

2011 ENGINE

Engine Mechanical - 1.4L (LUU) - Repair Instructions - On Vehicle - Volt

POWERTRAIN MOUNT BALANCING

WARNING: Do not use a service jack to lift this vehicle. Lifting the vehicle with a jack could cause the vehicle to slip off the jack and roll; this could cause injury or death.

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 .
2. Loosen the rear transaxle mount to transaxle bracket through bolt until it is finger tight.
3. Lower the vehicle.
4. Install the engine support fixture. Refer to Engine Support Fixture.

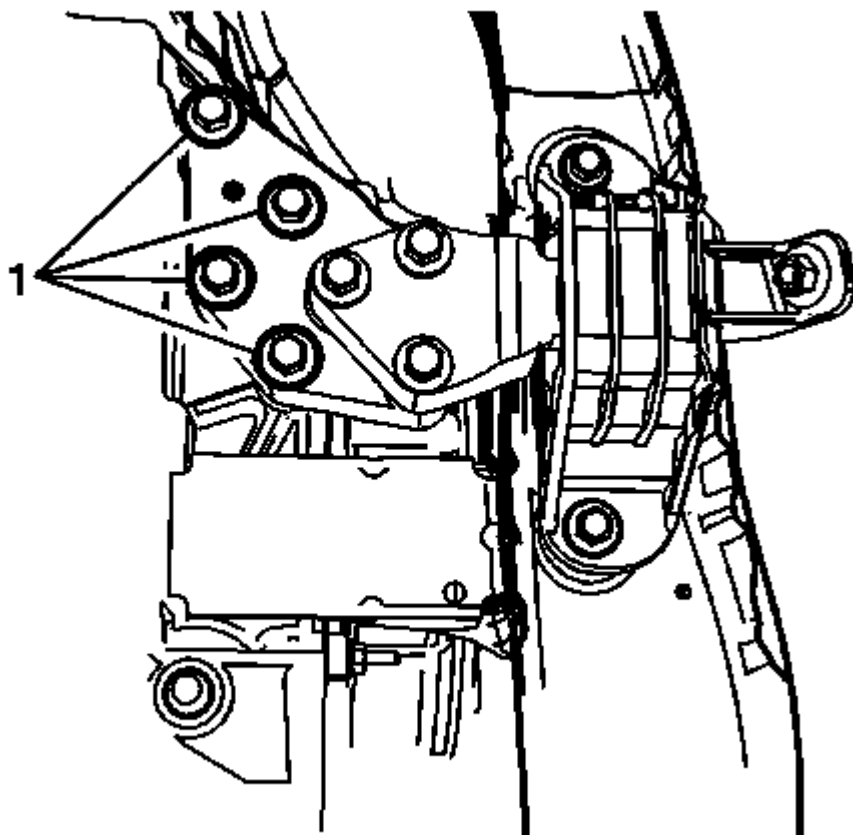


Fig. 1: Transaxle Bolts
Courtesy of GENERAL MOTORS CORP.

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

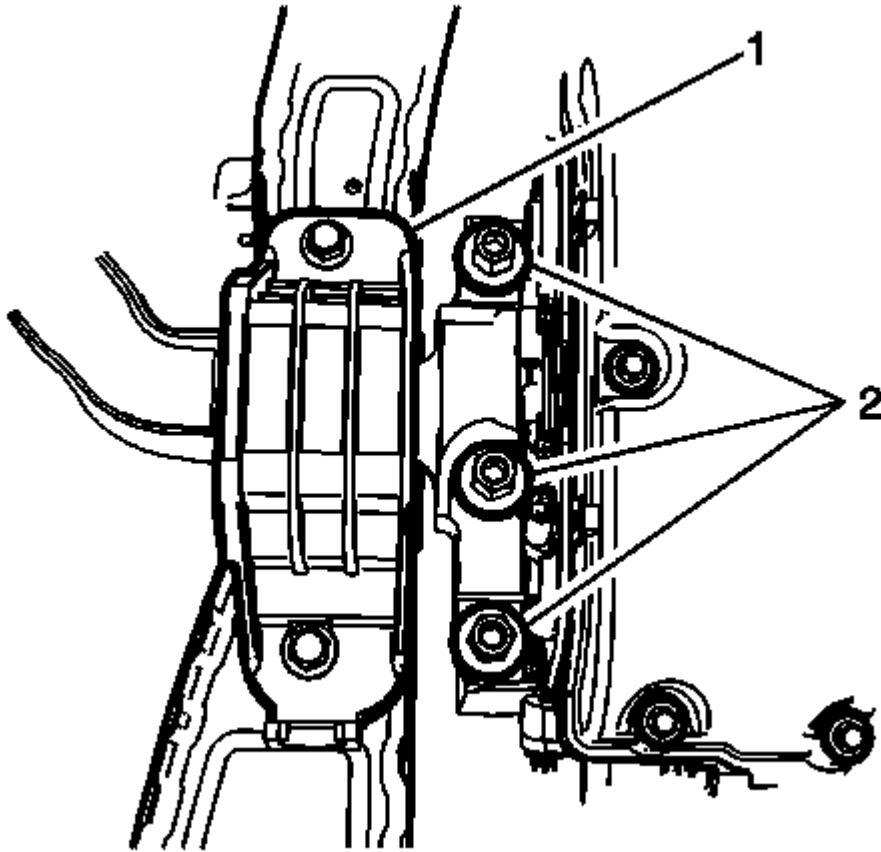


Fig. 2: Engine Mount And Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

6. Loosen the engine mount (1) to bracket bolts (2).
7. Raise the engine and transmission 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.
8. 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.
9. Tighten the right hand (engine side) mount bolts, starting with the bolt nearest to the center of the mount. See the appropriate engine mount replacement procedure for the fastener tightening specifications.

WARNING: Do not use a service jack to lift this vehicle. Lifting the vehicle with a jack could cause the vehicle to slip off the jack and roll; this could cause injury or death.

10. Raise the vehicle.
11. Shake the powertrain from front to rear and allow the powertrain to settle.
12. Tighten the rear transaxle mount through bolt. See the appropriate transmission mount replacement

procedure for the fastener tightening specifications.

13. Lower the vehicle.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

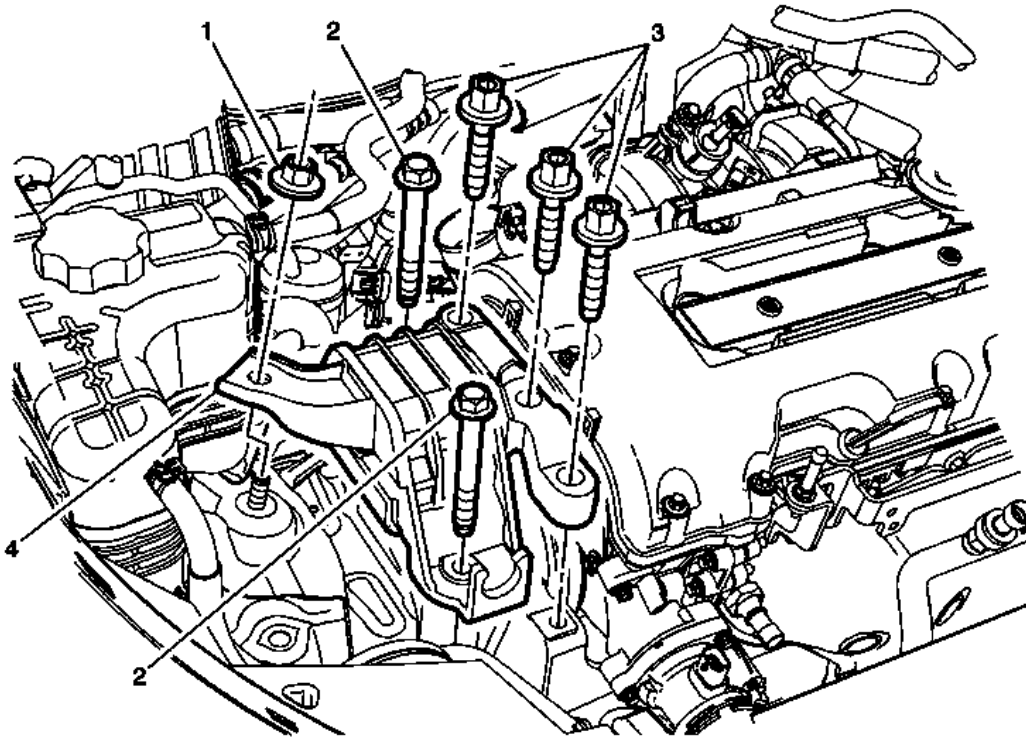


Fig. 3: Engine Mount - Right Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u> . 2. Install engine support fixture. Refer to <u>Engine Support Fixture</u>. 3. Prior to removing the mount, mark the mount location using spray paint or a marker for correct positioning during installation. 4. If all powertrain mounts are replaced, perform the Powertrain Mount Balancing. Refer to <u>Powertrain Mount Balancing</u>.	
1	Engine Mount Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tip: Perform the powertrain mount balancing - lower after installation of the fastener.

	Tighten: 50 N.m (37 lb ft)
2	Engine Mount Fastener (Qty: 2) Tighten: 58 N.m (43 lb ft)
3	Engine Mount Fastener (Qty: 3) Procedure: Ensure the washer is in place before installing the bolt. Tighten: 58 N.m (43 lb ft)
4	Engine Mount Procedure: Transfer components as necessary.

ENGINE MOUNT INSPECTION

1. Install the engine support fixture. Refer to **Engine Support Fixture**.
2. Observe the engine mount while raising the engine. Raising the engine removes the weight from the engine mount and creates slight tension on the rubber.
3. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber is covered with heat check cracks.
 - The rubber is separated from the metal plate of the engine mount.
 - The rubber is split through the center of the engine mount.
4. For engine mount replacement, refer to **Engine Mount Replacement - Right Side**.
5. For rear transmission mount replacement, refer to **Transmission Rear Mount Replacement**.
6. For left transmission mount replacement, refer to **Transmission Mount Replacement - Left Side**.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

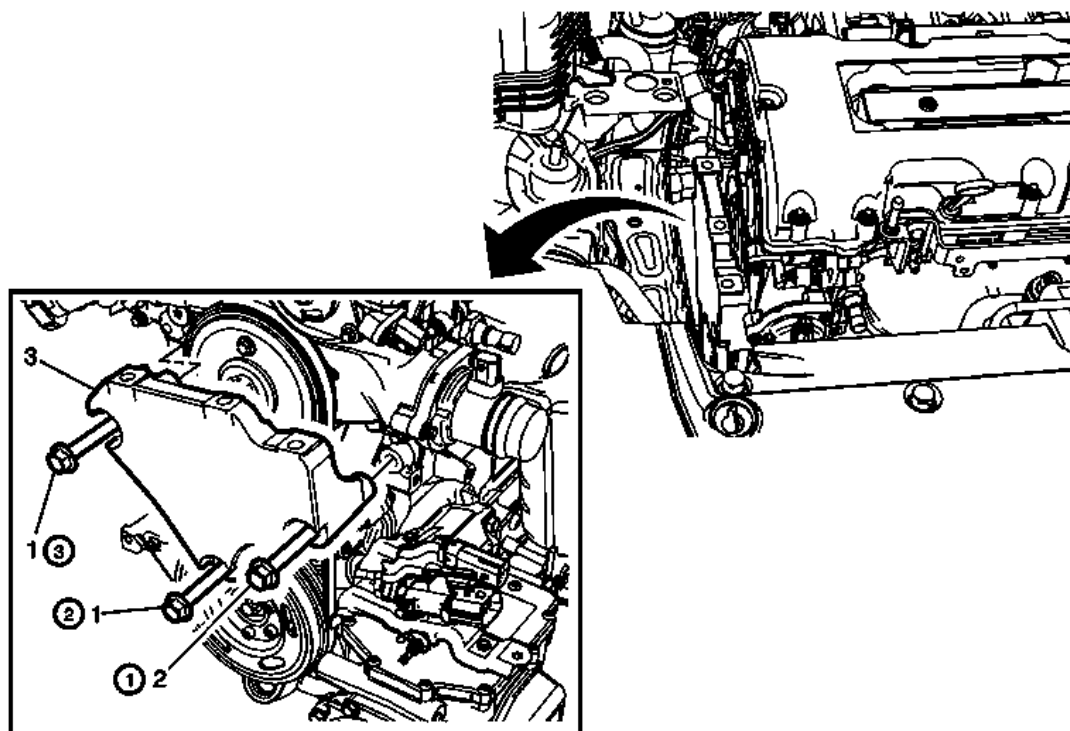


Fig. 4: Engine Mount Bracket - Right Side
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Remove the engine mount. Refer to <u>Engine Mount Replacement - Right Side</u>. 2. Remove the front wheelhouse front liner. Refer to <u>Front Wheelhouse Front Liner Replacement</u>.	
	Engine Mount Bracket Fastener (Qty: 2) CAUTION: This component uses torque-to-yield bolts. When servicing this component do not reuse the bolts, New torque-to-yield bolts must be installed. Reusing used torque-to-yield bolts will not provide proper bolt torque and clamp load. Failure to install NEW torque-to-yield bolts may lead to engine damage.
1	CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. Raise and lower the engine as needed to access the bolts. 2. Ensure to follow the tighten sequence. Tighten:

	1. First pass: 60 N.m (44 lb ft) 2. Final pass: additional 45-60 degrees
2	Engine Mount Bracket Fastener Procedure: Ensure to follow the tighten sequence. Tighten: 1. First pass: 60 N.m (44 lb ft) 2. Final pass: additional 45-60 degrees
3	Engine Mount Bracket Procedure: Transfer components as necessary.

ENGINE SUPPORT FIXTURE

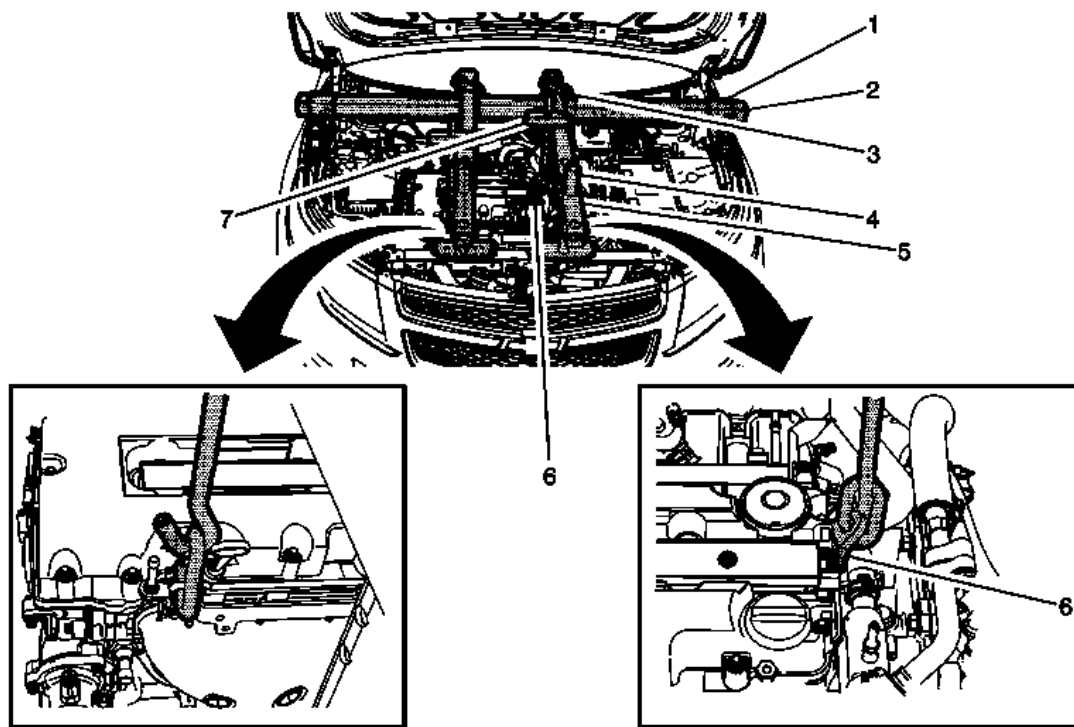


Fig. 5: Engine Support
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	
1.	Remove the front compartment side sight shield. Refer to Front Compartment Side Sight Shield

Replacement .

2. Remove the front compartment front sight shield. Refer to **Front Compartment Front Sight Shield Replacement .**
3. Remove the air cleaner resonator outlet duct. Refer **Air Cleaner Resonator Outlet Duct Replacement .**
4. Remove the heater outlet hose vapor vent hose. Refer to **Heater Outlet Hose Vapor Vent Hose Replacement .**

Special Tools

- **J-43405:** Engine Support Fixture Adapter
- **J-28467-518:** Main Support Beam
- **J-28467-1A:** Cross Bracket
- **J-28467-5A:** Strut Tower Support Assembly
- **J-28467-2A:** Radiator Tube Shelf Assembly
- **J-36857:** Engine Lift Bracket
- **J-28467-8A:** Hook Assembly

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

1	Engine Support Fixture Adapter Leg (Qty: 2) Procedure: Install the bracket to fender frame. Do not install on top of fender lip.
2	Main Support Beam
3	Cross Bracket (Qty: 2)
4	Strut Tower Support Assembly (Qty: 2) Procedure: Adjust the length of the strut tower support assembly.
5	Radiator Tube Shelf Assembly (Qty: 2)
6	Engine Lift Bracket Procedure: Use a grade 10.9 bolt to install the engine lift bracket.
7	Hook Assembly (Qty: 2)

INTAKE MANIFOLD REPLACEMENT**SPECIAL TOOLS**

BO-38185: Hose Clamp Pliers

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

REMOVAL PROCEDURE

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure will perform the following tasks:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Failure to follow the procedures exactly as written may result in serious injury or death.

1. Disable the high voltage system. Refer to **High Voltage Disabling** .
2. Drain the coolant fluid. Refer to **Cooling System Draining and Filling** .
3. Remove the Air Cleaner Outlet Duct. Refer to **Air Cleaner Outlet Duct Replacement** .
4. Remove the fuel injection fuel rail assembly only. Refer to **Fuel Injection Fuel Rail Assembly Replacement**

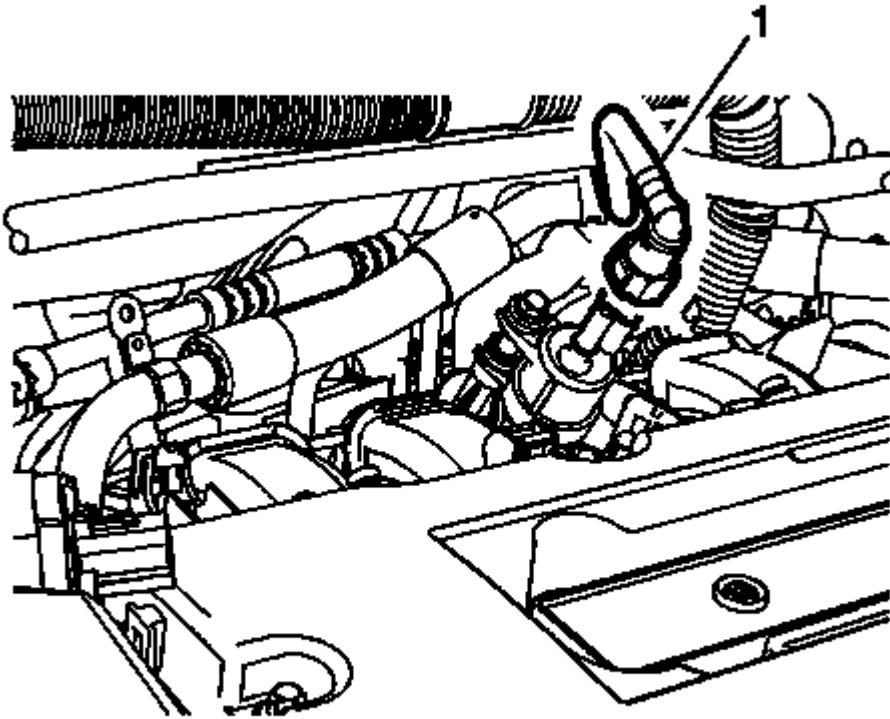


Fig. 6: Evaporative Emission Canister Purge Solenoid Valve Hose
Courtesy of GENERAL MOTORS CORP.

5. Remove the evaporative emission canister purge solenoid valve hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

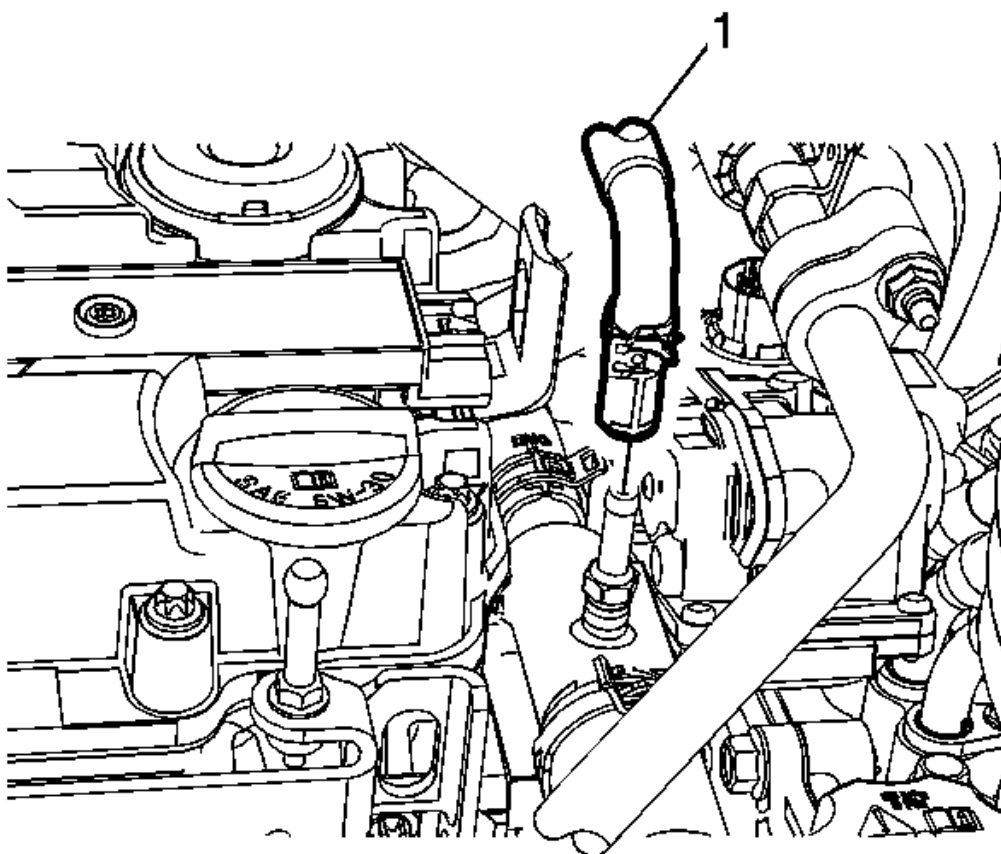


Fig. 7: Heater Outlet Hose Vapor Vent Hose
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the heater outlet hose vapor vent hose (1).
7. Reposition the heater outlet vapor vent hose clamps using **BO-38185: Hose Clamp Pliers**.
8. Reposition the outlet hose to a side.

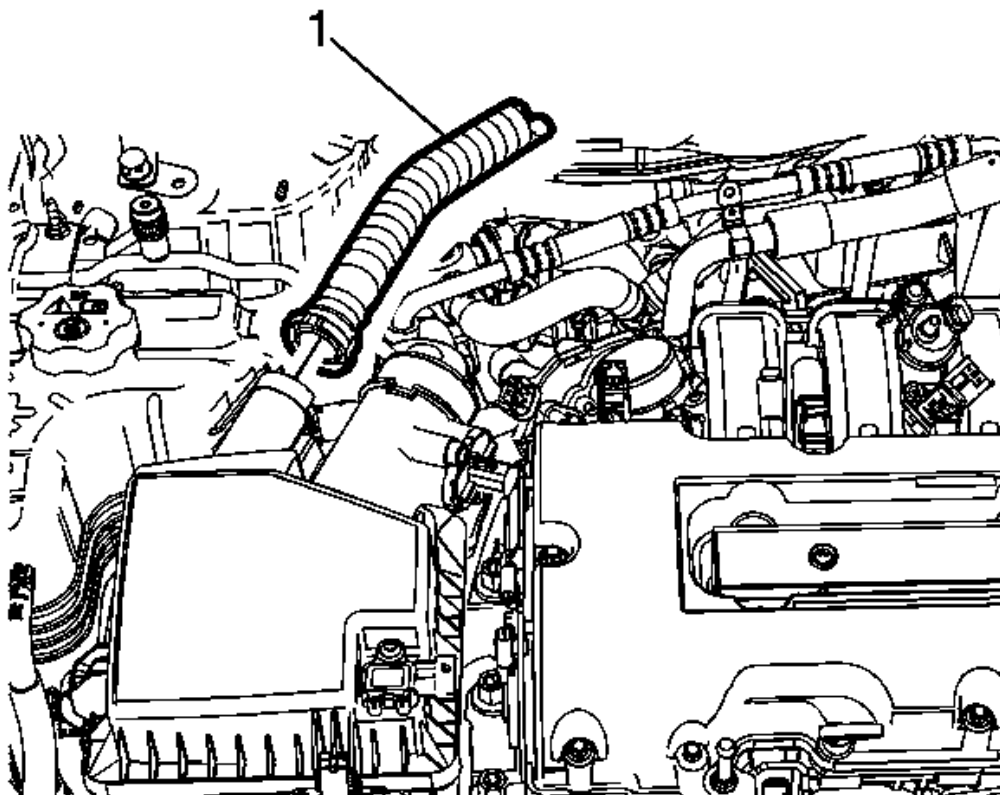


Fig. 8: Secondary Air Pump Hose
Courtesy of GENERAL MOTORS CORP.

9. Disconnect and reposition the secondary air pump hose (1).

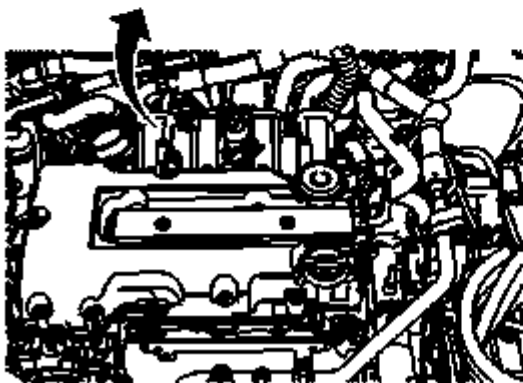
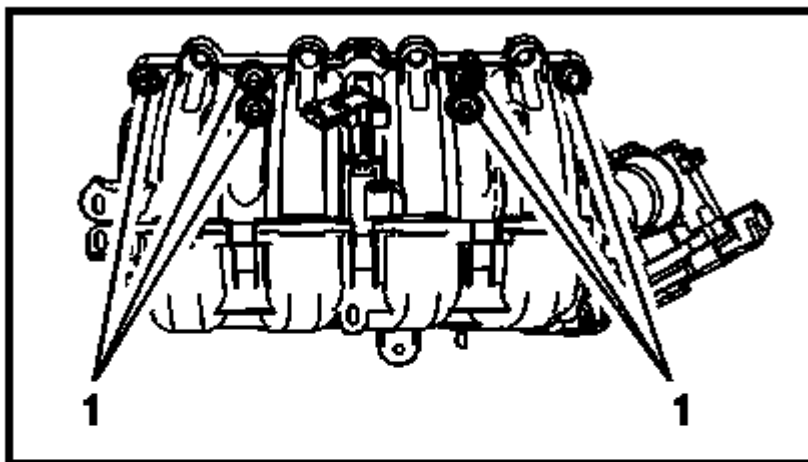


Fig. 9: Intake Manifold Bolts

Courtesy of GENERAL MOTORS CORP.

10. Remove the intake manifold bolts (1).

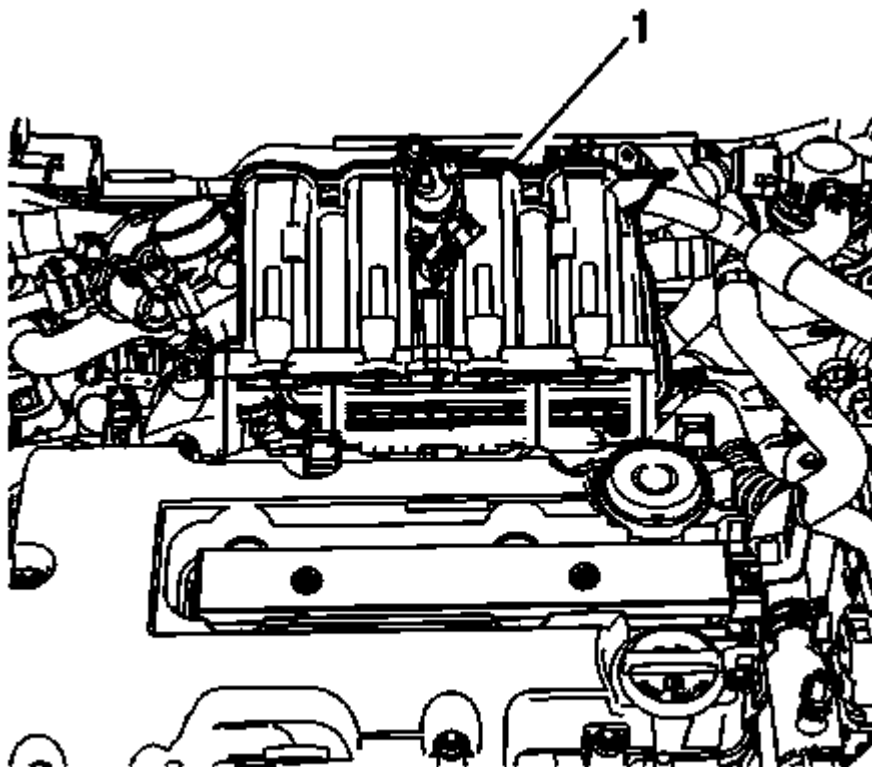


Fig. 10: Intake Manifold

Courtesy of GENERAL MOTORS CORP.

11. Remove the intake manifold from the vehicle (1).
12. Disconnect electrical connectors as necessary.
13. To disassemble the intake manifold. Refer to **Intake Manifold Disassemble**
14. For cleaning and inspection of the intake manifold. Refer to **Intake Manifold Cleaning and Inspection** .
15. Transfer components as necessary.

INSTALLATION PROCEDURE

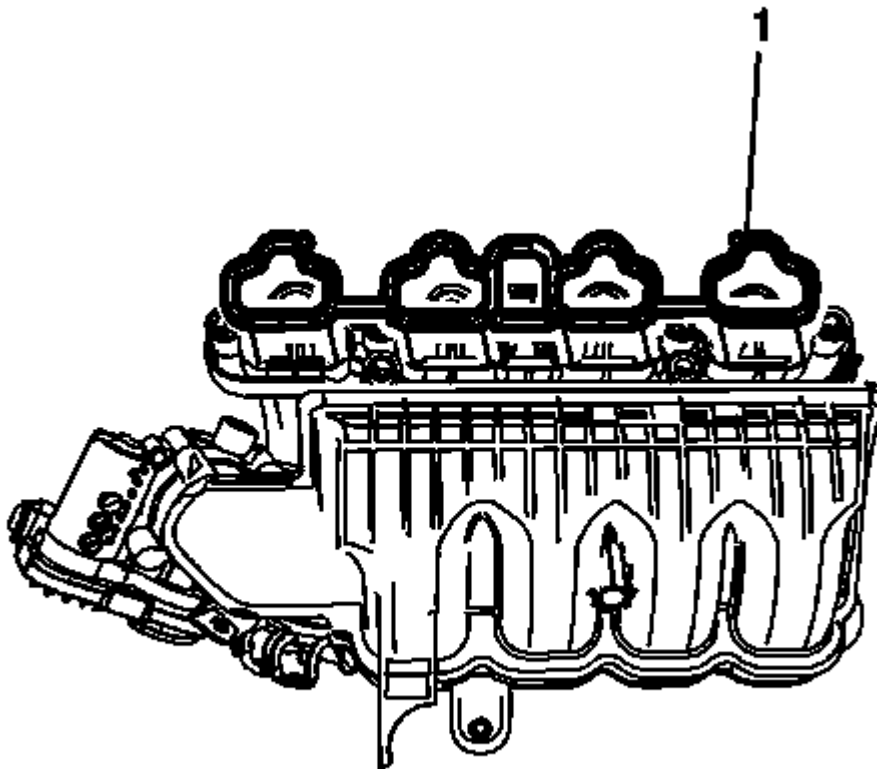


Fig. 11: Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

1. Ensure the surface of the intake manifold is clean before installing the new gasket.
2. Install the manifold gasket (1).

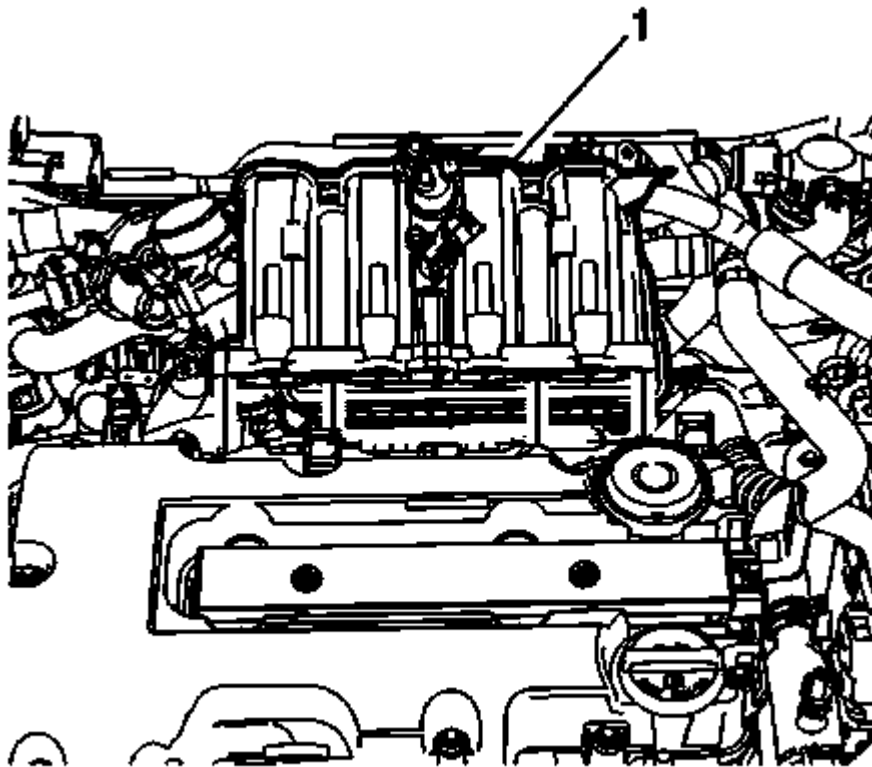


Fig. 12: Intake Manifold

Courtesy of GENERAL MOTORS CORP.

3. Install the intake manifold in the vehicle (1).

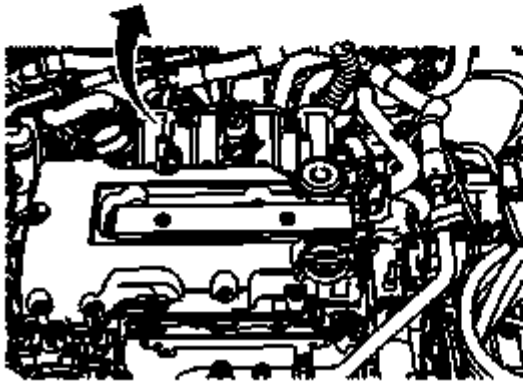
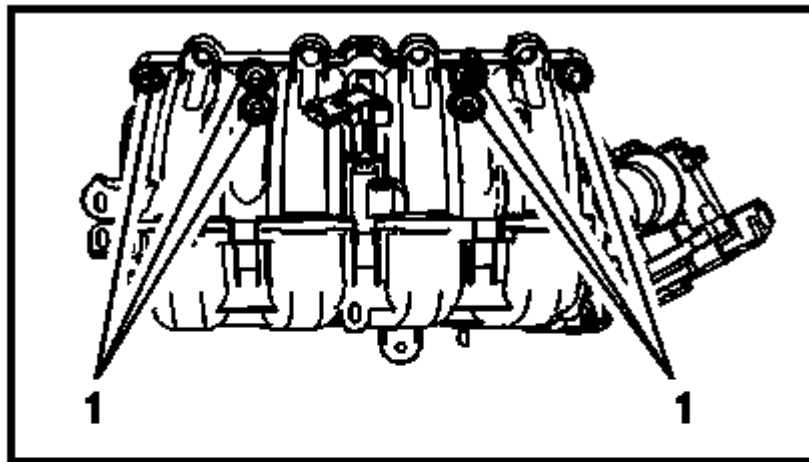


Fig. 13: Intake Manifold Bolts

Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install the intake manifold bolts (1).

Tighten: Tighten the intake manifold bolts 20 N.m (15 lb ft).

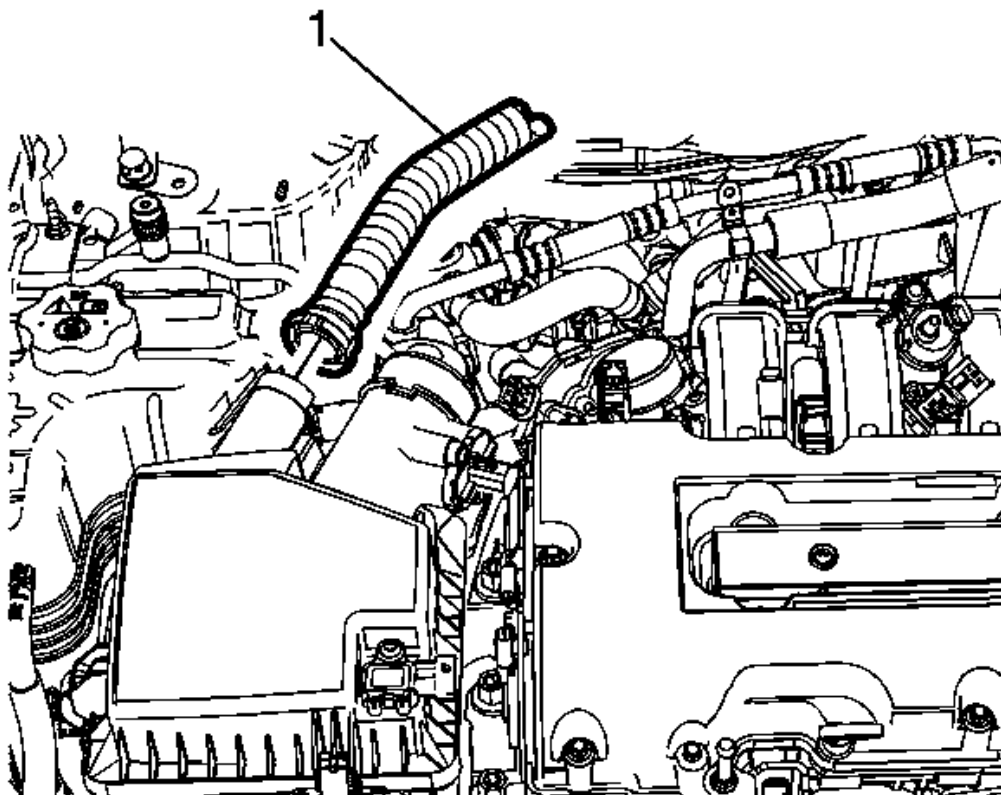


Fig. 14: Secondary Air Pump Hose
Courtesy of GENERAL MOTORS CORP.

5. Connect and reposition the secondary air pump hose (1).

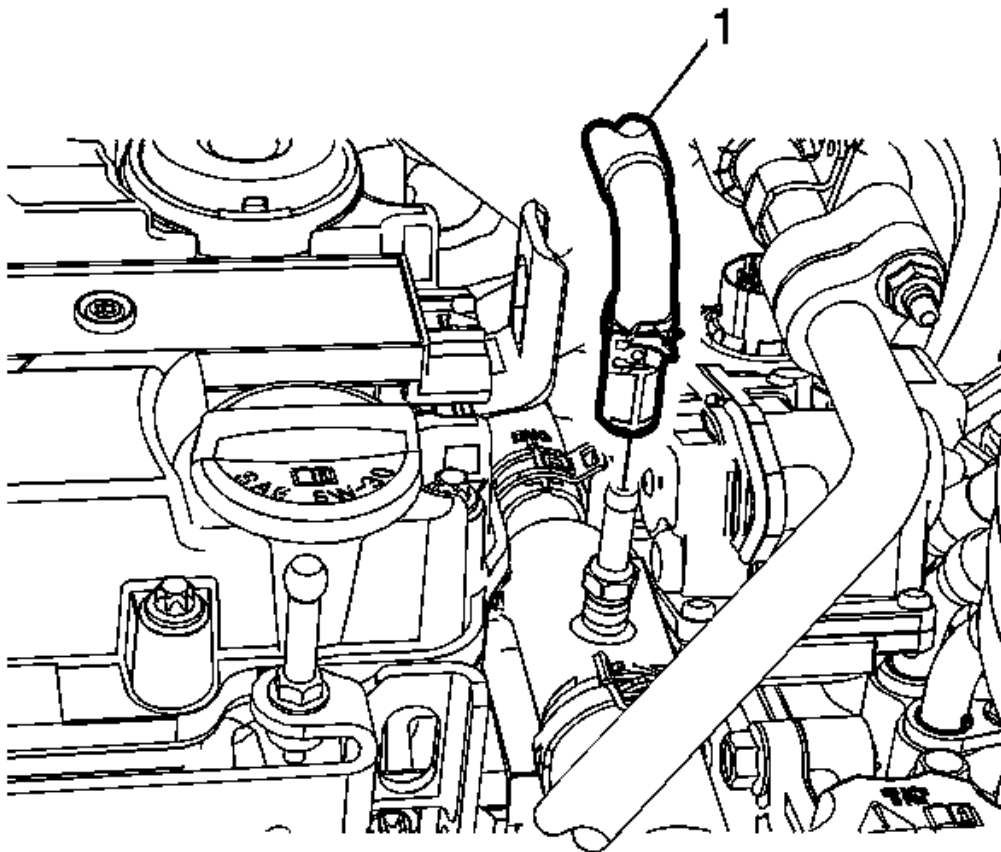


Fig. 15: Heater Outlet Hose Vapor Vent Hose
Courtesy of GENERAL MOTORS CORP.

6. Connect the heater outlet hose vapor vent hose (1).

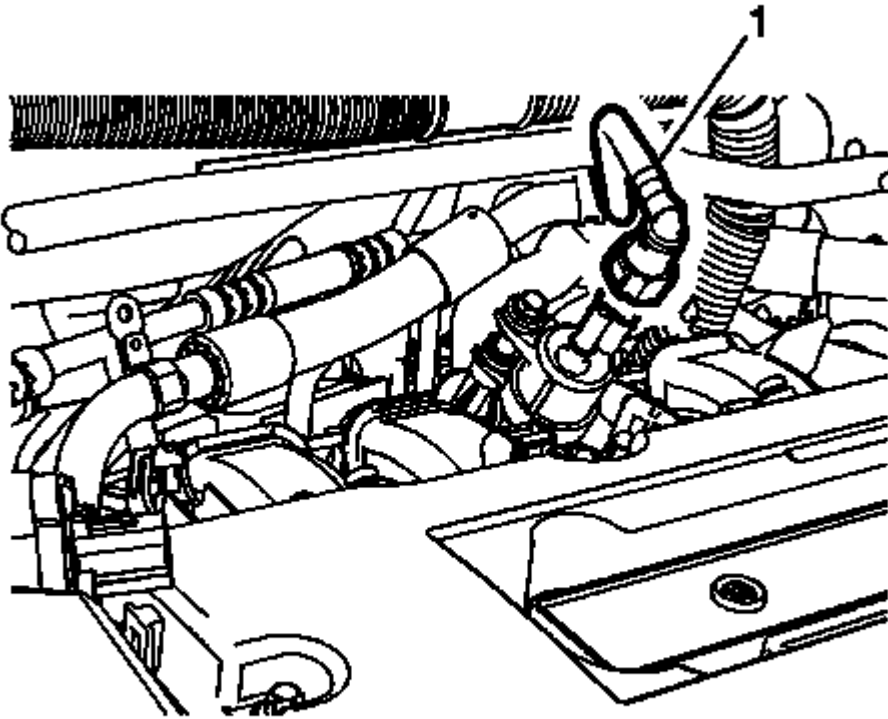


Fig. 16: Evaporative Emission Canister Purge Solenoid Valve Hose
Courtesy of GENERAL MOTORS CORP.

7. Install the evaporative emission canister purge solenoid valve hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
8. Install the fuel injection fuel rail assembly only. Refer to **Fuel Injection Fuel Rail Assembly Replacement** .
9. Install the Air Cleaner Outlet Duct. Refer to **Air Cleaner Outlet Duct Replacement** .
10. Fill the coolant fluid. Refer to **Cooling System Draining and Filling** .
11. Enable the high voltage system. Refer to **High Voltage Enabling** .

CAMSHAFT TIMING CHAIN REPLACEMENT

SPECIAL TOOLS

EN-955-1: Locking Pin

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

REMOVAL PROCEDURE

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

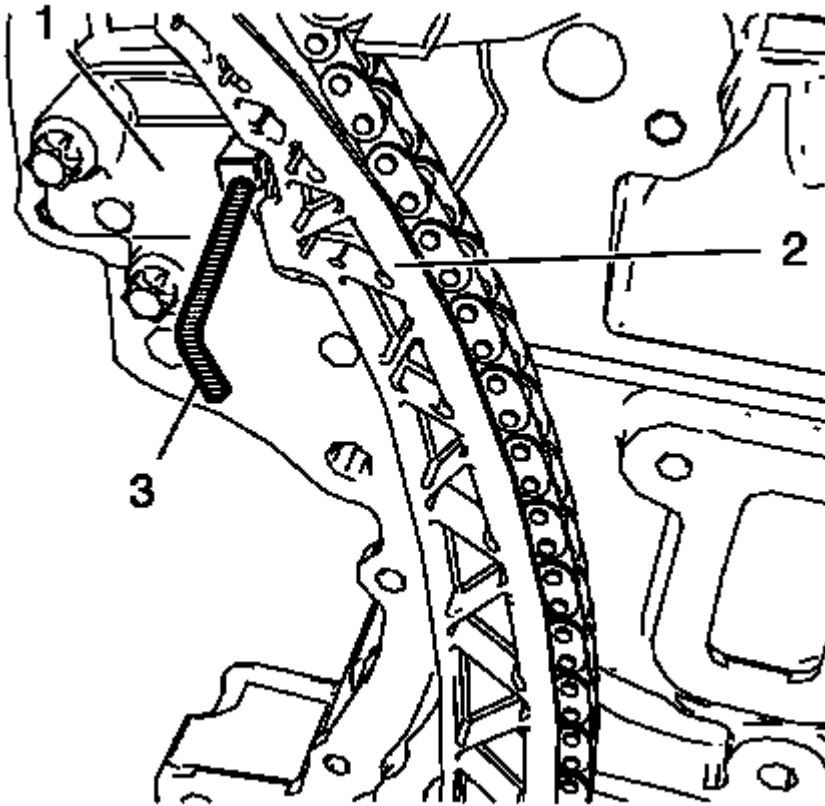


Fig. 17: Timing Chain And Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Push the timing chain (2) in direction to the timing chain tensioner (1) and install the **EN-955-1**: pin (3).

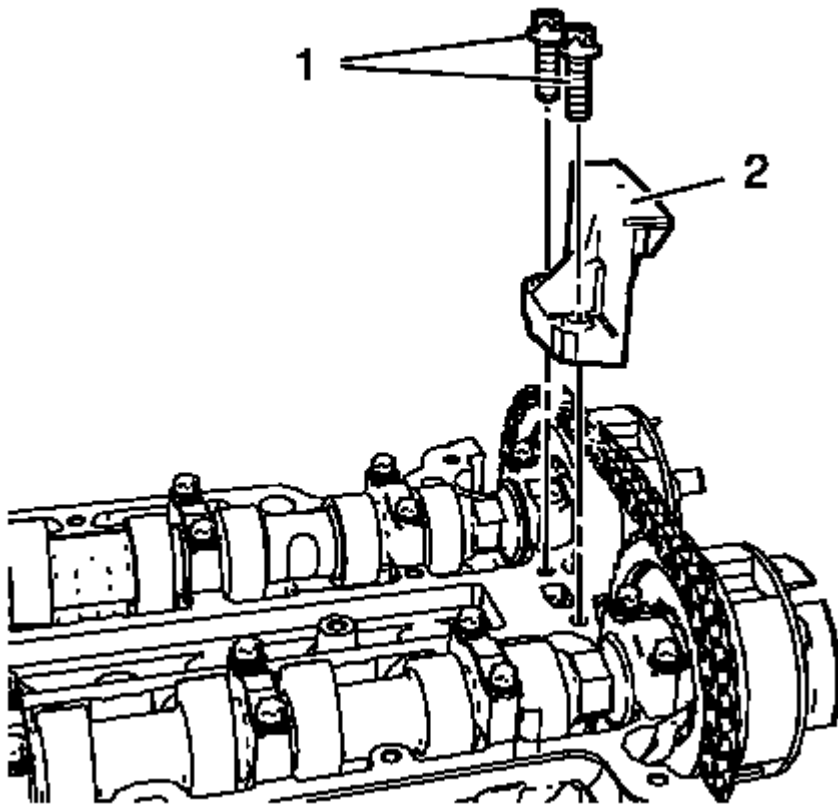


Fig. 18: Upper Timing Chain Guide And Bolts
Courtesy of GENERAL MOTORS CORP.

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

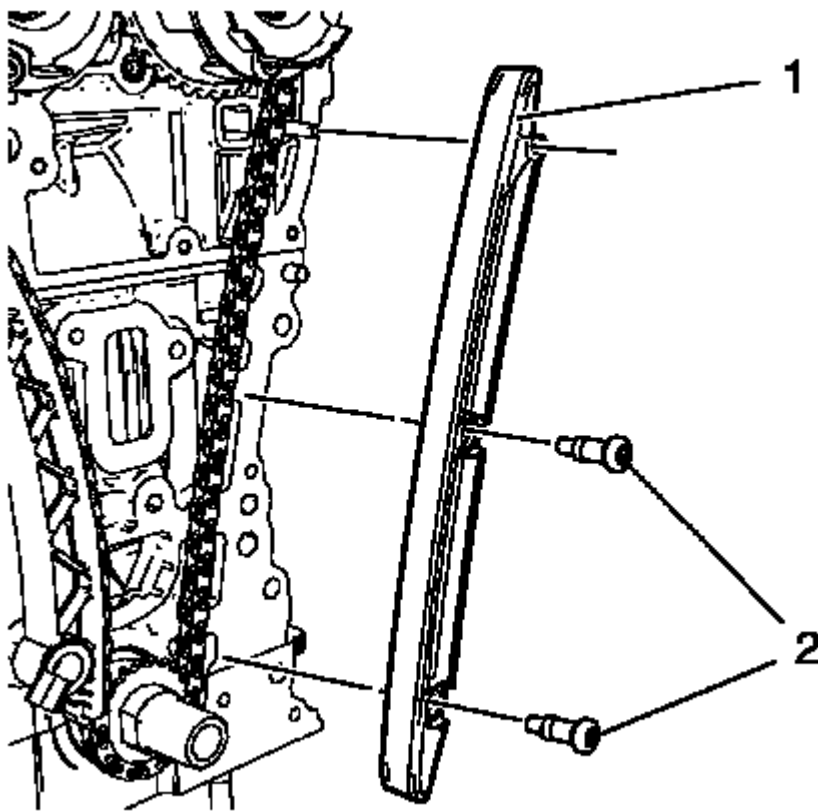


Fig. 19: Timing Chain Guide Right Side
Courtesy of GENERAL MOTORS CORP.

5. Remove the two timing chain guide right side bolts (2).
6. Remove the timing chain guide right side (1).

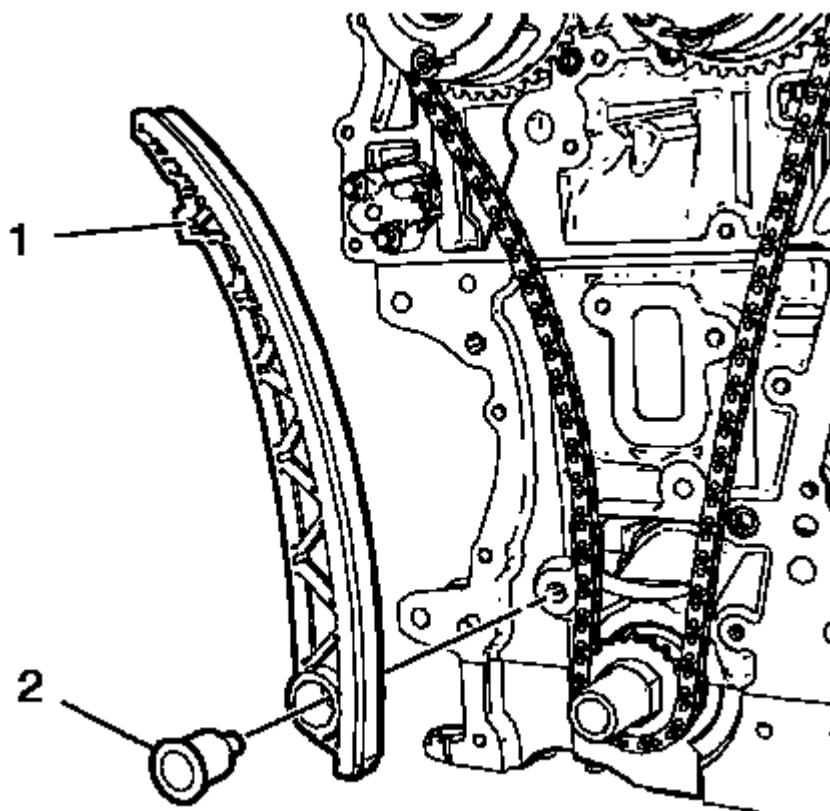


Fig. 20: Timing Chain Tensioner Shoe And Bolt
Courtesy of GENERAL MOTORS CORP.

7. Remove the timing chain tensioner shoe bolt (2).
8. Remove the timing chain tensioner shoe (1).

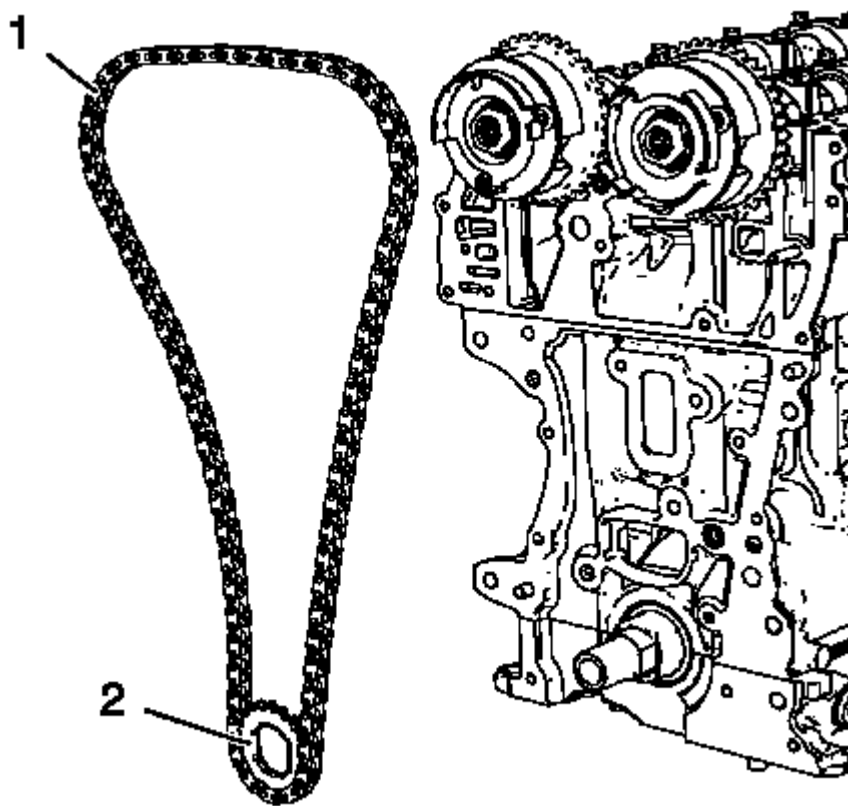


Fig. 21: Timing Chain And Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

9. Remove the timing chain (1) and crankshaft sprocket (2) together as a unit.

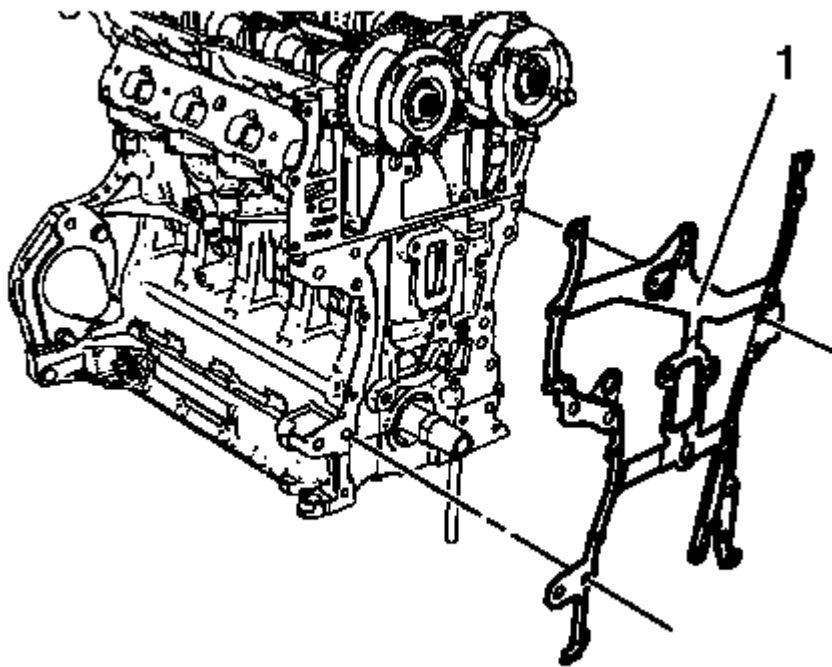


Fig. 22: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

10. Remove the engine front cover gasket (1).

INSTALLATION PROCEDURE

1. Clean the engine front cover sealing surfaces on engine block and cylinder head.

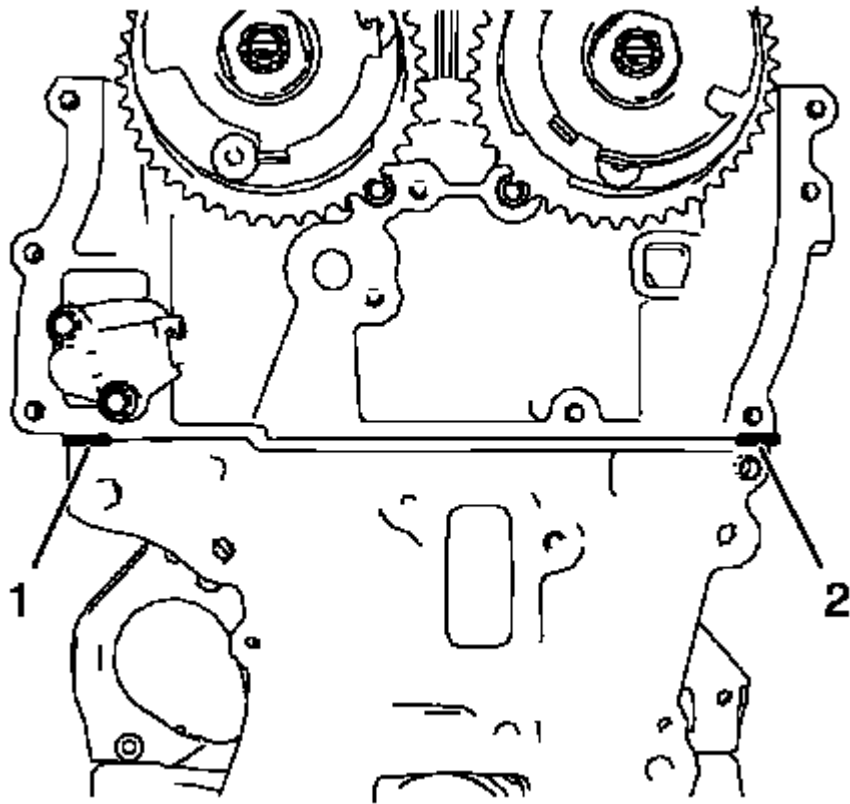


Fig. 23: Sealing Compound Application Areas
Courtesy of GENERAL MOTORS CORP.

2. Apply a 2 mm (0.0787 in) bead of RTV sealant the areas shown above (1, 2).

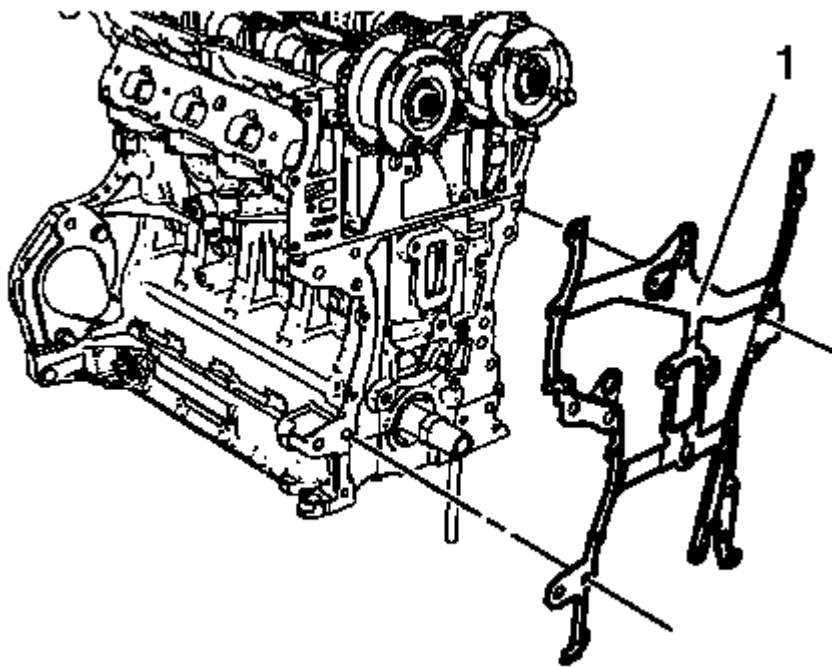


Fig. 24: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

3. Install the engine front cover gasket (1).

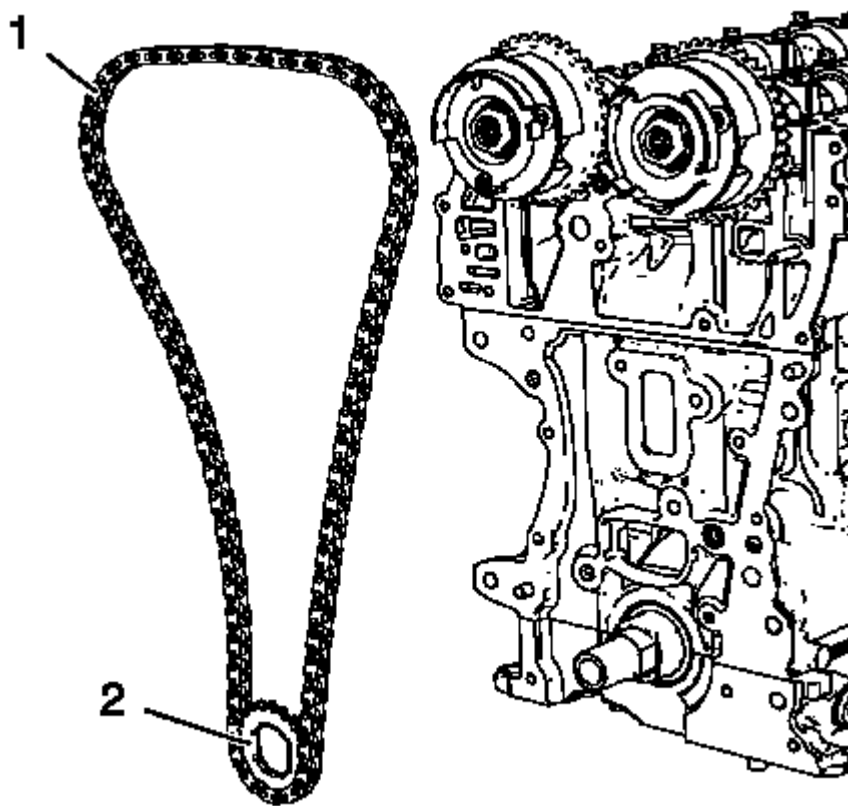


Fig. 25: Timing Chain And Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

4. Install the timing chain (1) and crankshaft sprocket (2) together as a unit.

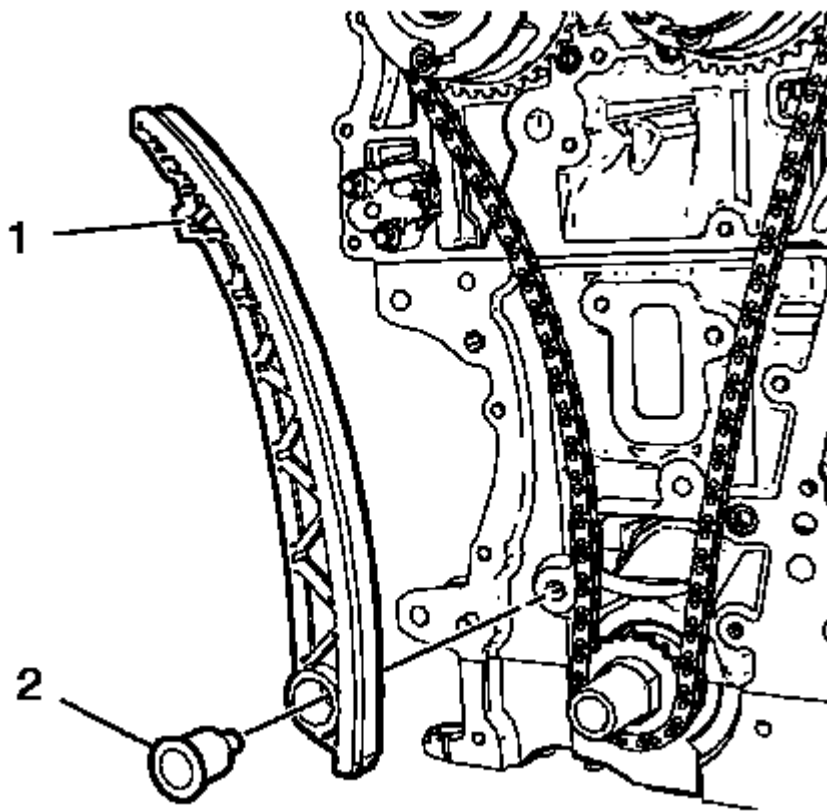


Fig. 26: Timing Chain Tensioner Shoe And Bolt
Courtesy of GENERAL MOTORS CORP.

5. Install the timing chain tensioner shoe (1).

CAUTION: Refer to Fastener Caution .

6. Install the timing chain tensioner shoe bolt (2) and tighten to 20 N.m (15 lb ft).

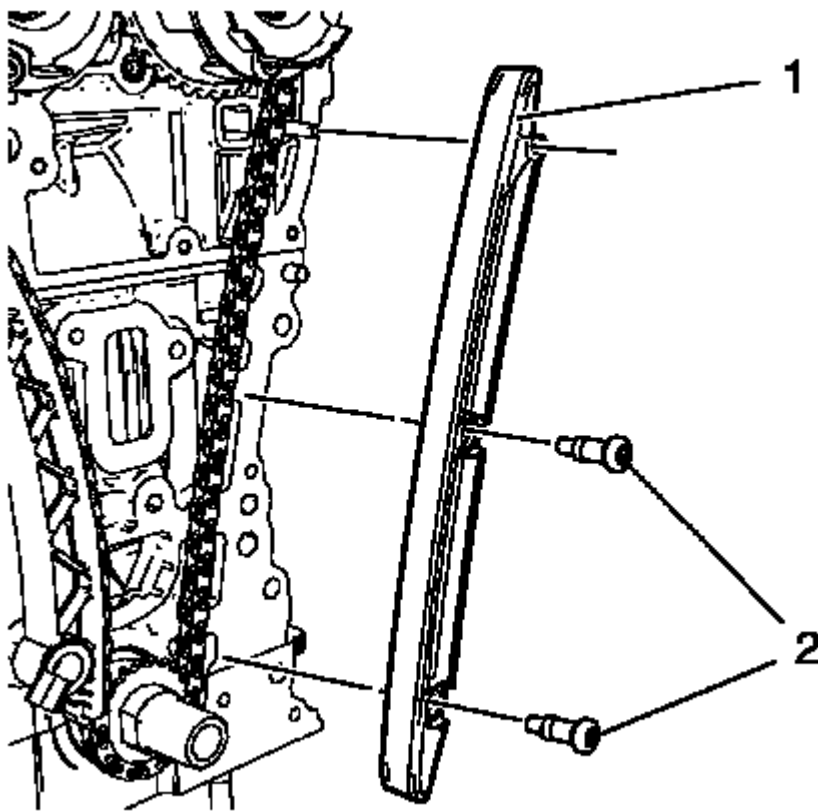


Fig. 27: Timing Chain Guide Right Side
Courtesy of GENERAL MOTORS CORP.

7. Install the timing chain guide right side (1).
8. Install the timing chain guide right side bolts (2) and tighten to 8 N.m (71 lb in).

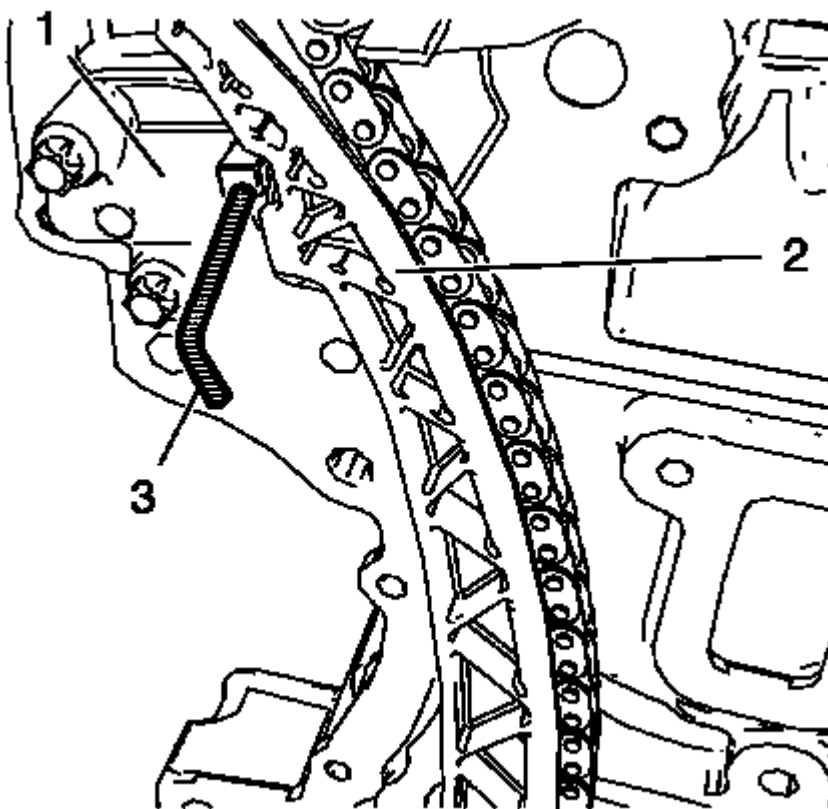
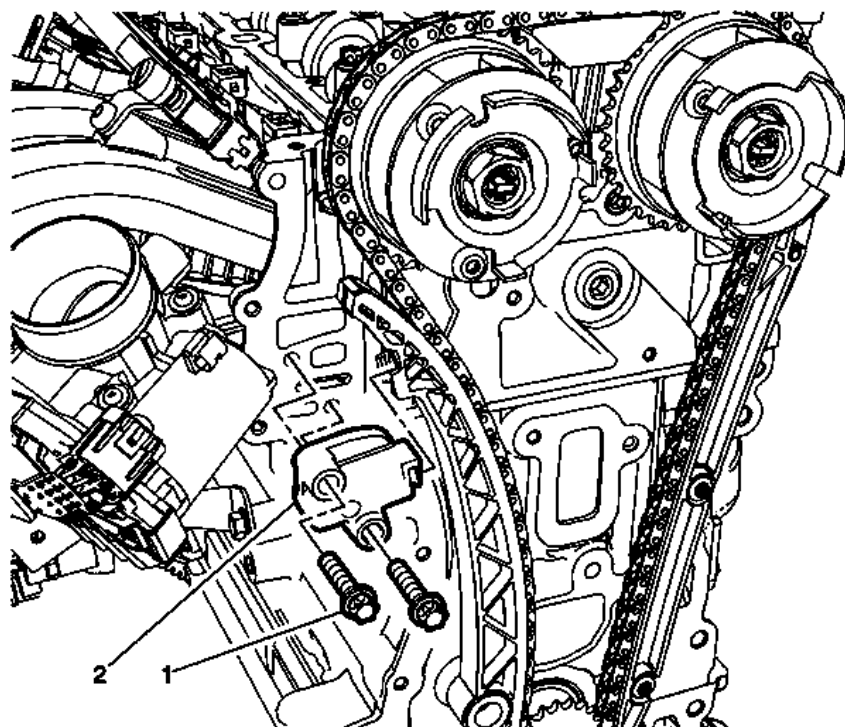


Fig. 28: Timing Chain And Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

9. Push the timing chain (2) in direction of the timing chain tensioner (1) and remove **EN-955-1: pin (3)**.
10. Install the engine front cover. Refer to **Engine Front Cover with Oil Pump Replacement**.

TIMING CHAIN TENSIONER REPLACEMENT

**Fig. 29: Timing Chain Tensioner**

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the camshaft timing chain. Refer to <u>Camshaft Timing Chain Replacement</u>	
1	Timing Chain Tensioner Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tip: The timing chain is installed in the graphic for location use only. But is required to be removed to perform the procedure. Tighten: 8 N.m (71 lb in)
2	Timing Chain Tensioner Procedure: Transfer parts as necessary.

HYDRAULIC VALVE LASH ADJUSTER ARM REPLACEMENT

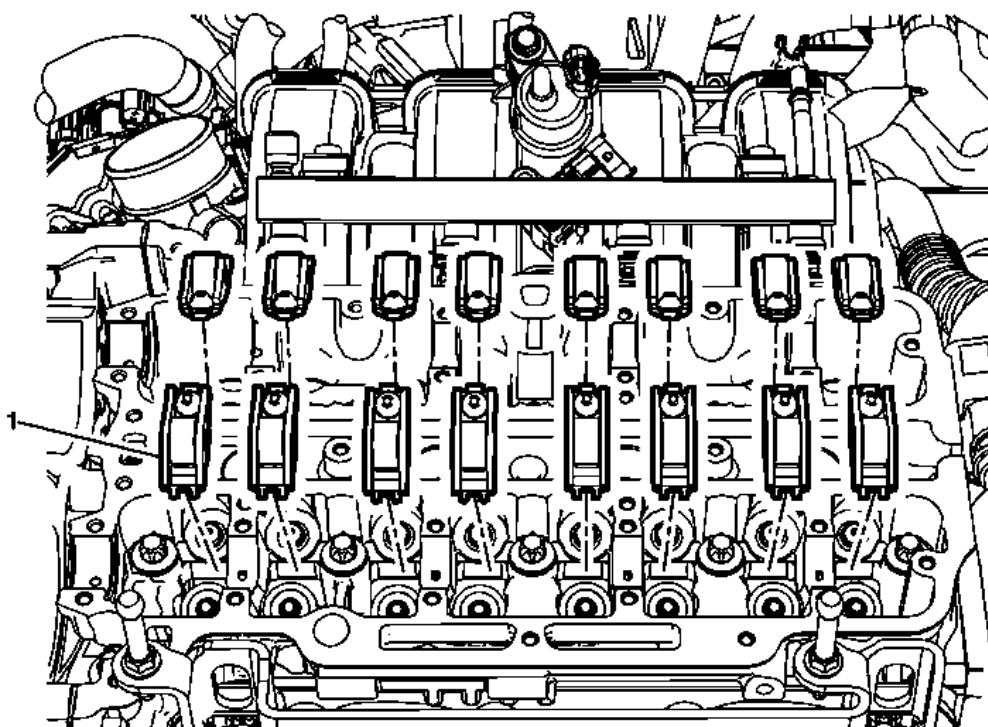


Fig. 30: Hydraulic Valve Lash Adjuster Arms
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Remove the intake camshaft. Refer to <u>Intake Camshaft Replacement</u> . 2. Remove the exhaust camshaft. Refer to <u>Exhaust Camshaft Replacement</u> .	
1	Remove the hydraulic valve lash adjuster arms
	Procedure 1. Mark the hydraulic valve lash adjuster arms upon removal to ensure installation is in the correct position. 2. Lubricate the hydraulic valve lash adjuster arms with engine oil before installing the arms. 3. Transfer Parts as necessary.

HYDRAULIC VALVE LASH ADJUSTER REPLACEMENT

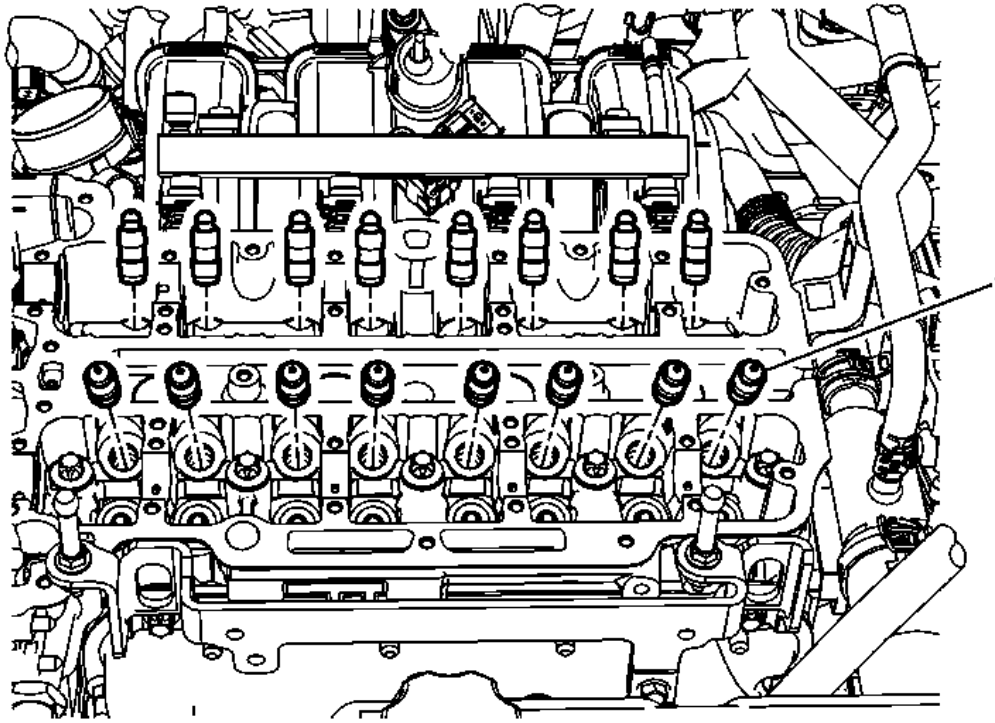


Fig. 31: Hydraulic Valve Lash Adjuster
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove the hydraulic valve lash adjuster arms. Refer to <u>Hydraulic Valve Lash Adjuster Arm Replacement</u>	
1	Remove the hydraulic valve lash adjuster Procedure 1. Mark the hydraulic valve lash adjuster upon removal to ensure installation is in the correct position. 2. Lubricate the hydraulic valve lash adjuster with engine oil before installtion. 3. Transfer Parts as necessary.

CAMSHAFT INTAKE AND EXHAUST SPROCKET REPLACEMENT

SPECIAL TOOLS

EN-955-1: Locking Pin

For equivalent regional tools, refer to Special Tools .

REMOVAL PROCEDURE

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure will perform the following tasks:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Failure to follow the procedures exactly as written may result in serious injury or death.

1. Disable the high voltage system. Refer to High Voltage Disabling .
2. Drain the cooling system. Refer to Drive Motor Generator Power Inverter Module Cooling System Draining and Filling .
3. Disable the high voltage system. Refer to High Voltage Disabling .
4. Remove the camshaft cover. Refer to Camshaft Cover Replacement.
5. Remove both camshaft position actuator solenoid valves. Refer to Camshaft Position Actuator Solenoid Valve Replacement (Intake) or Camshaft Position Actuator Solenoid Valve Replacement (Exhaust) .
6. Adjust the engine to TDC. Refer to Camshaft Timing Chain Adjustment .
7. Remove the engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side.
8. Place a floor jack with block of wood under the oil pan.
9. Remove engine support fixture. Refer Engine Support Fixture.

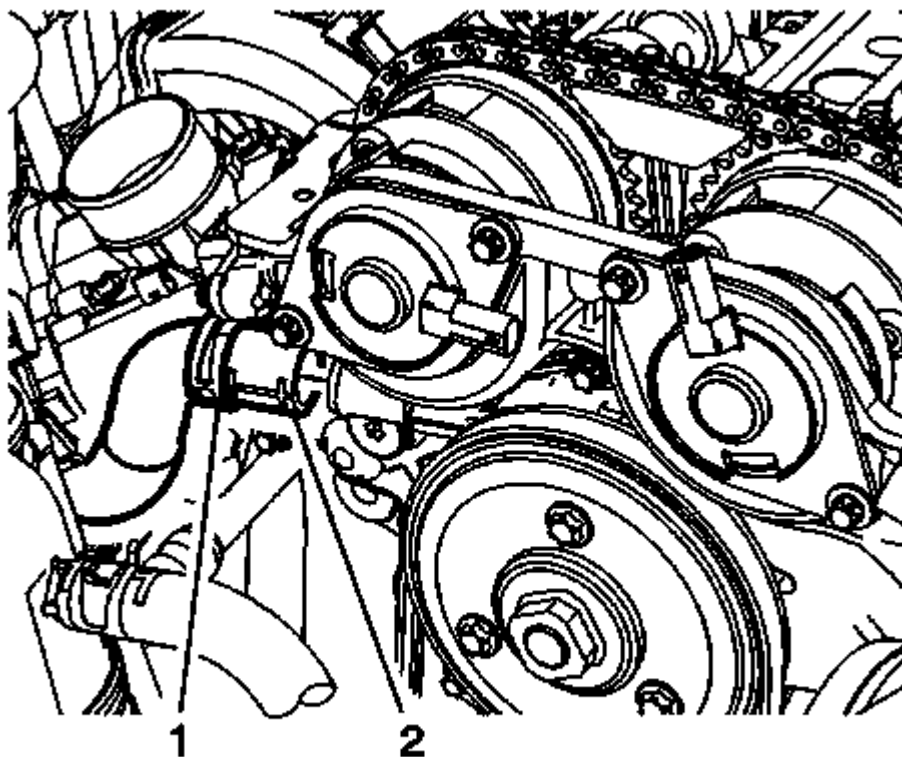


Fig. 32: Heater Water Shutoff Valve Inlet Hose And Clamp
Courtesy of GENERAL MOTORS CORP.

10. Remove the heater water shutoff valve inlet hose clamp (1) at engine.
11. Remove the heater water shutoff valve inlet hose (2) from engine.
12. Disconnect the heater water shutoff valve inlet hose from the engine.

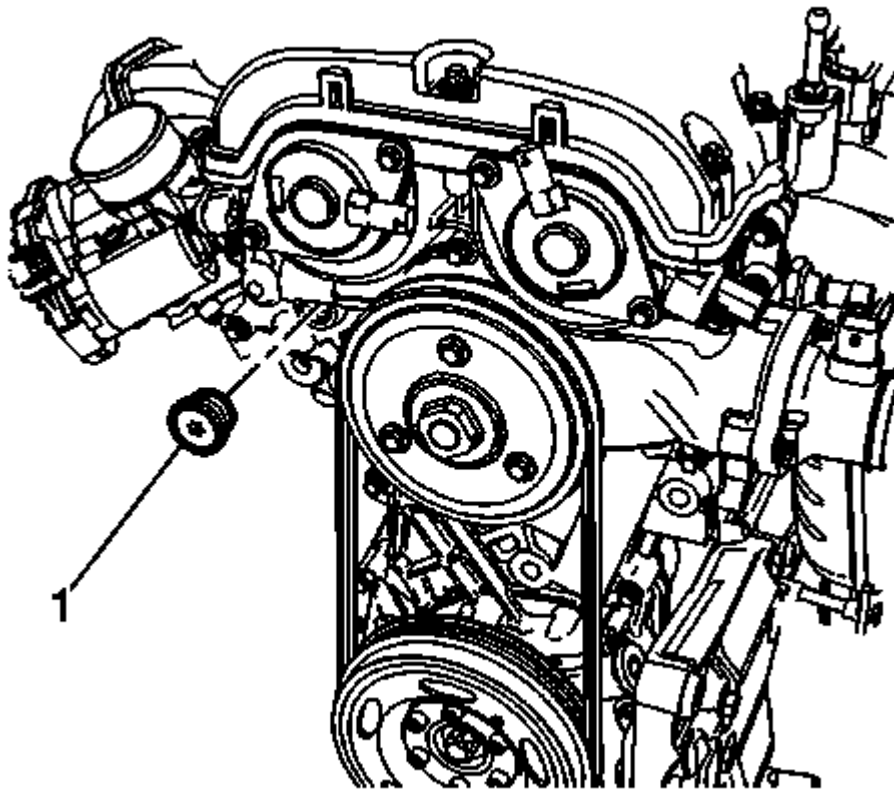


Fig. 33: Timing Chain Tensioner Plug
Courtesy of GENERAL MOTORS CORP.

13. Remove the timing chain tensioner plug (1) from the engine front cover.

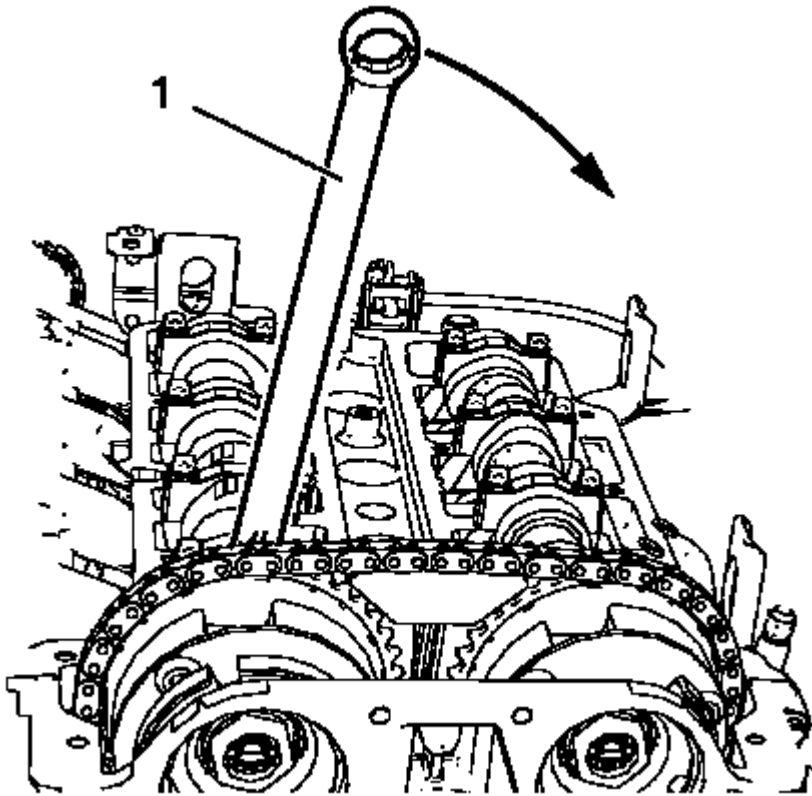


Fig. 34: Hexagonal Wrench Rotation Direction
Courtesy of GENERAL MOTORS CORP.

14. Install a wrench (1) on the cast hexagonal portion of the intake camshaft, rotate the camshaft toward the exhaust camshaft in order to apply tension.

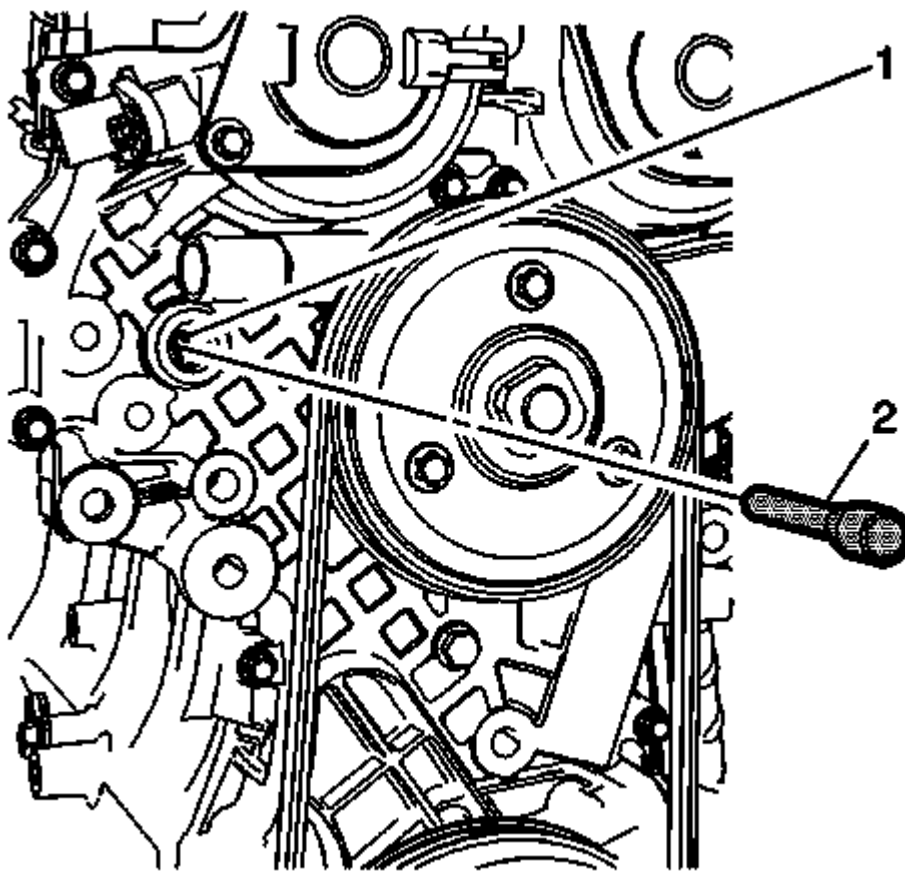


Fig. 35: Timing Chain Tensioner Bore And Special Tool
Courtesy of GENERAL MOTORS CORP.

15. Install EN-955-1: pin (2) to the timing chain tensioner bore (1).
16. Remove the wrench from intake camshaft.

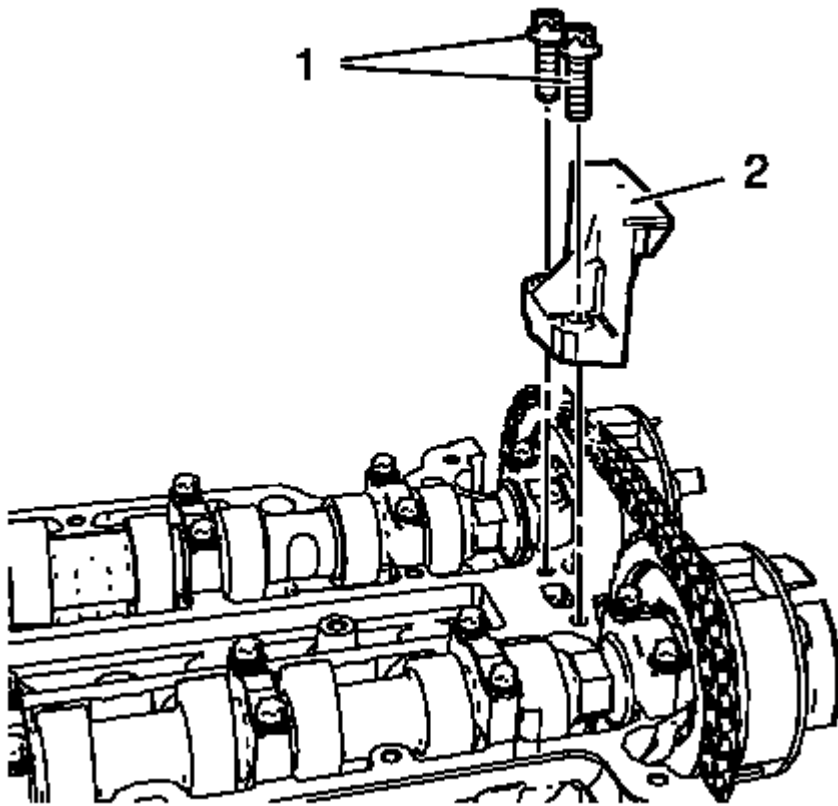


Fig. 36: Upper Timing Chain Guide And Bolts
Courtesy of GENERAL MOTORS CORP.

17. Remove the 2 upper timing chain guide bolts (1).
18. Remove the upper timing chain guide (2).

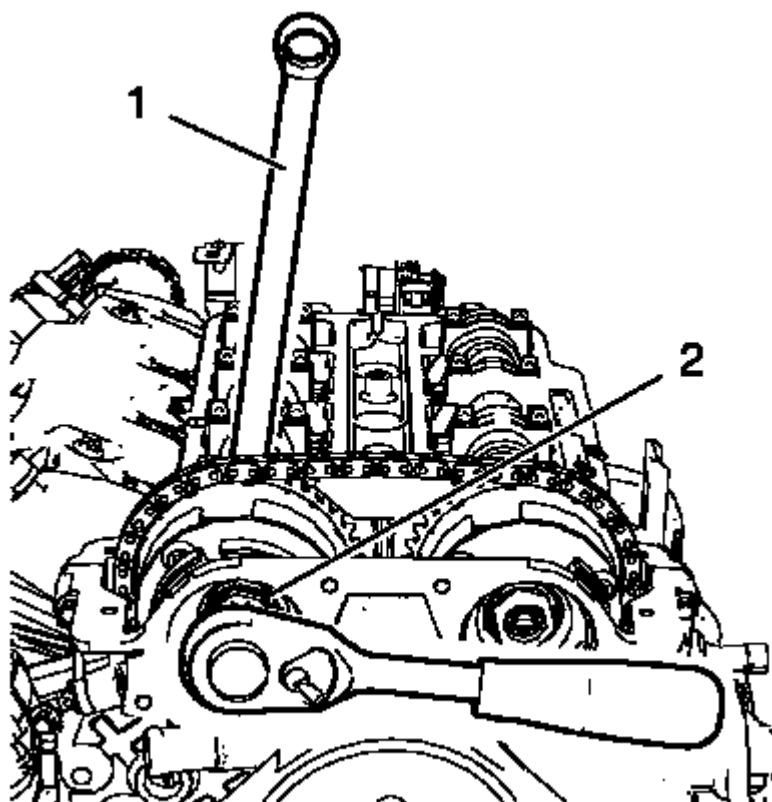


Fig. 37: Intake Camshaft Sprocket Bolt And Hexagonal Wrench
Courtesy of GENERAL MOTORS CORP.

19. Loosen the intake camshaft sprocket bolt (2) while holding up the hexagon of the intake camshaft with a wrench (1).
20. Loosen the exhaust camshaft sprocket bolt while holding up the hexagon of the exhaust camshaft with a wrench.

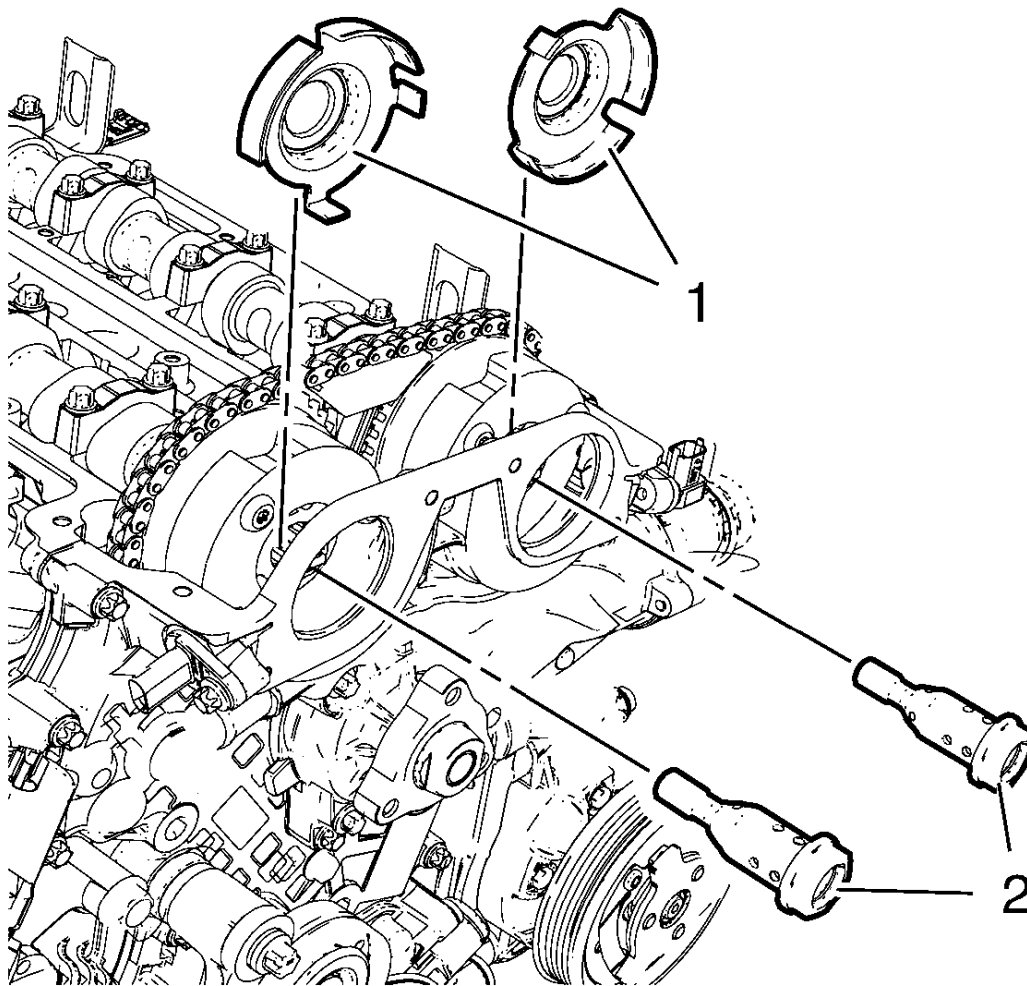


Fig. 38: Camshaft Position Exciter Wheels And Camshaft Sprocket Bolts
Courtesy of GENERAL MOTORS CORP.

21. Remove the camshaft sprocket bolts (2) and the camshaft position exciter wheels (1).

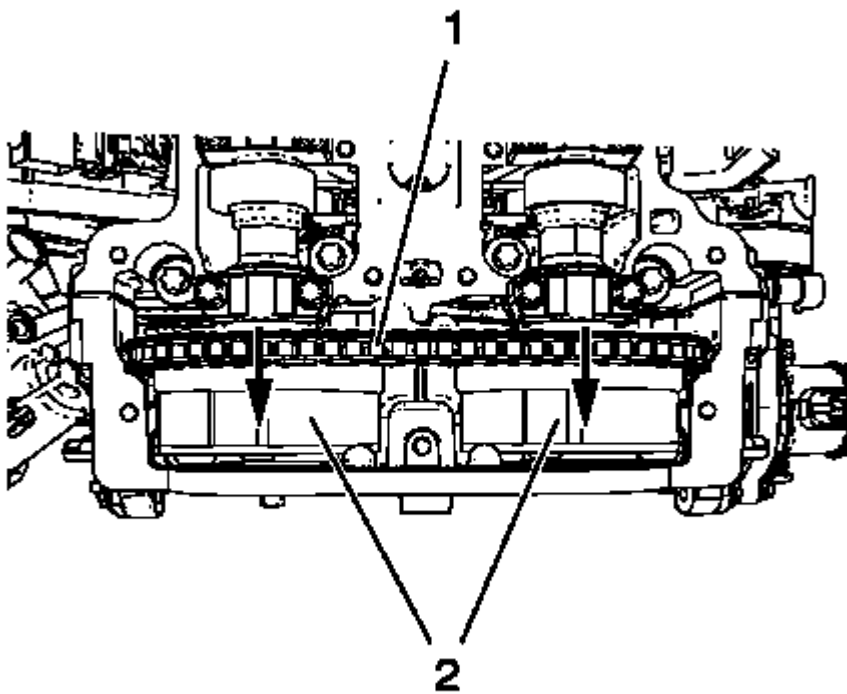


Fig. 39: Timing Chain And Camshaft Sprockets
Courtesy of GENERAL MOTORS CORP.

22. Remove the camshaft sprockets (2) and timing chain (1) as one unit.
23. Remove the intake and exhaust camshaft sprocket.
24. Allow the chain to rest on the front cover.

INSTALLATION PROCEDURE

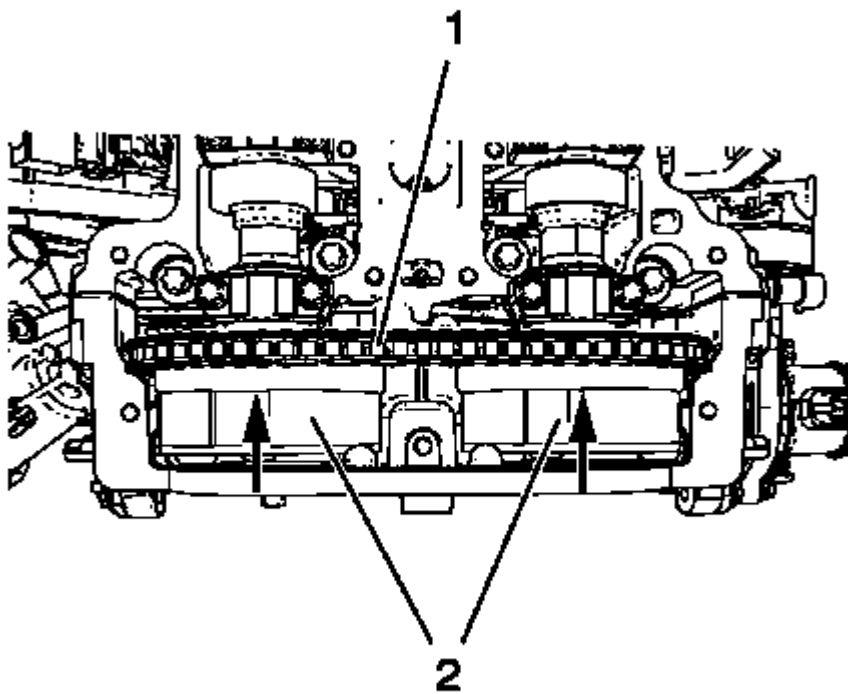


Fig. 40: Timing Chain And Camshaft Sprockets
Courtesy of GENERAL MOTORS CORP.

1. Install the camshaft sprockets (2) and timing chain (1) as one unit.

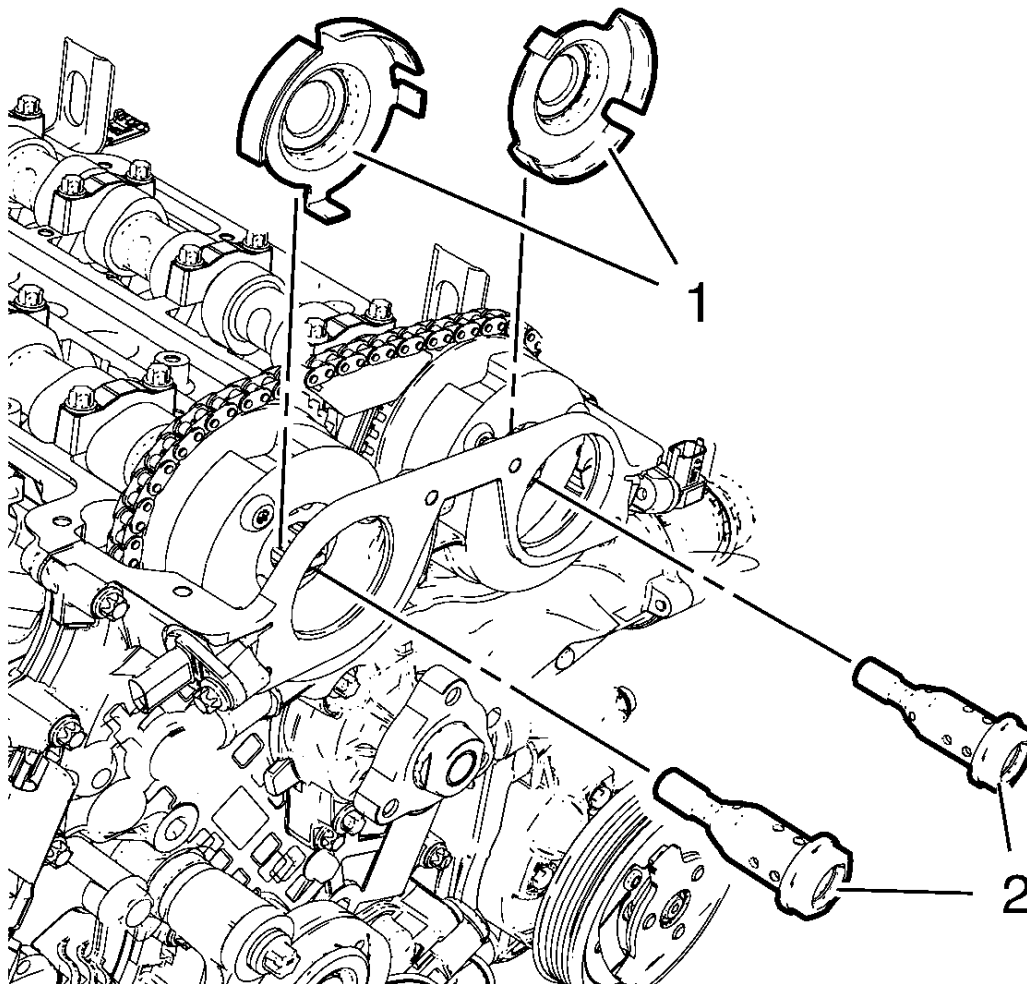


Fig. 41: Camshaft Position Exciter Wheels And Camshaft Sprocket Bolts
 Courtesy of GENERAL MOTORS CORP.

2. Install the camshaft position exciter wheels (1).

CAUTION: Refer to Fastener Caution .

3. Install the camshaft sprocket bolts (2) and tighten to 50 N.m plus 45+15 degrees (37 lb ft) plus 45+15 degrees.
4. Remove the **EN-955-1** pin.
5. Adjust the camshaft timing chain. Refer to Camshaft Timing Chain Adjustment .

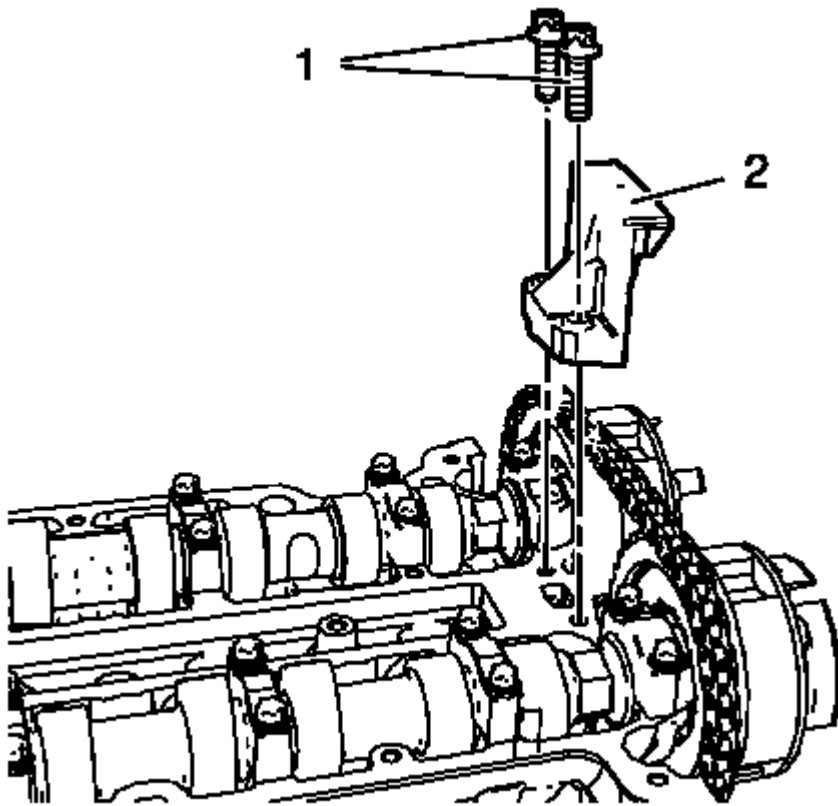


Fig. 42: Upper Timing Chain Guide And Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the upper timing chain guide (2).
7. Install the upper timing chain guide bolts (1) and tighten to 8 N.m (71 lb in).

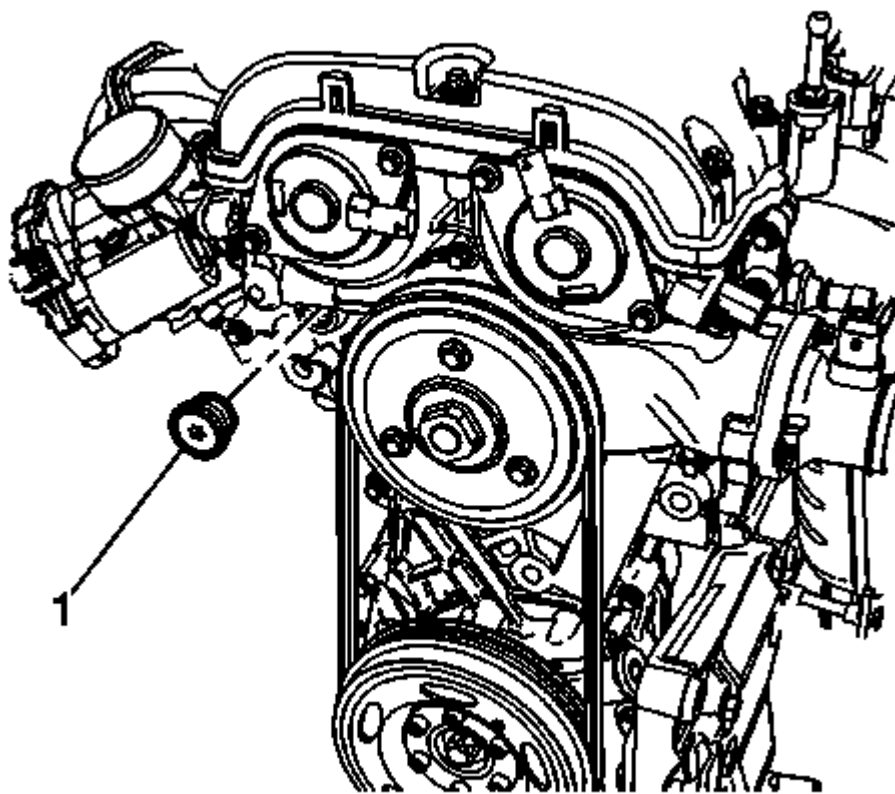


Fig. 43: Timing Chain Tensioner Plug
Courtesy of GENERAL MOTORS CORP.

8. Install the timing chain tensioner plug (1) and tighten to 50 N.m (37 lb ft).
9. Install both camshaft position actuator solenoid valves. Refer to **Camshaft Position Actuator Solenoid Valve Replacement (Intake)** or **Camshaft Position Actuator Solenoid Valve Replacement (Exhaust)** .

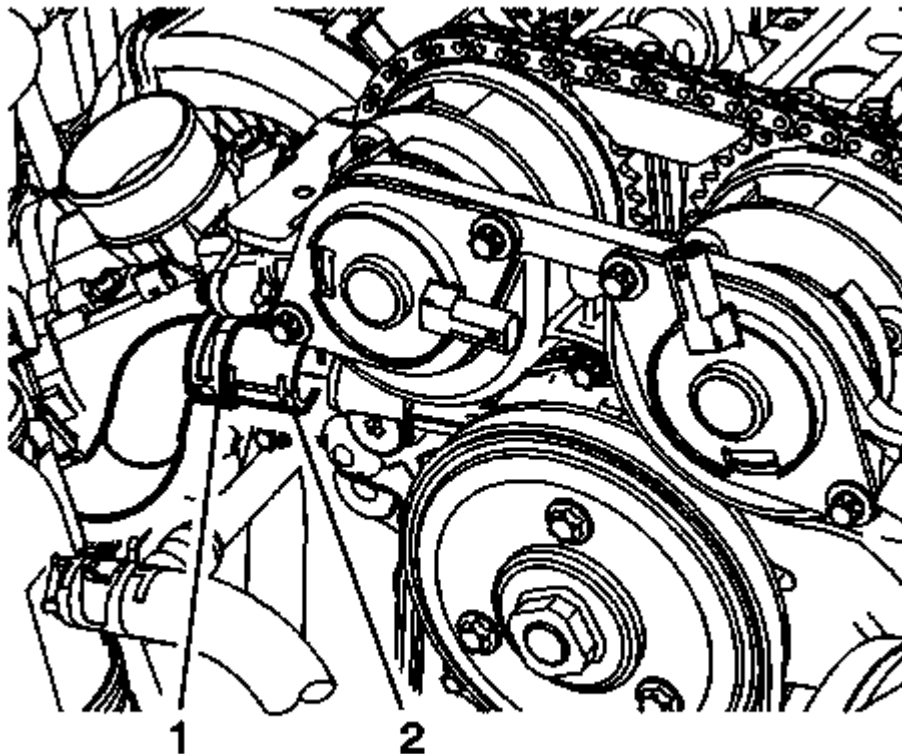


Fig. 44: Heater Water Shutoff Valve Inlet Hose And Clamp
Courtesy of GENERAL MOTORS CORP.

10. Connect the heater water shutoff valve inlet hose (2) to the engine.
11. Install the heater water shutoff valve inlet hose clamp (1).
12. Install the engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side**.
13. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
14. Fill the cooling system. Refer to **Drive Motor Generator Power Inverter Module Cooling System Draining and Filling**.
15. Enable the high voltage system. Refer to **High Voltage Enabling**.

CYLINDER HEAD REPLACEMENT

SPECIAL TOOLS

- **EN-470-B:** Angular Torque Wrench.
- **EN-955:** Fixing Pin.

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

REMOVAL PROCEDURE

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure will perform the following tasks:

- Identify how to disable high voltage.
- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Failure to follow the procedures exactly as written may result in serious injury or death.

1. Disable the high voltage system. Refer to **High Voltage Disabling** .
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.
3. Remove the exhaust manifold. Refer to **Exhaust Manifold with Catalytic Converter Replacement** .
4. Remove the Intake manifold. Refer to **Intake Manifold Replacement**
5. Install engine support fixture. Refer to **Engine Support Fixture**.
6. Remove the Water Pump. Refer to **Water Pump Replacement** .
7. Remove the Camshaft Position Actuator Solenoid Valve intake and exhaust. Refer to **Camshaft Position Actuator Solenoid Valve Replacement (Intake)** or **Camshaft Position Actuator Solenoid Valve Replacement (Exhaust)** .
8. Remove the Camshaft Position Sensor Exhaust only. Refer to **Camshaft Position Sensor Replacement (Exhaust)** or **Camshaft Position Sensor Replacement (Intake)** .
9. Adjust the engine to TDC. Refer to **Camshaft Timing Chain Inspection** .

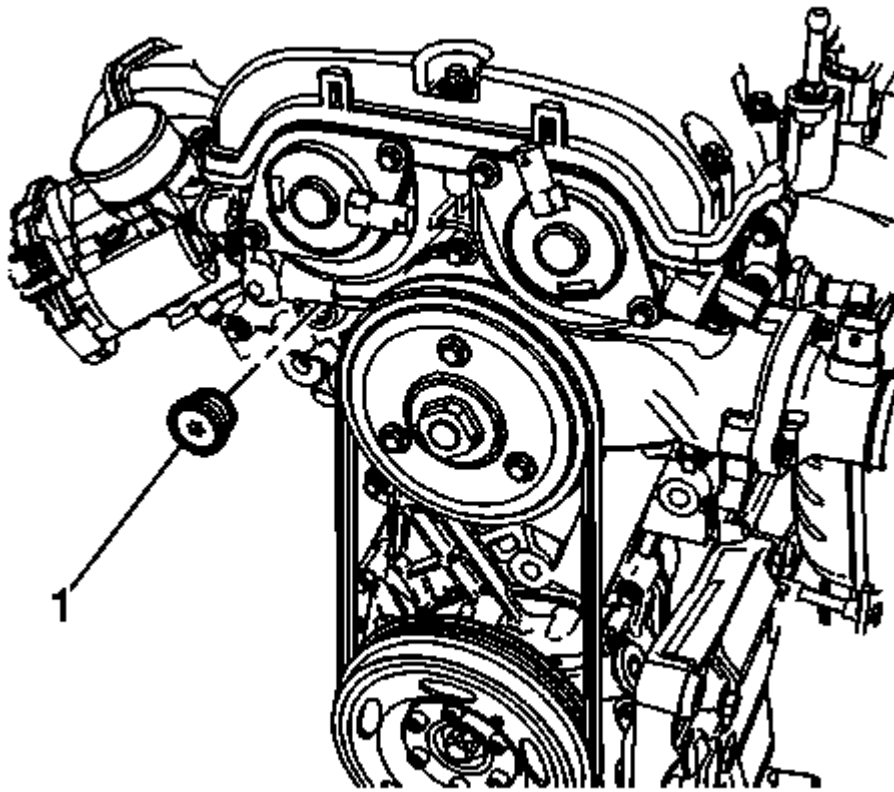


Fig. 45: Timing Chain Tensioner Plug
Courtesy of GENERAL MOTORS CORP.

10. Remove the timing chain tensioner plug (1) from the engine front cover.

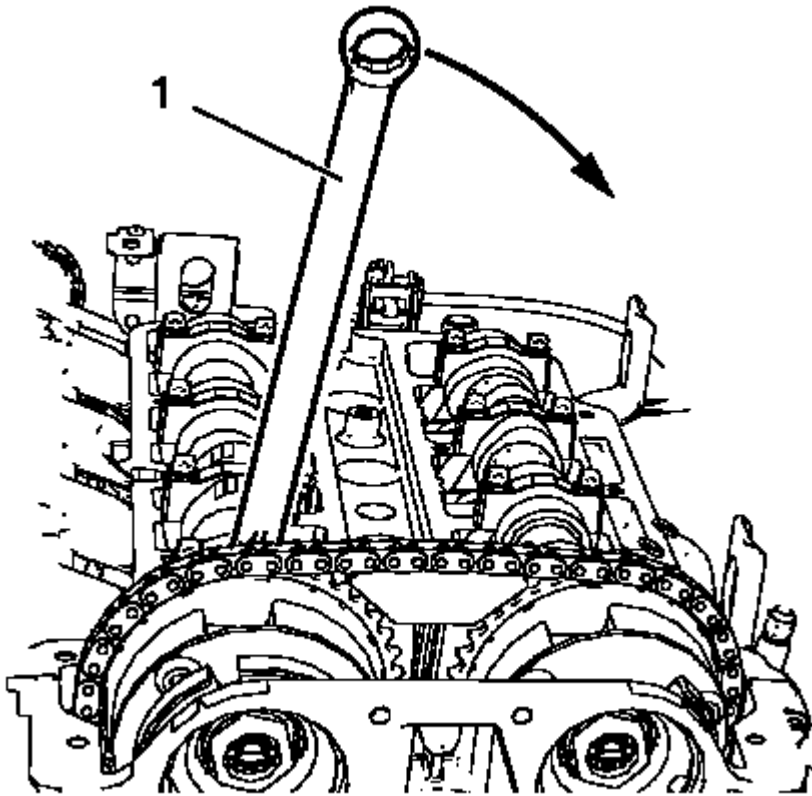


Fig. 46: Hexagonal Wrench Rotation Direction
Courtesy of GENERAL MOTORS CORP.

11. Install a wrench (1) on the cast hexagonal portion of the intake camshaft, rotate the camshaft toward the exhaust camshaft in order to apply tension.

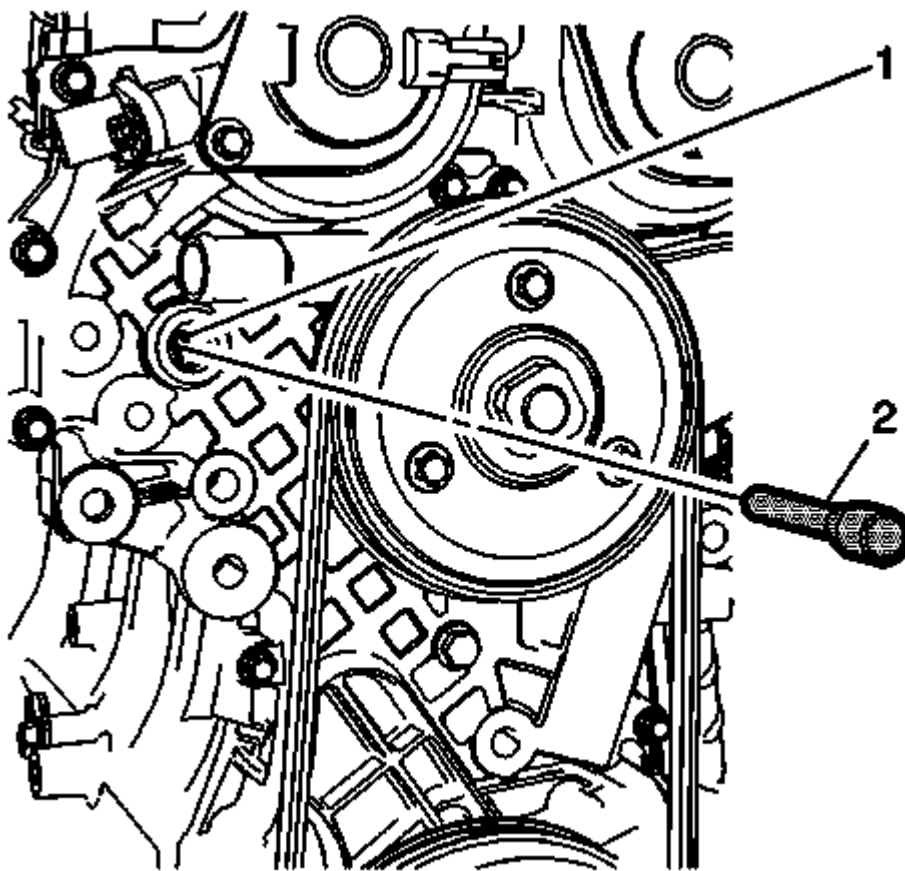


Fig. 47: Timing Chain Tensioner Bore And Special Tool
Courtesy of GENERAL MOTORS CORP.

12. Install **EN-955: Locking Pin (2)** to the timing chain tensioner bore (1).
13. Remove the wrench from intake camshaft.

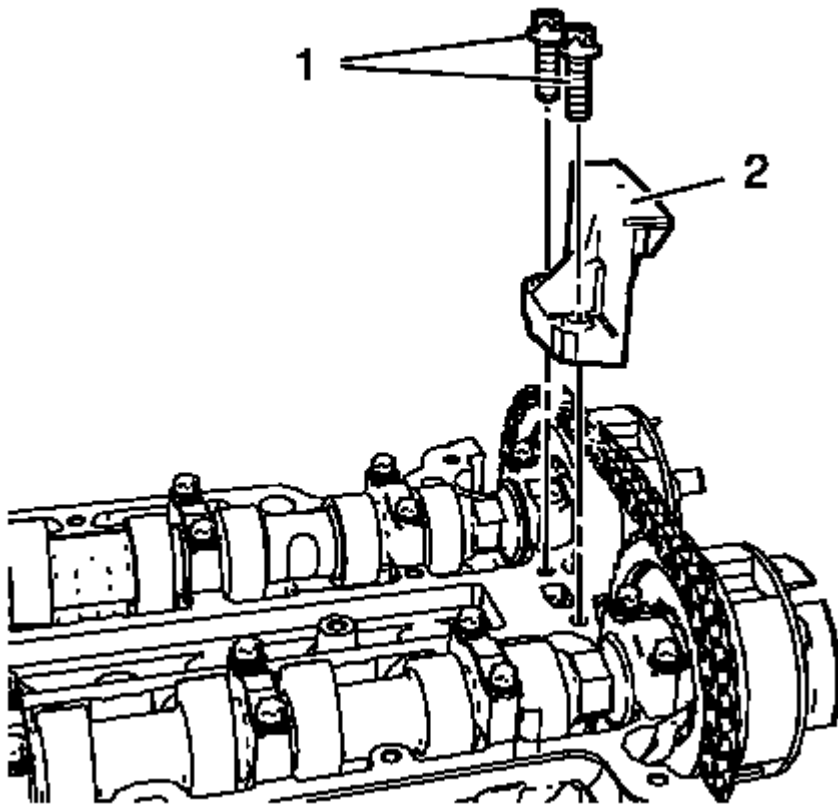


Fig. 48: Upper Timing Chain Guide And Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the 2 upper timing chain guide bolts (1).
15. Remove the upper timing chain guide (2).

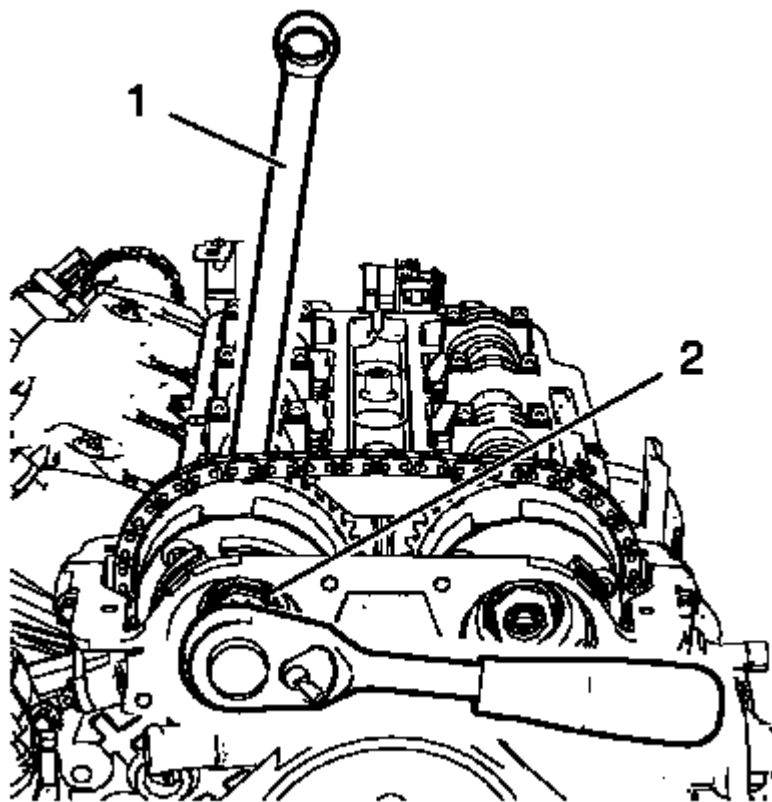


Fig. 49: Intake Camshaft Sprocket Bolt And Hexagonal Wrench
Courtesy of GENERAL MOTORS CORP.

16. Loosen the intake camshaft sprocket bolt (2) while holding up the hexagon of the intake camshaft with a wrench (1).
17. Loosen the exhaust camshaft sprocket bolt while holding up the hexagon of the exhaust camshaft with a wrench.

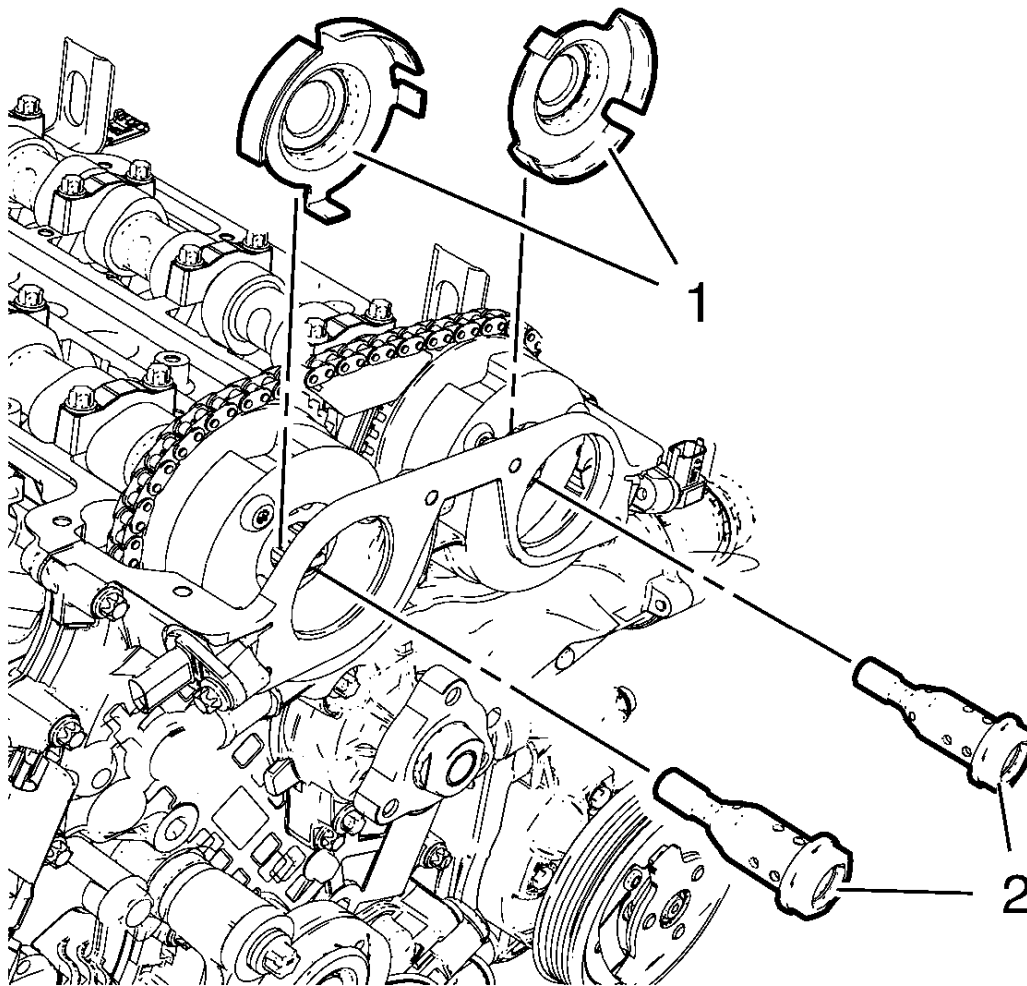


Fig. 50: Camshaft Position Exciter Wheels And Camshaft Sprocket Bolts
Courtesy of GENERAL MOTORS CORP.

18. Remove the camshaft sprocket bolts (2) and the camshaft position exciter wheels (1).

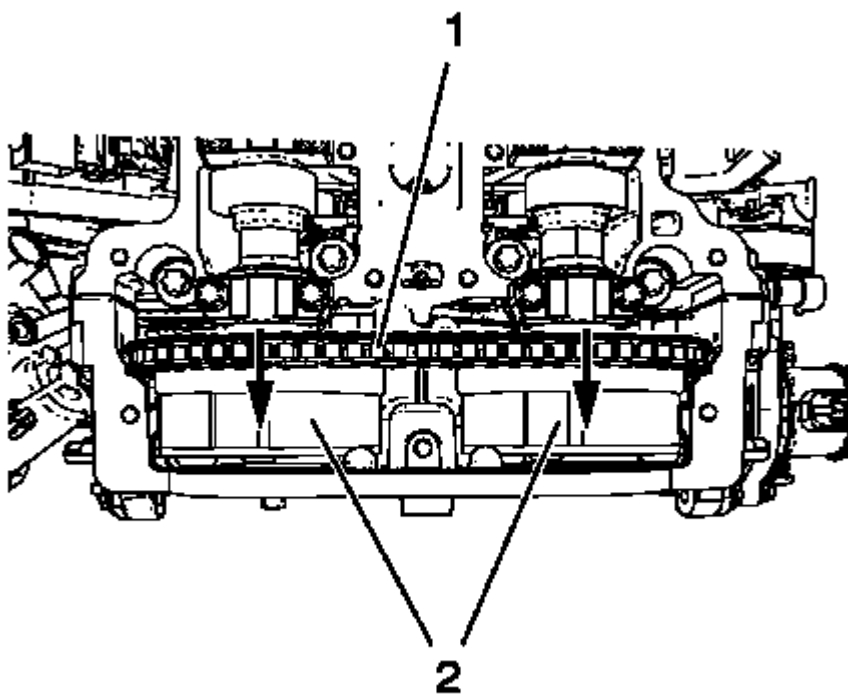


Fig. 51: Timing Chain And Camshaft Sprockets
Courtesy of GENERAL MOTORS CORP.

19. Remove the camshaft sprockets (2) and timing chain (1) as one unit.
20. Allow the camshaft sprockets (2) and timing chain (1) rest on the front cover Do NOT remove sprockets or chain.
21. Place a floor jack with block of wood under the oil pan.
22. Remove engine support fixture. Refer **Engine Support Fixture**.

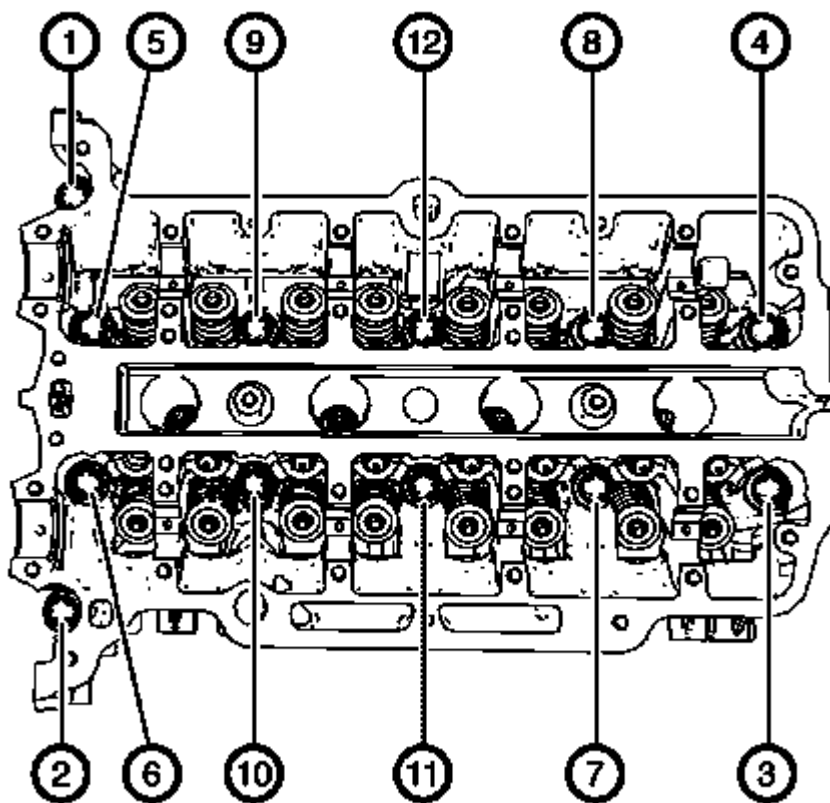


Fig. 52: Cylinder Head Bolts Loosening Sequence
Courtesy of GENERAL MOTORS CORP.

23. Loosen the 12 cylinder head bolts in the sequence as shown above. Use the following procedure:
- First pass: Loosen the cylinder head bolts 90 degrees.
 - Final pass: Loosen the cylinder head bolts 180 degrees.

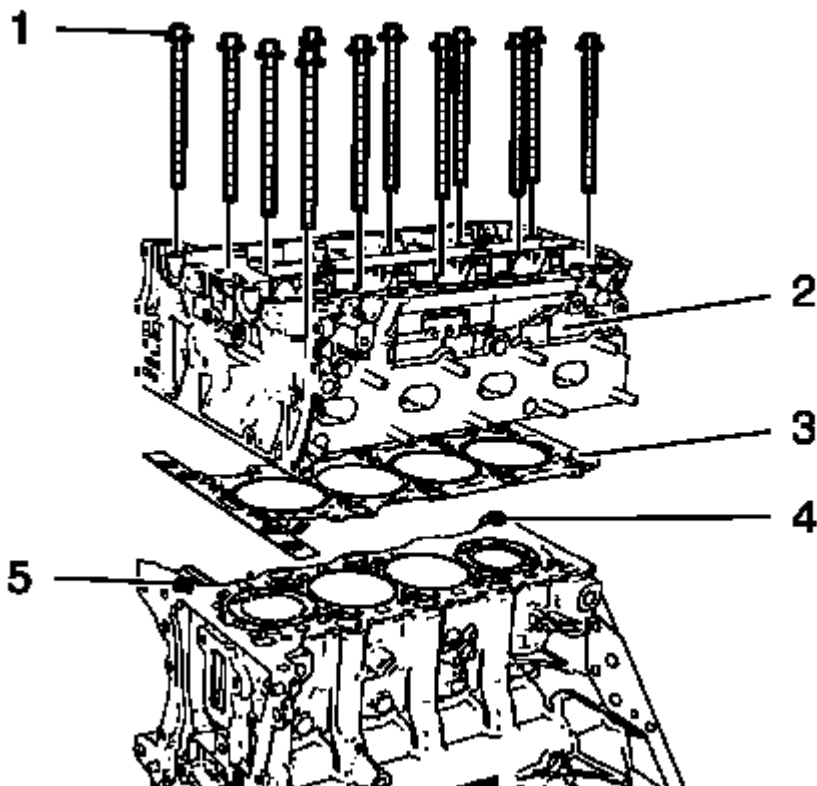


Fig. 53: Cylinder Head, Cylinder Head Gasket, Cylinder Head Bolts And Guide Sleeves
 Courtesy of GENERAL MOTORS CORP.

NOTE: Do not damage the guide sleeves (4) and (5).

24. Remove the cylinder head bolts (1).
25. With the aid of helper, lift the timing chain side of the cylinder head assembly slightly in direction of the transmission.
26. Remove the cylinder head (2).
27. Remove the cylinder head gasket (3) and discard the gasket.

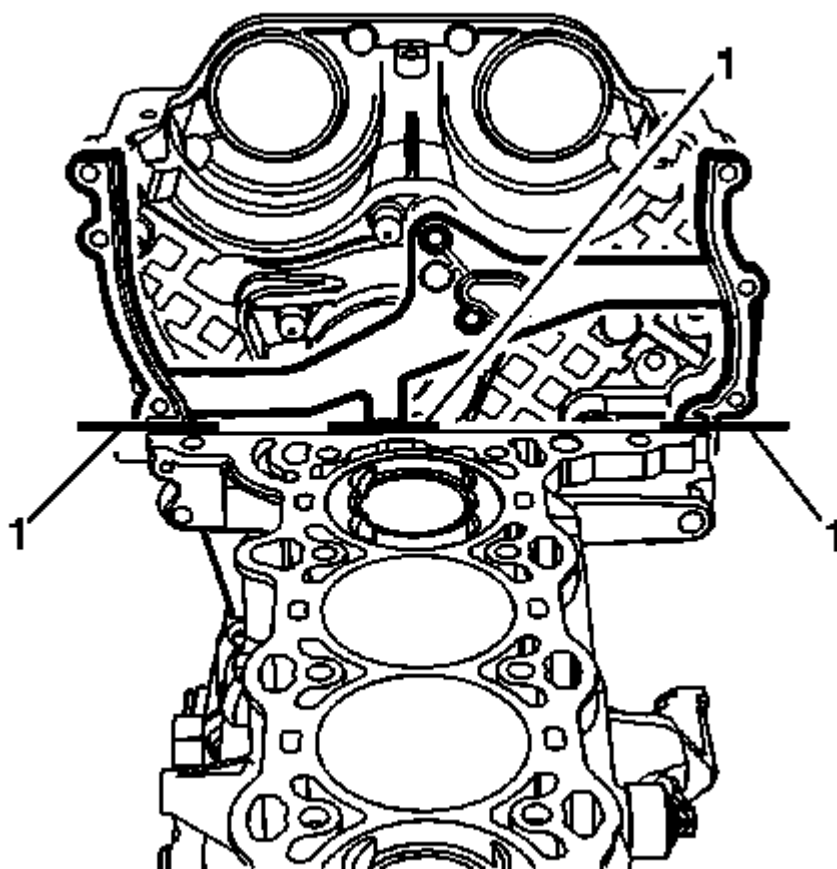


Fig. 54: Top Third Of Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

28. With the cylinder head out of vehicle bend the top third of the engine front cover gasket (1) back and forth until snaps off at the breaking point.
29. Transfer parts as necessary.
30. Clean and inspect the cylinder head. Refer to Cylinder Head Cleaning and Inspection .
31. For disassembly of the cylinder head. Refer to Cylinder Head Disassemble .

INSTALLATION PROCEDURE

1. For disassembly of the cylinder head. Refer to Cylinder Head Assemble
2. Clean sealing surfaces of engine front cover and engine block from grease and old gasket material.

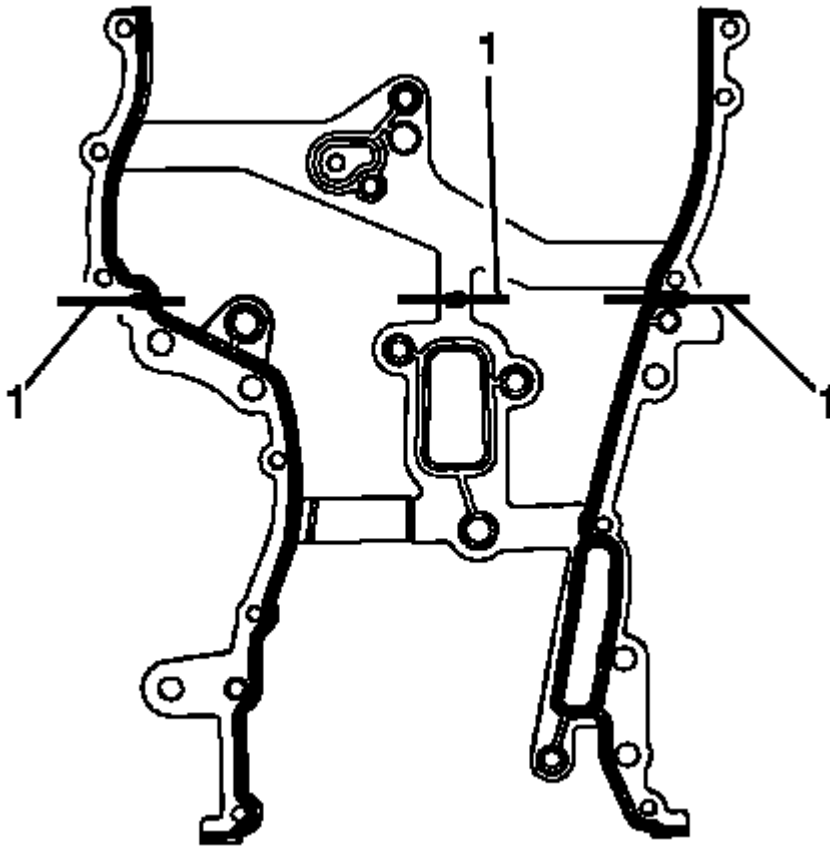


Fig. 55: engine front cover gasket

Courtesy of GENERAL MOTORS CORP.

NOTE: The engine front cover gasket comes as a complete unit.

3. Before installation the of the new front cover gasket, bend the top third of the engine front cover gasket (1) back and forth until snaps off at the breaking point.

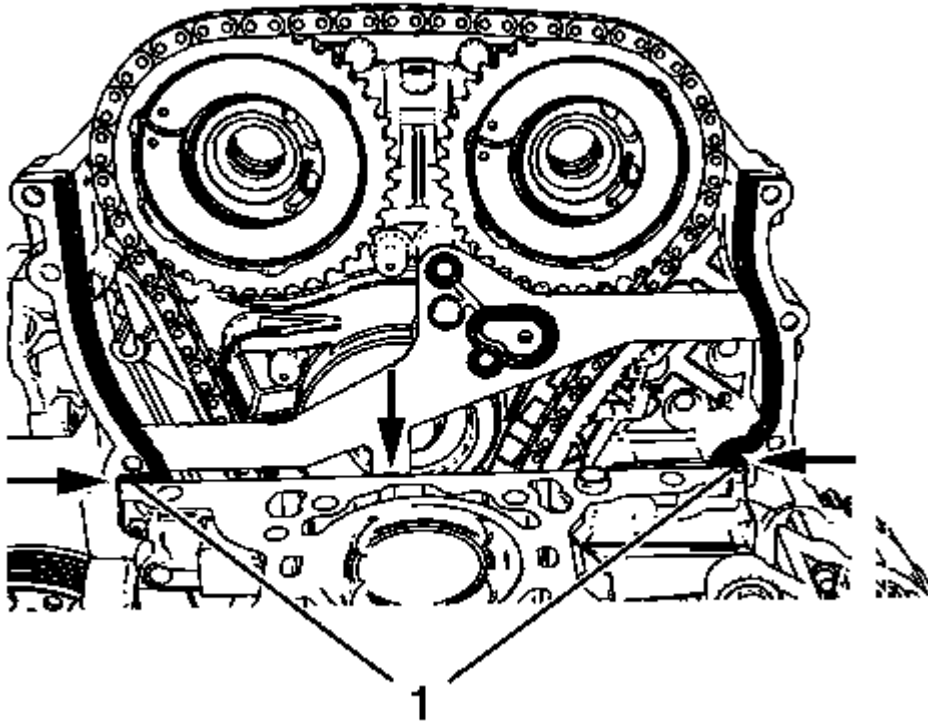


Fig. 56: Elastomer Sealing Strips

Courtesy of GENERAL MOTORS CORP.

4. Install the engine front cover gasket (1) to ensure for a proper fit and alignment.
5. Clean the surface of the cylinder head and engine front cover.
6. Install the cylinder head gasket to engine block.

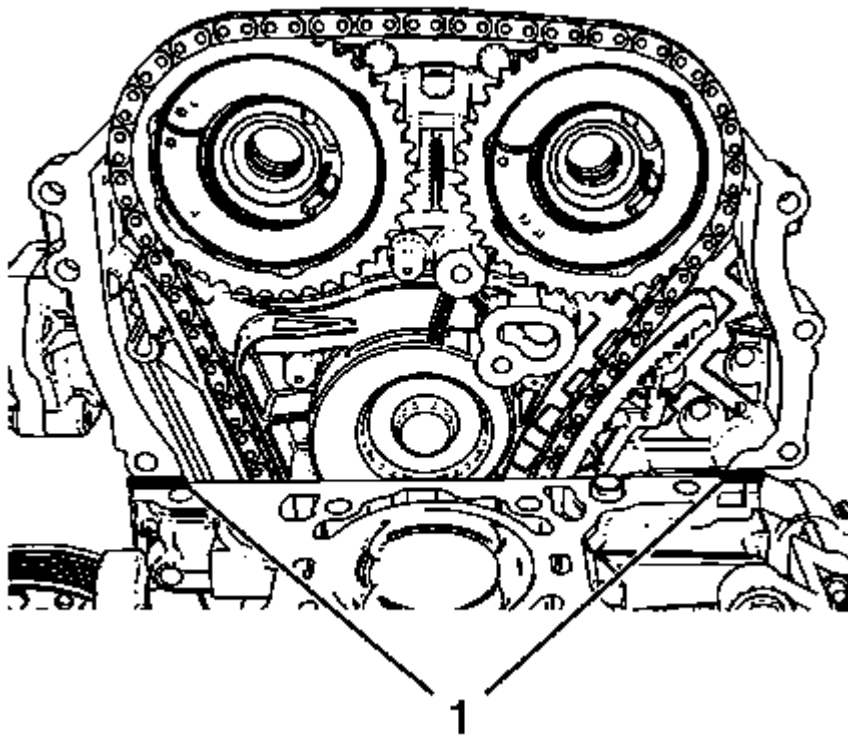


Fig. 57: Sealing Compound Application Area
Courtesy of GENERAL MOTORS CORP.

7. Apply a 2 mm (0.0787 in) bead of RTV sealant to the areas shown (1).

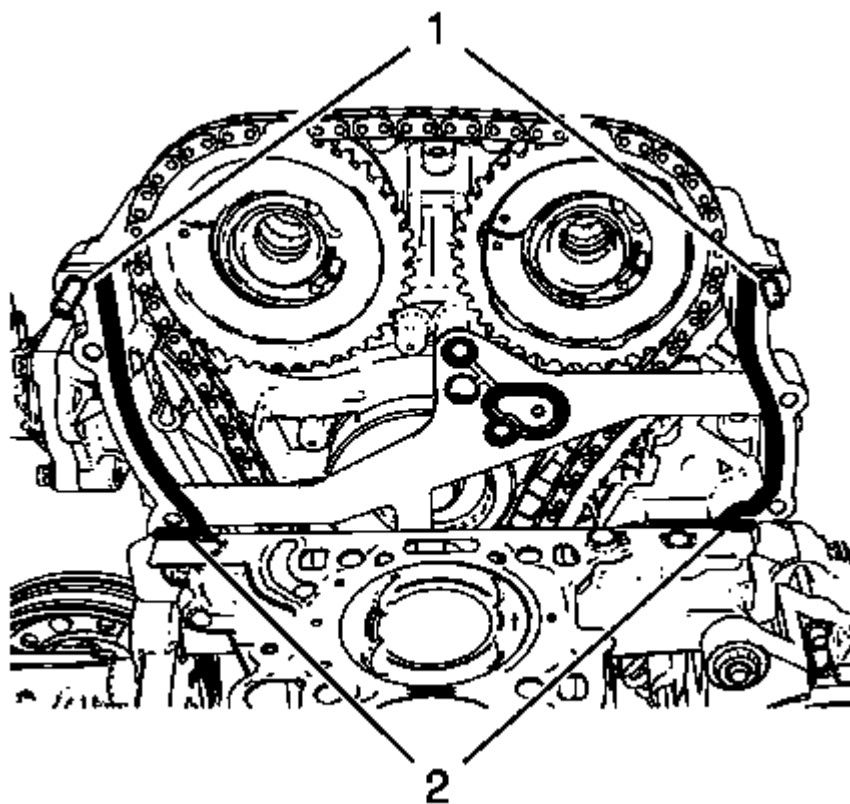


Fig. 58: Engine Front Cover Bolts And Sealing Compound Application Areas
Courtesy of GENERAL MOTORS CORP.

8. Install engine front cover bolts (1) in order to guide the NEW upper engine front cover gasket.
9. Apply a 2 mm (0.0787 in) bead of RTV sealant to the areas shown (2).

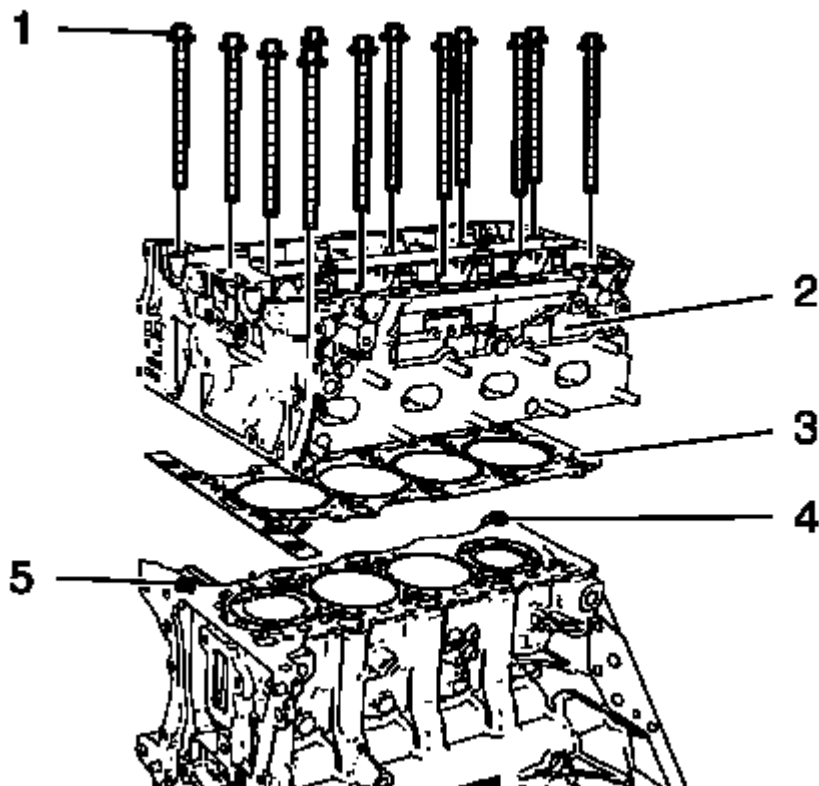


Fig. 59: Cylinder Head, Cylinder Head Gasket, Cylinder Head Bolts And Guide Sleeves
Courtesy of GENERAL MOTORS CORP.

10. Ensure the guide sleeves are in place (4) and (5) before installing the cylinder head.
11. Install a NEW cylinder head gasket (3). The marking "Top" should point to the cylinder head.
12. Install the cylinder head (2).
13. Install the cylinder head bolts (1) and hand tighten only.

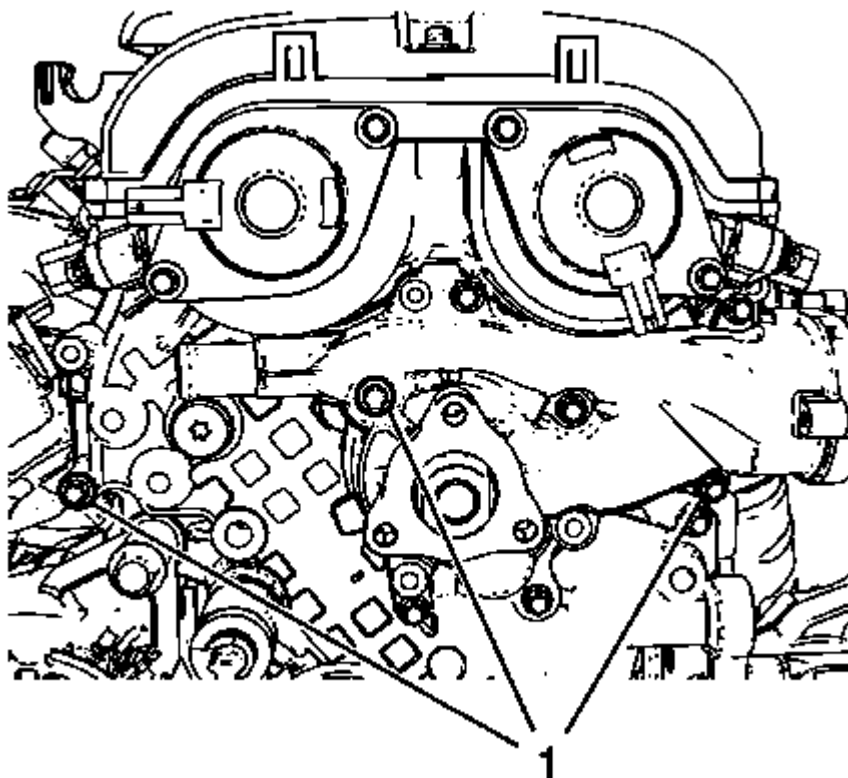


Fig. 60: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

14. Adjust the cylinder head to the engine front cover. Use a rubber mallet.
15. Position the engine front cover to cylinder head by installing 3 bolts (1).

CAUTION: Refer to Fastener Caution .

16. Tighten the 3 bolts (1) to 8 N.m (71 lb in).

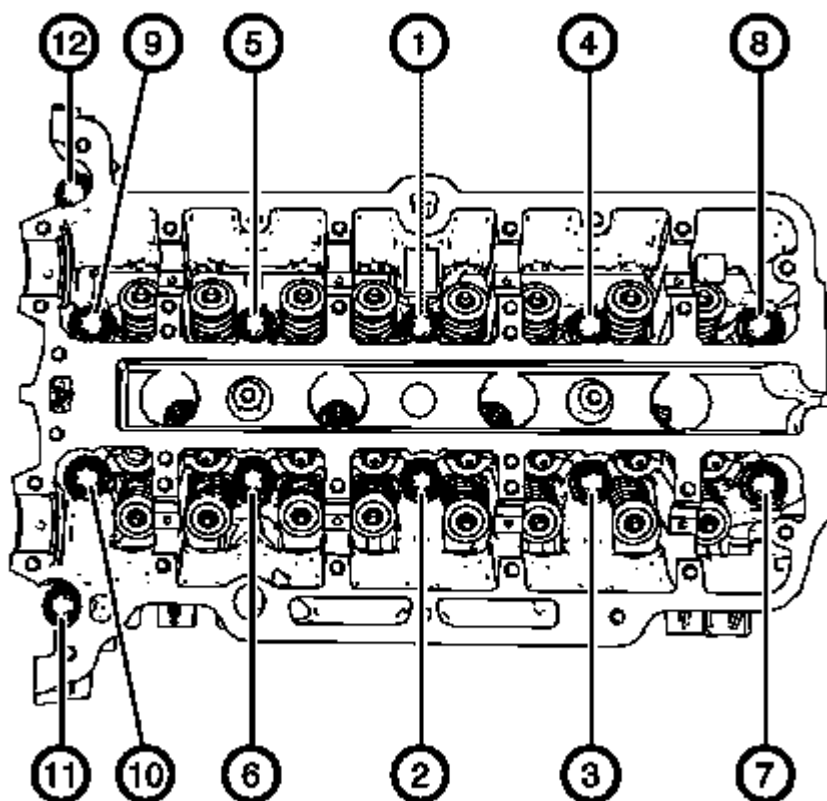


Fig. 61: Cylinder Head Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

17. Using a **EN-470-B**: angular torque wench tighten the cylinder head bolts in the sequence as shown above. Tighten the cylinder head bolts to 25 N.m (18 lb ft) plus 180 degrees.

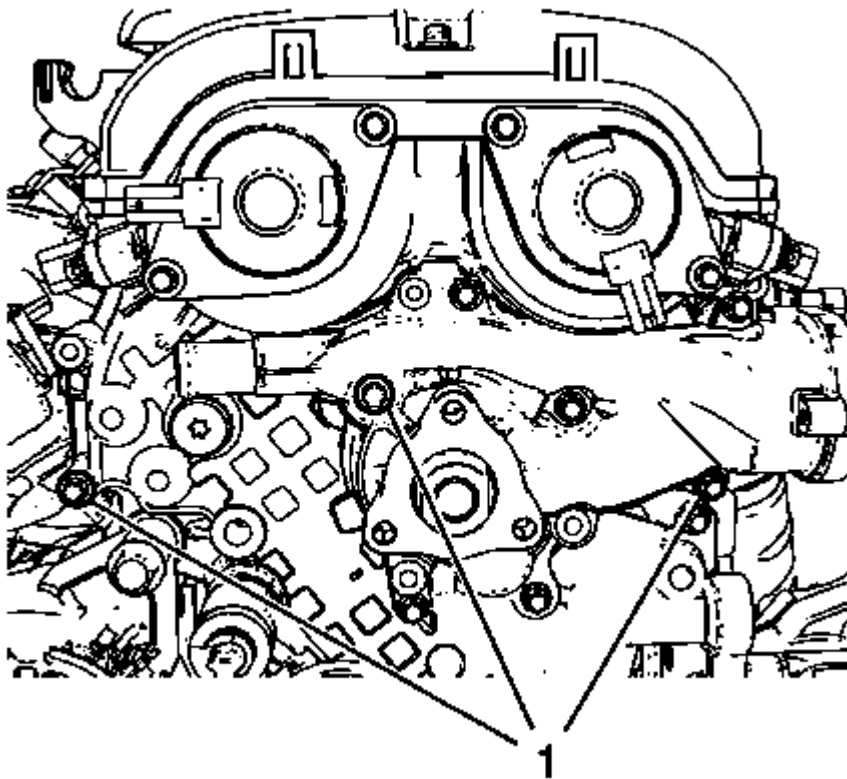


Fig. 62: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

18. Loosen the bolts from engine front cover (1).

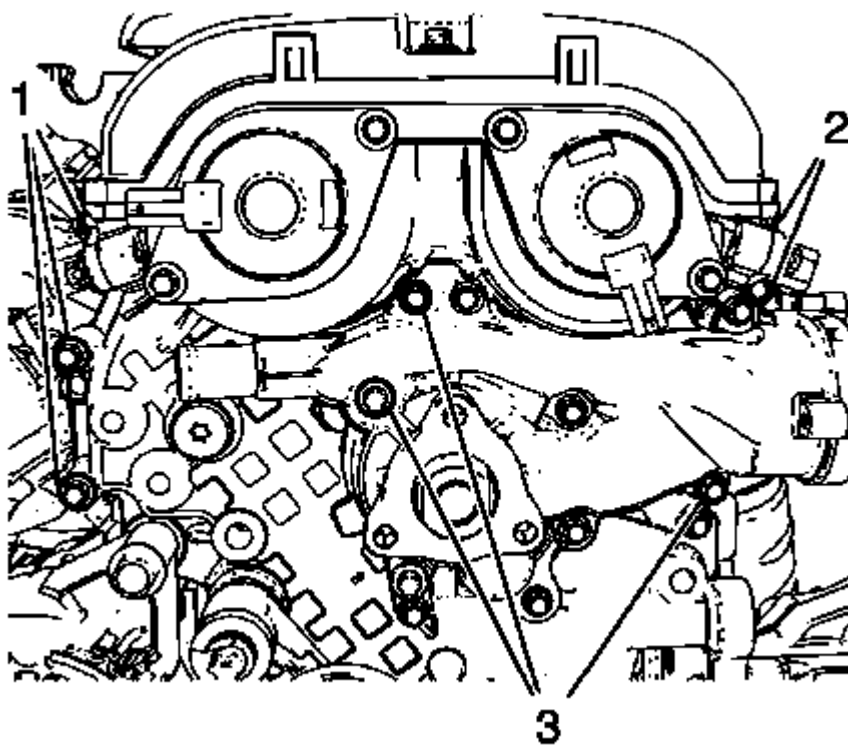


Fig. 63: Engine Front Cover Bolts And Water Pump Bolts
Courtesy of GENERAL MOTORS CORP.

19. Install the remaining bolts to engine front cover and water pump.
20. Tighten the engine front cover bolts (1) and (2) to 8 N.m (71 lb in).
21. Tighten the water pump bolts (3) to 8 N.m (71 lb in).
22. Install the water pump pulley. Refer to **Water Pump Pulley Replacement** .
23. Install engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side**.
24. Install the engine mount. Refer to **Engine Mount Replacement - Right Side**

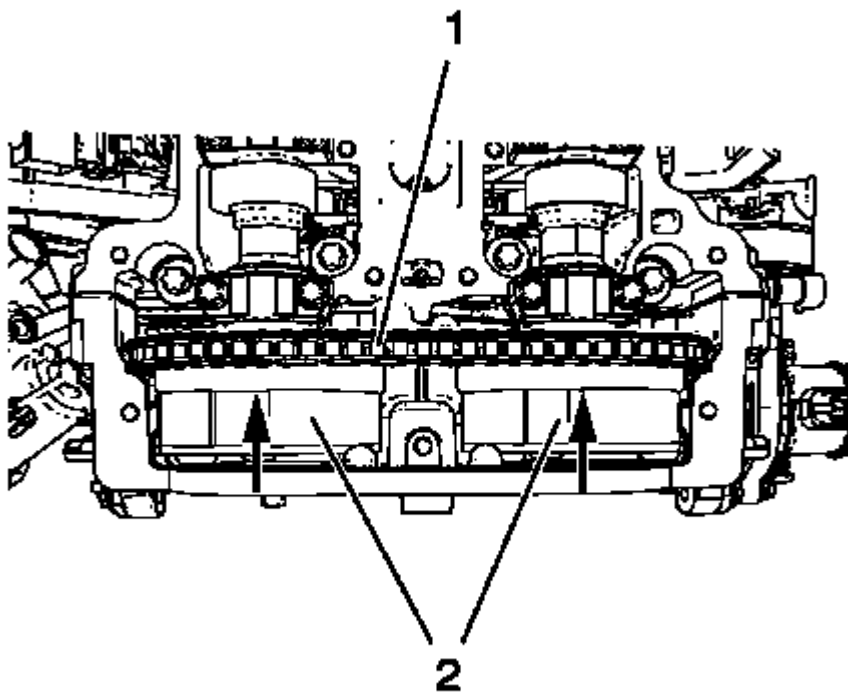


Fig. 64: Timing Chain And Camshaft Sprockets
Courtesy of GENERAL MOTORS CORP.

25. Install the camshaft sprockets (2) and timing chain (1) as one unit.

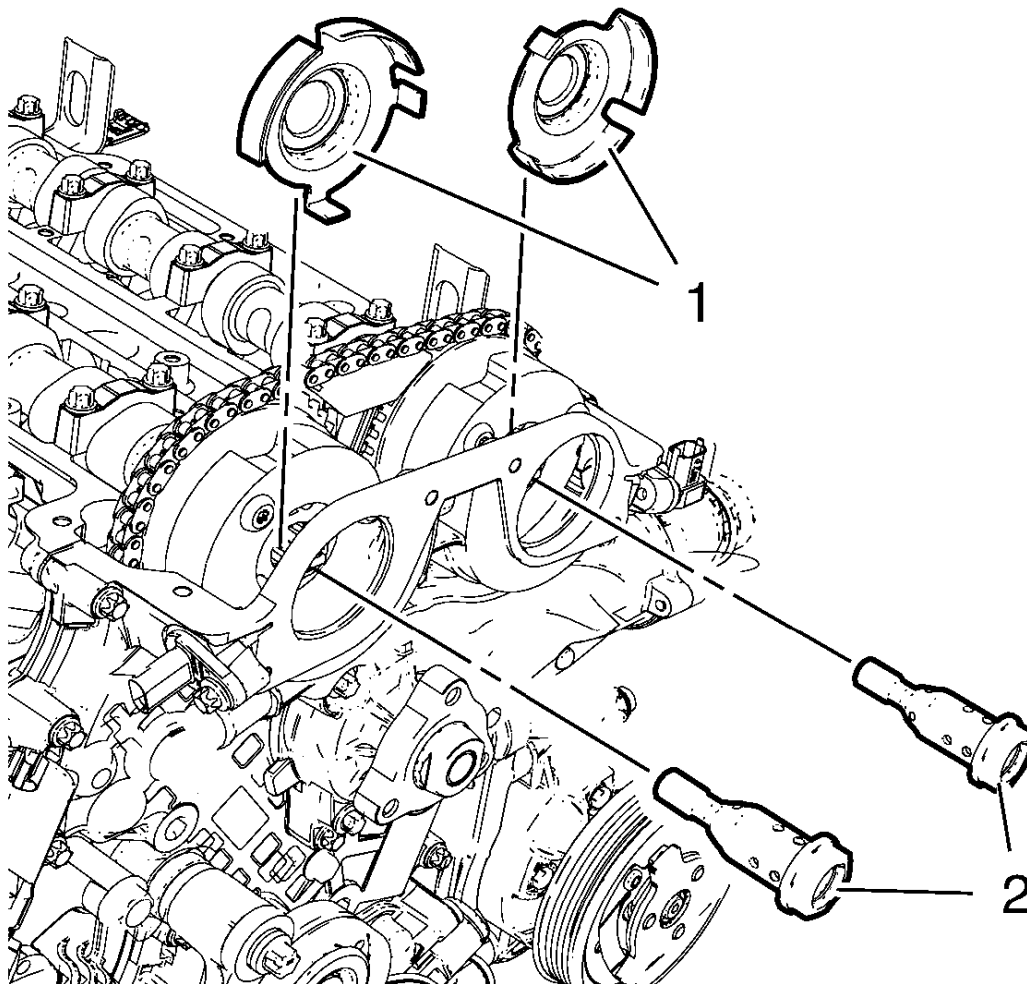


Fig. 65: Camshaft Position Exciter Wheels And Camshaft Sprocket Bolts
 Courtesy of GENERAL MOTORS CORP.

26. Install the camshaft position exciter wheels (1).
27. Install the camshaft sprocket bolts (2) and tighten to 50 N.m (37 lb ft) plus 45 + 15 degrees.
28. Remove the **EN-955:** locking pin.
29. Adjust the camshaft timing chain. Refer to **Camshaft Timing Chain Inspection**

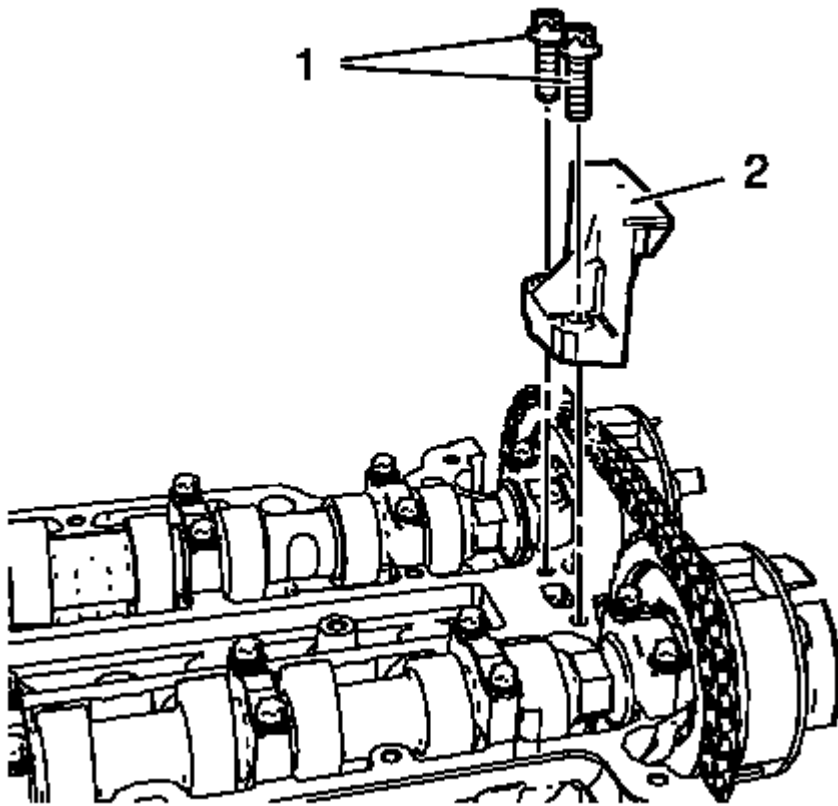


Fig. 66: Upper Timing Chain Guide And Bolts
Courtesy of GENERAL MOTORS CORP.

30. Install the upper timing chain guide (2).
31. Install the upper timing chain guide bolts (1) and tighten to 8 N.m (71 lb in).

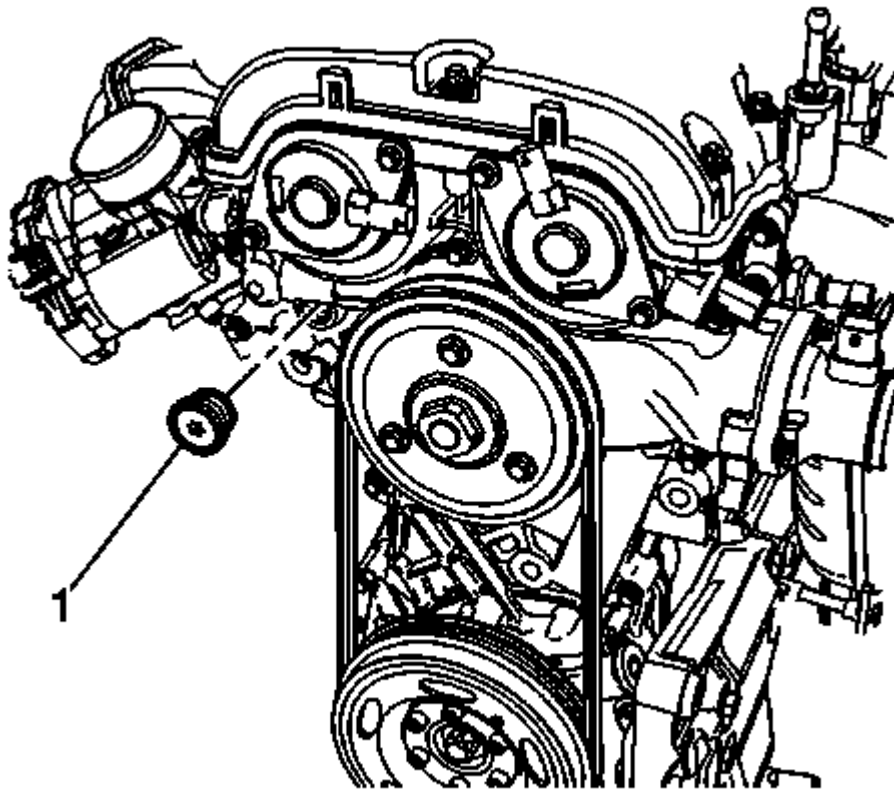


Fig. 67: Timing Chain Tensioner Plug
Courtesy of GENERAL MOTORS CORP.

32. Install the timing chain tensioner plug and tighten to 50 N.m (37 lb ft).
33. Install the Camshaft Position Actuator Solenoid Valve intake and exhaust. Refer to **Camshaft Position Actuator Solenoid Valve Replacement (Intake)** or **Camshaft Position Actuator Solenoid Valve Replacement (Exhaust)** .
34. Install the Camshaft Position Sensor Exhaust only. Refer to **Camshaft Position Sensor Replacement (Exhaust)** or **Camshaft Position Sensor Replacement (Intake)** .
35. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
36. Install the exhaust manifold. Refer to **Exhaust Manifold with Catalytic Converter Replacement** .
37. Install Intake manifold. Refer to **Intake Manifold Replacement**
38. Fill coolant fluid. Refer to **Cooling System Draining and Filling** .
39. Enable the high voltage system. Refer to **High Voltage Enabling** .
40. Test the vehicle using the following procedure:
 - Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
 - Start the engine and listen for unusual noises.
 - Check the vehicle oil pressure gauge or light and confirm that the engine has acceptable oil pressure.

- Run the engine speed at about 1, 000 RPM until the engine has reached normal operating temperature.
- Listen for sticking lifter and other unusual noises.
- Inspect for fuel, oil and/or coolant leaks while the engine is running.

41. Road test the vehicle for normal operation.

42. Inspect for coolant, oil, gas or exhaust leaks.

OIL PAN REPLACEMENT

SPECIAL TOOLS

EN-49980: Guidance Pins

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

REMOVAL PROCEDURE

1. Remove the oil filter and drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
2. Remove the catalytic converter. Refer to **Catalytic Converter Replacement** .
3. Remove the heater inlet and outlet pipes. Refer to **Heater Inlet And Outlet Pipe Replacement**
4. Remove the crankshaft pulley. Refer to **Crankshaft Balancer Replacement**.

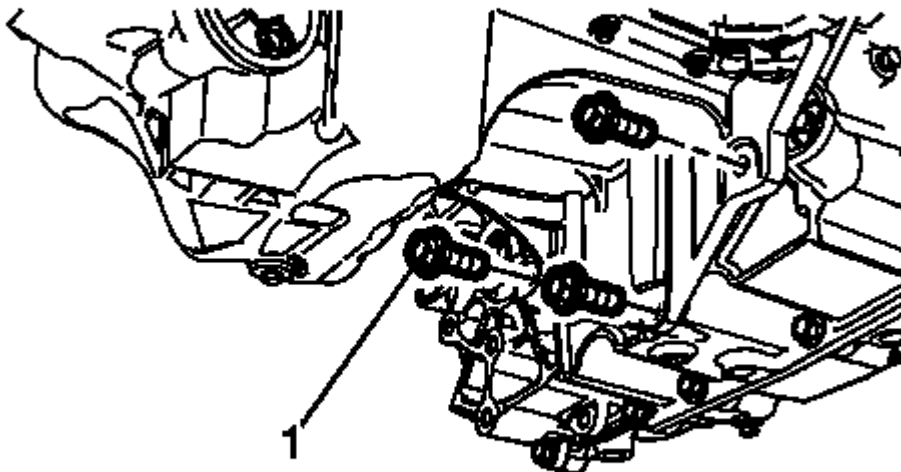


Fig. 68: Oil Pan To Transmission Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the oil pan to transmission bolts (1).

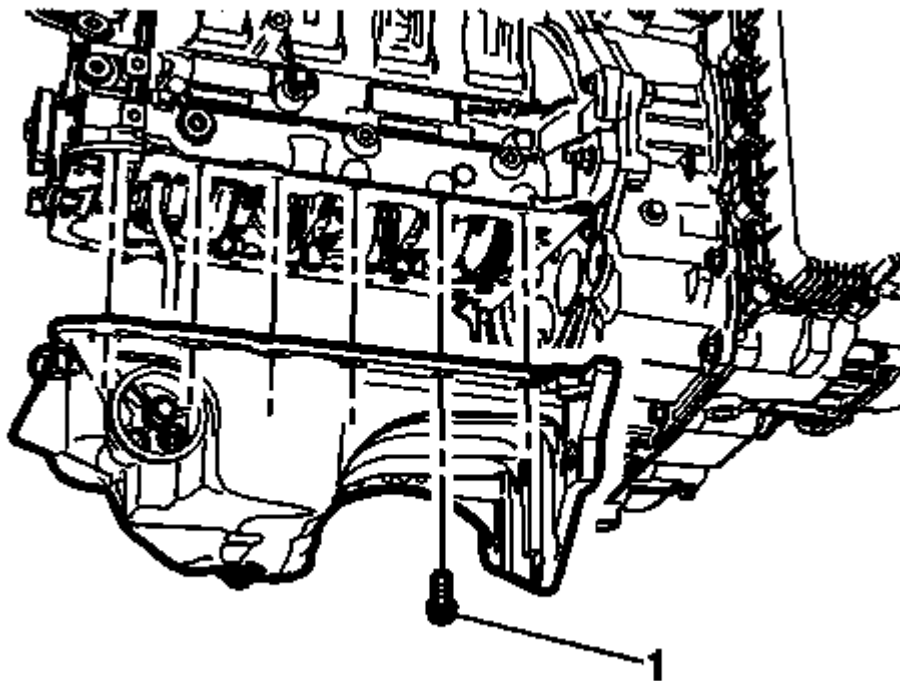


Fig. 69: Oil Pan Bolts

Courtesy of GENERAL MOTORS CORP.

6. Remove the oil pan bolts (1).

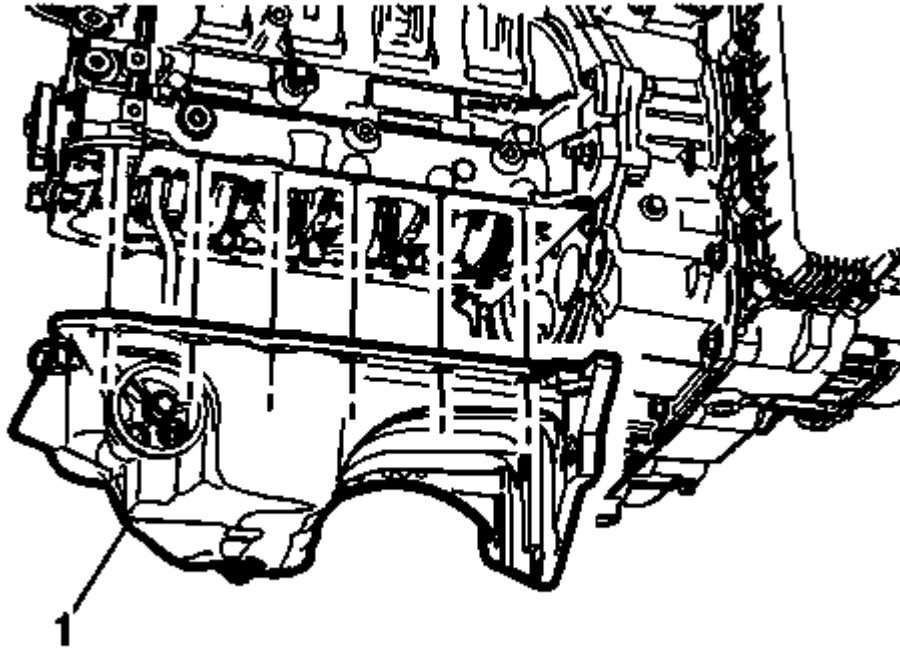


Fig. 70: Oil Pan

Courtesy of GENERAL MOTORS CORP.

7. Remove the oil pan.

INSTALLATION PROCEDURE

1. Clean the sealing surface of crankshaft bearing cap tie plate and the groove in the engine front cover from old gasket material, oil, dirt and grease.

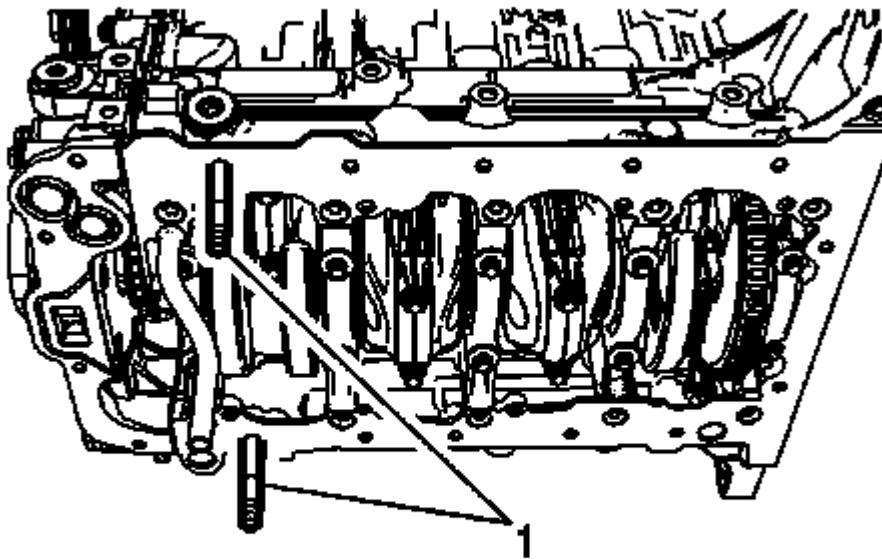


Fig. 71: Oil Pan Guidance Pins

Courtesy of GENERAL MOTORS CORP.

2. Install the 2 **EN-49980:** guidance pins (1) to the shown oil pan screw bores.

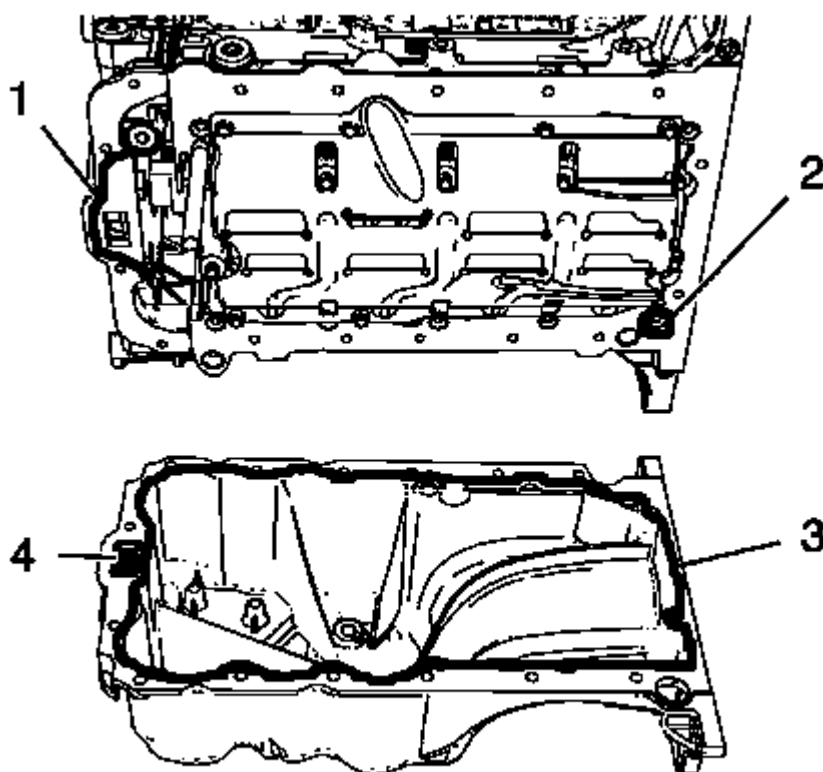


Fig. 72: Engine Front Cover, Oil Suction Gallery And Screw Bore
Courtesy of GENERAL MOTORS CORP.

NOTE: The sealing bead should be applied close to the inner edge of the oil pan. Take care that the oil suction gallery (4) will not get contaminated with sealing compound or dirt.

3. Apply 2 mm (0.0787 in) thickness of sealing compound (3, 2, 1).

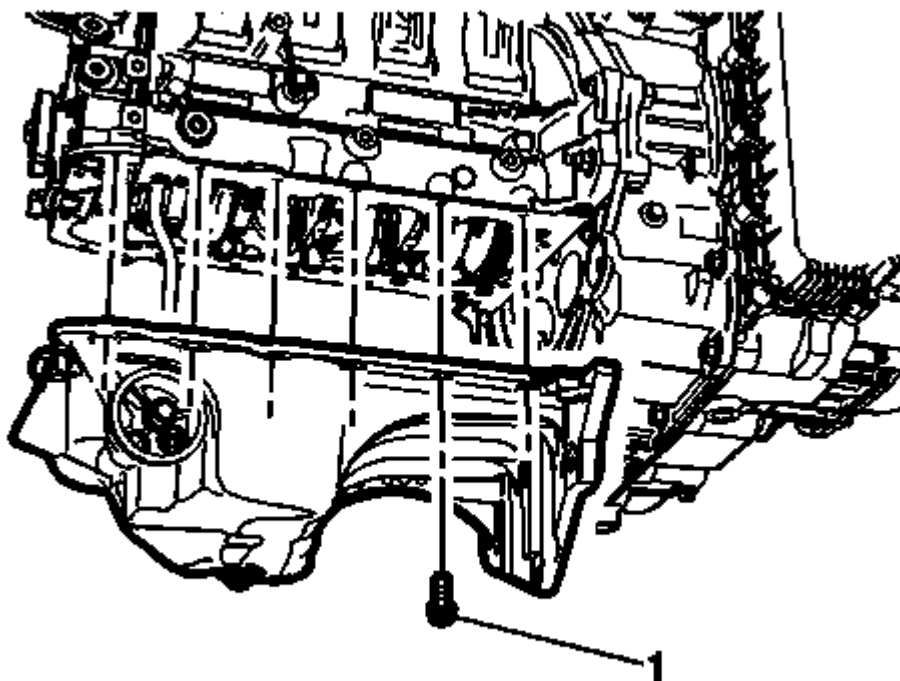


Fig. 73: Oil Pan Bolts

Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: The complete installation procedure of the oil pan should be done in 10 minutes.

4. Loosely install the oil pan bolts (1) in all but the guidance pin locations.
5. Remove the **EN-49980**: guidance pins and install the remaining oil pan bolts.
6. Tighten the oil pan bolts to 10 N.m (89 lb in).
7. Position the transmission converter cover and hand tighten the cover to transmission bolt.

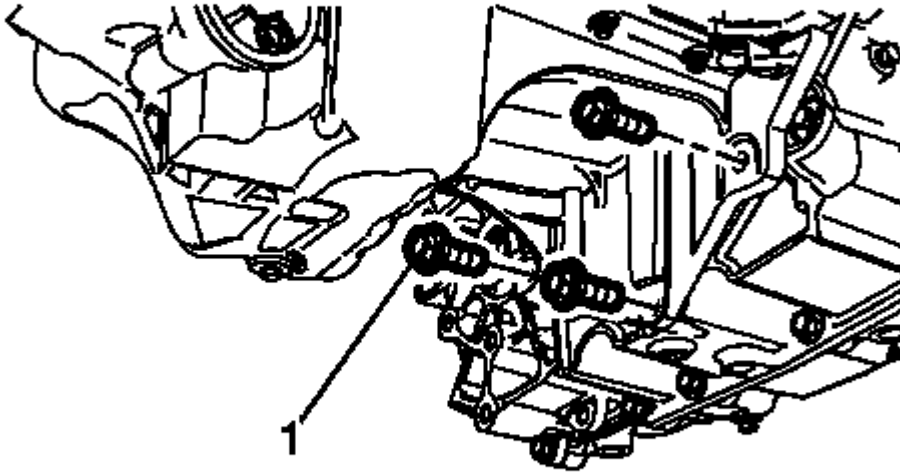


Fig. 74: Oil Pan To Transmission Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the oil pan to transmission bolts (1), and tighten to 40 N.m (30 lb ft).
9. Install a NEW oil filter and fill the engine with oil. Refer to **Engine Oil and Oil Filter Replacement**.
10. Install the catalytic converter. Refer to **Catalytic Converter Replacement**.
11. Install the crankshaft pulley. Refer to **Crankshaft Balancer Replacement**.
12. Install the heater inlet and outlet pipes, and refill the coolant system. Refer to **Heater Inlet And Outlet Pipe Replacement**

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

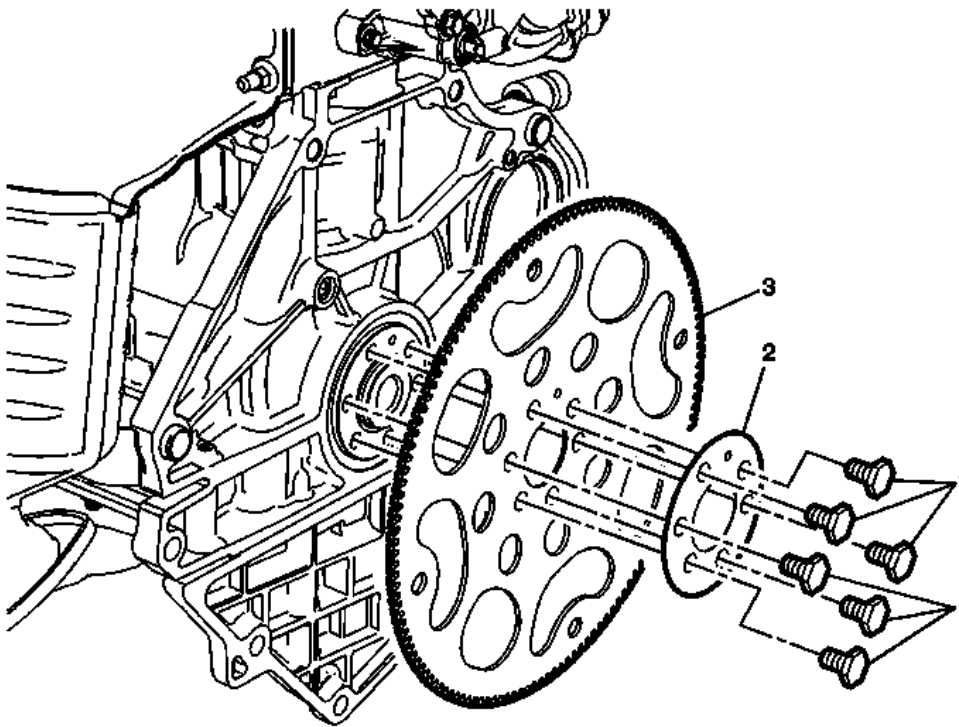


Fig. 75: Automatic Transmission Flex Plate And Bolts
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the transmission. Refer to <u>Transmission Replacement</u> .	
Special Tools • EN-470-B: Angular Torque Wrench • EN-956-1: Extension • EN-49979: Crankshaft Shock Mount Retainer	
For equivalent regional tools, refer to <u>Special Tools</u> .	
1	Automatic Transmission Flex Plate Fastener (Qty: 6) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: • 35 N.m (26 lb ft) • Tighten the bolt an additional 30 degrees, and one more pass at 15 degrees using EN-

	470-B: wrench.
2	Flex Plate
3	Automatic Transmission Flex Plate Procedure: Inspect the engine flywheel for the following: 1. Stress cracks around the engine flywheel 2. Cracks at welded areas that retain the ring gear onto the engine flywheel 3. Damaged or missing ring gear teeth 4. Do not attempt to repair the welded areas that retain the ring gear to the engine flywheel plate. Install a new engine flywheel.

CRANKSHAFT BALANCER REPLACEMENT

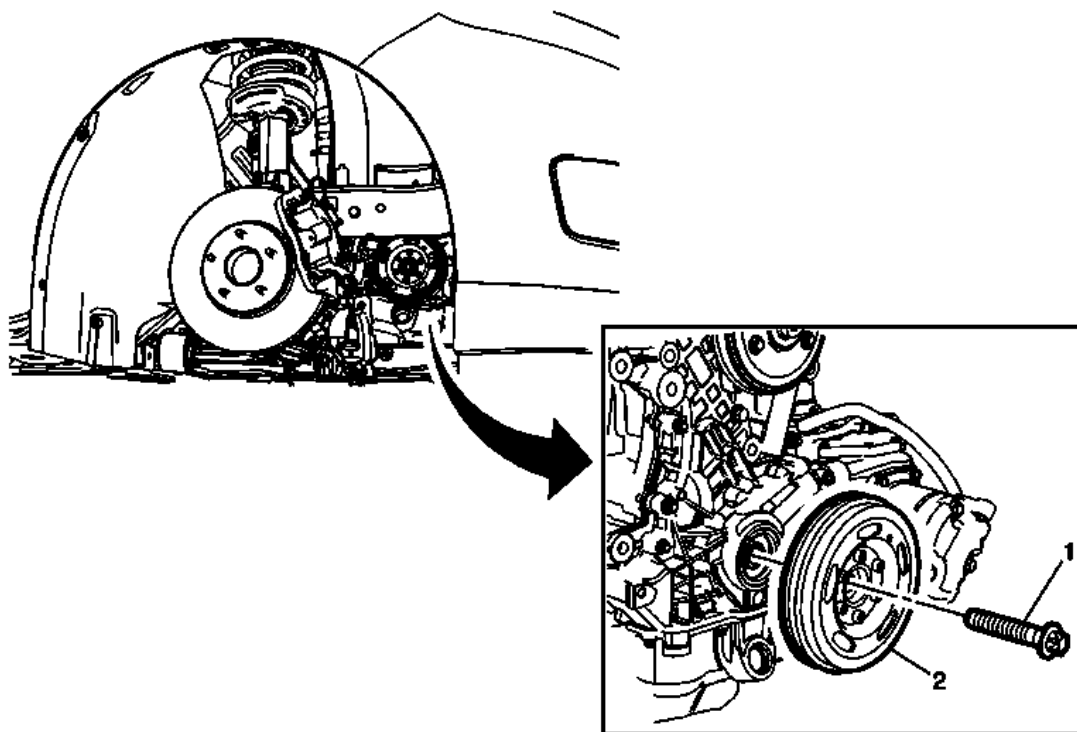


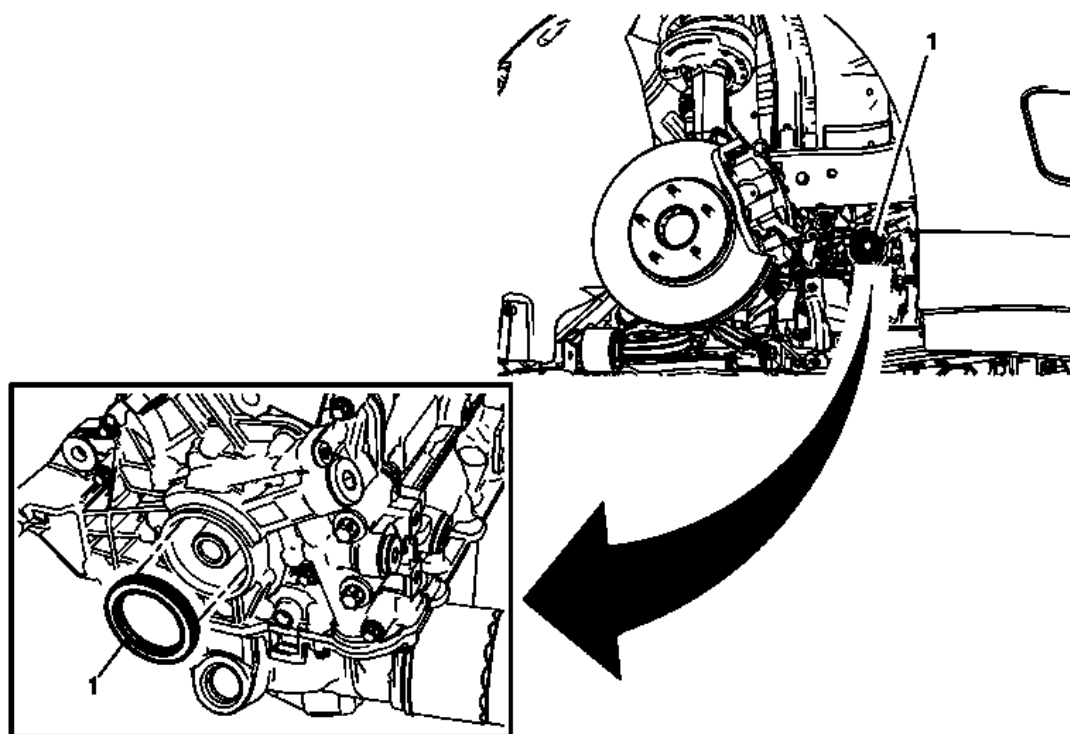
Fig. 76: Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1.	Remove the water pump belt. Refer to <u>Water Pump Belt Replacement</u> .
2.	Remove the heater water auxiliary pump. Refer to <u>Heater Water Auxiliary Pump Replacement</u>
3.	Remove the drive motor battery coolant cooler Inlet hose assembly. Refer to <u>Drive Motor Battery</u>

Coolant Cooler Inlet Hose Assembly Replacement

1	Crankshaft Pulley Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten: • 150 N.m (111 lb ft) • Tighten the bolt an additional 60 degrees.
2	Crankshaft Pulley Procedure 1. Use EN-49979: retainer and EN-956-1: extension to remove the crankshaft pulley. 2. To ensure correct installation of the crankshaft pulley, measure the distance between the pulley and the front cover. Refer to <u>Crankshaft Balancer Installation</u> . Special Tools • EN-470-B: Angular Torque Wrench • EN-956-1: Extension • EN-49979: Crankshaft Shock Mount Retainer For equivalent regional tools, refer to <u>Special Tools</u> .

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

**Fig. 77: Crankshaft Front Oil Seal**

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the crankshaft balancer. Refer to Crankshaft Balancer Replacement .	
1	Camshaft Front Oil Seal Procedure 1. Using a flat-bladed tool, remove the crankshaft front oil seal. 2. Use EN-960: installer to install the new crankshaft front oil seal. Special Tools: EN-960: Crankshaft Front Oil Seal Installer For equivalent regional tools, refer to Special Tools .

CRANKSHAFT REAR OIL SEAL REPLACEMENT

SPECIAL TOOLS

EN-658: Rear Main Seal Installer

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

REMOVAL PROCEDURE

1. Remove the automatic transmission flex plate. Refer to [Automatic Transmission Flex Plate Replacement](#).

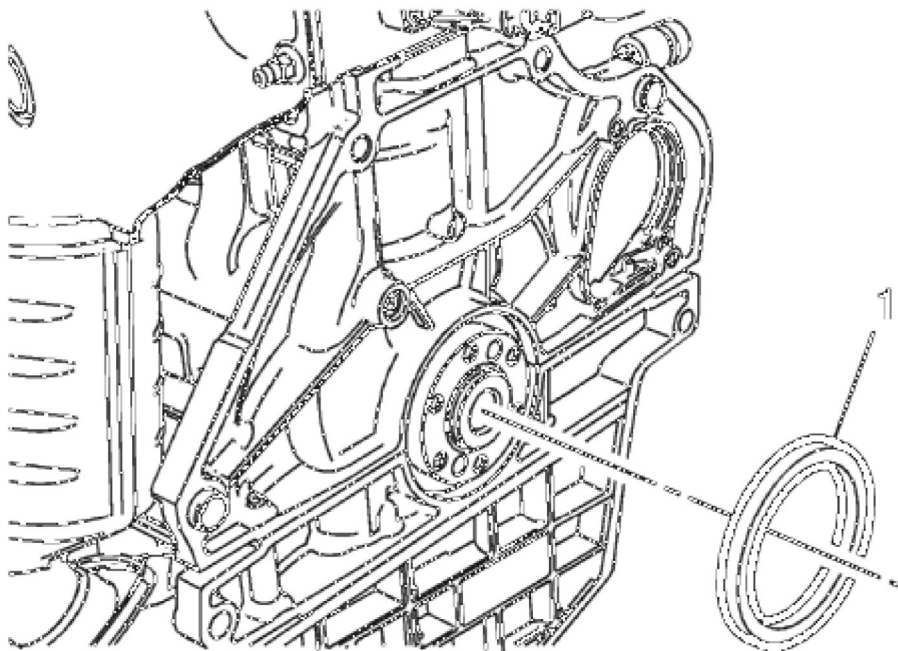


Fig. 78: Rear Crankshaft Oil Seal
Courtesy of GENERAL MOTORS CORP.

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

2. Using a flat-bladed tool, remove the rear crankshaft oil seal (1).

INSTALLATION PROCEDURE

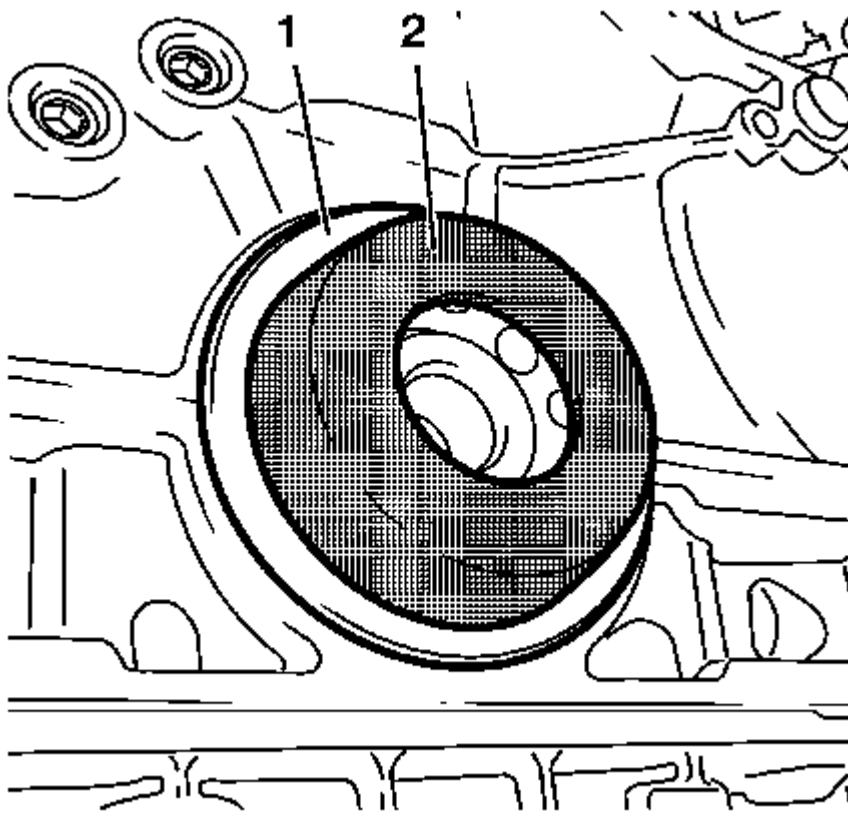


Fig. 79: Crankshaft Rear Oil Seal And Installer
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft rear oil seal (1) with **EN-658**: installer (2).

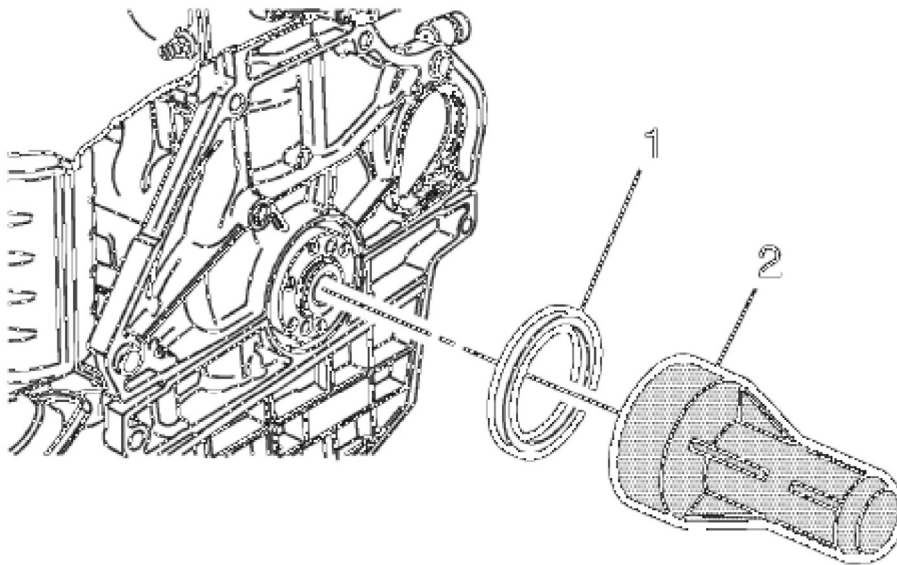


Fig. 80: Crankshaft Real Oil Seal Installer
 Courtesy of GENERAL MOTORS CORP.

2. Using the **EN-658:** installer (2), install a NEW crankshaft real oil seal (1).
3. Install the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Replacement.**

ENGINE FRONT COVER WITH OIL PUMP REPLACEMENT

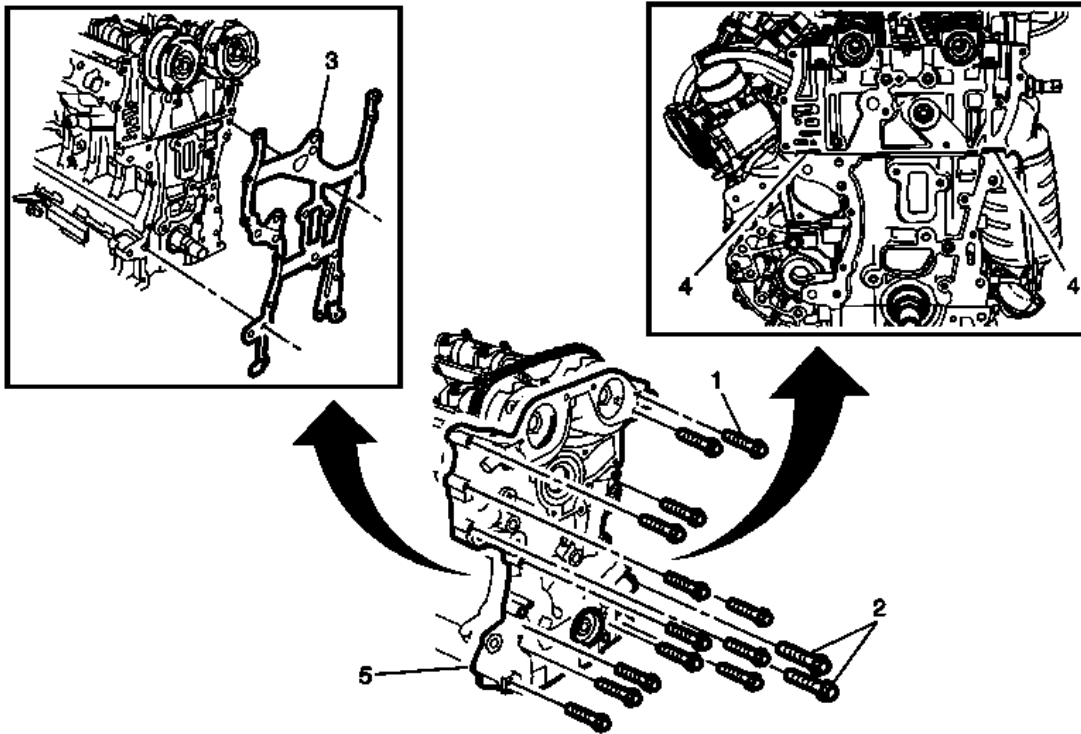
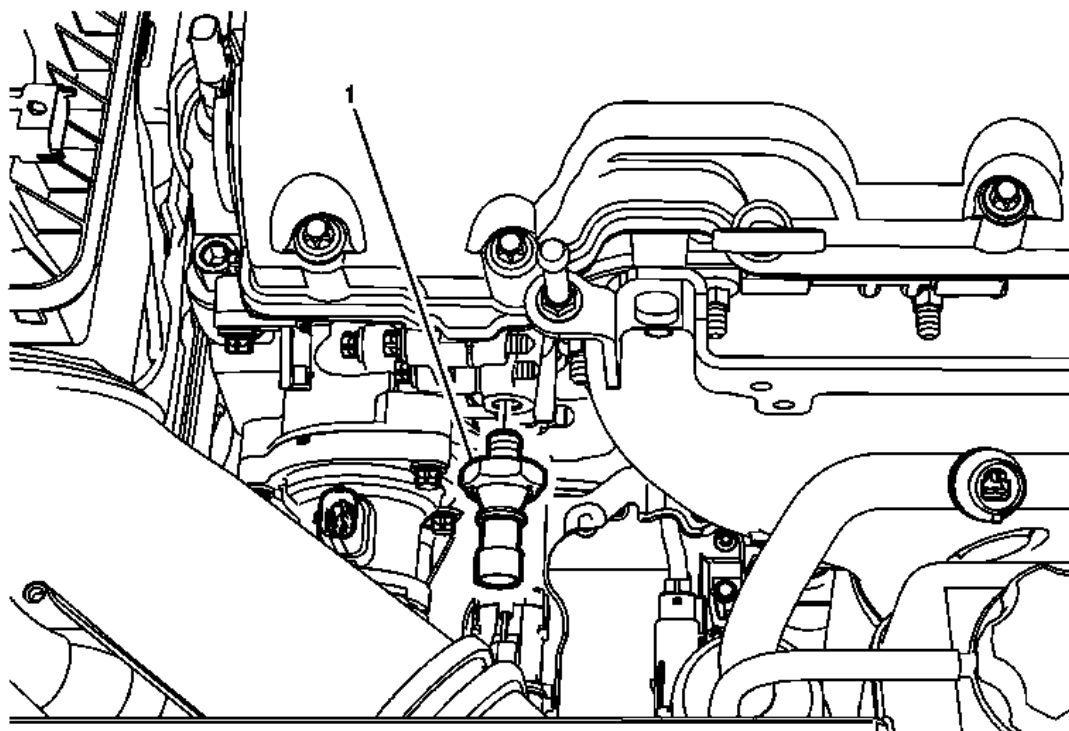


Fig. 81: Engine Front Cover with Oil Pump
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Remove the camshaft cover. Refer to <u>Camshaft Cover Replacement</u>. 2. Remove both camshaft position actuator solenoid valves. Refer to <u>Camshaft Position Actuator Solenoid Valve Replacement (Intake)</u> or <u>Camshaft Position Actuator Solenoid Valve Replacement (Exhaust)</u>. 3. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u>. 4. Install the engine support fixture. Refer to <u>Engine Support Fixture</u>. 5. Remove the water pump pulley and the water pump. Refer to <u>Water Pump Replacement</u>. 6. Remove the oil pan. Refer to <u>Oil Pan Replacement</u>.	
1	Engine Front Cover with Oil Pump Fastener (Qty: 13) CAUTION: Refer to <u>Fastener Caution</u>. Procedure: Ensure to mark the location of each bolt. Tighten: 8 N.m (71 lb in)

2	Engine Front Cover with Oil Pump Fastener (Qty: 2) Tighten: 35 N.m (26 lb ft)
3	Engine Front Cover with Oil Pump Gasket Procedure 1. Remove the camshaft timing chain out of the way before removing the engine front cover gasket. Refer to <u>Camshaft Timing Chain Replacement</u>. 2. Replace the engine front cover gasket whenever the cover is removed. Tip: Removal of timing chain is necessary to get access to engine front cover gasket.
4	Engine Front Cover RTV Sealant Procedure: Apply a 2 mm (0.0787 in) bead of RTV sealant to the areas shown (3).
5	Engine Front Cover with Oil Pump Procedure 1. To disassemble oil pump, refer to <u>Engine Front Cover and Oil Pump Disassemble</u> . 2. For cleaning and inspection of the oil pump, refer to <u>Engine Front Cover and Oil Pump Cleaning and Inspection</u> . 3. Reposition coolant hoses as necessary. 4. Disconnect electrical connector as necessary. 5. Transfer components as necessary.

ENGINE OIL PRESSURE INDICATOR SWITCH REPLACEMENT

**Fig. 82: Engine Oil Pressure Indicator Switch**

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the air cleaner resonator outlet duct. Refer to <u>Air Cleaner Resonator Outlet Duct Replacement</u>	
1	Engine Oil Pressure Sensor and/or Switch CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure 1. Disconnect the oil pressure sensor electrical connector. 2. Transfer components as necessary. Tighten: 20 N.m (15 lb ft)

ENGINE REPLACEMENT

REMOVAL PROCEDURE

WARNING: Always perform the High Voltage Disabling procedure prior to

servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure will perform the following tasks:

- **Identify how to disable high voltage.**
- **Identify how to test for the presence of high voltage.**
- **Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.**

Failure to follow the procedures exactly as written may result in serious injury or death.

1. Disable the high voltage system. Refer to **High Voltage Disabling** .
2. Drain the drive motor generator battery cooling system. Refer to **Drive Motor Battery Cooling System Draining and Filling** .
3. Drain the engine cooling system. Refer to **Cooling System Draining and Filling** .
4. Drain the drive motor generator cooling system. Refer to **Drive Motor Generator Power Inverter Module Cooling System Draining and Filling** .
5. Recover the air conditioning refrigerant. Refer to **Refrigerant Recovery and Recharging (High Voltage Electric Compressor)** .
6. Remove the drive motor generator power inverter module. Refer to **Drive Motor Generator Power Inverter Module Replacement** .

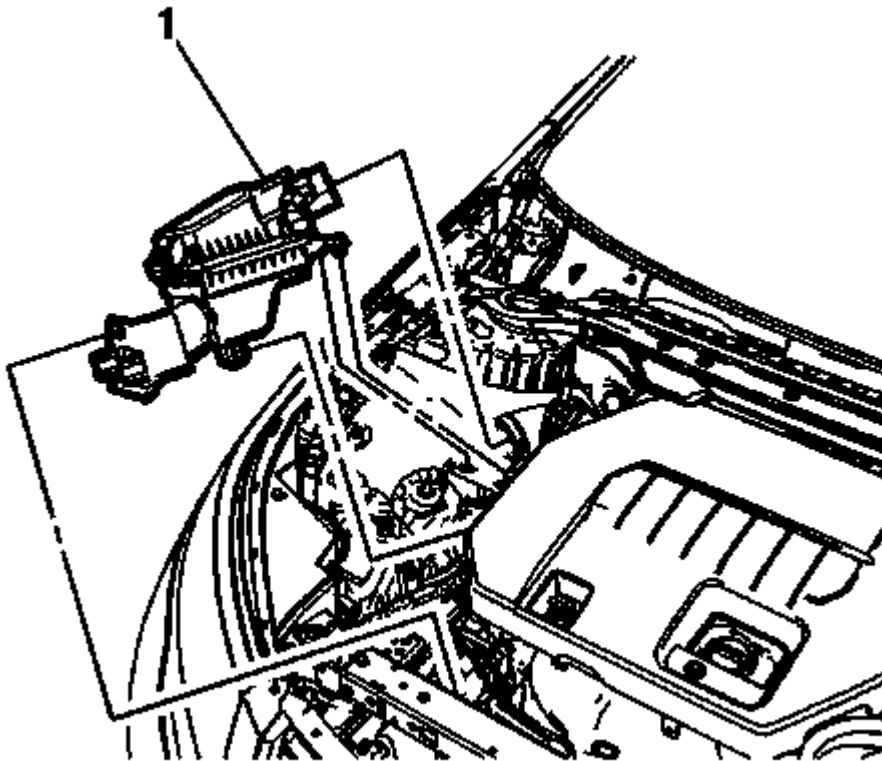


Fig. 83: Air Cleaner Assembly

Courtesy of GENERAL MOTORS CORP.

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

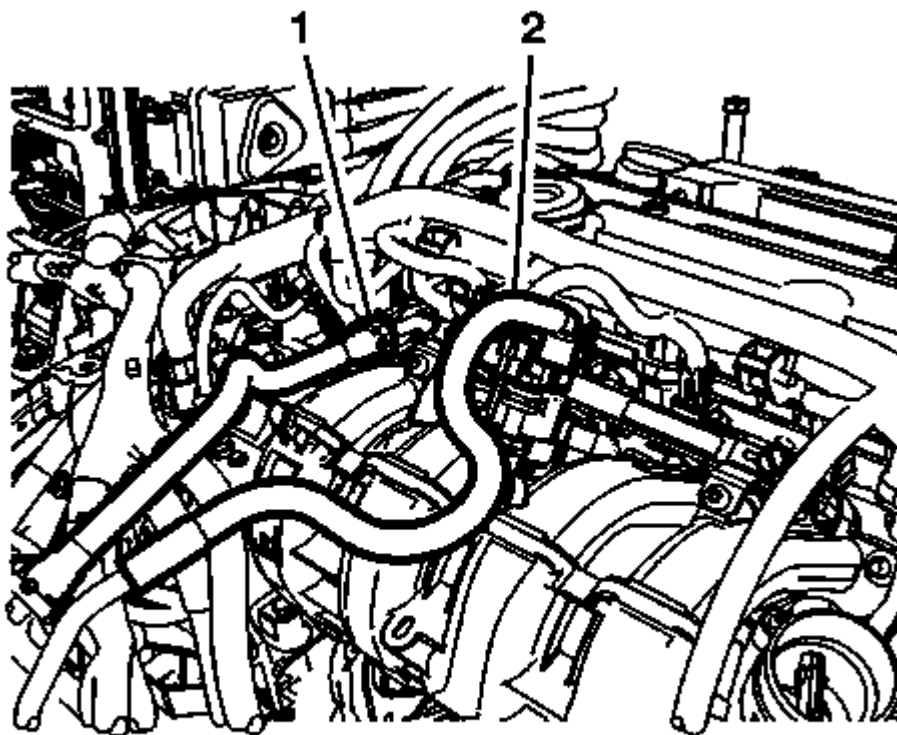


Fig. 84: Canister Purge Hose

Courtesy of GENERAL MOTORS CORP.

8. Disconnect the canister purge hose (2) from the purge solenoid located at the back of the of the valve cover.
9. Disconnect the fuel feed pipe (1) from the fuel rail assembly. Refer to **Fuel Feed Pipe Replacement (Engine Compartment)** or **Fuel Feed Pipe Replacement (Chassis)** .

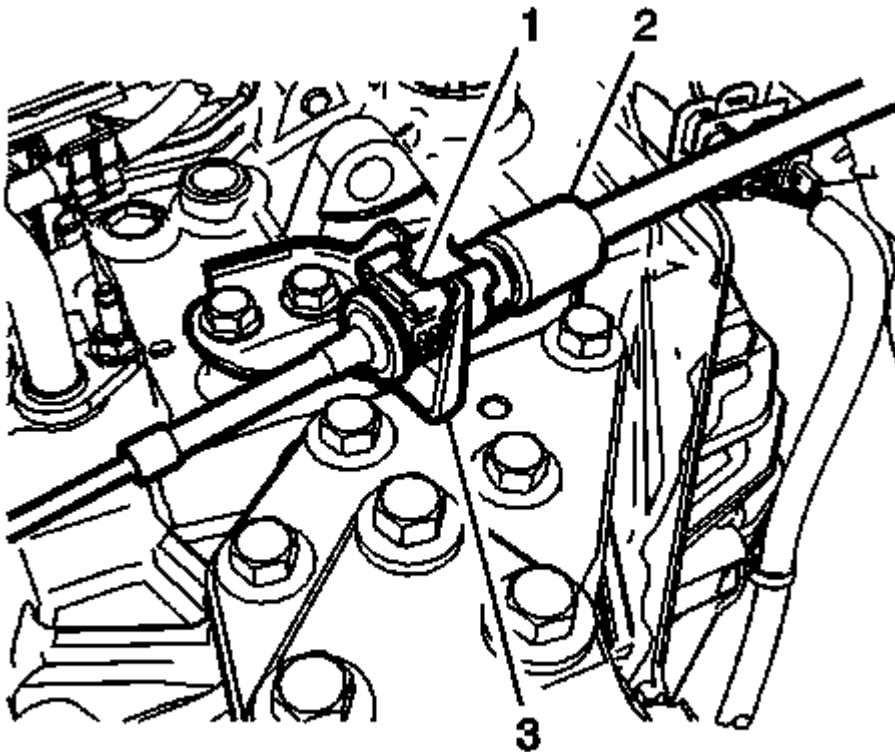


Fig. 85: Transmission Range Selector Lever Cable And Cable Bracket
Courtesy of GENERAL MOTORS CORP.

10. Press the locking tab (1) forward in order to release the transmission range selector lever cable (2) from the cable bracket.

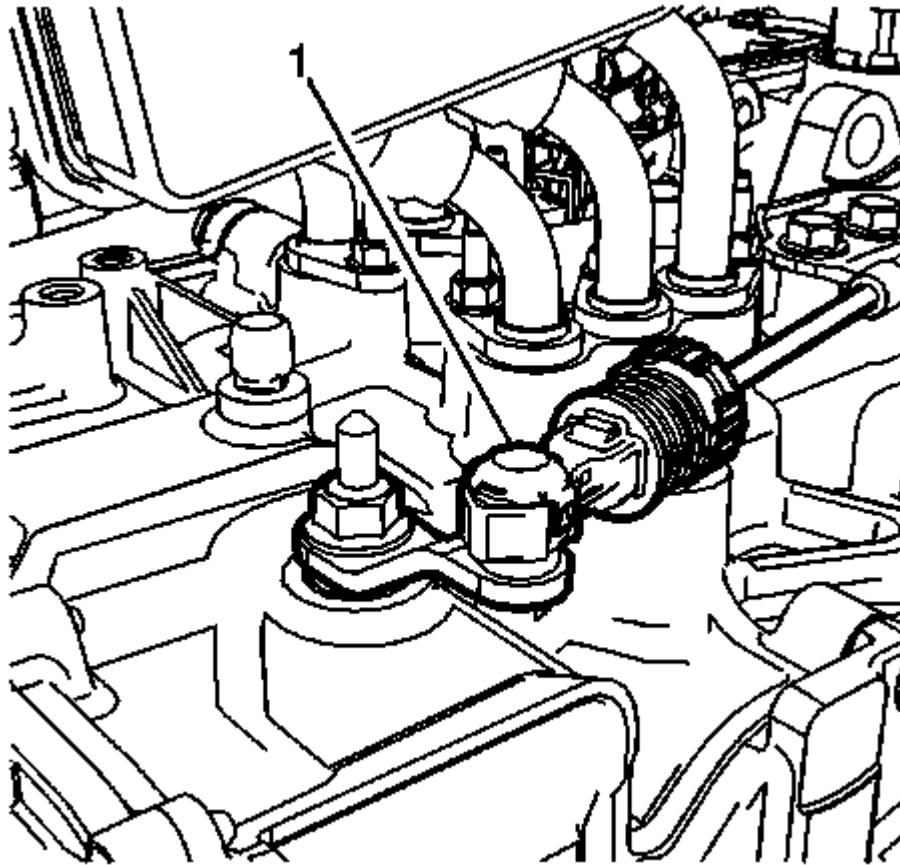


Fig. 86: Transmission Range Selector Lever Cable Terminal
Courtesy of GENERAL MOTORS CORP.

11. Disconnect the transmission range selector lever cable terminal (1) from the transmission manual pin, then position the cable out of the way.

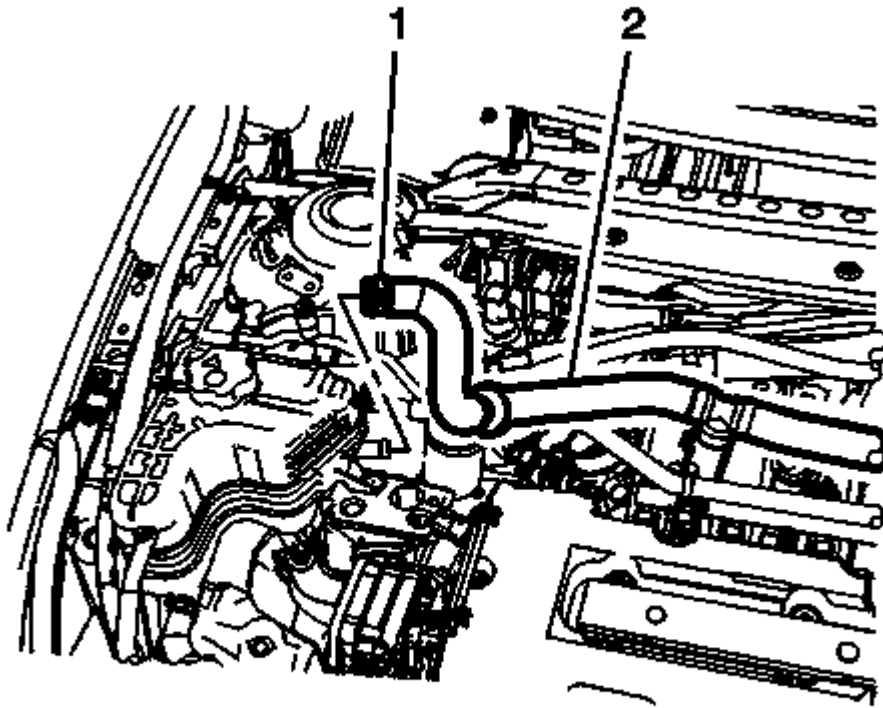


Fig. 87: Heater Water Auxiliary Pump Inlet Hose And Clamp
Courtesy of GENERAL MOTORS CORP.

12. Disconnect the heater water auxiliary pump inlet hose (2) from the coolant reservoir.

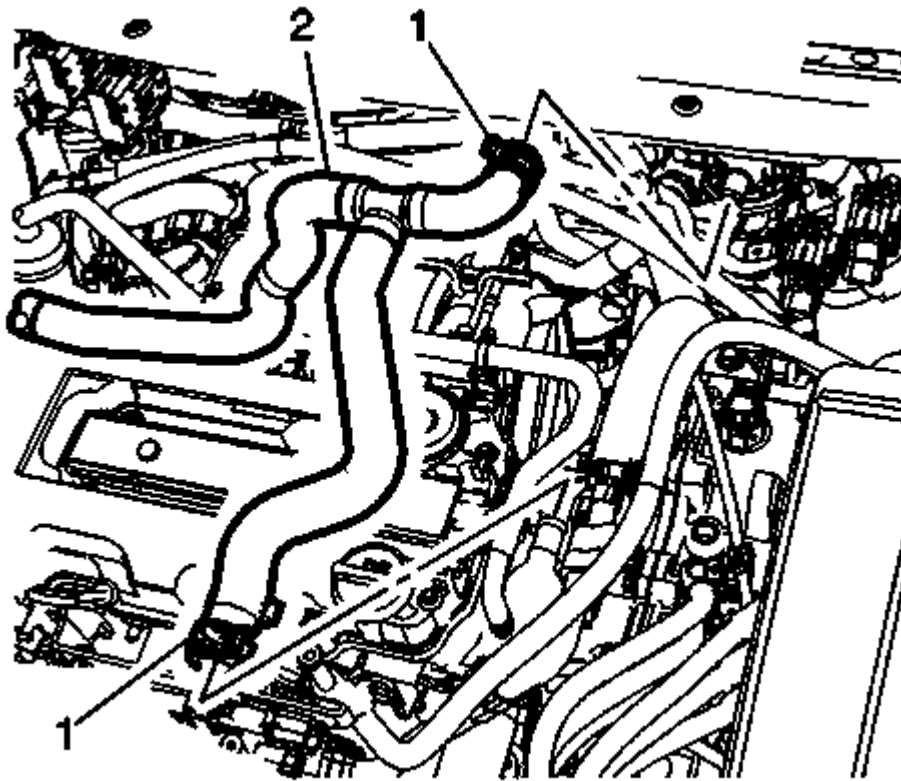


Fig. 88: Heater Water Auxiliary Pump Inlet Hose
Courtesy of GENERAL MOTORS CORP.

13. Disconnect the heater water auxiliary pump inlet hose (2) from the heater water shutoff valve.

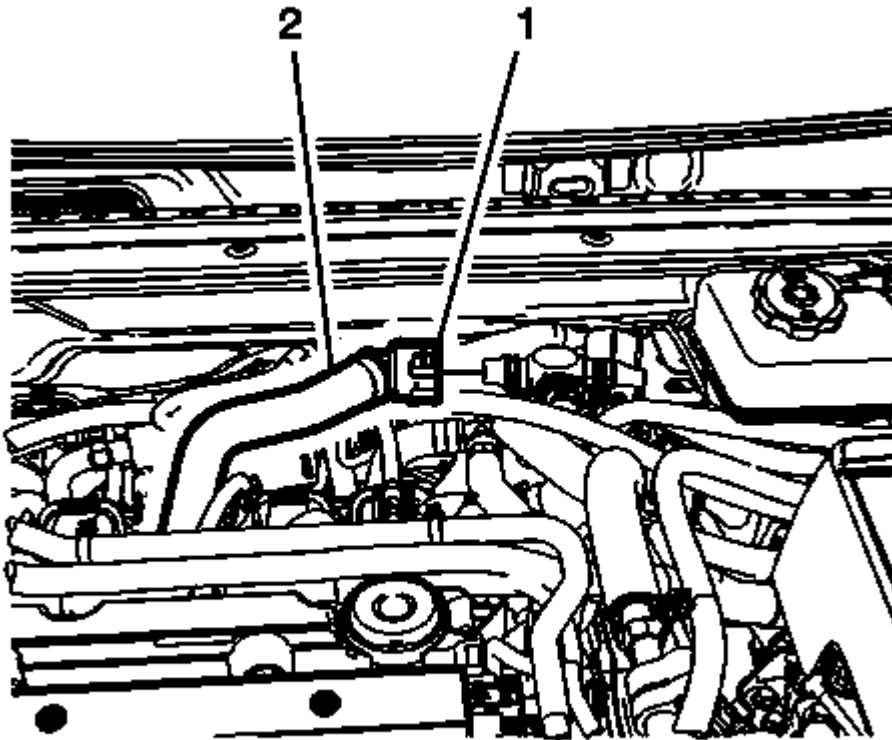


Fig. 89: Heater Water Shutoff Valve Inlet Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

14. Disconnect the heat water shutoff valve inlet hose (2) from the valve assembly. Refer to **Heater Water Shutoff Valve Inlet Hose Replacement** .

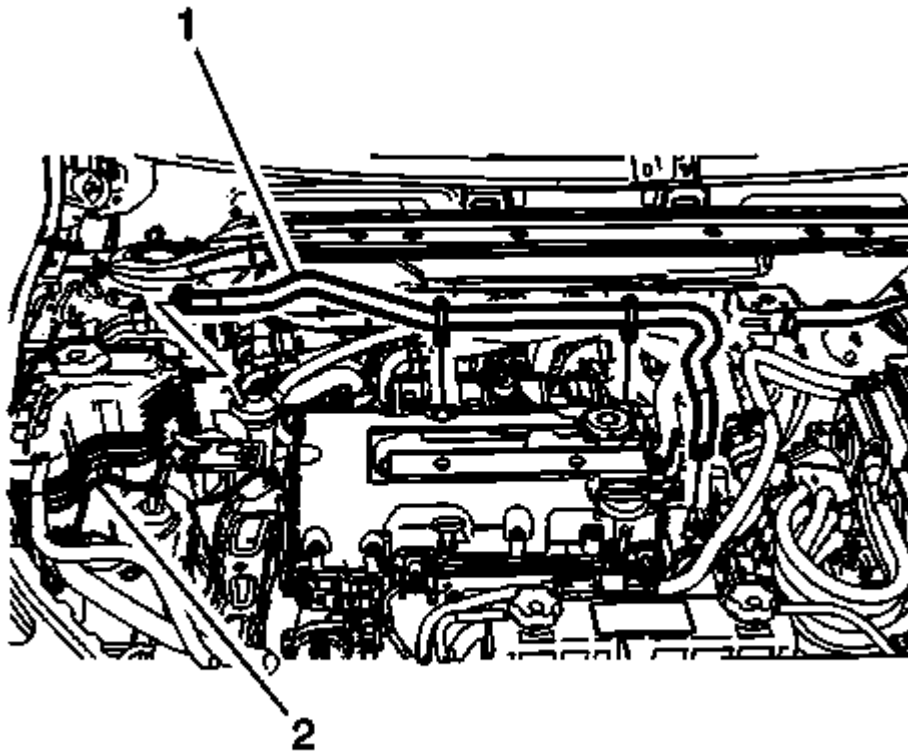


Fig. 90: Heater Outlet Hose Vapor Vent Hose
Courtesy of GENERAL MOTORS CORP.

15. Disconnect the heater outlet hose vapor vent hose (1) from the coolant reservoir (2). Refer to **Heater Outlet Hose Vapor Vent Hose Replacement** .

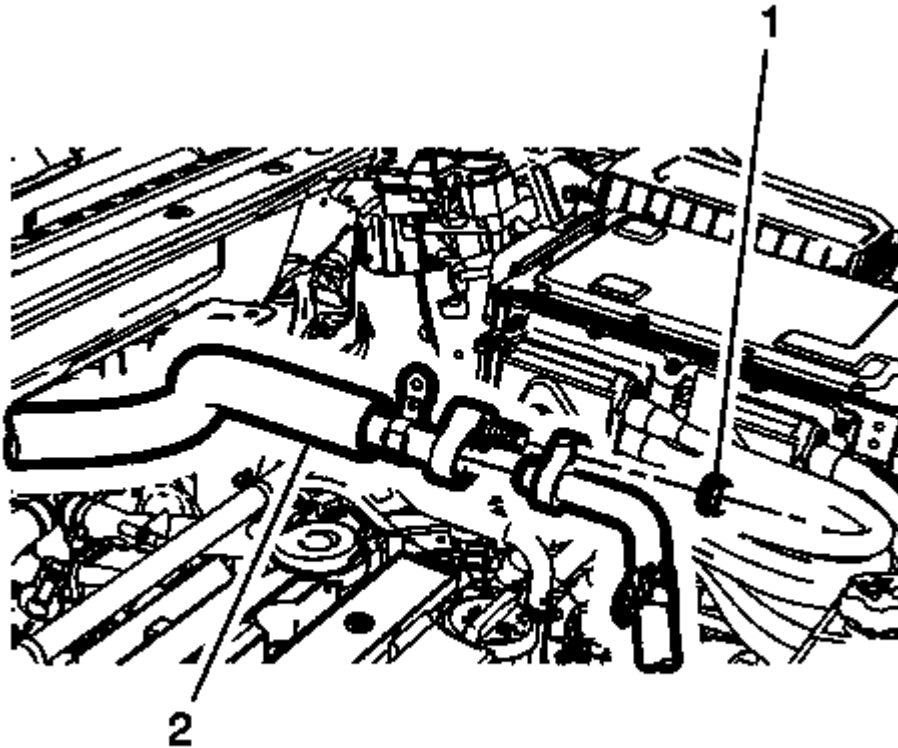


Fig. 91: Air Conditioning Compressor And Evaporator Hose And Nut
 Courtesy of GENERAL MOTORS CORP.

16. Separate the air conditioning compressor and evaporator hose (2) at the connection above the valve cover. Refer to **Air Conditioning Compressor and Evaporator Hose Replacement** .
17. Remove the front wheelhouse front liners. Refer to **Front Wheelhouse Front Liner Replacement** .
18. Remove the front fascia. Refer to **Front Bumper Fascia Removal and Installation** .
19. Disconnect the electrical connector from the engine coolant temperature sensor on the radiator assembly.
20. Disconnect the electrical connectors from the engine control module (ECM). Refer to **Engine Control Module Replacement** .
21. Disconnect the wiring connectors and ground strap from the transmission.
22. Disconnect the wheel speed connectors from the steering knuckles, then position out of the way.
23. Disconnect the wiring harness from the accessory wiring junction block. Refer to **Accessory Wiring Junction Block Replacement** .
24. Place the ECM, transmission and the accessory wiring junction block wiring harnesses on the top of engine assembly.
25. Remove the engine ground strap which is located above the air conditioning compressor on the engine block.

NOTE: Do Not disconnect the brake hoses from the calipers.

26. Remove the front brake calipers from the caliper brackets, then suspend the calipers with mechanics wire to the body.

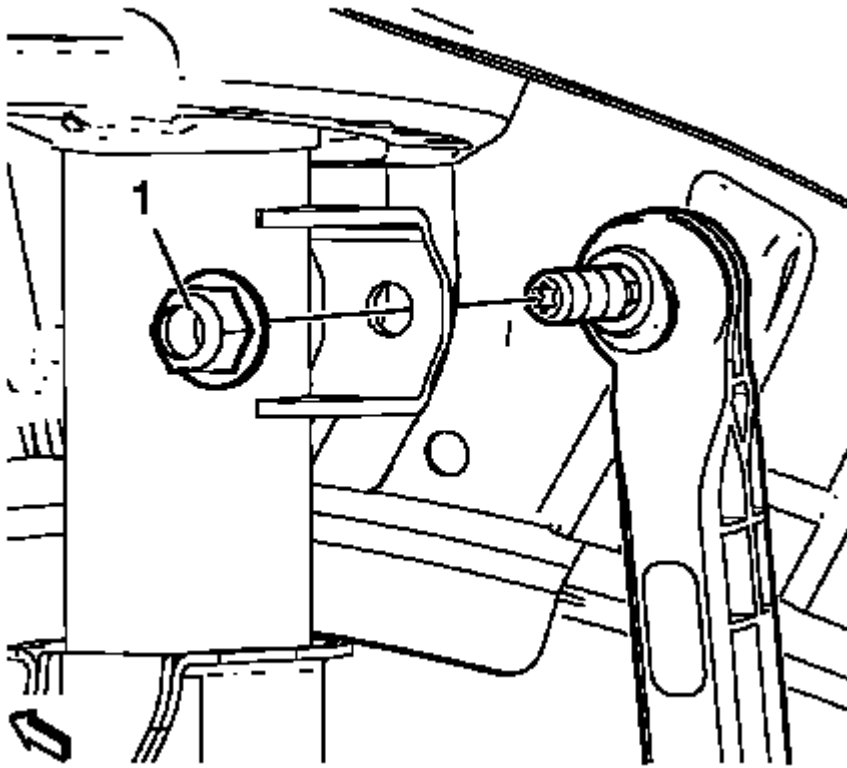


Fig. 92: Stabilizer Link Nut
Courtesy of GENERAL MOTORS CORP.

27. Remove the stabilizer link (1) nuts from the strut assemblies. Refer to **Stabilizer Shaft Link Replacement** .
28. Disconnect the stabilizer links from the strut assemblies.
29. Disconnect the right wheel drive shaft from the intermediate shaft.
30. Disconnect the intermediate steering shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
31. Disconnect the front steering knuckles from the strut assemblies. Refer to **Steering Knuckle Replacement** .

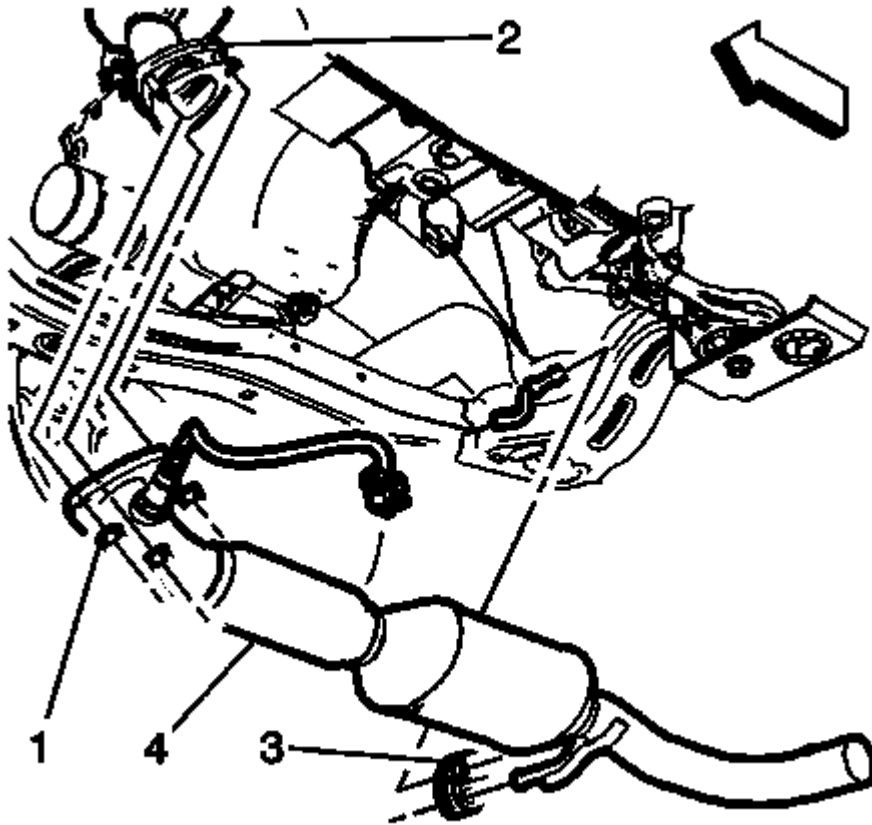


Fig. 93: Catalytic Converter Assembly
Courtesy of GENERAL MOTORS CORP.

32. Remove the catalytic converter assembly (4) from the vehicle. Refer to **Catalytic Converter Replacement**.
33. Disconnect the electronic power steering connectors from the electronic power steering assembly. Refer to **FEP Connectors (Steering Gear)**.

NOTE: Position the radiator wiring harness out of the way so it does not get trapped when lowering the powertrain

34. Disconnect the radiator assembly wiring harness connectors from the radiator assembly.
35. Install the engine support fixture. Refer to **Engine Support Fixture**.

NOTE: Use the engine support fixture to slightly raise the powertrain assembly to aid in the removal of the engine and transmission mount bolts.

36. Use the engine support fixture to slightly raise the powertrain assembly to aid in the removal of the engine and transmission mount bolts.
37. Remove the engine mount to engine mount bracket fasteners. Refer to **Engine Mount Replacement**.

Right Side.

38. Remove the transmission mount to transmission mount bracket fasteners. Refer to **Transmission Mount Replacement - Left Side**.
39. Using suitable straps or chains, secure the front of vehicle to the hoist arms.
40. Using a suitable engine support table, lower the vehicle until the drivetrain and front suspension frame contacts the engine support table.
41. Position blocks of wood below the oil pan and transmission to stabilize the powertrain on the support table.
42. Using the engine support fixture, lower the powertrain down until it is resting on the engine support table.
43. Remove the engine support fixture.

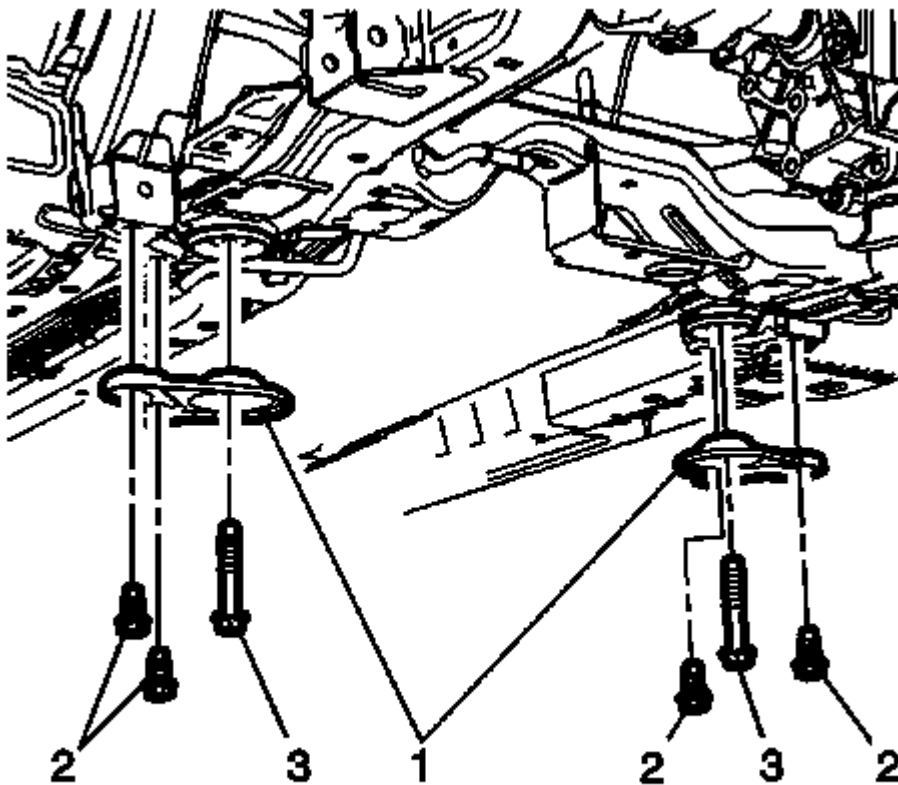


Fig. 94: Drivetrain And Front Suspension Frame Reinforcements
 Courtesy of GENERAL MOTORS CORP.

44. Remove the drivetrain and front suspension frame reinforcements (1) from the rear of the frame.
45. Remove the front drivetrain and front suspension frame retaining bolts.
46. Slowly and carefully raise the vehicle, ensure the engine, transmission, radiator assembly and drivetrain suspension frame are free from wiring, hoses and other engine compartment components.
47. Remove the starter opening cover located below the intake manifold.

48. Remove the four torque dampener to flywheel bolts.
49. Remove the intermediate drive shaft from the engine and transmission. Refer to **Front Wheel Drive Intermediate Shaft Replacement** .
50. Remove the nine transmission to engine fasteners.
51. Separate the transmission from the engine assembly.
52. Disconnect engine coolant hoses as necessary.
53. Disconnect electrical connectors as necessary.
54. Transfer components as necessary.

INSTALLATION PROCEDURE

1. Position the engine to the transmission assembly.

CAUTION: Refer to **Fastener Caution** .

2. Install the nine transmission to engine fasteners, then tighten to 80 N.m (59 lb ft)
3. Install the four torque dampener to flywheel bolts, then tighten to 62 N.m (46 lb ft).
4. Install the starter opening cover, then tighten to 20 N.m (15 lb ft).
5. Position the engine, transmission, radiator assembly and drivetrain suspension frame under the vehicle.
6. Slowly and carefully lower the vehicle, ensure the engine, transmission, radiator assembly and drivetrain suspension frame are free from wiring, hoses and other engine compartment components.

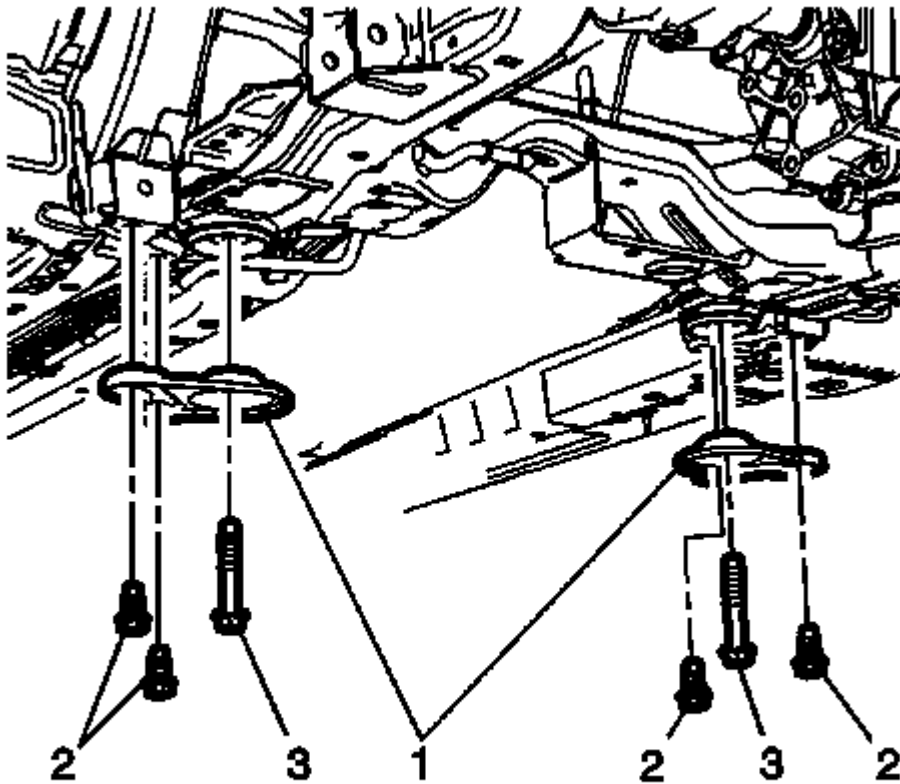


Fig. 95: Drivetrain And Front Suspension Frame Reinforcements
 Courtesy of GENERAL MOTORS CORP.

7. Install the four front drivetrain and front suspension frame retaining bolts, then tighten to the fasteners to 160 N.m (118 lb ft).
8. Install the drivetrain and front suspension frame reinforcements (1) to the rear of the frame, then tighten the reinforcement fasteners (2) to 22 N.m (16 lb ft).

NOTE: Use the engine support fixture to slightly raise the powertrain assembly to aid in the installation of the engine and transmission mount bolts.

9. Install the engine support fixture. Refer to Engine Support Fixture.
10. Install the engine mount to engine mount bracket fasteners. Refer to Engine Mount Replacement - Right Side.
11. Install the transmission mount to transmission mount bracket fasteners. Refer to Transmission Mount Replacement - Left Side.
12. Install the intermediate drive shaft to the engine and transmission. Refer to Front Wheel Drive Intermediate Shaft Replacement.
13. Connect the right wheel drive shaft to the intermediate shaft.
14. Connect the electronic power steering connectors to the electronic power steering assembly. Refer to FEP

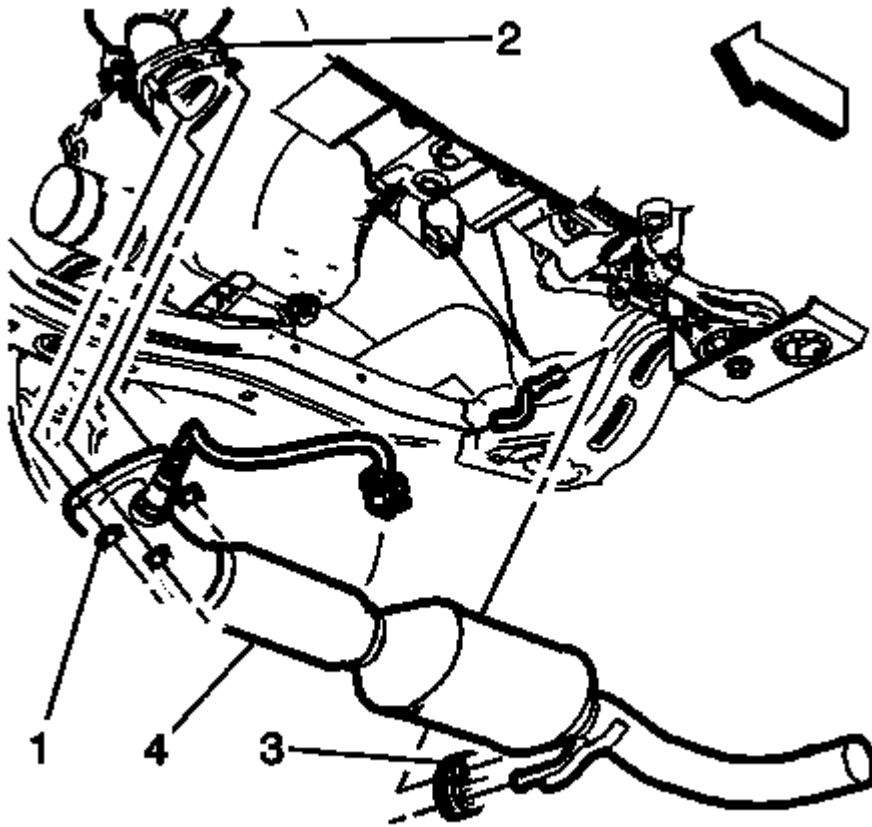
Connectors (Steering Gear) .

Fig. 96: Catalytic Converter Assembly
Courtesy of GENERAL MOTORS CORP.

15. Install the catalytic converter assembly (4). Refer to **Catalytic Converter Replacement** .
16. Connect the front steering knuckles to the strut assemblies. Refer to **Steering Knuckle Replacement** .

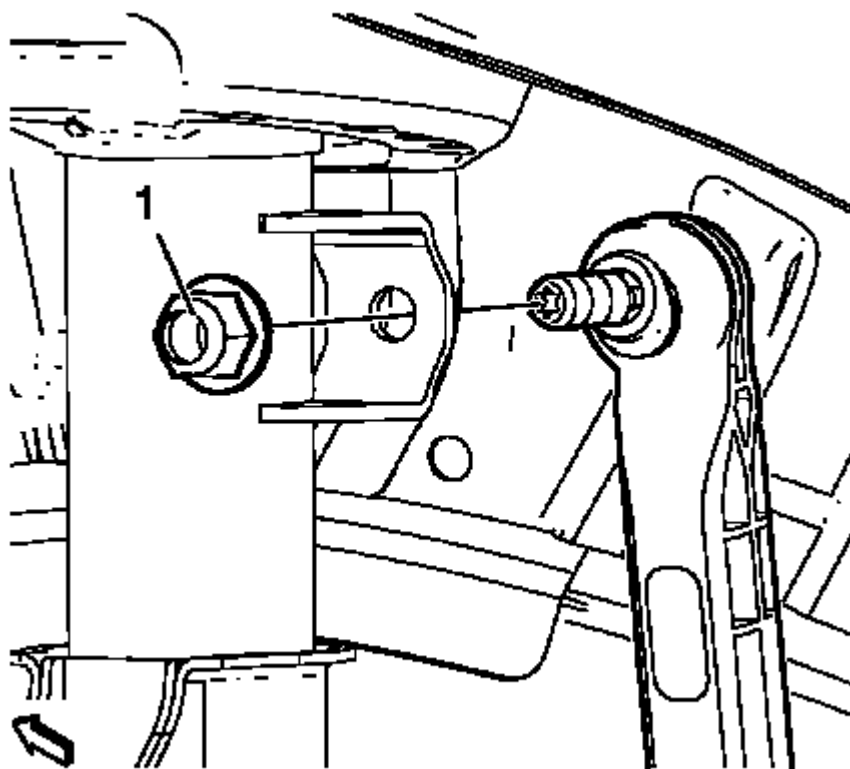


Fig. 97: Stabilizer Link Nut
Courtesy of GENERAL MOTORS CORP.

17. Connect the stabilizer link (1) to the strut assemblies. Refer to **Stabilizer Shaft Link Replacement**.
18. Install the front brake calipers to the caliper brackets. Refer to Step 2 of the installation procedure. **Front Brake Caliper Replacement**.
19. Connect the wheel speed connectors to the steering knuckles.
20. Remove the engine support fixture.
21. Install the engine ground strap which is located above the air conditioning compressor on the engine block.
22. Connect the wiring connectors and ground strap to the transmission.
23. Connect the wiring harness to the accessory wiring junction block. Refer to **Accessory Wiring Junction Block Replacement**.
24. Connect the electrical connectors to the ECM. Refer to **Engine Control Module Replacement**.
25. Connect the electrical connector to the engine coolant temperature sensor on the radiator assembly.

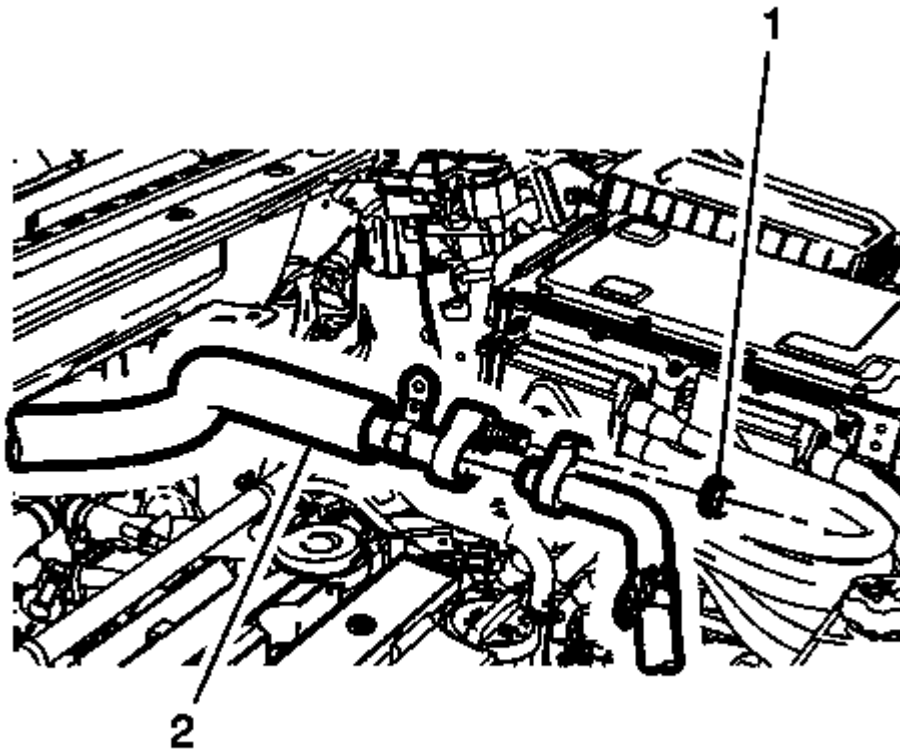


Fig. 98: Air Conditioning Compressor And Evaporator Hose And Nut
Courtesy of GENERAL MOTORS CORP.

26. Connect the air conditioning compressor and evaporator hose (2) located above the valve cover. Refer to **Air Conditioning Compressor and Evaporator Hose Replacement** .

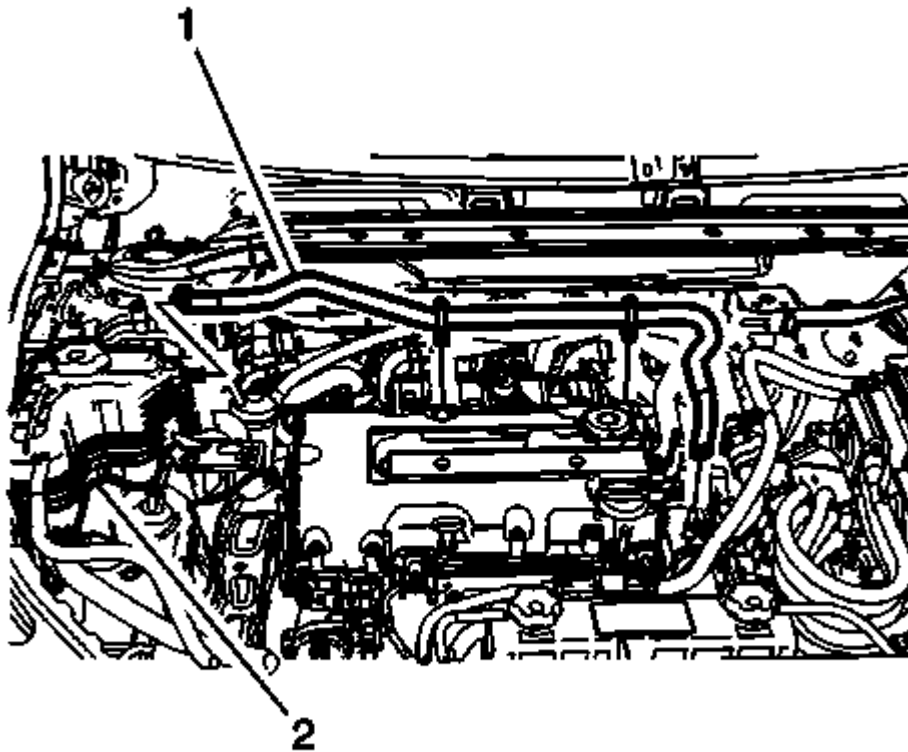


Fig. 99: Heater Outlet Hose Vapor Vent Hose
Courtesy of GENERAL MOTORS CORP.

27. Connect the heater outlet hose vapor vent hose (1) to the coolant reservoir (2). Refer to **Heater Outlet Hose Vapor Vent Hose Replacement** .

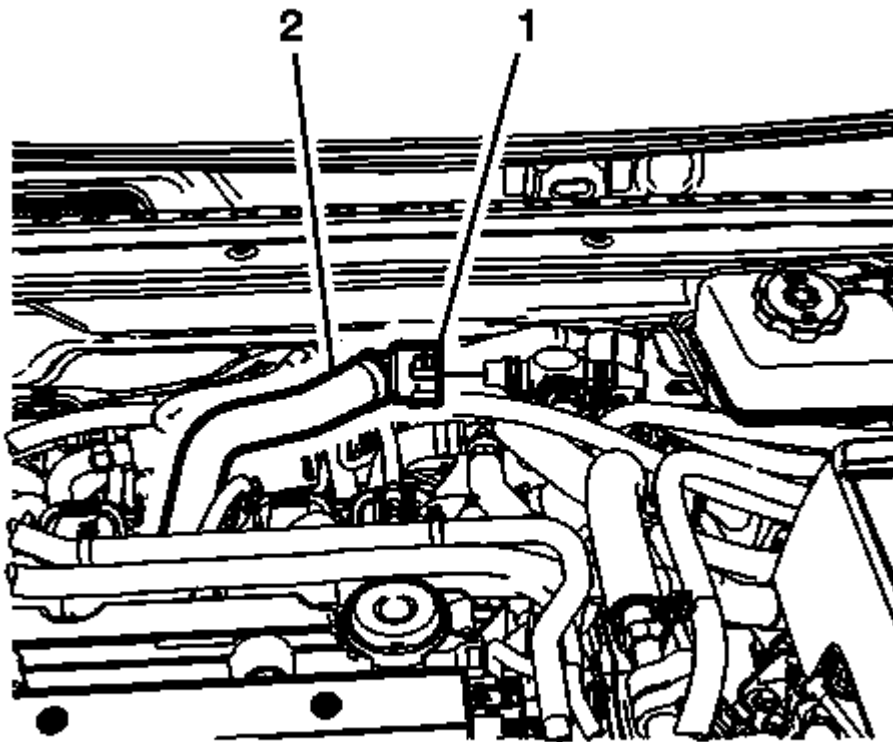


Fig. 100: Heater Water Shutoff Valve Inlet Hose Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

28. Connect the heat water shutoff valve inlet hose (2) to the valve assembly. Refer to **Heater Water Shutoff Valve Inlet Hose Replacement** .

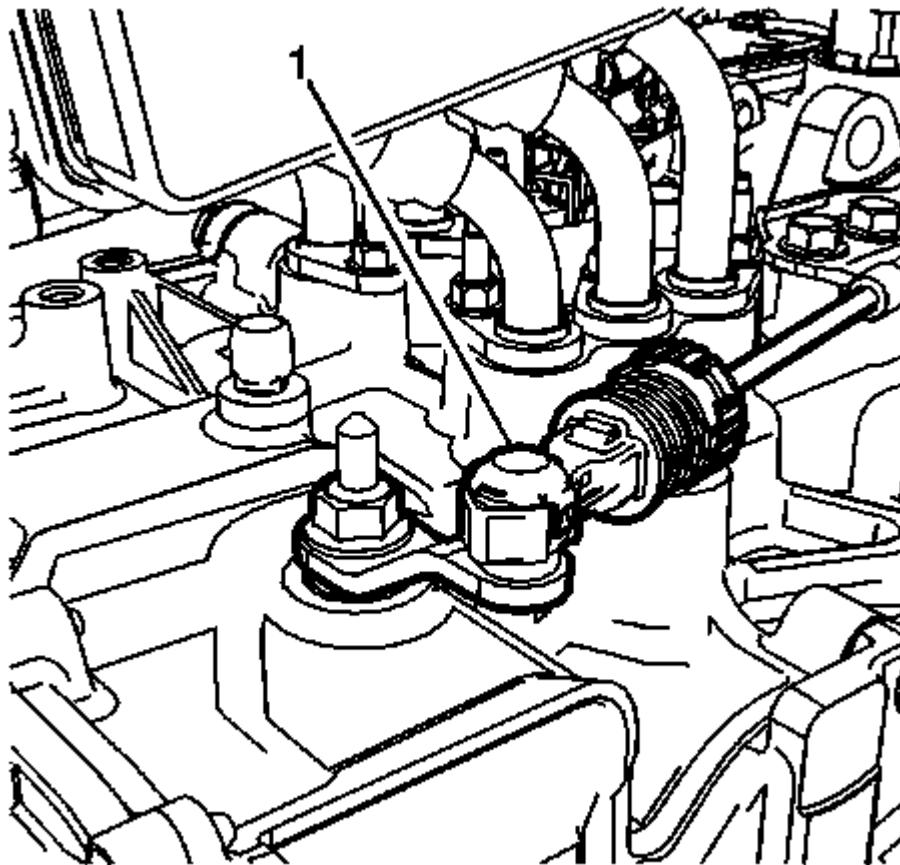


Fig. 101: Transmission Range Selector Lever Cable Terminal
Courtesy of GENERAL MOTORS CORP.

29. Connect the transmission range selector lever cable terminal (1) to the transmission manual pin.

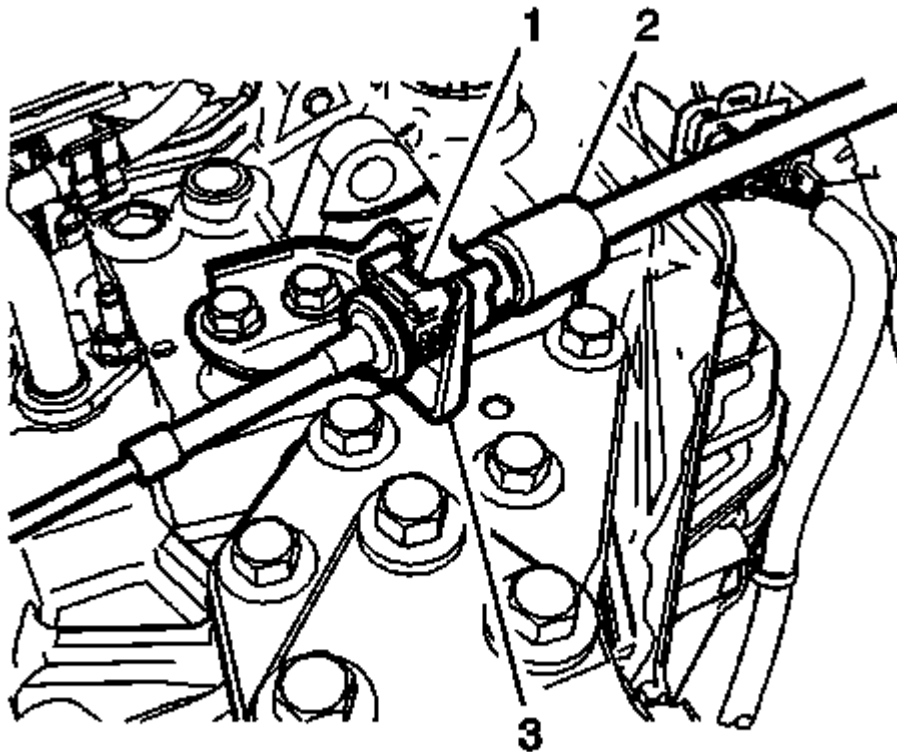


Fig. 102: Transmission Range Selector Lever Cable And Cable Bracket
Courtesy of GENERAL MOTORS CORP.

30. Press the locking tab (1) rearward in order to lock the transmission range selector lever cable (2) to the cable bracket.

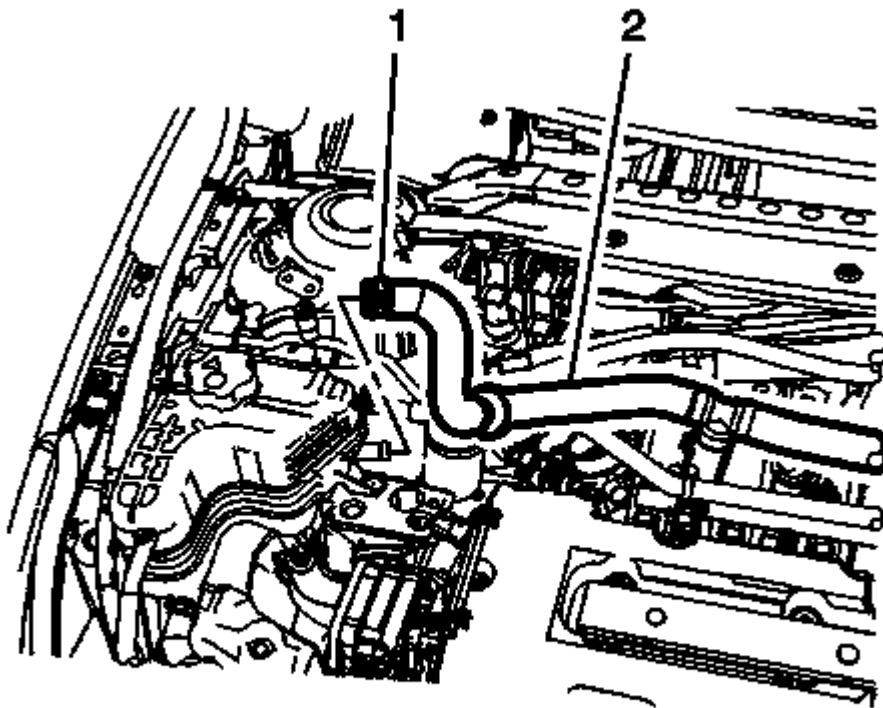


Fig. 103: Heater Water Auxiliary Pump Inlet Hose And Clamp
Courtesy of GENERAL MOTORS CORP.

31. Connect the heater water auxiliary pump inlet hose (2) to the coolant reservoir.

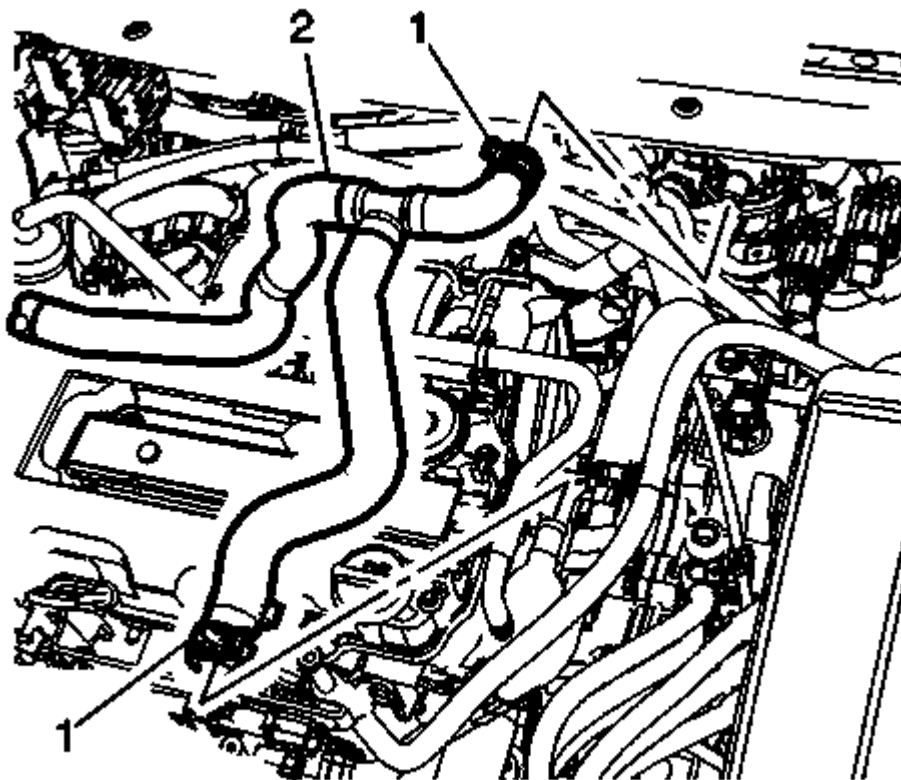


Fig. 104: Heater Water Auxiliary Pump Inlet Hose
Courtesy of GENERAL MOTORS CORP.

32. Connect the heater water auxiliary pump inlet hose (2) to the heater water shutoff valve.

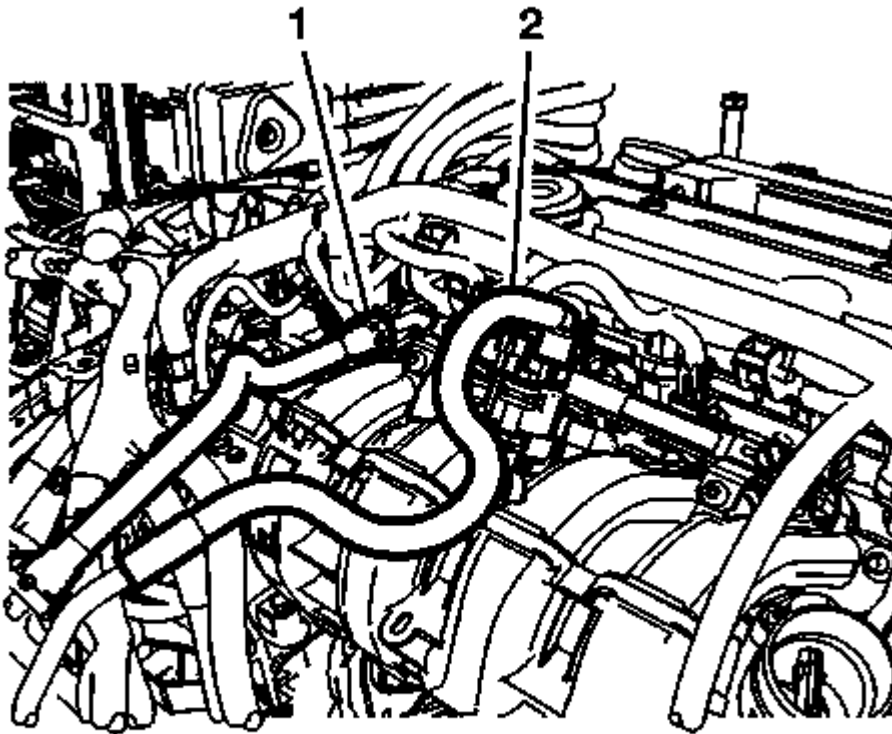


Fig. 105: Canister Purge Hose

Courtesy of GENERAL MOTORS CORP.

33. Connect the canister purge hose (2) to the purge solenoid located at the back of the of the valve cover.
34. Connect the fuel feed pipe (1) to the fuel rail assembly. Refer to **Fuel Feed Pipe Replacement (Engine Compartment)** or **Fuel Feed Pipe Replacement (Chassis)** .
35. Connect engine coolant hoses as necessary.
36. Connect electrical connectors as necessary.
37. Install the front fascia. Refer to **Front Bumper Fascia Removal and Installation** .
38. Install the front wheelhouse front liners. Refer to **Front Wheelhouse Front Liner Replacement** .
39. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.
The High Voltage Disabling procedure will perform the following tasks:

- Identify how to disable high voltage.

- Identify how to test for the presence of high voltage.
- Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.

Failure to follow the procedures exactly as written may result in serious injury or death.

40. Install the drive motor generator power inverter module. Refer to **Drive Motor Generator Power Inverter Module Replacement** .
41. Fill the engine cooling system. Refer to **Cooling System Draining and Filling** .
42. Fill the drive motor generator battery cooling system. Refer to **Drive Motor Battery Cooling System Draining and Filling** .
43. Fill the drive motor generator cooling system. Refer to **Drive Motor Generator Power Inverter Module Cooling System Draining and Filling** .
44. Charge the air conditioning system. Refer to **Refrigerant Recovery and Recharging (High Voltage Electric Compressor)** .
45. Check engine oil level. Refer to **Engine Oil and Oil Filter Replacement**
46. Enable the high voltage system. Refer to **High Voltage Enabling** .

ENGINE OIL AND OIL FILTER REPLACEMENT

REMOVAL PROCEDURE

WARNING: Do not use a service jack to lift this vehicle. Lifting the vehicle with a jack could cause the vehicle to slip off the jack and roll; this could cause injury or death.

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

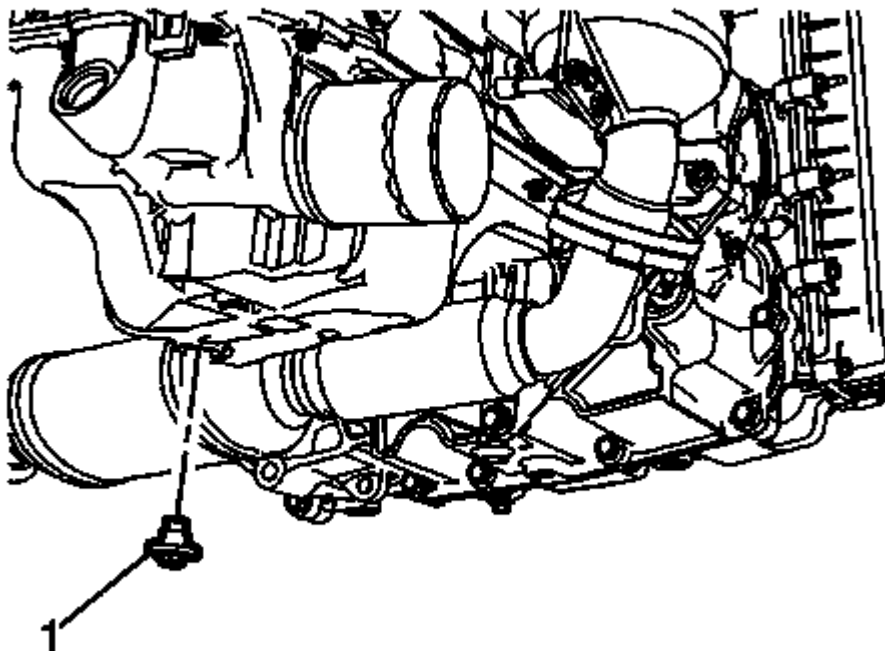


Fig. 106: Oil Pan Drain Plug

Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pan drain plug (1), and allow the oil to drain completely.

CAUTION: Refer to Fastener Caution .

4. Install the oil pan drain plug and tighten to 14 N.m (124 lb in).

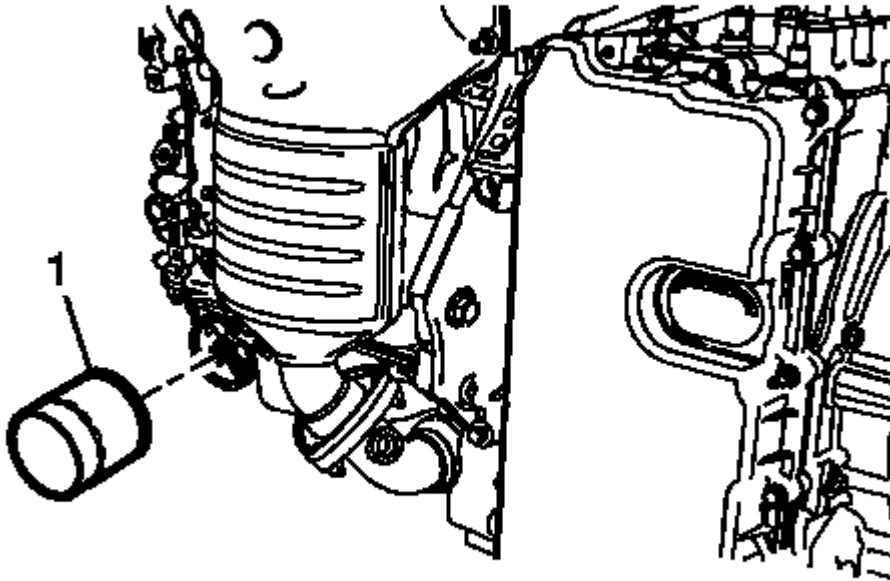


Fig. 107: Oil Filter

Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Hot Exhaust System Warning .

5. Place the drain pan under the oil filter (1).
6. Remove the oil filter. Allow the oil to drain completely.

INSTALLATION PROCEDURE

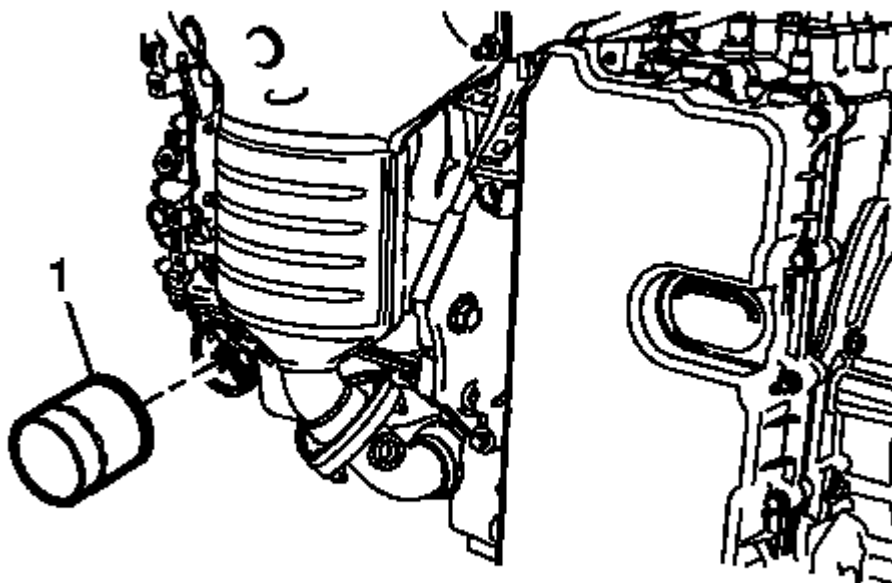
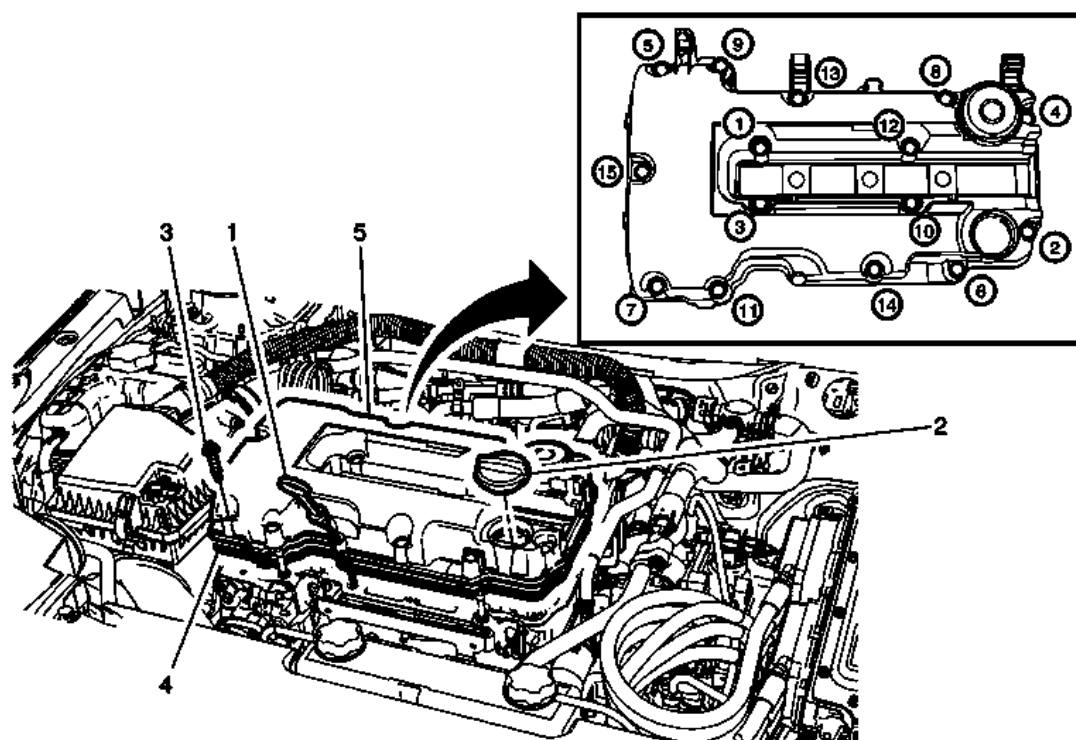


Fig. 108: Oil Filter

Courtesy of GENERAL MOTORS CORP.

1. Lubricate the NEW oil filter gasket with clean engine oil.
2. Tighten the oil filter (1) to 25 N.m (18 lb ft).
3. Lower the vehicle.
4. Refill the engine oil. Refer to **Approximate Fluid Capacities** .
5. Start the engine and inspect for leaks.

CAMSHAFT COVER REPLACEMENT

**Fig. 109: Camshaft Cover**

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the ignition coil. Refer to Ignition Coil Replacement .	
1	Remove the oil level indicator
2	Remove the oil cap
3	Camshaft Cover Fastener (Qty: 15) CAUTION: Refer to <u>Fastener Caution</u> . Procedure: Ensure to follow the tighten sequence shown. Tighten: 8 N.m (71 lb in)
4	Camshaft Cover Gasket Procedure: Do not reuse the camshaft gasket. Also use a new gasket when removing or replacing camshaft cover.
	Camshaft Cover Procedure

5

1. Remove or reposition the clips as necessary.
2. Disconnect electrical connector as necessary.
3. Transfer components as necessary.

INTAKE CAMSHAFT REPLACEMENT

REMOVAL PROCEDURE

1. Remove the camshaft sprocket. Refer to Camshaft Intake and Exhaust Sprocket Replacement.

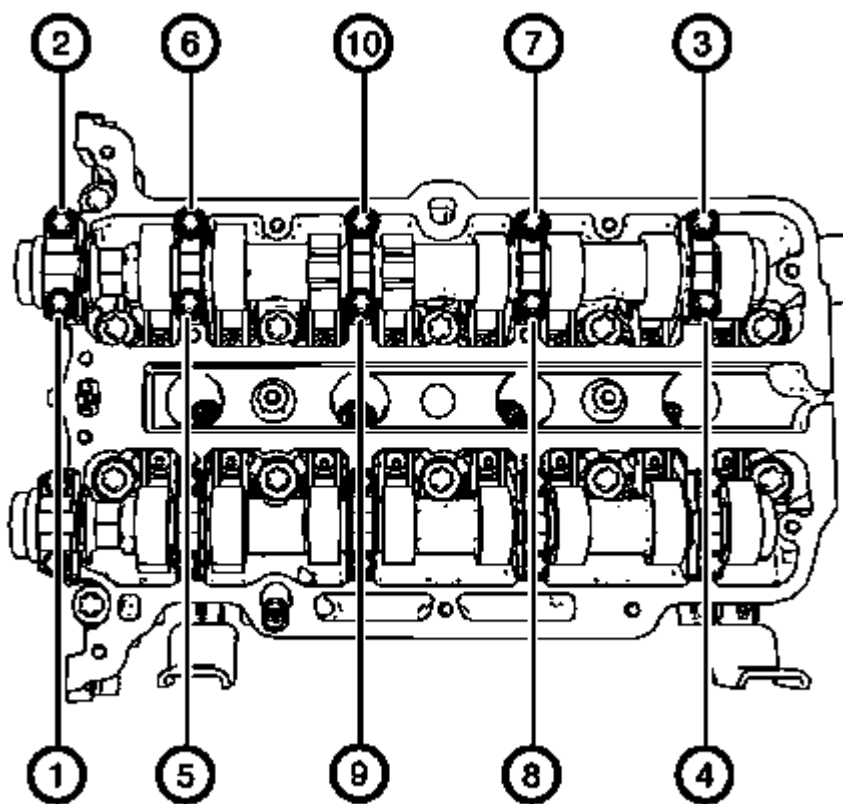


Fig. 110: Intake Camshaft Bearing Cap Bolts Removal Sequence
Courtesy of GENERAL MOTORS CORP.

2. Remove the camshaft bearing cap bolts in sequence shown. Ensure to remove the bolts one turn at a time until there is no spring tension pushing on the camshaft.

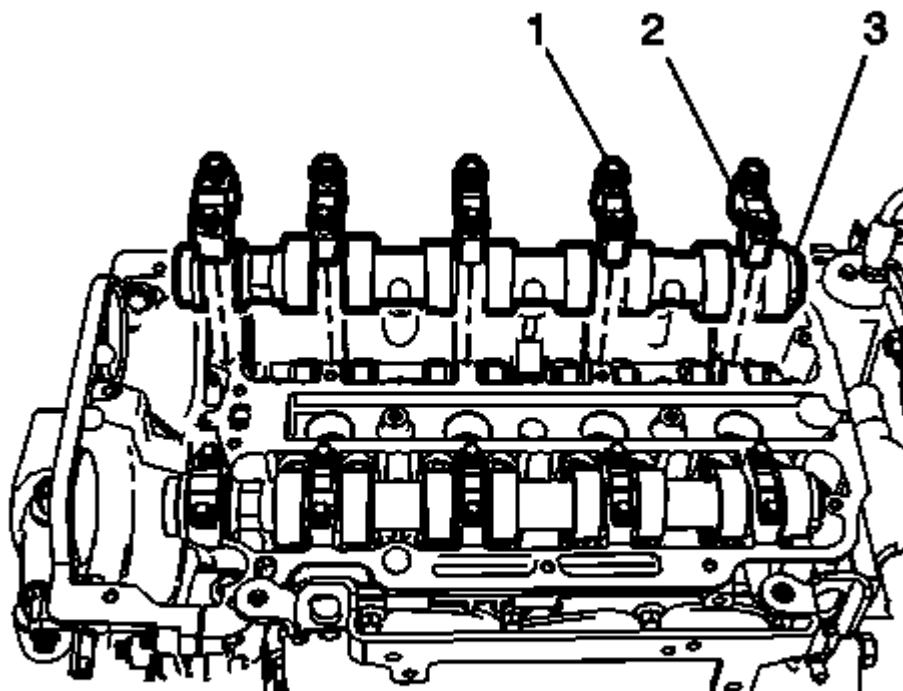


Fig. 111: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS CORP.

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

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

INSTALLATION PROCEDURE

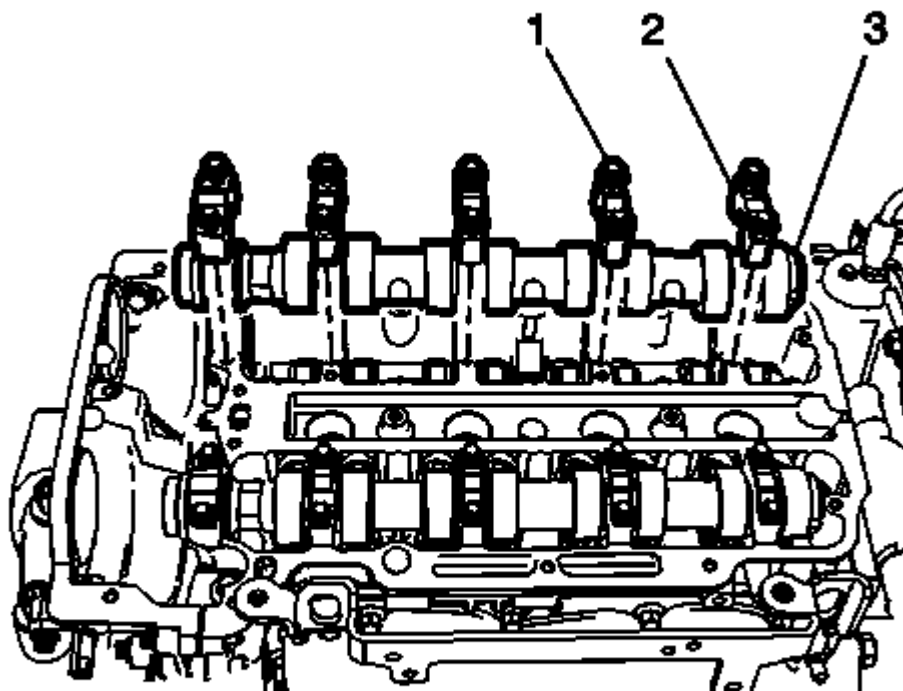


Fig. 112: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS CORP.

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

1. Lubricate the camshaft and camshaft bearing caps with engine oil.
2. Install the intake camshaft (3).
3. Install the camshaft bearing caps (2).

CAUTION: Refer to Fastener Caution .

4. Install the camshaft bearing cap and hand tighten the bolts (1).

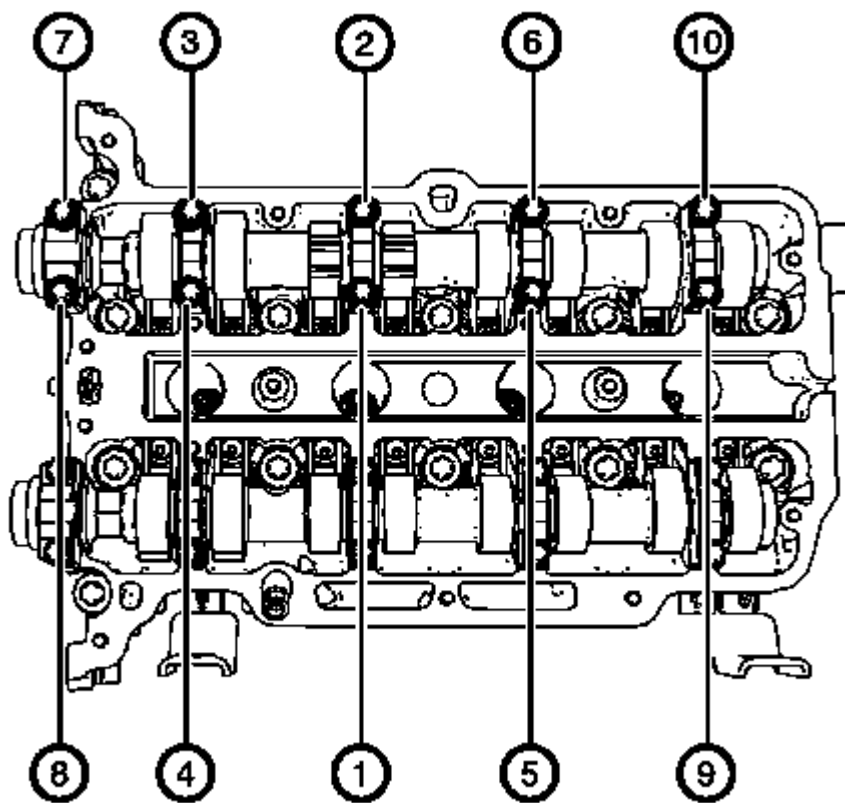


Fig. 113: Intake Camshaft Bearing Cap Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

5. Install and tighten the camshaft bearing cap bolts one turn at a time in sequence as shown to 8 N.m (71 lb in).
6. Install the camshaft intake sprocket. Refer to **Camshaft Intake and Exhaust Sprocket Replacement**.

EXHAUST CAMSHAFT REPLACEMENT

REMOVAL PROCEDURE

1. Remove the camshaft exhaust sprocket. Refer to **Camshaft Intake and Exhaust Sprocket Replacement**.

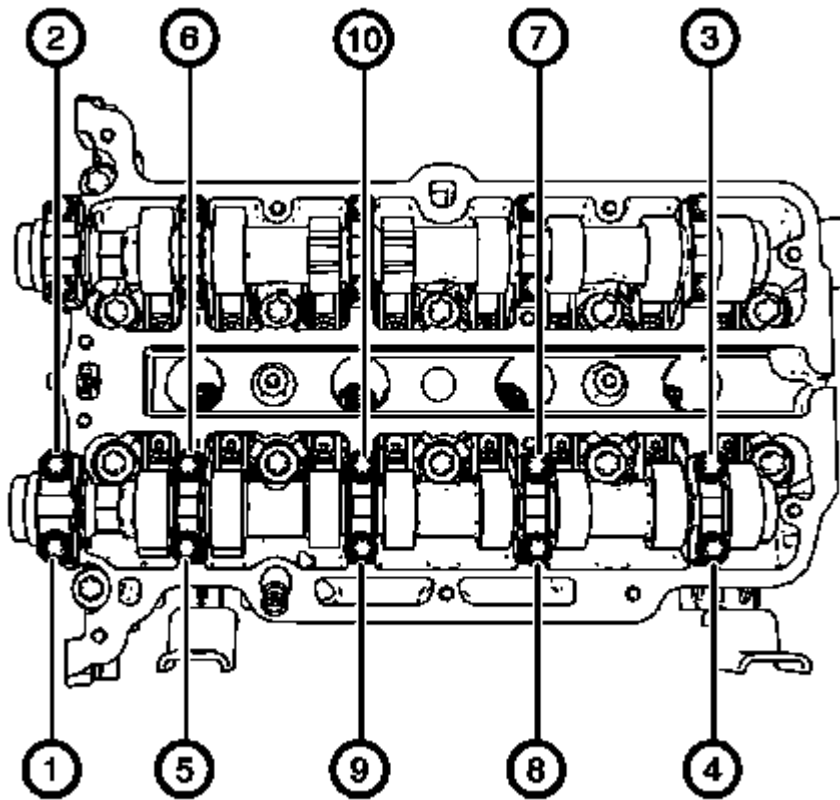


Fig. 114: Exhaust Camshaft Bearing Cap Bolts Removal Sequence
Courtesy of GENERAL MOTORS CORP.

2. Remove the camshaft bearing cap bolts in sequence shown. Ensure to remove the bolts one turn at a time until there is no spring tension pushing on the camshaft.

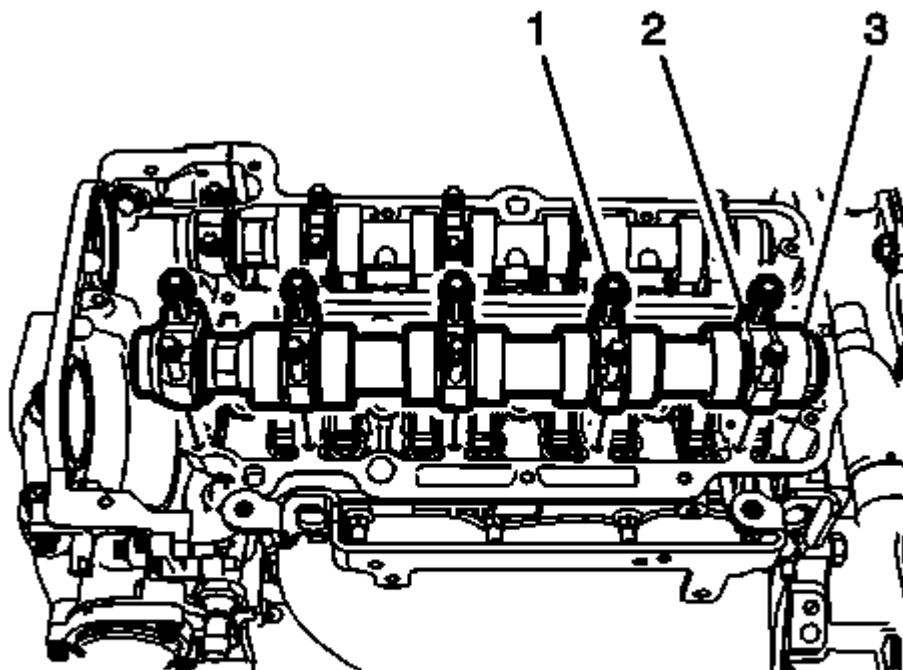


Fig. 115: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS CORP.

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

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

INSTALLATION PROCEDURE

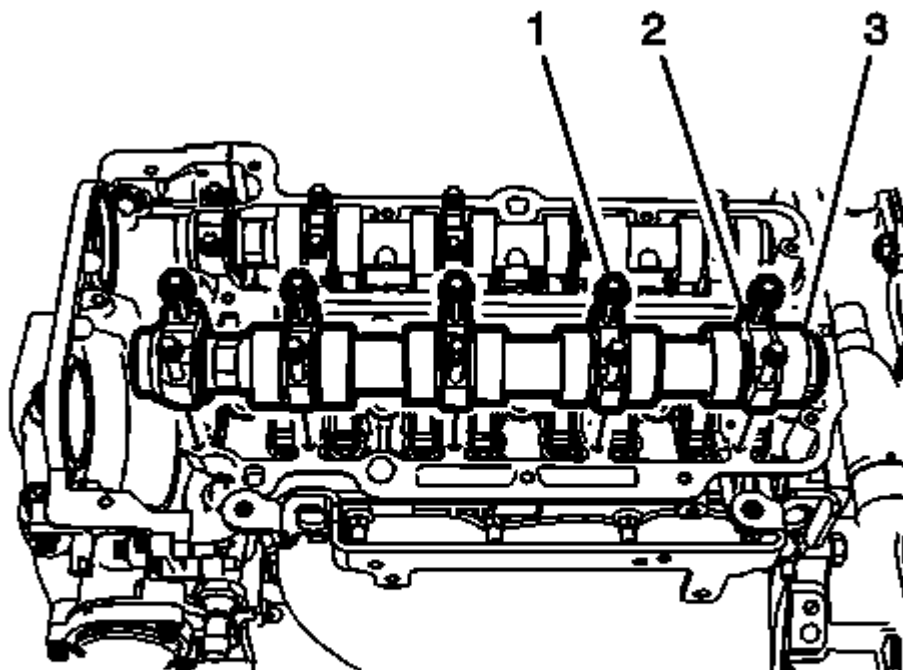


Fig. 116: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS CORP.

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

1. Lubricate camshaft and camshaft bearing caps with engine oil.
2. Install the exhaust camshaft (3).
3. Install the camshaft bearing caps (2).

CAUTION: Refer to Fastener Caution .

4. Install the camshaft bearing cap and hand tighten the bolts (1).

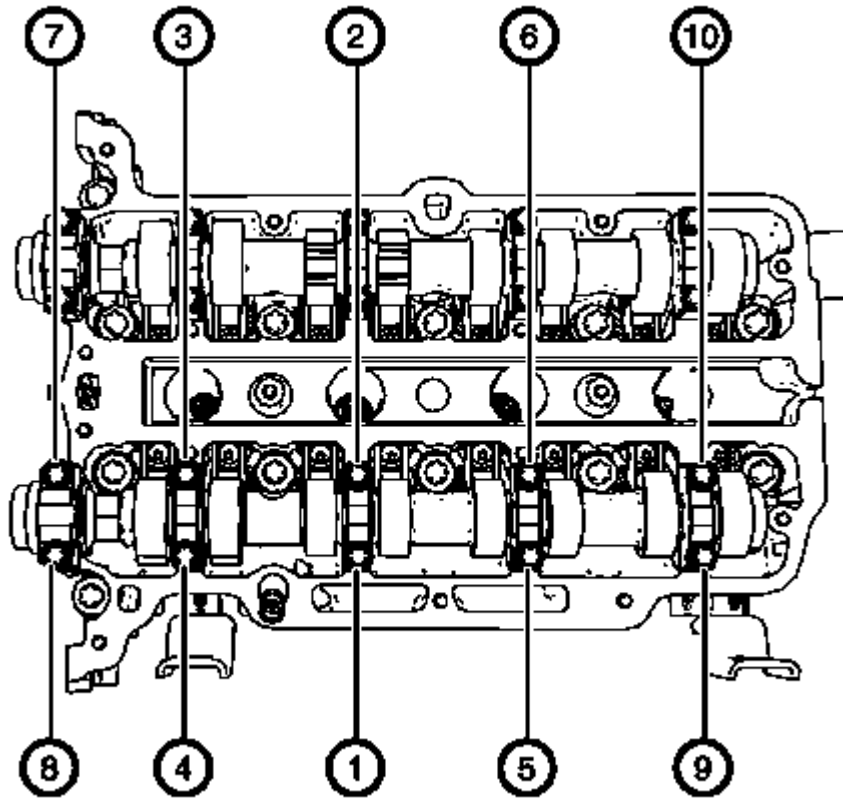


Fig. 117: Exhaust Camshaft Bearing Cap Bolts Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

5. Install and tighten the camshaft bearing cap bolts one turn at a time in sequence as shown 8 N.m (71 lb in).
6. Install the camshaft exhaust sprocket. Refer to **Camshaft Intake and Exhaust Sprocket Replacement**.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

SPECIAL TOOLS

- **EN-840:** Pliers / Remover
- **EN-958:** Installer
- **EN-6086:** Basic Kit, Spring and Wedge Replacer
- **EN-6625:** Flywheel Holder

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

REMOVAL PROCEDURE

1. Remove the intake camshaft. Refer to **Intake Camshaft Replacement**

2. Remove the exhaust camshaft. Refer to **Exhaust Camshaft Replacement**

NOTE: **180° offset to marking ignition TDC cylinder number 1.**

3. Make alignment mark on the toothed belt drive belt.
4. Turn the crankshaft to ignition TDC marking, cylinder number 1.

WARNING: Do not use a service jack to lift this vehicle. Lifting the vehicle with a jack could cause the vehicle to slip off the jack and roll; this could cause injury or death.

5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

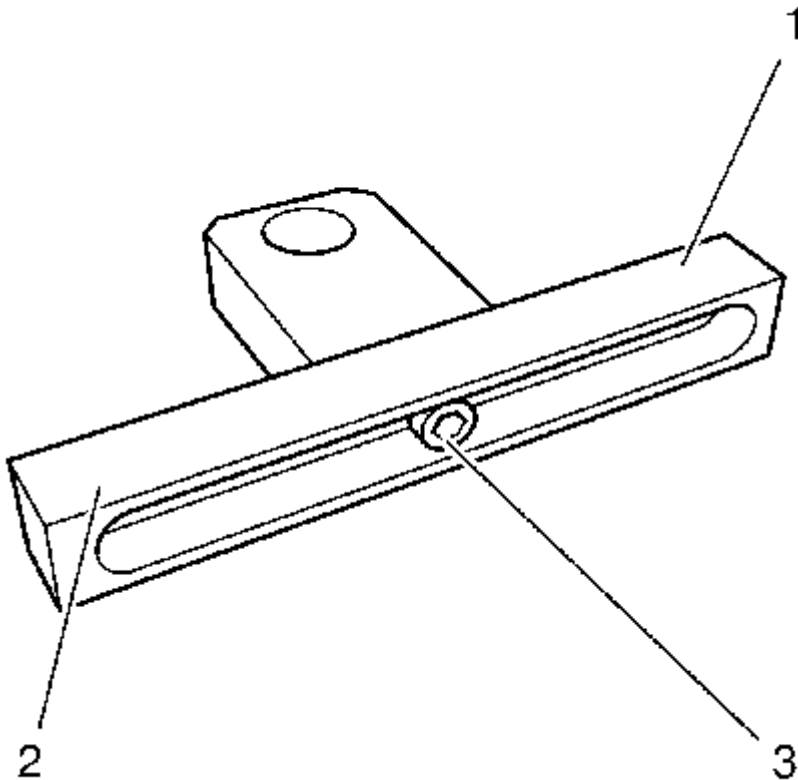


Fig. 118: Support Head, Rail And Fastener
Courtesy of GENERAL MOTORS CORP.

6. Tighten one of the support head (1) in the center of the rail (2) with the fastener (3).

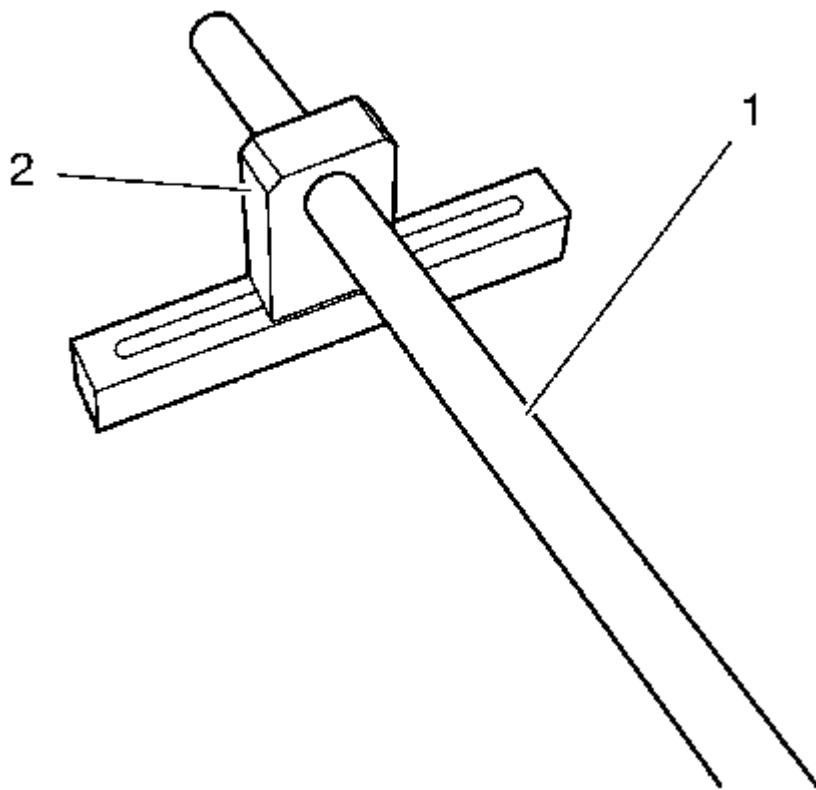


Fig. 119: Mounting Shaft And Supports
Courtesy of GENERAL MOTORS CORP.

7. Install the **EN-6086-5:** mounting shaft (1) to one of the **EN-6086-6:** support (2).
8. Install the second support to the mounting shaft.
9. Install the lever arm bracket to the cylinder head.

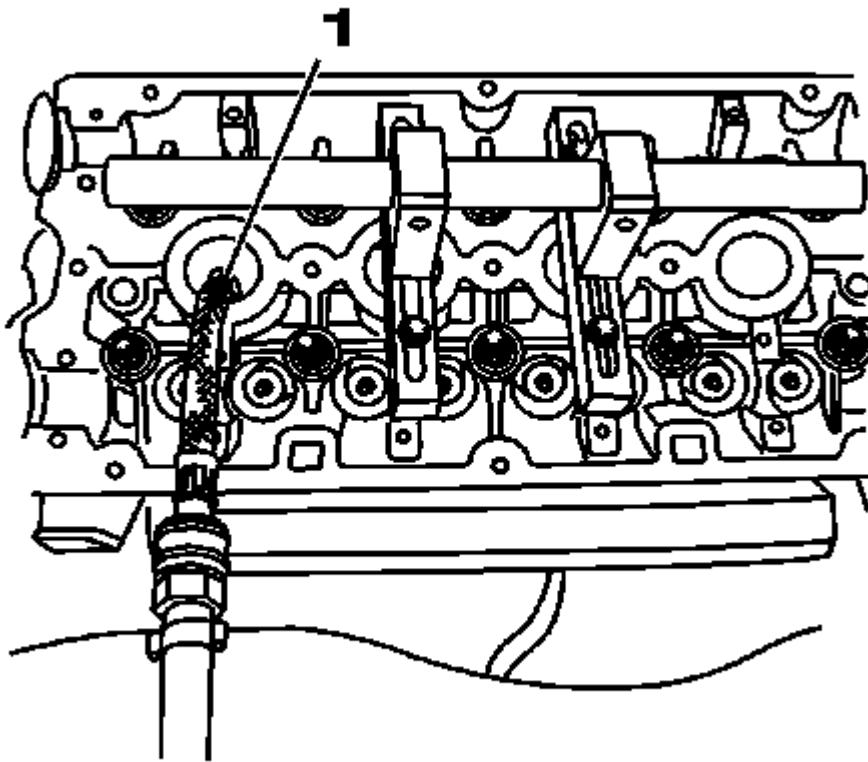


Fig. 120: View Of MKM-6086-15 Pneumatic Adapter
Courtesy of GENERAL MOTORS CORP.

10. Attach the **EN-6086-15:** pneumatic adapter (1).
 1. Attach the adapter to cylinder number 1.
 2. Apply compressed air to cylinder number 1.

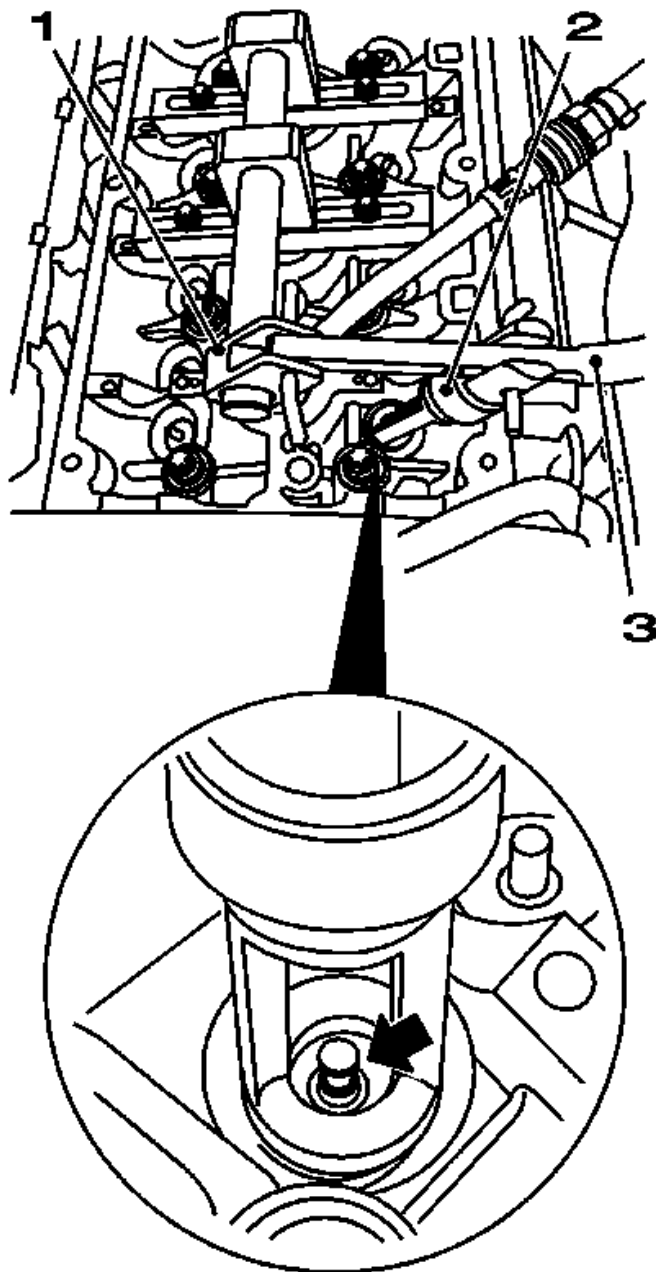


Fig. 121: View Of MKM-6086-8 Joint, MKM-6086-11 Removal Head And MKM-6086-7 Lever Arm

Courtesy of GENERAL MOTORS CORP.

11. Attach the EN-6086-7: lever arm (3).

1. Complete the lever arm with the **EN-6086-8:** joint (1) and the **EN-6086-11:** removal head (2).

NOTE: **Removal head must point toward the intake side.**

2. Slide assembly on installation shaft over the 1st cylinder.
12. Remove the intake valve springs, 1st cylinder.

NOTE: **Removal head must be positioned vertically over the valve stem.**

- 1.
2. Carefully push the valve springs down using the **EN-6086-7:** lever arm.

NOTE: **Observe correct assignment.**

3. Remove the valve keepers.
4. Remove the valve head and the valve springs.

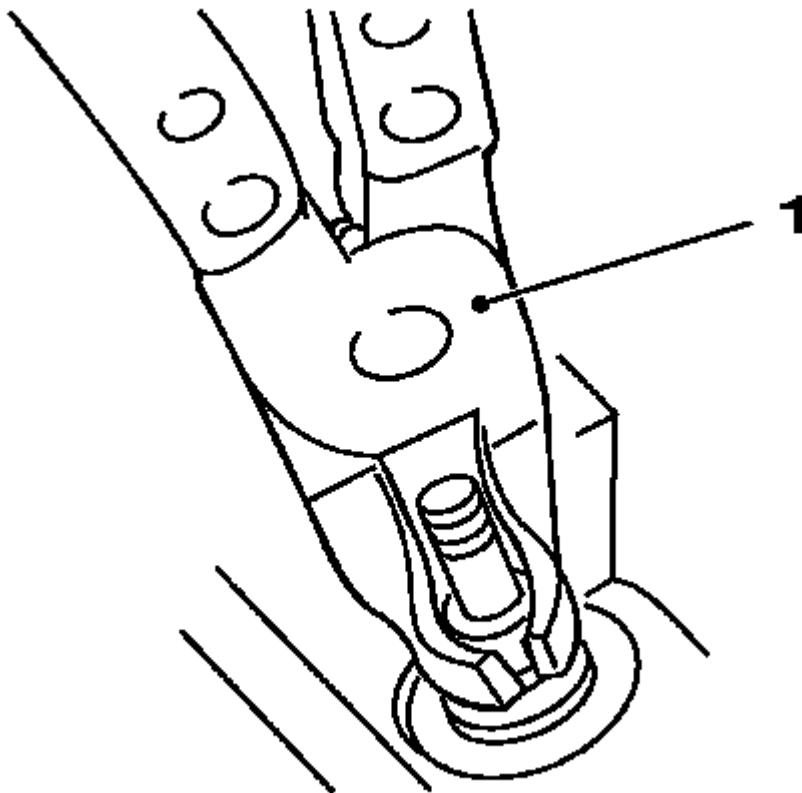


Fig. 122: View Of Seal Remover
Courtesy of GENERAL MOTORS CORP.

13. Remove the valve stem seals.

Remove the valve stem seals with the **EN-840:** remover (1).

14. Install the valve stem seals.

1. Coat the valve stem with engine oil.
2. Connect the new valve stem seals onto valve stem.
3. Using the **EN-958:** installer

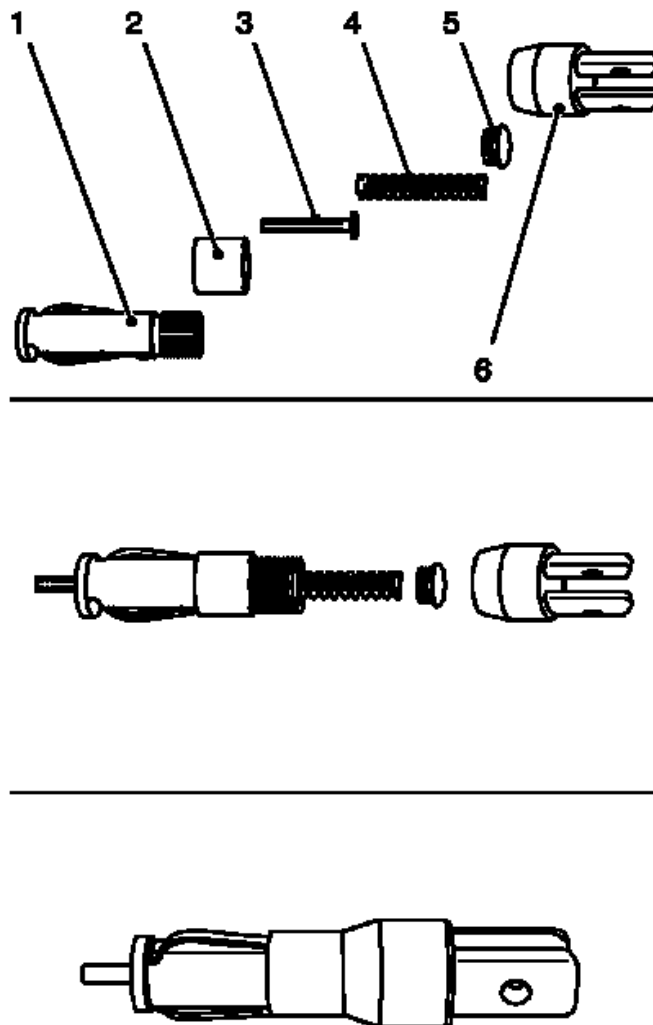


Fig. 123: View Of MKM-6086-200-1 Assembly Head Mount, Fixing Sleeve, Thrust Piece, Spring, Screw Fixing And Lever Mount
 Courtesy of GENERAL MOTORS CORP.

NOTE: Note manufacturer provisions.

15. Complete the EN-6086-200-1 assembly head.

1. Use the **EN-6086-200-10:** thrust piece.
2. Put together the assembly head consisting of mount (1), fixing sleeve (2), thrust piece (3), spring (4), screw fixing (5) and lever mount (6).

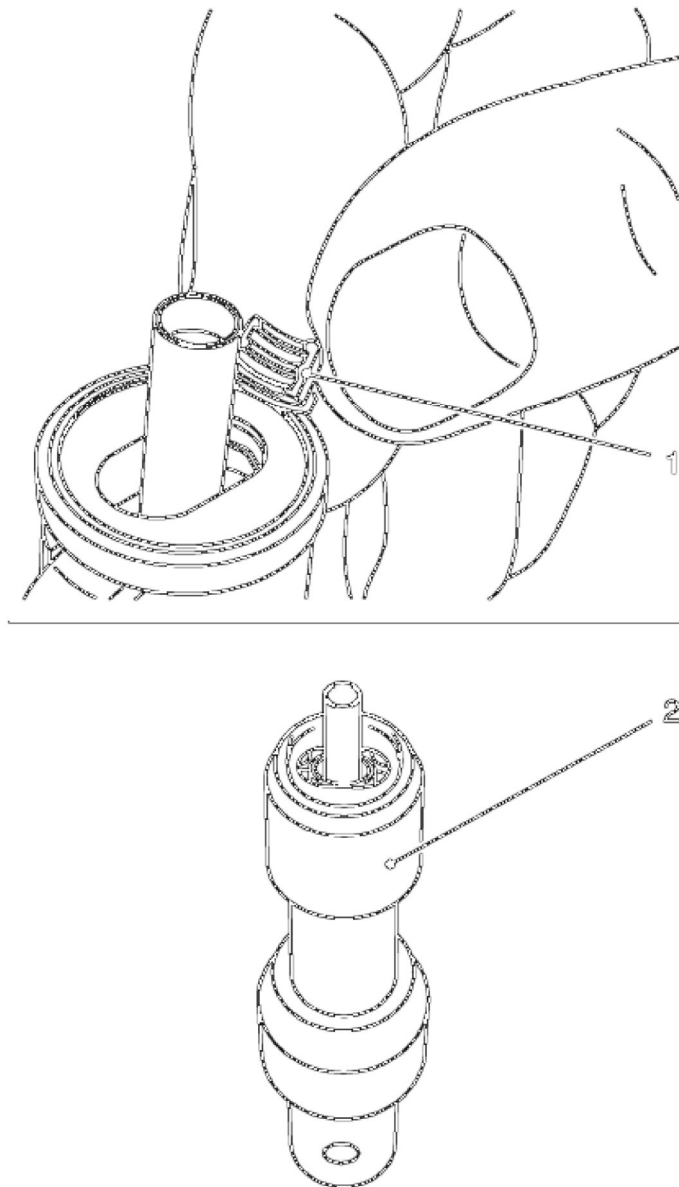


Fig. 124: Valve Cotten And Clamping Sleeve
Courtesy of GENERAL MOTORS CORP.

16. Install the intake valve springs, 1st cylinder.
 1. Insert the valve springs and valve head.

NOTE: Insert the valve cotters with the tapered end toward the valve.

2. Insert the valve cotters (1) in the **EN-6086-200-1**: assembly head.
 - Slide the plastic clamping sleeve (2) in the direction of the lever arm mount.
 - Push the plastic clamping sleeve toward the valve.

NOTE: Assembly head must stand vertically above the valve stem. Valve cotters must engage audibly.

3. Attach the assembly head to the lever arm.
4. Carefully push the valve spring down using the **EN-6086-7**: lever arm.

NOTE: Do not make 2nd attempt without inspecting that both valve cotters are seated in the assembly head.

17. Inspect installation position.

Inspect seating of the valve keepers (visual inspection).

18. Transfer the **EN-6086-7**: lever arm.
 1. Remove the lever arm.
 2. Detach the assembly head.

NOTE: Removal head must point toward the exhaust side.

3. Attach the removal head.
4. Install the lever arm.
19. Remove the exhaust valve springs, 1st cylinder.
 1. Carefully push the valve springs down using the **EN-889-12**: lever arm.

NOTE: Removal head must be positioned vertically over the valve stem.

2. Remove the valve keepers

NOTE: Observe correct assignment.

3. Remove the valve head and valve springs.
20. Replace the valve stem seals.
 1. Pull off with the **EN-840**: remover.
 2. Coat the valve stem with engine oil.
 3. Connect the new valve stem seals onto the valve stem.
 4. Using the **EN-958**: installer.

21. Attach the **EN-6086-7:** lever arm.

1. Insert the valve springs and valve head.
2. Insert the valve wedges in the **EN-889-2:** assembly head.

NOTE: Insert the valve cotters with the tapered end toward the valve.

-
- Push the plastic clamping sleeve toward the lever arm mounting.
- Push the plastic clamping sleeve toward the valve.

NOTE: Assembly head must stand vertically above the valve stem. Valve cotters must engage audibly.

3. Attach the assembly head to the lever arm.

NOTE: Do not make 2nd attempt without inspecting that both valve cotters are seated in the assembly head.

4. Carefully push the valve spring down using the **EN-889-12:** lever arm.

22. Inspect installation position.

Inspect seating of the valve keepers (visual inspection).

23. Transfer the **EN-6086-15:** pneumatic adapter.

1. Interrupt the compressed air feed.
2. Remove the adapter from cylinder number 1.
3. Install the adapter to cylinder number 4.
4. Apply compressed air to cylinder number 4.

24. Replace the valve stem seal of cylinder 4 by analogy with step 14-21.

25. Remove the **EN-6086-15:** pneumatic adapter.

1. Interrupt the compressed air feed.
2. Remove the adapter from cylinder number 4.

WARNING: Do not use a service jack to lift this vehicle. Lifting the vehicle with a jack could cause the vehicle to slip off the jack and roll; this could cause injury or death.

26. Raise the vehicle by its full height.

27. Remove **EN-6625:** holder.

28. Set the crankshaft to ignition TDC of cylinder 3.

NOTE: Alignment marking on toothed belt drive wheel must align with marking on rear toothed belt cover.

29. Turn crankshaft evenly by 180 degrees.
30. Block the crankshaft.
31. Install **EN-6625:** holder to the engine block.
32. Lower the vehicle by its full height
33. Replace the valve stem seal of cylinders 2 and 3 by analogy with step 7 to step 21.
34. Remove the **EN-6086-15:** pneumatic adapter.
 1. Interrupt the compressed air feed.
 2. Remove the adapter from cylinder number 3.
35. Remove the **EN-6086:** automatic valve spring lever.
 1. Release the installation shaft.
 2. Remove both supports with the installation shaft.
 3. Remove the installation head from the lever arm.

INSTALLATION PROCEDURE

WARNING: Do not use a service jack to lift this vehicle. Lifting the vehicle with a jack could cause the vehicle to slip off the jack and roll; this could cause injury or death.

1. Raise the vehicle.
2. Remove **EN-6625:** holder from the engine block.
 1. Detach the screwed connection.
 2. Tighten the bolted connection.
 3. Use new nuts.
3. Set the engine to 60 degrees (measurement) before TDC.

Set the crankshaft in direction of engine rotation to 60 degrees (measurement 1) before TDC.

4. Install the Intake camshaft. Refer to **Intake Camshaft Replacement**
5. Install the exhaust camshaft. Refer to **Exhaust Camshaft Replacement**