

ENGINE FRONT COVER DISASSEMBLE

Tools Required

J 45000 Seal Remover

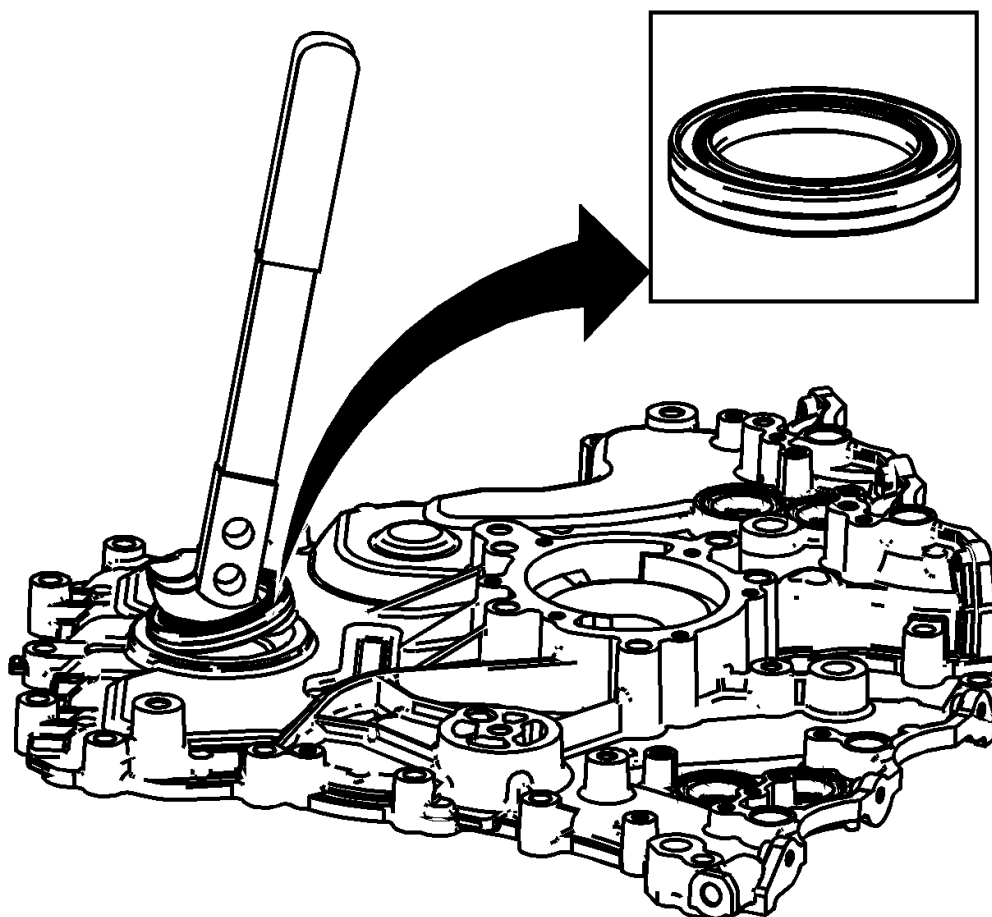


Fig. 302: Identifying Crankshaft Front Oil Seal & Removal Tool
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft front oil seal from the engine front cover using the **J 45000** seal remover.

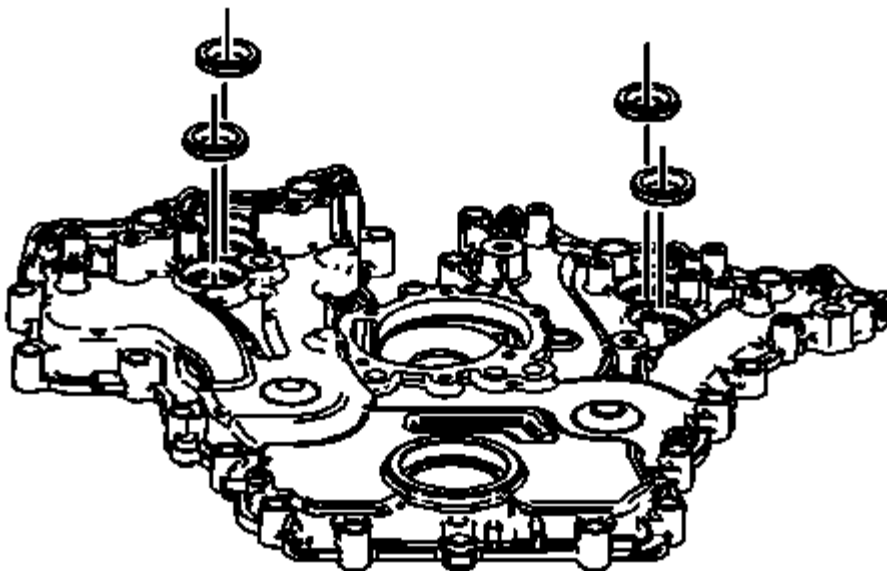


Fig. 303: Locating Camshaft Position Actuator Valve Oil Seals
Courtesy of GENERAL MOTORS COMPANY

2. Remove the camshaft position actuator valve oil seals from the engine front cover.

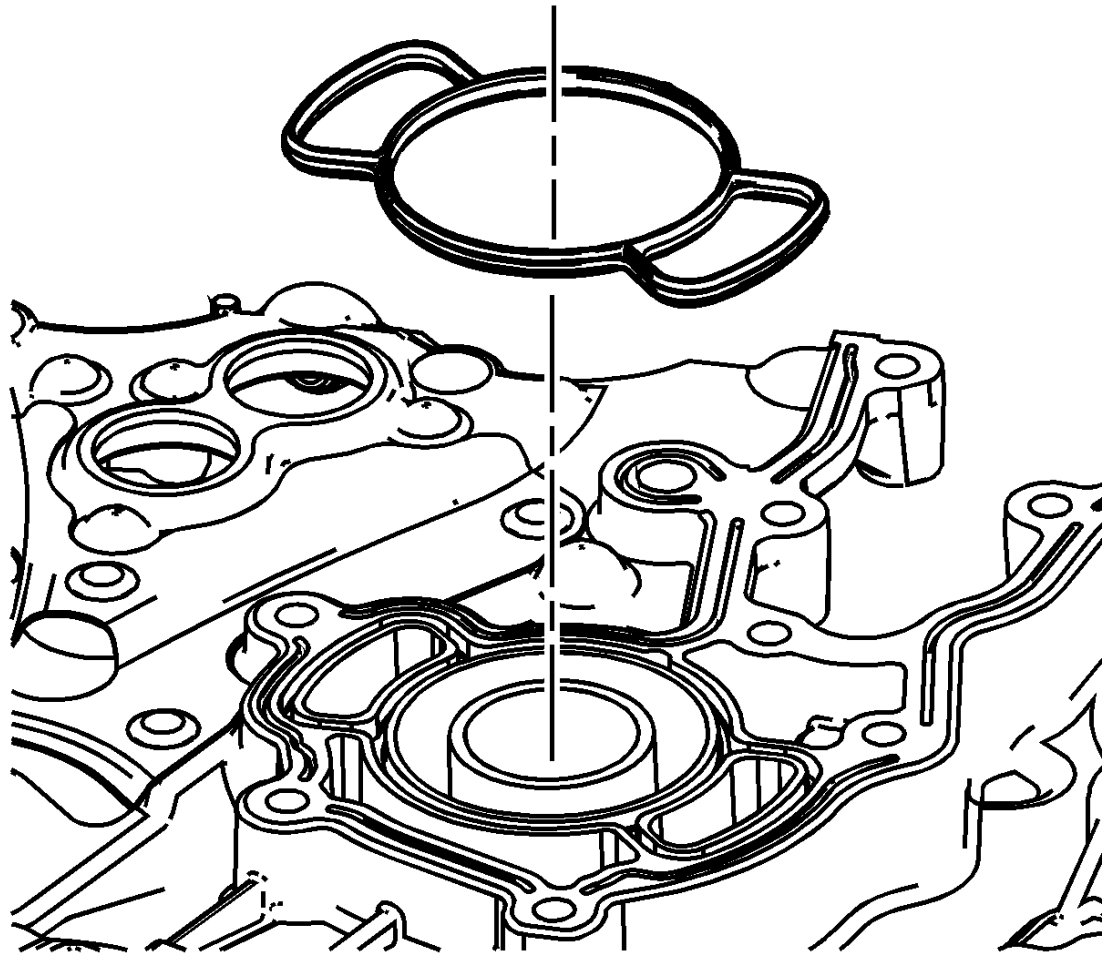


Fig. 304: Identifying Water Pump Seal
Courtesy of GENERAL MOTORS COMPANY

3. Remove the water pump seal from the engine front cover.
4. Discard the water pump seal.

ENGINE FRONT COVER CLEANING AND INSPECTION

Special Tools

EN 28410 Gasket Remover

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

Cleaning Procedure

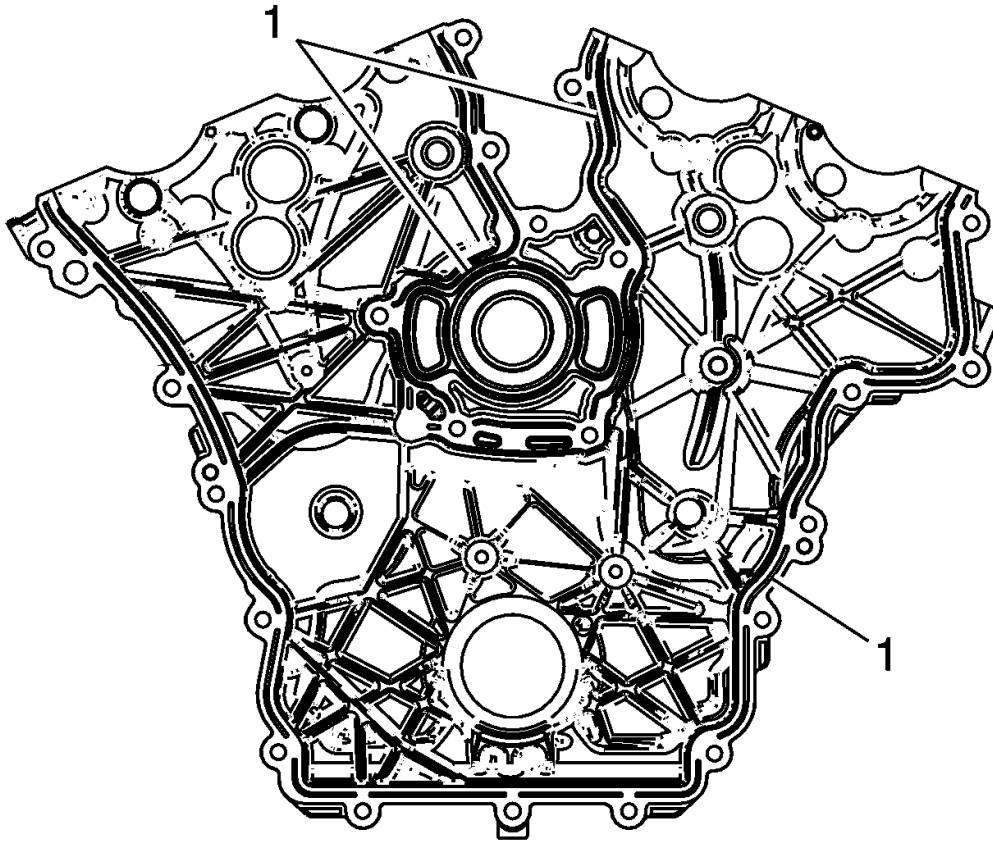


Fig. 305: Sealant On Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

1. Remove any RTV sealant (1) from the engine front cover using **EN 28410** remover.
2. Clean out debris from the bolt holes.
3. Clean the engine front cover in solvent.
4. Dry the engine front cover with compressed air.

WARNING: Refer to Safety Glasses Warning .

Inspection Procedure

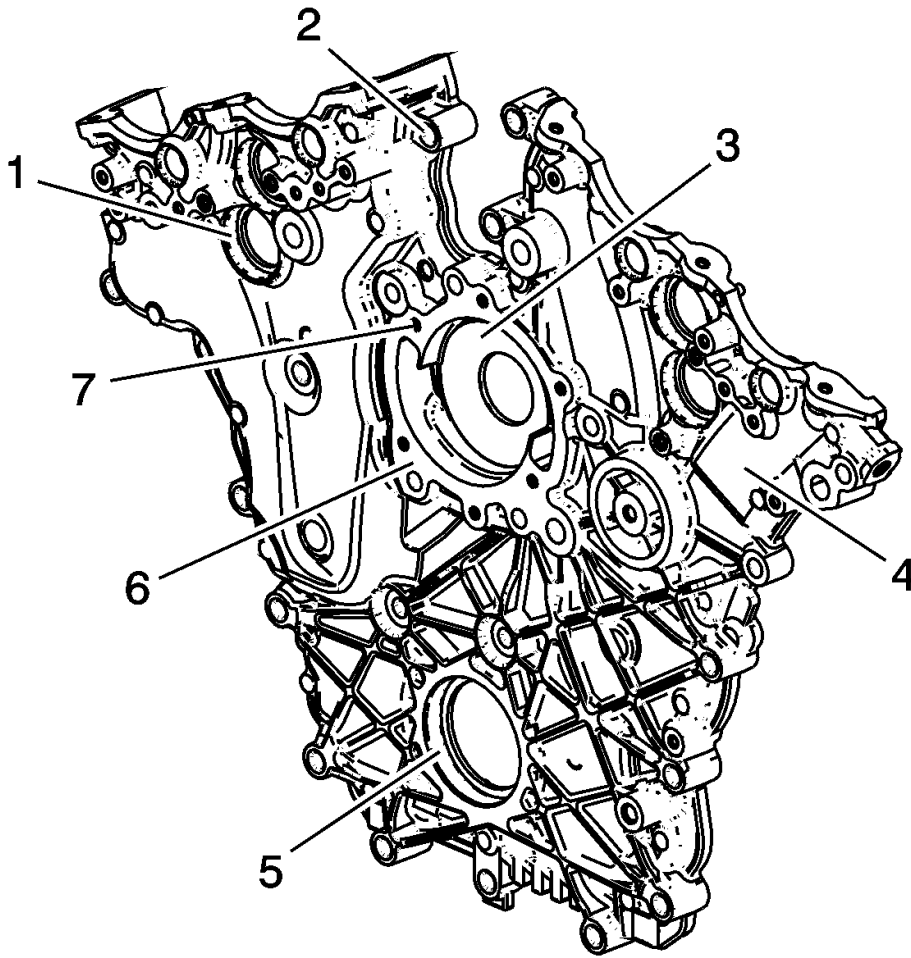


Fig. 306: View Of Exterior Of Engine Front Cover
 Courtesy of GENERAL MOTORS COMPANY

1. Inspect the exterior of the engine front cover for the following conditions:
 - Damage to the water pump bolt hole threads (7)
 - Gouges or damage to the water pump sealing surfaces (6)
 - Damage to the crankshaft front oil seal bore (5)
 - Damage to the camshaft position actuator valve oil seal bores (1)
 - Damage to the engine front cover bolt holes (2)
 - Damage and/or corrosion to the engine coolant passage (3)
 - Dents or damage to the exterior (4)

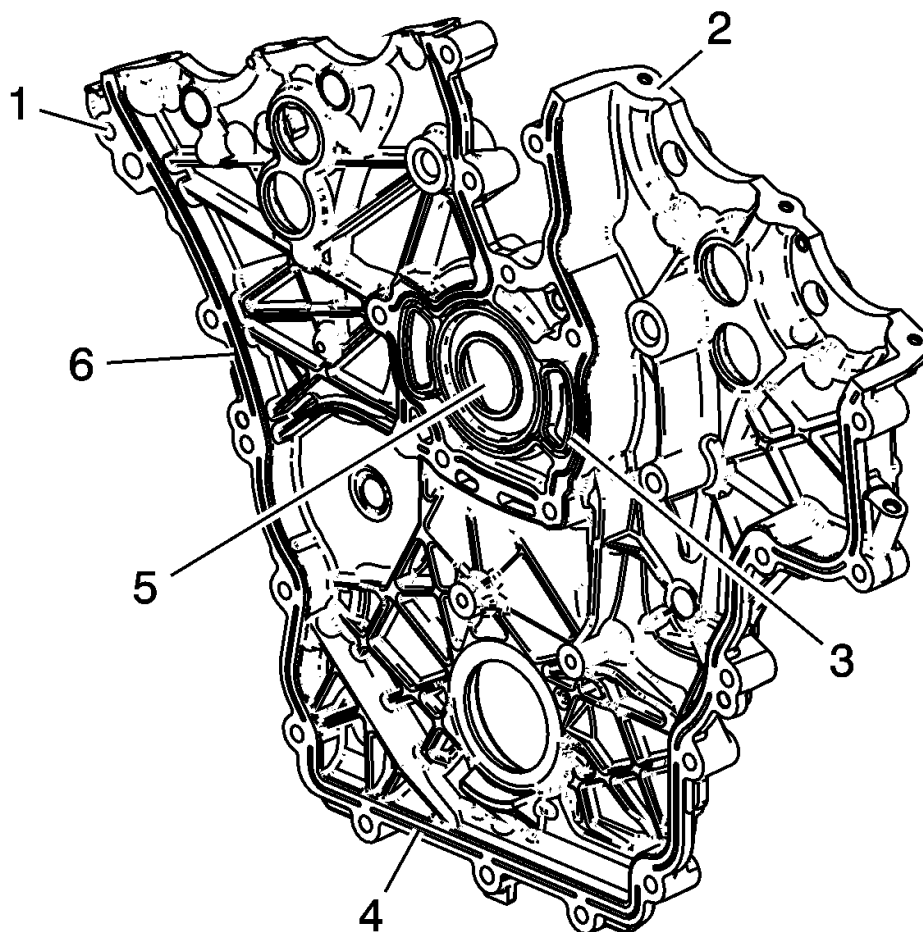


Fig. 307: View Of Interior Of Engine Front Cover
 Courtesy of GENERAL MOTORS COMPANY

2. Inspect the interior of the engine front cover for the following conditions:
 - Gouges or damage to the engine front cover sealing surfaces to the engine block (6), oil pan (4), and/or camshaft covers (2)
 - Damage and/or corrosion to the engine coolant passage (5)
 - Damage to the crankshaft front oil seal bore
 - Gouges or damage to the O-ring sealing areas
 - Gouges or damage to the water pump seal area (3)
 - Damage to the engine front cover bolt holes (1)
3. Repair or replace the engine front cover as necessary.

ENGINE FRONT COVER ASSEMBLE

Special Tools

- **EN-46103** Camshaft Actuator Valve Seal Remover/Installer
- **J 29184** Output Shaft Seal Installer

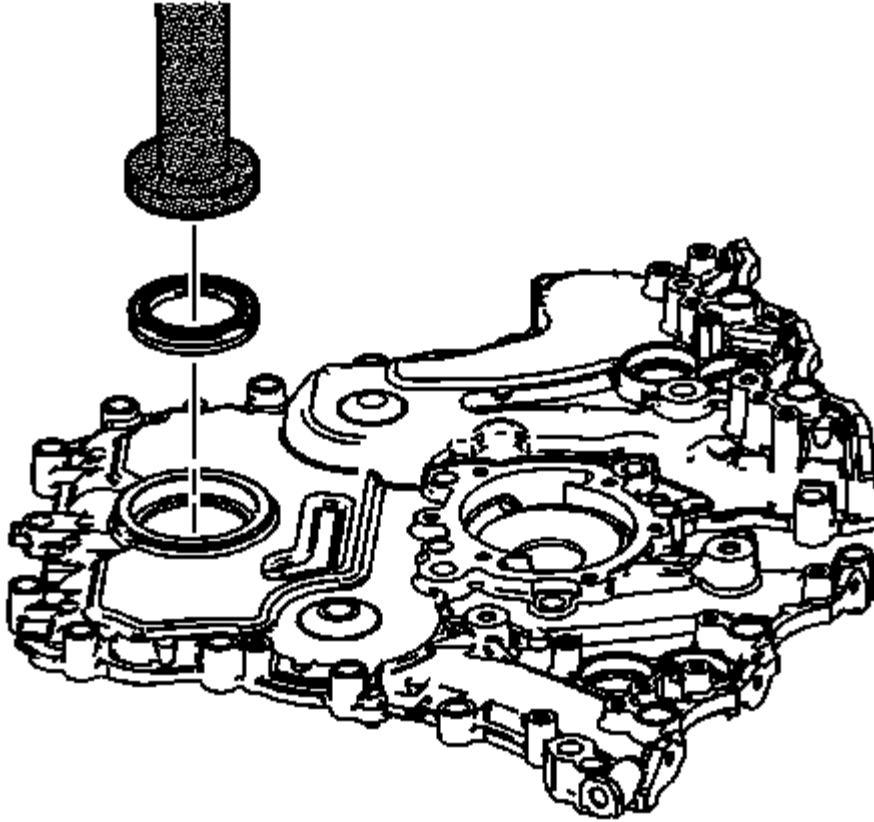


Fig. 308: View Of Crankshaft Front Oil Seal Installation
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Do not lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

1. Install the NEW crankshaft front oil seal into the engine front cover using the **J 29184** output shaft seal installer.

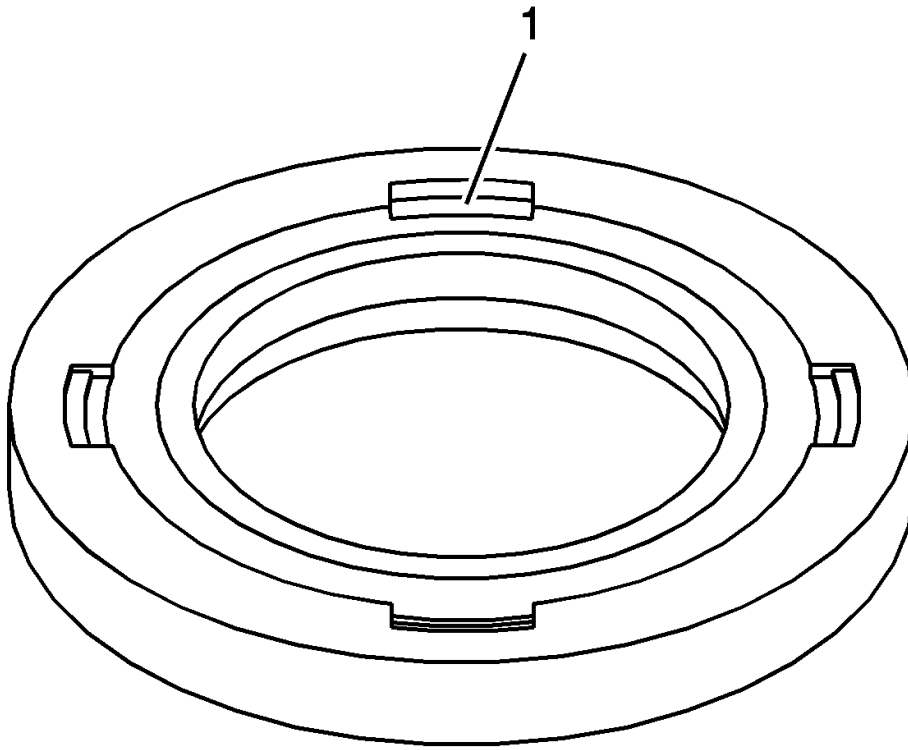


Fig. 309: View of Crankshaft Front Oil Seal Notches
Courtesy of GENERAL MOTORS COMPANY

2. Place the seal into position with the notches (1) in the seal down. The notches (1) will face inboard when properly installed.

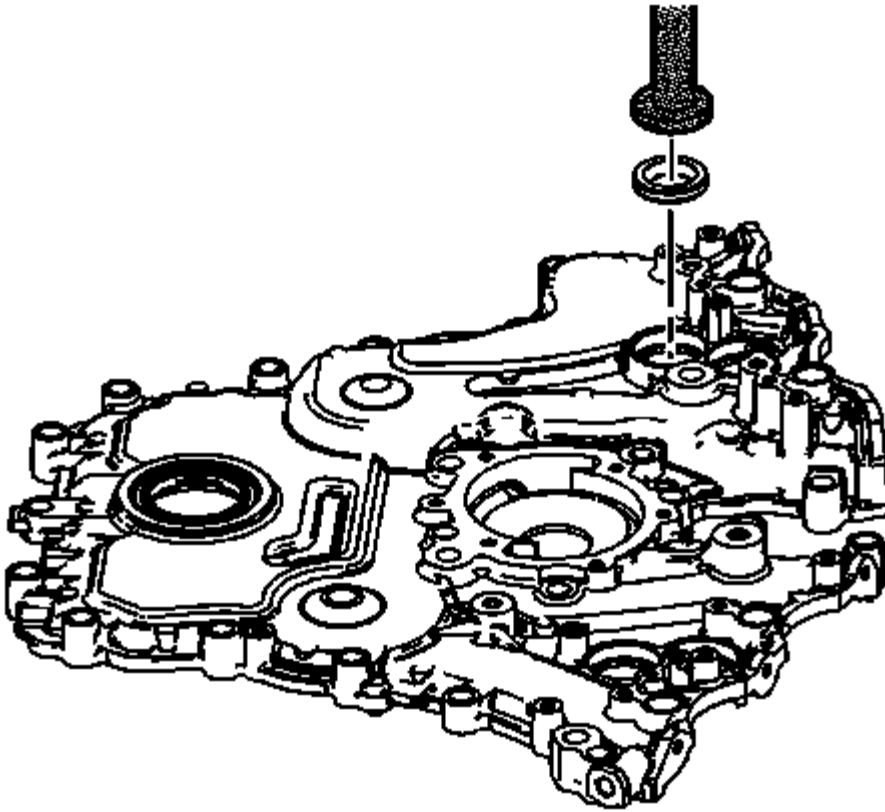


Fig. 310: Identifying Camshaft Position Actuator Valve Oil Seals
Courtesy of GENERAL MOTORS COMPANY

3. Install the NEW camshaft position actuator valve oil seals into the engine front cover using the **EN-46103** camshaft actuator valve seal remover/installer.

CAMSHAFT COVER DISASSEMBLE

Left Camshaft Cover

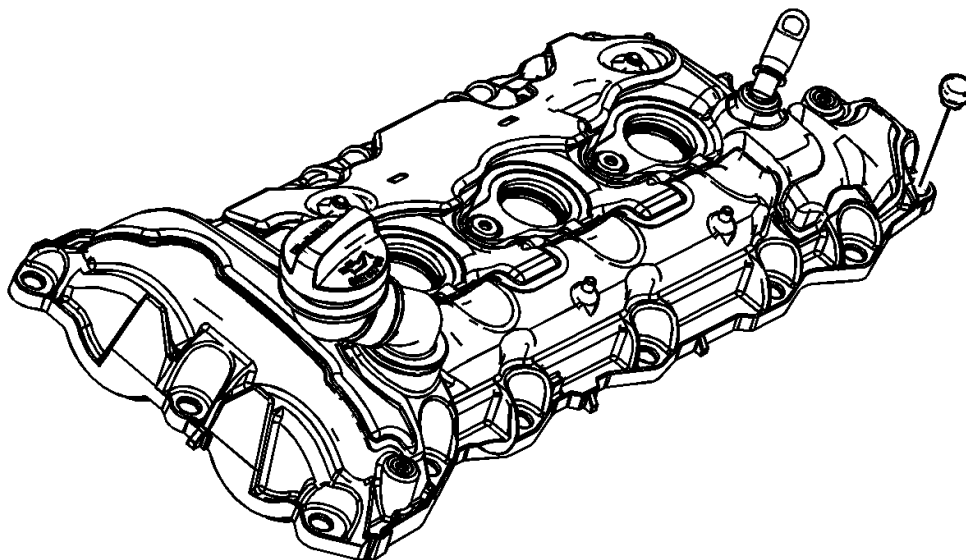


Fig. 311: View of Left Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

1. Remove and discard the left camshaft cover bolt grommets.

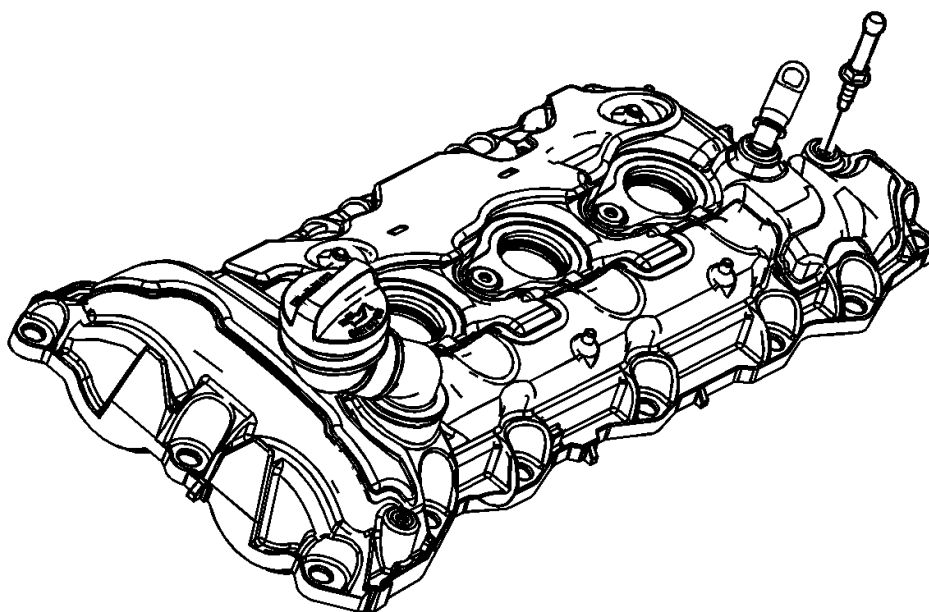


Fig. 312: View of Fuel Injector Sight Shield Cover Ballstud
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel injector sight shield ballstud.

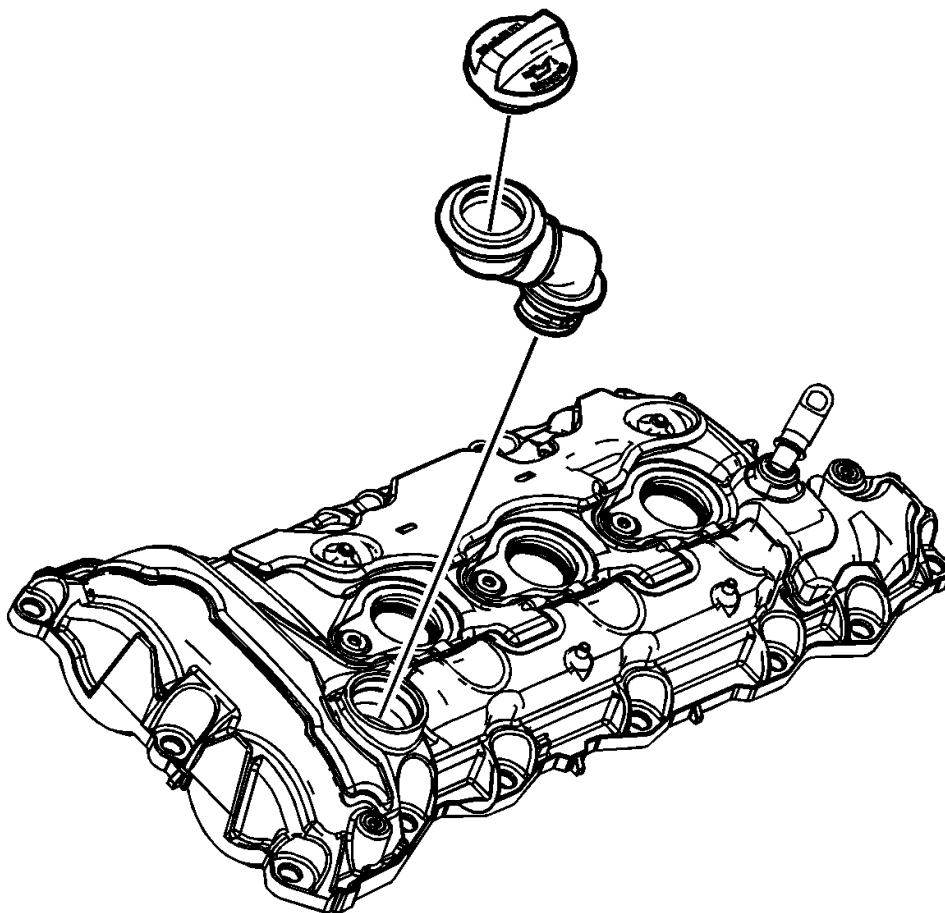


Fig. 313: View of Oil Filter Cap Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil fill cap.

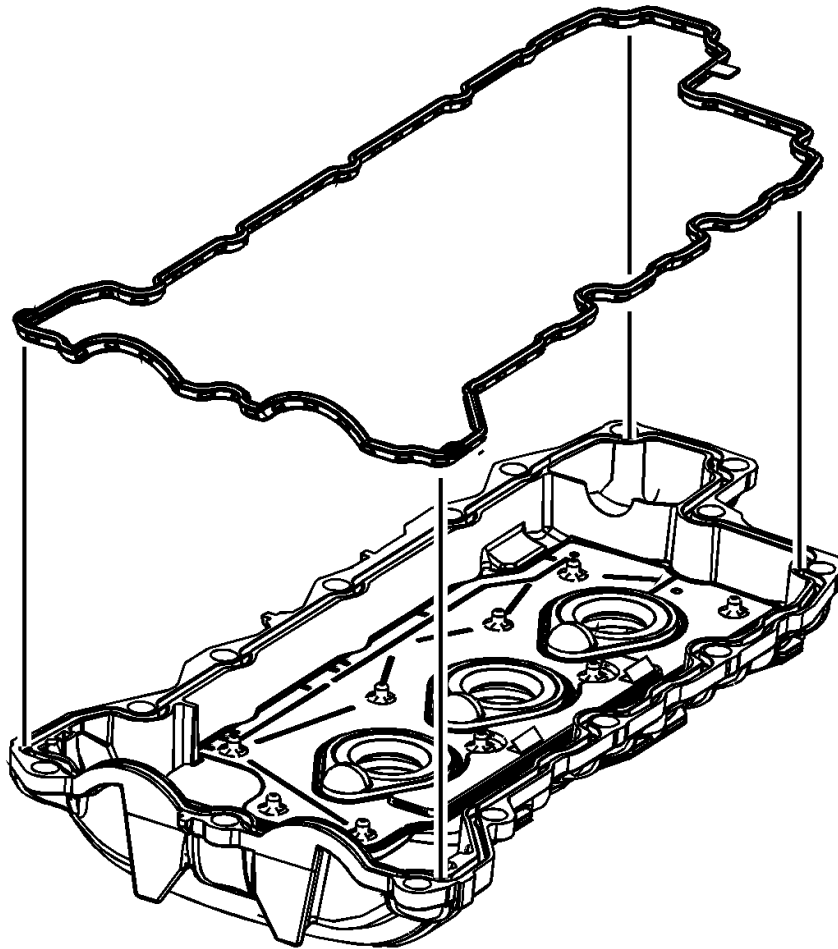


Fig. 314: View of Left Camshaft Cover Gasket Assembly
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Do not reuse the camshaft cover gasket and spark plug shield tube seals.

4. Remove and discard the left camshaft cover gasket.

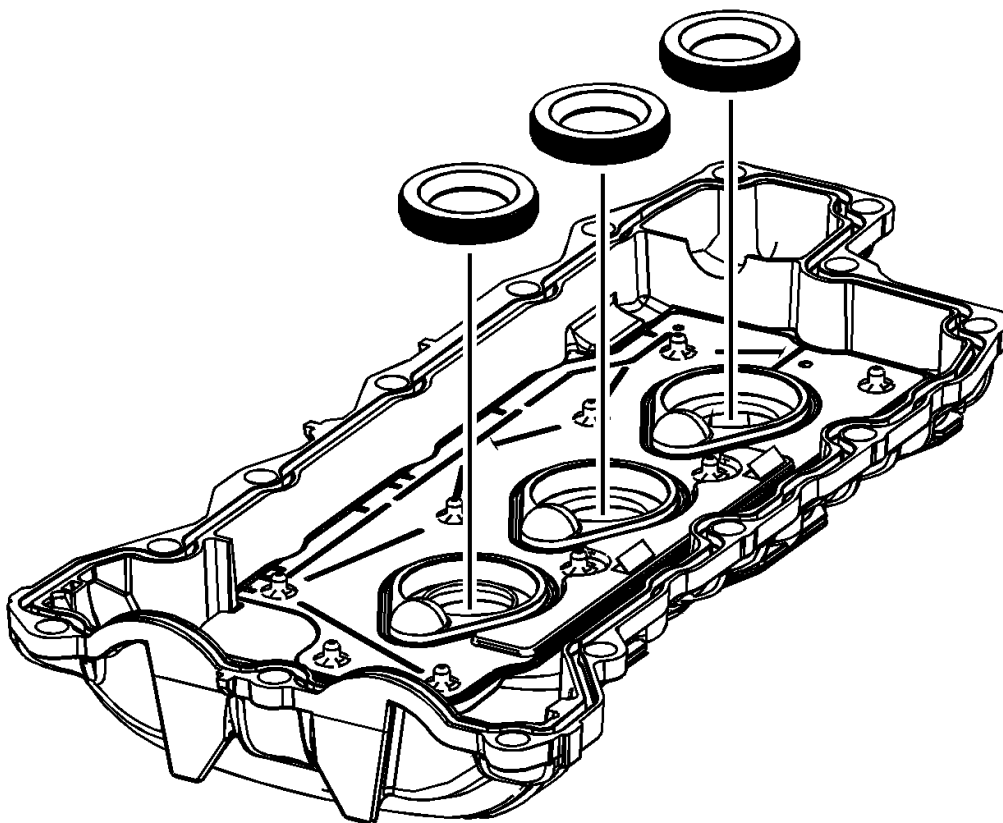


Fig. 315: View Of Right Spark Plug Shield Tube Seals
Courtesy of GENERAL MOTORS COMPANY

5. Remove and discard the left spark plug shield tube seals.

Right Camshaft Cover

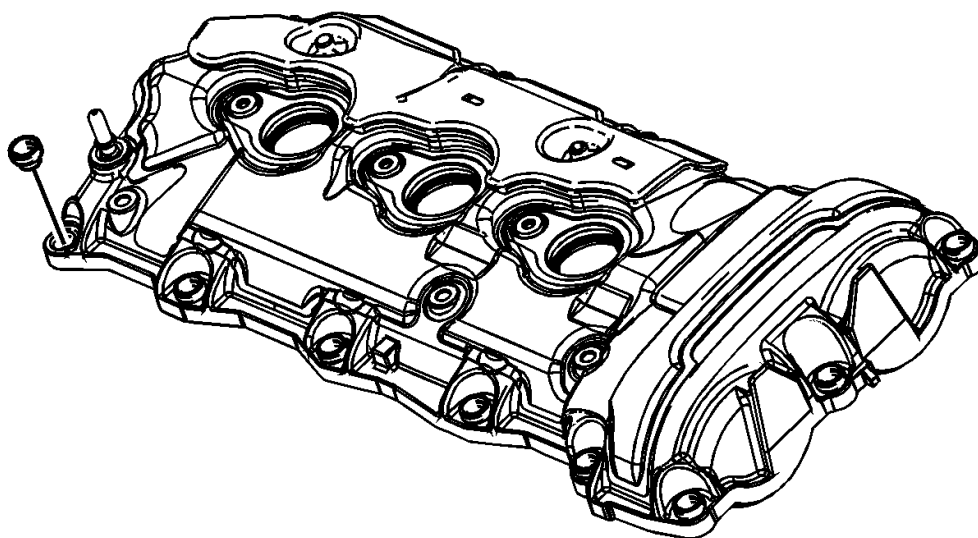


Fig. 316: View Of Right Camshaft Cover Bolt Grommet
Courtesy of GENERAL MOTORS COMPANY

1. Remove and discard the right camshaft cover bolt grommets.

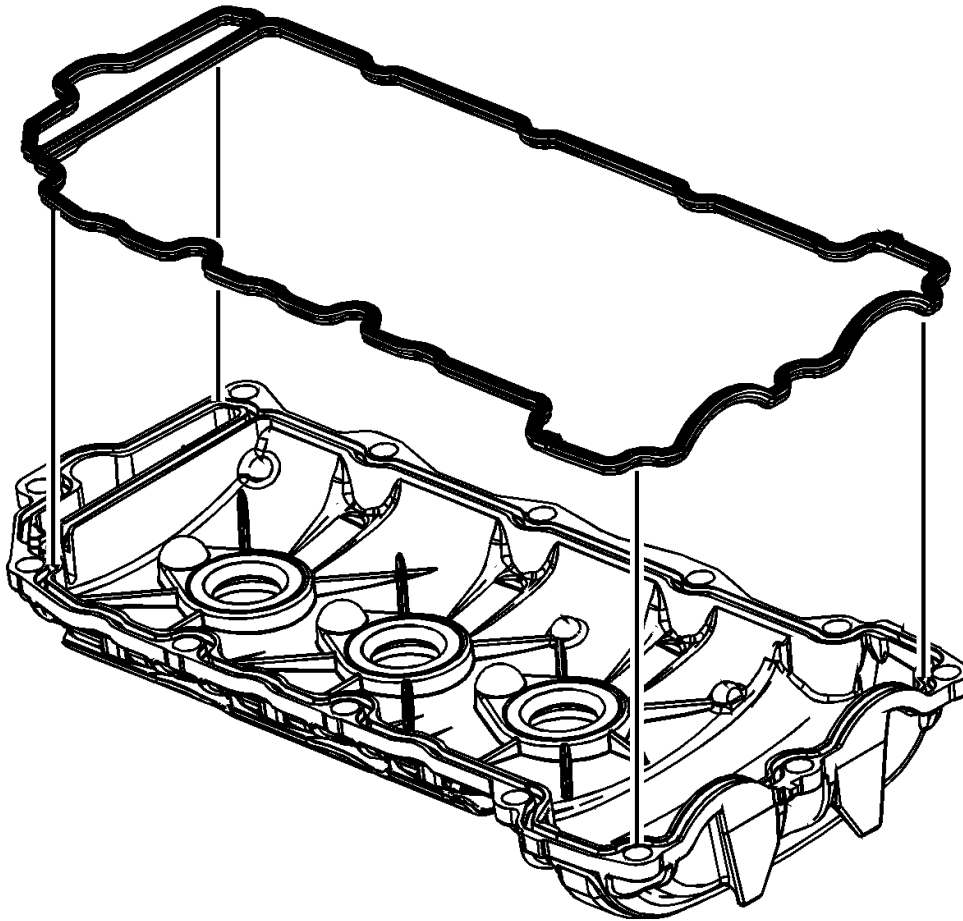


Fig. 317: View Of Right Camshaft Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Do not reuse the camshaft cover gasket and spark plug shield tube seals.

2. Remove and discard the right camshaft cover gasket.

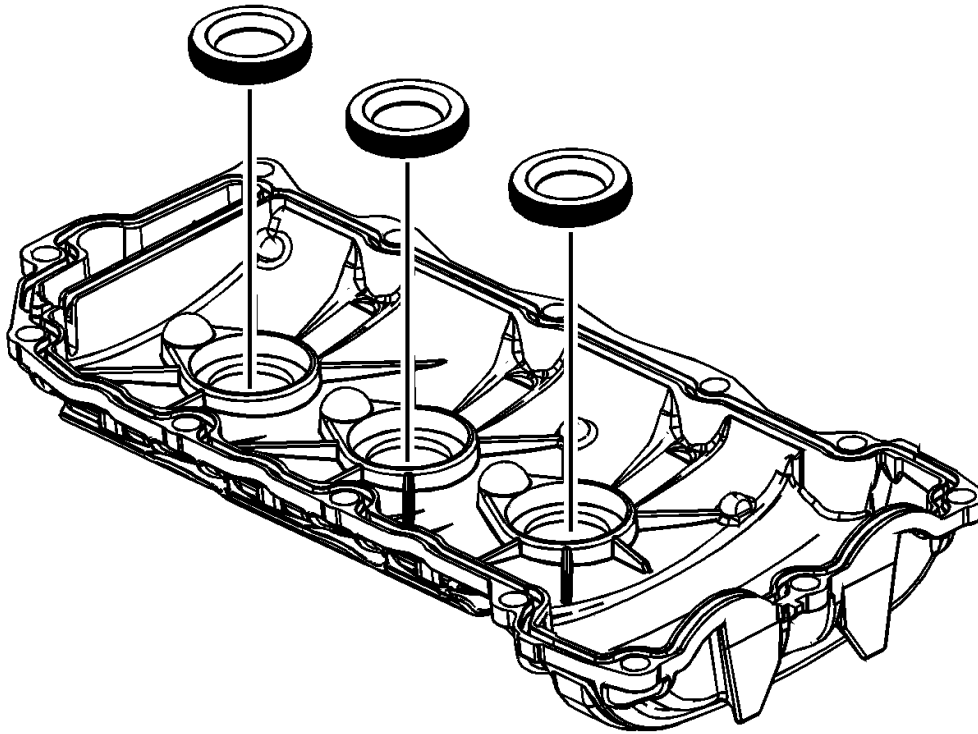


Fig. 318: View Of Right Spark Plug Shield Tube Seals
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the right spark plug shield tube seals.

CAMSHAFT COVER CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the camshaft covers in solvent.
2. Dry the camshaft covers with compressed air.

WARNING: Refer to Safety Glasses Warning .

Inspection Procedure

1. Inspect each camshaft cover for the dents or damage to the exterior. A dented or damaged camshaft cover may:
 - Leak engine oil
 - Effect crankcase ventilation
 - Interfere with the camshafts
 - Interfere with the ignition coil sealing
 - Allow water or condensation to enter the engine

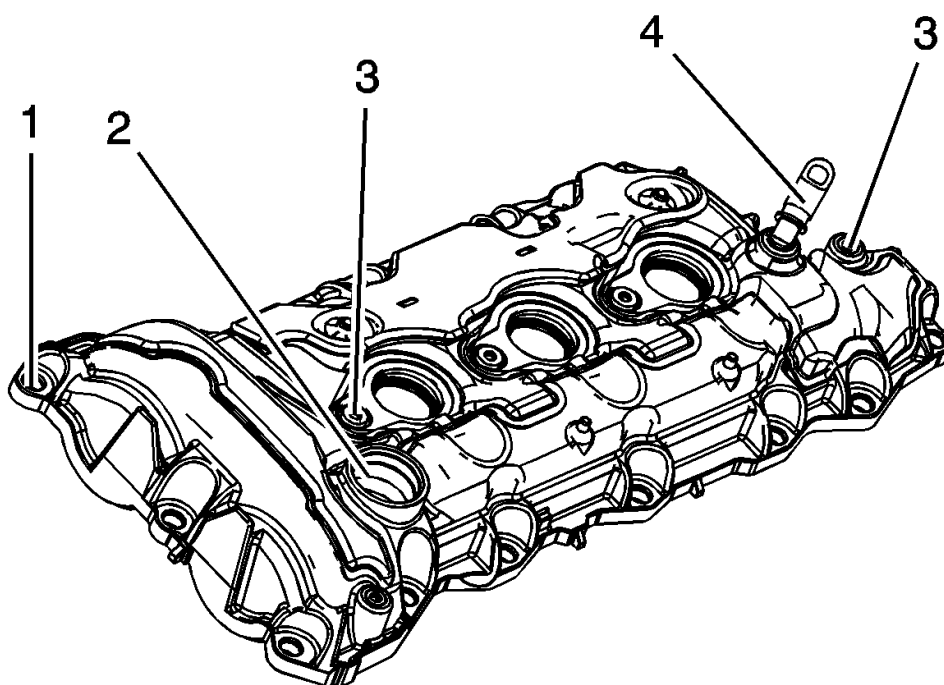


Fig. 319: Identifying Inspection Points Of Left Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the exterior of the left camshaft cover for the following conditions:
 - Damage to the camshaft cover bolt holes (1)
 - Damage to the oil fill hole (2)
 - Damage to the mounting holes (3) for the ignition coil assembly and fuel injector sight shield ballstud.

- Damage to the positive crankcase ventilation (PCV) hose connector (4)-A damaged PCV hose connector is replaceable.

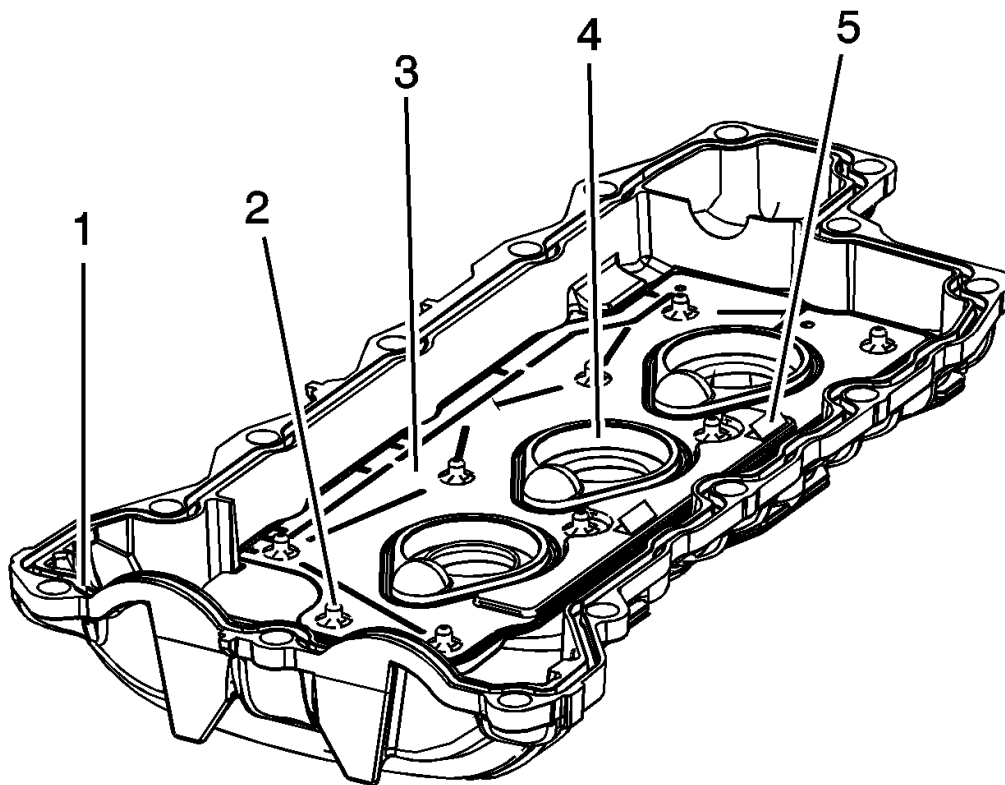


Fig. 320: Identifying Inspection Points Of Left Camshaft Cover Interior
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the interior of the left camshaft cover for the following conditions:
 - Gouges or damage to the camshaft cover sealing groove (1)
 - Damaged, loose or missing baffle fasteners (2)
 - Damaged, loose or missing baffle (3)
 - Gouges or damage to the spark plug shield seal bore (4)
 - Restrictions to the ventilation system (5)

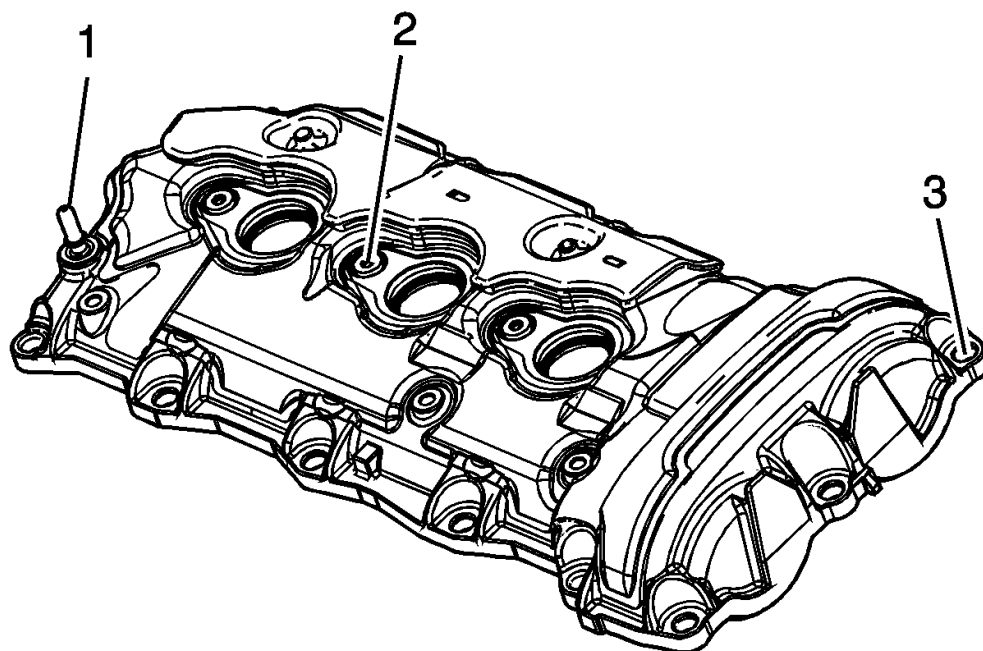


Fig. 321: View Of Right Camshaft Cover Inspection Locations
 Courtesy of GENERAL MOTORS COMPANY

4. Inspect the exterior of the right camshaft cover for the following conditions:
 - Damage to the PCV orifice (1)-A damaged PCV orifice can be replaced. Refer to **PCV Orifice Replacement**.
 - Damage to the mounting holes (2) for the ignition coil assembly
 - Damage to the camshaft cover bolt holes (3)

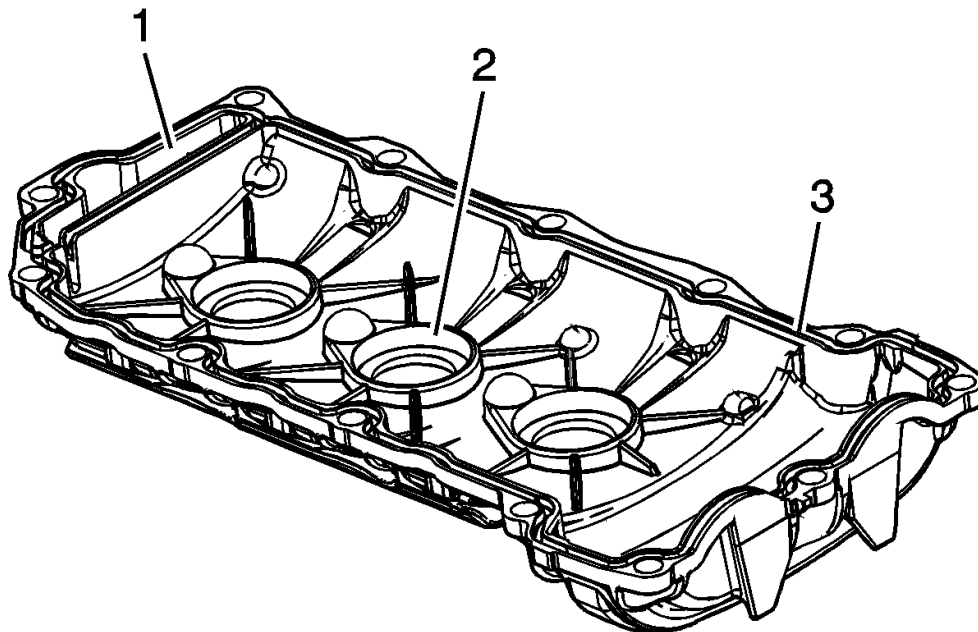


Fig. 322: View Of Right Camshaft Cover Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the interior of the right camshaft cover for the following conditions:
 - Restrictions to the ventilation system (1)
 - Gouges or damage to the spark plug shield seal bore (2)
 - Gouges or damage to the camshaft cover sealing groove (3)
6. Repair or replace the camshaft cover or covers as necessary.

PCV Orifice Replacement

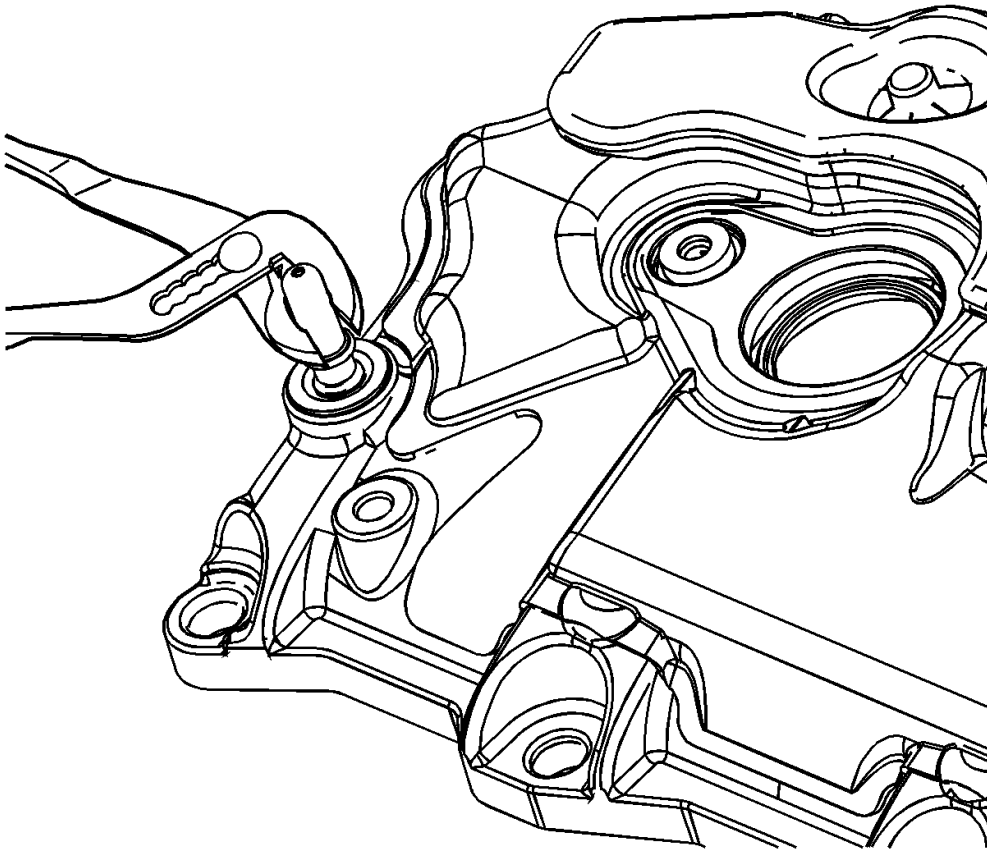


Fig. 323: View Of PCV Orifice

Courtesy of GENERAL MOTORS COMPANY

NOTE: If the PCV orifice is damaged or plugged and cannot be cleaned out, the PCV orifice can be replaced.

1. Remove the old PCV orifice by gripping the neck of the orifice with pliers and twisting and pulling out of the right camshaft cover.

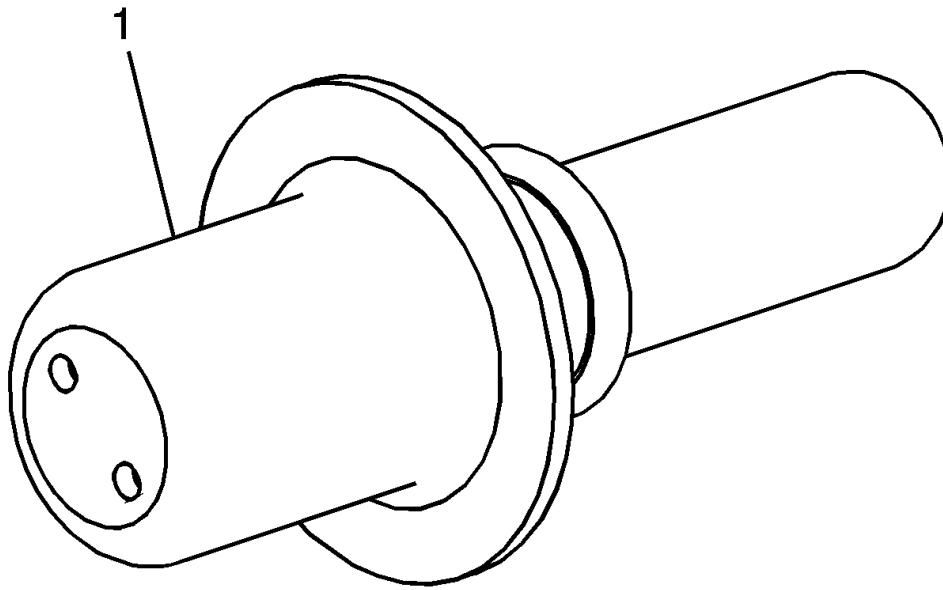


Fig. 324: Identifying Sealant Area On PCV Orifice
Courtesy of GENERAL MOTORS COMPANY

2. Apply sealant GM P/N 12378521 (Canadian P/N 88901148) or equivalent to the NEW PCV orifice (1).

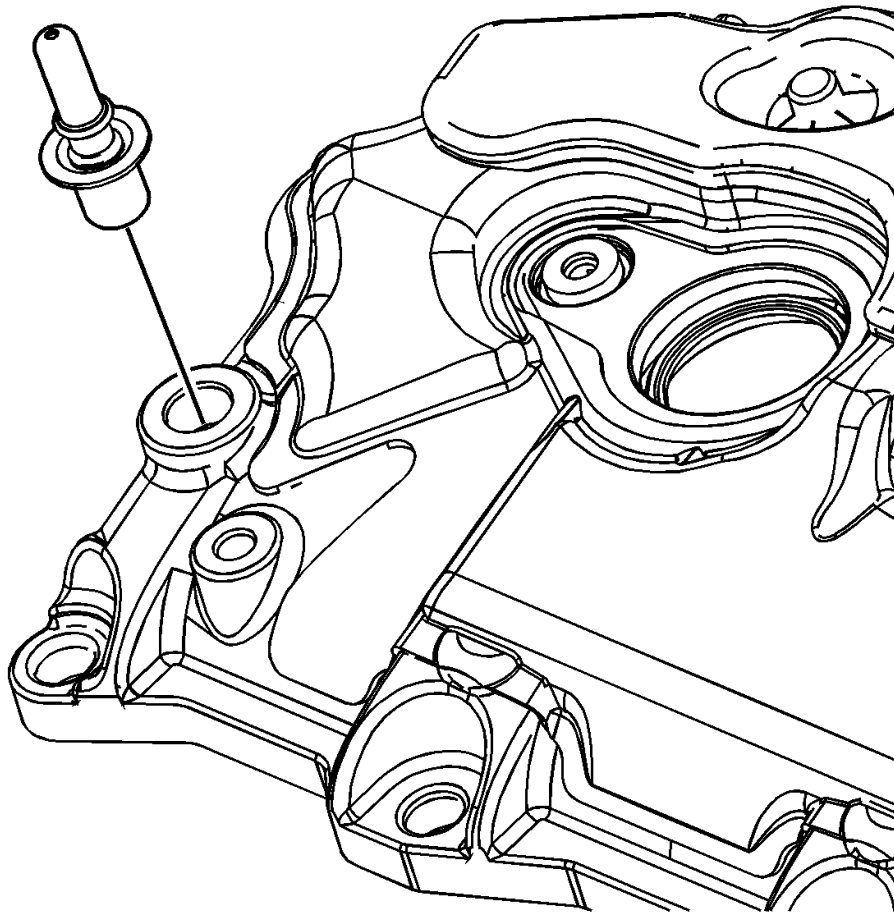


Fig. 325: View Of PCV Orifice & Right Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

3. Install the NEW PCV orifice into the right camshaft cover. After insertion, twist the PCV orifice in order to eliminate any vertical leak paths in the sealant.

PCV Fitting Replacement

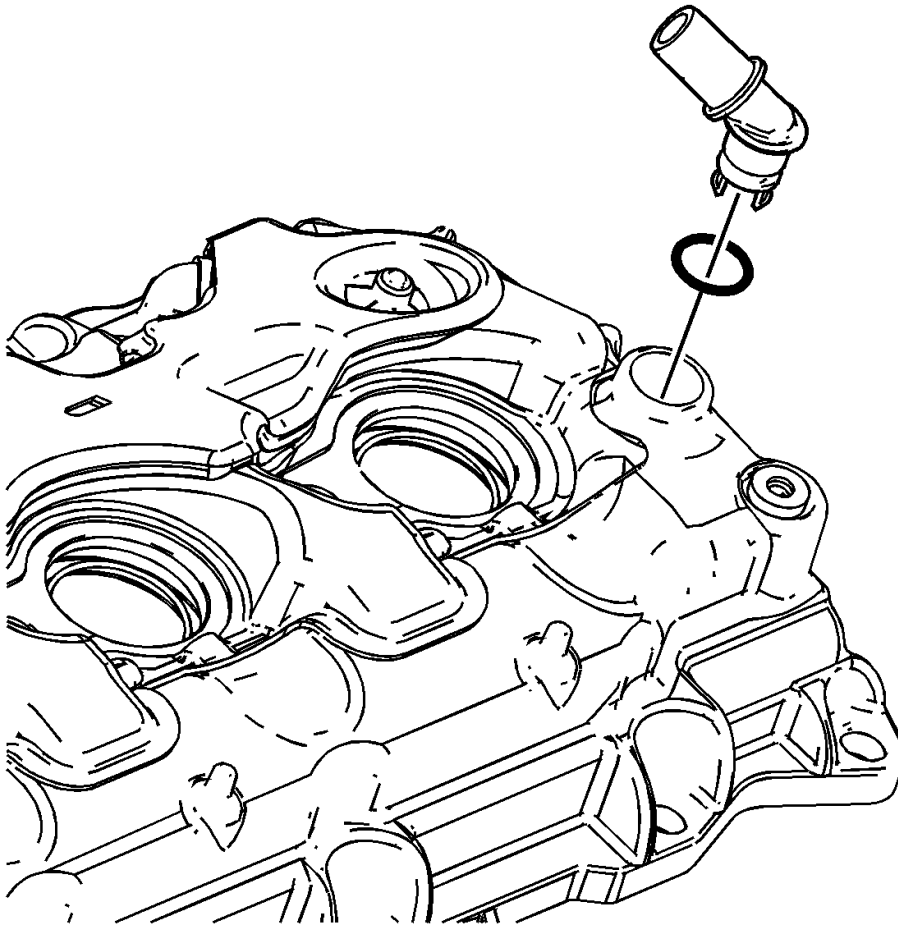


Fig. 326: View Of PCV Fitting & O-Ring
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the PCV fitting is damaged or plugged and cannot be cleaned out, the PCV fitting can be replaced.

1. Remove the old PCV fitting.
2. Install the new PCV fitting with a NEW O-ring.

CAMSHAFT COVER ASSEMBLE

Special Tools

- **J 5590** Bearing and Seal Driver
- **J-25254-A** Oil Seal Installer

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

Left Camshaft Cover

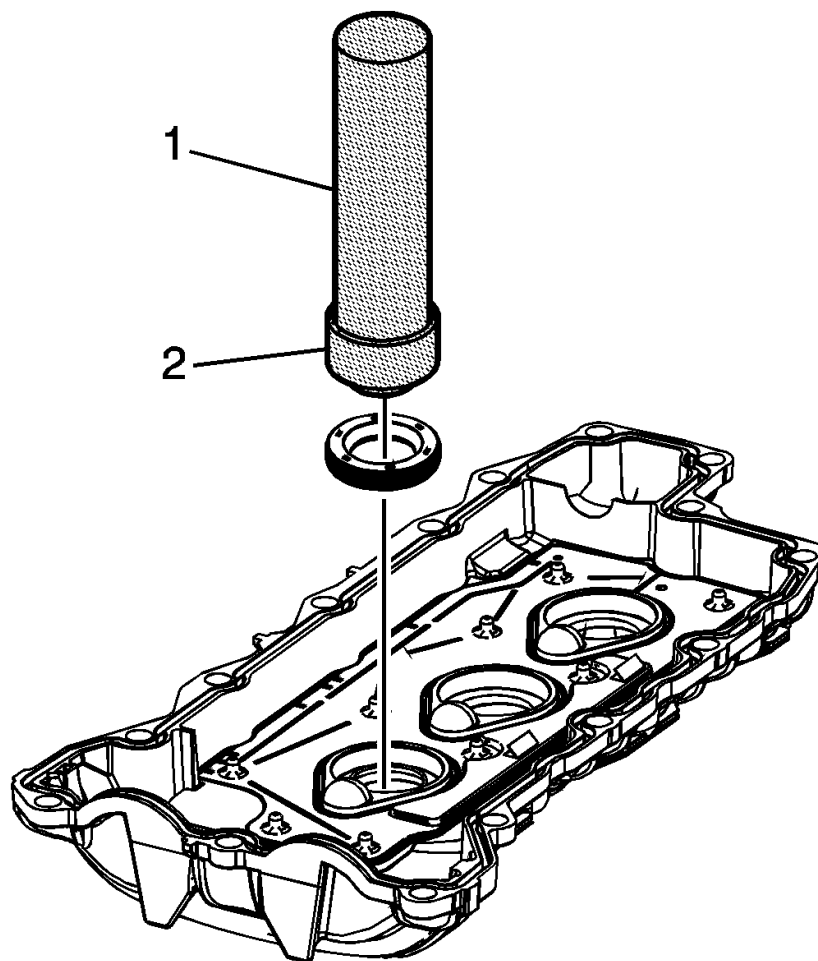


Fig. 327: Identifying Left Spark Plug Shield Tube Seals, J 5590 & J-25254-A
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW left spark plug shield tube seals using the **J 5590** driver (1) and **J-25254-A** installer (2).

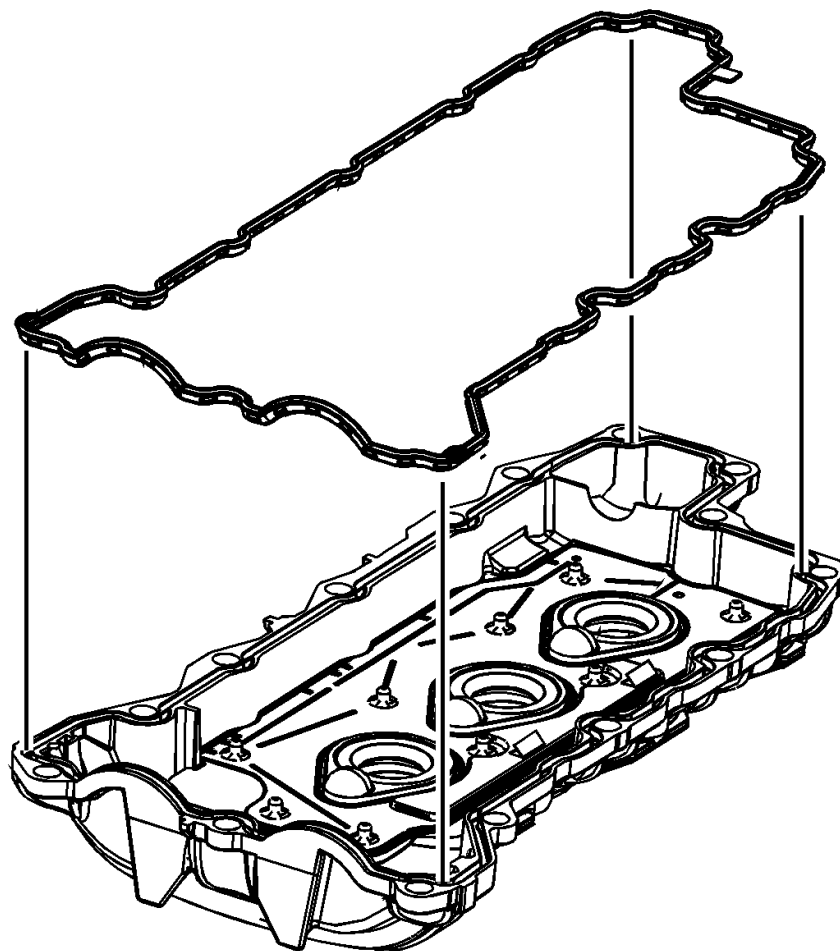


Fig. 328: View of Left Camshaft Cover Gasket Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW left camshaft cover gasket.

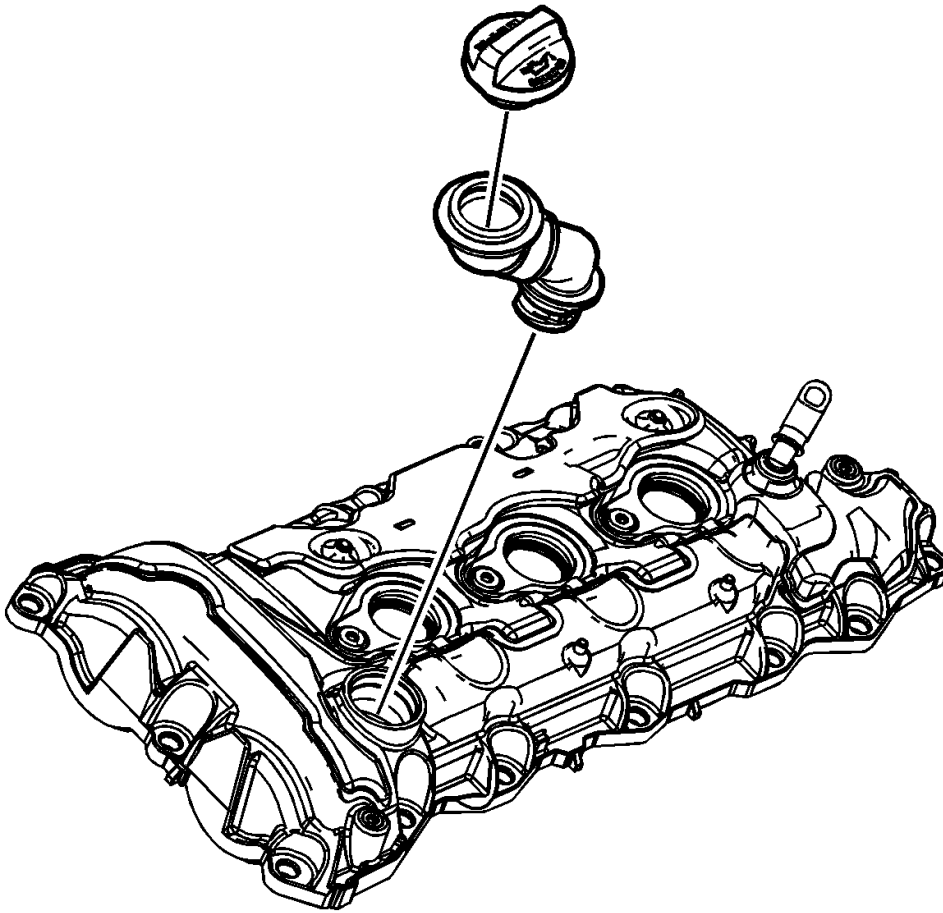


Fig. 329: View of Oil Filter Cap Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Install the oil fill cap.

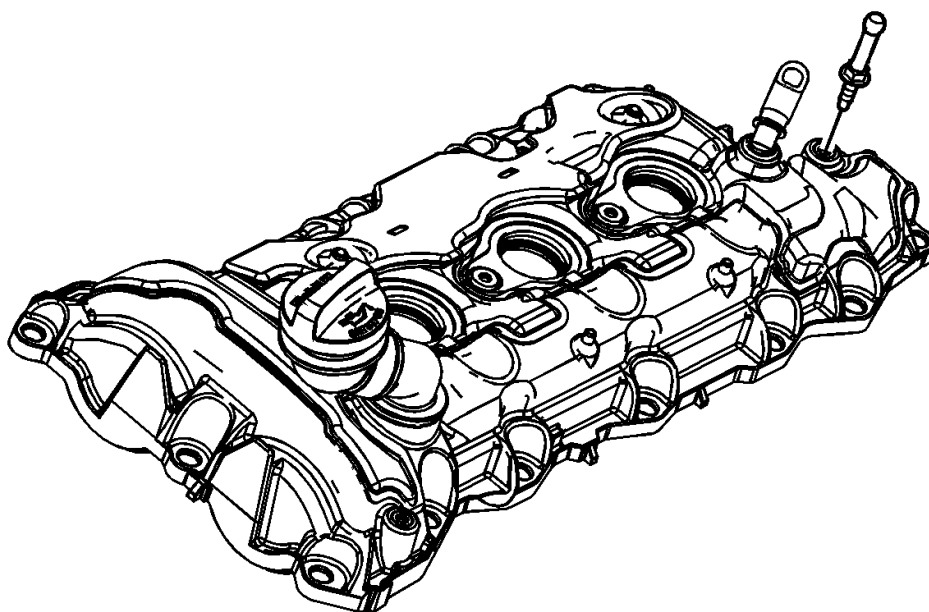


Fig. 330: View of Fuel Injector Sight Shield Cover Ballstud
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the fuel injector sight shield cover ballstud and tighten to 10 N.m (89 lb in).

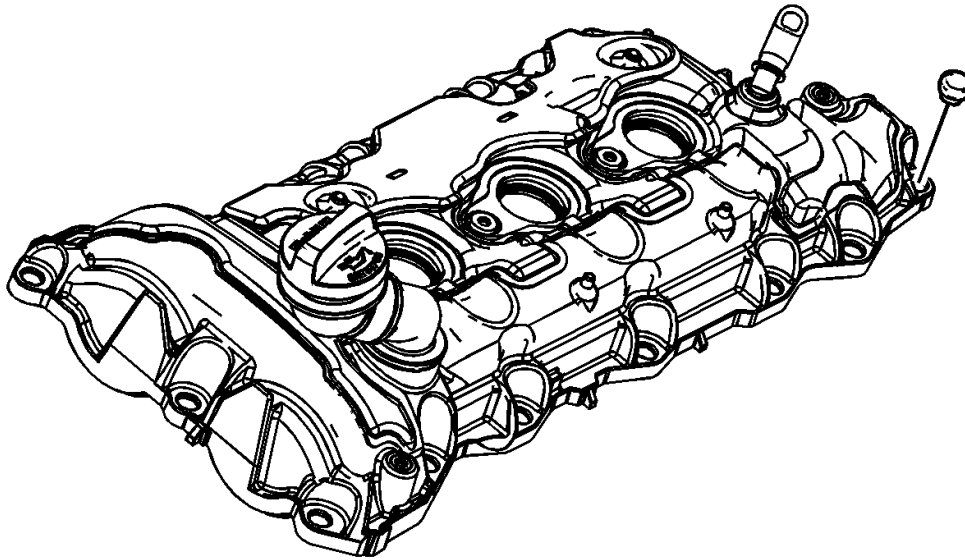


Fig. 331: View of Left Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

NOTE: The camshaft cover bolt grommet must be installed into the camshaft cover bolt hole before installing the camshaft cover bolt.

5. Install the NEW left camshaft cover bolt grommets.

Right Camshaft Cover

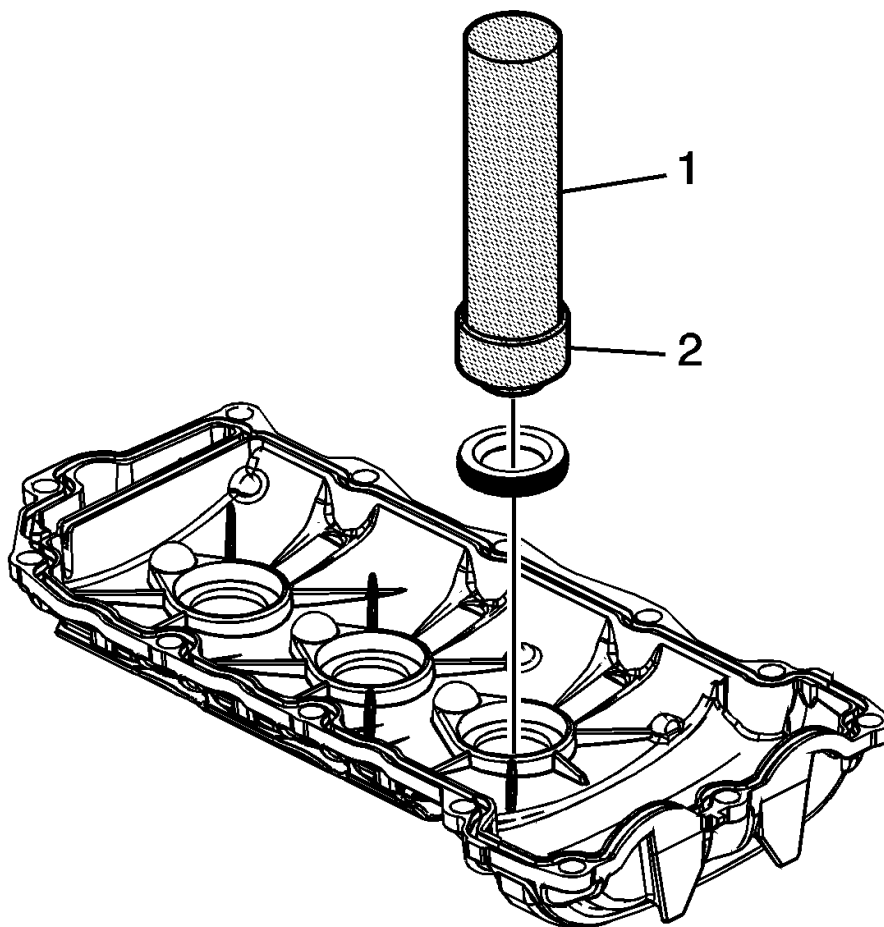


Fig. 332: Identifying Special Tools - J-5590 & J-25254-A
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW right spark plug shield tube coil seals using **J-5590** driver (1) and **J-25254-A** installer (2).

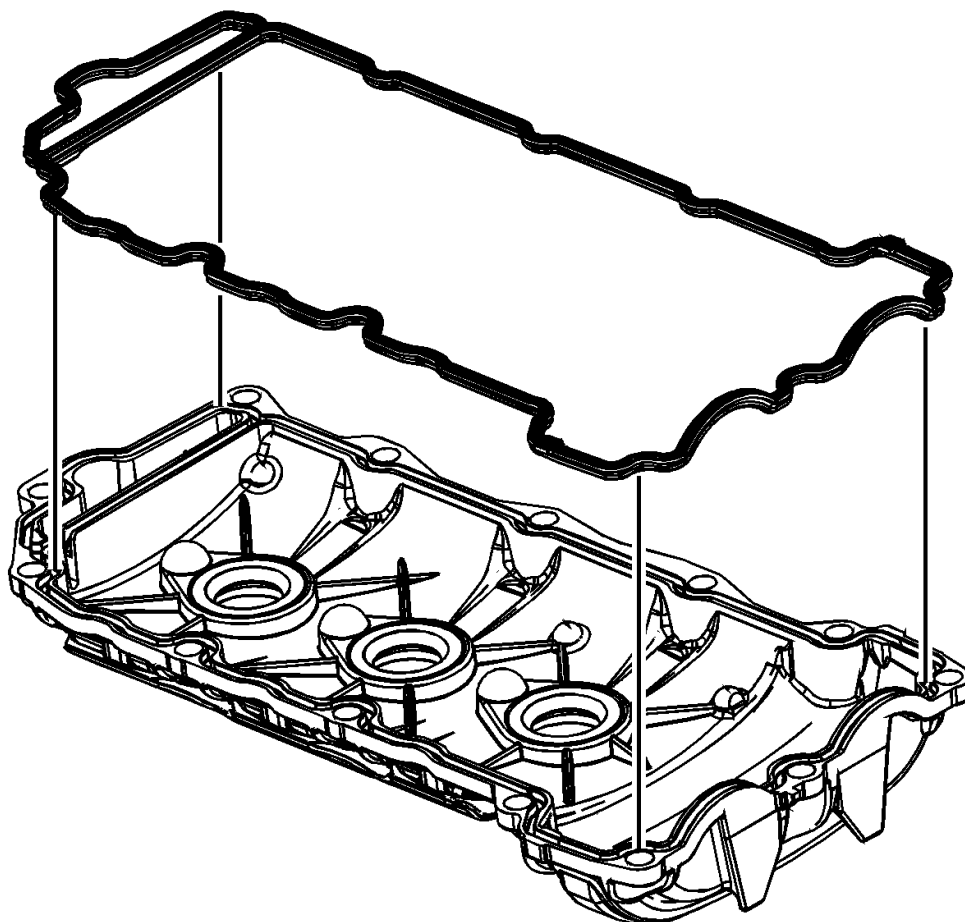


Fig. 333: View Of Right Camshaft Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW right camshaft cover gasket.

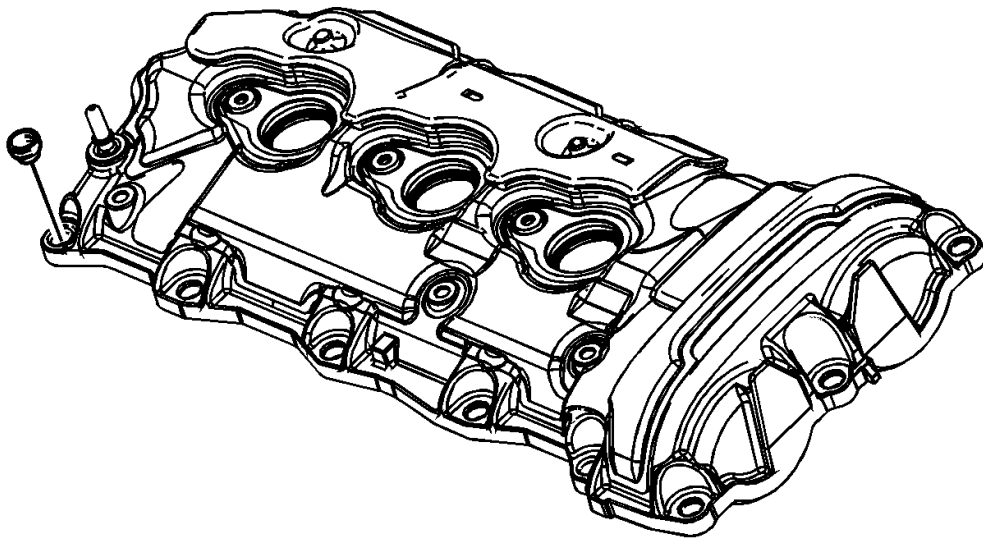


Fig. 334: View Of Right Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

NOTE: The camshaft cover bolt grommet must be installed into the camshaft cover bolt hole before installing the camshaft cover bolt.

3. Install the NEW right camshaft cover bolt grommets.

INTAKE MANIFOLD DISASSEMBLE

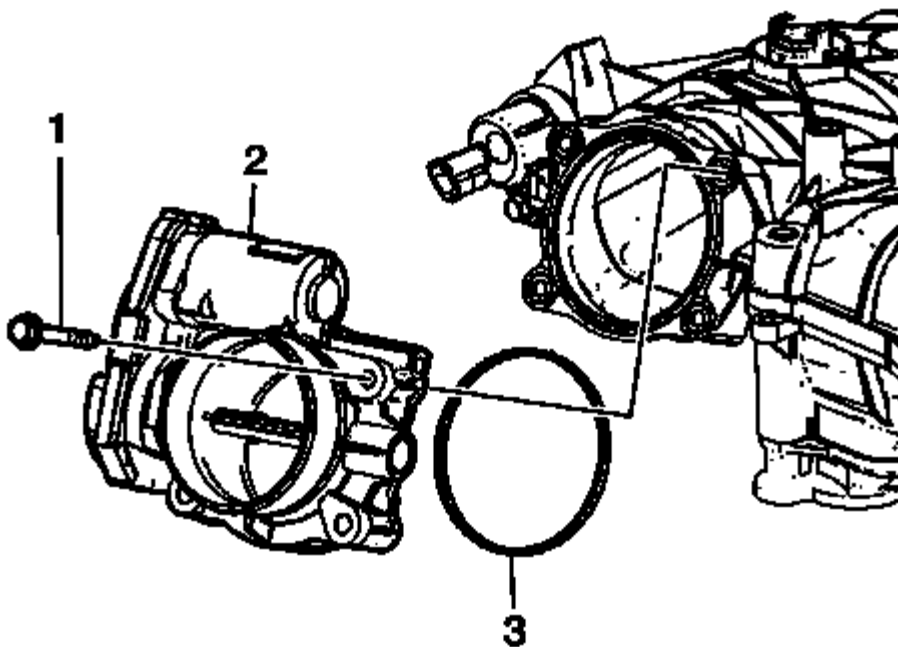


Fig. 335: Throttle Body Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove the throttle body bolts (1).
2. Remove the throttle body (2).
3. Remove and discard the throttle body seal (3).

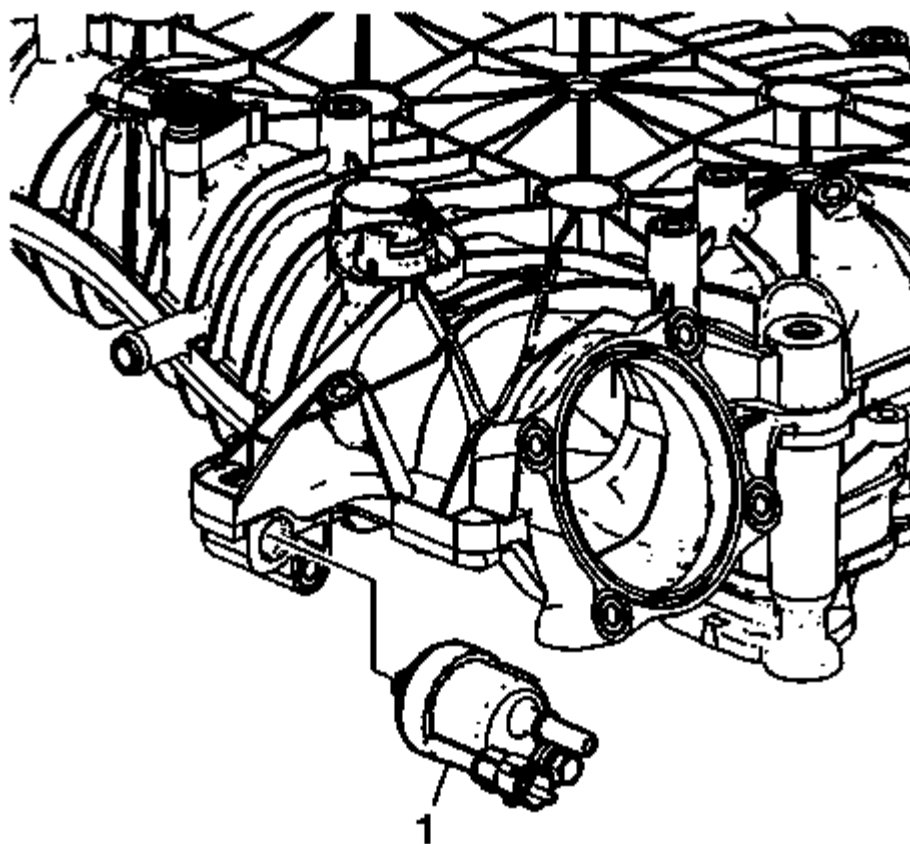


Fig. 336: Identifying EVAP Solenoid
Courtesy of GENERAL MOTORS COMPANY

4. Loosen the evaporative (EVAP) solenoid bolt.
5. Remove the EVAP solenoid (1).

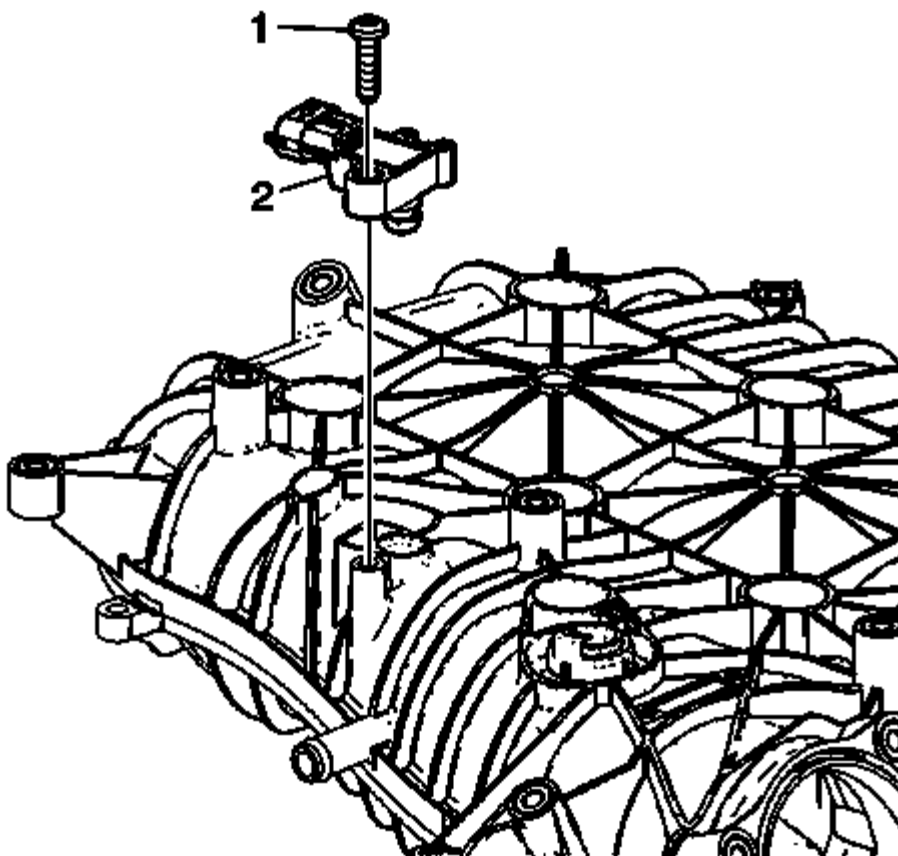


Fig. 337: MAP Sensor

Courtesy of GENERAL MOTORS COMPANY

6. Remove the manifold absolute pressure (MAP) sensor bolt (1).
7. Remove the MAP sensor (2).

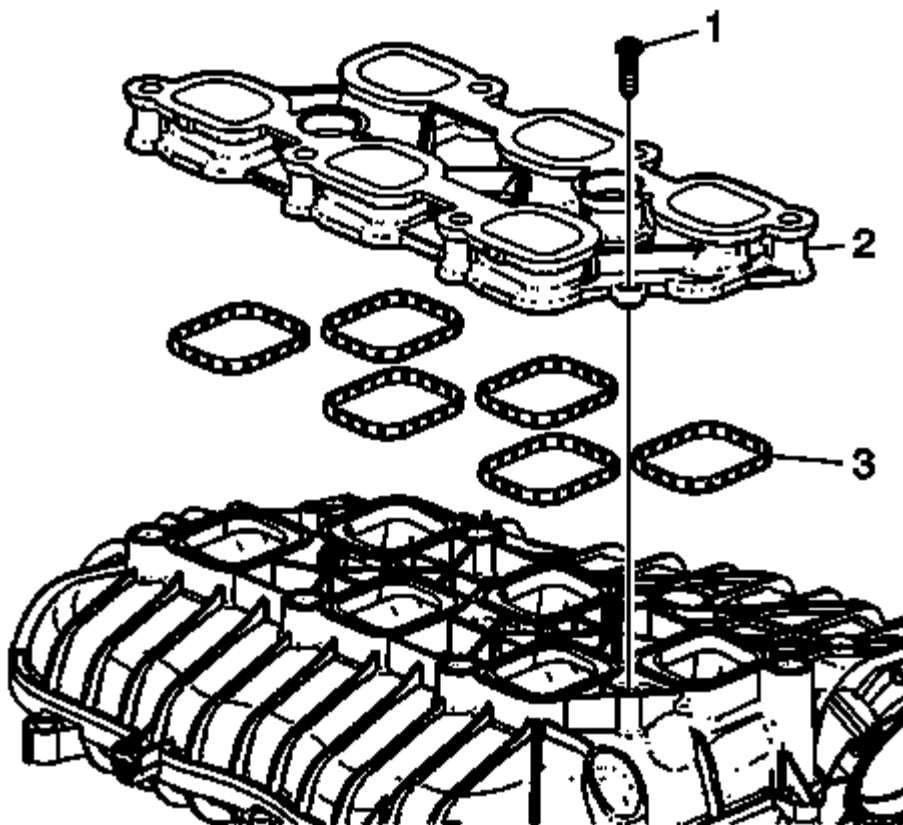


Fig. 338: Lower Intake Manifold Gaskets

Courtesy of GENERAL MOTORS COMPANY

8. Remove the lower intake manifold bolts 1) and lower intake manifold (2).
9. Remove and discard the lower intake manifold gaskets (3).

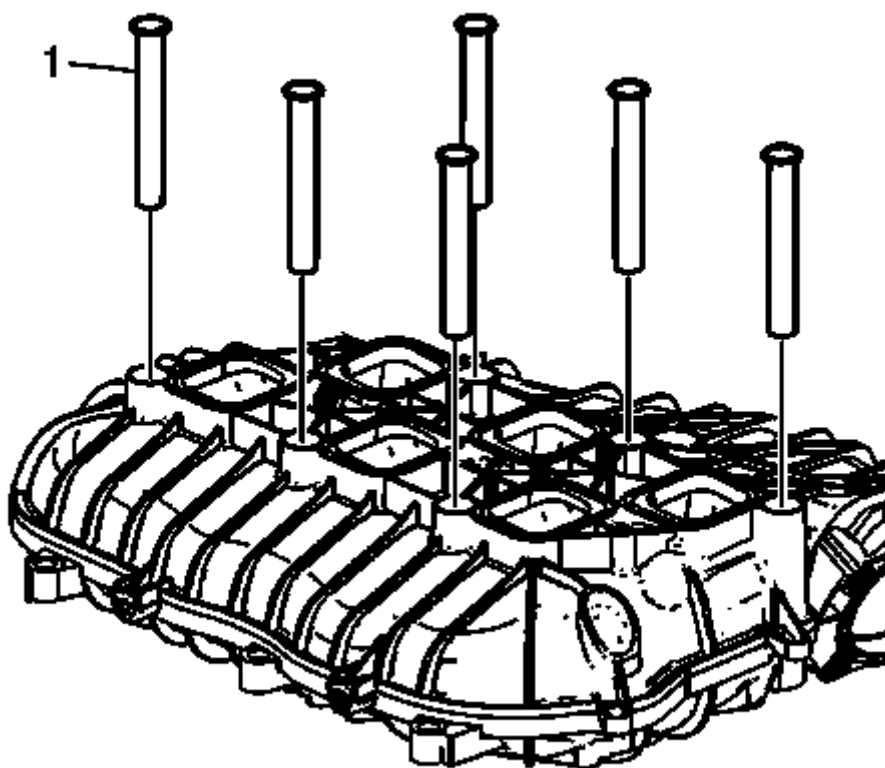


Fig. 339: Plastic Compression Limiters
Courtesy of GENERAL MOTORS COMPANY

10. Remove and discard the plastic compression limiters (1).

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

WARNING: Refer to Safety Glasses Warning .

Inspection Procedure

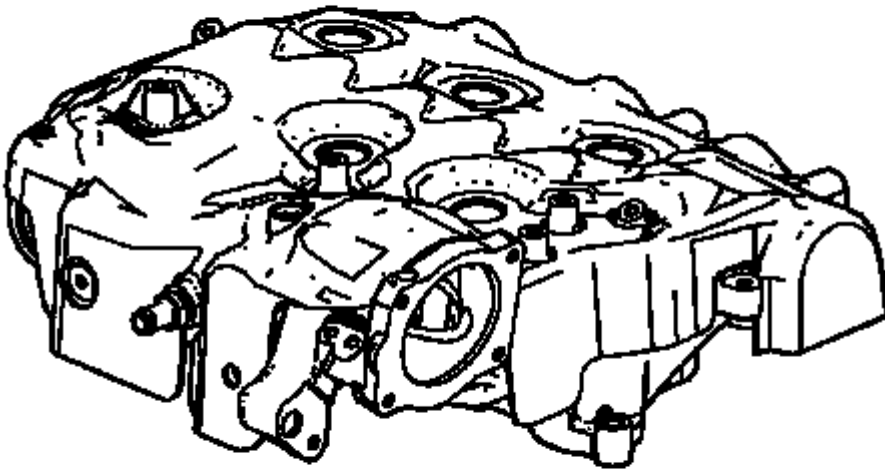


Fig. 340: View Of Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the upper intake manifold for the following conditions:
 - 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

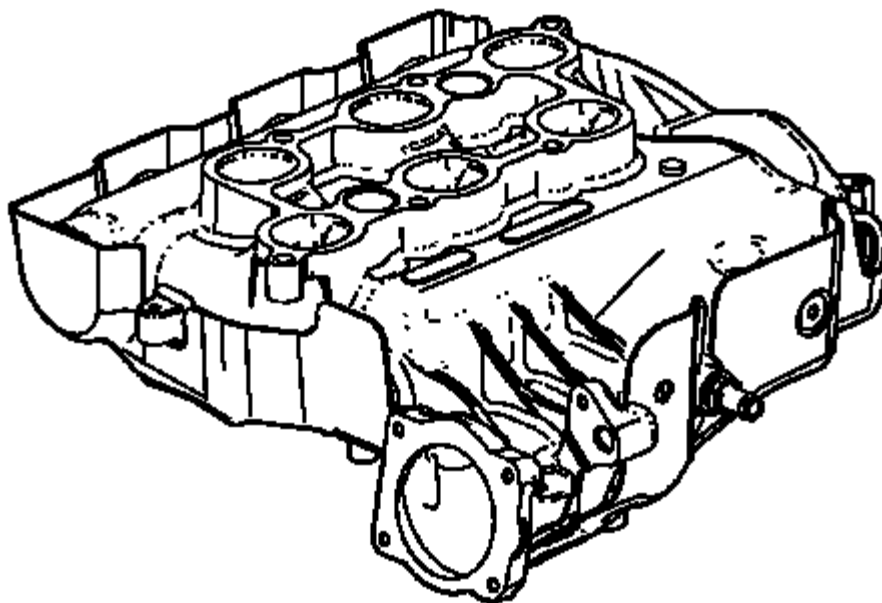


Fig. 341: View Of Upper Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

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
 - Gouges or damage to the intake manifold sealing surfaces
 - Damage to the gasket sealing surface for the throttle body

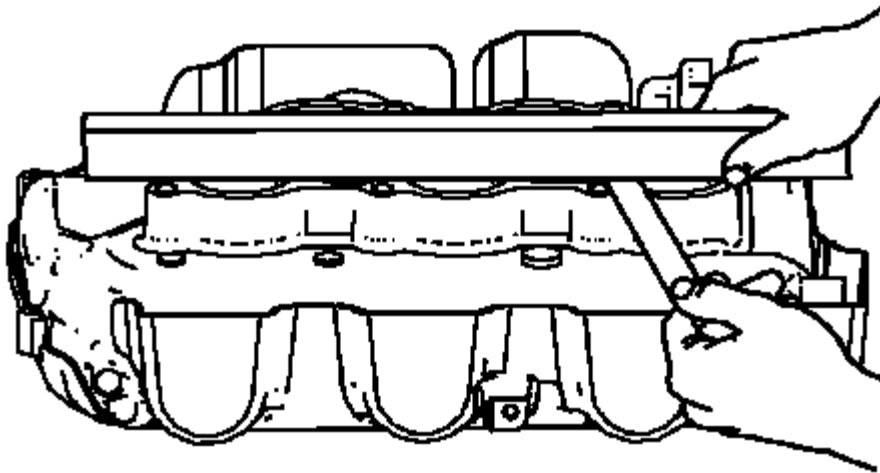


Fig. 342: Inspecting Intake Manifold Sealing Surface For Warpage
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the upper intake manifold sealing surface for warpage.
 1. Locate a straight edge across the intake manifold sealing surface.
 2. Insert a feeler gauge between the upper intake manifold and the straight edge. An intake manifold with warpage in excess of 0.50 mm (0.020 in) must be replaced.
4. Repair or replace the upper intake manifold as necessary.

INTAKE MANIFOLD ASSEMBLE

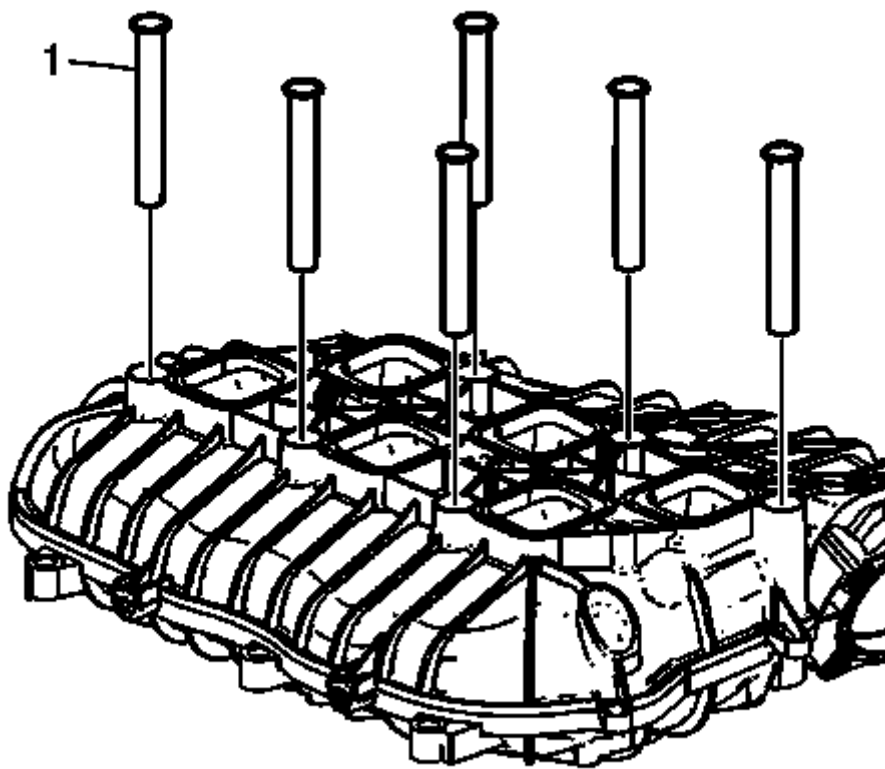


Fig. 343: Plastic Compression Limiters
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW plastic compression limiters (1).

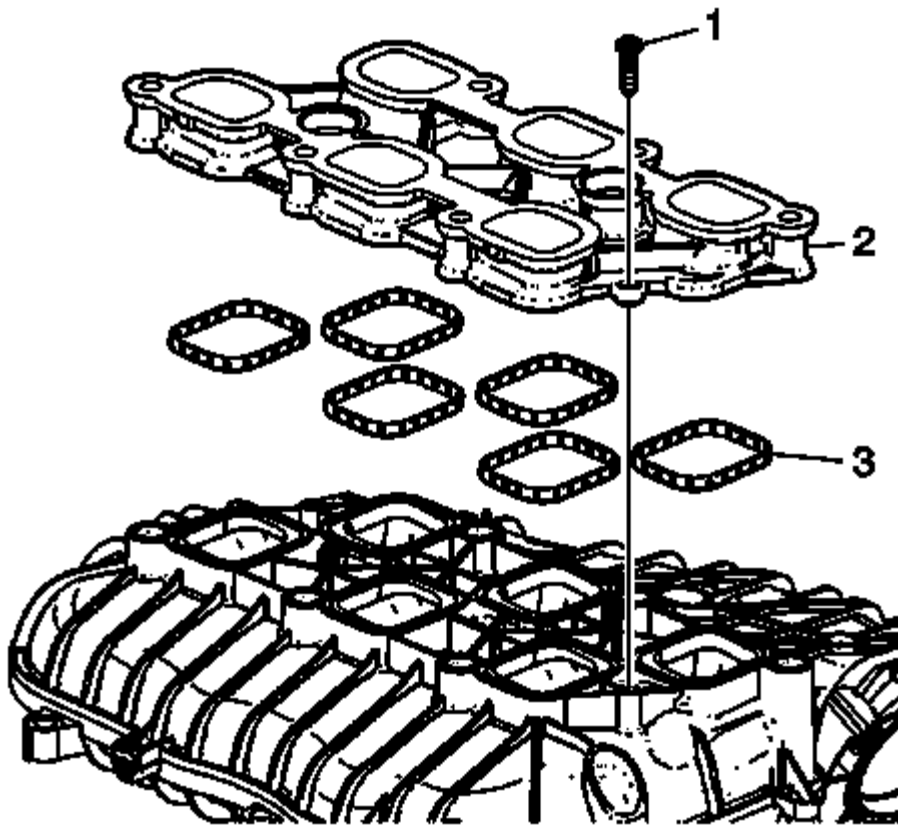


Fig. 344: Lower Intake Manifold Gaskets
 Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW lower intake manifold gaskets (3).
3. Install the lower intake manifold (2) and bolts (1).
4. Tighten the lower intake manifold bolts (1) to 7 N.m (62 lb in).

CAUTION: Refer to Fastener Caution .

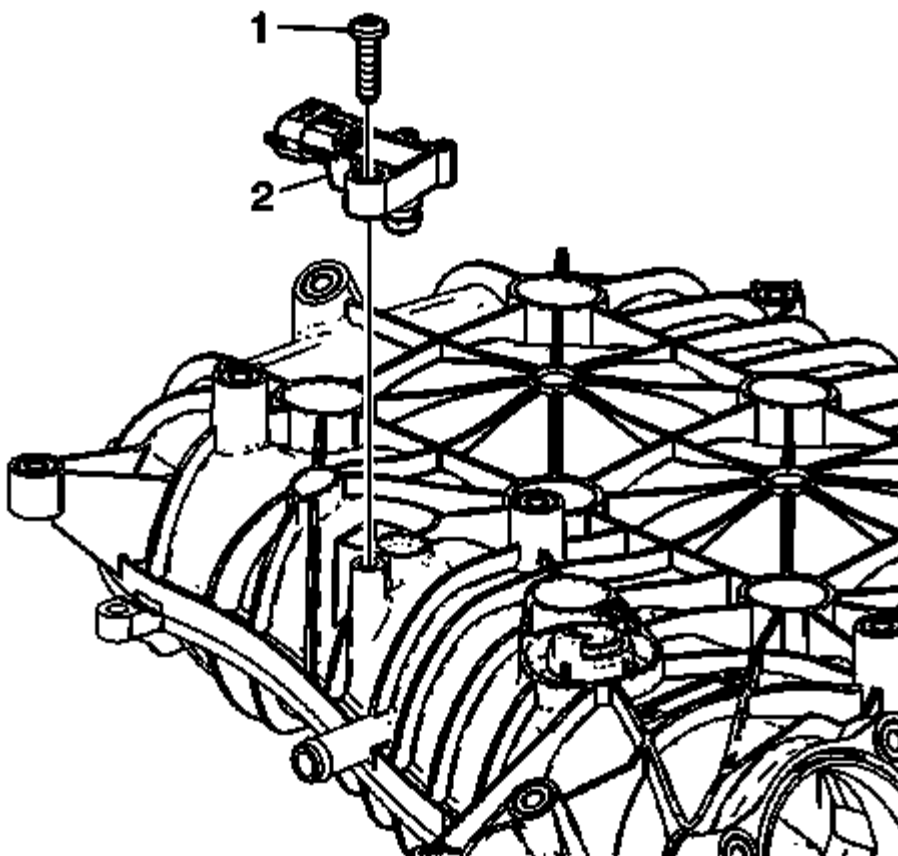


Fig. 345: MAP Sensor

Courtesy of GENERAL MOTORS COMPANY

5. Install the MAP sensor (2).
6. Install the MAP sensor bolt (1) and tighten to 4 N.m (35 lb in).

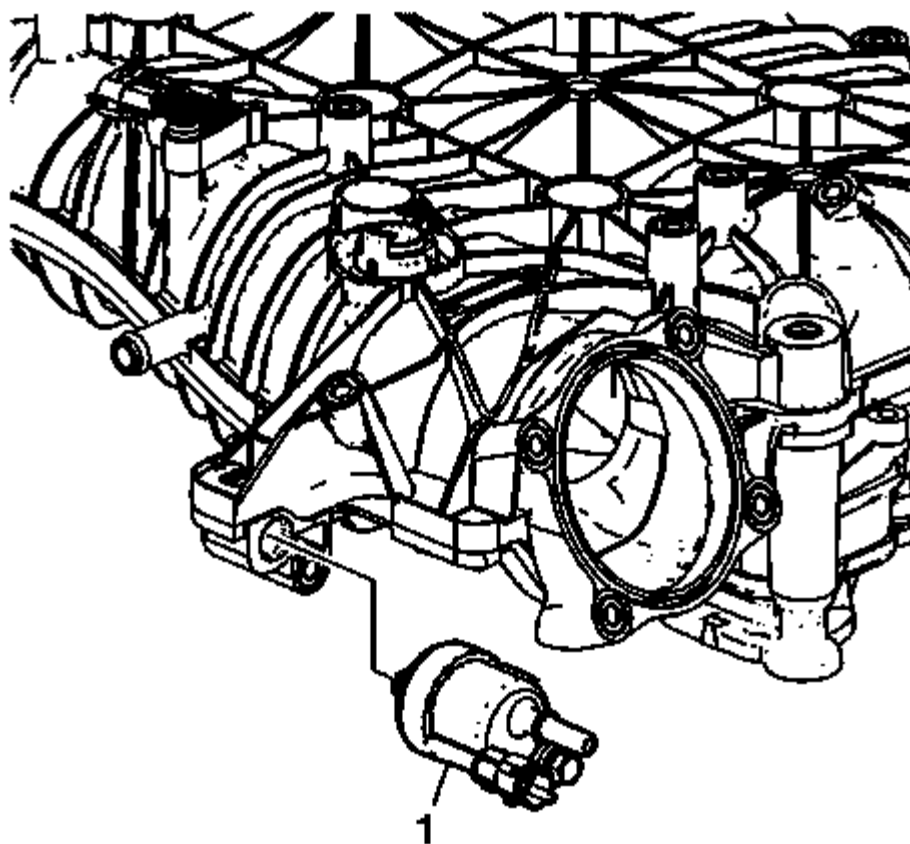


Fig. 346: Identifying EVAP Solenoid
Courtesy of GENERAL MOTORS COMPANY

7. Install the EVAP solenoid (1).
8. Tighten the EVAP solenoid bolt to 10 N.m (89 lb in).

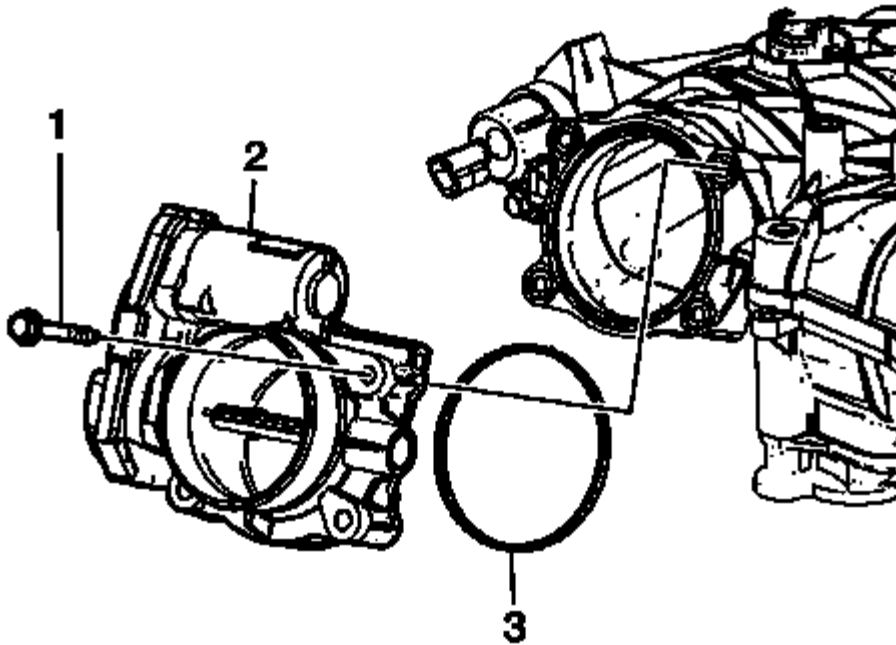


Fig. 347: Throttle Body Components
Courtesy of GENERAL MOTORS COMPANY

9. Install the NEW throttle body seal (3).
10. Install the throttle body (2).
11. Install the throttle body bolts (1) and tighten to 10 N.m (89 lb in).

EXHAUST MANIFOLD CLEANING AND INSPECTION - LEFT SIDE

Cleaning Procedure

1. Clean the exhaust manifold in solvent.
2. Dry the exhaust manifold with compressed air.

WARNING: Refer to Safety Glasses Warning .

Inspection Procedure

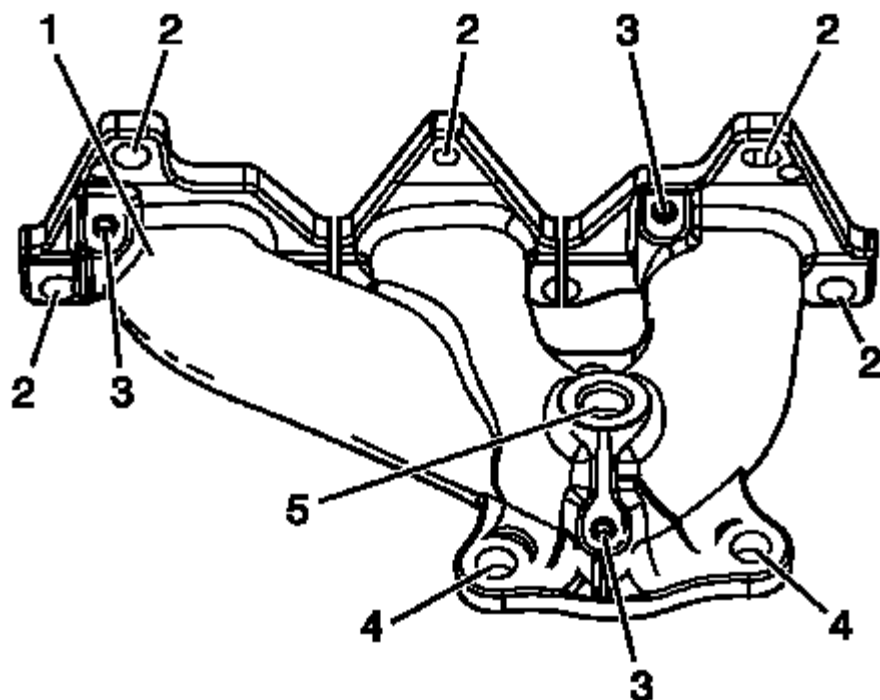


Fig. 348: Identifying Left Exhaust Manifold Component Inspection Areas
 Courtesy of GENERAL MOTORS COMPANY

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)
 - Damage to the heated oxygen sensor (HO2S) hole threads (5)

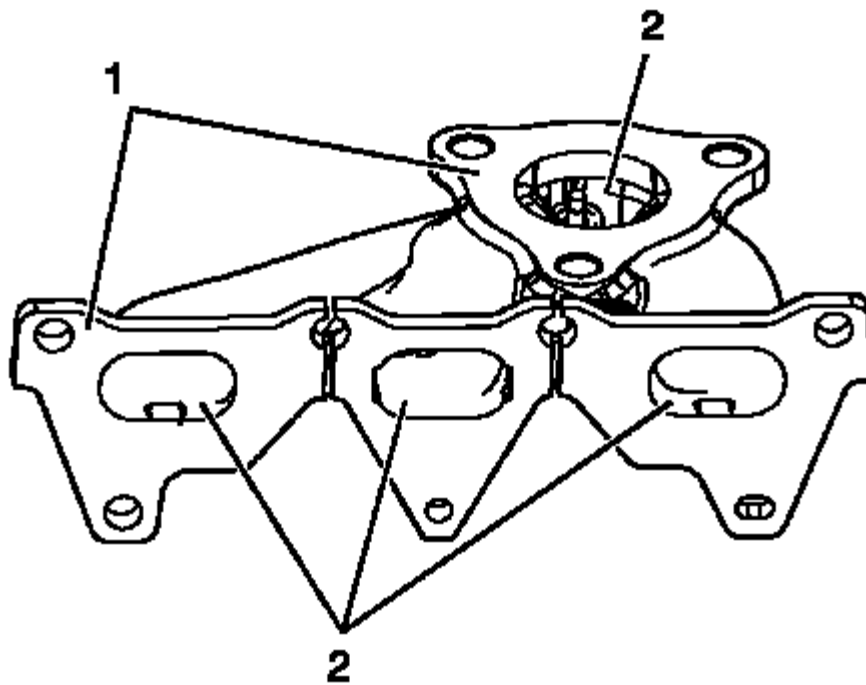


Fig. 349: Identifying Gasket Sealing Surfaces & Exhaust Passages
Courtesy of GENERAL MOTORS COMPANY

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.

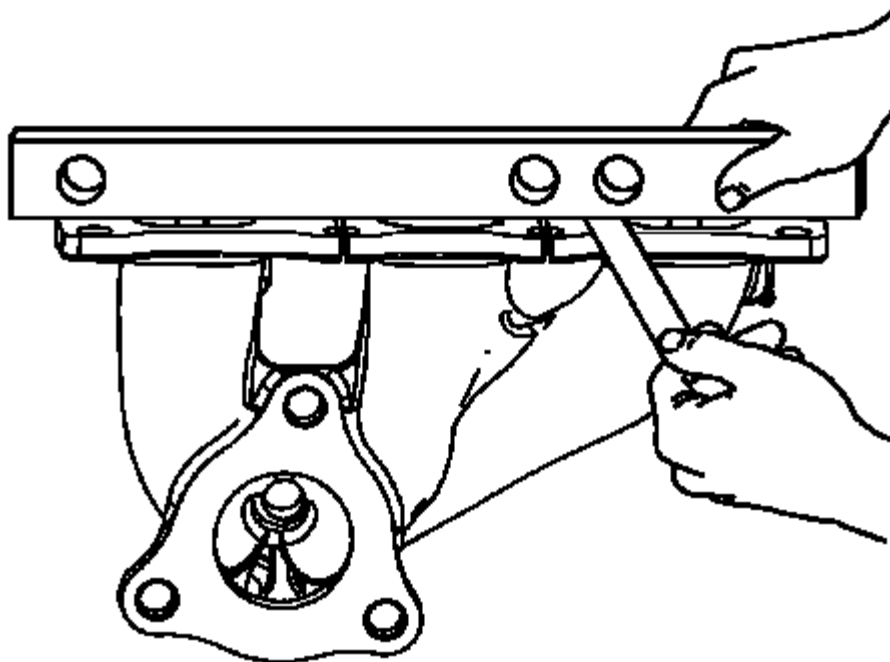


Fig. 350: Measuring Alignment Or Surface Flatness Of Exhaust Manifold Flanges
Courtesy of GENERAL MOTORS COMPANY

4. Measure the alignment or surface flatness of the exhaust manifold flanges, using a straight edge and a feeler gauge. 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 SIDE

Cleaning Procedure

1. Clean the exhaust manifold in solvent.
2. Dry the exhaust manifold with compressed air.

WARNING: Refer to Safety Glasses Warning .

Inspection Procedure

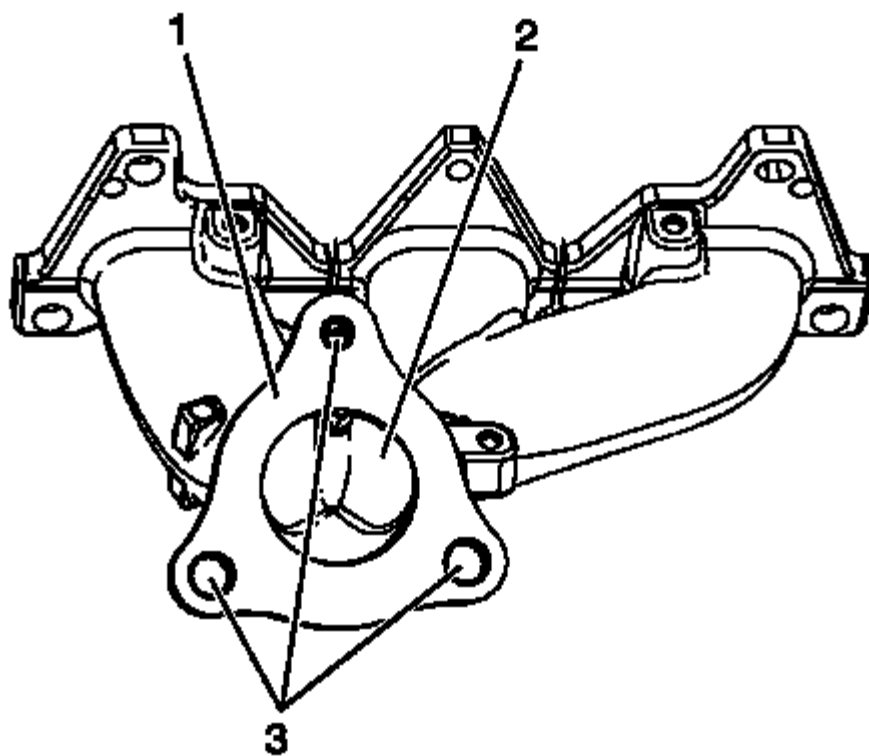


Fig. 351: Identifying Right Exhaust Manifold Component Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the right exhaust manifold for the following:
 - Damage to the gasket sealing surfaces (1)
 - Damage or restrictions within the exhaust passages (2)
 - Damage to the exhaust manifold flange bolt holes (3)

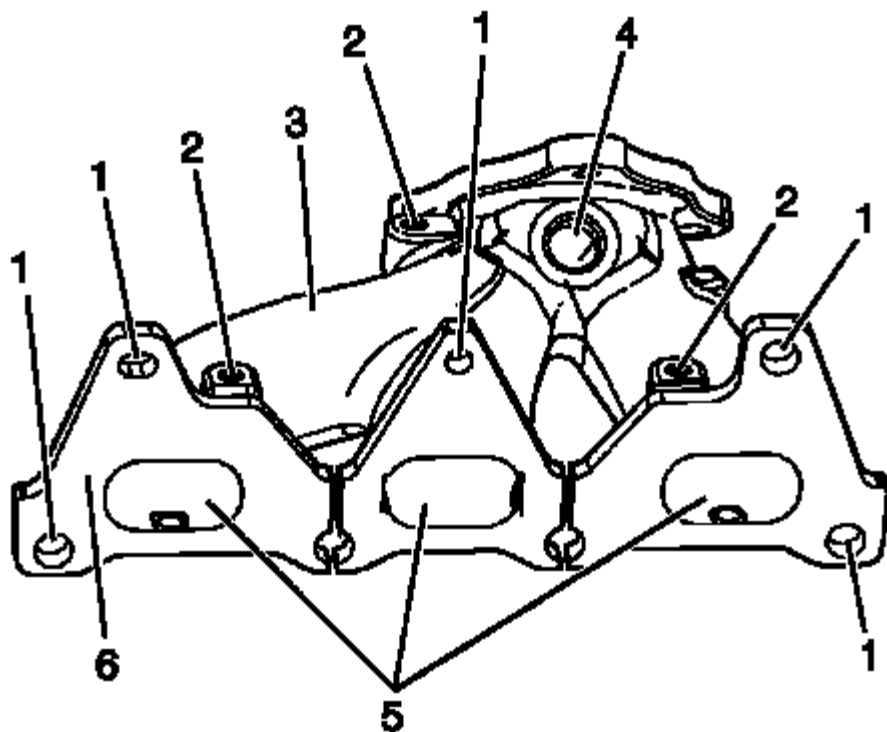


Fig. 352: Identifying Gasket Sealing Surfaces & Exhaust Passages
Courtesy of GENERAL MOTORS COMPANY

2. 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 heated oxygen sensor (HO2S) hole threads (4)
 - Damage or restrictions within the exhaust passages (5)
 - Damage to the gasket sealing surfaces (6)
3. Repair or replace the right exhaust manifold and/or components as necessary.

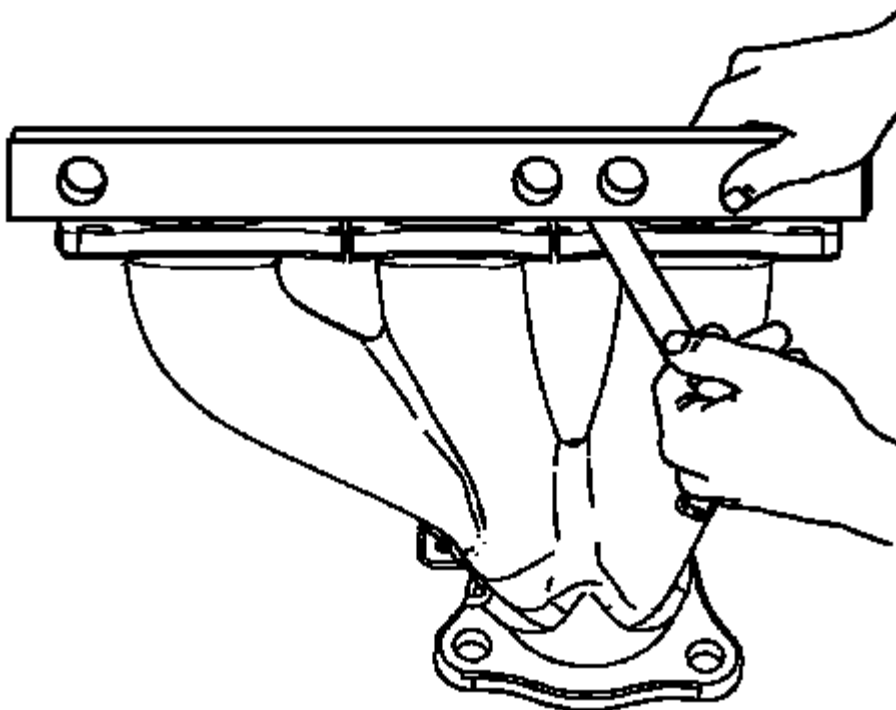


Fig. 353: Measuring Alignment Or Surface Flatness Of Right Exhaust Manifold Flanges
Courtesy of GENERAL MOTORS COMPANY

4. Measure the alignment or surface flatness of the exhaust manifold flanges, using a straight edge and a feeler gauge. 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

1. Remove the old gasket material from the water pump sealing surfaces.

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

2. Clean all excess dirt and debris from the water pump housing.

Inspection Procedure

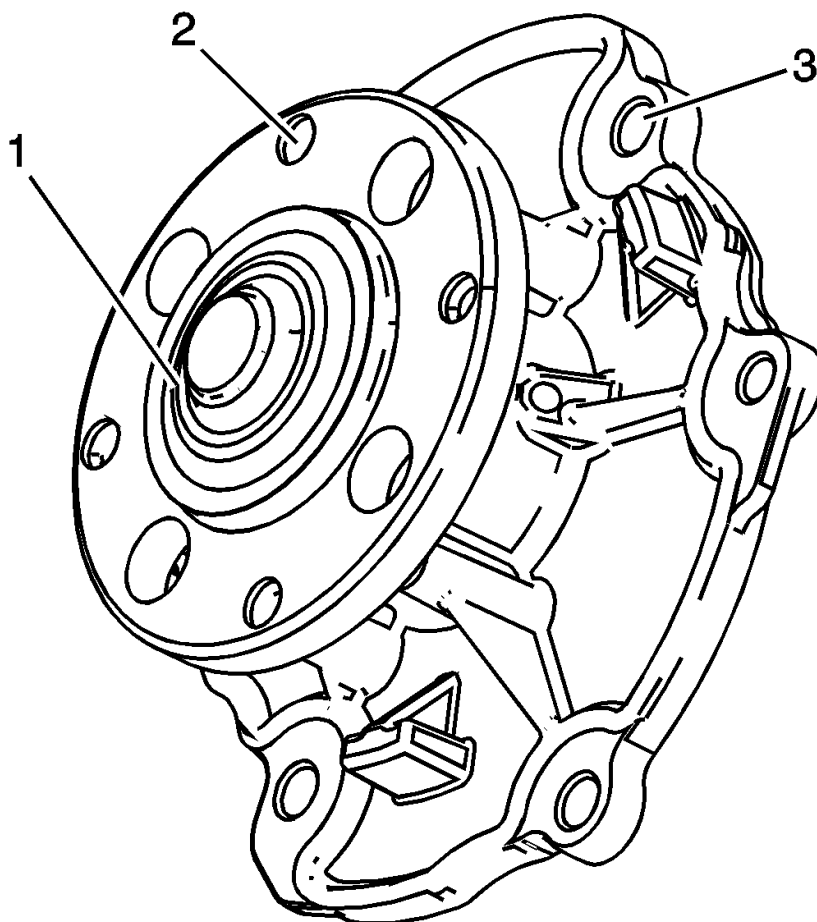


Fig. 354: Inspecting Water Pump & Hub
Courtesy of GENERAL MOTORS COMPANY

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)

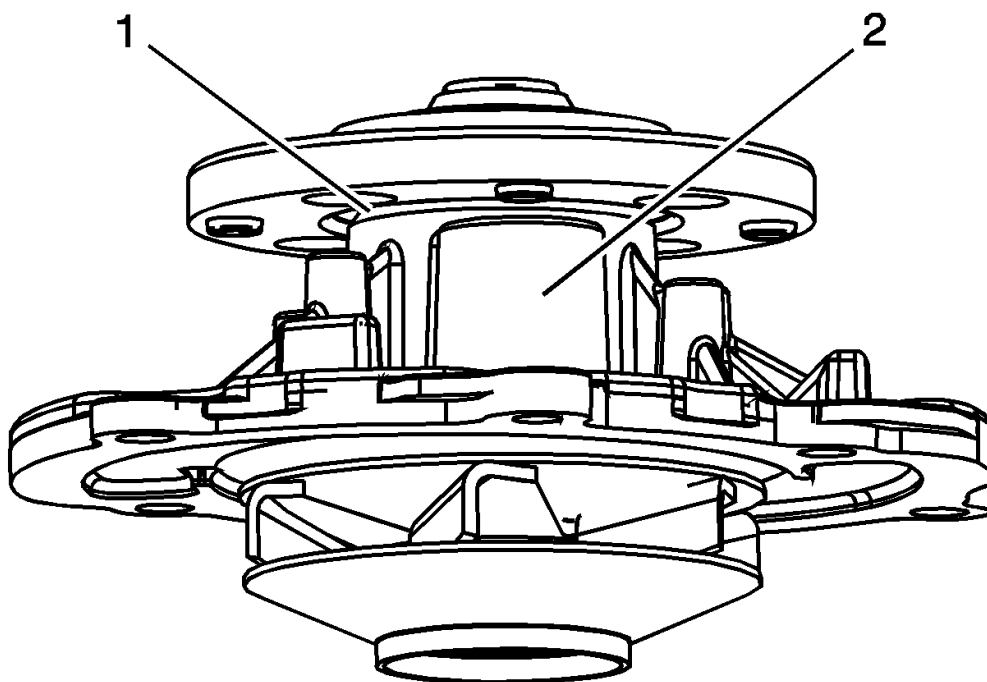


Fig. 355: Checking Water Pump Shaft & Weep Hole For Leakage
Courtesy of GENERAL MOTORS COMPANY

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

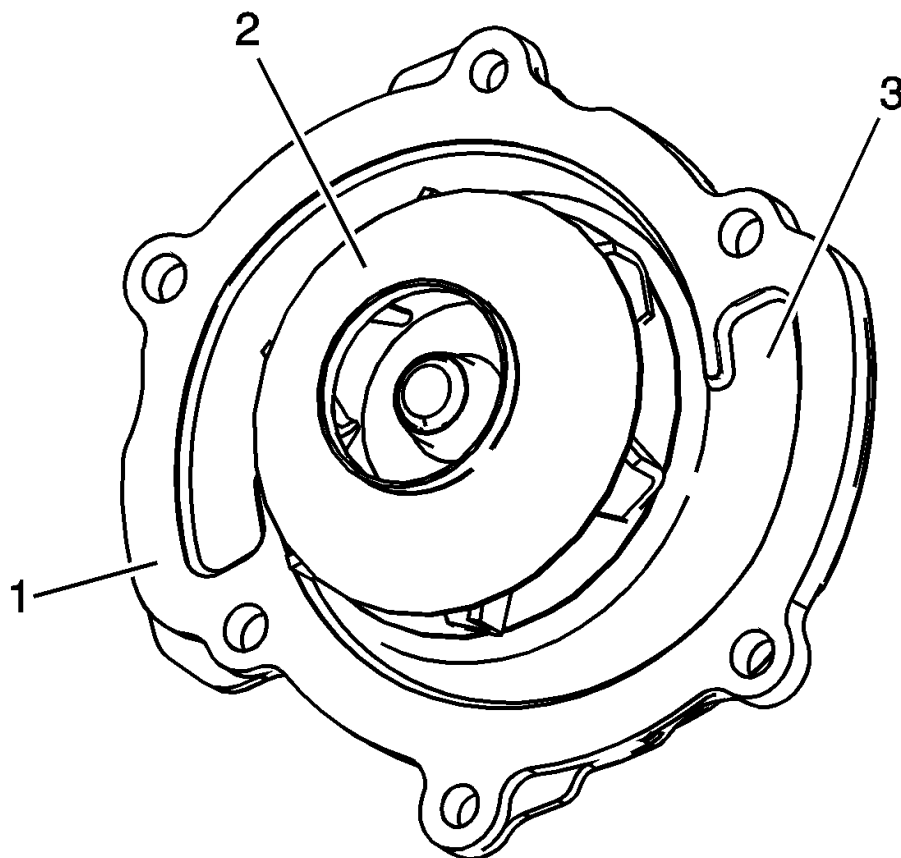


Fig. 356: Inspecting Interior Of Water Pump For Damage
 Courtesy of GENERAL MOTORS COMPANY

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

Special Tools

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

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

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.

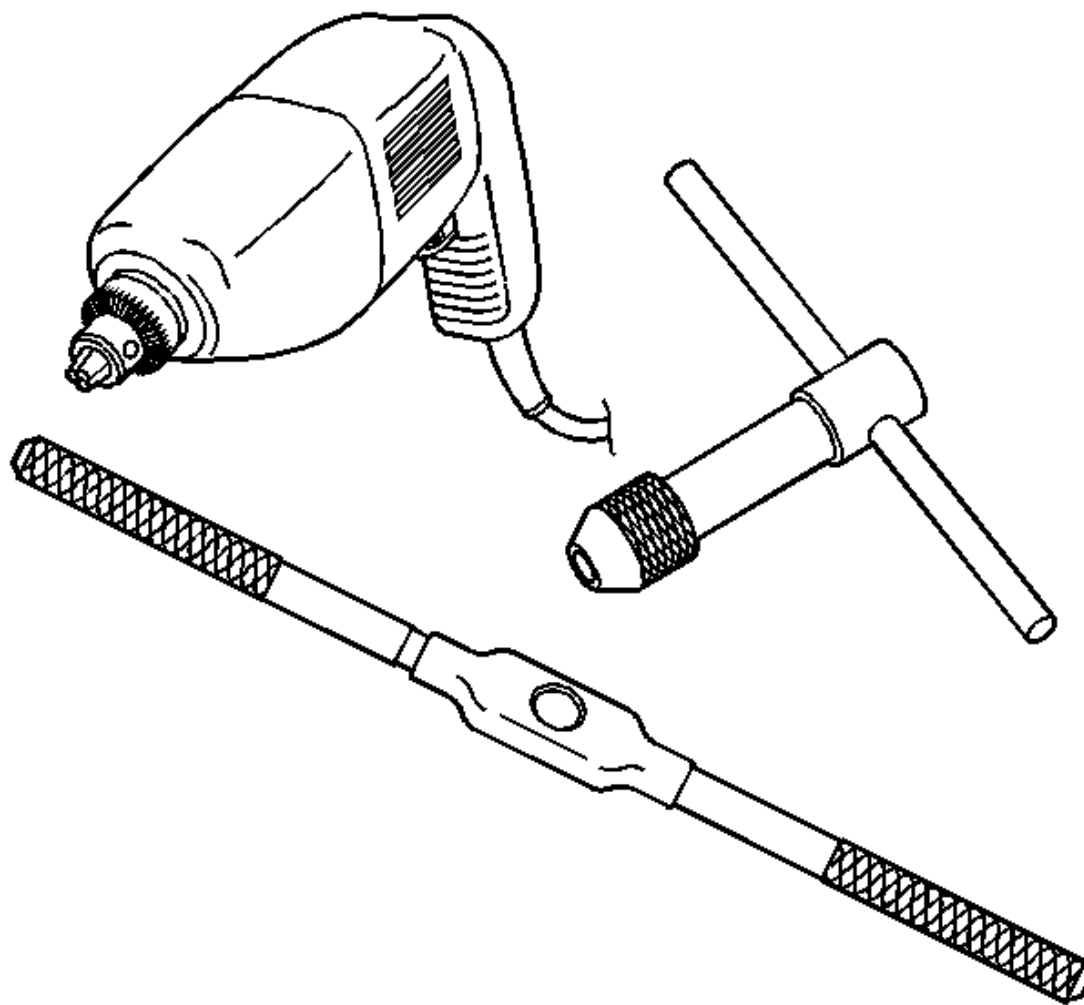


Fig. 357: View Of J 42385-400 Tool Kit
Courtesy of GENERAL MOTORS COMPANY

The drill bit and counter bore tool from the tool kit **EN 42385-700** kit and **EN 42385-2000** insert kit 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 **EN 43965** extension kit 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.

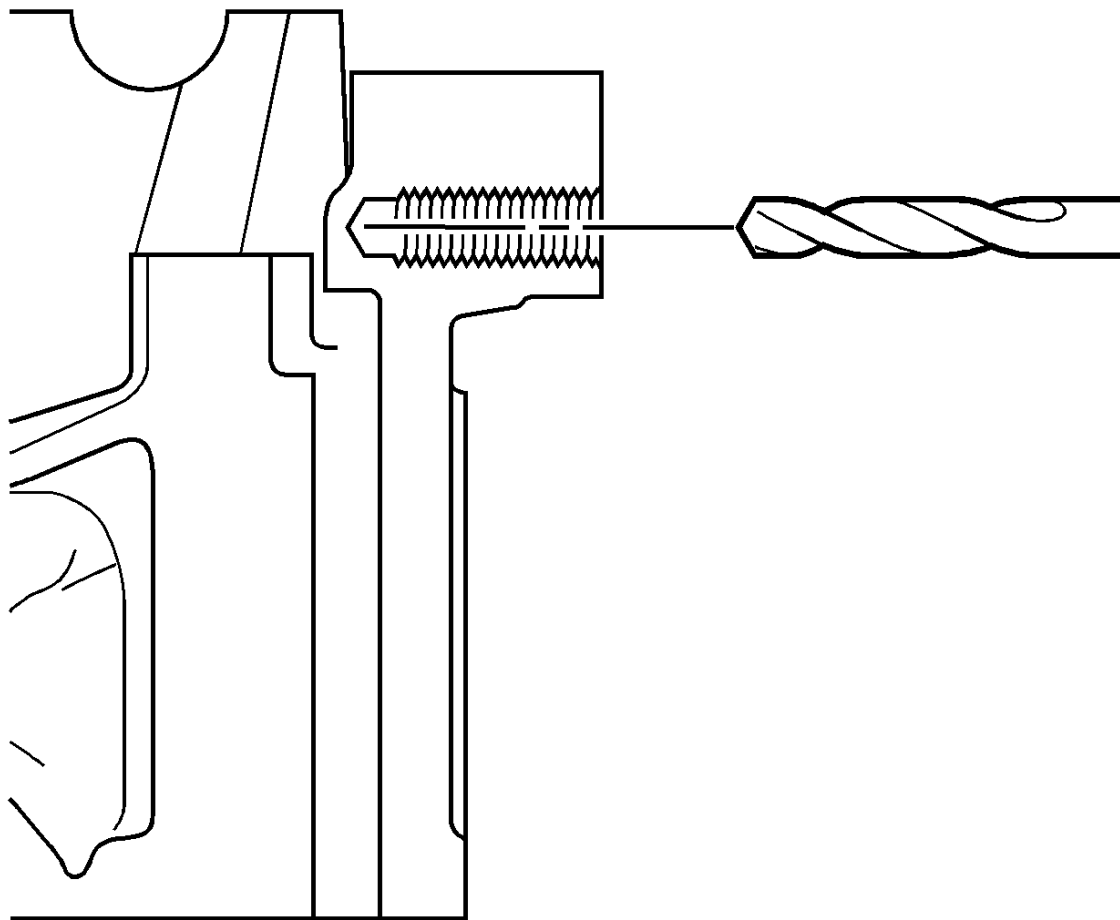


Fig. 358: Drilled Hole Centerline
Courtesy of GENERAL MOTORS COMPANY

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

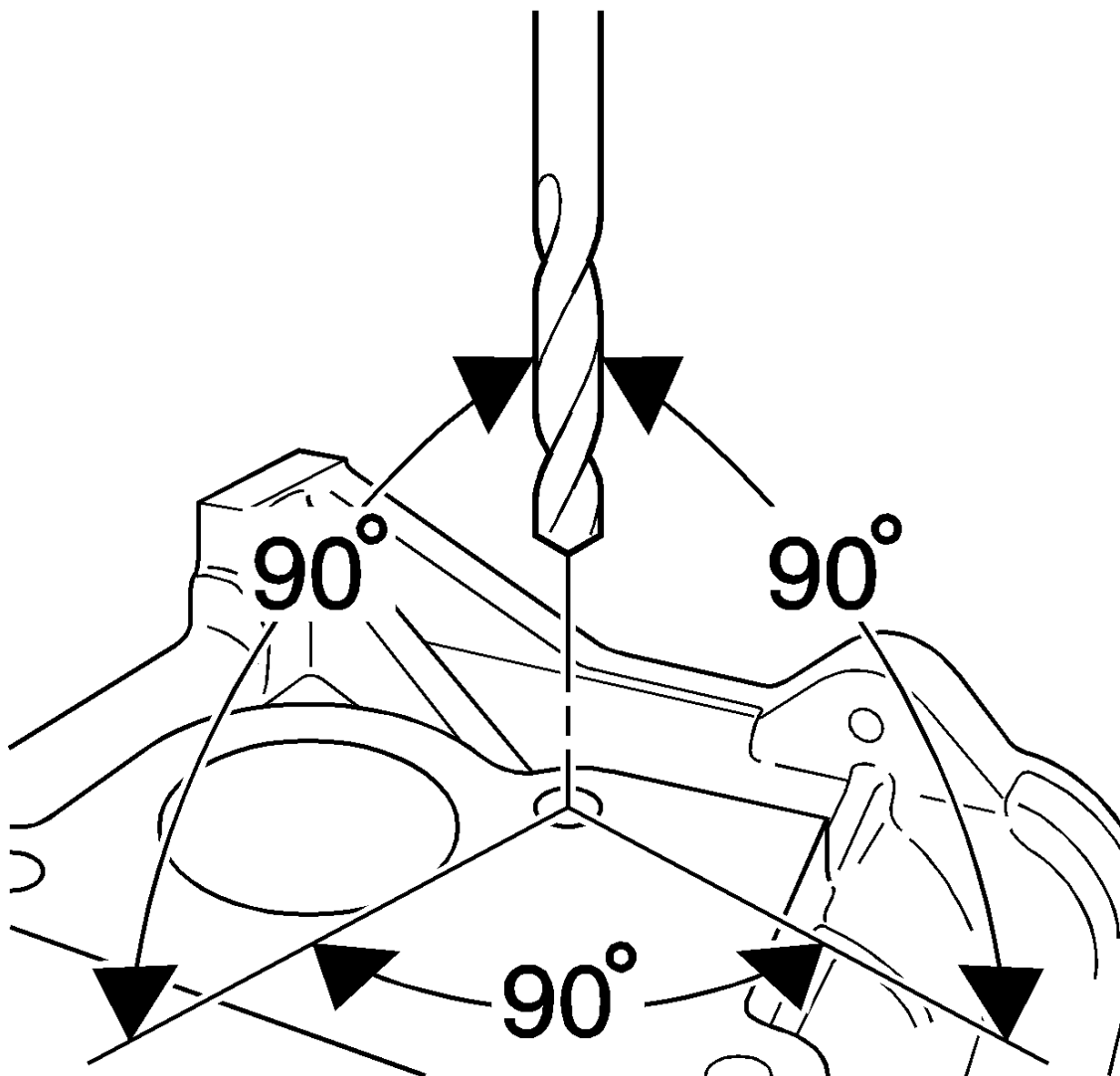


Fig. 359: Identifying Proper Drilling Angle
Courtesy of GENERAL MOTORS COMPANY

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

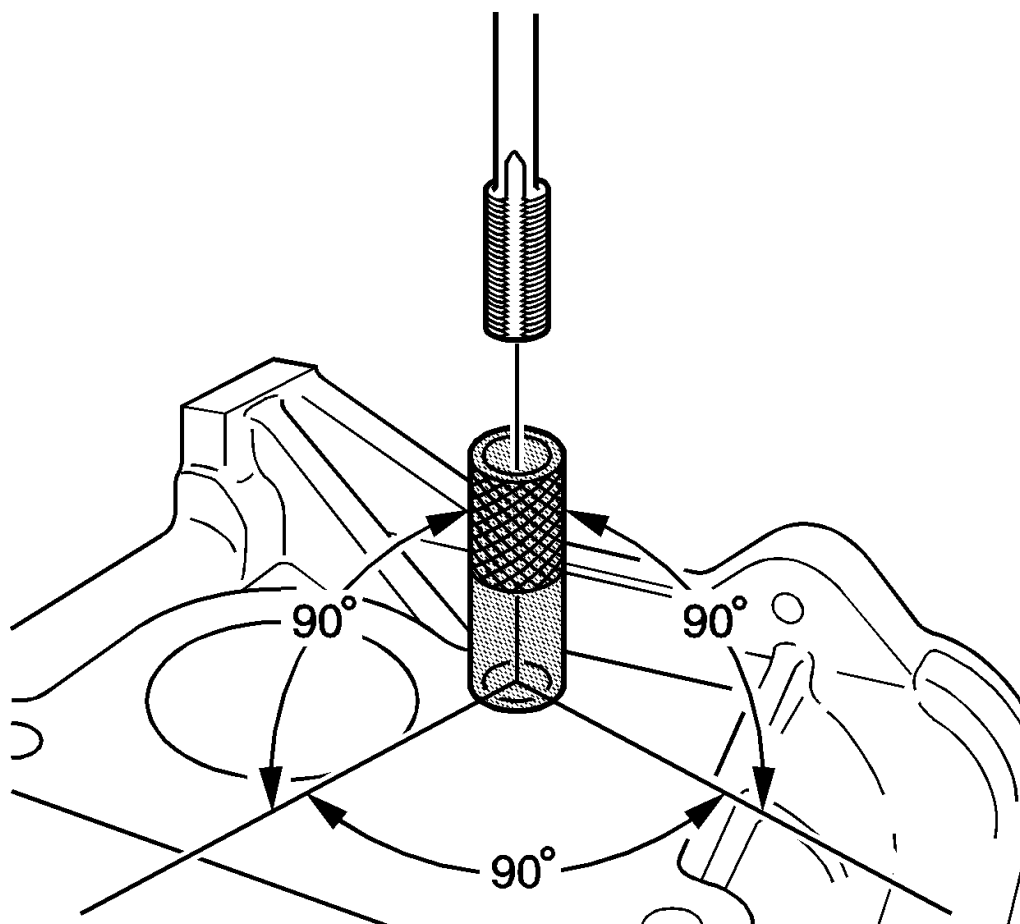


Fig. 360: View Of Tapping Guide
Courtesy of GENERAL MOTORS COMPANY

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.

Tap Size	Tap Guide	Tap Size	Tap Guide	Tap Size	Tap Guide
-	EN 42385-	-	EN 42385-	-	EN 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

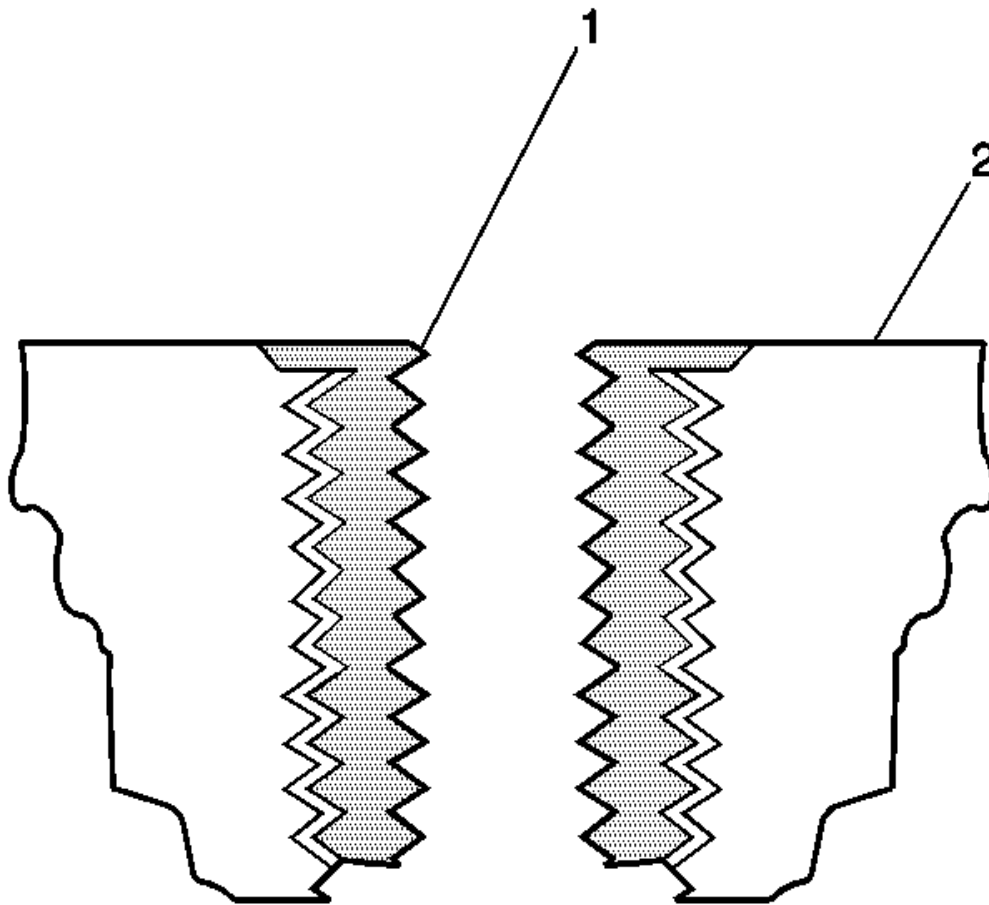


Fig. 361: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

NOTE: The use of a cutting type fluid is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants and Sealers for recommended cutting fluid. 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.

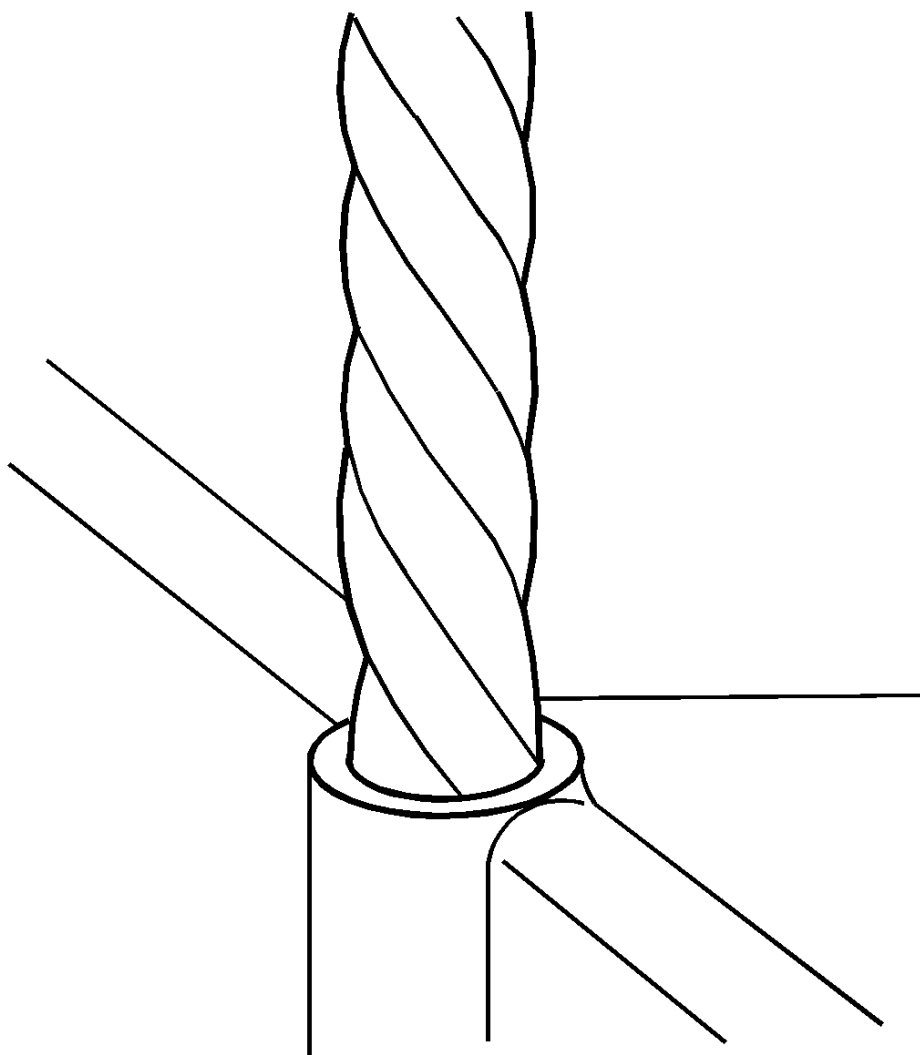


Fig. 362: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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).

2. Using compressed air, clean out any chips.

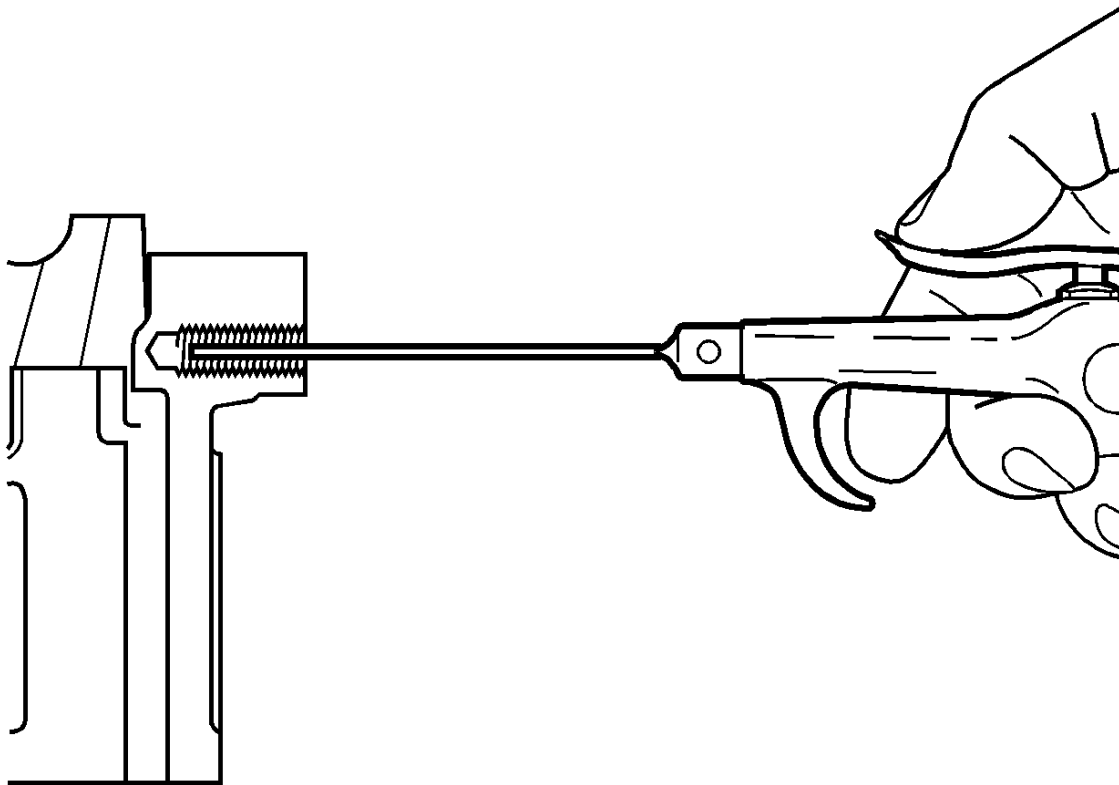


Fig. 363: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

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

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

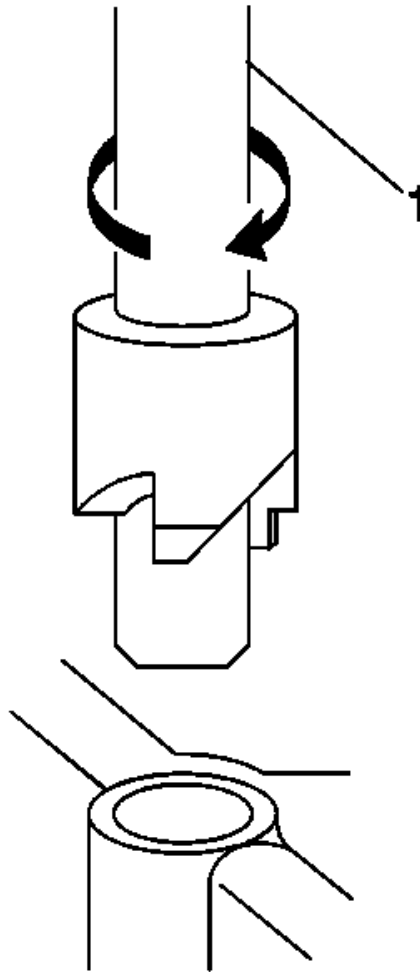


Fig. 364: Identifying Tool Used To Counterbore The Hole
Courtesy of GENERAL MOTORS COMPANY

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

4. Using compressed air, clean out any chips.

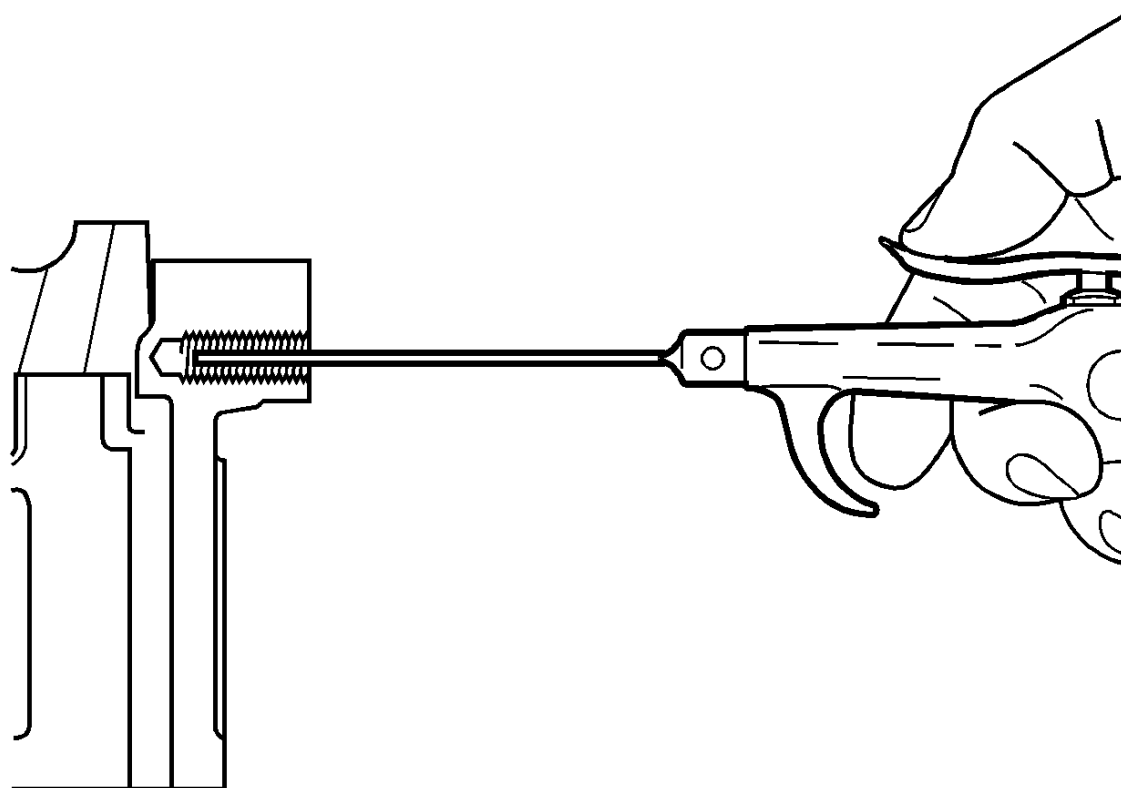


Fig. 365: Cleaning Out Metal Chips

Courtesy of GENERAL MOTORS COMPANY

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

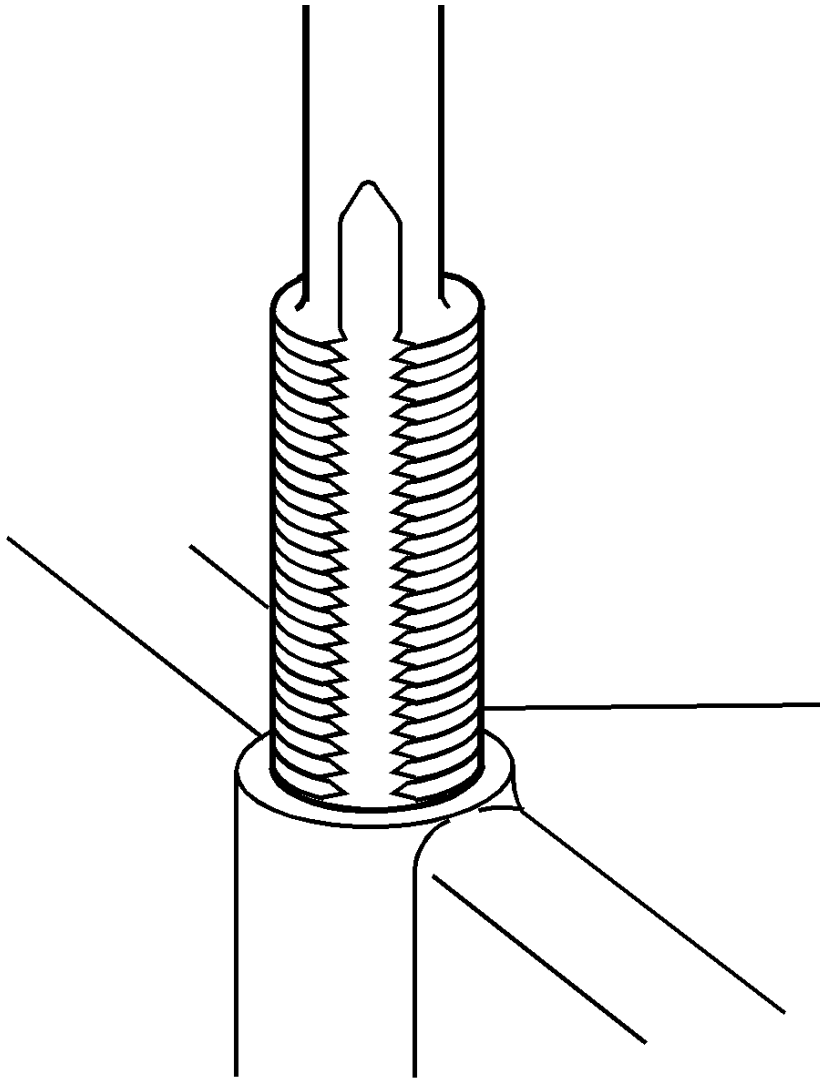


Fig. 366: Tapping Threads Of Drilled Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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).
6. Using compressed air, clean out any chips.

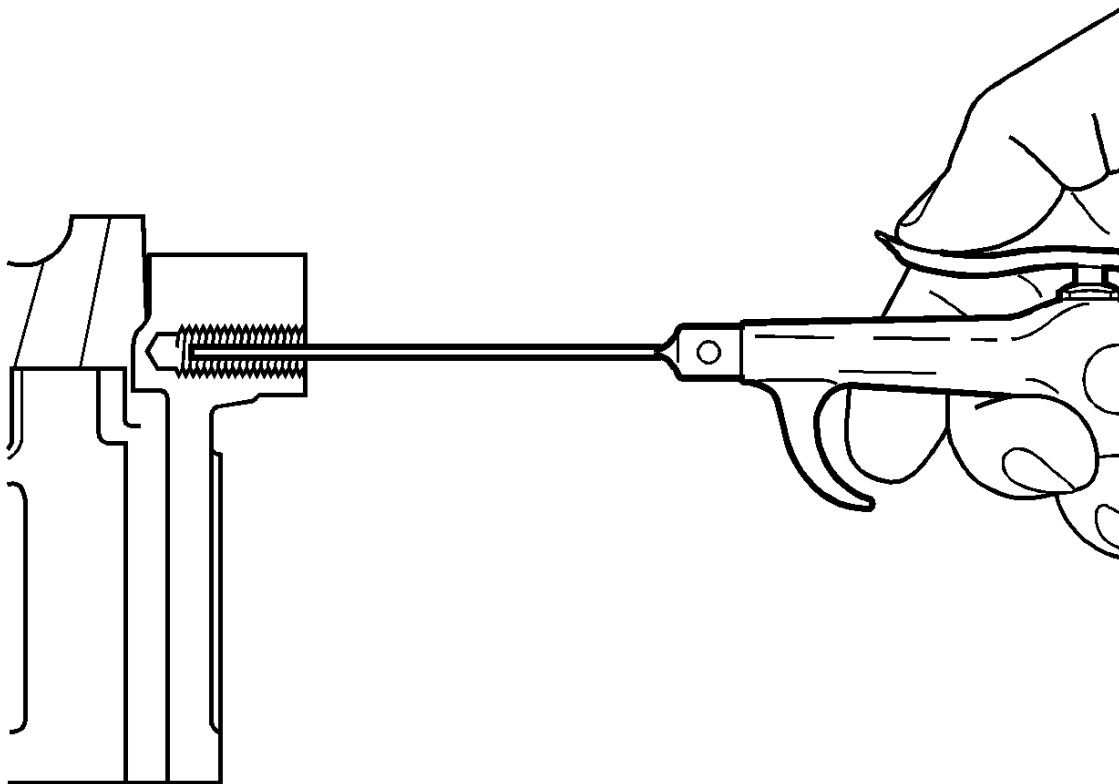


Fig. 367: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

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

7. Spray cleaner into the tapped hole. Refer to Adhesives, Fluids, Lubricants and Sealers for recommended cleaner.

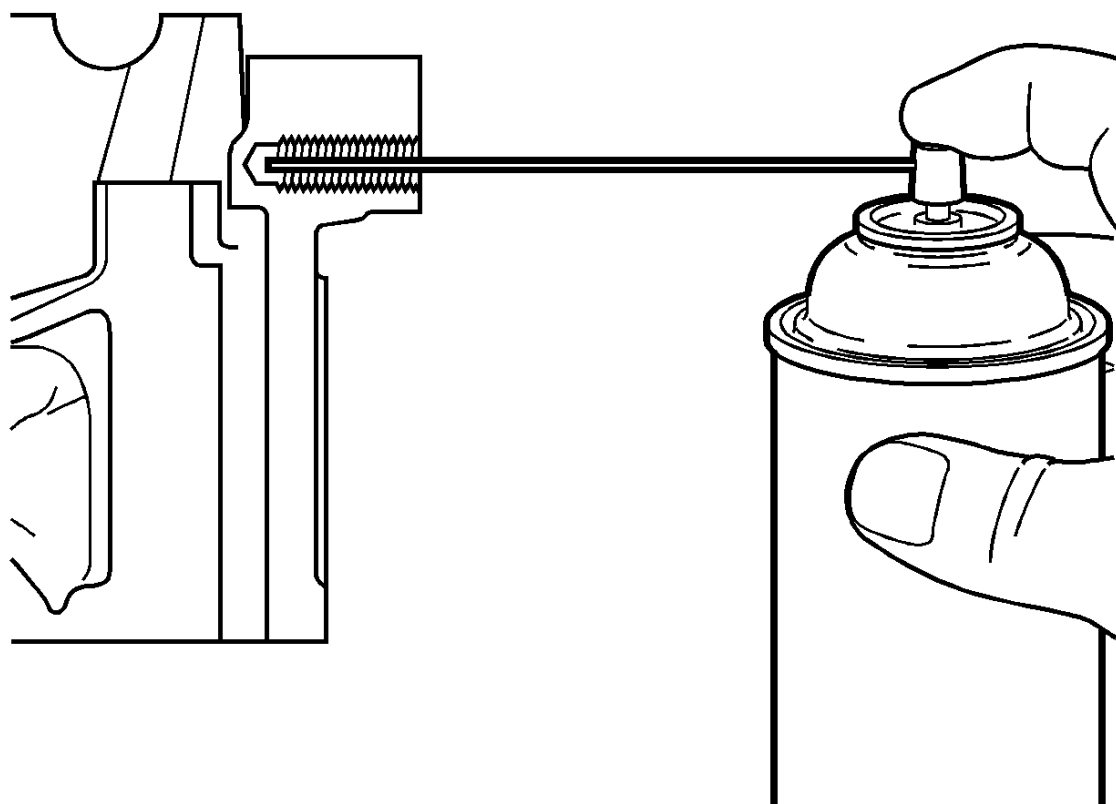


Fig. 368: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS COMPANY

8. Using compressed air, clean out any chips.

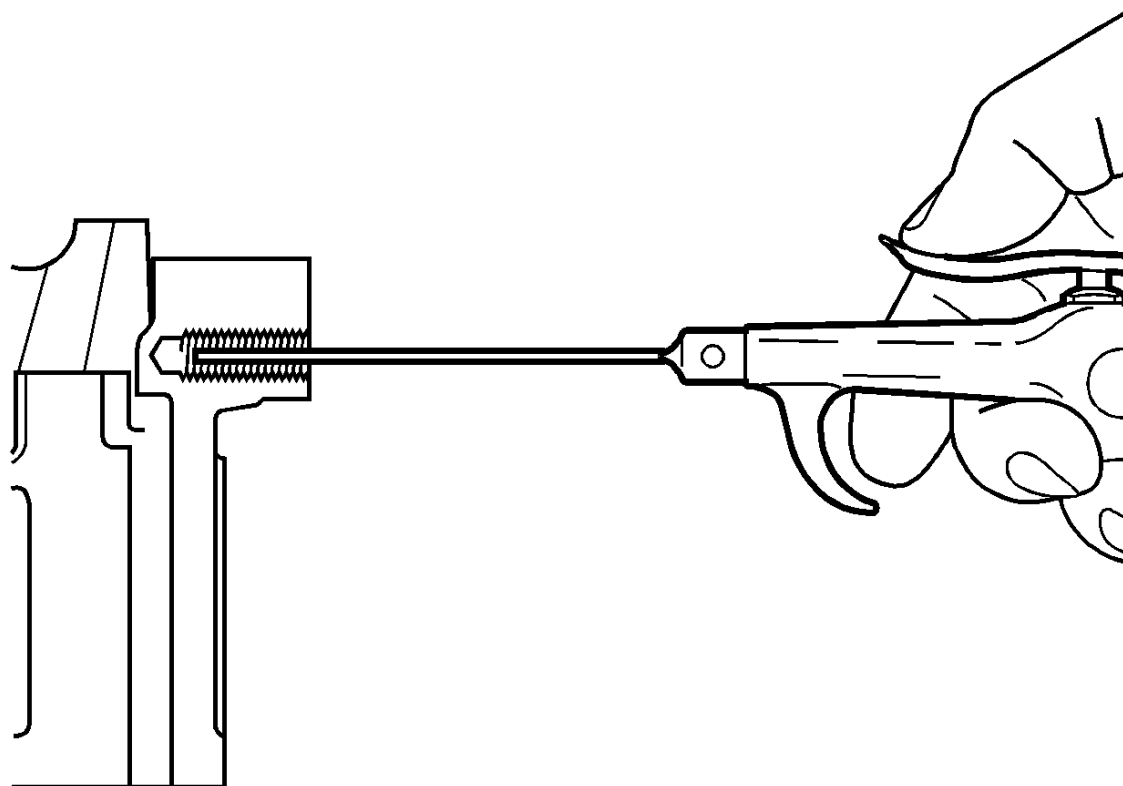


Fig. 369: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

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

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

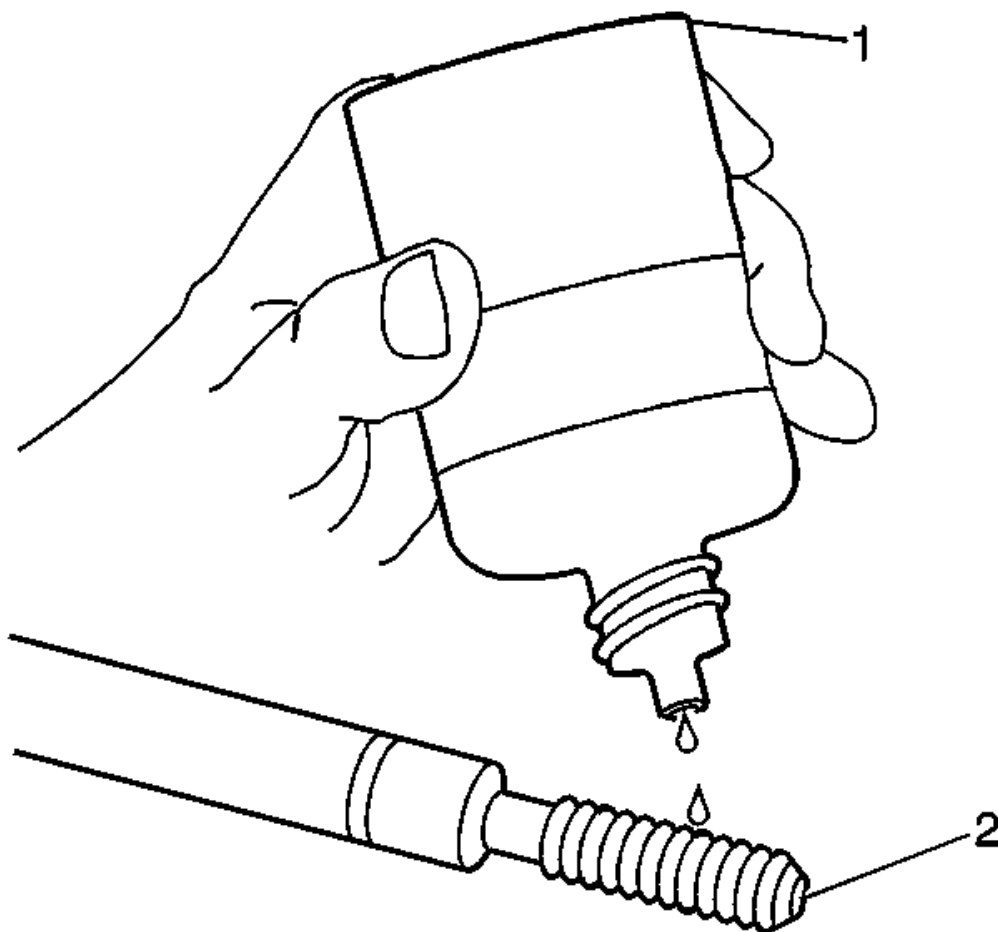


Fig. 370: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

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

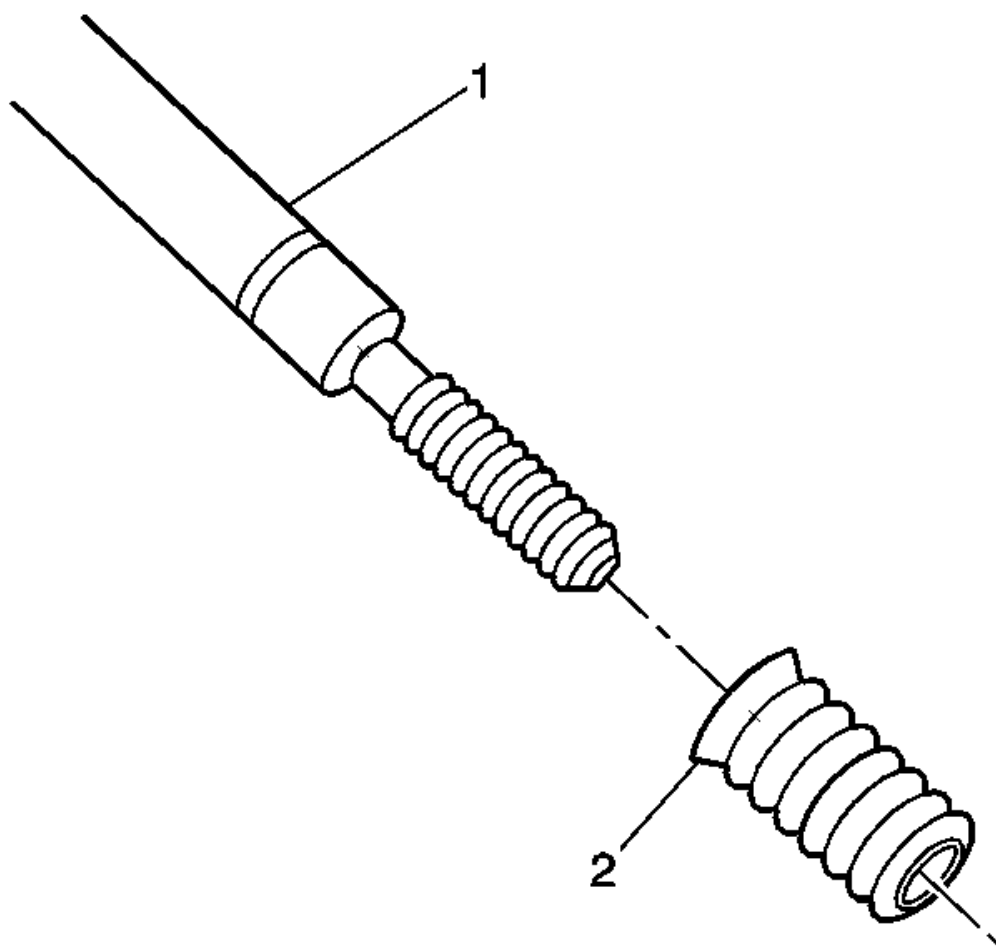


Fig. 371: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

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

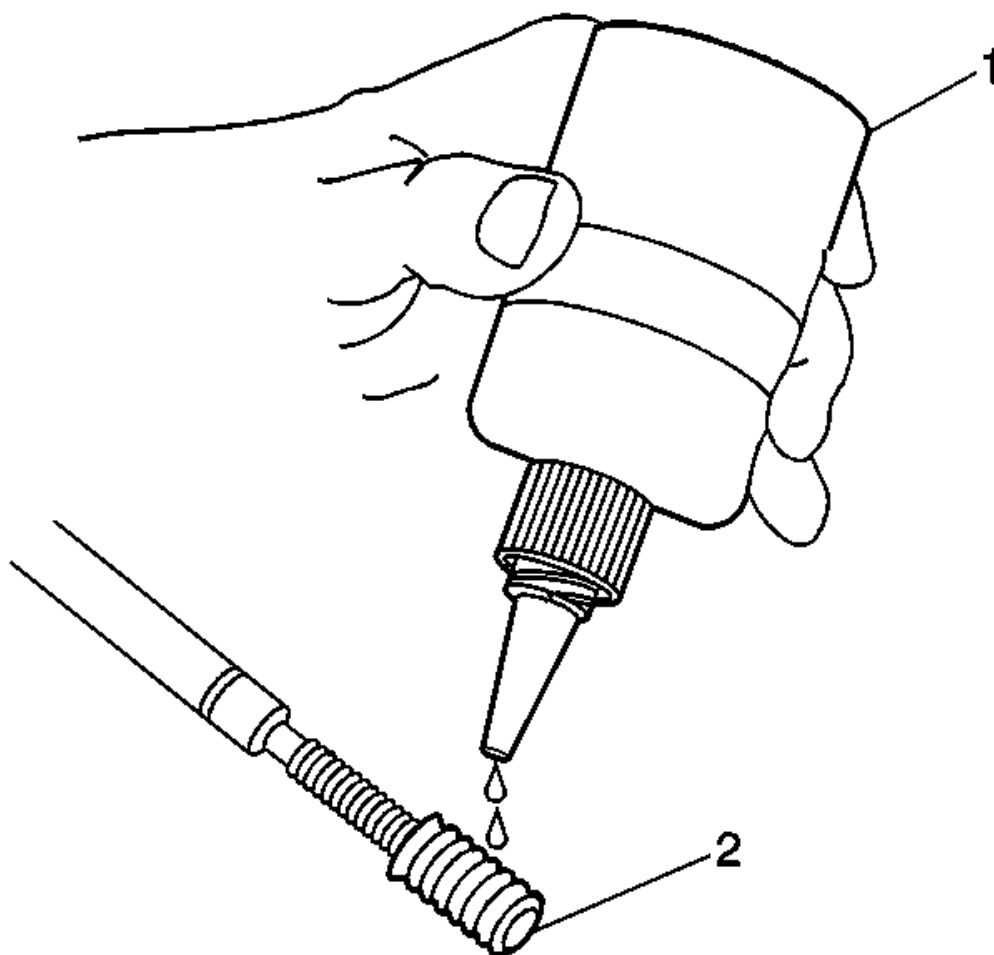


Fig. 372: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

11. Apply threadlock sealant, EN 42385-109, LOCTITE 277® or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.

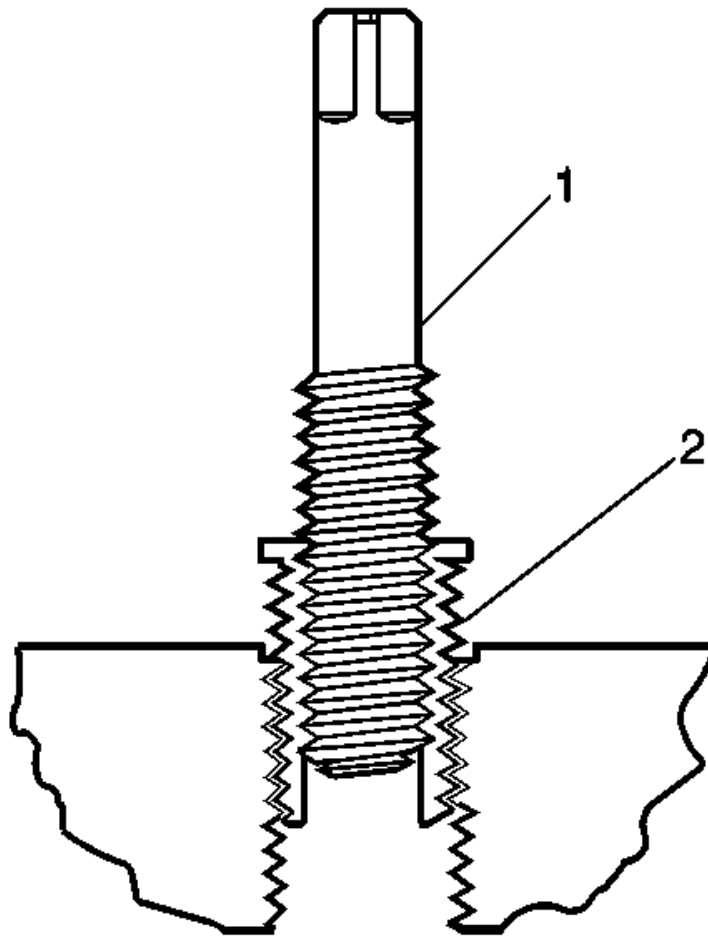


Fig. 373: View Of Insert In Tapped Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

12. Install the insert (2) into the tapped hole by hand only.
13. Install the insert until the flange (2) of the insert contacts the counterbored surface.

NOTE: 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.

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

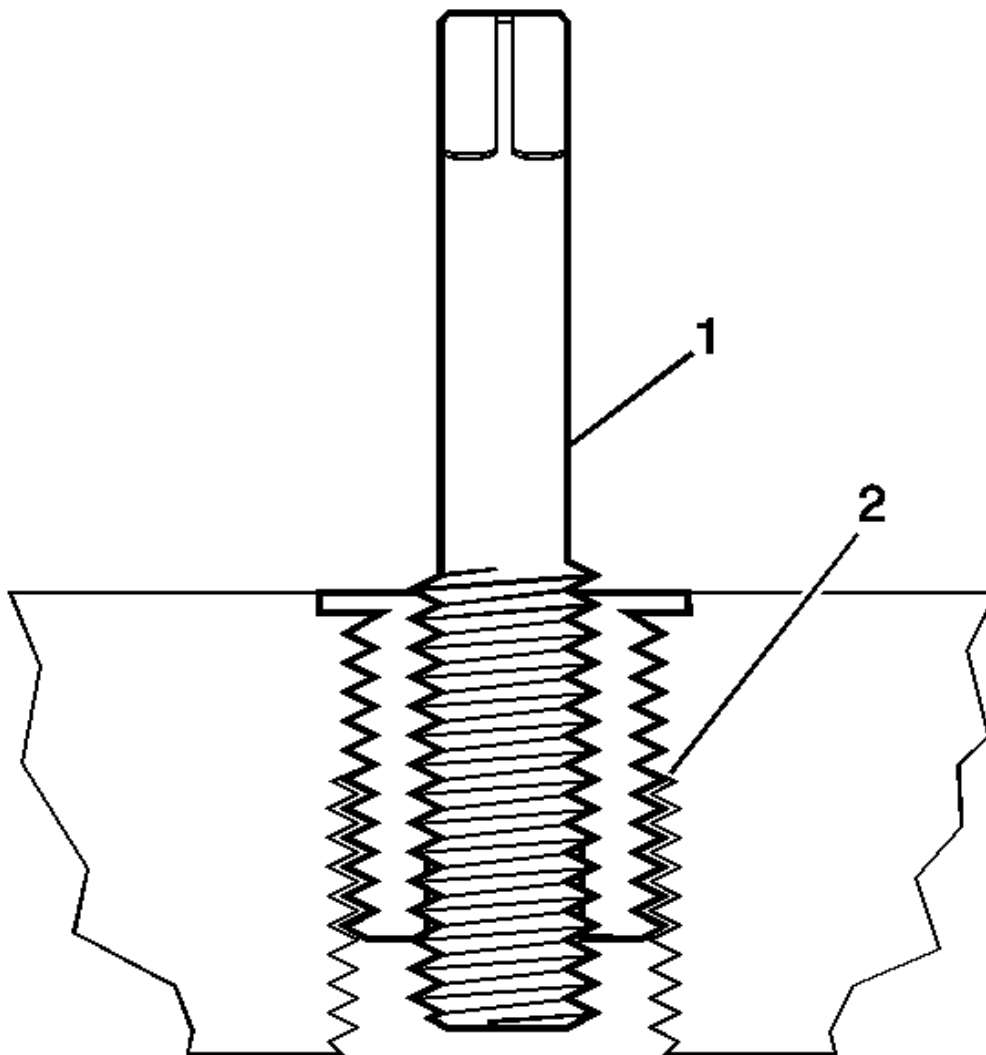


Fig. 374: View Insert & Tool - Standard Thread
Courtesy of GENERAL MOTORS COMPANY

NOTE: 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.

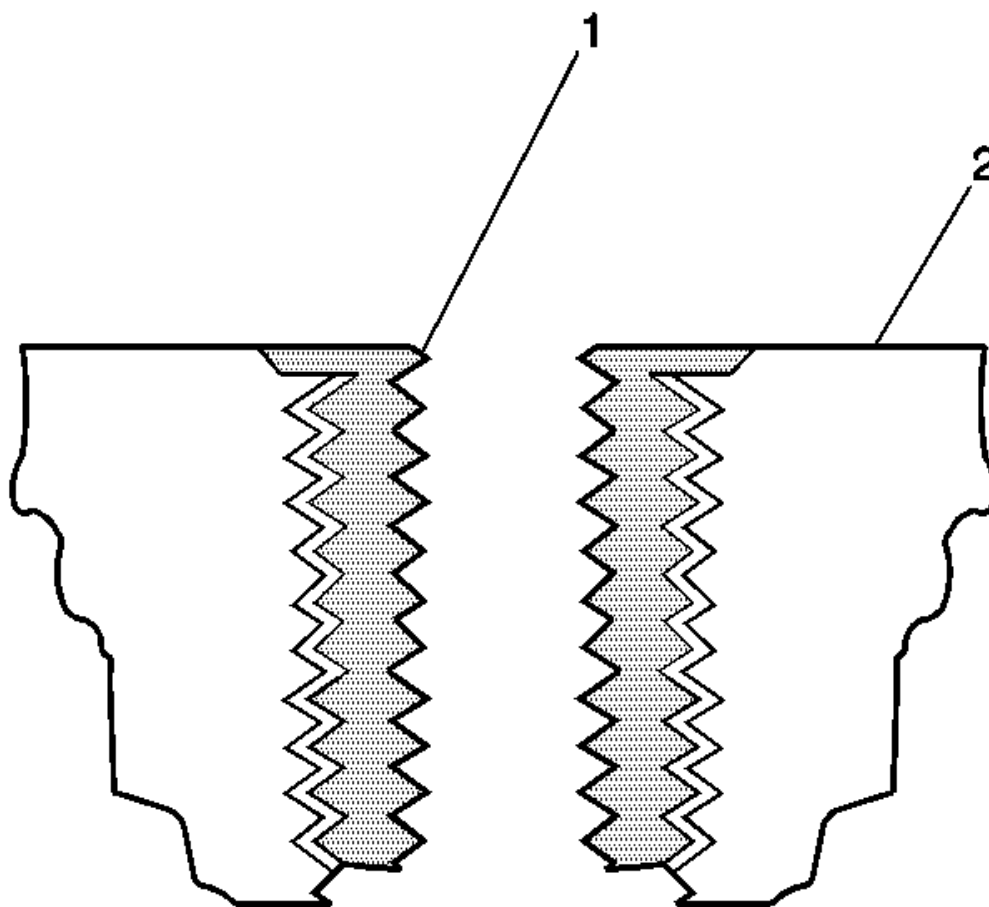


Fig. 375: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

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).

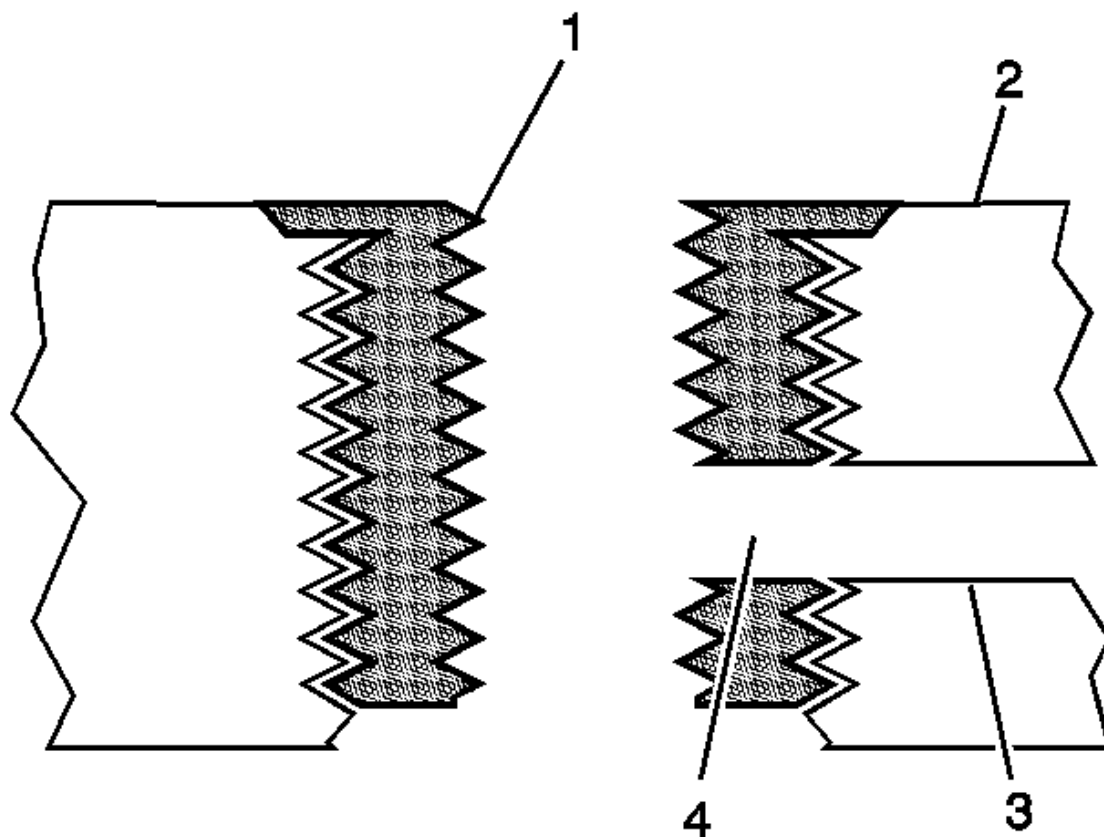


Fig. 376: View Of Restricted Engine Coolant Passages - Standard Thread Repair
Courtesy of GENERAL MOTORS COMPANY

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

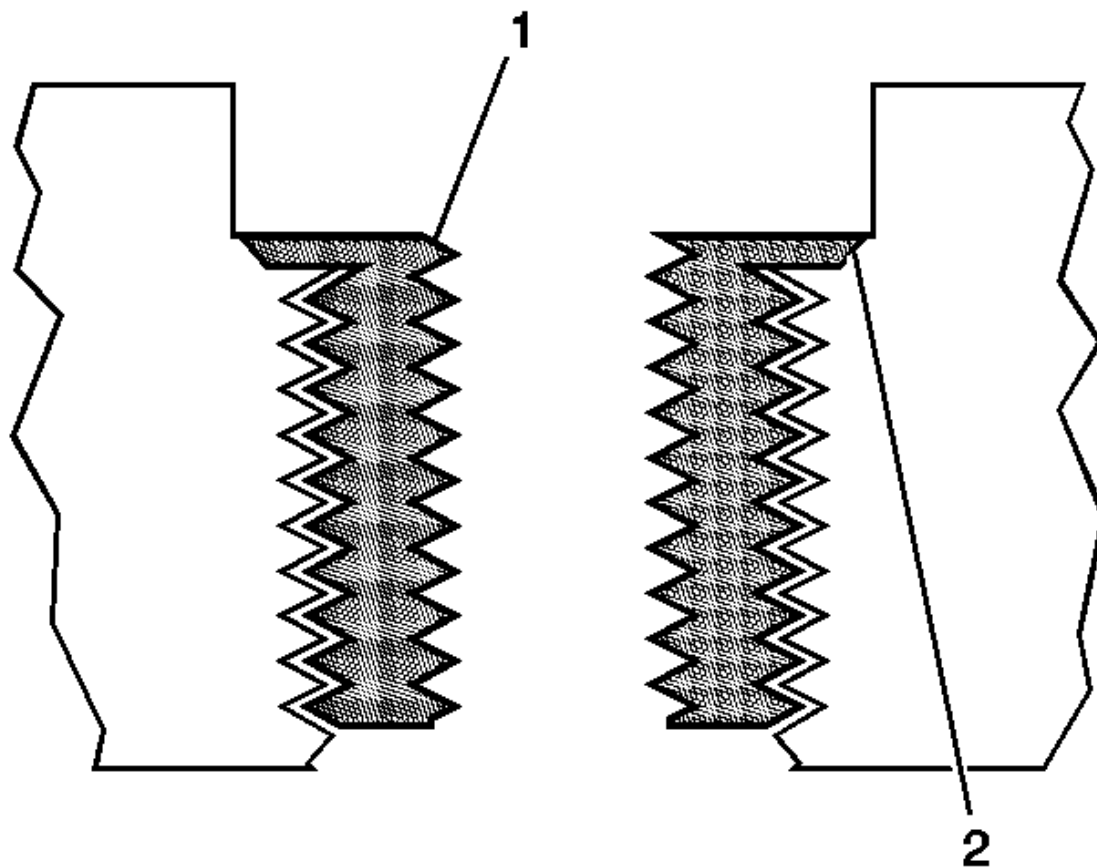


Fig. 377: Inspecting Insert For Proper Installation - Recessed Thread
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

NOTE:

- The use of a cutting type fluid, WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants and Sealers for recommended cutting fluid.
- 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.

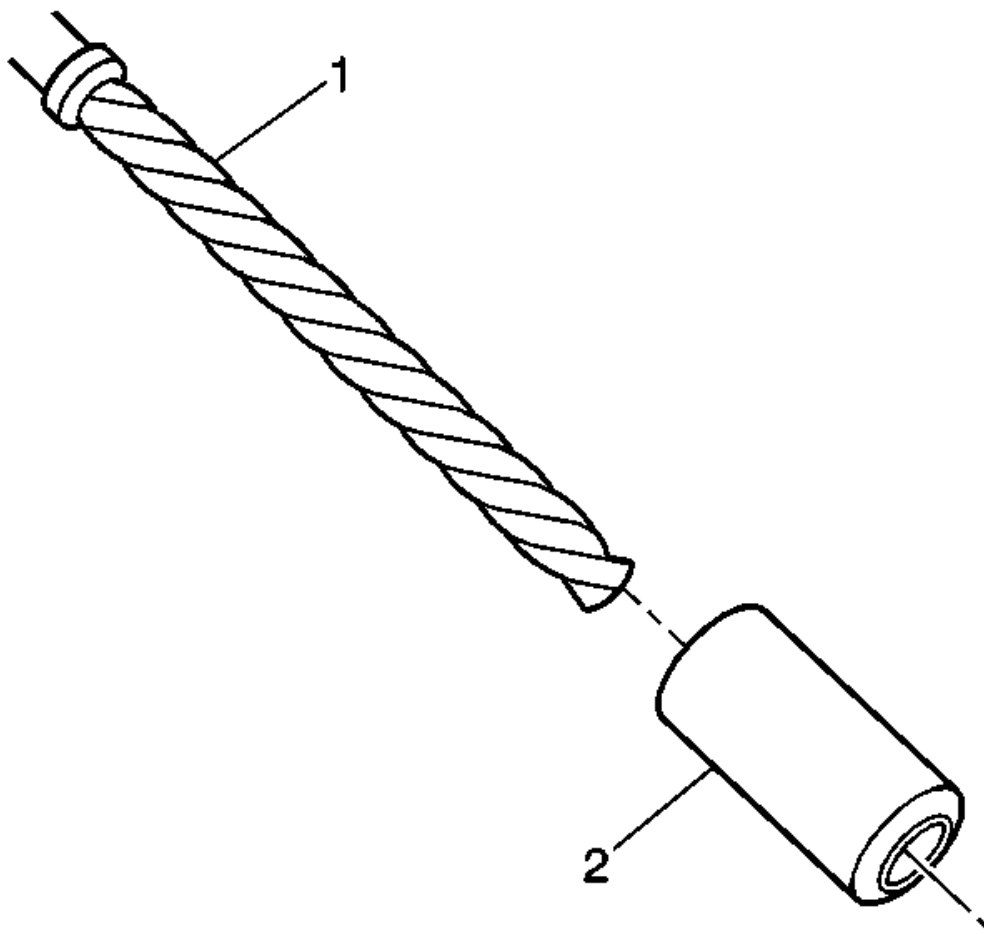


Fig. 378: View Of Stop Collar & Counterbore Drill
Courtesy of GENERAL MOTORS COMPANY

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

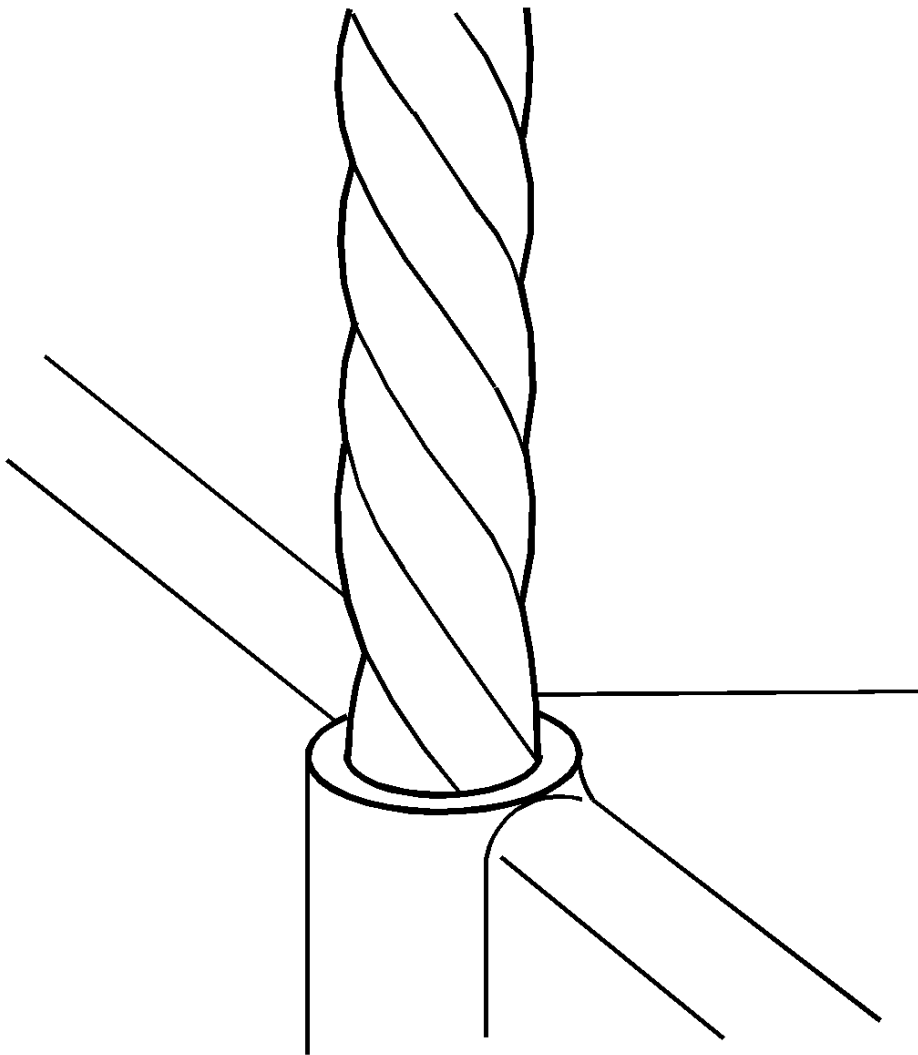


Fig. 379: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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.
3. Using compressed air, clean out any chips.

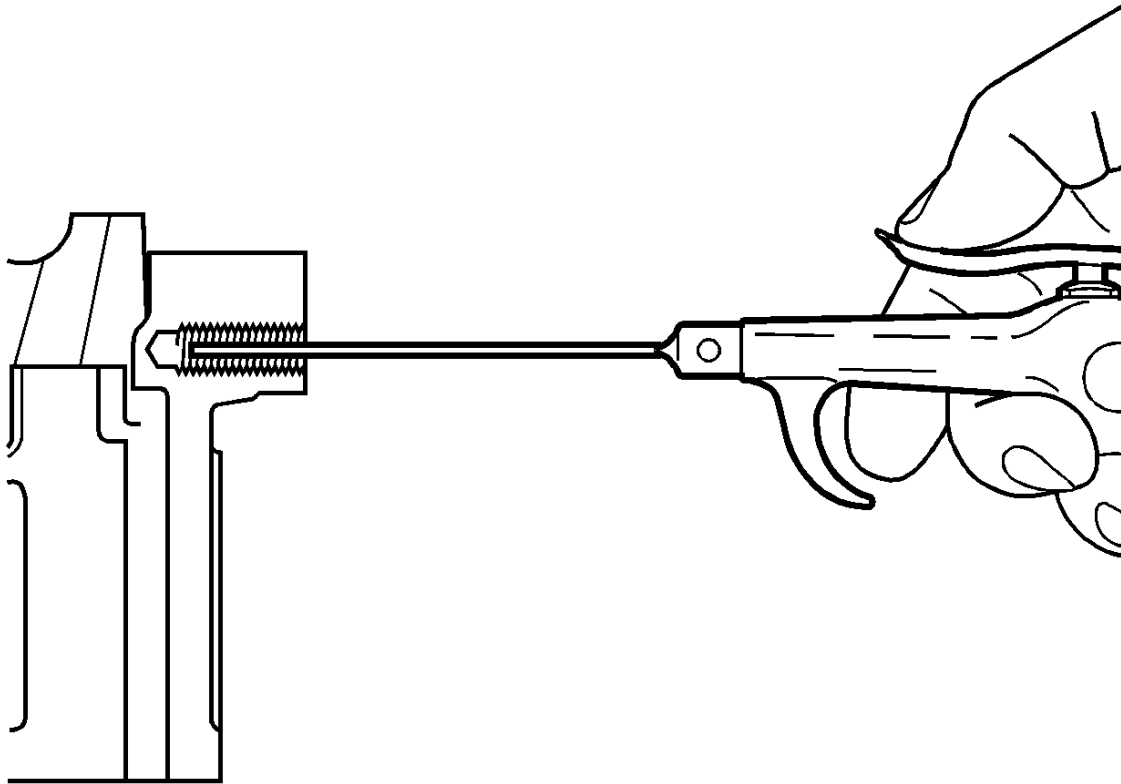


Fig. 380: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

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

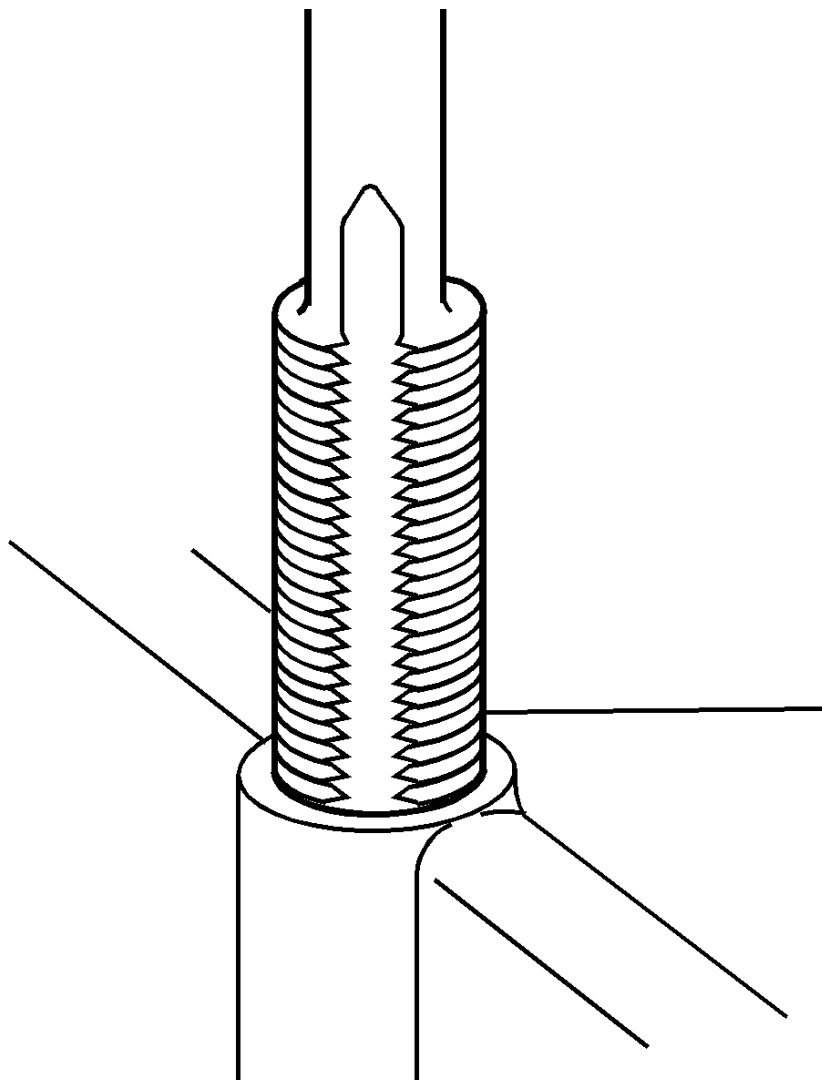


Fig. 381: Tapping Threads Of Drilled Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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.
5. Using compressed air, clean out any chips.

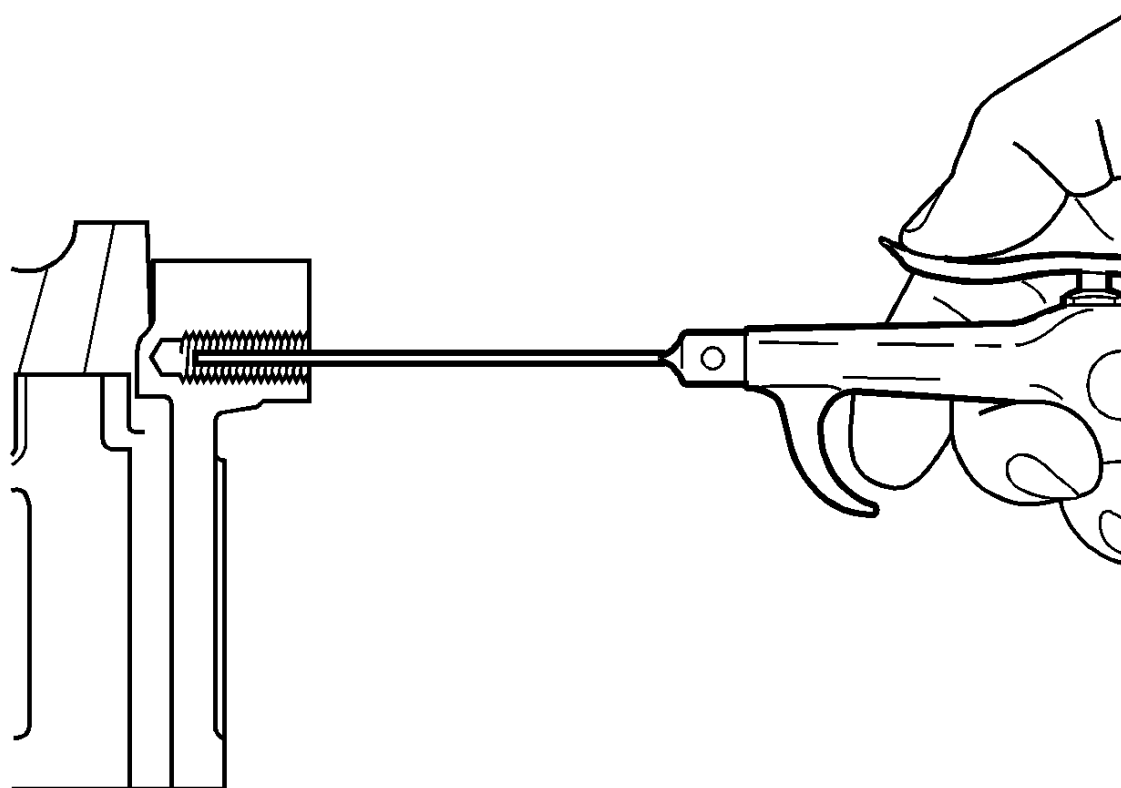


Fig. 382: Cleaning Out Metal Chips

Courtesy of GENERAL MOTORS COMPANY

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

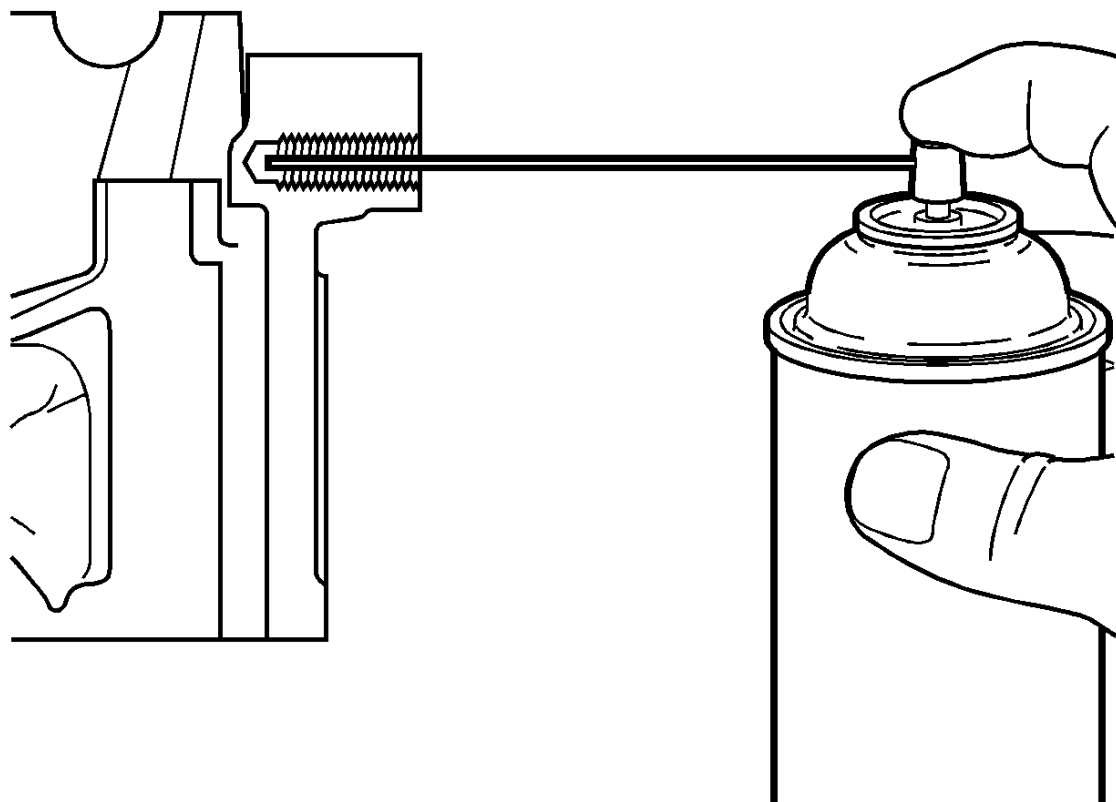


Fig. 383: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS COMPANY

6. Spray cleaner into the tapped hole. Refer to Adhesives, Fluids, Lubricants and Sealers for recommended cleaner.
7. Using compressed air, clean out any chips.

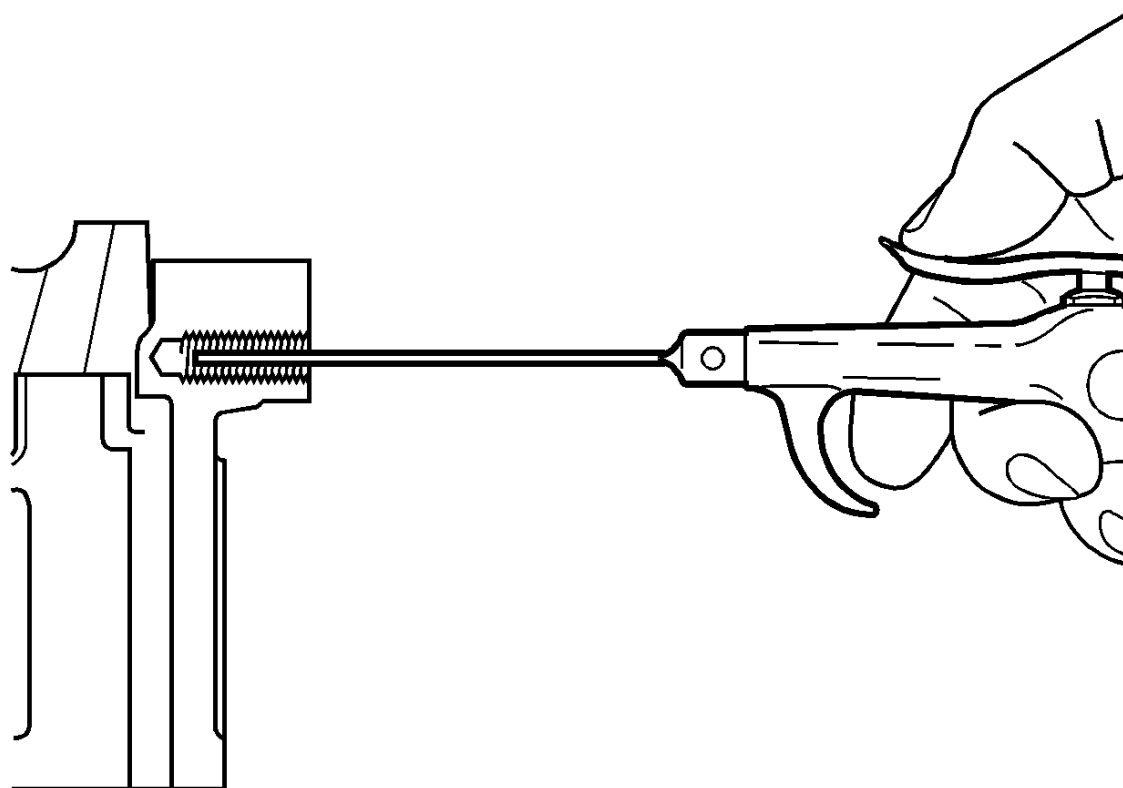


Fig. 384: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

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

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

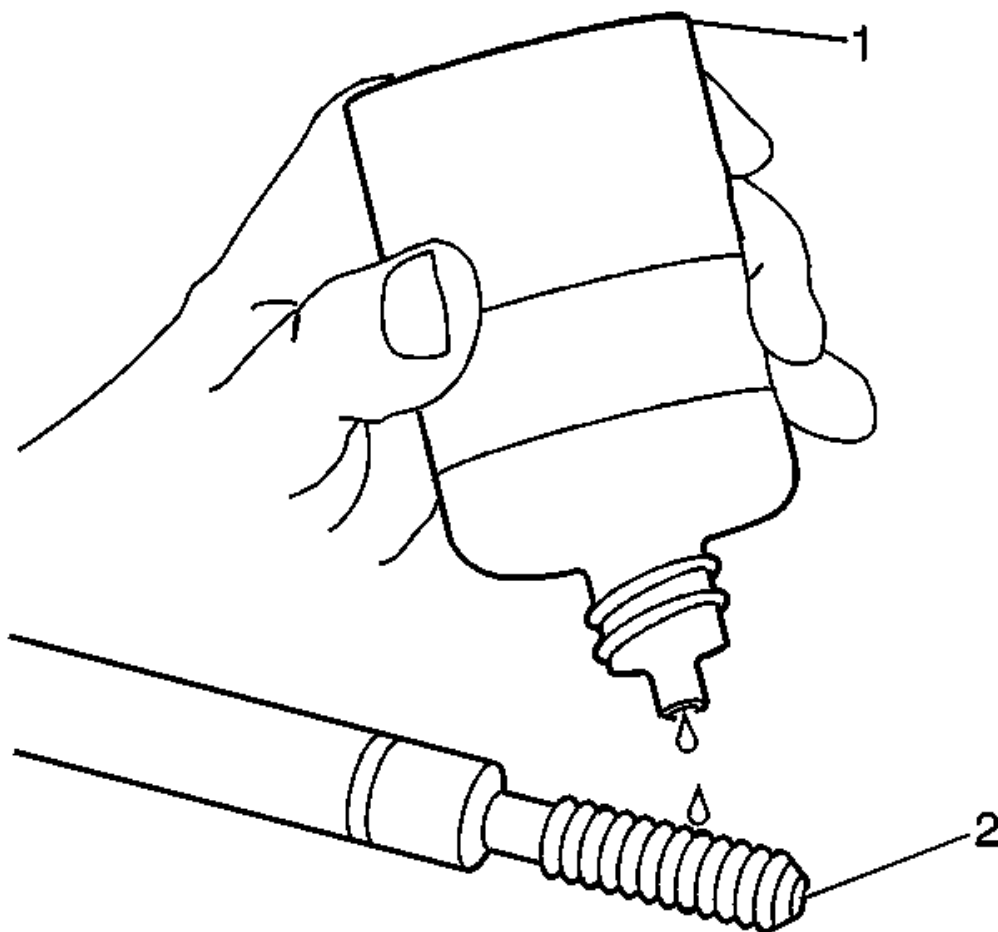


Fig. 385: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

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

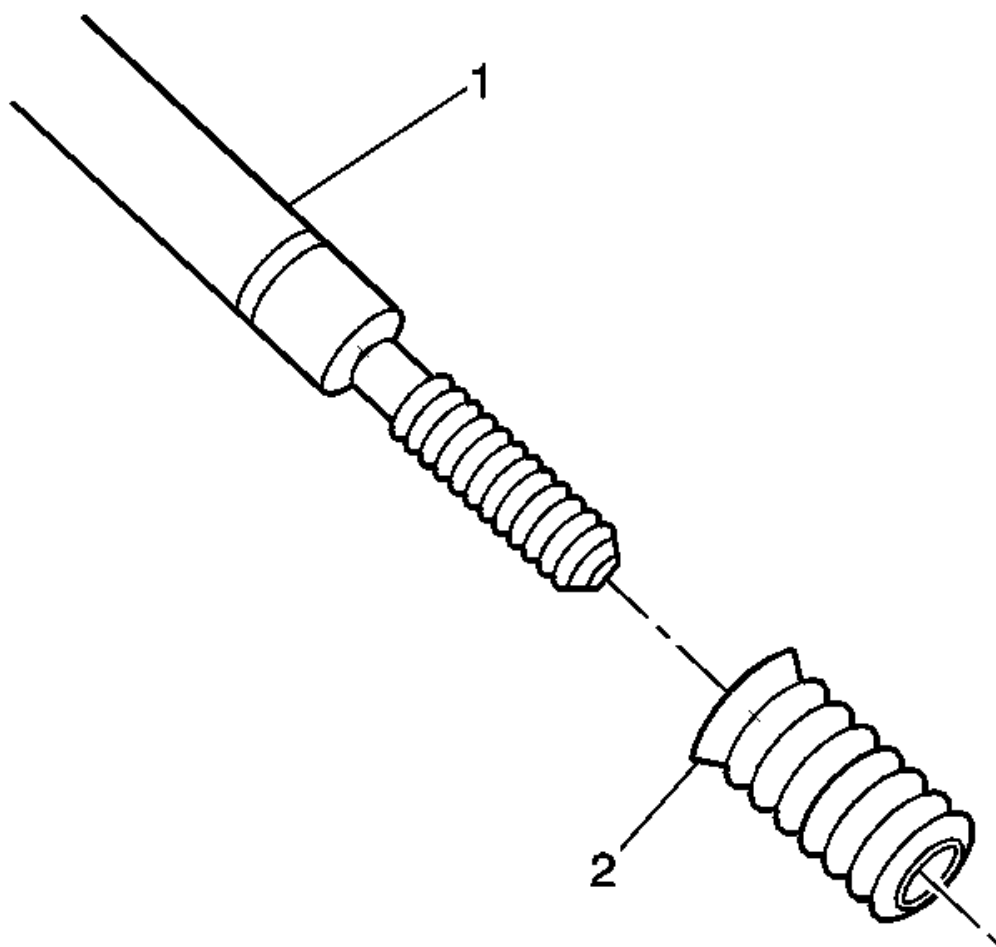


Fig. 386: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

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

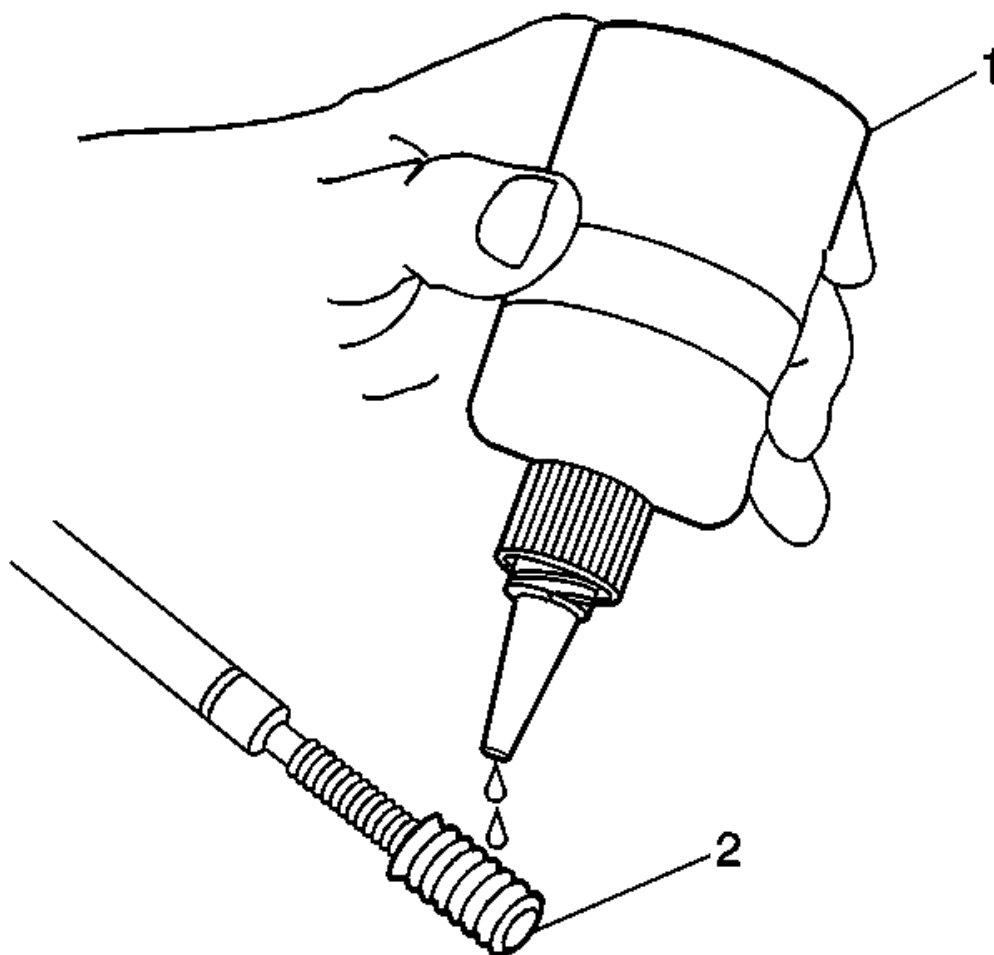


Fig. 387: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

10. Apply threadlock sealant, EN 42385-109, LOCTITE 277® or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.

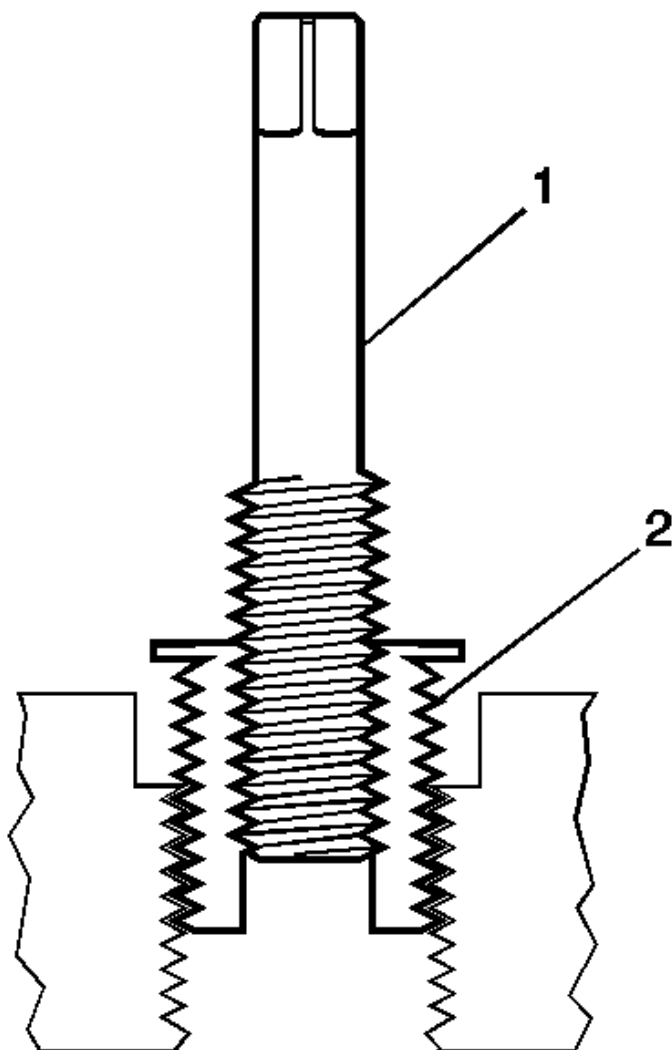


Fig. 388: Installing Insert - Recessed Thread
Courtesy of GENERAL MOTORS COMPANY

11. Install the insert (2) into the tapped hole by hand only.
12. Install the insert until the flange (2) of the insert contacts the counterbored surface.

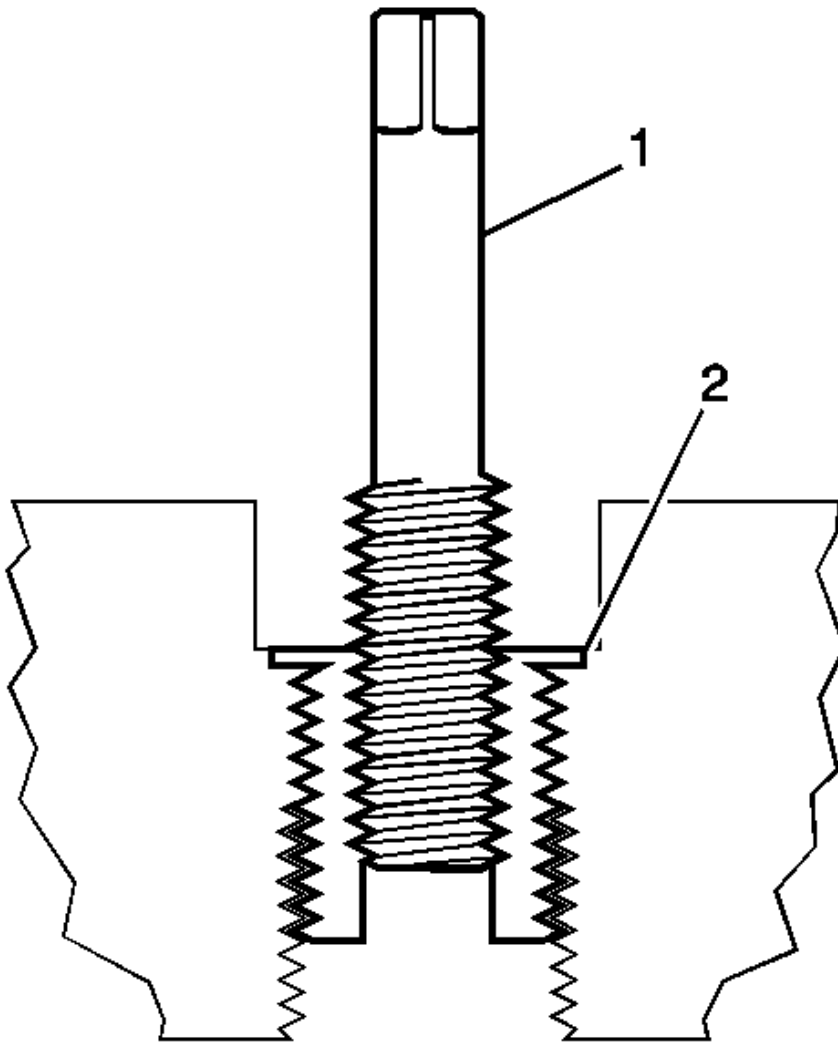


Fig. 389: View Of Installed Insert - Recessed Thread

Courtesy of GENERAL MOTORS COMPANY

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

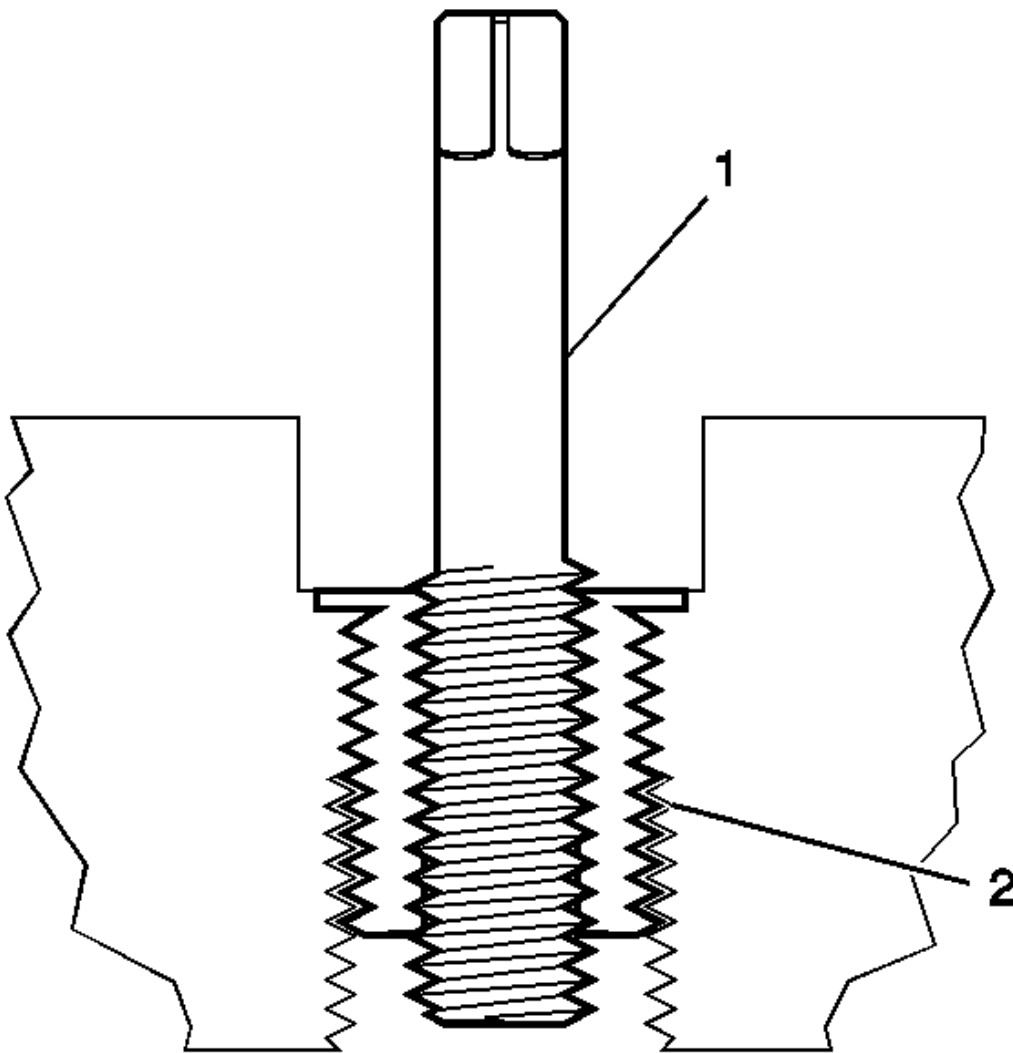


Fig. 390: Installed Insert - Recessed Thread Repair
Courtesy of GENERAL MOTORS COMPANY

NOTE: 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.

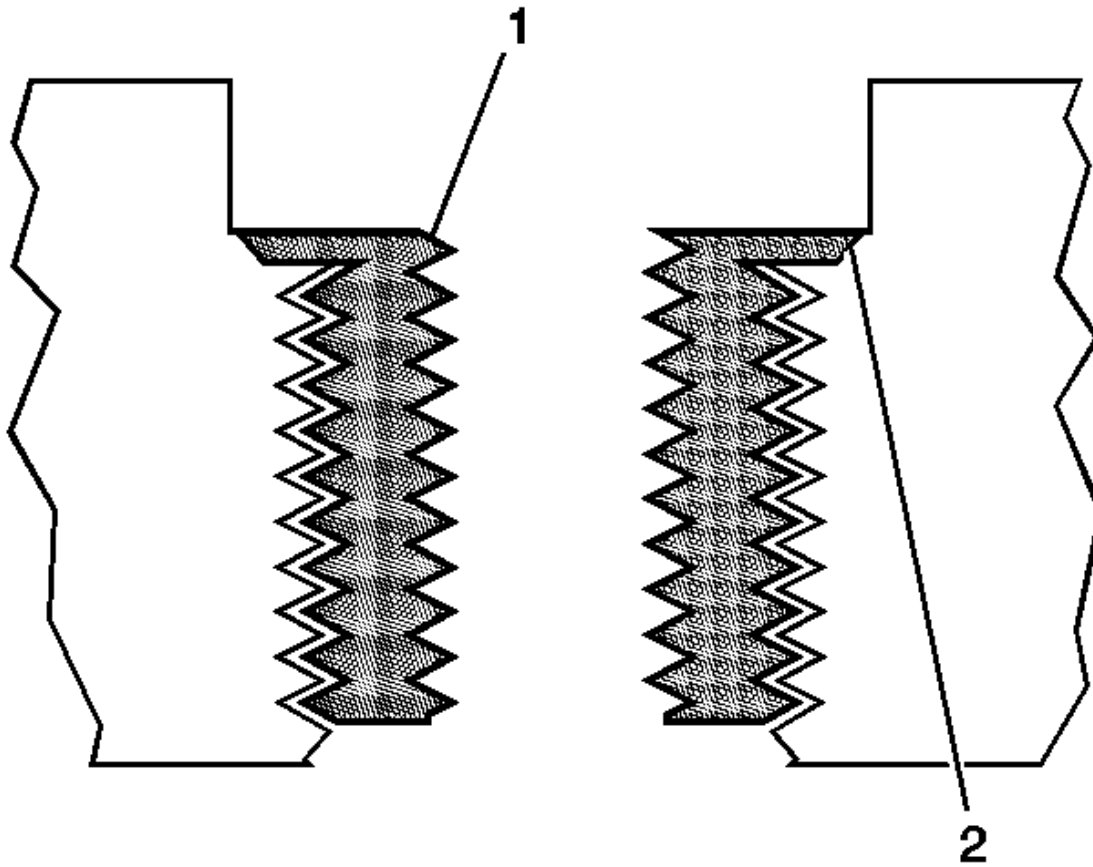


Fig. 391: Inspecting Insert For Proper Installation - Recessed Thread
Courtesy of GENERAL MOTORS COMPANY

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

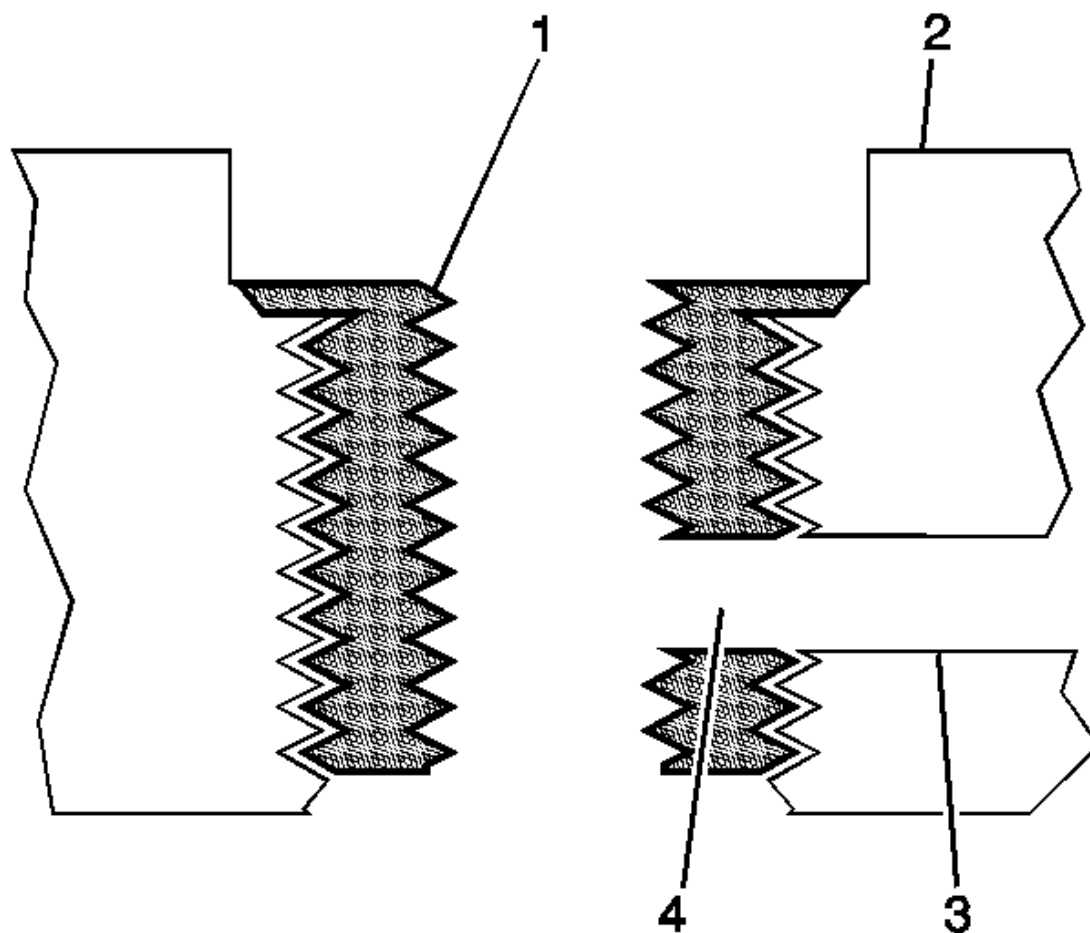


Fig. 392: View Of Restricted Engine Coolant Passage - Recessed Thread Repair
Courtesy of GENERAL MOTORS COMPANY

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.

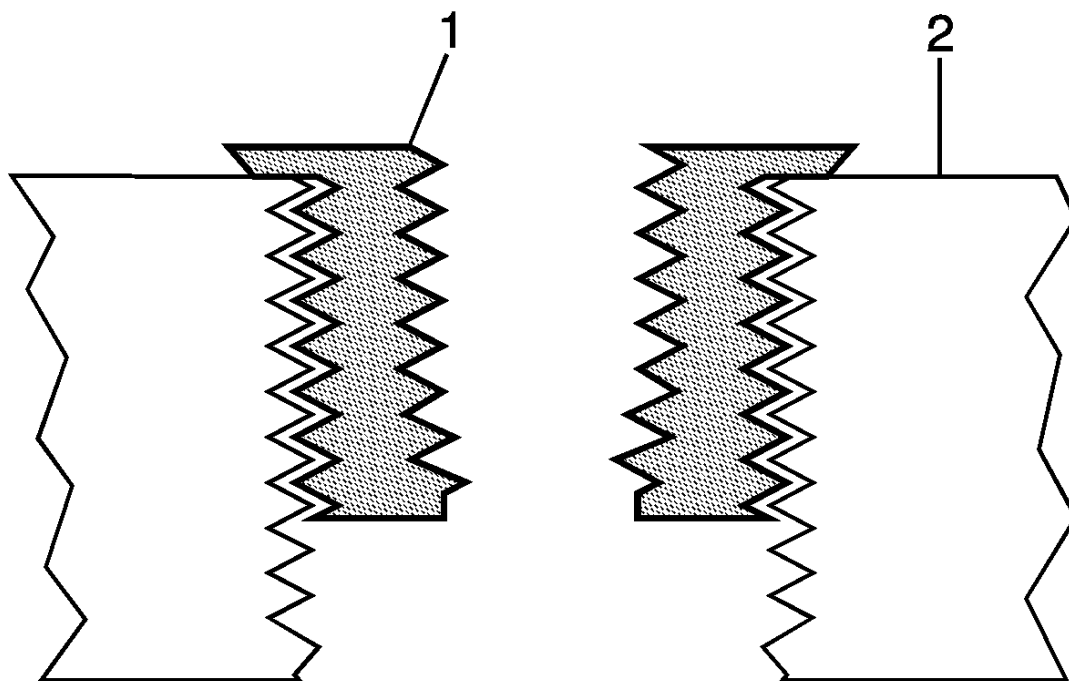


Fig. 393: Inspecting Insert For Proper Installation - Tapered Thread
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

NOTE: The use of a cutting type fluid, WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants and Sealers for recommended cutting fluid.

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.

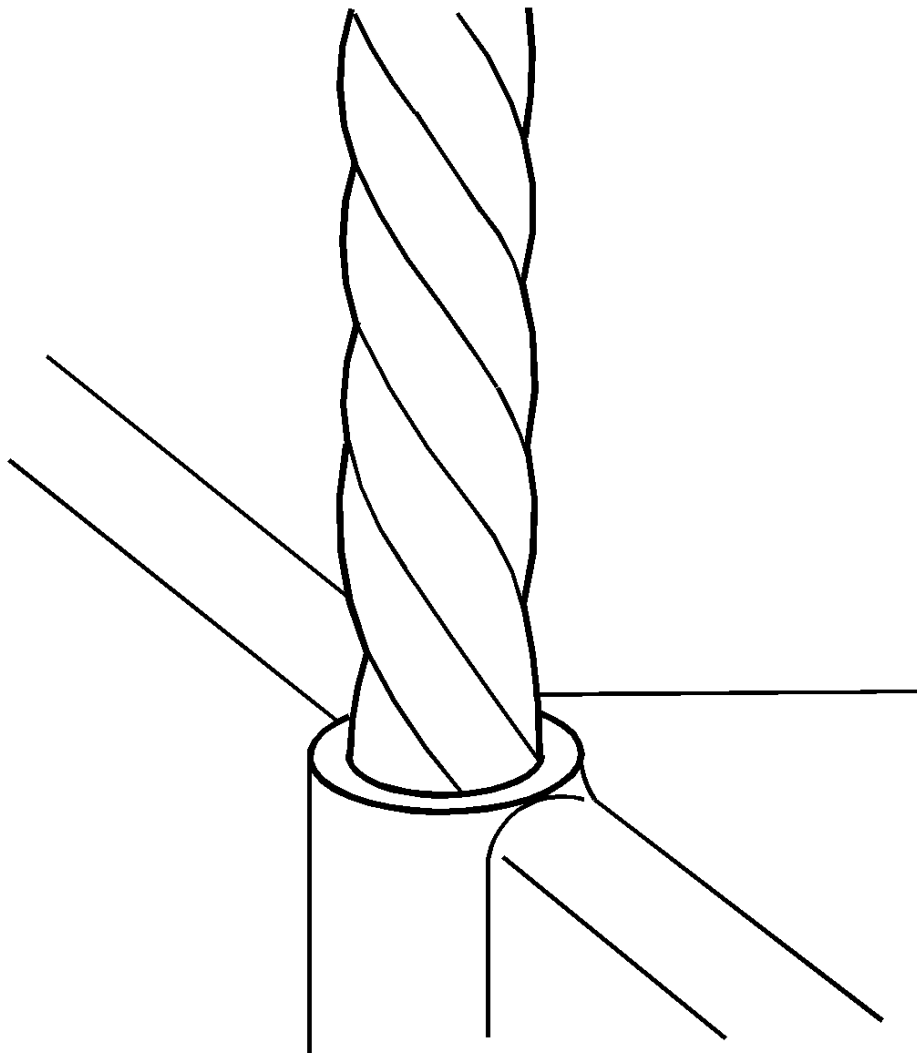


Fig. 394: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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.

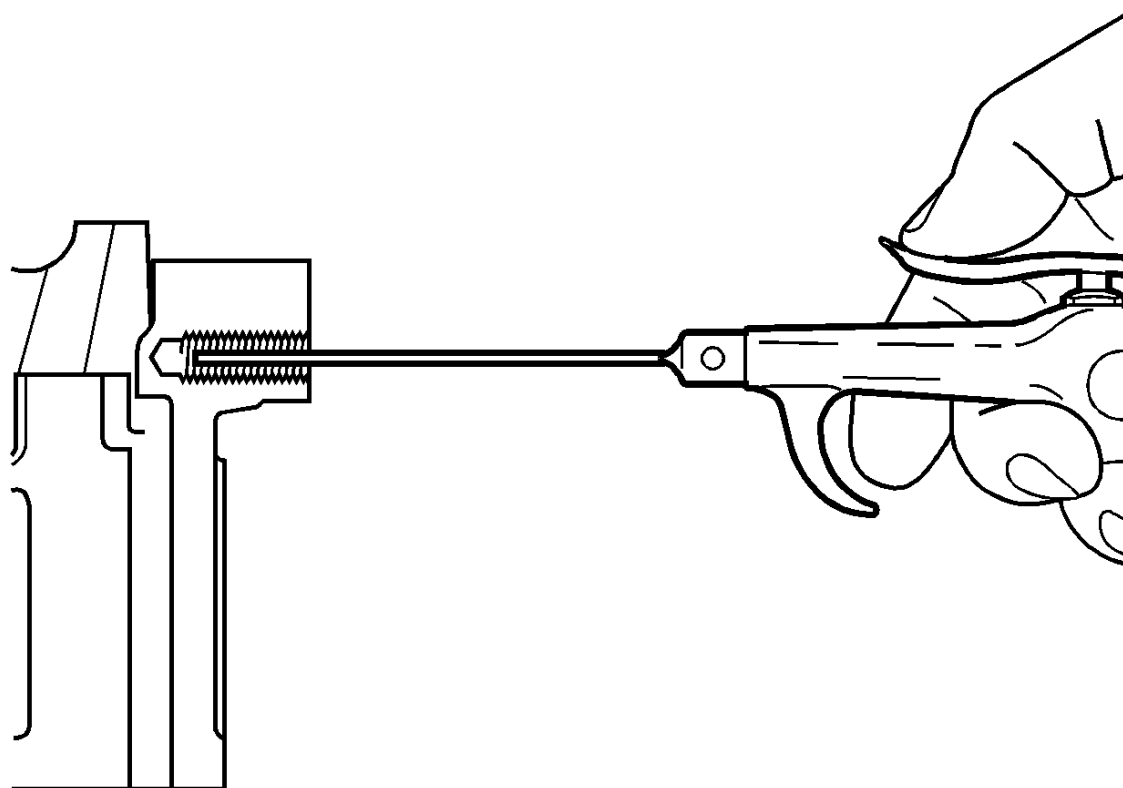


Fig. 395: Cleaning Out Metal Chips

Courtesy of GENERAL MOTORS COMPANY

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

2. Using compressed air, clean out any chips.

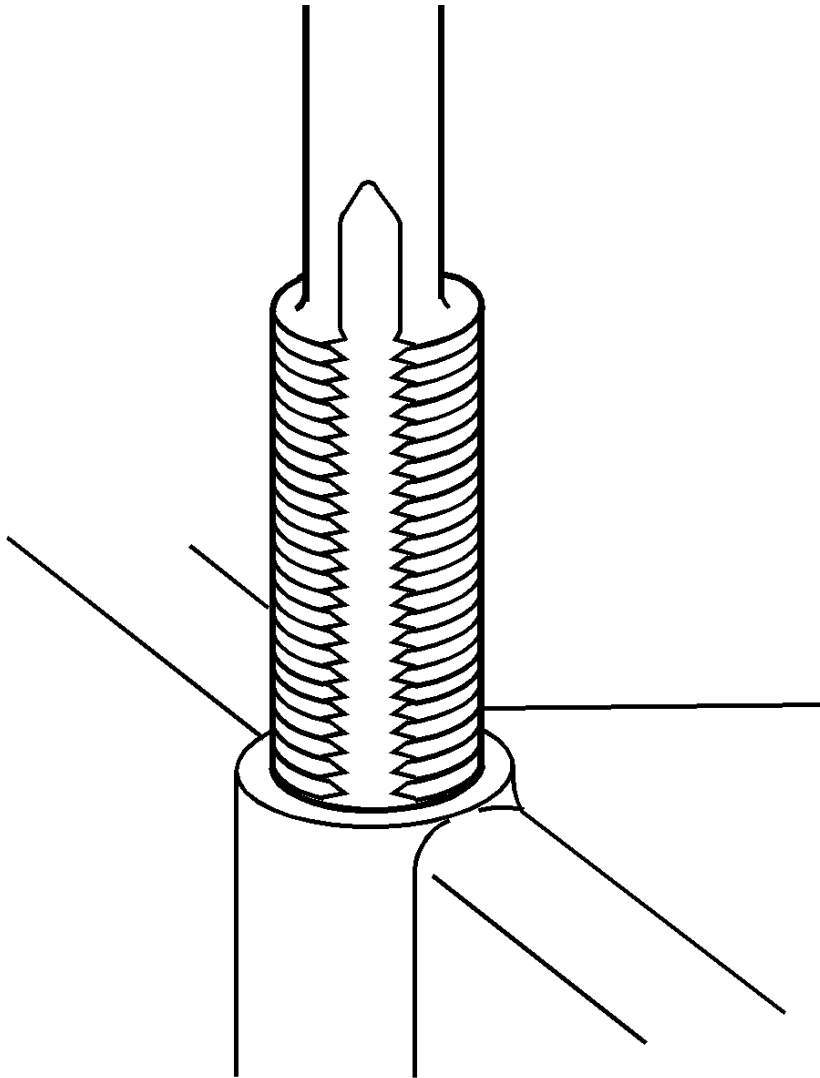


Fig. 396: Tapping Threads Of Drilled Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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.

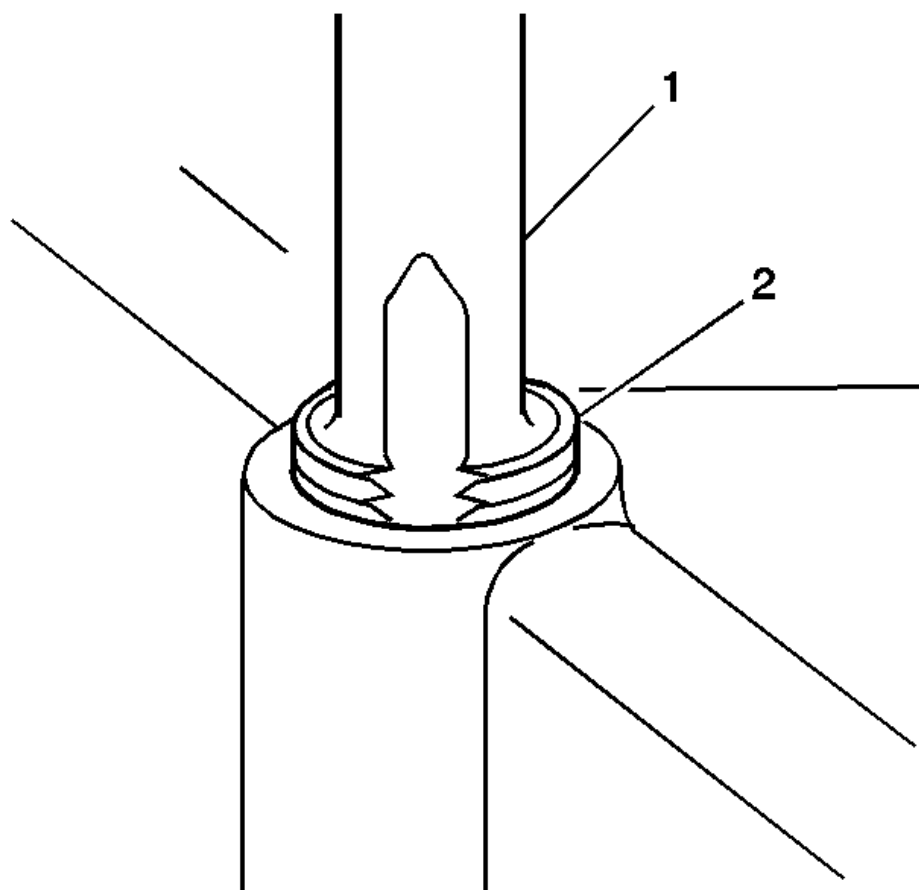


Fig. 397: View Of Proper Tapping Distance - Tapered Thread
Courtesy of GENERAL MOTORS COMPANY

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

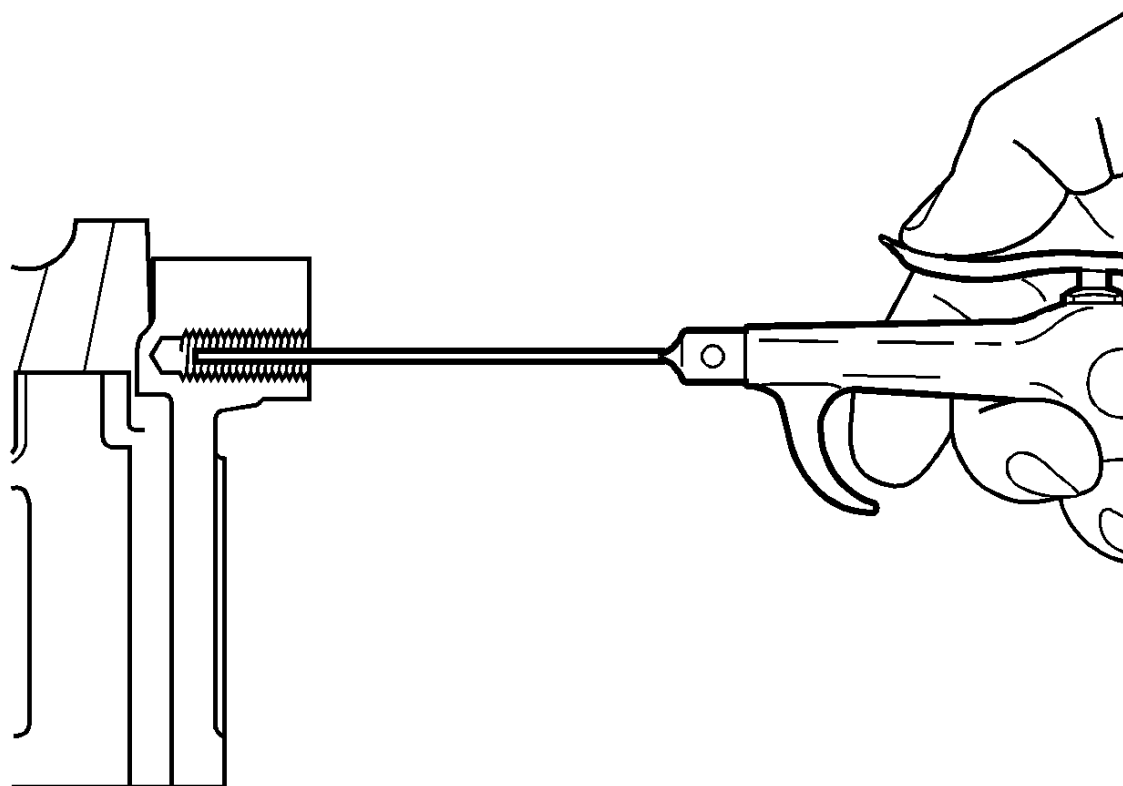


Fig. 398: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

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

5. Using compressed air, clean out any chips.

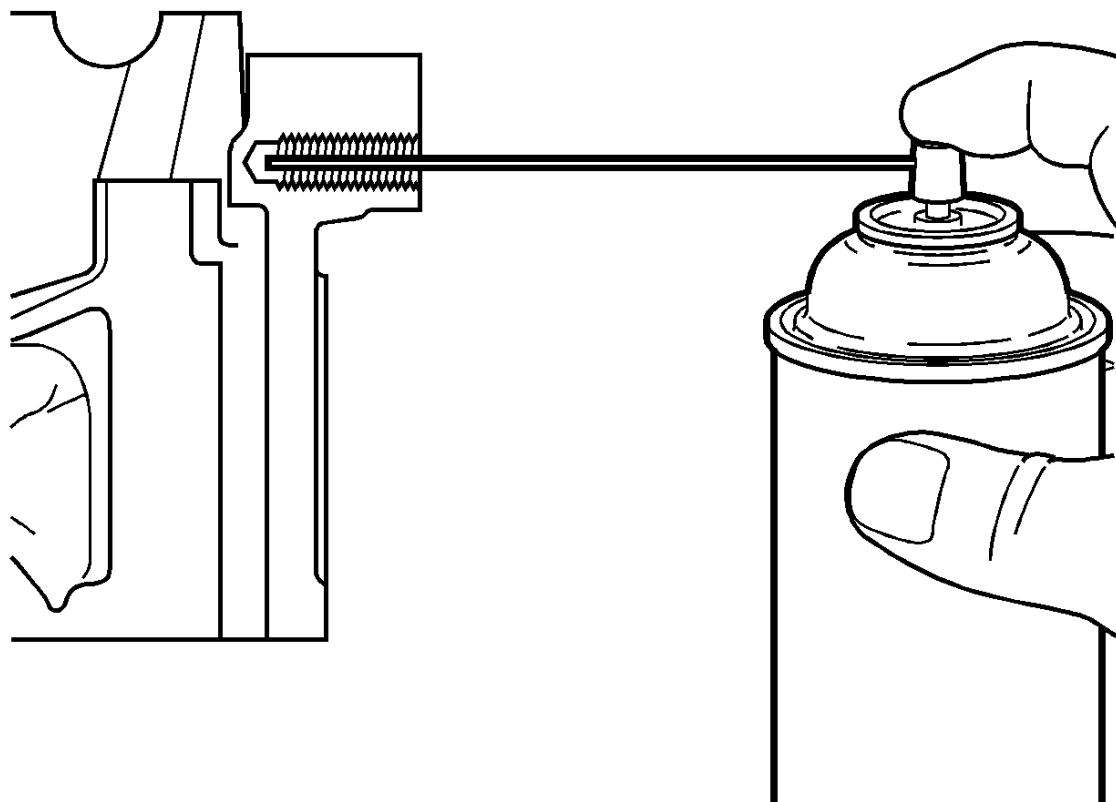


Fig. 399: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS COMPANY

6. Spray cleaner into the tapped hole. Refer to Adhesives, Fluids, Lubricants and Sealers for recommended cleaner.

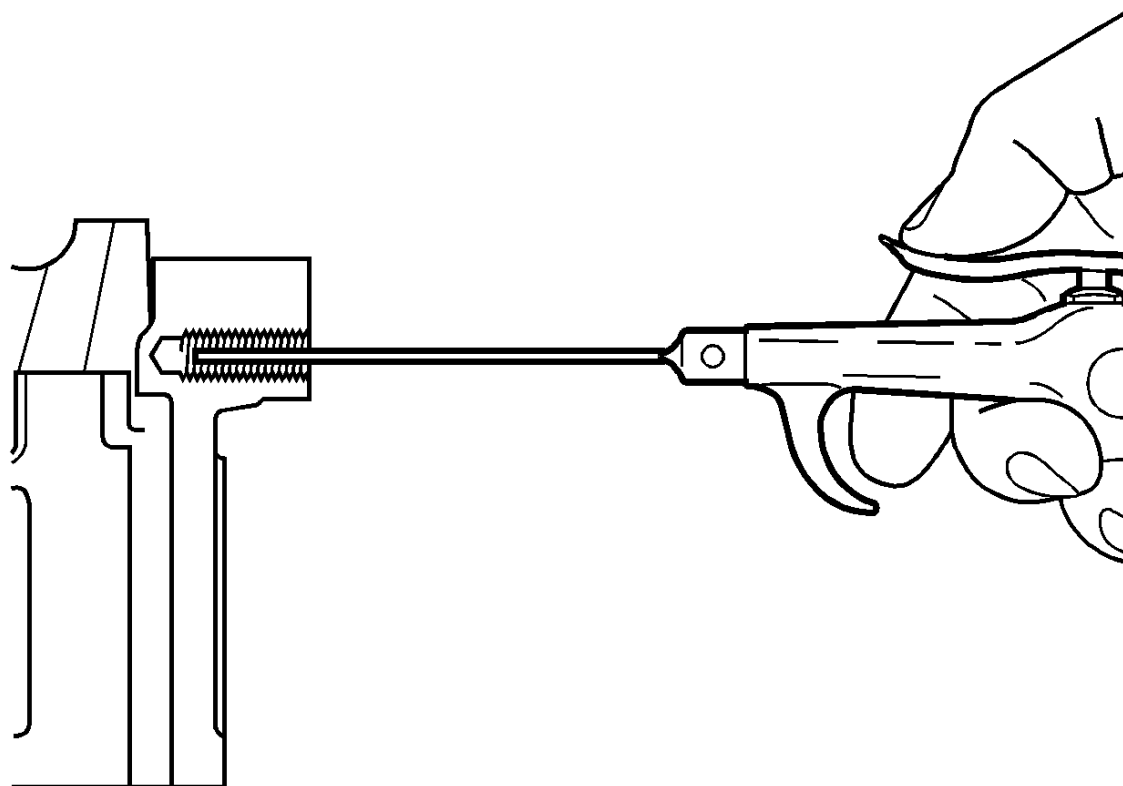


Fig. 400: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

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

7. Using compressed air, clean out any chips.

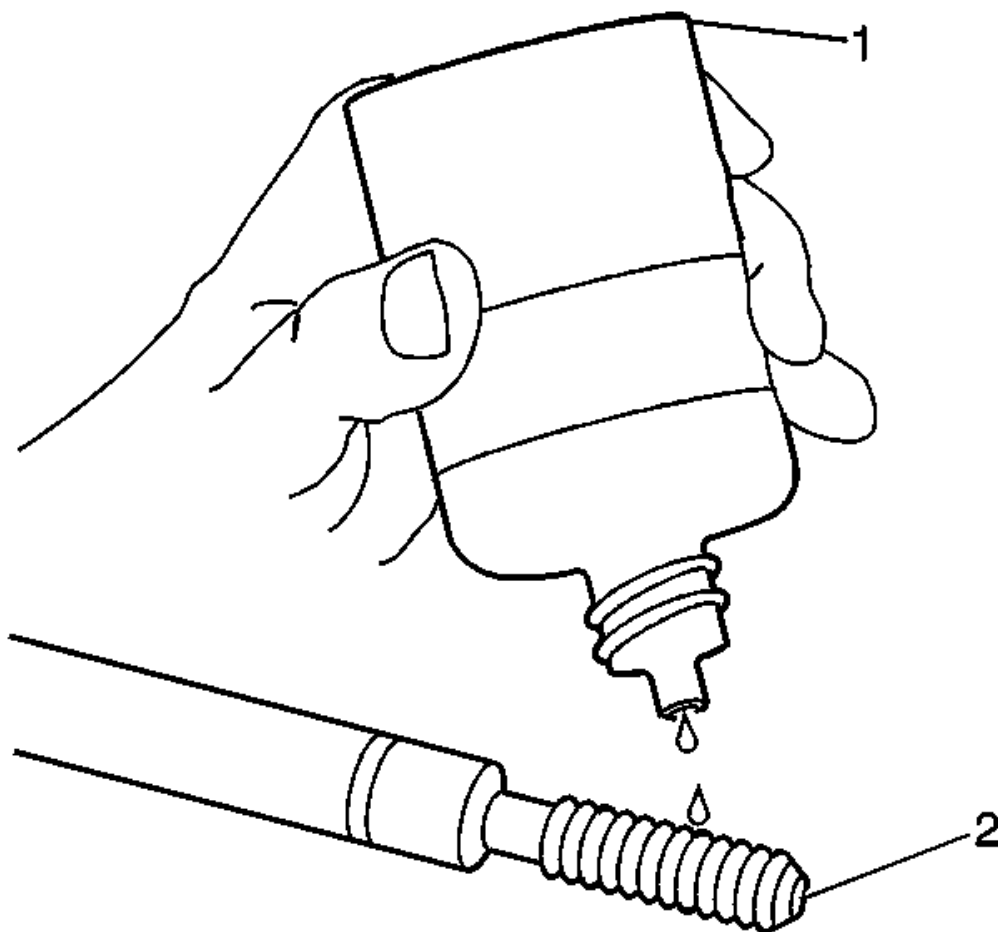


Fig. 401: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: 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 EN 42385-110 (1).

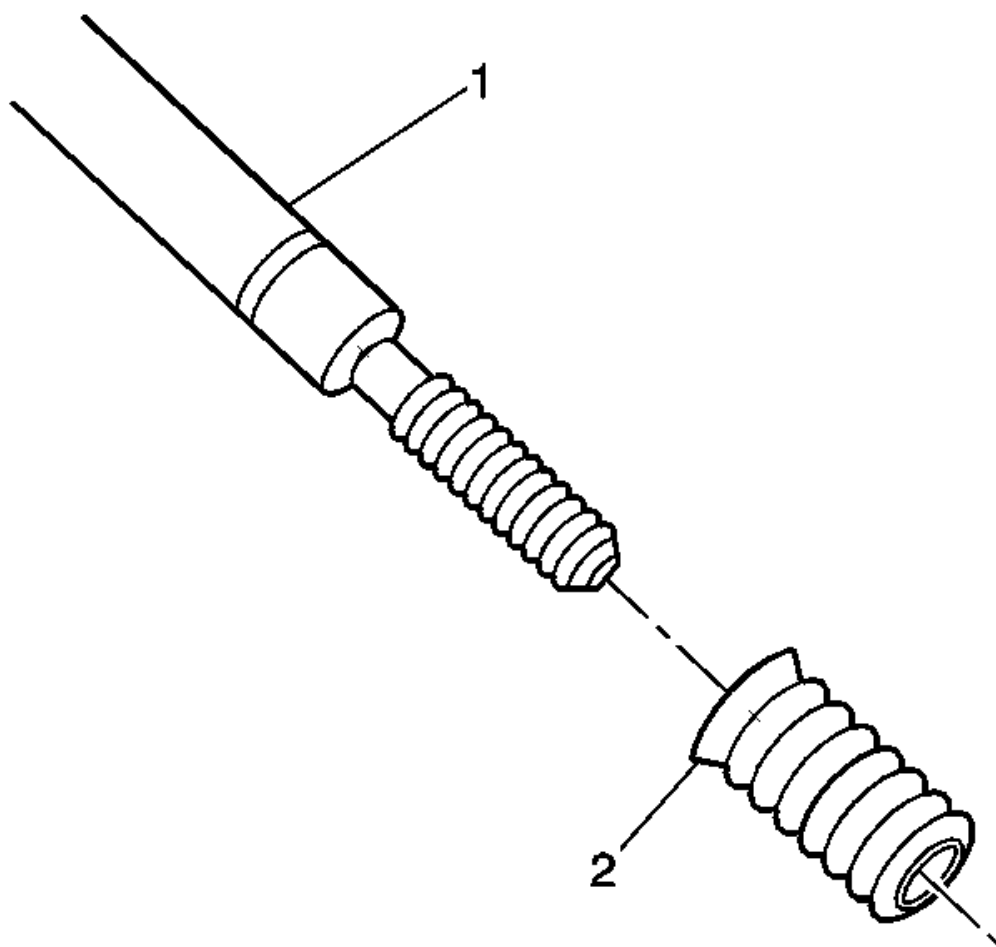


Fig. 402: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

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

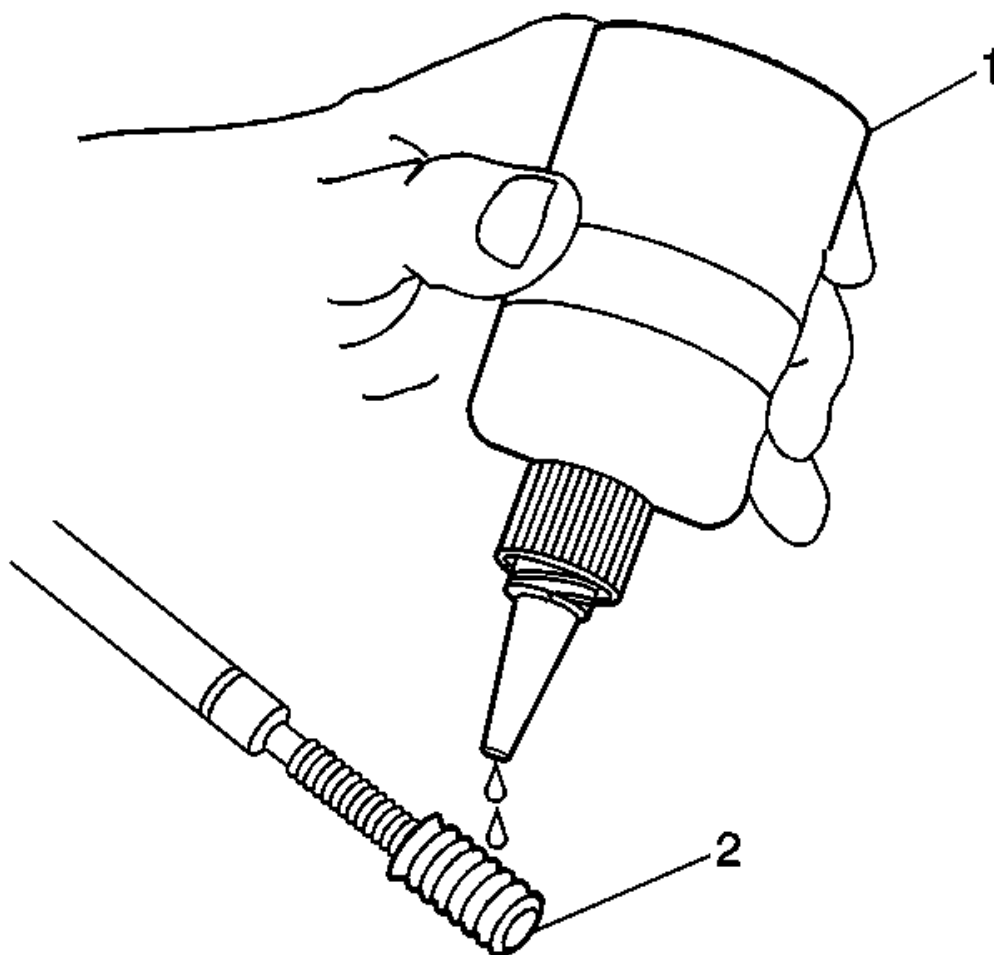


Fig. 403: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

10. Apply threadlock sealant, EN 42385-109, LOCTITE 277® or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.

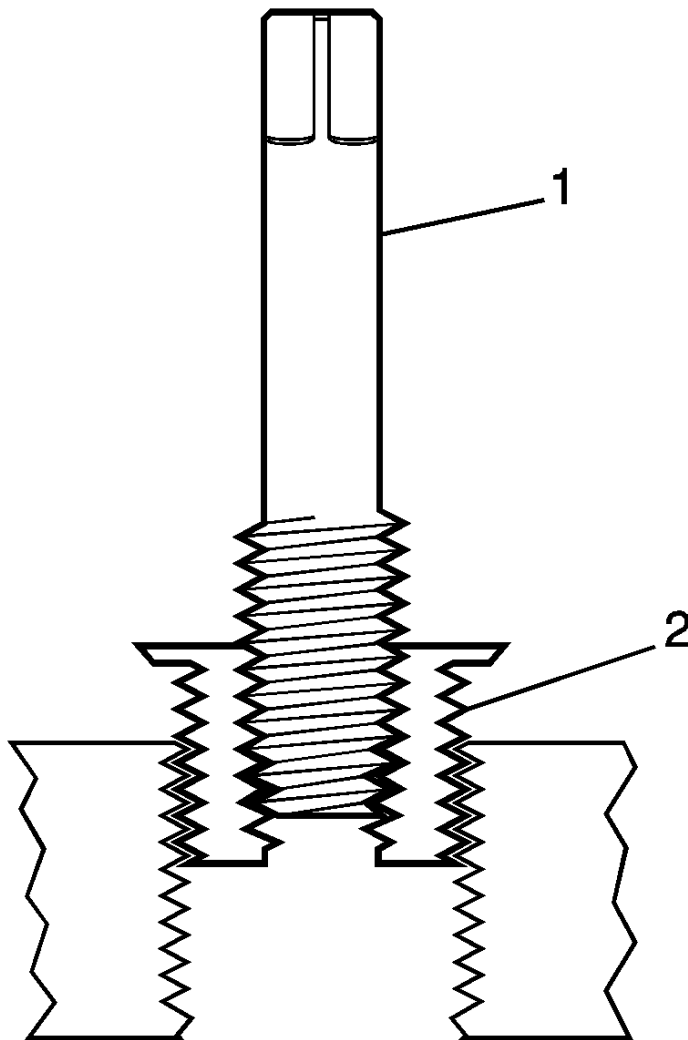


Fig. 404: Installing Insert - Tapered Thread
Courtesy of GENERAL MOTORS COMPANY

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

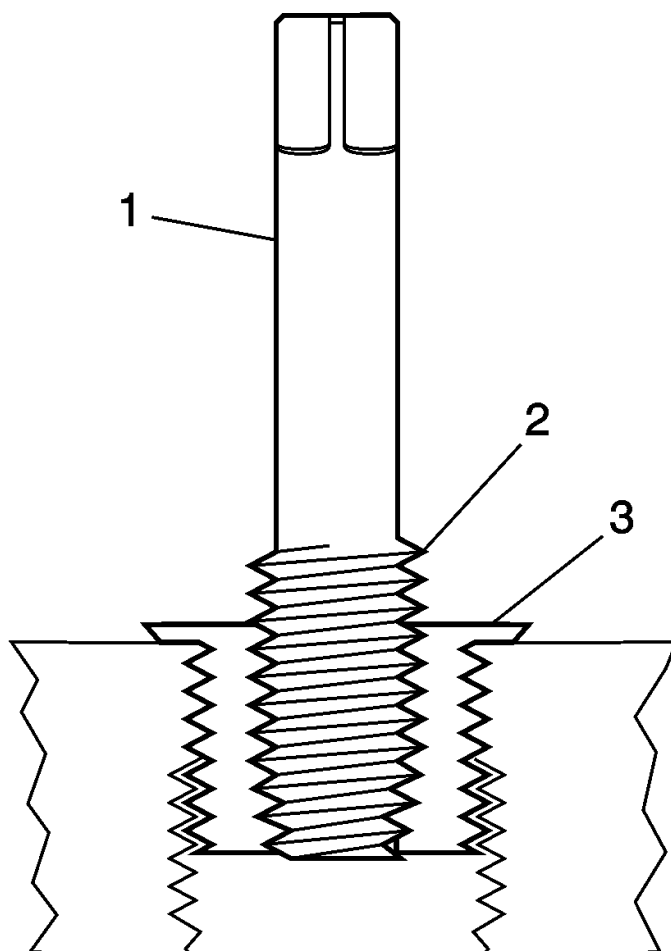


Fig. 405: Installing Insert - Tapered Pipe Thread Repair
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the insert will not thread down until the flange of the insert 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 of the insert (3) contacts the surface of the base material.
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).

NOTE: 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.

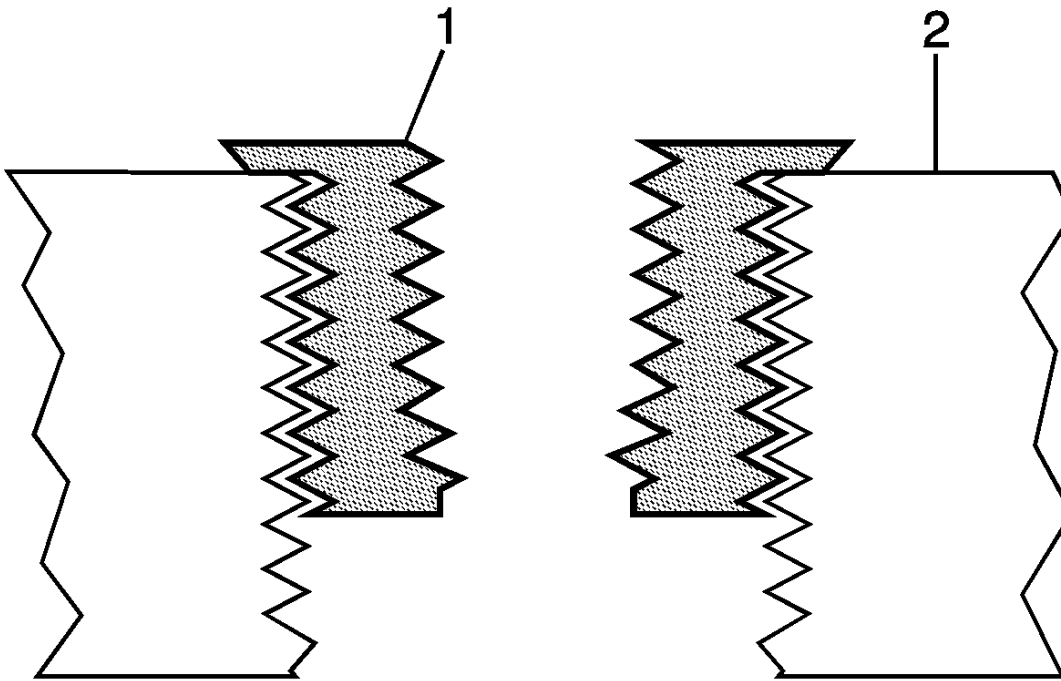


Fig. 406: Inspecting Insert For Proper Installation - Tapered Thread
Courtesy of GENERAL MOTORS COMPANY

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

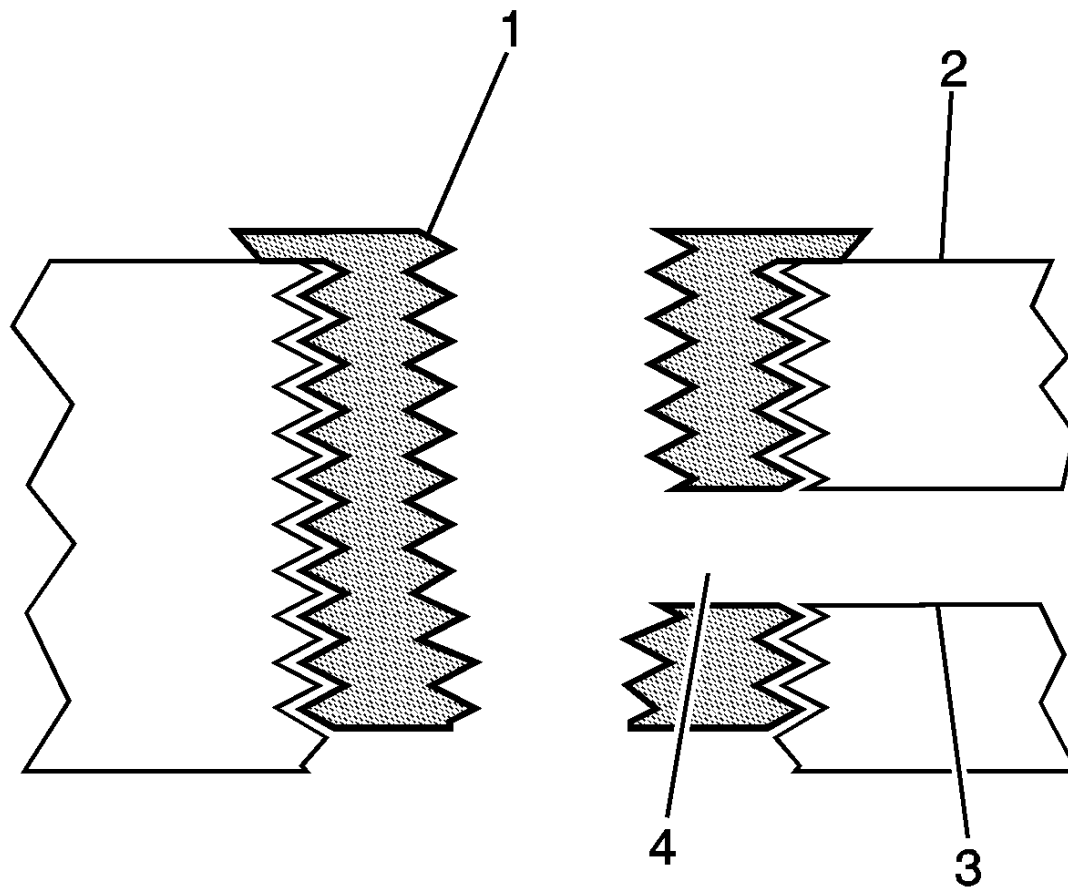


Fig. 407: View Of Restricted Engine Coolant Passages - Tapered Pipe Thread Repair
Courtesy of GENERAL MOTORS COMPANY

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

Special Tools

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

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

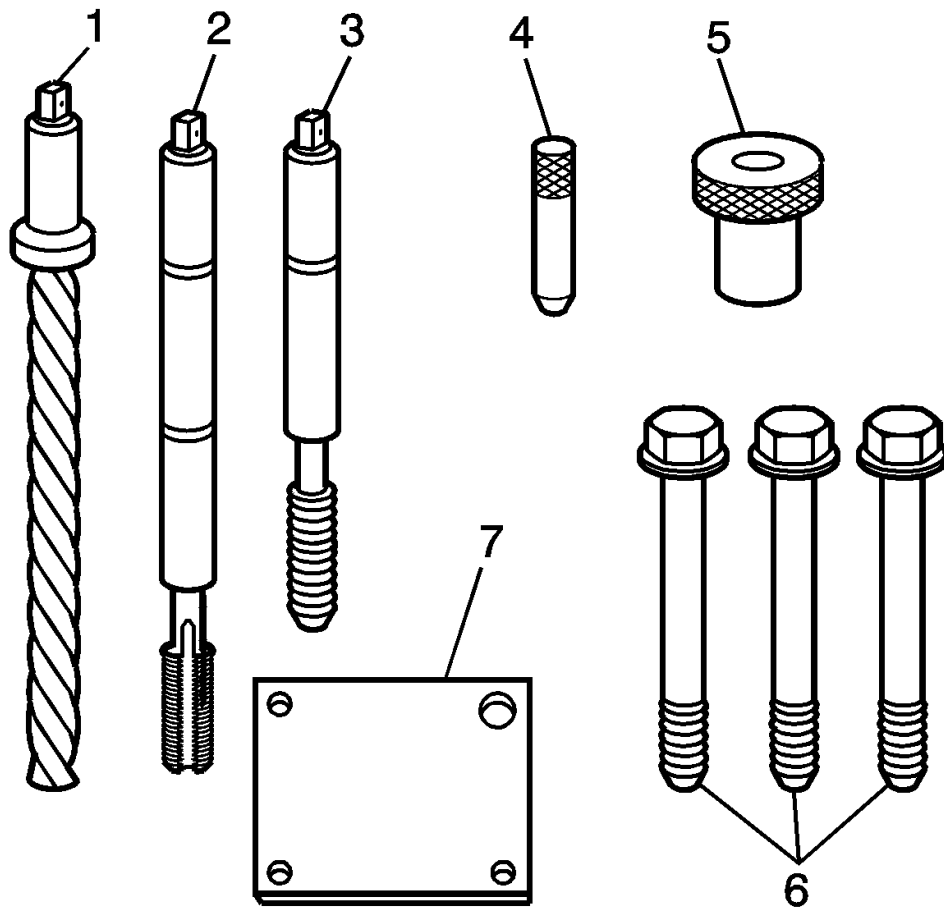


Fig. 408: Identifying Cylinder Head Bolt Hole Thread Repair Kit Components

Courtesy of GENERAL MOTORS COMPANY

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

- EN 42385-723 Drill (1)
- EN 42385-724 Tap (2)
- EN 42385-725 Installation driver (3)
- EN 42385-303 Alignment pin (4)
- EN 42385-302 Bushing (5)
- EN 42385-733 Bolts (6)
- EN 42385-401 Fixture plate (7)

WARNING: Refer to Safety Glasses Warning .

NOTE:

- Remove the fixture plate prior to installing the insert with the installer tool.
- The use of a cutting type fluid, WD 40®; or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants and Sealers for recommended cutting fluid.

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

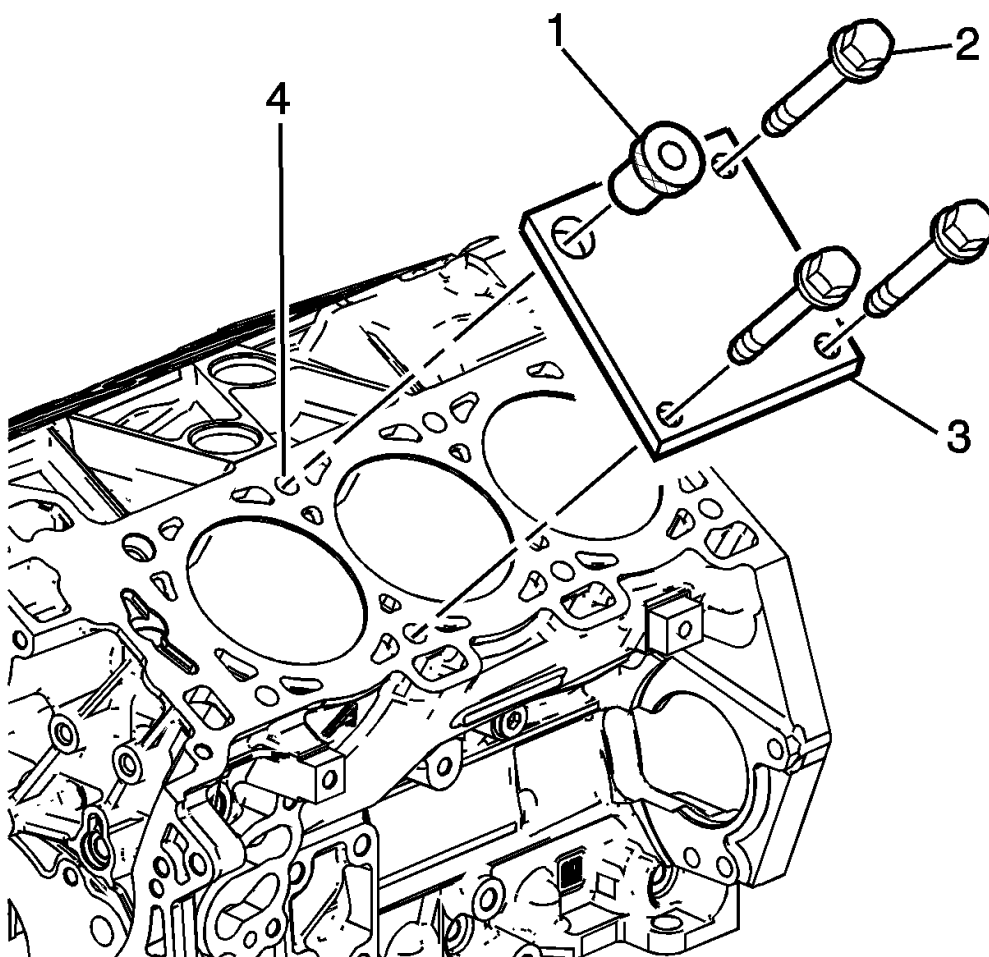


Fig. 409: View Of Fixture Plate & Components - Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

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.

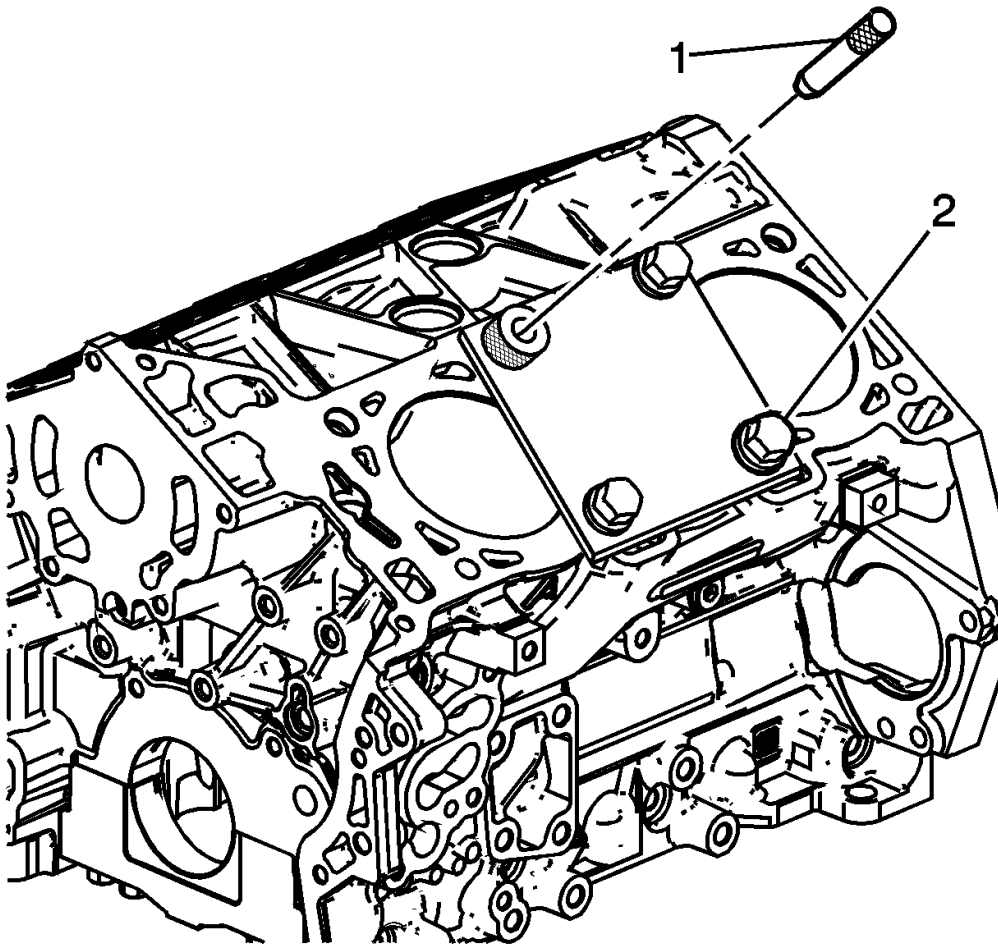


Fig. 410: Locating Alignment Pin

Courtesy of GENERAL MOTORS COMPANY

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.

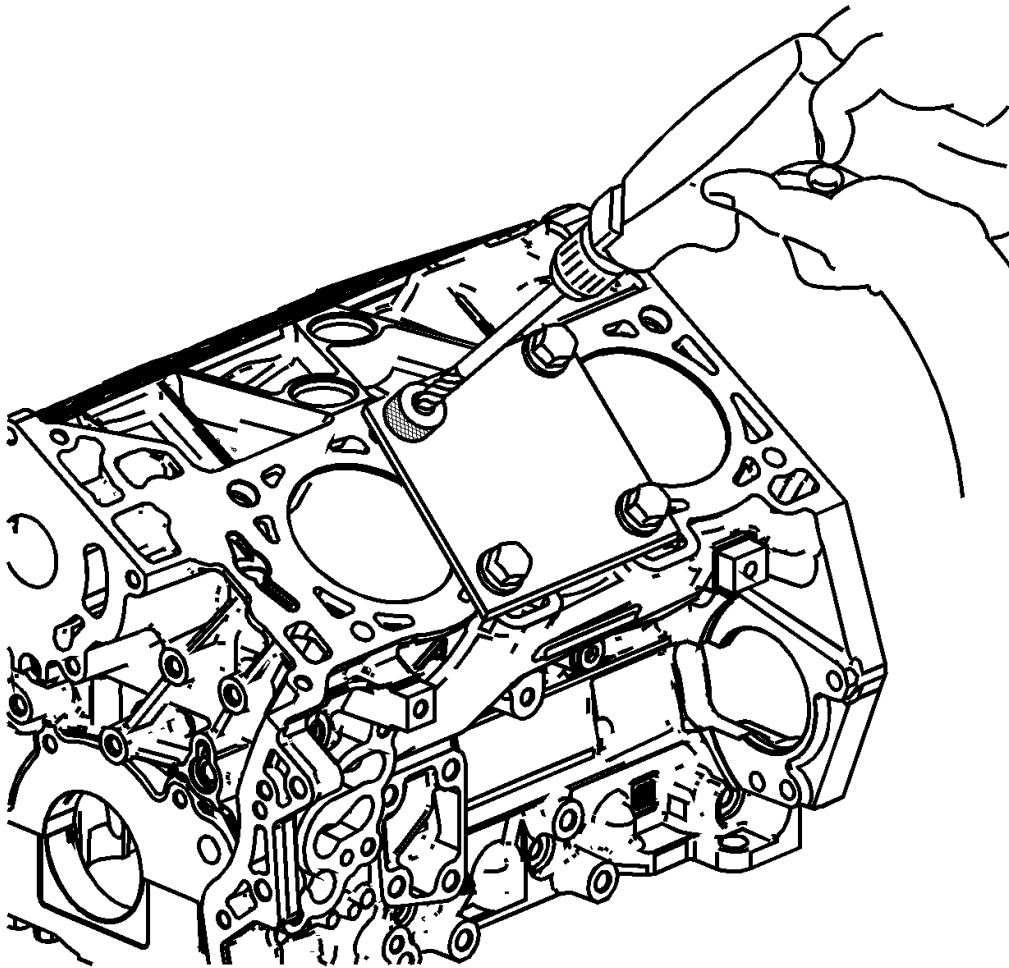


Fig. 411: Drilling Out Threads Of Damaged Hole - Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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.
7. Using compressed air, clean out any chips.

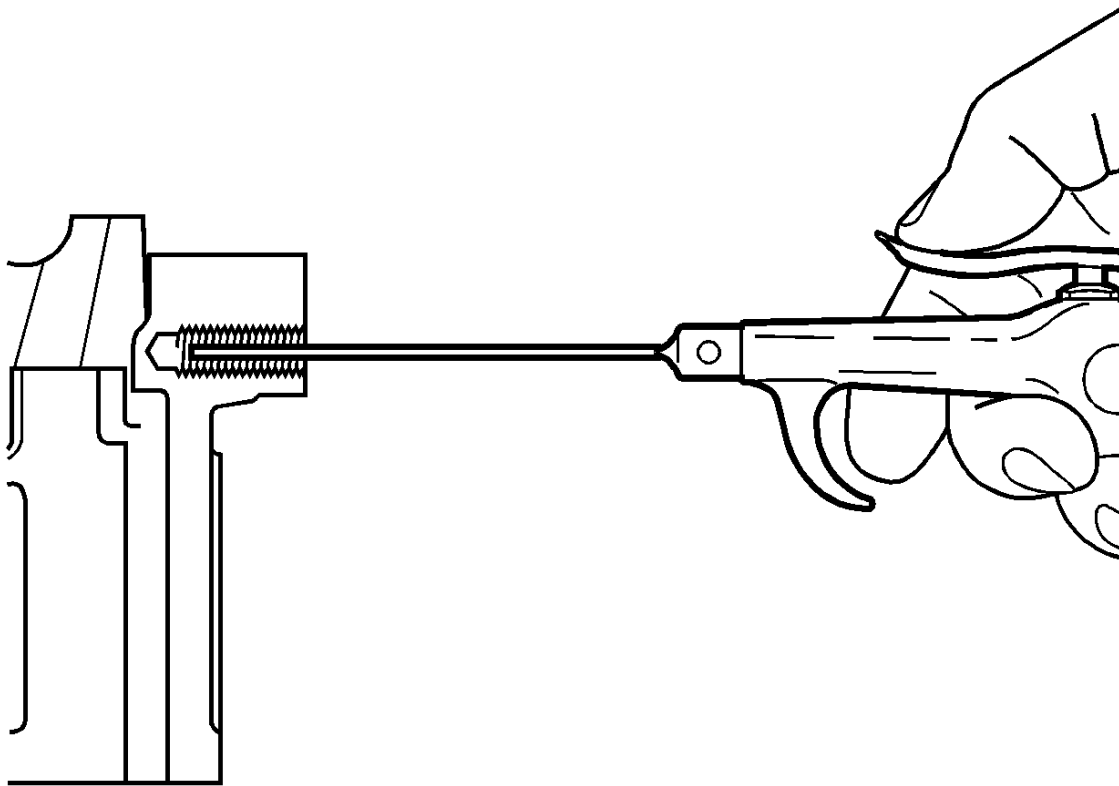


Fig. 412: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

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

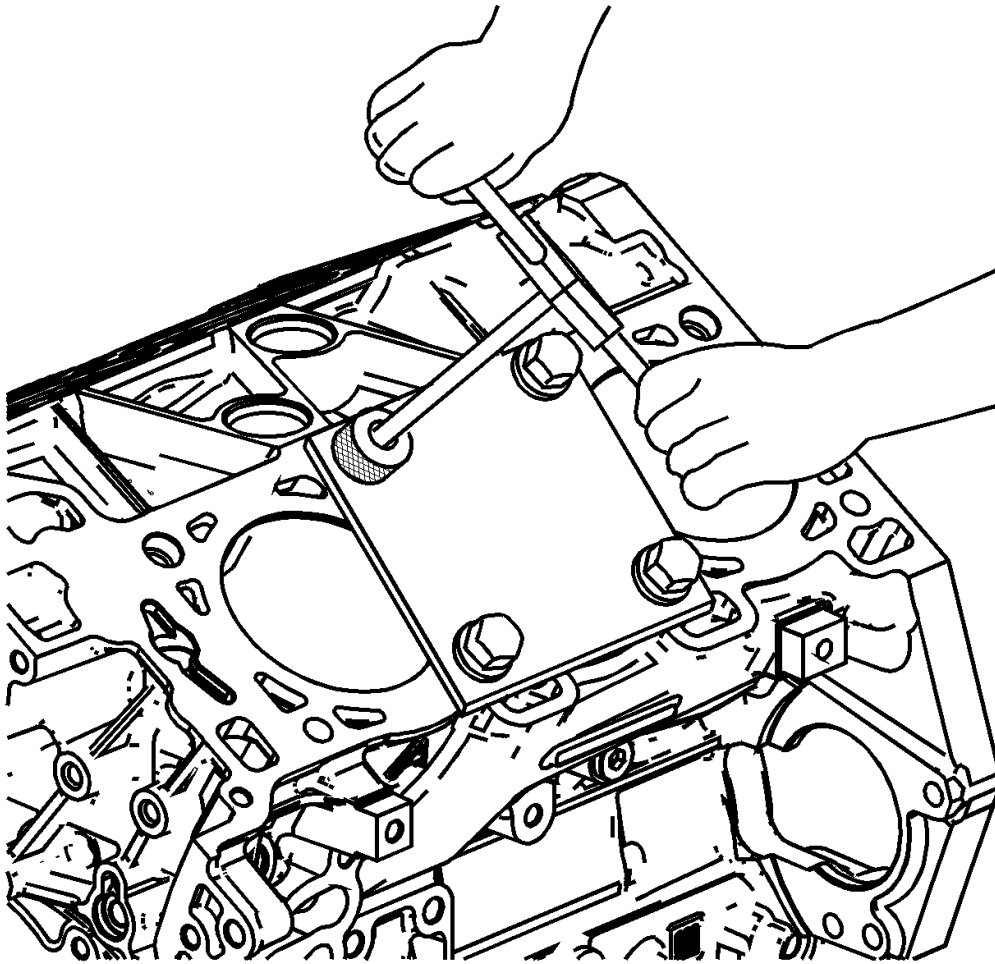


Fig. 413: Tapping Threads Of Drilled Hole Using Tapping Wrench - Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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.

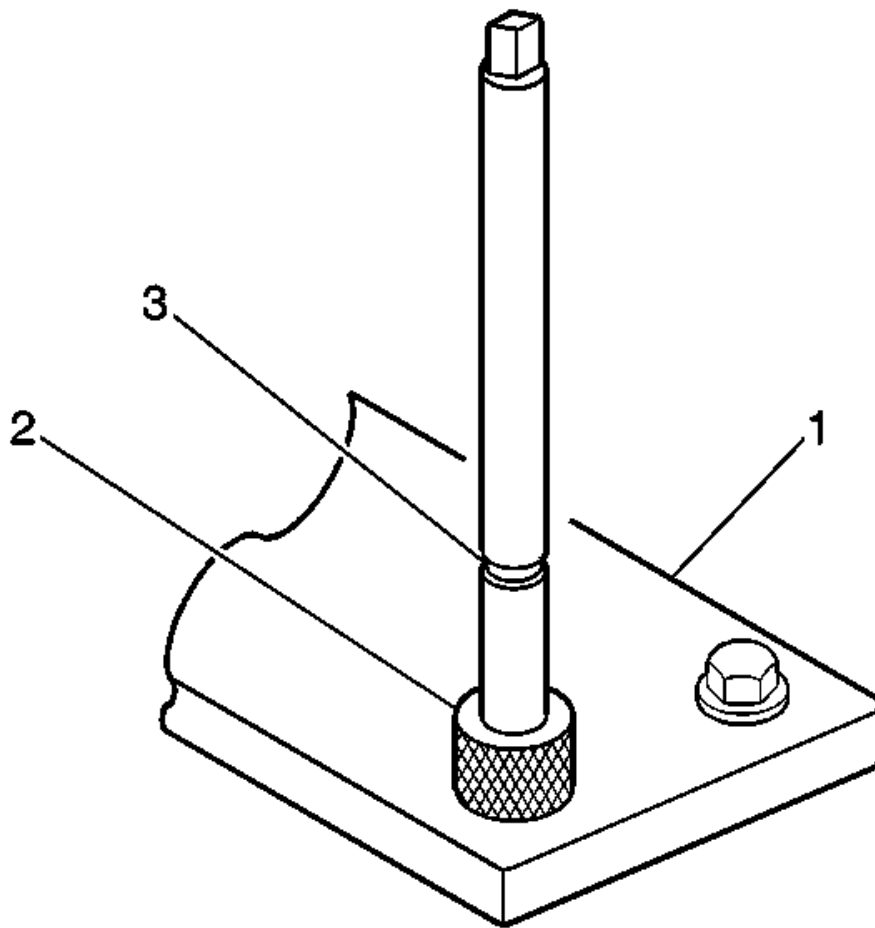


Fig. 414: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

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).
10. Remove the fixture plate bolts (2).

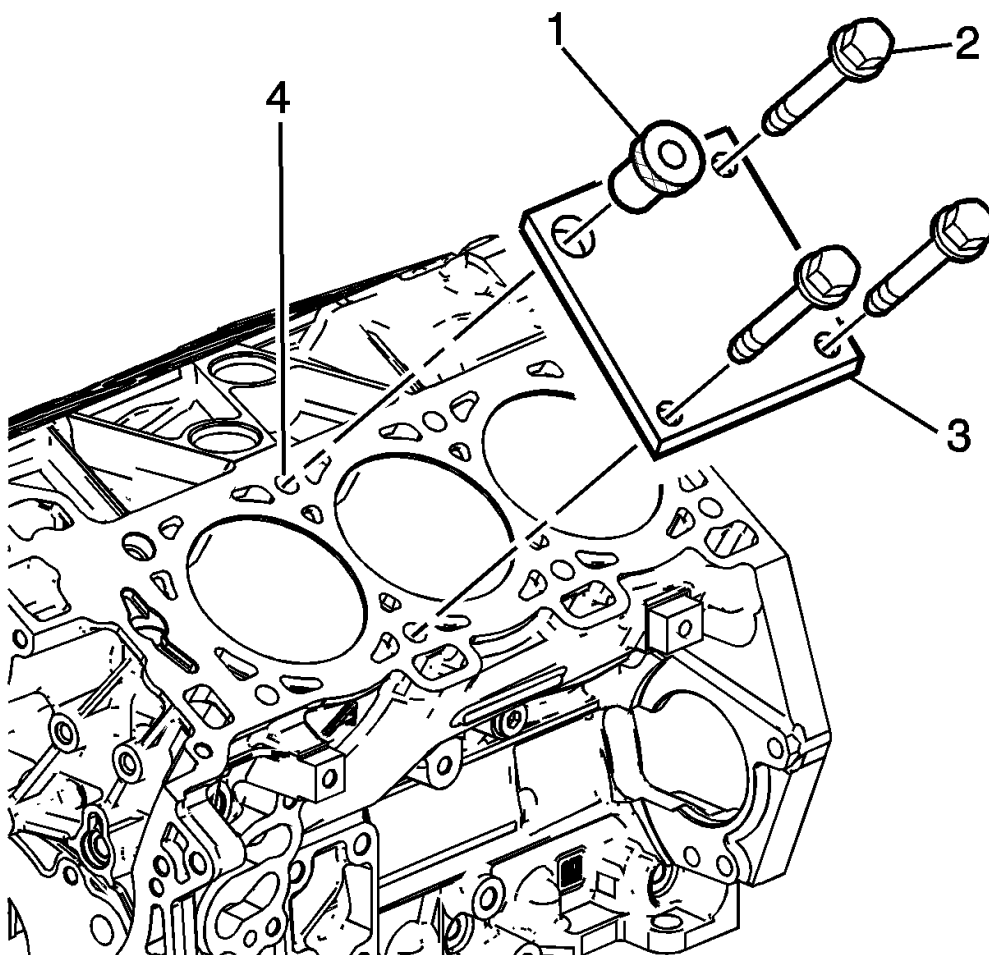


Fig. 415: View Of Fixture Plate & Components - Cylinder Head Bolt Hole
 Courtesy of GENERAL MOTORS COMPANY

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

11. Remove the fixture plate (3) and bushing (1).
12. Using compressed air, clean out any chips.

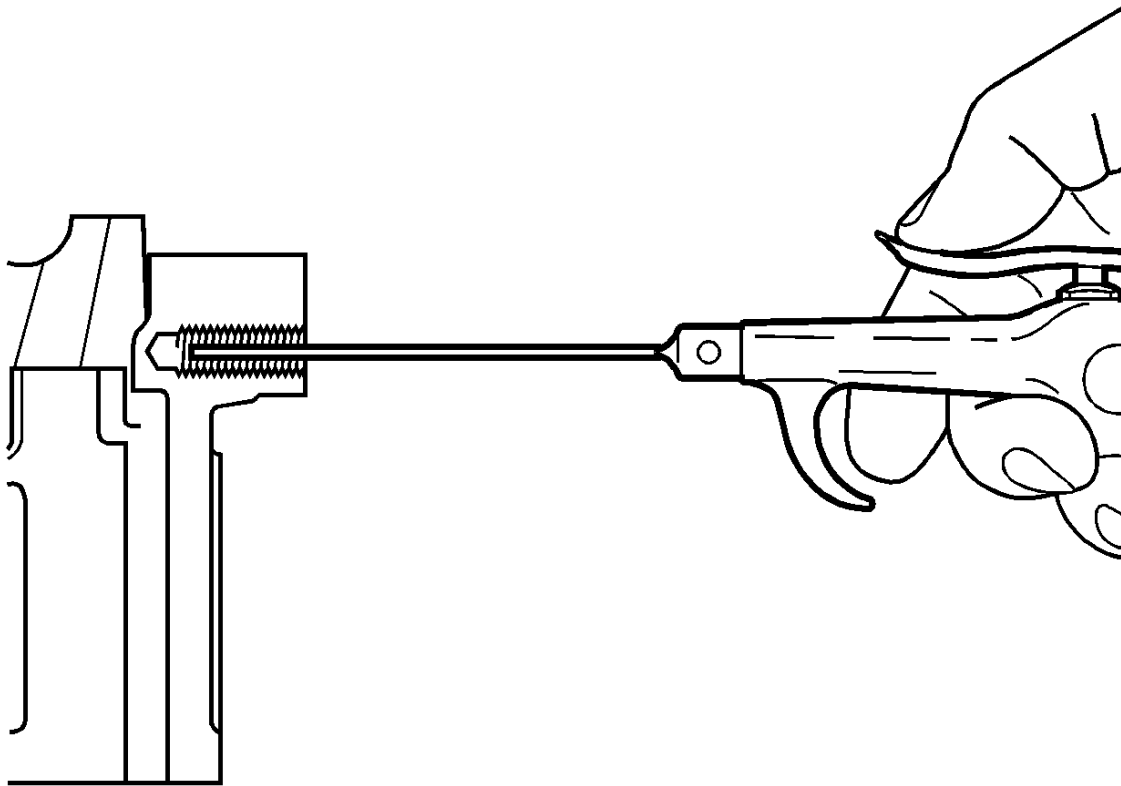


Fig. 416: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

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

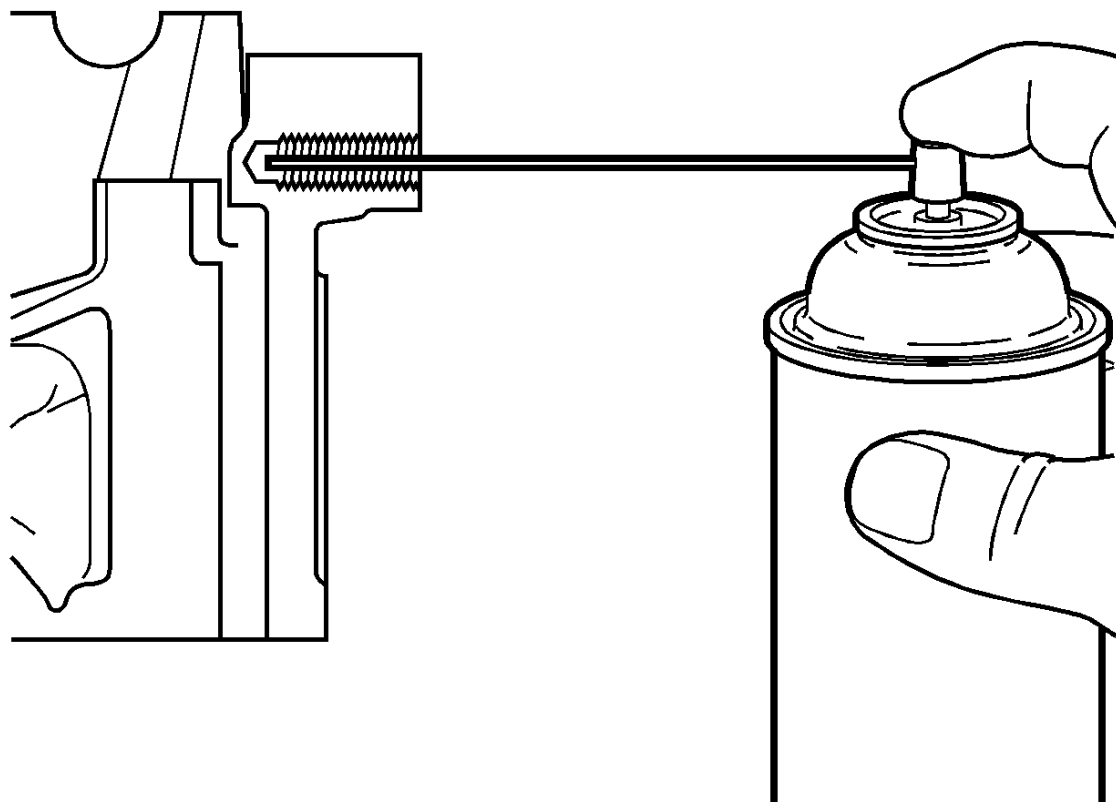


Fig. 417: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS COMPANY

13. Spray cleaner into the tapped hole. Refer to Adhesives, Fluids, Lubricants and Sealers for recommended cleaner.
14. Using compressed air, clean out any chips.

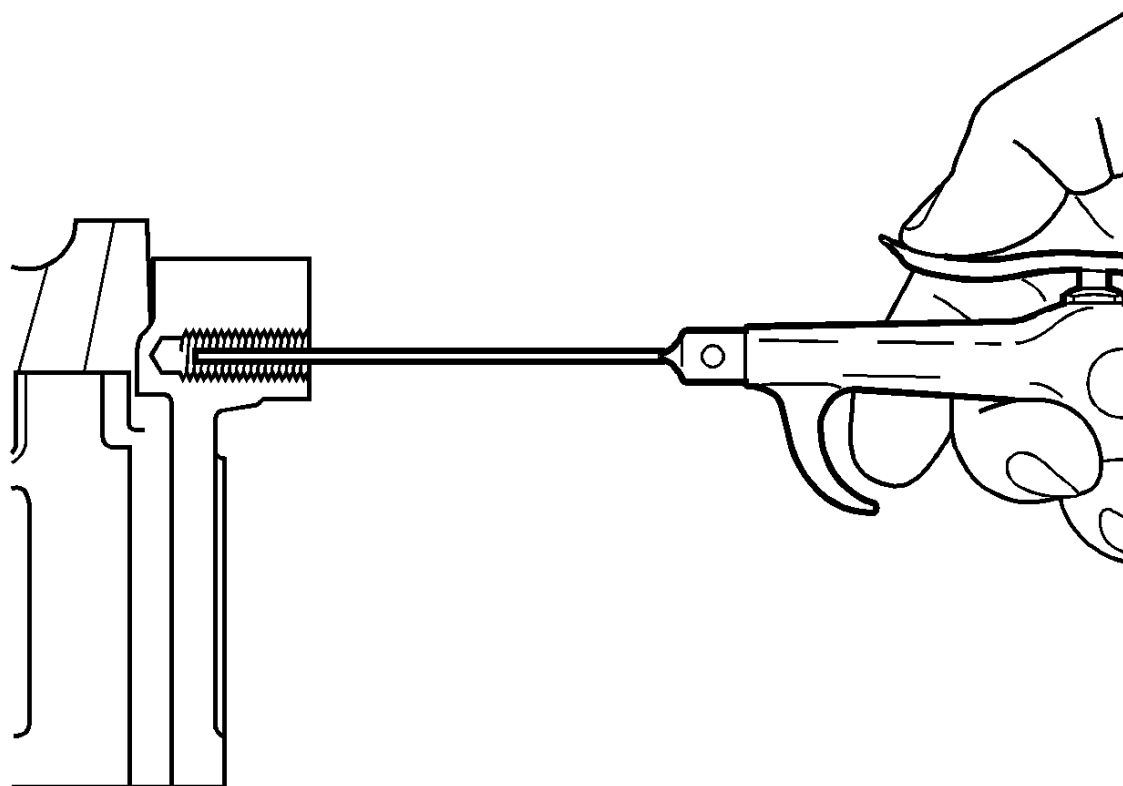


Fig. 418: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

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

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

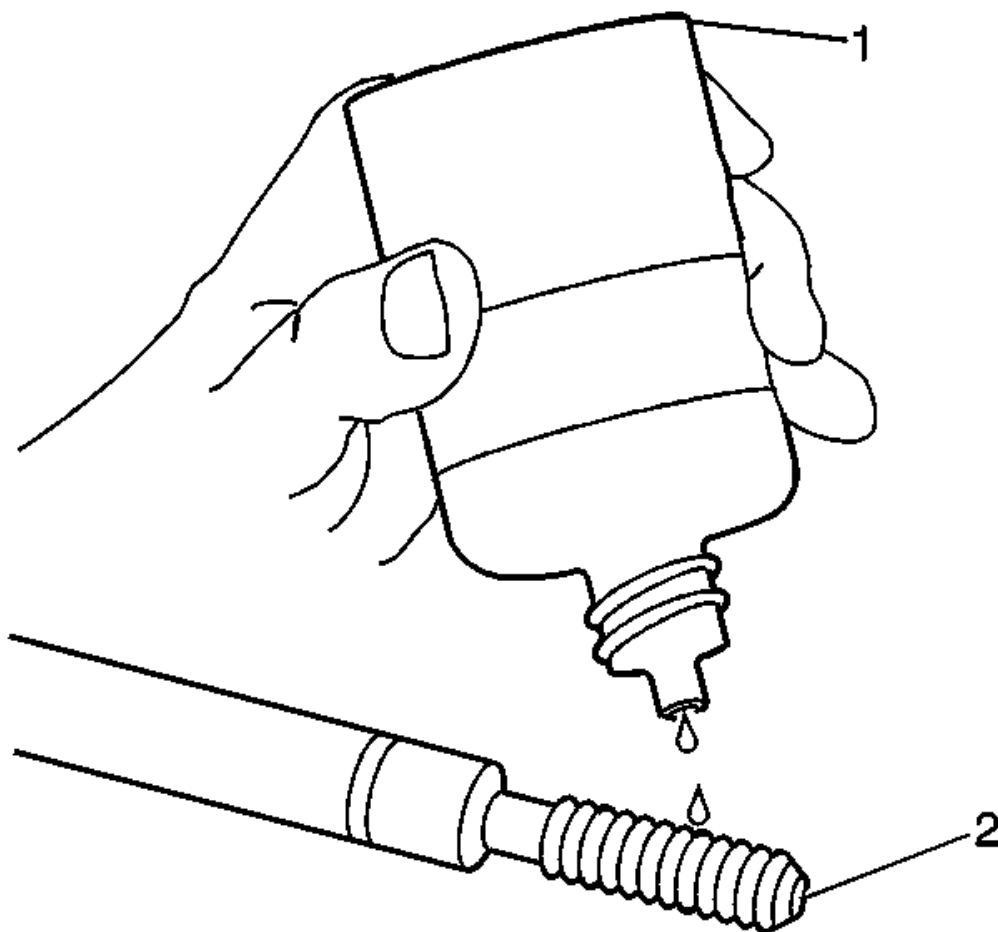


Fig. 419: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

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

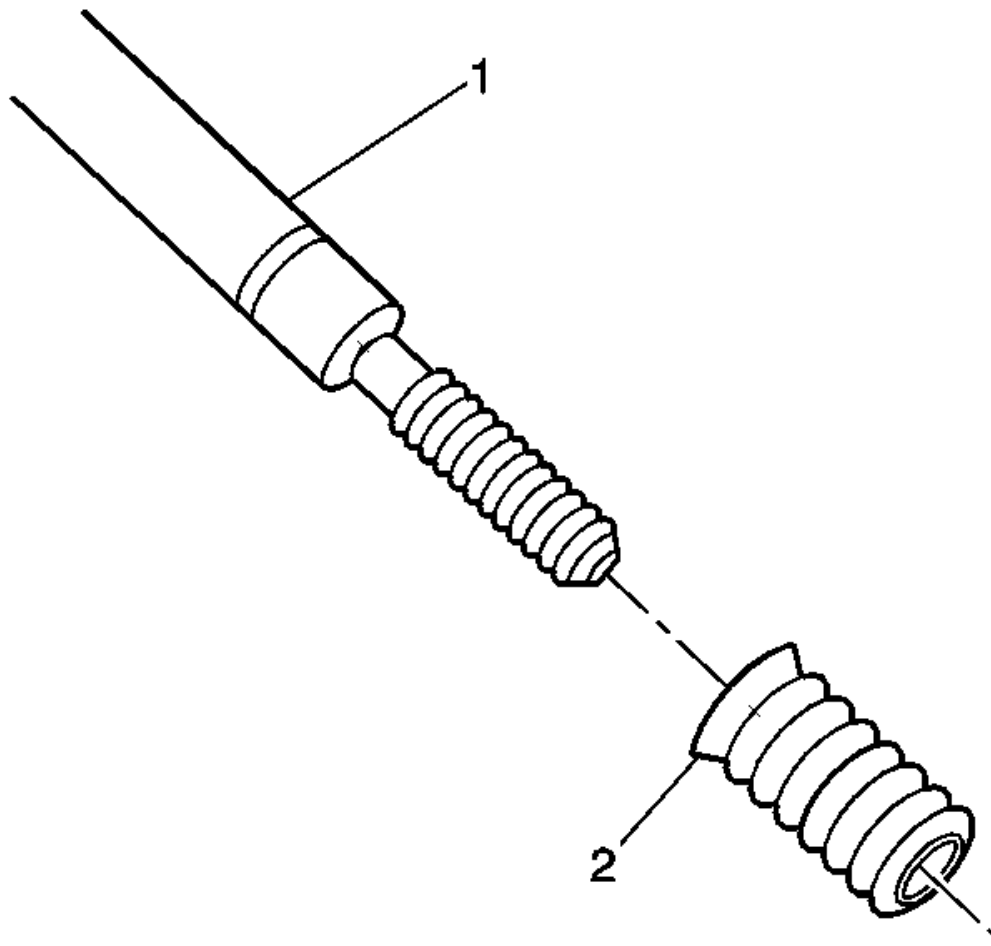


Fig. 420: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

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

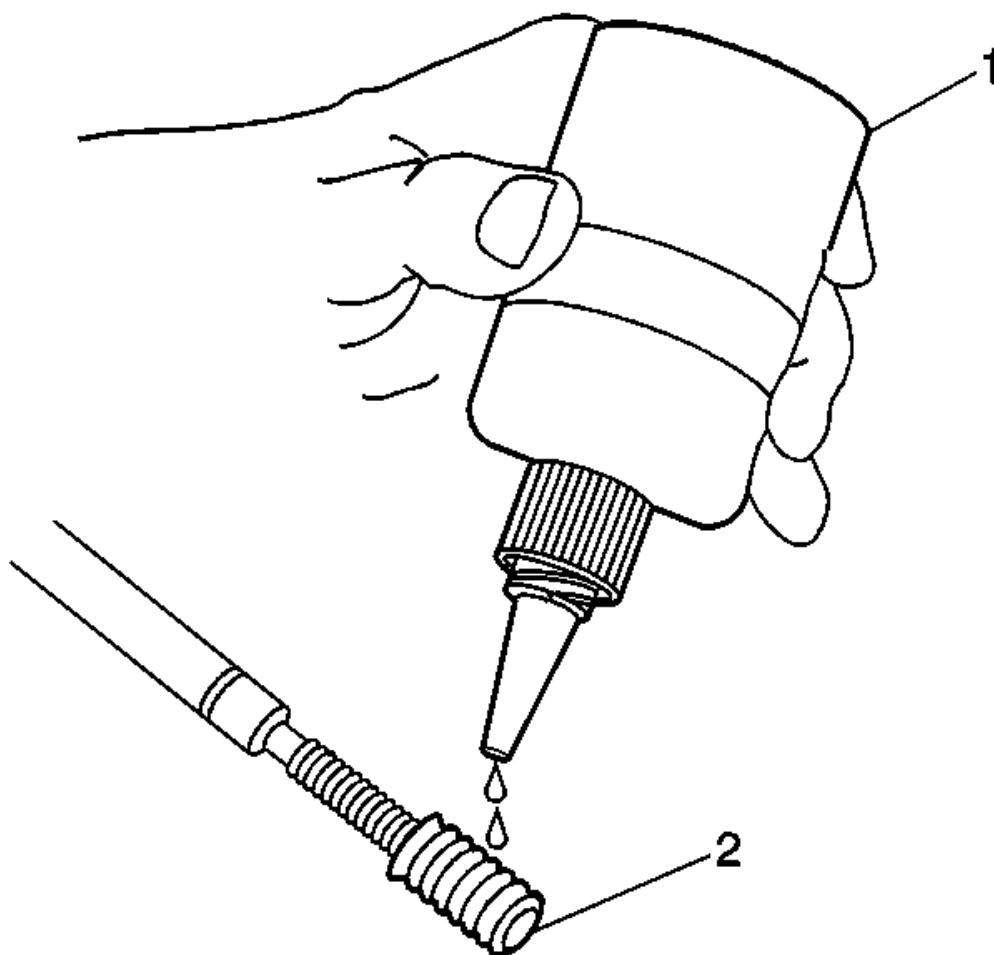


Fig. 421: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

17. Apply threadlock sealant, EN 42385-109, LOCTITE 277®; or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.

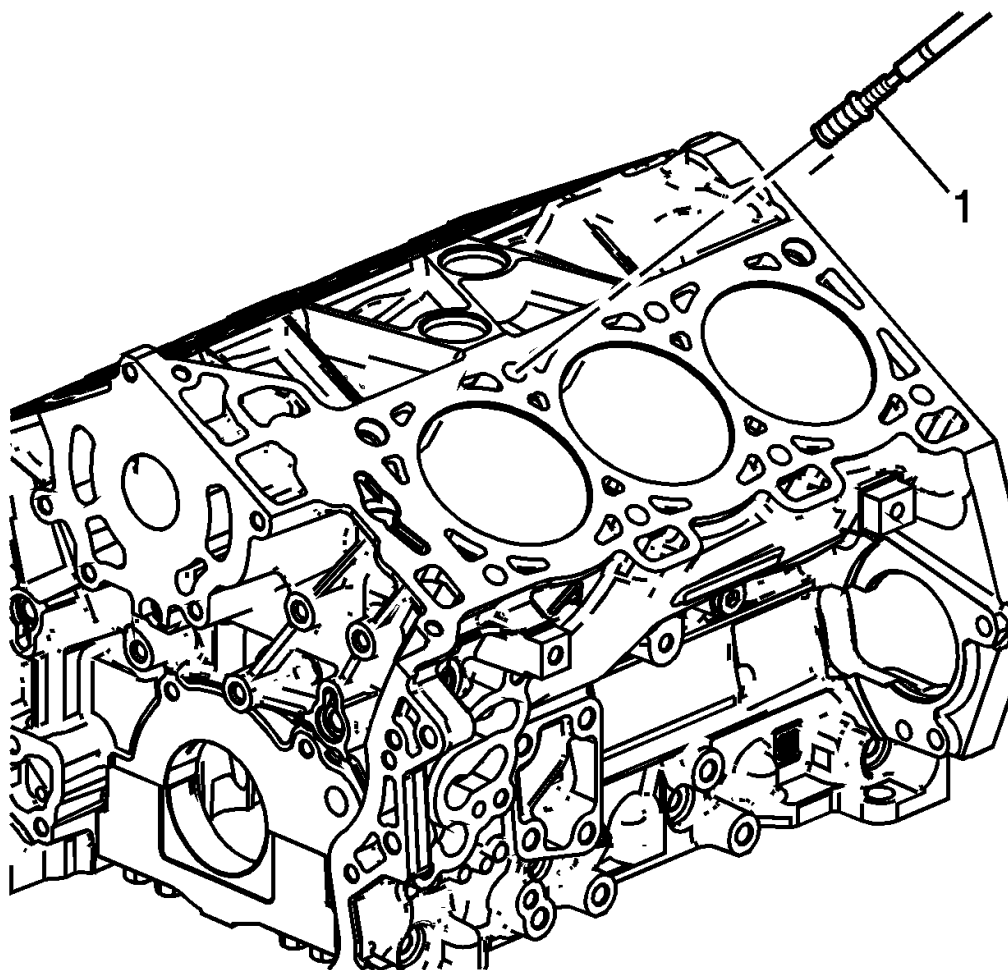


Fig. 422: Installing Installation Driver By Hand
Courtesy of GENERAL MOTORS COMPANY

18. Install the insert and installation driver (1) into the tapped hole by hand only.
19. Start the insert into the threaded hole.
20. Install the insert until the flange of the insert contacts the counterbored surface.

NOTE: 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.

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

NOTE: 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.

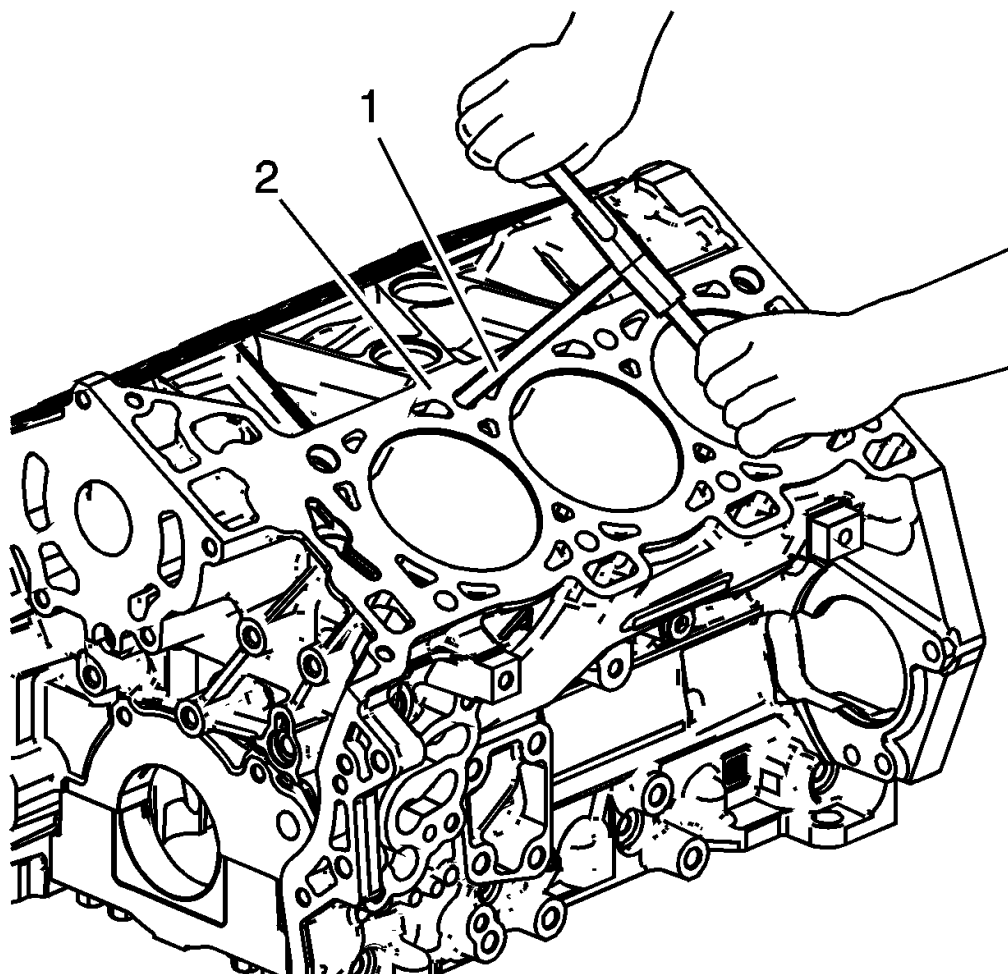


Fig. 423: View Of Driver Installation Tool & Surface Of Engine Block Deck
Courtesy of GENERAL MOTORS COMPANY

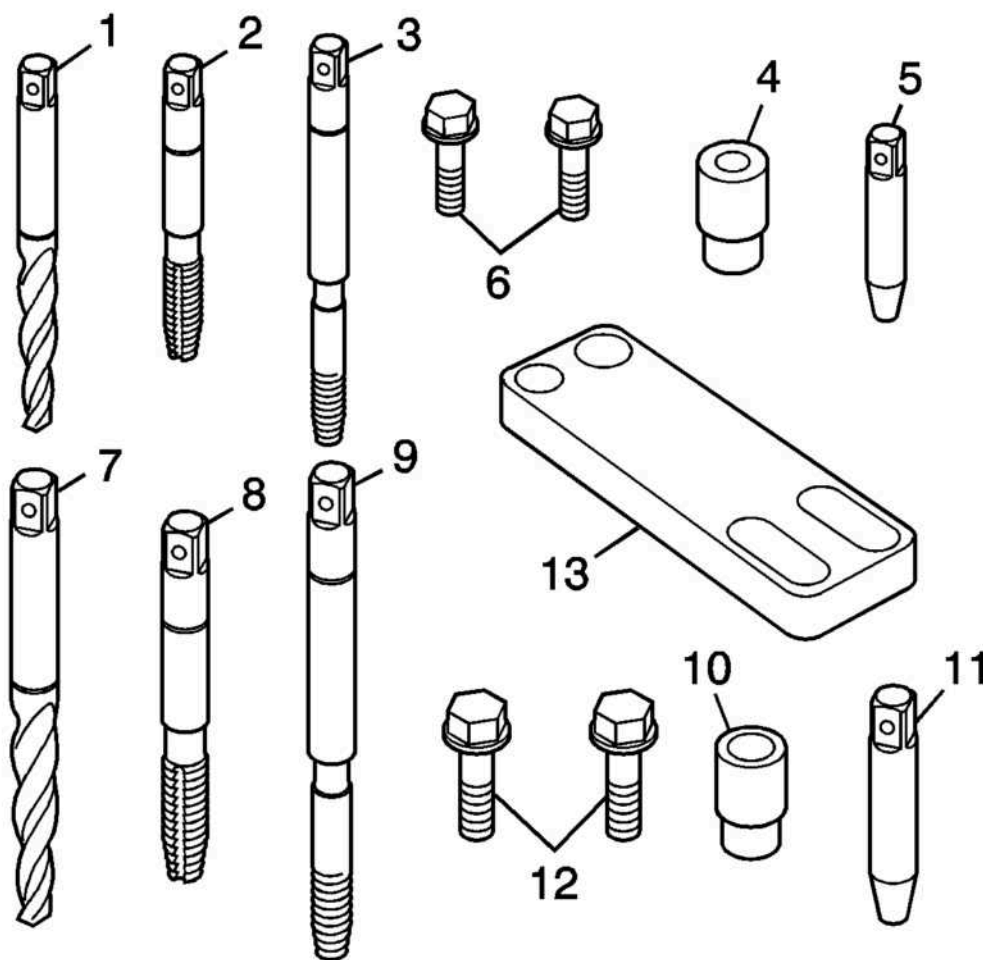
22. In order to completely form the new threads in the insert, rotate the driver installation tool through the insert until the mark (1) on the driver installation tool aligns with the surface of the engine block deck (2).
23. Inspect the insert for proper installation into the tapped hole.

Crankshaft Main Bolt Hole Thread Repair

Special Tools

- **EN 42385-700** High Feature Thread Repair Kit
- **EN 42385-2000** Thread Insert Kit

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

**Fig. 424: High Feature Thread Repair Kit**

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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 **EN 42385-2000** insert kit and **EN 42385-700** kit. The crankshaft main bearing bolt hole thread repair components consist of the following:

- EN 42385-702 Drill (1) for outboard holes
- EN 42385-703 Tap (2) for outboard holes
- EN 42385-704 Installation driver (3) for outboard holes
- EN 42385-726 Bushing (4) for outboard holes

- EN 42385-727 Alignment pin (5) for outboard holes
- EN 42385-728 Bolts (6) for outboard holes
- EN 42385-720 Drill (7) for inboard holes
- EN 42385-721 Tap (8) for inboard holes
- EN 42385-722 Installation driver (9) for inboard holes
- EN 42385-713 Bushing (10)
- EN 42385-308 Alignment pin (11)
- EN 42385-734 Bolts (12)
- EN 42385-712 Fixture plate (13)

Outboard Bolt Holes

WARNING: Refer to Safety Glasses Warning .

NOTE:

- Ensure the fixture plate is installed during the machining and installation processes of the insert.
- The use of a cutting type fluid, WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants and Sealers for recommended cutting fluid.

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

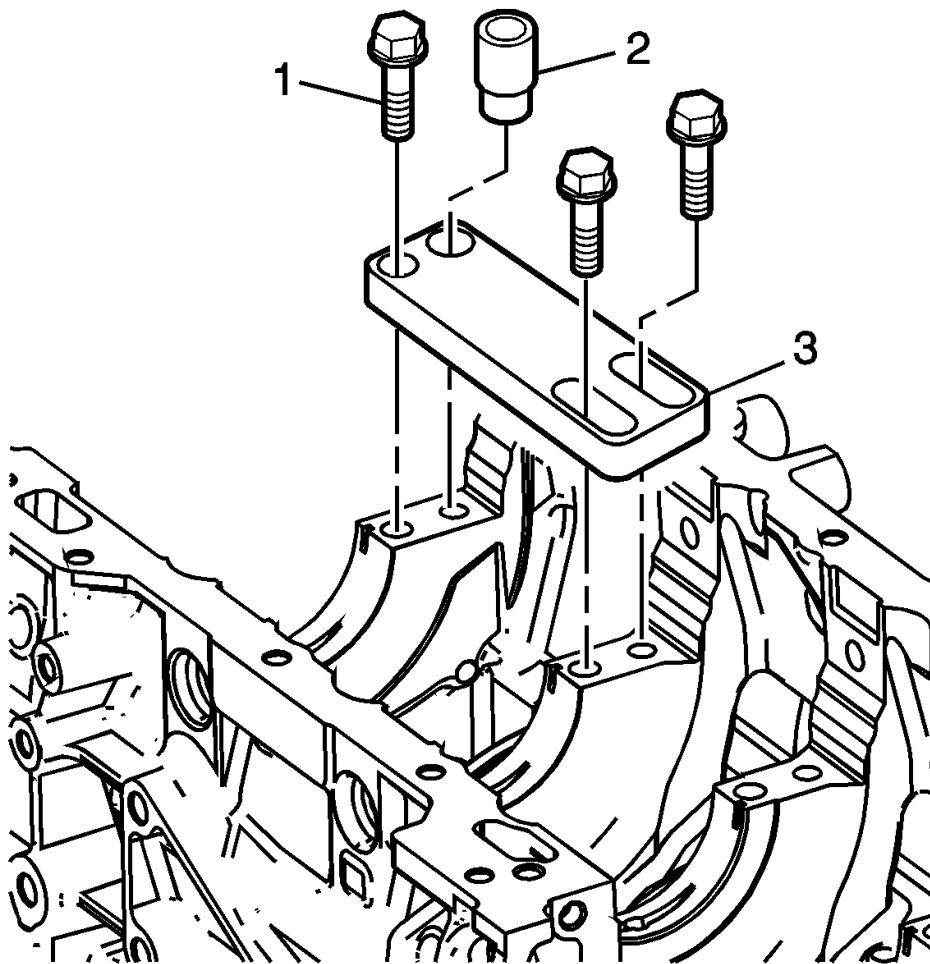


Fig. 425: Identifying Fixture Plate Over Crankshaft Main Cap Bolt Hole
 Courtesy of GENERAL MOTORS COMPANY

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.

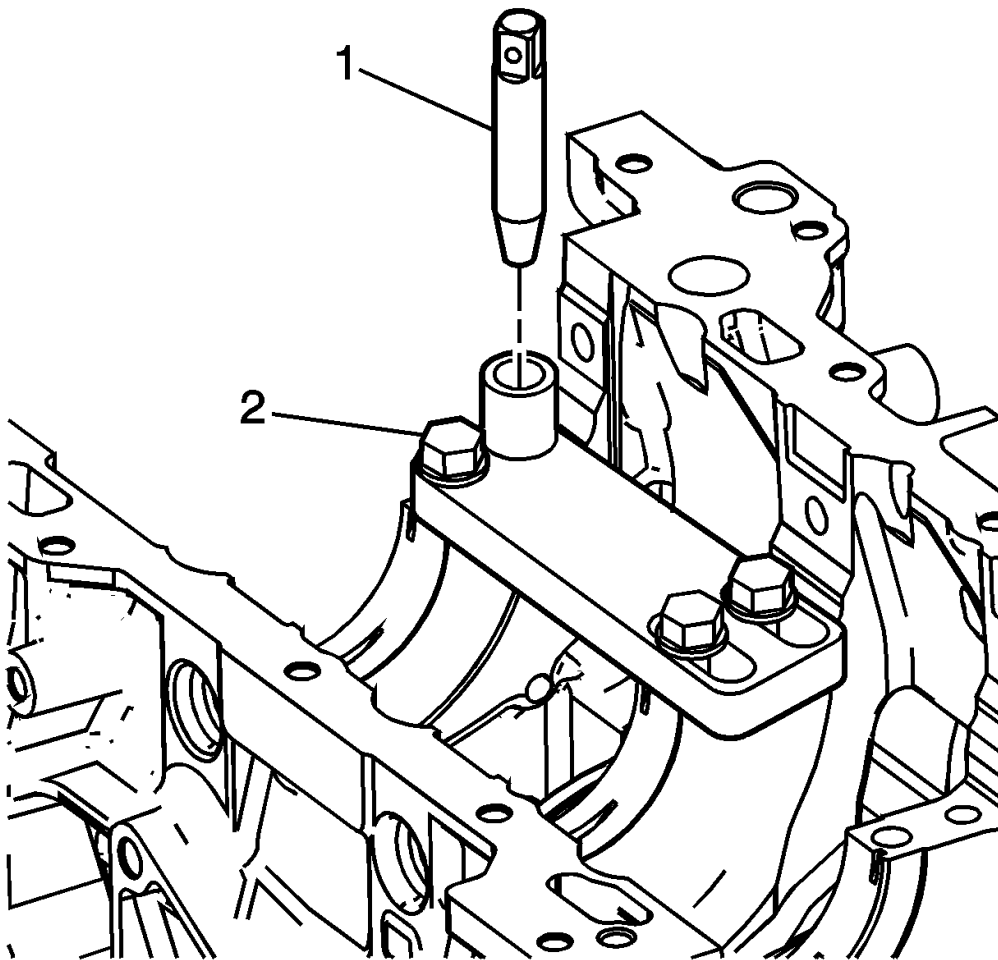


Fig. 426: Identifying Alignment Pin & Bushing
Courtesy of GENERAL MOTORS COMPANY

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.

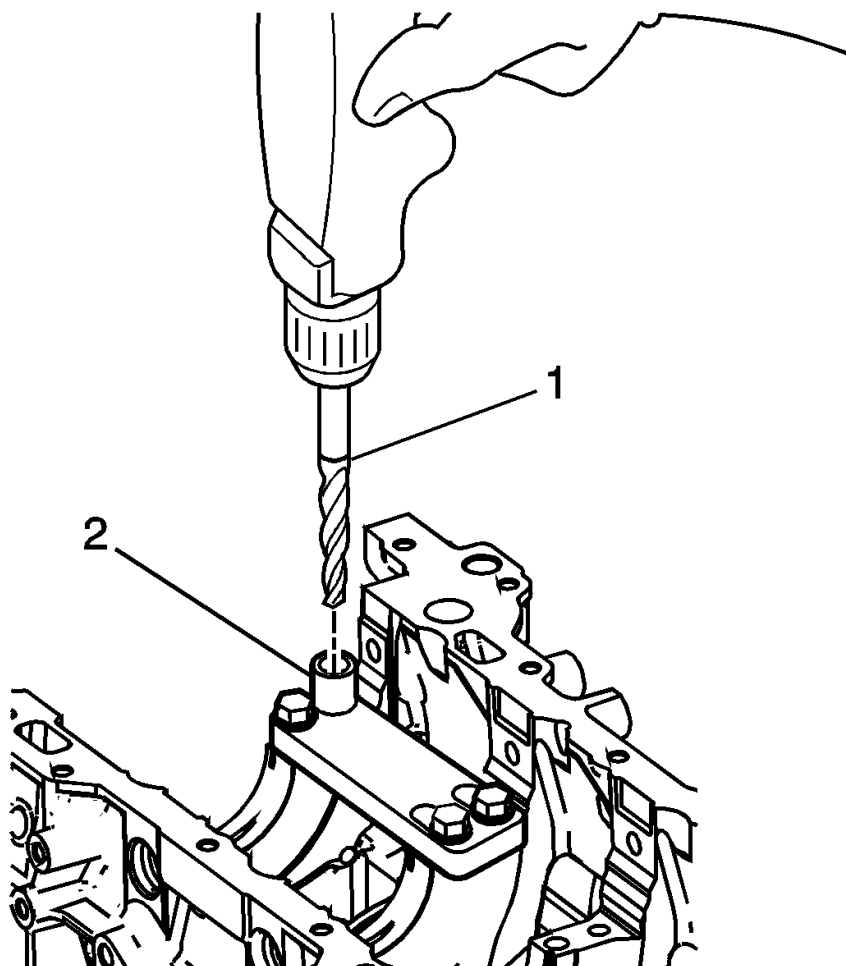


Fig. 427: Aligning Drill & Drill Bushing
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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.
7. Using compressed air, clean out any chips.

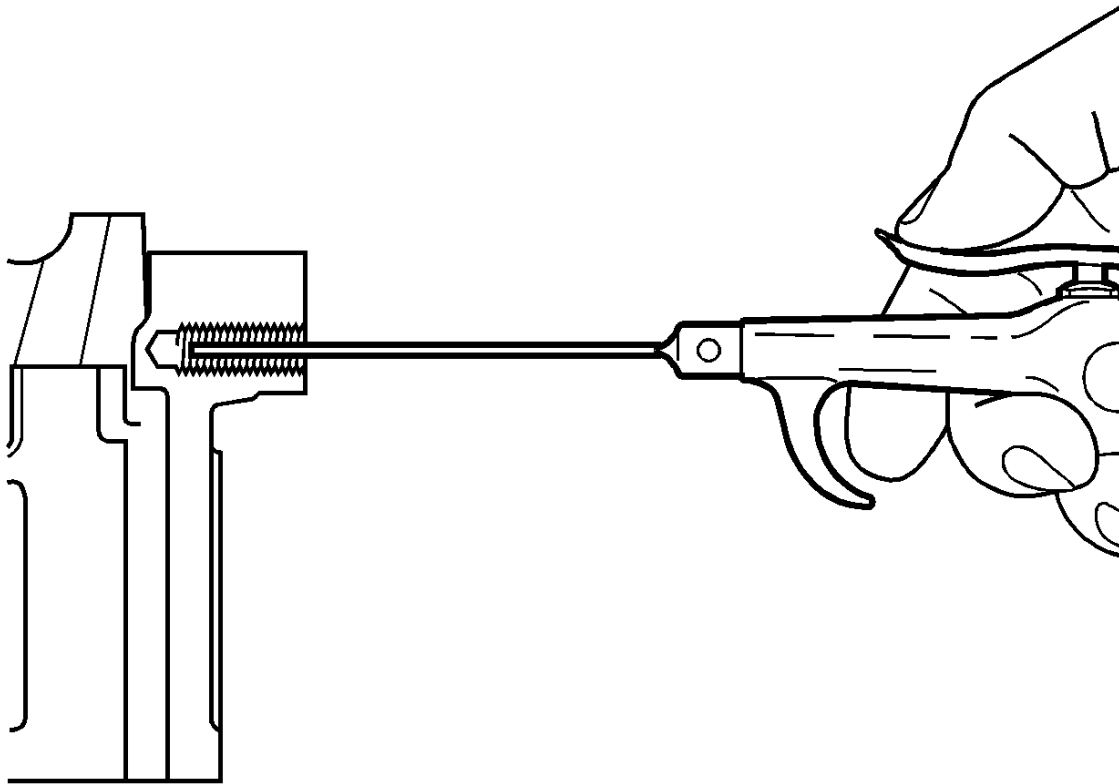


Fig. 428: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

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

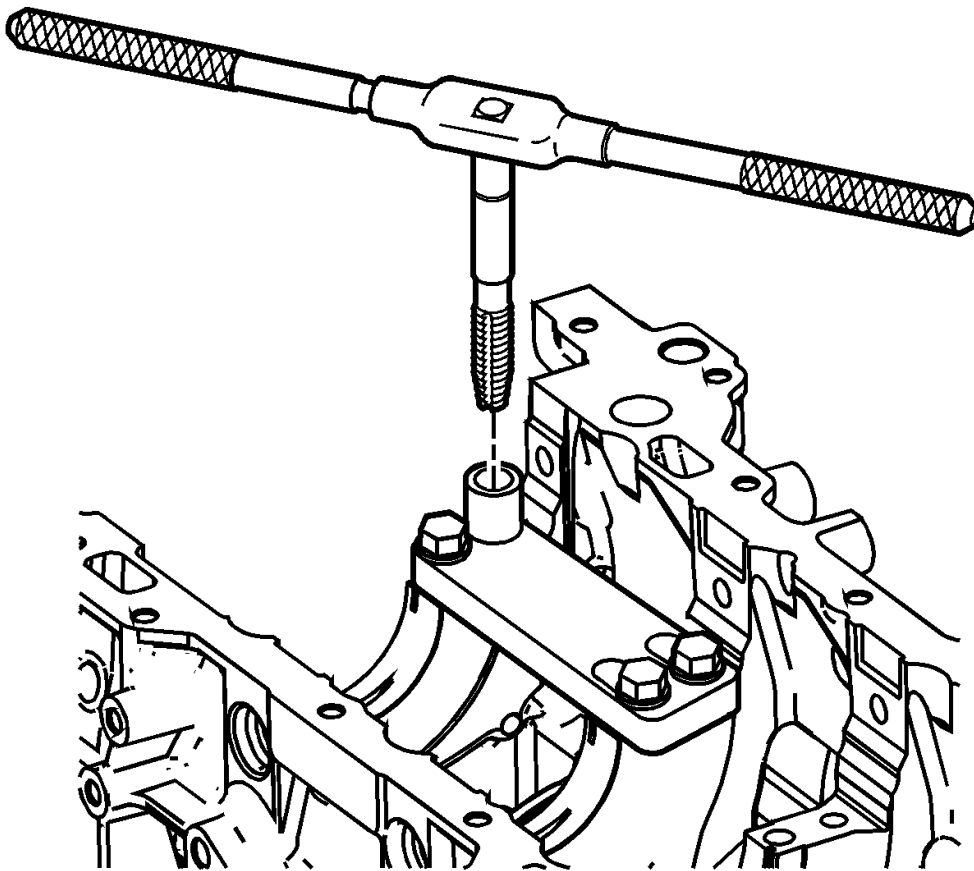


Fig. 429: View Of Tapping Wrench
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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.

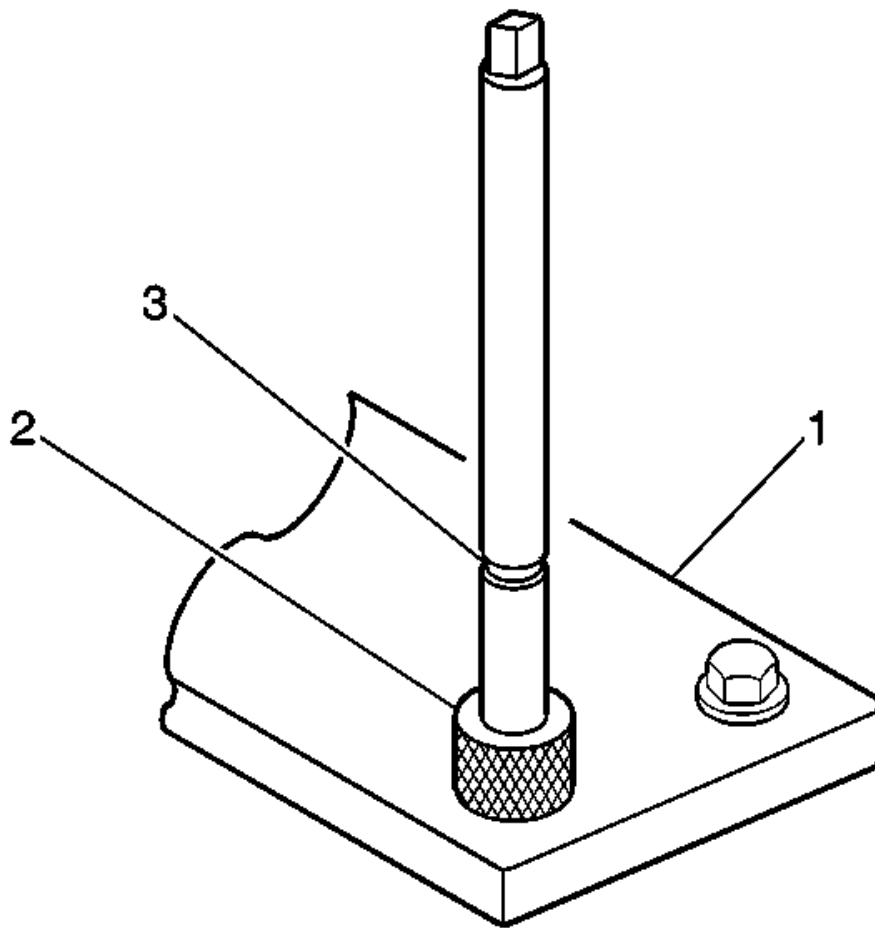


Fig. 430: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

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).
10. Using compressed air, clean out any chips.

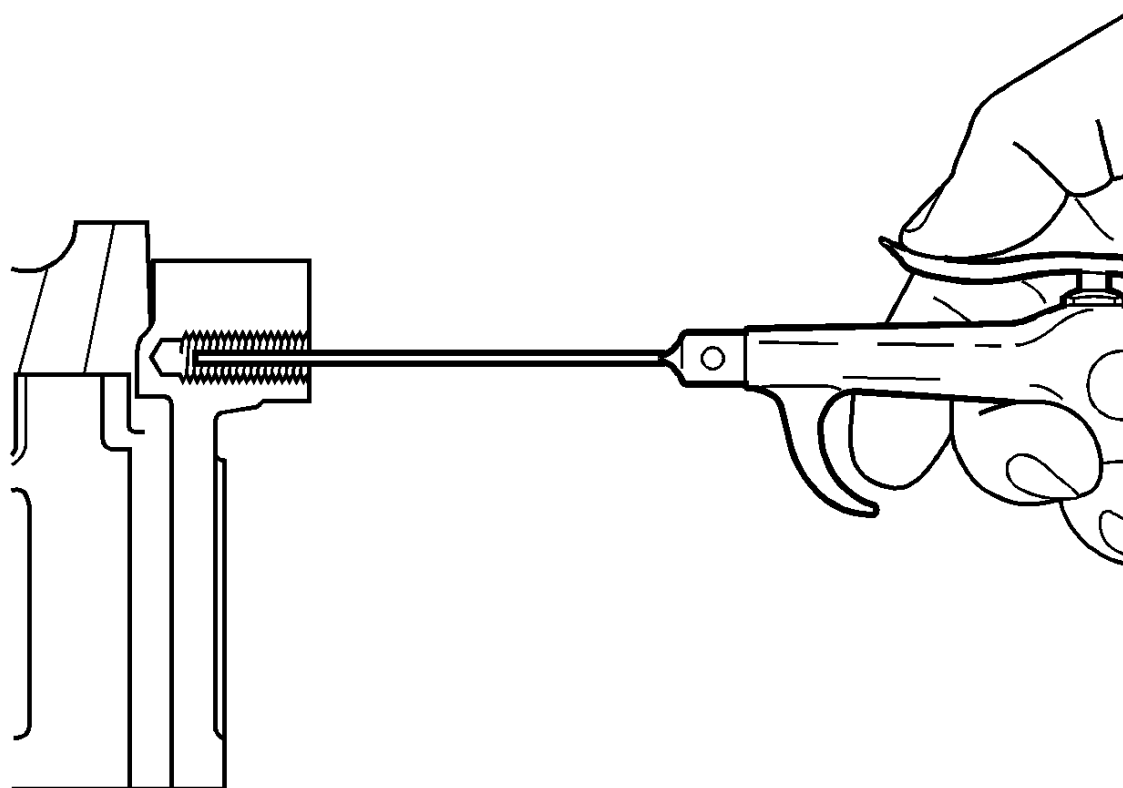


Fig. 431: Cleaning Out Metal Chips

Courtesy of GENERAL MOTORS COMPANY

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

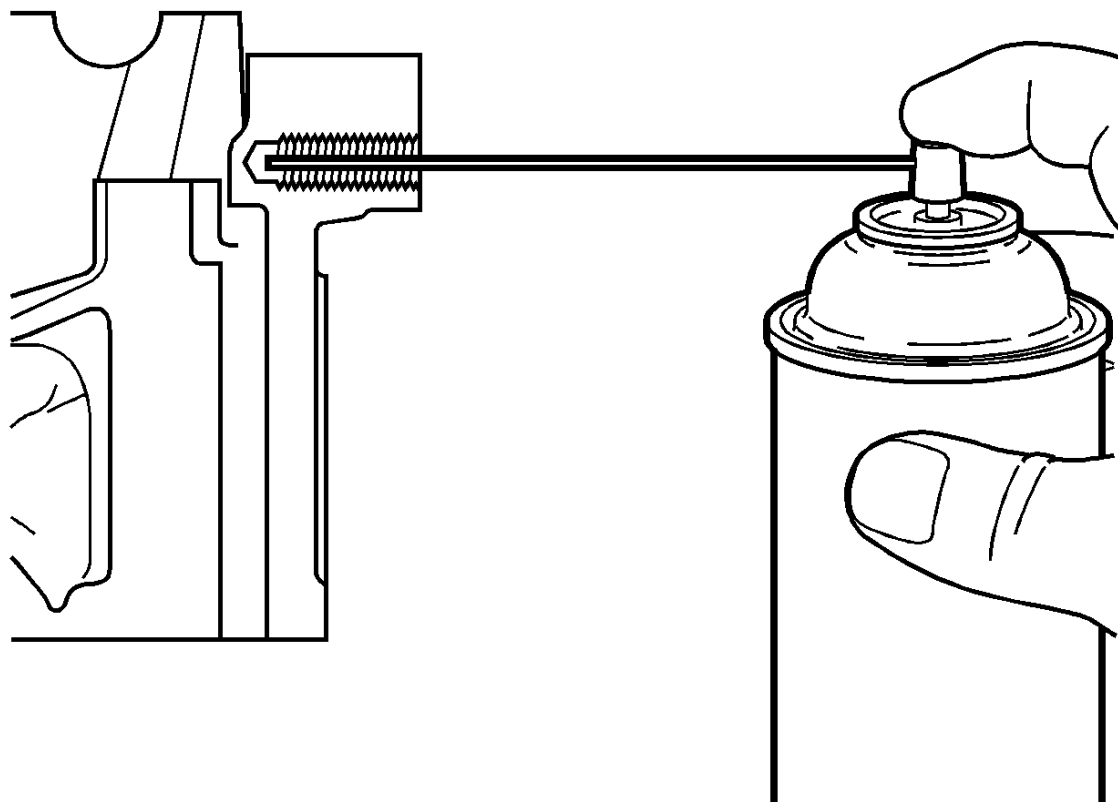


Fig. 432: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS COMPANY

11. Spray cleaner into the tapped hole. Refer to Adhesives, Fluids, Lubricants and Sealers for recommended cleaner.
12. Using compressed air, clean out any chips.

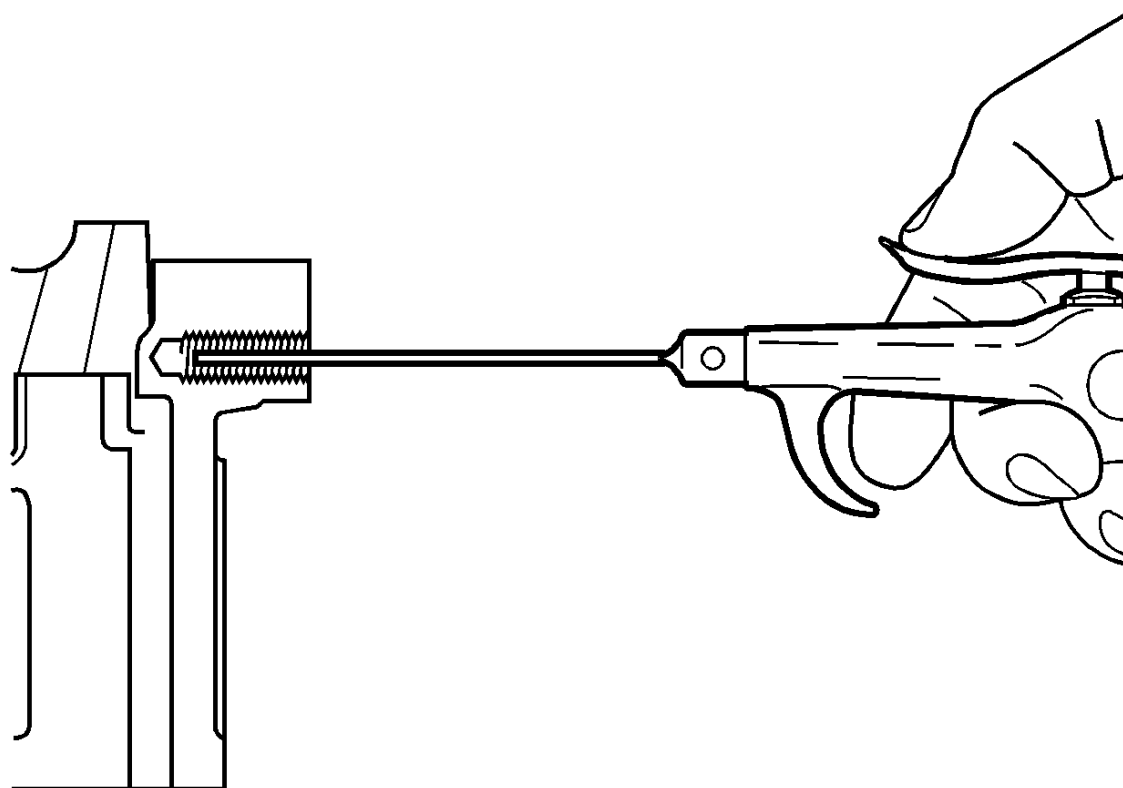


Fig. 433: Cleaning Out Metal Chips

Courtesy of GENERAL MOTORS COMPANY

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

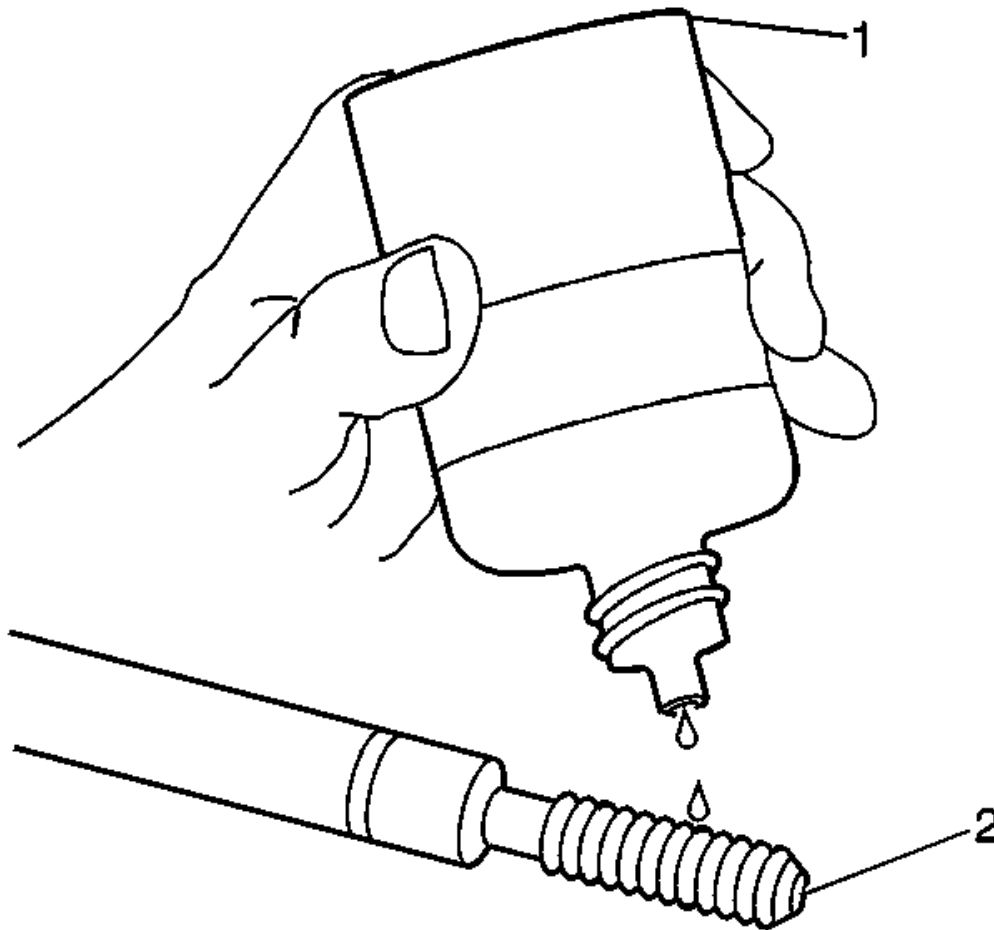


Fig. 434: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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 EN 42385-110 (1).

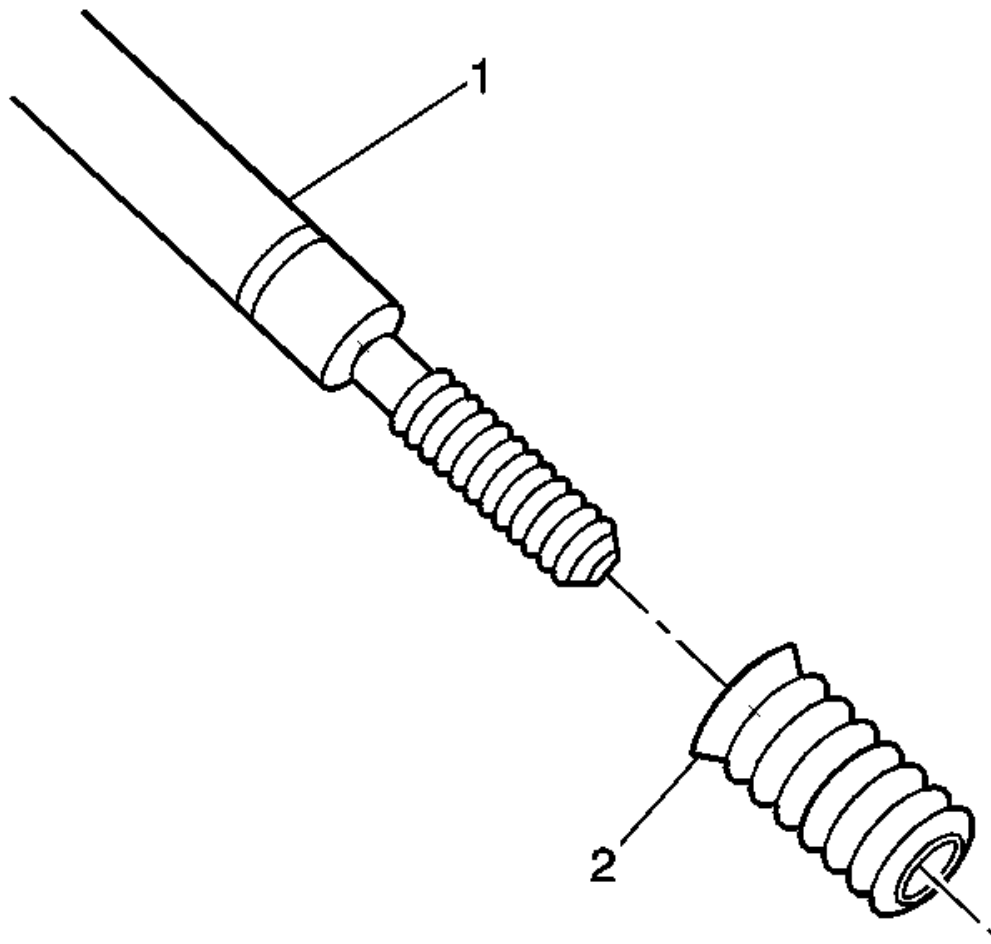


Fig. 435: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

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

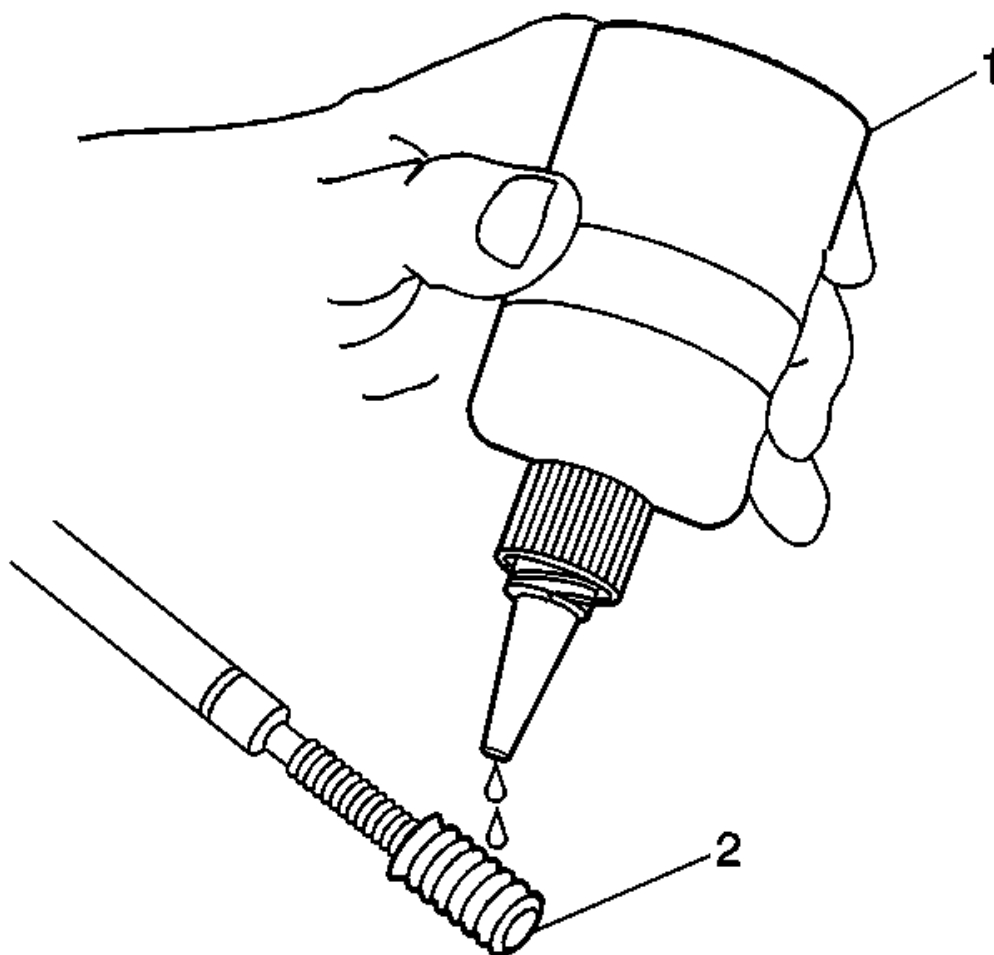


Fig. 436: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

15. Apply threadlock sealant, EN 42385-109, LOCTITE 277® or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.

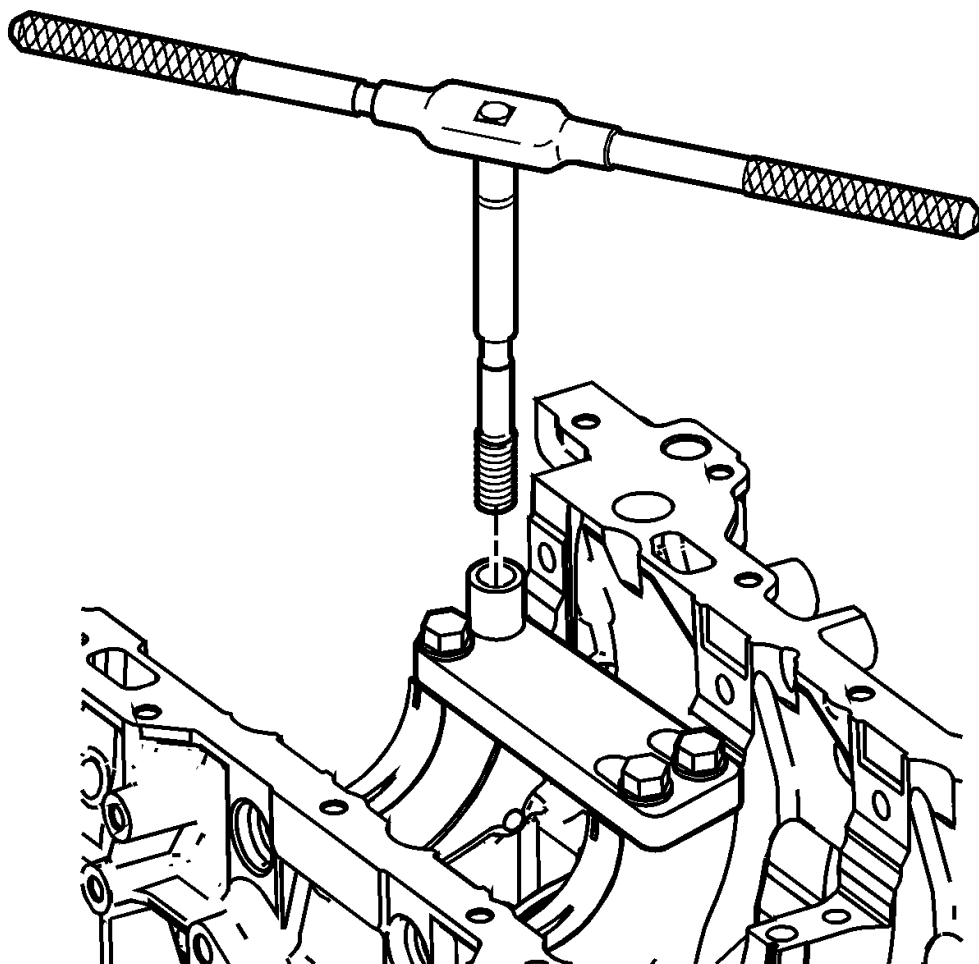


Fig. 437: Identifying Tapping Wrench
Courtesy of GENERAL MOTORS COMPANY

16. Install the insert and installation driver into the tapped hole by hand only.
17. Start the insert into the threaded hole.
18. Install the insert until the flange of the insert contacts the counterbored surface.

NOTE: 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.

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

NOTE: 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.

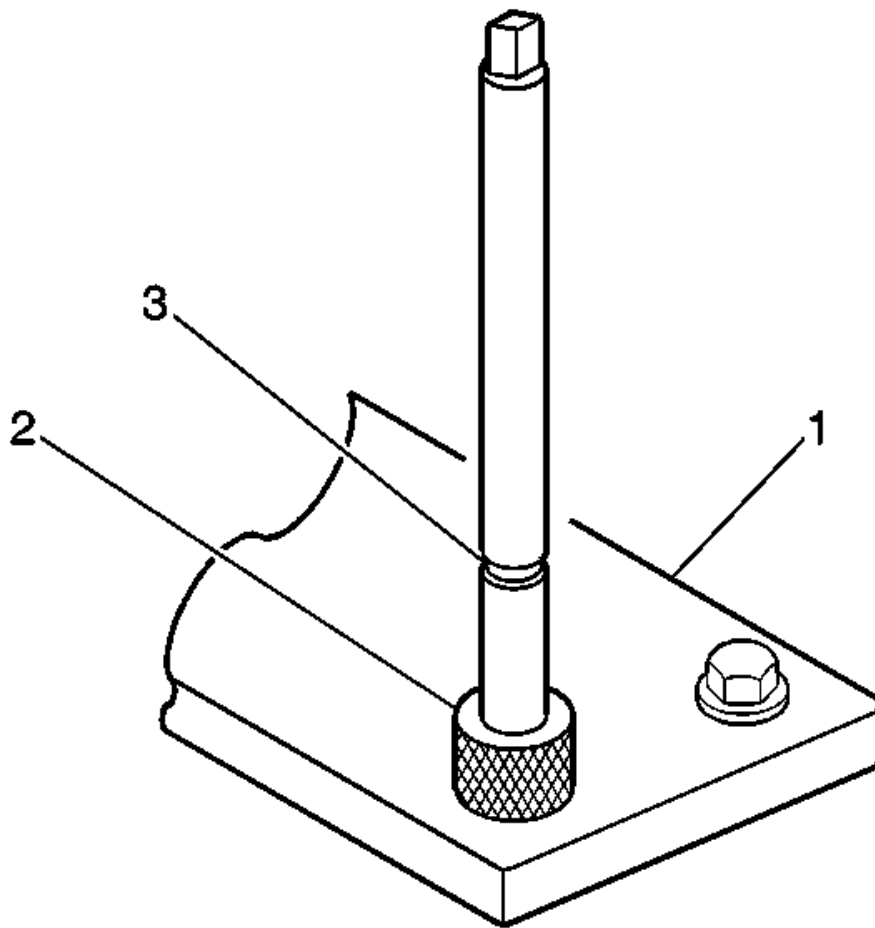


Fig. 438: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

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.

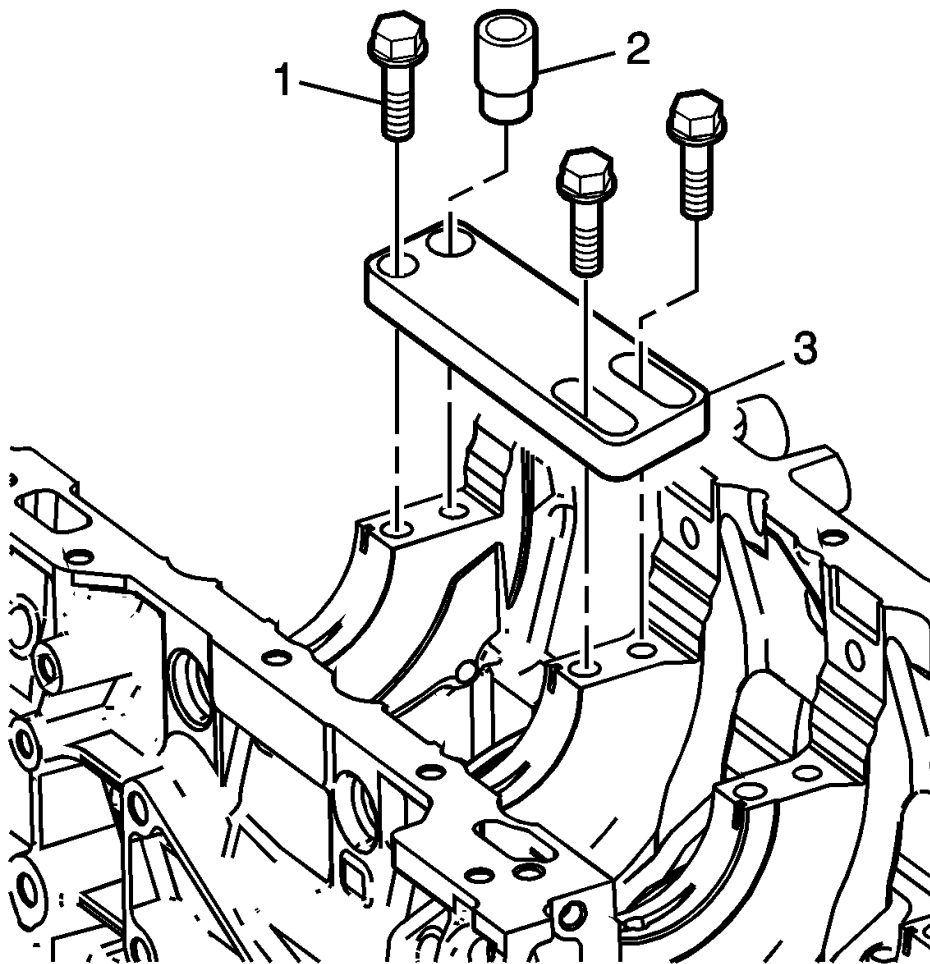


Fig. 439: Identifying Fixture Plate Over Crankshaft Main Cap Bolt Hole
 Courtesy of GENERAL MOTORS COMPANY

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

Inboard Bolt Holes

1. Position the fixture plate (3) with the bushing (1) installed over the crankshaft main cap bolt hole to be repaired.

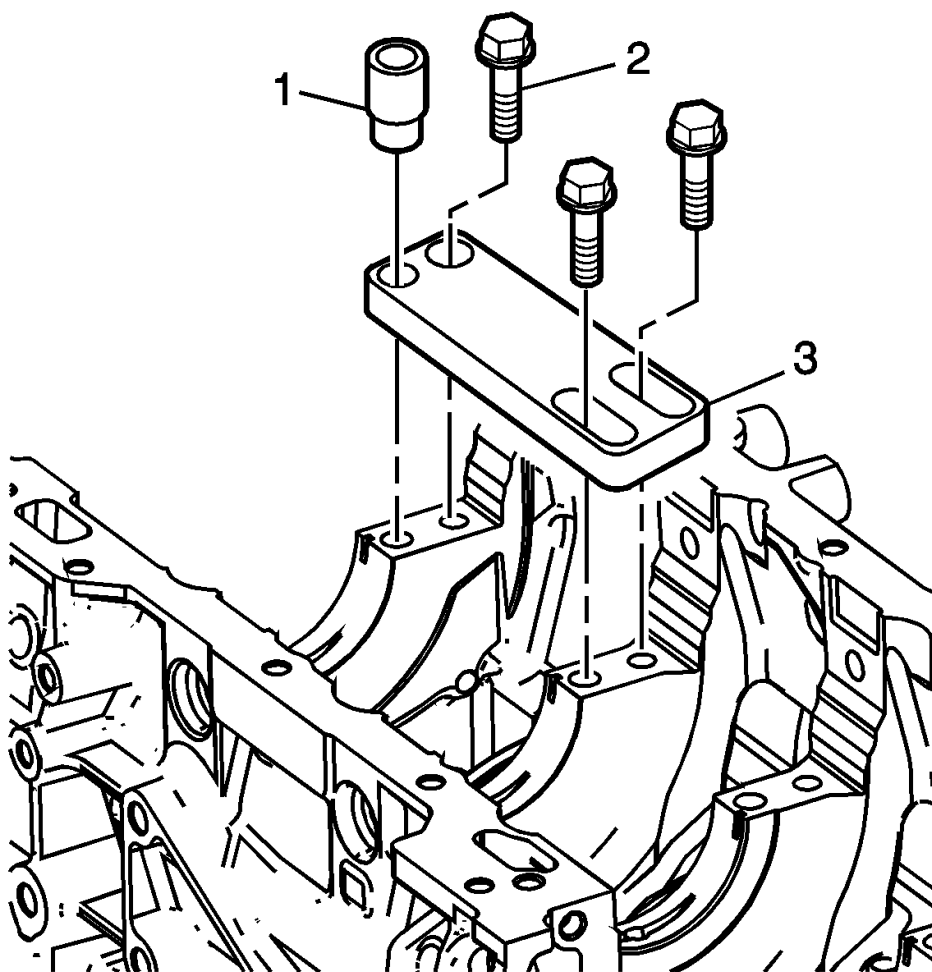


Fig. 440: View Of Fixture Plate & Components - Inboard Bolt Holes
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

NOTE:

- Ensure the fixture plate is installed during the machining and installation processes of the insert.
- The use of a cutting type fluid, WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants and Sealers for recommended cutting fluid.

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

2. Loosely install the fixture plate bolts (2) into the remaining crankshaft main cap bolt holes.

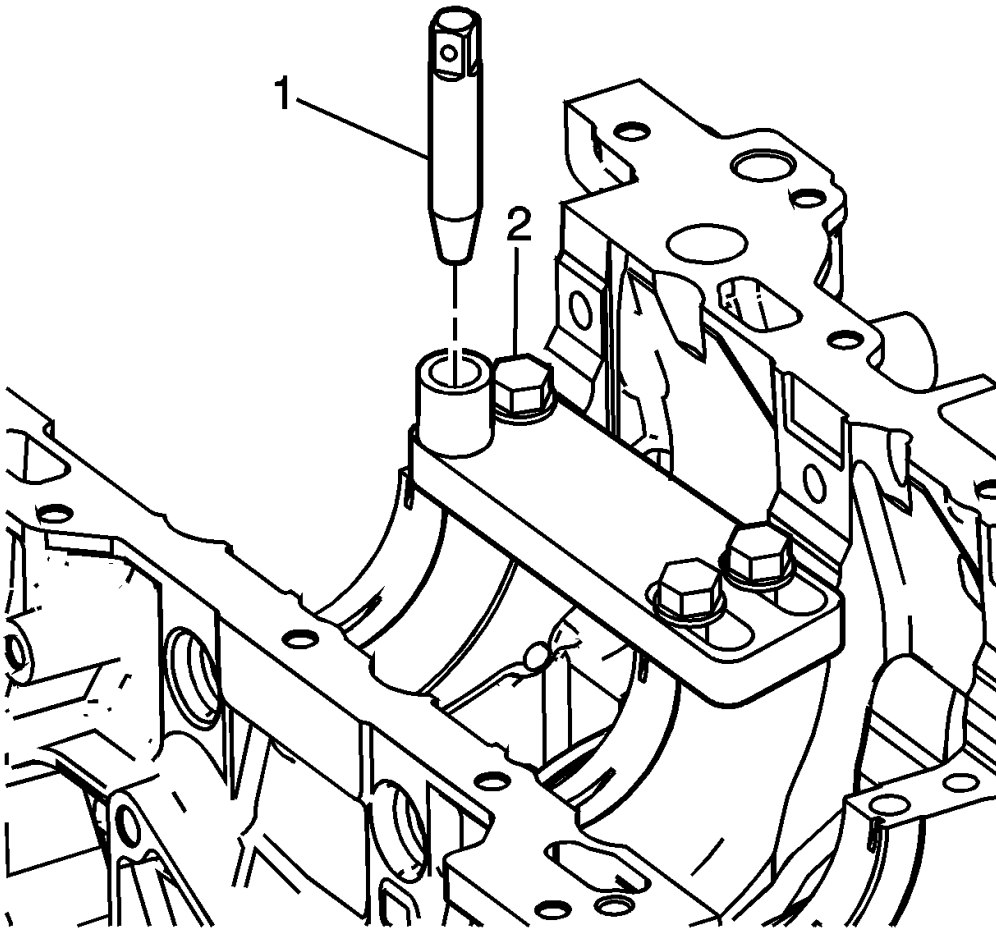


Fig. 441: Locating Alignment Pin

Courtesy of GENERAL MOTORS COMPANY

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.
6. Drill out the threads of the damaged hole.

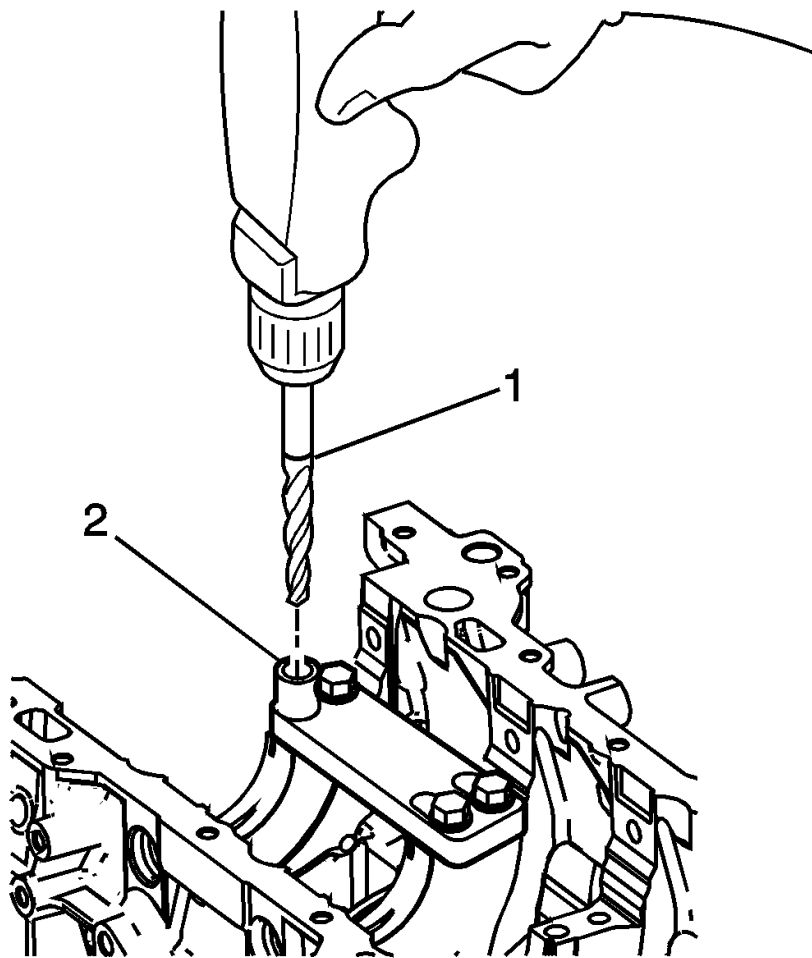


Fig. 442: Drilling Out Threads Of Damaged Hole - Inboard Bolt Holes
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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).

7. Using compressed air, clean out any chips.

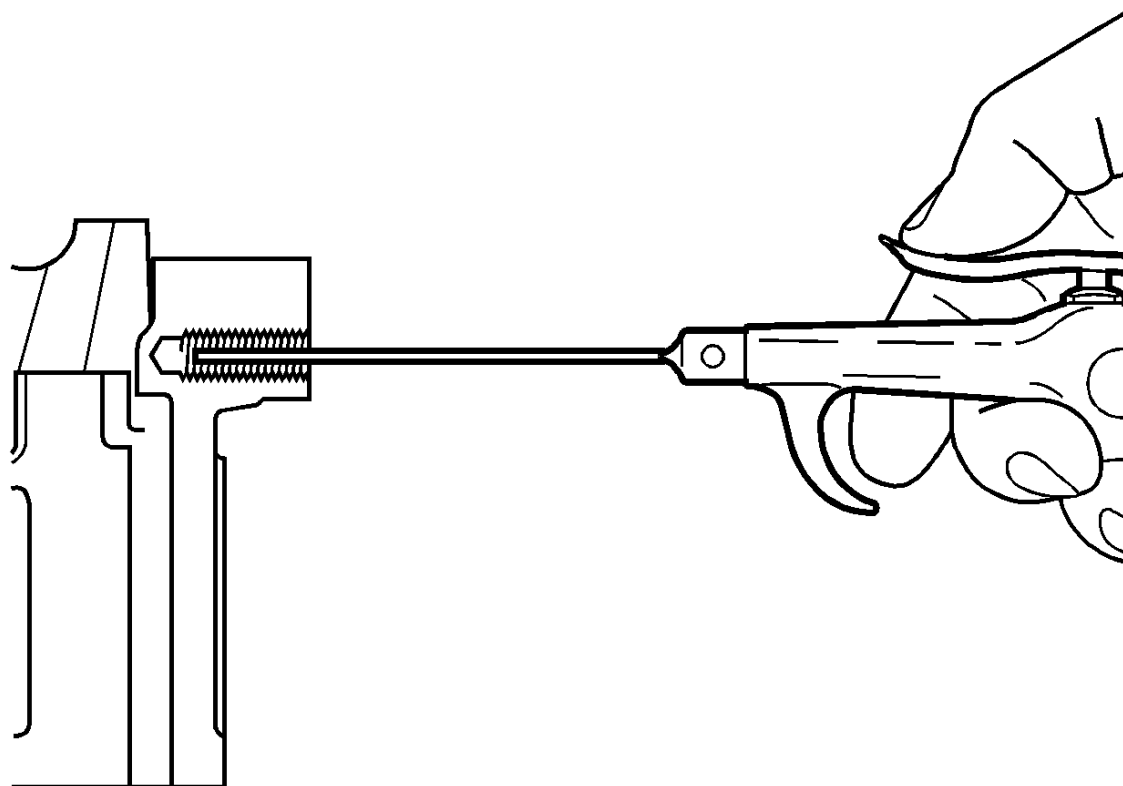


Fig. 443: Cleaning Out Metal Chips

Courtesy of GENERAL MOTORS COMPANY

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

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

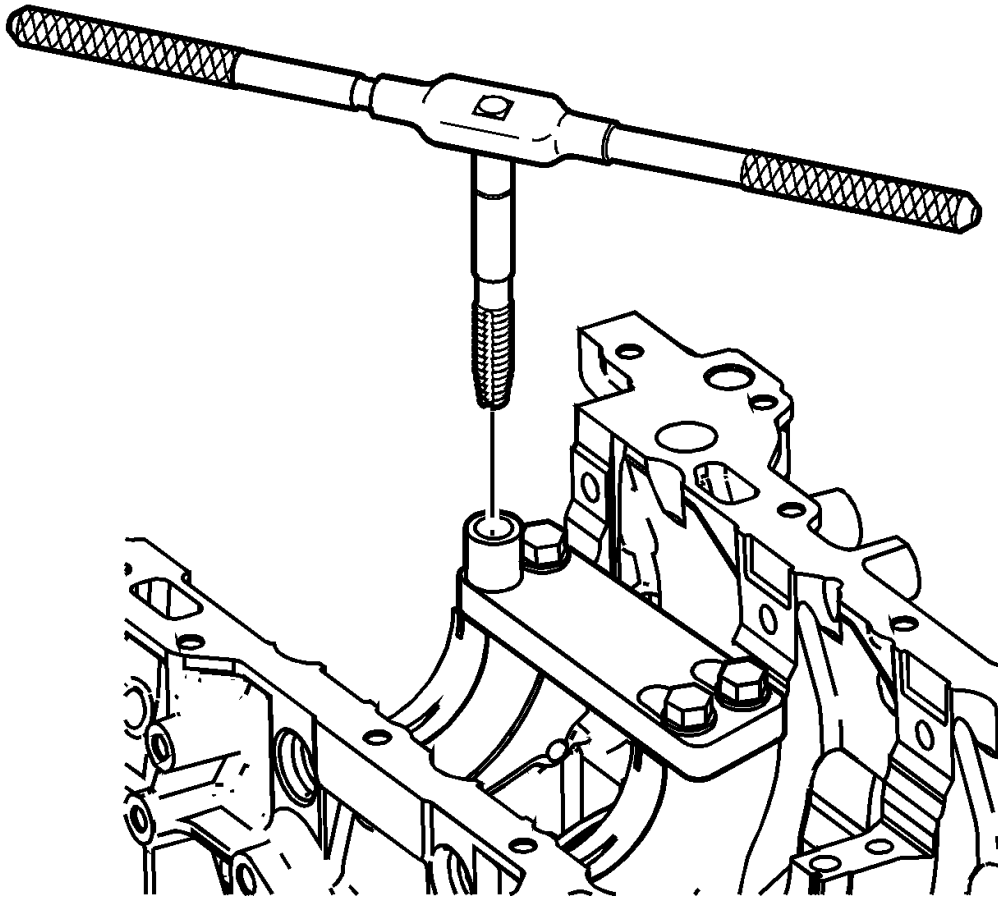


Fig. 444: Positioning Tapping Wrench
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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.

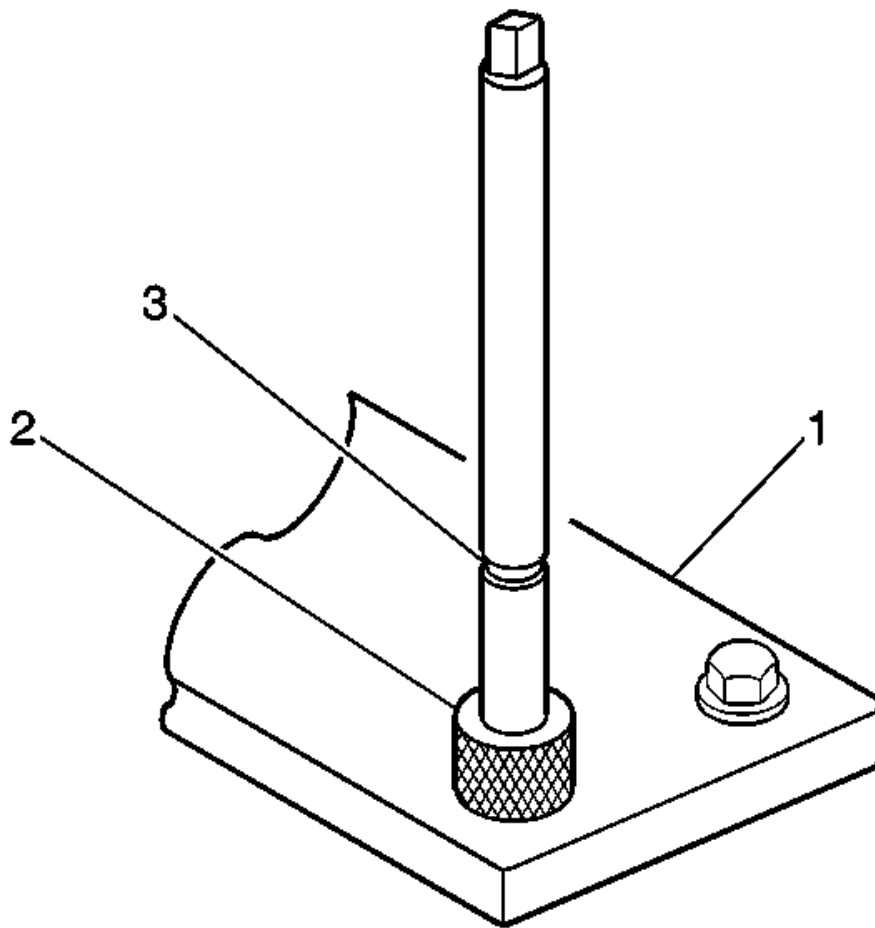


Fig. 445: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

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).
10. Using compressed air, clean out any chips.

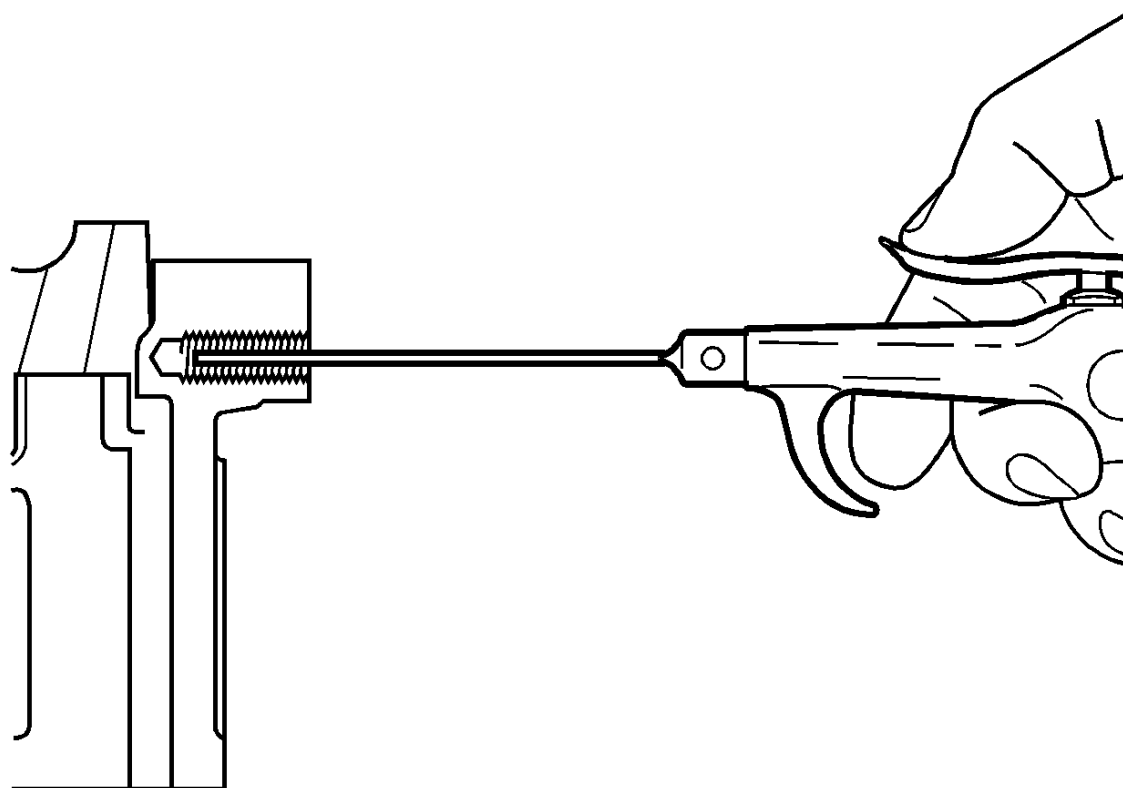


Fig. 446: Cleaning Out Metal Chips

Courtesy of GENERAL MOTORS COMPANY

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

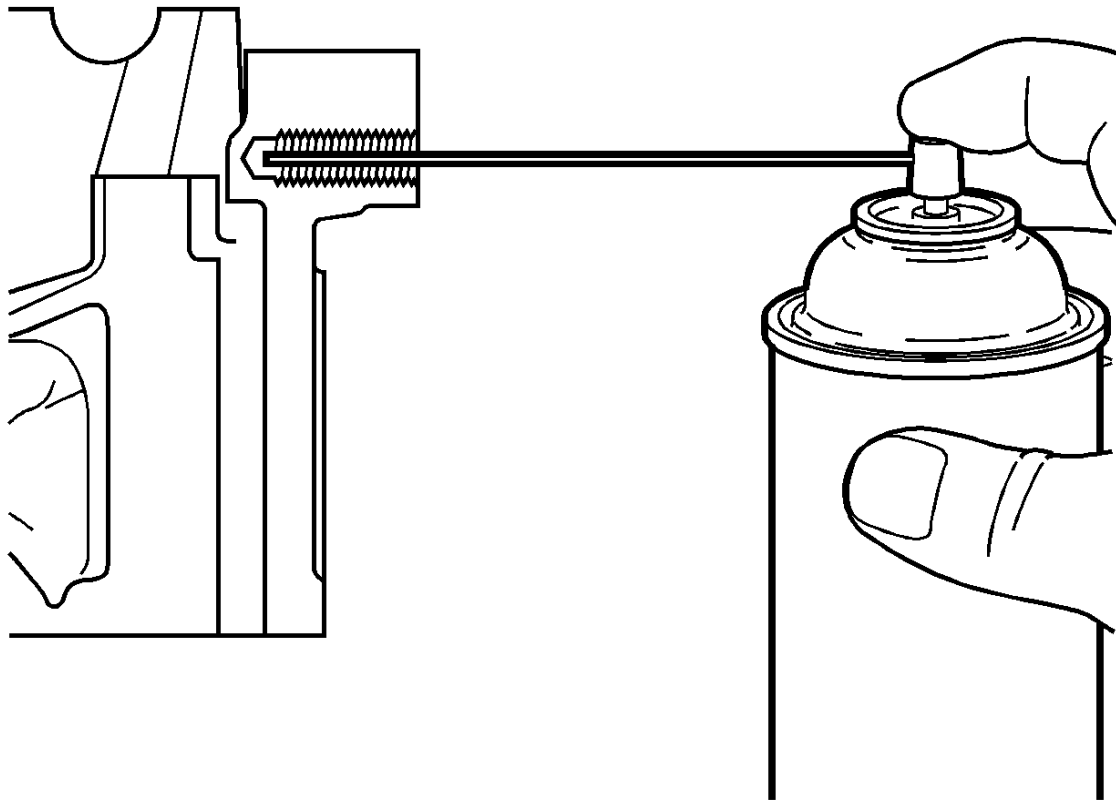


Fig. 447: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS COMPANY

11. Spray cleaner into the tapped hole. Refer to Adhesives, Fluids, Lubricants and Sealers for recommended cleaner.
12. Using compressed air, clean out any chips.

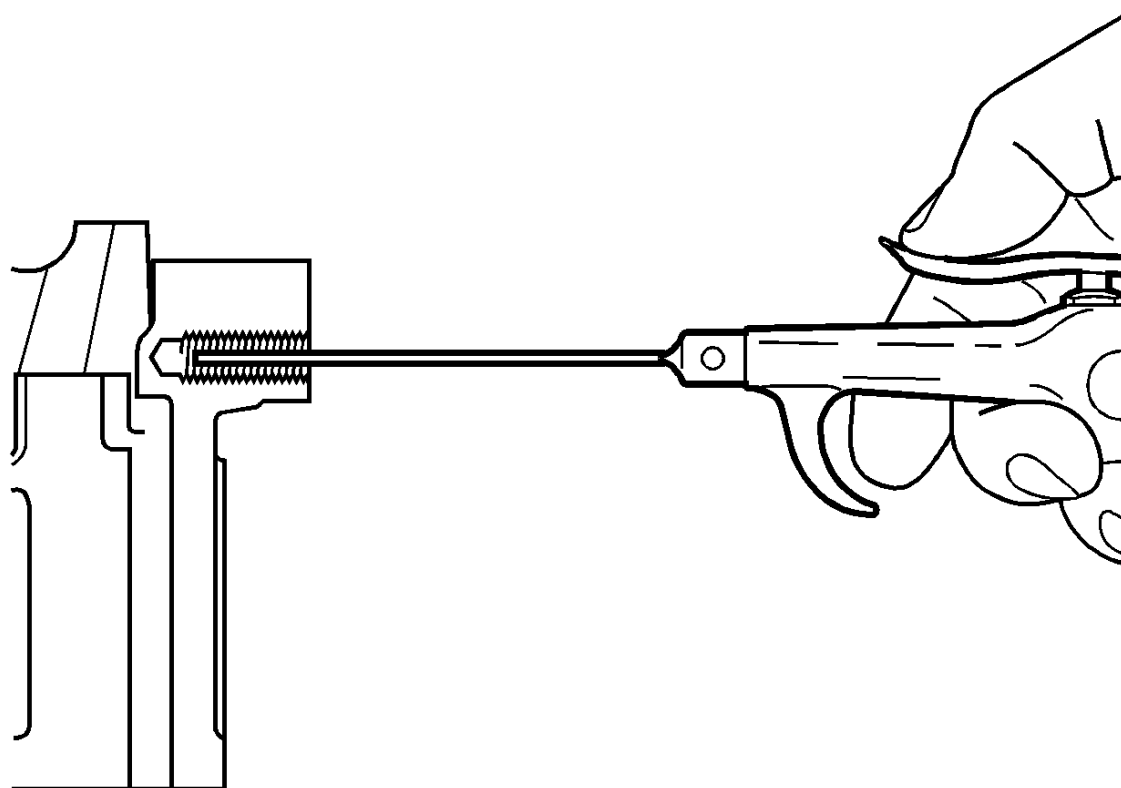


Fig. 448: Cleaning Out Metal Chips

Courtesy of GENERAL MOTORS COMPANY

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

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

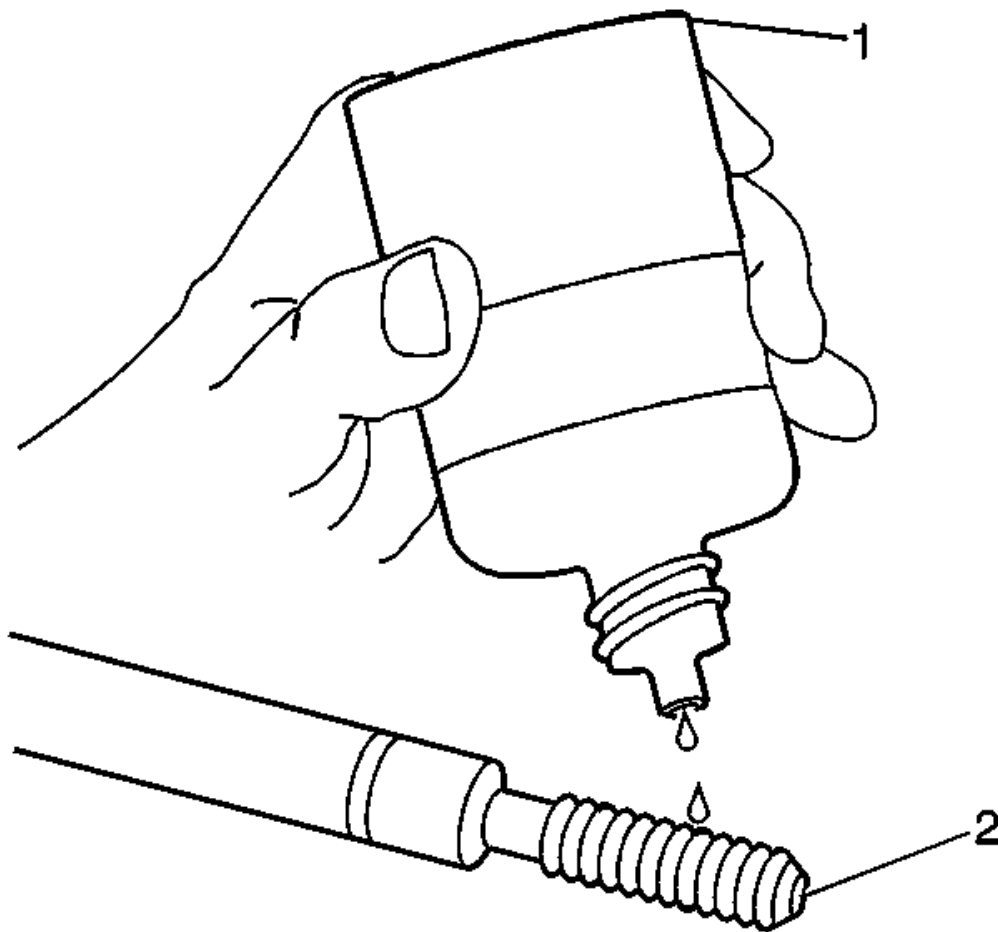


Fig. 449: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- 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.

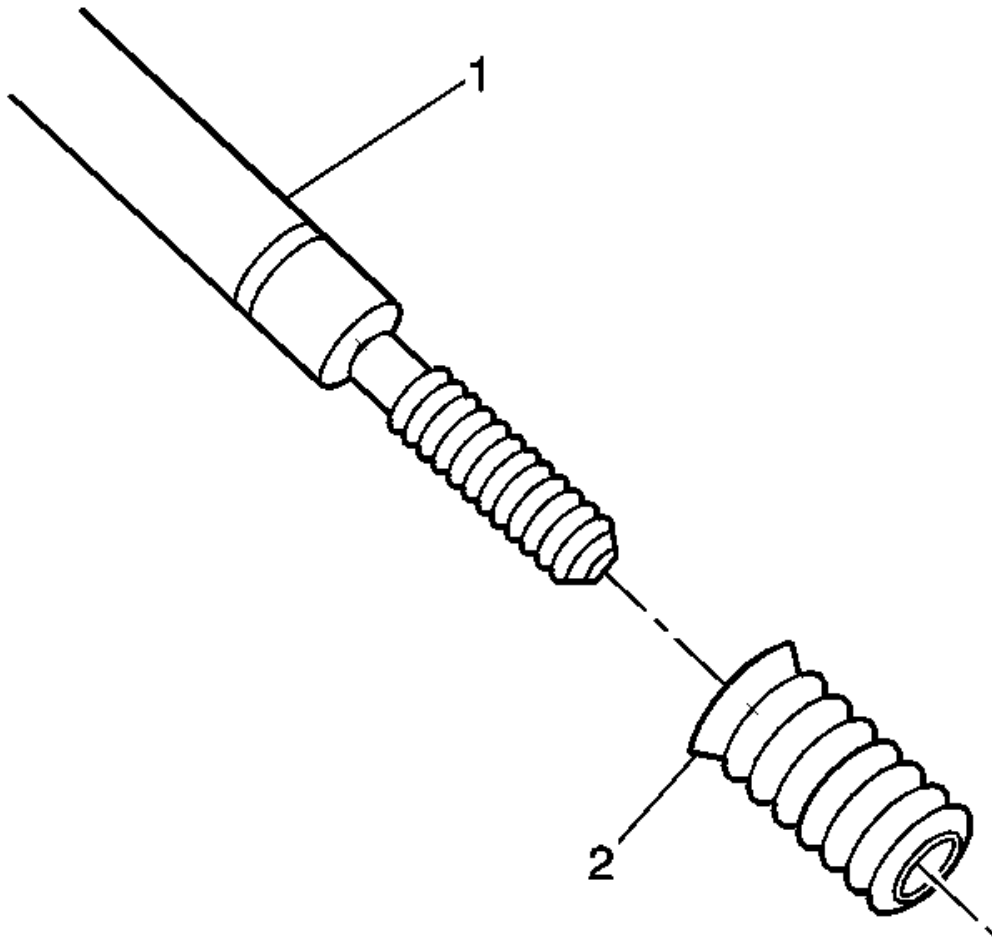


Fig. 450: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

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

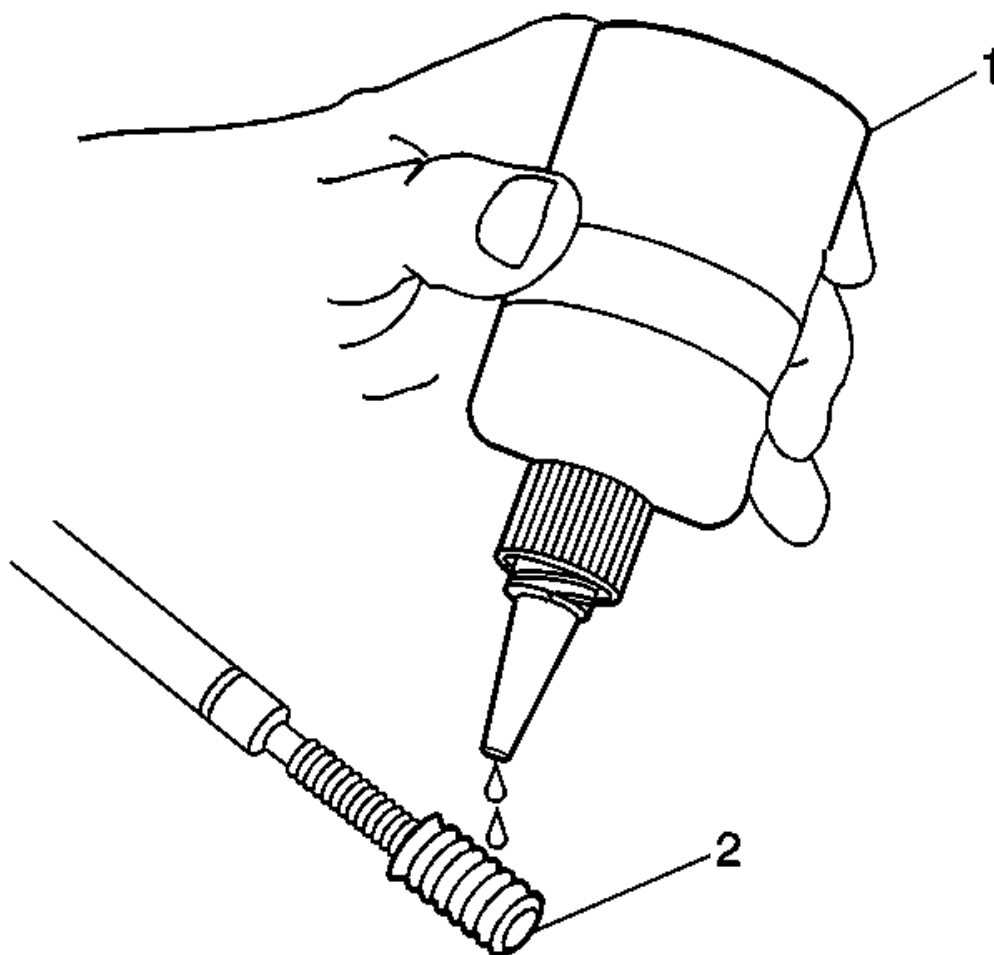


Fig. 451: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

15. Apply threadlock sealant, EN 42385-109, LOCTITE 277® or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.

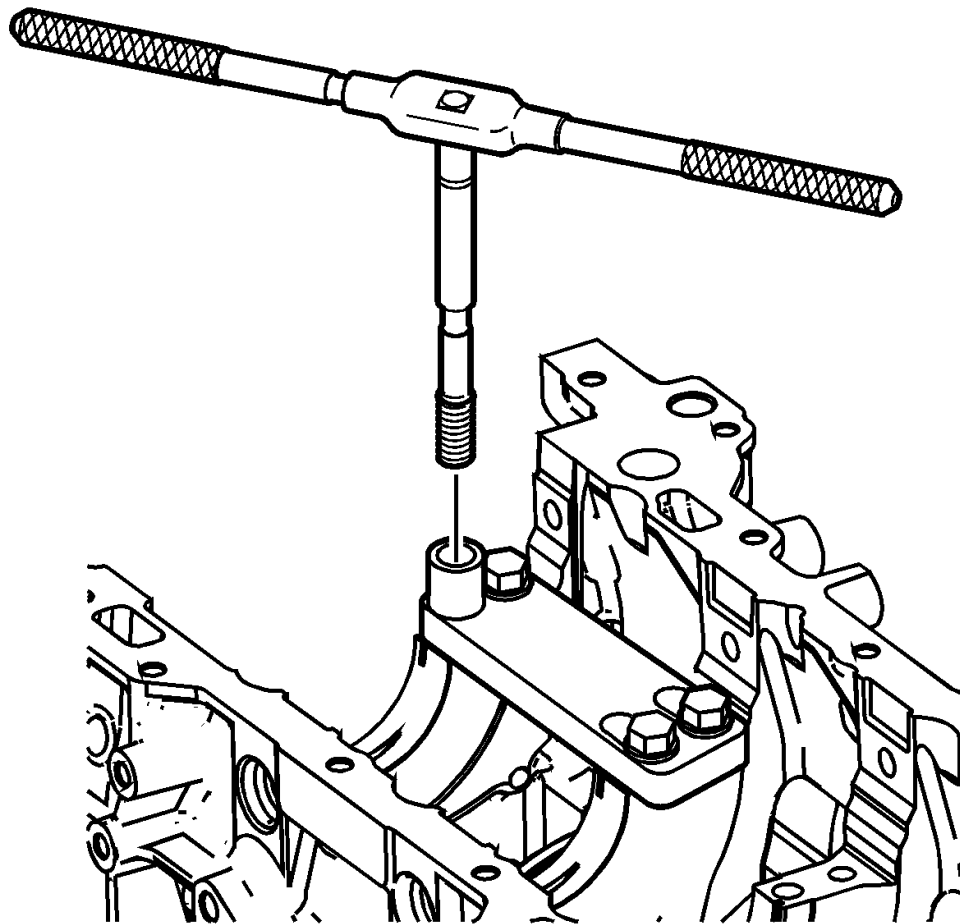


Fig. 452: View Of Insert & Installation Driver
Courtesy of GENERAL MOTORS COMPANY

16. Install the insert and installation driver into the tapped hole by hand only.
17. Start the insert into the threaded hole.
18. Install the insert until the flange of the insert contacts the counterbored surface.

NOTE: 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.

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

NOTE: 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.

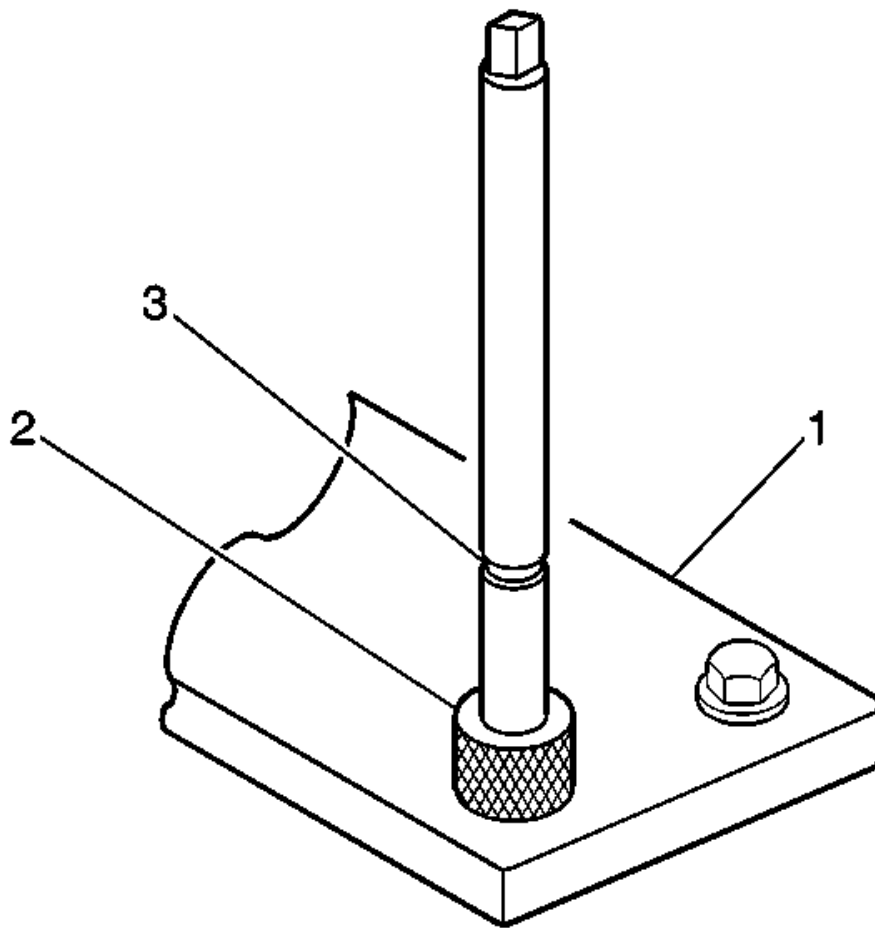


Fig. 453: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

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.

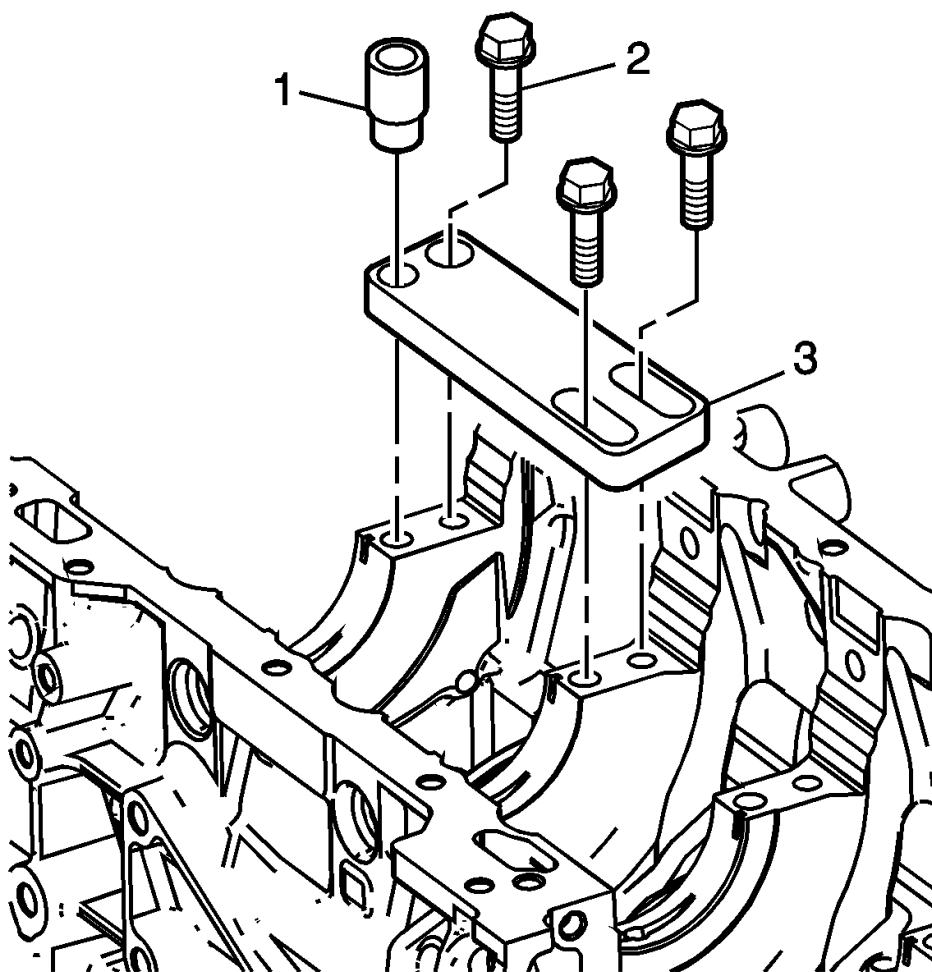


Fig. 454: View Of Fixture Plate & Components - Inboard Bolt Holes
Courtesy of GENERAL MOTORS COMPANY

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 ASSEMBLY

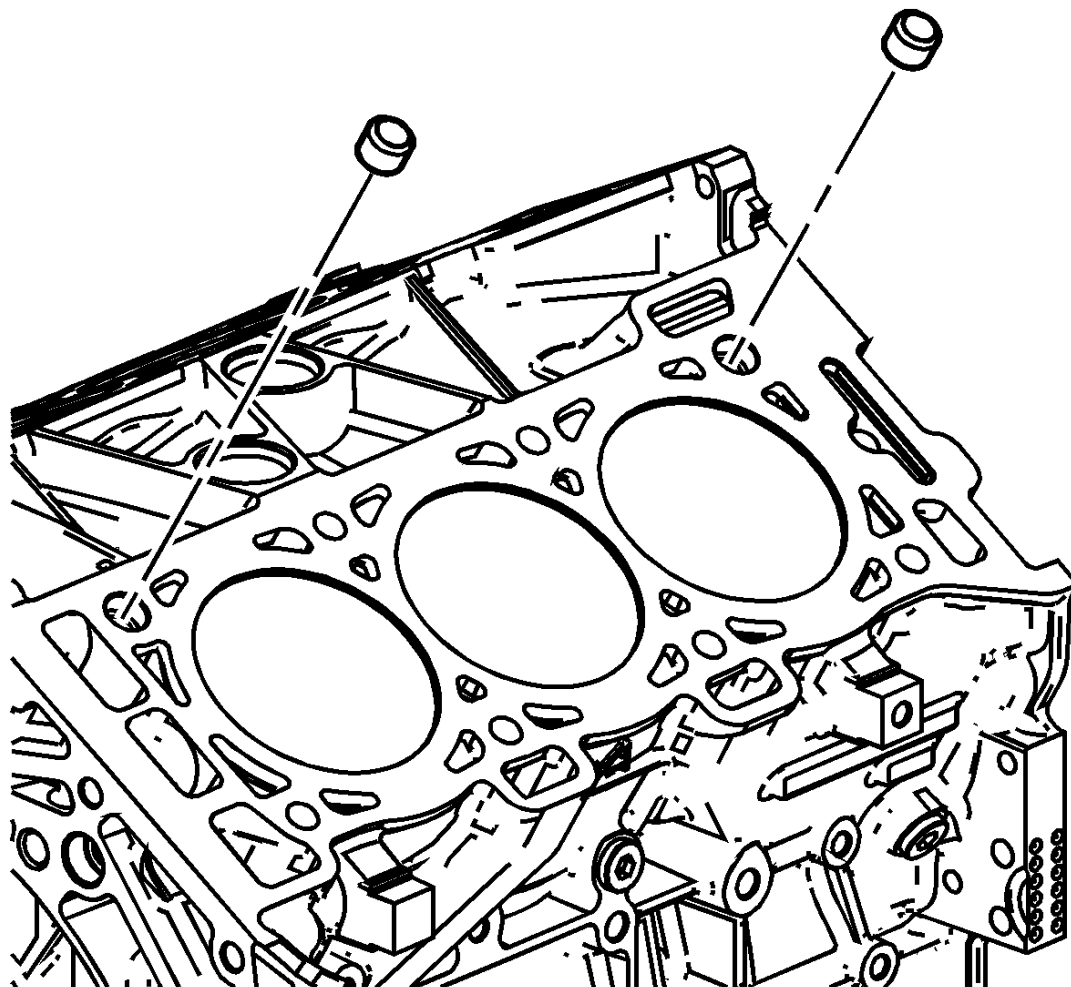


Fig. 455: Cylinder Block-To-Cylinder Head Alignment Dowels
Courtesy of GENERAL MOTORS COMPANY

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

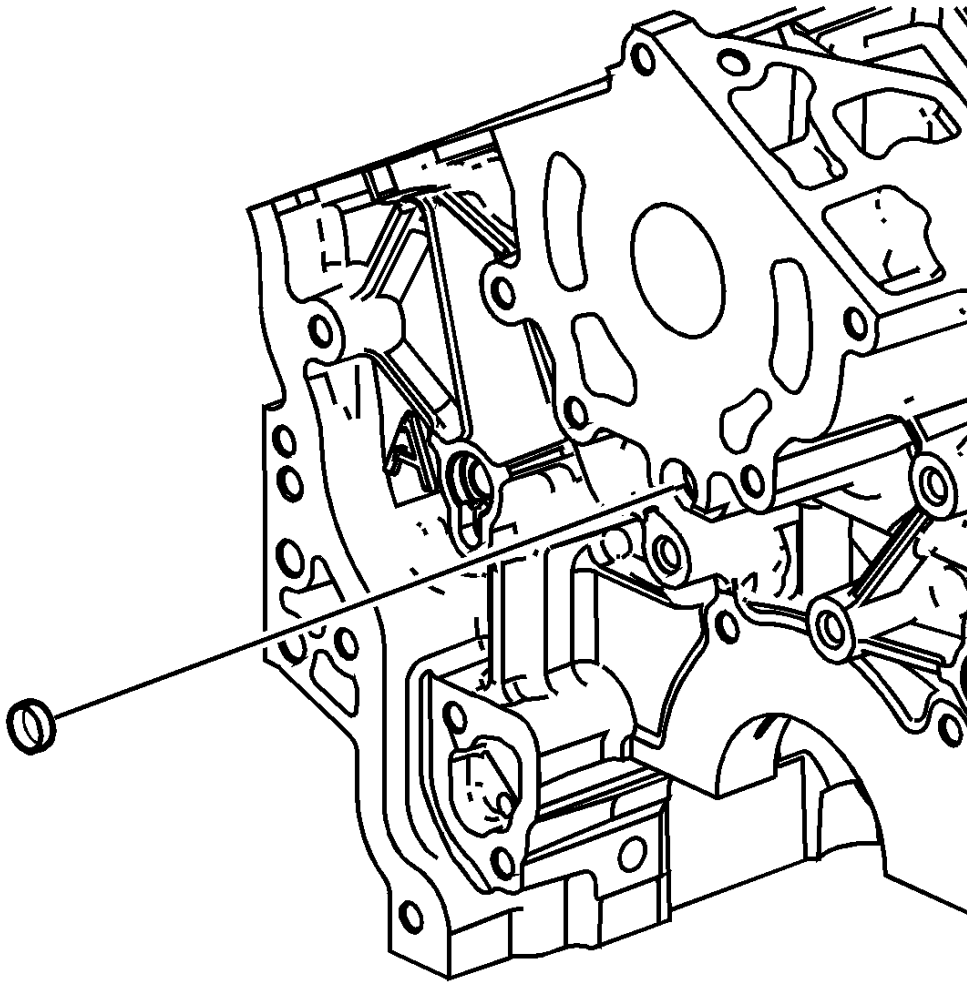


Fig. 456: View Of Front Oil Gallery Expansion Plug
Courtesy of GENERAL MOTORS COMPANY

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

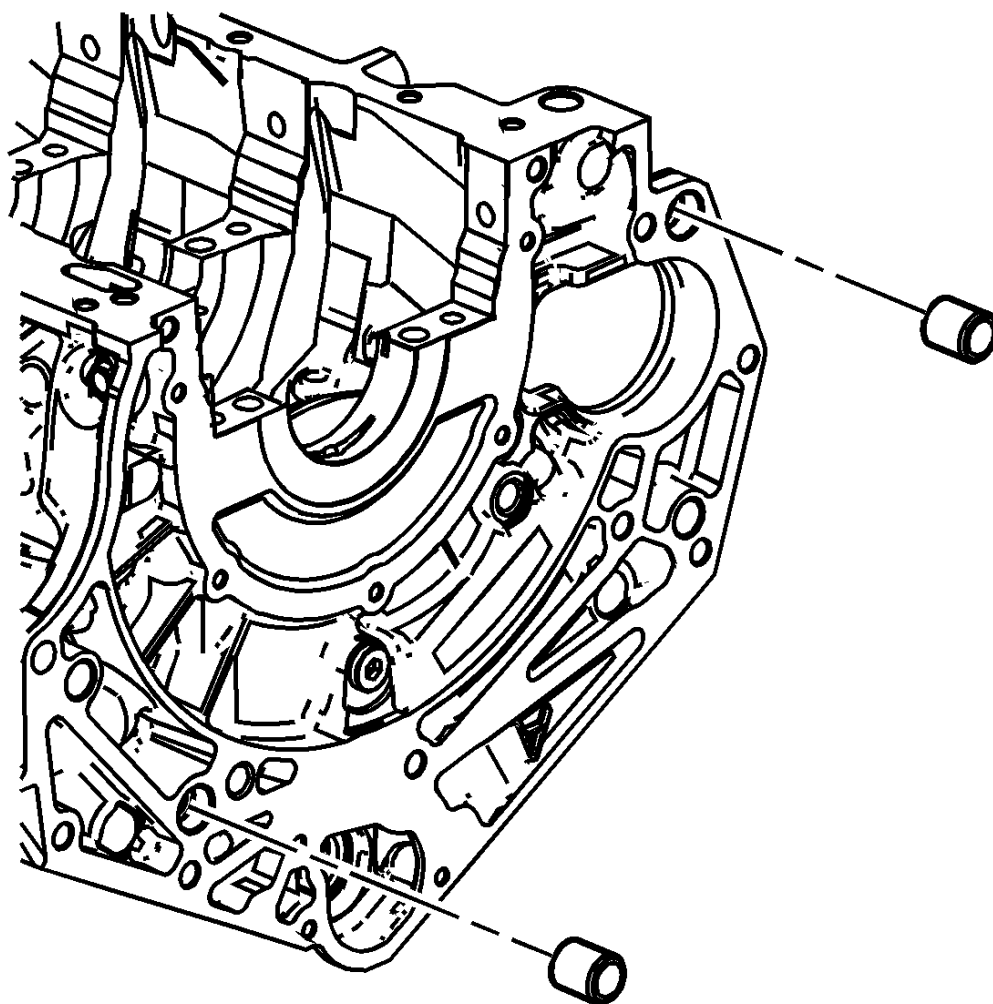


Fig. 457: Identifying Cylinder Block-To-Transmission Alignment Dowels
Courtesy of GENERAL MOTORS COMPANY

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

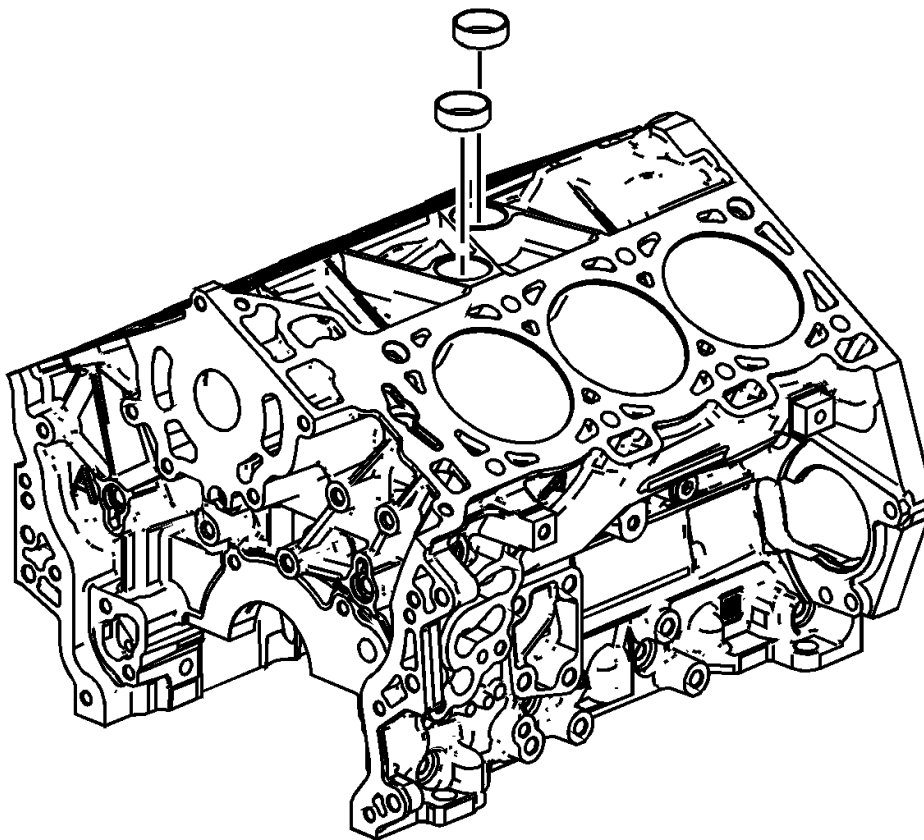


Fig. 458: Identifying Coolant Expansion Plugs
Courtesy of GENERAL MOTORS COMPANY

5. Apply the RTV sealant on the NEW coolant expansion plugs. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.
6. Install the NEW coolant expansion plugs.
7. Ensure the NEW coolant expansion plugs are installed to the proper depth.

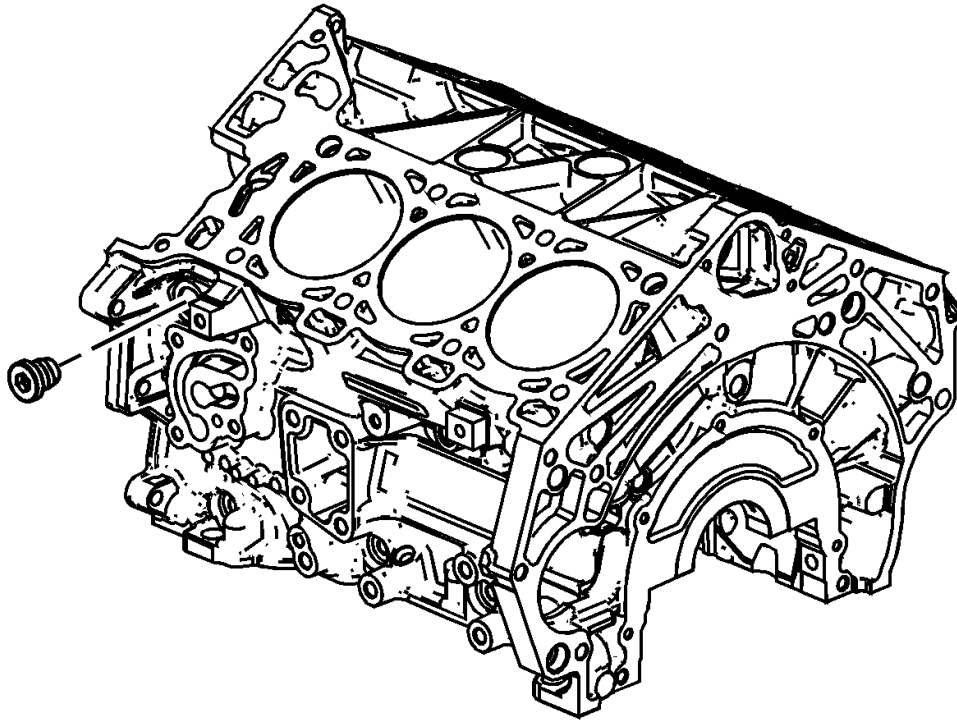


Fig. 459: Removing/Installing M20 Left Side Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

8. Apply thread sealant on the threads of the M20 left side oil gallery threaded plug. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.
9. Install the M20 left side oil gallery threaded plug and tighten to 75 N.m (55 lb ft).

CAUTION: Refer to Fastener Caution .

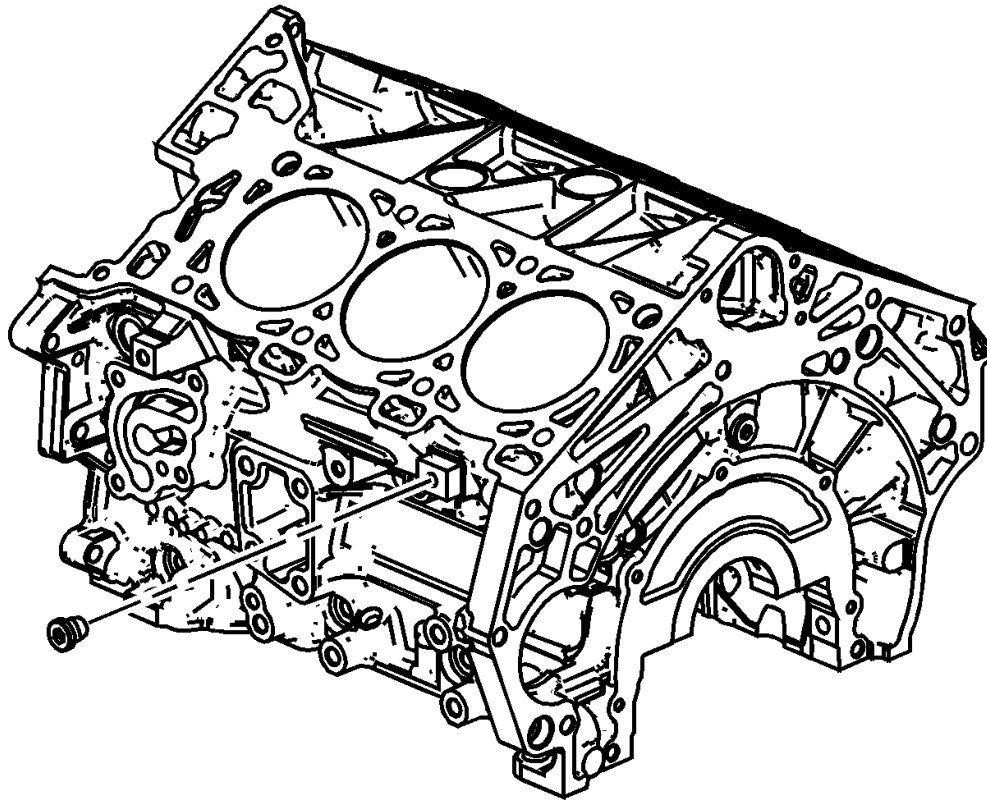


Fig. 460: View Of M14 Left Side Coolant Drain Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

10. Apply thread sealant on the threads of the M14 left side coolant drain threaded plug. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.
11. Install the M14 left side coolant drain threaded plug and tighten to 50 N.m (37 lb ft).

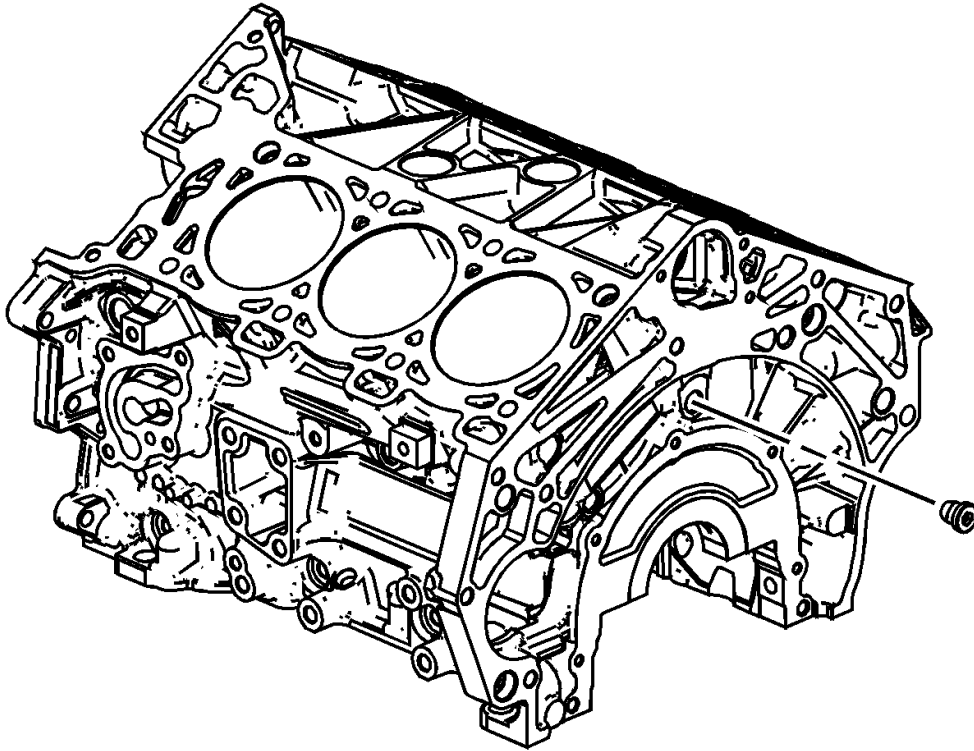


Fig. 461: Identifying M14 Rear Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

12. Apply thread sealant on the threads of the M14 rear oil gallery threaded plug. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.
13. Install the M14 rear oil gallery threaded plug and tighten to 50 N.m (37 lb ft).

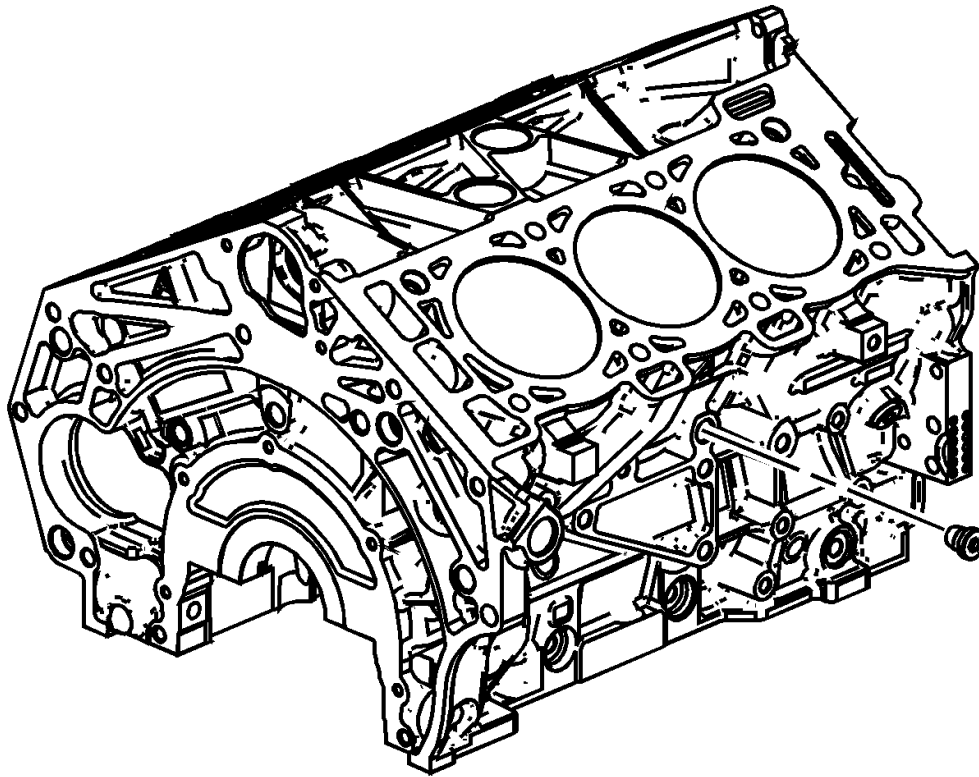


Fig. 462: Identifying M14 Right Side Coolant Drain Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

14. Apply thread sealant on the threads of the M14 right side coolant drain threaded plug. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.
15. Install the M14 right side coolant drain threaded plug and tighten to 50 N.m (37 lb ft).

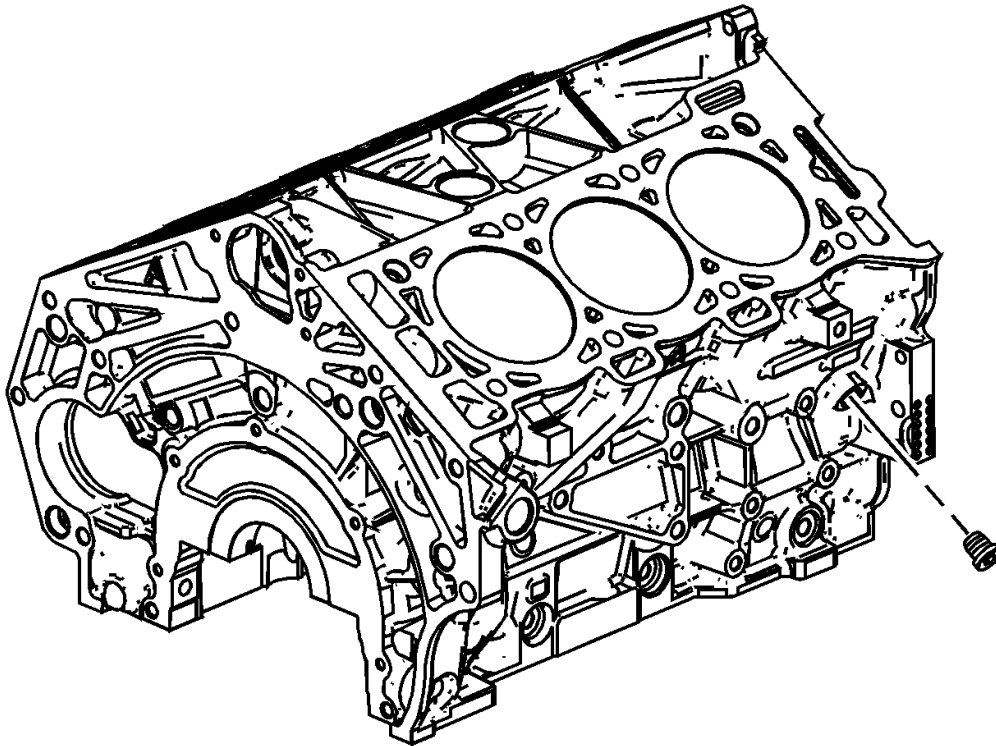


Fig. 463: Identifying M14 Right Side Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

16. Apply thread sealant on the threads of the M14 right side oil gallery threaded plug. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.
17. Install the M14 right side oil gallery threaded plug and tighten to 50 N.m (37 lb ft).

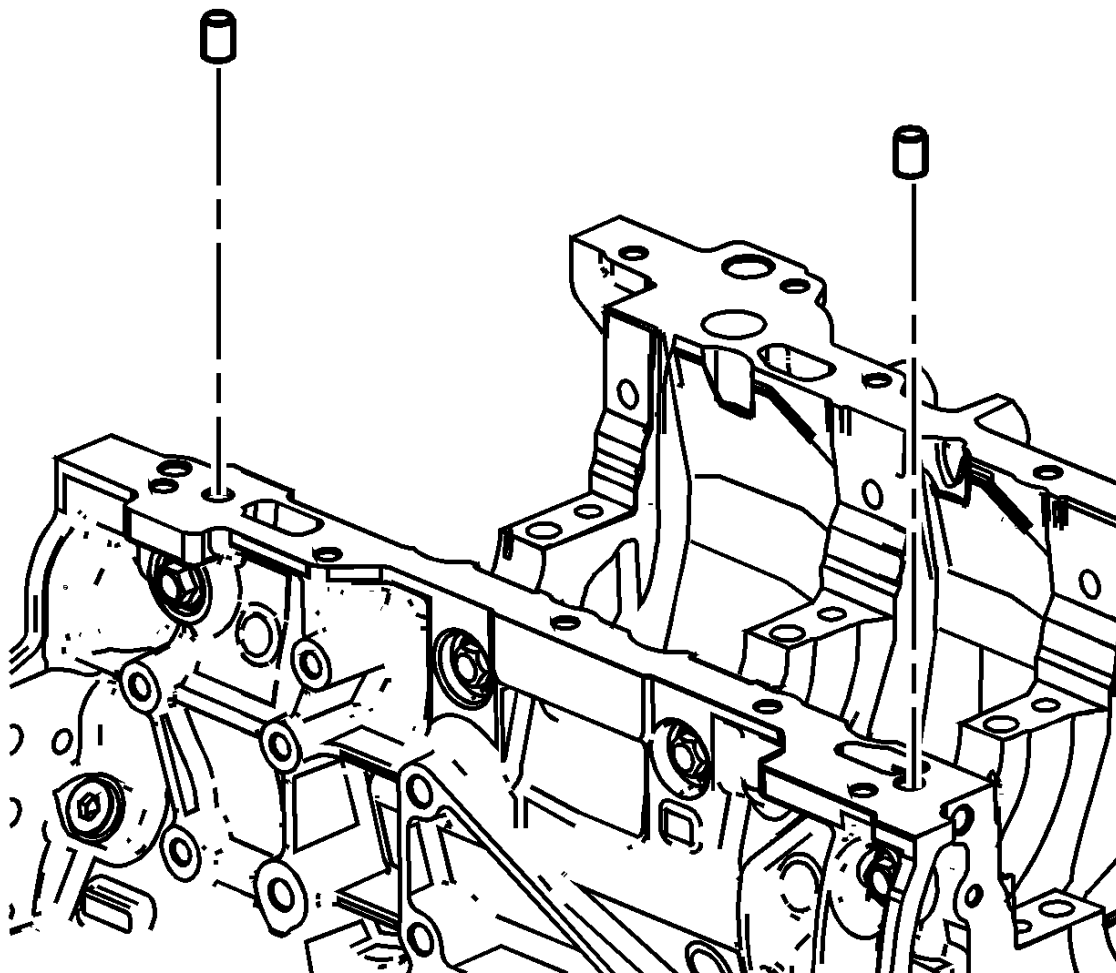


Fig. 464: Identifying Cylinder Block-To-Oil Pan Alignment Dowels
Courtesy of GENERAL MOTORS COMPANY

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

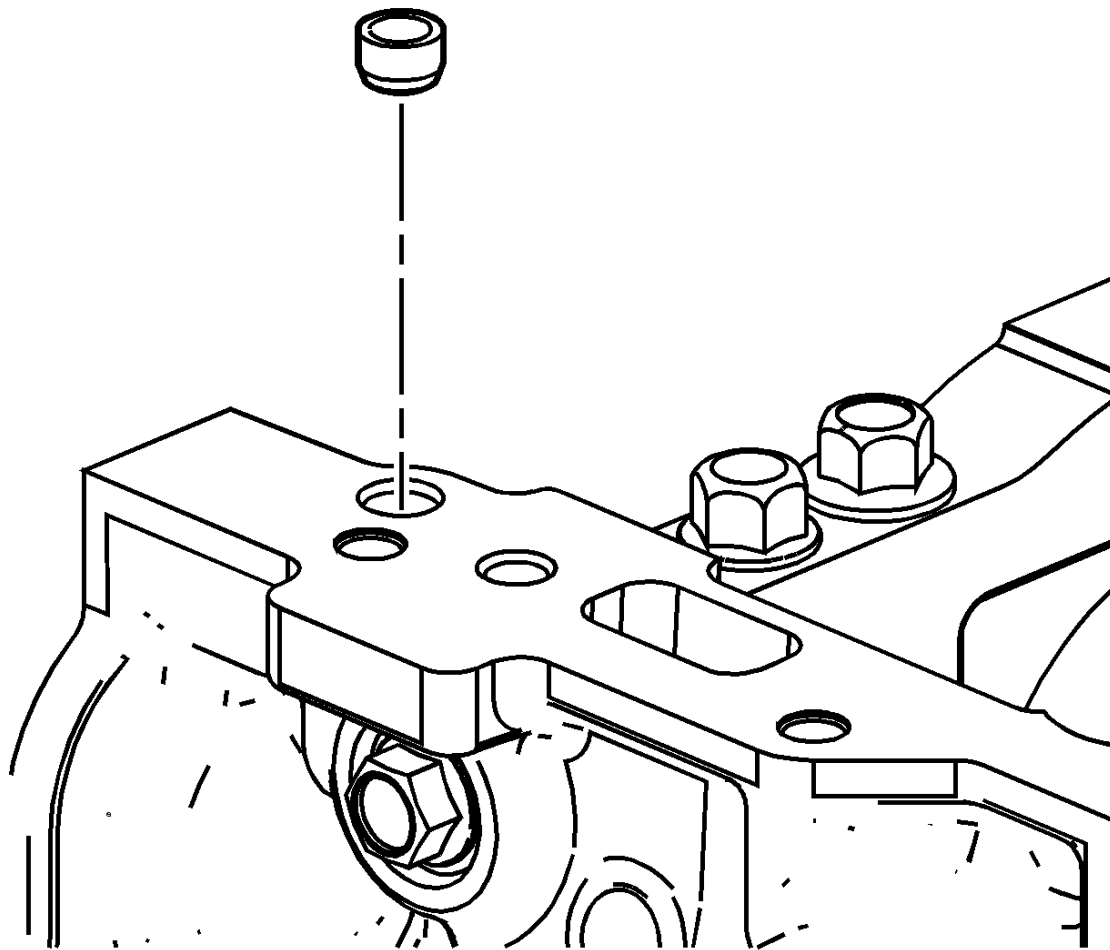


Fig. 465: Locating Right Front Oil Pan Rail Oil Gallery Expansion Plug
Courtesy of GENERAL MOTORS COMPANY

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.

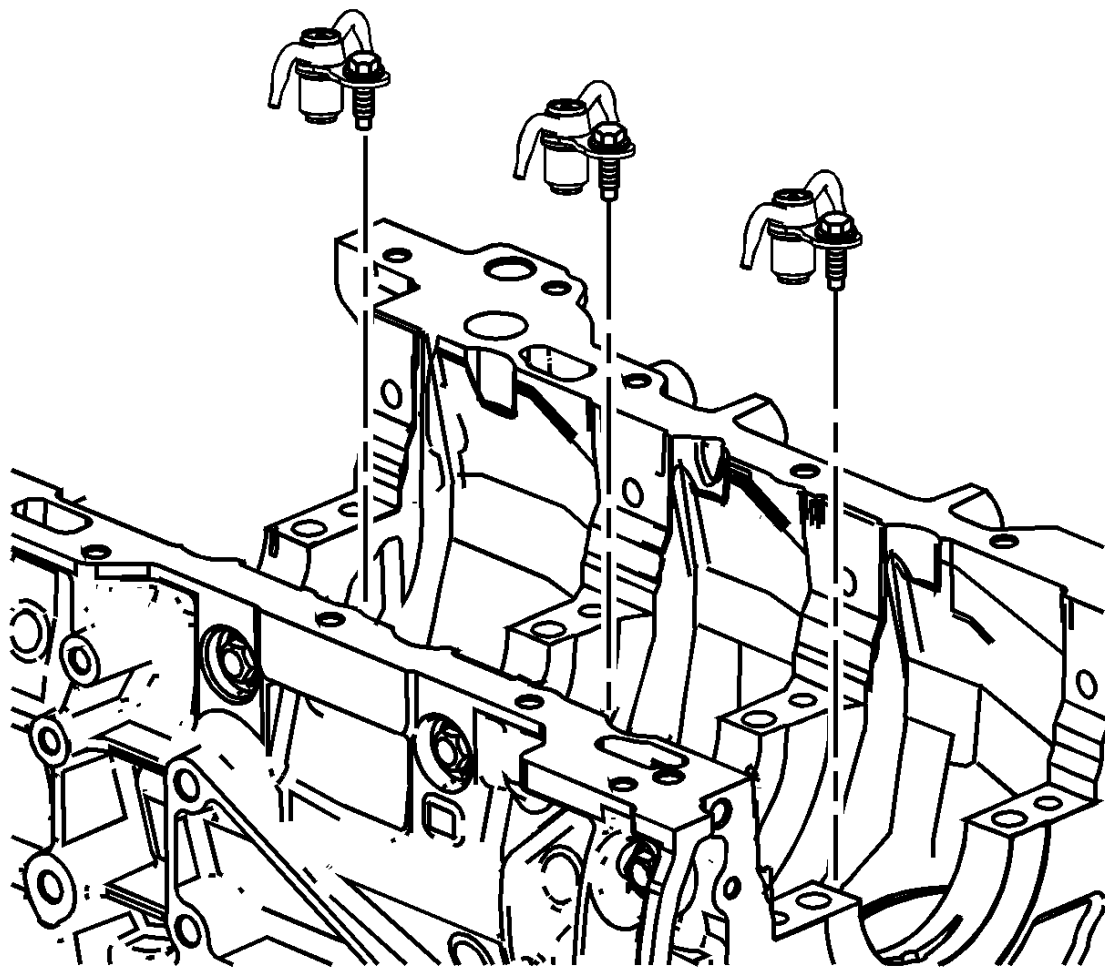


Fig. 466: Identifying Oil Jets & Bolts

Courtesy of GENERAL MOTORS COMPANY

21. Install the oil jets.
22. Install the oil jet bolts and tighten to 10 N.m (89 lb in).

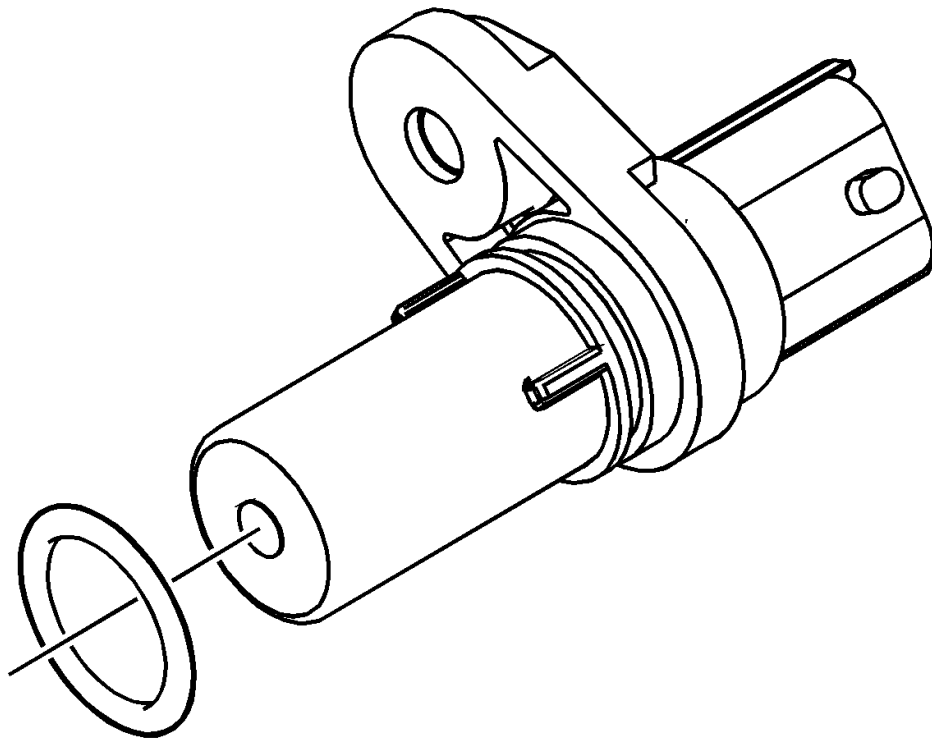


Fig. 467: View Of Crankshaft Position Sensor O-Ring
Courtesy of GENERAL MOTORS COMPANY

23. Install the NEW crankshaft position sensor O-ring, if damaged.

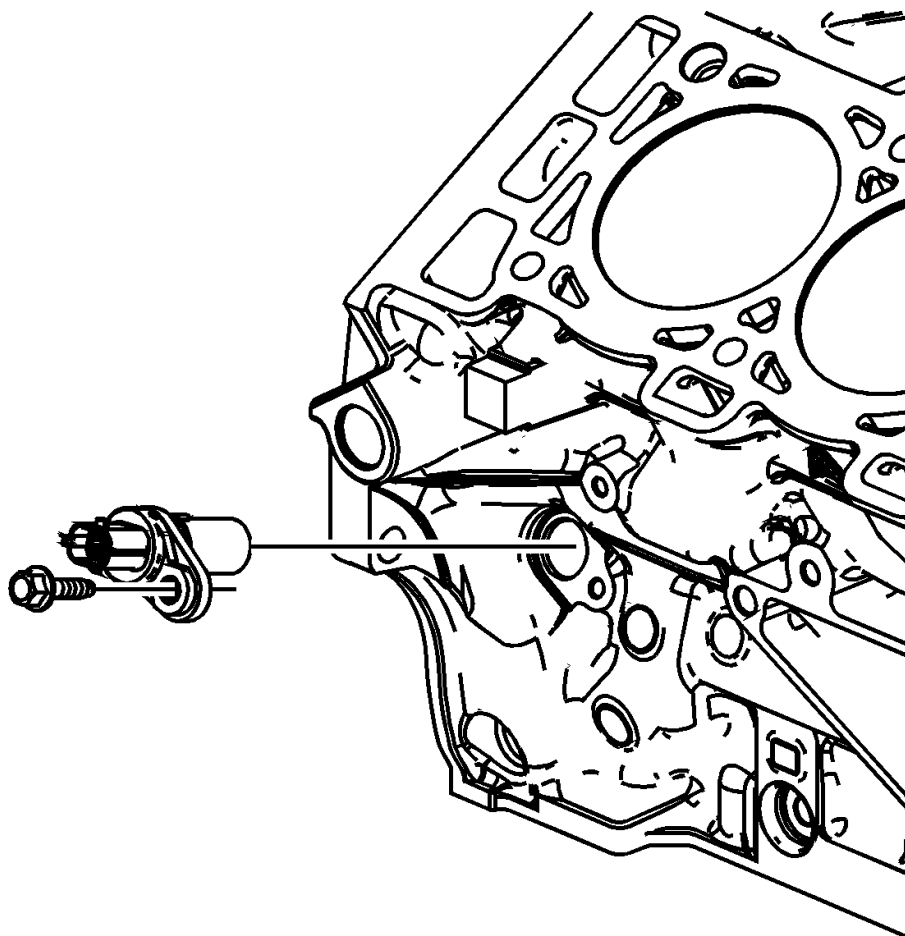


Fig. 468: View Of Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

24. Install the crankshaft position sensor.
25. Install the crankshaft position sensor bolt and tighten to 10 N.m (89 lb in).

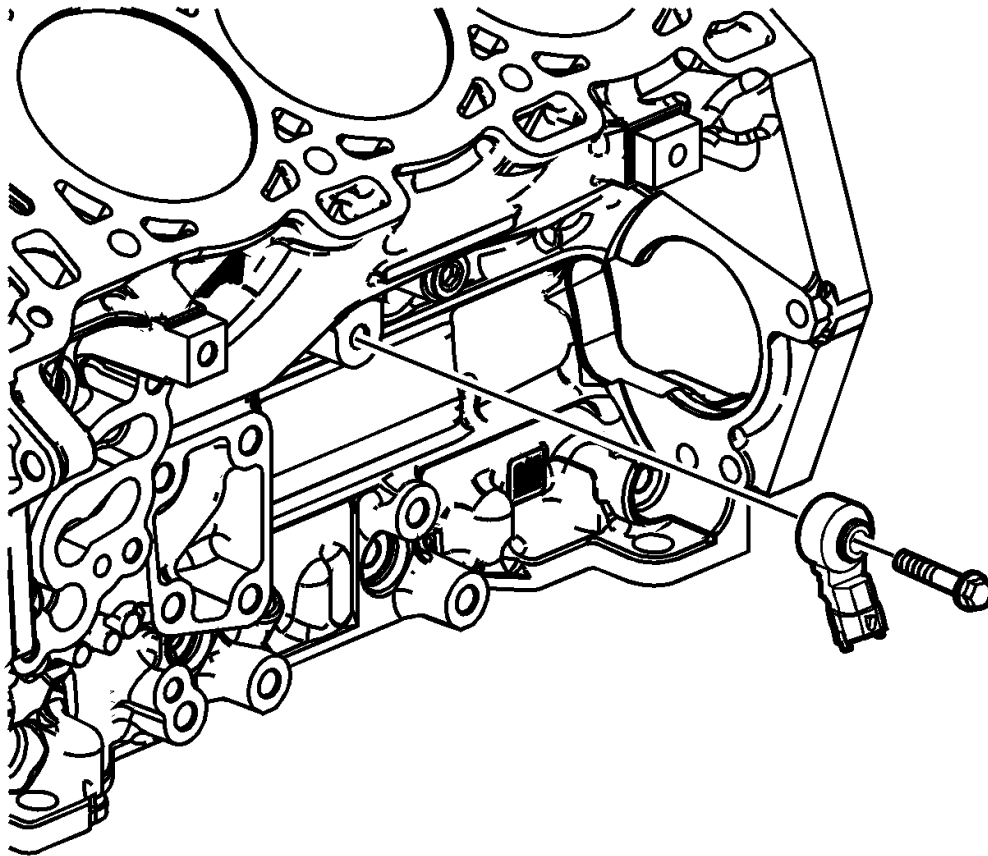


Fig. 469: Identifying Left Knock Sensor & Bolt
Courtesy of GENERAL MOTORS COMPANY

26. Install the left knock sensor to the cylinder block, as shown.
27. Install the left knock sensor bolt and tighten to 25 N.m (18 lb ft).
28. Ensure proper sensor orientation.

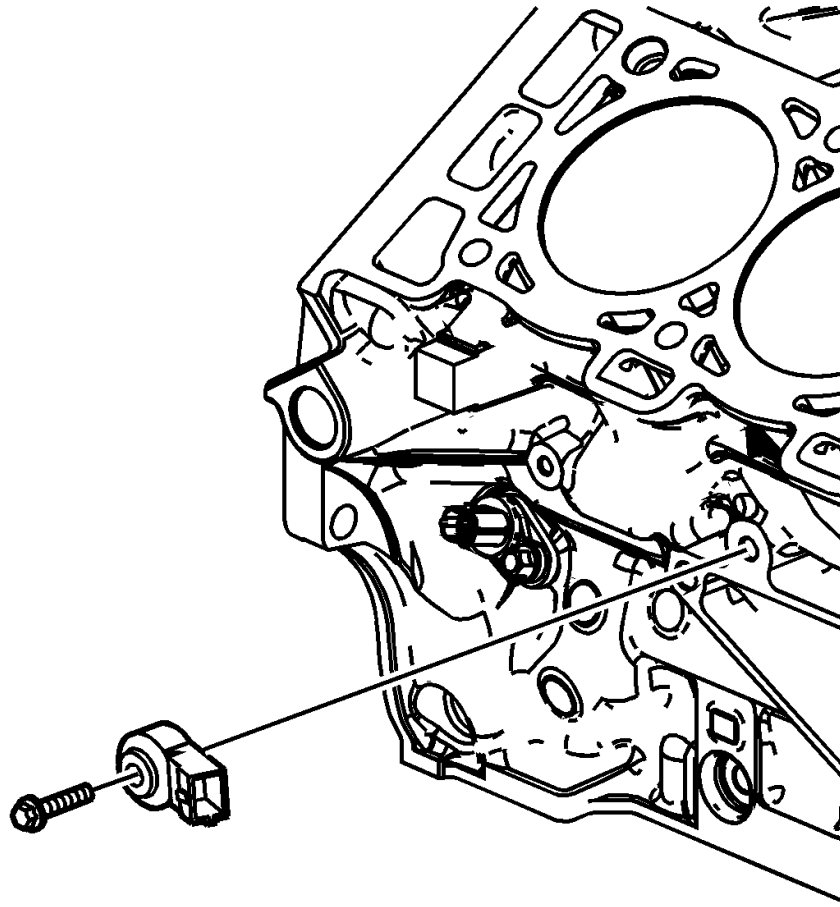


Fig. 470: View Of Right Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

29. Install the right knock sensor to the cylinder block, as shown.
30. Install the right knock sensor bolt and tighten to 25 N.m (18 lb ft).
31. Ensure proper sensor orientation.

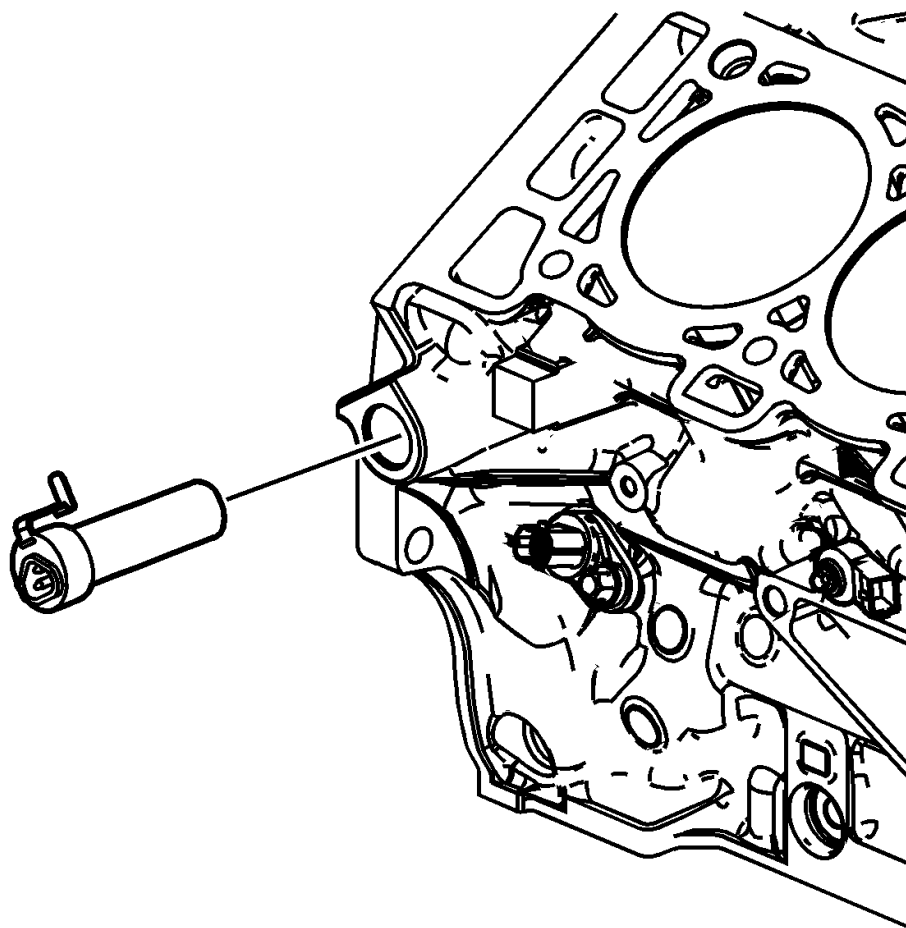


Fig. 471: View Of Block Heater Cartridge
Courtesy of GENERAL MOTORS COMPANY

32. Install the block heater cartridge, if equipped.

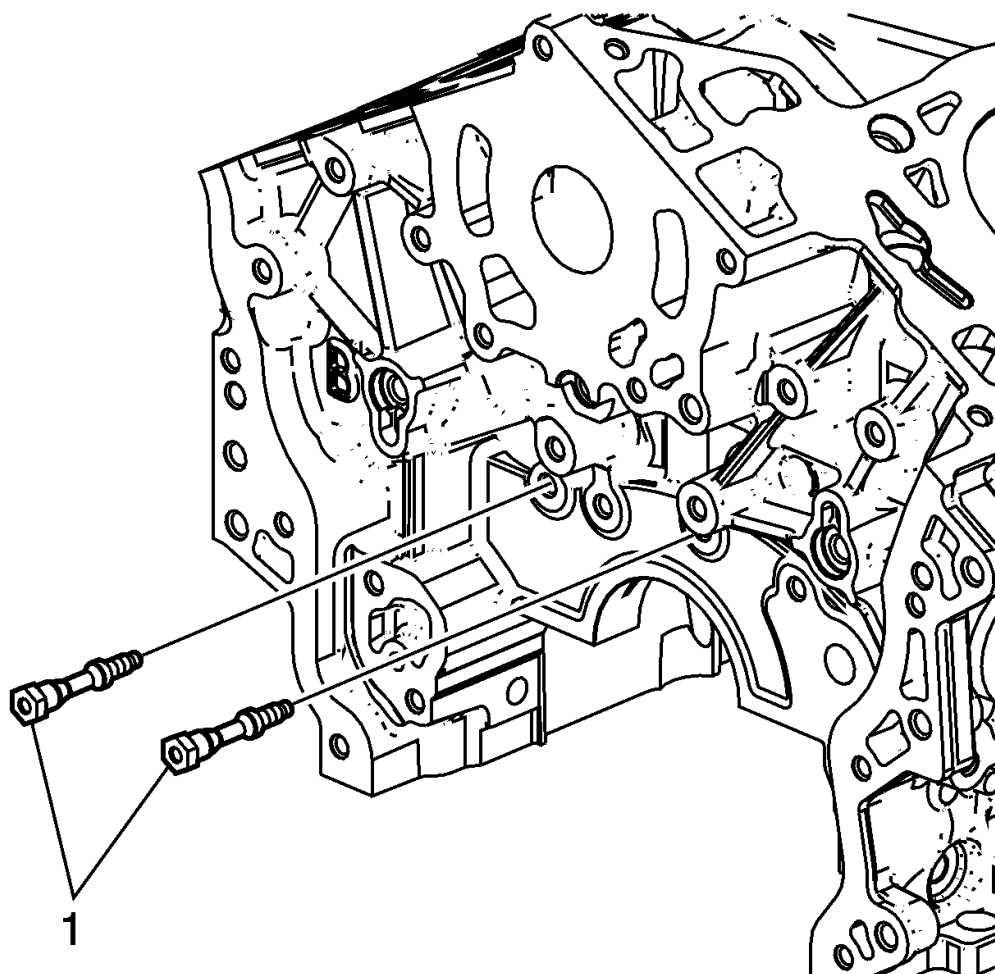


Fig. 472: Identifying Engine Front Cover Studs
Courtesy of GENERAL MOTORS COMPANY

33. Install the engine front cover studs (1) and tighten to 15 N.m (11 lb ft).

CRANKSHAFT AND BEARING INSTALLATION

Special Tools

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

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

Crankshaft Bearing Installation Procedure

1. Clean the crankcase crank bore with a lint-free cloth.

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

2. Clean all the oil from the backside of new bearing halves.

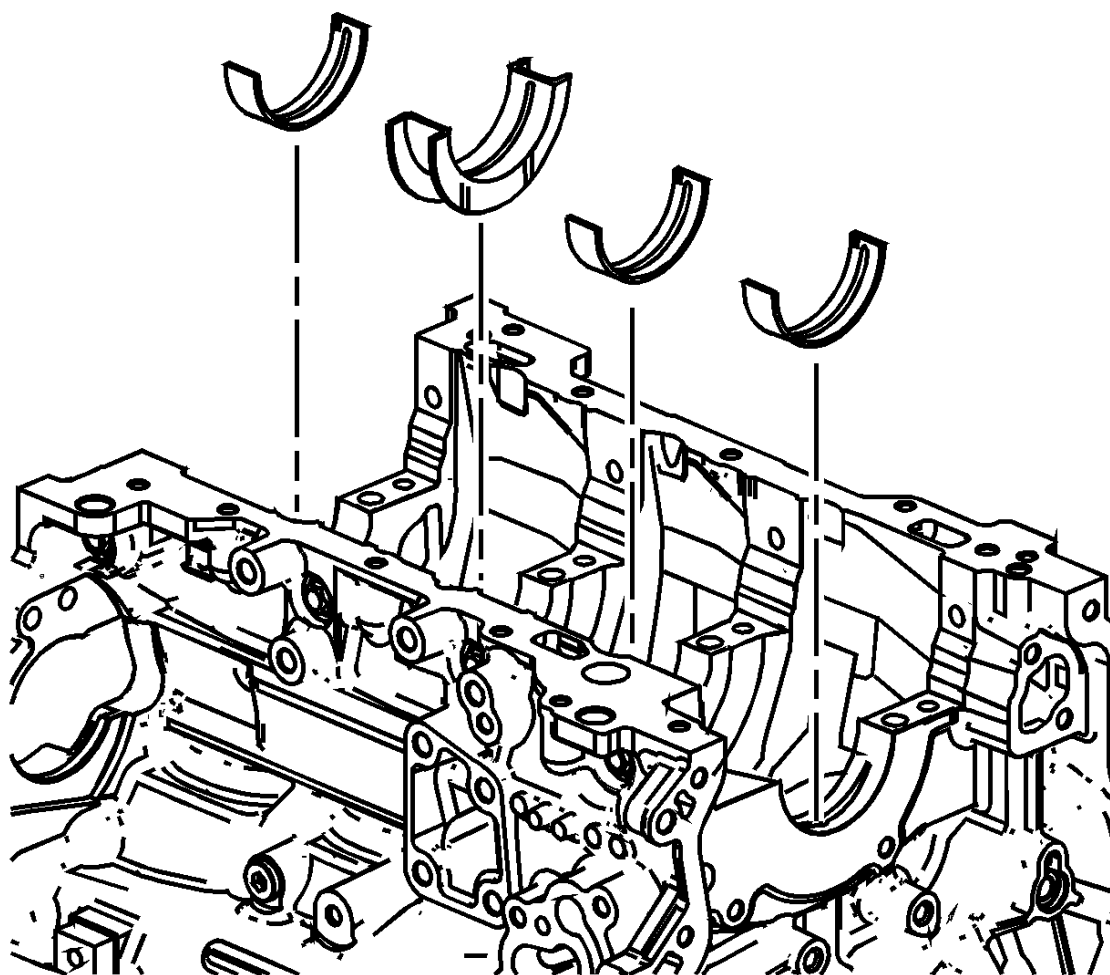


Fig. 473: View Of Upper Crankshaft Bearings
Courtesy of GENERAL MOTORS COMPANY

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.

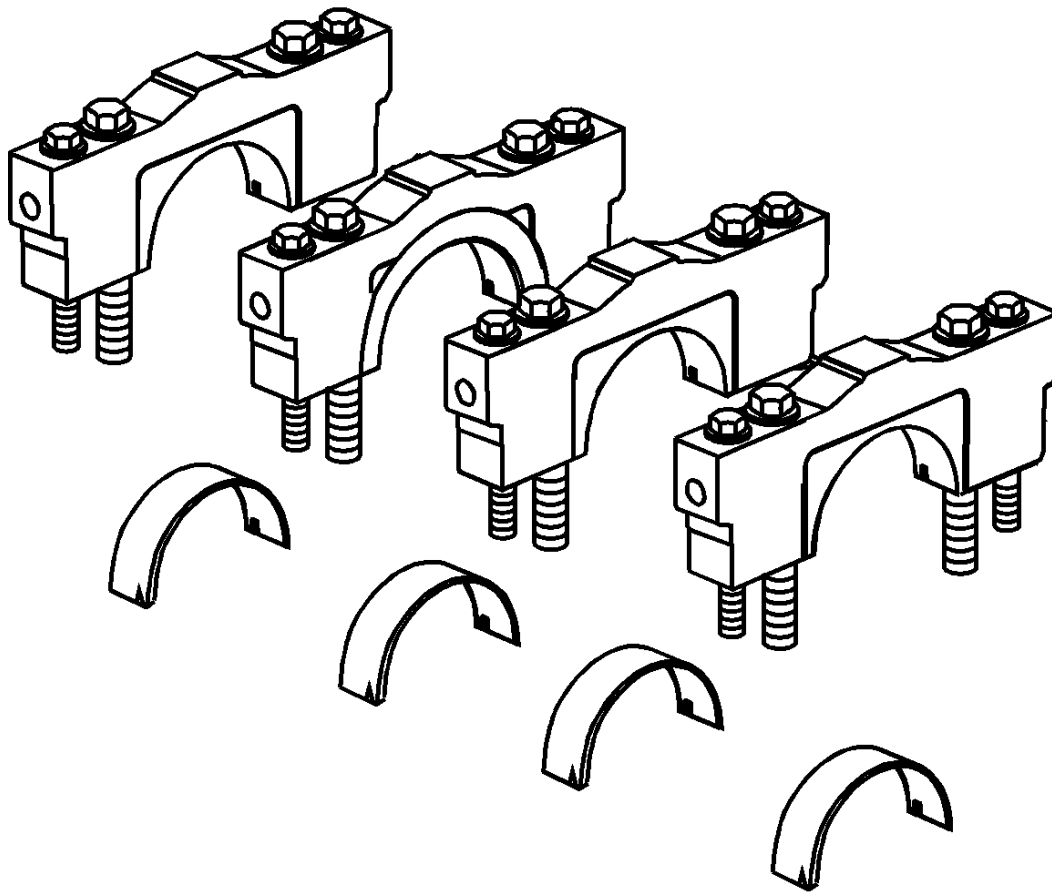


Fig. 474: View Of Crankshaft Bearing Caps & Lower Bearing Halves
Courtesy of GENERAL MOTORS COMPANY

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

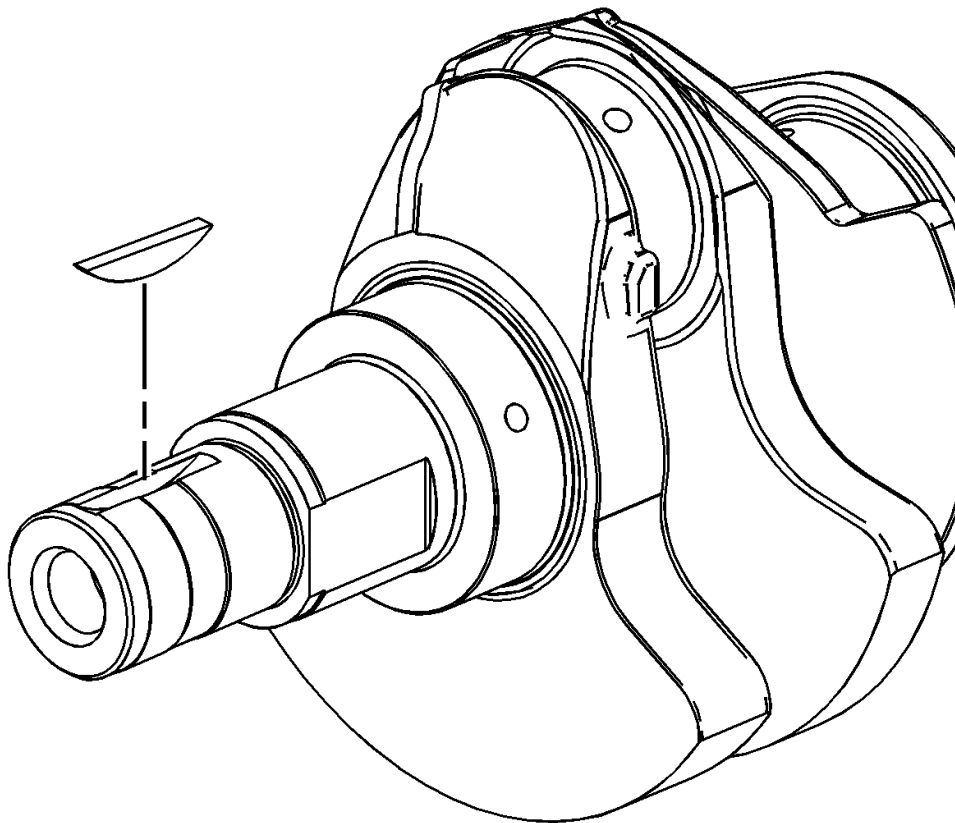


Fig. 475: Locating Crankshaft Sprocket Drive Pin
Courtesy of GENERAL MOTORS COMPANY

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

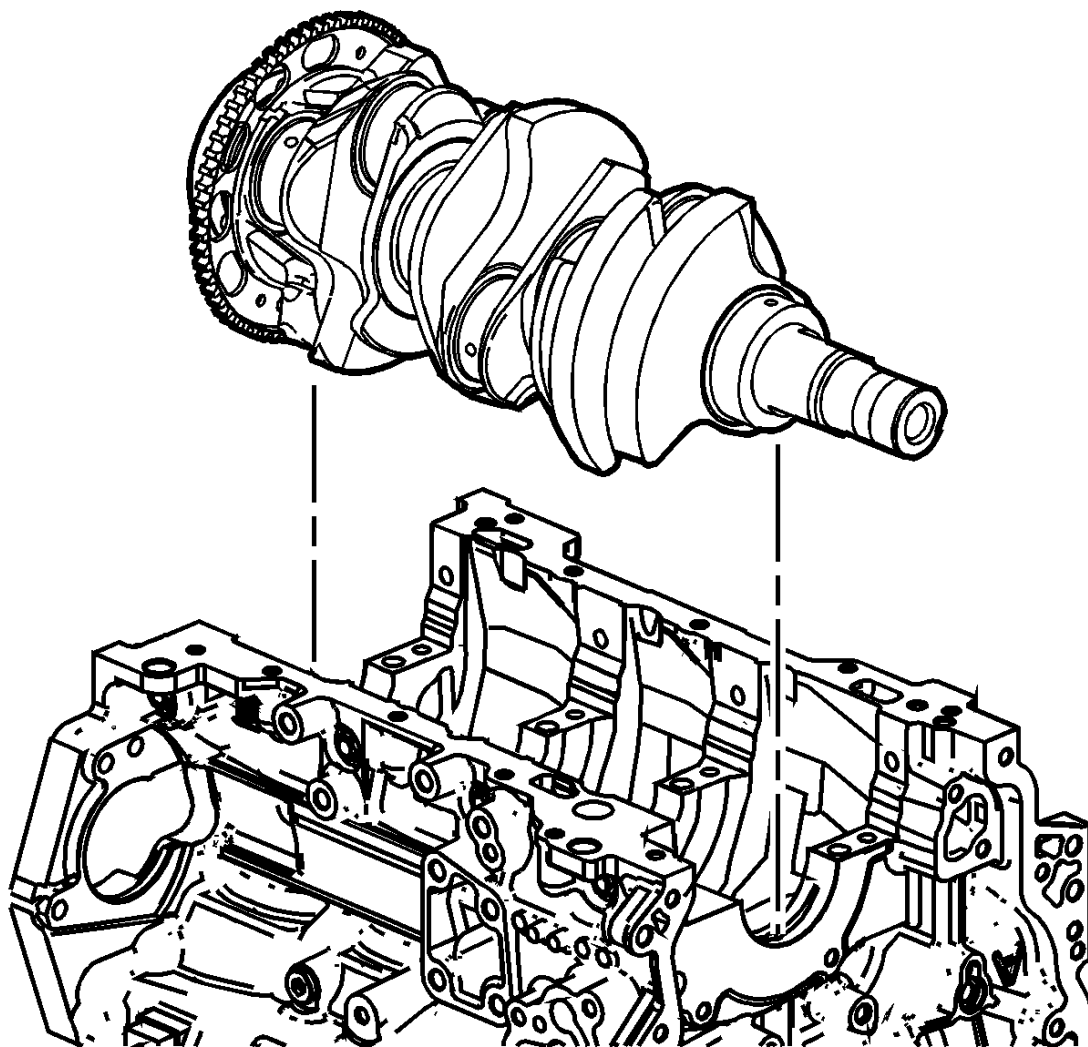


Fig. 476: View Of Crankshaft

Courtesy of GENERAL MOTORS COMPANY

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

Crankshaft Bearing Clearance Measurement Procedure

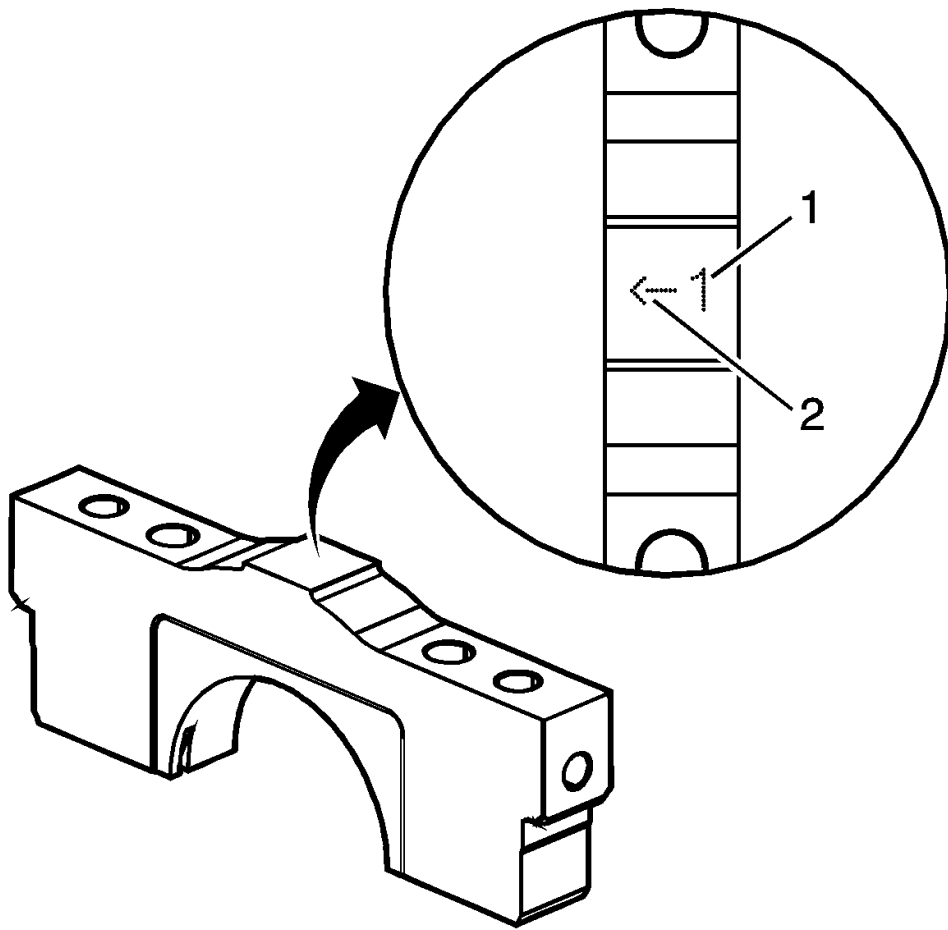


Fig. 477: Identifying Front Main Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

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.

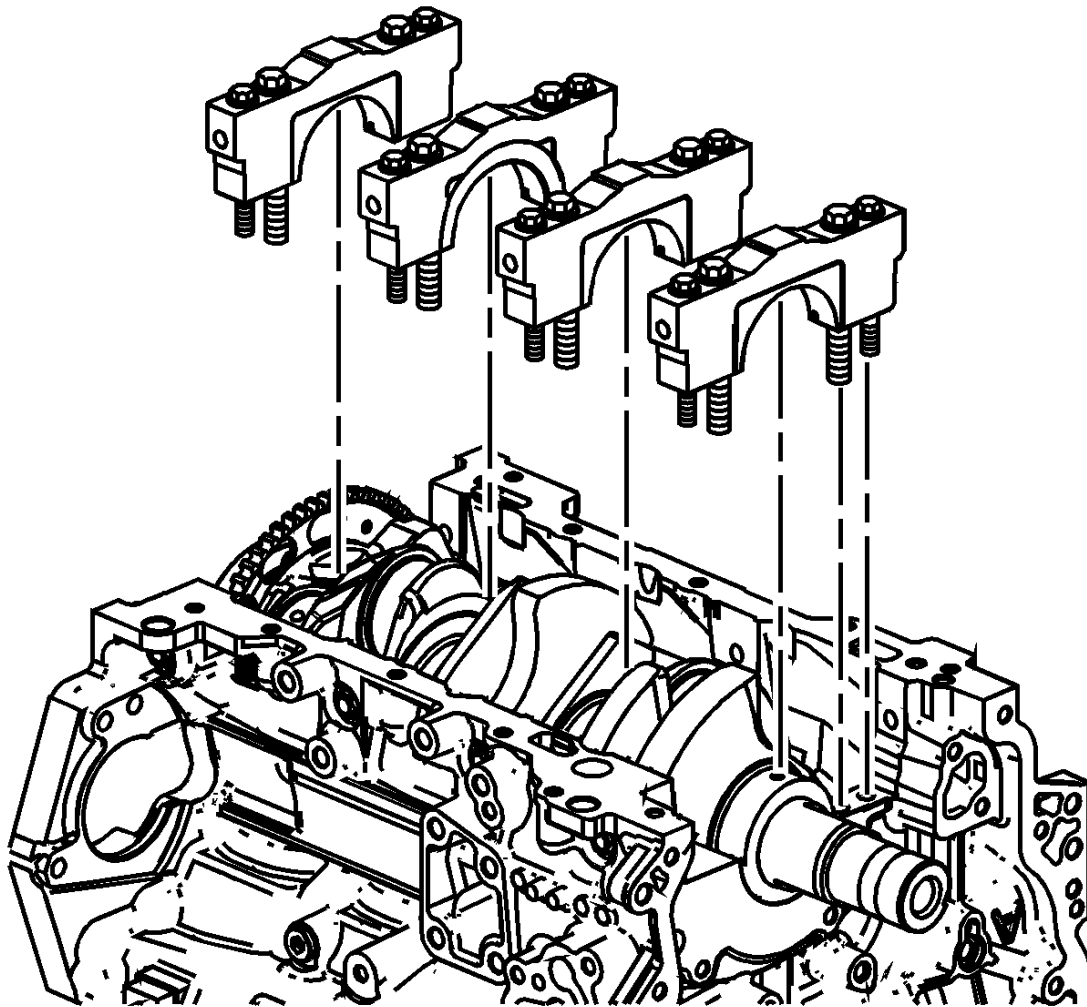


Fig. 478: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

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.

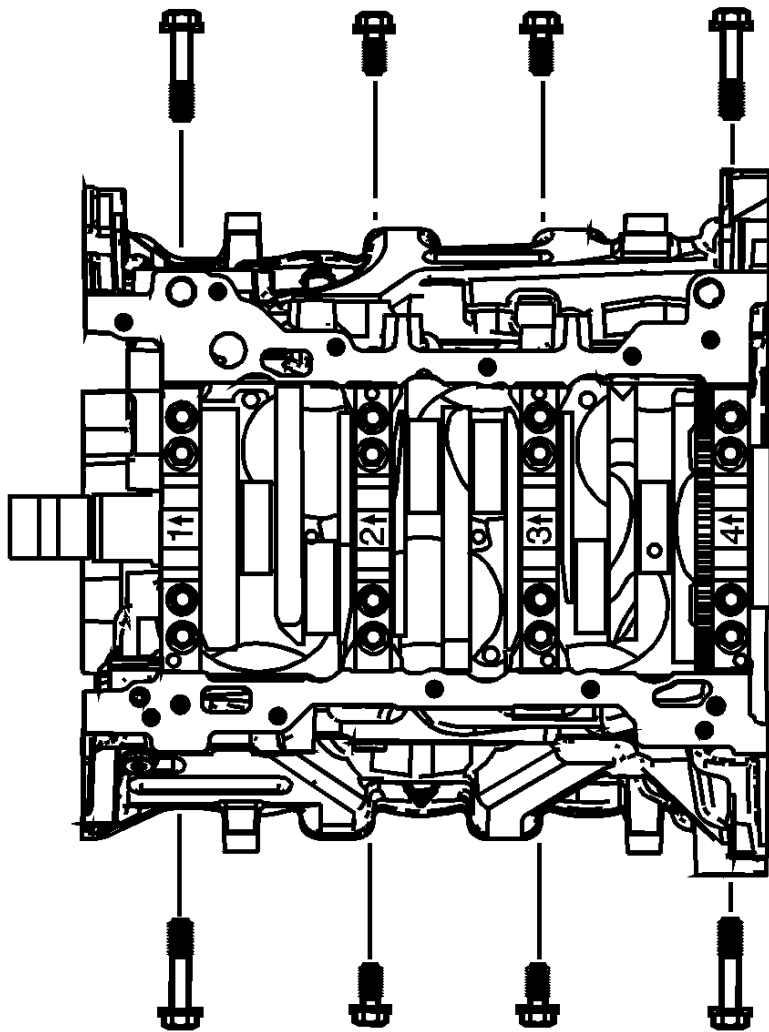


Fig. 479: Identifying Crankshaft Main Bearing Cap Side Bolts
Courtesy of GENERAL MOTORS COMPANY

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

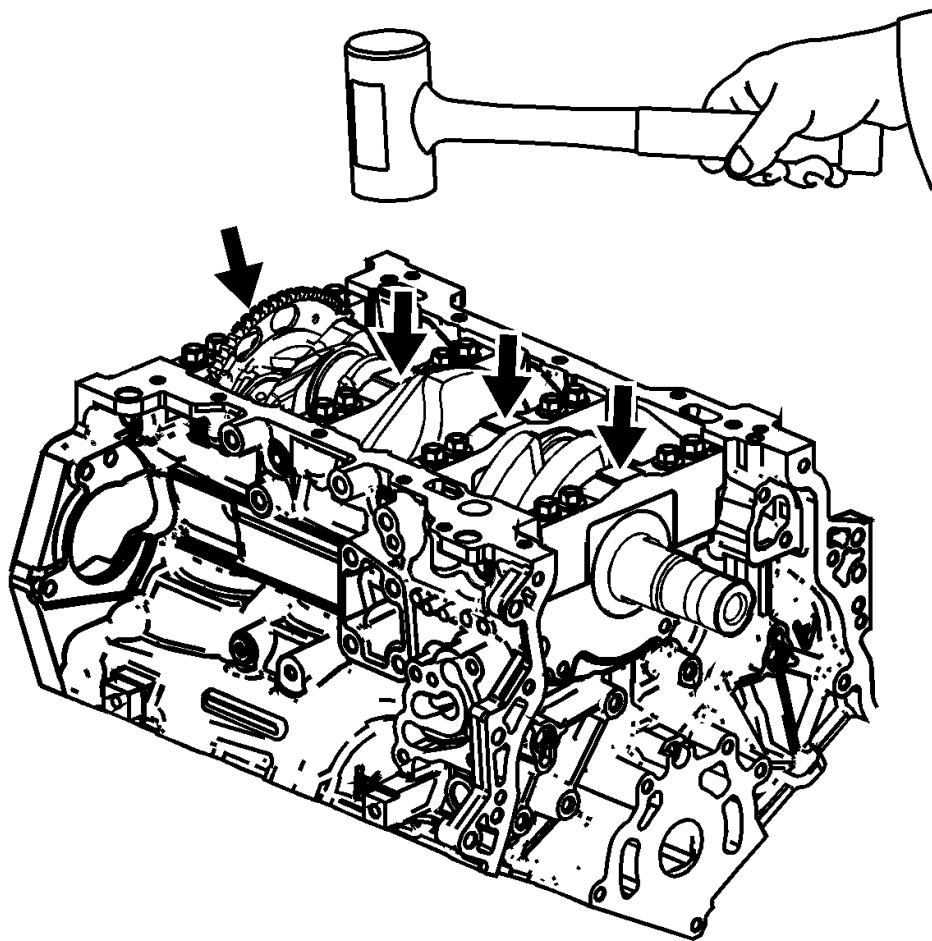


Fig. 480: Setting Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

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

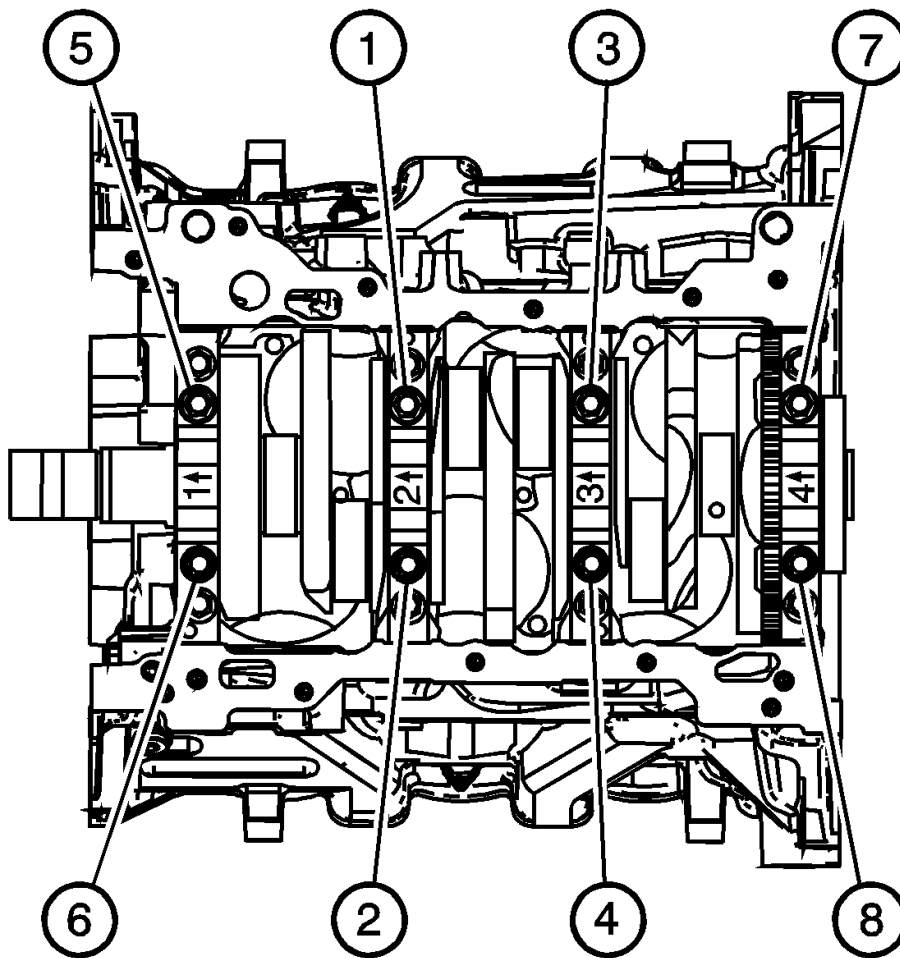


Fig. 481: Identifying Crankshaft Main Bearing Inboard Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

10. Tighten the inboard bolts (1-8) first, in two passes.

CAUTION: Refer to Fastener Caution .

1. Tighten the inboard bolts to 20 (15 lb ft) on the first pass.
2. Tighten the inboard bolts (1-8) an additional 80° on the 2nd pass.

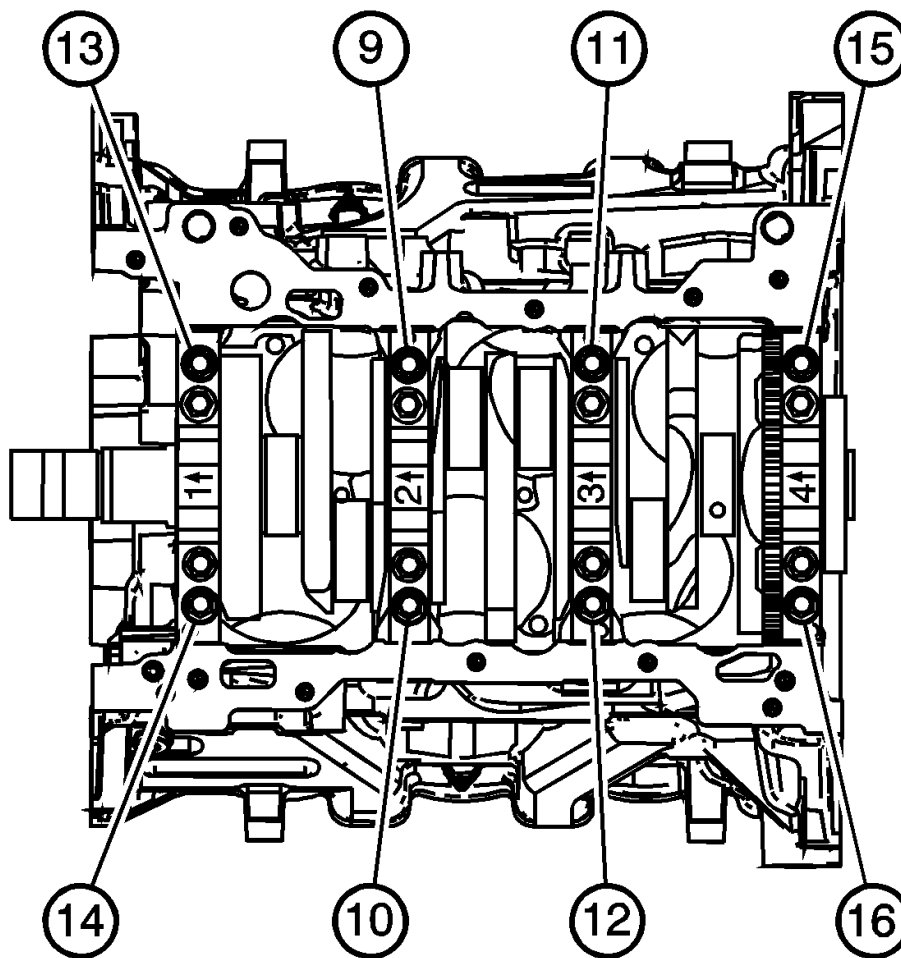


Fig. 482: Identifying Outboard Crankshaft Main Bearing Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

11. Tighten the outboard bolts (9-16) second, in two passes.
 1. Tighten the outboard bolts to 15 (11 lb ft) on the first pass.
 2. Tighten the outboard bolts (9-16) an additional 110° on the 2nd pass.

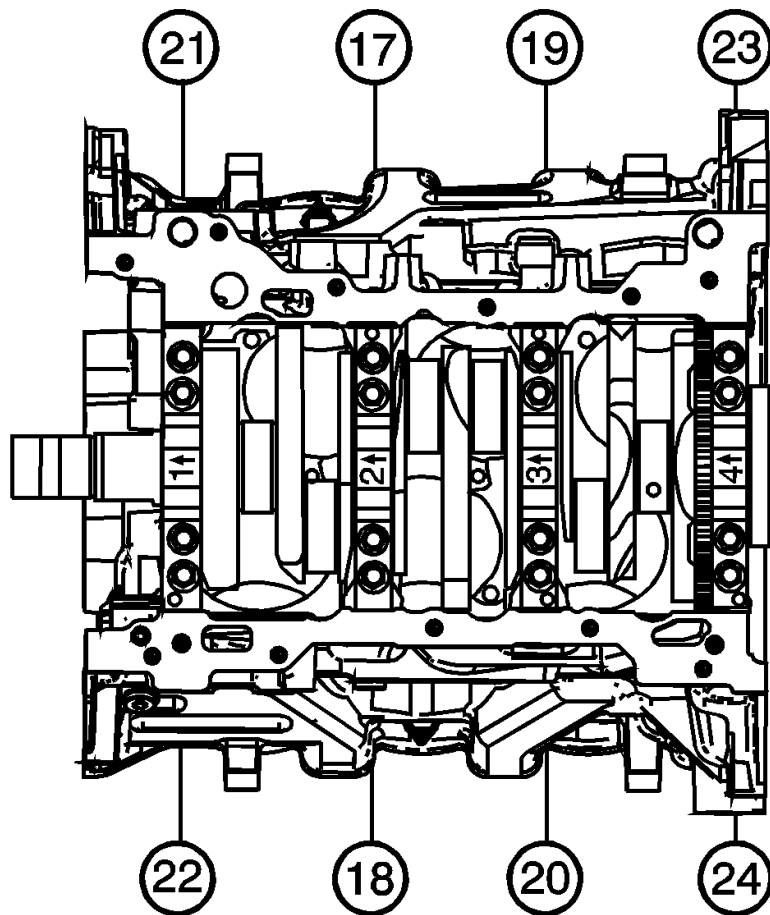


Fig. 483: Identifying Short/Inner Crankshaft Main Bearing (Bolt Tightening Sequence)
Courtesy of GENERAL MOTORS COMPANY

12. Tighten the short/inner bolts (17-20) third, in two passes.
 1. Tighten the short/inner bolts to 30 (22 lb ft) on the first pass.
 2. Tighten the short/inner bolts (17-20) an additional 60° on the 2nd pass.
13. Tighten the long/outer bolts (21-24) fourth, in two passes.
 1. Tighten the long/outer bolts to 30 (22 lb ft) on the first pass.
 2. Tighten the long/outer bolts (21-24) an additional 60° on the 2nd pass.
14. After reaching final torque, allow the assembly to sit for 2 minutes.

NOTE: Do not rotate the crankshaft.

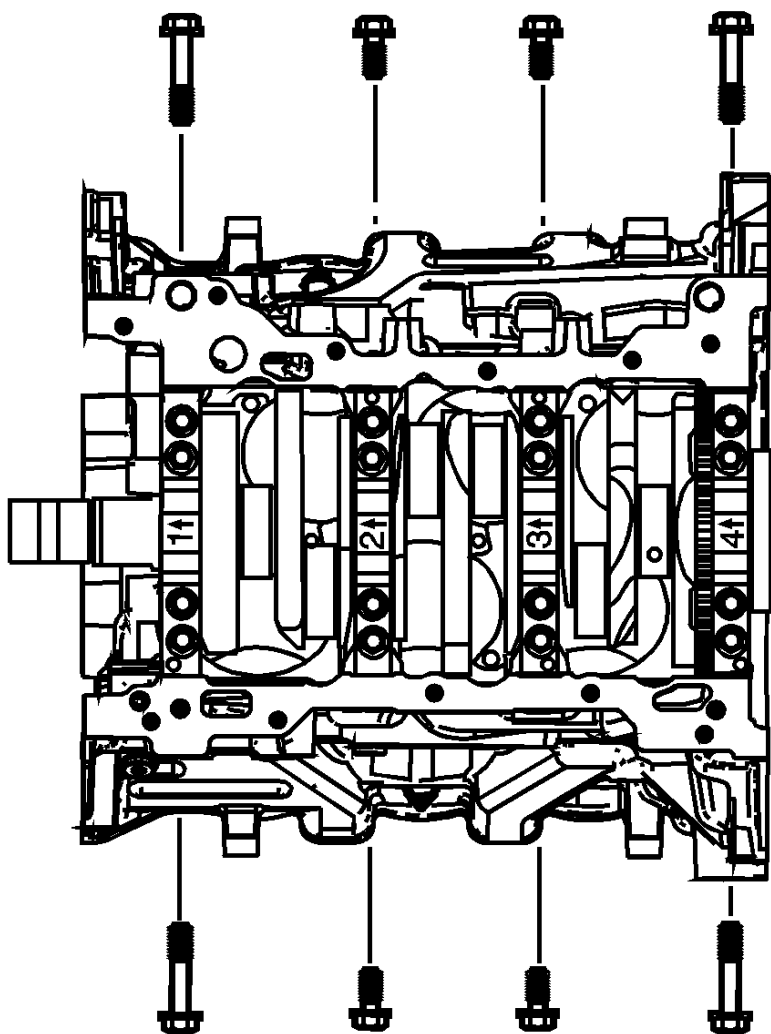


Fig. 484: Identifying Crankshaft Main Bearing Cap Side Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Remove the crankshaft bearing cap side bolts.

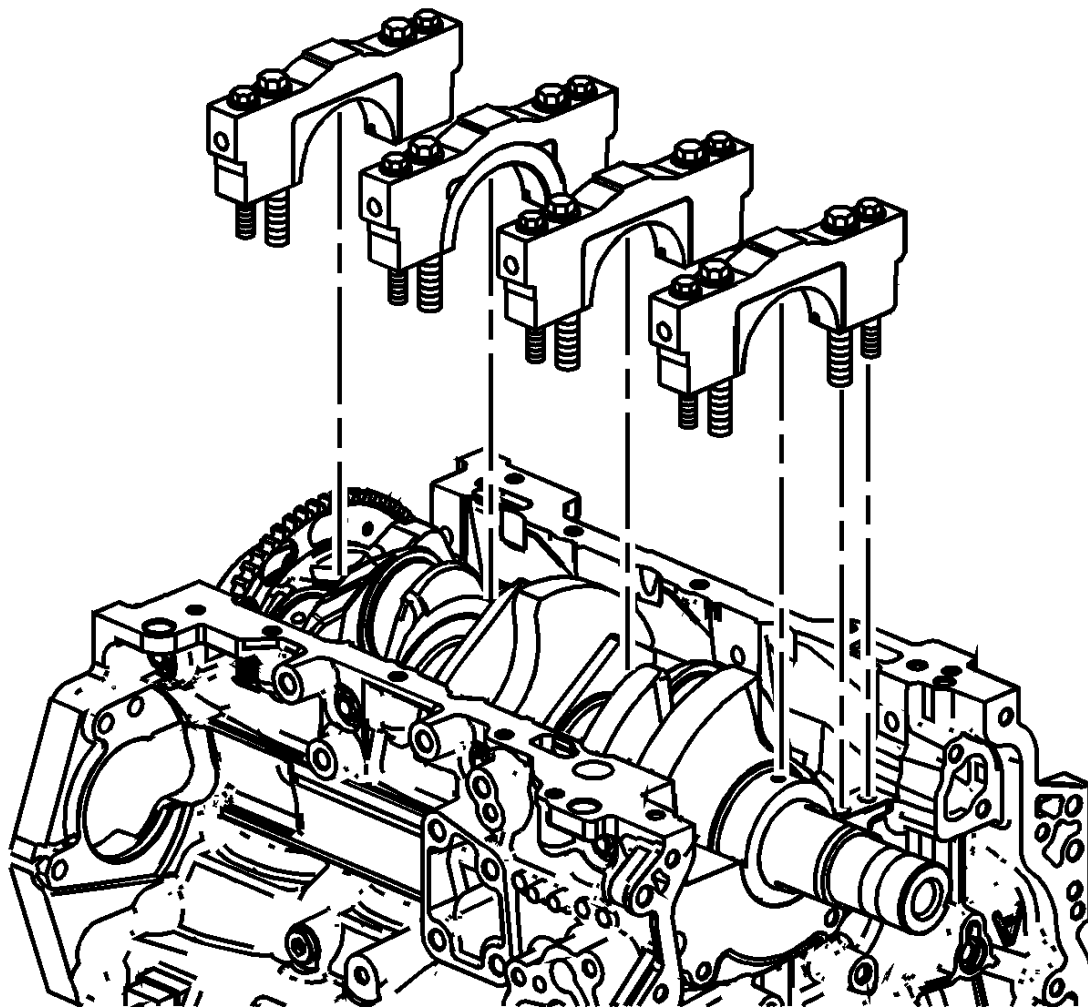


Fig. 485: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

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

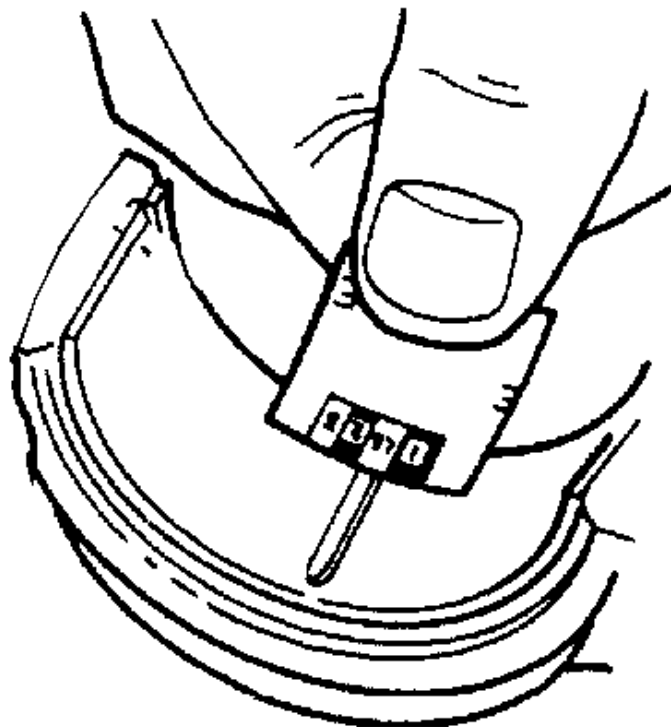


Fig. 486: Measuring Plastigage

Courtesy of GENERAL MOTORS COMPANY

19. 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.
20. Compare your measurements with the **Engine Mechanical Specifications** . If the new bearings do not provide the proper crankshaft to bearing clearance, inspect the following:

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

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.

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

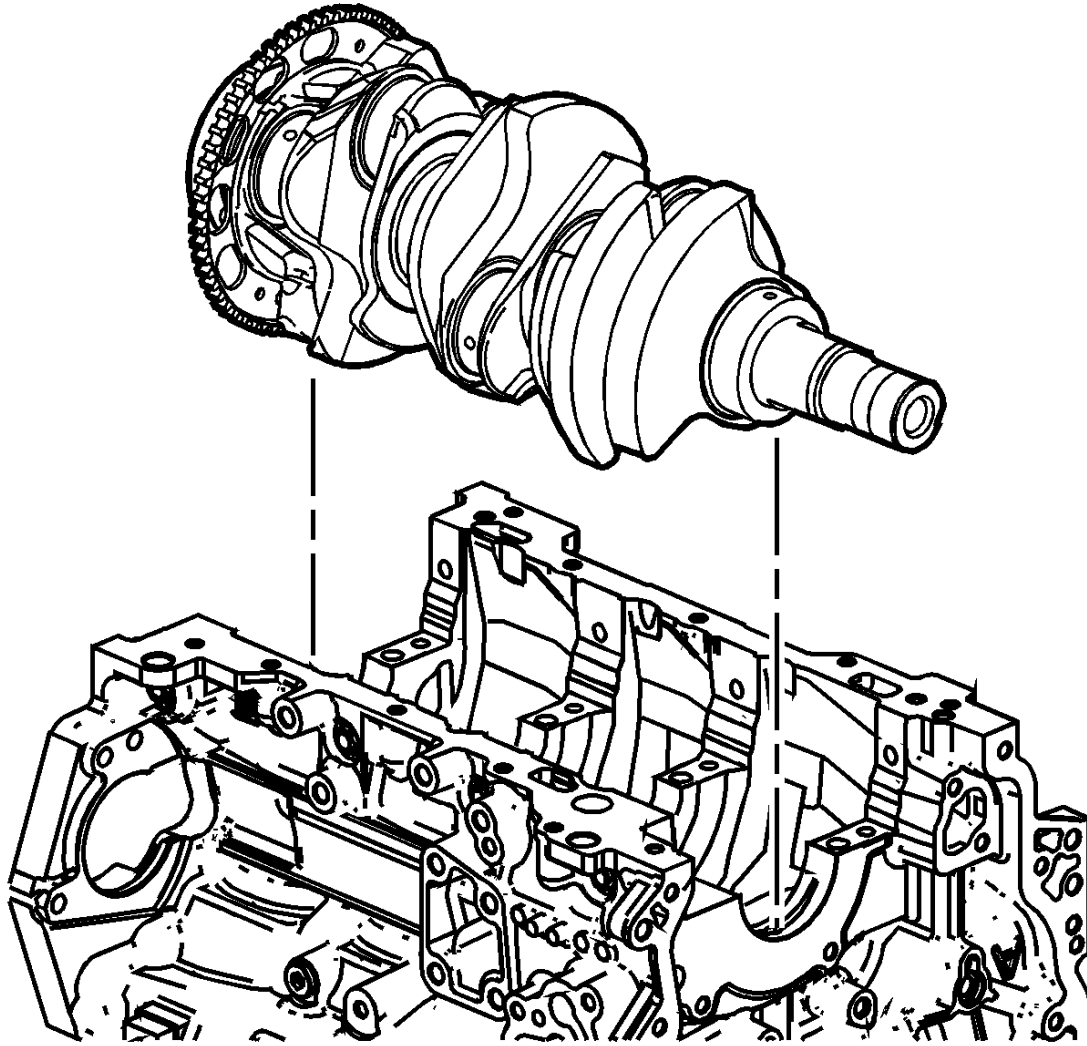


Fig. 487: View Of Crankshaft

Courtesy of GENERAL MOTORS COMPANY

22. Lift the crankshaft out of the cylinder block.

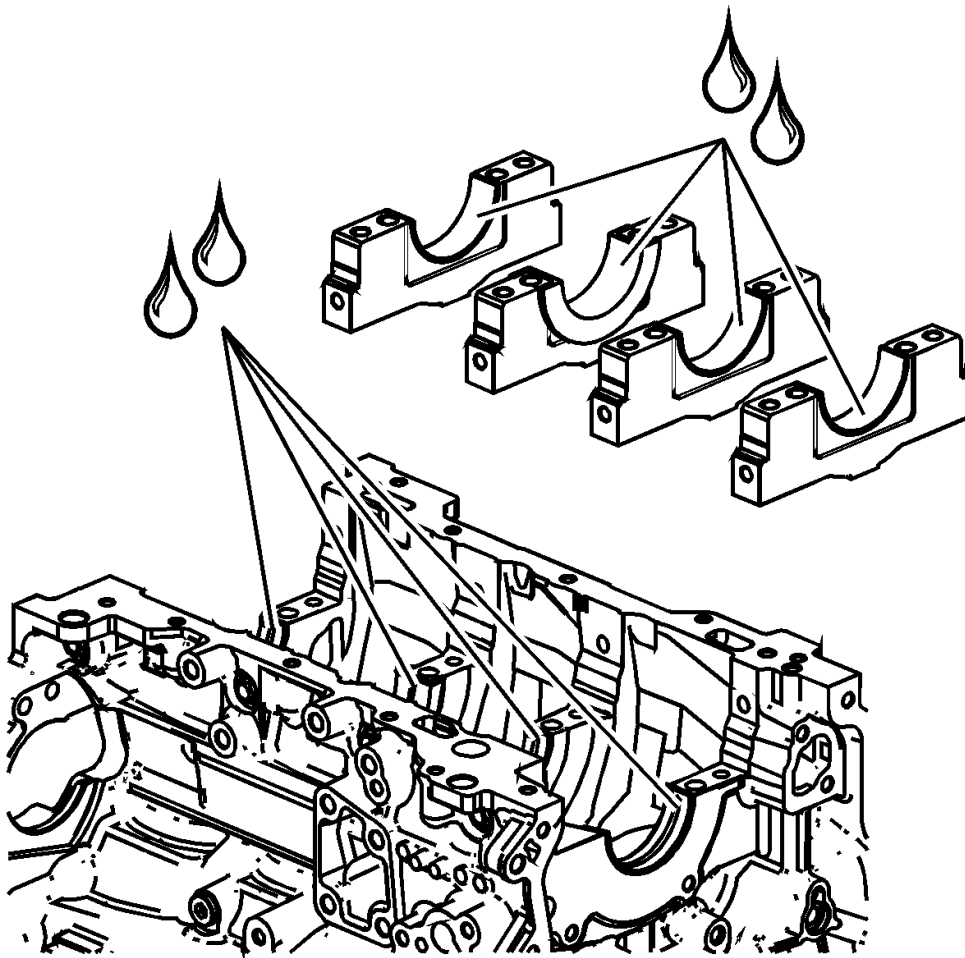


Fig. 488: Prelubing Upper & Lower Bearing Surfaces
Courtesy of GENERAL MOTORS COMPANY

23. 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.

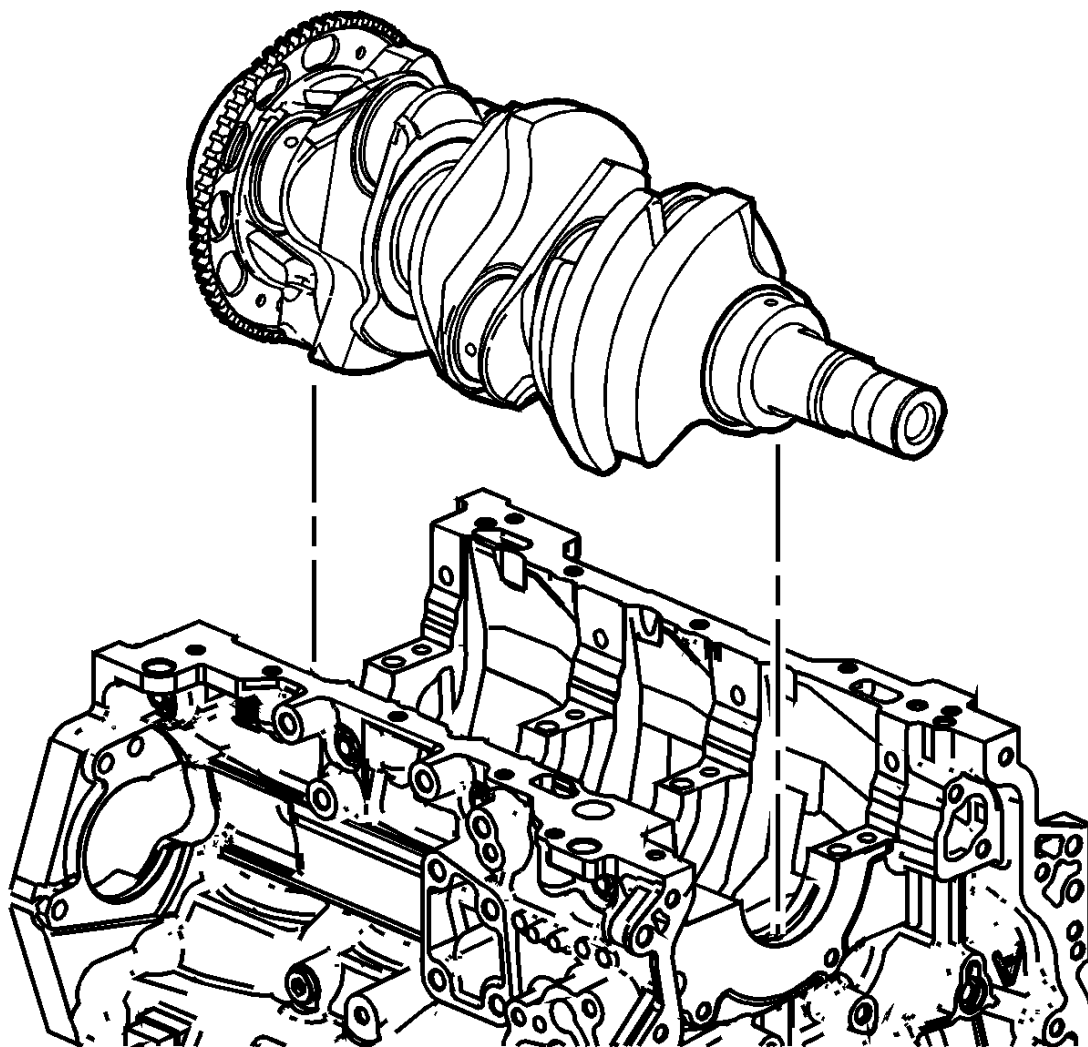


Fig. 489: View Of Crankshaft

Courtesy of GENERAL MOTORS COMPANY

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

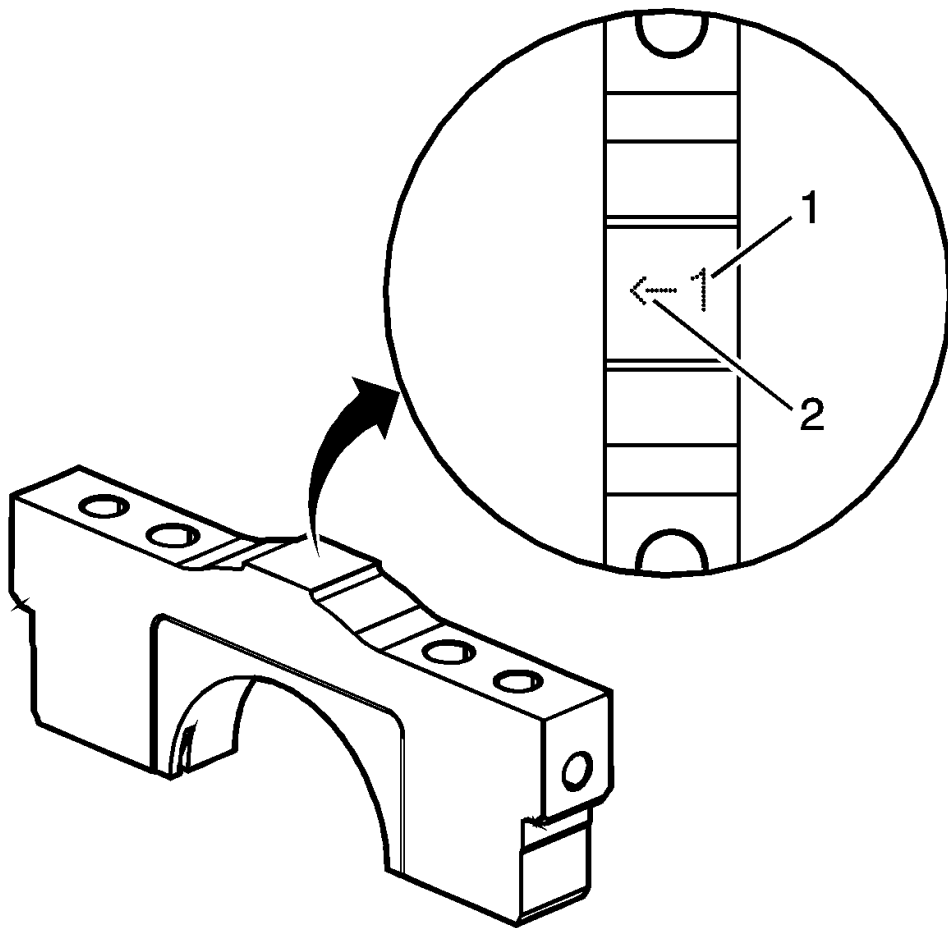


Fig. 490: Identifying Front Main Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

25. 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.

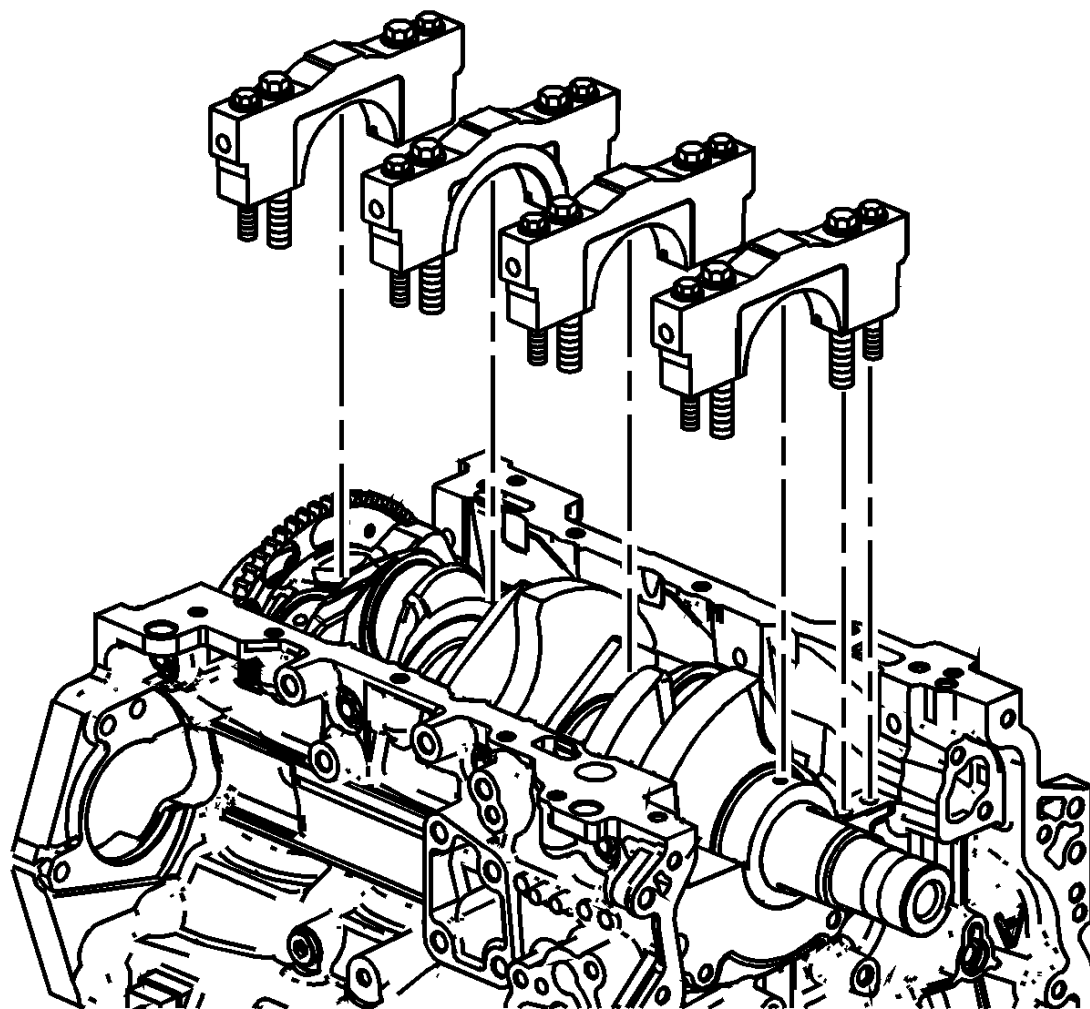


Fig. 491: View Of Crankshaft Main Bearing Caps
 Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

28. Loosely install the NEW outer main cap bolts.

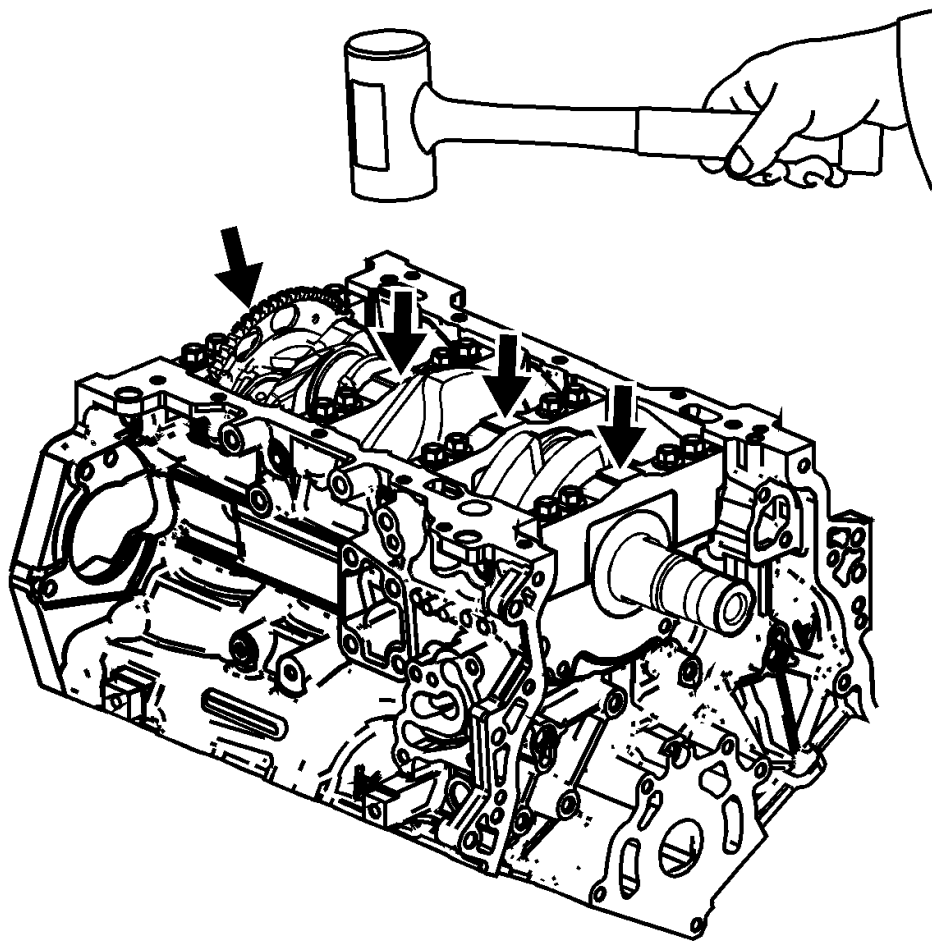


Fig. 492: Setting Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

29. Tap the crankshaft main bearing caps with a soft-faced hammer.
30. Loosely install the NEW short/inner side main cap bolts.

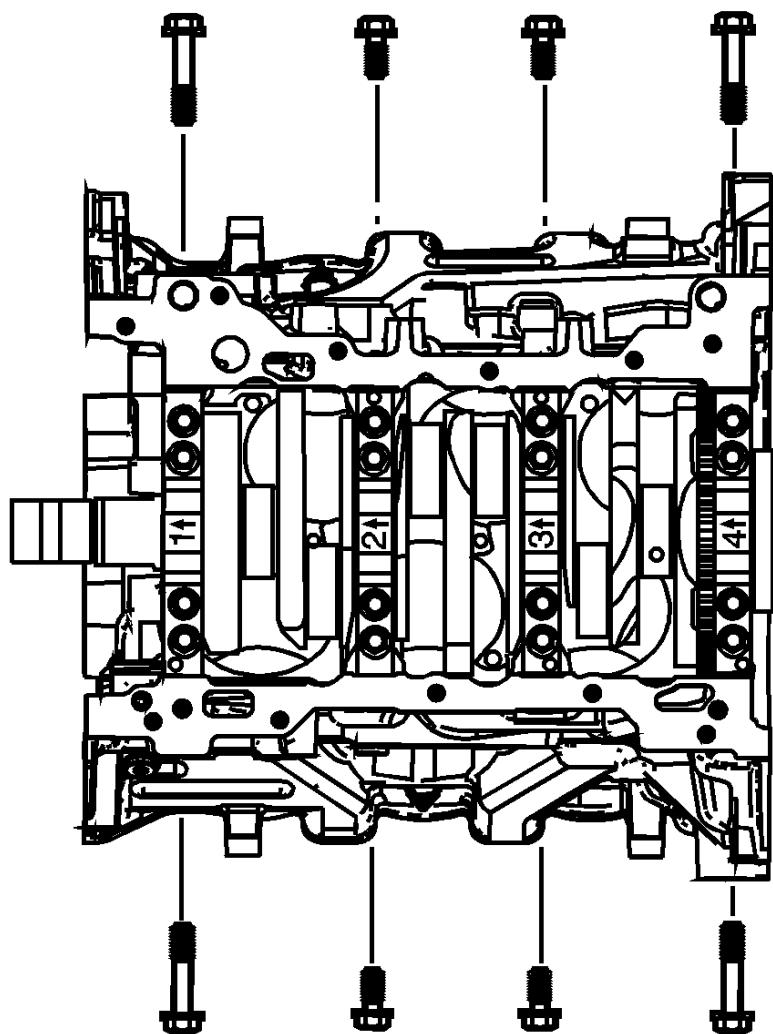


Fig. 493: Identifying Crankshaft Main Bearing Cap Side Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: 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.

31. Loosely install the NEW long/outer side main cap bolts.
32. Tighten the main cap bolts using the **J 45059** meter in the following sequence:

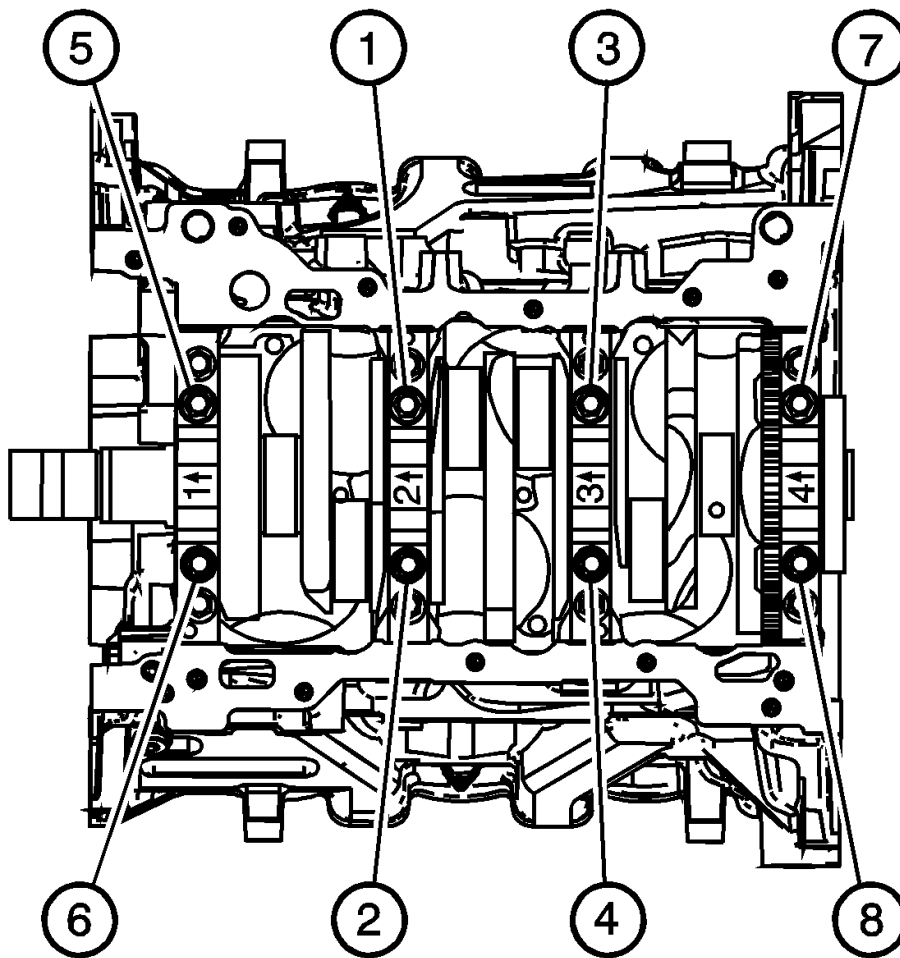


Fig. 494: Identifying Crankshaft Main Bearing Inboard Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

Tighten the inboard bolts (1-8) first, in two passes.

1. Tighten the inboard bolts to 20 (15 lb ft) on the first pass.
2. Tighten the inboard bolts (1-8) an additional 80° on the 2nd pass.

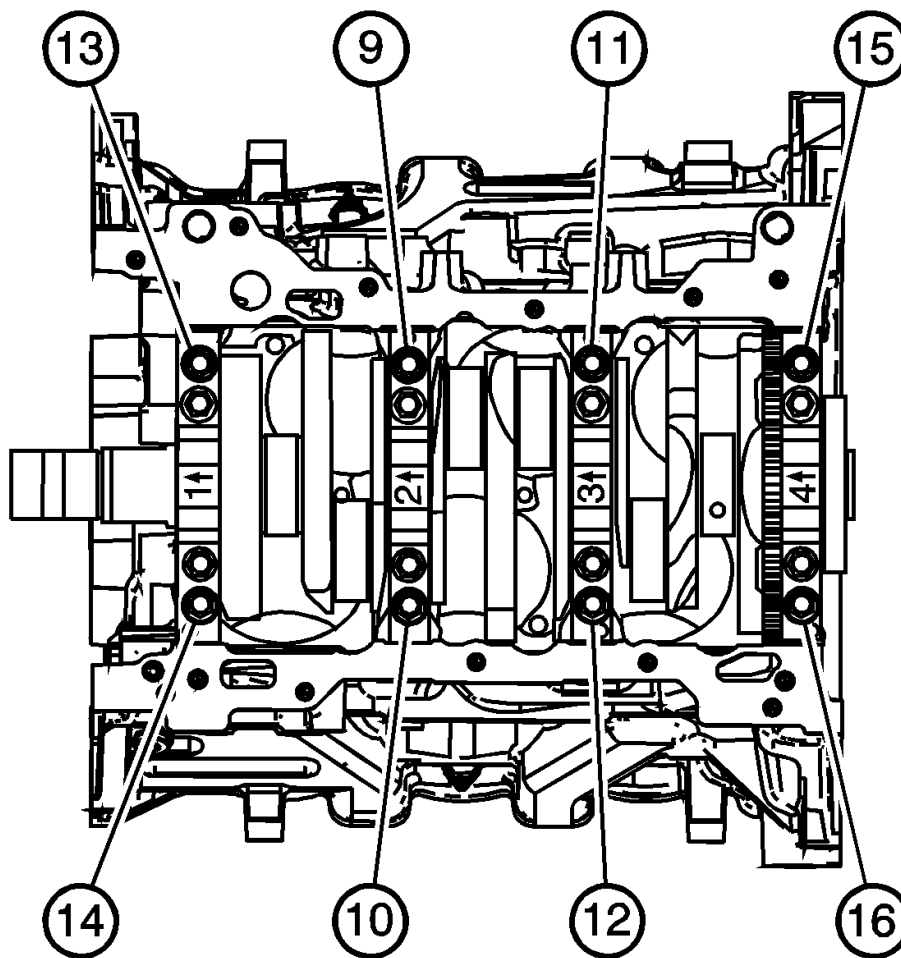


Fig. 495: Identifying Outboard Crankshaft Main Bearing Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

33. Tighten the outboard bolts (9-16) second, in two passes.
 1. Tighten the outboard bolts to 15 (11 lb ft) on the first pass.
 2. Tighten the outboard bolts (9-16) an additional 110° on the 2nd pass.

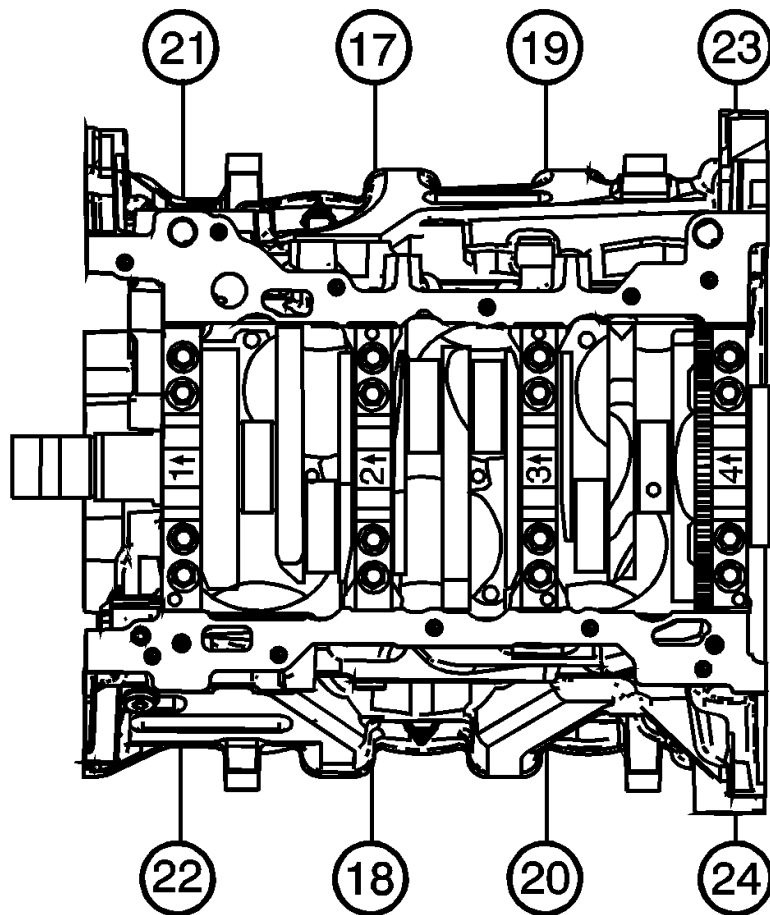


Fig. 496: Identifying Short/Inner Crankshaft Main Bearing (Bolt Tightening Sequence)
 Courtesy of GENERAL MOTORS COMPANY

34. Tighten the short/inner bolts (17-20) third, in two passes.
 1. Tighten the short/inner bolts to 30 (22 lb ft) on the first pass.
 2. Tighten the short/inner bolts (17-20) an additional 60° on the 2nd pass.
35. Tighten the long/outer bolts (21-24) fourth, in two passes.
 1. Tighten the long/outer bolts to 30 (22 lb ft) on the first pass.
 2. Tighten the long/outer bolts (21-24) an additional 60° on the 2nd pass.
36. Ensure that the crankshaft turns without binding or noise.

PISTON, CONNECTING ROD AND BEARING INSTALLATION

Special Tools

- **EN-46121** Connecting Rod Guide Pin Set
- **EN-48589** Crankshaft Rotation Socket

- **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

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

Piston and Connecting Rod Assembly Procedure

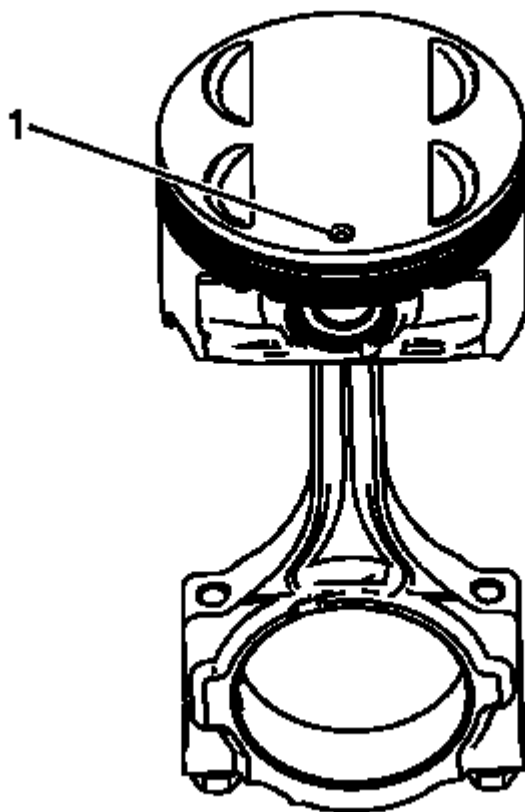


Fig. 497: Identifying Proper Piston Orientation With Dot On Piston
Courtesy of GENERAL MOTORS COMPANY

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

NOTE: The piston is directional and must be installed in the engine block in the proper direction. The dot on the top of the piston must face the front of the engine.

3. Install the connecting rod bearing into the connecting rod.

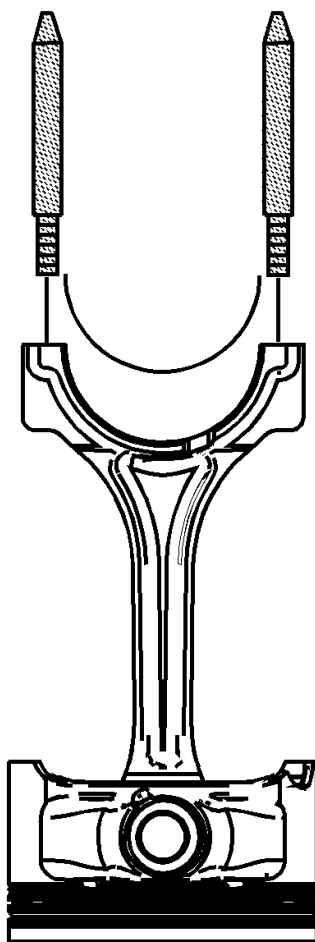


Fig. 498: View Of Piston/Connecting Rod Installation Tool
Courtesy of GENERAL MOTORS COMPANY

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

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

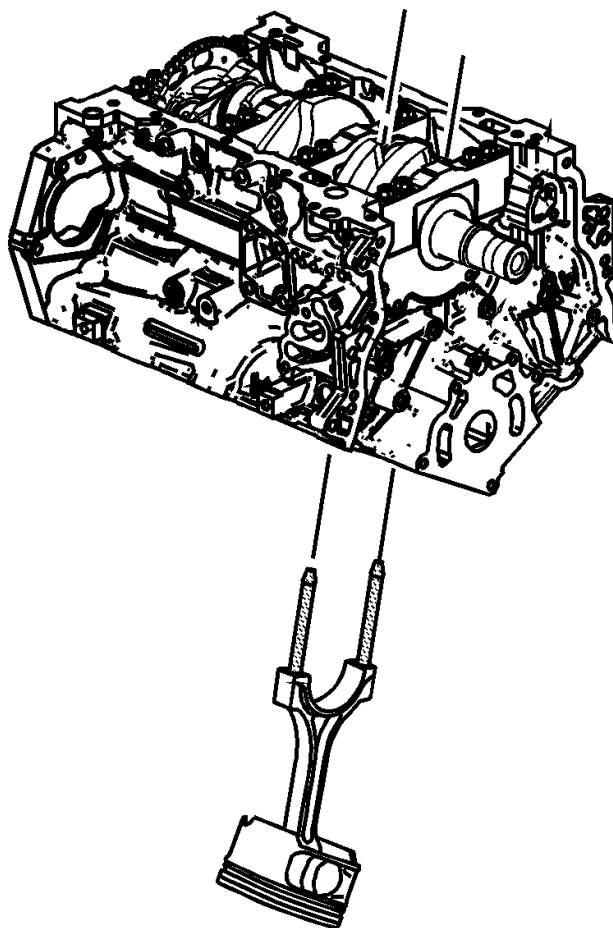


Fig. 499: View Of Connecting Rod & Piston Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: 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.

7. When the **J 8037** compressor 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** set while gently tapping the piston into the cylinder with a soft-blow hammer.

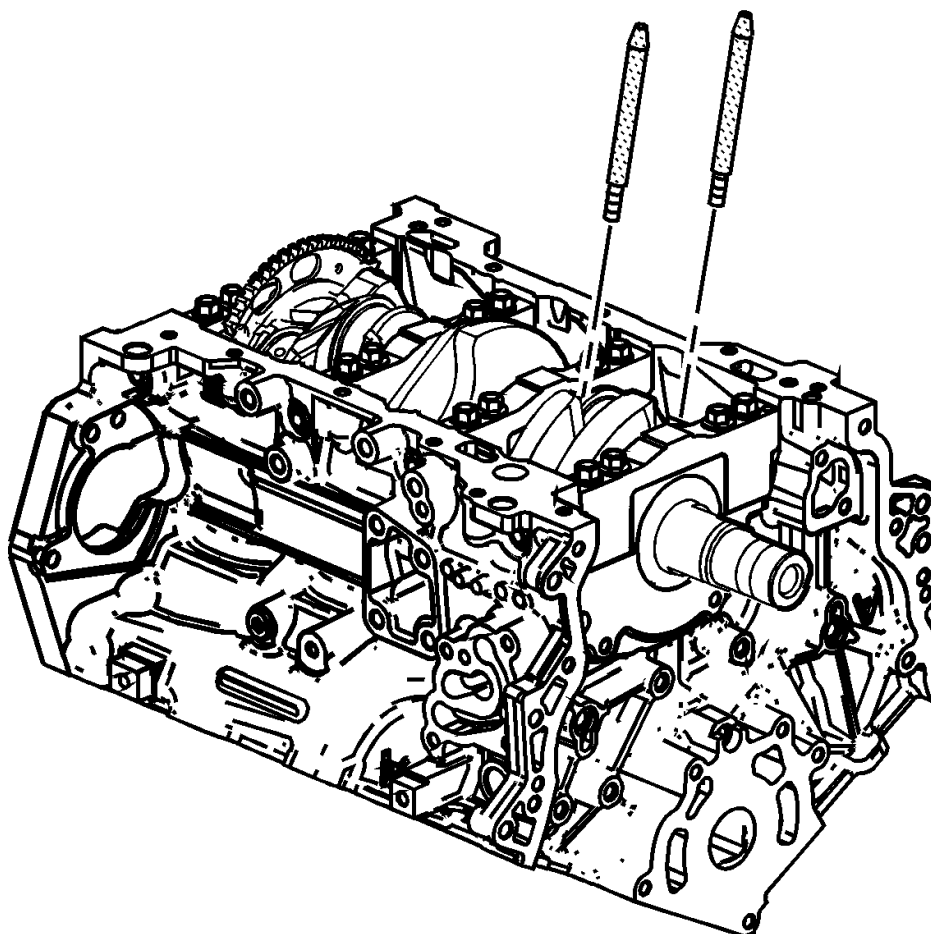


Fig. 500: Identifying Special Tool - EN 46121
 Courtesy of GENERAL MOTORS COMPANY

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

Connecting Rod Bearing Clearance Measurement Procedure - Using Plastic Gaging

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

NOTE: 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.

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

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

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

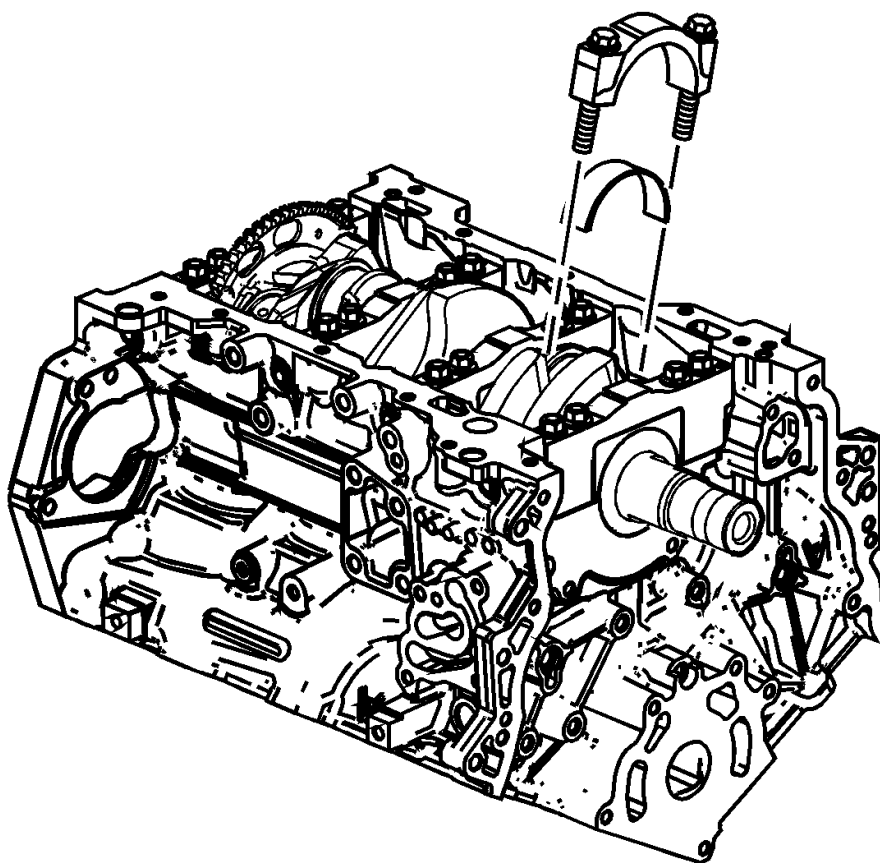


Fig. 501: View Of Connecting Rod Bearing & Cap
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

CAUTION: 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.

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

5. Tighten the connecting rod bolts.

1. First Pass

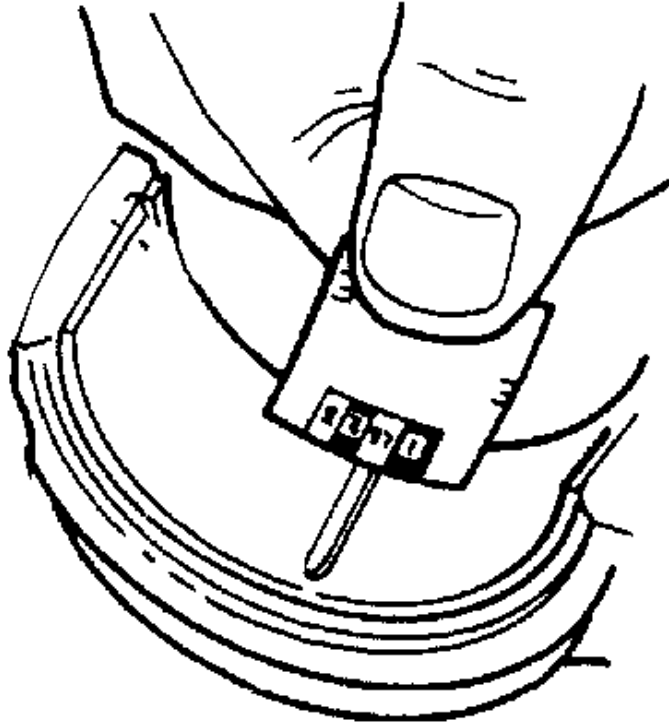
Tighten the connecting rod bolts to 25 N.m (18 lb ft).

2. Final Pass

Tighten the connecting rod bolts an additional 110° using the **J 45059** meter.

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

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Courtesy of GENERAL MOTORS COMPANY

10. 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.
11. Clean the plastic gaging material from the connecting rod bearing journals using a soft lint-free cloth.

Connecting Rod Bearing Clearance Measurement Procedure - Using J-43690 and J-43690-100

The **J 43690** tool and the **J 43690-100** adapter kit 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.

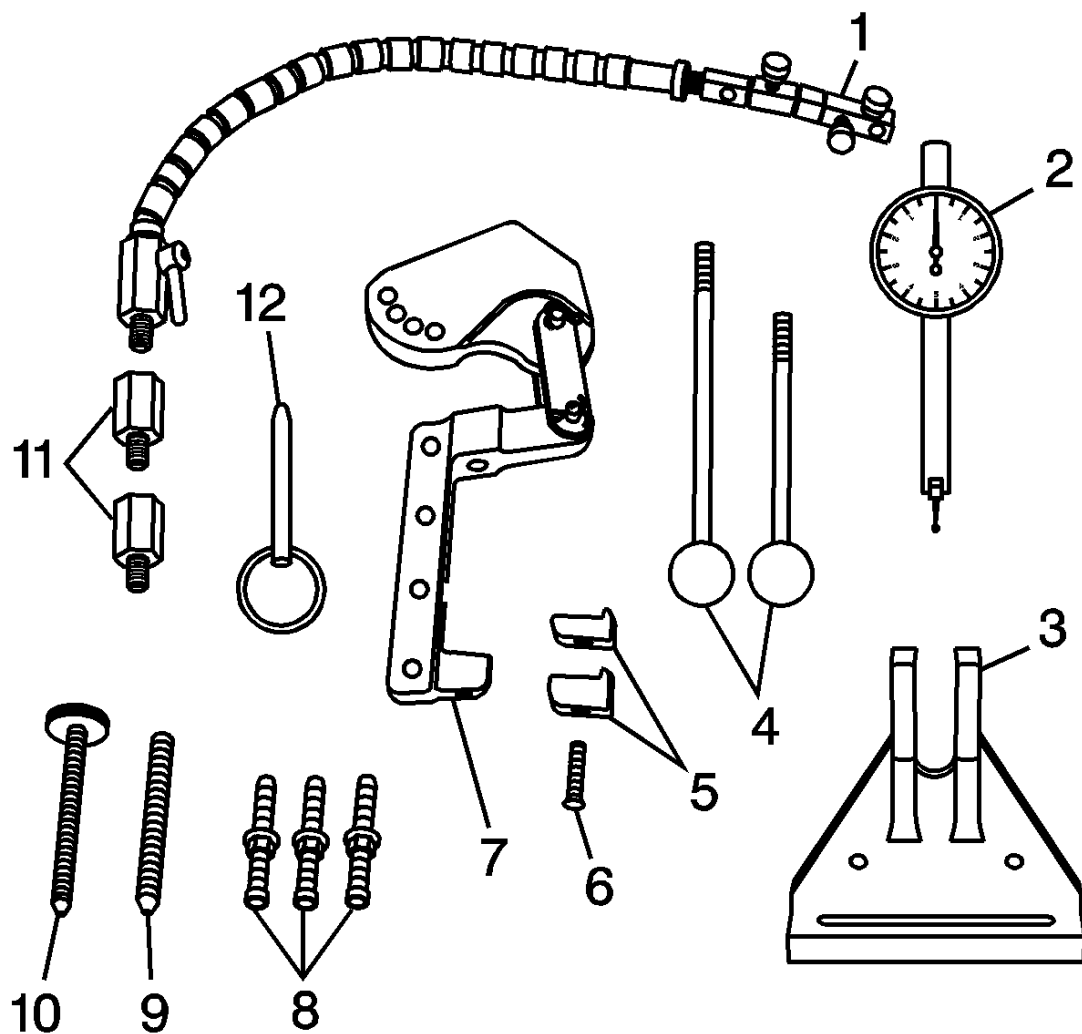


Fig. 503: Identifying Rod Bearing Clearance Checking Tool
 Courtesy of GENERAL MOTORS COMPANY

J 43690 tool

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

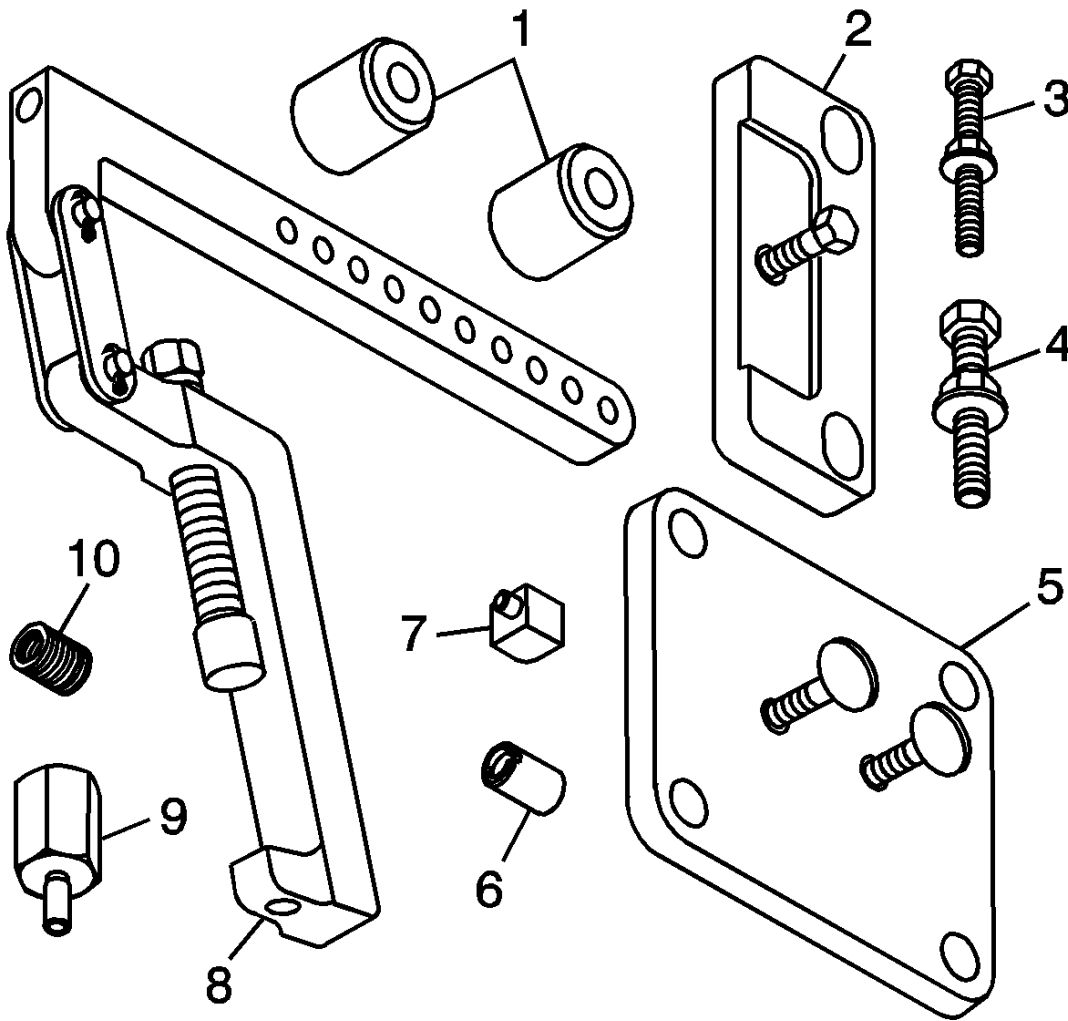


Fig. 504: Identifying Rod Bearing Clearance Tool - Adapter Kit
 Courtesy of GENERAL MOTORS COMPANY

J 43690-100 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)

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

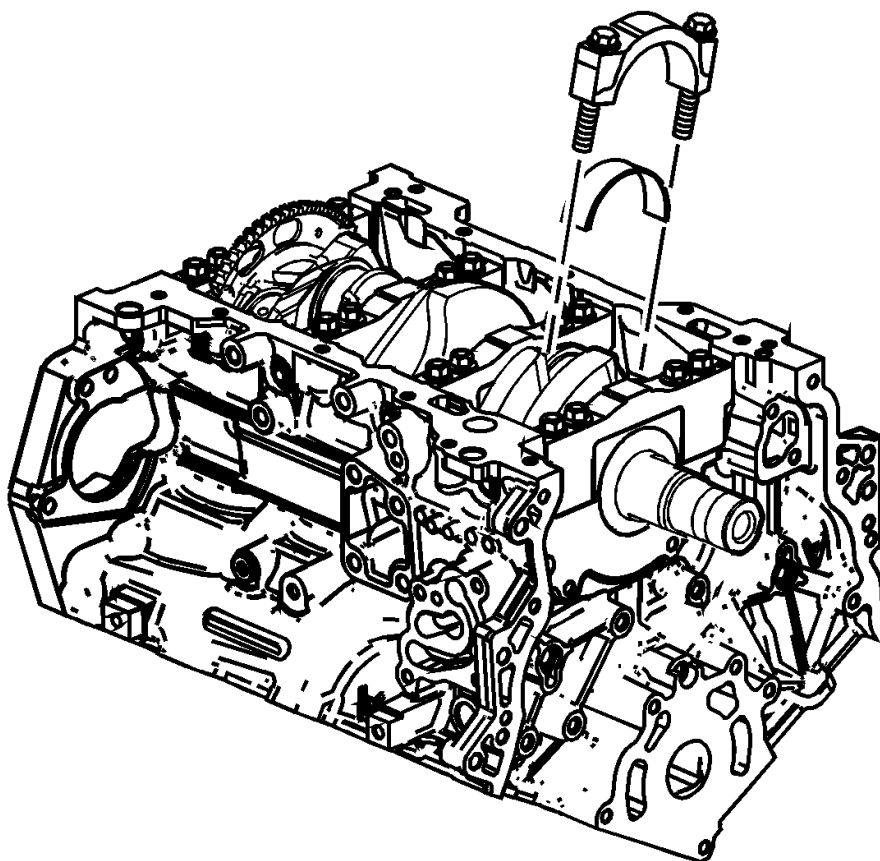


Fig. 505: View Of Connecting Rod Bearing & Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: 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.

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

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

CAUTION: Refer to **Fastener Caution** .

CAUTION: 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.

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

4. Tighten the connecting rod bolts.
 1. First Pass

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

2. Final Pass

Tighten the connecting rod bolts an additional 110° using the **J 45059** meter.

5. Rotate the crankshaft until the crankshaft journal and the connecting rod to be measured is in the 12 o'clock position.
6. Remove the crankshaft main bolts required to install the retainer plate J 43690-105.

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

7. Install the J 43690-105 and crankshaft main bolts.

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

8. Loosen the connecting rod bolts until the torque reading is zero.
9. Re-tighten the connecting rod bolts.

1. First Pass

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

2. Final Pass

Tighten the connecting rod bolts an additional 110° using the **J 45059** meter.

10. 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.
11. Repeat these procedures for the remaining piston/connecting rod assemblies using the **EN-48589** socket 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.
5. Install the NEW connecting rod bolts into the connecting rod cap.

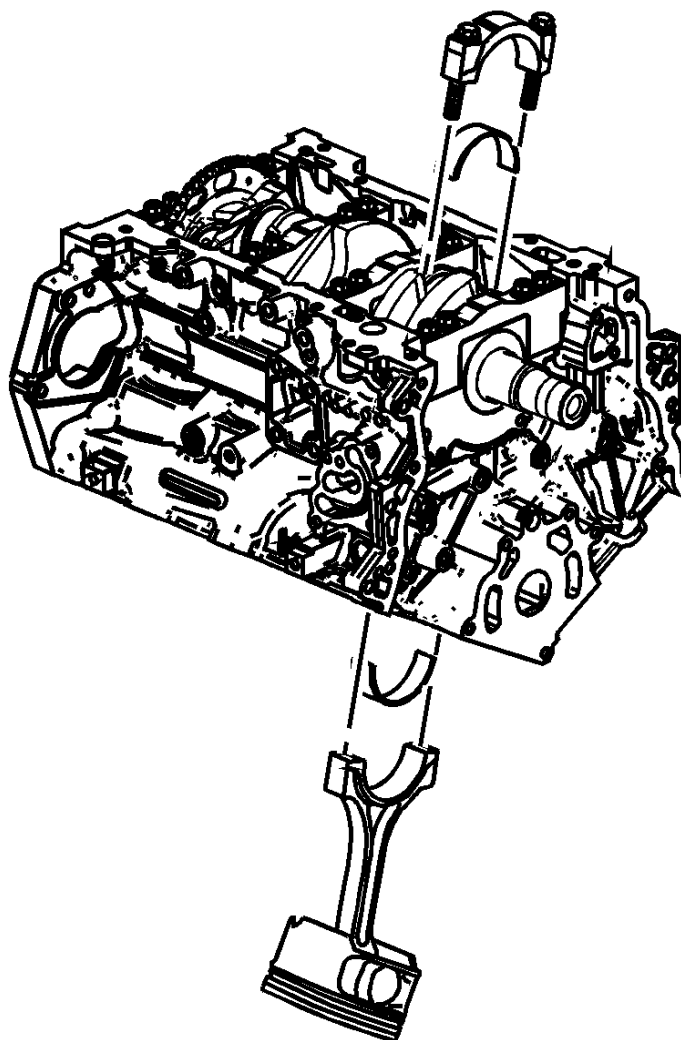


Fig. 506: Identifying Piston & Connecting Rod Assembly
Courtesy of GENERAL MOTORS COMPANY

CAUTION: 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.

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

NOTE: DO NOT reuse the old connecting rod bolts.

6. Tighten the connecting rod bolts.

1. First Pass

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

2. Final Pass

Tighten the connecting rod bolts an additional 110° using the **J 45059** meter.

7. 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.
8. Repeat these procedures for the remaining piston/connecting rod assemblies using the **EN-48589** socket in order to rotate the crankshaft.

CRANKSHAFT REAR OIL SEAL AND HOUSING INSTALLATION

Special Tools

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

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

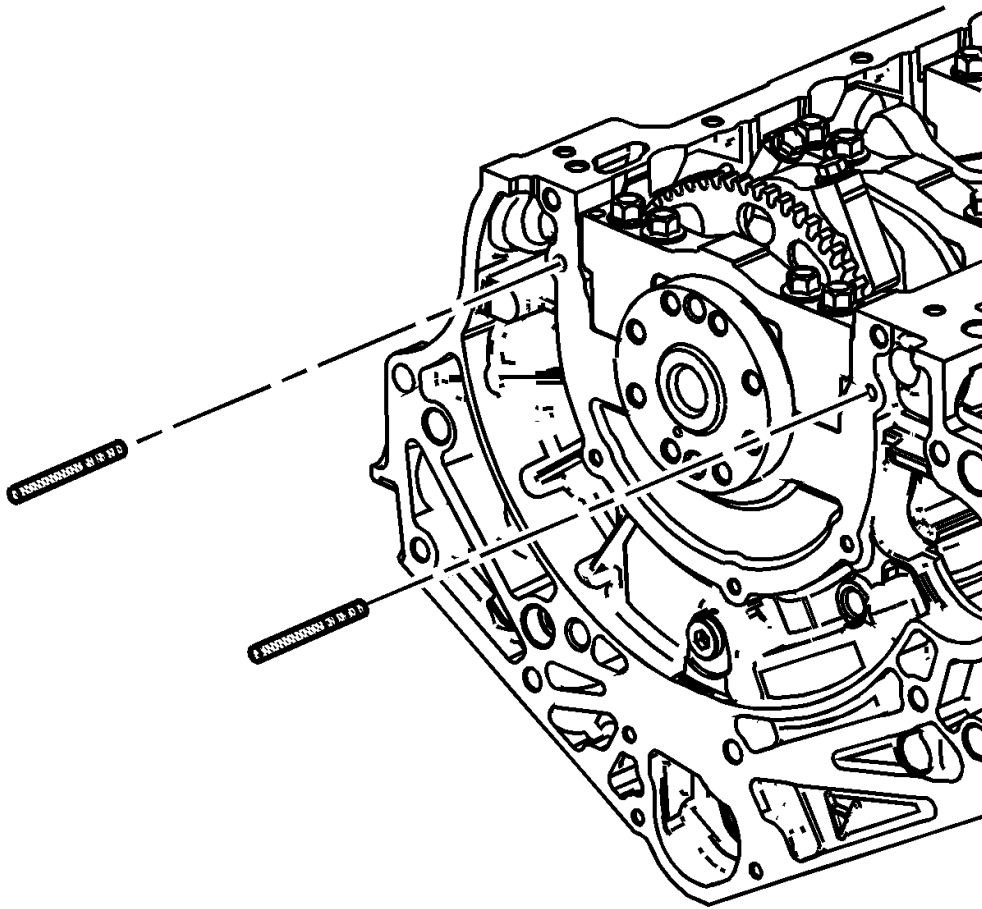


Fig. 507: Identifying Special Tool - EN 46109
Courtesy of GENERAL MOTORS COMPANY

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

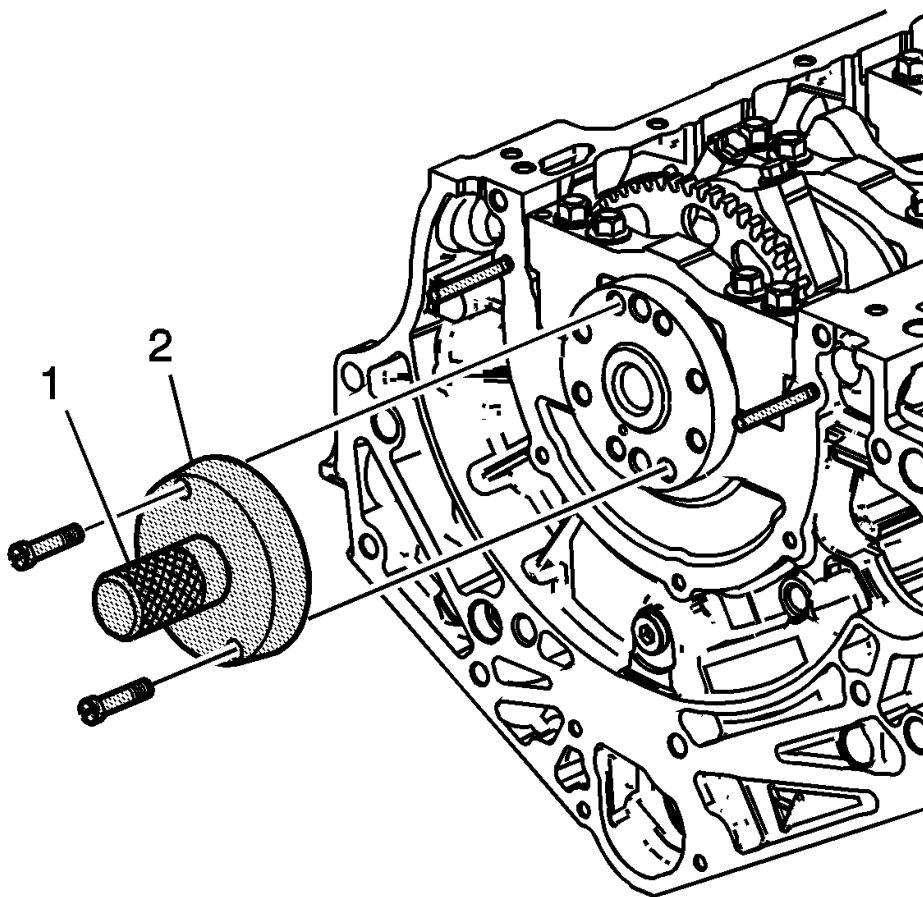


Fig. 508: Identifying Special Tools EN-47839 & J-42183
Courtesy of GENERAL MOTORS COMPANY

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

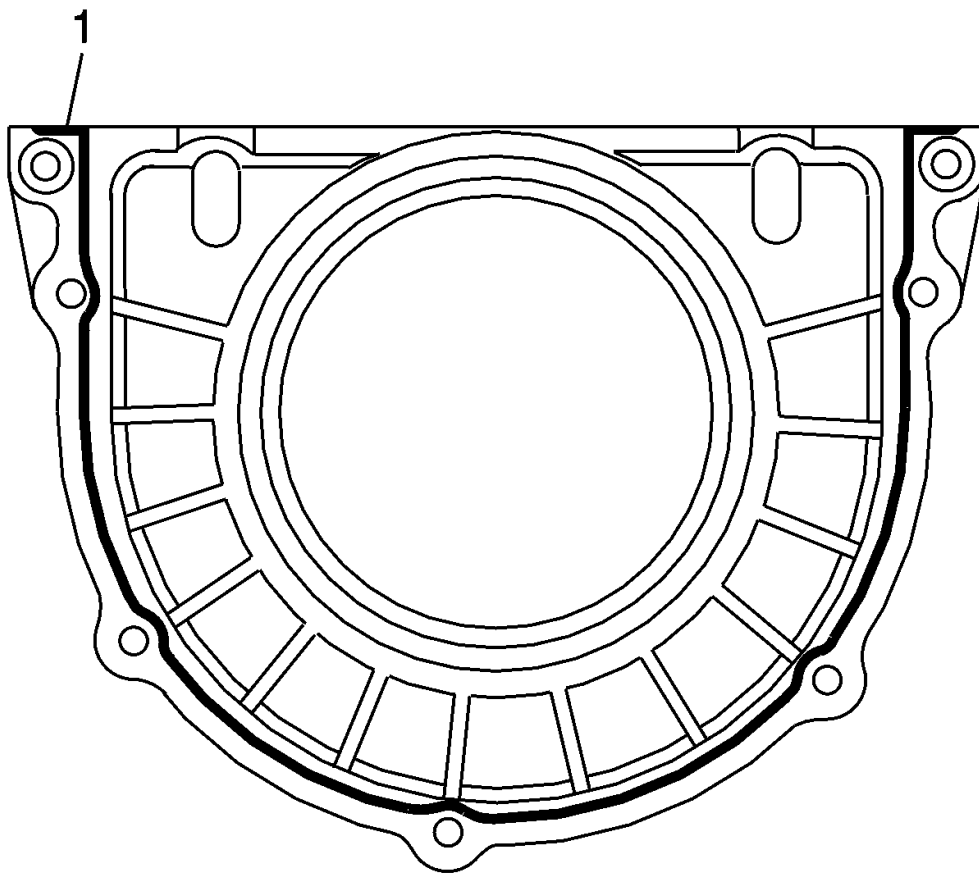


Fig. 509: Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

3. Place a 3 mm (0.118 in) bead of RTV sealant to the NEW crankshaft rear oil seal housing as shown (1). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended sealant.

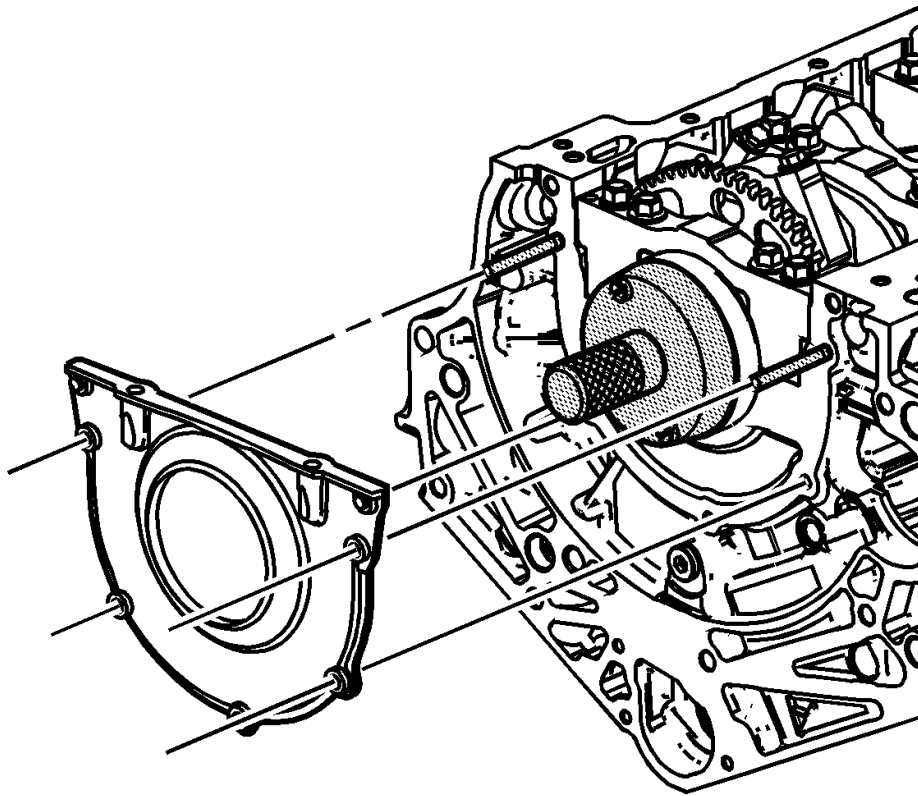


Fig. 510: Identifying Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

NOTE: 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.

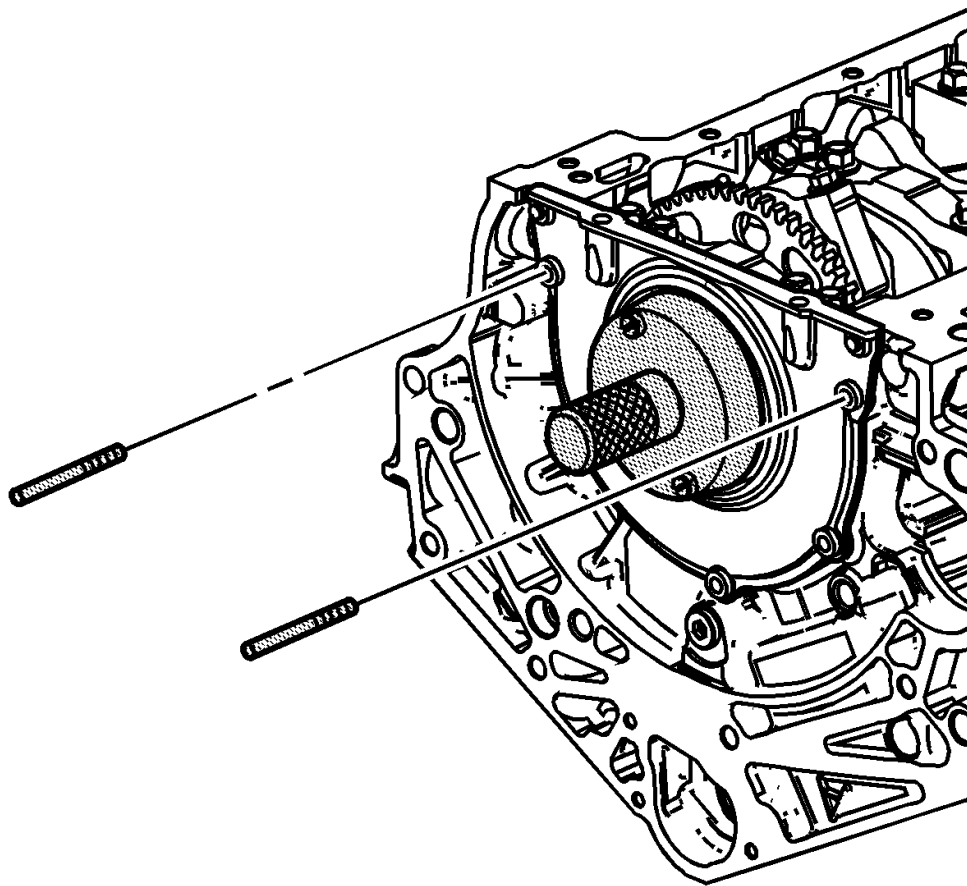


Fig. 511: Identifying Special Tool - EN 46109
Courtesy of GENERAL MOTORS COMPANY

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

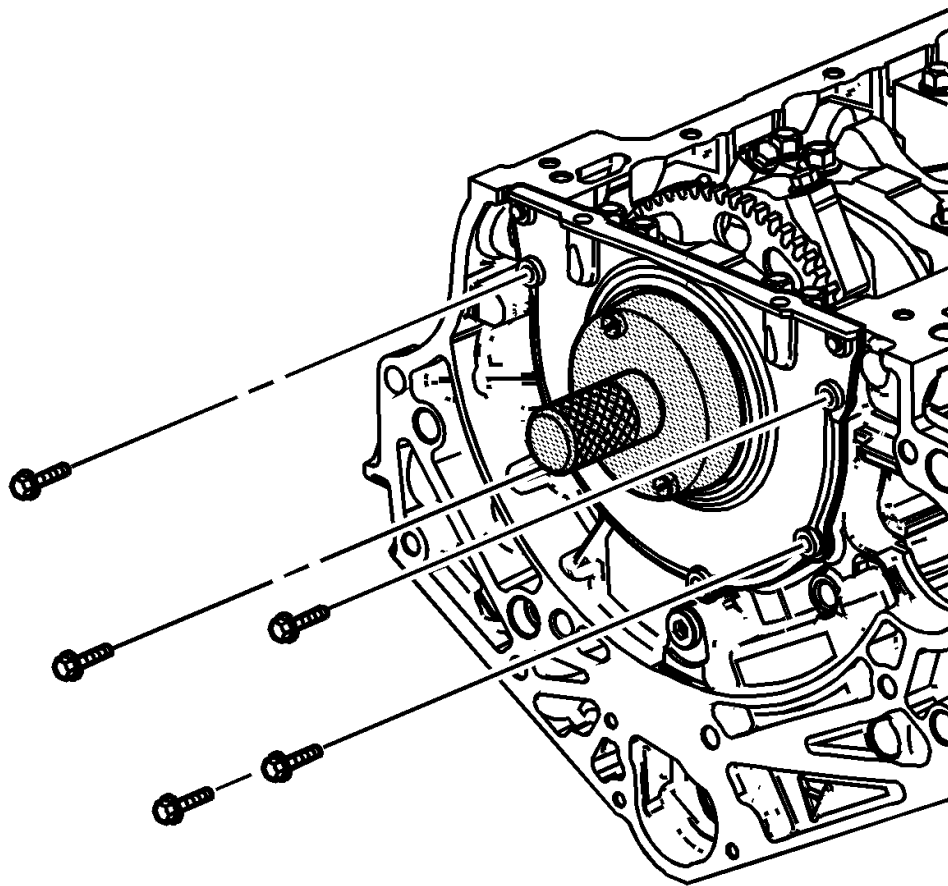


Fig. 512: Locating Crankshaft Rear Oil Seal Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install the crankshaft rear oil seal housing bolts.

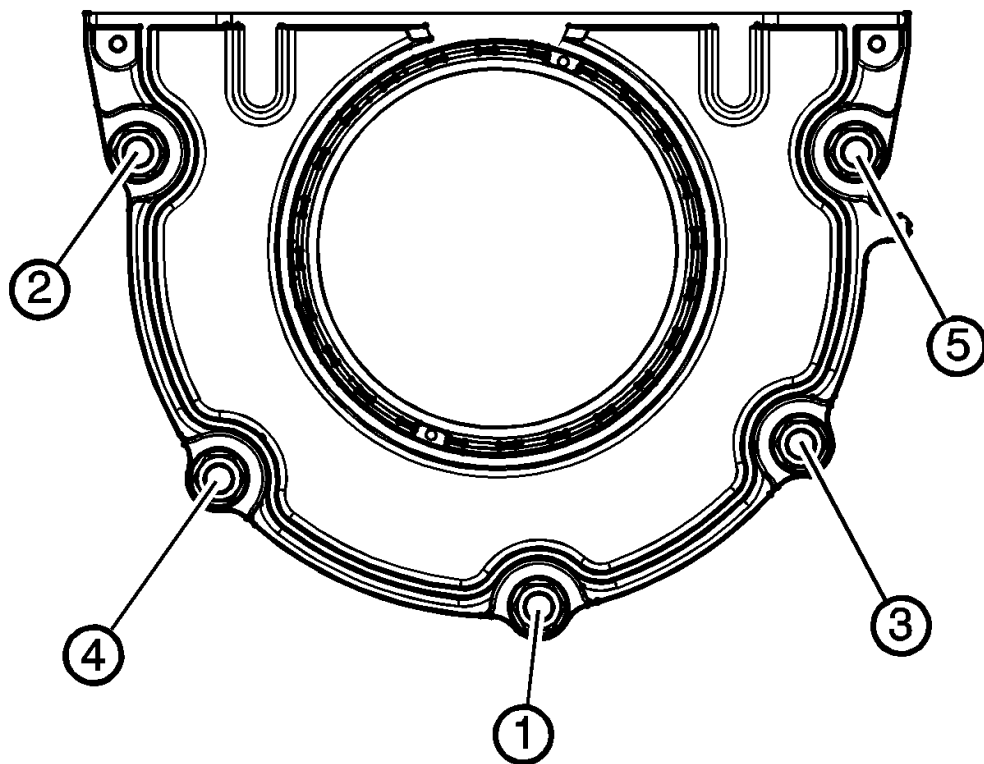


Fig. 513: Identifying Crankshaft Rear Oil Seal Housing Bolts Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

7. Tighten the crankshaft rear oil seal housing bolts in sequence and tighten to 10 N.m (89 lb in).

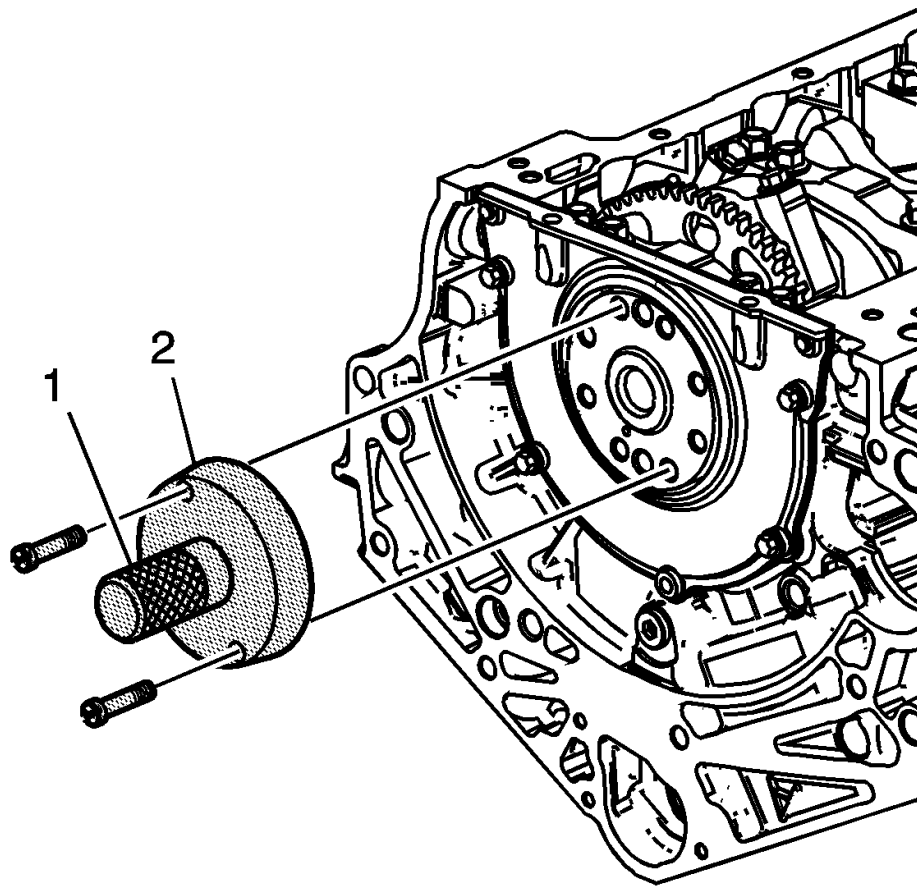


Fig. 514: Identifying Special Tools EN-47839 & J-42183
Courtesy of GENERAL MOTORS COMPANY

8. Remove the **EN-47839** tool and **EN-42183** handle (1, 2) from the crankshaft flange.

OIL PUMP INSTALLATION

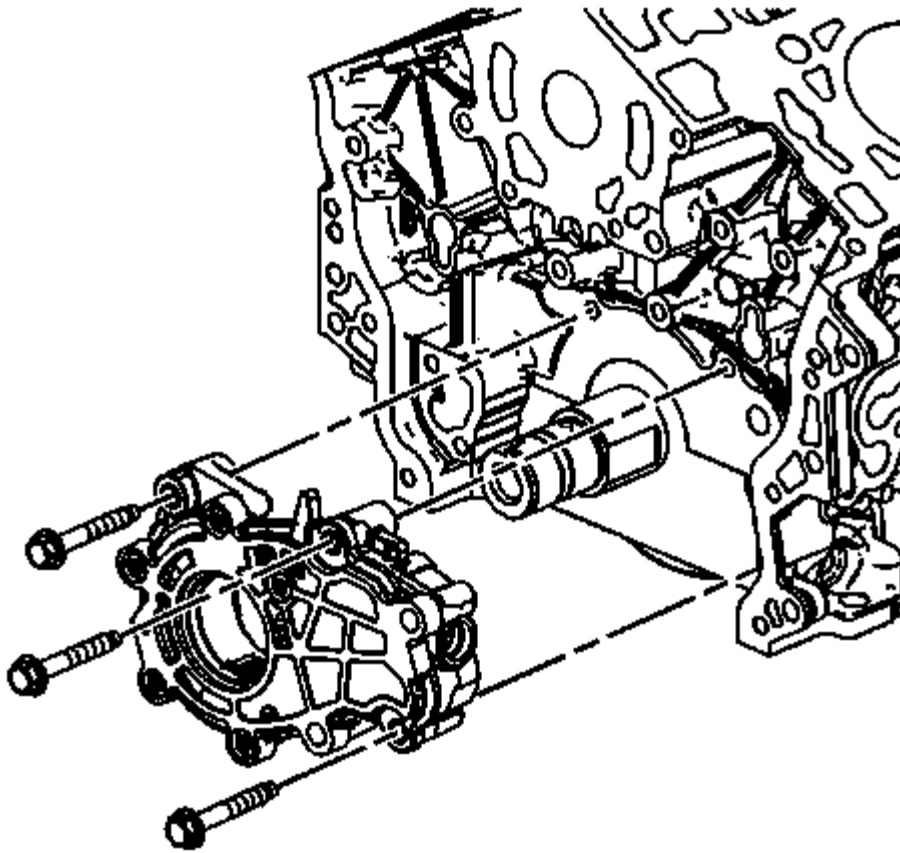


Fig. 515: Identifying Oil Pump & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Align the oil pump drive gear 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.
3. Install the oil pump bolts and tighten to 25 N.m (18 lb ft).

CAUTION: Refer to Fastener Caution .

OIL PAN INSTALLATION

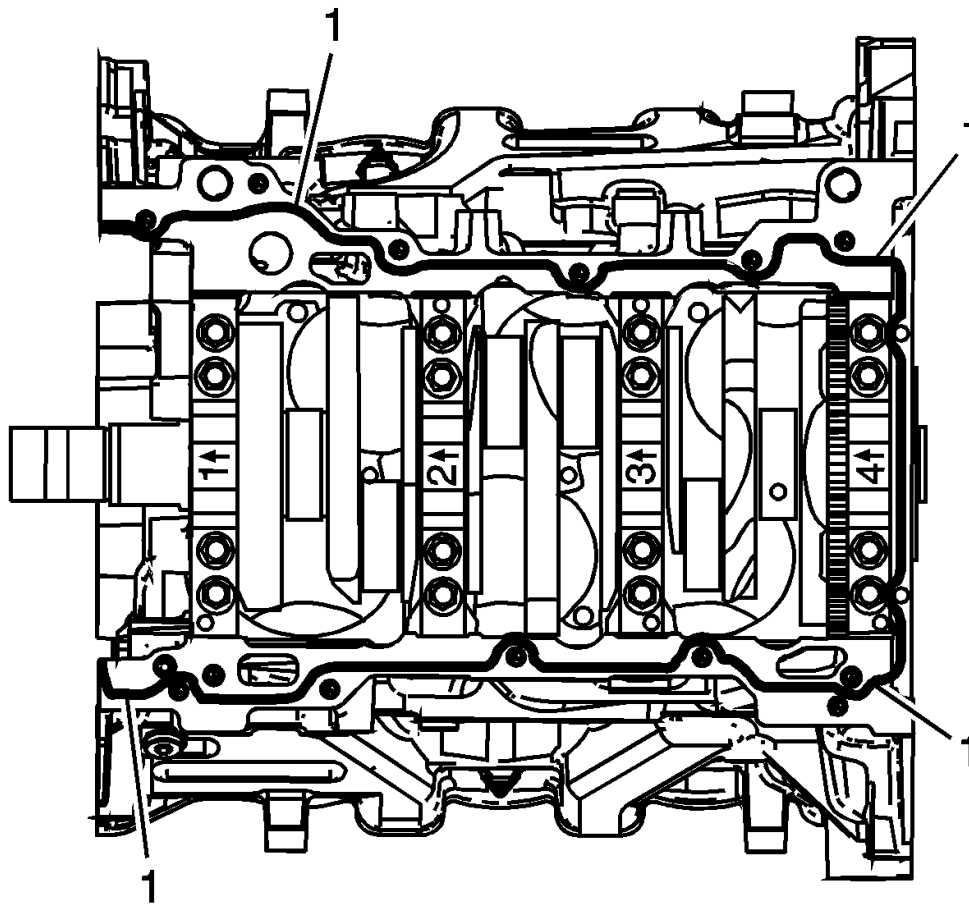


Fig. 516: Identifying Sealant Application Locations On Block Pan Rail & Crankshaft Rear Oil Seal Housing

Courtesy of GENERAL MOTORS COMPANY

1. Place a 3 mm (0.118 in) bead of RTV sealant on the block pan rail and the crankshaft rear oil seal housing (1). Refer to Adhesives, Fluids, Lubricants and Sealers for recommended sealant.

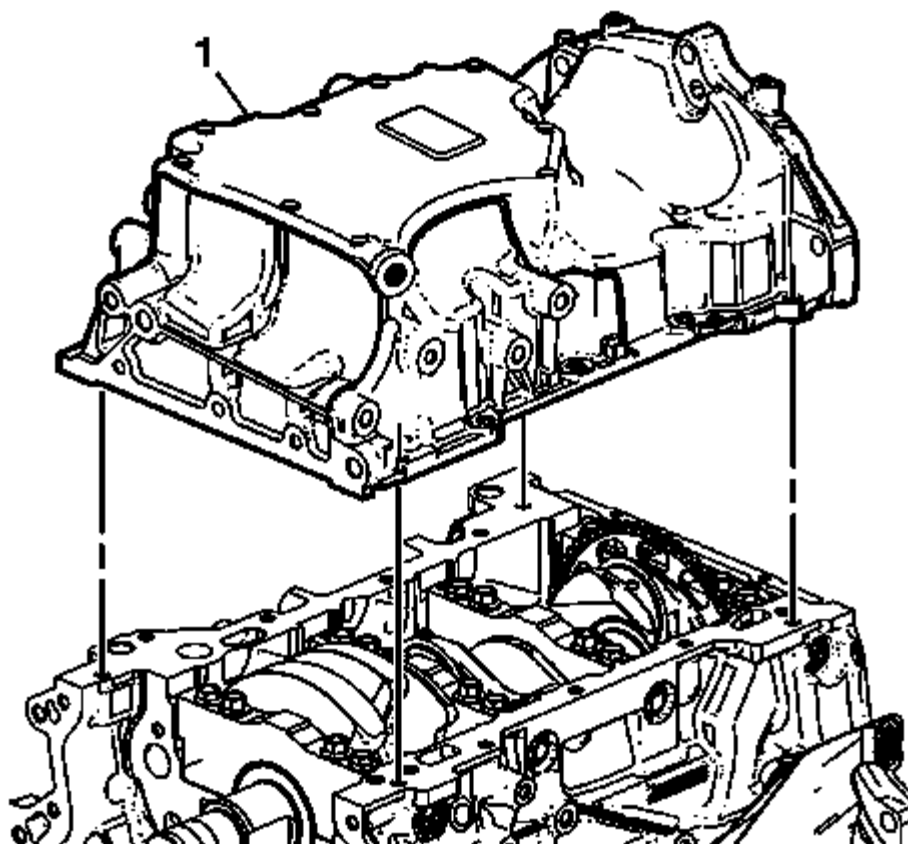


Fig. 517: View Of Oil Pan

Courtesy of GENERAL MOTORS COMPANY

2. Position the oil pan (1) onto the block.

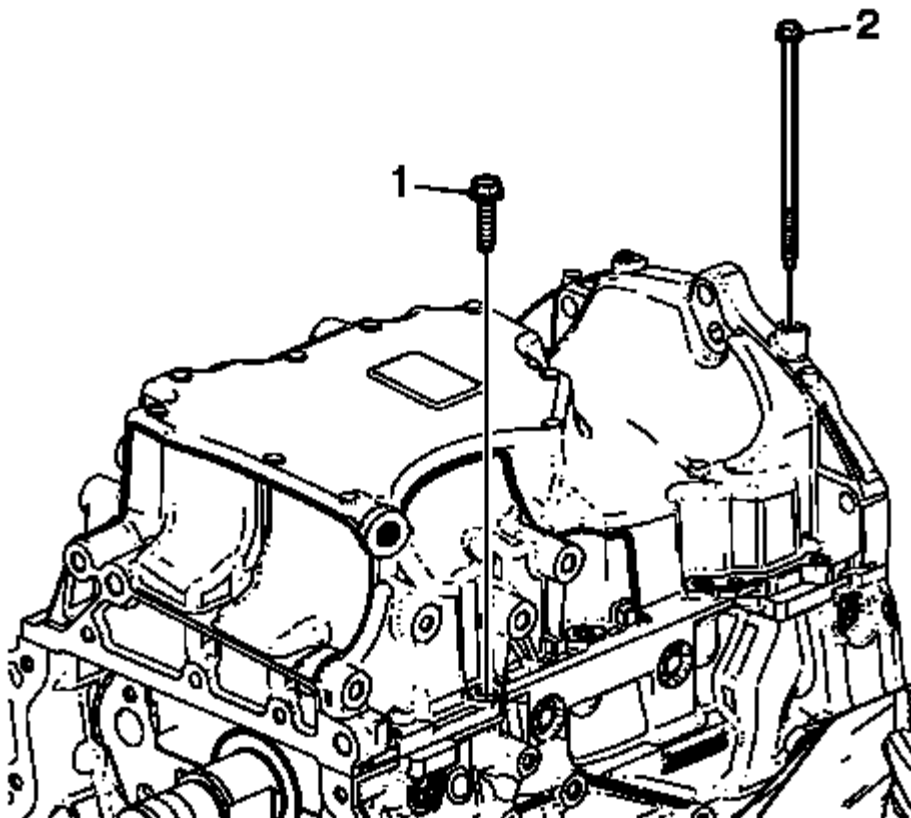


Fig. 518: Oil Pan Bolts

Courtesy of GENERAL MOTORS COMPANY

3. Loosely install the oil pan bolts (1) and (2).
4. Tighten the oil pan bolts in sequence shown.

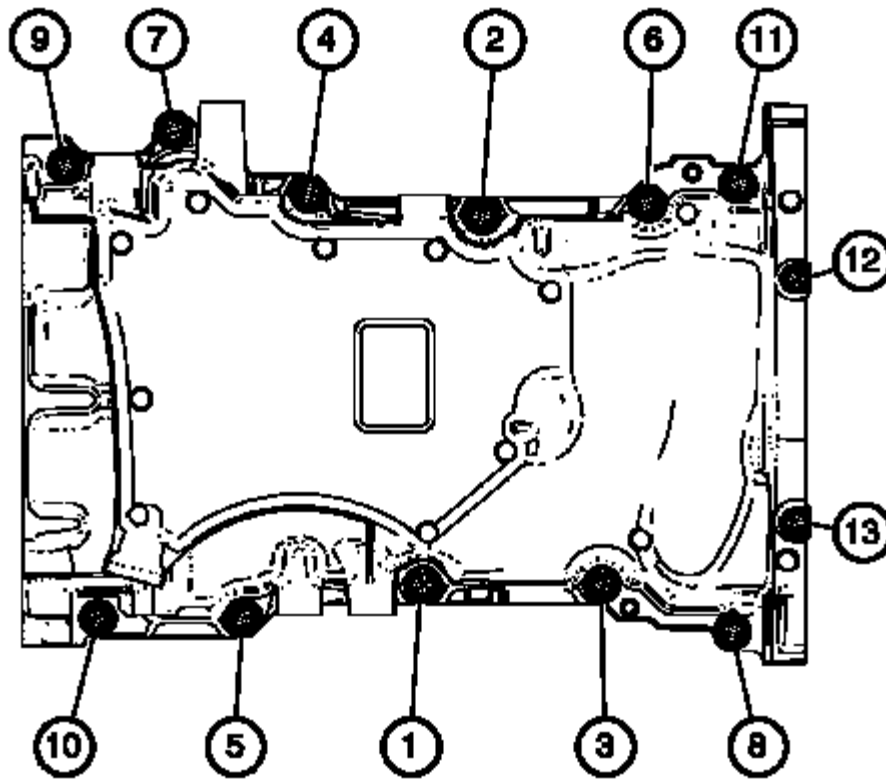


Fig. 519: Oil Pan Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Tighten the 8 mm bolts (1-11) to 25 N.m (18 lb ft).
2. Tighten the 6 mm bolts (12, 13) to 10 N.m (89 lb in).

CYLINDER HEAD INSTALLATION - RIGHT SIDE

Special Tools

EN-45059 Angle Meter

For equivalent regional tools, refer to Special Tools .

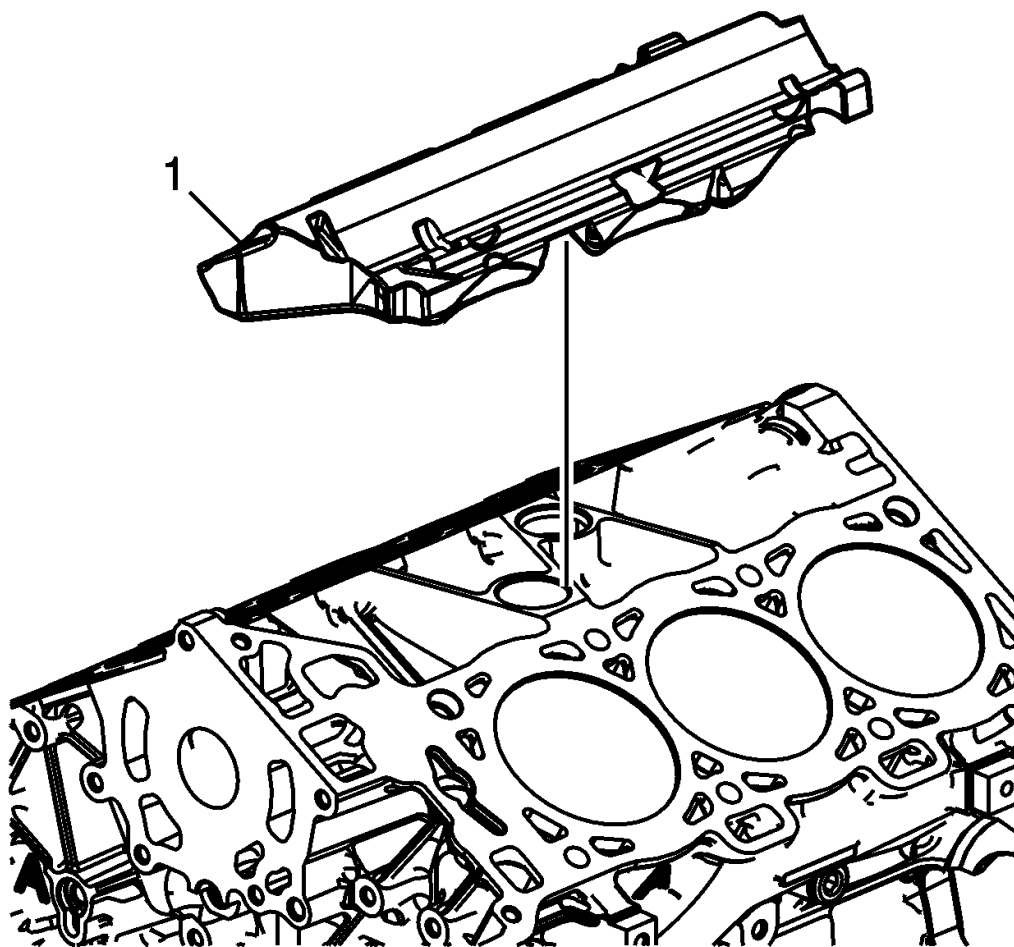


Fig. 520: Fuel Injection Fuel Rail Noise Shield-Lower
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel injection fuel rail noise shield-lower (1).

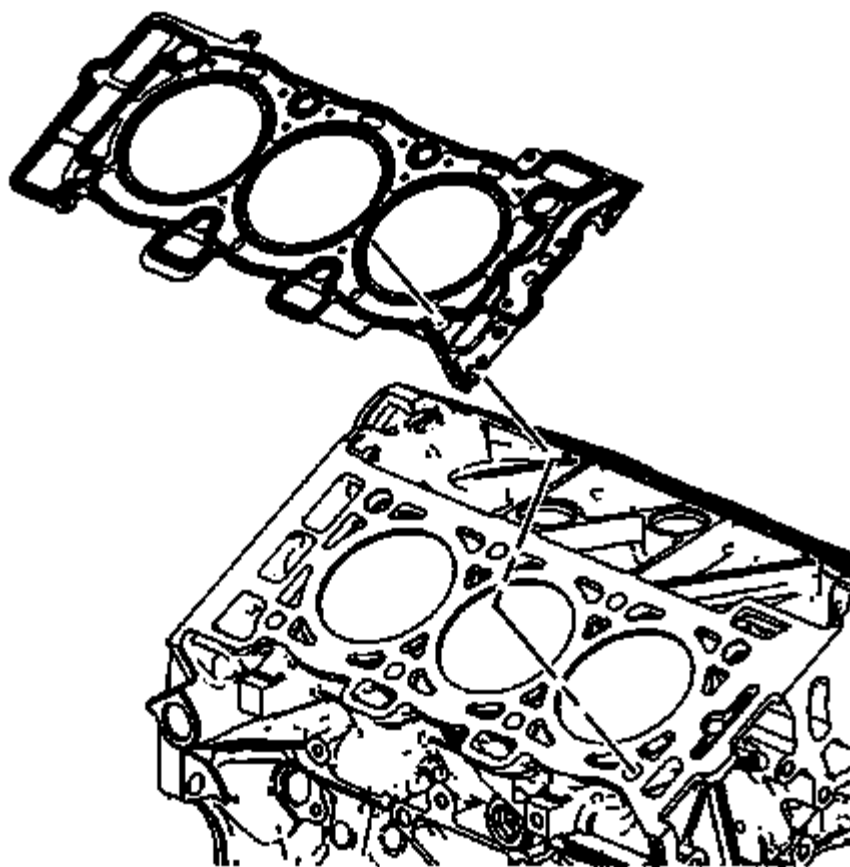


Fig. 521: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

2. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
3. Install a NEW right cylinder head gasket using the deck face locating pins for retention.

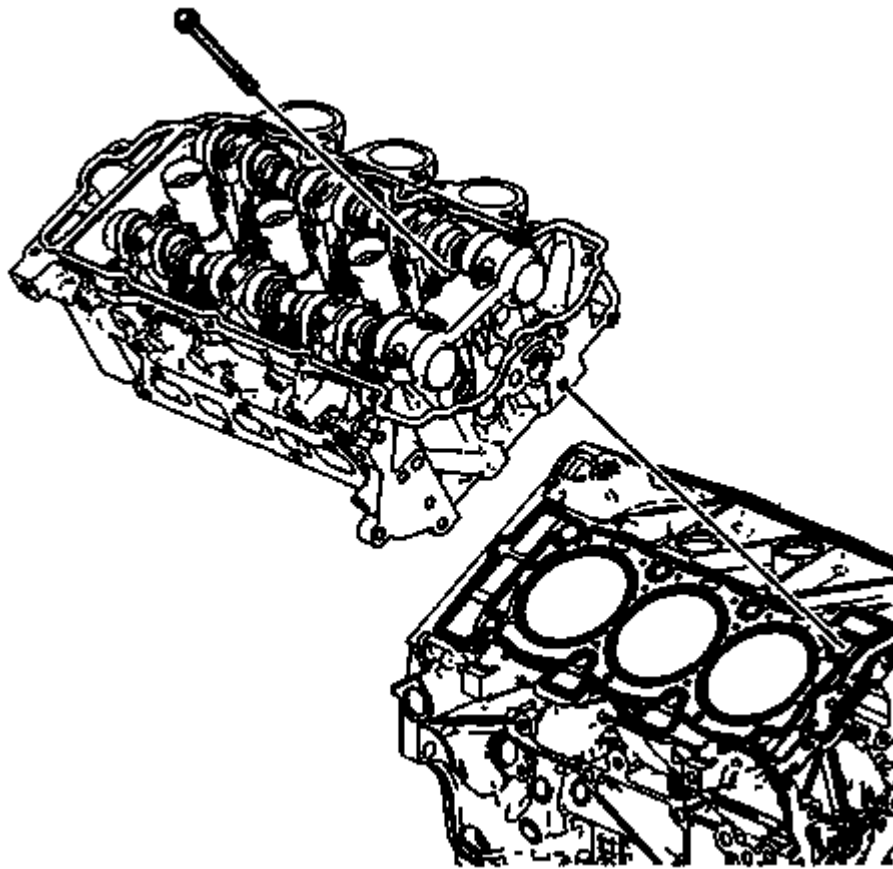


Fig. 522: View Of Right Cylinder Head (LLT)
Courtesy of GENERAL MOTORS COMPANY

4. Align the right cylinder head with the deck face locating pins.
5. Place the right cylinder head in position on the deck face.
6. Install the NEW M11 cylinder head bolts (1).

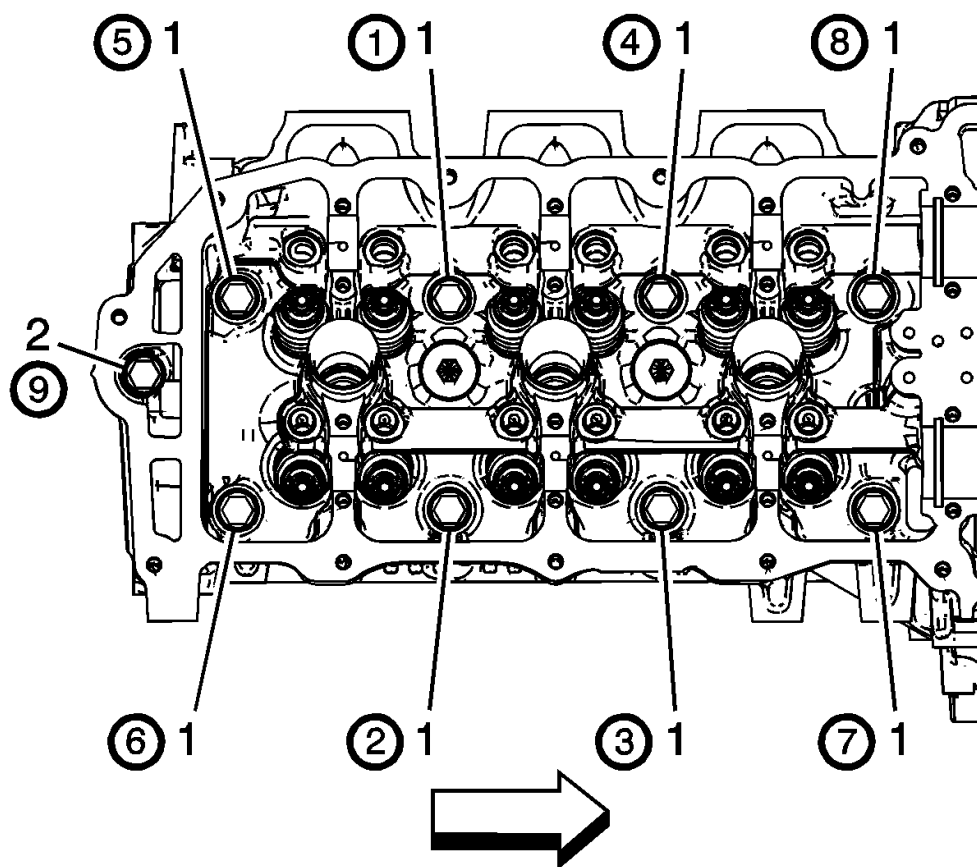


Fig. 523: Identifying M11 Cylinder Head Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

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

NOTE: DO NOT reuse the old cylinder head bolts.

1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).
2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150° using the **J 45059** meter.
7. Install the NEW M8 cylinder head bolt (2).
 1. Tighten the M8 cylinder head bolt a first pass to 15 N.m (11 lb ft).
 2. Tighten the M8 cylinder head bolt a second pass an additional 75° using the **J 45059** meter.

VALVE LIFTER INSTALLATION - RIGHT SIDE

1. Fill the stationary hydraulic lash adjuster (SHLA) with clean engine oil. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended engine oil. Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.

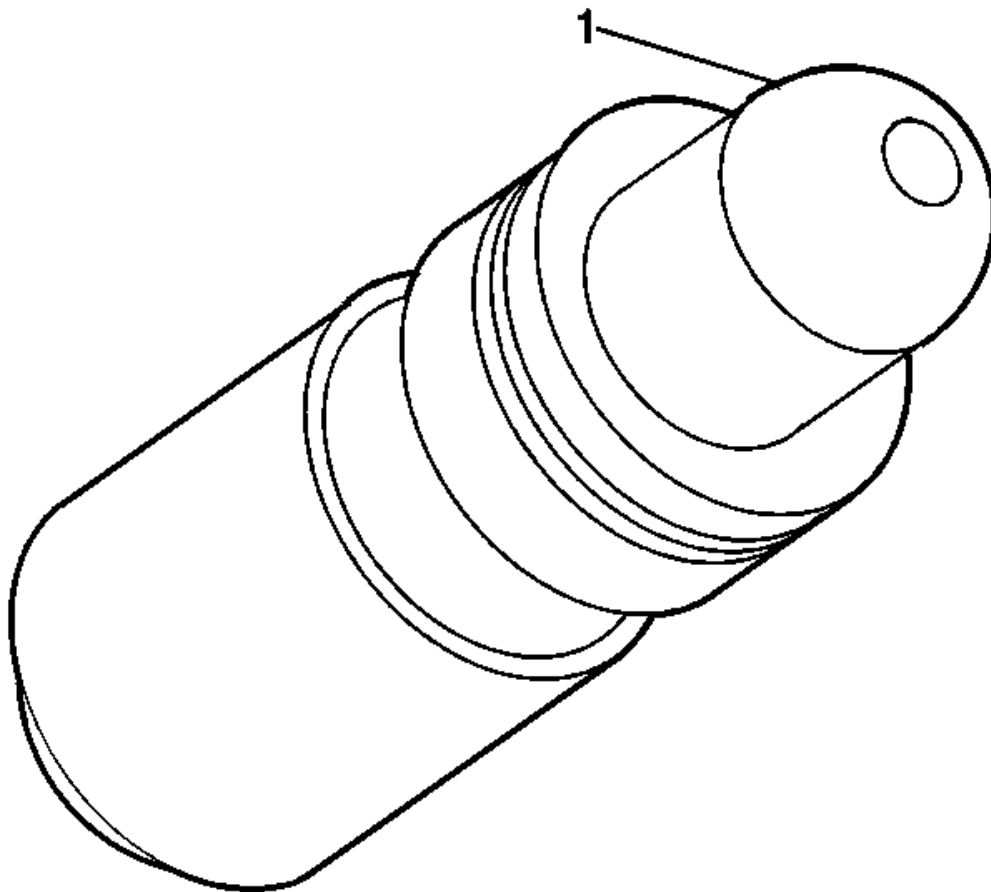


Fig. 524: View Of Valve Lifter

Courtesy of GENERAL MOTORS COMPANY

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

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

2. Lubricate the SHLA bores in the cylinder head with clean engine oil. Refer to **Adhesives, Fluids,**

Lubricants and Sealers for recommended lubricant.

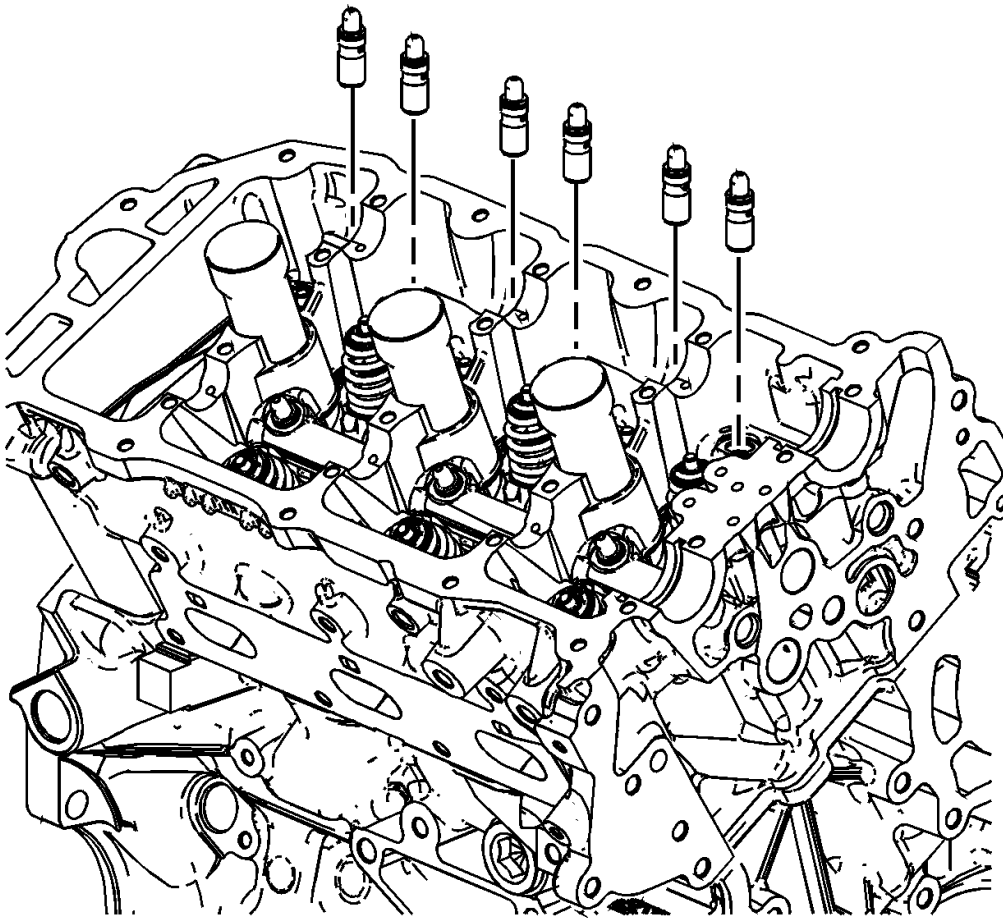


Fig. 525: Identifying Stationary Hydraulic Lash Adjuster (SHLA)

Courtesy of GENERAL MOTORS COMPANY

3. Install the SHLAs in the cylinder head.
4. Apply a liberal amount of lubricant to the SHLA pivot spheres. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.

VALVE ROCKER ARM INSTALLATION - RIGHT SIDE

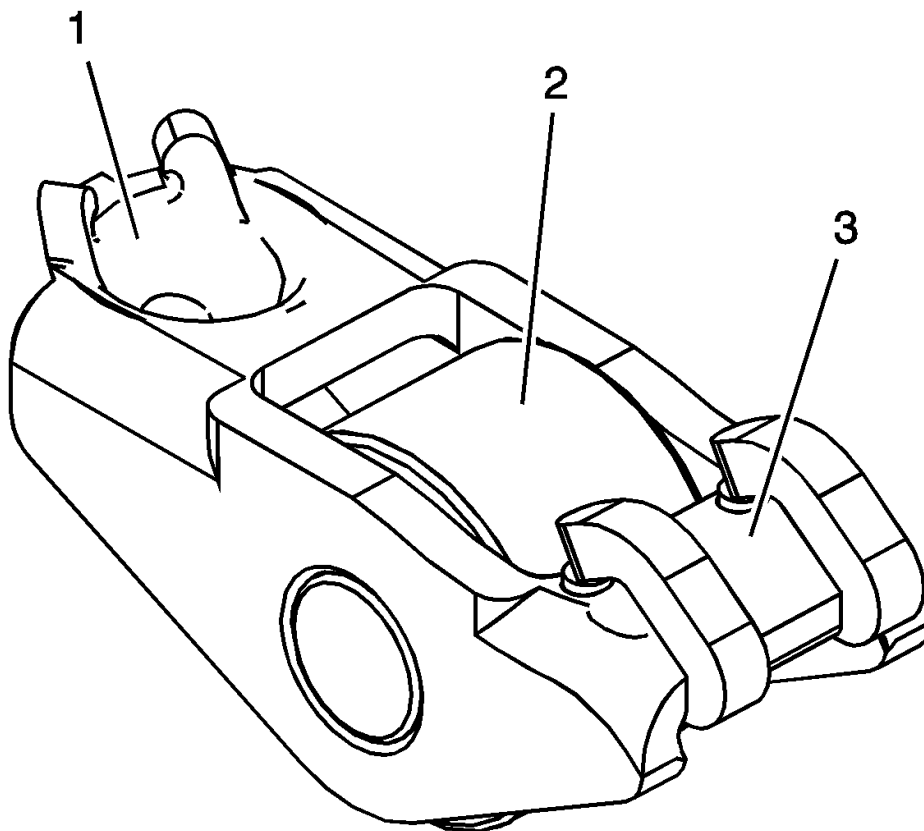


Fig. 526: Identifying Valve Rocker Arm Lubrication Areas
Courtesy of GENERAL MOTORS COMPANY

1. Apply a liberal amount of lubricant to the pivot pocket (1), roller (2) and valve slot (3) areas of the camshaft followers. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.

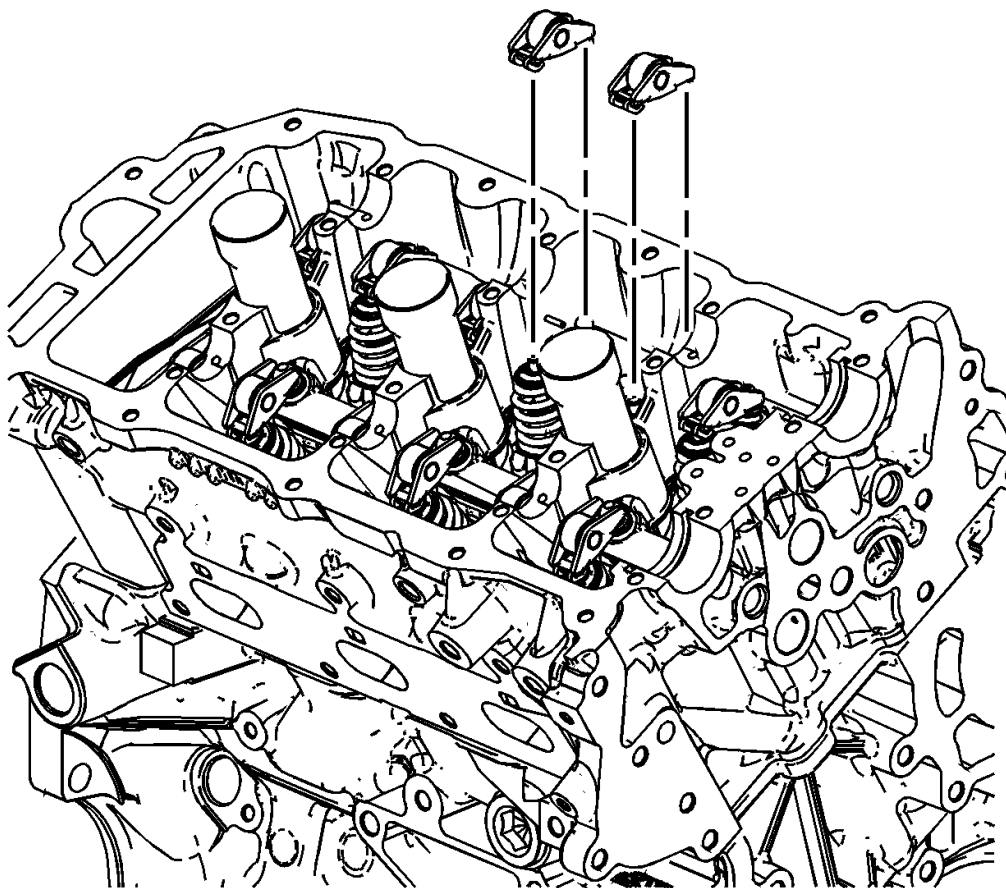


Fig. 527: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS COMPANY

NOTE: 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 SIDE

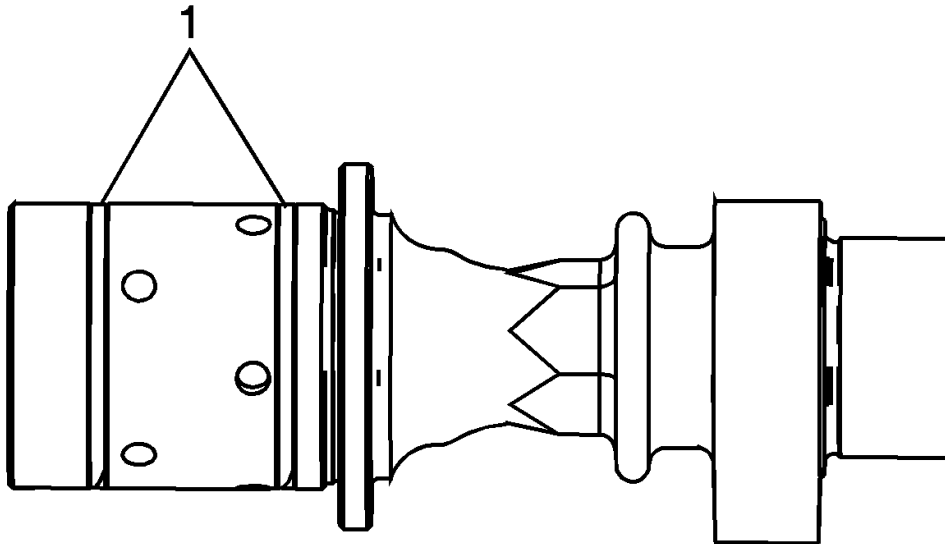


Fig. 528: Locating Camshaft Sealing Rings In Camshaft Grooves
 Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

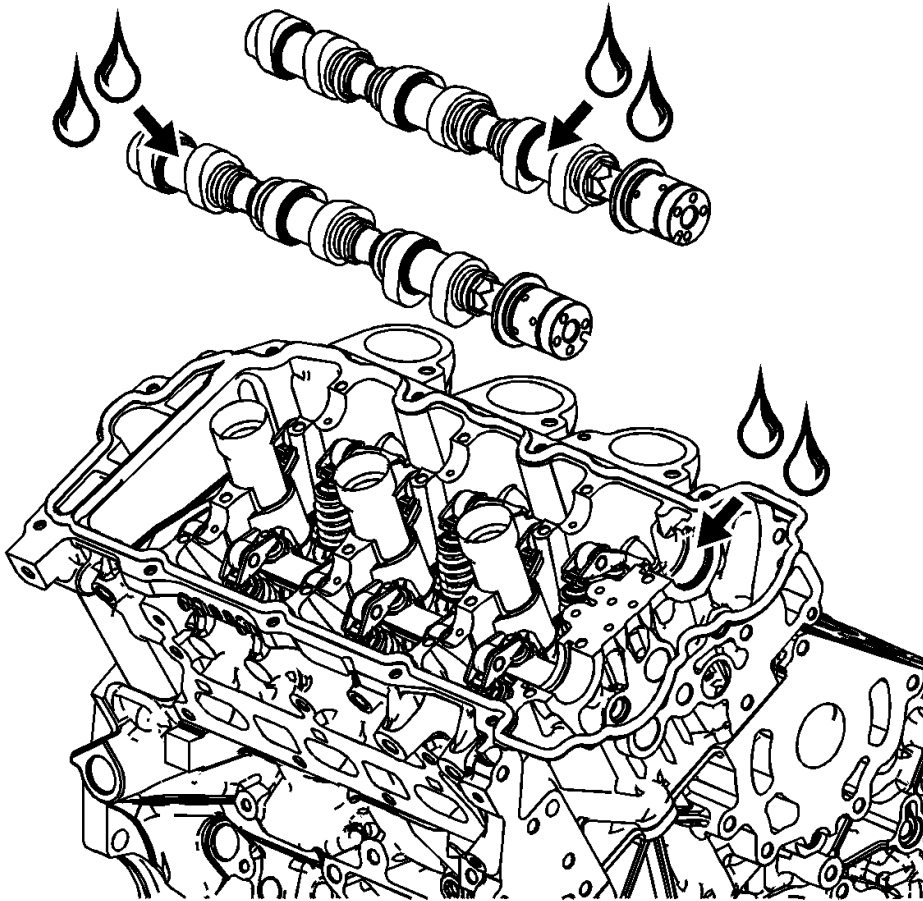


Fig. 529: Applying Liberal Amount Of Lubricant Or Equivalent To Camshaft Journals & Right Cylinder Head Camshaft Carriers
Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant to the camshaft journals and the right cylinder head camshaft carriers. Refer to Adhesives, Fluids, Lubricants and Sealers for recommended lubricant.

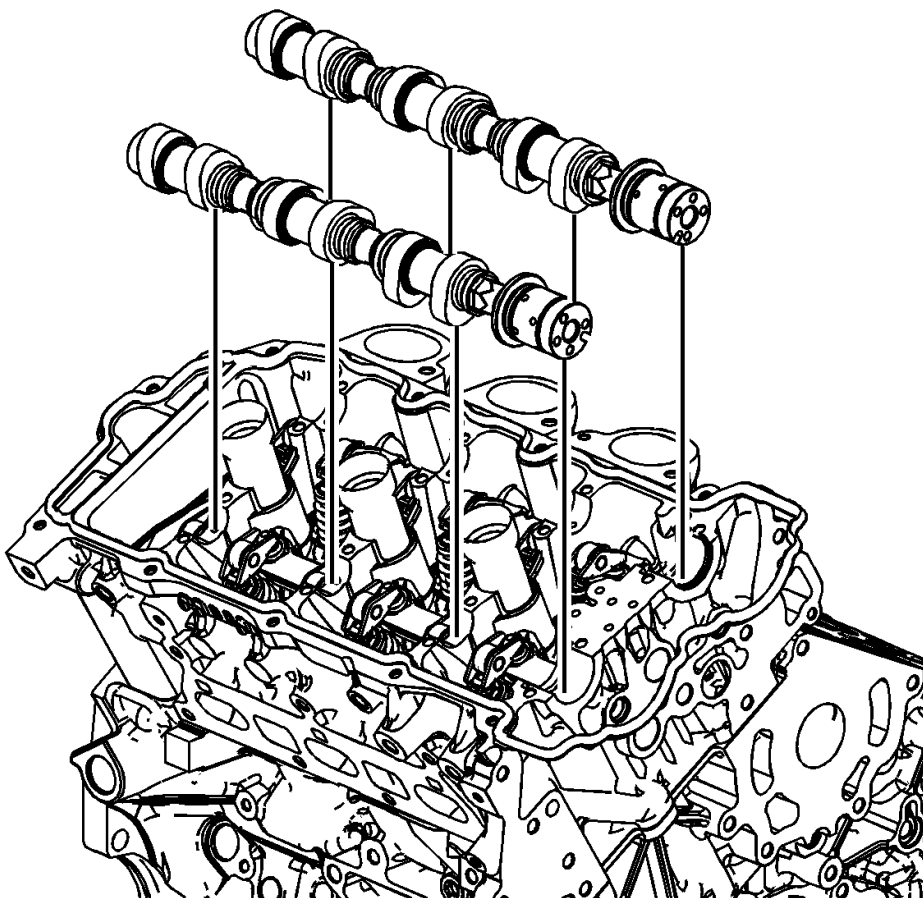


Fig. 530: Positioning Right Intake & Right Exhaust Camshafts In Right Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

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

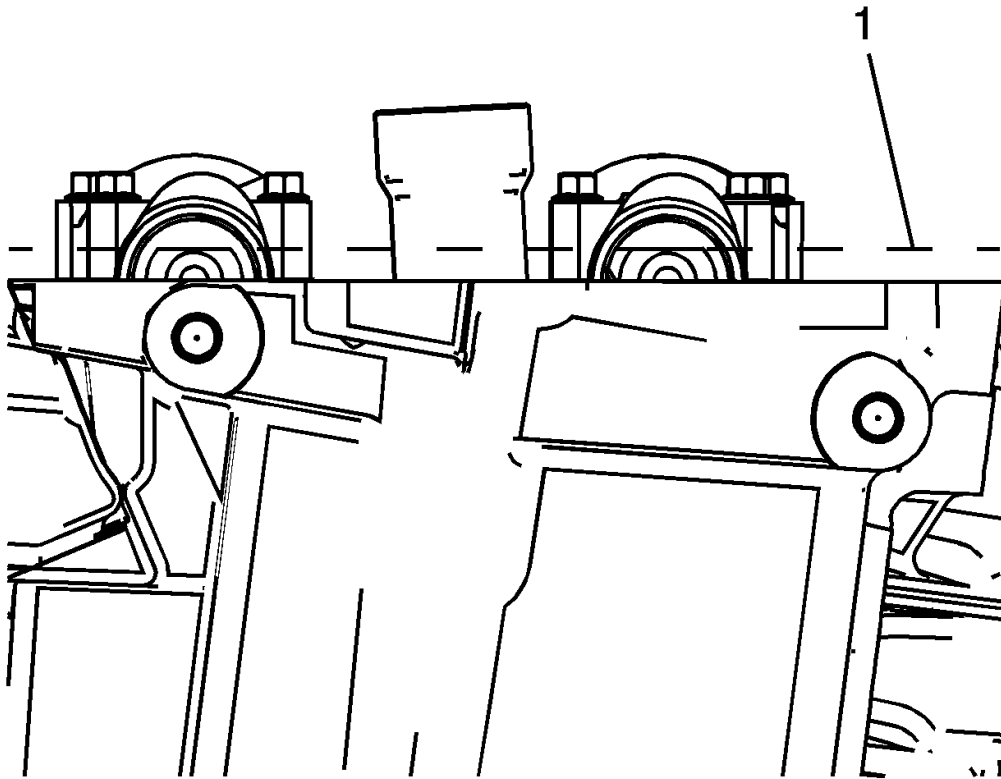


Fig. 531: Identifying Camshaft Neutral (Low Tension) Position
Courtesy of GENERAL MOTORS COMPANY

4. 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.

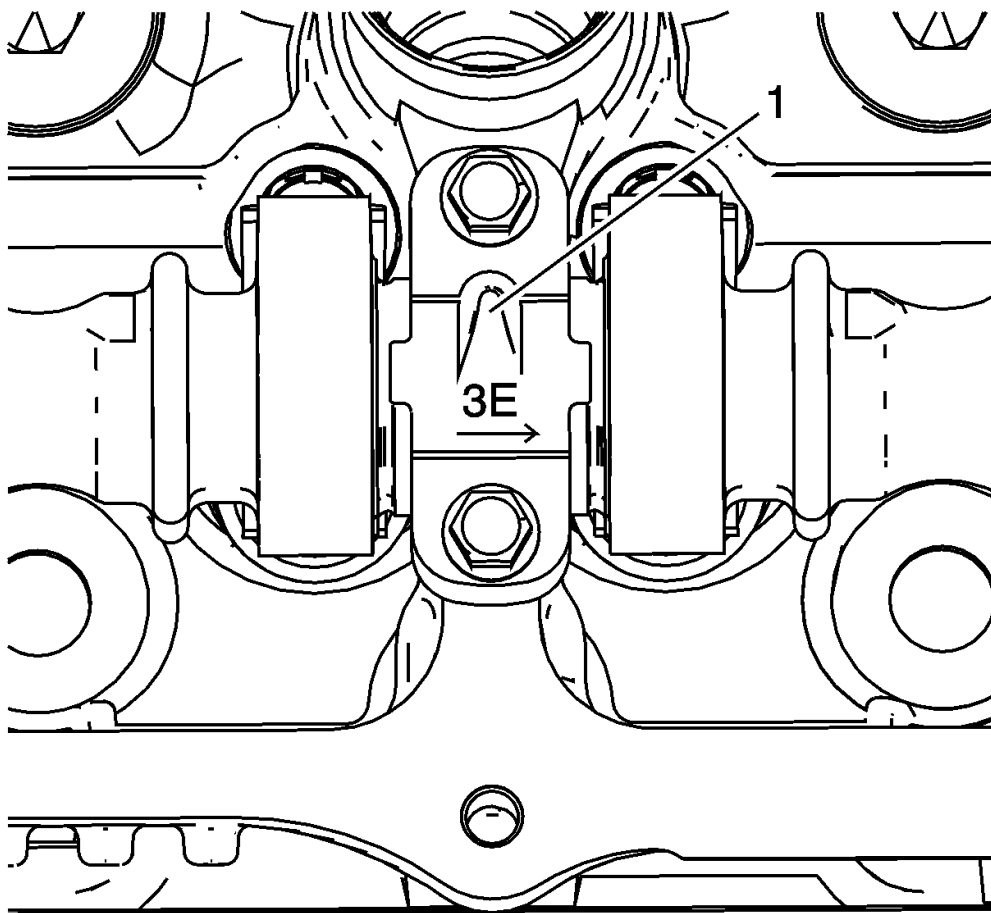


Fig. 532: Right Cylinder Head Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS COMPANY

5. 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 (1) 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.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.

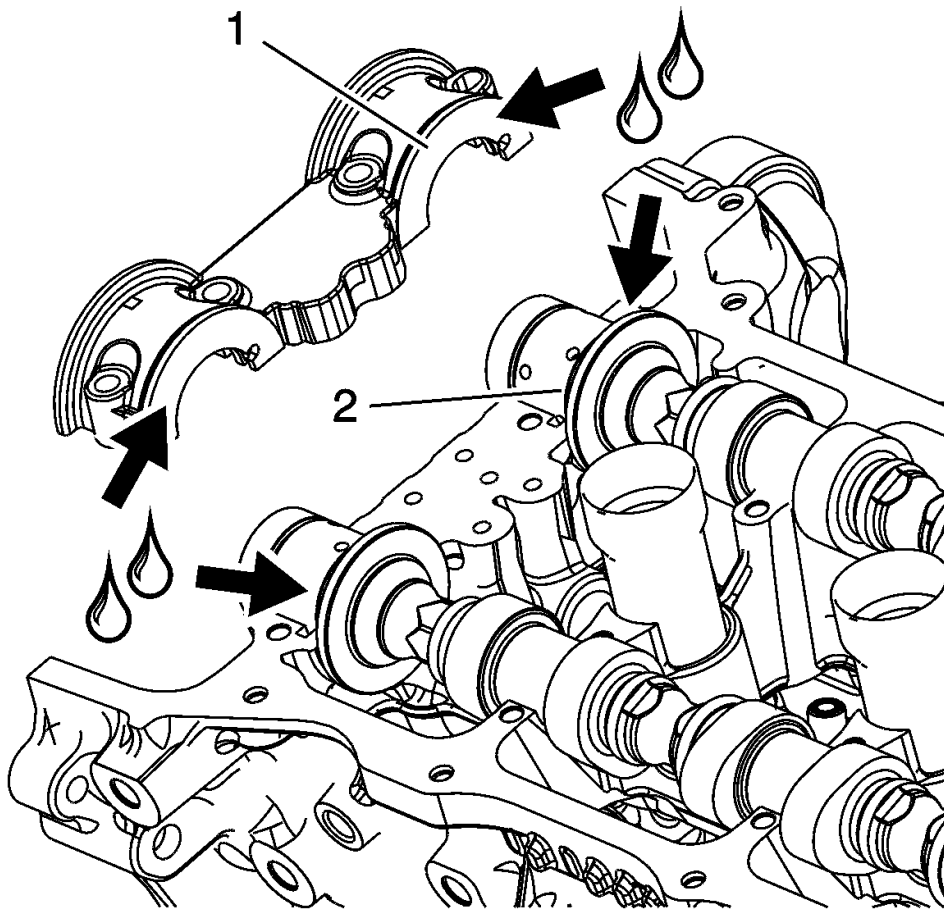


Fig. 533: Camshaft Bearing Cap And Camshaft Thrust Surface
 Courtesy of GENERAL MOTORS COMPANY

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.

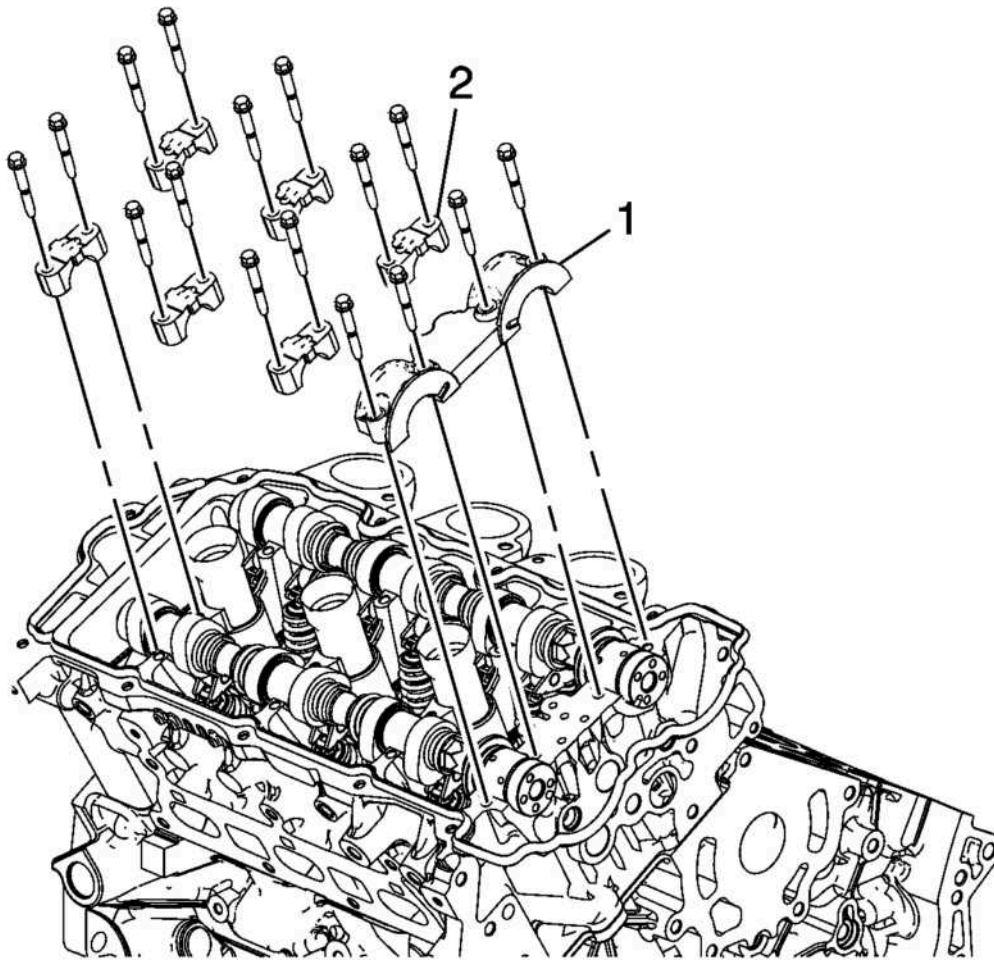


Fig. 534: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust caps (1) in the first journal of the right cylinder head.
9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.
11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).

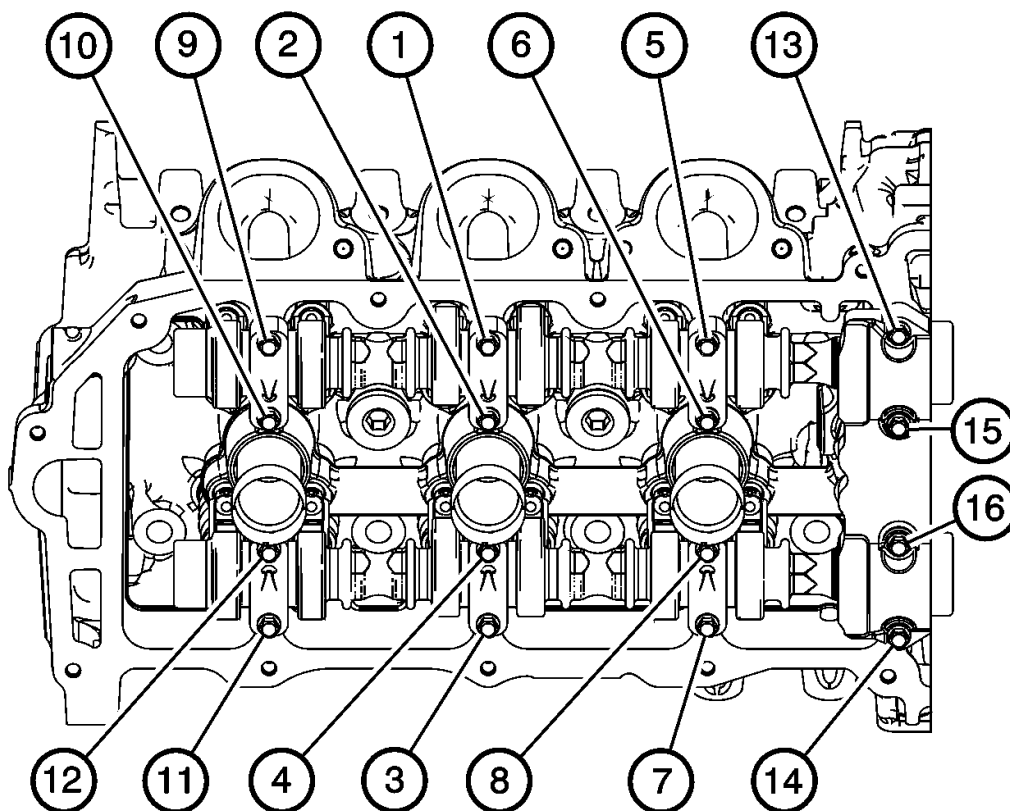


Fig. 535: Camshaft Bearing Cap Bolts Tighten Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a **NEW** torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

12. Loosen the center intake camshaft bearing cap bolts (1, 2) and the center exhaust camshaft bearing cap bolts (3, 4).
13. Retighten the center camshaft bearing cap bolts (1, 2, 3, 4) and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).

FUEL RAIL INSTALLATION

Refer to Cylinder Head Assemble.

CYLINDER HEAD INSTALLATION - LEFT SIDE

Special Tools

J 45059 Angle Meter

For equivalent regional tools, refer to Special Tools .

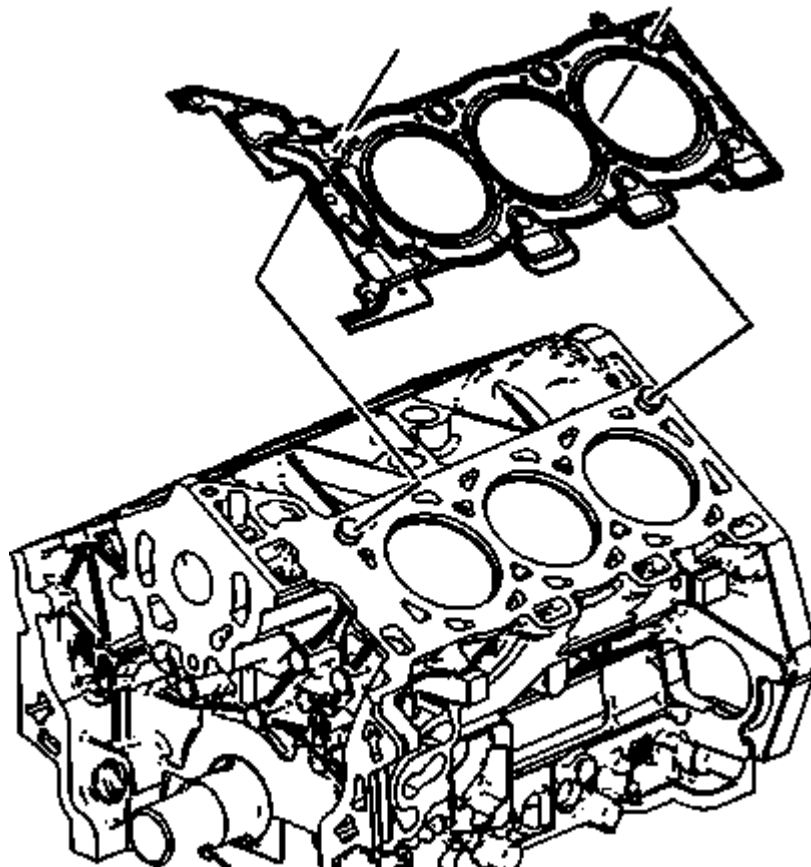


Fig. 536: View Of Left Cylinder Head Gasket (LLT)
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
2. Install a NEW left cylinder head gasket using the deck face locating pins for retention.

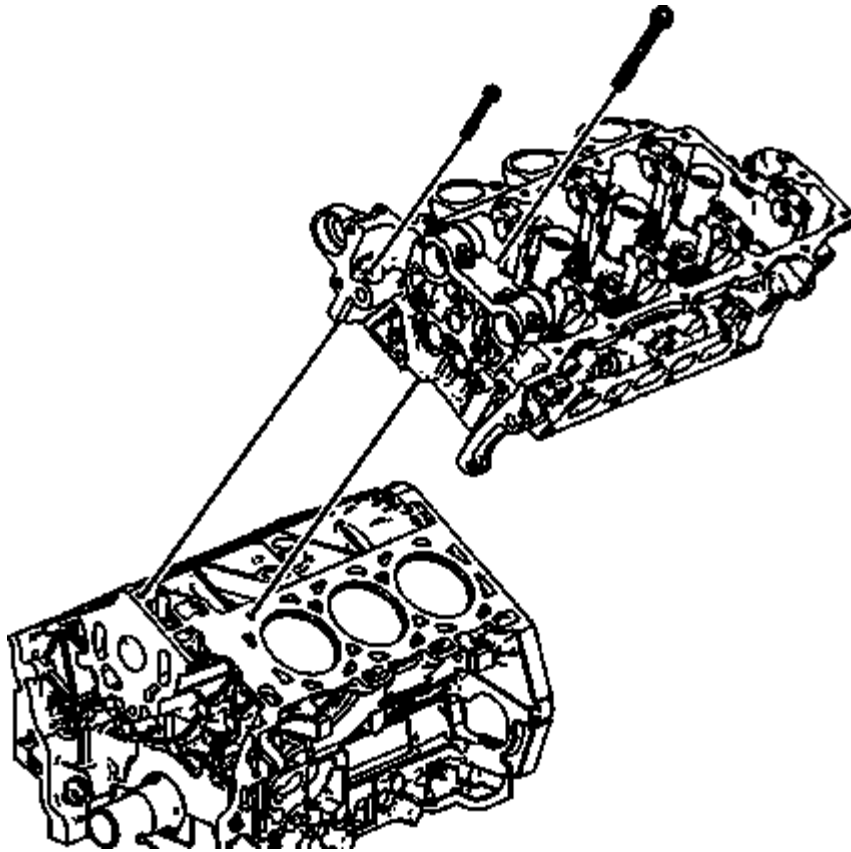


Fig. 537: View Of Left Cylinder Head & Bolts (LLT)
Courtesy of GENERAL MOTORS COMPANY

3. Align the left cylinder head with the deck face locating pins.
4. Place the left cylinder head in position on the deck face.
5. Install the NEW M11 cylinder head bolts (1).

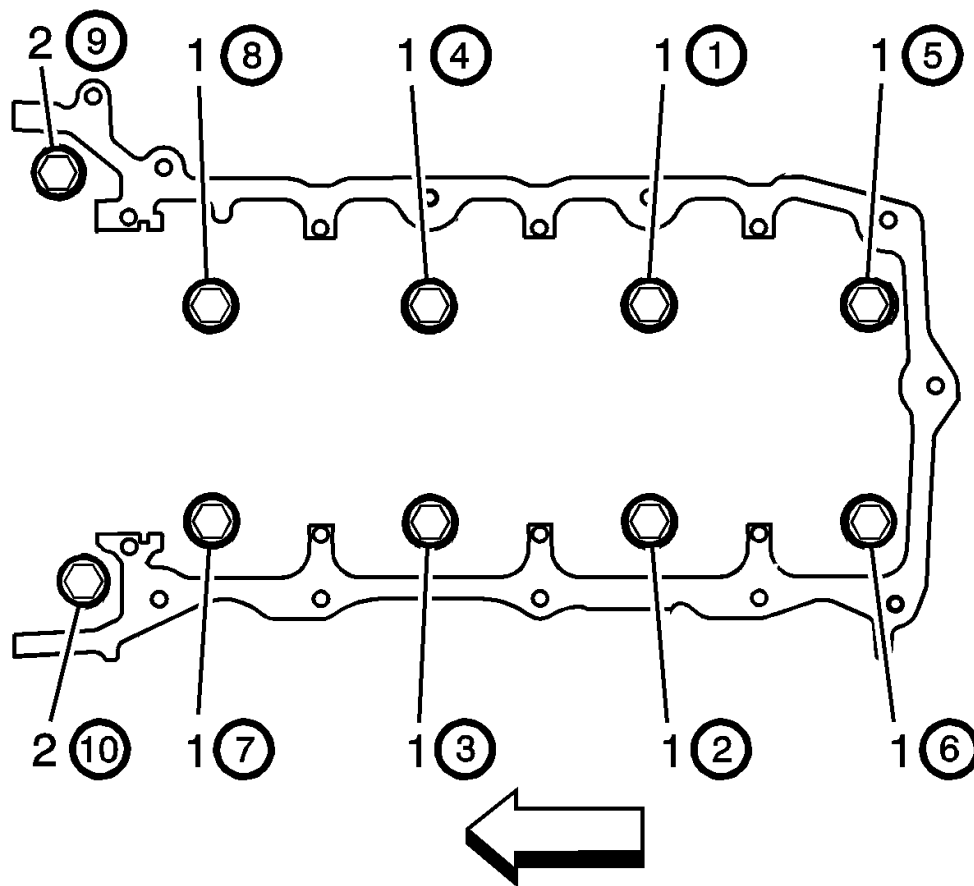


Fig. 538: Identifying M11 Cylinder Head Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a **NEW** torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

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

NOTE: DO NOT reuse the old cylinder head bolts.

1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).

2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150° using the **J 45059** meter.
6. Install the 2 NEW front M8 left cylinder head bolts (2).
 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 75° using the **J 45059** meter.

VALVE LIFTER INSTALLATION - LEFT SIDE

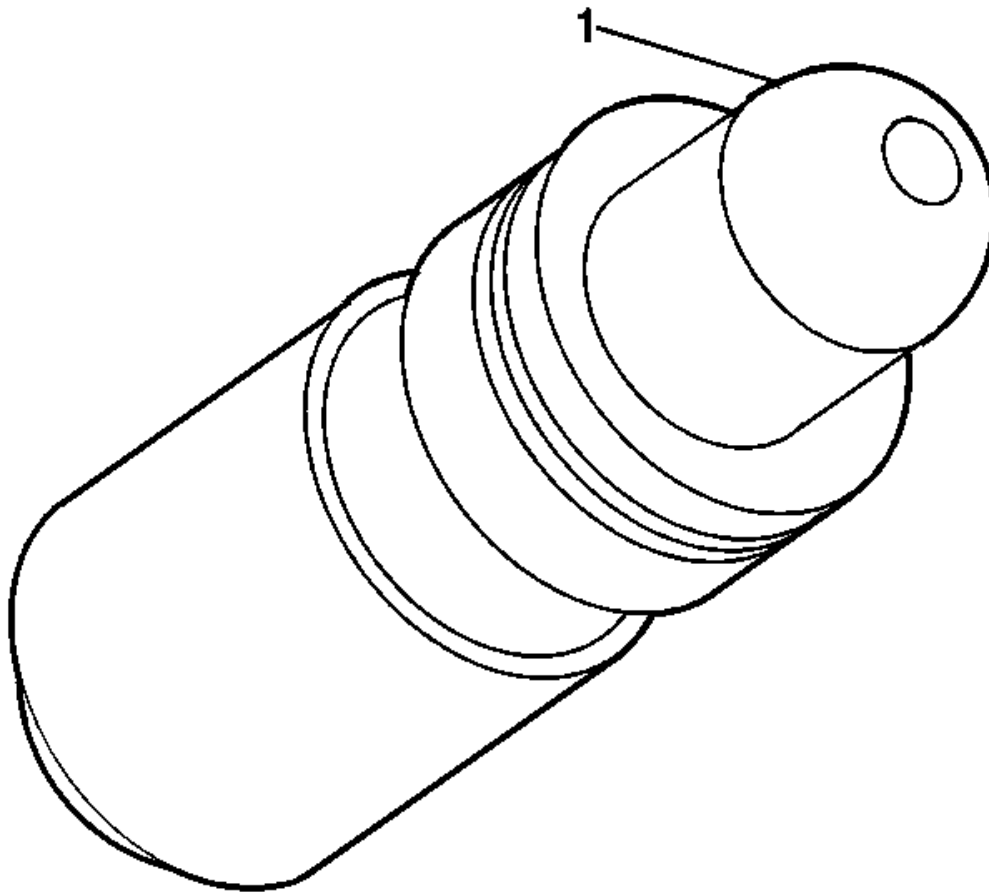


Fig. 539: View Of Valve Lifter

Courtesy of GENERAL MOTORS COMPANY

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.

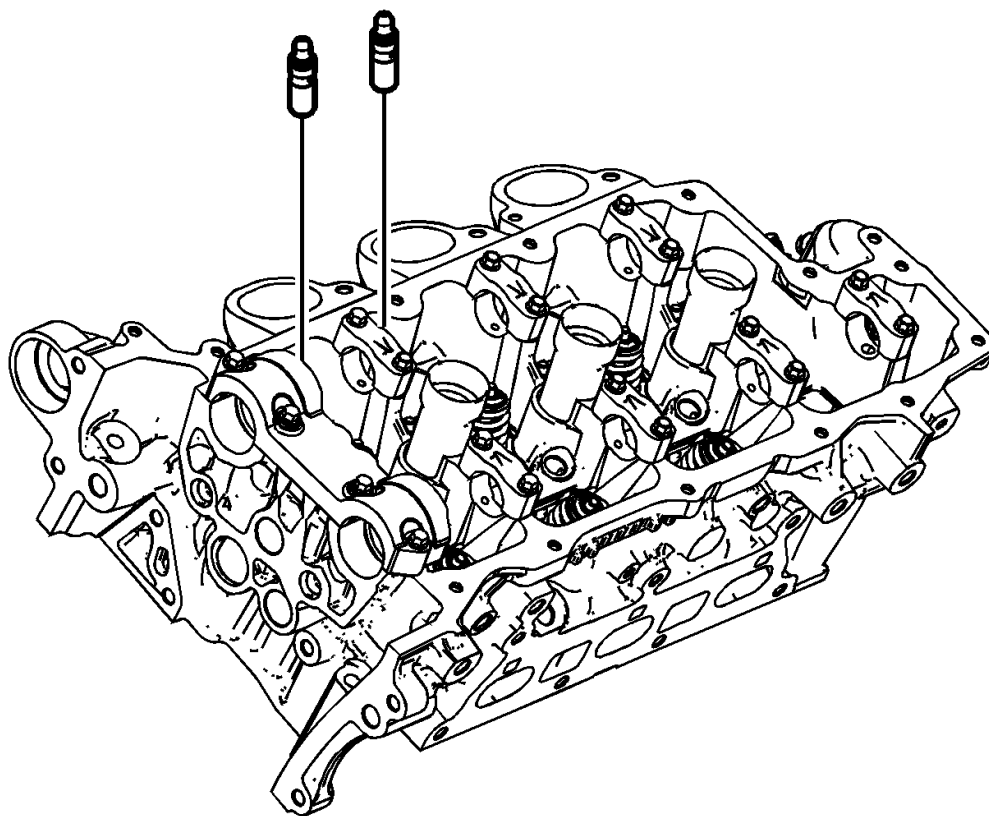


Fig. 540: Valve Lifter Removal - Left Side (LLT)
Courtesy of GENERAL MOTORS COMPANY

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 SIDE

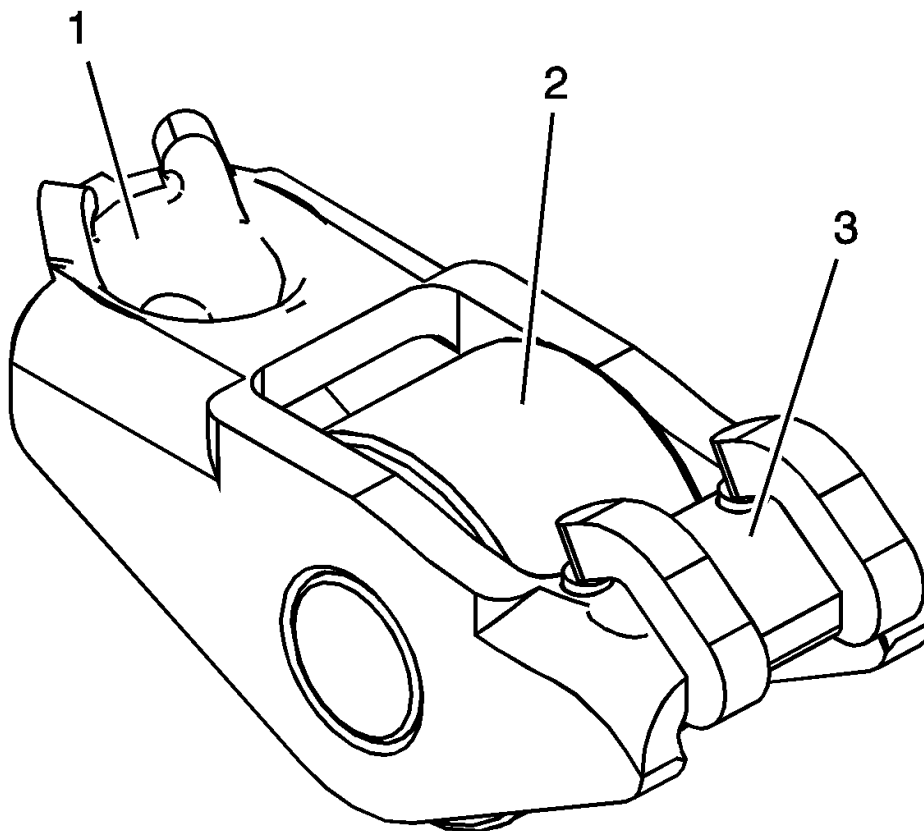


Fig. 541: Identifying Valve Rocker Arm Lubrication Areas
Courtesy of GENERAL MOTORS COMPANY

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.

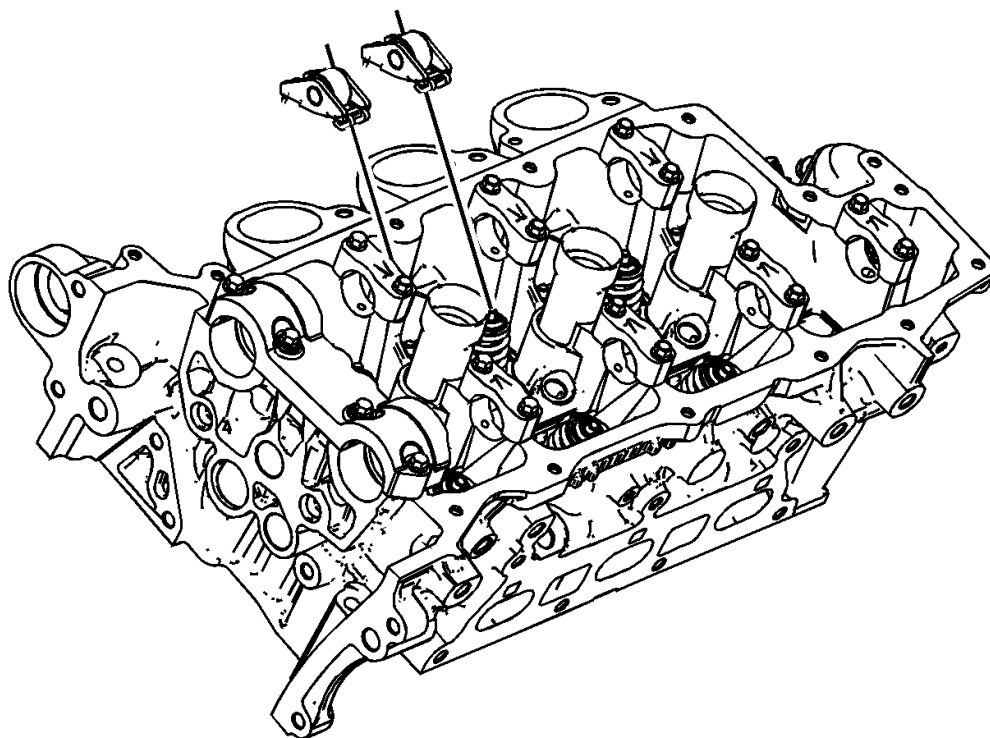


Fig. 542: View Of Valve Rocker Arm - Left Side (LLT)
Courtesy of GENERAL MOTORS COMPANY

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 SIDE

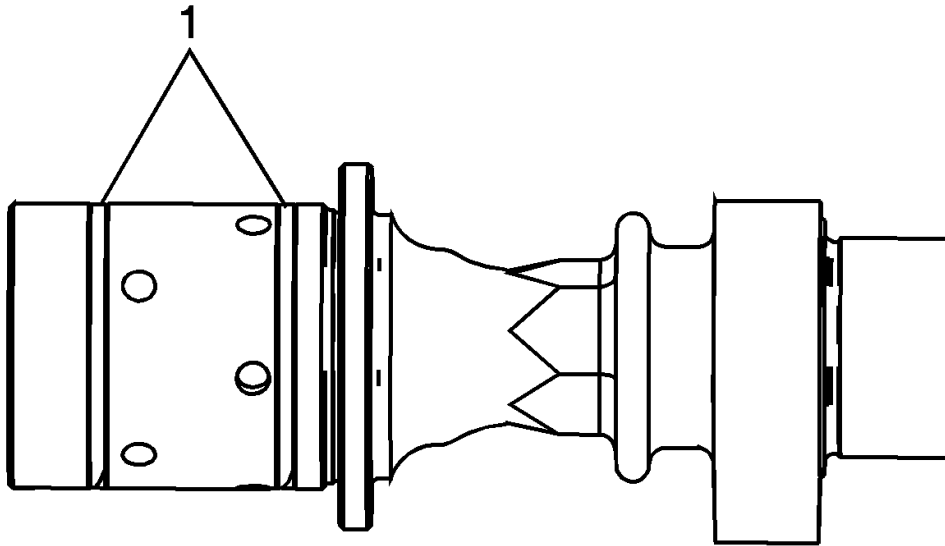


Fig. 543: Locating Camshaft Sealing Rings In Camshaft Grooves
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

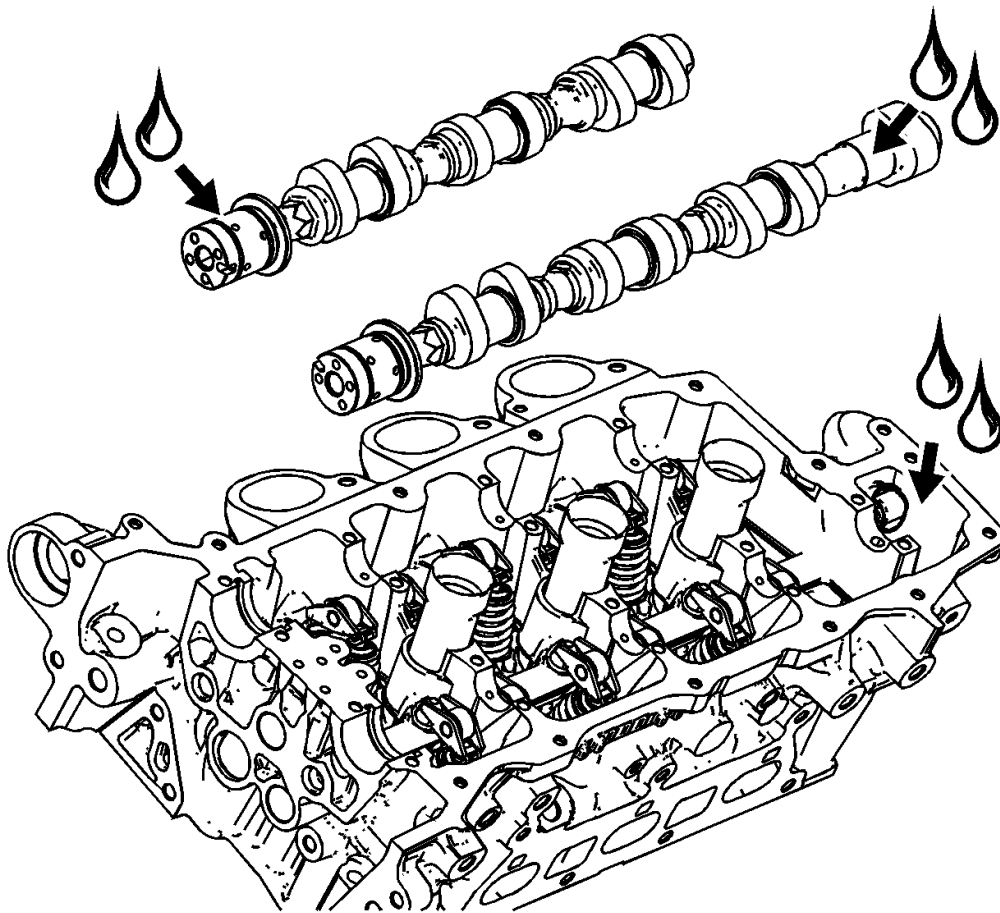


Fig. 544: Lubricating Camshaft Journals
Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant to the camshaft journals and the left cylinder head camshaft carriers. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.

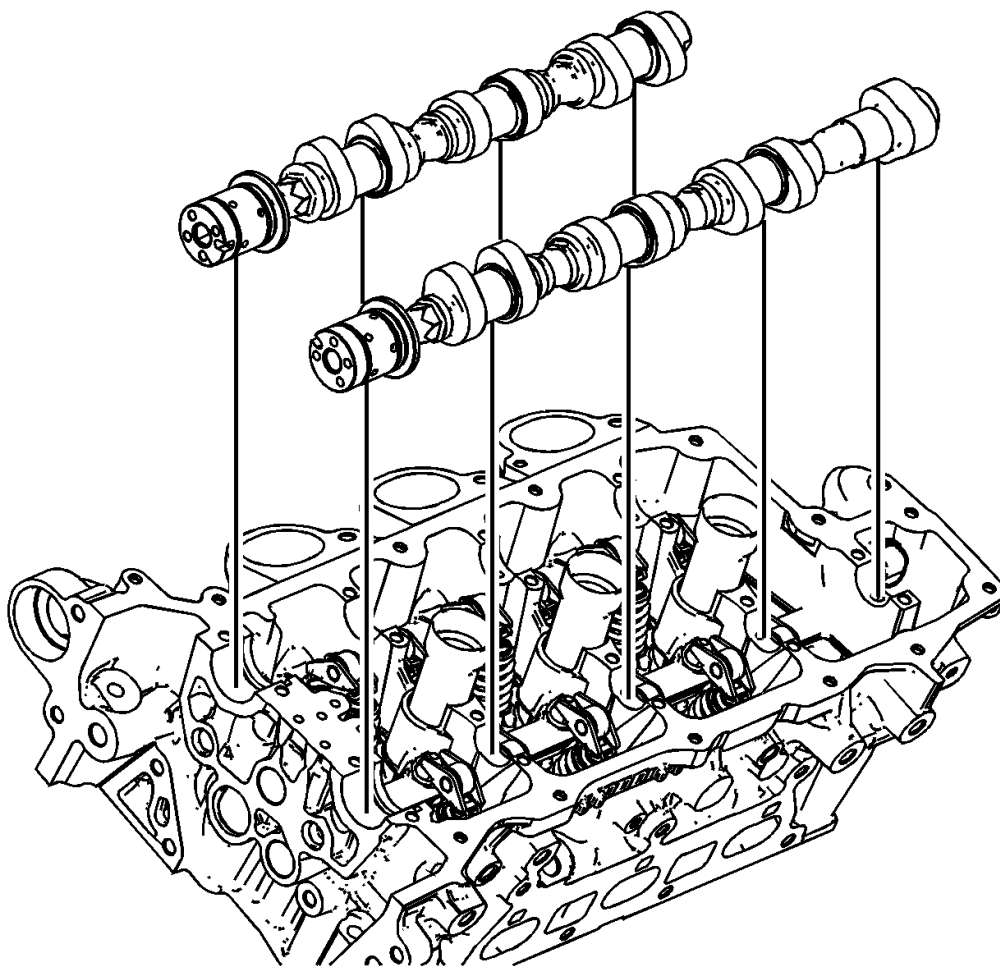


Fig. 545: View of Camshafts and Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

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

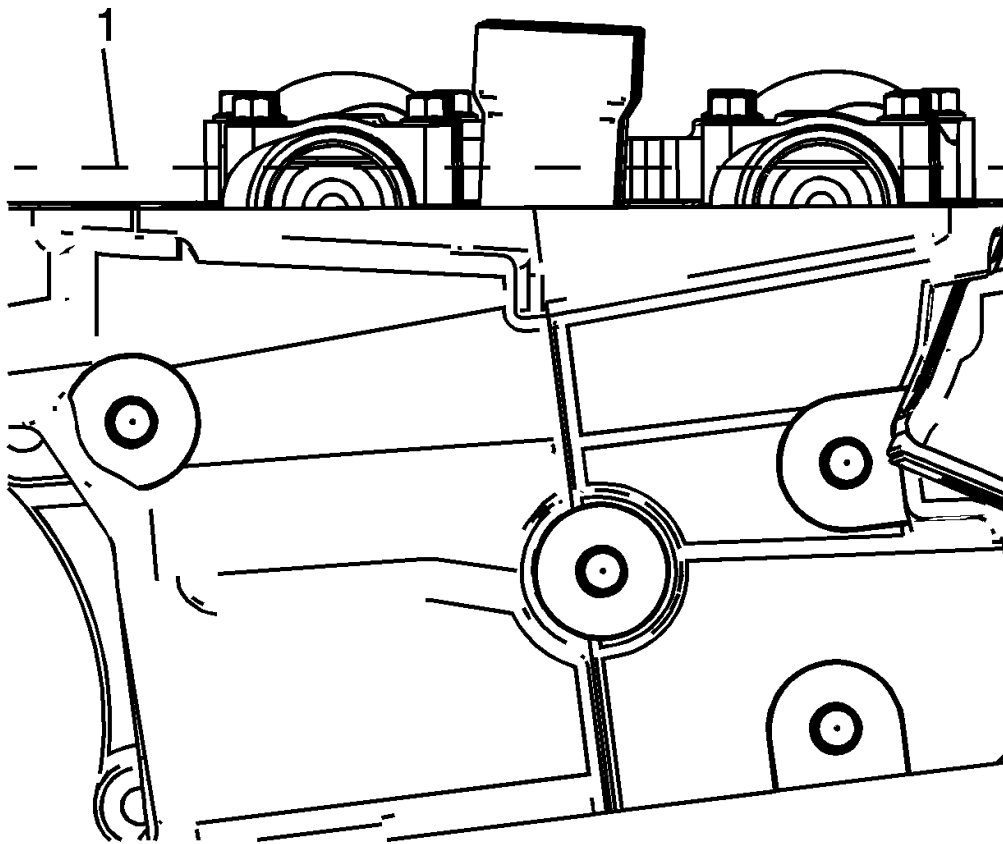


Fig. 546: View Of Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS COMPANY

4. 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.

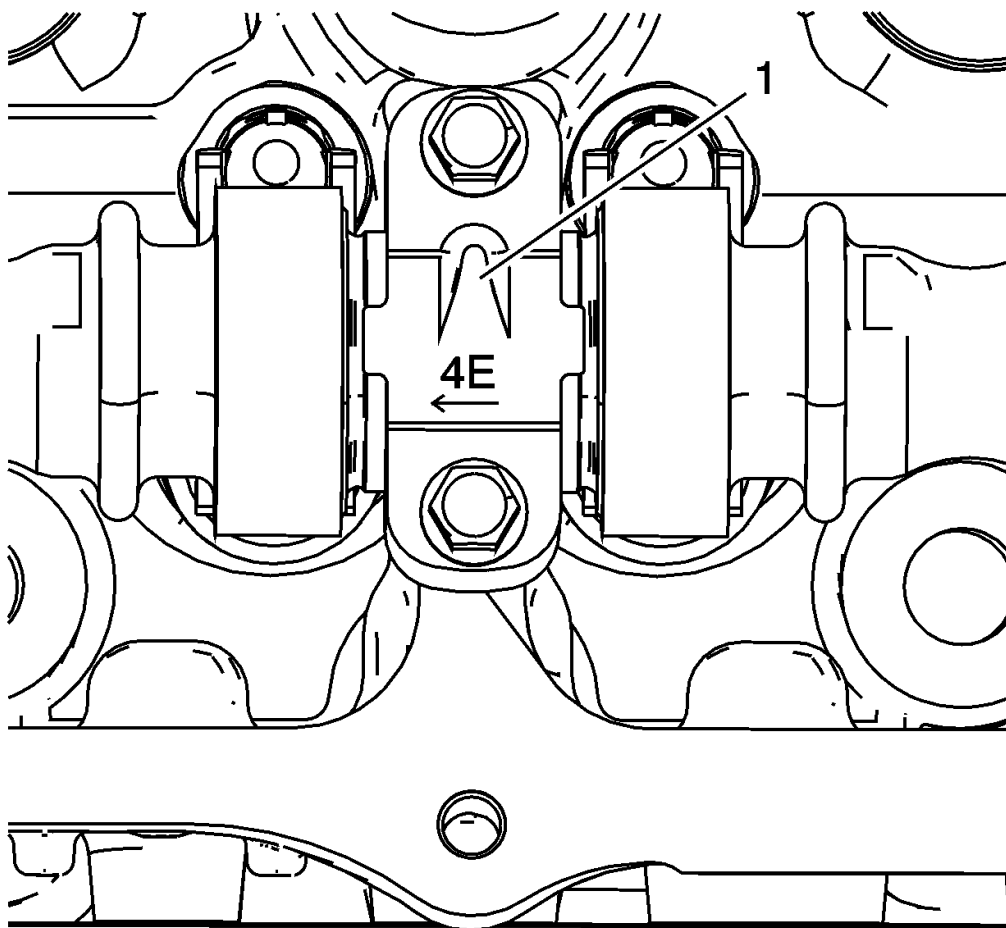


Fig. 547: Left Cylinder Head Camshaft Bearing Cap Markings

Courtesy of GENERAL MOTORS COMPANY

5. 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 (1) 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.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.

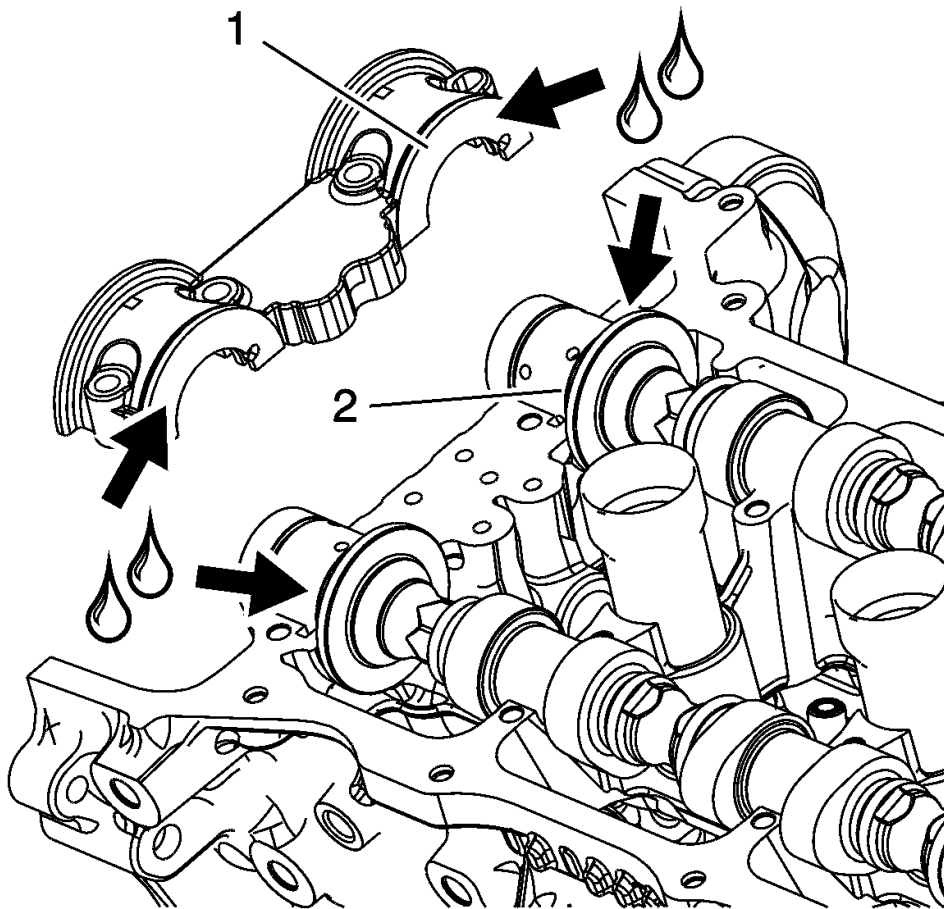


Fig. 548: Camshaft Bearing Cap And Camshaft Thrust Surface
 Courtesy of GENERAL MOTORS COMPANY

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.

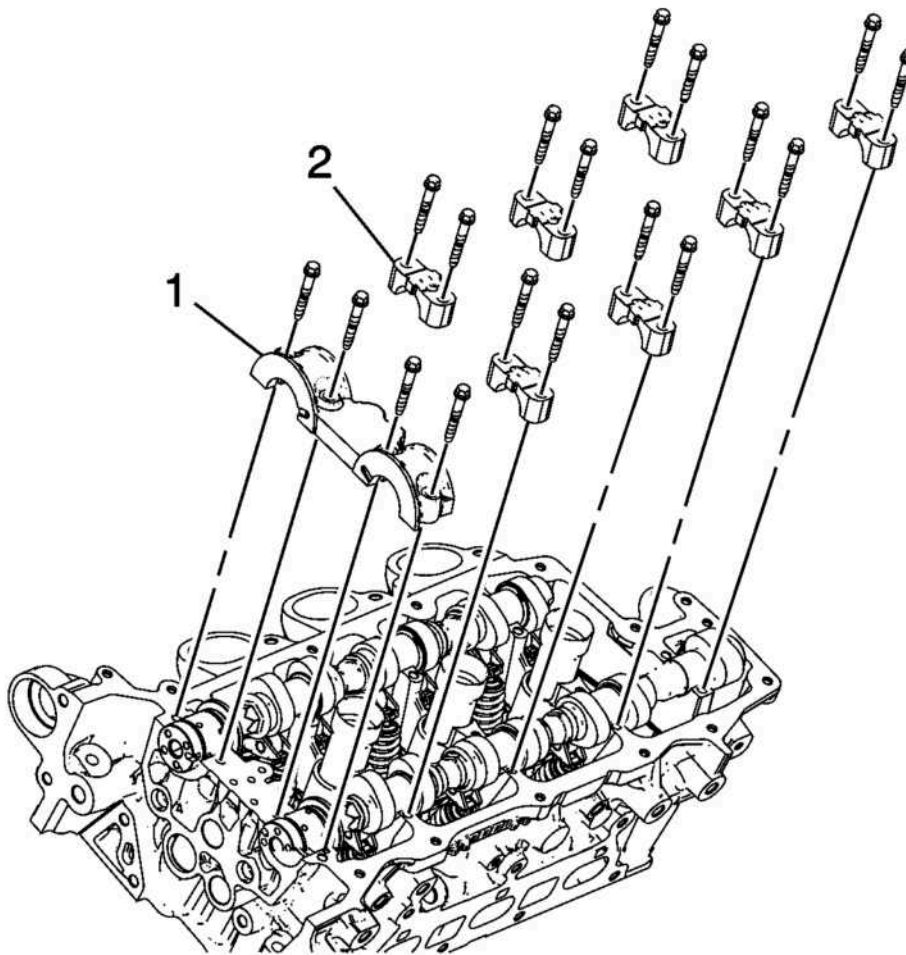


Fig. 549: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust cap (1) in the first journal of the left cylinder head.
9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.

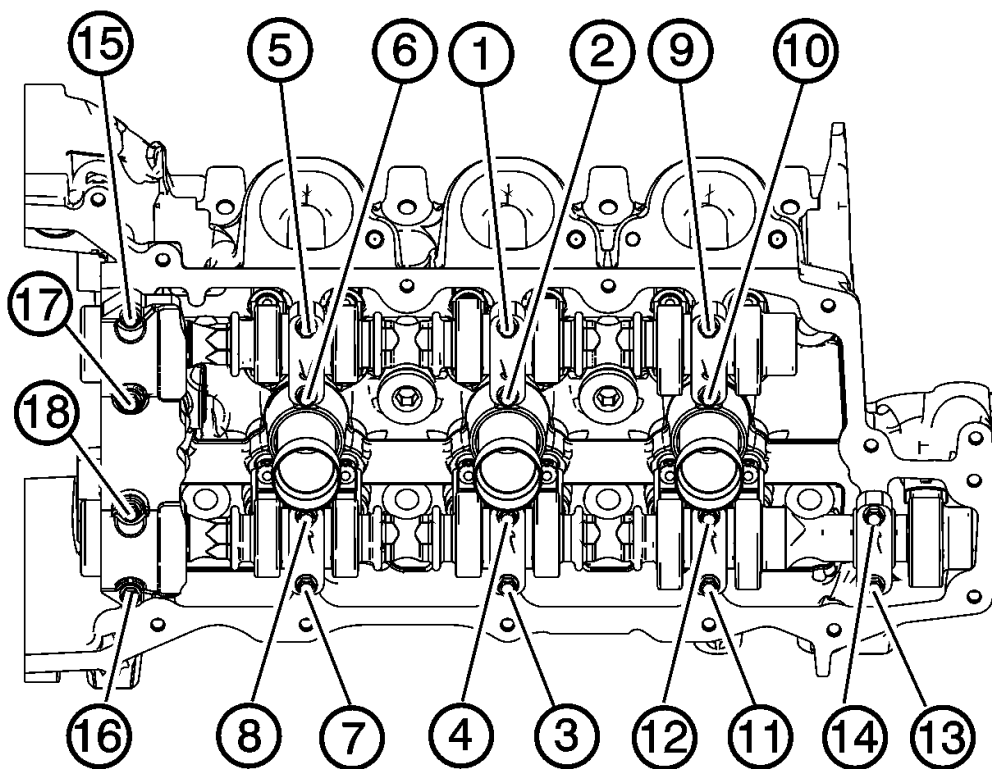


Fig. 550: Identifying Camshaft Bearing Cap Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).
12. Loosen the center intake camshaft bearing cap bolts 1, 2 and the center exhaust camshaft bearing cap bolts 3, 4.
13. Retighten the center camshaft bearing cap bolts 1, 2, 3, 4 and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).

FUEL PUMP INSTALLATION

Special Tools

EN 48896 HP Fuel Pump Installation Alignment Gauge

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

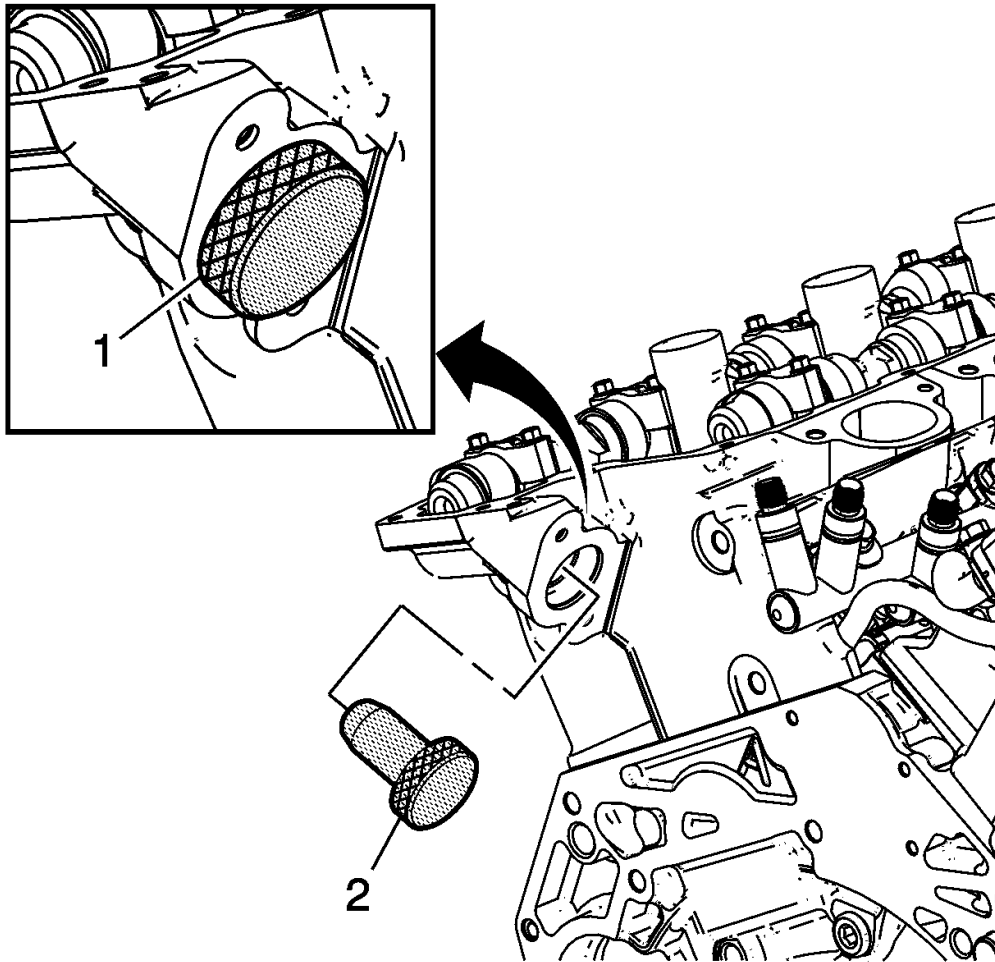


Fig. 551: View Of Alignment Gauge
Courtesy of GENERAL MOTORS COMPANY

NOTE: The camshaft must be in the base circle position before the high pressure fuel pump is installed.

1. Use the **EN 48896** alignment gauge (2) to ensure that the camshaft lobe is in the base circle position. At base circle position, the tool will be flush with the head (1).

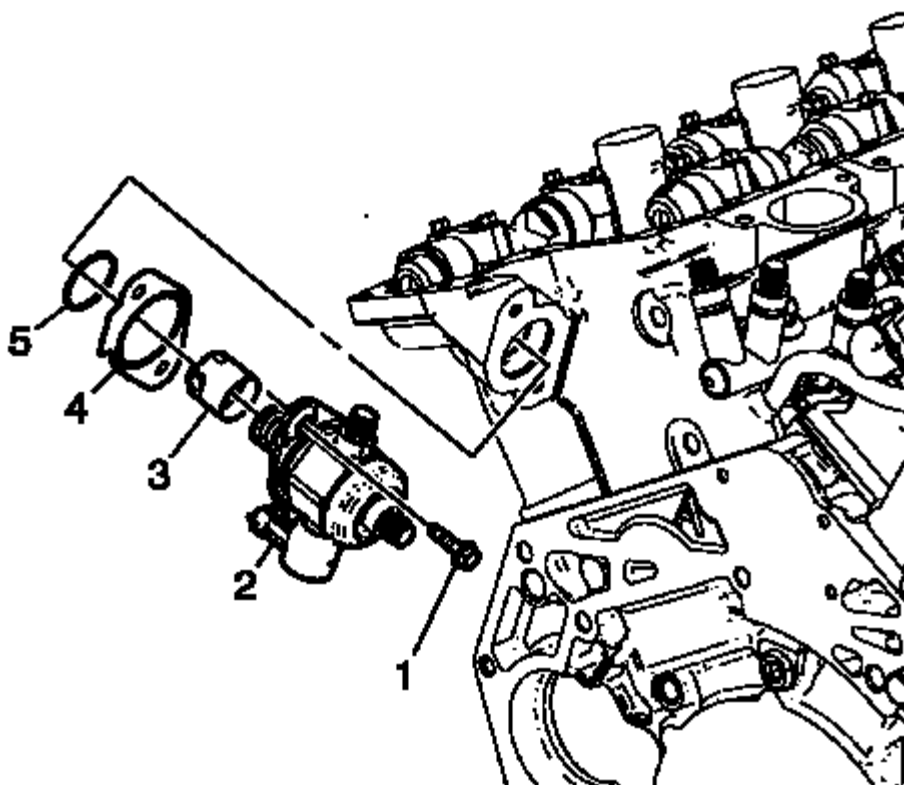


Fig. 552: View of Fuel Pump Bolts and Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

2. Lubricate the high pressure fuel pump cylinder head bore with 5W-30 engine oil.
3. Lubricate the high pressure fuel pump roller lifter with 5W-30 engine oil and install into the cylinder head bore.

NOTE: Ensure that the high pressure fuel pump roller lifter is oriented properly, the camshaft is at base circle and the number 1 piston is at top dead center (TDC) on the exhaust stroke. The distance from the mounting flange surface to the camshaft at base circle should be 52 mm (2.05 in).

4. Install a NEW high pressure fuel pressure fuel pump gasket (4).
5. Install a NEW high pressure fuel pump O-ring (5).
6. Install the valve lifter follower (3).

NOTE: Ensure the plastic bolt retainers are installed in the high pressure fuel pump mounting holes before installing.

7. Install the high pressure fuel pump (2).

8. Start and hand-tighten the high pressure fuel pump bolts (1) evenly to 15 N.m (11 lb ft).

CAUTION: Refer to **Fastener Caution** .

CAUTION: Alternately hand-tighten the fuel pump bolts one turn at a time until the pump is fully seated. Trying to draw down the pump without even side-to-side tightening may result in pump plunger damage.

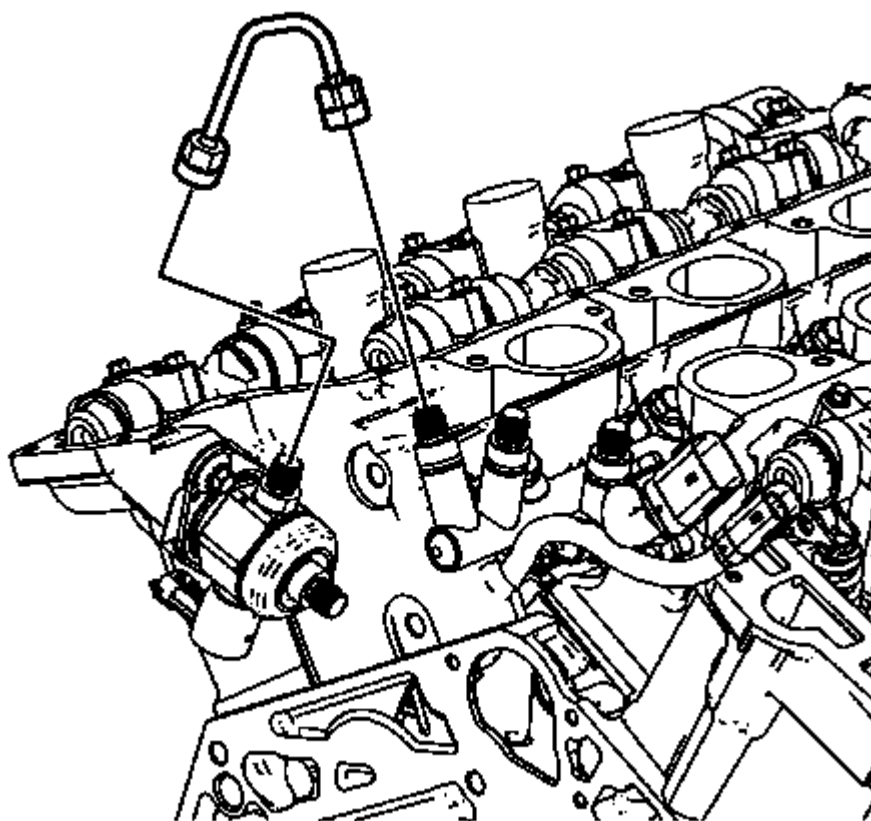


Fig. 553: View of Fuel Line & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

9. Install and hand-tighten both ends of the NEW high pressure fuel line and tighten the high pressure fuel line fitting nuts to 50 (37 lb ft).

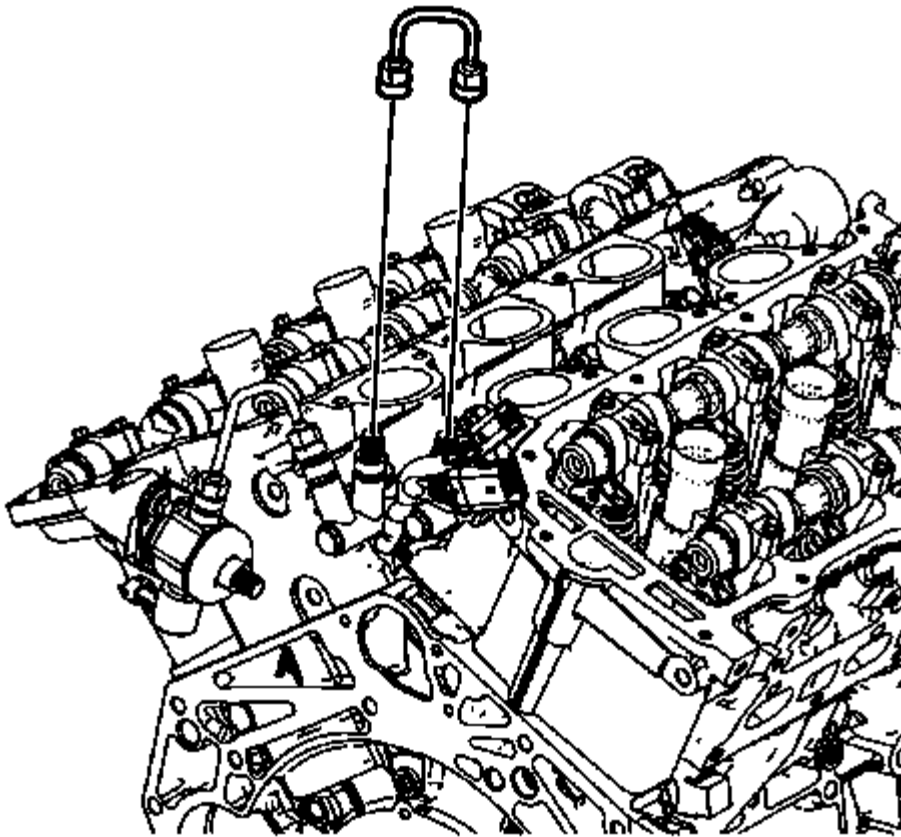


Fig. 554: Identifying Fuel Rail Crossover Pipe
Courtesy of GENERAL MOTORS COMPANY

10. Install the NEW LH to RH fuel rail crossover pipe and tighten the fuel rail crossover pipe fittings to 50 (37 lb ft).

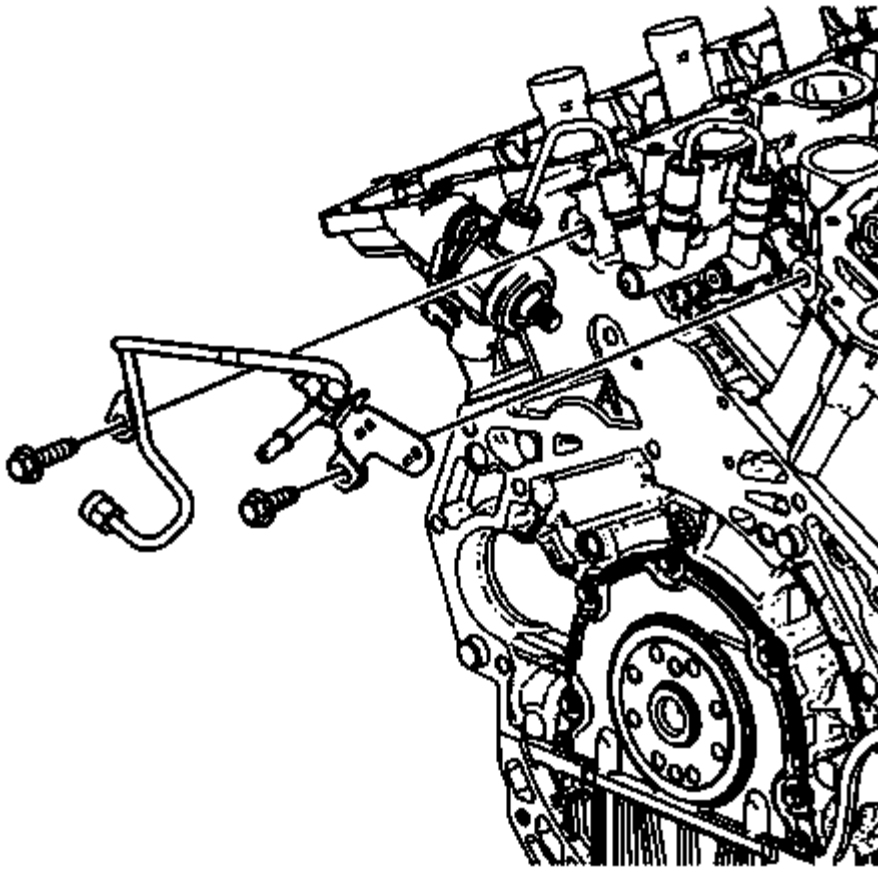


Fig. 555: Identifying Fuel Feed Pipe & Bracket
Courtesy of GENERAL MOTORS COMPANY

11. Install the NEW fuel feed pipe.
12. Install the fuel feed pipe bolts and tighten to 10 N.m (89 lb in).
13. Install the fuel rail wiring connectors to the fuel feed pipe bracket.

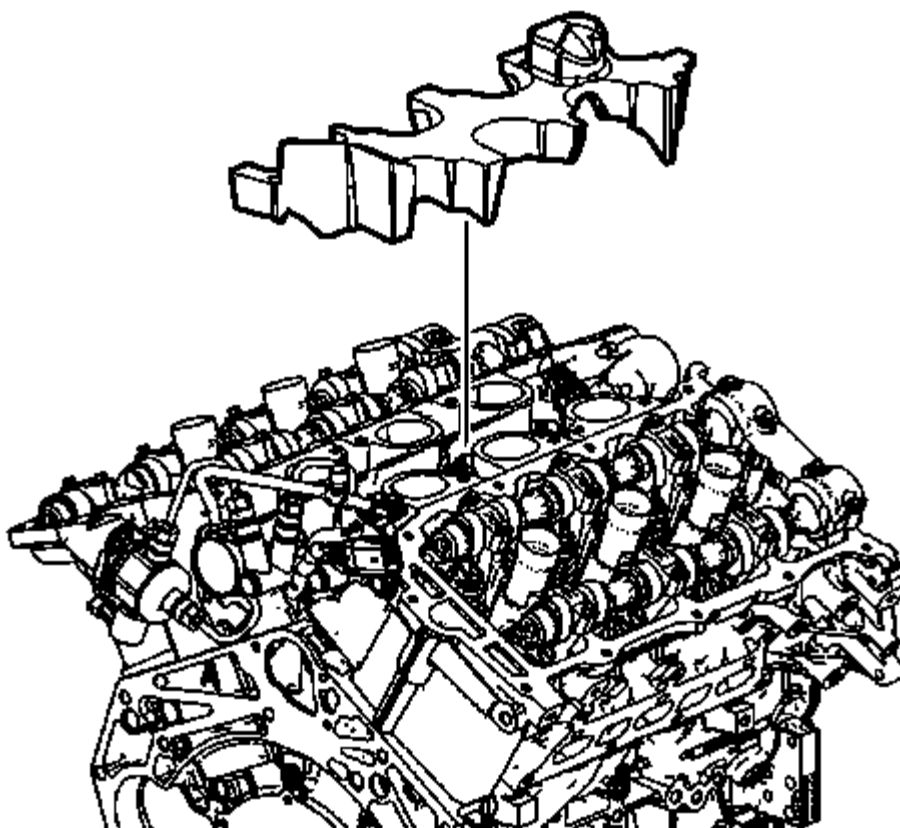


Fig. 556: View of Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

14. Install the fuel rail noise shield.