

**2006 ENGINE**

**Engine Mechanical - 3.6L (LY7) - CTS (3 Of 5)**

**INTAKE MANIFOLD CLEANING AND INSPECTION**

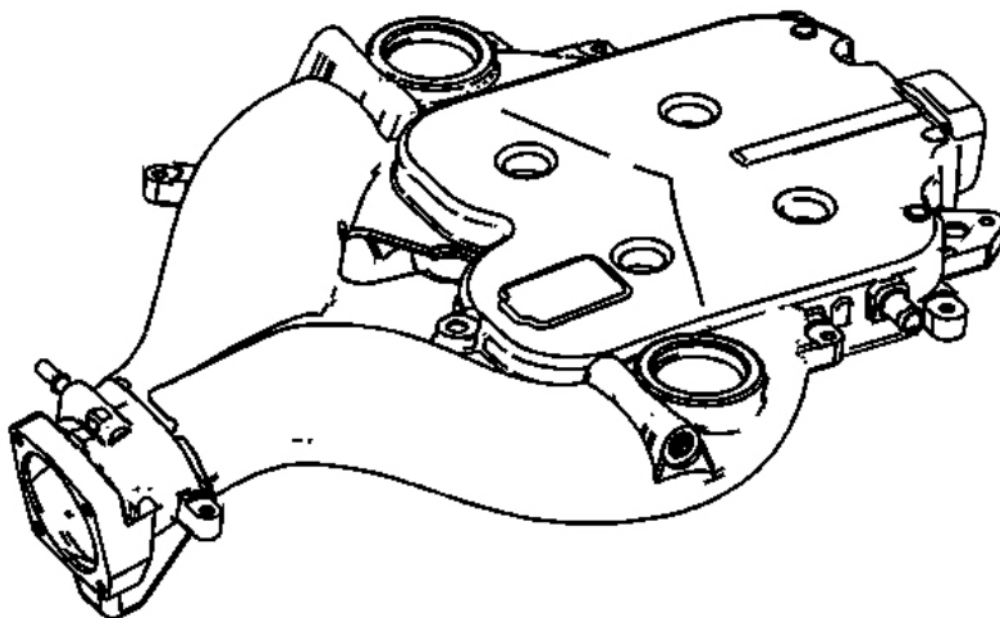
**UPPER INTAKE MANIFOLD CLEANING PROCEDURE**

1. Remove any remaining gasket and/or gasket material from the following:
  - Throttle body
  - Intake manifold
2. Clean the following intake manifold areas in solvent.
  - Intake manifold gasket sealing areas
  - Intake manifold passages
  - Brake booster hose passage
  - Evaporative emission (EVAP) solenoid passage
  - Positive crankcase ventilation (PCV) vacuum hose passages
  - Barometric pressure (BARO) sensor passage

**CAUTION: Refer to Safety Glasses Caution in Cautions and Notices.**

3. Dry the upper intake manifold and throttle body with compressed air.

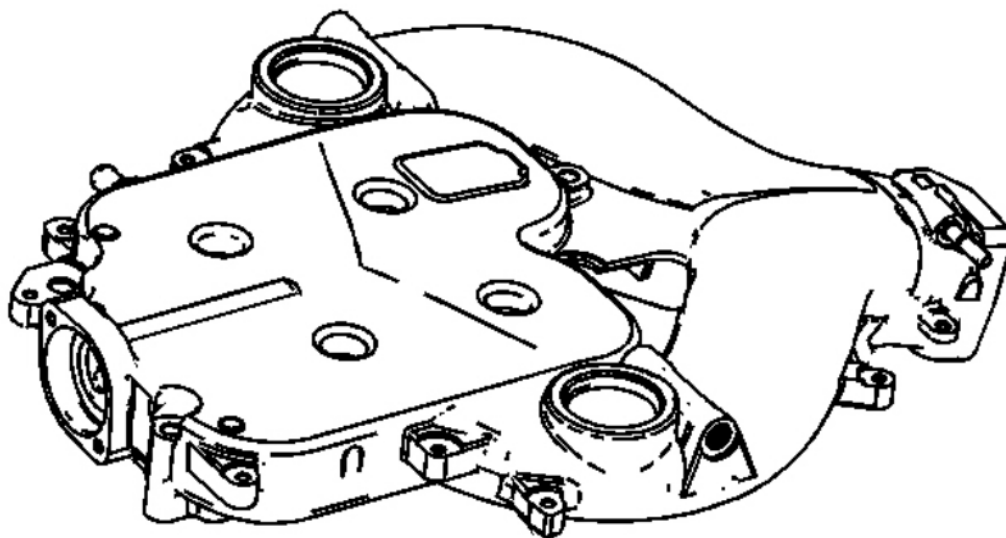
**INSPECTION PROCEDURE**



**Fig. 1: Inspecting Upper Intake Manifold**  
Courtesy of GENERAL MOTORS CORP.

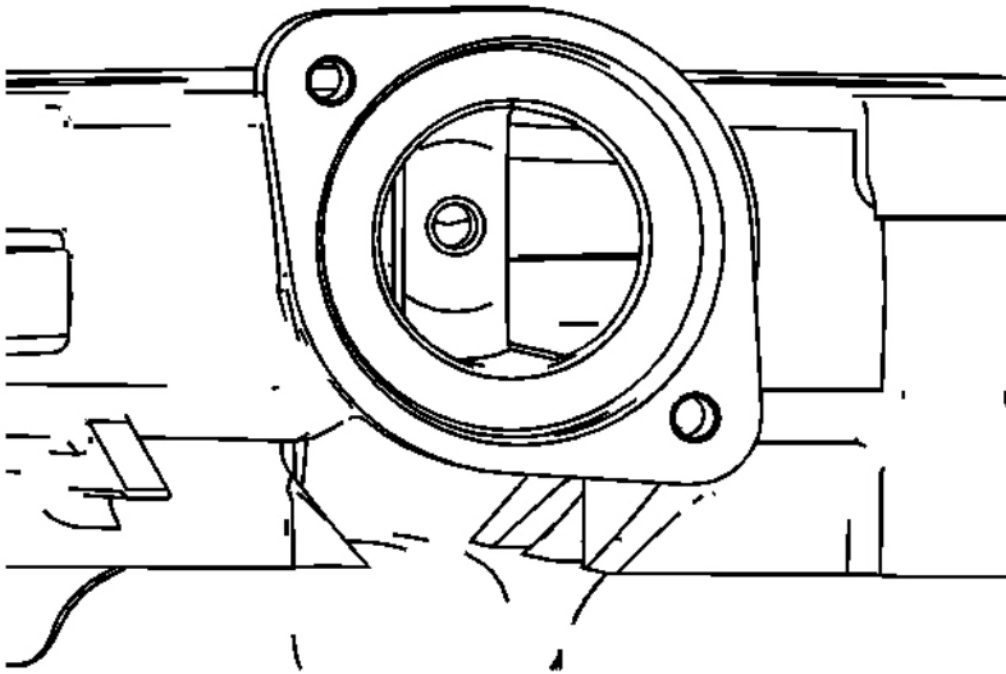
1. Inspect the upper intake manifold for the following conditions:
  - Damage, debris or restrictions to the BARO sensor mounting port
  - Damage, debris or restrictions to the brake vacuum booster hose port
  - Damage to the throttle body bolt holes
  - Damage, debris or restrictions to the PCV system hose ports





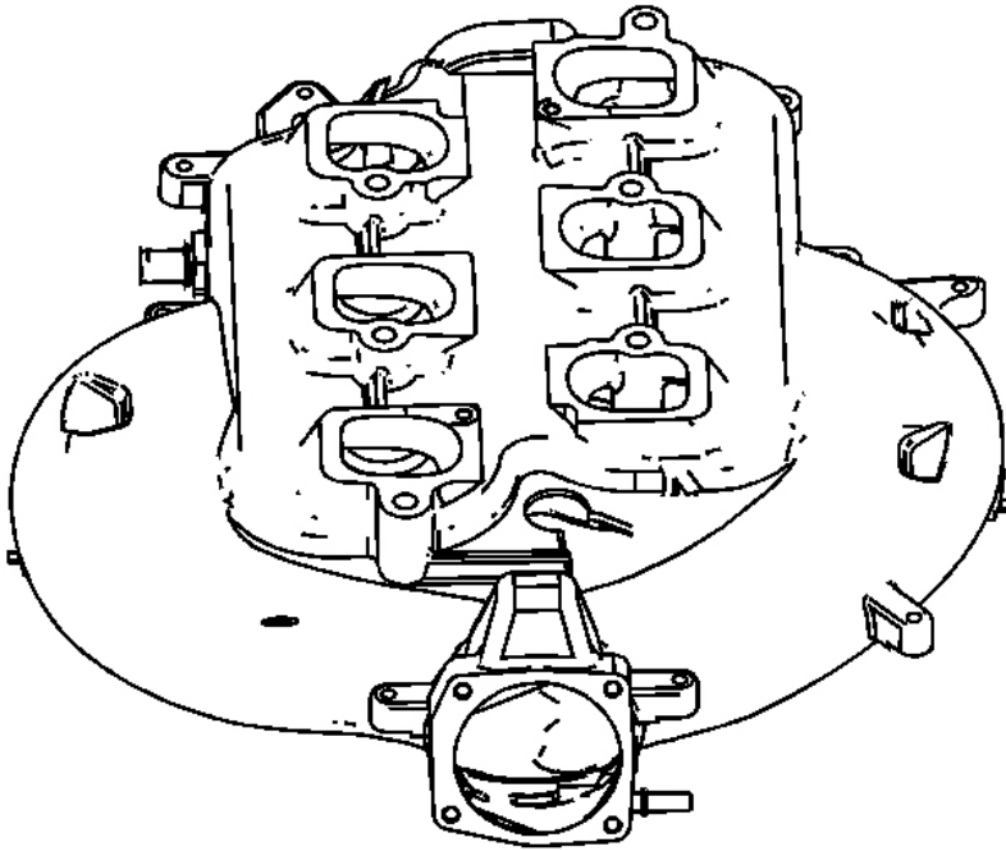
**Fig. 2: View Of Upper Intake Manifold**  
Courtesy of GENERAL MOTORS CORP.

2. Inspect the upper intake manifold for the following conditions:
  - Damage to the intake manifold bolt bosses
  - Damage to the EVAP purge solenoid mounting boss
  - Damage, debris or restrictions to the EVAP purge solenoid port
  - Damage, debris or restrictions in the vacuum passage



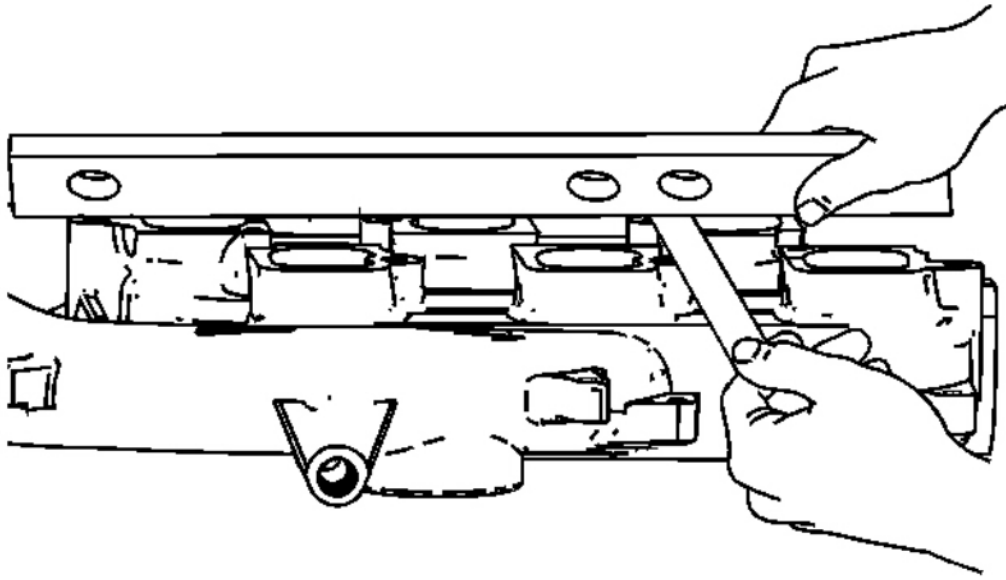
**Fig. 3: Inspecting Upper Intake Manifold For Communicator Valve Component Damage**  
Courtesy of GENERAL MOTORS CORP.

3. Inspect the upper intake manifold for the following conditions:
  - Damage to the communicator valve mounting bosses
  - Damage, debris or restrictions to the communicator valve port
  - Damage to the communicator valve components



**Fig. 4: Inspecting Upper Intake Manifold For Damage To Sealing Surfaces**  
Courtesy of GENERAL MOTORS CORP.

4. Inspect the upper intake manifold for the following conditions:
  - Gouges or damage to the upper intake manifold sealing surfaces
  - Damage to the gasket sealing surface for the throttle body



**Fig. 5: Inspecting Upper Intake Manifold Sealing Surface For Warpage**  
Courtesy of GENERAL MOTORS CORP.

5. Inspect the upper intake manifold sealing surface for warpage.
  1. Locate a straight edge across the upper-to-lower intake manifold sealing surface.
  2. Insert a feeler gage between the upper intake manifold and the straight edge. An upper intake manifold with warpage in excess of 0.05 mm (0.020 in) must be replaced.
6. Repair or replace the upper intake manifold as necessary.

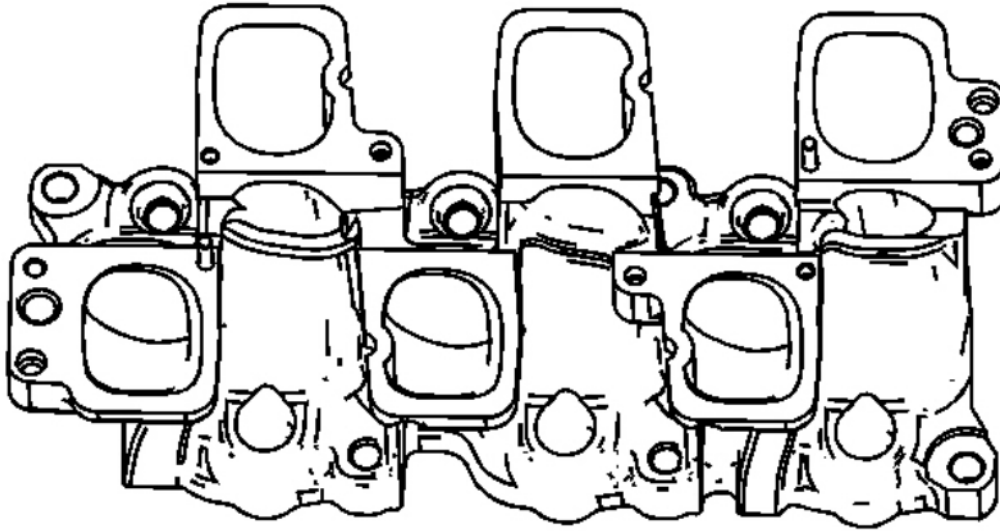
#### **LOWER INTAKE MANIFOLD CLEANING PROCEDURE**

1. Remove any remaining gasket and/or gasket material from the following:
  - Upper-to-lower intake manifold sealing surface
  - Cylinder head-to-lower intake manifold sealing surface
2. Clean the following intake manifold areas in solvent.
  - Intake manifold gasket sealing surfaces
  - Intake manifold passages

**CAUTION: Refer to Safety Glasses Caution in Cautions and Notices.**

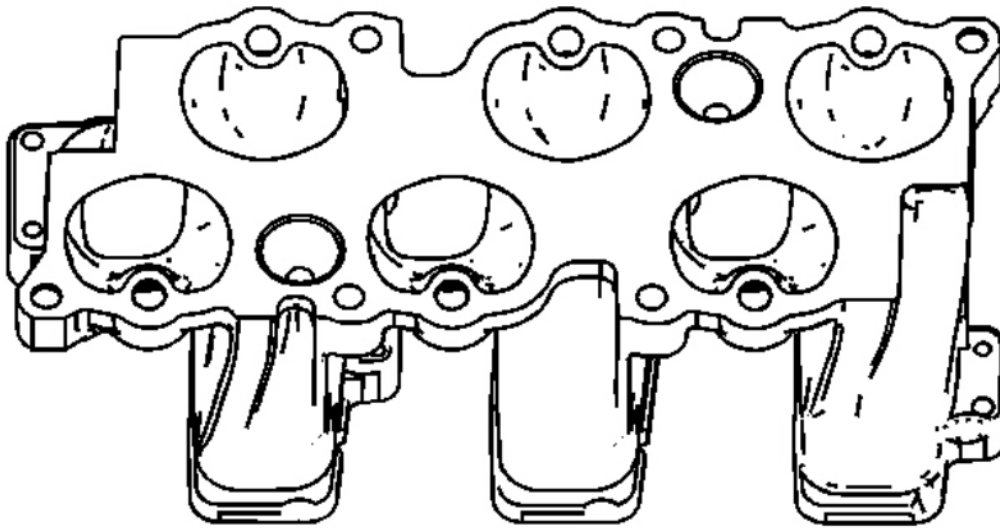
3. Dry the intake manifold with compressed air.

## INSPECTION PROCEDURE



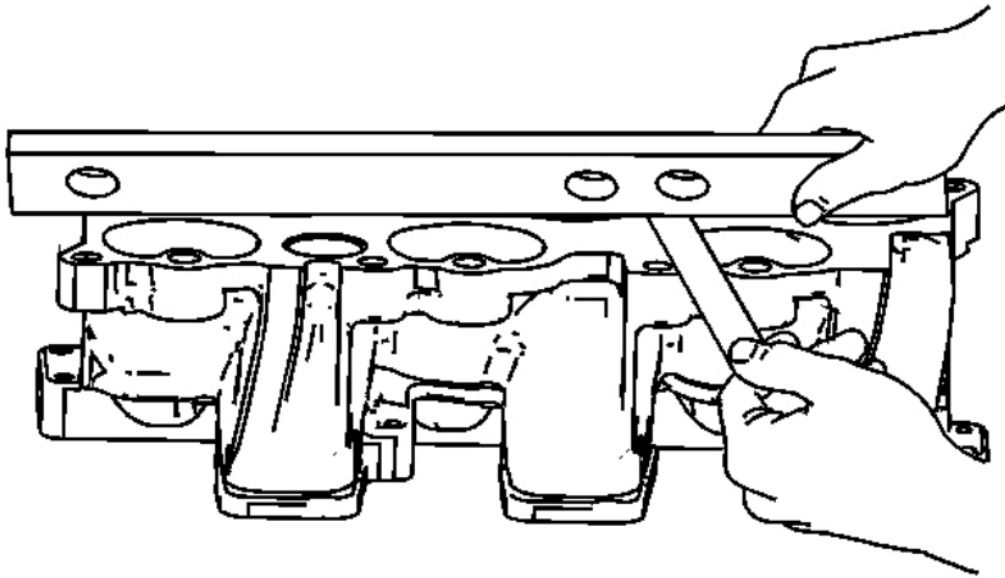
**Fig. 6: Inspecting Lower Intake Manifold For Damage**  
Courtesy of GENERAL MOTORS CORP.

1. Inspect the lower intake manifold for the following conditions:
  - Damage, debris or restrictions to the lower intake manifold ports
  - Damage to the fuel rail mounting bolt holes
  - Damage to the fuel rail



**Fig. 7: Checking Lower Intake Manifold For Damage**  
Courtesy of GENERAL MOTORS CORP.

2. Inspect the lower intake manifold for the following conditions:
  - Gouges or damage to the intake manifold sealing surfaces
  - Damage to the lower intake manifold bolt bosses
  - Damage to the fuel injector ports

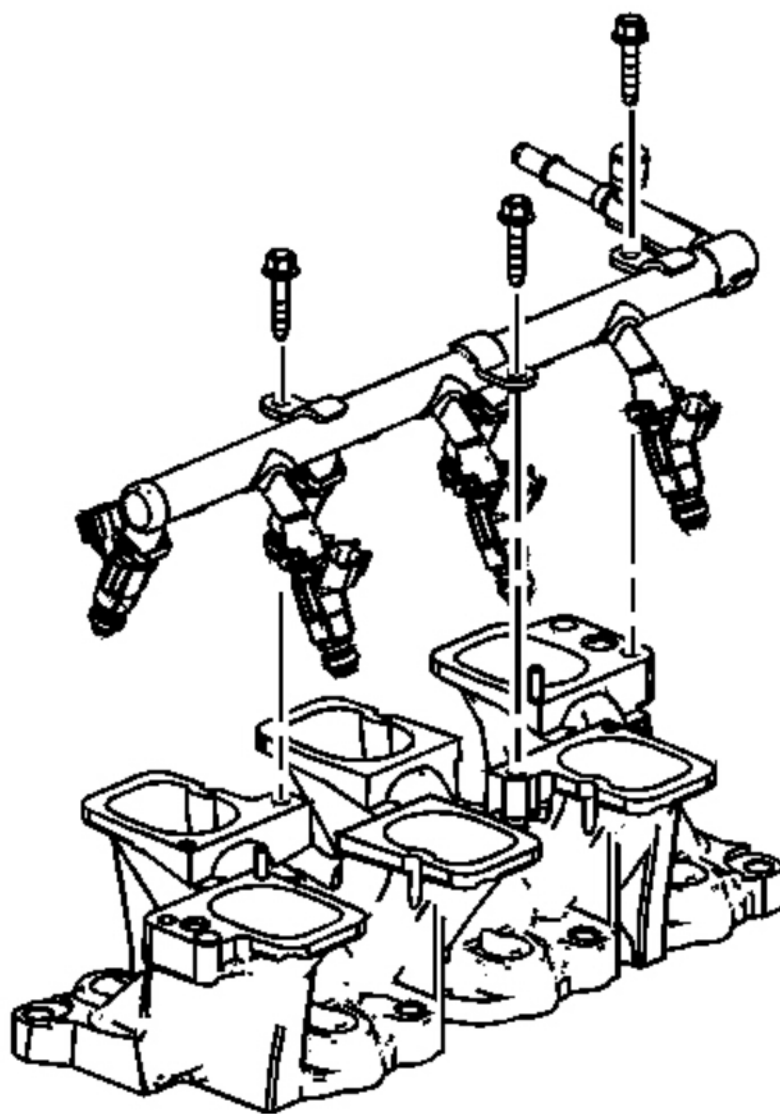


**Fig. 8: Measuring Lower Intake Manifold For Warpage**  
Courtesy of GENERAL MOTORS CORP.

3. Inspect the lower intake manifold sealing surfaces for warpage.
  1. Locate a straight edge across the lower intake manifold sealing surfaces.
  2. Insert a feeler gage between the lower intake manifold and the straight edge. A lower intake manifold with warpage in excess of 0.5 mm (0.020 in) must be replaced.
4. Repair or replace the lower intake manifold as necessary.

## INTAKE MANIFOLD ASSEMBLE

### LOWER INTAKE MANIFOLD ASSEMBLE PROCEDURE



**Fig. 9: View Of Fuel Injector Rail**  
Courtesy of GENERAL MOTORS CORP.

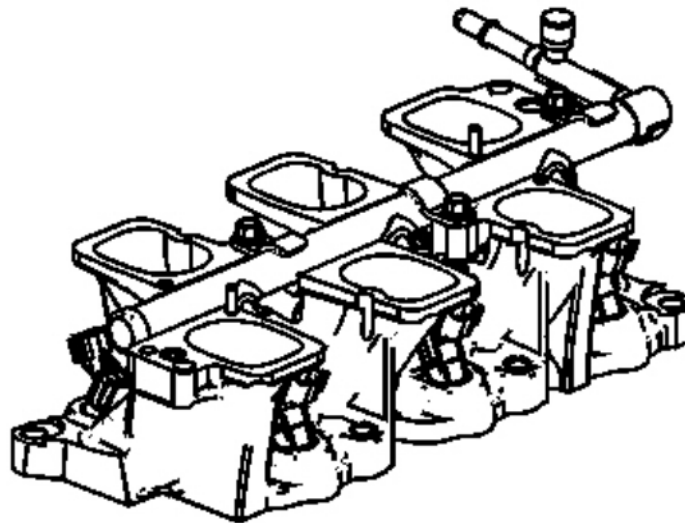
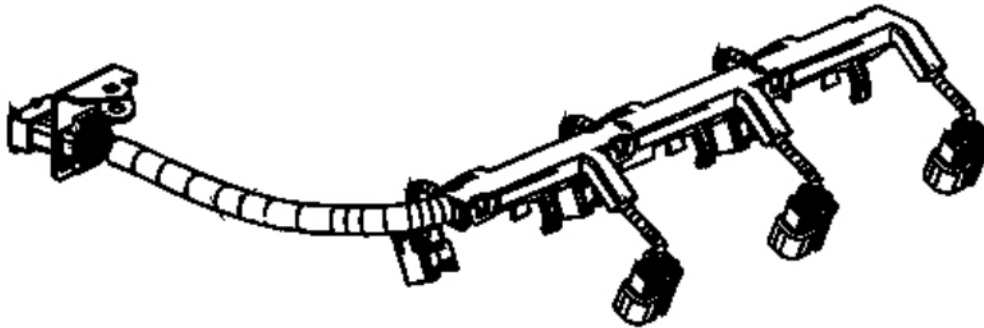
1. Install the fuel injector rail.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.



2. Install the fuel injector rail bolts.

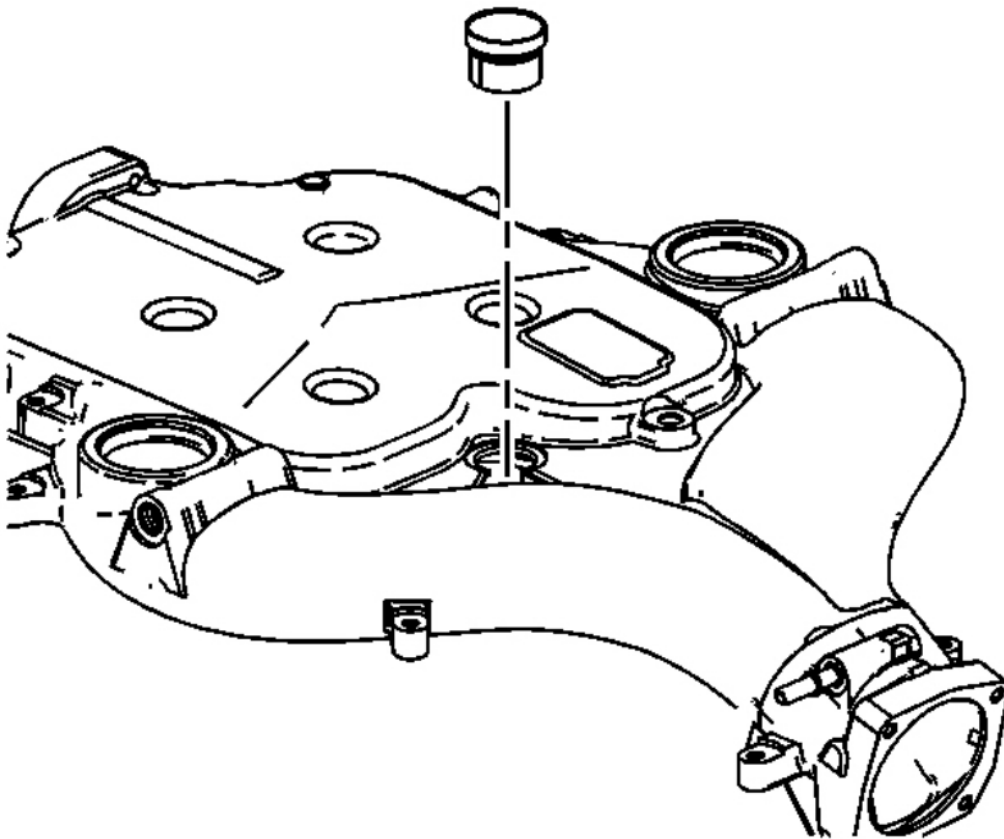
**Tighten:** Tighten the fuel injector rail bolts to 10 N.m (89 lb in).



**Fig. 10: View Of Fuel Injector Wiring Harness**  
Courtesy of GENERAL MOTORS CORP.

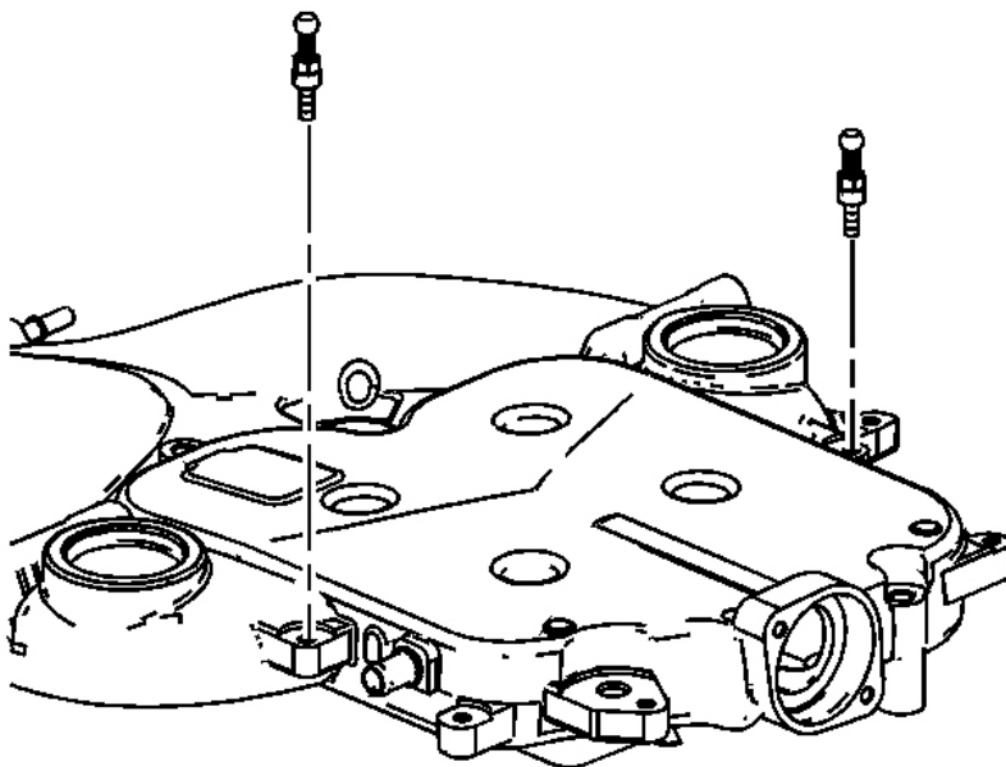
3. Install the fuel injector wiring harness connector.

#### UPPER INTAKE MANIFOLD ASSEMBLE PROCEDURE



**Fig. 11: View Of Sight Shield Grommet**  
Courtesy of GENERAL MOTORS CORP.

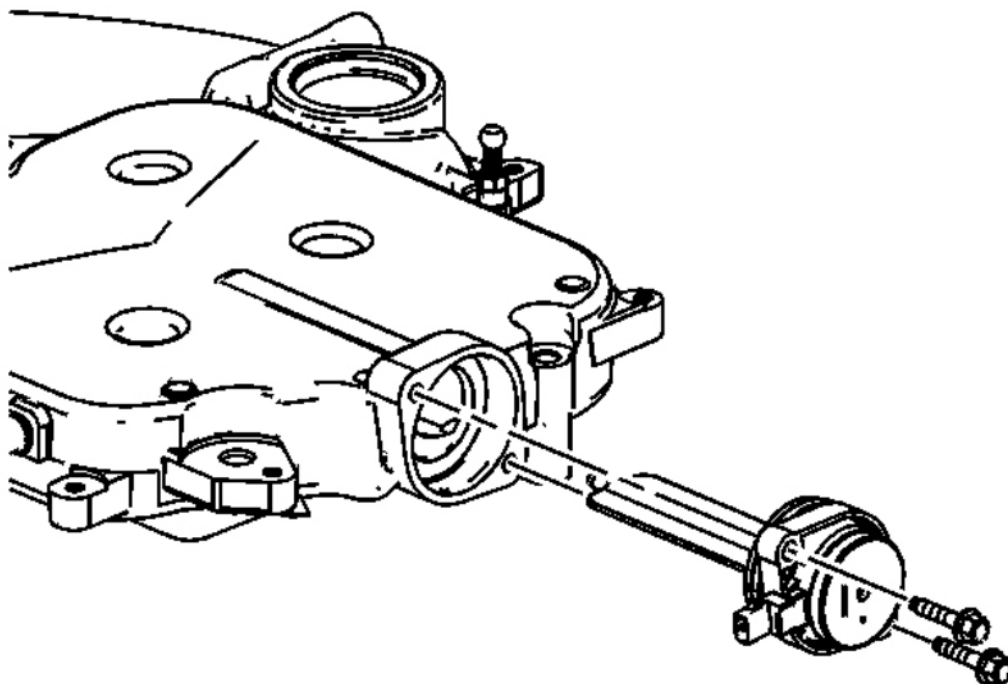
1. Install the sight shield grommet.



**Fig. 12: View Of Sight Shield Ball Studs**  
Courtesy of GENERAL MOTORS CORP.

2. Install the sight shield ball studs.

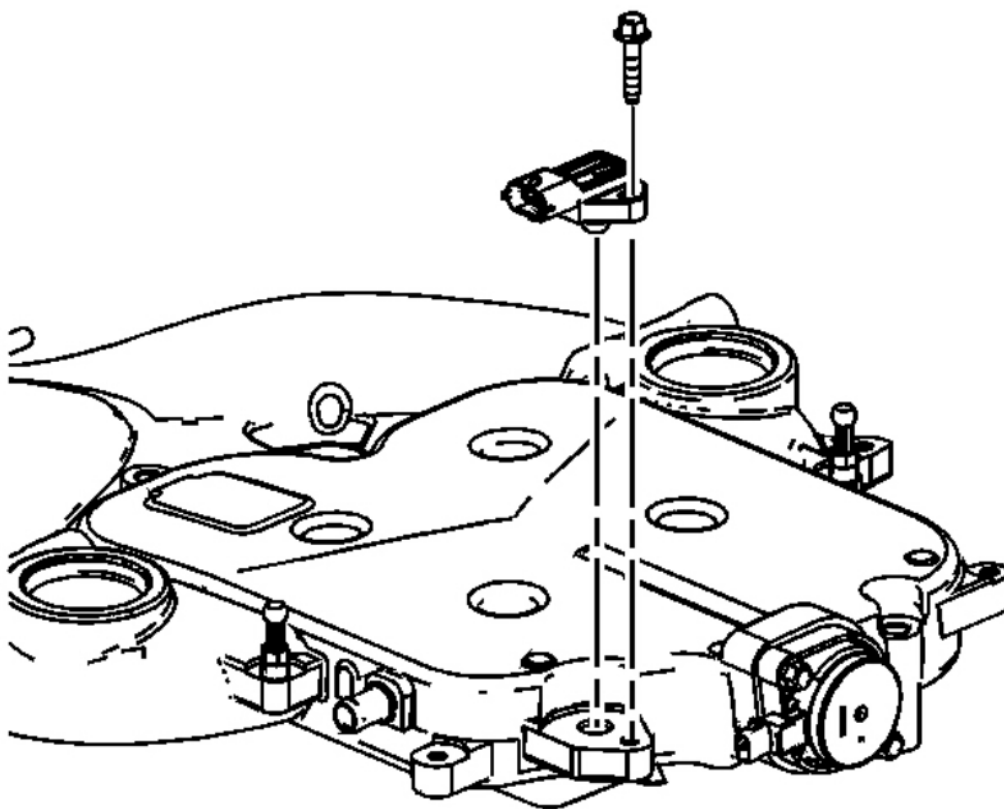
**Tighten:** Tighten the sight shield ball studs to 7 N.m (62 lb in).



**Fig. 13: View Of Communicator Valve**  
Courtesy of GENERAL MOTORS CORP.

3. Install the communicator valve.
4. Install the communicator valve bolts.

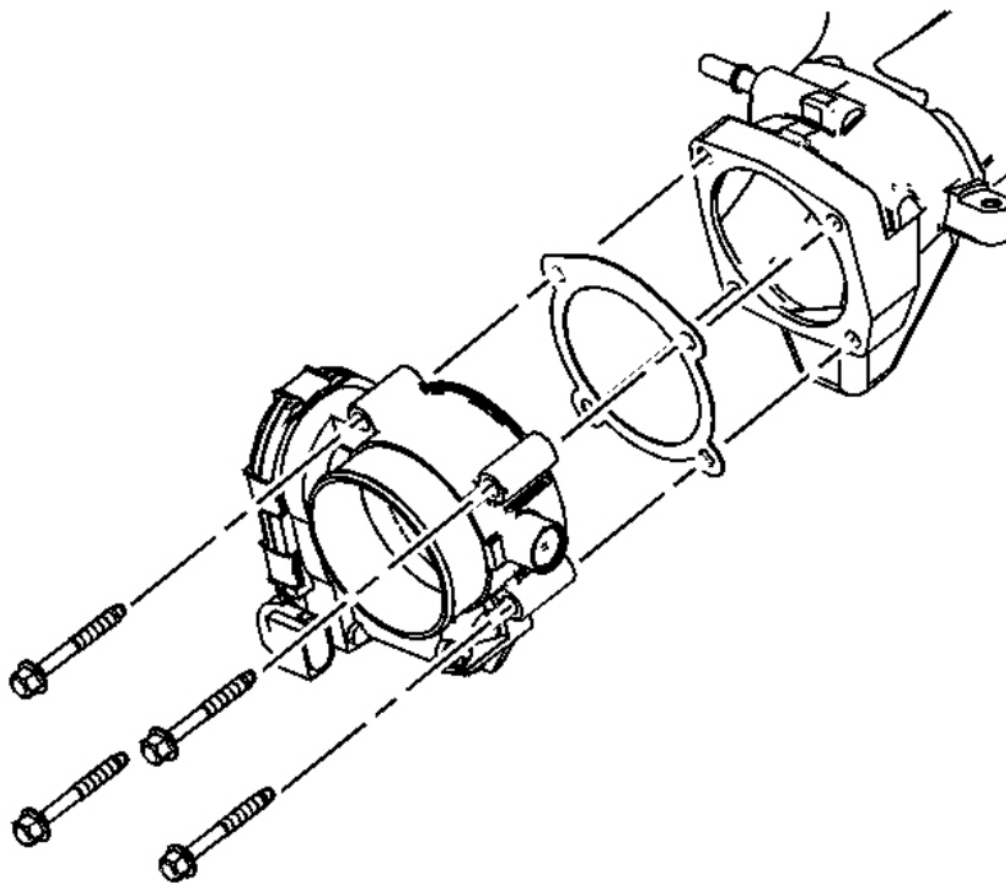
**Tighten:** Tighten the communicator valve bolts to 10 N.m (89 lb in).



**Fig. 14: View Of BARO Sensor**  
Courtesy of GENERAL MOTORS CORP.

5. Install the barometric pressure (BARO) sensor.
6. Install the BARO sensor bolt.

**Tighten:** Tighten the BARO sensor bolt to 10 N.m (89 lb in).

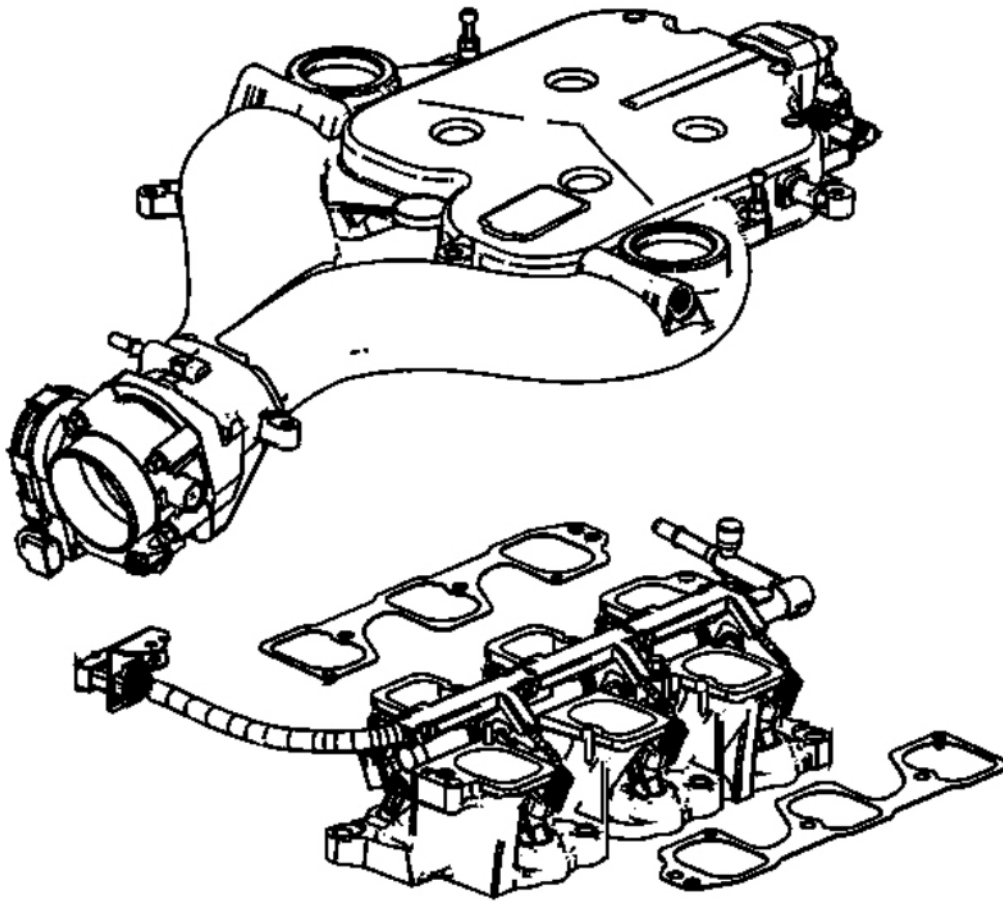


**Fig. 15: View Of Throttle Body**  
Courtesy of GENERAL MOTORS CORP.

7. Install the NEW throttle body gasket.
8. Install the throttle body.
9. Install the throttle body bolts.

**Tighten:** Tighten the throttle body bolts to 10 N.m (89 lb in).

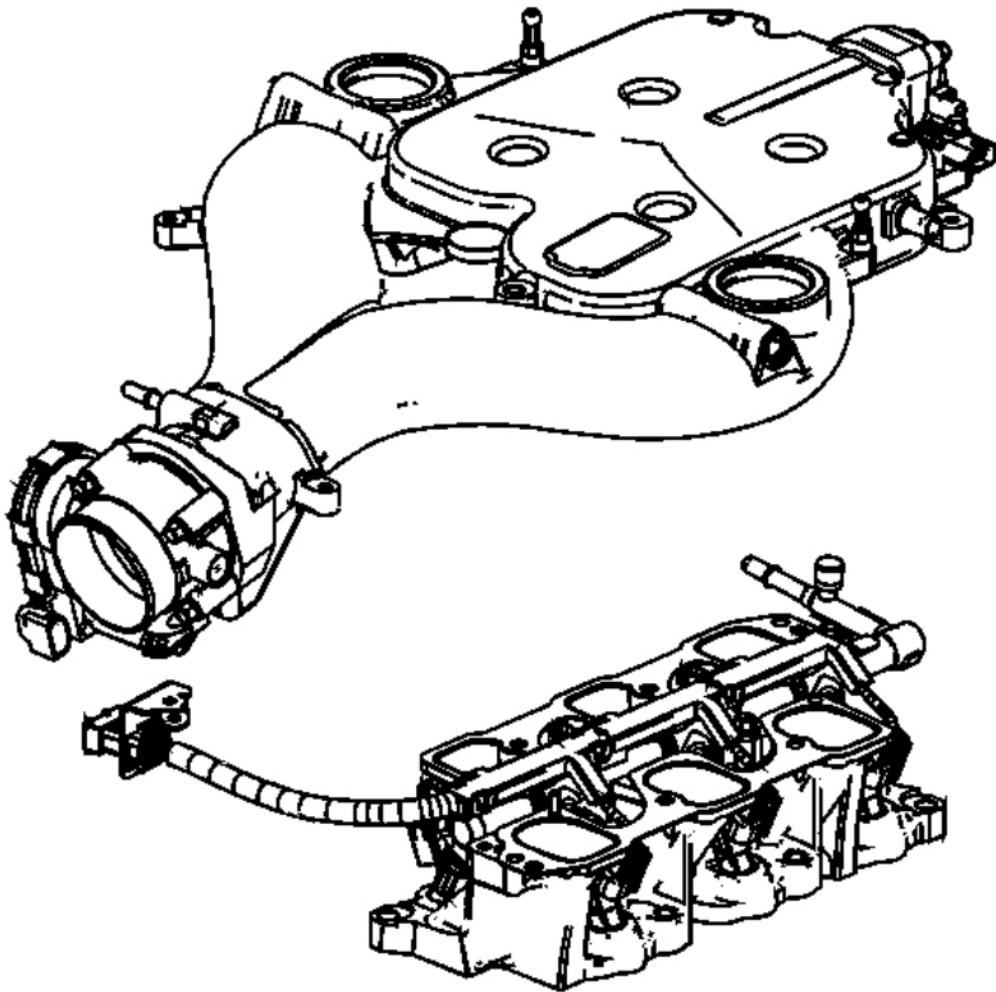
#### UPPER TO LOWER INTAKE MANIFOLD ASSEMBLE PROCEDURE



**Fig. 16: View Of Upper-To-Lower Intake Manifold Gaskets**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** Do not reuse the upper-to-lower intake manifold gasket and the intake manifold-to-cylinder head sealing gaskets.

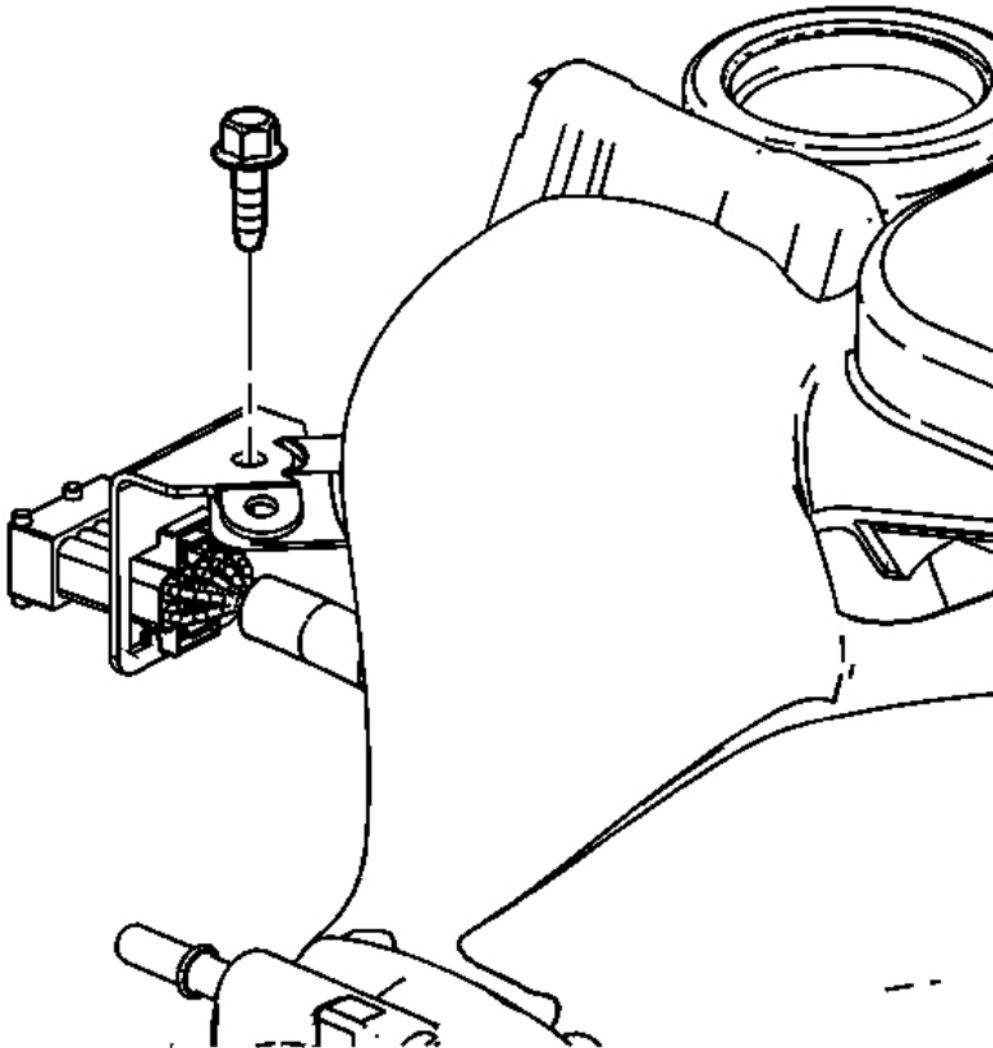
1. Install the NEW upper-to-lower intake manifold gaskets.



**Fig. 17: View Of Upper & Lower Intake Manifolds**  
**Courtesy of GENERAL MOTORS CORP.**

2. Install the upper intake manifold to the lower intake manifold.

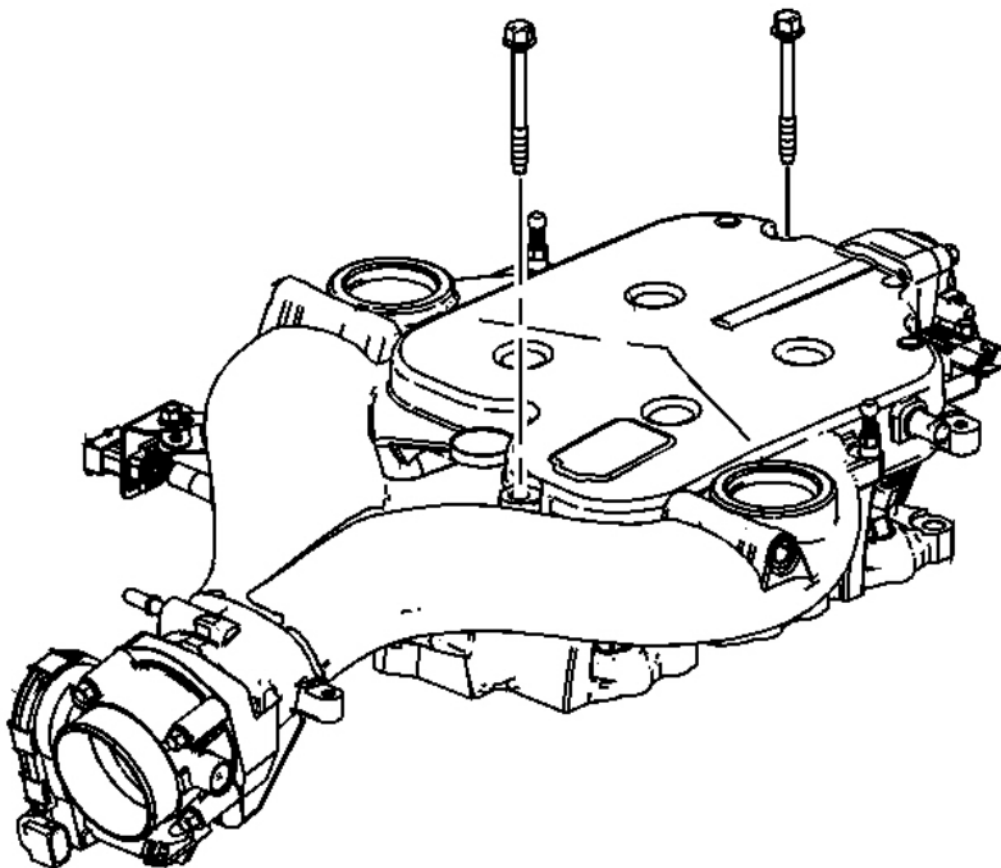




**Fig. 18: View Of Injector Harness Bracket Bolt**  
Courtesy of GENERAL MOTORS CORP.

3. Install the fuel injector wiring harness bracket bolt to the upper intake manifold.

**Tighten:** Tighten the fuel injector wiring harness bracket bolt to 10 N.m (89 lb in).



**Fig. 19: View Of Upper-To-Lower Intake Manifold Bolts**  
Courtesy of GENERAL MOTORS CORP.

4. Install the upper-to-lower intake manifold bolts.

**Tighten:** Tighten the upper-to-lower intake manifold bolts to 23 N.m (17 lb ft).

## EXHAUST MANIFOLD CLEANING AND INSPECTION - LEFT

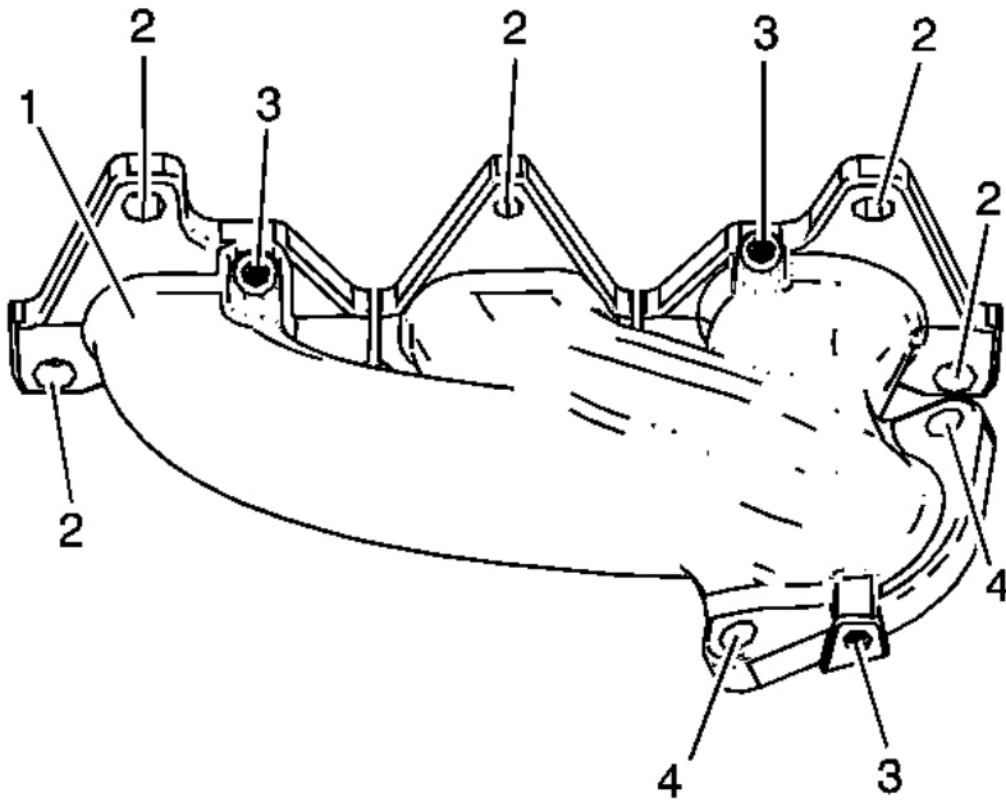
### CLEANING PROCEDURE

1. Clean the exhaust manifold in solvent.

**CAUTION:** Refer to Safety Glasses Caution in Cautions and Notices.

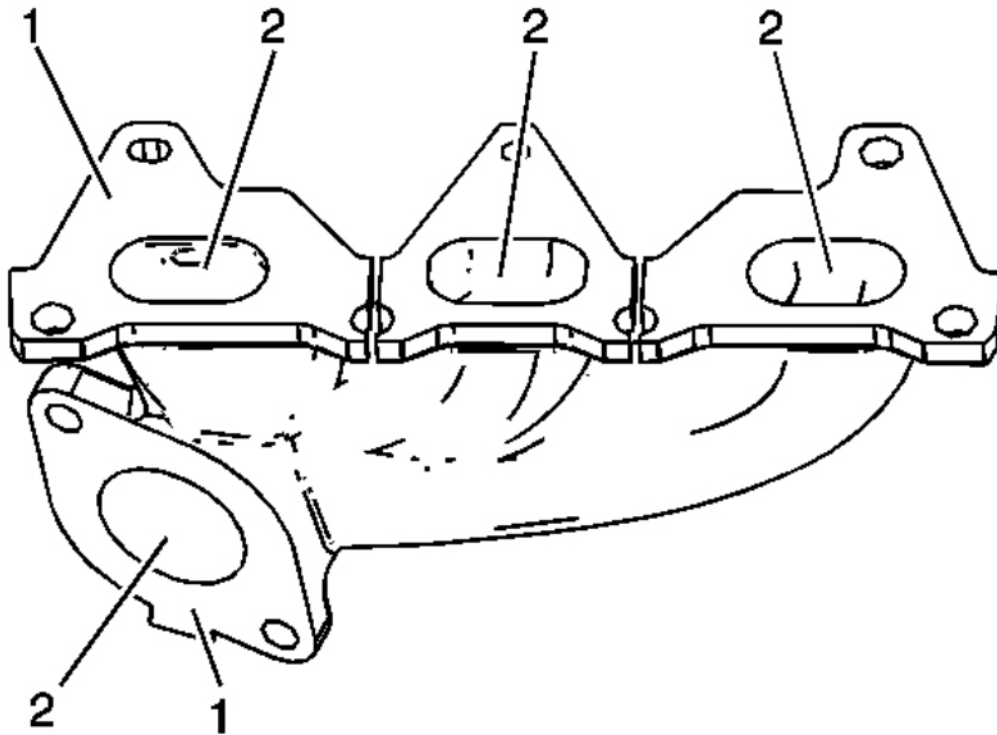
2. Dry the exhaust manifold with compressed air.

## INSPECTION PROCEDURE



**Fig. 20: Inspecting Left Exhaust Manifold For Corrosion & Bolt Hole Damage**  
Courtesy of GENERAL MOTORS CORP.

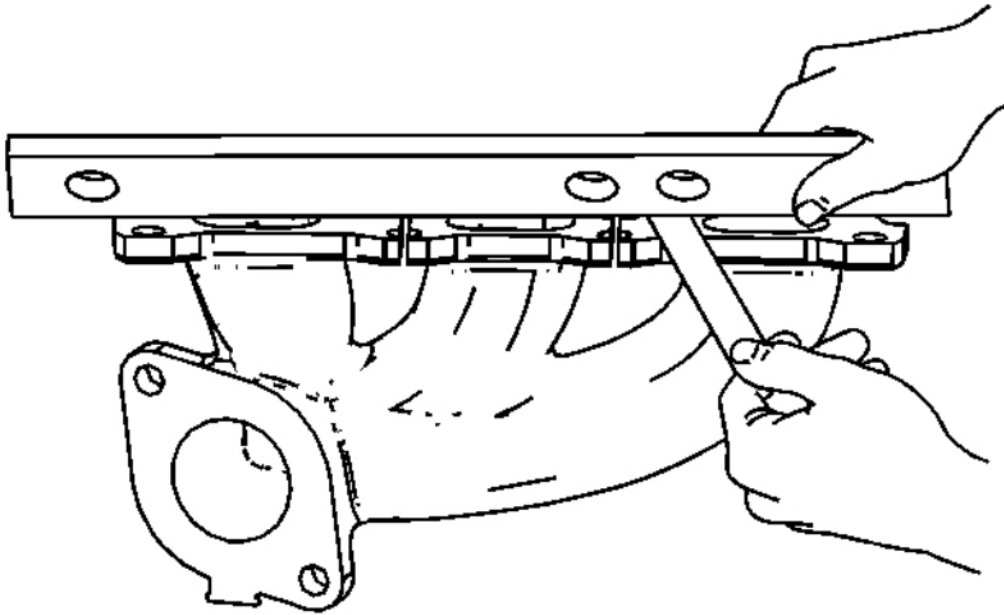
1. Inspect the left exhaust manifold for the following:
  - Damage or excessive corrosion to the exhaust manifold exterior (1)
  - Damage to the exhaust manifold mounting holes (2)
  - Damage to the threaded holes (3) for the heat shield
  - Damage to the exhaust manifold flange bolt holes (4)



**Fig. 21: Inspecting Left Exhaust Manifold For Damage To Exhaust Passages & Gasket Sealing Surfaces**

Courtesy of GENERAL MOTORS CORP.

2. Inspect the left exhaust manifold for the following:
  - Damage to the gasket sealing surfaces (1)
  - Damage or restrictions within the exhaust passages (2)
3. Repair or replace the left exhaust manifold and/or components as necessary.



**Fig. 22: Measuring Alignment Of Left Exhaust Manifold Flanges**

Courtesy of GENERAL MOTORS CORP.

4. Measure the alignment or surface flatness of the exhaust manifold flanges, using a straight edge and a feeler gage. Exhaust manifold surface flatness must not exceed 0.254 mm (0.010 in).
5. If the surface flatness is not within specifications, the exhaust manifold is warped and must be replaced.

## **EXHAUST MANIFOLD CLEANING AND INSPECTION - RIGHT**

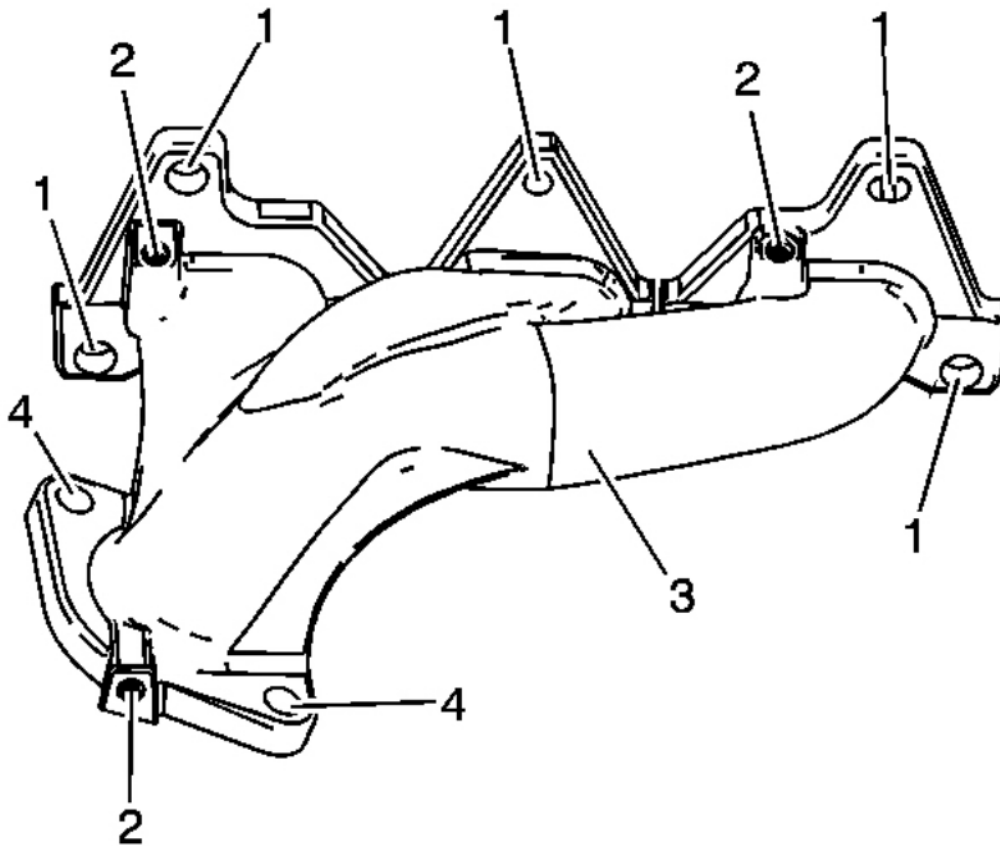
### **CLEANING PROCEDURE**

1. Clean the exhaust manifold in solvent.

**CAUTION:** Refer to Safety Glasses Caution in Cautions and Notices.

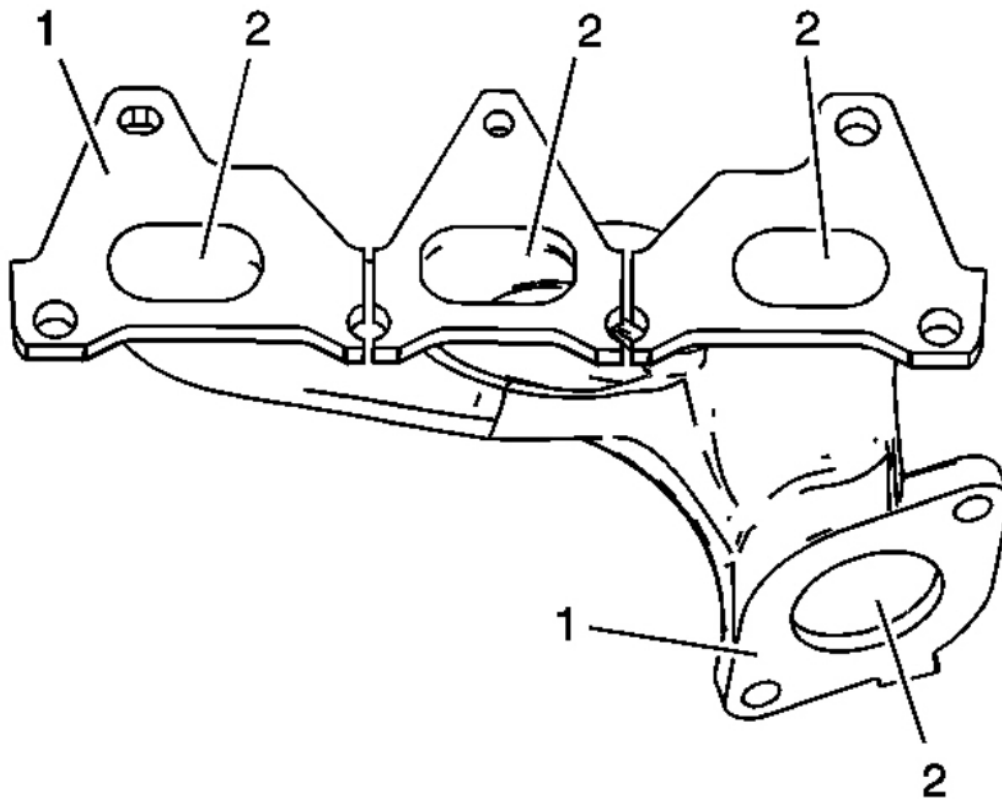
2. Dry the exhaust manifold with compressed air.

### **INSPECTION PROCEDURE**



**Fig. 23: Inspecting Right Exhaust Manifold For Corrosion & Bolt Hole Damage**  
Courtesy of GENERAL MOTORS CORP.

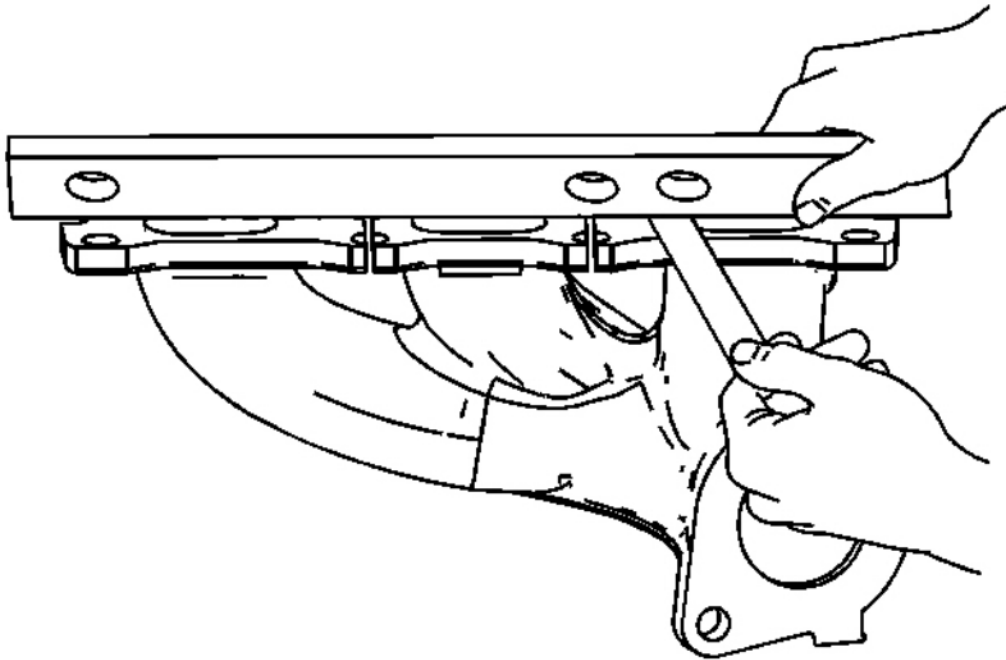
1. Inspect the right exhaust manifold for the following:
  - Damage to the exhaust manifold mounting holes (1)
  - Damage to the threaded holes (2) for the heat shield
  - Damage or excessive corrosion to the exhaust manifold exterior (3)
  - Damage to the exhaust manifold flange bolt holes (4)



**Fig. 24: Inspecting Right Exhaust Manifold For Damage To Exhaust Passages & Gasket Sealing Surfaces**

Courtesy of GENERAL MOTORS CORP.

2. Inspect the right exhaust manifold for the following:
  - Damage to the gasket sealing surfaces (1)
  - Damage or restrictions within the exhaust passages (2)
3. Repair or replace the right exhaust manifold and/or components as necessary.



**Fig. 25: Measuring Alignment Of Right Exhaust Manifold Flanges**  
Courtesy of GENERAL MOTORS CORP.

4. Measure the alignment or surface flatness of the exhaust manifold flanges, using a straight edge and a feeler gage. Exhaust manifold surface flatness must not exceed 0.254 mm (0.010 in).
5. If the surface flatness is not within specifications, the exhaust manifold is warped and must be replaced.

## WATER PUMP CLEANING AND INSPECTION

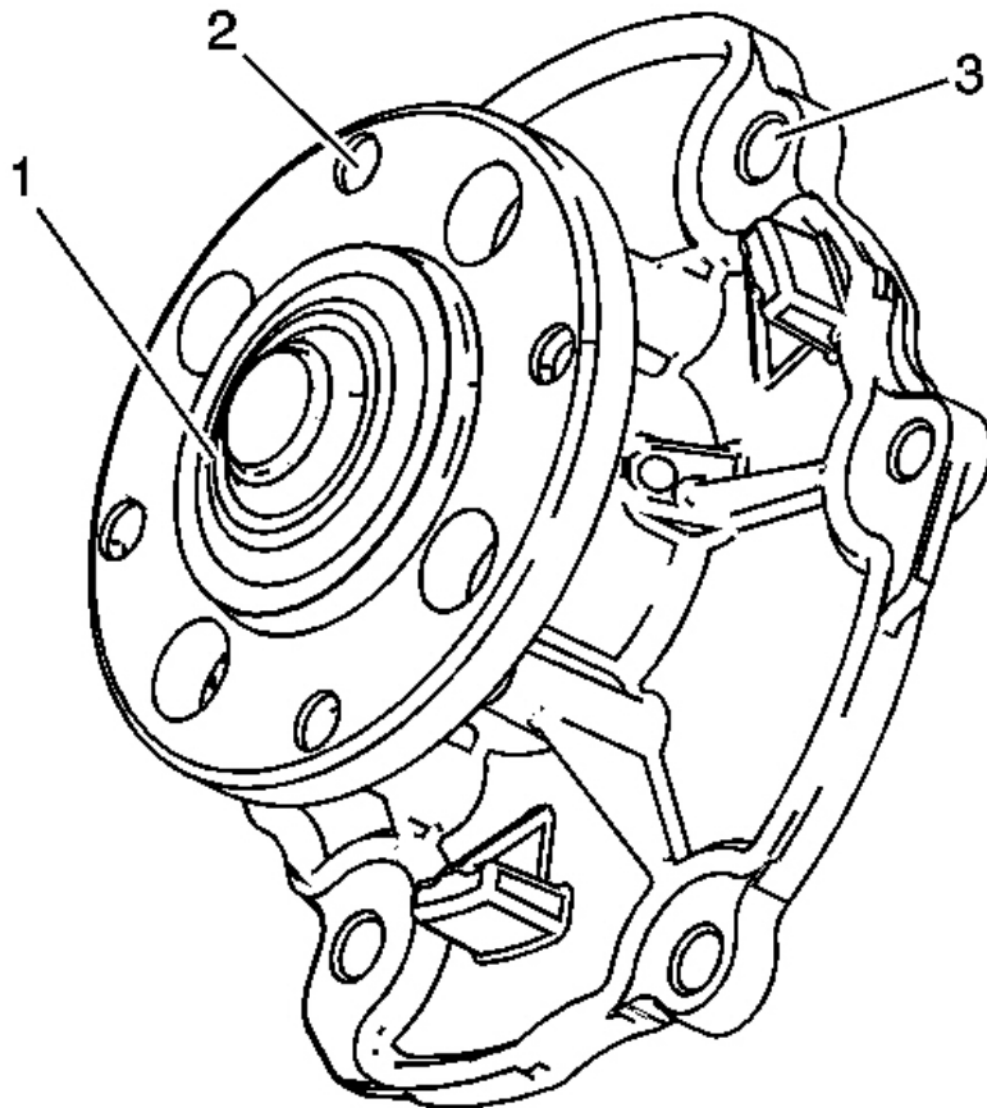
### CLEANING PROCEDURE

**NOTE:** Do not immerse the water pump in solvent. The solvent may enter the water pump's permanently lubricated bearings and cause premature bearing failure.

1. Remove the old gasket material from the water pump sealing surfaces.
2. Clean all excess dirt and debris from the water pump housing.

### INSPECTION PROCEDURE

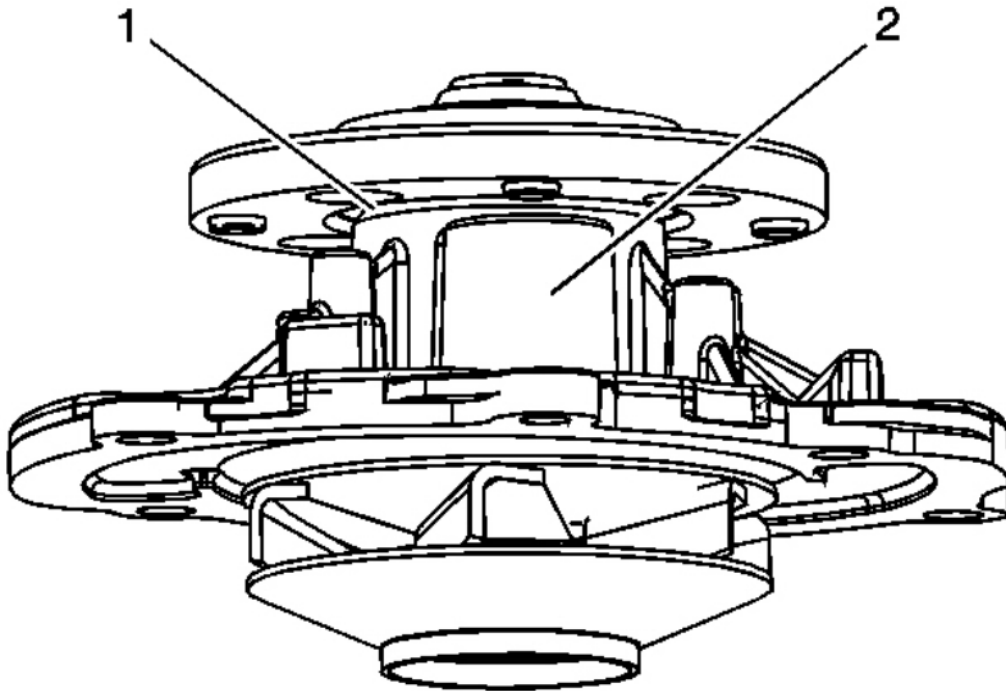




**Fig. 26: Inspecting Water Pump & Hub**  
Courtesy of GENERAL MOTORS CORP.

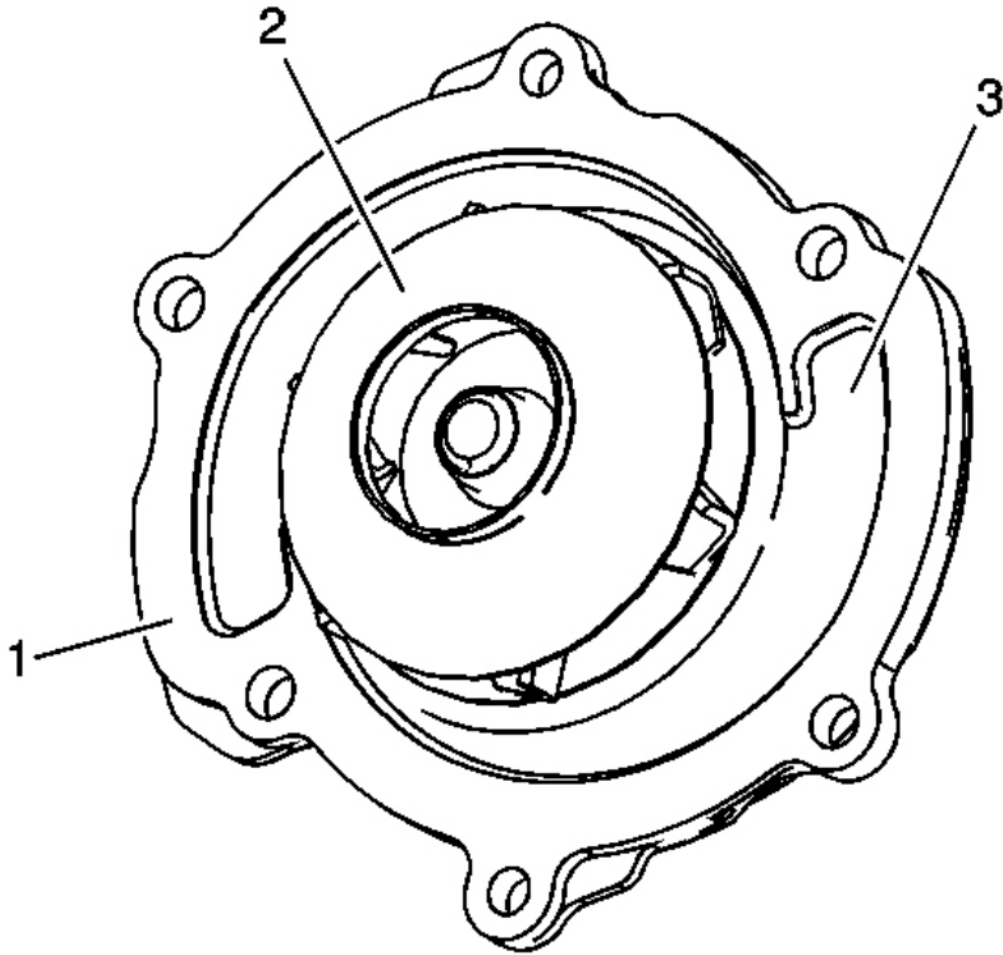
1. Rotate the water pump hub (1). The water pump hub and impeller should turn straight and smoothly. If the hub wobbles, is noisy, or feels rough when rotated, replace the water pump.
2. Inspect the exterior of the water pump for the following:
  - Damage to the water pump hub bolt threads (2) for the water pump pulley

- Damage to the water pump bolt holes (3)



**Fig. 27: Checking Water Pump Shaft & Weep Hole For Leakage**  
Courtesy of GENERAL MOTORS CORP.

3. Examine the water pump shaft (1) and the weep hole (2) in the water pump body for signs of leakage. If coolant leakage is evident, replace the water pump.



**Fig. 28: Inspecting Interior Of Water Pump For Damage**  
Courtesy of GENERAL MOTORS CORP.

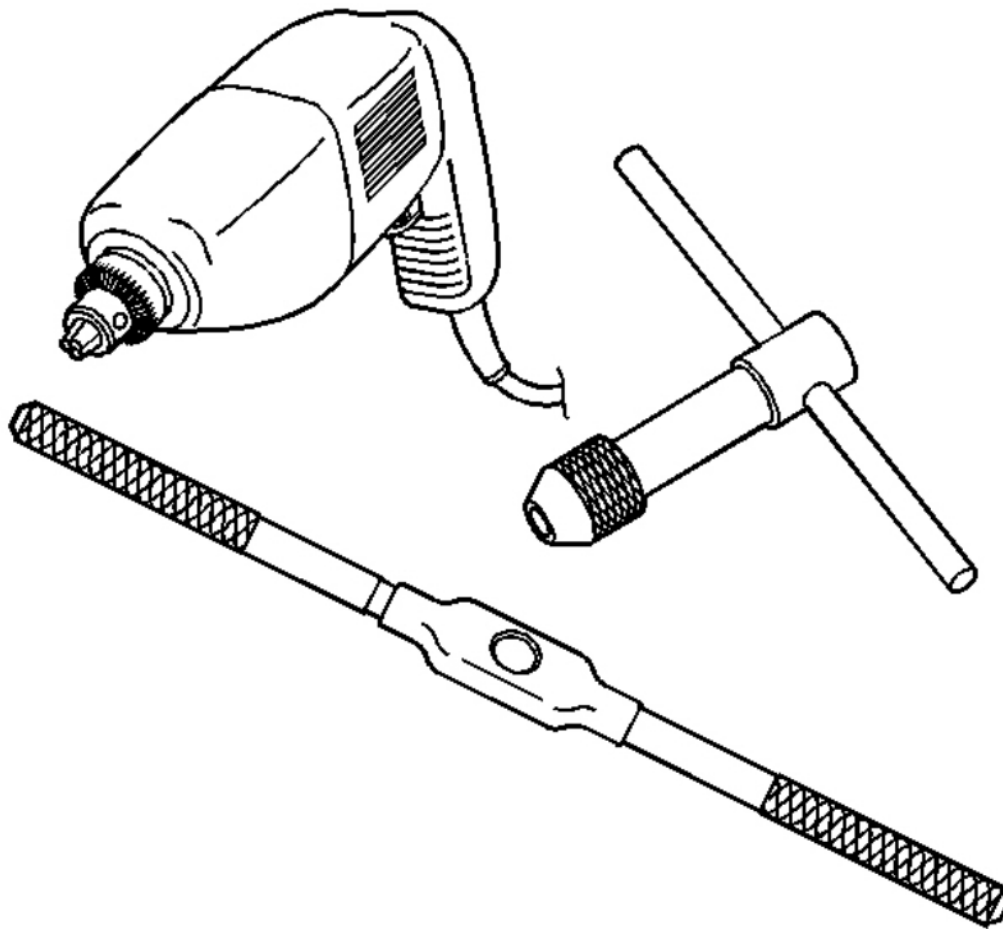
4. Inspect the interior of the water pump for the following:
  - Damage to the water pump gasket sealing surface (1)
  - Damage, corrosion or restrictions to the water pump impeller (2)
  - Damage, corrosion or restrictions to the coolant passages (3)
5. Repair or replace the water pump as necessary.

## THREAD REPAIR

### Tools Required

- **J 42385-700** High Feature Thread Repair Kit
- **J 42385-2000** Thread Insert Kit
- **J 43965** Thread Repair Extension Kit

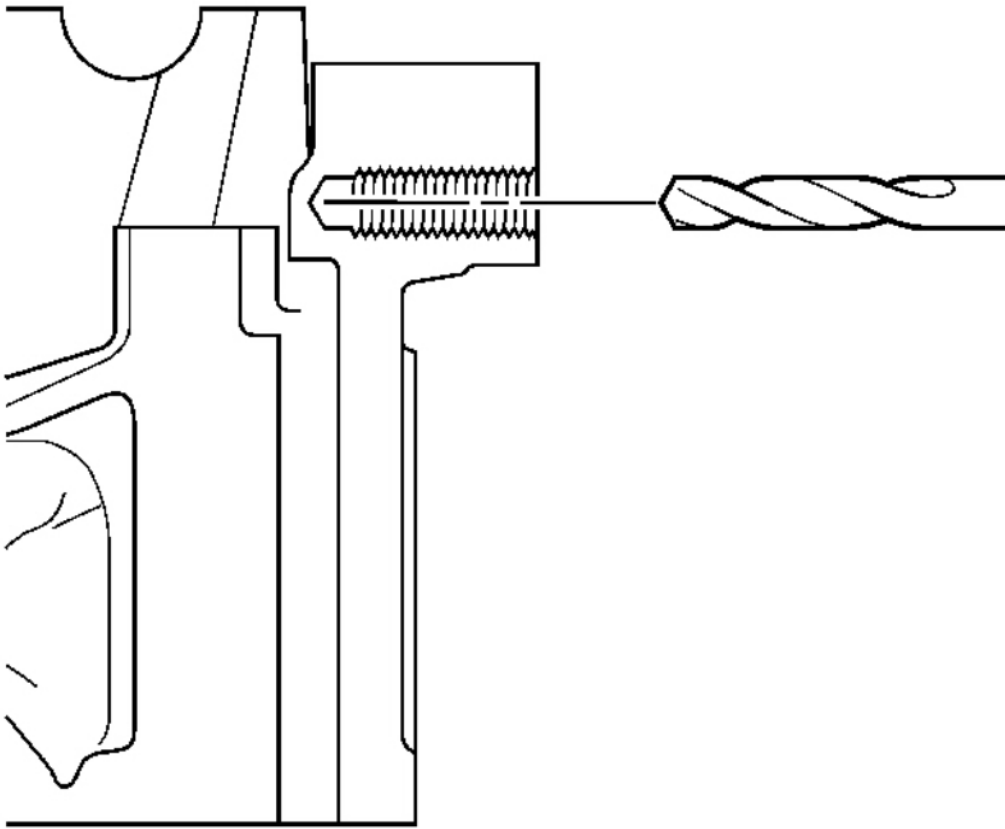
The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert. During the insert installation process, the installation driver tool cold-rolls the bottom internal threads and expands the bottom external threads of the insert into the base material. This action mechanically locks the insert into place.



**Fig. 29: View Of J 42385-400 Tool Kit**  
Courtesy of GENERAL MOTORS CORP.

The drill bit and counter bore tool from the tool kit **J 42385-700** and **J 42385-2000** is designed for use with either a suitable tap wrench or drill motor. Limited access and larger hole repair may process better using a tap

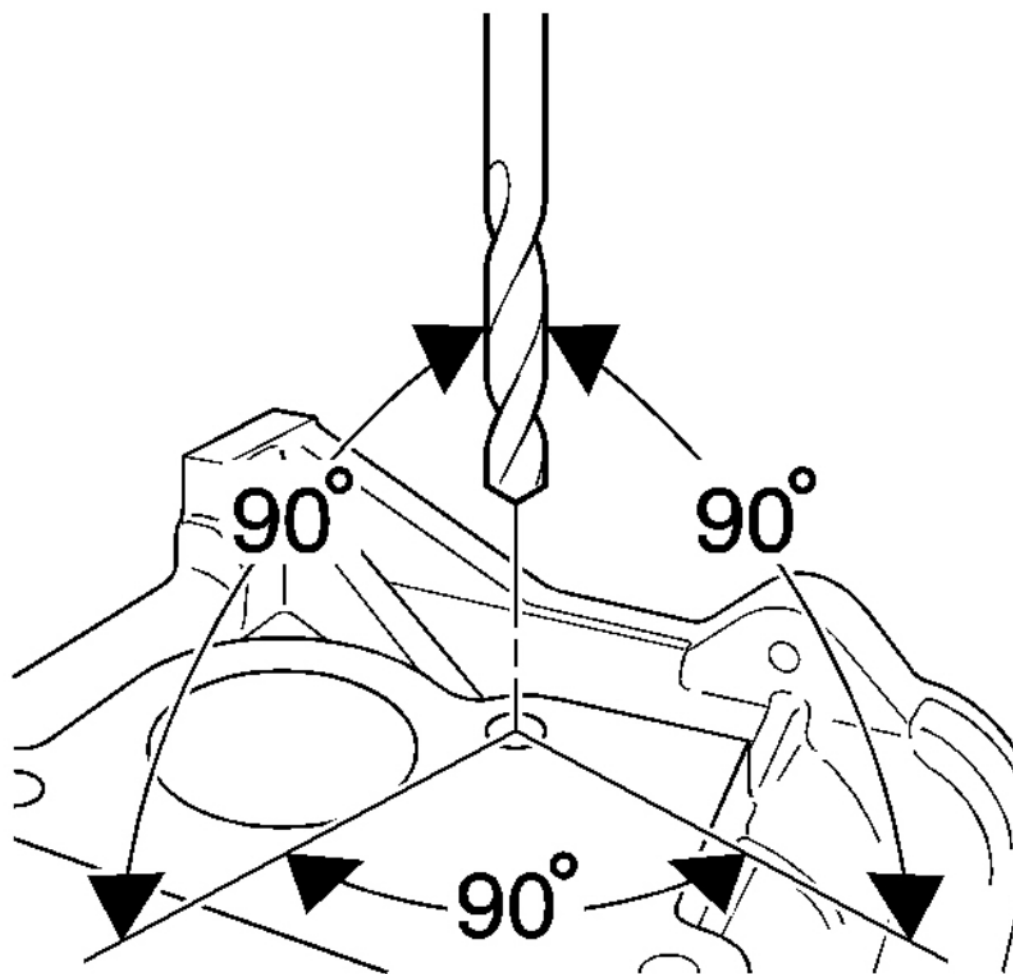
wrench. An extension from kit **J 43965** may also be necessary to drive the thread repair tooling dependent on access to the hole being repaired. Use only a tap wrench when tapping the hole and during installation of the insert.



**Fig. 30: Drilled Hole Centerline**

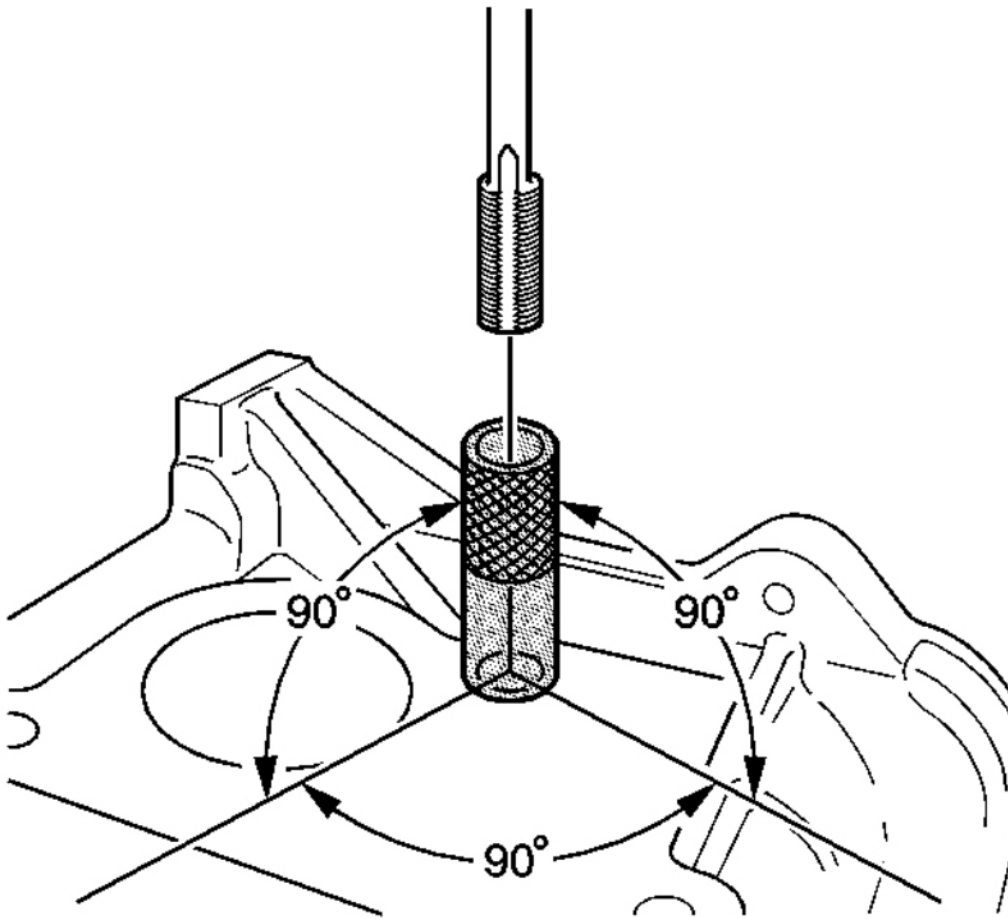
Courtesy of GENERAL MOTORS CORP.

It is critical that the drilling, counterboring and tapping of the hole to be repaired follows the same centerline as the original hole.



**Fig. 31: Identifying Proper Drilling Angle**  
Courtesy of GENERAL MOTORS CORP.

During the drilling and tapping of the hole being repaired ensure the tooling is consistently machining perpendicular to the surface of the base material.

**Fig. 32: View Of Tapping Guide**

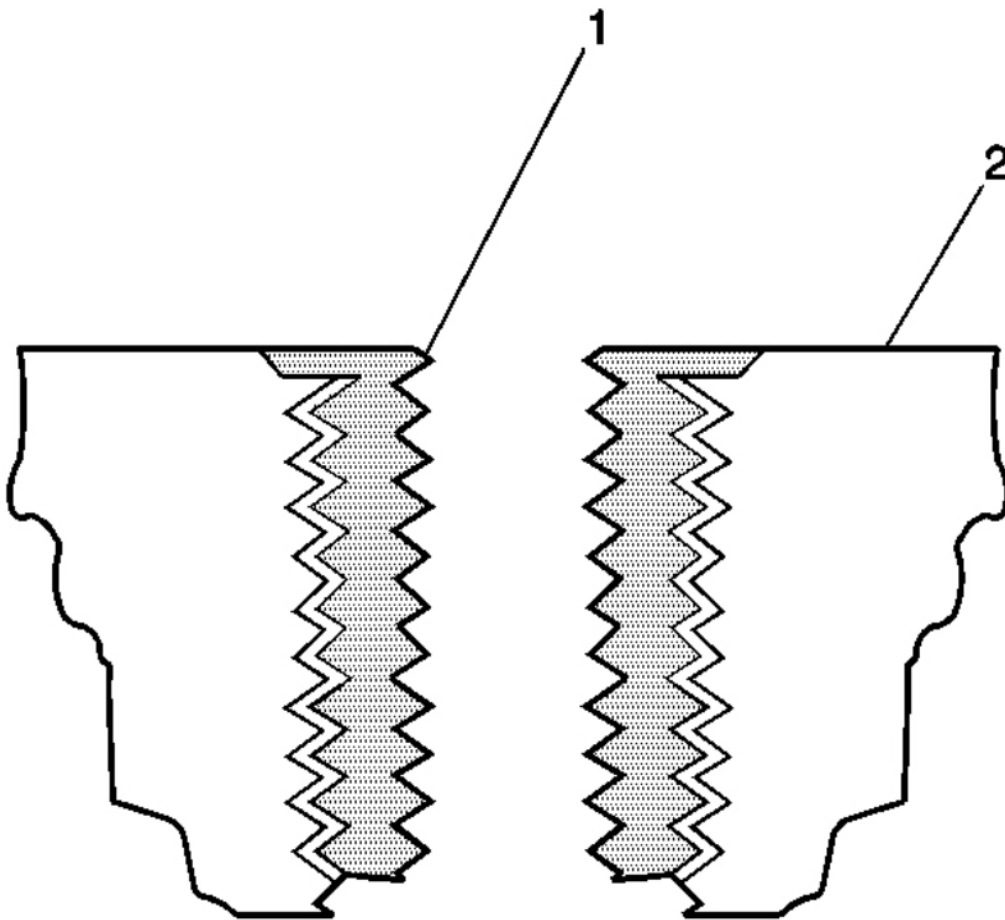
Courtesy of GENERAL MOTORS CORP.

If the threaded hole being repaired has a base surface perpendicular to the hole centerline, tapping guides are available to aid in tapping the hole.

**Thread Repair**

| Tap Size | Tap Guide | Tap Size | Tap Guide | Tap Size | Tap Guide |
|----------|-----------|----------|-----------|----------|-----------|
| -        | J 42385-  | -        | J 42385-  | -        | J 42385-  |
| 6 x 1.0  | 729       | 10 x 1.5 | 731       | 14 x 1.5 | 736       |
| 8 x 1.25 | 730       | 12 x 1.5 | 732       | 20 x 1.5 | 737       |

**STANDARD THREAD REPAIR - FLUSH HOLE**



**Fig. 33: View Of Bushing Type Insert & Base Material**

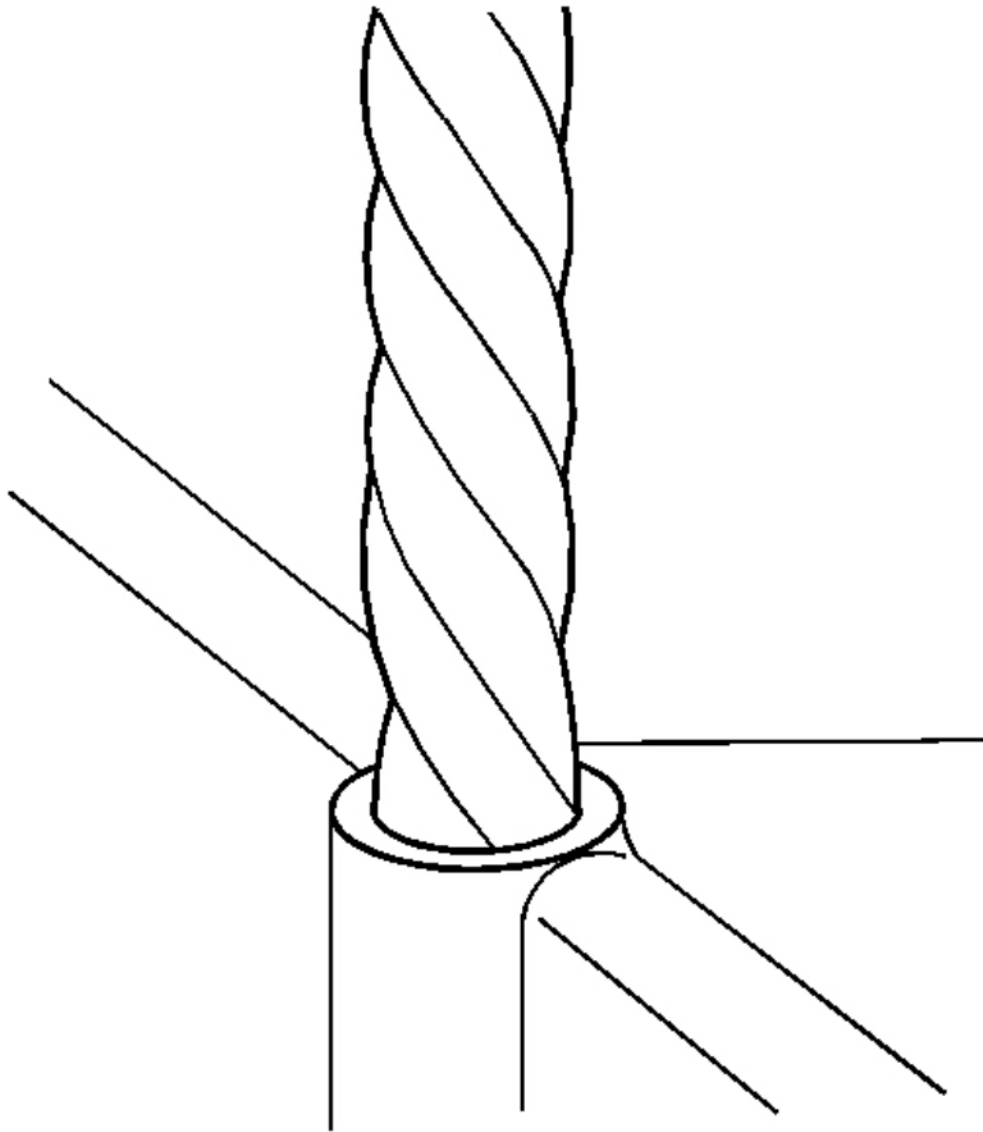
Courtesy of GENERAL MOTORS CORP.

**CAUTION:** Refer to Safety Glasses Caution in Cautions and Notices.

**IMPORTANT:** The use of a cutting type fluid GM P/N 1052864, (Canadian P/N 992881), WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures.

When installed to the proper depth, the flange (1) of the insert will be seated against the counterbore of the drilled/tapped hole and just below the surface (2) of the base material.





**Fig. 34: Drilling Out Threads Of Damaged Hole**  
Courtesy of GENERAL MOTORS CORP.

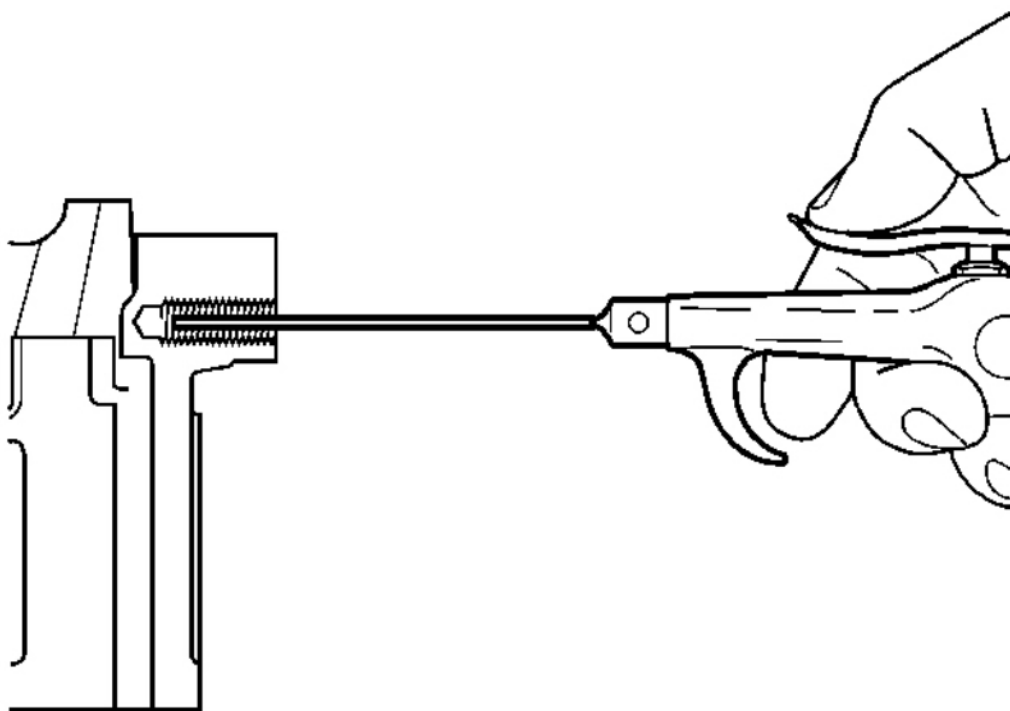
**IMPORTANT:**

- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Do NOT drill any further than the original hole depth.

1. Drill out the threads of the damaged hole.

**Specifications:**

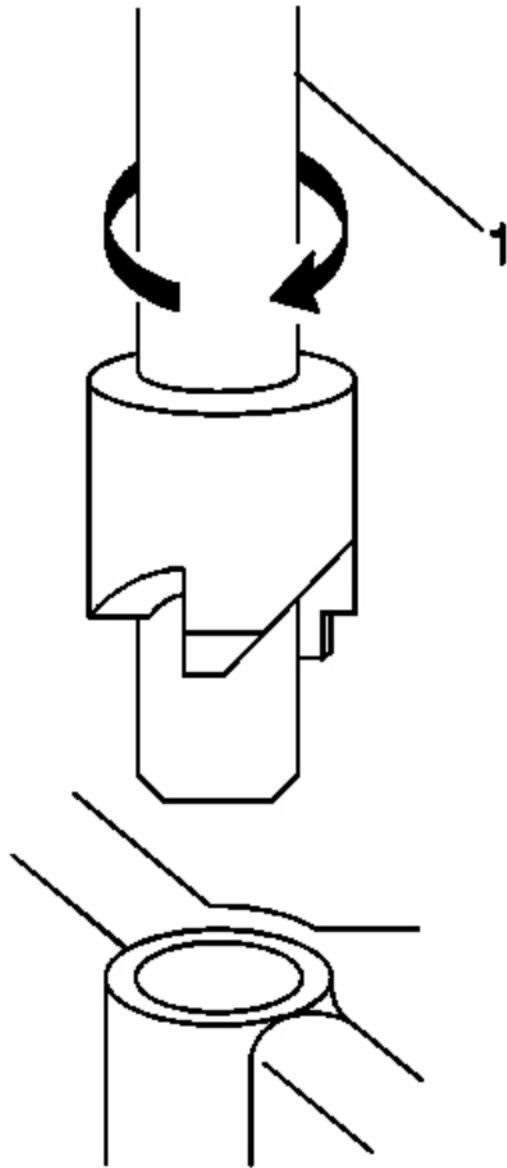
- M6 inserts require a minimum drill depth of 15 mm (0.59 in).
- M8 inserts require a minimum drill depth of 20 mm (0.79 in).
- M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).



**Fig. 35: Cleaning Out Metal Chips**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** All chips must be removed from the drilled hole prior to tapping.

2. Using compressed air, clean out any chips.

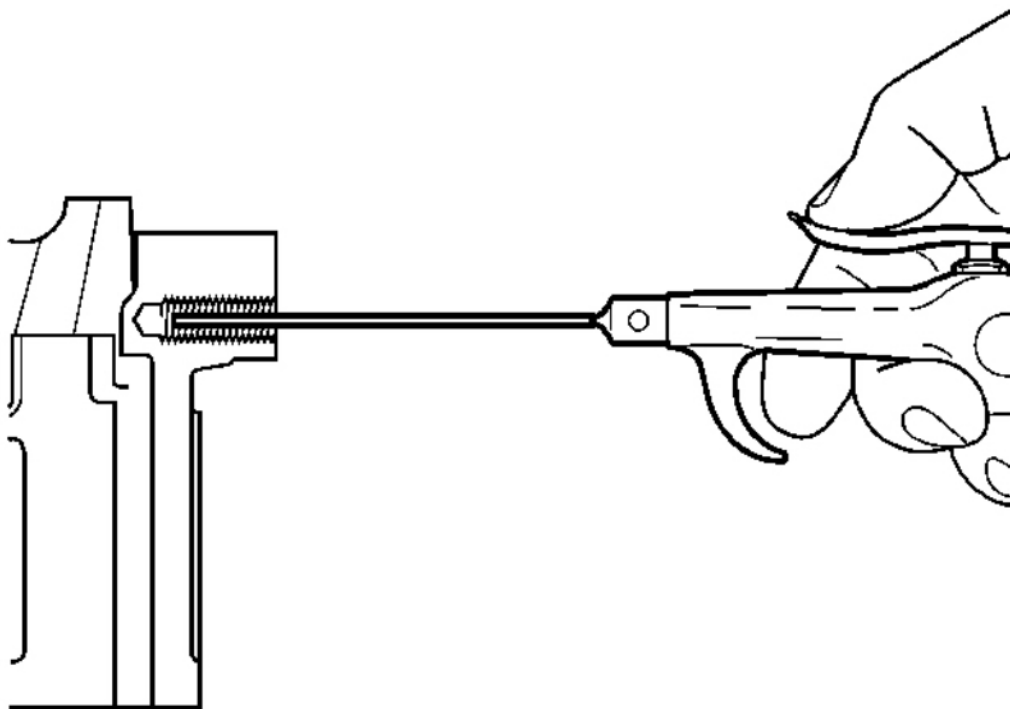


**Fig. 36: View Of Counterbore Drill**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** A properly counterbored hole will show a slight burnishing on the surface of the base material for 360 degrees around the drilled hole.

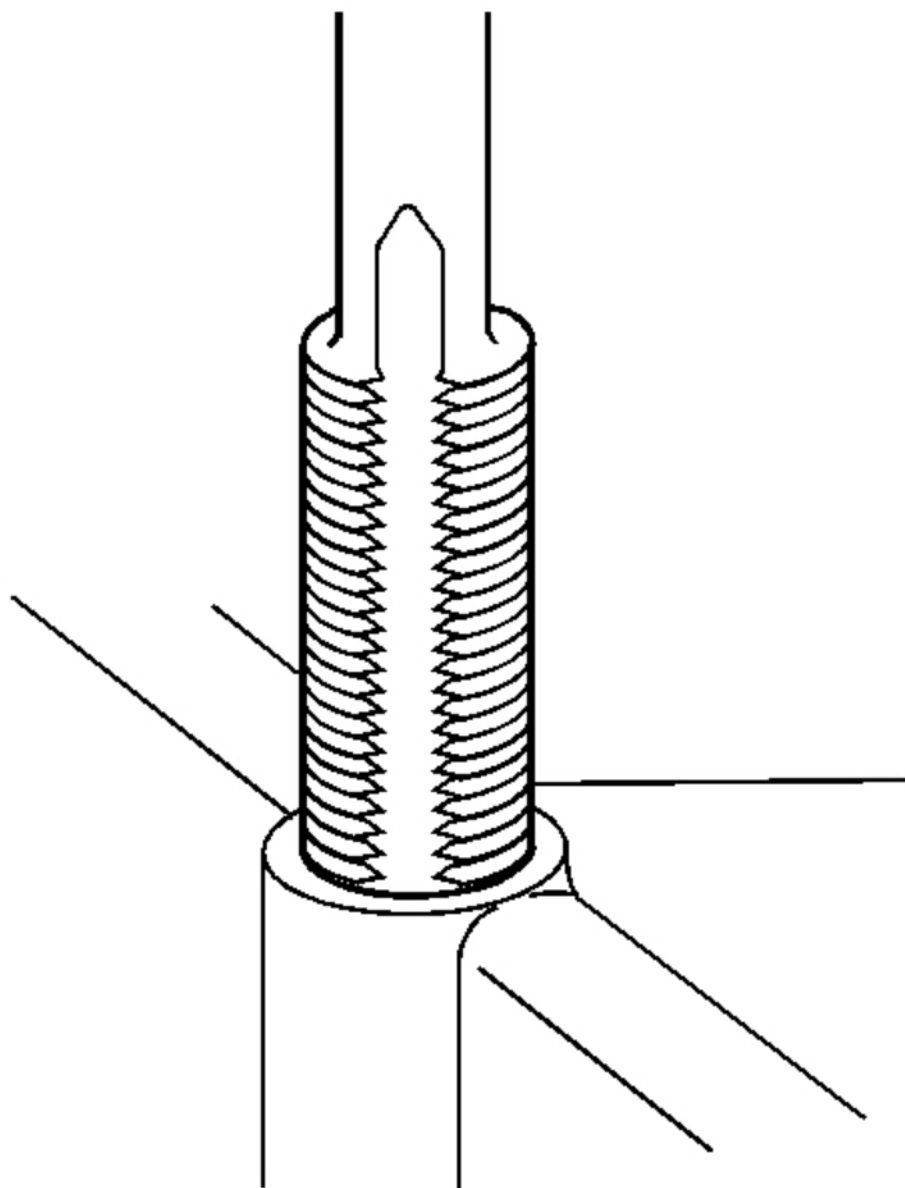
3. Counterbore the drilled hole to the full depth permitted by the tool (1).



**Fig. 37: Cleaning Out Metal Chips**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** All chips must be removed from the drilled hole prior to tapping.

4. Using compressed air, clean out any chips.



**Fig. 38: Tapping Threads Of Drilled Hole**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

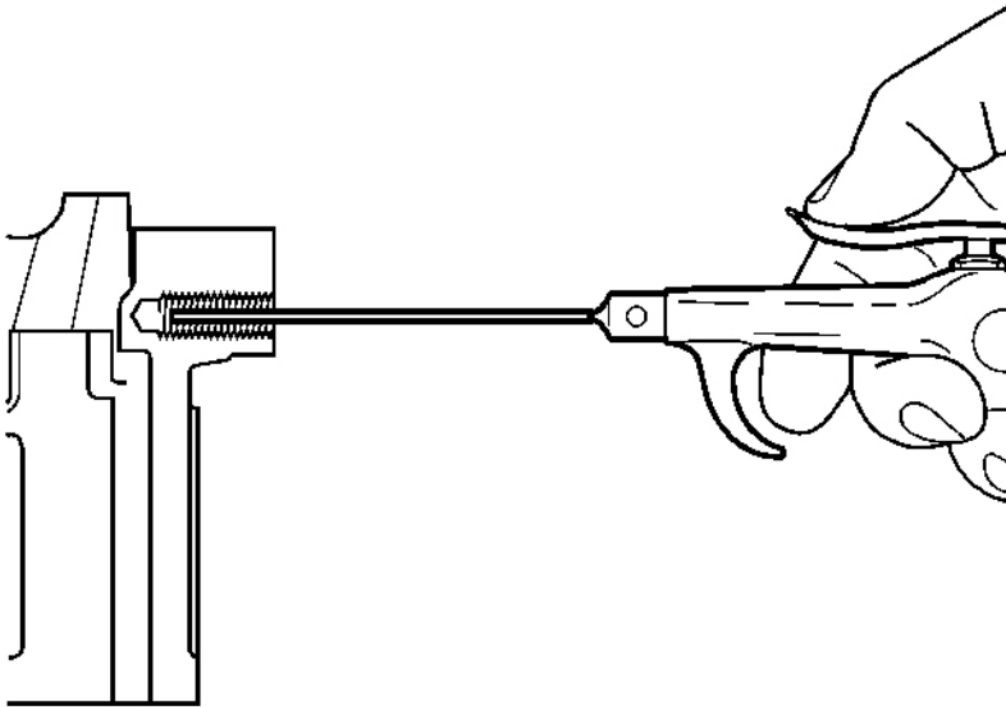
- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.

- Ensure the tap has created full threads at least to the depth equal to the insert length.

5. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

**Specifications:**

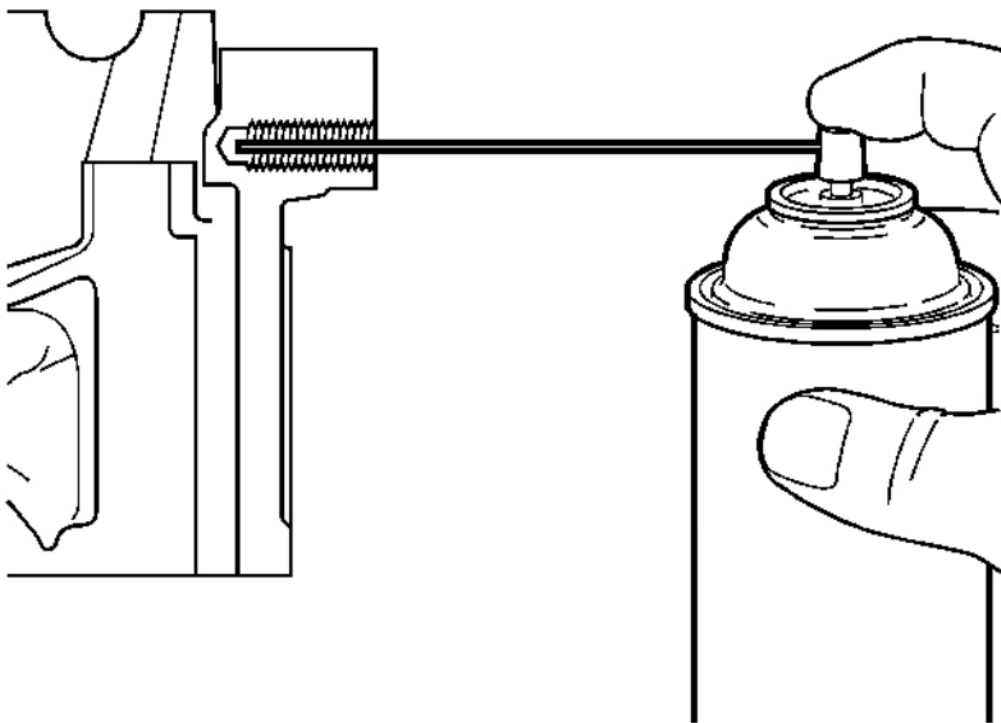
- M6 inserts require a minimum tap depth of 15 mm (0.59 in).
- M8 inserts require a minimum tap depth of 20 mm (0.79 in).
- M10 inserts require a minimum tap depth of 23.5 mm (0.93 in).



**Fig. 39: Cleaning Out Metal Chips**  
Courtesy of GENERAL MOTORS CORP.

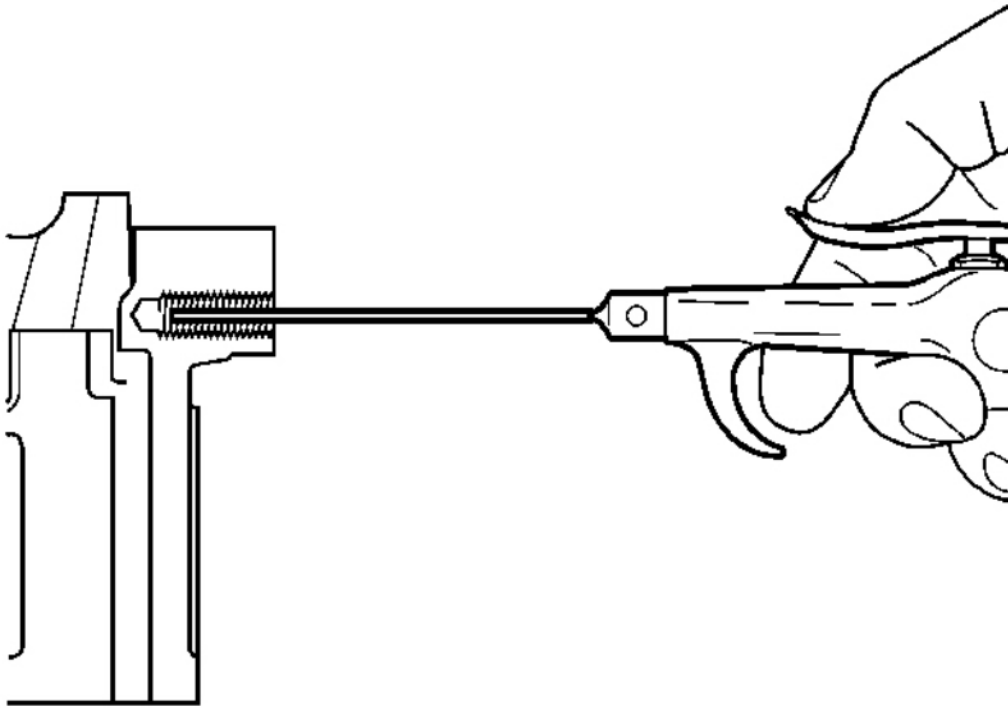
**IMPORTANT:** All chips must be removed from the tapped hole prior to insert installation.

6. Using compressed air, clean out any chips.



**Fig. 40: Spraying Cleaner Into Tapped Hole**  
Courtesy of GENERAL MOTORS CORP.

7. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463) or equivalent into the tapped hole.



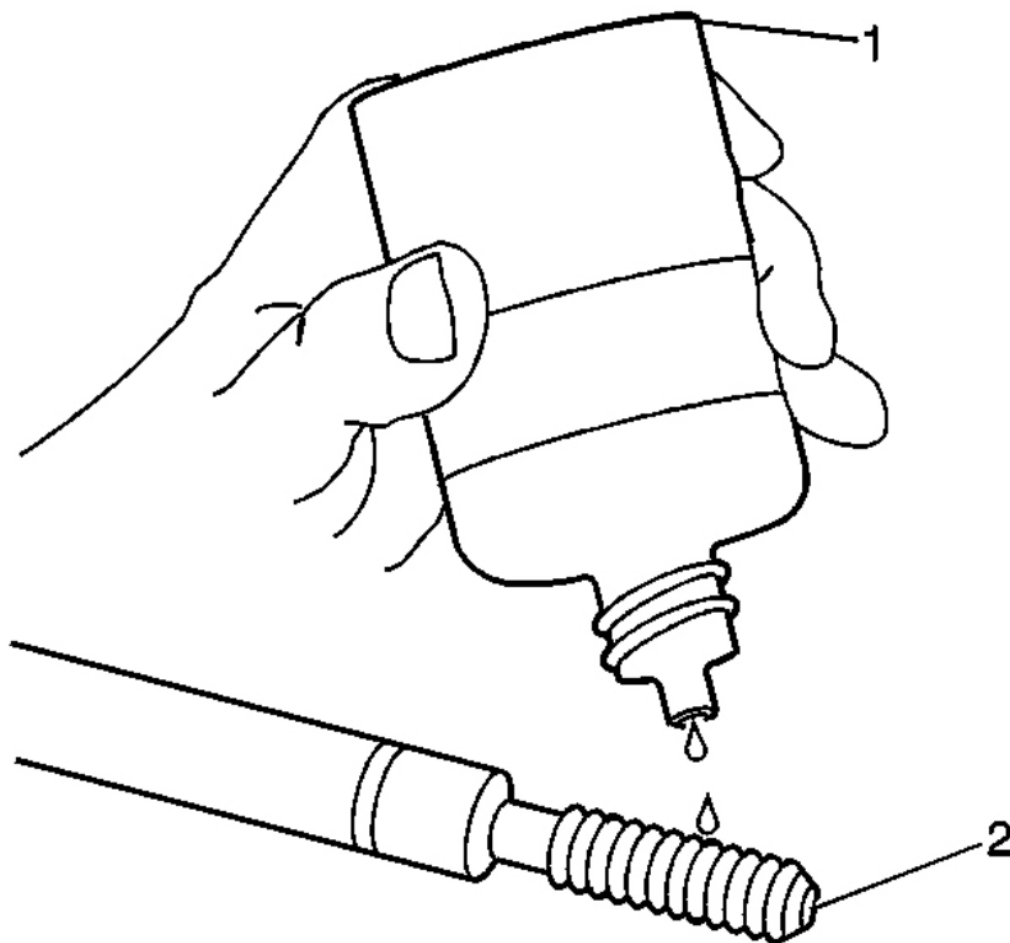
**Fig. 41: Cleaning Out Metal Chips**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** All chips must be removed from the tapped hole prior to insert installation.

8. Using compressed air, clean out any chips.

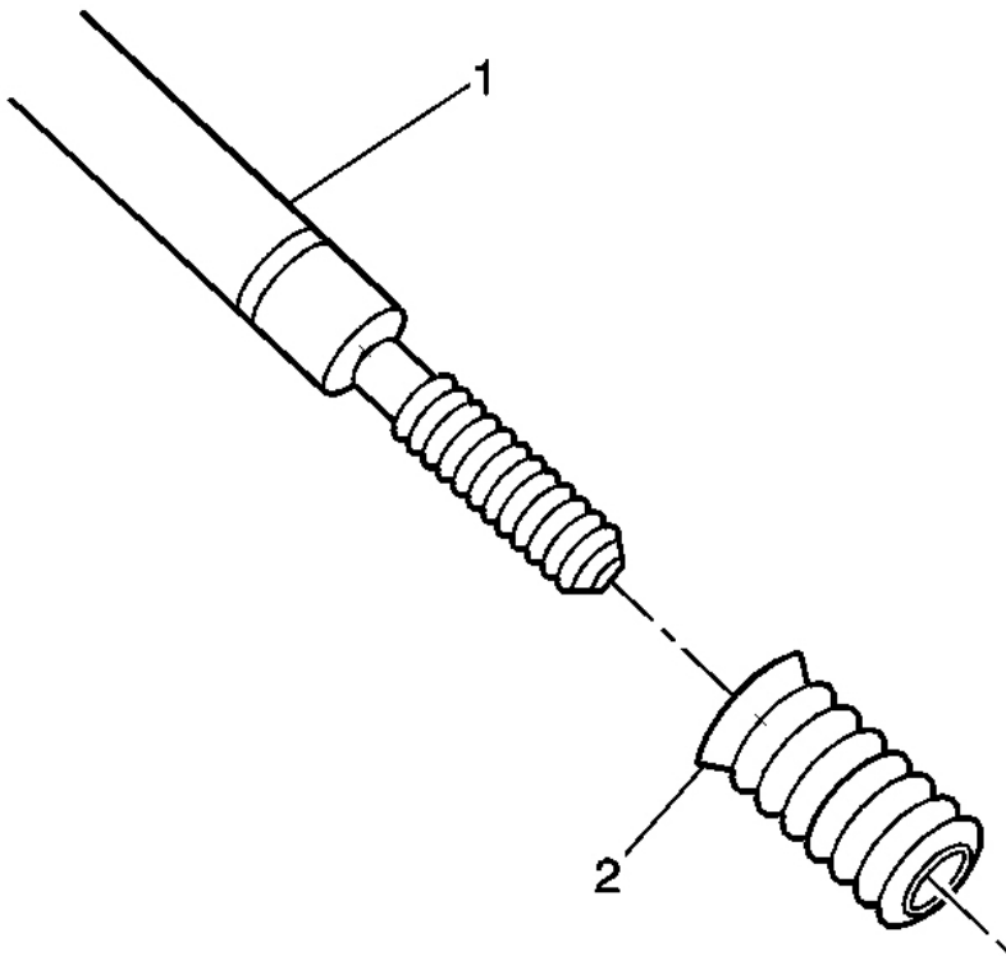




**Fig. 42: Lubricating Installer Tool Using Driver Oil**  
Courtesy of GENERAL MOTORS CORP.

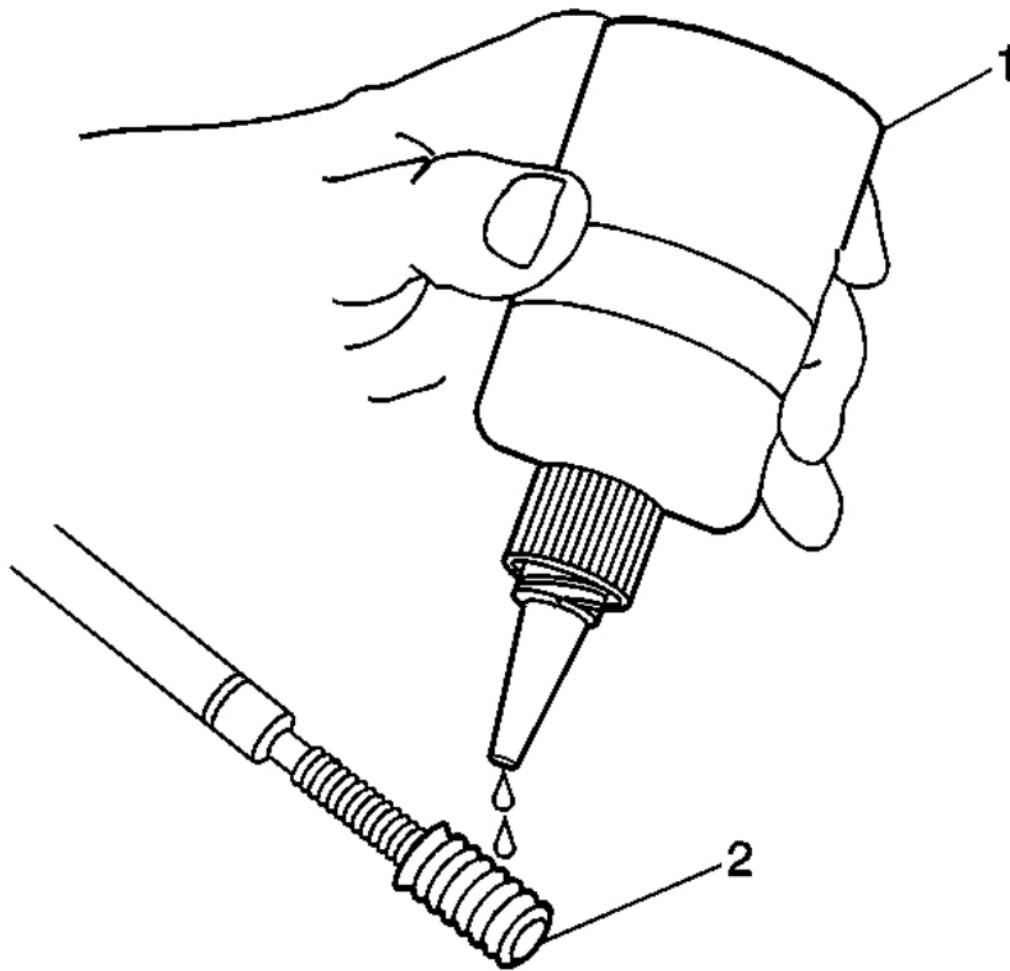
**IMPORTANT:** Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

9. Lubricate the threads of the driver installation tool (2) with the driver oil (1) J 42385-110.



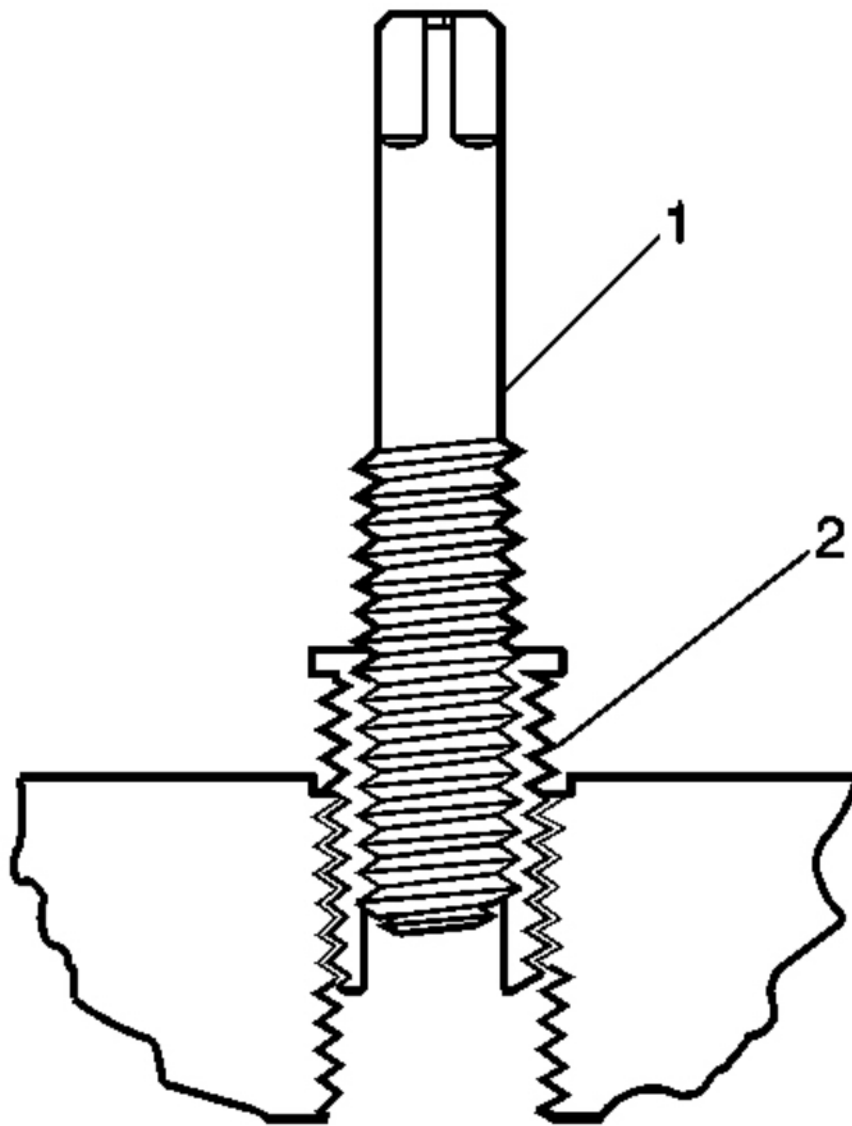
**Fig. 43: View of Bushing Type Insert**  
Courtesy of GENERAL MOTORS CORP.

10. Install the insert (2) onto the driver installation tool (1).



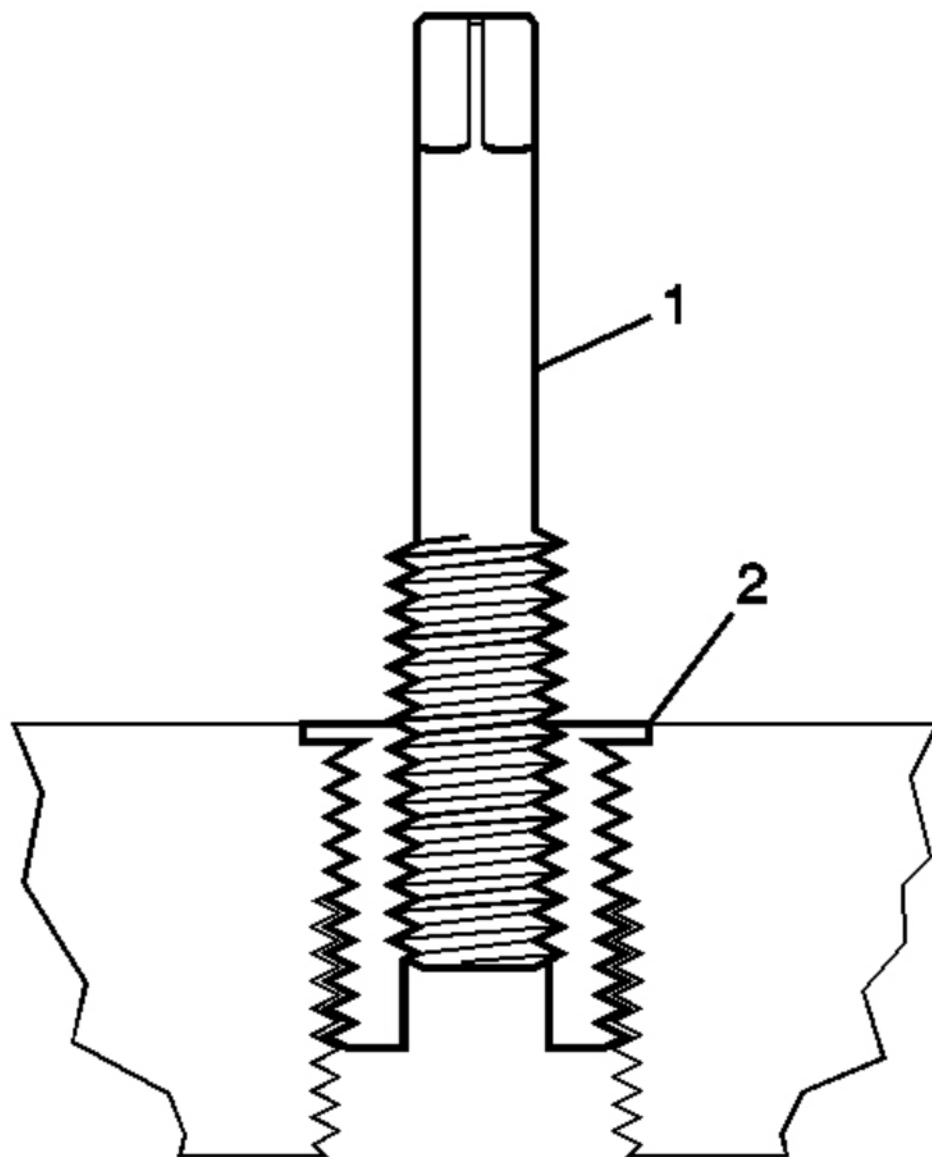
**Fig. 44: Applying Threadlock To Insert**  
Courtesy of GENERAL MOTORS CORP.

11. Apply threadlock sealant GM P/N 12345493, (Canadian P/N 10953488), J 42385-109, LOCTITE 277® or equivalent (1) to the insert OD threads (2).



**Fig. 45: Installing Insert Into Tapped Bolt Hole**  
Courtesy of GENERAL MOTORS CORP.

12. Install the insert (2) into the tapped hole by hand only.

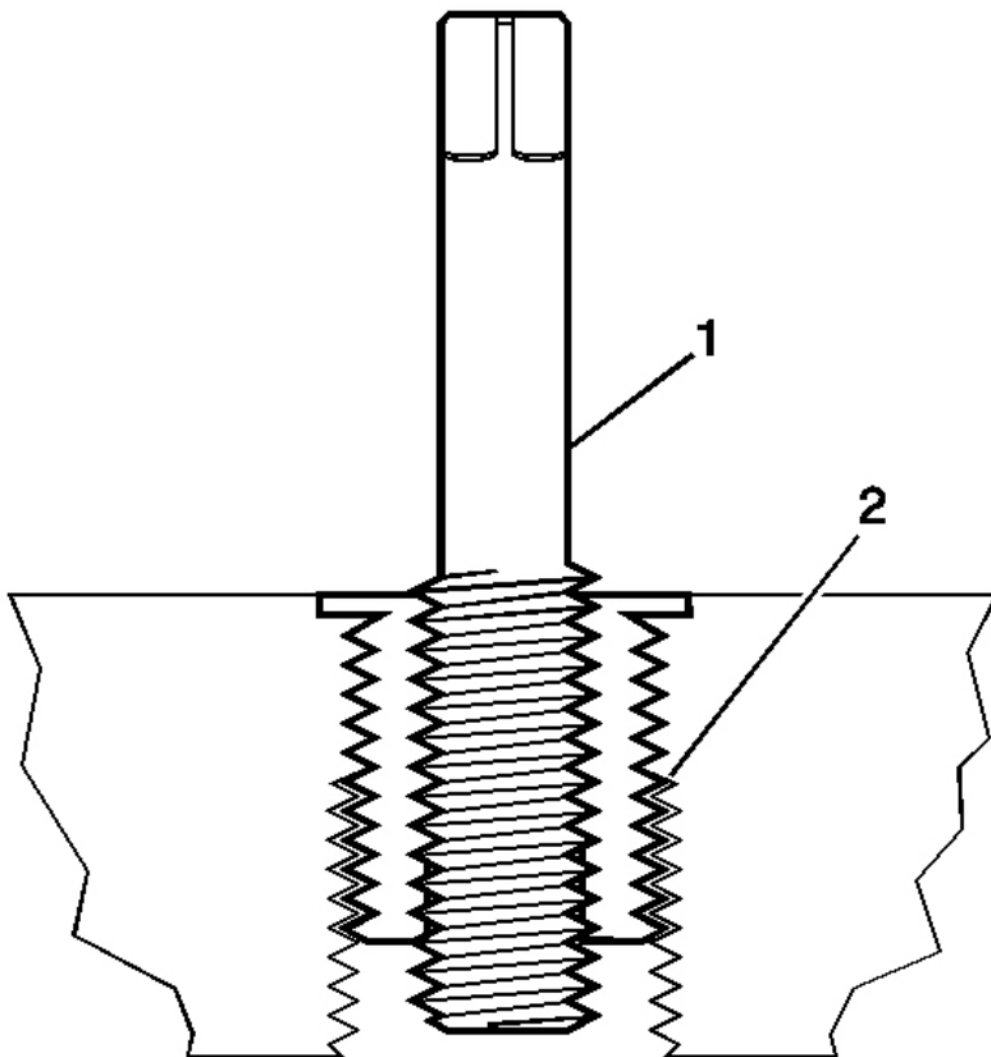


**Fig. 46: Installing Insert - Standard Thread**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** If the insert will not thread down until the flange contacts the counterbored surface, remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or

**improper tapping.**

13. Install the insert until the flange (2) of the insert contacts the counterbored surface.

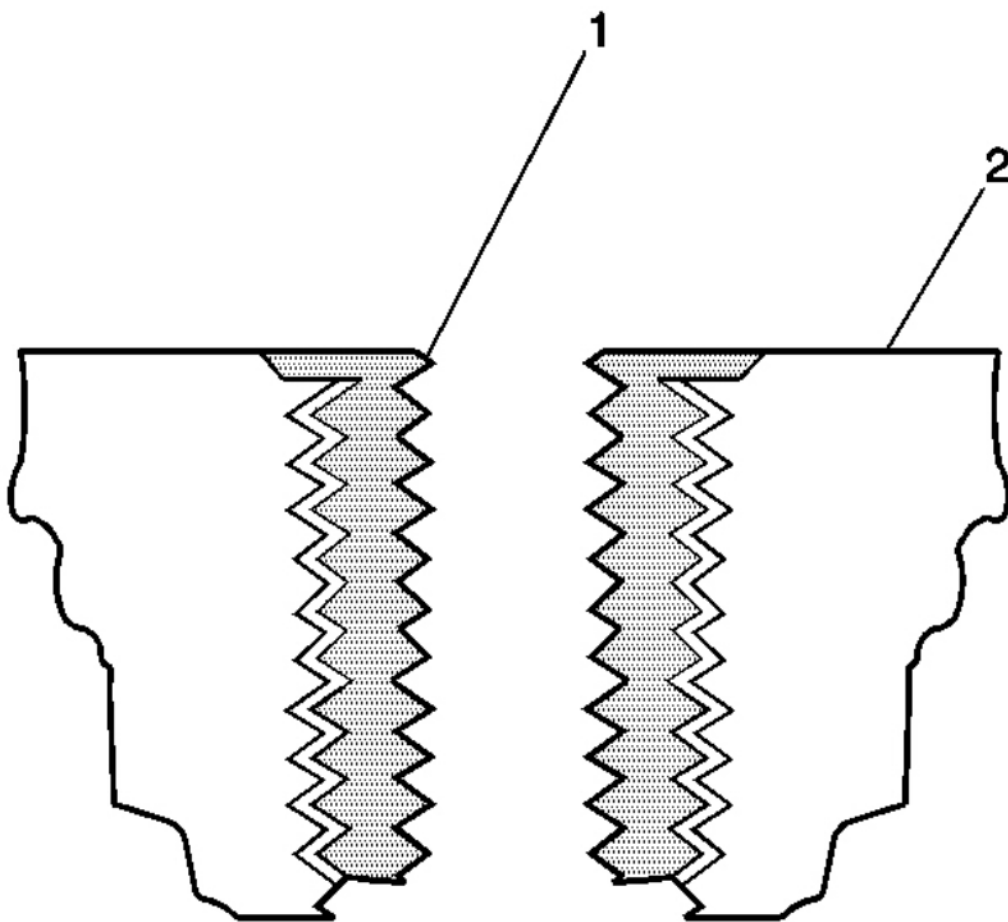


**Fig. 47: View Insert And Tool - Standard Thread**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the

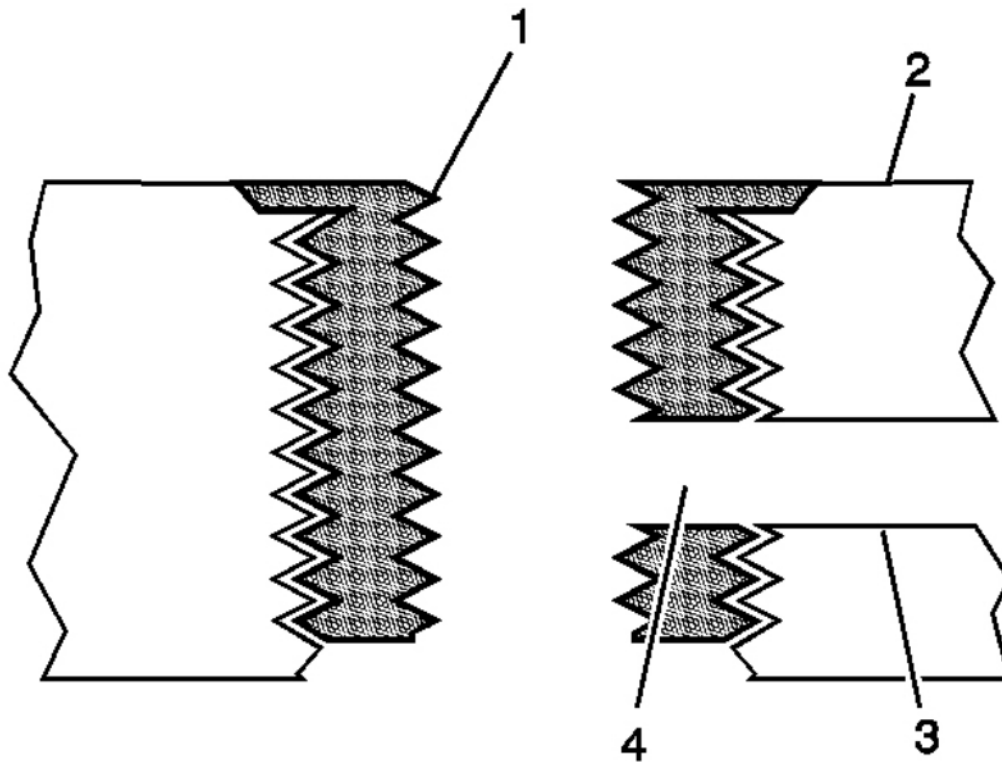
insert are being formed and the insert is mechanically locking the insert into the base material threads.

14. Continue to rotate the driver installation tool (1) through the insert (2).



**Fig. 48: View Of Bushing Type Insert & Base Material**  
Courtesy of GENERAL MOTORS CORP.

15. Inspect the insert for proper installation into the tapped hole. A properly installed insert (1) will be either flush or slightly below flush with the surface of the base material (2).

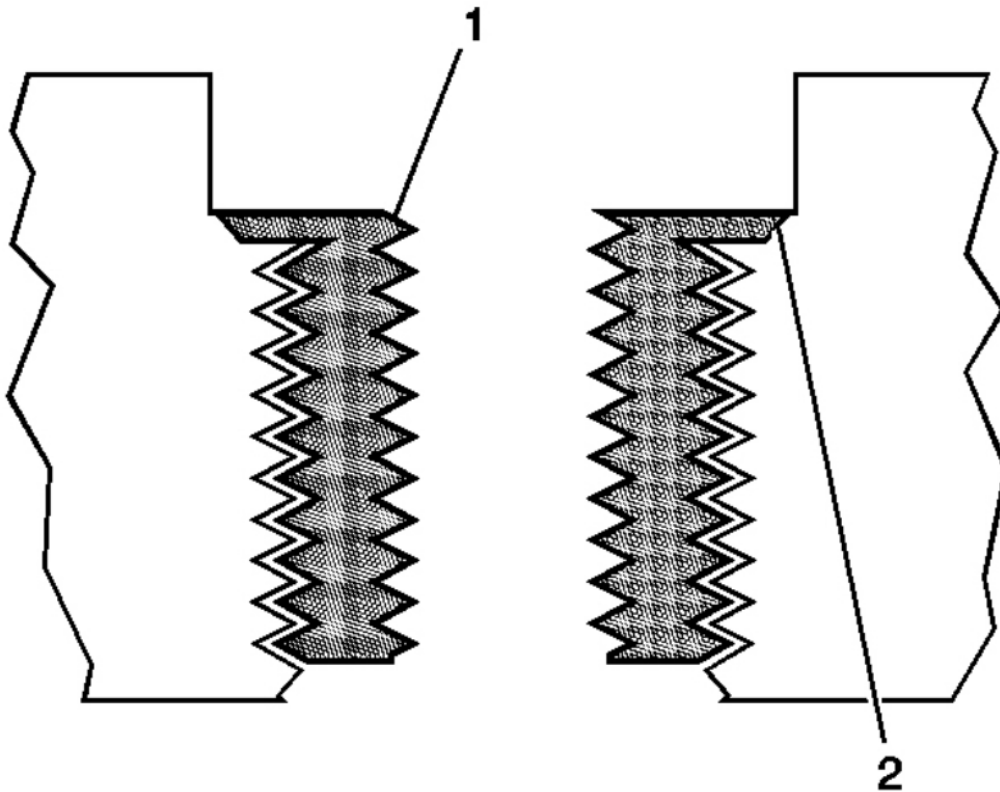


**Fig. 49: View Of Restricted Engine Coolant Passages - Standard Thread Repair**  
Courtesy of GENERAL MOTORS CORP.

16. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.

## RECESSED THREAD REPAIR





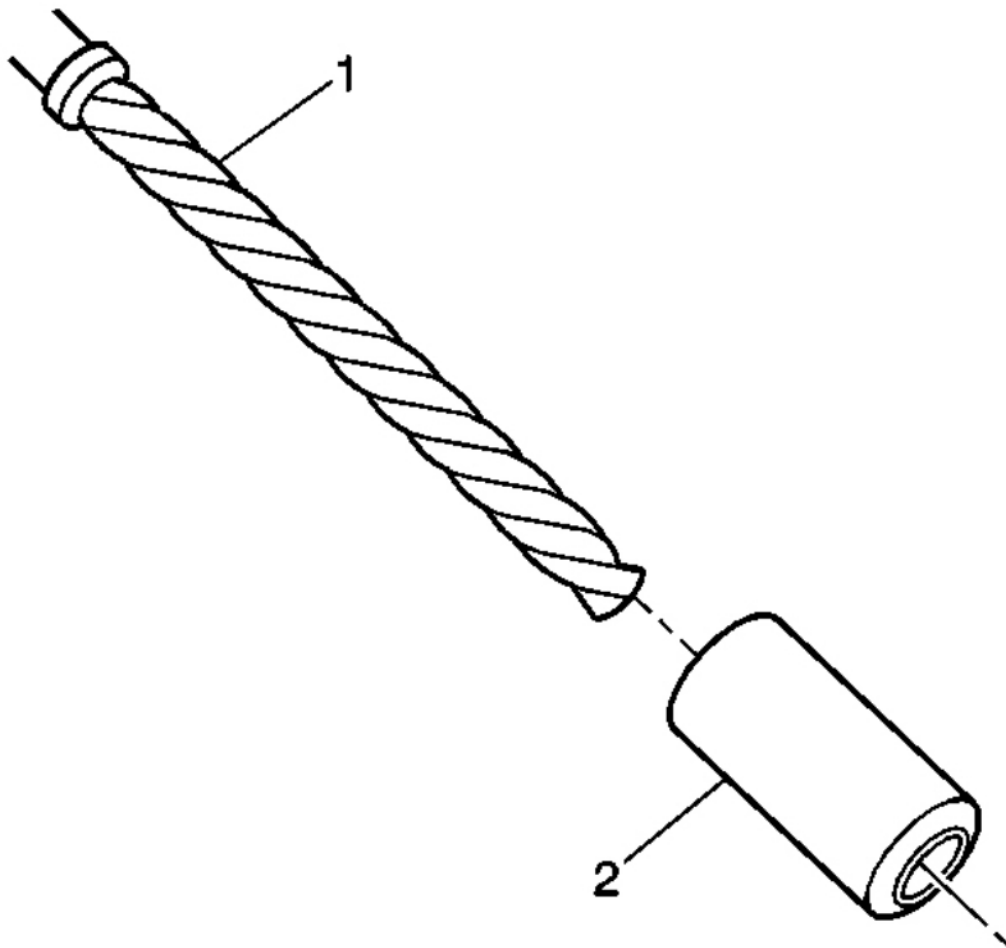
**Fig. 50: Inspecting Insert For Proper Installation - Recessed Thread**  
Courtesy of GENERAL MOTORS CORP.

**CAUTION:** Refer to Safety Glasses Caution in Cautions and Notices.

**IMPORTANT:**

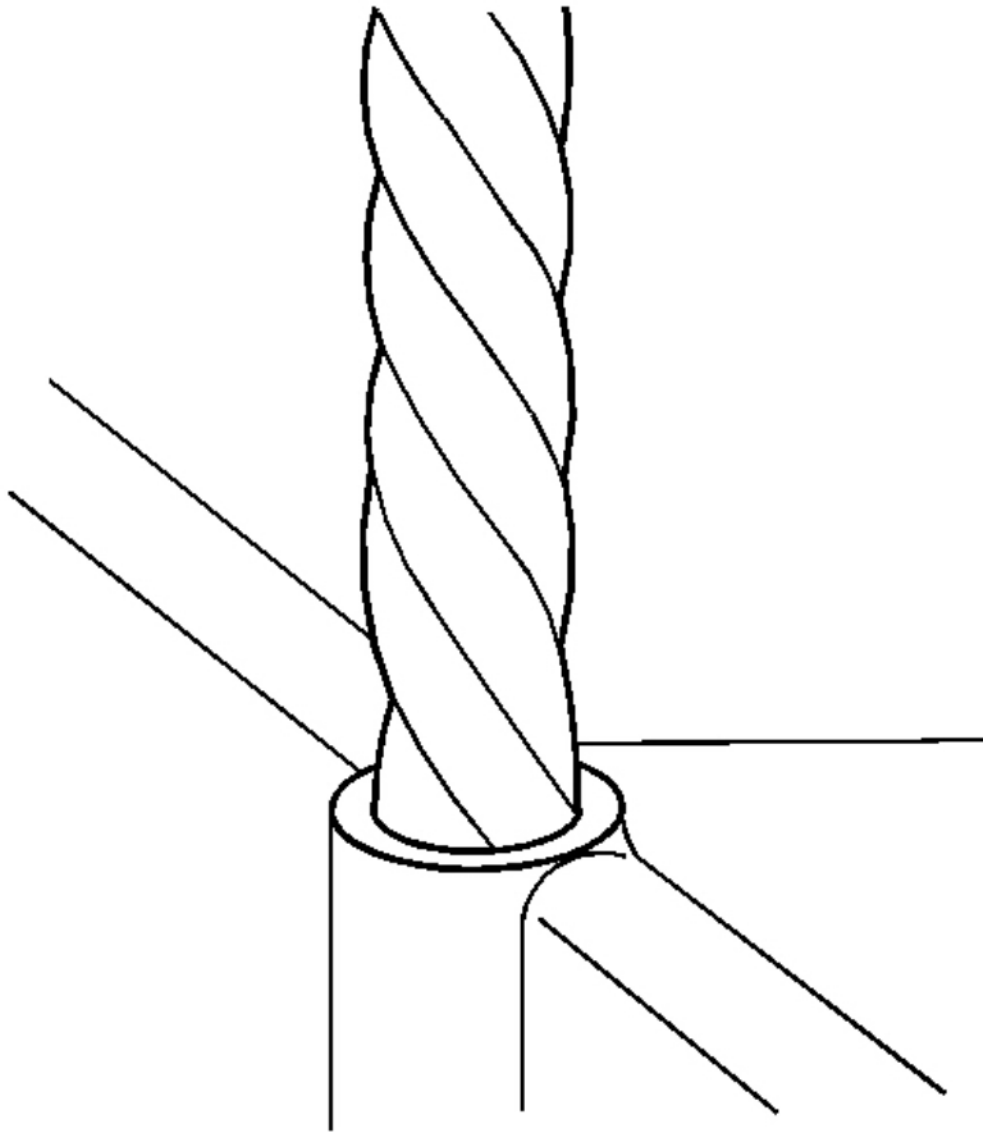
- The use of a cutting type fluid GM P/N 1052864, (Canadian P/N 992881), WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures.
- Do NOT remove the original stop collar from a counterbore drill.

When installed to the proper depth, the flange of the insert (1) will be seated against the counterbore (2) of the drilled/tapped hole.



**Fig. 51: View Of Stop Collar & Counterbore Drill**  
Courtesy of GENERAL MOTORS CORP.

1. Install a stop collar (2) on the counterbore drill (1), if required.

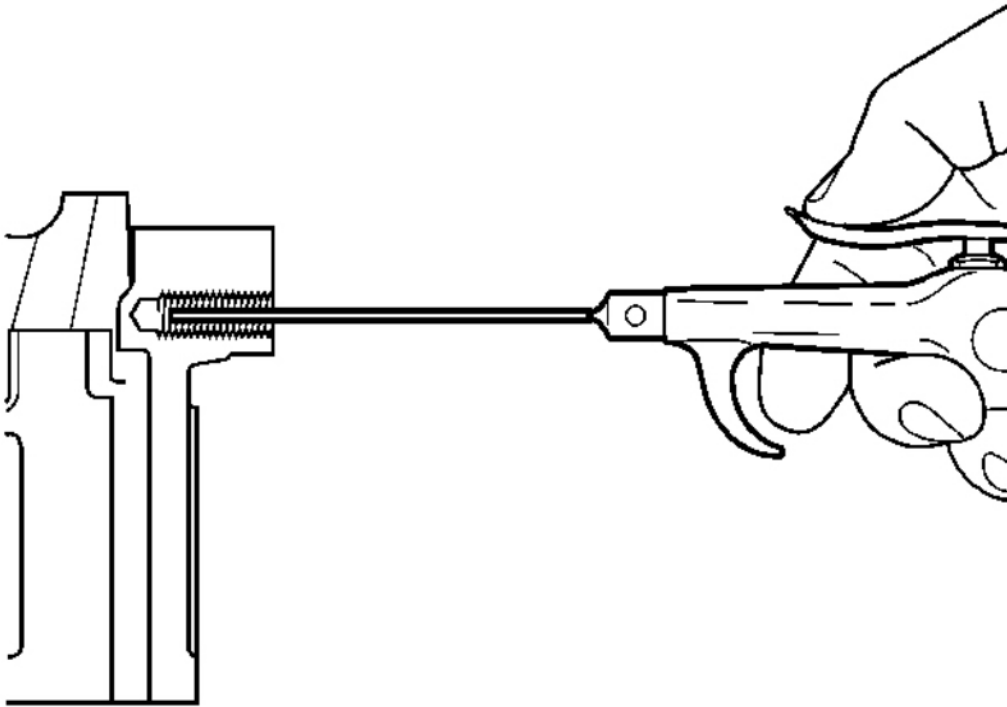


**Fig. 52: Drilling Out Threads Of Damaged Hole**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the hole until the stop collar contacts the surface of the base material.

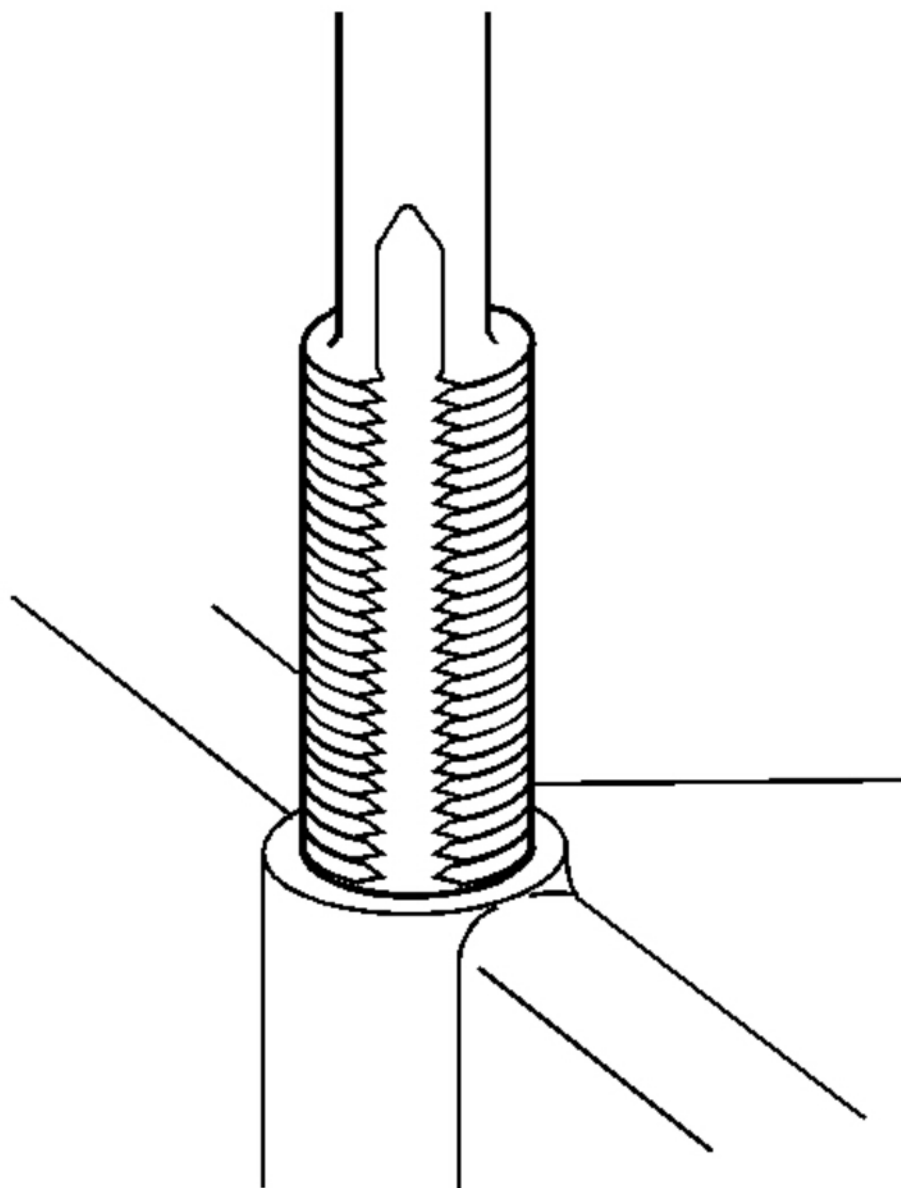
2. Drill out the threads of the damaged hole.



**Fig. 53: Cleaning Out Metal Chips**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** All chips must be removed from the drilled hole prior to tapping.

3. Using compressed air, clean out any chips.



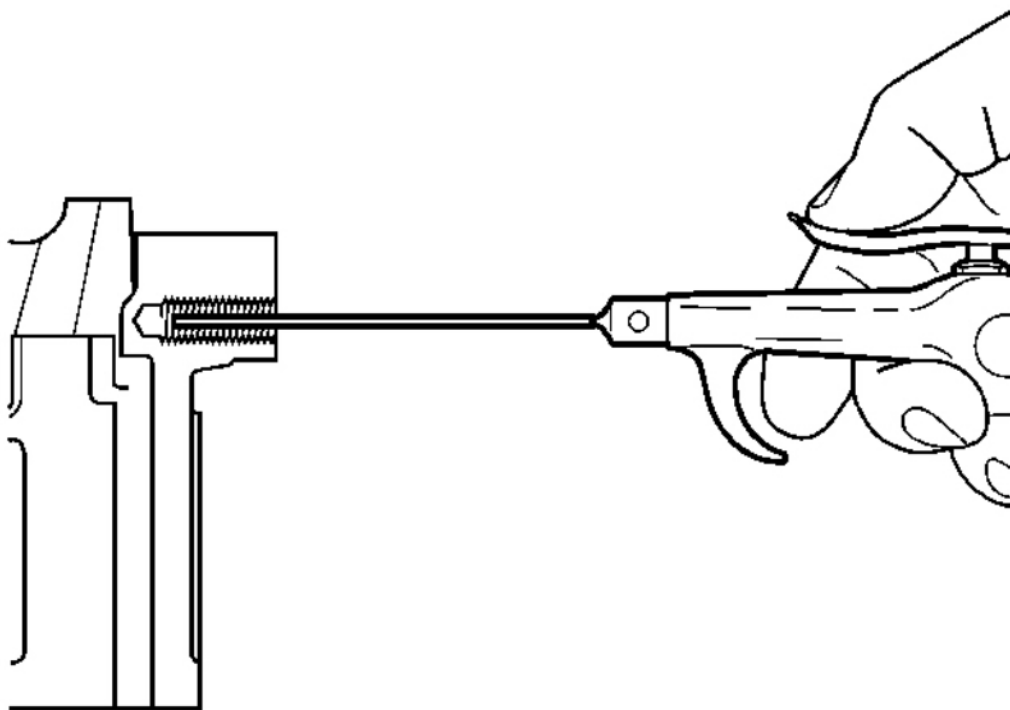
**Fig. 54: Tapping Threads Of Drilled Hole**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.

- Ensure the tap has created full threads at least to the depth equal to the insert length.

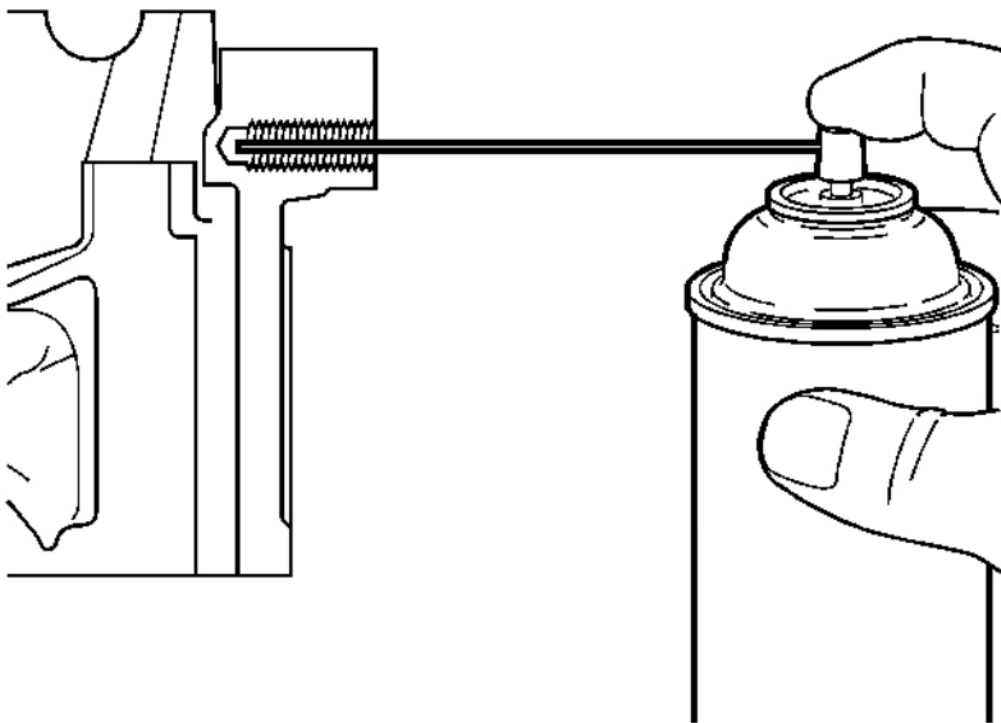
4. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.



**Fig. 55: Cleaning Out Metal Chips**  
Courtesy of GENERAL MOTORS CORP.

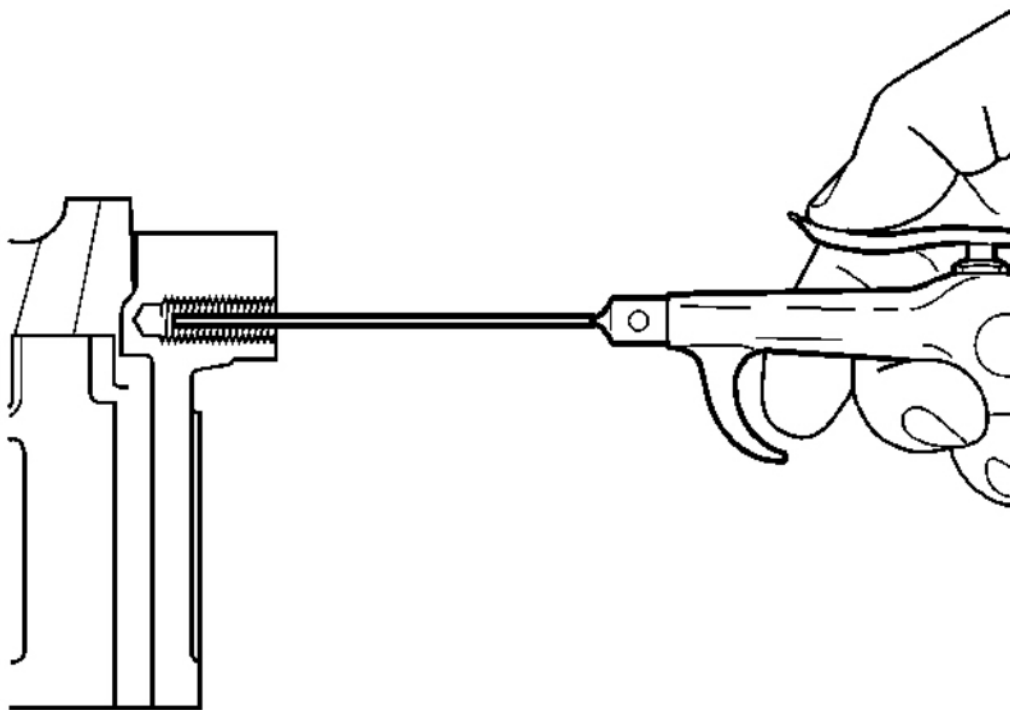
**IMPORTANT:** All chips must be removed from the tapped hole prior to insert installation.

5. Using compressed air, clean out any chips.



**Fig. 56: Spraying Cleaner Into Tapped Hole**  
Courtesy of GENERAL MOTORS CORP.

6. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463) or equivalent into the tapped hole.



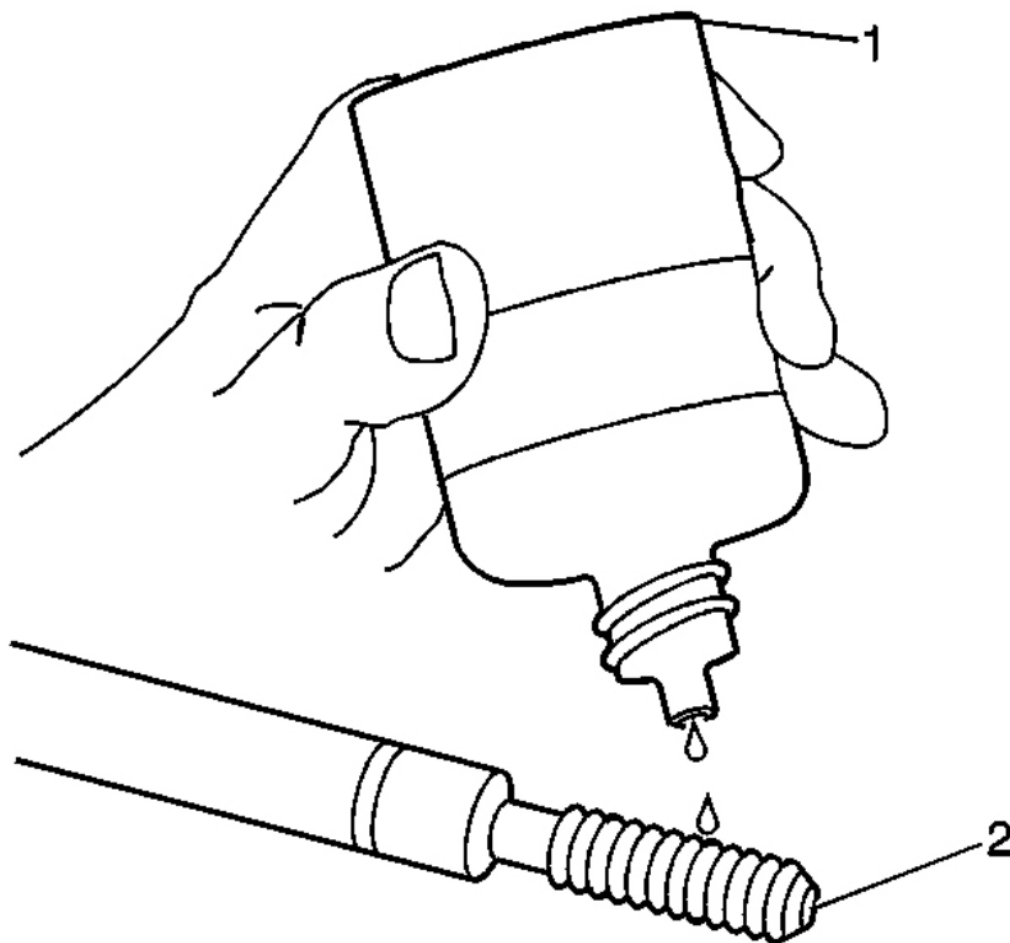
**Fig. 57: Cleaning Out Metal Chips**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** All chips must be removed from the tapped hole prior to insert installation.

7. Using compressed air, clean out any chips.

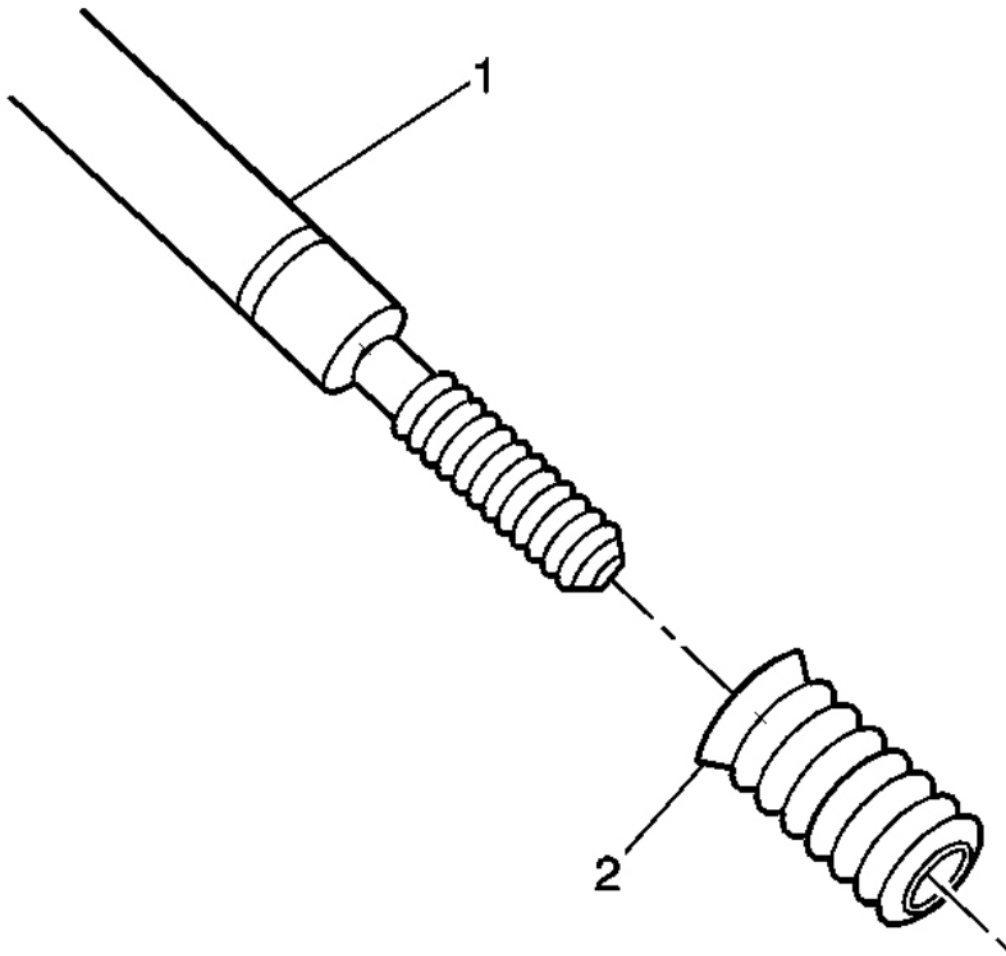




**Fig. 58: Lubricating Installer Tool Using Driver Oil**  
Courtesy of GENERAL MOTORS CORP.

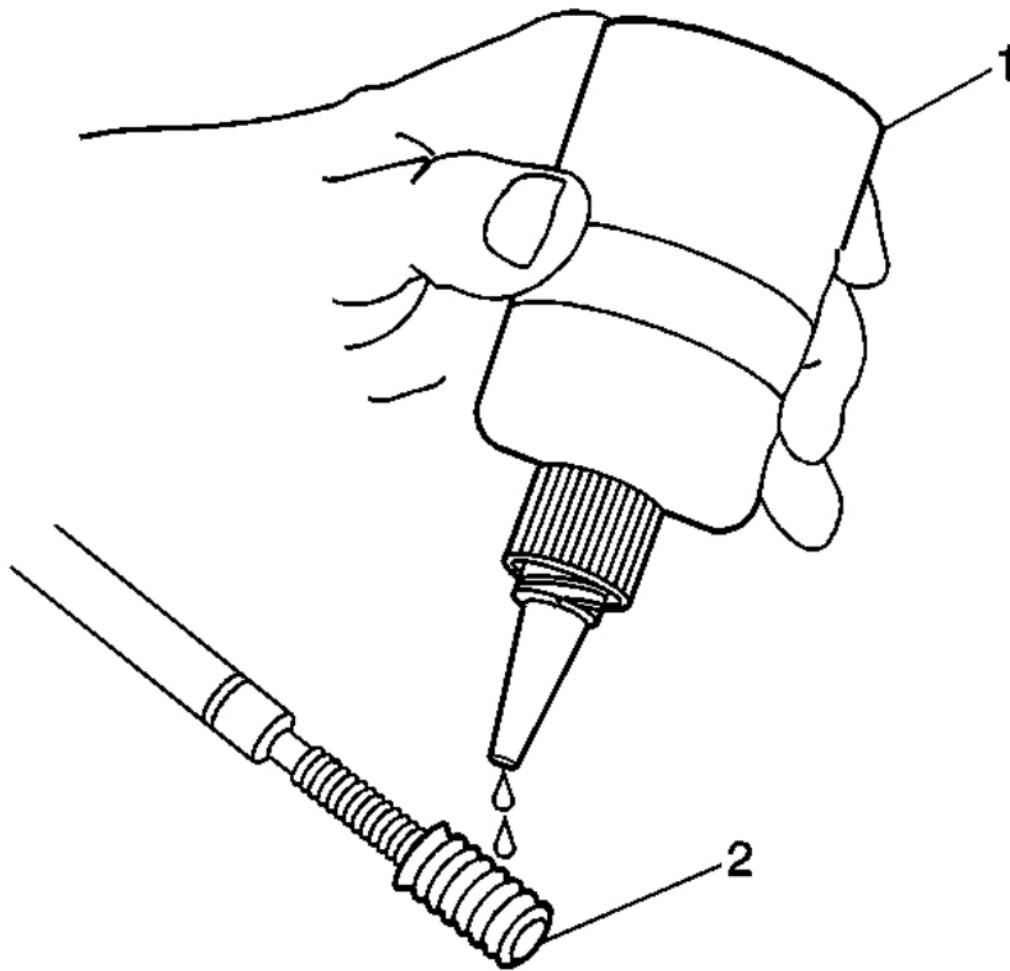
**IMPORTANT:** Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

8. Lubricate the threads of the driver installation tool (2) with the driver oil (1) J 42385-110.



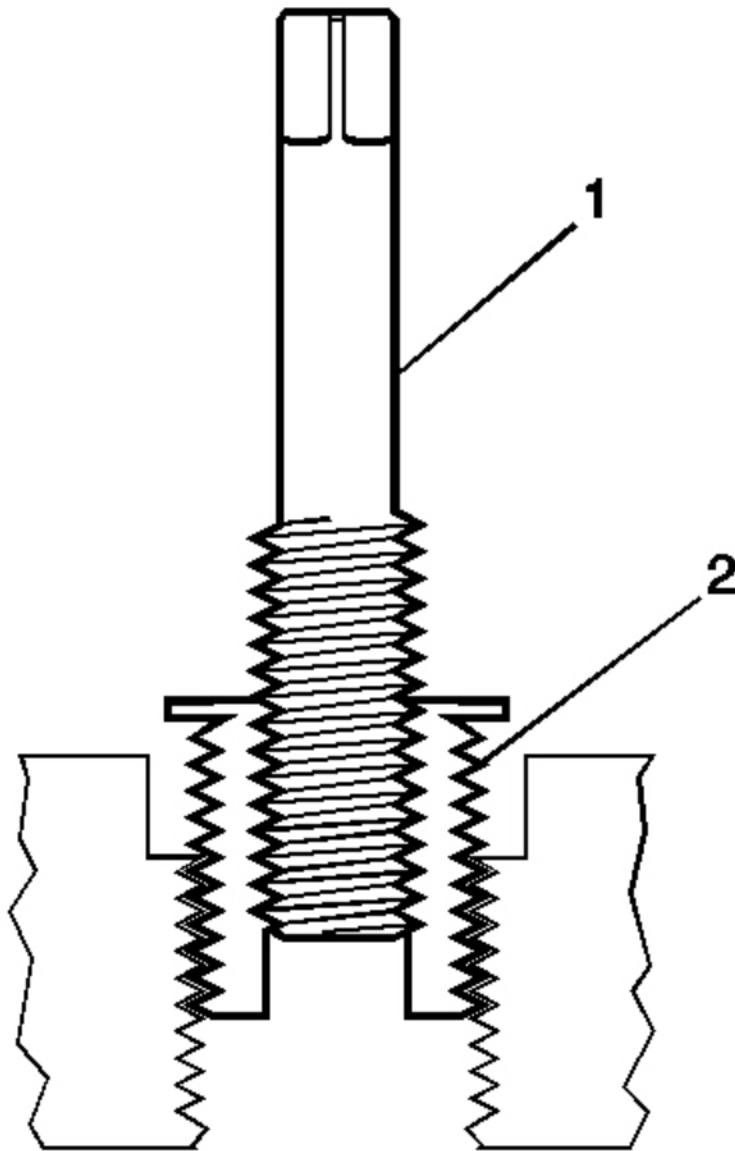
**Fig. 59: View of Bushing Type Insert**  
Courtesy of GENERAL MOTORS CORP.

9. Install the insert (2) onto the driver installation tool (1).



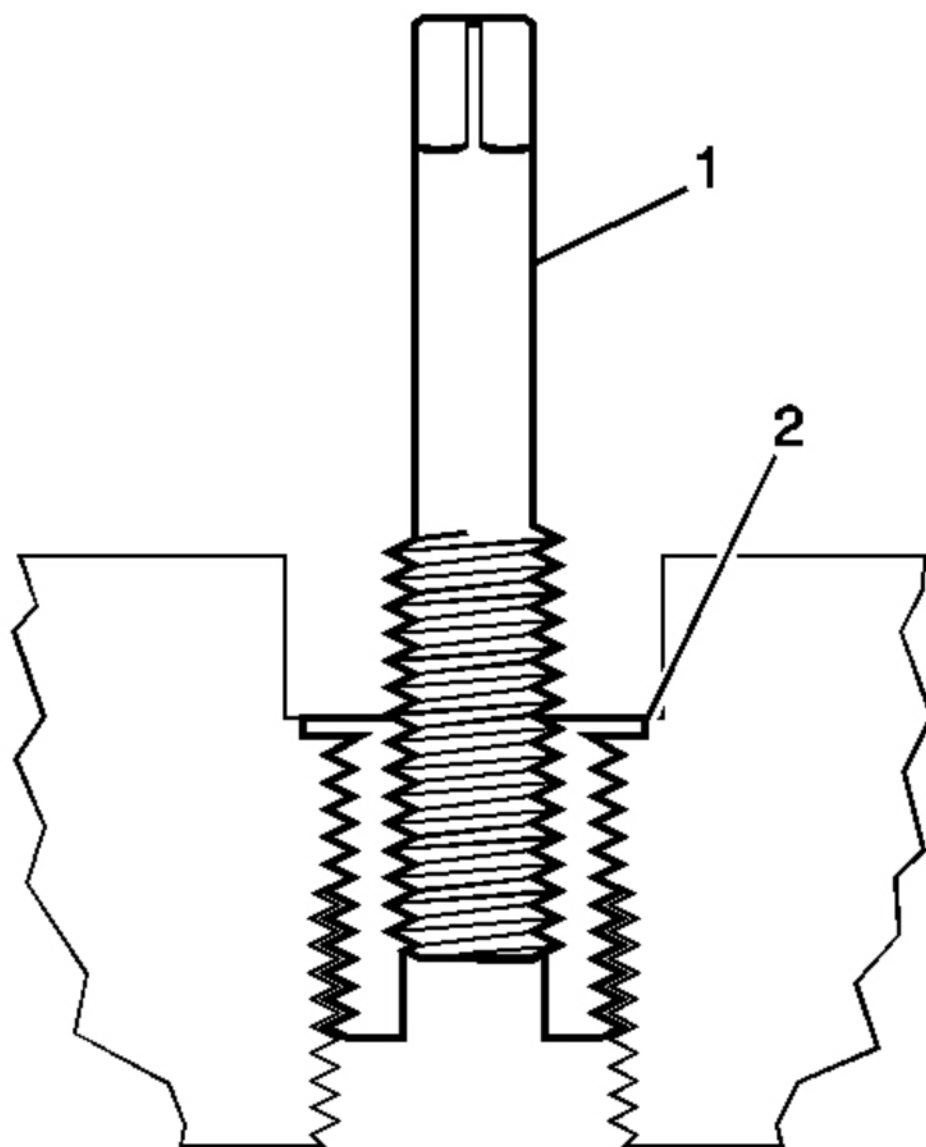
**Fig. 60: Applying Threadlock To Insert**  
Courtesy of GENERAL MOTORS CORP.

10. Apply threadlock sealant GM P/N 12345493, (Canadian P/N 10953488), J 42385-109, LOCTITE 277® or equivalent (1) to the insert OD threads (2).



**Fig. 61: Installing Insert - Recessed Thread**  
Courtesy of GENERAL MOTORS CORP.

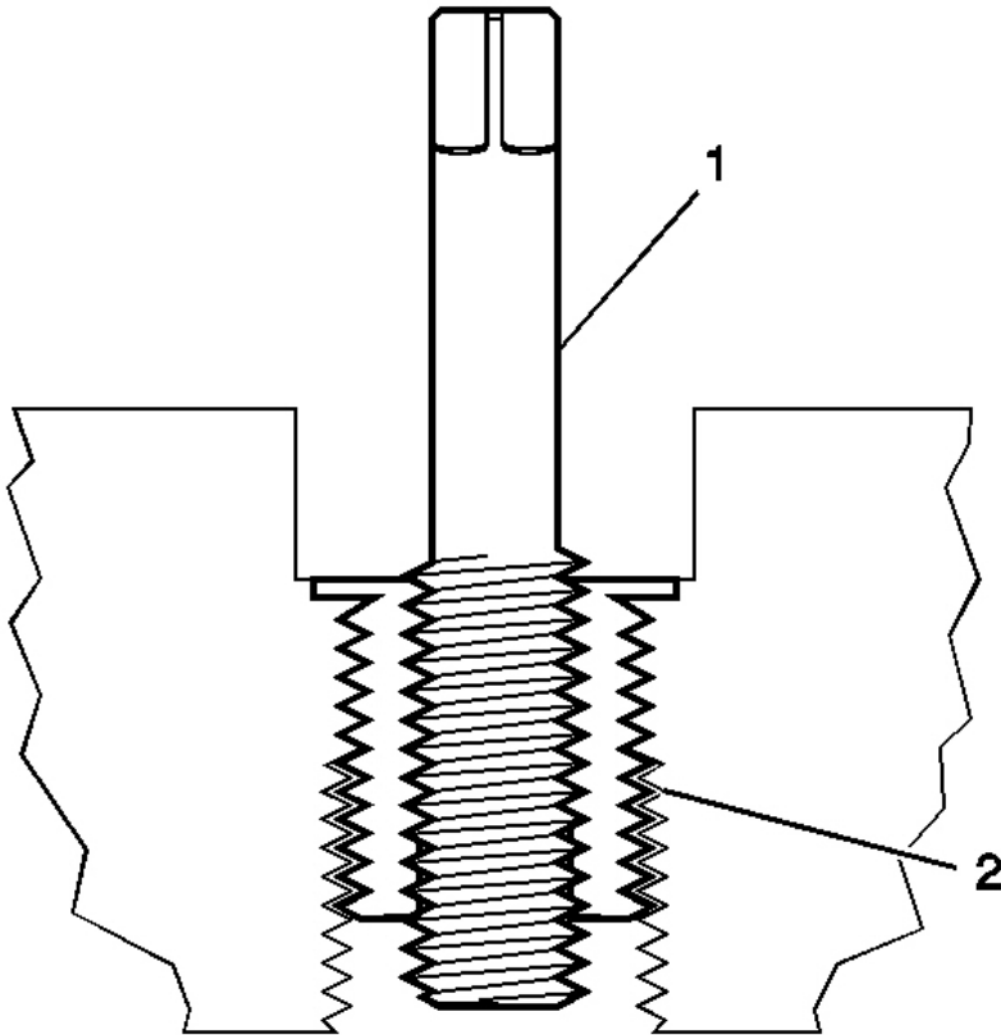
11. Install the insert (2) into the tapped hole by hand only.



**Fig. 62: View Of Installed Insert - Recessed Thread**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

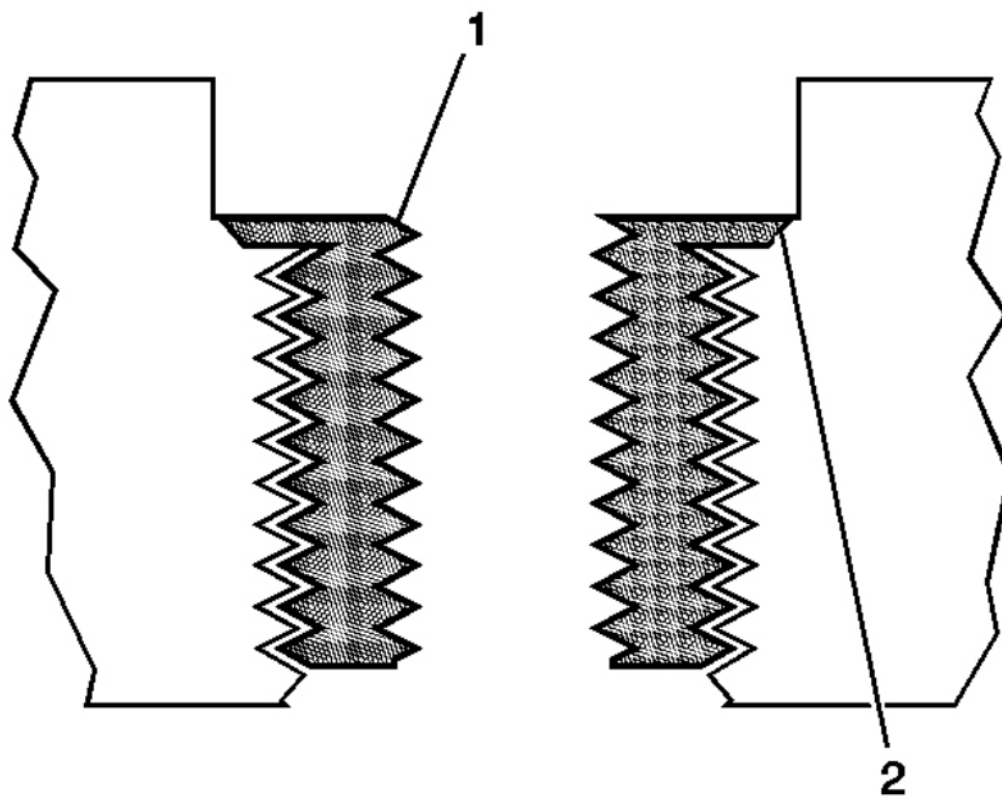
12. Install the insert until the flange (2) of the insert contacts the counterbored surface.



**Fig. 63: Installed Insert - Recessed Thread Repair**  
Courtesy of GENERAL MOTORS CORP.

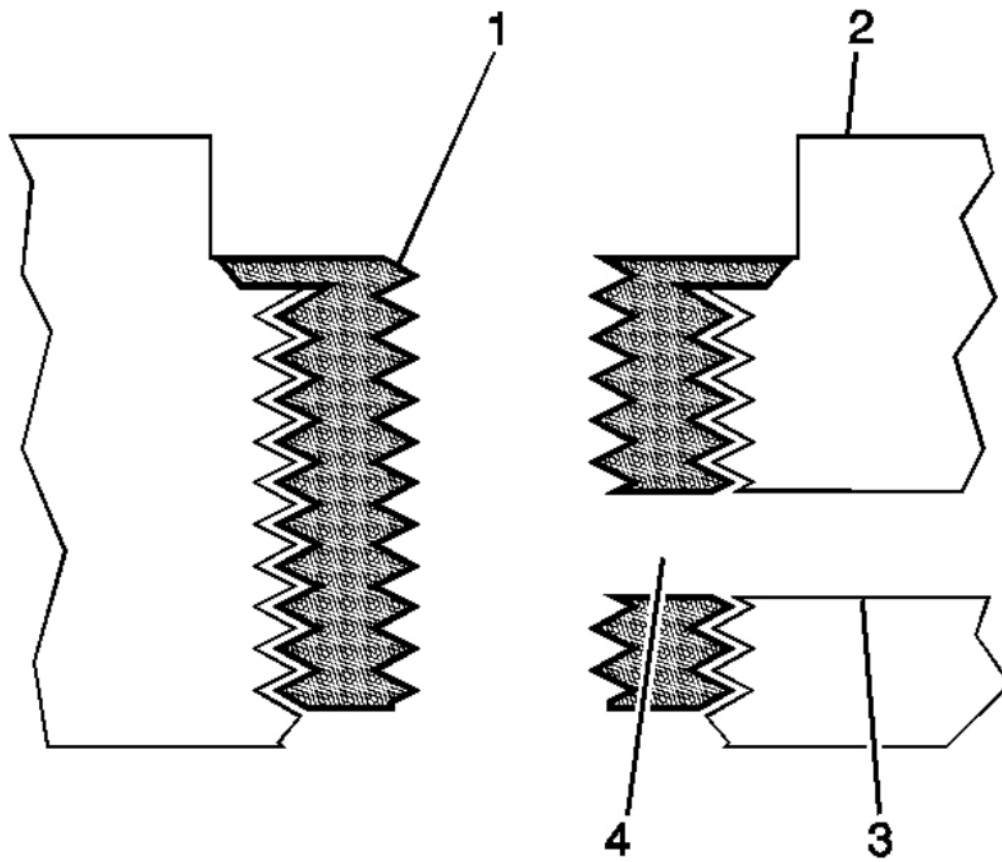
**IMPORTANT:** The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

13. Continue to rotate the driver installation tool (1) through the insert (2).



**Fig. 64: Inspecting Insert For Proper Installation - Recessed Thread**  
Courtesy of GENERAL MOTORS CORP.

14. Inspect the insert (1) for proper installation (2) into the tapped hole.



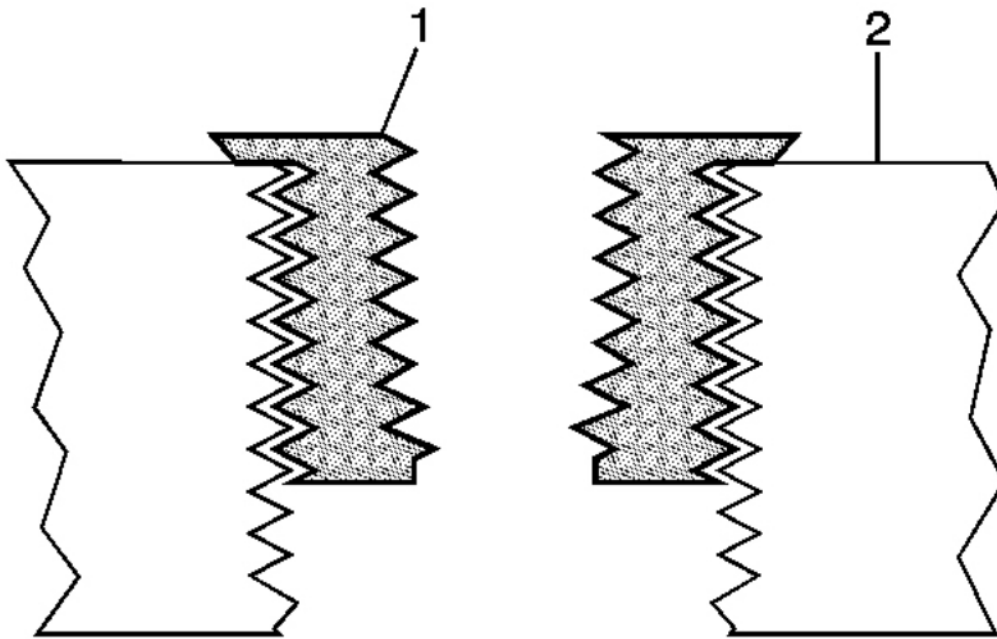
**Fig. 65: View Of Restricted Engine Coolant Passage - Recessed Thread Repair**  
Courtesy of GENERAL MOTORS CORP.

15. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.

### **TAPERED PIPE THREAD REPAIR**

The thread repair insert for tapered pipe threads is coated with a clear silver zinc coating.



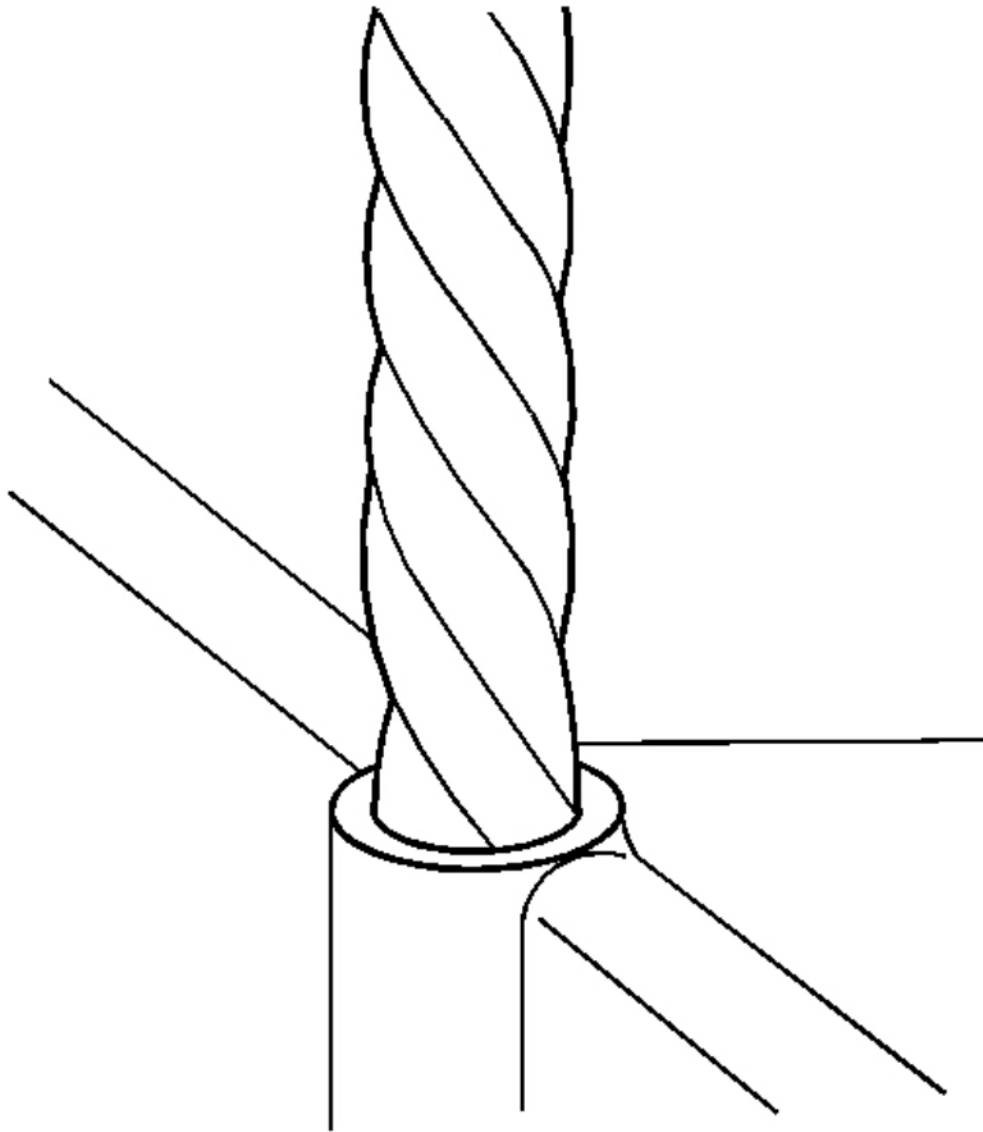


**Fig. 66: Inspecting Insert For Proper Installation - Tapered Thread**  
Courtesy of GENERAL MOTORS CORP.

**CAUTION:** Refer to Safety Glasses Caution in Cautions and Notices.

**IMPORTANT:** The use of a cutting type fluid GM P/N 1052864, (Canadian P/N 992881), WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures.

When installed to the proper depth, the flange (1) of the insert will be seated against surface (2) of the base material of the drilled/tapped hole.

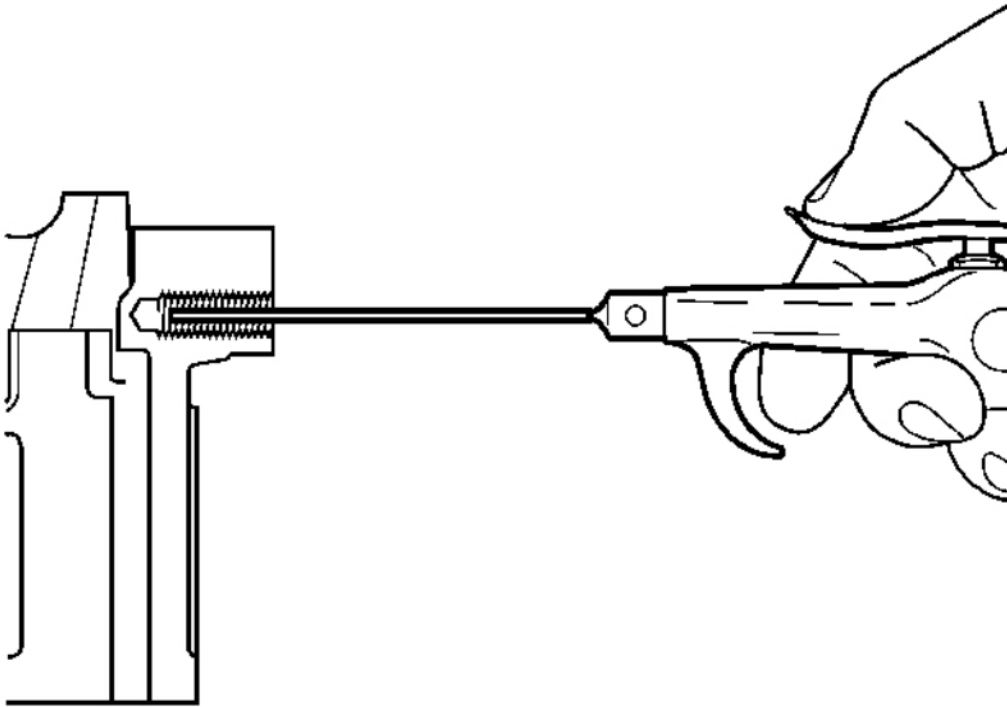


**Fig. 67: Drilling Out Threads Of Damaged Hole**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the hole until the stop collar contacts the surface of the base material.

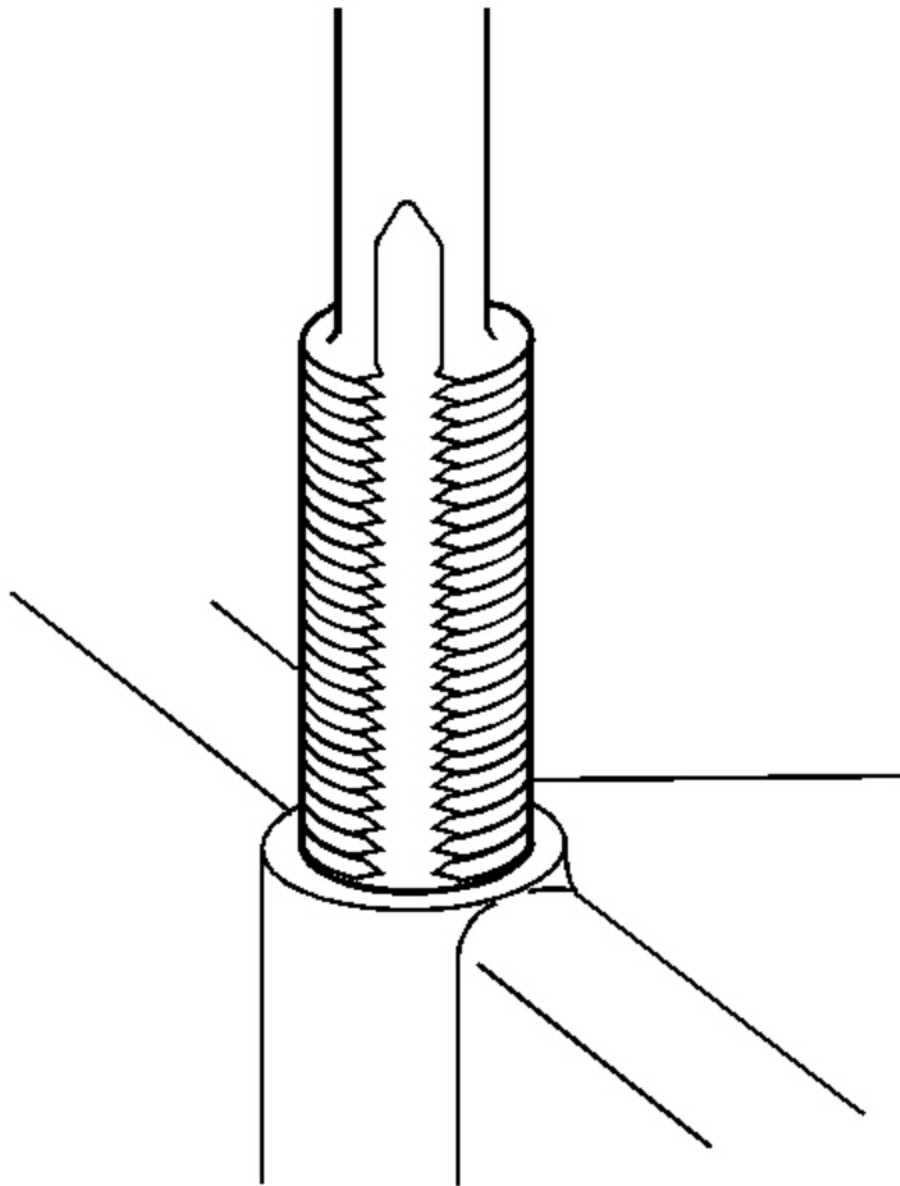
1. Drill out the threads of the damaged hole.



**Fig. 68: Cleaning Out Metal Chips**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** All chips must be removed from the drilled hole prior to tapping.

2. Using compressed air, clean out any chips.



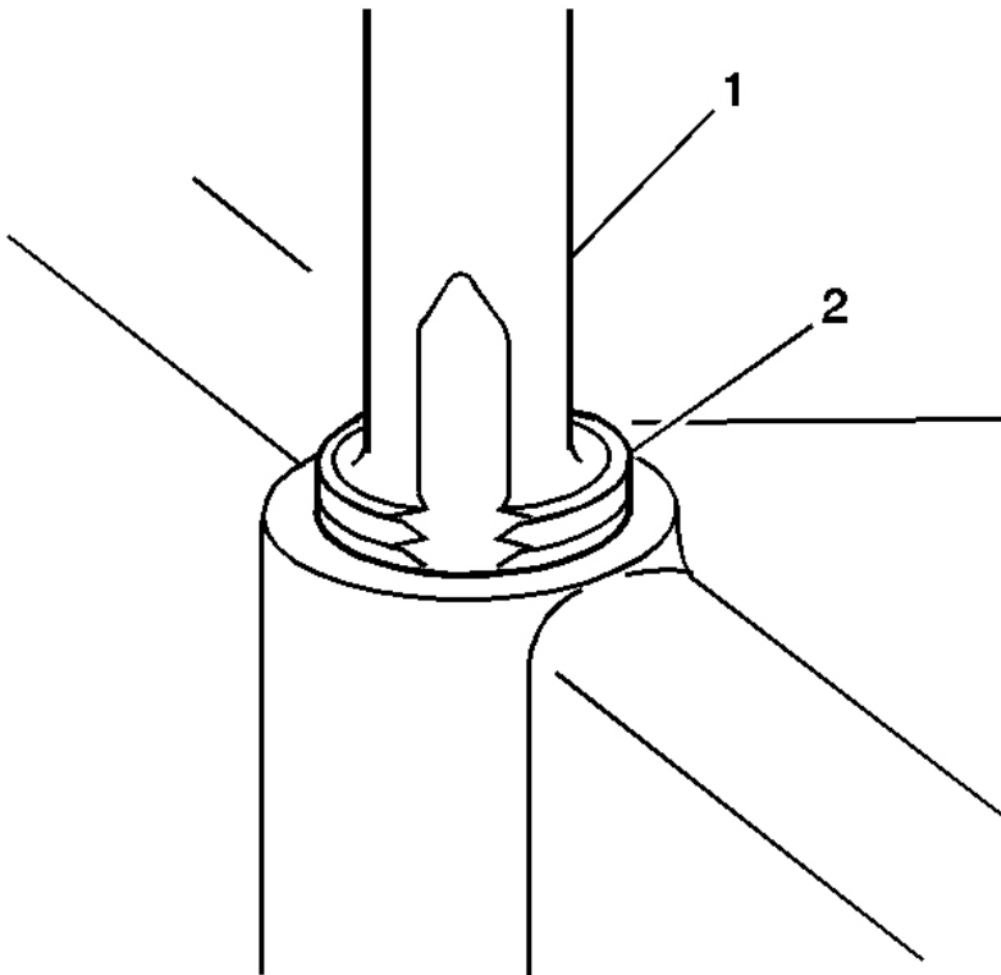
**Fig. 69: Tapping Threads Of Drilled Hole**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.

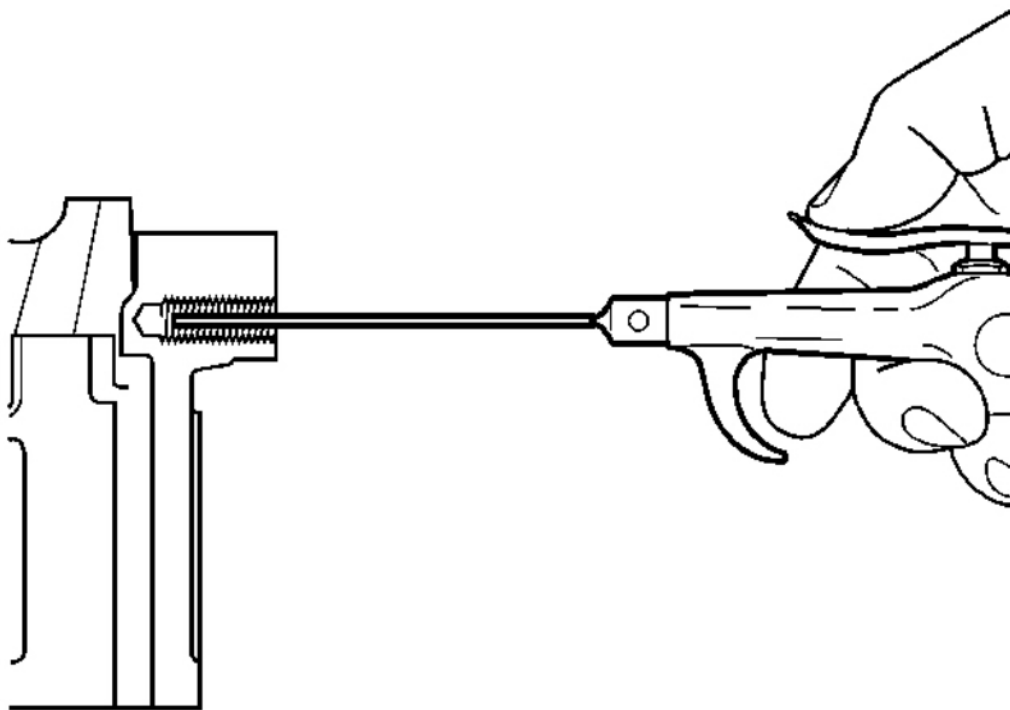
- Ensure the tap has created full threads at least to the depth equal to the insert length.

3. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.



**Fig. 70: View Of Proper Tapping Distance - Tapered Thread**  
Courtesy of GENERAL MOTORS CORP.

4. Tap the drilled hole until the threads at the top of the tap (2) are down to the surface of the base material.

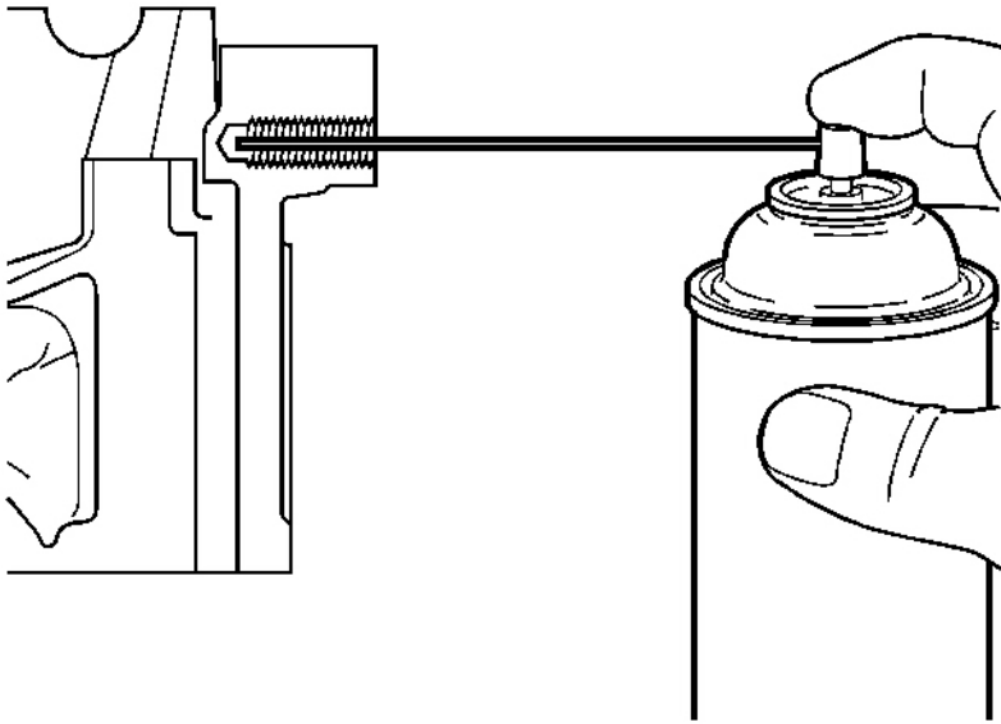


**Fig. 71: Cleaning Out Metal Chips**

Courtesy of GENERAL MOTORS CORP.

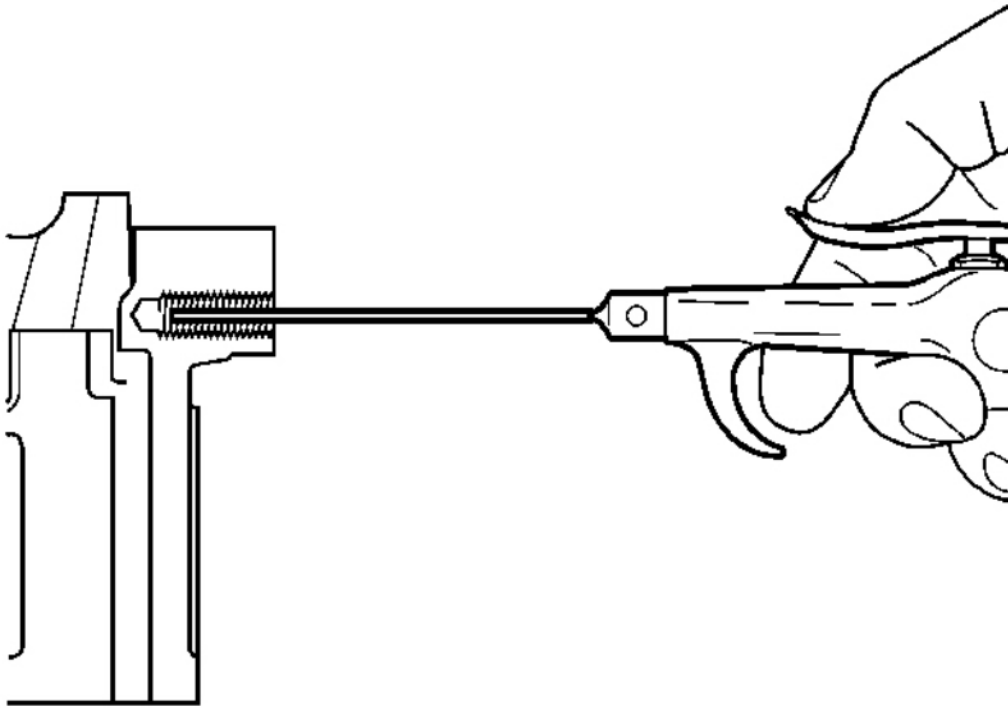
**IMPORTANT:** All chips must be removed from the tapped hole prior to insert installation.

5. Using compressed air, clean out any chips.



**Fig. 72: Spraying Cleaner Into Tapped Hole**  
Courtesy of GENERAL MOTORS CORP.

6. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463) or equivalent into the tapped hole.



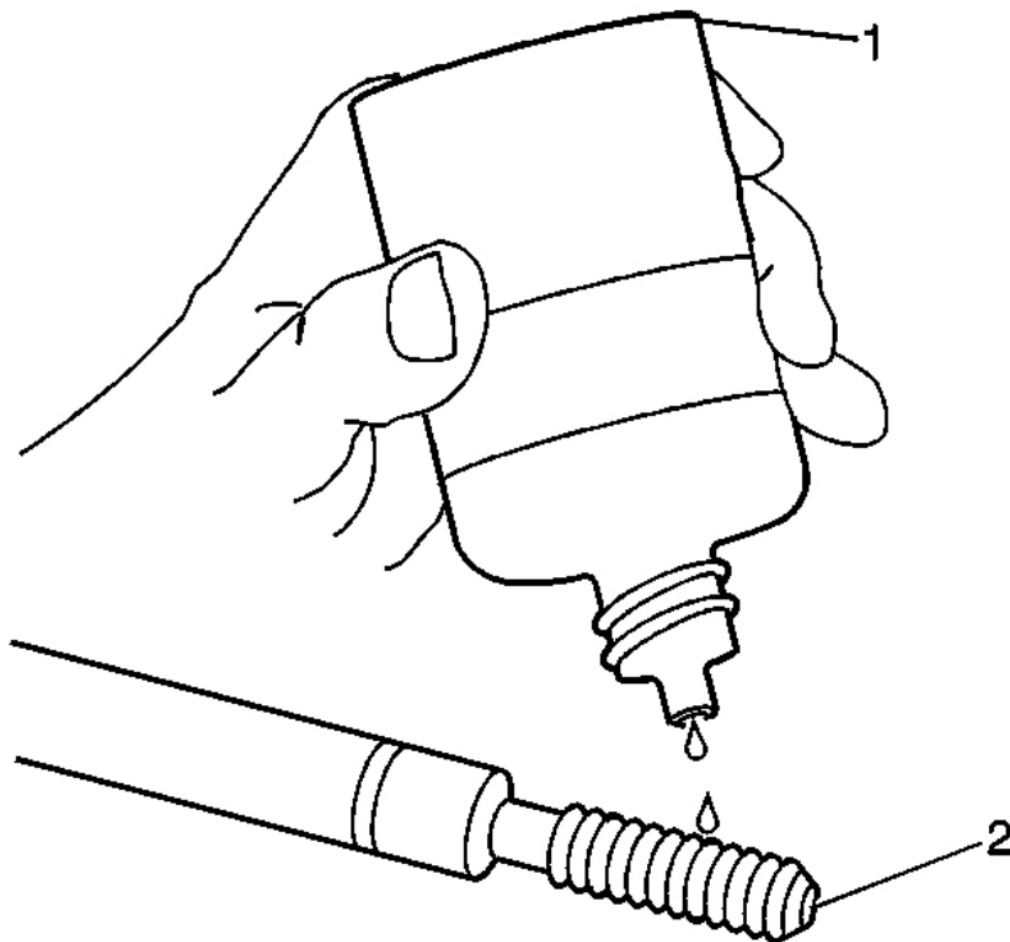
**Fig. 73: Cleaning Out Metal Chips**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** All chips must be removed from the tapped hole prior to insert installation.

7. Using compressed air, clean out any chips.

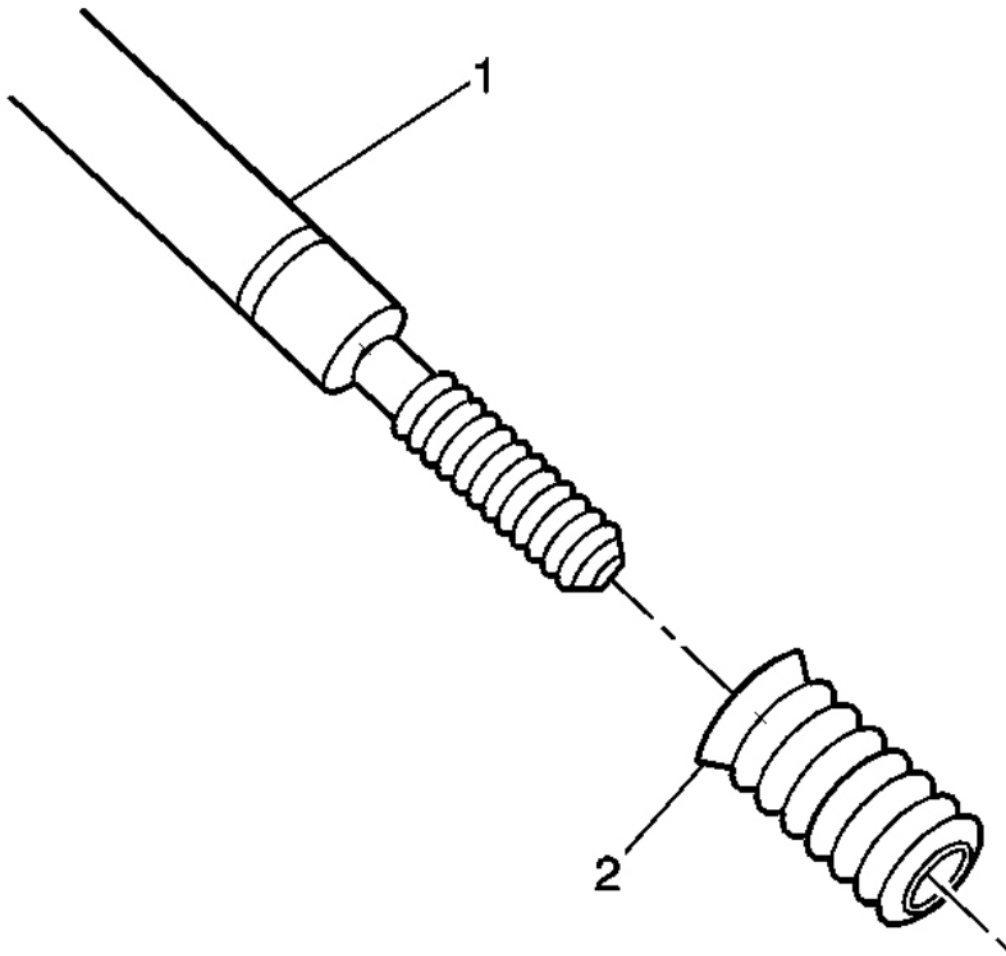




**Fig. 74: Lubricating Installer Tool Using Driver Oil**  
Courtesy of GENERAL MOTORS CORP.

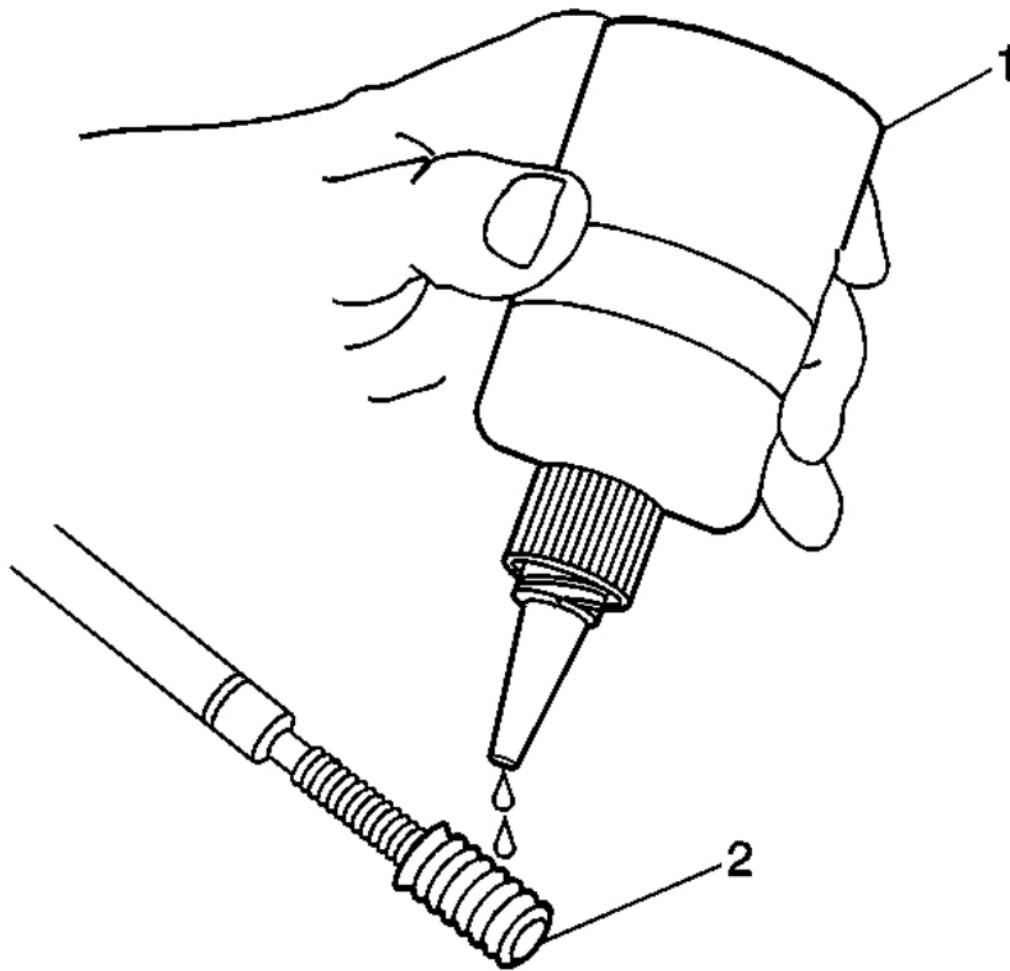
**IMPORTANT:** Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

8. Lubricate the threads of the driver installation tool (2) with the driver oil (1) J 42385-110.



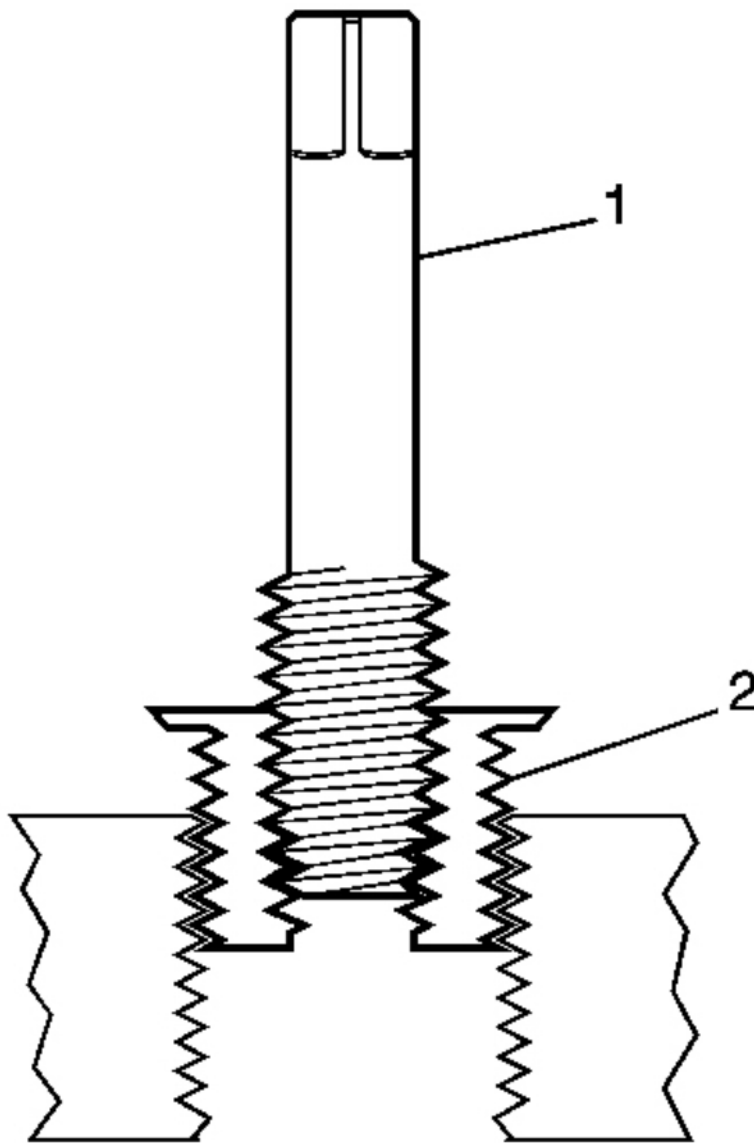
**Fig. 75: View of Bushing Type Insert**  
Courtesy of GENERAL MOTORS CORP.

9. Install the insert (2) onto the driver installation tool (1).



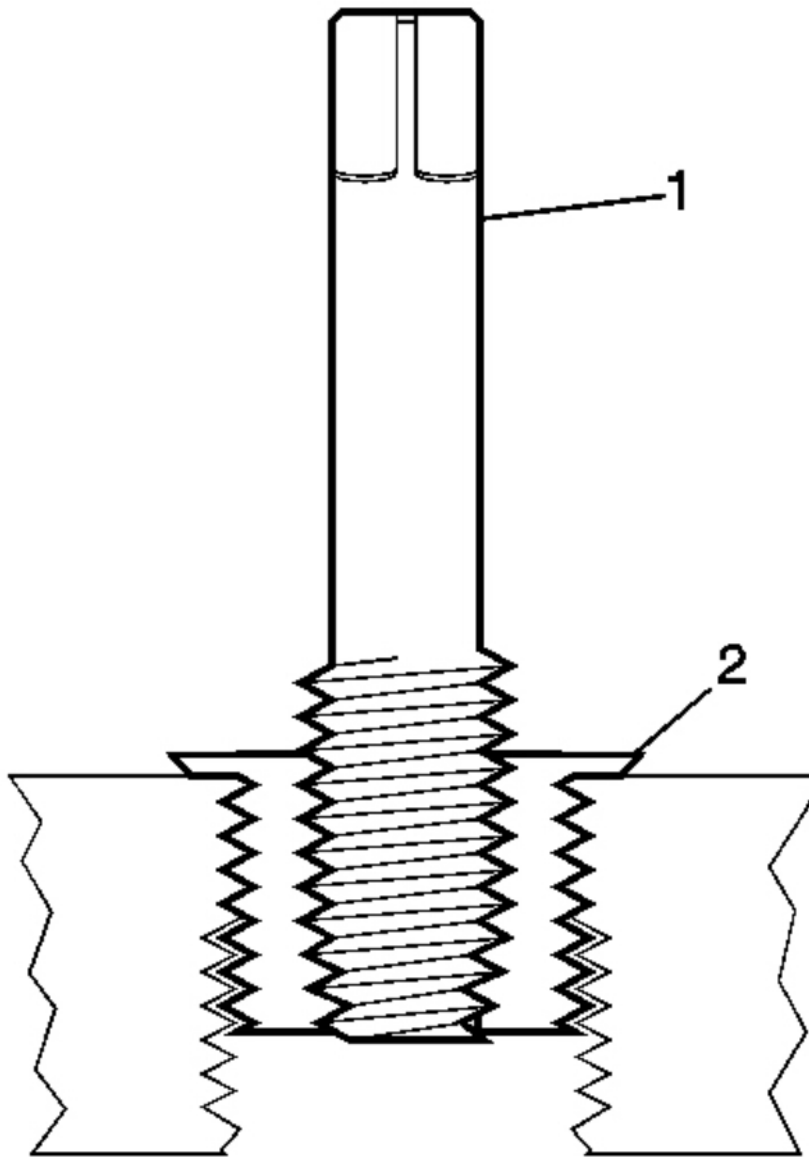
**Fig. 76: Applying Threadlock To Insert**  
Courtesy of GENERAL MOTORS CORP.

10. Apply threadlock sealant GM P/N 12345493, (Canadian P/N 10953488), J 42385-109, LOCTITE 277® or equivalent (1) to the insert OD threads (2).



**Fig. 77: Installing Insert - Tapered Thread**  
Courtesy of GENERAL MOTORS CORP.

11. Install the insert (2) into the tapped hole by hand only.

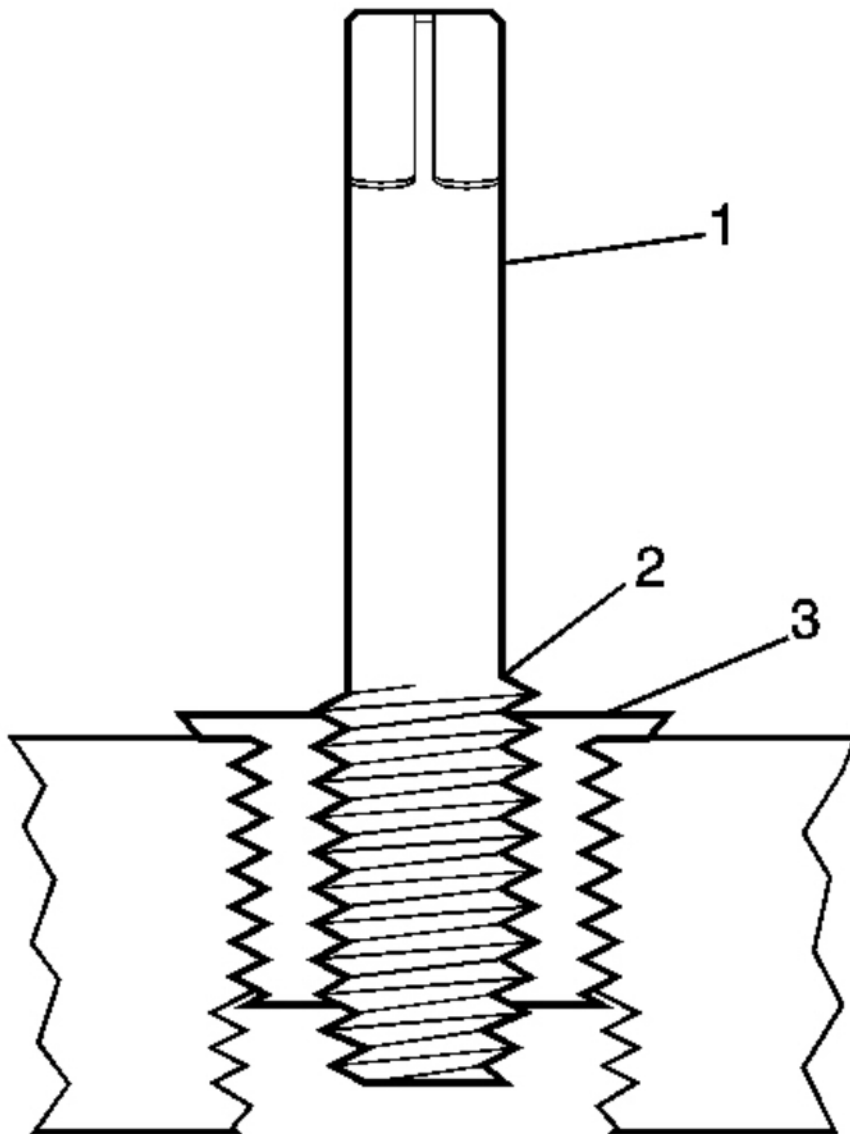


**Fig. 78: Installing Insert - Tapered Pipe Thread Repair**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** If the insert will not thread down until the flange contacts the surface of the base material remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper

tapping.

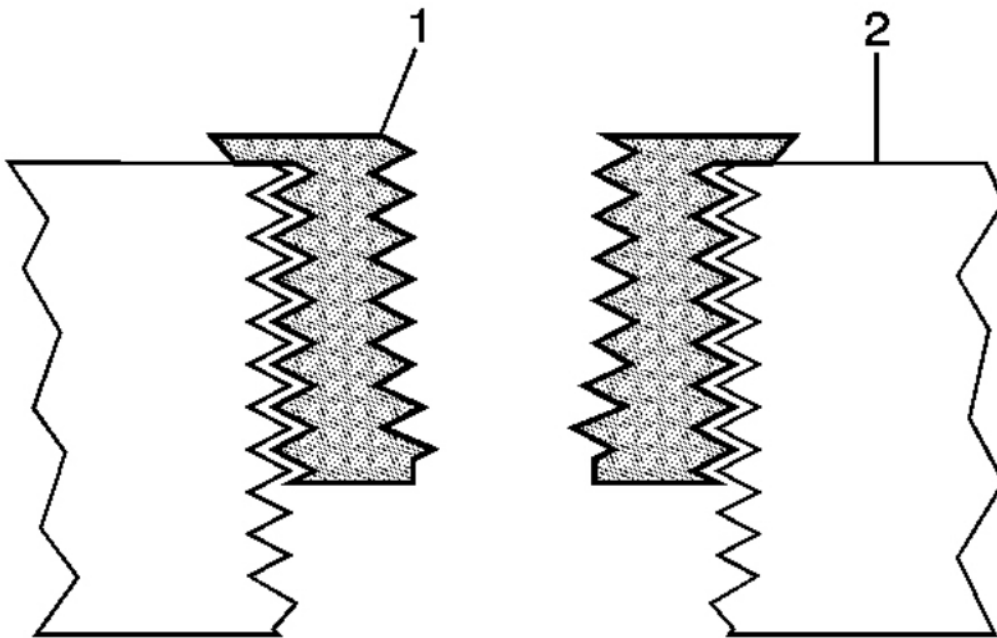
12. Install the insert until the flange (2) of the insert contacts the surface of the base material.



**Fig. 79: Installed Insert - Tapered Pipe Thread Repair**  
Courtesy of GENERAL MOTORS CORP.

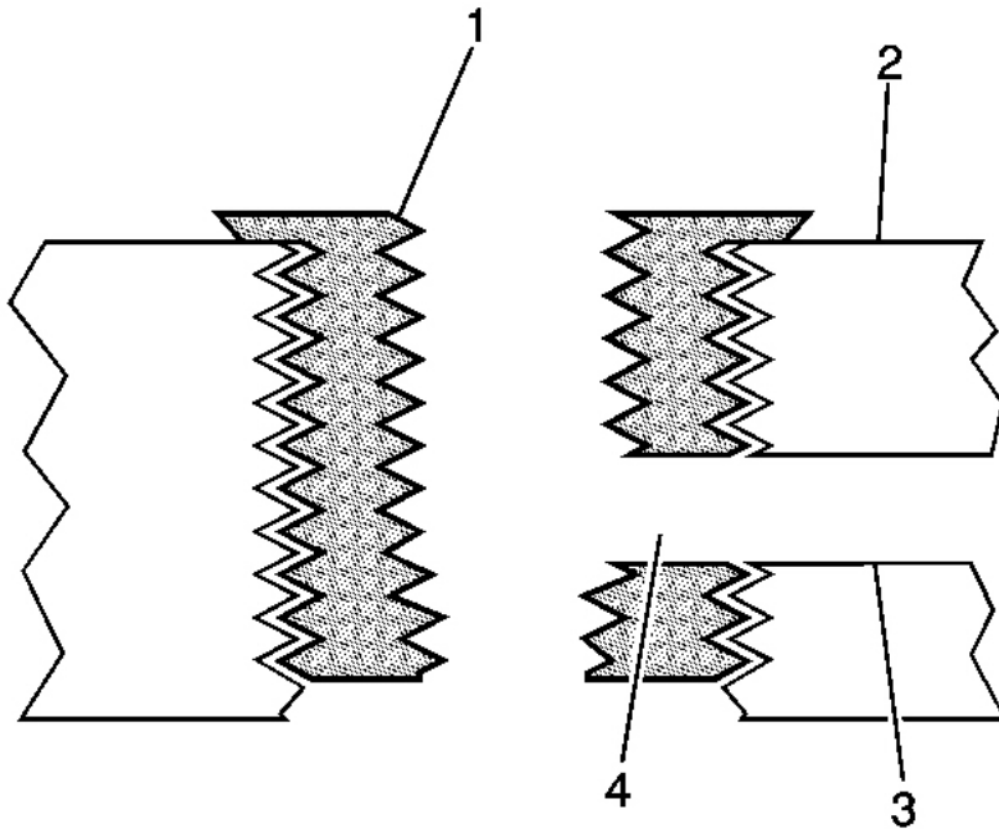
**IMPORTANT:** The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

13. Continue to rotate the driver installation tool (1) until the top of the threaded section (2) is level with the top of the insert (3).



**Fig. 80: Inspecting Insert For Proper Installation - Tapered Thread**  
Courtesy of GENERAL MOTORS CORP.

14. Inspect the insert (1) for proper installation (2) into the tapped hole.



**Fig. 81: View Of Restricted Engine Coolant Passages - Tapered Pipe Thread Repair**  
Courtesy of GENERAL MOTORS CORP.

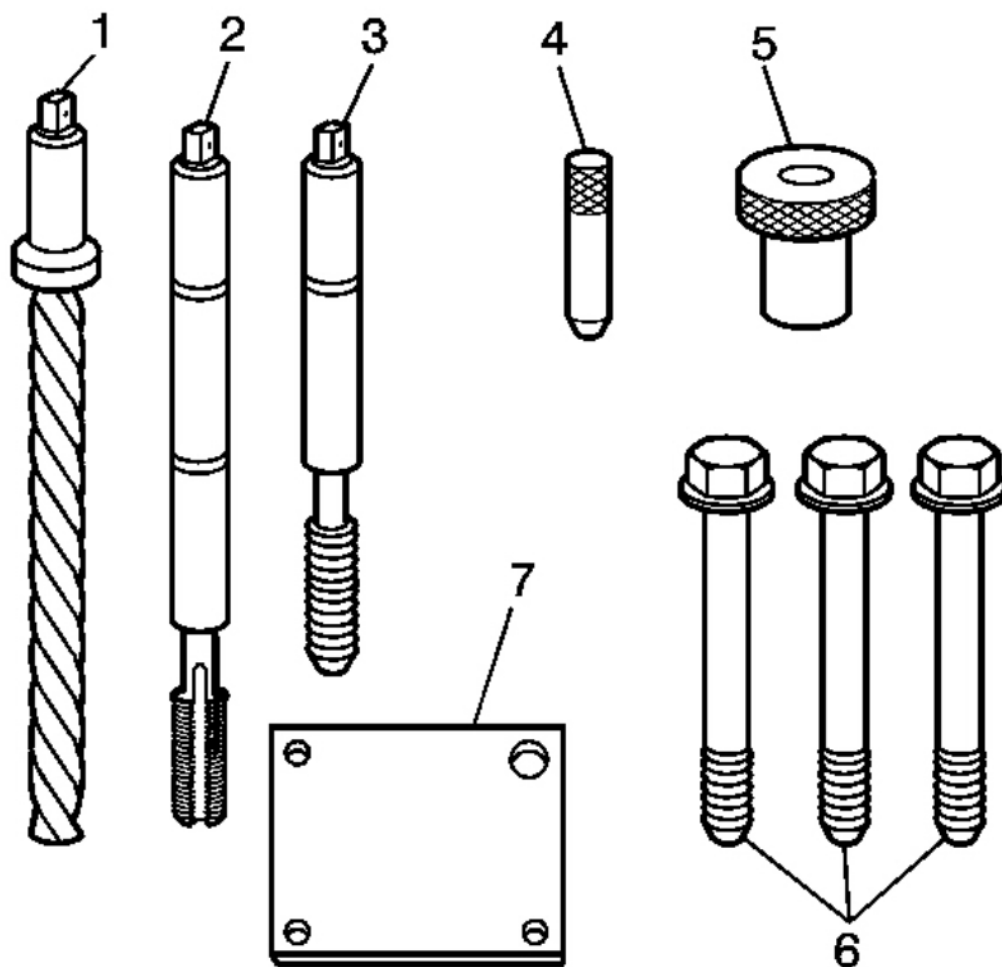
15. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.

## CYLINDER HEAD BOLT HOLE THREAD REPAIR

### Tools Required

- J 42385-700 High Feature Thread Repair Kit
- J 42385-2000 Thread Insert Kit





**Fig. 82: Identifying Cylinder Head Bolt Hole Thread Repair Components**  
Courtesy of GENERAL MOTORS CORP.

The cylinder head bolt hole thread repair tooling are in the kits **J 42385-2000** and **J 42385-700** . The cylinder head bolt hole thread repair components consist of the following:

- Drill (1) J 42385-723
- Tap (2) J 42385-724
- Installation driver (3) J 42385-725
- Alignment pin (4) J 42385-303
- Bushing (5) J 42385-302
- Bolts (6) J 42385-733

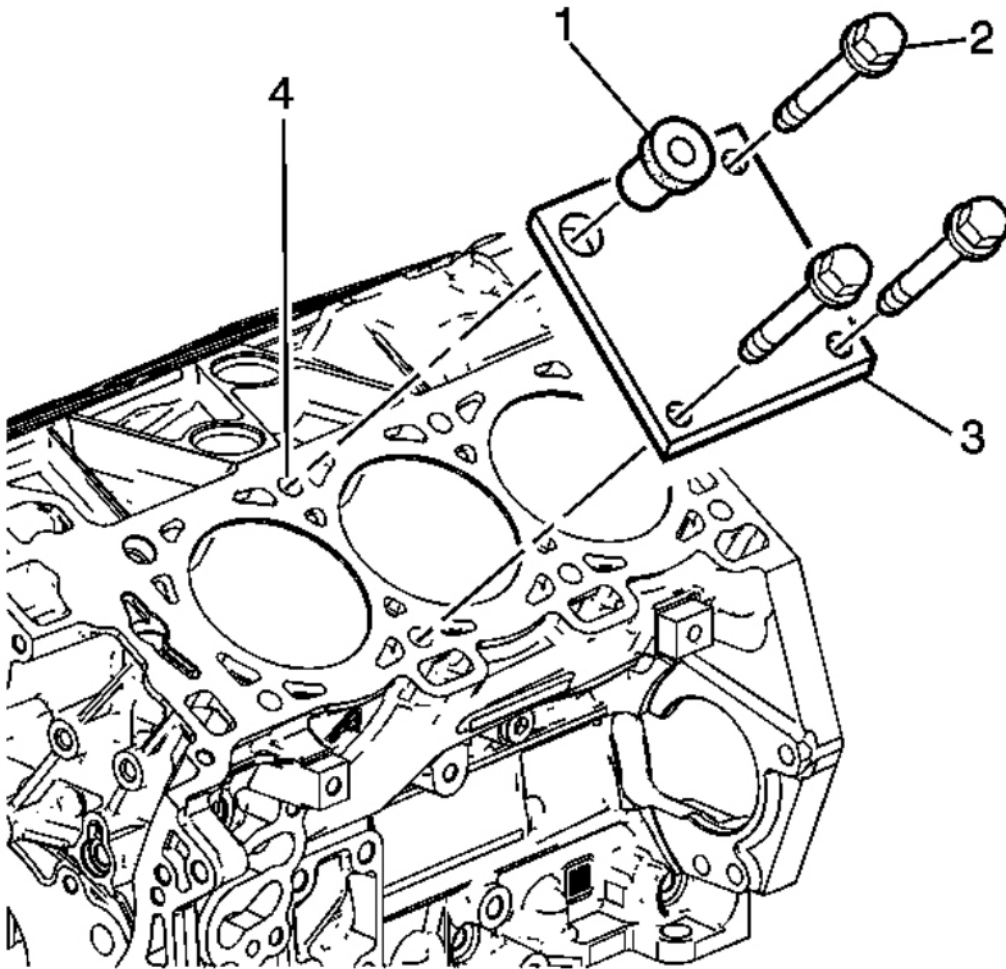
- Fixture plate (7) J 42385-401

**CAUTION:** Refer to Safety Glasses Caution in Cautions and Notices.

**IMPORTANT:**

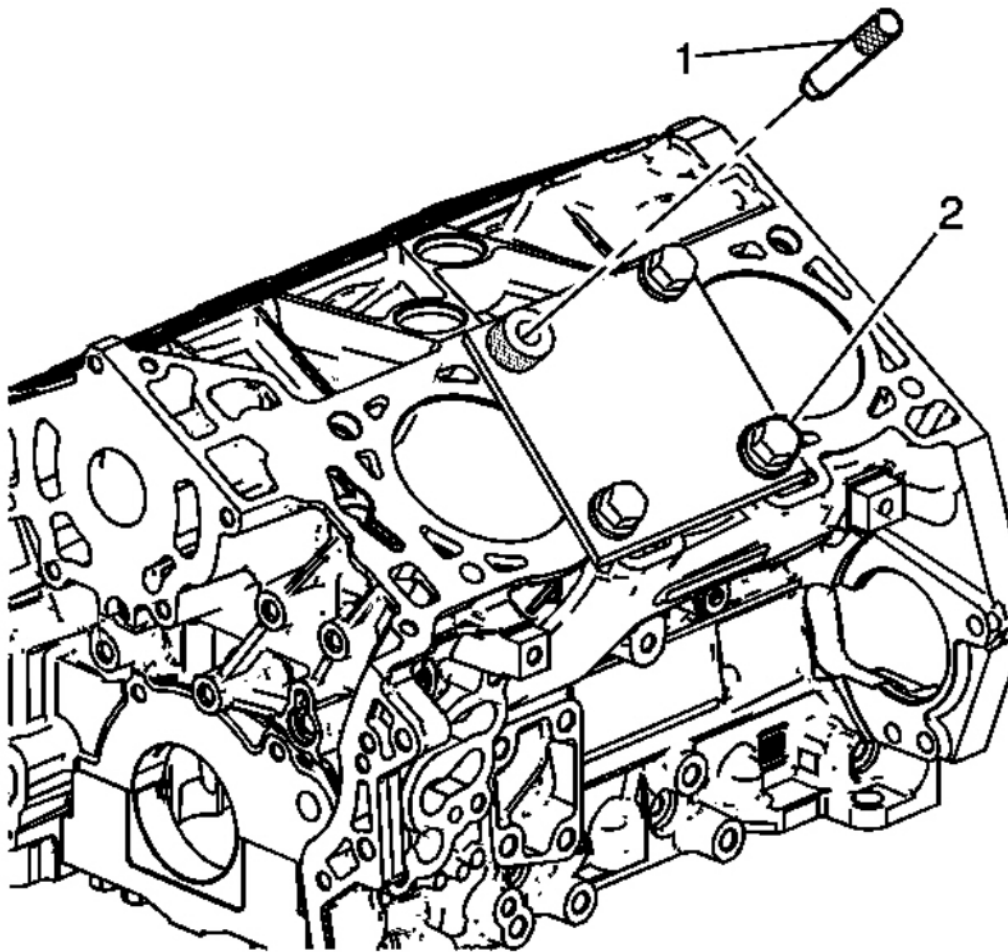
- Remove the fixture plate prior to installing the insert with the installer tool.
- The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881) WD 40®; or equivalent is recommended when performing the drilling, counterboring and tapping procedures.

When installed to the proper depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.



**Fig. 83: View Of Fixture Plate With Bushing**  
Courtesy of GENERAL MOTORS CORP.

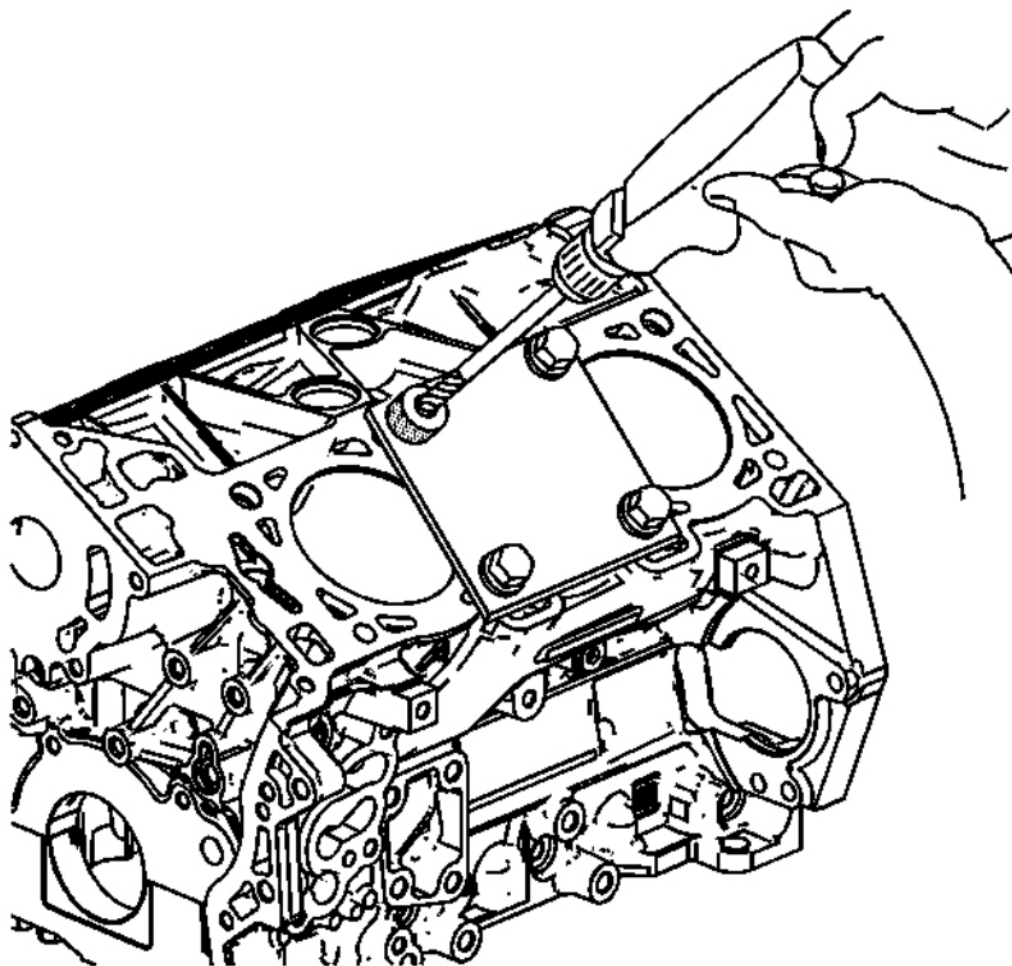
1. Position the fixture plate (3) with the bushing (1) installed over the cylinder head bolt hole to be repaired (4).
2. Loosely install the fixture plate bolts (2) into the remaining cylinder head bolt holes.



**Fig. 84: Locating Alignment Pin**

Courtesy of GENERAL MOTORS CORP.

3. Position the alignment pin (1) through the bushing and into the cylinder head bolt hole.
4. With the alignment pin in the desired cylinder head bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the cylinder head bolt hole.

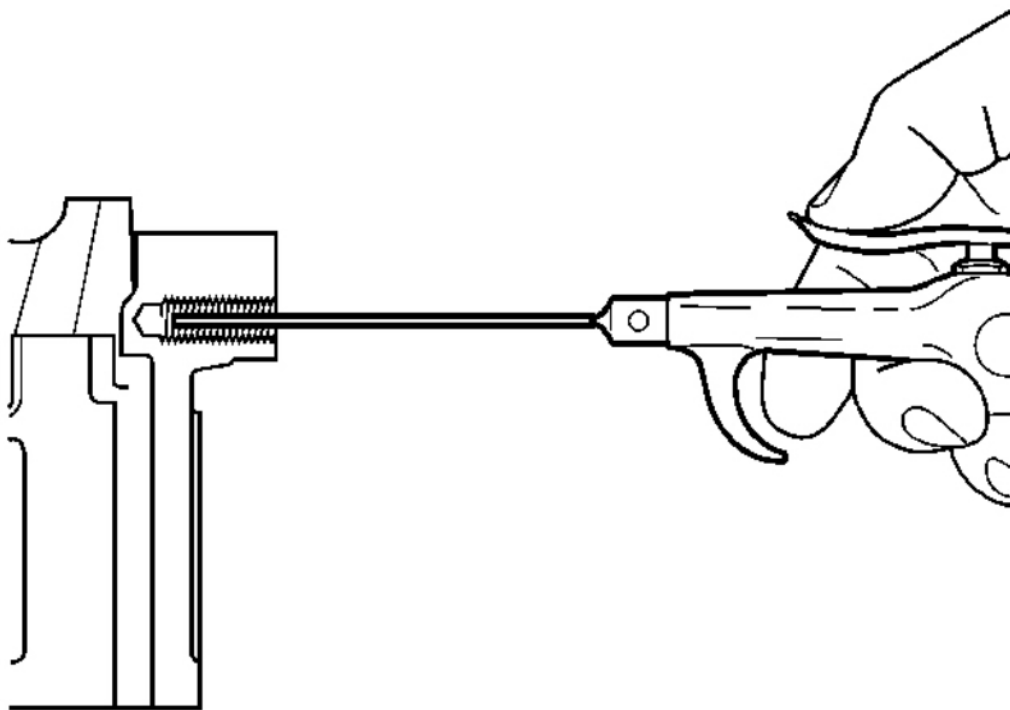


**Fig. 85: Drilling Out Threads Of Damaged Hole**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the hole until the stop collar contacts the top of the drill bushing.

6. Drill out the threads of the damaged hole.

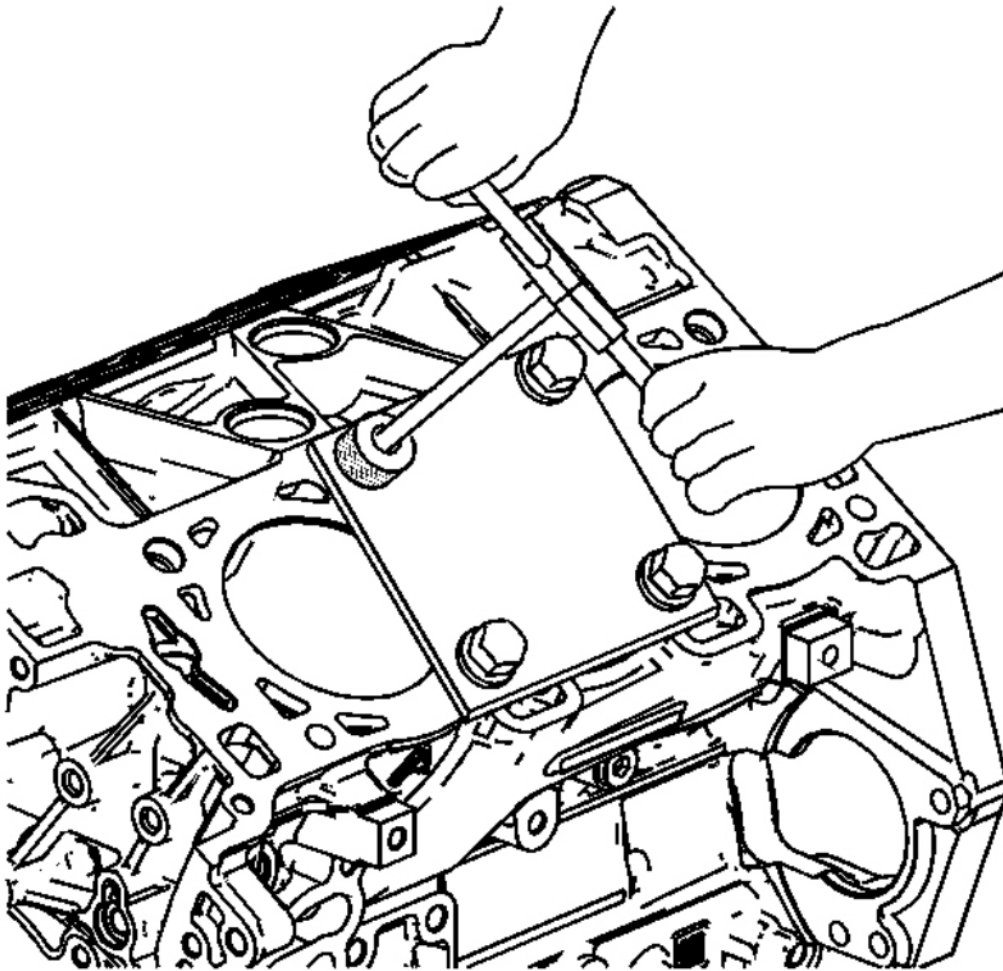


**Fig. 86: Cleaning Out Metal Chips**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** All chips must be removed from the drilled hole prior to tapping.

7. Using compressed air, clean out any chips.

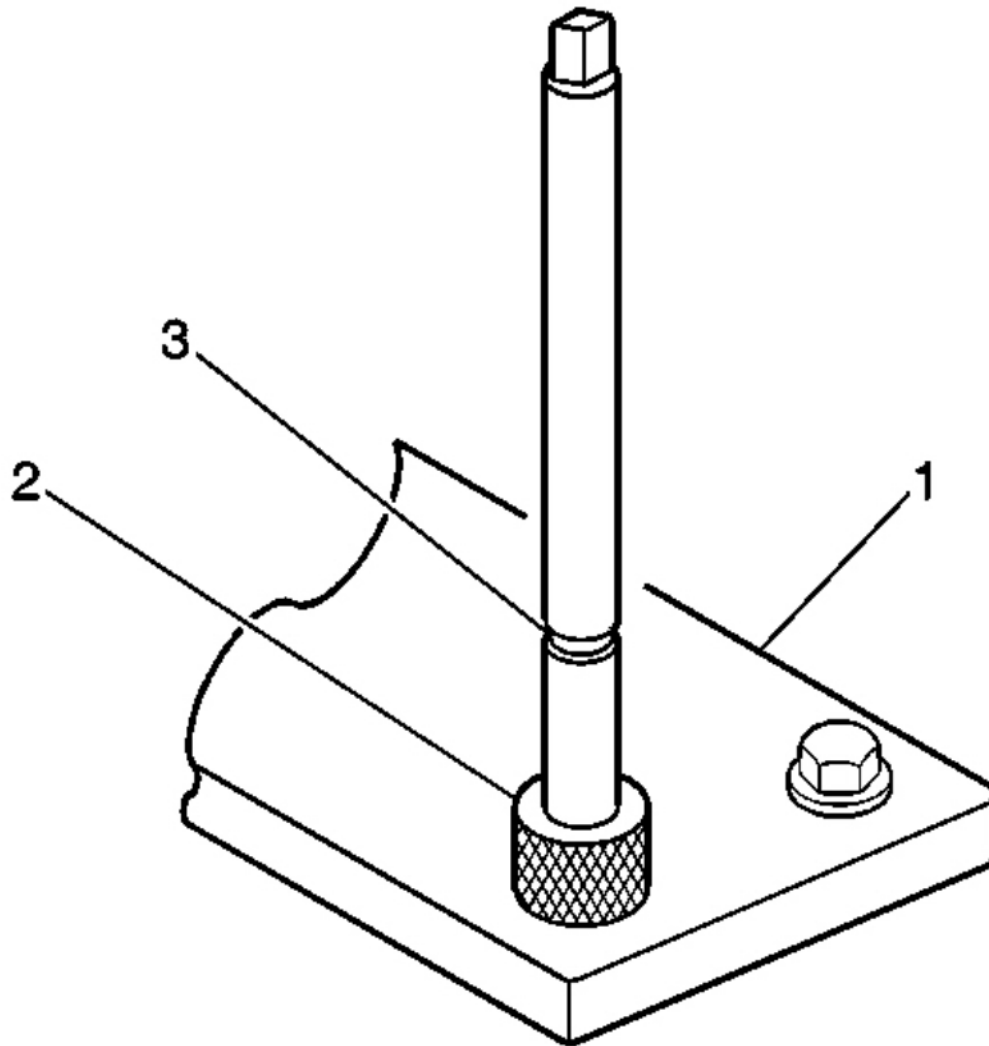


**Fig. 87: Tapping Threads In Hole**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Ensure the tap has created full threads at least to the depth equal to the insert length.

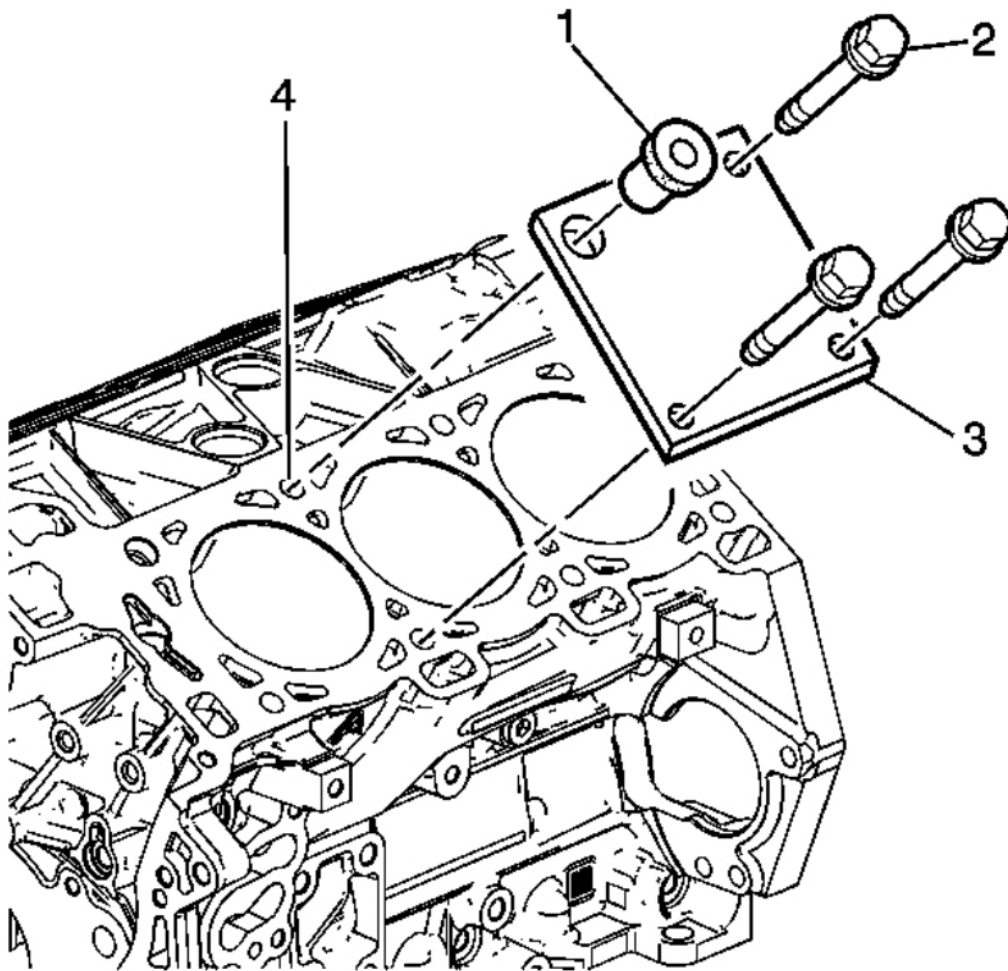
8. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.



**Fig. 88: View Of Fixture Plate, Drill Bushing & Tool Marking**  
Courtesy of GENERAL MOTORS CORP.

9. In order to tap the new threads for the insert to the proper depth, rotate the tap into the cylinder head bolt hole until the mark (3) on the tap aligns with the top of the drill bushing (2).

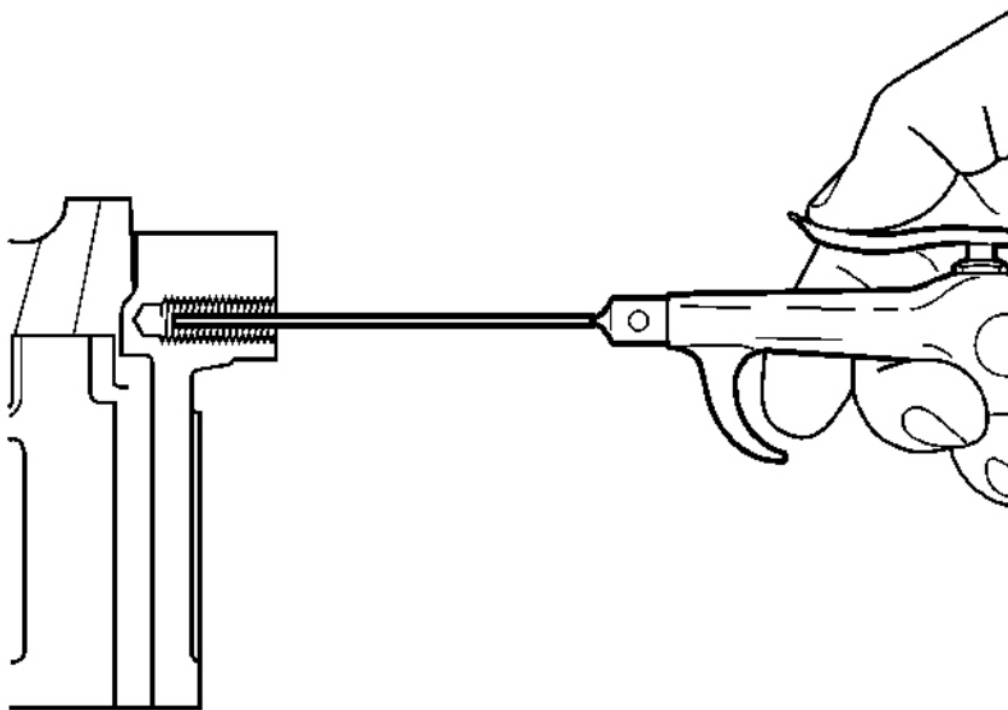




**Fig. 89: View Of Fixture Plate With Bushing**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** Remove the fixture plate prior to installing the insert with the installer tool.

10. Remove the fixture plate bolts (2).
11. Remove the fixture plate (3) and bushing (1).

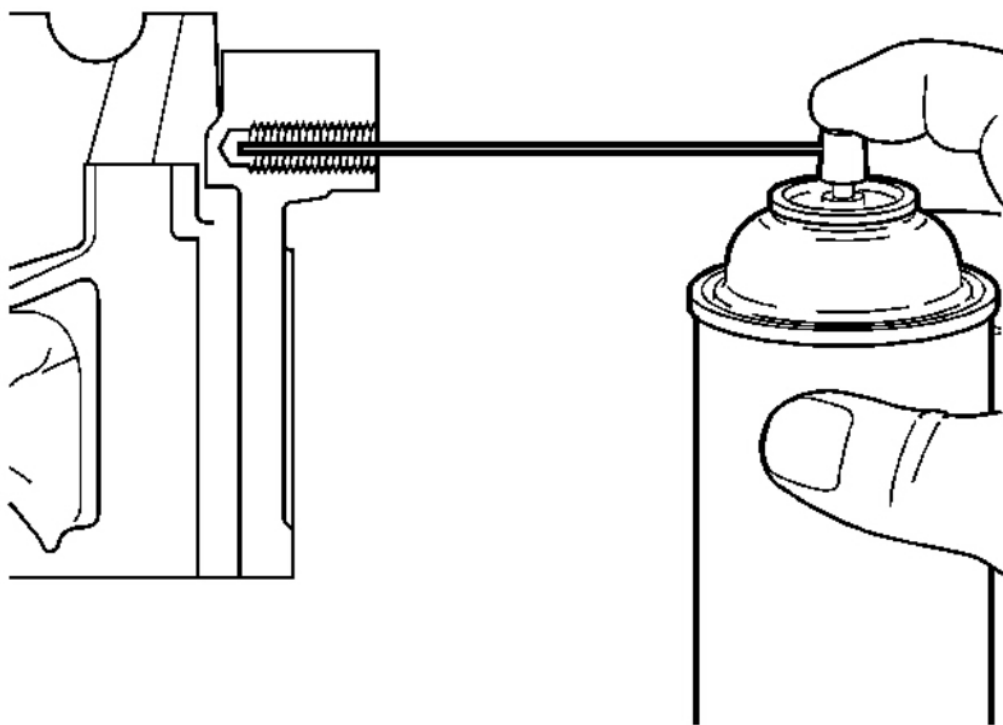


**Fig. 90: Cleaning Out Metal Chips**

Courtesy of GENERAL MOTORS CORP.

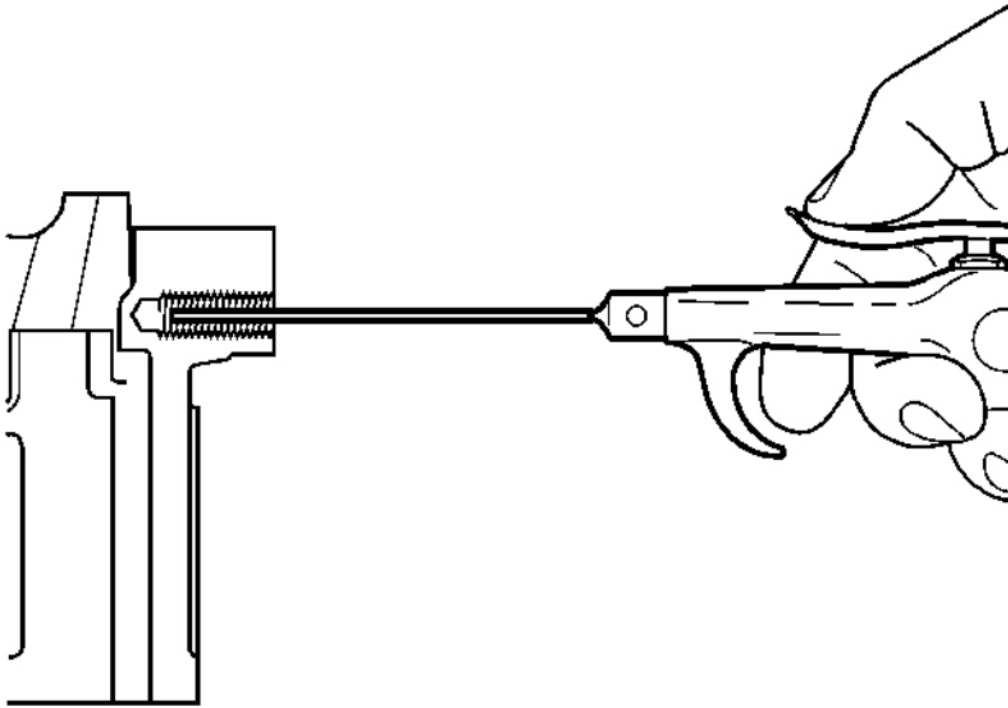
**IMPORTANT:** All chips must be removed from the tapped hole prior to insert installation.

12. Using compressed air, clean out any chips.



**Fig. 91: Spraying Cleaner Into Tapped Hole**  
Courtesy of GENERAL MOTORS CORP.

13. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463) or equivalent into the tapped hole.

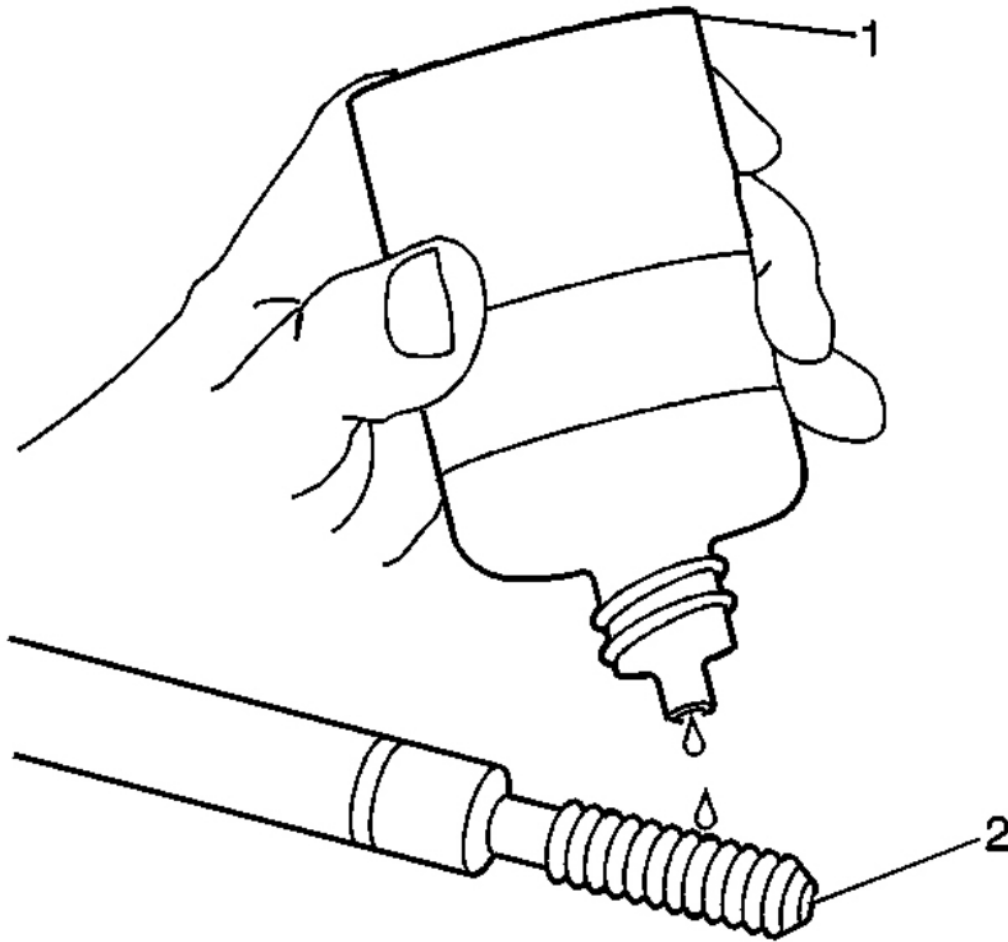


**Fig. 92: Cleaning Out Metal Chips**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** All chips must be removed from the tapped hole prior to insert installation.

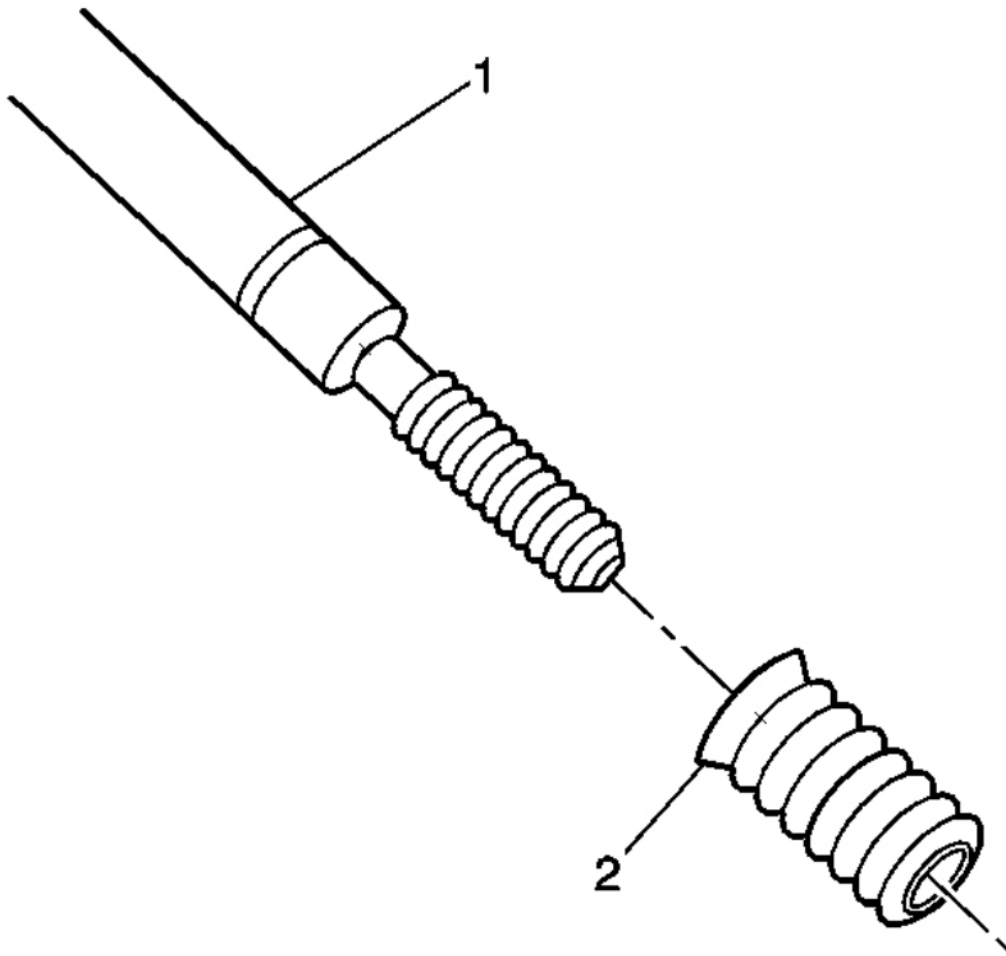
14. Using compressed air, clean out any chips.



**Fig. 93: Lubricating Installer Tool Using Driver Oil**  
Courtesy of GENERAL MOTORS CORP.

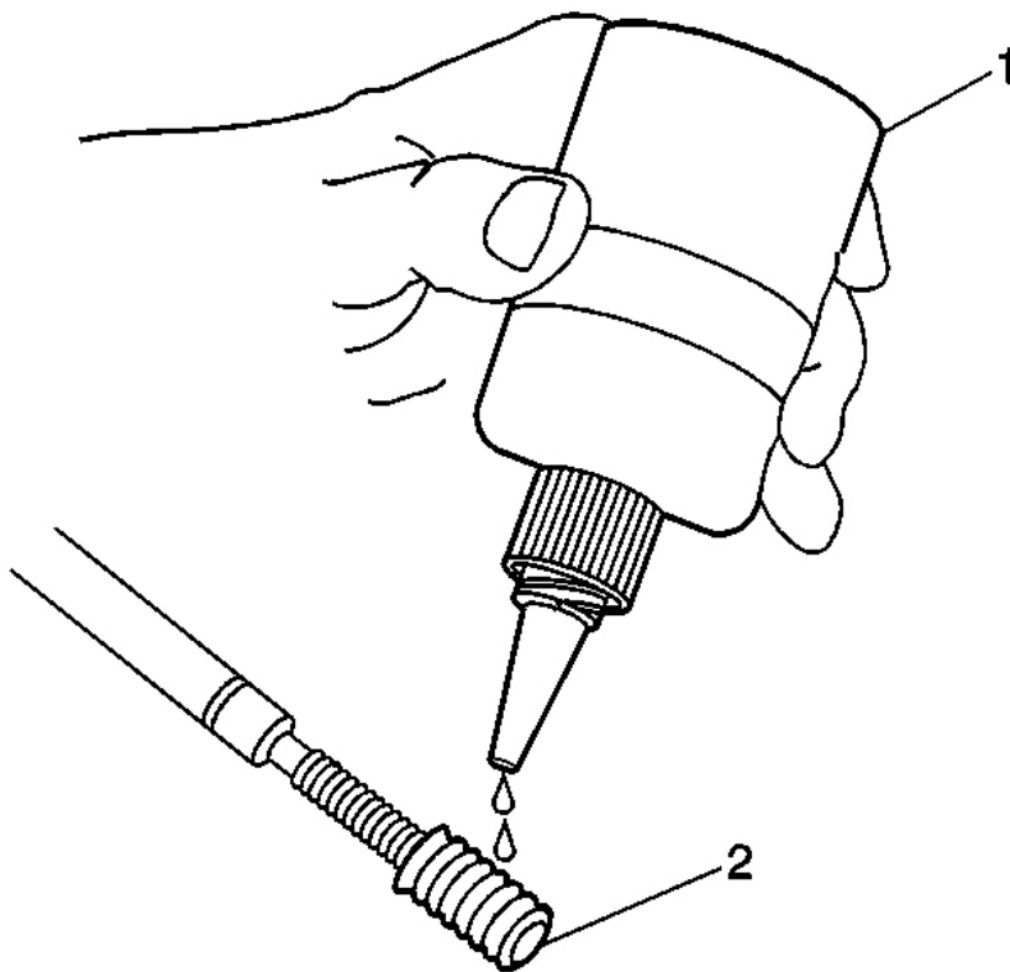
**IMPORTANT:** Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

15. Lubricate the threads of the driver installation tool (2) with the driver oil (1) J 42385-110.



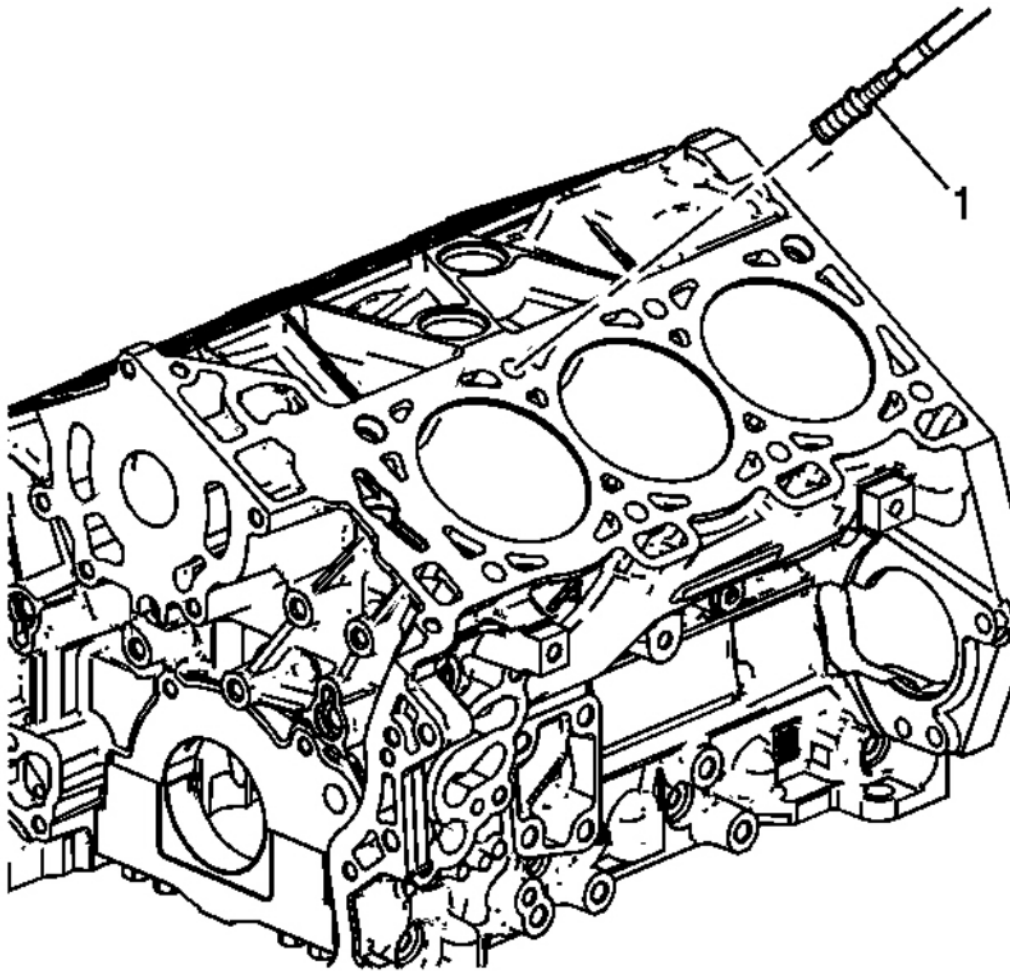
**Fig. 94: View of Bushing Type Insert**  
Courtesy of GENERAL MOTORS CORP.

16. Install the insert (2) onto the driver installation tool (1).



**Fig. 95: Applying Threadlock To Insert**  
Courtesy of GENERAL MOTORS CORP.

17. Apply threadlock sealant GM P/N 12345493, (Canadian P/N 10953488), J 42385-109, LOCTITE 277®; or equivalent (1) to the insert OD threads (2).



**Fig. 96: Installing Installation Driver By Hand**  
Courtesy of GENERAL MOTORS CORP.

18. Install the insert and installation driver (1) into the tapped hole by hand only.
19. Start the insert into the threaded hole.

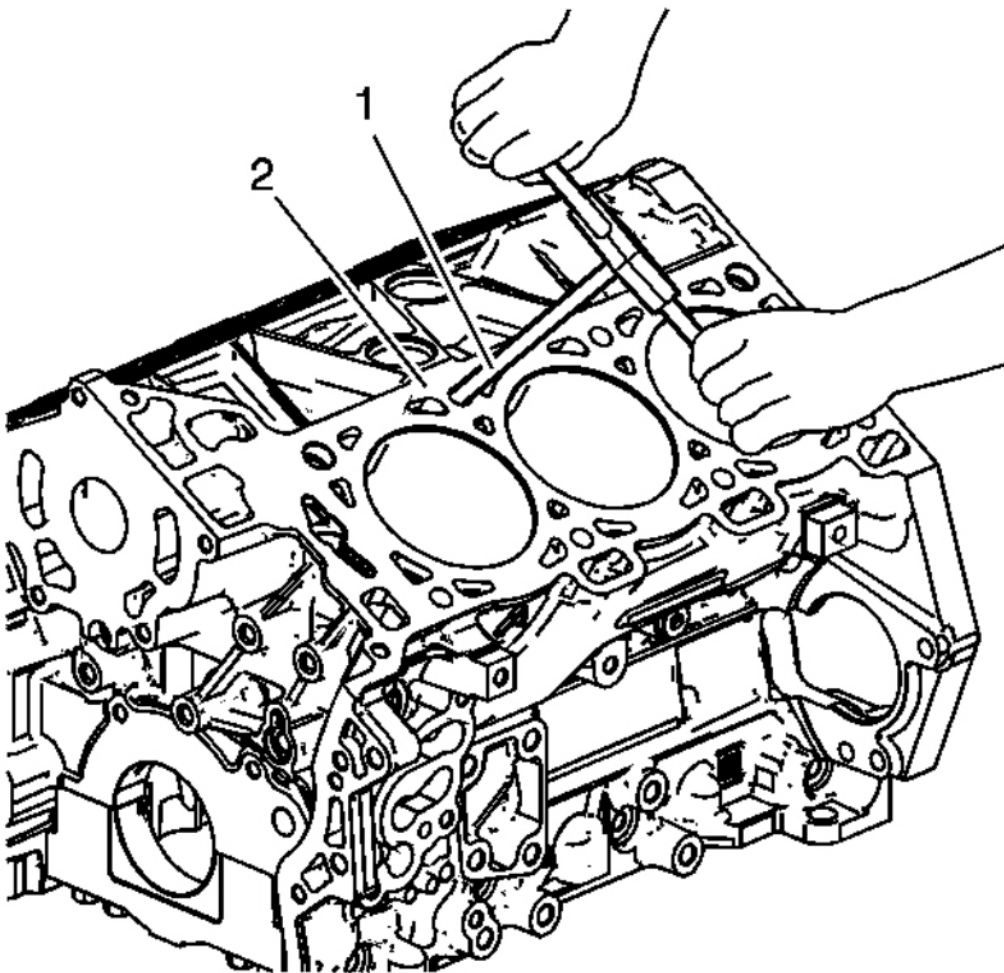
**IMPORTANT:** If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

20. Install the insert until the flange of the insert contacts the counterbored surface.



**IMPORTANT:** The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

21. Continue to rotate the driver installation tool through the insert.



**Fig. 97: Aligning Driver Installation Tool With Surface Of Engine Block Deck**  
Courtesy of GENERAL MOTORS CORP.

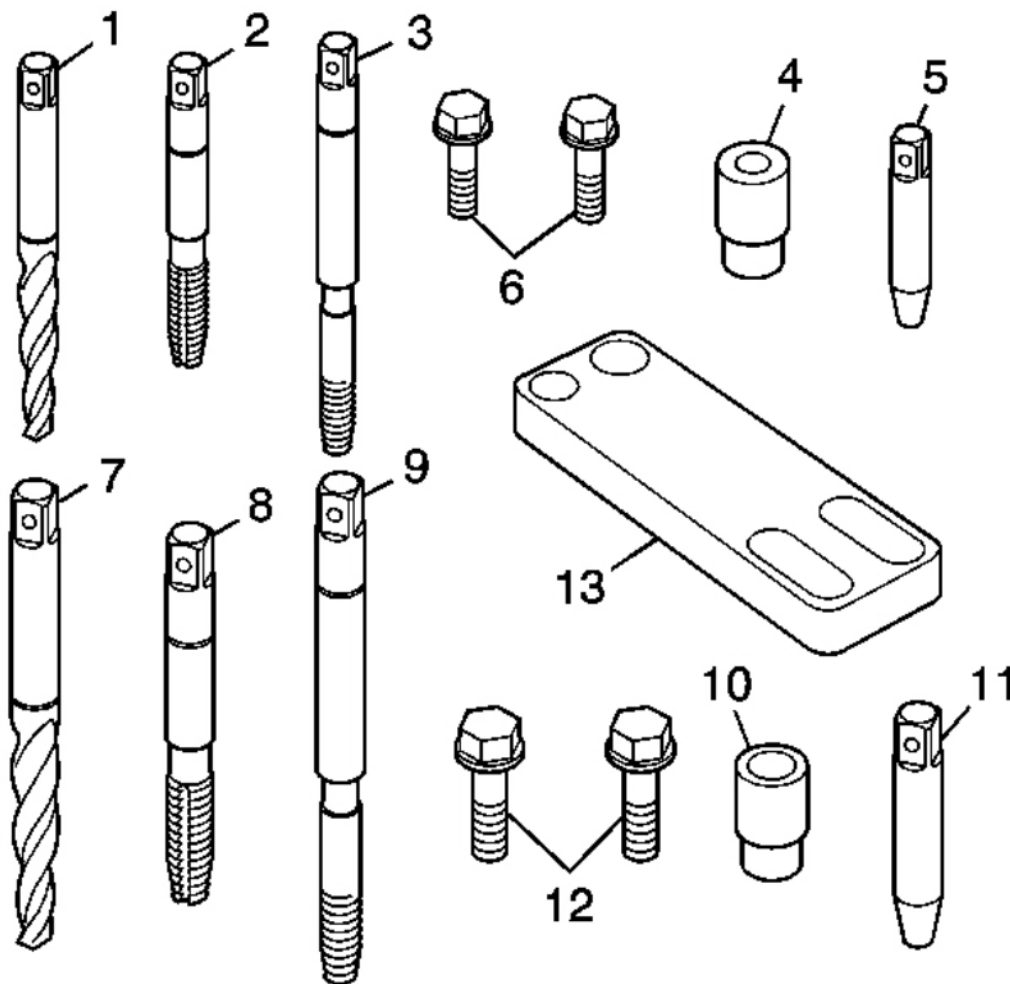
22. In order to completely form the new threads in the insert, rotate the driver installation tool through the insert until the mark (1) on the driver installation tool aligns with the surface of the engine block deck (2).

23. Inspect the insert for proper installation into the tapped hole.

## CRANKSHAFT MAIN BOLT HOLE THREAD REPAIR

### Tools Required

- J 42385-700 High Feature Thread Repair Kit
- J 42385-2000 Thread Insert Kit



**Fig. 98: View Of J 42385-2000 Components**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- In order to repair some crankshaft main bolt holes it will be necessary to mount the fixture plate upside down.
- Do NOT remove the fixture plate prior to installing the insert with the installation driver. The fixture plate remains in position throughout the thread repair process.

The crankshaft main bearing bolt hole thread repair tooling are in the kits **J 42385-2000** and **J 42385-700** . The crankshaft main bearing bolt hole thread repair components consist of the following:

- Drill (1) for outboard holes J 42385-702
- Tap (2) for outboard holes J 42385-703
- Installation driver (3) for outboard holes J 42385-704
- Bushing (4) for outboard holes J 42385-726
- Alignment pin (5) for outboard holes J 42385-727
- Bolts (6) for outboard holes J 42385-728
- Drill (7) for inboard holes J 42385-720
- Tap (8) for inboard holes J 42385-721
- Installation driver (9) for inboard holes J 42385-722
- Bushing (10) J 42385-713
- Alignment pin (11) J 42385-308
- Bolts (12) J 42385-734
- Fixture plate (13) J 42385-712

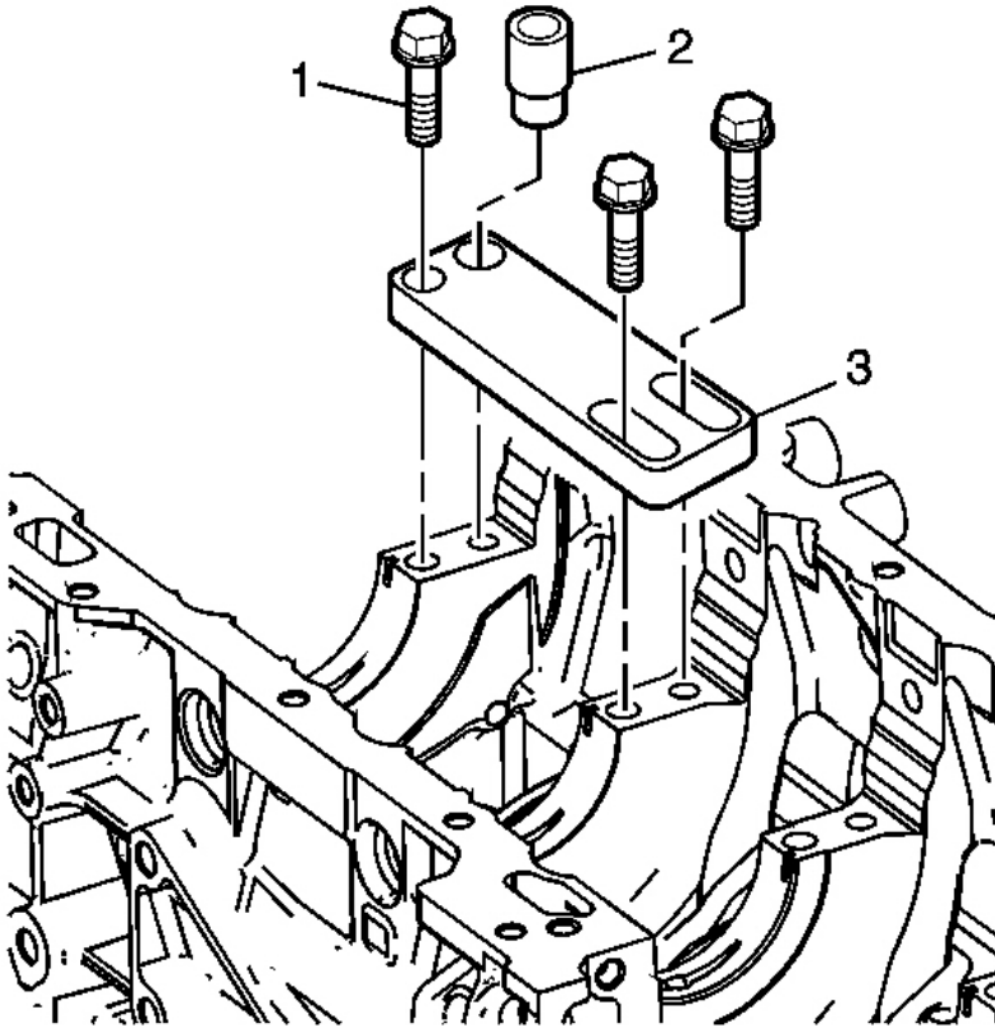
**OUTBOARD BOLT HOLES**

**CAUTION:** Refer to Safety Glasses Caution in Cautions and Notices.

**IMPORTANT:**

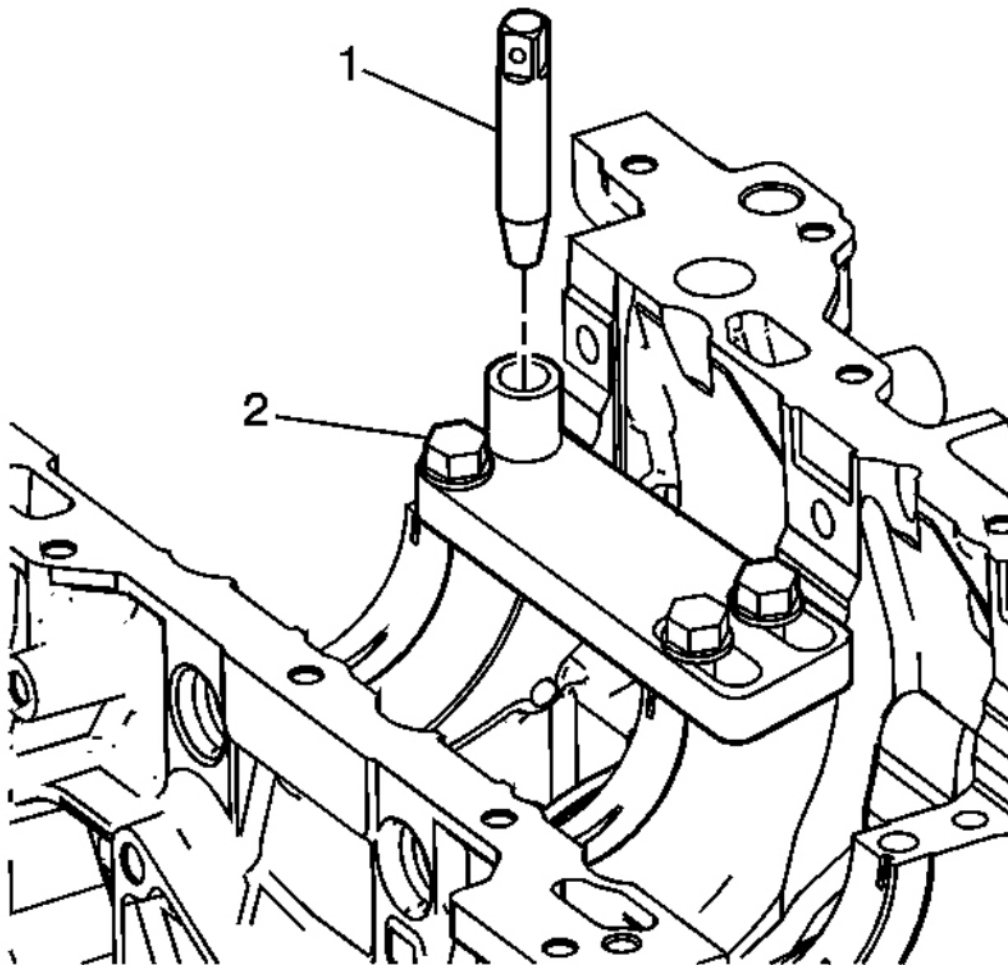
- Ensure the fixture plate is installed during the machining and installation processes of the insert.
- The use of a cutting type fluid GM P/N 1052864, (Canadian P/N 992881), WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures.

When installed to the proper depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.



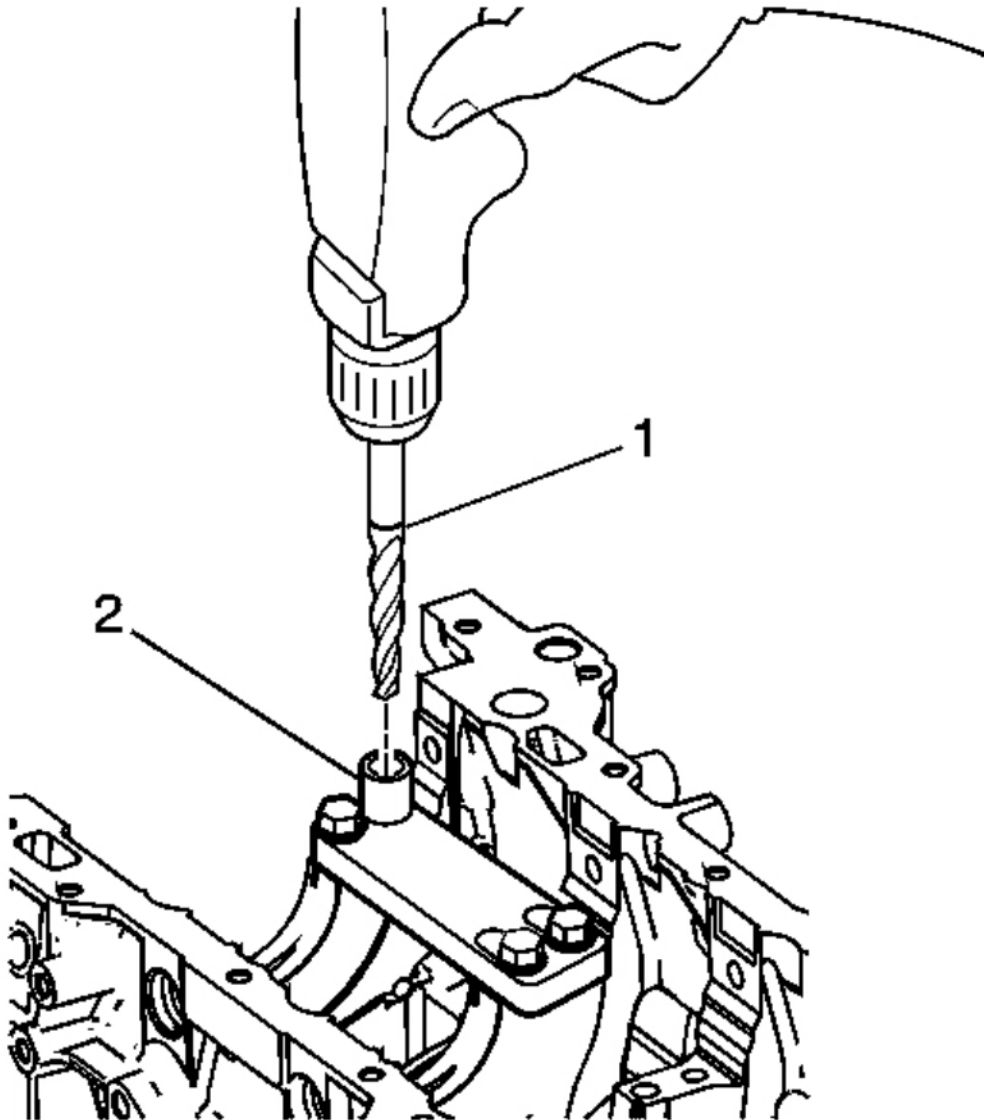
**Fig. 99: Identifying Fixture Plate Over Crankshaft Main Cap Bolt Hole**  
Courtesy of GENERAL MOTORS CORP.

1. Position the fixture plate (3) with the bushing (2) installed over the crankshaft main cap bolt hole to be repaired.
2. Loosely install the fixture plate bolts (1) into the remaining crankshaft main cap bolt holes.



**Fig. 100: Installing Alignment Pin & Bushing**  
Courtesy of GENERAL MOTORS CORP.

3. Position the alignment pin (1) through the bushing and into the crankshaft main cap bolt hole.
4. With the alignment pin in the desired crankshaft main cap bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the crankshaft main cap bolt hole.

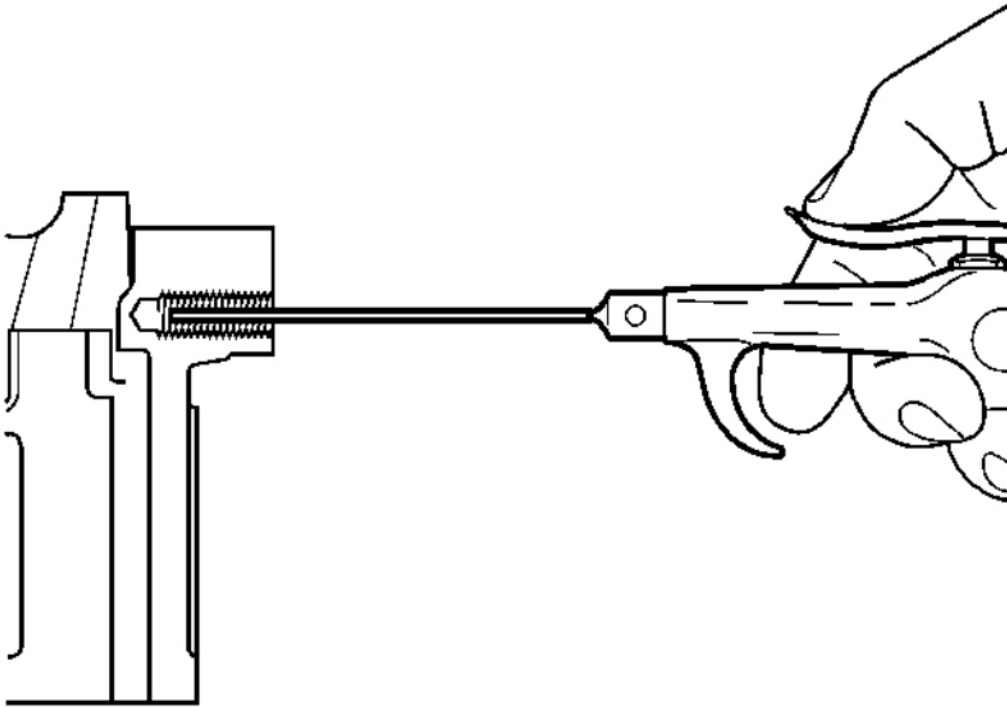


**Fig. 101: Aligning Drill and Drill Bushing**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the crankshaft main bolt hole until the mark (1) on the drill aligns with the top of the drill bushing (2).

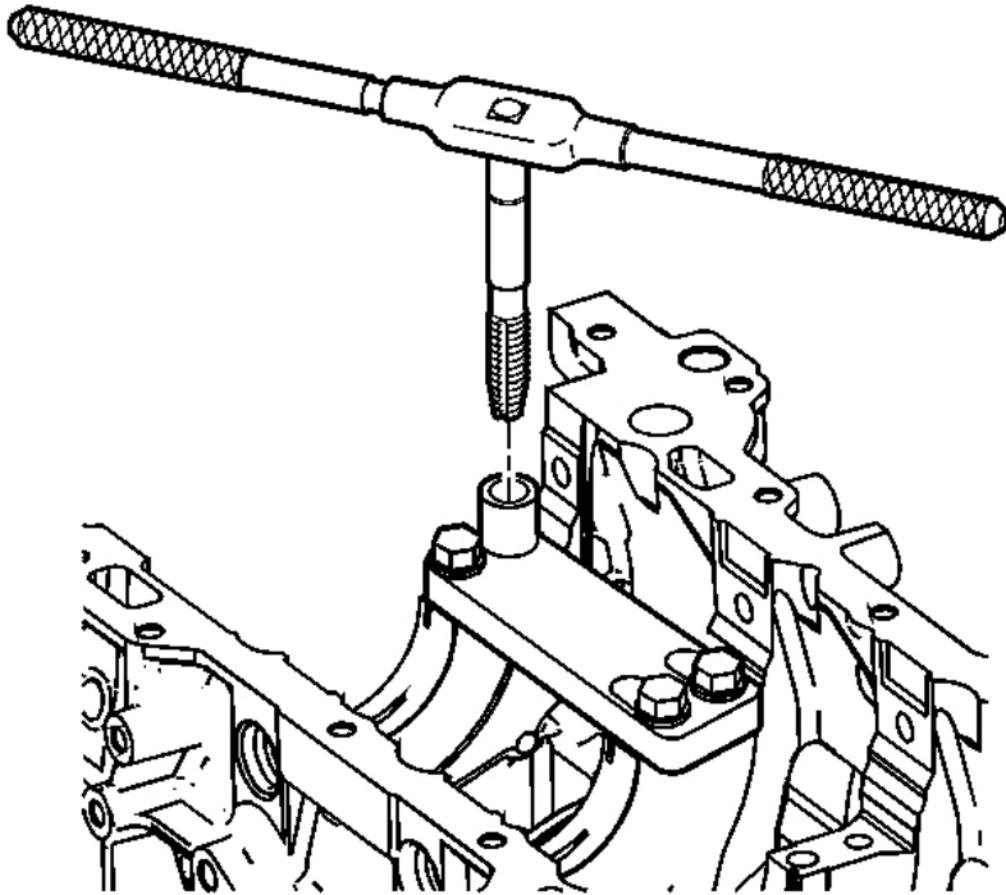
6. Drill out the threads of the damaged hole.



**Fig. 102: Cleaning Out Metal Chips**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** All chips must be removed from the drilled hole prior to tapping.

7. Using compressed air, clean out any chips.



**Fig. 103: View Of Tapping Wrench**

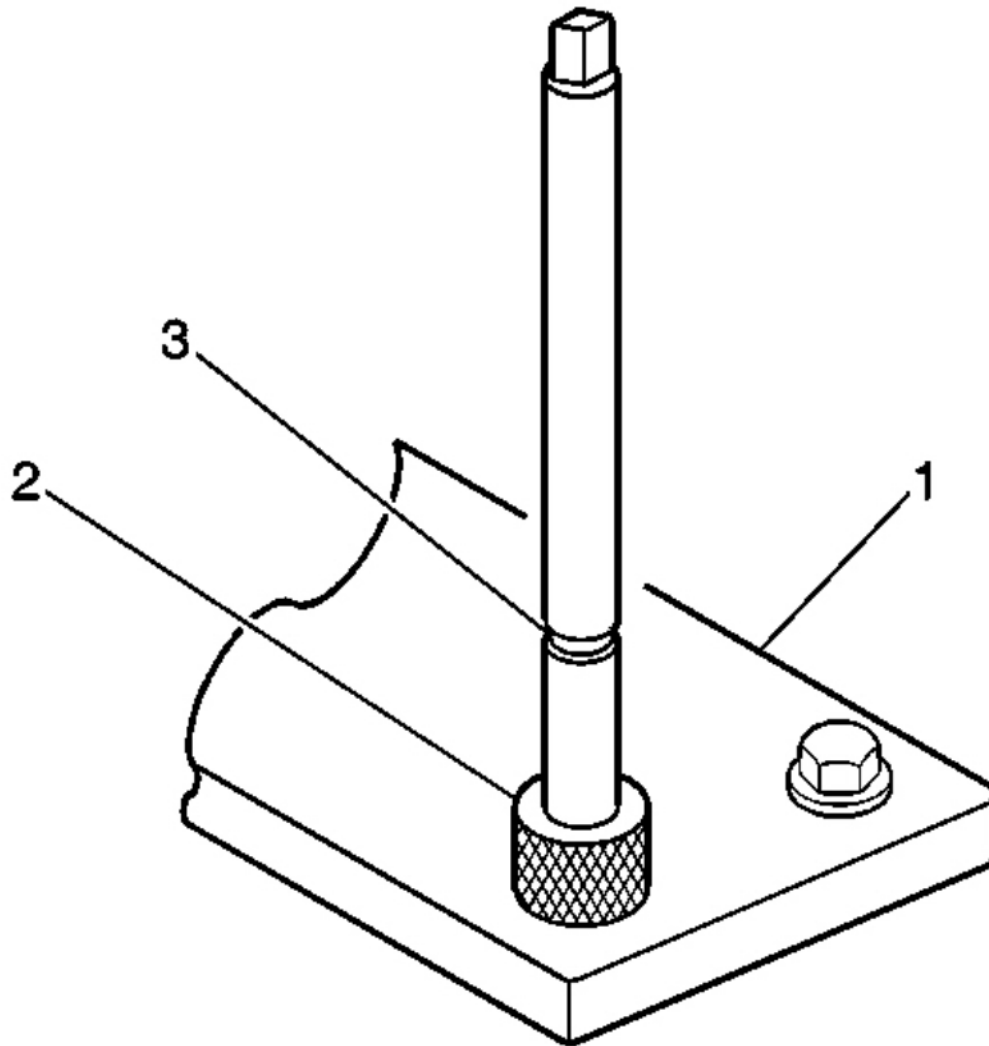
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- Do not remove the fixture plate, ensure the fixture plate is installed during the machining and installation processes of the insert.
- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Ensure the tap has created full threads at least to the depth equal to the insert length.

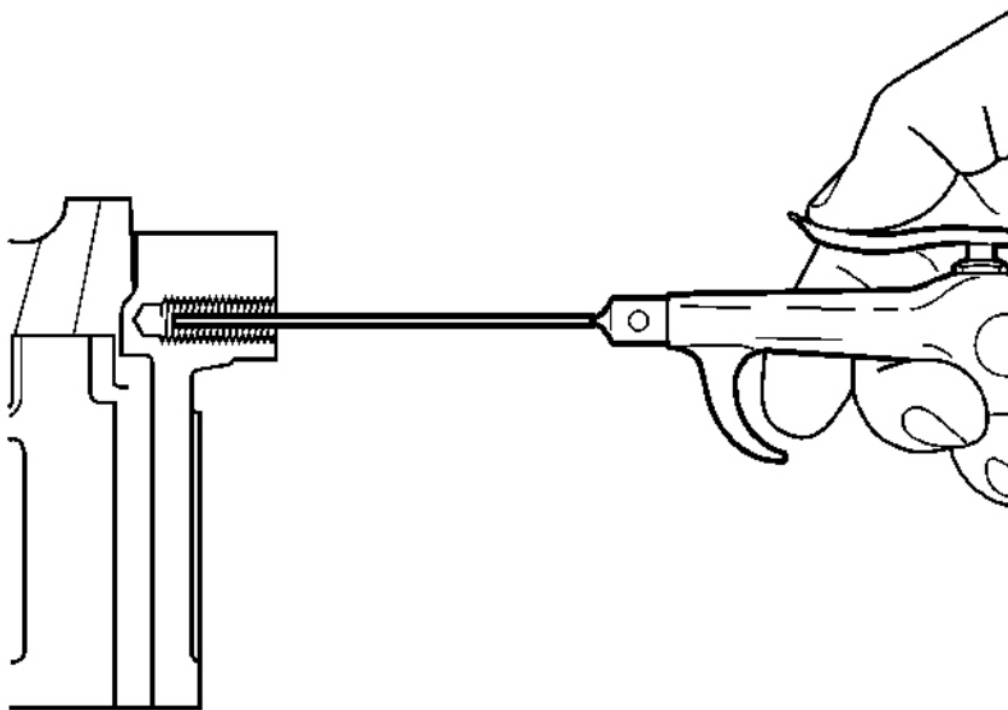
8. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.





**Fig. 104: View Of Fixture Plate, Drill Bushing & Tool Marking**  
Courtesy of GENERAL MOTORS CORP.

9. In order to tap the new threads for the insert to the proper depth, rotate the tap into the crankshaft main cap bolt hole until the mark (3) on the tap aligns with the top of the drill bushing (2).

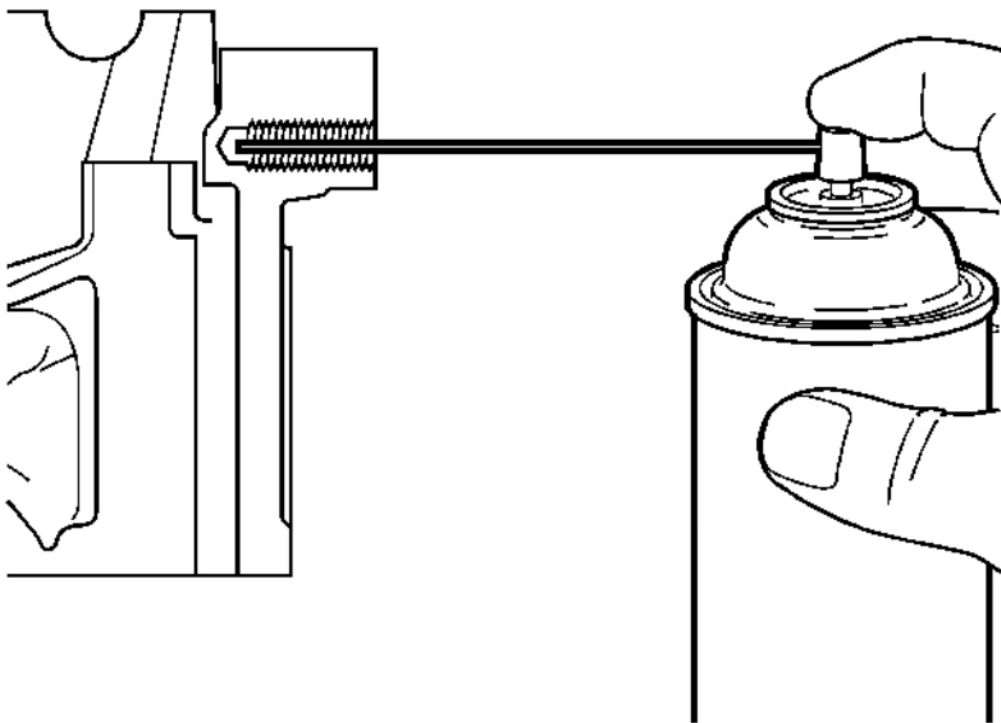


**Fig. 105: Cleaning Out Metal Chips**

Courtesy of GENERAL MOTORS CORP.

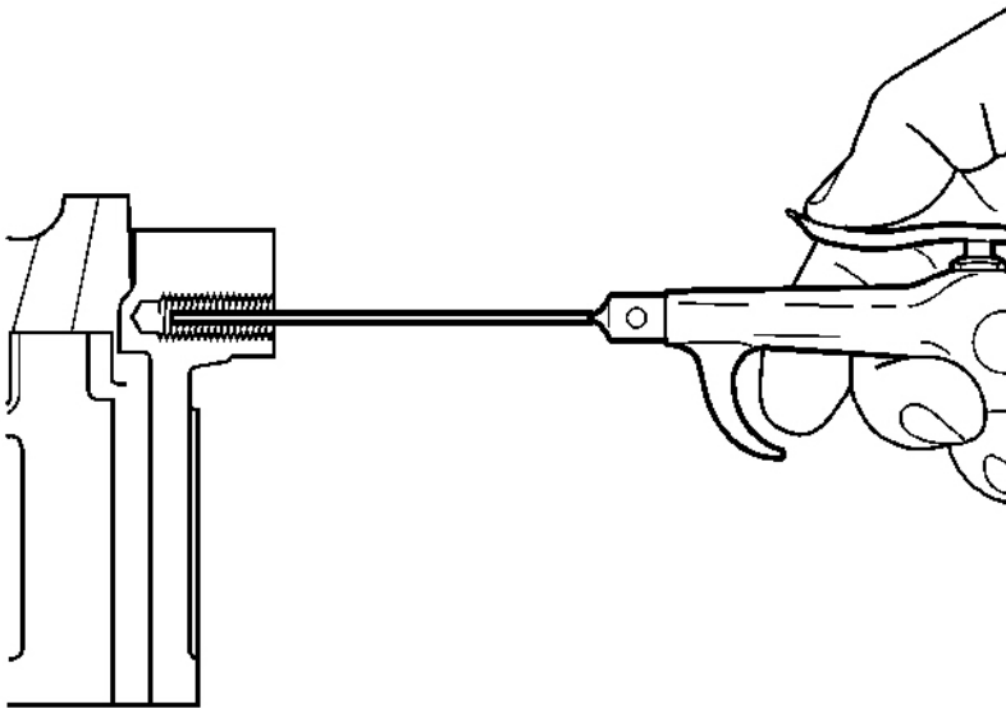
**IMPORTANT:** All chips must be removed from the tapped hole prior to insert installation.

10. Using compressed air, clean out any chips.



**Fig. 106: Spraying Cleaner Into Tapped Hole**  
Courtesy of GENERAL MOTORS CORP.

11. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463) or equivalent into the tapped hole.

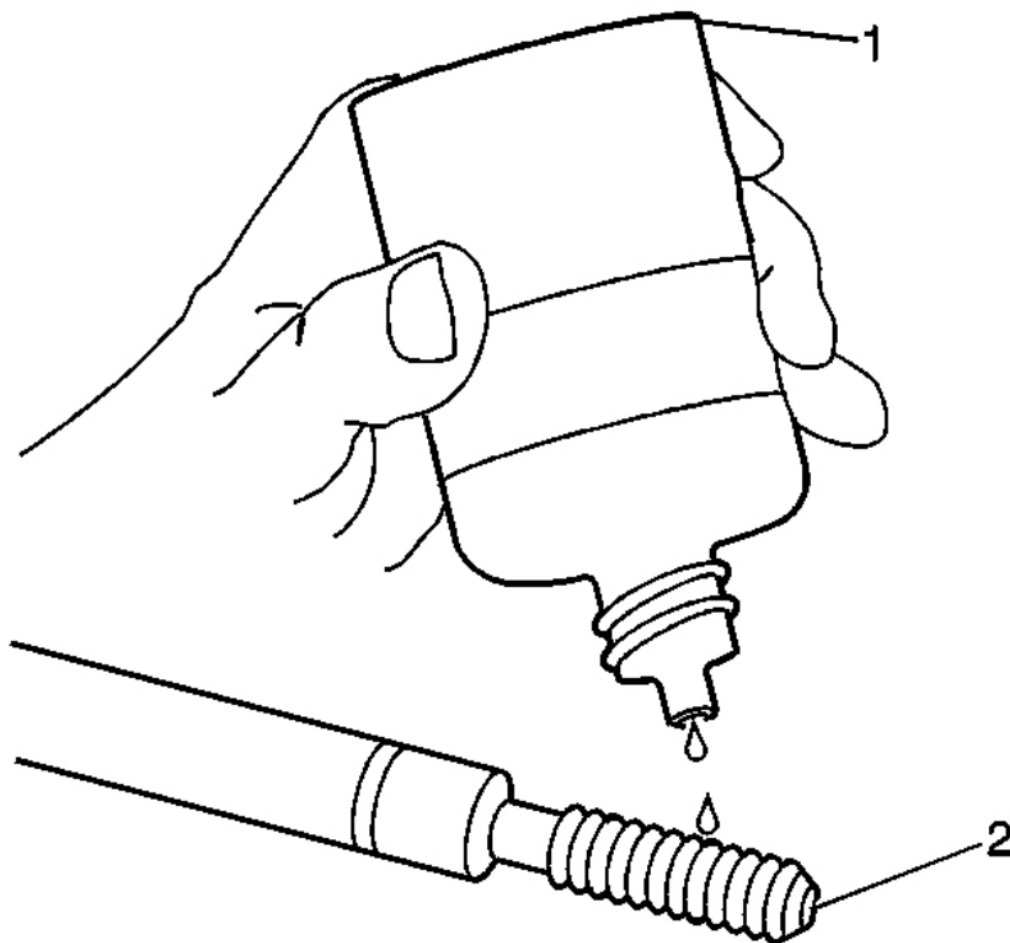


**Fig. 107: Cleaning Out Metal Chips**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** All chips must be removed from the tapped hole prior to insert installation.

12. Using compressed air, clean out any chips.

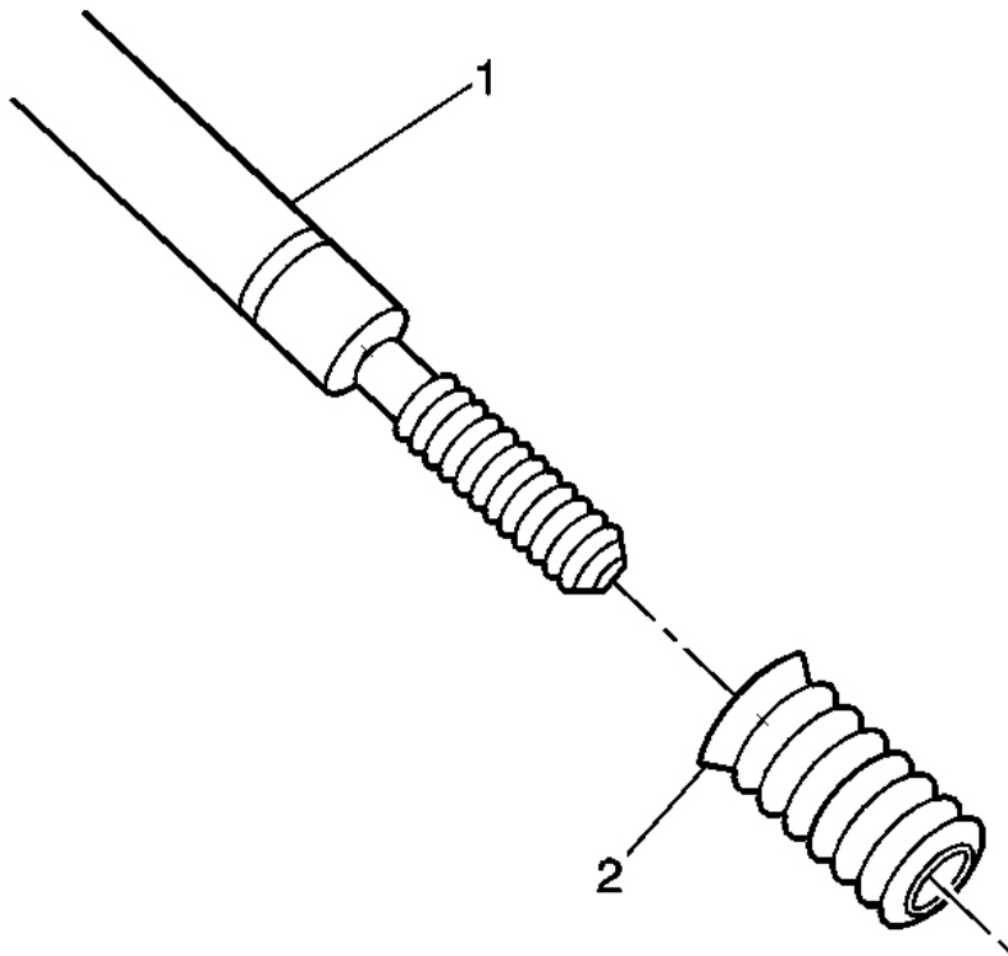


**Fig. 108: Lubricating Installer Tool Using Driver Oil**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

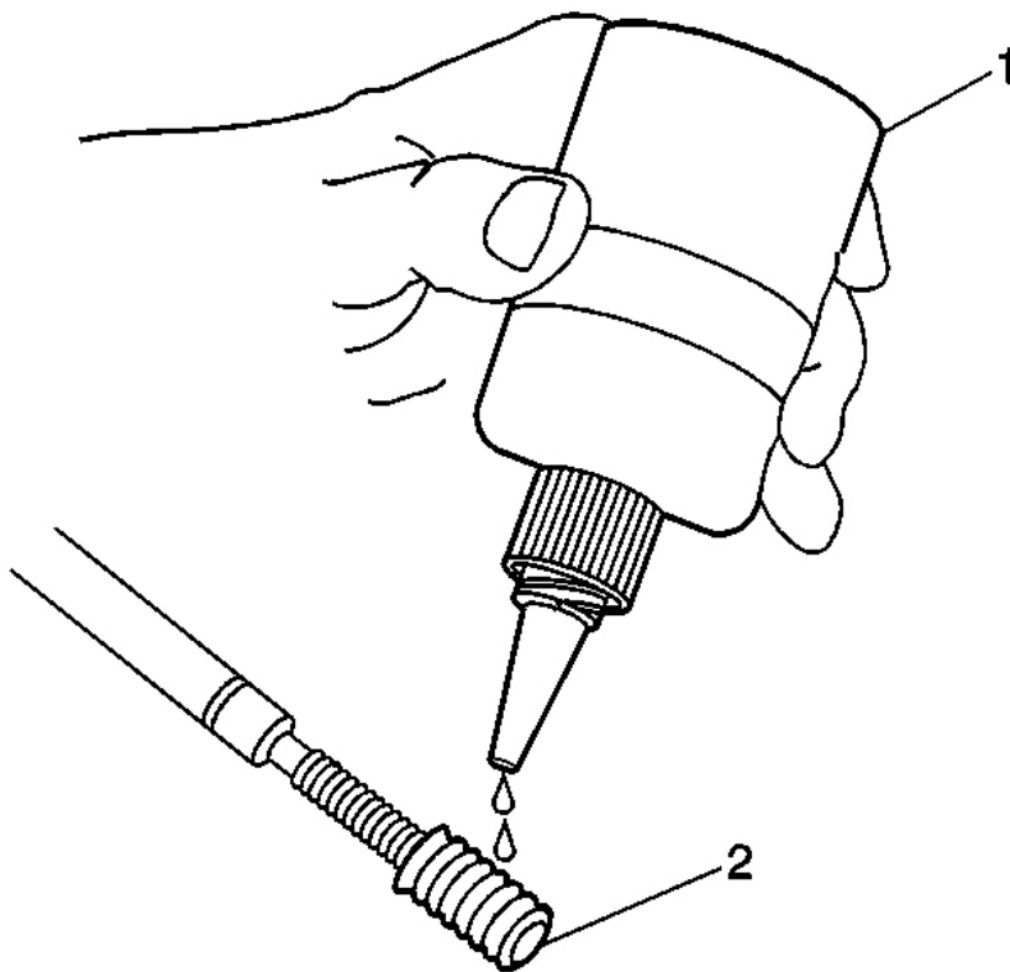
- Do not remove the fixture plate, ensure the fixture plate is installed during the installation process of the insert.
- Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

13. Lubricate the threads of the driver installation tool (2) with the driver oil (1) J 42385-110.



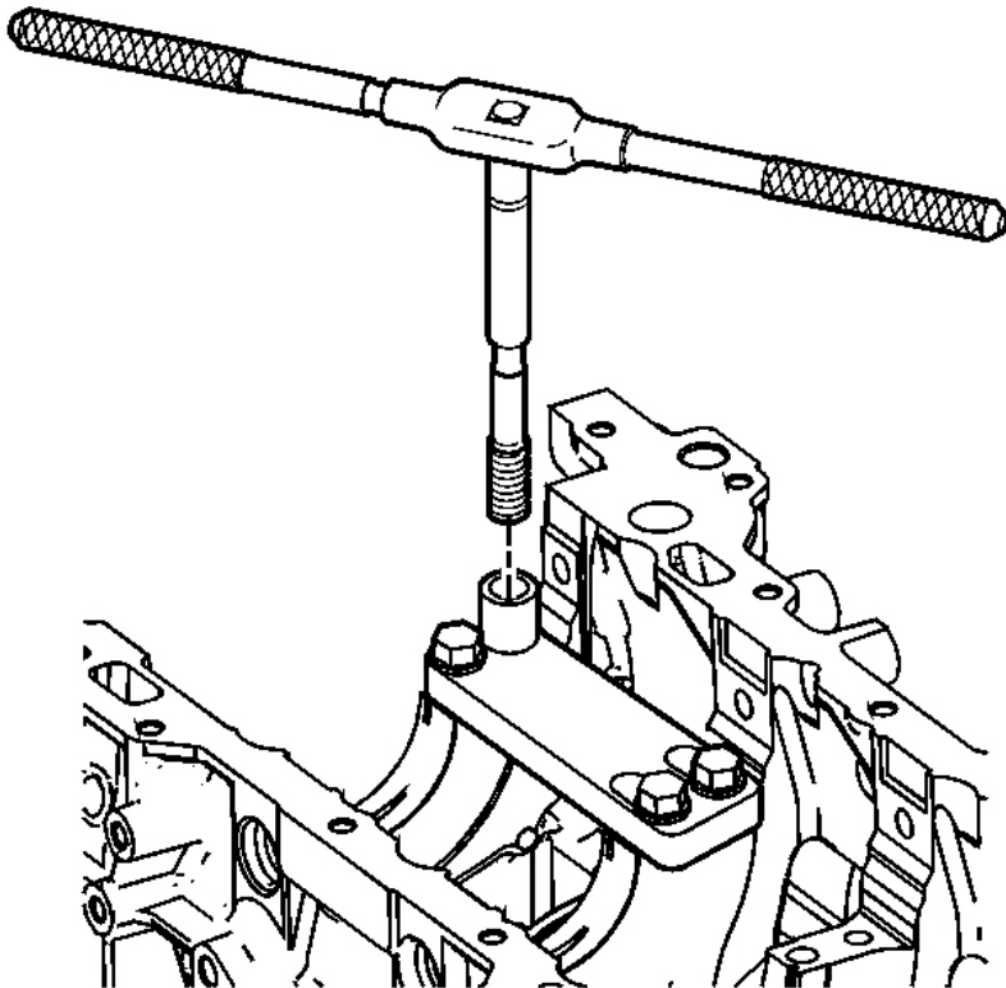
**Fig. 109: View of Bushing Type Insert**  
Courtesy of GENERAL MOTORS CORP.

14. Install the insert (2) onto the driver installation tool (1).



**Fig. 110: Applying Threadlock To Insert**  
Courtesy of GENERAL MOTORS CORP.

15. Apply threadlock sealant GM P/N 12345493, (Canadian P/N 10953488), J 42385-109, LOCTITE 277®, or equivalent (1) to the insert OD threads (2).



**Fig. 111: Identifying Tapping Wrench**  
Courtesy of GENERAL MOTORS CORP.

16. Install the insert and installation driver into the tapped hole by hand only.
17. Start the insert into the threaded hole.

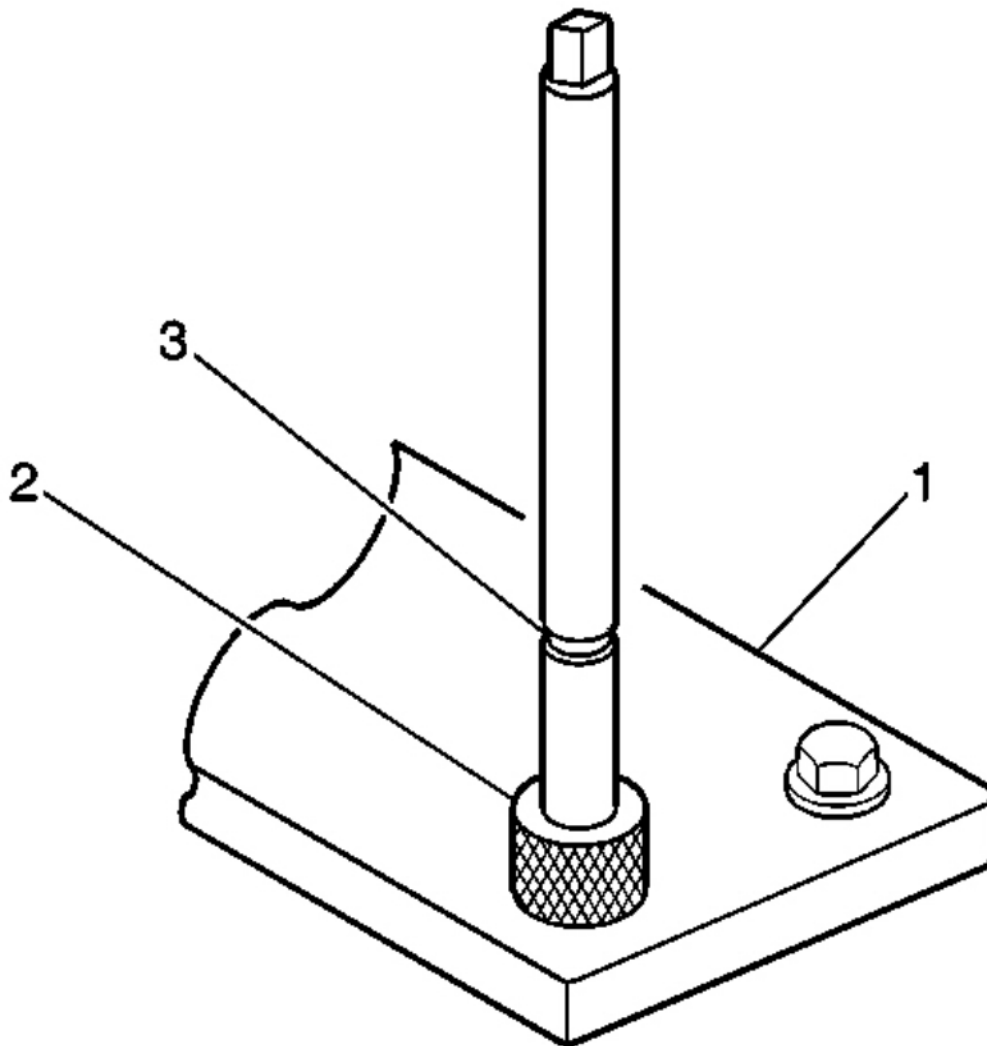
**IMPORTANT:** If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

18. Install the insert until the flange of the insert contacts the counterbored surface.



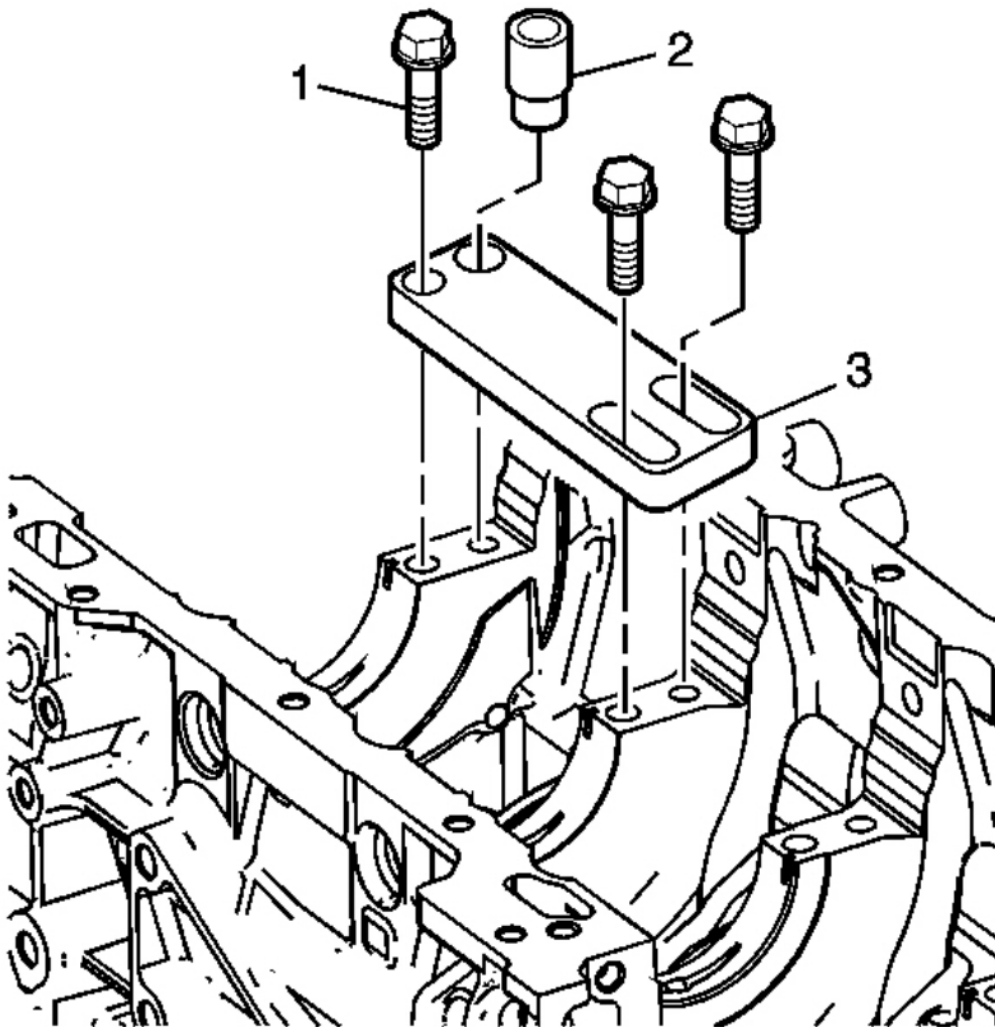
**IMPORTANT:** The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

19. Continue to rotate the driver installation tool through the insert.



**Fig. 112: View Of Fixture Plate, Drill Bushing & Tool Marking**  
Courtesy of GENERAL MOTORS CORP.

20. Rotate the driver installation tool until the mark (3) on the driver installation tool aligns with the top of the drill bushing (2).
21. Inspect the insert for proper installation into the tapped hole.



**Fig. 113: Identifying Fixture Plate Over Crankshaft Main Cap Bolt Hole**  
Courtesy of GENERAL MOTORS CORP.

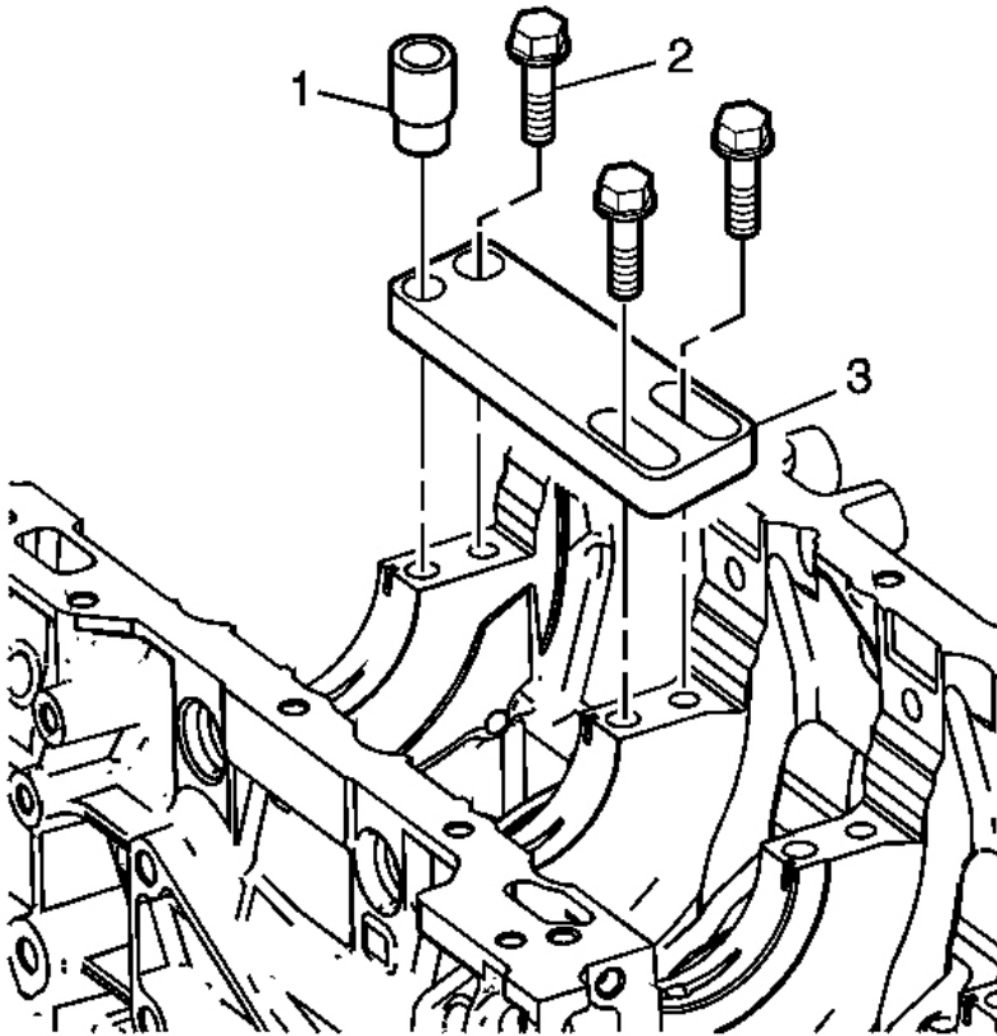
22. Remove the fixture plate bolts (1).
23. Remove the fixture plate (3) and bushing (2).

## **INBOARD BOLT HOLES**

**CAUTION:** Refer to Safety Glasses Caution in Cautions and Notices.

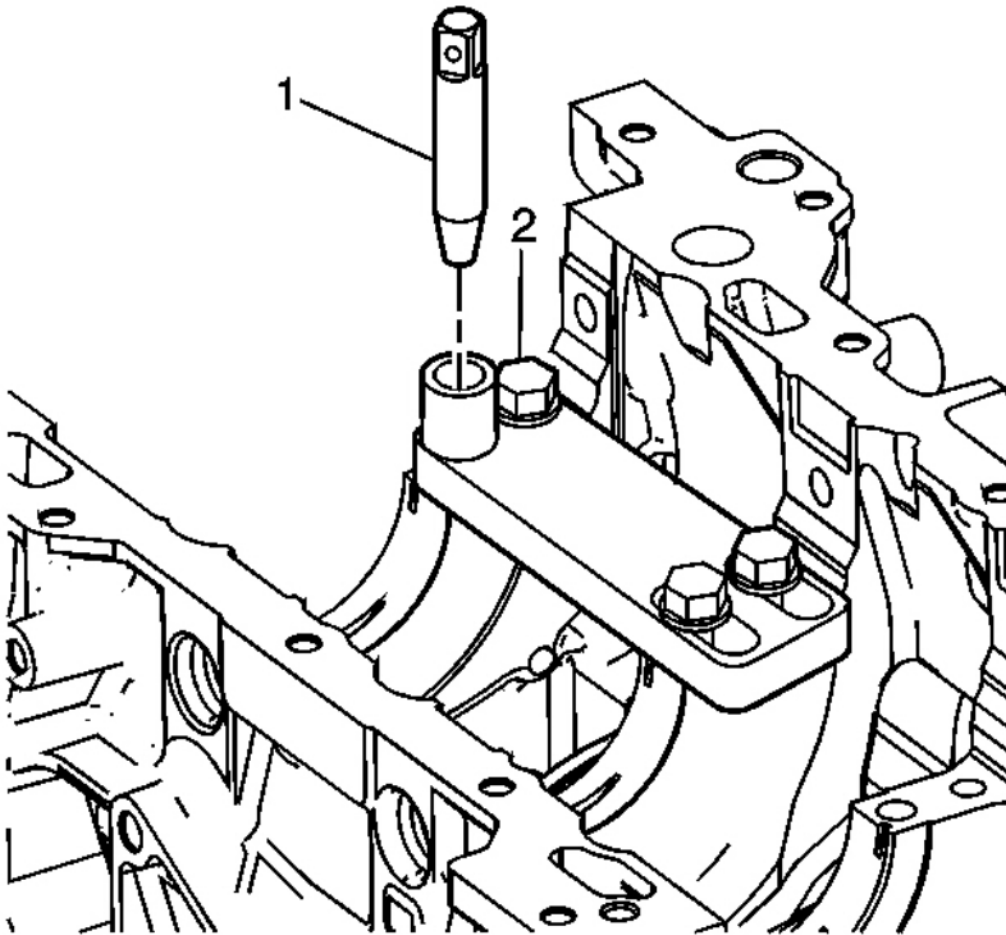
- IMPORTANT:**
- Ensure the fixture plate is installed during the machining and installation processes of the insert.
  - The use of a cutting type fluid GM P/N 1052864, (Canadian P/N 992881), WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures.

When installed to the proper depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.



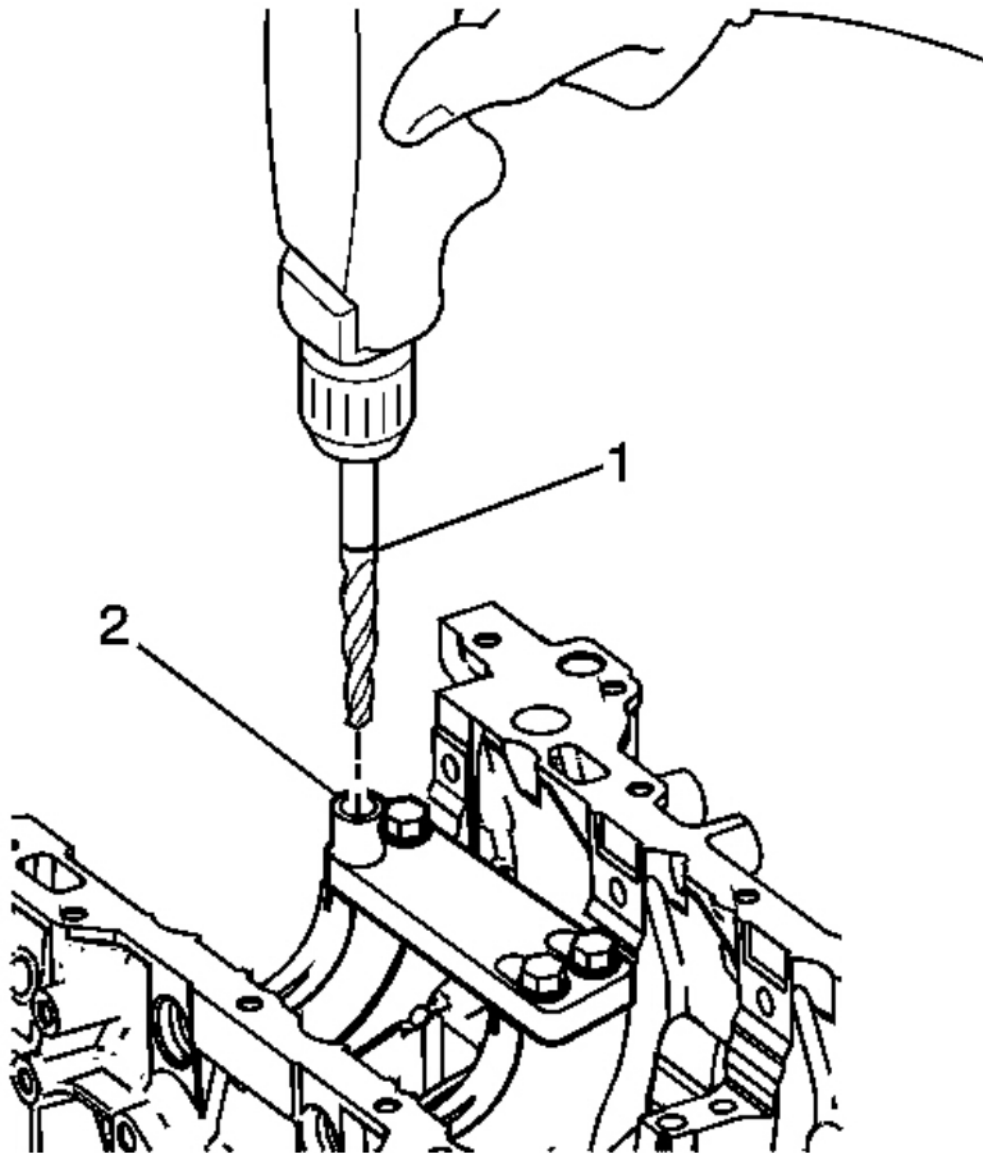
**Fig. 114: Positioning Fixture Plate**  
Courtesy of GENERAL MOTORS CORP.

1. Position the fixture plate (3) with the bushing (1) installed over the crankshaft main cap bolt hole to be repaired.
2. Loosely install the fixture plate bolts (2) into the remaining crankshaft main cap bolt holes.



**Fig. 115: Locating Alignment Pin**  
Courtesy of GENERAL MOTORS CORP.

3. Position the alignment pin (1) through the bushing and into the crankshaft main cap bolt hole.
4. With the alignment pin in the desired crankshaft main cap bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the crankshaft main cap bolt hole.



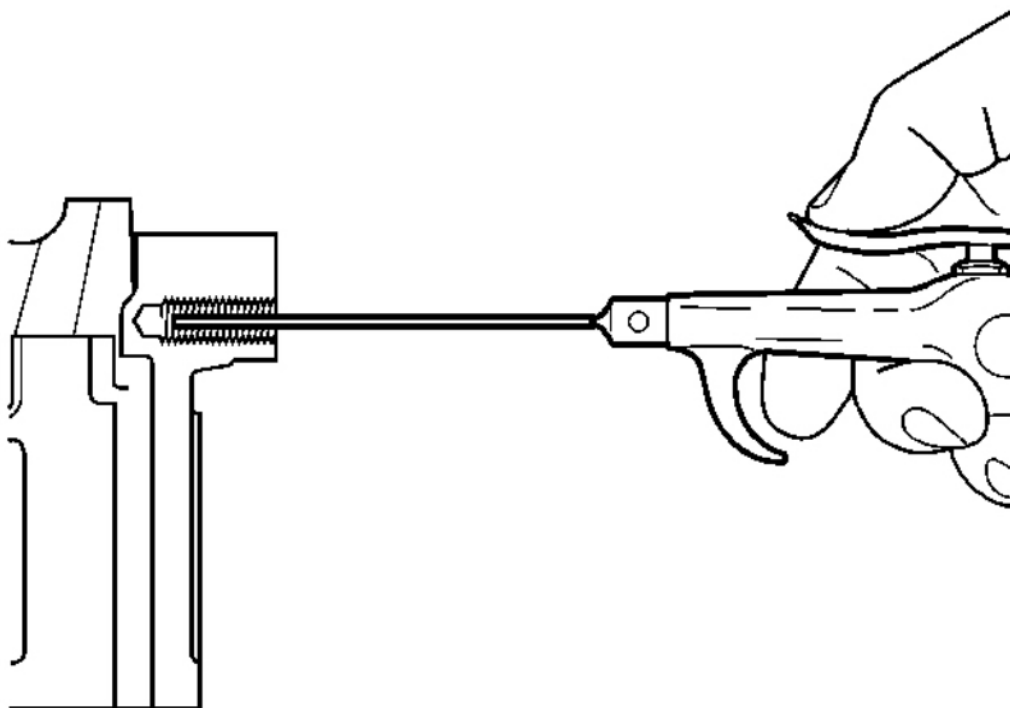
**Fig. 116: Drilling Out Damaged Threads**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the crankshaft main bolt hole until the mark (1) on the drill

aligns with the top of the drill bushing (2).

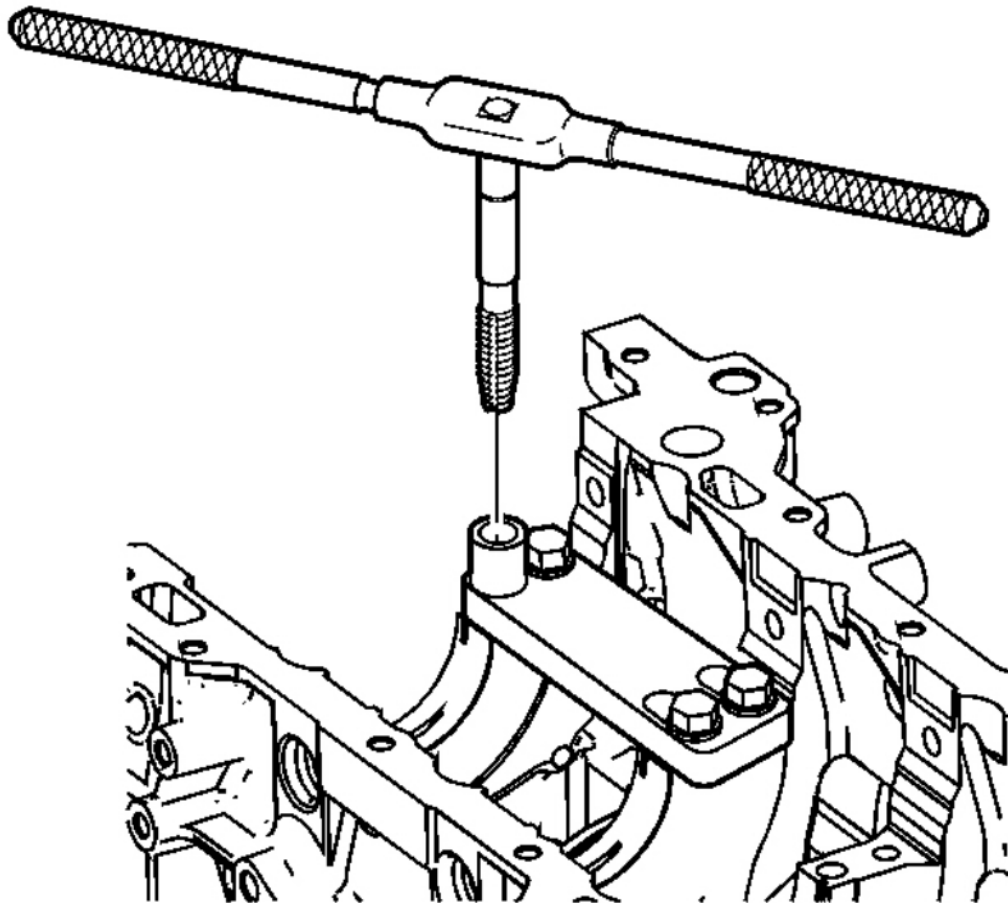
6. Drill out the threads of the damaged hole.



**Fig. 117: Cleaning Out Metal Chips**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** All chips must be removed from the drilled hole prior to tapping.

7. Using compressed air, clean out any chips.



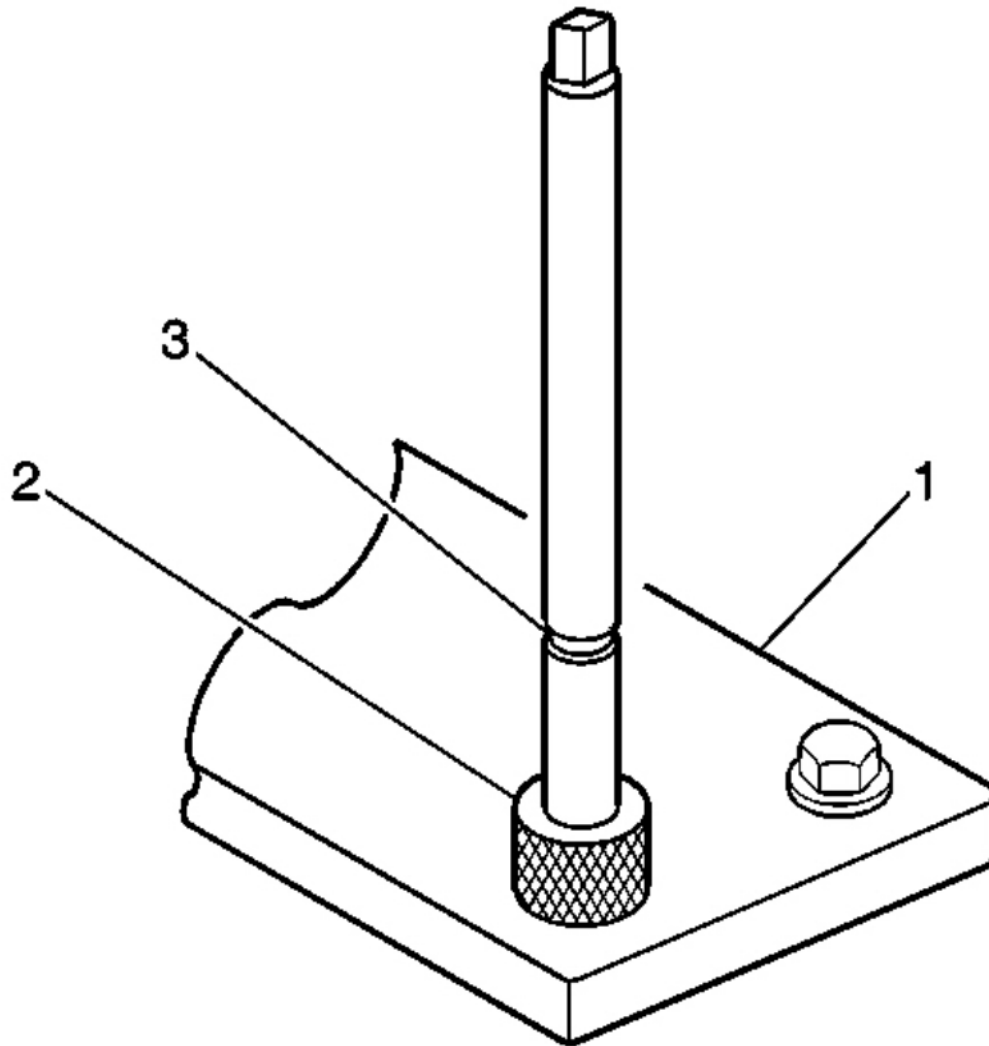
**Fig. 118: Positioning Tapping Wrench**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- Do not remove the fixture plate, ensure the fixture plate is installed during the machining and installation processes of the insert.
- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Ensure the tap has created full threads at least to the depth equal to the insert length.

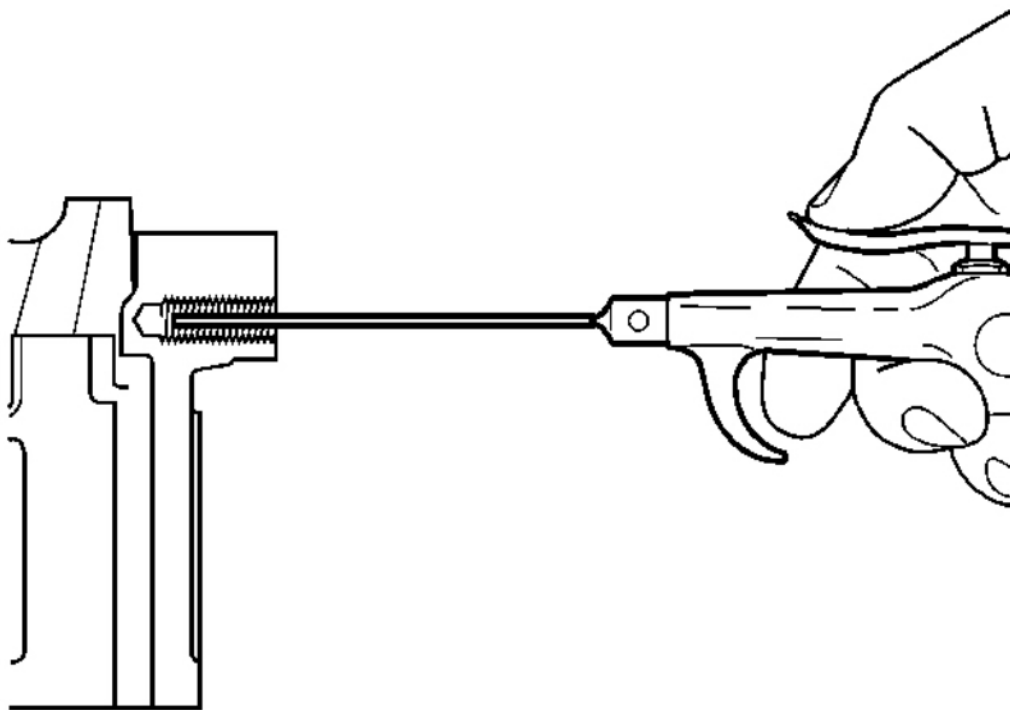
8. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.





**Fig. 119: View Of Fixture Plate, Drill Bushing & Tool Marking**  
Courtesy of GENERAL MOTORS CORP.

9. In order to tap the new threads for the insert to the proper depth, rotate the tap into the crankshaft main cap bolt hole until the mark (3) on the tap aligns with the top of the drill bushing (2).

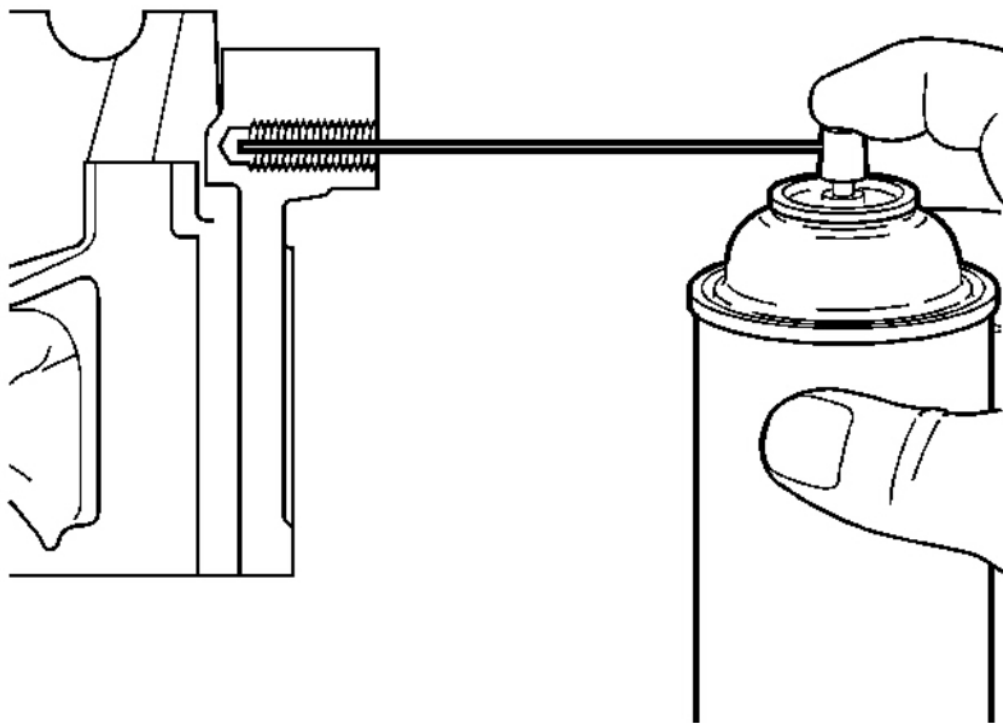


**Fig. 120: Cleaning Out Metal Chips**

Courtesy of GENERAL MOTORS CORP.

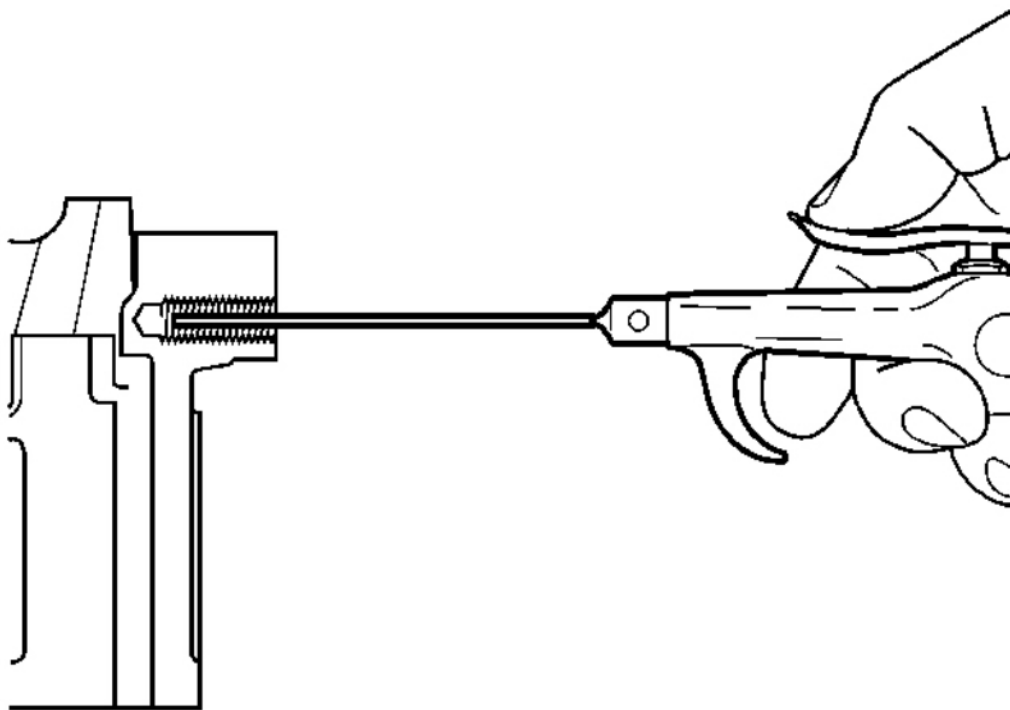
**IMPORTANT:** All chips must be removed from the tapped hole prior to insert installation.

10. Using compressed air, clean out any chips.



**Fig. 121: Spraying Cleaner Into Tapped Hole**  
Courtesy of GENERAL MOTORS CORP.

11. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463) or equivalent into the tapped hole.

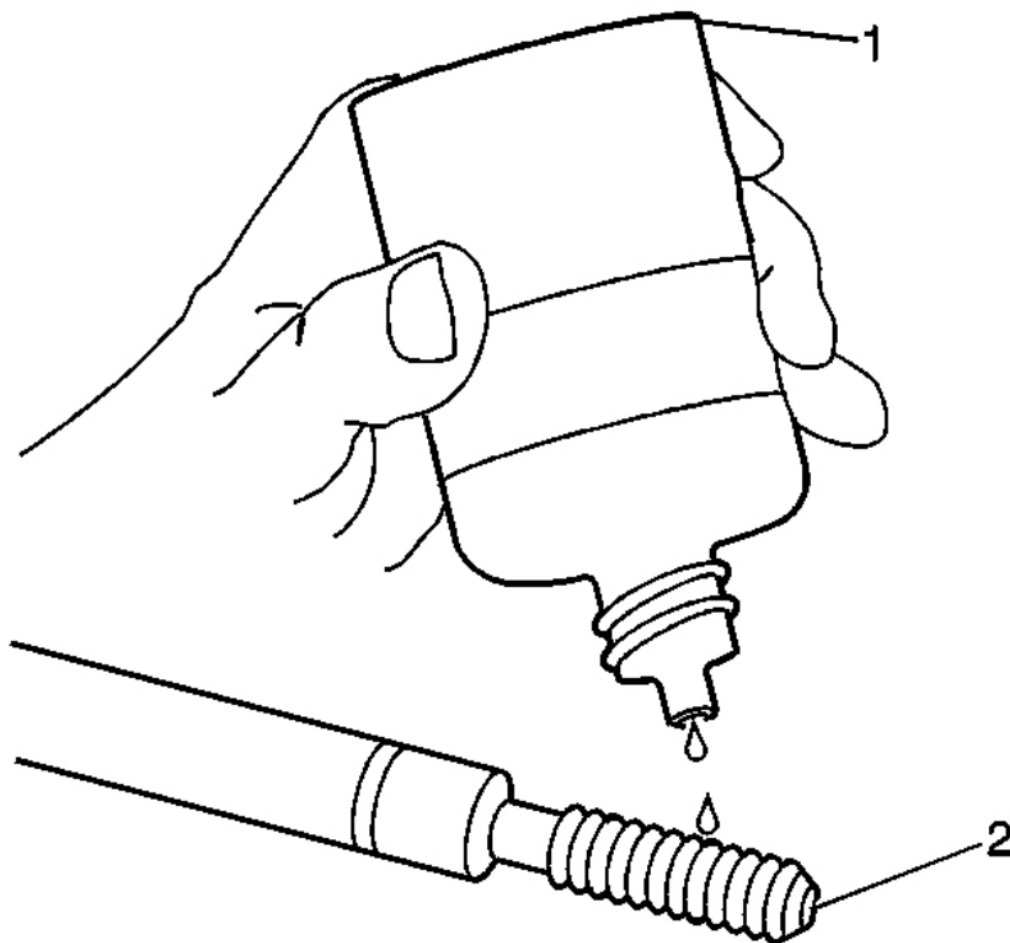


**Fig. 122: Cleaning Out Metal Chips**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** All chips must be removed from the tapped hole prior to insert installation.

12. Using compressed air, clean out any chips.

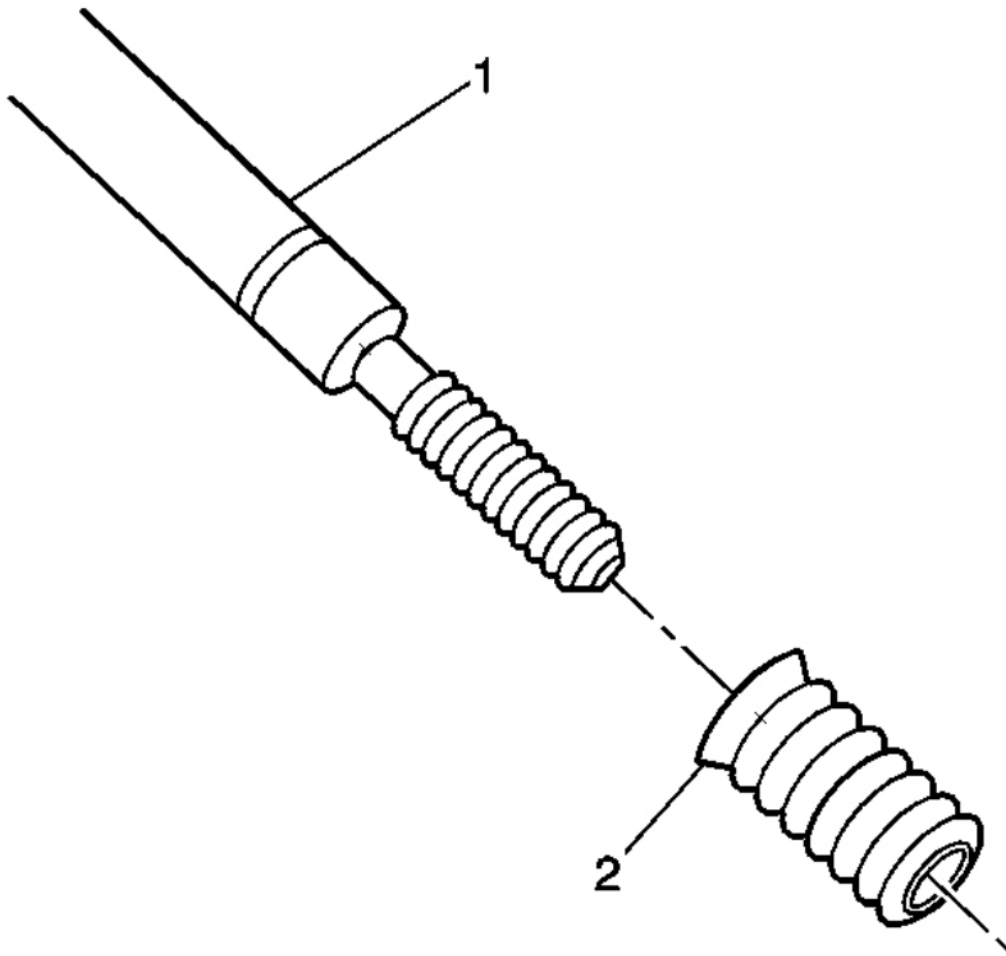


**Fig. 123: Lubricating Installer Tool Using Driver Oil**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

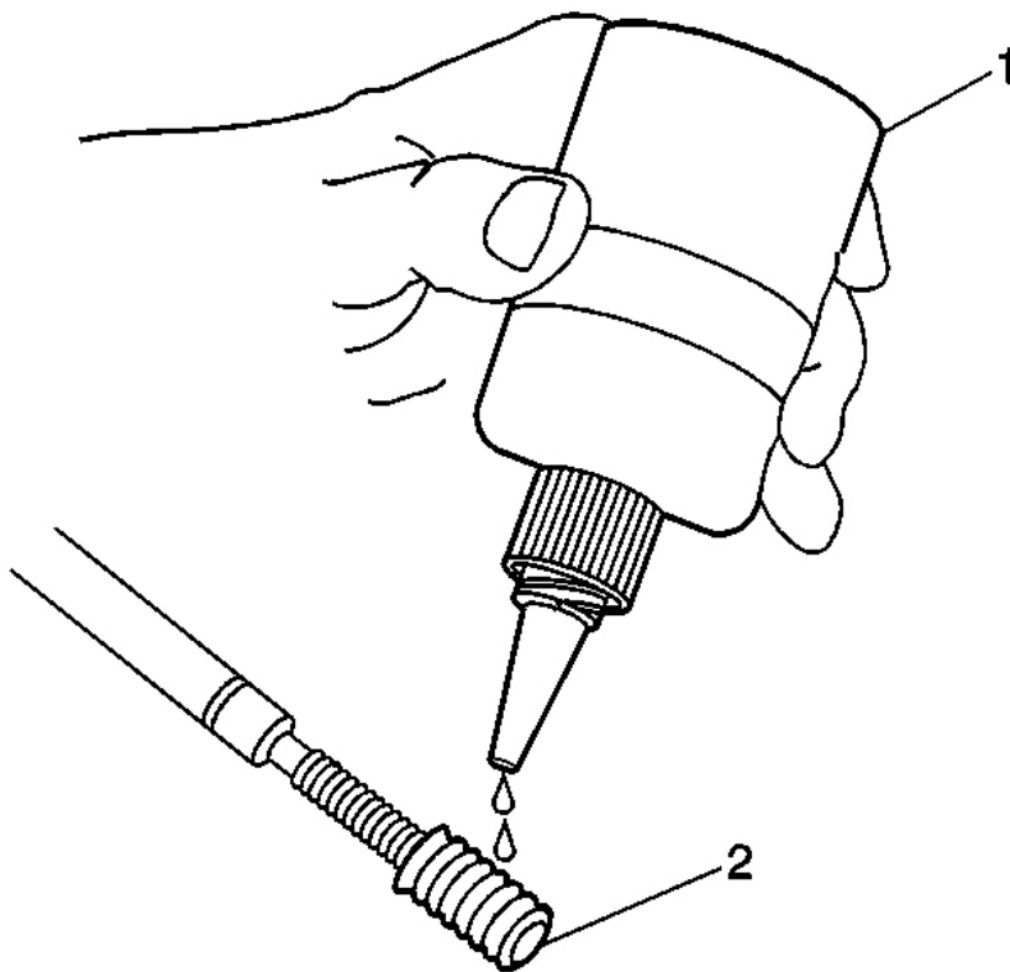
- Do not remove the fixture plate, ensure the fixture plate is installed during the installation process of the insert.
- Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

13. Lubricate the threads of the driver installation tool (2) with the driver oil (1) J 42385-110.



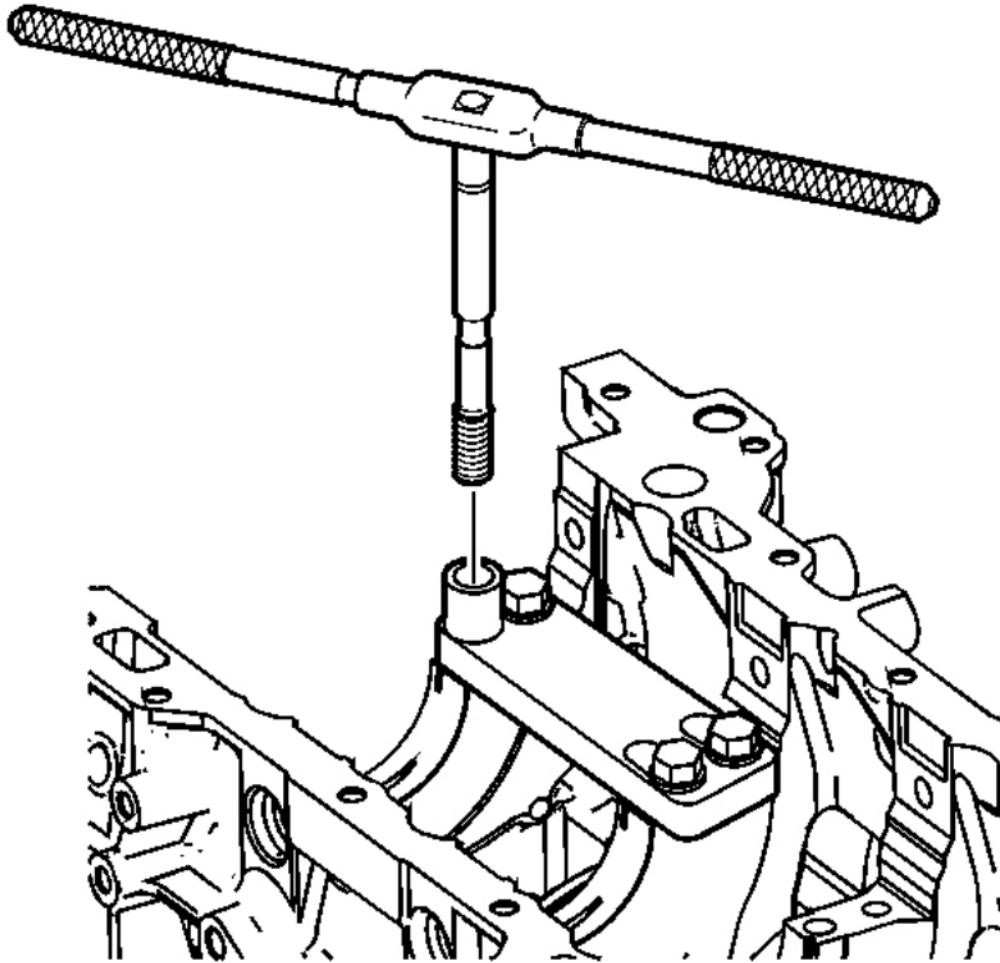
**Fig. 124: View of Bushing Type Insert**  
Courtesy of GENERAL MOTORS CORP.

14. Install the insert (2) onto the driver installation tool (1).



**Fig. 125: Applying Threadlock To Insert**  
Courtesy of GENERAL MOTORS CORP.

15. Apply threadlock sealant GM P/N 12345493, (Canadian P/N 10953488), J 42385-109, LOCTITE 277®, or equivalent (1) to the insert OD threads (2).



**Fig. 126: Insert & Installation Driver**  
Courtesy of GENERAL MOTORS CORP.

16. Install the insert and installation driver into the tapped hole by hand only.
17. Start the insert into the threaded hole.

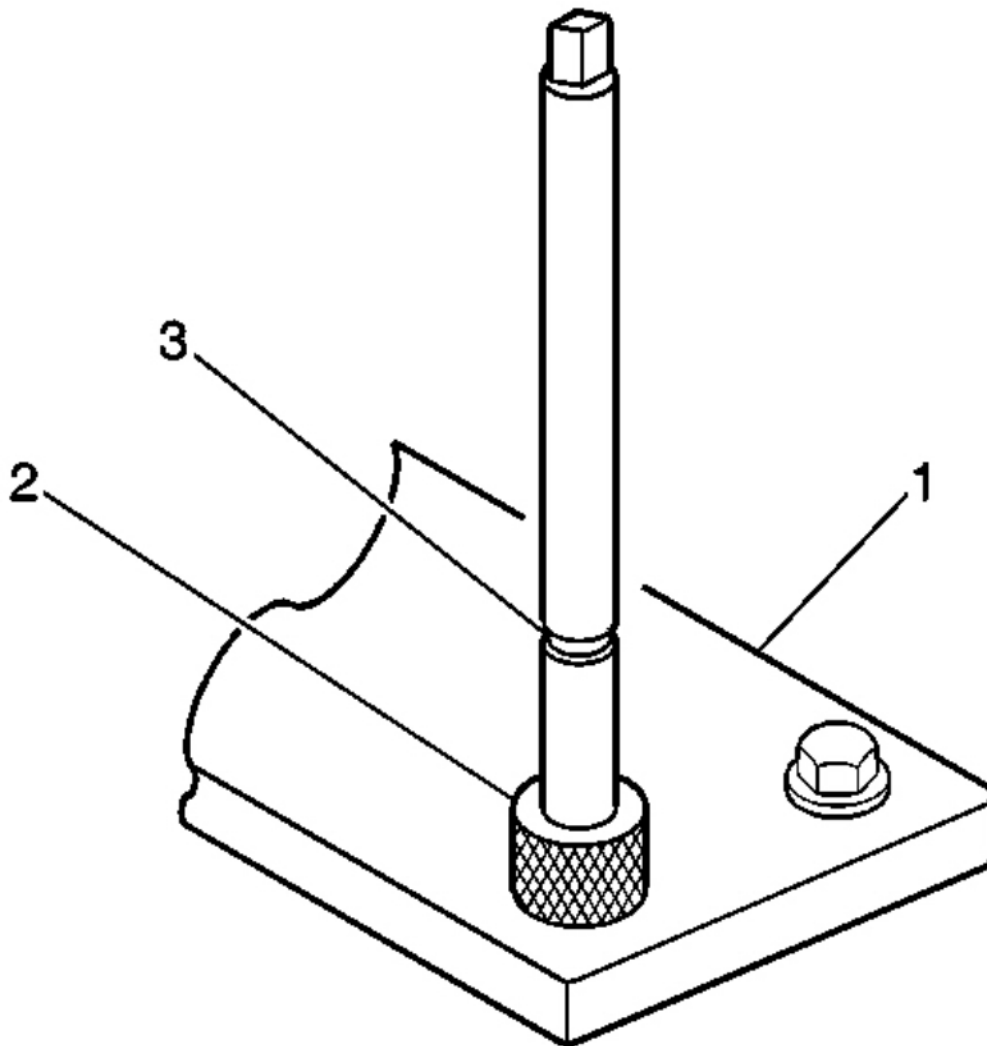
**IMPORTANT:** If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

18. Install the insert until the flange of the insert contacts the counterbored surface.



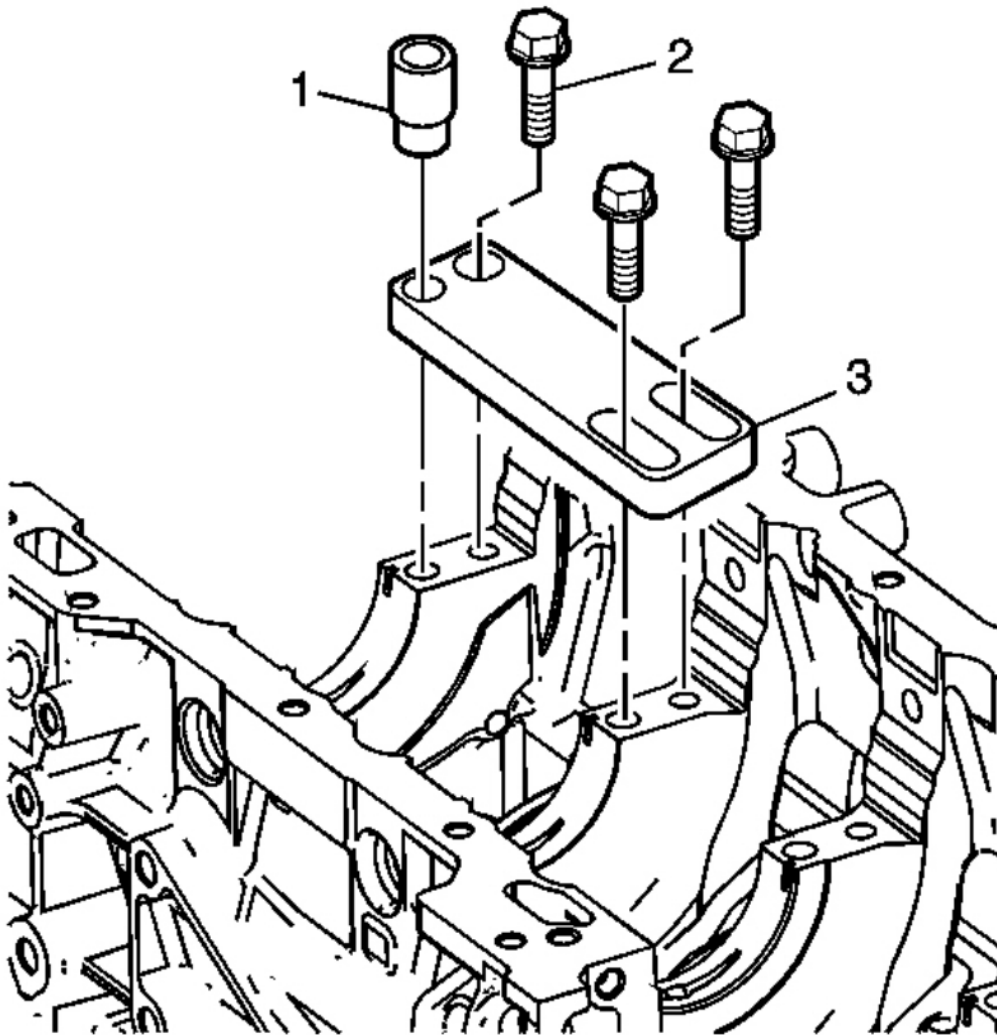
**IMPORTANT:** The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

19. Continue to rotate the driver installation tool through the insert.



**Fig. 127: View Of Fixture Plate, Drill Bushing & Tool Marking**  
Courtesy of GENERAL MOTORS CORP.

20. Rotate the driver installation tool until the mark (3) on the driver installation tool aligns with the top of the drill bushing (2).
21. Inspect the insert for proper installation into the tapped hole.



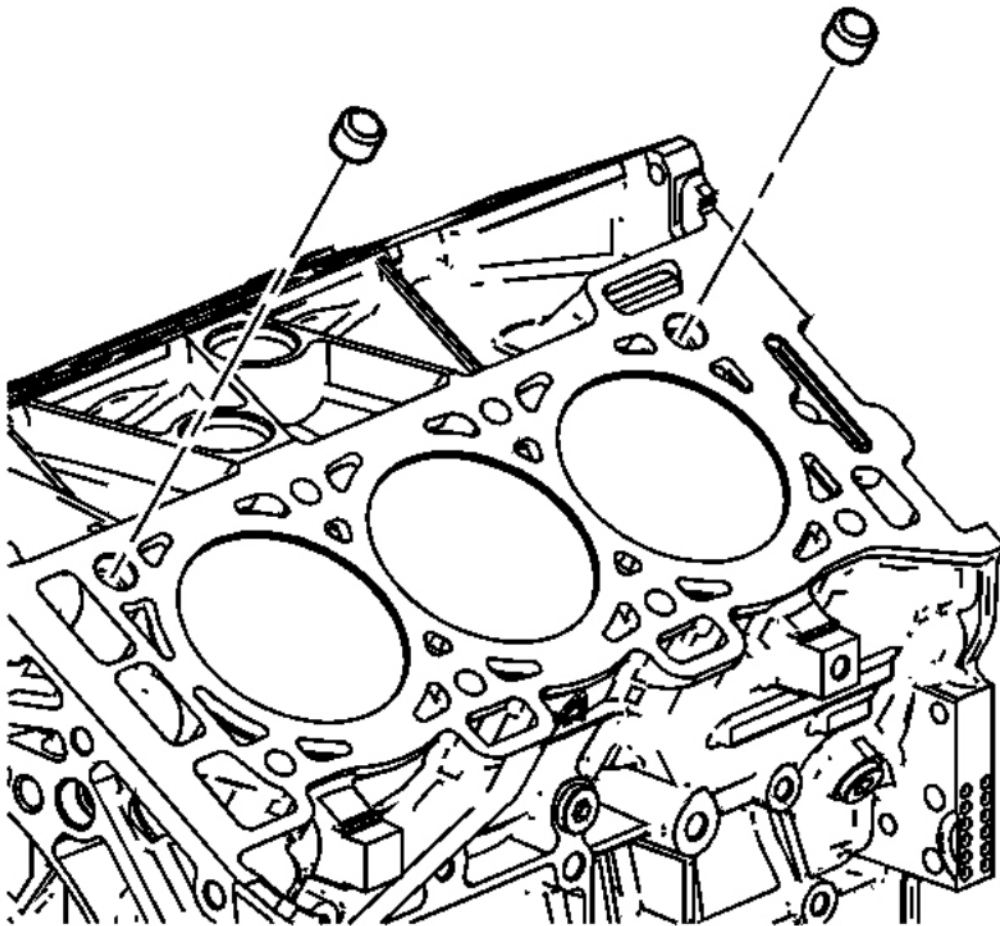
**Fig. 128: Positioning Fixture Plate**  
Courtesy of GENERAL MOTORS CORP.

22. Remove the fixture plate bolts (2).
23. Remove the fixture plate (3) and bushing (1).

## SERVICE PRIOR TO ASSEMBLY

- Dirt will cause premature wear of the rebuilt engine. Clean all the components.
- Use the proper tools to measure the components when checking for excessive wear. Components not within the manufacturer's specification must be repaired or replaced.
- When the components are reinstalled into an engine, return the components to their original location, position, and direction.
- During assembly, lubricate all the moving parts with clean engine oil (unless otherwise specified). This will provide initial lubrication when the engine is first started.

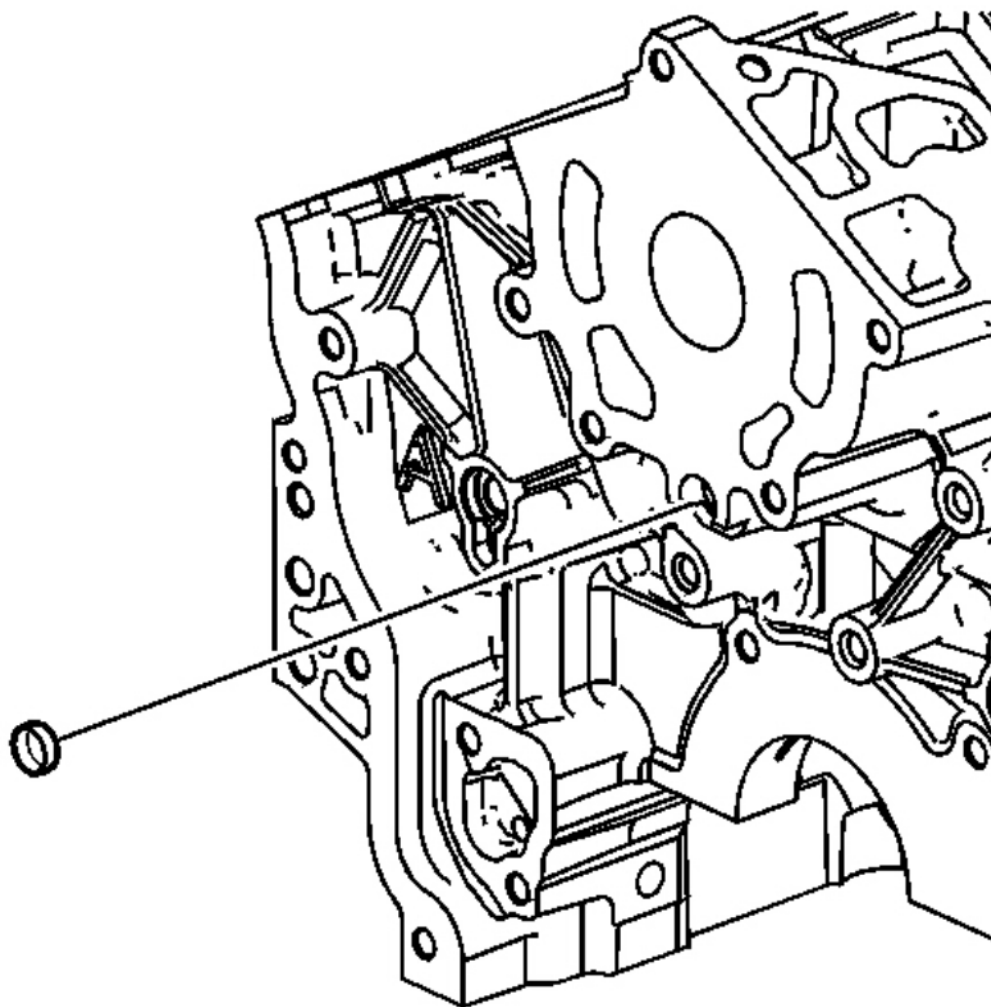
## ENGINE BLOCK ASSEMBLE



**Fig. 129: Cylinder Block-To-Cylinder Head Alignment Dowels**

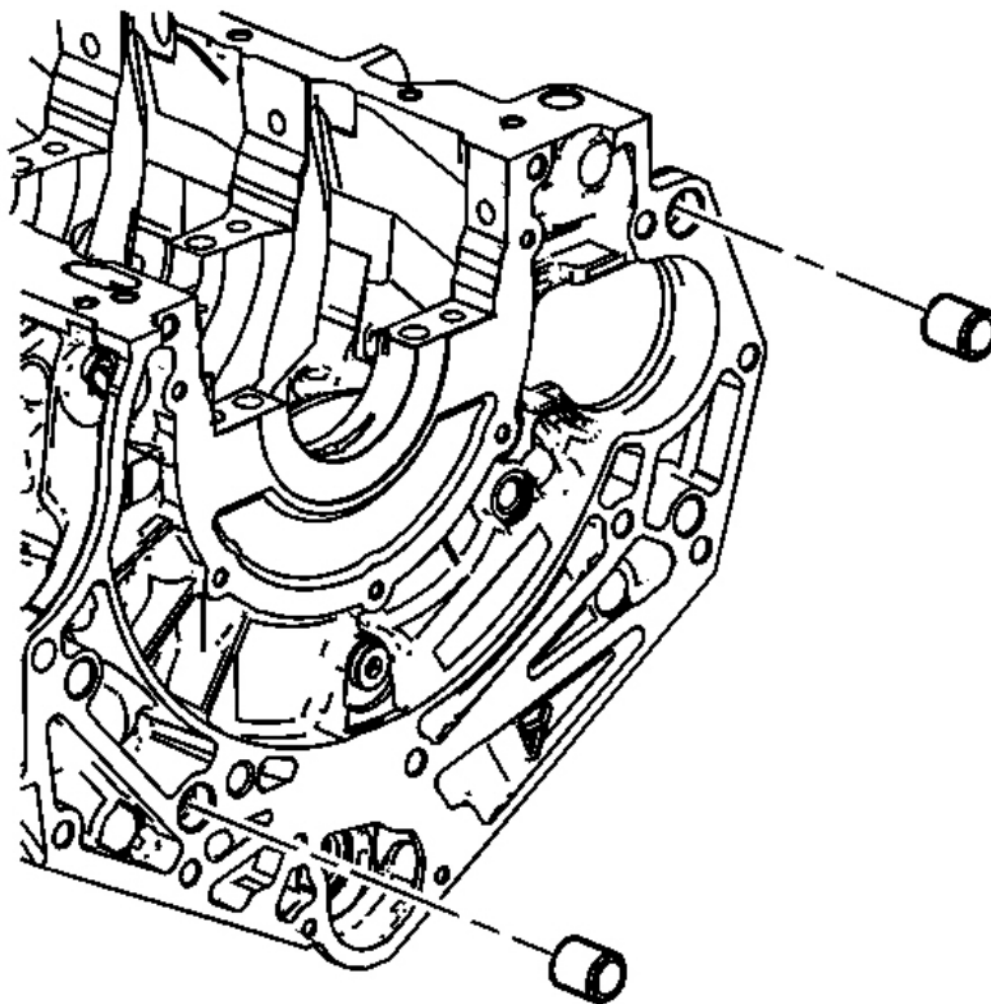
Courtesy of GENERAL MOTORS CORP.

1. Install the cylinder block-to-cylinder head alignment dowels.



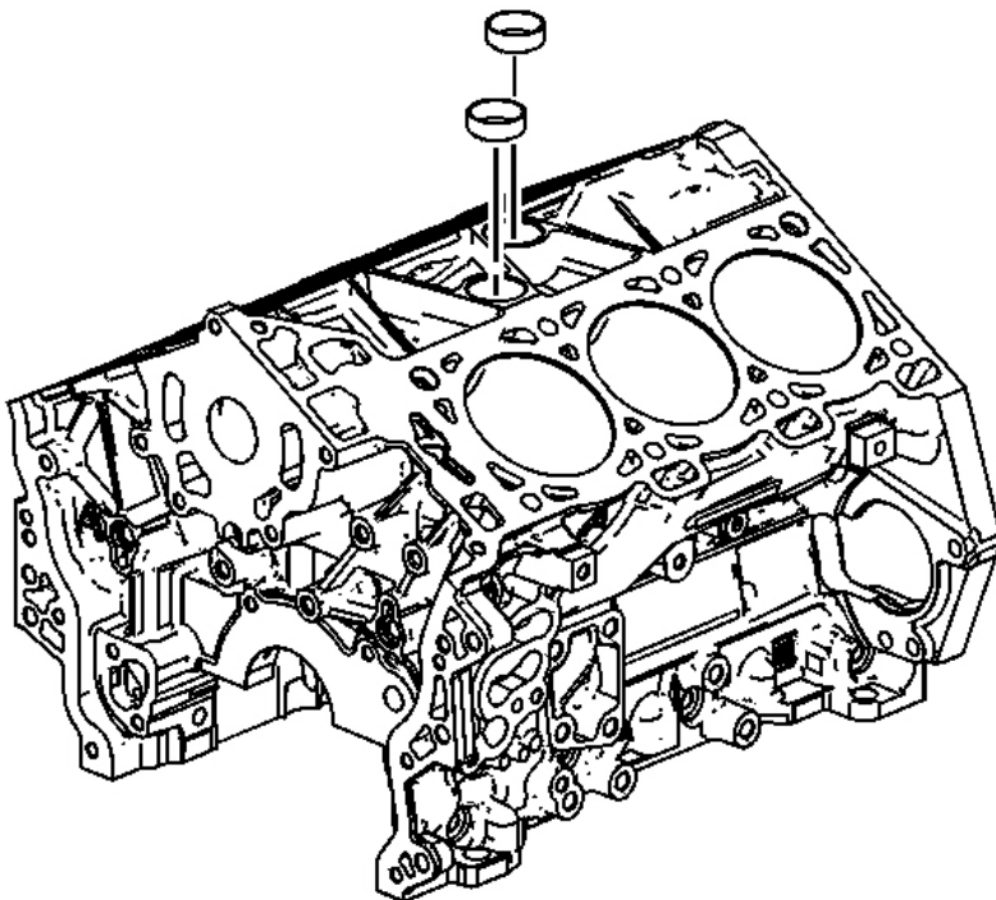
**Fig. 130: Locating Front Oil Gallery Expansion Plug**  
Courtesy of GENERAL MOTORS CORP.

2. Install the NEW front oil gallery expansion plug.
3. Ensure the NEW front oil gallery expansion plug is installed to the proper depth.



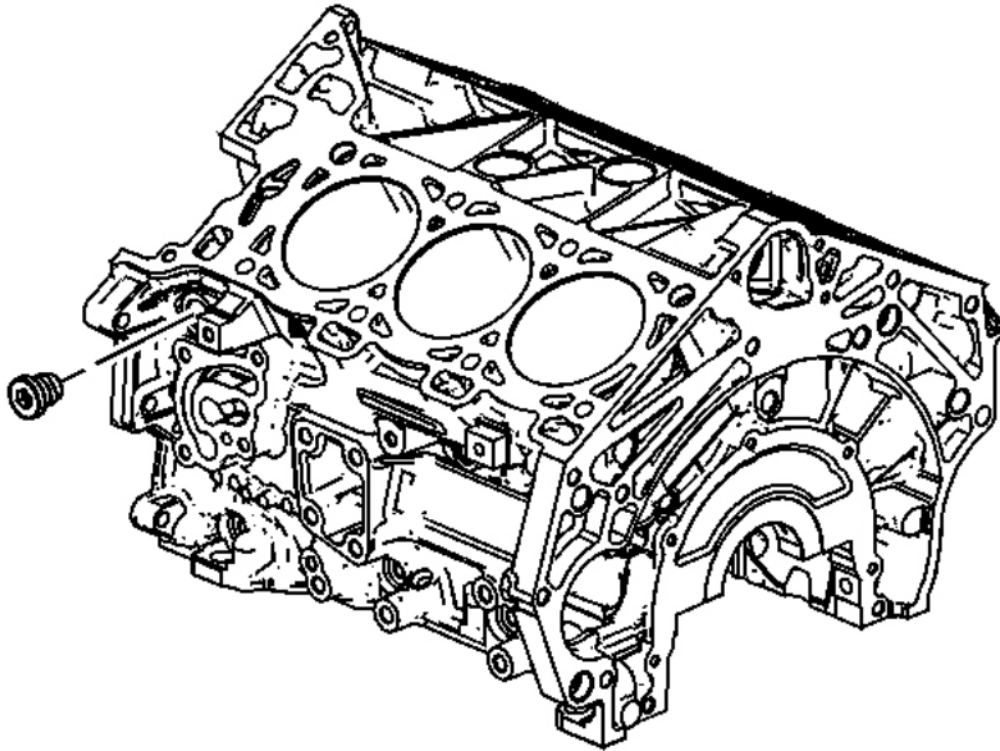
**Fig. 131: Cylinder Block-To-Transmission Alignment Dowels**  
Courtesy of GENERAL MOTORS CORP.

4. Install the cylinder block-to-transmission alignment dowels.



**Fig. 132: Identifying Coolant Expansion Plugs**  
Courtesy of GENERAL MOTORS CORP.

5. Apply the RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent on the NEW coolant expansion plugs.
6. Install the NEW coolant expansion plugs.
7. Ensure the NEW coolant expansion plugs are installed to the proper depth.



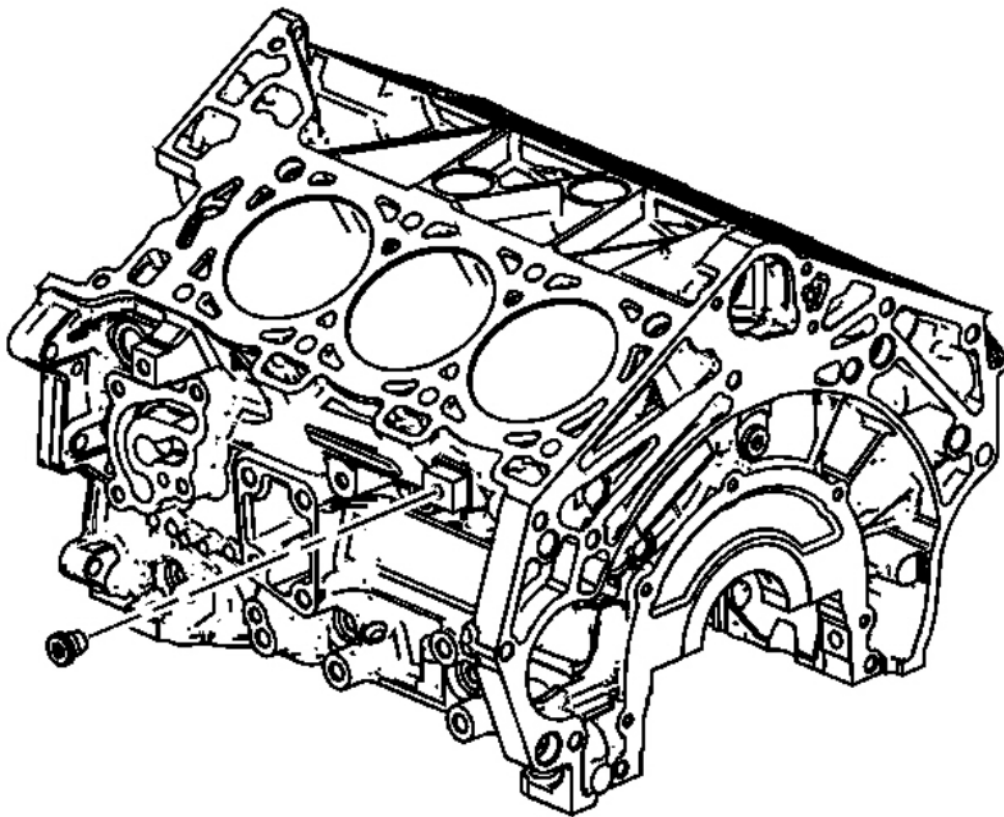
**Fig. 133: View Of M20 Left Side Oil Gallery Threaded Plug**  
Courtesy of GENERAL MOTORS CORP.

8. Apply thread sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent on the threads of the M20 left side oil gallery threaded plug.

**NOTE:** Refer to **Fastener Notice** in Cautions and Notices.

9. Install the M20 left side oil gallery threaded plug.

**Tighten:** Tighten the M20 left side oil gallery threaded plug to 31 N.m (23 lb ft).

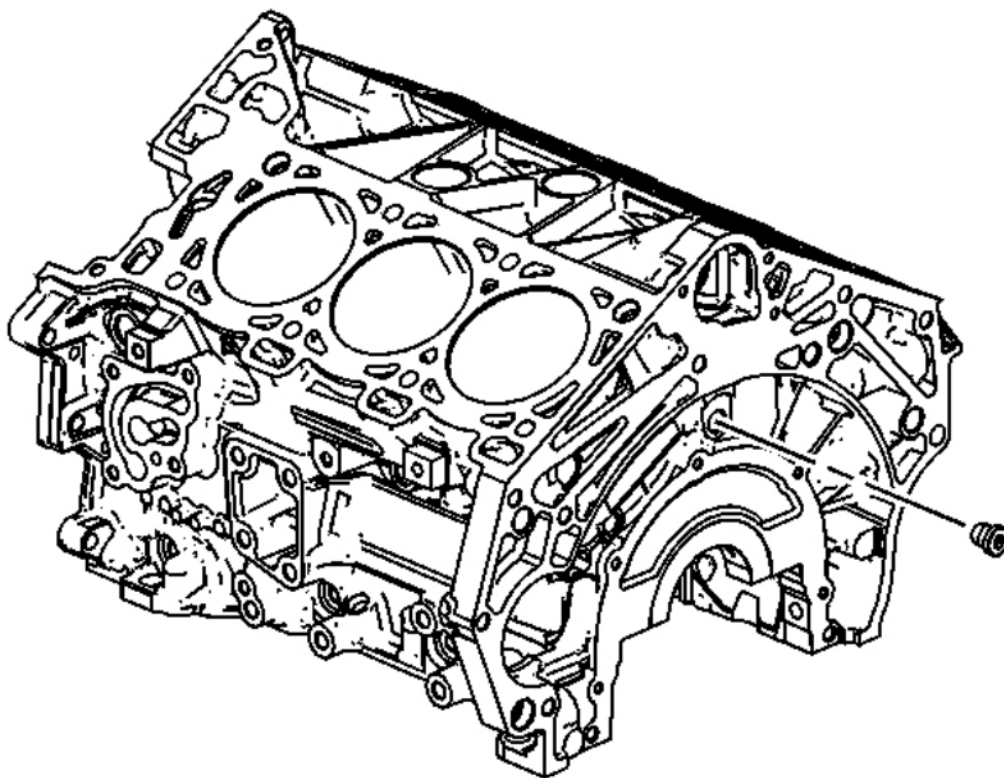


**Fig. 134: View Of M14 Left Side Coolant Drain Threaded Plug**  
Courtesy of GENERAL MOTORS CORP.

10. Apply thread sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent on the threads of the M14 left side coolant drain threaded plug.
11. Install the M14 left side coolant drain threaded plug.

**Tighten:** Tighten the M14 left side coolant drain threaded plug to 31 N.m (23 lb ft).



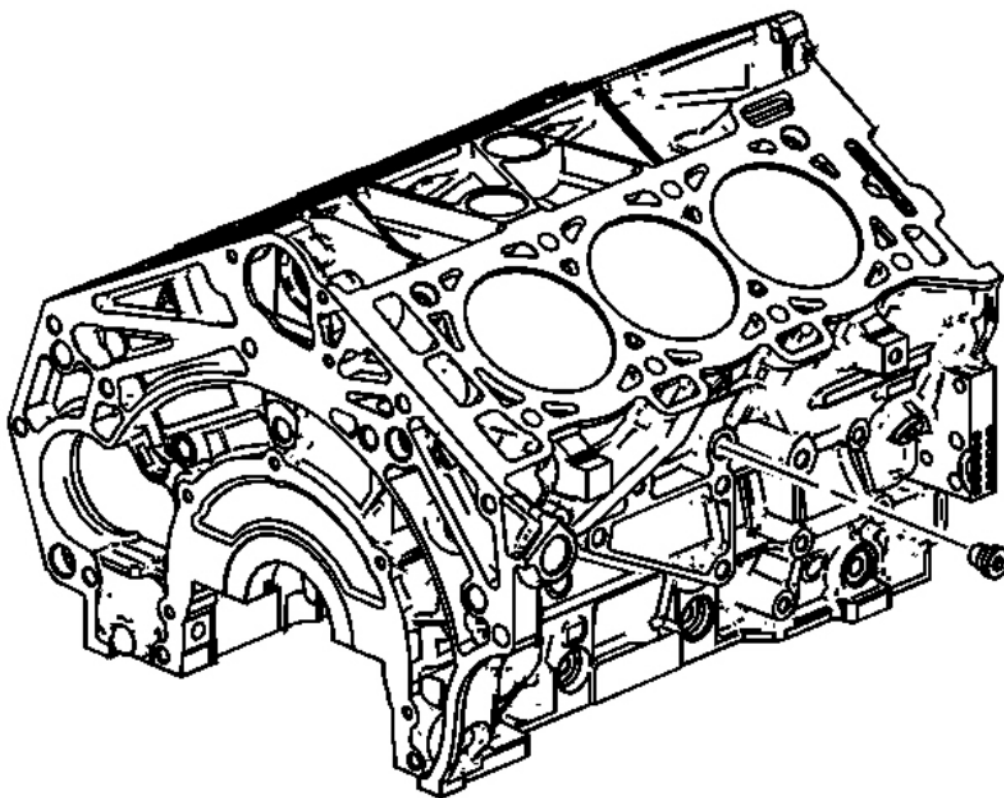


**Fig. 135: M14 Rear Oil Gallery Threaded Plug**

Courtesy of GENERAL MOTORS CORP.

12. Apply thread sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent on the threads of the M14 rear oil gallery threaded plug.
13. Install the M14 rear oil gallery threaded plug.

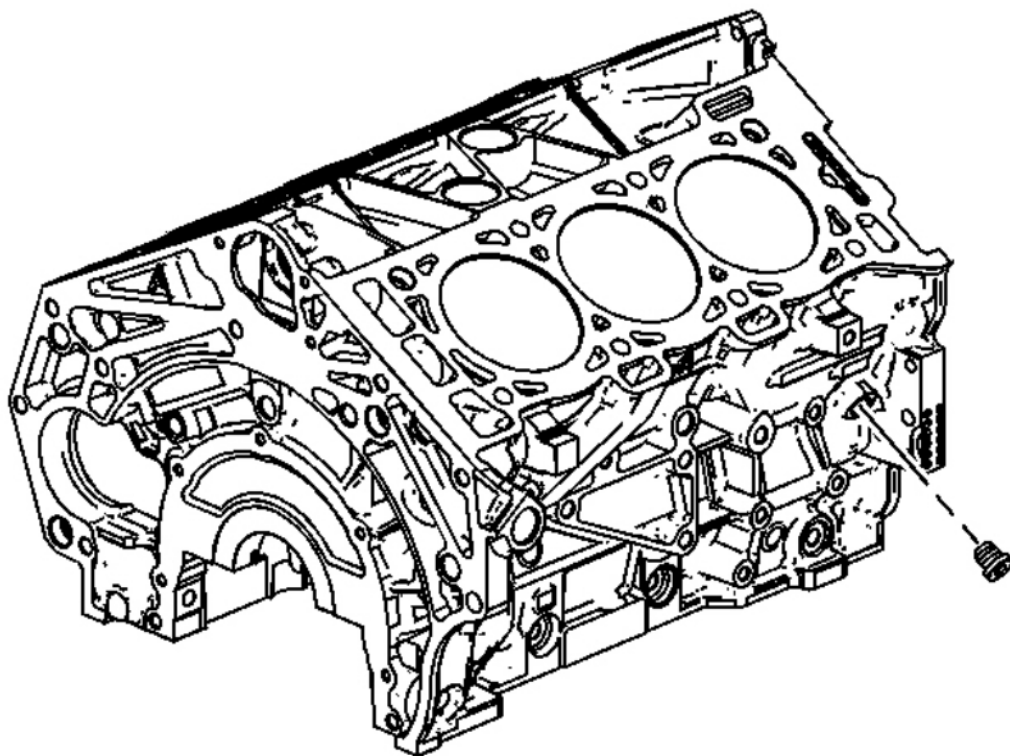
**Tighten:** Tighten the M14 rear oil gallery threaded plug to 31 N.m (23 lb ft).



**Fig. 136: Locating M14 Right Side Coolant Drain Threaded Plug**  
Courtesy of GENERAL MOTORS CORP.

14. Apply thread sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent on the threads of the M14 right side coolant drain threaded plug.
15. Install the M14 right side coolant drain threaded plug.

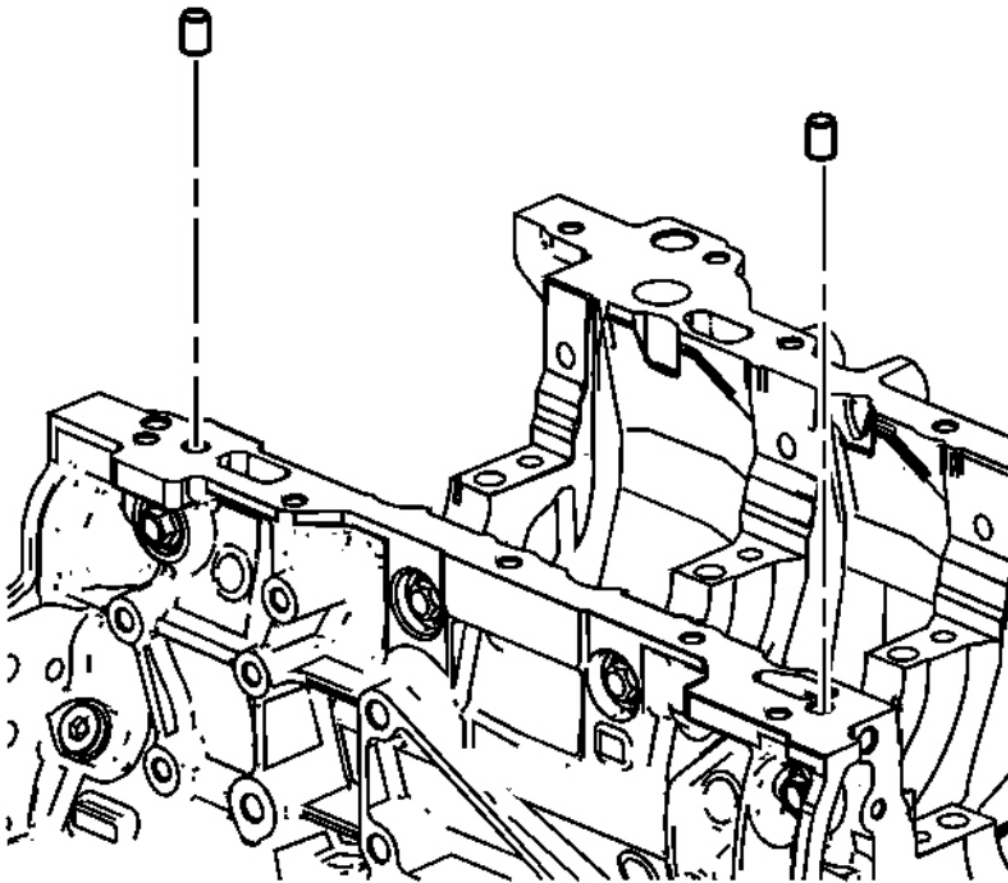
**Tighten:** Tighten the M14 right side coolant drain threaded plug to 31 N.m (23 lb ft).



**Fig. 137: Identifying M14 Right Side Oil Gallery Threaded Plug**  
Courtesy of GENERAL MOTORS CORP.

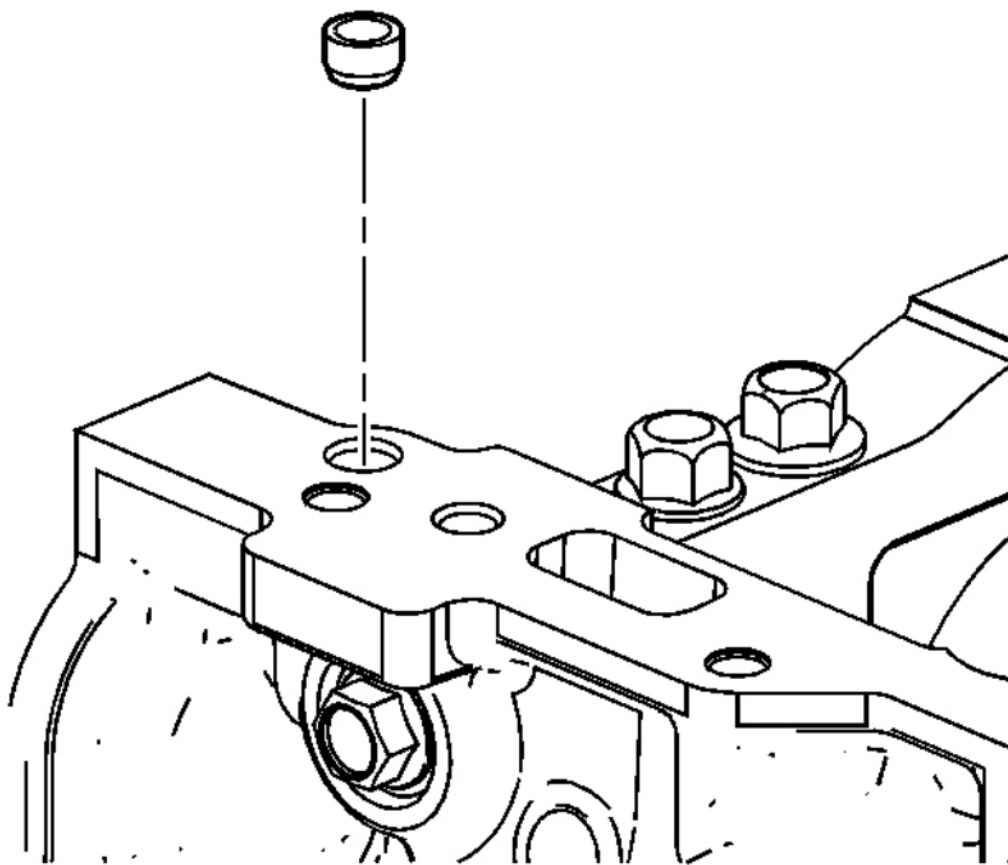
16. Apply thread sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent on the threads of the M14 right side oil gallery threaded plug.
17. Install the M14 right side oil gallery threaded plug.

**Tighten:** Tighten the M14 right side oil gallery threaded plug to 31 N.m (23 lb ft).



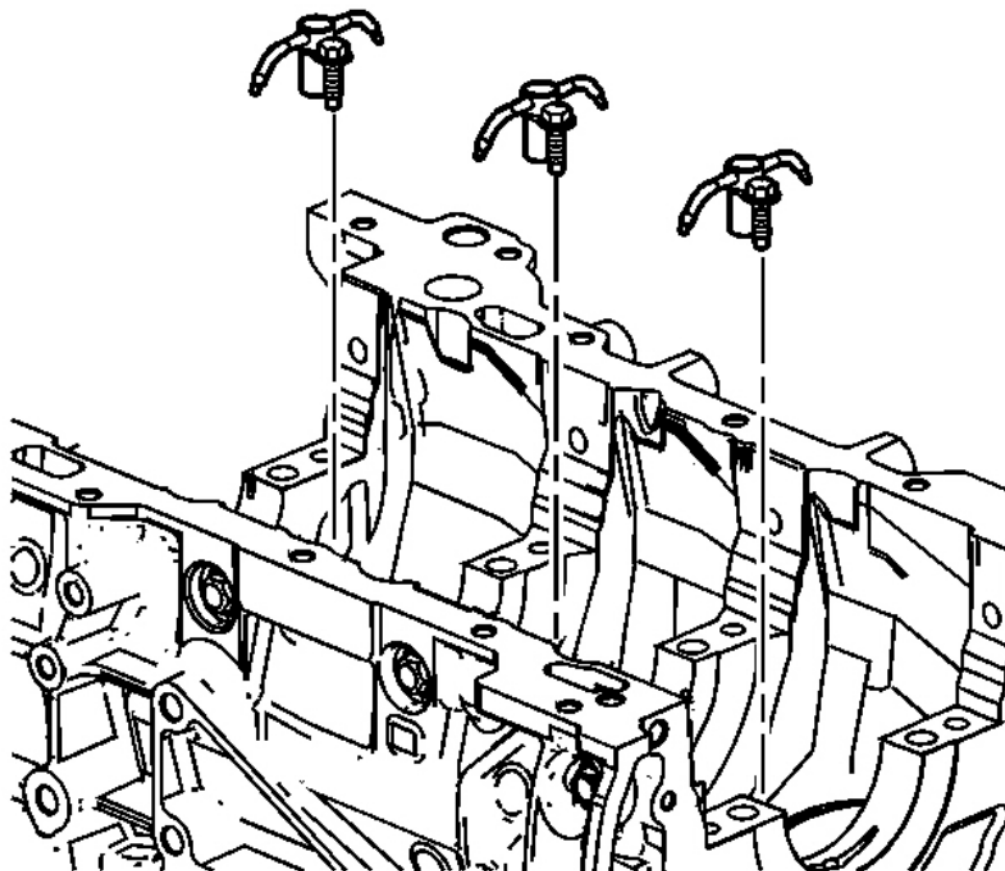
**Fig. 138: Cylinder Block-To-Oil Pan Alignment Dowels**  
Courtesy of GENERAL MOTORS CORP.

18. Install the cylinder block-to-oil pan alignment dowels.



**Fig. 139: Locating Right Front Oil Pan Rail Oil Gallery Expansion Plug**  
Courtesy of GENERAL MOTORS CORP.

19. Install the NEW right front oil pan rail oil gallery expansion plug.
20. Ensure the NEW right front oil pan rail oil gallery expansion plug is installed to the proper depth.



**Fig. 140: View Of Oil Jets & Bolts**  
Courtesy of GENERAL MOTORS CORP.

21. Install the oil jets.
22. Install the oil jet bolts.

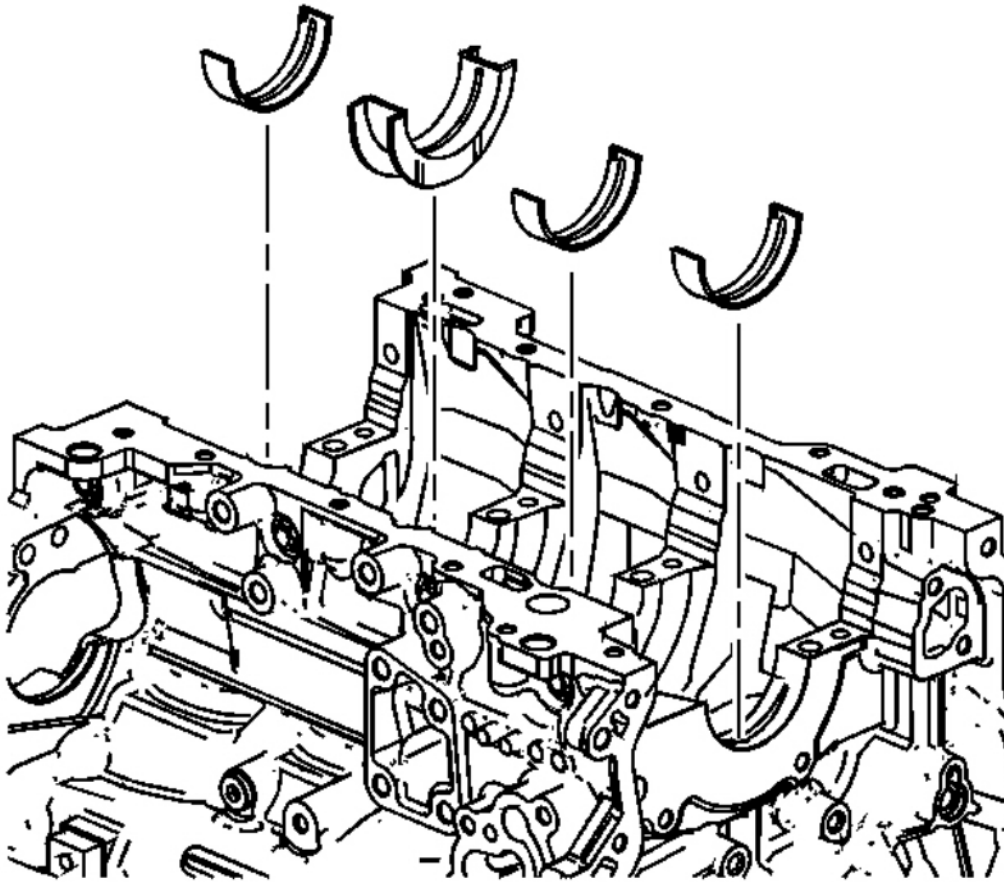
**Tighten:** Tighten the oil jet bolts to 10 N.m (89 lb in).

## CRANKSHAFT AND BEARINGS INSTALLATION

### CRANKSHAFT BEARING INSTALLATION PROCEDURE

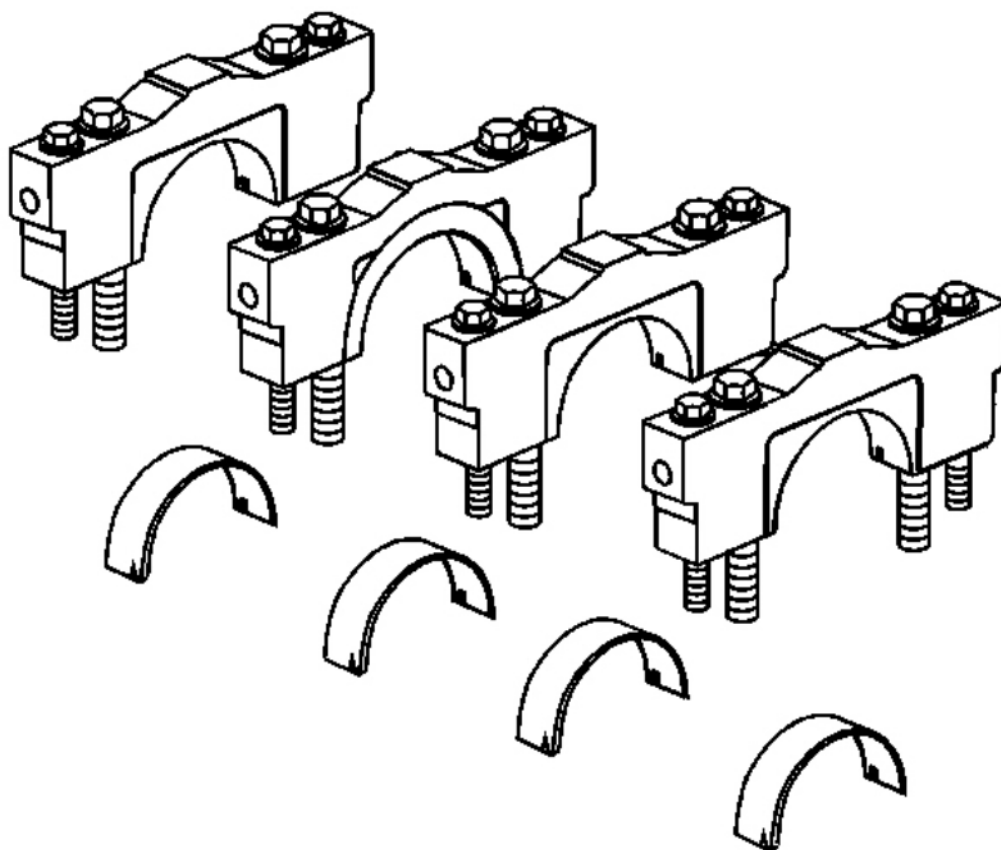
**IMPORTANT:** If the crankshaft bearings have been used in a running engine, you must replace them with **NEW** crankshaft bearings for reassembly.

1. Clean the crankcase crank bore with a lint-free cloth.
2. Clean all the oil from the backside of new bearing halves.



**Fig. 141: Locating Upper Crankshaft Bearings**  
Courtesy of GENERAL MOTORS CORP.

3. Install the new upper crankshaft bearings into position. The thrust bearing belongs in the number 3 journal. Ensure that the upper bearing insert contains the oil transfer hole and groove. Roll the bearing into position so that the lock tang engages the crank slot. The bearing must fit flush with the upper crankcase.

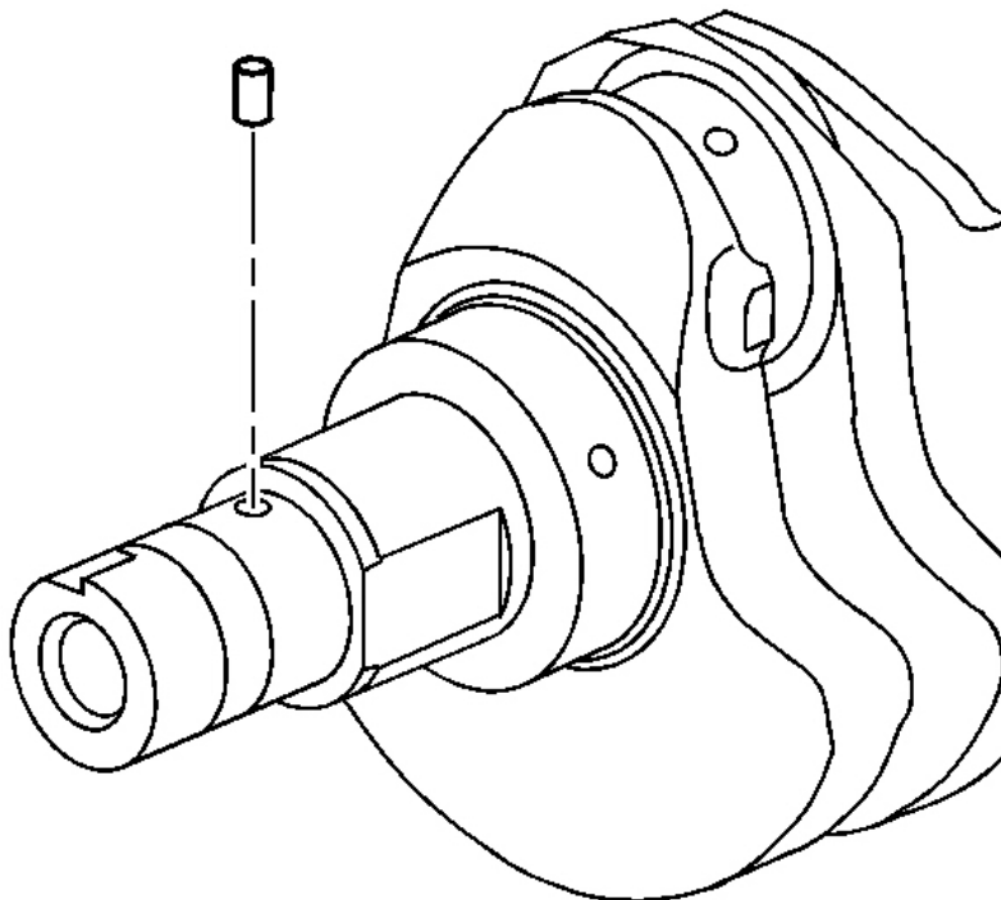


**Fig. 142: Identifying Crankshaft Lower Bearing Halves & Crankshaft Bearing Caps**  
Courtesy of GENERAL MOTORS CORP.

4. Install the new lower crankshaft bearings into position in the main bearing caps. The lower crankshaft bearings are identified by NO grooves or holes. The bearings must fit flush with the crankshaft bearing caps.

#### CRANKSHAFT INSTALLATION PROCEDURE

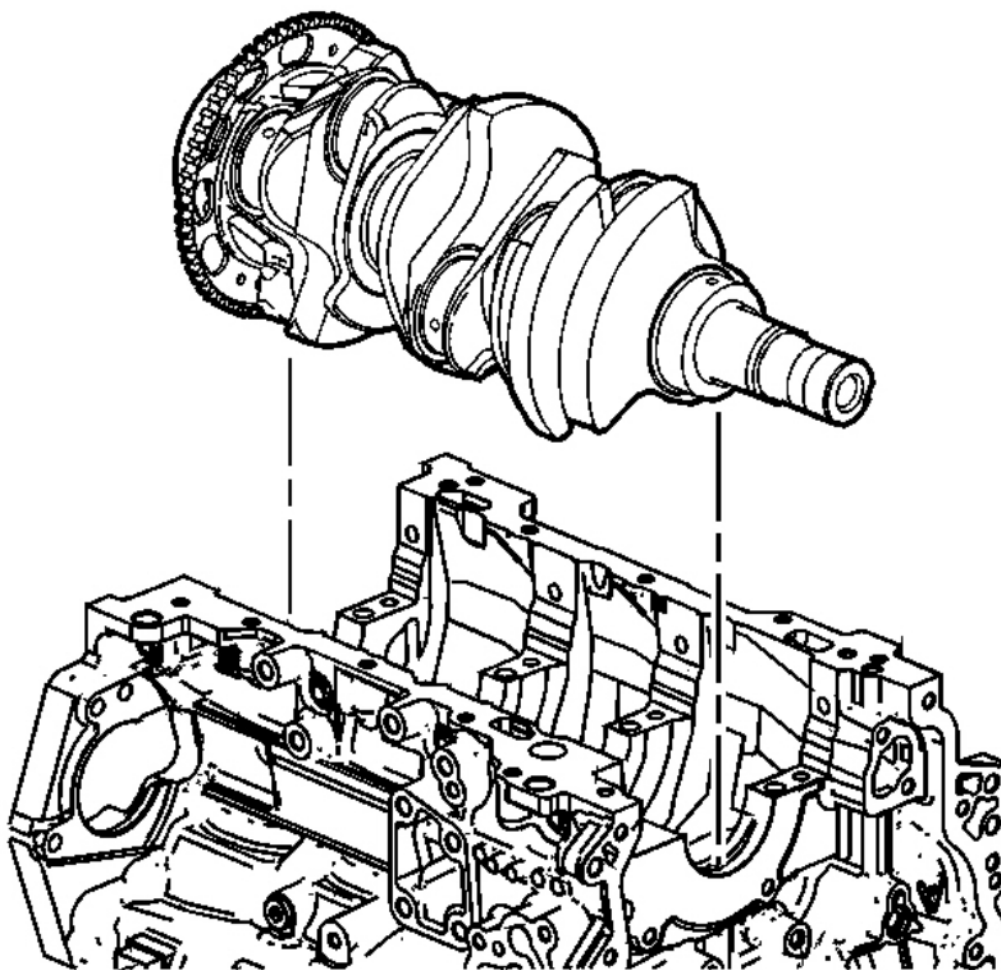




**Fig. 143: Locating Crankshaft Sprocket Drive Pin**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** The crankshaft sprocket drive pin must be set to the proper depth. Installing the crankshaft sprocket drive pin too deep can lead to damage to the crankshaft sprocket and extensive engine damage.

1. If removed, install the crankshaft sprocket drive pin. Lightly tap the pin in place with a small soft face, bronze/plastic, hammer until it bottoms in the hole.



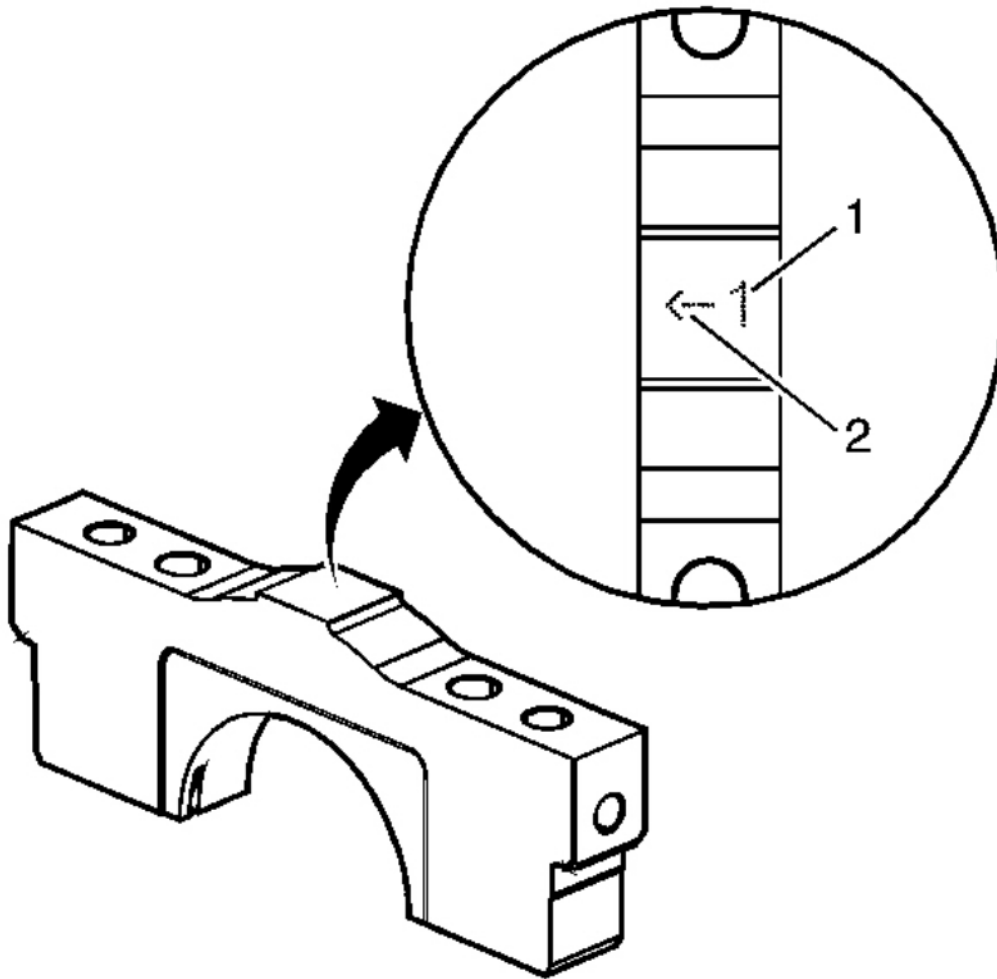
**Fig. 144: View Of Crankshaft**  
Courtesy of GENERAL MOTORS CORP.

2. Gently lower the crankshaft into position in the cylinder block.

## CRANKSHAFT BEARING CLEARANCE MEASUREMENT PROCEDURE

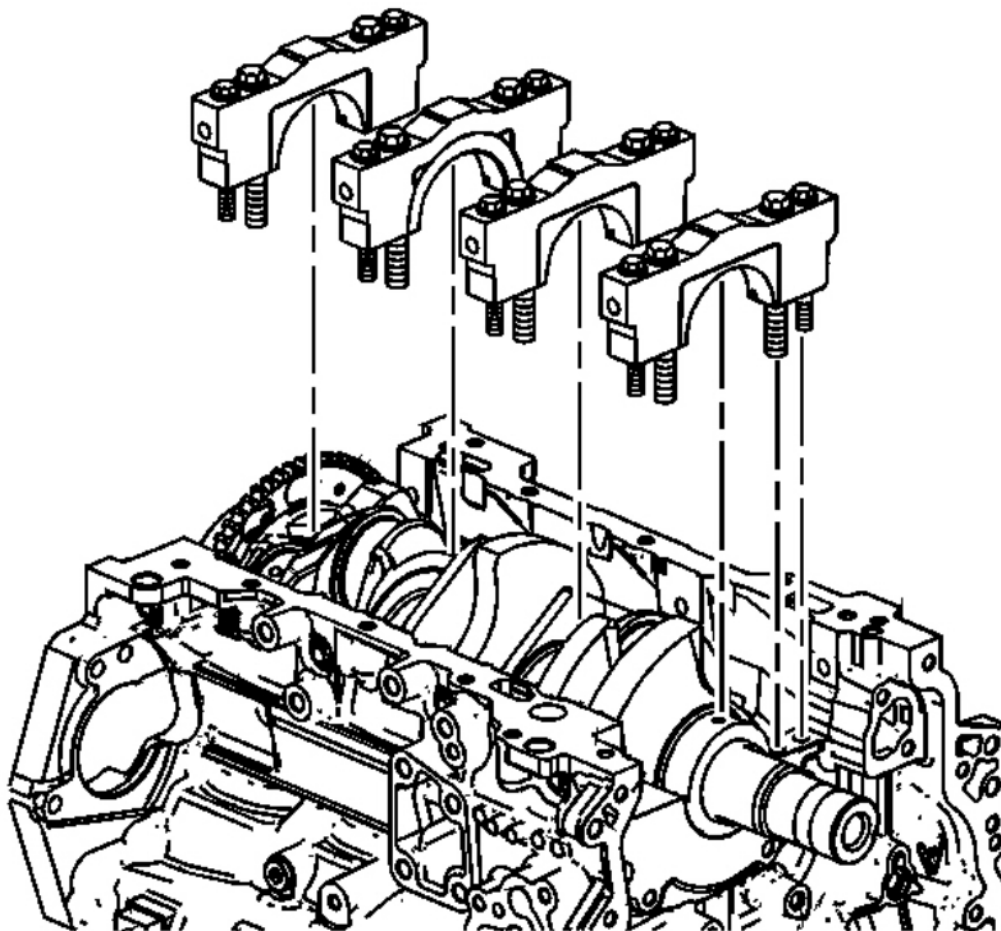
### Tools Required

- J 6125-1B Slide Hammer Adapter
- J 41818 Crankshaft Bearing Cap Remover
- J 45059 Angle Meter



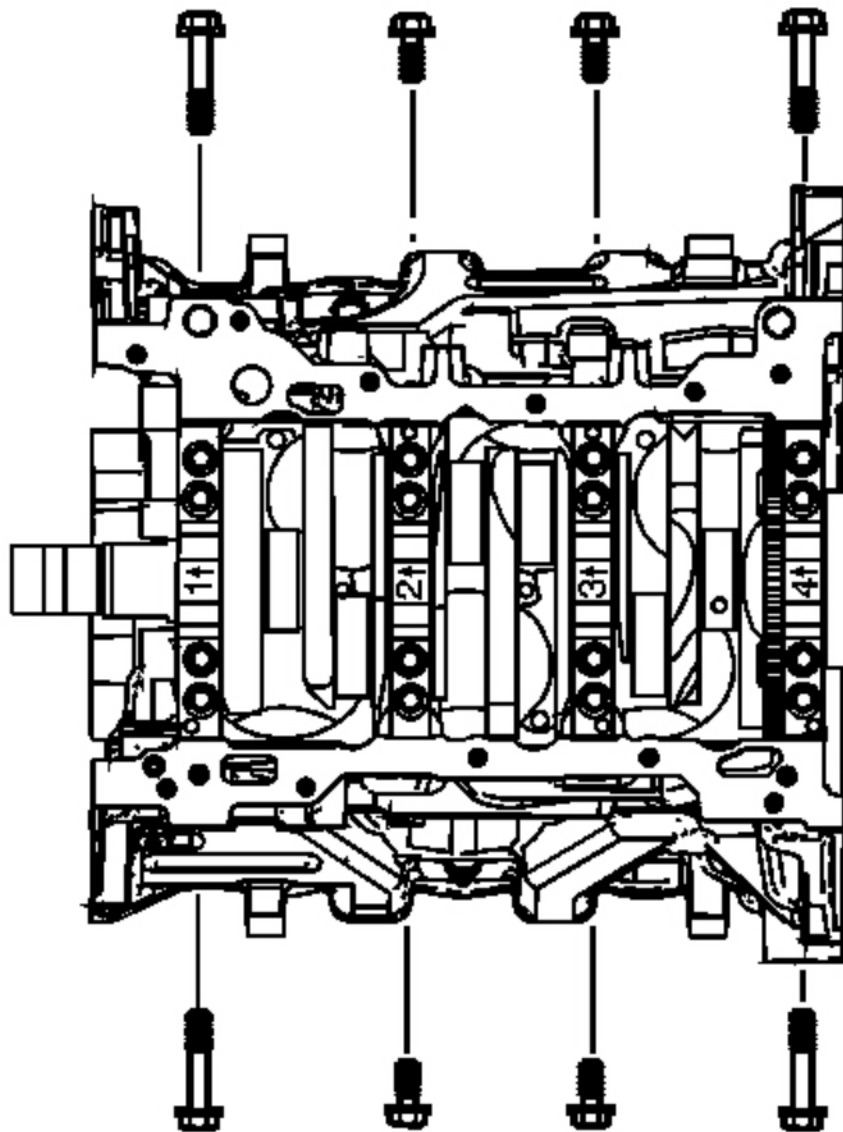
**Fig. 145: Identifying Front Main Bearing Cap**  
Courtesy of GENERAL MOTORS CORP.

1. Place a length of fresh, room temperature plastic gaging material all the way across all the crankshaft bearing journals.
2. Identify the proper order of the main bearing caps. The main bearing caps are numbered 1 (1) through 4, with the front main bearing cap marked with the number 1. The arrow (2) is to be oriented to the front of the engine.



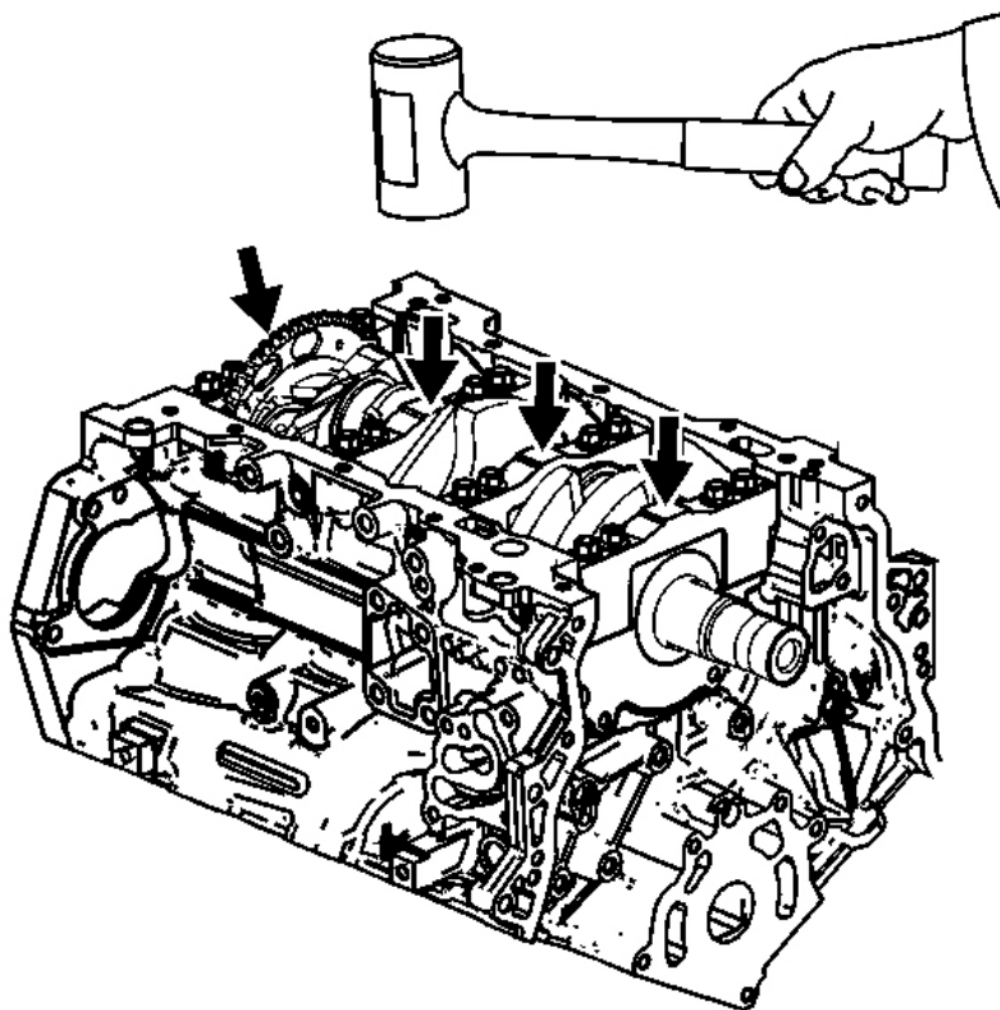
**Fig. 146: View Of Crankshaft Main Bearing Caps**  
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft main bearing caps.
4. Loosely install the original inner main cap bolts.
5. Loosely install the original outer main cap bolts.



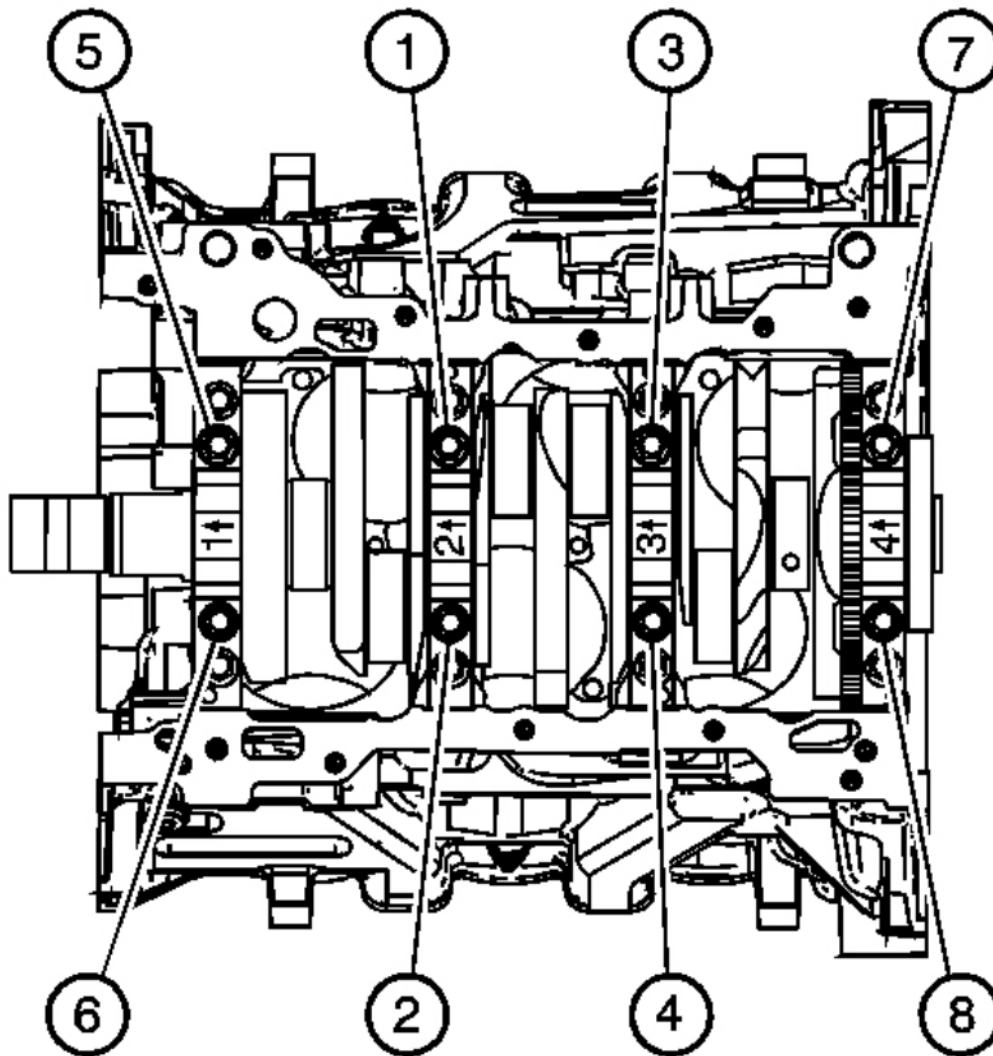
**Fig. 147: Identifying Crankshaft Main Bearing Cap Side Bolts**  
Courtesy of GENERAL MOTORS CORP.

6. Loosely install the original short/inner side main cap bolts.
7. Loosely install the original long/outer side main cap bolts.



**Fig. 148: Setting Crankshaft Main Bearing Caps**  
Courtesy of GENERAL MOTORS CORP.

8. Tap the crankshaft main bearing caps with a soft-faced hammer.
9. Tighten the main caps bolts using the **J 45059** in the following sequence:

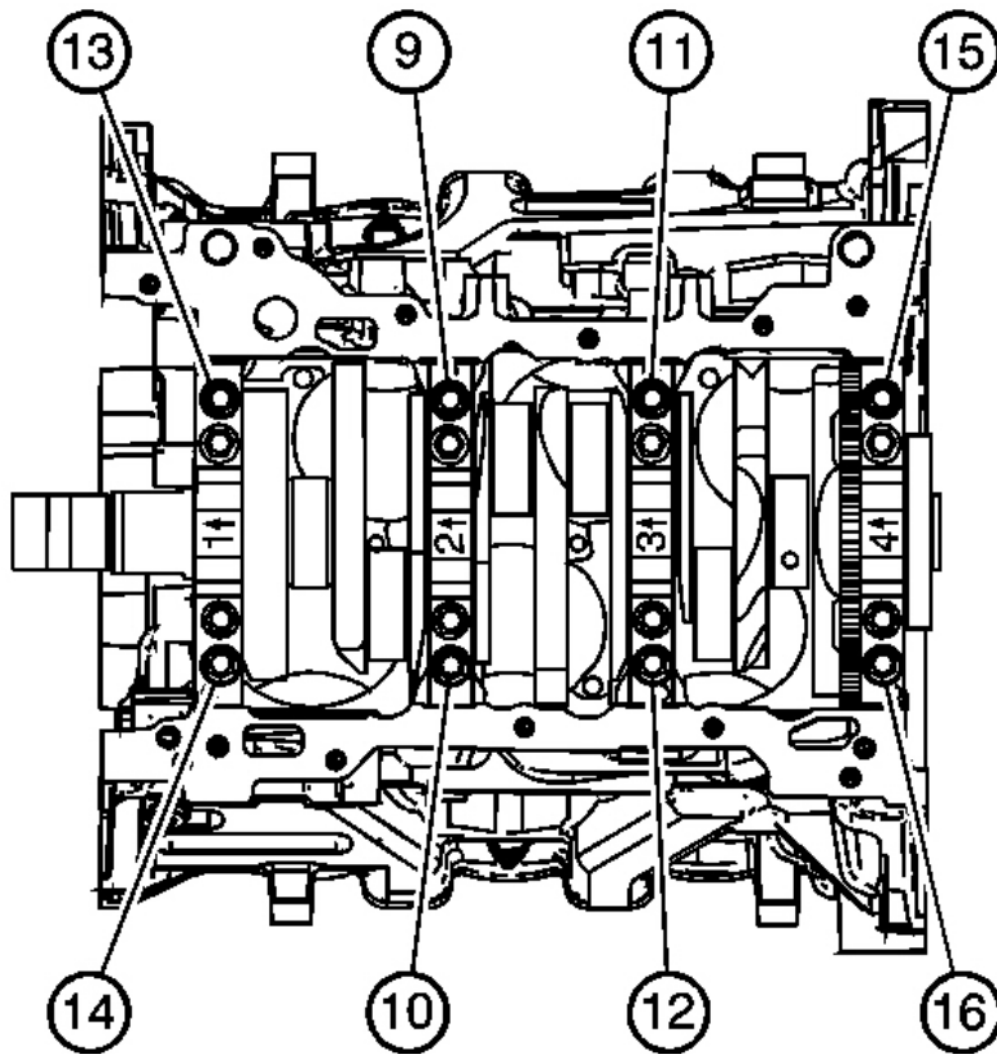


**Fig. 149: Main Cap Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

Tighten the inboard bolts (1-8).

**Tighten:** Tighten the inboard bolts (1-8) to 20 N.m (15 lb ft) plus 80 degrees.

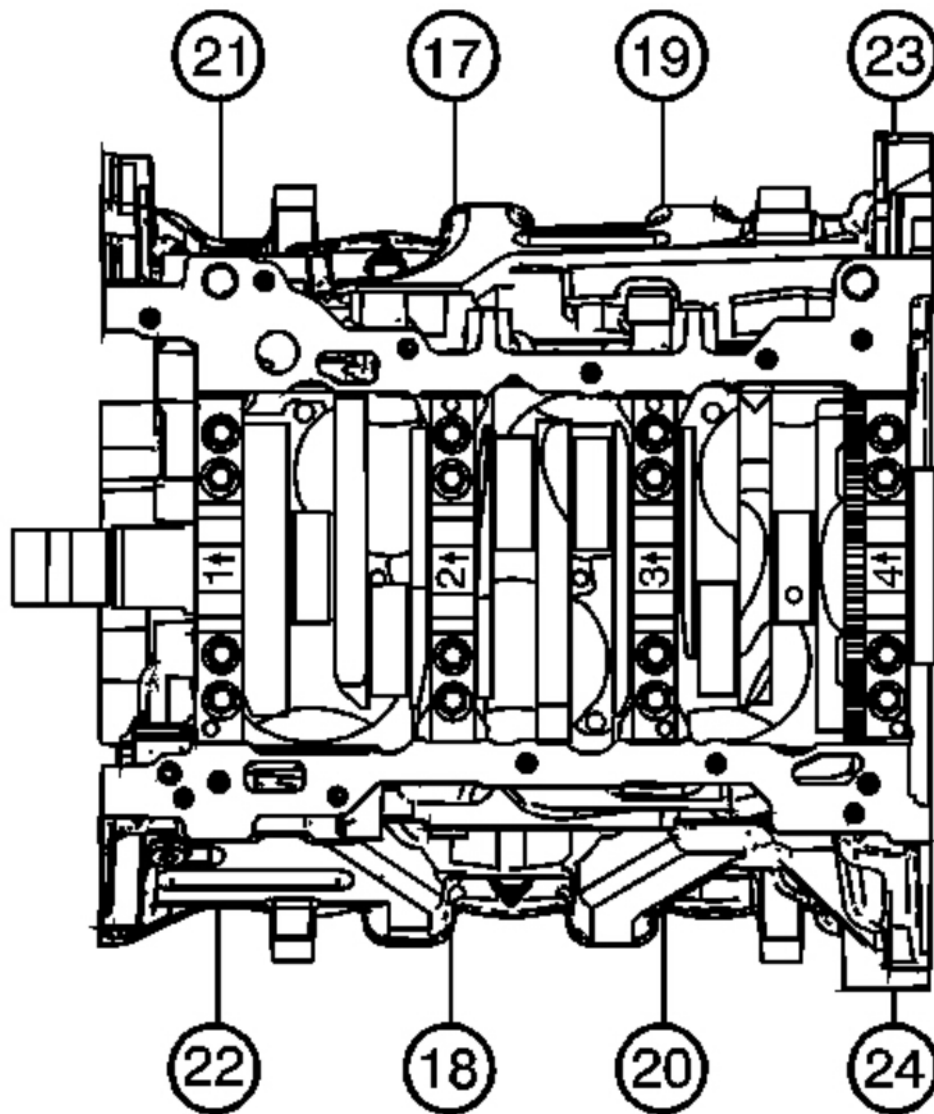


**Fig. 150: Outboard Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

10. Tighten the outboard bolts (9-16).

**Tighten:** Tighten the outboard bolts (9-16) to 15 N.m (11 lb ft) plus 110 degrees.





**Fig. 151: Short/Inner Bolts & Long/Outer Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

11. Tighten the short/inner bolts (17-20).

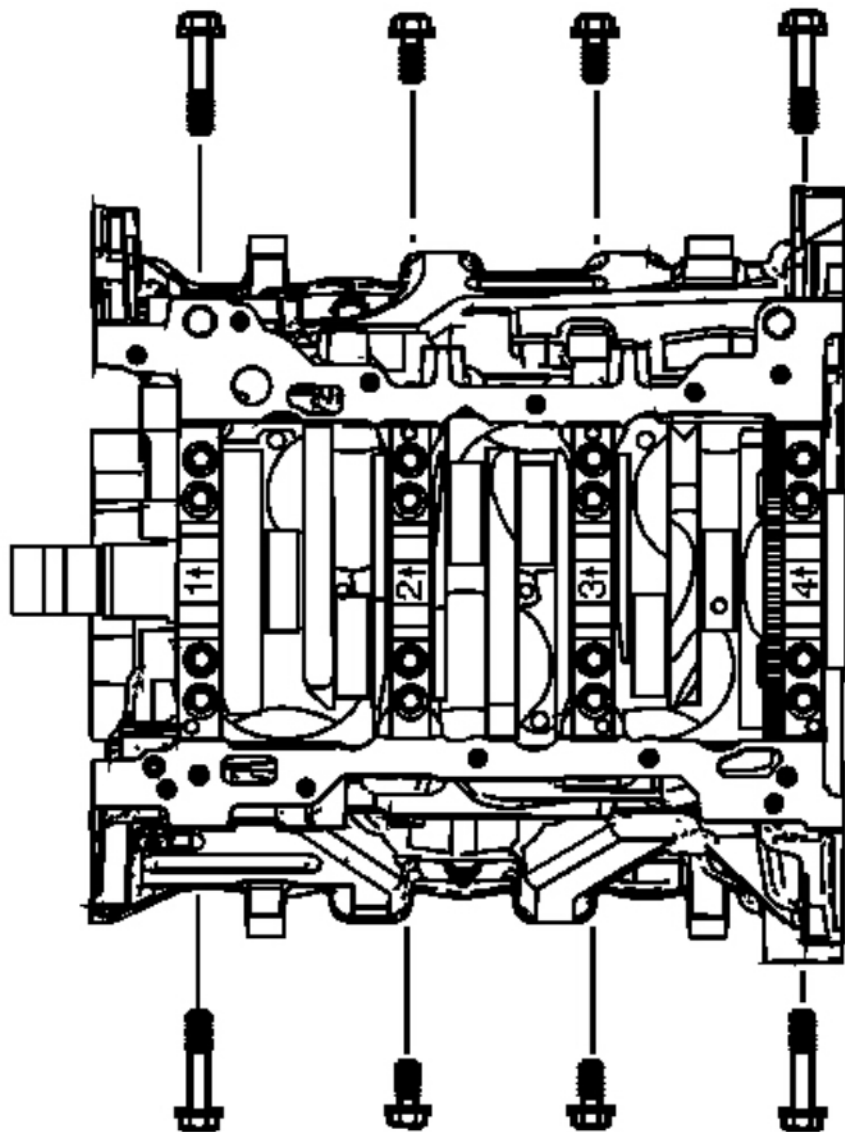
**Tighten:** Tighten the short/inner bolts (17-20) to 30 N.m (22 lb ft) plus 60 degrees.

12. Tighten the long/outer bolts (21-24).

**Tighten:** Tighten the long/outer bolts (21-24) to 30 N.m (22 lb ft) plus 60 degrees.

**IMPORTANT:** Do not rotate the crankshaft.

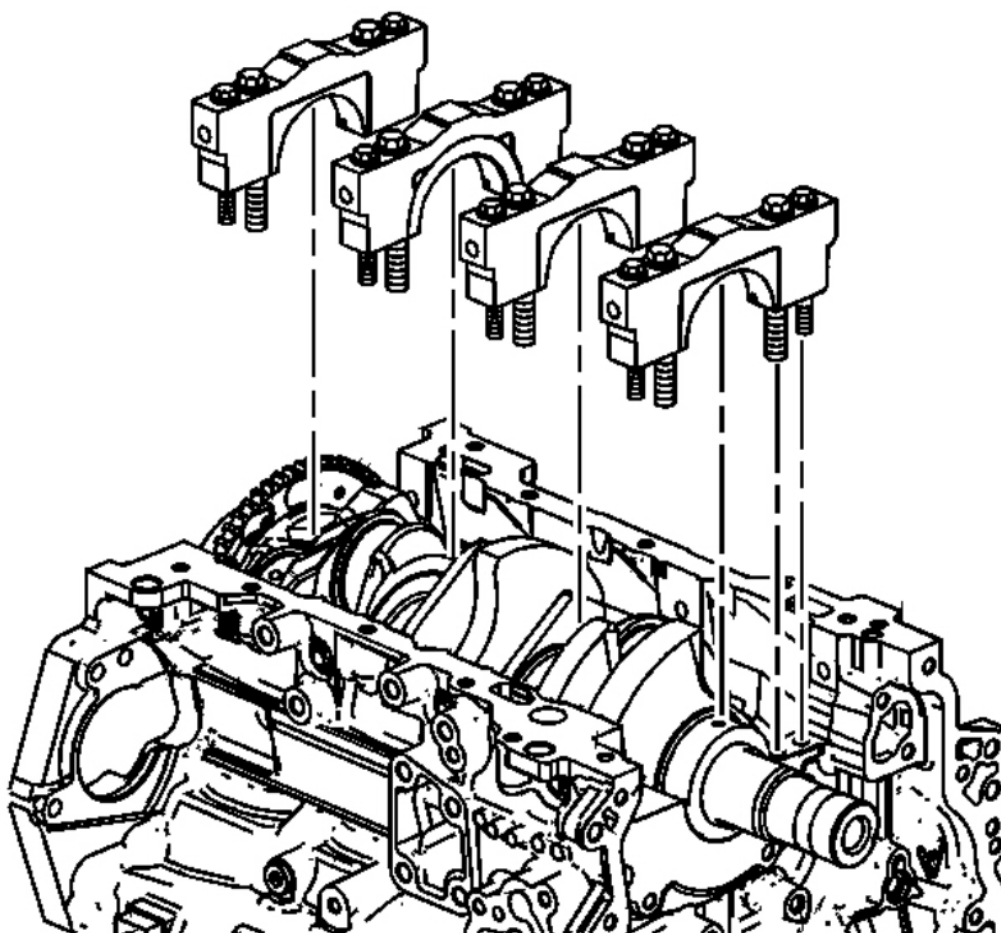
13. After reaching final torque, allow the assembly to sit for 2 minutes.



**Fig. 152: Identifying Crankshaft Main Bearing Cap Side Bolts**

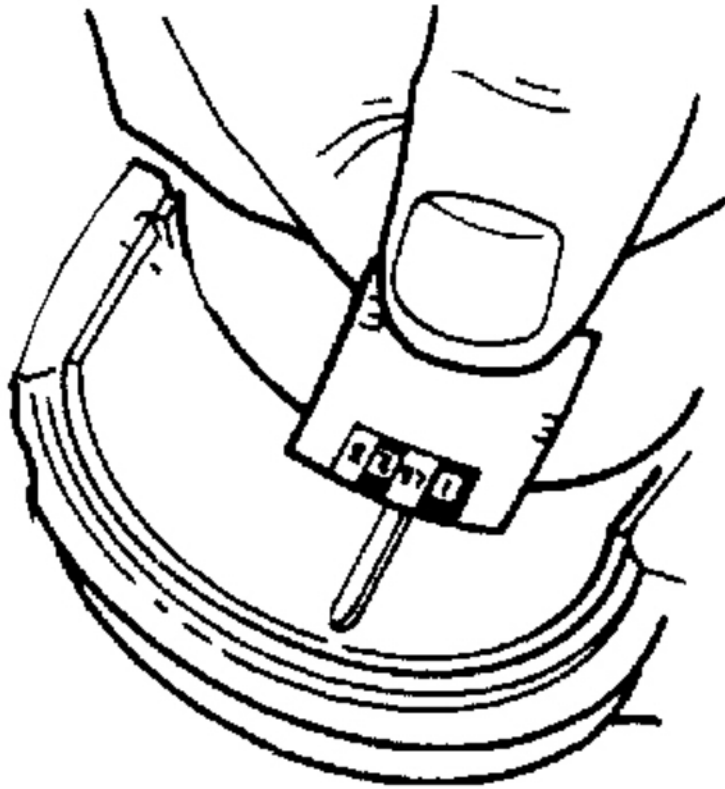
Courtesy of GENERAL MOTORS CORP.

14. Remove the crankshaft bearing cap side bolts.



**Fig. 153: View Of Crankshaft Main Bearing Caps**  
Courtesy of GENERAL MOTORS CORP.

15. Remove the crankshaft bearing cap outer bolts.
16. Remove the crankshaft bearing cap inner bolts.
17. Remove the crankshaft bearing caps using the J 6125-1B and J 41818 .



**Fig. 154: Measuring Plastigage**  
Courtesy of GENERAL MOTORS CORP.

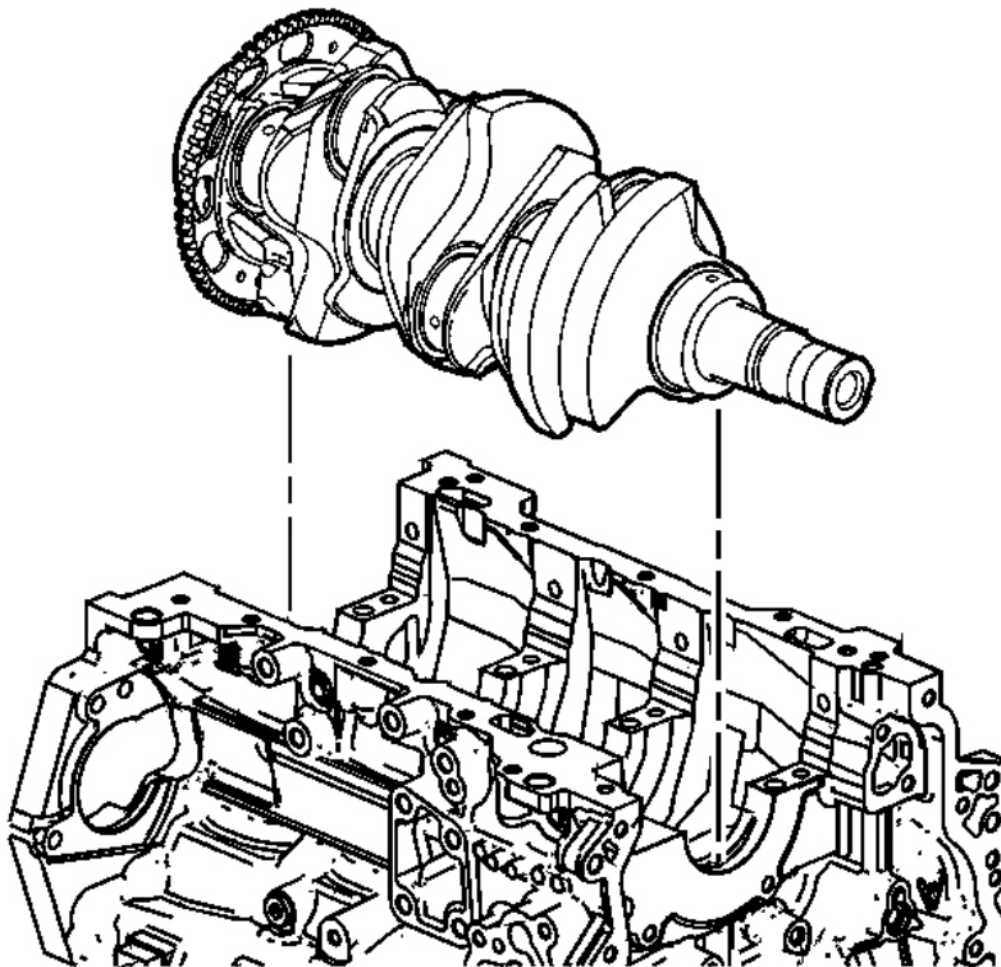
18. Determine the crankshaft bearing clearance by comparing the width of the flattened plastic gaging material at its widest point with the graduation on the gaging material container.

**IMPORTANT:** The crankshaft bearings **CAN** be reused after checking the clearance if the bearings have never been used in a running engine.

19. Compare your measurements with the Engine Mechanical Specifications . If the new bearings do not provide the proper crankshaft to bearing clearance, inspect the following:
  1. Re-measure the crankshaft journals for the correct specified size and ensure the proper new bearings are being installed. If the crankshaft journals are incorrectly sized, replace or regrind the crankshaft. Crankshaft machining is permitted and undersized bearings are available.
  2. Re-measure the engine block crankshaft bearing bore diameter to ensure proper size. The engine block crankshaft bearing bore is not machinable and the block must be replaced if out of

specification.

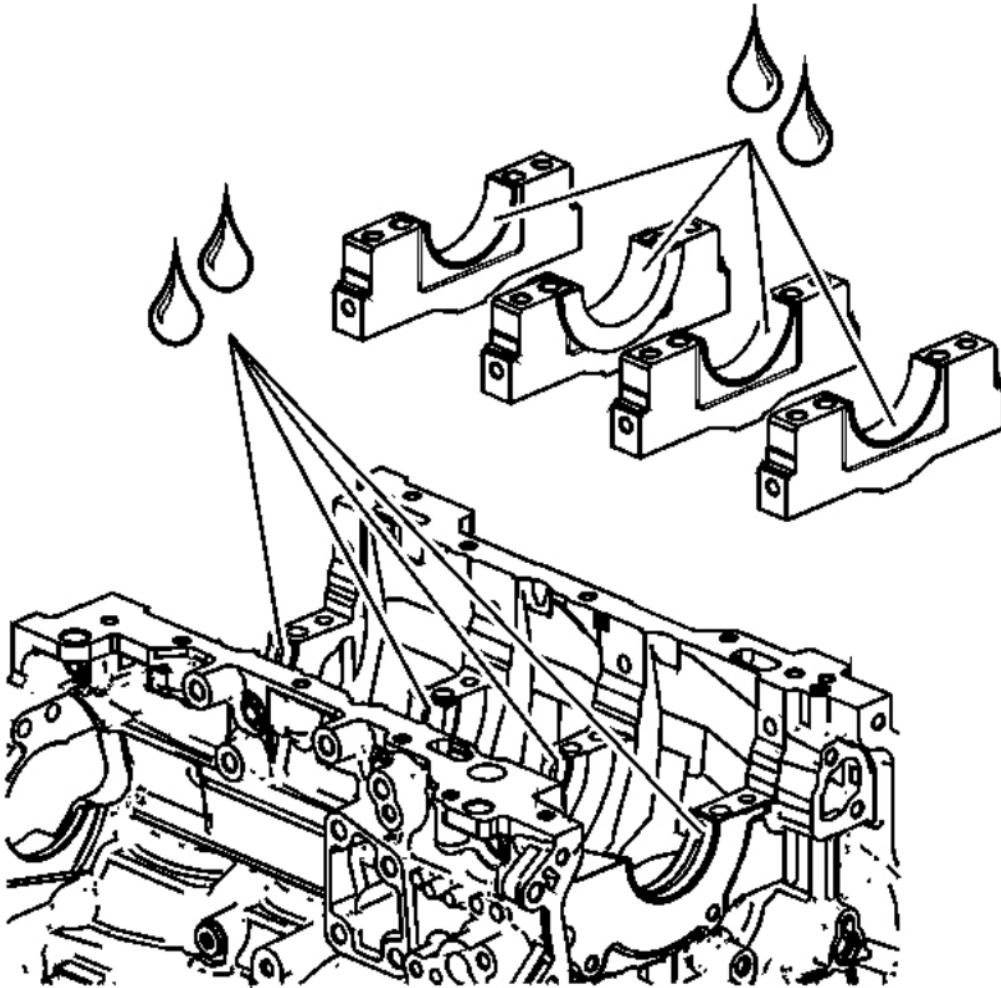
20. Clean the plastic gaging material from the crankshaft bearing journals with a soft, lint-free cloth.



**Fig. 155: View Of Crankshaft**

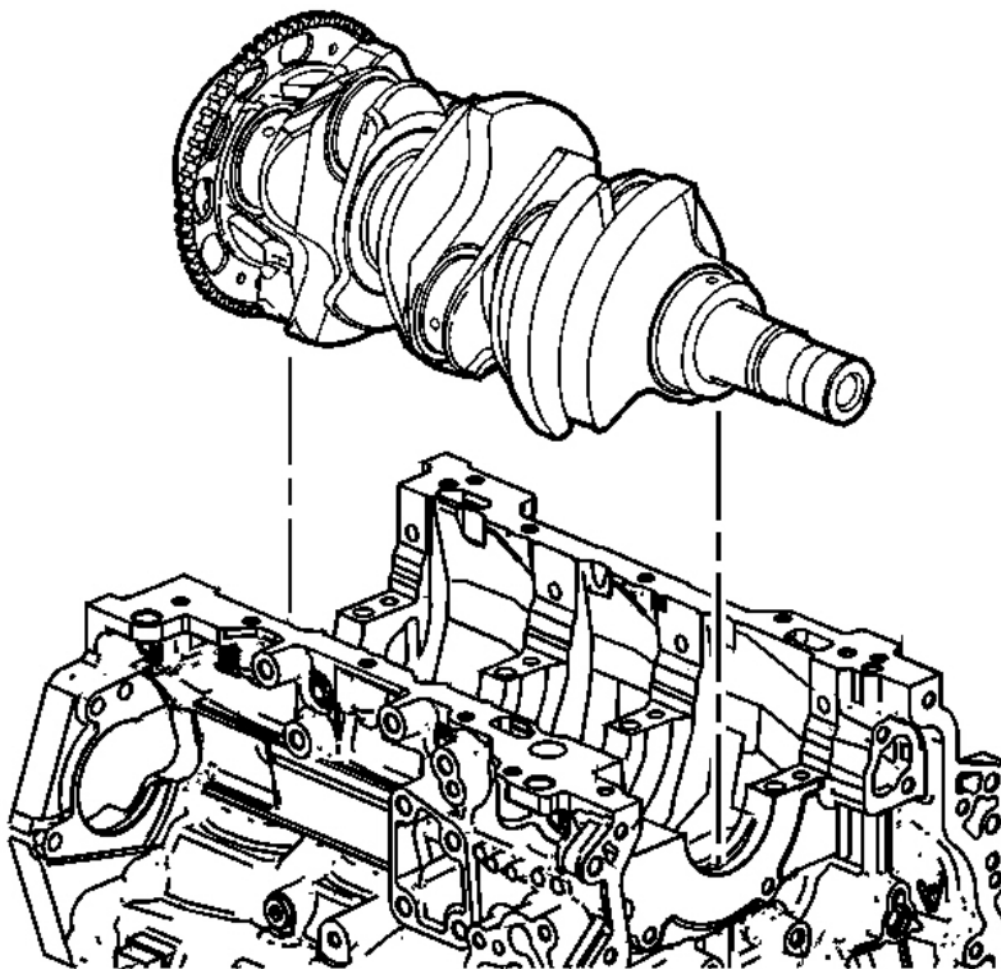
Courtesy of GENERAL MOTORS CORP.

21. Lift the crankshaft out of the cylinder block.



**Fig. 156: Prelubing Upper And Lower Bearing Surfaces**  
Courtesy of GENERAL MOTORS CORP.

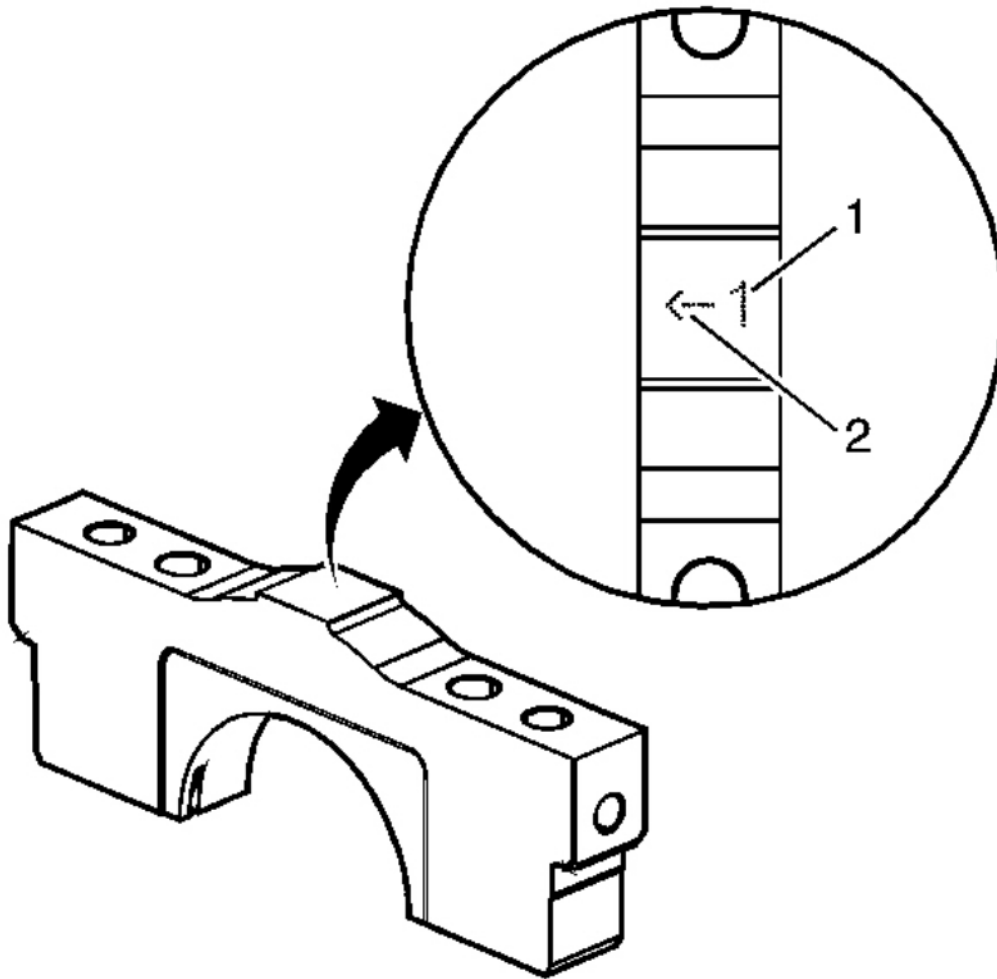
22. Apply a liberal amount of crankshaft prelube GM P/N 1052367 (Canadian P/N 992869) or clean engine oil GM P/N 12345501 (Canadian P/N 992704) to the upper and lower bearing surfaces.



**Fig. 157: View Of Crankshaft**

Courtesy of GENERAL MOTORS CORP.

23. Gently lower the crankshaft into position in the cylinder block.

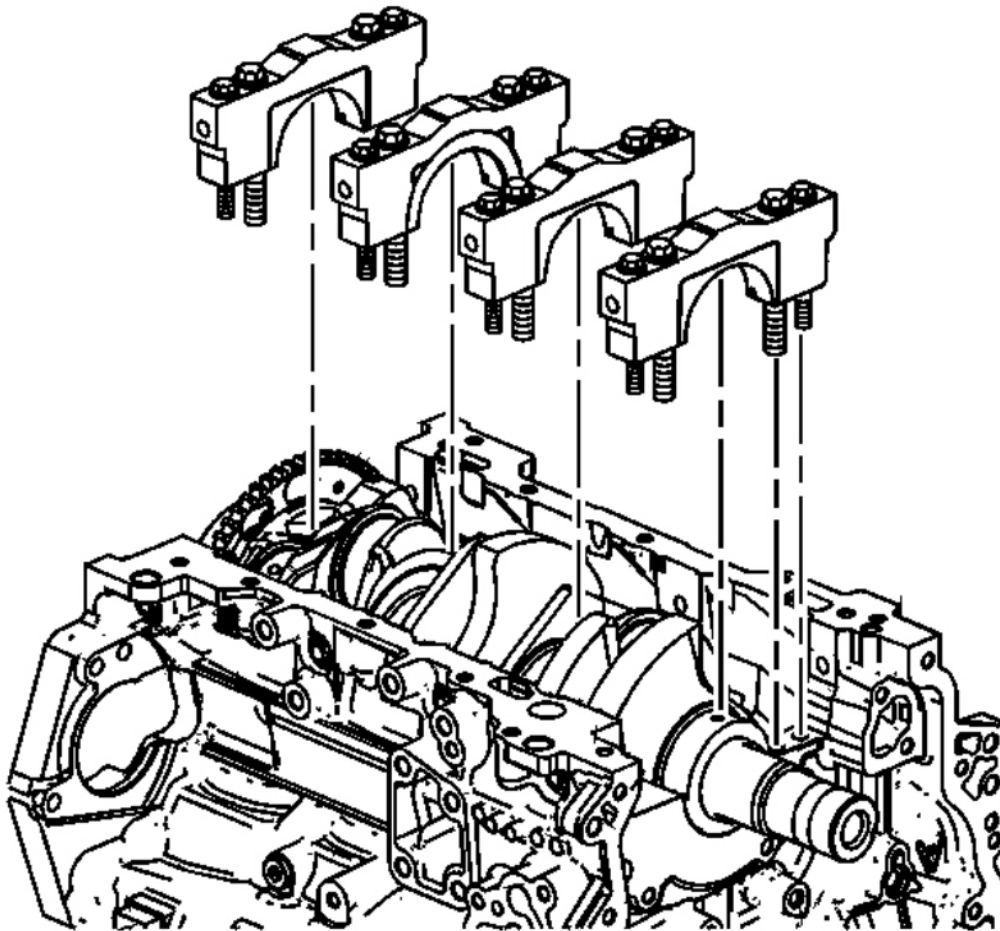


**Fig. 158: Identifying Front Main Bearing Cap**

Courtesy of GENERAL MOTORS CORP.

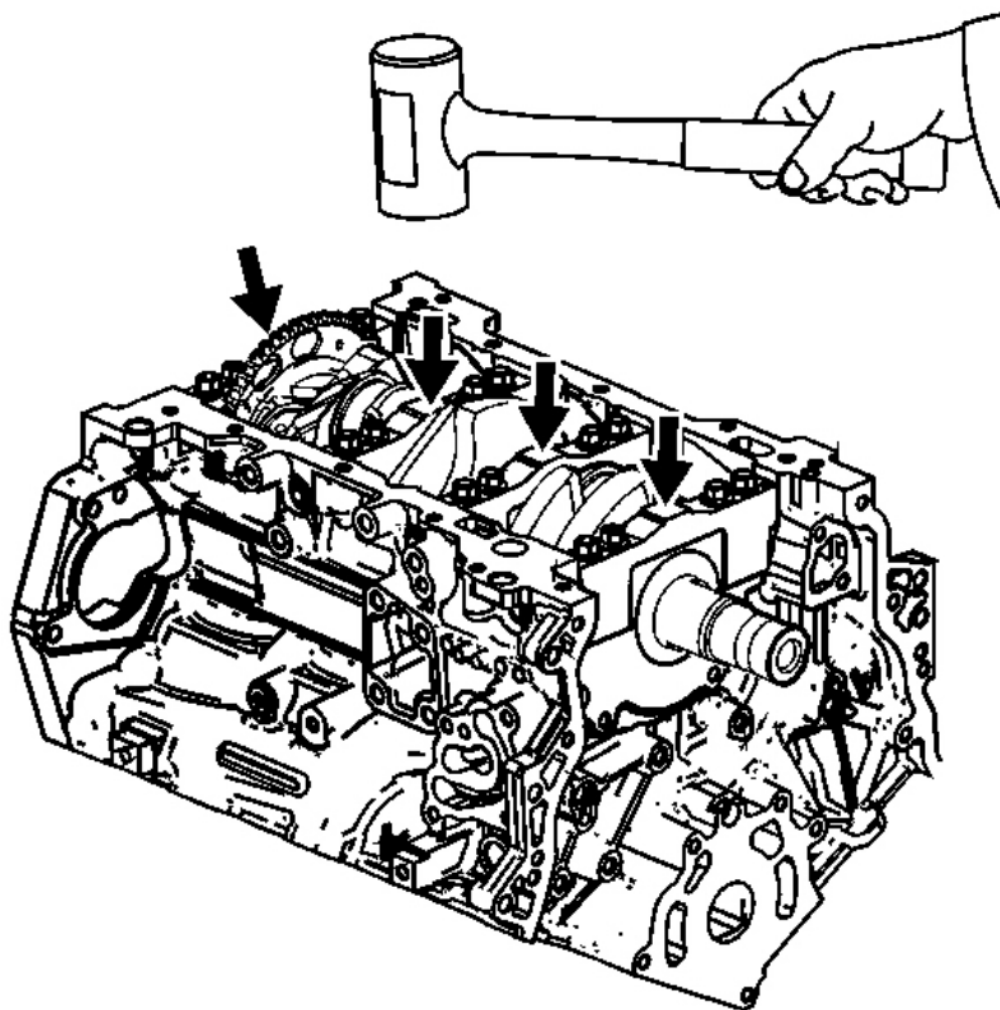
24. Identify the proper order of the main bearing caps. The main bearing caps are numbered 1 (1) through 4, with the front main bearing cap marked with the number 1. The arrow (2) is to be oriented to the front of the engine.





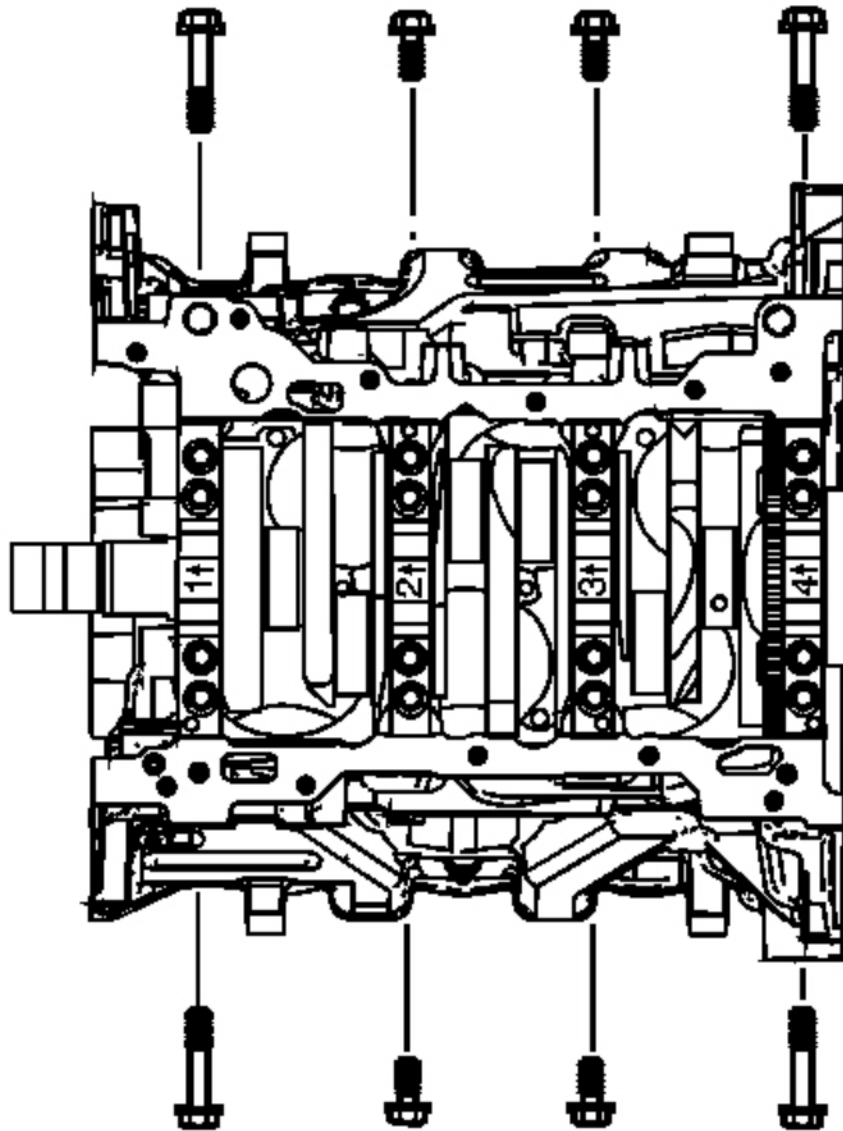
**Fig. 159: View Of Crankshaft Main Bearing Caps**  
Courtesy of GENERAL MOTORS CORP.

25. Install the crankshaft main bearing caps.
26. Loosely install the original inner main cap bolts.
27. Loosely install the NEW outer main cap bolts.



**Fig. 160: Setting Crankshaft Main Bearing Caps**  
Courtesy of GENERAL MOTORS CORP.

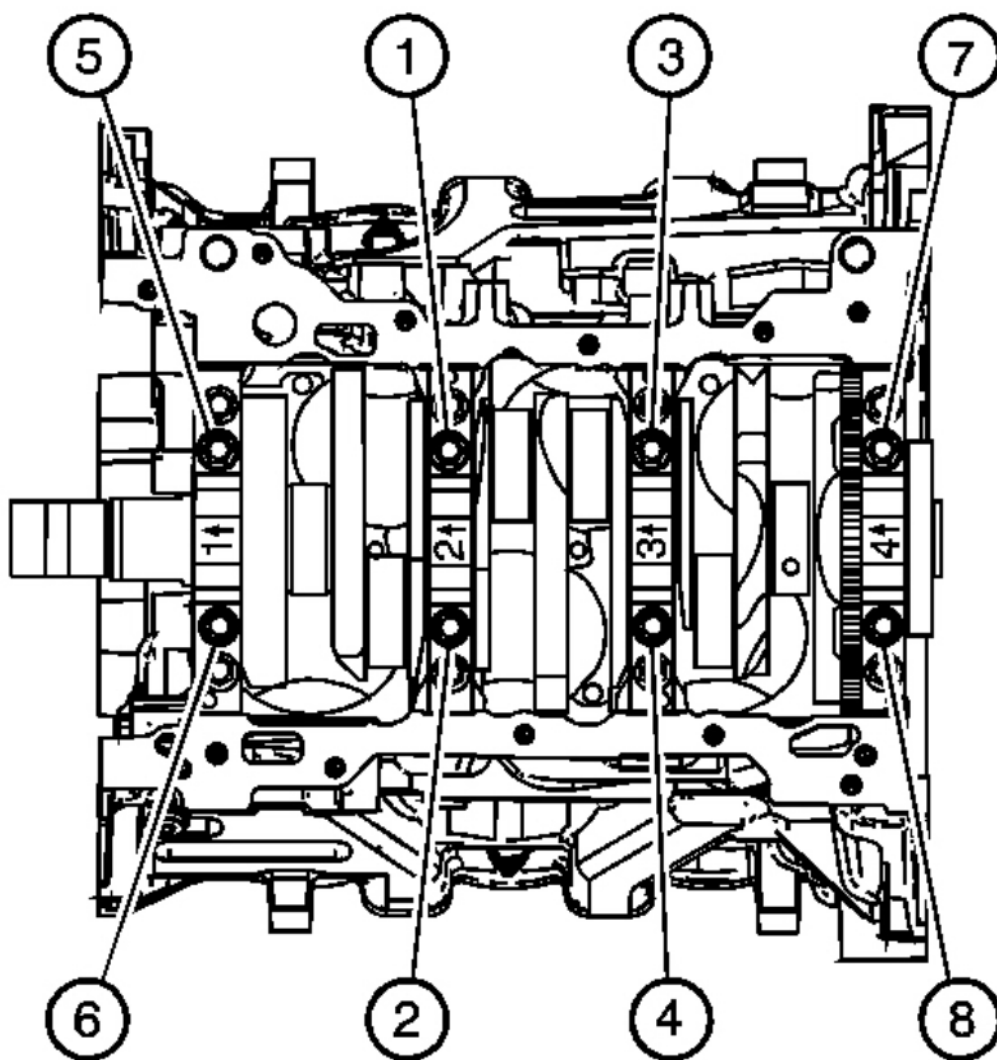
28. Tap the crankshaft main bearing caps with a soft-faced hammer.



**Fig. 161: Identifying Crankshaft Main Bearing Cap Side Bolts**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** The side main cap bolts originally have a sealant on the flange of the bolt head. NEW bolts must be used, if NEW bolts are not used, oil can leak from the crankcase past the bolts.

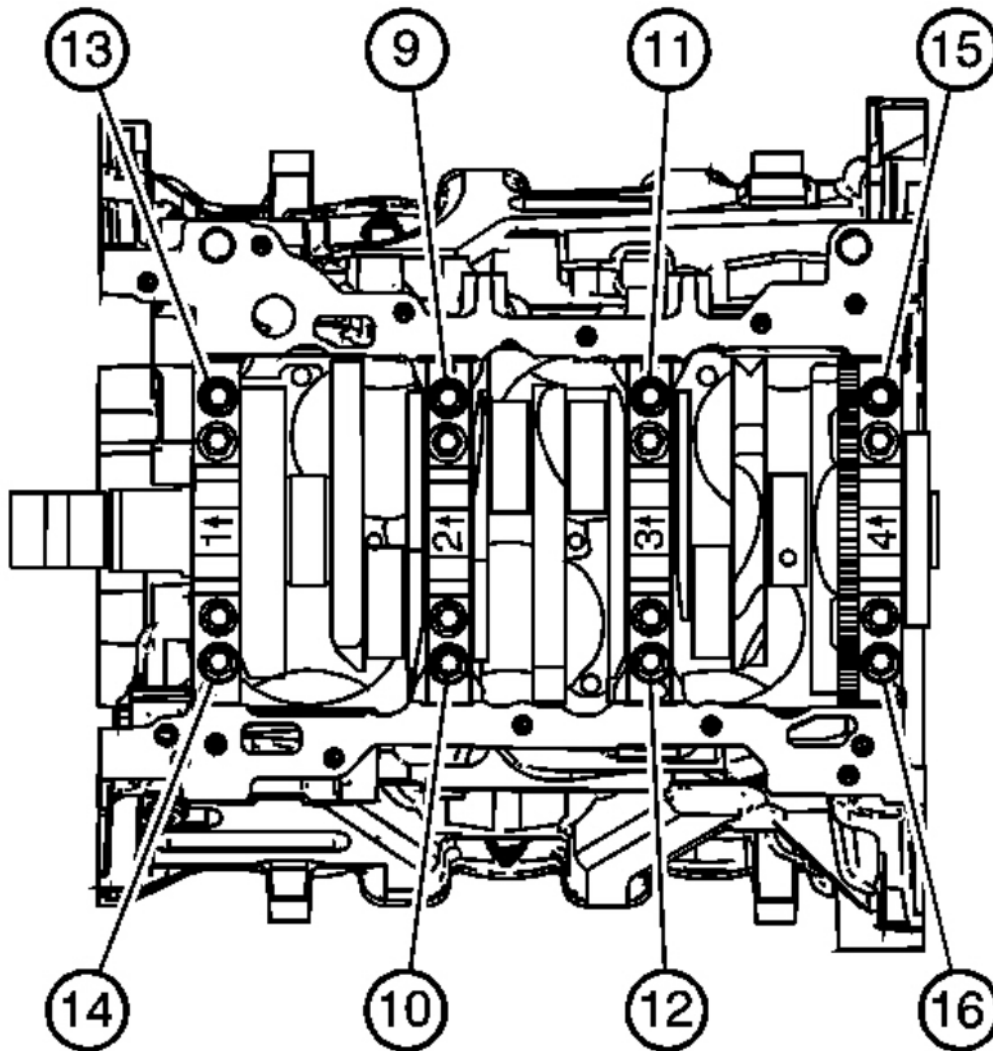
29. Loosely install the NEW short/inner side main cap bolts.
30. Loosely install the NEW long/outer side main cap bolts.
31. Tighten the main cap bolts using the **J 45059** in the following sequence:



**Fig. 162: Main Cap Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

Tighten the inboard bolts (1-8).

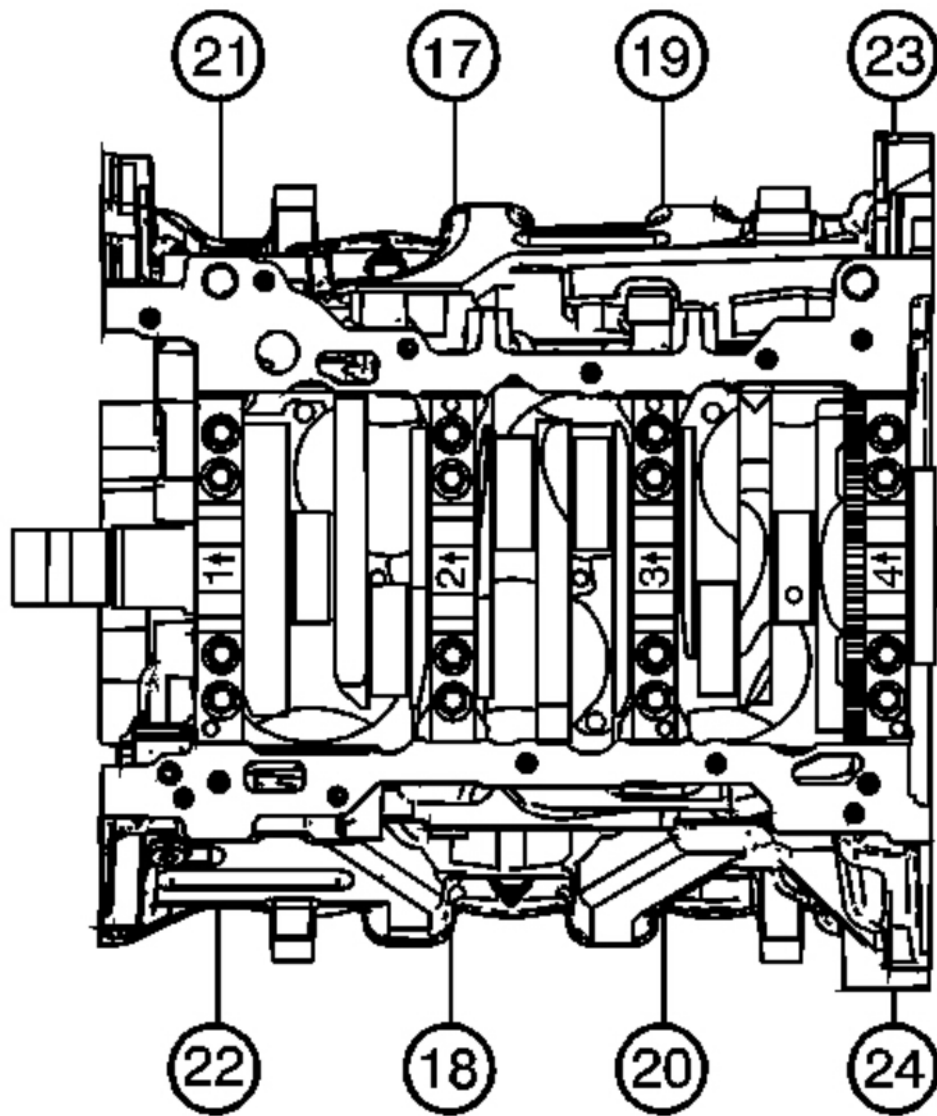
**Tighten:** Tighten the inboard bolts (1-8) to 20 N.m (15 lb ft) plus 80 degrees.



**Fig. 163: Outboard Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

32. Tighten the outboard bolts (9-16).

**Tighten:** Tighten the outboard bolts (9-16) to 15 N.m (11 lb ft) plus 110 degrees.



**Fig. 164: Short/Inner Bolts & Long/Outer Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

33. Tighten the short/inner bolts (17-20).

**Tighten:** Tighten the short/inner bolts (17-20) to 30 N.m (22 lb ft) plus 60 degrees.

34. Tighten the long/outer bolts (21-24).

**Tighten:** Tighten the long/outer bolts (21-24) to 30 N.m (22 lb ft) plus 60 degrees.

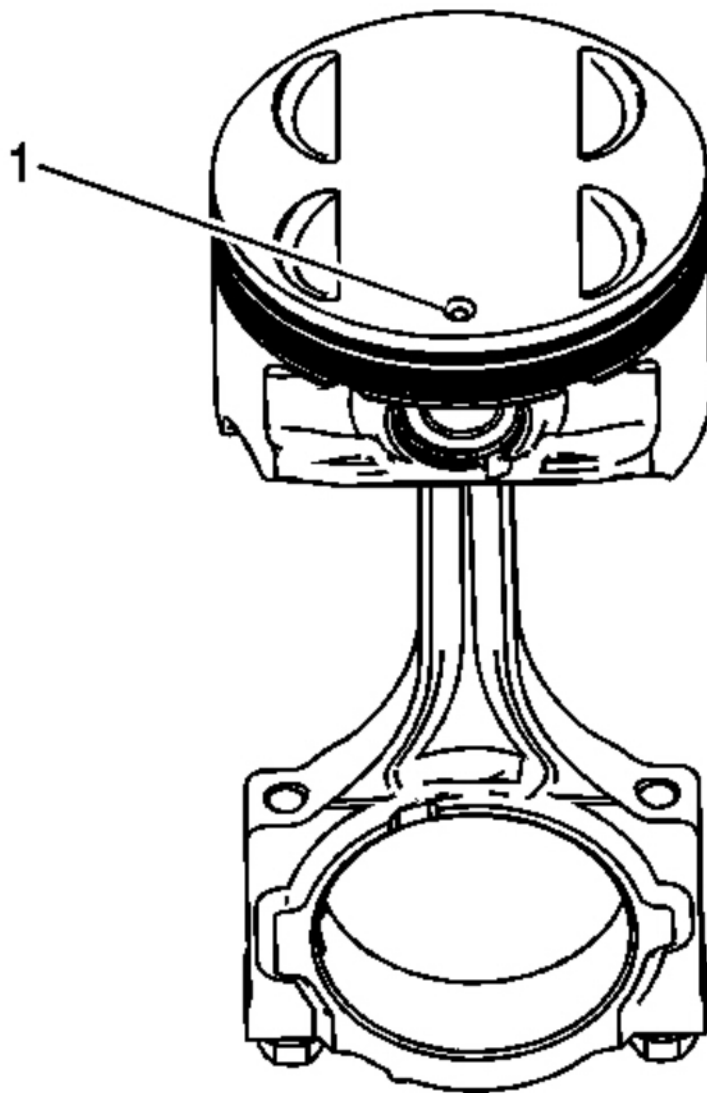
35. Ensure that the crankshaft turns without binding or noise.

## **PISTON, CONNECTING ROD, AND BEARING INSTALLATION**

### **Tools Required**

- **EN 46111** Crankshaft Rotation Socket
- **EN 46121** Connecting Rod Guide Pin Set
- **J 8037** Ring Compressor
- **J 43690** Rod Bearing Clearance Checking Tool
- **J 43690-100** Rod Bearing Clearance Checking Tool - Adapter Kit
- **J 45059** Angle Meter

### **PISTON AND CONNECTING ROD ASSEMBLY PROCEDURE**



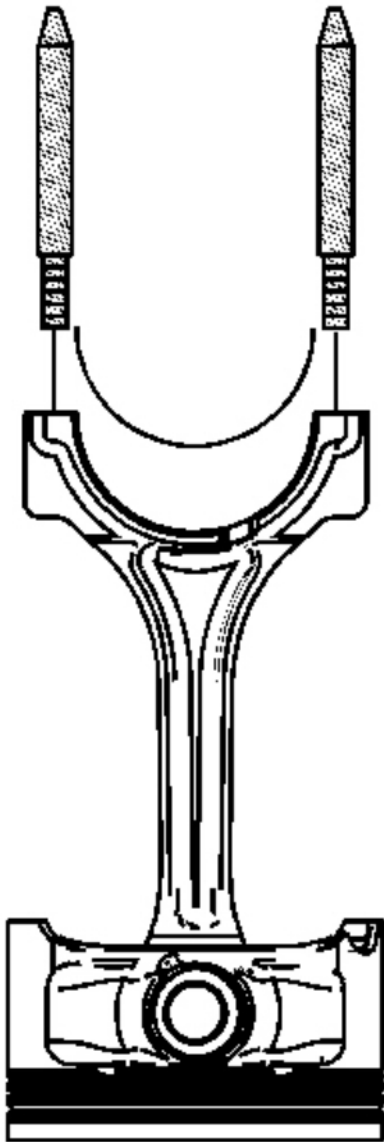
**Fig. 165: Identifying Proper Piston Orientation With Dot On Piston**  
Courtesy of GENERAL MOTORS CORP.

1. Liberally lubricate the cylinder walls, piston rings and piston skirts with engine oil.

**IMPORTANT:** The piston is directional and must be installed in the engine block in the proper direction.



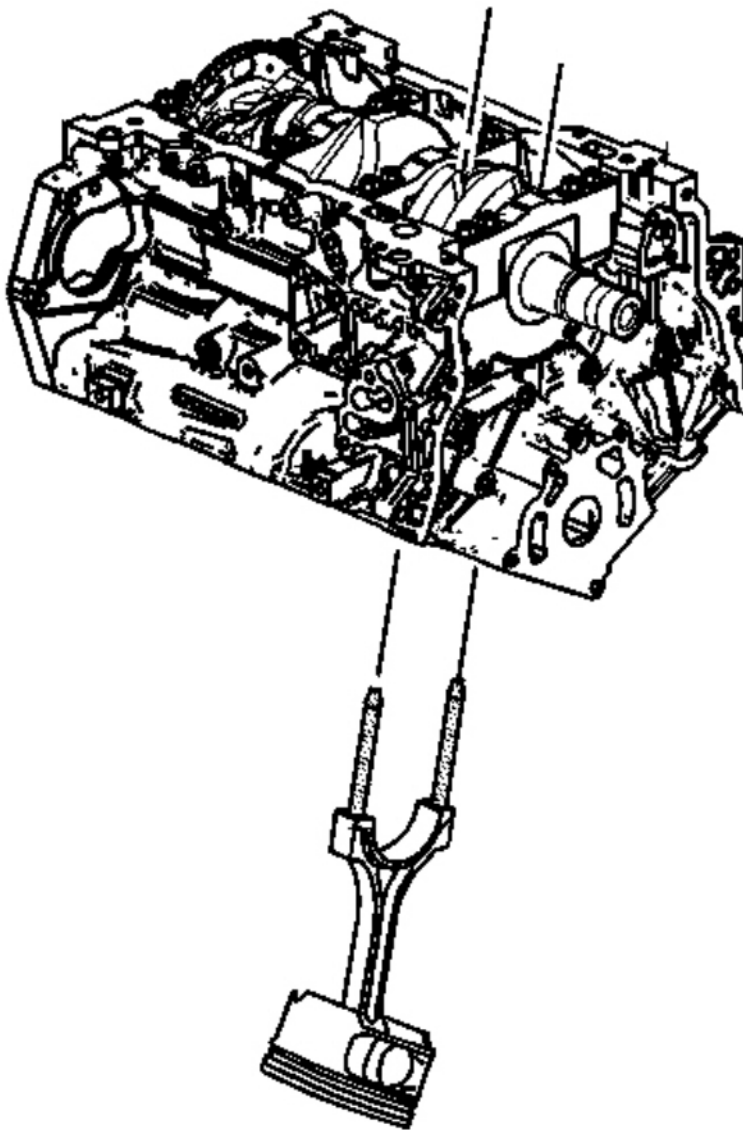
2. Select the correctly numbered piston/connecting rod assembly for the cylinder. A dot (1) showing proper piston orientation is located on the top of the piston.



**Fig. 166: View Of Piston/Connecting Rod Installation Tool**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** If the connecting rod bearings have been used in a running engine, you must replace them with **NEW** connecting rod bearings for reassembly.

3. Install the connecting rod bearing into the connecting rod.
4. Install the **EN 46121** into the connecting rod bolt holes.
5. Compress the piston rings using the **J 8037** or equivalent.

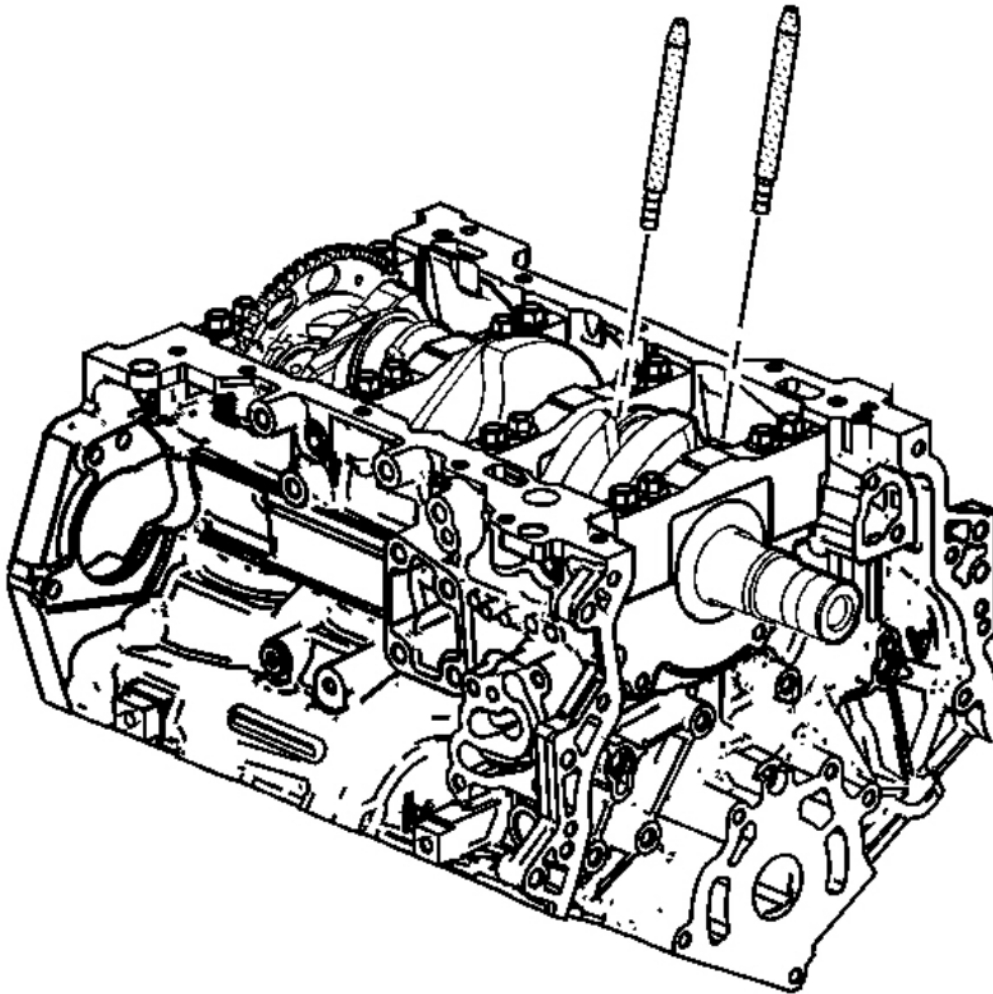


**Fig. 167: View Of Connecting Rod And Piston Assembly**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** Extreme care must be used when installing the piston and connecting rod in order to be sure the rod does not scrape or nick the cylinder bore, the oil jets, or the crankshaft surfaces.

6. Using both hands, slowly guide the piston and connecting rod assembly into the cylinder from the top and bottom of the cylinder. DO NOT allow the connecting rod to contact the cylinder wall.
7. When the **J 8037** contacts the deck surface, gently tap the piston into the cylinder using the handle end of a dead-blow hammer. Guide the connecting rod onto the crankshaft bearing journal using the **EN 46121** while gently tapping the piston into the cylinder with a soft-blow hammer.



**Fig. 168: Identifying EN 46121**

Courtesy of GENERAL MOTORS CORP.

8. Remove the EN 46121 from the connecting rod bolt holes.

#### **CONNECTING ROD BEARING CLEARANCE MEASUREMENT PROCEDURE - USING PLASTIC GAGING**

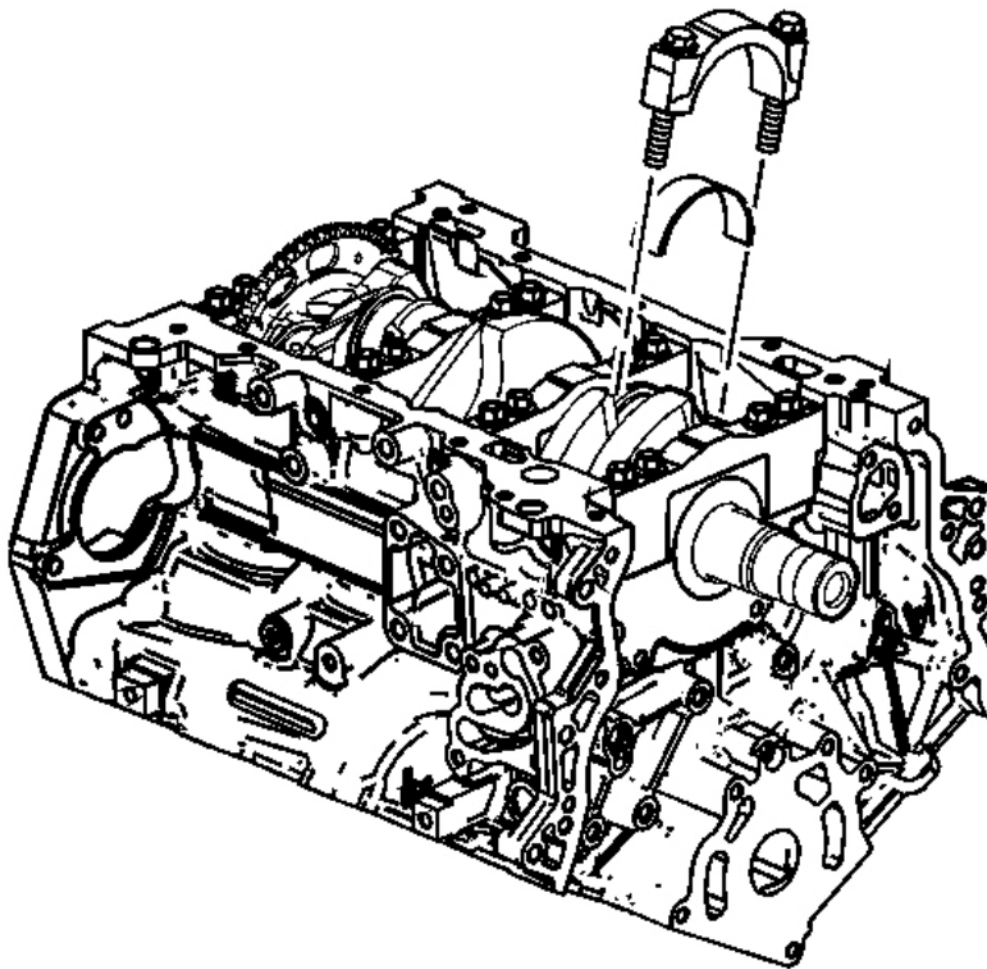
**IMPORTANT:** Connecting rod bearings that have been run in an engine should NEVER be reused.

Before final assembly it is important to check the clearance of the new connecting rod bearings.

1. Place a length of fresh, room temperature plastic gaging material all the way across the connecting rod bearing journal.
2. Install the connecting rod bearing into the connecting rod cap.

**IMPORTANT:** The connecting rod is non-directional therefore the connecting rod bearing lock tangs can face inboard or outboard.

3. Install the connecting rod end cap on its original connecting rod and ensure the bearing lock tangs are aligned on the same side of the rod.



**Fig. 169: View Of Connecting Rod Bearing And Cap**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

**NOTE:** Do not lubricate the NEW connecting rod bolts. The NEW bolts have a pre-applied graphite lubricant. Applying lubricant to the connecting rod bolts will effect the clamp load when the connecting rod bolts are torqued. Improper clamp load can lead to component failure and extensive engine damage.

**IMPORTANT:** Reuse the old connecting rod bolts ONLY for measuring the connecting rod bearing clearance.

4. Install the connecting rod bolts into the connecting rod cap.

**Tighten:** Tighten the connecting rod bolts to 30 N.m (22 lb ft).

5. Loosen the connecting rod bolts until the torque reading is zero.
6. Re-tighten the connecting rod bolts.

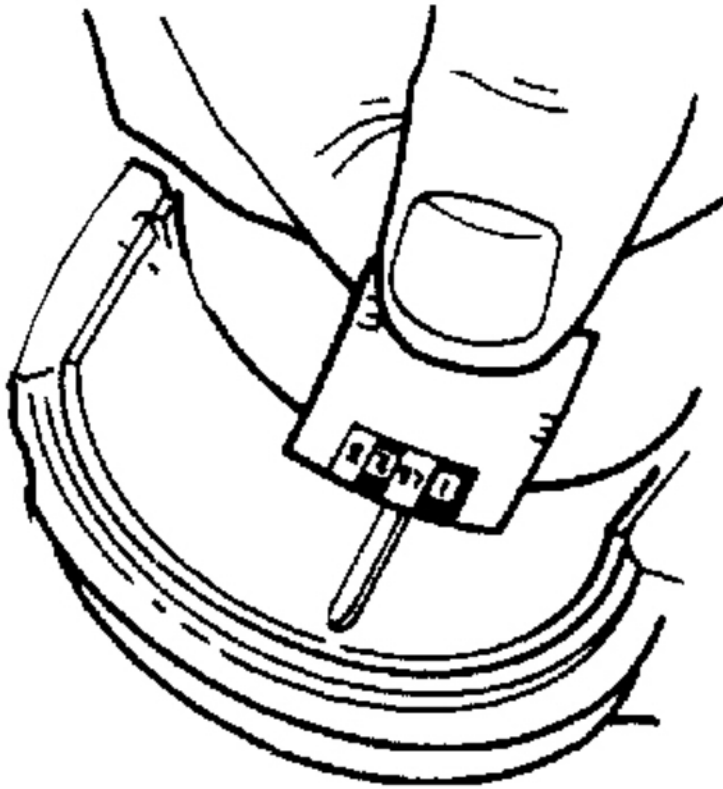
1. First Pass

**Tighten:** Tighten the connecting rod bolts to 25 N.m (18 lb ft).

2. Final Pass

**Tighten:** Tighten the connecting rod bolts an additional 110 degrees using the **J 45059** .

7. Allow the assembly to sit for at least 2 minutes.
8. Remove the connecting rod cap bolts.
9. Remove the connecting rod cap.

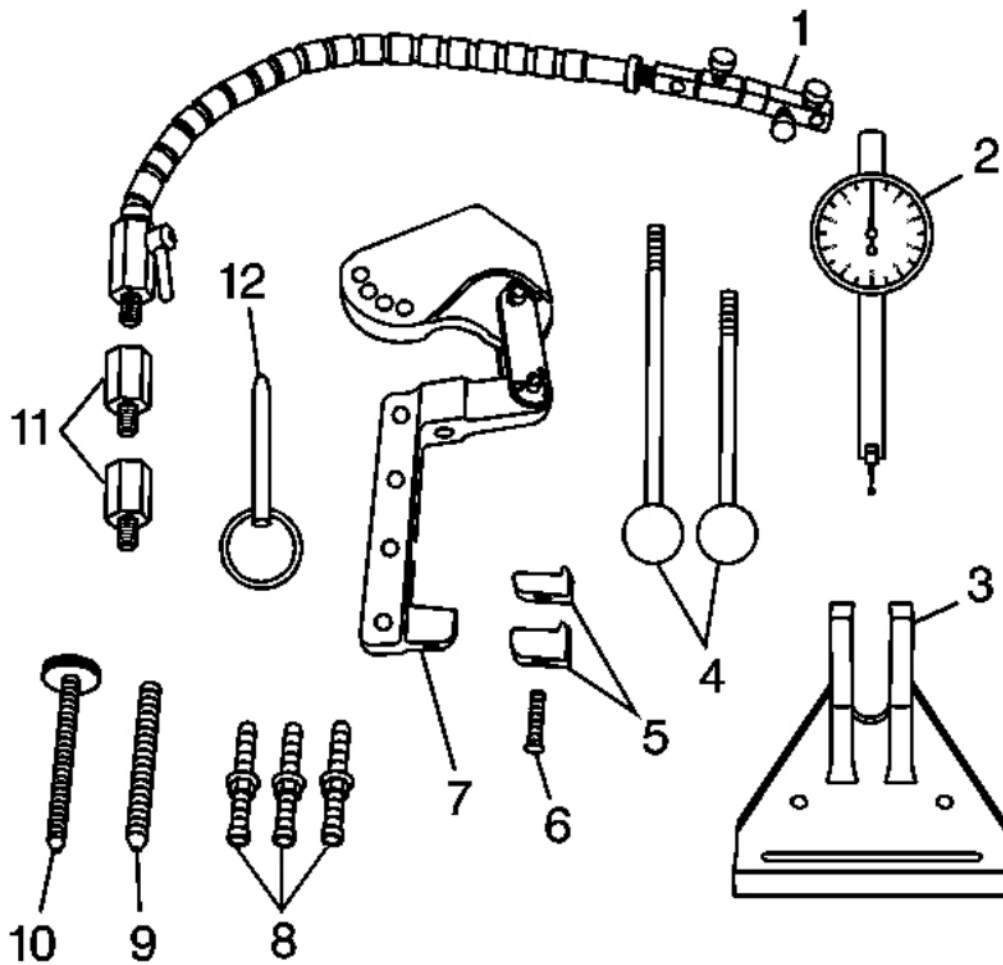


**Fig. 170: Measuring Plastigage**  
Courtesy of GENERAL MOTORS CORP.

10. Determine the connecting rod bearing clearance by comparing the width of the flattened plastic gaging material at its widest point with the graduation on the gaging material container.
11. Compare your measurements with the engine mechanical specifications. If the new bearings do not provide the proper crankshaft to connecting rod bearing clearance, inspect the following:
  1. Re-measure the crankshaft connecting rod journals for the correct specified size and ensure the proper new bearings are being installed. If the crankshaft connecting rod journals are incorrectly sized, replace or regrind the crankshaft. Crankshaft machining is permitted and undersized bearings are available.
  2. Re-measure the connecting rod bearing bore diameter to ensure proper size. The connecting rod is not machinable and the connecting rod must be replaced if out of specification.
12. Clean the plastic gaging material from the connecting rod bearing journals using a soft lint-free cloth.

**AND J 43690-100**

The **J 43690** and the **J 43690-100** have been developed as a more accurate method to measure connecting rod bearing clearances. The instructions below provide an overview of tool set-up and usage. For more detailed information, refer to the tool instruction sheets as supplied by the tool manufacturer.



**Fig. 171: Identifying Rod Bearing Clearance Checking Tool**  
 Courtesy of GENERAL MOTORS CORP.

**J 43690 Rod Bearing Clearance Checking Tool**

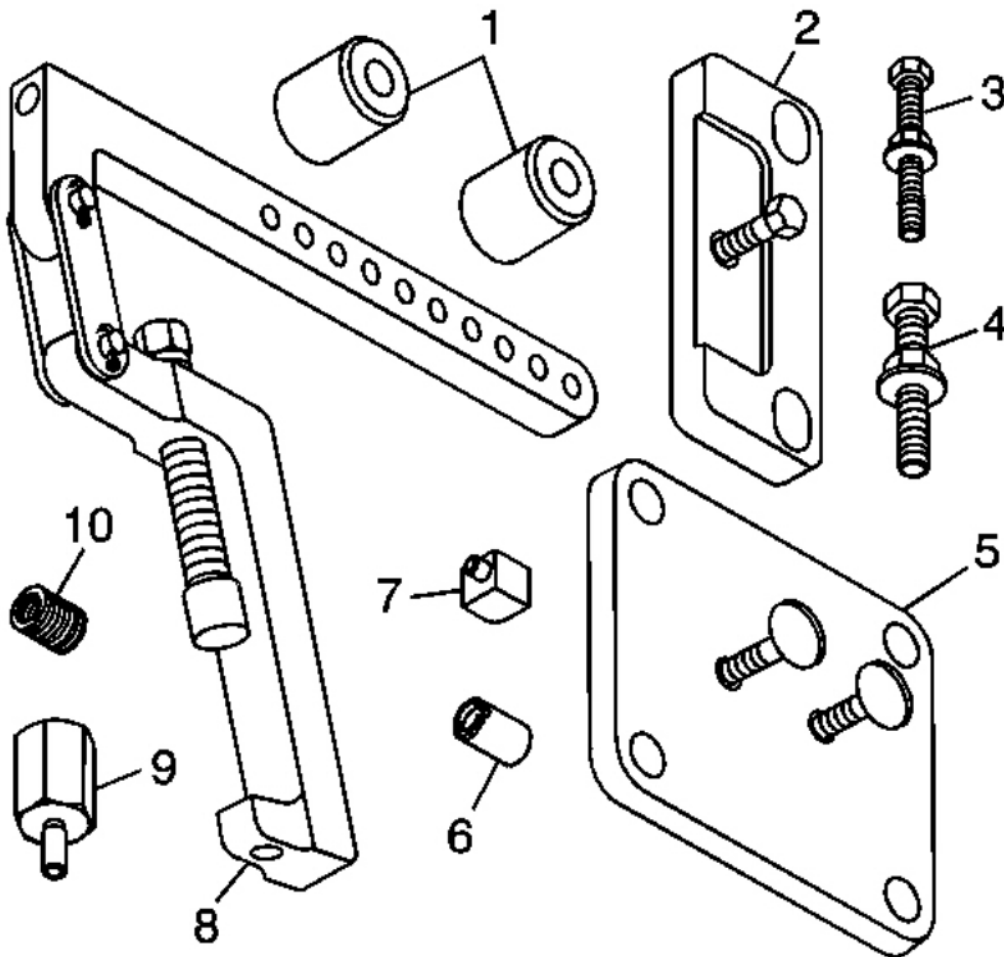
- J 43690-20 Swivel Base (1)
- J 43690-19 Dial Indicator (2)



## 2006 Cadillac CTS

2006 ENGINE Engine Mechanical - 3.6L (LY7) - CTS (3 Of 5)

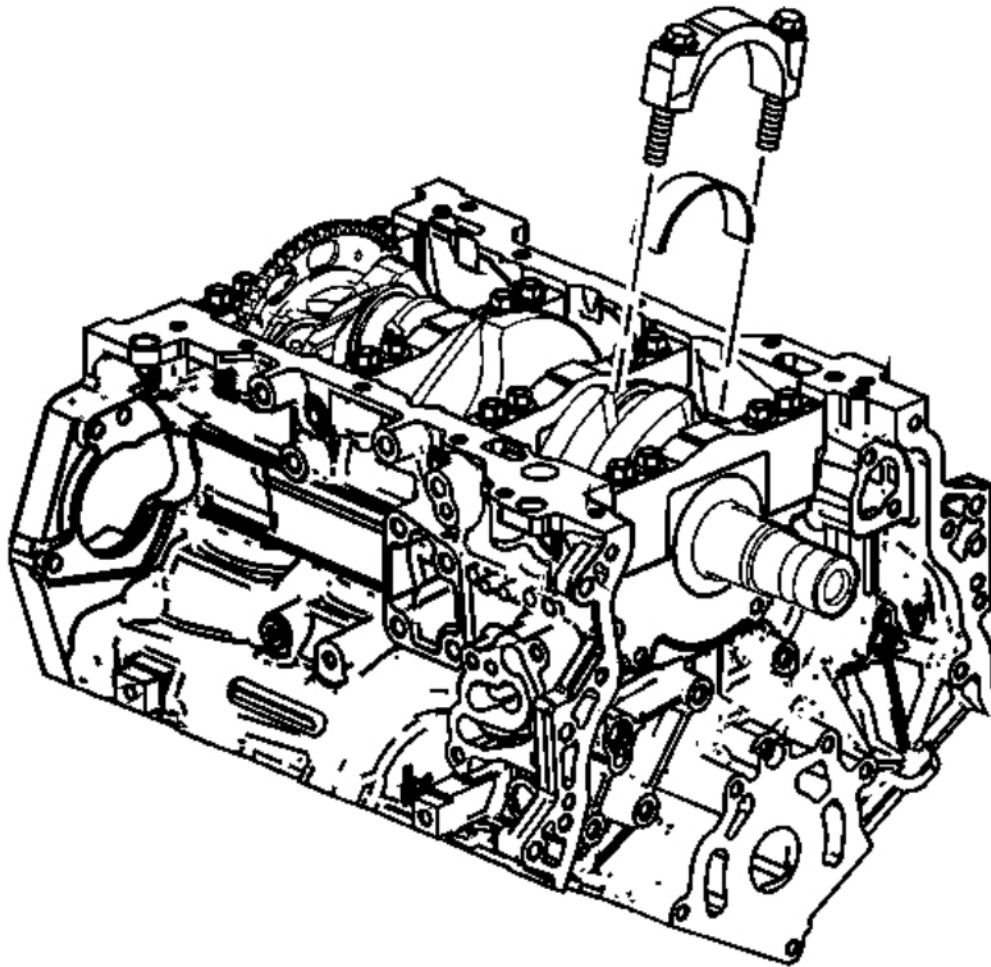
- J 43690-2 Base (3)
- J 43690-5, -6 Handle (4)
- J 43690-10, -11 Foot (5)
- 280307 Screw (6)
- J 43690-1 Pivot Arm Assembly (7)
- J 43690-3, -7, -8 Screws (8)
- 280319 Screw (9)
- 280311 Screw (10)
- J 43690-17, -18 Adapter (11)
- 280310 Pin (12)



**Fig. 172: Identifying Rod Bearing Clearance Tool - Adapter Kit**  
**Courtesy of GENERAL MOTORS CORP.**

**J 43690-100 Rod Bearing Clearance Tool - Adapter Kit**

- J 43690-104 Spacer (1)
- J 43690-105 Retainer Plate (2)
- 505478 Bolt (3)
- 511341 Bolt (4)
- J 43690-106 Retainer Plate (5)
- J 43690-107 Cap (6)
- J 43690-102 Foot (7)
- J 43690-101 Pivot Arm Assembly (8)
- J 43690-103 Adapter (9)
- 505439 Adapter (10)



**Fig. 173: View Of Connecting Rod Bearing And Cap**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** Connecting rod bearings that have been run in an engine should **NEVER** be reused.

Before final assembly it is important to check the clearance of the new connecting rod bearings.

1. Install the connecting rod bearing into the connecting rod cap.

**IMPORTANT:** The connecting rod is non-directional therefore the connecting rod bearing lock tangs can face inboard or outboard.

2. Install the connecting rod end cap on its original connecting rod and ensure the bearing lock tangs are aligned on the same side of the rod.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

**NOTE:** Do not lubricate the NEW connecting rod bolts. The NEW bolts have a pre-applied graphite lubricant. Applying lubricant to the connecting rod bolts will effect the clamp load when the connecting rod bolts are torqued. Improper clamp load can lead to component failure and extensive engine damage.

**IMPORTANT:** Reuse the old connecting rod bolts ONLY for measuring the connecting rod bearing clearance.

3. Install the connecting rod bolts into the connecting rod cap.

**Tighten:** Tighten the connecting rod bolts to 30 N.m (22 lb ft).

4. Loosen the connecting rod bolts until the torque reading is zero.
5. Re-tighten the connecting rod bolts.

1. First Pass

**Tighten:** Tighten the connecting rod bolts to 25 N.m (18 lb ft).

2. Final Pass

**Tighten:** Tighten the connecting rod bolts an additional 110 degrees using the **J 45059**.

6. Rotate the crankshaft until the crankshaft journal and the connecting rod to be measured is in the 12 o'clock position.

**IMPORTANT:** The crankshaft must be secure with no movement or rotation in order to obtain an accurate reading.

7. Remove the crankshaft main bolts required to install the retainer plate J 43690-105.

**IMPORTANT:** Do not allow the J 43690-105 retainer plate screw to contact the reluctor ring.

8. Install the J 43690-105 and crankshaft main bolts.
9. Loosen the connecting rod bolts until the torque reading is zero.
10. Re-tighten the connecting rod bolts.
  1. First Pass

**Tighten:** Tighten the connecting rod bolts to 25 N.m (18 lb ft).

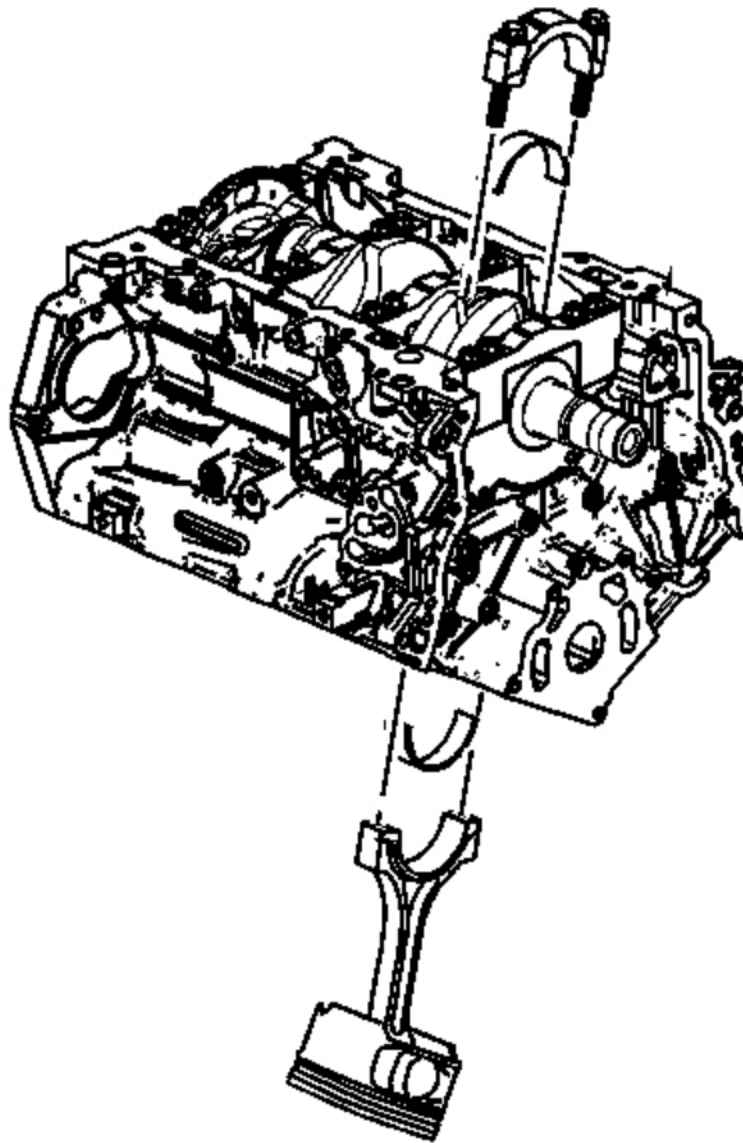
2. Final Pass

**Tighten:** Tighten the connecting rod bolts an additional 110 degrees using the **J 45059** .

11. During and after installation, ensure each piston is positioned properly in the correct cylinder. The locating arrow on the top of each piston must be pointing toward the front of the engine.
12. Repeat these procedures for the remaining piston/connecting rod assemblies using the **EN 46111** in order to rotate the crankshaft.

### CONNECTING ROD FINAL ASSEMBLY PROCEDURE

1. Guide the connecting rod away from the crankshaft connecting rod journal in order to lubricate the crankshaft connecting rod bearing journal.
2. Apply a liberal amount of crankshaft prelube GM P/N 1052367 (Canadian P/N 992869) or clean engine oil GM P/N 12345501 (Canadian P/N 992704) to the crankshaft connecting rod bearing journal.
3. Guide the connecting rod to the crankshaft connecting rod journal.
4. Install the connecting rod end cap on its original connecting rod and ensure the bearing lock tangs are aligned on the same side of the rod.



**Fig. 174: Identifying Piston & Connecting Rod Assembly**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Do not lubricate the NEW connecting rod bolts. The NEW bolts have a pre-applied graphite lubricant. Applying lubricant to the connecting rod bolts will effect the clamp load when the connecting rod bolts are torqued. Improper clamp load can lead to component failure and extensive engine

**damage.**

**IMPORTANT: DO NOT reuse the old connecting rod bolts.**

5. Install the NEW connecting rod bolts into the connecting rod cap.

**Tighten:** Tighten the NEW connecting rod bolts to 30 N.m (22 lb ft).

6. Loosen the connecting rod bolts until the torque reading is zero.
7. Re-tighten the connecting rod bolts.

1. First Pass

**Tighten:** Tighten the connecting rod bolts to 25 N.m (18 lb ft).

2. Final Pass

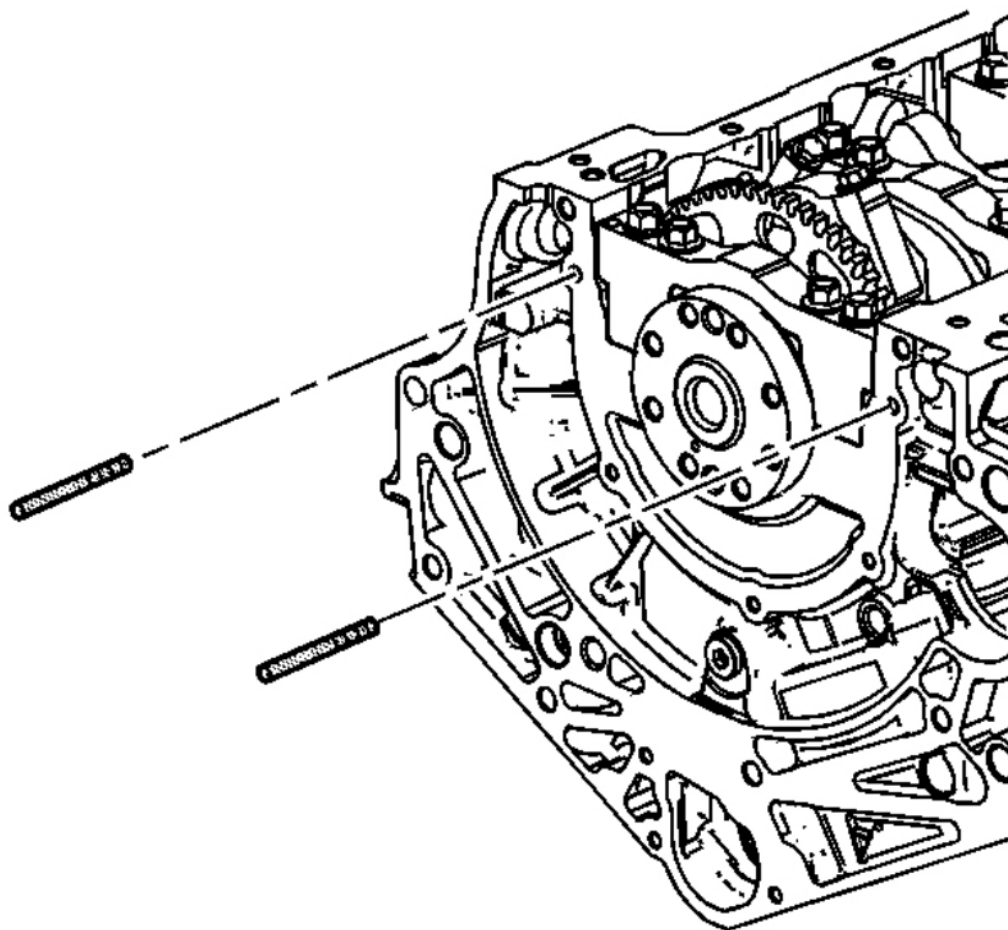
**Tighten:** Tighten the connecting rod bolts an additional 110 degrees using the **J 45059** .

8. During and after installation, ensure each piston is positioned properly in the correct cylinder. The locating arrow on the top of each piston (1) must be pointing toward the front of the engine.
9. Repeat these procedures for the remaining piston/connecting rod assemblies using the **EN 46111** in order to rotate the crankshaft.

## **CRANKSHAFT REAR OIL SEAL AND HOUSING INSTALLATION**

### **Tools Required**

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

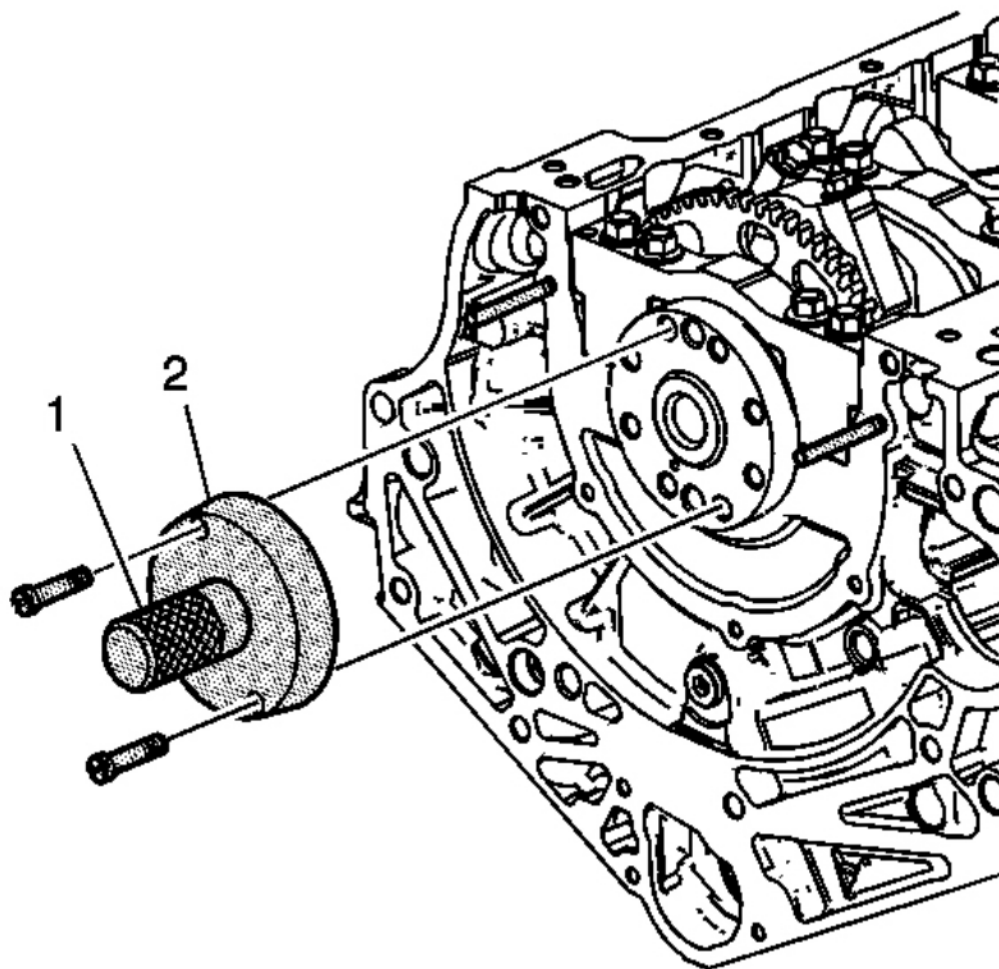


**Fig. 175: View Of EN 46109**

Courtesy of GENERAL MOTORS CORP.

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

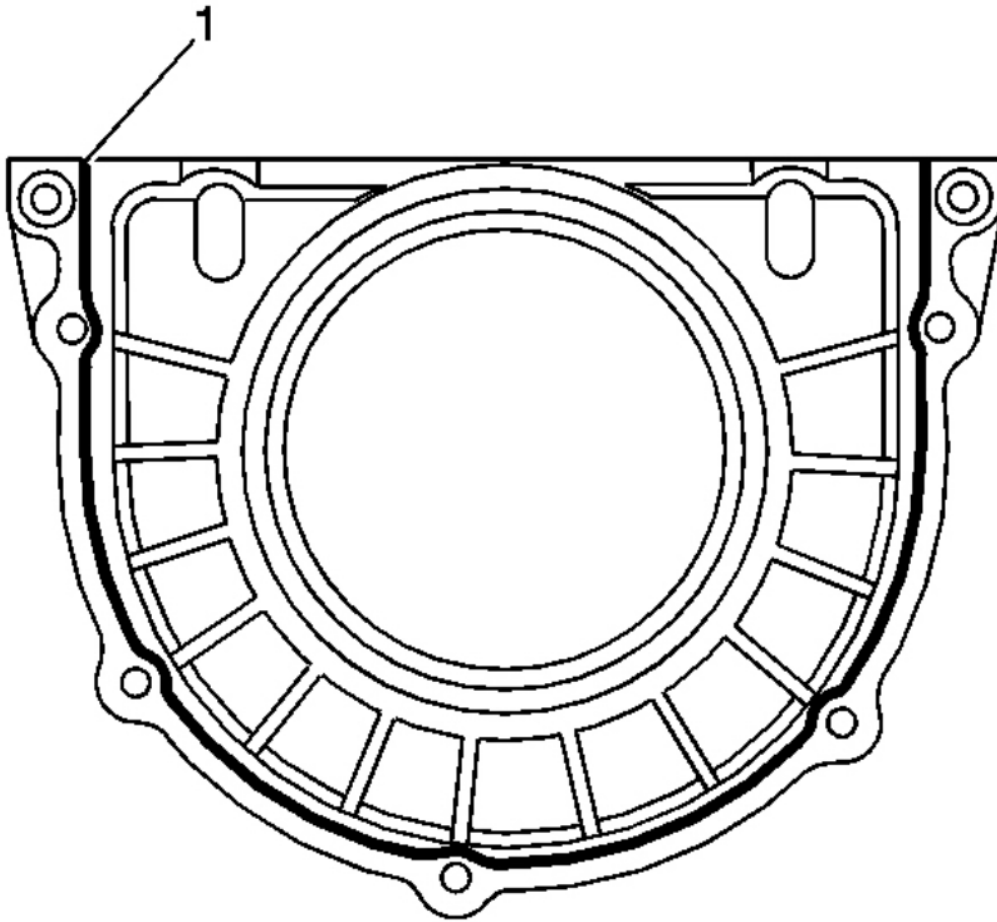




**Fig. 176: Installing EN-47839**

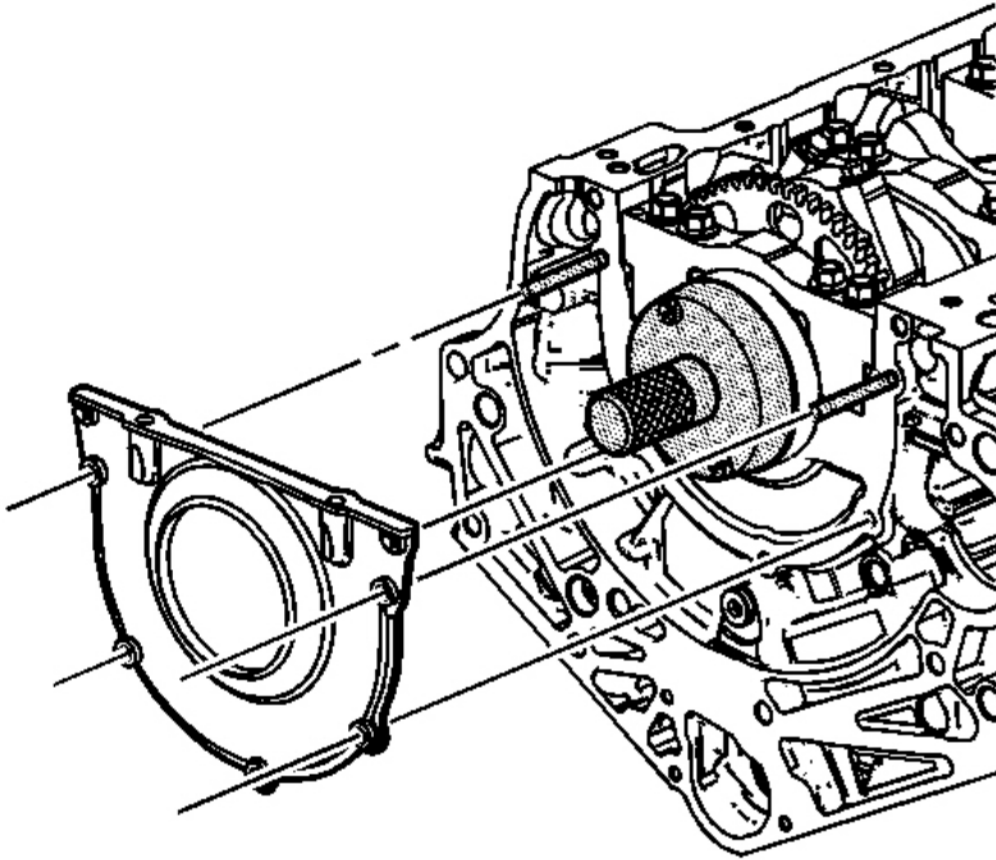
Courtesy of GENERAL MOTORS CORP.

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



**Fig. 177: Identifying Sealant Application Area On Crankshaft Rear Oil Seal Housing**  
Courtesy of GENERAL MOTORS CORP.

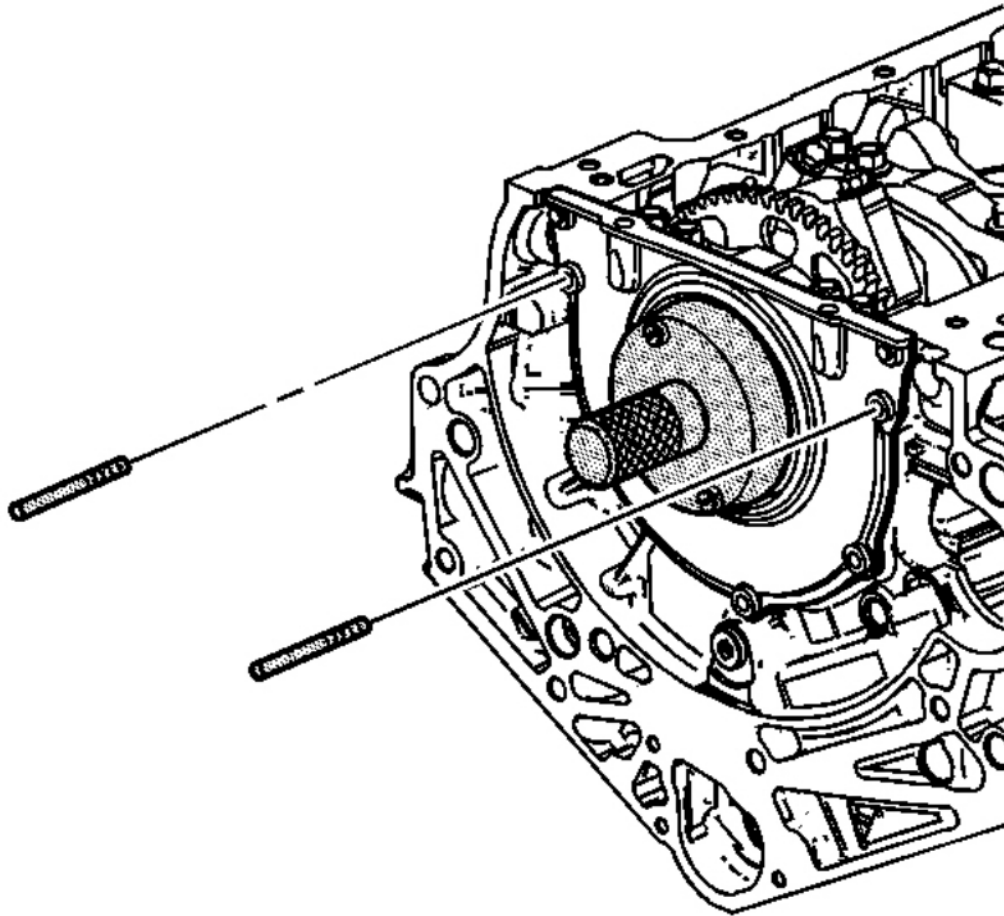
3. Place a 3 mm (0.118 in) bead of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, to the NEW crankshaft rear oil seal housing as shown (1).



**Fig. 178: Installing Crankshaft Rear Oil Seal Housing**  
Courtesy of GENERAL MOTORS CORP.

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

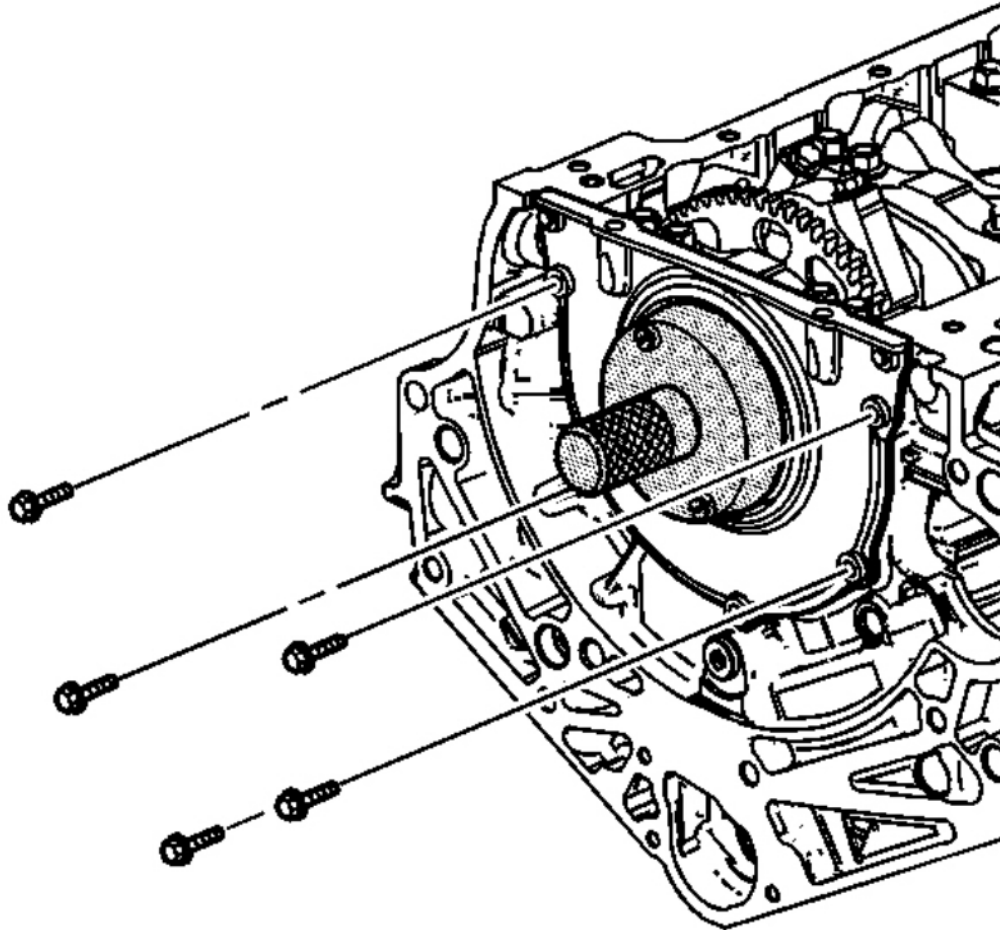
4. Install the crankshaft rear oil seal housing to the engine block.



**Fig. 179: View Of EN 46109**

Courtesy of GENERAL MOTORS CORP.

5. Remove the **EN 46109** 6 mm (0.236 in) guides from the engine block.

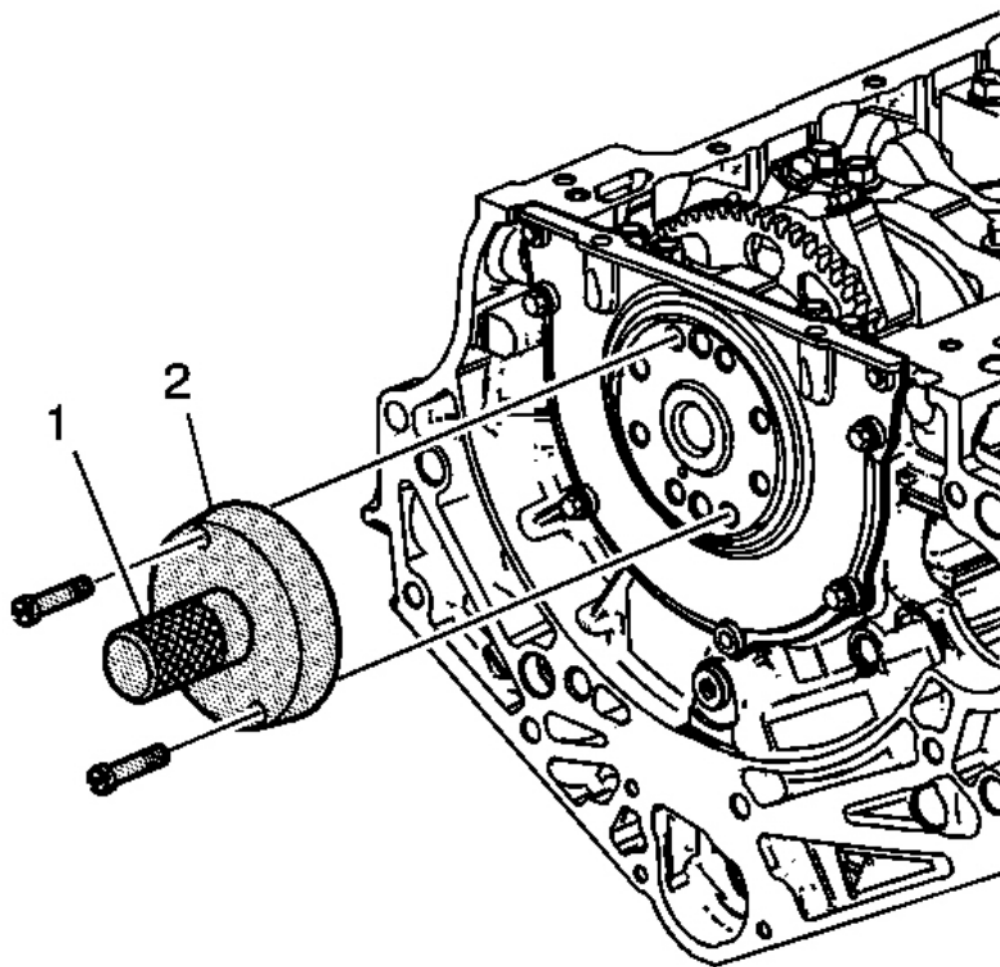


**Fig. 180: Locating Crankshaft Rear Oil Seal Housing Bolts**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

6. Install the crankshaft rear oil seal housing bolts.

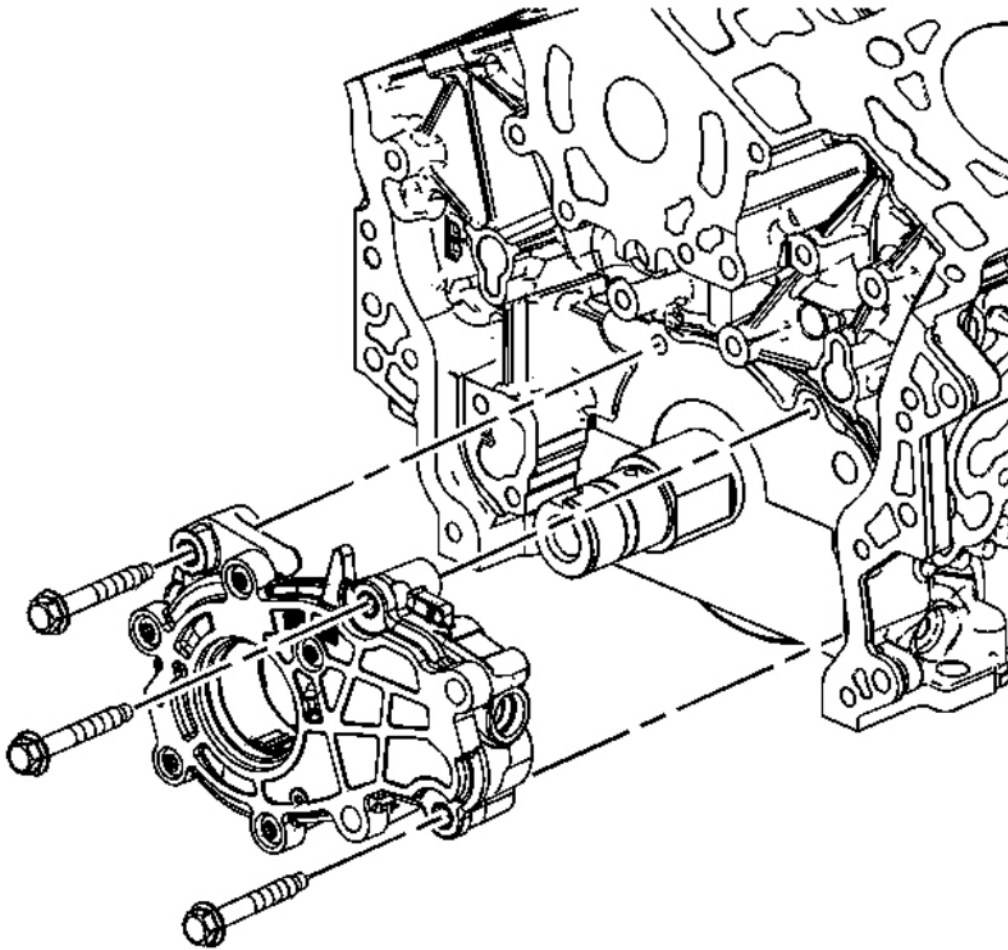
**Tighten:** Tighten the crankshaft rear oil seal housing bolts to 10 N.m (89 lb in).



**Fig. 181: View Of EN-47839 & J-42183**  
Courtesy of GENERAL MOTORS CORP.

7. Remove the **EN-47839** and **J 42183** (1, 2) from the crankshaft flange.

## OIL PUMP INSTALLATION



**Fig. 182: Oil Pump Generator**

Courtesy of GENERAL MOTORS CORP.

1. Align the oil pump generator with the crankshaft flats and install the oil pump to the engine block.
2. Align the pump body with the mounting holes in the cylinder block.

**NOTE:** Refer to Fastener Notice .

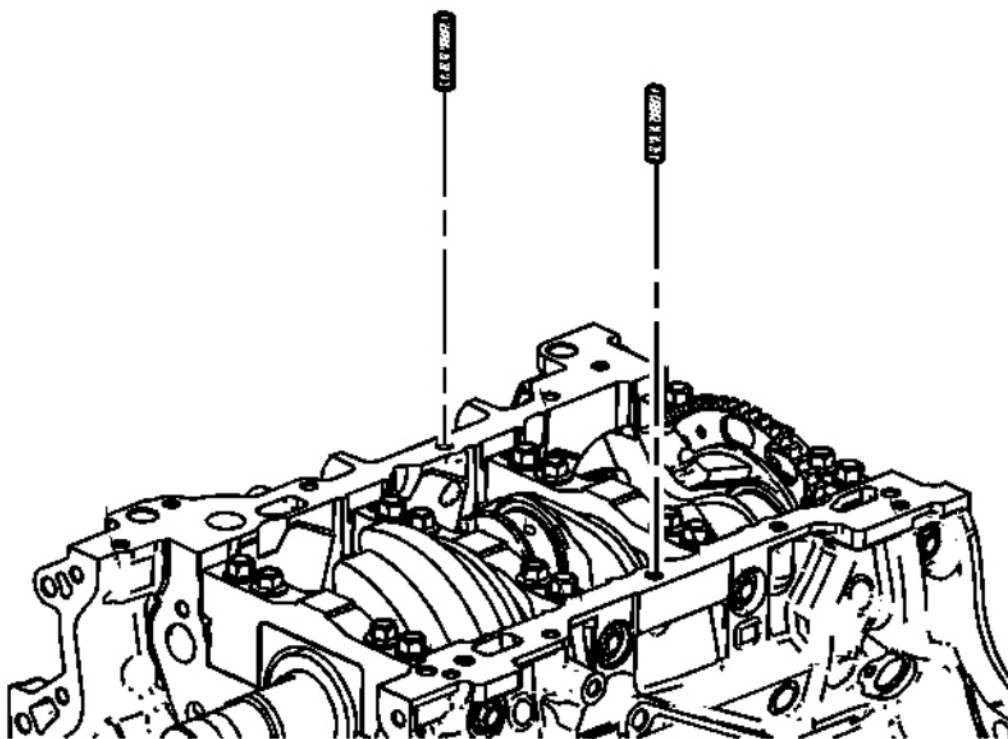
3. Install the oil pump bolts.

**Tighten:** Tighten the oil pump bolts to 23 N.m (17 lb ft).

## OIL PAN INSTALLATION

## Tools Required

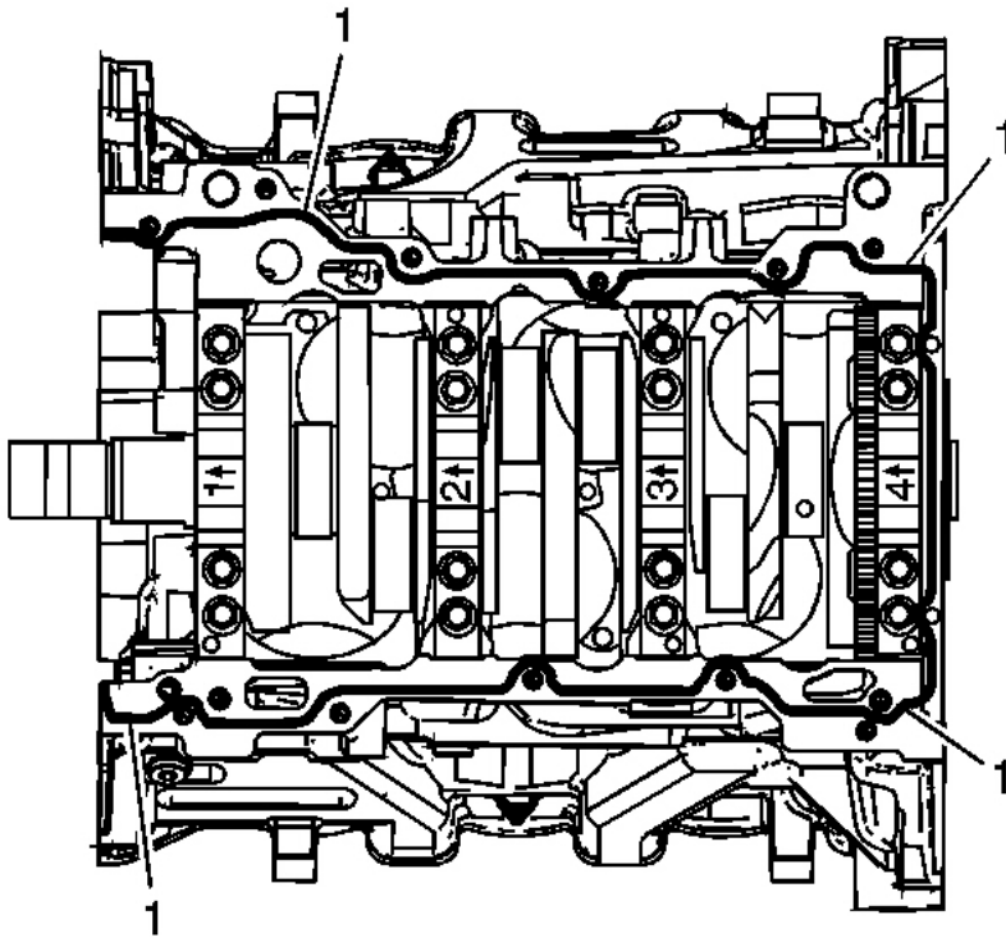
EN 46109 Guide Pin Set



**Fig. 183: Identifying EN 46109 Guides**  
Courtesy of GENERAL MOTORS CORP.

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

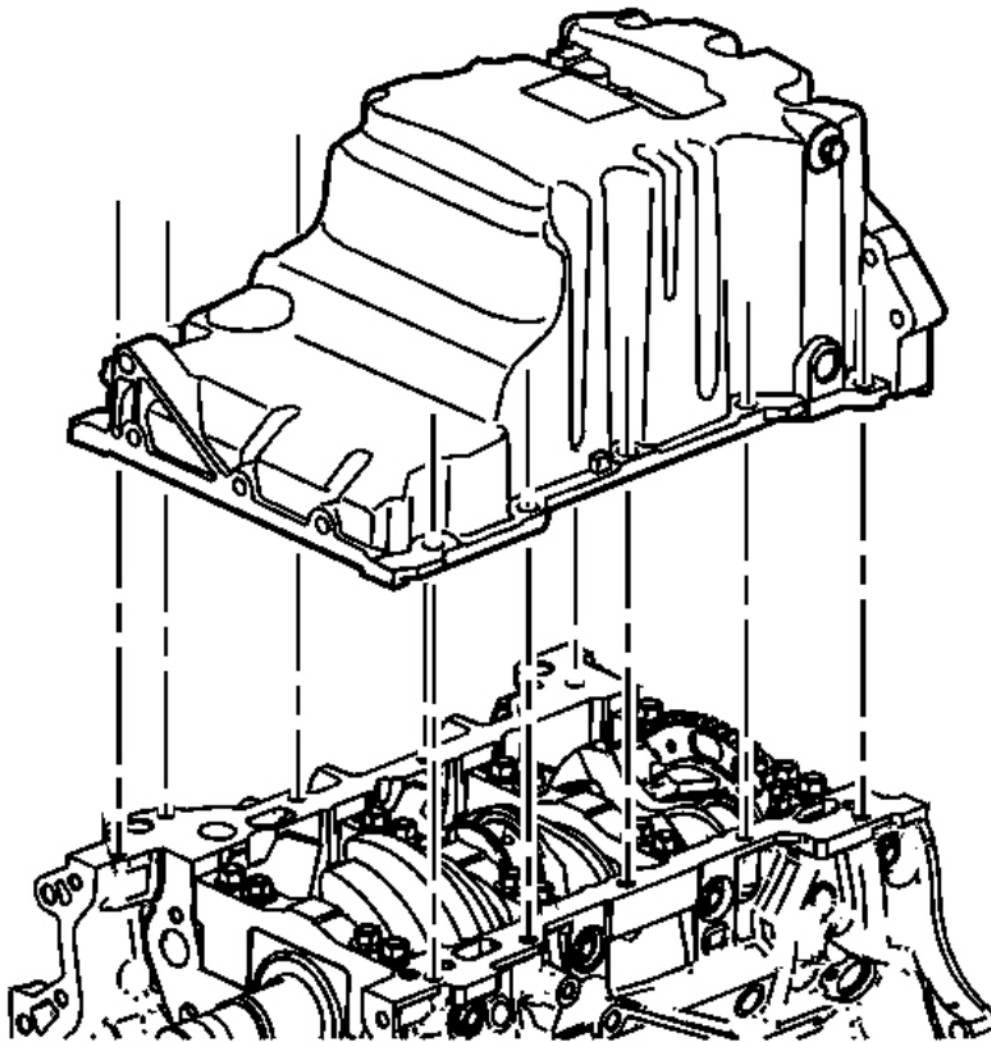




**Fig. 184: Sealant Application Locations On Block Pan Rail And The Crankshaft Rear Oil Seal Housing**

Courtesy of GENERAL MOTORS CORP.

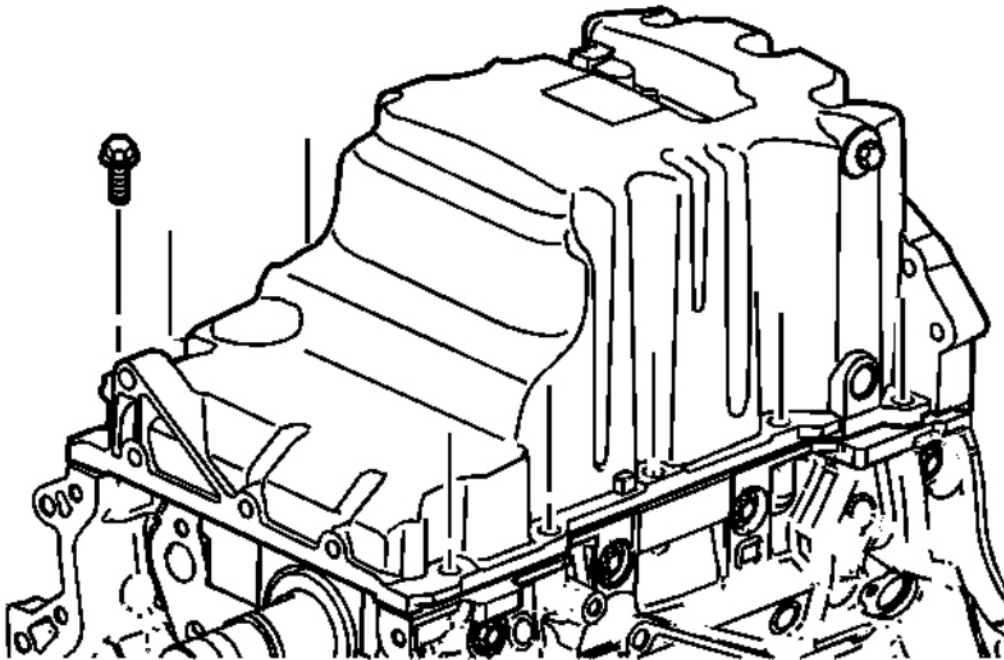
2. Place a 3 mm (0.118 in) bead of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the block pan rail and the crankshaft rear oil seal housing.



**Fig. 185: View Of Oil Pan**

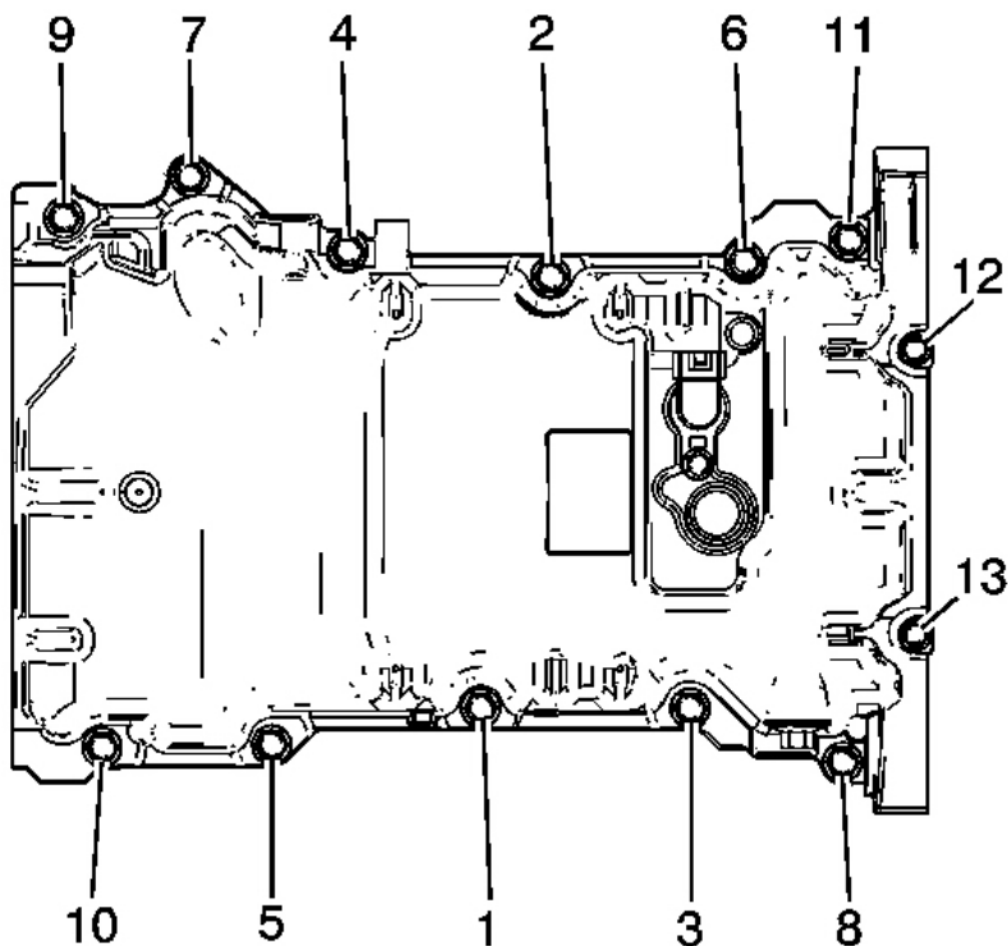
Courtesy of GENERAL MOTORS CORP.

3. Position the oil pan onto the block.
4. Remove the **EN 46109** 8 mm (0.315 in) guides from the engine block.



**Fig. 186: Identifying Oil Pan Bolts**  
Courtesy of GENERAL MOTORS CORP.

5. Loosely install the oil pan bolts.



**Fig. 187: Identifying Oil Pan Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

6. Tighten the oil pan bolts in sequence shown.

**Tighten:**

1. Tighten the 8 mm bolts (1-11) to 23 N.m (17 lb ft).
2. Tighten the 6 mm bolts (12, 13) to 10 N.m (89 lb in).

**CYLINDER HEAD INSTALLATION - RIGHT**

### Tools Required

- EN 46111 Crankshaft Rotation Socket
- J 45059 Angle Meter

**IMPORTANT:** Ensure that the crankshaft is in the timing drive assembly position using the EN 46111 .

1. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.

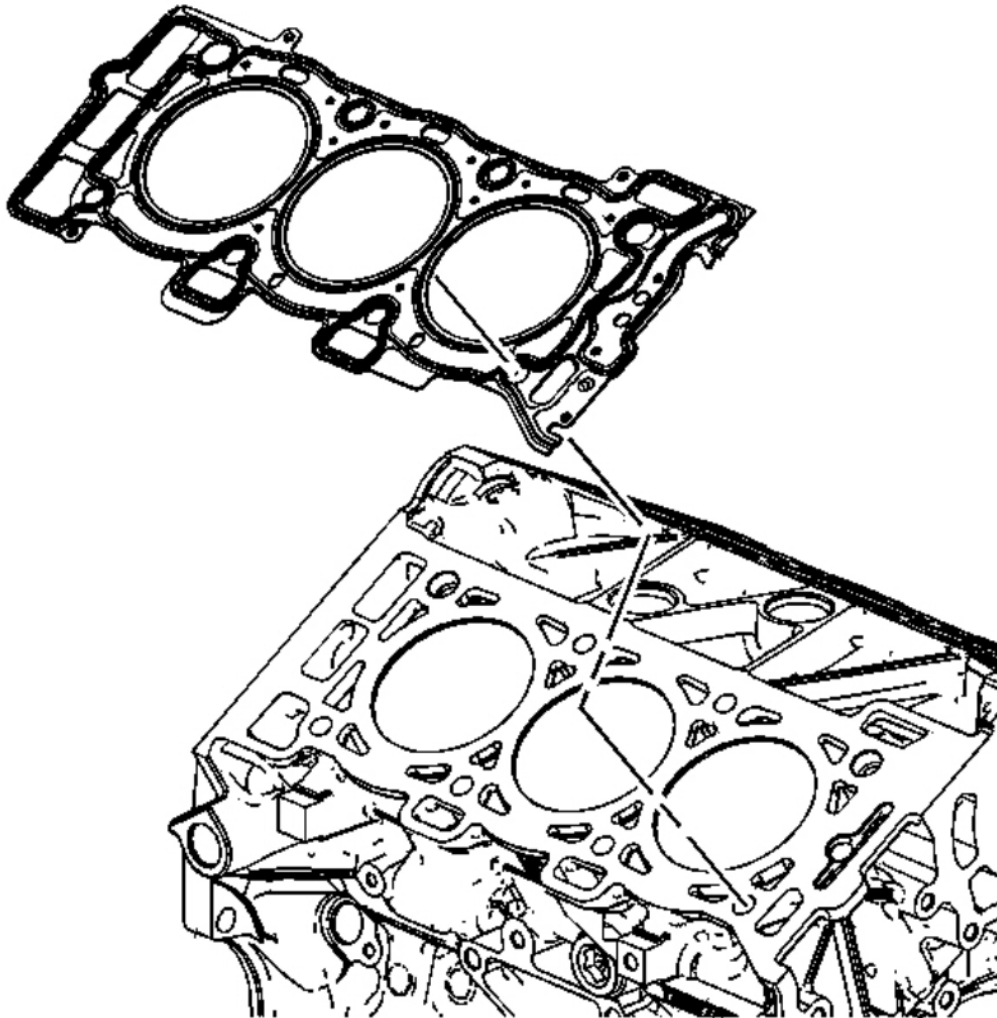
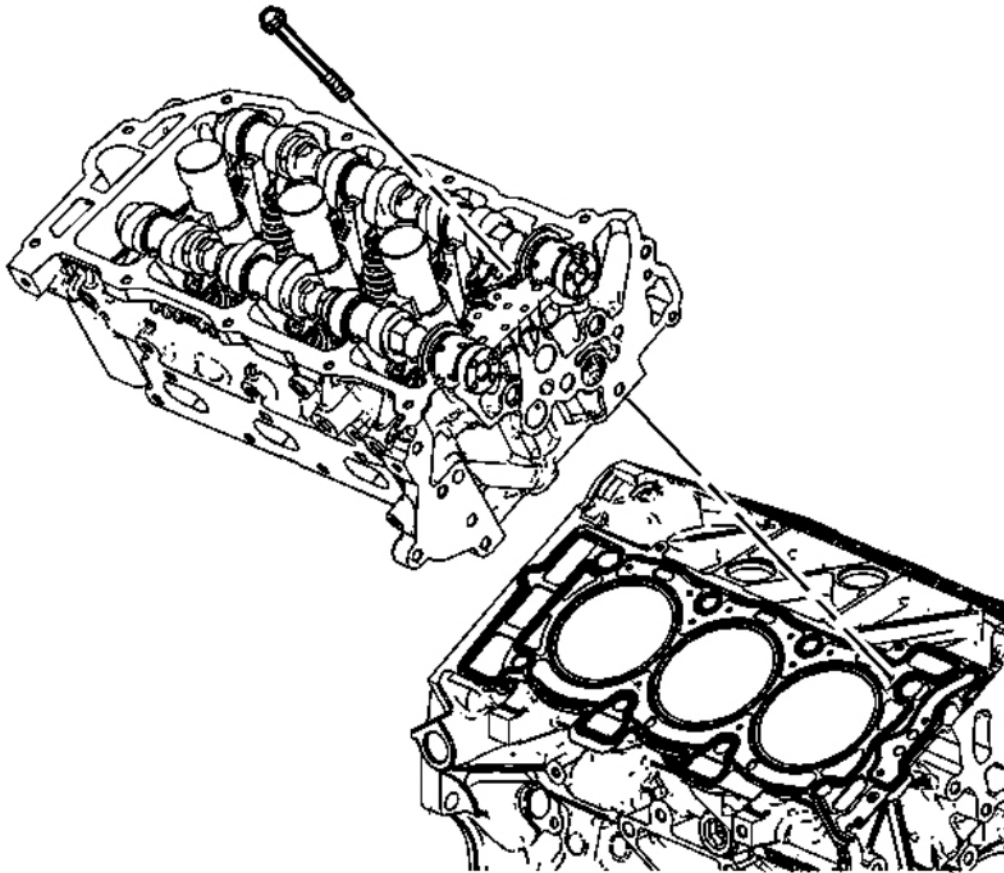


Fig. 188: View Of Right Cylinder Head Gasket

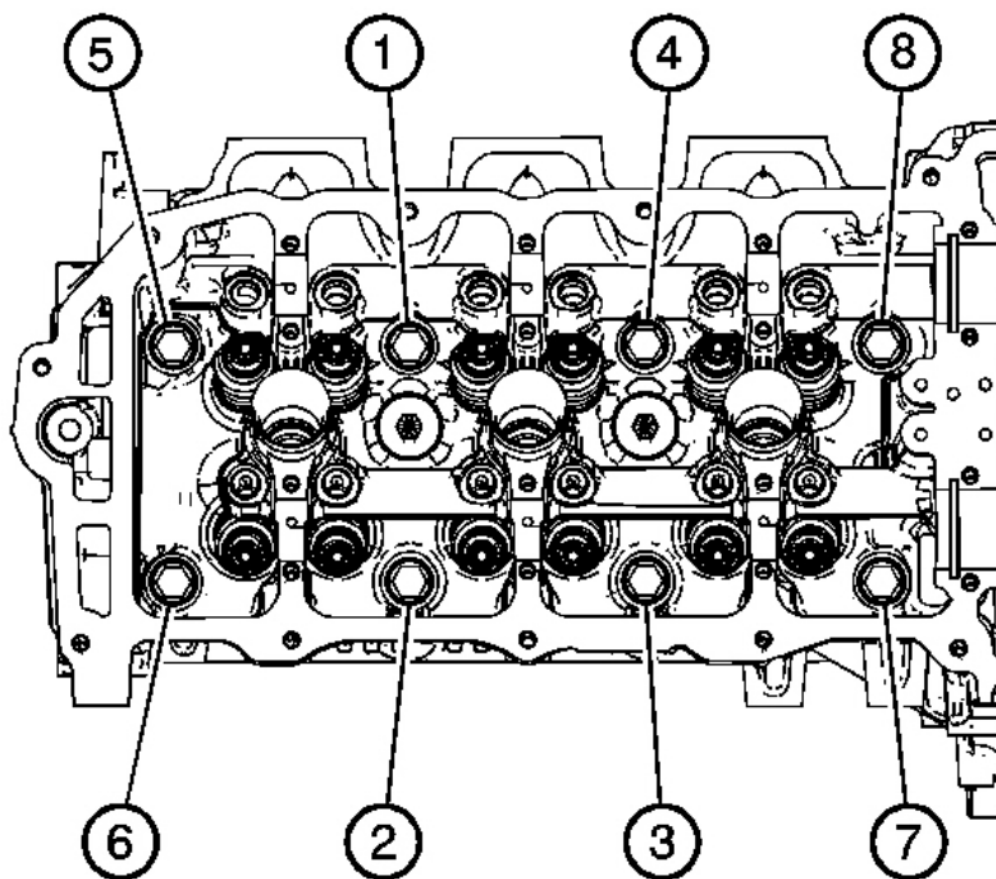
Courtesy of GENERAL MOTORS CORP.

2. Install a NEW right cylinder head gasket using the deck face locating pins for retention.



**Fig. 189: View Of Right Cylinder Head**  
Courtesy of GENERAL MOTORS CORP.

3. Align the right cylinder head with the deck face locating pins.
4. Place the right cylinder head in position on the deck face.



**Fig. 190: M11 Cylinder Head Bolts Tightening Sequence**

Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

**IMPORTANT:** DO NOT allow oil on the cylinder head bolt bosses.

**IMPORTANT:** DO NOT reuse the old M11 cylinder head bolts.

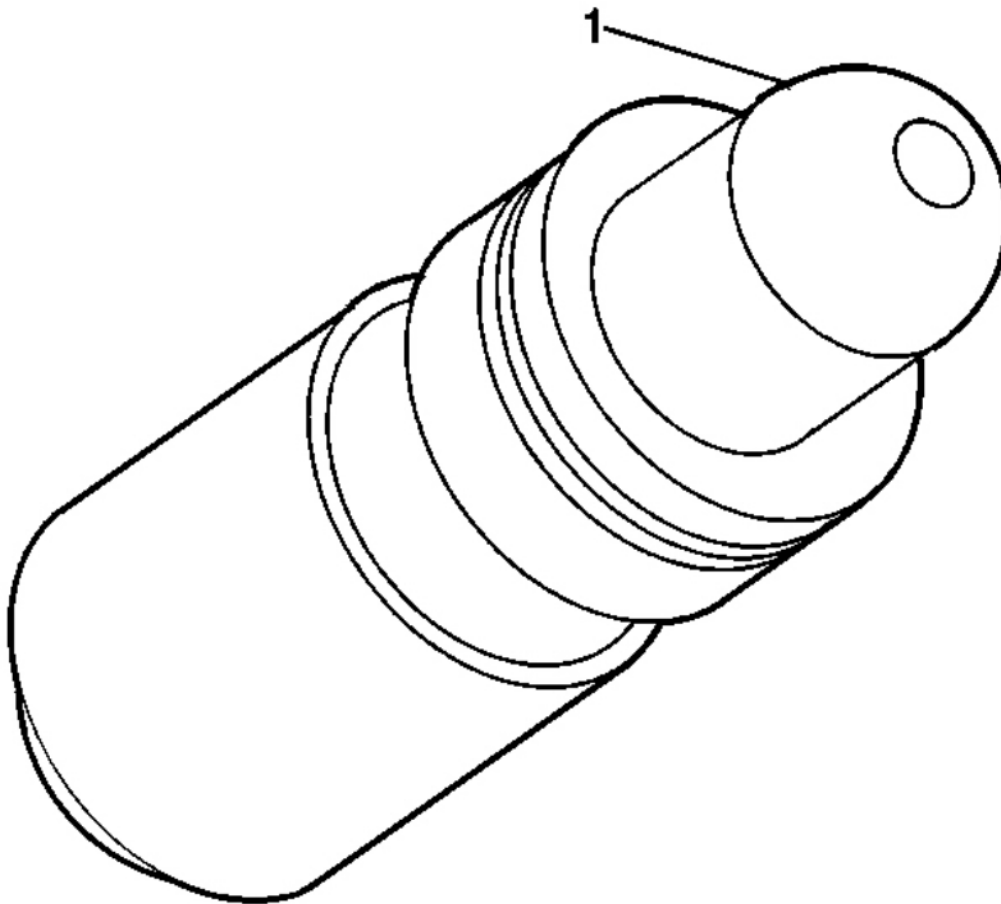
5. Install new M11 cylinder head bolts.

**Tighten:**

1. Tighten the M11 cylinder head bolts a first pass in sequence to 45 N.m (33 lb ft).
2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 120 degrees using the

J 45059 .

## VALVE LIFTER INSTALLATION - RIGHT



**Fig. 191: View Of Valve Lifter**

Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.

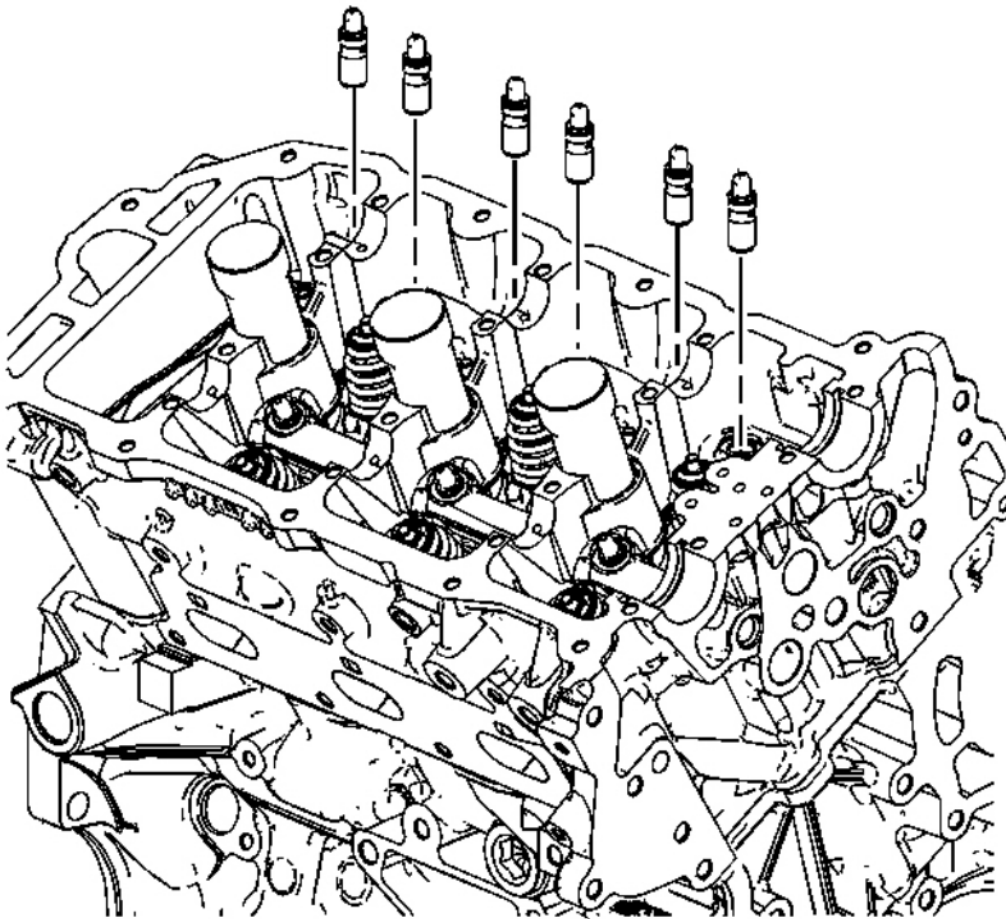
**IMPORTANT:** Do not allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.

1. Fill the stationary hydraulic lash adjuster (SHLA) with clean engine oil GM P/N 12378006 or equivalent.



Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.

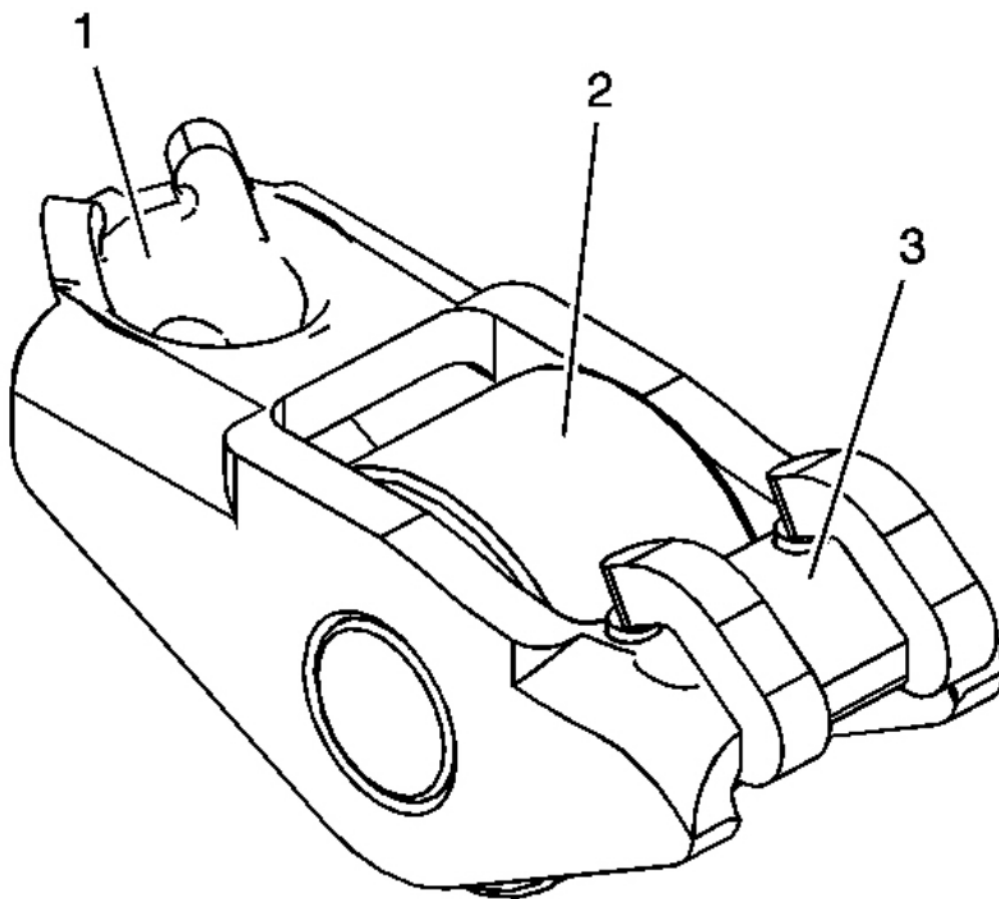
2. Lubricate the SHLA bores in the cylinder head with clean engine oil GM P/N 12378006 or equivalent.



**Fig. 192: Identifying Stationary Hydraulic Lash Adjuster (SHLA)**  
Courtesy of GENERAL MOTORS CORP.

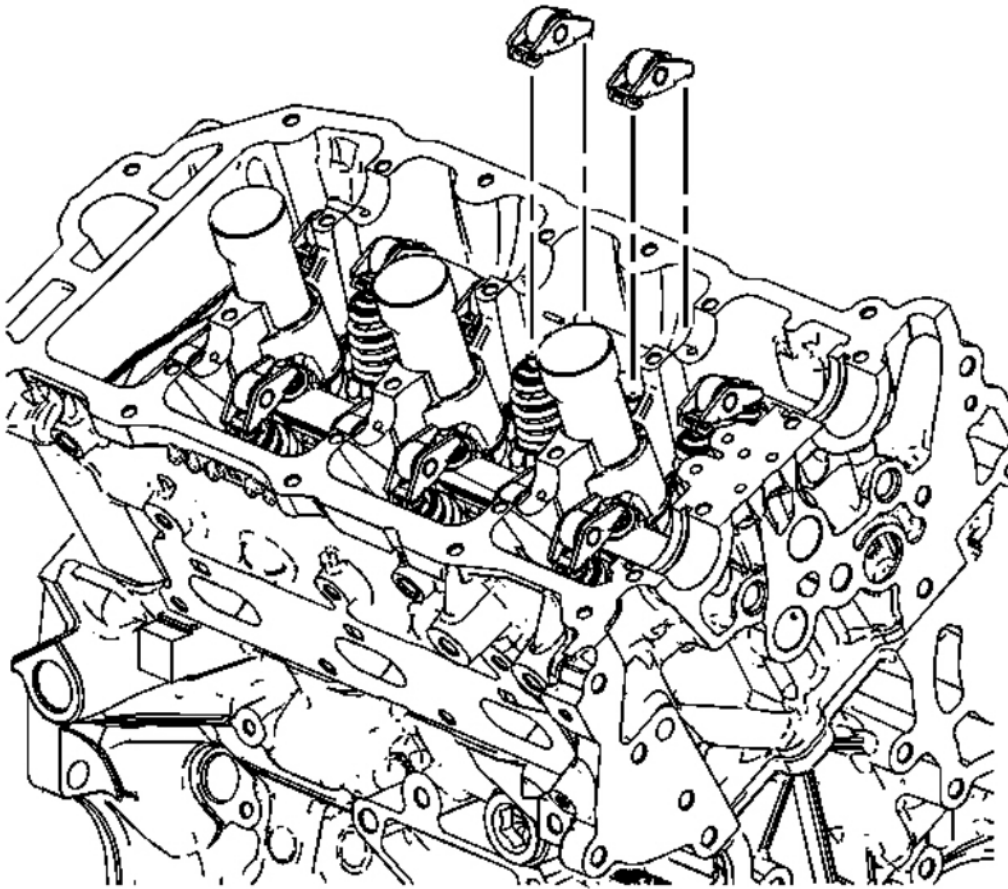
3. Install the SHLAs in the cylinder head.
4. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the SHLA pivot spheres.

## **VALVE ROCKER ARM INSTALLATION - RIGHT**



**Fig. 193: Identifying Valve Rocker Arm Lubrication Areas**  
Courtesy of GENERAL MOTORS CORP.

1. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the pivot pocket (1), roller (2) and valve slot (3) areas of the camshaft followers.



**Fig. 194: Identifying Valve Rocker Arms**  
Courtesy of GENERAL MOTORS CORP.

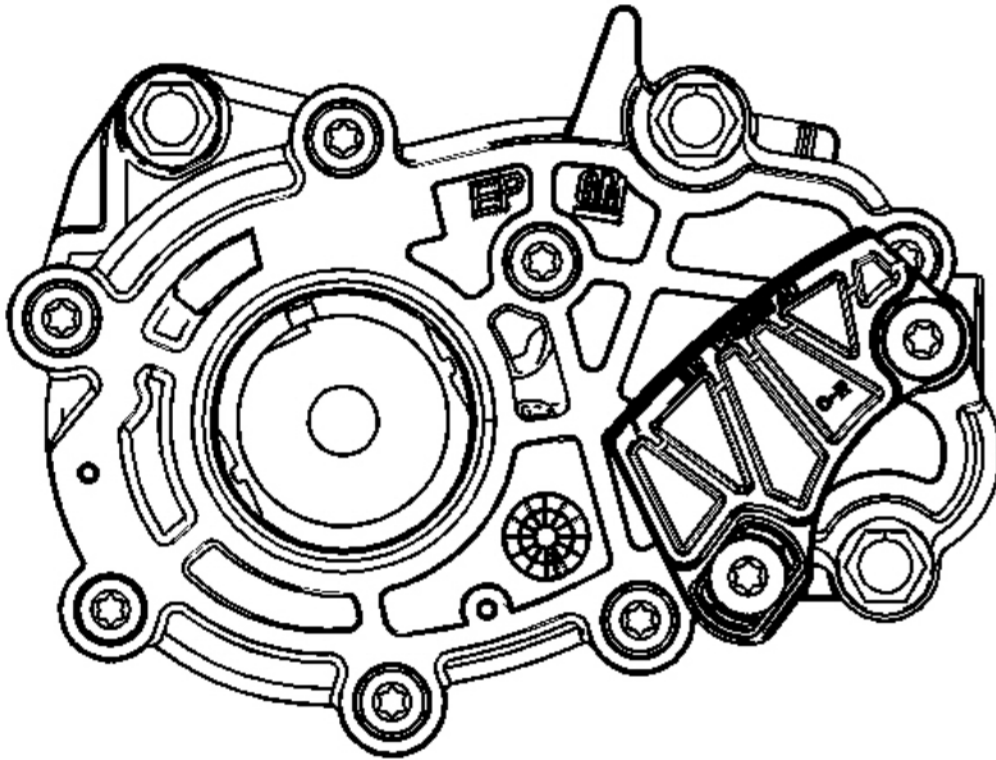
**IMPORTANT:** The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip and stationary hydraulic lash adjuster (SHLA).
3. The rounded head end of the follower goes on the SHLA while the flat end goes on the valve tip.
4. Clean the camshaft journals and carriers with a clean, lint-free cloth.

## **CAMSHAFT INSTALLATION - RIGHT**

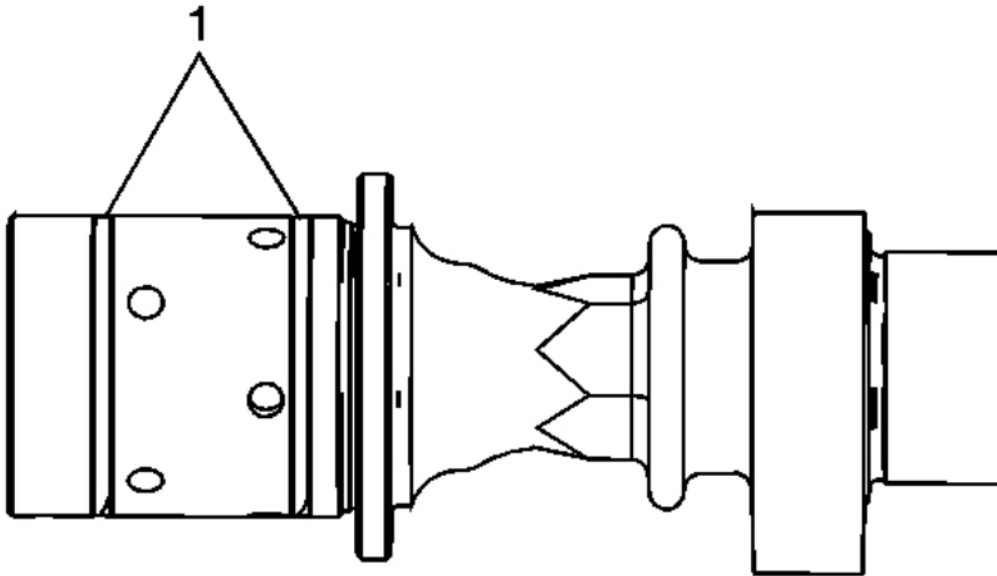
## Tools Required

EN 46111 Crankshaft Rotation Socket



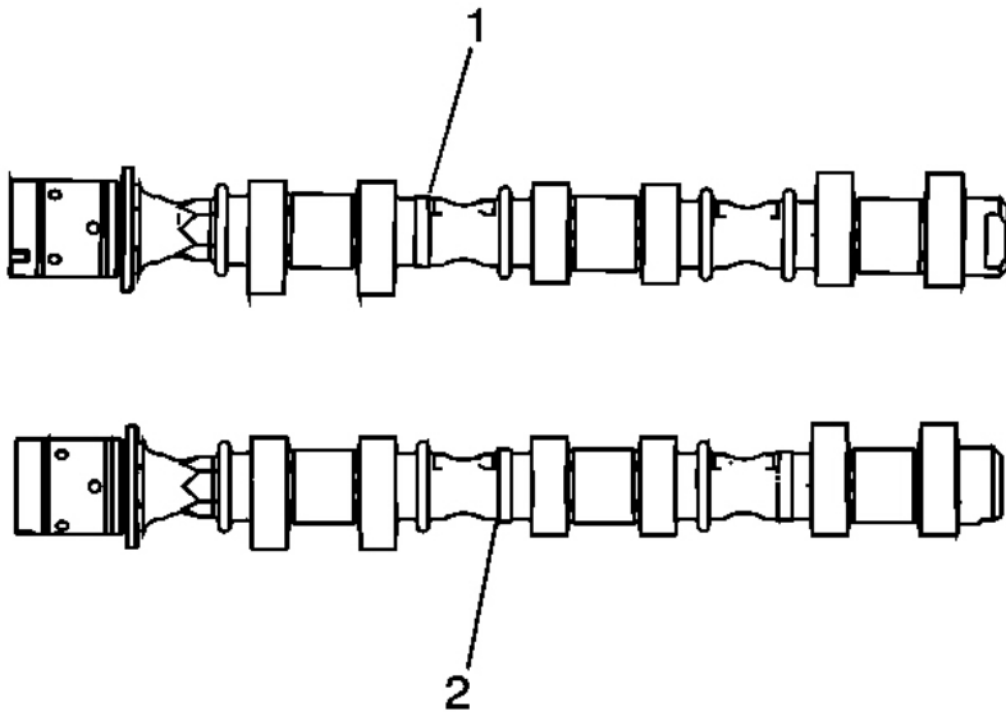
**Fig. 195: Identifying Stage One Timing Drive Assembly Position**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the crankshaft is in the stage one timing drive assembly position using the **EN 46111** . Refer to **Camshaft Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain)** .



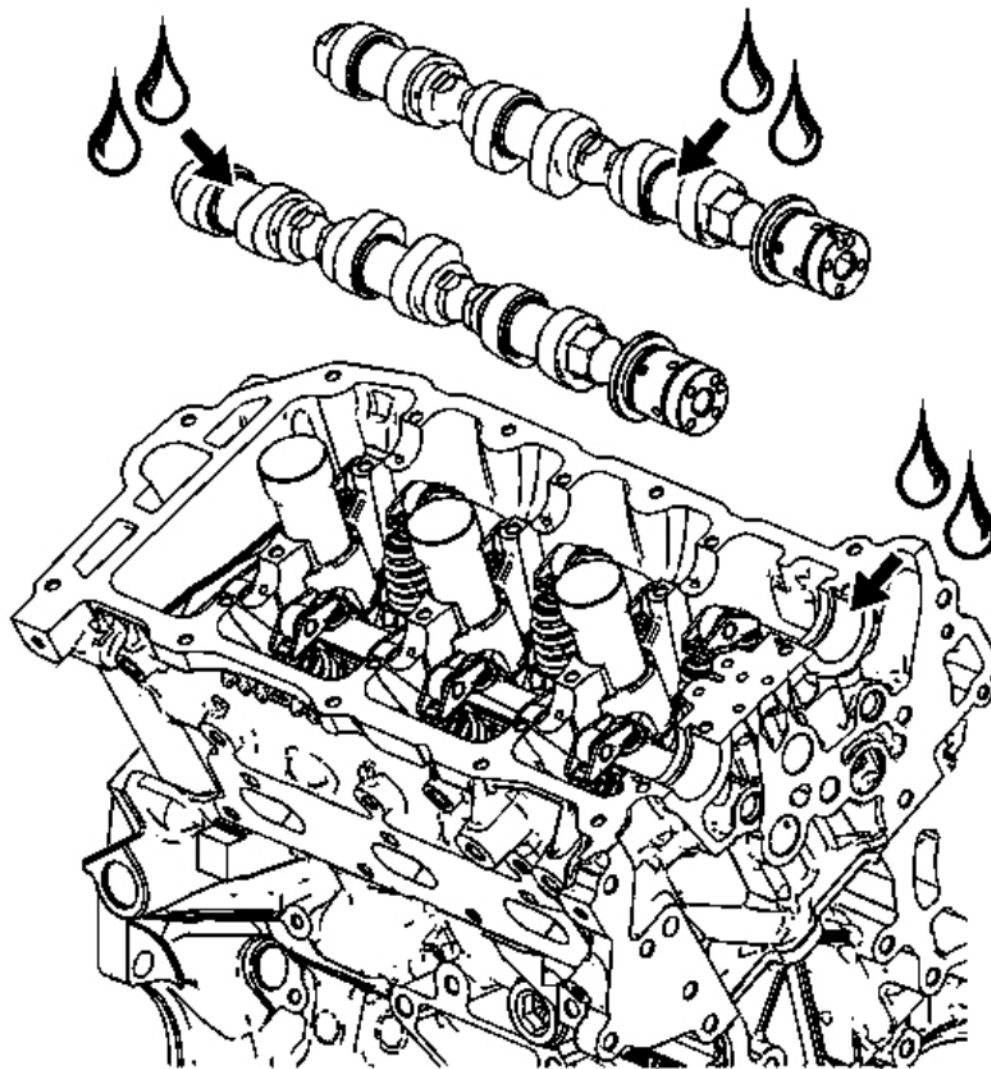
**Fig. 196: Locating Camshaft Sealing Rings In The Camshaft Grooves**  
Courtesy of GENERAL MOTORS CORP.

2. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves.



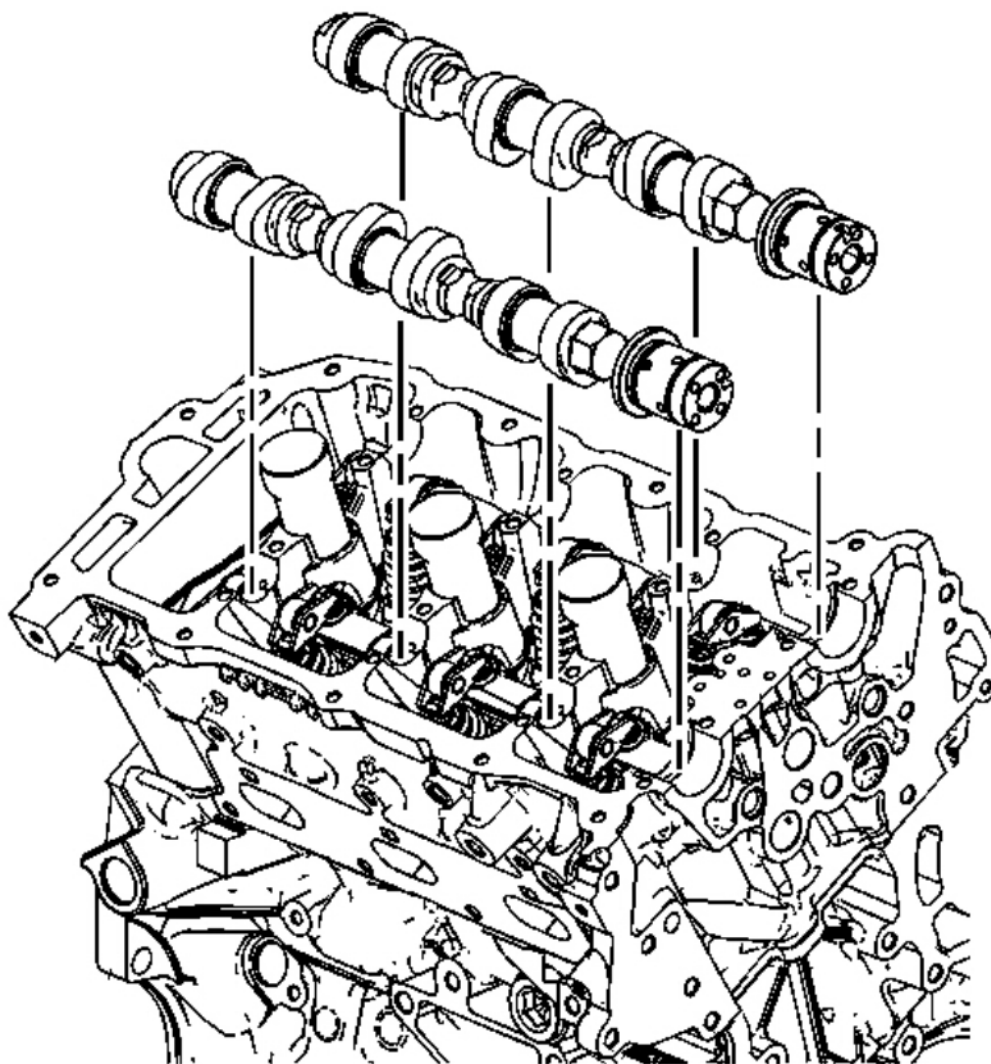
**Fig. 197: Identifying Camshaft Identification Rings**  
Courtesy of GENERAL MOTORS CORP.

3. Select the proper camshaft for the particular installation location. The ring placement is defined as follows:
  1. The number 2 identification ring for the right exhaust camshaft is machined off (1).
  2. The number 3 identification ring for the right intake camshaft is machined off (2).



**Fig. 198: Prelubing Camshaft Journals And Cylinder Head Camshaft Carriers**  
Courtesy of GENERAL MOTORS CORP.

4. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the camshaft journals and the right cylinder head camshaft carriers.

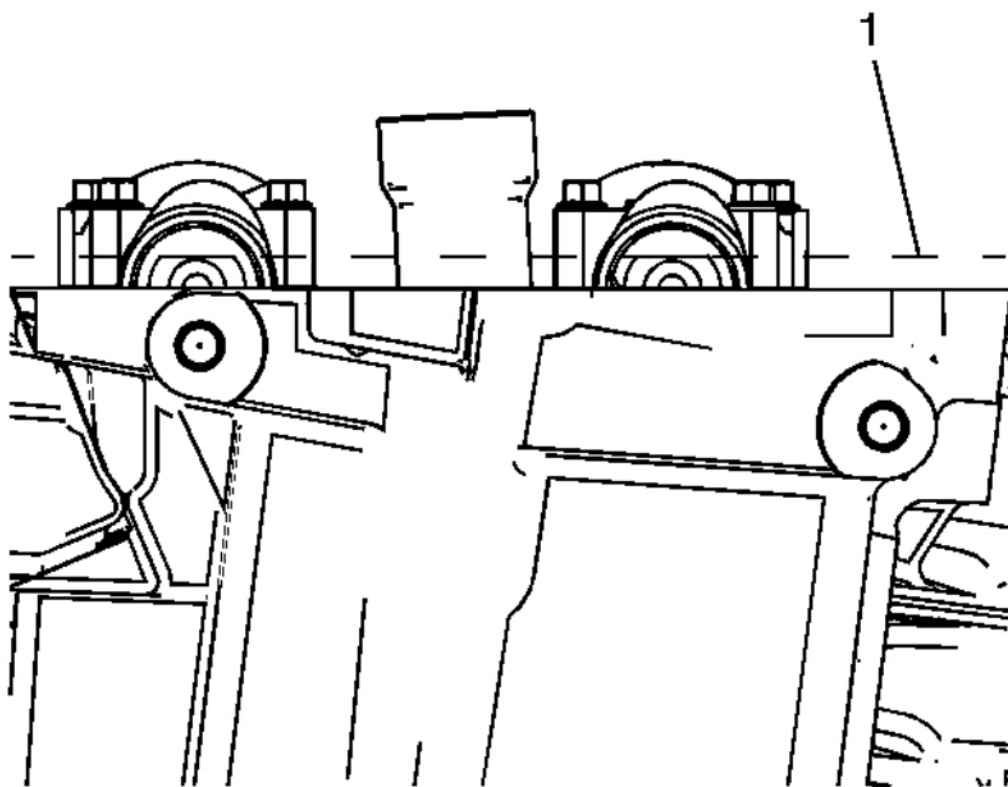


**Fig. 199: Locating Camshafts**

Courtesy of GENERAL MOTORS CORP.

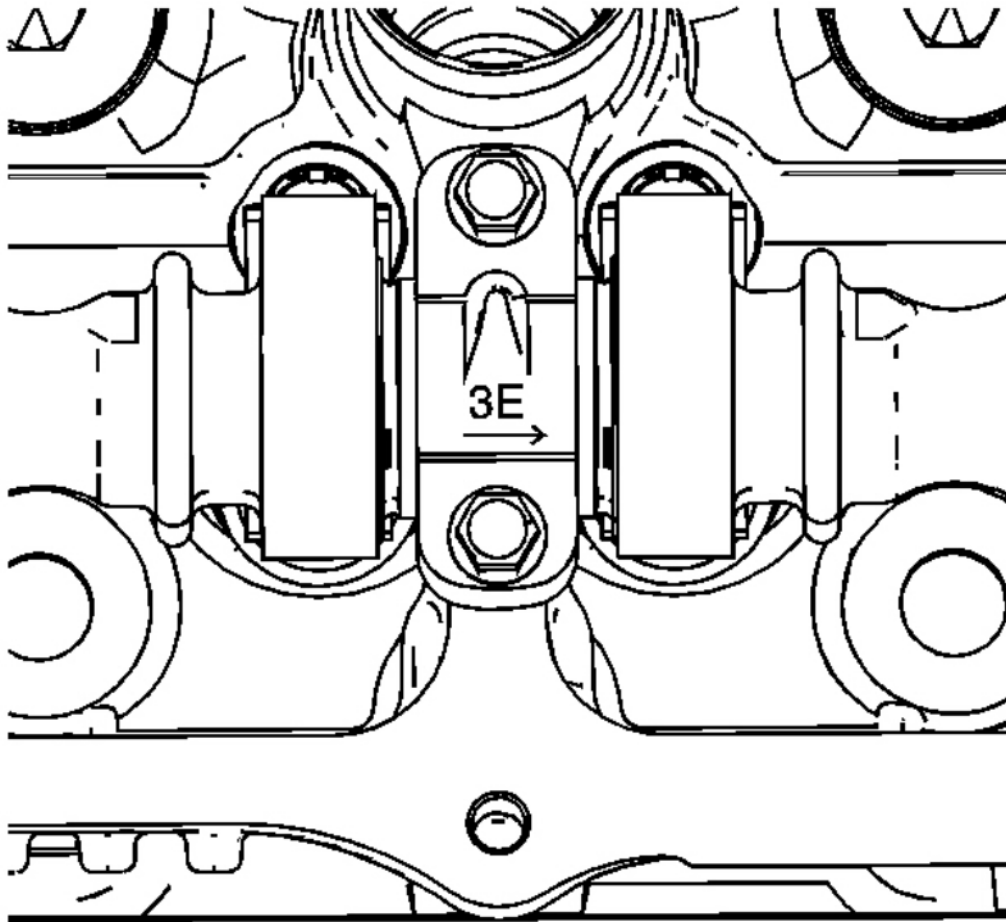
5. Place the right intake and right exhaust camshafts in position in the right cylinder head.





**Fig. 200: Identifying Camshaft Neutral (Low Tension) Position**  
Courtesy of GENERAL MOTORS CORP.

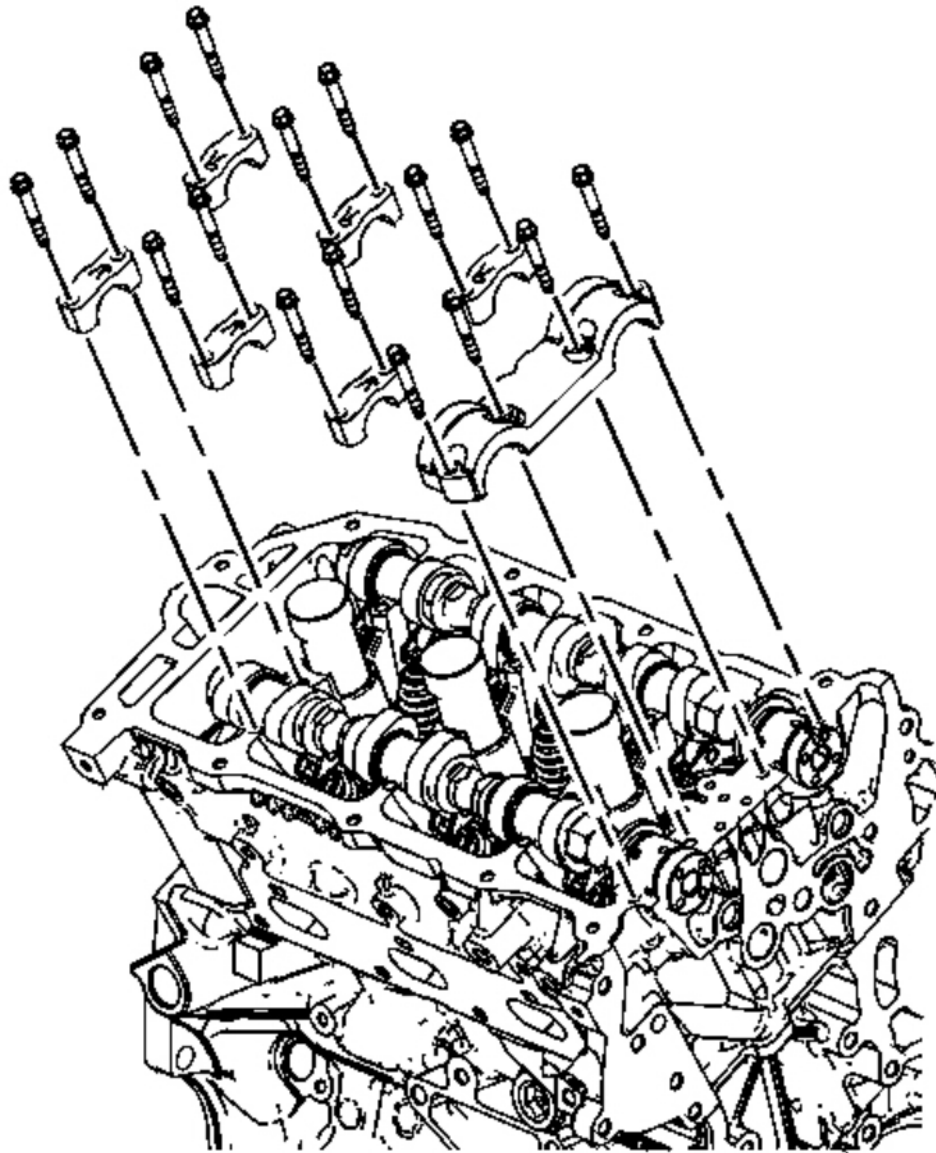
6. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the right cylinder head camshaft cover rail.



**Fig. 201: Identifying Markings On Bearing Caps**

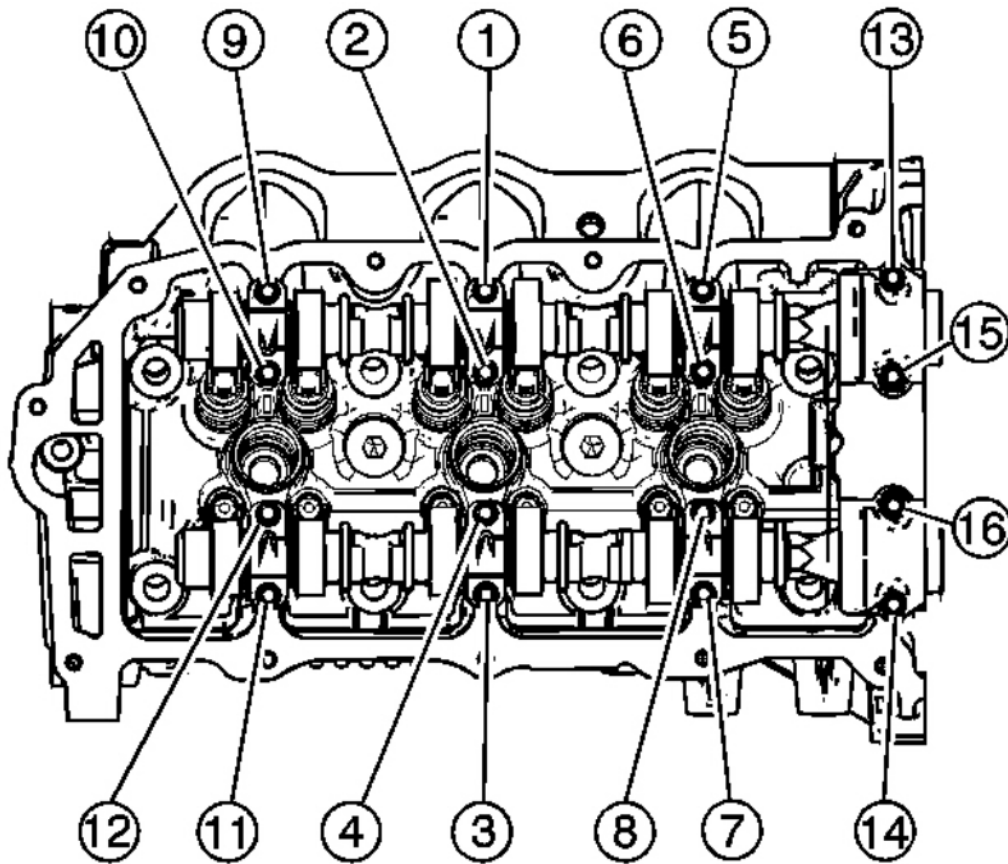
Courtesy of GENERAL MOTORS CORP.

7. Observe the markings on the right cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
  - The raised feature must always be oriented toward the center of the cylinder head.
  - The I indicates the intake camshaft.
  - The E indicates the exhaust camshaft.
  - The number 1, 3, 5 indicates the cylinder position from the front of the engine.
8. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the camshaft bearing caps.



**Fig. 202: View Of Camshaft Bearing Caps & Bolts**  
Courtesy of GENERAL MOTORS CORP.

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



**Fig. 203: Illustrating Proper Tightening Sequence For Camshaft Bearing Cap Bolts**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

12. Tighten the camshaft bearing cap bolts in the sequence shown.

**Tighten:** Tighten the camshaft bearing cap bolts in sequence to 10 N.m (89 lb in).

13. Loosen the center intake camshaft bearing cap bolts (1, 2) and the center exhaust camshaft bearing cap bolts (3, 4).
14. Retighten the center camshaft bearing cap bolts (1, 2, 3, 4).

**Tighten:** Retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).

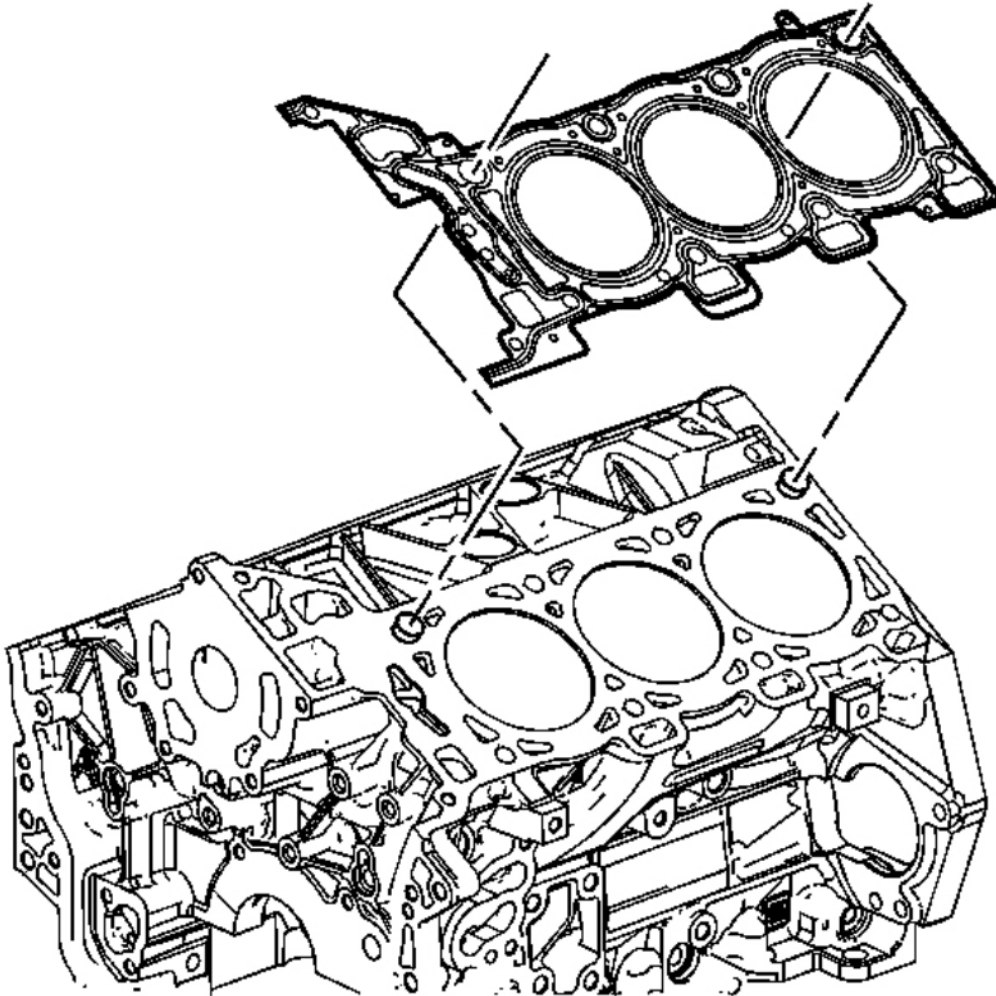
## **CYLINDER HEAD INSTALLATION - LEFT**

### **Tools Required**

- **EN 46111** Crankshaft Rotation Socket
- **J 45059** Angle Meter

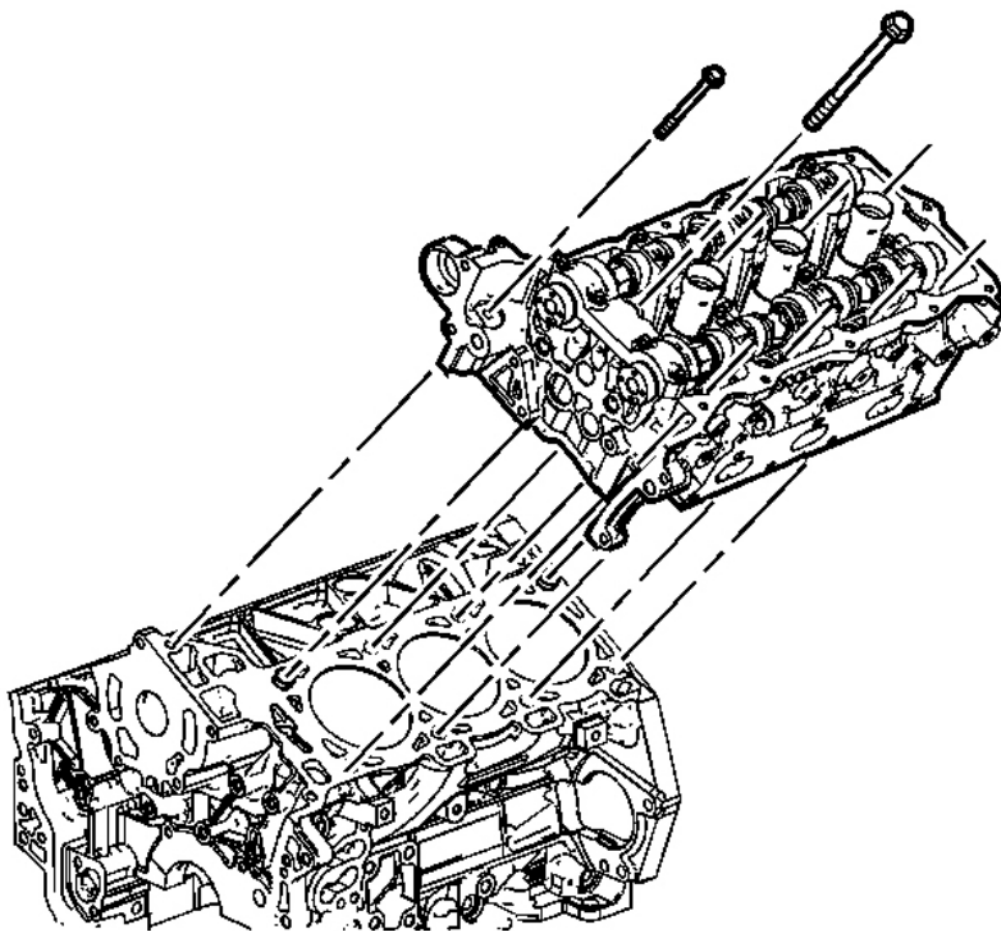
**IMPORTANT:** Ensure that the crankshaft is in the stage one timing drive assembly position using the **EN 46111** .

1. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.



**Fig. 204: View Of Left Cylinder Head Gasket**  
Courtesy of GENERAL MOTORS CORP.

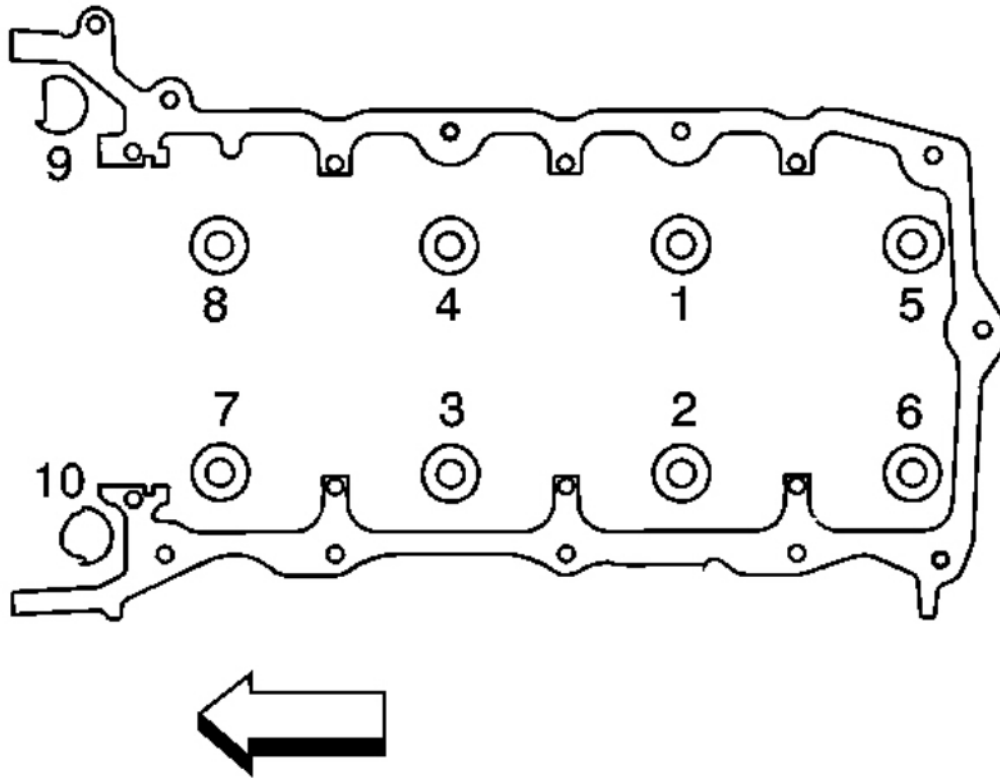
2. Install a NEW left cylinder head gasket using the deck face locating pins for retention.



**Fig. 205: View Of Left Cylinder Head**

Courtesy of GENERAL MOTORS CORP.

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



**Fig. 206: View Of M11 Cylinder Head Bolts**

Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

**IMPORTANT:** DO NOT allow oil on the cylinder head bolt bosses.

**IMPORTANT:** DO NOT reuse the old M11 cylinder head bolts.

5. Install new M11 cylinder head bolts.

**Tighten:**

1. Tighten the M11 cylinder head bolts a first pass in sequence to 45 N.m (33 lb ft).
2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 120 degrees using the **J 45059**.

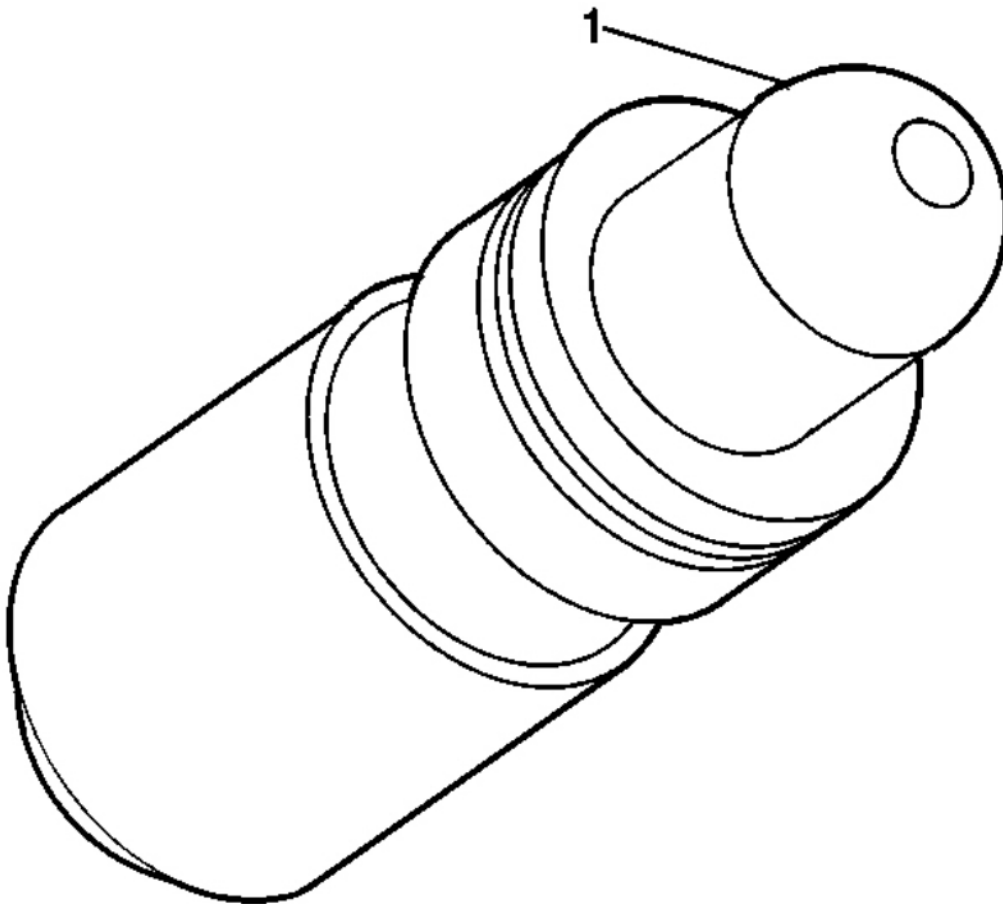


6. Install the 2 front M8 left cylinder head bolts.

**Tighten:**

1. Tighten the M8 cylinder head bolts a first pass to 15 N.m (11 lb ft).
2. Tighten the M8 cylinder head bolts a second pass in sequence an additional 60 degrees using the **J 45059** .

## VALVE LIFTER INSTALLATION - LEFT



**Fig. 207: View Of Valve Lifter**

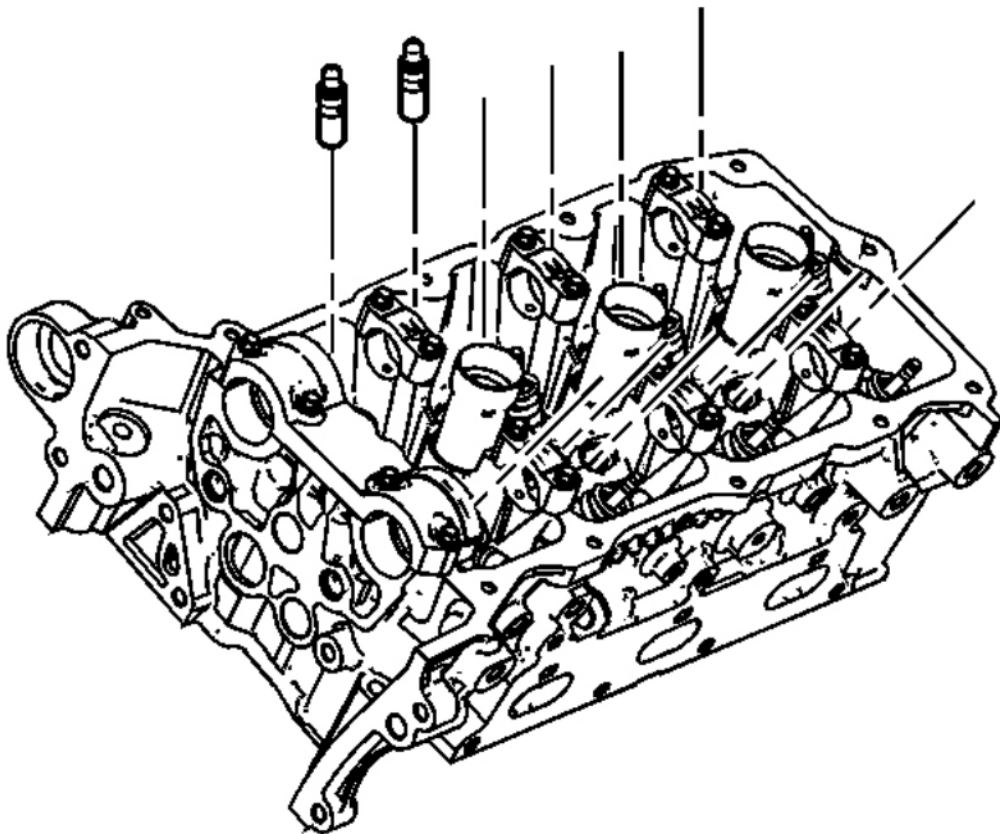
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** Do not stroke/cycle the stationary hydraulic lash adjuster plunger without

oil in the lower pressure chamber.

**IMPORTANT:** Do not allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.

1. Fill the stationary hydraulic lash adjuster (SHLA) with clean engine oil GM P/N 12378006 or equivalent. Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.
2. Lubricate the SHLA bores in the cylinder head with clean engine oil GM P/N 12378006 or equivalent.

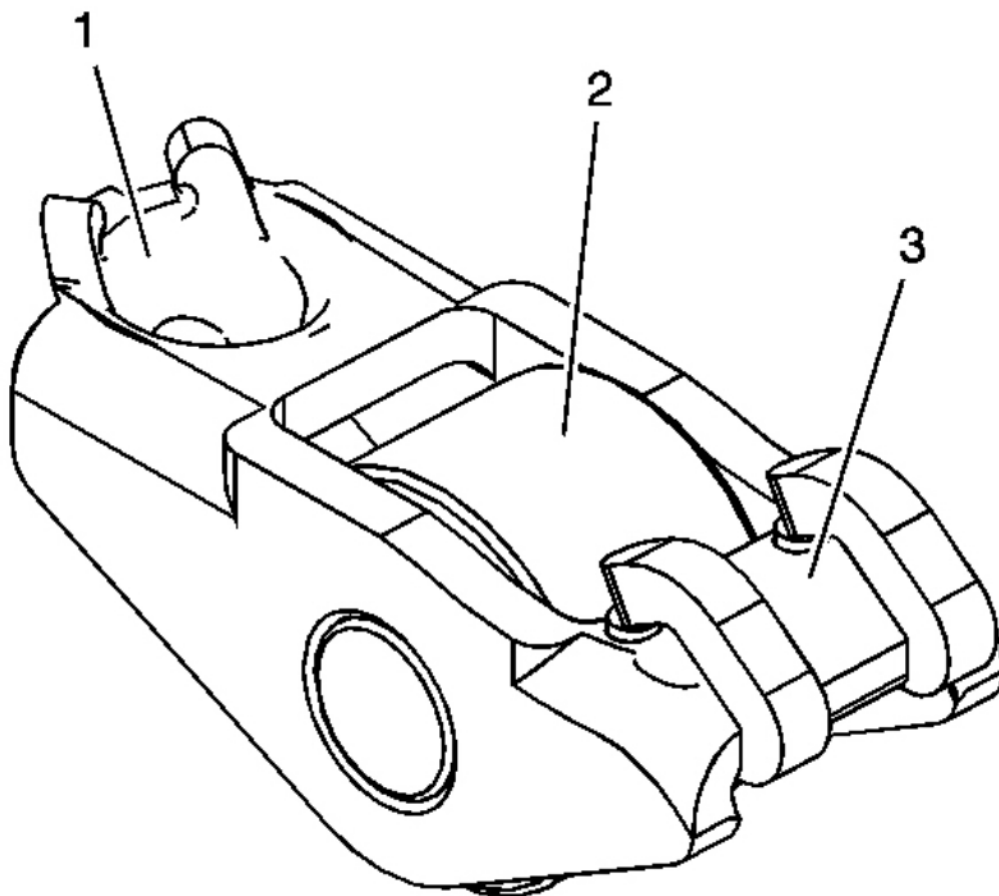


**Fig. 208: View Of SHLAs**

Courtesy of GENERAL MOTORS CORP.

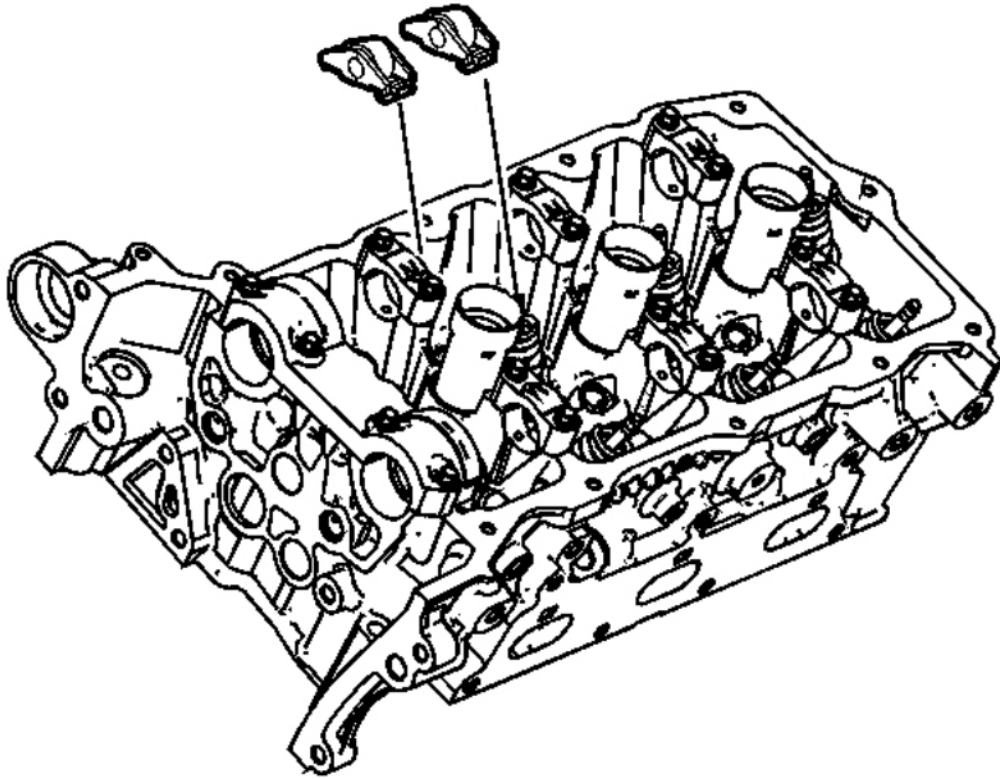
3. Install the SHLAs in the cylinder head.
4. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the SHLA pivot spheres.

## VALVE ROCKER ARM INSTALLATION - LEFT



**Fig. 209: Identifying Valve Rocker Arm Lubrication Areas**  
Courtesy of GENERAL MOTORS CORP.

1. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the pivot pocket (1), roller (2) and valve slot (3) areas of the camshaft followers.



**Fig. 210: View Of Valve Rocker Arm**  
Courtesy of GENERAL MOTORS CORP.

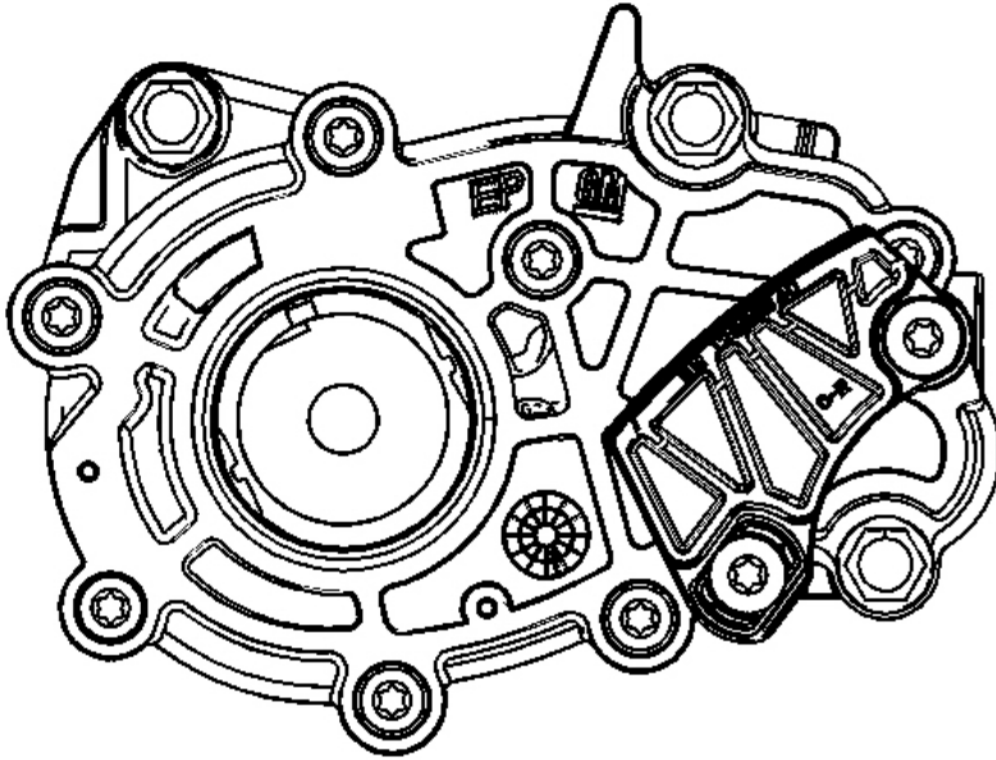
**IMPORTANT:** The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip and stationary hydraulic lash adjuster (SHLA).
3. The rounded head end of the follower goes on the SHLA while the flat end goes on the valve tip.
4. Clean the camshaft journals and carriers with a clean, lint-free cloth.

## CAMSHAFT INSTALLATION - LEFT

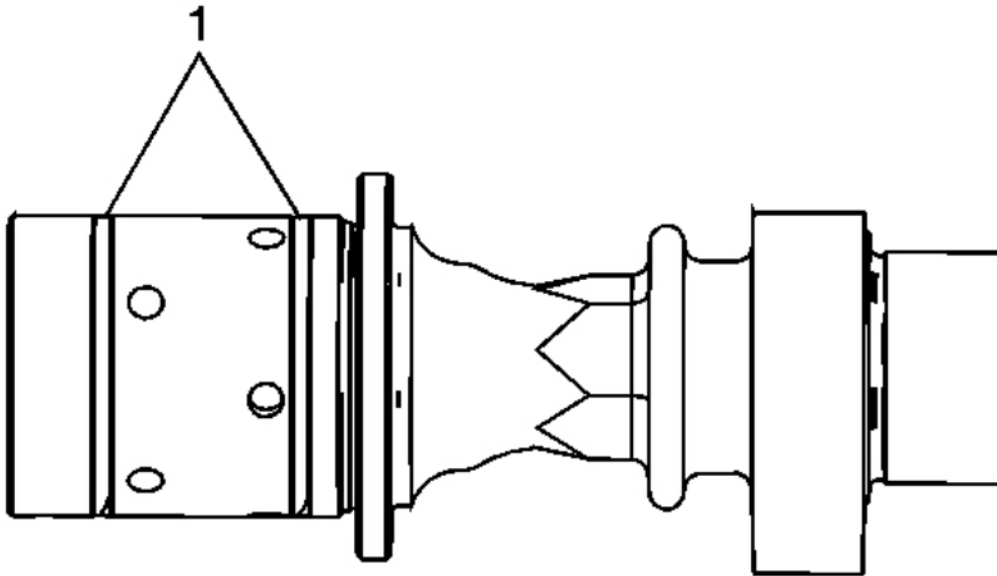
### Tools Required

EN 46111 Crankshaft Rotation Socket



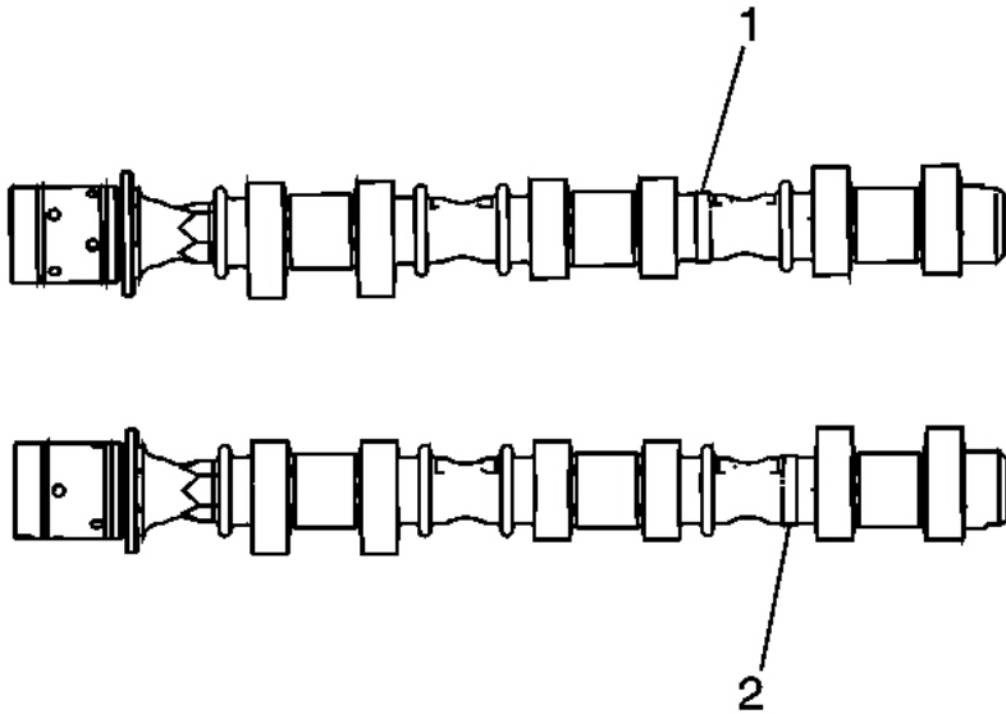
**Fig. 211: Identifying Stage One Timing Drive Assembly Position**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the crankshaft is in the stage one timing drive assembly position using the **EN 46111** . Refer to **Camshaft Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain)** .



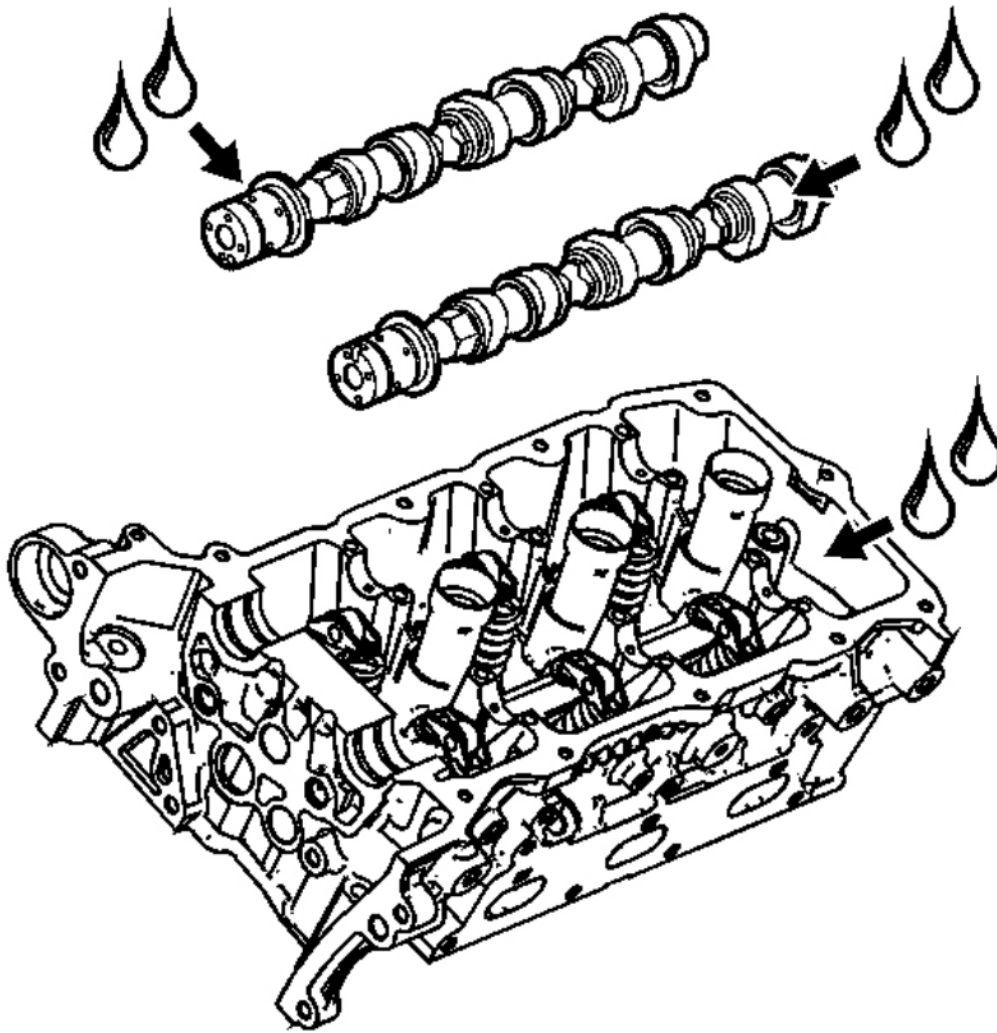
**Fig. 212: Locating Camshaft Sealing Rings In The Camshaft Grooves**  
Courtesy of GENERAL MOTORS CORP.

2. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves.



**Fig. 213: Identifying Camshaft Ring Placement**  
**Courtesy of GENERAL MOTORS CORP.**

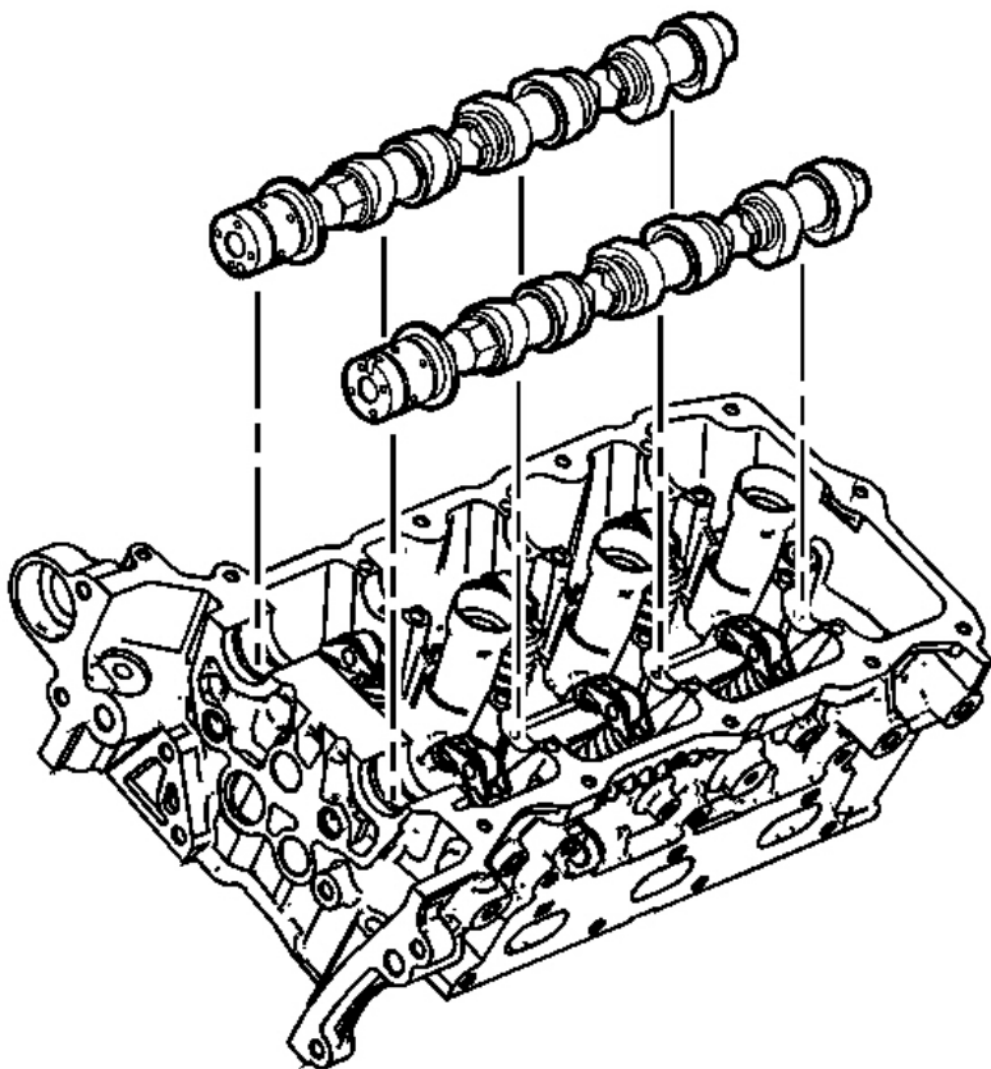
3. Select the proper camshaft for the particular installation location. The ring placement is defined as follows:
  1. The number 4 identification ring for the left intake camshaft is machined off (1).
  2. The number 5 identification ring for the left exhaust camshaft is machined off (2).



**Fig. 214: Lubricating Camshaft Journals And The Left Cylinder Head Camshaft Carriers**  
Courtesy of GENERAL MOTORS CORP.

4. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the camshaft journals and the left cylinder head camshaft carriers.

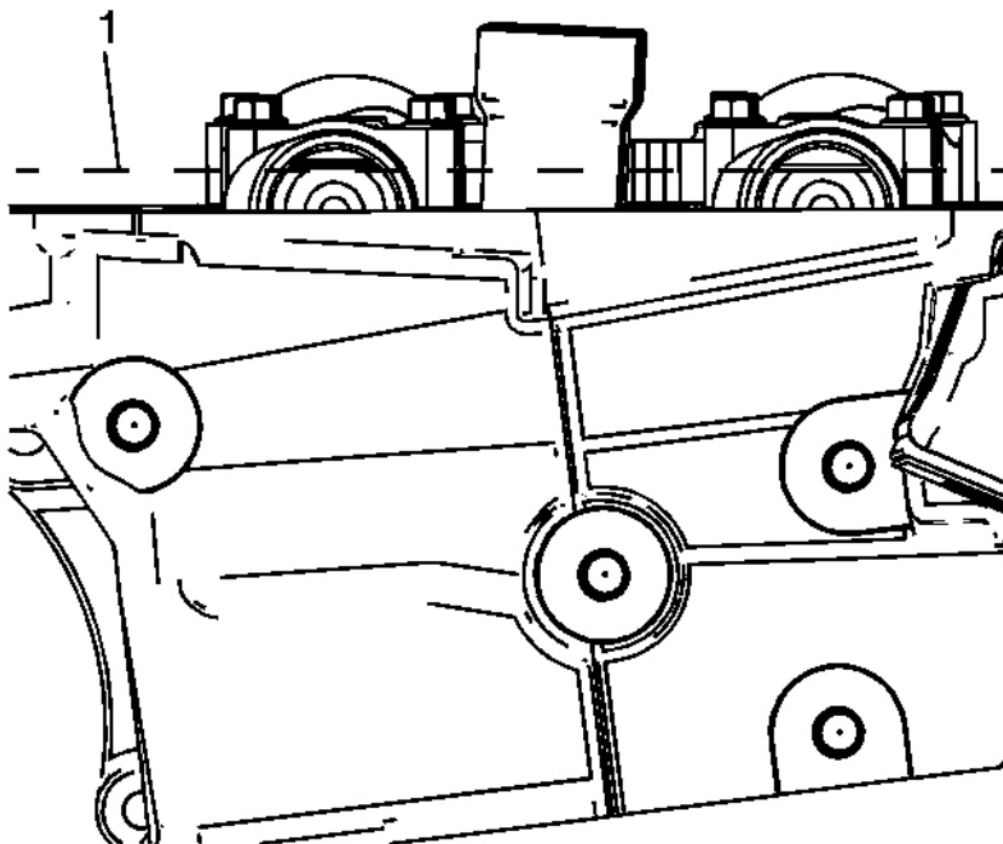




**Fig. 215: View Of Camshafts**

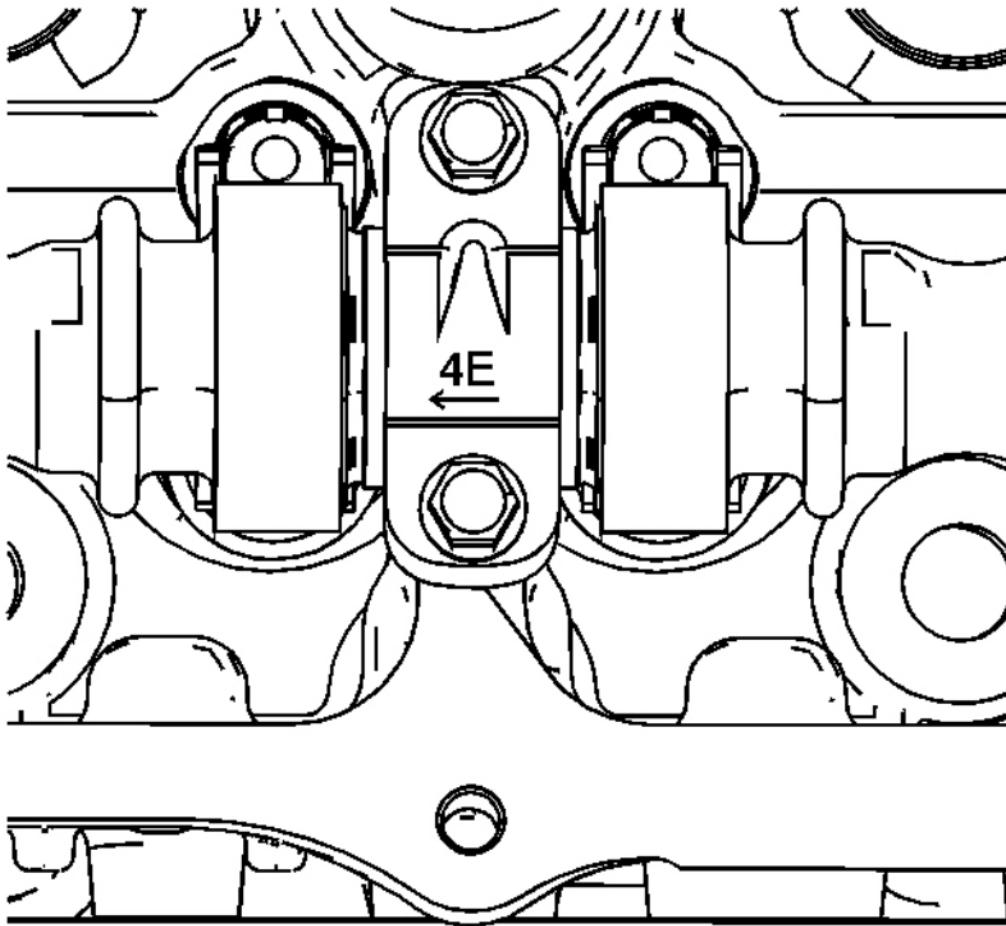
Courtesy of GENERAL MOTORS CORP.

5. Place the left intake and left exhaust camshafts in position in the left cylinder head.



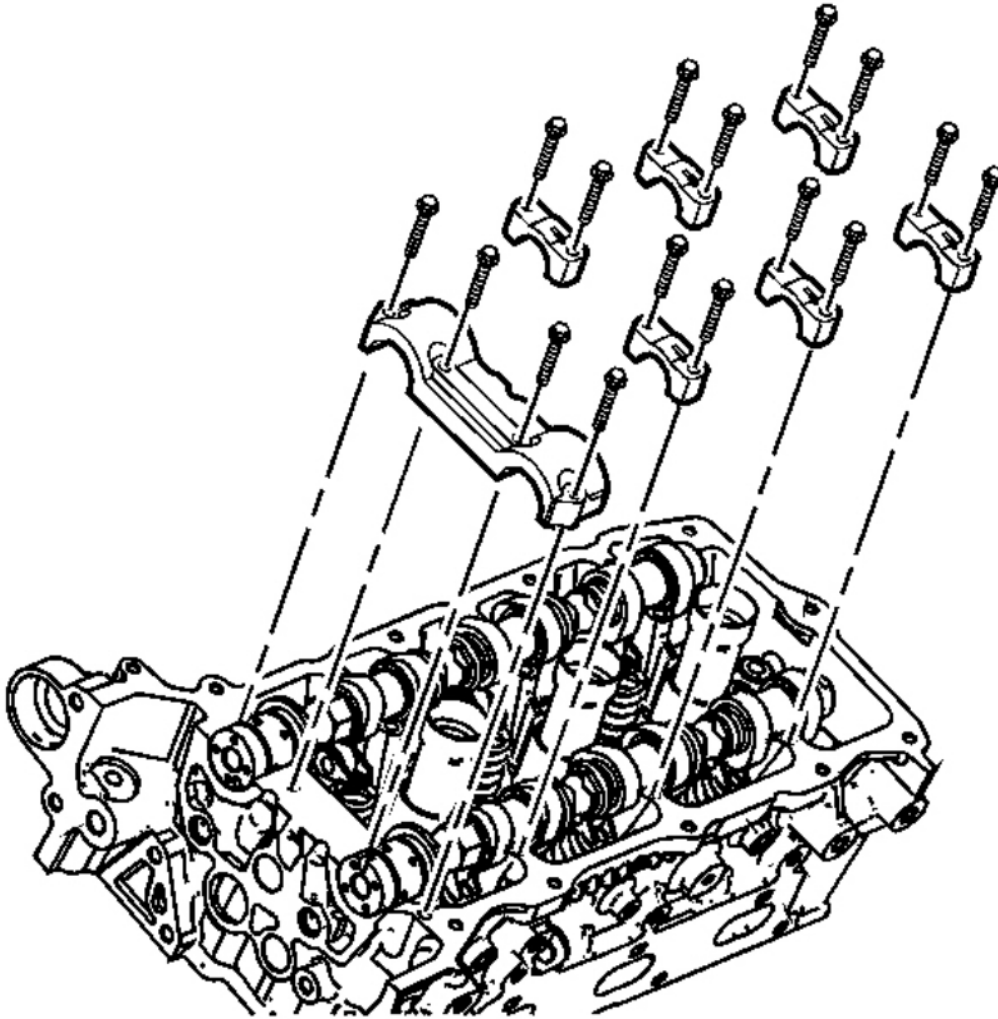
**Fig. 216: Camshaft Flats Parallel With Camshaft Cover Rail**  
Courtesy of GENERAL MOTORS CORP.

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



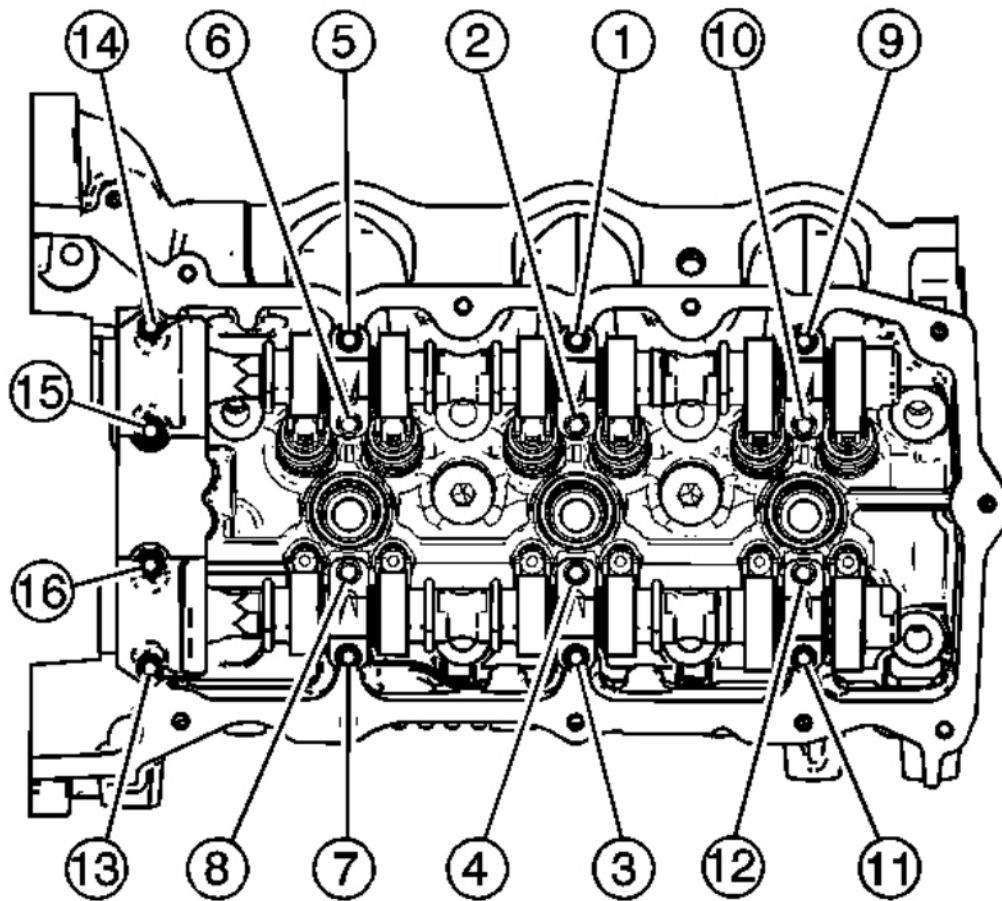
**Fig. 217: Identifying Markings On Bearing Caps**  
Courtesy of GENERAL MOTORS CORP.

7. Observe the markings on the left cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
  - The raised feature must always be oriented toward the center of the cylinder head.
  - The I indicates the intake camshaft.
  - The E indicates the exhaust camshaft.
  - The number 2, 4, 6 indicates the cylinder position from the front of the engine.
8. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the camshaft bearing caps.



**Fig. 218: Locating Camshaft Bearing Cap & Bolts**  
Courtesy of GENERAL MOTORS CORP.

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



**Fig. 219: Identifying Camshaft Bearing Cap Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

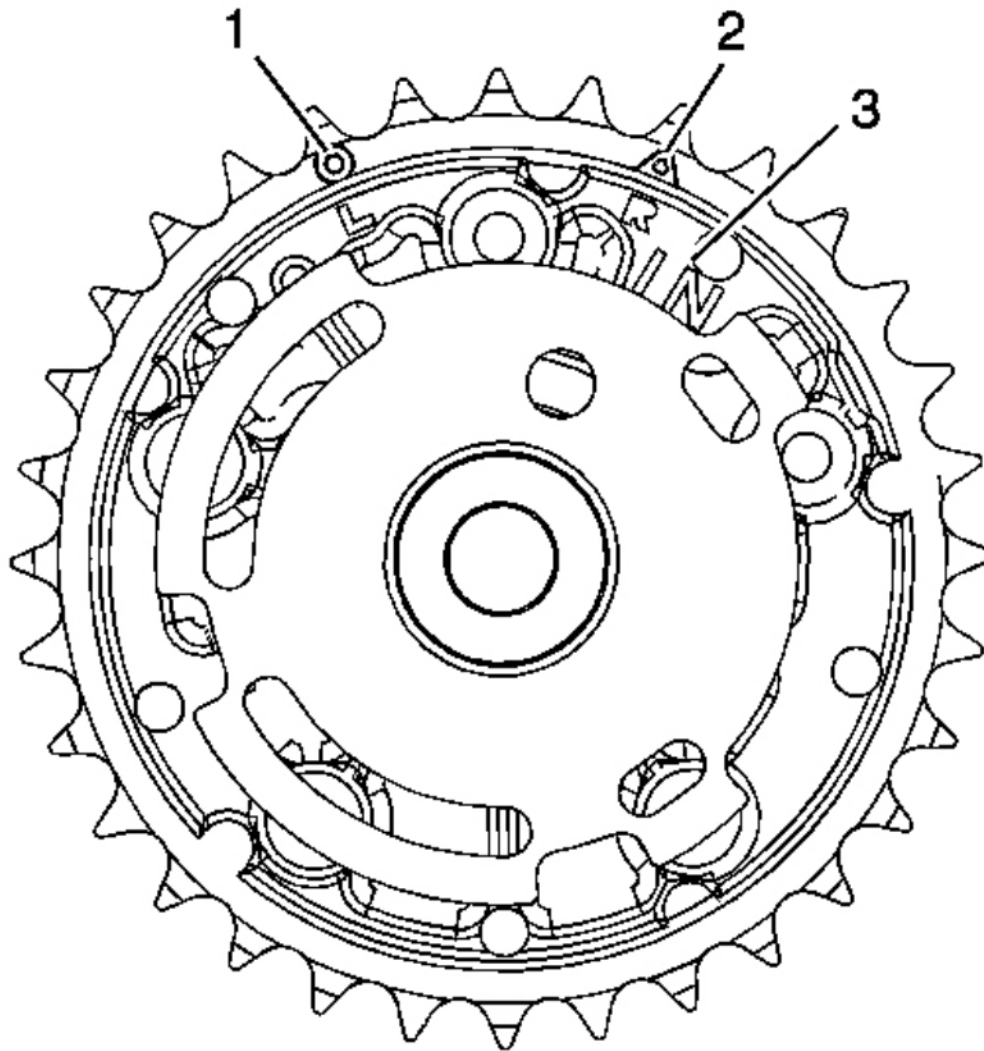
**NOTE:** Refer to Fastener Notice in Cautions and Notices.

12. Tighten the camshaft bearing cap bolts in the sequence shown.

**Tighten:** Tighten the camshaft bearing cap bolts in sequence to 10 N.m (89 lb in).

13. Loosen the center intake camshaft bearing cap bolts 1, 2 and the center exhaust camshaft bearing cap bolts 3, 4.
14. Retighten the center camshaft bearing cap bolts 1, 2, 3, 4.

**Tighten:** Retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).

**CAMSHAFT POSITION (CMP) ACTUATOR INSTALLATION - RIGHT INTAKE**

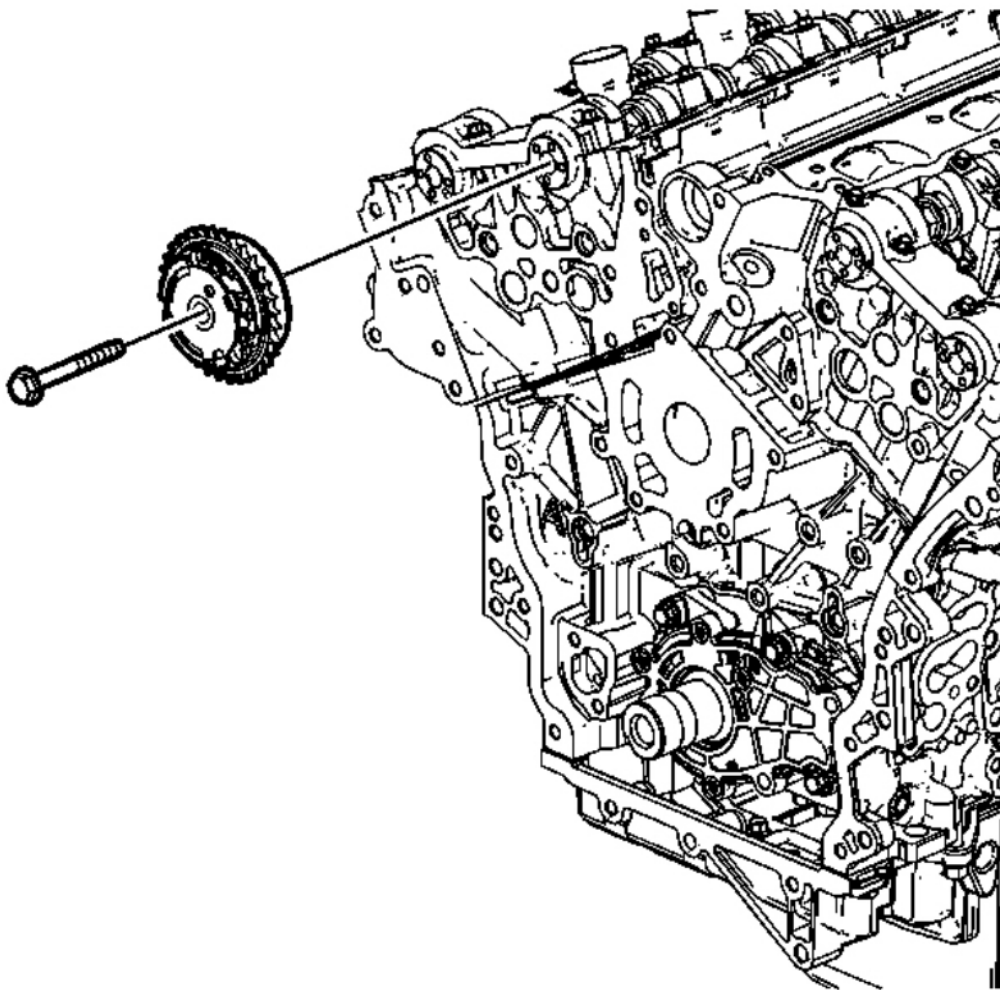
**Fig. 220: Identifying Right Intake Camshaft Position Actuator**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "IN" marking (3). The marking is for an intake camshaft position actuator.
2. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the "R" and triangle marking (2). The marking is for alignment to the highlighted timing chain link on the

right side of the engine.

**NOTE:** Refer to Torque Reaction Against Timing Drive Chain Notice .

3. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.



**Fig. 221: Right Intake Camshaft Position Actuator**  
Courtesy of GENERAL MOTORS CORP.

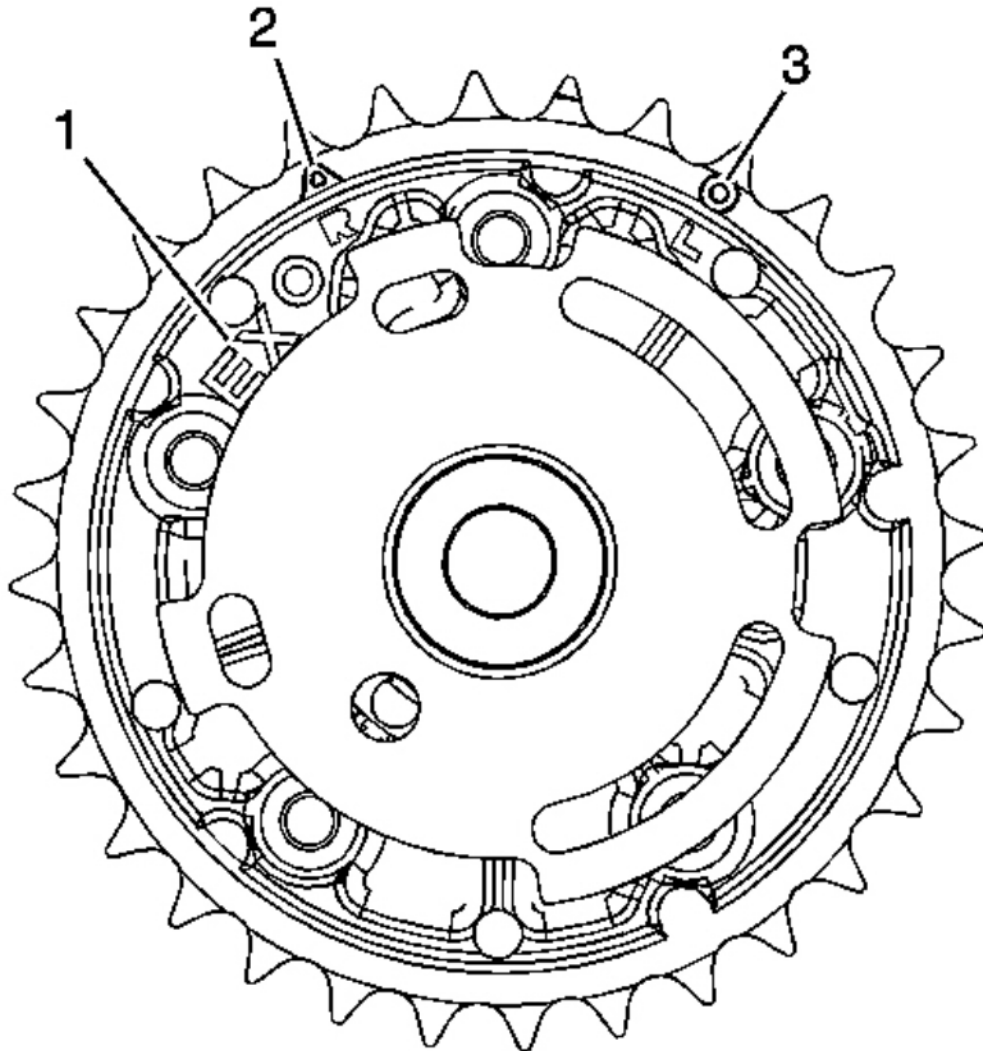
4. Install the right intake camshaft position actuator.

**NOTE:** Refer to Fastener Notice .

5. Install the camshaft position actuator bolt.

**Tighten:** Tighten the camshaft position actuator bolt to 58 N.m (43 lb ft).

## CAMSHAFT POSITION (CMP) ACTUATOR INSTALLATION - RIGHT EXHAUST



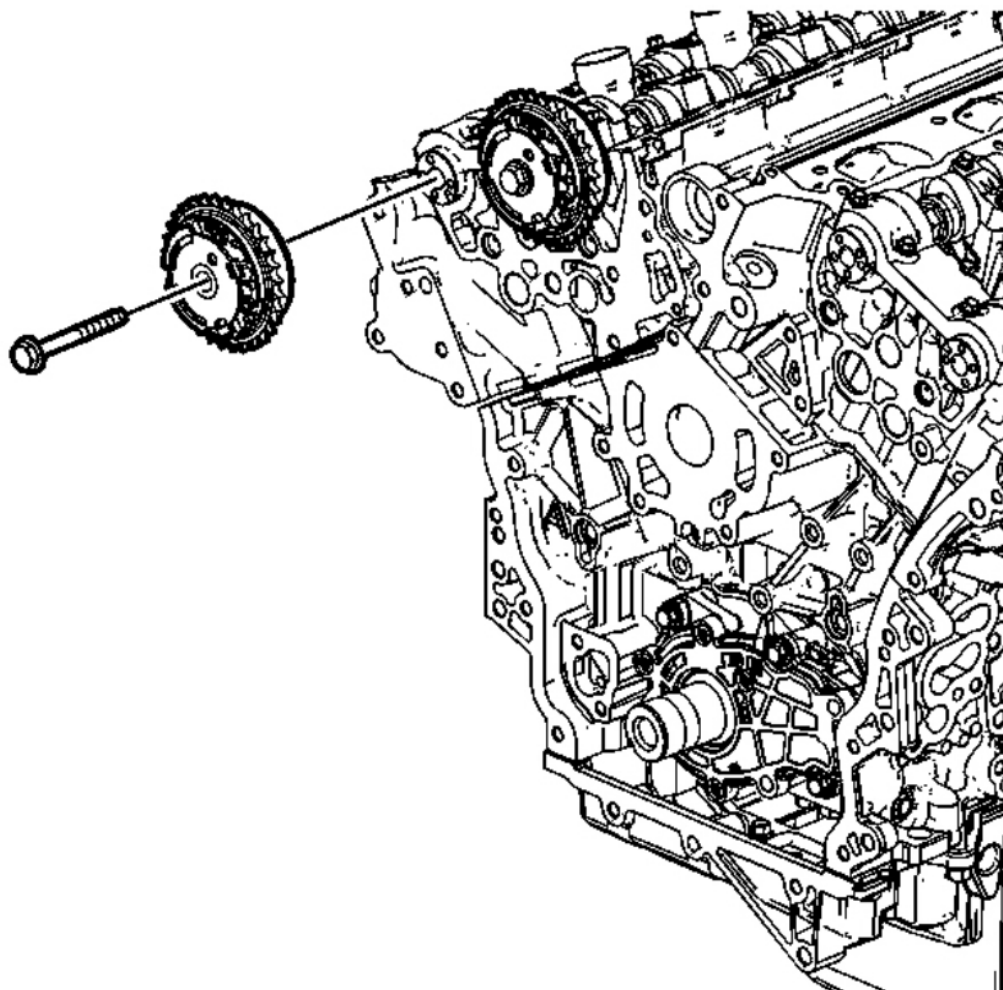


**Fig. 222: Identifying Right Exhaust Camshaft Position Actuator**  
**Courtesy of GENERAL MOTORS CORP.**

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "EX" marking (1). The marking is for an exhaust camshaft position actuator.
2. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the "R" and triangle marking (2). The marking is for alignment to the highlighted timing chain link on the right side of the engine.

**NOTE:** Refer to **Torque Reaction Against Timing Drive Chain Notice** .

3. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.



**Fig. 223: Right Exhaust Camshaft Position Actuator**  
Courtesy of GENERAL MOTORS CORP.

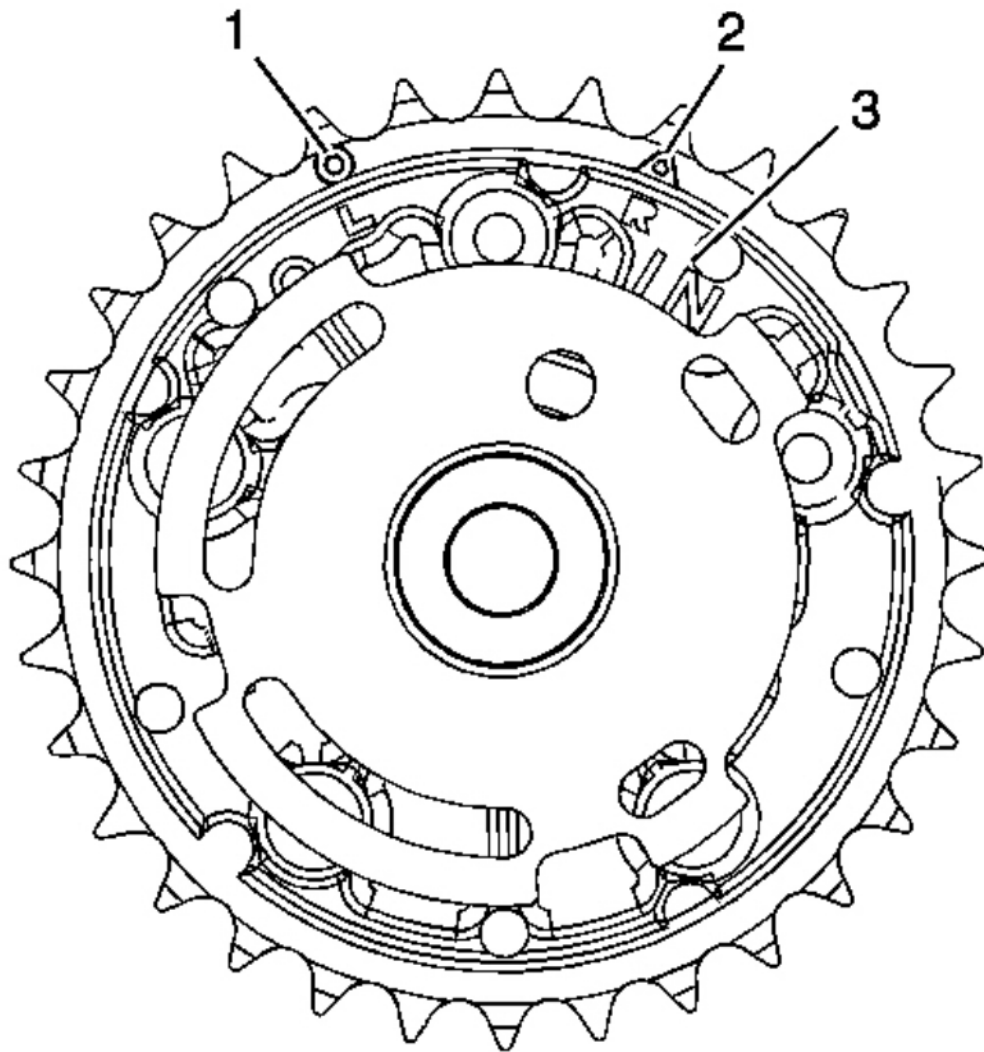
4. Install the right exhaust camshaft position actuator.

**NOTE:** Refer to Fastener Notice .

5. Install the camshaft position actuator bolt.

**Tighten:** Tighten the camshaft position actuator bolt to 58 N.m (43 lb ft).

## CAMSHAFT POSITION (CMP) ACTUATOR INSTALLATION - LEFT INTAKE

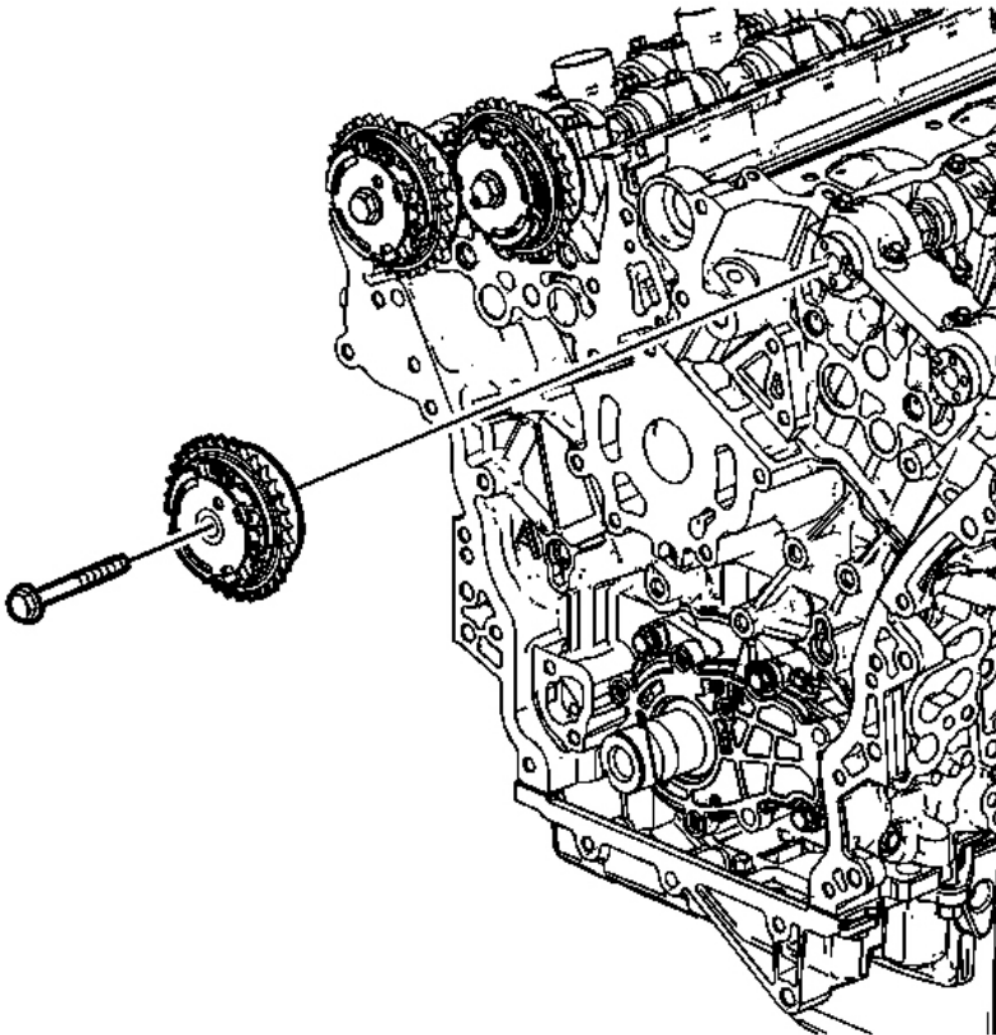


**Fig. 224: Identifying Right Intake Camshaft Position Actuator**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "IN" marking (3). The marking is for an intake camshaft position actuator.
2. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the "L" and circle marking (1). The marking is for alignment to the highlighted timing chain link on the left side of the engine.

**NOTE:** Refer to Torque Reaction Against Timing Drive Chain Notice .

3. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.



**Fig. 225: Left Intake Camshaft Position Actuator**  
Courtesy of GENERAL MOTORS CORP.

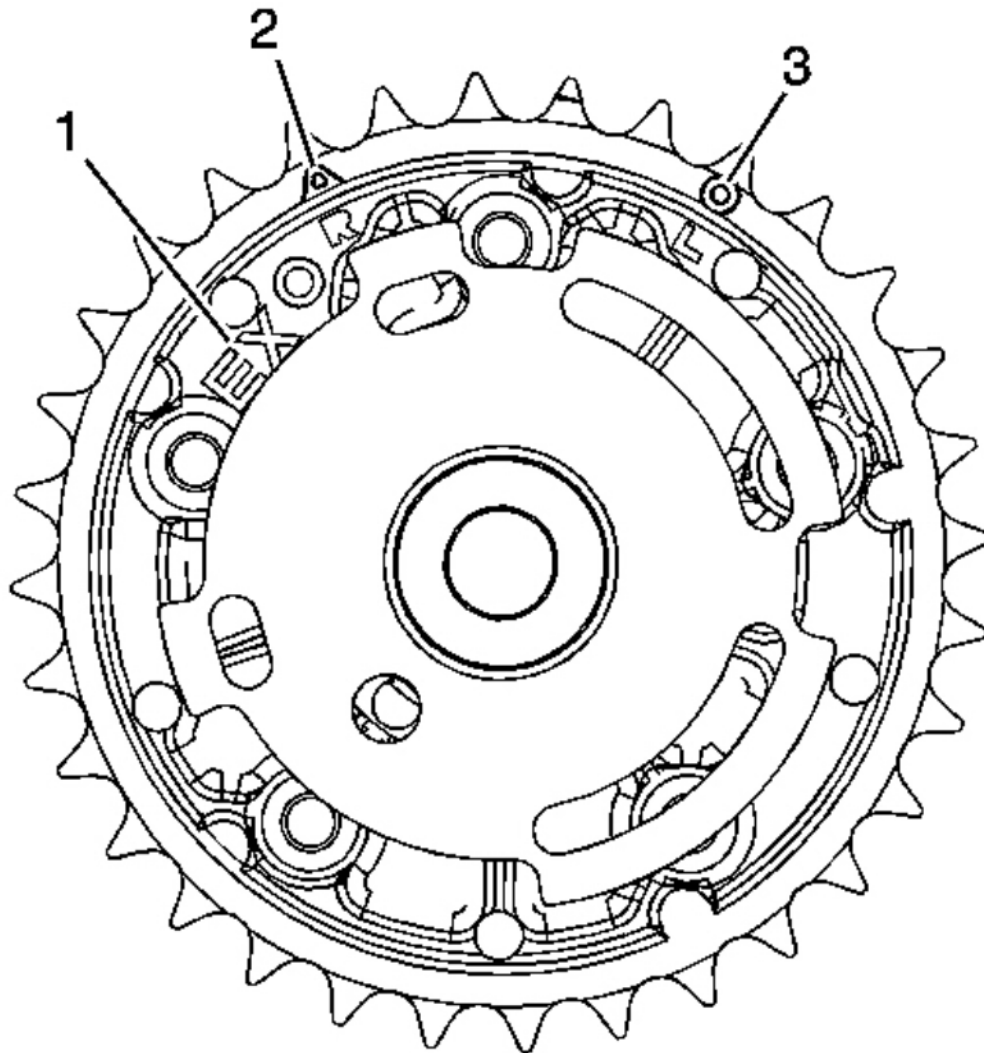
4. Install the left intake camshaft position actuator.

**NOTE:** Refer to Fastener Notice .

5. Install the camshaft position actuator bolt.

**Tighten:** Tighten the camshaft position actuator bolt to 58 N.m (43 lb ft).

## CAMSHAFT POSITION (CMP) ACTUATOR INSTALLATION - LEFT EXHAUST



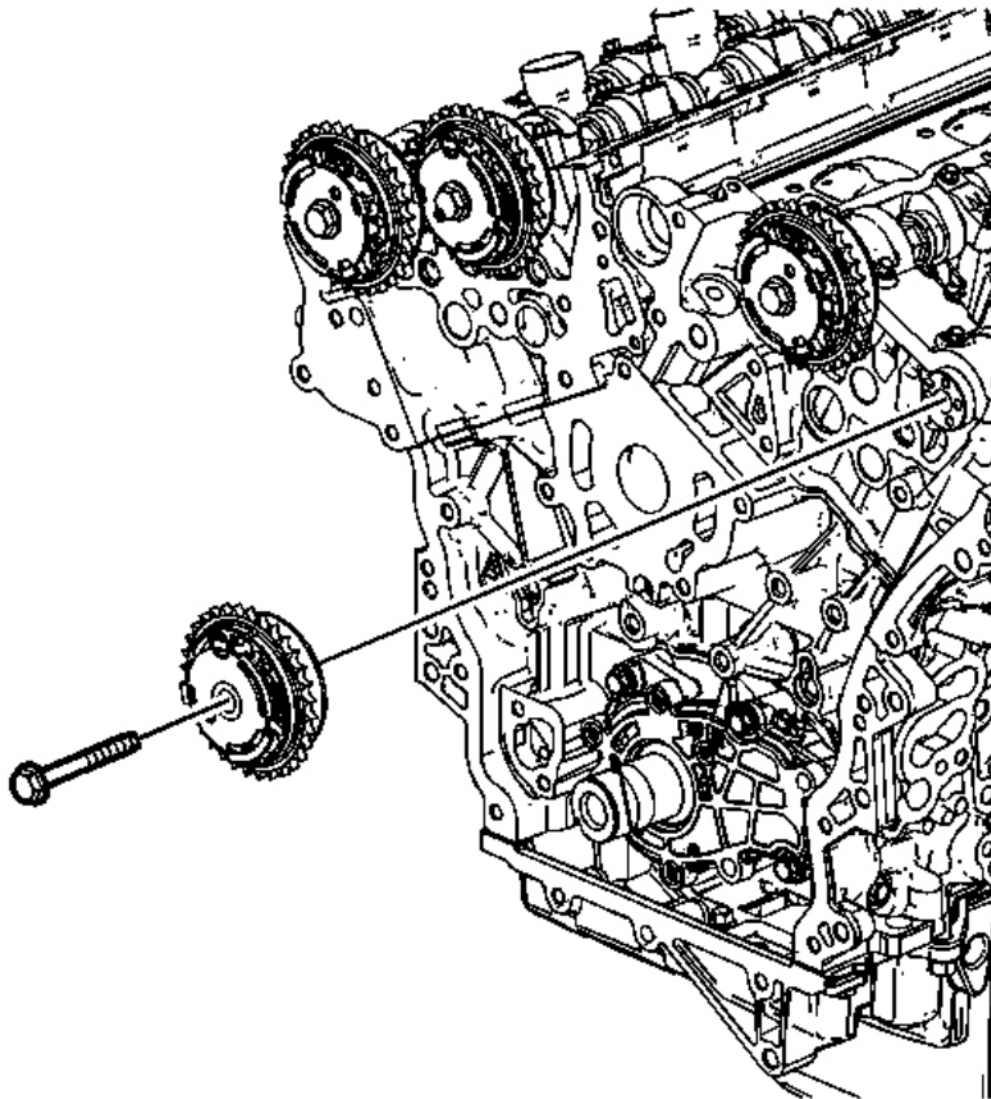
**Fig. 226: Identifying Right Exhaust Camshaft Position Actuator**

**Courtesy of GENERAL MOTORS CORP.**

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "EX" marking (1). The marking is for an exhaust camshaft position actuator.
2. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the "L" and circle marking (3). The marking is for alignment to the highlighted timing chain link on the left side of the engine.

**NOTE:** Refer to **Torque Reaction Against Timing Drive Chain Notice** .

3. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.



**Fig. 227: Left Exhaust Camshaft Position Actuator**  
Courtesy of GENERAL MOTORS CORP.

4. Install the left exhaust camshaft position actuator.

**NOTE:** Refer to Fastener Notice .

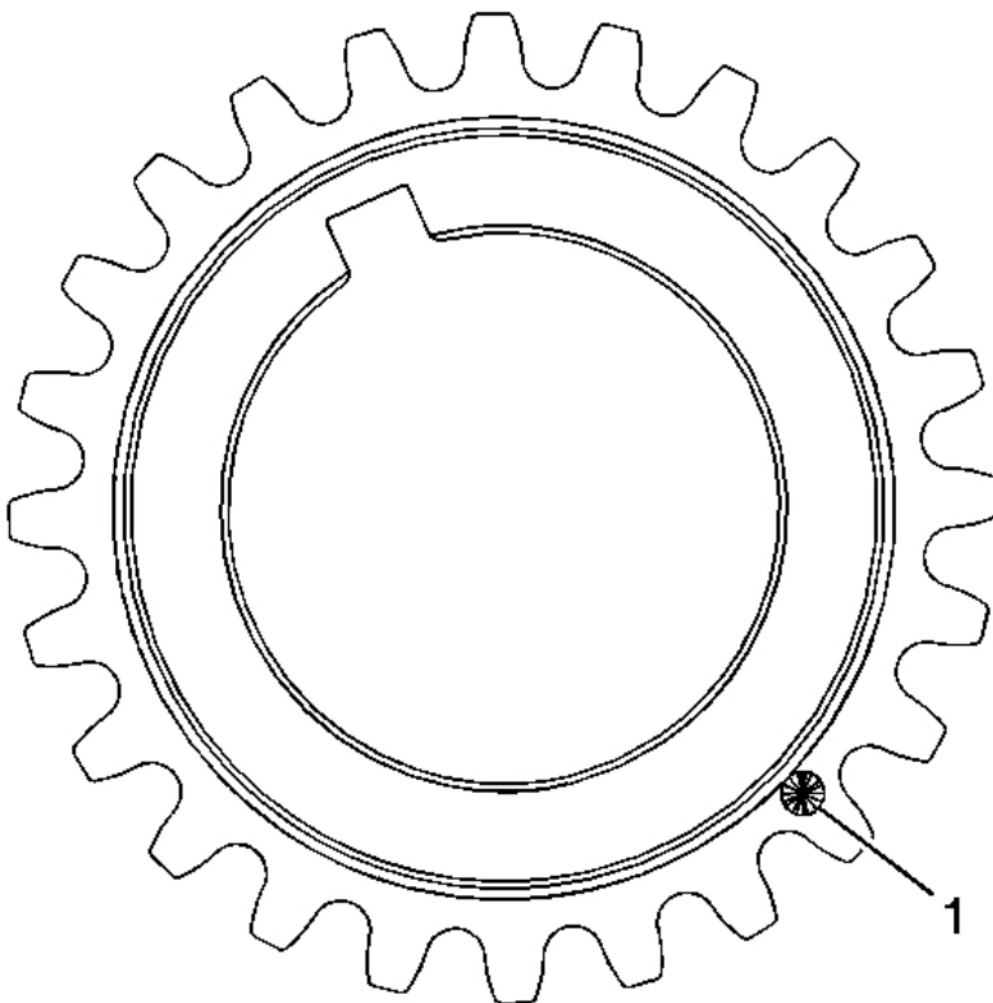
5. Install the camshaft position actuator bolt.

**Tighten:** Tighten the camshaft position actuator bolt to 58 N.m (43 lb ft).

## CRANKSHAFT SPROCKET INSTALLATION

### Tools Required

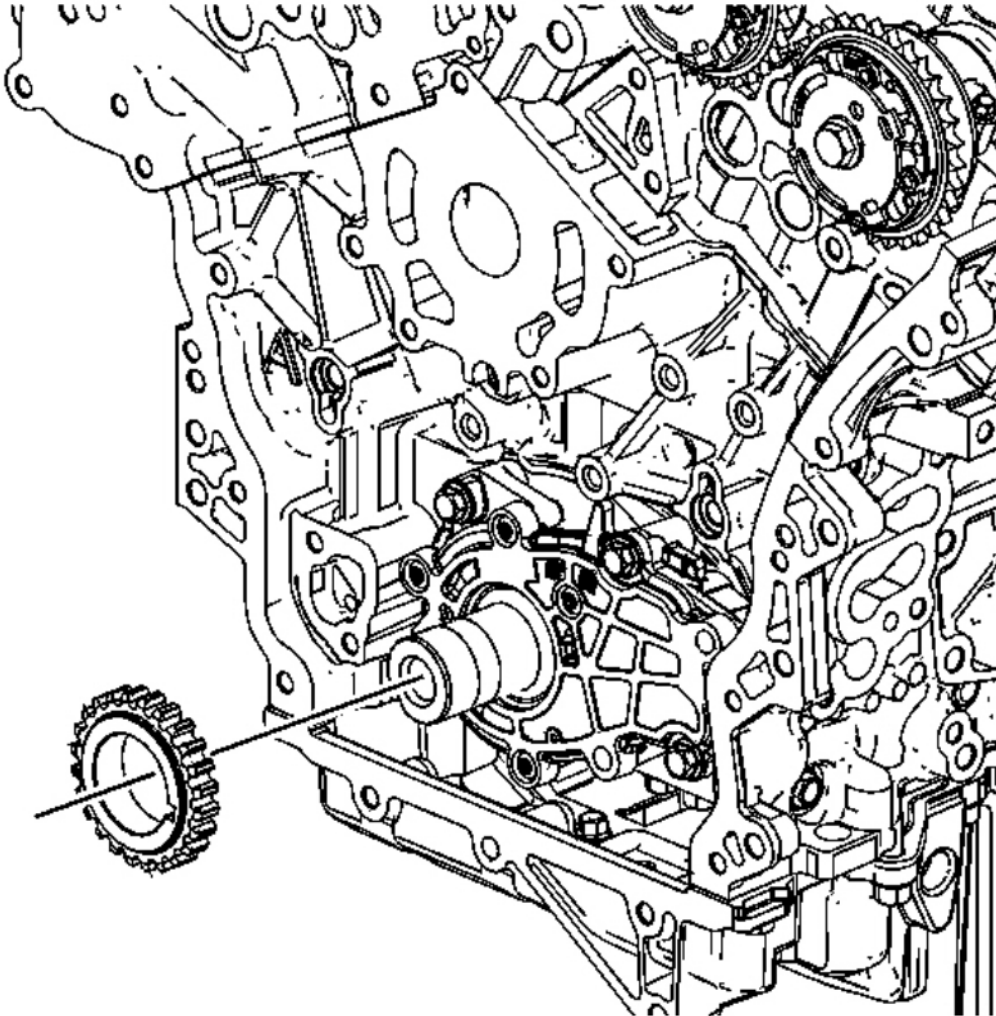
EN 46111 Crankshaft Rotation Socket



**Fig. 228: Crankshaft Sprocket With Timing Mark**  
Courtesy of GENERAL MOTORS CORP.

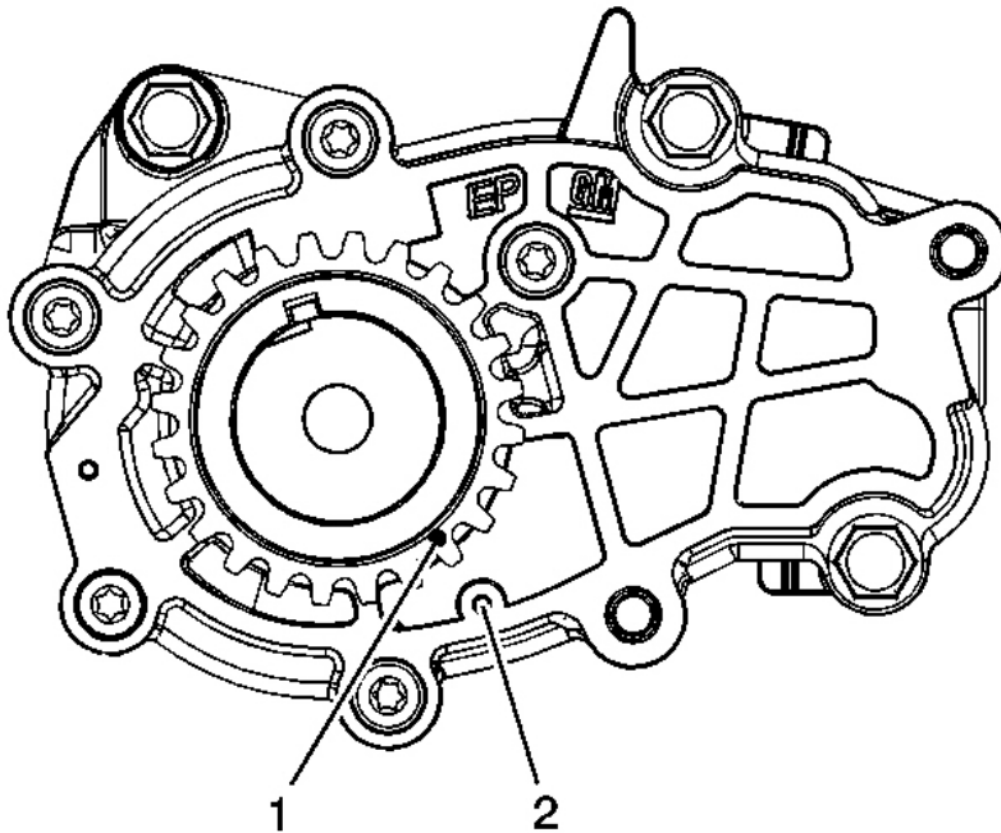


1. Ensure the crankshaft sprocket is installed with the timing mark (1) visible.



**Fig. 229: Installing Crankshaft Sprocket On Nose Of Crankshaft**  
Courtesy of GENERAL MOTORS CORP.

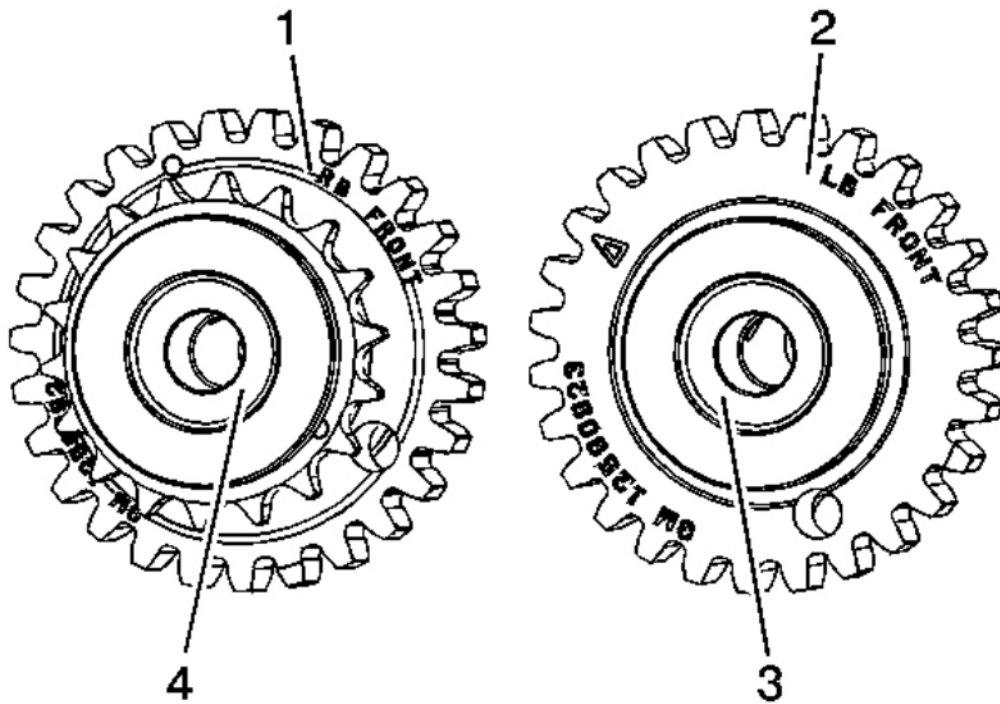
2. Install the crankshaft sprocket on to the nose of the crankshaft.
3. Align the notch in the crankshaft sprocket with the pin in the crankshaft.
4. Slide the crankshaft sprocket on the crankshaft nose until the crankshaft sprocket contacts the step in the crankshaft.



**Fig. 230: Crankshaft In Stage One Timing Position**  
Courtesy of GENERAL MOTORS CORP.

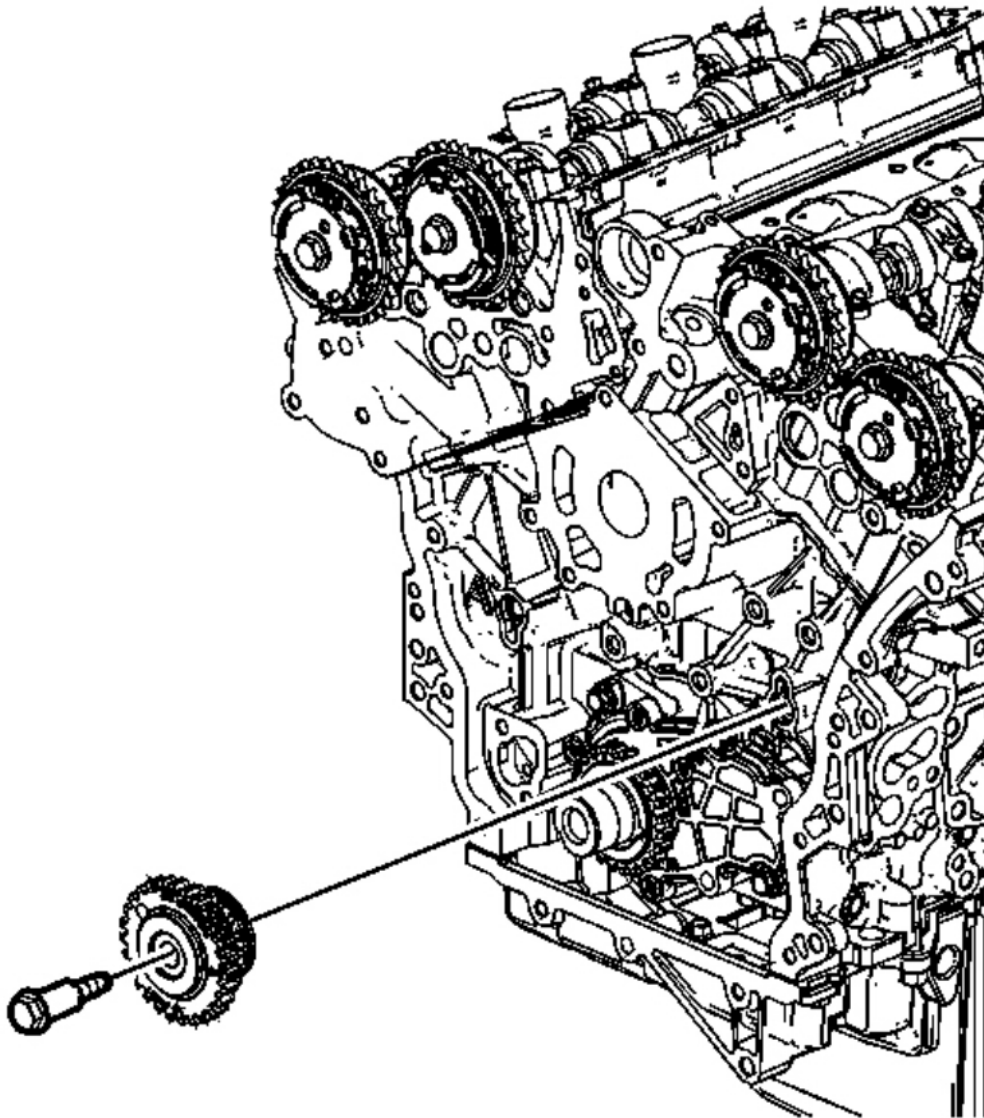
5. Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (1) aligned to the stage one timing mark on the oil pump cover (2) using the **EN 46111** . Refer to **Camshaft Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain)** - Stage One.

## **CAMSHAFT INTERMEDIATE DRIVE CHAIN IDLER INSTALLATION - LEFT**



**Fig. 231: Camshaft Intermediate Drive Chain Idler**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the left camshaft intermediate drive chain idler (2) is being installed. The recessed hub (3) and the larger sprocket of the left camshaft intermediate drive chain idler is installed outward. The raised hub and the smaller sprocket of the left camshaft intermediate drive chain idler is installed towards the block.



**Fig. 232: Left Camshaft Intermediate Drive Chain Idler**  
Courtesy of GENERAL MOTORS CORP.

2. Place the left camshaft intermediate drive chain idler to the cylinder block.

**NOTE:** Refer to Fastener Notice .

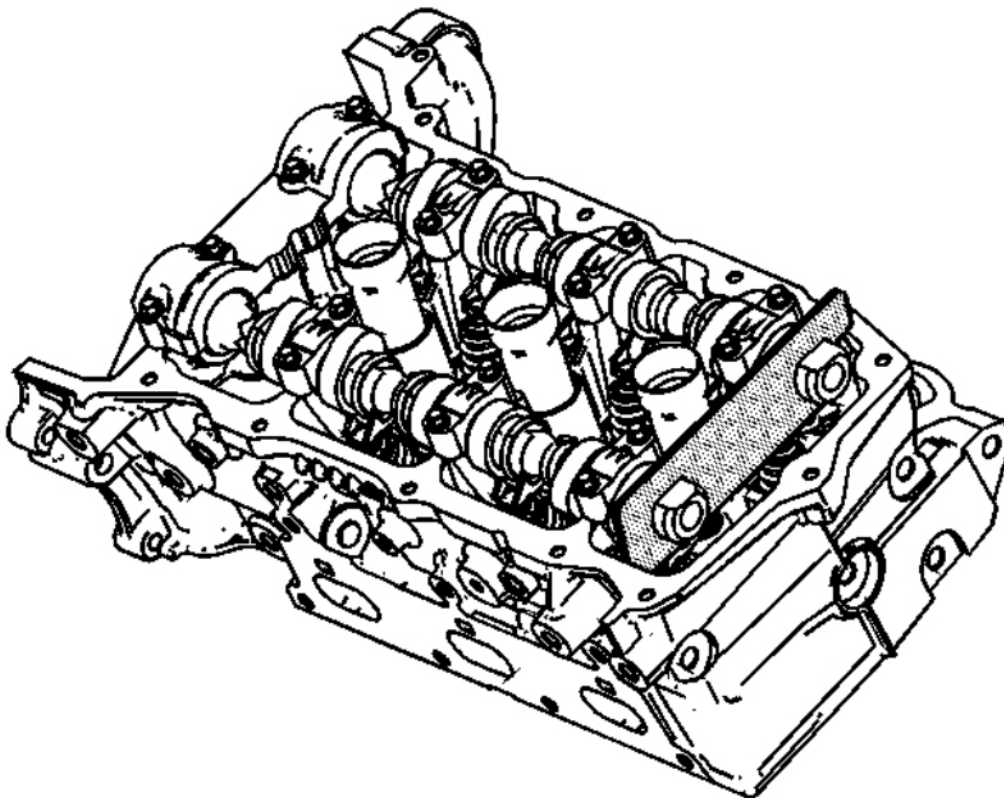
3. Install the camshaft intermediate drive chain idler bolt.

**Tighten:** Tighten the camshaft intermediate drive chain idler bolt to 58 N.m (43 lb ft).

## SECONDARY CAMSHAFT DRIVE CHAIN INSTALLATION - LEFT

### Tools Required

- EN 46105 Camshaft Holding Tool
- EN 46111 Crankshaft Rotation Socket



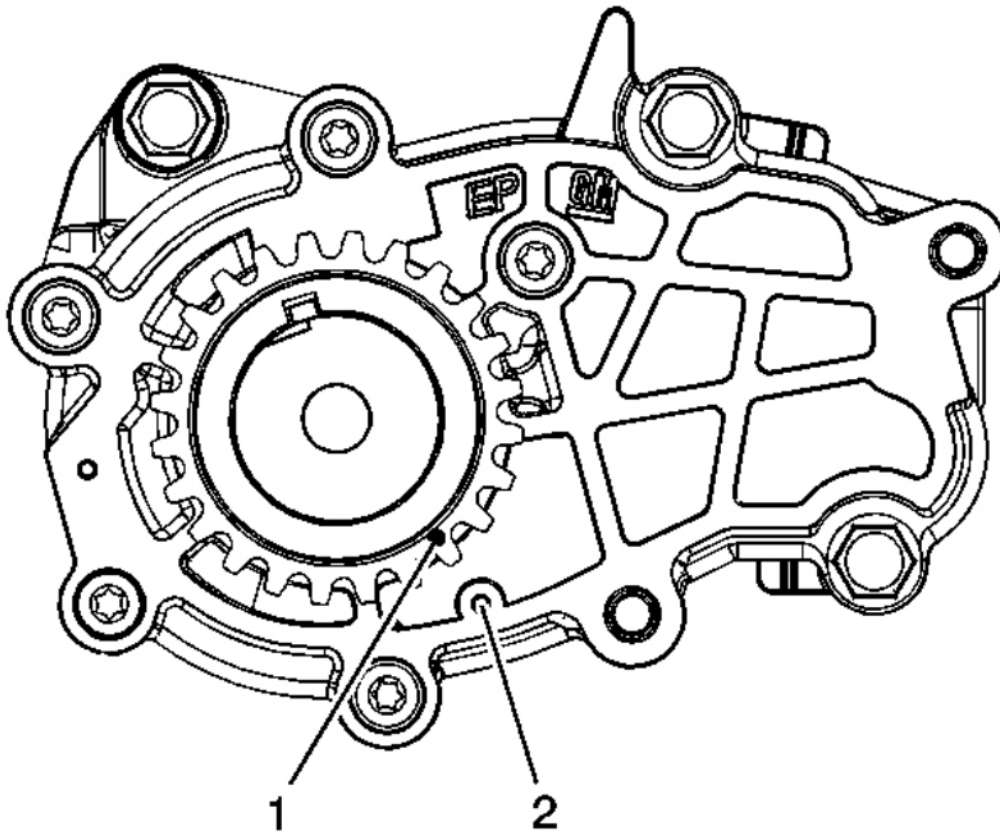
**Fig. 233: Installing EN 46105-1**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** There should be no need to rotate the camshaft more than 10 degrees.  
Using the hex cast into the camshaft rotate the camshaft in order to install the EN 46105 .

1. Install the EN 46105-1 onto the rear of the left camshafts.

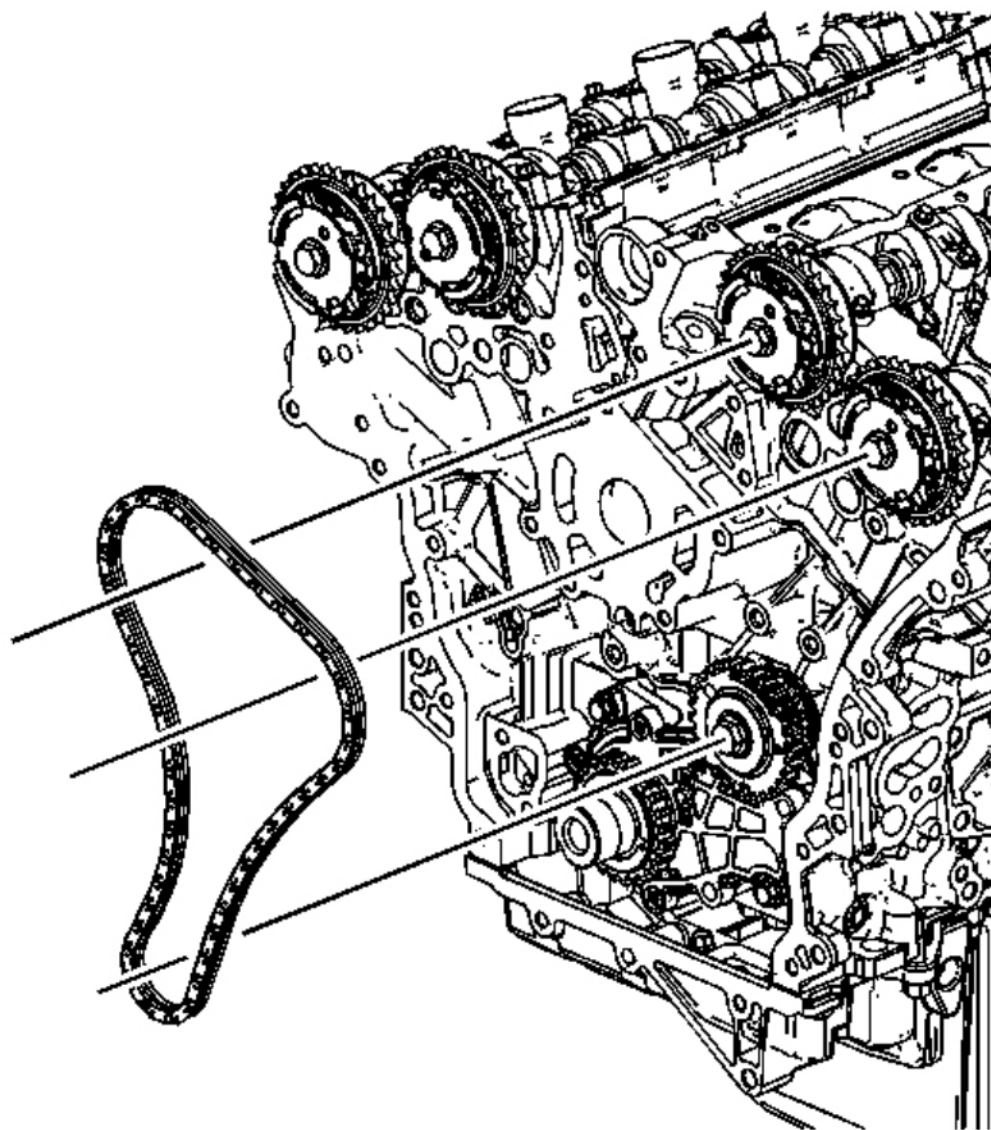
**IMPORTANT: All camshafts must be locked in place before installation of any camshaft drive chains.**

2. Ensure that the EN 46105-1 is fully seated onto the camshafts.



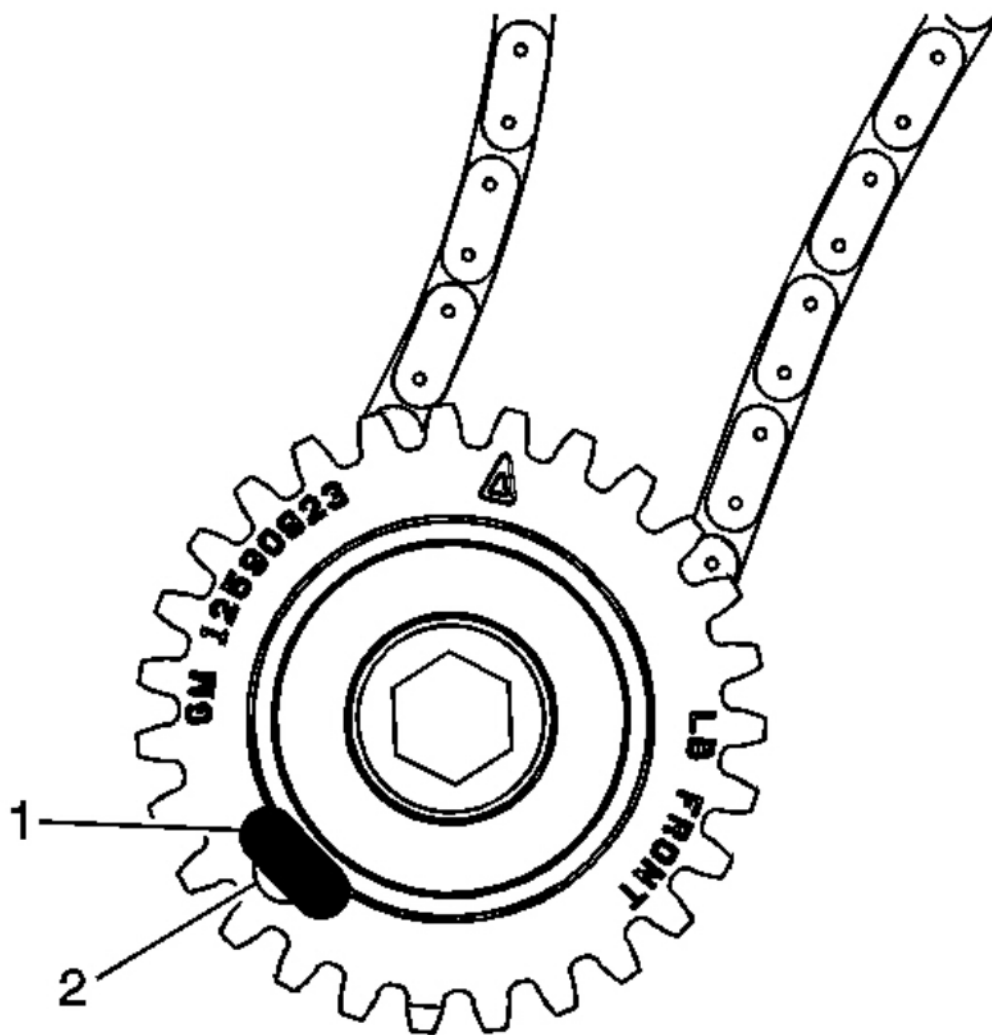
**Fig. 234: Aligning Stage One Timing Mark On Oil Pump Cover**  
Courtesy of GENERAL MOTORS CORP.

3. Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (1) aligned to the stage one timing mark on the oil pump cover (2) using the **EN 46111** . Refer to **Camshaft Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain)** - Stage One.



**Fig. 235: Left Secondary Camshaft Drive Chain**  
Courtesy of GENERAL MOTORS CORP.

4. Install the left secondary camshaft drive chain.

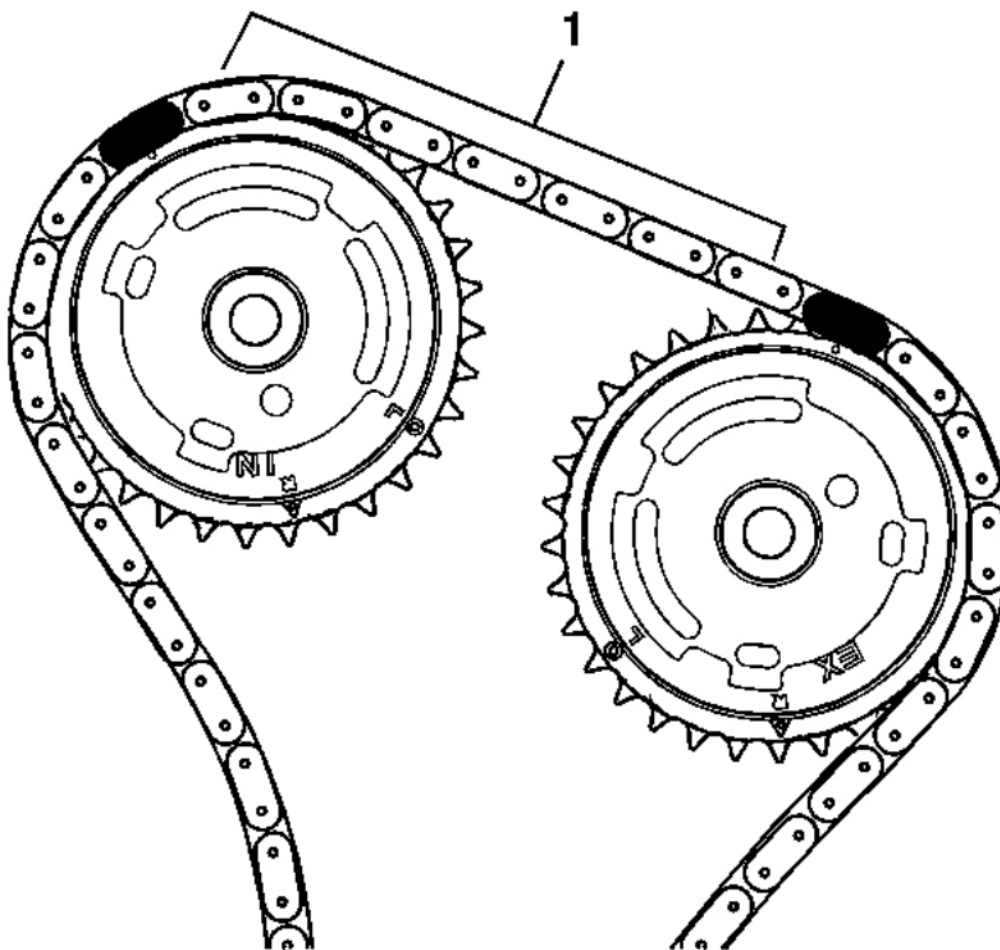


**Fig. 236: Timing Camshaft Drive Chain Link**

Courtesy of GENERAL MOTORS CORP.

5. Place the left secondary camshaft drive chain around the inner sprocket of the left camshaft intermediate drive chain idler with the timing camshaft drive chain link (1) aligned to the alignment access hole (2) made in the left camshaft intermediate drive chain idler outer sprocket.

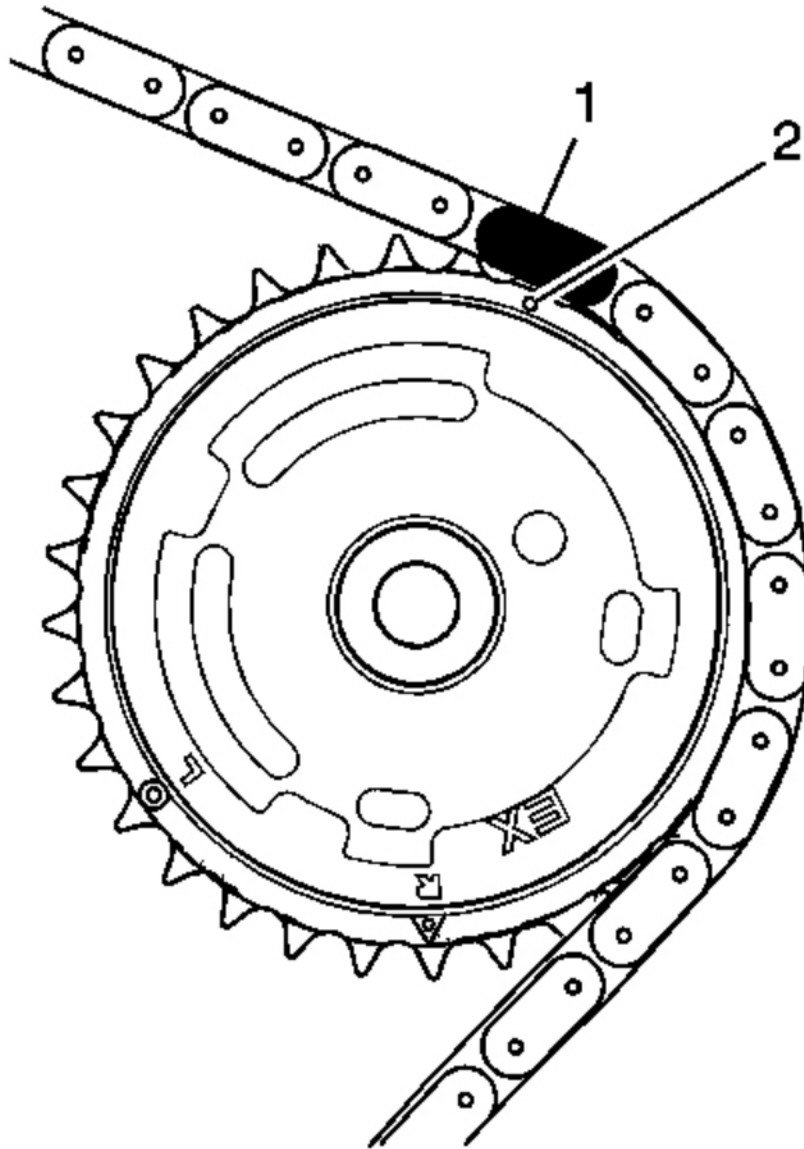




**Fig. 237: Identifying 7 Links Between The Timing Camshaft Drive Chain Links For The Camshaft Position Actuator Sprockets**

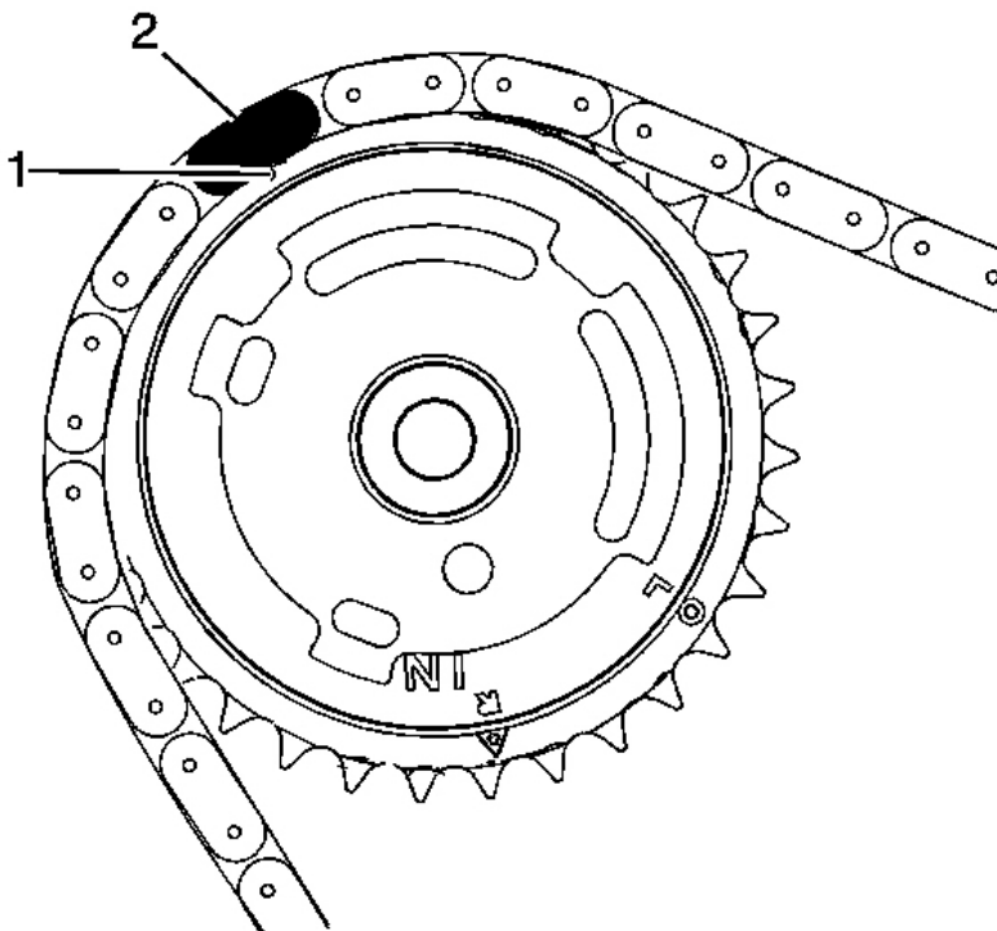
Courtesy of GENERAL MOTORS CORP.

6. Wrap the secondary camshaft drive chain around both left actuator drive sprockets.
7. Ensure there are 7 links (1) between the timing camshaft drive chain links for the camshaft position actuator sprockets.



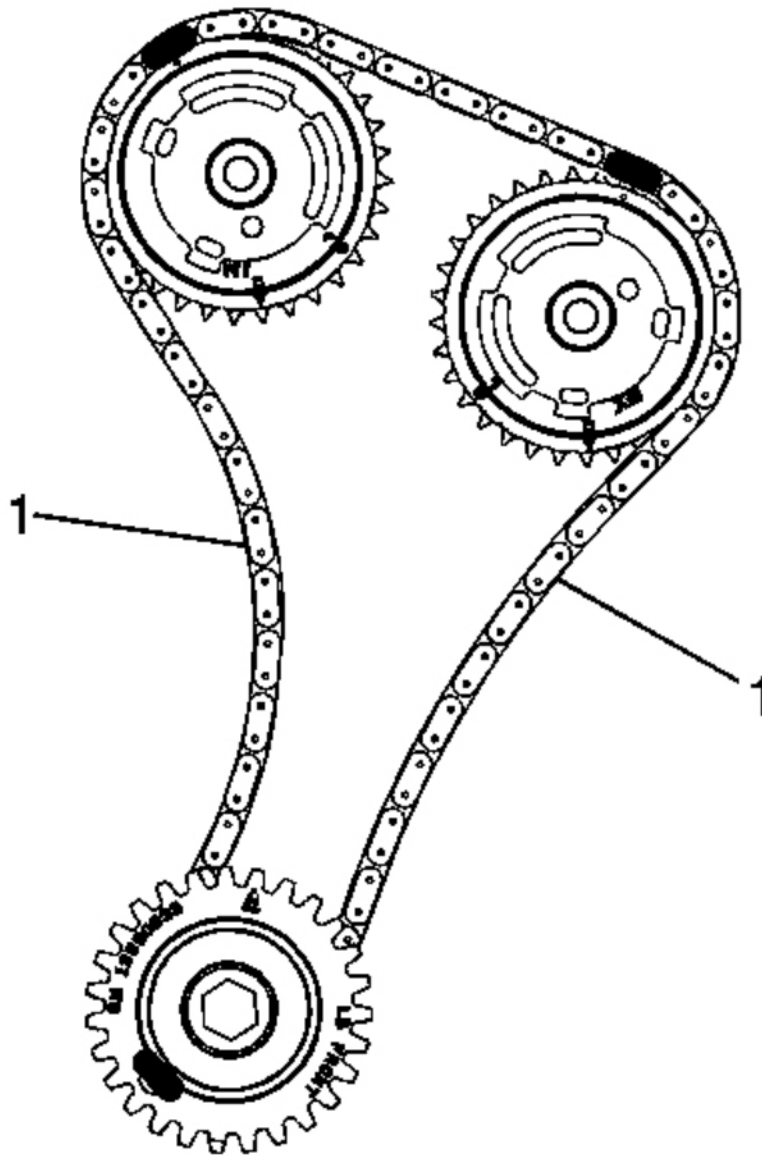
**Fig. 238: Locating Left Exhaust Camshaft Position Actuator Sprocket Alignment Circle Mark**  
Courtesy of GENERAL MOTORS CORP.

8. Align the left exhaust camshaft position actuator sprocket alignment circle mark (2) with the timing camshaft drive chain link (1).



**Fig. 239: View Of Timing Camshaft Drive Chain Link & Left Intake Camshaft Position Actuator Sprocket Alignment Circle Mark**  
Courtesy of GENERAL MOTORS CORP.

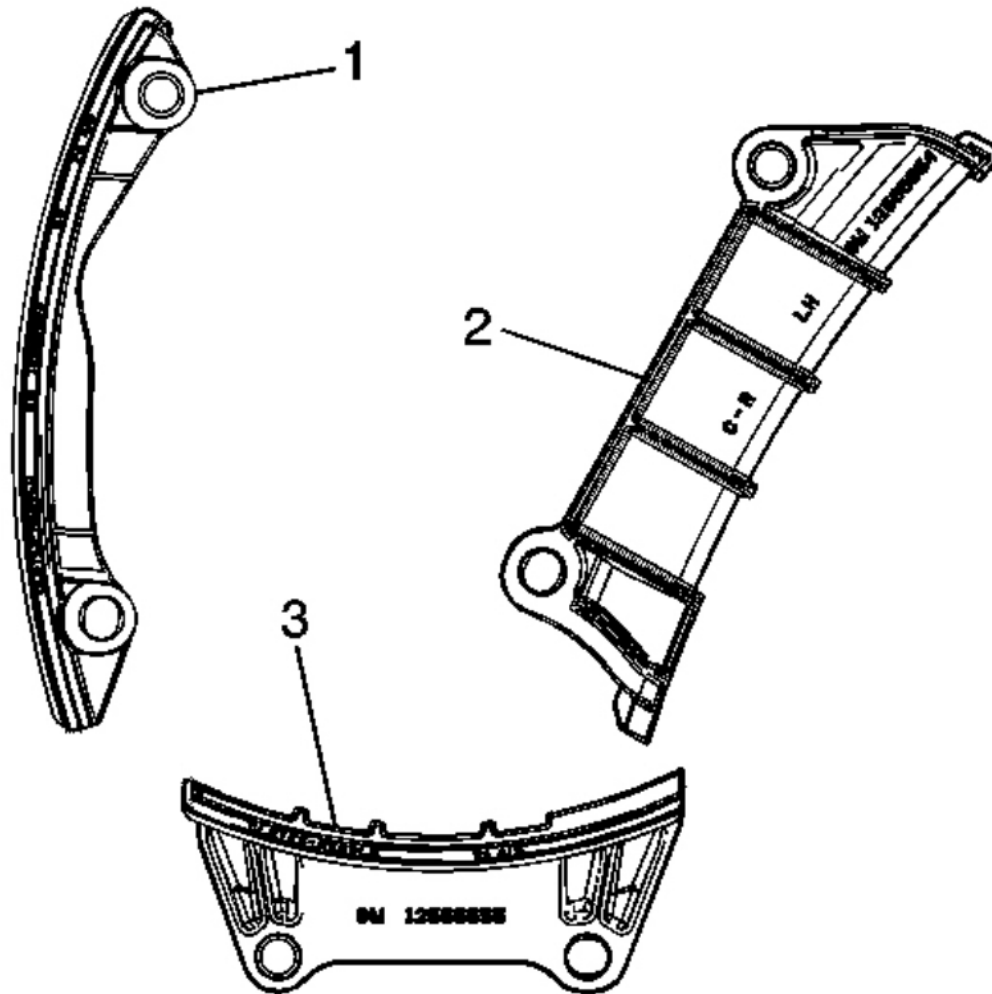
9. Align the left intake camshaft position actuator sprocket alignment circle mark (1) with the timing camshaft drive chain link (2).



**Fig. 240: Intermediate Drive Chain**  
Courtesy of GENERAL MOTORS CORP.

10. There will be 18 links (1) between the left camshaft intermediate drive chain idler timing secondary camshaft drive chain link and each left camshaft position actuator sprocket timing secondary camshaft drive chain link.

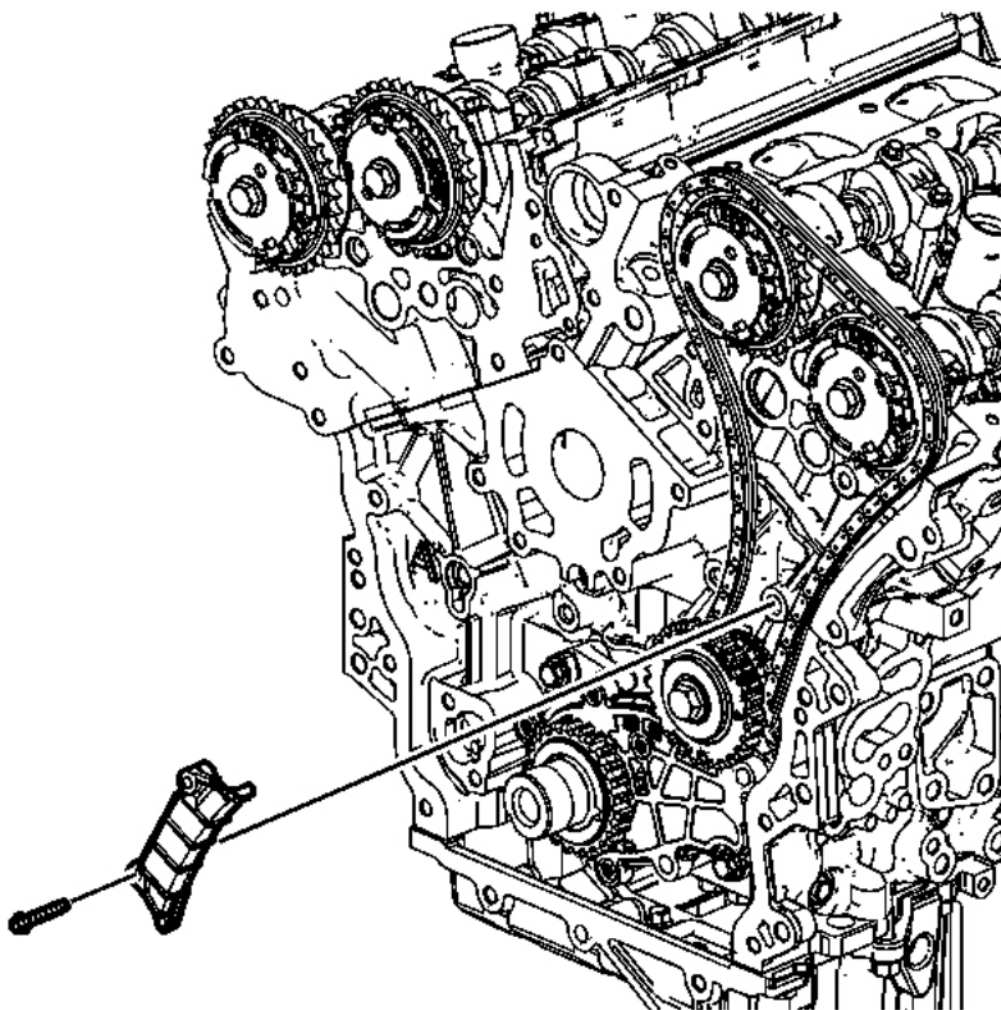
## SECONDARY CAMSHAFT DRIVE CHAIN GUIDE INSTALLATION - LEFT



**Fig. 241: Identifying Left & Right Secondary Camshaft Drive Chain Guide & Upper Primary Camshaft Drive Chain Guide**

Courtesy of GENERAL MOTORS CORP.

1. Ensure that the left secondary camshaft drive chain guide (2) is being installed.



**Fig. 242: Left Secondary Camshaft Drive Chain Guide**  
Courtesy of GENERAL MOTORS CORP.

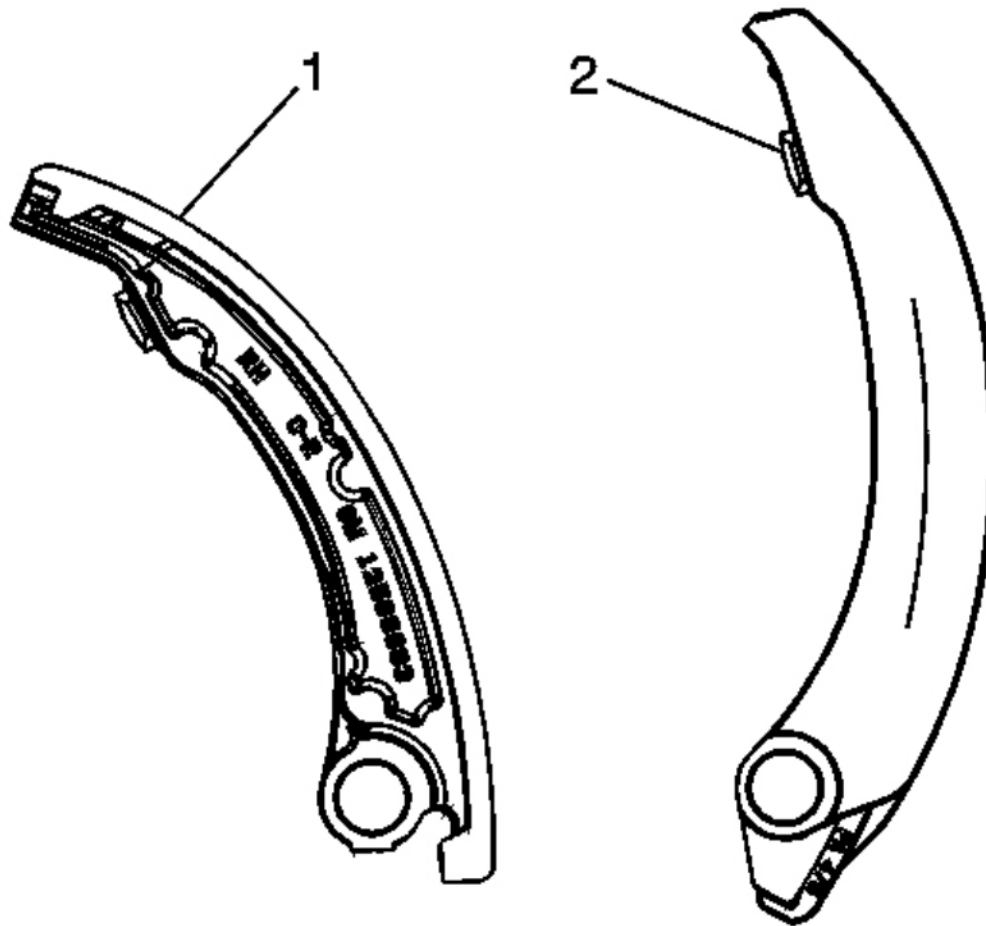
2. Position the left secondary camshaft drive chain guide.

**NOTE:** Refer to Fastener Notice .

3. Install the secondary camshaft drive chain guide bolts.

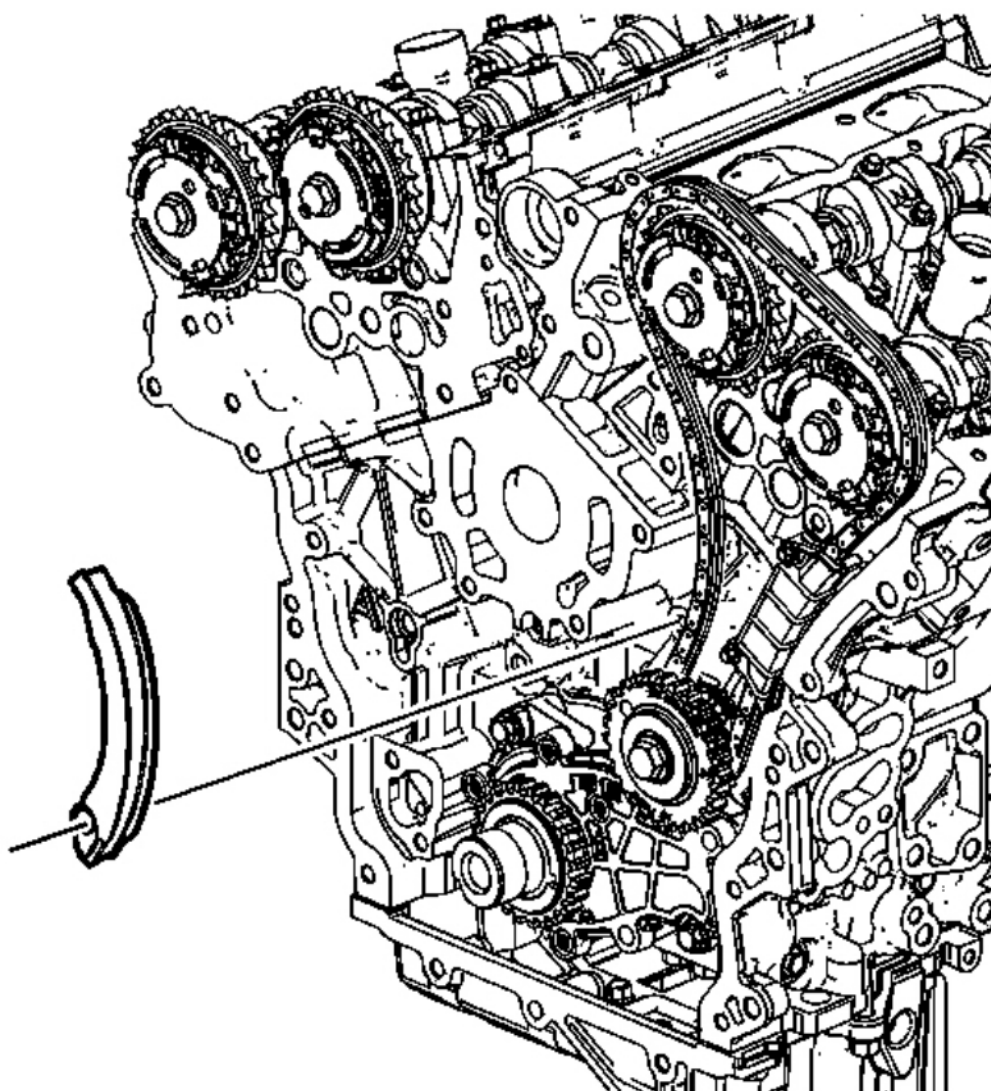
**Tighten:** Tighten the secondary camshaft drive chain guide bolts to 23 N.m (17 lb ft).

## SECONDARY CAMSHAFT DRIVE CHAIN SHOE INSTALLATION - LEFT



**Fig. 243: Left Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS CORP.

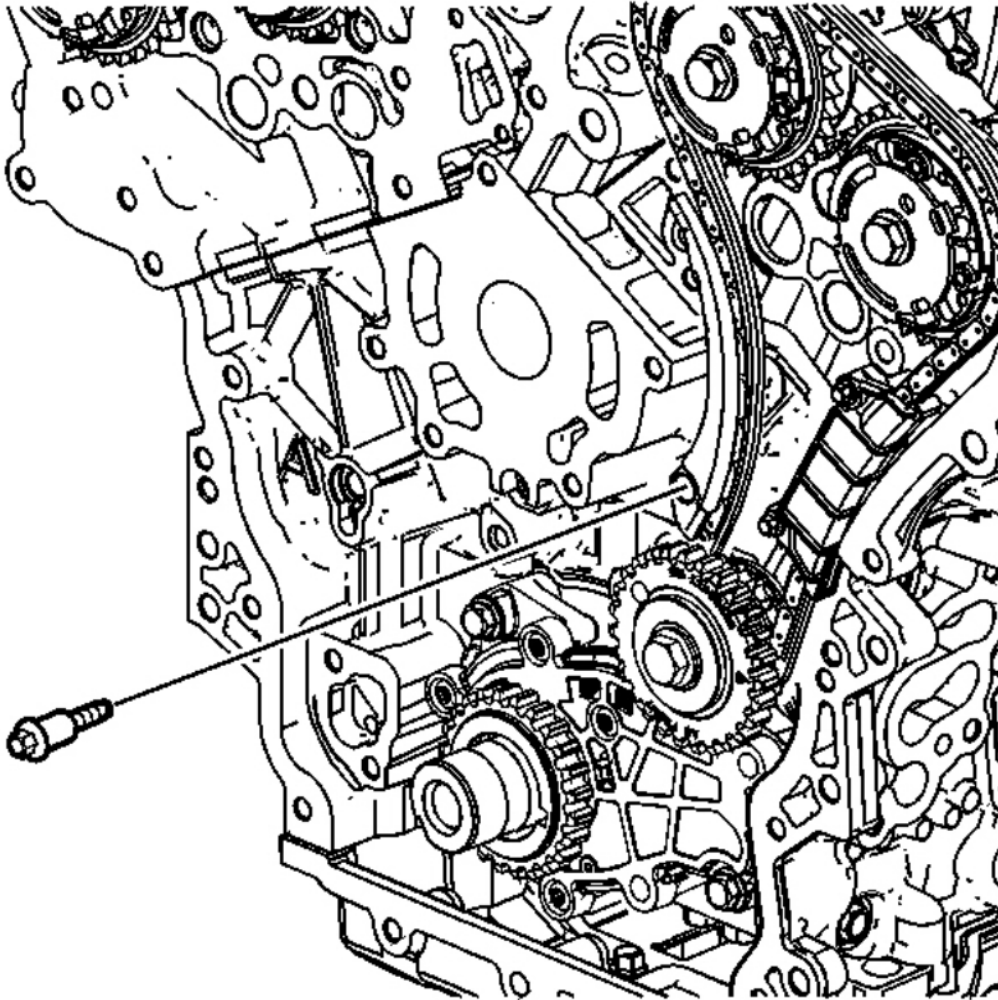
1. Ensure that the left secondary camshaft drive chain shoe (2) is being installed.



**Fig. 244: Left Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS CORP.

2. Position the left secondary camshaft drive chain shoe.





**Fig. 245: Secondary Camshaft Drive Chain Shoe Bolt**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

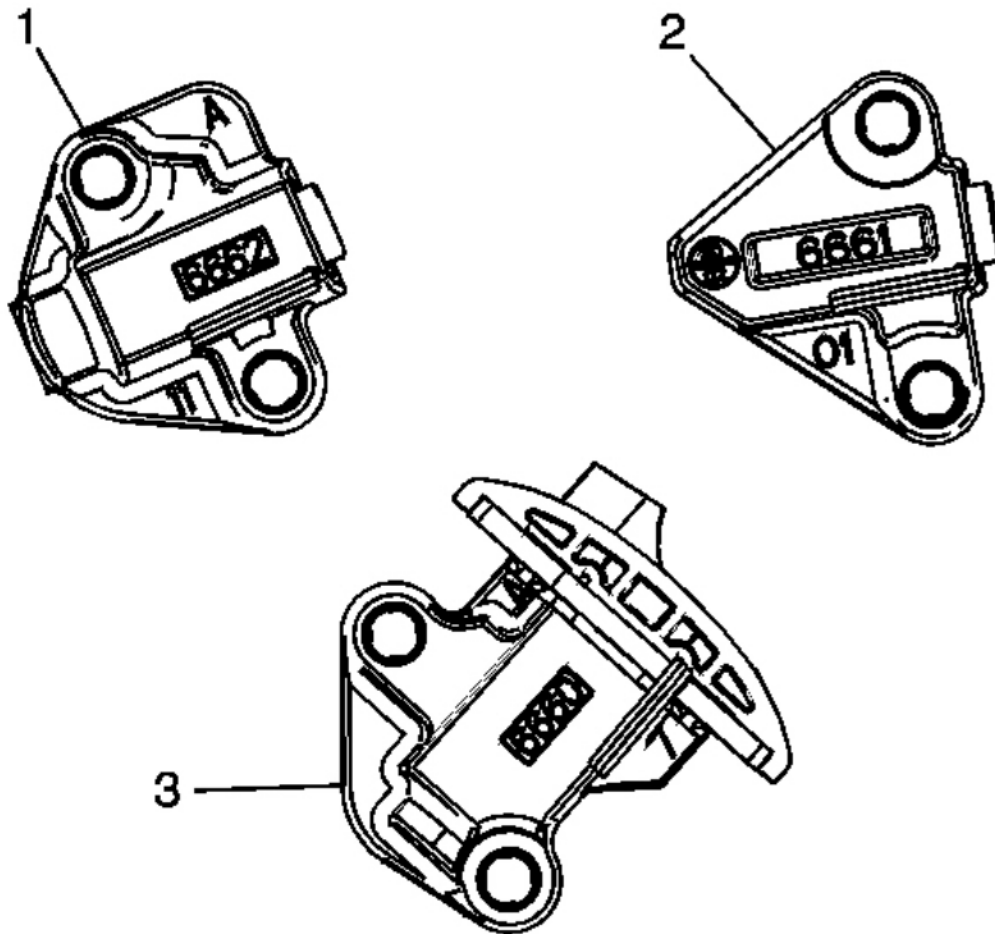
3. Install the secondary camshaft drive chain shoe bolt.

**Tighten:** Tighten the secondary camshaft drive chain shoe bolt to 23 N.m (17 lb ft).

## SECONDARY CAMSHAFT DRIVE CHAIN TENSIONER INSTALLATION - LEFT

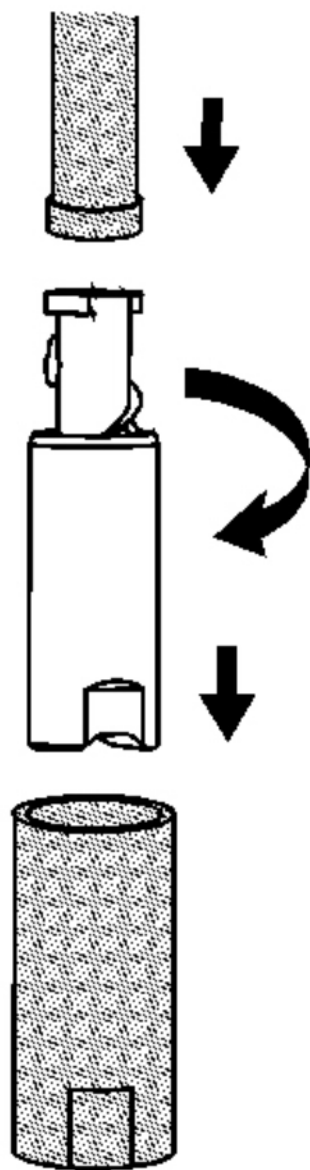
**Tools Required**

- EN 46112 Tensioner Retraction Pins
- J 45027 Tensioner Tool



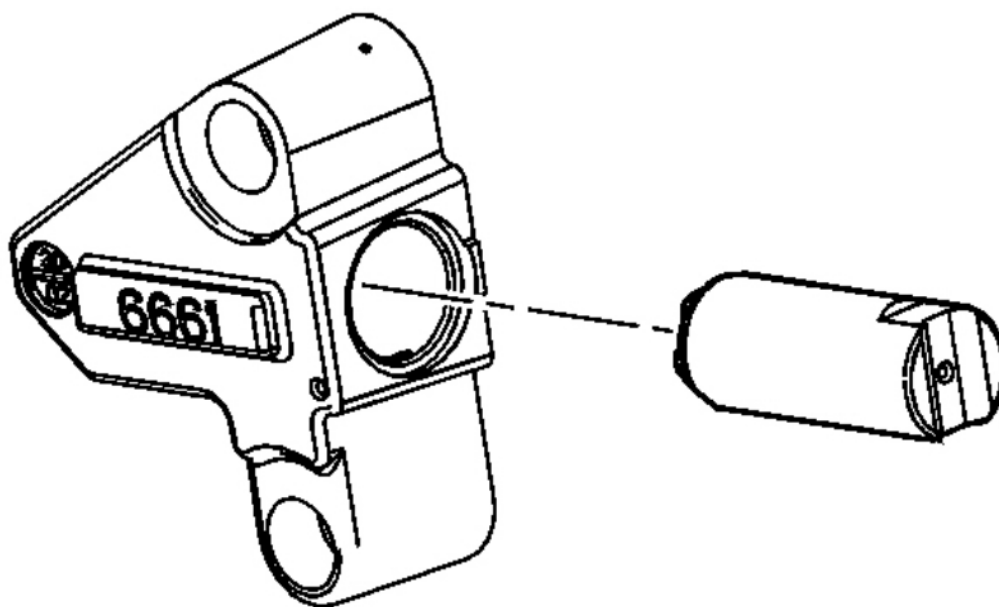
**Fig. 246: Identifying Left & Right Secondary Camshaft Drive Chain Tensioner & Primary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the left secondary camshaft drive chain tensioner (2) is being installed.



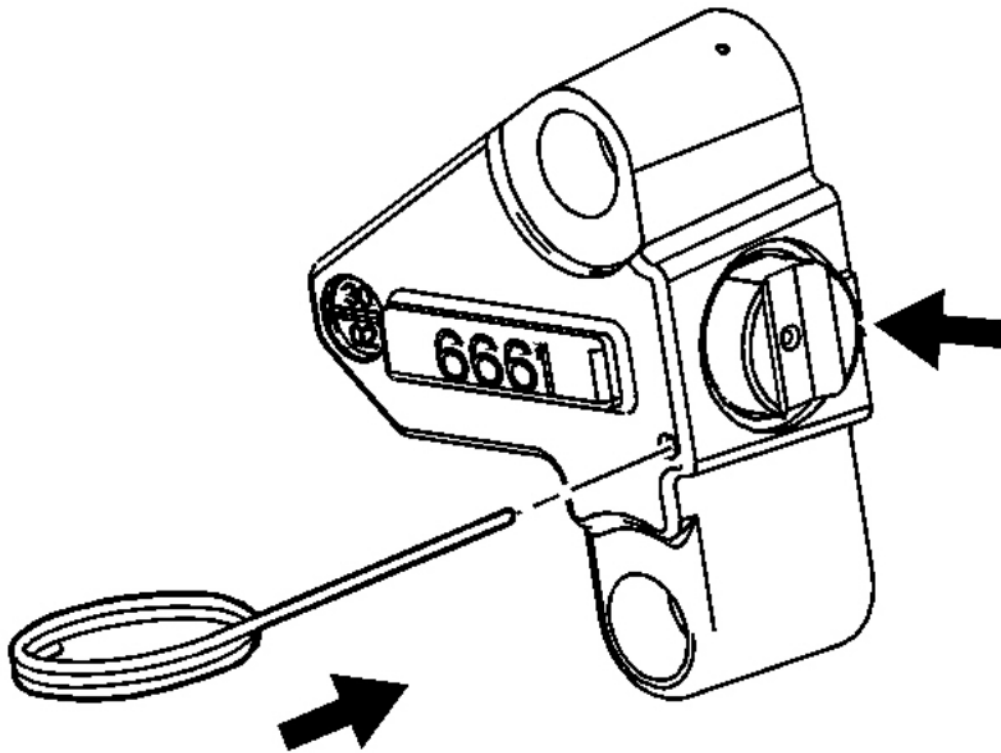
**Fig. 247: Resetting Left Secondary Camshaft Drive Chain Tensioner Plunger With J 45027**  
Courtesy of GENERAL MOTORS CORP.

2. Using the **J 45027** reset the left secondary camshaft drive chain tensioner plunger.



**Fig. 248: Installing Plunger Into Left Secondary Camshaft Drive Chain Tensioner Body**  
Courtesy of GENERAL MOTORS CORP.

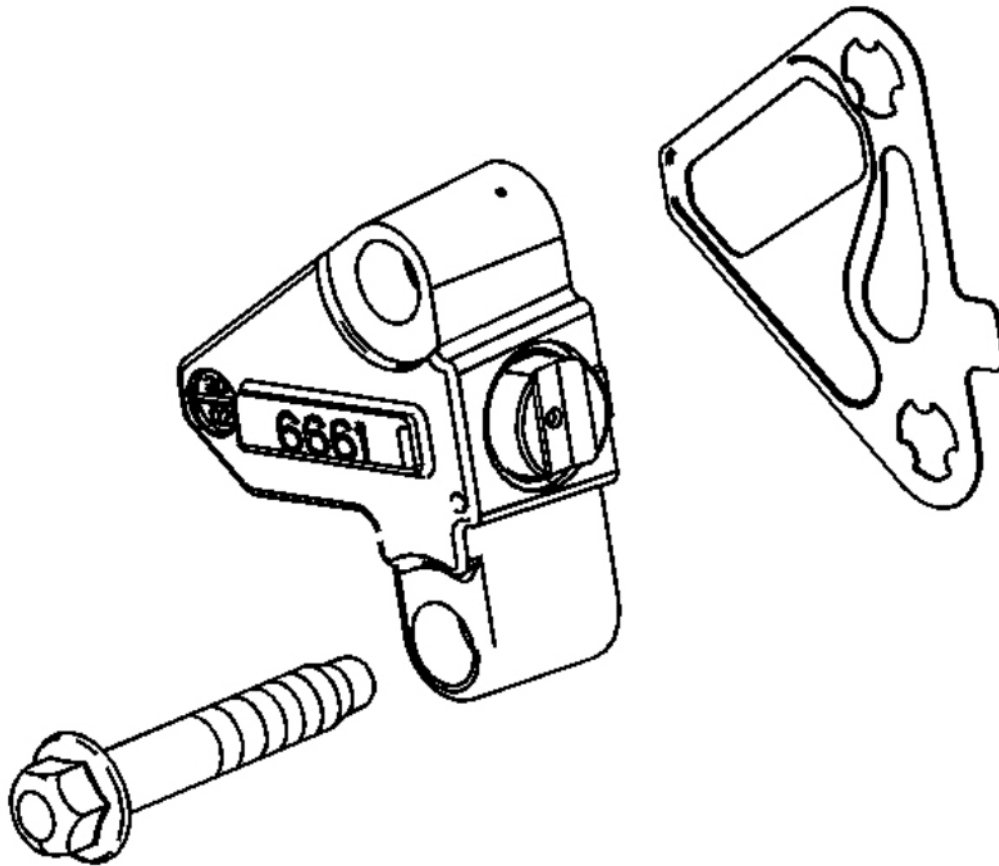
3. Install the plunger into the left secondary camshaft drive chain tensioner body.



**Fig. 249: Inserting EN 46112 Into Access Hole In Side Of Left Secondary Camshaft Drive Chain Tensioner Body**

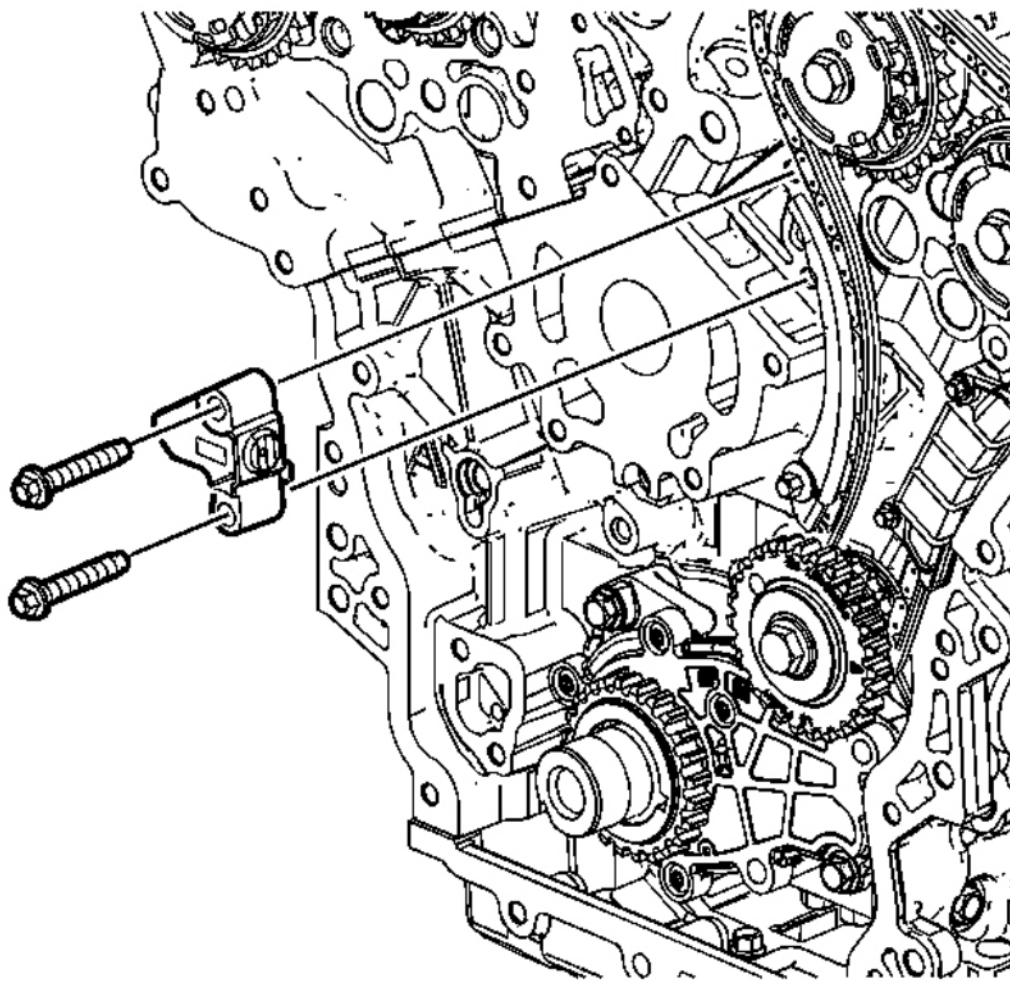
**Courtesy of GENERAL MOTORS CORP.**

4. Compress the plunger into the body and lock the left secondary camshaft drive chain tensioner by inserting the **EN 46112** into the access hole in the side of the left secondary camshaft drive chain tensioner body.
5. Slowly release pressure on the left secondary camshaft drive chain tensioner. The left secondary camshaft drive chain tensioner should remain compressed.



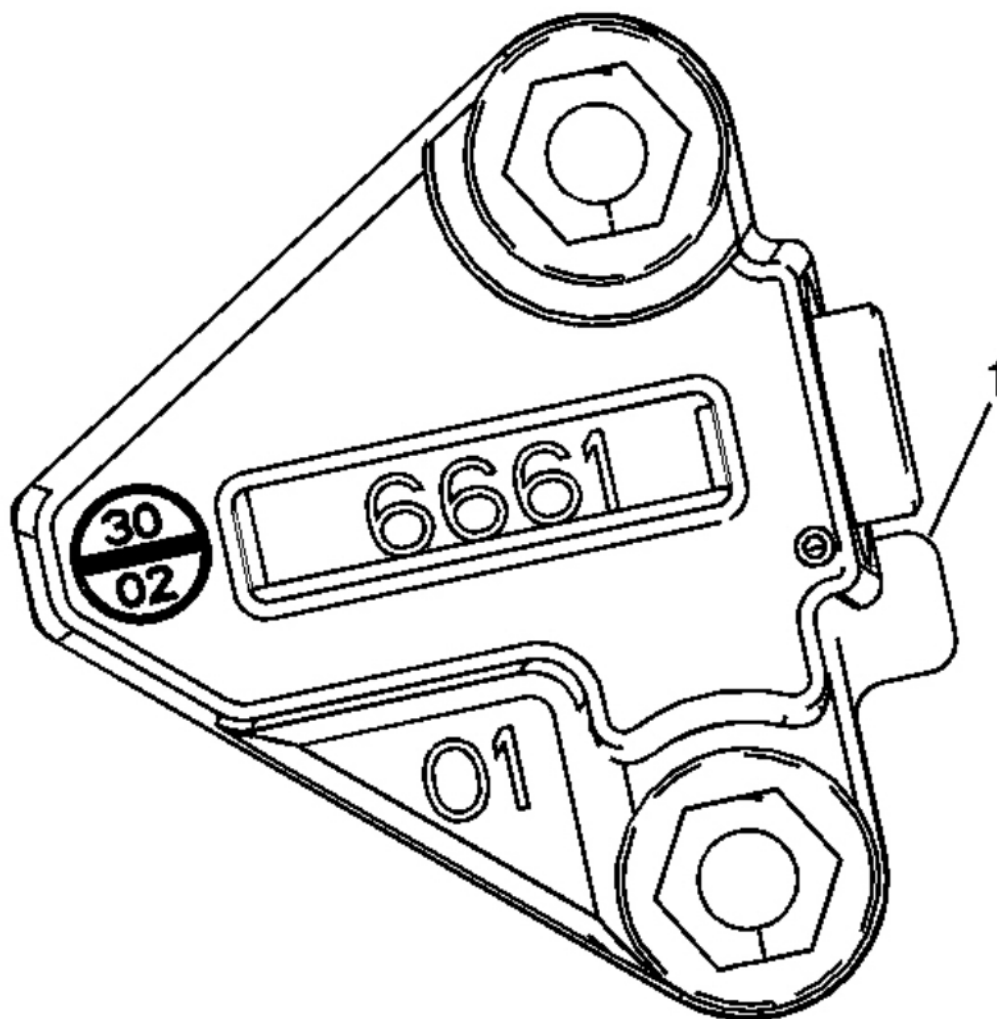
**Fig. 250: Identifying Left Secondary Camshaft Drive Chain Tensioner Gasket**  
Courtesy of GENERAL MOTORS CORP.

6. Install a NEW left secondary camshaft drive chain tensioner gasket to the left secondary camshaft drive chain tensioner.
7. Install the left secondary camshaft drive chain tensioner bolts through the left secondary camshaft drive chain tensioner and gasket.
8. Ensure the left secondary camshaft drive chain tensioner mounting surface on the left cylinder head does not have any burrs or defects that would degrade the sealing of the NEW left secondary camshaft drive chain tensioner gasket.



**Fig. 251: Left Secondary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS CORP.

9. Place the left secondary camshaft drive chain tensioner into position and loosely install the bolts to the block.



**Fig. 252: Locating Left Secondary Camshaft Drive Chain Tensioner Gasket Tab**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

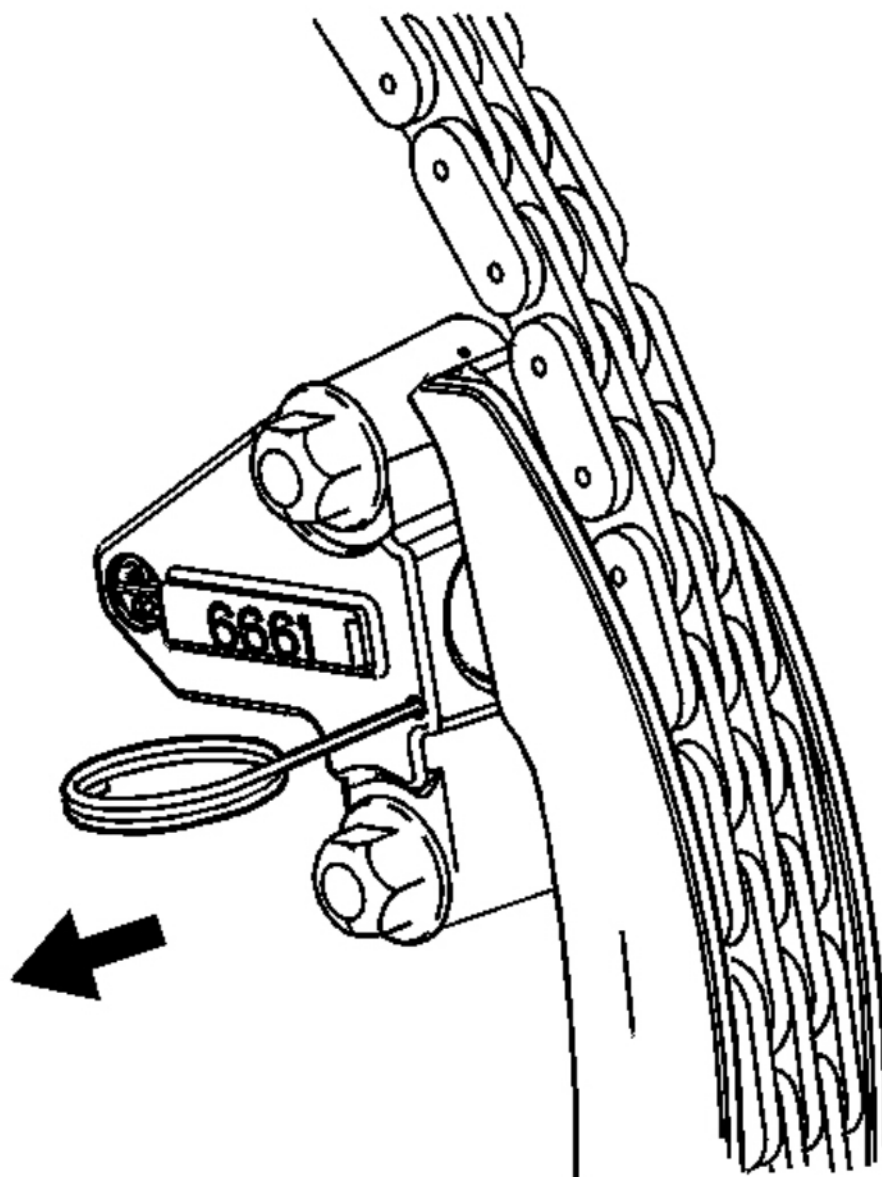
10. Verify the proper placement of the left secondary camshaft drive chain tensioner gasket tab (1).
  1. First Pass

**Tighten:** Tighten the left secondary camshaft drive chain tensioner bolts to 5 N.m (44 lb in).



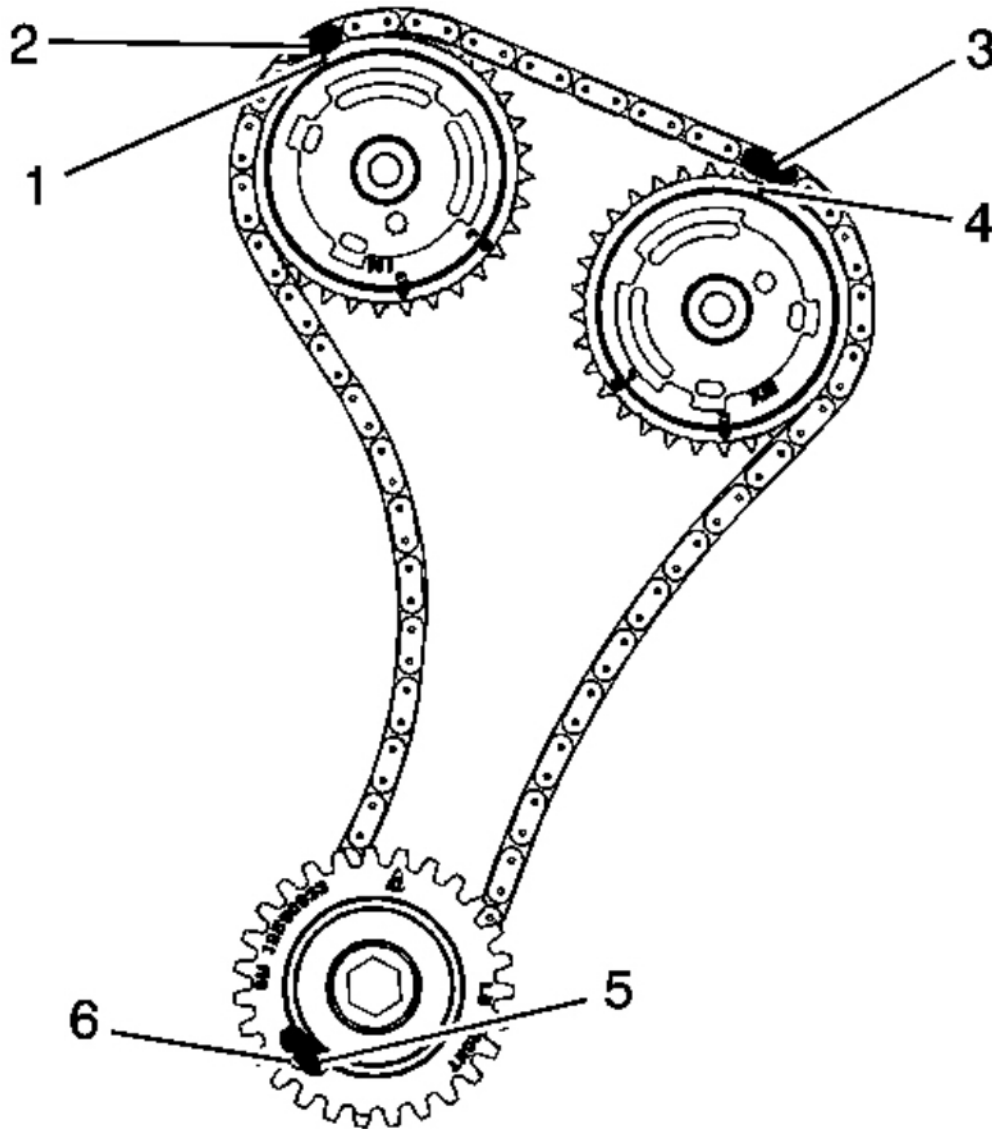
## 2. Final Pass

**Tighten:** Tighten the left secondary camshaft drive chain tensioner bolts to 23 N.m (17 lb ft).



**Fig. 253: Removing EN 46112 From Tensioner Plunger**  
Courtesy of GENERAL MOTORS CORP.

11. Release the left secondary camshaft drive chain tensioner by pulling out the **EN 46112** and unlocking the tensioner plunger.

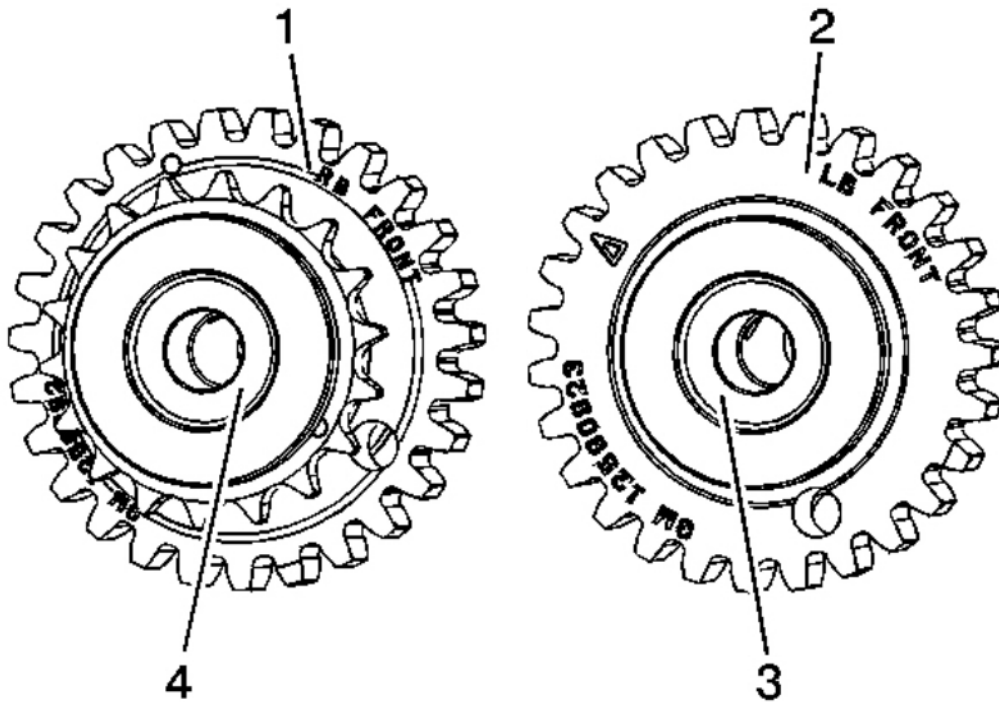


**Fig. 254: Drive Chain Timing Mark Alignments**  
Courtesy of GENERAL MOTORS CORP.

12. Verify the left secondary camshaft drive chain timing mark alignments (1-6) also refer to **Camshaft**

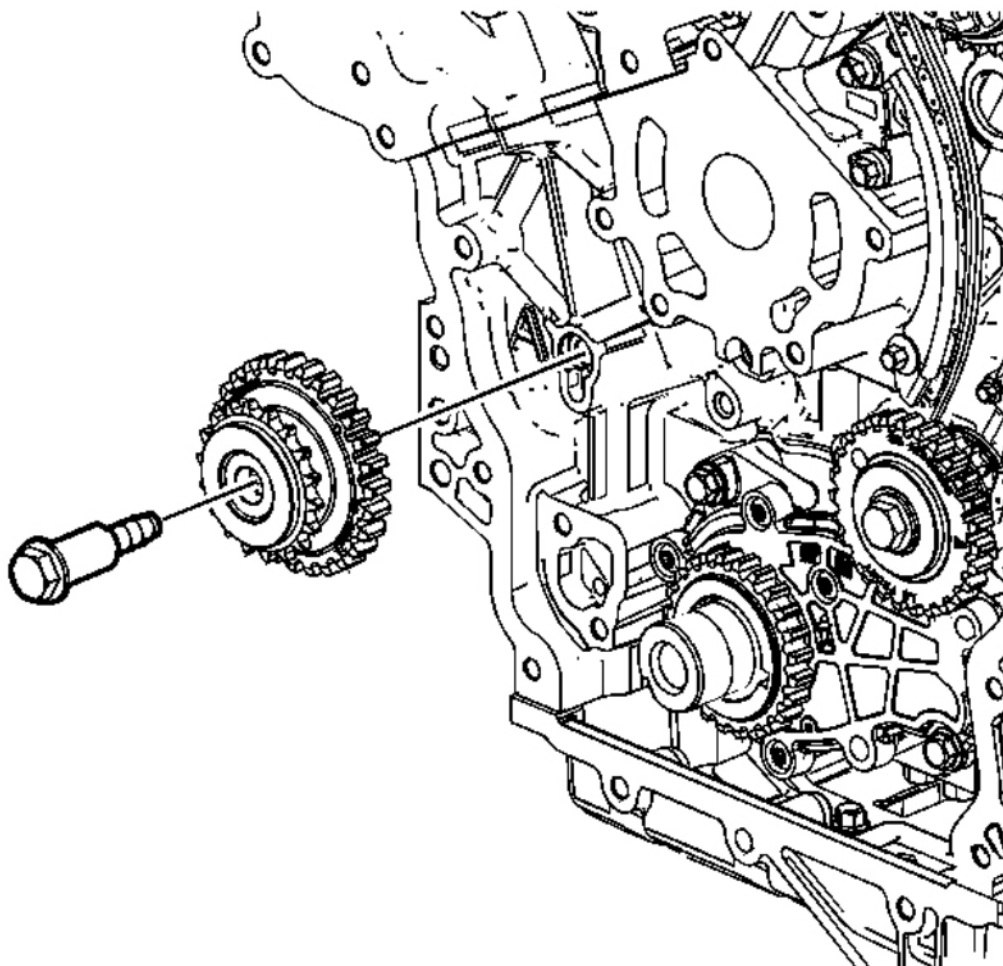
Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain) - Stage One.

## CAMSHAFT INTERMEDIATE DRIVE CHAIN IDLER INSTALLATION - RIGHT



**Fig. 255: Camshaft Intermediate Drive Chain Idler**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the right camshaft intermediate drive chain idler (1) is being installed. The recessed hub (4) and the smaller sprocket of the right camshaft intermediate drive chain idler is installed outward. The raised hub and the larger sprocket of the right camshaft intermediate drive chain idler is installed towards the block.



**Fig. 256: Right Camshaft Intermediate Drive Chain Idler**  
Courtesy of GENERAL MOTORS CORP.

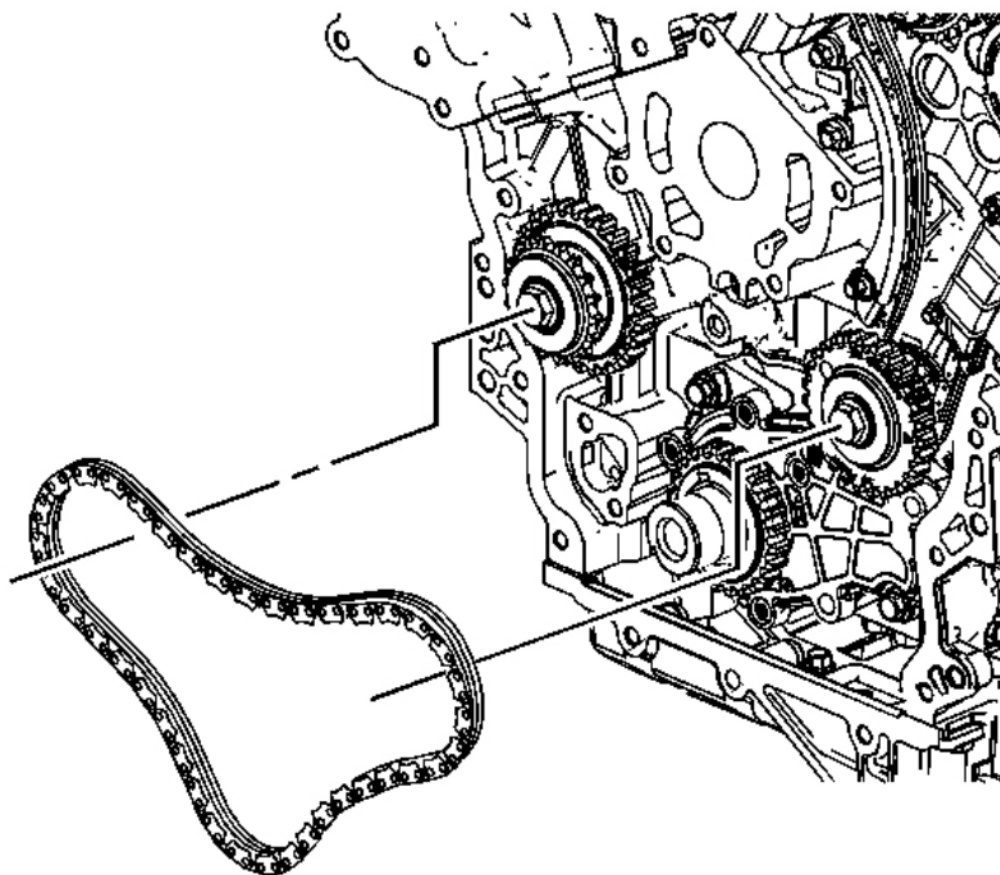
2. Install the right camshaft intermediate drive chain idler.

**NOTE:** Refer to Fastener Notice .

3. Install the camshaft intermediate drive chain idler bolt.

**Tighten:** Tighten the camshaft intermediate drive chain idler bolt to 58 N.m (43 lb ft).

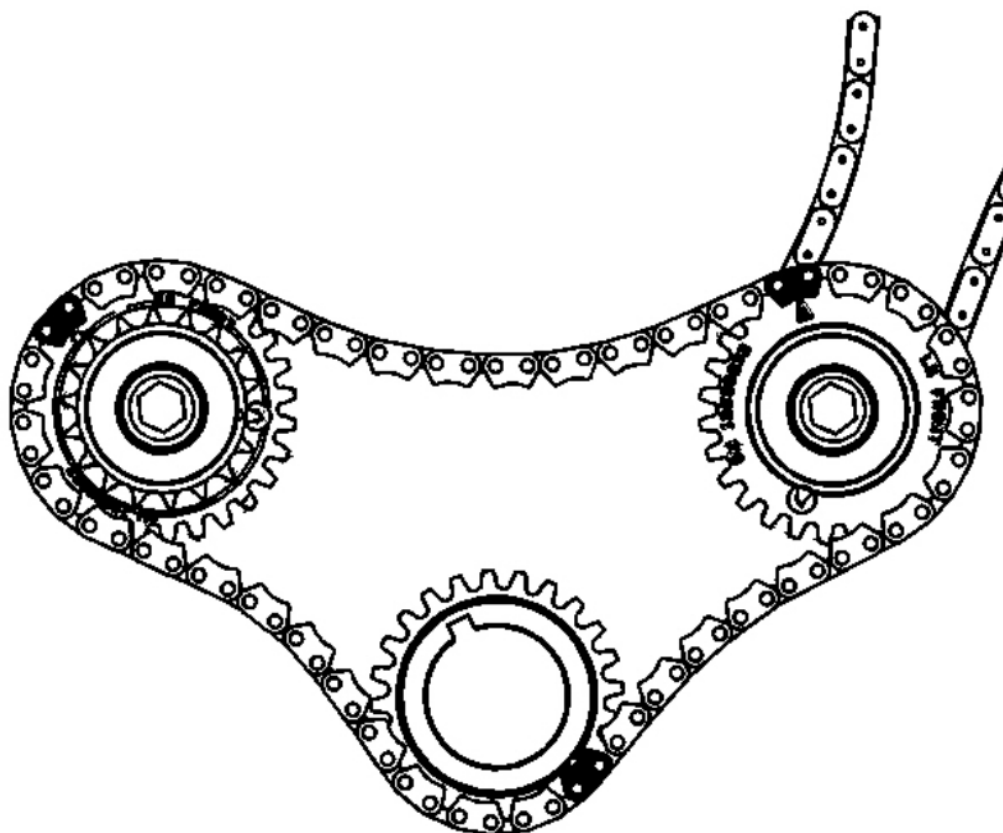
## PRIMARY CAMSHAFT DRIVE CHAIN INSTALLATION



**Fig. 257: Primary Camshaft Drive Chain**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** Ensure that the crankshaft is in the stage one timing drive assembly position.

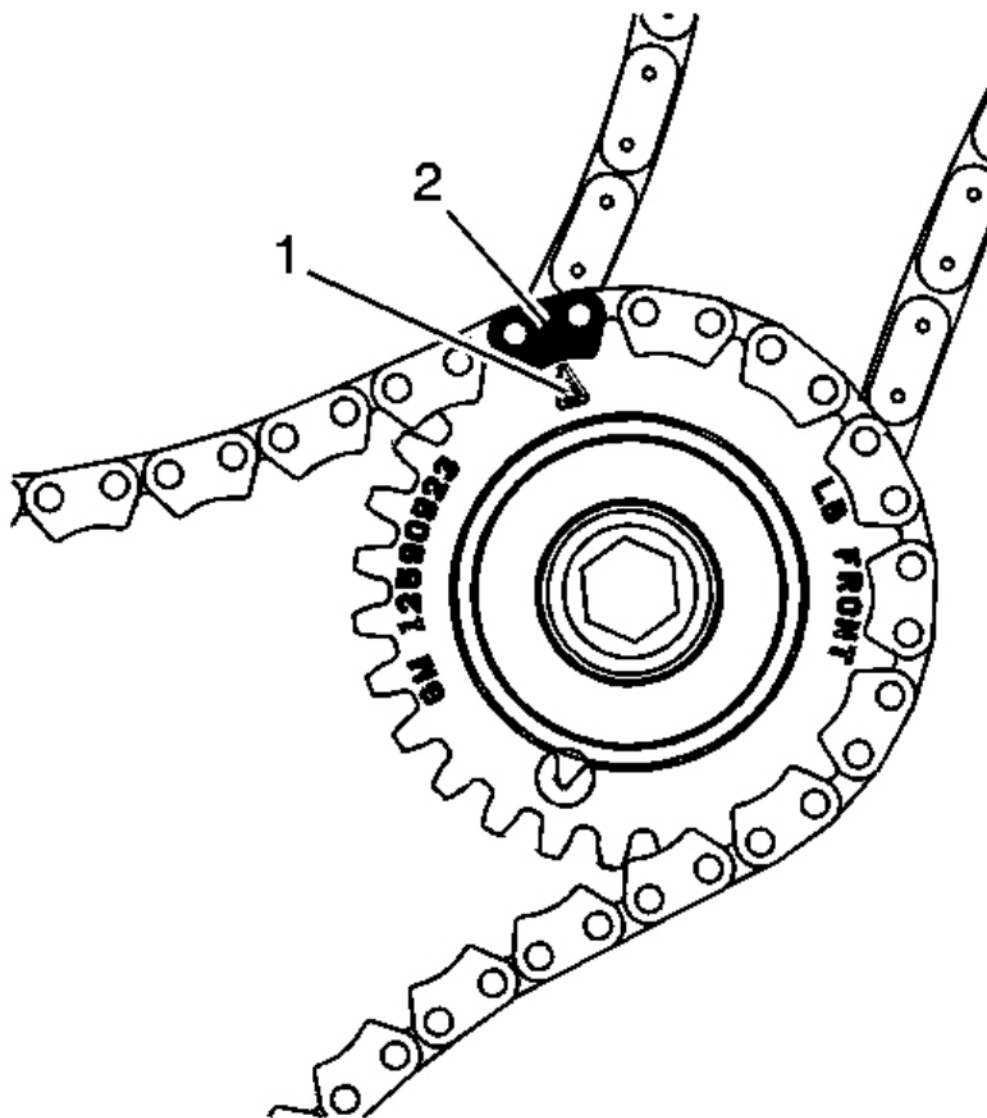
1. Install the primary camshaft drive chain.



**Fig. 258: Intermediate Drive Chain**

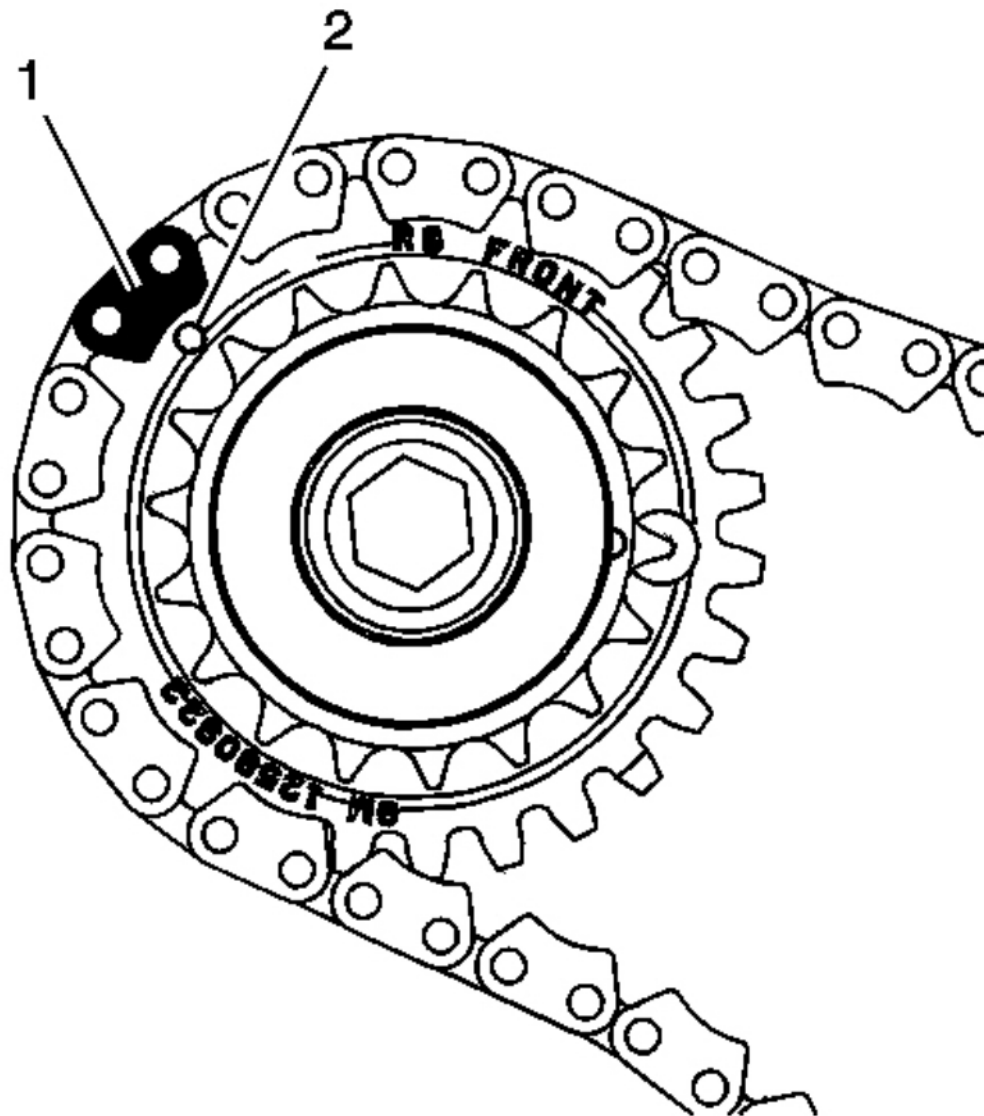
Courtesy of GENERAL MOTORS CORP.

2. Wrap the primary camshaft drive chain around the large sprockets of each camshaft intermediate drive chain idler and the crankshaft sprocket.



**Fig. 259: Left Camshaft Intermediate Drive Chain Idler Timing Mark**  
Courtesy of GENERAL MOTORS CORP.

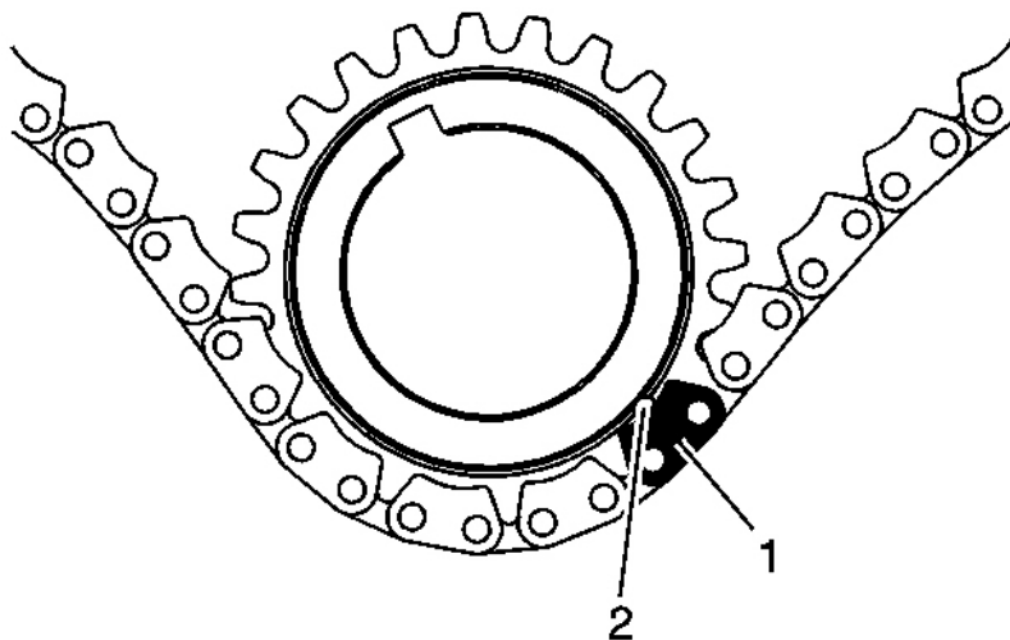
3. The left camshaft intermediate drive chain idler timing mark (1) will align with a timing camshaft drive chain link (2).



**Fig. 260: Right Camshaft Intermediate Drive Chain Idler Timing Mark**  
Courtesy of GENERAL MOTORS CORP.

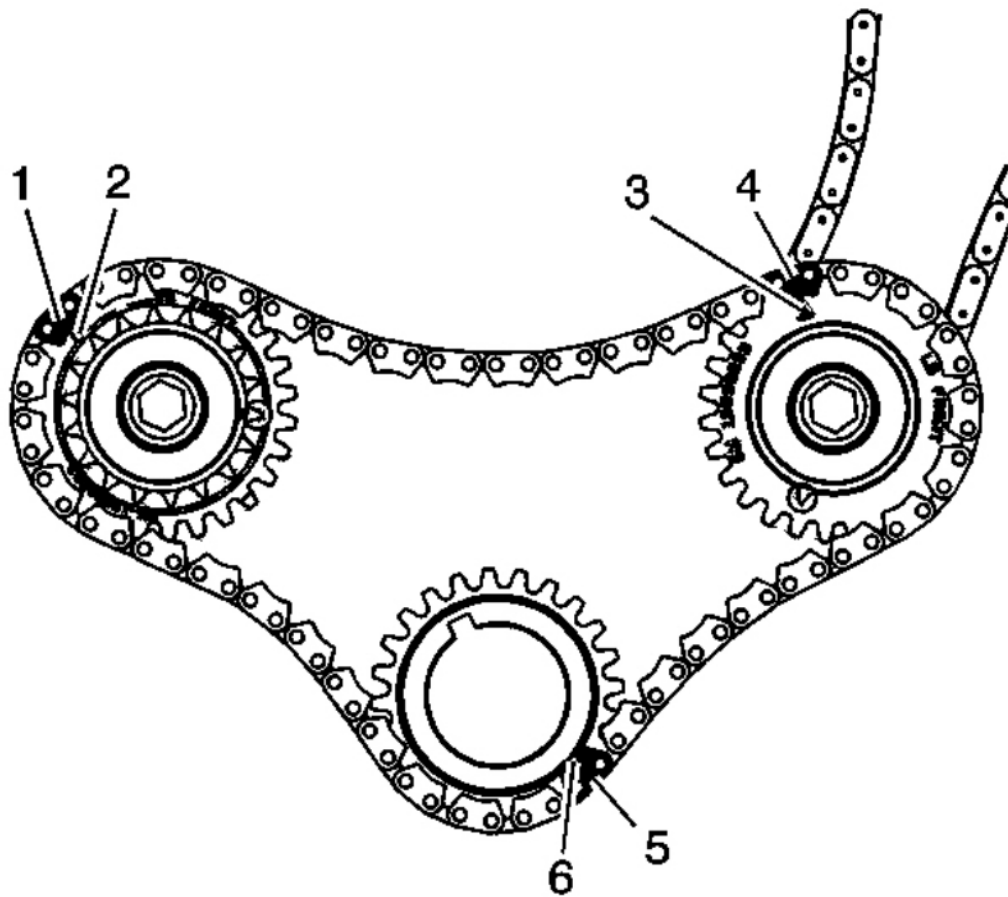
4. The right camshaft intermediate drive chain idler timing mark (2) will align with a timing camshaft drive chain link (1).





**Fig. 261: Crankshaft Sprocket Timing Mark**  
Courtesy of GENERAL MOTORS CORP.

5. The crankshaft sprocket timing mark (2) will align with a timing camshaft drive chain link (1).

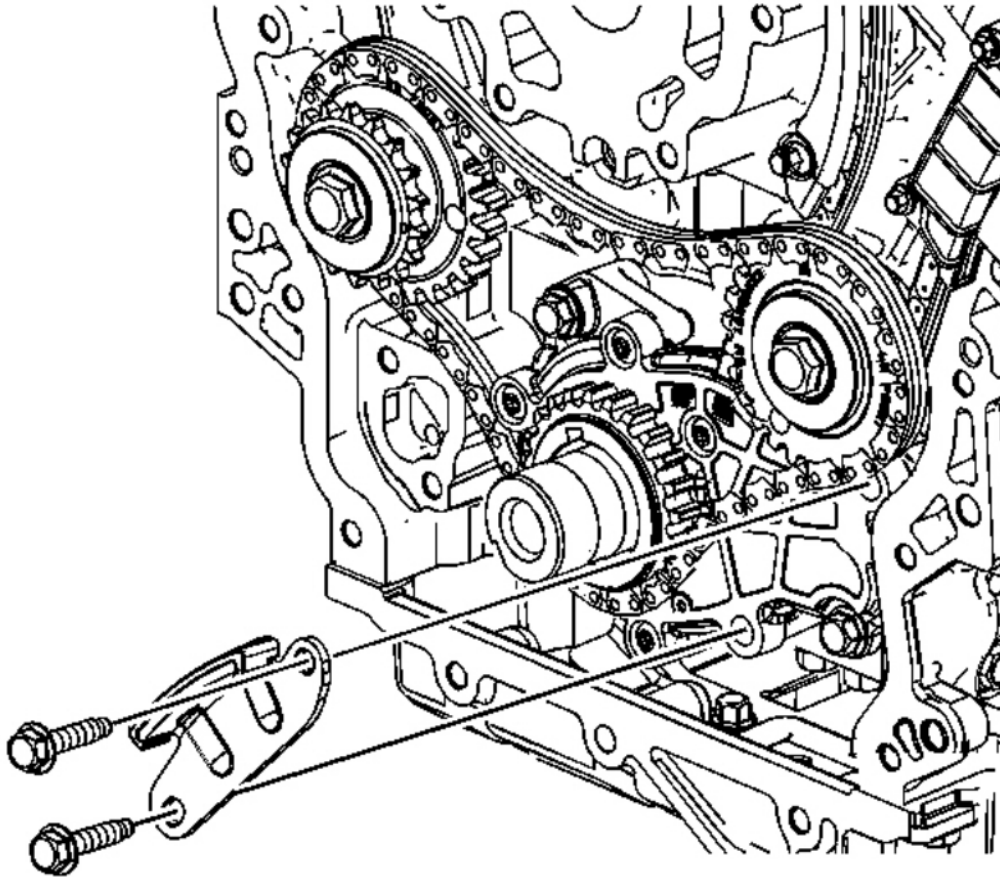


**Fig. 262: Timing Camshaft Drive Chain Links**

Courtesy of GENERAL MOTORS CORP.

6. Ensure all the timing marks (2, 3, 6) are properly aligned with the timing camshaft drive chain links (1, 4, 5).

## PRIMARY CAMSHAFT DRIVE CHAIN GUIDE INSTALLATION - LOWER



**Fig. 263: Primary Camshaft Drive Chain Lower Guide**  
Courtesy of GENERAL MOTORS CORP.

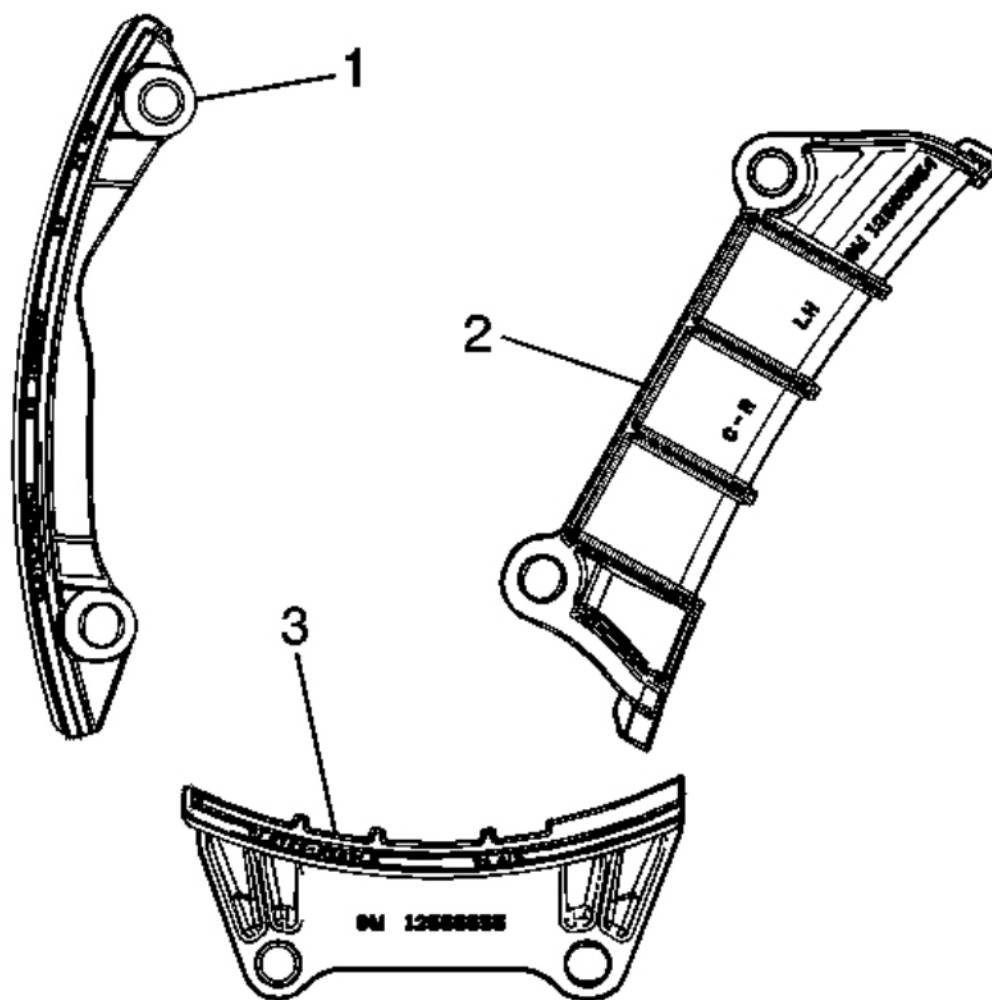
1. Position the primary camshaft drive chain lower guide to the oil pump.

**NOTE:** Refer to Fastener Notice .

2. Install the primary camshaft drive chain lower guide bolts.

**Tighten:** Tighten the primary camshaft drive chain lower guide bolts to 23 N.m (17 lb ft).

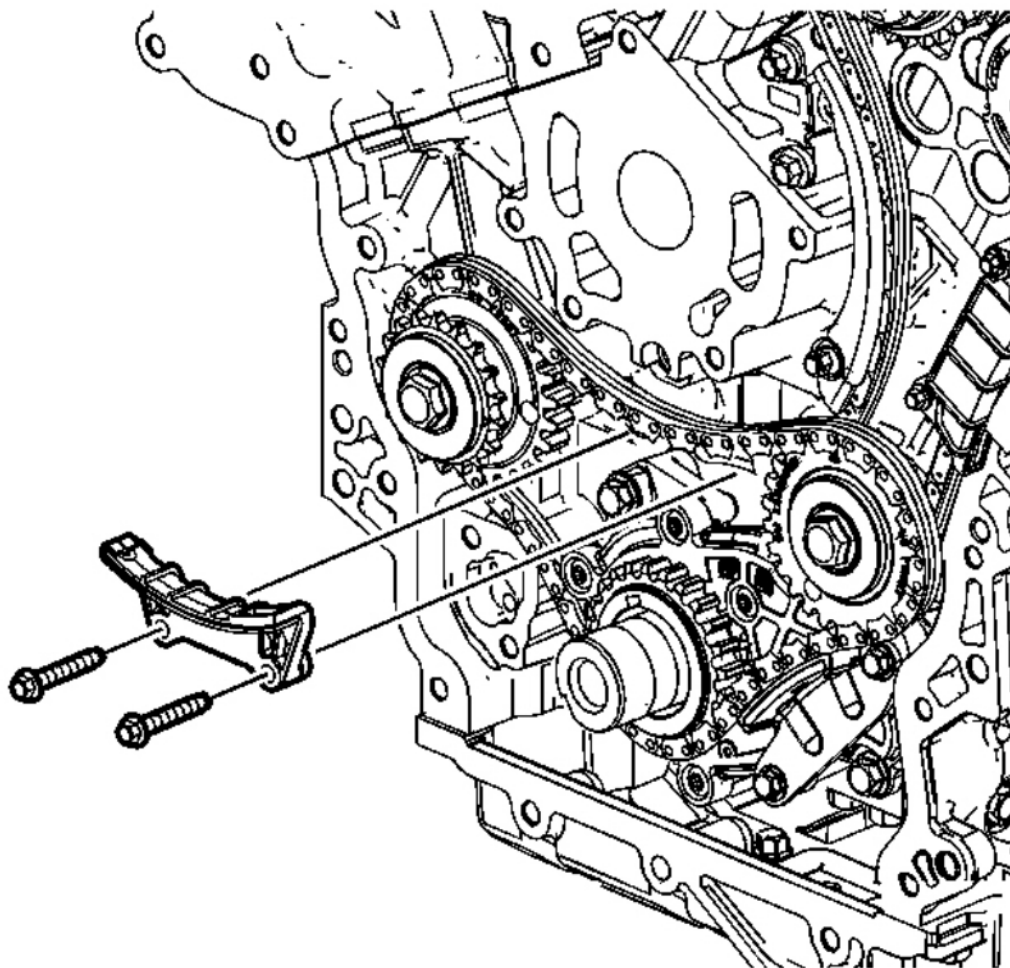
## PRIMARY CAMSHAFT DRIVE CHAIN GUIDE INSTALLATION - UPPER



**Fig. 264: Identifying Left & Right Secondary Camshaft Drive Chain Guide & Upper Primary Camshaft Drive Chain Guide**

Courtesy of GENERAL MOTORS CORP.

1. Ensure the upper primary camshaft drive chain guide (3) is being installed.



**Fig. 265: Upper Primary Camshaft Drive Chain Guide**  
Courtesy of GENERAL MOTORS CORP.

2. Install the upper primary camshaft drive chain guides.

**NOTE:** Refer to Fastener Notice .

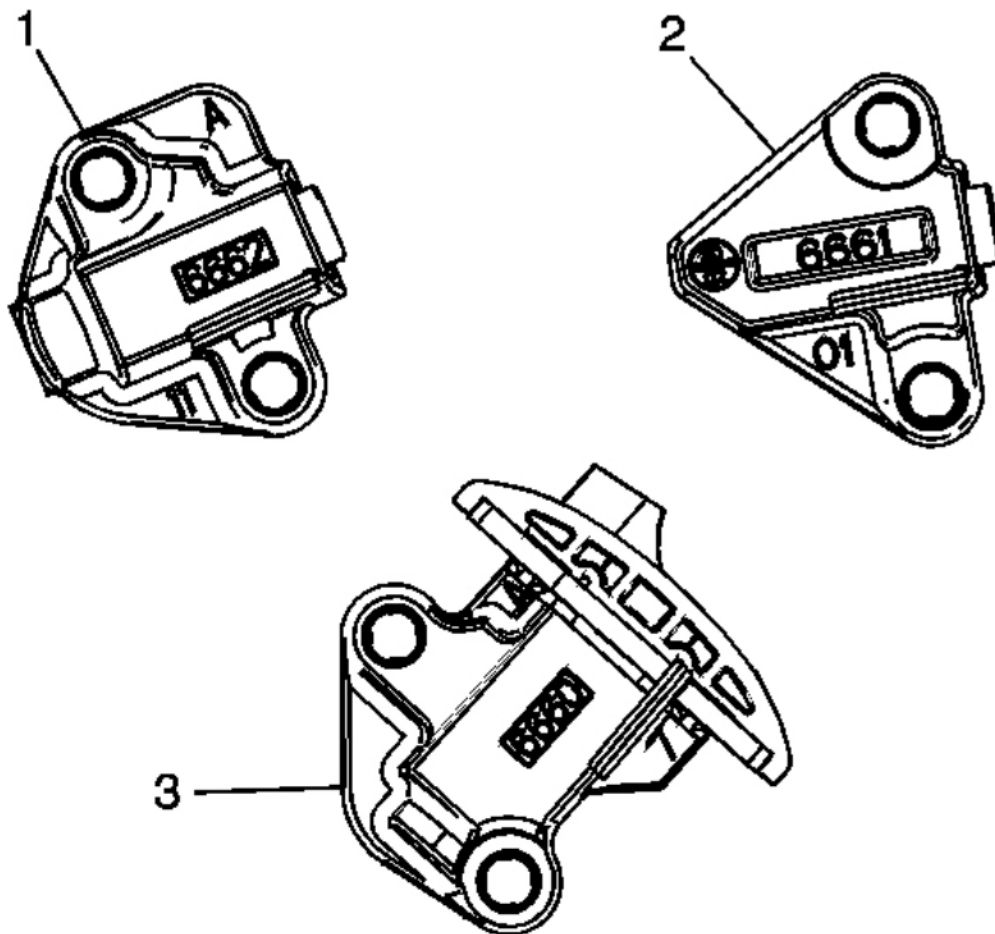
3. Install the upper primary camshaft drive chain guide bolts.

**Tighten:** Tighten the upper primary camshaft drive chain guide bolts to 23 N.m (17 lb ft).

## PRIMARY CAMSHAFT DRIVE CHAIN TENSIONER INSTALLATION

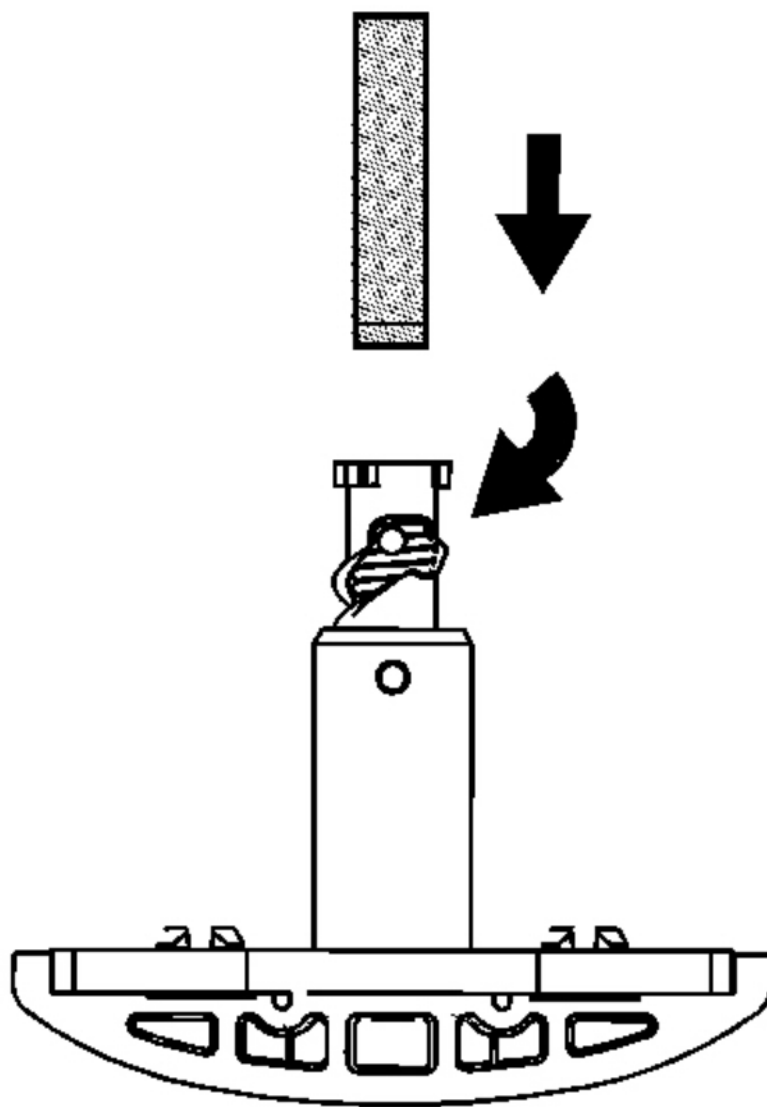
### Tools Required

- EN 46105 Camshaft Locking Tool
- EN 46111 Crankshaft Rotation Socket
- EN 46112 Tensioner Retraction Pins
- J 45027 Tensioner Tool



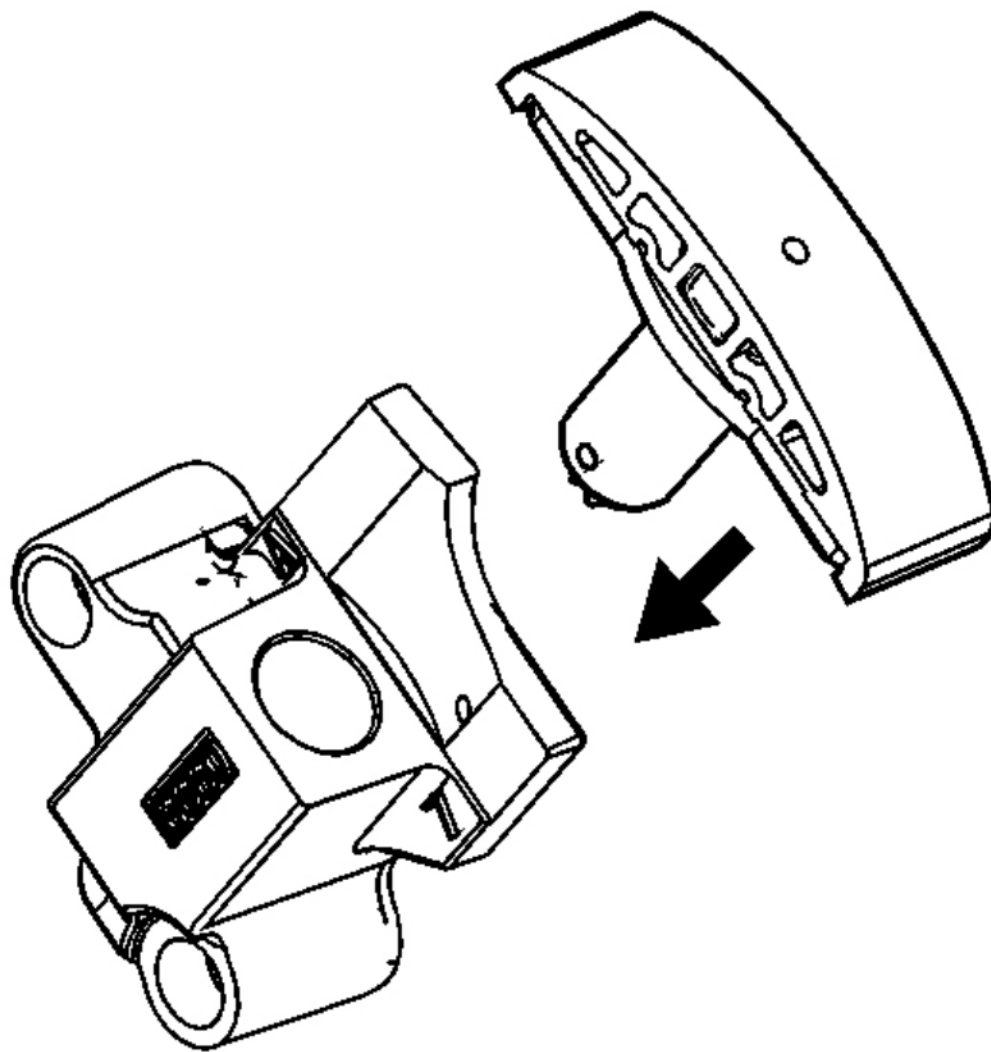
**Fig. 266: Identifying Left & Right Secondary Camshaft Drive Chain Tensioner & Primary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the primary camshaft drive chain tensioner (3) is being installed.



**Fig. 267: View Of Primary Camshaft Drive Chain Tensioner Plunger & J 45027**  
Courtesy of GENERAL MOTORS CORP.

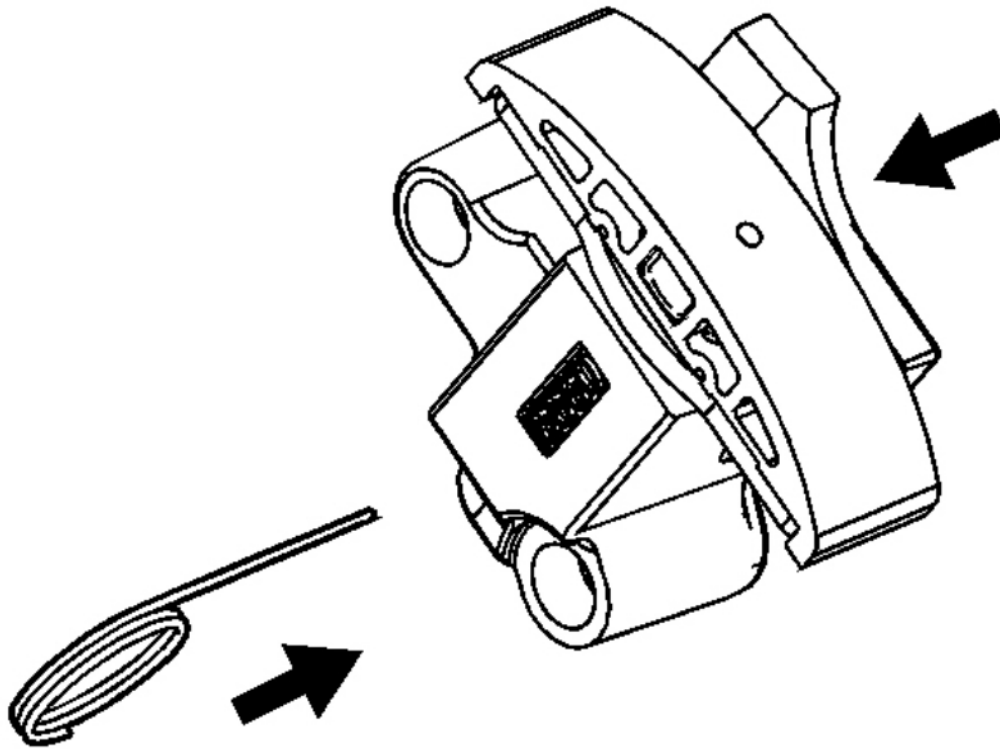
2. Using the **J 45027** reset the primary camshaft drive chain tensioner plunger.



**Fig. 268: Installing Plunger Into Primary Camshaft Drive Chain Tensioner Body**  
Courtesy of GENERAL MOTORS CORP.

3. Install the plunger into the primary camshaft drive chain tensioner body.

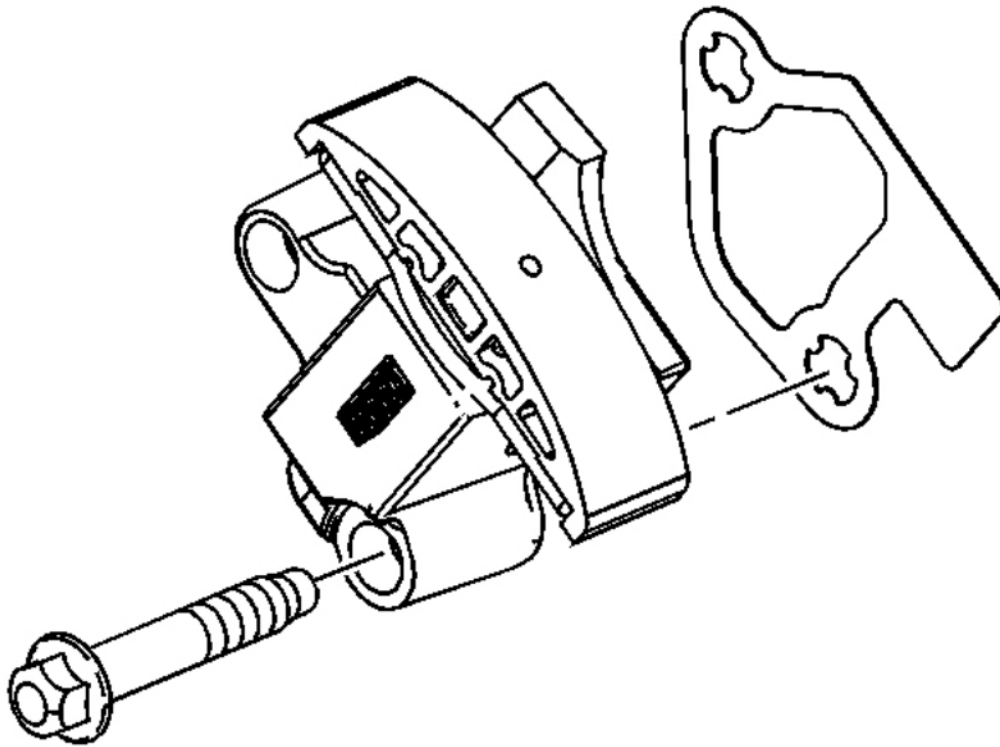




**Fig. 269: Identifying EN 46112**

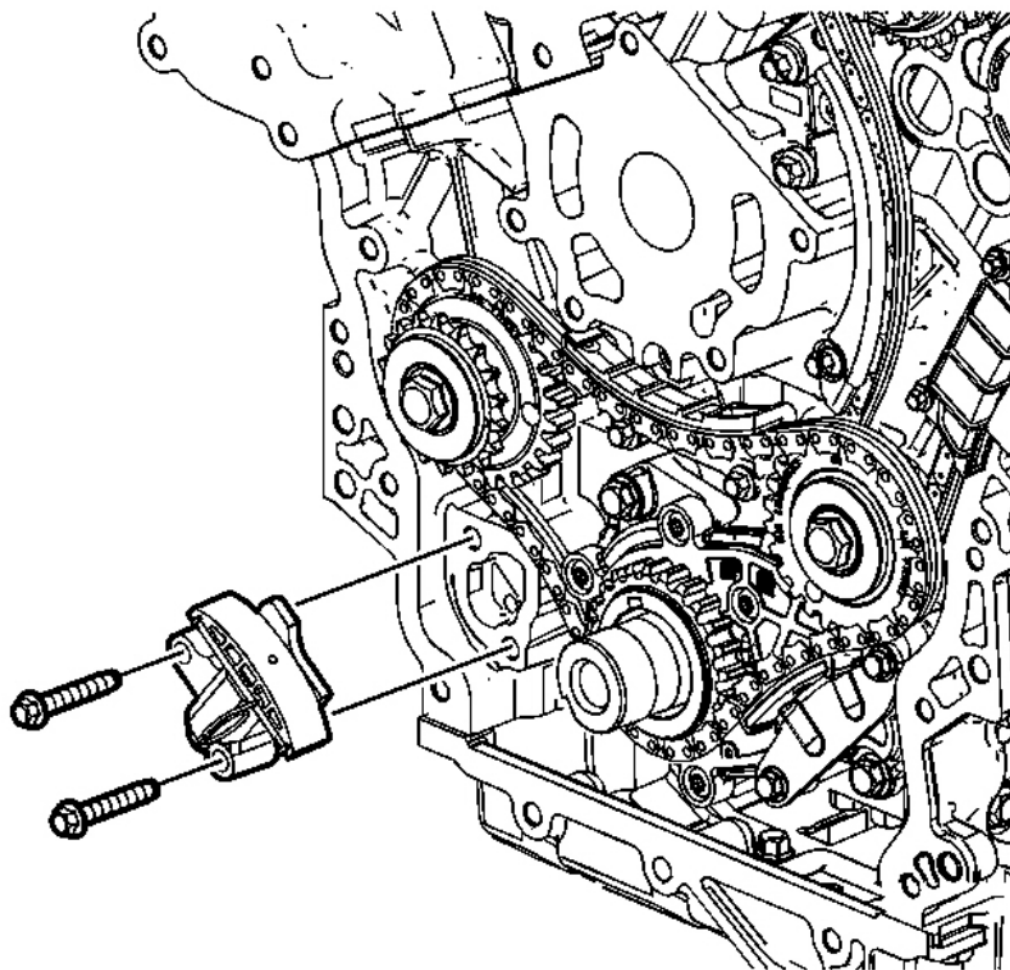
Courtesy of GENERAL MOTORS CORP.

4. Compress the plunger into the body and lock the primary camshaft drive chain tensioner by inserting the **EN 46112** into the access hole in the side of the primary camshaft drive chain tensioner body.
5. Slowly release pressure on the primary camshaft drive chain tensioner. The primary camshaft drive chain tensioner should remain compressed.



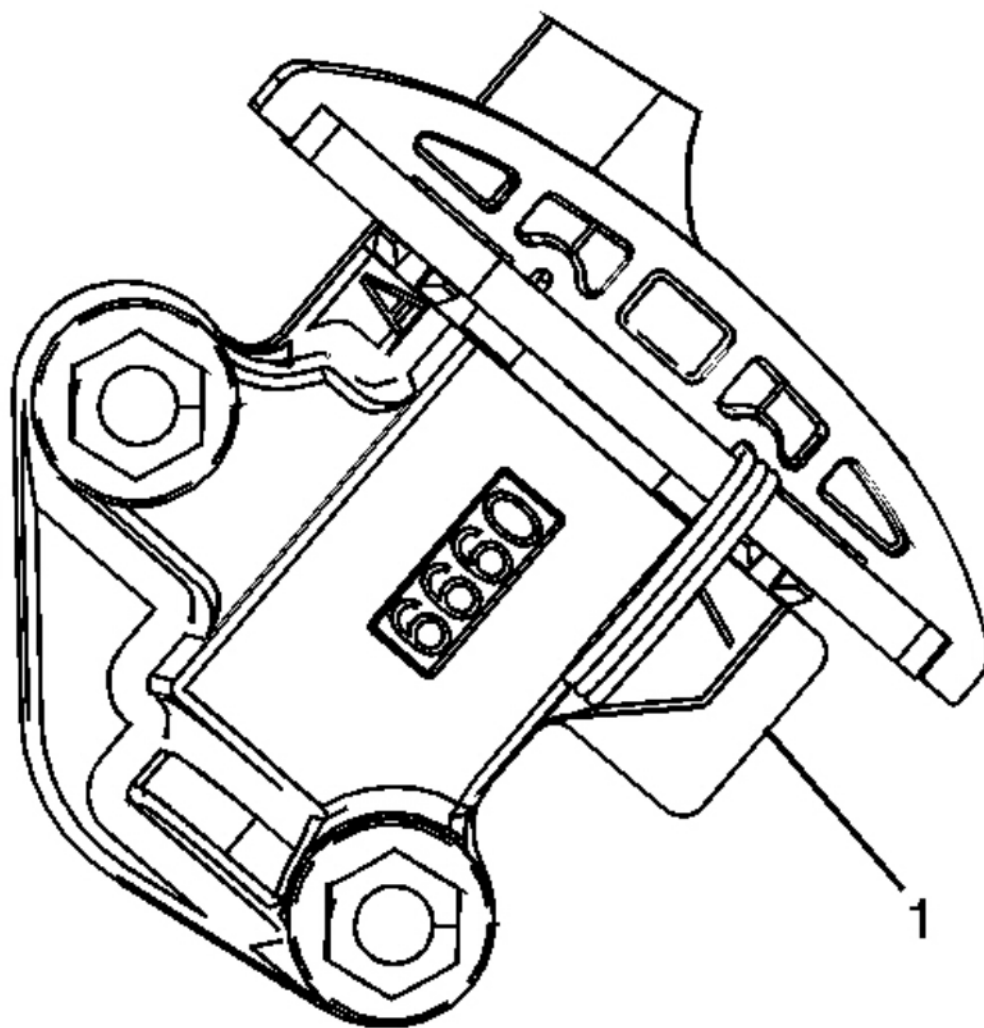
**Fig. 270: Identifying Primary Camshaft Drive Chain Tensioner Gasket**  
Courtesy of GENERAL MOTORS CORP.

6. Install a NEW primary camshaft drive chain tensioner gasket to the primary camshaft drive chain tensioner.
7. Install the primary camshaft drive chain tensioner bolts through the primary camshaft drive chain tensioner and gasket.
8. Ensure the primary camshaft drive chain tensioner mounting surface on the engine block does not have any burrs or defects that would degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.



**Fig. 271: Primary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS CORP.

9. Place the primary camshaft drive chain tensioner into position and loosely install the bolts to the block.



**Fig. 272: Locating Primary Camshaft Drive Chain Tensioner Gasket Tab**  
Courtesy of GENERAL MOTORS CORP.

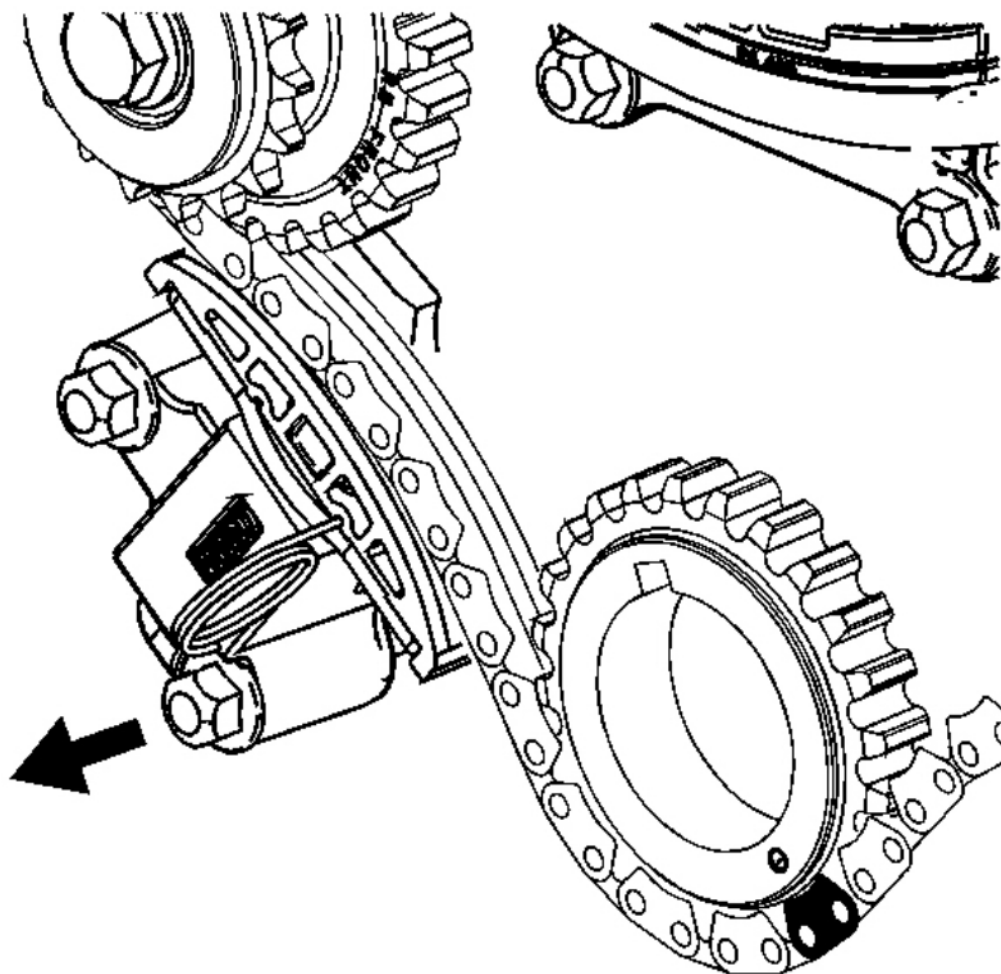
**NOTE:** Refer to Fastener Notice .

10. Verify the proper placement of the primary camshaft drive chain tensioner gasket tab (1).
  1. First Pass

**Tighten:** Tighten the primary camshaft drive chain tensioner bolts to 5 N.m (44 lb in).

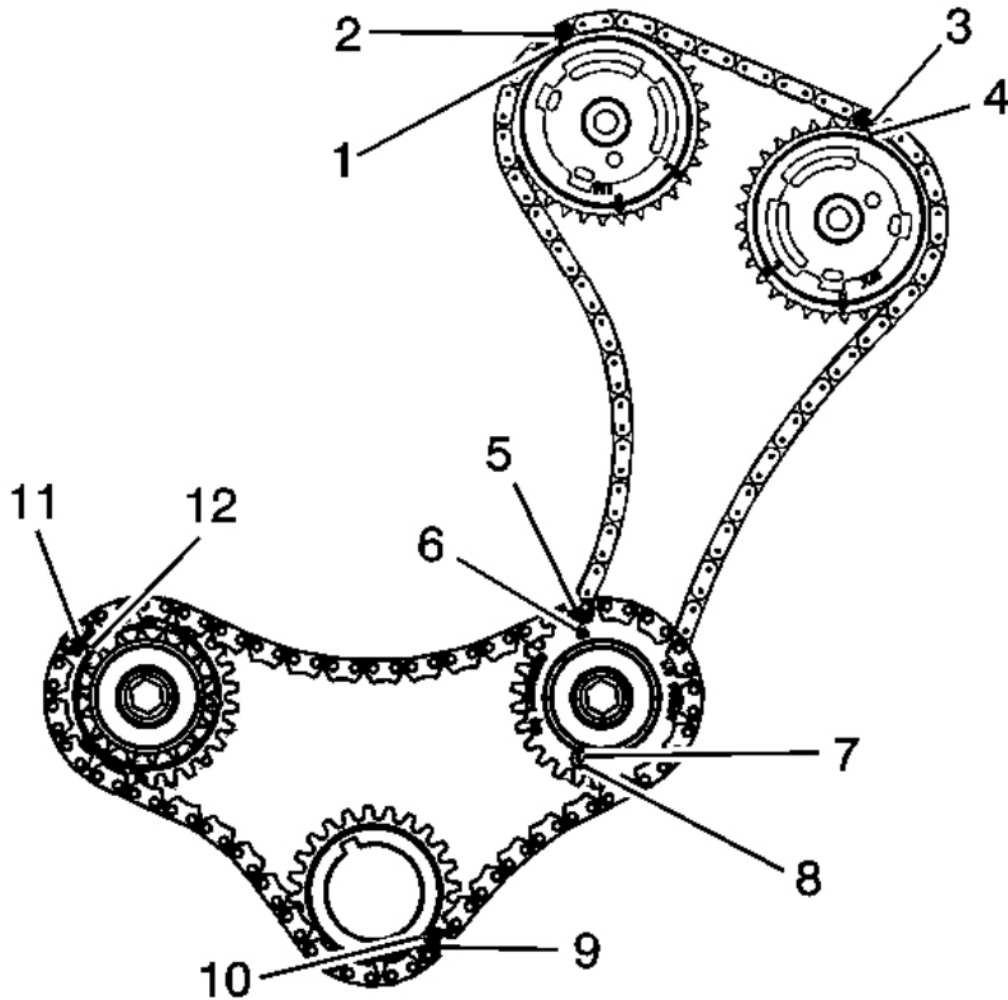
## 2. Final Pass

**Tighten:** Tighten the primary camshaft drive chain tensioner bolts to 23 N.m (17 lb ft).



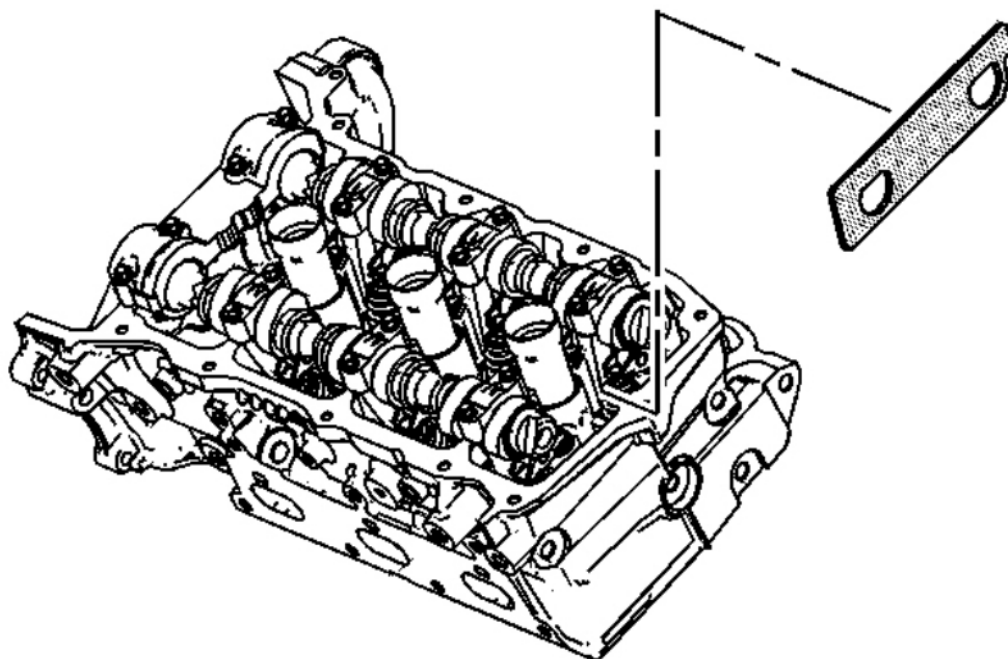
**Fig. 273: Primary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS CORP.

11. Release the primary camshaft drive chain tensioner by pulling out the **EN 46112** and unlocking the tensioner plunger.



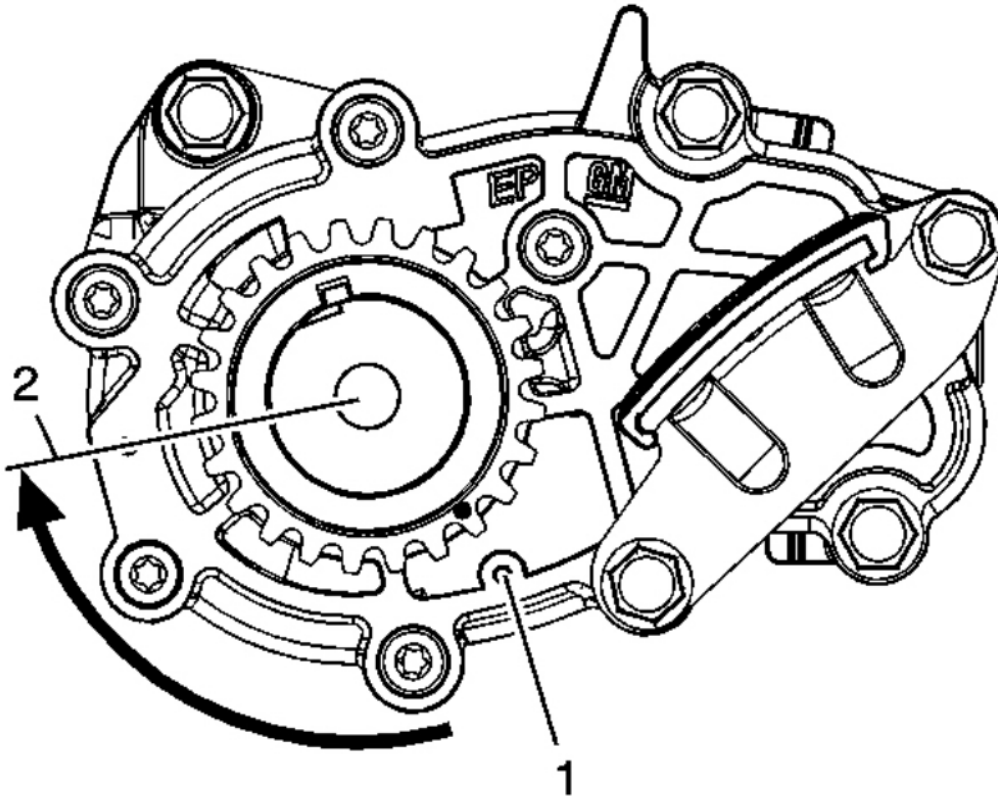
**Fig. 274: Drive Chain Timing Mark Alignments**  
Courtesy of GENERAL MOTORS CORP.

12. Verify the primary and left secondary camshaft drive chain timing mark alignments (1-12) also refer to **Camshaft Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain)** - Stage One.



**Fig. 275: Identifying EN 46105-1**  
Courtesy of GENERAL MOTORS CORP.

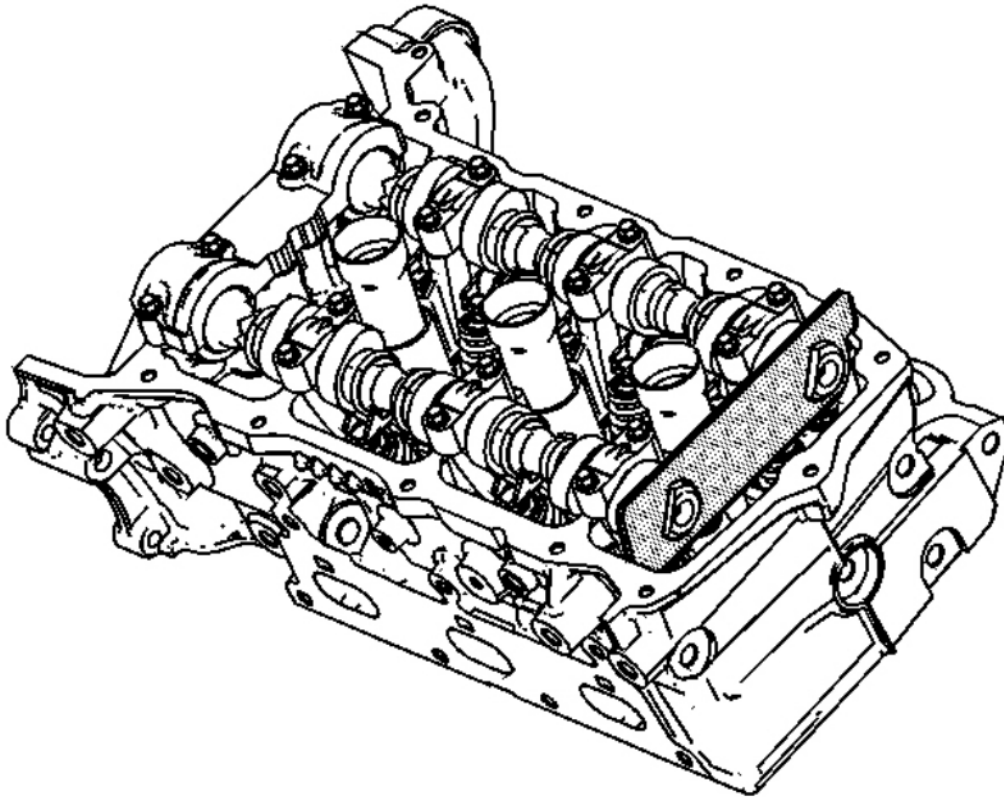
13. Remove the EN 46105-1 from the rear of the left camshafts.



**Fig. 276: Rotating Crankshaft And Crankshaft Sprocket**  
Courtesy of GENERAL MOTORS CORP.

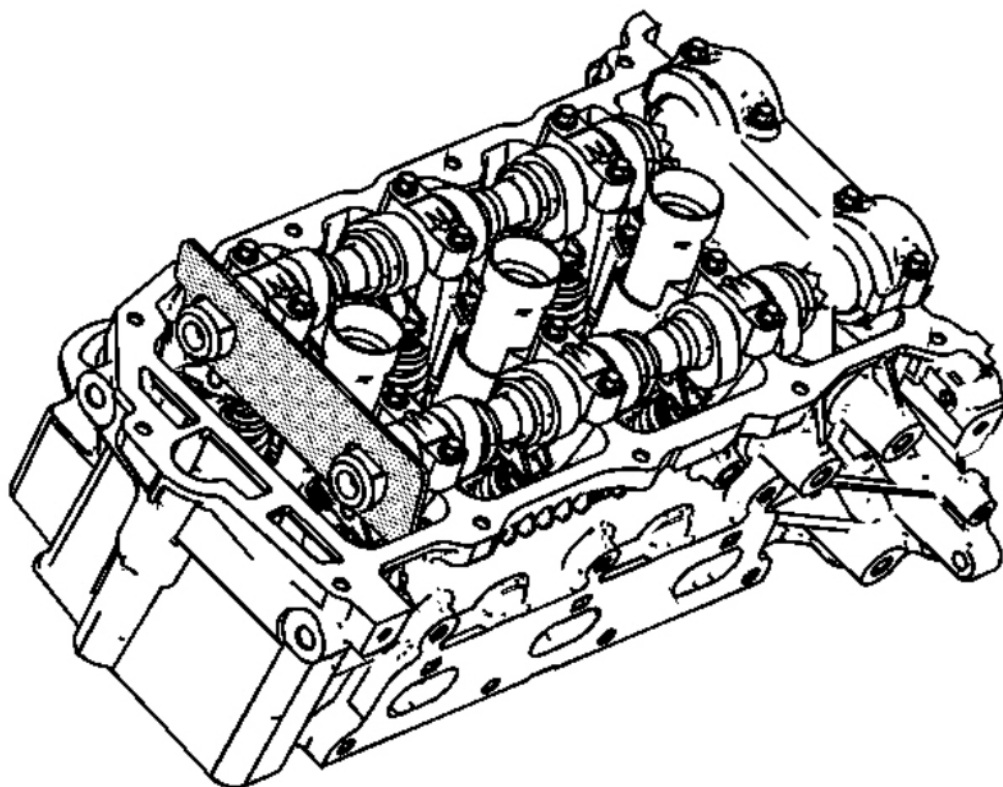
14. Using the **EN 46111** rotate the crankshaft and crankshaft sprocket from the stage one alignment position (1) to the stage two alignment position (2), 115 crankshaft degrees, in order to install the right secondary camshaft drive chain components.





**Fig. 277: EN 46105-2 Installed To Left Camshafts**  
Courtesy of GENERAL MOTORS CORP.

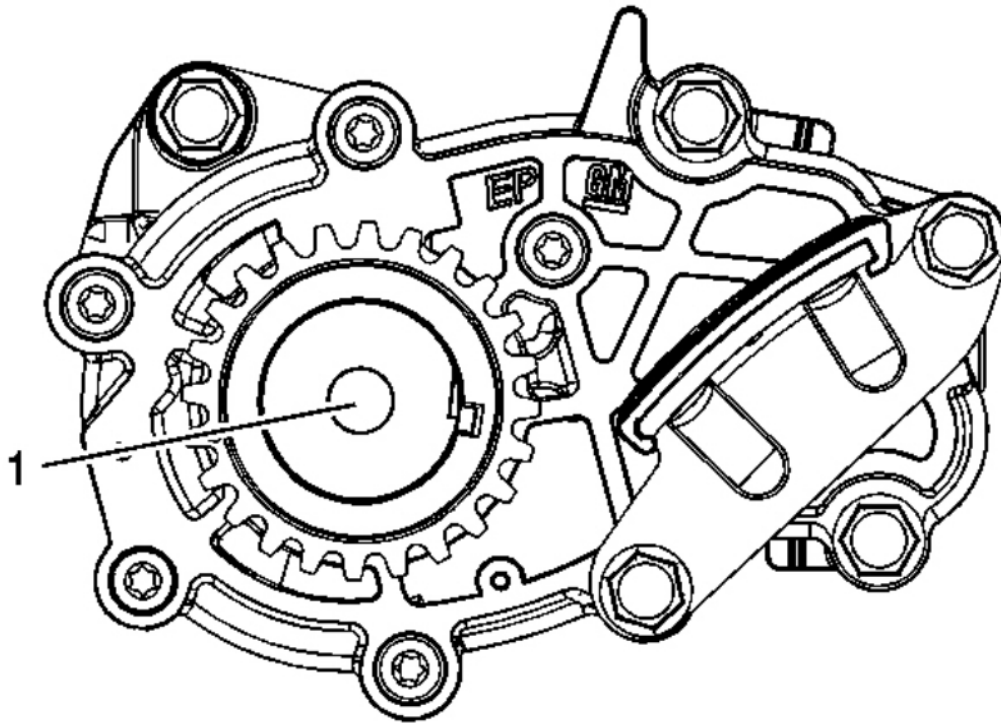
15. Install the EN 46105-2 onto the rear of the left camshafts.



**Fig. 278: EN 46105-1 Installed To Right Camshafts**  
Courtesy of GENERAL MOTORS CORP.

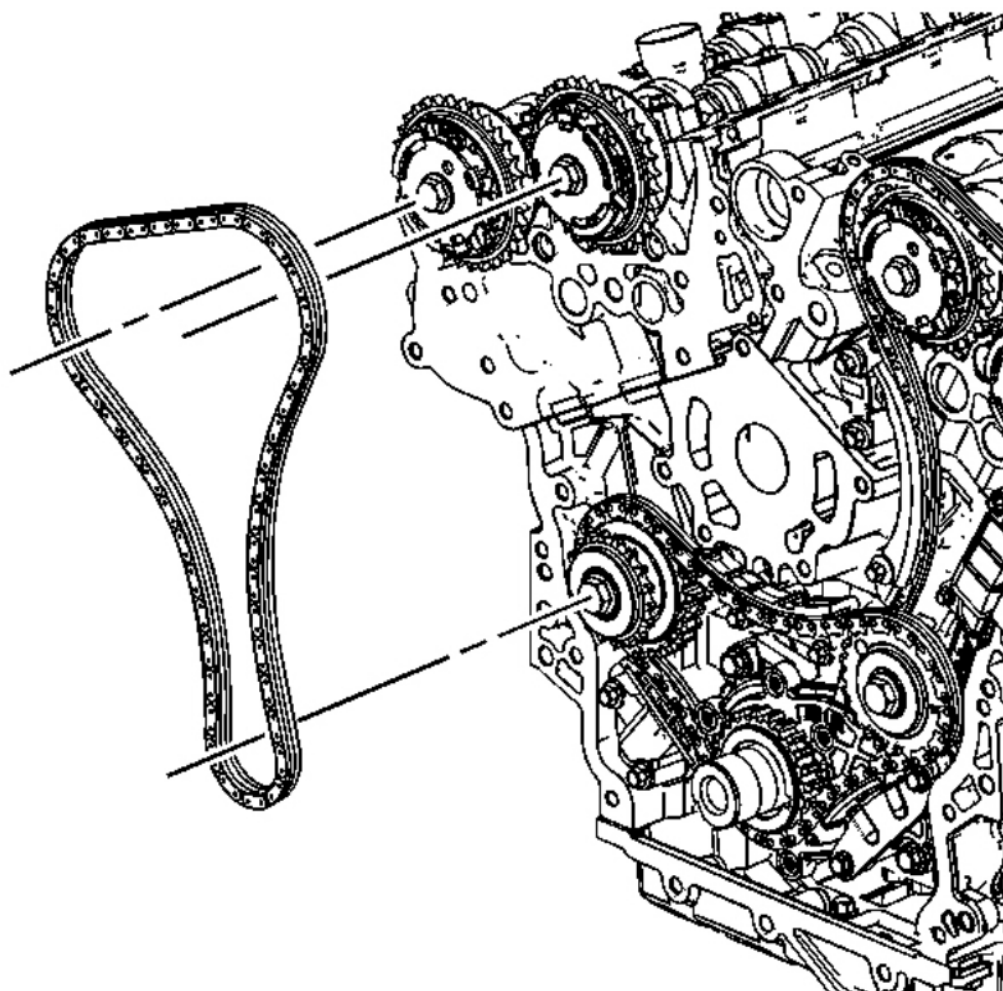
16. Install the EN 46105-1 onto the rear of the right camshafts.

## **SECONDARY CAMSHAFT DRIVE CHAIN INSTALLATION - RIGHT**



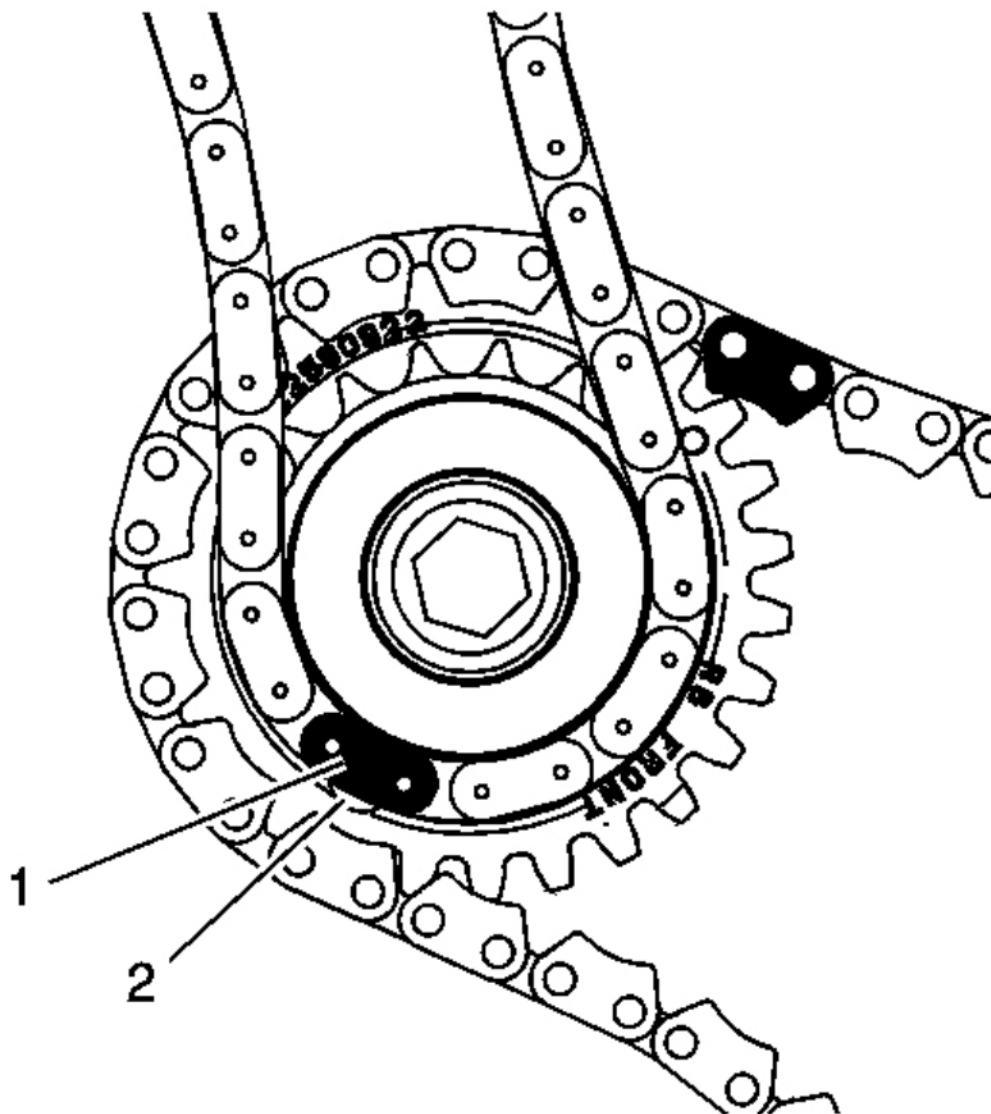
**Fig. 279: Stage Two Timing Drive Assembly Position**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the crankshaft is in the stage two timing drive assembly position (1).



**Fig. 280: Right Secondary Camshaft Drive Chain**  
Courtesy of GENERAL MOTORS CORP.

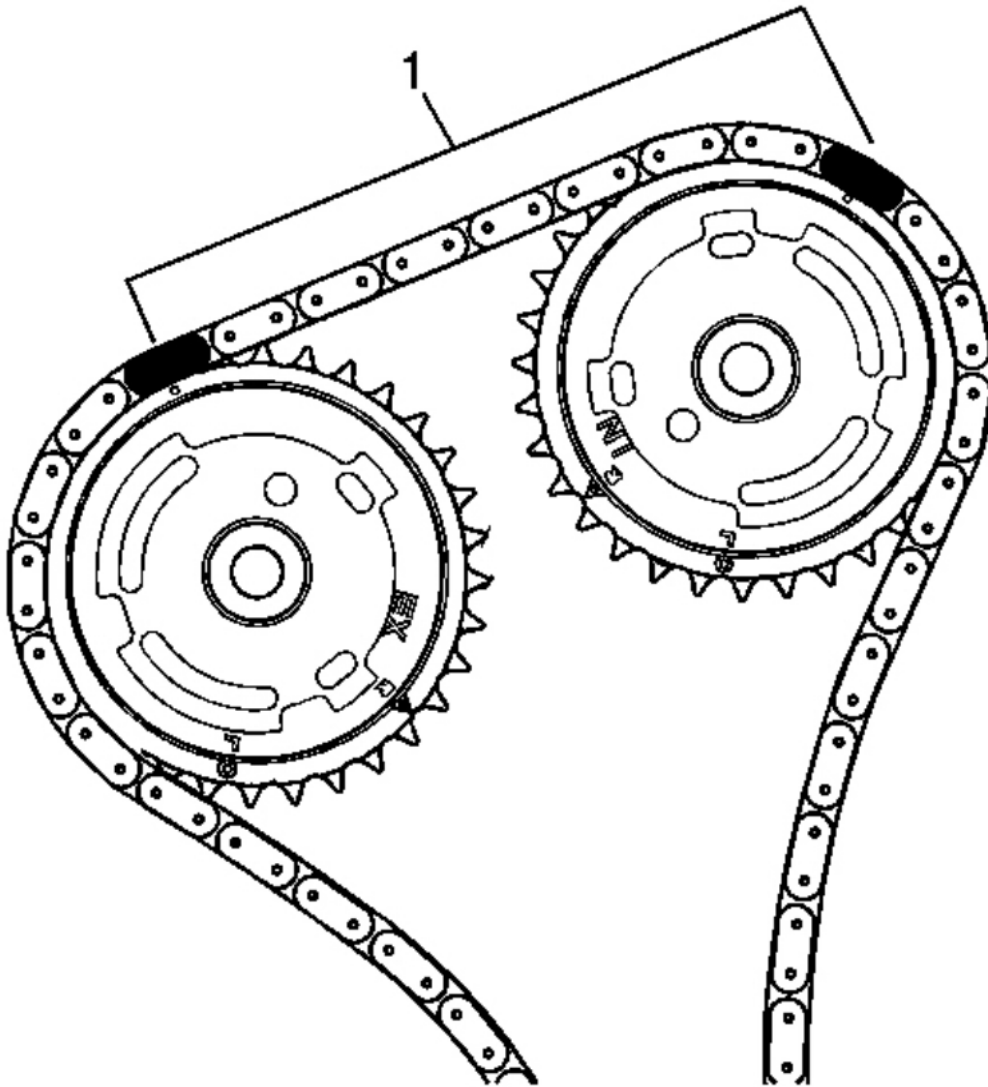
2. Install the right secondary camshaft drive chain.



**Fig. 281: Drive Chain Link**

Courtesy of GENERAL MOTORS CORP.

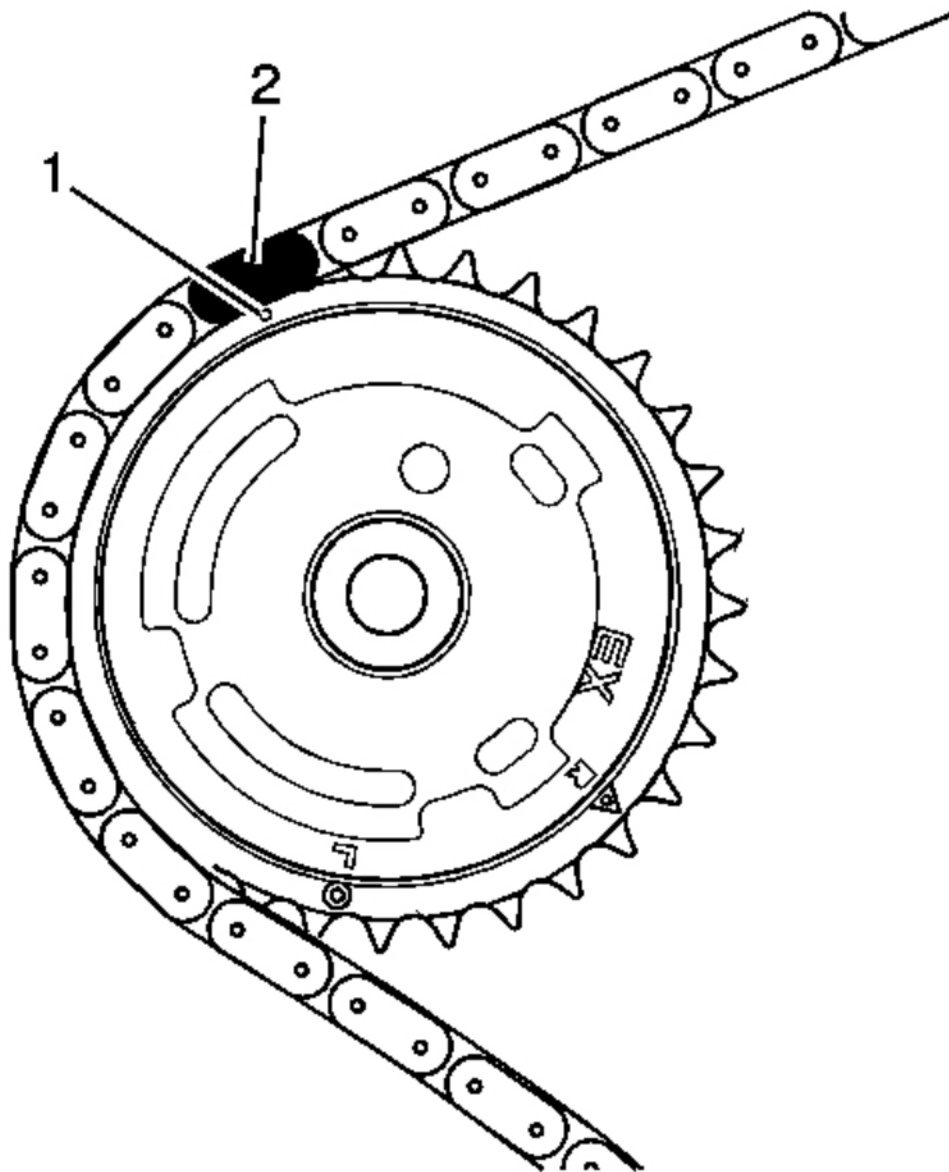
3. Place the secondary camshaft drive chain around the right camshaft intermediate drive chain idler outer sprocket, aligning the timing camshaft drive chain link (1) with the alignment access hole (2) made in the right camshaft intermediate drive chain idler inner sprocket.



**Fig. 282: Verifying 7 Links Between Timing Camshaft Drive Chain Links For The Camshaft Position Actuator Sprockets**

Courtesy of GENERAL MOTORS CORP.

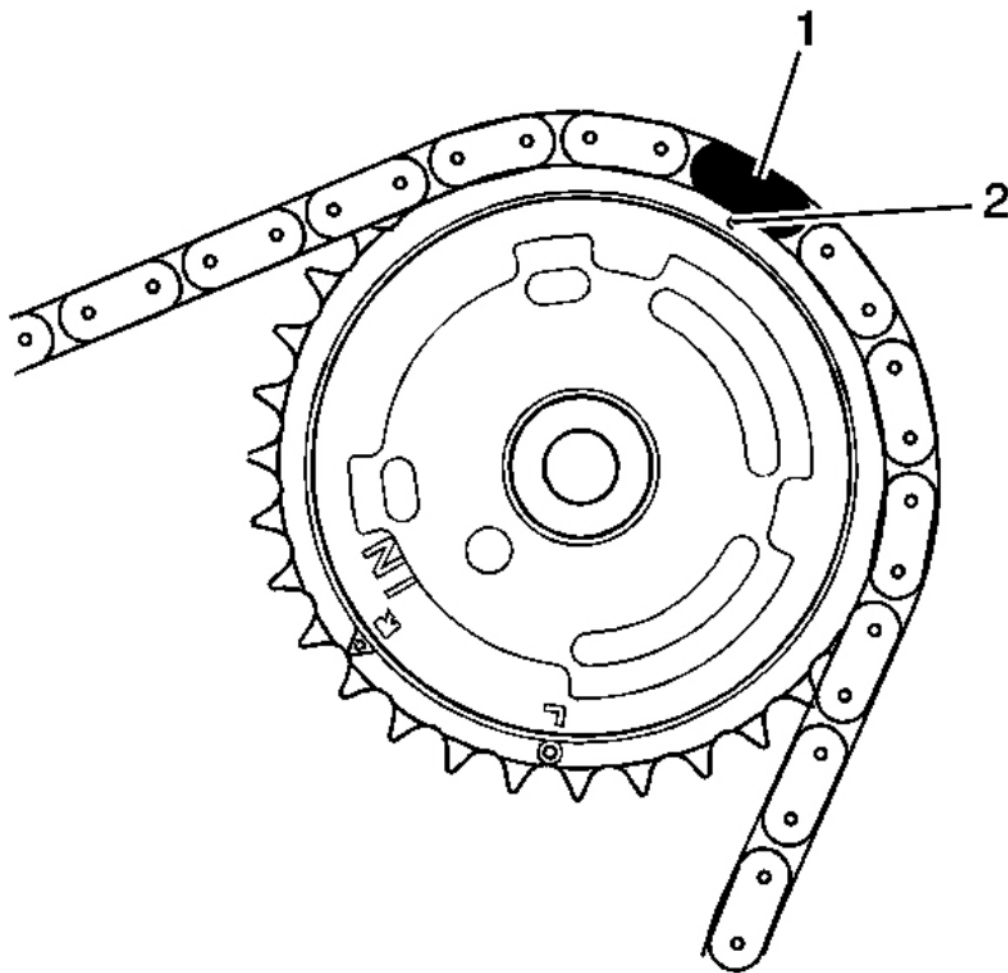
4. Wrap the secondary camshaft drive chain around both right actuator drive sprockets.
5. Ensure there are 7 links (1) between the timing camshaft drive chain links for the camshaft position actuator sprockets.



**Fig. 283: Aligning Right Exhaust Camshaft Position Actuator Sprocket Alignment Triangle Mark With Drive Chain Link**

Courtesy of GENERAL MOTORS CORP.

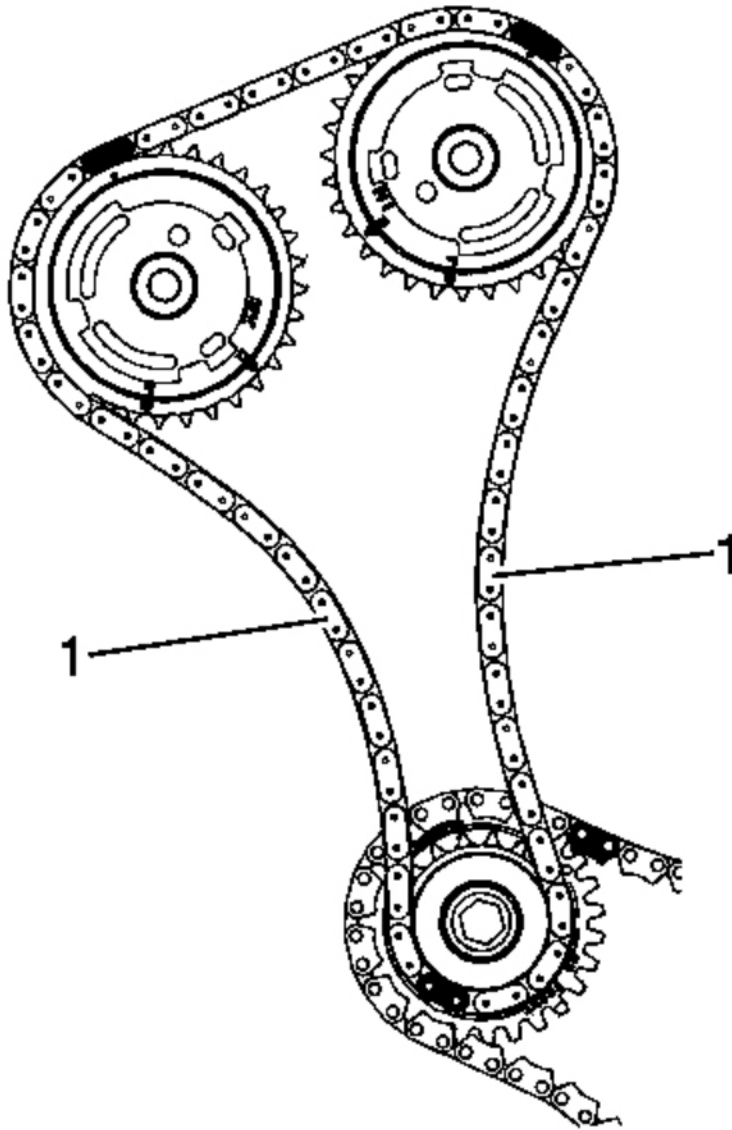
6. Align the right exhaust camshaft position actuator sprocket alignment triangle mark (1) with the timing camshaft drive chain link (2).



**Fig. 284: View Of Right Intake Camshaft Position Actuator Sprocket Alignment Triangle Mark**  
Courtesy of GENERAL MOTORS CORP.

7. Align the right intake camshaft position actuator sprocket alignment triangle mark (2) with the timing camshaft drive chain link (1).



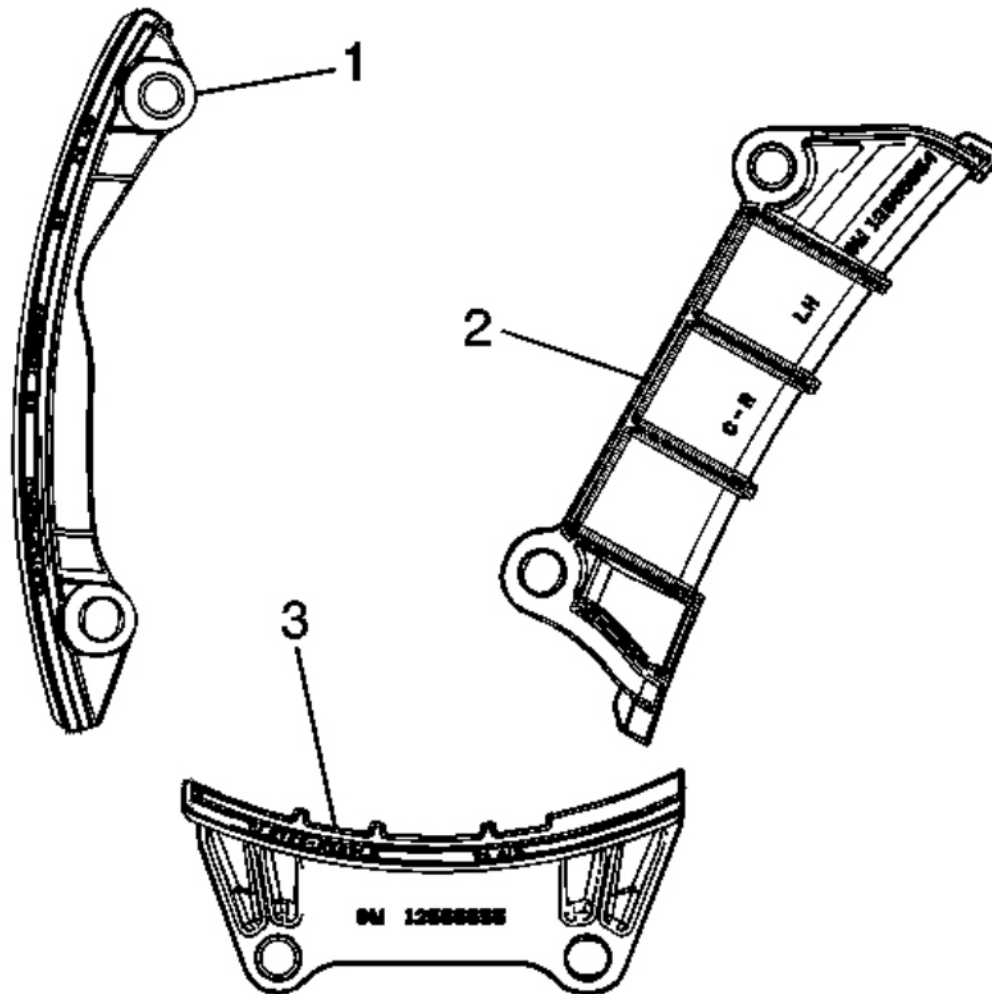


**Fig. 285: Intermediate Drive Chain**

Courtesy of GENERAL MOTORS CORP.

8. There will be 18 links (1) between the right camshaft intermediate drive chain idler timing camshaft drive chain link and each right camshaft position actuator sprocket timing camshaft drive chain link.

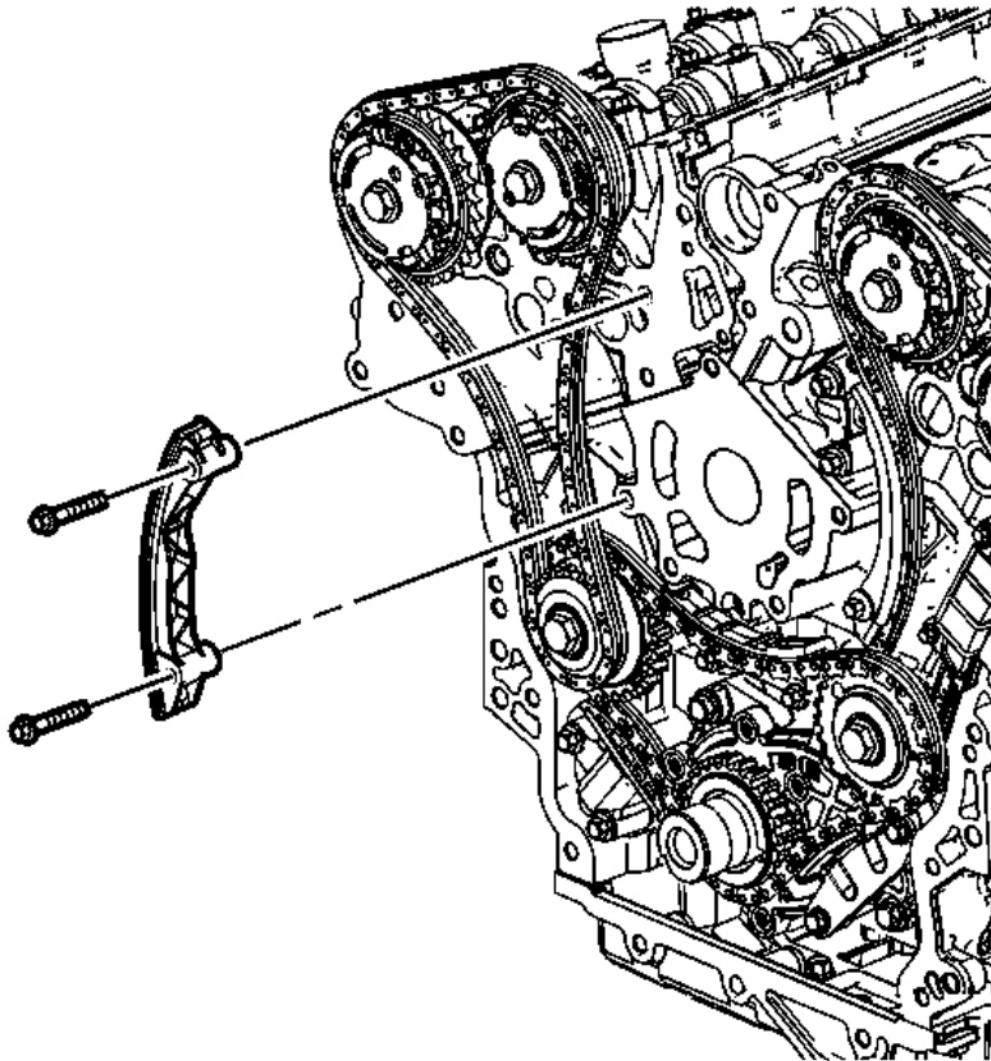
## SECONDARY CAMSHAFT DRIVE CHAIN GUIDE INSTALLATION - RIGHT



**Fig. 286: Identifying Left & Right Secondary Camshaft Drive Chain Guide & Upper Primary Camshaft Drive Chain Guide**

Courtesy of GENERAL MOTORS CORP.

1. Ensure that the right secondary camshaft drive chain guide (1) is being installed.



**Fig. 287: Right Secondary Camshaft Drive Chain Guide**  
Courtesy of GENERAL MOTORS CORP.

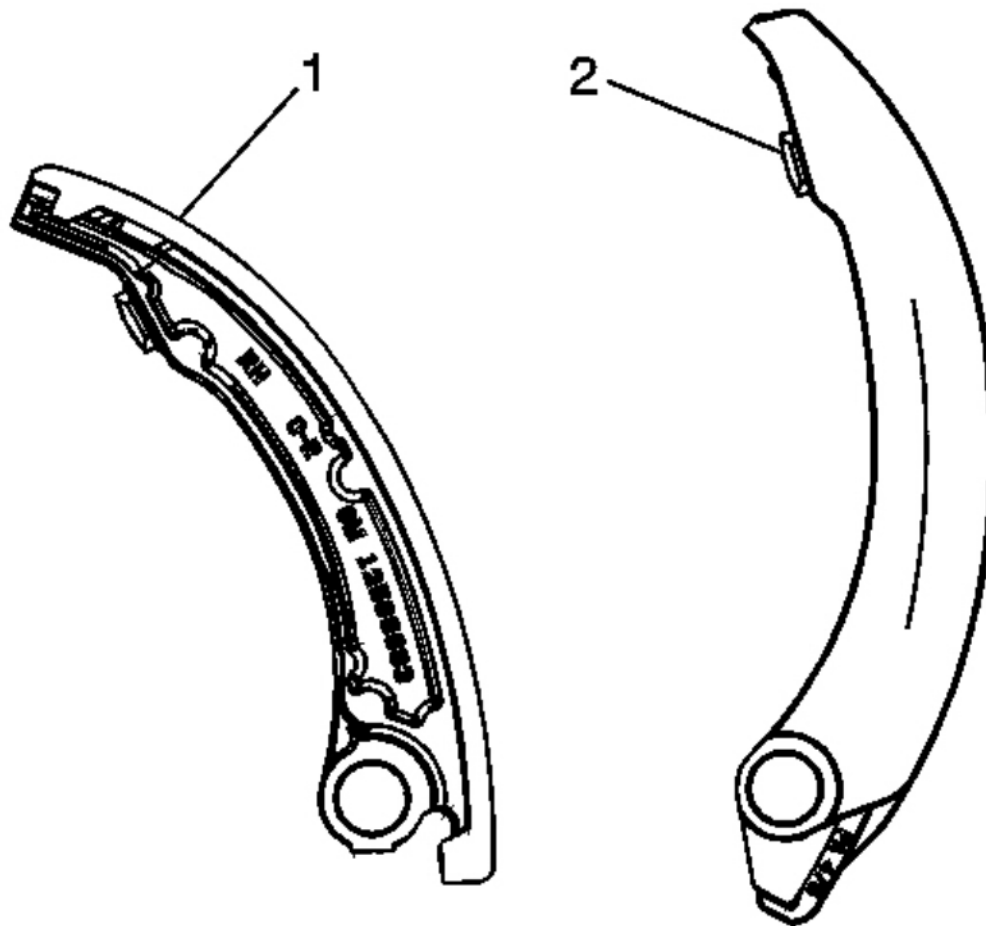
2. Position the right secondary camshaft drive chain guide.

**NOTE:** Refer to Fastener Notice .

3. Install the secondary camshaft drive chain guide bolts.

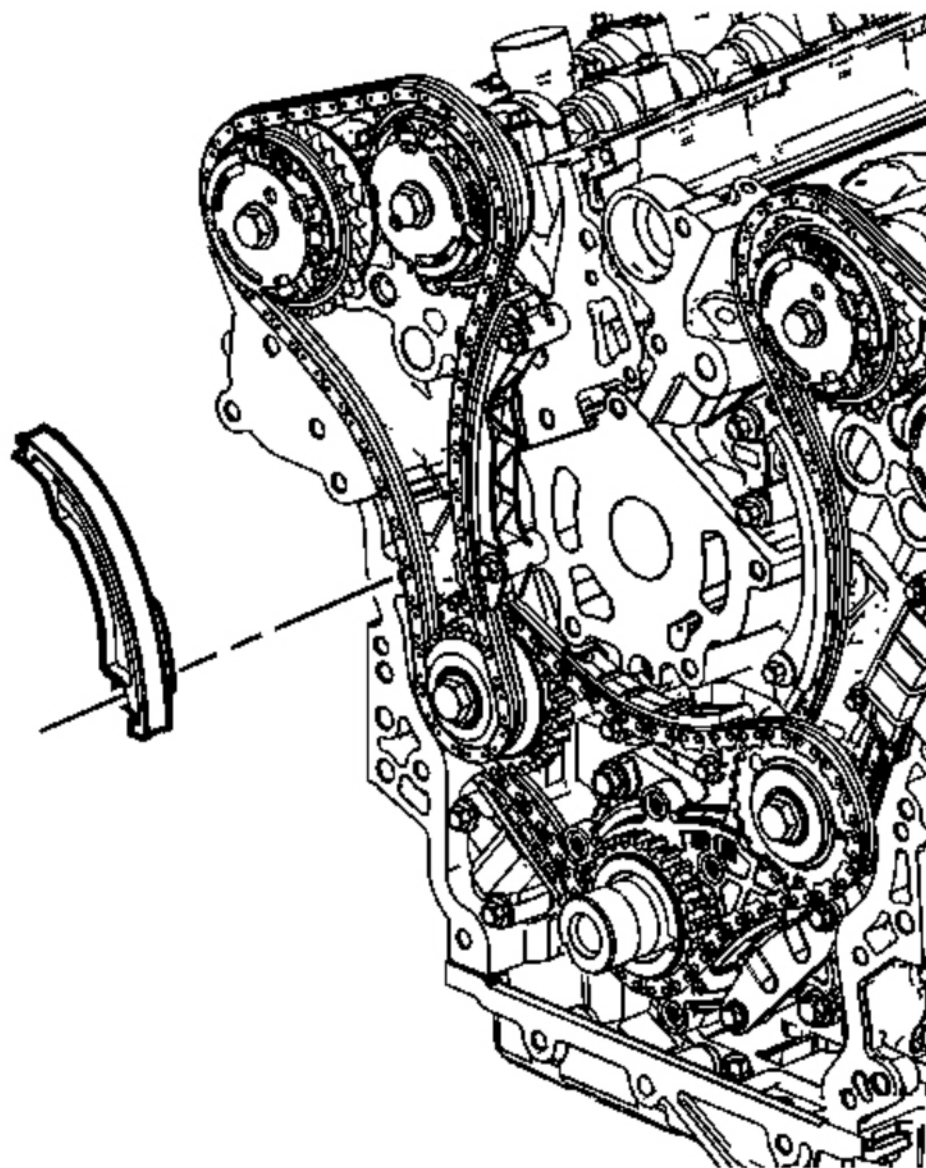
**Tighten:** Tighten the secondary camshaft drive chain guide bolts to 23 N.m (17 lb ft).

## SECONDARY CAMSHAFT DRIVE CHAIN SHOE INSTALLATION - RIGHT



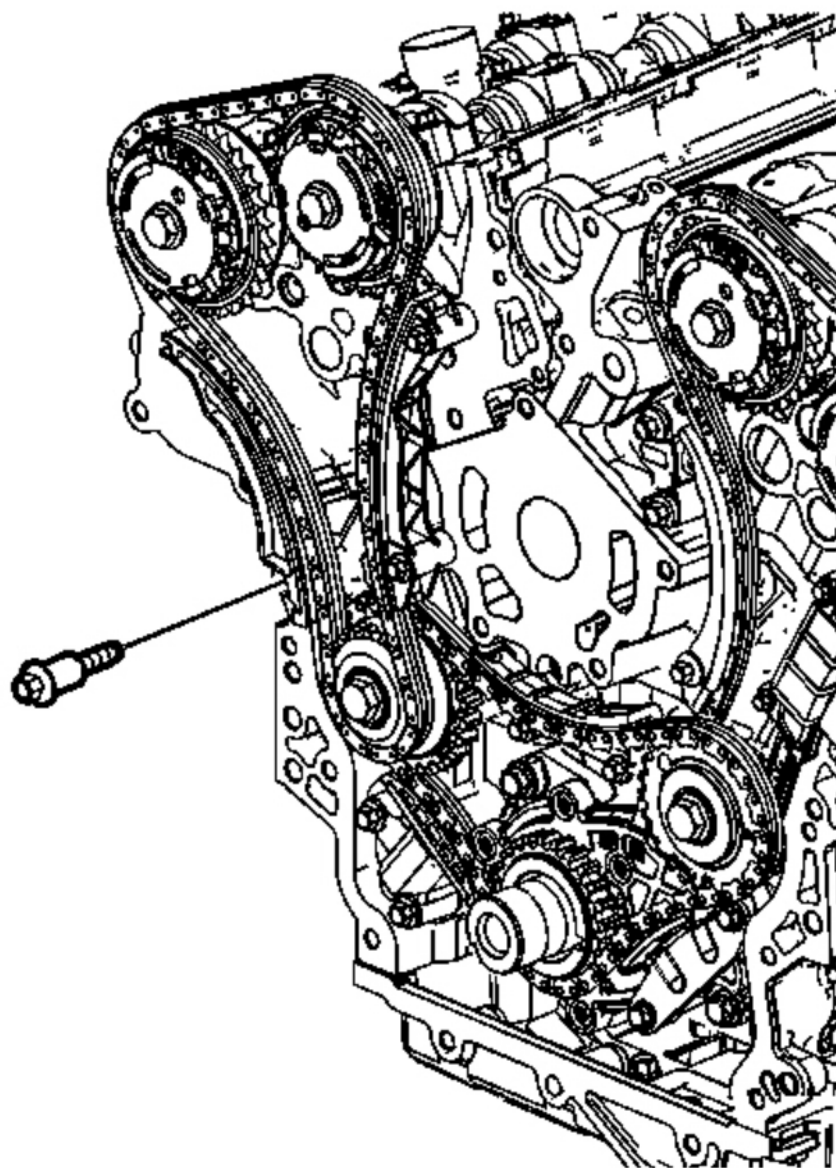
**Fig. 288: Left Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the right secondary camshaft drive chain shoe (1) is being installed.



**Fig. 289: Right Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS CORP.

2. Position the right secondary camshaft drive chain shoe.



**Fig. 290: Secondary Camshaft Drive Chain Shoe Bolt**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

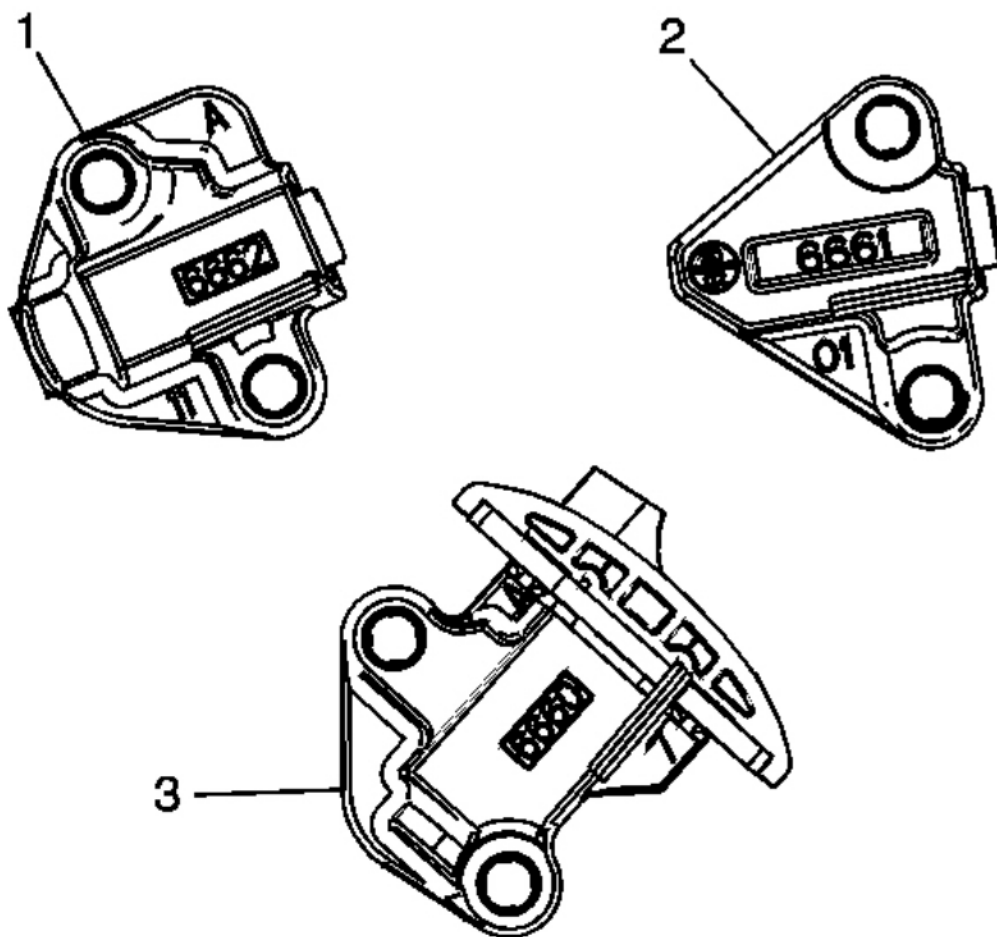
3. Install the secondary camshaft drive chain shoe bolt.

**Tighten:** Tighten the secondary camshaft drive chain shoe bolt to 23 N.m (17 lb ft).

## SECONDARY CAMSHAFT DRIVE CHAIN TENSIONER INSTALLATION - RIGHT

### Tools Required

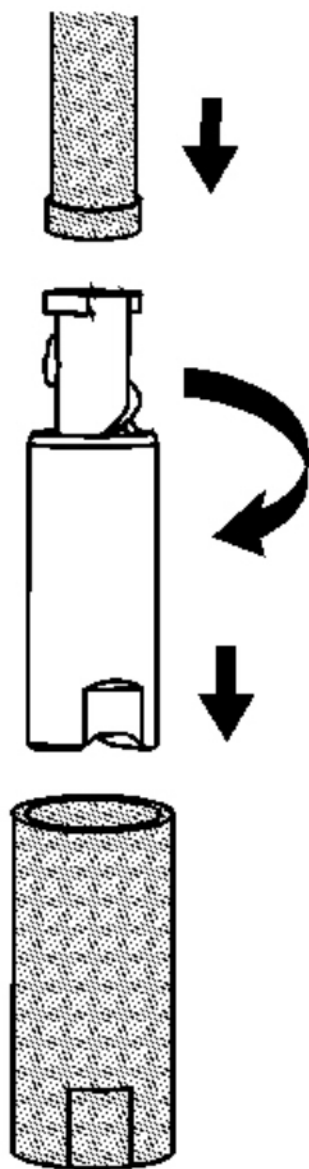
- EN 46112 Tensioner Retraction Pins
- J 45027 Tensioner Tool



**Fig. 291: Identifying Left & Right Secondary Camshaft Drive Chain Tensioner & Primary Camshaft Drive Chain Tensioner**

Courtesy of GENERAL MOTORS CORP.

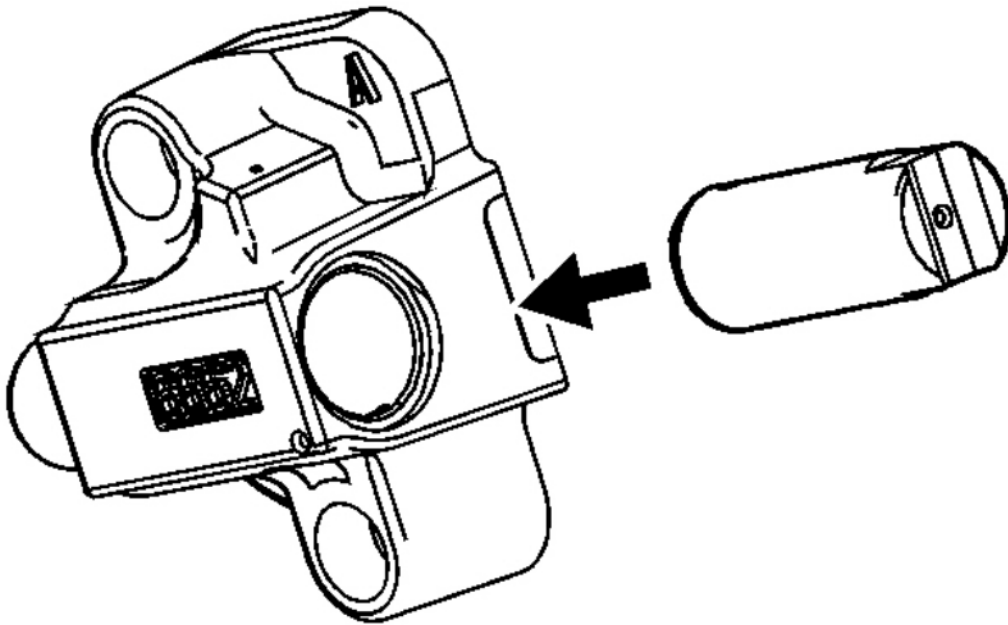
1. Ensure that the right secondary camshaft drive chain tensioner (1) is being installed.



**Fig. 292: Resetting Left Secondary Camshaft Drive Chain Tensioner Plunger With J 45027**  
Courtesy of GENERAL MOTORS CORP.

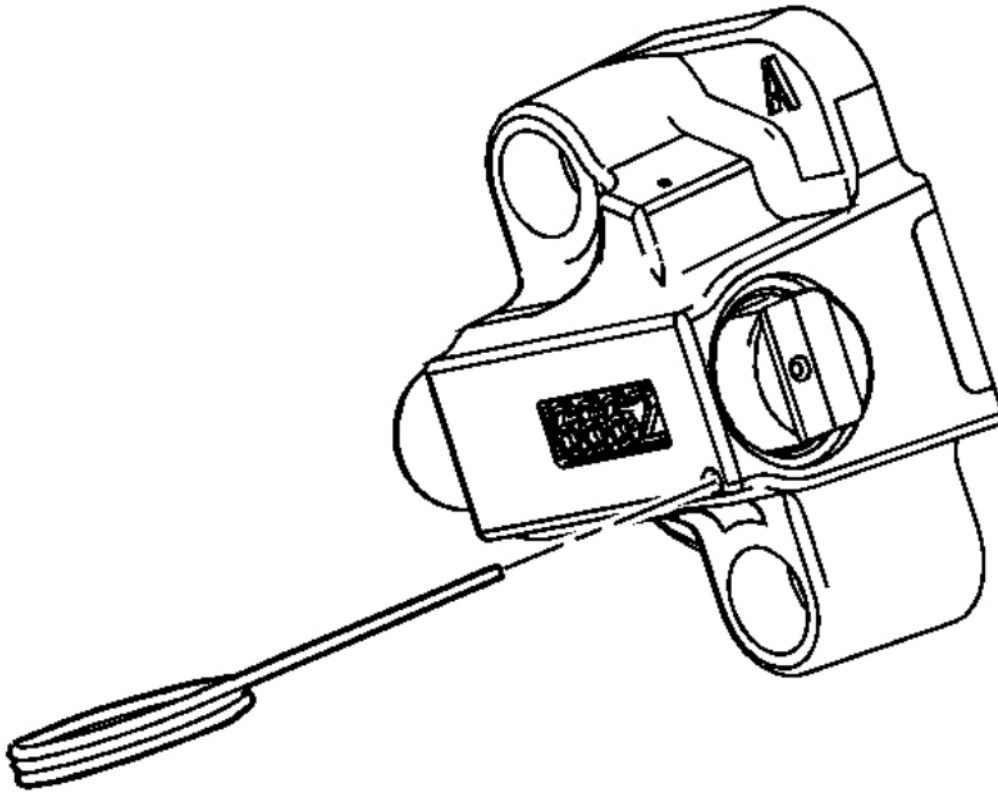
2. Using the **J 45027** reset the right secondary camshaft drive chain tensioner plunger.





**Fig. 293: Installing Plunger Into Right Secondary Camshaft Drive Chain Tensioner Body**  
Courtesy of GENERAL MOTORS CORP.

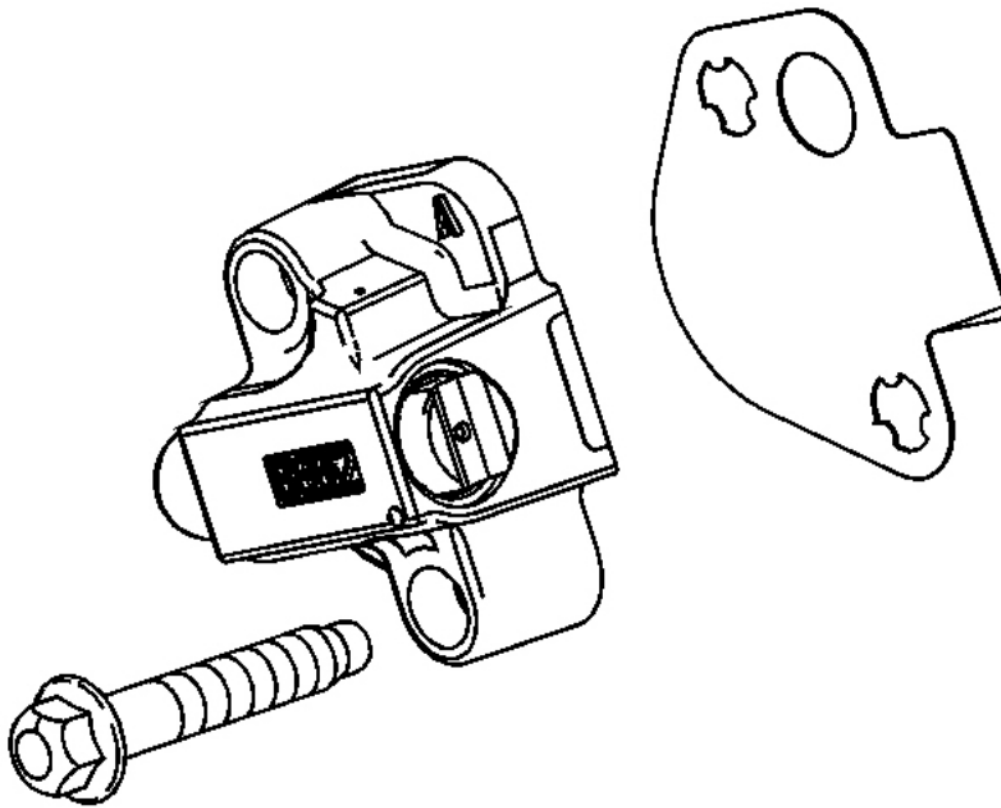
3. Install the plunger into the right secondary camshaft drive chain tensioner body.



**Fig. 294: Identifying EN 46112**

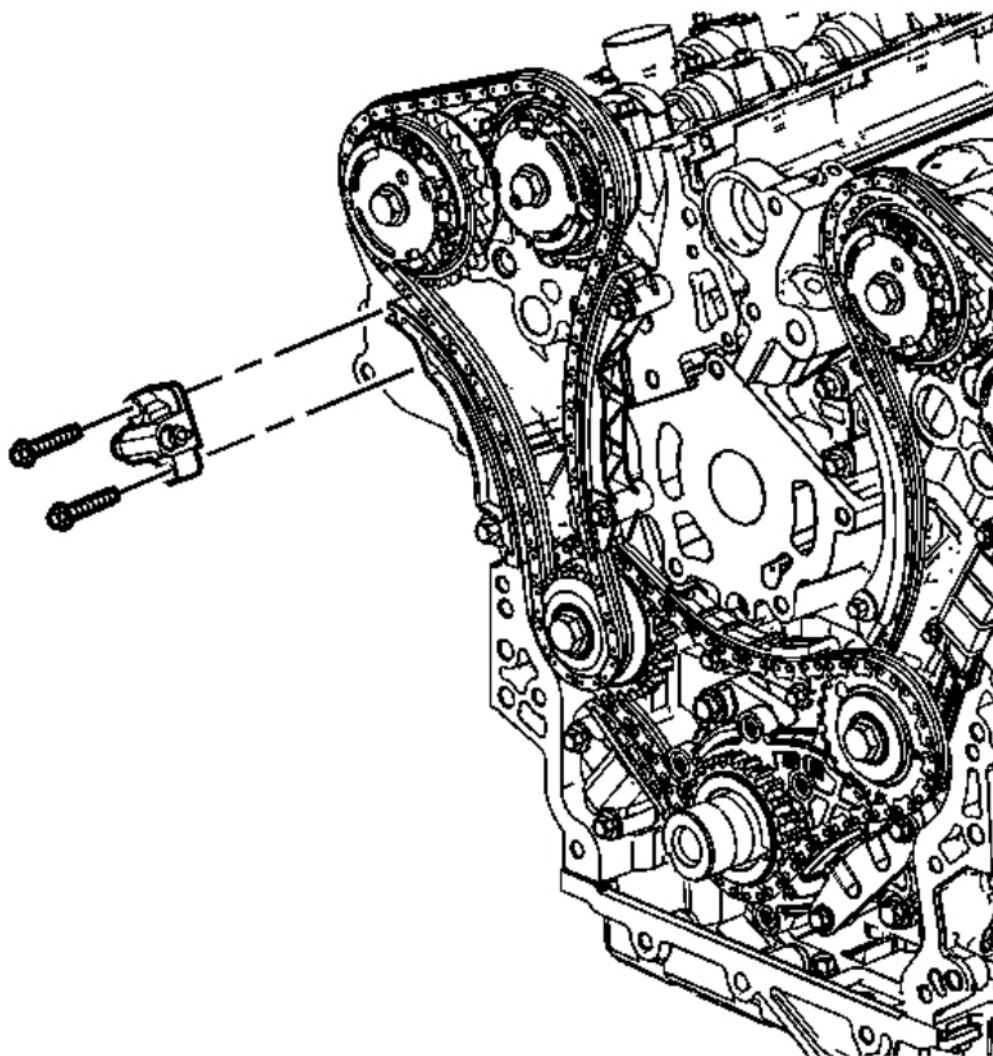
Courtesy of GENERAL MOTORS CORP.

4. Compress the plunger into the body and lock the right secondary camshaft drive chain tensioner by inserting the **EN 46112** into the access hole in the side of the right secondary camshaft drive chain tensioner body.
5. Slowly release pressure on the right secondary camshaft drive chain tensioner. The right secondary camshaft drive chain tensioner should remain compressed.



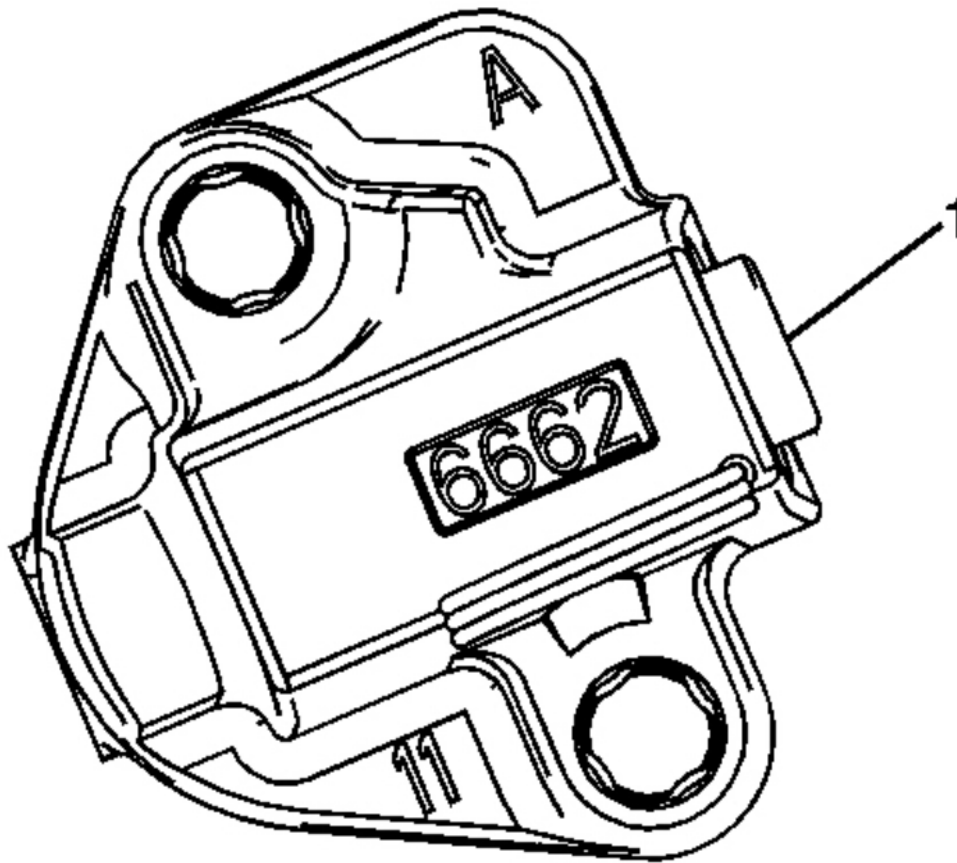
**Fig. 295: Identifying Right Secondary Camshaft Drive Chain Tensioner Gasket**  
Courtesy of GENERAL MOTORS CORP.

6. Install a NEW right secondary camshaft drive chain tensioner gasket to the right secondary camshaft drive chain tensioner.
7. Install the right secondary camshaft drive chain tensioner bolts through the right secondary camshaft drive chain tensioner and gasket.
8. Ensure the right secondary camshaft drive chain tensioner mounting surface on the right cylinder head does not have any burrs or defects that would degrade the sealing of the NEW right secondary camshaft drive chain tensioner gasket.



**Fig. 296: Right Secondary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS CORP.

9. Place the right secondary camshaft drive chain tensioner into position and loosely install the bolts to the block.



**Fig. 297: Identifying Right Secondary Camshaft Drive Chain Tensioner Gasket Tab**  
Courtesy of GENERAL MOTORS CORP.

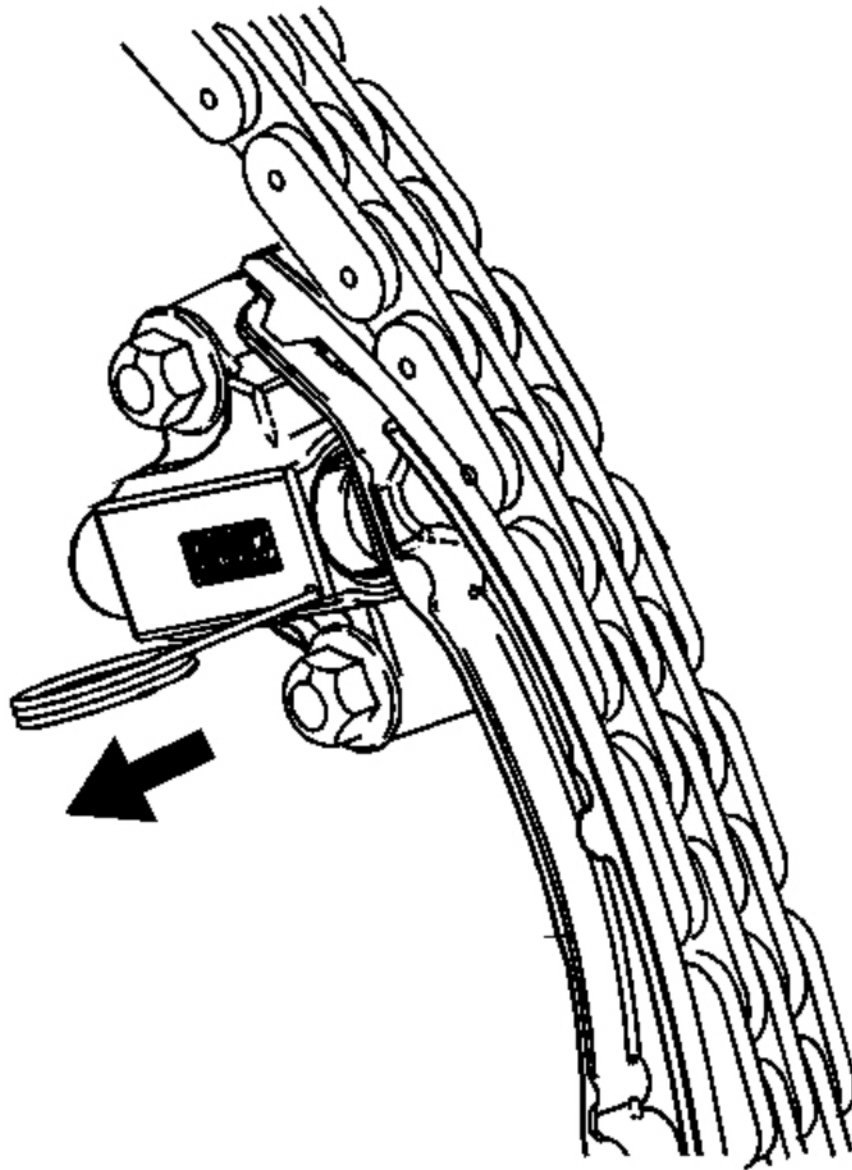
**NOTE:** Refer to Fastener Notice .

10. Verify the proper placement of the right secondary camshaft drive chain tensioner gasket tab (1).
  1. First Pass

**Tighten:** Tighten the right secondary camshaft drive chain tensioner bolts to 5 N.m (44 lb in).

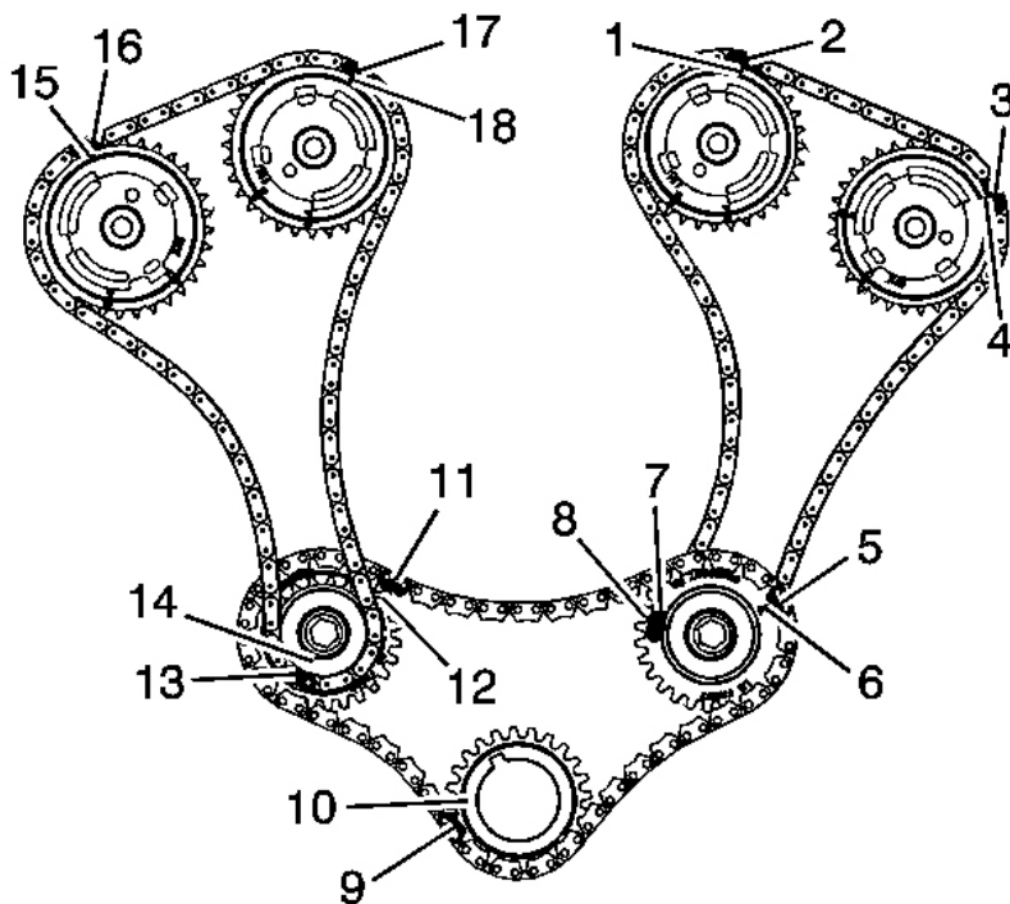
2. Final Pass

**Tighten:** Tighten the right secondary camshaft drive chain tensioner bolts to 23 N.m (17 lb ft).



**Fig. 298: Unlocking Tensioner Plunger By Removing EN 46112**  
Courtesy of GENERAL MOTORS CORP.

11. Release the right camshaft drive chain tensioner by pulling out the **EN 46112** and unlocking the tensioner plunger.



**Fig. 299: Drive Chain Timing Mark Alignments**

Courtesy of GENERAL MOTORS CORP.

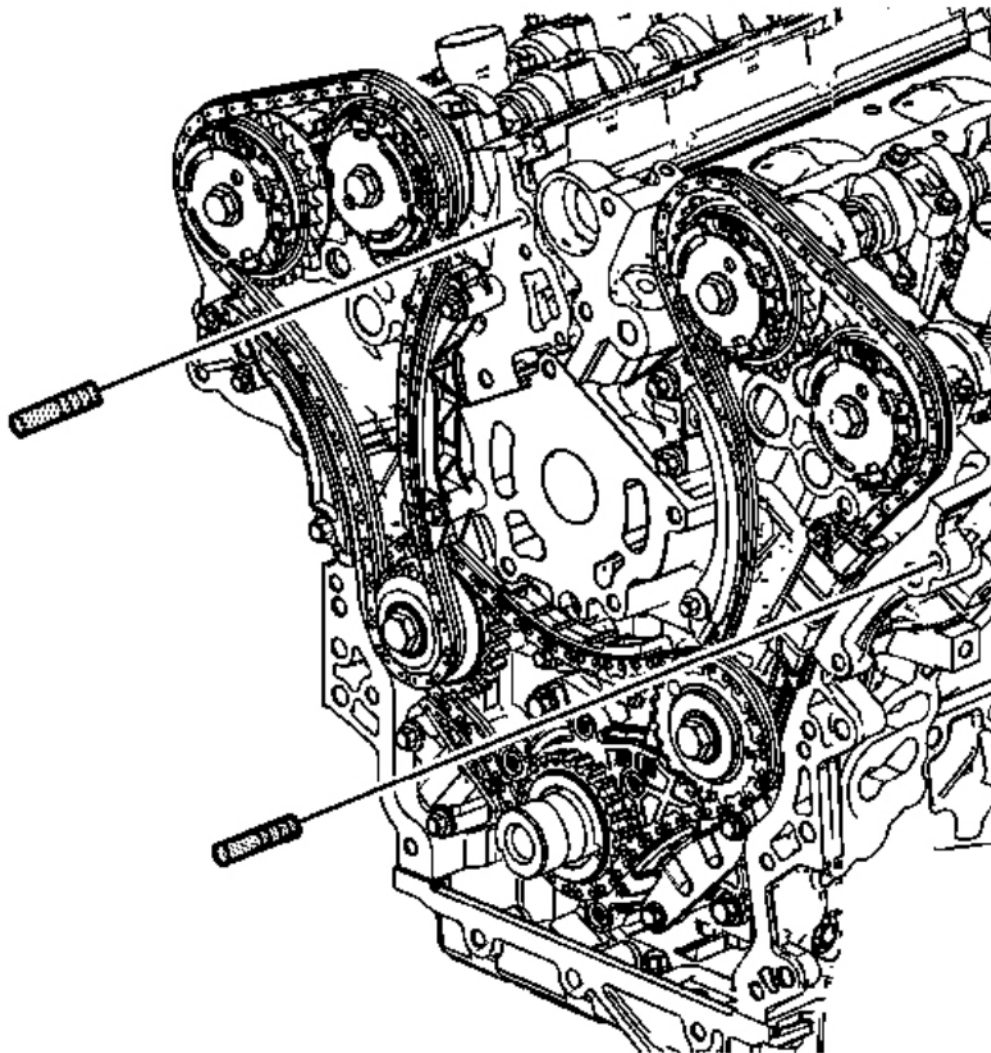
**NOTE:** Ensure that all timing chain tensioners are completely released. A timing chain tensioner that is not properly released can lead to serious engine damage.

12. Verify all primary and secondary camshaft drive chain timing mark alignments (1-18) also refer to Camshaft Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain) - Stage Two.

## ENGINE FRONT COVER INSTALLATION

### Tools Required

EN 46109 Guide Pin Set

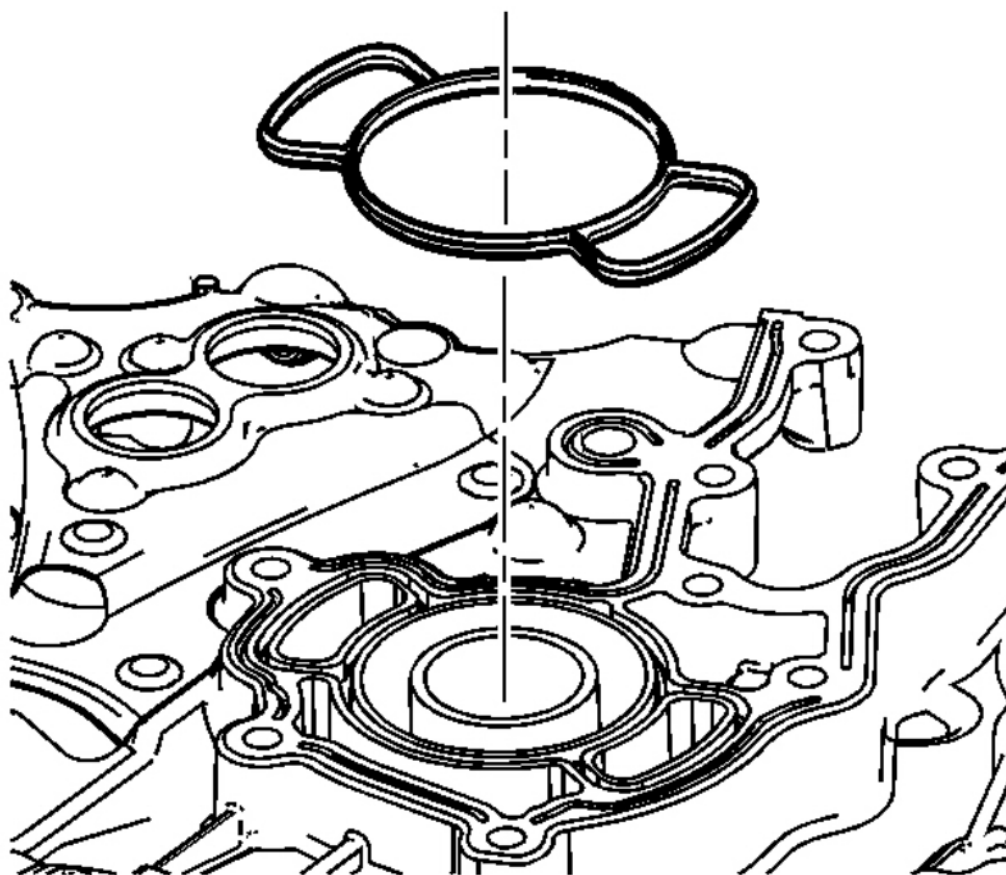


**Fig. 300: Identifying Guide Pins**

Courtesy of GENERAL MOTORS CORP.

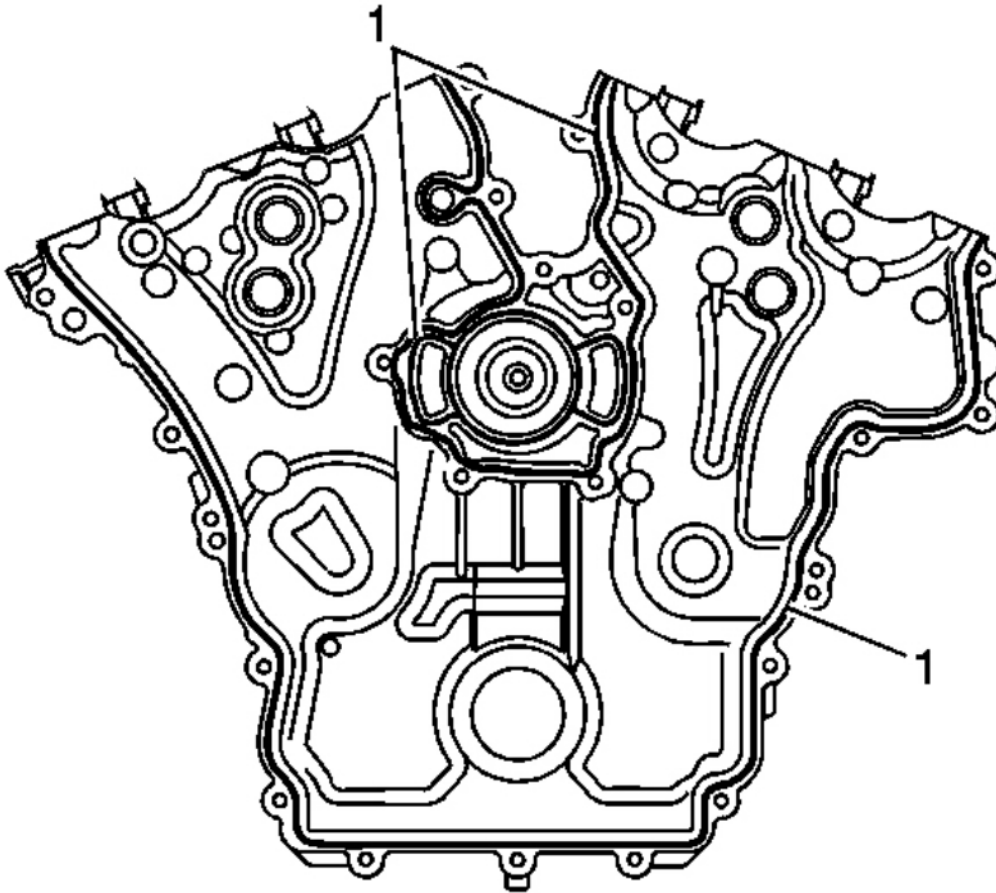
1. Install the 8 mm (0.315 in) guide from the EN 46109 into the cylinder block positions as shown.





**Fig. 301: Identifying Water Pump Seal**  
Courtesy of GENERAL MOTORS CORP.

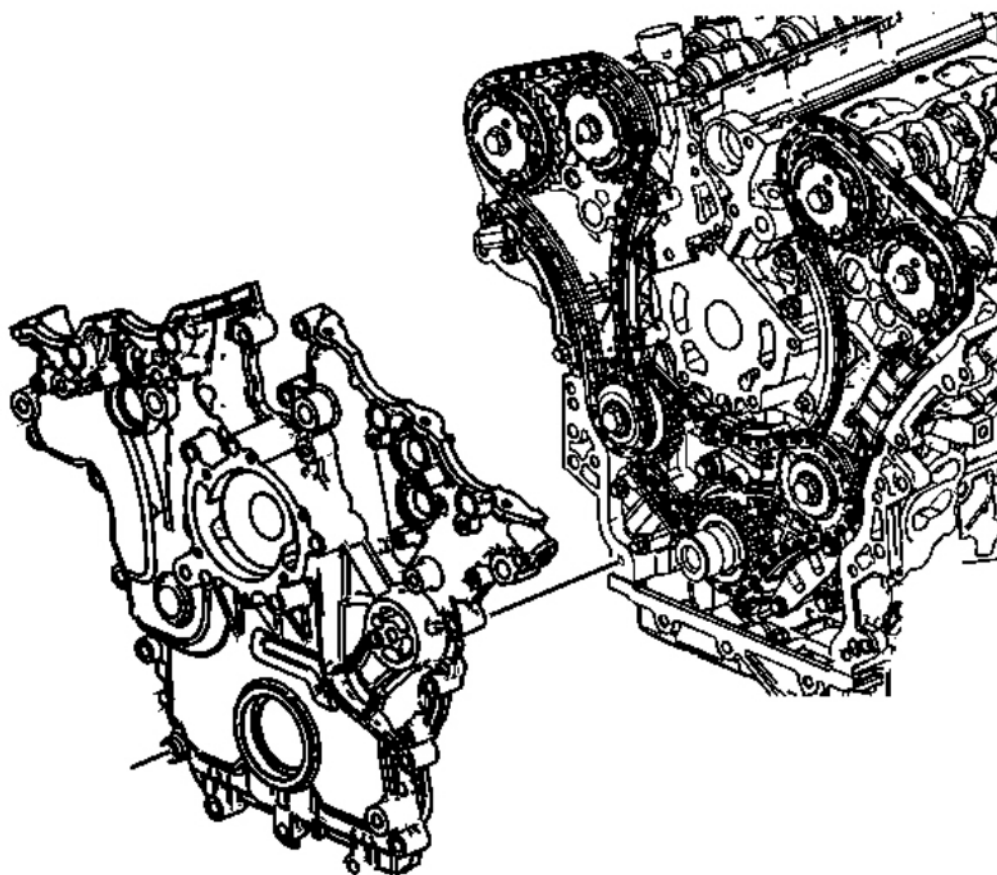
2. Install the NEW engine front cover to cylinder block seal.



**Fig. 302: Locating RTV Sealant**

Courtesy of GENERAL MOTORS CORP.

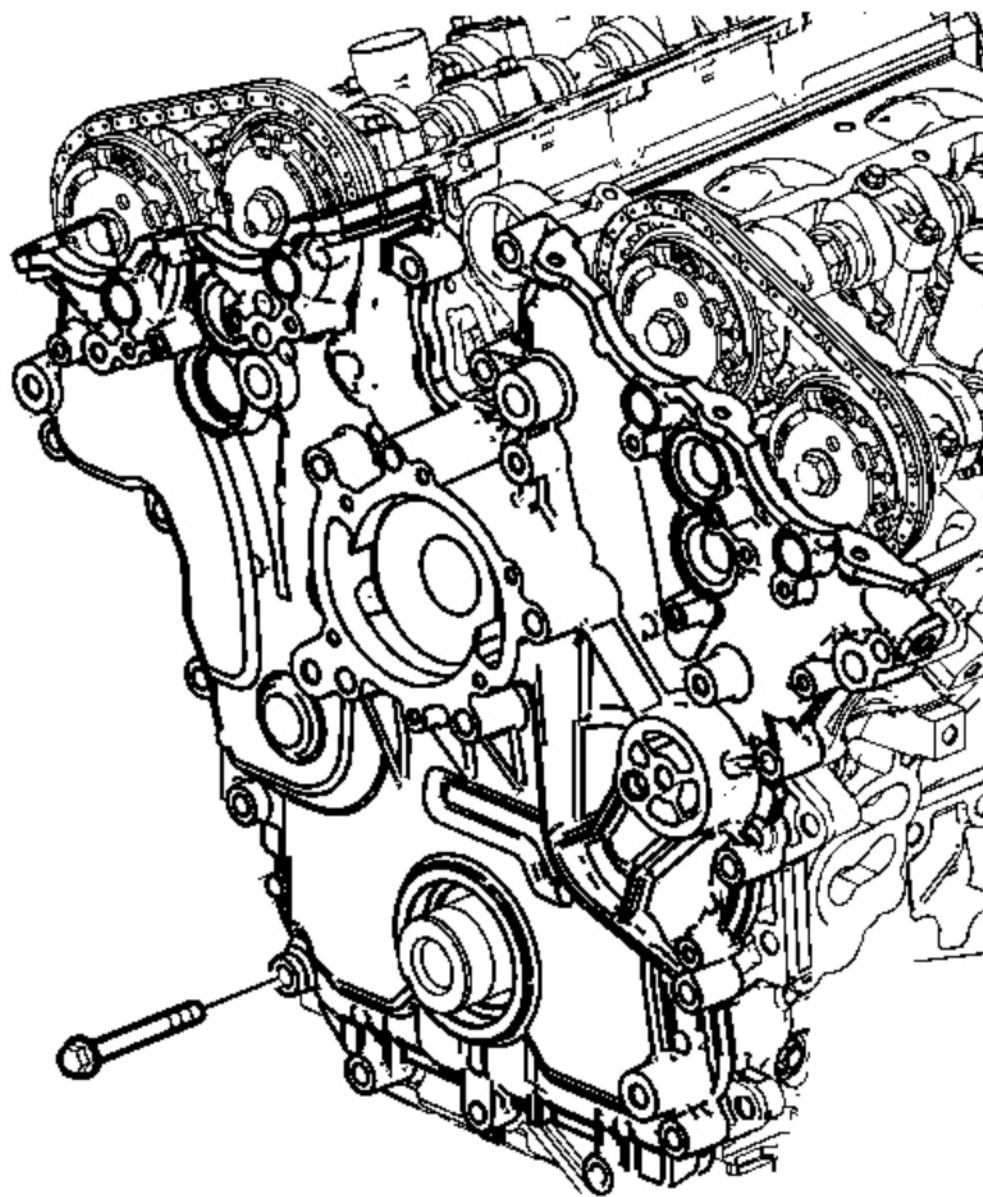
3. Place a 3 mm (0.118 in) bead of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the engine front cover as shown (1).



**Fig. 303: Engine Front Cover**

Courtesy of GENERAL MOTORS CORP.

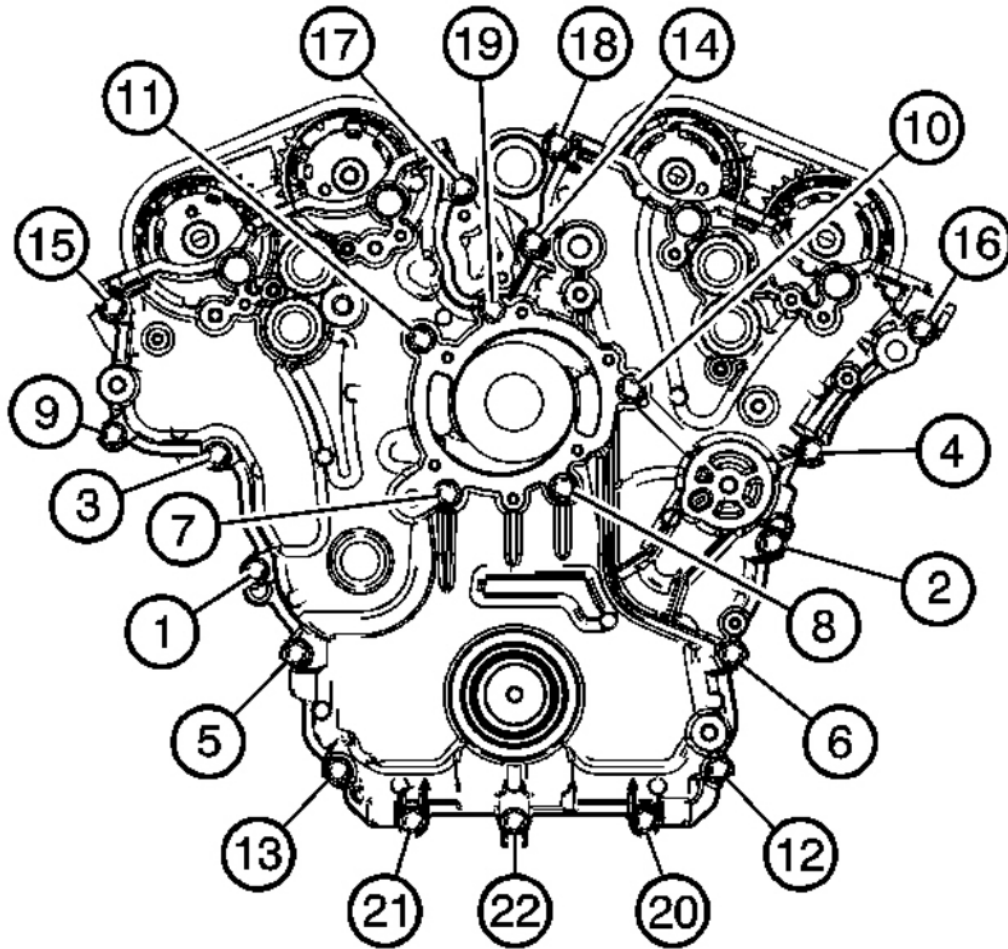
4. Place the engine front cover onto the **EN 46109** and slide into position.
5. Remove the **EN 46109** from the cylinder block.



**Fig. 304: View Of Engine Front Cover Bolt**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

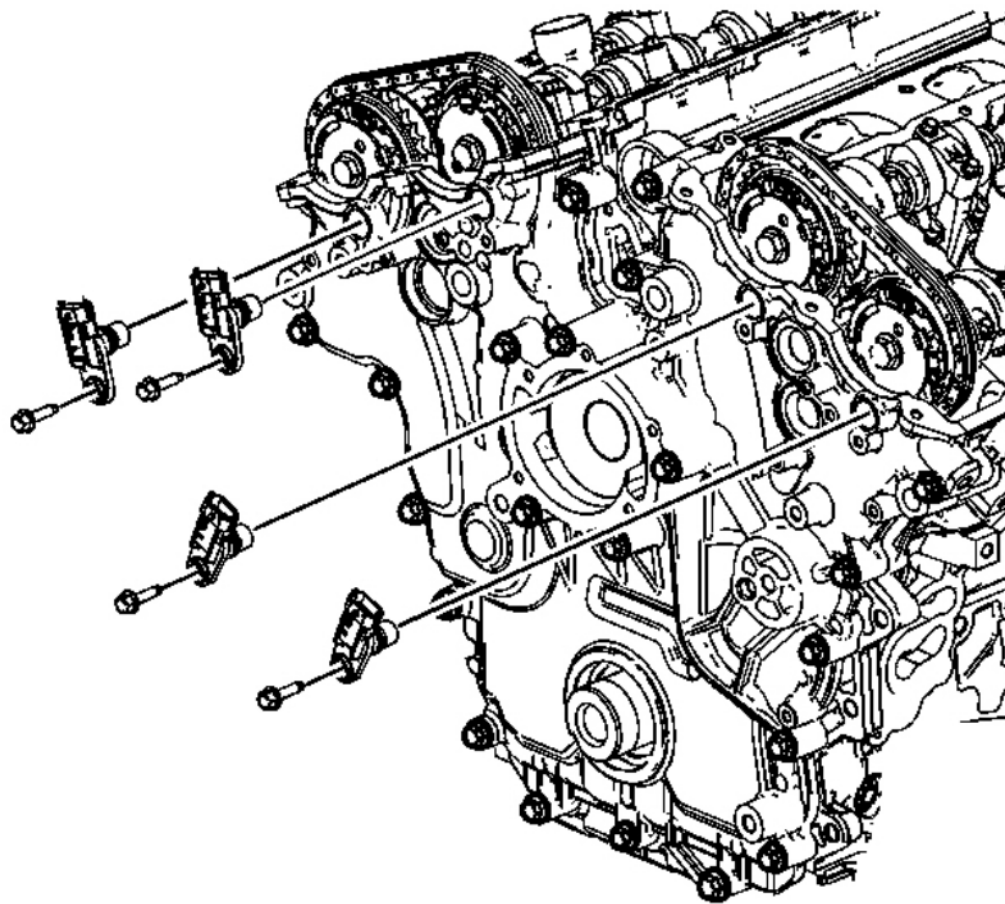
6. Hand start all the engine front cover bolts.



**Fig. 305: Tightening Engine Front Cover Bolts**  
Courtesy of GENERAL MOTORS CORP.

7. Tighten the engine front cover bolts in the sequence shown.

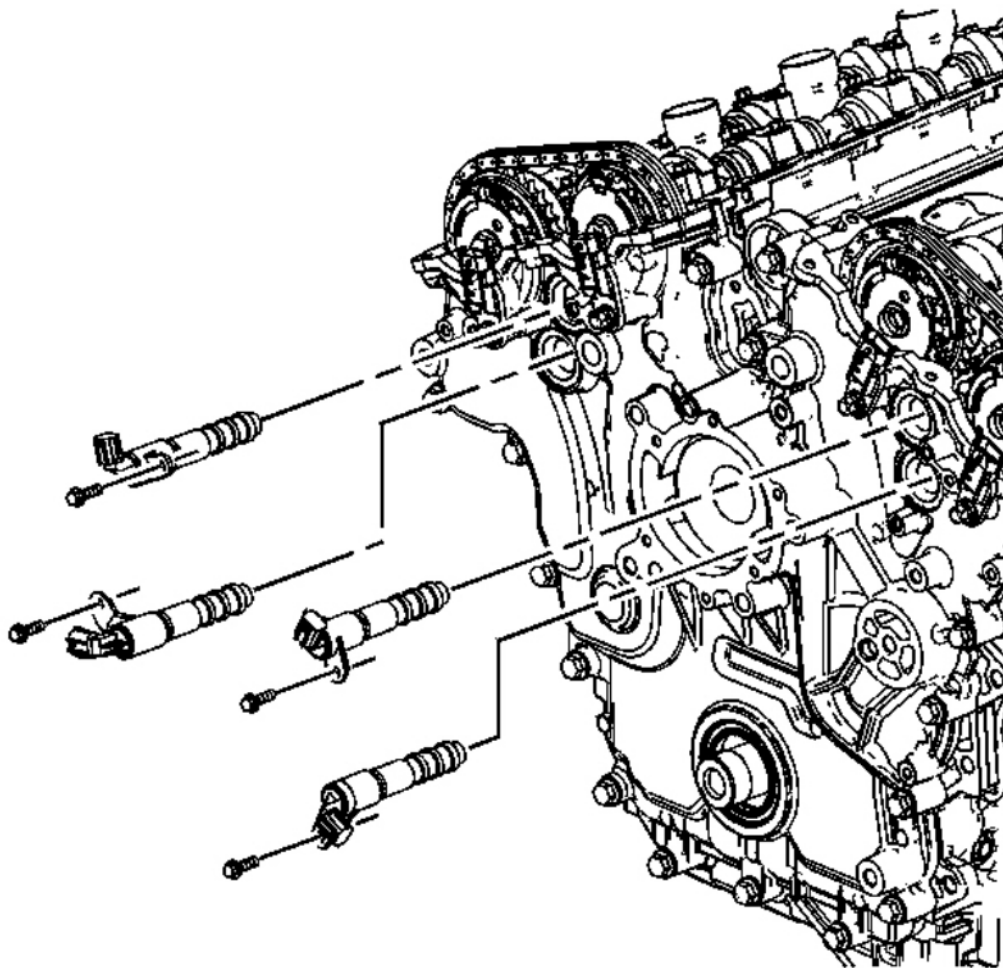
**Tighten:** Tighten the engine front cover bolts in the sequence to 23 N.m (17 lb ft).



**Fig. 306: View Of Camshaft Position Sensors**  
Courtesy of GENERAL MOTORS CORP.

8. Install NEW O-rings on the camshaft position sensor.
9. Place the camshaft position sensors in position on the front cover.
10. Install the camshaft position sensor bolts.

**Tighten:** Tighten the camshaft position sensor bolts to 10 N.m (89 lb in).



**Fig. 307: View Of Camshaft Position Actuator Valves**  
Courtesy of GENERAL MOTORS CORP.

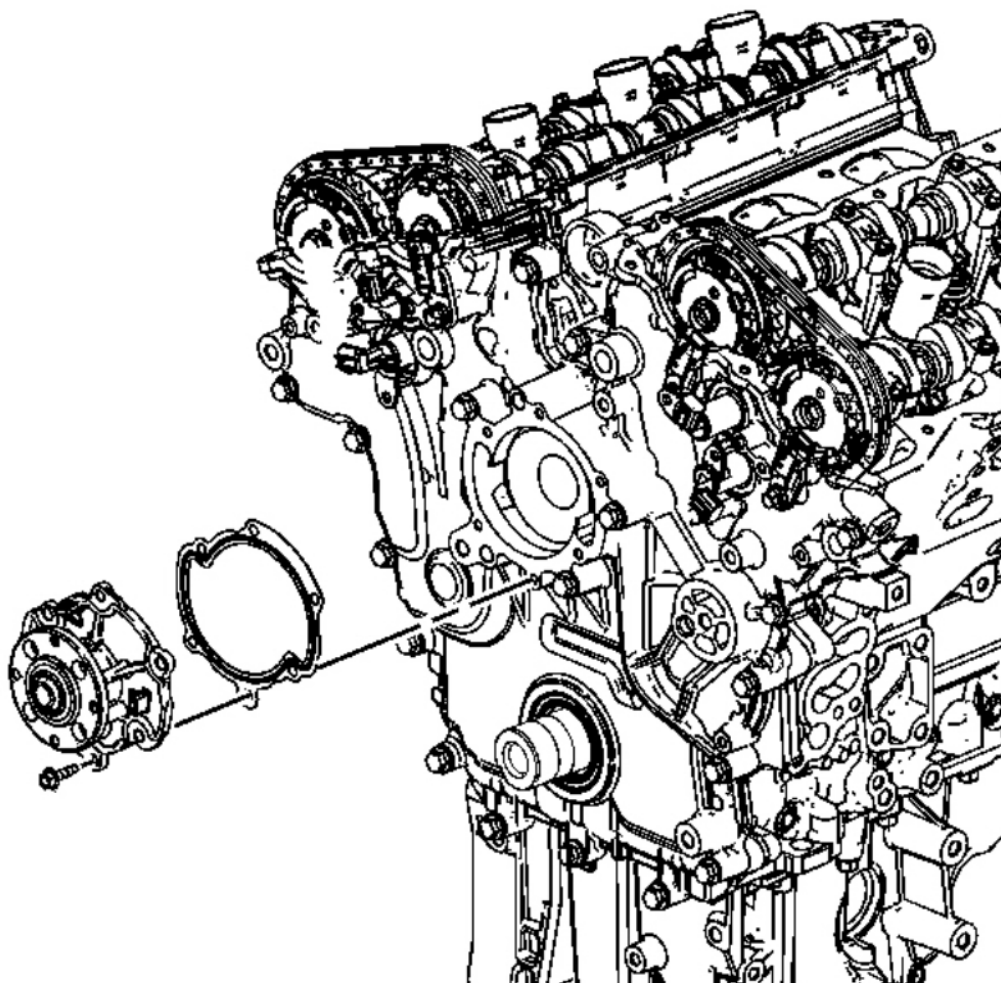
11. Place the camshaft position actuator valves in position on the front cover.
12. Install the camshaft position actuator valve bolts.

**Tighten:** Tighten the camshaft position actuator valve bolts to 10 N.m (89 lb in).

## WATER PUMP INSTALLATION

### Tools Required

EN 46104 Water Pump Pulley Holding Tool



**Fig. 308: View Of Water Pump**

Courtesy of GENERAL MOTORS CORP.

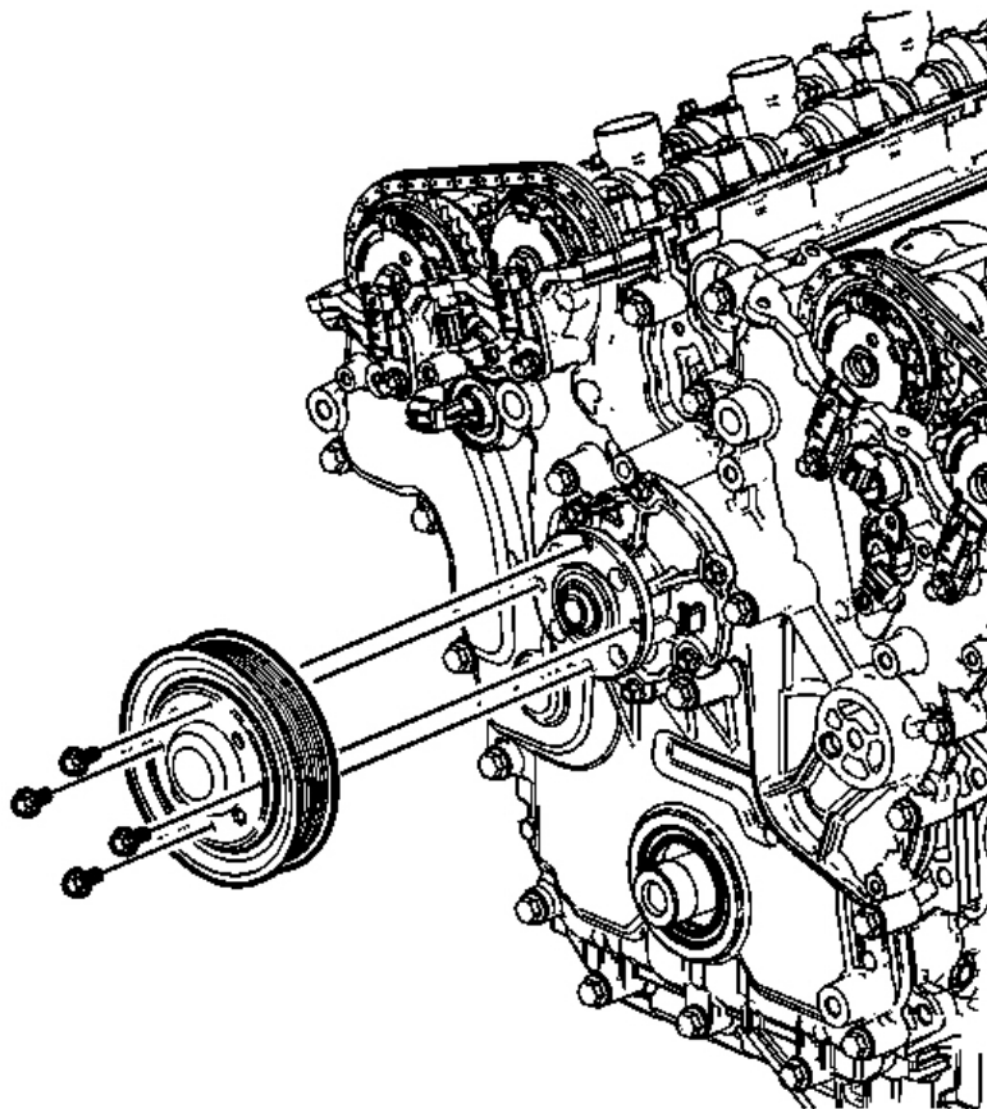
1. Ensure that the engine front cover and water pump are clear of old gasket material.
2. Place a new water pump gasket on the water pump.
3. Place the water pump in position on the front cover.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

4. Install the water pump bolts.

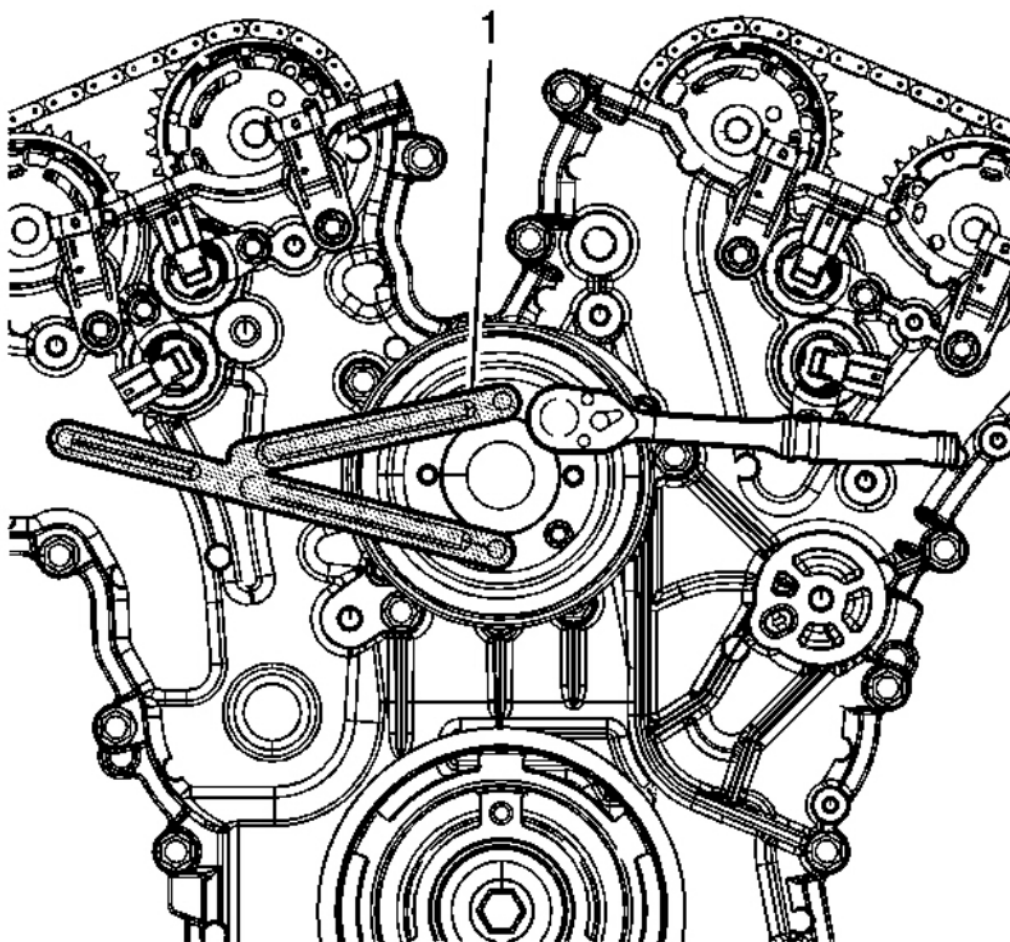
**Tighten:** Tighten the water pump bolts in the sequence shown to 10 N.m (89 lb in).





**Fig. 309: View Of Water Pump Pulley**  
Courtesy of GENERAL MOTORS CORP.

5. Install the water pump pulley.
6. Loosely install the water pump pulley bolts.



**Fig. 310: View Of EN 46104**

Courtesy of GENERAL MOTORS CORP.

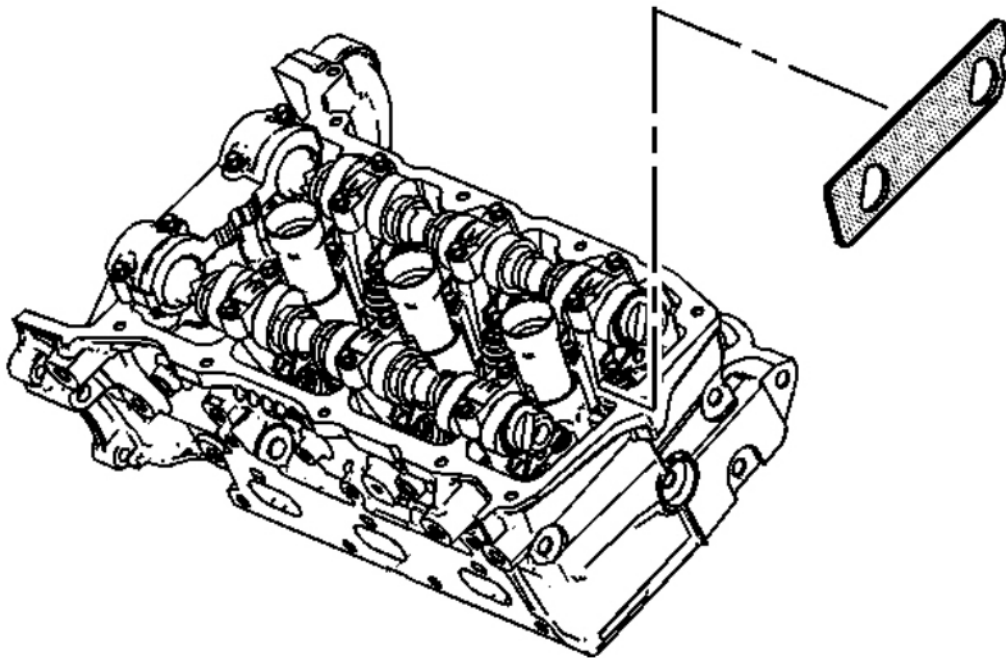
7. Install the **EN 46104** (1) onto the water pump pulley.

**Tighten:** Tighten the water pump pulley bolts to 10 N.m (89 lb in).

## CAMSHAFT COVER INSTALLATION - LEFT

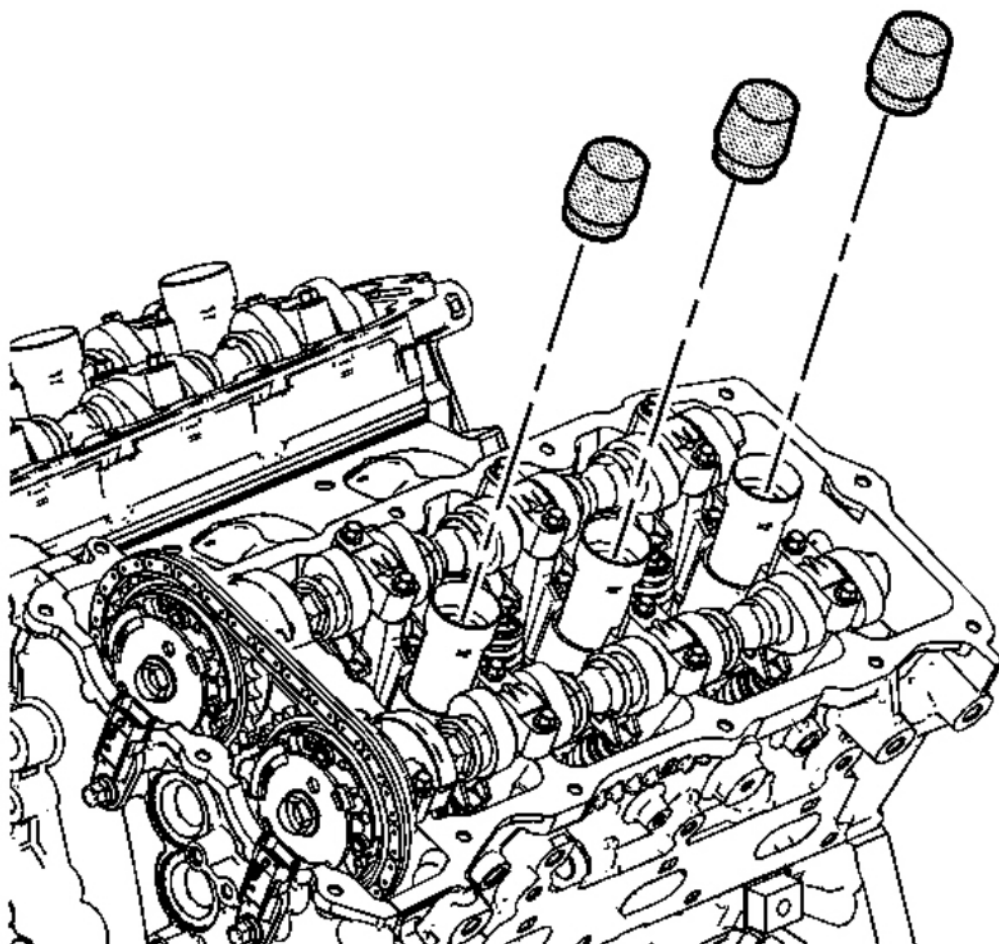
### Tools Required

- **EN 46101** Spark Plug Tube Seal Guide
- **EN 46105** Camshaft Locking Tool



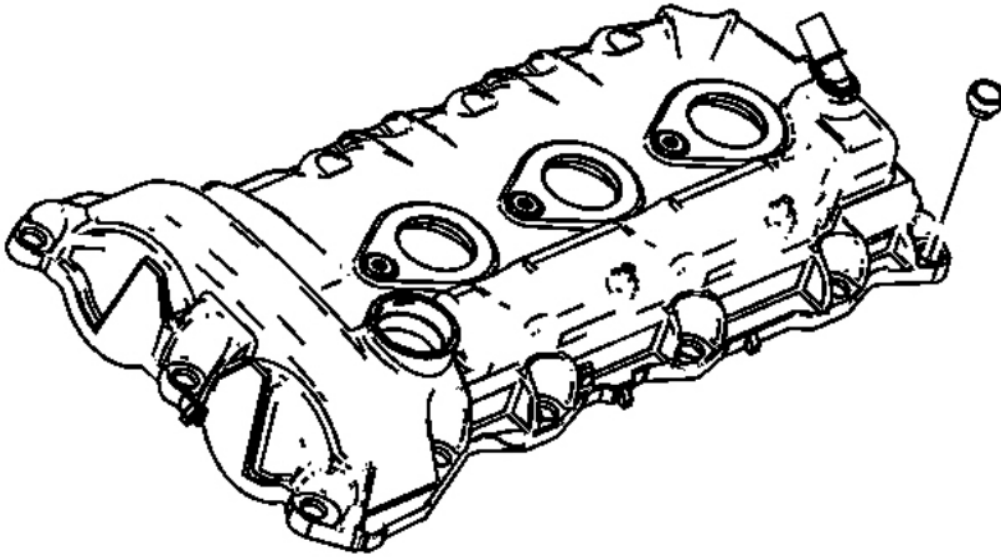
**Fig. 311: Identifying EN 46105-2**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the EN 46105-2 from the rear of the left camshafts.



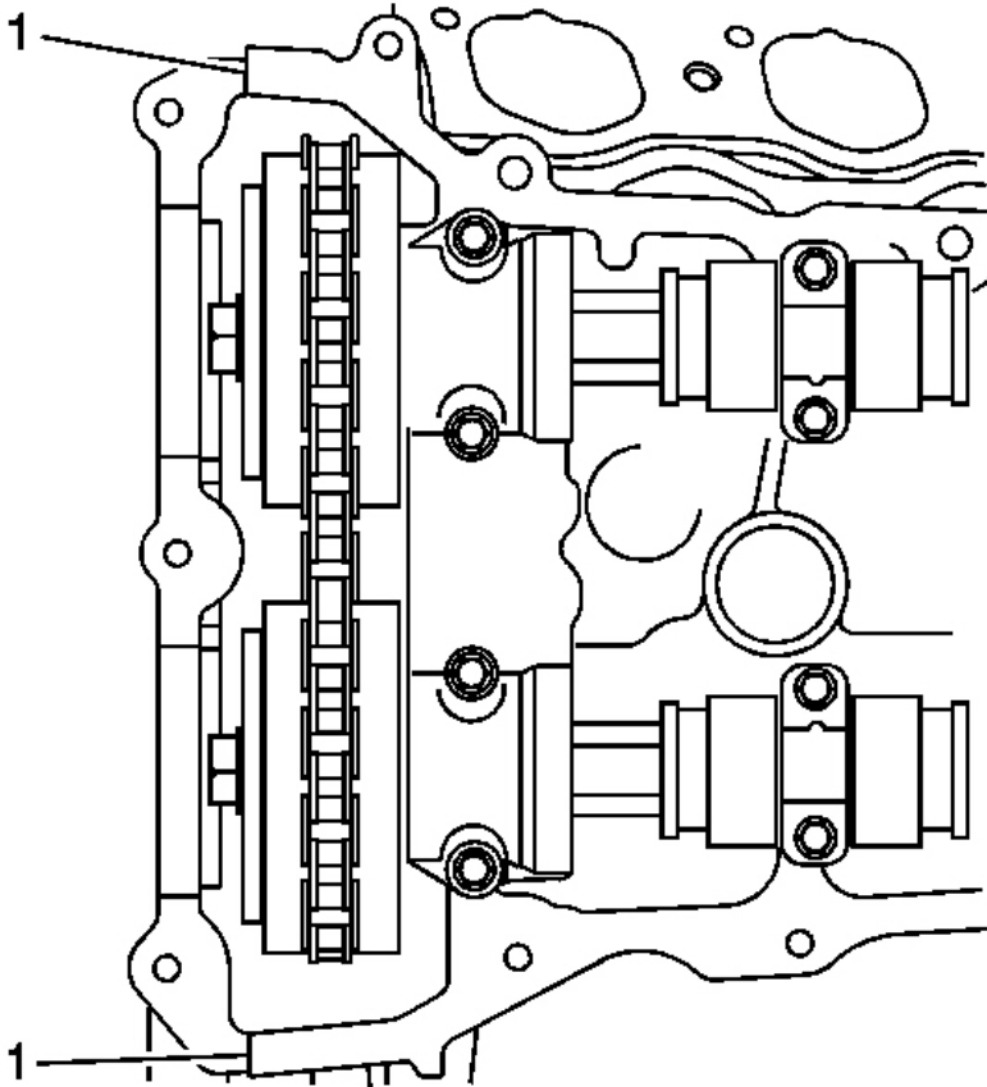
**Fig. 312: Installing EN 46101 Into Spark Plug Holes**  
Courtesy of GENERAL MOTORS CORP.

2. Install the **EN 46101** onto the spark plug tubes of the left cylinder head.



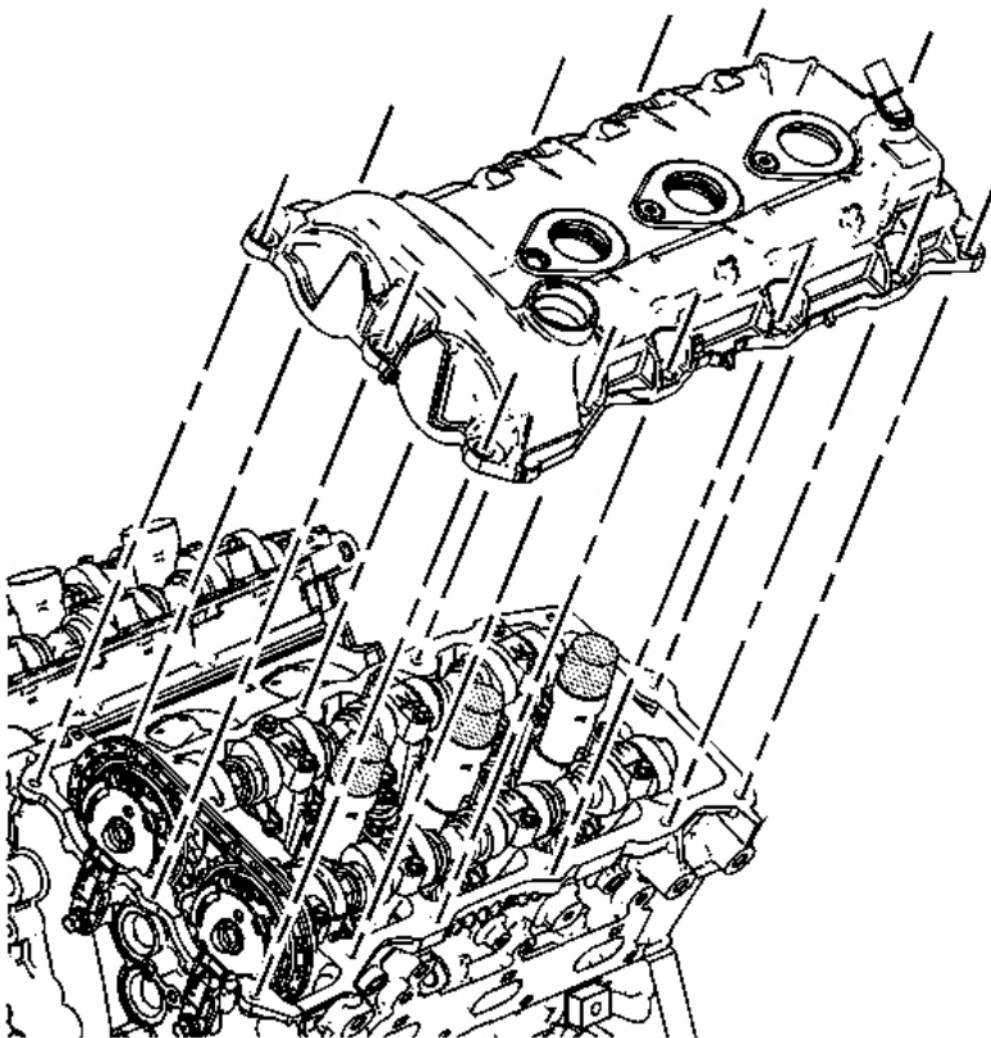
**Fig. 313: Identifying Camshaft Cover Bolt Grommets**  
Courtesy of GENERAL MOTORS CORP.

3. Install the camshaft cover bolt grommets prior to installing the camshaft cover bolts.
4. Wipe the camshaft cover sealing surface on the left cylinder head with a clean, lint-free cloth.



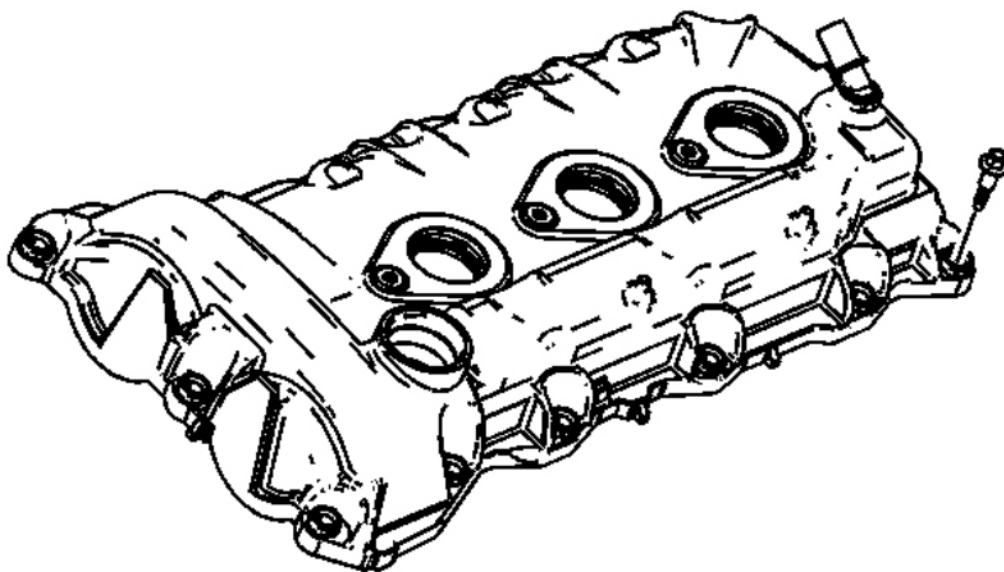
**Fig. 314: Locating Engine Front Cover Split Lines**  
Courtesy of GENERAL MOTORS CORP.

5. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the engine front cover split lines (1).



**Fig. 315: Aligning Left Camshaft Cover On Left Cylinder Head**  
Courtesy of GENERAL MOTORS CORP.

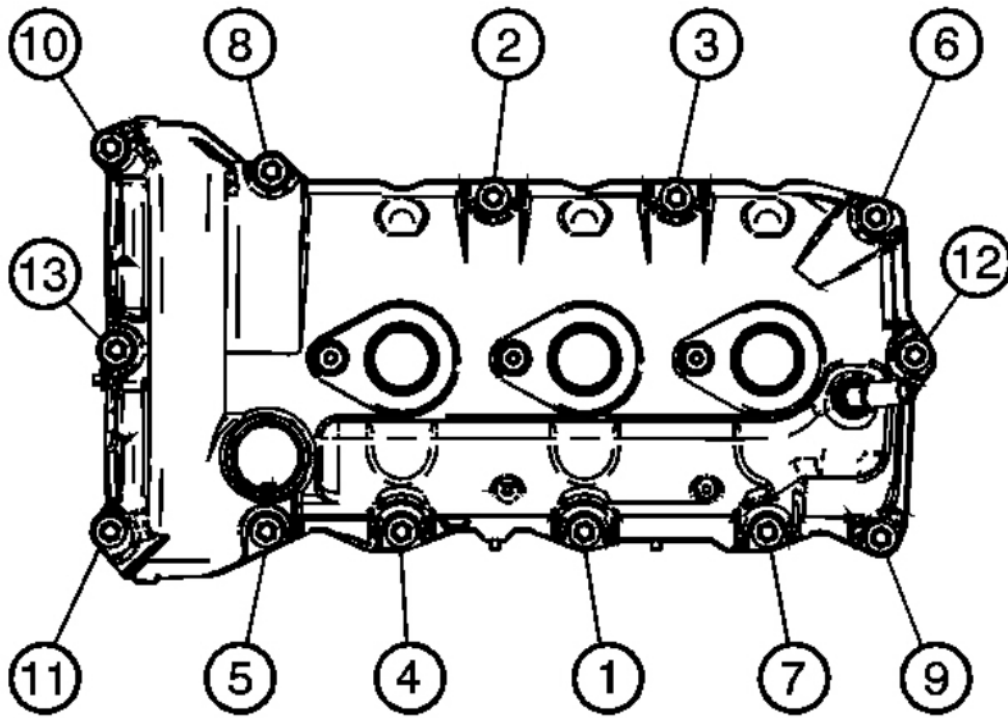
6. Place the left camshaft cover into position onto the left cylinder head.



**Fig. 316: Identifying Left Camshaft Cover Bolts**  
Courtesy of GENERAL MOTORS CORP.

7. Loosely install the left camshaft cover bolts.



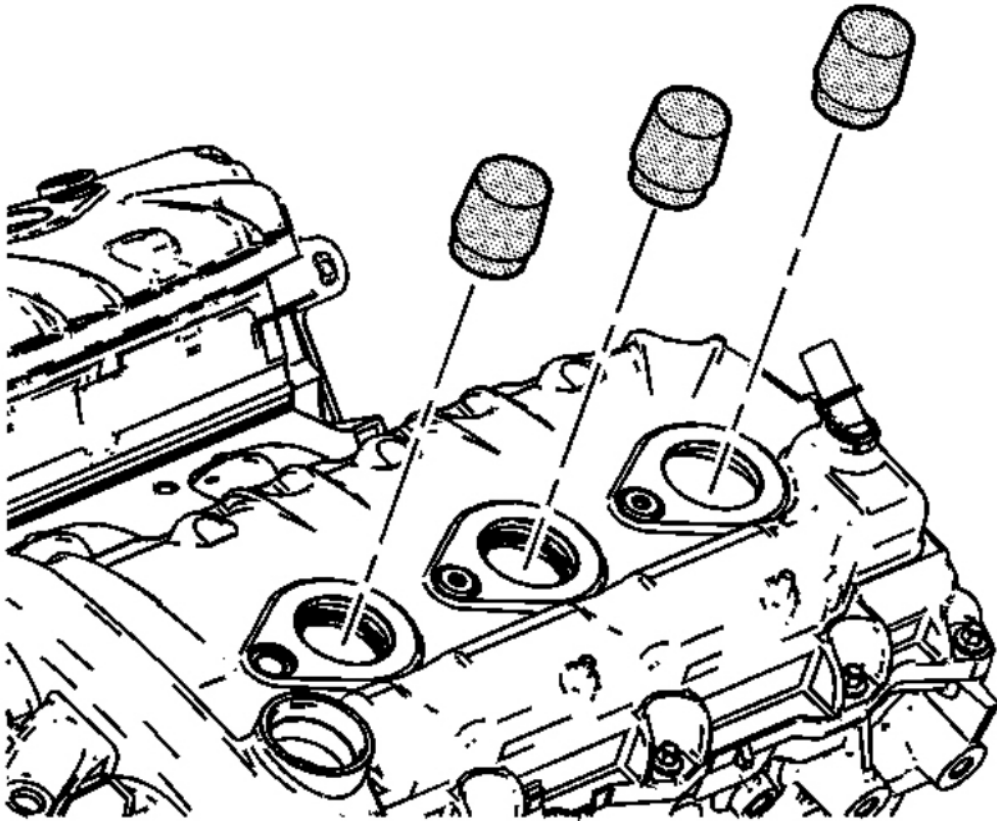


**Fig. 317: Tightening Sequence For Left Camshaft Cover Bolts**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

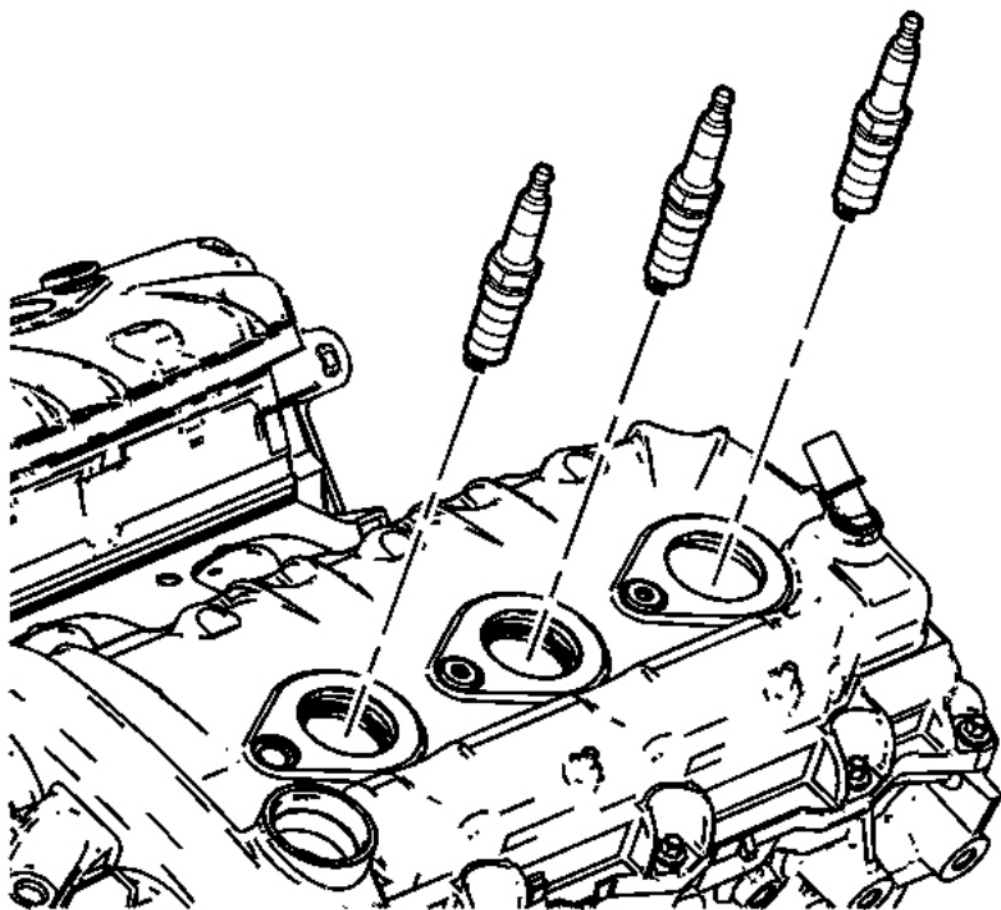
8. Tighten the left camshaft cover bolts in the sequence shown.

**Tighten:** Tighten the left camshaft cover bolts in the sequence to 10 N.m (89 lb in).



**Fig. 318: Removing EN 46101 From Spark Plug Tubes**  
Courtesy of GENERAL MOTORS CORP.

9. Remove the **EN 46101** from the spark plug tubes of the left cylinder head.

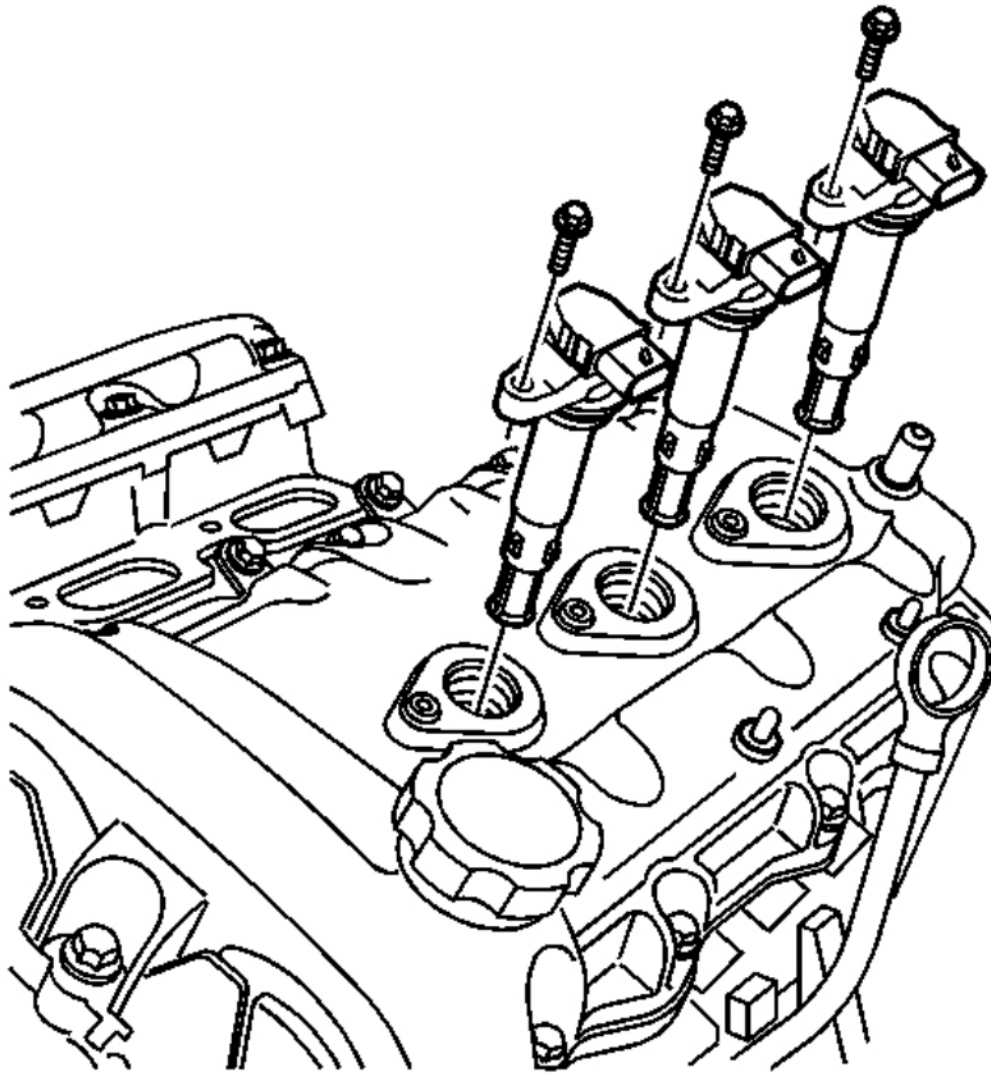


**Fig. 319: View Of Spark Plugs**

Courtesy of GENERAL MOTORS CORP.

10. Install the NEW spark plugs into the left cylinder head.

**Tighten:** Tighten the spark plugs to 20 N.m (15 lb ft).



**Fig. 320: Identifying Left Cylinder Head Ignition Coils**  
Courtesy of GENERAL MOTORS CORP.

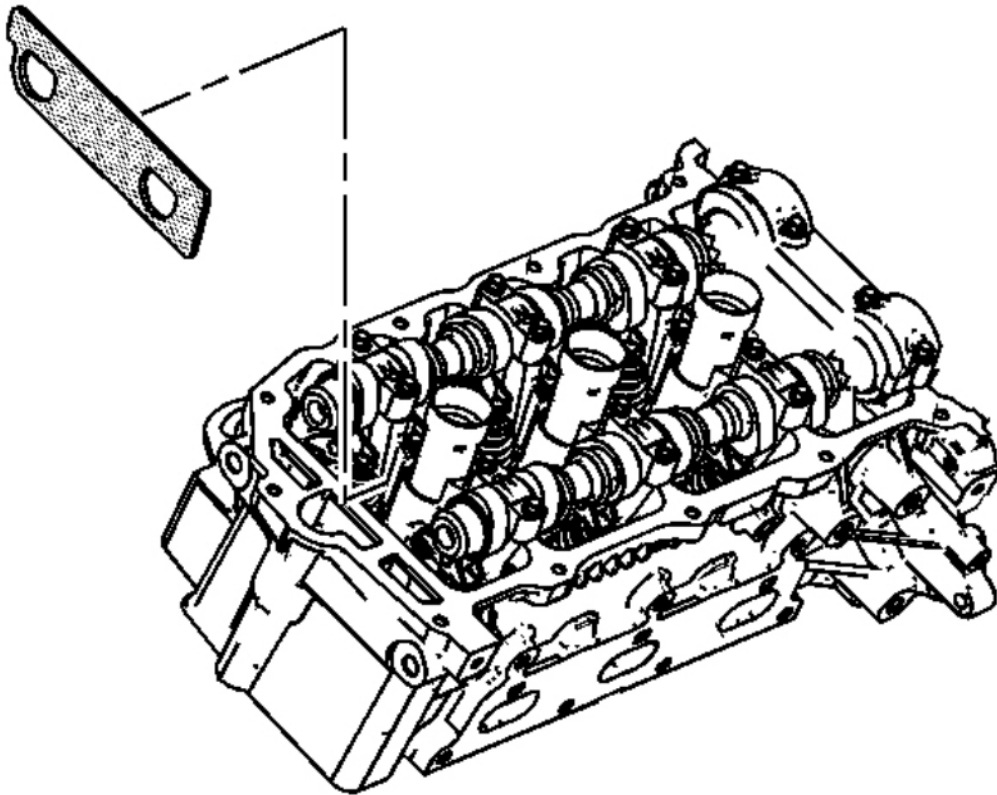
11. Install each ignition coil through the left camshaft cover into the spark plug tube taking care not to damage the spark plug and/or the seal in the left camshaft cover.
12. Install each ignition coil bolt.

**Tighten:** Tighten the ignition coil bolt to 10 N.m (89 lb in).

## CAMSHAFT COVER INSTALLATION - RIGHT

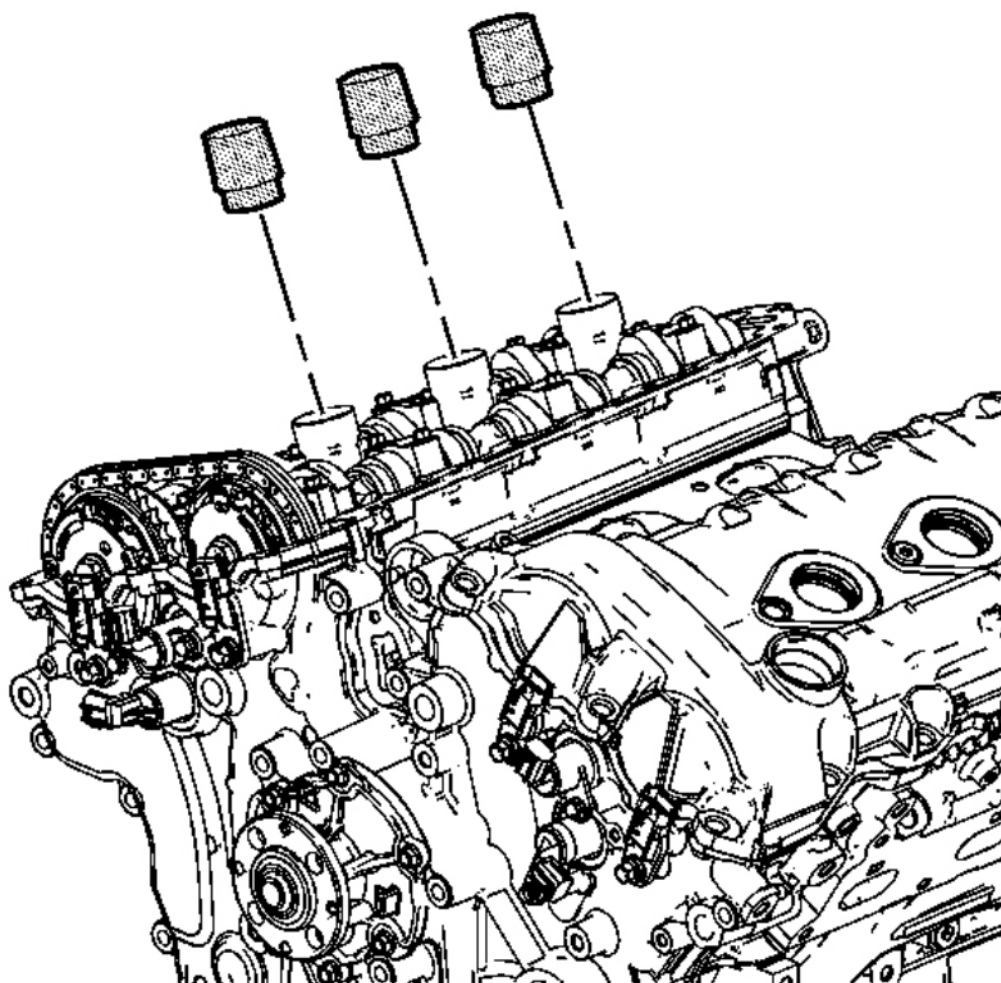
### Tools Required

- EN 46101 Spark Plug Tube Seal Guide
- EN 46105 Camshaft Locking Tool



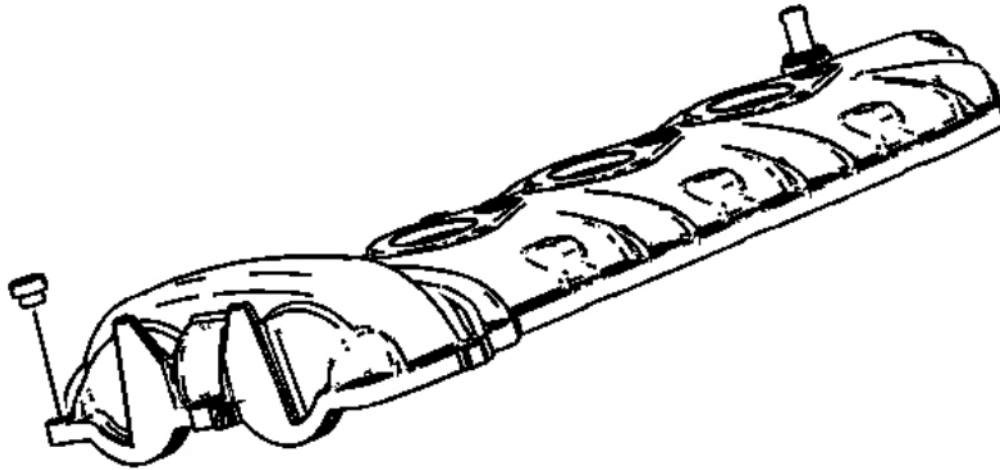
**Fig. 321: Identifying EN 46105-1**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the EN 46105-1 from the rear of the right camshafts.



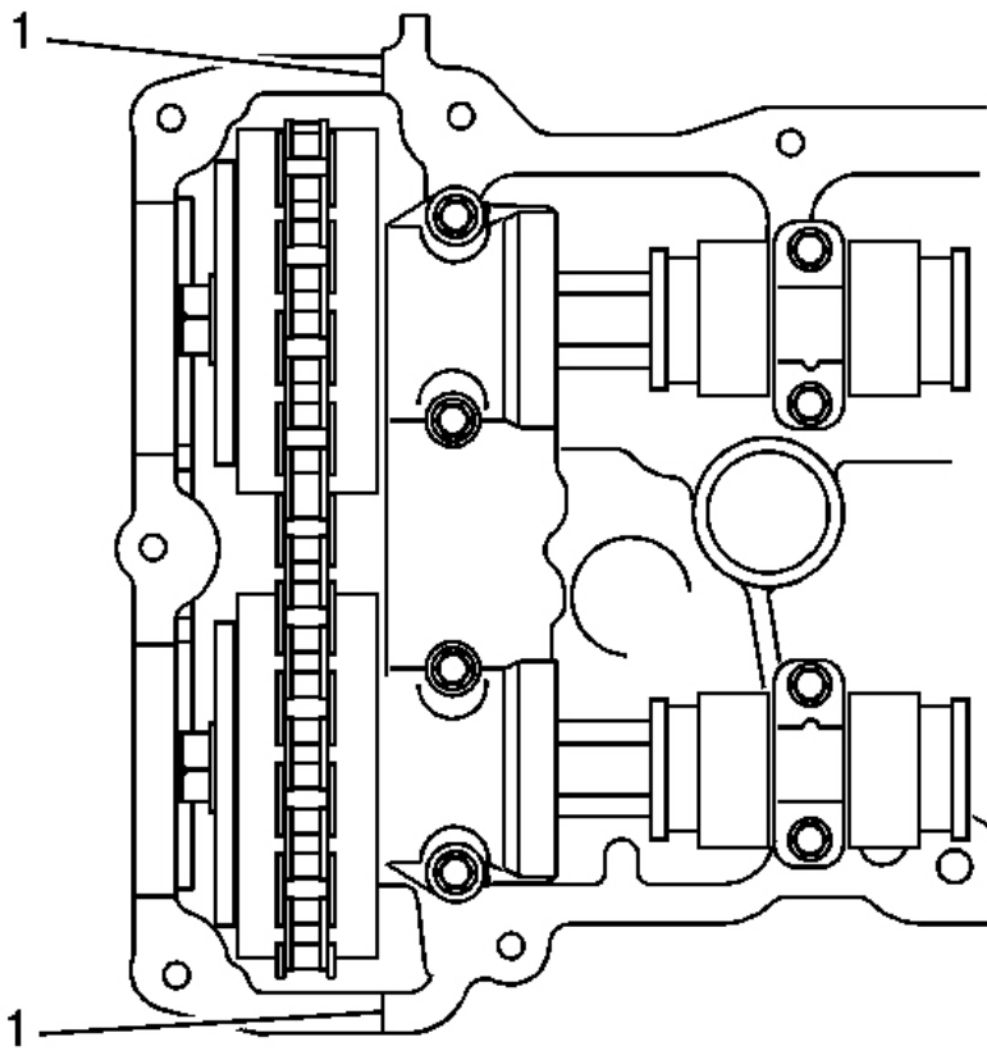
**Fig. 322: Installing EN 46101 Into Spark Plug Tubes**  
Courtesy of GENERAL MOTORS CORP.

2. Install the **EN 46101** onto the spark plug tubes of the right cylinder head.



**Fig. 323: Locating Camshaft Cover Bolt Grommets**  
Courtesy of GENERAL MOTORS CORP.

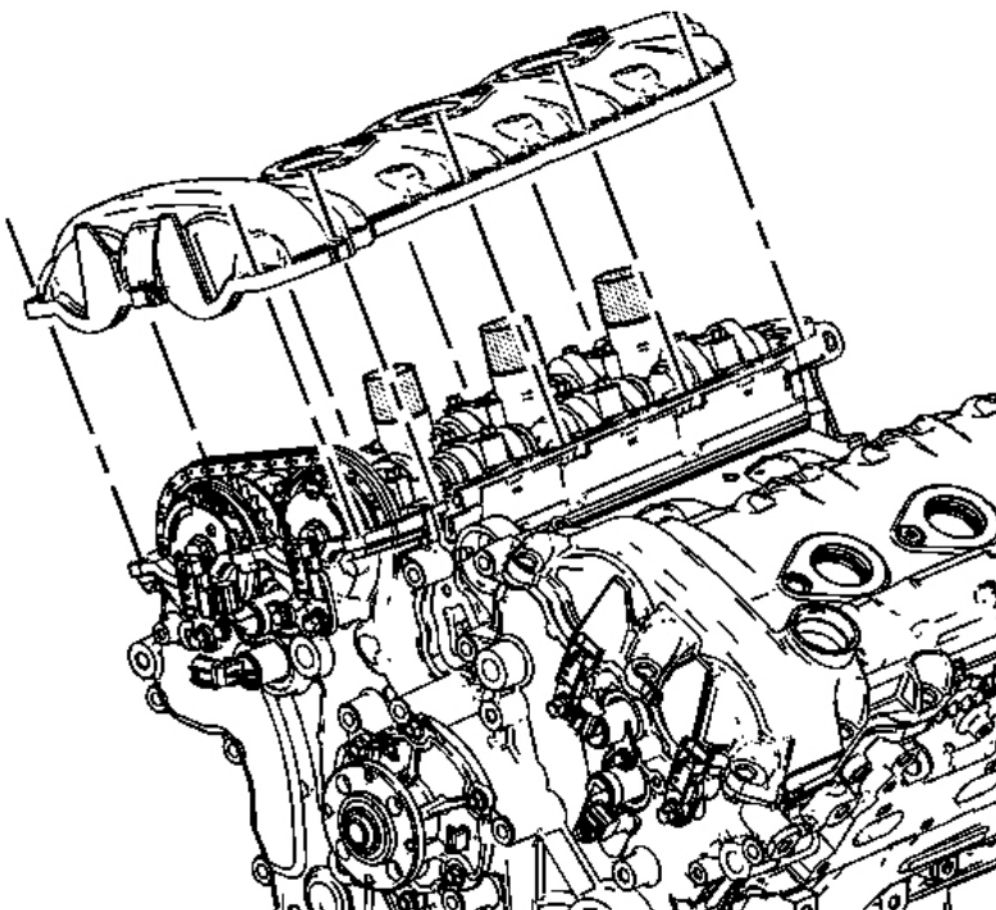
3. Install the camshaft cover bolt grommets prior to installing the camshaft cover bolts.
4. Wipe the camshaft cover sealing surface on the right cylinder head with a clean, lint-free cloth.



**Fig. 324: Identifying Engine Front Cover Split Lines**  
Courtesy of GENERAL MOTORS CORP.

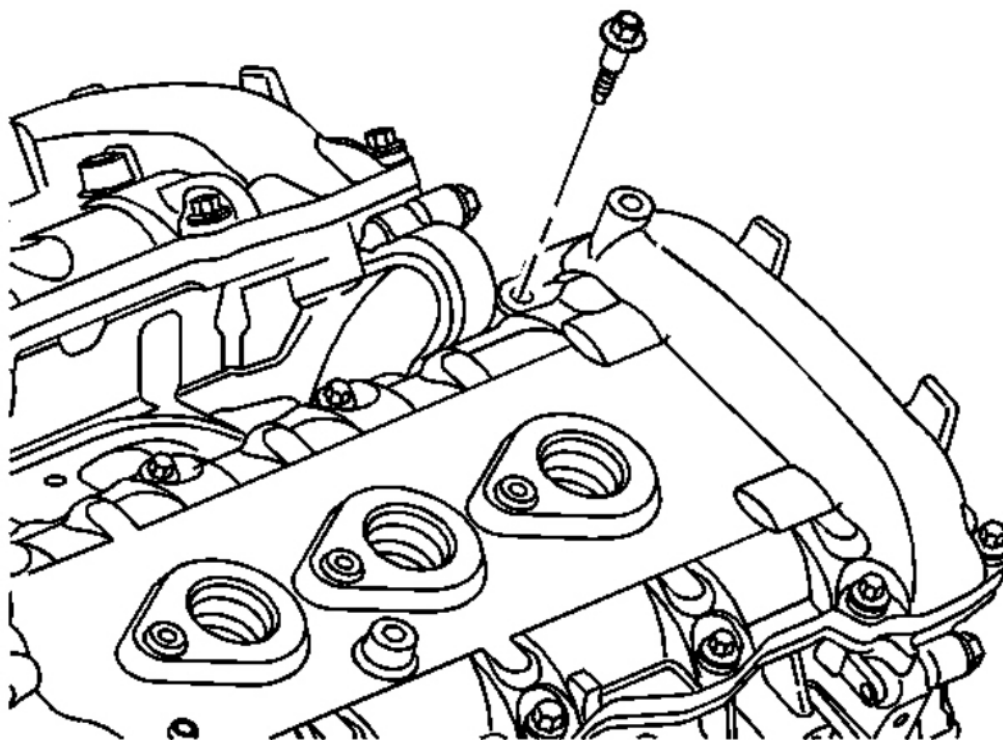
5. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the engine front cover split lines (1).





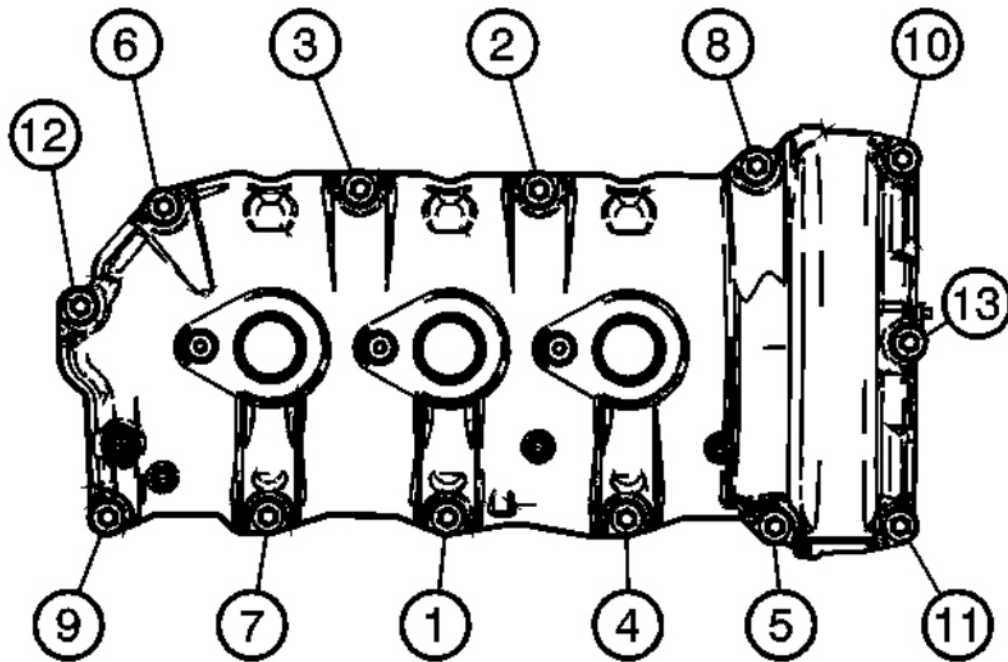
**Fig. 325: View Of Right Camshaft Cover**  
Courtesy of GENERAL MOTORS CORP.

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



**Fig. 326: Locating Right Camshaft Cover Bolts**  
Courtesy of GENERAL MOTORS CORP.

7. Loosely install the right camshaft cover bolts.

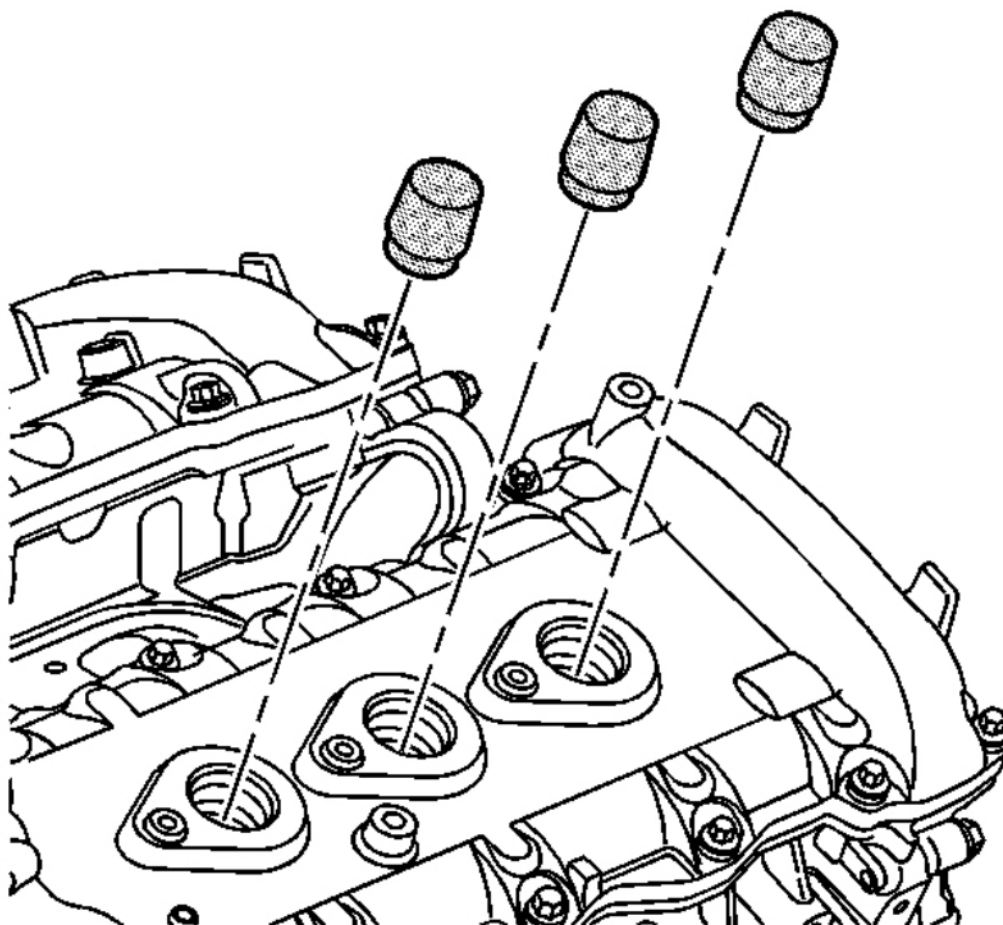


**Fig. 327: Tightening Sequence for Right Camshaft Cover Bolts**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

8. Tighten the right camshaft cover bolts in the sequence shown.

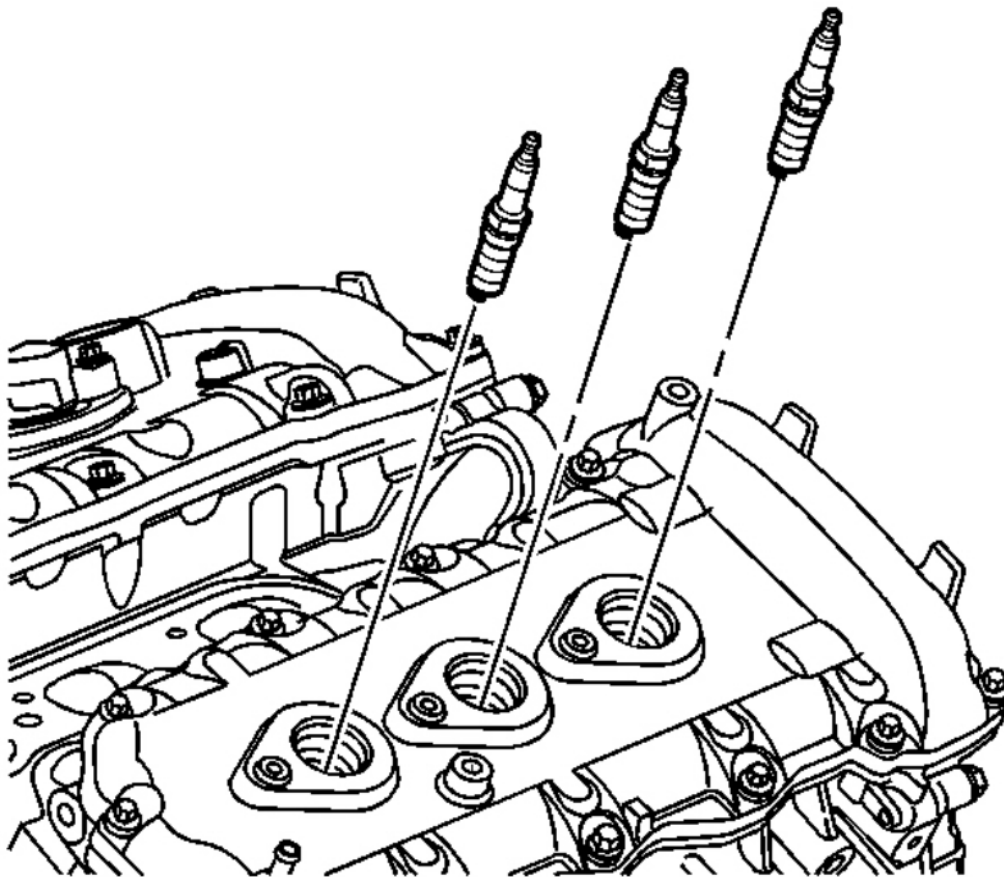
**Tighten:** Tighten the right camshaft cover bolts in the sequence to 10 N.m (89 lb in).



**Fig. 328: View Of EN 46101**

Courtesy of GENERAL MOTORS CORP.

9. Remove the **EN 46101** from the spark plug tubes of the right cylinder head.

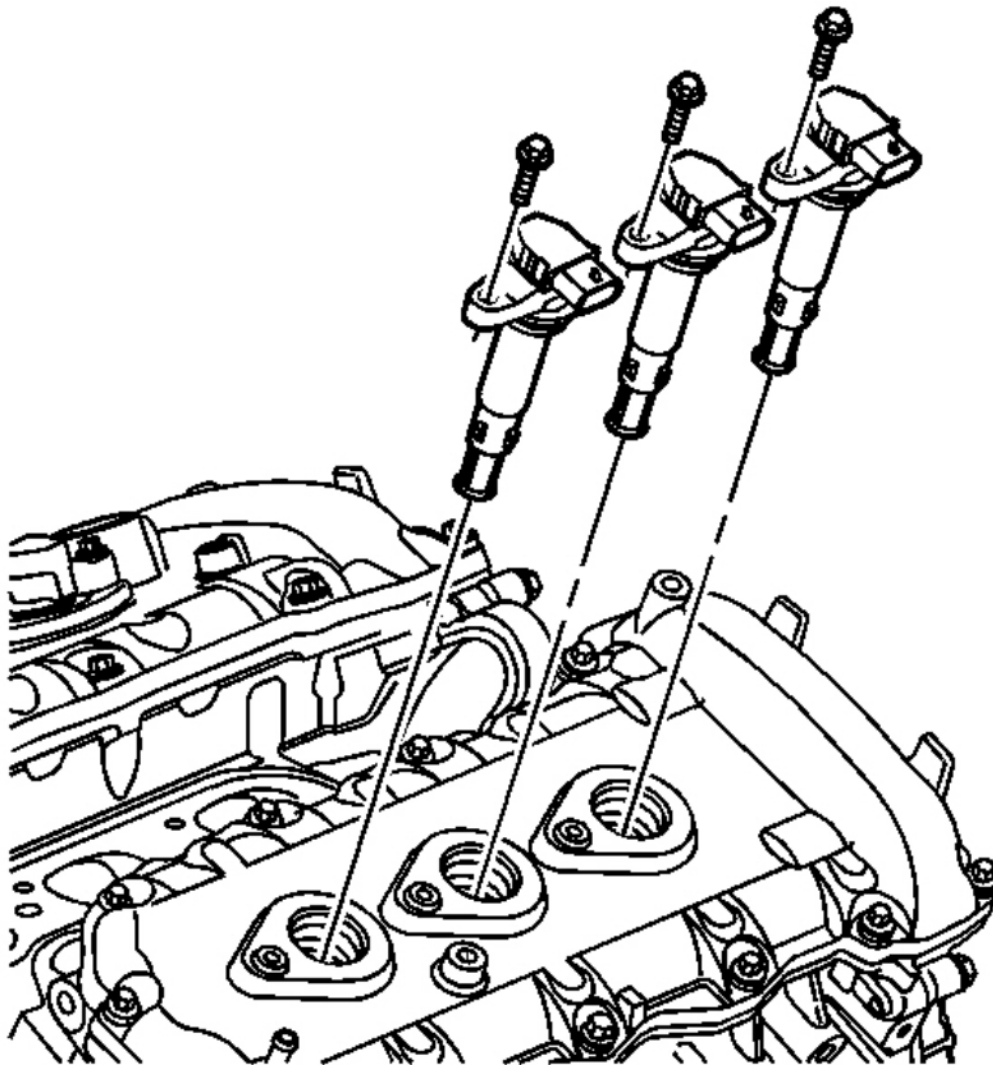


**Fig. 329: View Of Spark Plugs**

Courtesy of GENERAL MOTORS CORP.

10. Install the NEW spark plugs into the right cylinder head.

**Tighten:** Tighten the spark plugs to 20 N.m (15 lb ft).



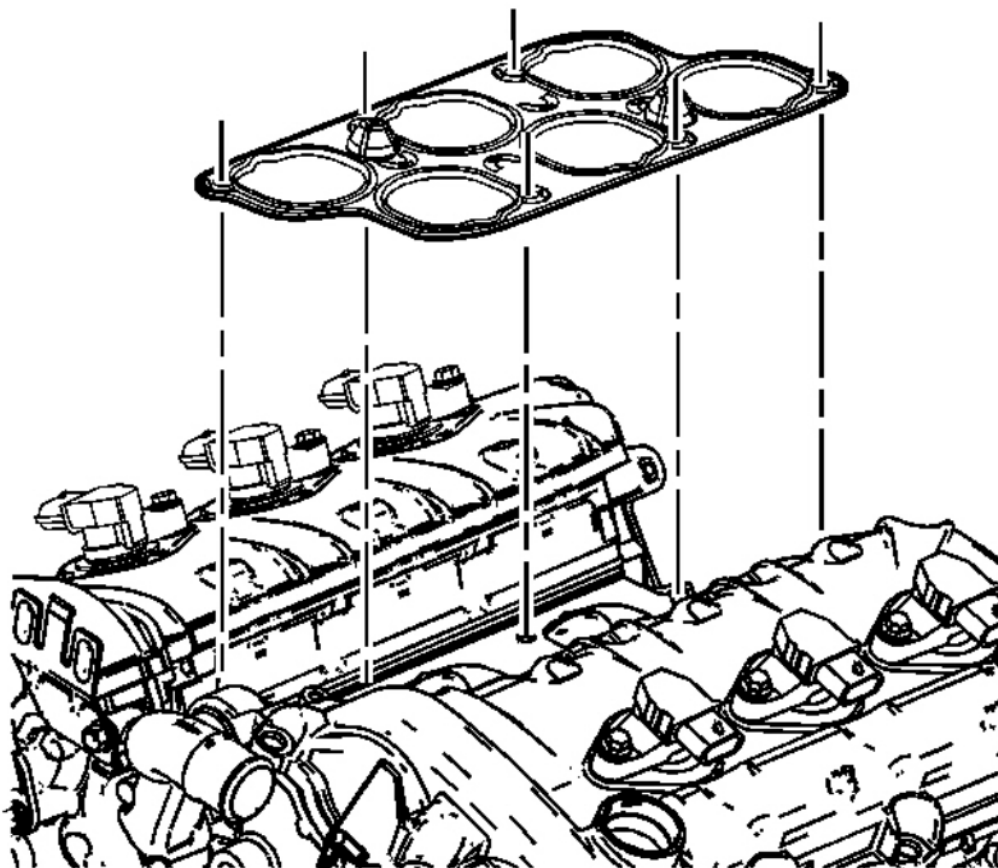
**Fig. 330: Ignition Coil View**

Courtesy of GENERAL MOTORS CORP.

11. Install each ignition coil through the right camshaft cover into the spark plug tube taking care not to damage the spark plug and/or the seal in the right camshaft cover.
12. Install each ignition coil bolt.

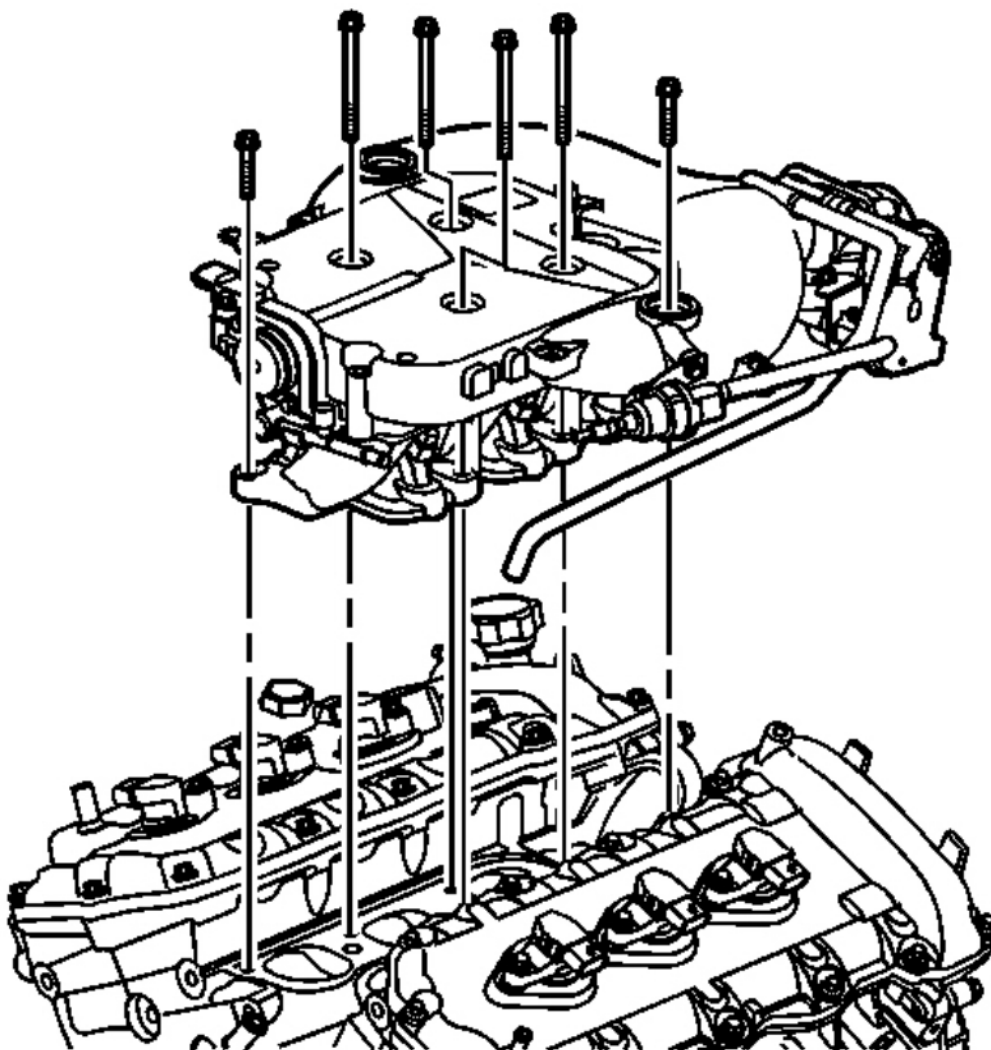
**Tighten:** Tighten the ignition coil bolt to 10 N.m (89 lb in).

## INTAKE MANIFOLD INSTALLATION



**Fig. 331: View Of Lower Intake Manifold Gasket**  
Courtesy of GENERAL MOTORS CORP.

1. Install the NEW intake manifold gasket.



**Fig. 332: View Of Intake Manifold Assembly**  
Courtesy of GENERAL MOTORS CORP.

2. Install the intake manifold assembly.

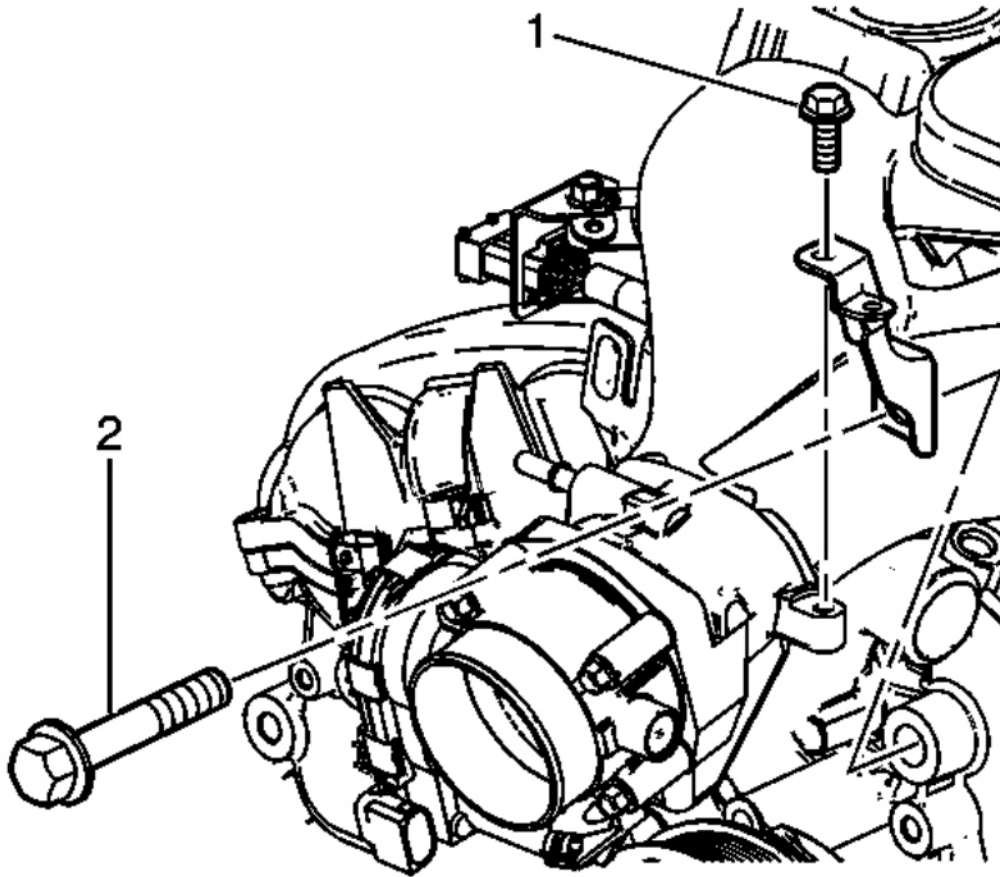
**NOTE:** Refer to Fastener Notice in Cautions and Notices.

**IMPORTANT:** Tighten the intake manifold bolts in a circular pattern starting from the center and moving outward.



3. Install the intake manifold bolts.

**Tighten:** Tighten the intake manifold bolts to 23 N.m (17 lb ft).



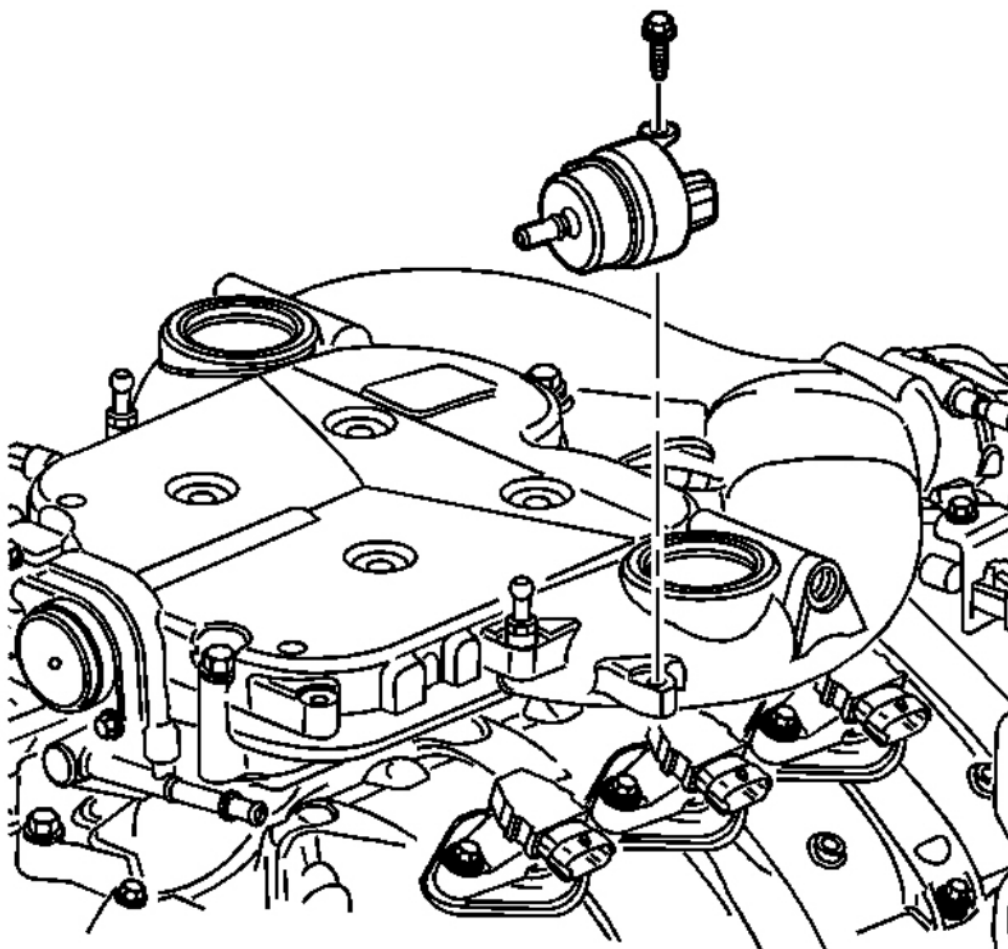
**Fig. 333: View Of Intake Manifold Brace & Bolts**  
Courtesy of GENERAL MOTORS CORP.

4. Place the intake manifold brace to the engine front cover and intake manifold.
5. Loosely install the bolts.
6. First tighten the intake manifold brace bolt (1) to the intake manifold.

**Tighten:** Tighten the intake manifold brace bolt at the intake manifold to 10 N.m (89 lb in).

7. Finally tighten the intake manifold brace bolt (2) to the engine front cover.

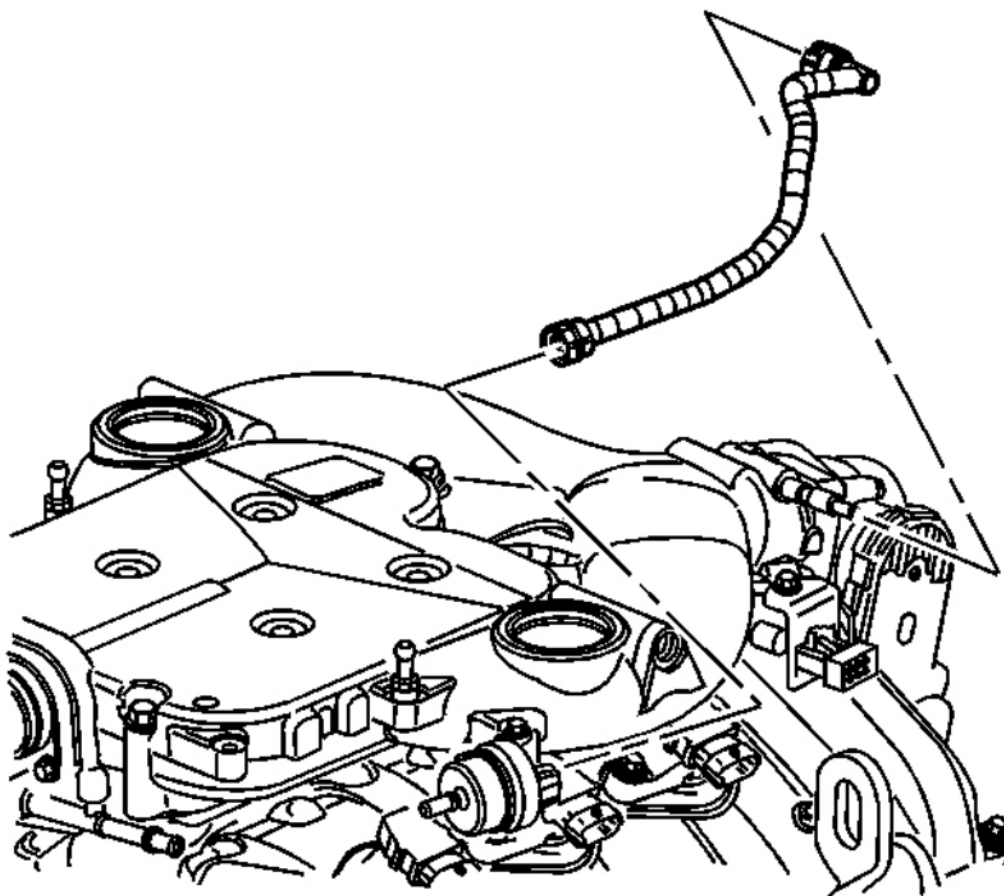
**Tighten:** Tighten the intake manifold brace bolt to the engine front cover to 65 N.m (48 lb ft).



**Fig. 334: View Of EVAP Solenoid**  
Courtesy of GENERAL MOTORS CORP.

8. Install the EVAP solenoid.
9. Install the EVAP solenoid bolt.

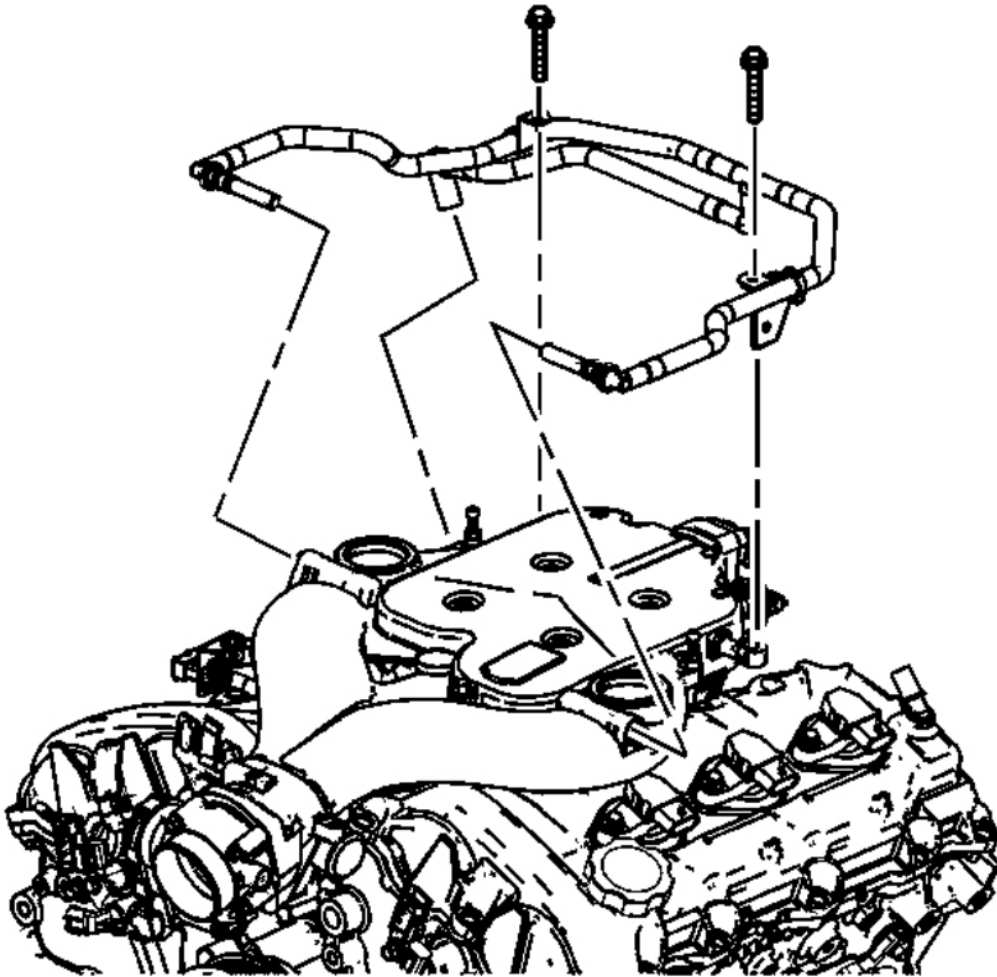
**Tighten:** Tighten the EVAP solenoid bolt to 10 N.m (89 lb in).



**Fig. 335: View Of EVAP Hose**

Courtesy of GENERAL MOTORS CORP.

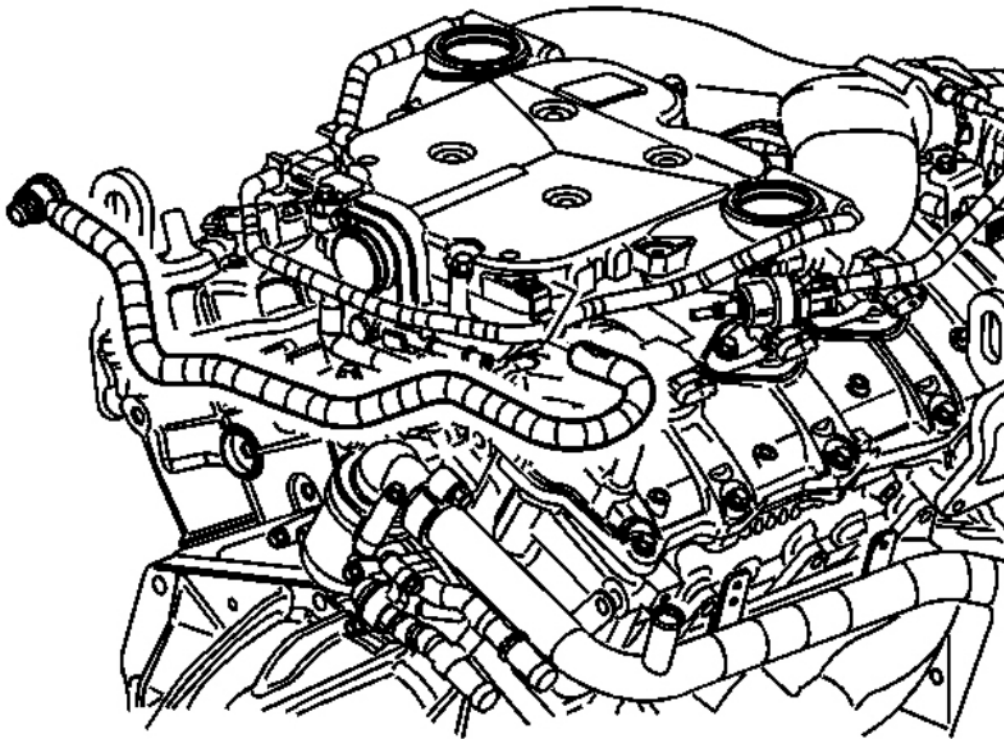
10. Connect the EVAP hose to the upper intake manifold and EVAP solenoid.



**Fig. 336: View Of PCV Dirty Air Tube**  
Courtesy of GENERAL MOTORS CORP.

11. Connect the PCV tube assembly to the upper intake manifold and the right camshaft cover.
12. Install the PCV tube assembly bracket bolts.

**Tighten:** Tighten the PCV tube assembly bracket bolts to 10 N.m (89 lb in).



**Fig. 337: View Of Brake Booster Hose**  
Courtesy of GENERAL MOTORS CORP.

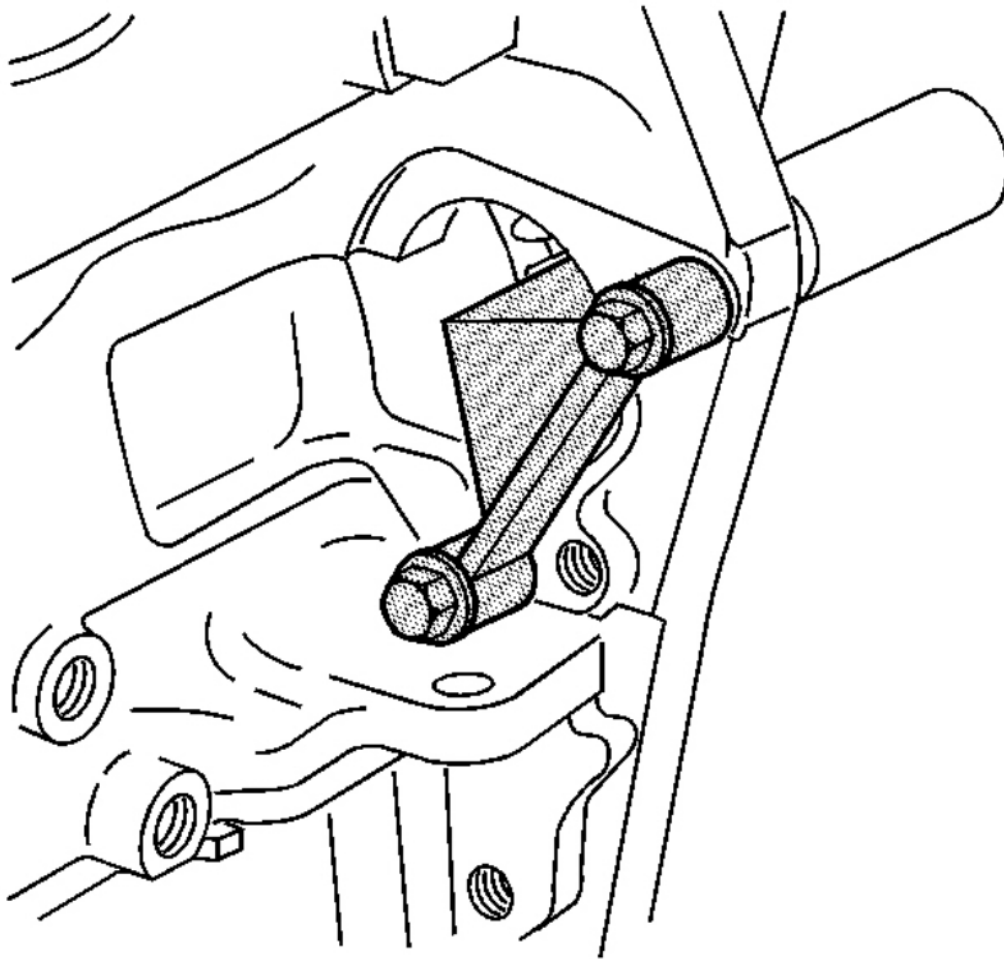
13. Install the brake booster hose to the upper intake manifold.

## ENGINE FLYWHEEL INSTALLATION (AUTOMATIC TRANSMISSION)

### Tools Required

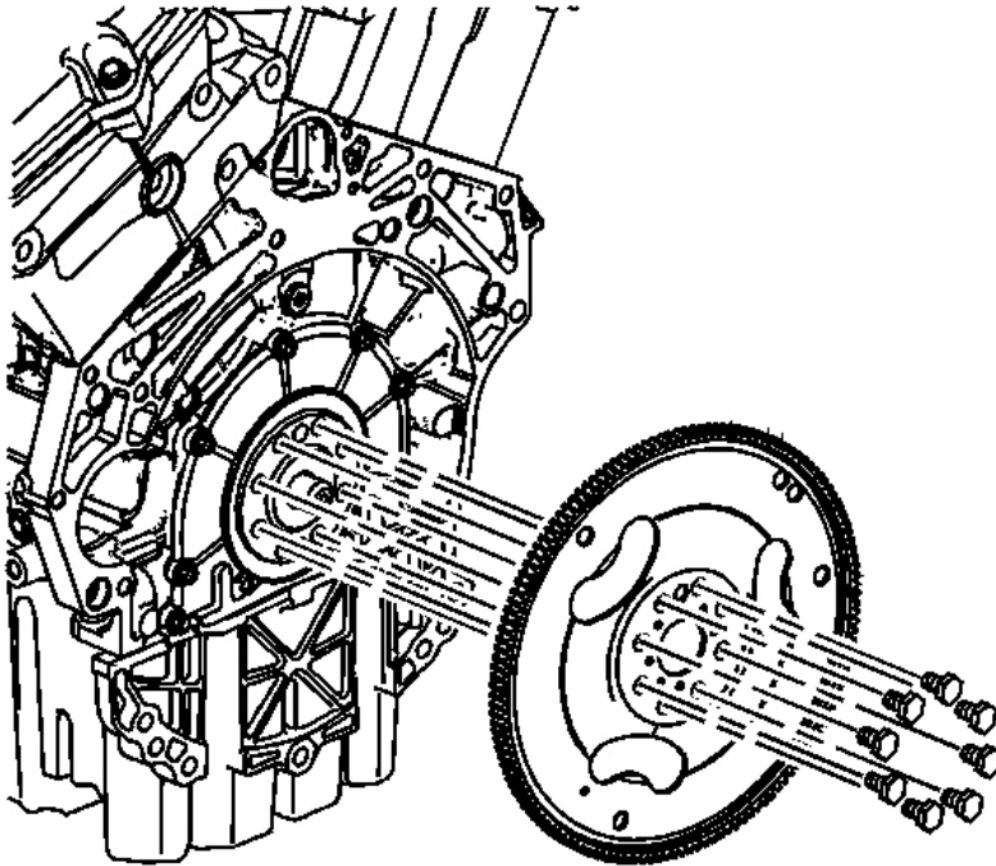
- EN 46106 Engine Flywheel Holding Tool
- J 45059 Angle Meter

1. Place the engine flywheel in position on the crankshaft.
2. Install 2 NEW bolts in location at the top and bottom of the engine flywheel bolt pattern allowing the engine flywheel to hang in position.



**Fig. 338: View Of Tool EN 46106**  
Courtesy of GENERAL MOTORS CORP.

3. Install the EN 46106 .



**Fig. 339: View Of Engine Flywheel**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

4. Install the remaining NEW engine flywheel bolts.

**Tighten:**

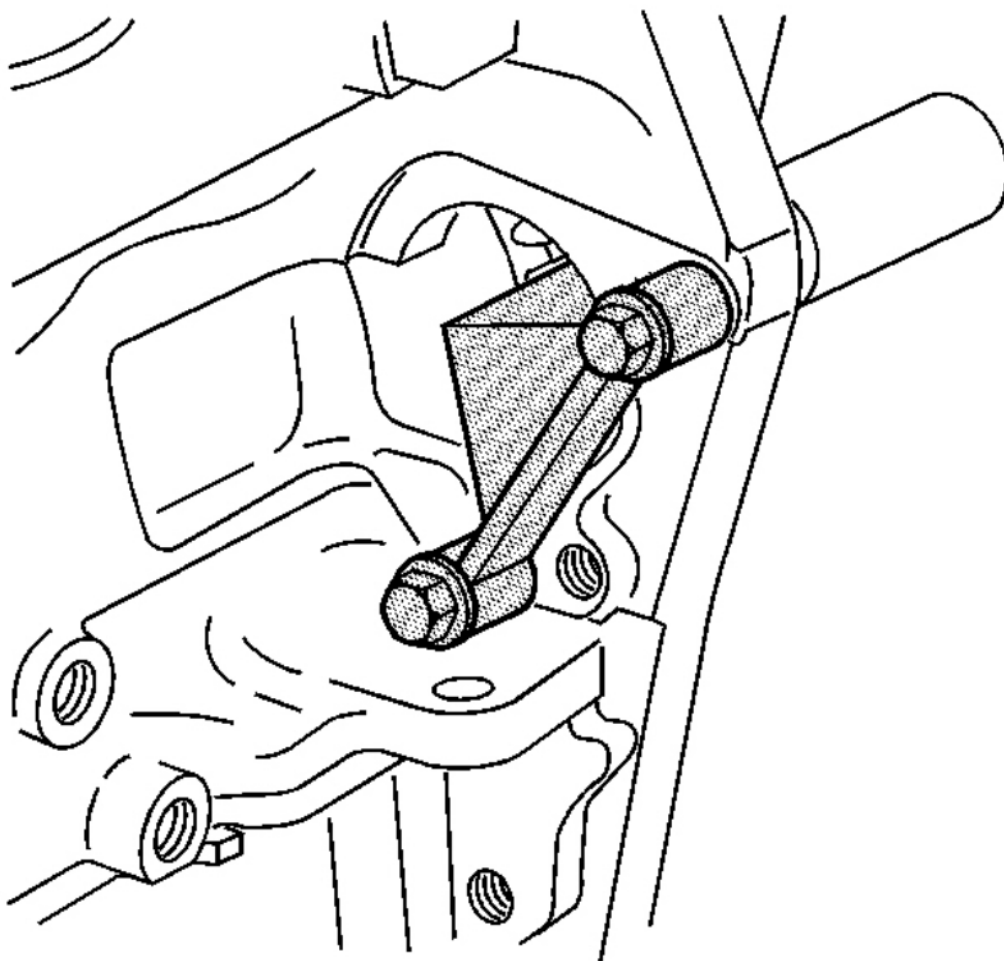
1. Tighten the NEW engine flywheel bolts to 30 N.m (22 lb ft).
2. Tighten the NEW engine flywheel bolts an additional 45 degrees using the **J 45059**.

## ENGINE FLYWHEEL INSTALLATION (MANUAL TRANSMISSION )

### Tools Required

- **EN 46106** Engine Flywheel Holding Tool
- **J 33169** Clutch Alignment Tool
- **J 45059** Angle Meter

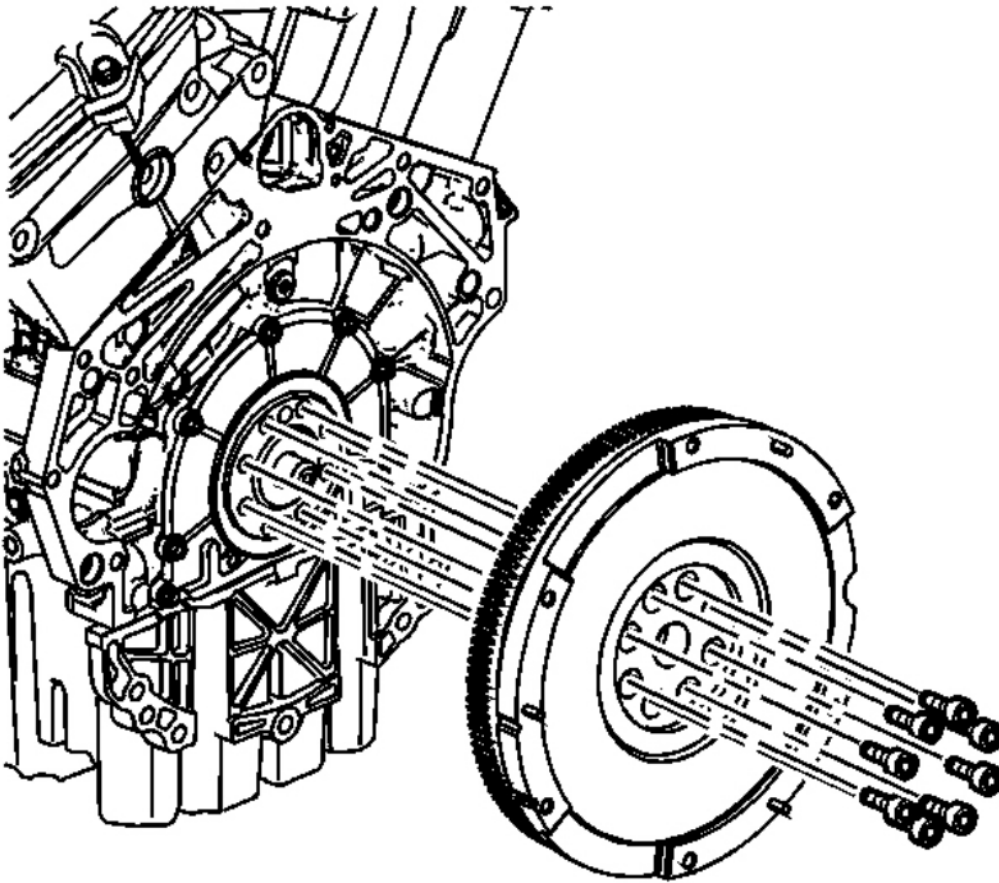
1. Place the engine flywheel in position on the crankshaft.
2. Install 2 NEW bolts in location at the top and bottom of the engine flywheel bolt pattern allowing the engine flywheel to hang in position.



**Fig. 340: View Of Tool EN 46106**  
Courtesy of GENERAL MOTORS CORP.

3. Install the **EN 46106** .





**Fig. 341: Engine Flywheel Bolts**

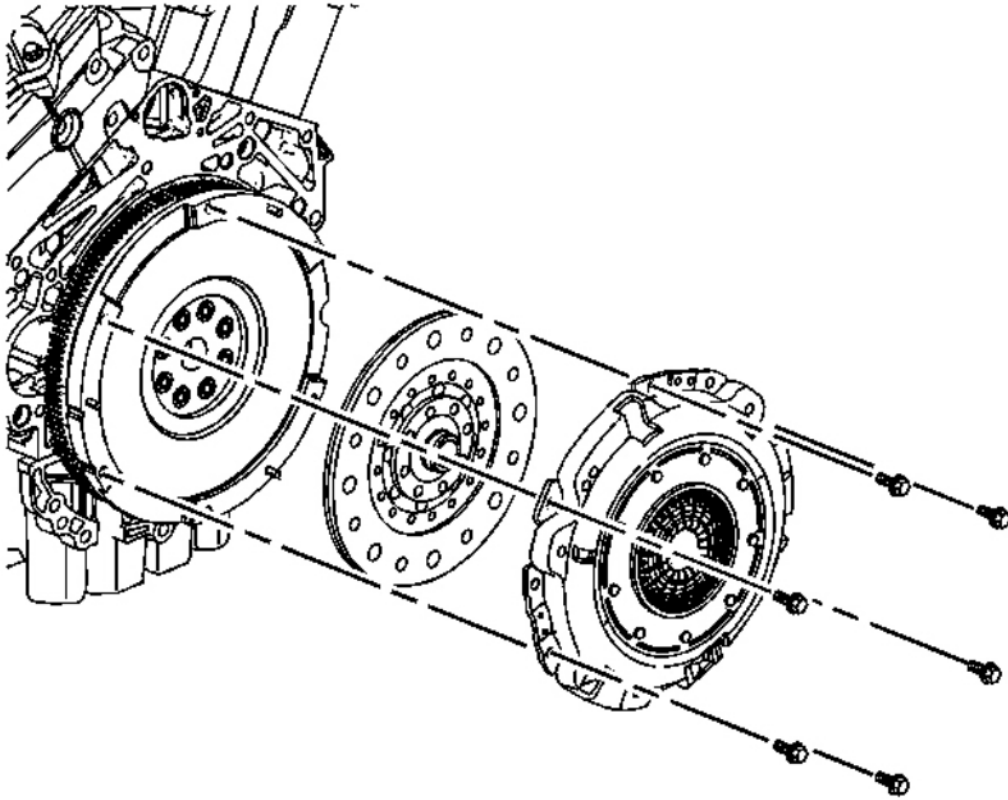
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

4. Install the remaining NEW engine flywheel bolts.

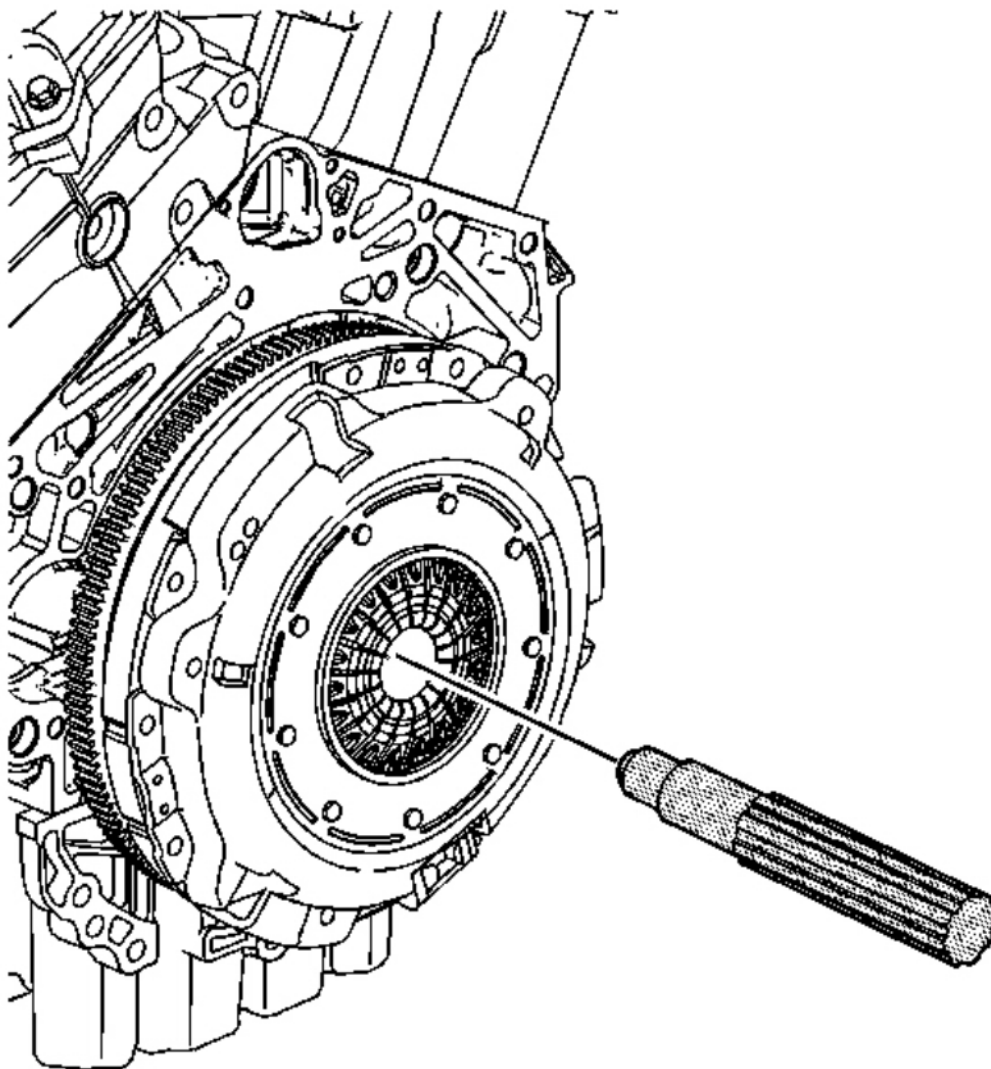
**Tighten:**

1. Tighten the NEW engine flywheel bolts to 30 N.m (22 lb ft).
2. Tighten the NEW engine flywheel bolts an additional 75 degrees using the **J 45059**.



**Fig. 342: View Of Clutch Pressure Plate & Clutch Disc**  
Courtesy of GENERAL MOTORS CORP.

5. Install the clutch driven plate disc and the clutch pressure plate to the engine flywheel. Ensure to align the clutch pressure plate to the pins in the engine flywheel.
6. Loosely install the clutch pressure plate bolts.



**Fig. 343: View Of Clutch Pressure Plate & Clutch Disc**  
Courtesy of GENERAL MOTORS CORP.

7. Install the **J 33169** through the clutch driven plate disc and into the end of the crankshaft in order to align the clutch driven plate disc.
8. Tighten the clutch pressure plate bolts.

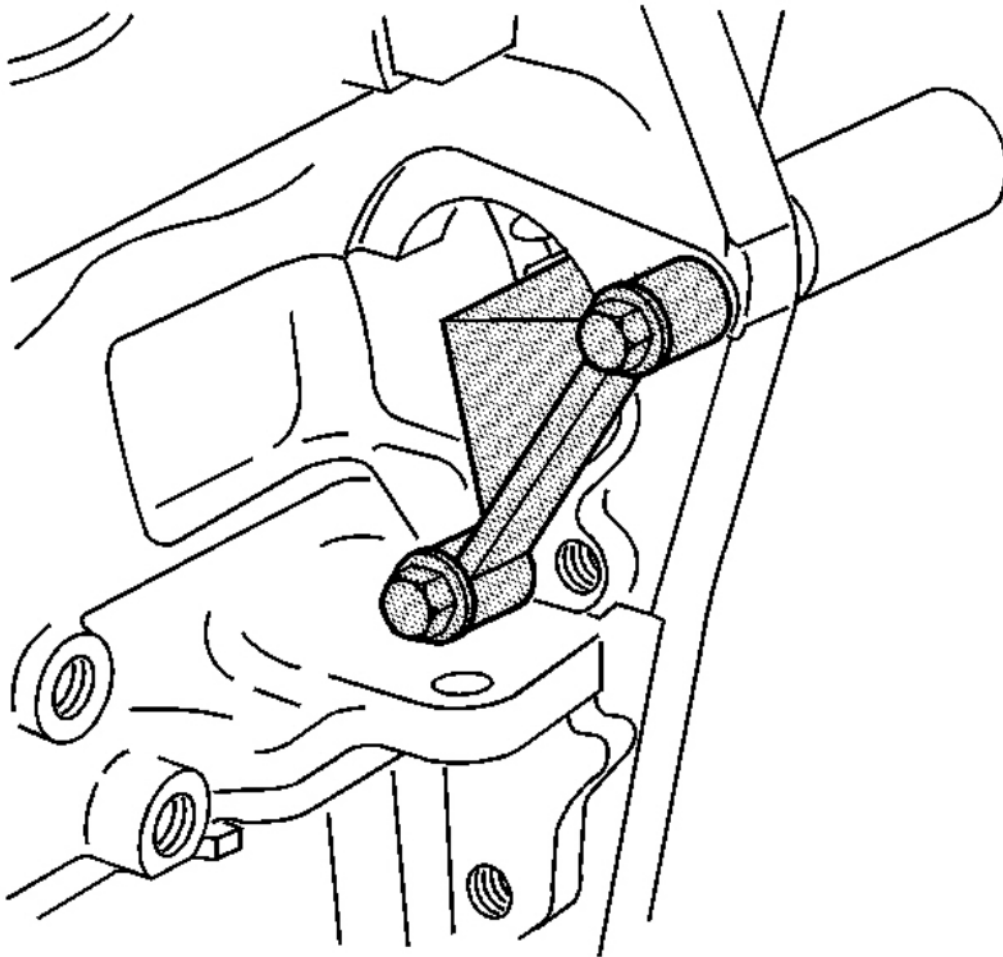
**Tighten:** Tighten the clutch pressure plate bolts to 23 N.m (17 lb ft).

9. Remove the **J 33169** .

## CRANKSHAFT BALANCER INSTALLATION

### Tools Required

- **EN 46106** Engine Flywheel Holding Tool
- **J 41998-B** Crankshaft Balancer Installer
- **J 45059** Angle Meter



**Fig. 344: View Of Tool EN 46106**  
Courtesy of GENERAL MOTORS CORP.

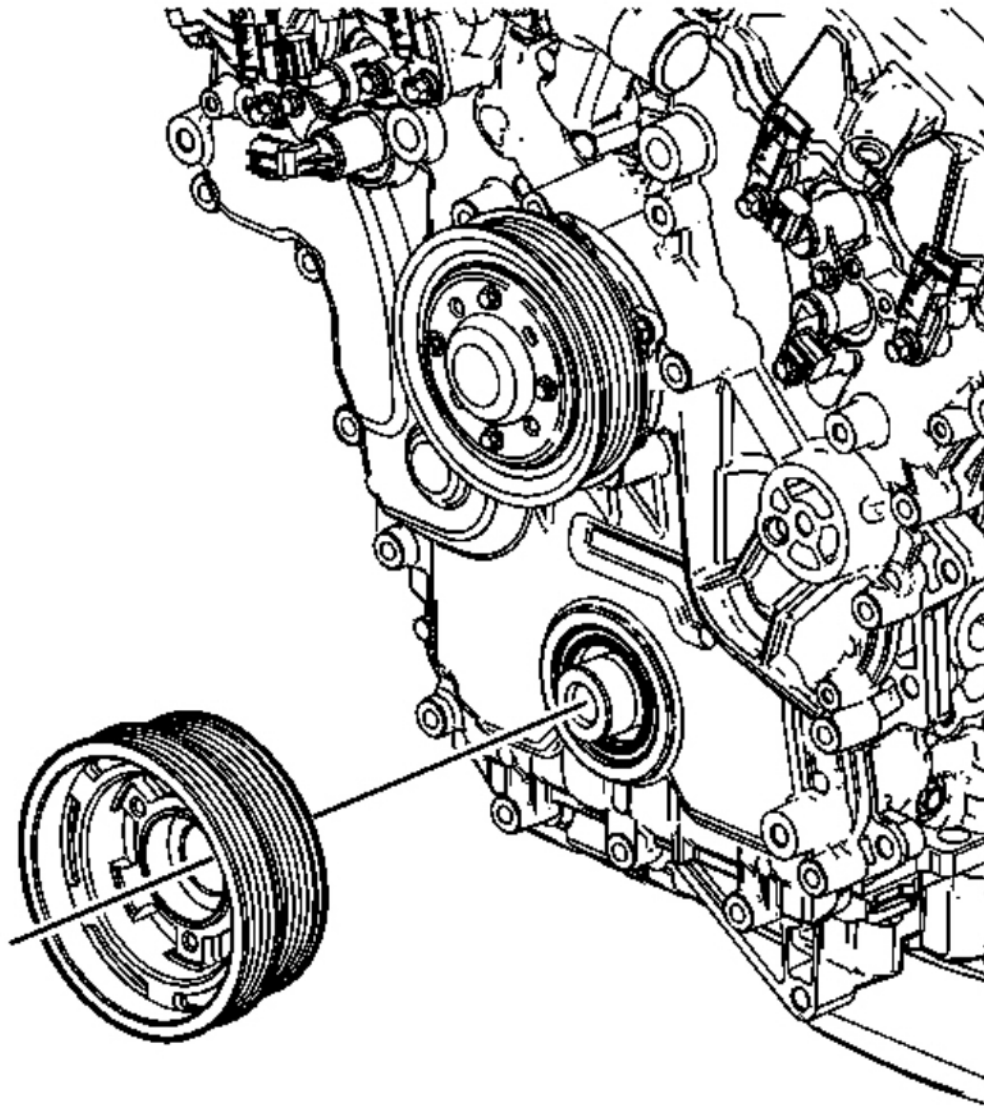
1. The **EN 46106** must be installed onto the flywheel.
2. Use the **J 41998-B** , nut, bearing and washer to install the crankshaft balancer.



**Fig. 345: Lubricating Inside Of Crankshaft Balancer Hub Bore**  
Courtesy of GENERAL MOTORS CORP.

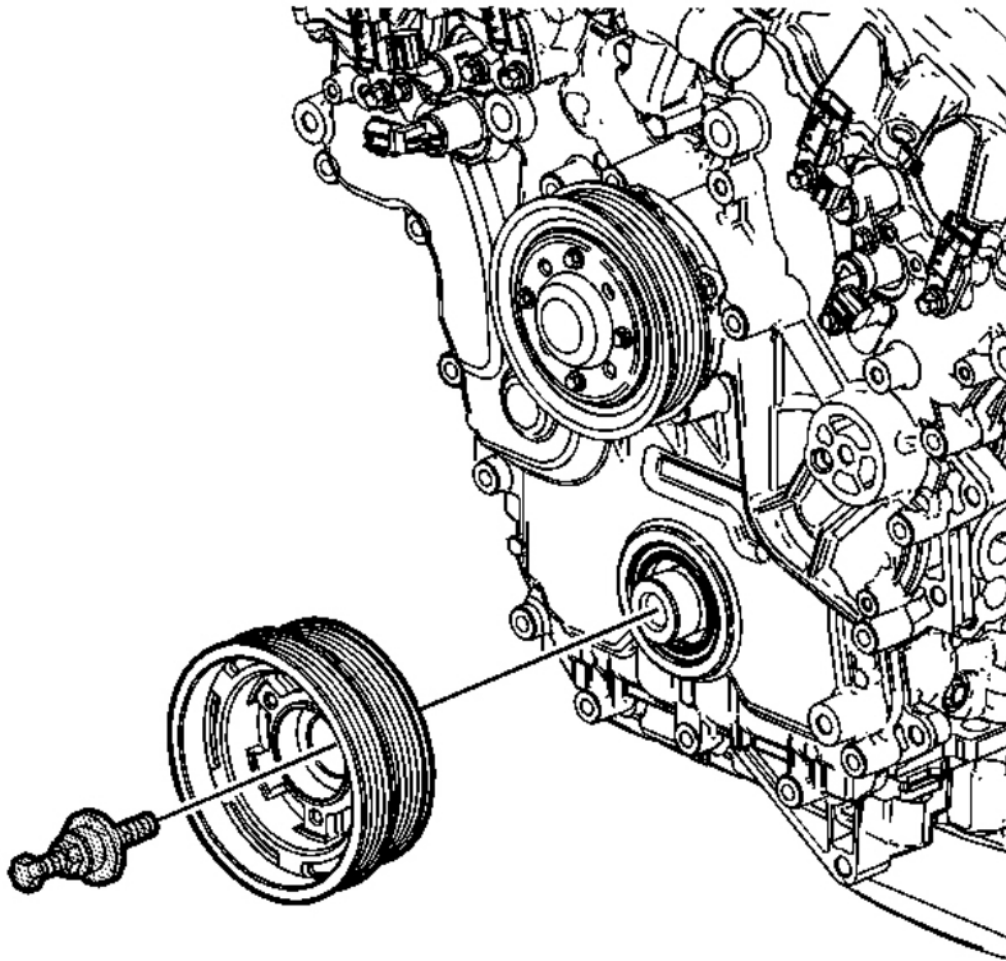
**IMPORTANT:** Do not lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

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



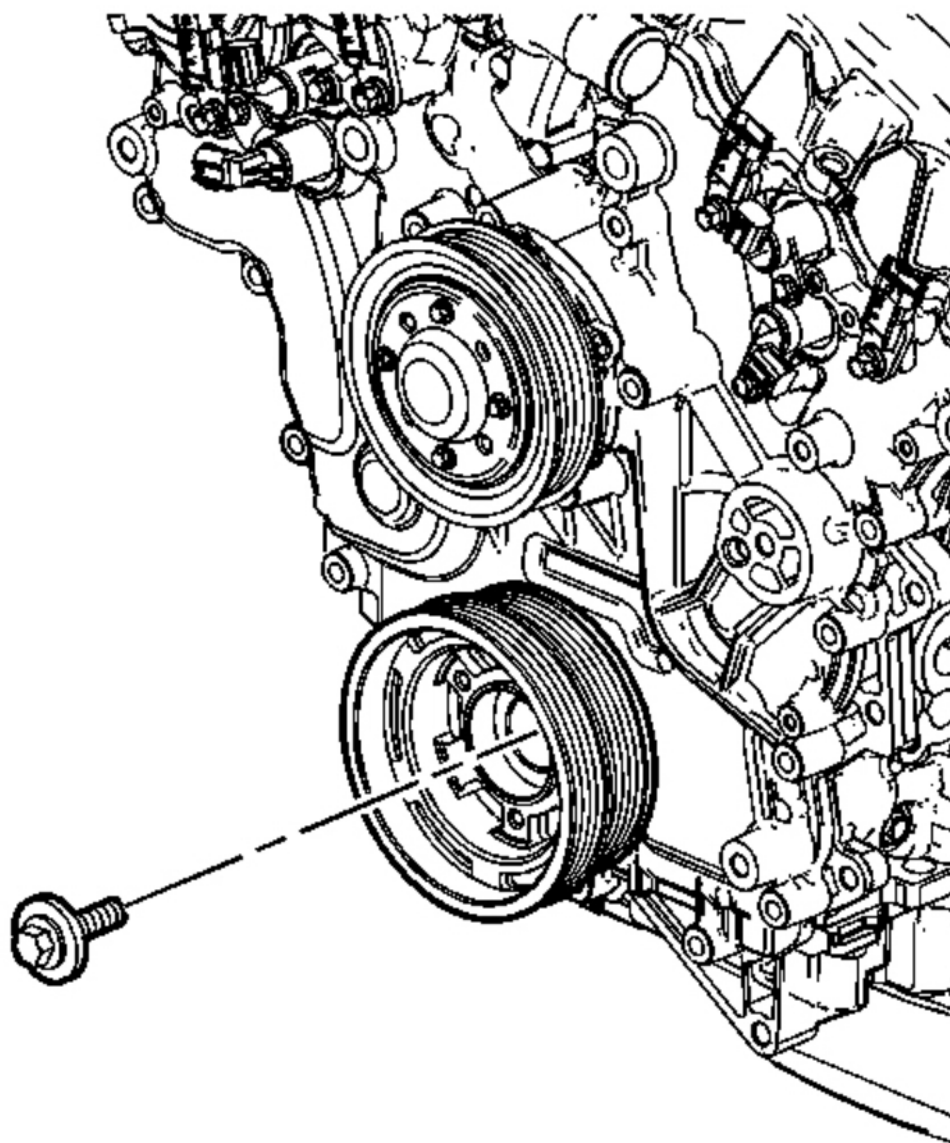
**Fig. 346: View Of Crankshaft Balancer**  
Courtesy of GENERAL MOTORS CORP.

4. Place the crankshaft balancer in position on the crankshaft.



**Fig. 347: Installing Crankshaft Balancer**  
Courtesy of GENERAL MOTORS CORP.

5. Thread the **J 41998-B** in the crankshaft. Ensure you engage at least 10 threads of the **J 41998-B** before pressing the crankshaft balancer in place.
6. Push the crankshaft balancer into position by tightening the nut on the **J 41998-B** until the large washer bottoms out on the crankshaft end.
7. Remove the **J 41998-B**.



**Fig. 348: View Of Crankshaft Balancer & Bolt**  
Courtesy of GENERAL MOTORS CORP.

8. Install the crankshaft balancer bolt.

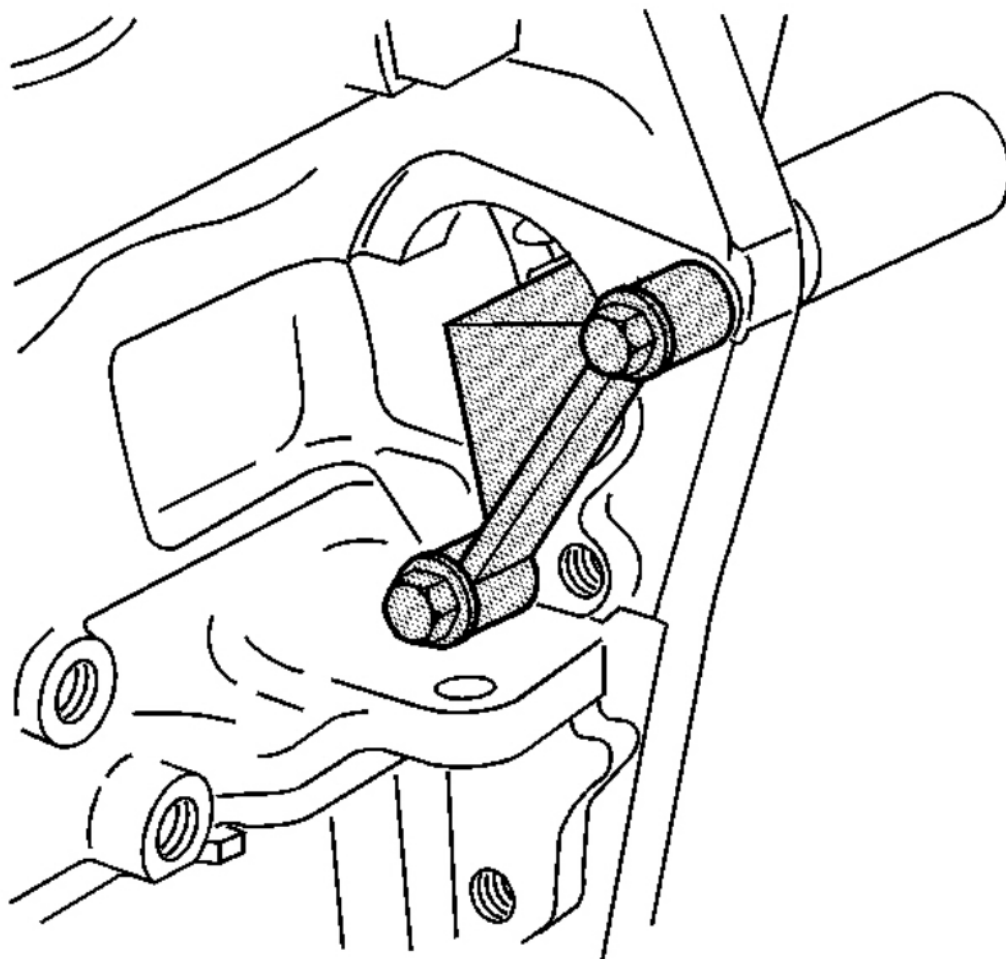
**NOTE:** Refer to Fastener Notice in Cautions and Notices.



9. Tighten the crankshaft balancer bolt.

**Tighten:**

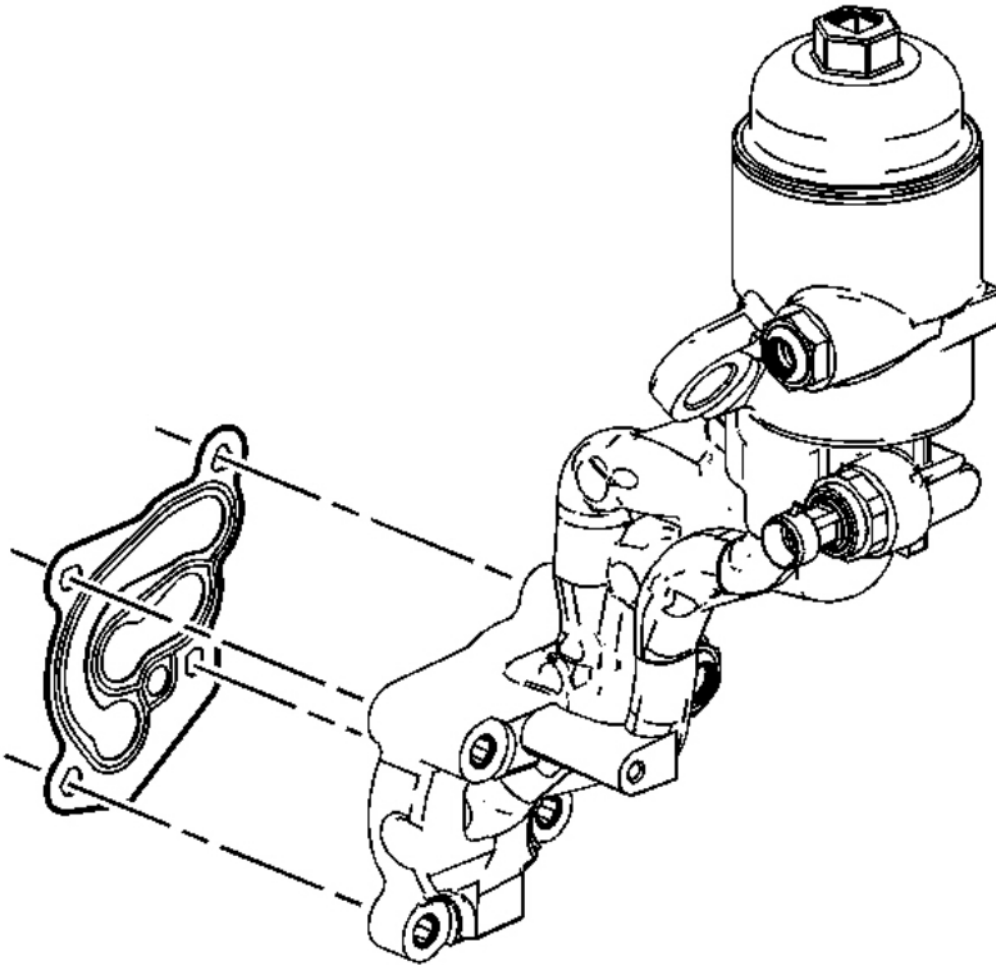
1. Tighten the crankshaft balancer bolt to 100 N.m (74 lb ft).
2. Tighten the crankshaft balancer bolt an additional 150 degrees using the **J 45059** .



**Fig. 349: View Of Tool EN 46106**  
Courtesy of GENERAL MOTORS CORP.

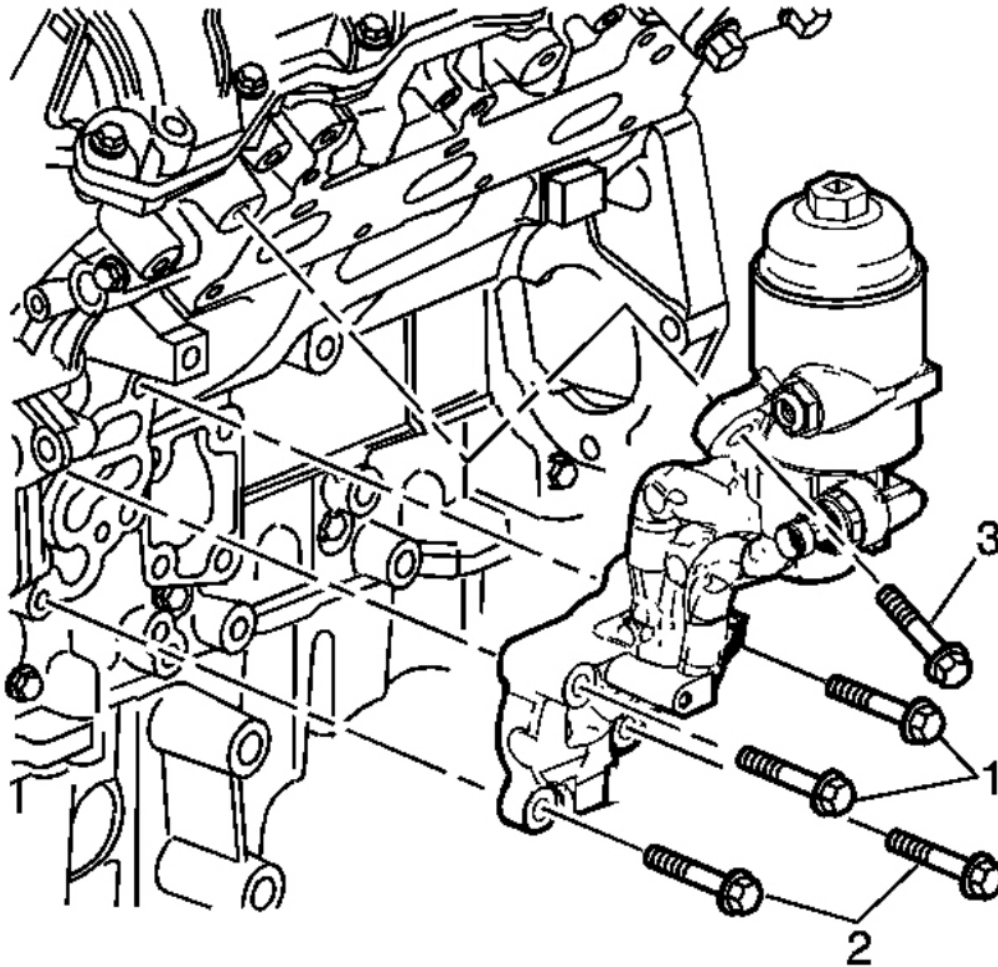
10. Remove the **EN 46106** .

**OIL FILTER ADAPTER INSTALLATION**



**Fig. 350: View Of Oil Filter Adapter & Gasket**  
Courtesy of GENERAL MOTORS CORP.

1. Position a NEW oil filter adapter gasket onto the oil filter adapter.



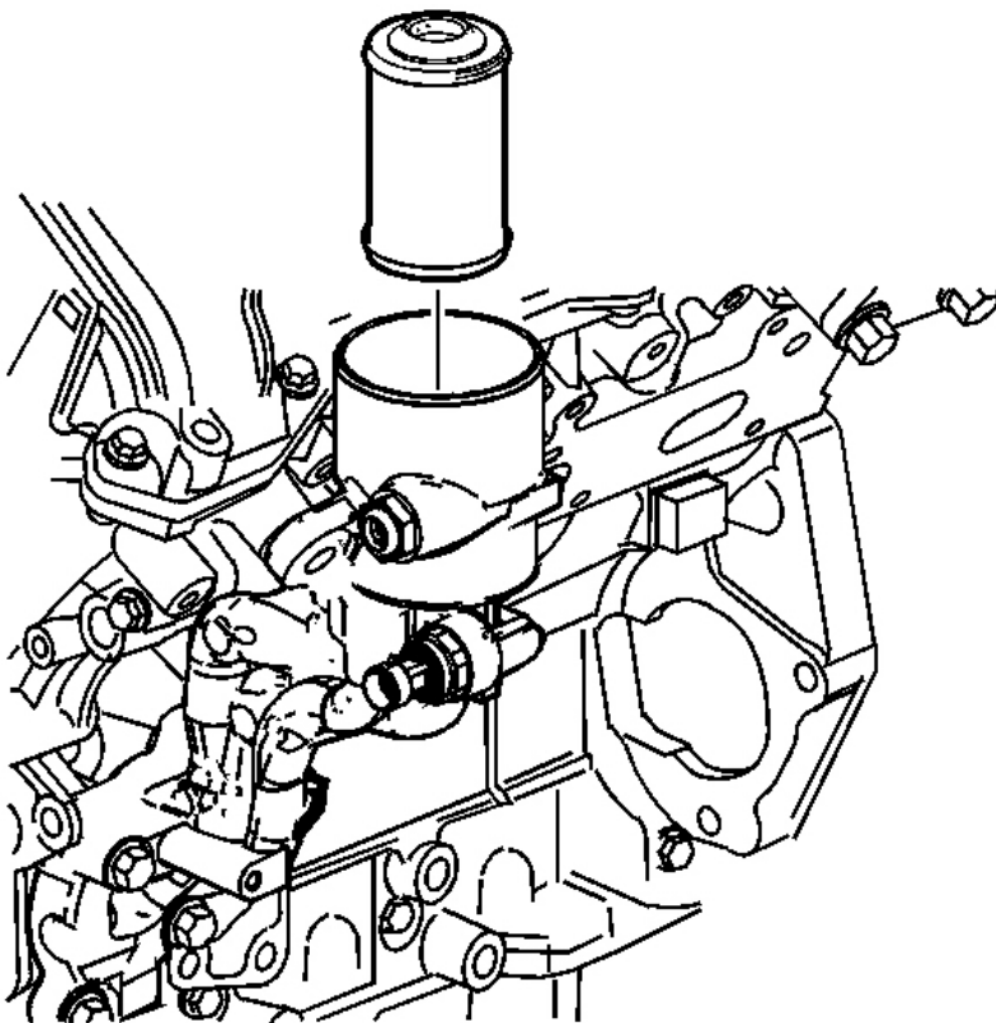
**Fig. 351: View Of Oil Filter Adapter & Bolts**  
Courtesy of GENERAL MOTORS CORP.

2. Install the oil filter adapter bolts (1, 2) into the oil filter adapter.
3. Loosely tighten the oil filter adapter bolts (1, 2).
4. Install and loosely tighten the oil filter adapter bolt (3) into the oil filter adapter.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

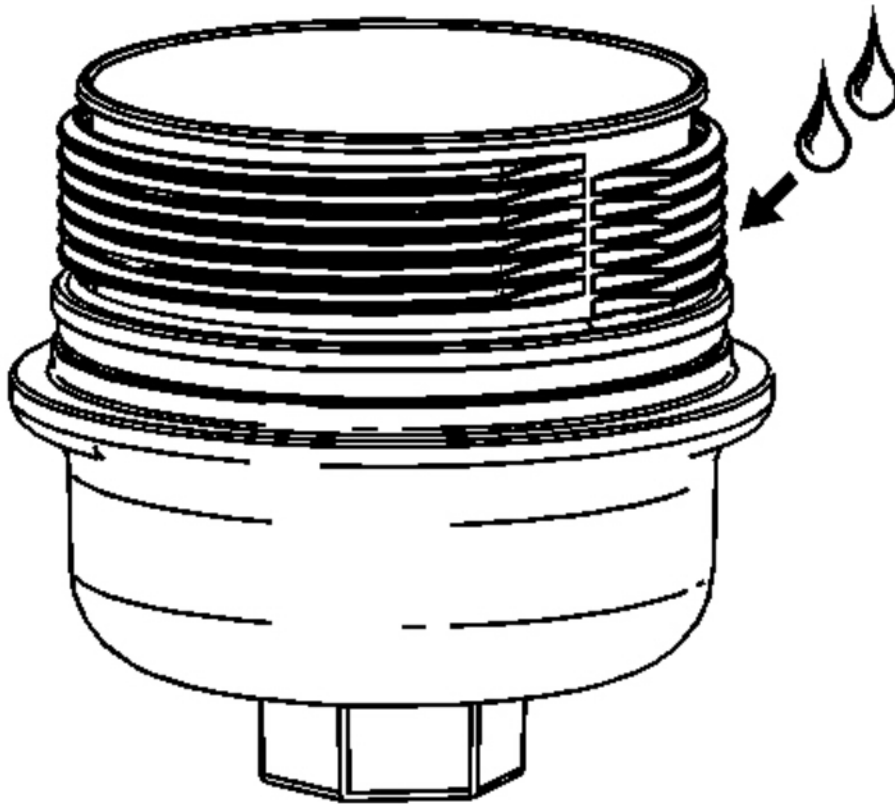
5. Tighten the oil filter adapter bolts (1, 2, 3) into the engine block in the sequence shown.

**Tighten:** Tighten the oil filter adapter bolts in sequence to 23 N.m (17 lb ft).



**Fig. 352: View Of Oil Filter Cartridge**  
Courtesy of GENERAL MOTORS CORP.

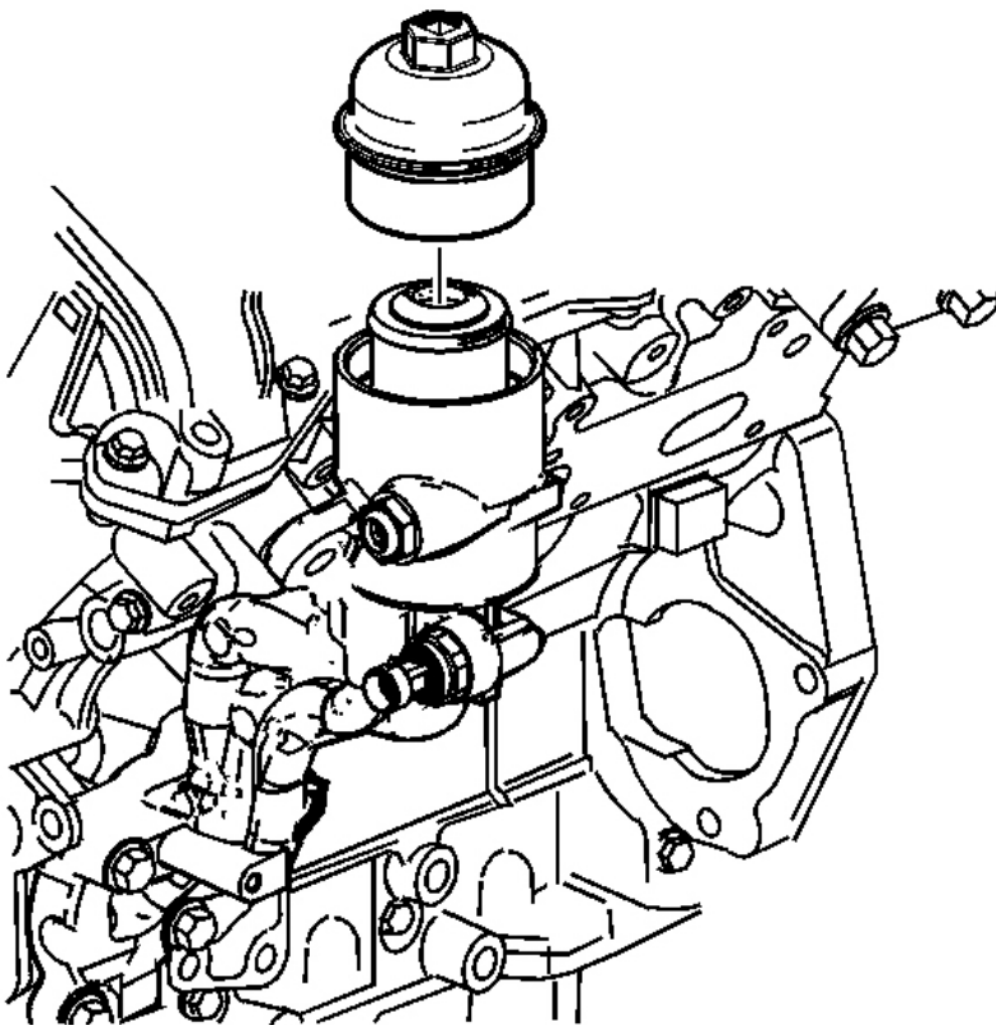
6. Install a NEW oil filter cartridge.



**Fig. 353: Lubricating Threads Of Oil Filter Cap**  
Courtesy of GENERAL MOTORS CORP.

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

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



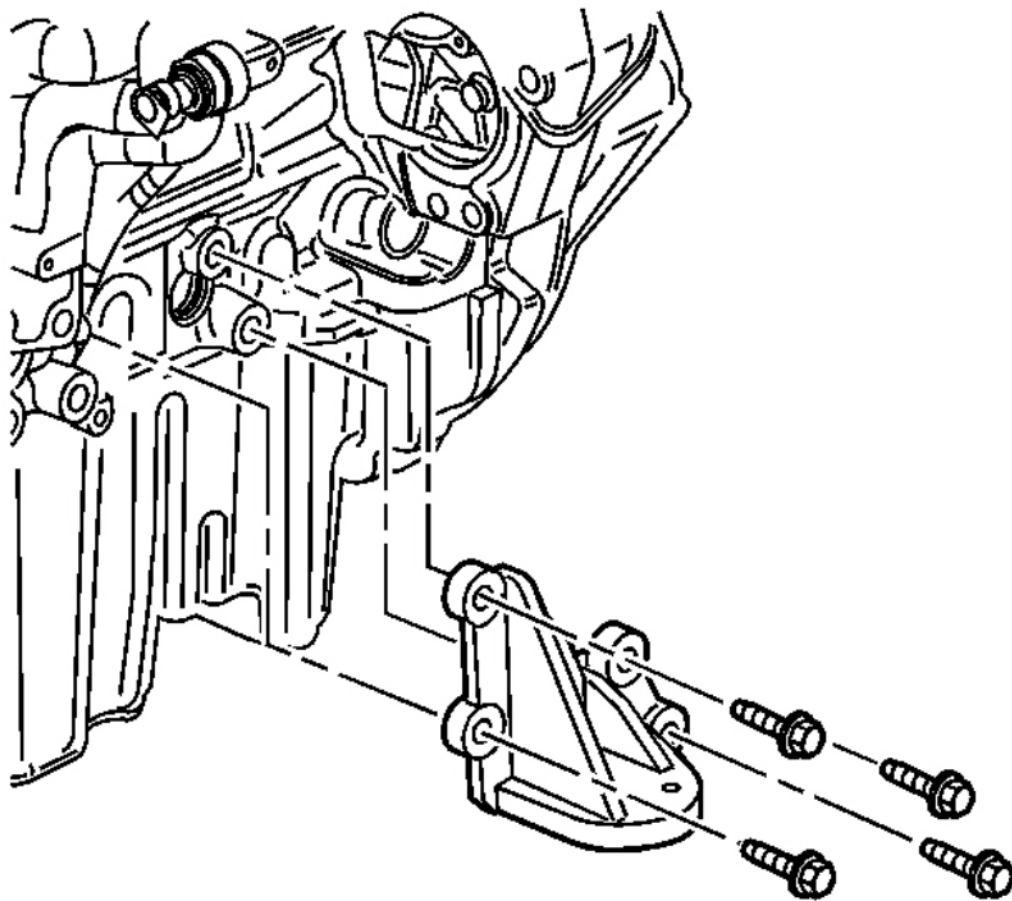
**Fig. 354: View Of Oil Filter Cap**  
Courtesy of GENERAL MOTORS CORP.

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

8. Install the oil filter cap.

**Tighten:** Tighten the oil filter cap to 25 N.m (18 lb ft).

## EXHAUST MANIFOLD INSTALLATION - LEFT



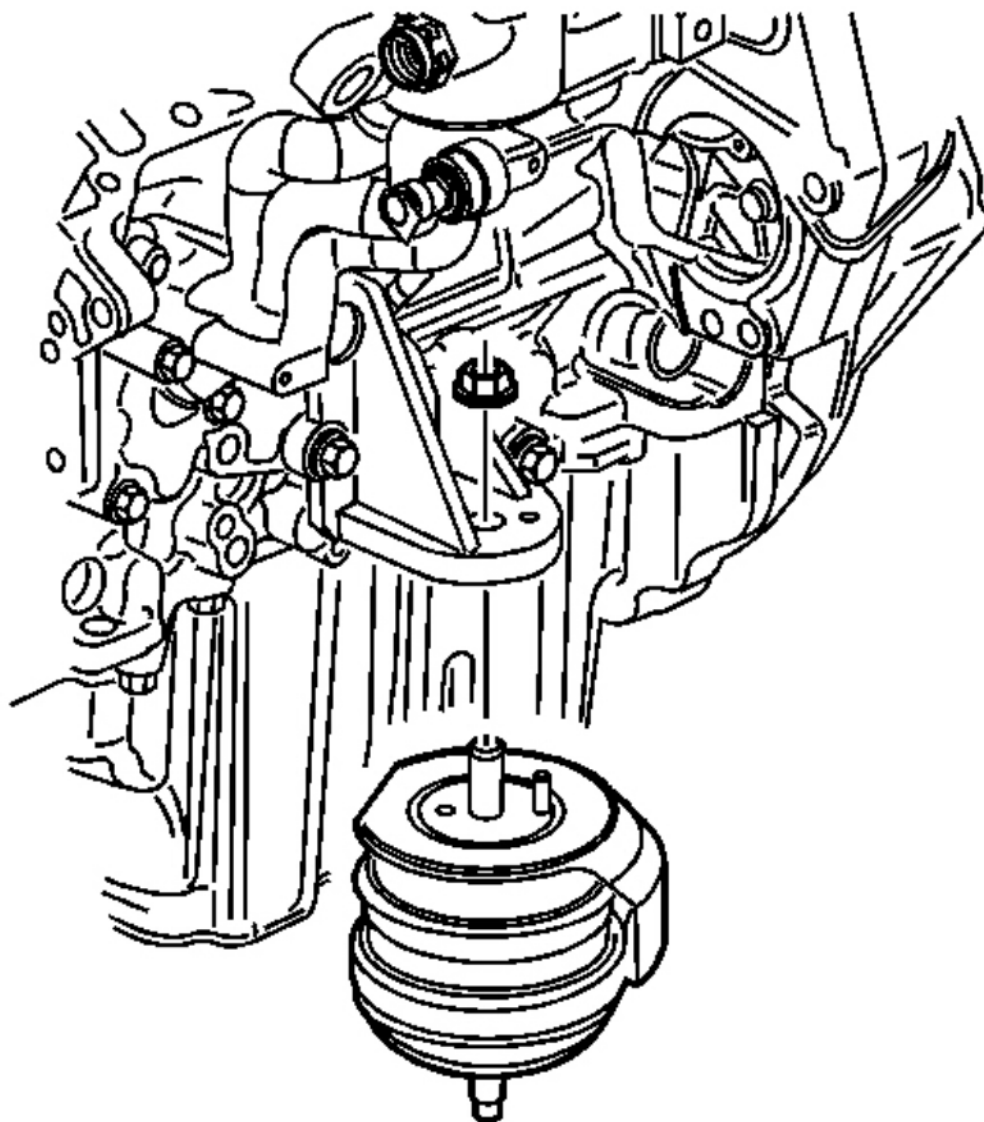
**Fig. 355: View Of Engine Mount Bracket**  
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount bracket.

**NOTE:** Refer to Fastener Notice in Cautions and Notices.

2. Install the engine mount bracket bolts.

**Tighten:** Tighten the engine mount bracket bolts to 60 N.m (44 lb ft).

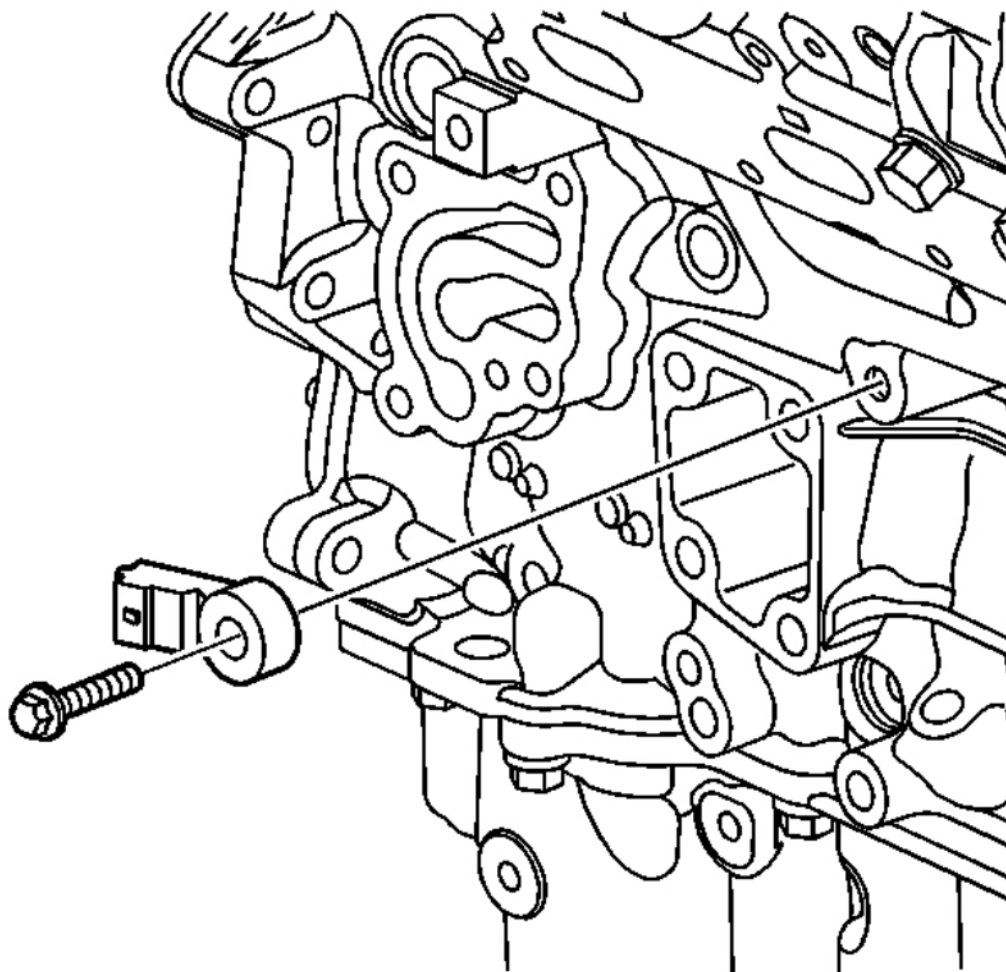


**Fig. 356: Identifying Left Engine Mount**  
Courtesy of GENERAL MOTORS CORP.

3. Install the engine mount.
4. Install the engine mount nut.

**Tighten:** Tighten the engine mount nut to 80 N.m (59 lb ft).



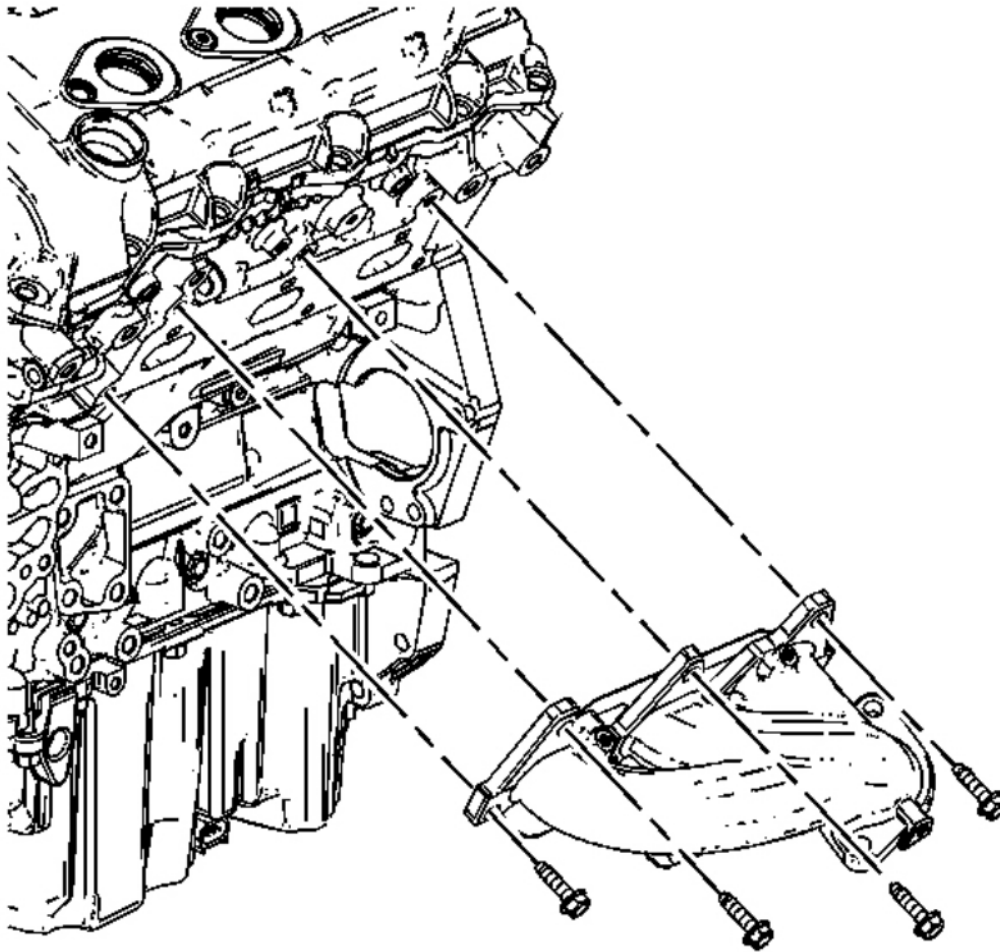


**Fig. 357: View Of Left Knock Sensor**  
Courtesy of GENERAL MOTORS CORP.

5. Position the left knock sensor to the cylinder block as shown.
6. Install the knock sensor bolt.

**Tighten:** Tighten the knock sensor bolt to 23 N.m (17 lb ft).

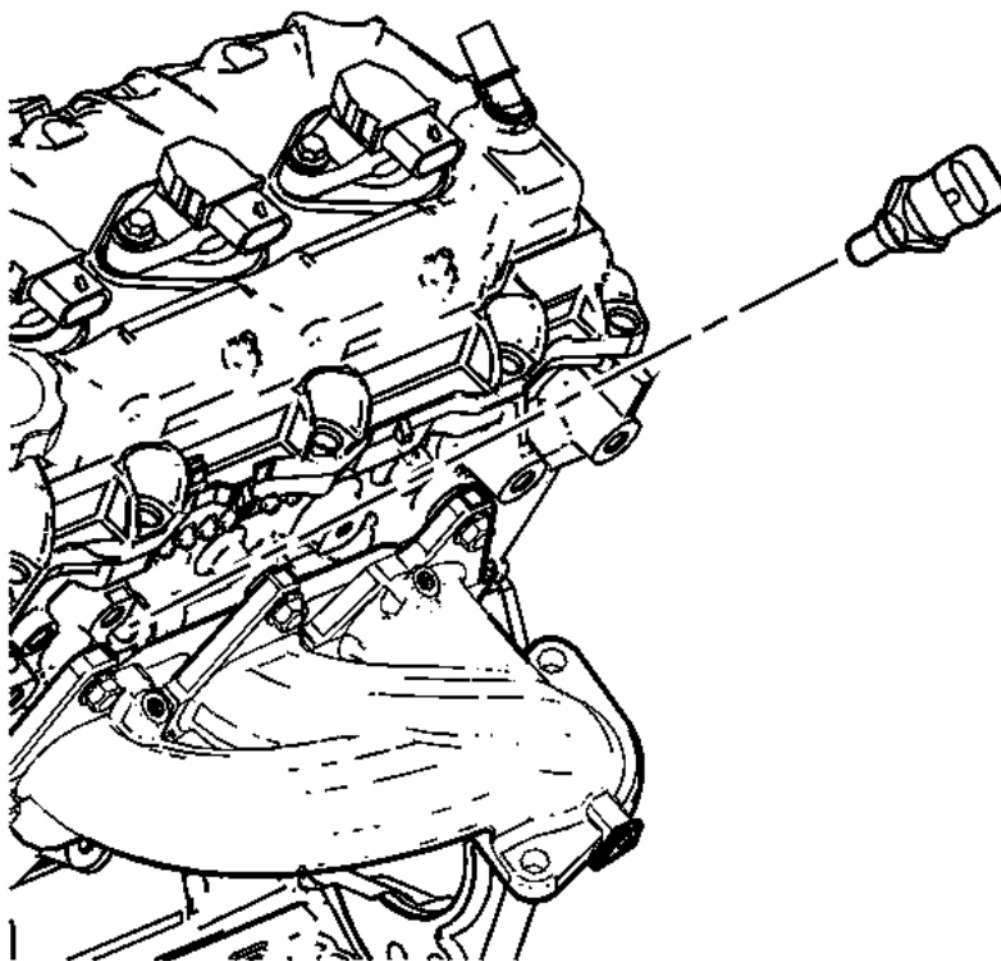
7. Ensure proper knock sensor orientation.



**Fig. 358: View Of Left Exhaust Manifold**  
Courtesy of GENERAL MOTORS CORP.

8. Position a NEW exhaust manifold gasket onto the left exhaust manifold.
9. Install the exhaust manifold bolts into the left exhaust manifold.
10. Place the left exhaust manifold, exhaust manifold gasket and bolts as an assembly in position on the left cylinder head.
11. Install the exhaust manifold bolts into the left cylinder head.

**Tighten:** Tighten the exhaust manifold bolts to 25 N.m (18 lb ft).



**Fig. 359: View Of ECT Sensor**

Courtesy of GENERAL MOTORS CORP.

12. Install the engine coolant temperature (ECT) sensor.

**Tighten:** Tighten the ECT sensor to 22 N.m (16 lb ft).