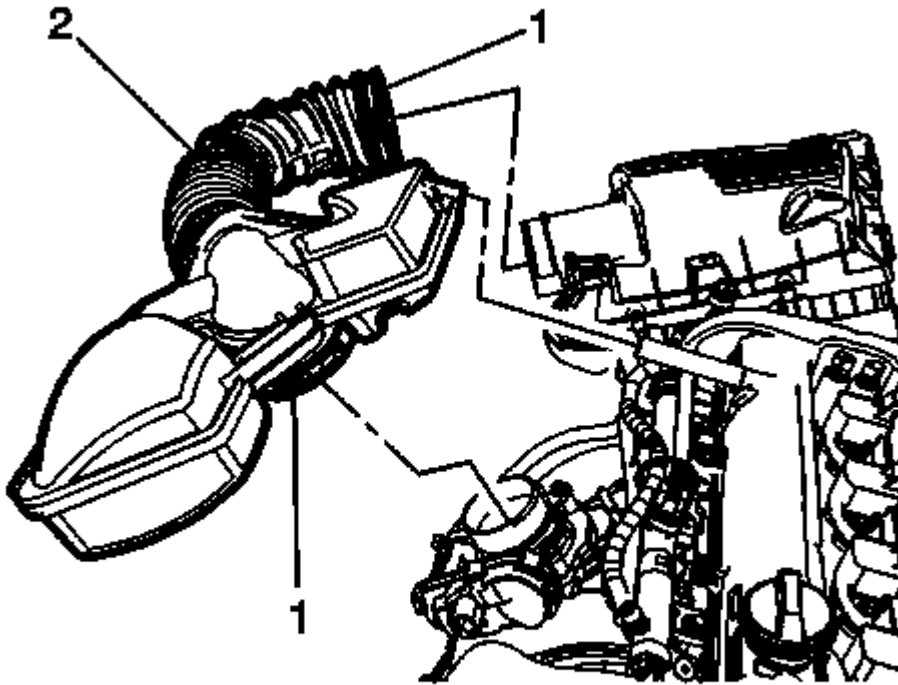


Fig. 50: Air Cleaner Outlet Duct

Courtesy of GENERAL MOTORS COMPANY

1. Remove the air cleaner outlet duct (2). Refer to [Air Cleaner Outlet Duct Replacement](#) .

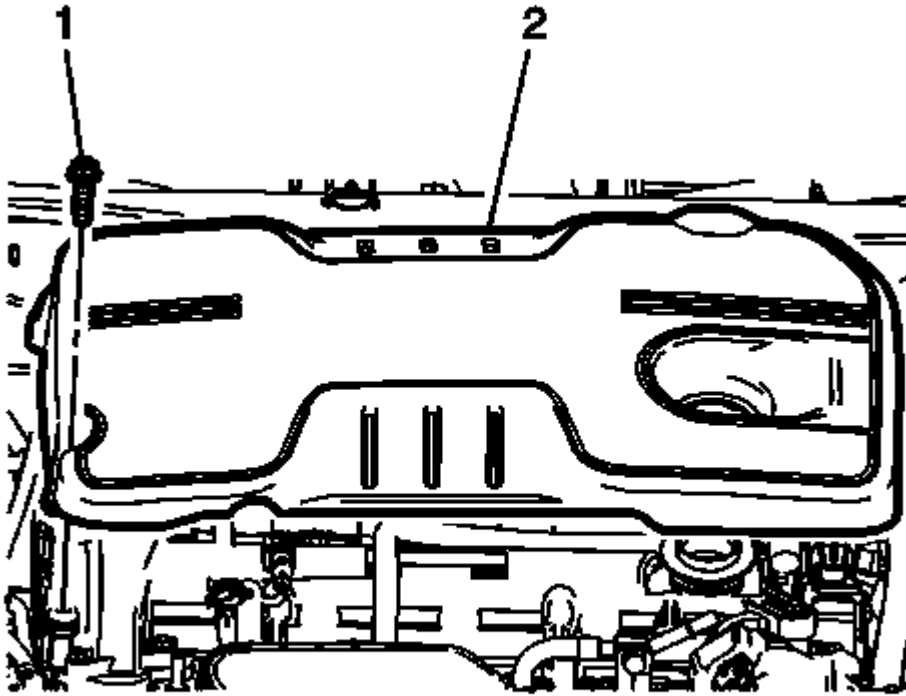


Fig. 51: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

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

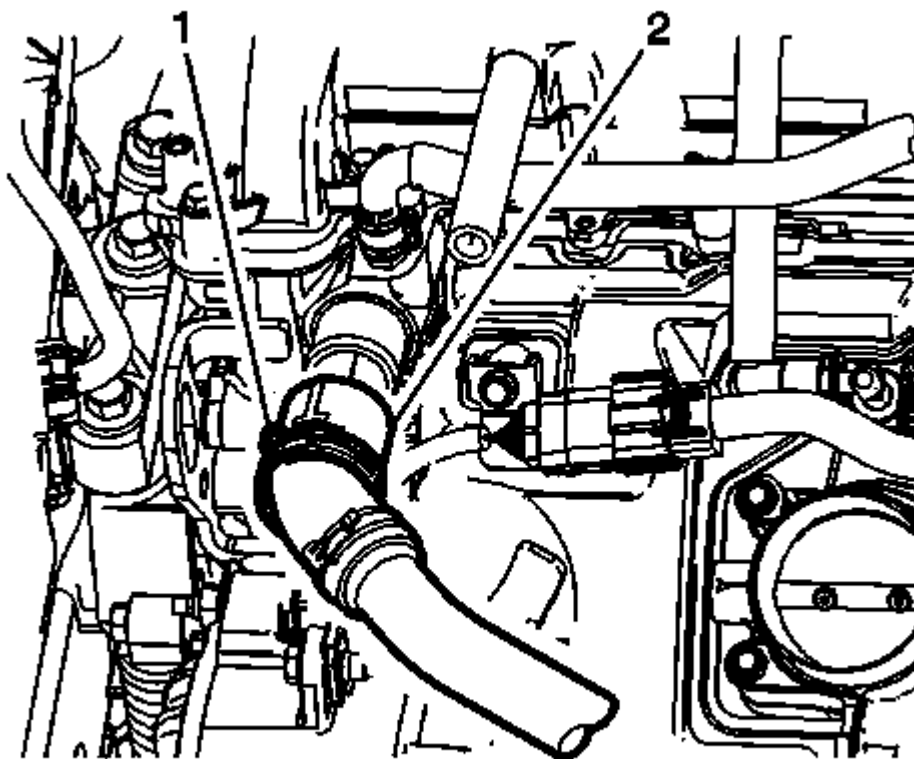


Fig. 52: Hose Clamp And Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

3. Reposition the hose clamp (1) and disconnect the radiator inlet hose (2). Refer to **Radiator Inlet Hose Replacement (LUK)** .

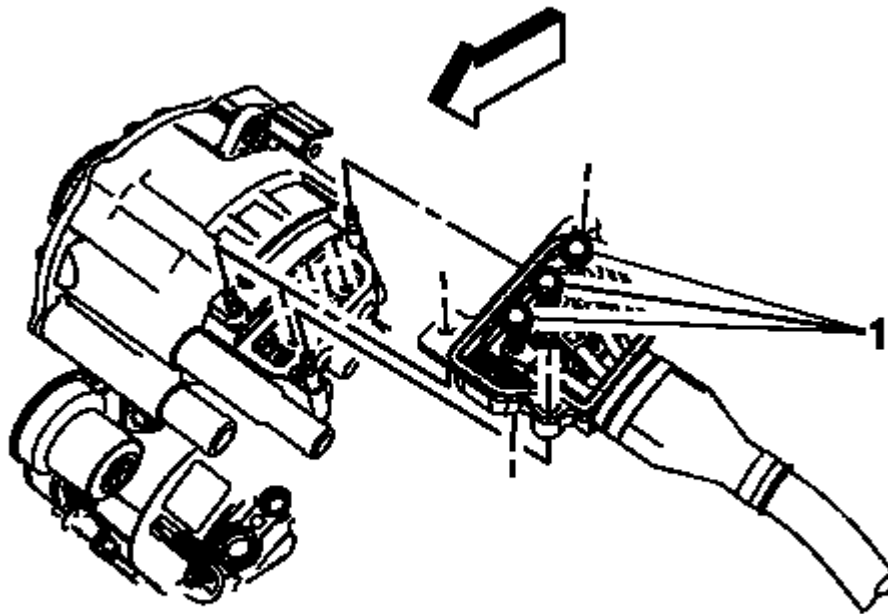


Fig. 53: Starter Generator

Courtesy of GENERAL MOTORS COMPANY

4. Remove the starter generator. Refer to **Starter Generator Replacement**

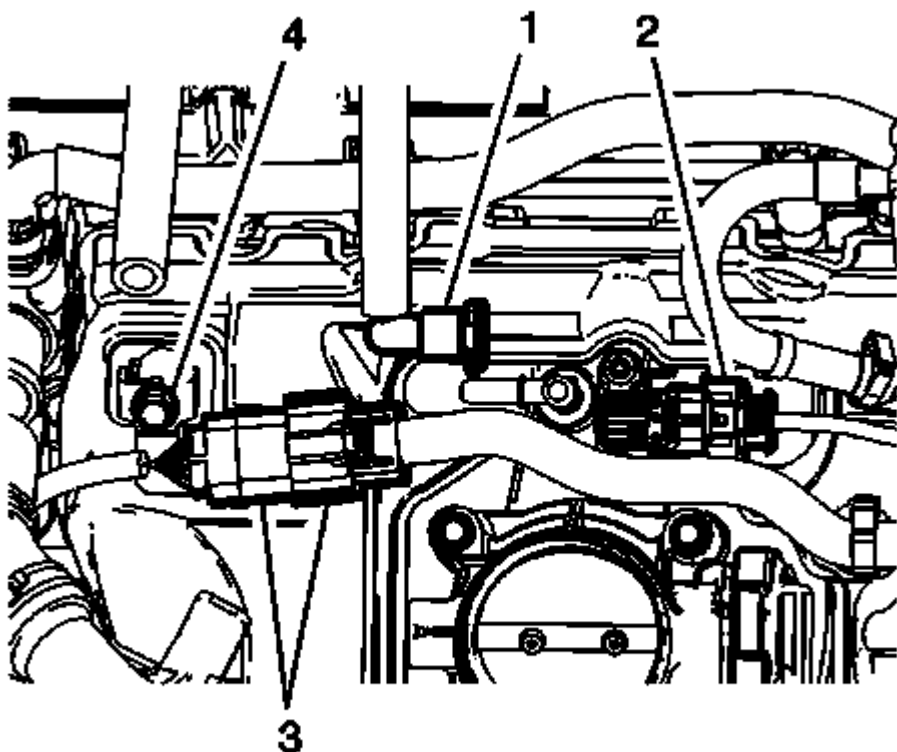


Fig. 54: Fuel Injector Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the fuel injector wiring harness electrical connector (3) from the engine wiring harness electrical connector.
6. Remove the fuel injector wiring harness fastener (4) from the intake manifold.
7. Disconnect the evaporative emission (EVAP) canister purge tube (1) from the intake manifold. Refer to **Plastic Collar Quick Connect Fitting Service** .
8. Disconnect the MAP sensor connector (2).

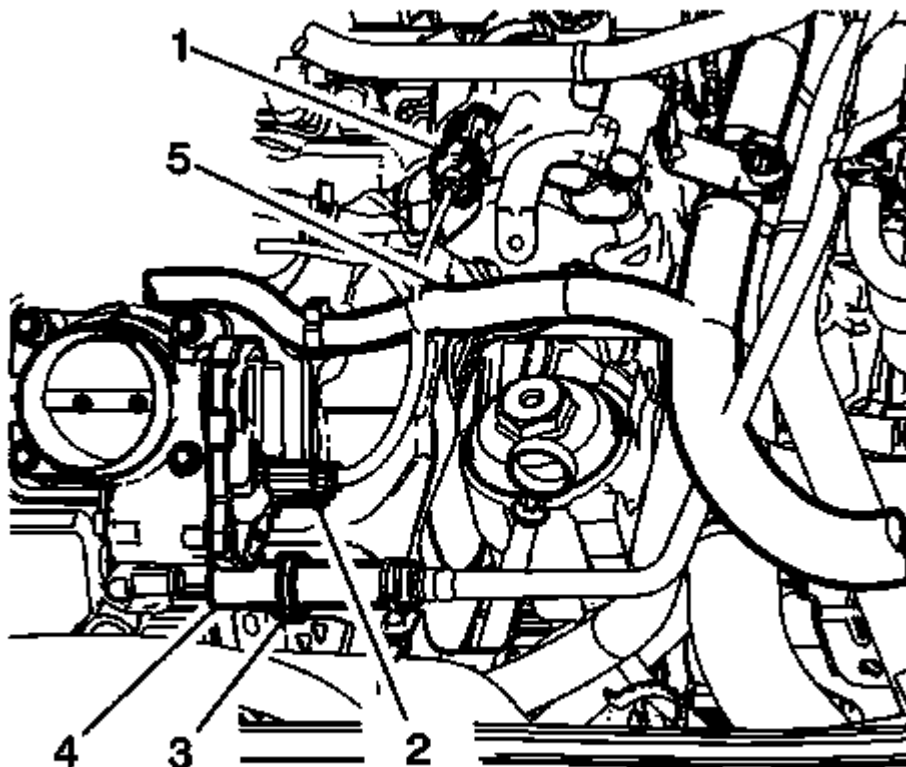


Fig. 55: Engine Harness And Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the fuel pump electrical connector (1).
10. Disconnect the engine wiring harness electrical connector (2) from the throttle actuator control (TAC).
11. Reposition the vacuum brake booster hose clamp (3) at the intake manifold.
12. Remove the vacuum brake booster hose (4) from the intake manifold.
13. Reposition the engine harness (5) away from the intake manifold.

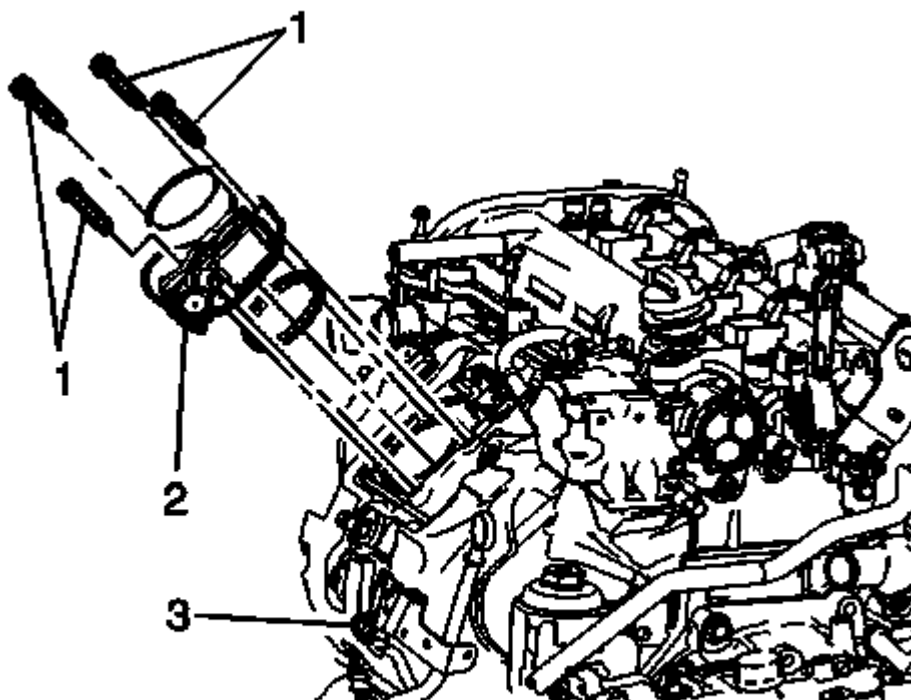


Fig. 56: Throttle Body

Courtesy of GENERAL MOTORS COMPANY

14. Remove the throttle body (2). Refer to **Throttle Body Assembly Replacement** .
15. Remove the fastener (3) from the oil level indicator tube and remove the tube. Refer to **Oil Level Indicator Tube Replacement**.

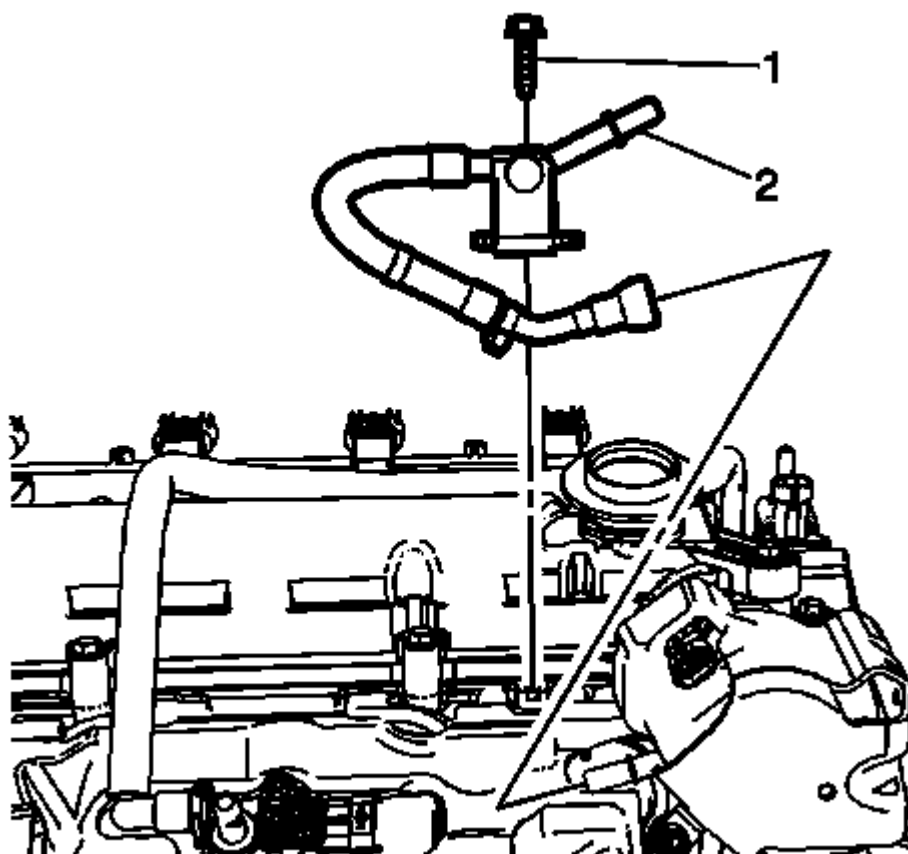


Fig. 57: Fuel Feed Pipe

Courtesy of GENERAL MOTORS COMPANY

16. Remove the fuel feed pipe (2). Refer to **Fuel Feed Pipe Replacement (Engine)** , **Fuel Feed Pipe Replacement (Chassis)** .

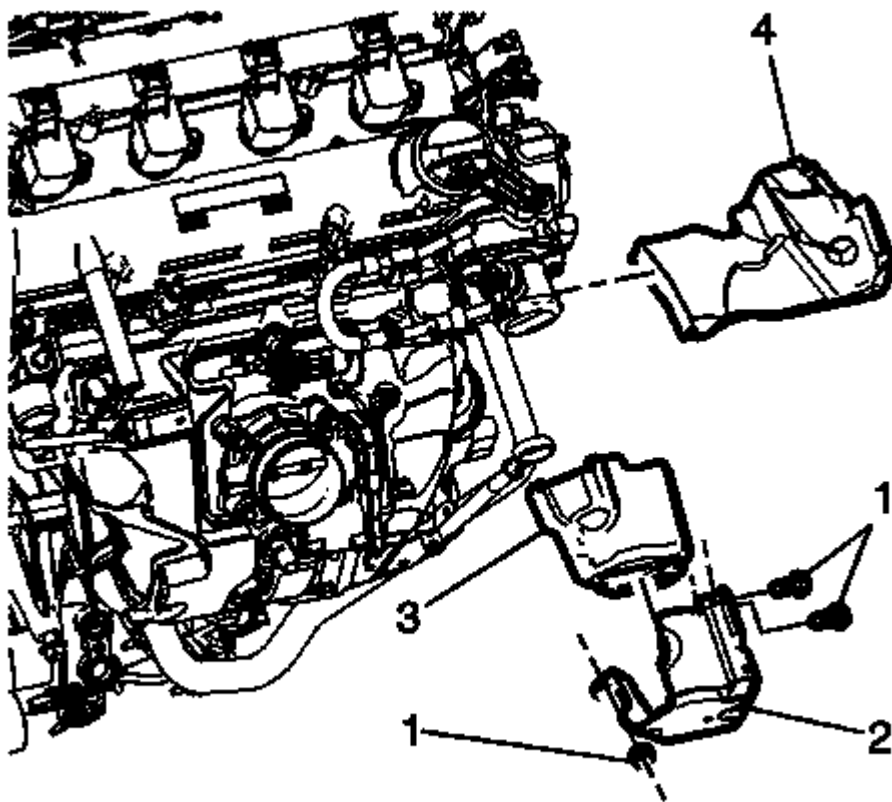


Fig. 58: Fuel Pump Cover

Courtesy of GENERAL MOTORS COMPANY

17. Remove the fuel pump cover (1-4). Refer to **Fuel Pump Cover Replacement** .

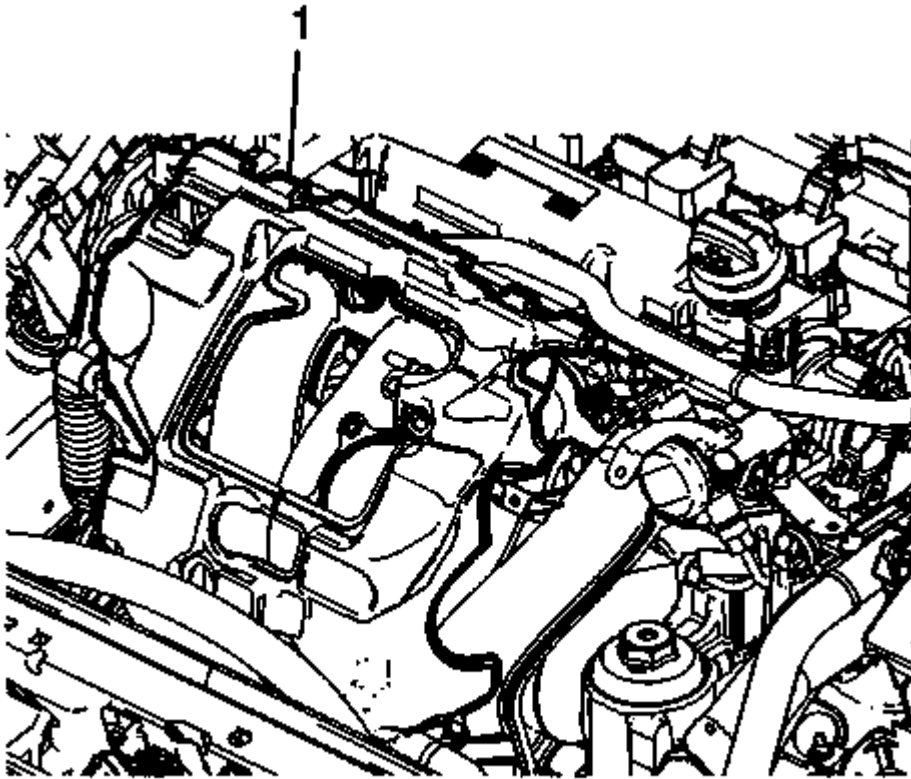


Fig. 59: Intake Manifold Heat Shield
Courtesy of GENERAL MOTORS COMPANY

18. Remove the intake manifold heat shield (1).

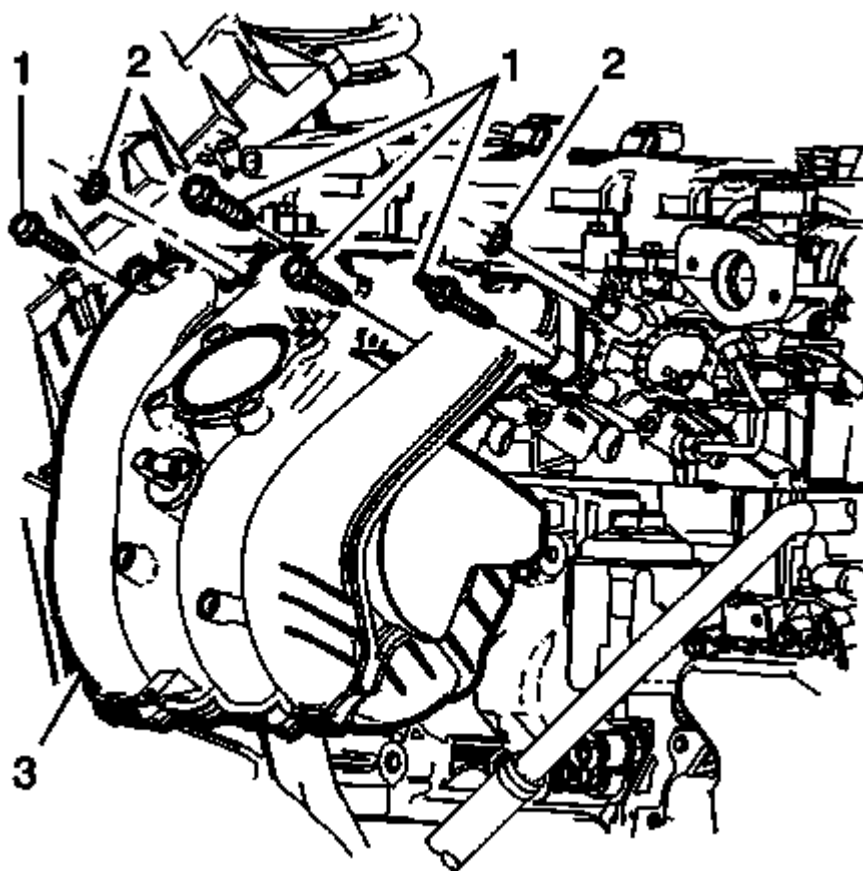


Fig. 60: Intake Manifold Lower Bolts

Courtesy of GENERAL MOTORS COMPANY

19. Remove the intake manifold lower bolts (1).
20. Remove the intake manifold upper nuts (2).
21. Remove the intake manifold (3).

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

22. Remove and inspect the intake manifold gasket.

Installation Procedure

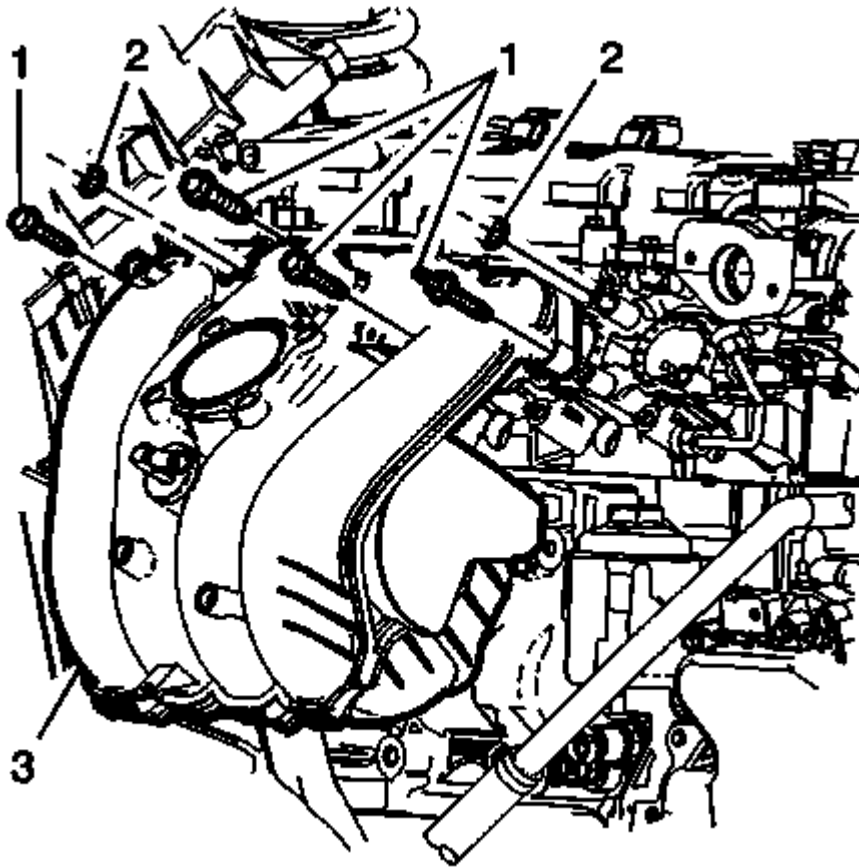


Fig. 61: Intake Manifold Lower Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW intake manifold gasket if necessary, otherwise install the old gasket.
2. Install the intake manifold (3).
3. Install the intake manifold upper nuts (2).

CAUTION: Refer to Fastener Caution .

4. Install the intake manifold lower bolts (1). Tighten the bolts/nuts (1 and 2) to 10 N.m (89 lb in).

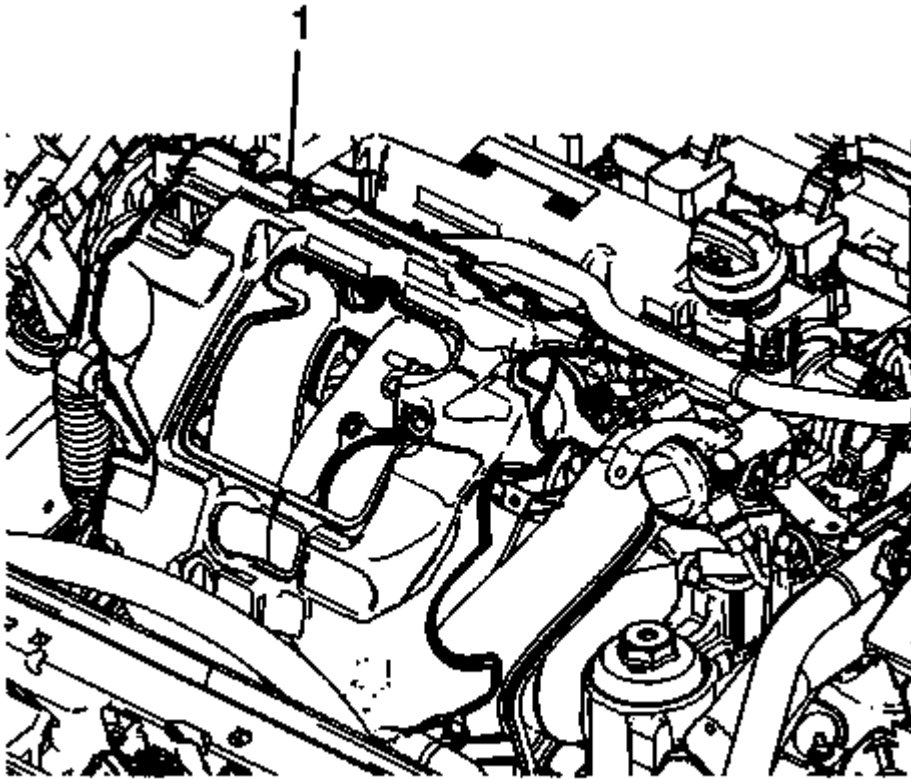


Fig. 62: Intake Manifold Heat Shield

Courtesy of GENERAL MOTORS COMPANY

5. Install the intake manifold heat shield (1).

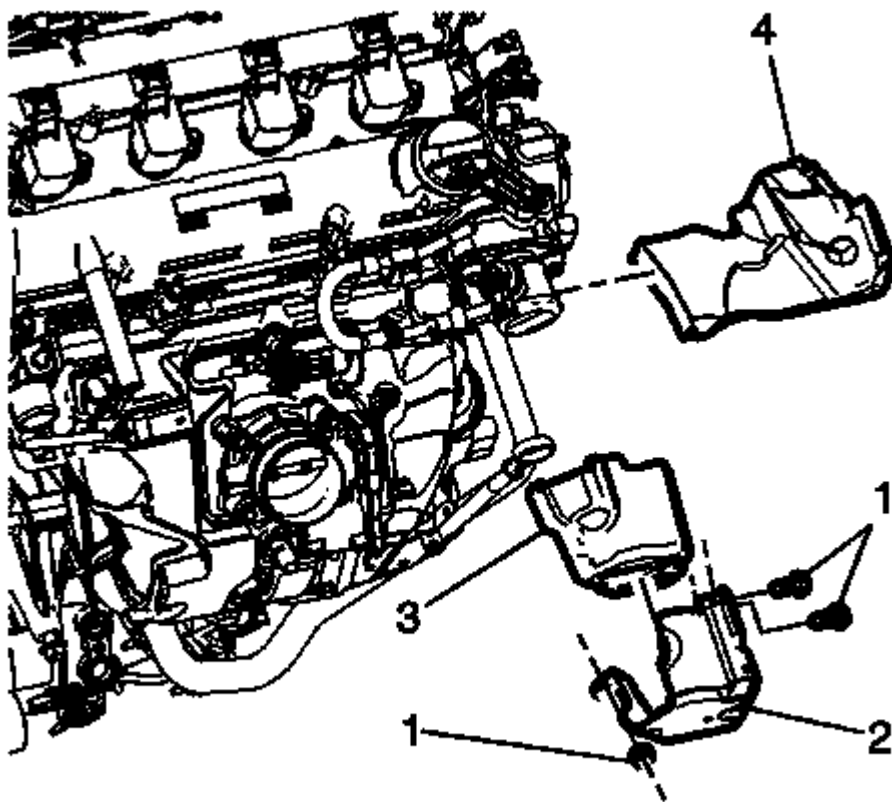


Fig. 63: Fuel Pump Cover

Courtesy of GENERAL MOTORS COMPANY

6. Install the fuel pump cover (1-4). Refer to **Fuel Pump Cover Replacement** .

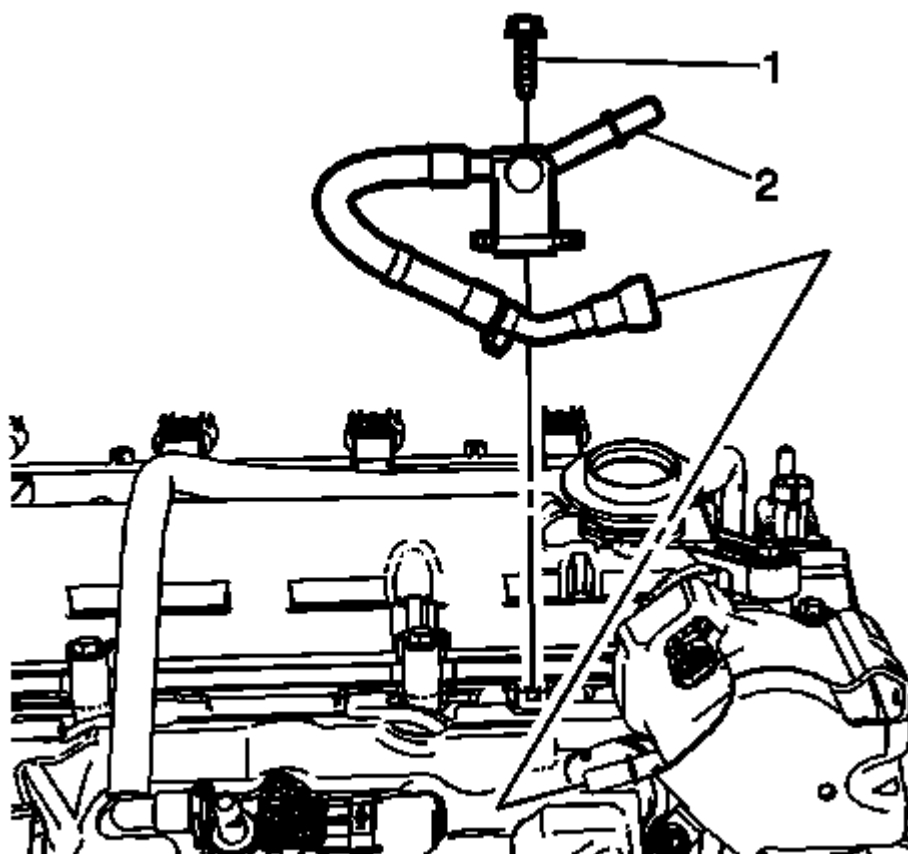


Fig. 64: Fuel Feed Pipe

Courtesy of GENERAL MOTORS COMPANY

7. Install the fuel feed pipe (2). Refer to **Fuel Feed Pipe Replacement (Engine)** , **Fuel Feed Pipe Replacement (Chassis)** .

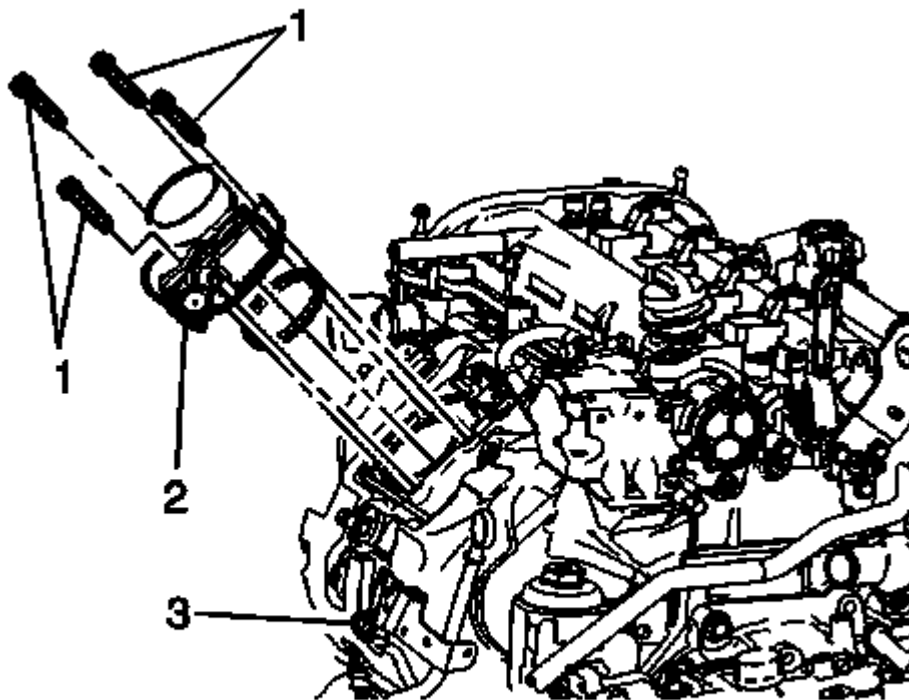


Fig. 65: Throttle Body

Courtesy of GENERAL MOTORS COMPANY

8. Install the throttle body (2). Refer to **Throttle Body Assembly Replacement** .
9. Remove the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.

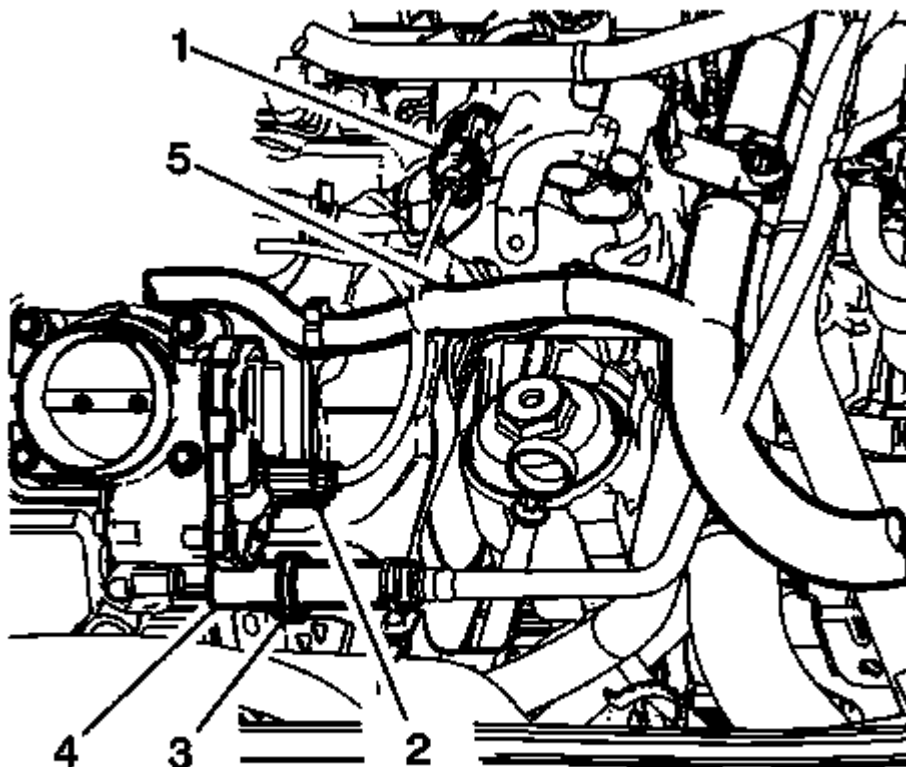


Fig. 66: Engine Harness And Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS COMPANY

10. Reposition the engine harness (5) across the intake manifold.
11. Connect the engine wiring harness electrical connector (2) to the throttle actuator control (TAC).
12. Connect the vacuum brake booster hose (4) at the intake manifold.
13. Install the brake booster hose clamp (3).
14. Connect the fuel pump electrical connector (1).

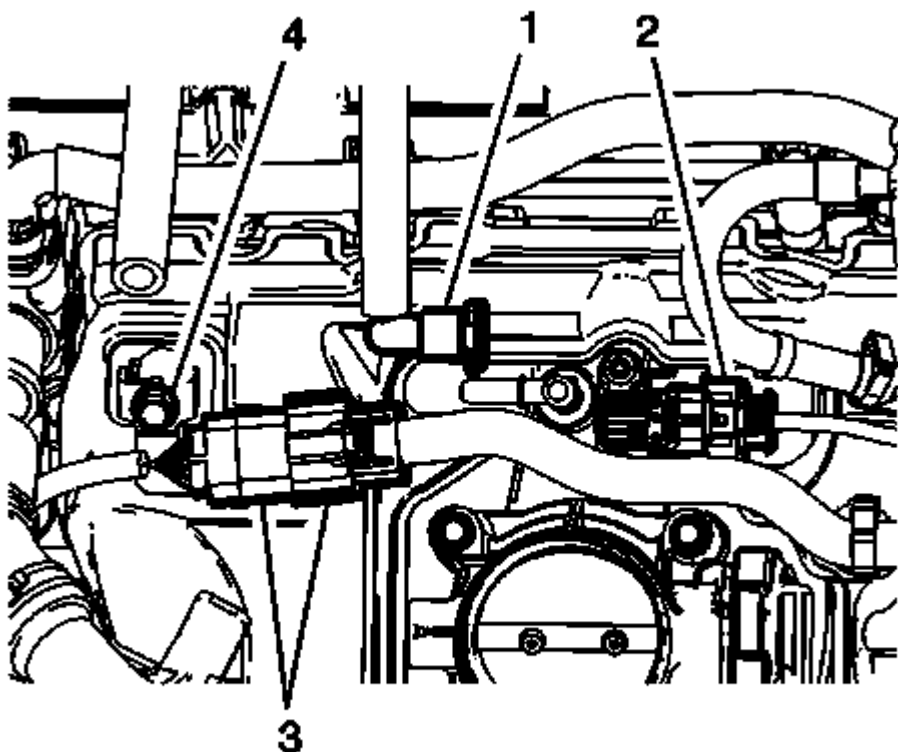


Fig. 67: Fuel Injector Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

15. Connect the fuel injector wiring harness electrical connector (3) to the engine wiring harness electrical connector.
16. Install the fuel injector wiring harness fastener (4) to the intake manifold.
17. Connect the evaporative emission (EVAP) canister purge tube (1) to the intake manifold. Refer to **Plastic Collar Quick Connect Fitting Service** .
18. Connect the MAP sensor connector (2).

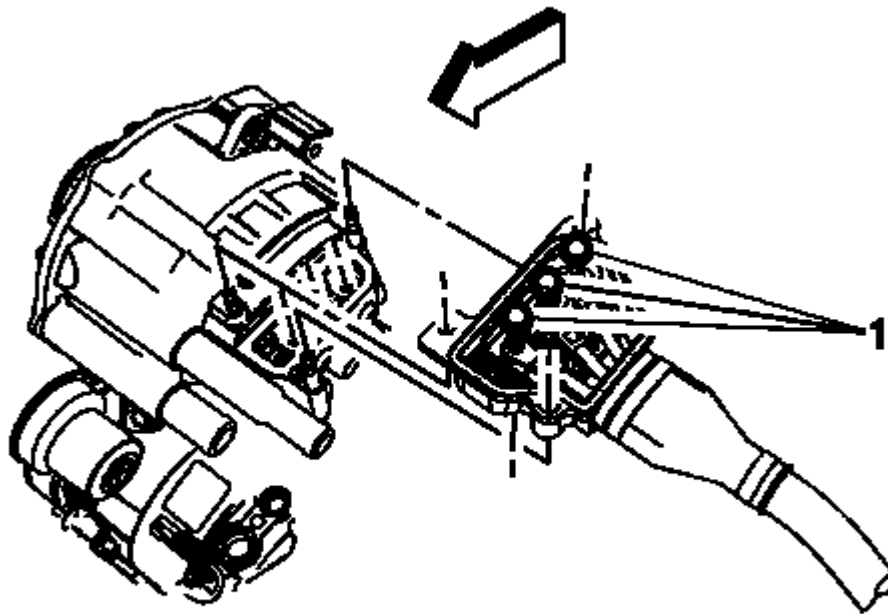


Fig. 68: Starter Generator

Courtesy of GENERAL MOTORS COMPANY

19. Install the starter generator. Refer to **Starter Generator Replacement**

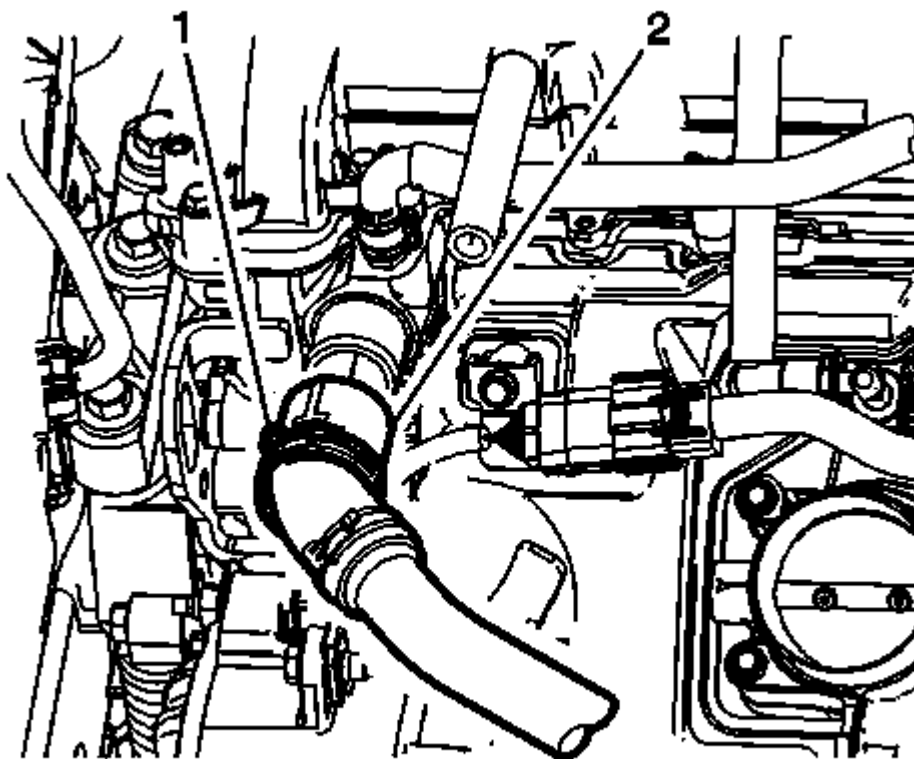


Fig. 69: Hose Clamp And Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

20. Connect the radiator inlet hose (2), reposition the hose clamp (1). Refer to **Radiator Inlet Hose Replacement (LUK)** .

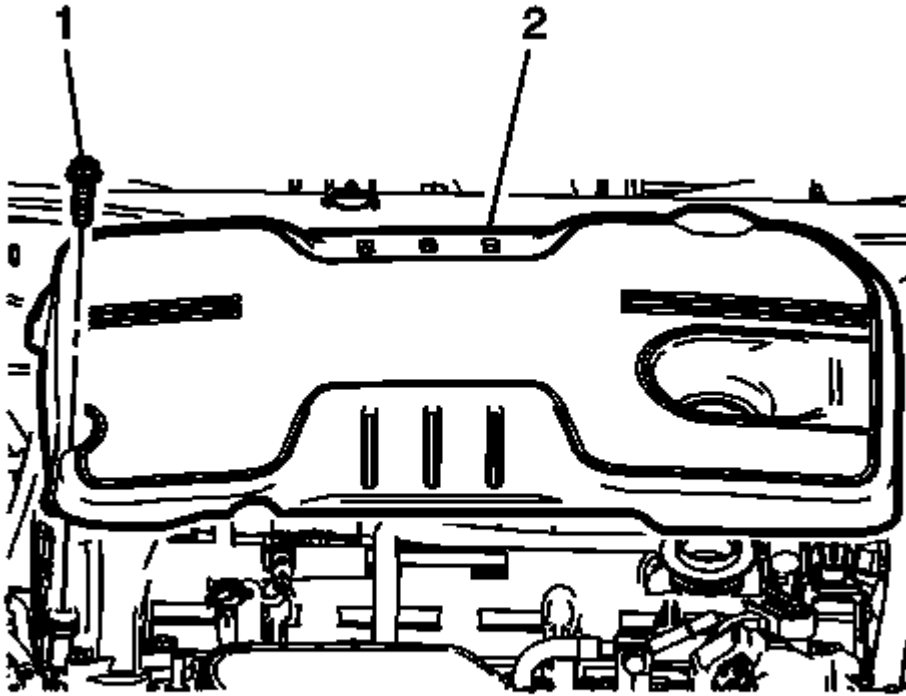


Fig. 70: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

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

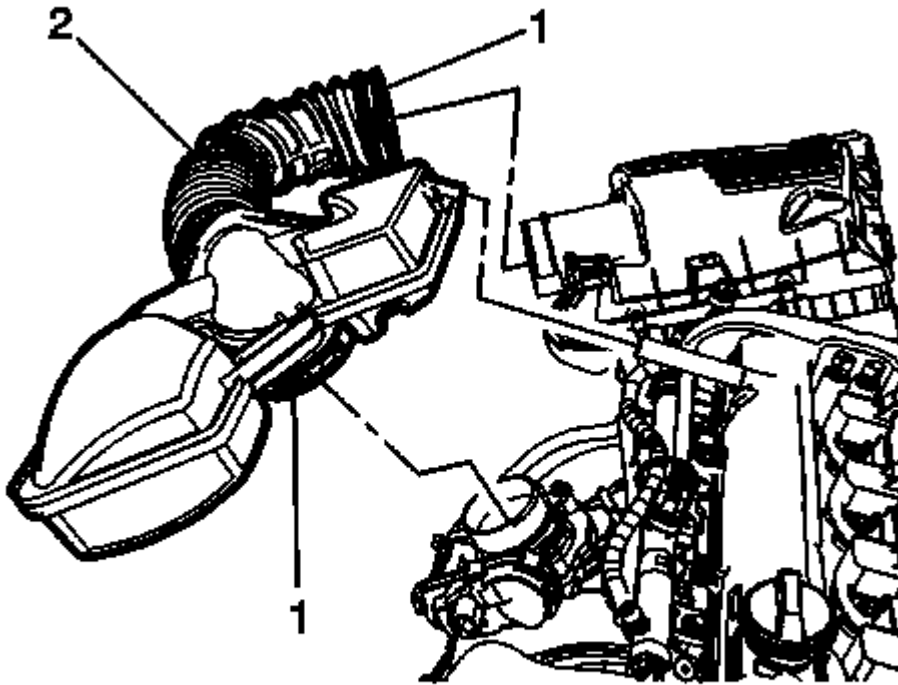


Fig. 71: Air Cleaner Outlet Duct

Courtesy of GENERAL MOTORS COMPANY

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

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- **EN-45059** Angle Meter.
- **J-43653** Flywheel Holding Tool.

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

Removal Procedure

1. Remove the wheelhouse front liner. Refer to **Front Wheelhouse Front Liner Replacement** .
2. Remove the drive belt. Refer to **Drive Belt Replacement (LUK)**.
3. Remove the starter.
4. Install the **J-43653** flywheel holding tool in the starter opening.
5. Remove and discard the crankshaft balancer bolt.

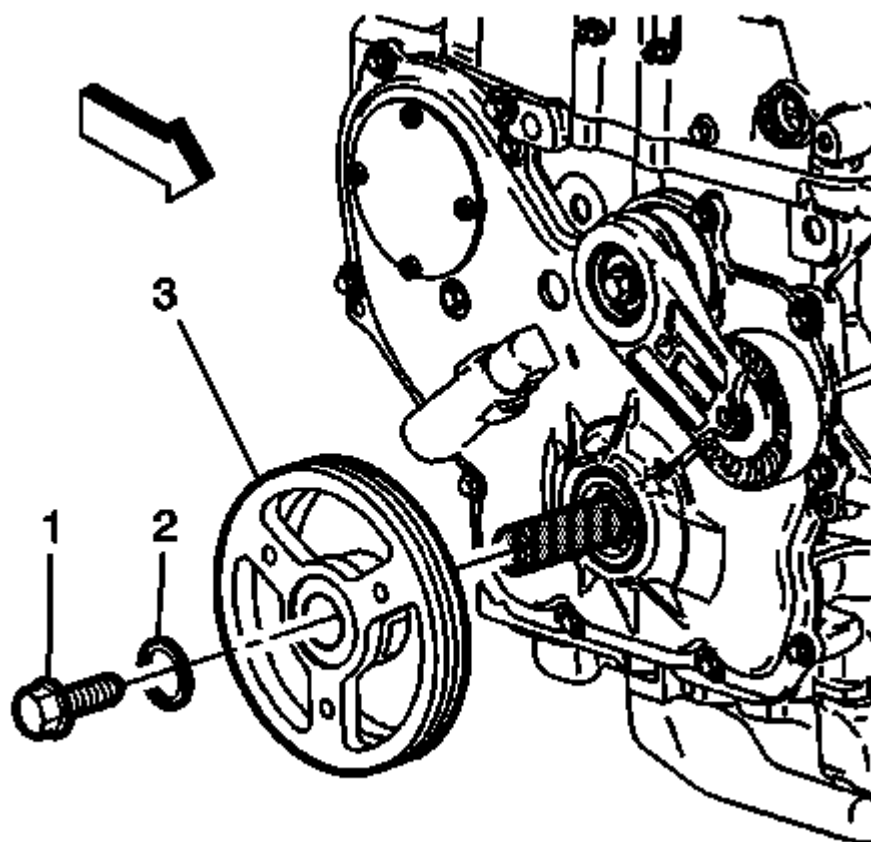


Fig. 72: Bolt, Washer And Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

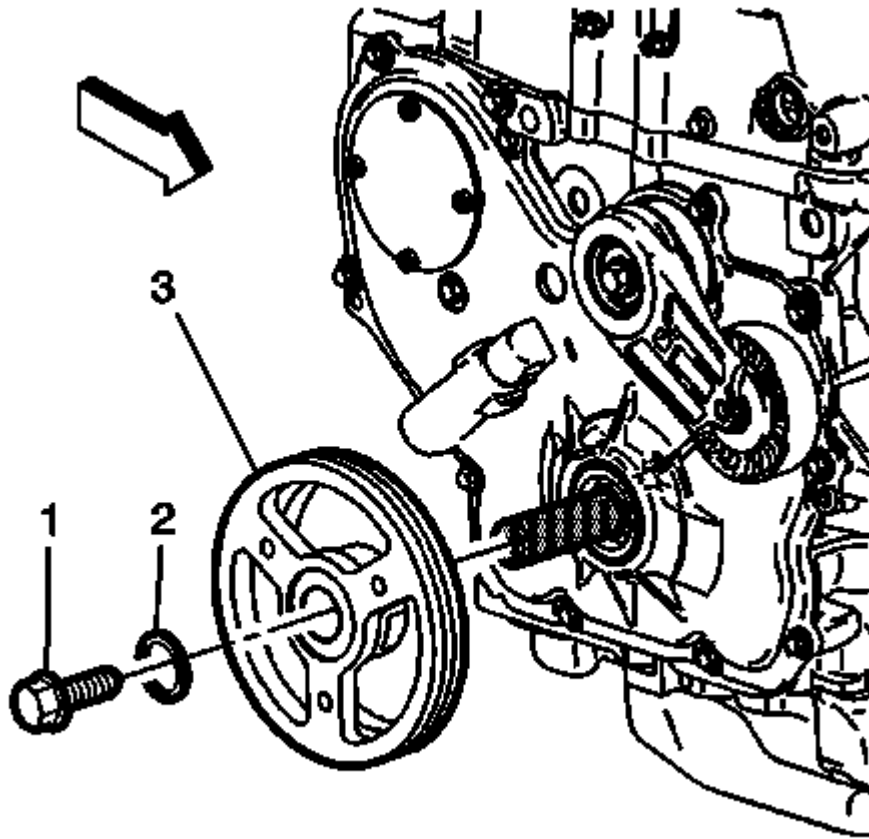


Fig. 73: Bolt, Washer And Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

1. Position the crankshaft balancer (3) .
2. Install washer (2) and a NEW crankshaft balancer bolt (1).

CAUTION: Refer to Fastener Caution .

3. Tighten the crankshaft balancer bolt to 100 (74 lb ft) plus an additional 125 degrees using the **EN-45059** meter.
4. Install the starter.
5. Install the drive belt. Refer to **Drive Belt Replacement (LUK)**.
6. Install the wheelhouse front liner. Refer to **Front Wheelhouse Front Liner Replacement** .

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

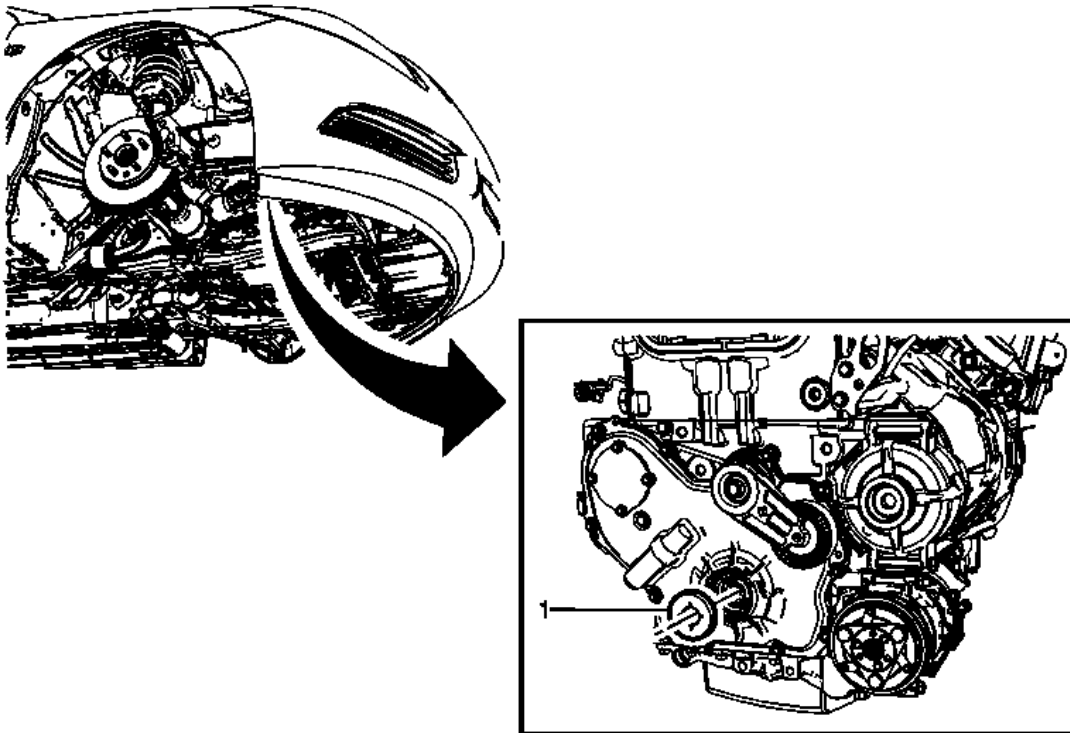


Fig. 74: Crankshaft Front Oil Seal
 Courtesy of GENERAL MOTORS COMPANY

Crankshaft Front Oil Seal Replacement

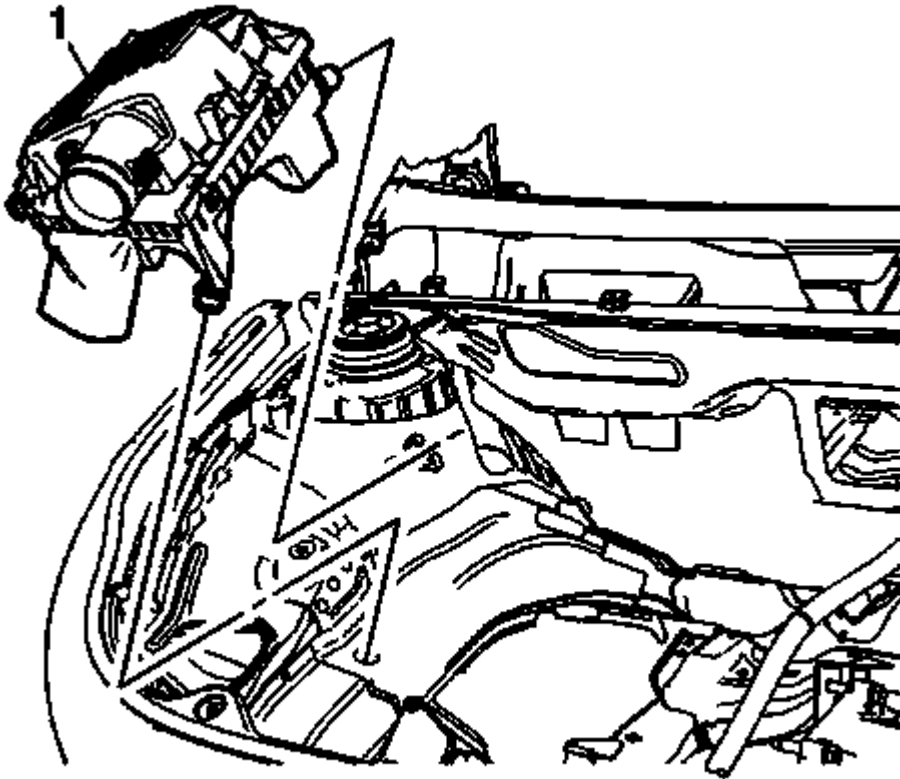
Callout	Component Name
Preliminary Procedure Remove the crankshaft balancer. Refer to <u>Crankshaft Balancer Replacement</u> .	
1	Crankshaft Front Oil Seal NOTE: Use a flat-bladed tool to remove the seal from the front cover. Special Tools Use EN-35268-A Camshaft/Front Main Seal Installer to install the front crankshaft front oil seal.

ENGINE FRONT COVER REPLACEMENT (LUK)

Special Tools

- **J 38122-A** Harmonic Balancer Holder
- **J 45059** Angle Meter

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

Removal Procedure**Fig. 75: Air Cleaner Assembly****Courtesy of GENERAL MOTORS COMPANY**

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

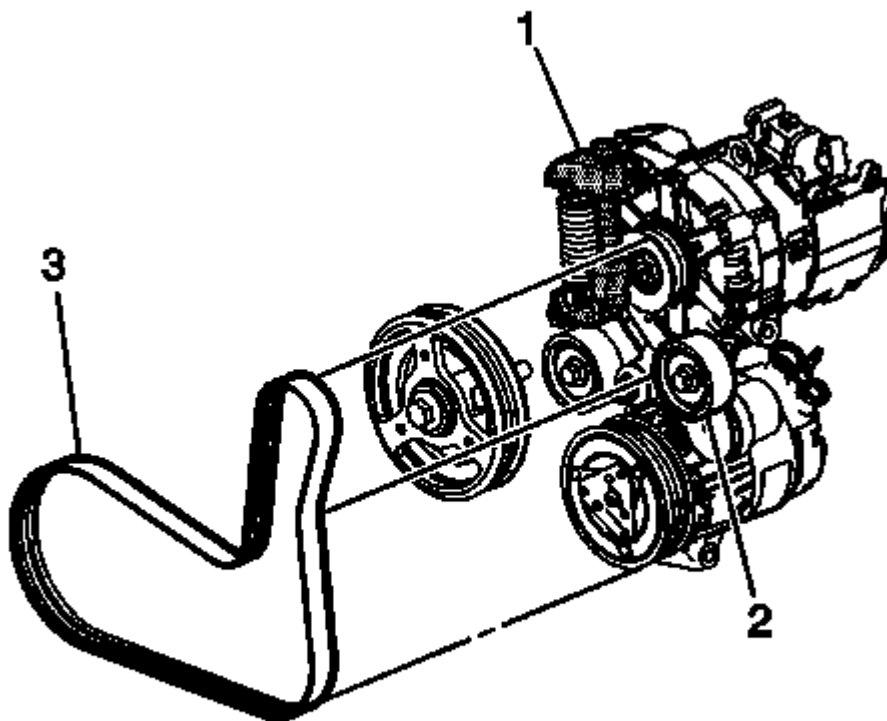


Fig. 76: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

2. Remove the drive belt (1). Refer to **Drive Belt Replacement (LUK)**.
3. Remove the wheelhouse splash shield. Refer to **Front Compartment Splash Shield Replacement**.

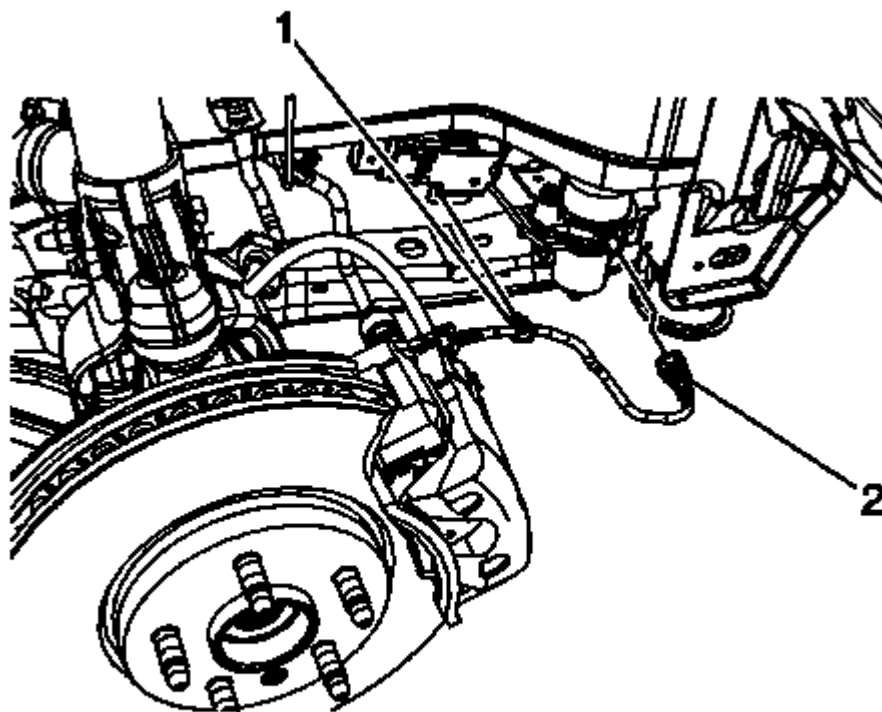


Fig. 77: Power Brake Booster Vacuum Rear Pipe Quick Connect And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect and reposition the vacuum booster rear pipe (2). Refer to **Power Brake Booster Vacuum Rear Pipe Replacement (2.4L)** .

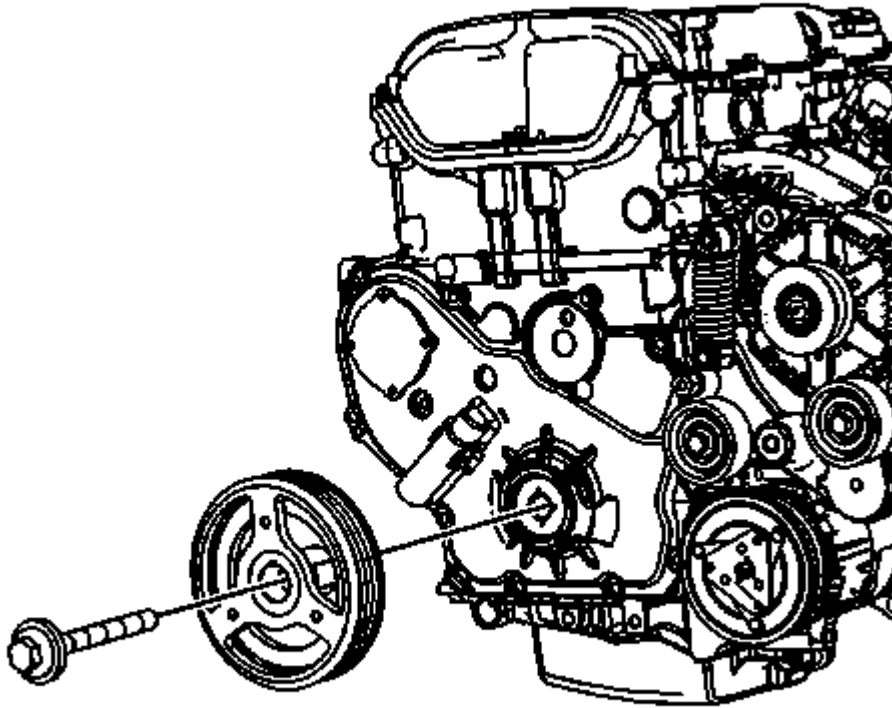


Fig. 78: Crankshaft Balancer And Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).

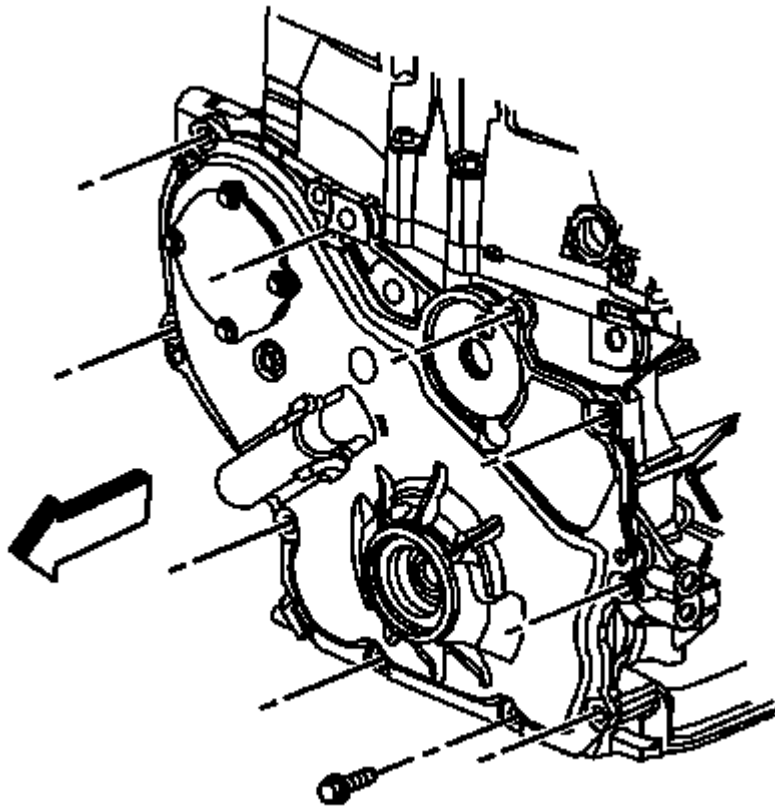


Fig. 79: Engine Front Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine front cover bolts.

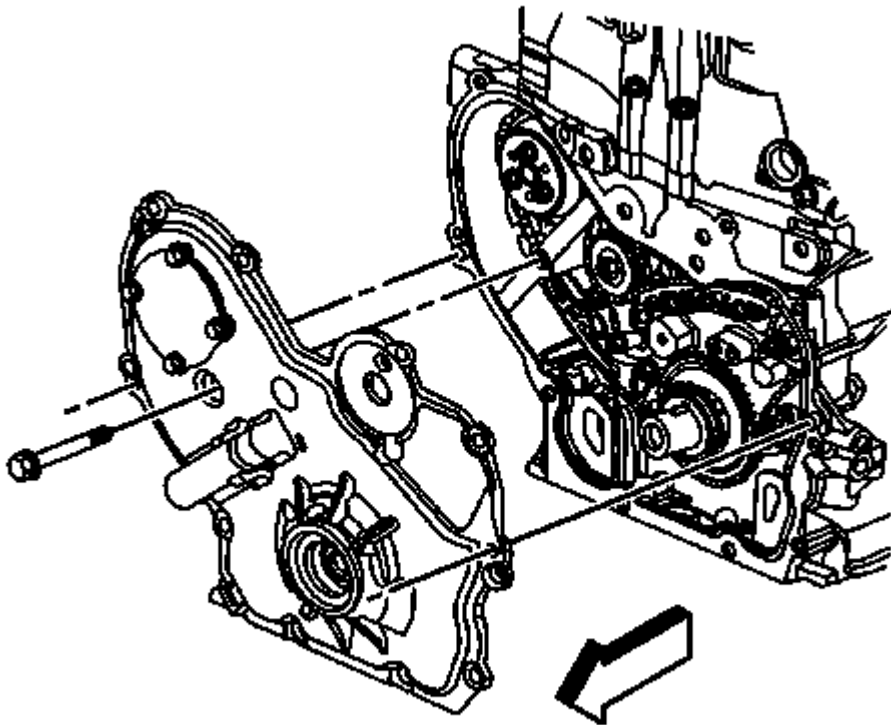


Fig. 80: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

7. Remove the engine front cover to water pump bolt.
8. Remove the engine front cover.

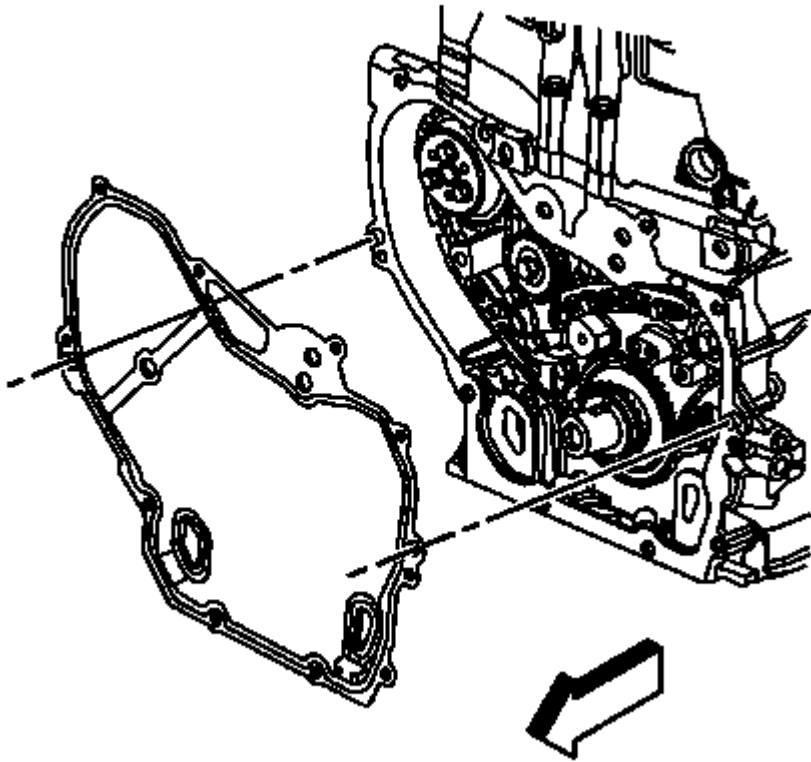


Fig. 81: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

9. Remove and discard the engine front cover gasket.

Installation Procedure

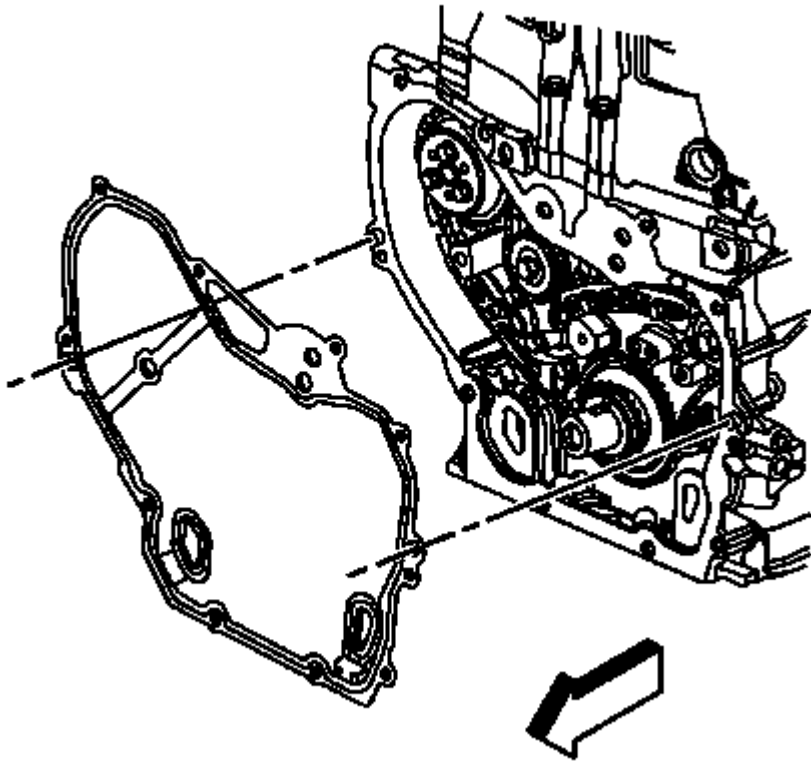


Fig. 82: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW engine front cover gasket to the dowel pins.

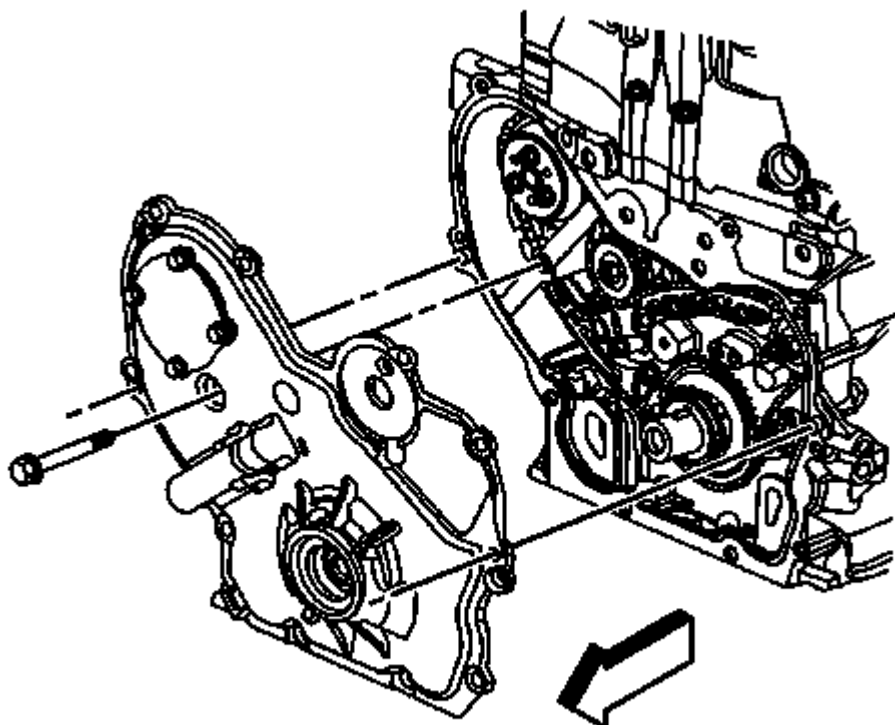


Fig. 83: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the engine front cover and install the water pump bolt and tighten to 25 N.m (18 lb ft).

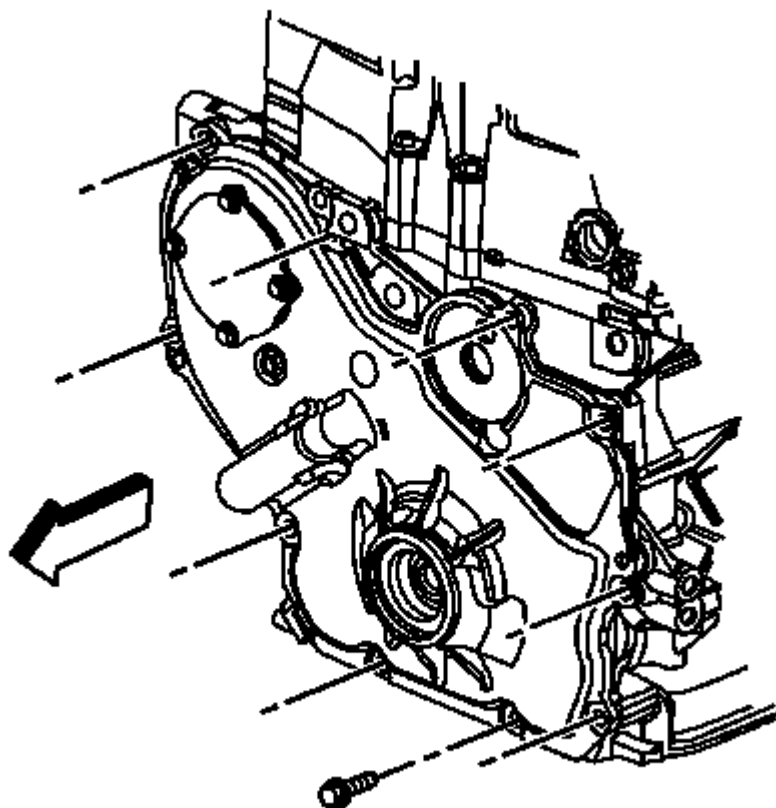


Fig. 84: Engine Front Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

3. Install the engine front cover bolts and tighten to 25 N.m (18 lb ft).

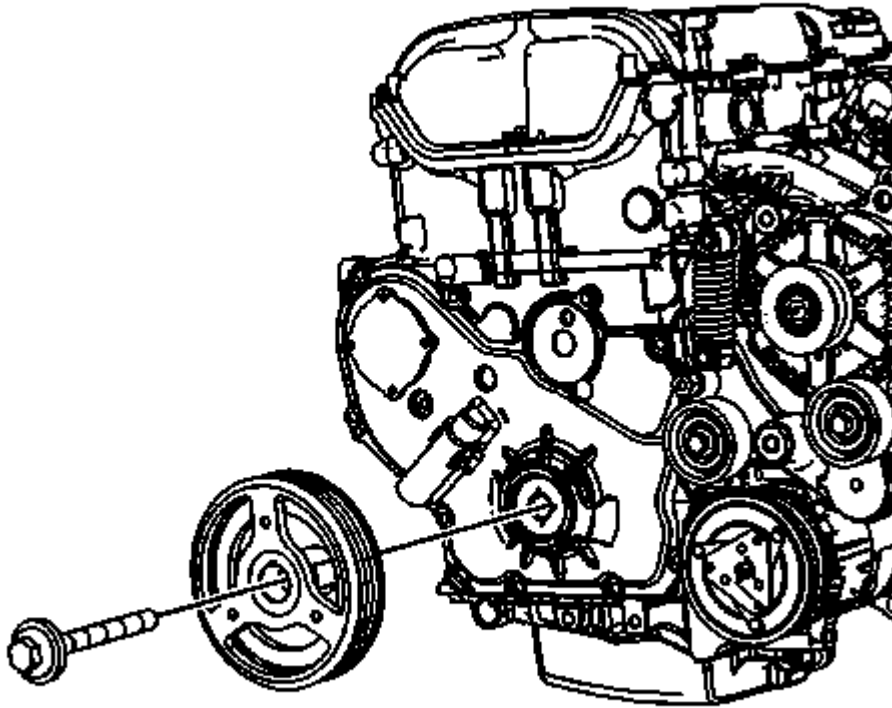


Fig. 85: Crankshaft Balancer And Bolt
Courtesy of GENERAL MOTORS COMPANY

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

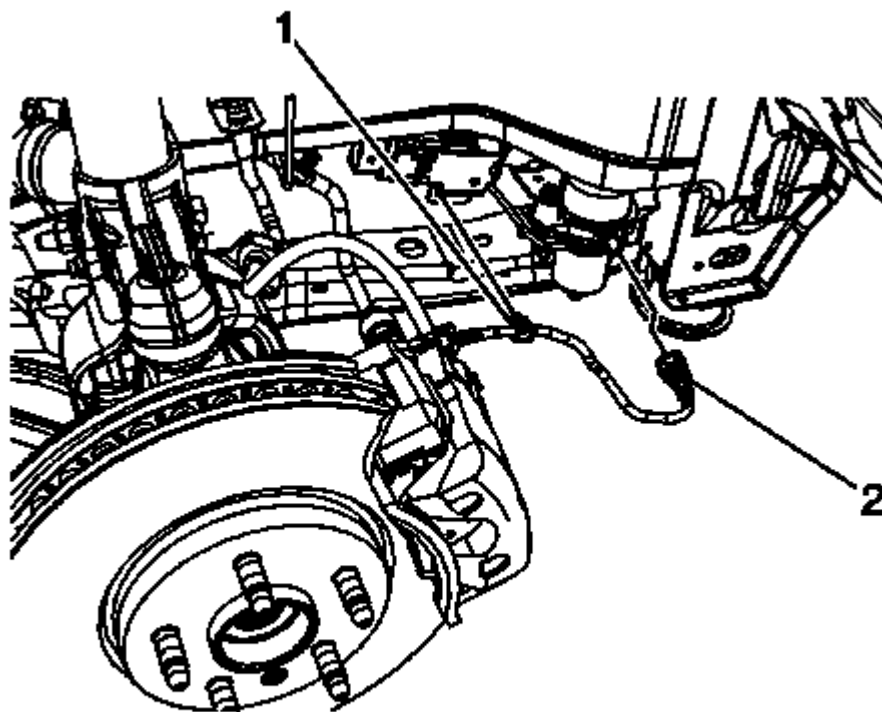


Fig. 86: Power Brake Booster Vacuum Rear Pipe Quick Connect And Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Reposition and connect the vacuum booster rear pipe (2). Refer to **Power Brake Booster Vacuum Rear Pipe Replacement (2.4L)** .
6. Install the wheelhouse splash shield. Refer to **Front Compartment Splash Shield Replacement** .

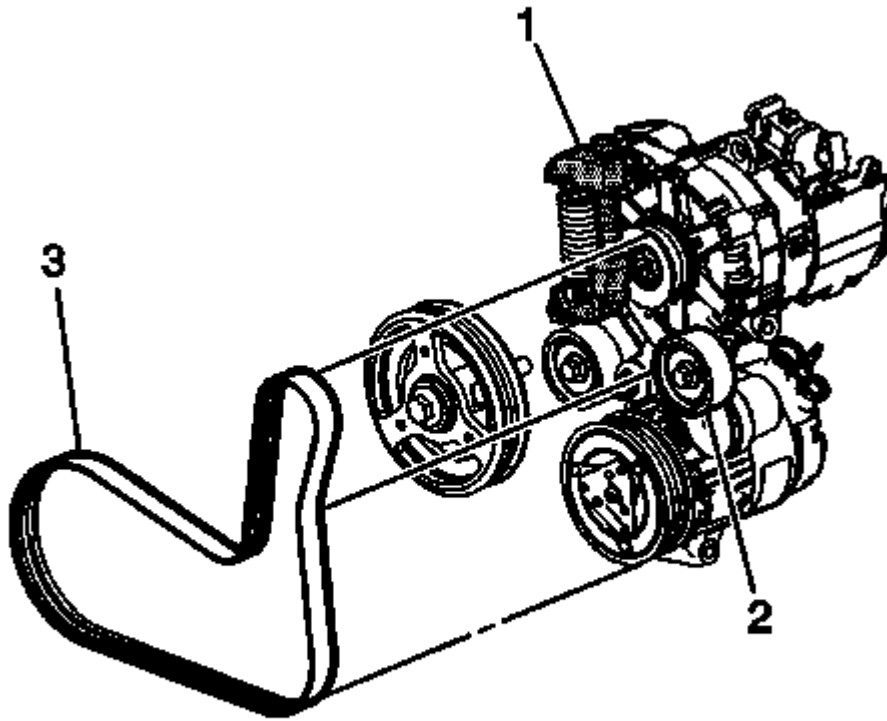


Fig. 87: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

7. Install the drive belt (1). Refer to **Drive Belt Replacement (LUK)**.

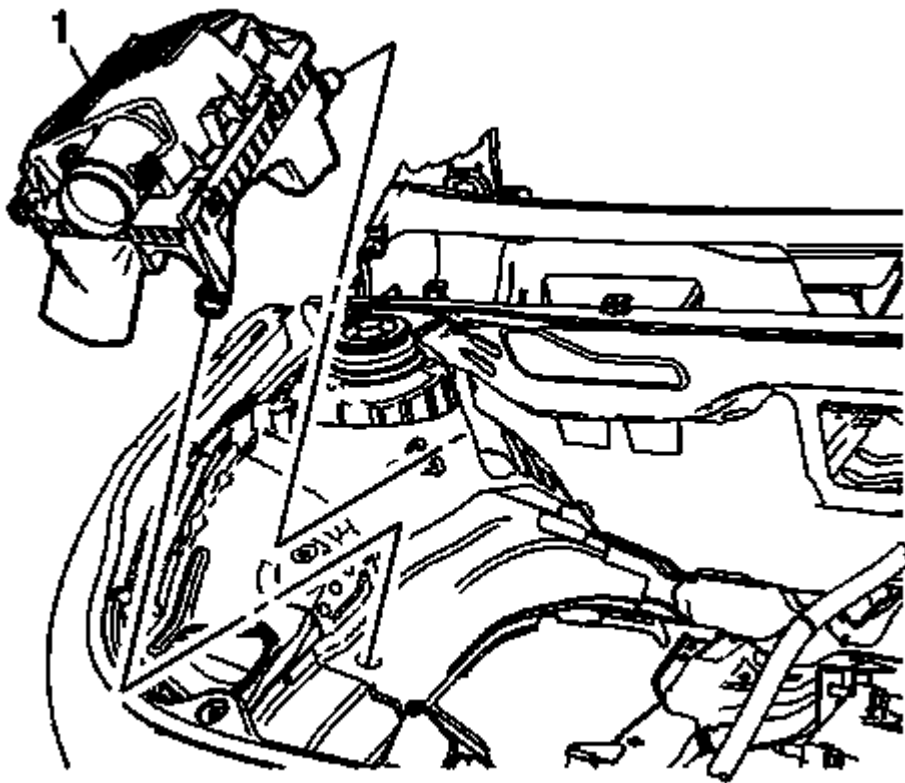


Fig. 88: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

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

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER REPLACEMENT

Special Tools

- **EN-45027** Tensioner Tool
- **EN-45059** Angle Meter
- **EN-48953** Camshaft Actuator Locking Tool

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

Removal Procedure

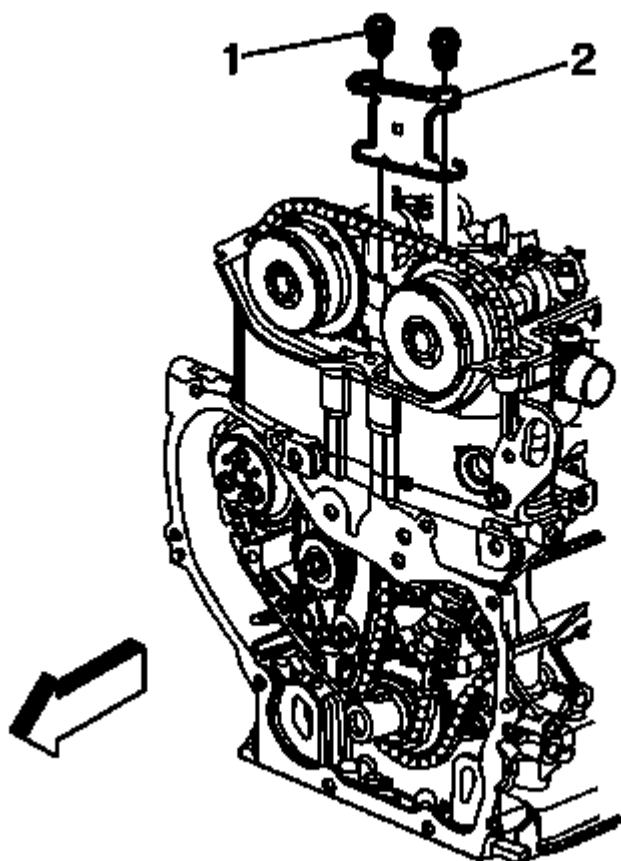


Fig. 89: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

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

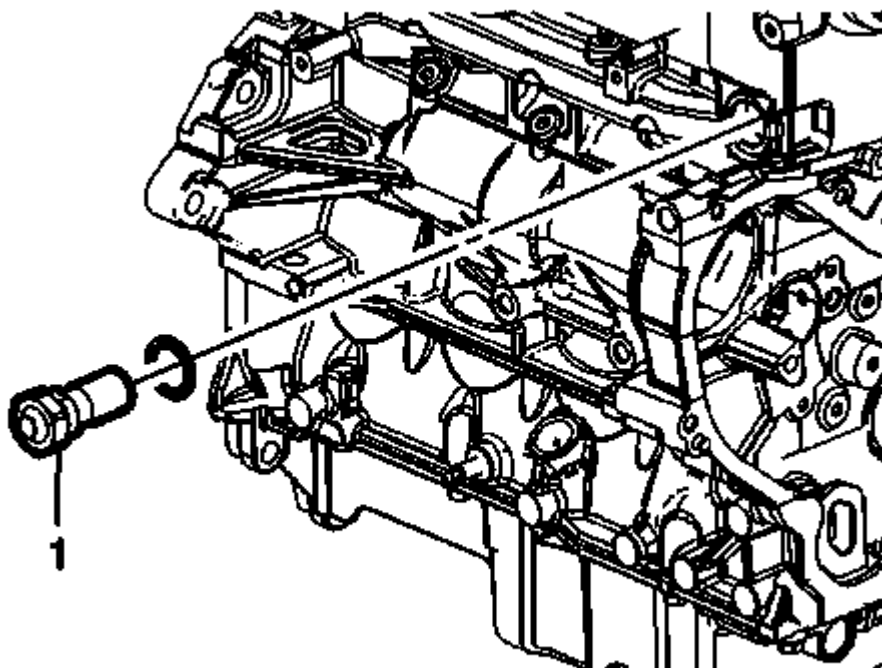


Fig. 90: Timing Chain Tensioner

Courtesy of GENERAL MOTORS COMPANY

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

6. Remove the timing chain tensioner (1).

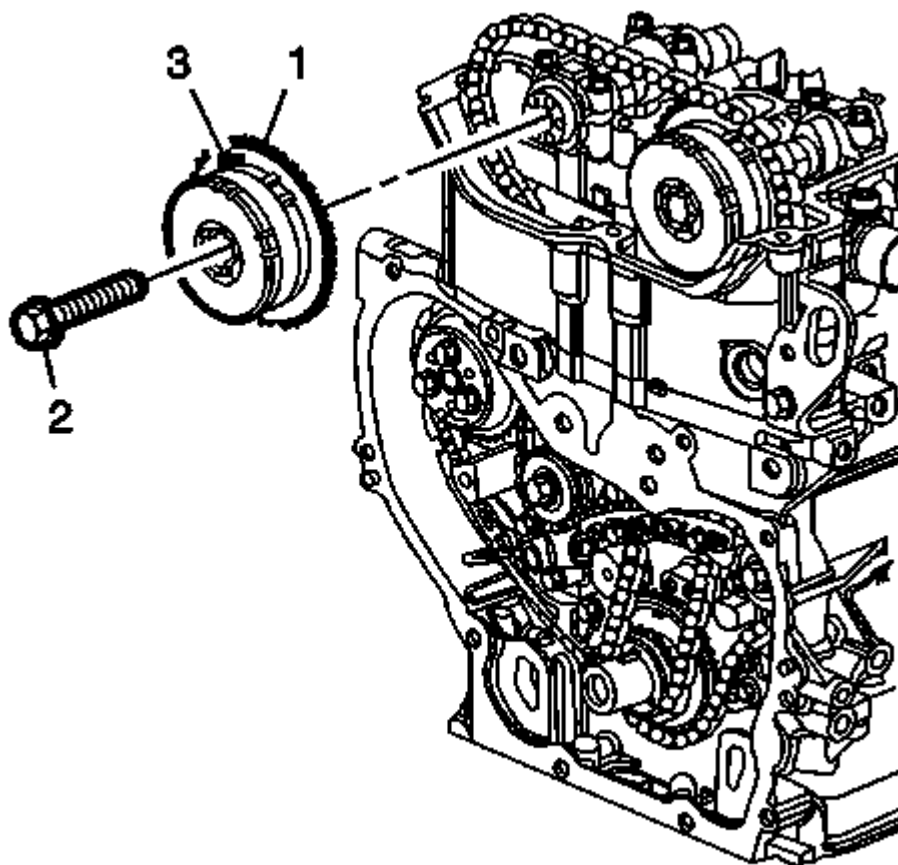


Fig. 91: Exhaust Camshaft Sprocket

Courtesy of GENERAL MOTORS COMPANY

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

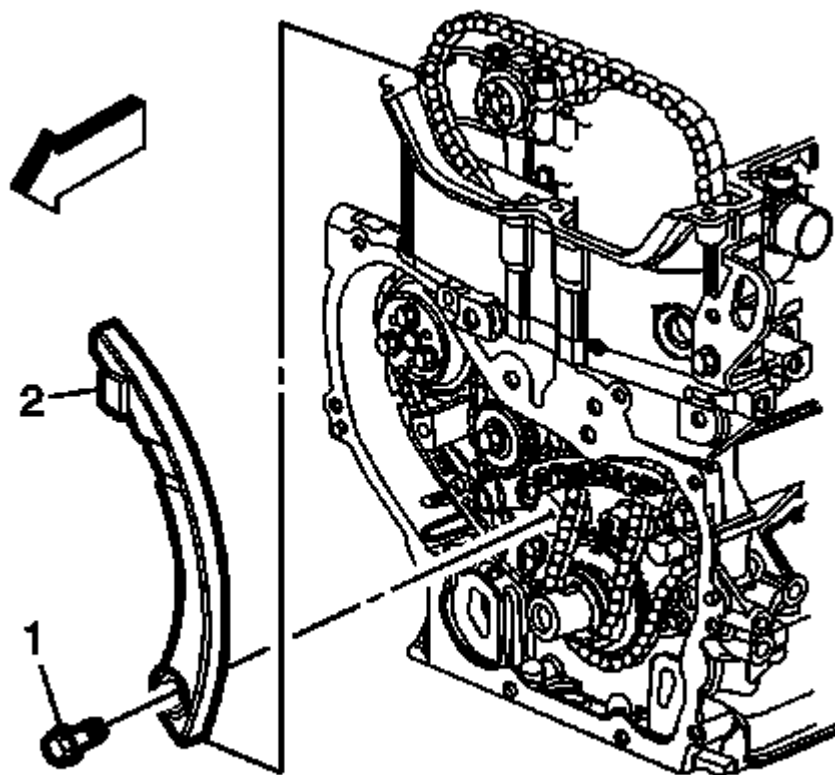


Fig. 92: Timing Chain Tensioner Guide Bolt And Guide
Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain tensioner guide bolt (1) and guide (2).

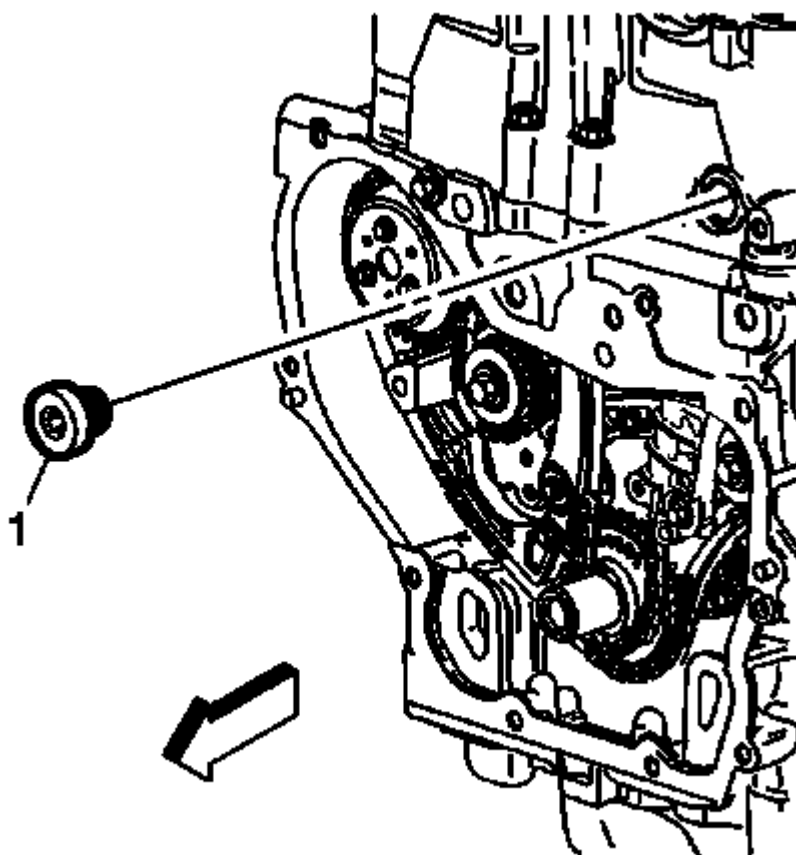


Fig. 93: Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS COMPANY

11. Remove the fixed timing chain guide access plug (1).

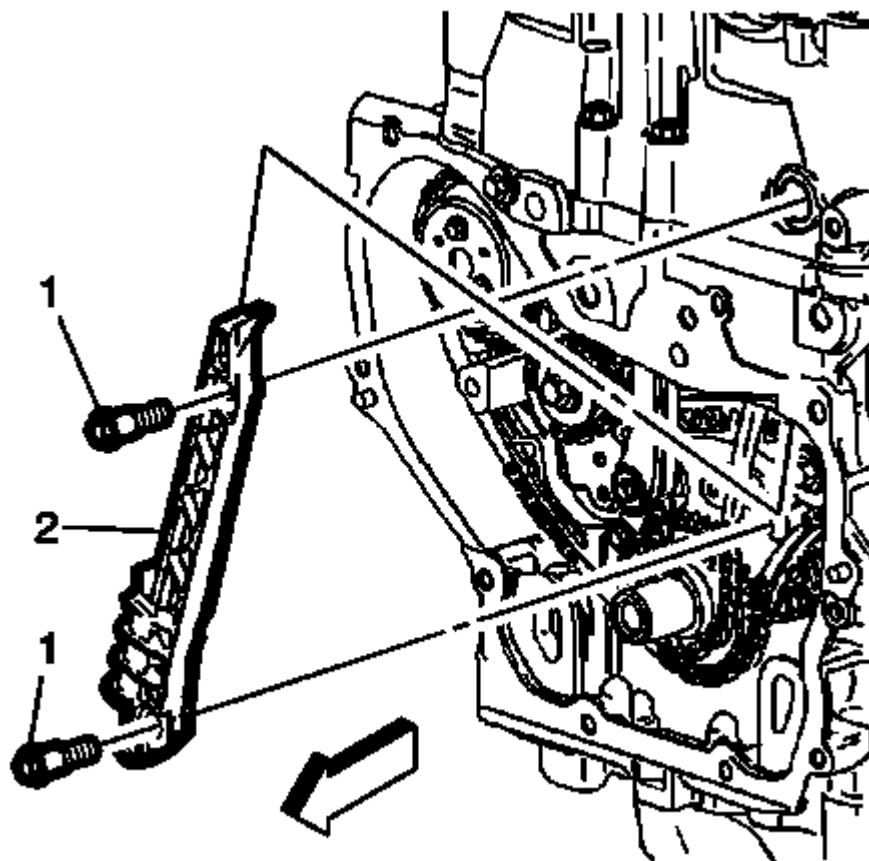


Fig. 94: Fixed Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS COMPANY

12. Remove the fixed timing chain guide bolts (1) and guide (2).

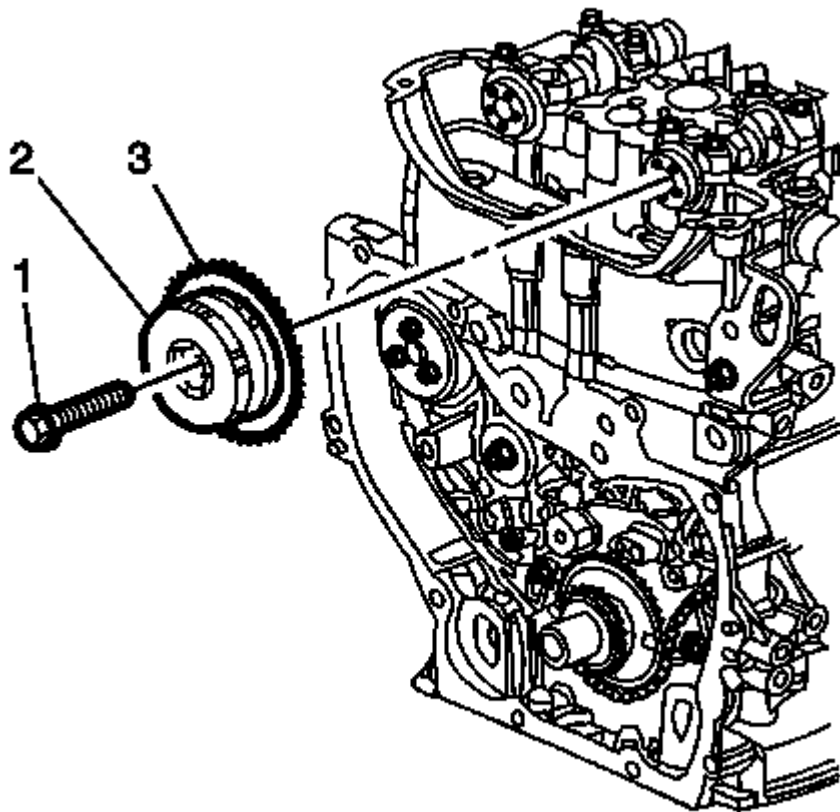


Fig. 95: Timing Chain & Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

13. Install a 24 mm wrench on the hex on the intake camshaft in order to hold the camshaft.
14. Remove and discard the intake camshaft actuator bolt (1).
15. Remove the intake camshaft actuator (3), and the timing chain through the top of the cylinder head.

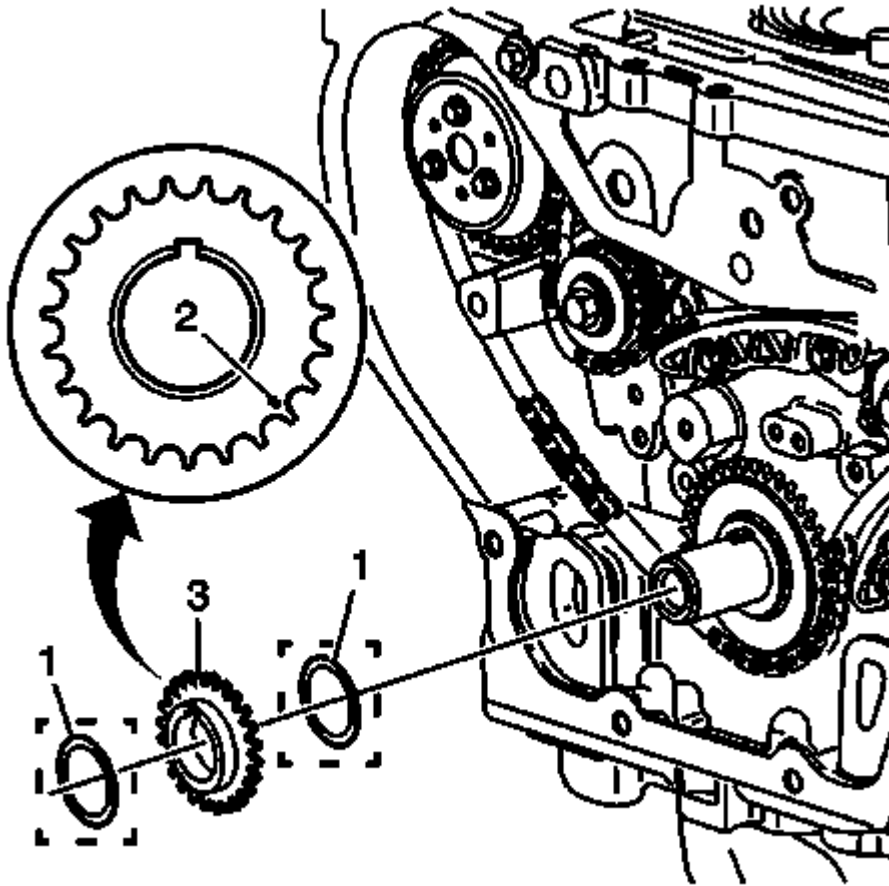


Fig. 96: View of Friction Washer and Timing Chain Drive Sprocket
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ecotec 4 cylinder engines with SIDI-Direct Injection, the lower timing chain crank gear may be equipped with a second spacing washer installed in front of the lower timing chain crank gear. The outer spacer/washer is in between the crank/balancer pulley and the lower timing gear and may remain in place when the pulley is removed. The spacer/washer has a dot/mark on its surface that may be mistaken for the lower timing mark. If applicable, the washer must be removed in order to view the correct timing mark on the lower crank gear.

16. Remove the outer friction washer (1) if equipped.
17. Ensure the crankshaft gear timing mark (2) is in the 5 o'clock position and crankshaft key is in the 12 o'clock position.
18. Remove the crankshaft sprocket (3).
19. Remove the inner friction washer (1).

Installation Procedure

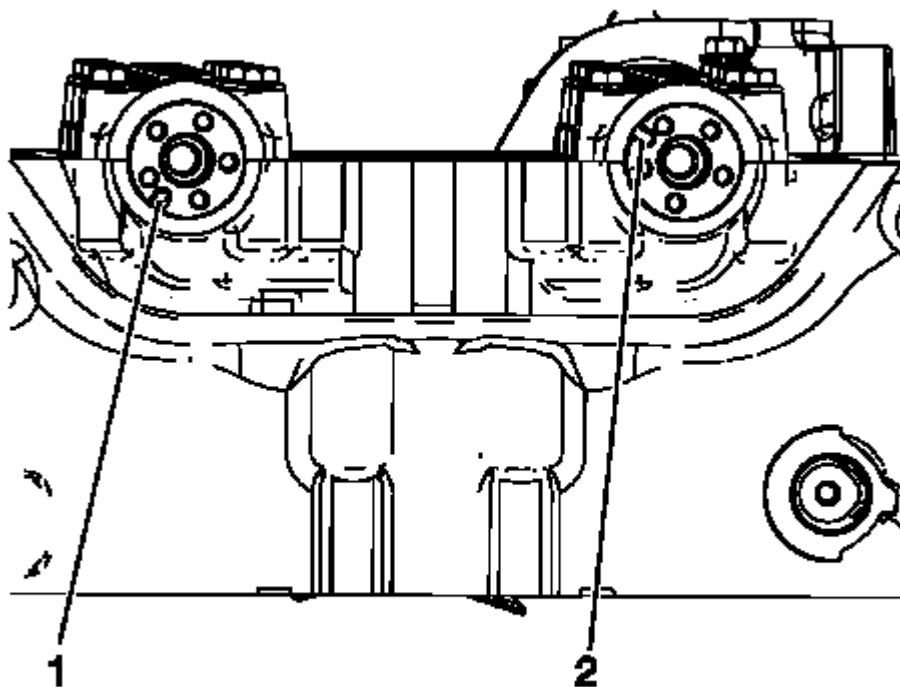


Fig. 97: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

1. When installing the camshafts, ensure the intake camshaft notch is in the 10 o'clock position (2) and the exhaust camshaft notch is in the 7 o'clock position (1). The number 1 piston should be at top dead center (TDC), crankshaft key at 12 o'clock.

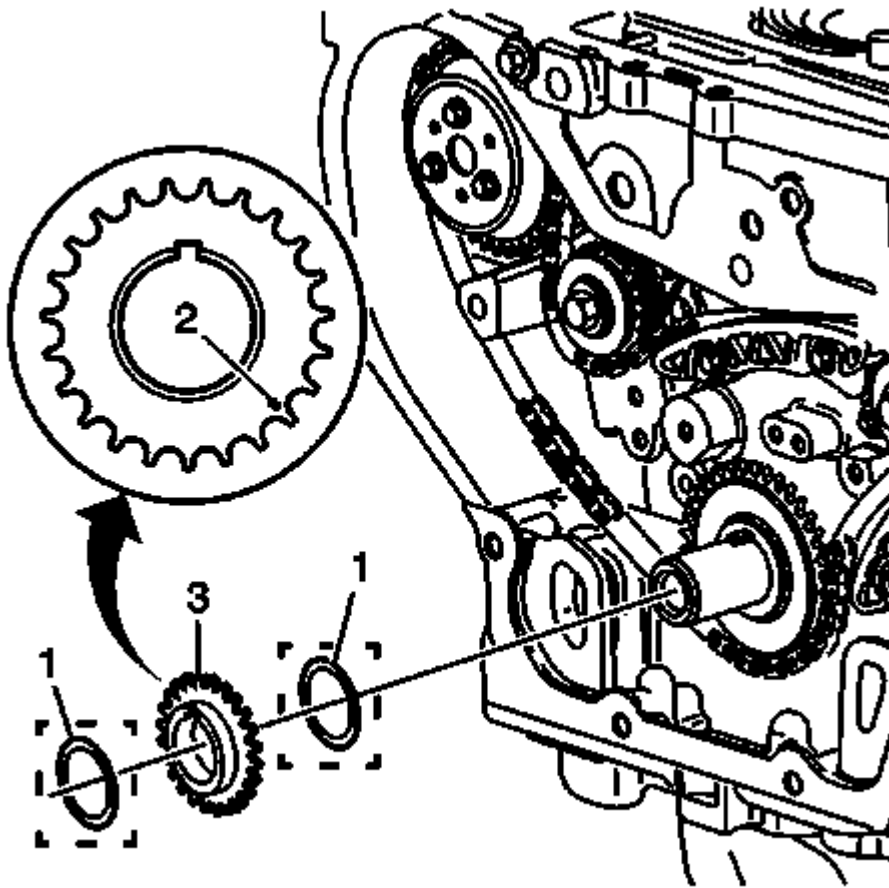


Fig. 98: View of Friction Washer and Timing Chain Drive Sprocket
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ecotec 4 cylinder engines with SIDI-Direct Injection, the lower timing chain crank gear may be equipped with a second spacing washer installed in front of the lower timing chain crank gear. The outer spacer/washer is in between the crank/balancer pulley and the lower timing gear and may remain in place when the pulley is removed. The spacer/washer has a dot/mark on its surface that may be mistaken for the lower timing mark. If applicable, the washer must be removed in order to view the correct timing mark on the lower crank gear.

2. Install the inner friction washer (1).
3. Install the crankshaft sprocket with the timing mark (2) is in the 5 o'clock position and facing outward.
4. Install the outer friction washer (1) if equipped.

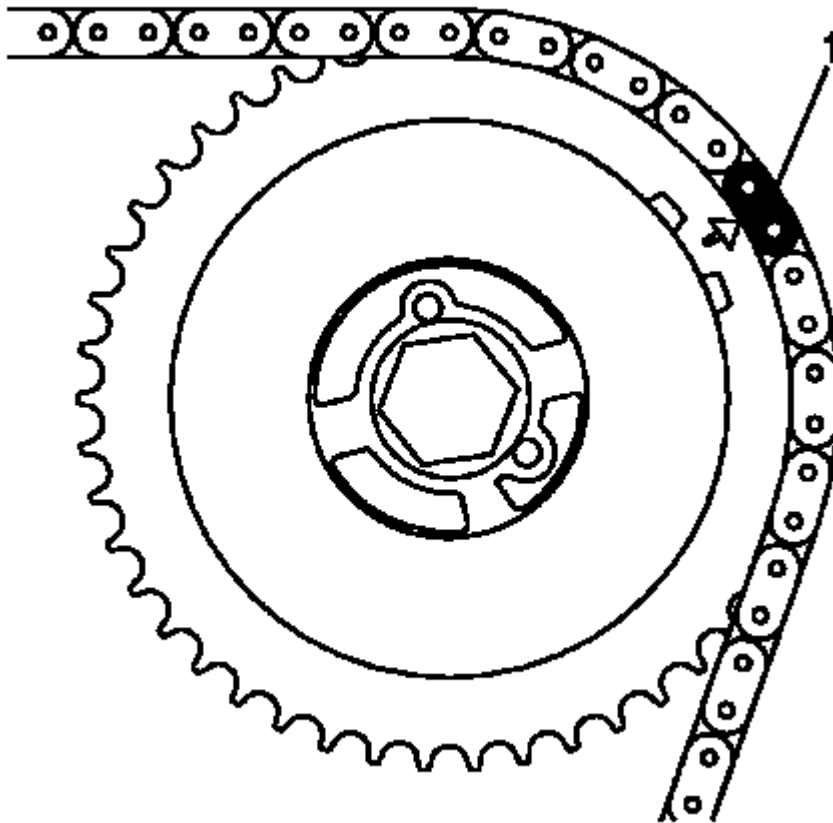


Fig. 99: Identifying Colored Links On Timing Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- There are 3 colored links on the timing chain. Two links are of matching color, and 1 link is of a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.
 - Always use new actuator bolts.
5. Assemble the intake camshaft actuator into the timing chain with the timing mark lined up with the uniquely colored link (1).

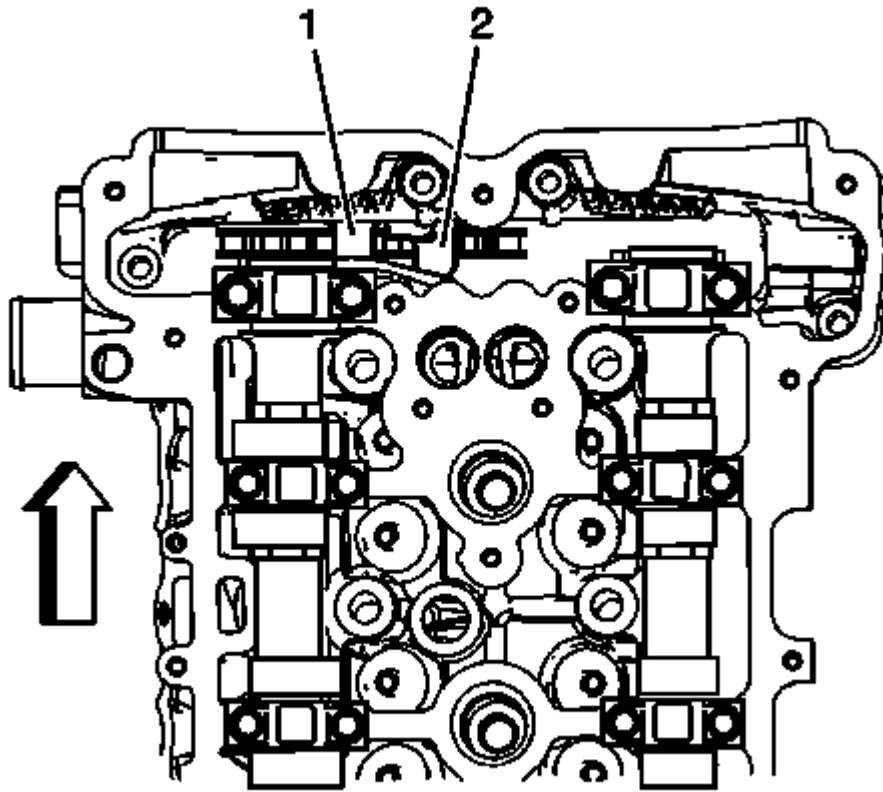


Fig. 100: Identifying Cylinder Head Opening
Courtesy of GENERAL MOTORS COMPANY

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

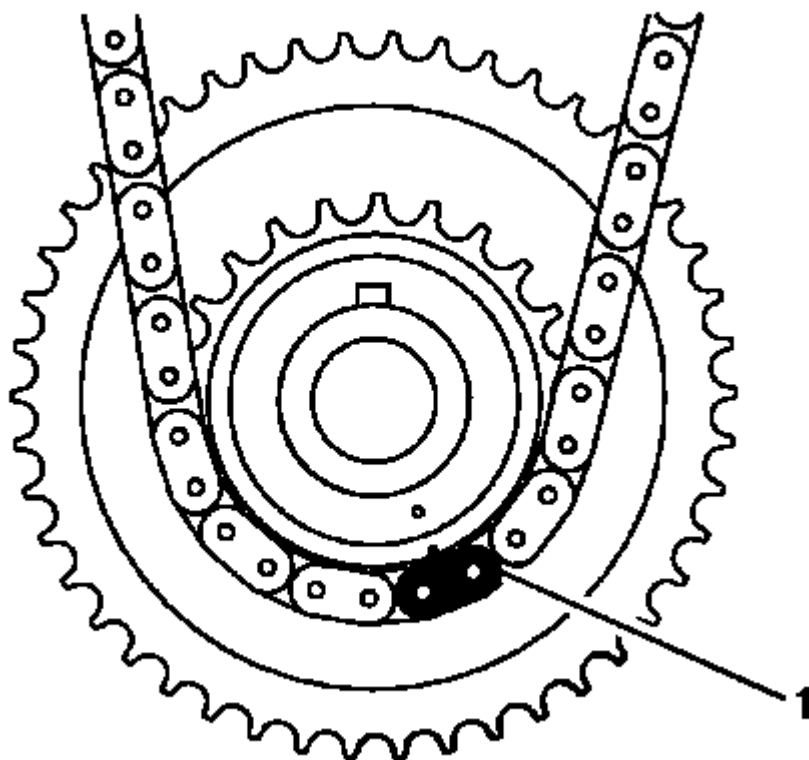


Fig. 101: Lining Up First Pink Link With Timing Mark On Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

9. Route the timing chain around the crankshaft sprocket and line up the first matching colored (1) link with the timing mark on the crankshaft sprocket, in approximately the 5 o'clock position.
10. Install the friction washer, if applicable.

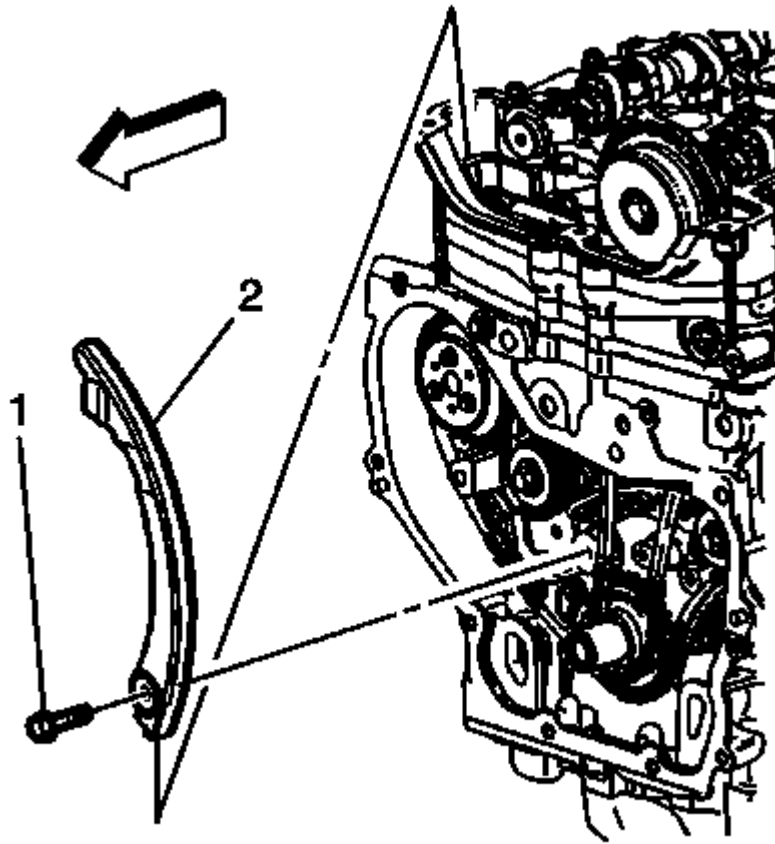


Fig. 102: Adjustable Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

11. Rotate the crankshaft clockwise to remove all chain slack. Do not rotate the intake camshaft.

CAUTION: Refer to Fastener Caution .

12. Install the adjustable timing chain guide (2) down through the opening in the cylinder head and install the adjustable timing chain bolt. Tighten the adjustable timing chain guide bolt (1) to 10 N.m (89 lb in).

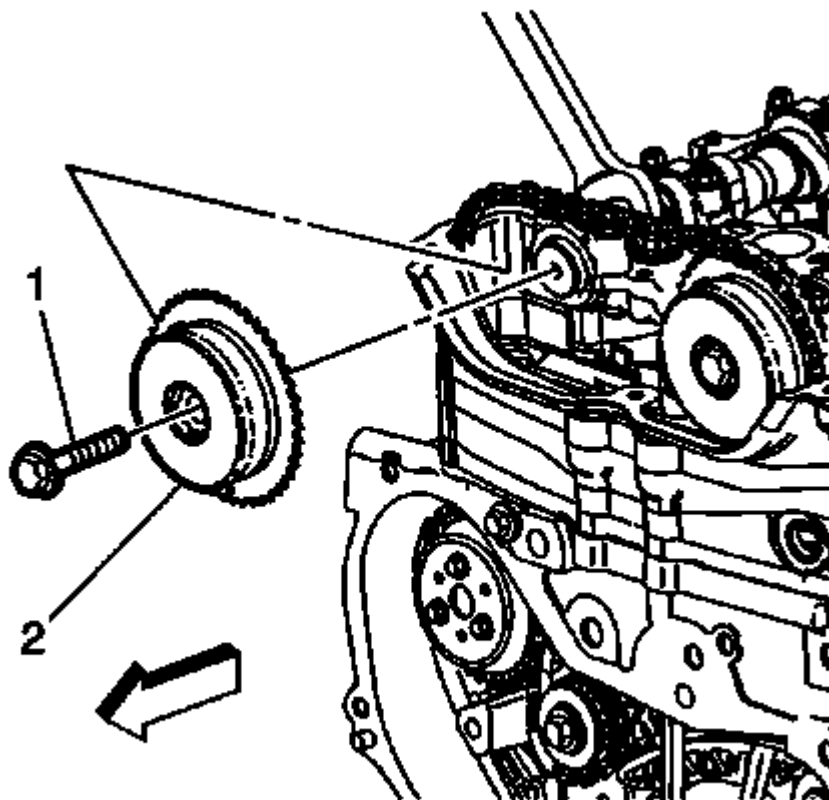


Fig. 103: Camshaft Actuator

Courtesy of GENERAL MOTORS COMPANY

NOTE: Always install NEW actuator bolts.

13. Install the exhaust camshaft actuator (2) into the timing chain with the timing mark lined up with the second matching colored link.

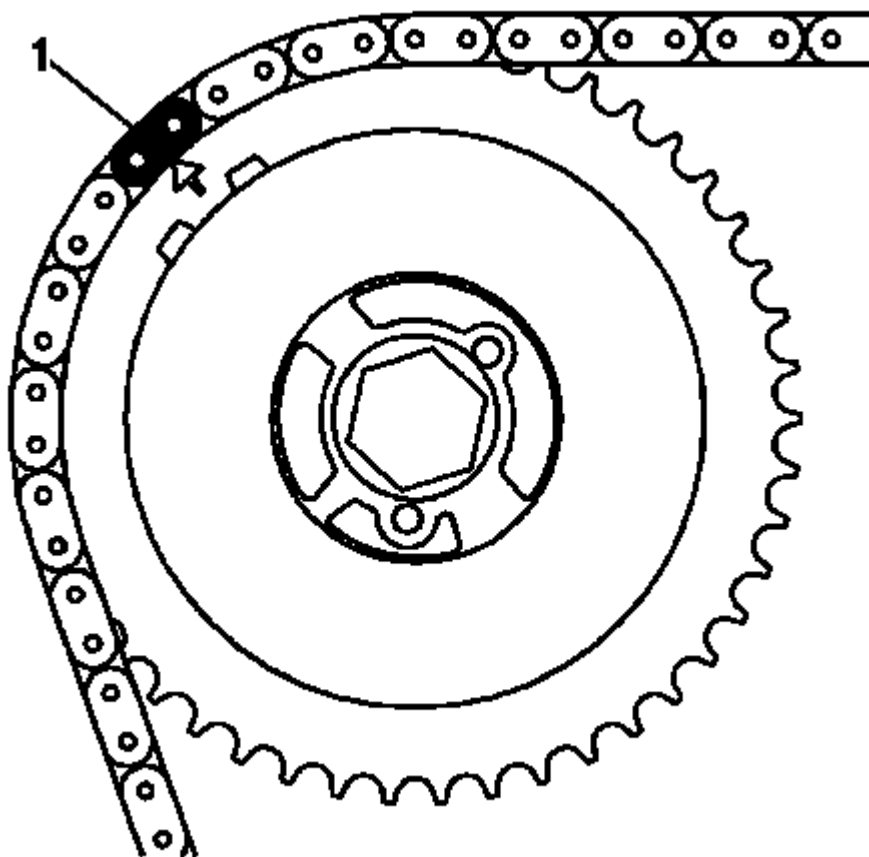


Fig. 104: Camshaft Slot

Courtesy of GENERAL MOTORS COMPANY

14. Install the exhaust camshaft actuator onto the exhaust camshaft, aligning the dowel pin into the camshaft slot (1).
15. Use 24 mm open ended wrench, rotate the exhaust camshaft approximately 45 degrees until the dowel pin in the camshaft actuator goes into the camshaft slot.
16. When the actuator seats on the cam, tighten the new exhaust camshaft actuator bolt hand tight.

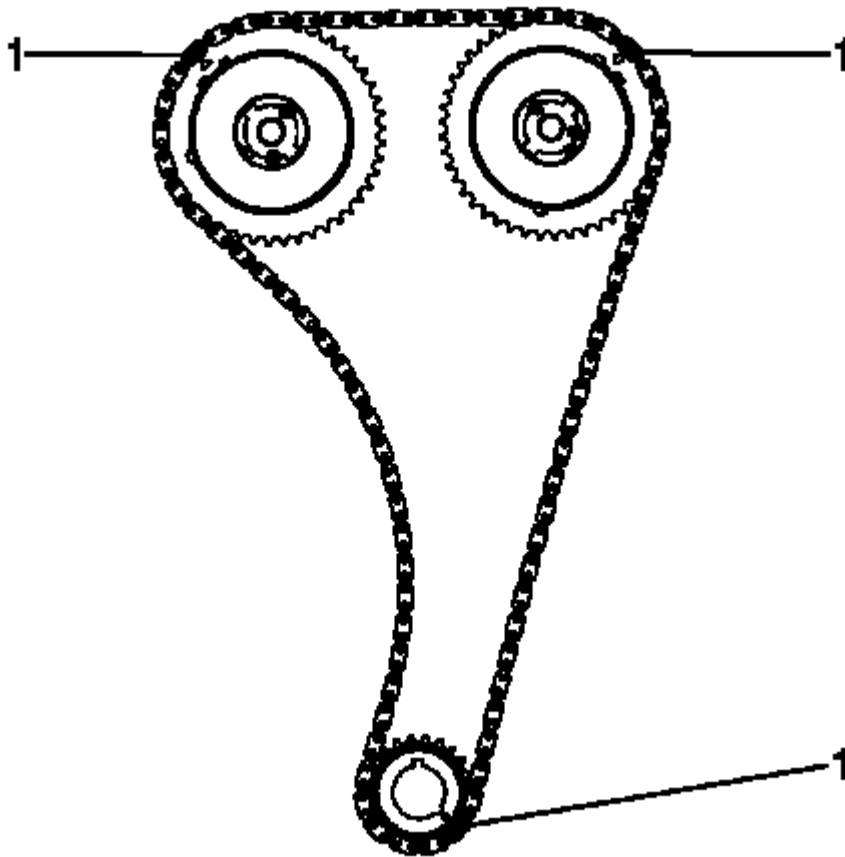


Fig. 105: Colored Links

Courtesy of GENERAL MOTORS COMPANY

17. Verify that all of the colored links (1) and the appropriate timing marks are still aligned. If they are not aligned, repeat the portion of the procedure necessary to align the timing marks.

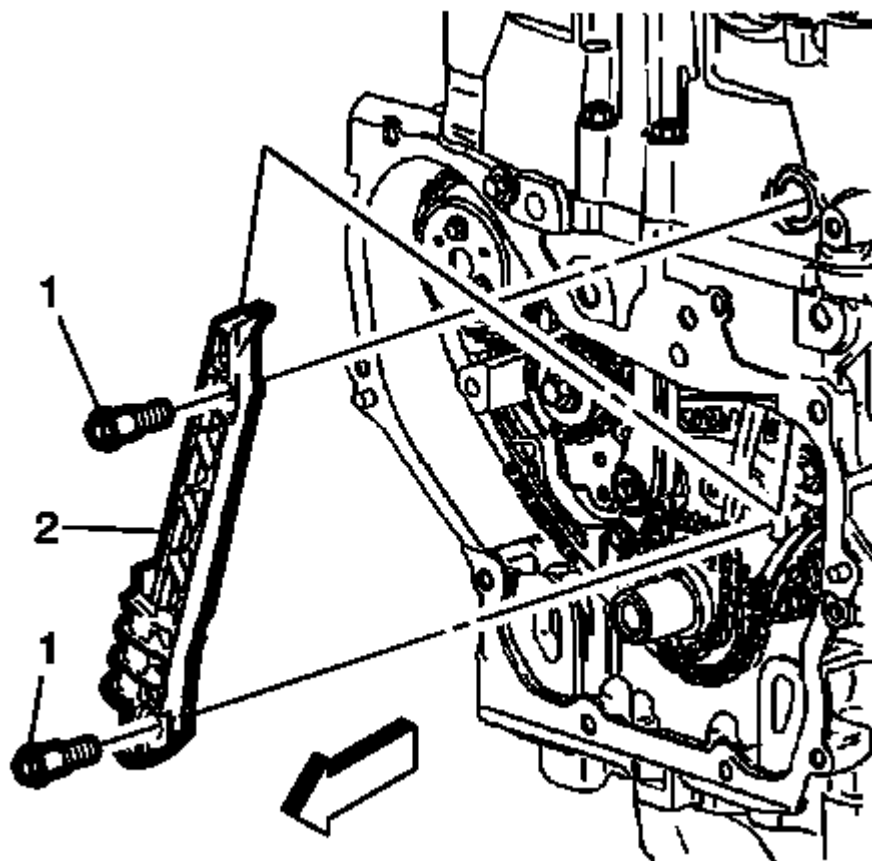


Fig. 106: Fixed Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS COMPANY

18. Install the fixed timing chain guide (2) and bolts (1). Tighten the fixed timing chain guide bolts to 12 N.m (106 lb in).

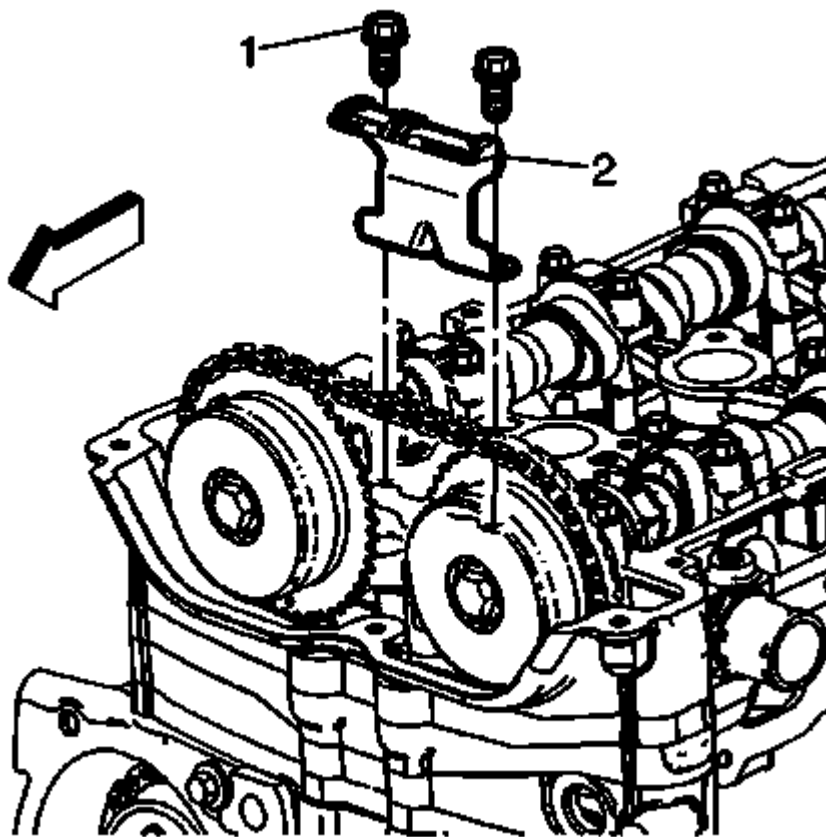


Fig. 107: Upper Timing Chain Guide

Courtesy of GENERAL MOTORS COMPANY

19. Install the upper timing chain guide (2) and bolts (1). Tighten the upper timing chain guide bolts to 10 N.m (89 lb in).

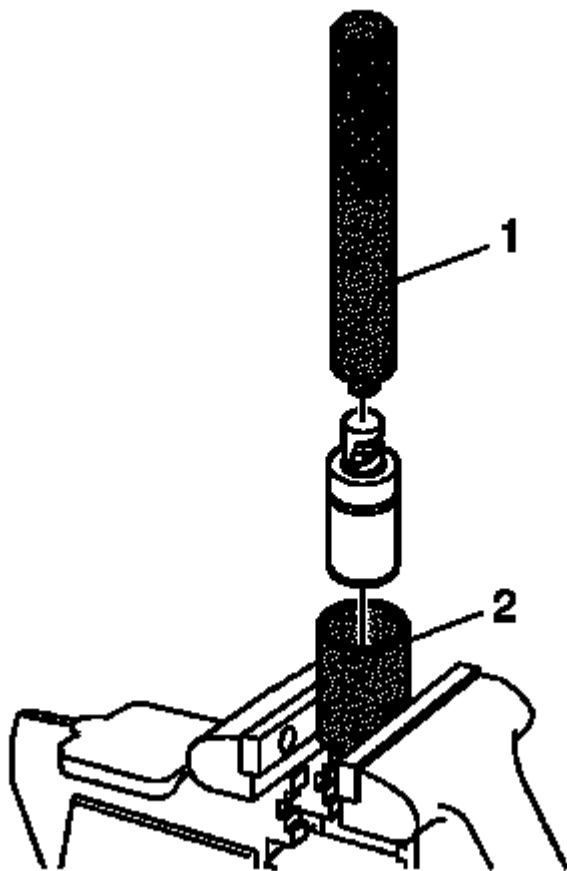


Fig. 108: Compressing Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

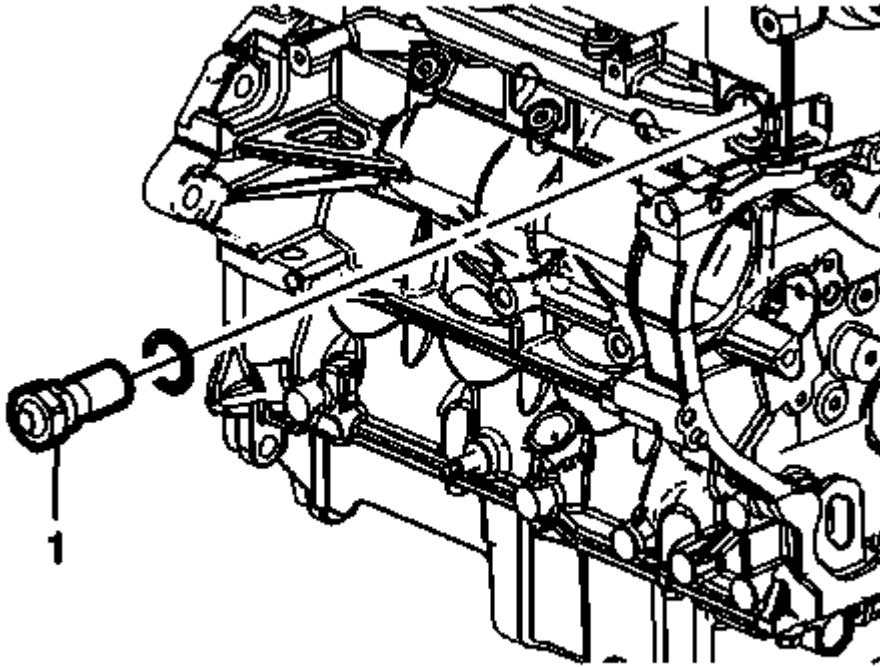


Fig. 109: Timing Chain Tensioner

Courtesy of GENERAL MOTORS COMPANY

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

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

23. Install the timing chain tensioner assembly. Tighten the timing chain tensioner (1) to 75 N.m (55 lb ft).
24. The timing chain tensioner is released by compressing it 2 mm (0.079 in), which will release the locking mechanism in the ratchet. To release the timing chain tensioner, use a suitable tool with a rubber tip on the end. Feed the tool down through the cam drive chest to rest on the cam chain. Then give a sharp jolt diagonally downwards to release the tensioner.

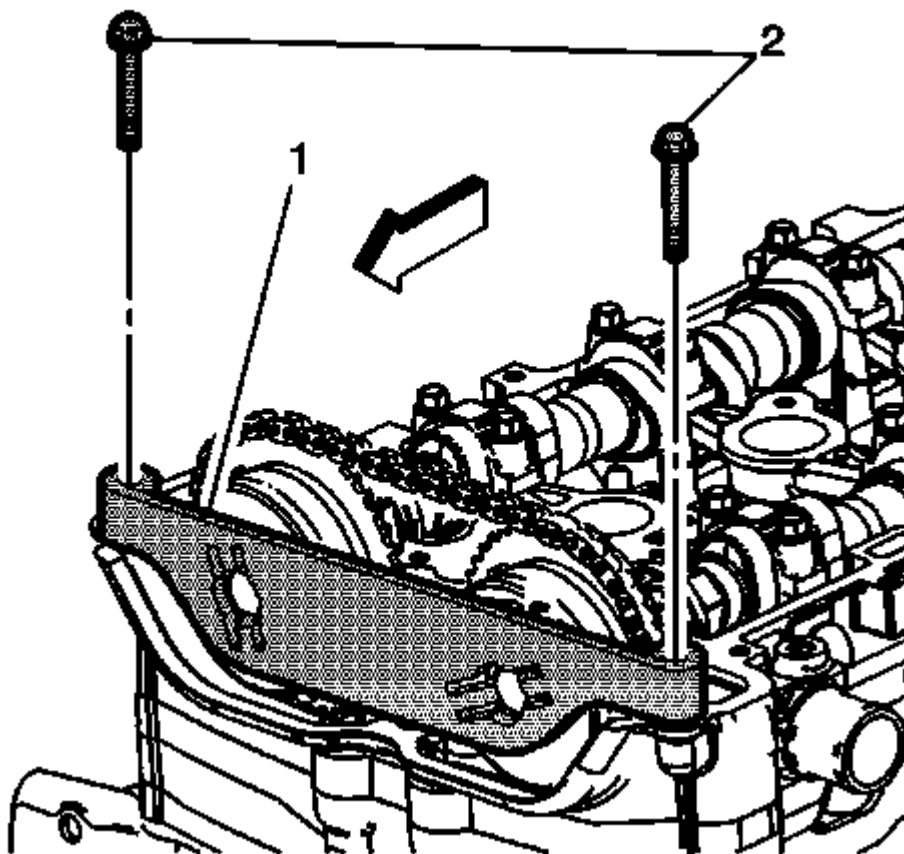


Fig. 110: View Locking Tool

Courtesy of GENERAL MOTORS COMPANY

25. Install **EN-48953** locking tool (1) and tighten the bolts into the cylinder head to 10 N.m (89 lb in).
26. Using a torque wrench, tighten the camshaft actuator bolt (2) to 30 N.m (22 lb ft) plus 100 degrees using the **EN-45059** meter.
27. Remove the **EN-48953** locking tool.

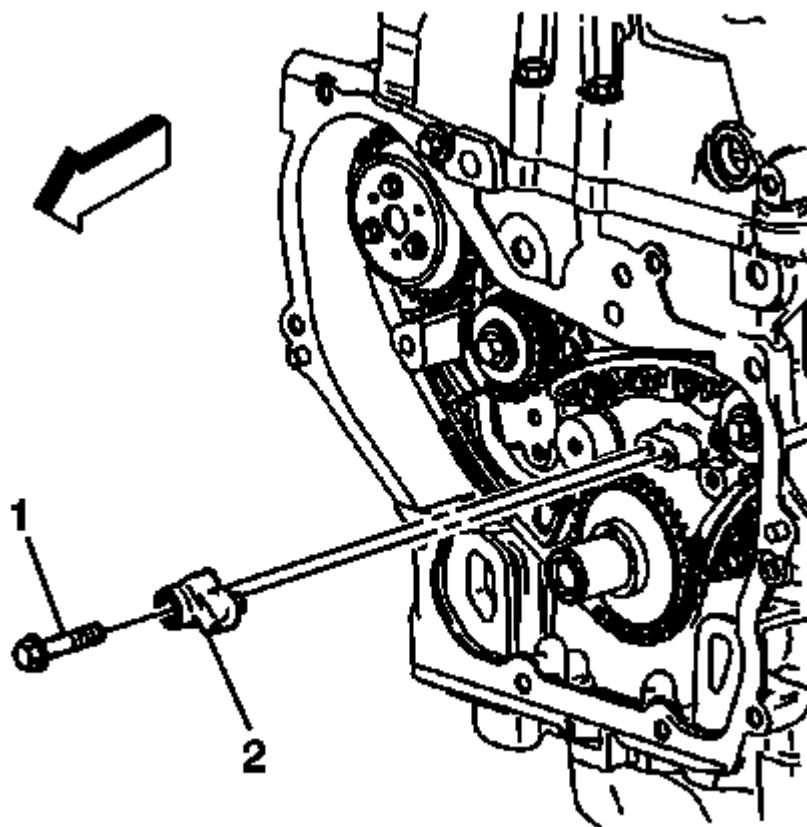


Fig. 111: View Of Oil Nozzle & Bolt
Courtesy of GENERAL MOTORS COMPANY

28. Install the timing chain oiling nozzle (2). Tighten the timing chain oiling nozzle bolt (1) to 10 N.m (89 lb in).

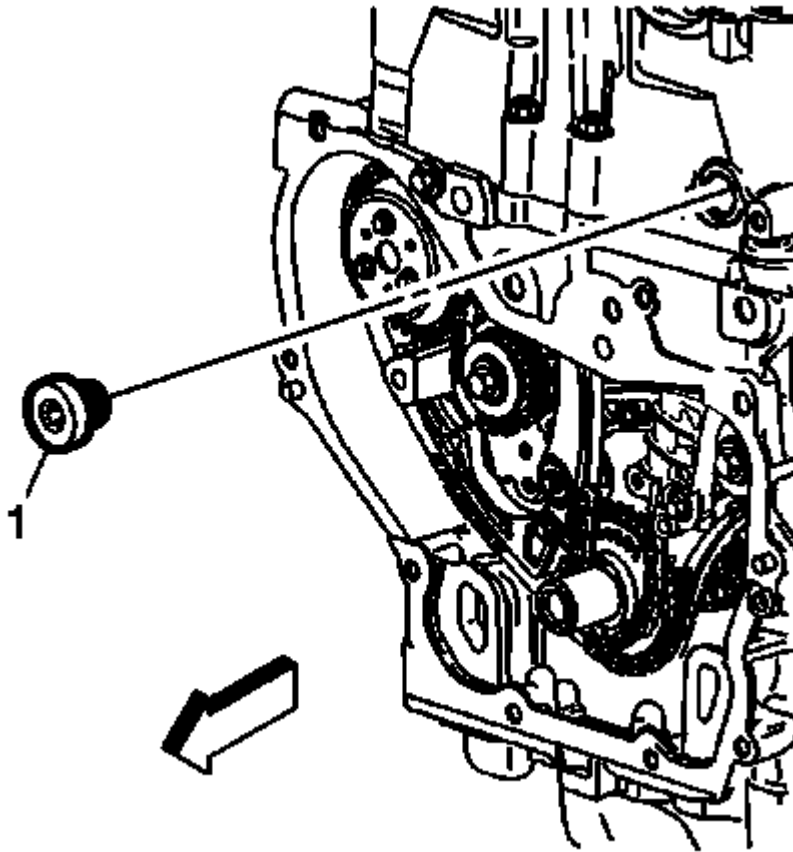


Fig. 112: Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS COMPANY

29. Apply sealant compound to the thread of the timing chain guide bolt access hole plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
30. Install the timing chain guide bolt access hole plug (1) . Tighten the access hole plug to 90 N.m (66 lb ft).
31. Install the engine front cover. Refer to **Engine Front Cover Replacement (LUK)**.
32. Install the camshaft cover. Refer to **Camshaft Cover Replacement (LUK)**.
33. Install the number 1 cylinder spark plug. Refer to **Spark Plug Replacement** .

WATER PUMP AND BALANCE SHAFT CHAIN REPLACEMENT

Removal Procedure

1. Remove the camshaft timing chain, sprocket, and tensioner. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Replacement**.

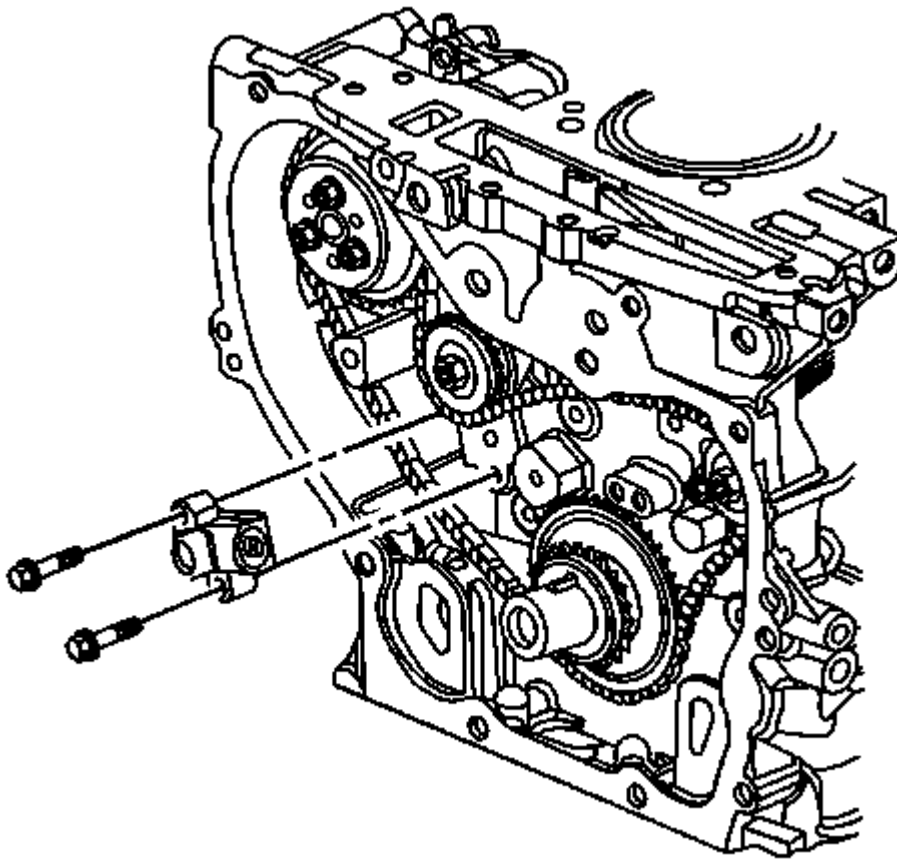


Fig. 113: Balance Shaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

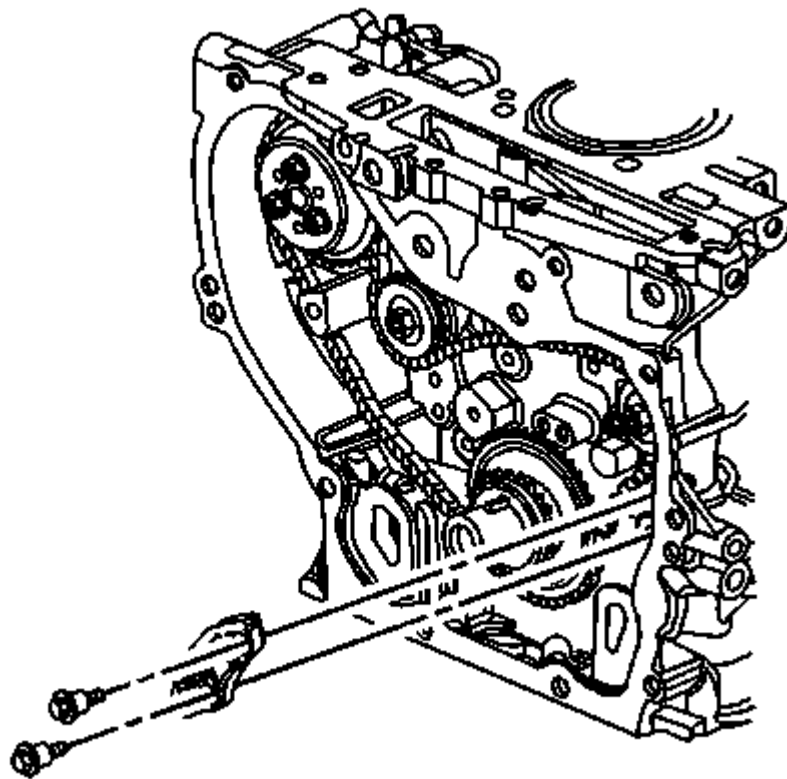


Fig. 114: Small Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

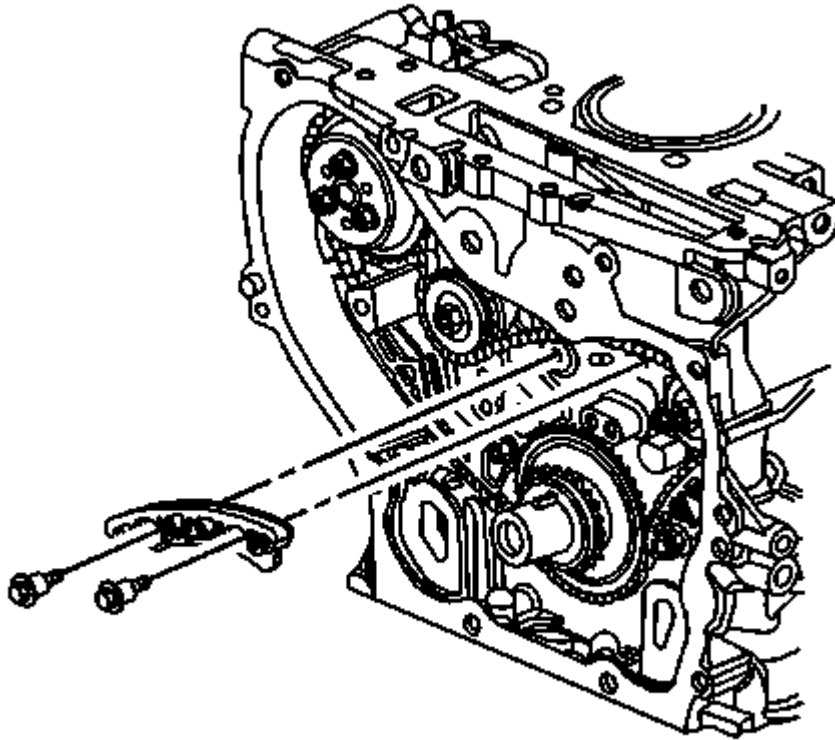


Fig. 115: Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

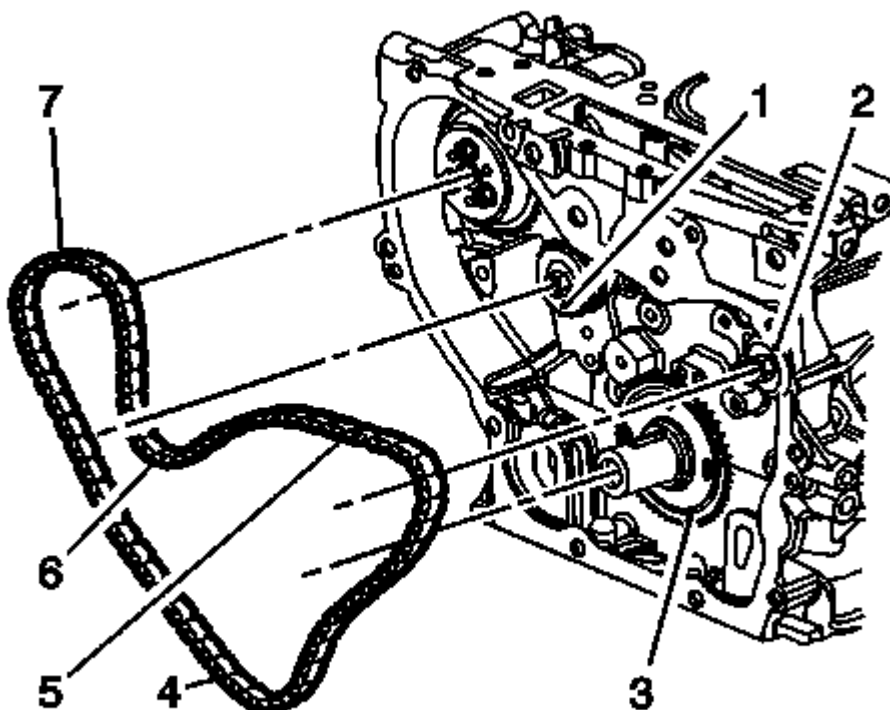


Fig. 116: Balance Shaft Drive Chain

Courtesy of GENERAL MOTORS COMPANY

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

5. Remove the balance shaft drive chain (7).
6. Remove the balance shaft drive sprocket.

Installation Procedure

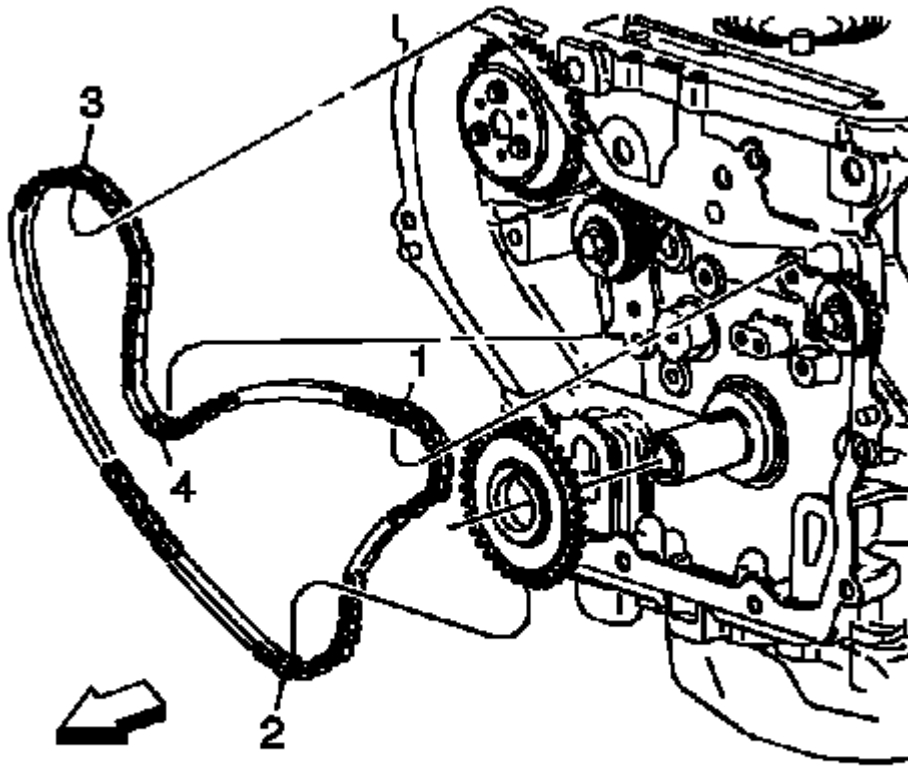


Fig. 117: Aligning Balance Shaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

1. Install the balance shaft drive sprocket.

NOTE: If the balance shafts are not properly timed to the engine, the engine may vibrate or make noise. Refer to Balance Shaft to Engine Timing (LAF, LEA, or LUK) .

2. Install the balance shaft drive chain with the colored link lined up with the marks on the balance shaft sprockets and the balance shaft drive sprocket. There are three colored links on the chain. Two links are of matching colors, and one link is of a unique color. Use the following procedure to line up the links with the sprockets.

NOTE: Orient the chain so that the colored links are visible.

1. Place the uniquely colored link (1) so that it lines up with the timing mark on the intake side balance shaft sprocket.
2. Working clockwise around the chain, place the first matching colored link (2) in line with the timing mark on the crankshaft drive sprocket, approximately 6 o'clock position on the sprocket.
3. Place the chain (3) on the water pump drive sprocket. The alignment is not critical.

4. Align the last matching colored link (4) with the timing mark on the exhaust side balance shaft drive sprocket.

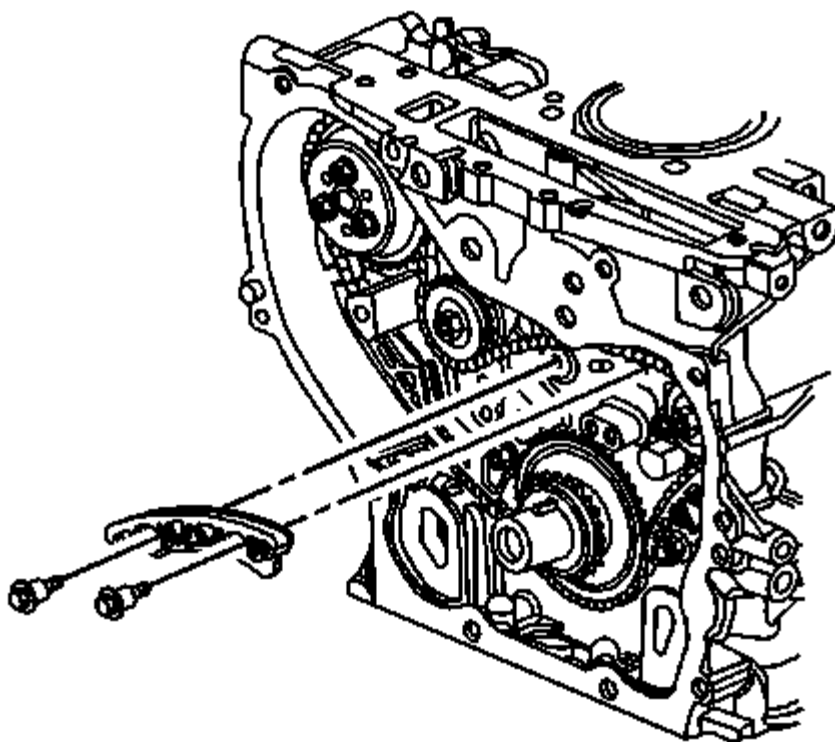


Fig. 118: Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the upper balance shaft drive chain guide and bolts and tighten to 12 (106 lb in).

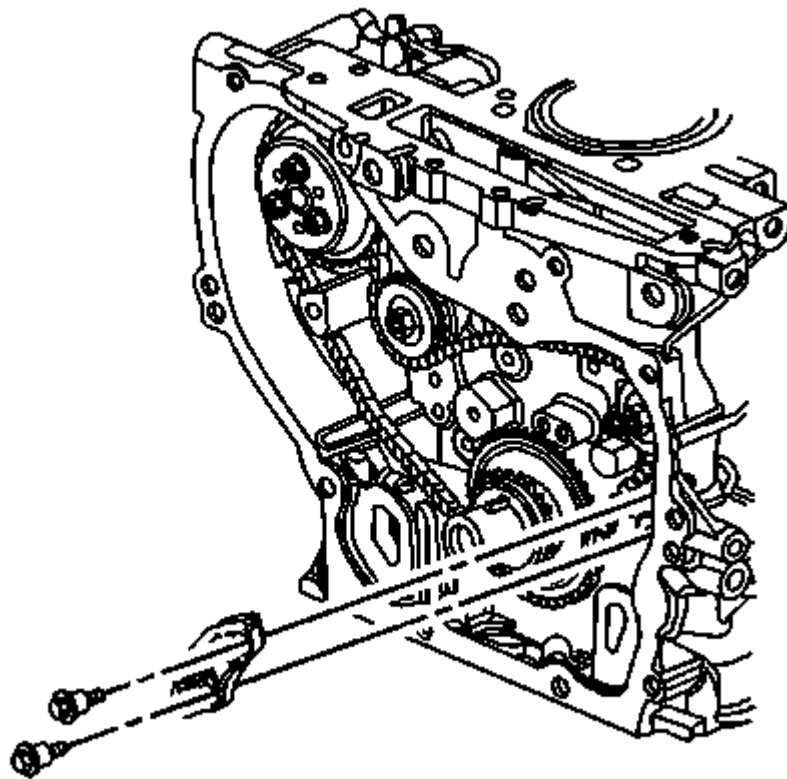


Fig. 119: Small Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

4. Install the small balance shaft drive chain guide and bolts and tighten to 12 (106 lb in).

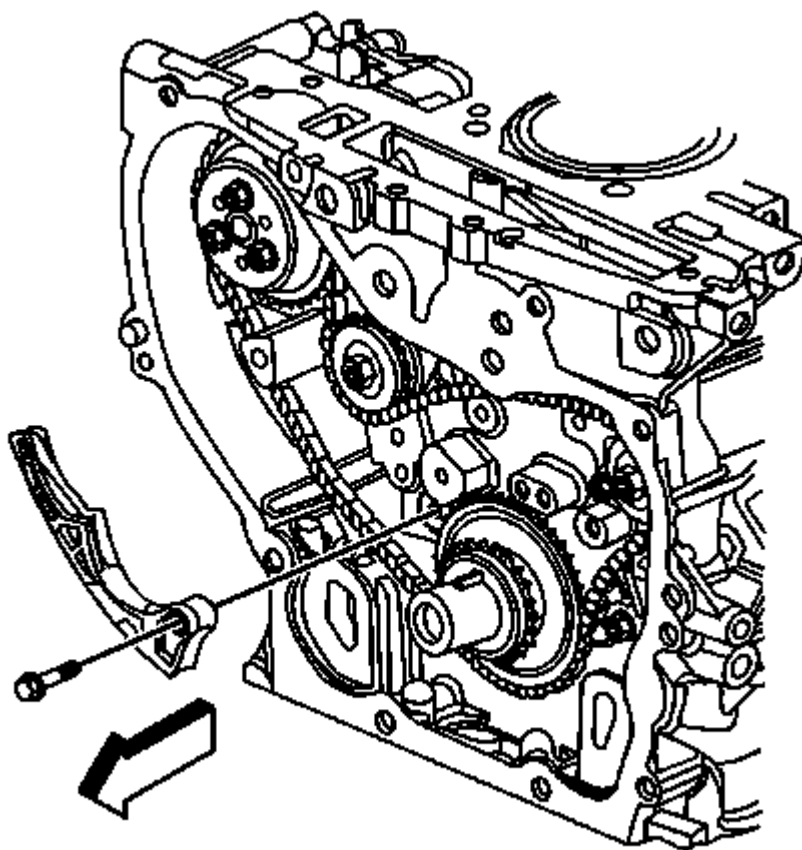


Fig. 120: Adjustable Balance Shaft Chain Guide
Courtesy of GENERAL MOTORS COMPANY

5. Install the adjustable balance shaft chain guide and bolt and tighten to 10 (89 lb in).

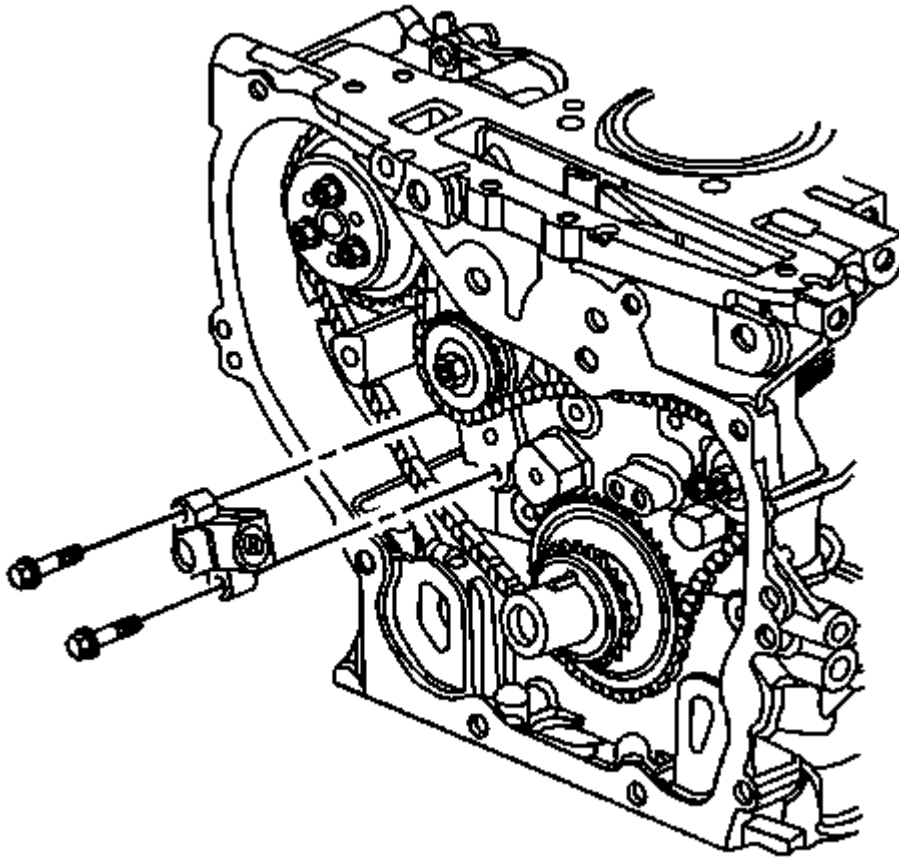


Fig. 121: Balance Shaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

6. Reset the timing chain tensioner by performing the following steps:
 - Rotate the tensioner plunger 90 degrees in its bore and compress the plunger.
 - Rotate the tensioner back to the original 12 o'clock position and insert a paper clip through the hole in the plunger body and into the hole in the tensioner plunger.
7. Install the balance shaft drive chain tensioner and bolts and tighten to 10 N•m (89 lb in).
8. Remove the paper clip from the balance shaft drive chain tensioner.
9. Install the camshaft timing chain, sprocket, and tensioner. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Replacement**.

CAMSHAFT COVER REPLACEMENT (LUK)

Removal Procedure

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** Air Cleaner Outlet Duct Replacement
2. Remove the ignition coils. Refer to **Ignition Coil Replacement** Ignition Coil Replacement

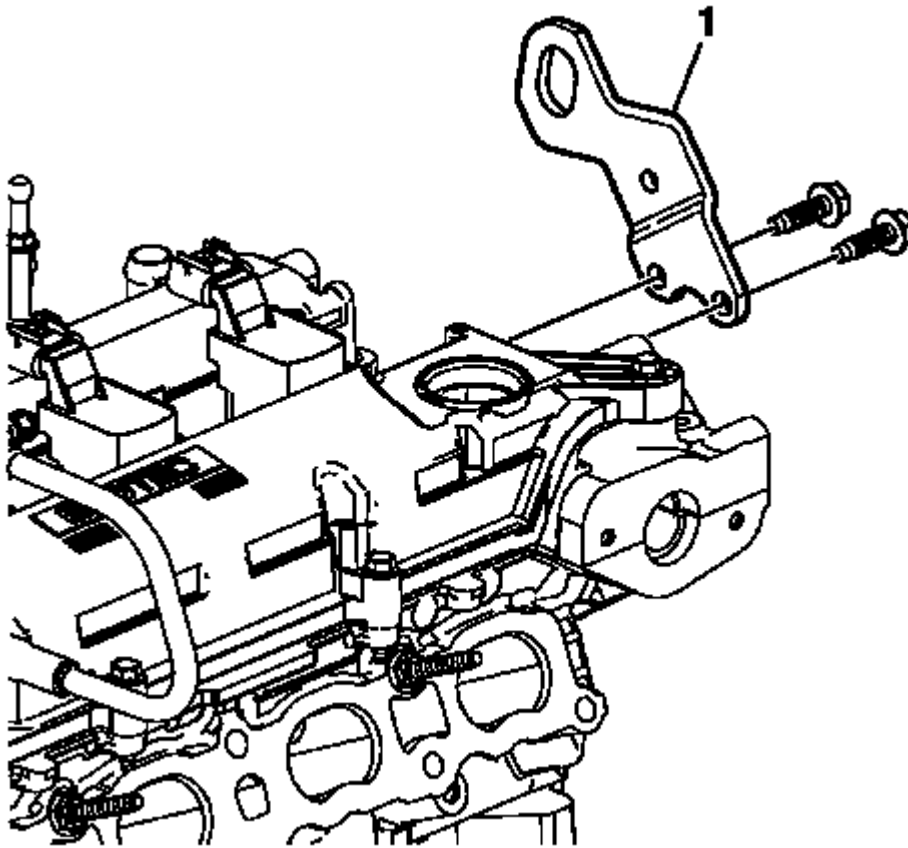


Fig. 122: Rear Lift Bracket

Courtesy of GENERAL MOTORS COMPANY

3. Remove the rear lift bracket (1).

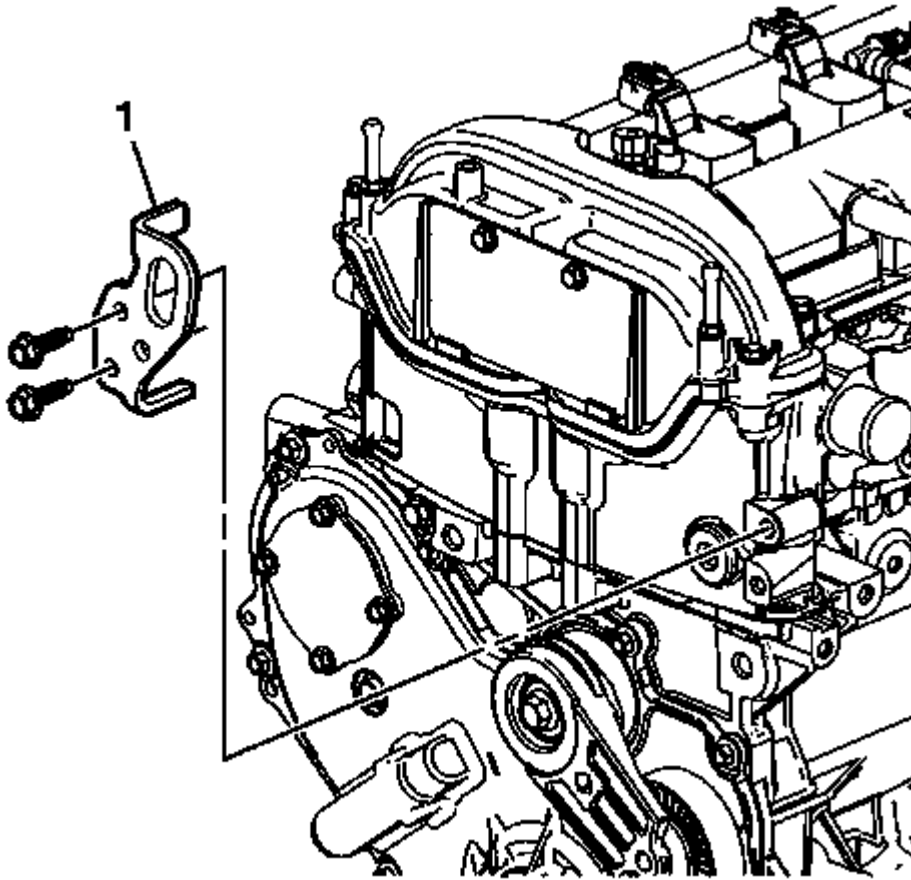


Fig. 123: Front Lift Bracket

Courtesy of GENERAL MOTORS COMPANY

4. Remove the front lift bracket (1).

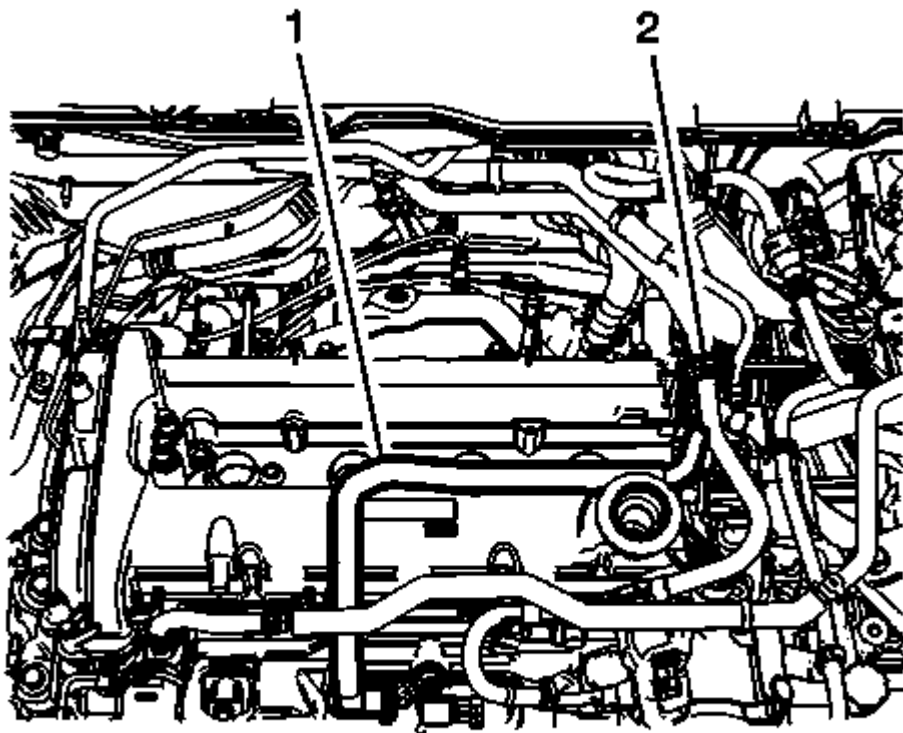


Fig. 124: Evaporative Emission Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

5. Remove the evaporative emission canister purge tube (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
6. Disconnect fuel line clip (2).

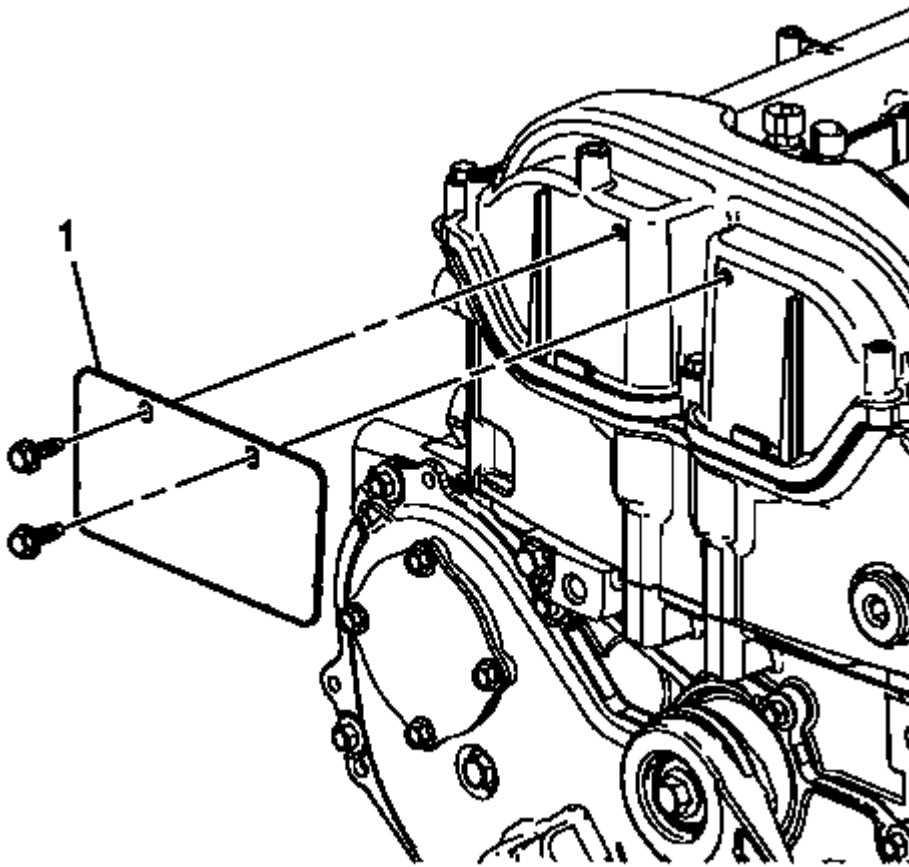


Fig. 125: Camshaft Housing Cover Insulator
Courtesy of GENERAL MOTORS COMPANY

7. Remove the camshaft housing cover insulator (1).

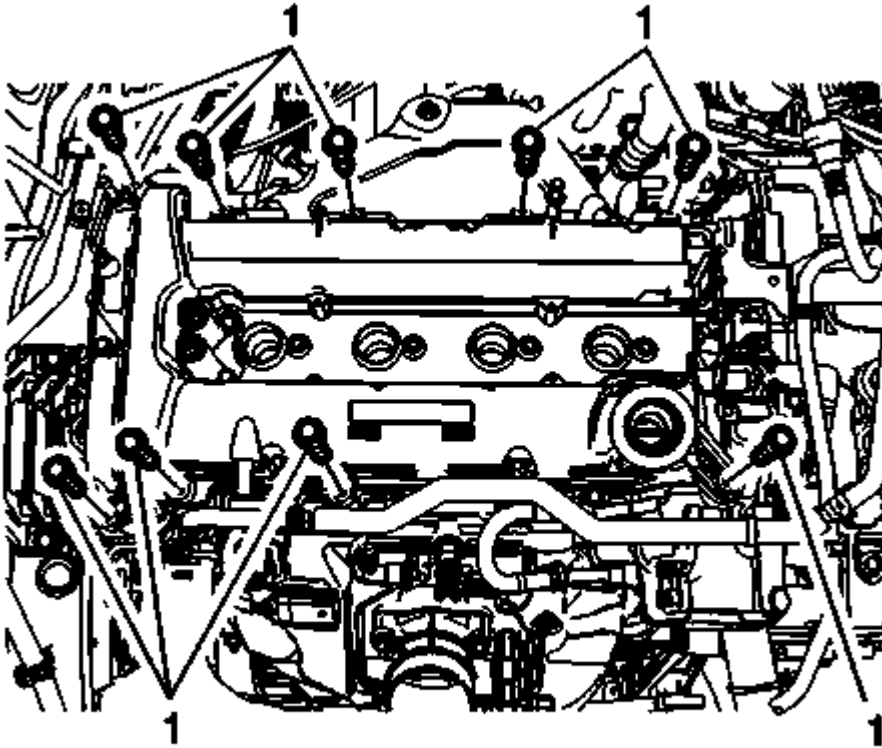


Fig. 126: Camshaft Cover Bolt

Courtesy of GENERAL MOTORS COMPANY

8. Remove the camshaft cover bolts (1).

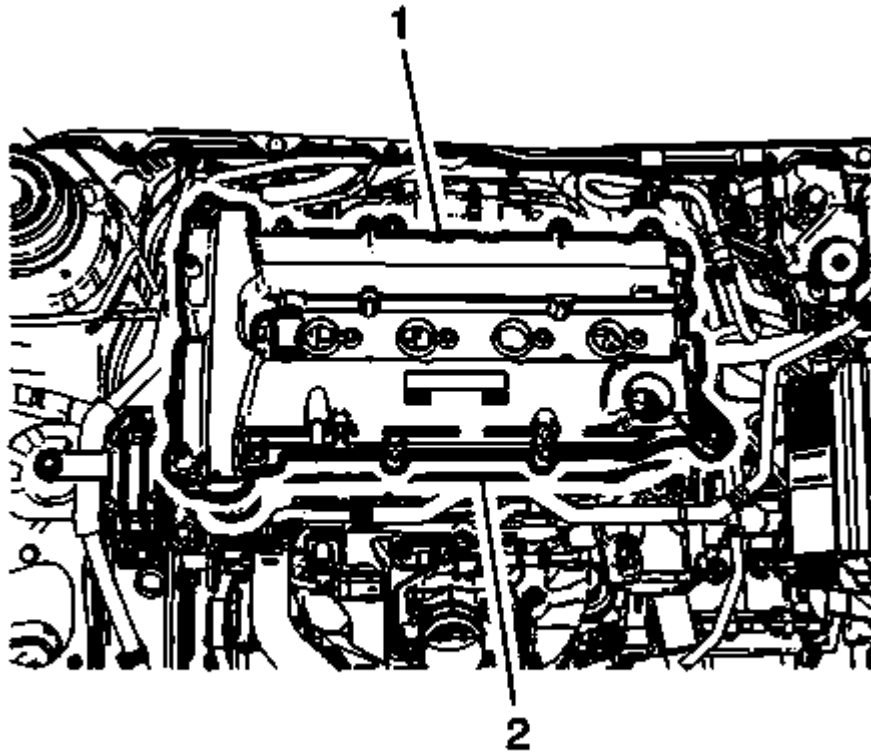


Fig. 127: Camshaft Cover And Gasket
Courtesy of GENERAL MOTORS COMPANY

9. Remove the camshaft cover (1) and gasket (2).

Installation Procedure

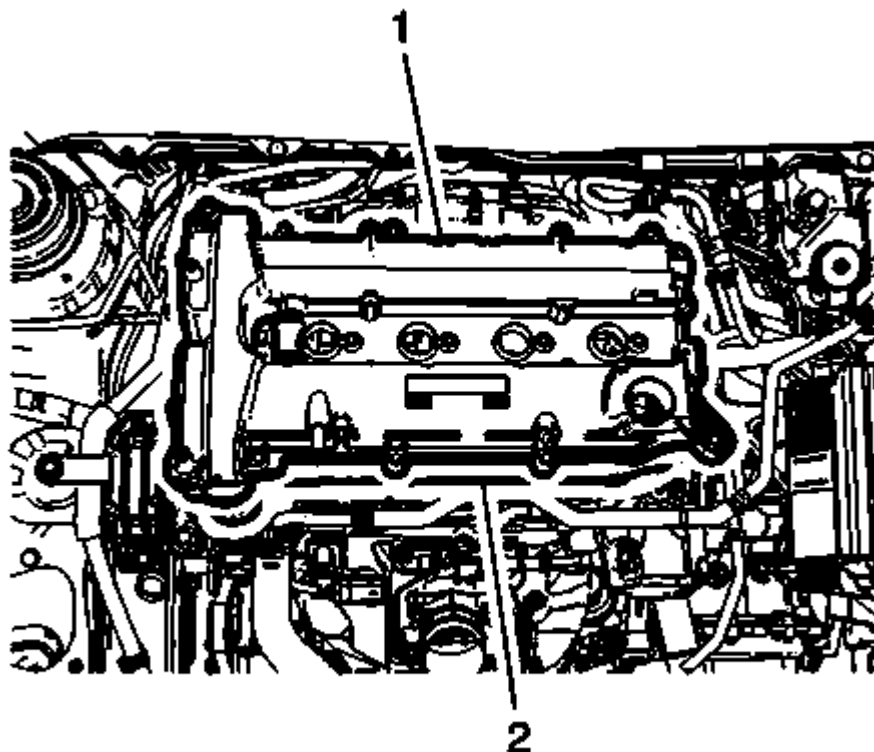


Fig. 128: Camshaft Cover And Gasket

Courtesy of GENERAL MOTORS COMPANY

1. Assemble the camshaft cover (1) and a NEW gasket (2). Ensure that the gasket is located in the retaining groove in the camshaft cover.

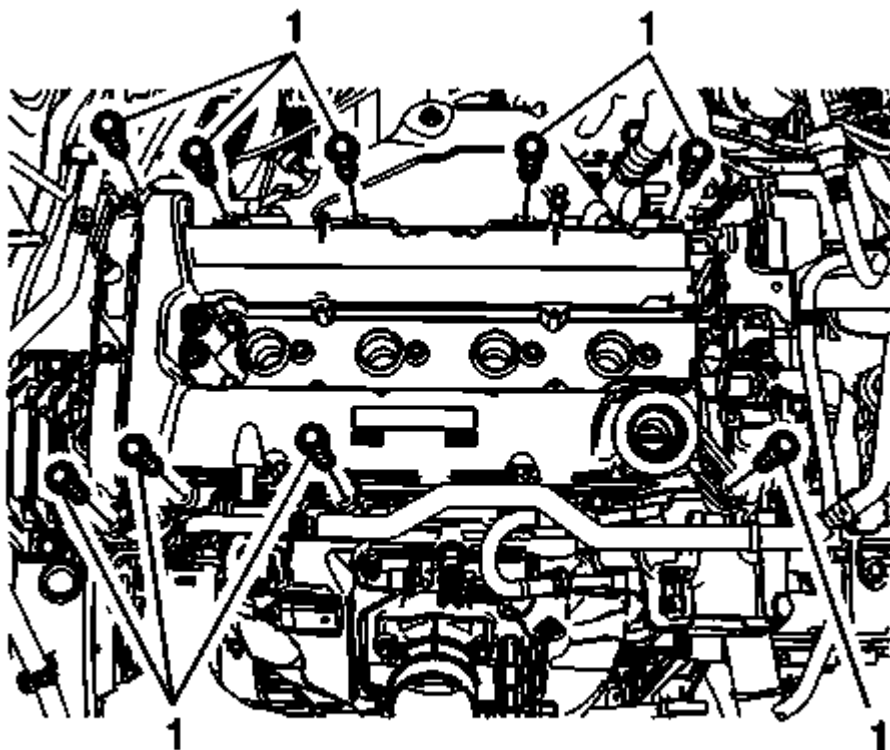


Fig. 129: Camshaft Cover Bolt

Courtesy of GENERAL MOTORS COMPANY

2. Install NEW camshaft cover grommets and camshaft cover bolts (1).
3. Install the cover on the cylinder head and hand start the bolts. Tighten the bolts to 10 N.m (89 lb in).

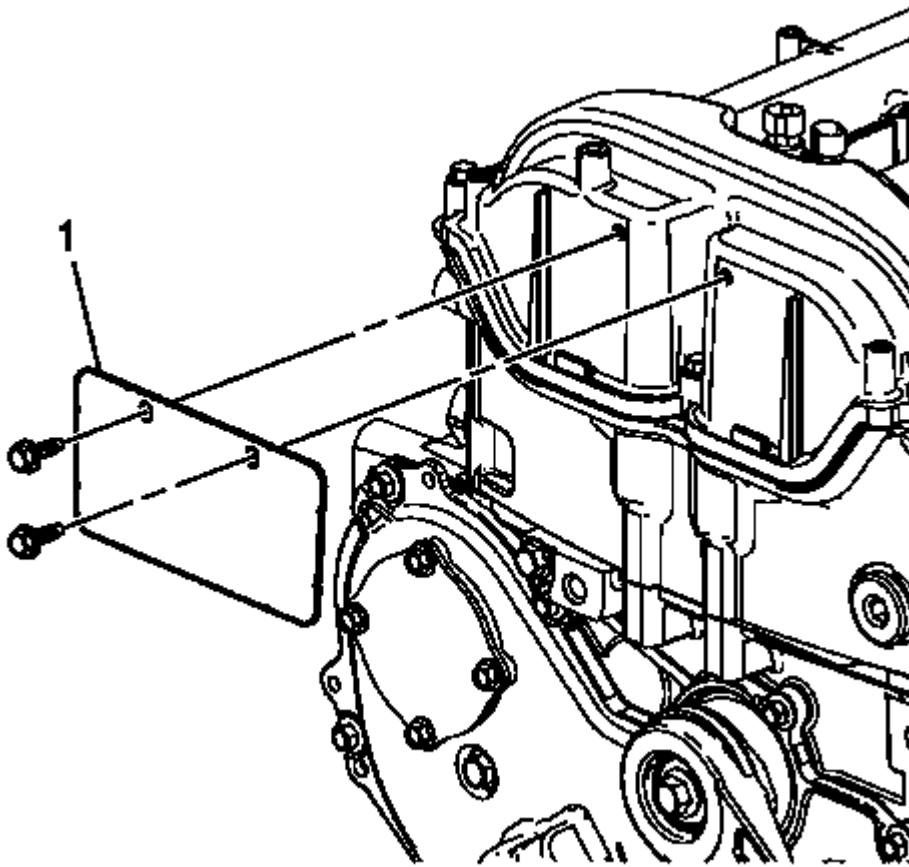


Fig. 130: Camshaft Housing Cover Insulator
Courtesy of GENERAL MOTORS COMPANY

4. Install the camshaft housing cover insulator (1). Tighten the bolts to 10 N.m (89 lb in).

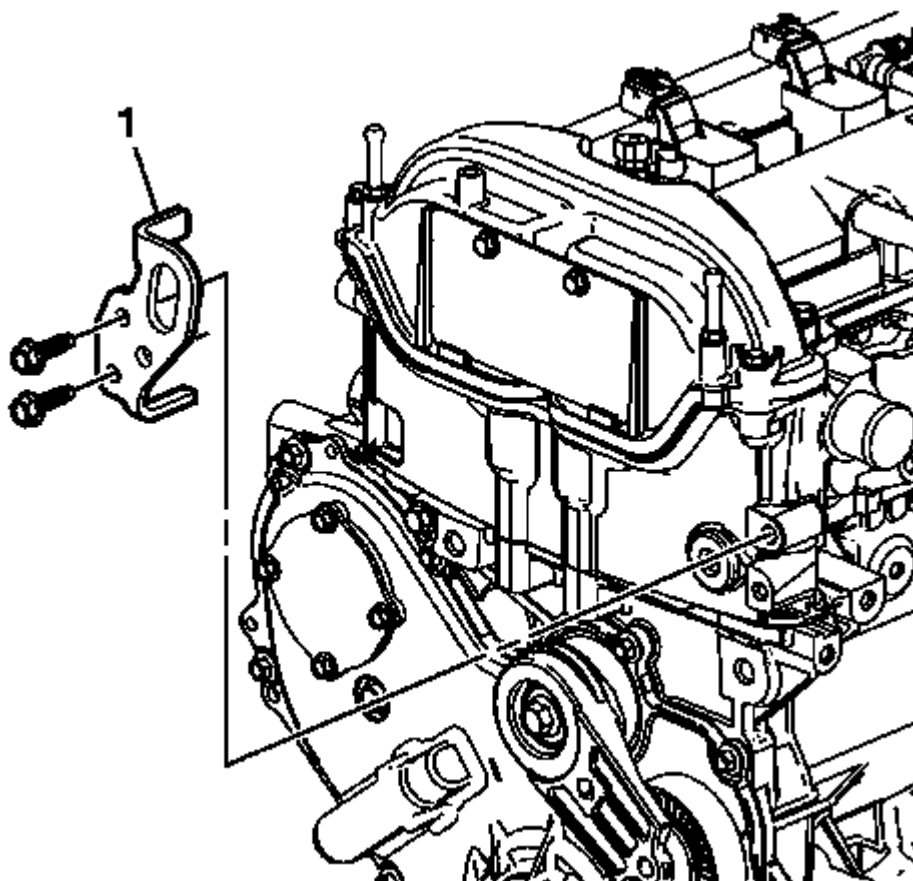


Fig. 131: Front Lift Bracket

Courtesy of GENERAL MOTORS COMPANY

5. Install the front lift bracket (1).
6. Install the front lift bracket bolts and tighten to 25 N.m (18 lb ft).

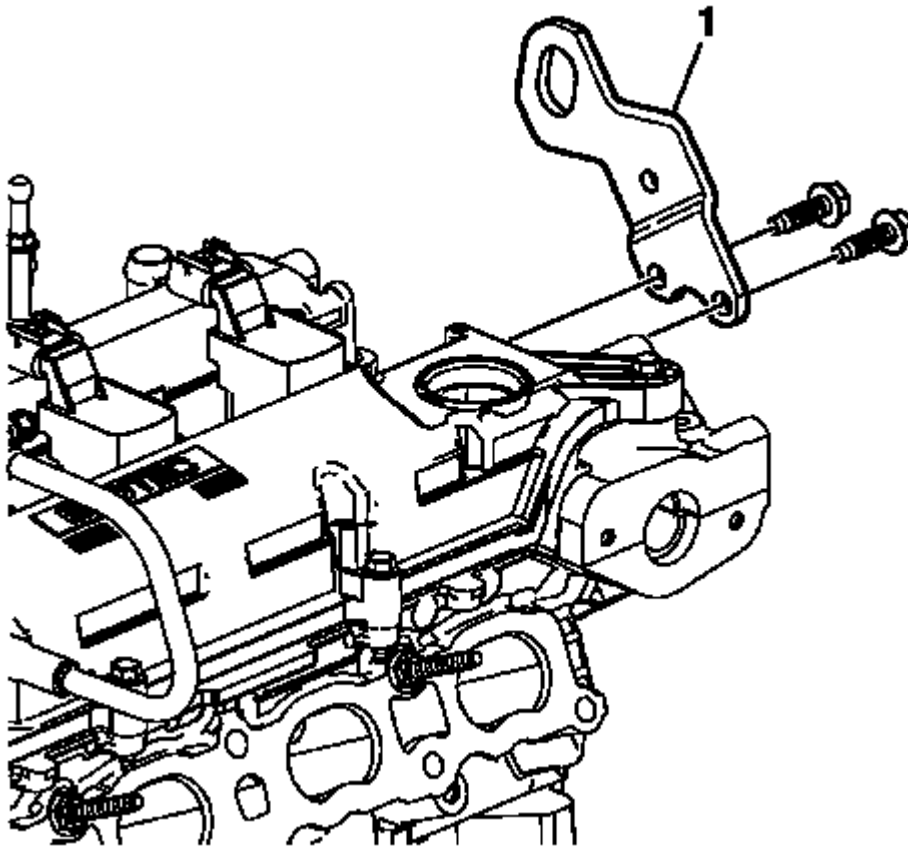


Fig. 132: Rear Lift Bracket

Courtesy of GENERAL MOTORS COMPANY

7. Install the rear lift bracket (1).
8. Install the rear lift bracket bolts and tighten to 25 N.m (18 lb ft).

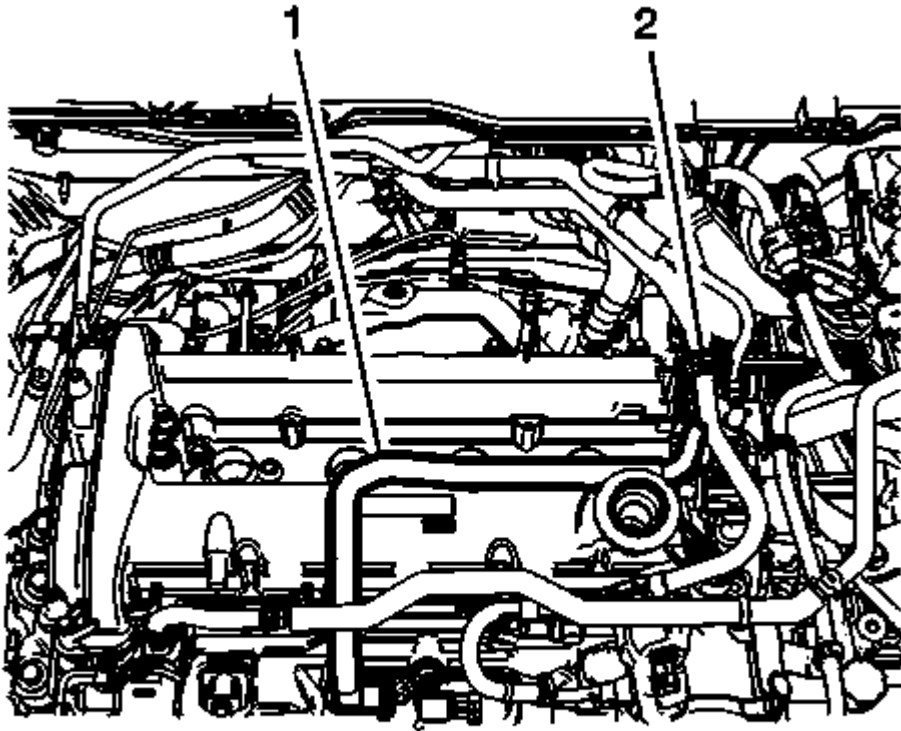


Fig. 133: Evaporative Emission Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

9. Install the evaporative emission canister purge tube (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
10. connect the fuel like clip.
11. install the ignition coils. Refer to **Ignition Coil Replacement** Ignition Coil Replacement.
12. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** Air Cleaner Outlet Duct Replacement.

TIMING CHAIN TENSIONER REPLACEMENT

Special Tools

EN-45027 Tensioner Tool

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

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and**

Connection .

2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement (LUK)**.

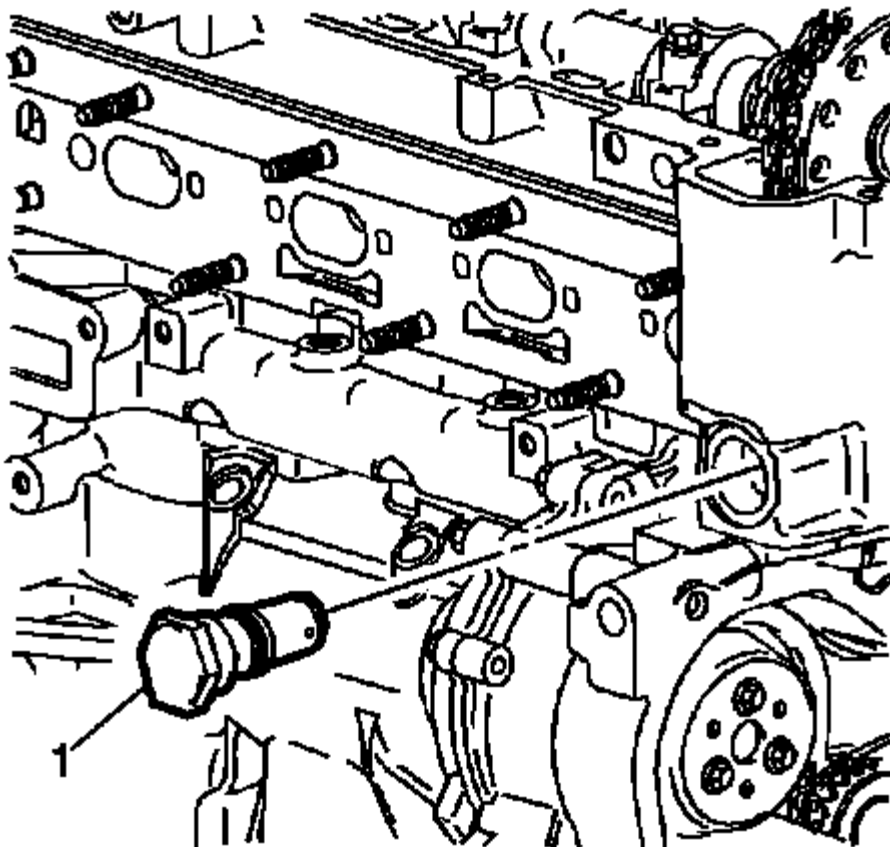


Fig. 134: Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

3. Remove the timing chain tensioner (1).
4. Remove the seal from the tensioner and DISCARD.

Installation Procedure

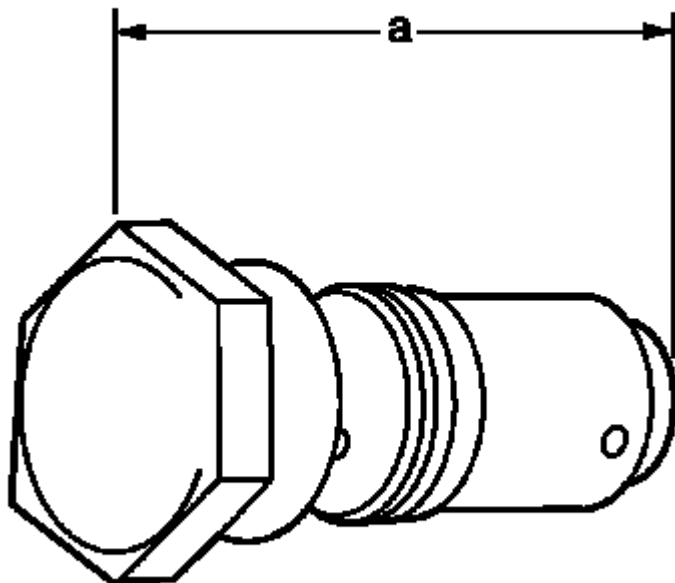


Fig. 135: Measuring Timing Chain Tensioner Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the timing chain tensioner. If the timing chain tensioner, O-ring seal, or washer is damaged, replace the timing chain tensioner or O-ring seal as applicable.
2. Measure the timing chain tensioner assembly from end to end. If the timing chain tensioner is to be replaced, a new tensioner should be supplied in the fully compressed non-active state.

A tensioner in the compressed state will measure 72 mm (2.83 in) (a) from end to end. A tensioner in the active state will measure 85 mm (3.35 in) (a) from end to end.

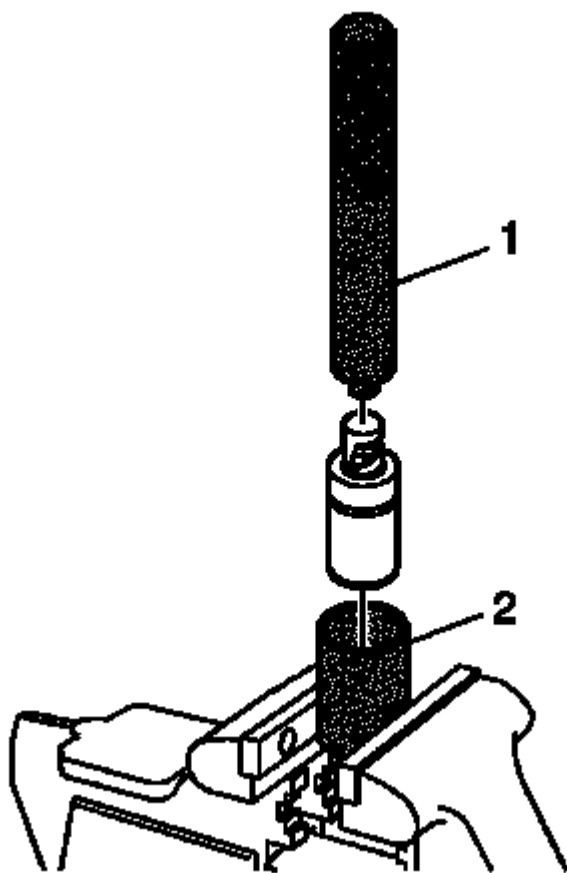


Fig. 136: Compressing Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

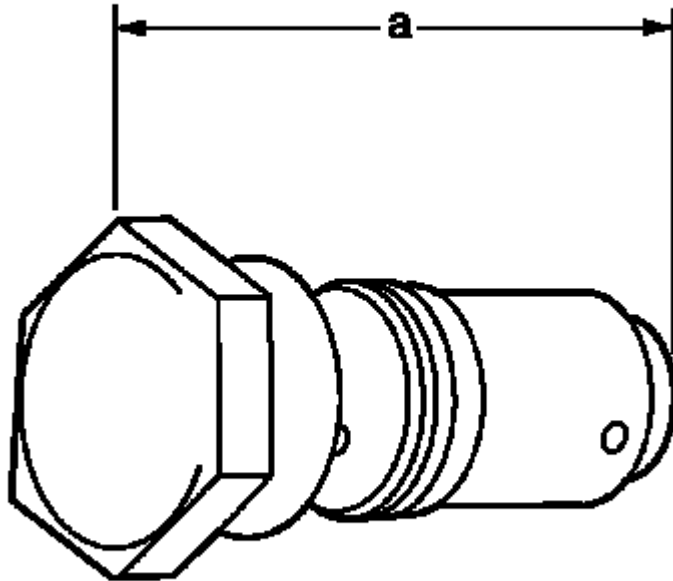


Fig. 137: Measuring Timing Chain Tensioner Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the bore of the tensioner body for dirt, debris, and damage. If any damage appears, replace the tensioner. Clean dirt or debris out with a lint-free cloth.
5. Install the compressed piston assembly back into the timing chain tensioner body until it stops at the bottom of the bore.

Do not compress the piston assembly against the bottom of the bore. If the piston assembly is compressed against the bottom of the bore, it will activate the tensioner, which will then need to be reset again.

6. At this point the tensioner should measure approximately 72 mm (2.83 in) (a) from end to end. If the tensioner does not read 72 mm (2.83 in) (a) from end to end, repeat steps 3-5.

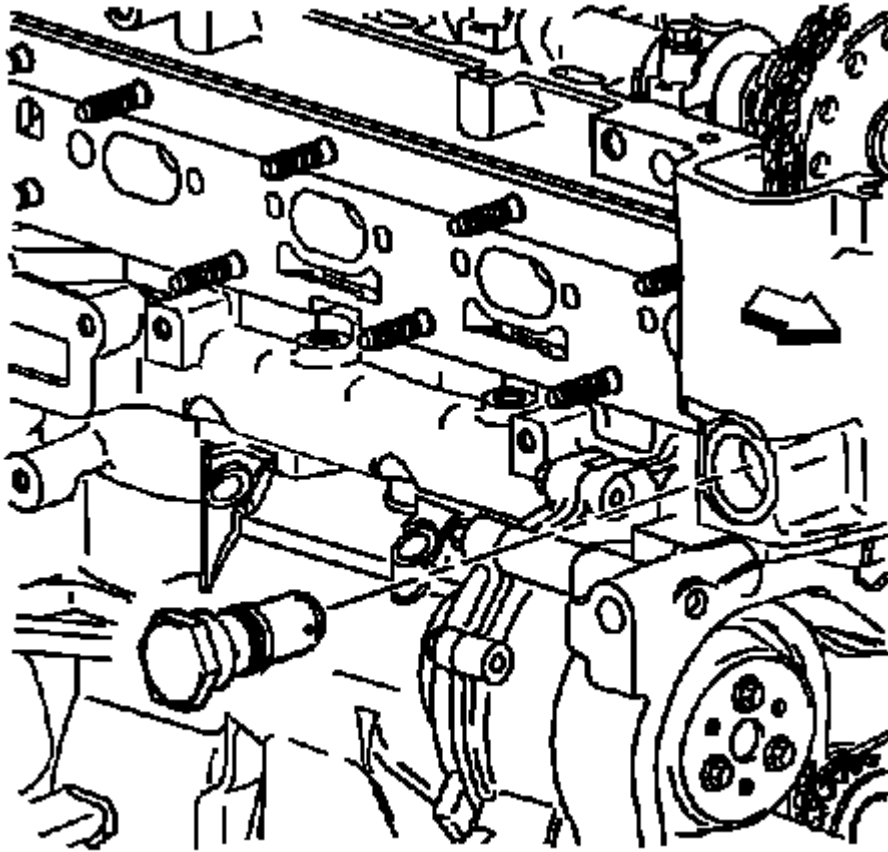


Fig. 138: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to Fastener Caution .

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

8. Install the timing chain tensioner assembly (1) and tighten the tensioner to 75 N.m (55 lb ft).
9. The timing chain tensioner is released by compressing the tensioner 2 mm (0.079 in) which will release the locking mechanism in the ratchet.

To release the timing chain tensioner, use a suitable tool with a rubber tip on the end. Feed the tool down through the cam drive chest to rest on the cam chain. Then give a sharp jolt diagonally downwards to release the tensioner.

10. Install the camshaft cover. Refer to [Camshaft Cover Replacement \(LUK\)](#).
11. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

INTAKE CAMSHAFT AND VALVE LIFTER REPLACEMENT

Removal Procedure

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

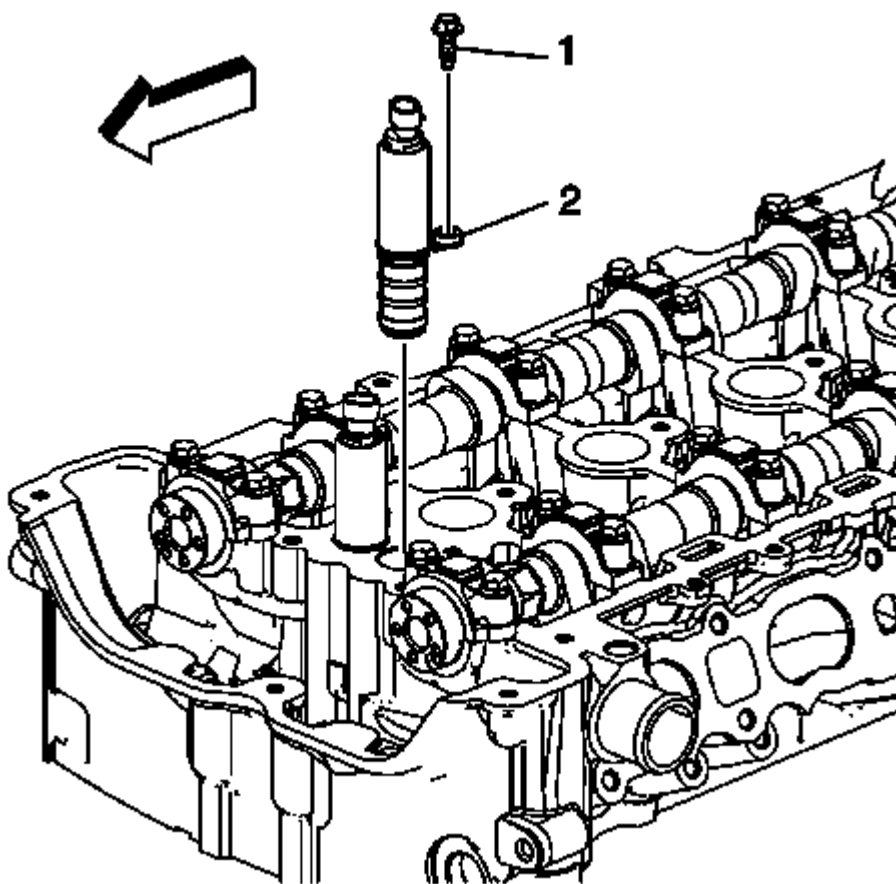


Fig. 139: Intake Camshaft Position Actuator Solenoid Valve & Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the intake camshaft position actuator solenoid valve bolt (1) and valve (2).

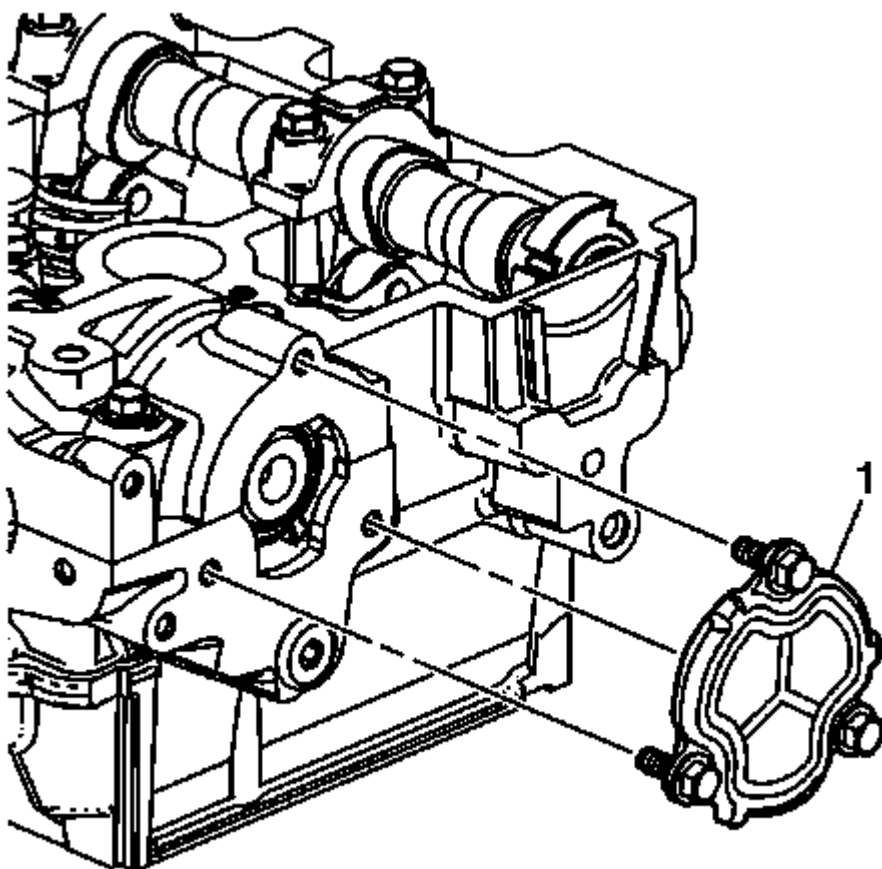


Fig. 140: Rear Cylinder Head Cover Plate
Courtesy of GENERAL MOTORS COMPANY

3. Remove the rear cylinder head cover plate (1).
4. Remove the fuel pump. Refer to **Fuel Pump Replacement** .

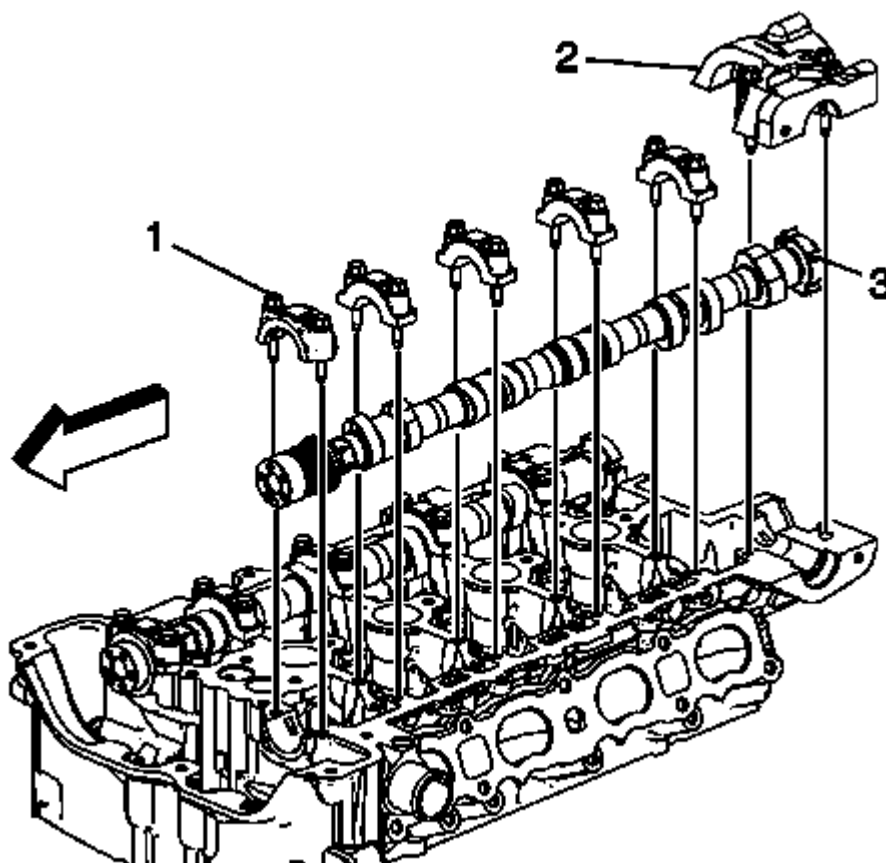


Fig. 141: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

5. Remove the intake camshaft bearing rear cap bolts and cap (2).

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

6. Mark camshaft caps to ensure they are installed in the same position.
7. Remove the intake camshaft cap bolts.
8. Remove the camshaft caps (1).
9. Remove the intake camshaft (3).

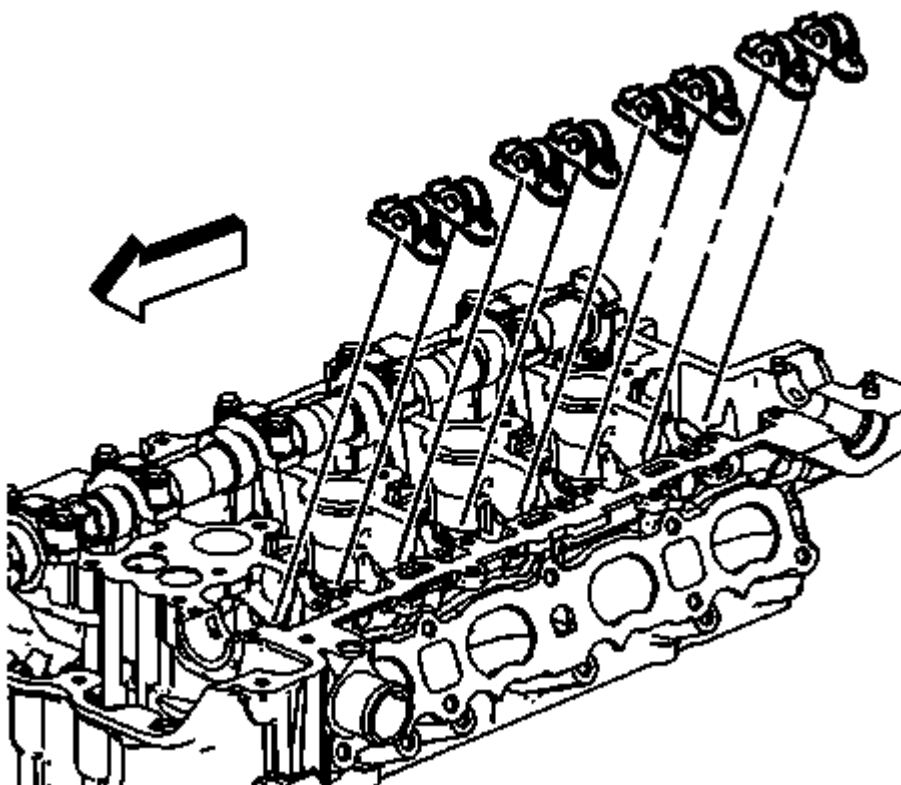


Fig. 142: Intake Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

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

10. Remove the intake camshaft roller finger followers.

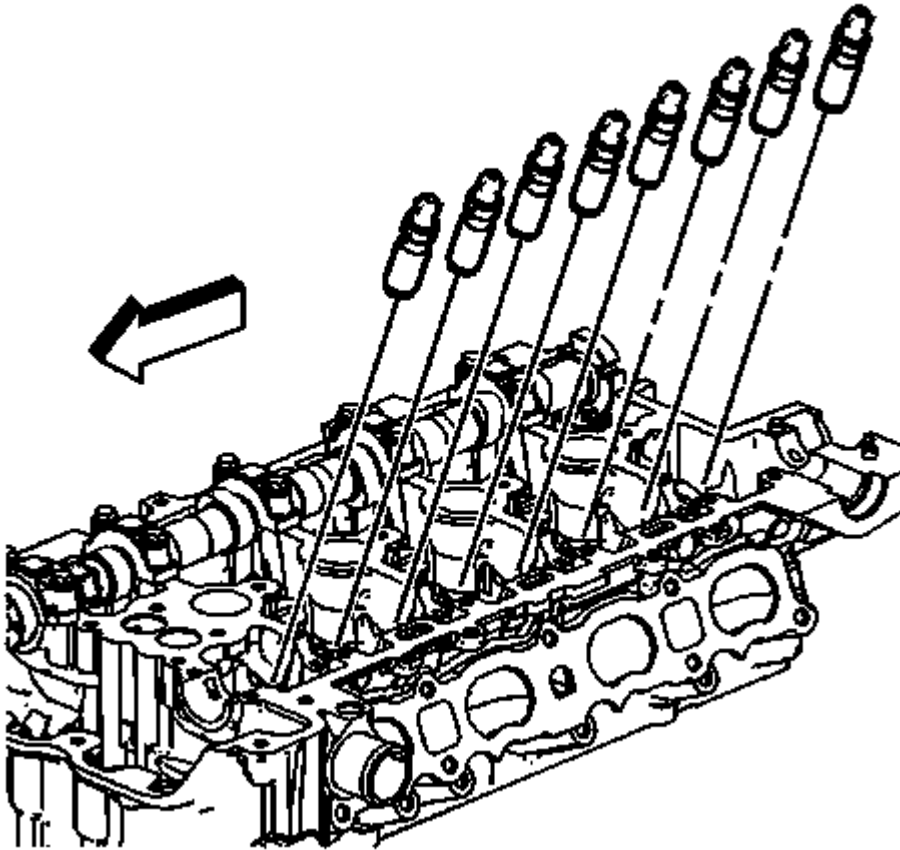


Fig. 143: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

11. Remove the hydraulic lash adjusters.

Installation Procedure

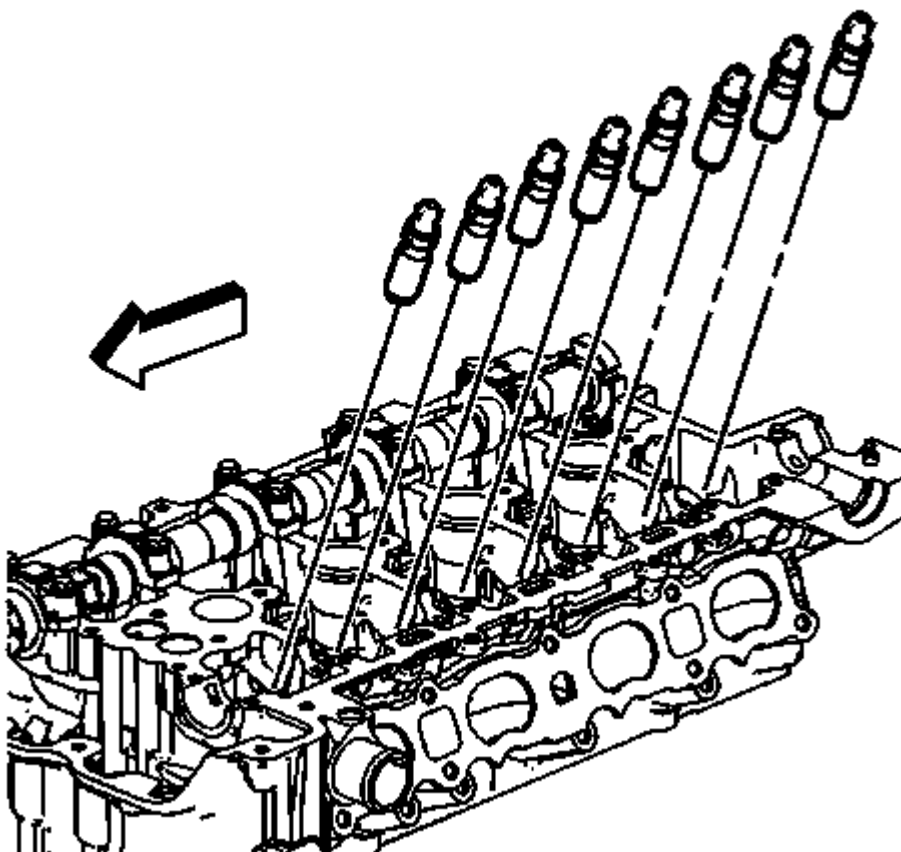


Fig. 144: Hydraulic Lash Adjusters

Courtesy of GENERAL MOTORS COMPANY

1. Install the hydraulic lash adjusters into their bores in the cylinder head.
2. Lubricate the hydraulic lash adjusters. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

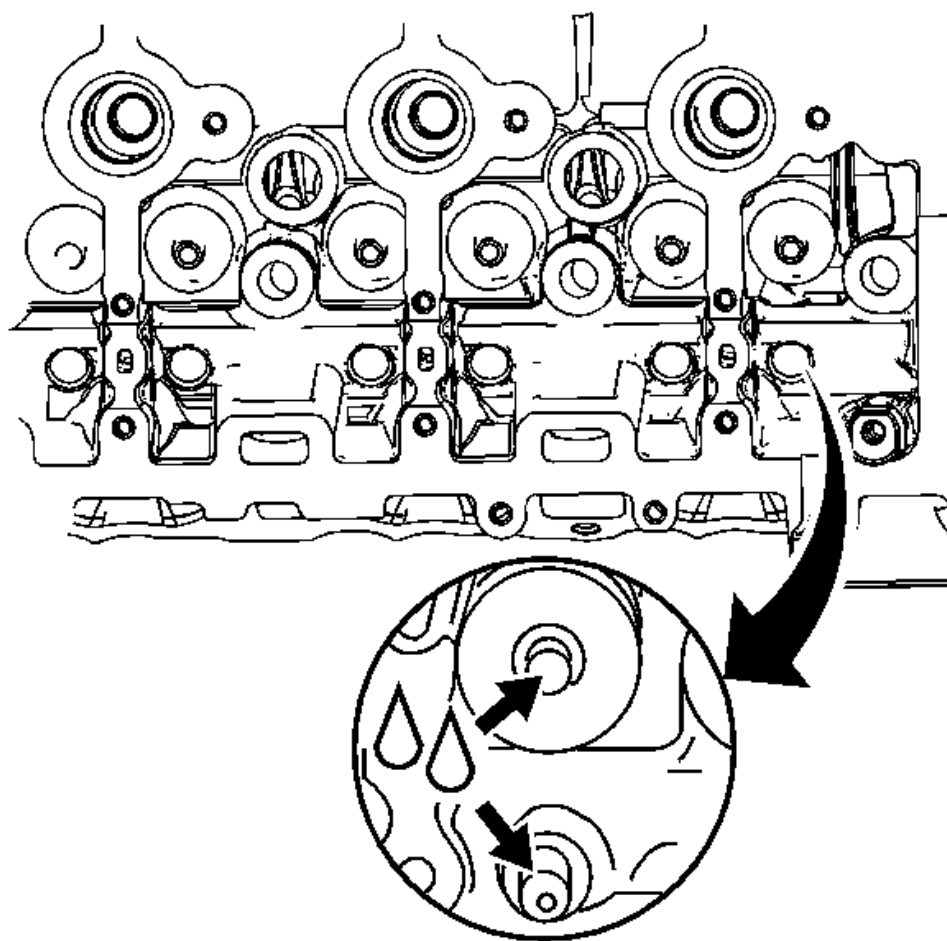


Fig. 145: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

3. Lubricate the valve tips. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) .

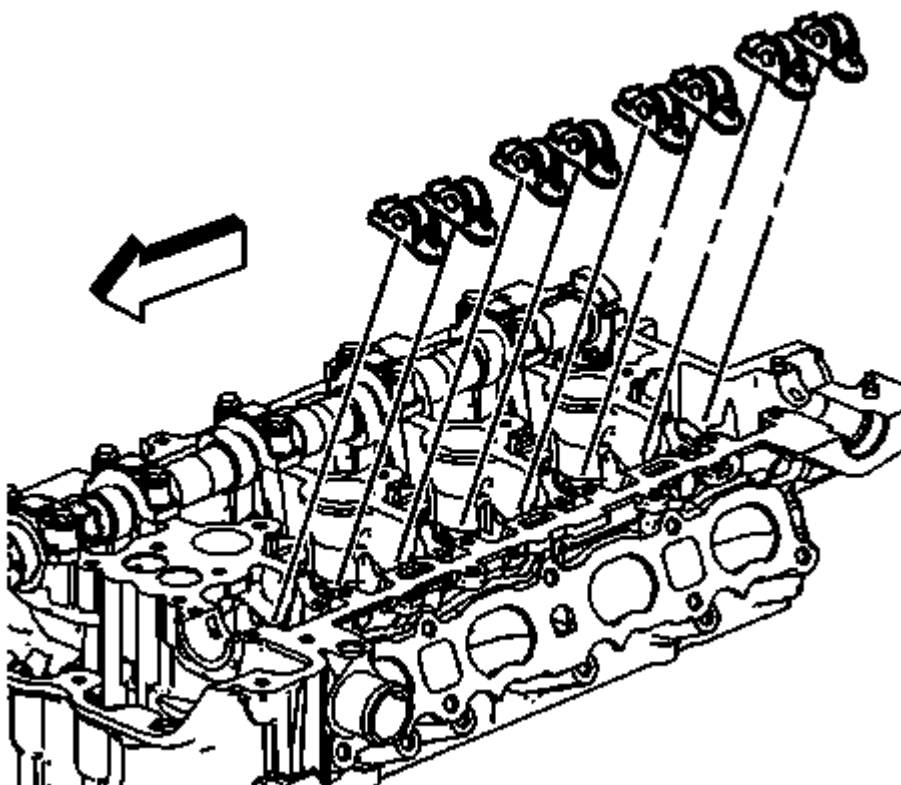


Fig. 146: Intake Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

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

4. Position the roller followers on the tip of the valve stem and on the lash adjuster. Lubricate roller followers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

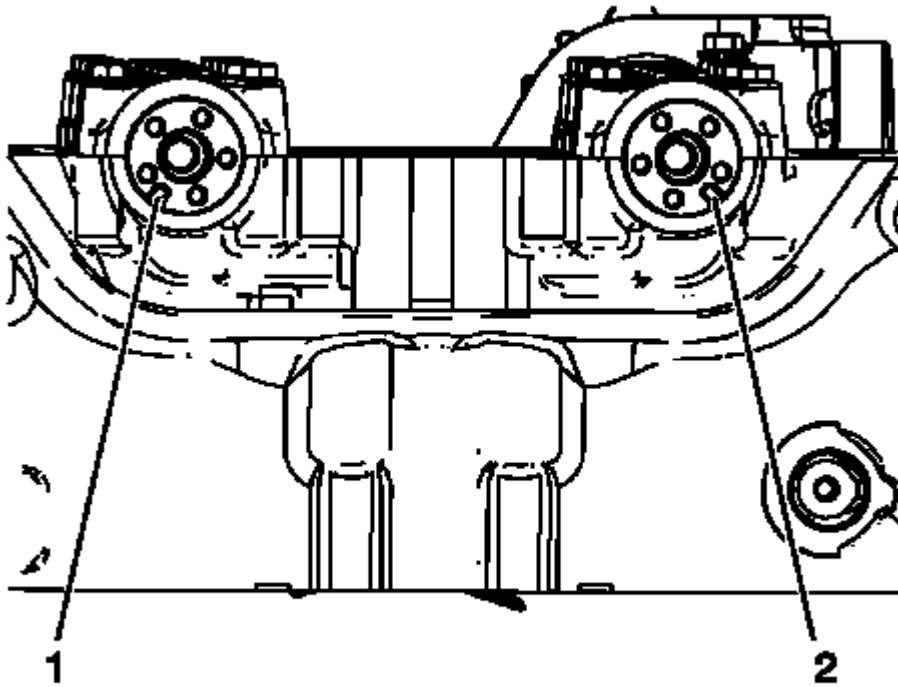


Fig. 147: Identifying Proper Exhaust/Intake Camshaft Alignment positions
Courtesy of GENERAL MOTORS COMPANY

NOTE: If equipped with the following engine; LE5, LE9, LAT, LNF, LDK, LHU, LTD, LBN, or 2010 LAF, ensure the intake camshaft notch is in the 5 o'clock position and the exhaust camshaft notch is in the 7 o'clock position.

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

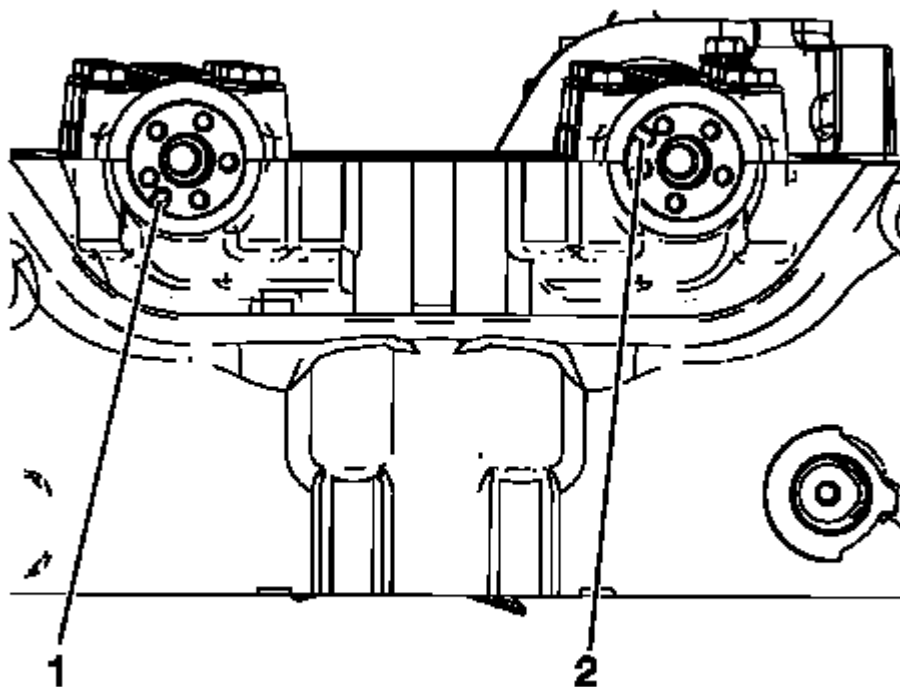


Fig. 148: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

NOTE: If equipped with following engine; LAP, LE8, LEA, LUK, or 2011 LAF and beyond ensure the intake camshaft notch is in the 10 o'clock position and the exhaust camshaft notch is in the 7 o'clock position.

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

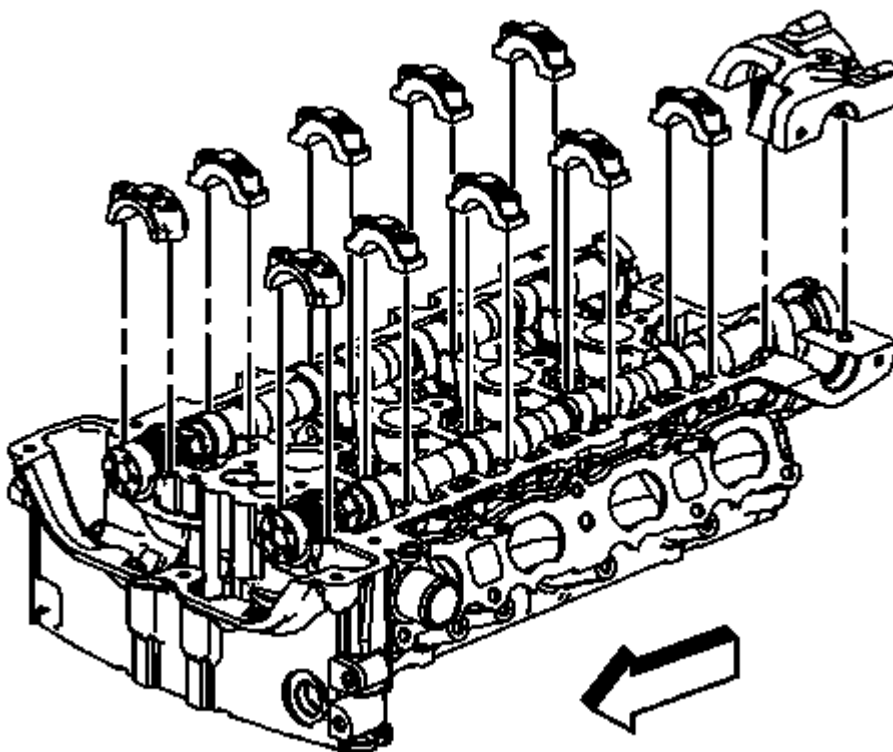
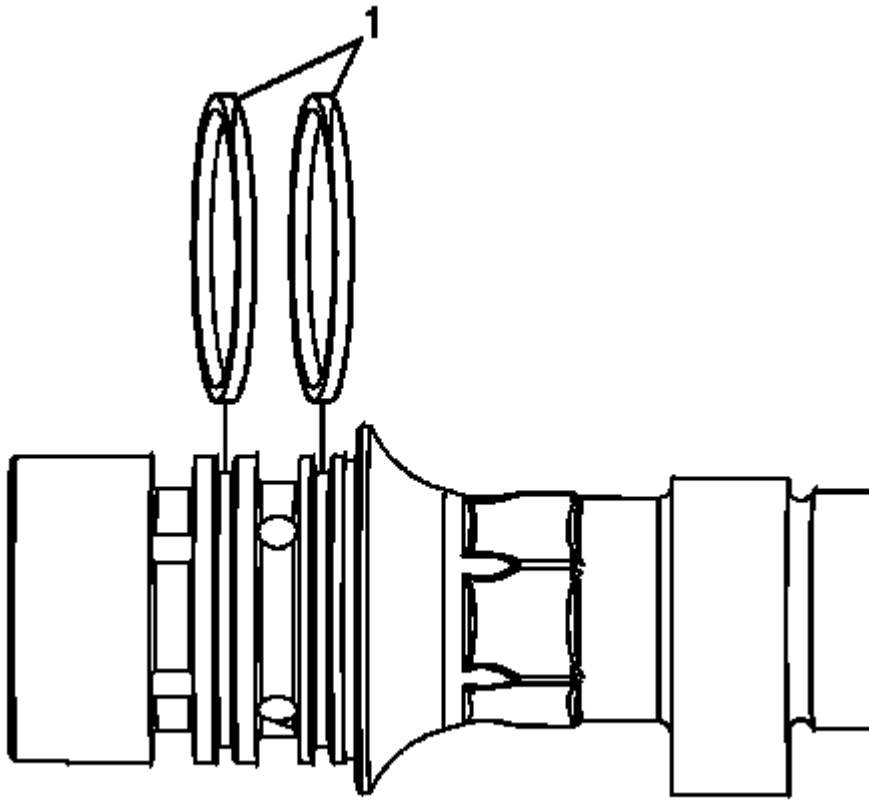


Fig. 149: Intake Camshaft & Caps

Courtesy of GENERAL MOTORS COMPANY

7. Set the intake camshaft on top of the roller followers in the camshaft bearing journals and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

**Fig. 150: Oil Seals****Courtesy of GENERAL MOTORS COMPANY**

8. Rotate the oil seal in the groove of the number one camshaft journal so the split line (1) is at approximately the 12:00 position before installing the camshaft caps.

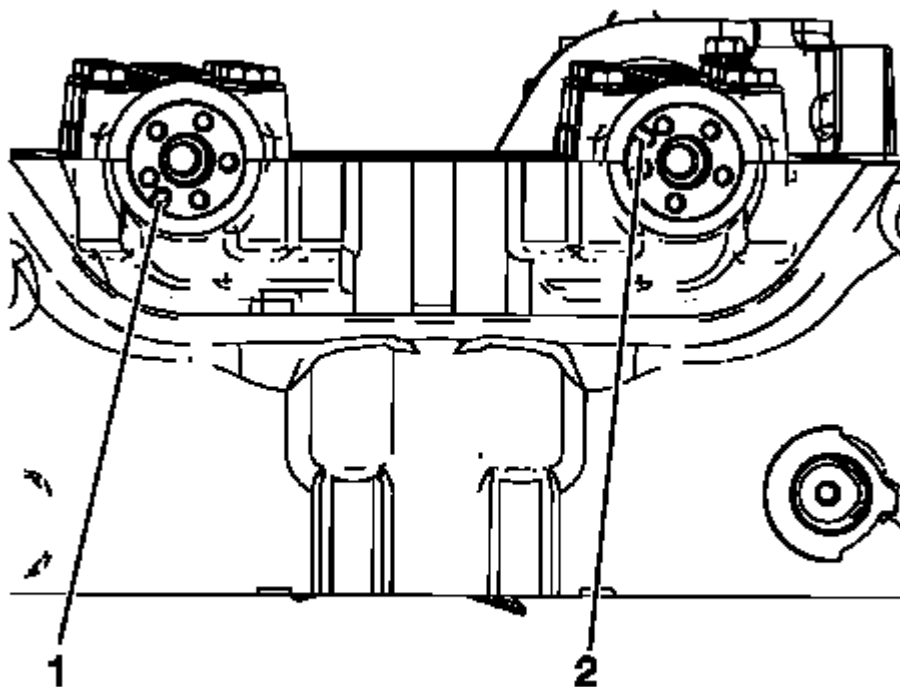
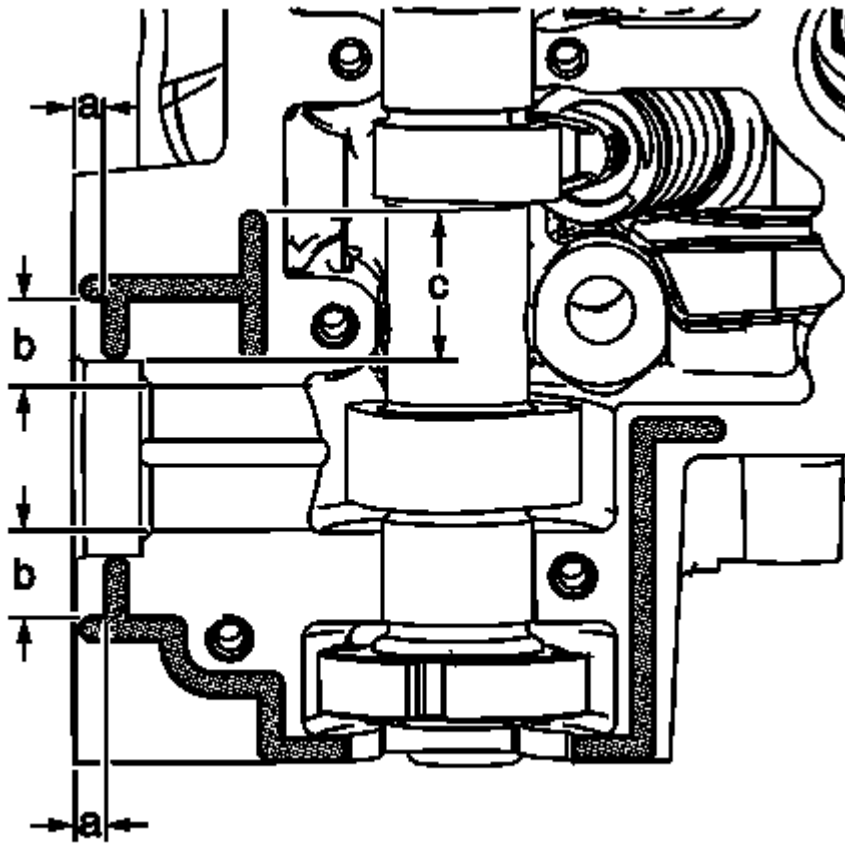


Fig. 151: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

NOTE: The number 1 cylinder must be at top dead center (TDC), crankshaft keyway at the 12 o'clock position.

9. Install the intake camshaft with the notch on the front at approximately the 10 o'clock position (2).
10. Install the camshaft caps and hand start the camshaft cap bolts.
11. Tighten the camshaft cap bolts in increments of 3 turns until they are seated. Tighten the camshaft caps to 10 N.m (89 lb in).

**Fig. 152: Sealer Application Areas**

Courtesy of GENERAL MOTORS COMPANY

NOTE: It is critical during installation to ensure the bearing rear cap and cylinder head alignment is correct and the mating surfaces are flush.

- Ensure that all sealing material has been removed from the components, and the sealing surfaces are clean and free of contamination prior to applying the sealer.
- Install and align the rear cap within 20 minutes of applying the sealer.

NOTE: Apply the sealer to all locations centrally locating the bead on the rail.

- Run bead to 5.0 mm, dimension a, as shown.
- Where the cap ends on the perimeter rail, extend bead approximately 4.0 mm beyond edge of cap.
- Run bead, dimension c, 32 mm from the edge of the cylinder head as shown.
- Run beads, dimension b, 20 mm from edge of cylinder head as shown.

12. Apply a 2.5 mm bead of sealer to the cylinder head at the number 6 intake camshaft rear cap mating surface. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
13. Install the number 6 intake camshaft rear cap.
 1. Tighten the cap bolts evenly to 5 N.m (44 lb in).
 2. Tighten the cap bolts evenly to 10 N.m (89 lb in).
 3. Back the cap bolts out 120 degrees.
 4. Tighten the cap bolts evenly a final pass to 10 N.m (89 lb in).

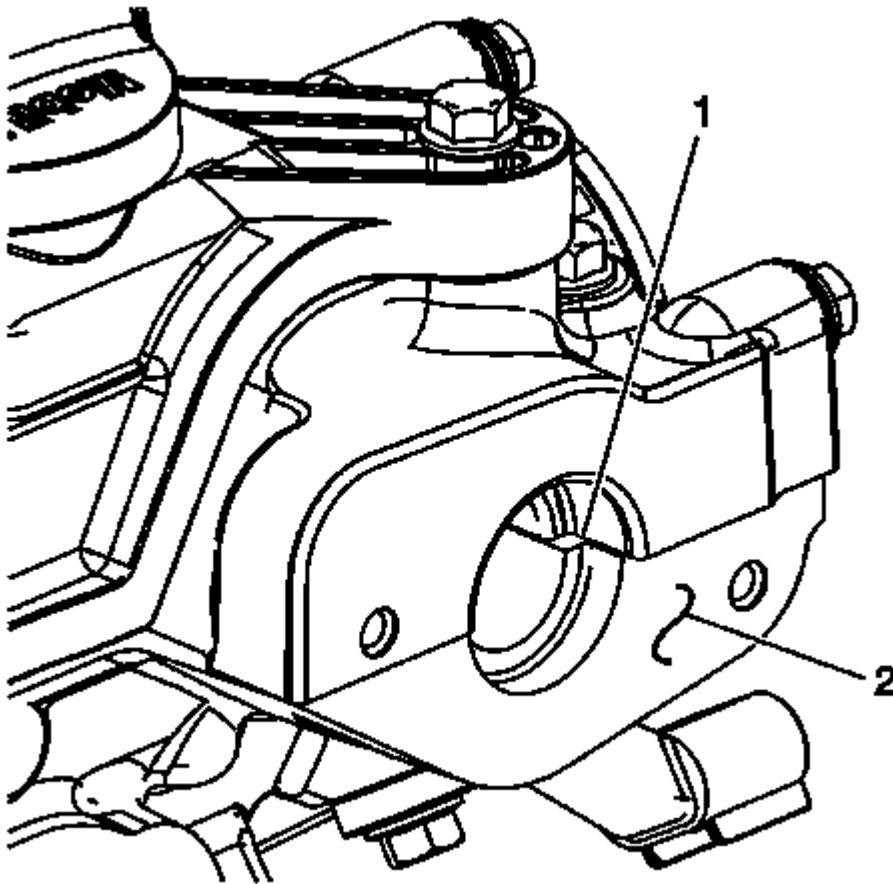


Fig. 153: Identifying Fuel Pump Roller Lifter Orifice
Courtesy of GENERAL MOTORS COMPANY

14. Remove all excess sealing material from the fuel pump roller lifter bore (1), and ensure the bore is free of debris. Do not allow any excess sealing material to remain within the cylinder head or on any sealing surface.
15. Remove all excess sealing material from the fuel pump assembly sealing surface (2).
16. Install the fuel pump. Refer to **Fuel Pump Replacement**.

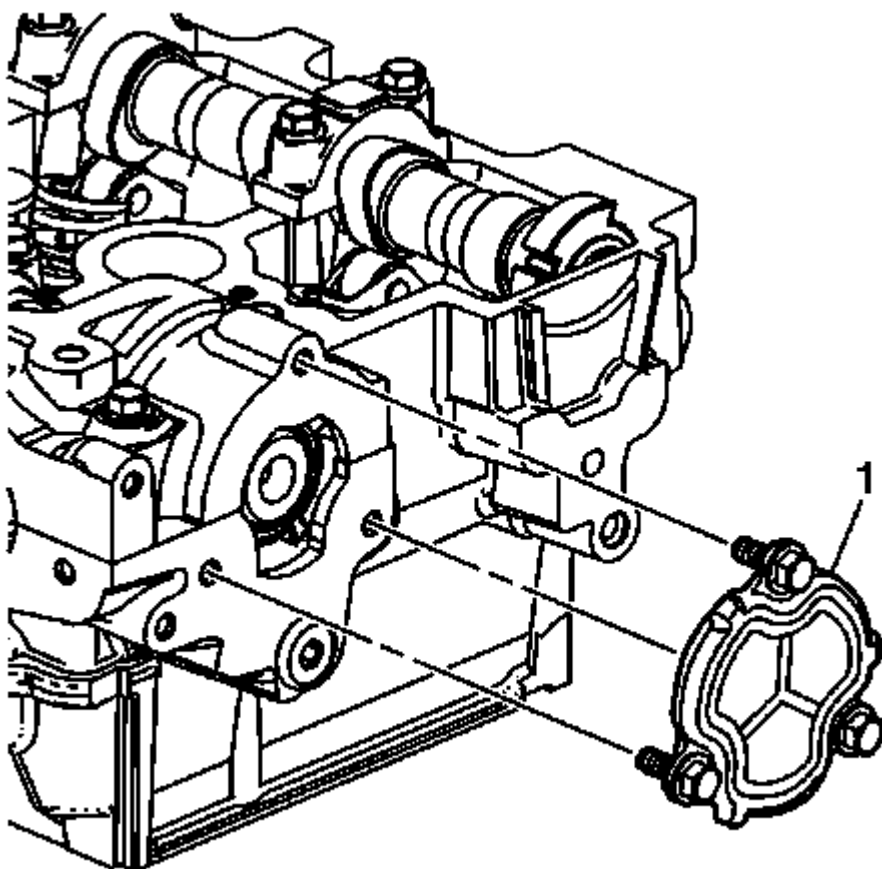


Fig. 154: Rear Cylinder Head Cover Plate

Courtesy of GENERAL MOTORS COMPANY

17. Verify the seal on the cylinder head cover plate (1) is intact and in good condition.
18. Ensure that the opening plate sealing surface is clean and free of excess sealing material. Install the rear cylinder head opening plate (1) and tighten the bolts to 10 N.m (89 lb in).

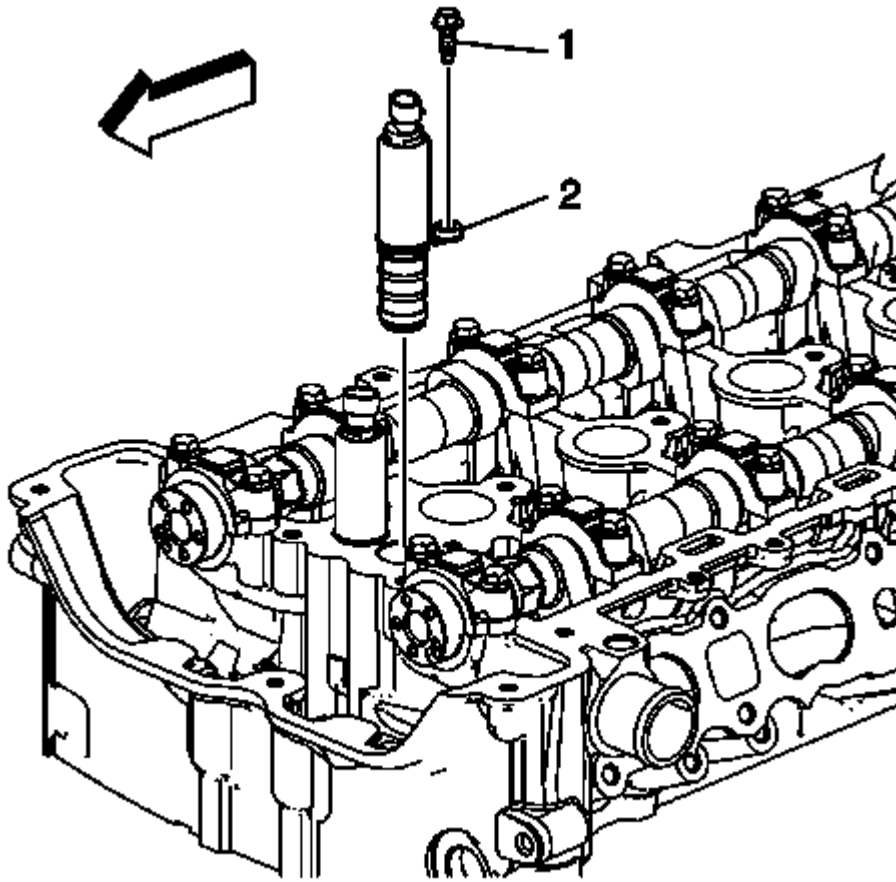


Fig. 155: Intake Camshaft Position Actuator Solenoid Valve & Bolt
Courtesy of GENERAL MOTORS COMPANY

19. Install the intake camshaft position actuator solenoid valve (2). Tighten the solenoid valve bolt (1) to 10 N.m (89 lb in).
20. Install the intake camshaft position actuator. Refer **Camshaft Position Intake Actuator Replacement**.

EXHAUST CAMSHAFT AND VALVE LIFTER REPLACEMENT

Removal Procedure

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

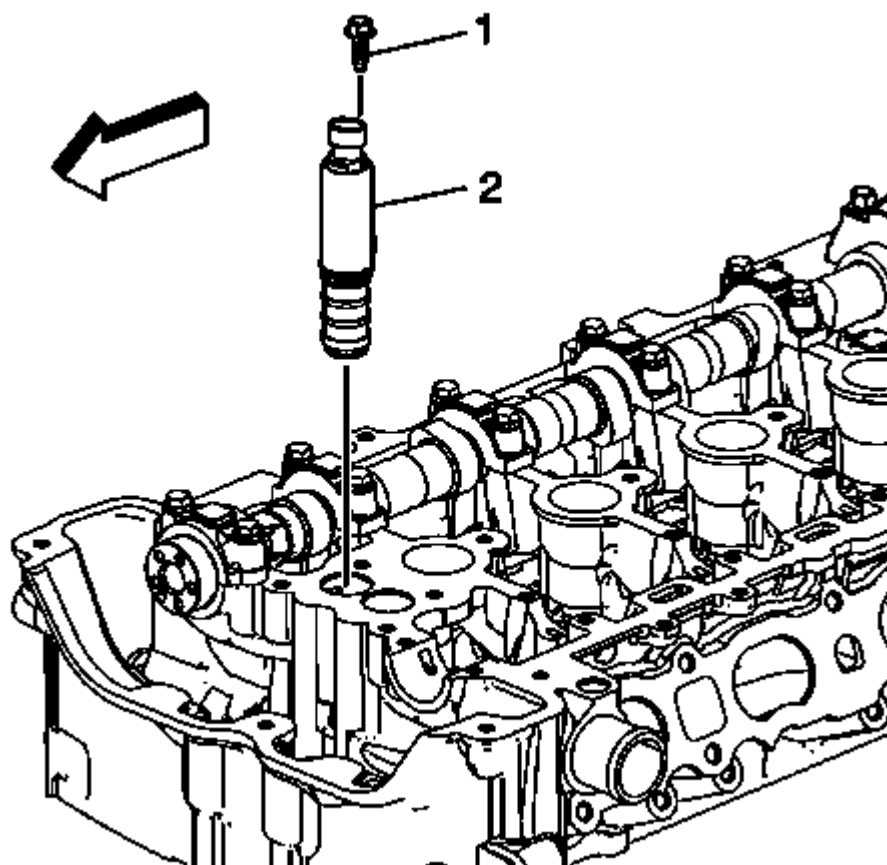


Fig. 156: Exhaust Camshaft Position Actuator Solenoid Valve & Bolt
 Courtesy of GENERAL MOTORS COMPANY

2. Remove the exhaust camshaft position actuator solenoid valve bolt (1) and valve (2).

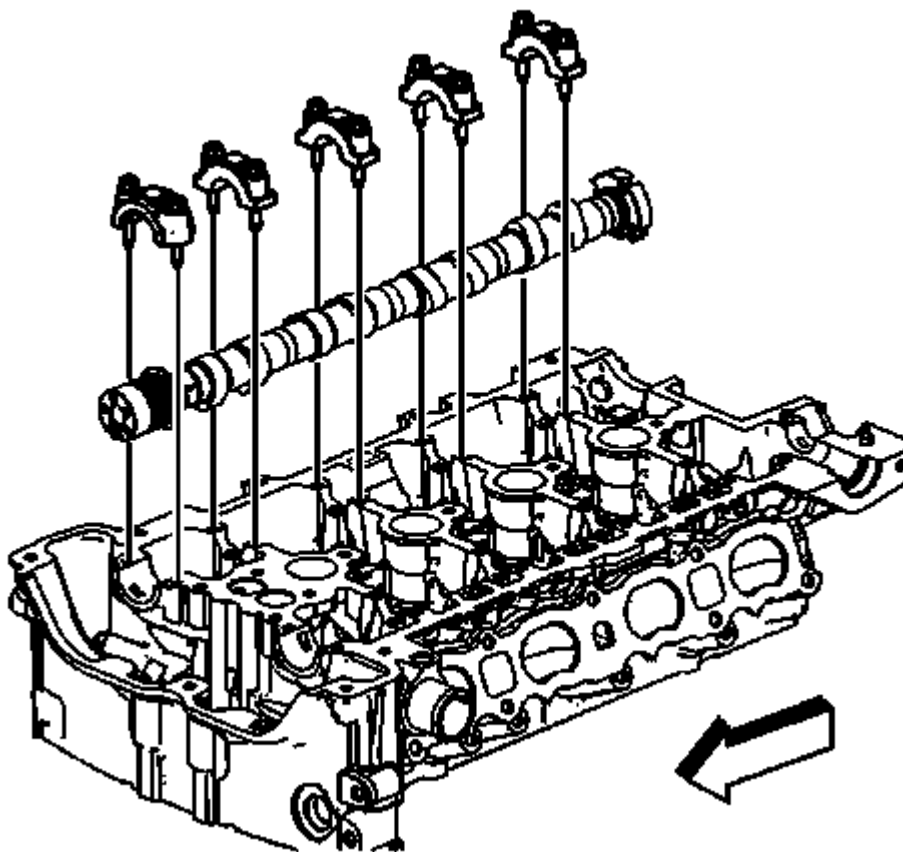


Fig. 157: Exhaust Camshaft & Caps

Courtesy of GENERAL MOTORS COMPANY

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

3. Mark camshaft caps to ensure they are installed in the same position.
4. Remove the exhaust camshaft cap bolts.
5. Remove the camshaft caps ensuring they are marked and refitted in same position on assembly.
6. Remove the exhaust camshaft.

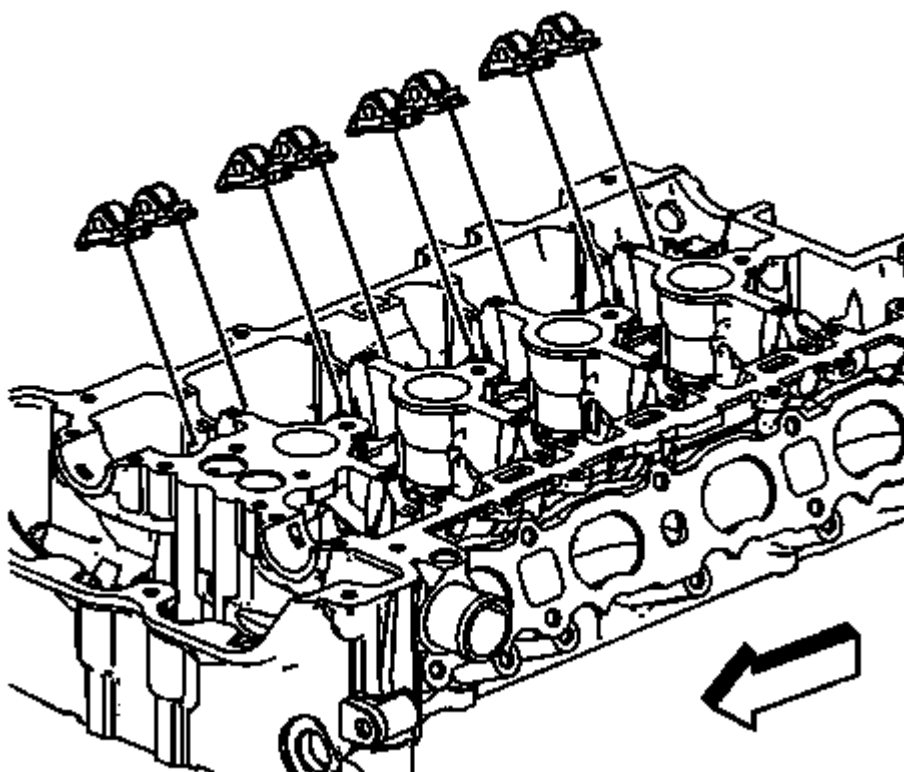


Fig. 158: Exhaust Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

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

7. Remove the exhaust camshaft roller finger followers.

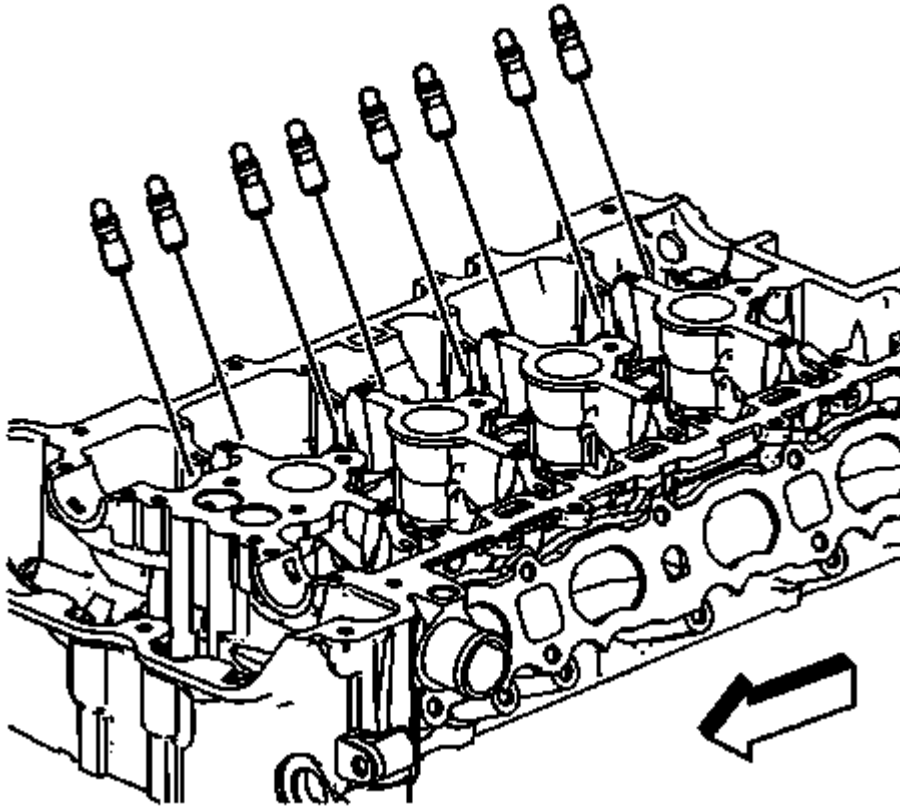


Fig. 159: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

8. Remove the hydraulic lash adjusters.

Installation Procedure

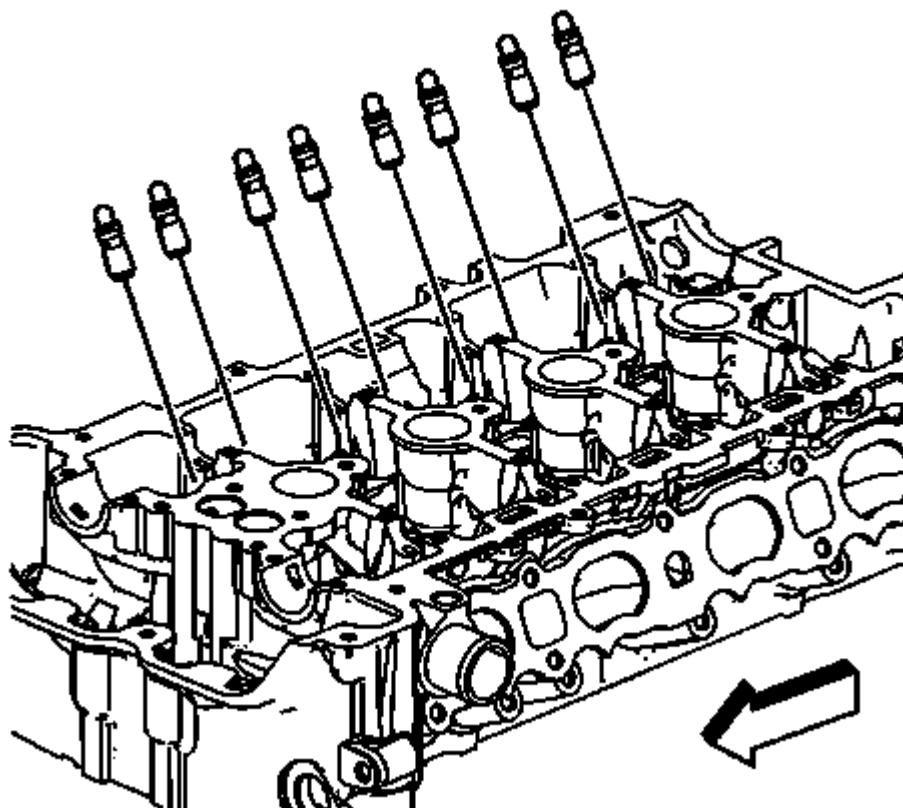


Fig. 160: Hydraulic Lash Adjusters

Courtesy of GENERAL MOTORS COMPANY

1. Install the hydraulic lash adjusters into their bores in the cylinder head and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

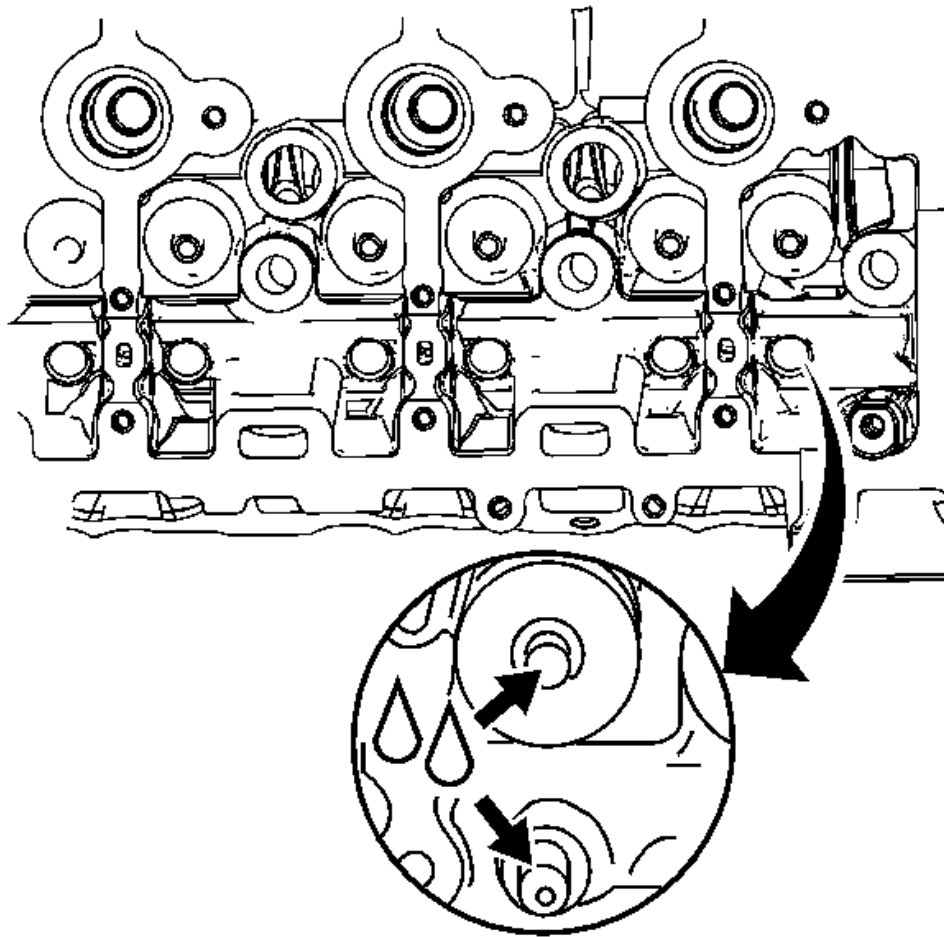


Fig. 161: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

2. Lubricate the valve tips. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) .

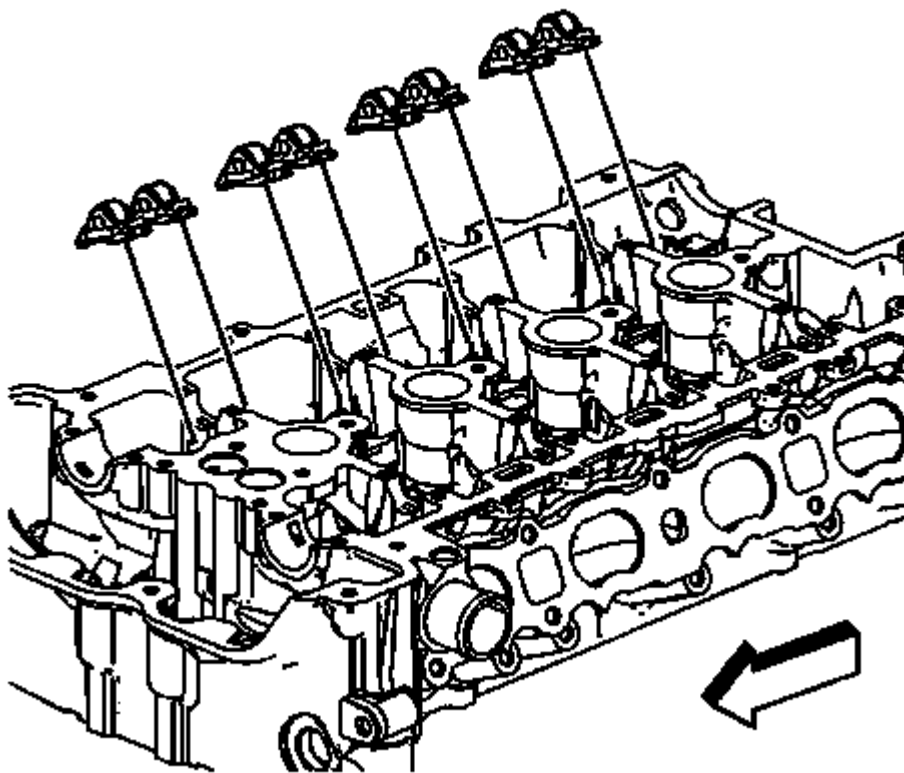


Fig. 162: Exhaust Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

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

3. Position the roller followers on the tip of the valve stem and on the lash adjuster and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

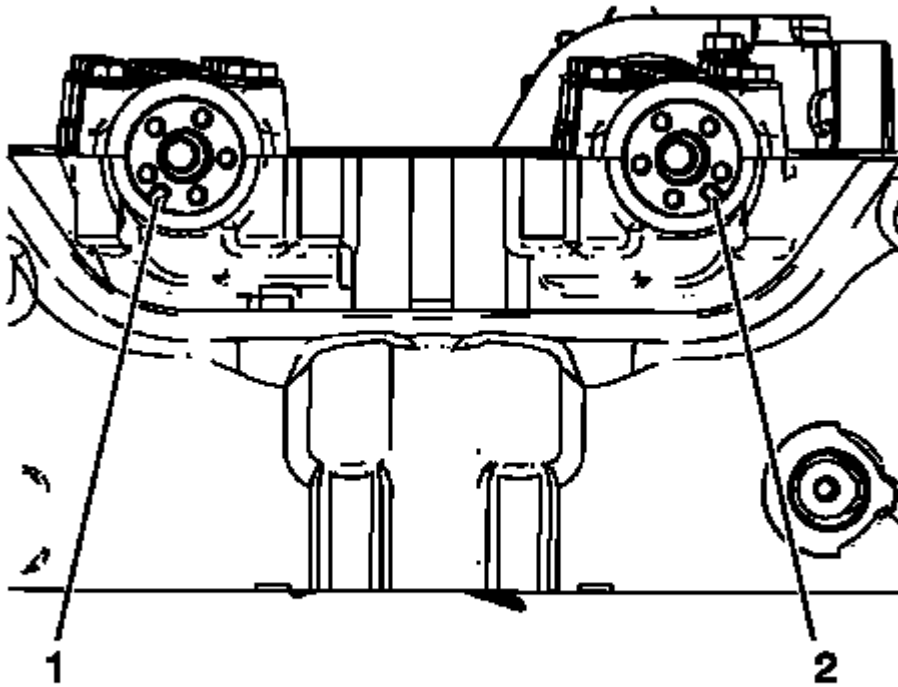


Fig. 163: Identifying Proper Exhaust/Intake Camshaft Alignment positions
Courtesy of GENERAL MOTORS COMPANY

NOTE: If equipped with the following engine; LE5, LE9, LAT, LNF, LDK, LHU, LTD, LBN, or 2010 LAF, ensure the intake camshaft notch is in the 5 o'clock position and the exhaust camshaft notch is in the 7 o'clock position.

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

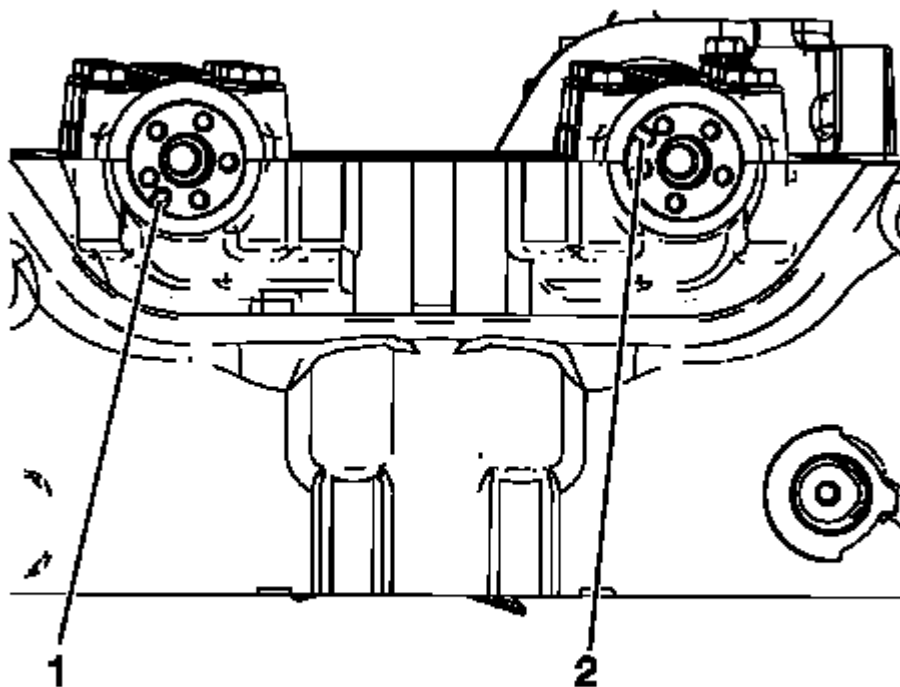


Fig. 164: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

NOTE: If equipped with following engine; LAP, LE8, LEA, LUK. or 2011 LAF and beyond, ensure the intake camshaft notch is in the 10 o'clock position and the exhaust camshaft notch is in the 7 o'clock position.

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

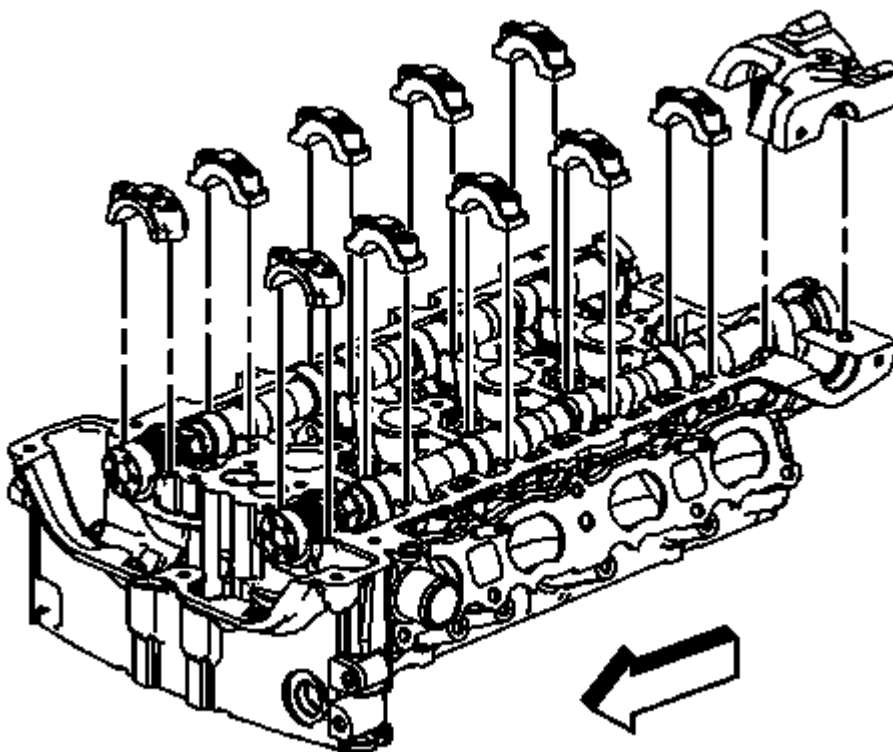
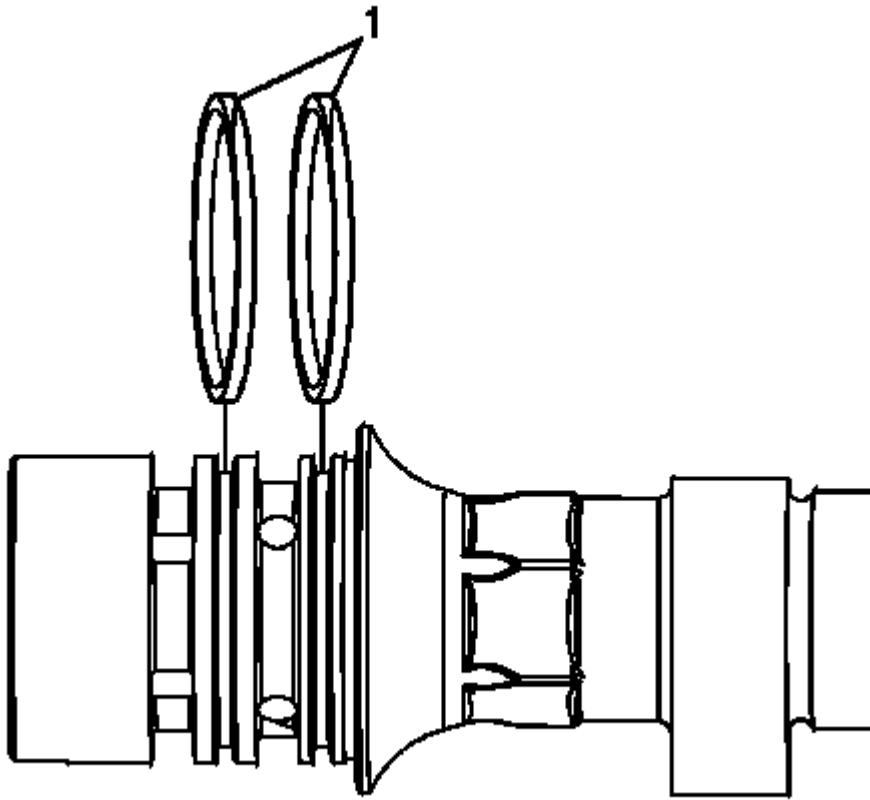


Fig. 165: Intake Camshaft & Caps

Courtesy of GENERAL MOTORS COMPANY

6. Set the exhaust camshaft on top of the roller followers in the camshaft bearing journals and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

**Fig. 166: Oil Seals****Courtesy of GENERAL MOTORS COMPANY**

7. Rotate the oil seal in the groove of the number one camshaft journal so the split line (1) is at approximately the 12:00 position before installing the camshaft caps.

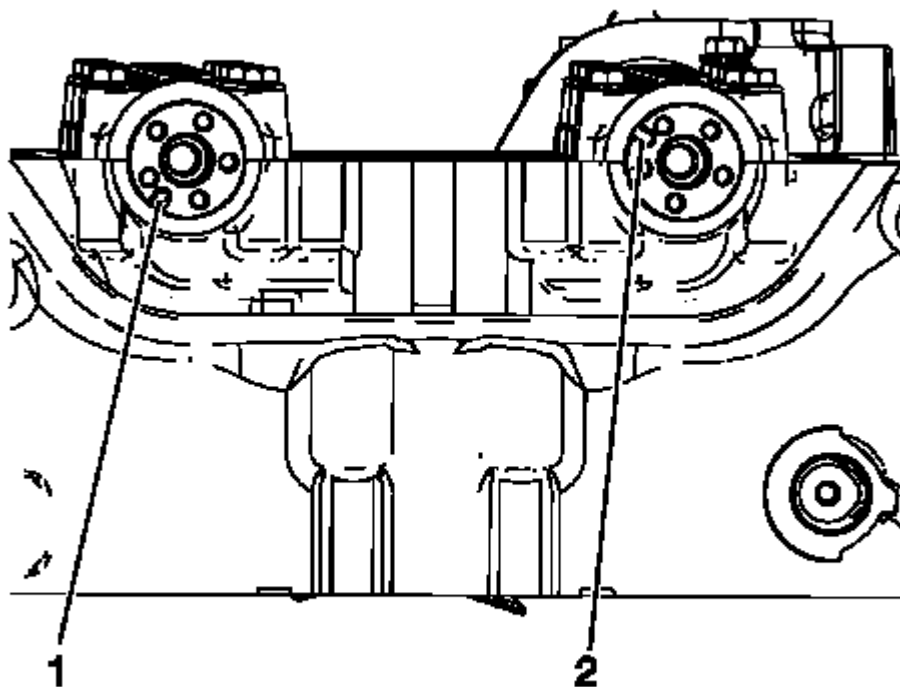


Fig. 167: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

8. Install the exhaust camshaft with the notch on the front (1) at approximately the 7 o'clock position.
9. Install the camshaft caps and hand start the camshaft cap bolts.

CAUTION: Refer to Fastener Caution .

10. Tighten the camshaft cap bolts in increments of 3 turns until they are seated. Tighten the camshaft caps to 10 N.m (89 lb in).

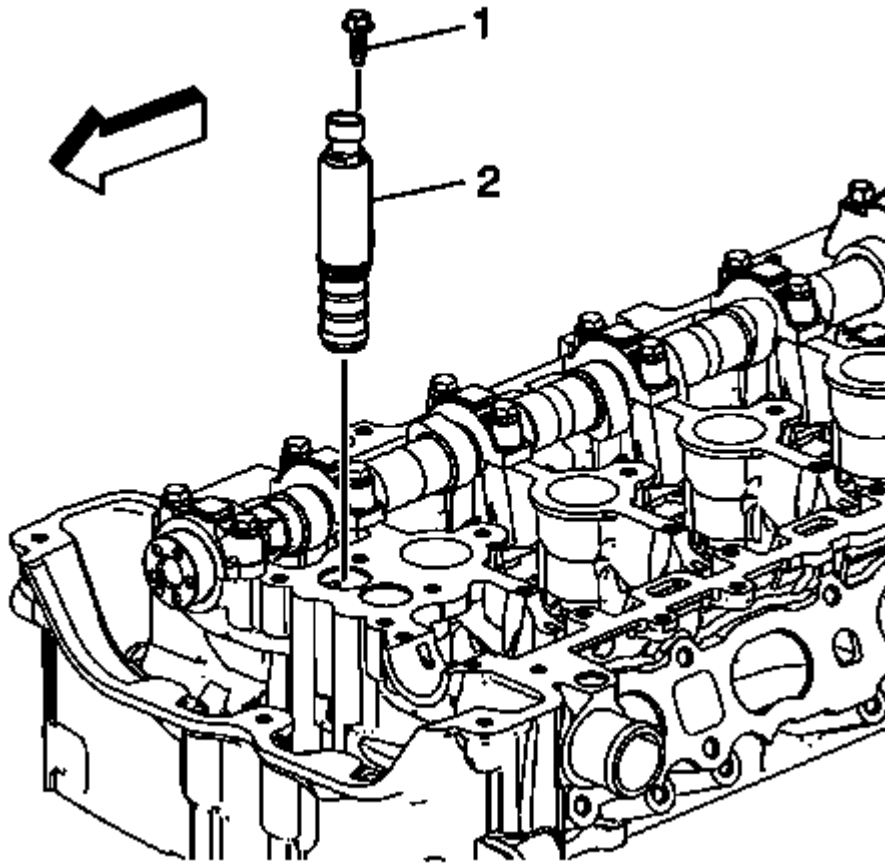


Fig. 168: Exhaust Camshaft Position Actuator Solenoid Valve & Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Install the exhaust camshaft position actuator solenoid valve (2). Tighten the solenoid valve bolt (1) to 10 N.m (89 lb in).
12. Install the exhaust camshaft position actuator. Refer to **Camshaft Position Exhaust Actuator Replacement**.

CAMSHAFT POSITION INTAKE ACTUATOR REPLACEMENT

Special Tools

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

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

Removal Procedure

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement (LUK)**.

2. Remove the spark plugs. Refer to **Spark Plug Replacement** .

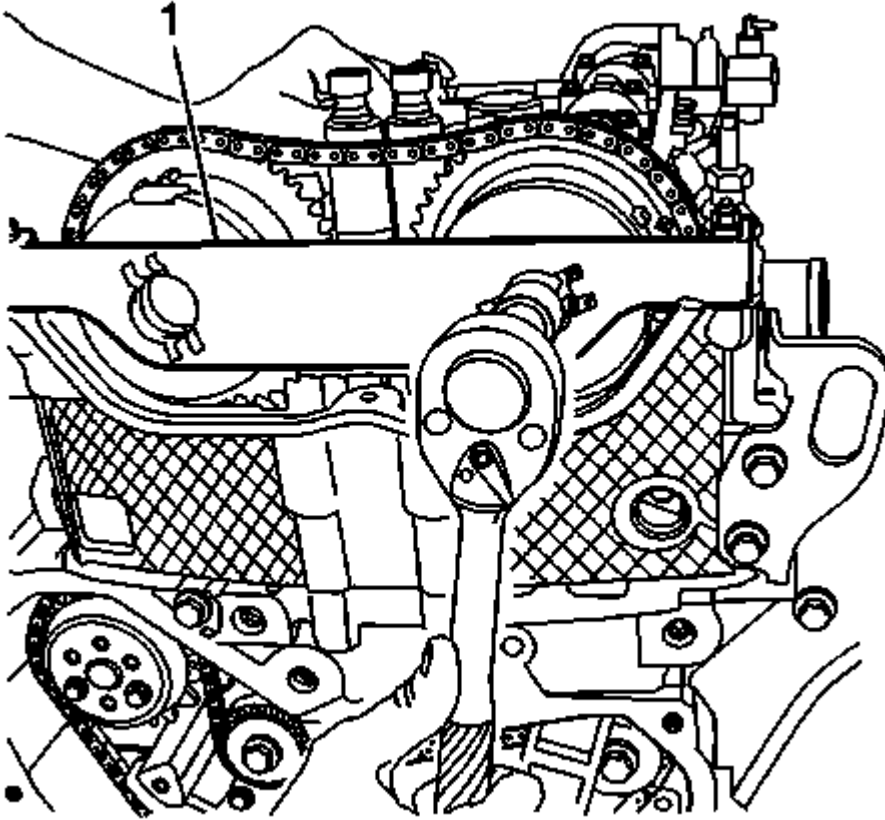


Fig. 169: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Rotate the crankshaft clockwise and install the EN-48953 retention tool (1).

CAUTION: Refer to **Fastener Caution** .

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

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

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

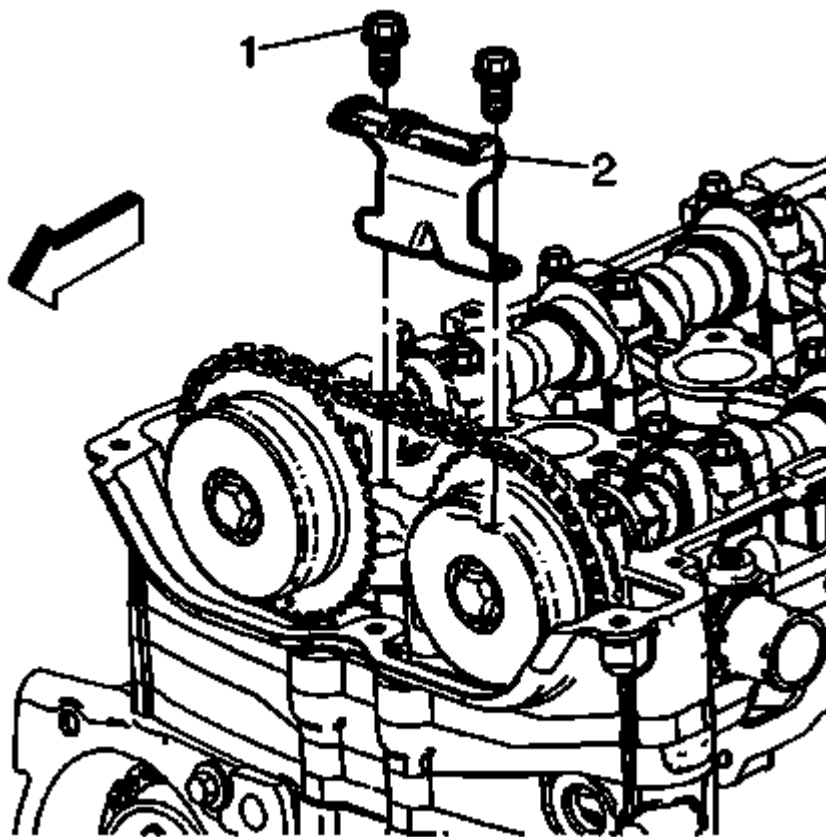


Fig. 170: Upper Timing Chain Guide

Courtesy of GENERAL MOTORS COMPANY

9. Remove the upper timing chain guide bolts (1) and guide (2).

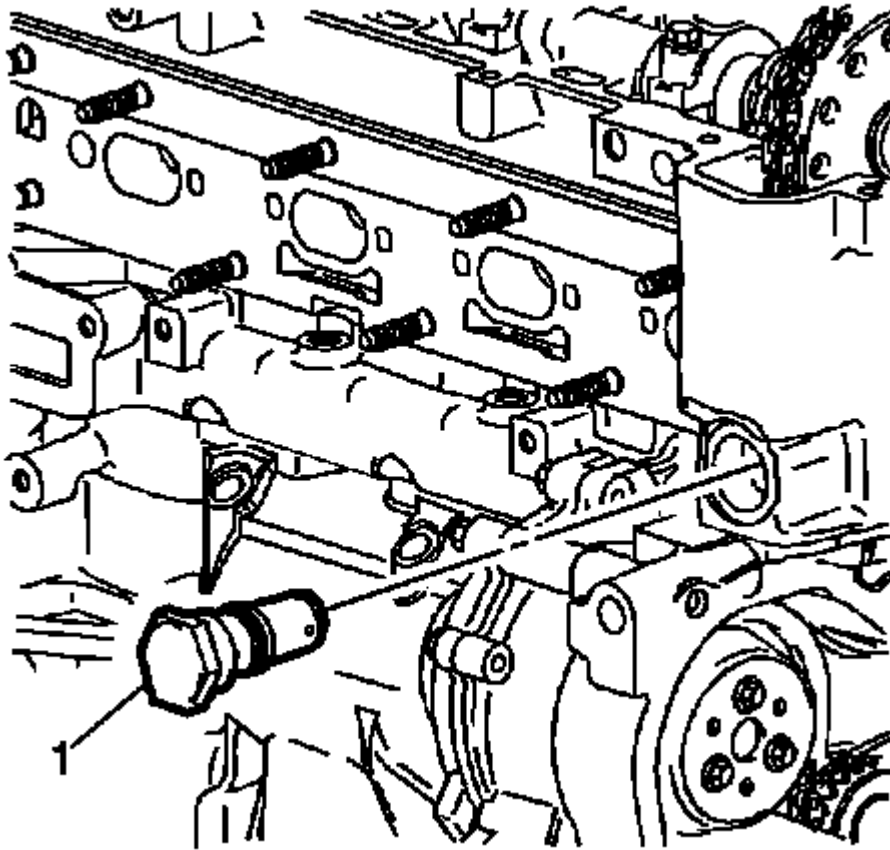


Fig. 171: Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain tensioner (1).

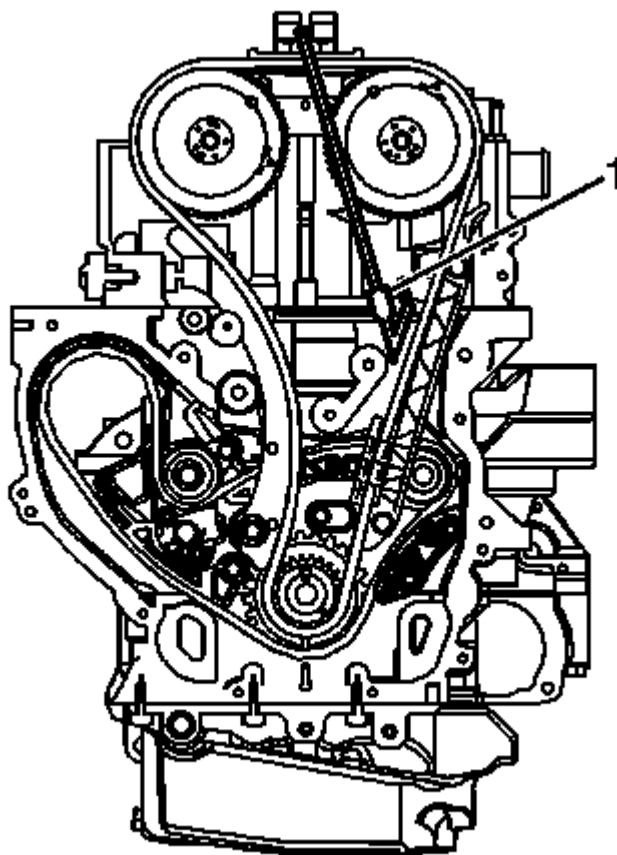


Fig. 172: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

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

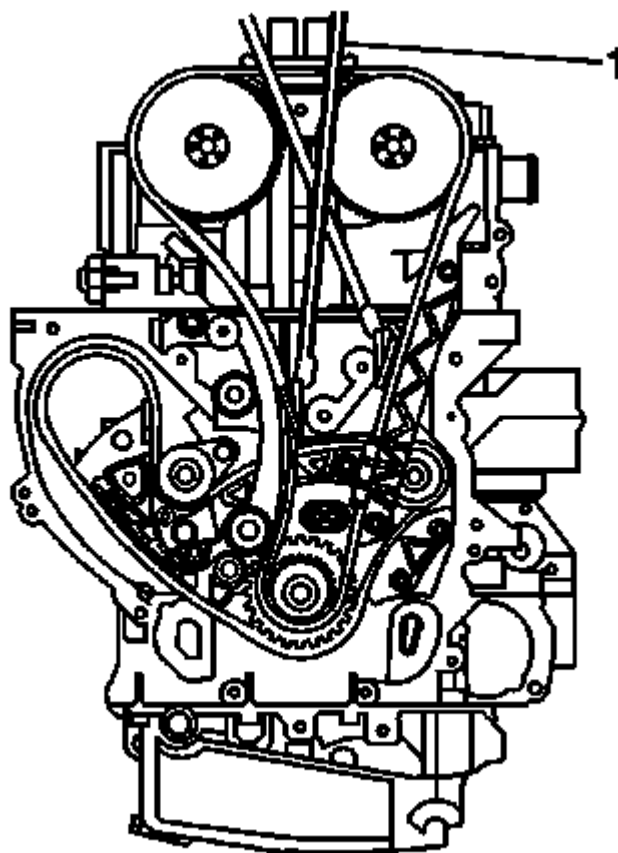


Fig. 173: Identifying Timing Chain & Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

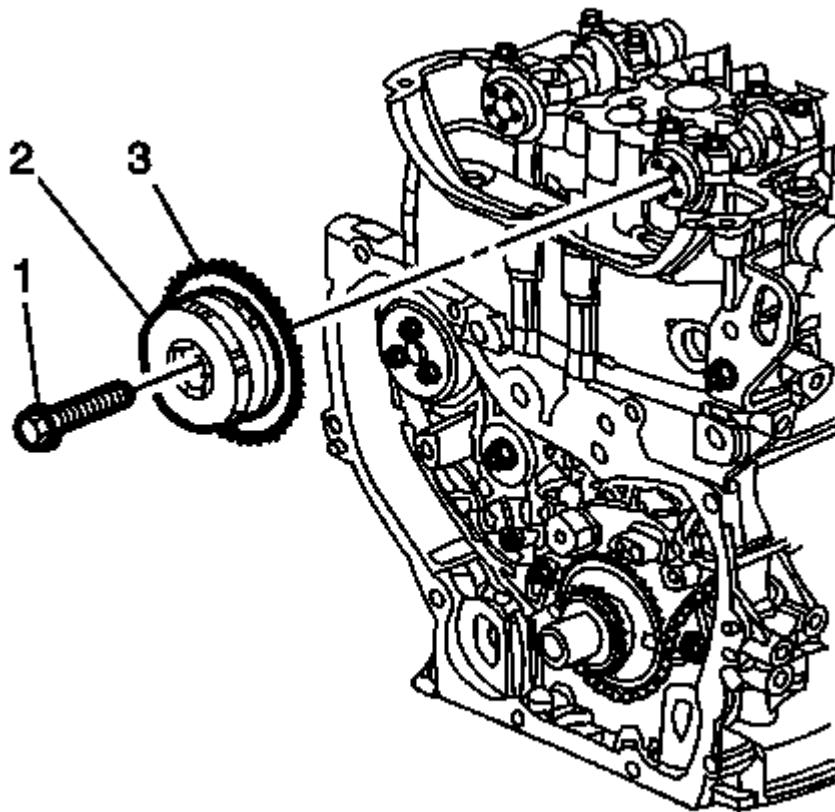


Fig. 174: Timing Chain & Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

13. Remove and discard the intake camshaft actuator bolt (1).
14. Rotate the exhaust camshaft clockwise slightly to take the tension off of the timing chain on the intake actuator.
15. Remove the intake camshaft actuator (3) from the camshaft while also removing the actuator from the timing chain.

Installation Procedure

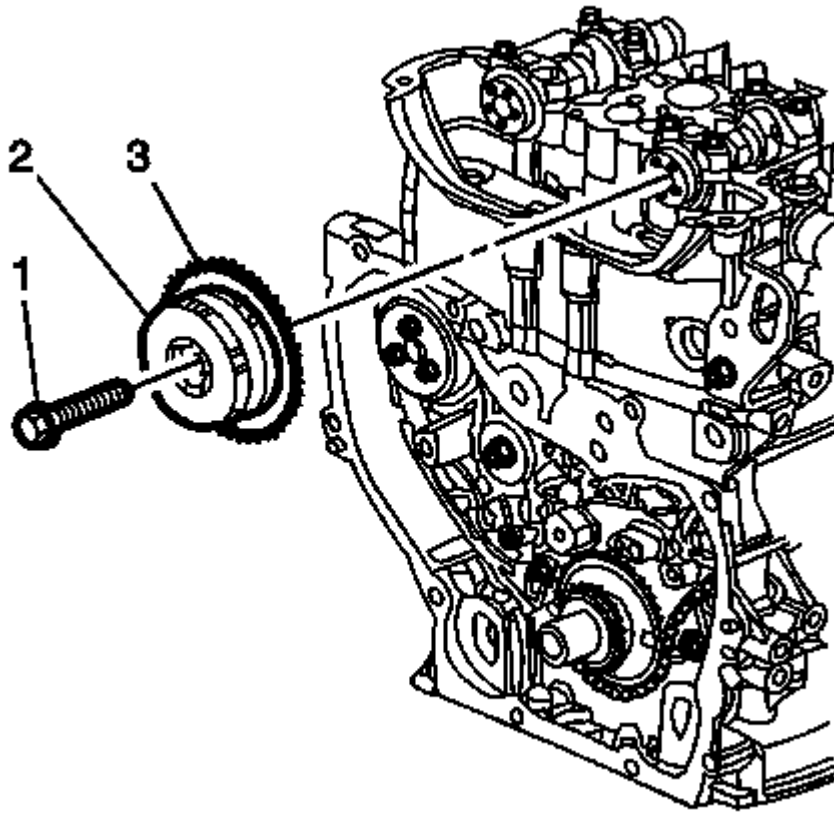


Fig. 175: Timing Chain & Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

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

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

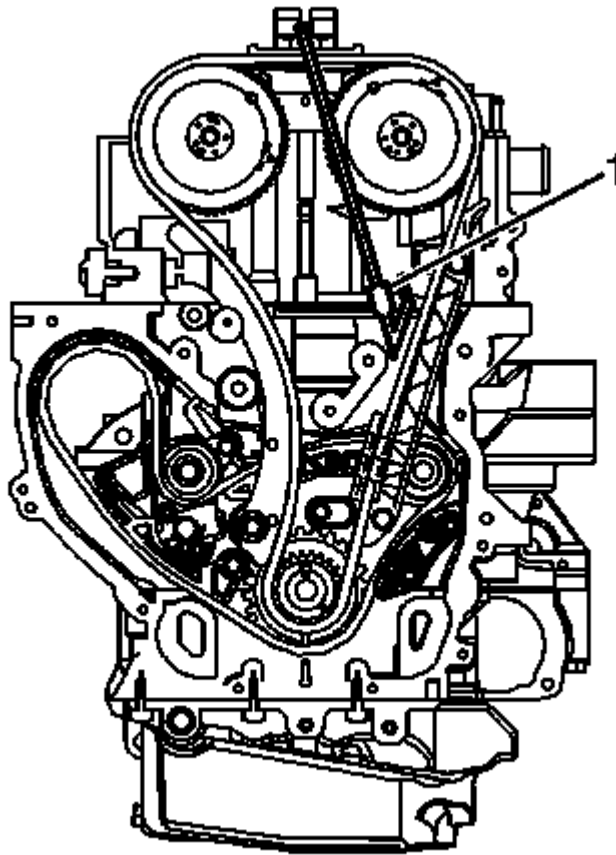


Fig. 176: View Of Timing Chain & Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

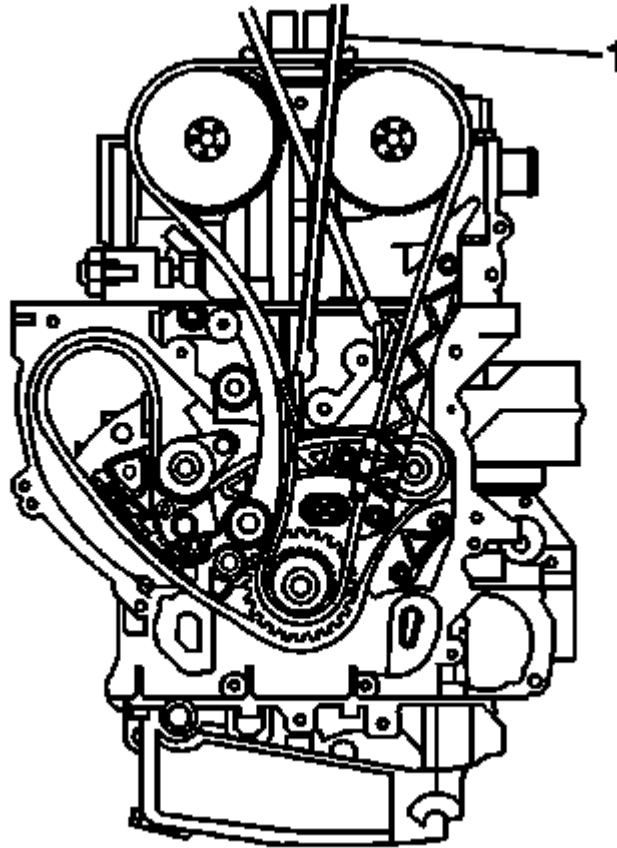


Fig. 177: Identifying Timing Chain & Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

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

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

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

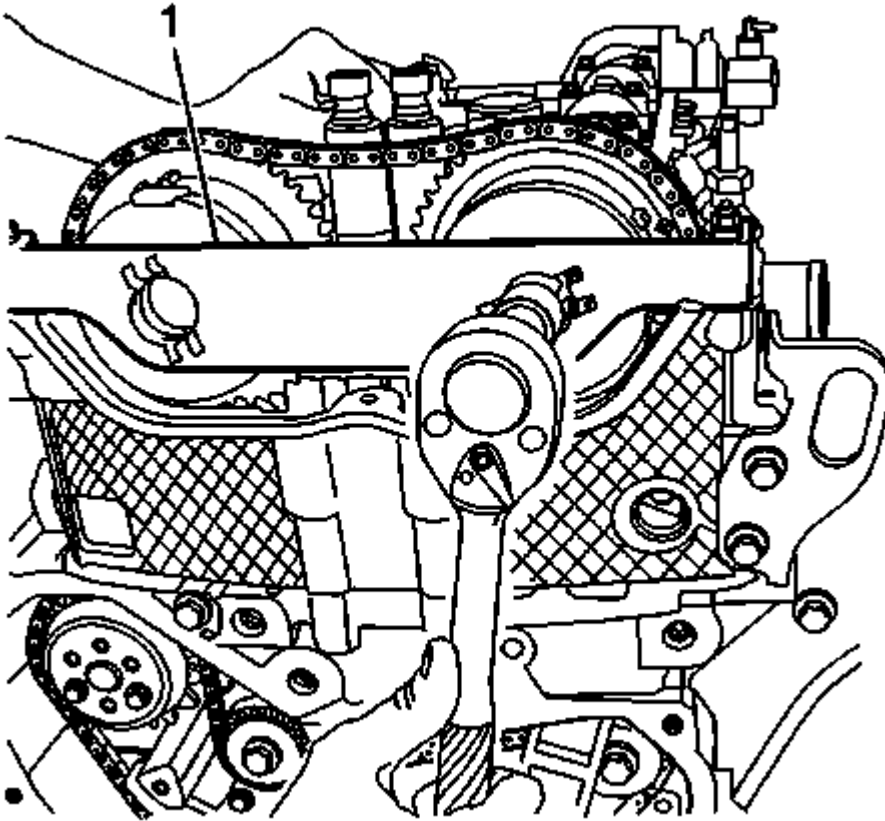


Fig. 178: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

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

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

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

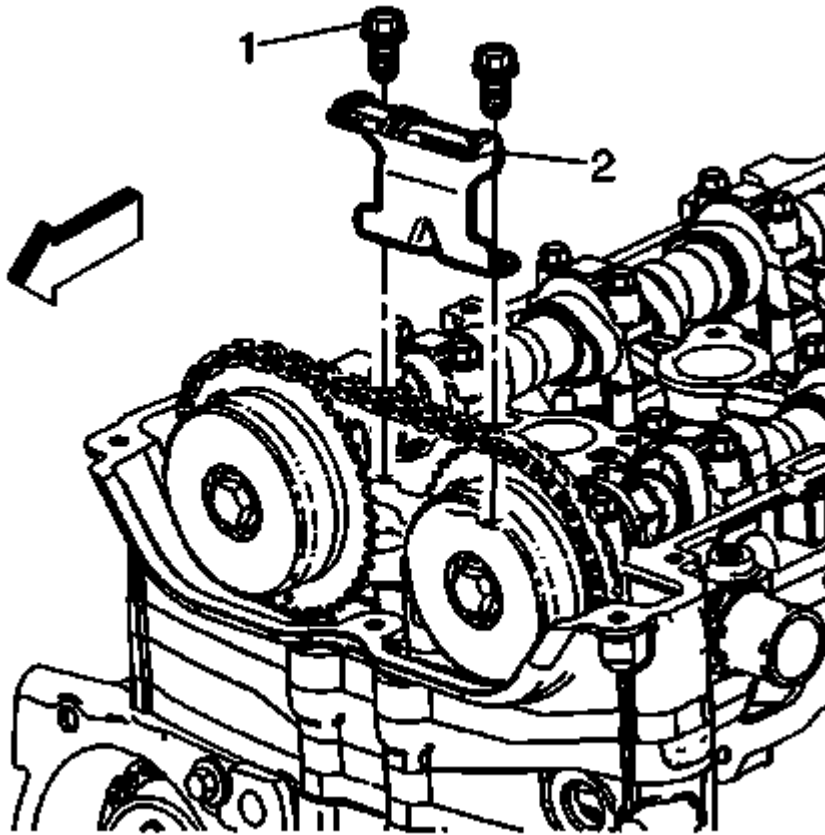


Fig. 179: Upper Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

12. Install the upper timing chain guide (2) and bolts (1) and tighten to 10 N.m (89 lb in).
13. Install the spark plugs. Refer to [Spark Plug Replacement](#) .
14. Install the camshaft cover. Refer to [Camshaft Cover Replacement \(LUK\)](#).

CAMSHAFT POSITION EXHAUST ACTUATOR REPLACEMENT

Special Tools

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

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

Removal Procedure

1. Remove the camshaft cover. Refer to [Camshaft Cover Replacement \(LUK\)](#).
2. Remove the spark plugs. Refer to [Spark Plug Replacement](#) .

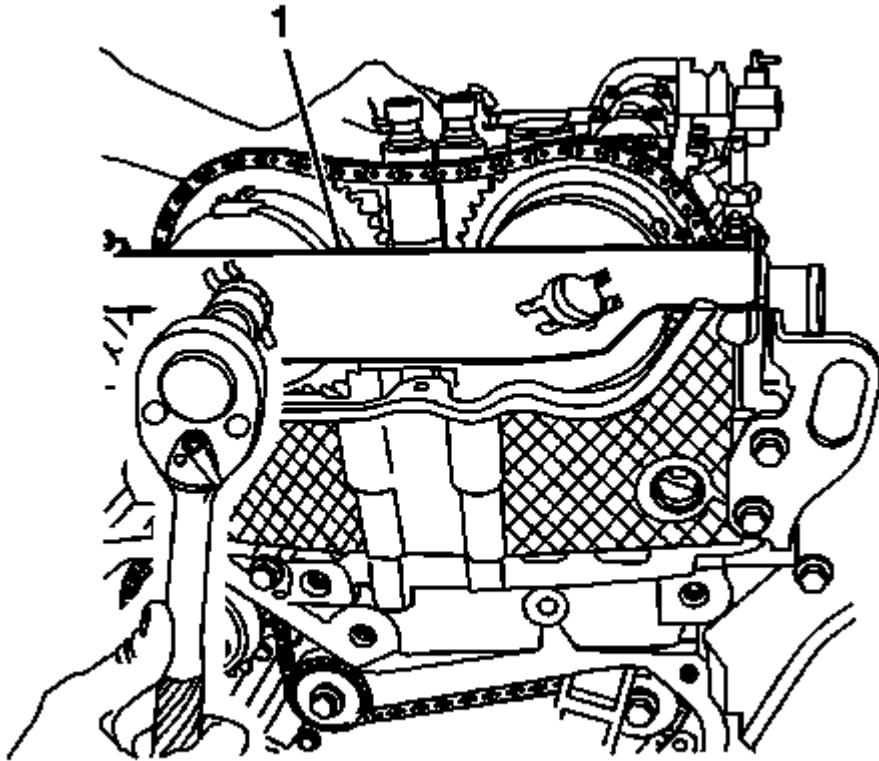


Fig. 180: View of Camshaft Actuator Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Rotate the crankshaft clockwise and install the **EN-48953** locking tool (1).

CAUTION: Refer to Fastener Caution .

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

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

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

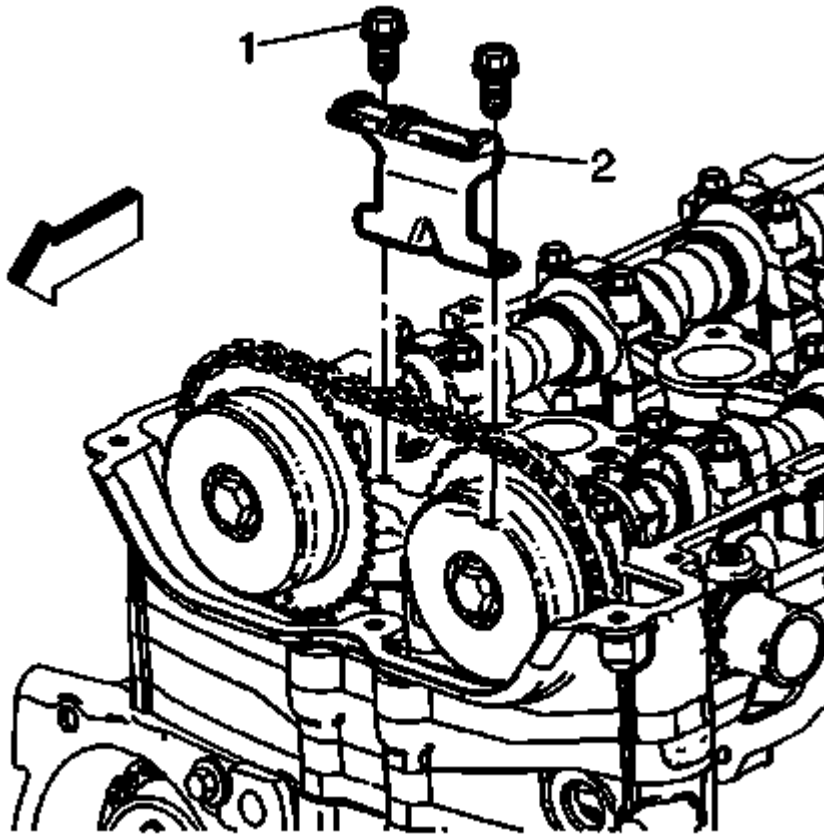


Fig. 181: Upper Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

9. Remove the upper timing chain guide bolts (1) and guide (2).

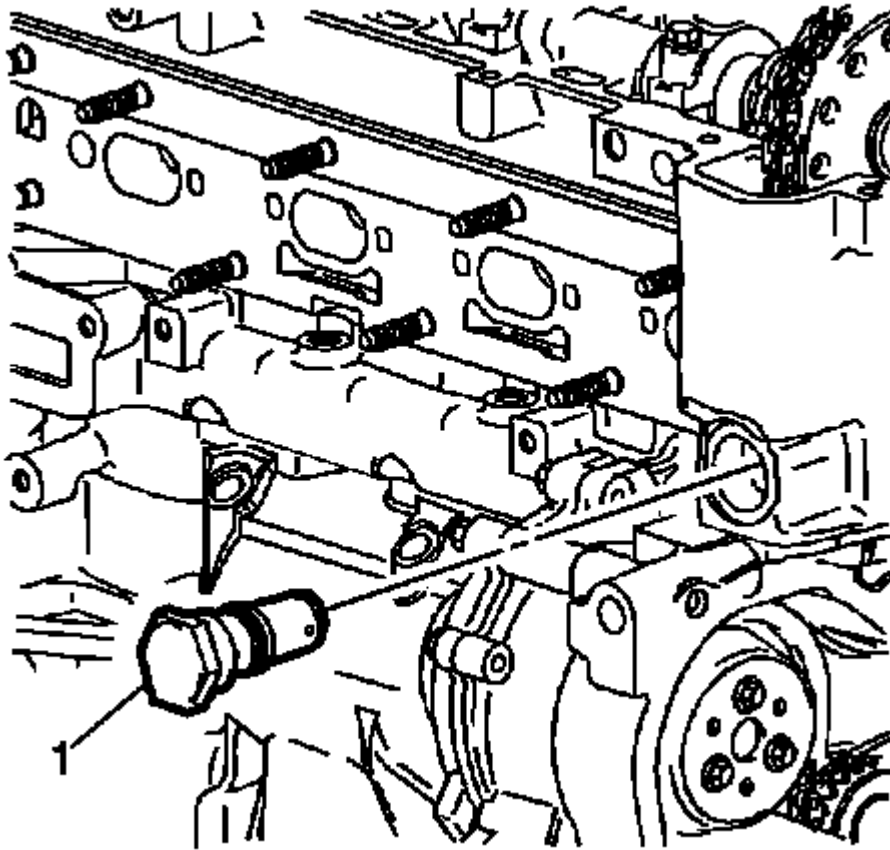


Fig. 182: Timing Chain Tensioner

Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain tensioner (1).

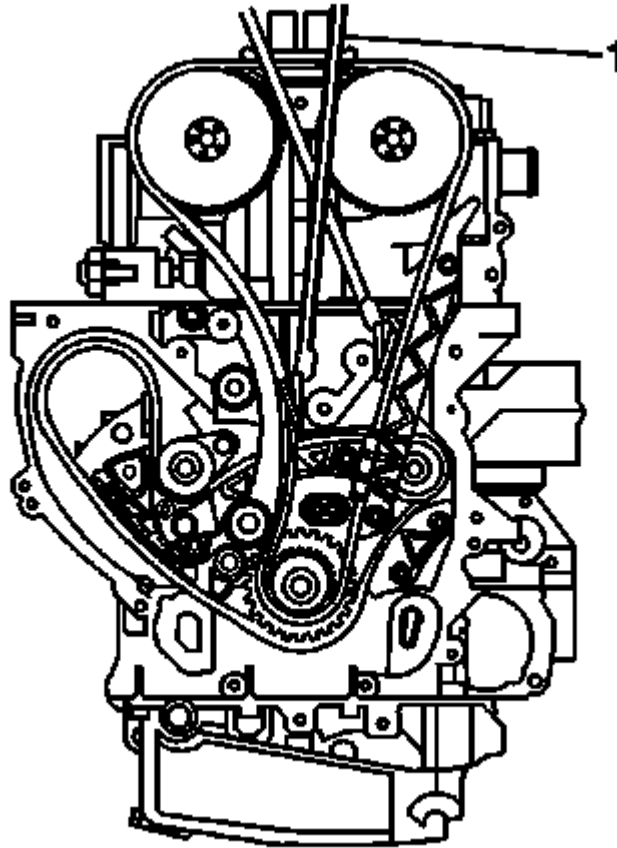


Fig. 183: Identifying Timing Chain & Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

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

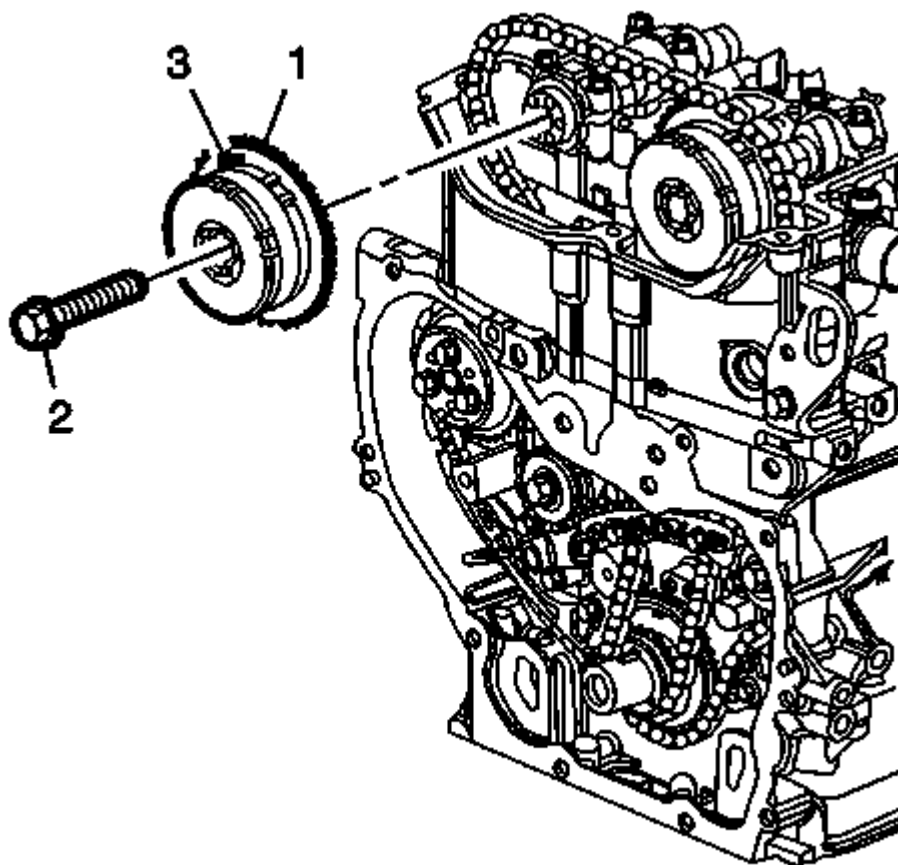


Fig. 184: Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

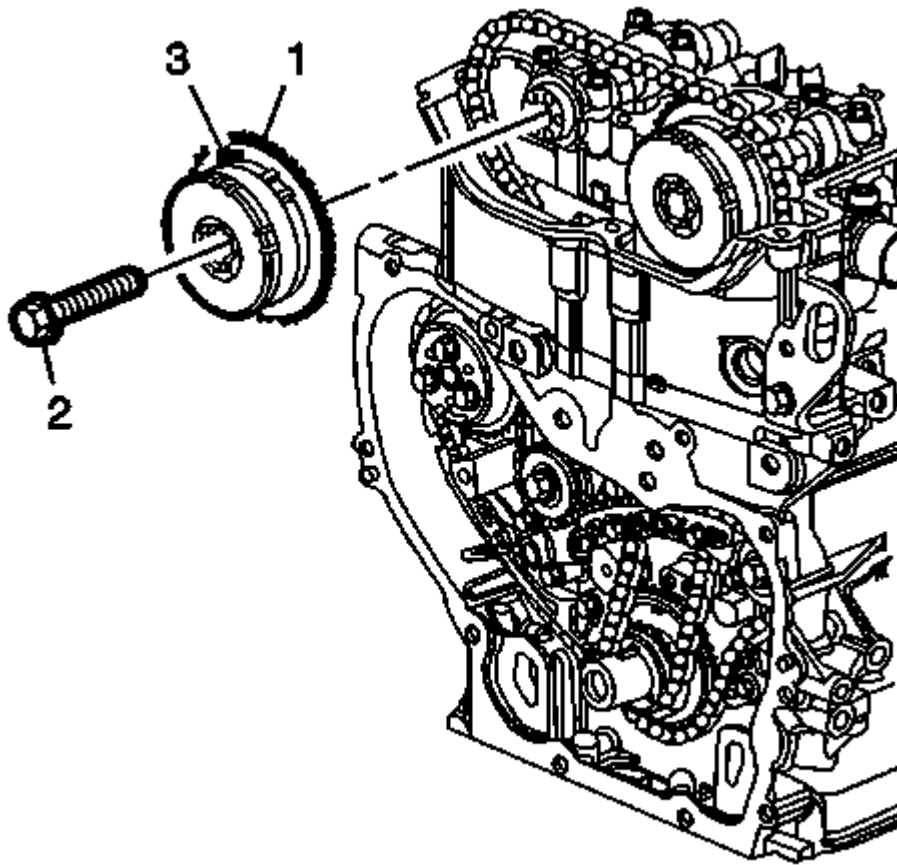


Fig. 185: Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

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

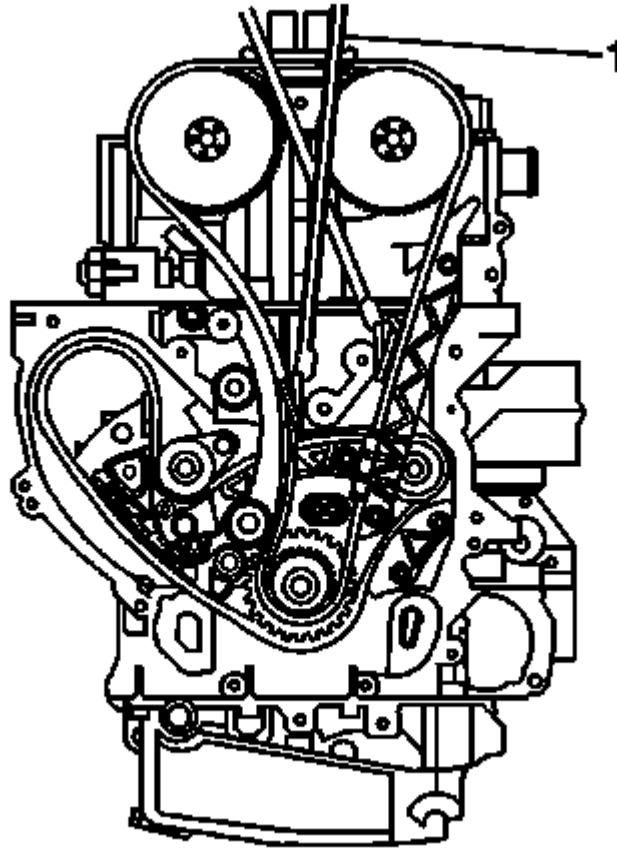


Fig. 186: Identifying Timing Chain & Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

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

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

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

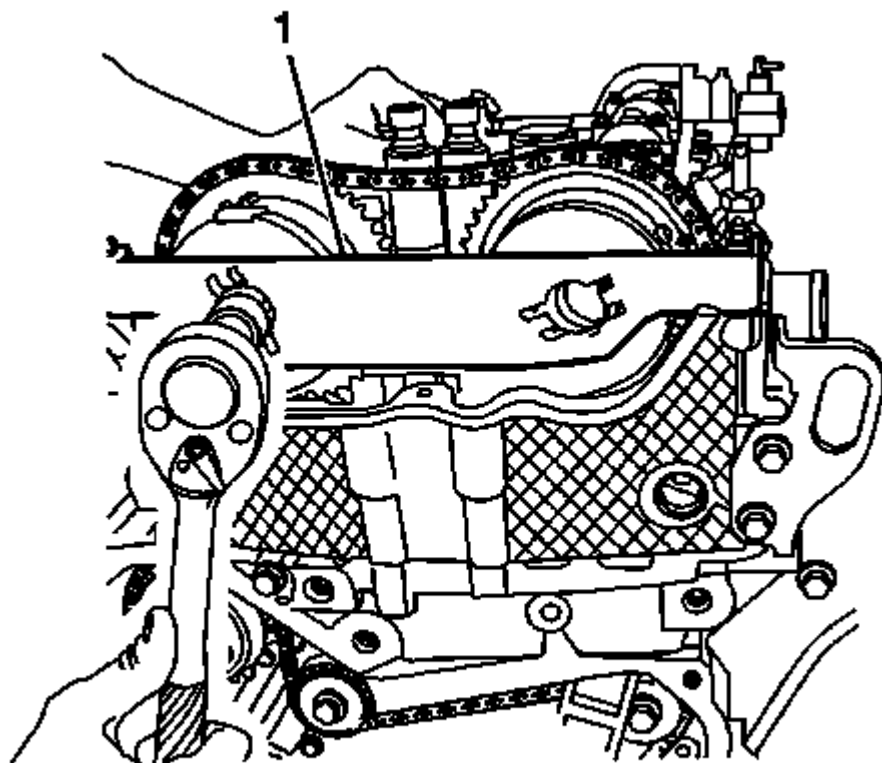


Fig. 187: View of Camshaft Actuator Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Install the **EN-48953** locking tool (1).
7. Install the camshaft actuator retainer bolts and tighten 10 N.m (89 lb in).
8. Tighten the NEW camshaft actuator bolt to 30 N.m (22 lb ft) plus an additional 100 degrees using the **EN-45059** meter.

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

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

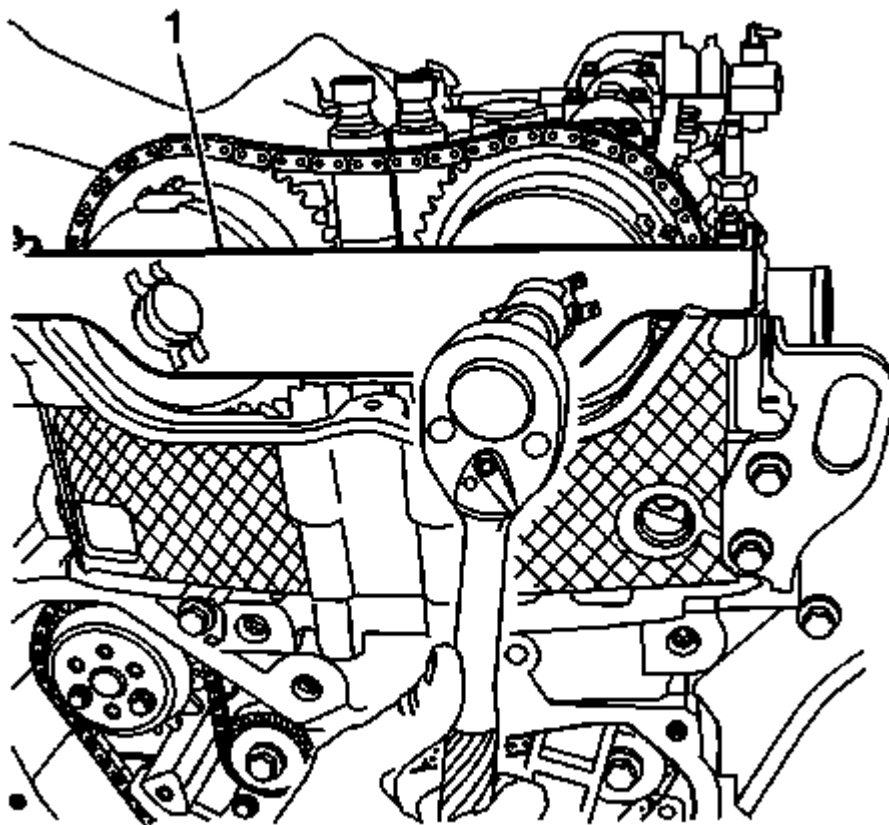


Fig. 188: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

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

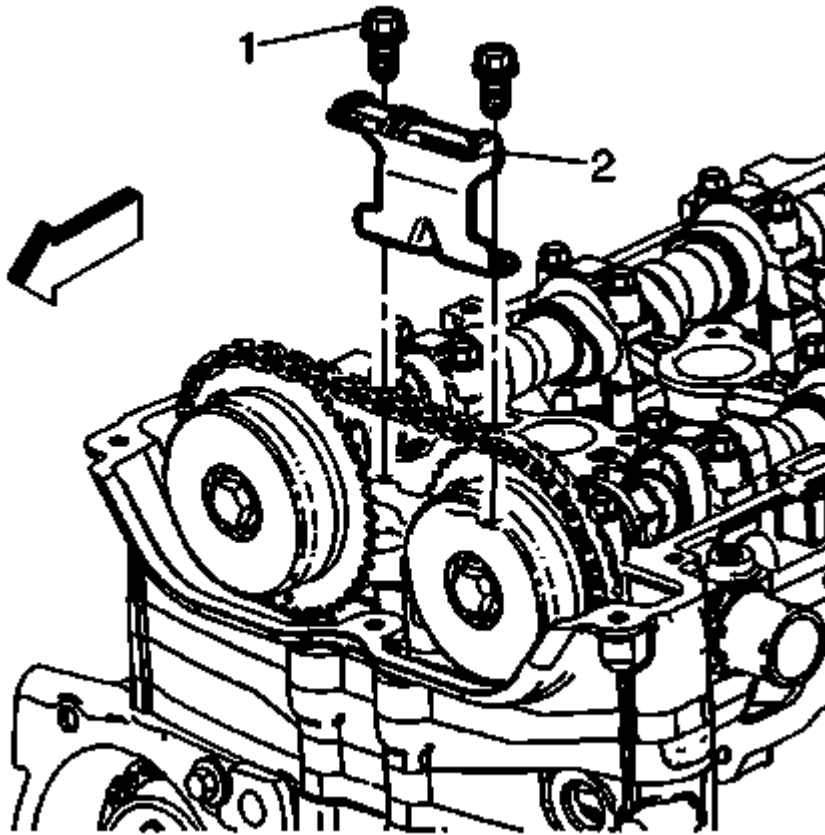


Fig. 189: Upper Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

11. Install the upper timing chain guide (2) and bolts (1) and tighten to 10 N.m (89 lb in).
12. Install the camshaft cover. Refer to **Camshaft Cover Replacement (LUK)**.
13. Install the spark plugs. Refer to **Spark Plug Replacement**.

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-43653** Flywheel Holding Tool

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

Removal Procedure

NOTE: This procedure is not used in Brazil.

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-43653 holding tool.

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.
3. Install **EN-43653** holding tool.
4. Remove the camshaft. Refer to **Intake Camshaft and Valve Lifter Replacement**, or **Exhaust Camshaft and Valve Lifter Replacement**.

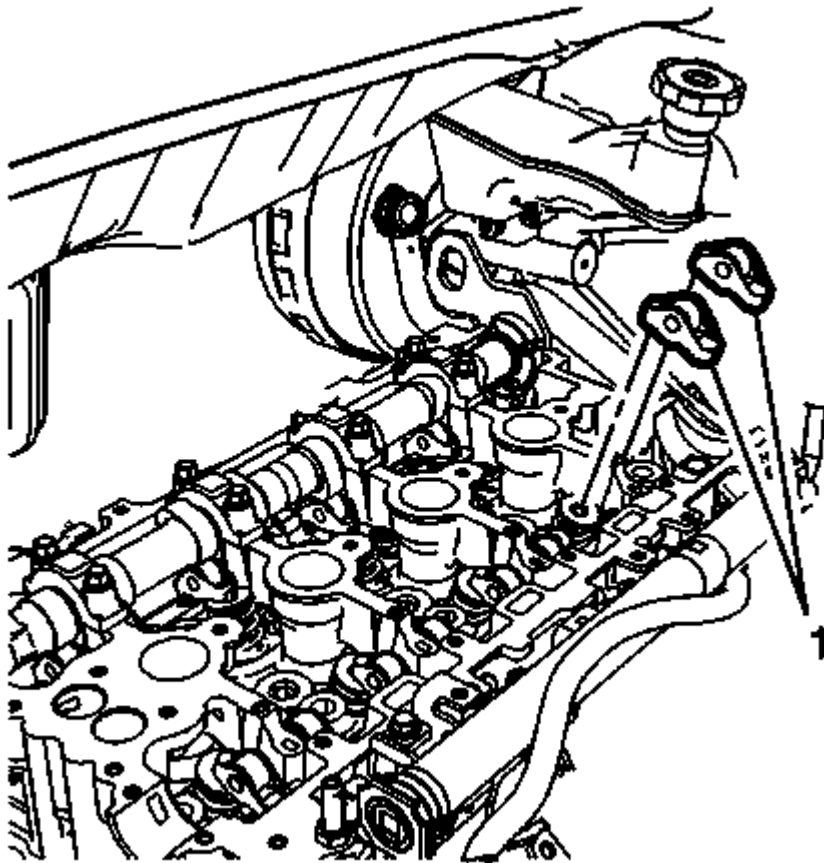


Fig. 190: Identifying Camshaft Roller Followers
Courtesy of GENERAL MOTORS COMPANY

5. Remove the camshaft roller followers (1).

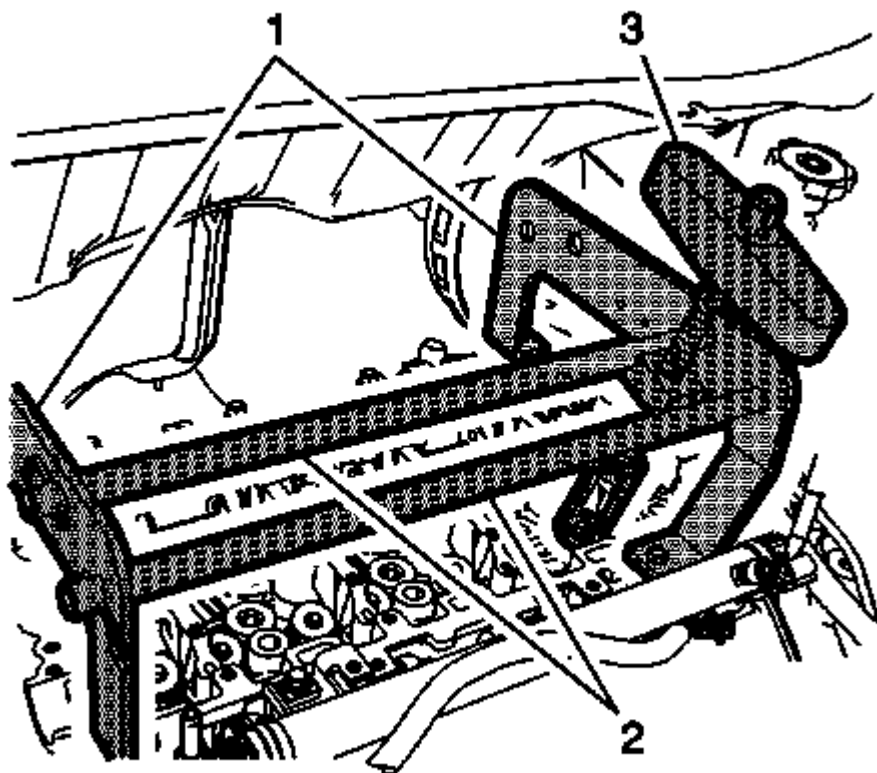


Fig. 191: View Of Valve Spring Compressor Adaptor Set
Courtesy of GENERAL MOTORS COMPANY

6. Install the **EN-43649-10** adaptor set (1) to the front and rear of the cylinder head.
7. Install the cross bars and locks (2) of the **EN-43649** compressor to the valve spring compressor adaptors.
8. Remove the spark plugs. Refer to **Spark Plug Replacement** .
9. Install an air hose adapter into the spark plug hole.
10. Attach an air hose to the adapter and pressurize the cylinder to 690 kPa (100 psi).
11. Compress the valve spring using the valve spring compressor (3).

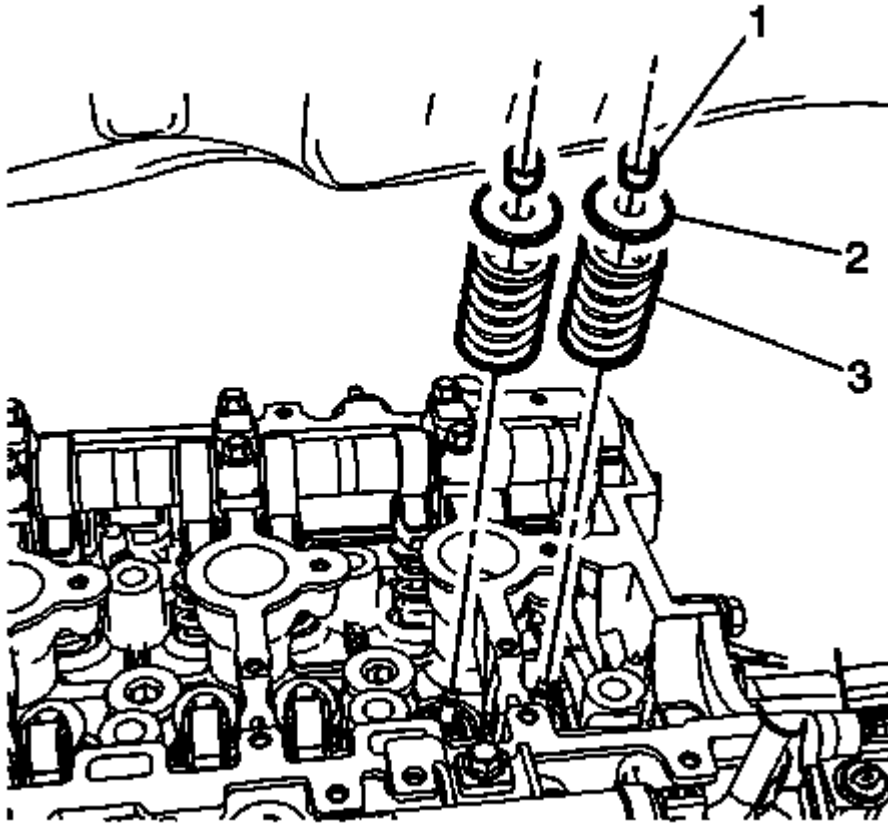


Fig. 192: View Of Valve Spring, Keepers & Retainer
Courtesy of GENERAL MOTORS COMPANY

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

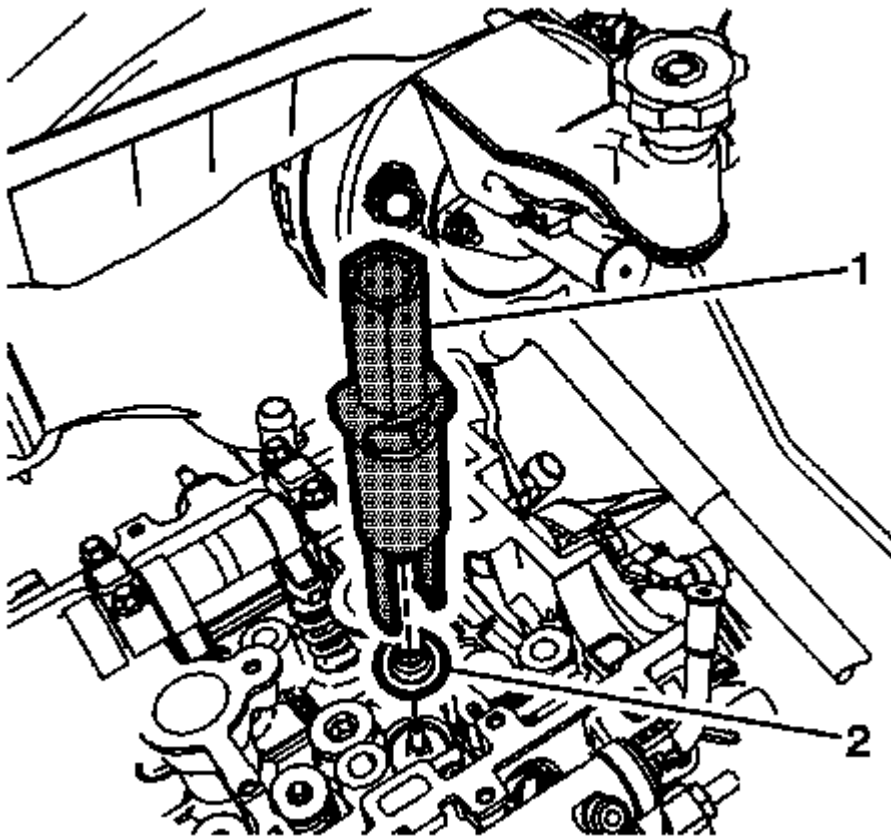


Fig. 193: View Of Valve Guide Seal Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

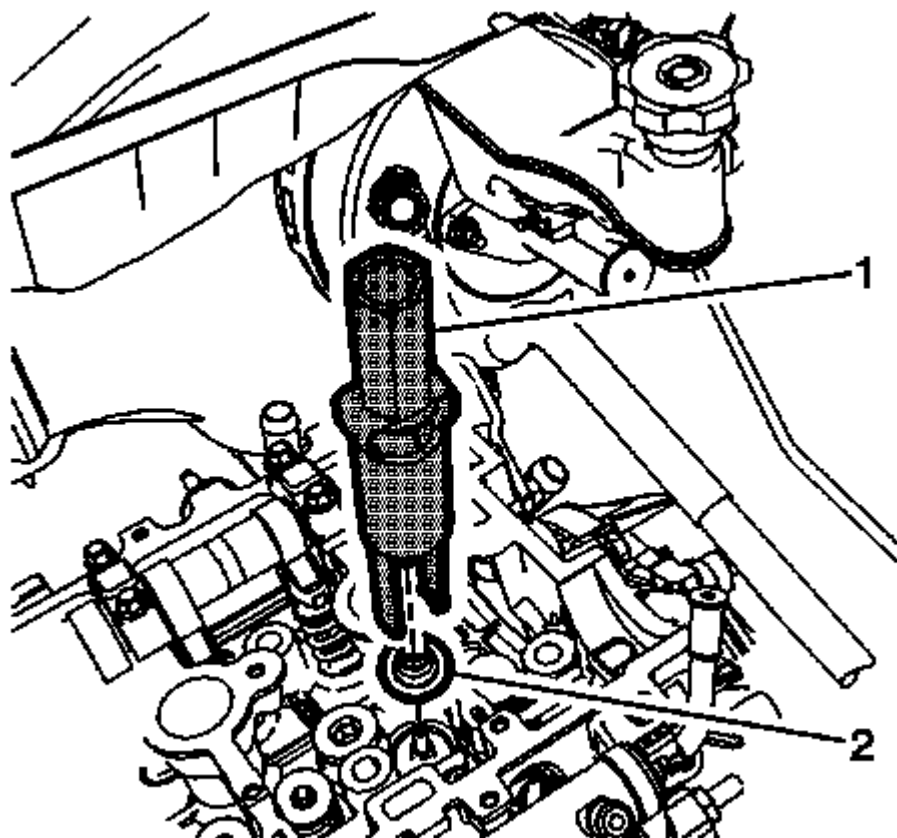


Fig. 194: View Of Valve Guide Seal Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

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

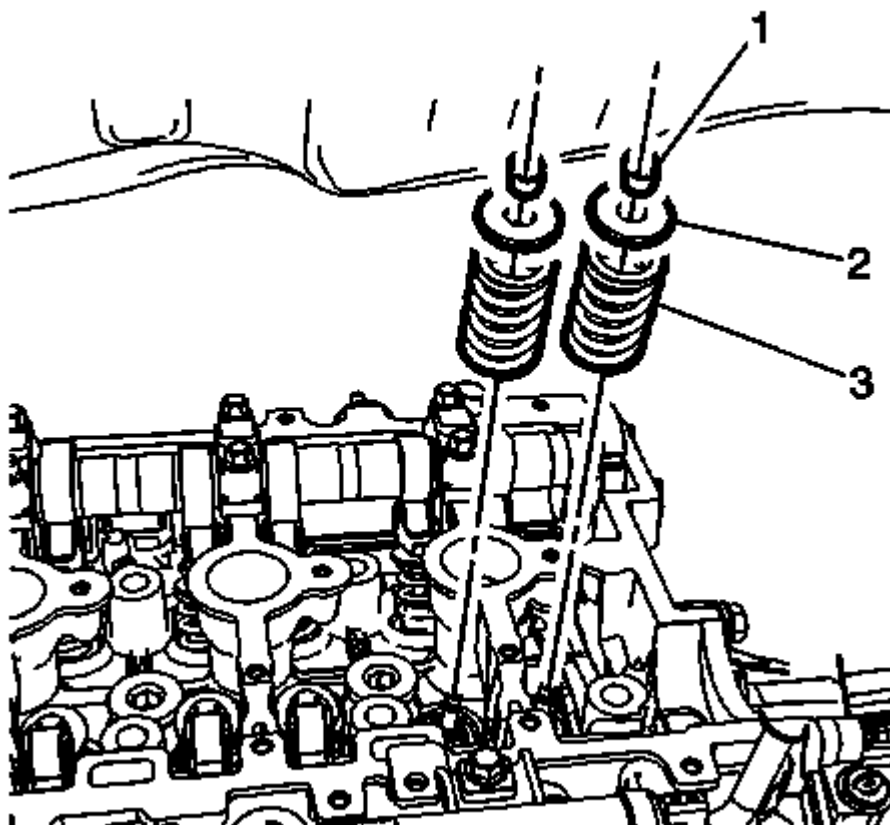


Fig. 195: View Of Valve Spring, Keepers & Retainer
Courtesy of GENERAL MOTORS COMPANY

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.

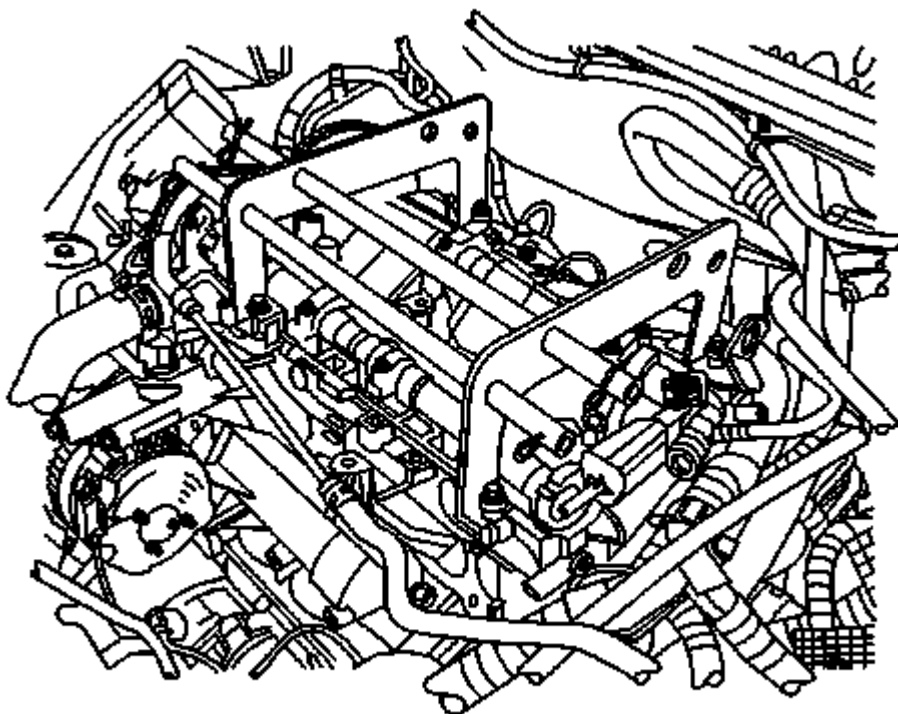


Fig. 196: Cylinder Head Valve Spring Compressor
Courtesy of GENERAL MOTORS COMPANY

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** .

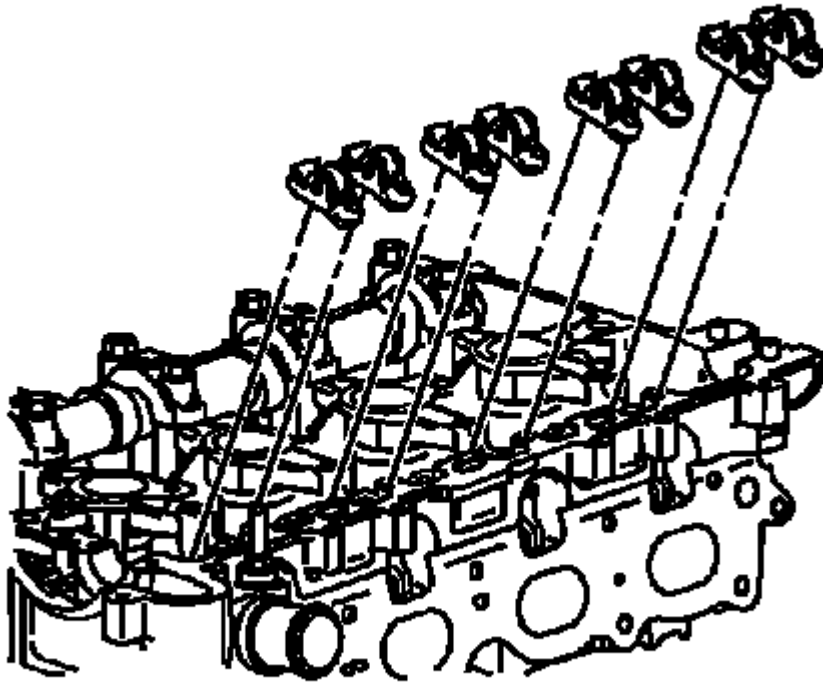


Fig. 197: Identifying Camshaft Roller Followers
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft roller followers.
9. Install the camshaft. Refer to Intake Camshaft and Valve Lifter Replacement, or Exhaust Camshaft and Valve Lifter Replacement.
10. If used, remove the EN-43653 holding tool.
11. If removed, install the starter.

CYLINDER HEAD REPLACEMENT

Special Tools

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

For equivalent regional tools, refer to Special Tools .

Removal Procedure

1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .

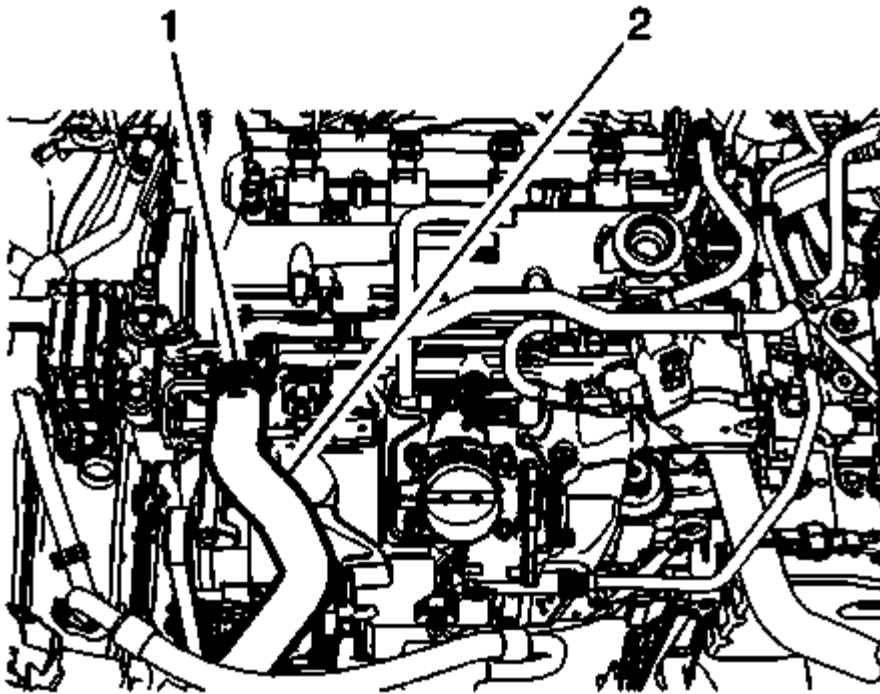


Fig. 198: Radiator Inlet Hose Clamp

Courtesy of GENERAL MOTORS COMPANY

2. Reposition the radiator inlet hose clamp (1) .
3. Remove the radiator inlet hose from the cylinder head (2).
4. Remove the exhaust manifold. Refer to Exhaust Manifold Replacement (LEA or LUK) .
5. Remove the intake manifold. Refer to Intake Manifold Replacement (LUK).
6. Remove the fuel pump. Refer to Fuel Pump Replacement .
7. Remove the radiator surge tank air bleed hose from the cylinder head.
8. Disconnect all electrical connectors as necessary.
9. Remove the camshaft cover. Refer to Camshaft Cover Replacement (LUK).
10. Remove the purge solenoid and bracket. Refer to Evaporative Emission Canister Purge Solenoid Valve Replacement .

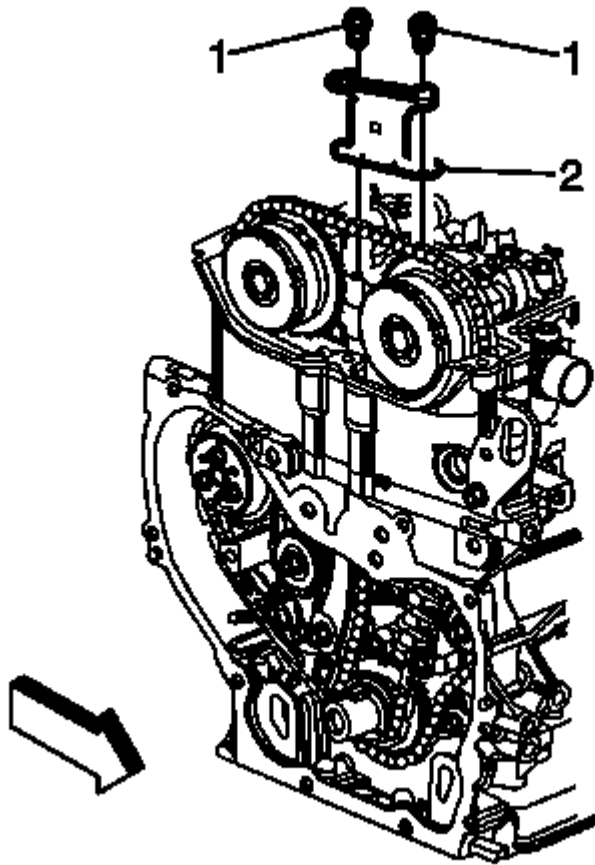


Fig. 199: Upper Timing Chain Guide & Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove the upper timing chain guide bolts (1) and guide (2).

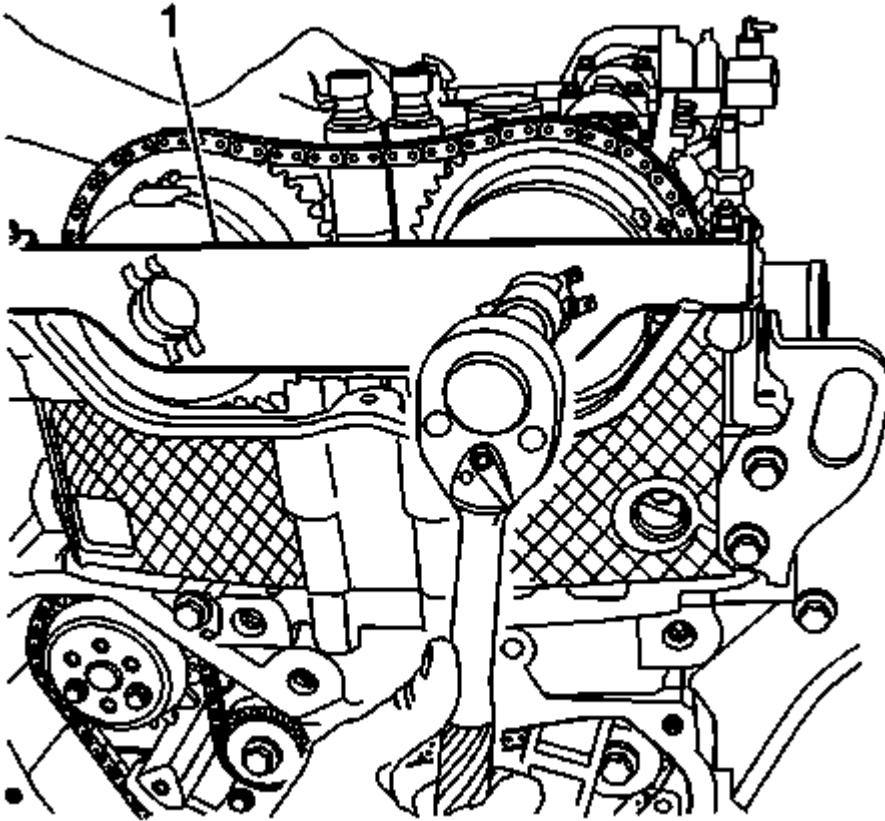


Fig. 200: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- If the intake camshaft actuator is moving independently of the camshaft, this means the camshaft is not locked to the actuator. Rotate the camshaft counterclockwise while the holding tool is installed and this will lock the camshaft to the actuator.
- Ensure the timing chain and the camshaft position actuators are marked for proper assembly.

12. Rotate the intake camshaft clockwise and install the **EN-48953** locking tool (1) to the actuators.

CAUTION: Refer to Fastener Caution .

13. Install the camshaft actuator retainer bolts and tighten to 10 N.m (89 lb in).
14. Clean the timing chain and gears with solvent.
15. Mark the timing gear sprockets and the timing chain. It is recommended that the paint marks are located in the 12 o'clock position.

16. Use a 24 mm wrench on the hex flats of the camshaft to prevent camshaft rotation.
17. Loosen, but do not remove the intake and exhaust camshaft actuator bolts.
18. Remove the **EN-48953** locking tool.

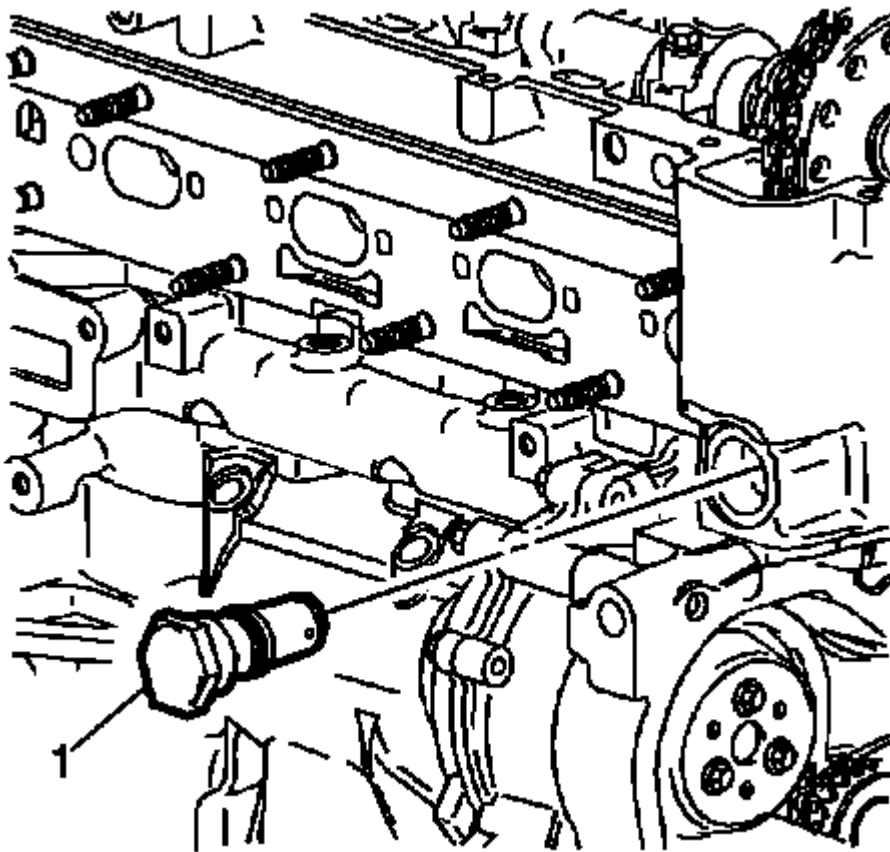


Fig. 201: Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

19. Remove the timing chain tensioner (1).

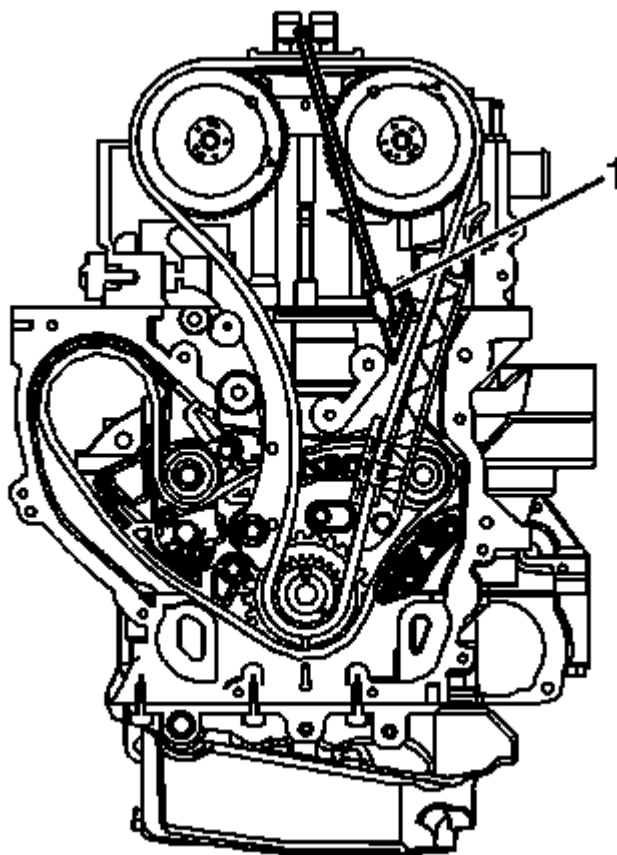


Fig. 202: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

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

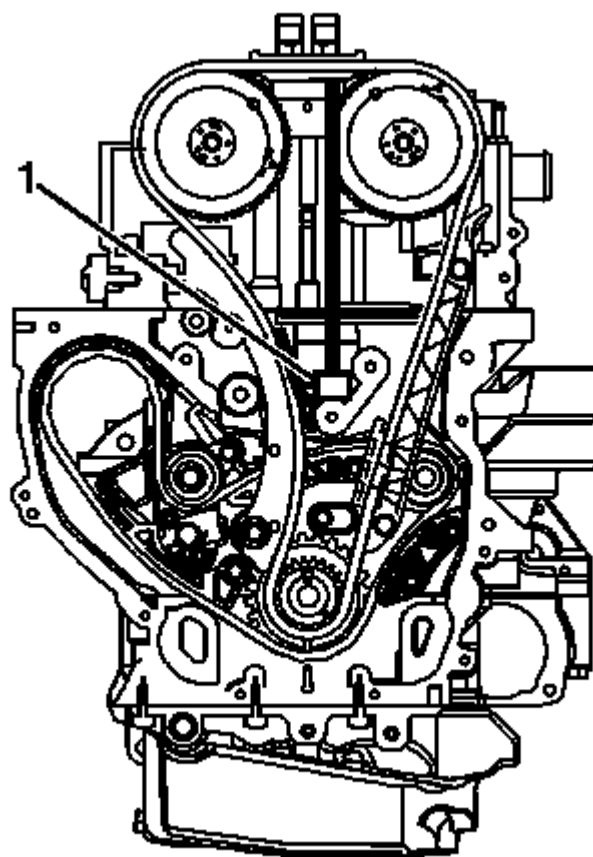


Fig. 203: View Of Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: The camshaft actuators should not rotate during the removal of installation.

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

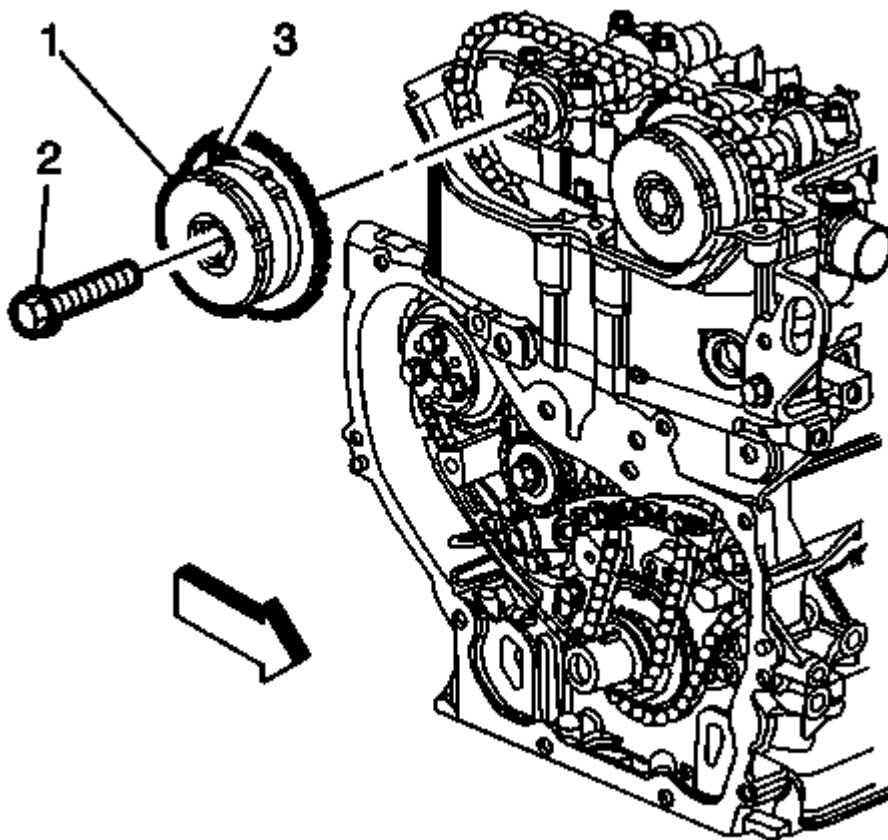


Fig. 204: Exhaust Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

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

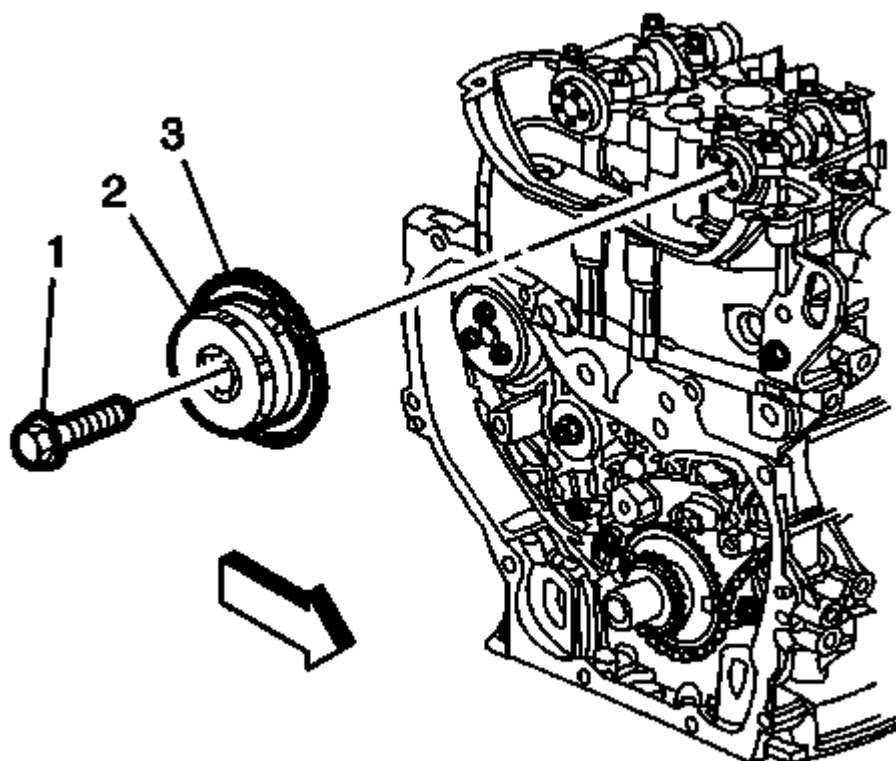


Fig. 205: Intake Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

24. Remove and discard the intake camshaft actuator bolt (1).
25. Remove the intake camshaft actuator (2) from the camshaft while also removing the actuator from the timing chain.

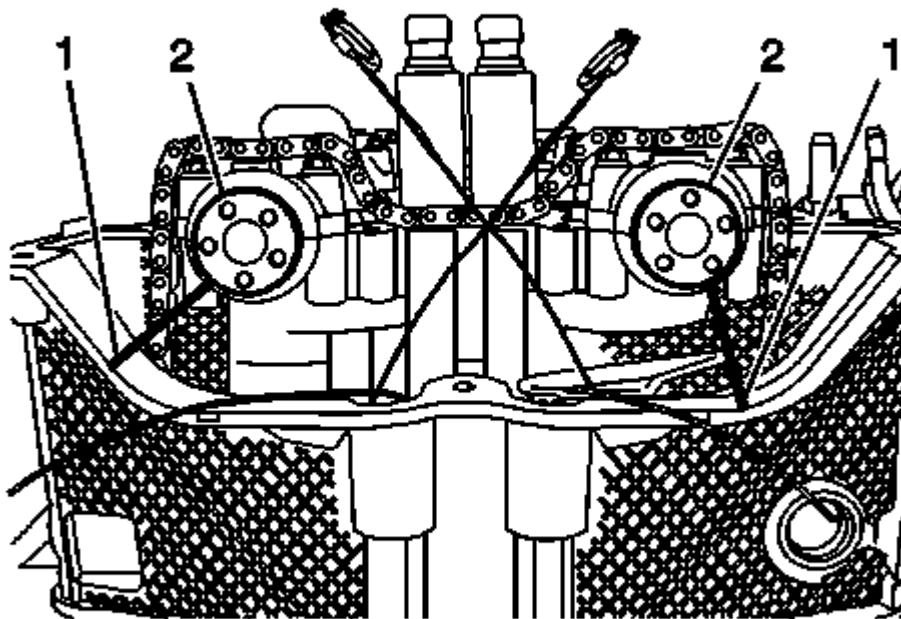


Fig. 206: Aligning Marks On Cylinder Head In Relationship To Camshaft Actuator Notches
Courtesy of GENERAL MOTORS COMPANY

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

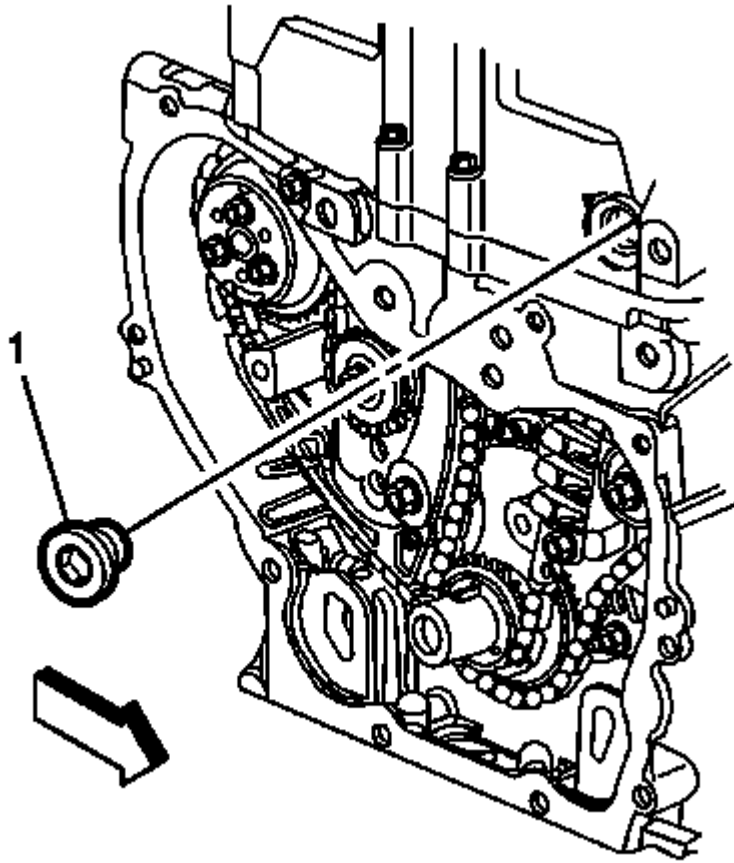


Fig. 207: Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS COMPANY

27. Remove the fixed timing chain guide access plug (1).
28. Remove the fixed guide upper bolt.

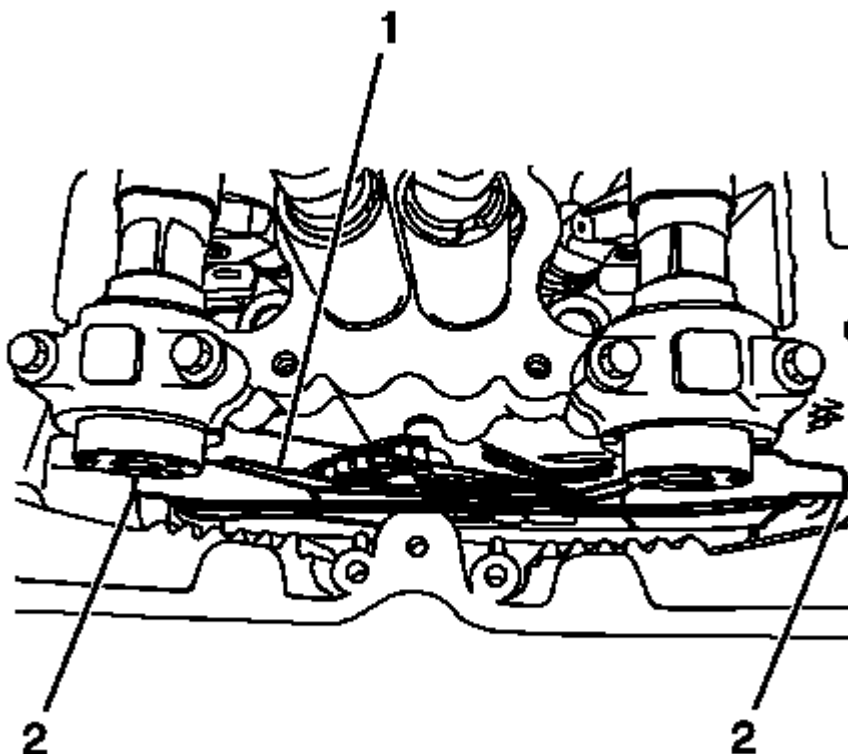


Fig. 208: View Of Rubber Band To Pull Guides Together
Courtesy of GENERAL MOTORS COMPANY

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

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

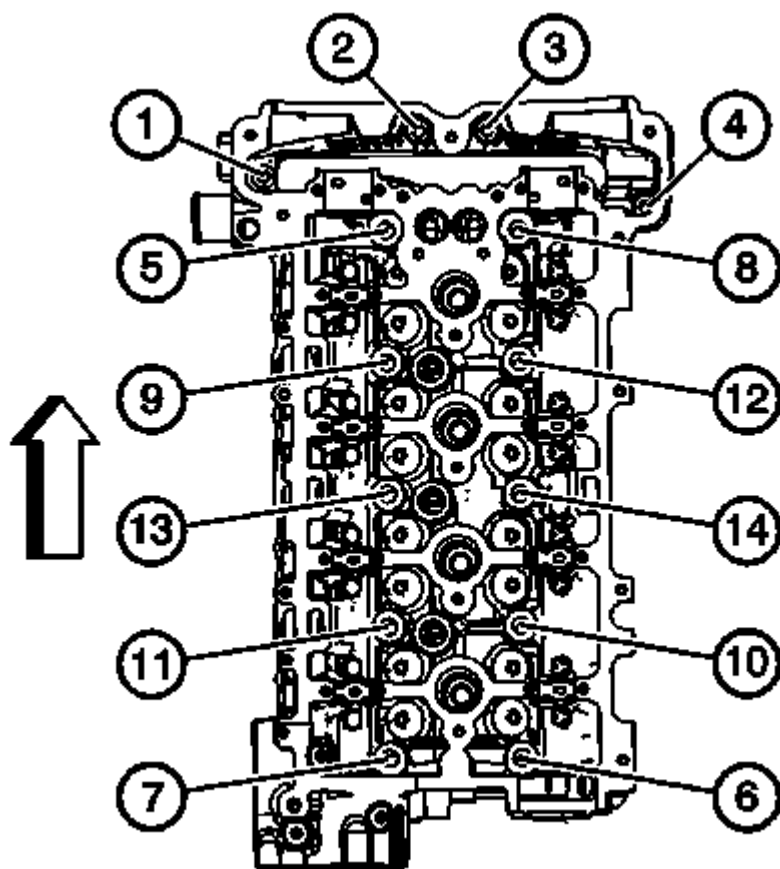


Fig. 209: Cylinder Head-To-Block Bolt Sequence
Courtesy of GENERAL MOTORS COMPANY

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

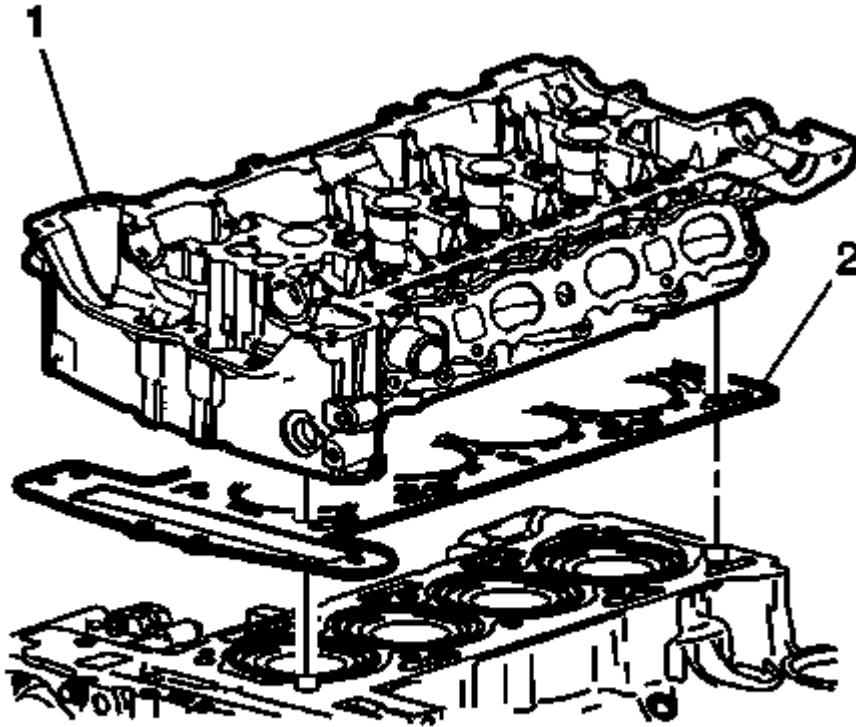


Fig. 210: Cylinder Head

Courtesy of GENERAL MOTORS COMPANY

31. Remove the cylinder head (1).
32. Remove the cylinder head gasket (2).
33. Clean all of the gasket surfaces.
34. Use the following steps when cleaning the cylinder head and cylinder block surfaces:
 - Use a razor blade gasket scraper to clean the cylinder head and cylinder block gasket surfaces. Do not scratch or gouge either surface.

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

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

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

by the NEW gasket.

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

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

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

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

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

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

Installation Procedure

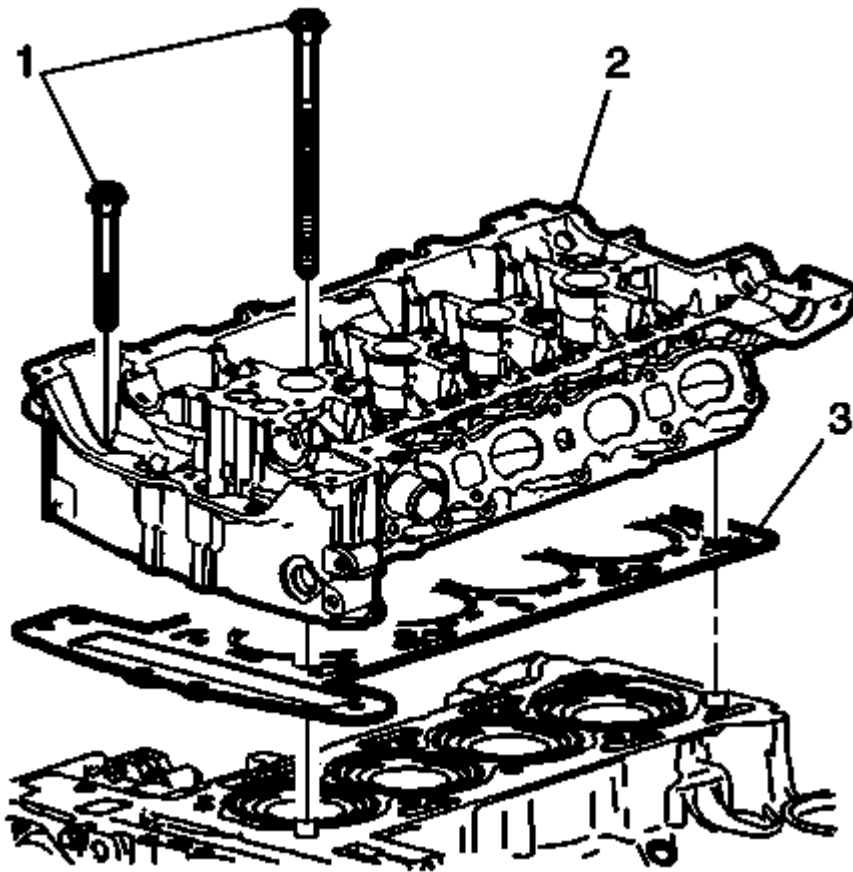


Fig. 211: Cylinder Head Gasket

Courtesy of GENERAL MOTORS COMPANY

NOTE: DO NOT use any sealing material.

1. Install the cylinder head gasket (3).

2. Install the cylinder head (2).
3. Install NEW cylinder head bolts (1).

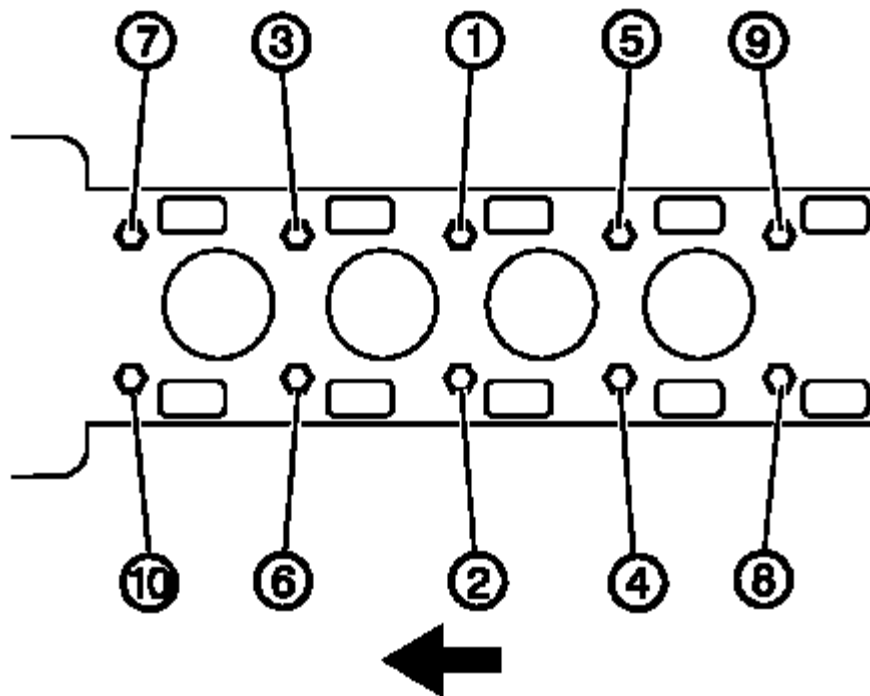


Fig. 212: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

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

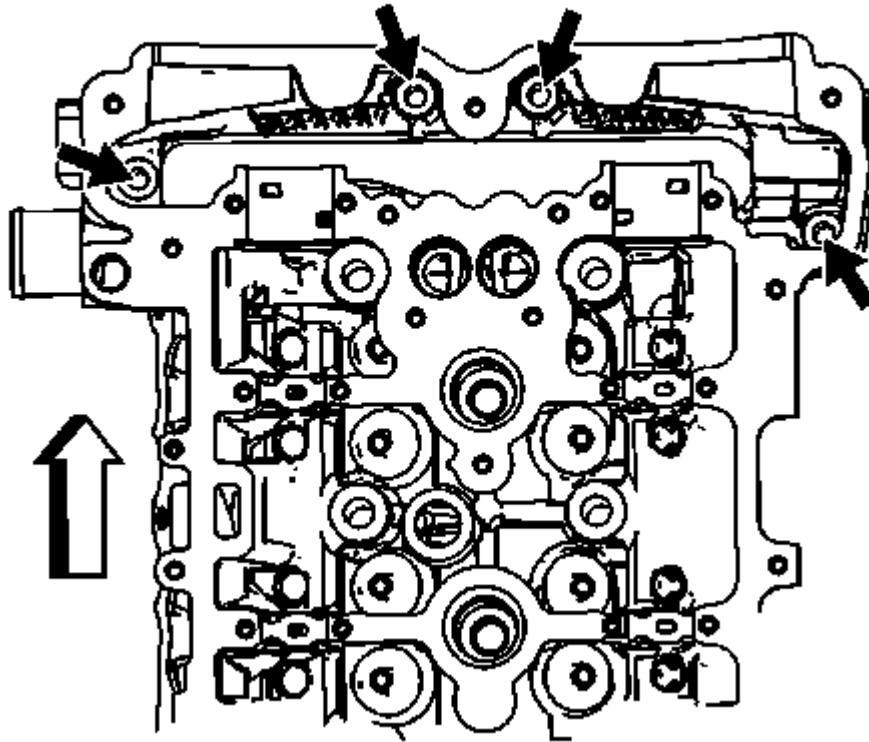


Fig. 213: Locating Front Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

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

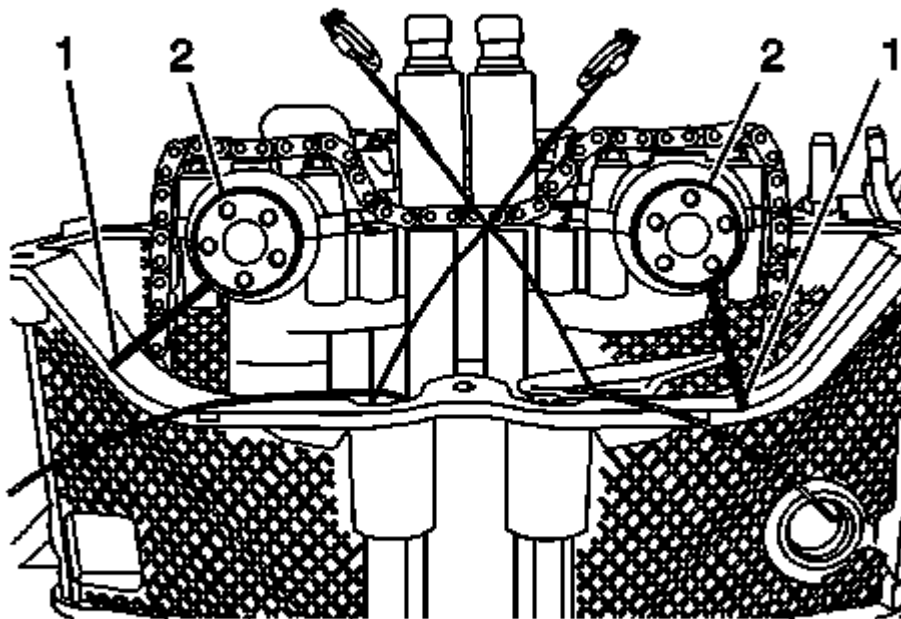


Fig. 214: Aligning Marks On Cylinder Head In Relationship To Camshaft Actuator Notches
Courtesy of GENERAL MOTORS COMPANY

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

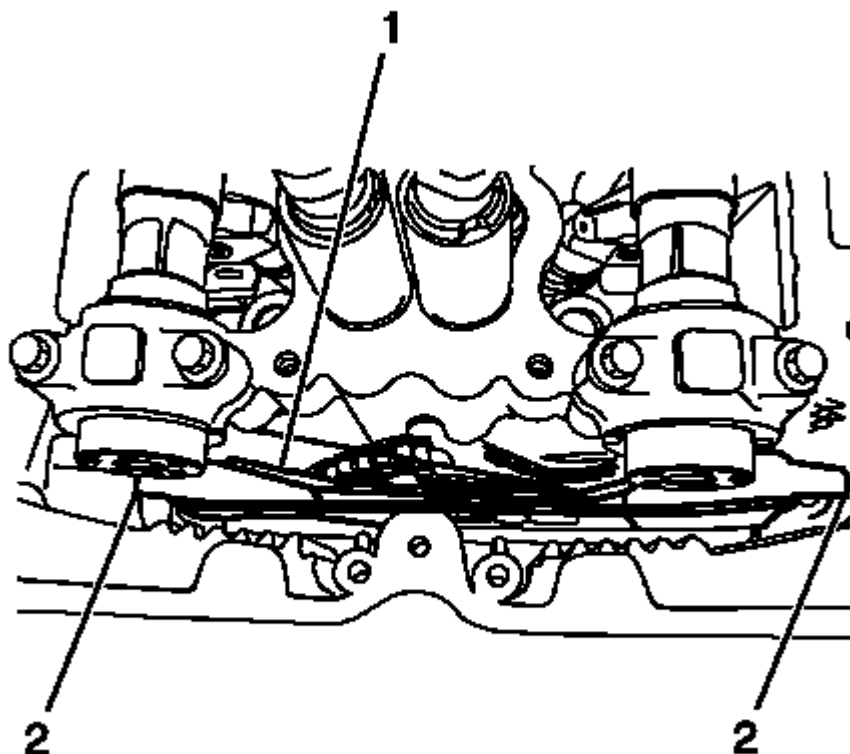


Fig. 215: View Of Rubber Band To Pull Guides Together
Courtesy of GENERAL MOTORS COMPANY

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

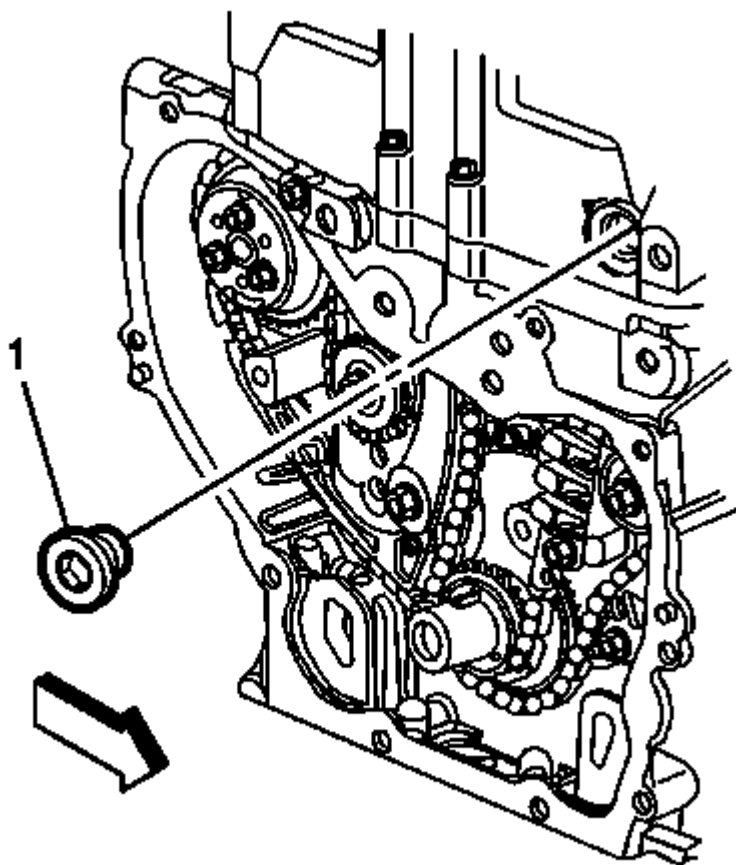


Fig. 216: Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS COMPANY

9. Apply sealant compound to thread and install the timing chain guide bolt access hole plug (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers**
10. Install the fixed timing chain guide access plug. Tighten the chain guide plug to 90 N.m (59 lb ft).

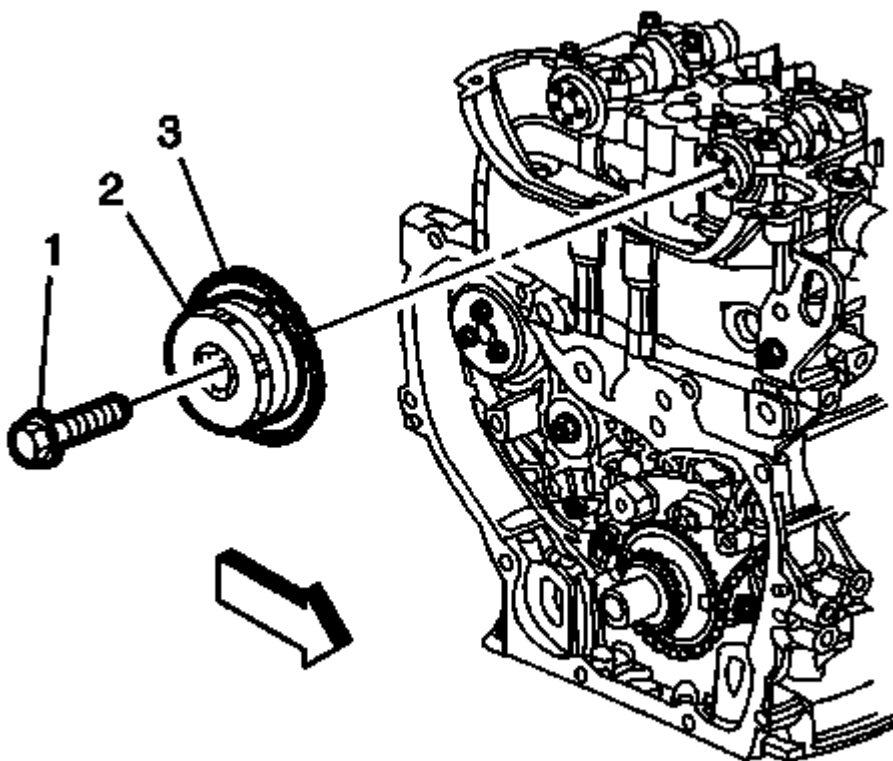


Fig. 217: Intake Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

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

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

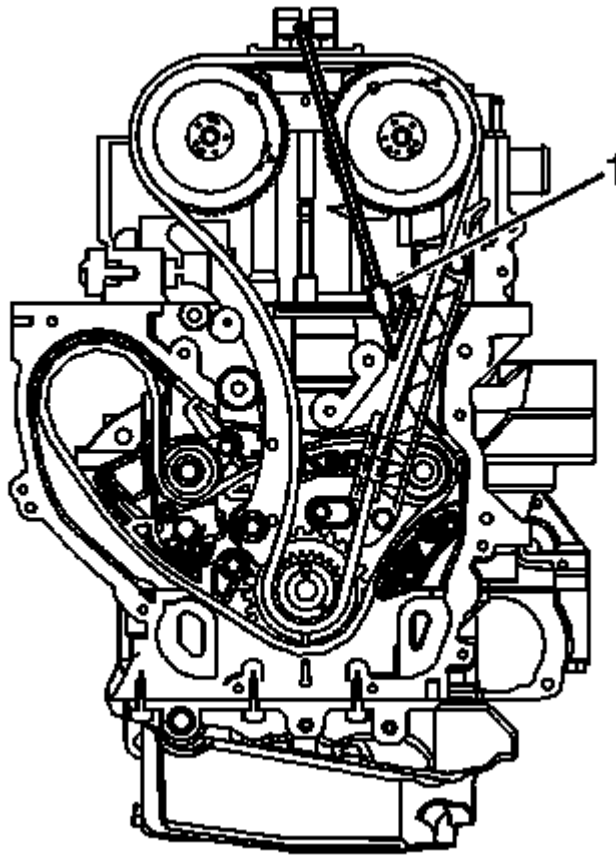


Fig. 218: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

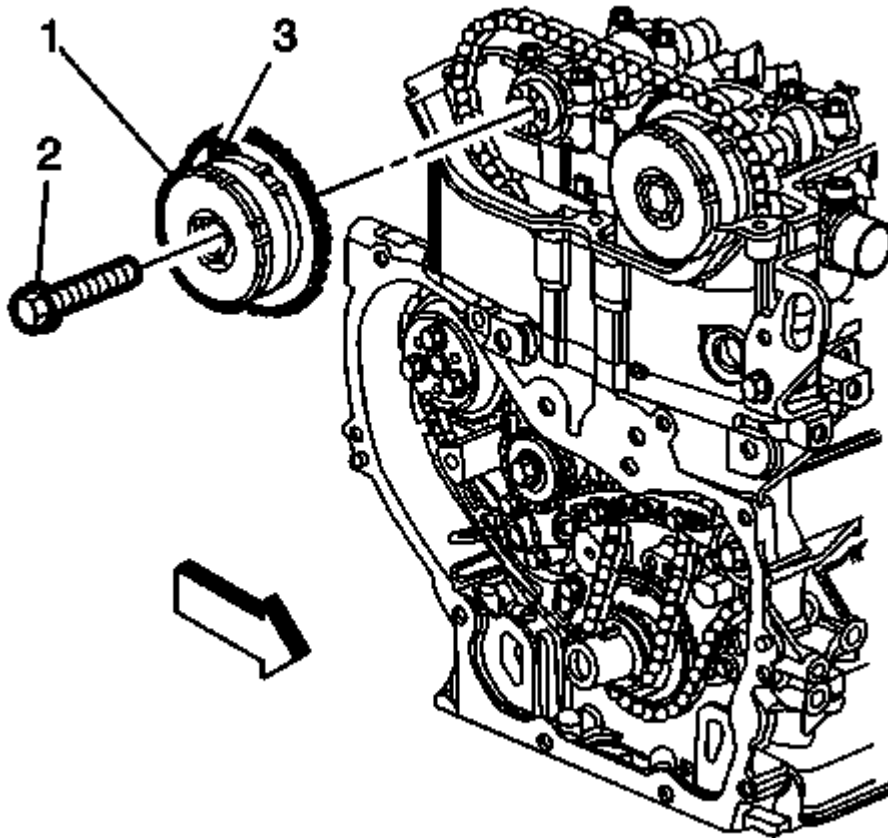


Fig. 219: Exhaust Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

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

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

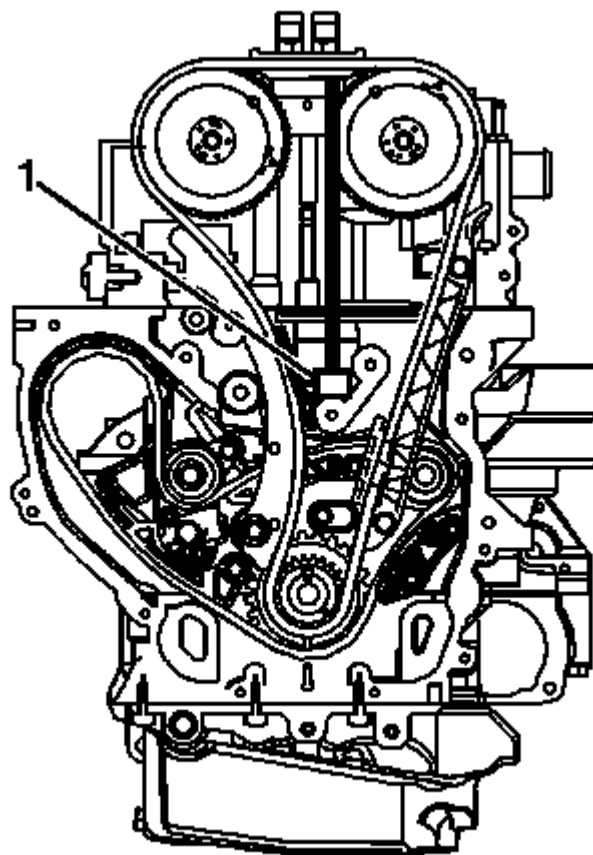


Fig. 220: View Of Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

18. Remove the **EN-48749** retention tool (1) from the exhaust side of the timing chain.
19. Reset and install the timing chain tensioner. Refer to **Timing Chain Tensioner Replacement**

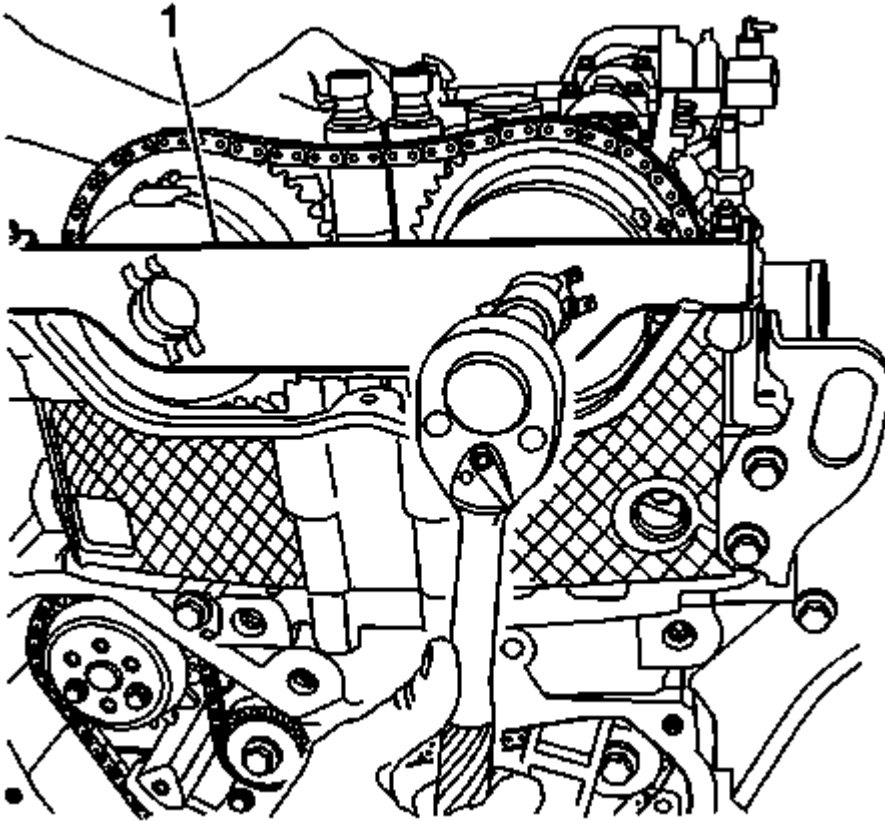


Fig. 221: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

20. Install the **EN-48953** locking tool (1) to the actuators.
21. Install the camshaft actuator locking tool bolts and tighten to 10 N.m (89 lb in).
22. Release the tensioner by applying a counterclockwise torque on the harmonic balancer bolt and tighten the bolt to 45 N.m (33 lb ft).
23. Tighten the NEW camshaft actuator bolt to 85 N.m (63 lb ft), plus an additional 30 degrees using the **EN-45059** meter.
24. Remove the camshaft actuator locking tool, **EN-48953** locking tool.

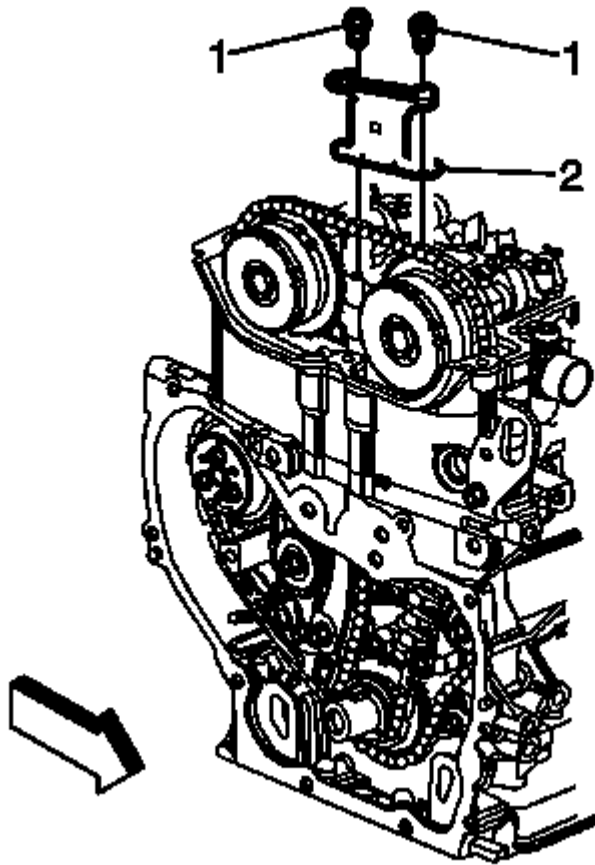


Fig. 222: Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS COMPANY

25. Install the upper timing chain guide bolts (1) and guide (2). Tighten the bolts to 10 N.m (89 lb in).
26. Install the camshaft cover. Refer to **Camshaft Cover Replacement (LUK)**.
27. Install the fuel pump. Refer to **Fuel Pump Replacement**.
28. Install the purge solenoid and bracket. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**.
29. Connect all electrical connectors as necessary.
30. Install the radiator surge tank air bleed hose to the cylinder head.
31. Position the radiator surge tank air bleed hose clamp.
32. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement (LEA or LUK)**.
33. Install the intake manifold. Refer to **Intake Manifold Replacement (LUK)**.

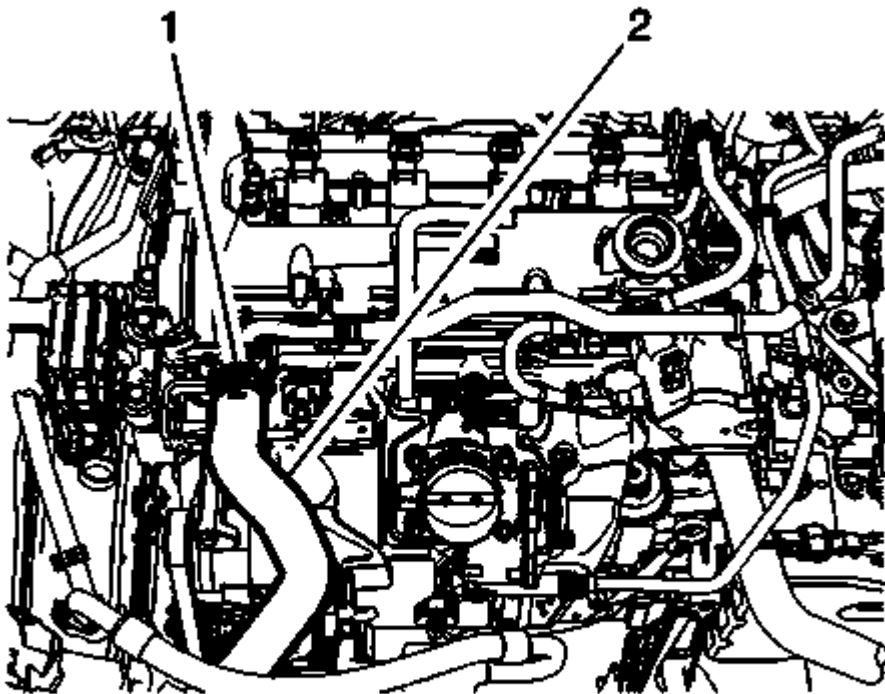


Fig. 223: Radiator Inlet Hose Clamp

Courtesy of GENERAL MOTORS COMPANY

34. Install the radiator inlet hose to the cylinder head (2).
35. Position the radiator inlet hose clamp (1) .
36. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .

OIL PAN REPLACEMENT (LUK)

Removal Procedure

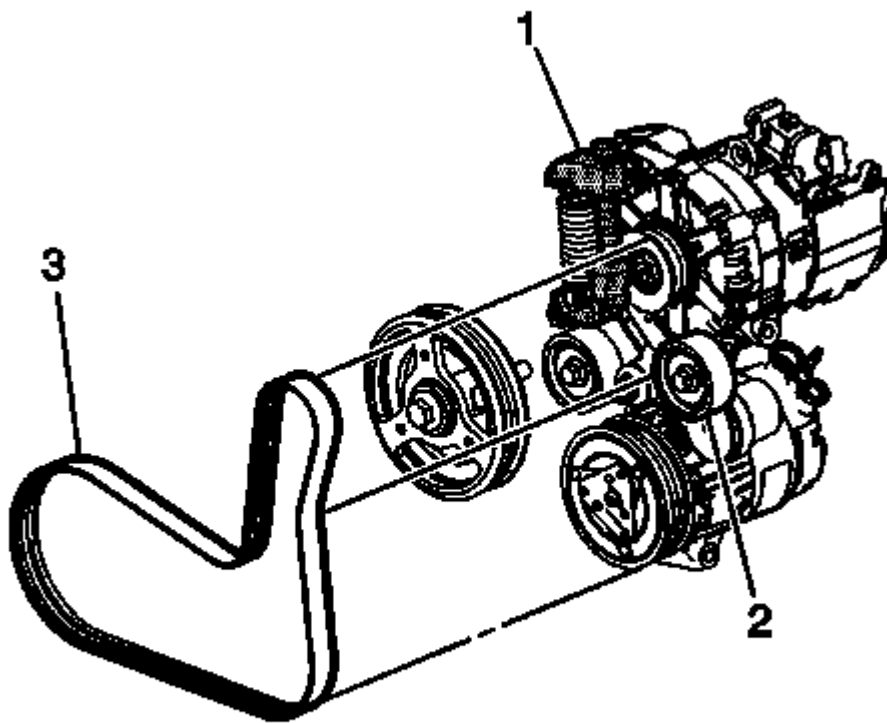


Fig. 224: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt. Refer to **Drive Belt Replacement (LUK)**.
2. Remove the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.

NOTE: The support fixture bar must be installed to provide enough access to remove and properly tighten the oil pan bolts.

3. Install the engine support fixture. Refer to **Engine Support Fixture**.

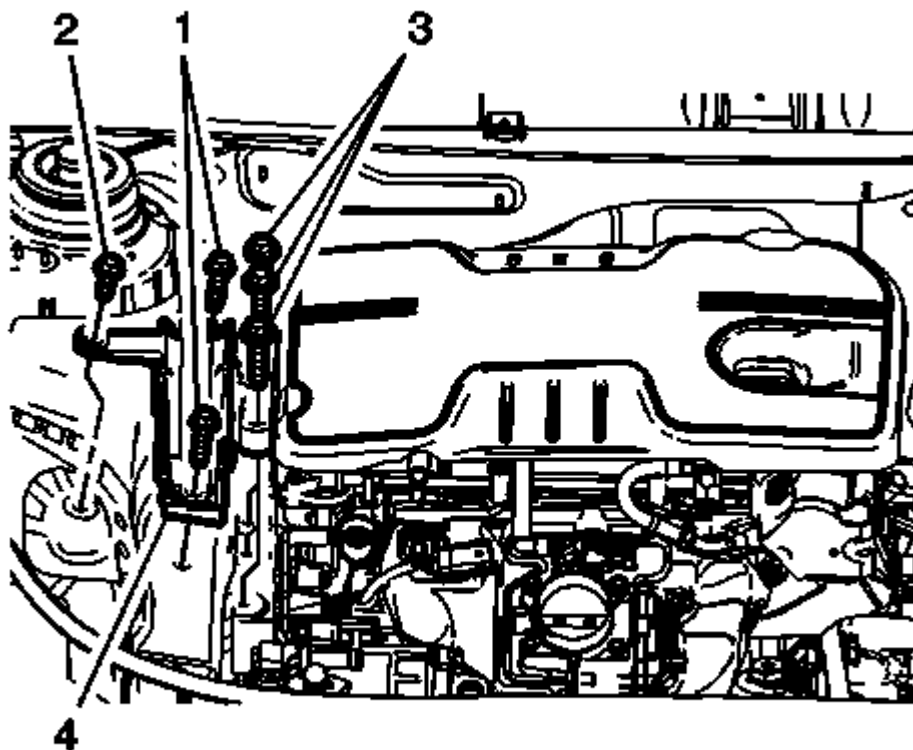


Fig. 225: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

4. Remove engine mount (4). Refer to **Engine Mount Replacement**.
5. Using the engine support fixture, raise the engine approximately 76 mm (3 in).
6. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

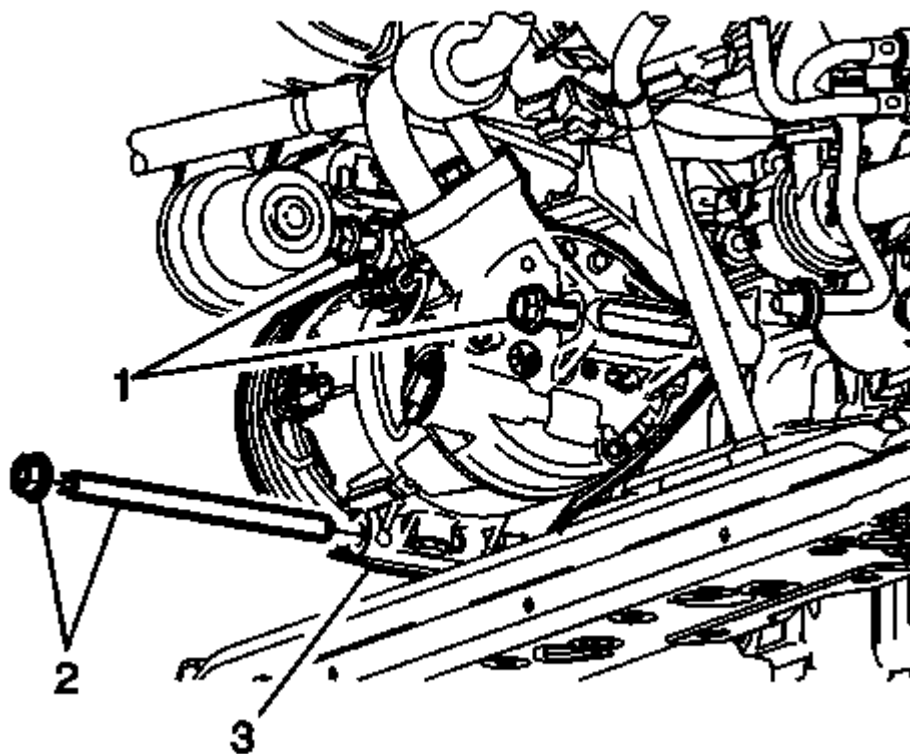


Fig. 226: Air Conditioning (A/C) Compressor Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Loosen the upper air conditioning (A/C) compressor bolts (1).
8. Remove the lower A/C compressor nut and stud (2).

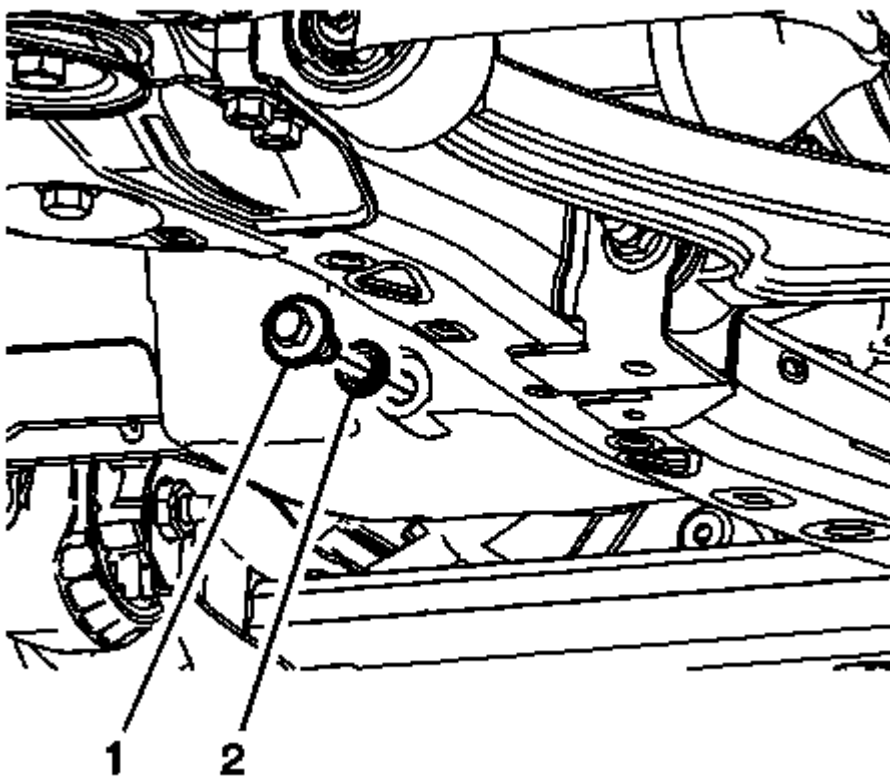


Fig. 227: Oil Pan Drain Plug

Courtesy of GENERAL MOTORS COMPANY

9. Place a suitable drain pan under the oil pan drain plug (1).
10. Remove the oil pan drain plug.
11. Drain the engine oil.
12. Reinstall the oil pan drain plug until snug.

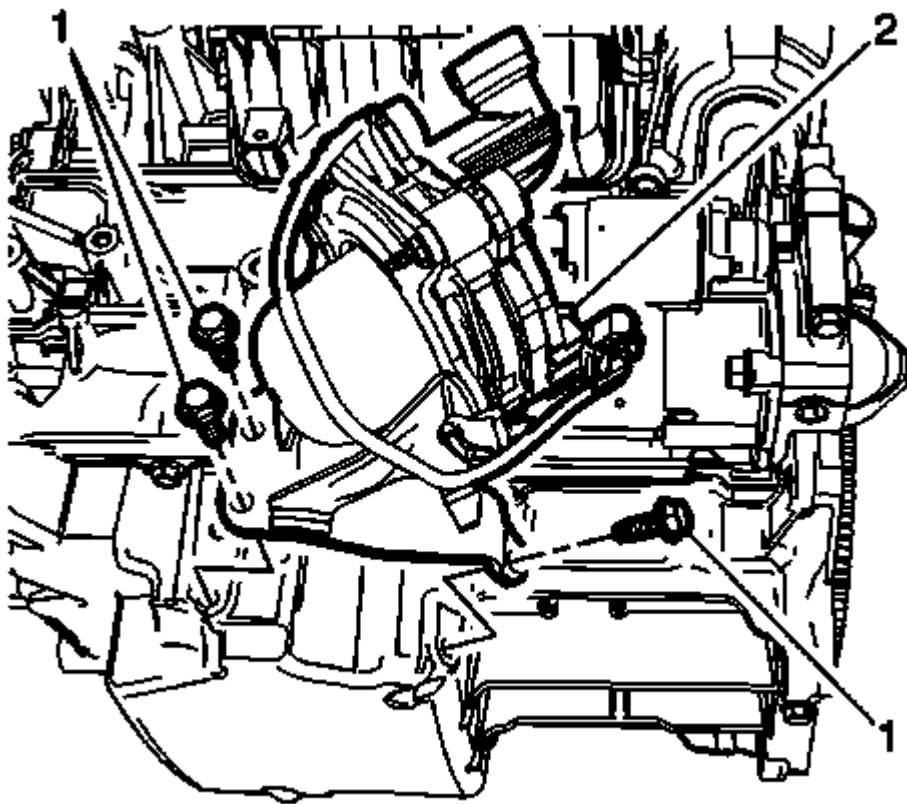


Fig. 228: Bolts And Secondary Air Injection Pump
Courtesy of GENERAL MOTORS COMPANY

13. Remove the bolts (1) retaining the secondary air injection pump (2) to the oil pan.
14. Tie the secondary air injection pump out of the way of the oil pan.

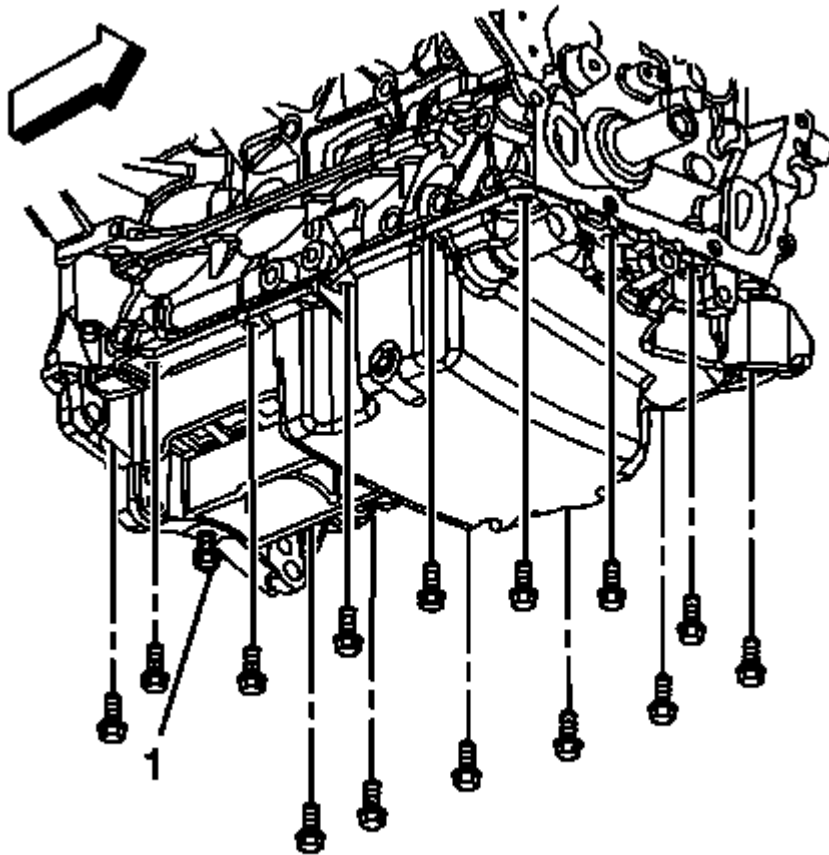


Fig. 229: Identifying Oil Pan Bolts

Courtesy of GENERAL MOTORS COMPANY

15. Remove the 4 oil pan to transaxle bolts.
16. Remove the oil pan bolts.

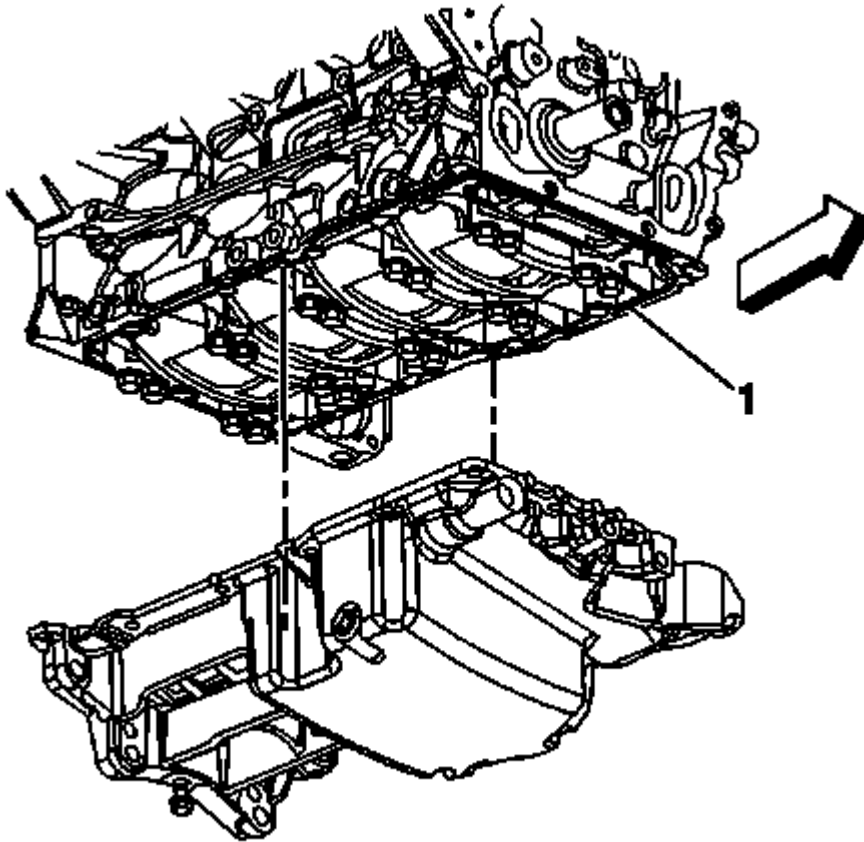


Fig. 230: Identifying Oil Pan

Courtesy of GENERAL MOTORS COMPANY

17. Remove the oil pan
18. Remove any old oil pan sealant (1).

Installation Procedure

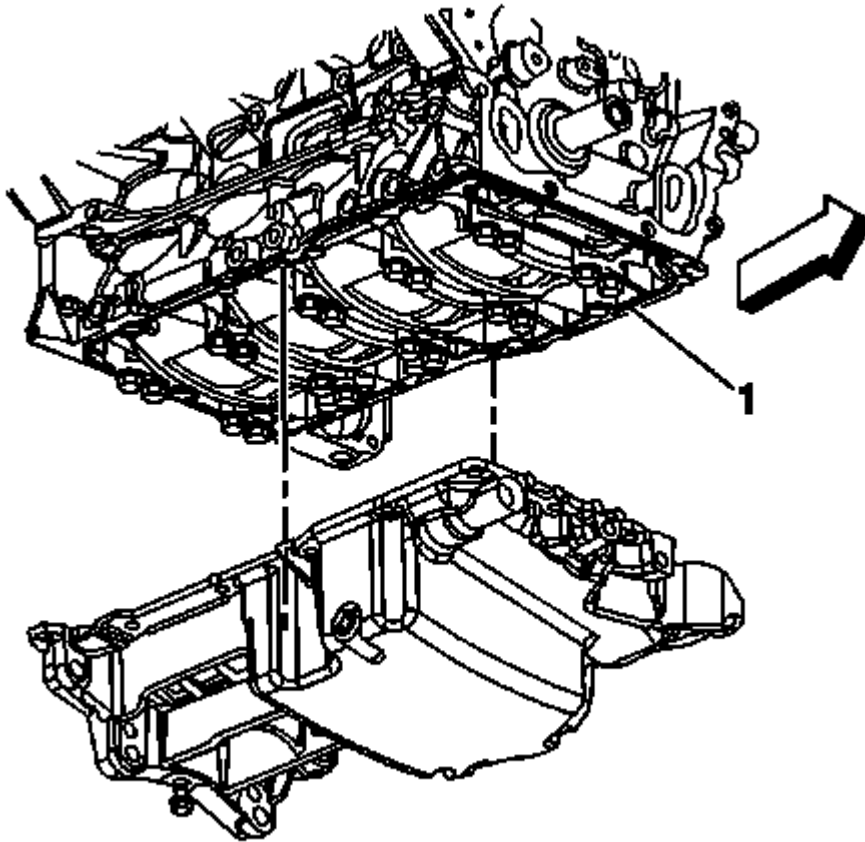


Fig. 231: Identifying Oil Pan

Courtesy of GENERAL MOTORS COMPANY

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

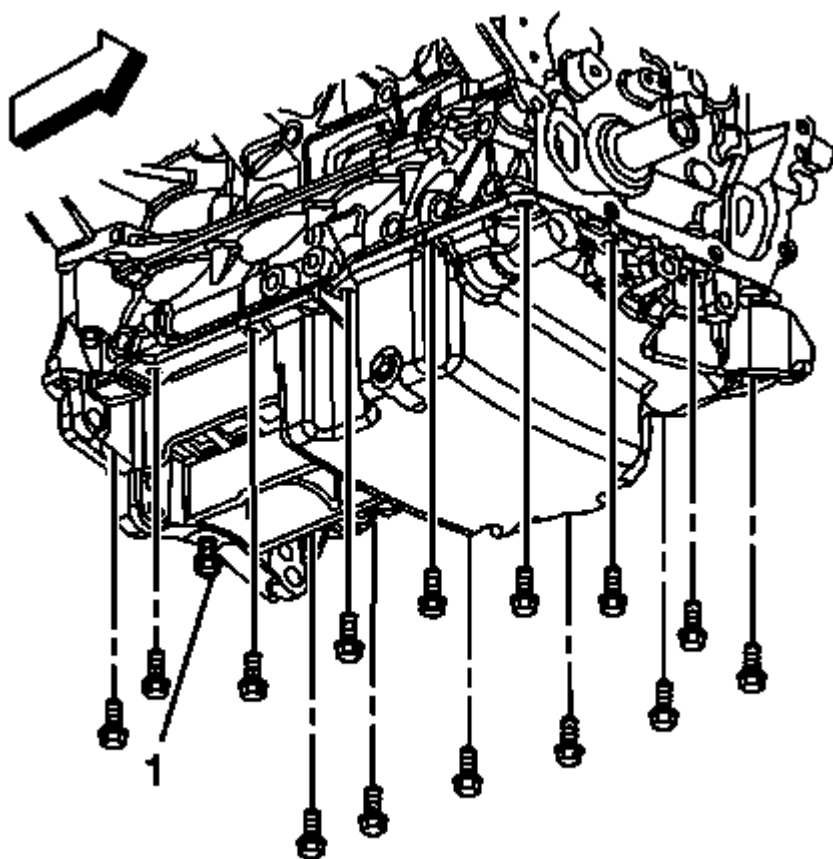


Fig. 232: Identifying Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the oil pan bolts.

CAUTION: Refer to Fastener Caution .

5. Install the 4 oil pan to transaxle bolts and tighten to 75 N.m (55 lb ft).

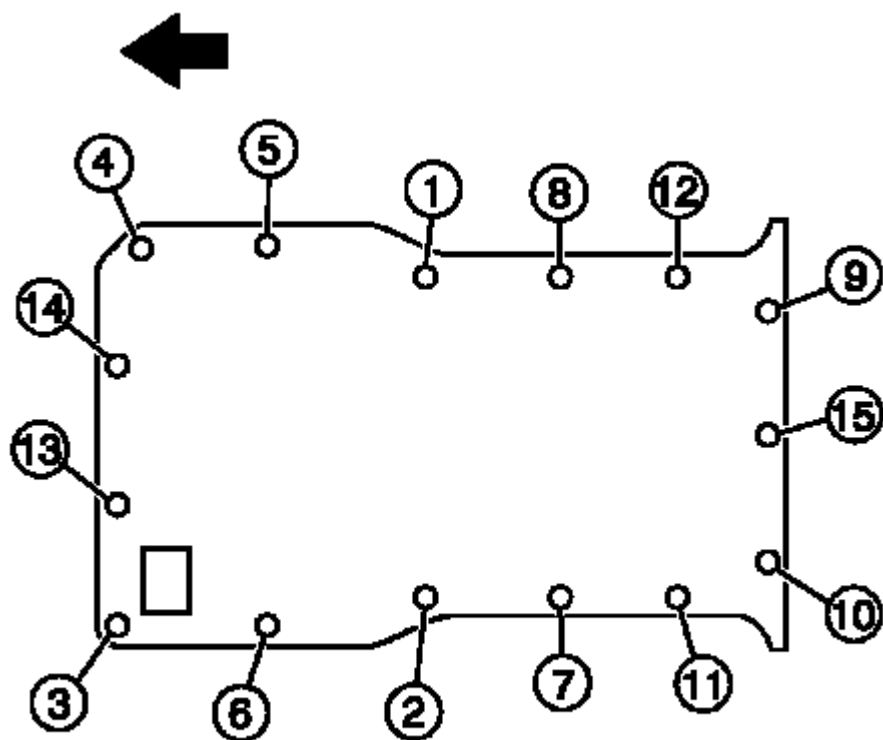


Fig. 233: Identifying Oil Pan Bolts Removal & Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

6. Tighten the oil pan bolts in the sequence shown to 25 N.m (18 lb ft).

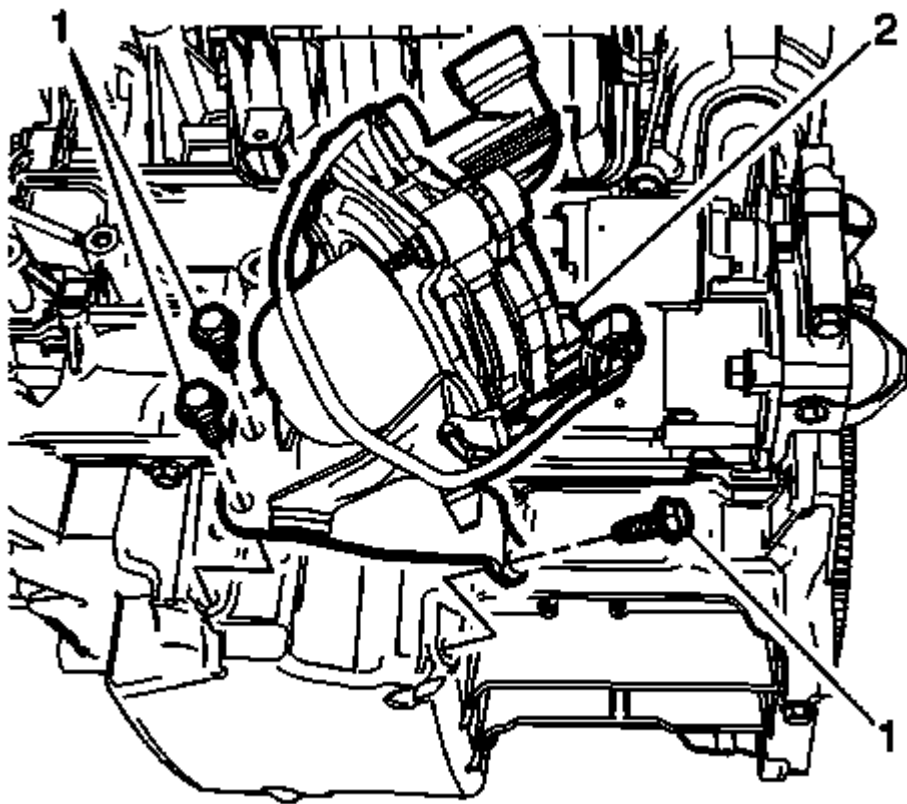


Fig. 234: Bolts And Secondary Air Injection Pump
Courtesy of GENERAL MOTORS COMPANY

7. Position the secondary air injection pump (2) to the oil pan.
8. Install the injection pump bolts (1) and tighten to 25 N.m (18 lb ft).
9. Lower the vehicle.
10. Using the engine support fixture, lower the engine.

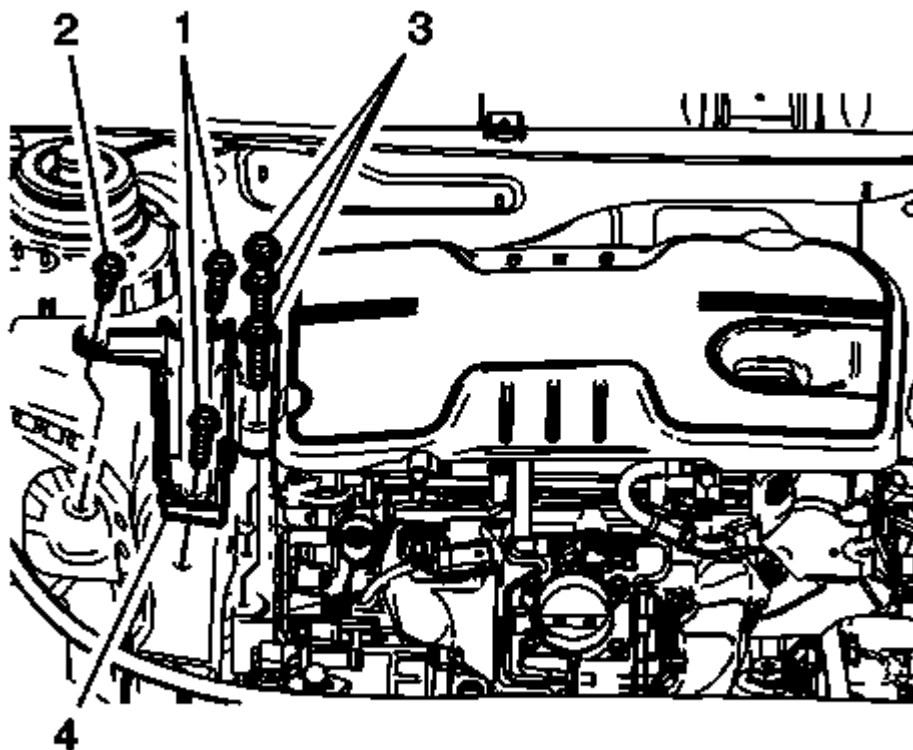


Fig. 235: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

11. Install the engine mount. Refer to **Engine Mount Replacement**.
12. Remove the engine support fixture.
13. Install the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.

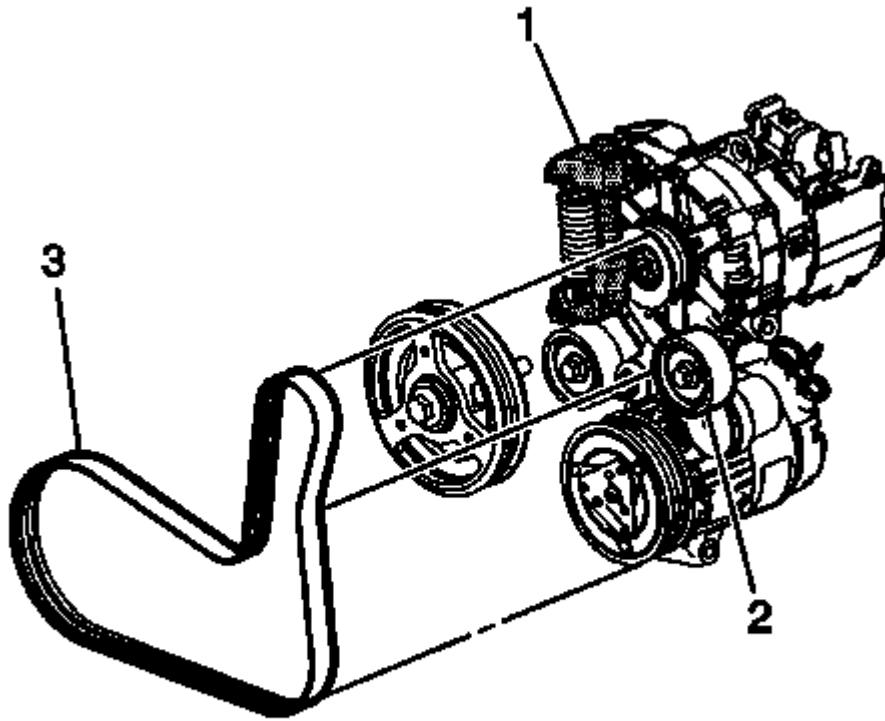
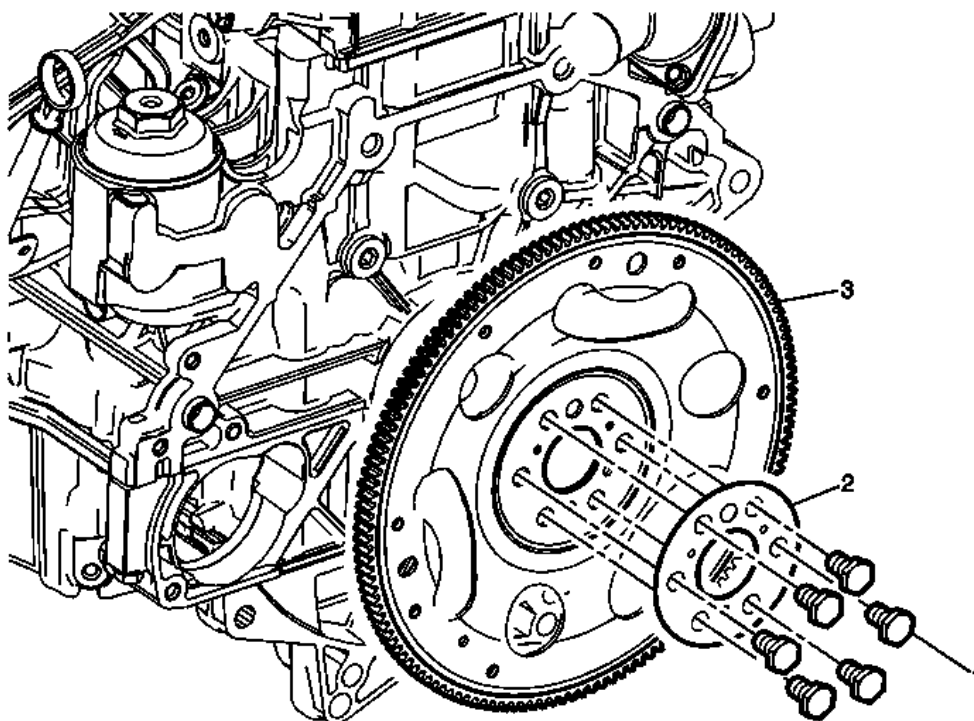


Fig. 236: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

14. Install the drive belt. Refer to **Drive Belt Replacement (LUK)**.
15. Fill the engine oil to the proper level.

ENGINE FLYWHEEL REPLACEMENT

**Fig. 237: Engine Flywheel Components**

Courtesy of GENERAL MOTORS COMPANY

Engine Flywheel Replacement

Callout	Component Name
Preliminary Procedure Remove the transmission. Refer to Transmission Replacement .	
Special Tools J-38122-A Crankshaft Balancer Holder. For equivalent regional tools. Refer to Special Tools .	
1	Engine Flywheel Fastener (Qty: 6) CAUTION: Refer to Fastener Caution . Tighten • 53 N.m (39 lb ft) • Tighten the bolt an additional 2 degrees.
2	Engine Flywheel Plate
	Engine Flywheel Procedure Inspect the engine flywheel for the following:

3

1. Stress cracks around the engine flywheel .
2. Cracks at welded areas that retain the ring gear onto the engine flywheel.
3. Damaged or missing ring gear teeth.
4. Do not attempt to repair the welded areas that retain the ring gear to the engine flywheel.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

EN-42067 Rear Main Seal Installer

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

Removal Procedure

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

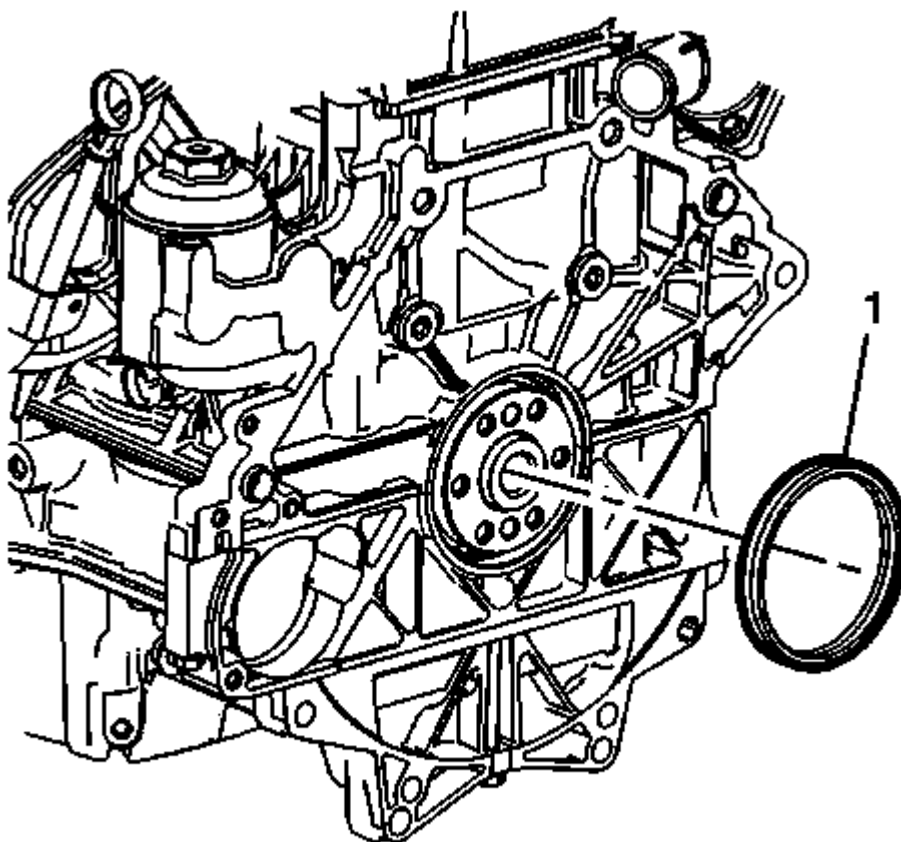


Fig. 238: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

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

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

Installation Procedure

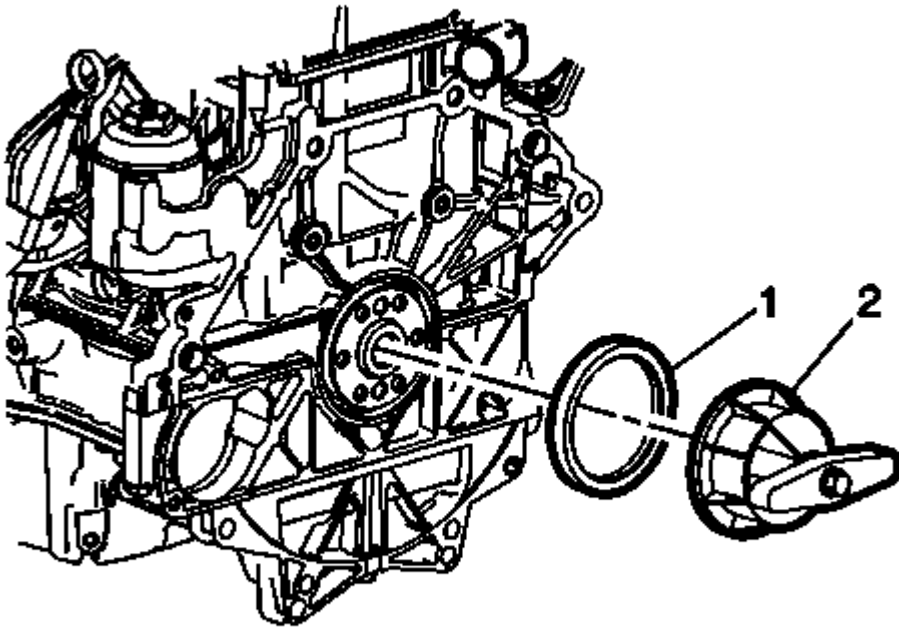


Fig. 239: Crankshaft Rear Oil Seal

Courtesy of GENERAL MOTORS COMPANY

1. Using the (2) **EN-42067** installer, install a NEW crankshaft rear oil seal (1).
2. Install the flywheel. Refer to **Engine Flywheel Replacement**.

ENGINE REPLACEMENT (LUK)

Special Tools

- **BO-38185** Hose Clamp Pliers.
- **J-39580** Engine Support Table.

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

Removal Procedure

1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
2. Recover the refrigerant system. Refer to Refrigerant Recovery and Recharging .
3. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .
4. Drain the engine oil. Refer to Engine Oil and Oil Filter Replacement.
5. Relieve the fuel system pressure. Refer to Fuel Pressure Relief .

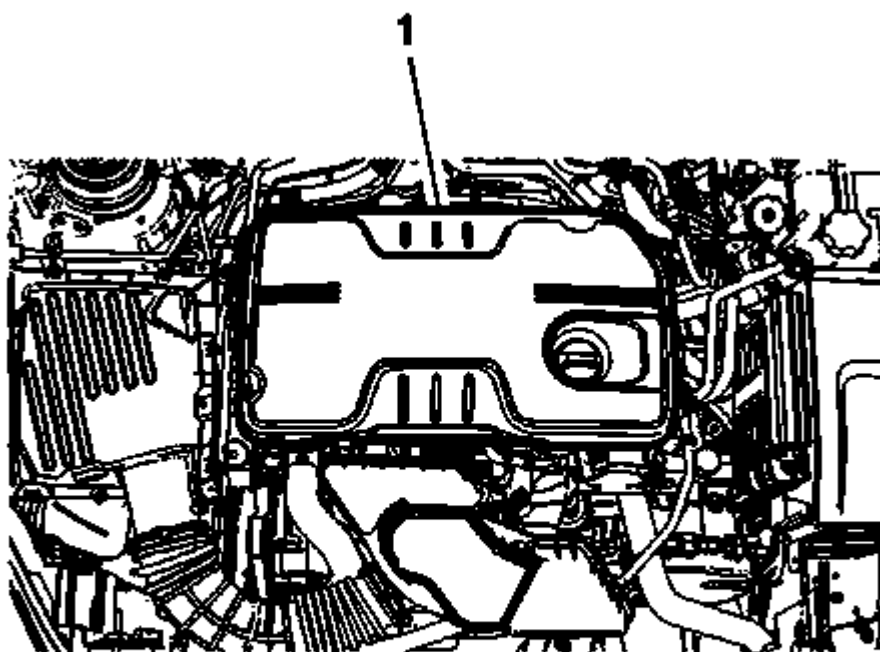


Fig. 240: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

6. Remove the intake manifold cover (1). Refer to Intake Manifold Cover Replacement.

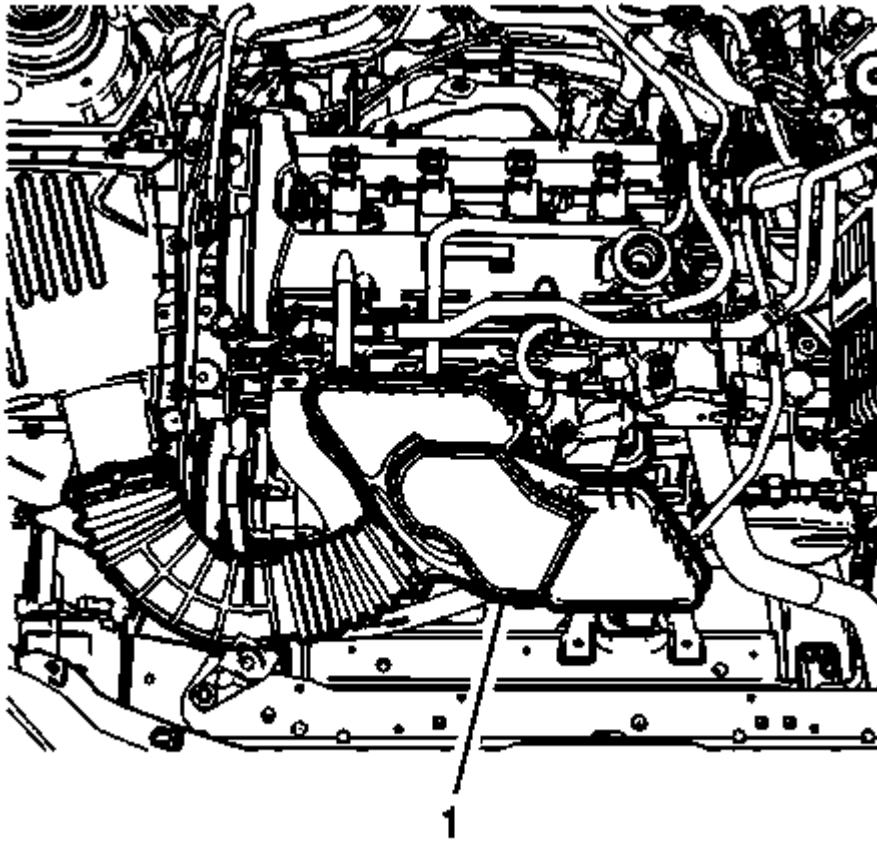


Fig. 241: Air Cleaner Outlet Duct Assembly
Courtesy of GENERAL MOTORS COMPANY

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

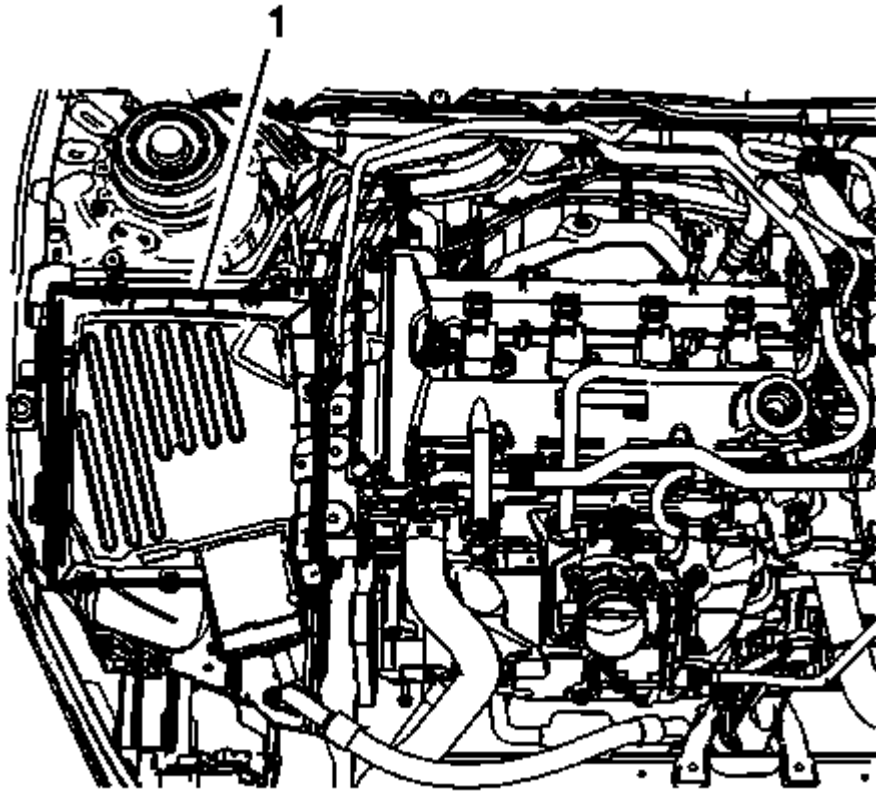


Fig. 242: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

8. Remove the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .

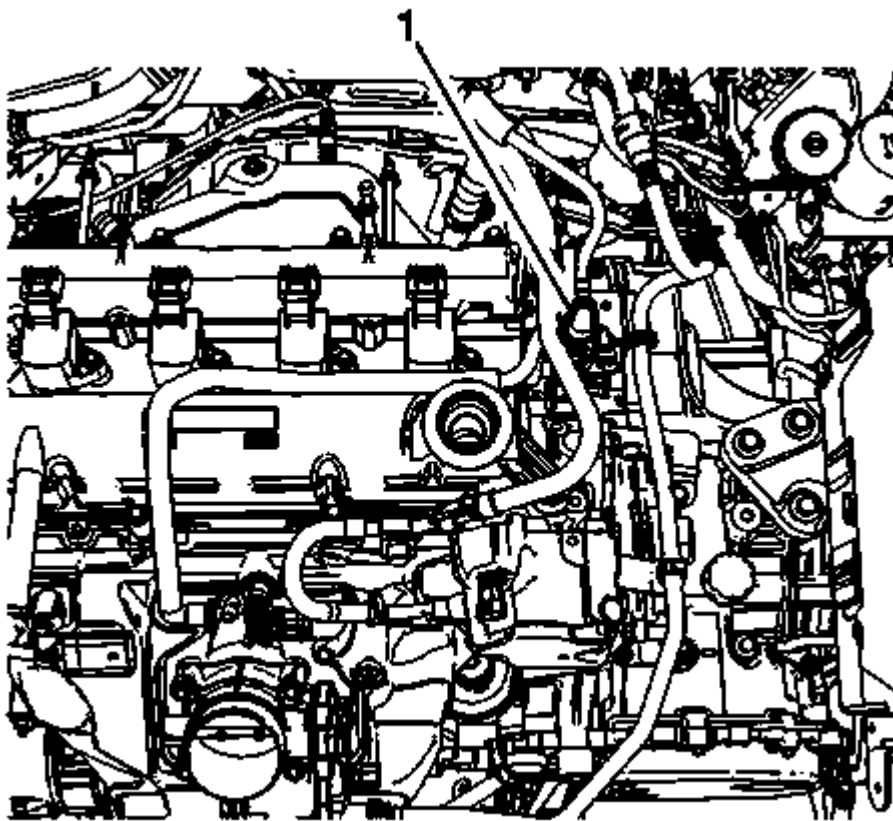


Fig. 243: Evaporative Emission (EVAP) Line Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the evaporative emission (EVAP) line quick connect fitting (1) from the EVAP purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service** .

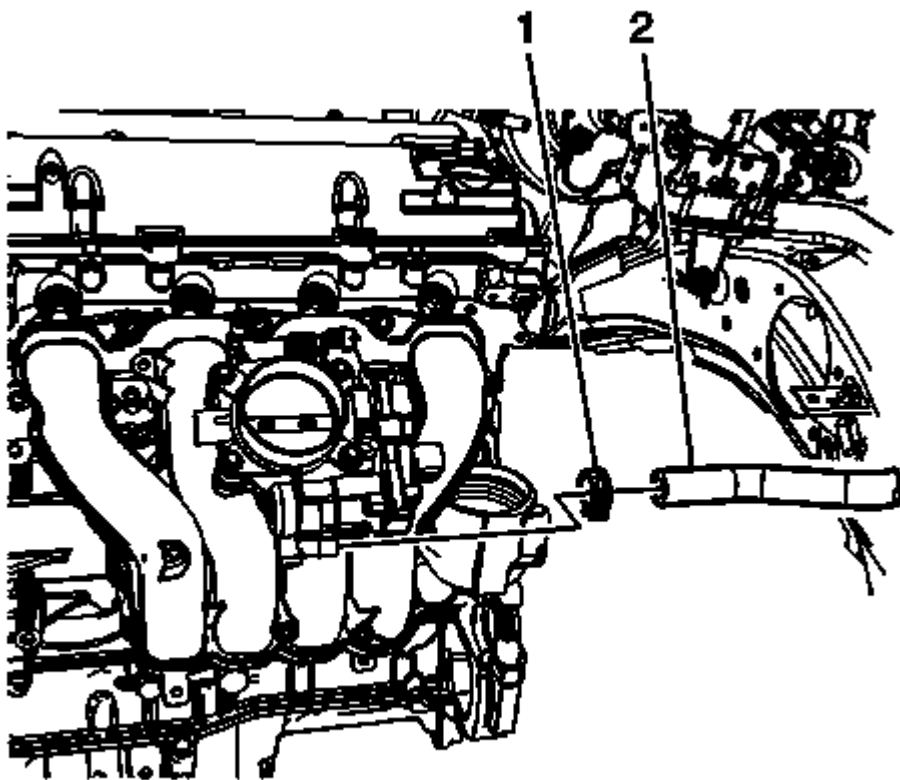


Fig. 244: Clamp And Power Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

10. Release the clamp (1) and remove the power brake booster vacuum pipe (2) from the intake manifold vacuum port.
11. Release the power brake booster vacuum pipe from the routing clips and remove the vacuum pipe.

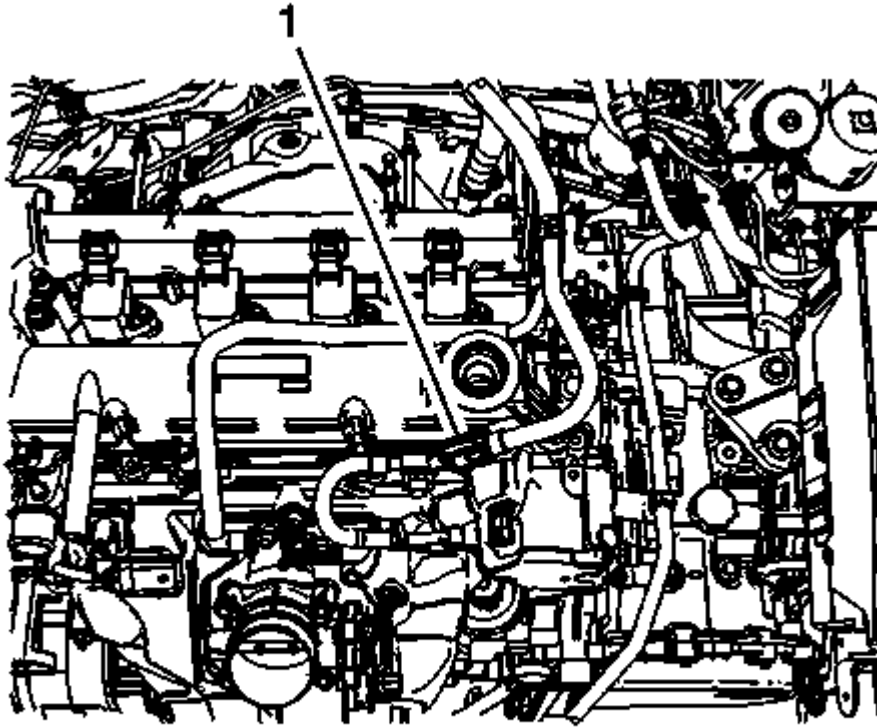


Fig. 245: Fuel Feed Line

Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the fuel feed line (1). Refer to **Metal Collar Quick Connect Fitting Service** .

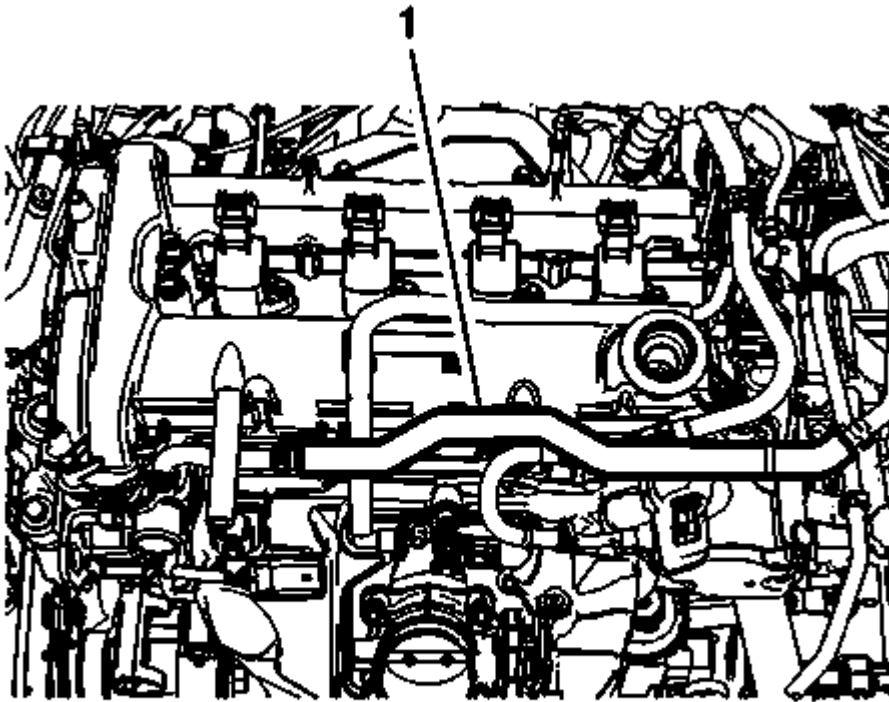


Fig. 246: Radiator Surge Tank Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

13. Remove the radiator surge tank inlet hose (1).

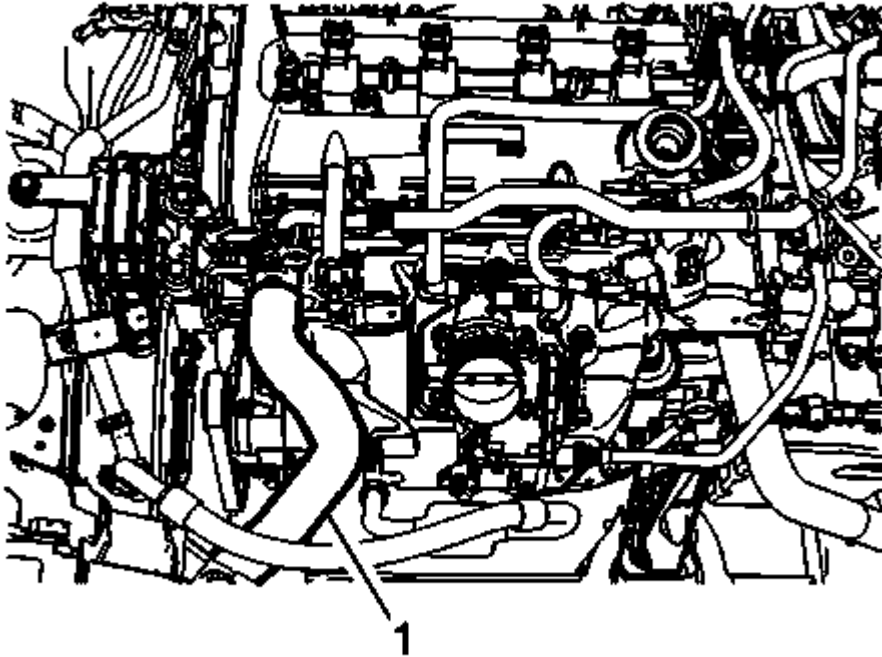


Fig. 247: Radiator Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

14. Remove the radiator inlet hose (1). Refer to **Radiator Inlet Hose Replacement (LUK)** .
15. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LUK)** .

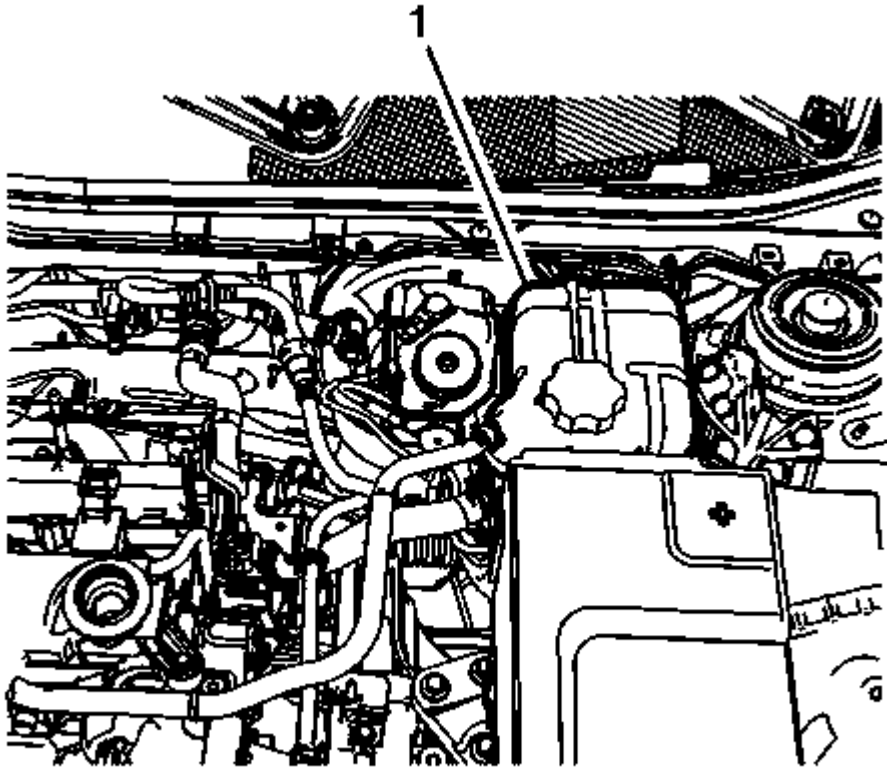


Fig. 248: Radiator Surge Tank

Courtesy of GENERAL MOTORS COMPANY

16. Remove the radiator surge tank (1). Refer to **Radiator Surge Tank Replacement** .

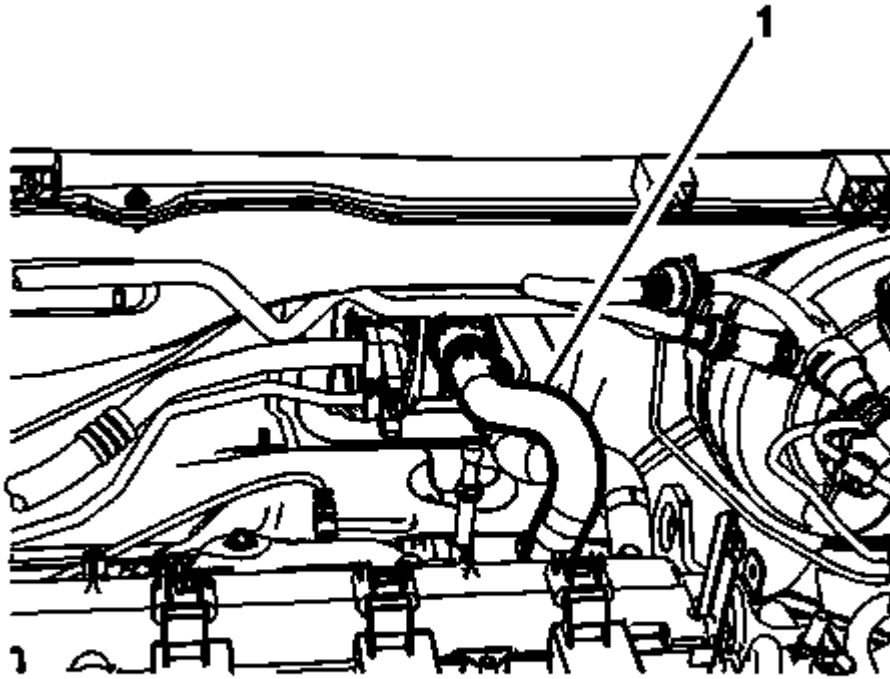


Fig. 249: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LUK)** .

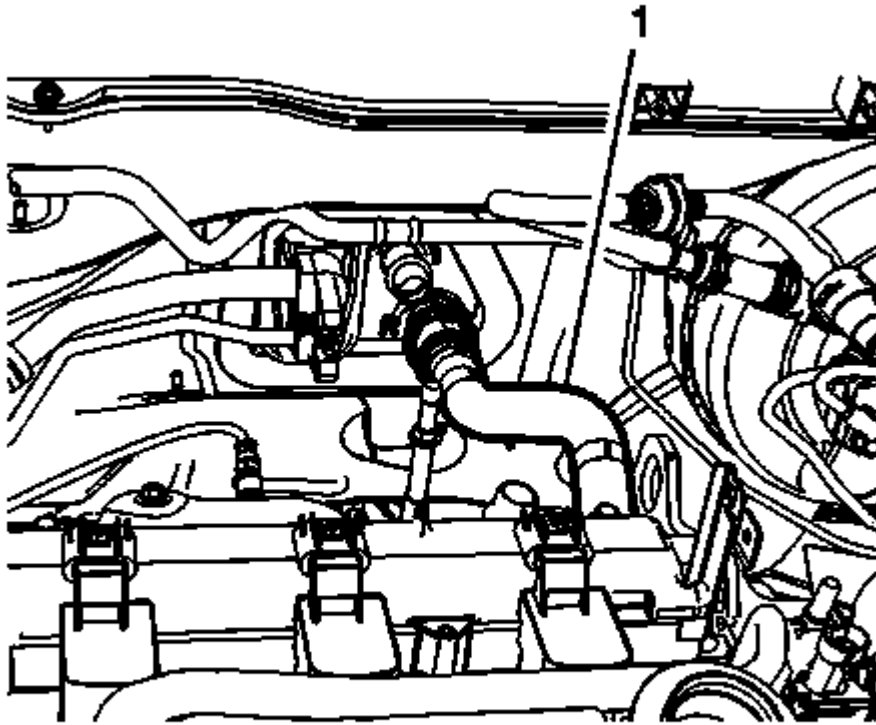


Fig. 250: Heater Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

18. Disconnect the heater outlet hose (1). Refer to **Heater Outlet Hose Replacement (LUK)** .

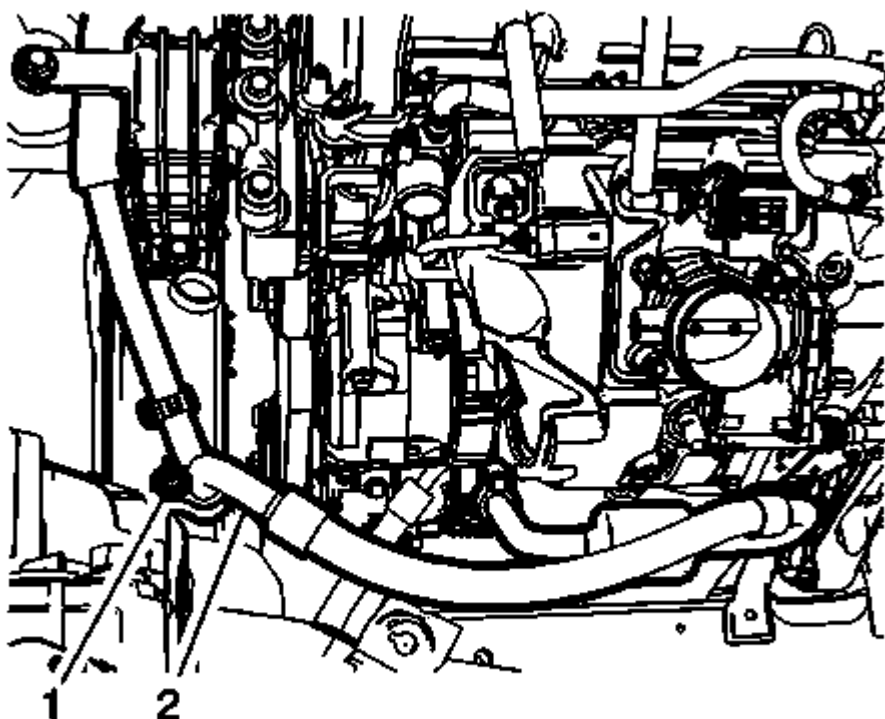


Fig. 251: Evaporator Outlet Hose And Nut
Courtesy of GENERAL MOTORS COMPANY

19. Remove the A/C compressor hose to evaporator outlet hose nut (1).
20. Disconnect the A/C compressor hose to evaporator outlet hose (2).

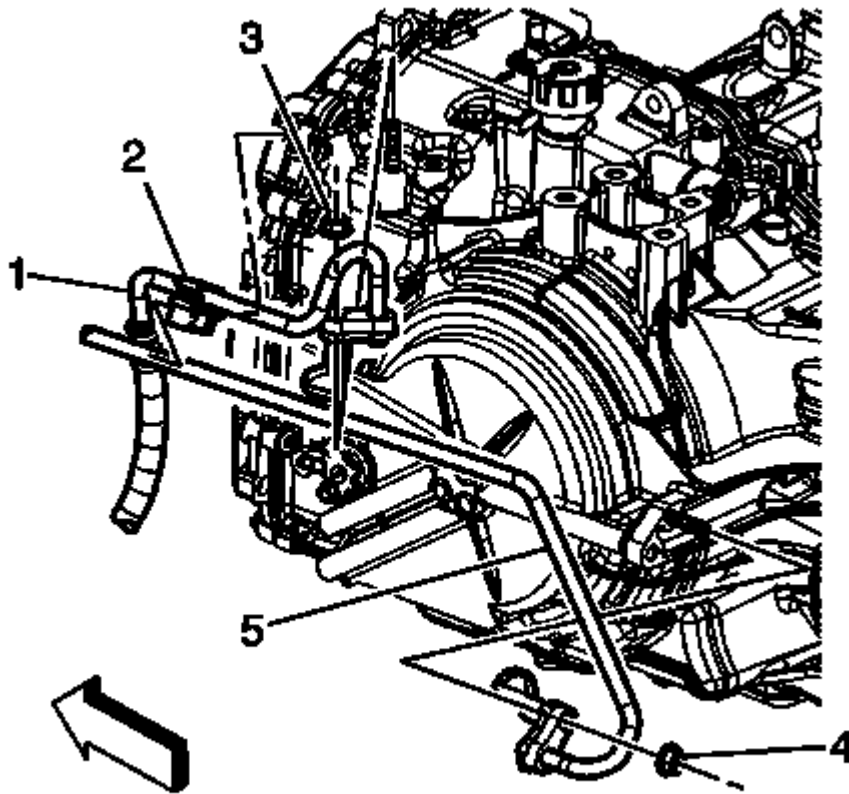


Fig. 252: Identifying Cooler Inlet & Outlet Hoses
Courtesy of GENERAL MOTORS COMPANY

21. Remove the transmission fluid cooler inlet (1) and outlet (5) hoses from the retainer (2) on the control valve body cover.
22. Remove the transmission fluid cooler inlet hose nut (3) from the transmission.
23. Remove the transmission fluid cooler inlet hose (1) from the transmission.
24. Remove the transmission fluid cooler outlet hose nut (4) from the transmission.
25. Remove the transmission fluid cooler outlet hose (5) from the transmission.
26. Plug and/or cap the hose and transmission to prevent contamination.
27. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
28. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement**.
29. Remove the exhaust front pipe.

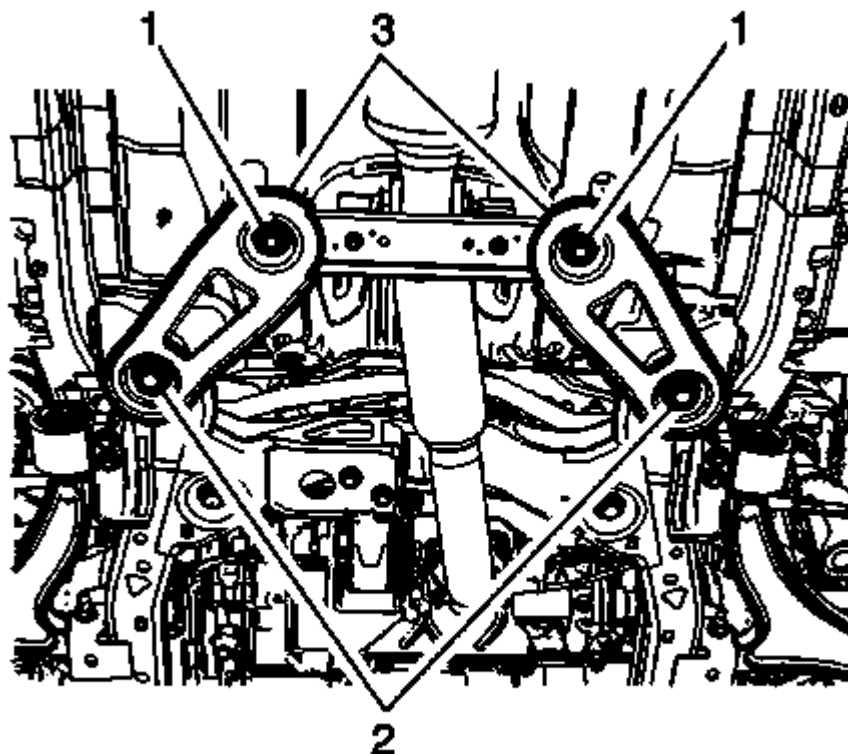


Fig. 253: Frame Reinforcements Bracket And Bolts
 Courtesy of GENERAL MOTORS COMPANY

30. Remove the frame reinforcements bracket bolts (1) and (2).
31. Remove the frame reinforcements bracket (3).
32. Remove the starter.

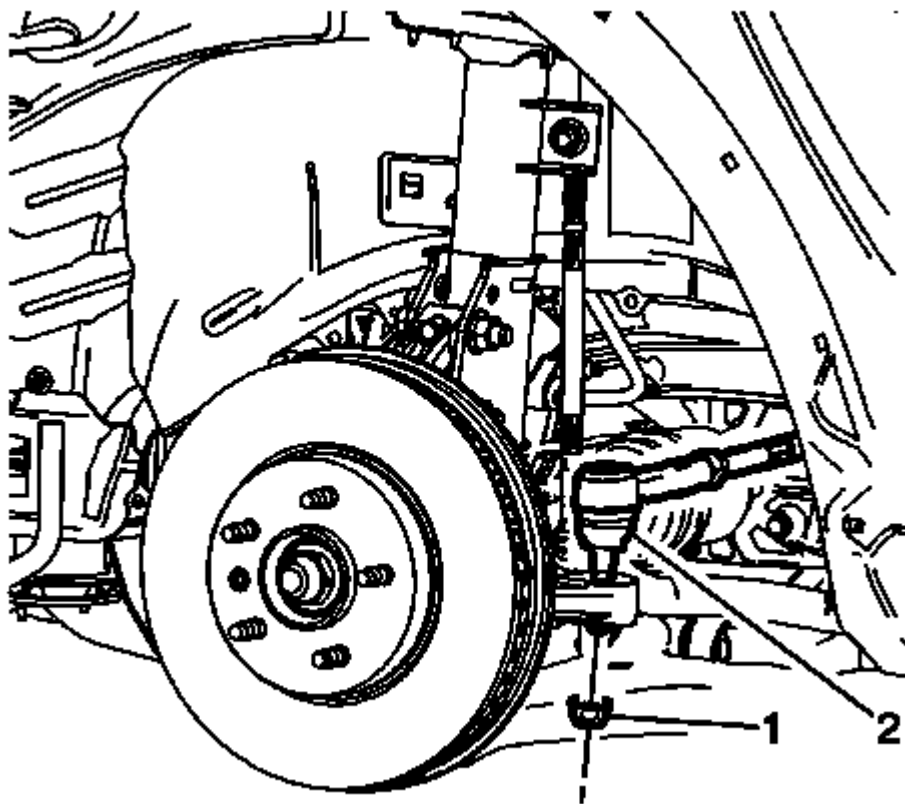


Fig. 254: Steering Linkage Outer Tie Rod Nut And Tie Rod
Courtesy of GENERAL MOTORS COMPANY

33. Remove the steering linkage outer tie rod nut (1) and tie rod (2). Refer to **Steering Linkage Outer Tie Rod Replacement** .

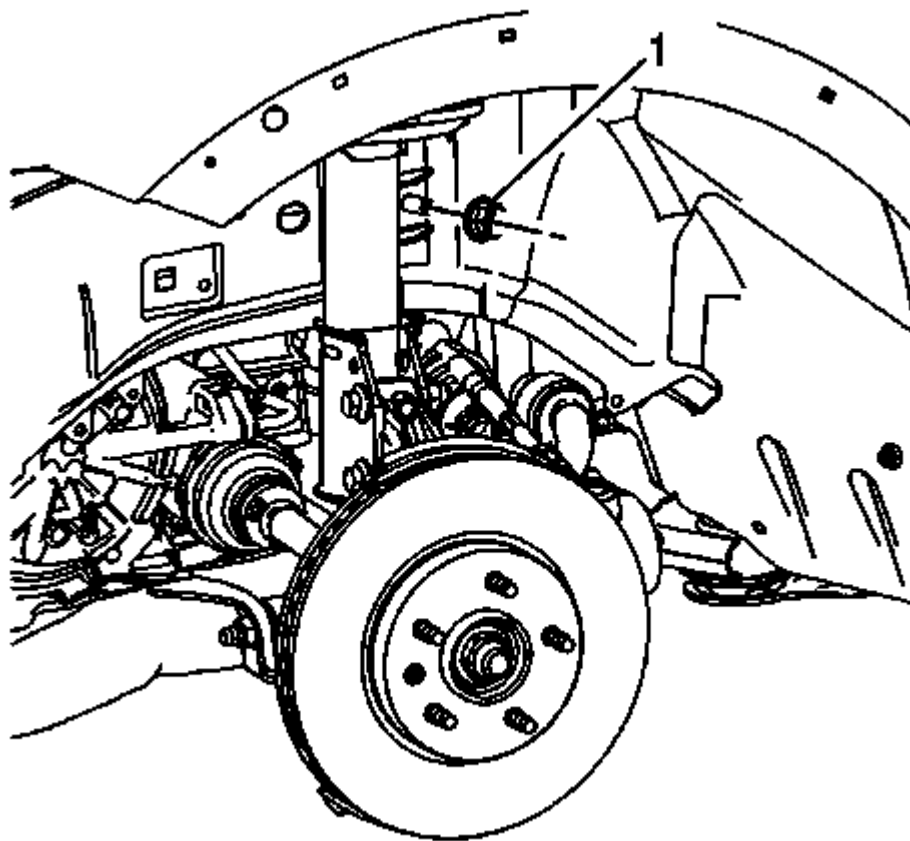


Fig. 255: Stabilizer Link And Strut Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not allow the stabilizer link ball stud to rotate while removing the link nut.

34. Remove the nut (1) and separate the stabilizer link from the strut assembly. Refer to **Stabilizer Shaft Link Replacement** .

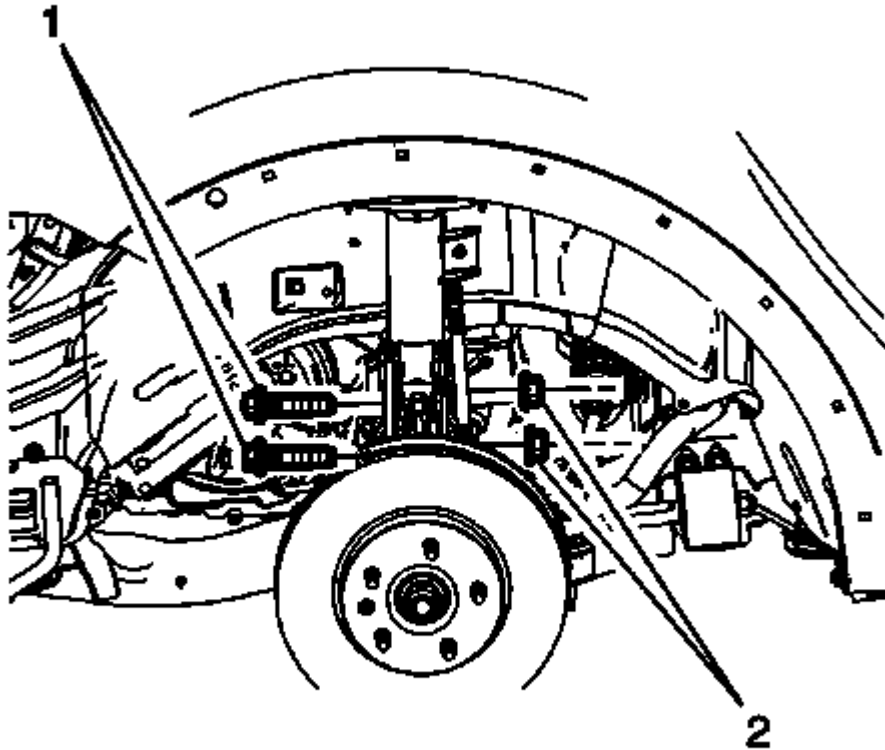


Fig. 256: Steering Knuckle To Strut Bolts And Nuts
Courtesy of GENERAL MOTORS COMPANY

35. Remove the steering knuckle to strut bolts (1) and nuts (2). Refer to **Strut Assembly Removal and Installation (GNB)** , **Strut Assembly Removal and Installation (GNA)** .

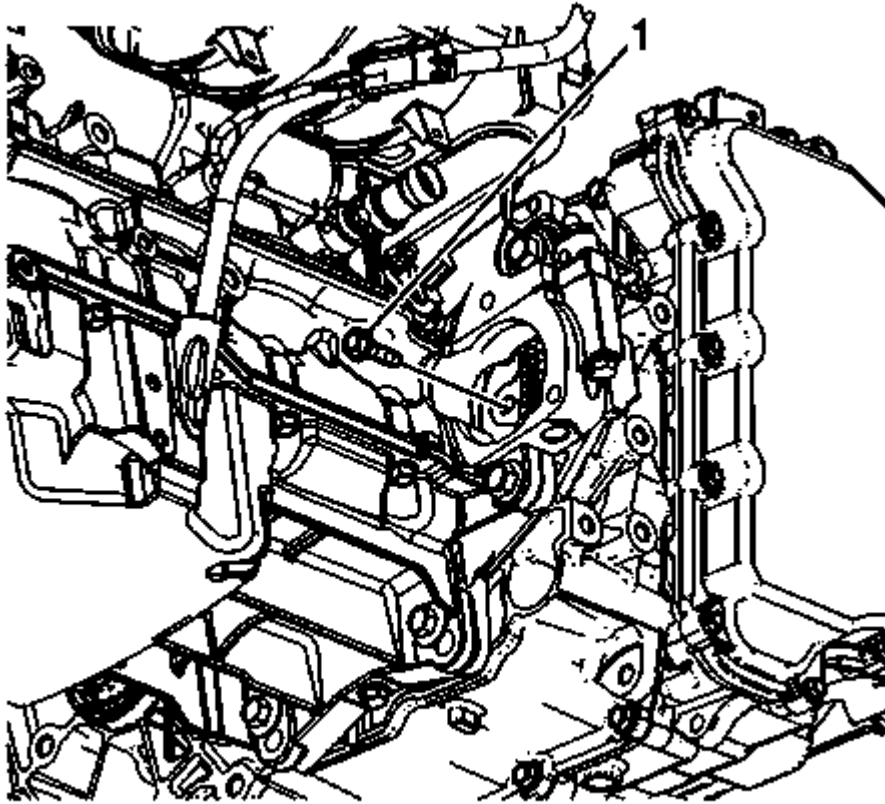


Fig. 257: Identifying Starter Bolts

Courtesy of GENERAL MOTORS COMPANY

36. Mark the relationship of the flywheel to the torque converter for reassembly.
37. Remove the torque converter to flywheel bolt (1).

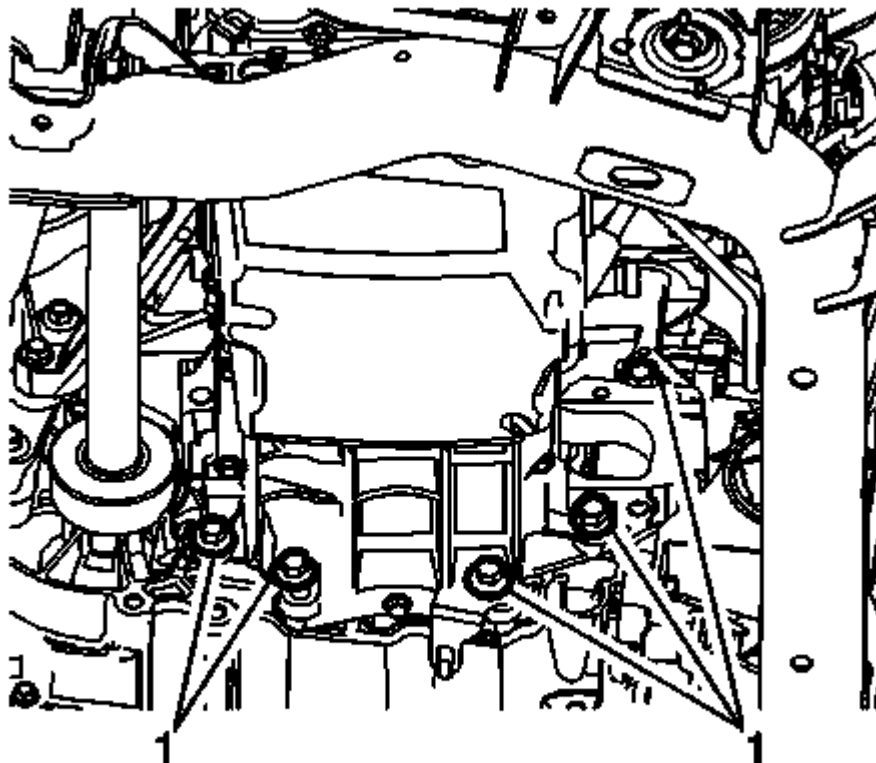


Fig. 258: Lower Transmission Bolts

Courtesy of GENERAL MOTORS COMPANY

38. Remove the lower transmission bolts (1).

NOTE: 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.

39. Position a engine support table under the powertrain assembly.

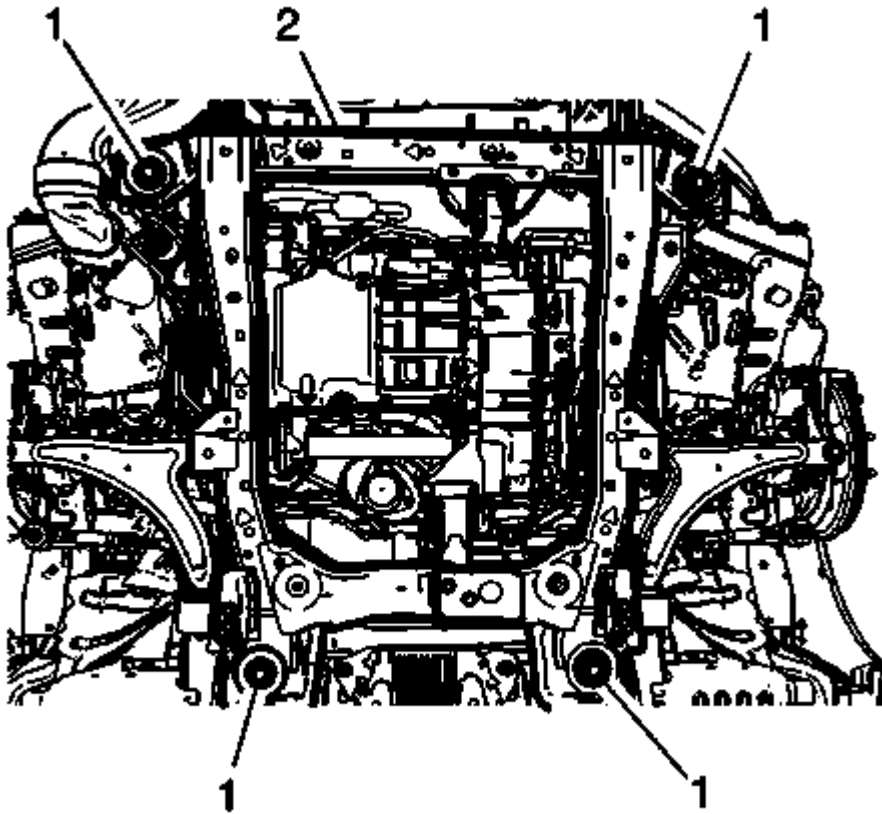


Fig. 259: Frame Bolts

Courtesy of GENERAL MOTORS COMPANY

40. Remove the frame bolts (1).
41. Lower the vehicle on the engine support table.

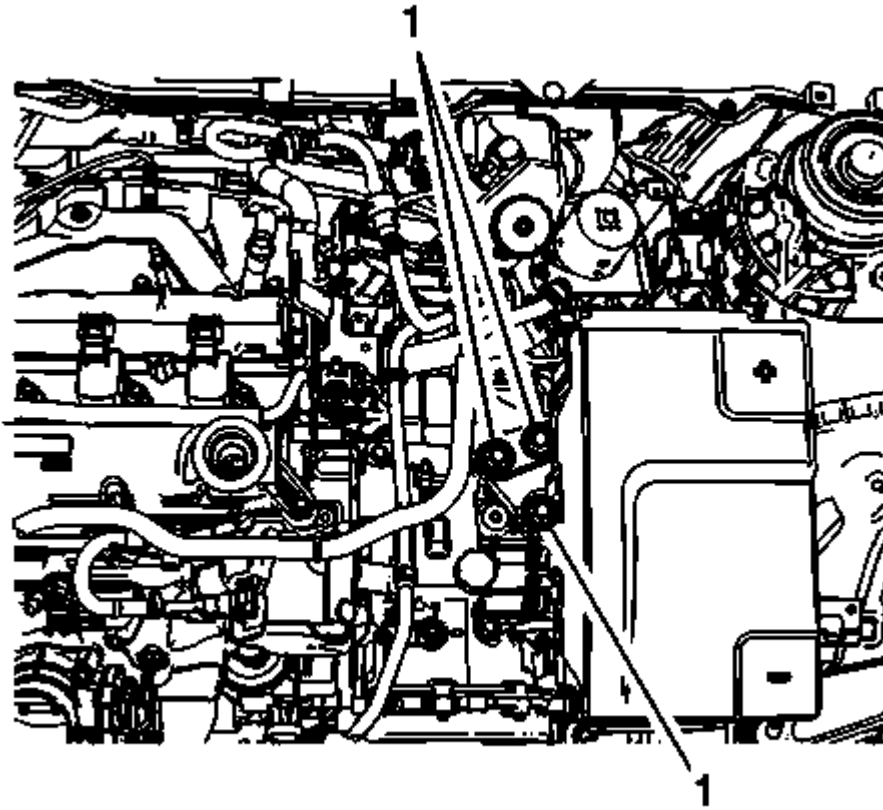


Fig. 260: Transmission Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

42. Remove the transmission mount bolts (1).

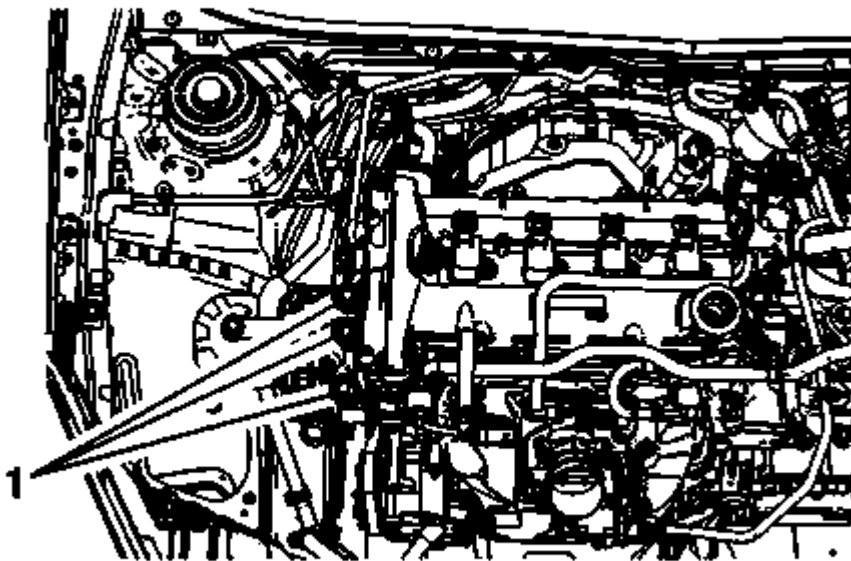


Fig. 261: Engine Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

43. Remove the engine mount bolts (1).
44. Disconnect electrical connector as necessary.
45. Disconnect coolant hoses as necessary.

NOTE: When lowering the engine/transaxle assembly, verify all brake lines, shifter cables and other components are free during removal

46. Lower the engine table and raise the body on the hoist until the engine/transaxle and cradle are free from the vehicle.

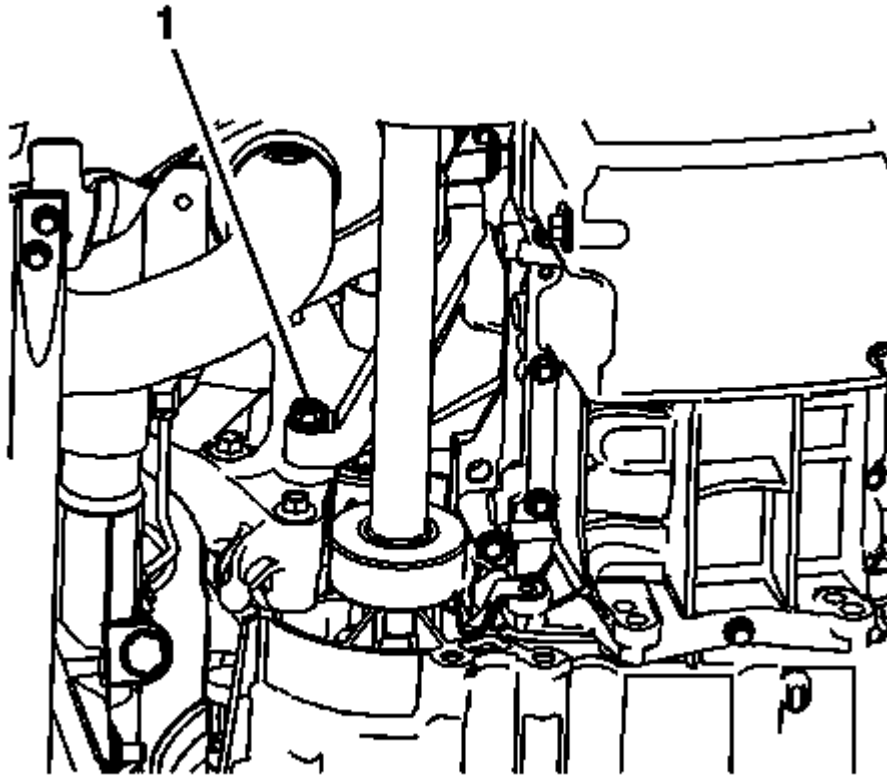


Fig. 262: Transmission Brace

Courtesy of GENERAL MOTORS COMPANY

47. Remove the transmission brace (1).

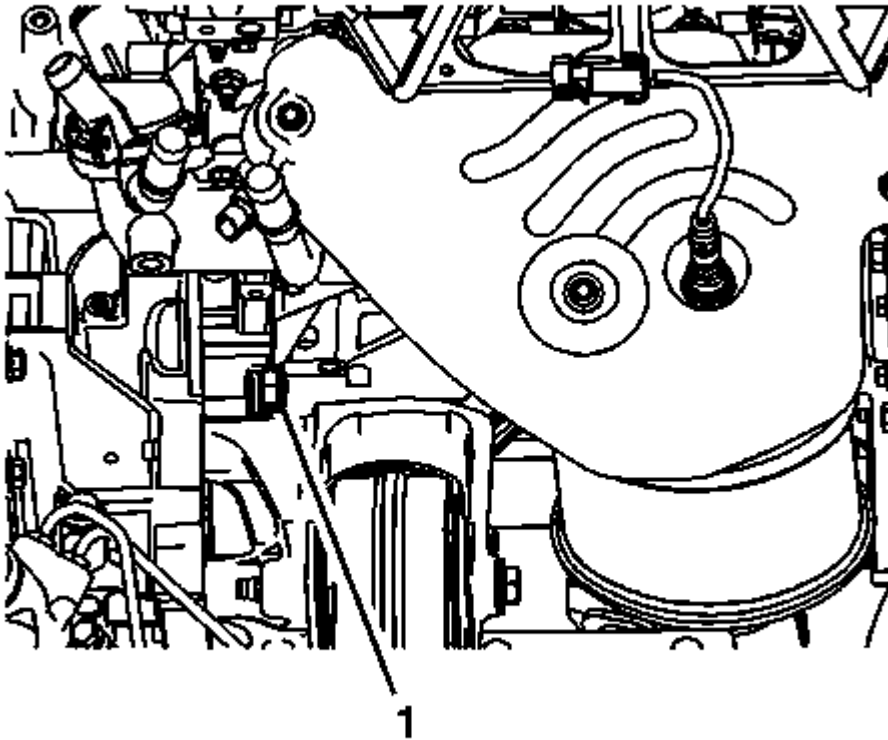


Fig. 263: Lower Trans Bolts

Courtesy of GENERAL MOTORS COMPANY

48. Remove the lower trans bolts (1).

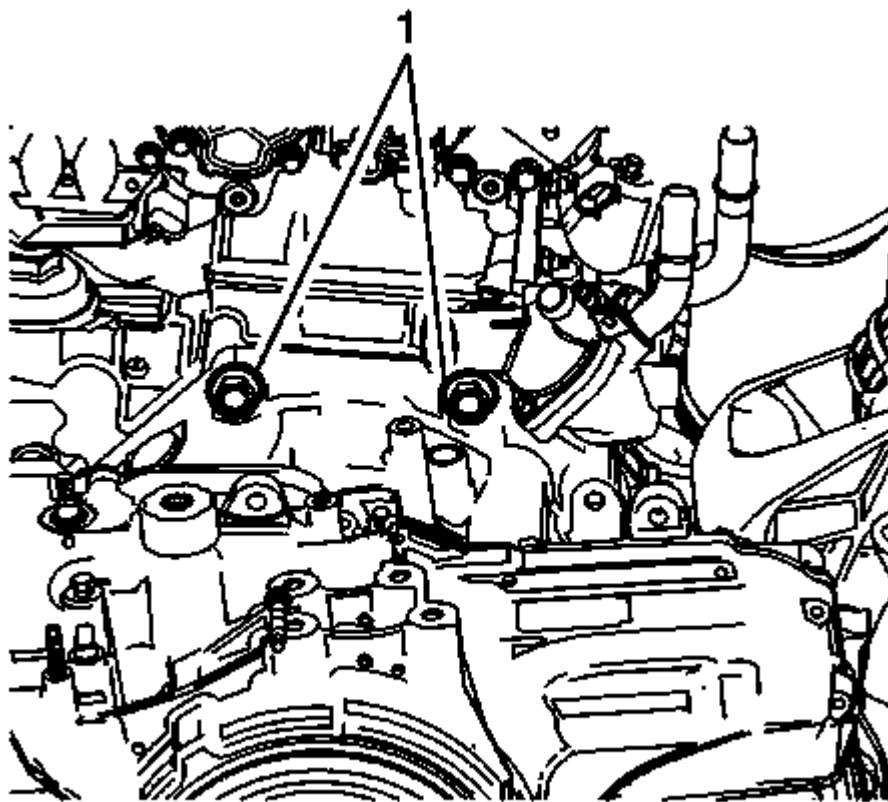


Fig. 264: Upper Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

49. Remove the upper transmission bolts (1).
50. Separate the engine from the transmission.
51. Install the engine to a suitable engine stand.

Installation Procedure

1. Remove the engine from the engine stand.
2. Install the transmission to the engine.

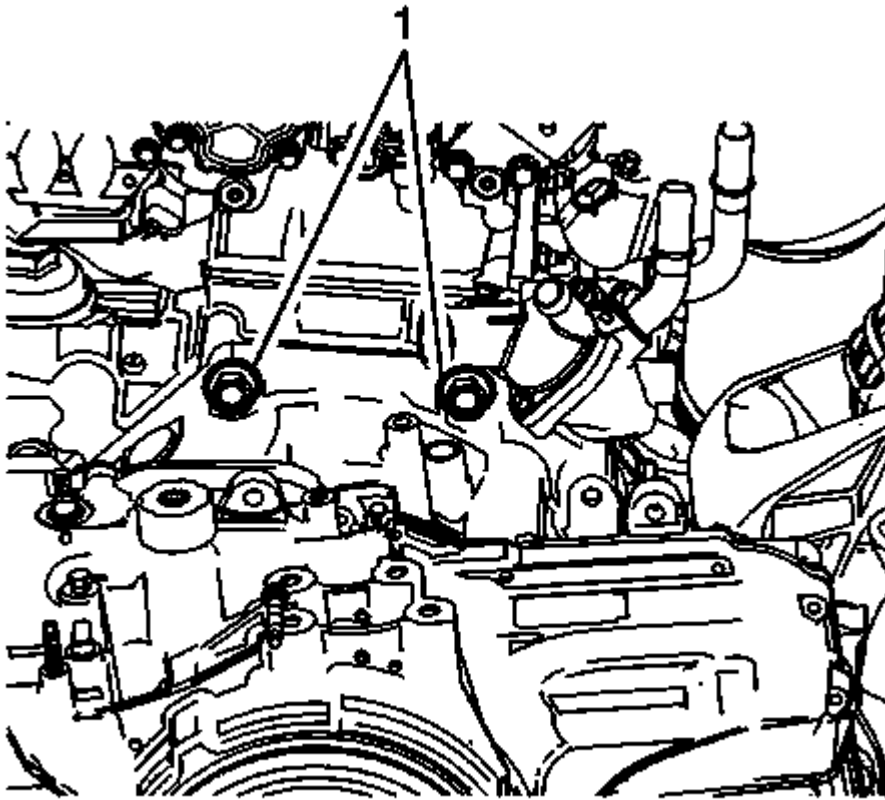


Fig. 265: Upper Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the upper transmission bolts (1) and tighten to 75 (55 lb ft).

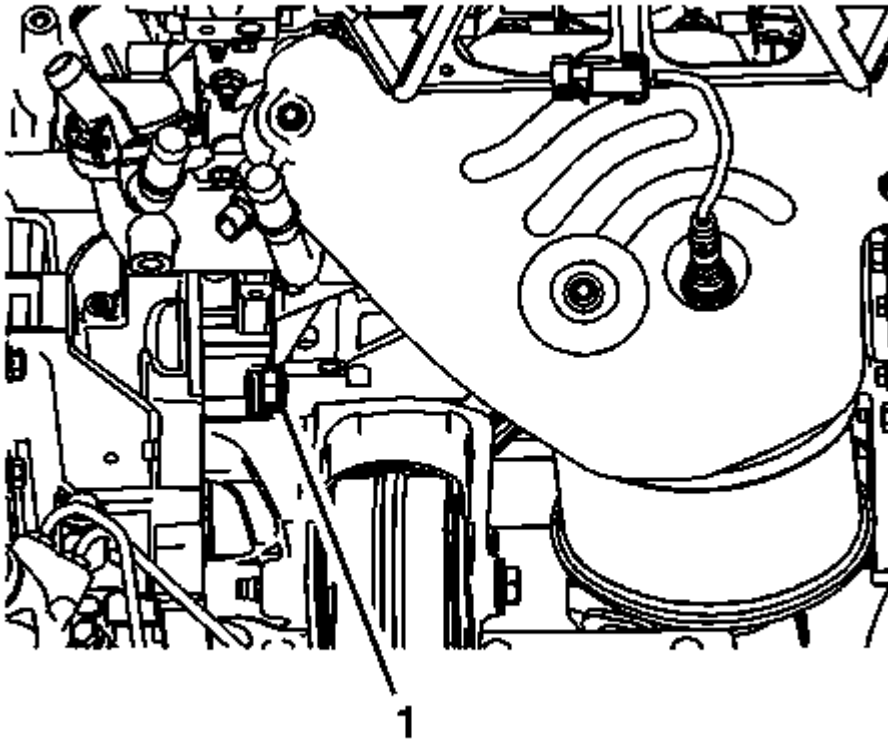


Fig. 266: Lower Trans Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Install the upper transmission bolts (1) and tighten to 75 (55 lb ft).

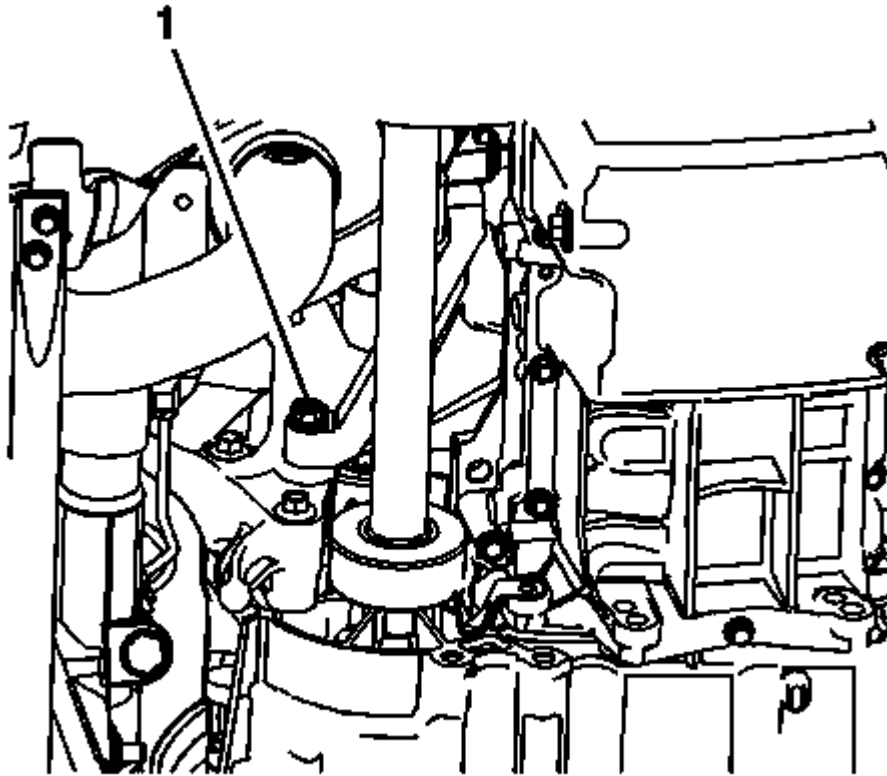


Fig. 267: Transmission Brace

Courtesy of GENERAL MOTORS COMPANY

5. Install the transmission brace (1) and tighten to 58 (43 lb ft).
6. Slowly lower the body onto the powertrain.

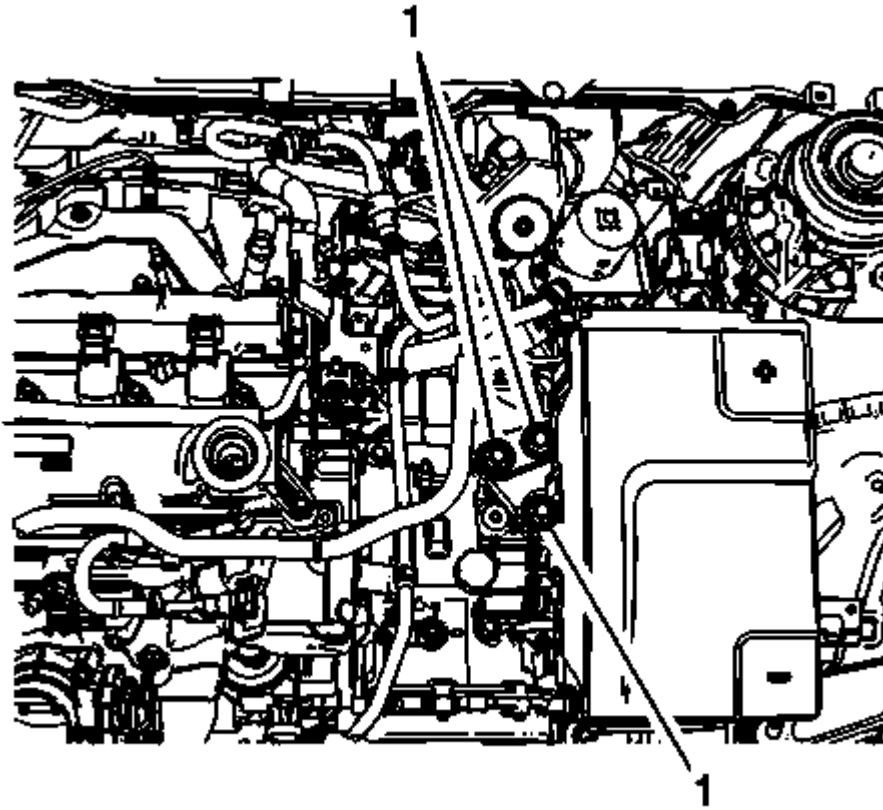


Fig. 268: Transmission Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the NEW left transmission mount to transmission bolts (1) and tighten to 50 (37 lb ft).

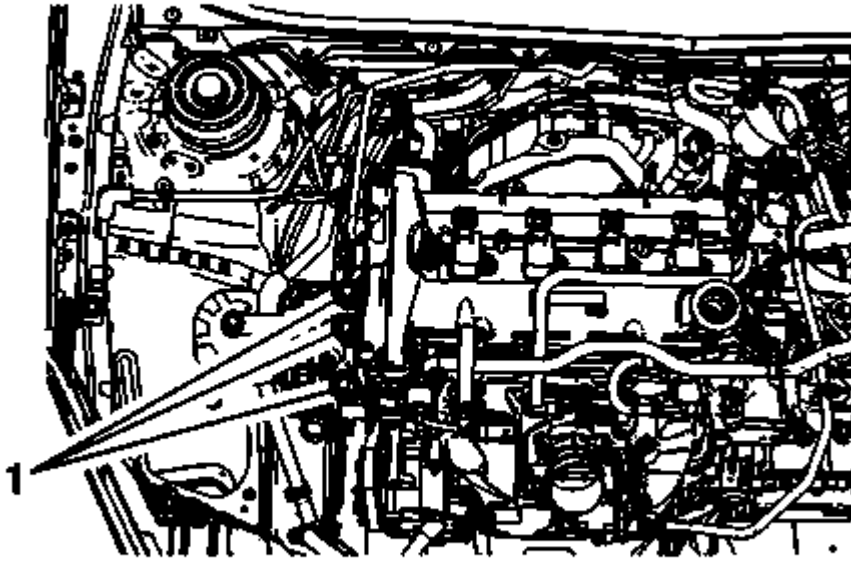


Fig. 269: Engine Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

8. Install the NEW right side engine mount bolts (1) and tighten to 62 (46 lb ft).

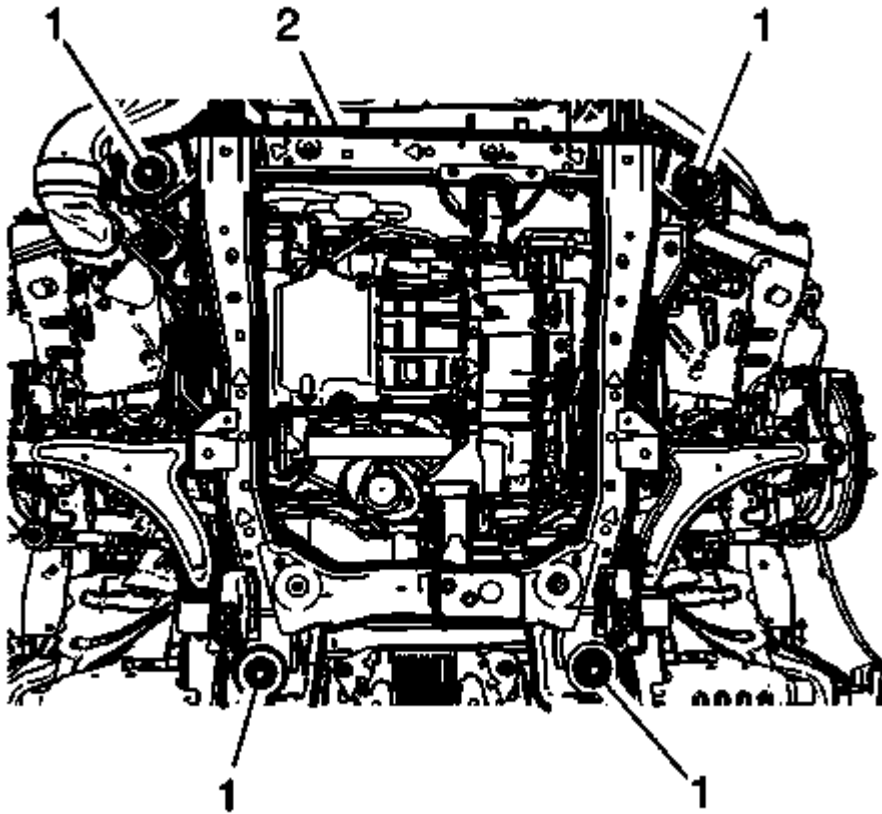


Fig. 270: Frame Bolts

Courtesy of GENERAL MOTORS COMPANY

9. Install the frame retaining bolts (1) then tighten the bolts to 160 (118 lb ft)

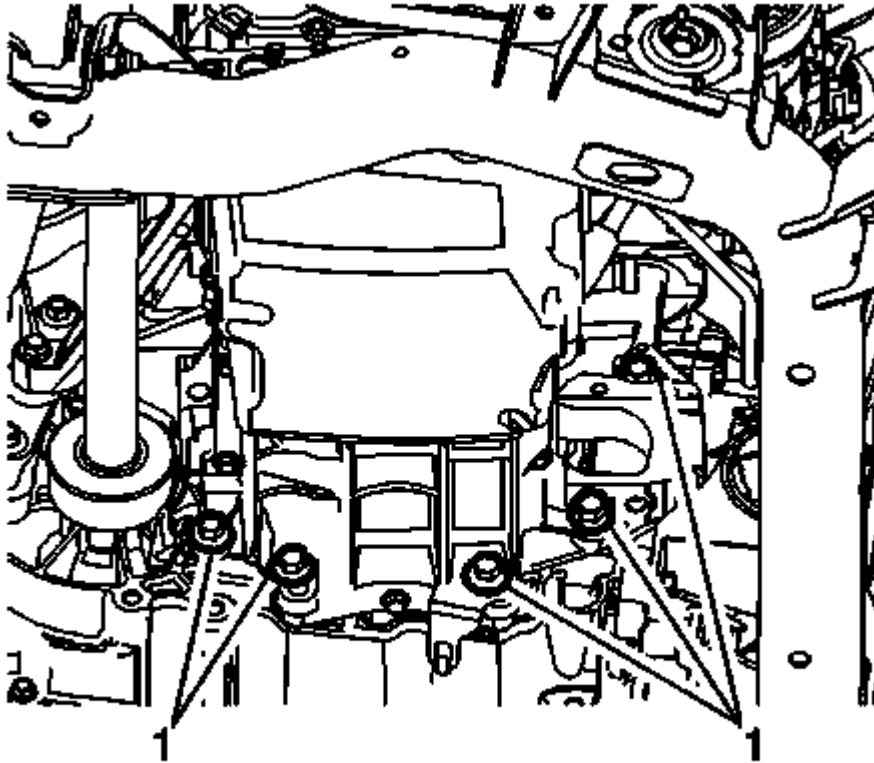


Fig. 271: Lower Transmission Bolts

Courtesy of GENERAL MOTORS COMPANY

10. Install the lower transmission bolts (1) and tighten to 75 (55 lb ft).

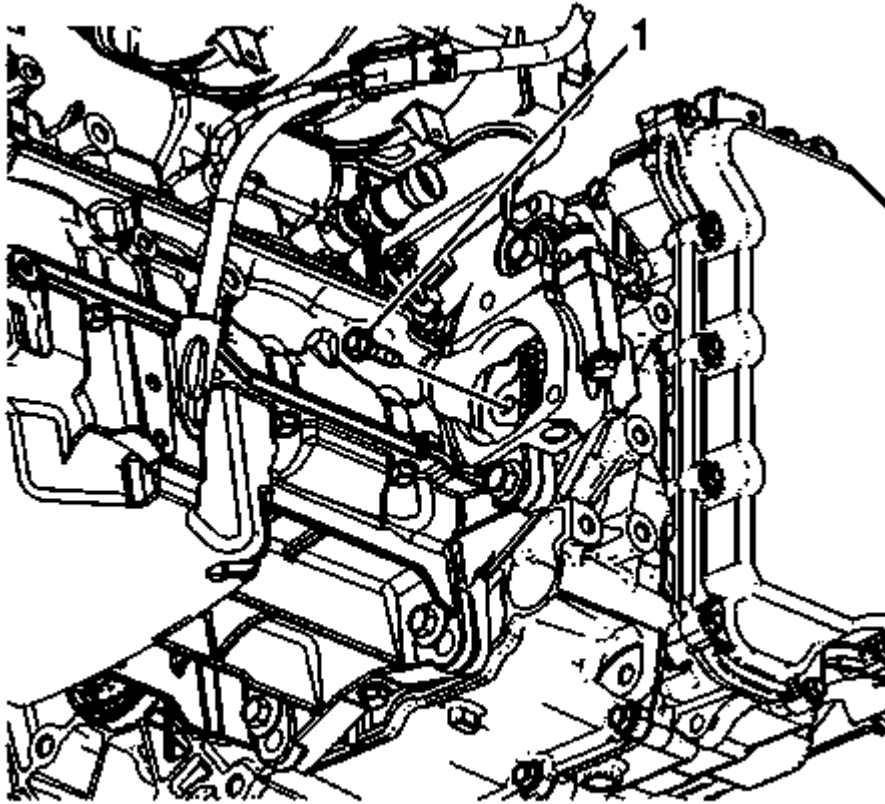


Fig. 272: Identifying Starter Bolts

Courtesy of GENERAL MOTORS COMPANY

11. Install the torque converter to flywheel bolts (1) and tighten to 62 (46 lb ft)
12. Install the starter.
13. Install the exhaust front pipe.

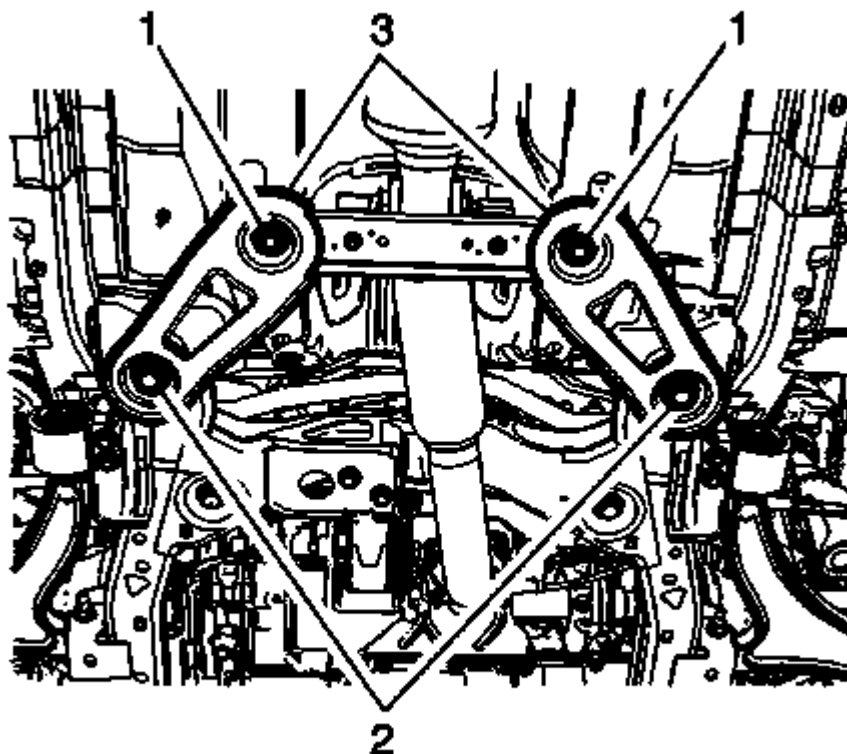


Fig. 273: Frame Reinforcements Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Install the frame reinforcements bracket (3) then tighten the bolts (1) and (2) to 42 (31 lb ft).

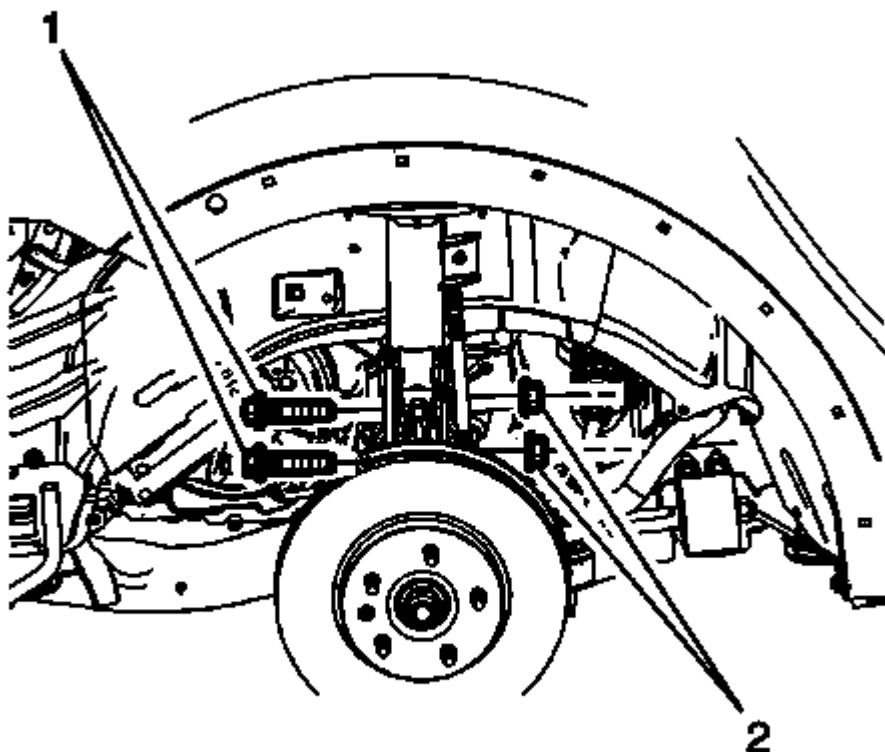


Fig. 274: Steering Knuckle To Strut Bolts And Nuts
Courtesy of GENERAL MOTORS COMPANY

15. Install the NEW strut to the steering knuckle using new bolts (1) and nuts (2) and tighten to 185 (136 lb ft).
16. Inspect the stabilizer link seals for damage and replace the link as necessary.

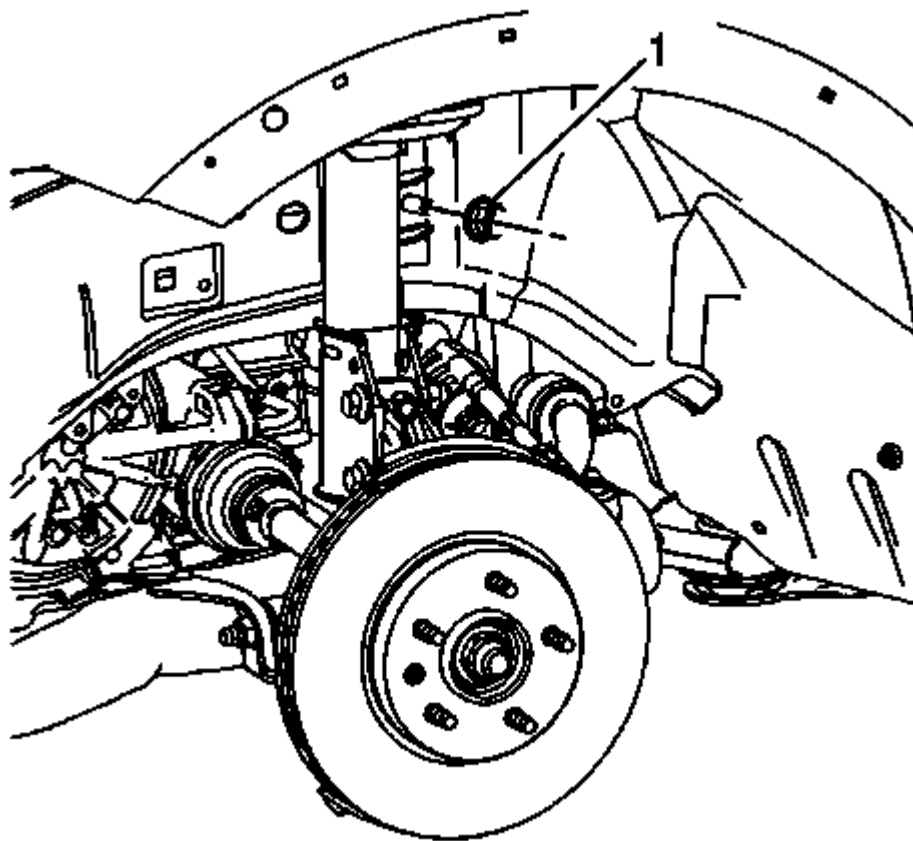


Fig. 275: Stabilizer Link And Strut Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use the proper size allen wrench to keep the stabilizer link ball stud from rotate while installing the nut.

17. Install the stabilizer link to the strut nut (1) and tighten to 65 (48 lb ft)

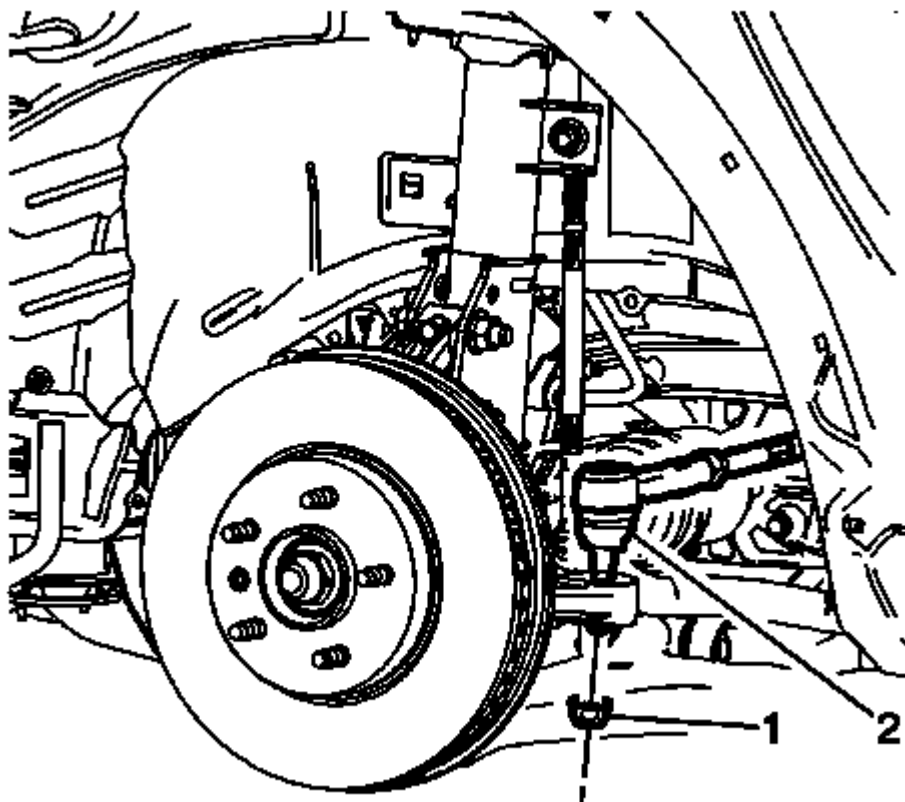


Fig. 276: Steering Linkage Outer Tie Rod Nut And Tie Rod
Courtesy of GENERAL MOTORS COMPANY

18. Install the steering linkage outer tie rod (2). Refer to **Steering Linkage Outer Tie Rod Replacement**
19. Install the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .

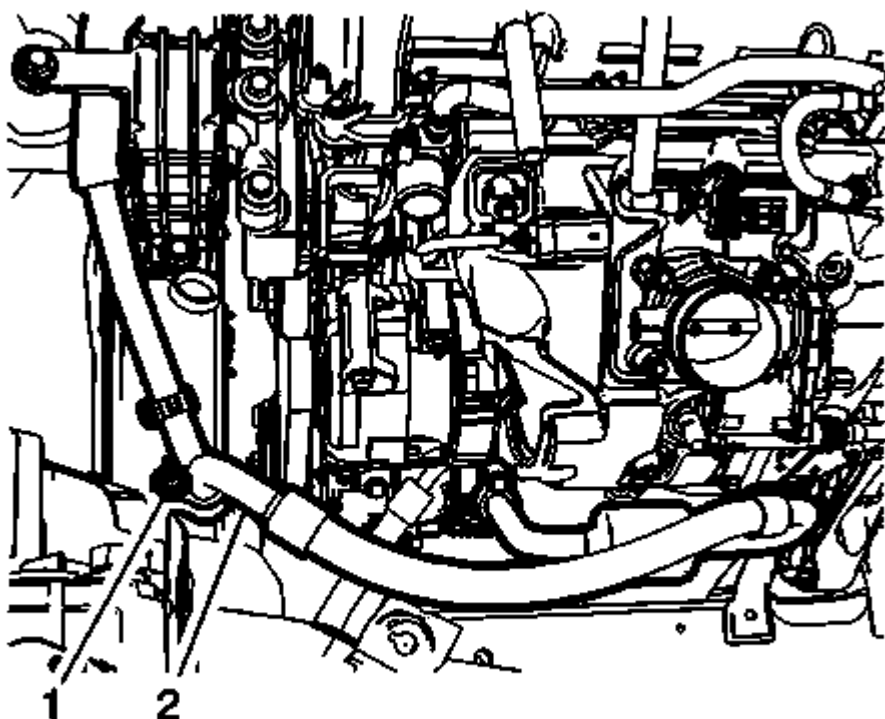


Fig. 277: Evaporator Outlet Hose And Nut
Courtesy of GENERAL MOTORS COMPANY

20. Install the air conditioning compressor and condenser hose (2). Refer to **Air Conditioning Compressor and Condenser Hose Replacement** .

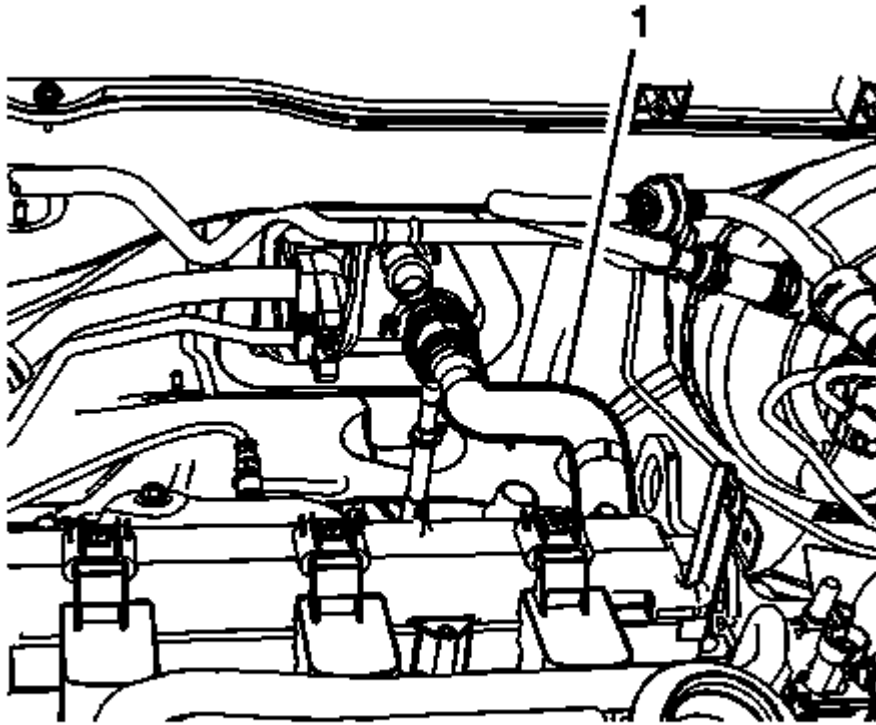


Fig. 278: Heater Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

21. Connect the heater outlet hose (1). Refer to **Heater Outlet Hose Replacement (LUK)** .

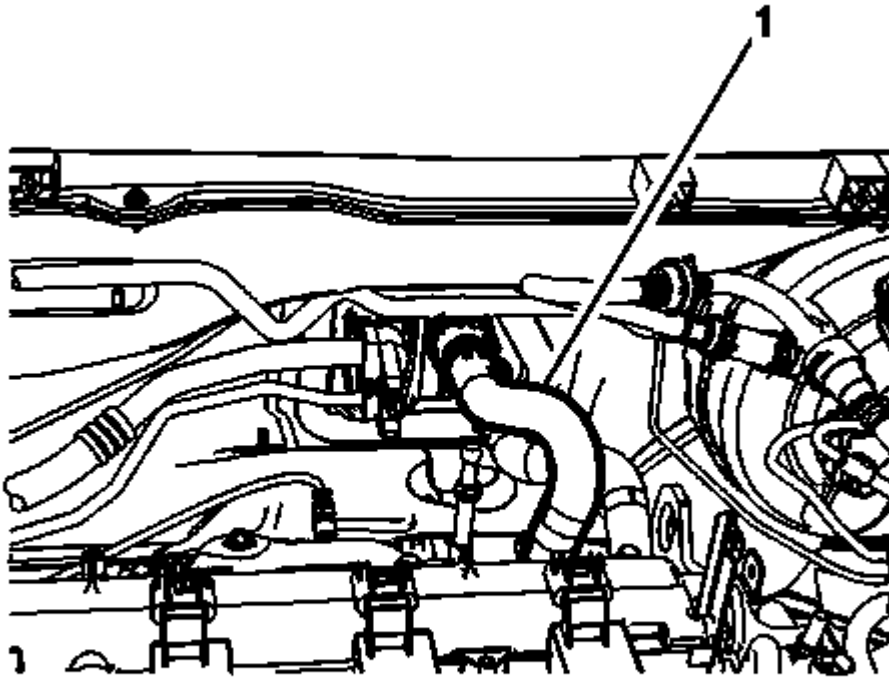


Fig. 279: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

22. Connect the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LUK)** .

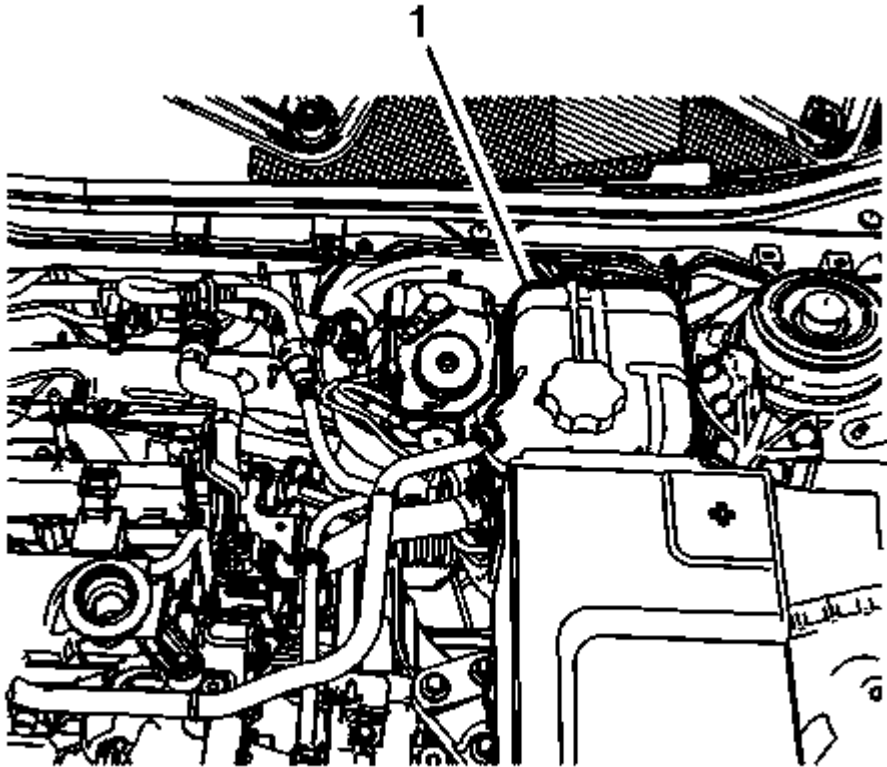


Fig. 280: Radiator Surge Tank

Courtesy of GENERAL MOTORS COMPANY

23. Install the radiator surge tank (1). Refer to **Radiator Surge Tank Replacement** .

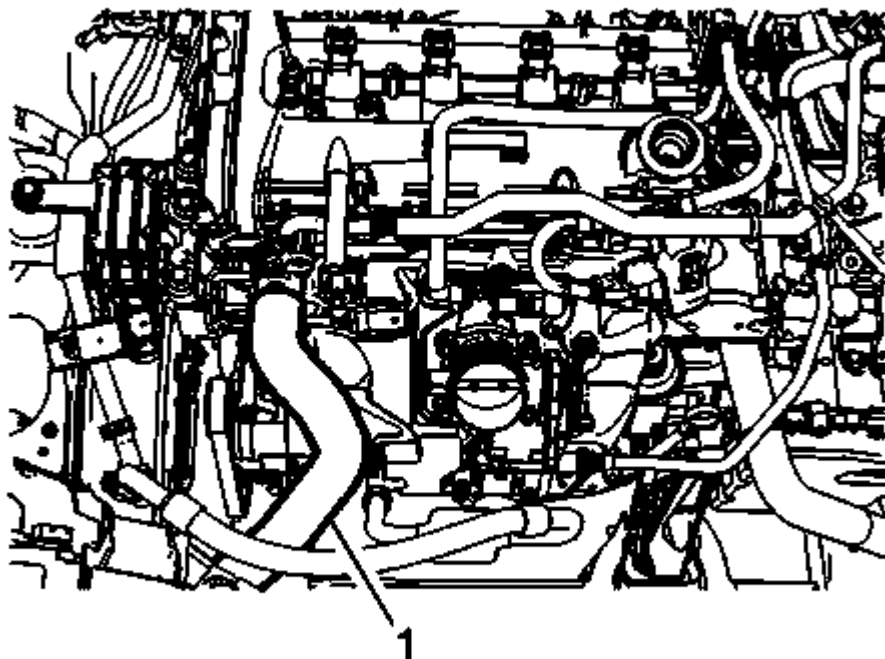


Fig. 281: Radiator Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

24. Install the radiator inlet hose (1). Refer to **Radiator Inlet Hose Replacement (LUK)** .
25. Install radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LUK)** .

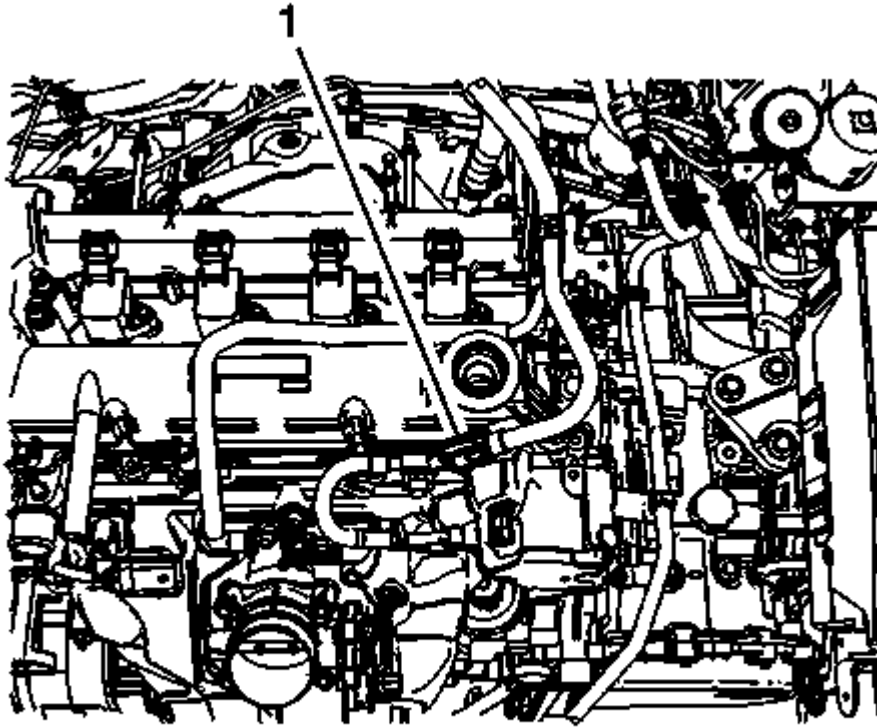


Fig. 282: Fuel Feed Line

Courtesy of GENERAL MOTORS COMPANY

26. Install the fuel feed line (1).

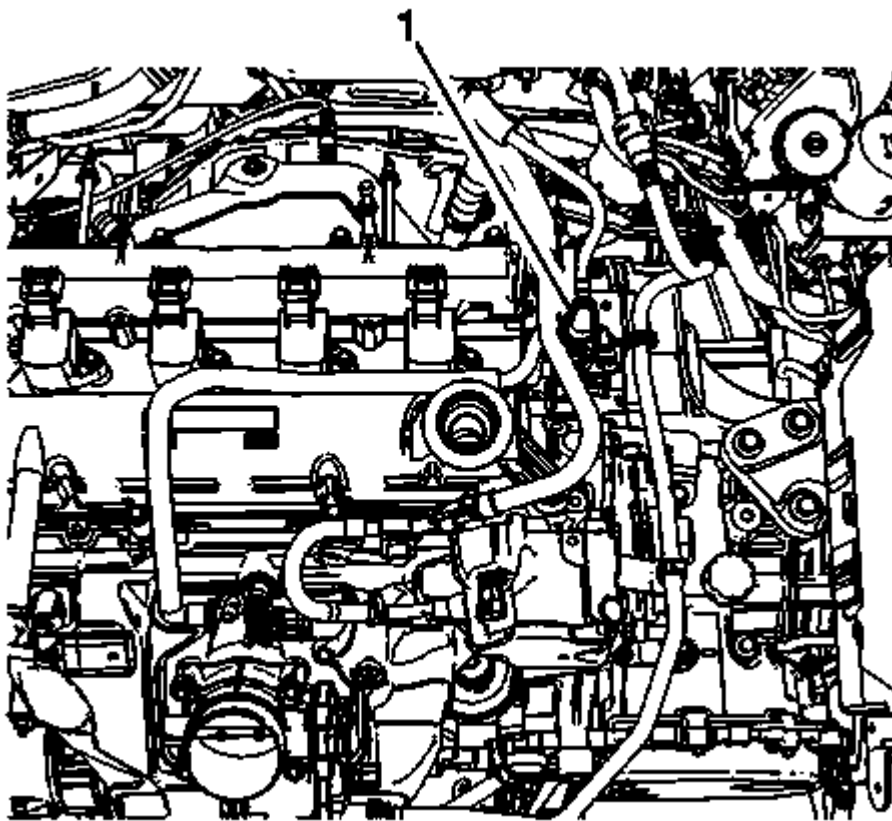


Fig. 283: Evaporative Emission (EVAP) Line Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

27. Connect the EVAP pipe (1).

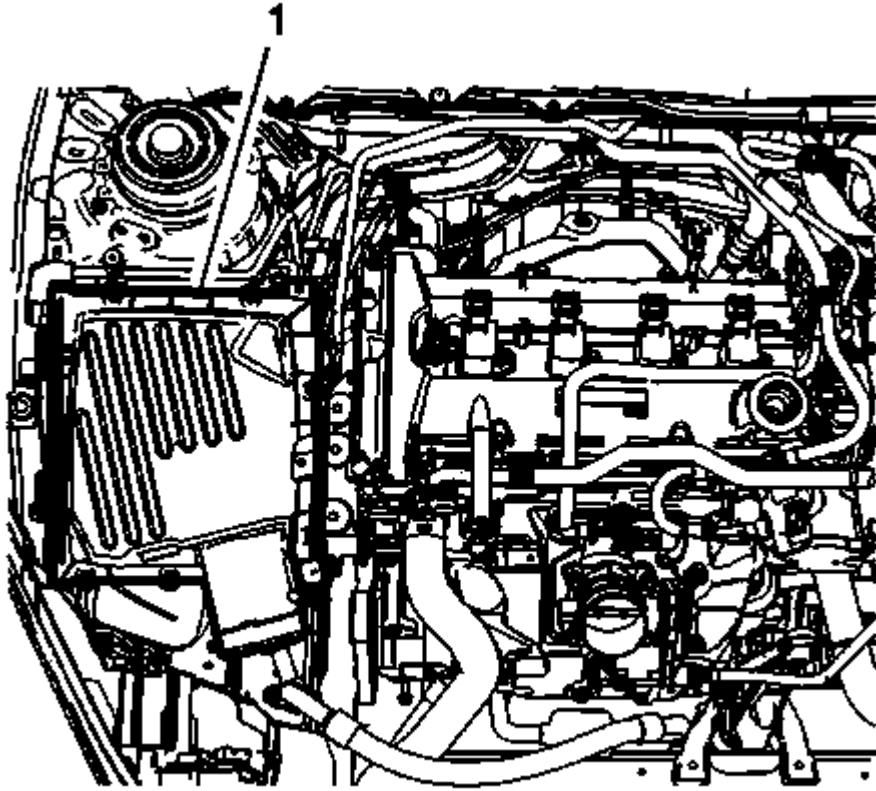


Fig. 284: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

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

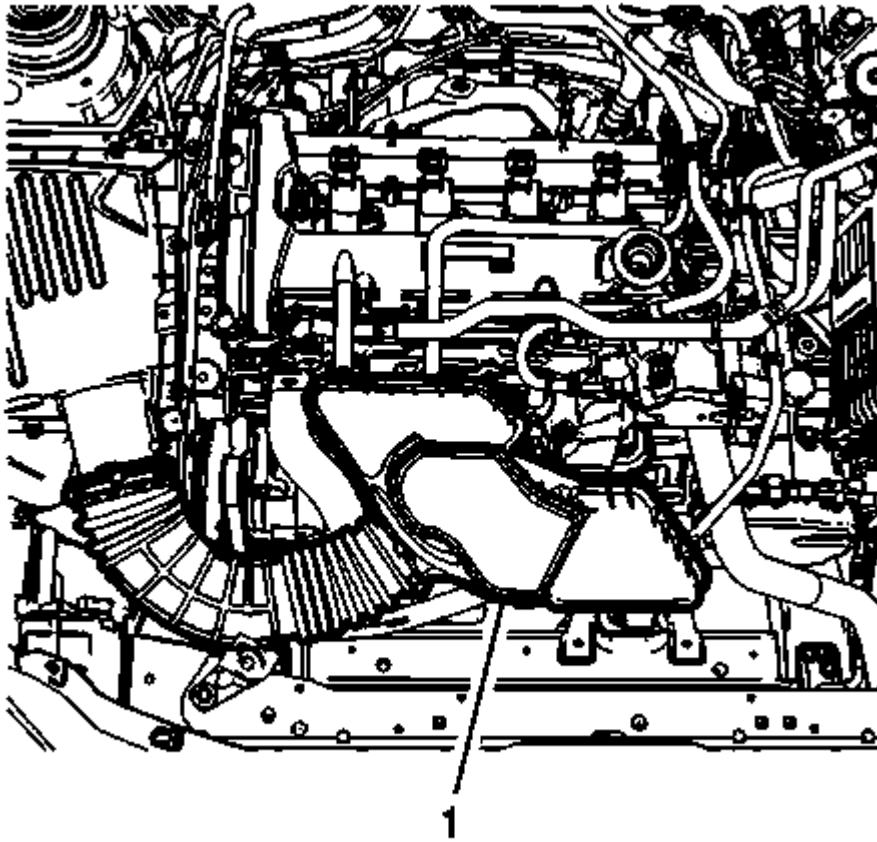


Fig. 285: Air Cleaner Outlet Duct Assembly
Courtesy of GENERAL MOTORS COMPANY

29. Install the air cleaner outlet duct assembly (1). Refer to [Air Cleaner Outlet Duct Replacement](#) .

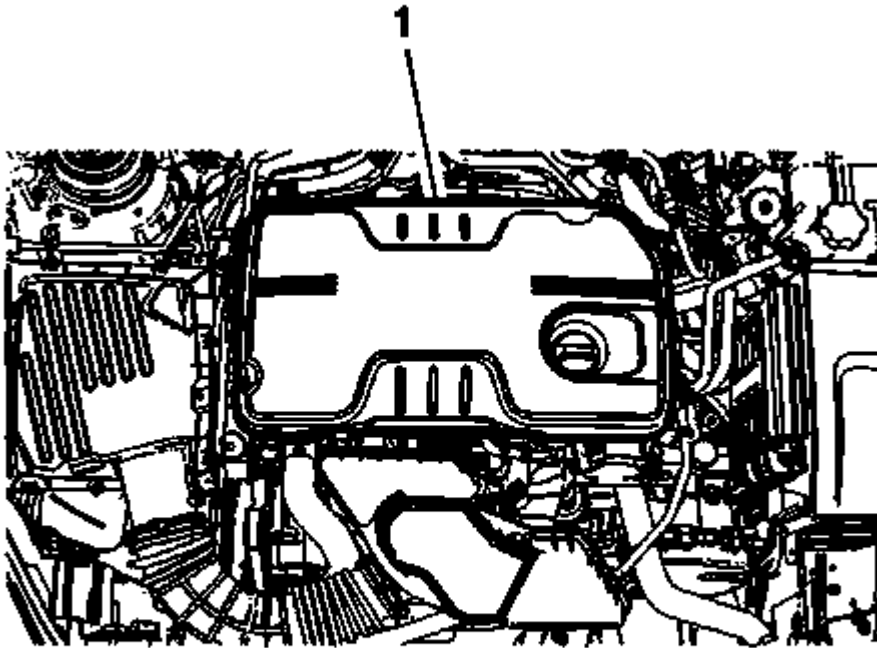


Fig. 286: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

30. Install the intake manifold cover (1). Refer to **Intake Manifold Cover Replacement**.
31. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
32. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
33. Refill the refrigerant system. Refer to **Refrigerant Recovery and Recharging** .
34. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

ENGINE OIL AND OIL FILTER REPLACEMENT

Special Tools

EN-44887 Oil Filter Wrench

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

Removal Procedure

1. Place a collecting pan underneath the oil filter.

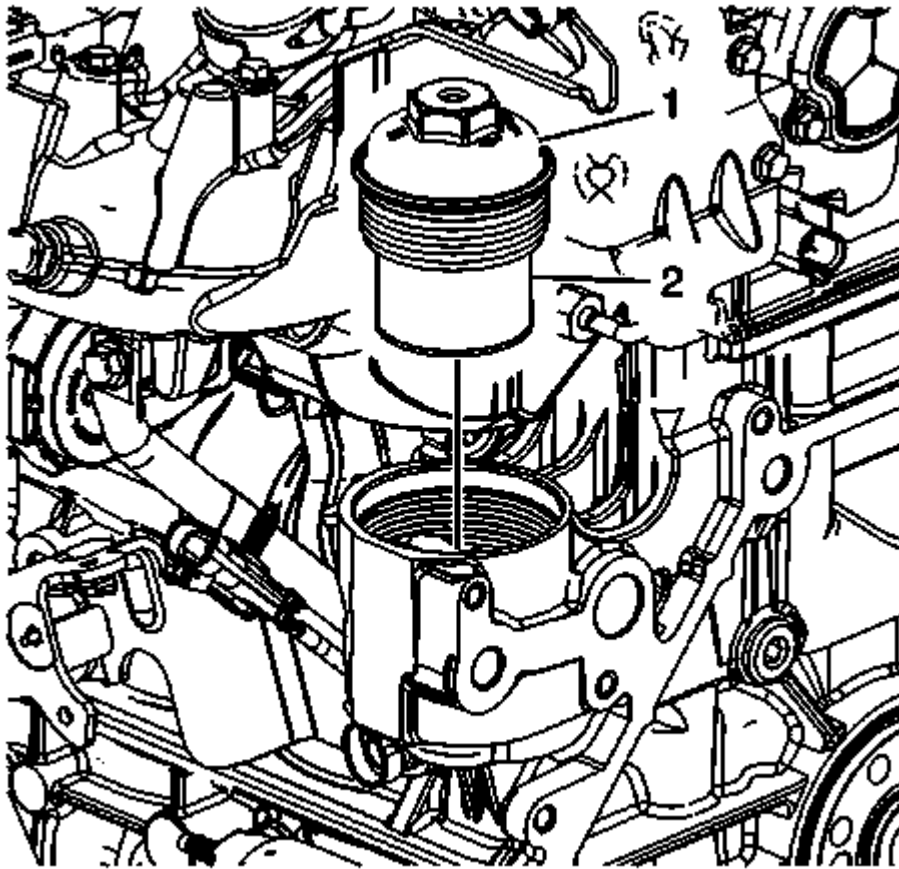


Fig. 287: Identifying Oil Filter & Cap
Courtesy of GENERAL MOTORS COMPANY

2. Use EN-44887 wrench to remove the oil filter cap (1) and seal .

CAUTION: This engine uses a special high performance oil filter. Use of any other filter may lead to filter failure and/or severe engine damage.

3. Remove and properly dispose of the oil filter insert (2).
4. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Place a collecting pan underneath the oil drain plug.

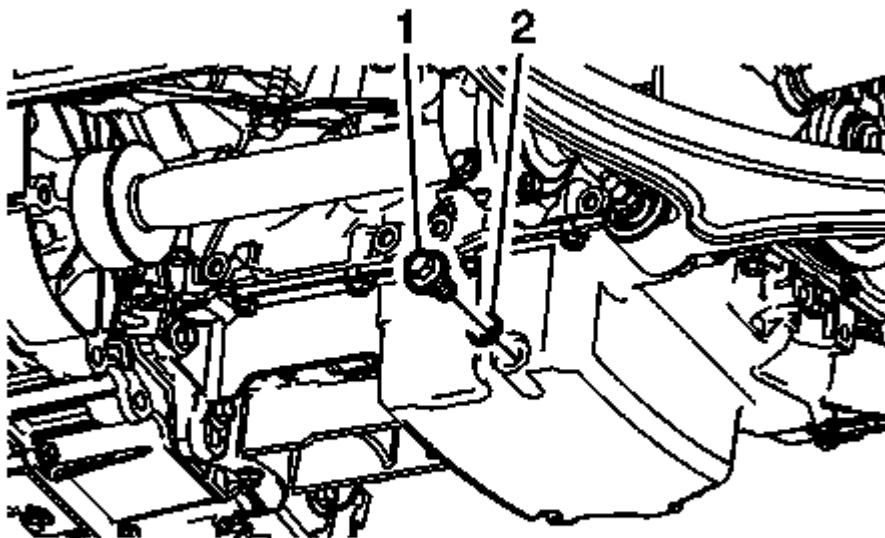


Fig. 288: Engine Oil Drain Plug And Seal
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil drain plug (1) and seal (2).

Installation Procedure

1. Clean the oil drain plug thread and the thread in the oil pan.

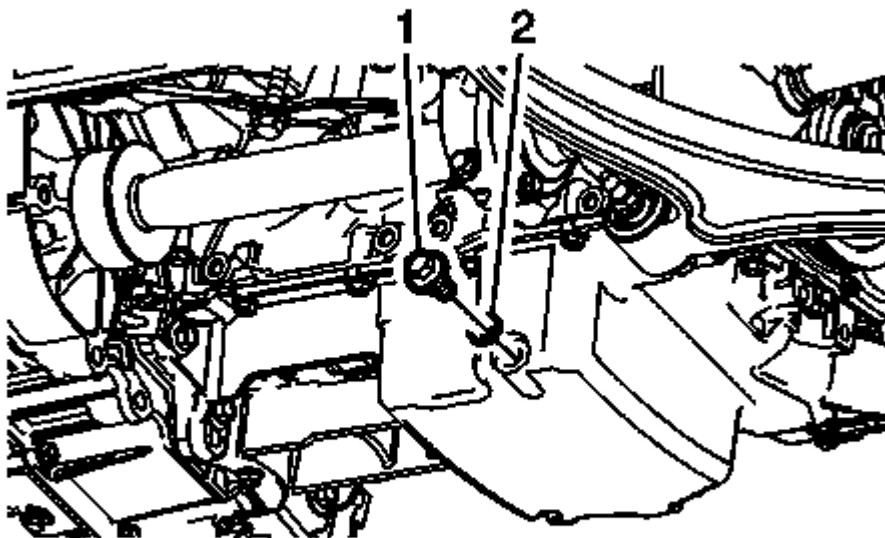


Fig. 289: Engine Oil Drain Plug And Seal
 Courtesy of GENERAL MOTORS COMPANY

2. Install a seal (2) to the oil drain plug (1).

CAUTION: Refer to Fastener Caution .

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

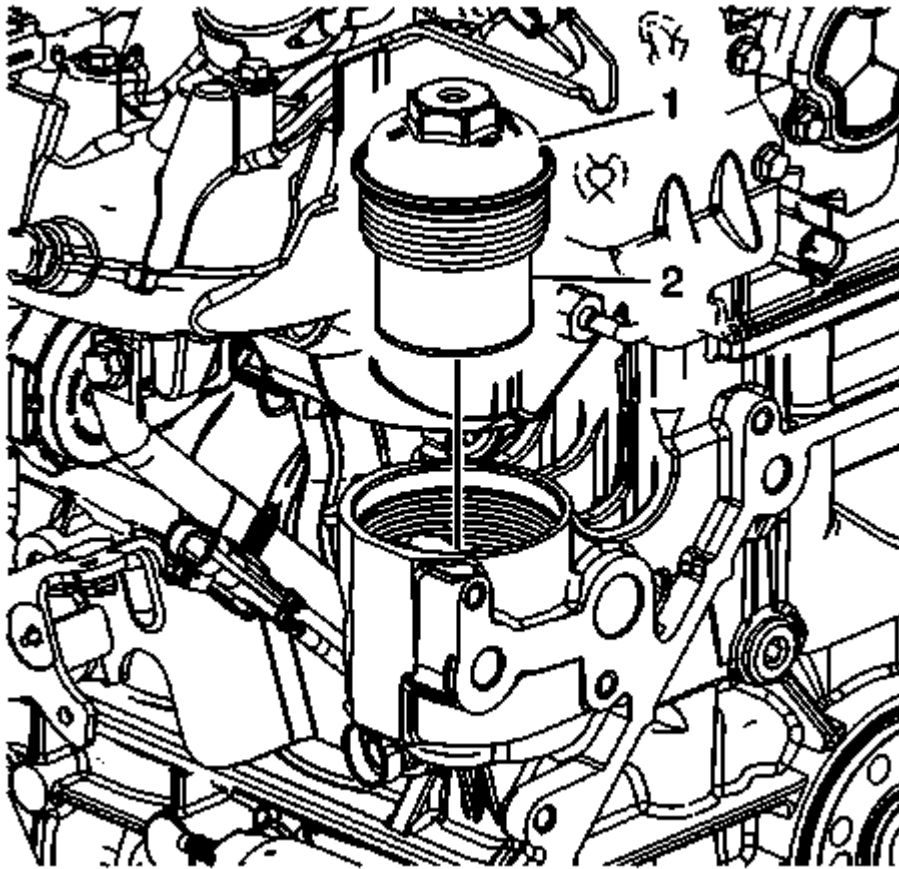


Fig. 290: Identifying Oil Filter & Cap
Courtesy of GENERAL MOTORS COMPANY

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

NOTE: Coat the oil filter seal with NEW engine oil.

5. Use EN-44887 wrench to Install a NEW oil filter (2) and a NEW seal and tighten the oil filter cap (1) to 22 N.m (16 lb ft).

CAUTION: Using engine oils of any viscosity other than those viscosities recommended could result in engine damage.

NOTE:

- Use specified volume of engine oil with the specified viscosity class.
- Start the engine and allow it to run until the oil pressure control indicator goes off.
- Inspect the engine oil level.

6. Fill in NEW engine oil. Refer to **Engine Mechanical Specifications (LAF, LEA, or LUK)** .
7. Reset the service interval indicator.