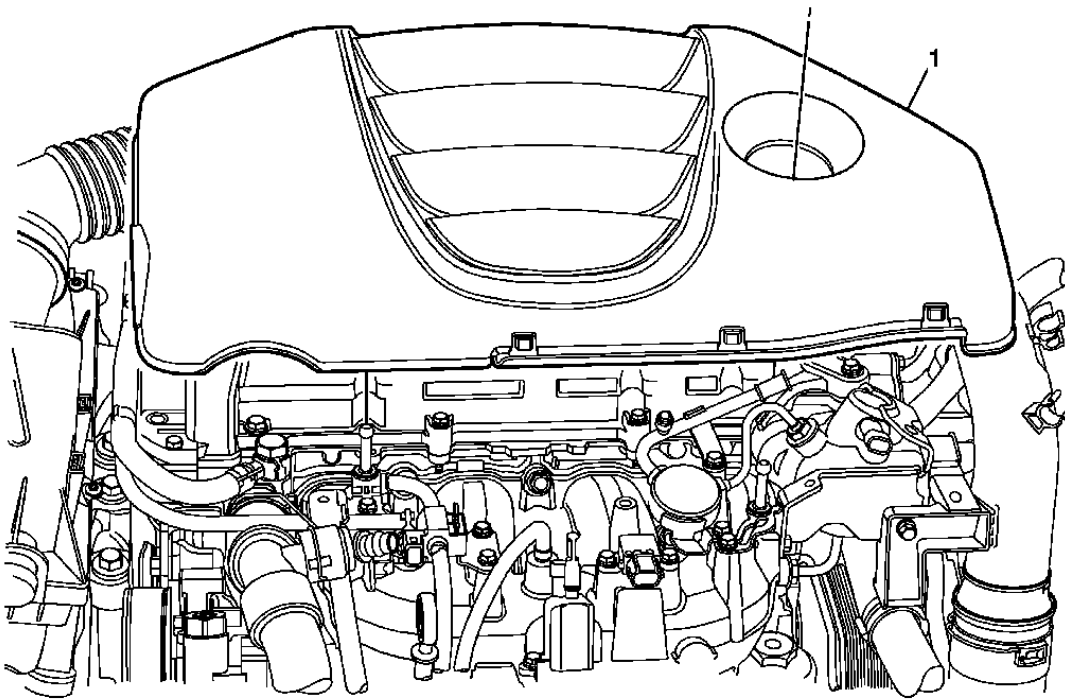


2012 ENGINE

Engine Mechanical - 2.0L - Repair Instructions - On Vehicle - Regal

REPAIR INSTRUCTIONS - ON VEHICLE

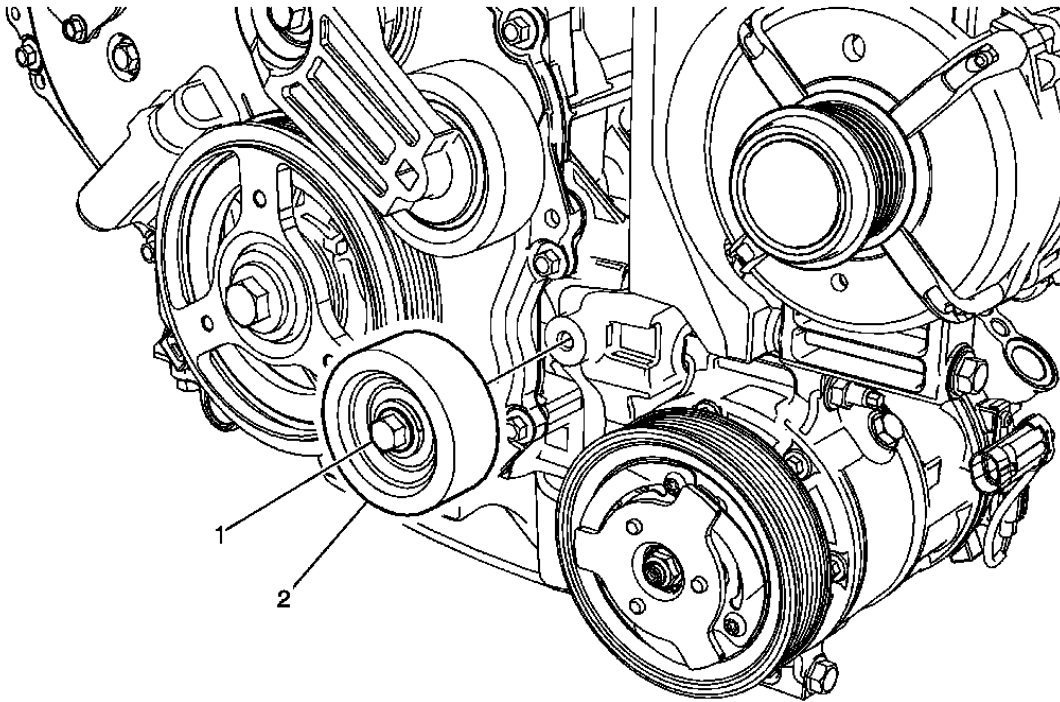
INTAKE MANIFOLD COVER REPLACEMENT

**Fig. 1: Intake Manifold Cover**

Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Cover Replacement

Callout	Component Name
1	Intake Manifold Cover Procedure 1. Remove the oil cap before removing the intake manifold cover. 2. The intake manifold cover needs to be pulled straight up to disconnect from the ball studs to prevent joysticking of the ball studs. 3. Install the intake manifold cover straight down and ensure the oil fill tube is properly seated. 4. Install the oil cap.

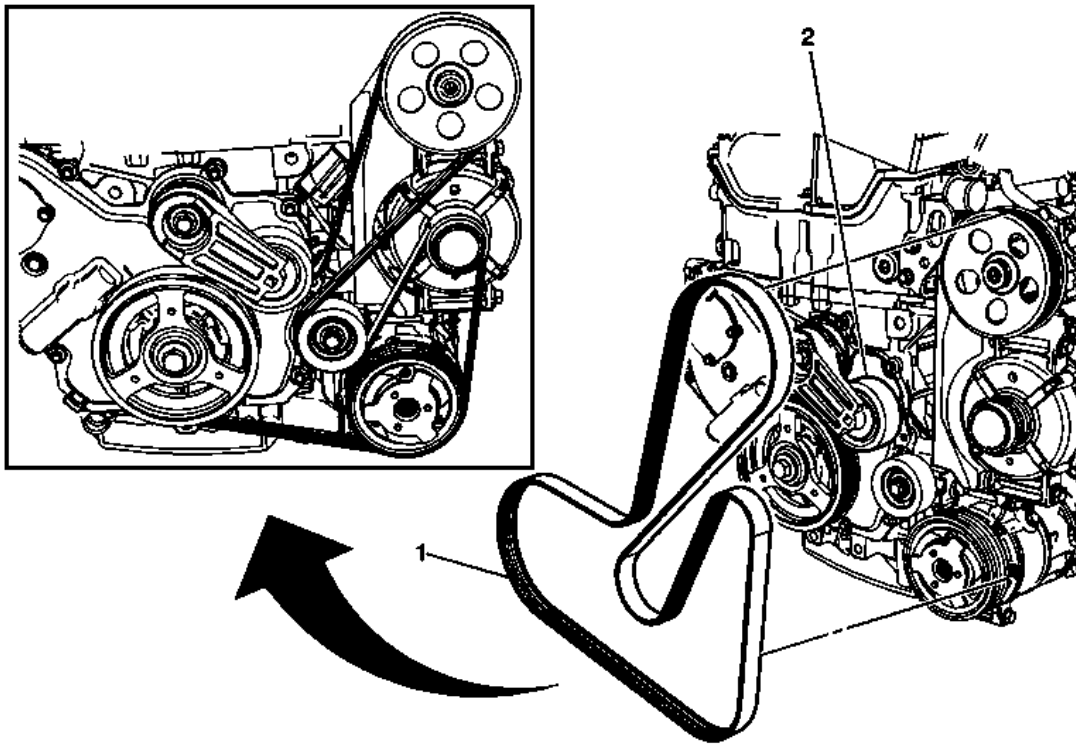
BELT IDLER PULLEY REPLACEMENT**Fig. 2: Belt Idler Pulley**

Courtesy of GENERAL MOTORS COMPANY

Belt Idler Pulley Replacement

Callout	Component Name
Preliminary Procedure Remove the drive belt. Refer to <u>Drive Belt Replacement</u> .	
1	Drive Belt Idler Pulley Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 20 N.m (16 lb ft)
2	Drive Belt Idler Pulley Procedure Transfer components as necessary.

DRIVE BELT REPLACEMENT

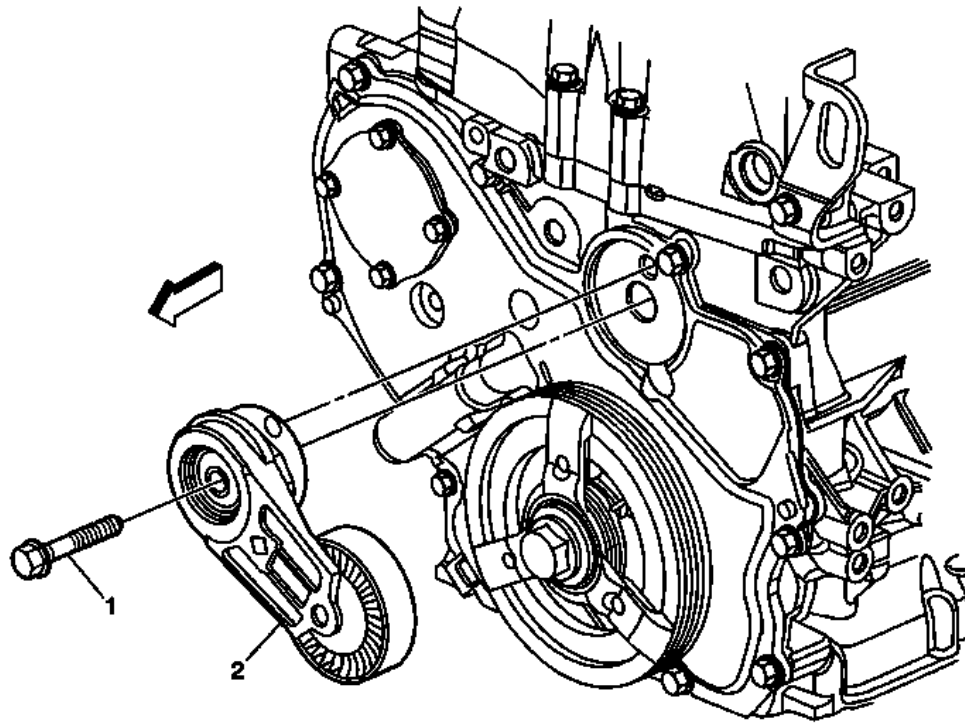
**Fig. 3: Drive Belt Routing**

Courtesy of GENERAL MOTORS COMPANY

Drive Belt Replacement

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 TENSIONER REPLACEMENT

**Fig. 4: Drive Belt Tensioner**

Courtesy of GENERAL MOTORS COMPANY

Drive Belt Tensioner Replacement

Callout	Component Name
Preliminary Procedure	
Remove the Engine Mount Bracket. Refer to <u>Engine Mount Bracket Replacement</u> .	
1	Drive Belt Tensioner Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 45 N.m (33 lb ft)
2	Drive Belt Tensioner Procedure Transfer components as necessary.

ENGINE MOUNT INSPECTION

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

1. Install a engine hoist to the lift brackets and raise the engine slightly putting pressure on the engine

mounts.

2. Observe the engine mount while slightly lifting the engine. Lifting the engine removes the weight from the engine mount and creates slight tension on the rubber.
3. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber is covered with heat check cracks.
 - The rubber is separated from the metal plate of the engine mount.
 - The rubber is split through the center of the engine mount.
 - The engine mount is leaking fluid, if applicable.
4. For engine mount replacement, refer to **Engine Mount Replacement**.

ENGINE MOUNT BRACKET REPLACEMENT

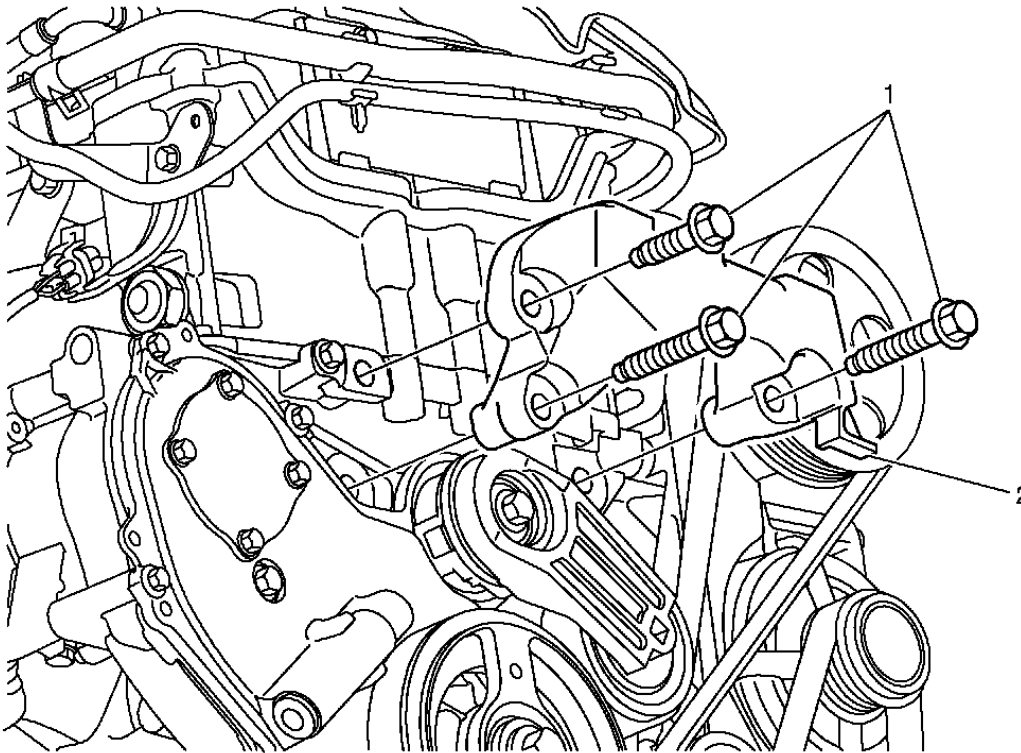


Fig. 5: Engine Mount Bracket

Courtesy of GENERAL MOTORS COMPANY

Engine Mount Bracket Replacement

Callout	Component Name
Preliminary Procedure	
Prior to removing the engine mount, mark mount bolt to mount interfaces using spray paint or a marker for correct positioning during installation of the engine mount. Refer to <u>Engine Mount Replacement</u> .	
	Engine Mount Fastener (Qty: 3)
	CAUTION:

1	Refer to <u>Fastener Caution</u> .
	Tighten 100 N.m (74 lb ft)
2	Engine Mount Bracket Procedure Transfer components as necessary.

ENGINE SUPPORT FIXTURE

Special Tools

- **EN-28467-B** Universal Engine Support Fixture
- **EN-43405-1** Engine Support Feet (Passenger Side)
- **EN-43405-2** Engine Support Feet (Drivers Side)

For equivalent regional tools, refer to **Special Tools (LDK, LHU)** .

Installation Procedure

1. Remove the Intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

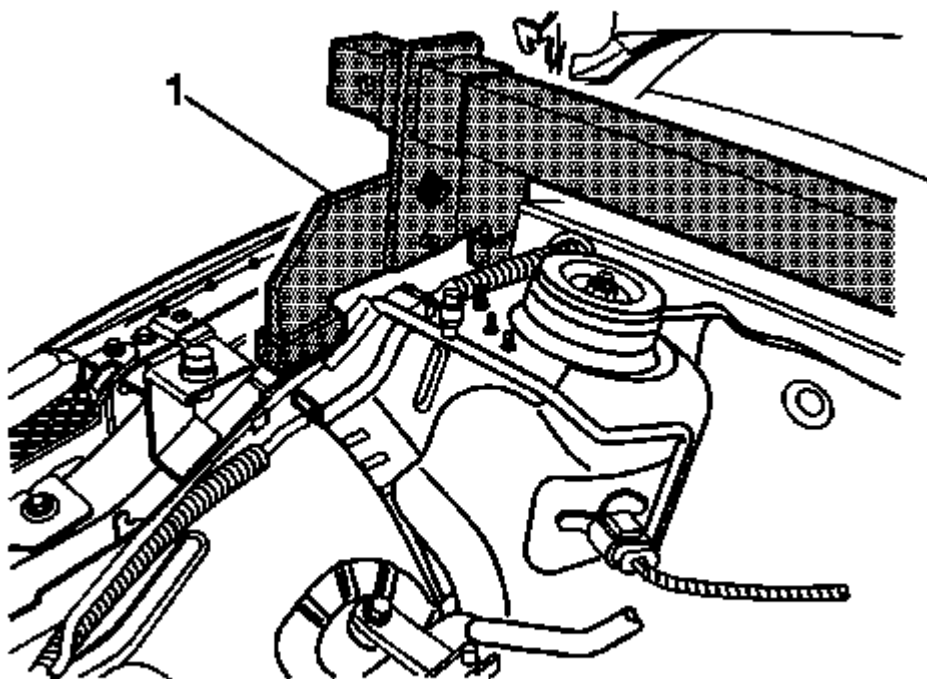


Fig. 6: Special Tool

Courtesy of GENERAL MOTORS COMPANY

3. 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) and place across the engine compartment.

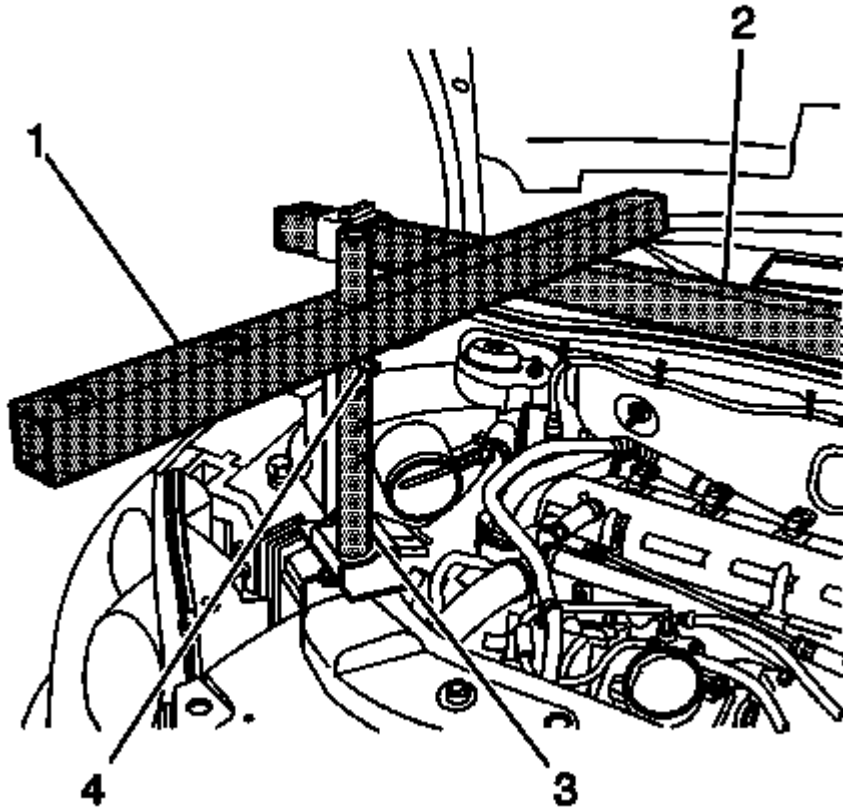


Fig. 7: View Of Engine Support Fixture
Courtesy of GENERAL MOTORS COMPANY

4. From the **EN-28467-B** universal engine support fixture 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.
5. 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.
6. Locate the J-28467-4A front support assembly to the upper tie bar.
7. 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.

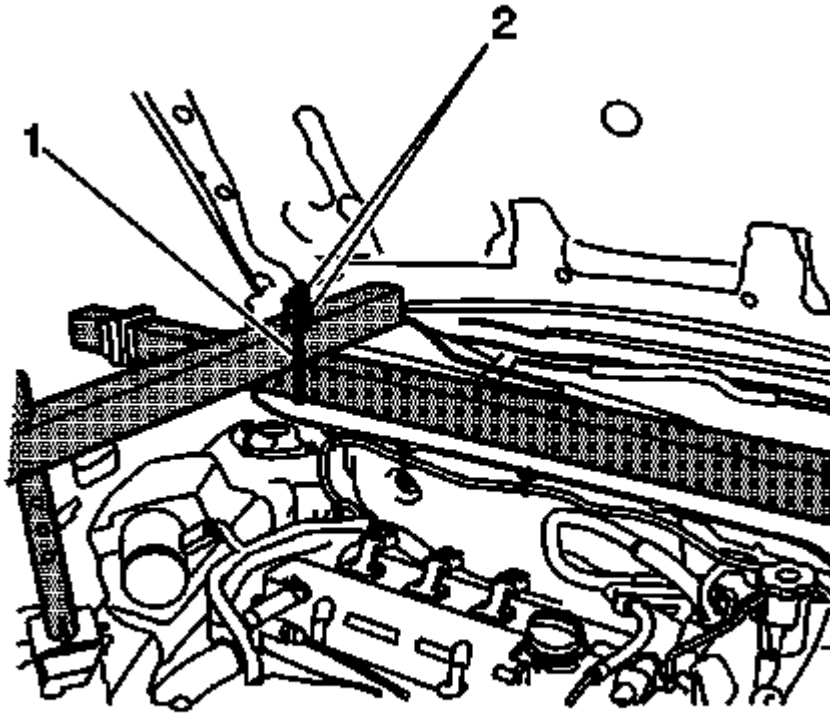


Fig. 8: View Of Engine Support Fixture & Cross Bracket
Courtesy of GENERAL MOTORS COMPANY

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

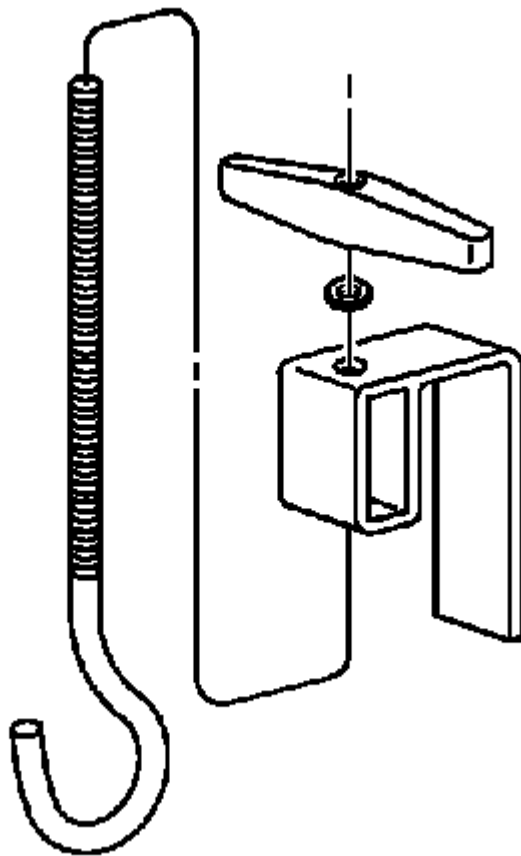


Fig. 9: View Of Lift Hook Assembly
Courtesy of GENERAL MOTORS COMPANY

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

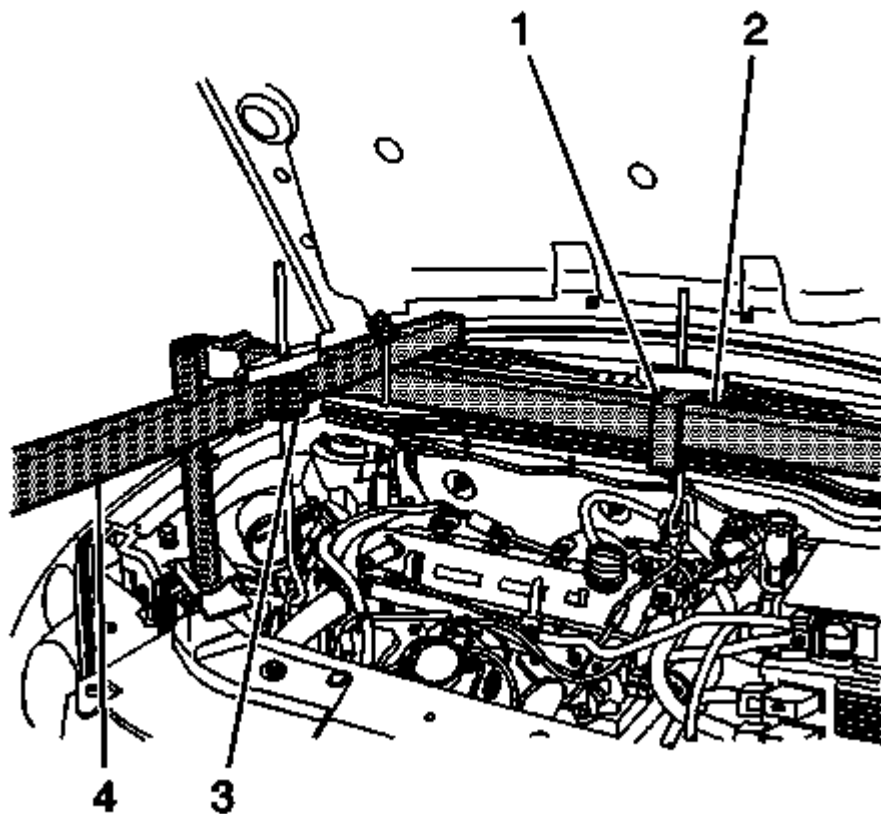


Fig. 10: Identifying Engine Support Fixture & Cross Bracket
Courtesy of GENERAL MOTORS COMPANY

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

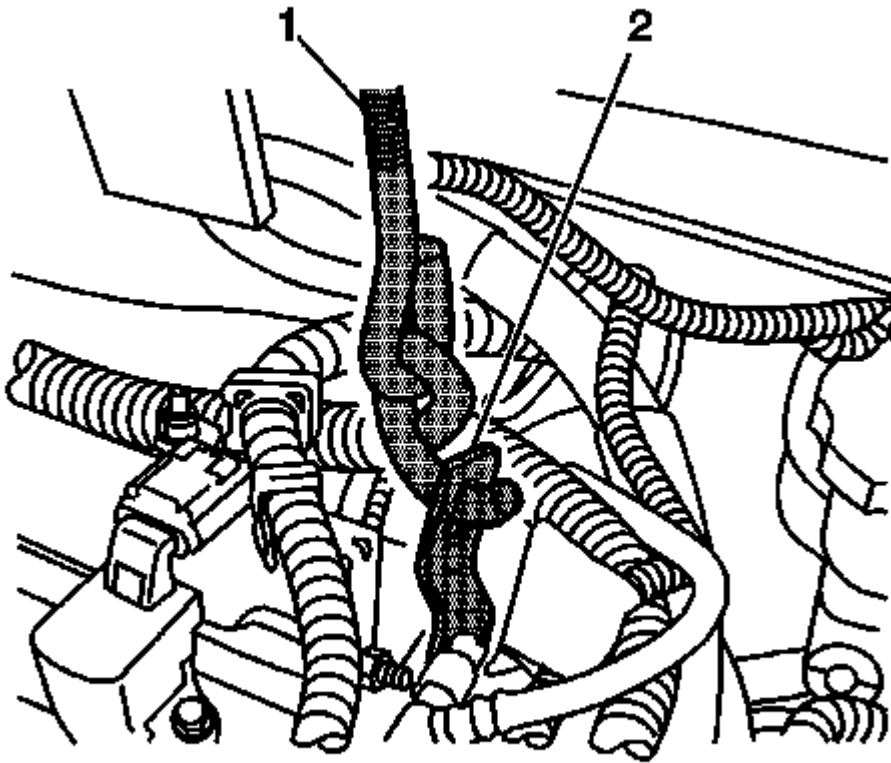


Fig. 11: Inserting Lift Hook Through Engine Rear Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

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

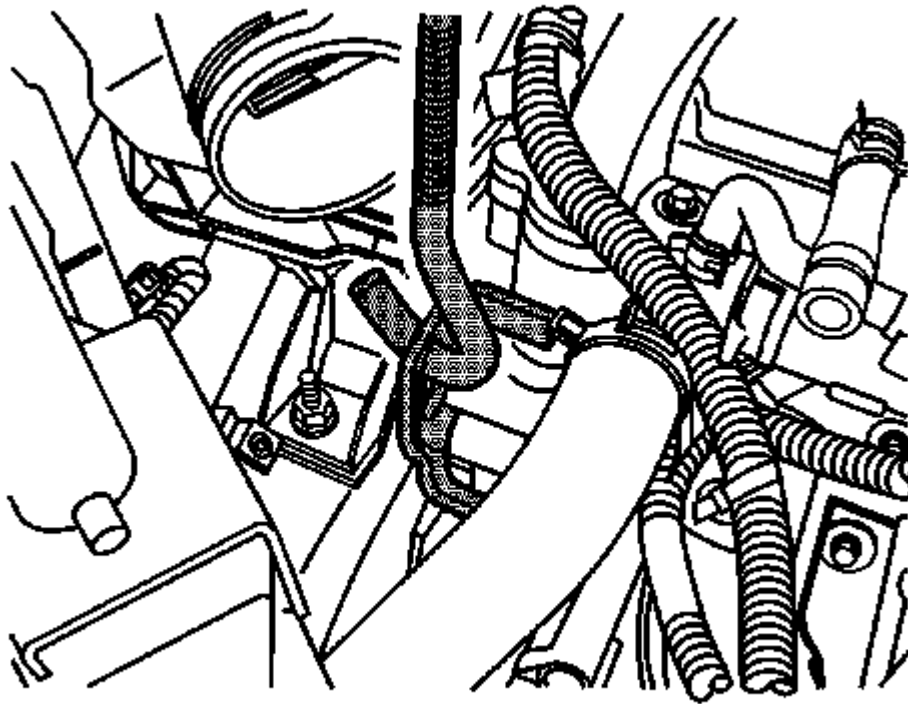


Fig. 12: Inserting Lift Hook Through Engine Front Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

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

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 .

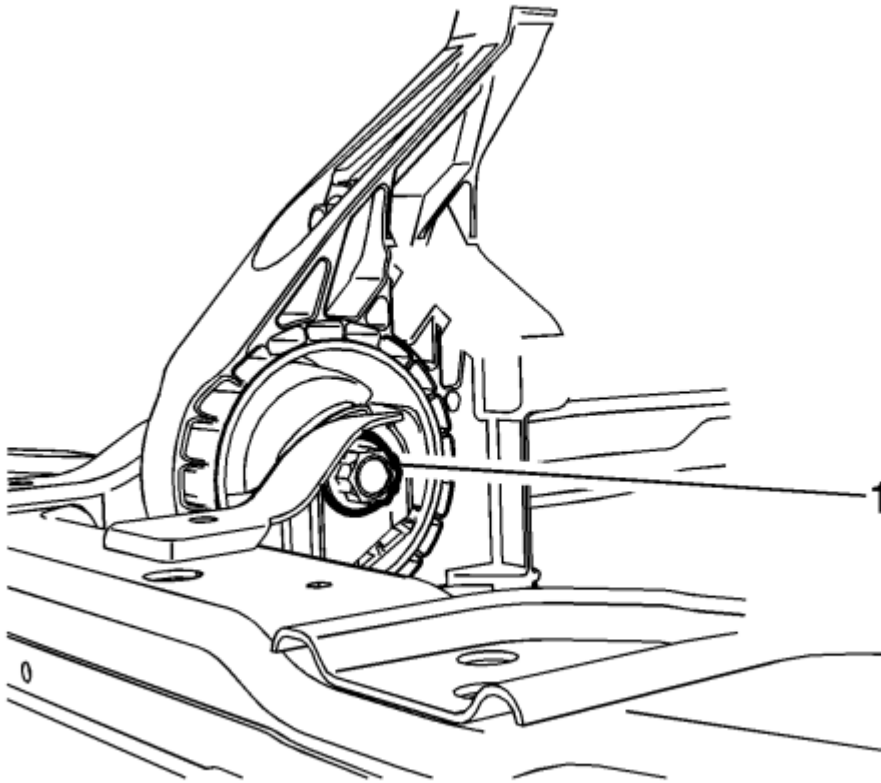


Fig. 13: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

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

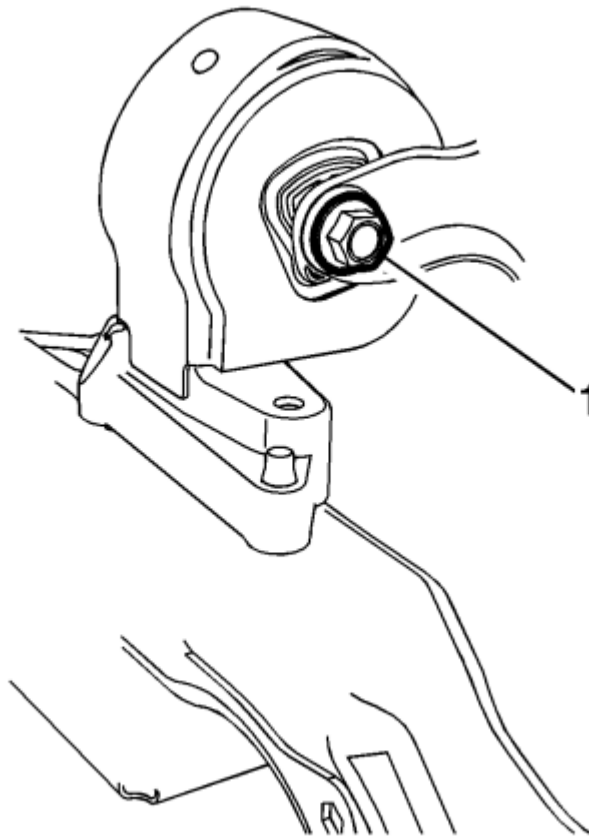


Fig. 14: Rear Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

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

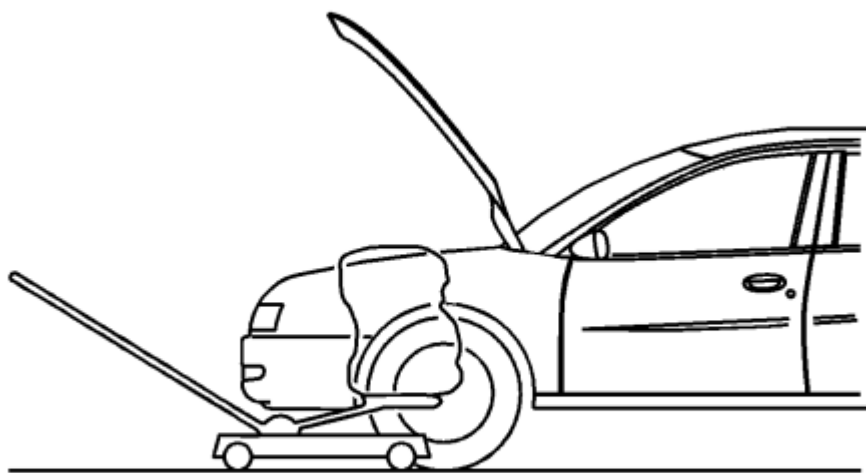


Fig. 15: Supporting Engine/Transmission With Hydraulic Floor Jack
Courtesy of GENERAL MOTORS COMPANY

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

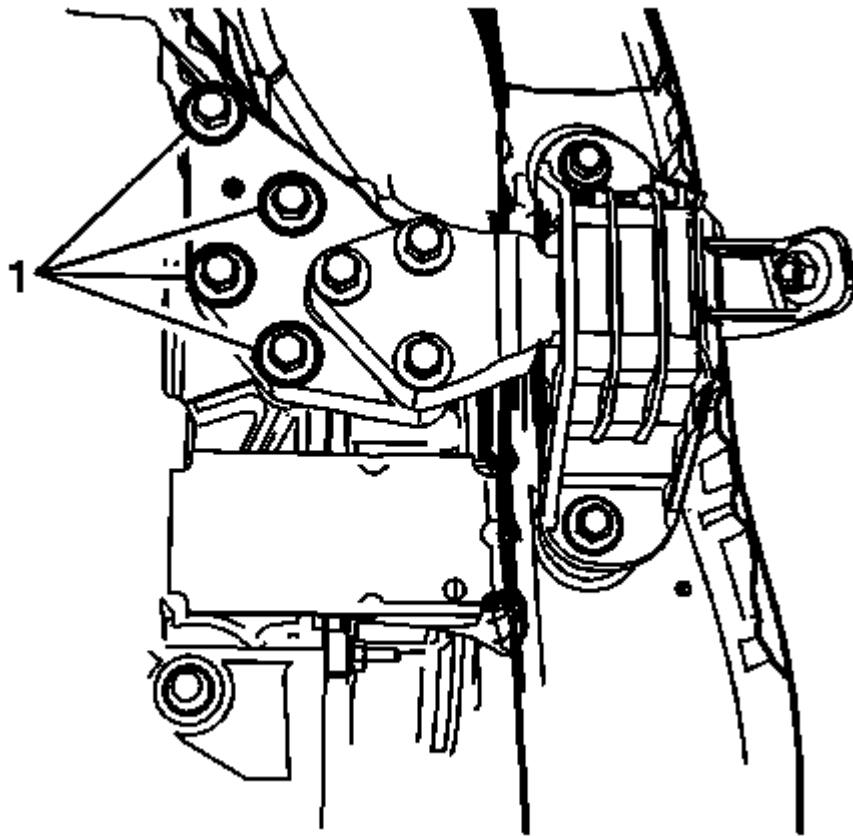


Fig. 16: Transaxle Bolts

Courtesy of GENERAL MOTORS COMPANY

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

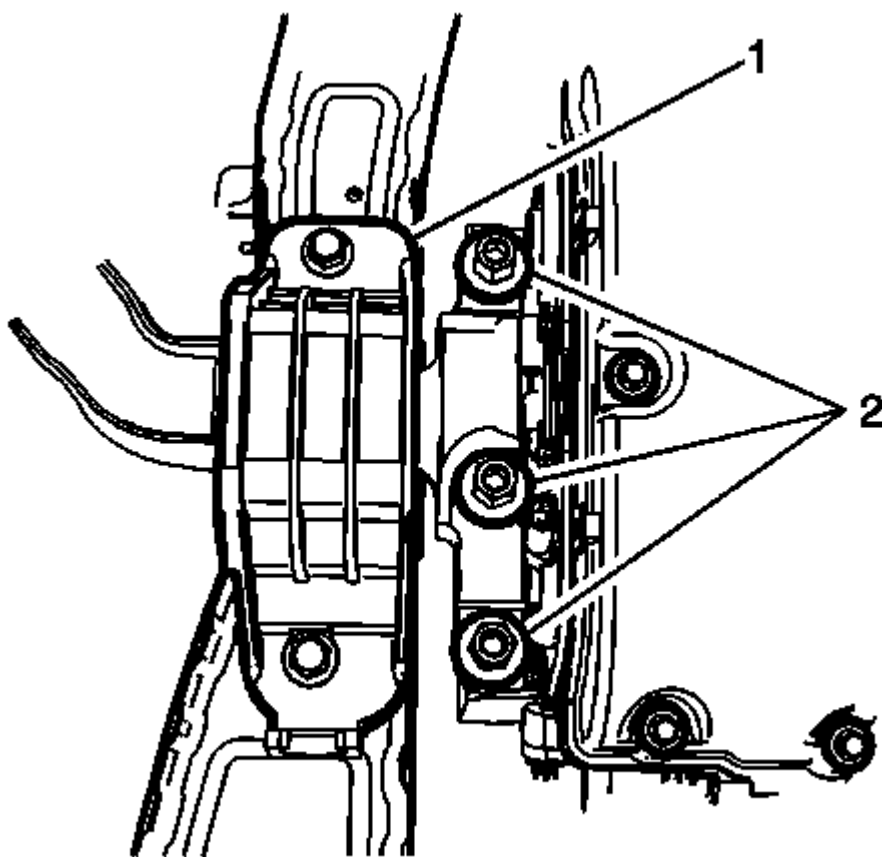


Fig. 17: Engine Mount And Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

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.

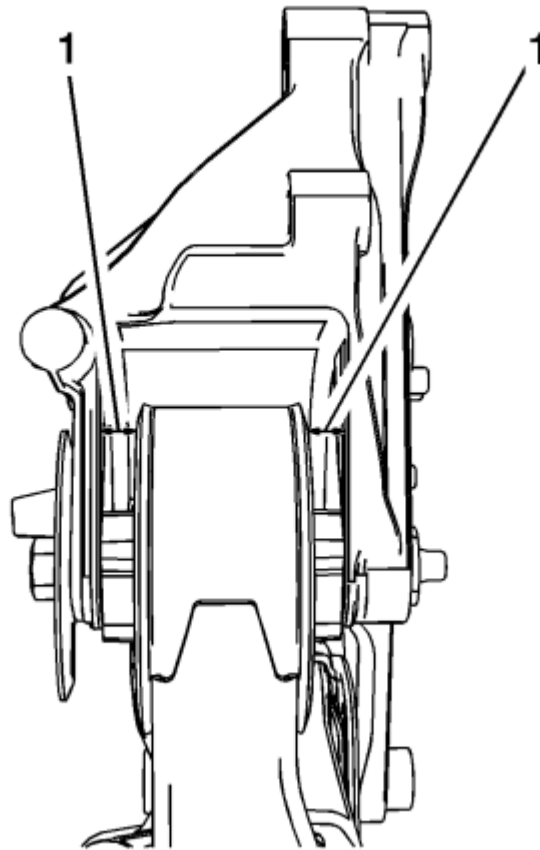


Fig. 18: Front And Rear Powertrain Mounts
Courtesy of GENERAL MOTORS COMPANY

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.

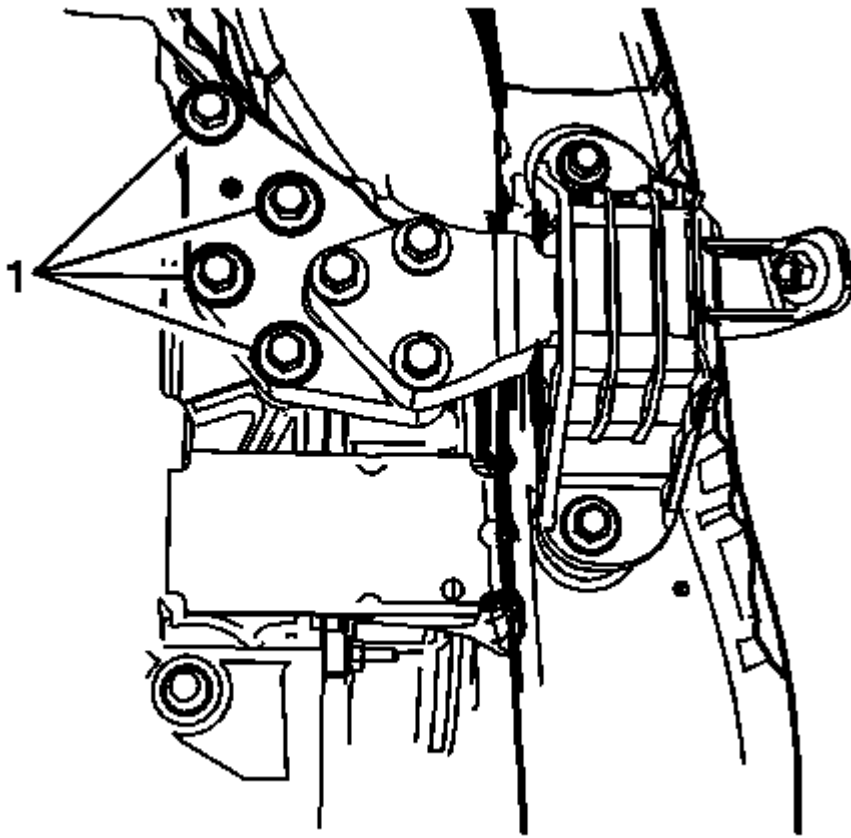


Fig. 19: Transaxle Bolts

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.

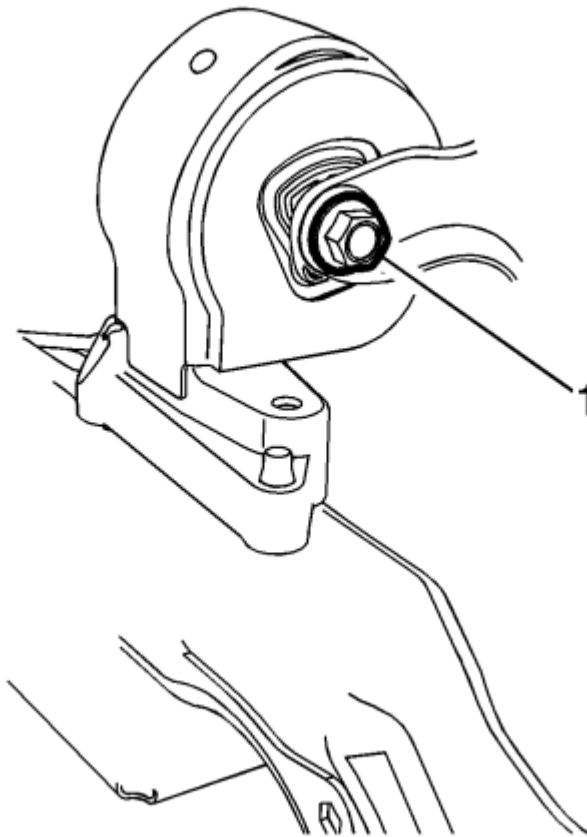


Fig. 20: Rear Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

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.

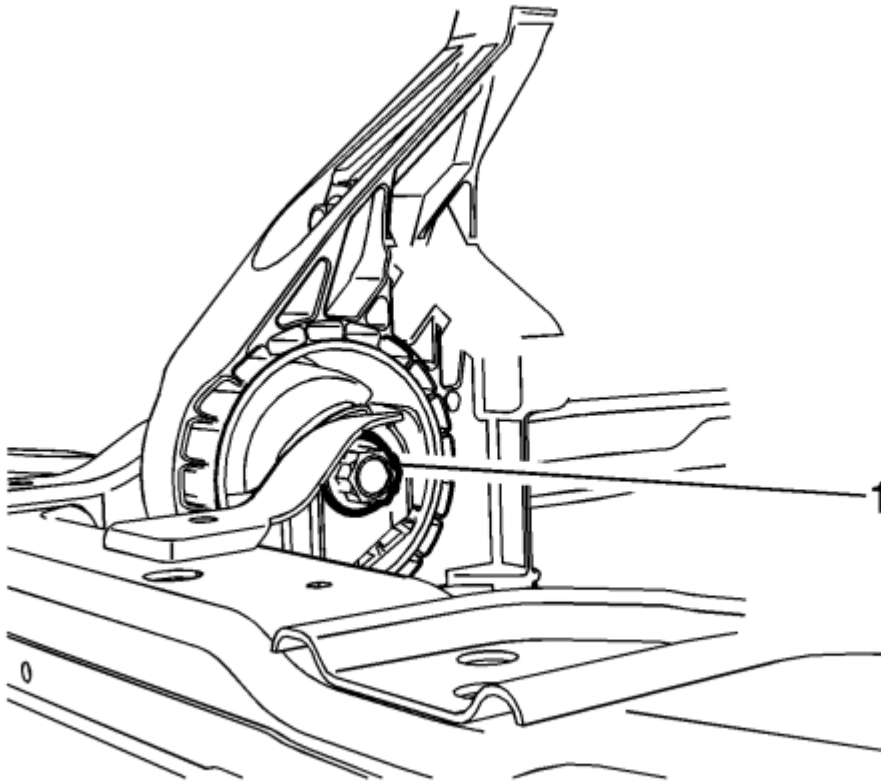


Fig. 21: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

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 .

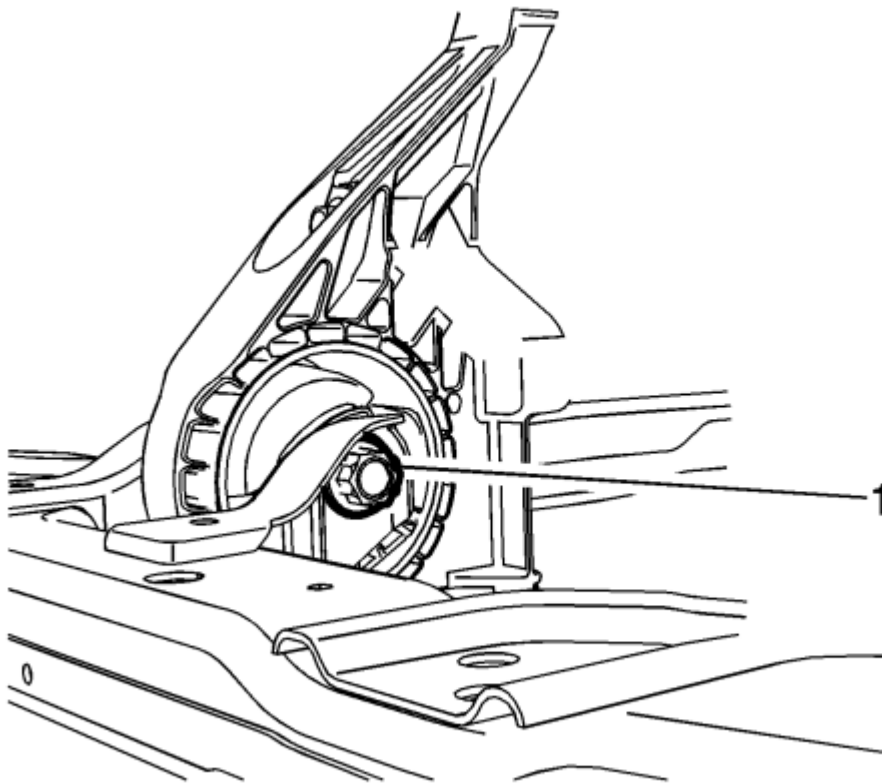


Fig. 22: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

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

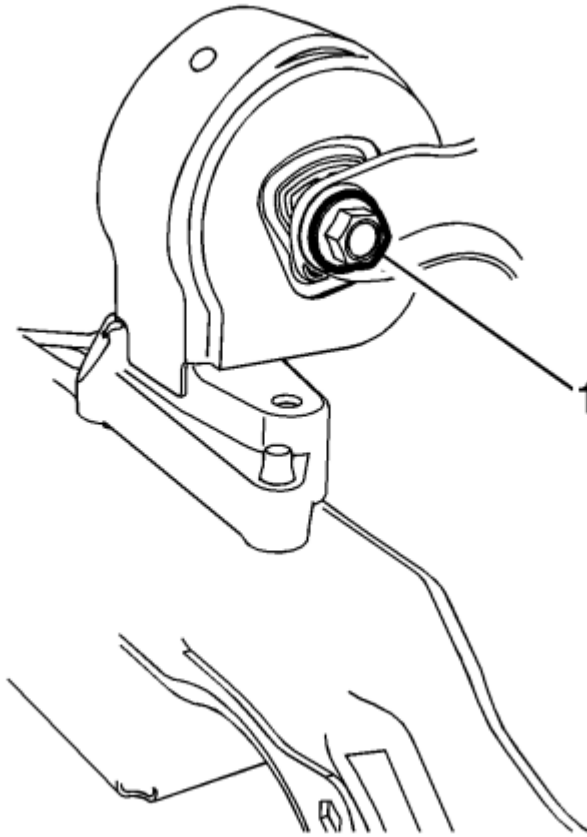


Fig. 23: Rear Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

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.

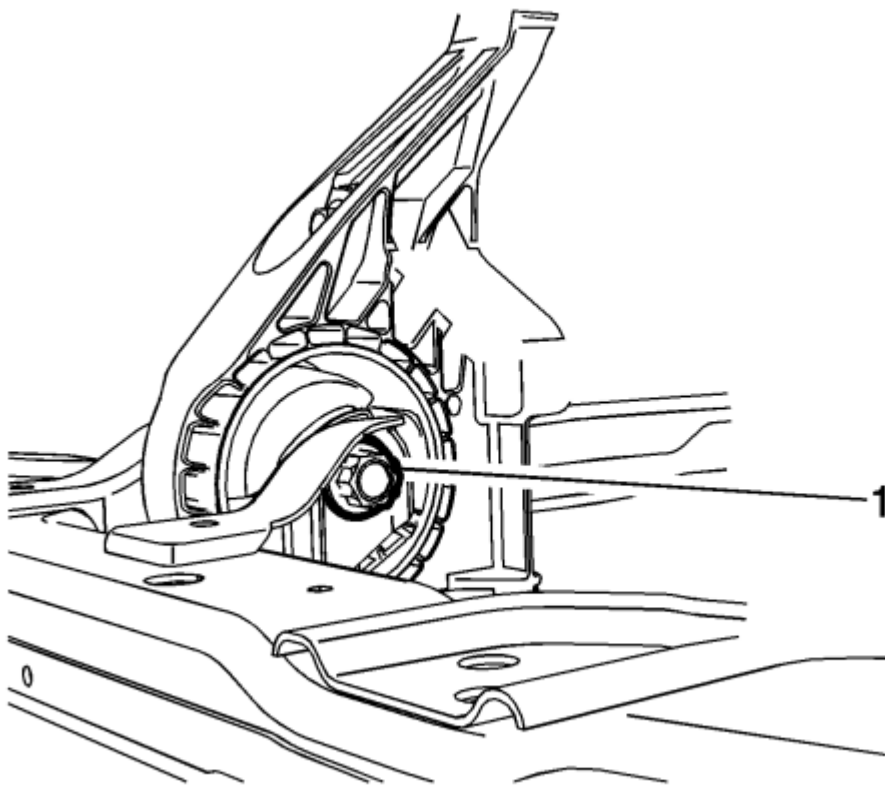
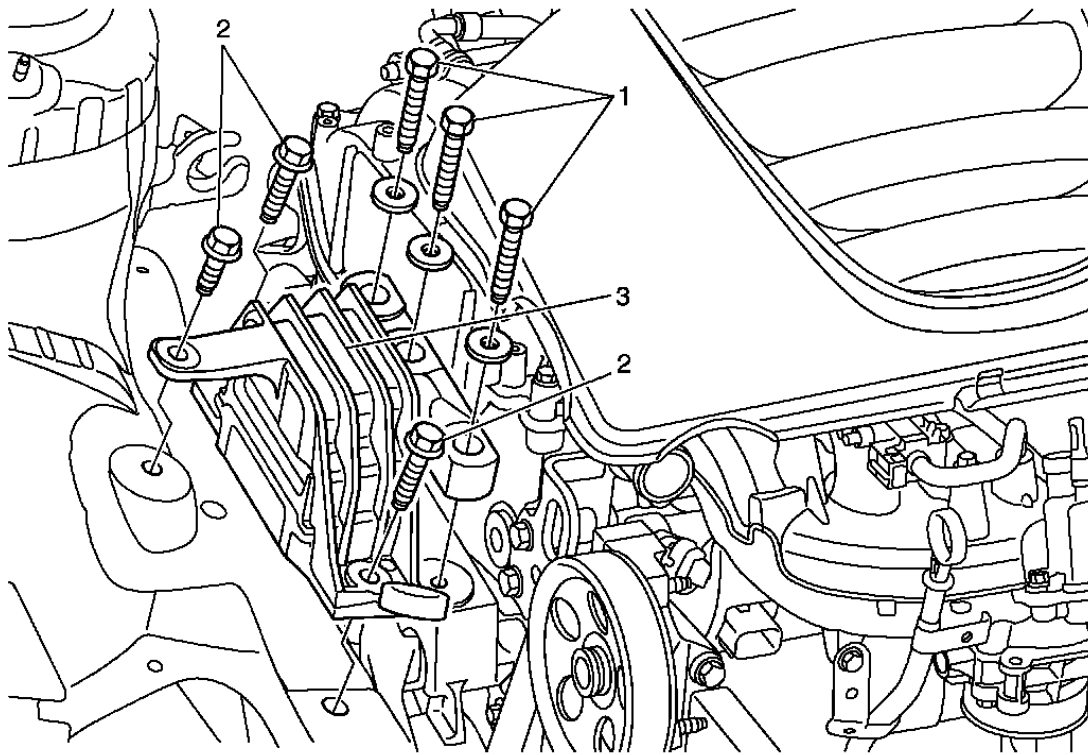


Fig. 24: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

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**

Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement

Callout	Component Name
Preliminary Procedures	
1. Install engine support fixture. Refer to Engine Support Fixture. 2. Prior to removing the mount, mark mount to bracket, mount to body interfaces and fasteners to mount interfaces using spray paint or a marker for correct positioning during installation.	
1	Engine Mount Fastener (Qty: 3) CAUTION: Refer to Fastener Caution . Procedure If the front and/or rear lower mount through bolts were loosened or removed, perform the Powertrain Mount Balancing - Lower. If ALL powertrain mounts were replaced with new components, perform the Powertrain Mount Balancing. Refer to the appropriate engine service information. Tighten 50 N.m (37 lb ft) +60 degrees +15 degrees
2	Engine Mount Fastener (Qty: 3) Tighten

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

OIL LEVEL INDICATOR TUBE REPLACEMENT

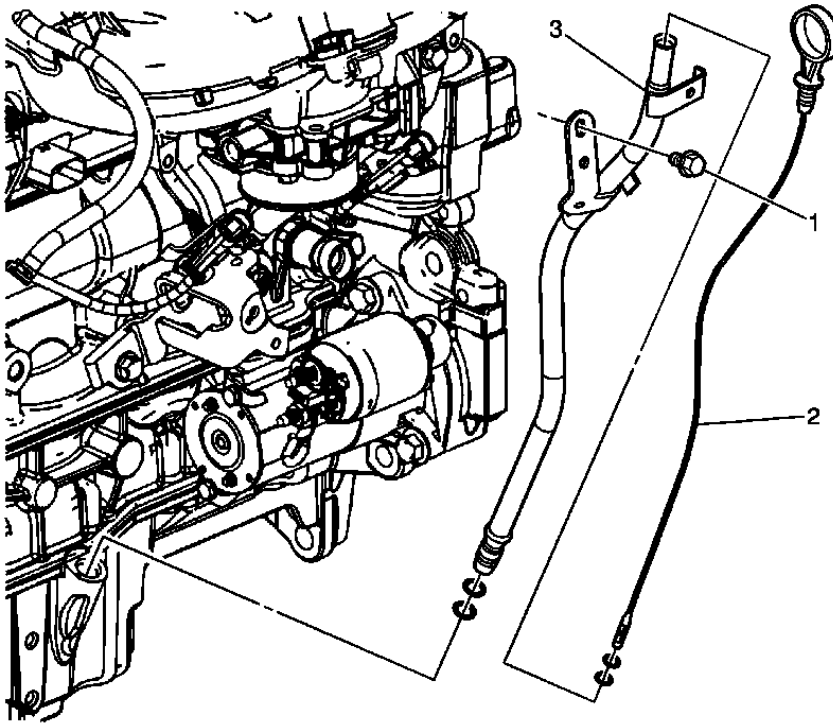


Fig. 26: Oil Level Indicator Tube
Courtesy of GENERAL MOTORS COMPANY

Oil Level Indicator Tube Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>	
1	Oil level indicator tube fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Oil level indicator Procedure Remove the oil level indicator

Oil level indicator tube

Procedure

3

1. Disconnect electrical connectors as needed.
2. Remove the electrical wiring harness from the oil level indicator tube.
3. Remove the oil level indicator tube from the oil pan.
4. Inspect the O-rings for damage. Replace if damaged.
5. Transfer parts as needed.

TURBOCHARGER REPLACEMENT

Removal Procedure

CAUTION: If a turbocharger has failed, clean any turbocharger debris or excessive oil from the charge air cooler system before installing the new turbocharger. Failure to clean debris from the charge air cooler system will cause severe turbocharger and engine damage upon startup. Failure to clean excessive oil from the charge air cooler system may cause an engine runaway condition on startup, resulting in severe engine damage.

1. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .
2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement.
3. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .
4. Remove the catalytic converter. Refer to Catalytic Converter Replacement (LDK or LHU) .

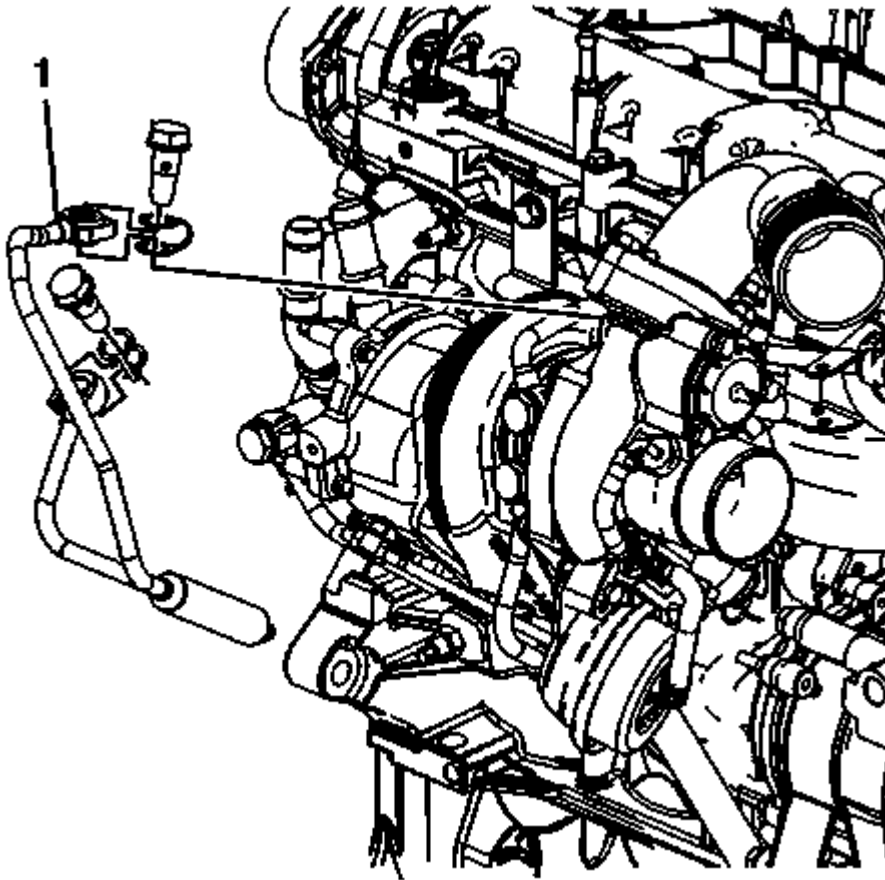


Fig. 27: Turbocharger Oil Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

5. Remove the turbocharger oil feed pipe bolts.
6. Remove the turbocharger oil feed pipe gaskets.
7. Remove the turbocharger oil feed pipe (1).

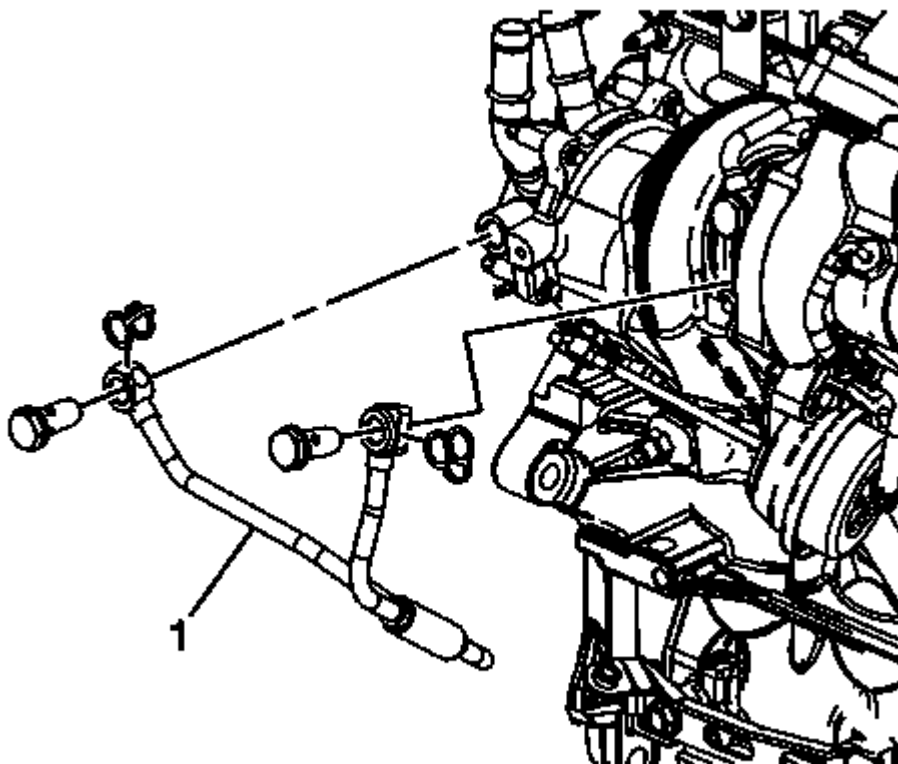


Fig. 28: Turbocharger Coolant Return Pipe
Courtesy of GENERAL MOTORS COMPANY

8. Remove the turbocharger coolant return pipe bolts.
9. Remove the turbocharger coolant return pipe gaskets.
10. Remove the turbocharger coolant return pipe (1).
11. Remove the turbocharger air cooler outlet pipe. Refer to **Charge Air Cooler Outlet Pipe Replacement** .

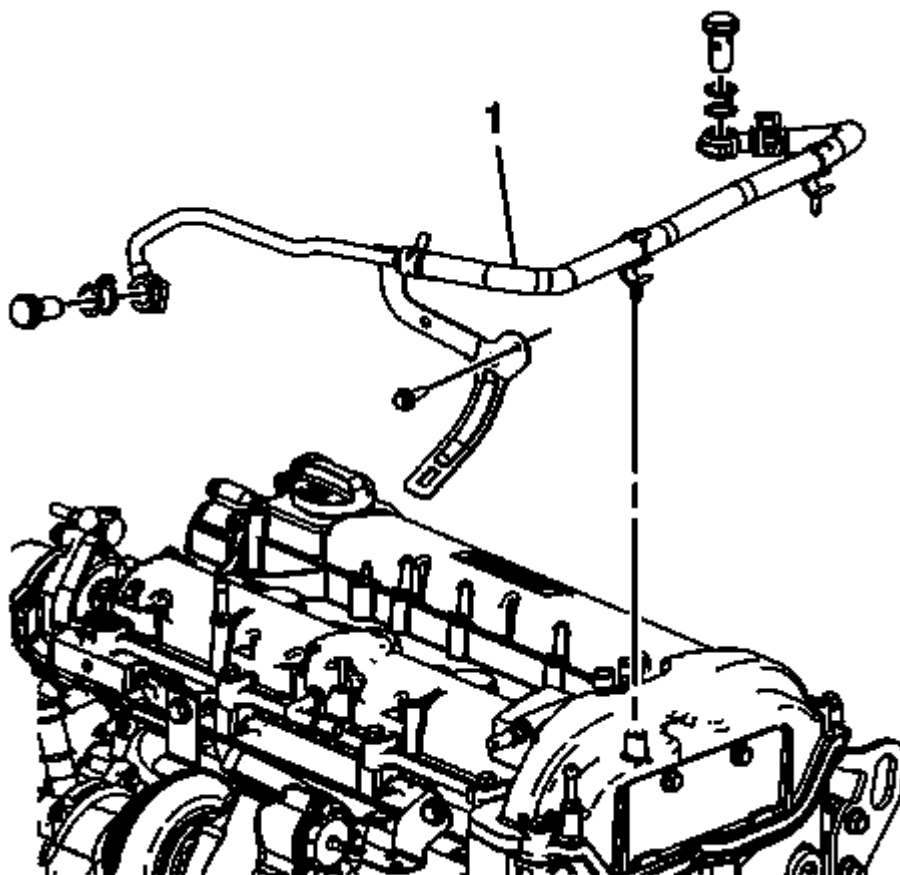


Fig. 29: Turbocharger Coolant Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

12. Remove the turbocharger coolant feed pipe bolts.
13. Remove the turbocharger coolant feed pipe gaskets.
14. Remove the turbocharger coolant feed pipe (1).

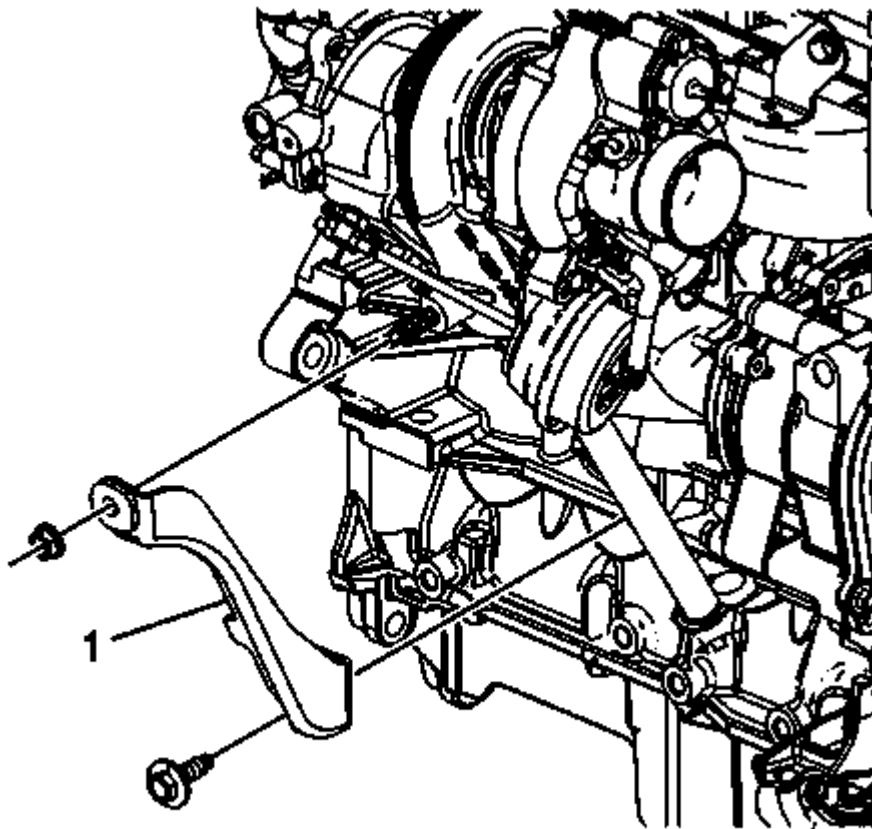


Fig. 30: Turbocharger Brace

Courtesy of GENERAL MOTORS COMPANY

15. Remove the turbocharger brace nuts.
16. Remove the turbocharger brace (1).

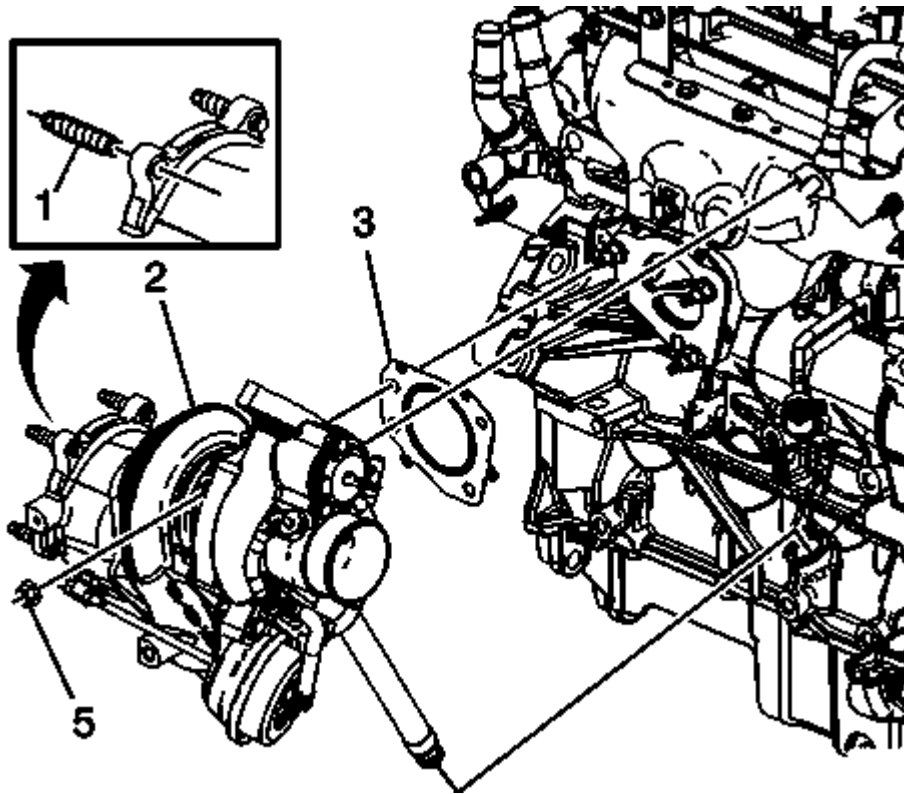


Fig. 31: Turbocharger Assembly

Courtesy of GENERAL MOTORS COMPANY

NOTE: The PCV hose should not be disconnected from the camshaft cover. The PCV hose and the camshaft cover cannot be serviced individually.

17. Remove the PCV hose fitting bolt at the turbocharger.
18. Remove the PCV hose fitting from the turbocharger.
19. Remove the turbocharger nuts (1).
20. Remove the turbocharger (2) and the oil return pipe.
21. Remove the turbocharger gasket (3).

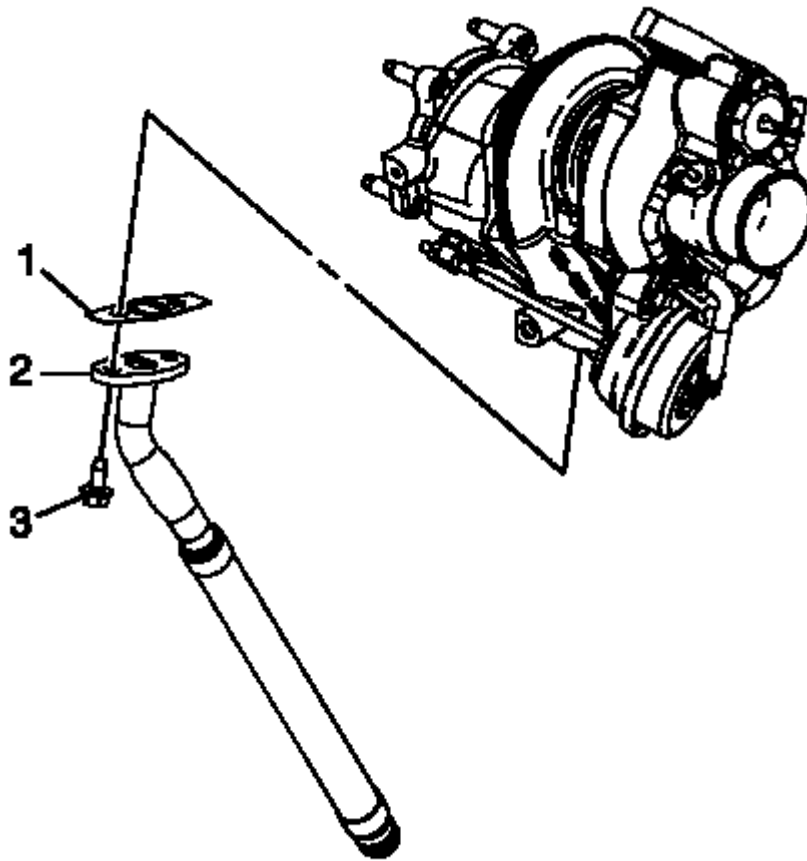


Fig. 32: Turbocharger Oil Return Pipe
Courtesy of GENERAL MOTORS COMPANY

22. Remove the turbocharger oil return pipe bolts (3).
23. Remove the turbocharger oil return pipe (2) from the turbocharger.
24. Remove and discard the turbocharger oil return pipe gasket (1).
25. Disconnect vacuum hose as needed.
26. Disconnect coolant hoses as needed.
27. Disconnect electrical connectors as needed.

Installation Procedure

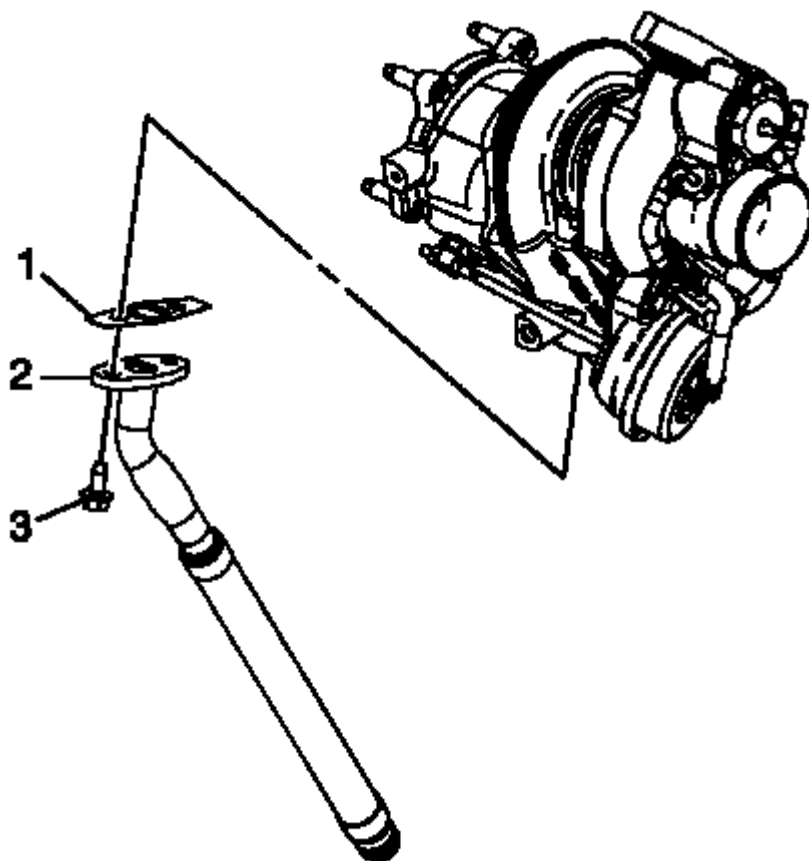


Fig. 33: Turbocharger Oil Return Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Install a new turbocharger oil return pipe gasket (1).
2. Install the turbocharger oil return pipe (2) on the turbocharger.

CAUTION: Refer to Fastener Caution .

3. Install the turbocharger oil return pipe bolts (3) and tighten to 10 N.m (89 lb in).

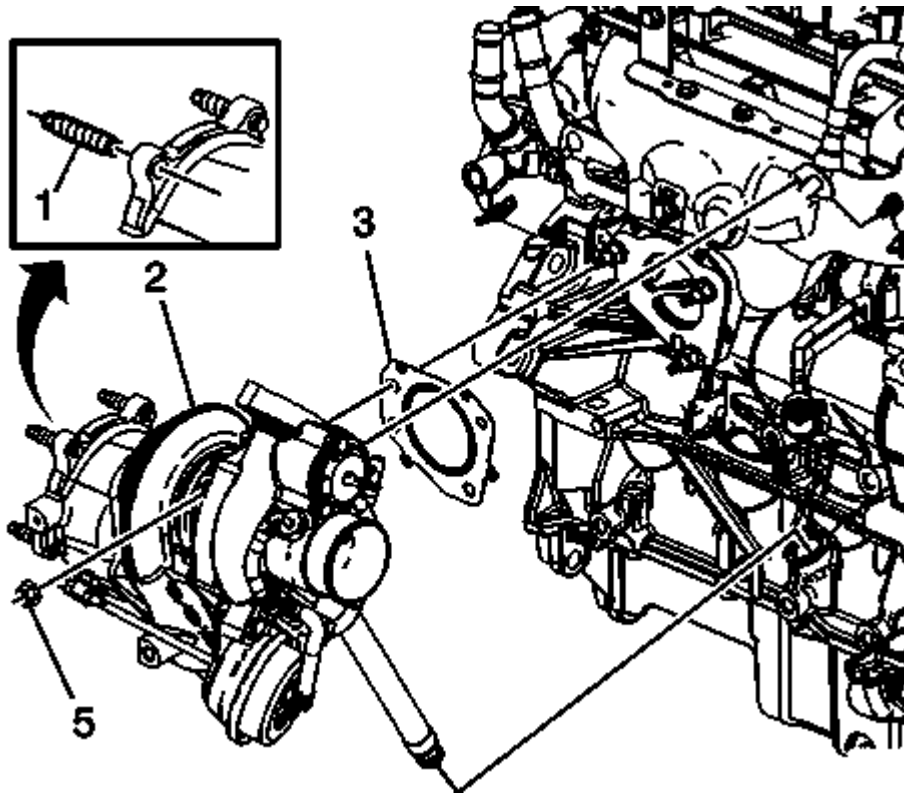


Fig. 34: Turbocharger Assembly

Courtesy of GENERAL MOTORS COMPANY

4. Attach the positive crankcase ventilation (PCV) hose and fitting with O-ring from the camshaft cover to the turbocharger.
5. Install the PCV hose fitting bolt and tighten to 10 N.m (89 lb in).
6. Lubricate the O-ring on the turbocharger oil return pipe with clean engine oil.
7. Install a new turbocharger gasket (3).
8. Install the turbocharger (2) with the oil return pipe.
9. Install the turbocharger nuts (1).
 1. Tighten the turbocharger nuts to 30 N.m (22 lb ft).
 2. Tighten the turbocharger nuts a second time to 35 N.m (26 lb ft).

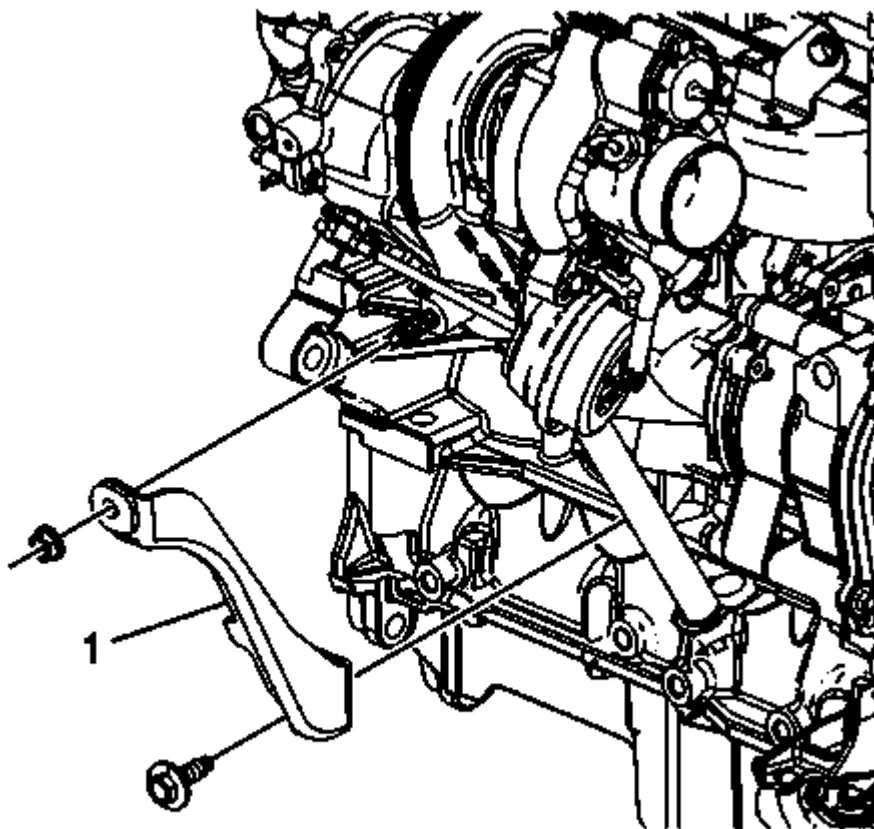


Fig. 35: Turbocharger Brace

Courtesy of GENERAL MOTORS COMPANY

10. Install the turbocharger brace (1).
11. Install the turbocharger brace nuts and tighten to 50 N.m (37 lb ft).
12. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LDK or LHU)** .

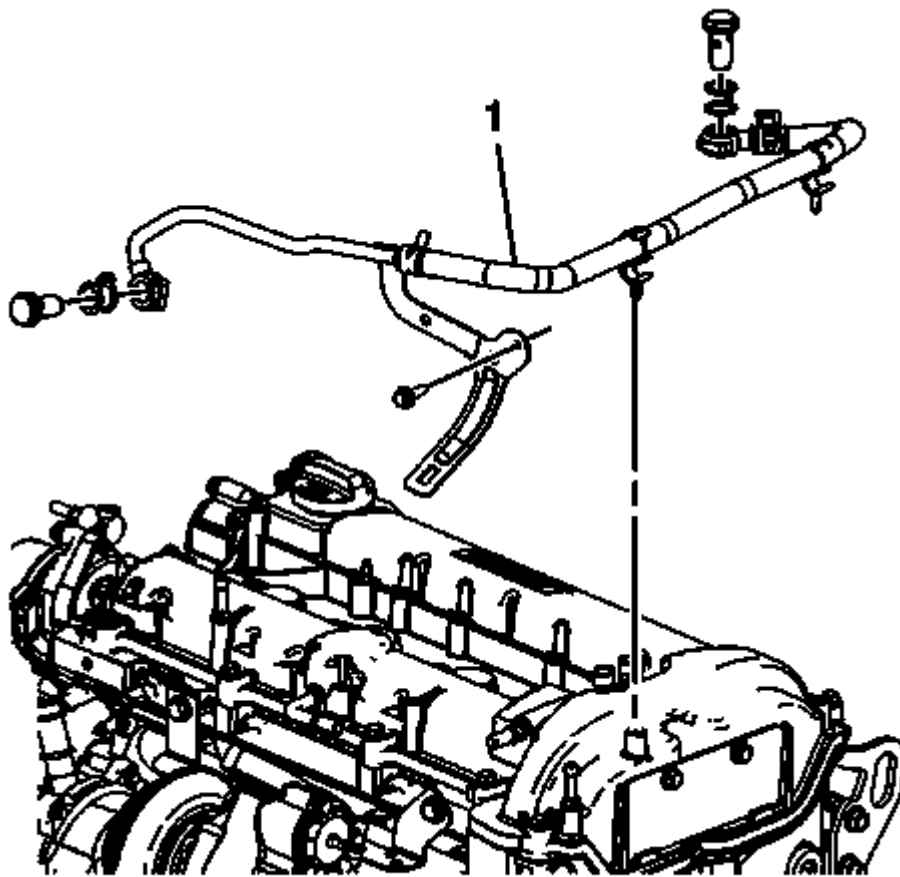


Fig. 36: Turbocharger Coolant Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

13. Install the turbocharger coolant feed pipe (1).
14. Install the turbocharger coolant feed pipe gaskets.
15. Install the turbocharger coolant feed pipe bolts.
 1. Tighten the turbocharger coolant feed pipe bolts to 35 N.m (26 lb ft).
 2. Tighten the turbocharger coolant feed pipe mounting bolt to 10 N.m (89 lb in).
16. Connect the PCV and hose assembly.
17. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .

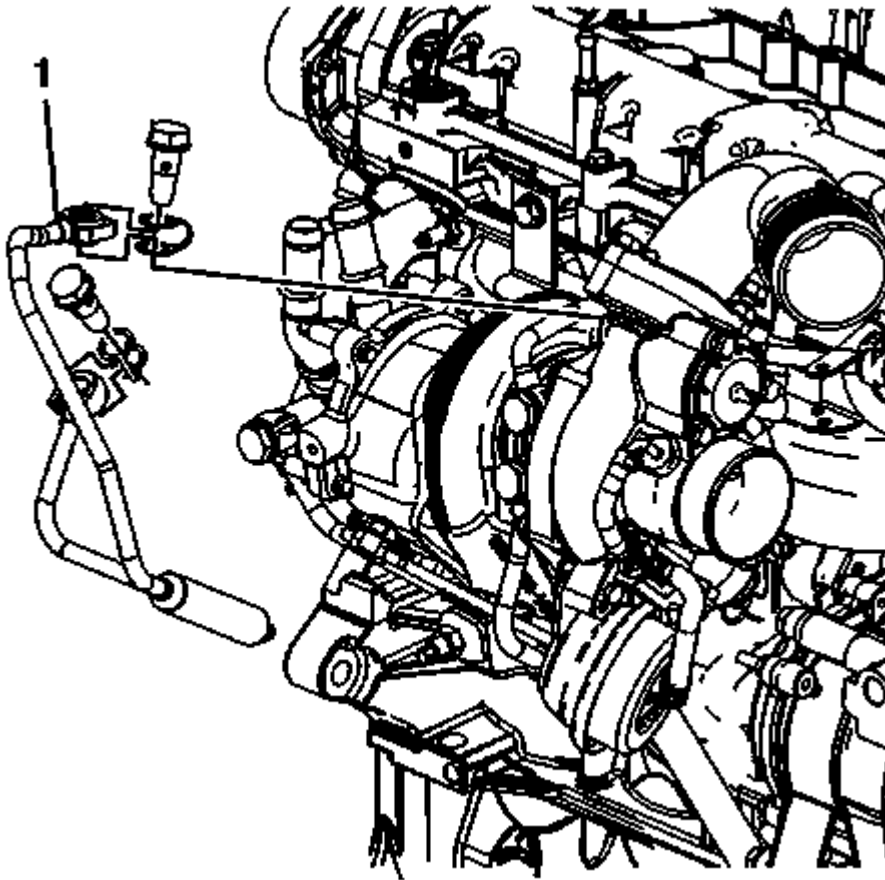


Fig. 37: Turbocharger Oil Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

NOTE: The engine block end of the oil feed pipe fitting has an anti-rotation feature. Ensure that the fitting is fully seated against the block when installing the bolt.

18. Install the turbocharger oil feed pipe (1) on the engine block side.
19. Install the turbocharger oil feed pipe gasket on the engine block side.
20. Install the bolt and tighten to 40 N.m (30 lb ft).

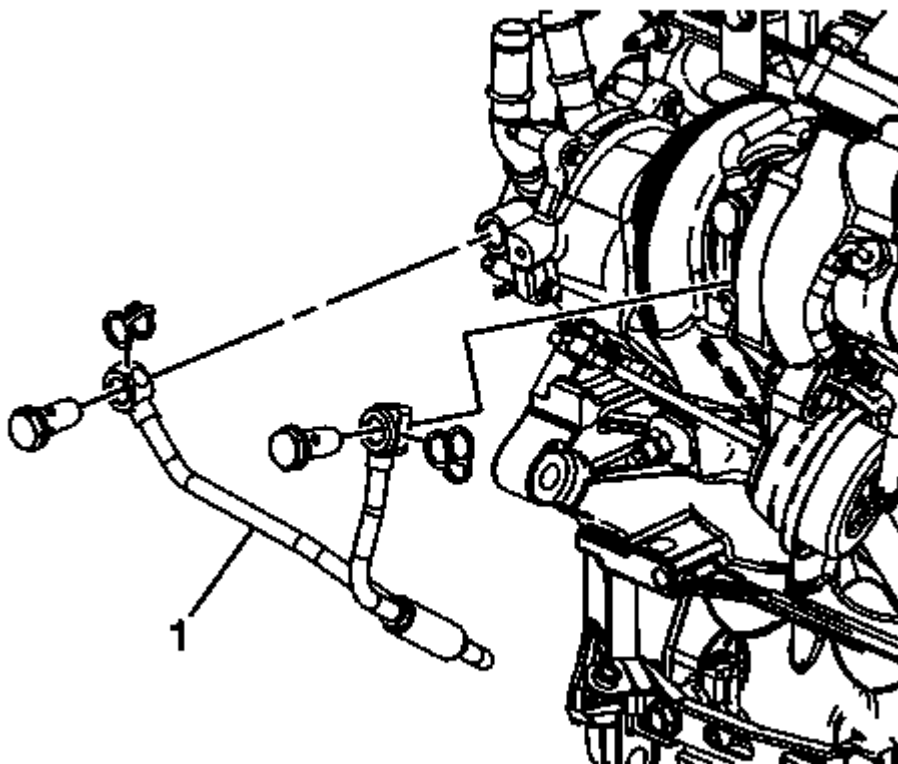


Fig. 38: Turbocharger Coolant Return Pipe
Courtesy of GENERAL MOTORS COMPANY

21. Install the turbocharger coolant return pipe (1).
22. Install the turbocharger coolant return pipe gaskets.
23. Install the turbocharger coolant return pipe bolts and tighten to 35 N.m (26 lb ft).

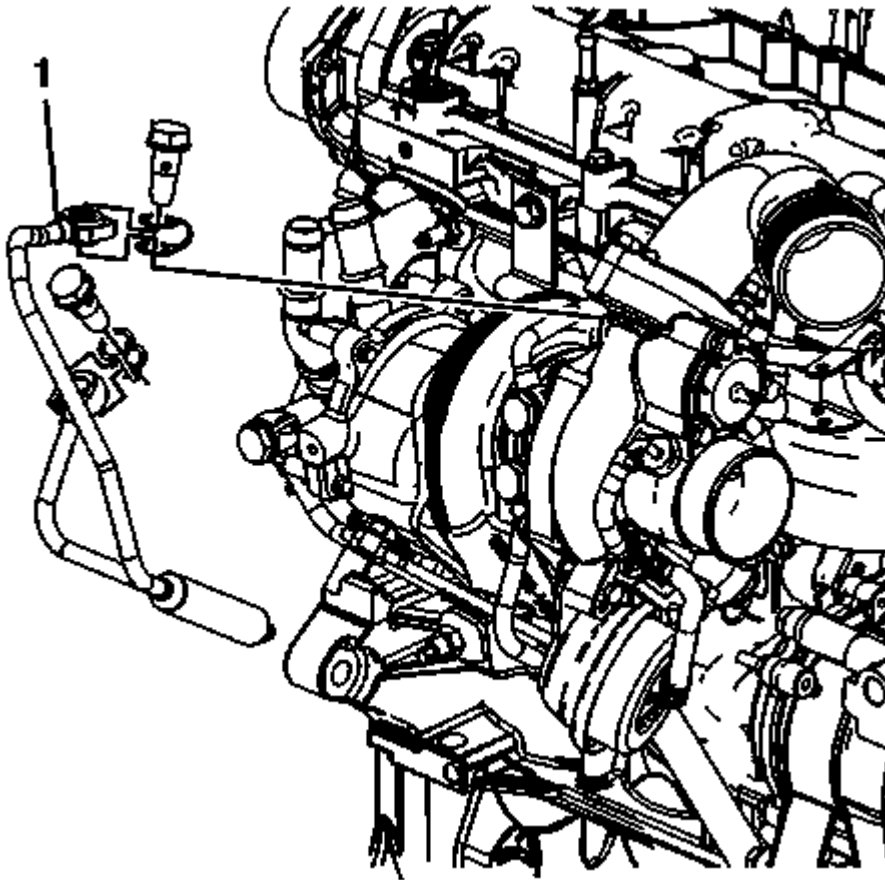


Fig. 39: Turbocharger Oil Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

24. Install the turbocharger oil feed pipe (1) onto the turbocharger.
25. Install the turbocharger oil feed pipe gasket for the turbocharger side.
26. Install the turbocharger oil feed pipe bolt and tighten to 40 N.m (30 lb ft).
27. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LDK or LHU)** .
28. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
29. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
30. Replace the oil filter and fill the engine oil system. Refer to **Engine Oil and Oil Filter Replacement**.

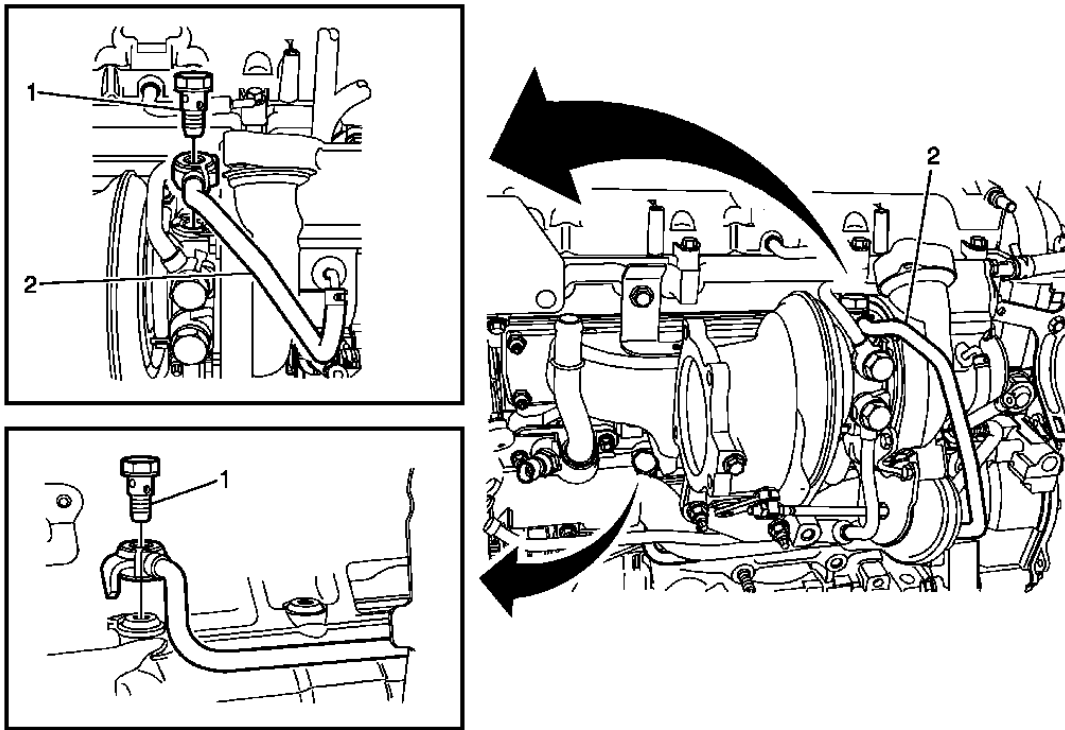
TURBOCHARGER OIL FEED PIPE REPLACEMENT

Fig. 40: Turbocharger Oil Feed Pipe
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Oil Feed Pipe Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the catalytic converter. Refer to Catalytic Converter Replacement (LDK or LHU) . 2. Remove the turbocharger brace.	
1	Turbocharger Oil Feed Pipe Fastener (Qty: 2) CAUTION: Refer to Fastener Caution . Procedure Do not reuse gasket. A new Gasket must be used. Tighten 35 N.m (26 lb ft)
	Turbocharger Oil Feed Pipe Procedure

2

1. Disconnect coolant hose's as needed.
2. Disconnect electrical connectors as needed.
3. Transfer parts as needed.

TURBOCHARGER OIL RETURN PIPE REPLACEMENT

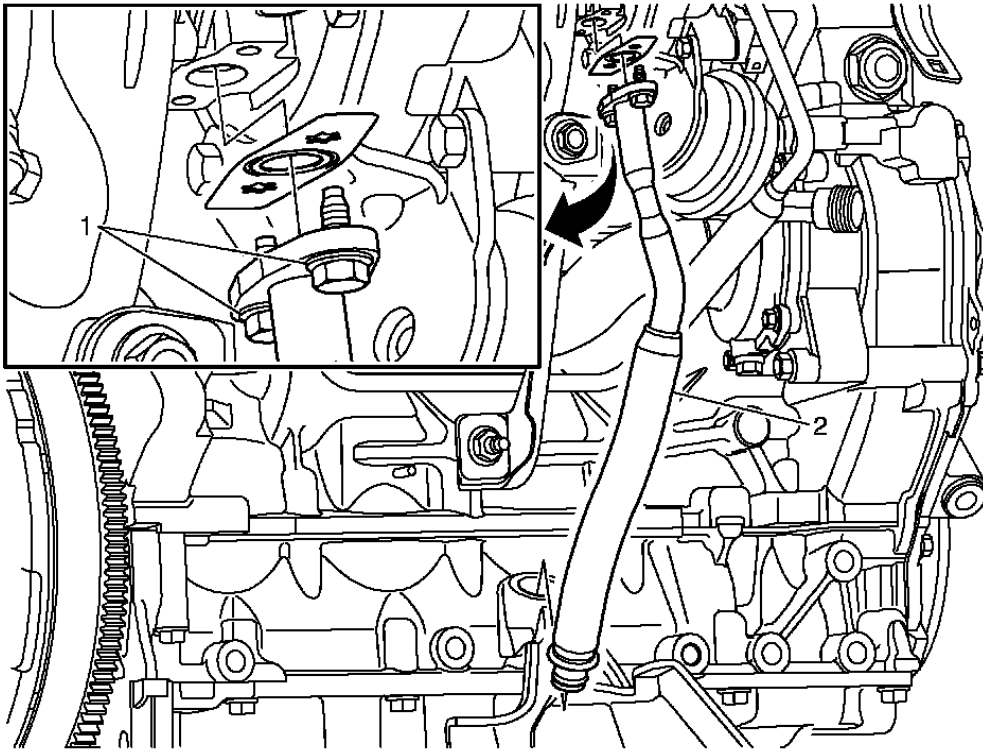


Fig. 41: Turbocharger Oil Return Pipe
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Oil Return Pipe Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the Turbocharger. Refer to <u>Turbocharger Replacement</u>. 2. Remove the catalytic converter. Refer to <u>Catalytic Converter Replacement (LDK or LHU)</u>.	
1	Turbocharger Oil Return Pipe Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)

Turbocharger Oil Return Pipe

Procedure

2

1. A new gasket should be used whenever the pipe is removed from the turbo or engine assembly
2. Transfer components as necessary

INTAKE MANIFOLD REPLACEMENT**Removal Procedure**

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
3. Release the charge air cooler outlet pipe. Refer to **Charge Air Cooler Outlet Pipe Replacement** .
4. Relief the fuel pressure. Refer to **Fuel Pressure Relief** .

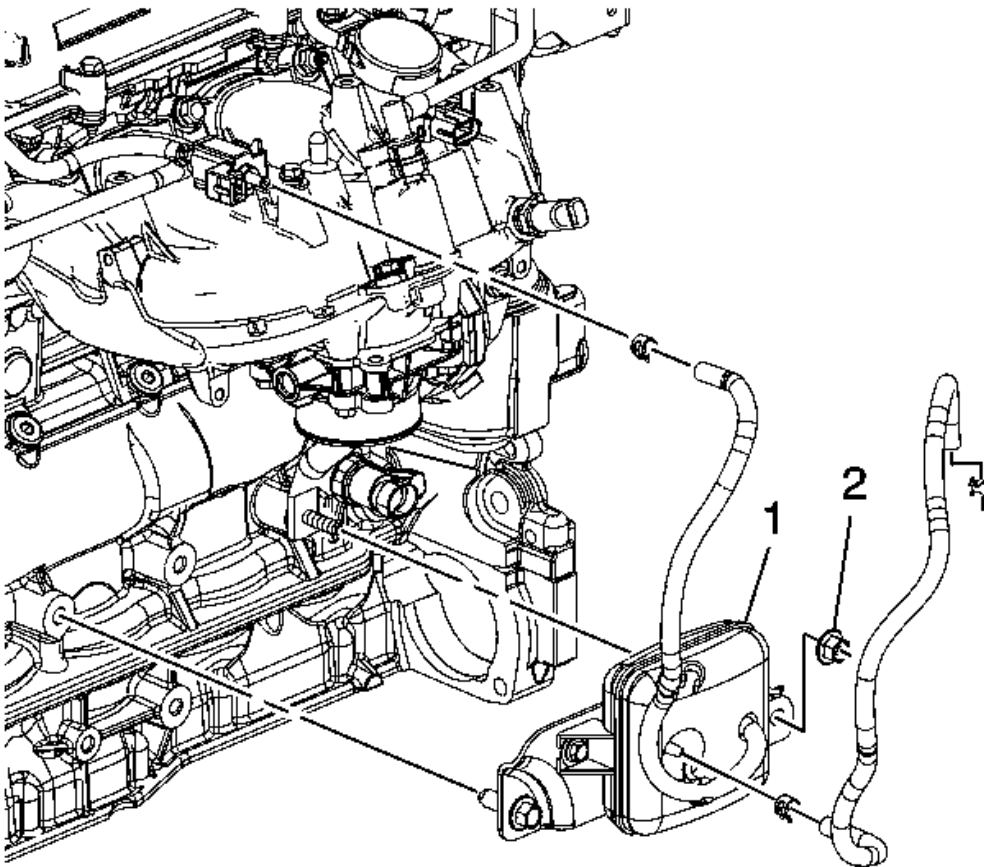


Fig. 42: Identifying AIR Bypass Valve Tank Assembly
Courtesy of GENERAL MOTORS COMPANY

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.

NOTE: The charger AIR bypass tube assembly connected from the charger AIR bypass valve solenoid to the charger AIR bypass valve tank assembly is permanently attached to the tank assembly. Do not attempt to disconnect the charger AIR bypass tube assembly at the charger AIR bypass valve tank assembly.

5. Disconnect the charger AIR bypass tube assembly from the intake manifold.
6. Disconnect the charger AIR bypass tube with the retaining clip from the charger AIR bypass valve solenoid.
7. Remove the charger AIR bypass valve tank assembly nut (2).

NOTE: The charger AIR bypass bolt is captured on the bracket and should not be removed from the bracket. Loosen the bolt only until it is no longer attached to the block when removing the charger AIR bypass valve tank assembly.

8. Loosen the charger AIR bypass valve tank assembly bolt.
9. Remove the charger AIR bypass valve tank assembly (1).

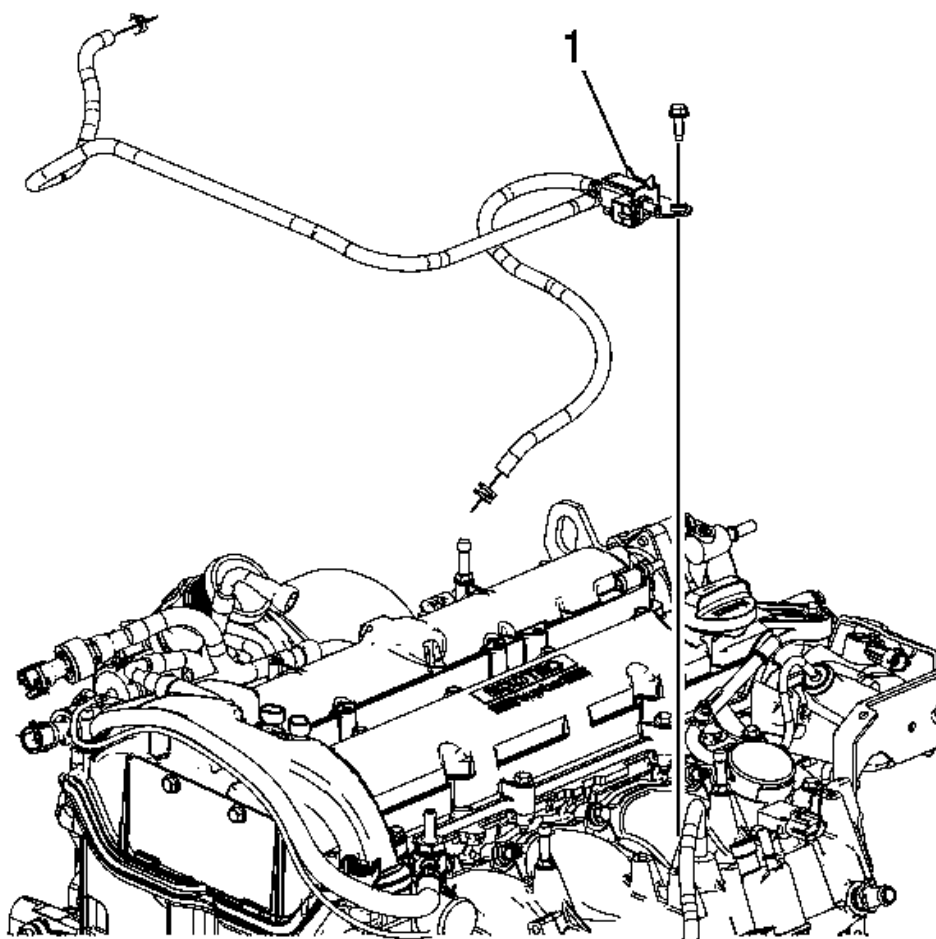


Fig. 43: Charger AIR Bypass Valve Solenoid
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect the remaining charger AIR bypass tubes at the turbocharger and vehicle.
11. Remove the charger AIR bypass valve solenoid bolts.
12. Remove the charger AIR bypass valve solenoid (1).

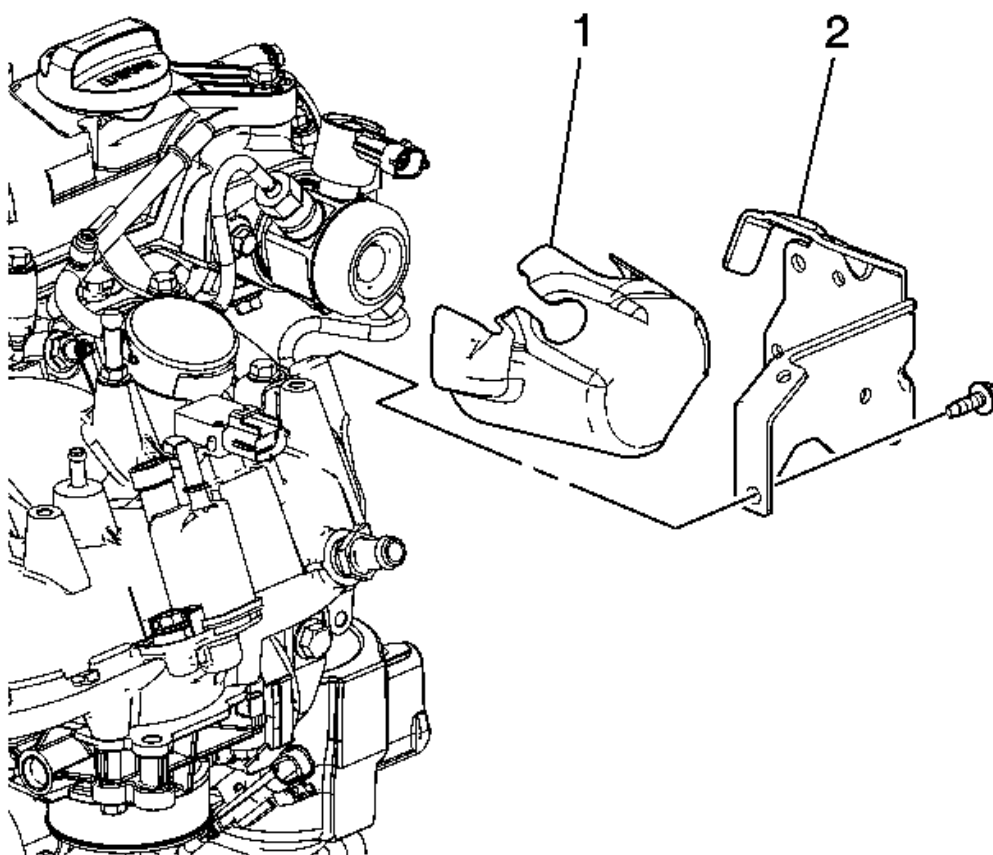


Fig. 44: High Pressure Fuel Pump Cover And High Pressure Fuel Pump Noise Insulator
 Courtesy of GENERAL MOTORS COMPANY

13. Remove the high pressure fuel pump cover bolts.
14. Remove the high pressure fuel pump cover (2).
15. Remove the high pressure fuel pump noise insulator (1).

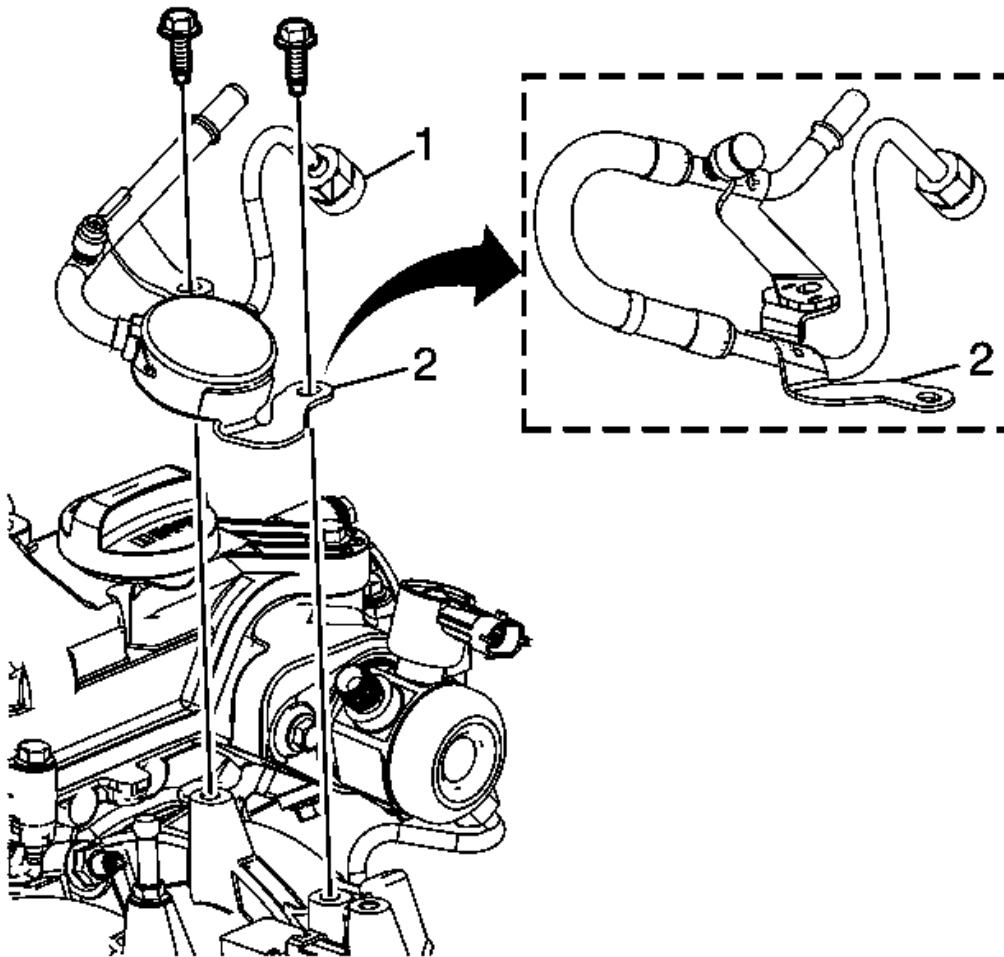


Fig. 45: Fuel Feed Line And Fuel Feed Line Tube Nut
Courtesy of GENERAL MOTORS COMPANY

WARNING: Fuel that flows out at high pressure can cause serious injury to the skin and eyes. **ALWAYS** depressurize the fuel system before removing components that are under high fuel pressure.

16. Loosen and disconnect the fuel feed line tube nut (1).
17. Remove the fuel feed line bolts.
18. Remove the fuel feed line (2).
19. Inspect the fuel feed line nut for damaged threads.
20. Inspect the fuel feed line sealing bail for damage or debris.
21. Replace the fuel feed line if any damage is found.

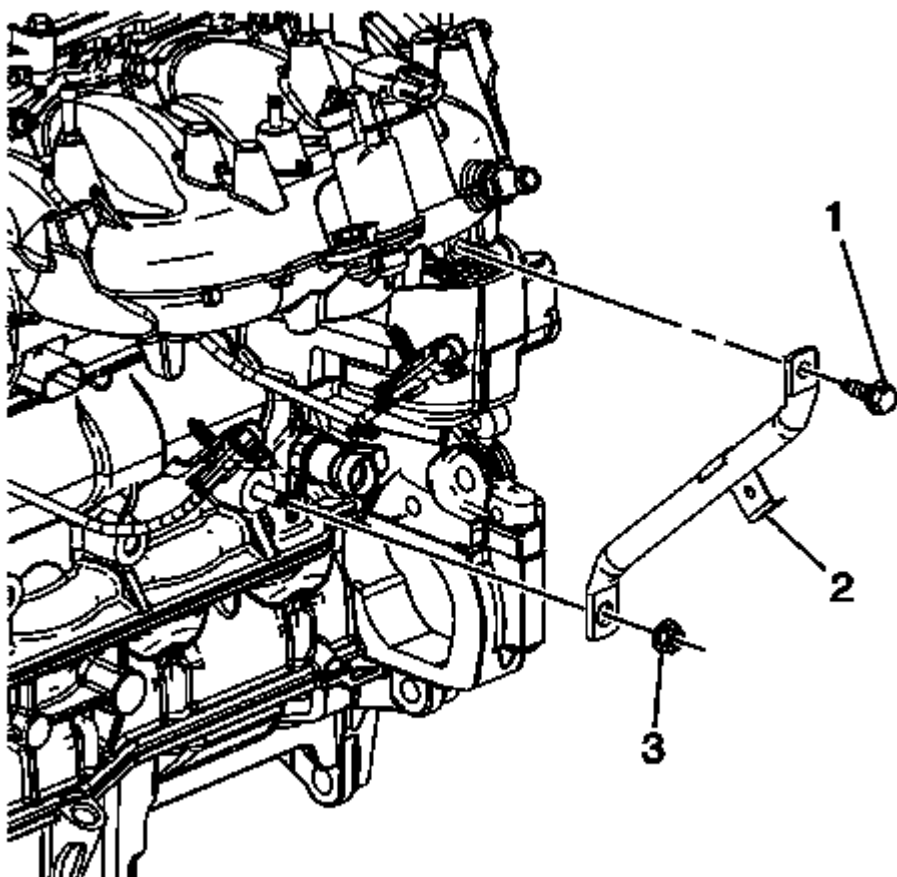


Fig. 46: Intake Manifold Brace

Courtesy of GENERAL MOTORS COMPANY

22. Disconnect the rear knock sensor from the intake manifold brace.
23. Remove the intake manifold brace bolt (1) and nut (3).
24. Remove the intake manifold brace (2).

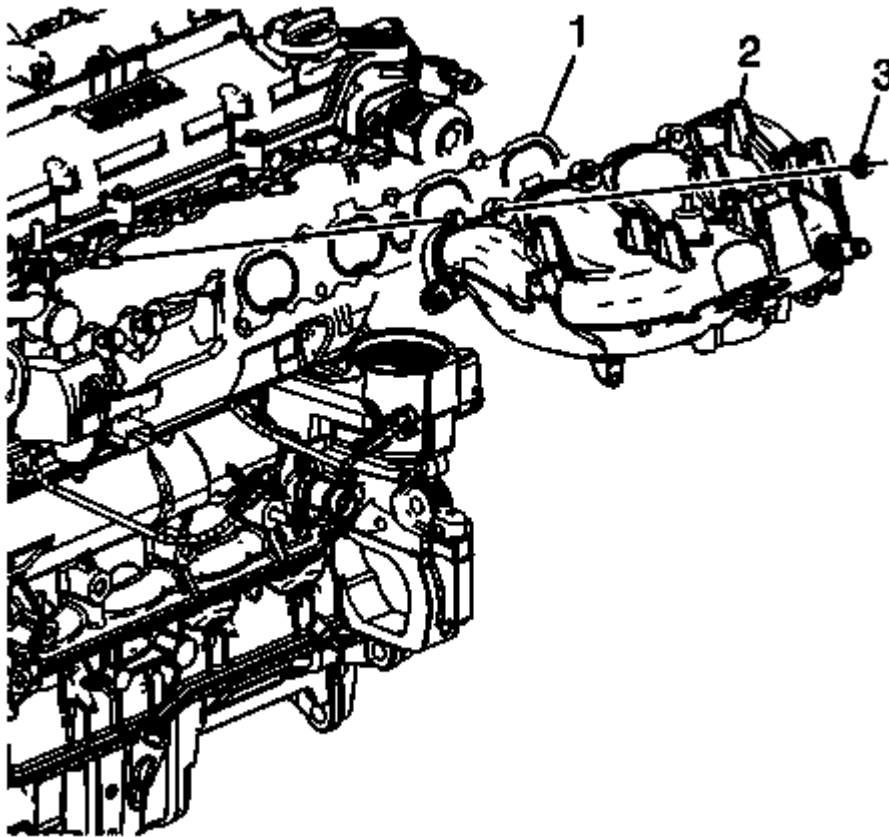


Fig. 47: Intake Manifold, Intake Manifold Bolts And Intake Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

25. Remove the intake manifold bolts and nuts (3).
26. Remove the intake manifold (2).
27. Remove the intake manifold gasket (1).
28. Clean and Inspection intake manifold. Refer to **Intake Manifold Cleaning and Inspection (LDK, LHU)**.
29. Transfer parts as needed.
30. Disconnect electrical connectors as needed.

Installation Procedure

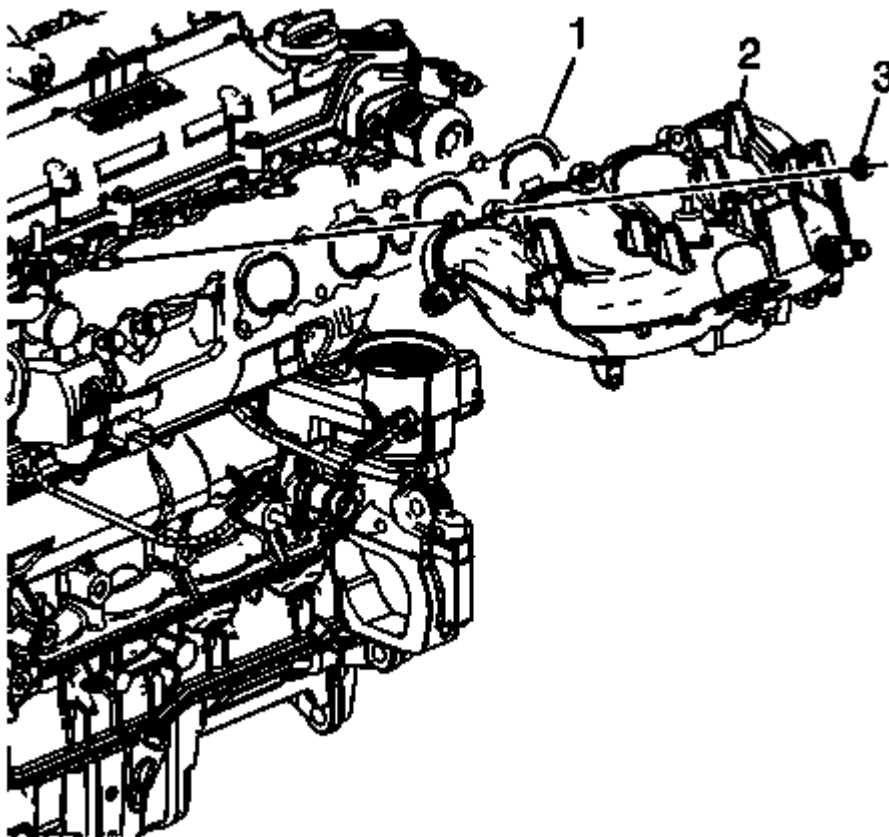


Fig. 48: Intake Manifold, Intake Manifold Bolts And Intake Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to Fastener Caution .

3. Install the intake manifold bolts and nuts (3) finger tight.

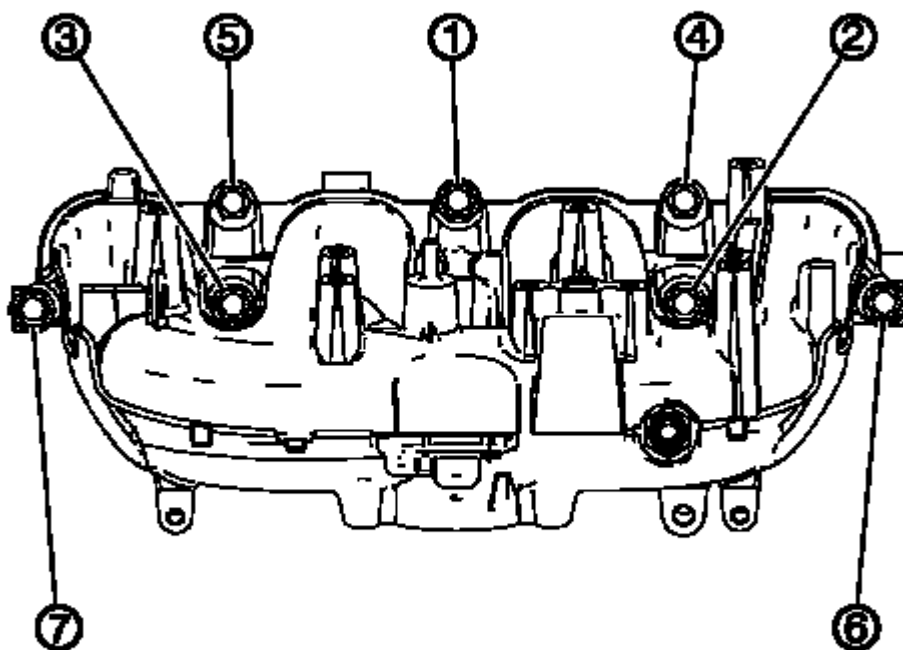


Fig. 49: Identifying Intake Manifold Bolt & Nut Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

4. Tighten the intake manifold bolts and nuts in sequence:
 1. Tighten the intake manifold bolts to 25 N.m (18 lb ft).
 2. Tighten the intake manifold nuts to 22 N.m (16 lb ft).

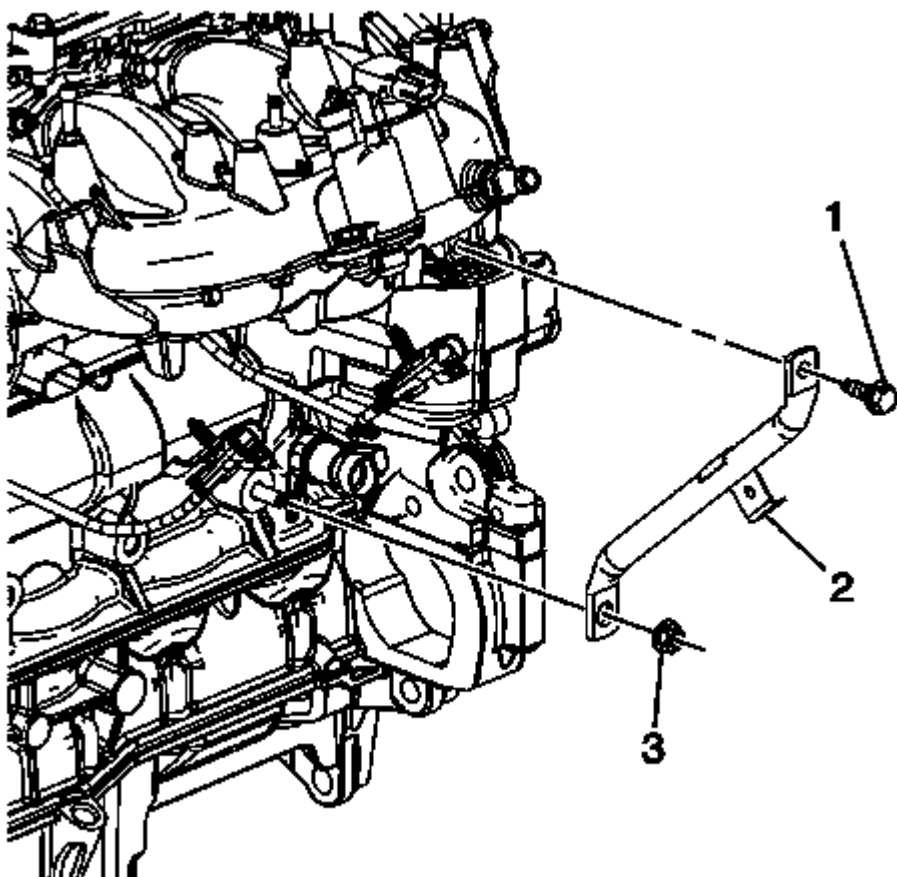


Fig. 50: Intake Manifold Brace

Courtesy of GENERAL MOTORS COMPANY

5. Install the intake manifold brace (2).
6. Install the intake manifold brace bolt (1) and nut (3) and tighten to 25 N.m (18 lb ft).
7. Connect the rear knock sensor to the intake manifold brace.

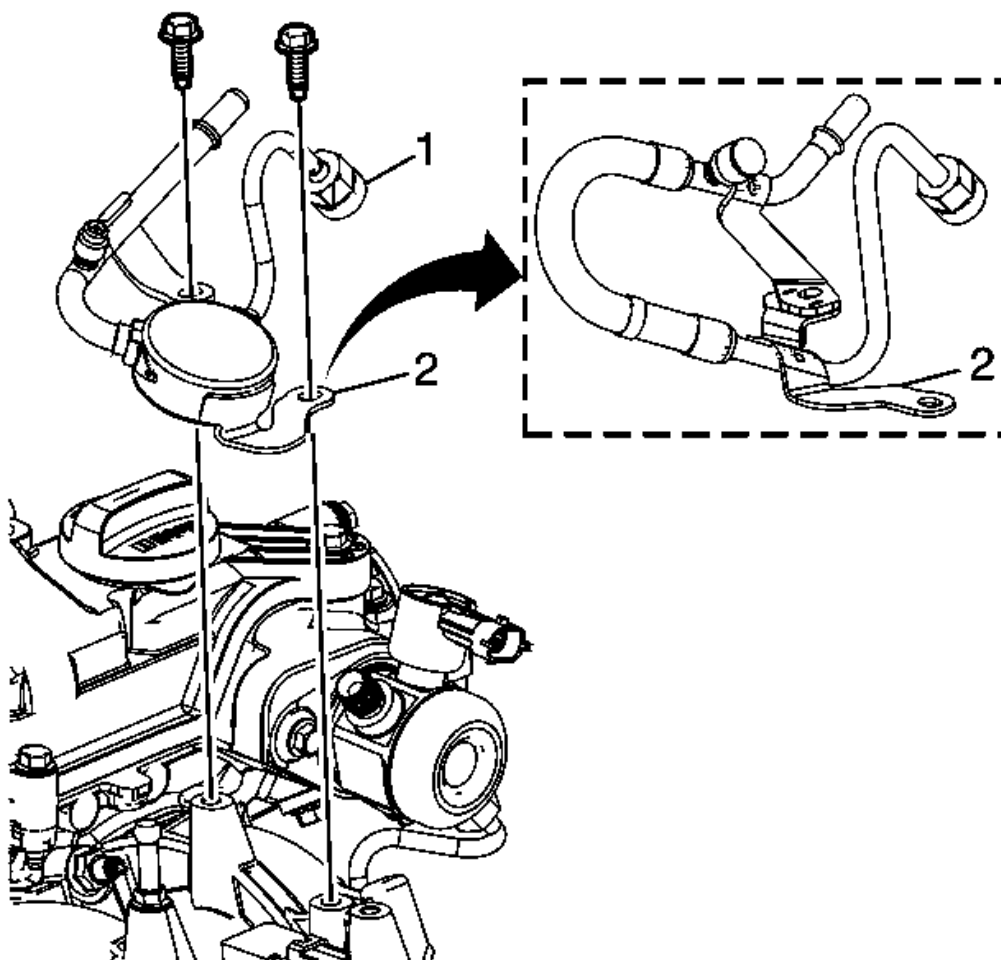


Fig. 51: Fuel Feed Line And Fuel Feed Line Tube Nut
Courtesy of GENERAL MOTORS COMPANY

8. Lubricate the high pressure fuel pump fuel feed line connection threads with clean 5W30 engine oil.
9. Install the fuel feed line (2).
10. Install the fuel feed line bolts.
11. Connect the low pressure fuel line nut (1) and tighten to 30 N.m (22 lb ft).
12. Tighten the fuel feed line bolts to 10 N.m (89 lb in).

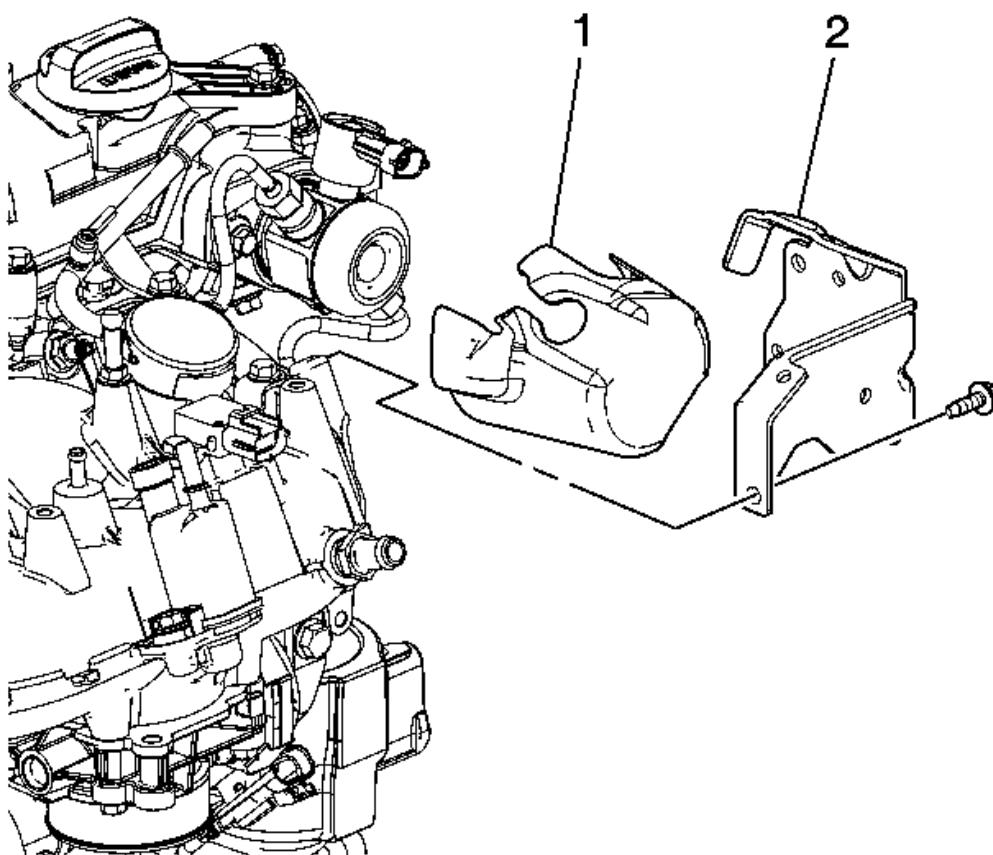


Fig. 52: High Pressure Fuel Pump Cover And High Pressure Fuel Pump Noise Insulator
Courtesy of GENERAL MOTORS COMPANY

13. Install the high pressure fuel pump noise insulator (1).
14. Install the high pressure fuel pump cover (2).
15. Install the high pressure fuel pump cover bolts and tighten to 10 N.m (89 lb in).

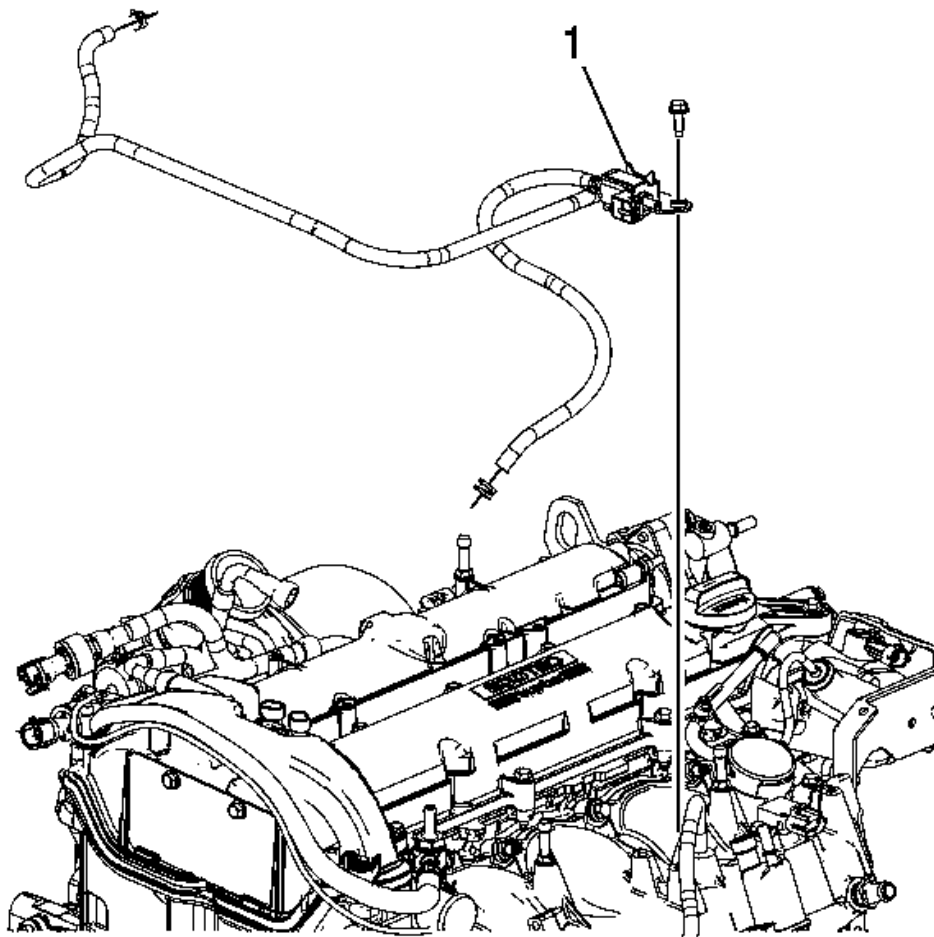


Fig. 53: Charger AIR Bypass Valve Solenoid
Courtesy of GENERAL MOTORS COMPANY

16. Install the charger AIR bypass valve solenoid (1) with charger AIR bypass tube assemblies.
17. Install the charger AIR bypass valve solenoid bolts and tighten to 10 N.m (89 lb in).

NOTE: **Ensure proper connection of the charger AIR bypass tube assemblies and retaining clips to maintain proper pressure. Connect each tube to the appropriate location.**

18. Connect the charger AIR bypass tube assemblies and clips from the charger AIR bypass valve solenoid to the turbocharger and vehicle.

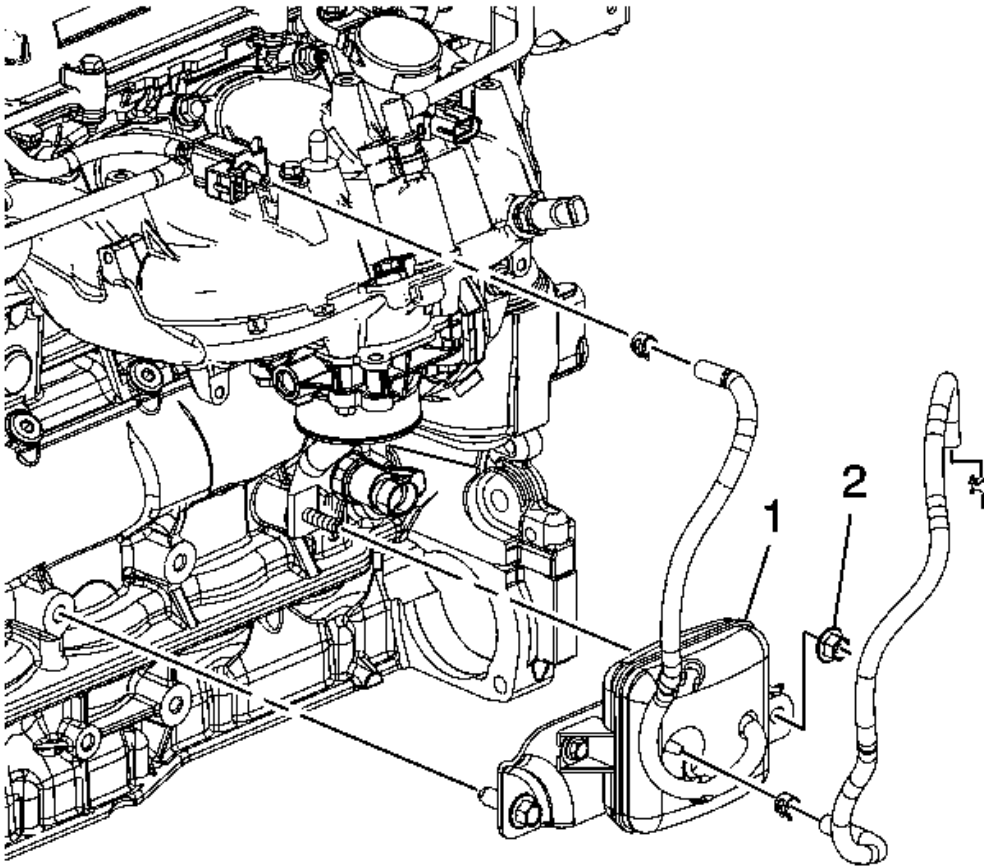


Fig. 54: Identifying AIR Bypass Valve Tank Assembly
Courtesy of GENERAL MOTORS COMPANY

19. Install the charger AIR bypass valve tank assembly (1).
20. Tighten the charger AIR bypass valve tanks assembly bolt to 25 N.m (18 lb ft).
21. Install the charger AIR bypass valve tank assembly nut (2) and tighten to 25 N.m (18 lb ft).

NOTE: Ensure proper connection of the charger AIR bypass tube assemblies and retaining clips to maintain proper pressure. Connect each tube to the appropriate location. The tube with retaining clamp located on the charger AIR bypass valve tank assembly left side connects to the charger AIR bypass valve solenoid. The right side, permanently attached tube connects to the intake manifold.

22. Connect the appropriate charger AIR bypass tube assembly to the intake manifold.
23. Connect the final charger AIR Bypass tube assembly from the charger AIR bypass valve tank assembly to the charger AIR bypass valve solenoid.
24. Install the charge air cooler outlet pipe. Refer to Charge Air Cooler Outlet Pipe Replacement .

25. Fill the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .
26. Install the intake manifold cover. Refer to Intake Manifold Cover Replacement.

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- EN-47981 Harmonic Balancer Holder
- EN-45059 Angle Meter

For equivalent regional tools, refer to Special Tools (LDK, LHU) .

Removal Procedure

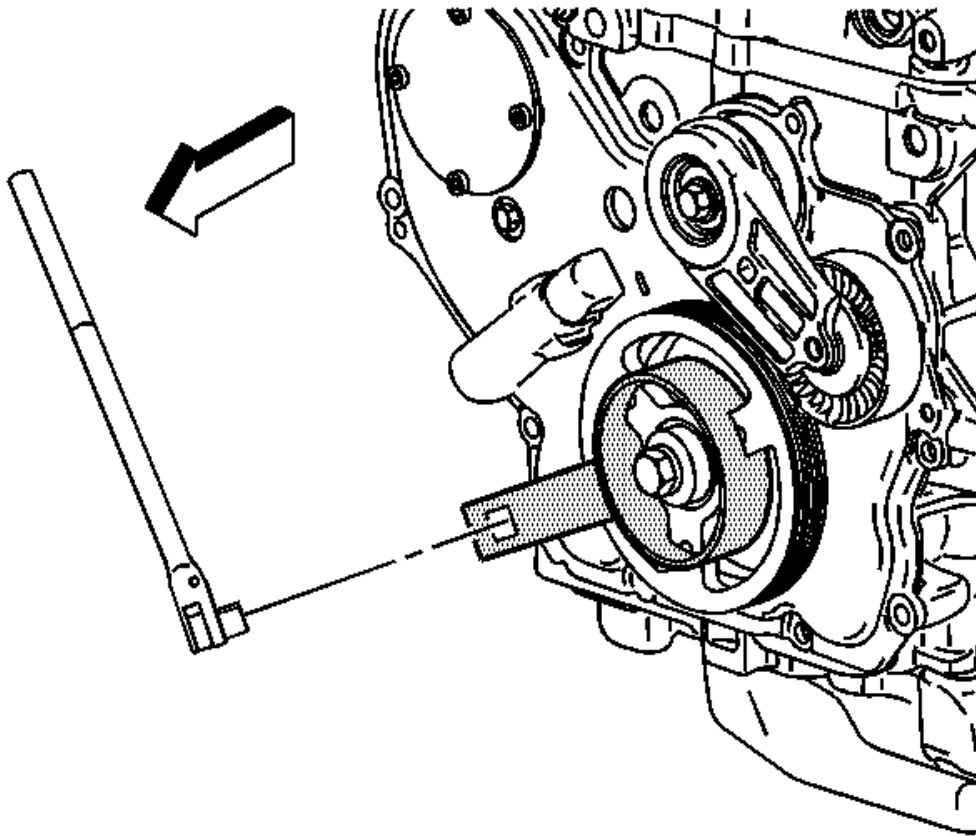


Fig. 55: View Of Harmonic Balancer Holder J38122-A
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine drive belt. Refer to **Drive Belt Replacement**.
2. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
3. Use the **EN-47981** Harmonic Balancer Holder to prevent the crankshaft from rotating while loosening the crankshaft balancer bolt.

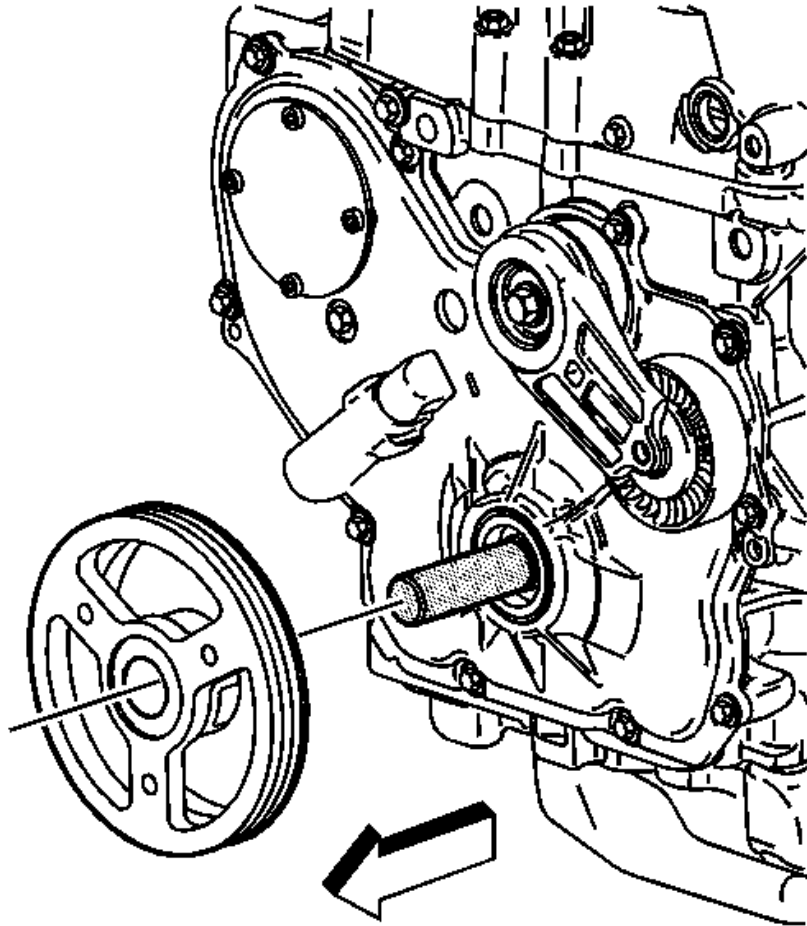


Fig. 56: View Of Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

4. Remove the crankshaft balancer bolt. Discard the bolt.
5. Remove the balancer using a universal removal tool.

Installation Procedure

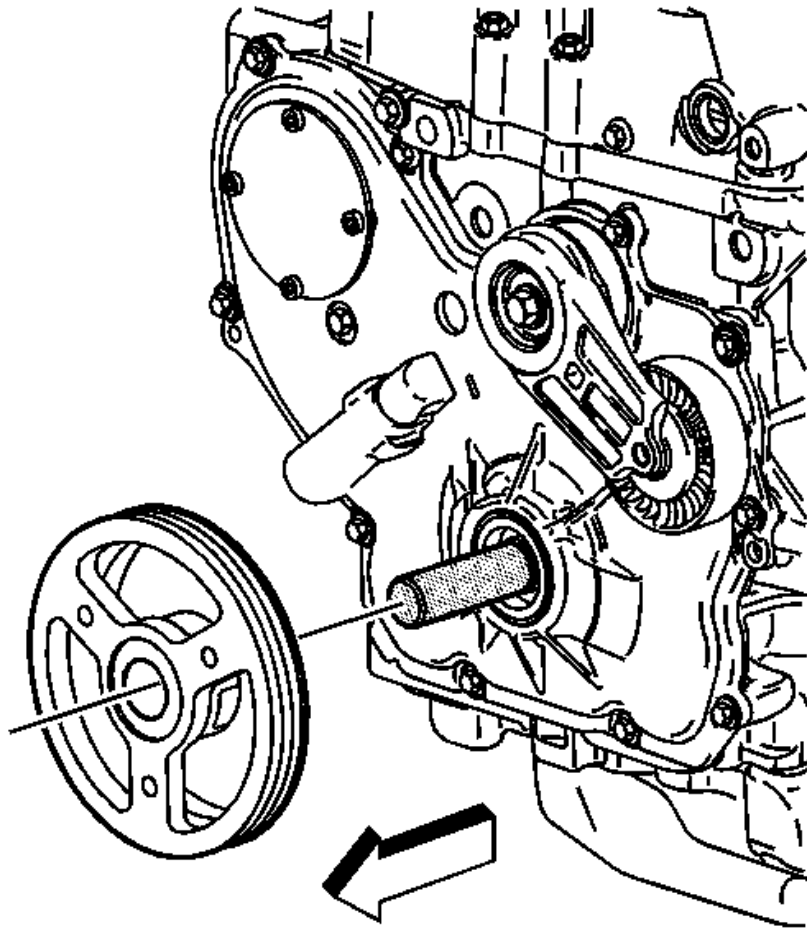


Fig. 57: View Of Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Ensure both components are aligned correctly or serious engine damage will occur.

1. Install the crankshaft balancer onto the crankshaft indexing keyway. Use care to properly align the keyway and the flats on the balancer with the oil pump drive.
2. Install the crankshaft balancer using a universal balancer installer.

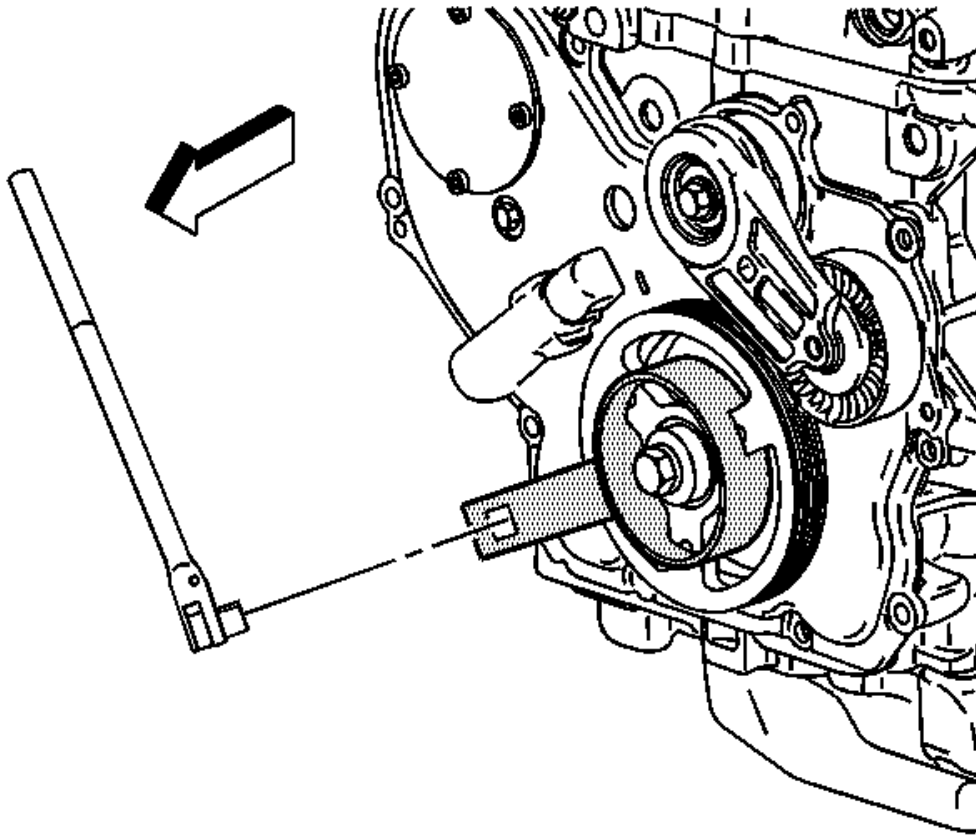


Fig. 58: View Of Harmonic Balancer Holder J38122-A
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Always install a NEW crankshaft balancer bolt and washer.

3. Install a NEW crankshaft balancer bolt. Use the **EN-47981** Harmonic Balancer Holder to prevent the crankshaft from rotating when tightening the bolt.

Tighten the bolt to 100 N.m (74 lb ft) plus an additional 125 degrees using the **EN-45059** Angle Meter.

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

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

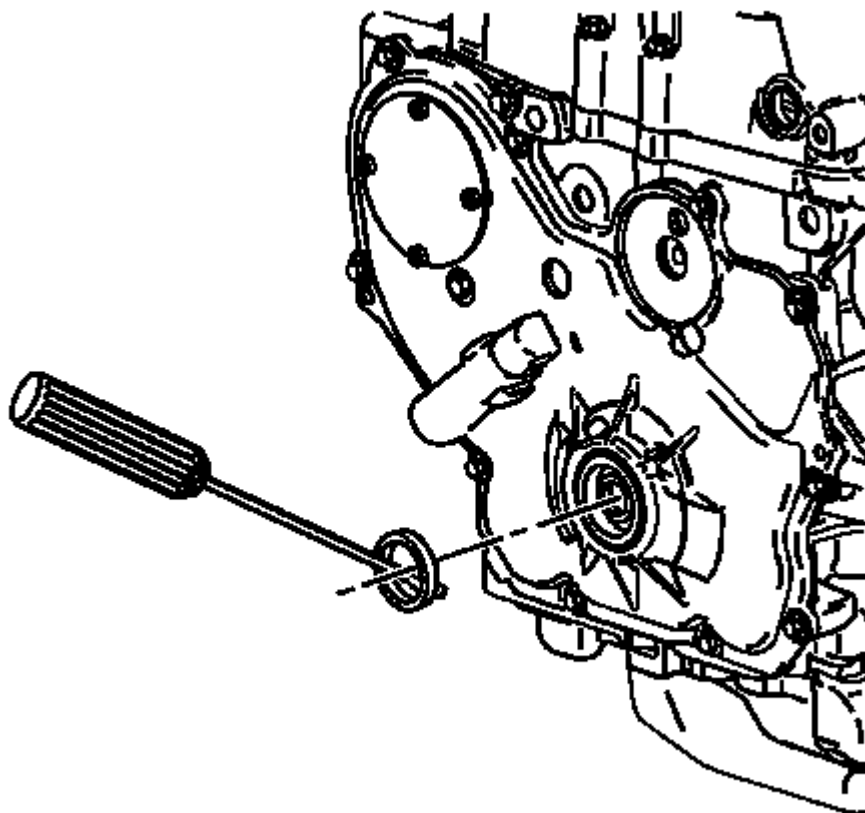
Special Tools**EN-34115 Sprocket Bearing Installer****Removal Procedure**

Fig. 59: Removing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

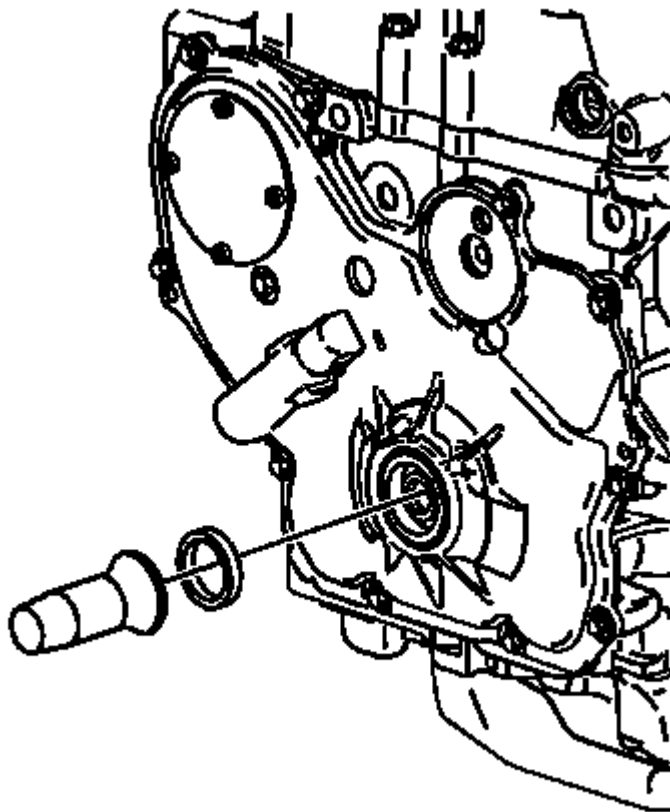


Fig. 60: Installing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

1. Use the **EN-34115** Sprocket Bearing Installer in order to install the oil seal to the front cover.
2. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

ENGINE FRONT COVER REPLACEMENT

Removal Procedure

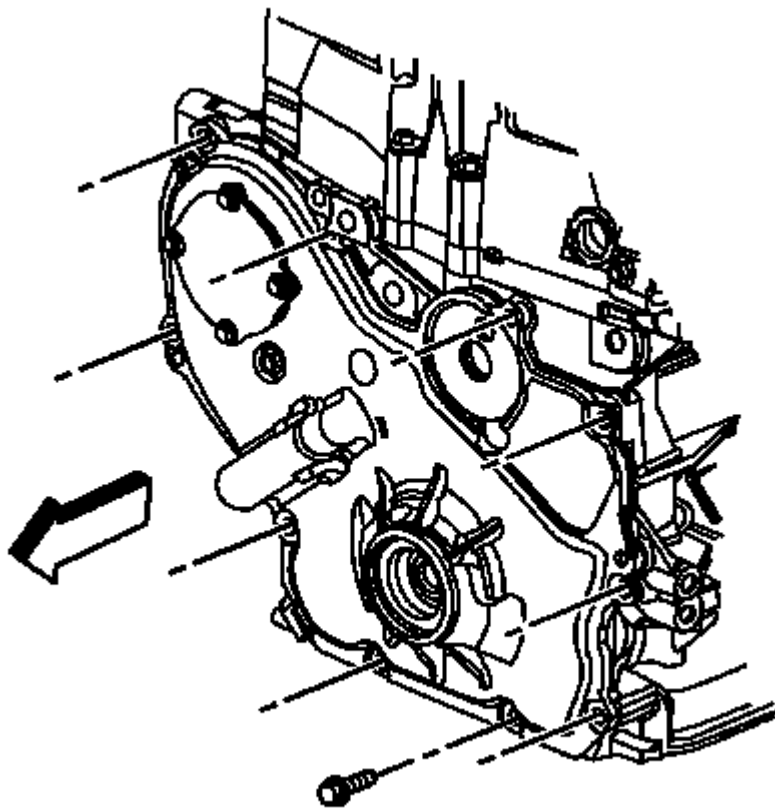


Fig. 61: Engine Front Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
3. Remove the belt idler pulley. Refer to **Belt Idler Pulley Replacement**
4. Remove the engine front cover bolts.

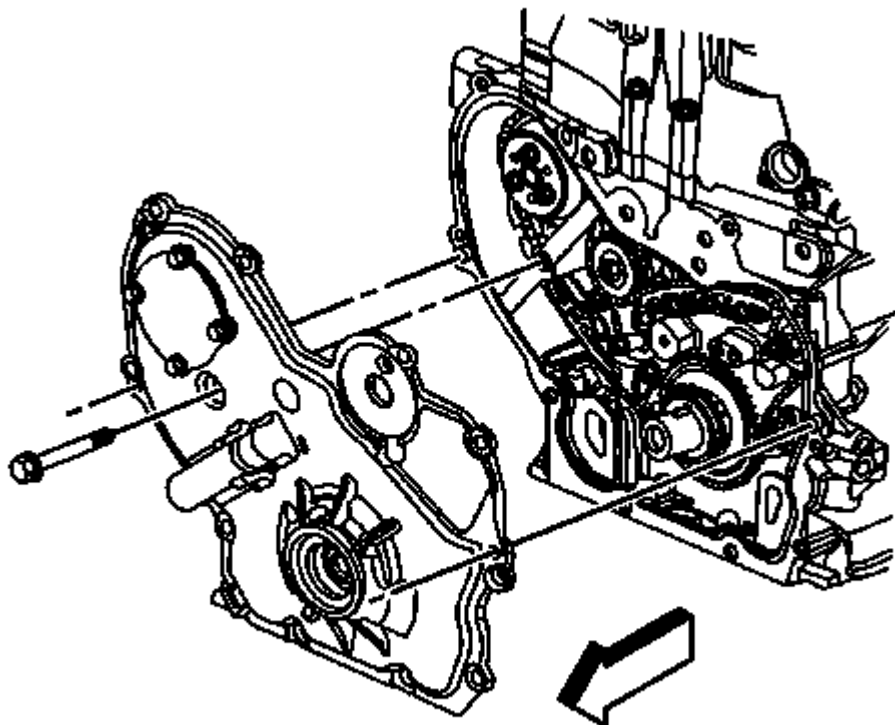


Fig. 62: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

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

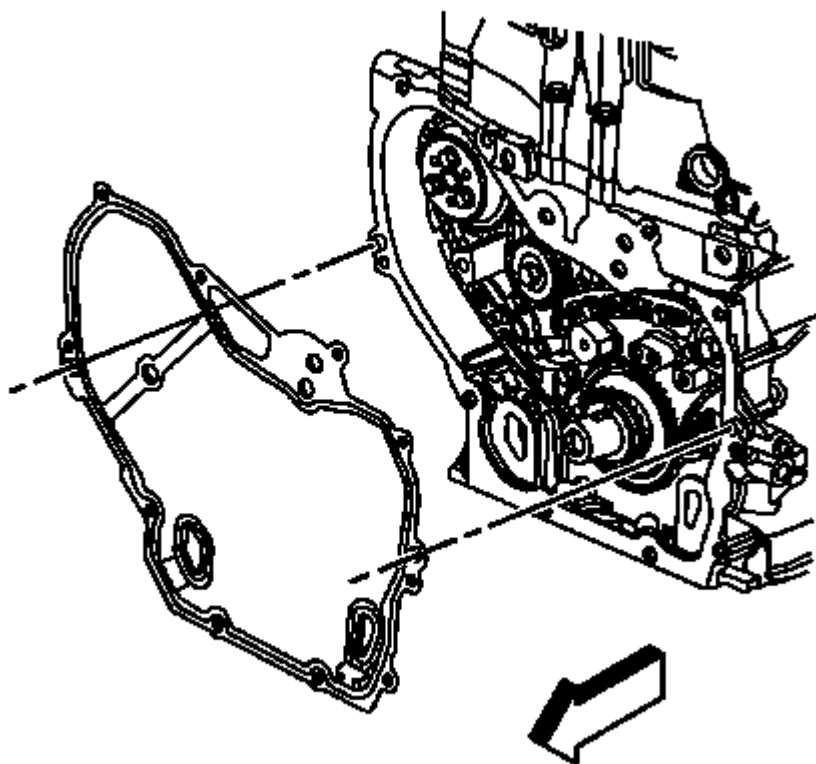


Fig. 63: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the engine front cover gasket.
7. Remove the crankshaft front cover oil seal with an appropriate tool.
8. Remove and discard the friction washer.

Installation Procedure

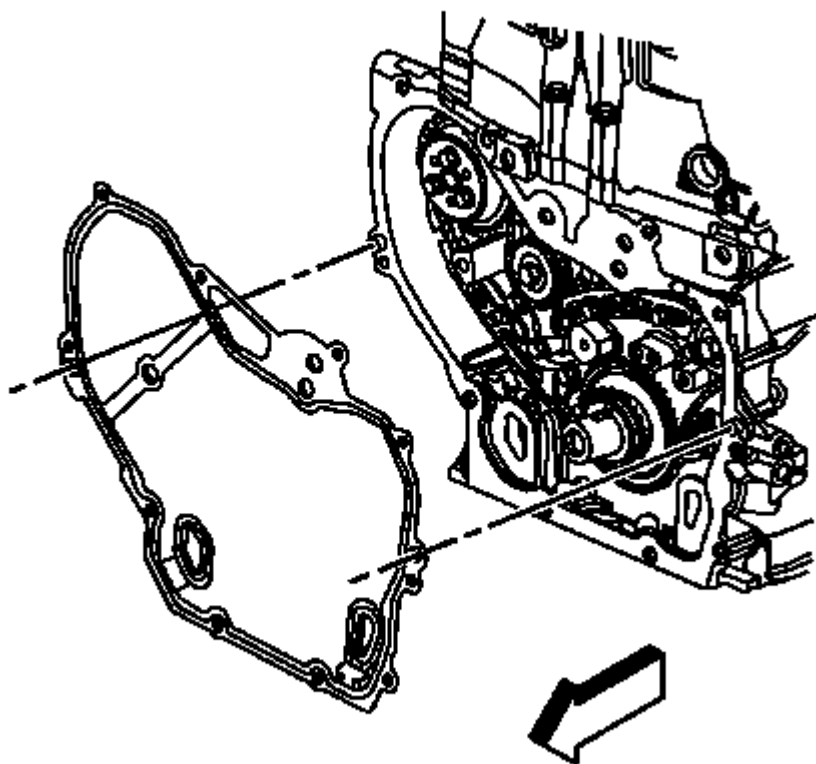


Fig. 64: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW crankshaft front oil seal. Refer to Crankshaft Front Oil Seal Installation (LDK, LHU) .
2. Install a NEW friction washer.
3. Position and install a NEW engine front cover gasket to the dowel pins.

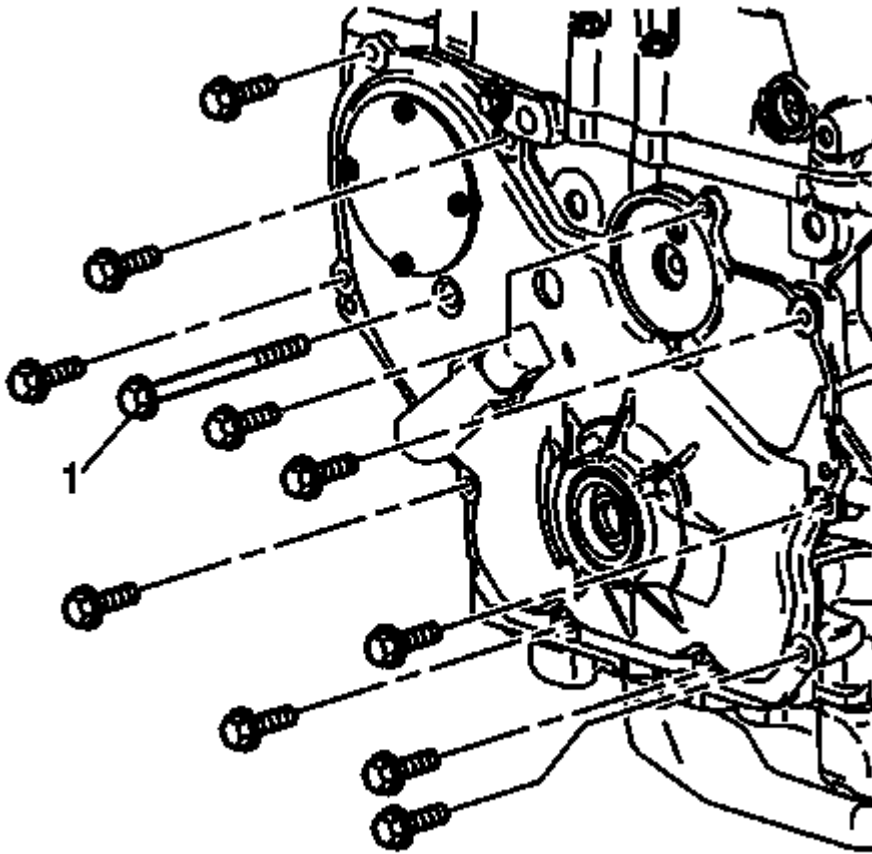


Fig. 65: Engine Front Cover Bolts & Long Water Pump Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the engine front cover bolts

CAUTION: Refer to Fastener Caution .

5. Install the long water pump bolt (1)

Tighten

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

6. Install the crankshaft balancer. Refer to Crankshaft Balancer Replacement .
7. Install the belt idler pulley. Refer to Belt Idler Pulley Replacement
8. Install the drive belt tensioner. Refer to Drive Belt Tensioner Replacement.

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER REPLACEMENT

Special Tools

- **EN-45027** Tensioner Tool
- **EN-45059** Angle Meter

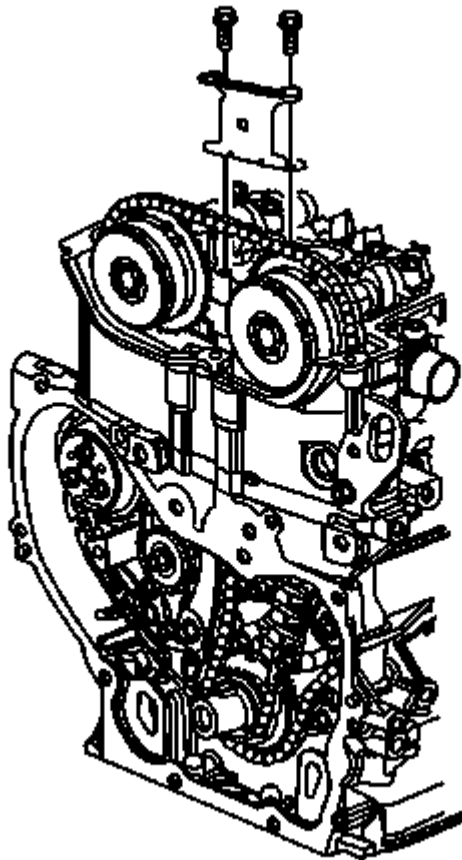
Removal Procedure

Fig. 66: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS COMPANY

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

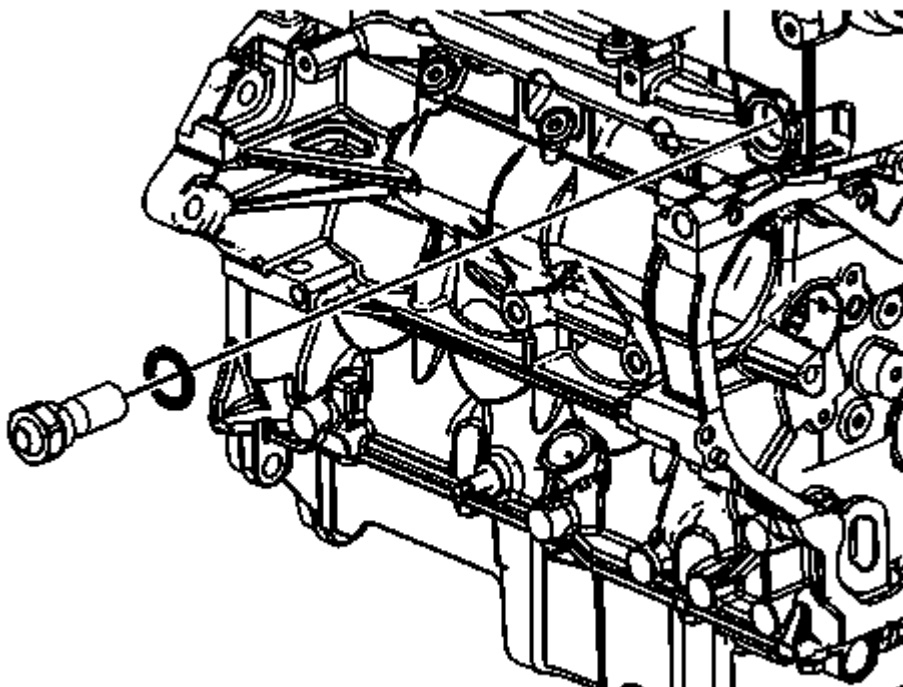


Fig. 67: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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.

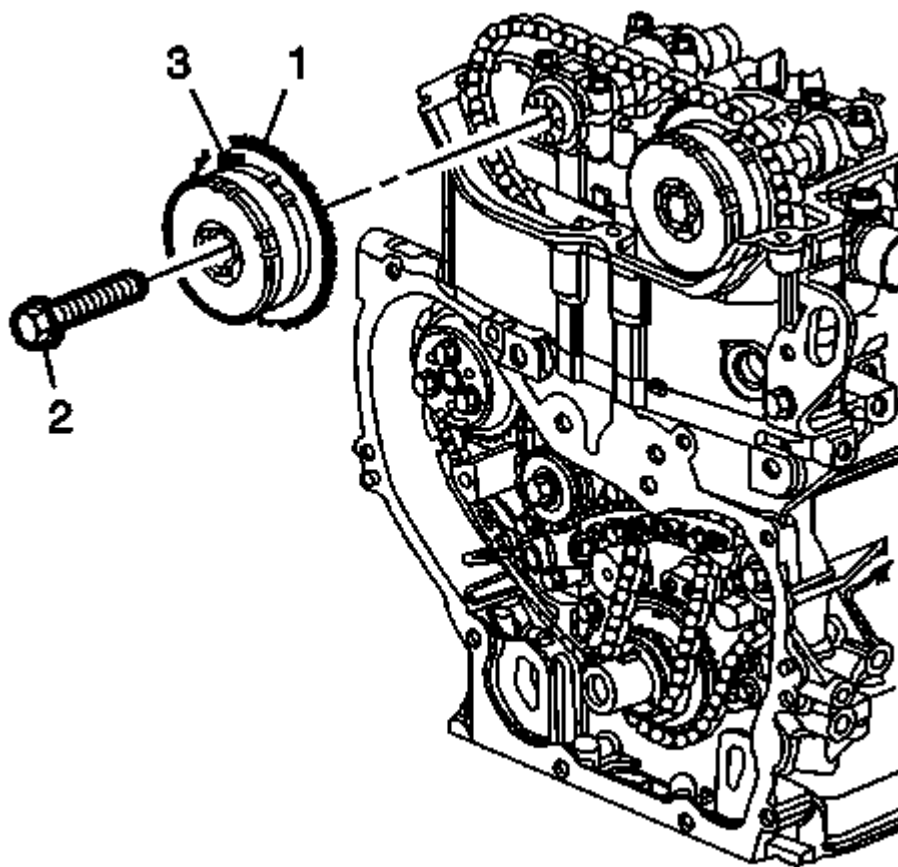


Fig. 68: Exhaust Camshaft Sprocket

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.

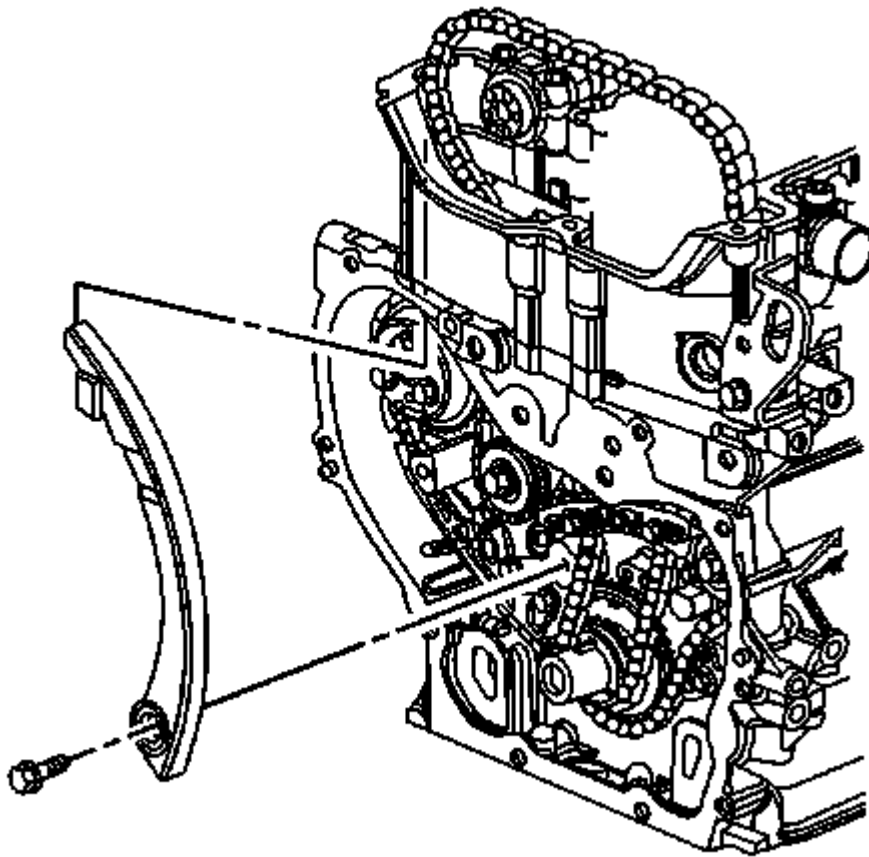


Fig. 69: Timing Chain Tensioner Guide
Courtesy of GENERAL MOTORS COMPANY

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

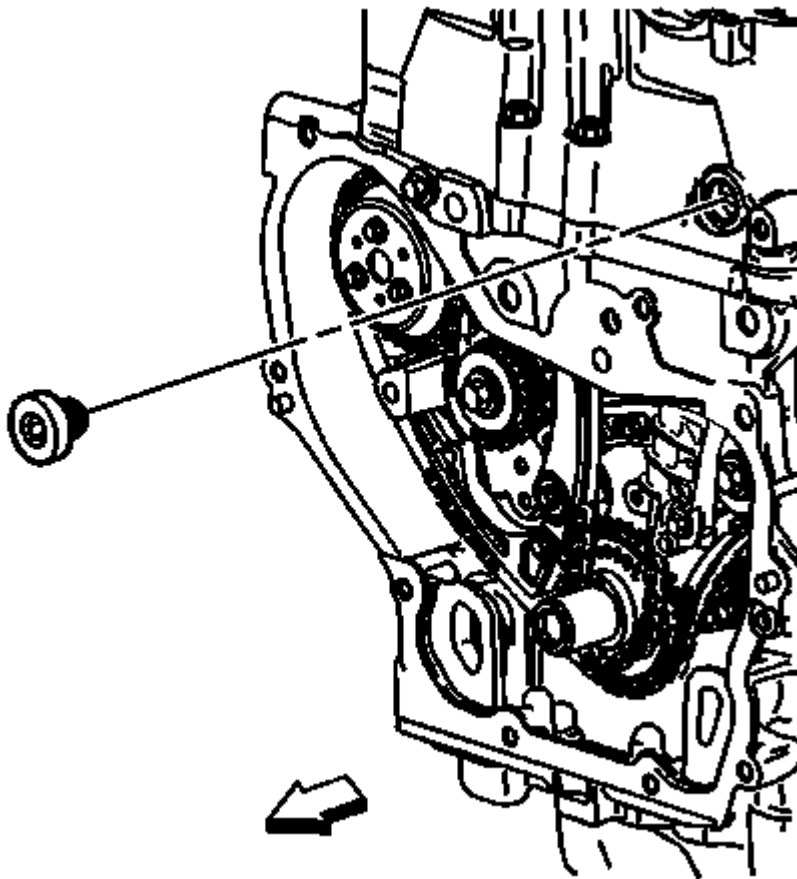


Fig. 70: View Of Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS COMPANY

11. Remove the fixed timing chain guide access plug.

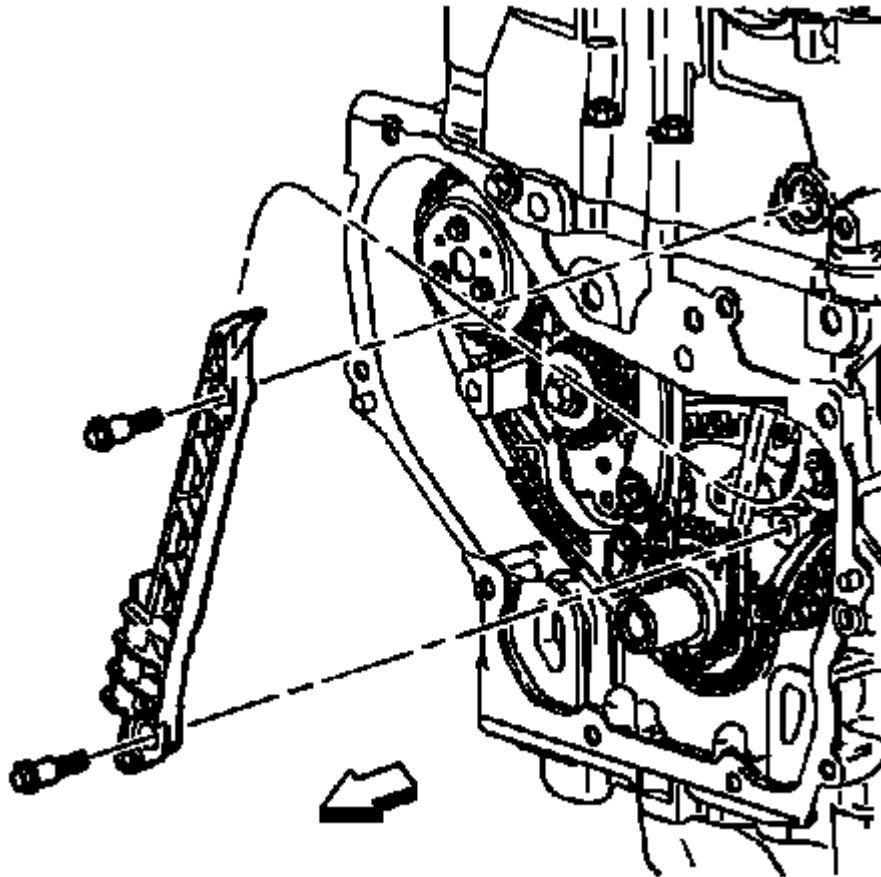


Fig. 71: View Of Fixed Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

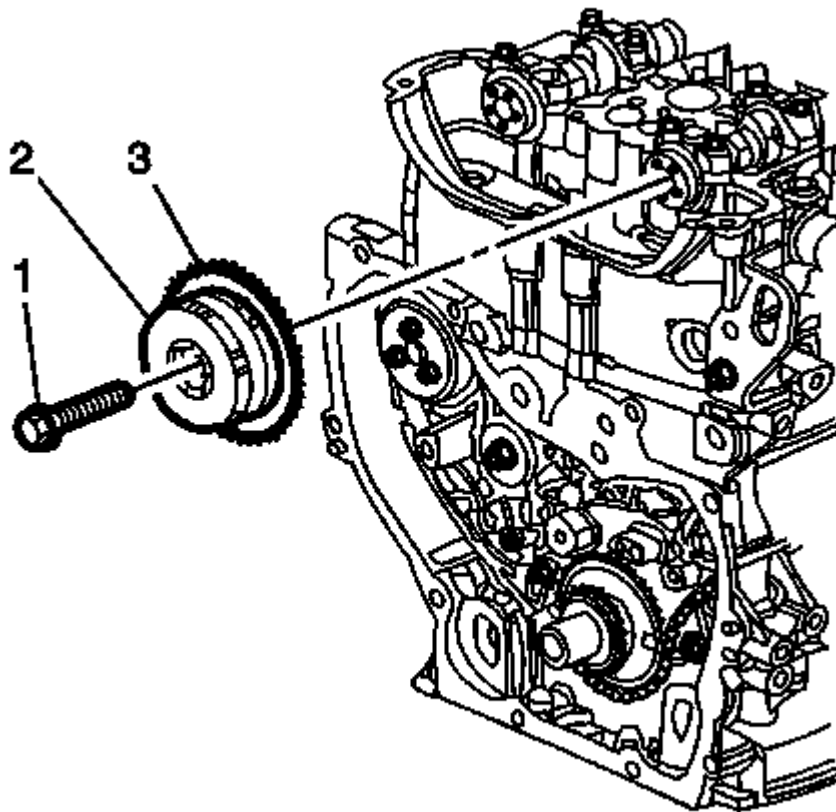


Fig. 72: Timing Chain & Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

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 (2).
15. Remove the intake camshaft actuator (3), and the timing chain through the top of the cylinder head.

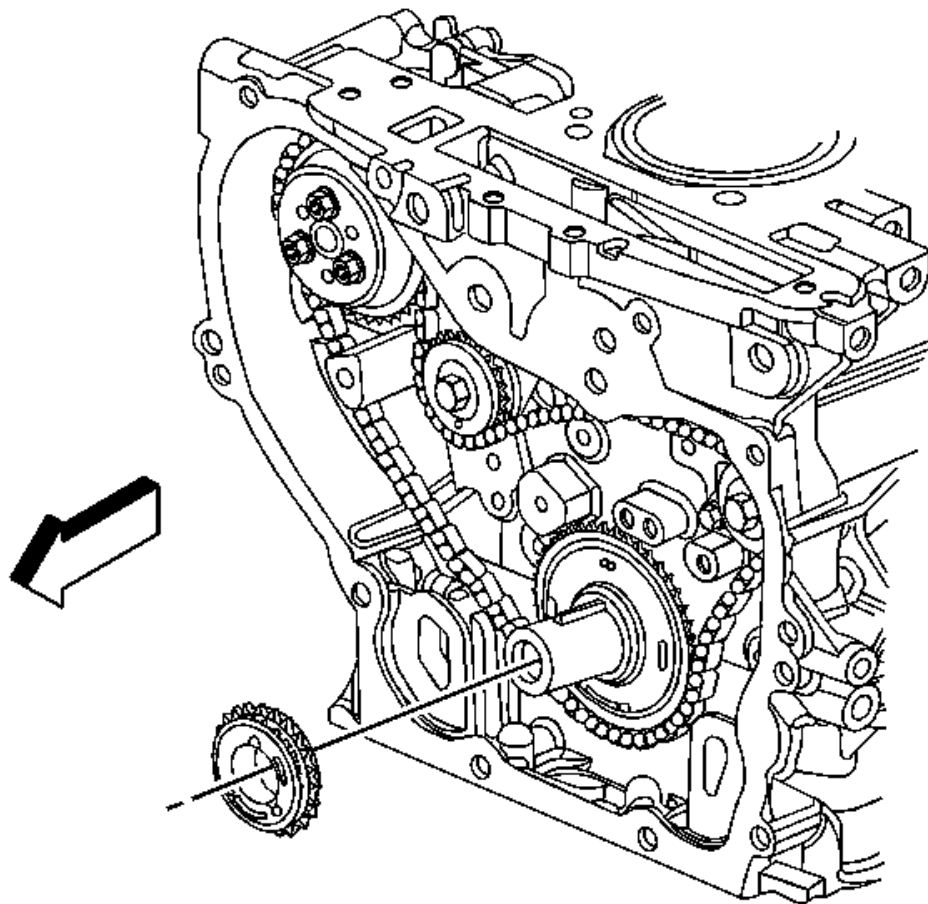


Fig. 73: Timing Chain Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

16. Remove the timing chain crankshaft sprocket.

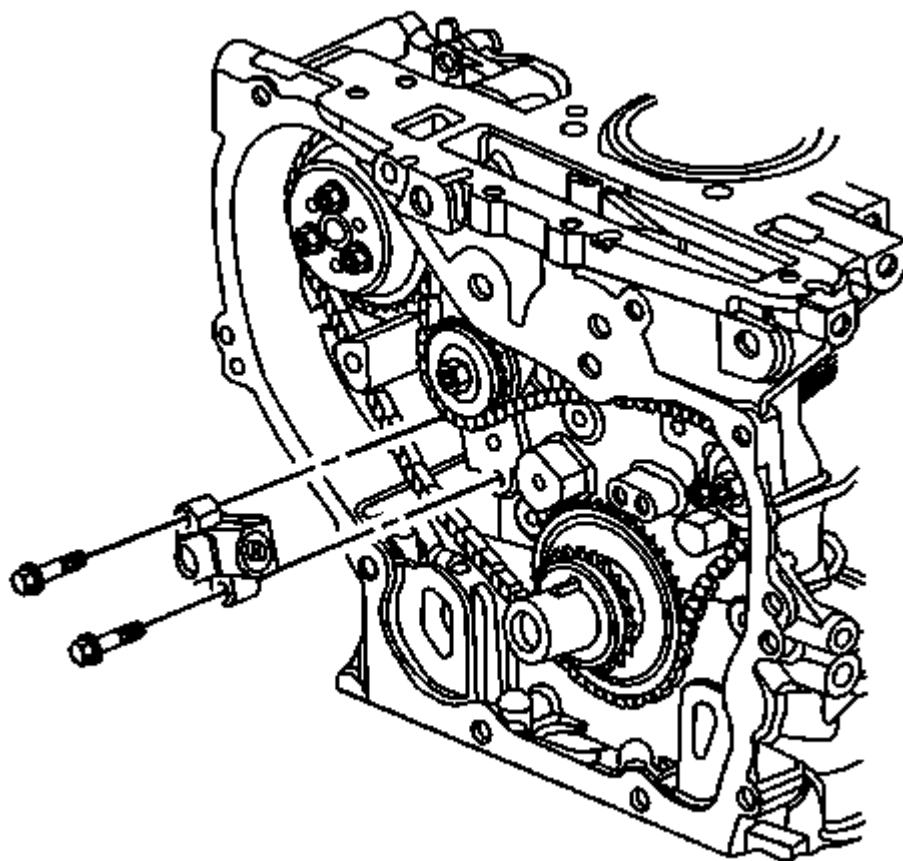


Fig. 74: Balance Shaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

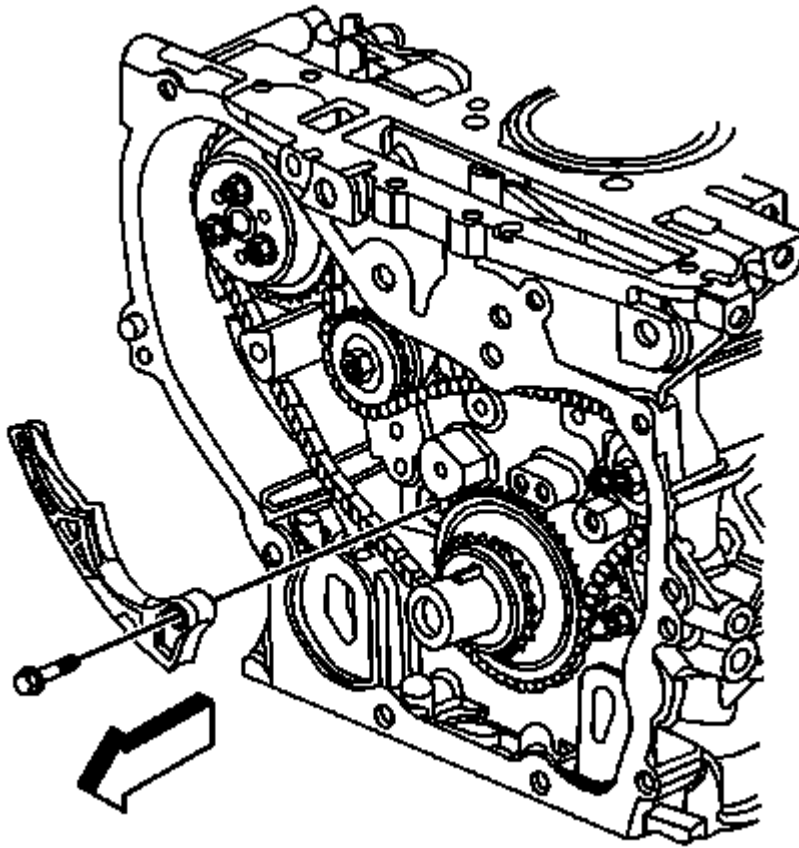


Fig. 75: Adjustable Balance Shaft Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

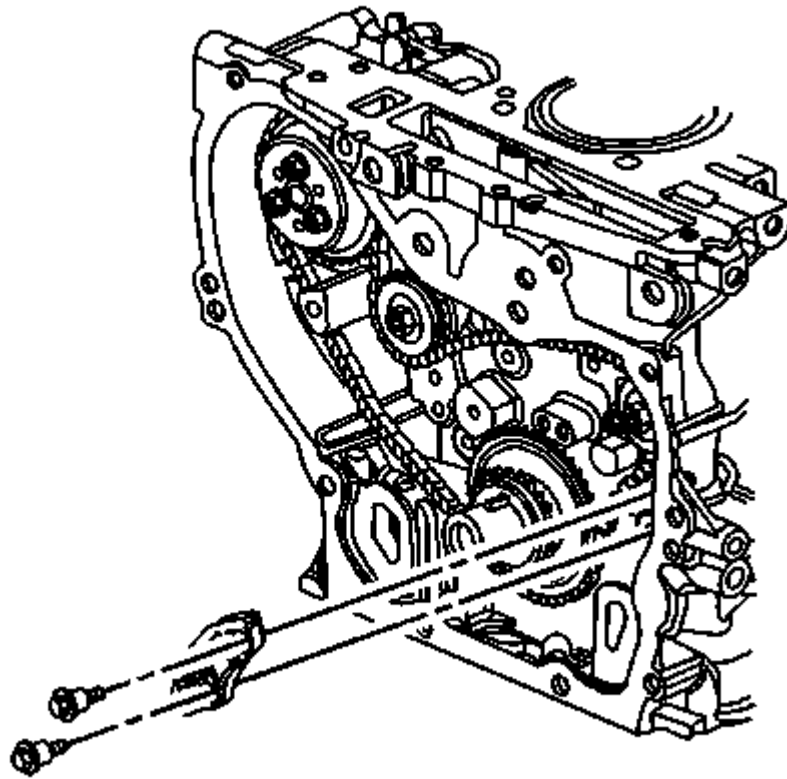


Fig. 76: Small Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

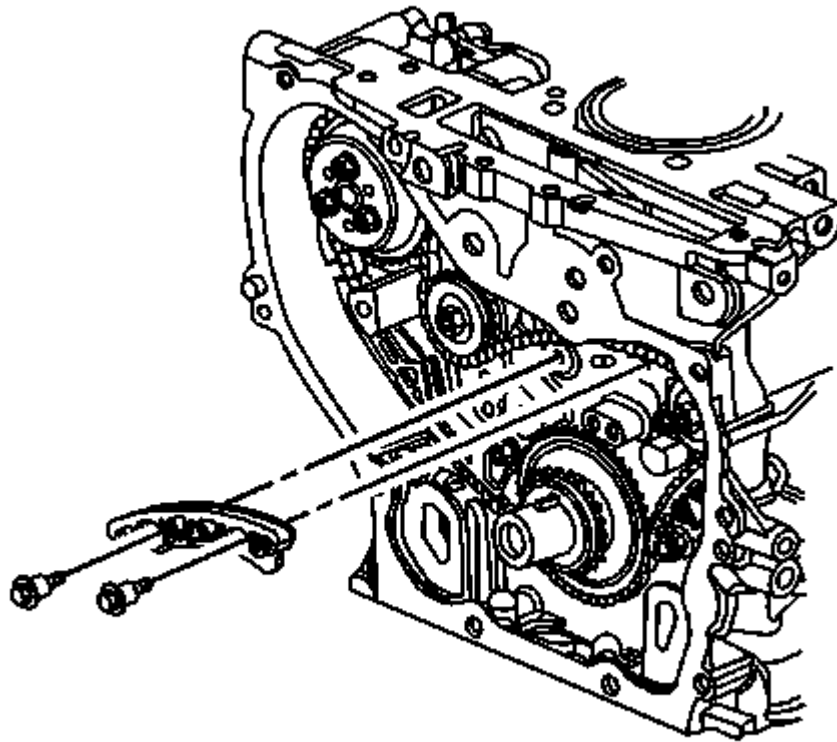


Fig. 77: Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

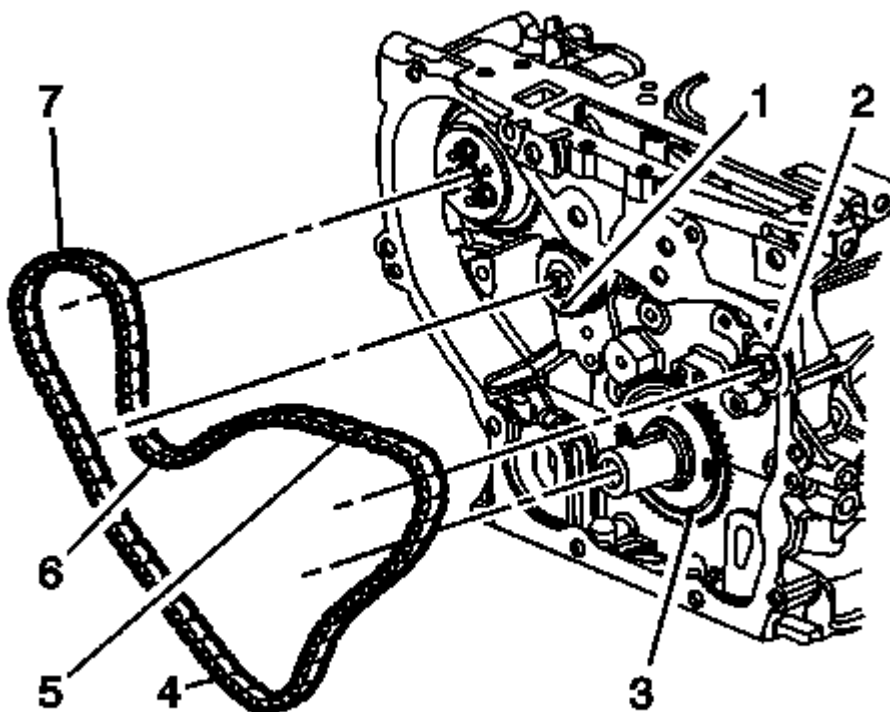


Fig. 78: Balance Shaft Drive Chain

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.

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

Installation Procedure

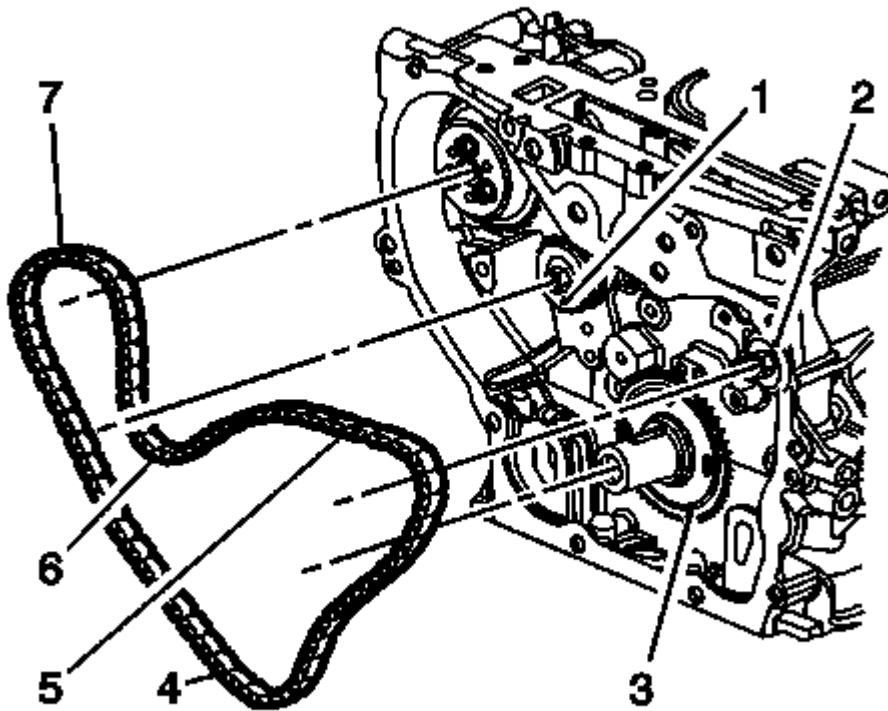


Fig. 79: Balance Shaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

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

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

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

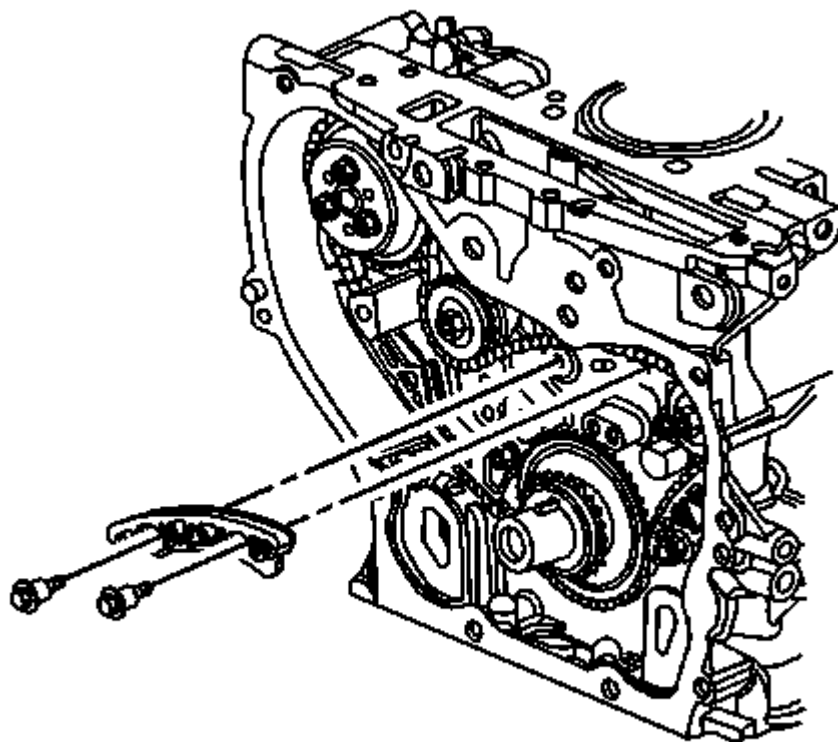


Fig. 80: Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the upper balance shaft drive chain guide and bolts and tighten to 15 N.m (11 lb ft).

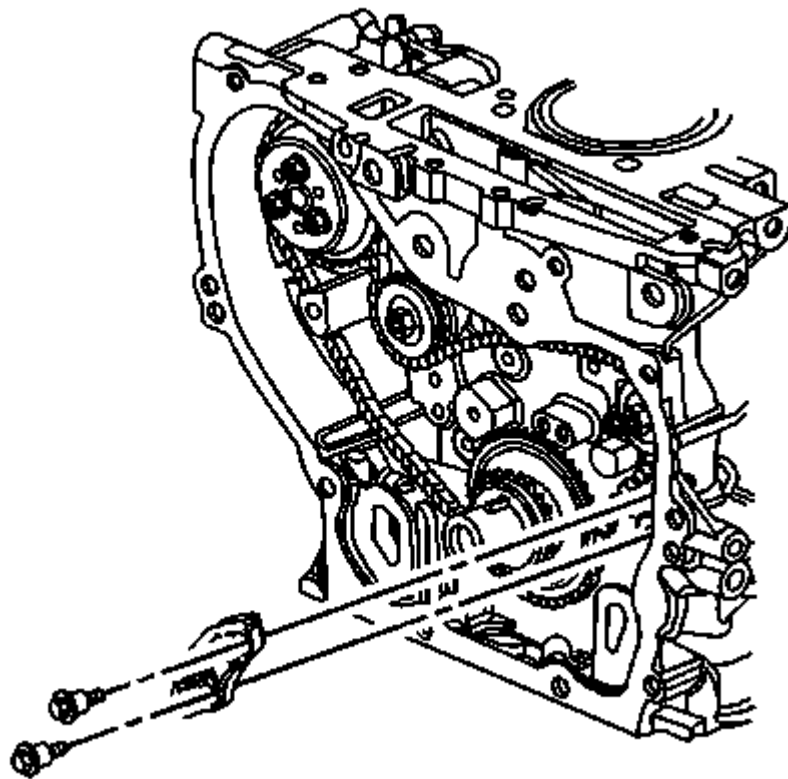


Fig. 81: Small Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

5. Install the small balance shaft drive chain guide and bolts and tighten to 15 N.m (11 lb ft).

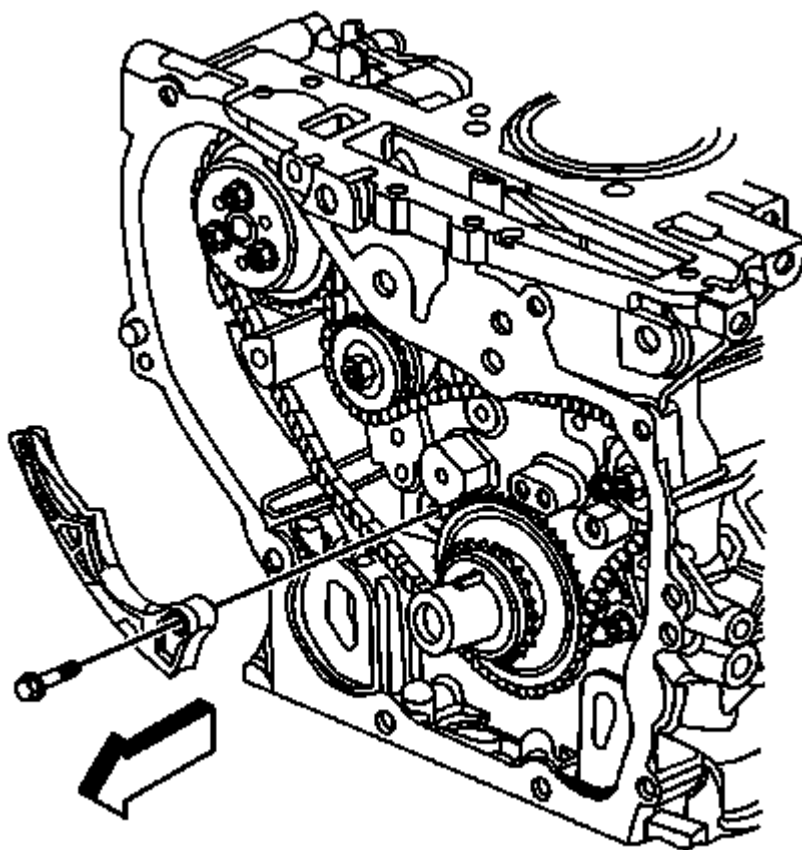


Fig. 82: Adjustable Balance Shaft Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

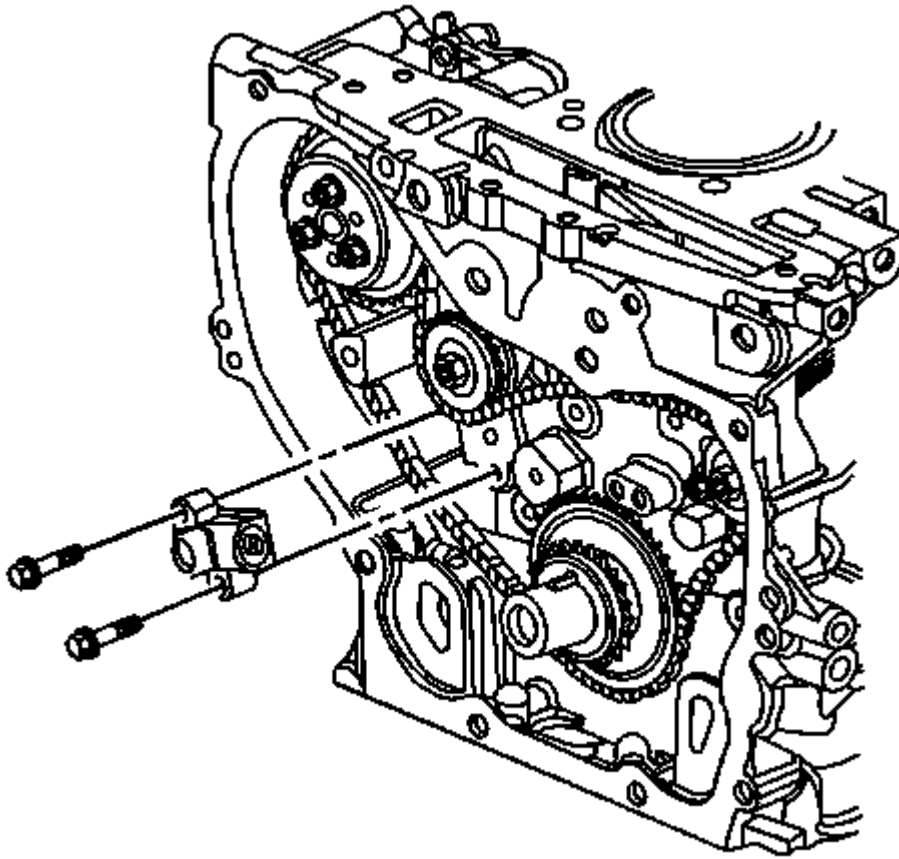


Fig. 83: Balance Shaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

7. Reset the timing chain tensioner by performing the following steps:
 1. Rotate the tensioner plunger 90 degrees in its bore and compress the plunger.
 2. Rotate the tensioner back to the original 12 o'clock position and insert a paper clip through the hole in the plunger body and into the hose in the tensioner plunger.
8. Install the balance shaft drive chain tensioner and bolts and tighten to 10 N.m (89 lb in).
9. Remove the paper clip from the balance shaft drive chain tensioner.

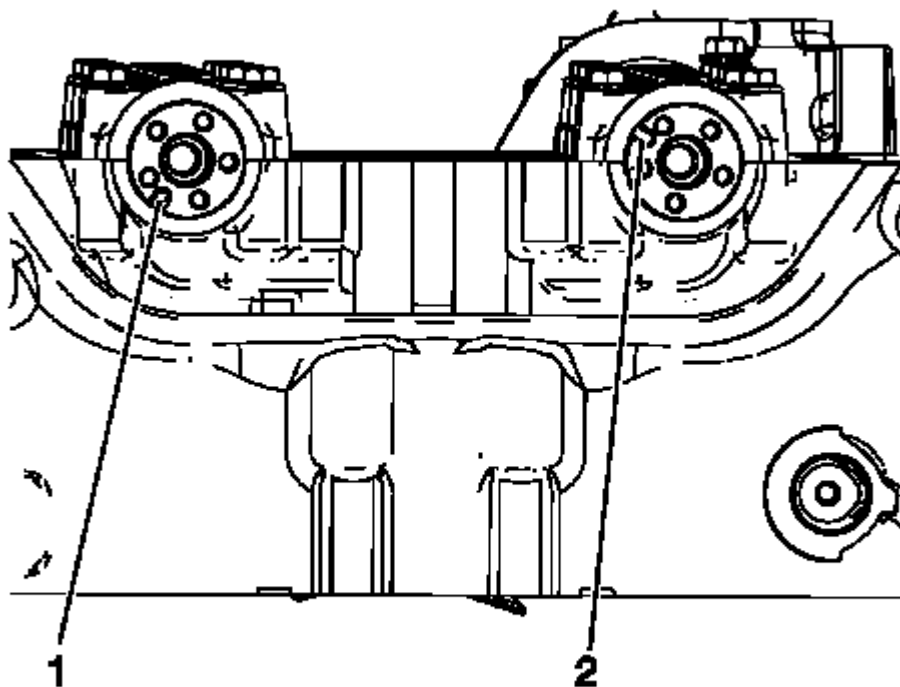


Fig. 84: Camshaft Notches

Courtesy of GENERAL MOTORS COMPANY

10. On 2.2L engines, 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 TDC, crankshaft key at 12 o'clock.

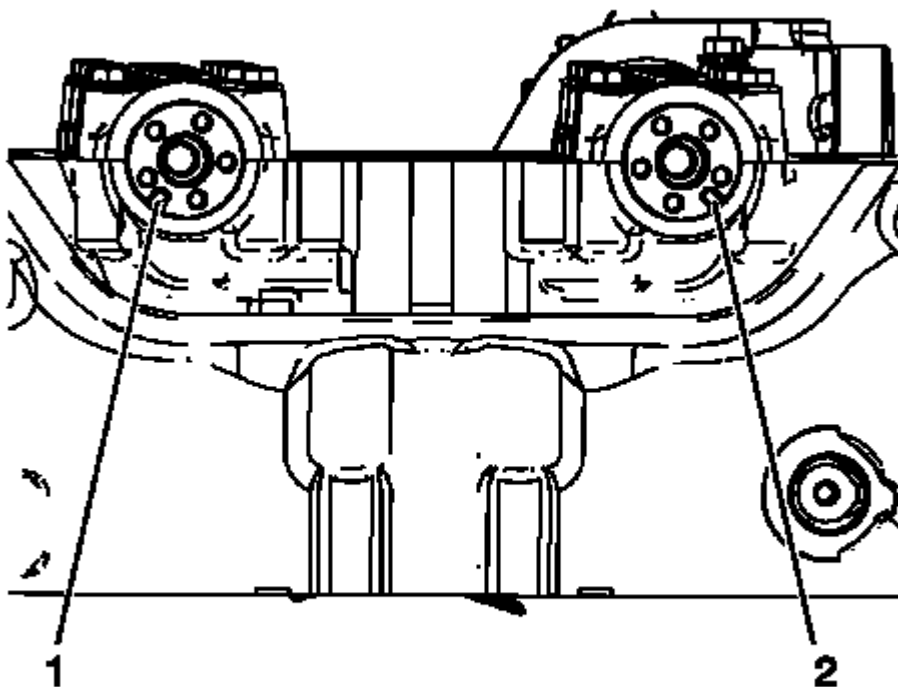


Fig. 85: Identifying Proper Exhaust/Intake Camshaft Alignment positions
Courtesy of GENERAL MOTORS COMPANY

11. On 2.4L engines, ensure the intake camshaft notch is in the 5 o'clock position (2) and the exhaust camshaft notch is in the 7 o'clock position (1). The number 1 piston should be at TDC, crankshaft key at 12 o'clock.

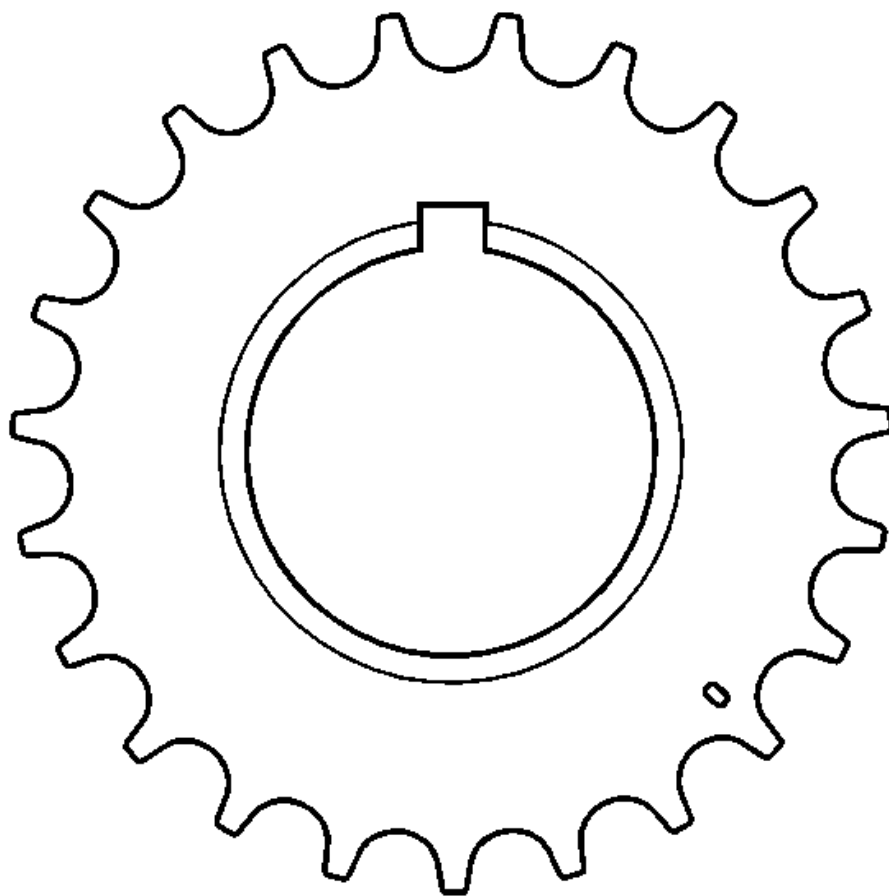


Fig. 86: View Of Crankshaft Sprocket Timing Mark
Courtesy of GENERAL MOTORS COMPANY

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

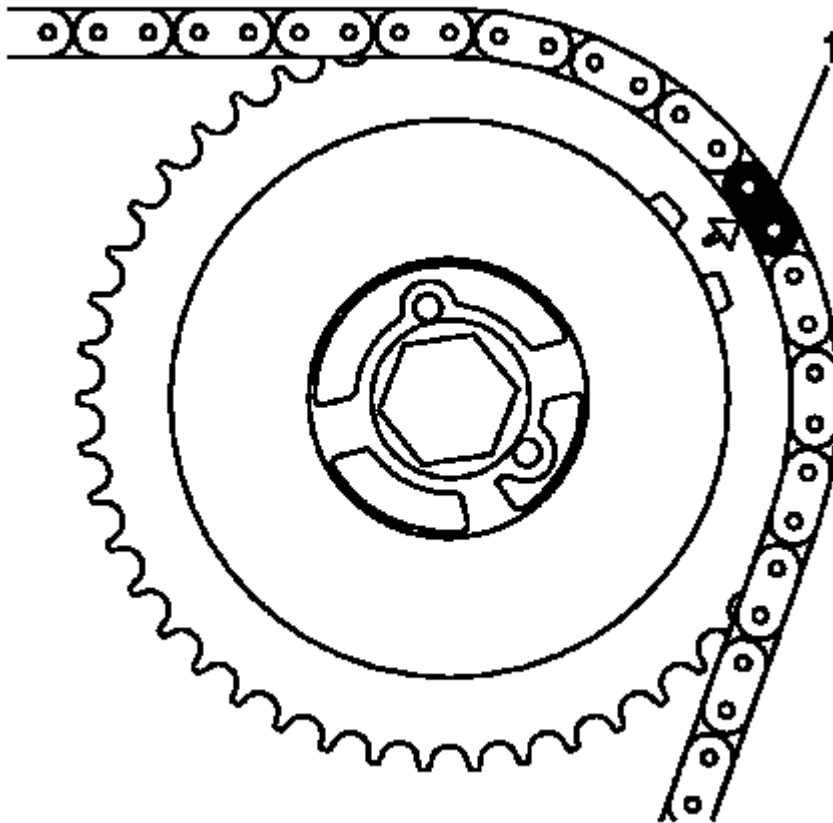


Fig. 87: Identifying Colored Links On Timing Chain
Courtesy of GENERAL MOTORS COMPANY

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.

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

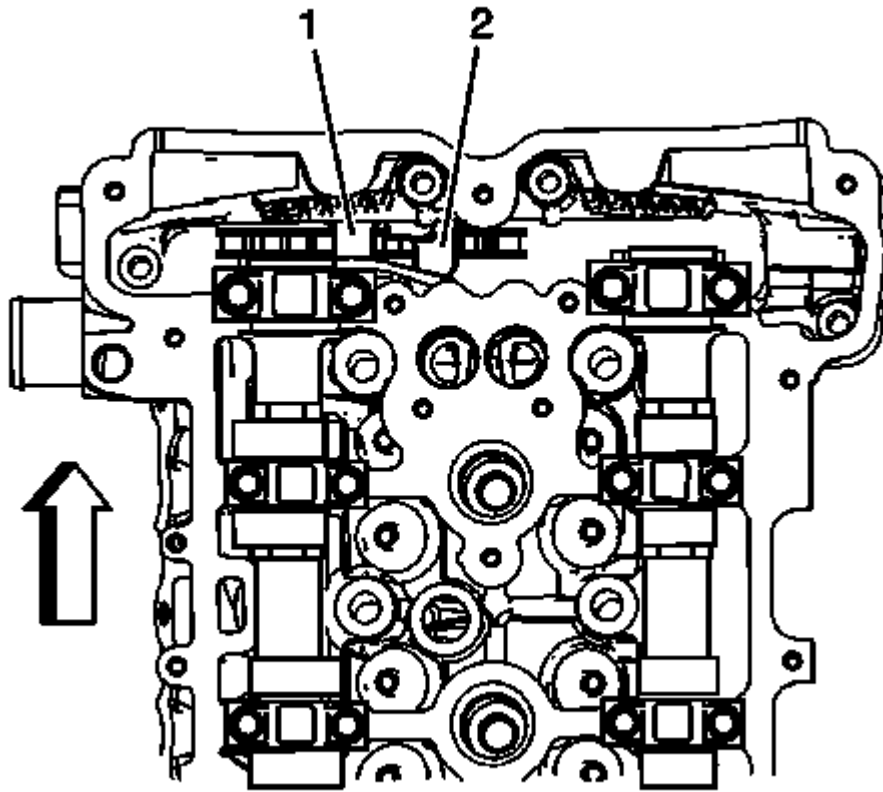


Fig. 88: Identifying Cylinder Head Opening
Courtesy of GENERAL MOTORS COMPANY

14. 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).
15. Install the intake camshaft actuator onto the intake camshaft while aligning the dowel pin into the camshaft slot.
16. Hand tighten the new intake camshaft actuator bolt.

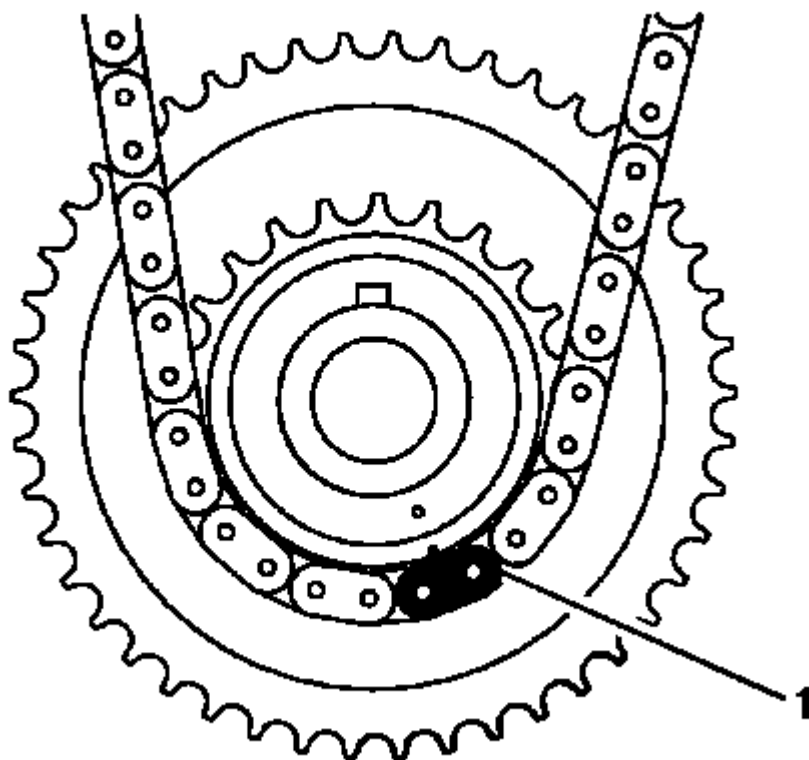


Fig. 89: Lining Up First Pink Link With Timing Mark On Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

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

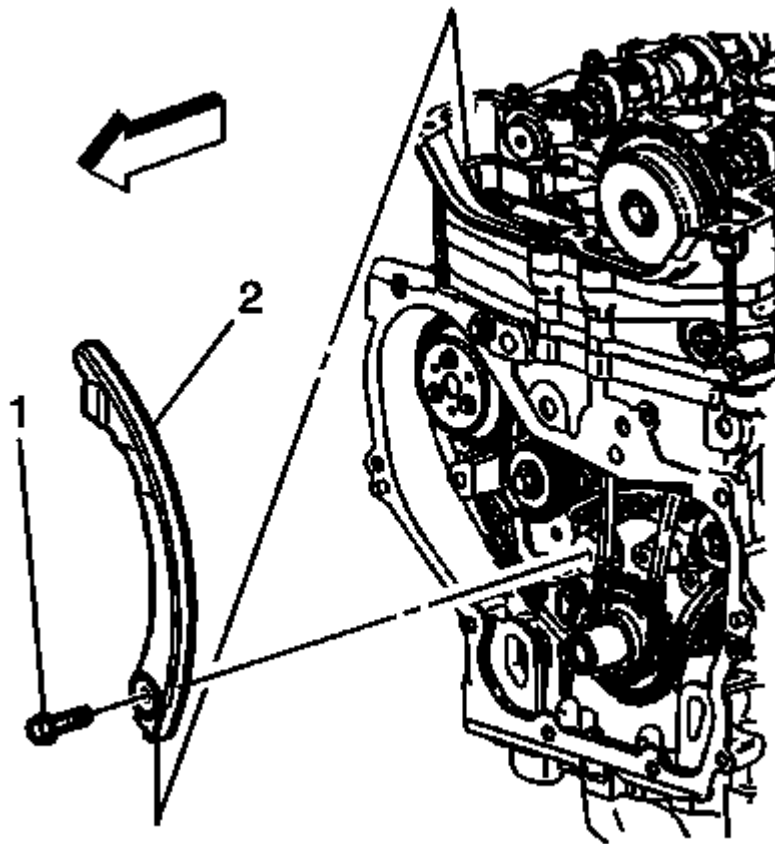


Fig. 90: Adjustable Timing Chain Guide

Courtesy of GENERAL MOTORS COMPANY

18. Rotate the crankshaft clockwise to remove all chain slack. Do not rotate the intake camshaft.
19. Install the adjustable timing chain guide down through the opening in the cylinder head and install the adjustable timing chain bolt. Tighten the adjustable timing chain guide bolt to 10 N.m (89 lb in).

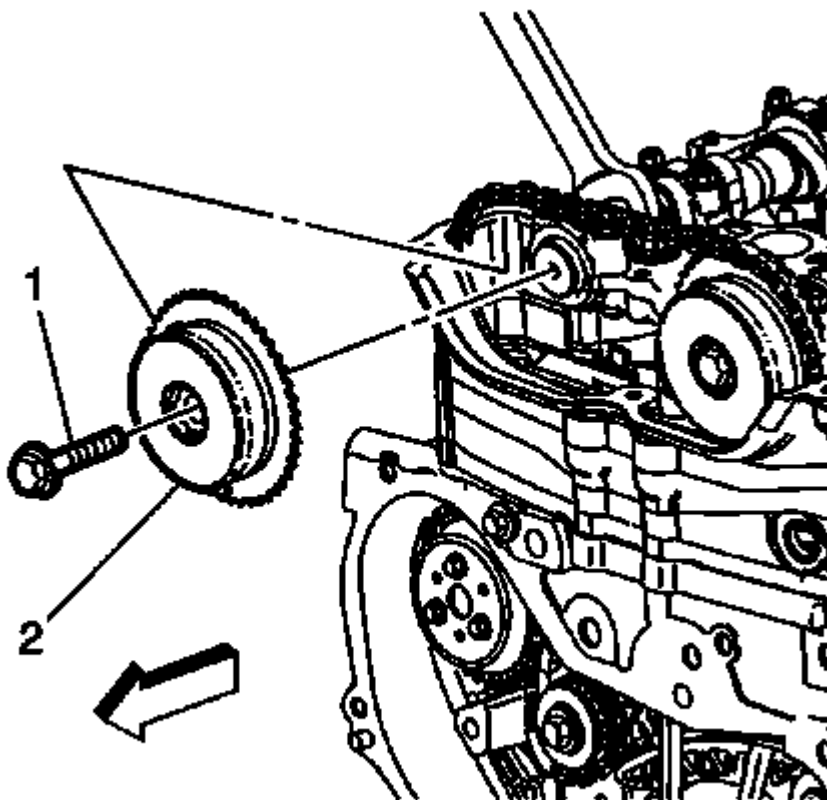


Fig. 91: Camshaft Actuator

Courtesy of GENERAL MOTORS COMPANY

NOTE: Always install NEW actuator bolts.

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

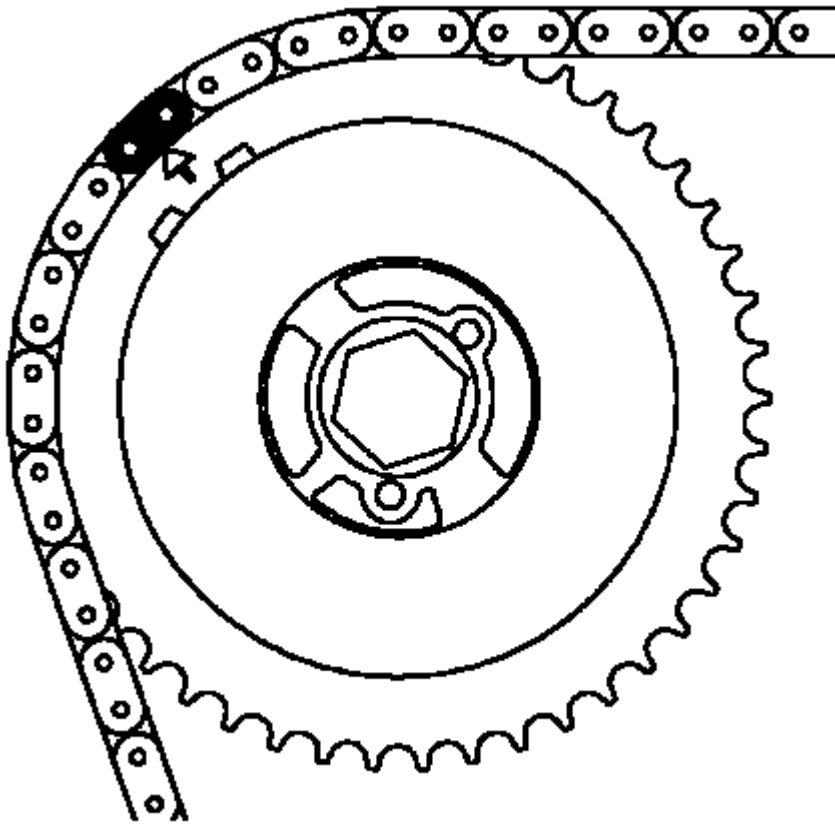


Fig. 92: Aligning Timing Mark On Actuator With Last Pink Colored Link
Courtesy of GENERAL MOTORS COMPANY

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

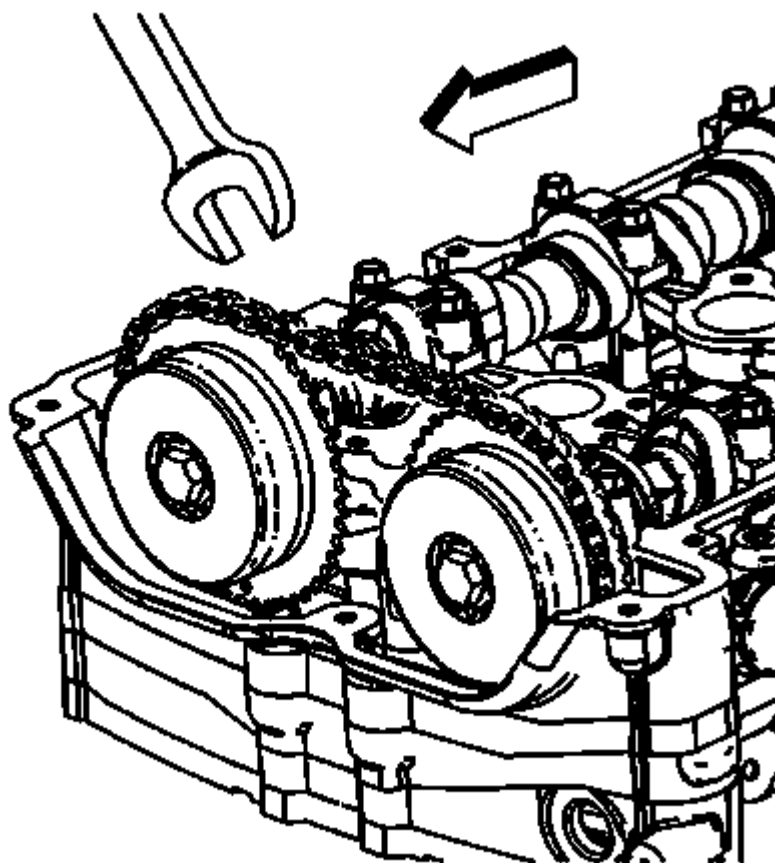


Fig. 93: Identifying Cam Actuator, Camshaft & Chain
Courtesy of GENERAL MOTORS COMPANY

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

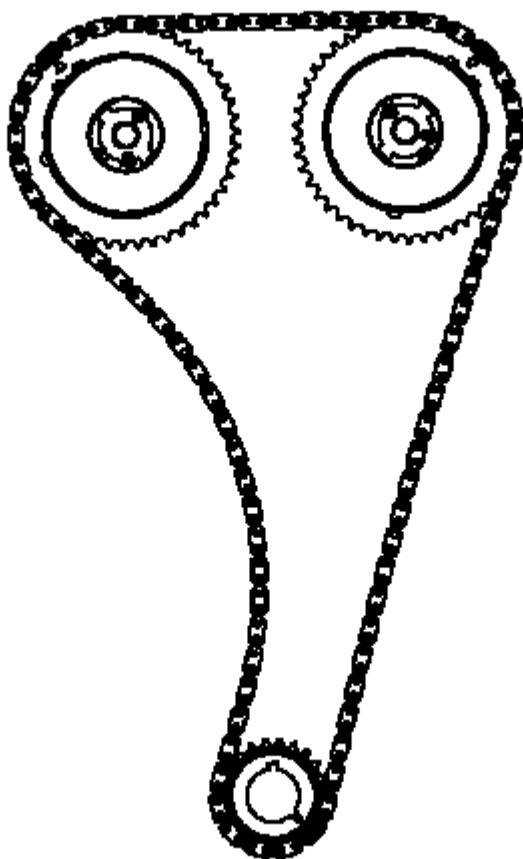


Fig. 94: Identifying Chain & Sprockets

Courtesy of GENERAL MOTORS COMPANY

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

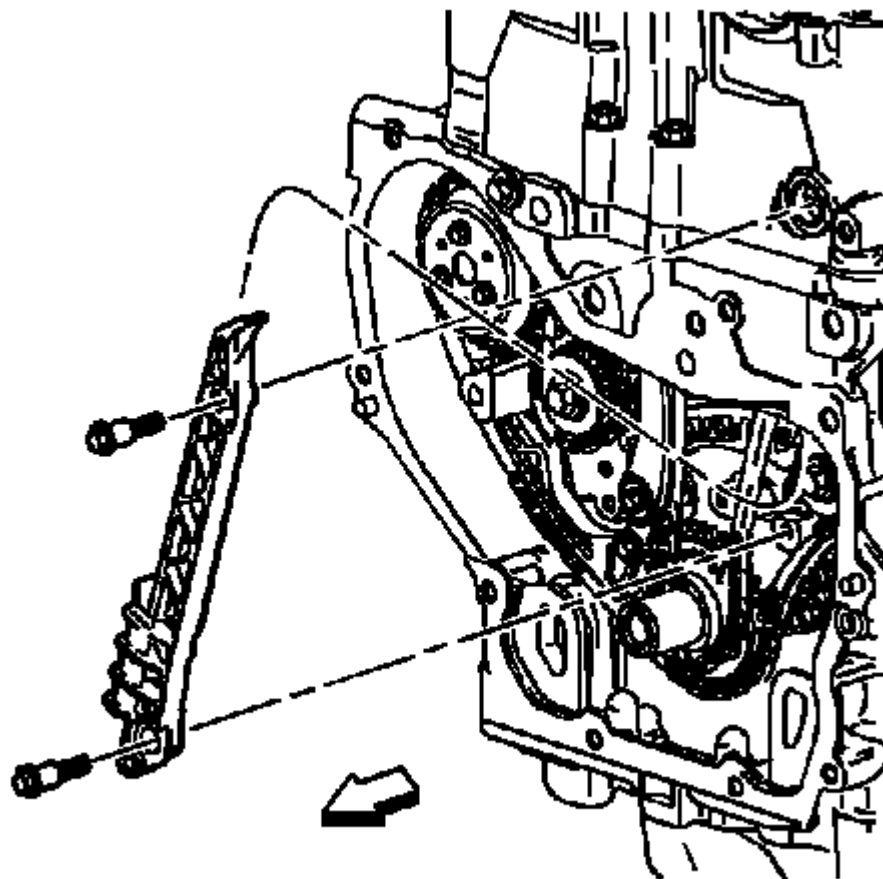


Fig. 95: View Of Fixed Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

25. Install the fixed timing chain guide and bolts. Tighten the fixed timing chain guide bolts to 10 N.m (89 lb in).

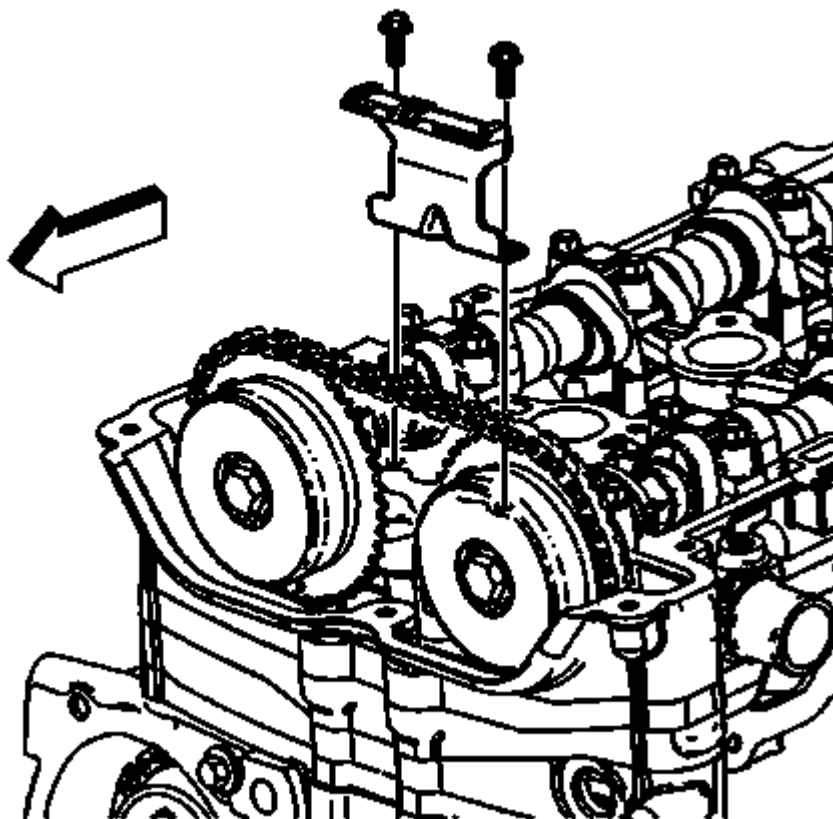


Fig. 96: Upper Timing Chain Guide

Courtesy of GENERAL MOTORS COMPANY

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

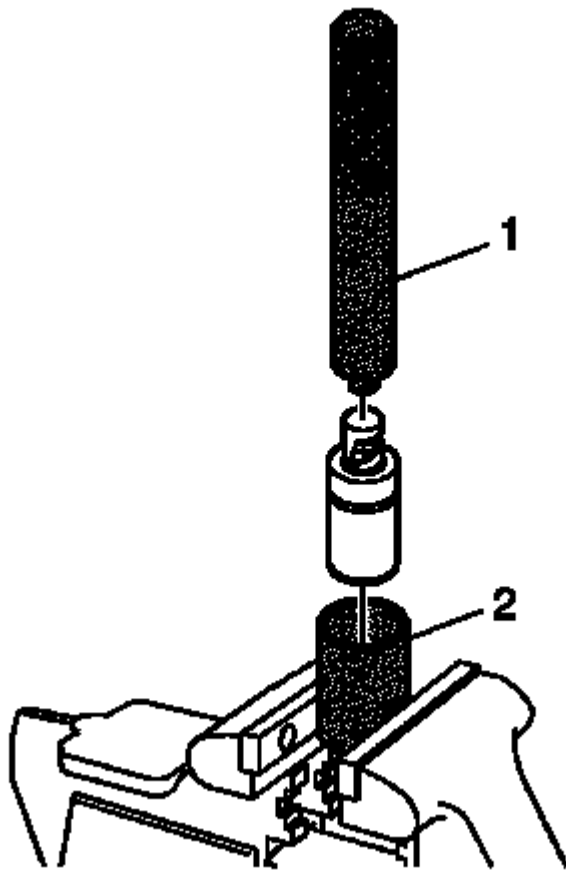


Fig. 97: Compressing Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

27. 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 (2) into a vise.
 4. Install the notch end of the piston assembly into the J-45027-2 (2).
 5. Using the EN-45027-1 (1), turn the ratchet cylinder into the piston.
 6. Reinstall the piston assembly into the body of the tensioner.
 7. Install the snap ring.

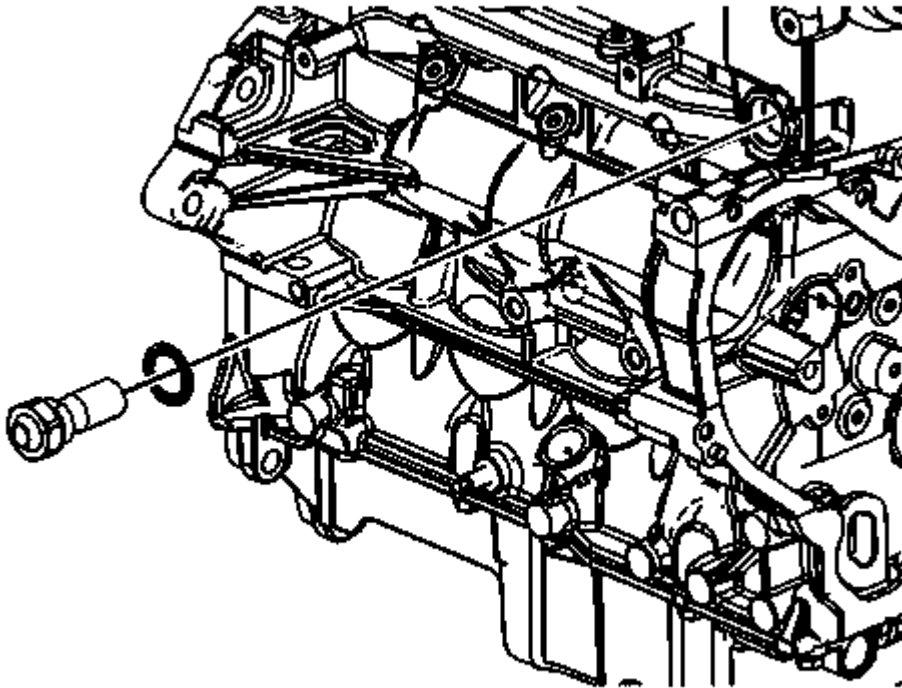


Fig. 98: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

28. Inspect the timing chain tensioner seal for damage. If damaged, replace the seal.
29. 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.**

30. Install the timing chain tensioner assembly. Tighten the timing chain tensioner to 75 N.m (55 lb ft).
31. 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.

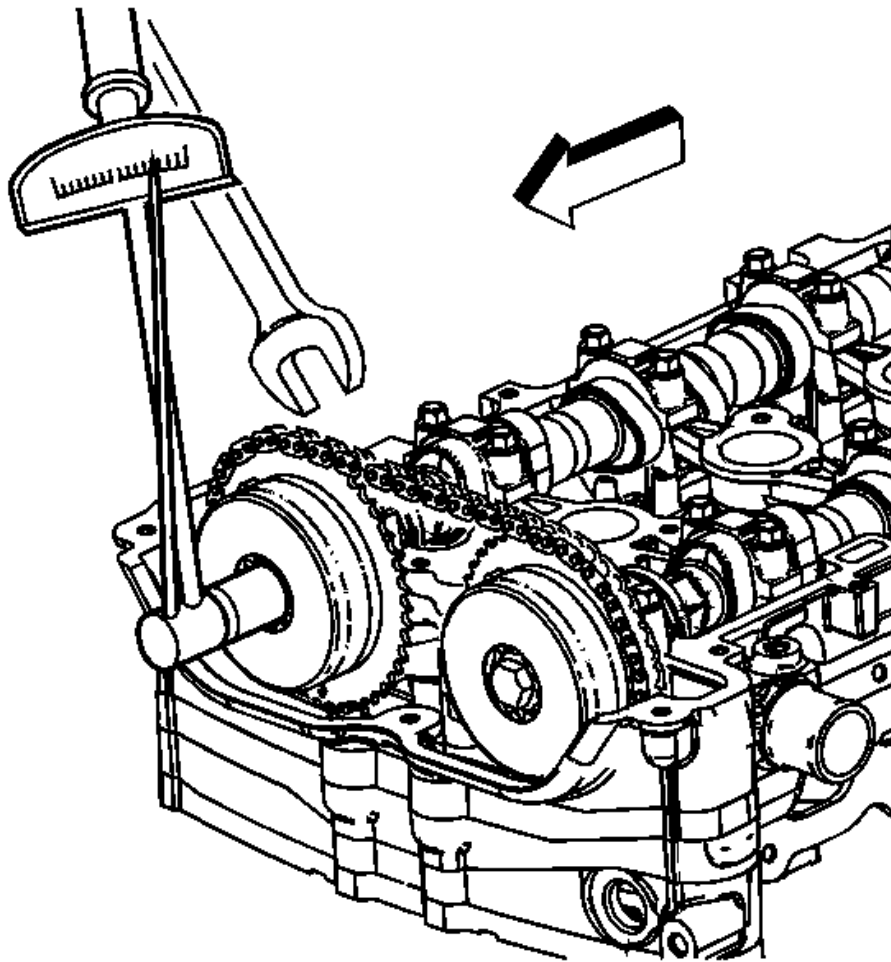


Fig. 99: Tightening Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

32. Using a 23 mm wrench, engage the hex on the intake camshaft, and using a torque wrench, tighten the camshaft actuator bolt. Tighten the intake camshaft position actuator bolt to 30 N.m (22 lb ft) plus 100 degrees using the **EN-45059** meter.
33. Using a 23 mm wrench, engage the hex on the exhaust camshaft, and using a torque wrench, tighten the camshaft actuator bolt. Tighten the exhaust camshaft position actuator bolt to 30 N.m (22 lb ft) plus 100 degrees using the **EN-45059** meter.

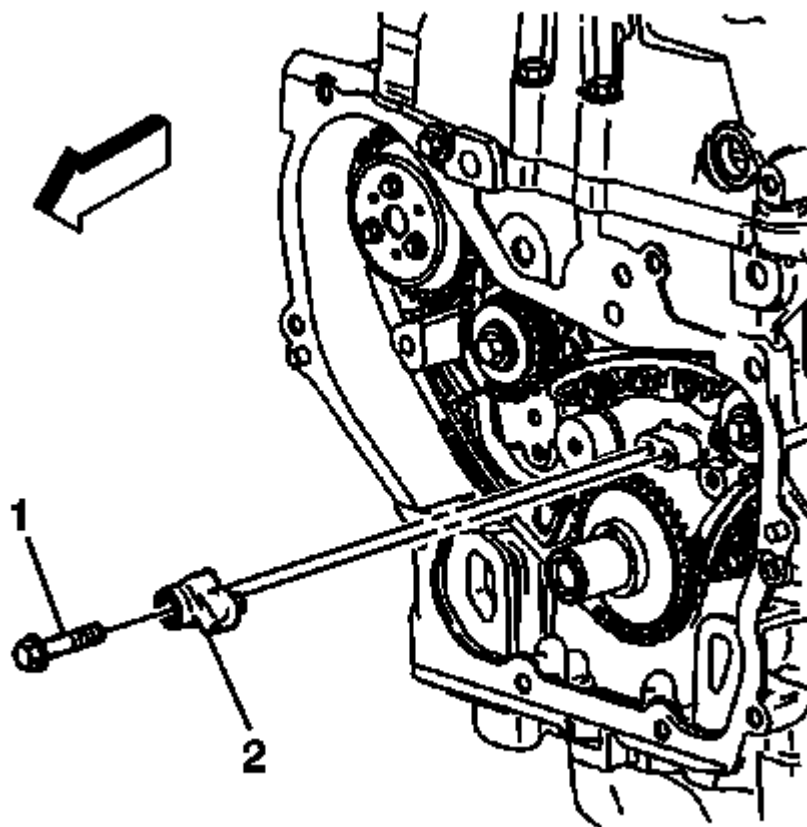


Fig. 100: View Of Oil Nozzle & Bolt
Courtesy of GENERAL MOTORS COMPANY

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

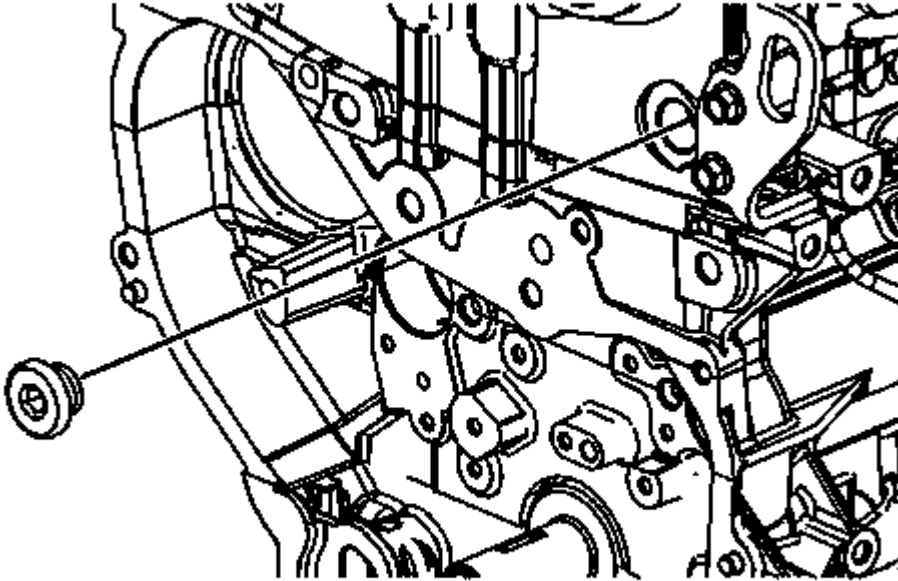
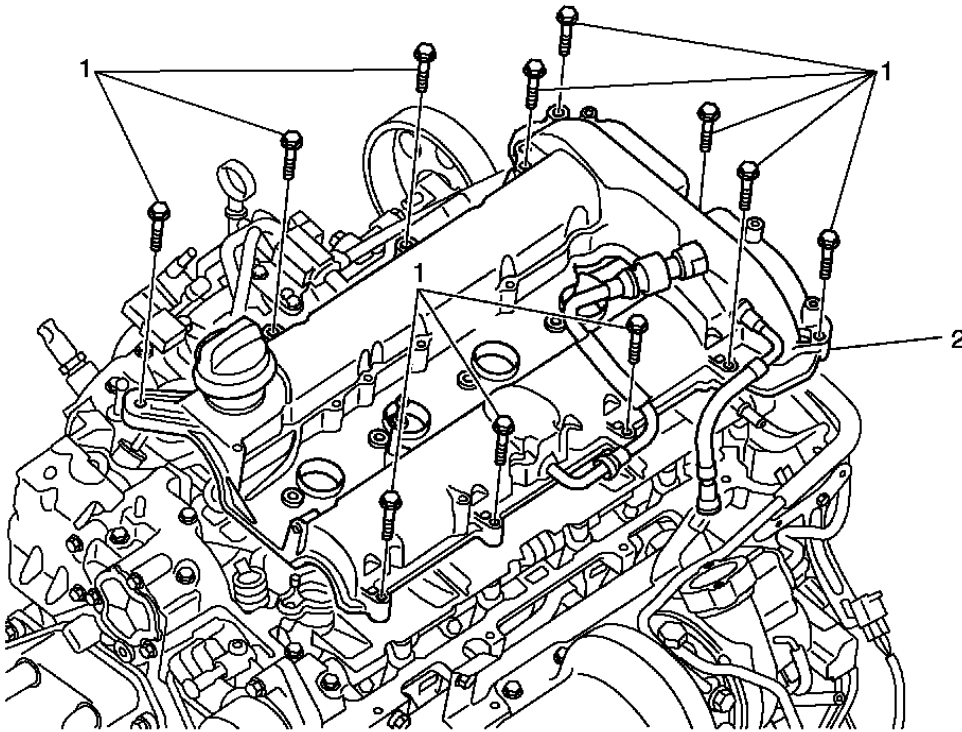


Fig. 101: View Of Timing Chain Guide Bolt Access Hole & Plug
Courtesy of GENERAL MOTORS COMPANY

35. Apply sealant compound to the thread of the timing chain guide bolt access hole plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended sealant.
36. Install the timing chain guide bolt access hole plug. Tighten the access hole plug to 90 N.m (66 lb ft).
37. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
38. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
39. Install the number 1 cylinder spark plug. Refer to **Spark Plug Replacement** .

CAMSHAFT COVER REPLACEMENT

**Fig. 102: Camshaft Cover**

Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Replacement

Callout	Component Name
Preliminary Procedures	
1.	Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .
2.	Remove the ignition coil. Refer to <u>Ignition Coil Replacement</u> .
3.	Remove the Charge air cooler inlet air tube. Refer to <u>Charge Air Cooler Inlet Air Tube Replacement</u>
4.	Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u>
5.	Remove the positive crankcase ventilation hose from the turbocharger.
6.	Remove the camshaft position actuator sensor intake. Refer to <u>Camshaft Position Actuator Solenoid Valve Replacement (Intake)</u> , <u>Camshaft Position Actuator Solenoid Valve Replacement (Exhaust)</u>
7.	Remove the camshaft position actuator sensor exhaust. Refer to <u>Camshaft Position Actuator Solenoid Valve Replacement (Intake)</u> , <u>Camshaft Position Actuator Solenoid Valve Replacement (Exhaust)</u>
8.	Remove the Power Brake Booster Pump. Refer to <u>Power Brake Booster Pump Replacement (2.0L)</u>
	Camshaft Cover Fastener (Qty: 11)

1	CAUTION: Refer to <u>Fastener Caution</u> . Procedure A new gasket should be used whenever the cover is removed from the engine assembly. Tighten 10 N.m (89 lb in)
2	Camshaft Cover Procedure 1. Disconnect any electrical connectors. 2. Transfer parts as needed.

CAMSHAFT TIMING CHAIN ADJUSTMENT

Special Tools

EN-49212 Camshaft Fixer

For equivalent regional tools, refer to **Special Tools (LDK, LHU)** .

Removal Procedure

1. Remove the timing chain tensioner. Refer to **Timing Chain Tensioner Replacement**.

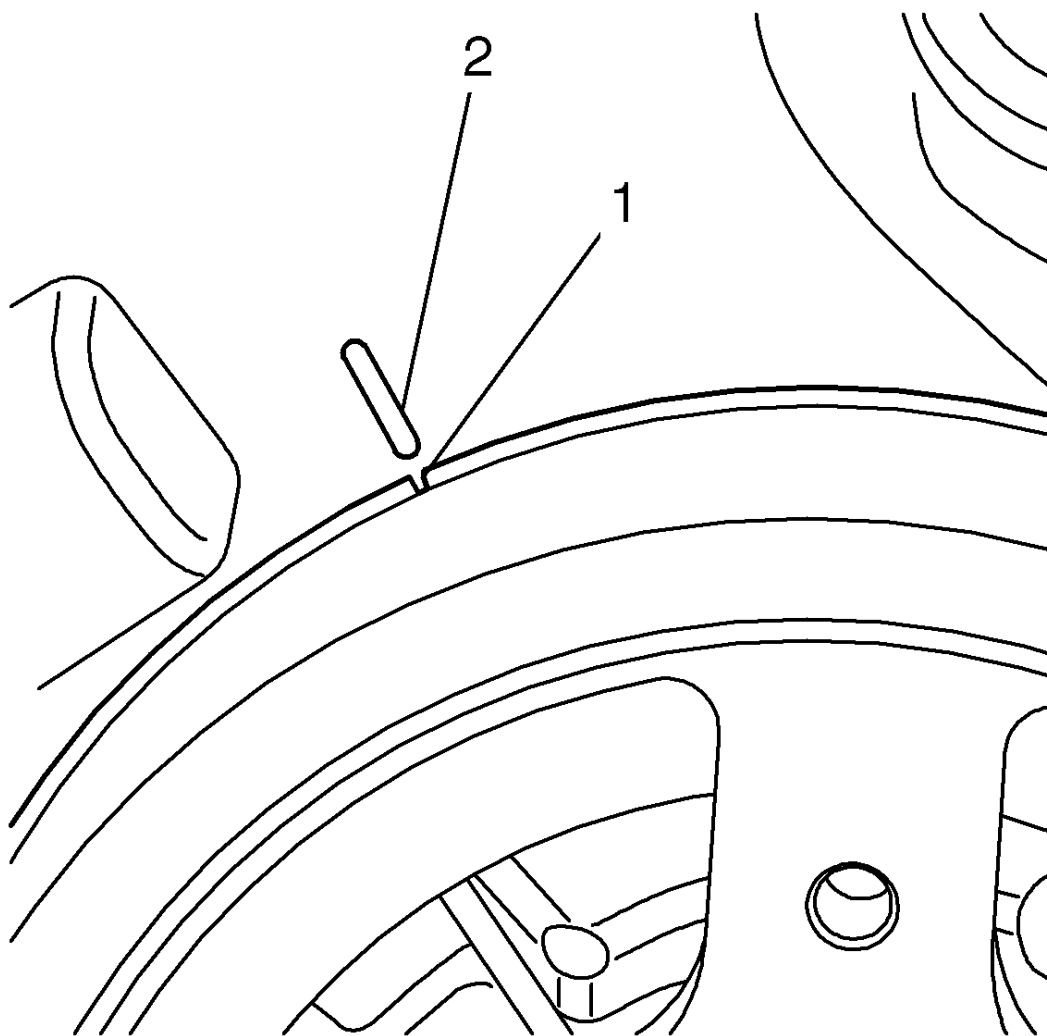


Fig. 103: Crankshaft Balancer Mark And Oil Pump Housing Mark
Courtesy of GENERAL MOTORS COMPANY

2. Rotate the crankshaft balancer mark (1) to the oil pump housing mark (2).
3. Remove the camshaft position actuator - exhaust. Refer to **Camshaft Position Exhaust Actuator Replacement**.

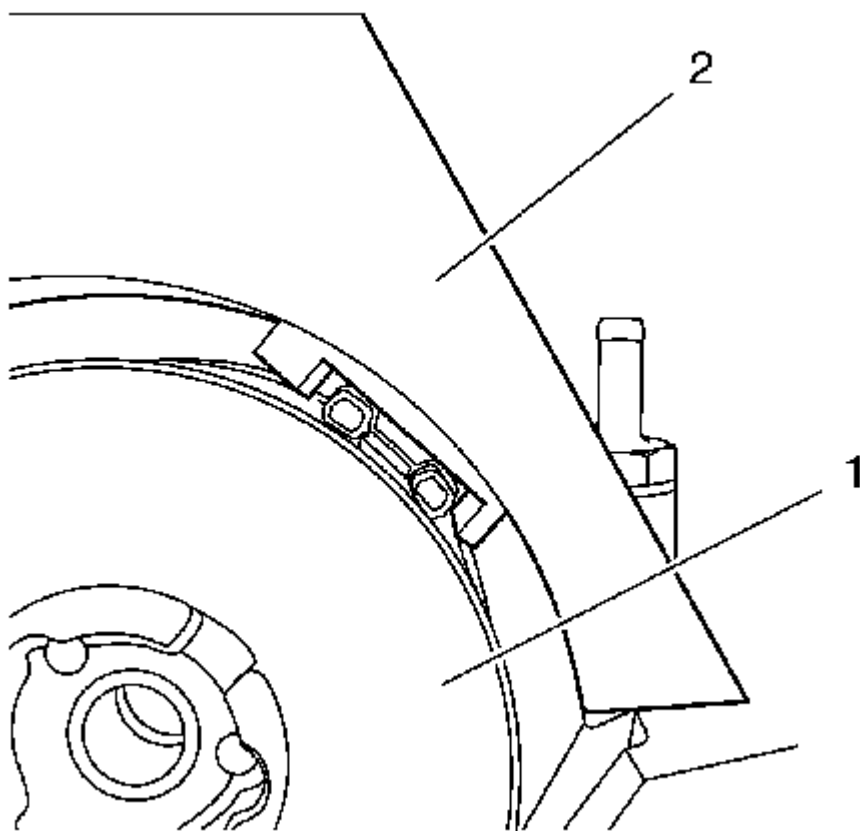


Fig. 104: Intake Actuator And Camshaft Fixer
Courtesy of GENERAL MOTORS COMPANY

4. If the adjustment is NOT correct, release the timing chain from camshaft position actuator - intake (1) and rotate counterclockwise the intake camshaft up to the fixing from the **EN-49212-2** camshaft fixer (2).

Installation Procedure

1. Install the timing chain to the camshaft position actuator - intake.

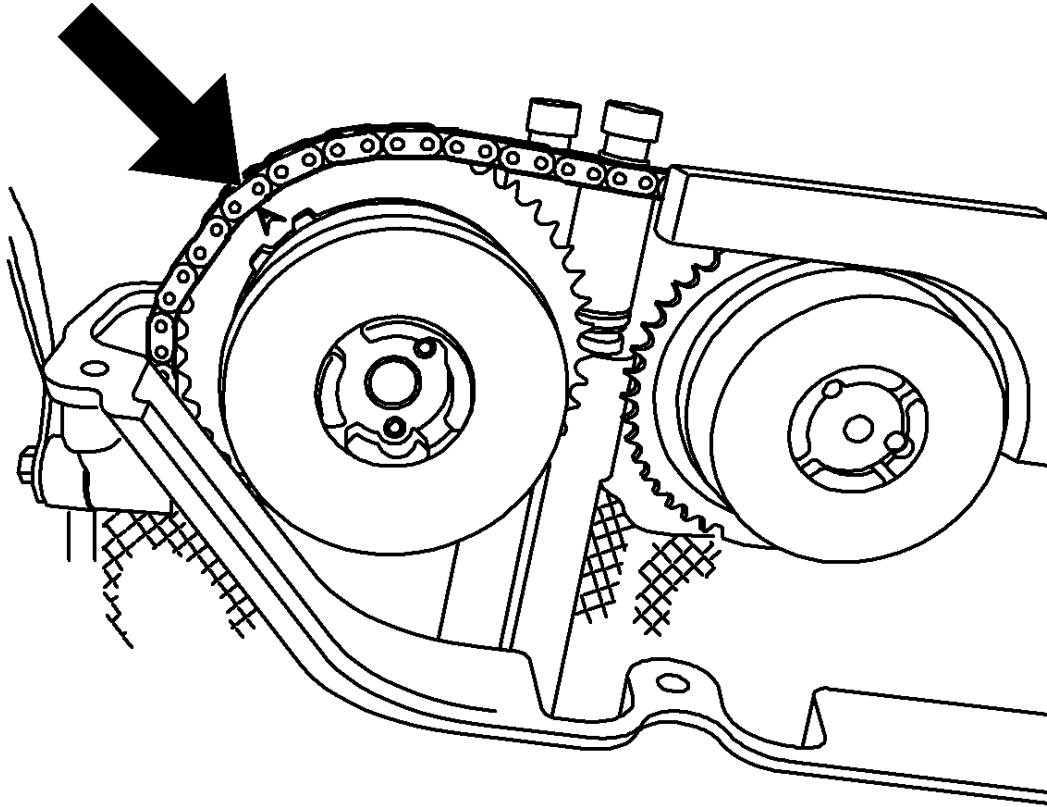


Fig. 105: Camshaft Drive Pulley Mark
Courtesy of GENERAL MOTORS COMPANY

2. Install the camshaft position actuator - exhaust. Refer to **Camshaft Position Exhaust Actuator Replacement**.
 - Count the number of the end to end connectors of the camshaft timing chain between the mark on the intake camshaft drive pulley and the mark on the exhaust camshaft drive pulley.
 - The timing chain must have 29 end to end connectors to guarantee a correct adjustment.
 - During assembly it is necessary to tension the timing chain.
 - Turn the camshaft in clockwise direction to install the exhaust camshaft drive pulley.
 - Install the exhaust camshaft drive pulley and fix it with that fastener in the camshaft.
3. Fix the exhaust camshaft with the **EN-49212-1** camshaft fixer. When complete, check setup over again.

CAUTION: Refer to Fastener Caution .

4. Tighten the camshaft position actuator - intake to 30 N.m (22 lb ft) 100 degrees.
5. Tighten the camshaft position actuator - exhaust to 30 N.m (22 lb ft) 100 degrees.
6. Remove **EN-49212** camshaft fixer.
7. Install the timing chain tensioner. Refer to **Timing Chain Tensioner Replacement**.

TIMING CHAIN TENSIONER REPLACEMENT

Special Tools

J 45027 Tensioner Tool

Removal Procedure

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

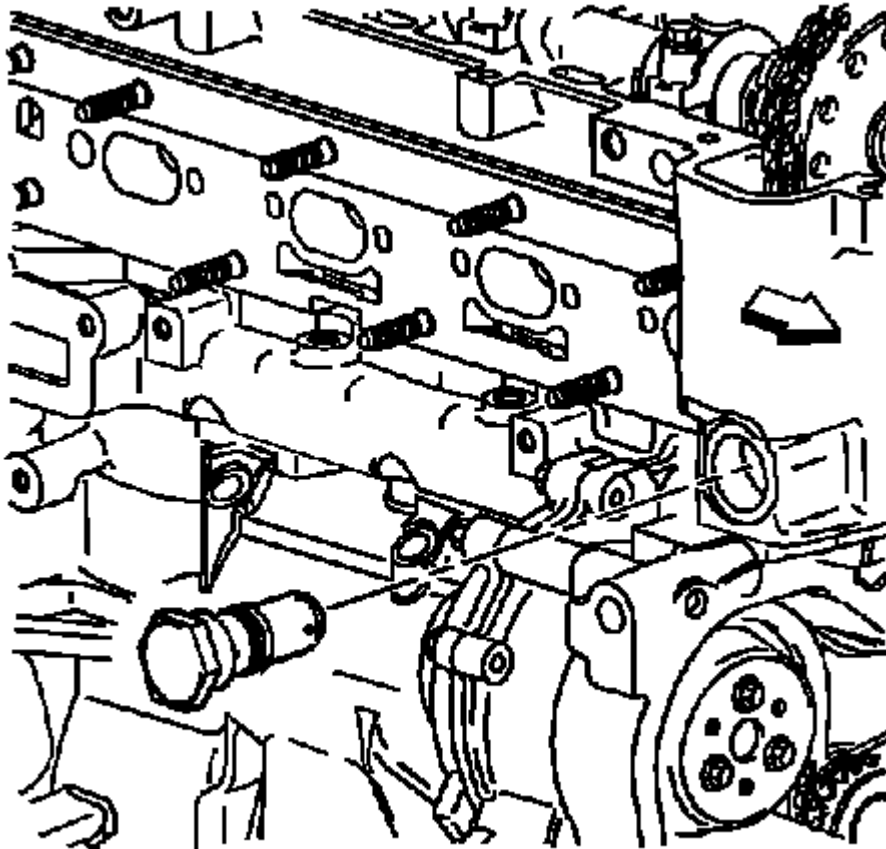


Fig. 106: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

3. Remove the timing chain tensioner.

4. Remove the seal from the tensioner.

Installation Procedure

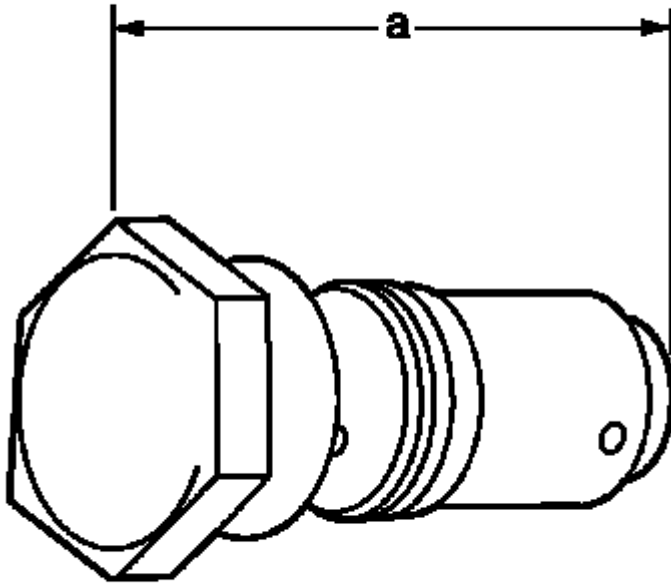


Fig. 107: Measuring Timing Chain Tensioner Assembly
Courtesy of GENERAL MOTORS COMPANY

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.

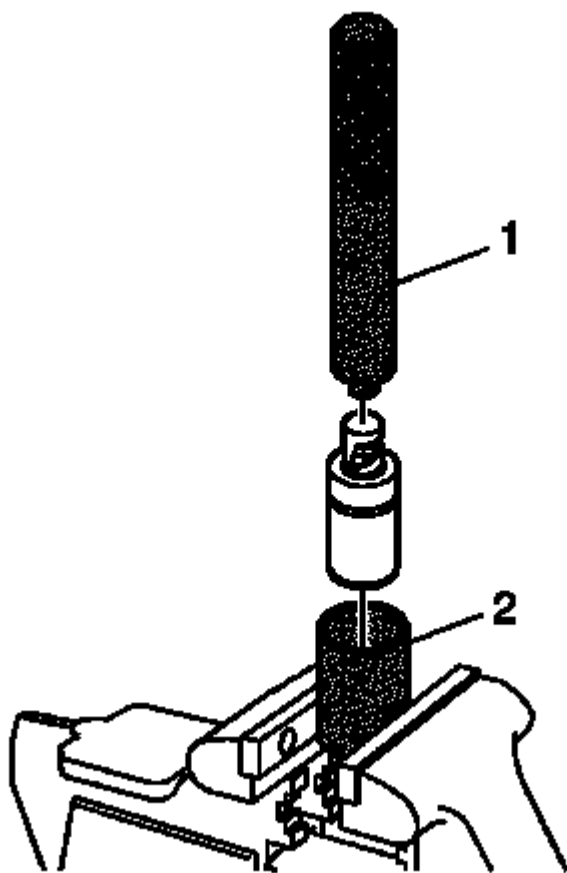


Fig. 108: Compressing Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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 J 45027-2 (2) into a vise.
 3. Install the notch end of the piston assembly into the J 45027-2 (2).
 4. Using the J 45027-1 (1), turn the ratchet cylinder into the piston.

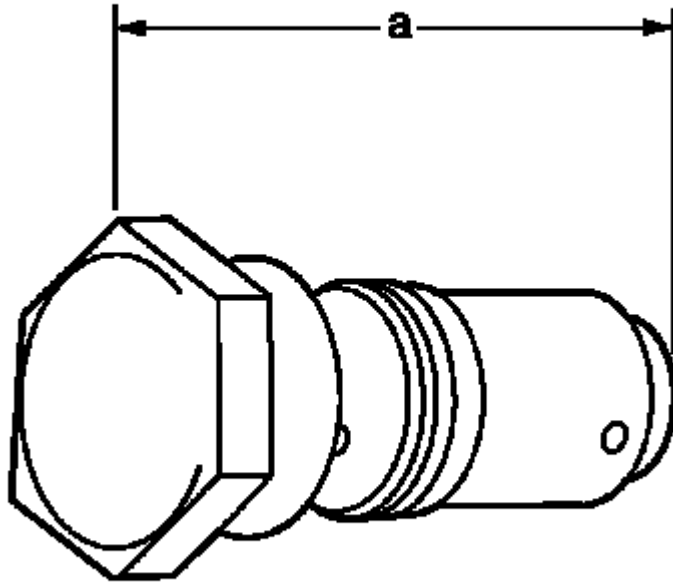


Fig. 109: Measuring Timing Chain Tensioner Assembly
Courtesy of GENERAL MOTORS COMPANY

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.

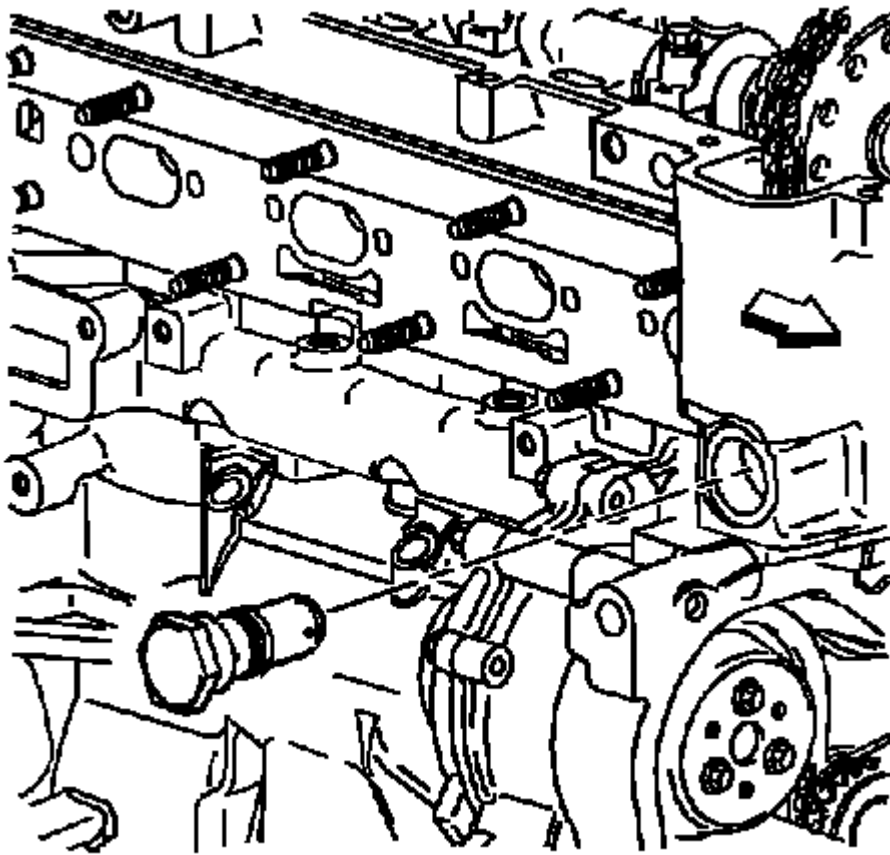


Fig. 110: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

INTAKE CAMSHAFT AND VALVE LIFTER REPLACEMENT

Removal Procedure

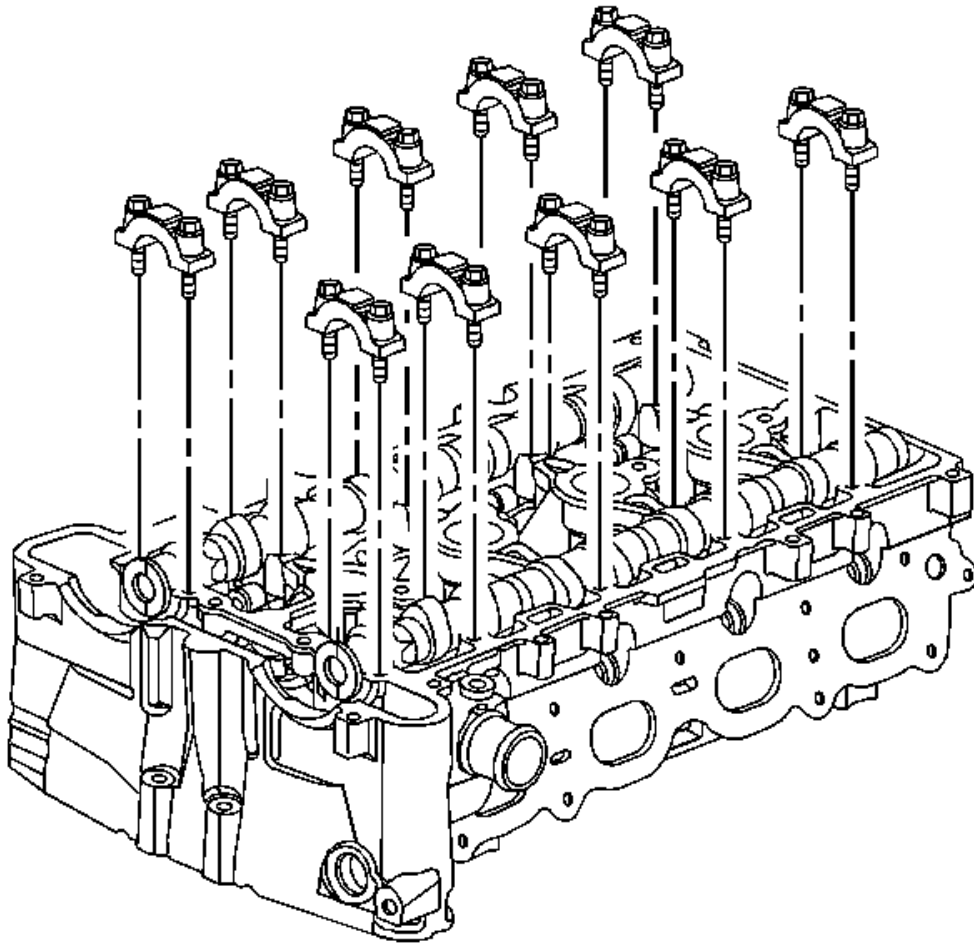


Fig. 111: Camshaft Bearing Caps

Courtesy of GENERAL MOTORS COMPANY

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

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

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

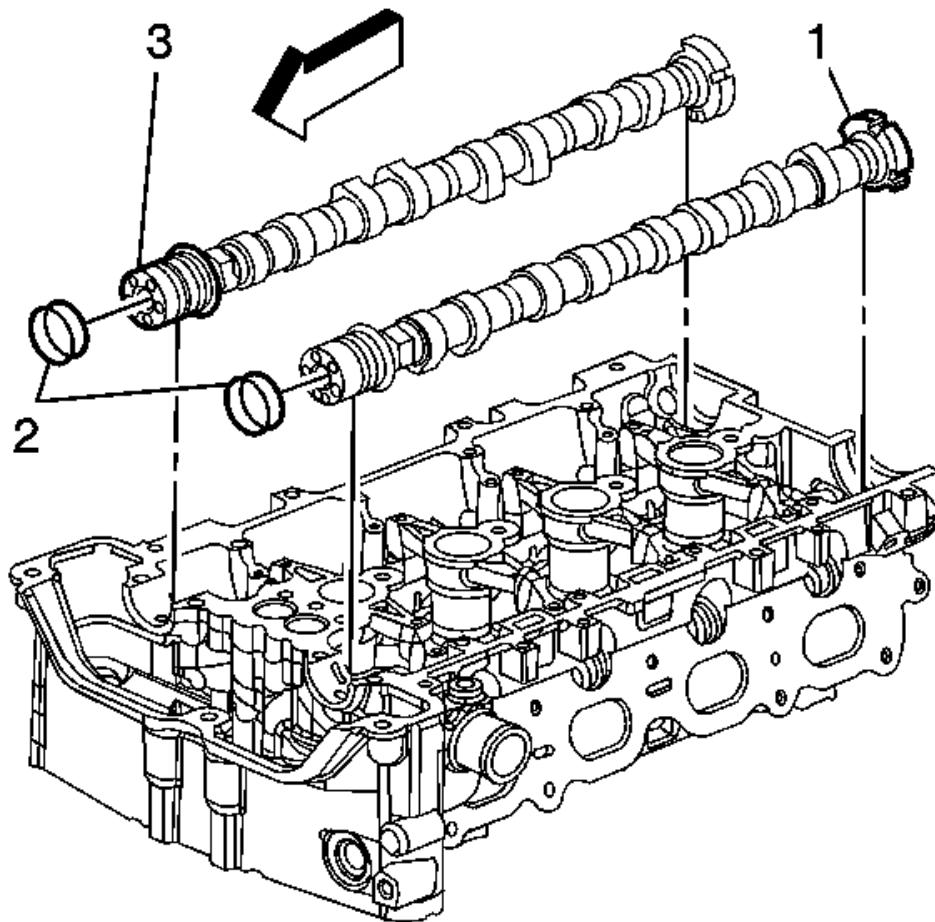


Fig. 112: Intake/Exhaust Camshaft
 Courtesy of GENERAL MOTORS COMPANY

5. Remove the intake camshaft (1).

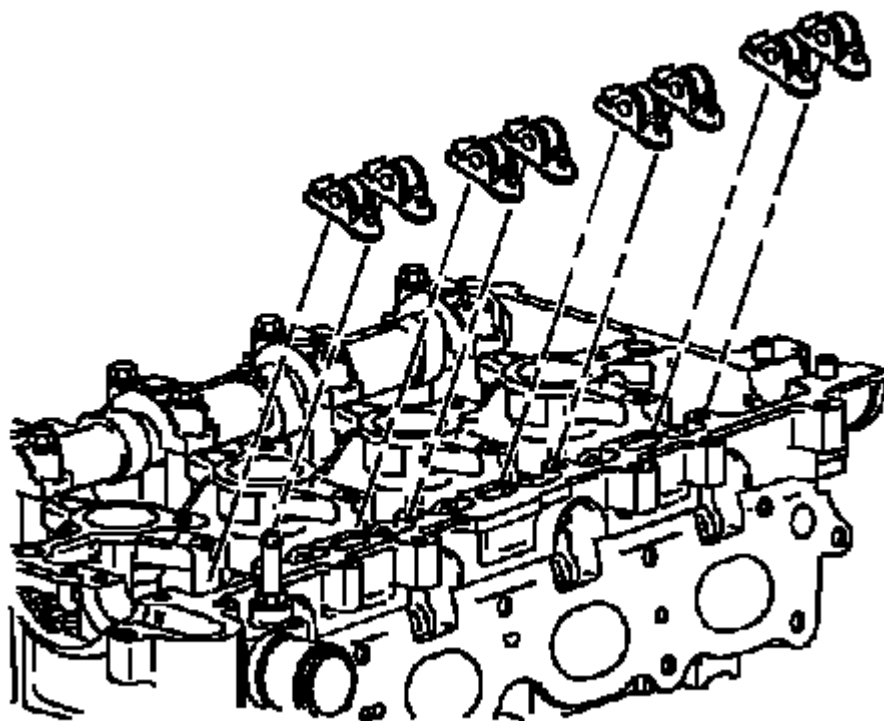


Fig. 113: View Of Camshaft Roller Followers
Courtesy of GENERAL MOTORS COMPANY

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

6. Remove the camshaft roller followers.

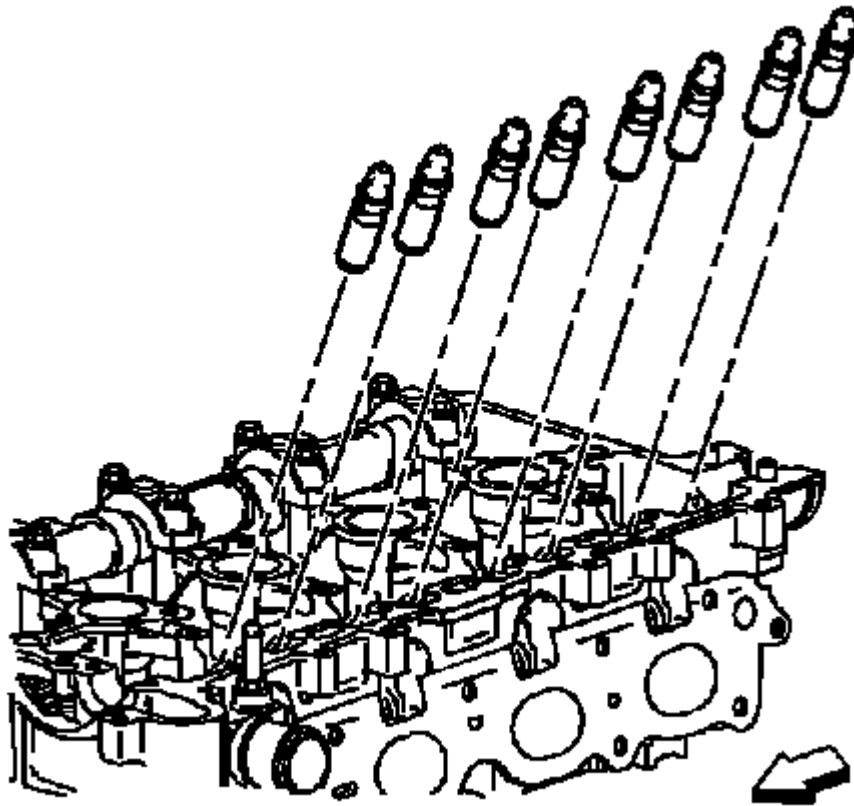


Fig. 114: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

7. Remove the hydraulic element lash adjusters.

Installation Procedure

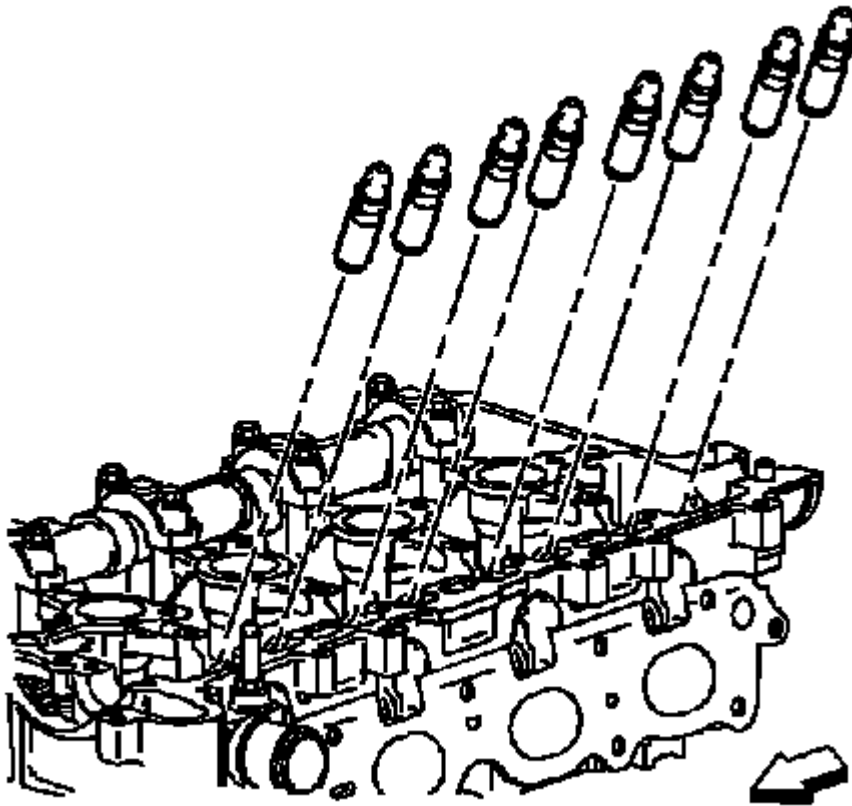


Fig. 115: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

1. Install the hydraulic element lash adjusters into their bores in the cylinder head. Install the camshaft caps and hand start the camshaft cap bolts.
2. Install the camshaft caps.

CAUTION: Refer to Fastener Caution .

3. 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).

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.

- **Apply the sealer to all locations centrally locating the bead on the rail.**
4. Apply a 3.5 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** for the recommended sealant.
 5. 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 a final pass to 10 N.m (89 lb in).

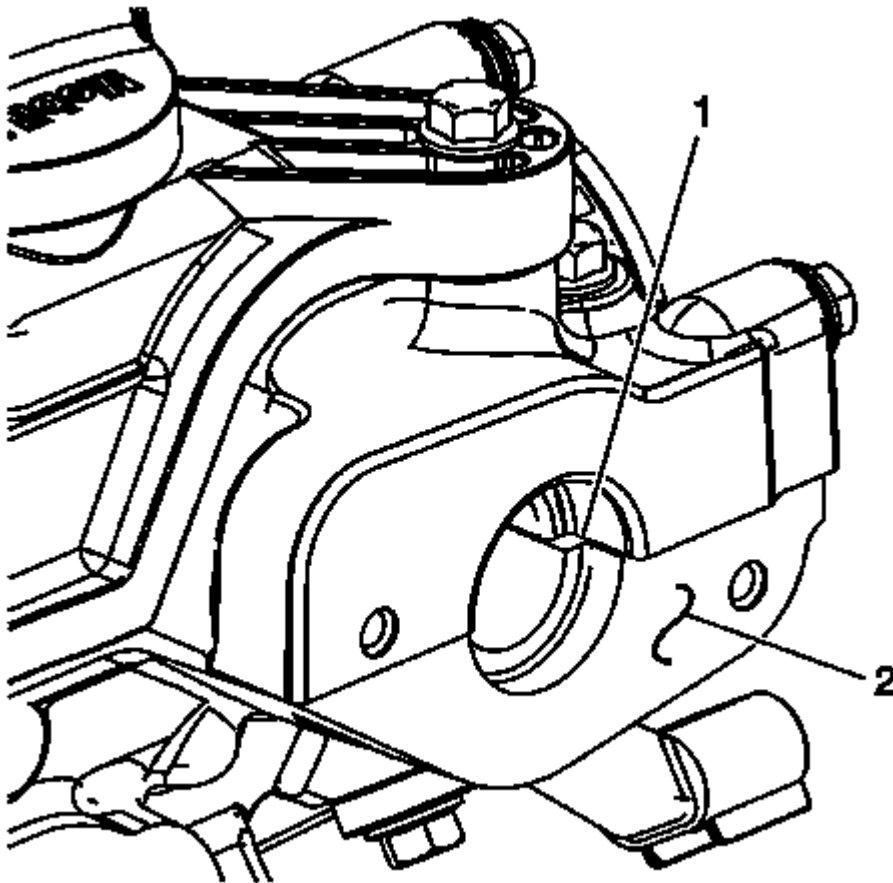


Fig. 116: Identifying Fuel Pump Roller Lifter Orifice
Courtesy of GENERAL MOTORS COMPANY

6. Remove all excess sealing material from the fuel pump roller lifter orifice (1), and ensure the orifice is free of debris.
7. Remove all excess sealing material from the sealing surfaces.

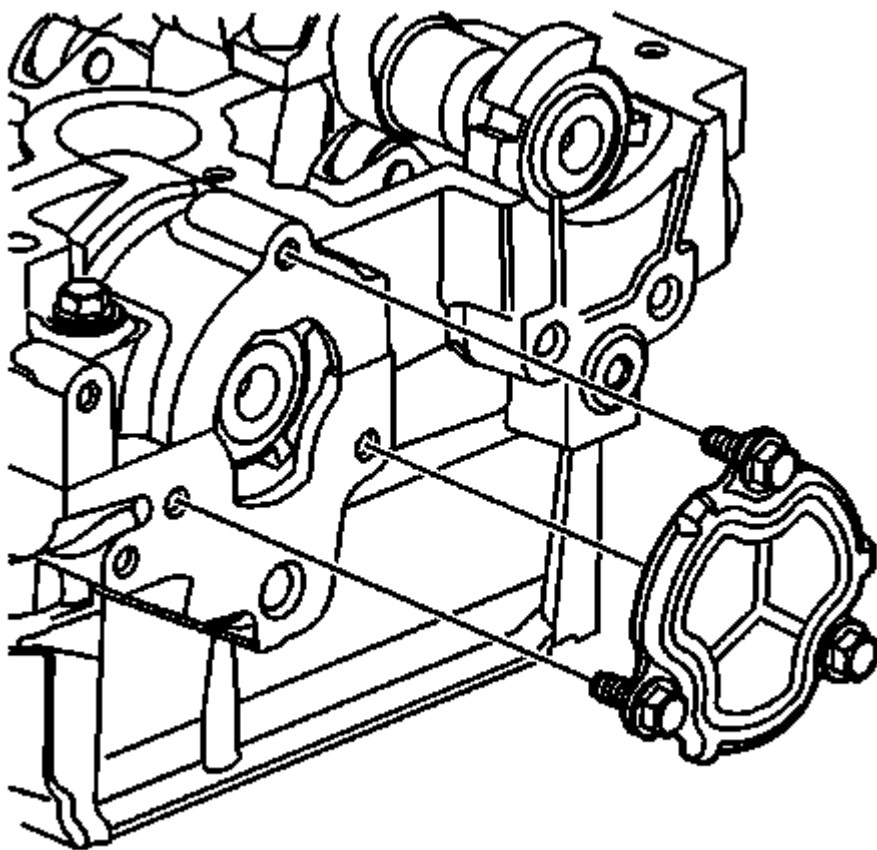


Fig. 117: Cylinder Head Opening Plate
Courtesy of GENERAL MOTORS COMPANY

8. Install the rear cylinder head opening plate and bolts and tighten to 10 N.m (89 lb in).
9. Install the camshaft position intake actuator. Refer to **Camshaft Position Intake Actuator Replacement**.

EXHAUST CAMSHAFT AND VALVE LIFTER REPLACEMENT

Removal Procedure

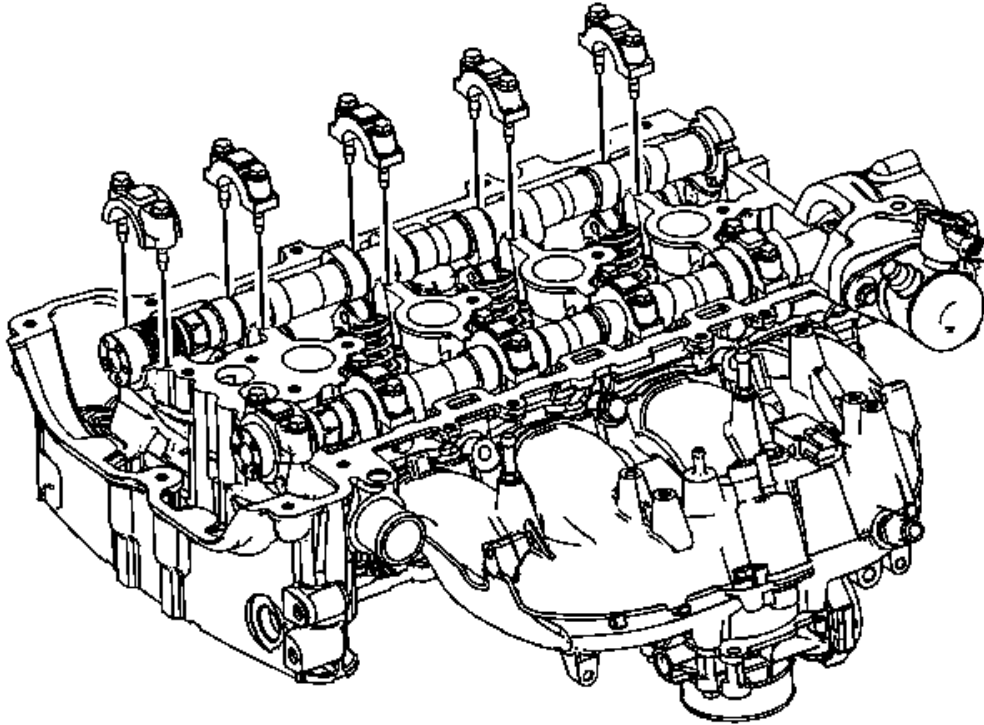


Fig. 118: Camshaft Bearing Caps

Courtesy of GENERAL MOTORS COMPANY

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

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

2. Mark the camshaft bearing caps to ensure they are installed in the same position.
3. Remove the camshaft bearing cap bolts and cap.

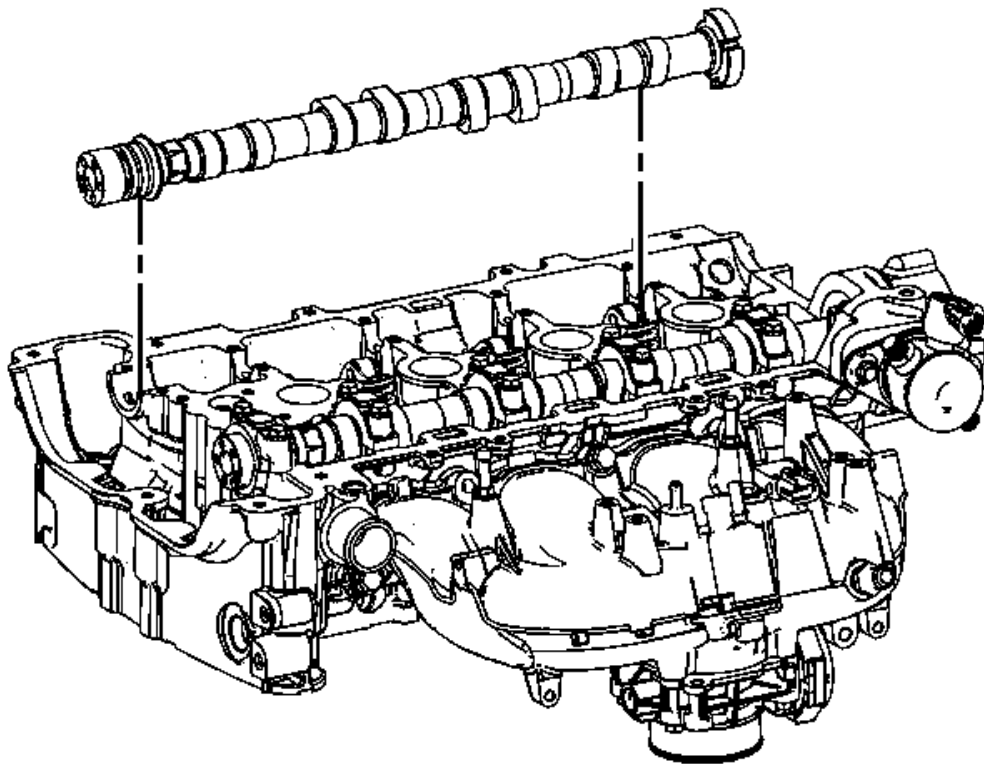


Fig. 119: Exhaust Camshaft

Courtesy of GENERAL MOTORS COMPANY

4. Remove the exhaust camshaft.

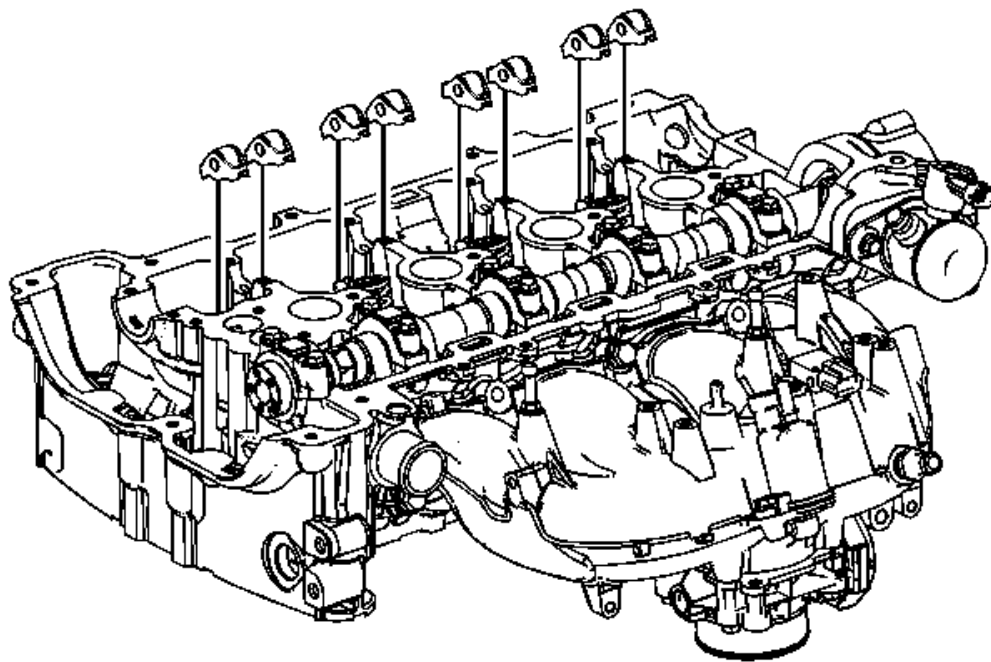


Fig. 120: Valve Rocker Arms

Courtesy of GENERAL MOTORS COMPANY

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

5. Remove the valve rocker arms.

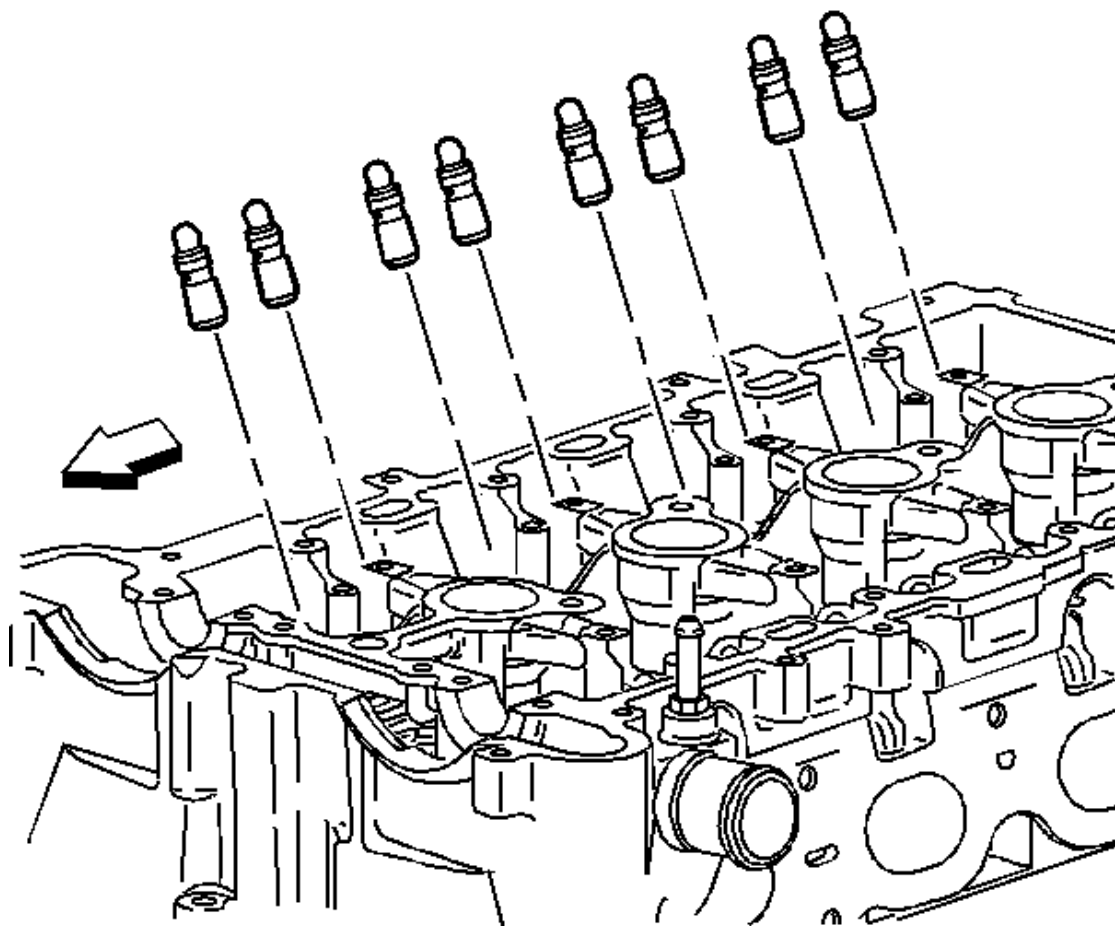


Fig. 121: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

6. Remove the hydraulic valve lash adjusters.

Installation Procedure

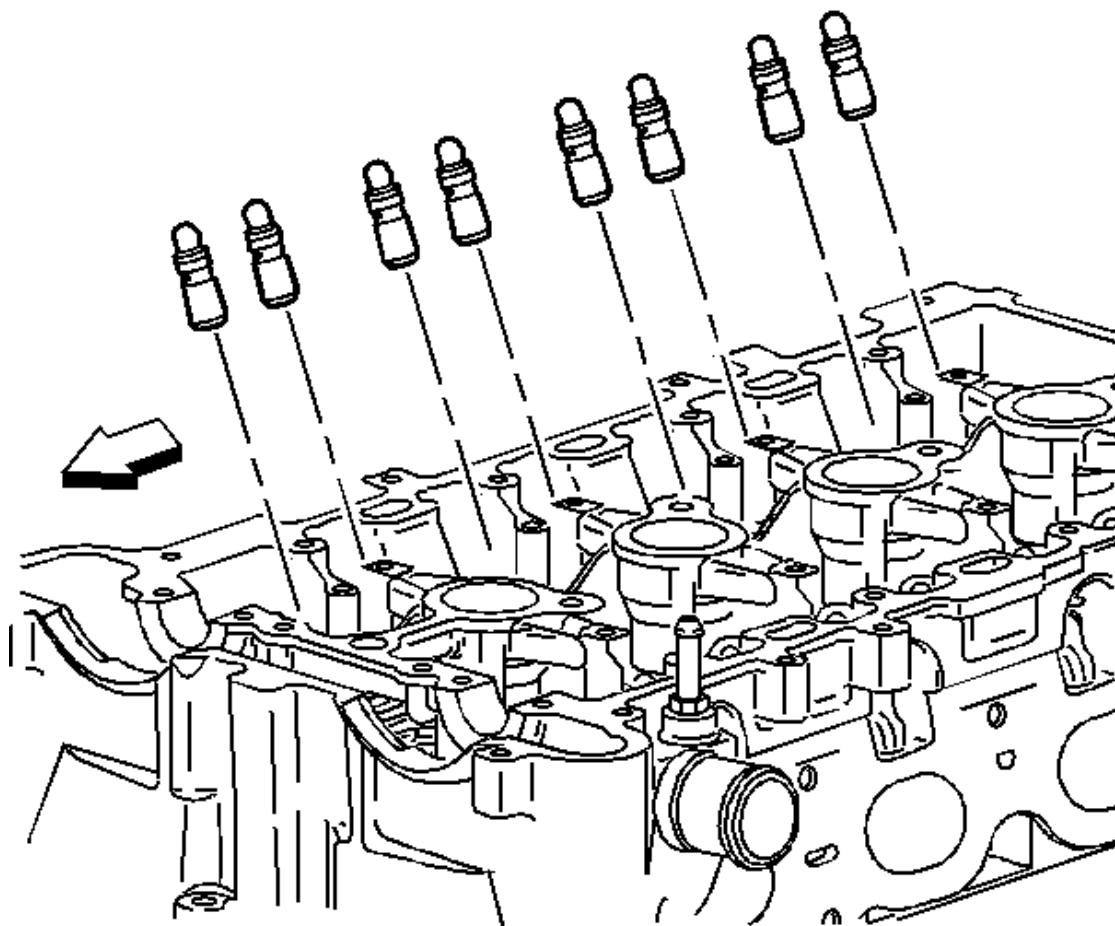


Fig. 122: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

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

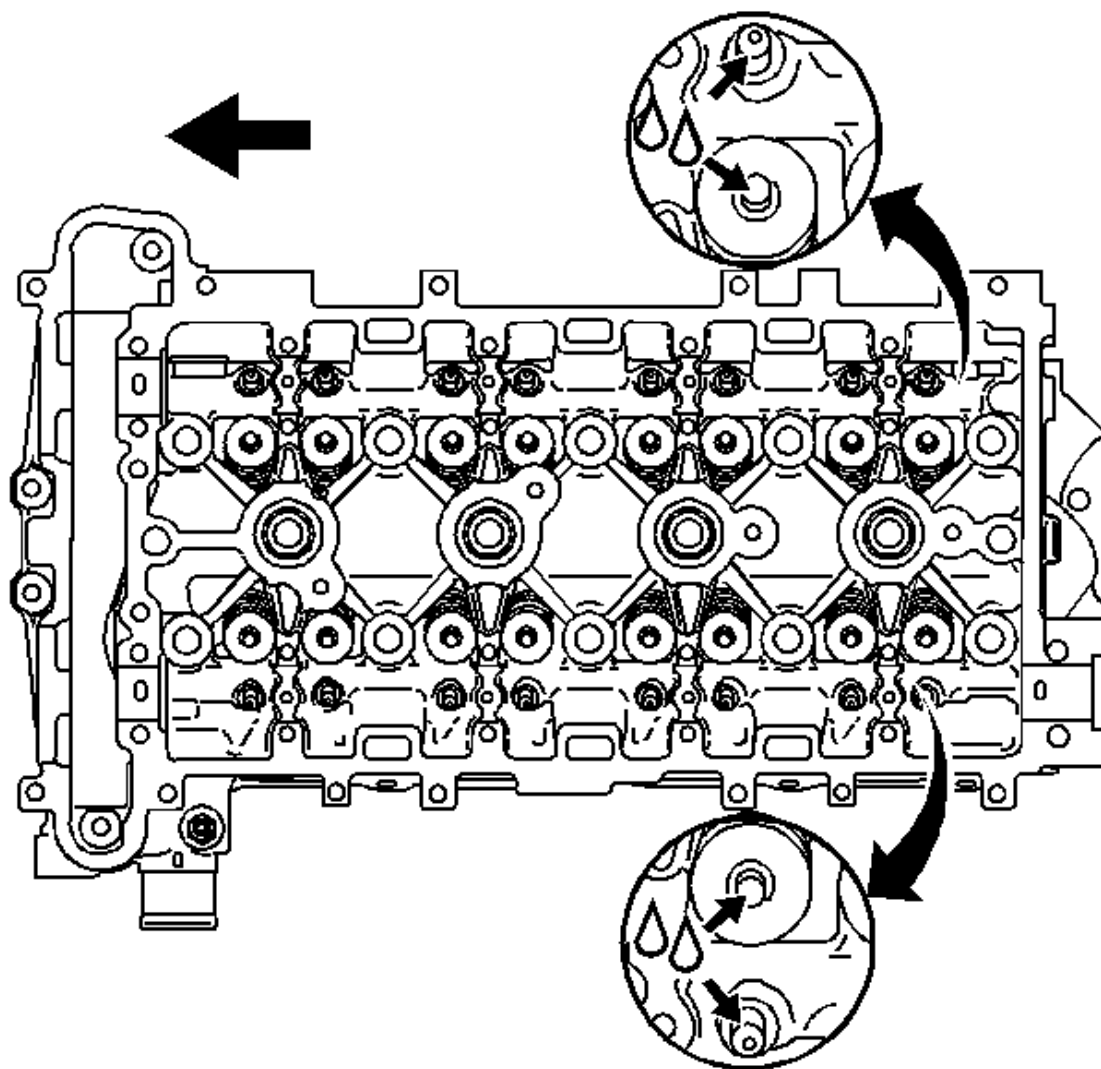


Fig. 123: Lubricating Valve Tips

Courtesy of GENERAL MOTORS COMPANY

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

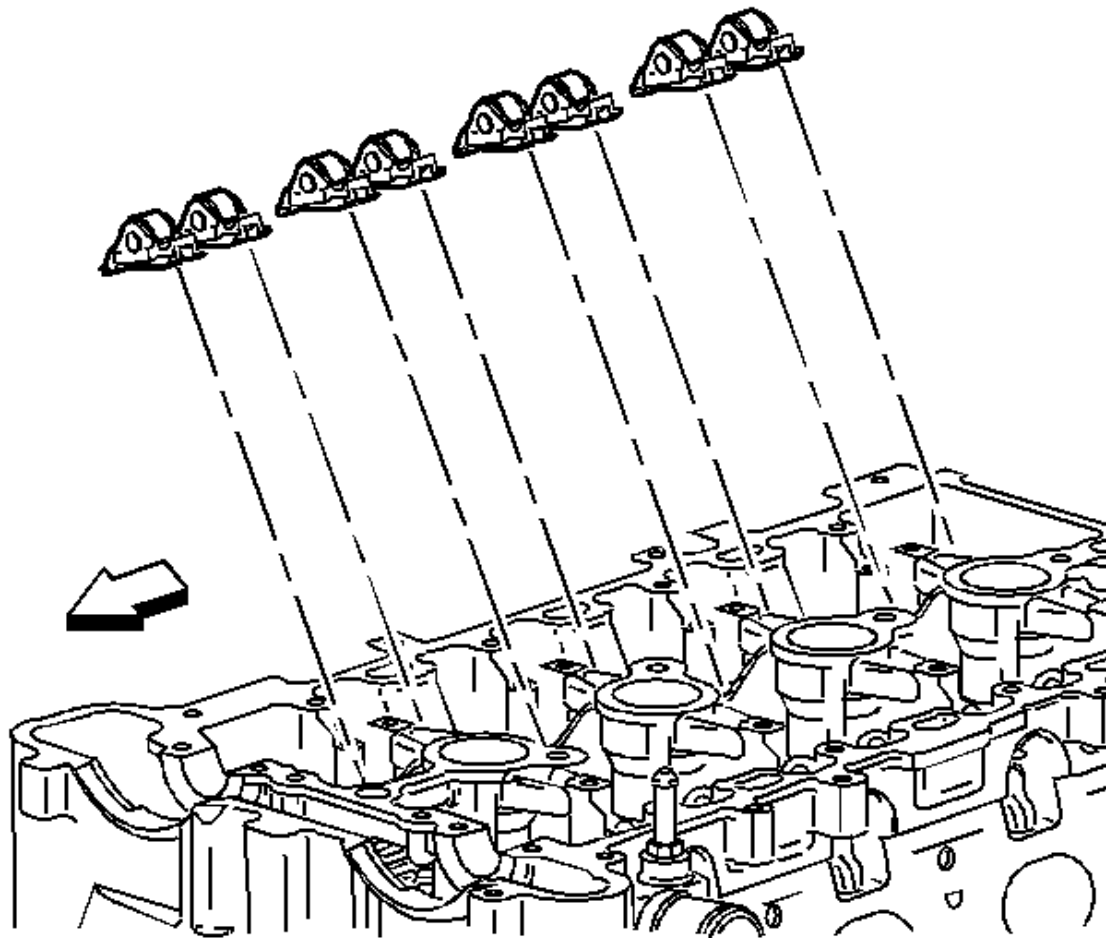


Fig. 124: Identifying Exhaust Camshaft Roller Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Used rocker arms **MUST** be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms **MUST** also be replaced.

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

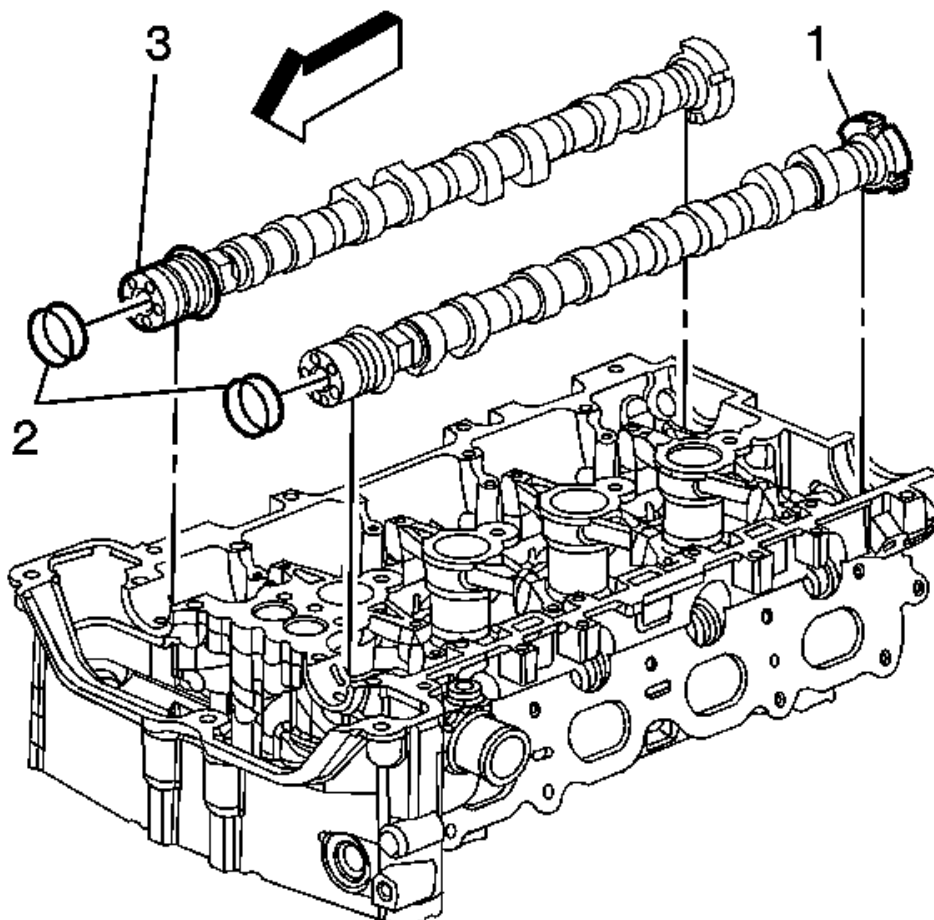


Fig. 125: Intake/Exhaust Camshaft
Courtesy of GENERAL MOTORS COMPANY

5. Install the exhaust camshaft. Lubricate the camshaft. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

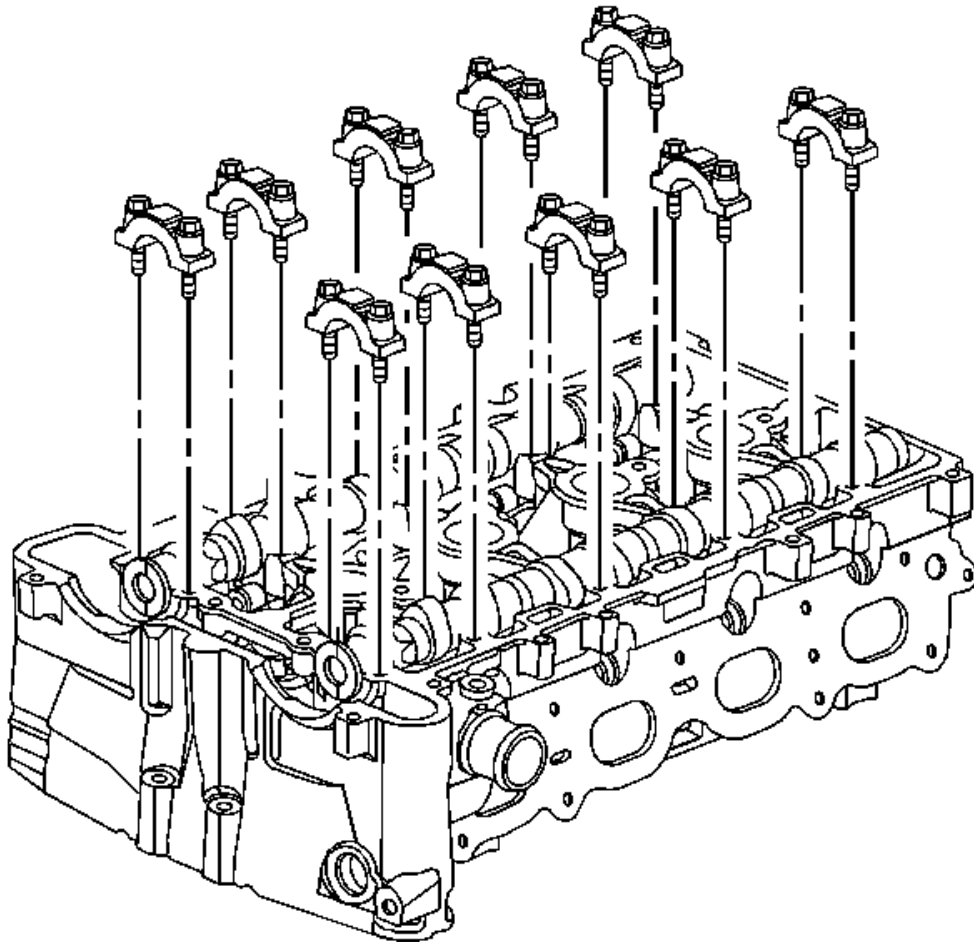


Fig. 126: Camshaft Bearing Caps

Courtesy of GENERAL MOTORS COMPANY

NOTE: The caps should be installed on the cylinder head in sequence as shown in the graphic on top of the bearing caps.

6. Position the camshaft bearing caps. Install the bearing cap bolts hand tight.

CAUTION: Refer to Fastener Caution .

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

Tighten

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

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

Replacement.**CAMSHAFT POSITION INTAKE ACTUATOR REPLACEMENT****Special Tools**

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

Removal Procedure

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

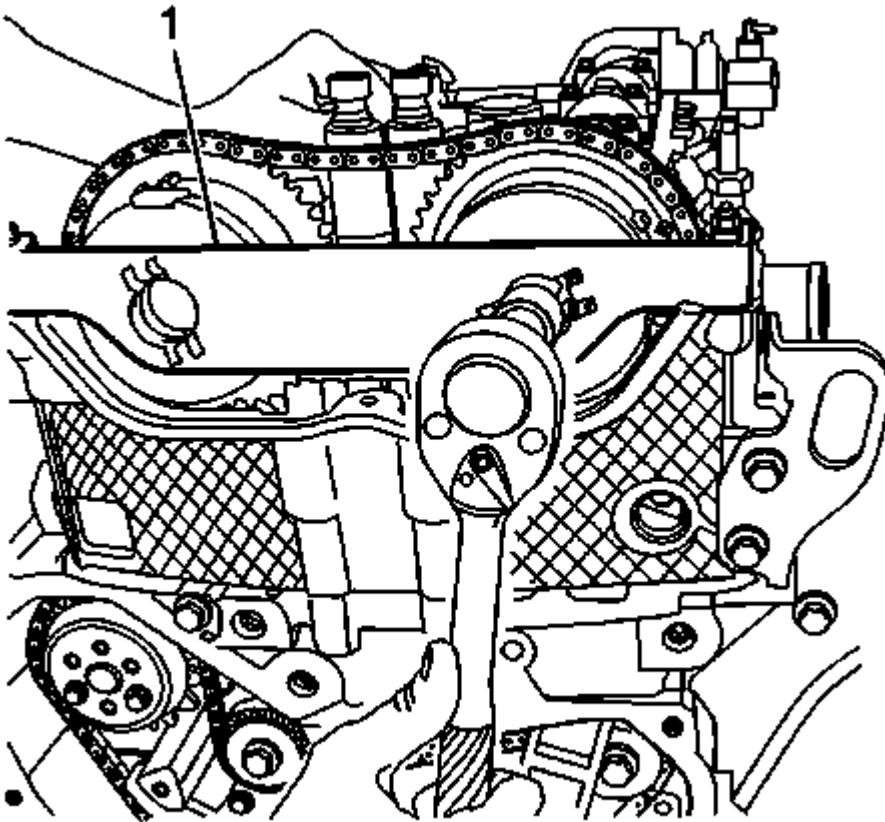


Fig. 127: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to Fastener Caution .

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

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

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

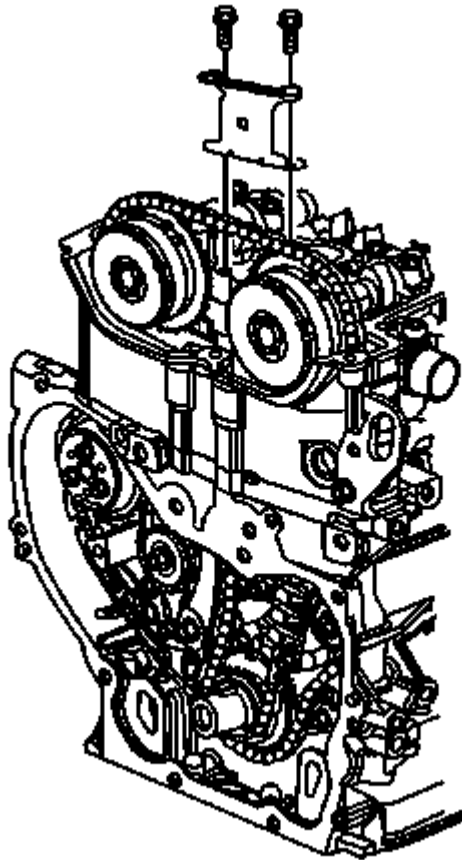


Fig. 128: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS COMPANY

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

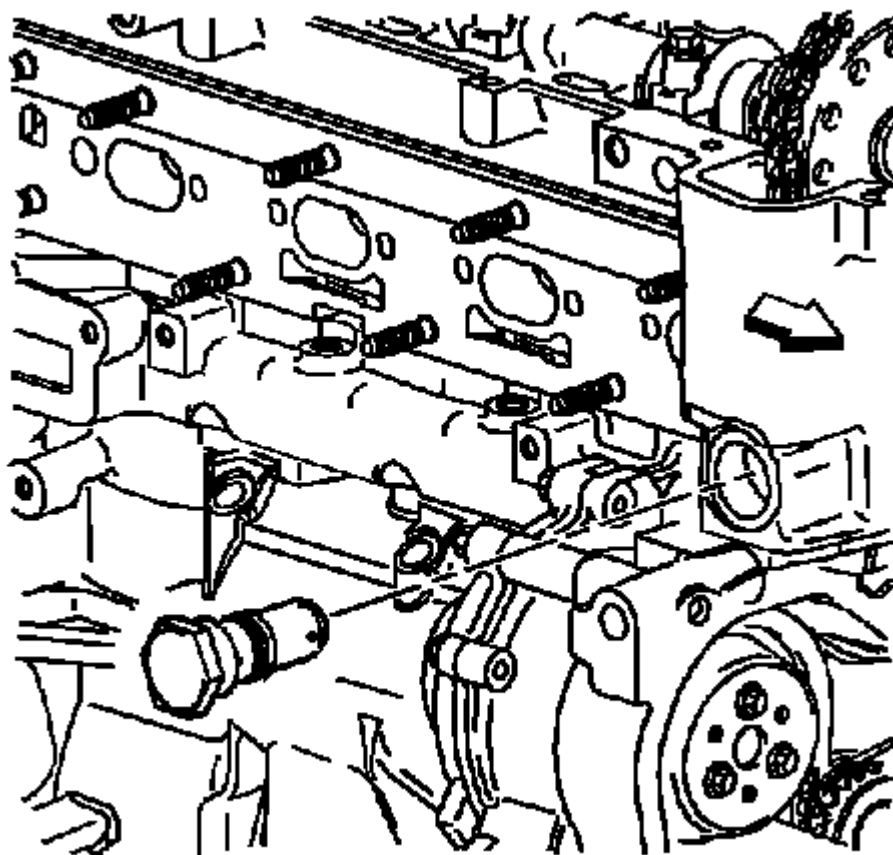


Fig. 129: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain tensioner.

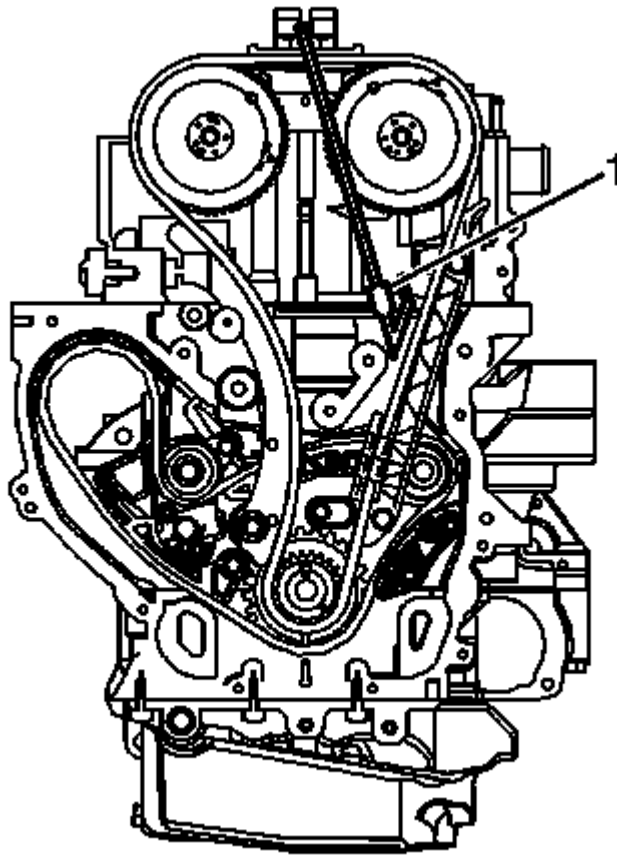


Fig. 130: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

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

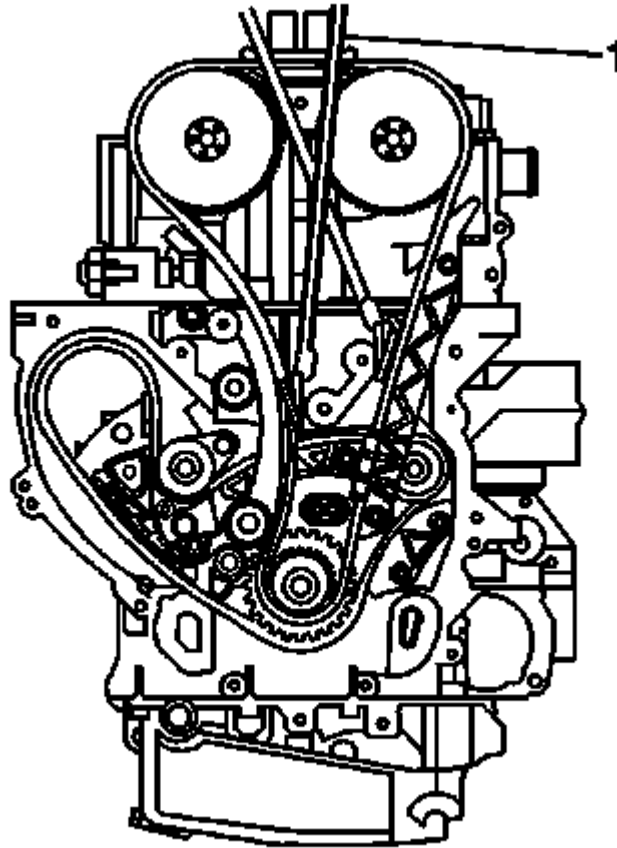


Fig. 131: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

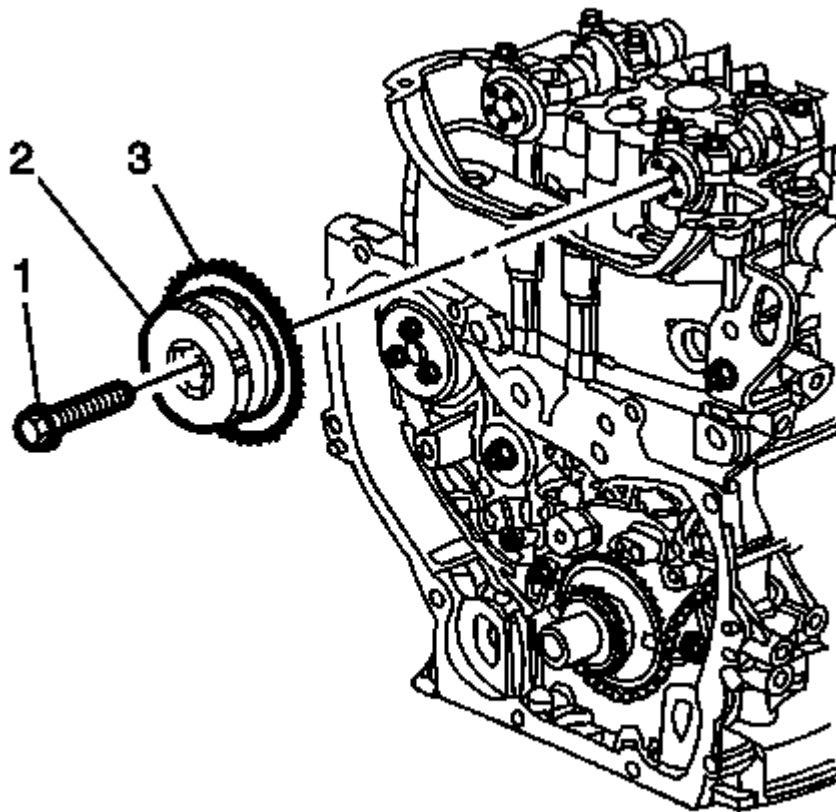


Fig. 132: Timing Chain & Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

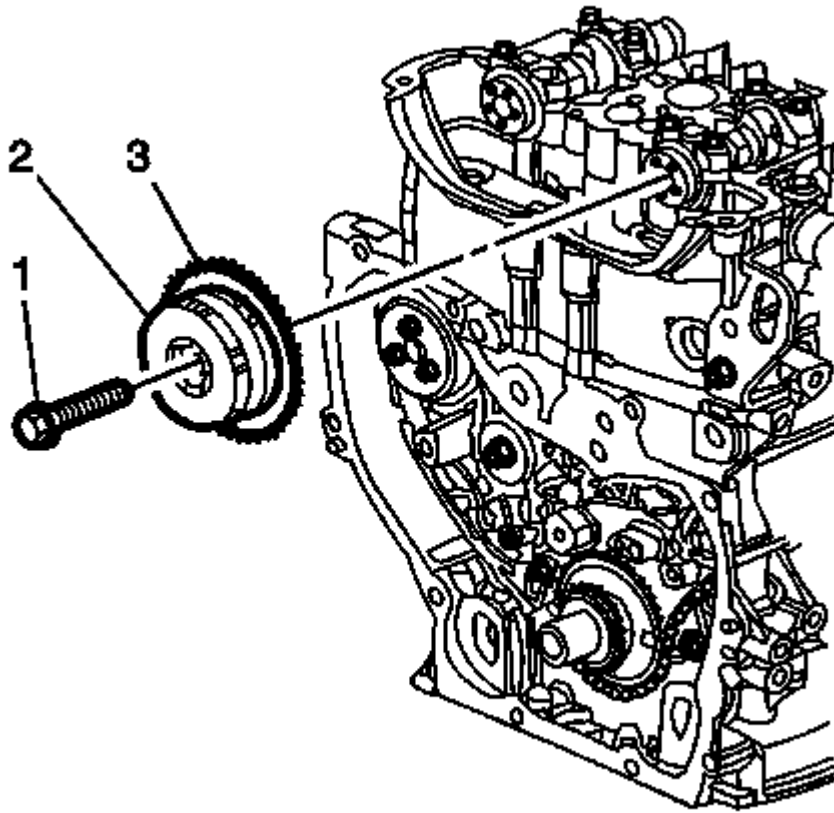


Fig. 133: Timing Chain & Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

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 (2) until snug.

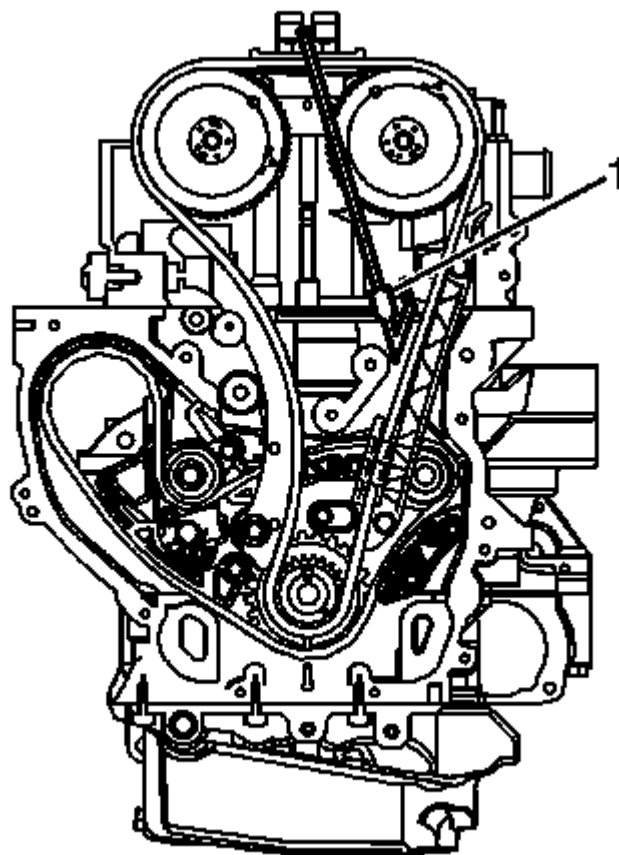


Fig. 134: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

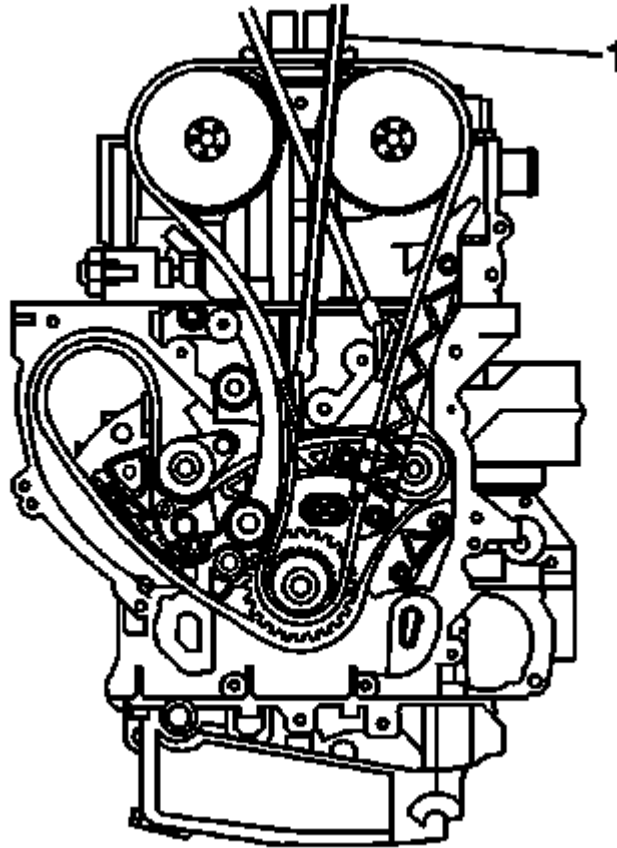


Fig. 135: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

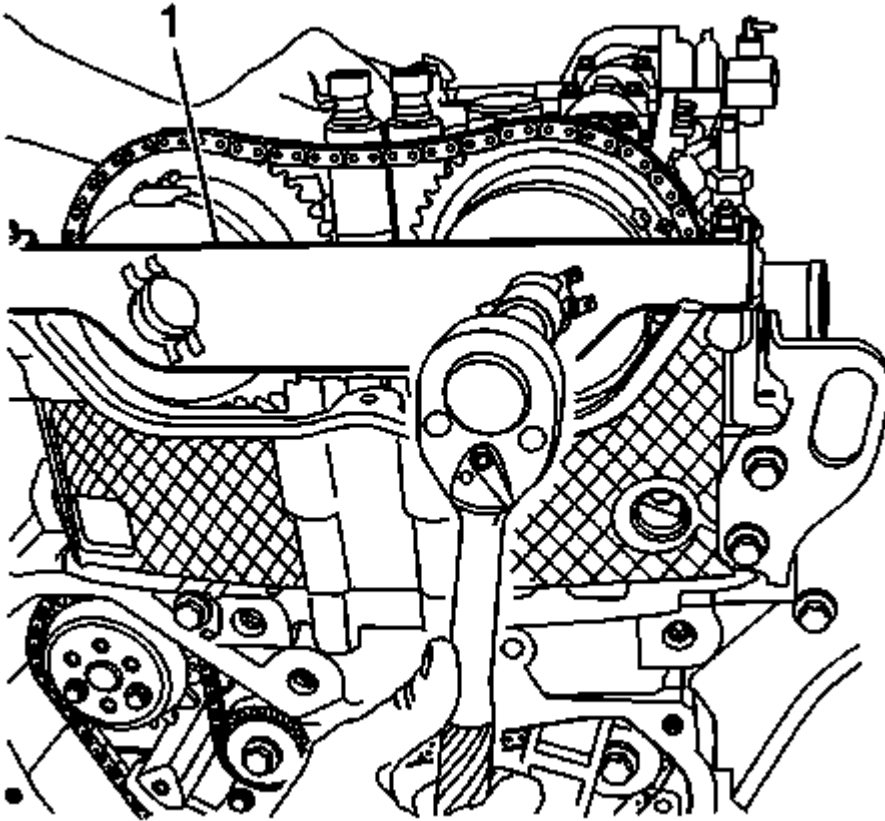


Fig. 136: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

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

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

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

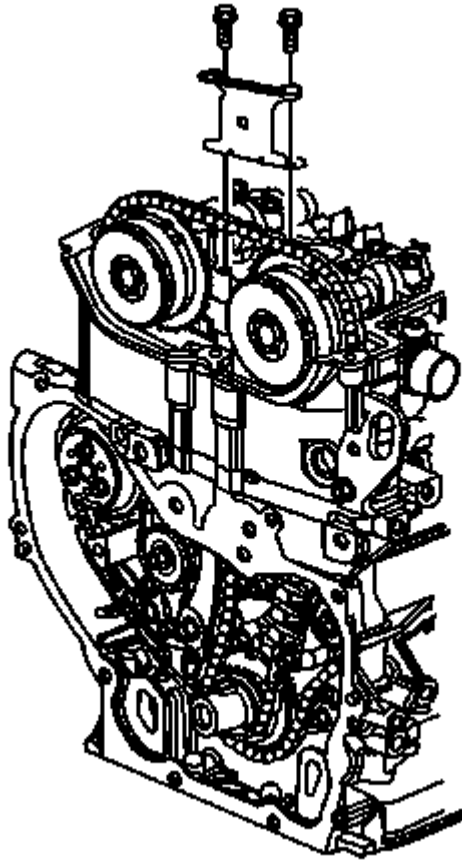


Fig. 137: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS COMPANY

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

CAMSHAFT POSITION EXHAUST ACTUATOR REPLACEMENT

Special Tools

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

Removal Procedure

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

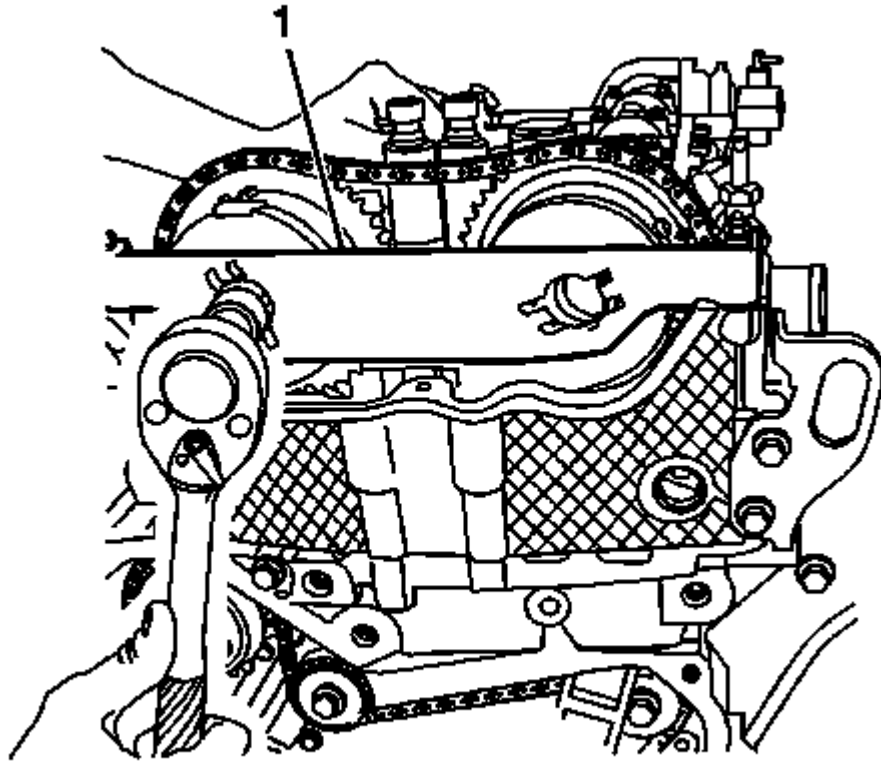


Fig. 138: View of Camshaft Actuator Retainer
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to **Fastener Caution** .

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

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

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

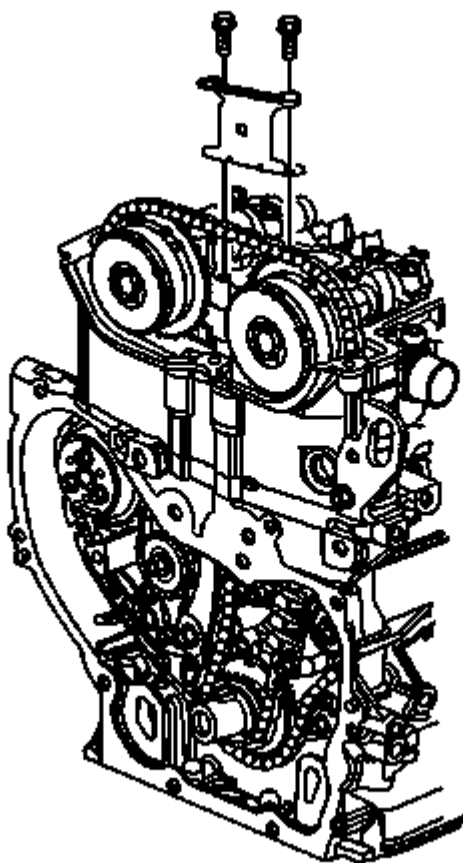


Fig. 139: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS COMPANY

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

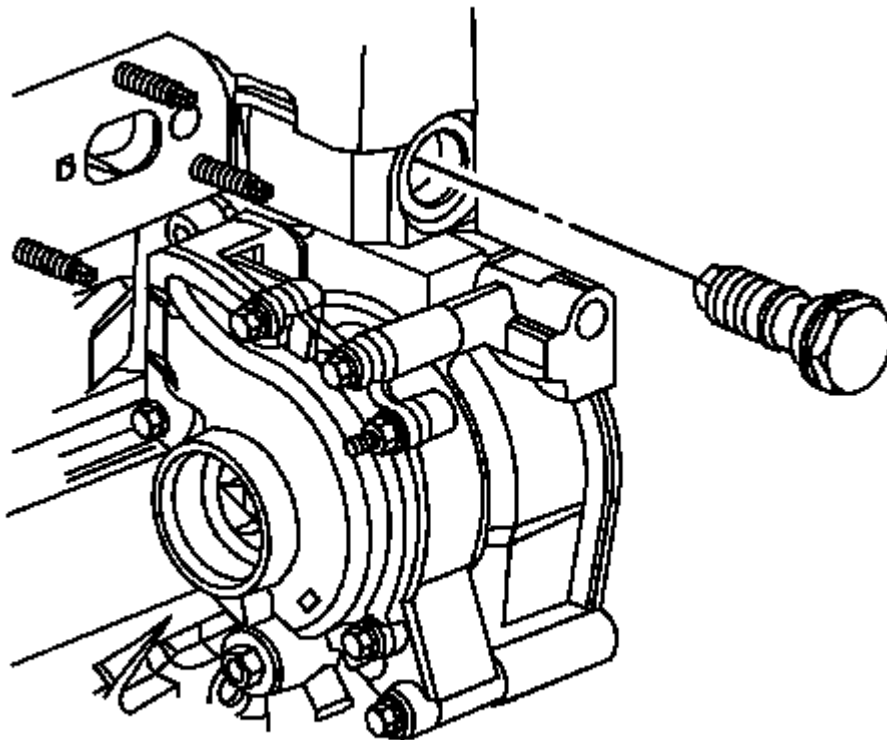


Fig. 140: Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

9. Remove the timing chain tensioner.

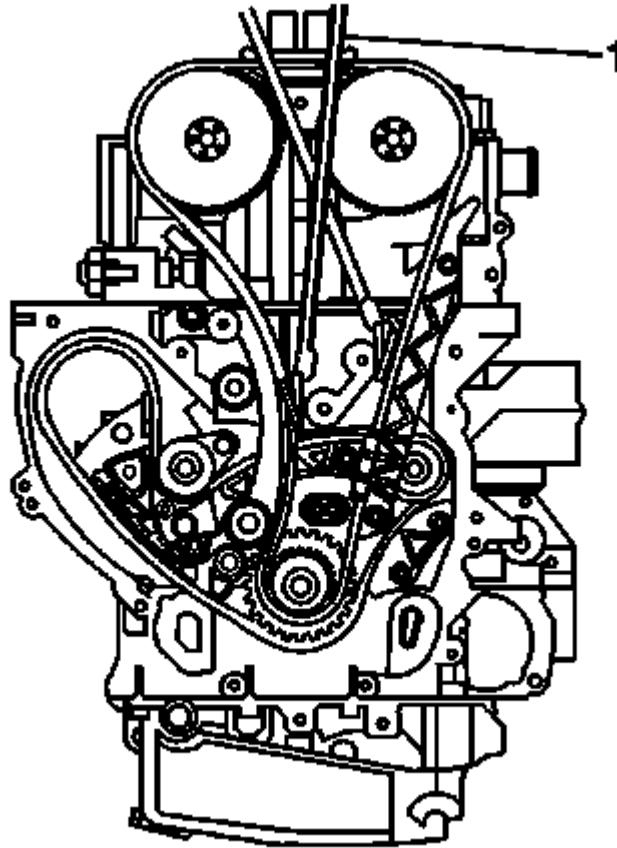


Fig. 141: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

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

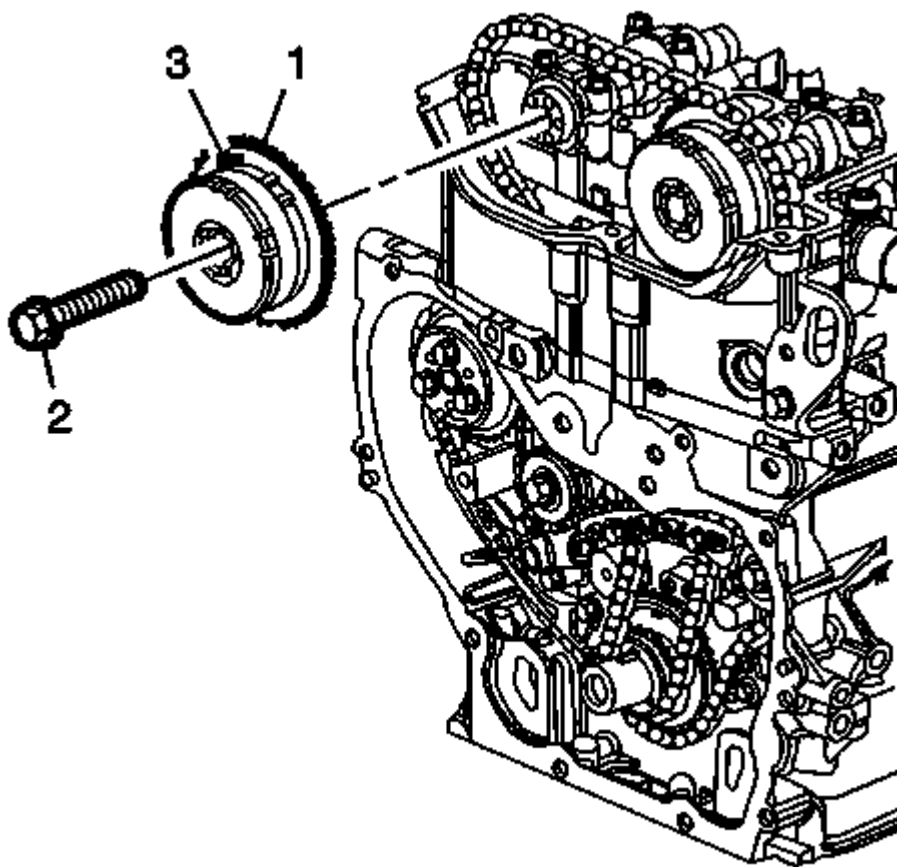


Fig. 142: Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

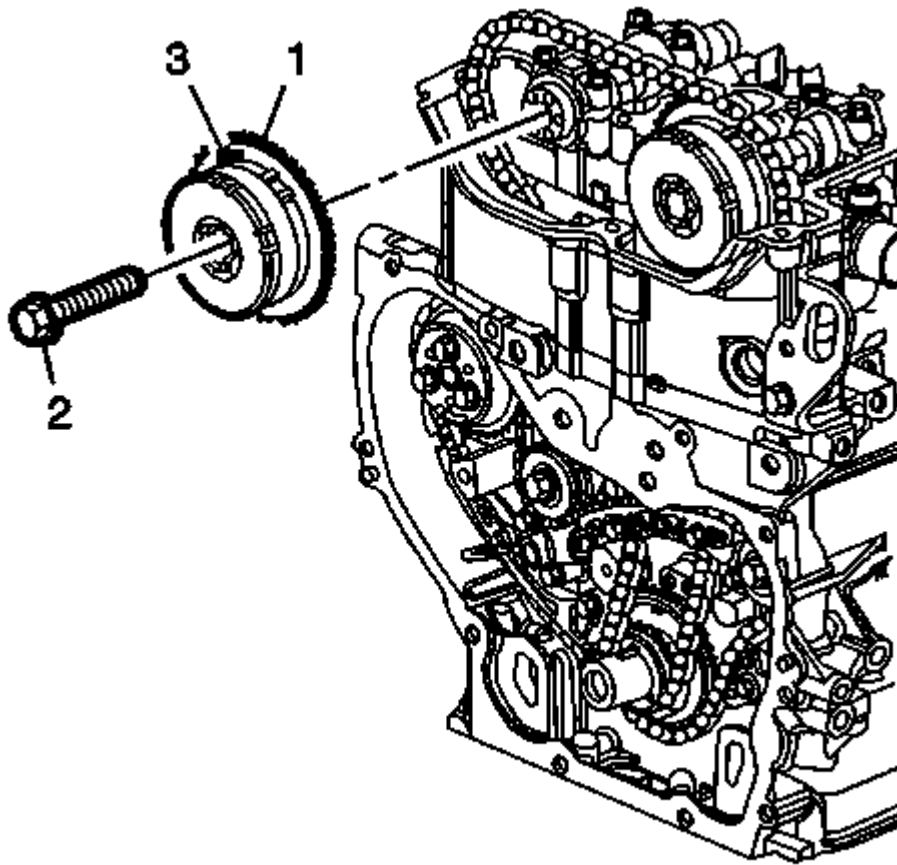


Fig. 143: Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

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.

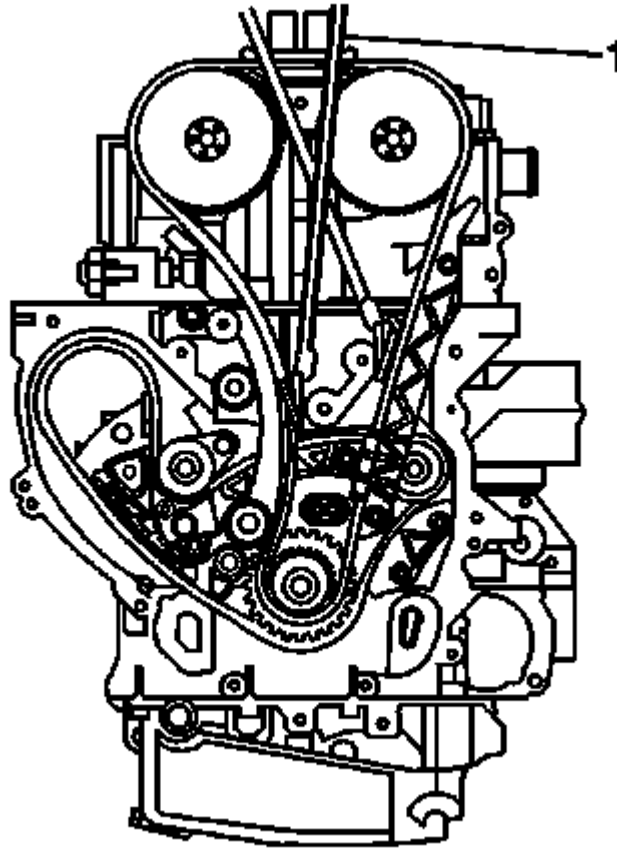


Fig. 144: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

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

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

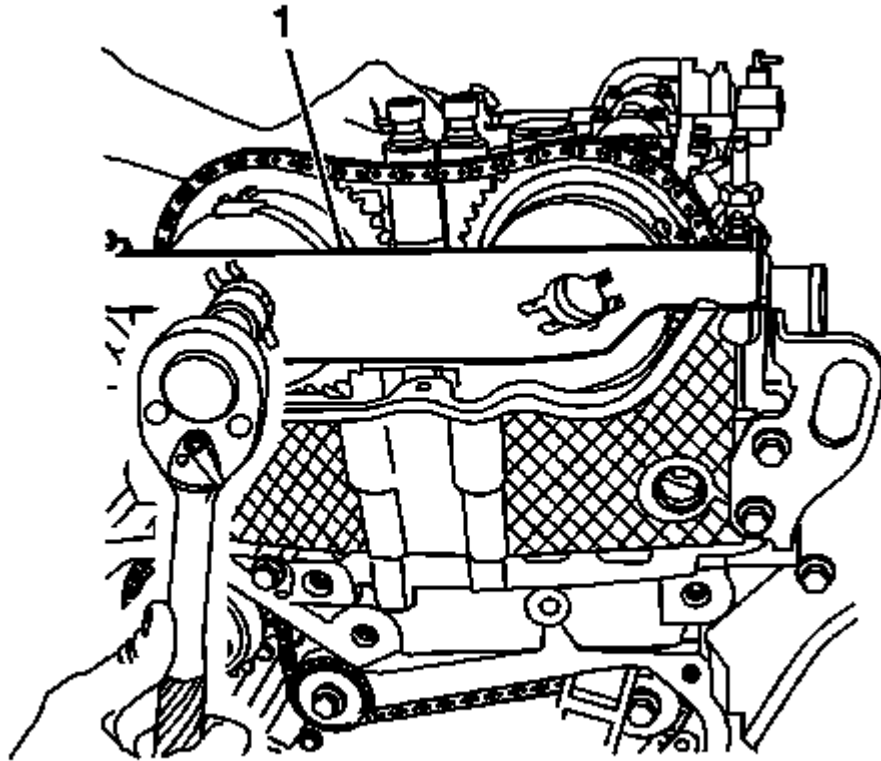


Fig. 145: View of Camshaft Actuator Retainer
Courtesy of GENERAL MOTORS COMPANY

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

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

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

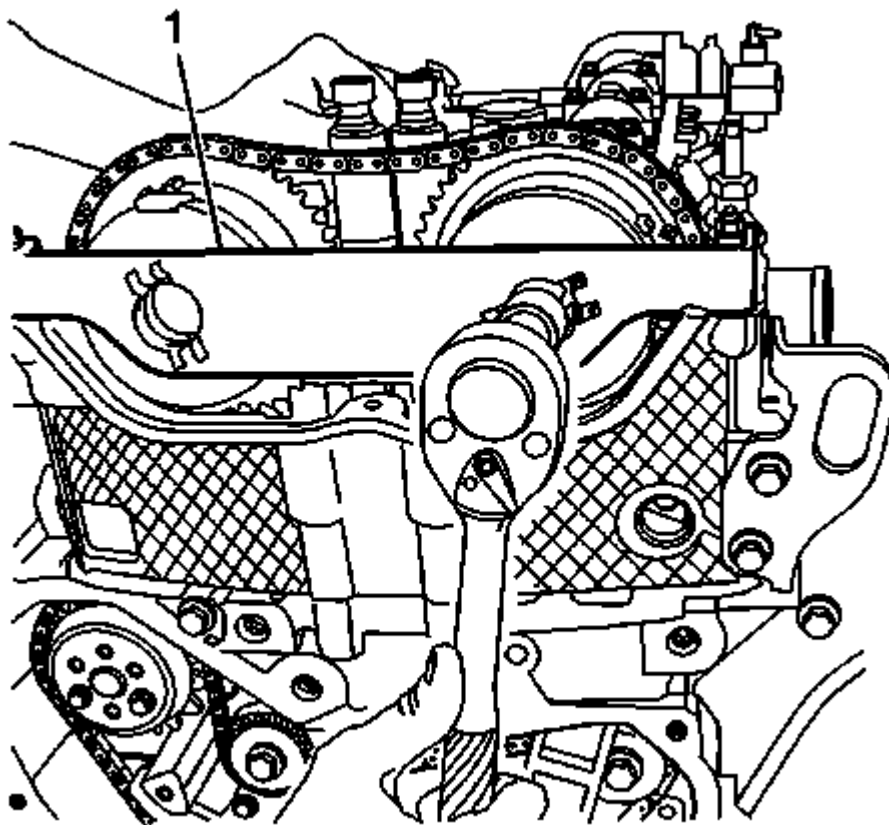


Fig. 146: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

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

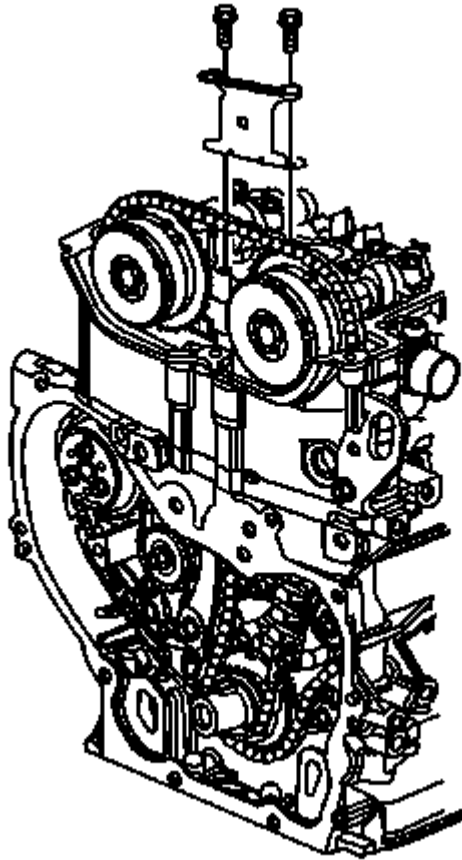


Fig. 147: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS COMPANY

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

CYLINDER HEAD REPLACEMENT

Special Tools

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

For equivalent regional tools, refer to **Special Tools (LDK, LHU)**.

Removal Procedure

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

Draining and Filling (GE 47716) .

3. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**
4. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
5. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement (LDK or LHU) .**
6. Remove the camshaft timing chain. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Replacement**.

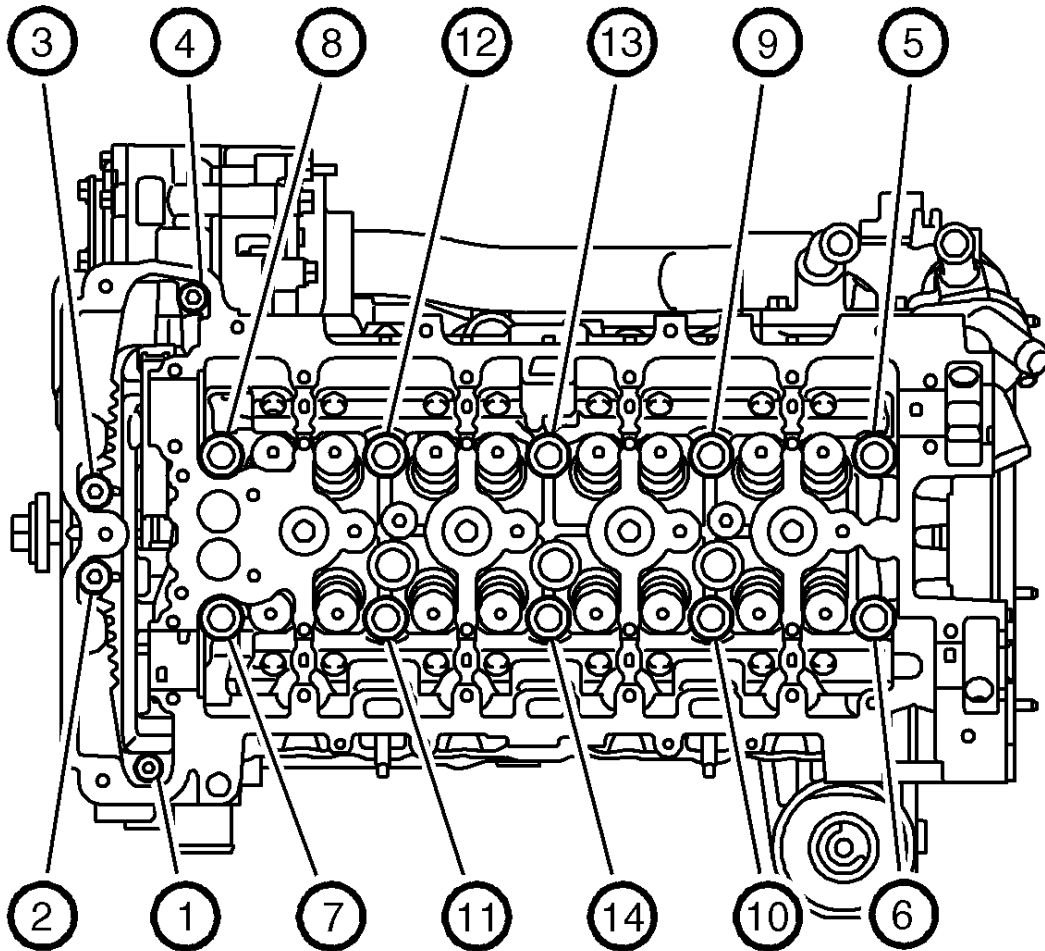


Fig. 148: Cylinder Head Bolt Removal Sequence
Courtesy of GENERAL MOTORS COMPANY

7. Remove the cylinder head bolts opposite to the block fastener sequence.

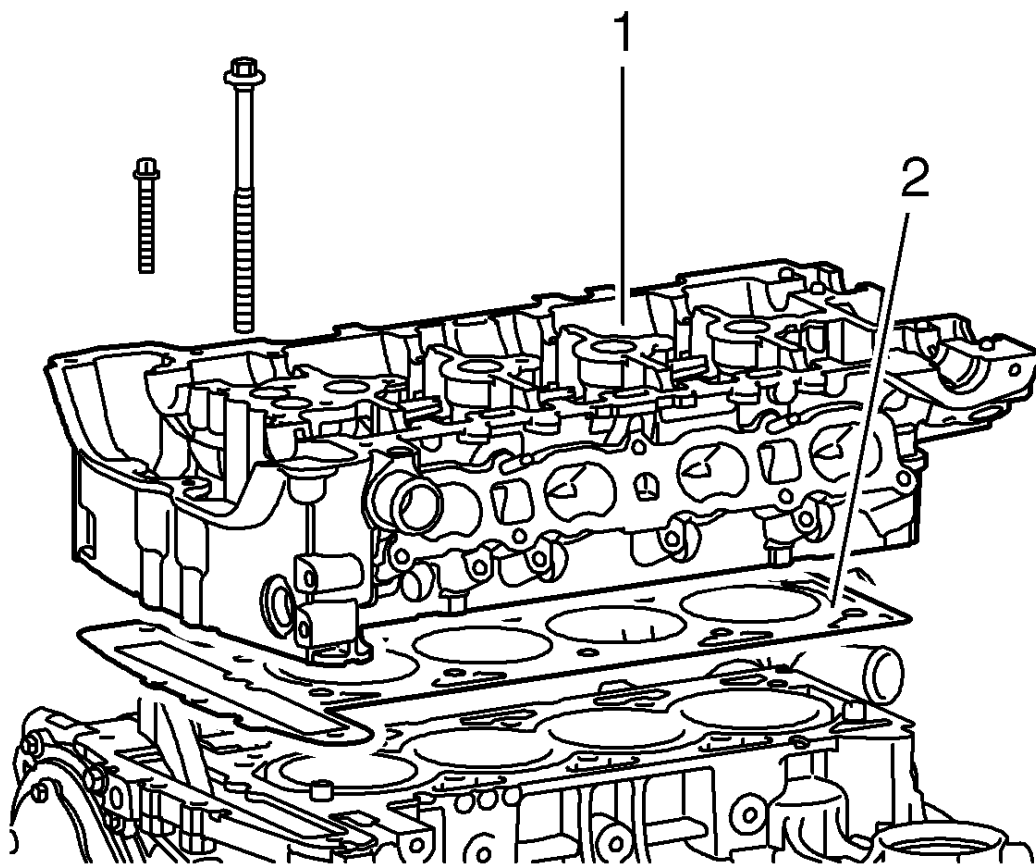


Fig. 149: Cylinder Head And Gasket

Courtesy of GENERAL MOTORS COMPANY

8. Remove the cylinder head (1) and the cylinder head gasket (2) from the block.
9. Clean all of the gasket surfaces. Refer to **Cylinder Head Cleaning and Inspection (LDK, LHU)**

Installation Procedure

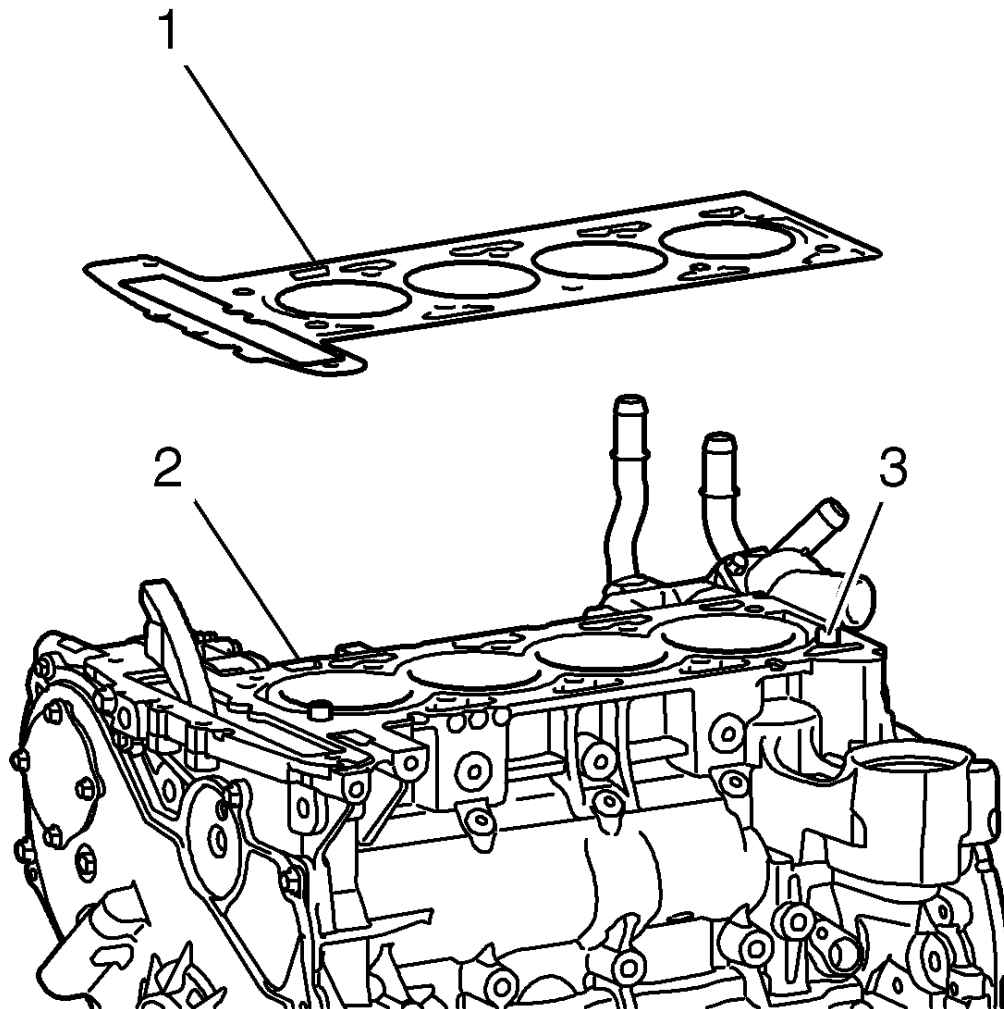


Fig. 150: Cylinder Head Gasket And Lock Pin
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use any sealing material.

1. Install the cylinder head gasket (1) to the cylinder block (2). On right side pay attention to the cylinder head lock pin (3).

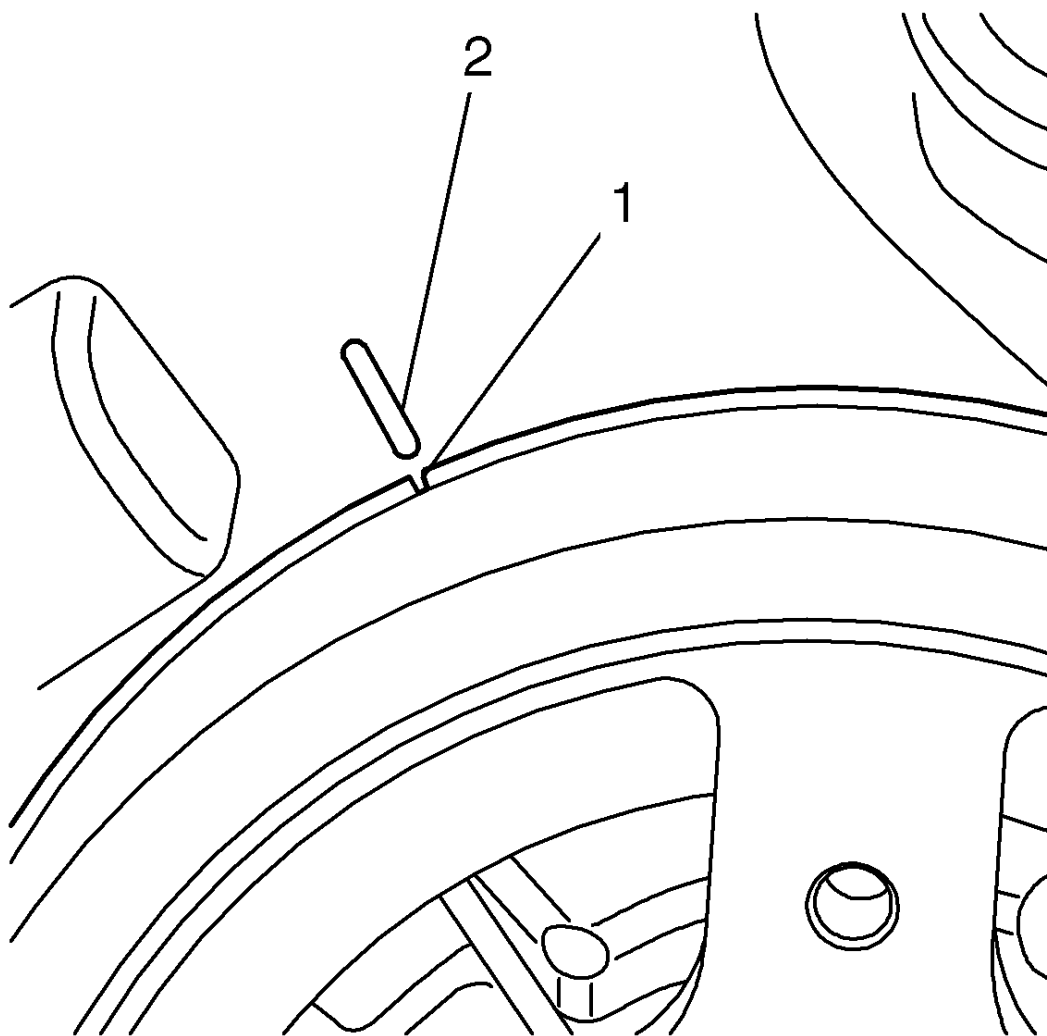


Fig. 151: Crankshaft Balancer Mark And Oil Pump Housing Mark
Courtesy of GENERAL MOTORS COMPANY

2. Ensure the number 1 cylinder is at top dead center (TDC).

Setting up the crankshaft balancer mark (1) to the oil pump housing mark (2).

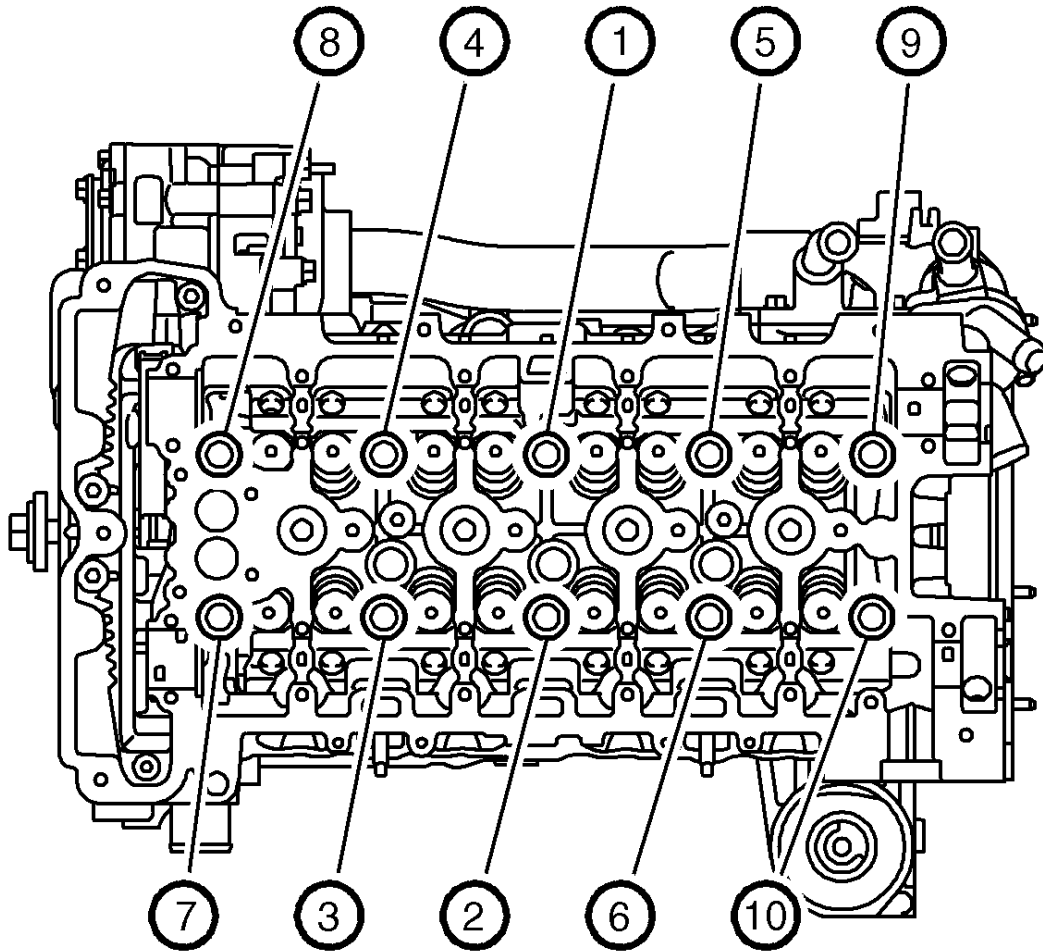


Fig. 152: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: Always use NEW cylinder head fasteners.

3. Install the cylinder head.

CAUTION: Refer to Fastener Caution .

4. Install NEW cylinder head fasteners.
 - Tighten the fastener in sequence to 30 N.m (22 lb ft).
 - Tighten the fastener in additional 155 degrees in sequence using the **EN-45059** angle meter.

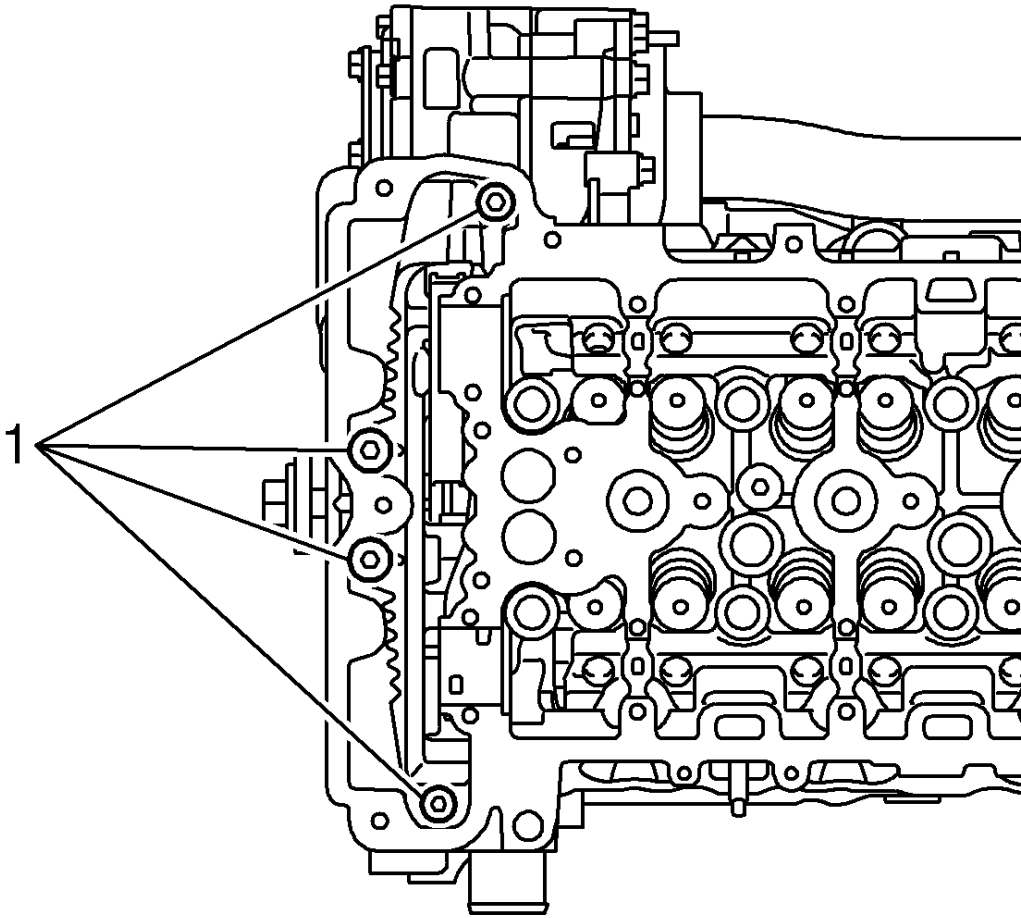
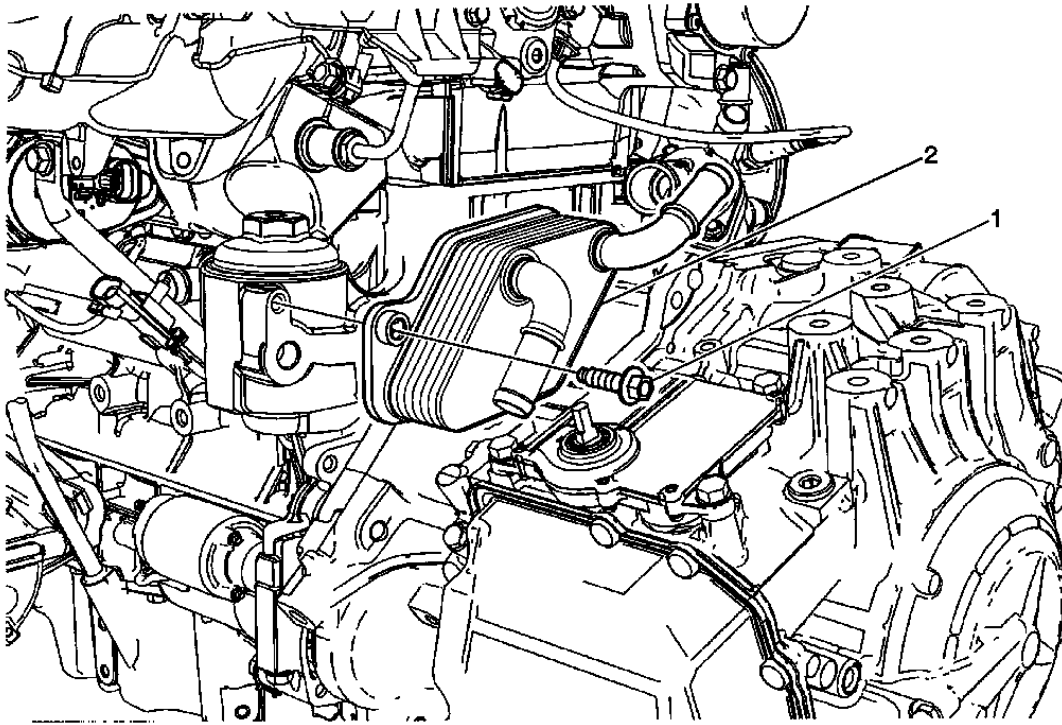


Fig. 153: Front Cylinder Head Fasteners
Courtesy of GENERAL MOTORS COMPANY

5. Install the front cylinder head fastener (1) and tighten to 35 N.m (26 lb ft).
6. Install camshaft timing chain. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Replacement**.
7. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement (LDK or LHU)** .
8. Install the intake manifold. Refer to **Intake Manifold Replacement**.
9. Install camshaft cover. Refer to **Camshaft Cover Replacement**
10. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
11. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

ENGINE OIL COOLER REPLACEMENT

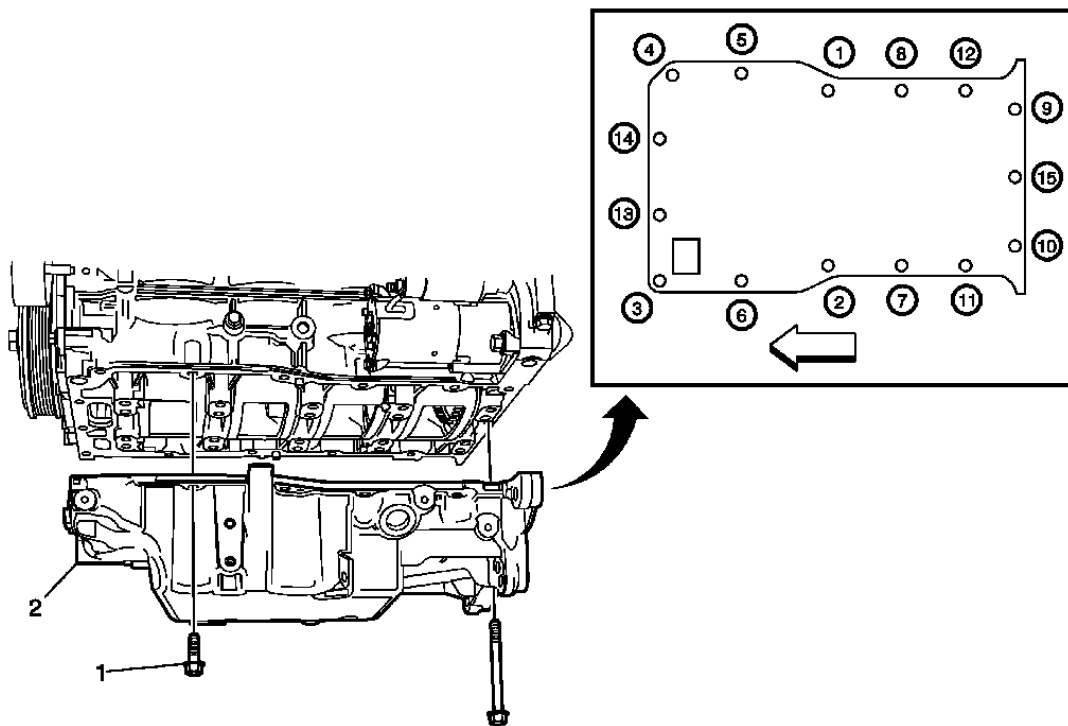
**Fig. 154: Engine Oil Cooler**

Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Replacement

Callout	Component Name
primarily procedure 1. Remove the Radiator Outlet Hose. Refer to <u>Radiator Outlet Hose Replacement (LHU)</u> . 2. Remove the Radiator Surge Tank Inlet Hose. Refer to <u>Radiator Surge Tank Inlet Hose Replacement (LEA)</u> .	
1	Engine oil cooler fastener (Qty, 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft)
2	Engine oil cooler Procedure 1. Disconnect electrical connector as needed. 2. Transfer components as necessary.

OIL PAN REPLACEMENT

**Fig. 155: Engine Oil Pan**

Courtesy of GENERAL MOTORS COMPANY

Oil Pan Replacement

Callout	Component Name
Preliminary Procedure	
1. Drain the oil. Refer to <u>Engine Oil and Oil Filter Replacement</u>. 2. Remove the oil level indicator Tube. Refer to <u>Oil Level Indicator Tube Replacement</u>. 3. Remove the air conditioning compressor bracket. Refer to <u>Air Conditioning Compressor Bracket Replacement</u>. 4. Remove the catalytic converter bracket. Refer to <u>Catalytic Converter Brace Replacement (LDK OR LHU)</u>.	
	Oil Pan Fastener (Qty: 15) NOTE: • The lower crankcase surface must be free of contamination prior to applying the sealer. • Install and align the oil pan to block within 20 minutes of applying the sealer. • The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.

1	Procedure 1. Before removing the oil pan note the location of the bolts. 2. Ensure to clean and inspect the oil. Refer to <u>Oil Pan Cleaning and Inspection (LDK, LHU)</u>. 3. Apply a 2.25 mm bead of sealer (1) on the level part of the flange next to the chamfer around the perimeter of the oil pan and the oil suction port opening. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>. 4. Follow the tighten bolt sequence. Tighten 25 N.m (18 lb ft)
2	Oil Pan Procedure 1. Disconnect electrical connectors as needed. 2. Transfer components as necessary.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

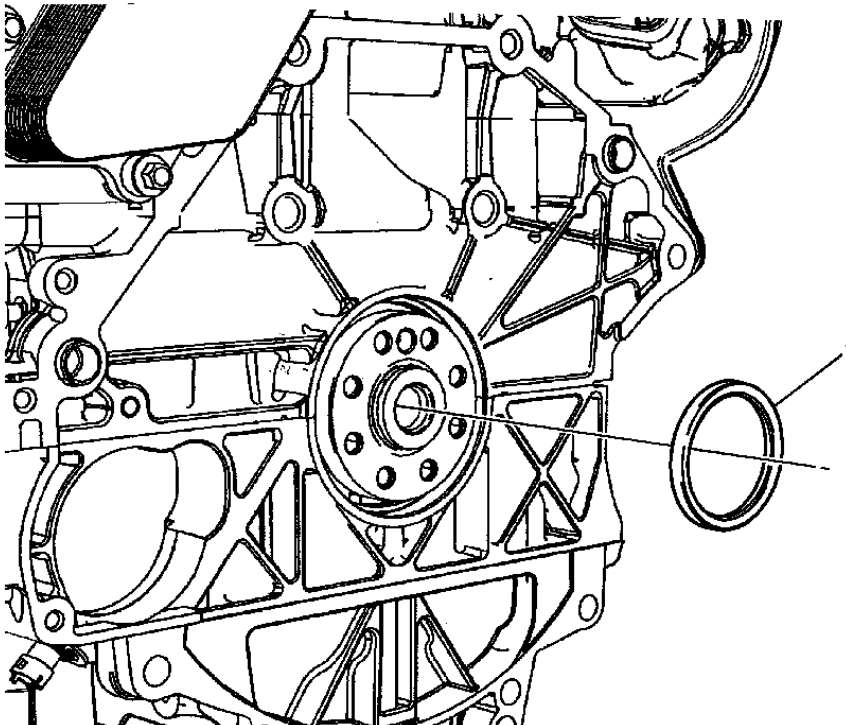
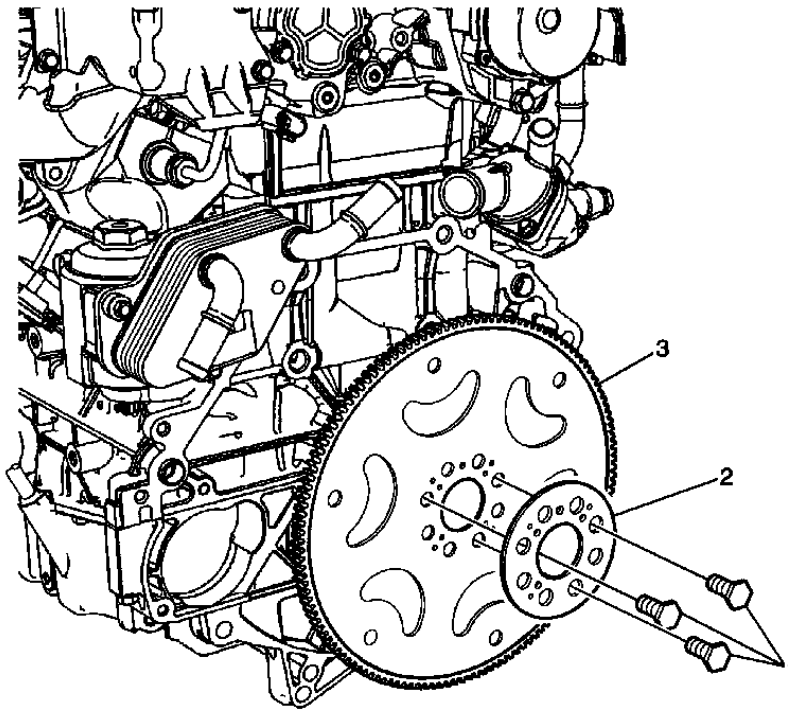


Fig. 156: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Rear Oil Seal Replacement

Callout	Component Name
Preliminary Procedure Remove the flywheel. Refer to <u>Engine Flywheel Replacement.</u>	
1	Crankshaft Rear Oil Seal Procedure 1. Use flat-bladed tool to remove the seal. 2. Use the EN-42027 installer and install a NEW crankshaft rear oil seal. 3. Transfer components as necessary. Special Tools EN-42067 Rear Main Seal Installer For equivalent regional tools, refer to <u>Special Tools (LDK, LHU)</u> .

ENGINE FLYWHEEL REPLACEMENT**Fig. 157: Engine Flywheel**

Courtesy of GENERAL MOTORS COMPANY

Engine Flywheel Replacement

Callout	Component Name

Preliminary Procedure

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

1	Flywheel Fastener (Qty: 8) CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. Install the EN-43653 Flywheel Holding Tool. 2. Clean the thread adhesive from the flywheel bolt holes. Use a nylon bristle brush to clean the holes in the crankshaft. 3. Ensure to use NEW bolt whenever removing the flywheel. Tighten 53 N.m (39 lb ft) plus an additional 25 degrees Special Tools EN-43653 Flywheel Holding Tool For equivalent regional tools, refer to <u>Special Tools (LDK, LHU)</u> .
2	Flywheel Spacer
3	Flywheel Procedure 1. Clean and inspect the flywheel. Refer to <u>Engine Flywheel Cleaning and Inspection</u> . If the flywheel teeth are damaged, inspect the starter for proper operation. Replace the starter if you find excessive wear or damage to the starter drive. 2. Transfer components as necessary.

ENGINE REPLACEMENT**Removal Procedure**

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .
2. Recover the refrigerant from the air conditioning system. Refer to **Refrigerant Recovery and Recharging** .
3. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .
4. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
5. Disconnect the fuel feed pipe quick connect fitting at the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
6. Remove the fuel feed pipe clip from the fuel line bracket.
7. Remove the transaxle shift cable clip from the fuel line bracket.

8. Remove the battery tray. Refer to **Battery Tray Replacement**.
9. Remove the vacuum brake booster hose from the intake manifold.
10. Disconnect all necessary electrical connectors to remove engine from vehicle.
11. Remove the coolant recovery inlet pipe clip from the fuel rail.
12. Disconnect the coolant recovery inlet hose from the engine.
13. Disconnect the radiator inlet hose from the engine. Refer to **Radiator Inlet Hose Replacement (LHU)**.
14. Disconnect the radiator outlet hose from the engine. Refer to **Radiator Outlet Hose Replacement (LHU)**.

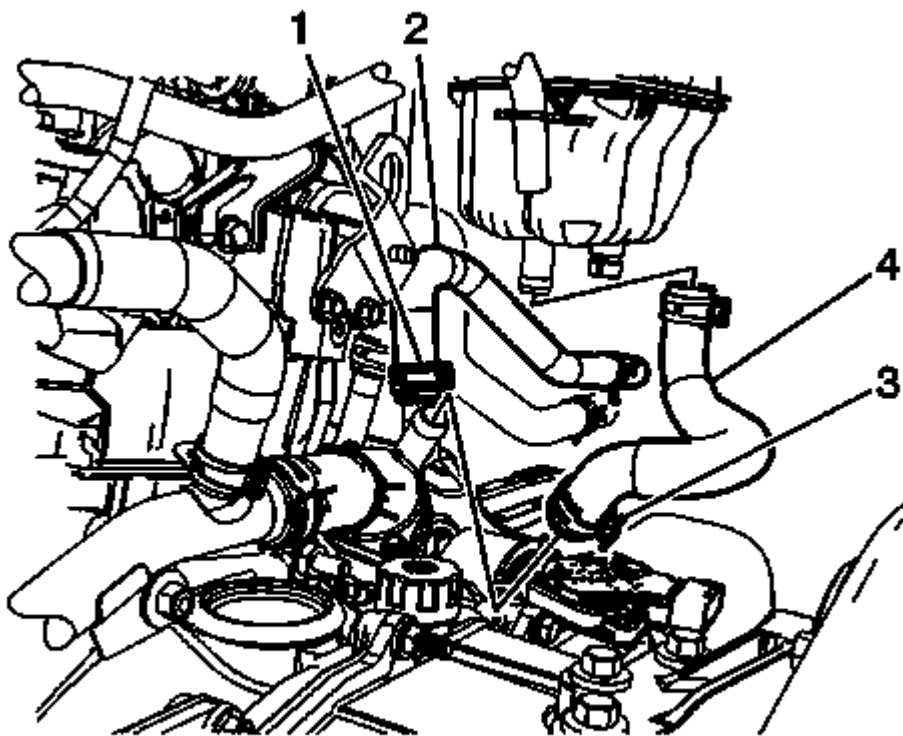


Fig. 158: Inlet Hoses

Courtesy of GENERAL MOTORS COMPANY

15. Remove the heater inlet and outlet hoses from the thermostat housing.
16. Remove the charge air cooler inlet air tube from the engine. Refer to **Charge Air Cooler Inlet Air Tube Replacement**.
17. Remove the charge air cooler outlet air tube from the engine. Refer to **Charge Air Cooler Outlet Pipe Replacement**.
18. Remove the coolant recovery reservoir/heater inlet hose (4) from the thermostat housing.
19. Disconnect the transmission fluid cooler hose. Refer to **Transmission Fluid Cooler Hose Replacement**.

20. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
21. Using spray paint, mark the location of the frame to body for correct alignment during installation.
22. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
23. Disconnect the engine wiring harness electrical connector from the air conditioning (A/C) compressor.
24. Remove the positive battery cable from the starter motor.
25. Disconnect the generator electrical connectors.
26. Lower the vehicle.
27. Remove the transaxle shift cable from the range select lever.
28. Release the shift control cable retaining clip and remove the cable from the shift control cable bracket.

NOTE: **The radiator/condenser/fan assembly will stay in the vehicle during engine removal.**

29. Using long tie straps, secure the radiator/condenser/fan assembly to the radiator support.
30. Raise the vehicle.
31. Remove the front wheels and tires. Refer to **Tire and Wheel Removal and Installation** .
32. Drain the transaxle fluid.
33. Remove the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LHU)** , **Exhaust Front Pipe Replacement (LDK or LHU)**

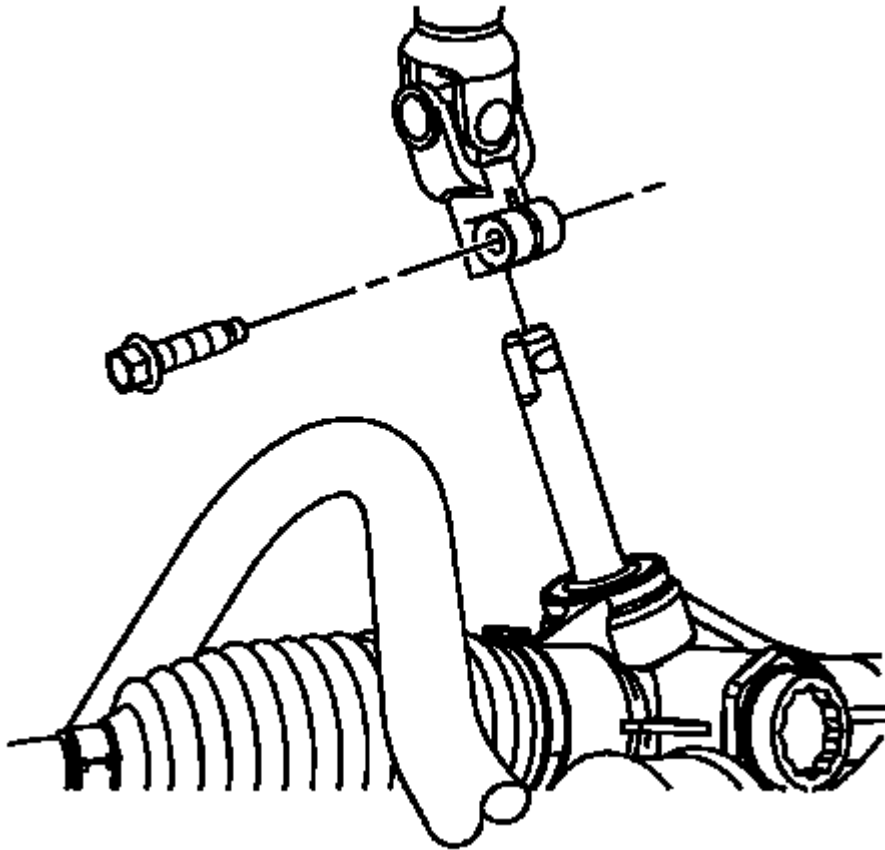


Fig. 159: View Of Intermediate Shaft To Steering Gear Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Secure the steering wheel in the straight forward position before separating the intermediate shaft from the steering gear, or damage to the SIR coil will occur.

34. Remove the intermediate to steering gear pinch bolt and disconnect the intermediate shaft from the steering gear. Discard the pinch bolt.
35. Remove the left and right wheel drive shafts. Refer to Front Wheel Drive Shaft Replacement - Left Side (GNA) , and Front Wheel Drive Shaft Replacement - Right Side (GNA) .
36. Lower the vehicle.

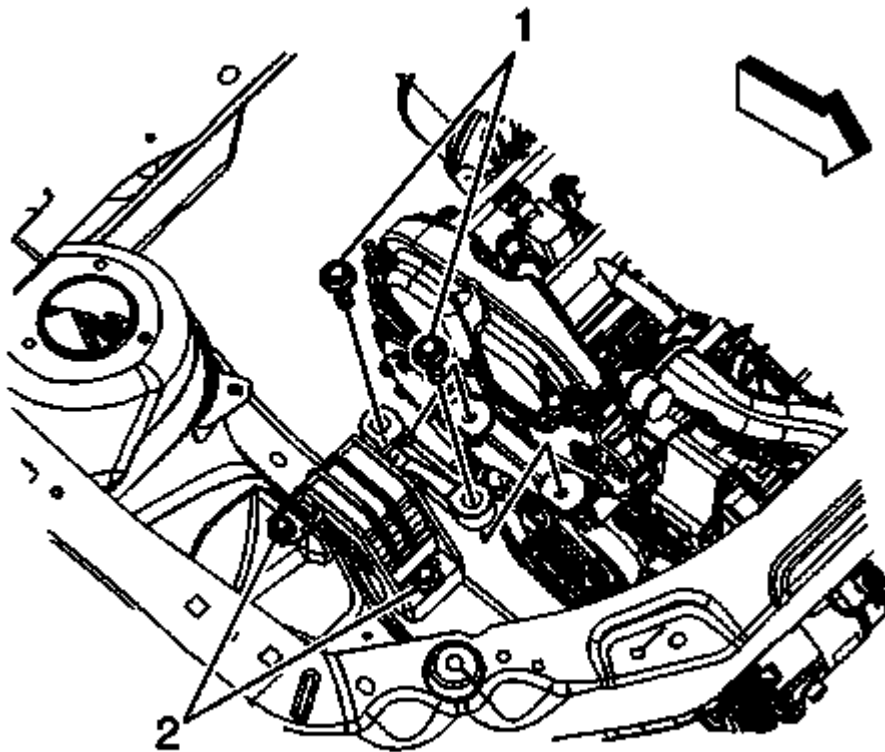


Fig. 160: Engine Mount To Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

37. Remove the engine mount to bracket bolts (1).

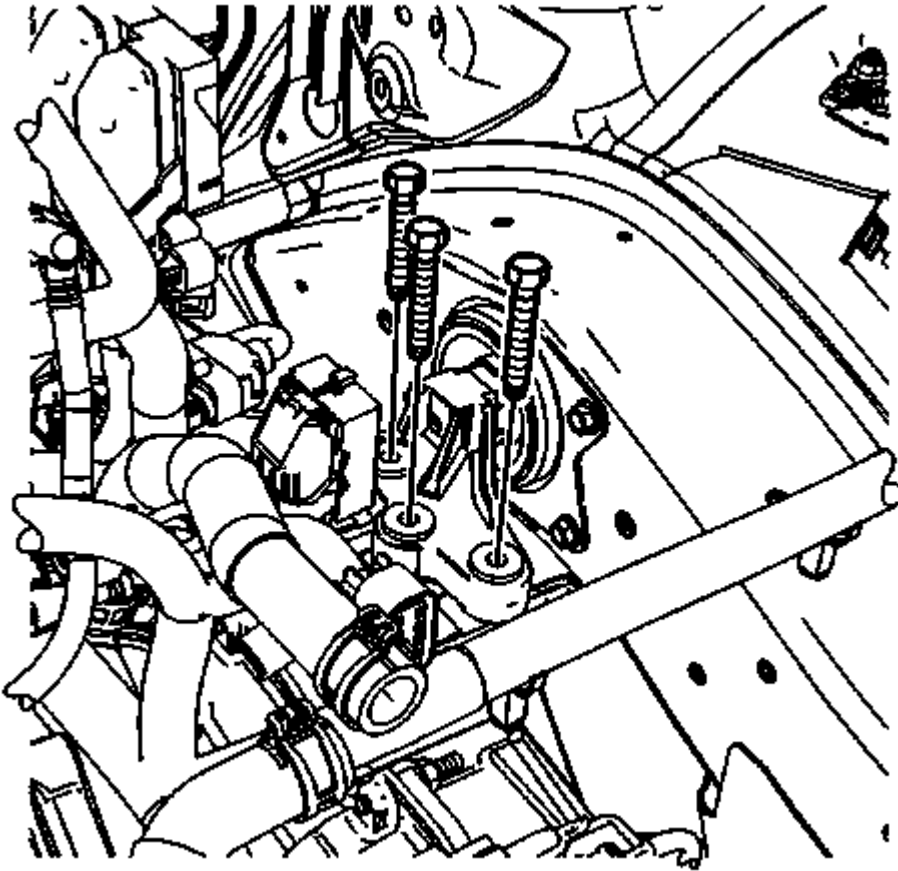


Fig. 161: Transaxle Mount To Transaxle Bolts
Courtesy of GENERAL MOTORS COMPANY

38. Remove the transaxle mount to transaxle bolts.
39. Raise the vehicle.

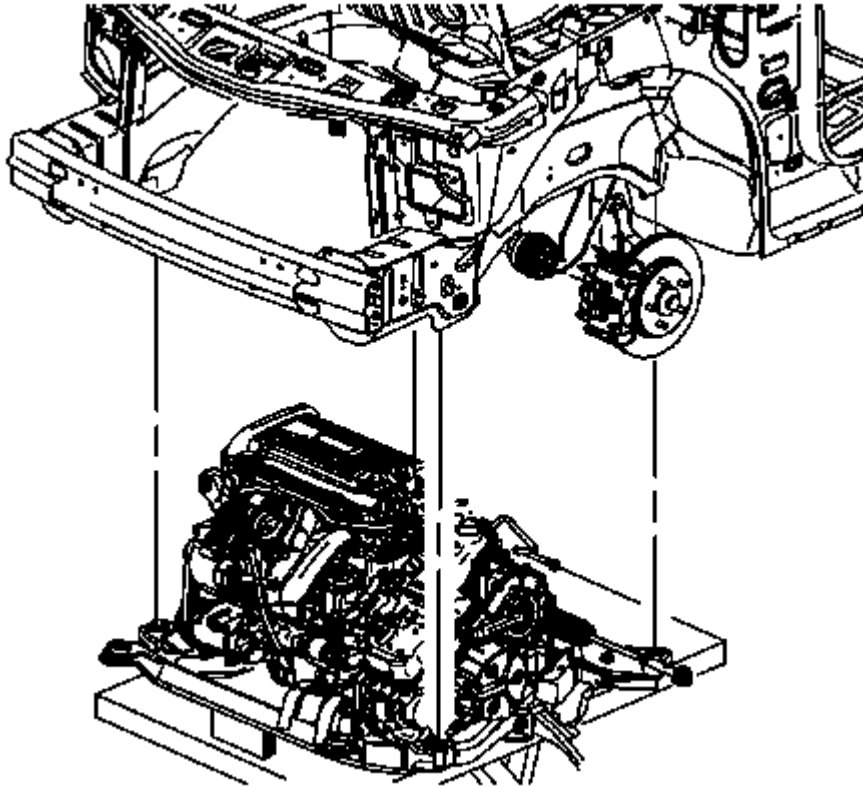


Fig. 162: Positioning Powertrain Assembly
Courtesy of GENERAL MOTORS COMPANY

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

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

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.

41. With the table positioned, fully raise the table to contact the powertrain assembly.
42. Remove the frame to body bolts. Discard the bolts.

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

43. Lower the engine table and raise the body on the hoist until the engine/transaxle and frame are free from the vehicle.
44. Disconnect the engine wiring harness electrical connectors as necessary.

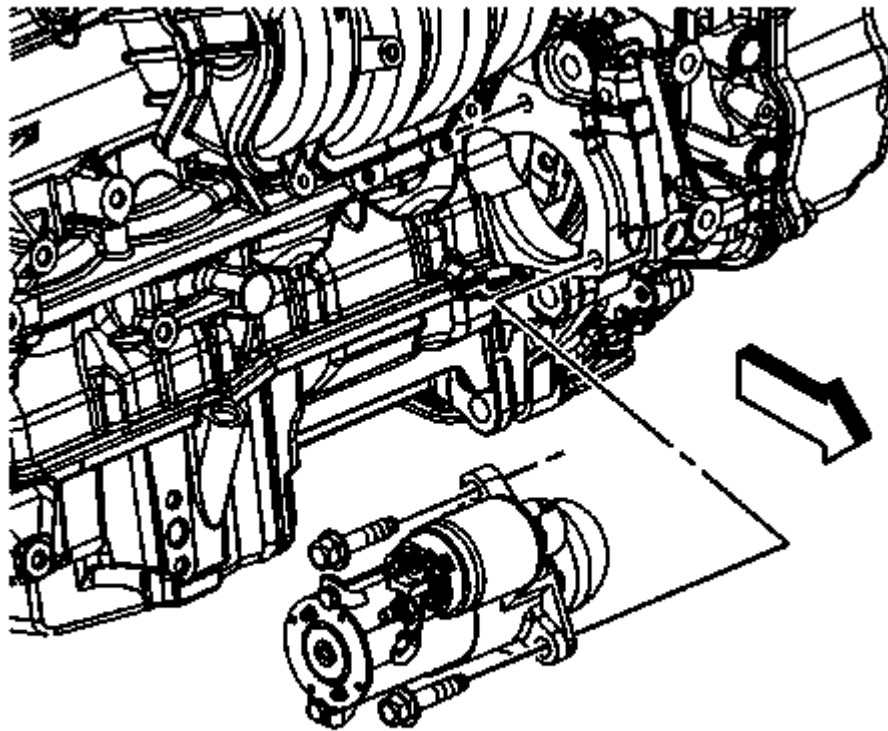


Fig. 163: Identifying Starter Motor Bolts & Starter
Courtesy of GENERAL MOTORS COMPANY

45. Remove the starter motor bolts and starter.

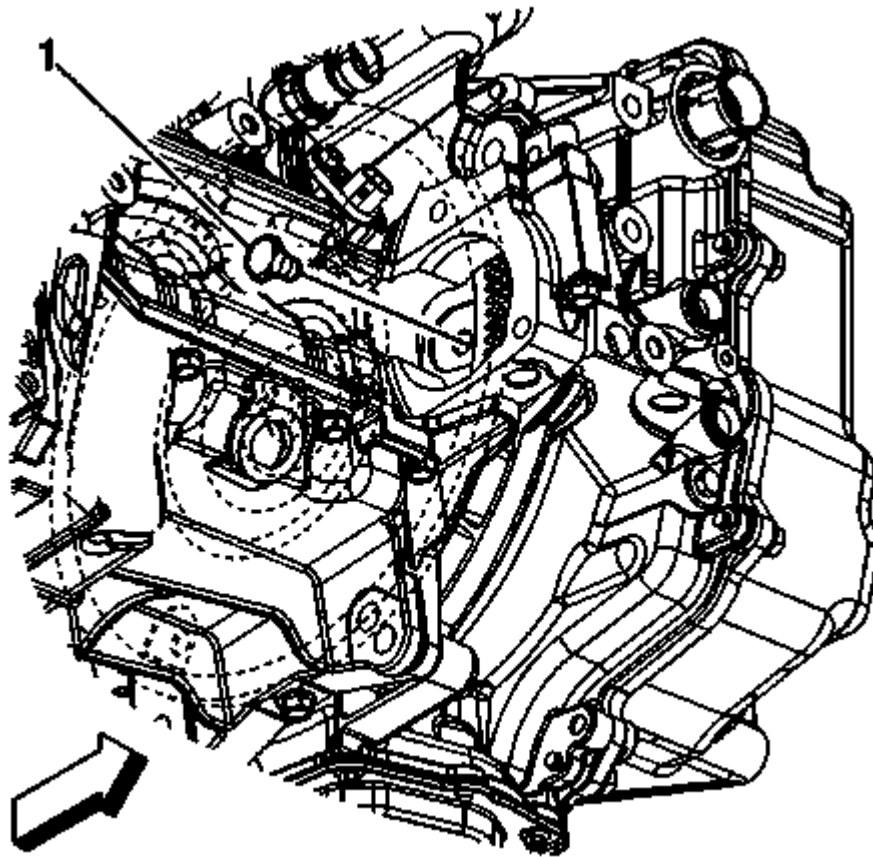


Fig. 164: Torque Converter Flexplate Bolts
Courtesy of GENERAL MOTORS COMPANY

46. Remove the torque converter to flexplate bolts (1).
47. Install a suitable lifting device to the engine.

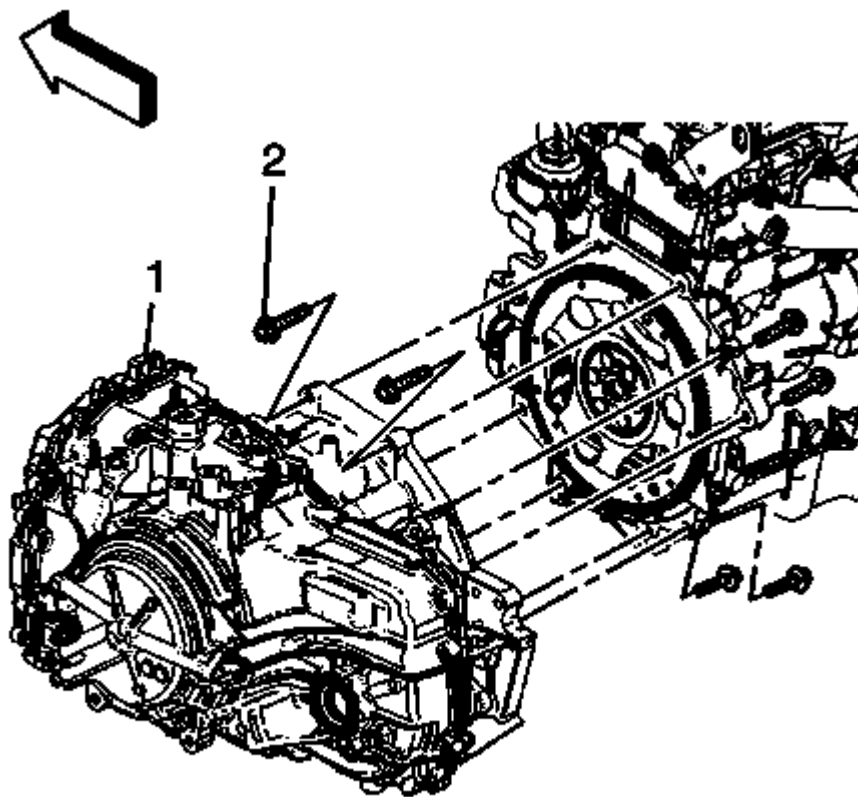


Fig. 165: Transaxle And Transaxle Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

48. Remove the transaxle bolts (2) from the engine.
49. Separate the engine from the transaxle (1).
50. Install the engine to a suitable engine stand.

Installation Procedure

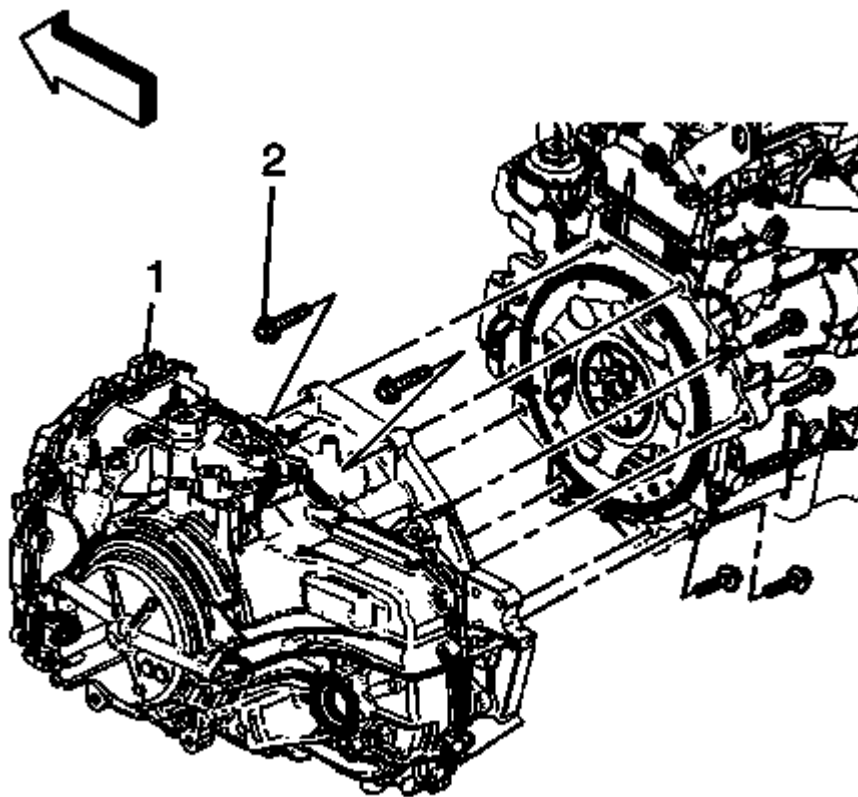


Fig. 166: Transaxle And Transaxle Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install a suitable lifting device to the engine.
2. Using the lifting device, position and install the engine to the transaxle (1).

CAUTION: Refer to Fastener Caution .

3. Install the transaxle bolts (2) to the engine and tighten to 75 N.m (55 lb ft).

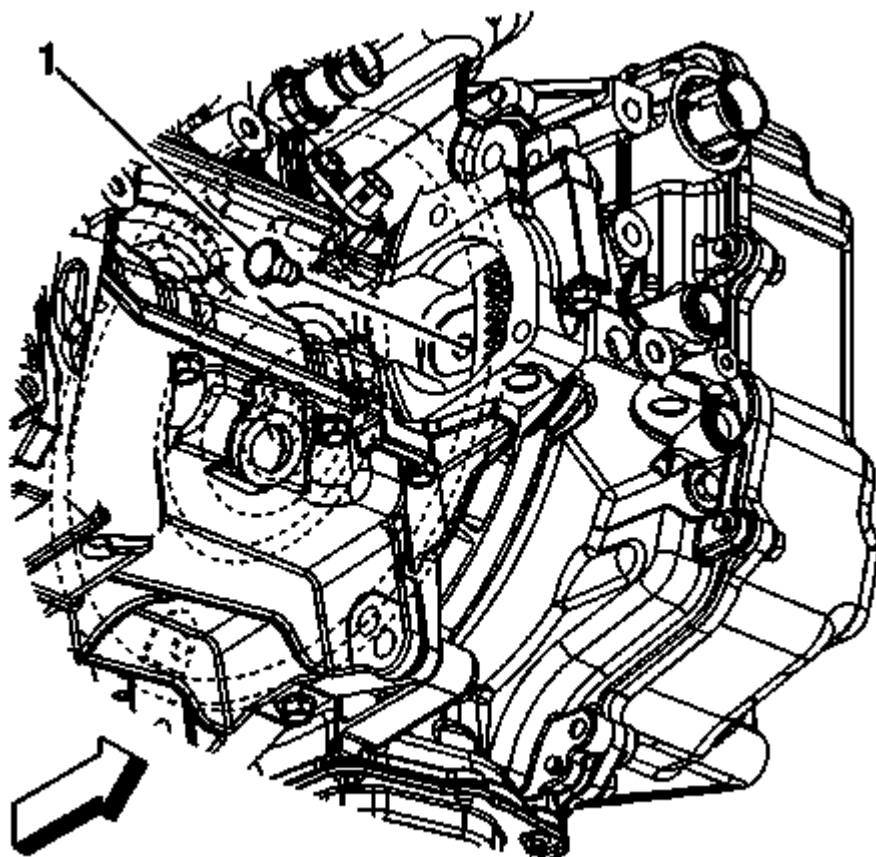


Fig. 167: Torque Converter Flexplate Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the torque converter to flexplate bolts (1) and tighten to 60 N.m (44 lb ft).
5. Remove the engine lifting device.

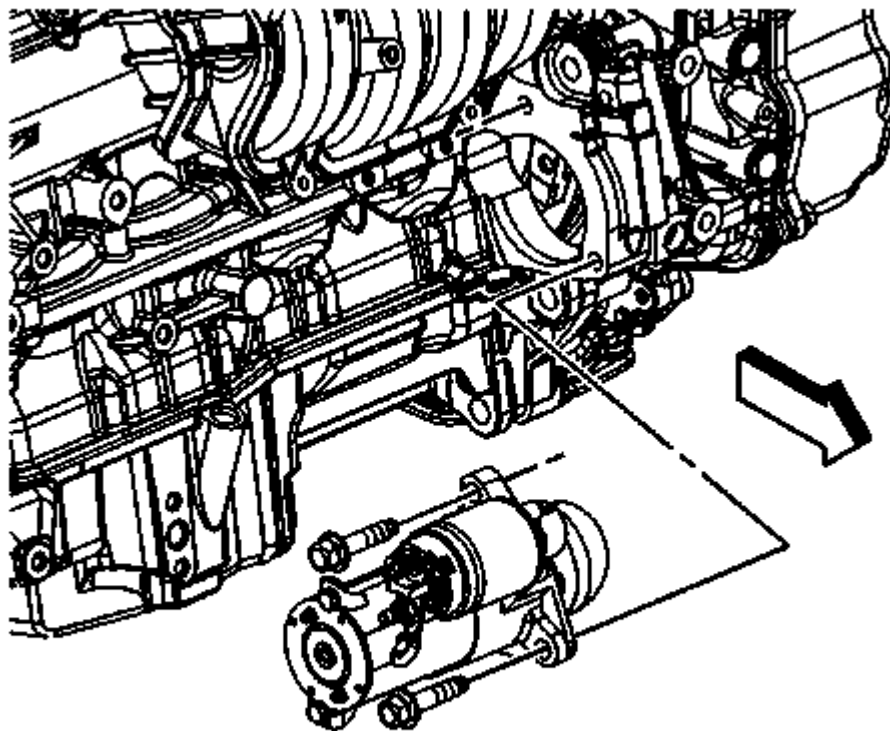


Fig. 168: Identifying Starter Motor Bolts & Starter
Courtesy of GENERAL MOTORS COMPANY

6. Install the starter motor and bolts and tighten to 53 N.m (39 lb ft).

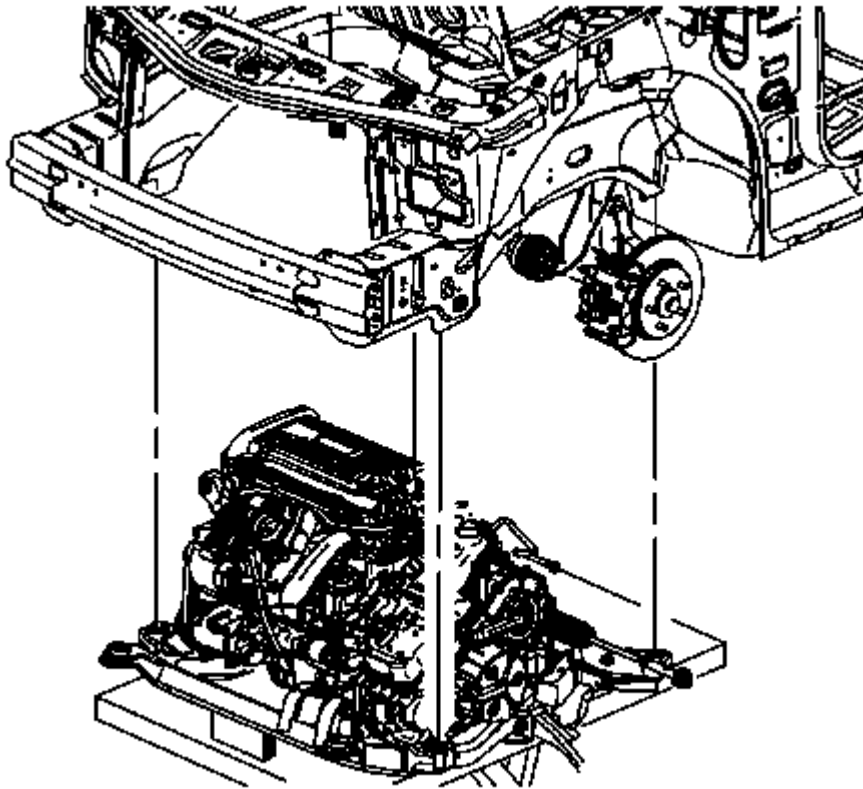


Fig. 169: Positioning Powertrain Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Position the powertrain and support table under the vehicle.
8. Raise the powertrain into position under the vehicle.
9. With the table positioned, if required, lower the vehicle over the powertrain.
10. Align the lower radiator pins with the frame. Ensure all hoses and electrical harnesses are correctly routed and free from the loading path of the powertrain.
11. Install the NEW frame to body bolts and tighten to 155 N.m (114 lb ft).
12. Lower the vehicle.

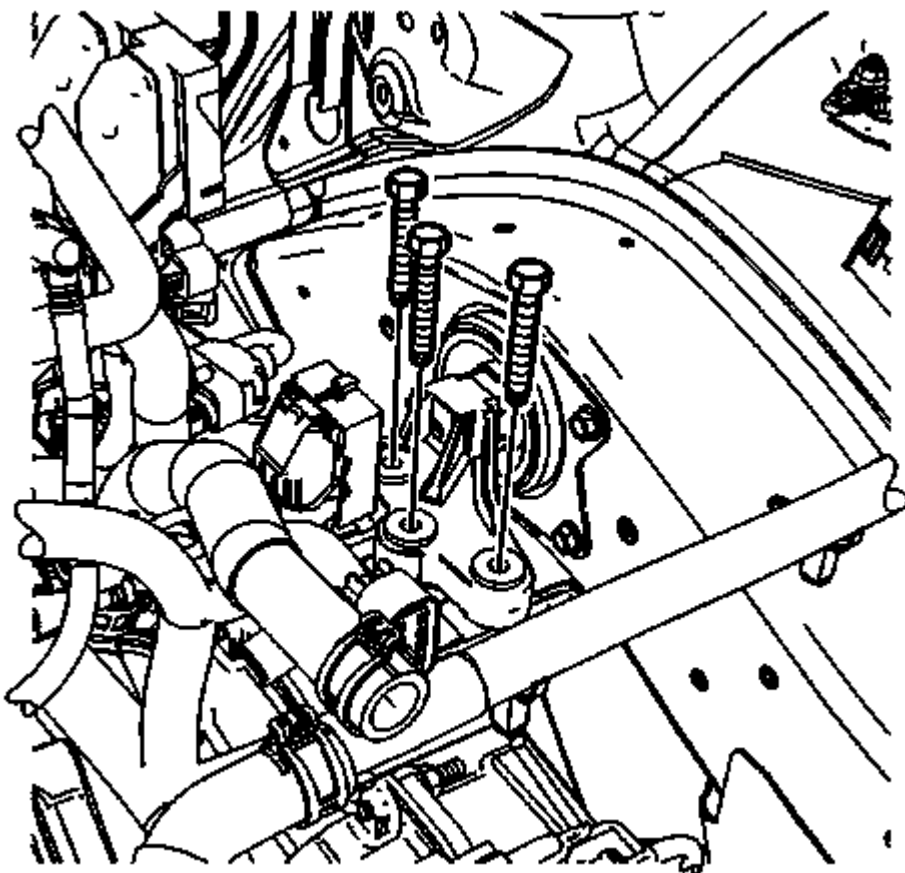


Fig. 170: Transaxle Mount To Transaxle Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Install the transaxle mount to transaxle bolts and tighten to 55 N.m (41 lb ft).

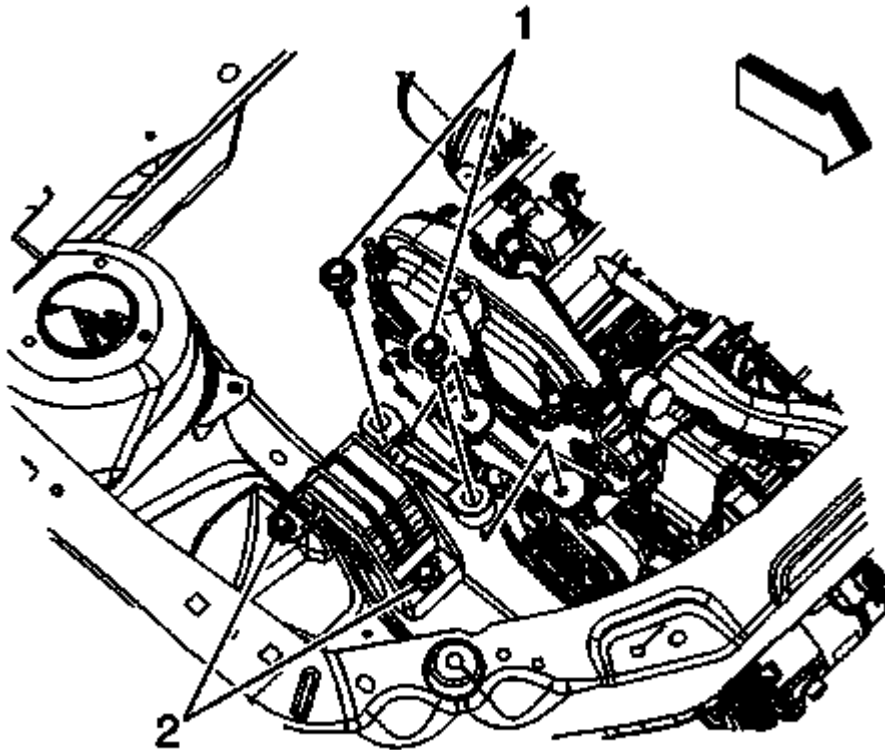


Fig. 171: Engine Mount To Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: The engine mount to bracket bolts must be hand started. Do not pry the engine mount to align the holes.

14. Install the engine mount to bracket bolts (1) and tighten to 50 N.m (37 lb ft).
15. Raise and support the vehicle.
16. Install the left and right wheel drive shafts. Refer to **Front Wheel Drive Shaft Replacement - Left Side (GNA)** , and **Front Wheel Drive Shaft Replacement - Right Side (GNA)** .

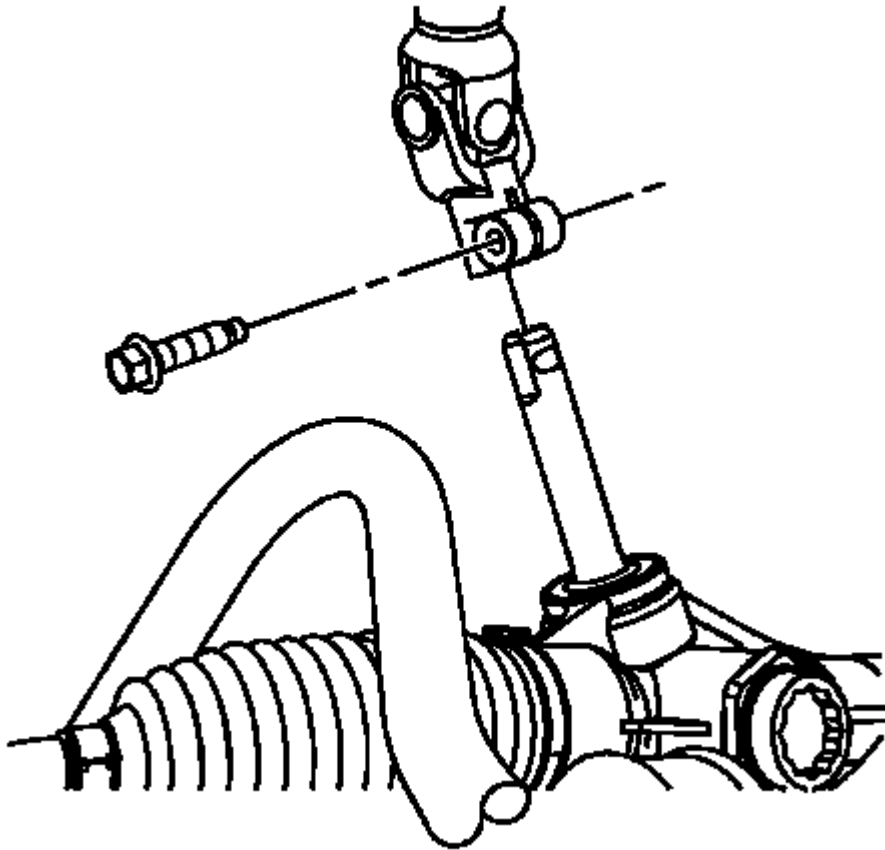


Fig. 172: View Of Intermediate Shaft To Steering Gear Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

17. Position the intermediate shaft to the steering gear and install a NEW pinch bolt and tighten to 34 N.m (25 lb ft).
18. Install the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LHU)** , **Exhaust Front Pipe Replacement (LDK or LHU)**
19. Install the front wheels and tires. Refer to **Tire and Wheel Removal and Installation** .
20. Lower the vehicle.

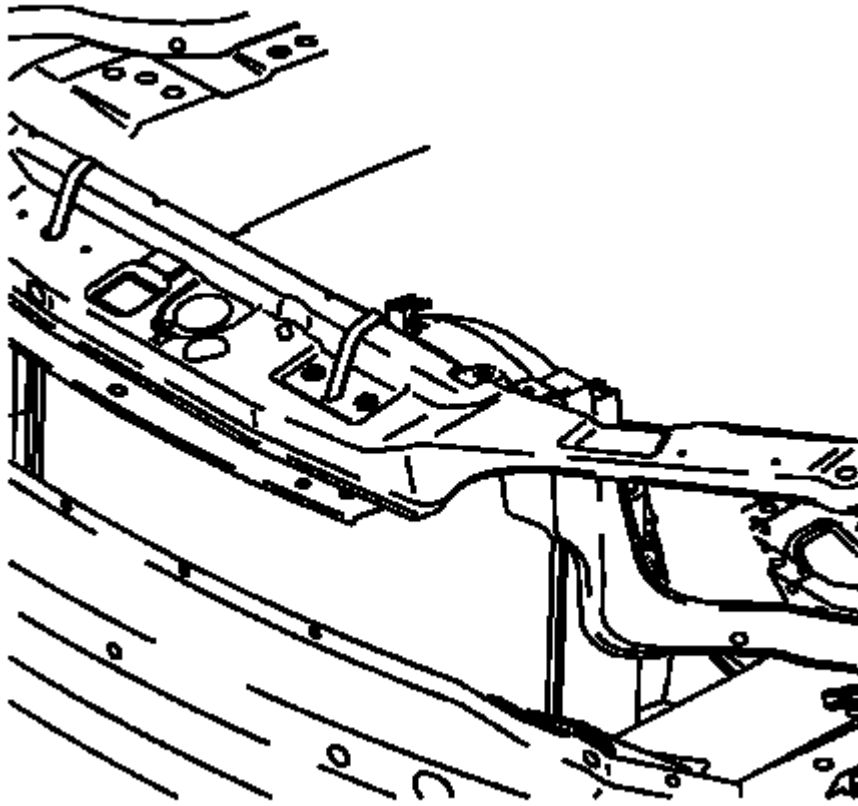


Fig. 173: View Of Cooling Module Secured To Upper Body Structure
Courtesy of GENERAL MOTORS COMPANY

21. Unsecure and position the radiator/condenser/fan assembly.
22. Install the charge air cooler inlet air tube to the engine and the air charge cooler. Refer to **Charge Air Cooler Inlet Air Tube Replacement** .
23. Install the charge air cooler outlet air tube to the engine and the air charge cooler. Refer to **Charge Air Cooler Outlet Pipe Replacement** .

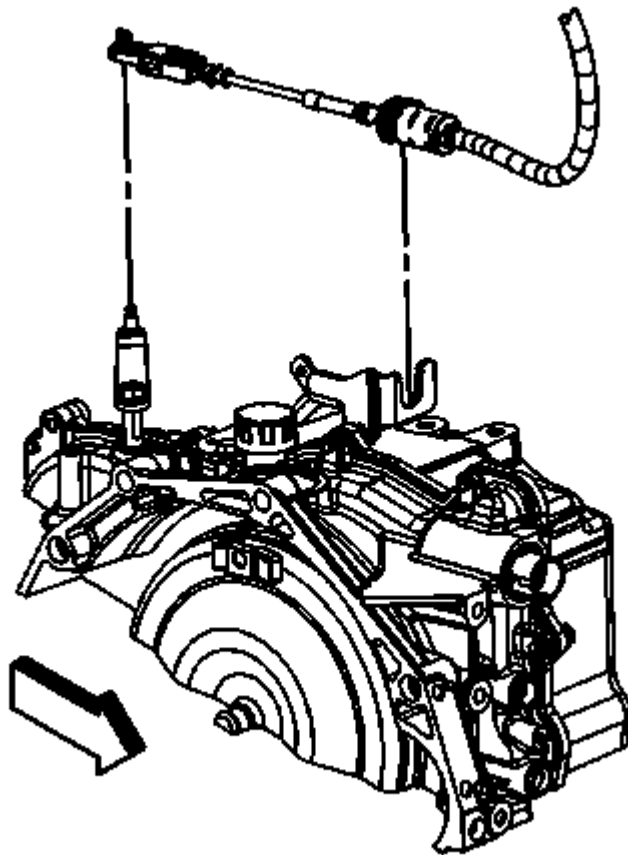


Fig. 174: Transaxle Shift Cable And Range Select Lever
Courtesy of GENERAL MOTORS COMPANY

24. Install the shift control cable to the shift control cable bracket and engage the shift control cable retaining clip.
25. Install the transaxle shift cable to the range select lever.
26. Raise and support the vehicle.
27. Connect the generator electrical connectors.
28. Install the positive battery cable to the starter motor, tighten to 9 N.m (80 lb in)

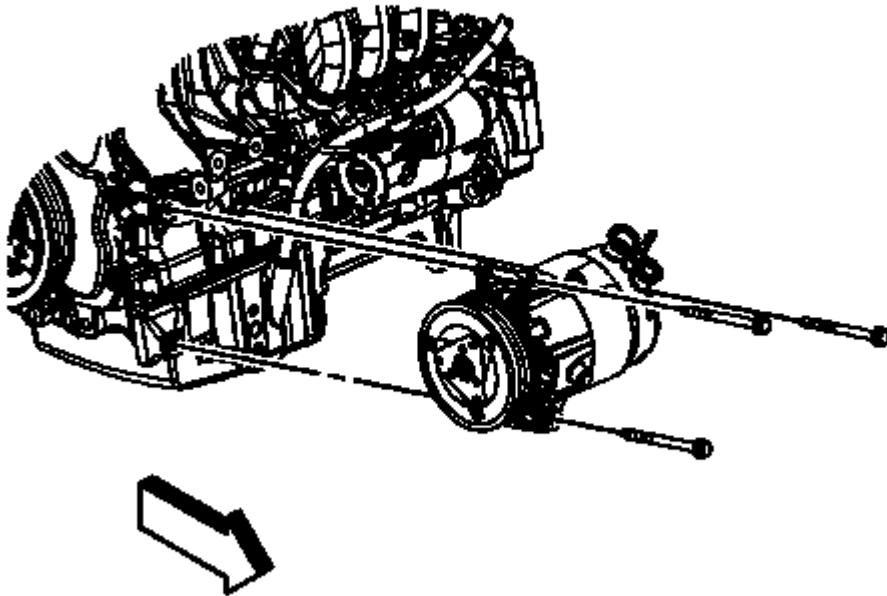


Fig. 175: Compressor Bolts

Courtesy of GENERAL MOTORS COMPANY

29. Position the A/C compressor and install the bolts and tighten to 50 N.m (37 lb ft).
30. Connect the engine wiring harness electrical connector to the A/C compressor.
31. Lower the vehicle.
32. Connect the engine wiring harness electrical connectors as necessary.
33. Install the coolant recovery reservoir/heater inlet hose to the thermostat housing.
34. Connect the radiator inlet hose to the engine. Refer to **Radiator Inlet Hose Replacement (LHU)** .
35. Connect the radiator outlet hose to the engine. Refer to **Radiator Outlet Hose Replacement (LHU)** .
36. Install the heater inlet and outlet hoses to the thermostat housing.
37. Position and install the coolant recovery inlet hose to the cylinder head.
38. Install the coolant recovery inlet pipe clip to the fuel rail.
39. Position and install the vacuum brake booster hose to the intake manifold.
40. Install the battery tray. Refer to **Battery Tray Replacement** .
41. Install the transaxle shift cable clip to the fuel line bracket.
42. connect the transmission fluid cooler hose. Refer to **Transmission Fluid Cooler Hose Replacement**
43. Install the fuel feed pipe clip to the fuel line bracket.

44. Connect the fuel feed pipe quick connect fitting at the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
45. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
46. Fill the transaxle with fluid. Refer to **Transmission Fluid Level and Condition Check** .
47. Refill the engine with oil. Refer to **Engine Oil and Oil Filter Replacement**.
48. Recharge the air conditioning system. Refer to **Refrigerant Recovery and Recharging**
49. Install the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .
50. Perform the CKP system variation learn procedure. Refer to **Crankshaft Position System Variation Learn** .
51. Start the engine and allow the engine to run, inspect for leaks. Correct as necessary.

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

Special Tools

EN-44887 Oil Filter Wrench

For equivalent regional tools, refer to **Special Tools (LDK, LHU)** .

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

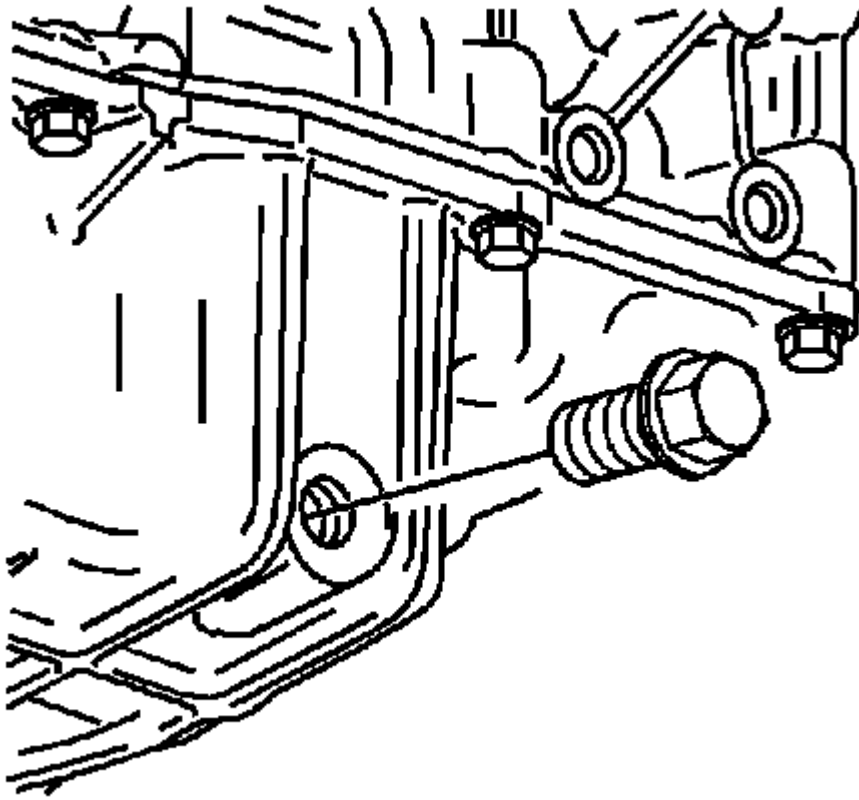


Fig. 176: View Of Oil Pan Drain Bolt
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to **Fastener Caution** .

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

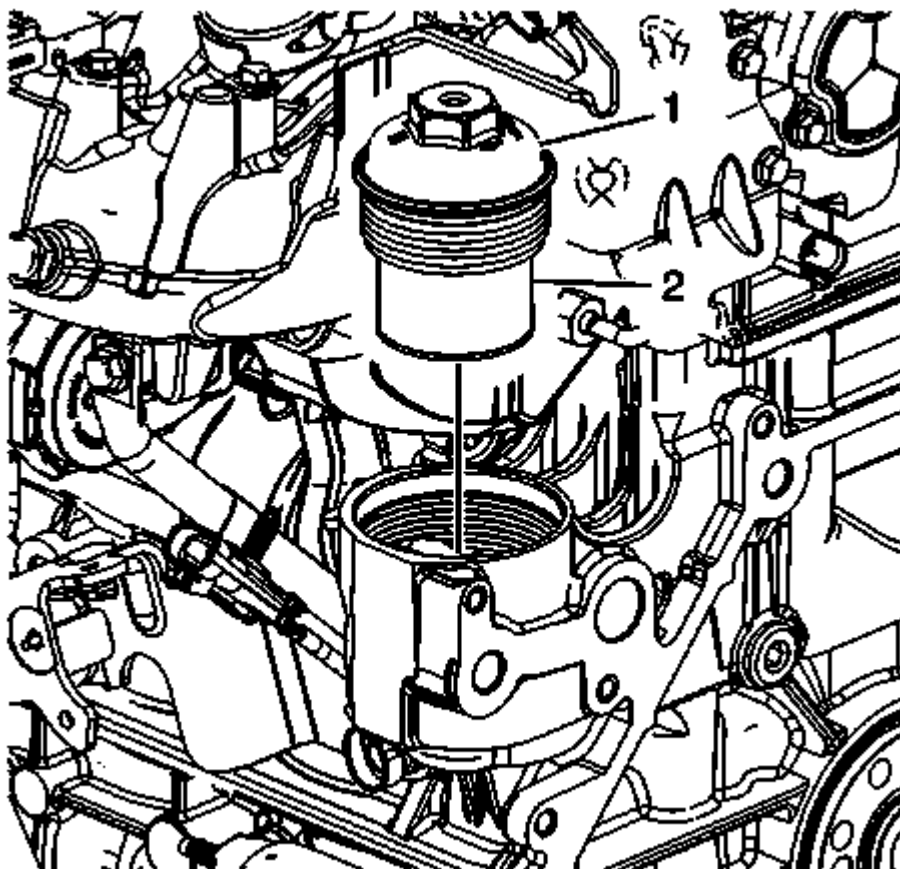


Fig. 177: View of Draining Fluids and Oil Filter
Courtesy of GENERAL MOTORS COMPANY

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

8. Use EN-44887 wrench to remove the oil filter cap (1).
9. Remove the oil filter (2) from the cap and discard.
10. Clean the oil filter housing in the engine block.

Installation Procedure

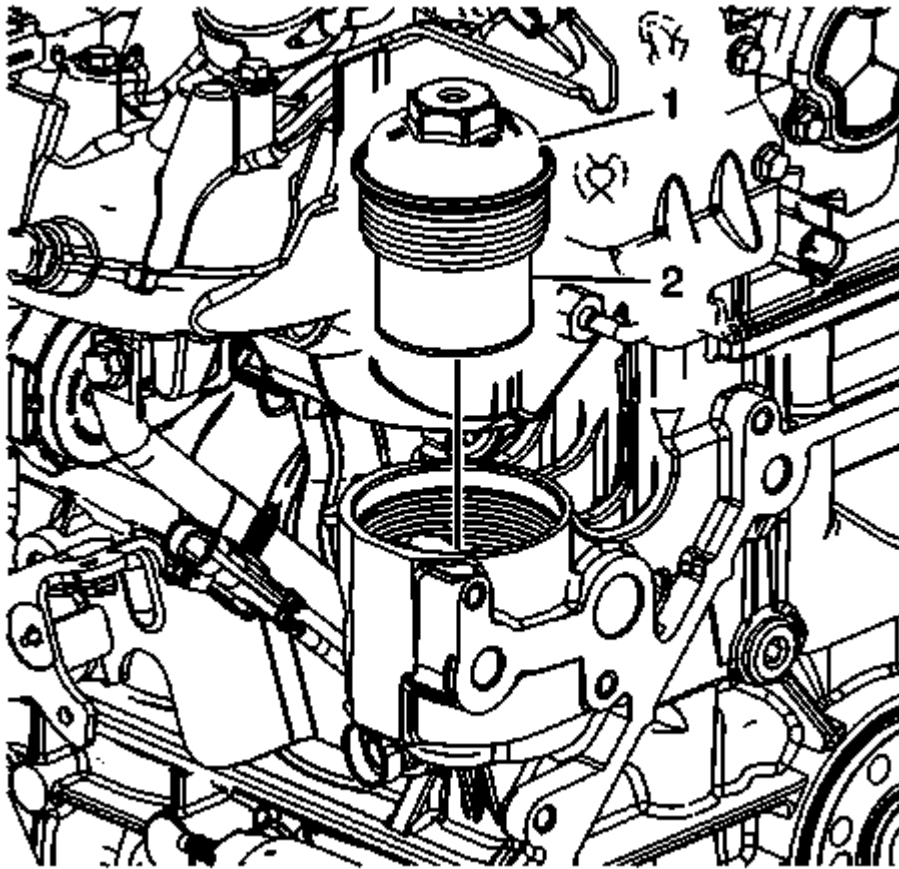


Fig. 178: View of Draining Fluids and Oil Filter
Courtesy of GENERAL MOTORS COMPANY

1. Install a new oil filter (2) on the oil filter cap (1).
2. Lubricate the oil filter cap O-ring with engine oil.

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

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

3. Use the **EN-44887** wrench to install the oil filter and cap. Tighten the oil filter cap until fully seated. DO NOT exceed 22 N.m (16 lb ft).
4. Fill the engine with oil. Refer to **Fluid and Lubricant Recommendations**.
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.