2007 ENGINE

Engine Mechanical - 4.8L, 5.3L, 6.0L and 6.2L - Avalanche, Escalade, Suburban, Tahoe & Yukon

CRANKSHAFT AND BEARINGS CLEANING AND INSPECTION

Tools Required

- **J 7872** Magnetic Base Dial Indicator Set
- **J 43690** Rod Bearing Checking Tool. See **Special Tools** .
- **J 43690-100** Rod Bearing Checking Tool - Adapter Kit. See **Special Tools** .

CLEANING PROCEDURE

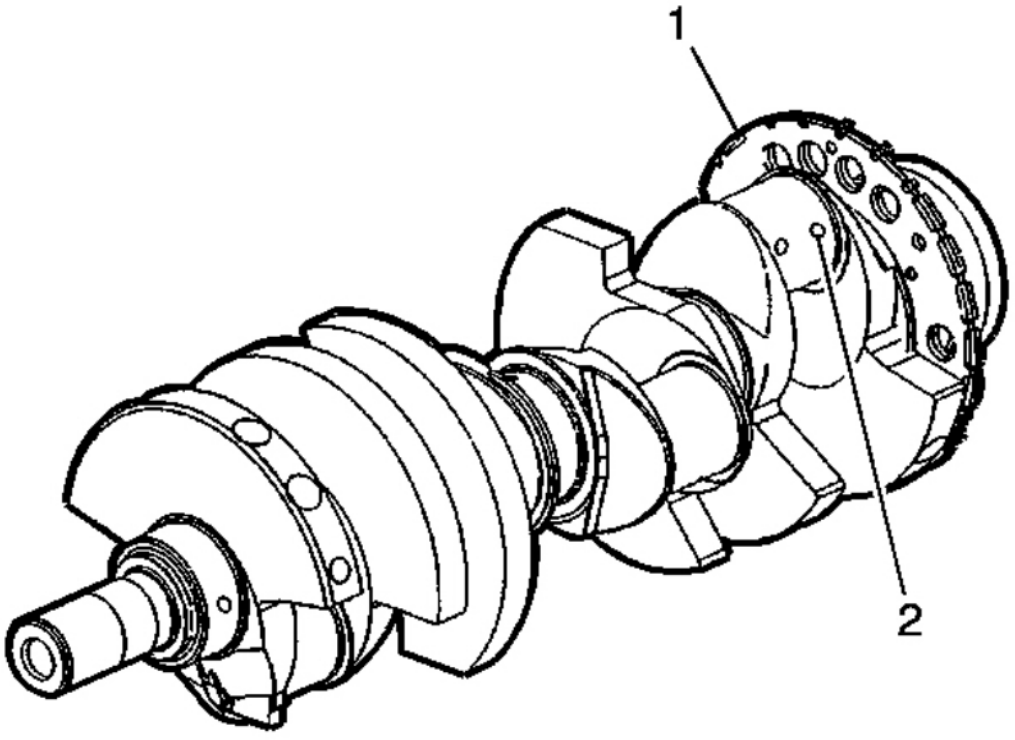


Fig. 1: Oil Passages & CKP Reluctor Ring Teeth
Courtesy of GENERAL MOTORS CORP.

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IMPORTANT: Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the lobes of the crankshaft position (CKP) reluctor ring. Damage to the teeth of the CKP reluctor ring may affect on-board diagnostics (OBD) II system performance.

1. Clean the crankshaft with solvent.
2. Thoroughly clean all oil passages (2) and inspect for restrictions or burrs.

CAUTION: Refer to Safety Glasses Caution .

3. Dry the crankshaft with compressed air.

INSPECTION PROCEDURE

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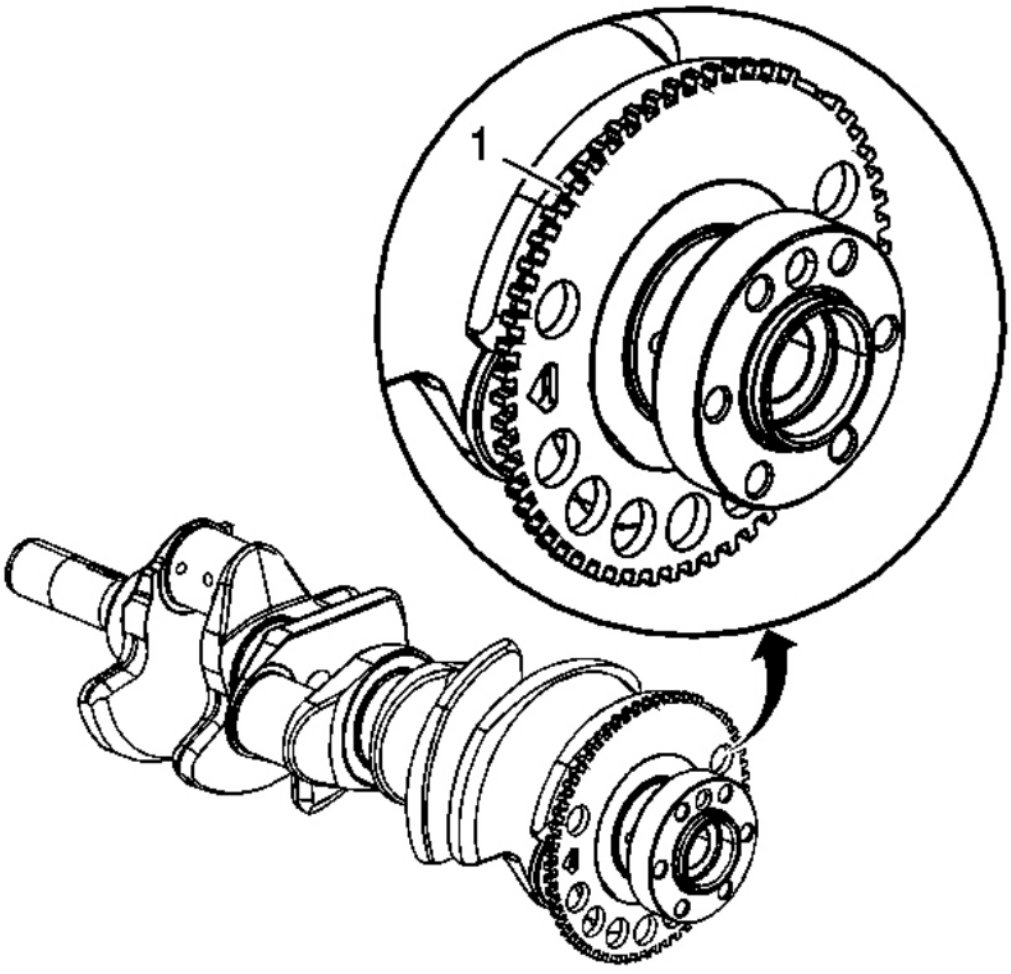


Fig. 2: View Of Reluctor Ring Teeth
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The reluctor ring teeth should not have imperfections on the rising or falling edges. Imperfections of the reluctor ring teeth may effect OBD II system performance.

1. Inspect the CKP reluctor ring teeth (1) for damage.

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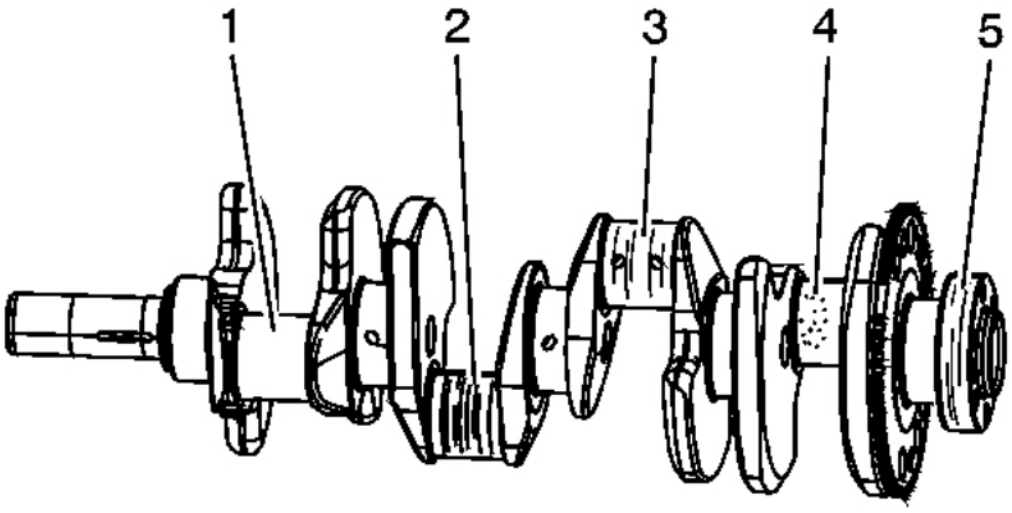


Fig. 3: View Of Crankshaft Journals
Courtesy of GENERAL MOTORS CORP.

2. Inspect the crankshaft journals for wear.

   Journals should be smooth (1) with no signs of scoring, wear, or damage.

3. Inspect the crankshaft journals for grooves or scoring (2).
4. Inspect the crankshaft journals for scratches or wear (3).
5. Inspect the crankshaft journals for pitting or imbedded bearing material (4).
6. Inspect the crankshaft rear oil seal surface (5) for grooves or scoring.

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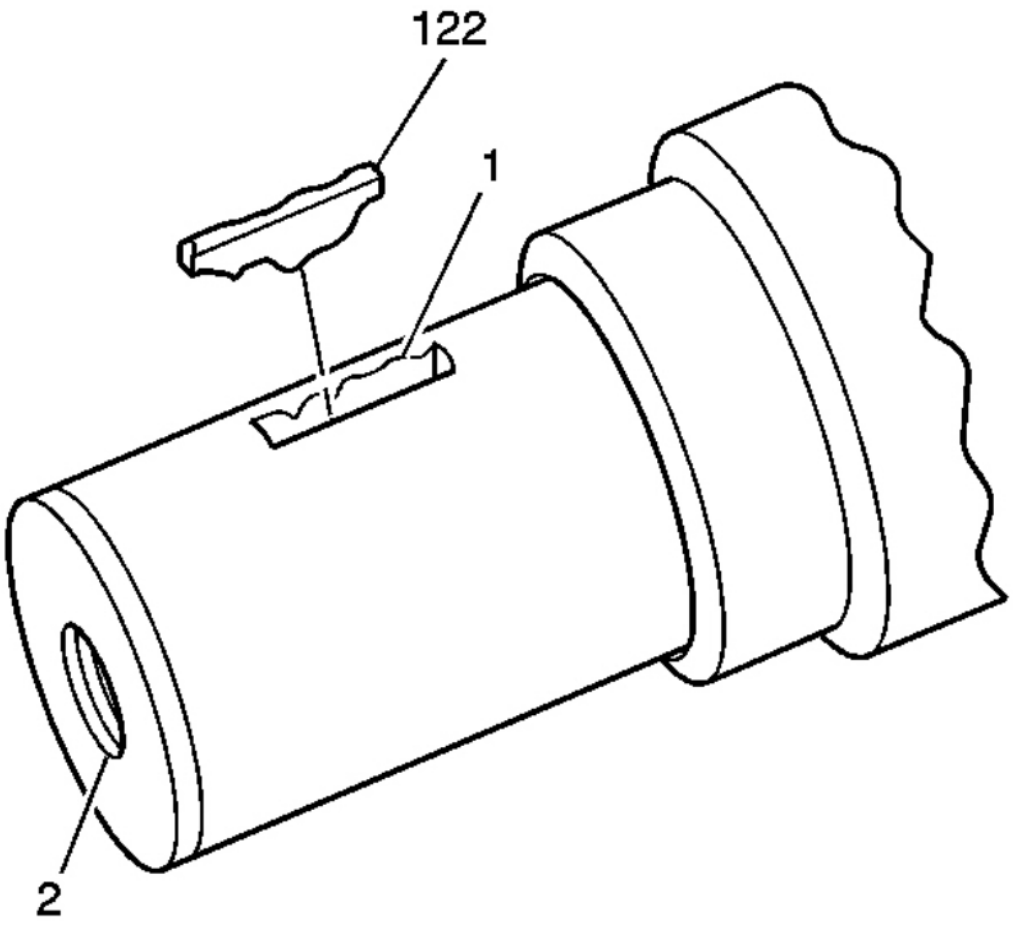


Fig. 4: View Of Crankshaft Key, Keyway & Threaded Hole
Courtesy of GENERAL MOTORS CORP.

7. Inspect the crankshaft key (122), keyway (1), and threaded hole (2) for damage.

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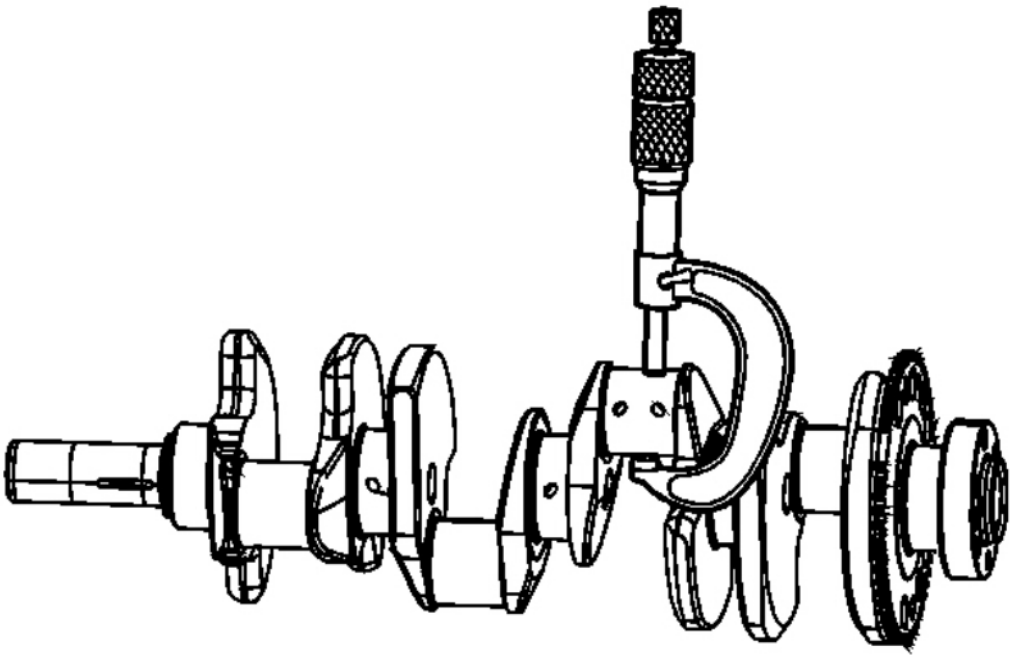


Fig. 5: Measuring Crankpins For Out-Of-Round
Courtesy of GENERAL MOTORS CORP.

8. Measure the connecting rod journals for out-of-round and taper.

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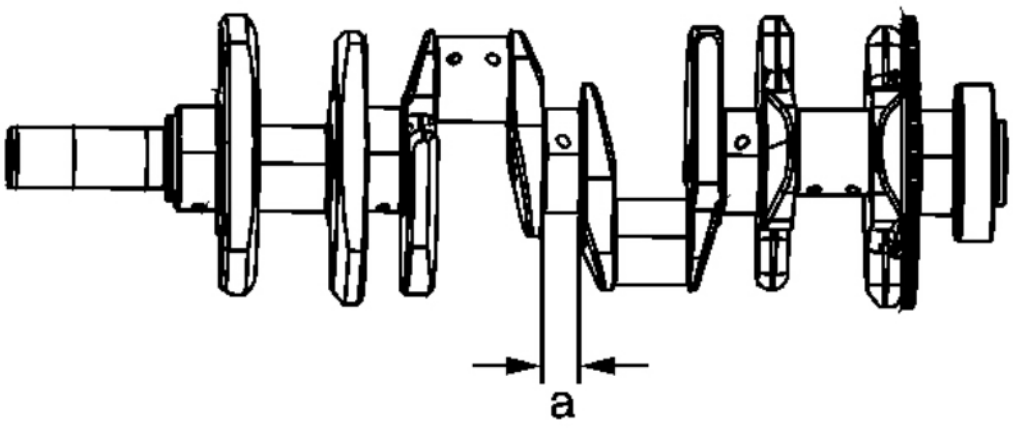


Fig. 6: Measuring Crankshaft Thrust Wall Width
Courtesy of GENERAL MOTORS CORP.

9. Measure the crankshaft thrust wall width.

   A crankshaft with a thrust wall width in excess of 26.2 mm (1.0315 in) (a) must be replaced.

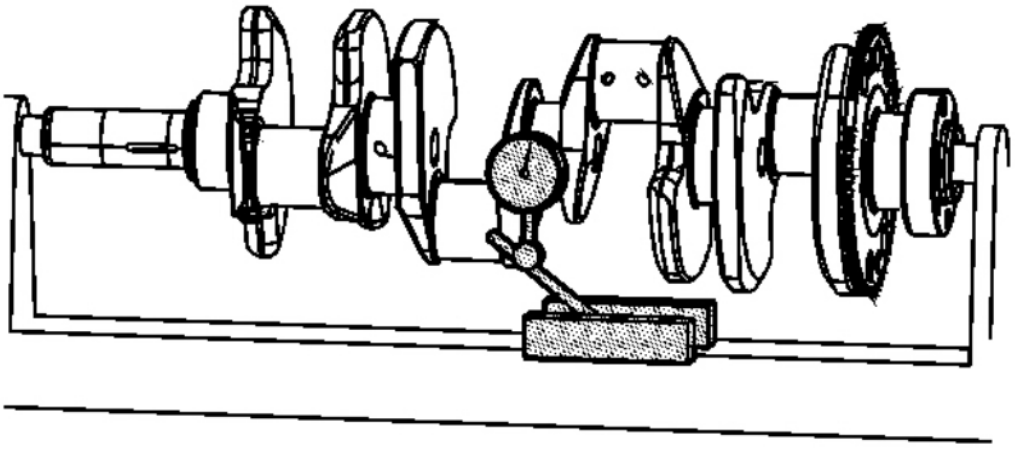


Fig. 7: Measuring Crankshaft Runout
Courtesy of GENERAL MOTORS CORP.

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10. Measure the crankshaft runout.

    Use wooden V-blocks or a fixture to support the crankshaft on the front and rear journals.

11. Use the **J 7872** in order to measure the crankshaft runout at the front and rear intermediate journals.
12. Use the **J 7872** in order to measure the runout of the crankshaft rear flange.
13. Use the **J 7872** in order to measure the runout of the crankshaft position reluctor ring. Reluctor ring runout should be measured 1.0 mm (0.04 in) below the ring teeth.

    If the reluctor ring has runout in excess of 0.7 mm (0.028 in), replace the crankshaft.

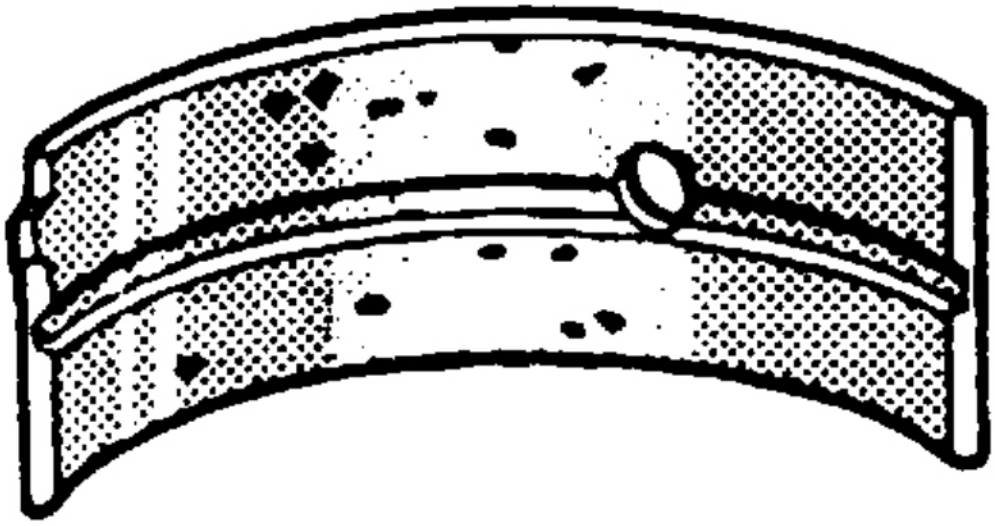


Fig. 8: Identifying Crankshaft Bearing Craters Or Pockets
Courtesy of GENERAL MOTORS CORP.

14. Inspect crankshaft bearings for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.

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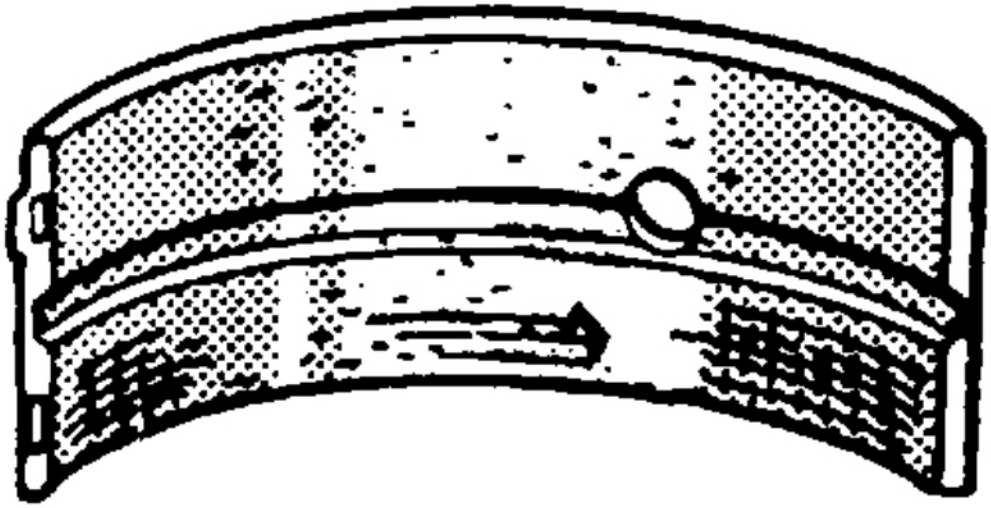


Fig. 9: Identifying Connecting Rod Bearing Scoring Or Discoloration
Courtesy of GENERAL MOTORS CORP.

15. Inspect the crankshaft bearings for excessive scoring or discoloration.
16. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.

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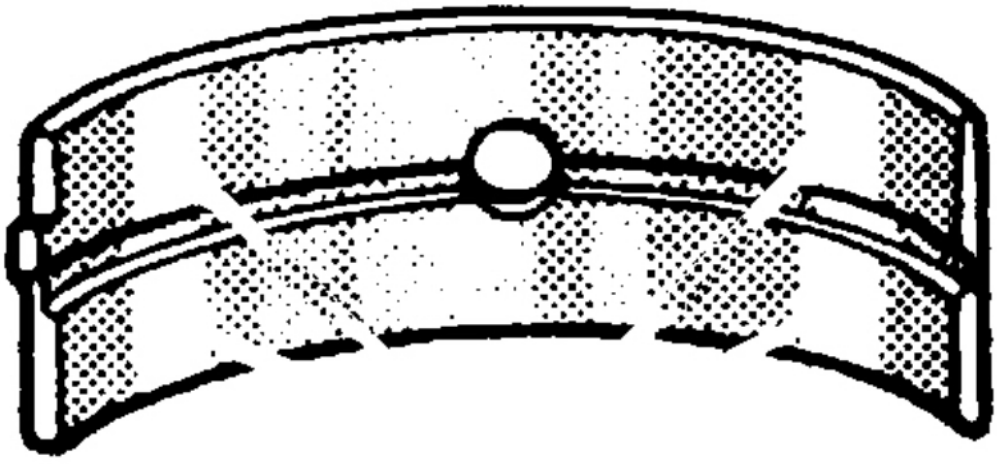


Fig. 10: Crankshaft Bearing Polished Sections (Improper Seating)
Courtesy of GENERAL MOTORS CORP.

17. Inspect the crankshaft bearings for improper seating, indicated by bright, polished sections of the bearing.

    If the lower half of the bearing is worn or damaged, both upper and lower halves should be replaced.

    Generally, if the lower half is suitable for use, the upper half should also be suitable for use.

MEASURING MAIN BEARING CLEARANCE - GAGING PLASTIC METHOD

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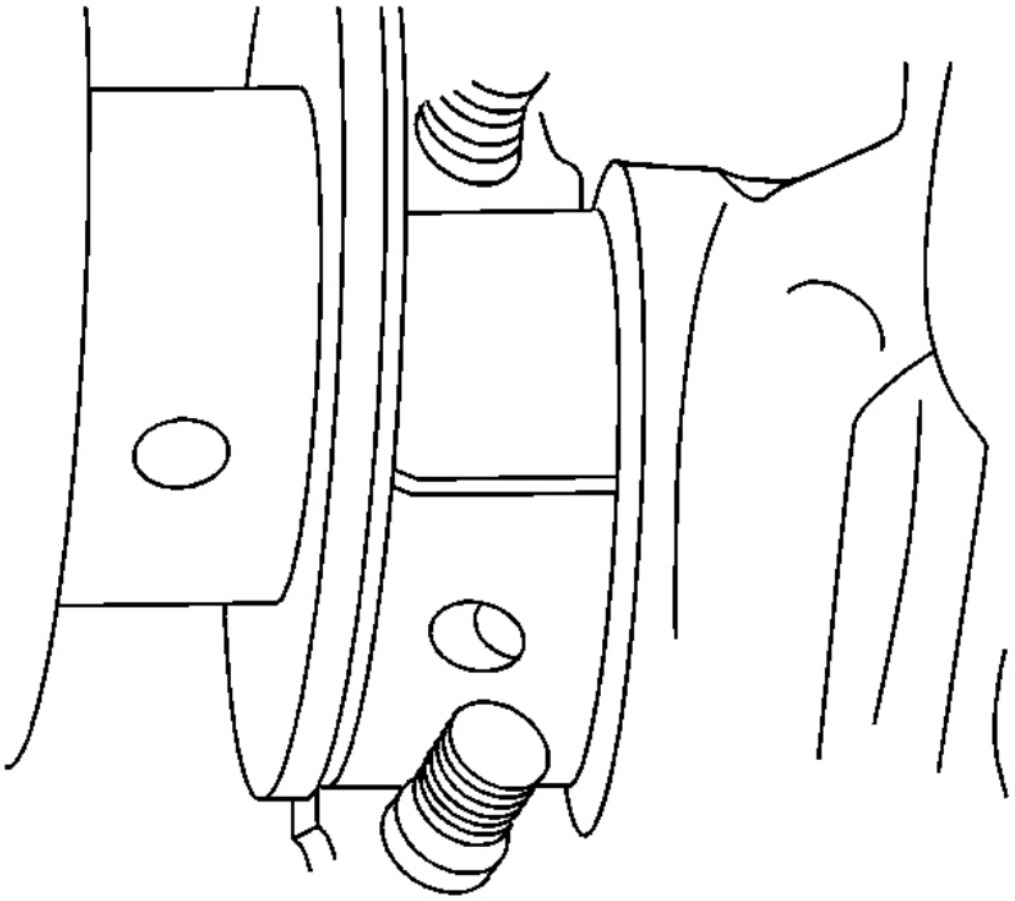


Fig. 11: View Of Gaging Plastic Installed On Crankshaft Journal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **The crankshaft main bearings are a precision insert type. Main bearing caps are machined with the engine block, for proper clearance, and cannot be shimmed or filed for bearing fit. If the clearances are found to be excessive, new bearings and/or engine block and cap repair or replacement may be required.**
- **Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.**
- **The crankshaft bearing clearances are critical. Excessive bearing clearance may affect crankshaft position sensor signals and may affect OBD II system operation.**
- **Remove the bearing cap side bolts prior to cap removal.**

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1. Remove the bearing caps, bearing half, and bolts. Refer to **Crankshaft and Bearings Removal** .
2. Install gaging plastic onto the crankshaft journal. Install the gaging plastic the full width of the crankshaft bearing journal.
3. Install the bearing caps, bearing half, and bolts. Refer to **Crankshaft and Bearings Installation**.
4. Remove the bearing caps, bearing half, and bolts. Refer to **Crankshaft and Bearings Removal** .

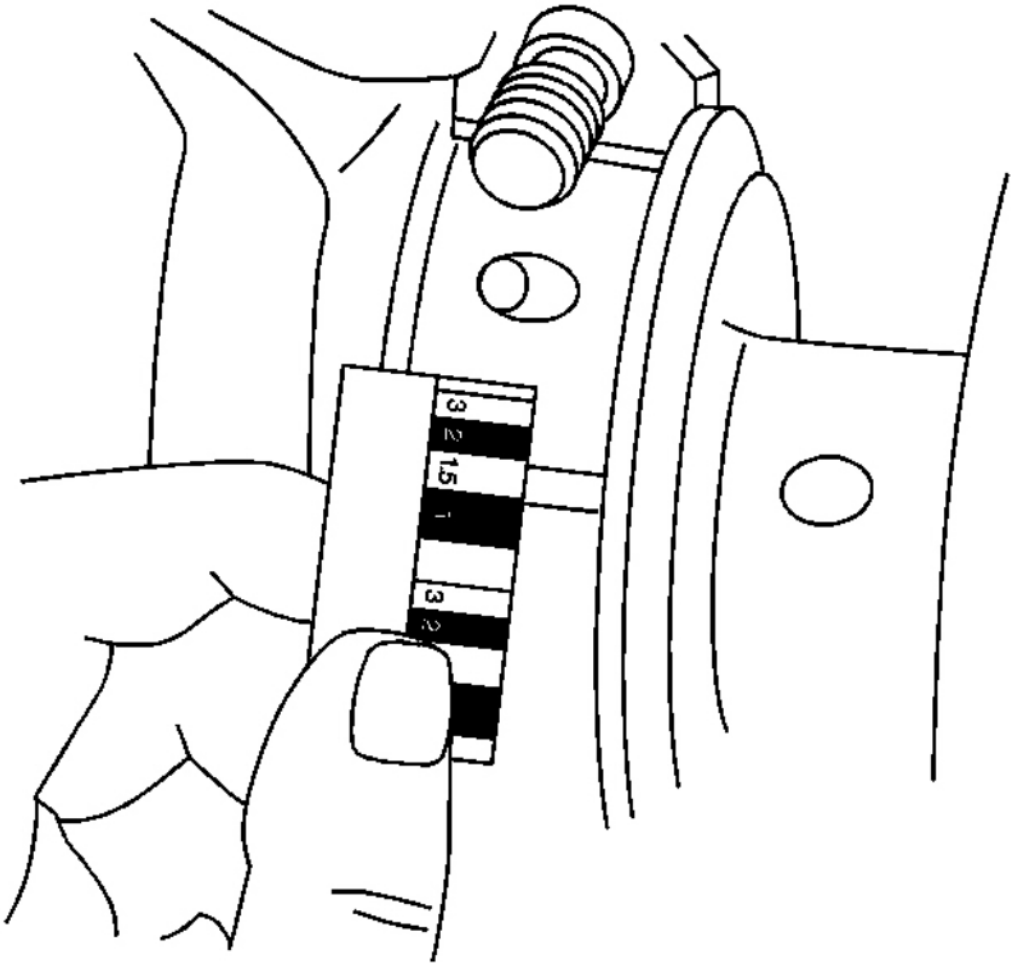


Fig. 12: Measuring Gaging Plastic
Courtesy of GENERAL MOTORS CORP.

5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area.
   - If the gaging plastic shows irregularity in the journal, exceeding 0.025 mm (0.001 in), remove the crankshaft and measure the journal with a micrometer.

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- If clearance cannot be brought to specifications, replace the crankshaft or engine block as required. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

MEASURING CONNECTING ROD BEARING CLEARANCE - GAGING PLASTIC METHOD

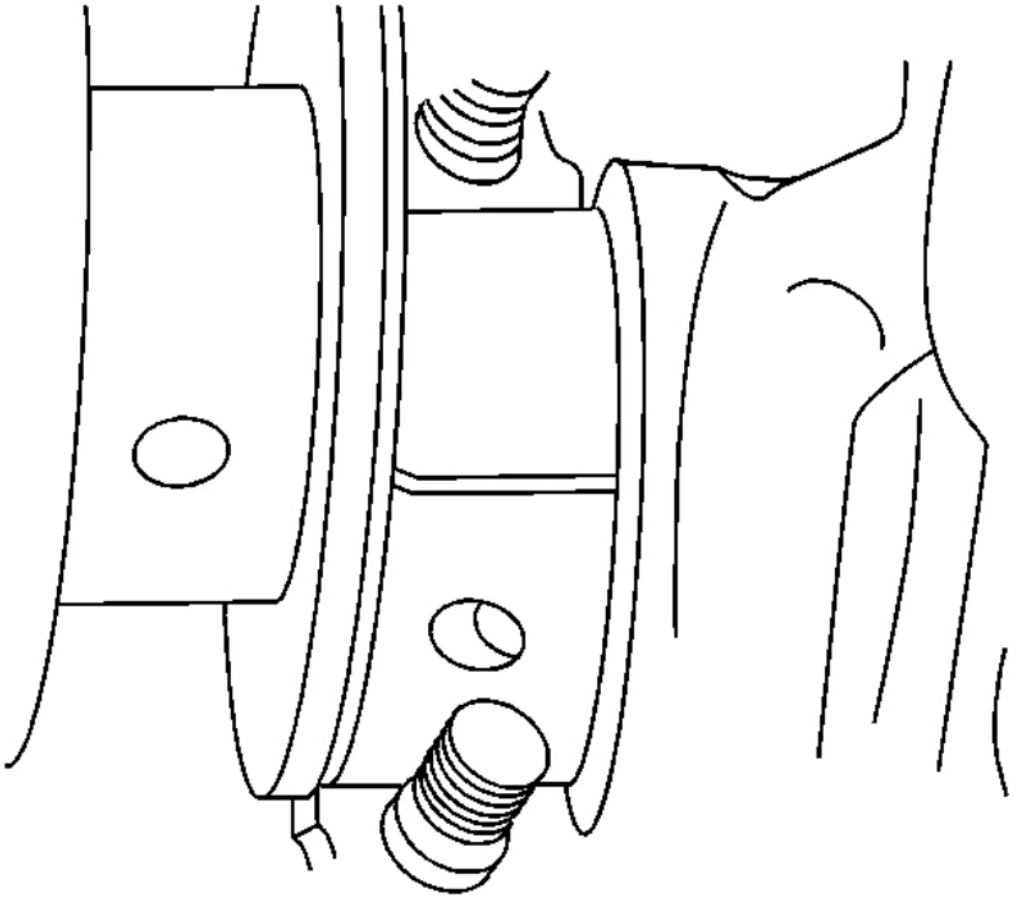


Fig. 13: View Of Gaging Plastic Installed On Crankshaft Journal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Connecting rod bearings are a precision insert type. Connecting rods are of a powdered metal design and cannot be shimmed or filed**

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for bearing fit. If clearances are found to be excessive, a new bearing and/or connecting rod is required.

- **Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.**

1. Remove the bearing cap, bearing half, and bolts. Refer to **Piston, Connecting Rod, and Bearing Removal** .
2. Install the gaging plastic onto the connecting rod bearing journal. Install the gaging plastic the full width of the journal.
3. Install the bearing cap, bearing half, and bolts. Refer to **Piston, Connecting Rod, and Bearing Installation**.
4. Remove the bearing cap, bearing half, and bolts. Refer to **Piston, Connecting Rod, and Bearing Removal** .

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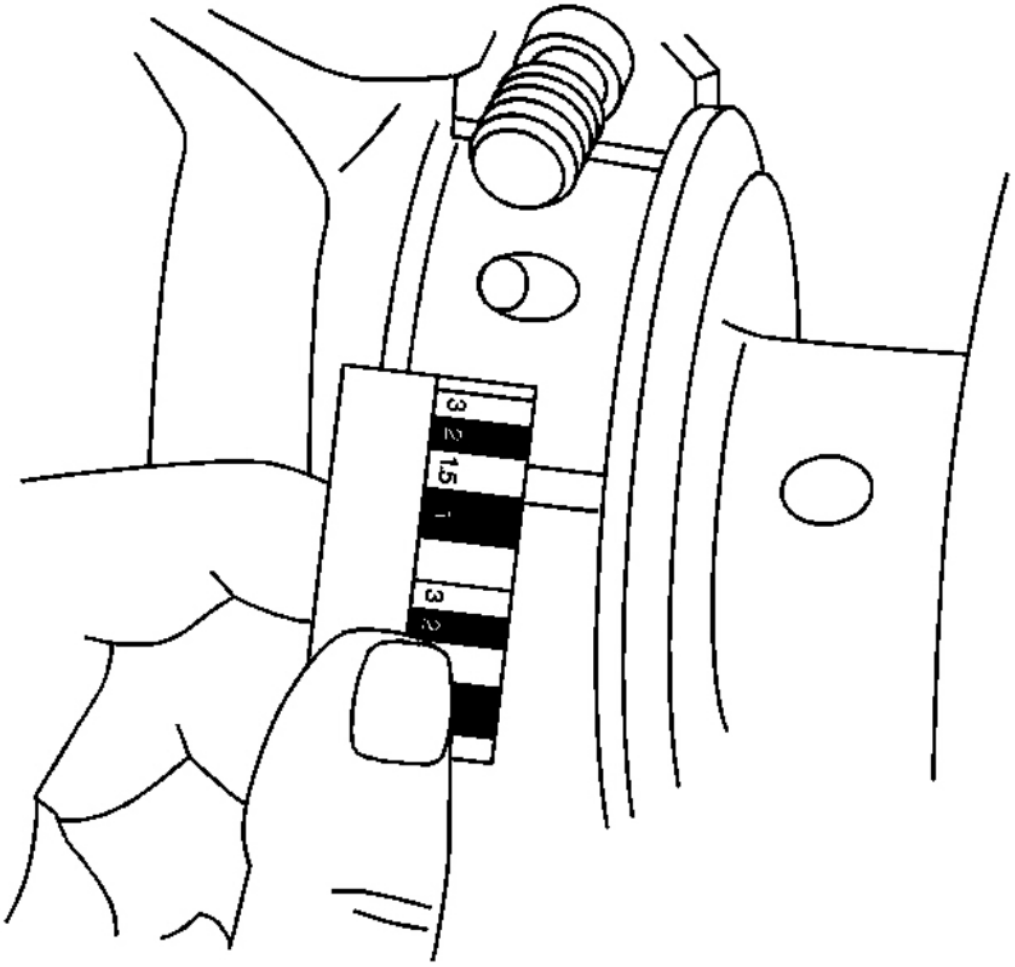


Fig. 14: Measuring Gaging Plastic
Courtesy of GENERAL MOTORS CORP.

5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

MEASURING CONNECTING ROD BEARING CLEARANCE - USING J 43690/J 43690-100

J 43690 and **J 43690-100** have been developed as a more accurate method to measure connecting rod bearing

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clearances. See **Special Tools** . The instructions below provide an overview of tool set-up and usage. For more detailed information, refer to the tool instruction sheets supplied by the tool manufacturer.

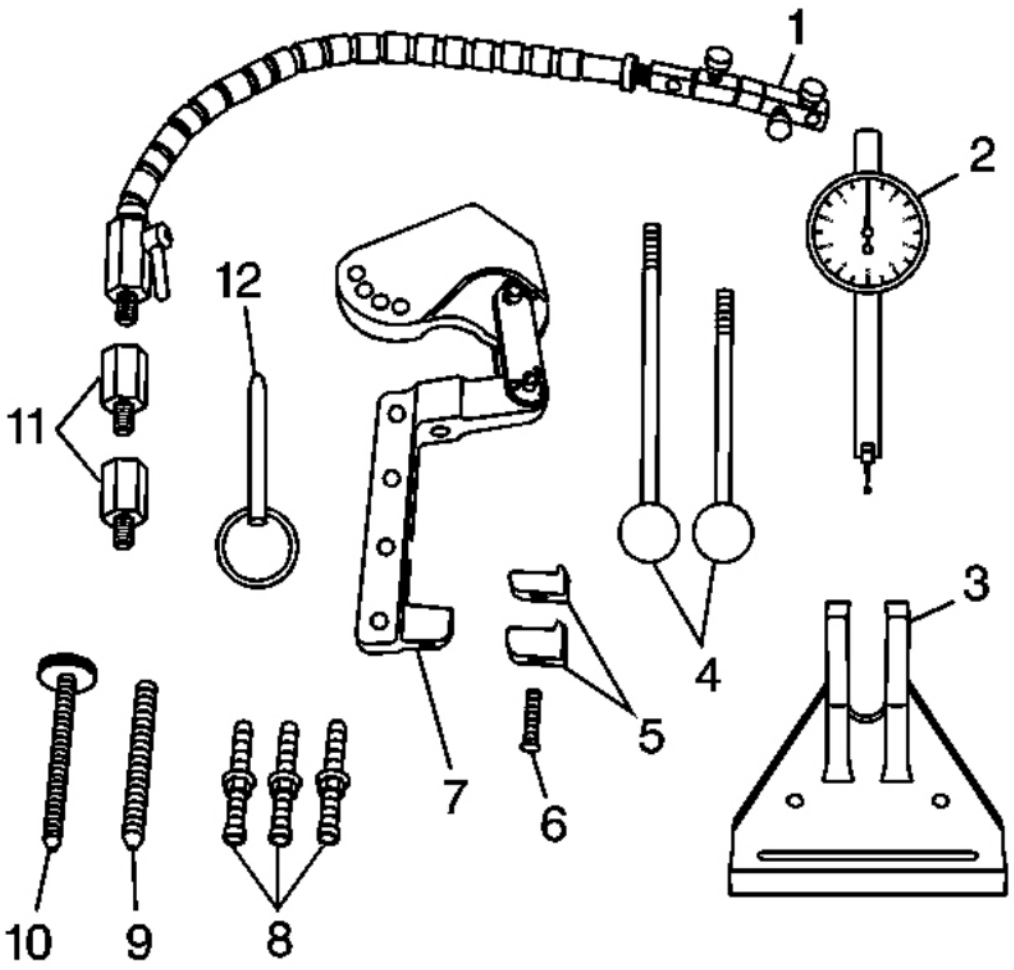


Fig. 15: Identifying Rod Bearing Clearance Checking Tool
Courtesy of GENERAL MOTORS CORP.

J 43690 Rod Bearing Checking Tool. See Special Tools .

- J 43690-20 Swivel Base (1)
- J 43690-19 Dial Indicator (2)
- J 43690-2 Base (3)
- J 43690-5, J 43690-6 Handle (4)

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

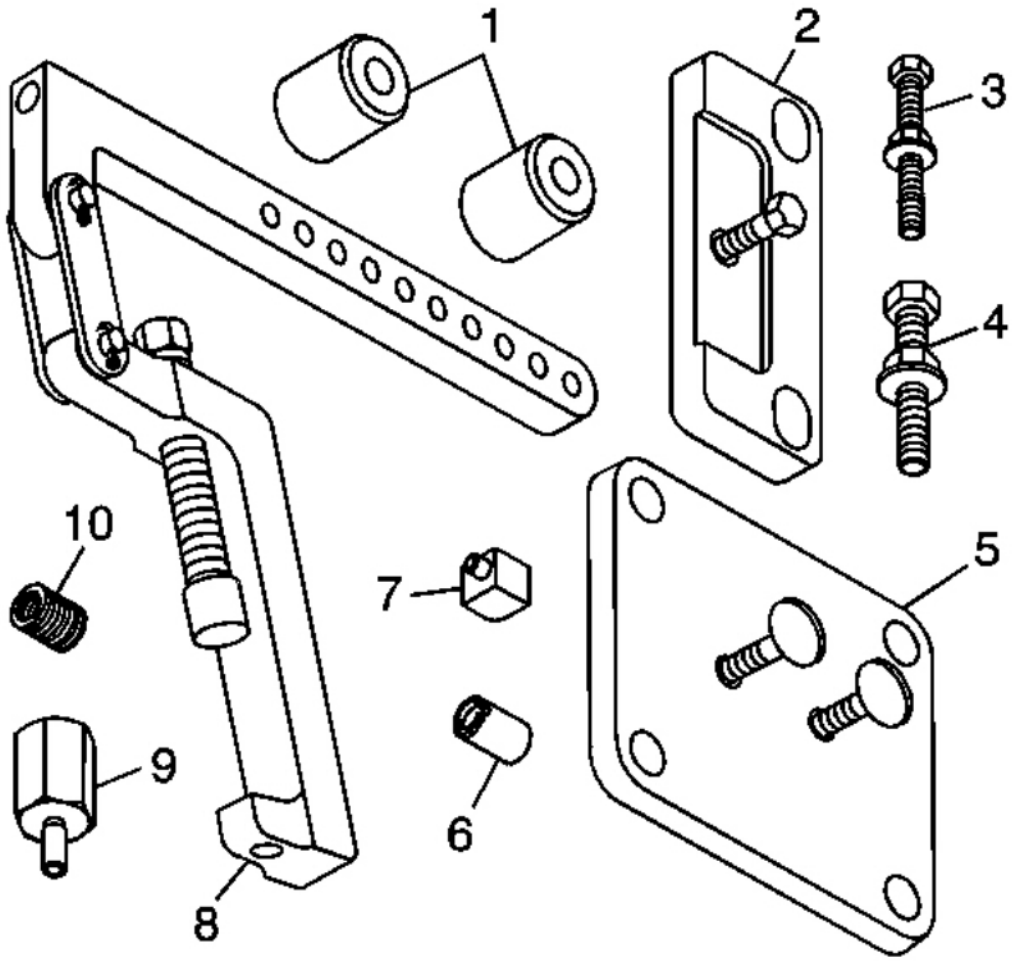


Fig. 16: Identifying Rod Bearing Clearance Tool - Adapter Kit
Courtesy of GENERAL MOTORS CORP.

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J 43690-100 Rod Bearing Checking Tool - Adapter Kit. See Special Tools .

- 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)

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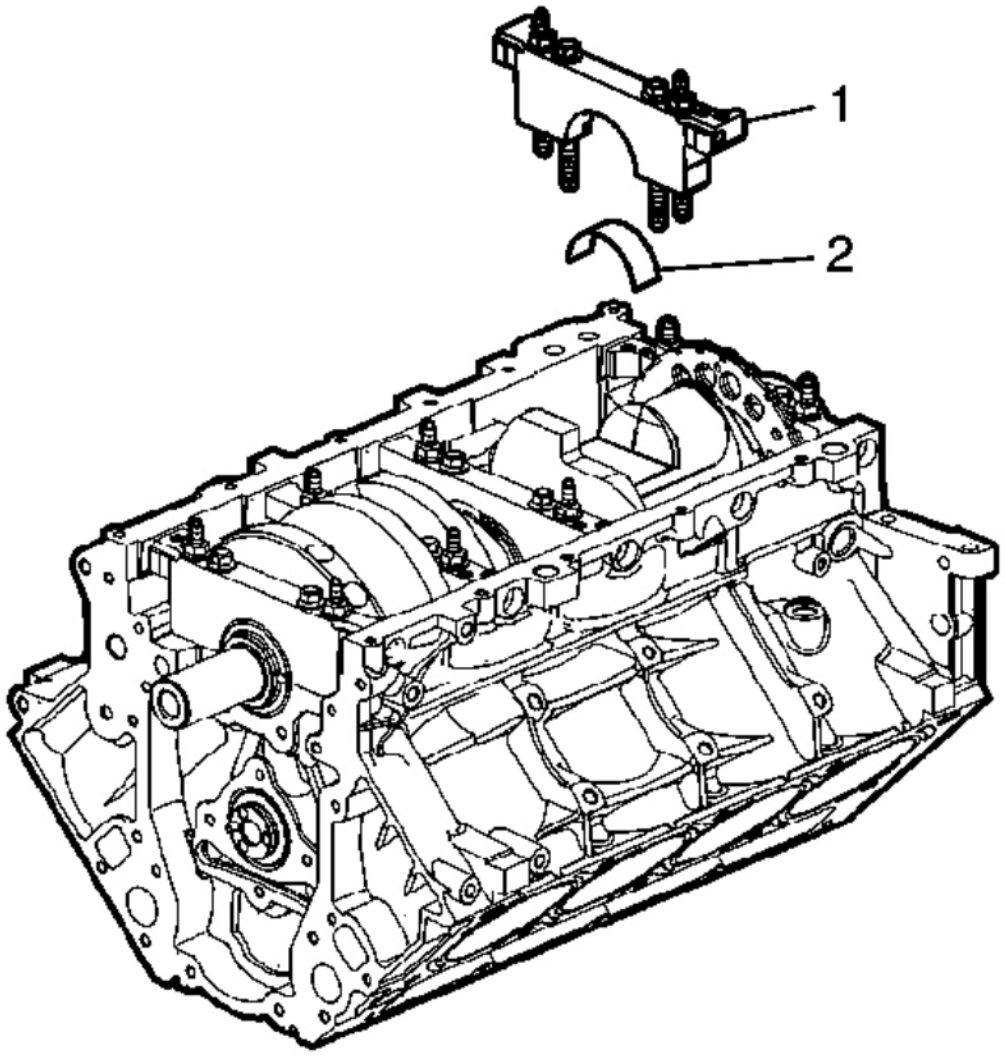


Fig. 17: View Of Bearing Cap, Bolt & Bearing Half
Courtesy of GENERAL MOTORS CORP.

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

1. Rotate the crankshaft until the journal/connecting rod to be measured is in the 12 o'clock position.
2. Remove a bearing cap and bolts (1).
3. Remove the bearing half (2).

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4. Insert a piece of paper card stock onto the crankshaft journal.
5. Install the bearing half (2) and cap and bolts (1). Refer to **Fastener Tightening Specifications** .

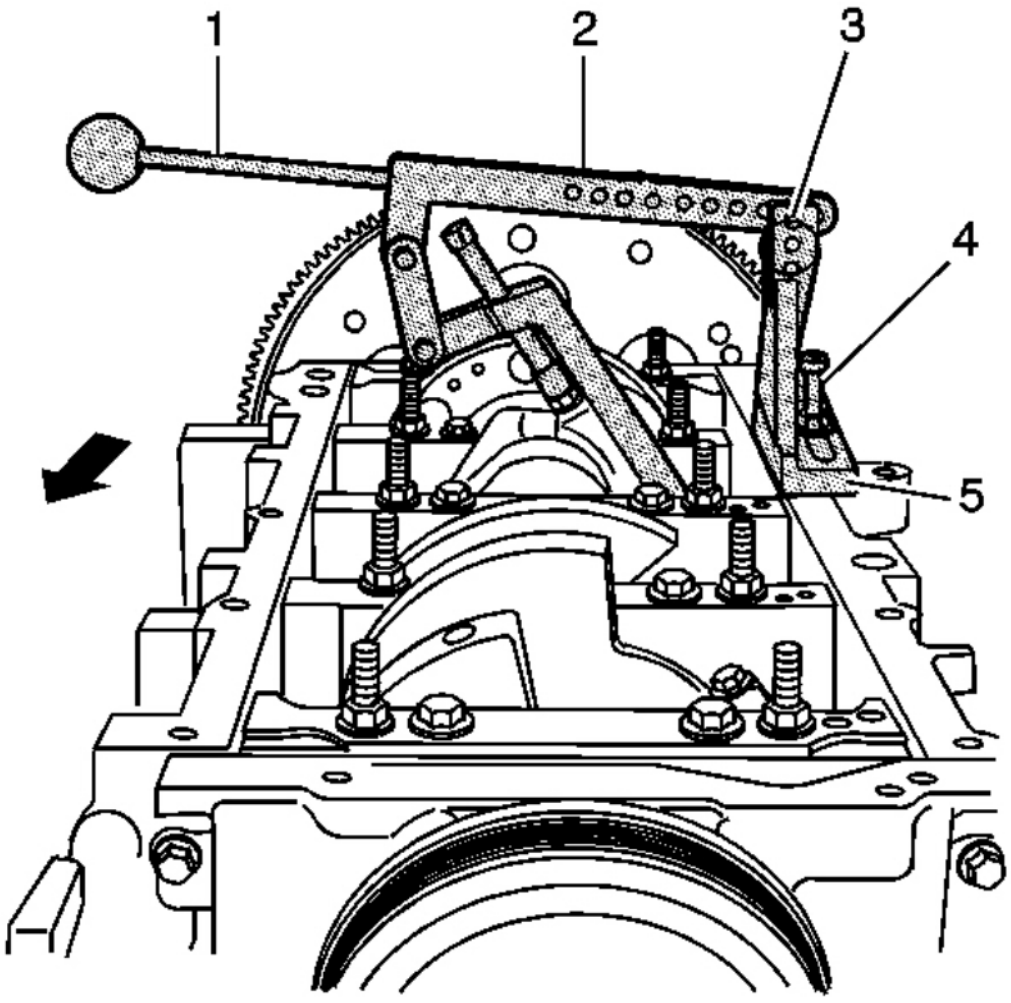


Fig. 18: View Of Special Tool Installed On Engine Block
Courtesy of GENERAL MOTORS CORP.

6. Install the following:
   1. J 43690-2 (5)
   2. J 43690-3 (4)
   3. J 43690-101 (2)
   4. 280310 (3)

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5. J 43690-5 (1)

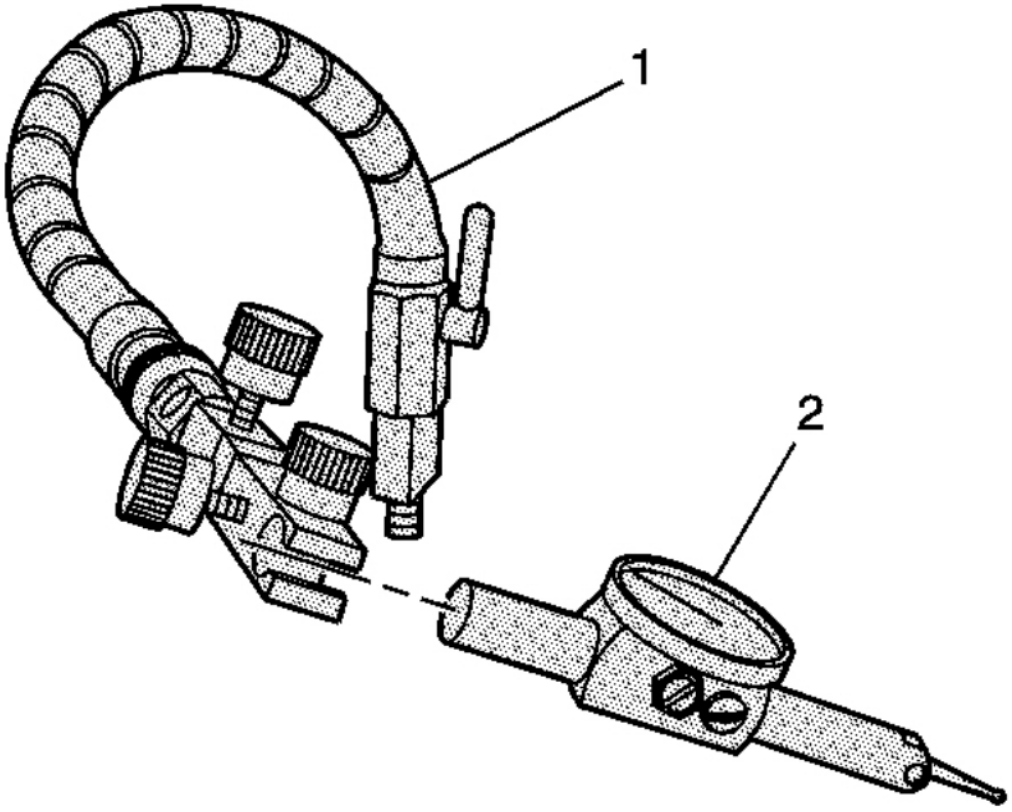


Fig. 19: View Of Swivel Base & Dial Indicator
Courtesy of GENERAL MOTORS CORP.

7. Install the swivel base (1) and dial indicator (2).
8. Adjust per the manufacturers instructions and measure the connecting rod bearing clearance.

   A connecting rod with a clearance in excess of 0.076 mm (0.003 in) is considered excessive. Service components, as required.

CRANKSHAFT BALANCER CLEANING AND INSPECTION

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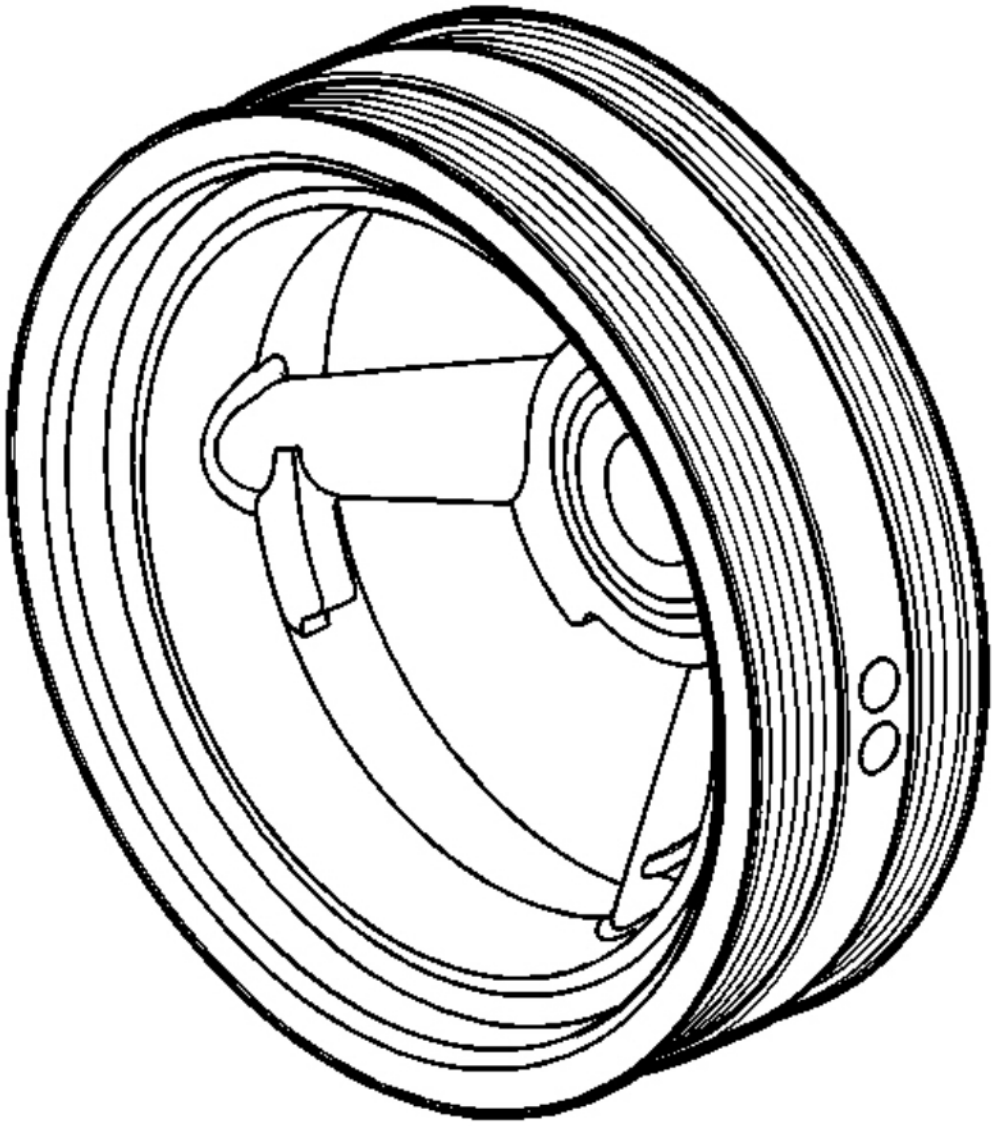


Fig. 20: View Of Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

1. Clean the crankshaft balancer in solvent.
2. Clean the belt grooves of all dirt or debris with a wire brush.
3. Dry the crankshaft balancer with compressed air.
4. Inspect the crankshaft balancer for the following conditions:

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- Worn, grooved, or damaged hub seal surface

  A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.

  Minor imperfections on the hub seal surface may be removed with polishing compound or fine grade emery cloth.

  IMPORTANT: In order for the belt to track properly, the belt grooves should be free of all dirt or debris.

- Dirty or damaged belt grooves

  The balancer belt grooves should be free of any nicks, gouges, or other damage that may not allow the belt to track properly.

  Minor imperfections may be removed with a fine file.

- Worn, chunking, or deteriorated rubber between the hub and pulley

AUTOMATIC TRANSMISSION FLEX PLATE CLEANING AND INSPECTION

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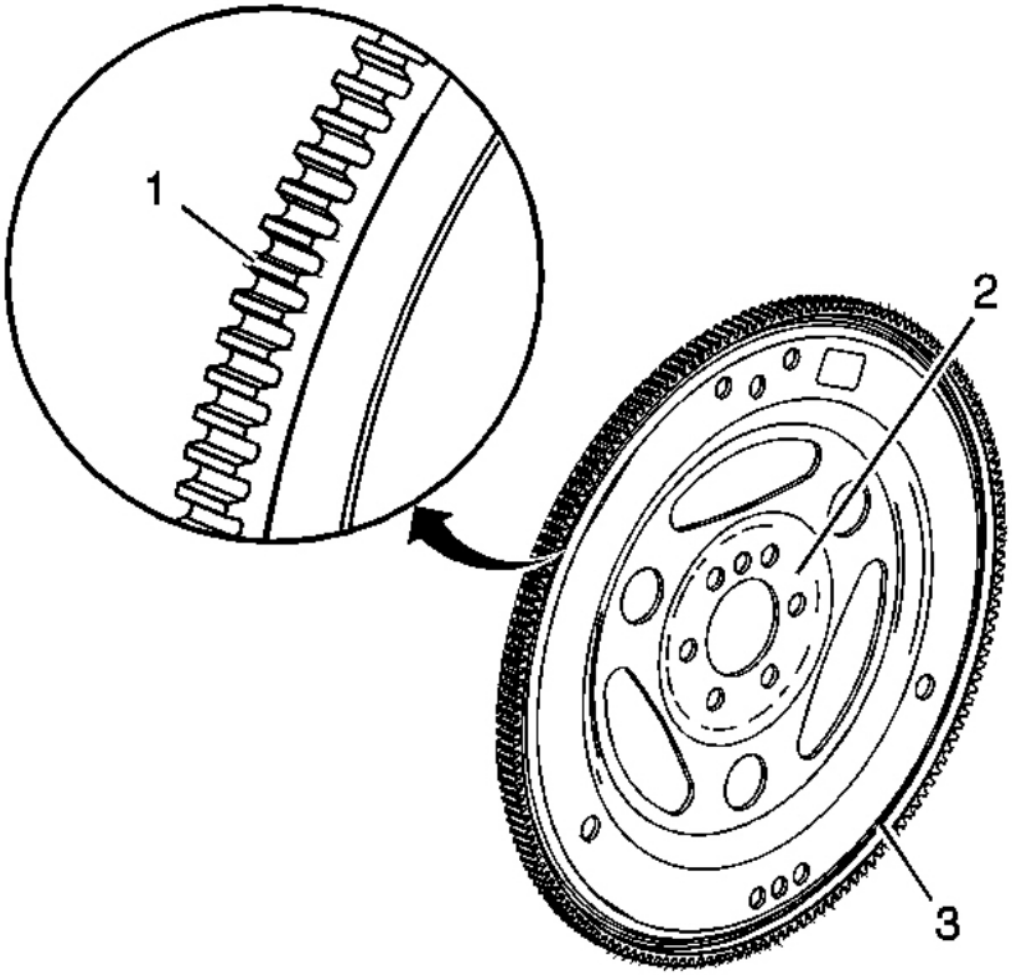


Fig. 21: View Of Ring Gear Teeth
Courtesy of GENERAL MOTORS CORP.

1. Clean the flex plate in solvent.

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

2. Dry the flex plate with compressed air.
3. Inspect the flex plate for the following conditions:
   - Damaged ring gear teeth (1)

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- Stress cracks around the flex plate-to-crankshaft bolt hole locations (2)

IMPORTANT: Do not attempt to repair the welded areas that retain the ring gear to the flex plate. Install a new flex plate.

- Welded areas (3) that retain the ring gear onto the flex plate for cracking

PISTON AND CONNECTING ROD DISASSEMBLE

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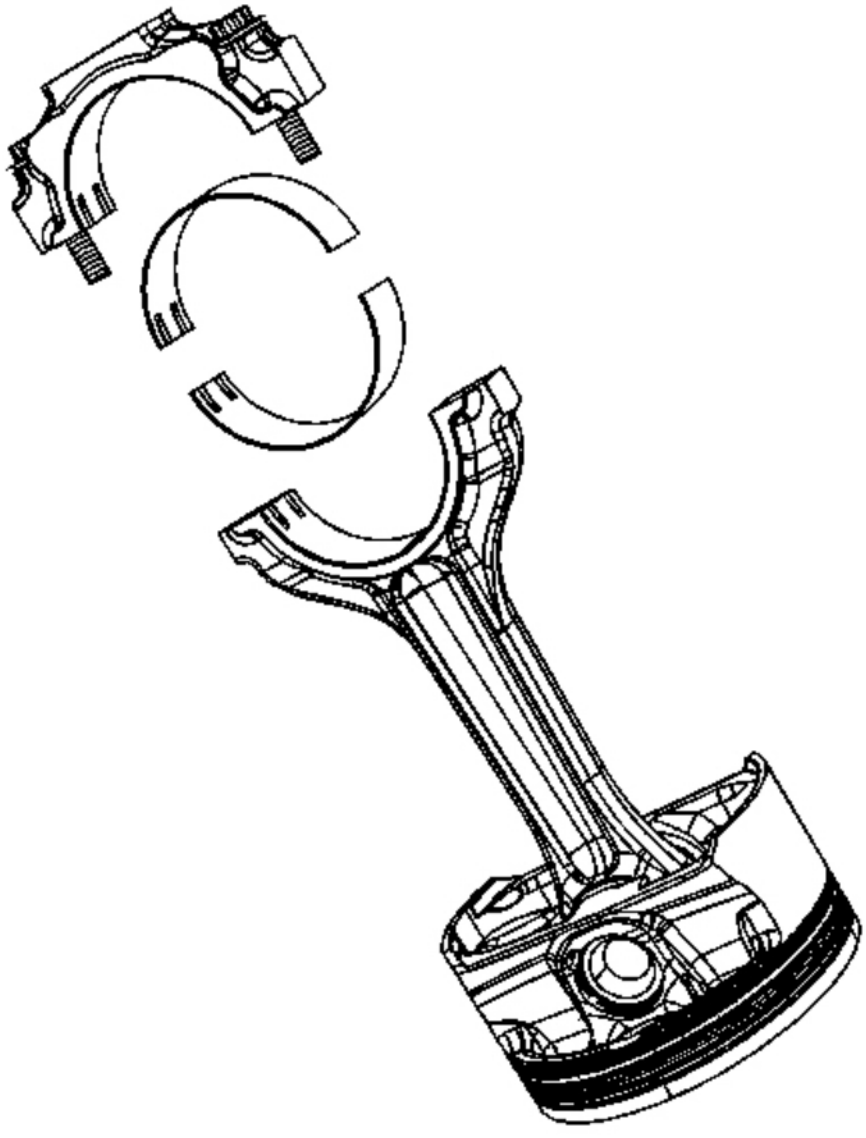


Fig. 22: View Of Piston, Connecting Rod & Bearing Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the connecting rod bearings from the rod and cap.

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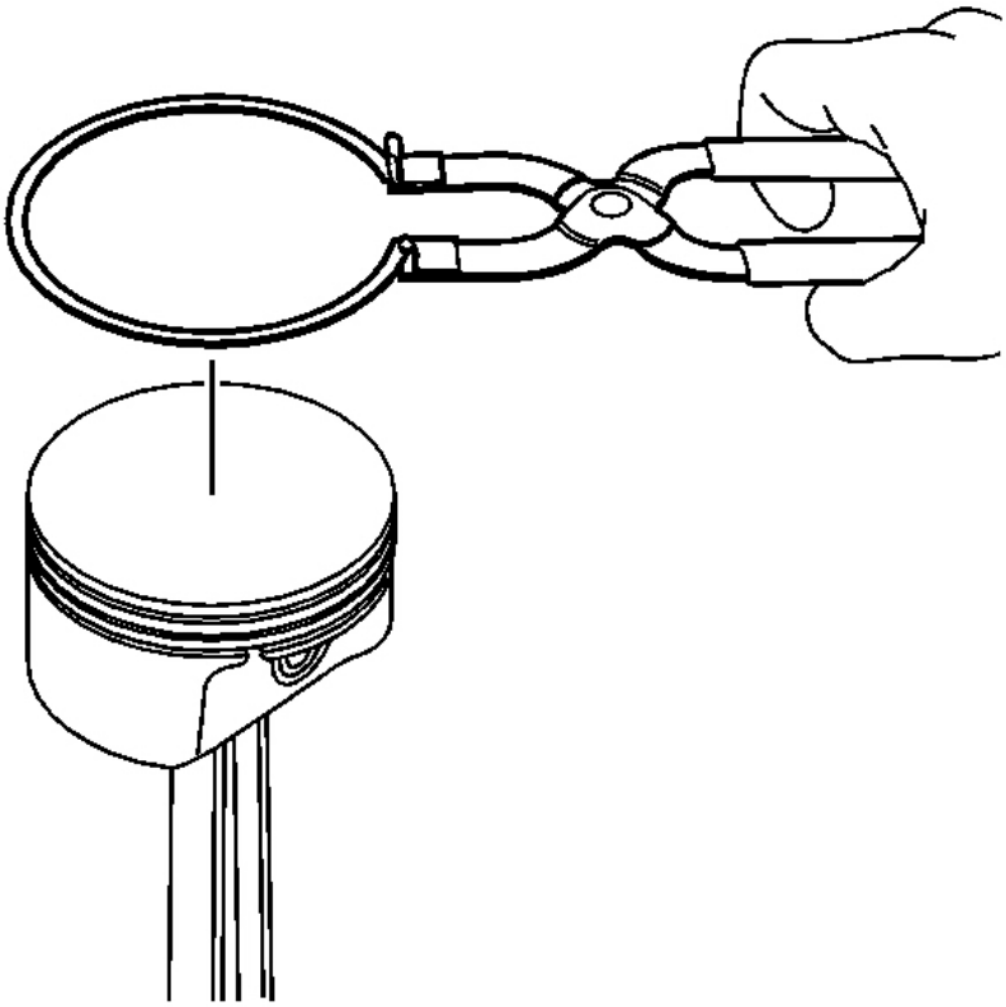


Fig. 23: Removing/Installing Piston Rings
Courtesy of GENERAL MOTORS CORP.

2. Using piston ring pliers, remove the piston rings from the piston.

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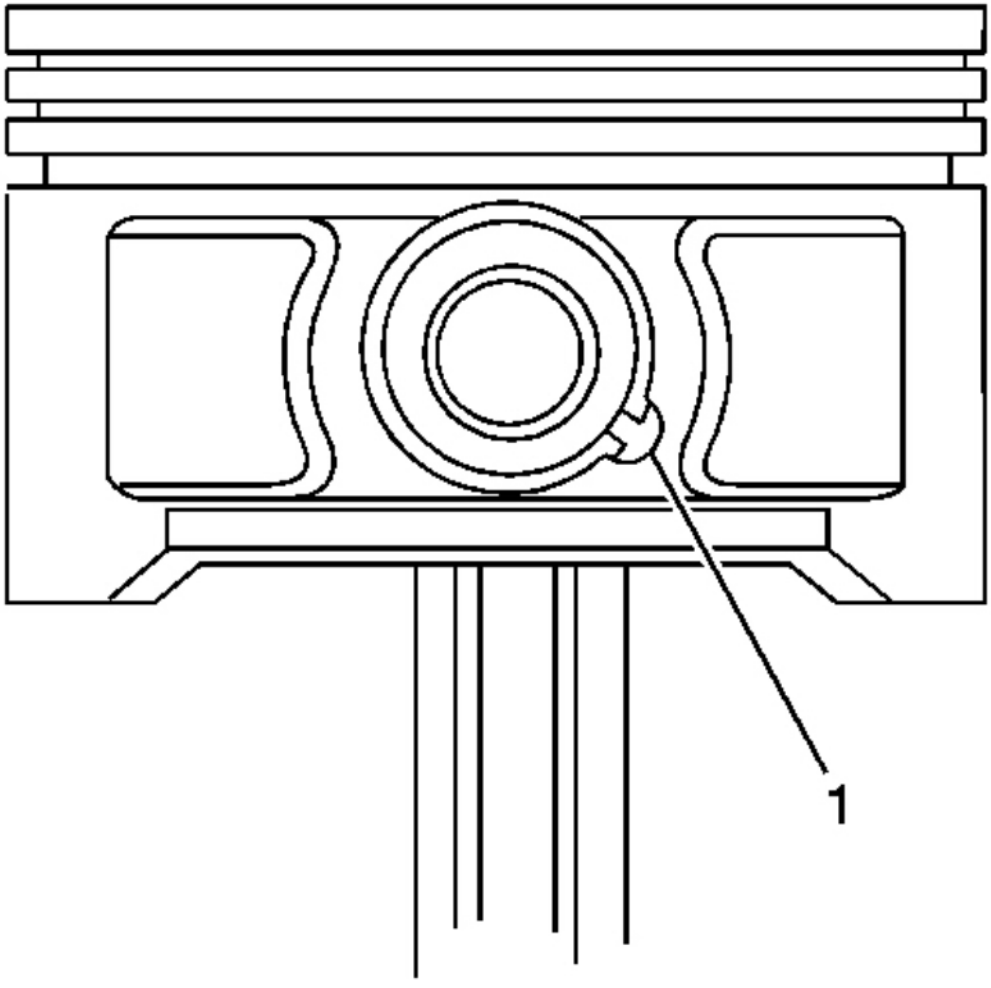


Fig. 24: View Of Piston Pin Retaining Clip & Cutout Area Of Pin Bore
Courtesy of GENERAL MOTORS CORP.

3. Rotate the piston pin retainers until the ring end gaps are positioned in the cutout area (1) of the pin bore.

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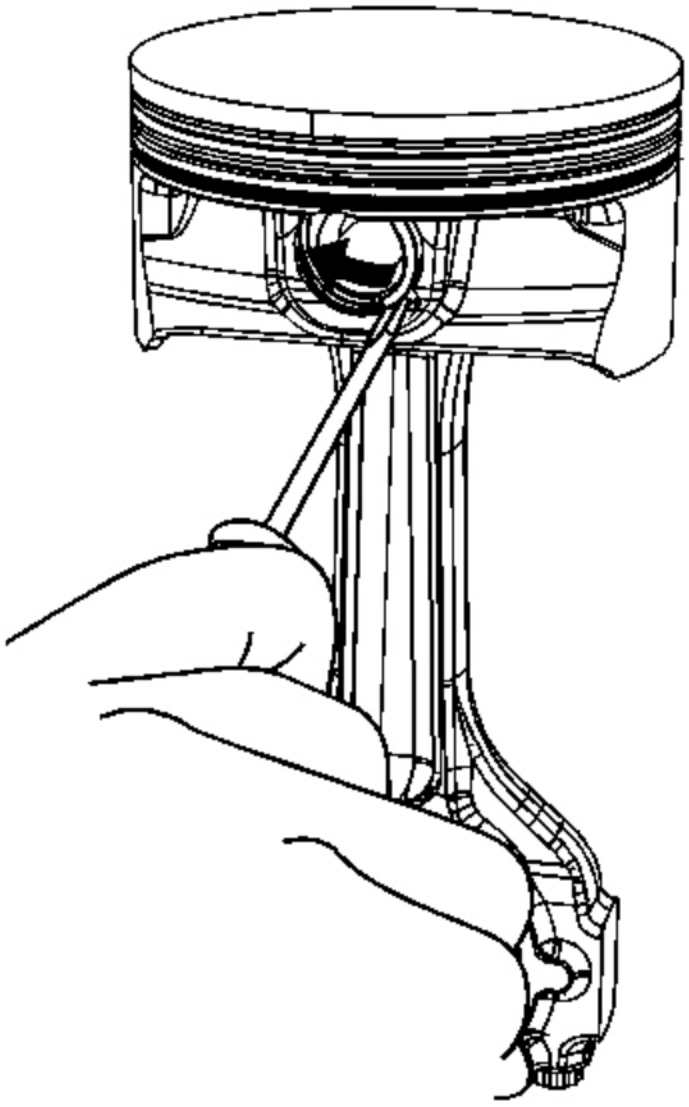


Fig. 25: Removing Piston Retainers
Courtesy of GENERAL MOTORS CORP.

4. Remove the retainers starting in the cutout area of the pin bore.

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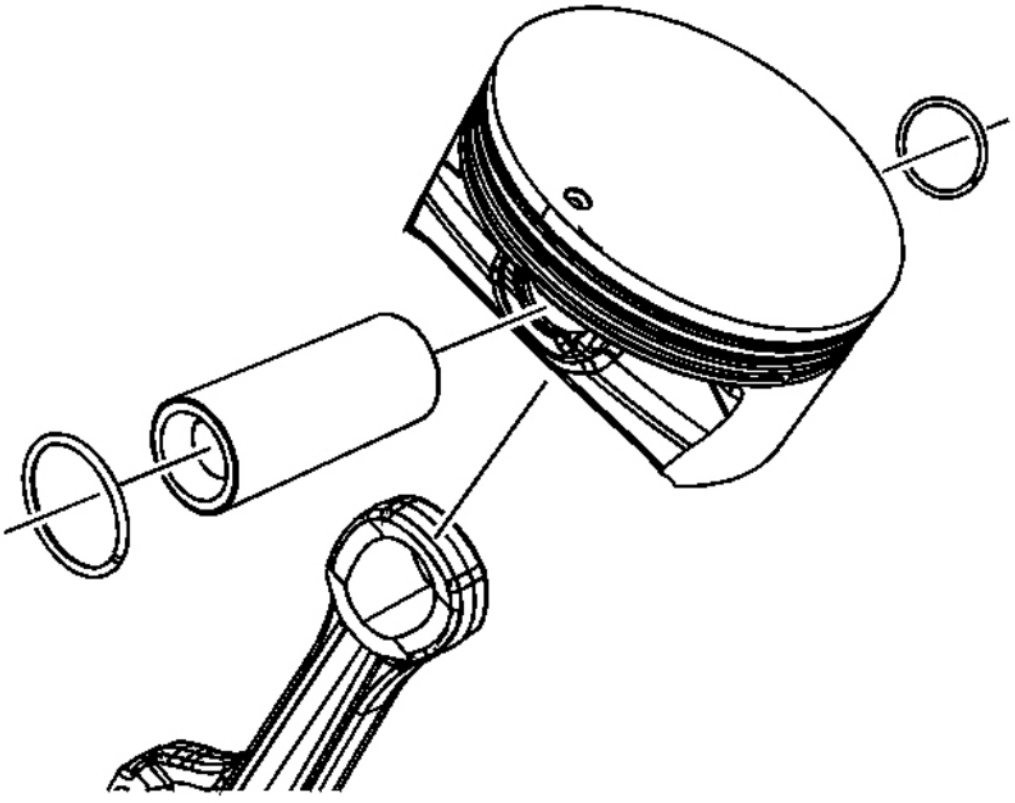


Fig. 26: View Of Piston Pin, Piston & Connecting Rod
Courtesy of GENERAL MOTORS CORP.

5. Remove the pin from the piston and connecting rod.
6. The piston and pin are a matched set and are not to be serviced separately.

   Mark, sort, or organize the piston and the matching piston pin.

PISTON, CONNECTING ROD, AND BEARINGS CLEANING AND INSPECTION

PISTON, PIN, AND PISTON RINGS

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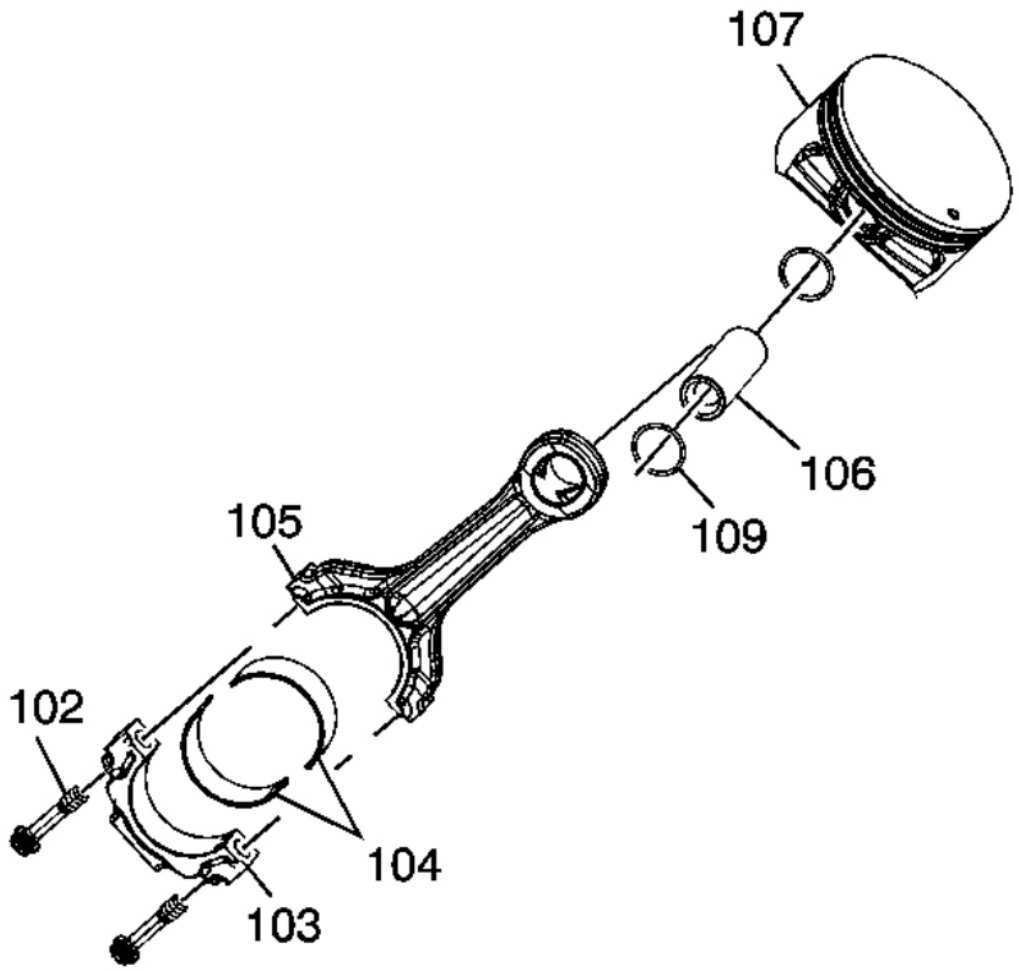


Fig. 27: Piston, Connecting Rod & Bearings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Replace pistons, pins, and connecting rods that are damaged or show signs of excessive wear.**
- **The piston and pin are to be serviced as an assembly.**
- **Do not wire brush any part of the piston.**
- **Measurement of the components should be taken with the components at normal room temperature.**

1. Clean the varnish and carbon from the piston (107) using cleaning solvent.

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CAUTION: Refer to Safety Glasses Caution .

2. Dry the components with compressed air.

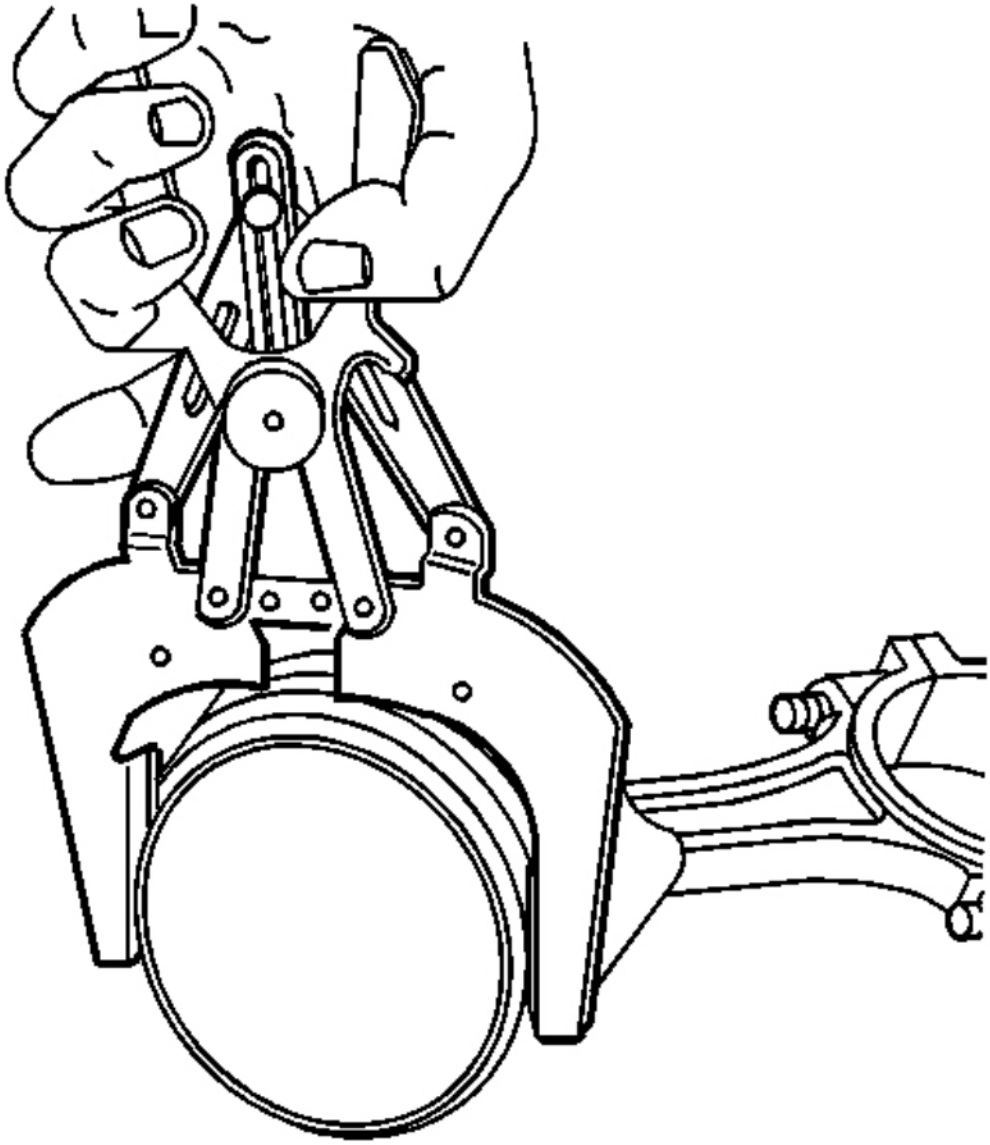


Fig. 28: Cleaning The Piston Ring Grooves With Suitable Ring Groove Cleaning Tool

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Courtesy of GENERAL MOTORS CORP.

3. Clean the piston ring grooves with a suitable ring groove cleaning tool.
4. Clean the oil lubrication holes and slots.

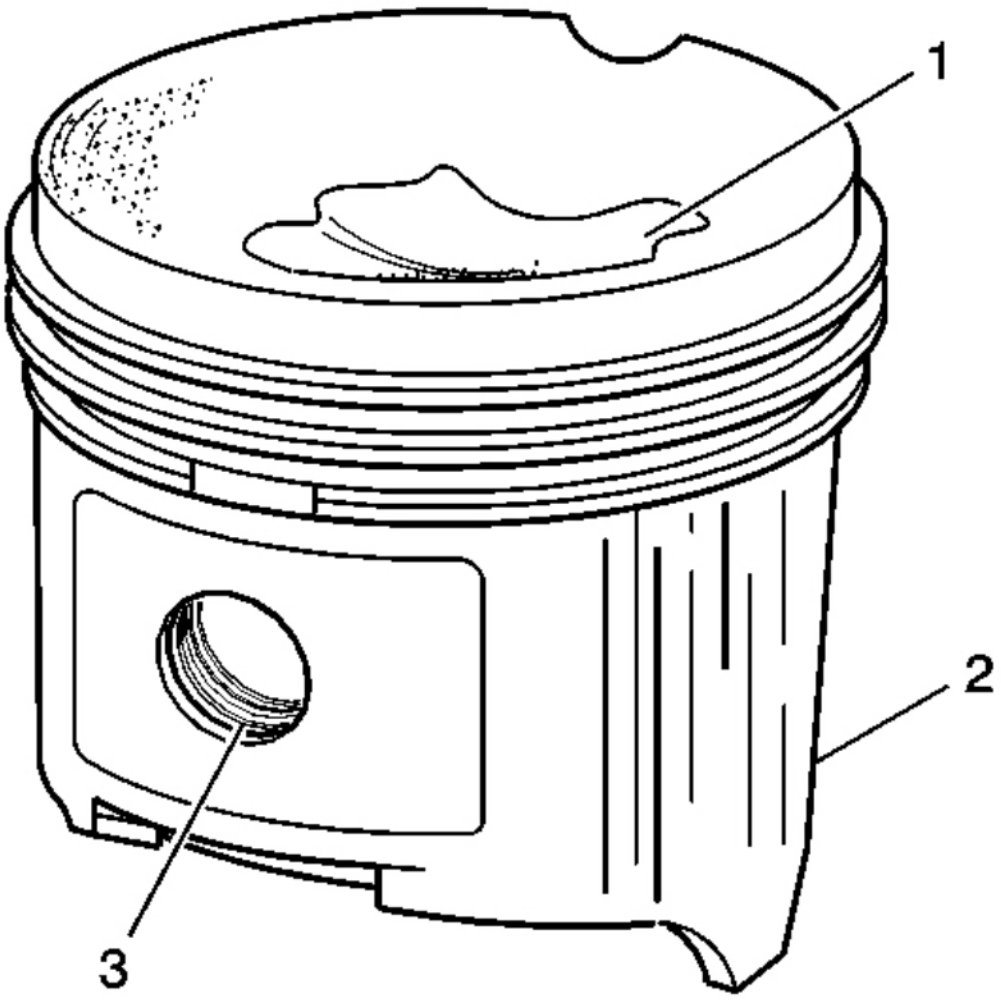


Fig. 29: Identifying Piston Damage Inspection Areas
Courtesy of GENERAL MOTORS CORP.

5. Inspect the piston for the following conditions:
    - Cracks in the piston ring lands, the piston skirt, or pin bosses
    - Piston ring grooves for nicks, burrs, or warpage which may cause the piston ring to bind

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MINOR imperfections may be removed from the piston with a fine file.

- Eroded areas at the top of the piston (1)
- Scuffed or damaged skirts (2)
- Scoring to the piston pin bore (3) or piston pin

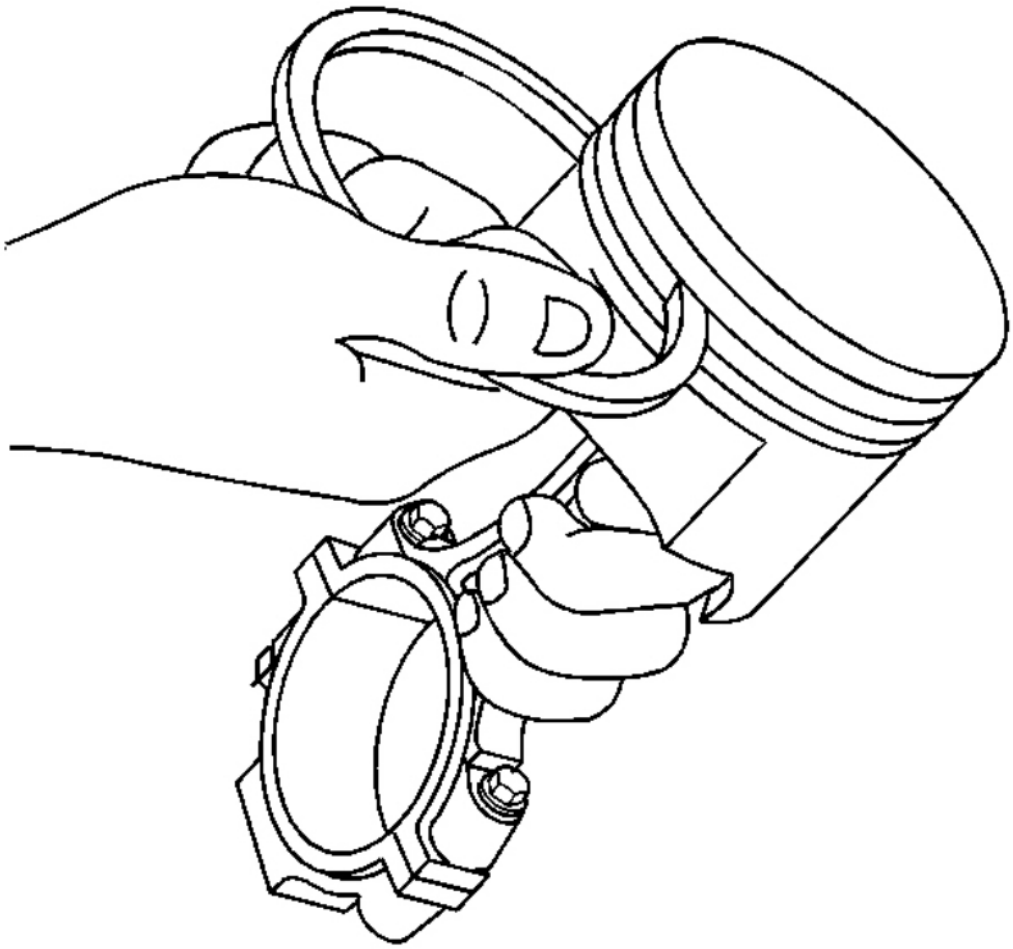


Fig. 30: Inserting Piston Ring Into Ring Groove
Courtesy of GENERAL MOTORS CORP.

6. Insert the edge of the piston ring into the piston ring groove.

   Roll the piston ring completely around the piston. If binding is caused by a distorted ring groove, MINOR imperfections may be removed with a fine file. If binding is caused by a distorted piston ring, replace the

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rings, as required.

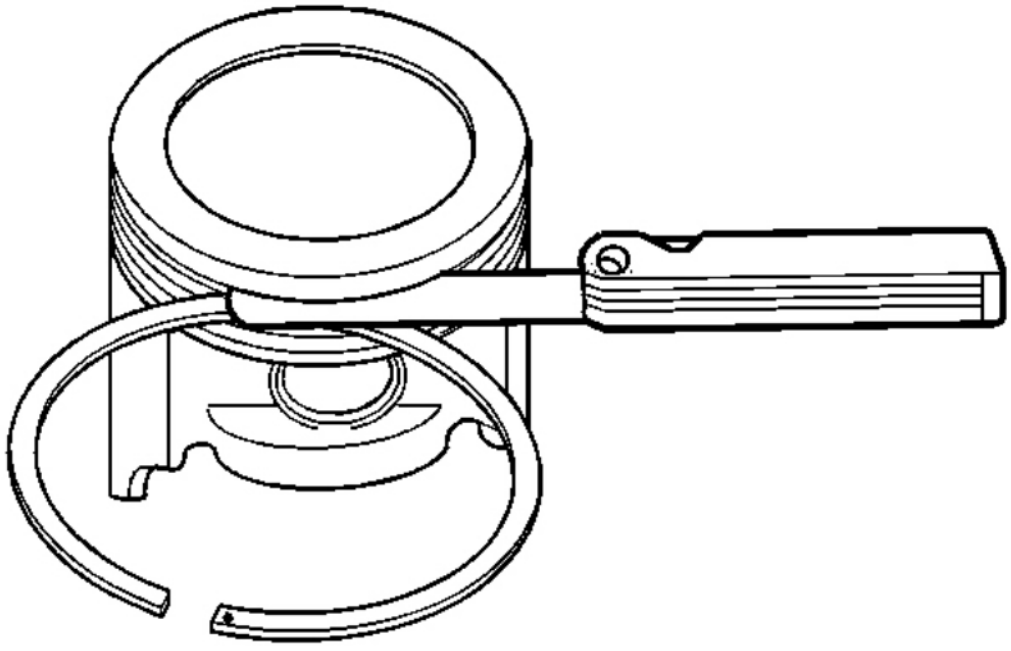


Fig. 31: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS CORP.

7. Measure the piston ring side clearance with a feeler gage. If side clearance is not within specifications, try another piston ring. If the proper ring-to-groove clearance cannot be obtained, replace the piston and pin as an assembly. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

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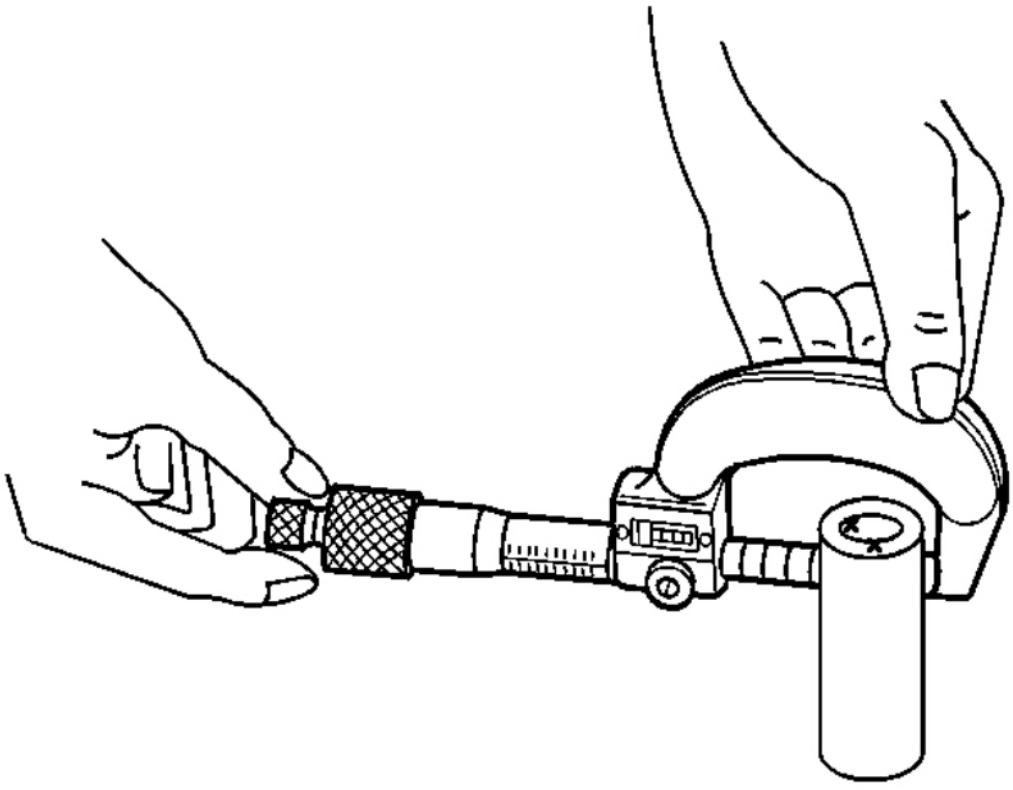


Fig. 32: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS CORP.

8. To determine piston pin-to-bore clearance, use a micrometer and measure the piston pin outside diameter (OD).

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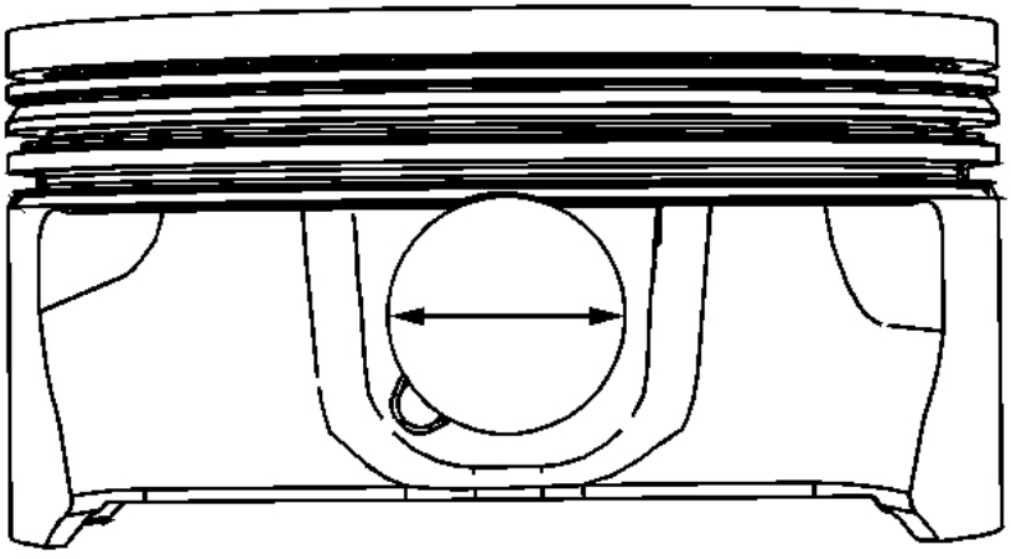


Fig. 33: Measuring Piston Pin-To-Bore Clearance
Courtesy of GENERAL MOTORS CORP.

9. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore inside diameter (ID).
10. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

MEASURING PISTON RING END GAP

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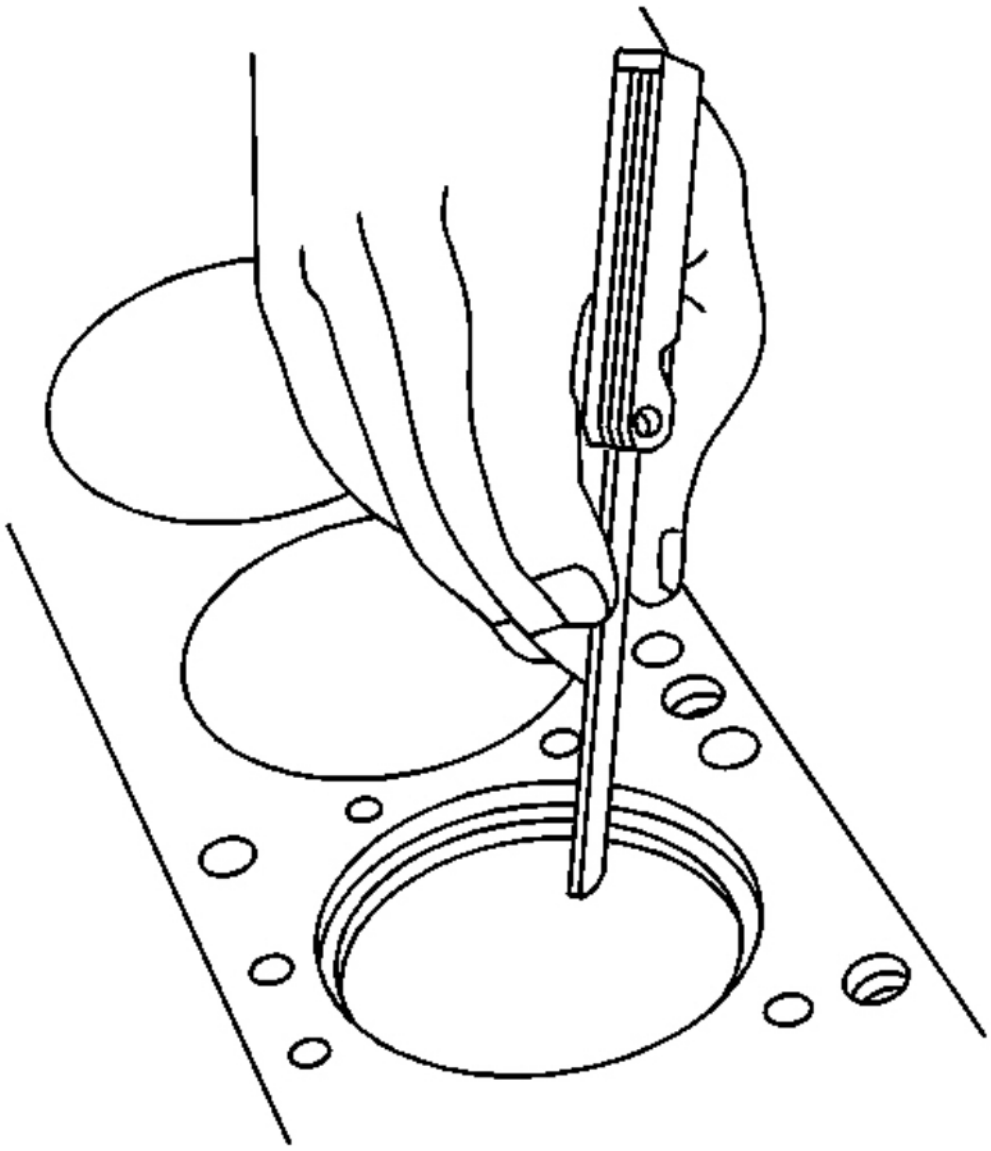


Fig. 34: Measuring Piston Ring End Gap
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Do not attempt to file the end of the piston ring to achieve the proper end gap clearance.**
- **Measure the piston ring in the cylinder in which it will be used.**

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1. Place the piston ring into the cylinder bore 6.5 mm (0.25 in) below the top of the ring travel area. Both rings should be installed with the orientation marks facing the top of the piston.
2. Insert a feeler gage and measure the piston ring end gap. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

CONNECTING ROD AND BEARINGS

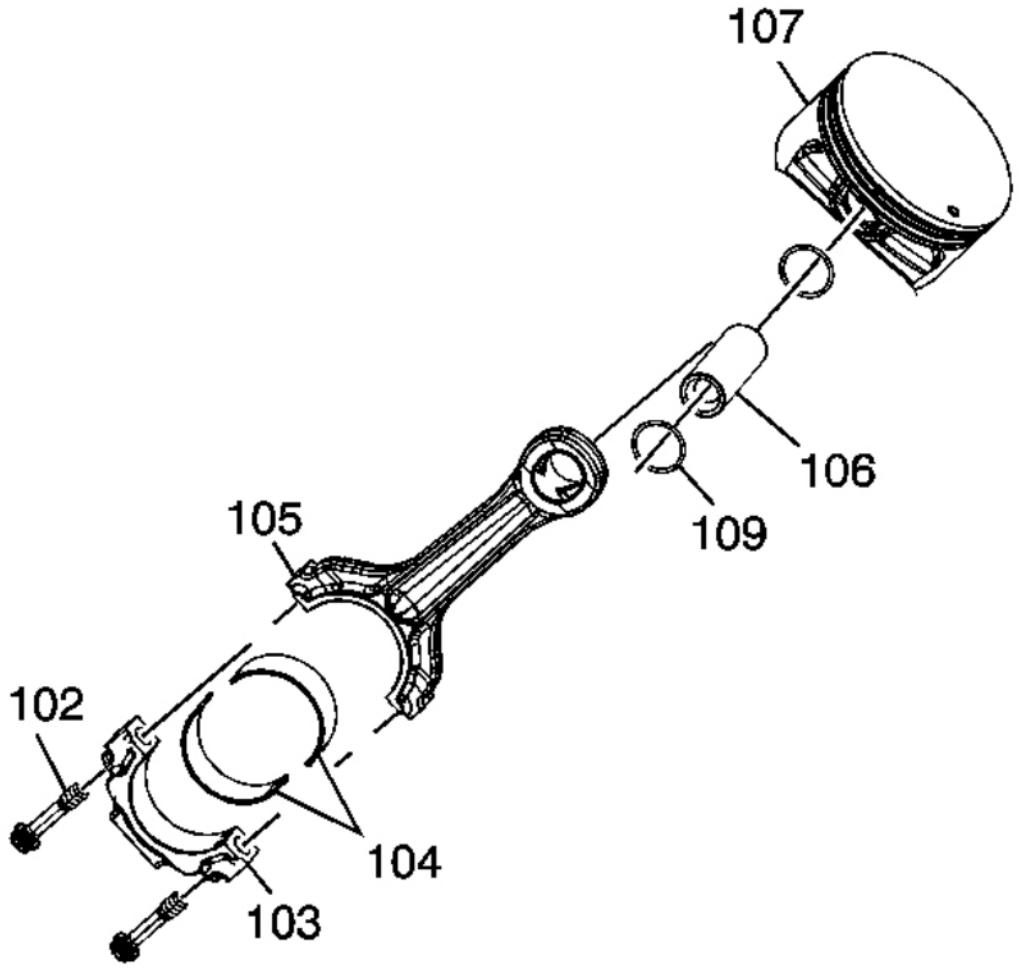


Fig. 35: Piston, Connecting Rod & Bearings
Courtesy of GENERAL MOTORS CORP.

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IMPORTANT:

- **The powdered metal connecting rod and cap are machined for proper clearances. The connecting rod and cap must be used as an assembly with no repair or modifications to either mating surface. Do not attempt to repair the rod or cap. If service is required, replace the rod and cap as an assembly.**
- **Do not attempt to repair the bolt hole threads of the connecting rod.**

1. Clean the connecting rod (105) and cap (103) in solvent.

CAUTION: Refer to Safety Glasses Caution .

2. Dry the components with compressed air.

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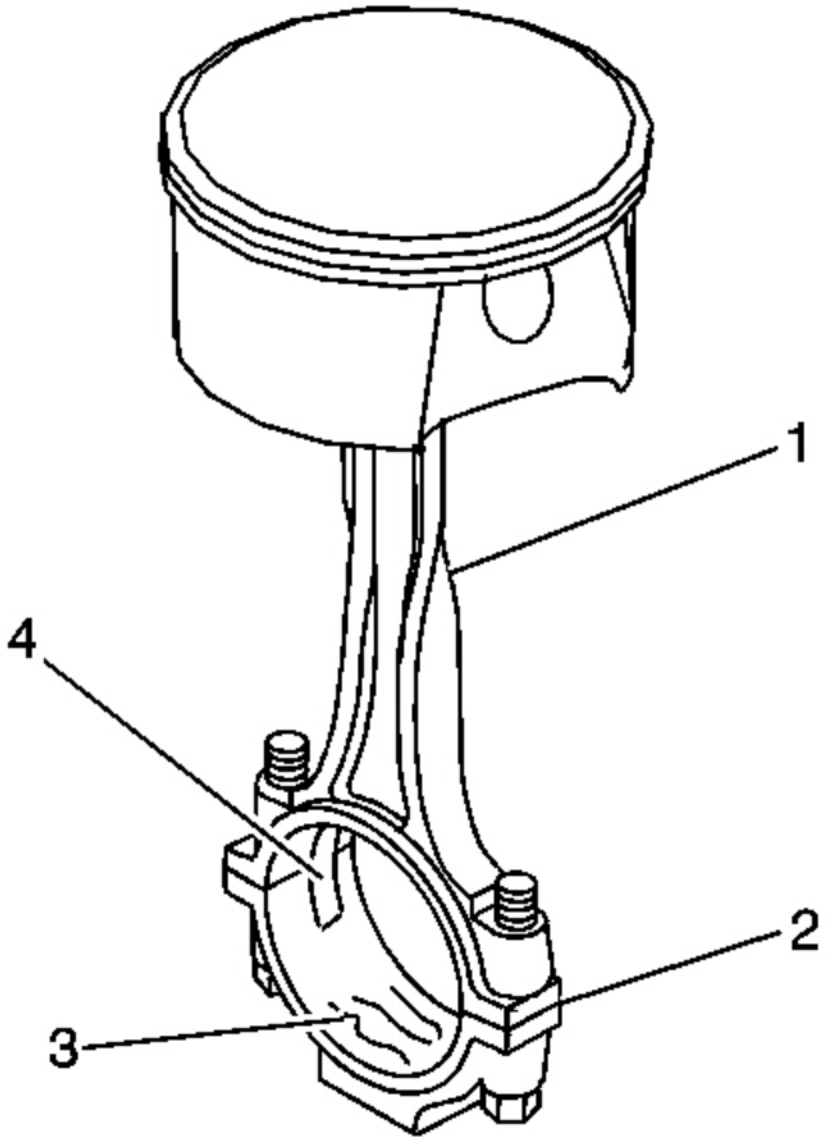


Fig. 36: Identifying Connecting Rod Inspection Areas
Courtesy of GENERAL MOTORS CORP.

3. Inspect the connecting rod for the following conditions:
   - Twisting (1)
   - Proper fit of the connecting rod and cap mating surfaces (2)

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- Nicks or gouges in the bearing bore (3)
- Damage to the bearing locating slots (4)

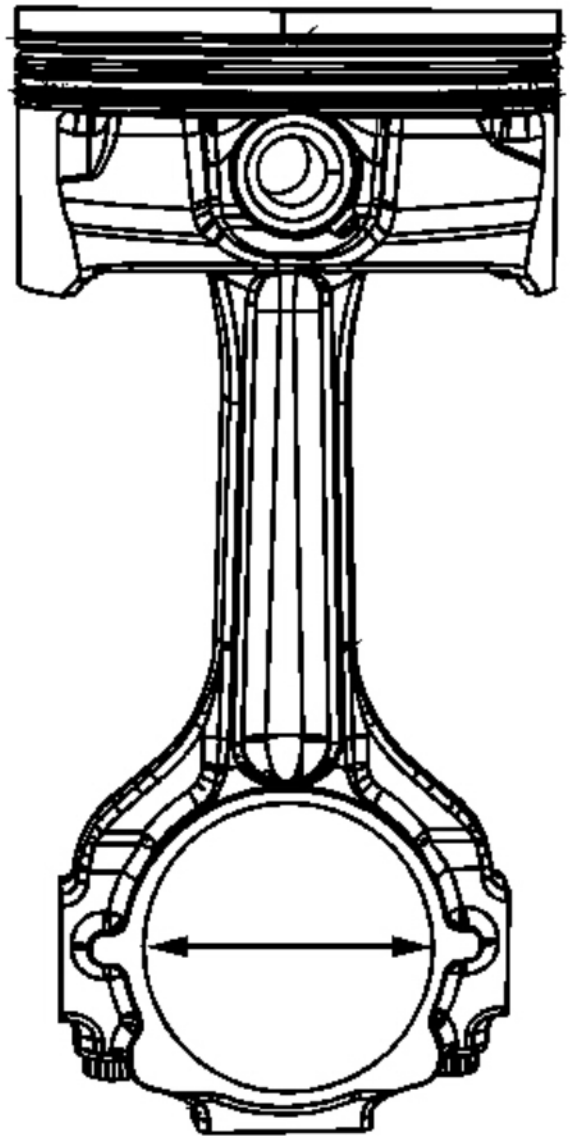


Fig. 37: Measuring Connecting Rod Bearing Bore For An Out-Of-Round
Courtesy of GENERAL MOTORS CORP.

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4. Measure the connecting rod bearing bore for an out-of-round condition. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

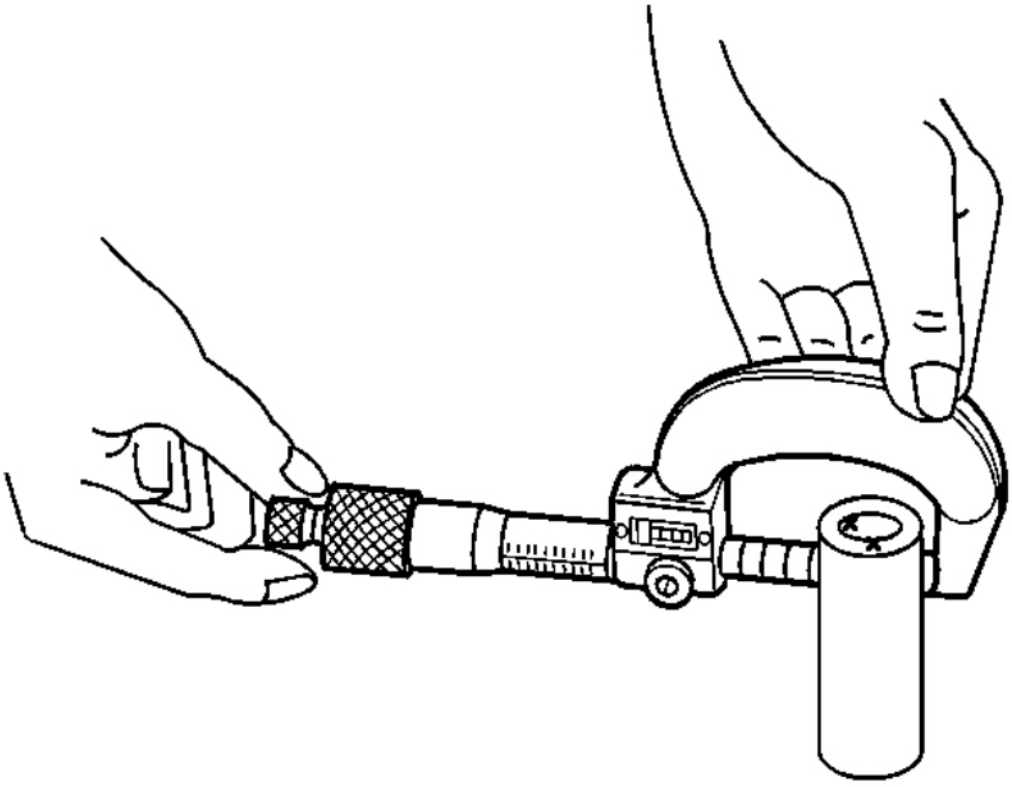


Fig. 38: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS CORP.

5. To determine piston pin-to-connecting rod bore clearance, use a micrometer and measure the piston pin OD.

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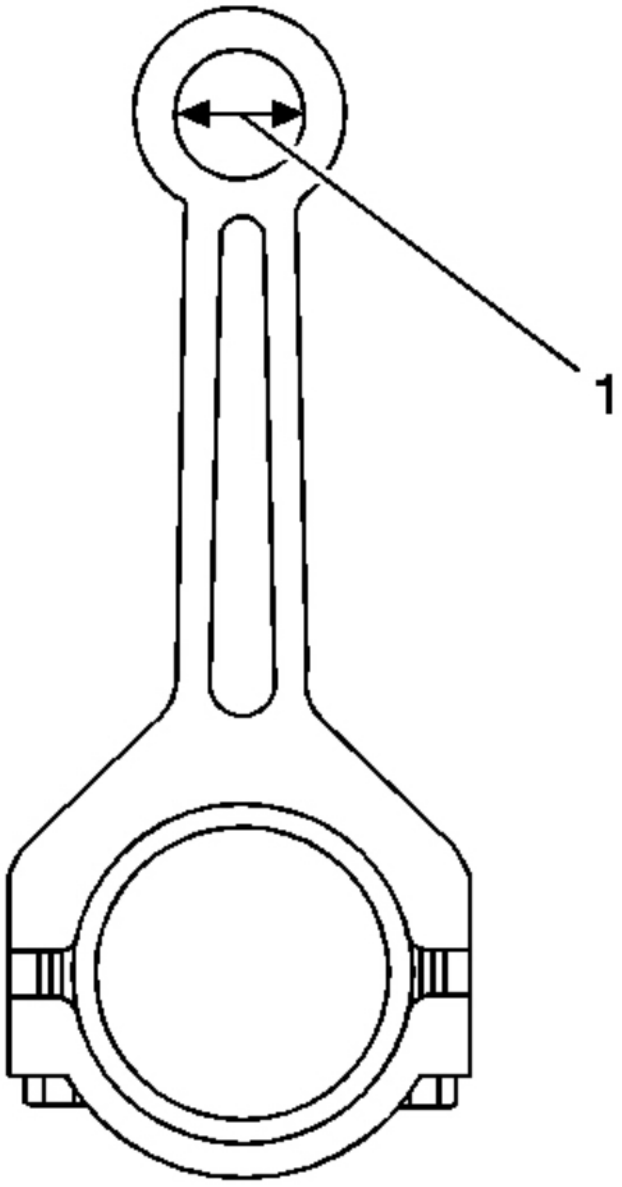


Fig. 39: Measuring Connecting Rod Pin Bore Inside Diameter
Courtesy of GENERAL MOTORS CORP.

6. To determine the piston pin-to-connecting rod bore clearance, use a micrometer and measure the connecting rod pin bore (1) ID.
7. Subtract the piston pin OD measurement from the connecting rod pin bore ID measurement to determine

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pin-to-bore clearance. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

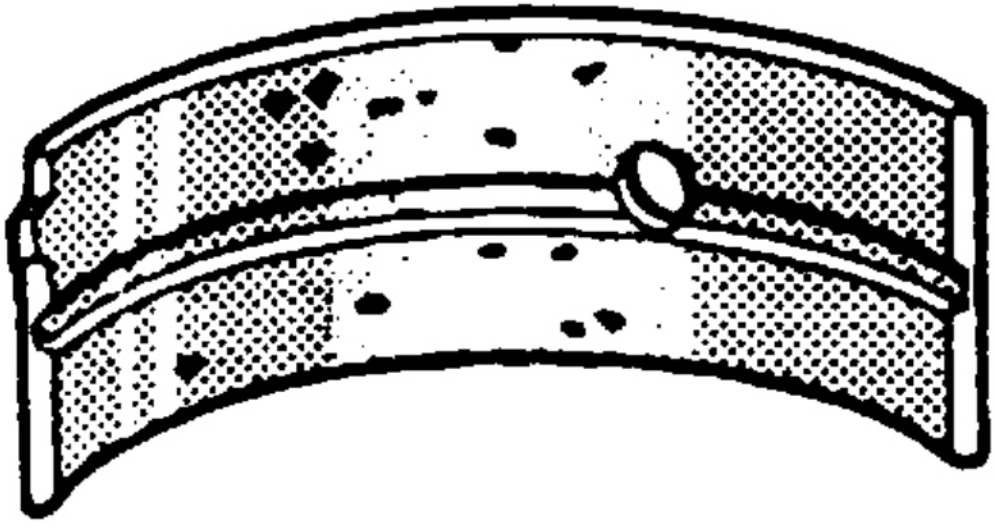


Fig. 40: Identifying Crankshaft Bearing Craters Or Pockets
Courtesy of GENERAL MOTORS CORP.

8. Inspect the connecting rod bearings for craters or pockets. Flattened sections on the bearing halves indicate fatigue.

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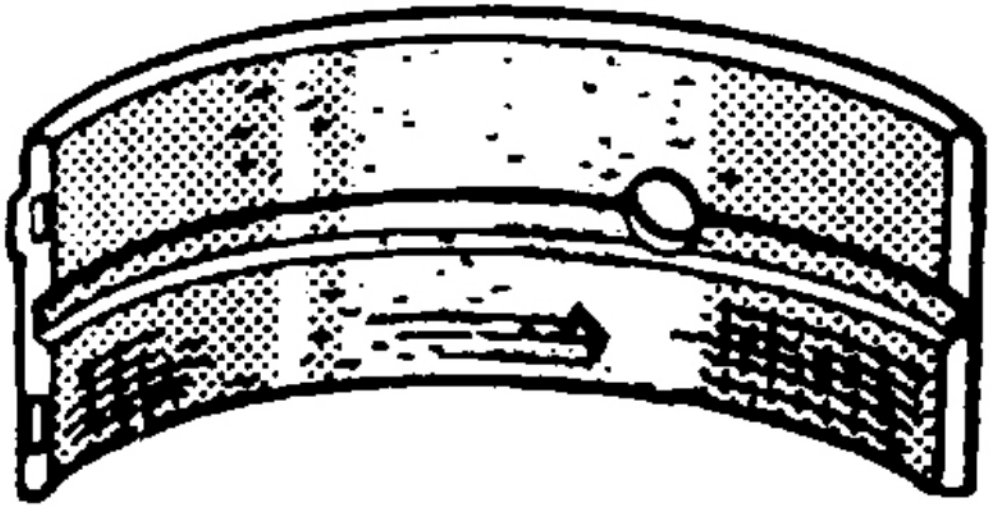


Fig. 41: Identifying Connecting Rod Bearing Scoring Or Discoloration
Courtesy of GENERAL MOTORS CORP.

9. Inspect the connecting rod bearings for excessive scoring or discoloration.
10. Inspect the connecting rod bearings for dirt or debris imbedded into the bearing material.

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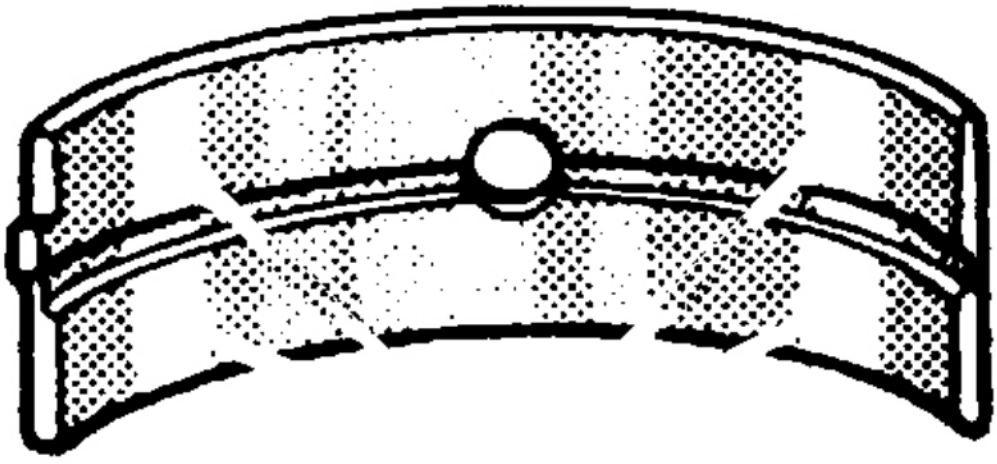


Fig. 42: Crankshaft Bearing Polished Sections (Improper Seating)
Courtesy of GENERAL MOTORS CORP.

11. Inspect the connecting rod bearings for improper seating indicated by bright, polished sections of the bearing surface.
12. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore ID.
13. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

PISTON AND CONNECTING ROD ASSEMBLE

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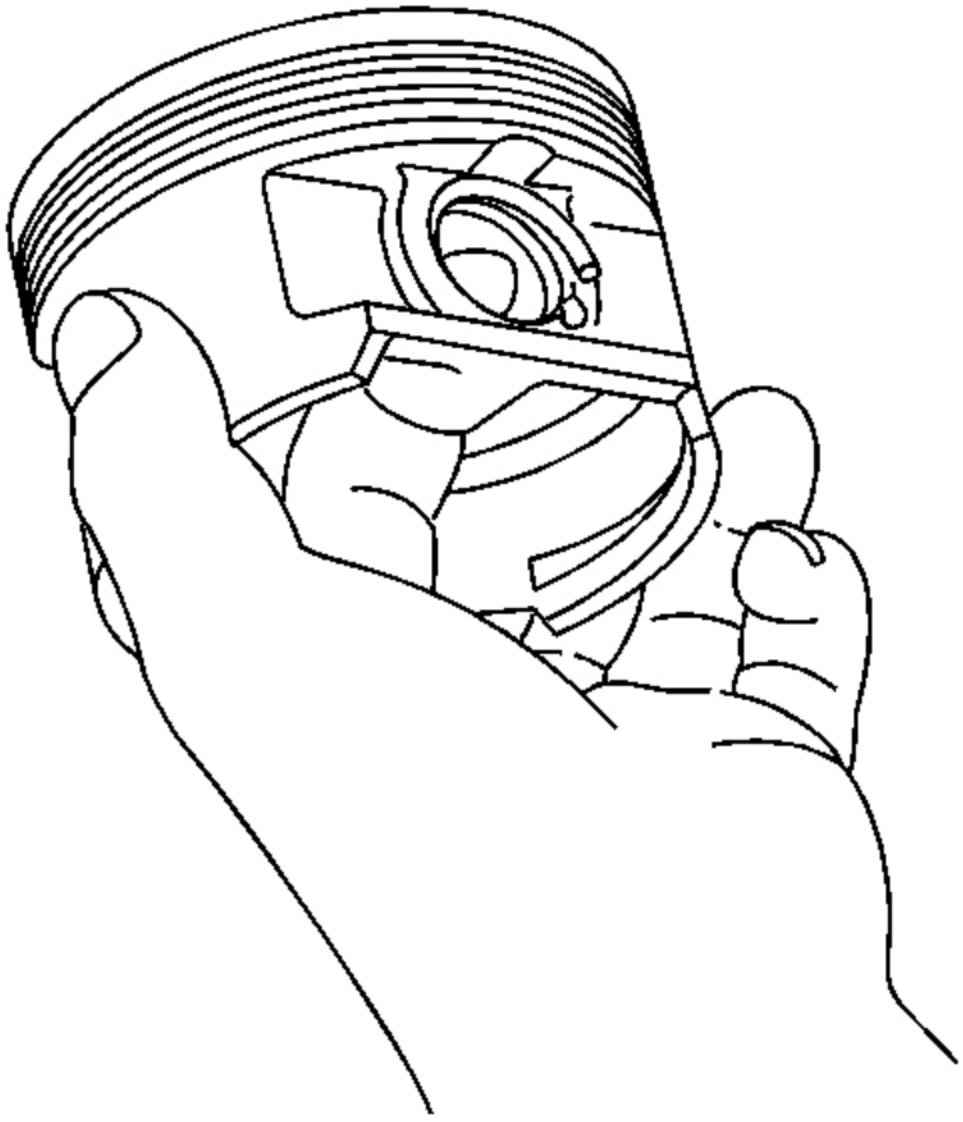


Fig. 43: View Of Retaining Clip In Pin Bore Groove
Courtesy of GENERAL MOTORS CORP.

1. Install the retainer. The retainer should be seated in the groove of the pin bore.

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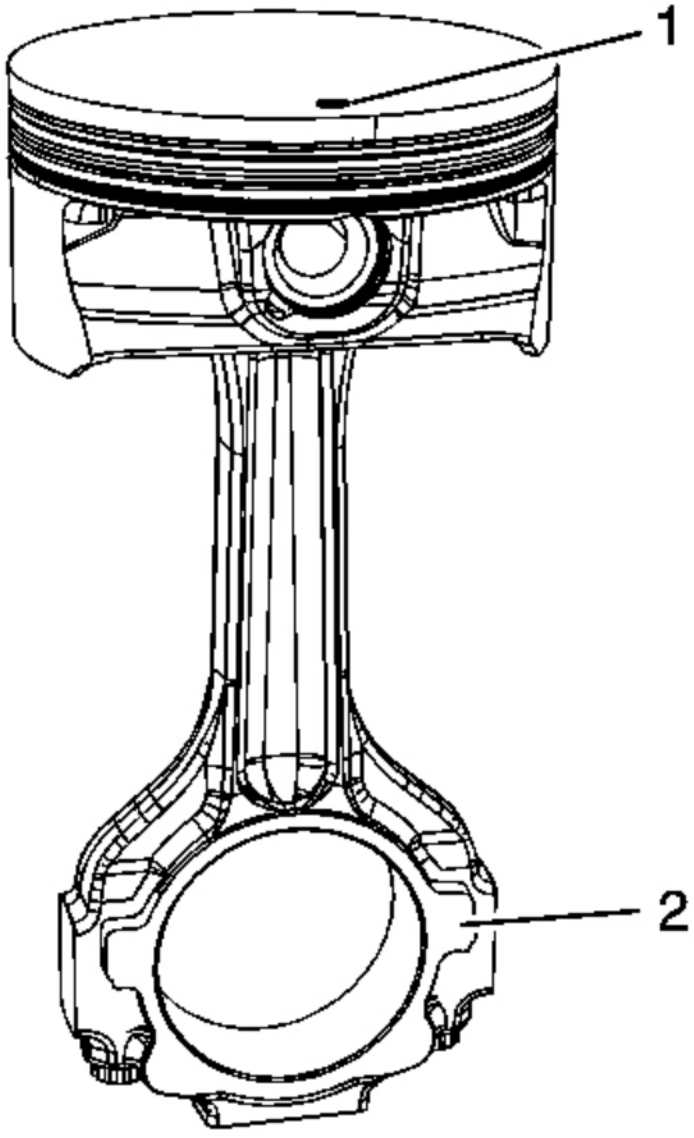


Fig. 44: Locating Mark On Top Of Piston & Connecting Rod Tab
Courtesy of GENERAL MOTORS CORP.

2. Assemble the piston and connecting rod. The mark (1) on the top of the piston and the tab (2) on the side of the connecting rod should be facing the same direction.

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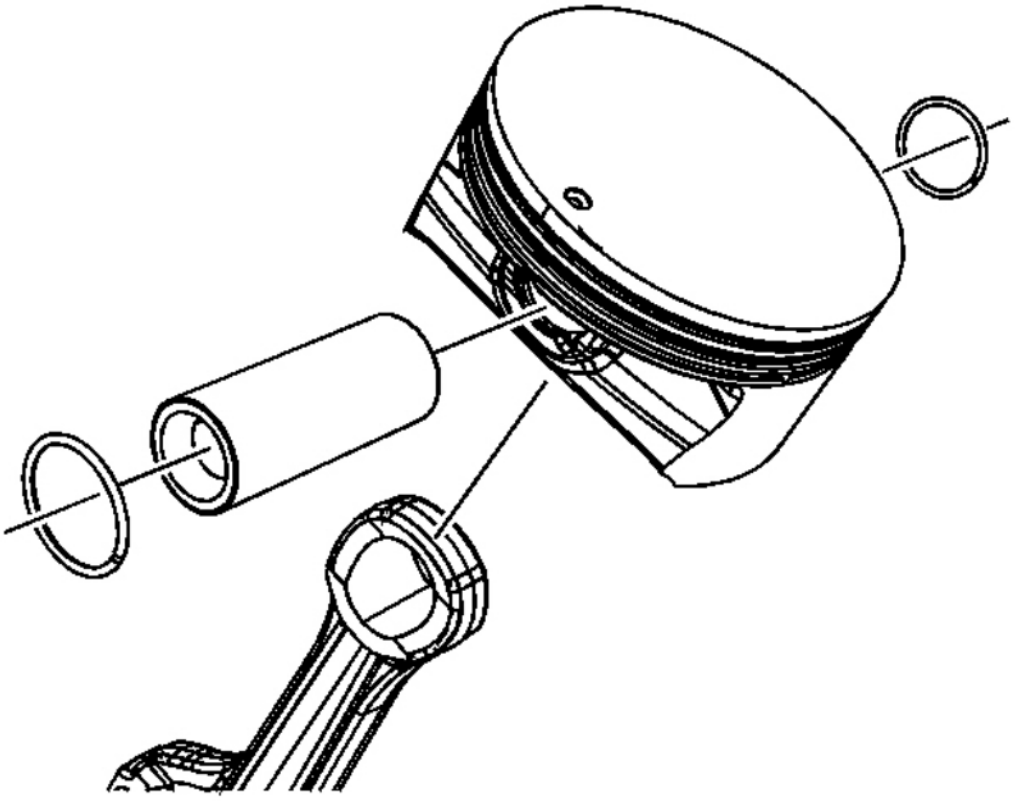


Fig. 45: View Of Piston Pin, Piston & Connecting Rod
Courtesy of GENERAL MOTORS CORP.

3. Install the piston pin to the piston and connecting rod.
4. Install the retainers. The retainers should be seated in the groove of the pin bore.

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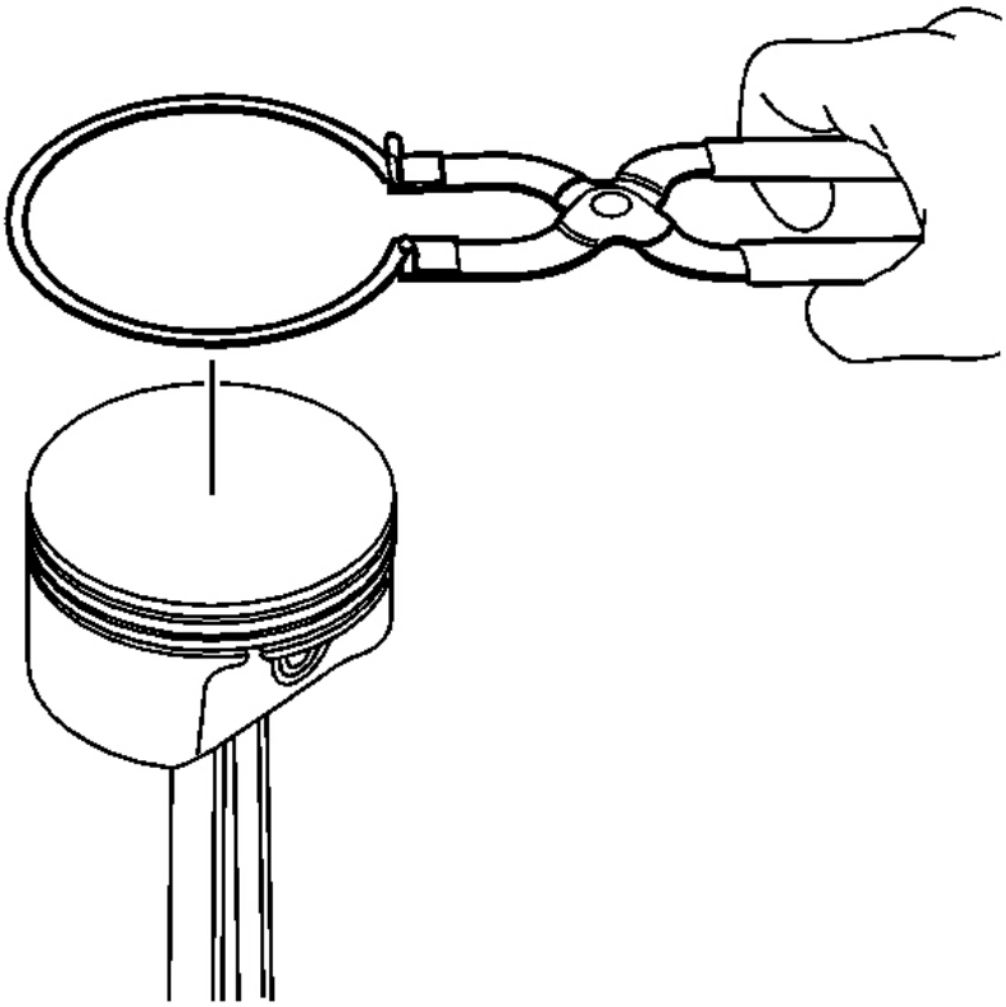


Fig. 46: Removing/Installing Piston Rings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: When installing piston rings, use a ring expander plier type tool. Do not roll the rings into the grooves of the piston. Use caution and care to expand the rings only slightly larger than the outside diameter (OD) of the piston.

5. Using piston ring pliers, install the piston rings onto the piston. The dimple or mark on the piston ring should face the top of the piston.
6. Position the oil control ring end gaps a minimum of 25 mm (1.0 in) from each other.

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7. Position the compression ring end gaps 180 degrees opposite each other.

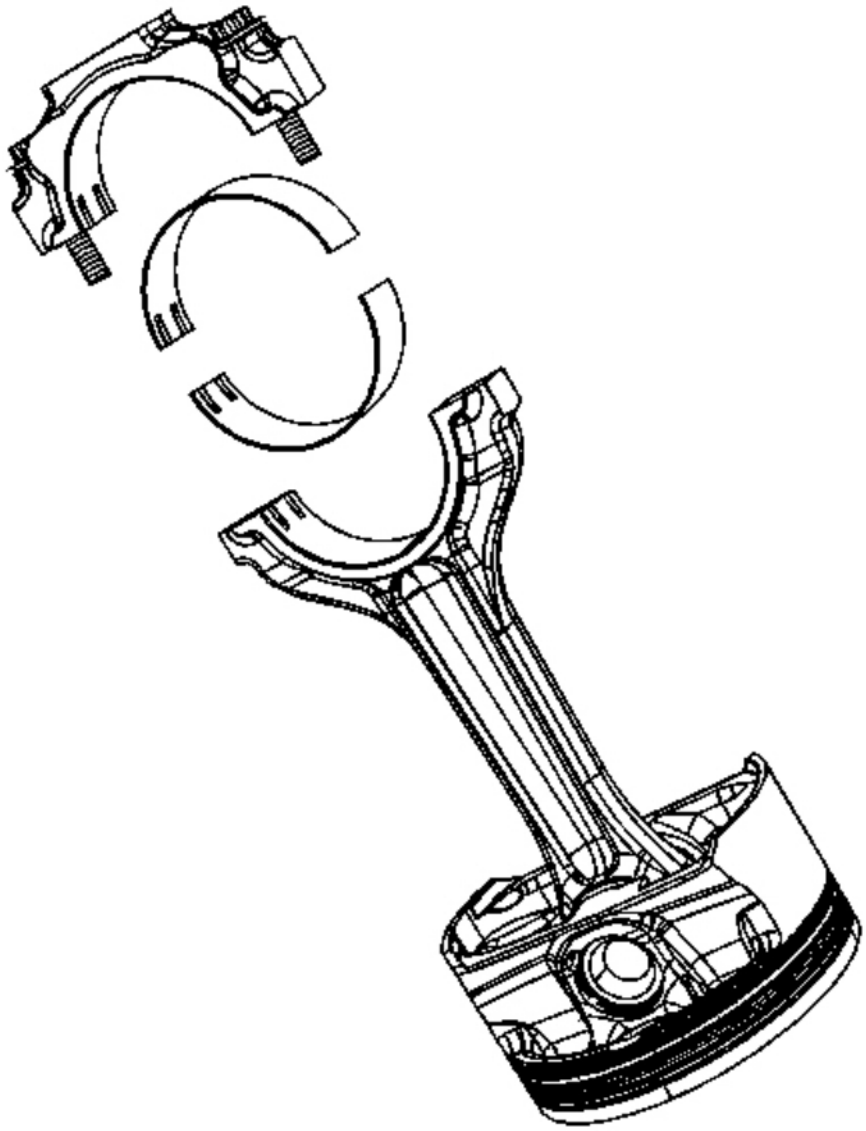


Fig. 47: View Of Piston, Connecting Rod & Bearing Assembly
Courtesy of GENERAL MOTORS CORP.

8. Install the connecting rod bearings to the rod and cap.

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CAMSHAFT BEARING REMOVAL

TOOLS REQUIRED

J 33049 Camshaft Bearing Service Set. See **Special Tools** .

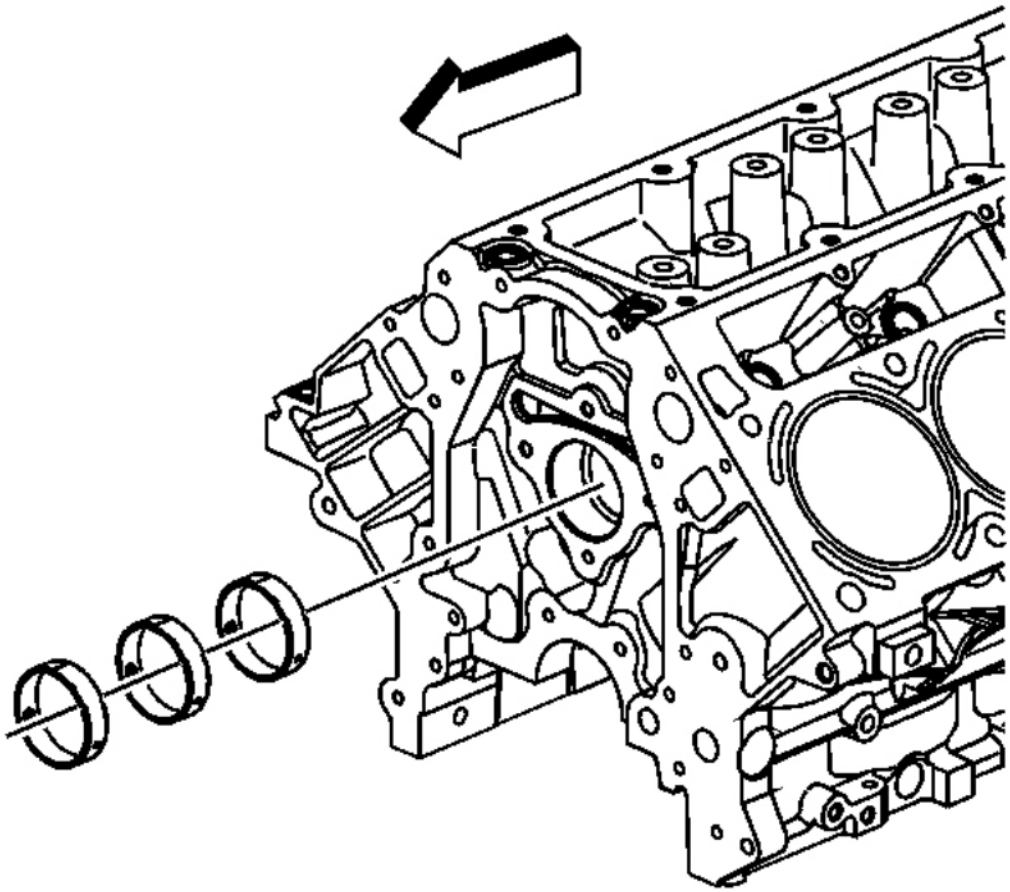


Fig. 48: View Of Camshaft Bearings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: A loose camshaft bearing may be caused by an enlarged, out of round, or damaged engine block bearing bore.

1. Prior to bearing removal, inspect the camshaft bearings for loose fit in the engine block bearing bores. Refer to **Camshaft and Bearings Cleaning and Inspection (RPO LY2/LC9/LY5/LMG)** or **Camshaft**

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and Bearings Cleaning and Inspection (RPO LY6/L76/L92).

2. Repair or replace the components, as required.

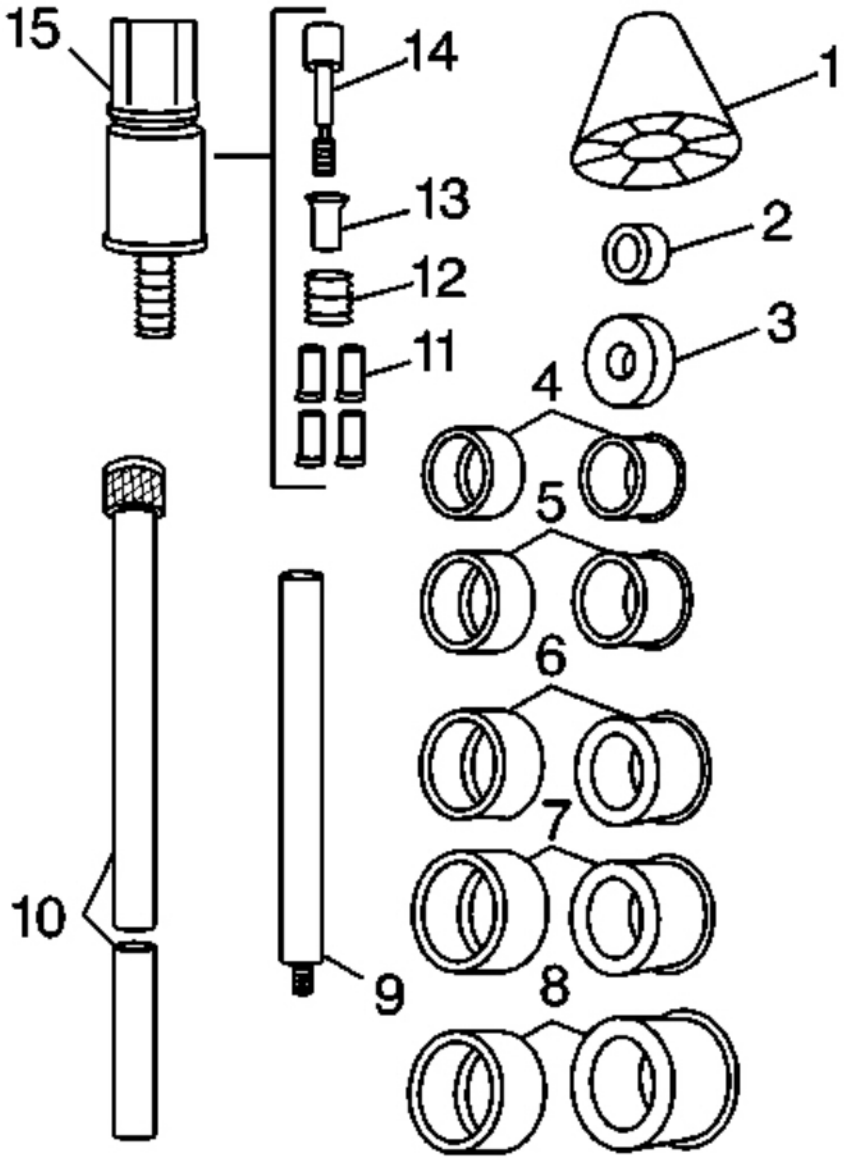


Fig. 49: View Of J 33049 Camshaft Bearing Service Kit Components
Courtesy of GENERAL MOTORS CORP.

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3. Select the expanding driver (4-8) and washer (2 or 3) from the **J 33049** . See **Special Tools** .
4. Assemble the tool.
5. Insert the tool through the front of the engine block and into the bearing.
6. Tighten the expander assembly (15) nut until snug.
7. Push the guide cone (1) into the front camshaft bearing in order to align the tool.

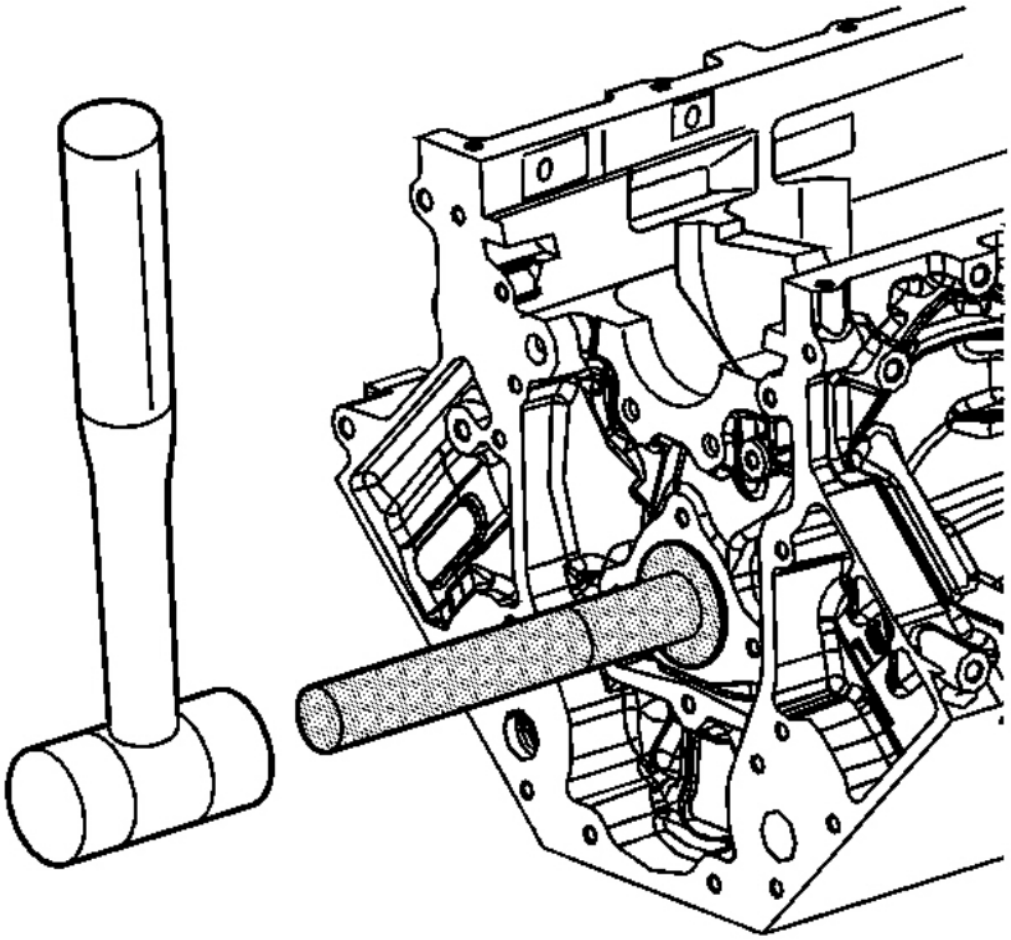


Fig. 50: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

8. Drive the bearing from the block bore.

IMPORTANT: In order to remove the front camshaft bearing, operate the tool from the

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rear of the block, using the guide cone in the rear camshaft bearing bore.

9. Repeat the above procedures in order to remove the remaining bearings.

TOOL USAGE INFORMATION

Bearing, Expander, and Expander Driver Information

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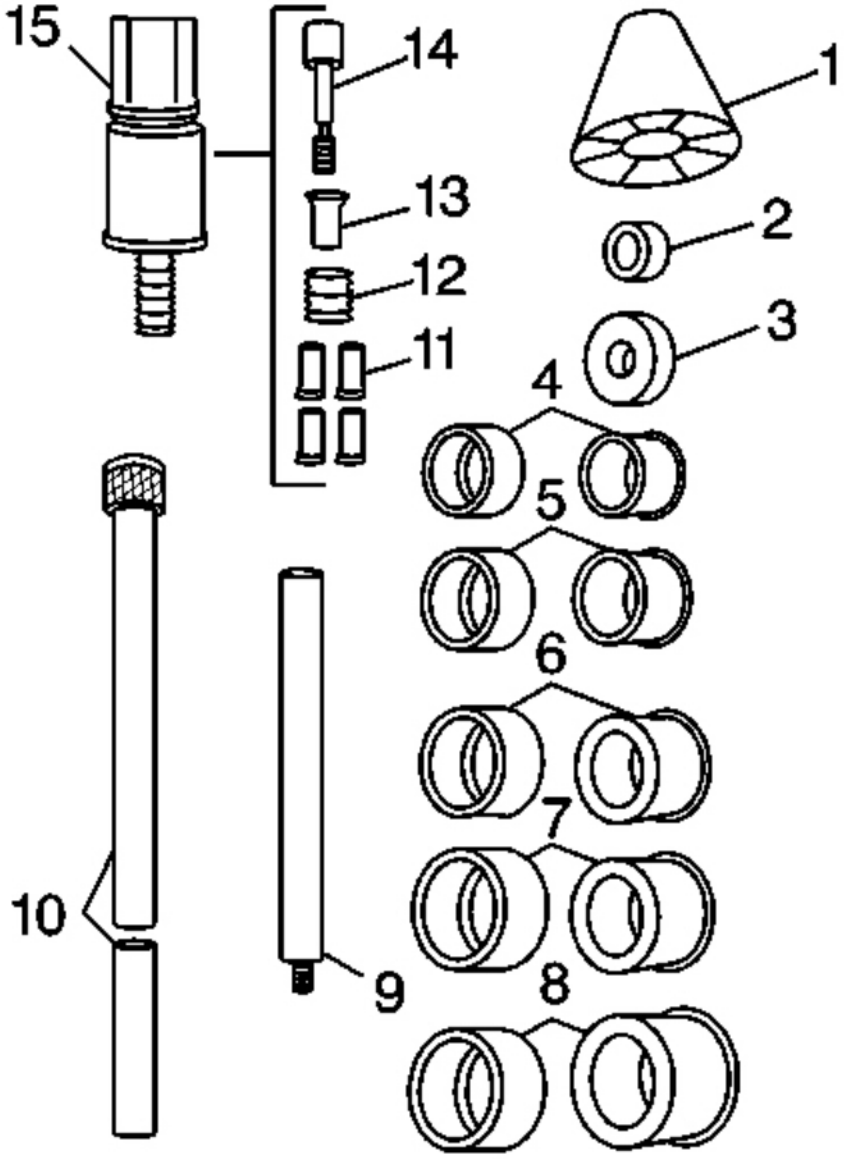


Fig. 51: View Of J 33049 Camshaft Bearing Service Kit Components
Courtesy of GENERAL MOTORS CORP.

- The tool consists of a guide cone (1), driving washers (2 or 3), expander bearing drivers (4-8), driver bars (9 or 10), expander jaws (11), expander sleeve (12), expander cone (13), expander shaft (14), and expander assembly (15).

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- Expander bearing driver number 1 inside diameter is 28.575-37.465 mm (1.125-1.475 in) and is used with the expander assembly and the small washer.
- Expander bearing driver number 2 inside diameter is 37.465-43.18 mm (1.475-1.7 in) and is used with number 1 expanding driver and the small washer.
- Expander bearing driver number 3 inside diameter is 43.18-48.895 mm (1.7-1.925 in) and is used with number 2 expanding driver and the large washer.
- Expander bearing driver number 4 inside diameter is 48.895-54.61 mm (1.925-2.15 in) and is used with number 3 expanding driver and the large washer.
- Expander bearing driver number 5 inside diameter is 54.61-60.325 mm (2.150-2.375 in) and is used with number 4 expanding driver and the large washer.
- Expander bearing driver number 6 inside diameter is 60.325-68.326 mm (2.375-2.69 in) and is used with number 5 expanding driver and the large washer.

Tool Assembly and Operation

1. Select the proper expanding driver and washer from the expanding driver and washer information.

IMPORTANT: To install or remove the expanding driver, always push on or pull from the ends.
Pressure on the outside diameter may cause a bind against the rubber expanding sleeve.

2. Place the expanding driver onto the expander assembly.
3. Ensure the separation lines between the segments of the expanding driver align with the separation lines of the expander assembly.
4. With the small end of the cone facing the driver assembly, place the guide cone over the driving bar.
5. Place the driving washer over the threaded portion of the expander assembly.
6. Screw the expander assembly, with driving washer, onto the driving bar.

For removal of the inner bearings, it may be necessary to install the driver bar extension.

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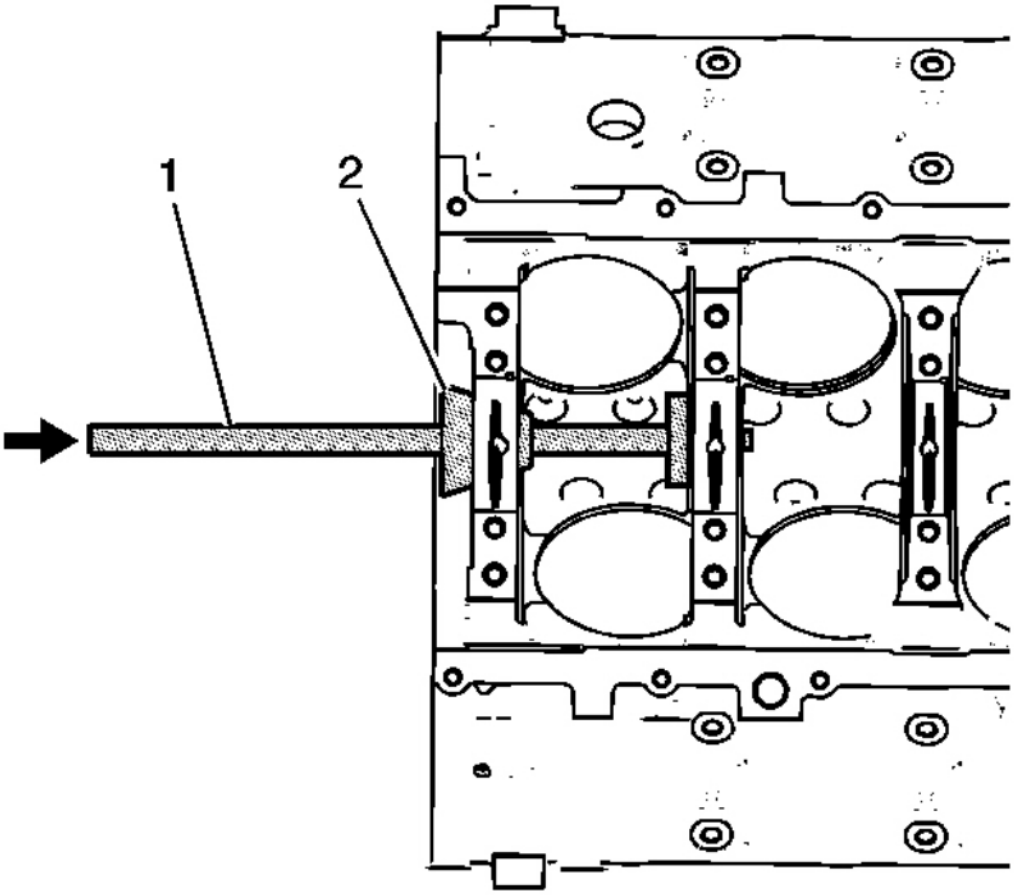


Fig. 52: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

7. Insert the tool into an inner camshaft bearing and tighten until snug.

   Operate the tool from the front or rear of the engine block.

   On some engine blocks, the nut on the expander assembly is inaccessible, except from either end. In this case, you must use a socket and extension to enlarge and reduce the expander assembly.

8. Slide the nylon cone (2) into the front or rear camshaft bearing. This will properly align the tool.
9. Drive the bearing out of or into the engine block.
10. Repeat the procedure for the additional inner bearings.

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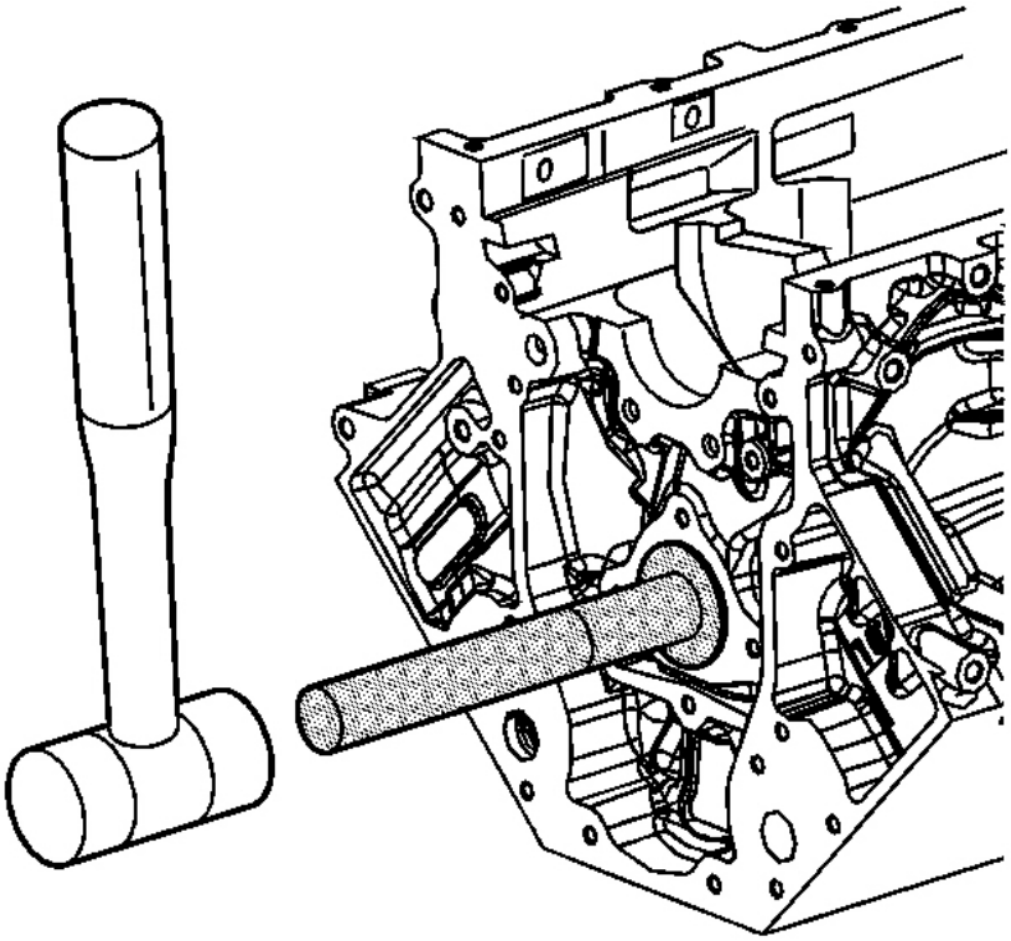


Fig. 53: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

11. For the 2 end bearings, front and rear, remove the nylon cone and driver bar extension.
12. Drive the bearings out of or into the engine block.

CAMSHAFT AND BEARINGS CLEANING AND INSPECTION (RPO LY2/LC9/LY5/LMG)

Tools Required

- **J 7872** Magnetic Base Dial Indicator Set
- **J 8520** Camshaft Lobe Lift Indicator. See **Special Tools** .

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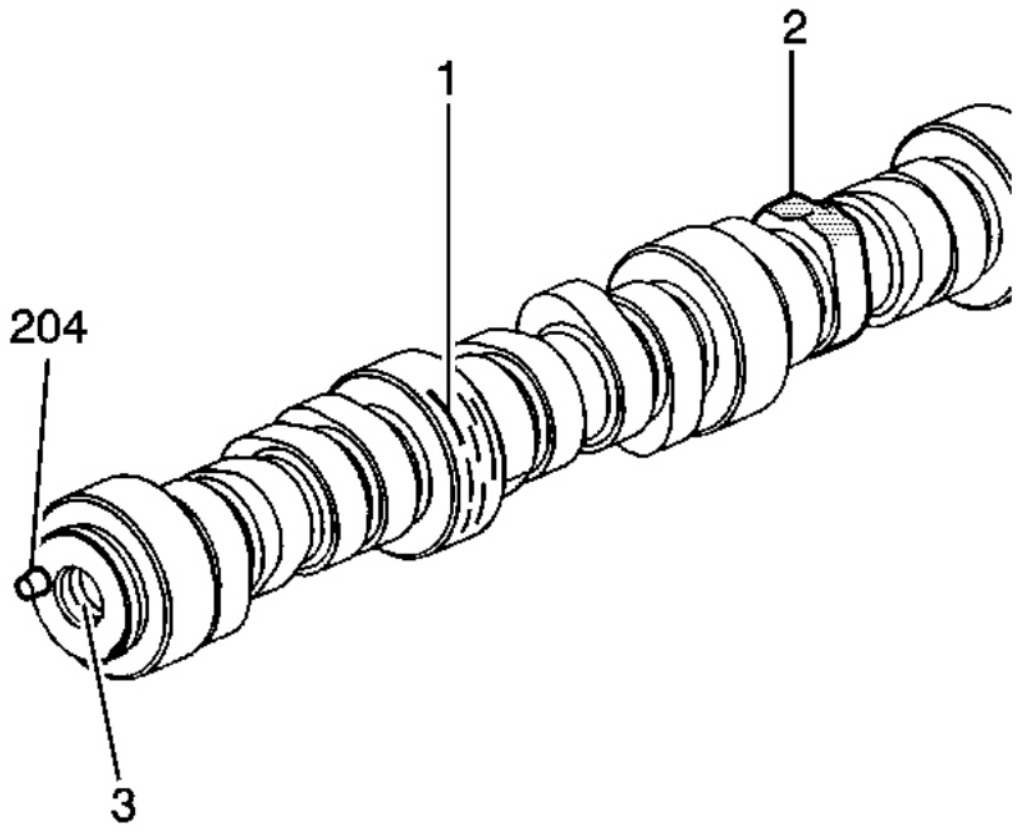


Fig. 54: Identifying Camshaft Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Clean the components in solvent.

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

2. Dry the components with compressed air.
3. Inspect the camshaft bearing journals (1) for scoring or excessive wear.
4. Inspect the camshaft valve lifter lobes (2) for scoring or excessive wear.
5. Inspect the threaded bolt hole (3) in the front of the camshaft for damaged threads or debris.
6. Inspect the camshaft sprocket pin (204) for damage.
7. Inspect the camshaft retainer plate for wear or a damaged sealing gasket.

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If the camshaft retainer plate sealing gasket is not cut or damaged, it may be used again.

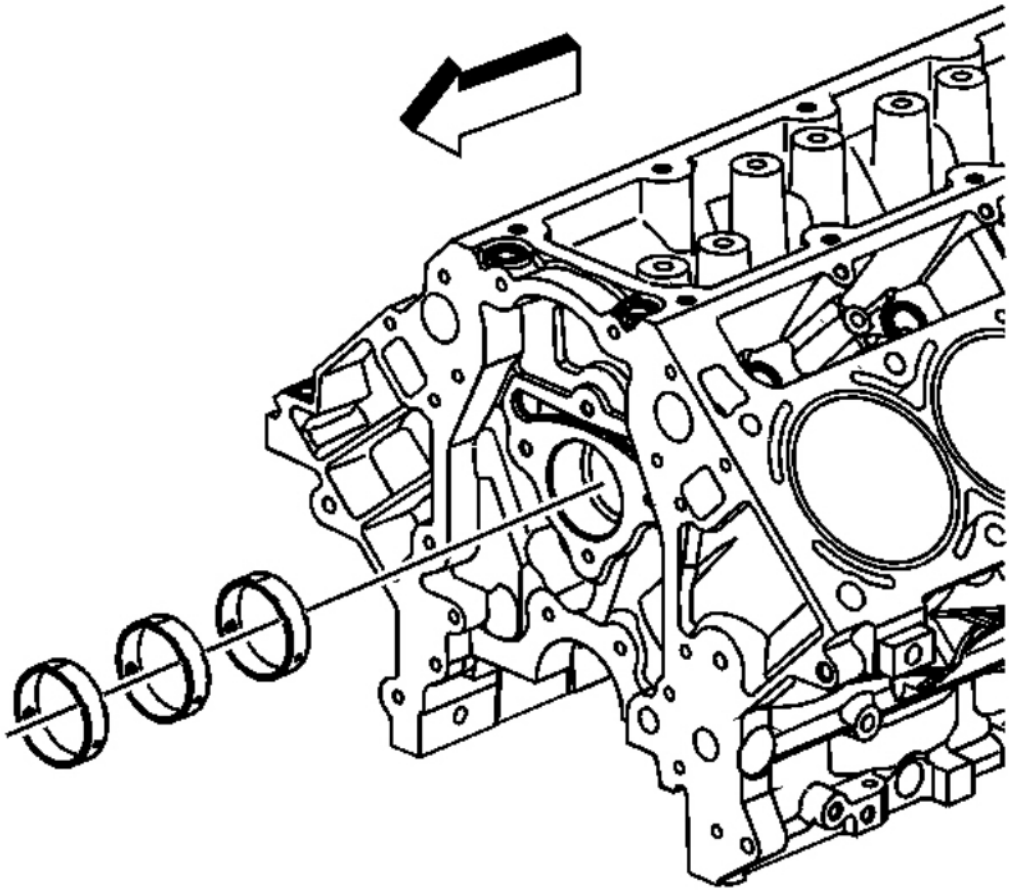


Fig. 55: View Of Camshaft Bearings
Courtesy of GENERAL MOTORS CORP.

8. Inspect the camshaft bearings for proper fit in the engine block. Camshaft bearings have an interference fit to the engine block and should not be loose in the engine block bearing bores.
9. Inspect the camshaft bearings for excessive wear or scoring.

   Bearings with excessive scoring or wear must be replaced.

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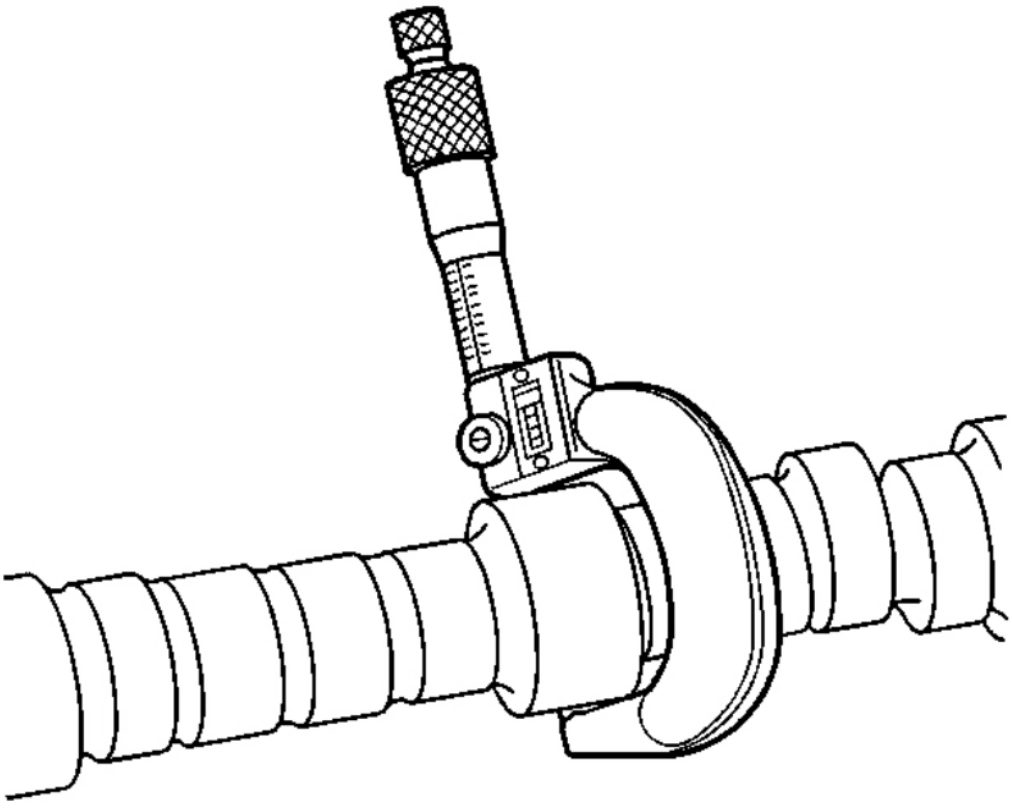


Fig. 56: Measure Camshaft Journals With Micrometer
Courtesy of GENERAL MOTORS CORP.

10. Using a micrometer, measure the camshaft journals for wear and out-of-round.
    - If the camshaft bearing journals are greater than 0.025 mm (0.001 in) out-of-round, replace the camshaft.
    - If the camshaft bearing journal diameter is less than 54.99 mm (2.164 in), replace the camshaft.

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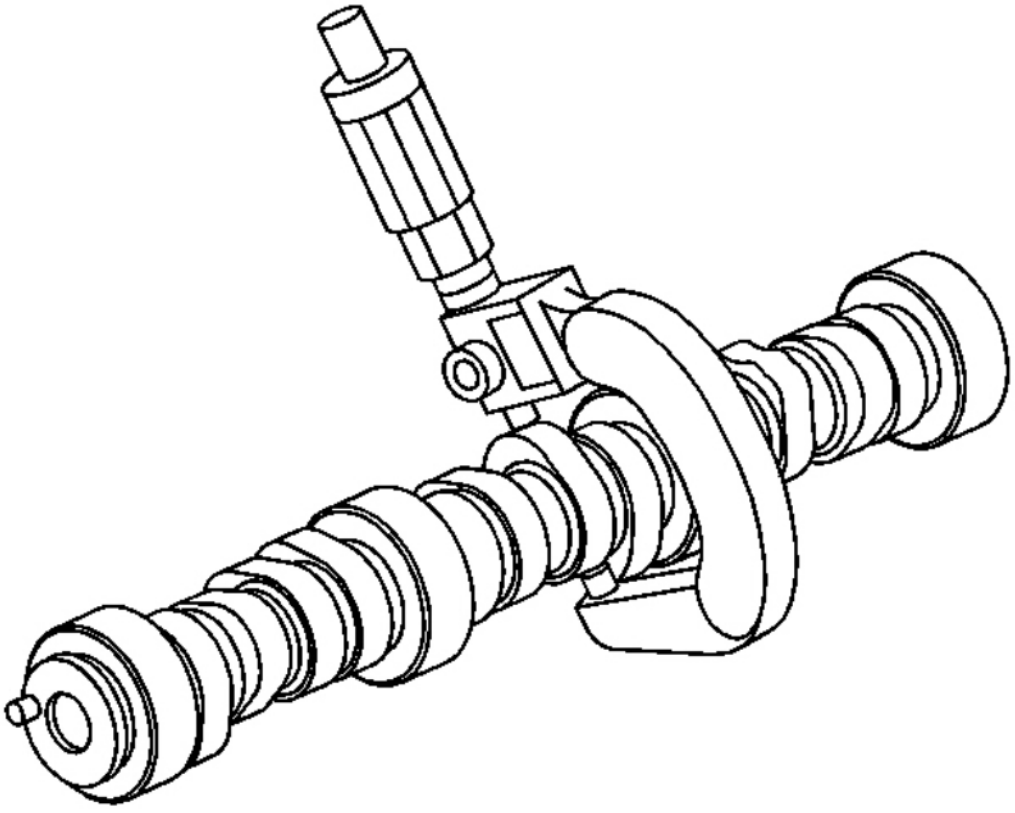


Fig. 57: Measuring Camshaft Lobes
Courtesy of GENERAL MOTORS CORP.

11. Using a micrometer, measure the camshaft lobes for wear. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

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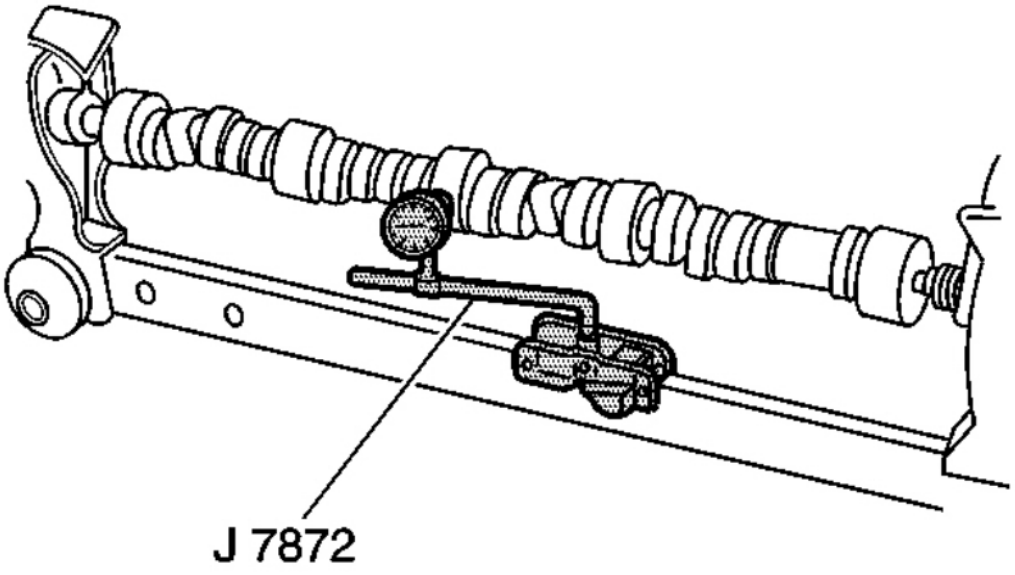
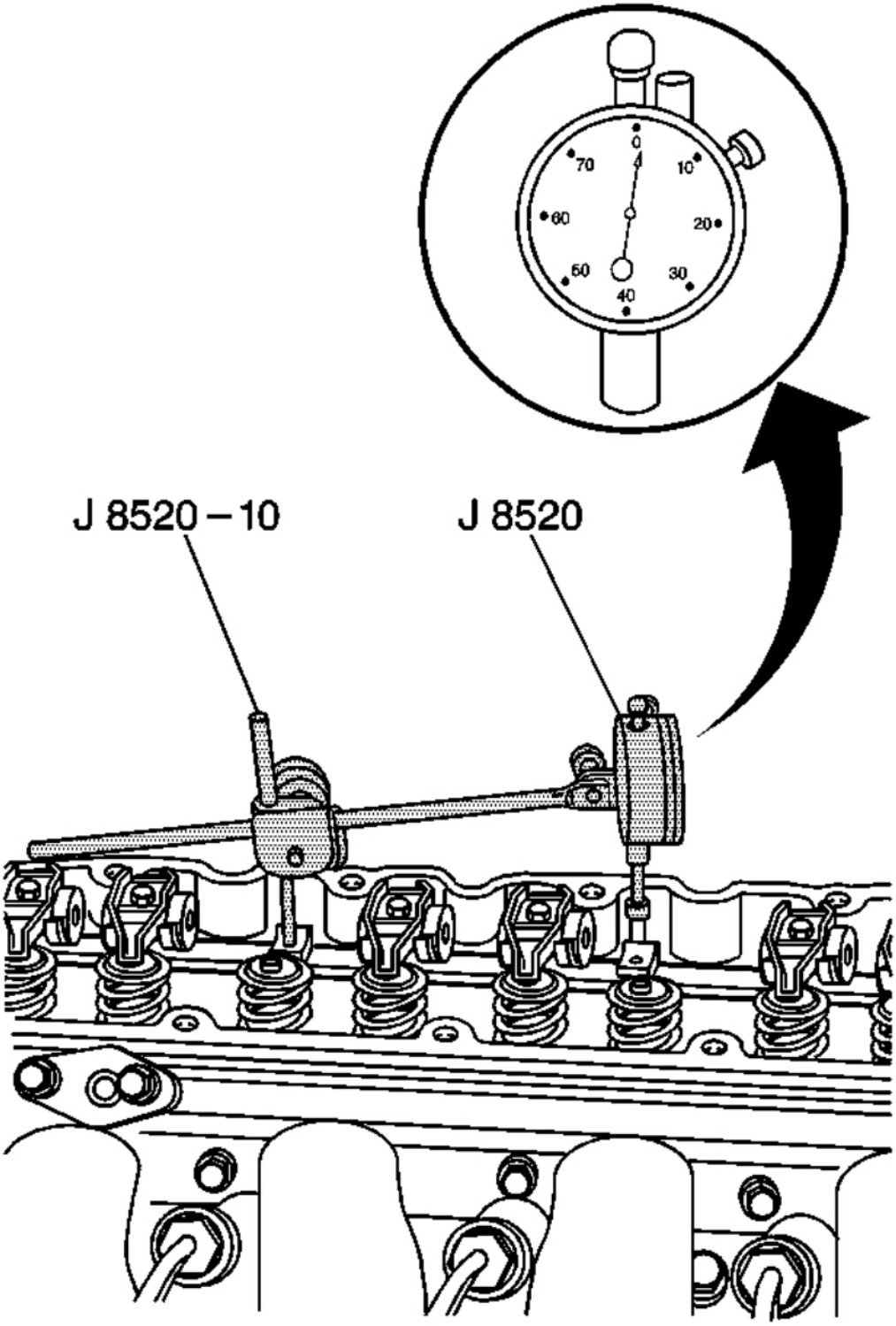


Fig. 58: Measuring Camshaft Runout
Courtesy of GENERAL MOTORS CORP.

12. Measure the camshaft runout.
    1. Mount the camshaft in wooden V-blocks or between centers on a fixture.
    2. Using the **J 7872** , measure the runout of the intermediate camshaft bearing journals.
    3. If camshaft runout exceeds 0.05 mm (0.002 in), the camshaft is bent and should be replaced.

MEASURING CAMSHAFT LOBE LIFT

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Fig. 59: Measuring Camshaft Lobe Lift
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Measuring camshaft lobe lift is a procedure used to determine if the camshaft lobes have worn. This test is to be performed prior to engine disassembly and with the camshaft and valve train components installed in the engine.

1. Using the **J 8520** , measure camshaft lobe lift. See **Special Tools** .
2. Remove the valve rocker arms and bolts.
3. Install the dial indicator mounting stud into the valve rocker arm bolt hole.
4. Assemble the components of the **J 8520** and position onto the stud. See **Special Tools** .
5. Position the shaft of the dial indicator onto the end of the pushrod.
6. Rotate the face of the dial indicator to zero.
7. Slowly rotate the crankshaft clockwise, until the dial indicator obtains its highest and lowest readings.
8. Compare the total to specifications. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

CAMSHAFT AND BEARINGS CLEANING AND INSPECTION (RPO LY6/L76/L92)

Tools Required

- **J 7872** Magnetic Base Dial Indicator Set
- **J 8520** Camshaft Lobe Lift Indicator. See **Special Tools** .

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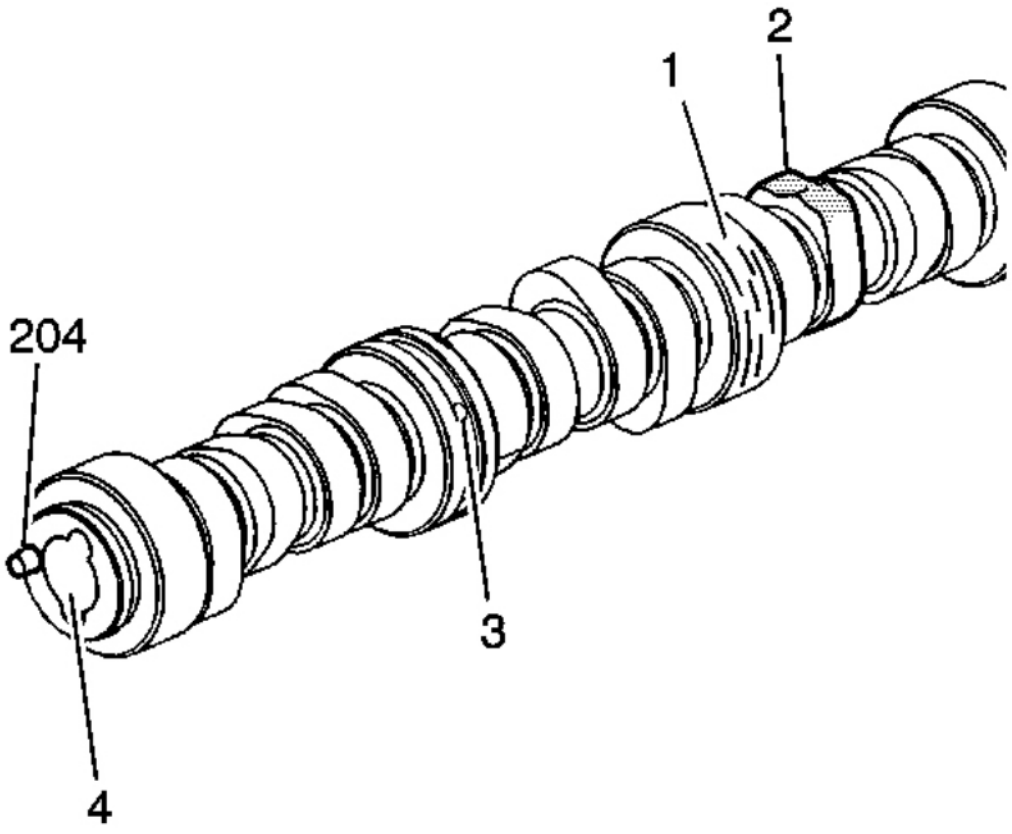


Fig. 60: View Of Camshaft Inspection Points
Courtesy of GENERAL MOTORS CORP.

1. Clean the components in solvent.

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

2. Dry the components with compressed air.
3. Inspect the camshaft bearing journals (1) for scoring or excessive wear.
4. Inspect the camshaft valve lifter lobes (2) for scoring or excessive wear.
5. Inspect the camshaft position (CMP) actuator oil passages (3) for restrictions.
6. Inspect the threaded bolt hole (4) in the front of the camshaft for damaged threads or debris.
7. Inspect the camshaft sprocket pin (204) for damage.
8. Inspect the camshaft retainer plate for wear or a damaged sealing gasket.

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If the camshaft retainer plate sealing gasket is not cut or damaged, it may be used again.

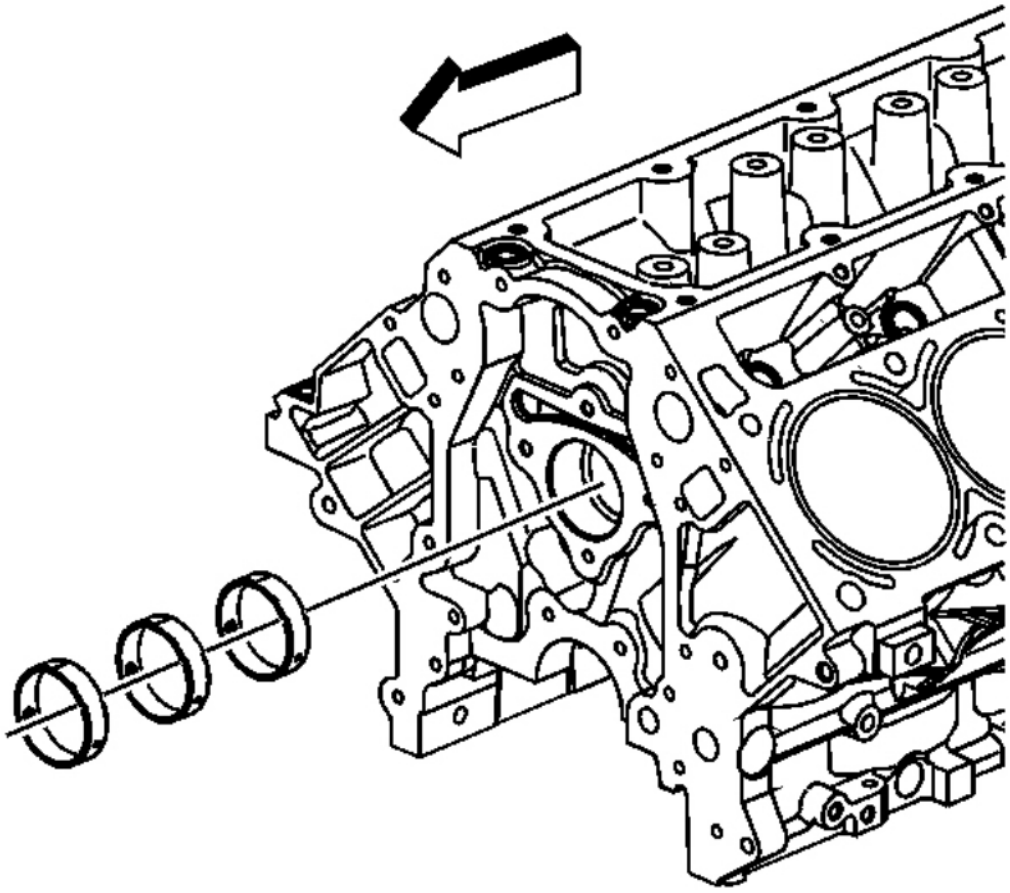


Fig. 61: View Of Camshaft Bearings
Courtesy of GENERAL MOTORS CORP.

9. Inspect the camshaft bearings for proper fit in the engine block. Camshaft bearings have an interference fit to the engine block and should not be loose in the engine block bearing bores.
10. Inspect the camshaft bearings for excessive wear or scoring.

    Bearings with excessive scoring or wear must be replaced.

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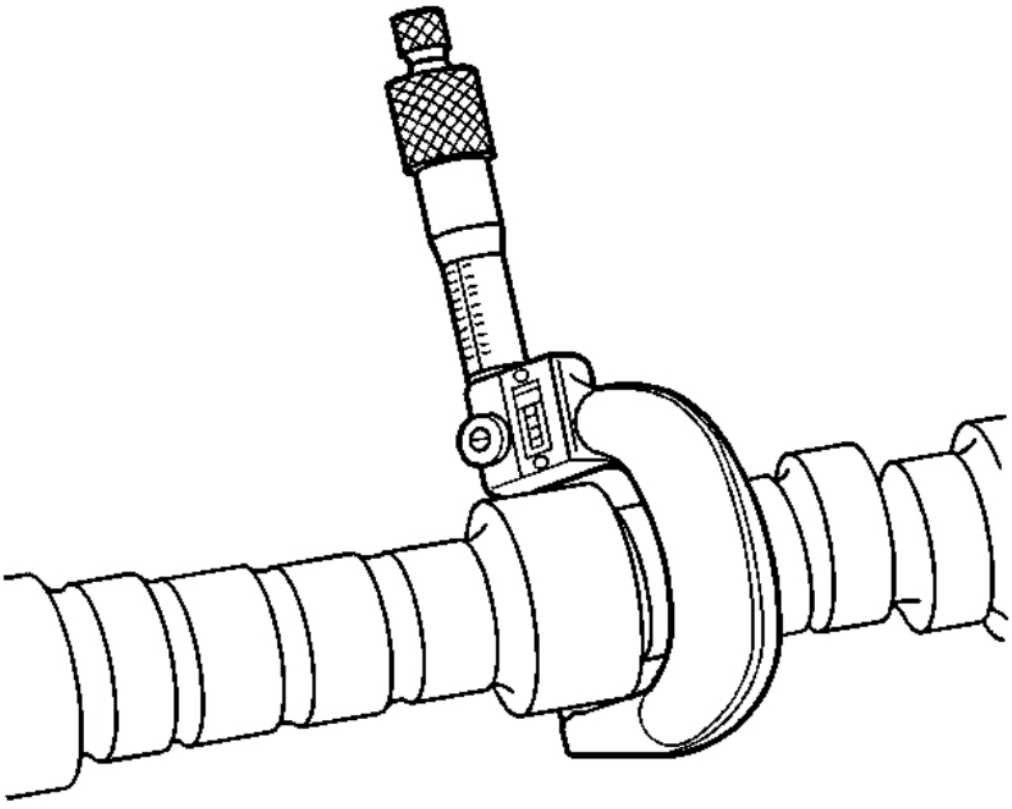


Fig. 62: Measure Camshaft Journals With Micrometer
Courtesy of GENERAL MOTORS CORP.

11. Using a micrometer, measure the camshaft journals for wear and out-of-round.
    - If the camshaft bearing journals are greater than 0.025 mm (0.001 in) out-of-round, replace the camshaft.
    - If the camshaft bearing journal diameter is less than 54.99 mm (2.164 in), replace the camshaft.

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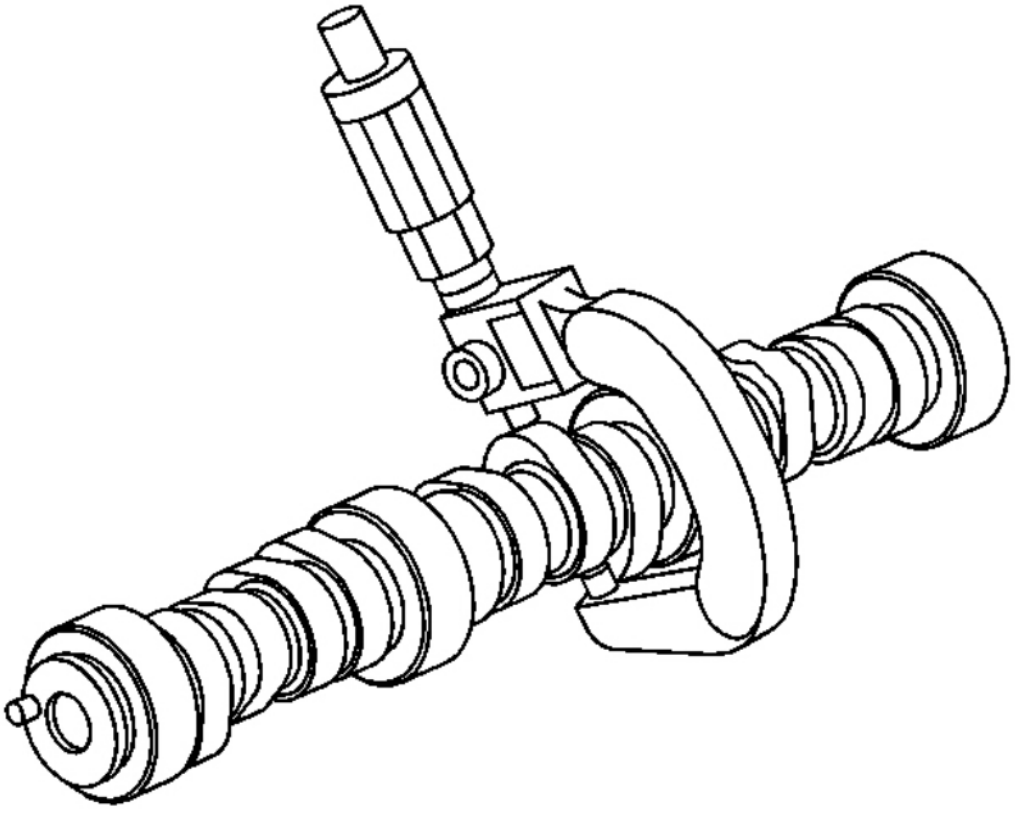


Fig. 63: Measuring Camshaft Lobes
Courtesy of GENERAL MOTORS CORP.

12. Using a micrometer, measure the camshaft lobes for wear. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

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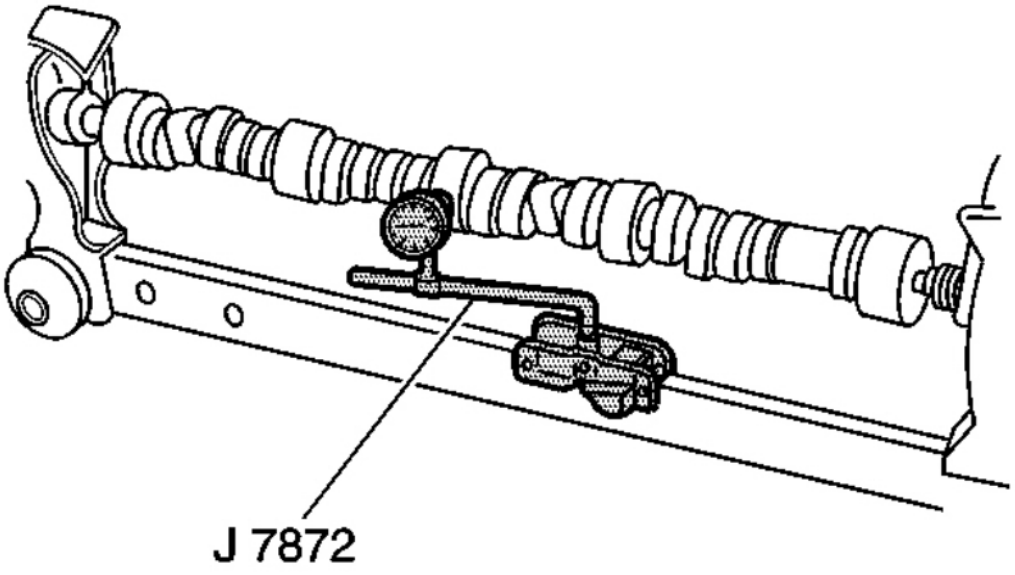
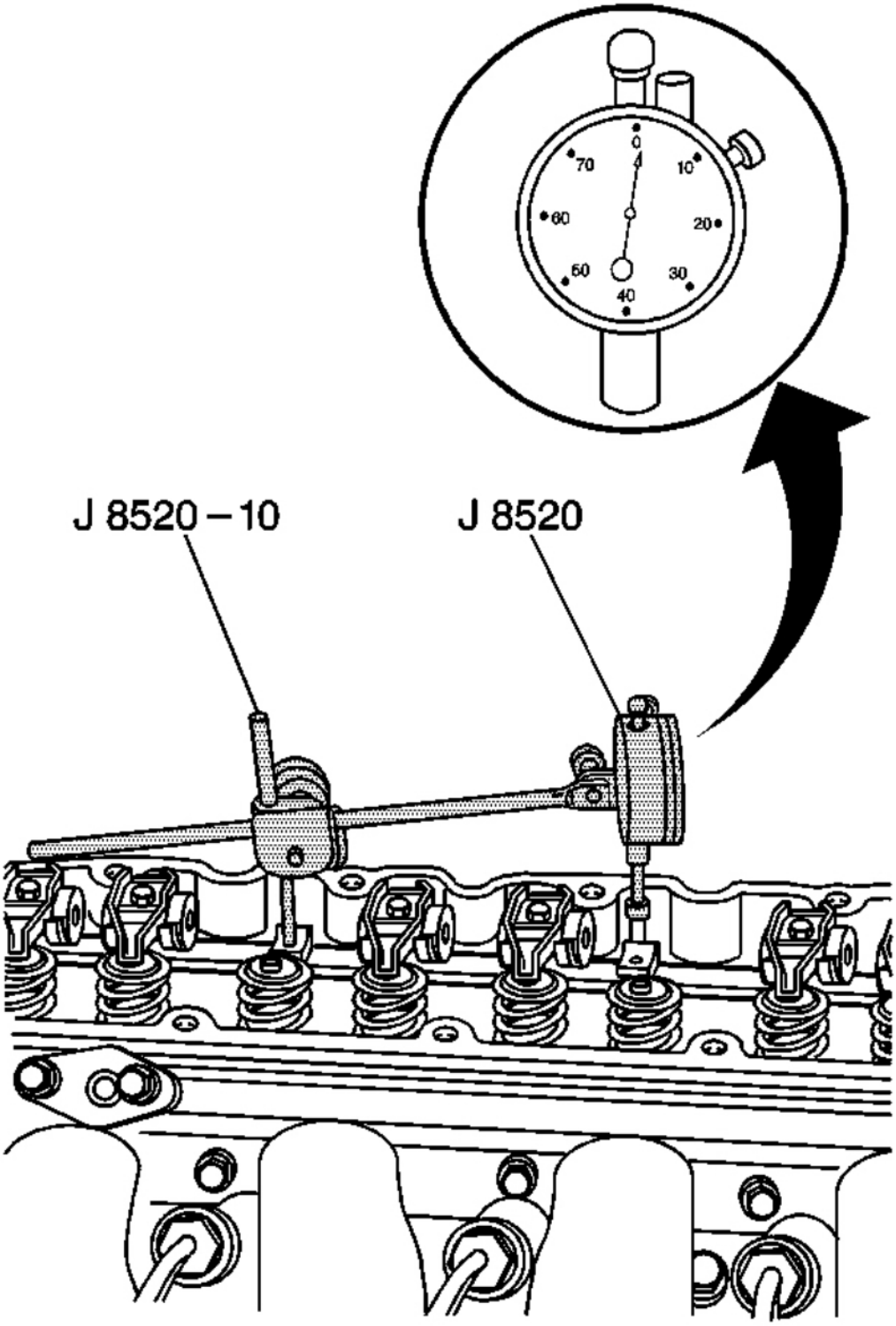


Fig. 64: Measuring Camshaft Runout
Courtesy of GENERAL MOTORS CORP.

13. Measure the camshaft runout.
    1. Mount the camshaft in wooden V-blocks or between centers on a fixture.
    2. Using the **J 7872** , measure the runout of the intermediate camshaft bearing journals.
    3. If camshaft runout exceeds 0.05 mm (0.002 in), the camshaft is bent and should be replaced.

MEASURING CAMSHAFT LOBE LIFT

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Fig. 65: Measuring Camshaft Lobe Lift
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Measuring camshaft lobe lift is a procedure used to determine if the camshaft lobes have worn. This test is to be performed prior to engine disassembly and with the camshaft and valve train components installed in the engine.

1. Using the **J 8520** , measure camshaft lobe lift. See **Special Tools** .
2. Remove the valve rocker arms and bolts.
3. Install the dial indicator mounting stud into the valve rocker arm bolt hole.
4. Assemble the components of the **J 8520** and position onto the stud. See **Special Tools** .
5. Position the shaft of the dial indicator onto the end of the pushrod.
6. Rotate the face of the dial indicator to zero.
7. Slowly rotate the crankshaft clockwise, until the dial indicator obtains its highest and lowest readings.
8. Compare the total to specifications. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

CAMSHAFT BEARING INSTALLATION

TOOLS REQUIRED

J 33049 Camshaft Bearing Service Set. See **Special Tools** .

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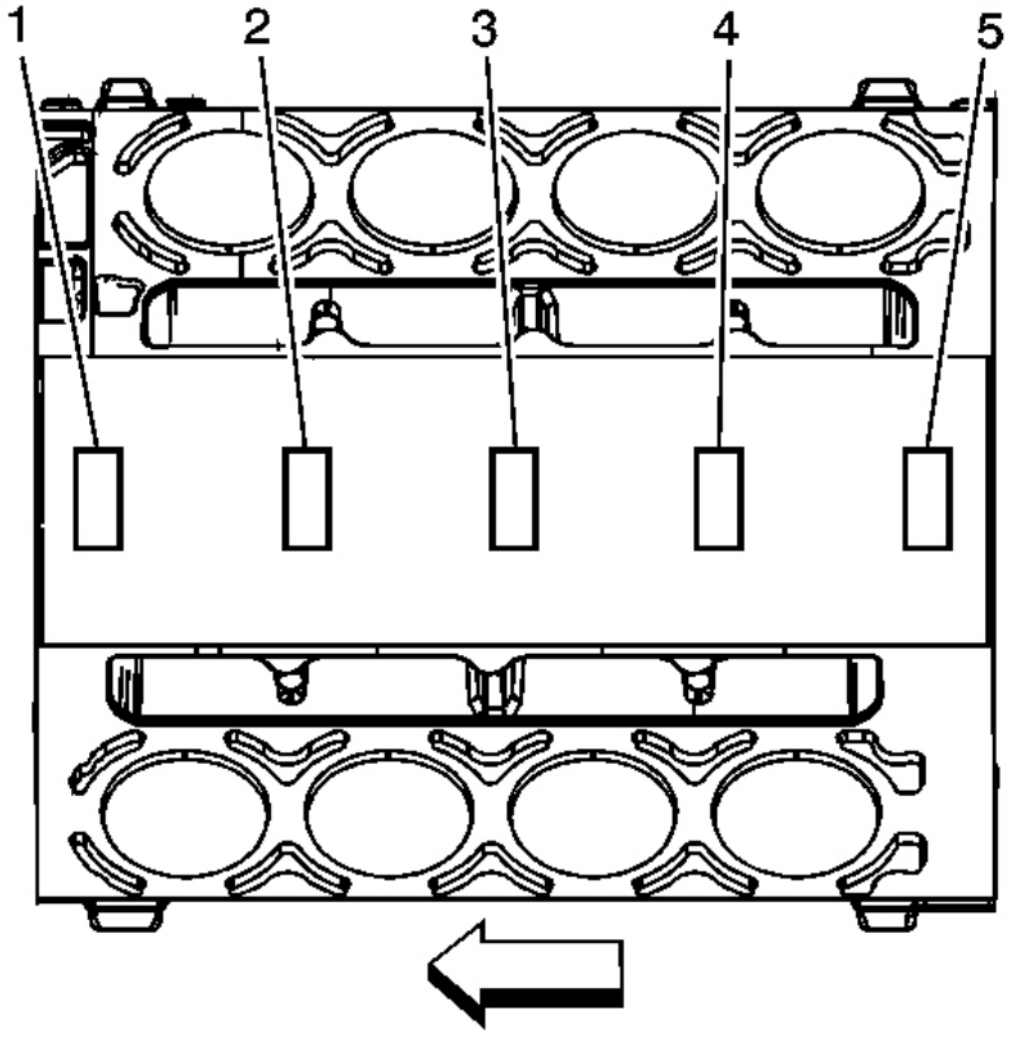


Fig. 66: Identifying Engine Block Camshaft Bearing Bores
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The engine block camshaft bearing bores are machined for 3 different outside diameter (OD) size bearings. Position 1 and 5 are the largest diameter bores. Position 3 is the smallest diameter bore. Position 2 and 4 are the intermediate size bores. The inside diameter (ID) for all camshaft bearings is the same size.

1. Measure the engine block camshaft bearing bores (1-5) in order to identify the correct OD size bearing for each position. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical**

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Specifications (RPO LMG VIN 0) or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

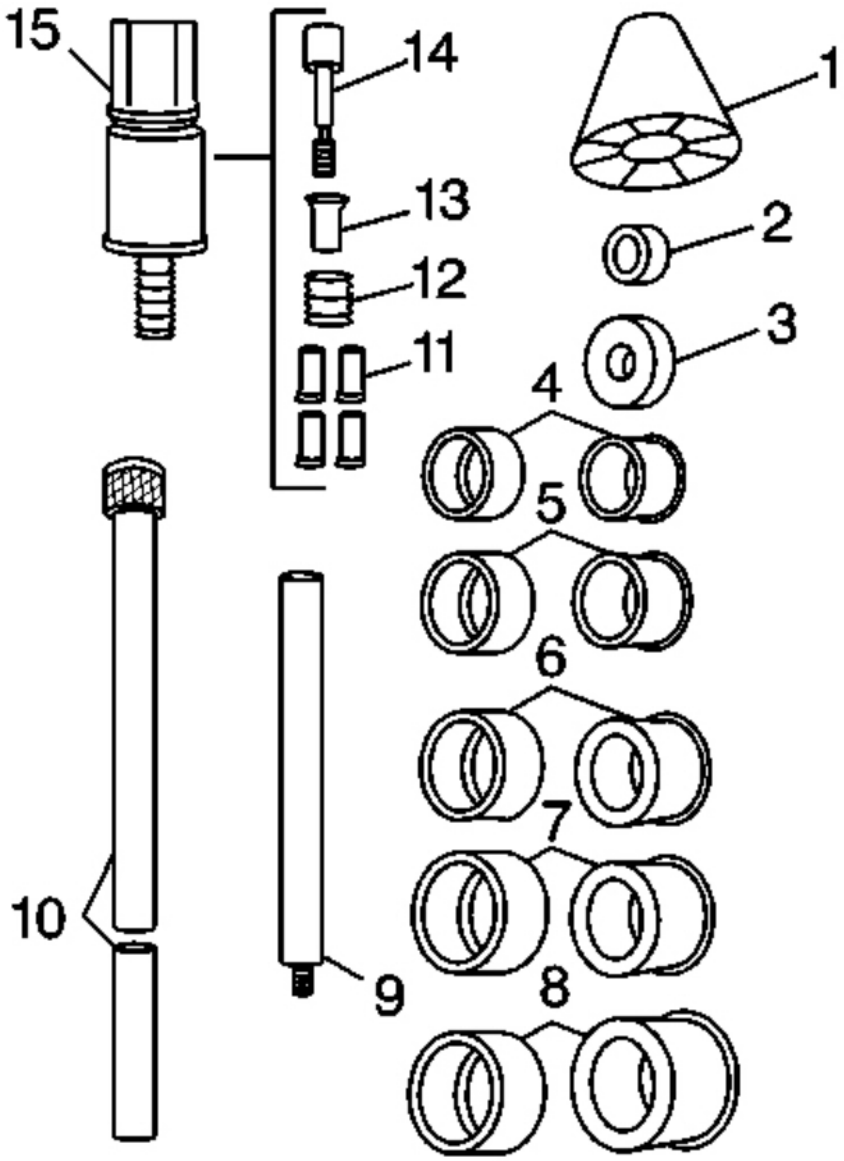


Fig. 67: View Of J 33049 Camshaft Bearing Service Kit Components
Courtesy of GENERAL MOTORS CORP.

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2. Select the expanding driver (4-8) and washer (2 or 3) from the **J 33049** . See **Special Tools** . Refer to **Piston and Connecting Rod Assemble**.
3. Assemble the tool.

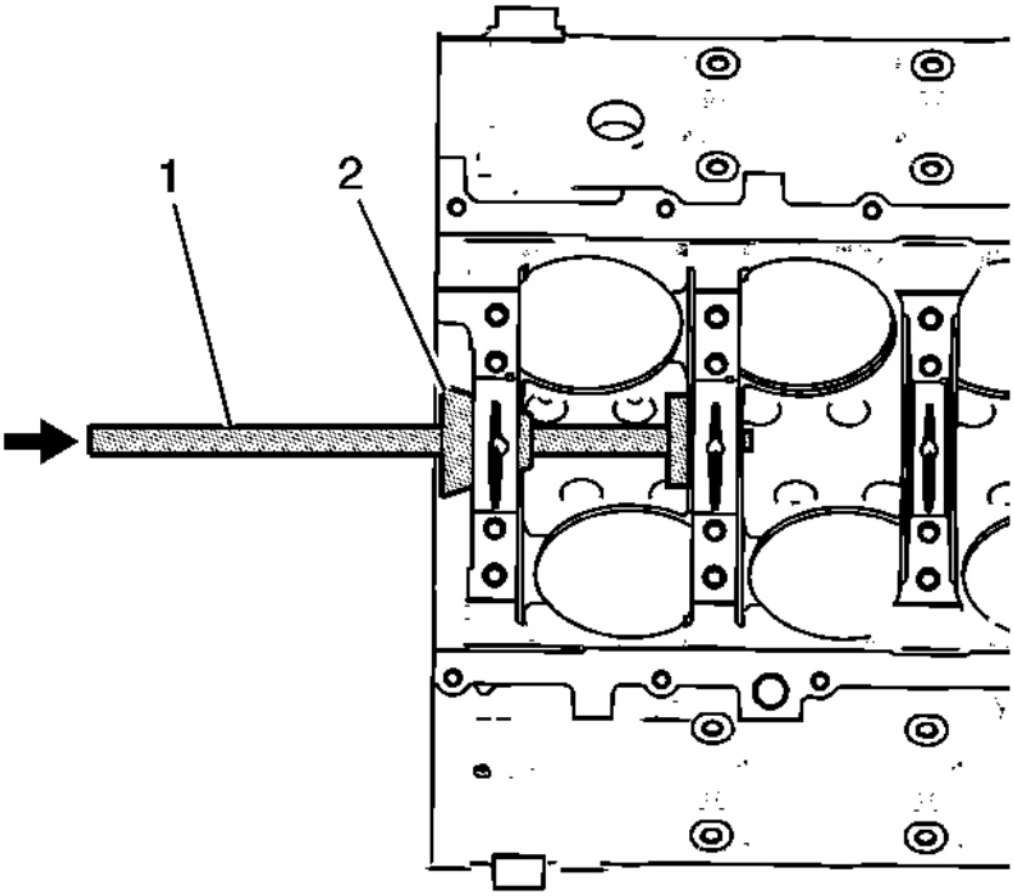


Fig. 68: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

4. Insert the tool (1) through the front of the engine block and into the bearing.
5. Tighten the expander assembly nut until snug.
6. Push the guide cone (2) into the front camshaft bearing in order to align the tool.
7. Drive the bearing into the block bore.

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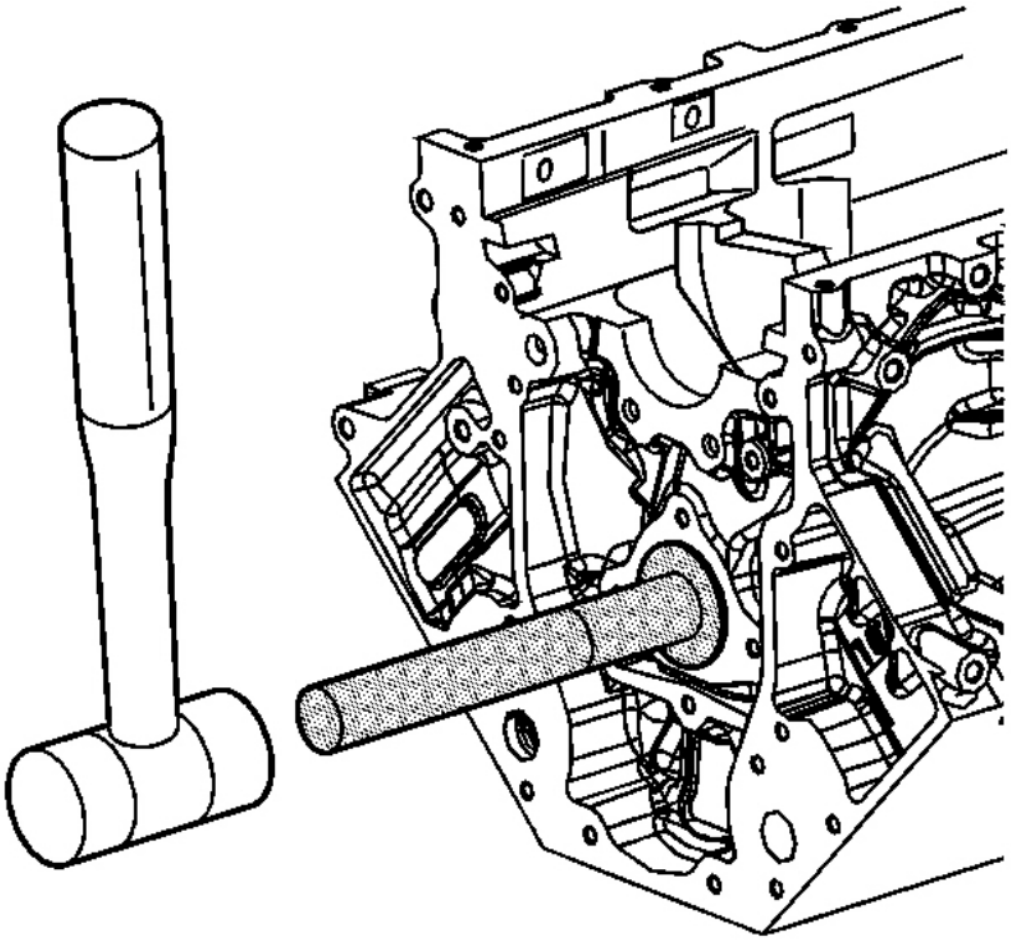


Fig. 69: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

8. Install the front and rear bearings to the block.

TIMING CHAIN AND SPROCKETS CLEANING AND INSPECTION

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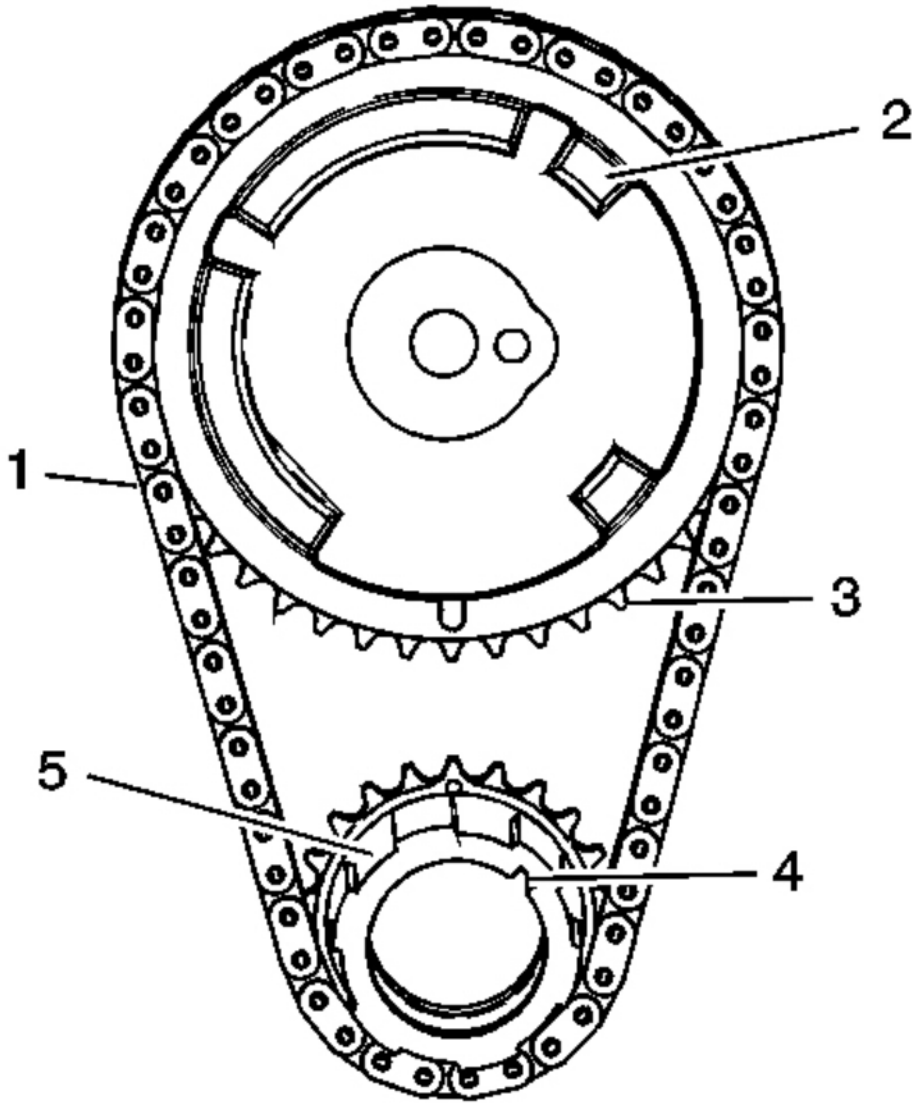


Fig. 70: Identifying Timing Chain and Sprockets Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Clean the components with cleaning solvent.

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

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2. Dry the components with compressed air.
3. Inspect the timing chain (1) for binding or wear.
4. Inspect the camshaft position (CMP) sensor raised areas (2) for nicks or damage.
5. Inspect for worn, damaged, or chipped teeth (3).
6. Inspect for a damaged keyway (4).
7. Inspect for worn oil pump drive splines (5).

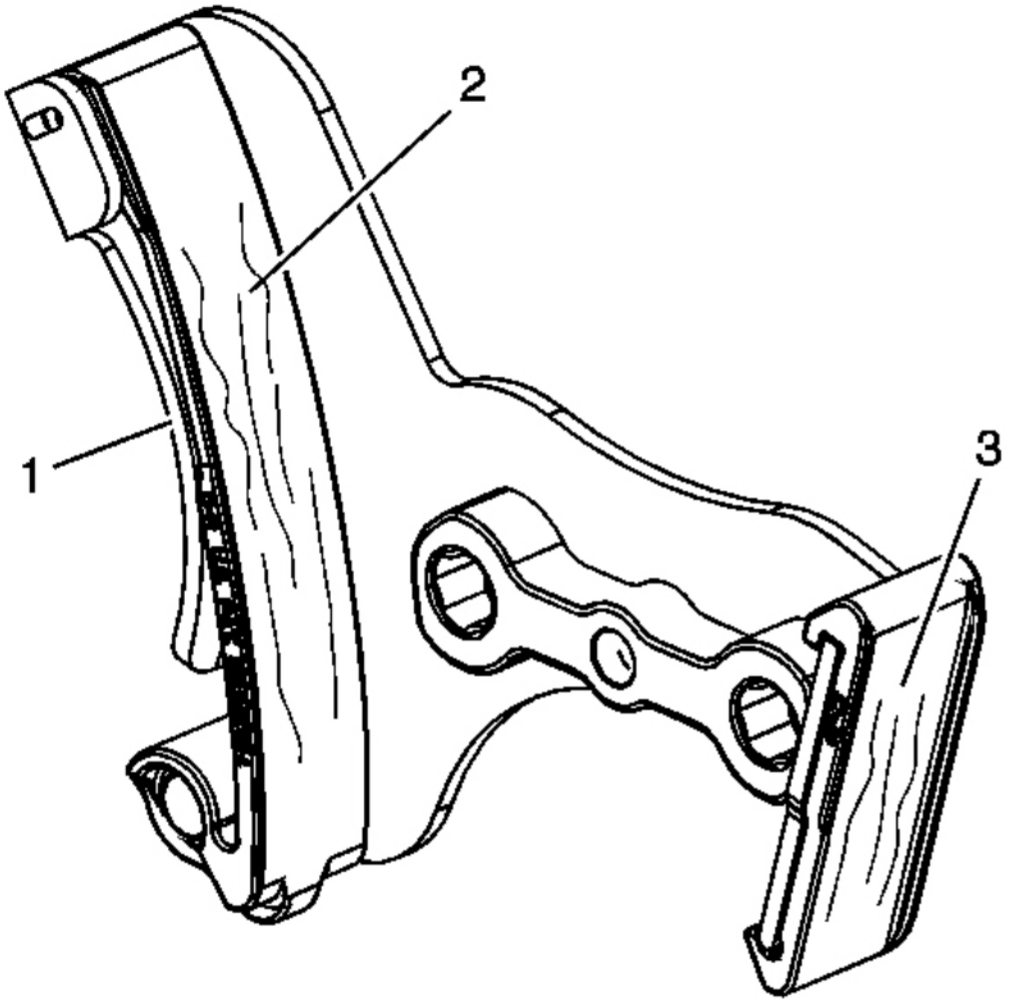


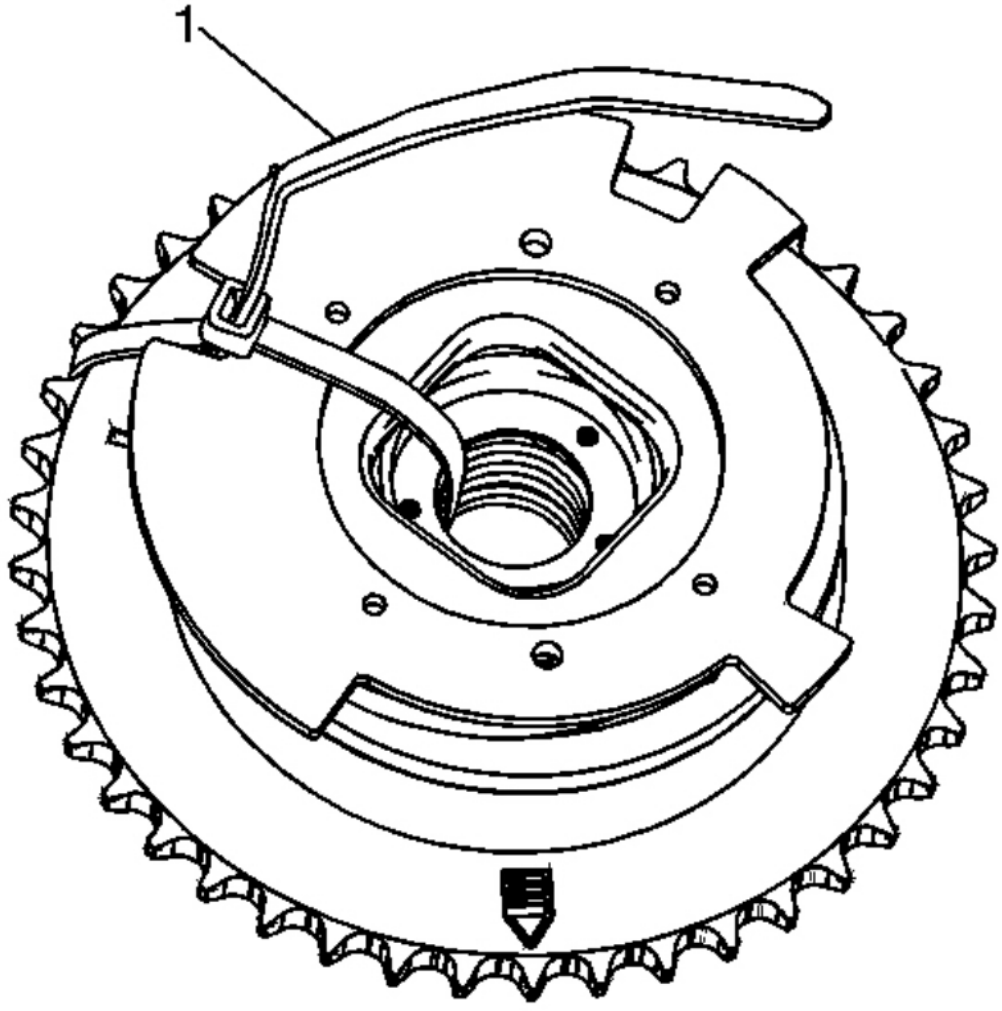
Fig. 71: Timing Chain Tensioner Inspection Points
Courtesy of GENERAL MOTORS CORP.

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8. Inspect the timing chain tensioner for the following conditions:
   - Damaged or broken tension spring (1)
   - Excessive wear or scoring on the chain guide surfaces (2, 3)

CAMSHAFT POSITION ACTUATOR CLEANING AND INSPECTION

CAUTION: Refer to Camshaft Position Actuator Removal and Installation Caution .



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Fig. 72: View Of Tie Strap Through Center Of Actuator
Courtesy of GENERAL MOTORS CORP.

1. Insert a tie strap (1) through the center of the camshaft position (CMP) actuator and over the reluctor wheel.

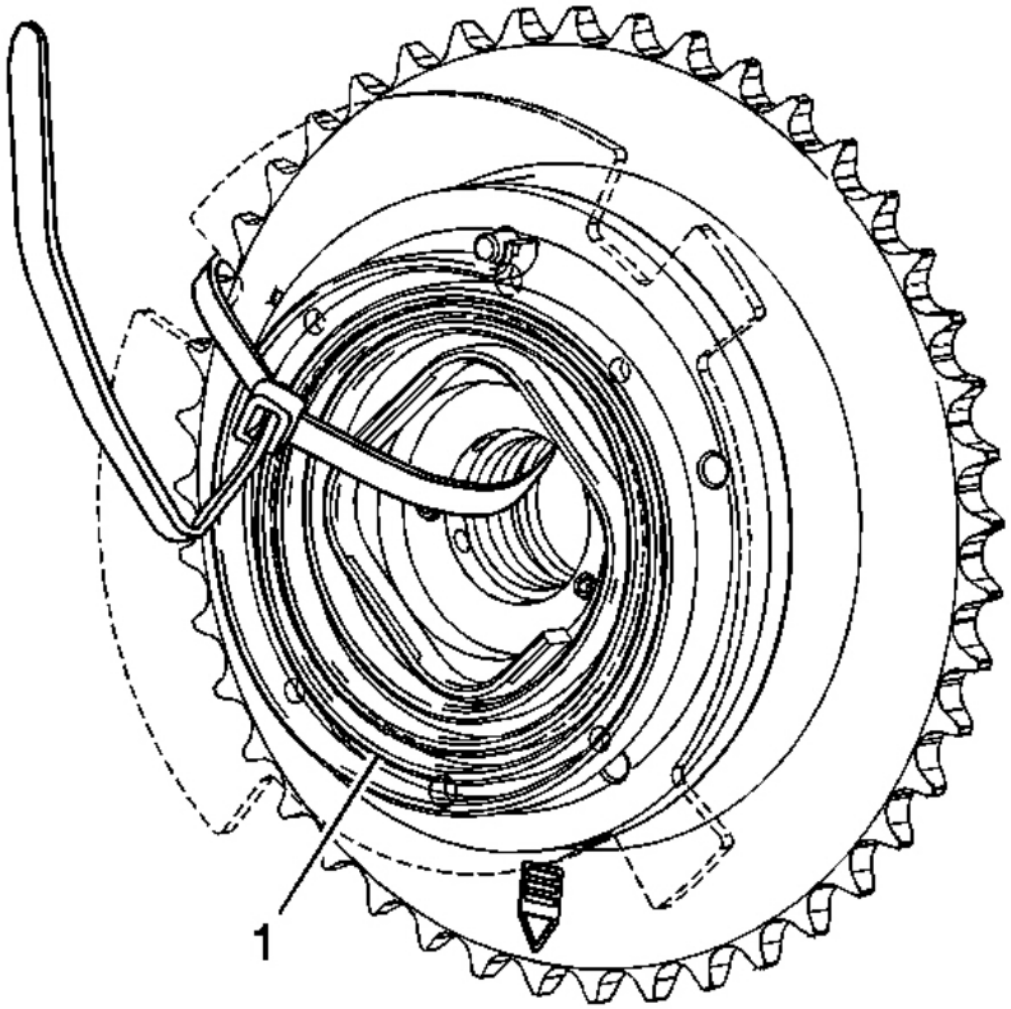


Fig. 73: Inspecting CMP Actuator For Broken Spring
Courtesy of GENERAL MOTORS CORP.

2. Clean the CMP actuator with cleaning solvent.

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CAUTION: Refer to Safety Glasses and Compressed Air Caution .

3. Dry the components with compressed air.
4. Inspect the CMP actuator for a broken spring (1).

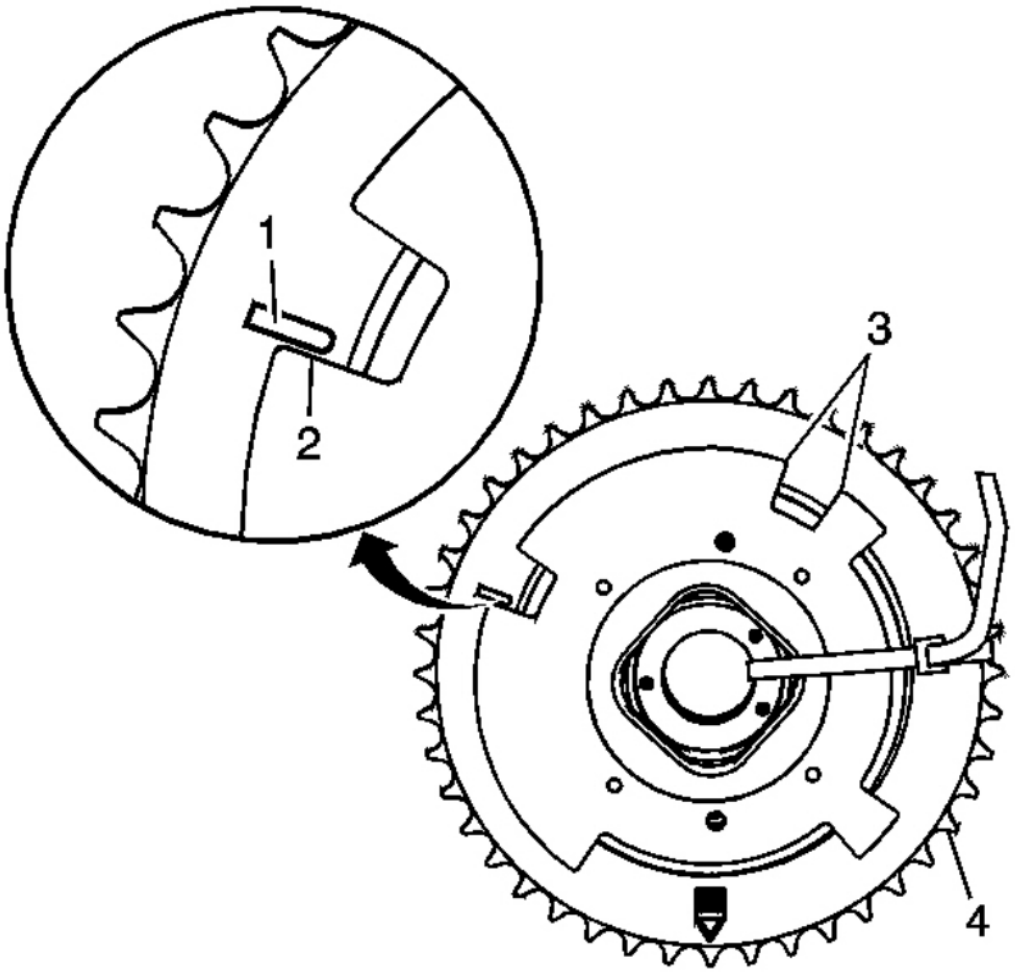


Fig. 74: CMP Actuator Inspection Points
Courtesy of GENERAL MOTORS CORP.

5. Inspect the CMP actuator for the following conditions:
   - Improper positioning of the CMP reluctor wheel. The actuator return spring should reposition the reluctor wheel to the PARK position. Inspect for proper alignment of the mark on the face of the sprocket (1) with the flat edge of the reluctor wheel (2). If the reluctor wheel is not properly

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positioned, the internal components of the actuator are sticking or the return spring is broken and the actuator should be replaced as an assembly.

- Nicked or damaged edges (3) on the CMP reluctor wheel
- Damaged timing chain teeth (4)

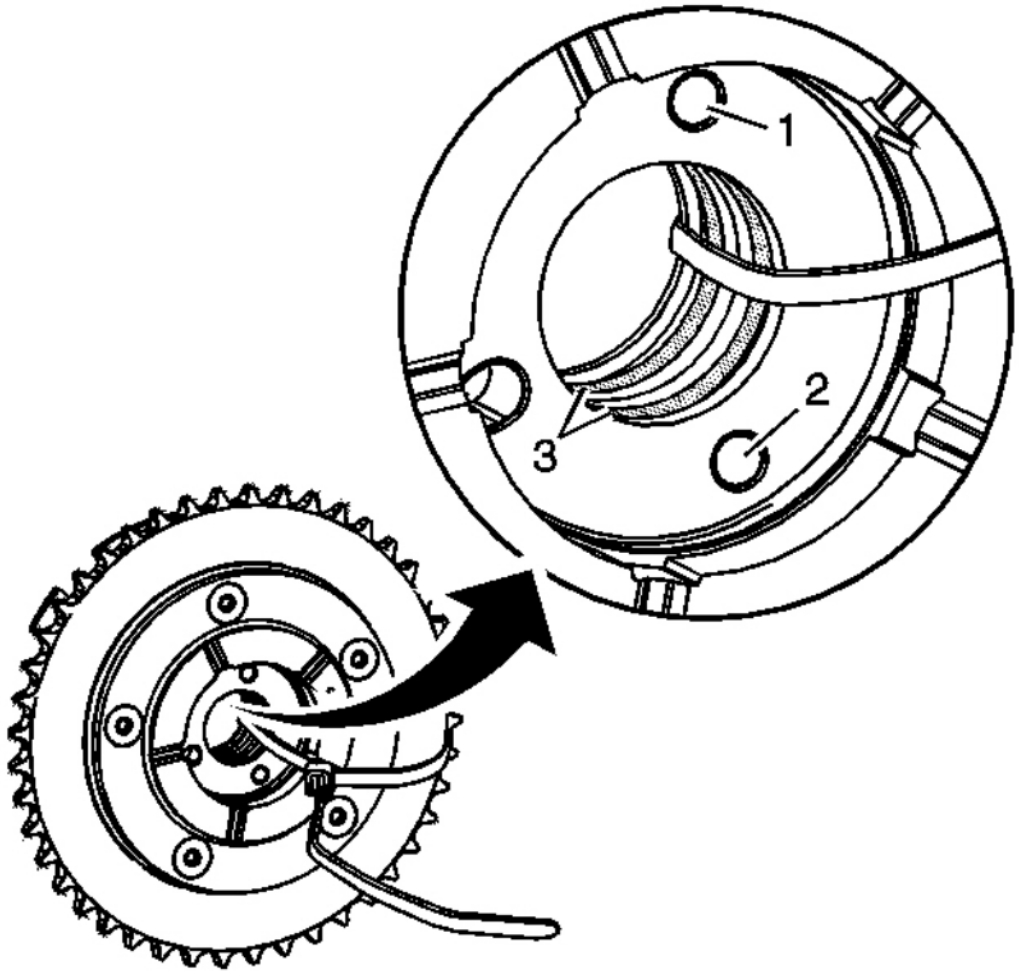


Fig. 75: View Of Oil Passages
Courtesy of GENERAL MOTORS CORP.

6. Inspect the CMP actuator for dirt, debris, or restrictions within the oil passages (1, 2, 3).

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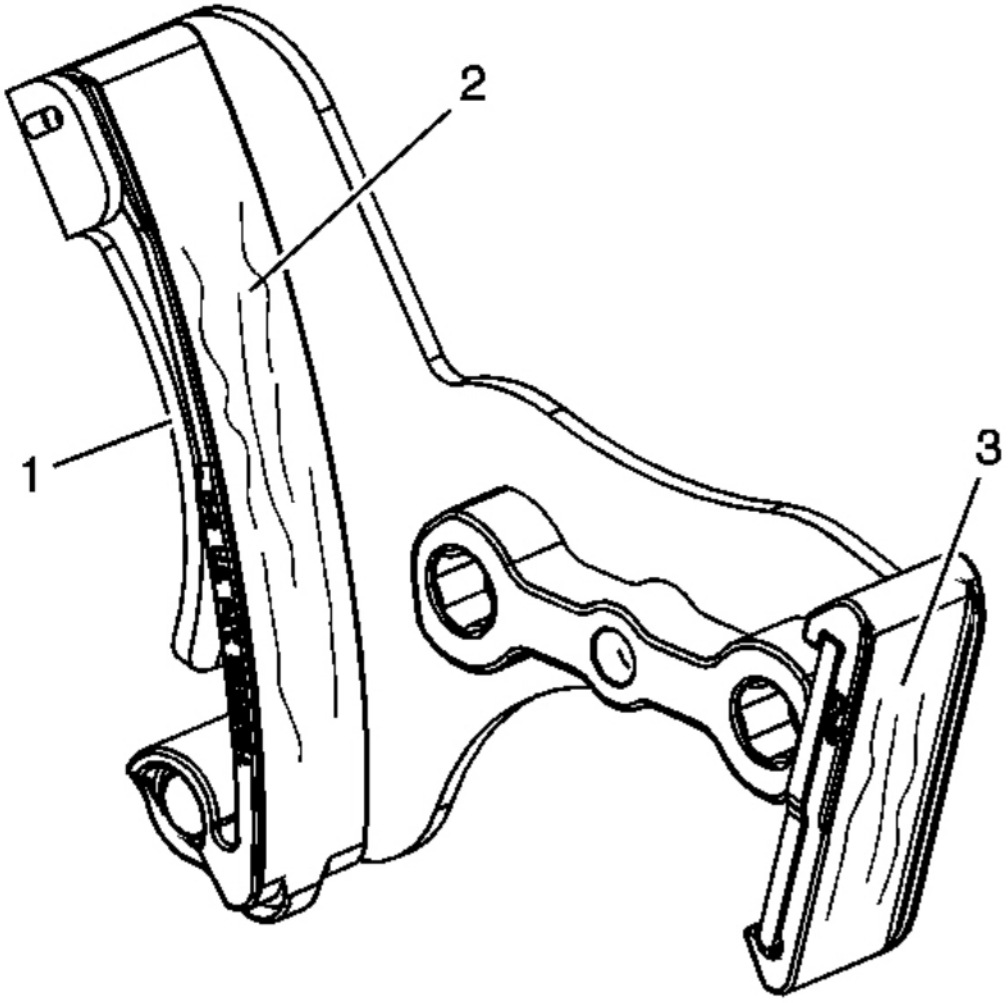


Fig. 76: View Of Timing Chain Tensioner Inspection Points
Courtesy of GENERAL MOTORS CORP.

7. Inspect the timing chain tensioner for the following conditions:
   - Damaged or broken tension spring (1)
   - Excessive wear or scoring on the chain guide surfaces (2, 3)

CAMSHAFT POSITION ACTUATOR MAGNET CLEANING AND INSPECTION

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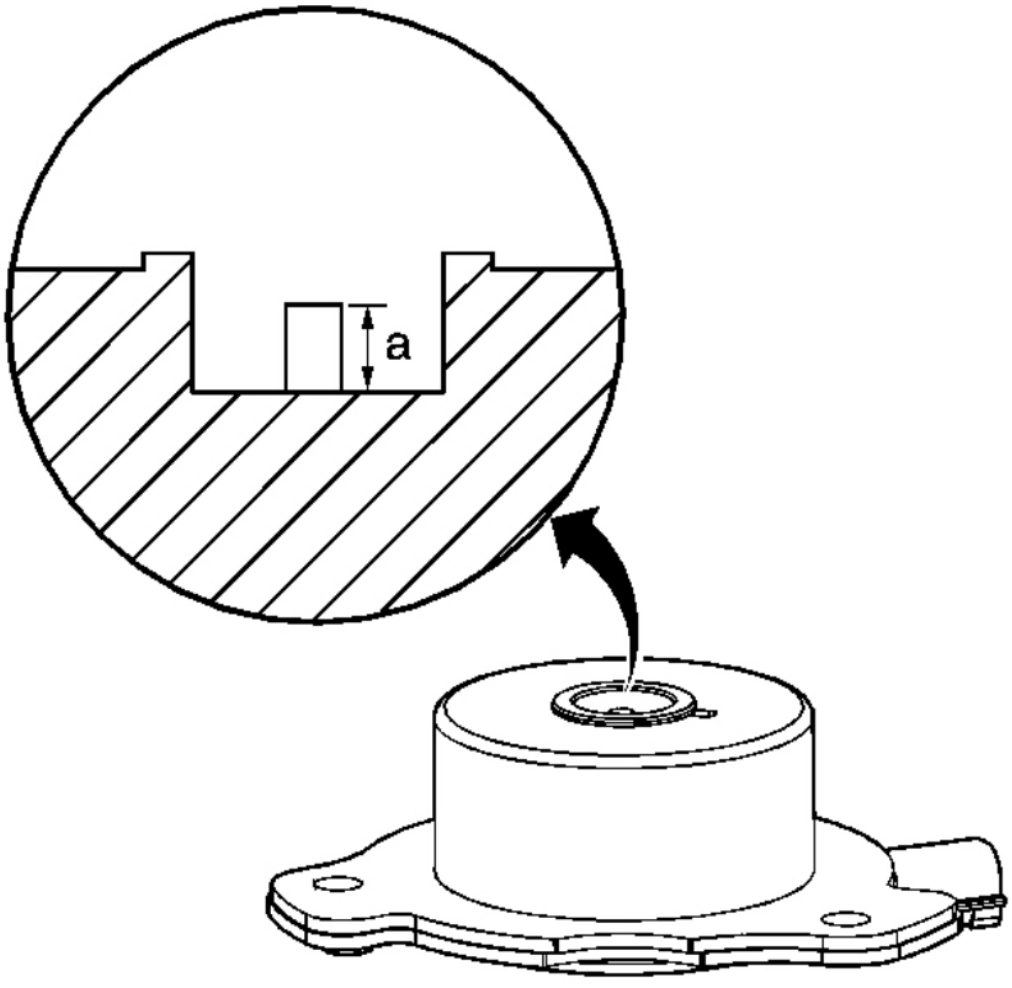


Fig. 77: Measuring The Retracted Position
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not energize the camshaft position (CMP) magnet using a 12-volt power supply.

1. Inspect the CMP magnet for the following conditions:
   - A damaged electrical connector
   - An accumulation of dirt or debris in the recessed area around the pintle
   - A build-up of burnt engine oil on the shaft of the pintle which may cause the pintle to stick and not move freely within the proper range of travel

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2. Holding the CMP magnet with the pintle facing upward, measure the pintle retracted position (a). Record the dimension.

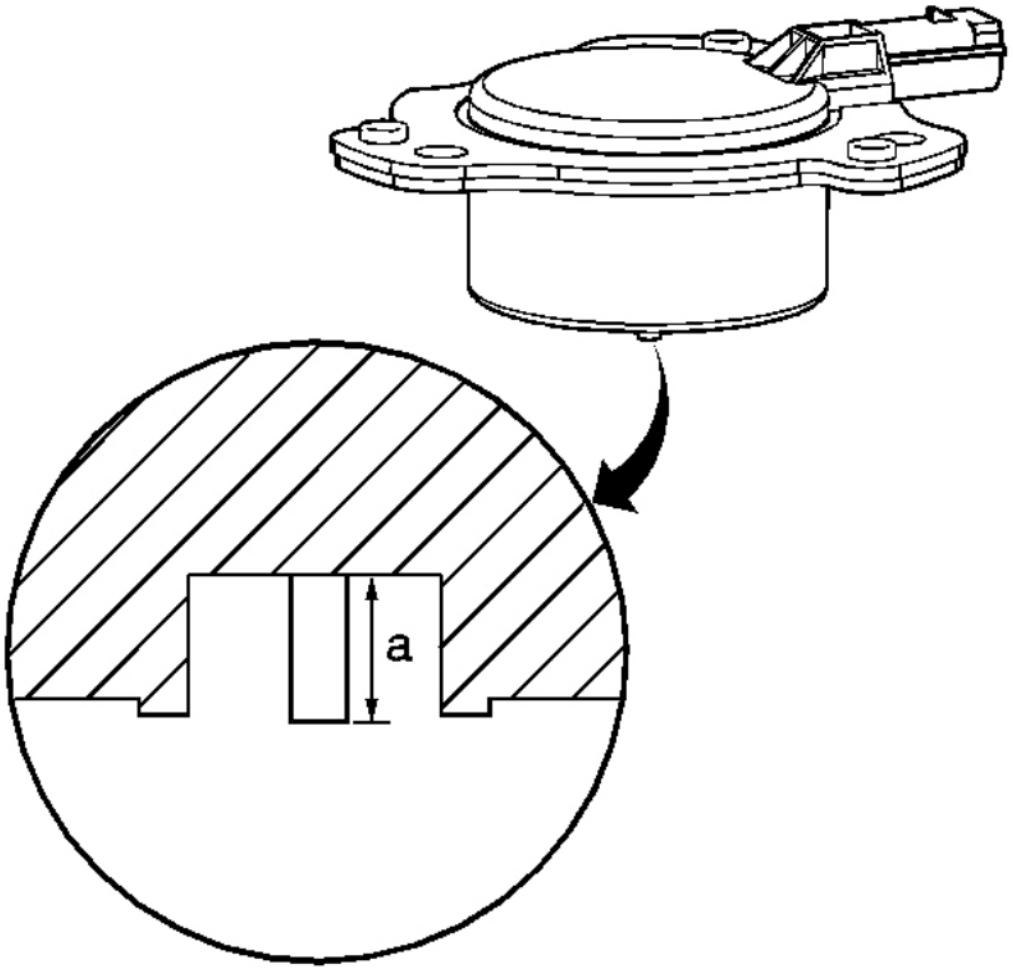


Fig. 78: Measuring The Pintle Extended Position
Courtesy of GENERAL MOTORS CORP.

3. Holding the CMP magnet with the pintle facing downward, measure the pintle extended position (a). Record the dimension.
4. Subtract the retracted dimension from the extended dimension to determine pintle travel. A properly moving pintle will travel 3.0-5.5 mm (0.12-0.22 in).
5. If the pintle of the CMP magnet is binding or does not move within the proper range of travel, replace the CMP magnet as an assembly.

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CAMSHAFT POSITION ACTUATOR SOLENOID VALVE INSPECTION (ON-VEHICLE)

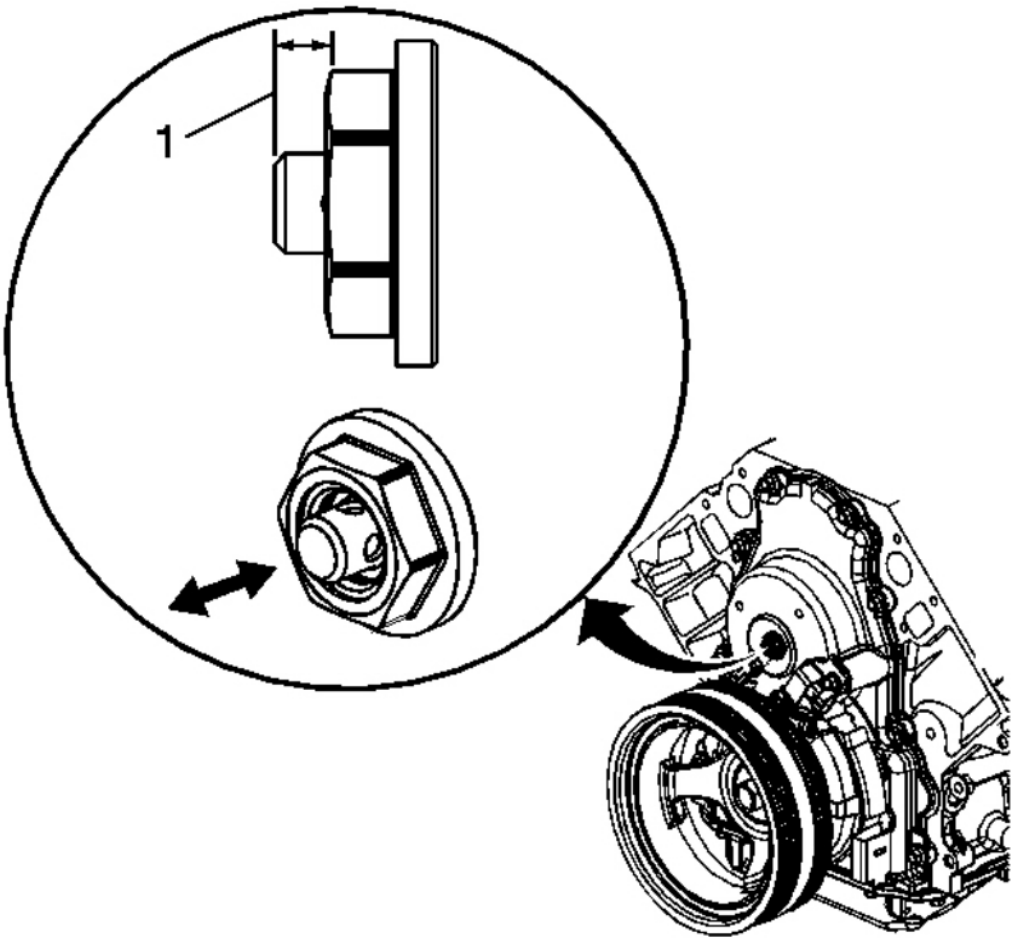


Fig. 79: View Of Proper Valve Spool Position
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not use the camshaft position (CMP) actuator solenoid valve again. Install a NEW valve during assembly. The inspection procedure below is provided for on-vehicle diagnostic purposes only.

1. With the CMP magnet removed, inspect for a sticking valve spool or broken valve spool spring.
2. Depress the valve spool into the housing. The valve should move freely with no binding or sticking and minimal resistance inward. When released, the valve spring should return the spool to the proper

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extended position (1) of 6.08-6.12 mm (0.239-0.241 in).

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE INSPECTION (OFF-VEHICLE)

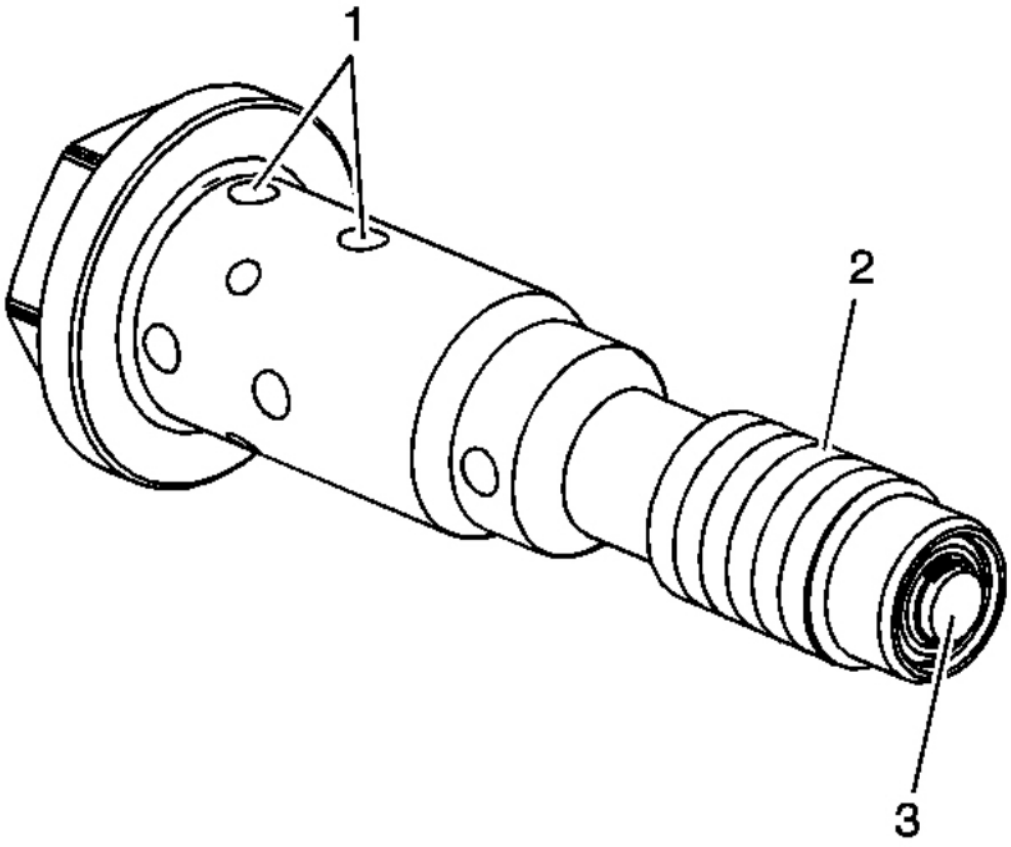


Fig. 80: View Of CMP Inspection Points
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not use the camshaft position (CMP) actuator solenoid valve again. Install a NEW valve during assembly. The inspection procedure below is provided for off-vehicle diagnostic purposes only.

1. Inspect the CMP valve for the following conditions:
   - Dirt, debris, or restrictions within the oil passages (1)
   - Damaged threads (2)

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If the threads of the valve are damaged, also inspect the threads in the front of the camshaft for damage.

- Dirt, debris, or restrictions within the oil inlet check valve (3)

  If debris is detected, the engine assembly should be inspected to determine the source of contamination.

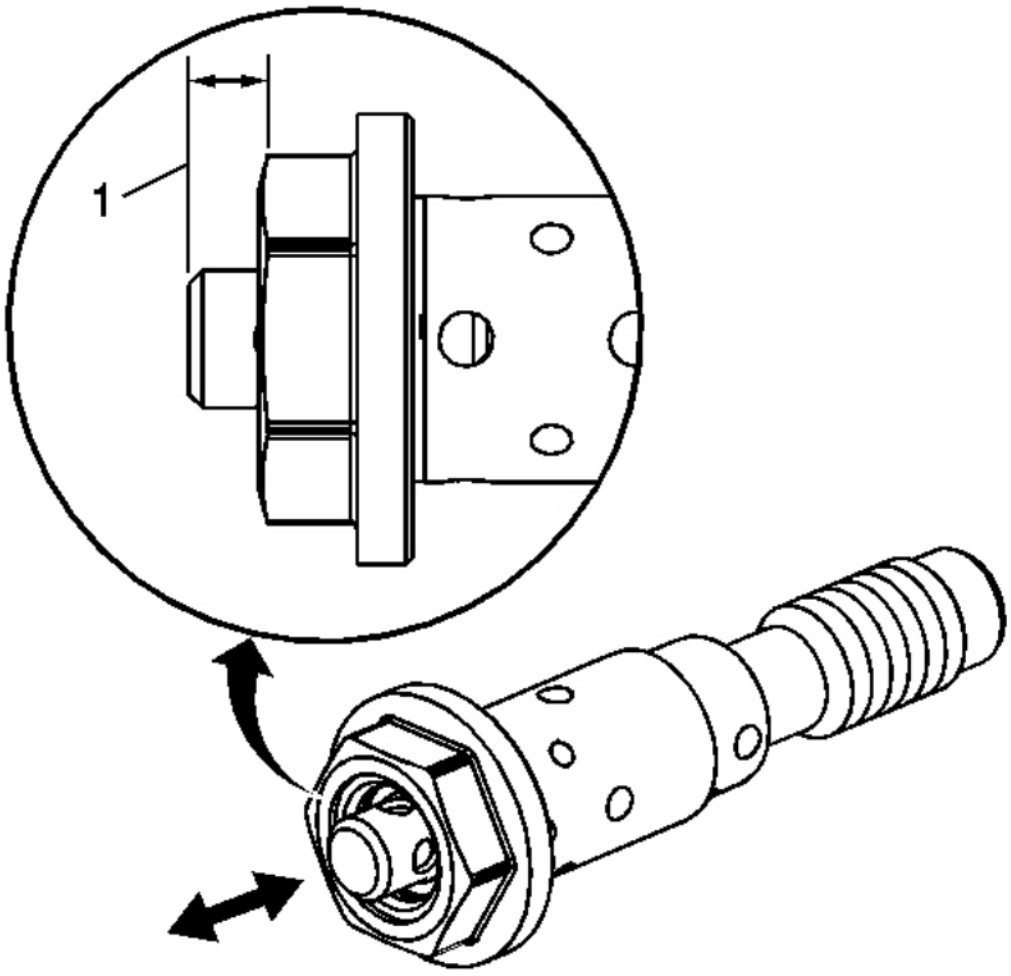


Fig. 81: View Of Proper Valve Spool Position
Courtesy of GENERAL MOTORS CORP.

2. Inspect for a sticking valve spool or broken valve spool spring.
3. Depress the valve spool into the housing. The valve should move freely with no binding or sticking and

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minimal resistance inward. When released, the valve spring should return the spool to the proper extended position (1) of 6.08-6.12 mm (0.239-0.241 in).

VALVE ROCKER ARM AND PUSH RODS CLEANING AND INSPECTION

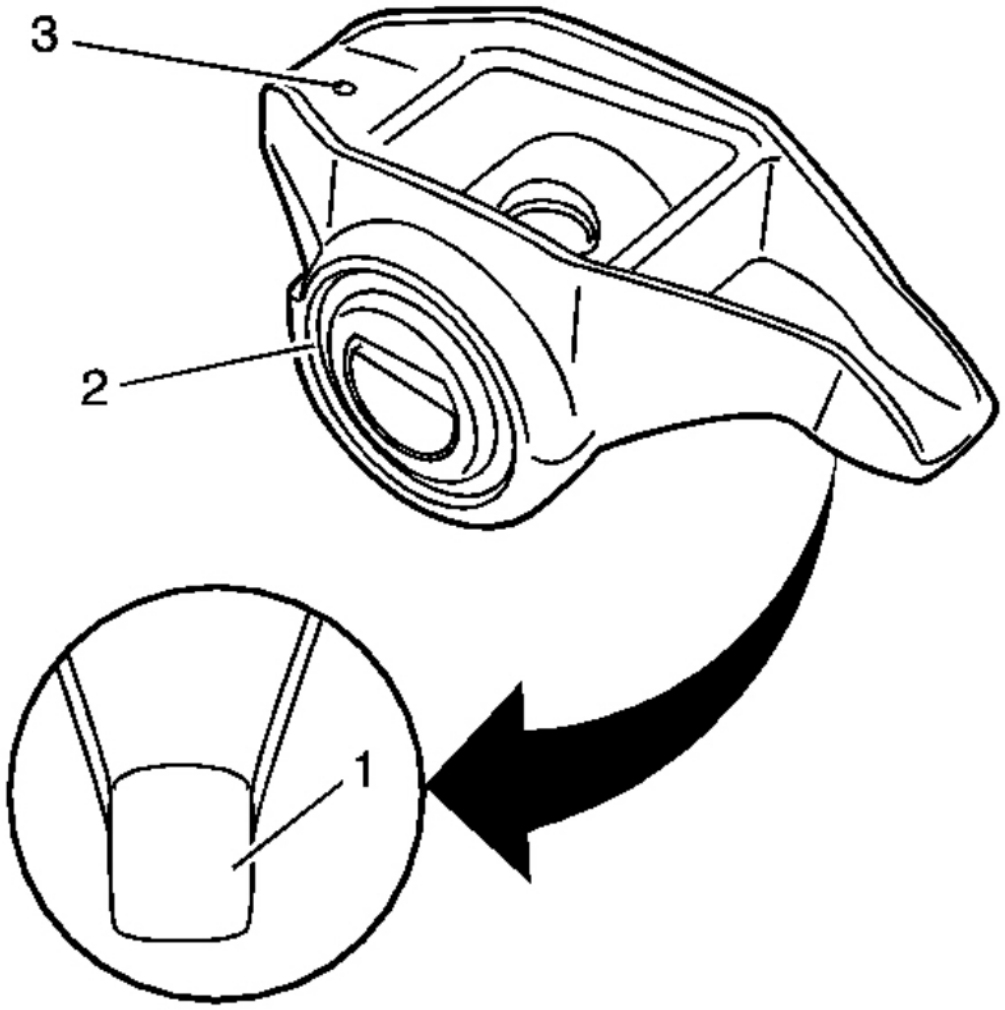


Fig. 82: Identifying Valve Rocker Arm Components
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Parts that are to be used again must be marked, sorted or organized for assembly.

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1. Mark, sort, or organize the components for assembly. Refer to **Separating Parts** .
2. Clean the components with cleaning solvent.

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

3. Dry the components with compressed air.
4. Inspect the valve rocker arms bearings (2) for binding or roughness.
5. Inspect the valve rocker arm pushrod sockets (3) and valve stem mating surfaces (1). These surfaces should be smooth with no scoring or exceptional wear.
6. Inspect the pushrods for worn or scored ends. These surfaces should be smooth with no scoring or exceptional wear.
7. Inspect the pushrods for bends. Roll the pushrod on a flat surface to determine if the pushrod is bent.
8. Inspect the pushrod oil passages for restrictions.
9. Inspect the rocker arm pivot supports for cracks, wear, or other damage.

VALVE LIFTERS AND GUIDES CLEANING AND INSPECTION (RPO LY2/LY6)

VALVE LIFTERS

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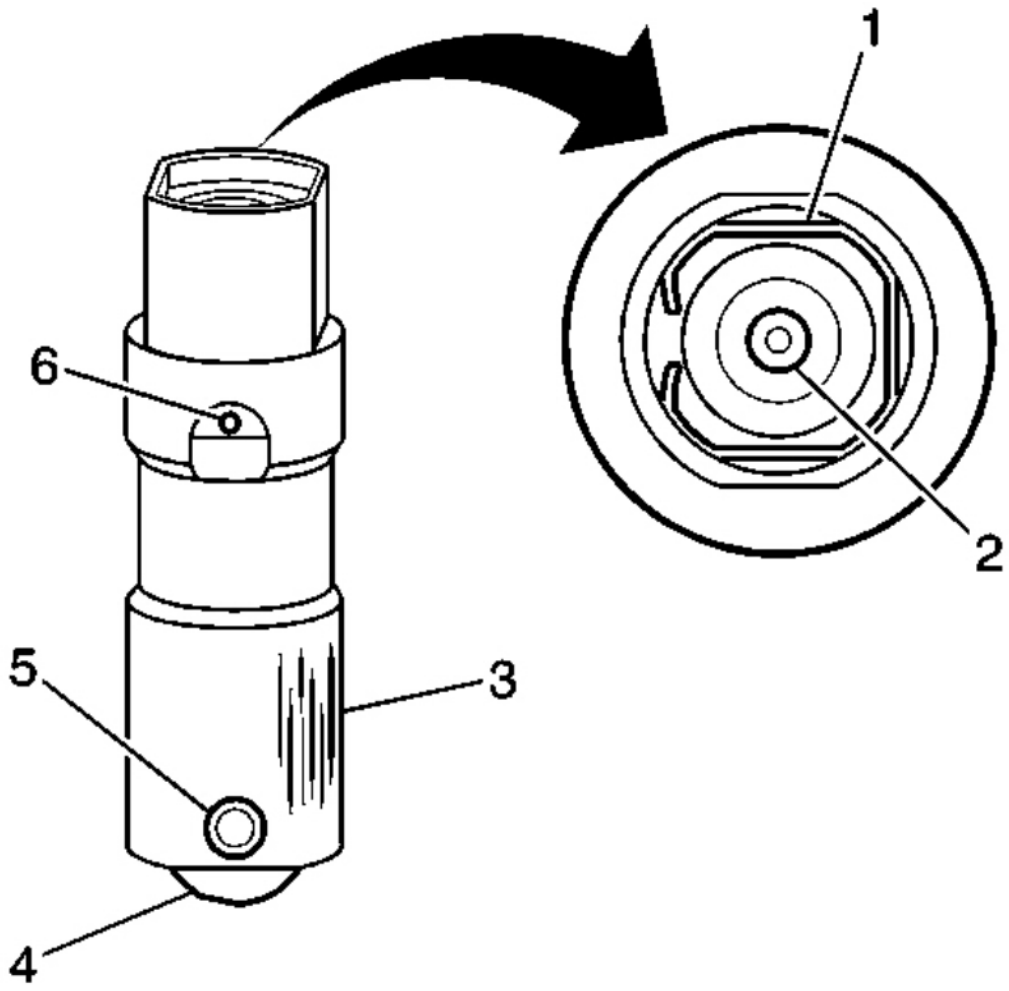


Fig. 83: Inspecting Areas Of Valve Lifters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Components that are to be used again must be marked, sorted or organized for assembly.

1. Clean the components in cleaning solvent.

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

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2. Dry the components with compressed air.
3. Inspect the valve lifters for the following conditions:
    - Bent or broken clip (1)
    - Worn pushrod socket (2)
    - Scuffed or worn sides (3)

      If the valve lifter shows wear, inspect the engine block lifter bores for wear or damage.

    - Flat spots on the roller (4)
    - Loose or damaged pin (5)
    - Plugged oil hole (6)
    - Worn or damaged roller bearing

      The roller should rotate freely with no binding or roughness.

VALVE GUIDES

Inspect the valve lifter guides for the following conditions:

- Cracks or damage
- Excessive wear in the lifter mounting bores

VALVE LIFTERS AND GUIDES CLEANING AND INSPECTION (RPO LC9/LY5/LMG/L76/L92)

NON ACTIVE FUEL MANAGEMENT VALVE LIFTERS

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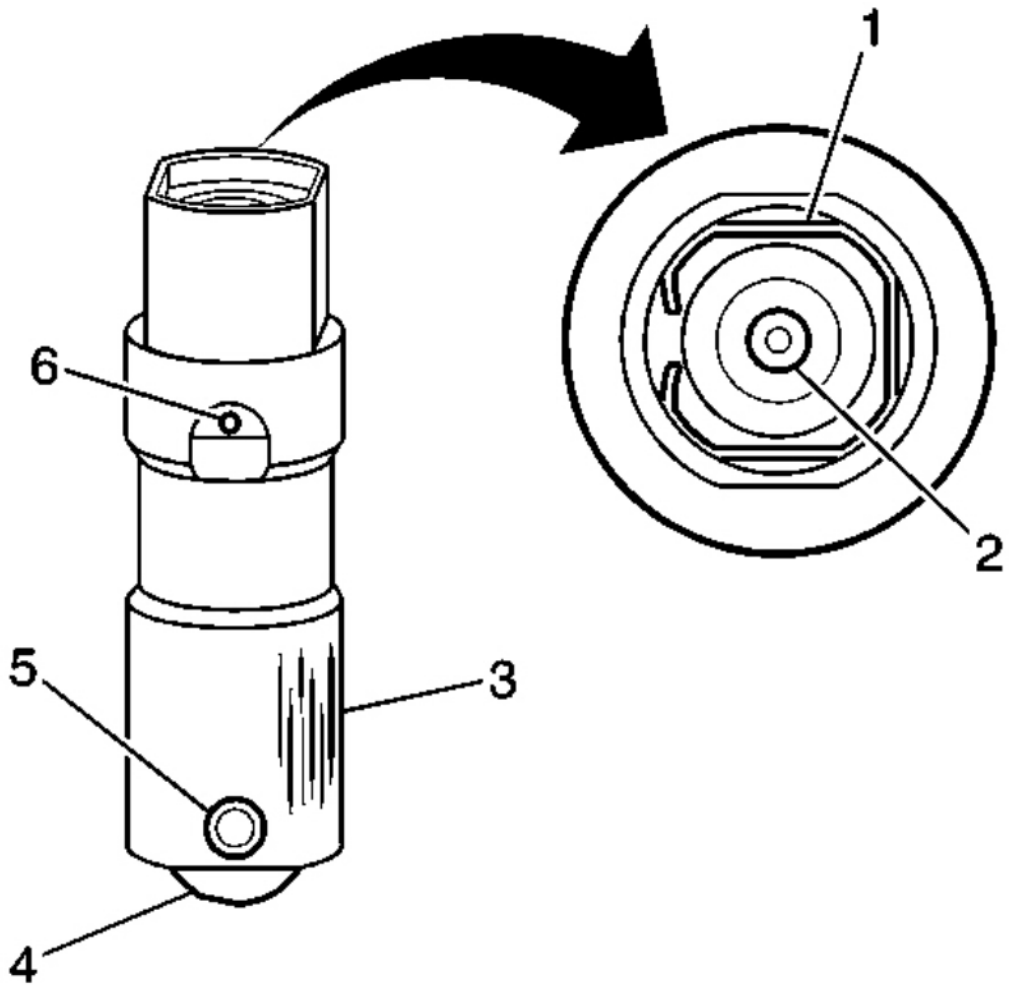


Fig. 84: Inspecting Areas Of Valve Lifters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Components that are to be used again must be marked, sorted or organized for assembly.

1. Clean the components in cleaning solvent.

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

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2. Dry the components with compressed air.
3. Inspect the valve lifters for the following conditions:
    - Bent or broken clip (1)
    - Worn pushrod socket (2)
    - Scuffed or worn sides (3)

      If the valve lifter shows wear, inspect the engine block lifter bores for wear or damage.

    - Flat spots on the roller (4)
    - Loose or damaged pin (5)
    - Plugged oil hole (6)
    - Worn or damaged roller bearing

      The roller should rotate freely with no binding or roughness.

ACTIVE FUEL MANAGEMENT VALVE LIFTERS

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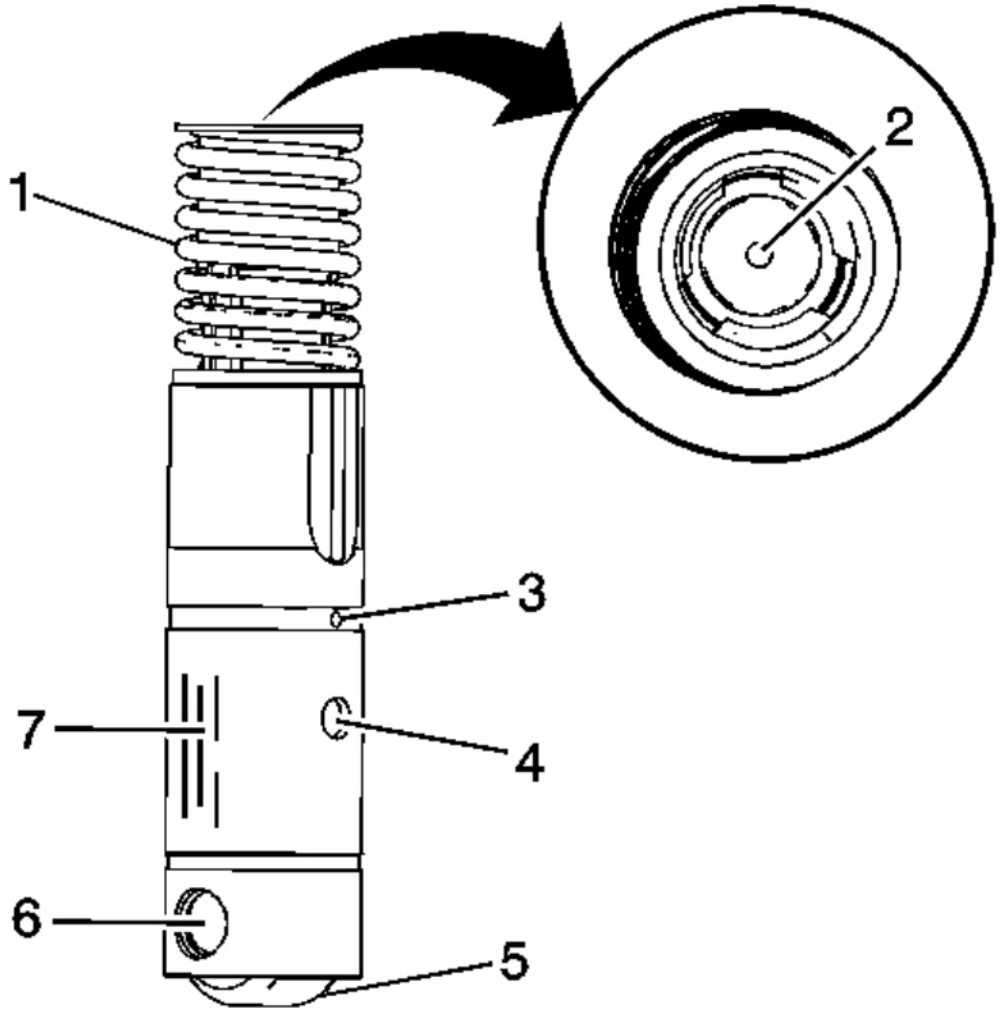


Fig. 85: Displacement On Demand Valve Lifters Assembly
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Components that are to be used again must be marked, sorted or organized for assembly.

1. Clean the components in cleaning solvent.

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

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2. Dry the components with compressed air.
3. Inspect the valve lifters for the following conditions:
    - Broken or collapsed spring (1)
    - Worn pushrod socket (2)
    - Plugged lubrication hole (3)
    - Plugged lifter oil-switching hole (4)
    - Flat spots on the roller (5)
    - Worn or damaged roller bearing (6)

      The roller should rotate freely with no binding or roughness.

    - Scuffed or worn sides (7)

VALVE GUIDES

Inspect the valve lifter guides for the following conditions:

- Cracks or damage
- Excessive wear in the lifter mounting bores

CYLINDER HEAD DISASSEMBLE

TOOLS REQUIRED

J 8062 Valve Spring Compressor - Head Off. See **Special Tools** .

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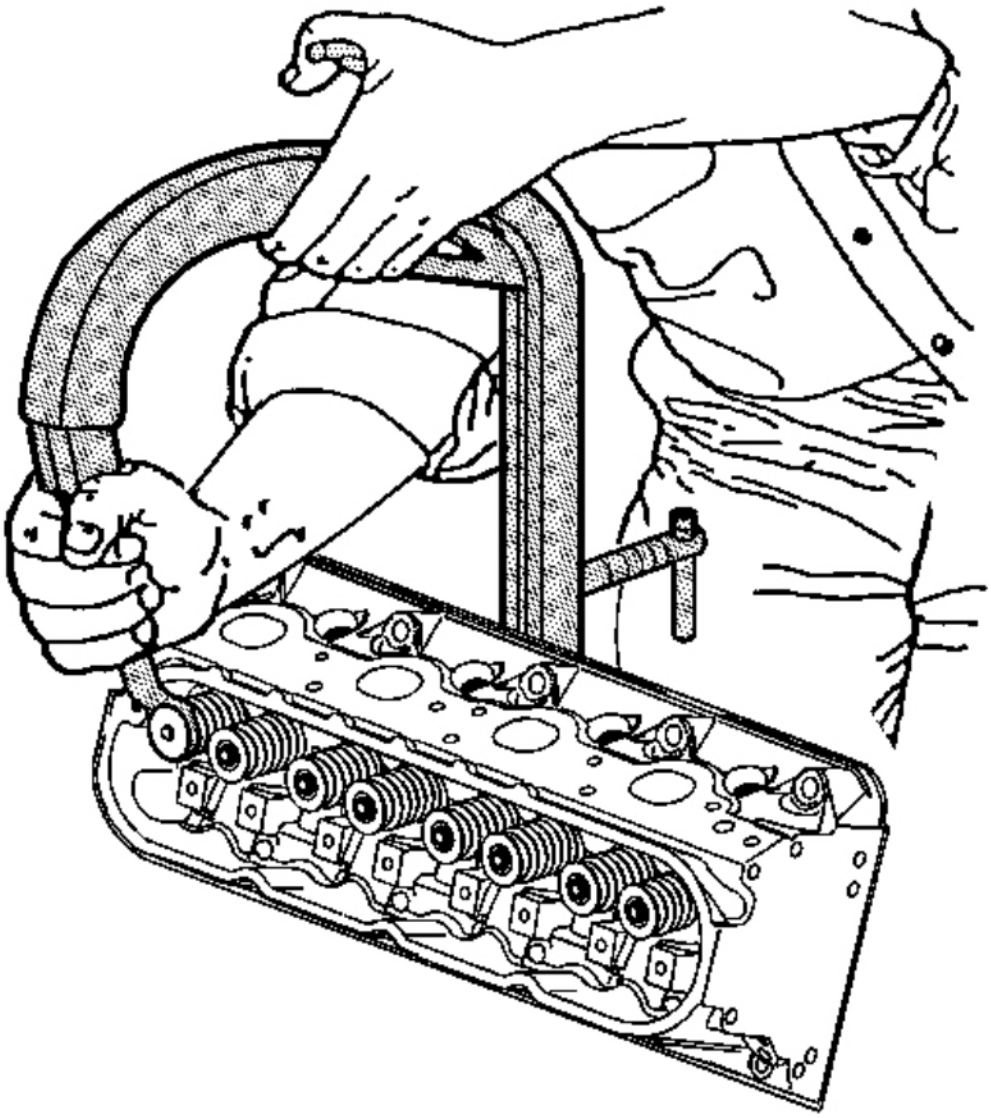


Fig. 86: Compressing Valve Spring Using J 8062
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **With the components at room temperature, remove the spark plugs from the cylinder head.**
- **Mark, organize, or sort the cylinder head components for assembly. Return the components to their original location during assembly.**

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1. Remove the spark plugs from the cylinder heads.
2. Use the **J 8062** in order to compress the valve spring. See **Special Tools** .

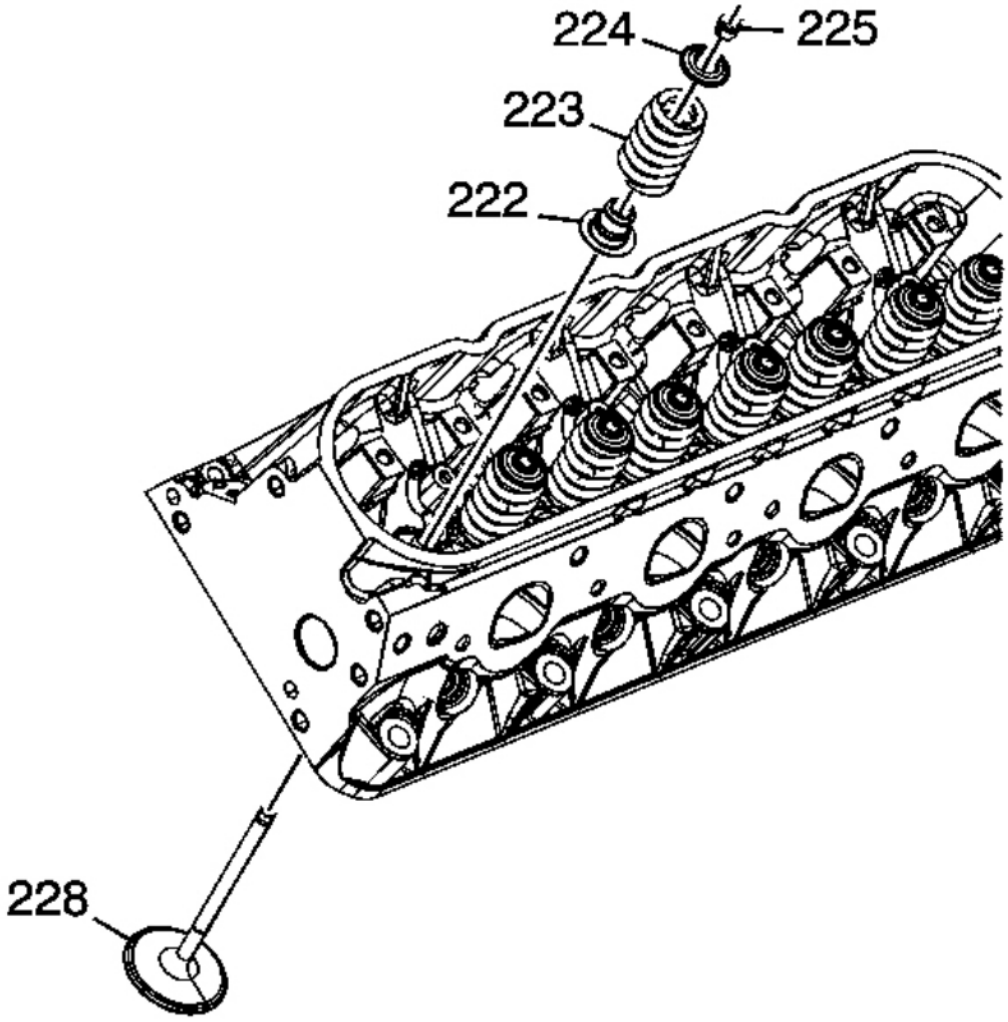


Fig. 87: View Of Valve Components
Courtesy of GENERAL MOTORS CORP.

3. Remove the valve stem keys (225).
4. Remove the valve spring cap (224).
5. Remove the valve spring (223).
6. Remove the valves (228).

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7. Remove the valve stem oil seal (222). Refer to **Separating Parts** .

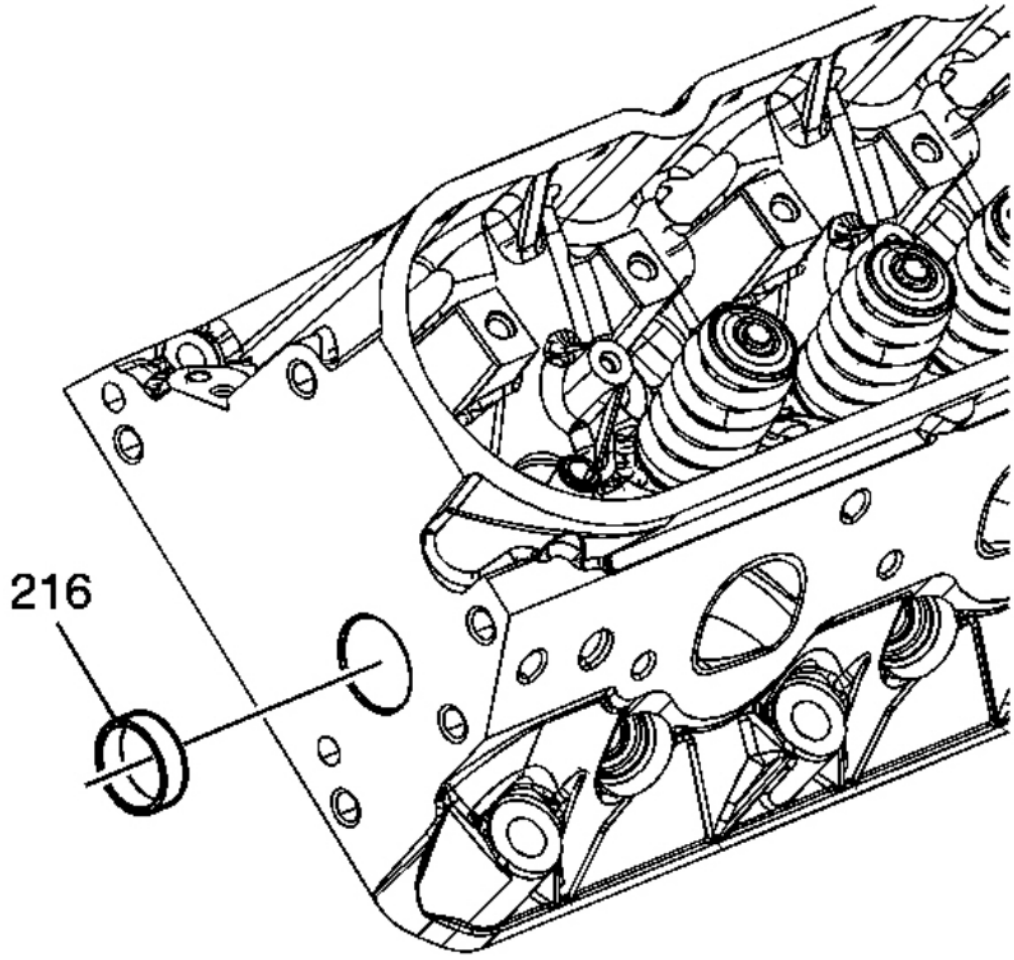


Fig. 88: Locating Cylinder Head Core Hole Plug
Courtesy of GENERAL MOTORS CORP.

8. Remove the cylinder head core hole plugs (216), as required.

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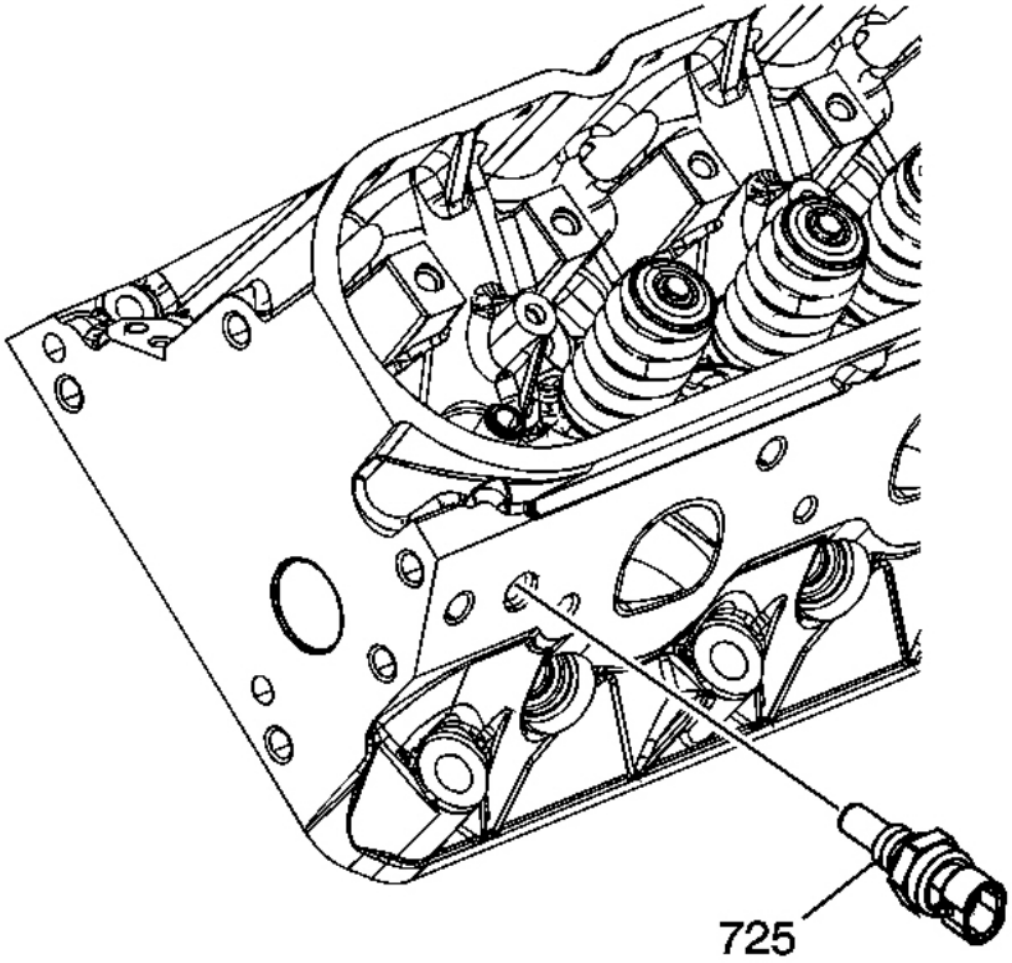


Fig. 89: Locating Coolant Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

9. Remove the coolant temperature sensor (725) from the left cylinder head.

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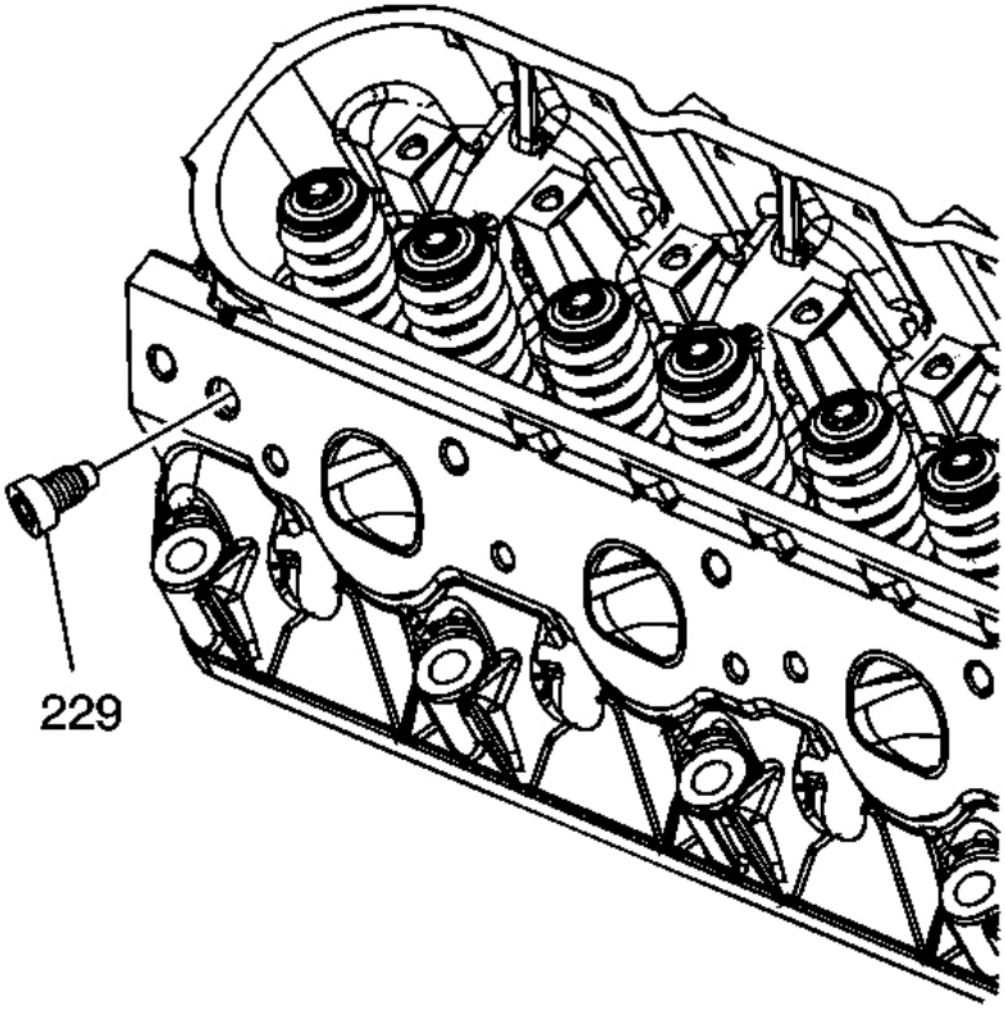


Fig. 90: Locating Coolant Plug
Courtesy of GENERAL MOTORS CORP.

10. Remove the cylinder head plug (229) from the right cylinder head.

CYLINDER HEAD CLEANING AND INSPECTION

Tools Required

- **J 8089** Carbon Removal Brush. See **Special Tools** .
- **J 9666** Valve Spring Tester. See **Special Tools** .

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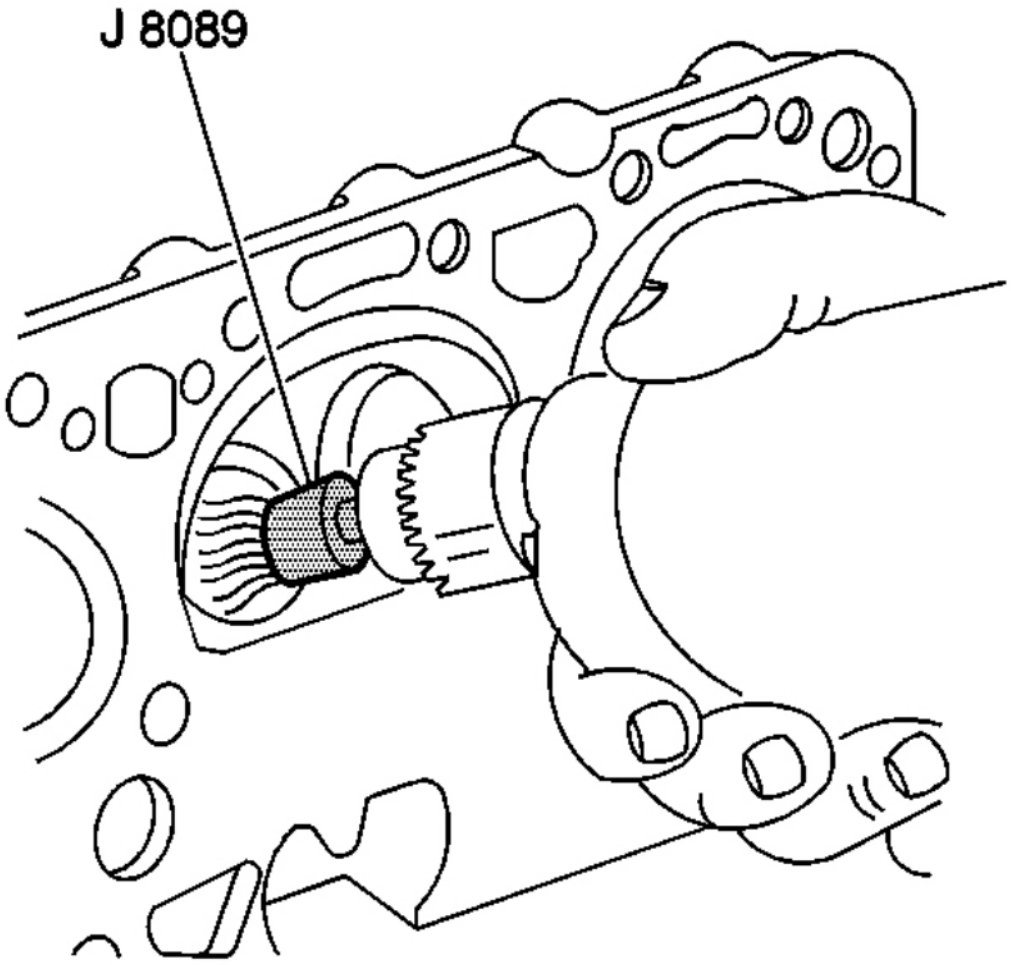


Fig. 91: Removing Carbon From Combustion Chambers
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Safety Glasses Caution .

IMPORTANT:

- **When cleaning a cylinder head in a thermal type oven, do not exceed 204°C (400°F).**
- **Be careful not to scuff the chamber.**

1. Clean the following components:

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- Use the **J 8089** in order to remove the carbon from the combustion chambers. See **Special Tools** .
- Gasket surfaces

  Refer to **Replacing Engine Gaskets** .

- Valve stems and heads on a buffing wheel
- Bolt hole threads

  Remove all dirt, debris, or threadlocking material from the bolt holes.

2. Inspect the cylinder head for the following conditions:
   1. Cracks in the exhaust ports and combustion chambers
   2. External cracks in the water chambers
   3. Gasket surfaces for excessive scratches or gouging

      Refer to **Replacing Engine Gaskets** .

   4. Bolt hole threads for debris or damaged threads

      Refer to **Thread Repair** or **Thread Repair Specifications** .

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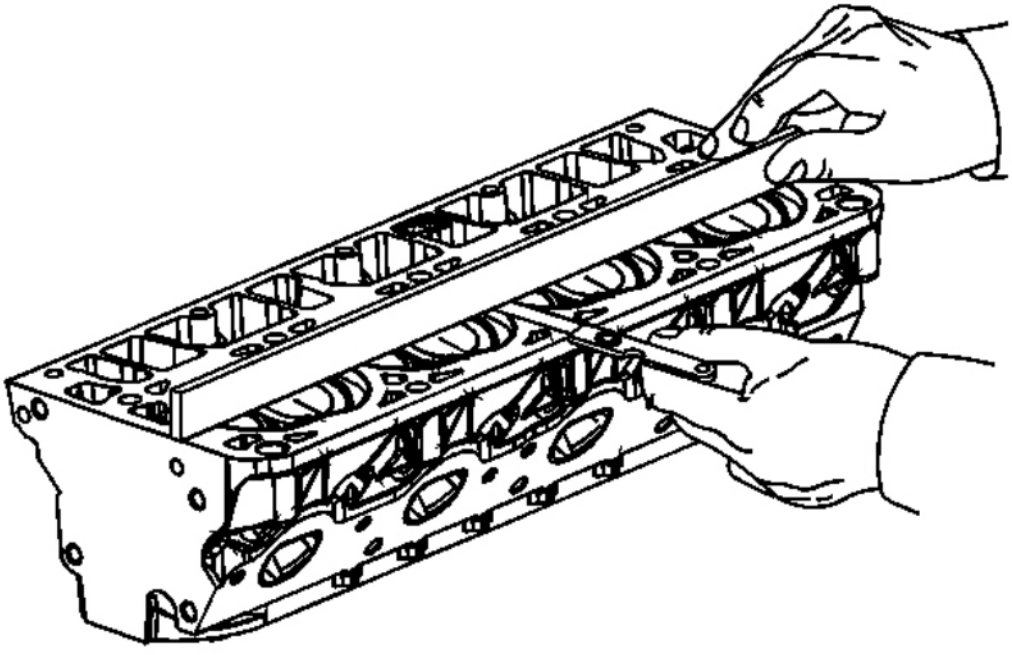


Fig. 92: Inspecting The Cylinder Head For Warpage
Courtesy of GENERAL MOTORS CORP.

3. Inspect the cylinder head for warpage. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

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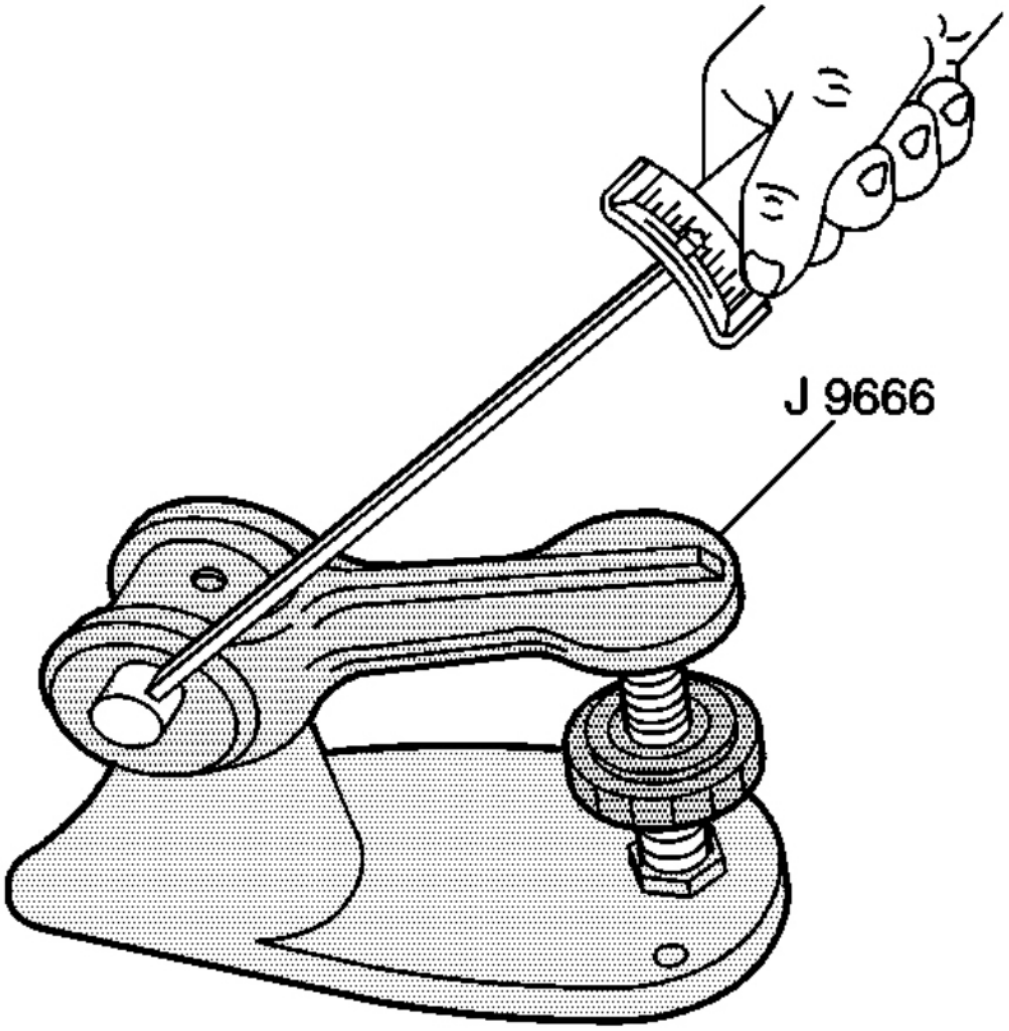


Fig. 93: Measuring Valve Spring Tension
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 9666** in order to measure the valve spring tension. See **Special Tools** . Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

VALVE GUIDE REAMING/VALVE AND SEAT GRINDING

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TOOLS REQUIRED

J 37378-1 Valve Guide Reamer. See **Special Tools** .

VALVE GUIDE REAMING

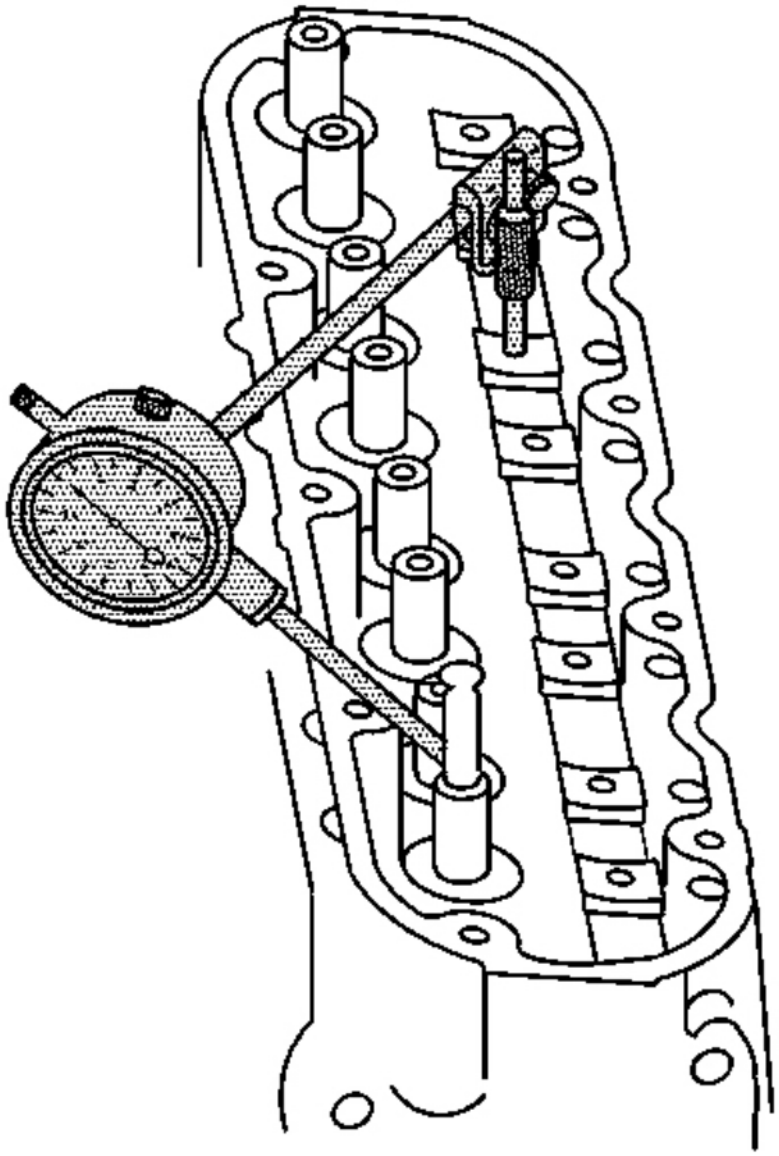


Fig. 94: Measuring Valve Stem-To-Guide Clearance

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Courtesy of GENERAL MOTORS CORP.

NOTE: Excessive valve stem-to-guide clearance may cause a noisy valve train, premature valve stem oil seal wear, component damage, and/or excessive engine oil consumption.

NOTE: Insufficient valve stem-to-guide clearance will result in noisy or sticking valves. Valves that are too tight may disturb engine smoothness or lead to component damage.

1. Using a dial indicator, measure the valve stem-to-guide clearance. Position the tip of the dial indicator at the top of the valve guide.

   Valve stem-to-guide clearance may also be obtained by using a micrometer to measure the valve stem diameter and a ball type measuring gage to measure the guide bore.

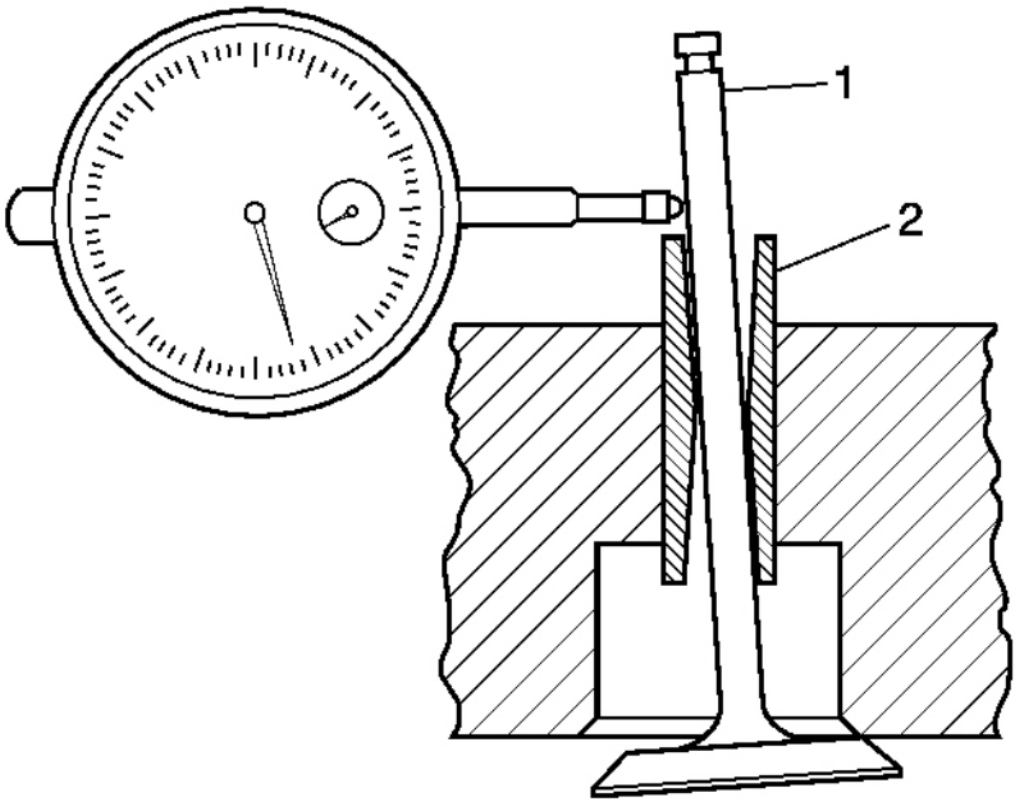


Fig. 95: Inspecting For Excessive Valve Stem To Guide Clearance

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Courtesy of GENERAL MOTORS CORP.

2. A valve stem (1) and guide (2), with excessive clearance, must be replaced or the cylinder head replaced. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

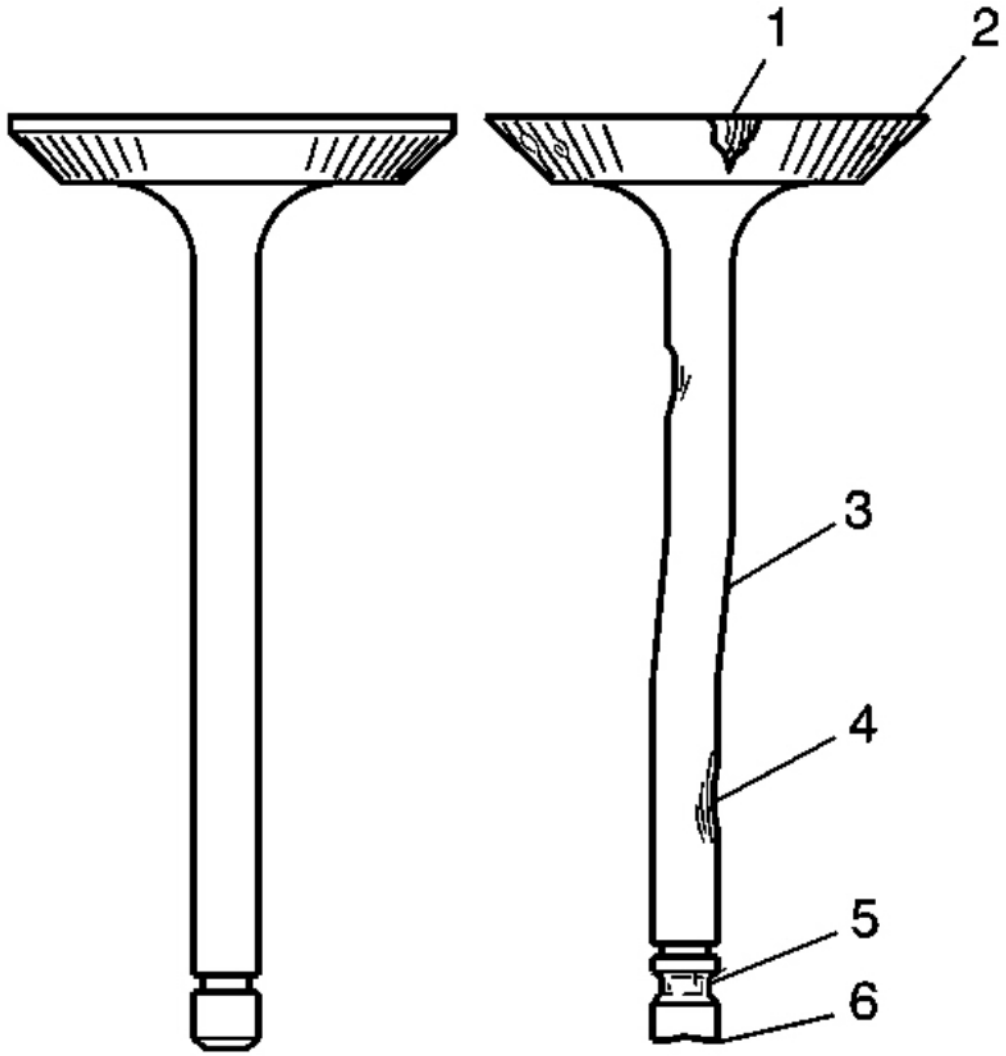


Fig. 96: Identifying Inspection Points For Valves Damage

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Courtesy of GENERAL MOTORS CORP.

3. Inspect the valve stems for excessive scoring, wear, or warpage.
   - A valve stem that has excessive scoring (3 or 4) or wear (4 or 6) must be replaced.
   - If a valve guide is worn or has excessive stem-to-guide clearance, the cylinder head should be replaced.
4. Measure the valve stem diameter. A valve stem with a diameter less than 7.95 mm (0.313 in) must be replaced.

   If the valve stem diameter is within specifications, and the stem-to-guide clearance is excessive, the cylinder head must be replaced.

VALVE AND SEAT GRINDING

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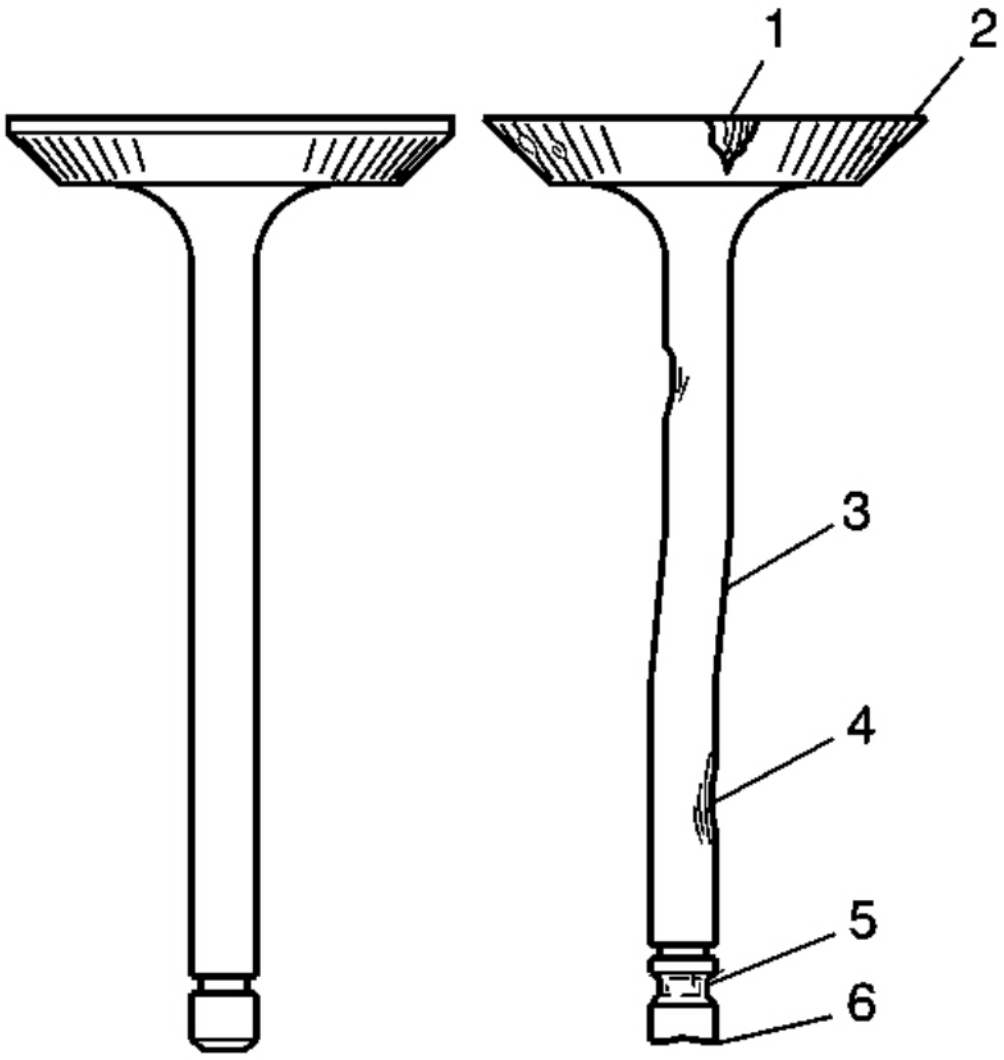


Fig. 97: Identifying Inspection Points For Valve Damage
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Reconditioning the valve seats is very important. The seating of the valves must be perfect for the engine to deliver optimum power and performance. Several different types of equipment are available for grinding valve seats.**
- **Another important factor is the cooling of the valve head. Good contact between the valve and the seat will ensure that heat will be**

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properly dissipated.

- **The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free of carbon or dirt to ensure proper centering of the tool pilot in the guide.**
- **Valves that are pitted must be refaced to the proper angle. Valve stems that show excessive wear, or valves that are warped excessively must be replaced. When a valve head that is warped excessively is refaced, a knife edge may be ground on part or all of the valve head due to the amount of metal that must be removed. Knife edges lead to breakage, burning or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head is less than 1.25 mm (0.05 in) after grinding, replace the valve.**
- **Several different types of equipment are available for refacing valves. The recommendation of the equipment manufacturer should be carefully followed to obtain the proper results.**
- **DO NOT reface intake valves. Intake valves with excessive wear or damage MUST be replaced.**

1. Inspect the valve for the following conditions:
   - Burnt or eroded areas (1)
   - A worn margin (2)
   - A bent stem (3)
   - A worn or scored stem (4)
   - A worn key groove (5)
   - A worn stem tip (6)

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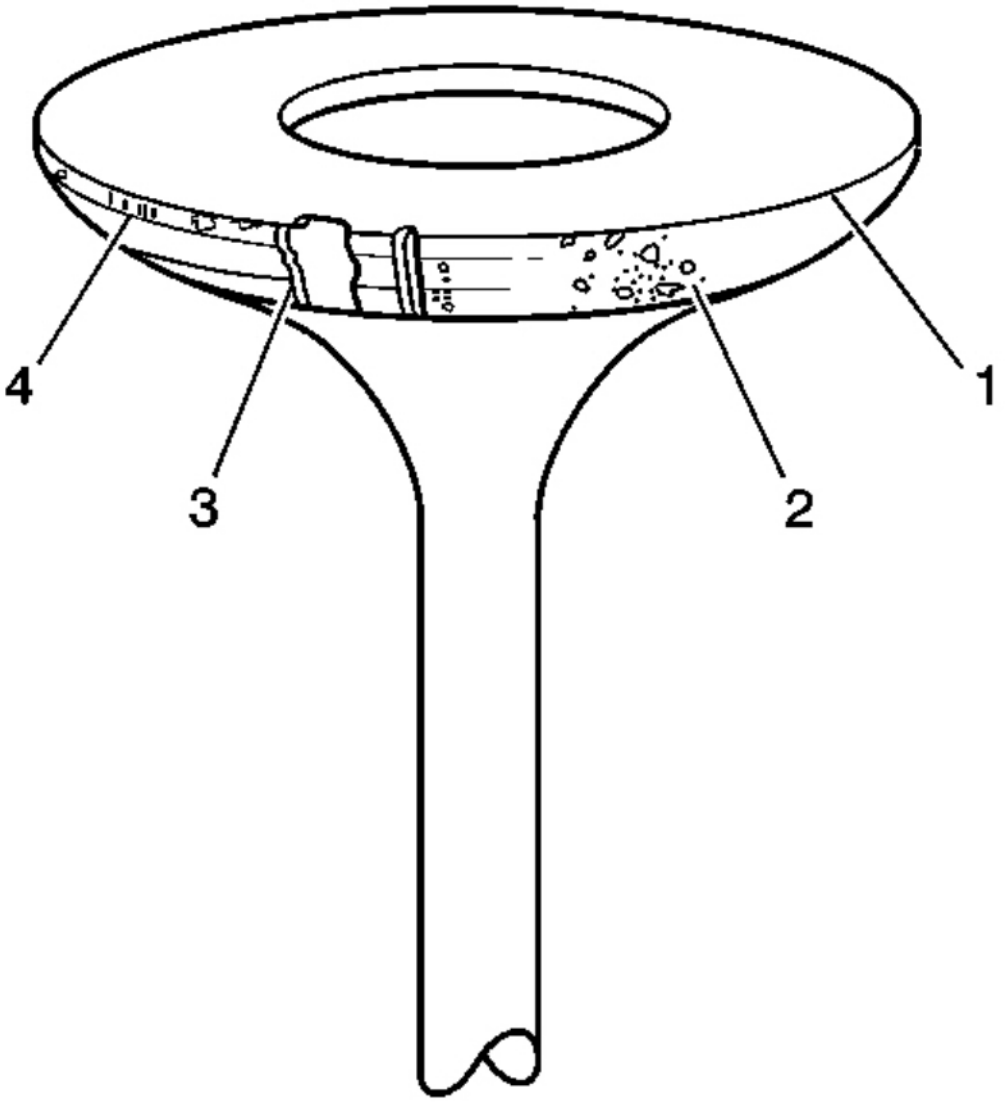


Fig. 98: Inspecting Valve Face For Burning, Pitting & Cracking
Courtesy of GENERAL MOTORS CORP.

2. Inspect the valve face for the following conditions:
   - Worn or no margin (1 or 4)
   - Pitted surfaces (2)
   - Burnt or eroded areas (3)

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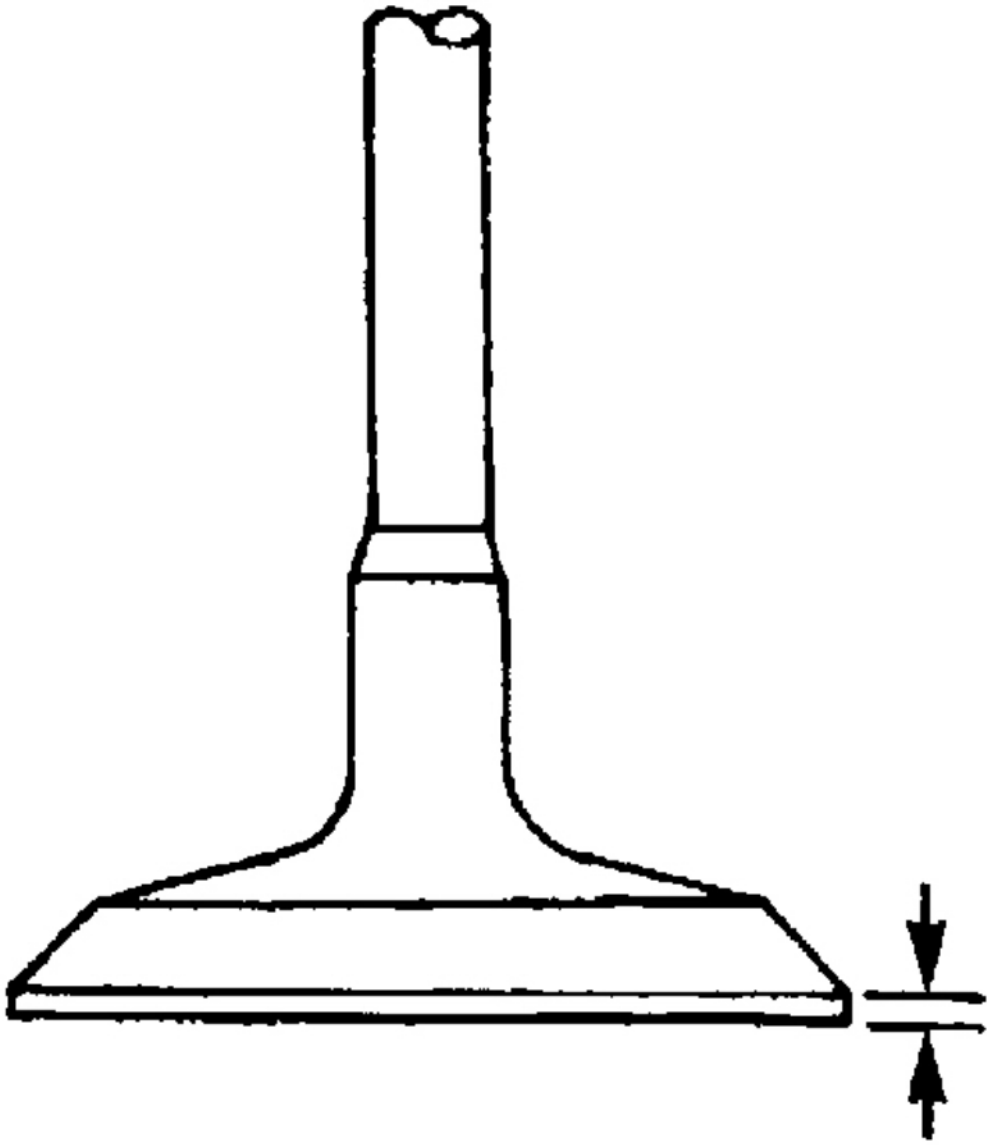


Fig. 99: Inspecting Valve Margin
Courtesy of GENERAL MOTORS CORP.

3. Inspect the valve margin.

   The exhaust valve may be refaced if the margin is greater than 1.25 mm (0.05 in) thick before grinding.

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4. Reface pitted exhaust valves on a suitable valve refacing machine.
5. Replace the valve if the margin is less than 1.25 mm (0.05 in) thick after grinding.
6. If the valve face has been ground, it may be necessary to shim the valve spring in order to obtain the proper spring installed height. Refer to **Cylinder Head Disassemble**.
7. Inspect for a loose valve seat in the cylinder head. The valve seat has an interference fit to the cylinder head.
8. Clean the valve guide bores with a suitable tool. Remove all carbon or dirt from the bores.

   The valve guide must be clean for the seat grinding tool to obtain proper results.

9. Grind the valve seat.

   The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free from carbon or dirt to ensure proper centering of the tool pilot in the guide.

10. Inspect the valve seats.
    - The valve seats should be concentric to within 0.05 mm (0.0021 in) total indicator reading.
    - If the valve seat has been ground, it may be necessary to shim the valve spring in order to attain the proper spring installed height. Refer to **Cylinder Head Disassemble**.

CYLINDER HEAD ASSEMBLE

TOOLS REQUIRED

J 8062 Valve Spring Compressor - Head Off. See **Special Tools** .

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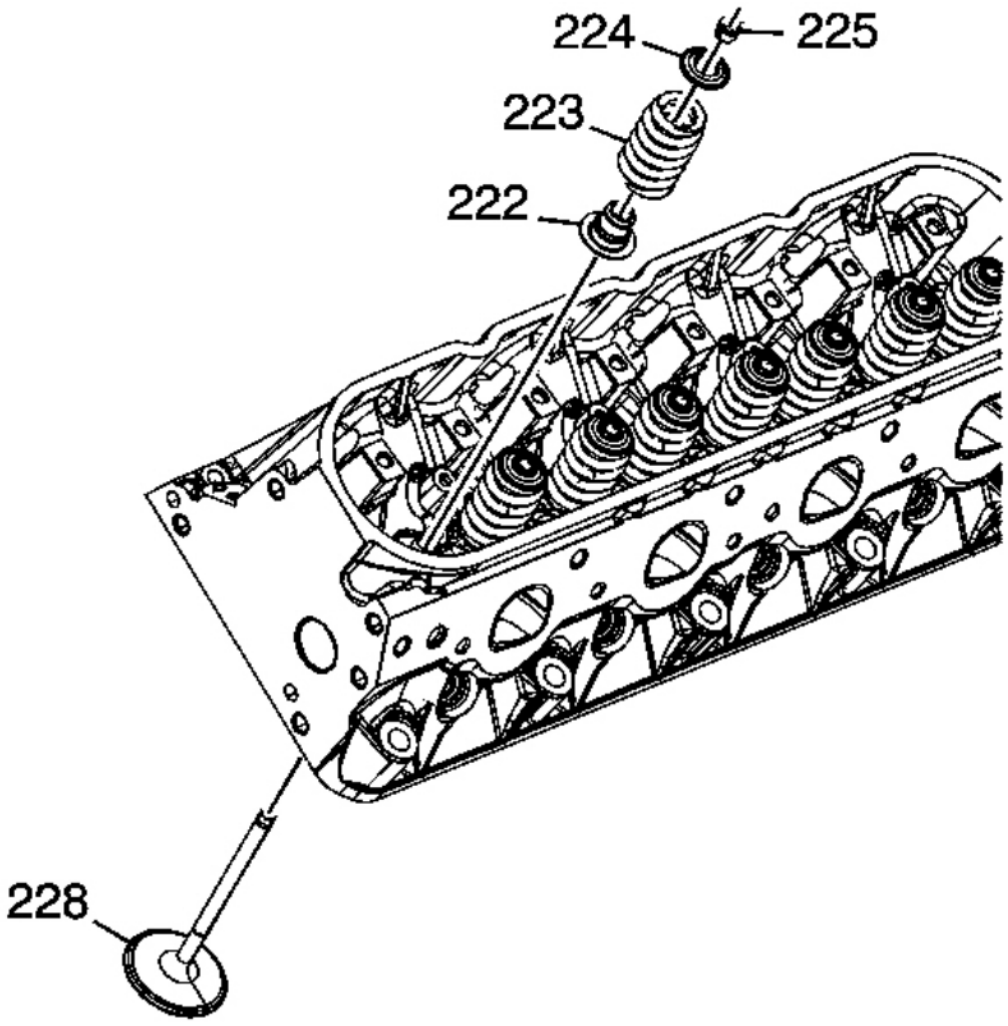


Fig. 100: View Of Valve Components
Courtesy of GENERAL MOTORS CORP.

1. Clean the cylinder head valve spring shim area.

IMPORTANT: When using the valves and related components again, install the parts to their original location.

2. Install the valves (228) into the proper port. Refer to **Separating Parts** .
3. Install the valve stem oil seal (222).

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4. Install the valve spring (223).
5. Install the valve spring cap (224).

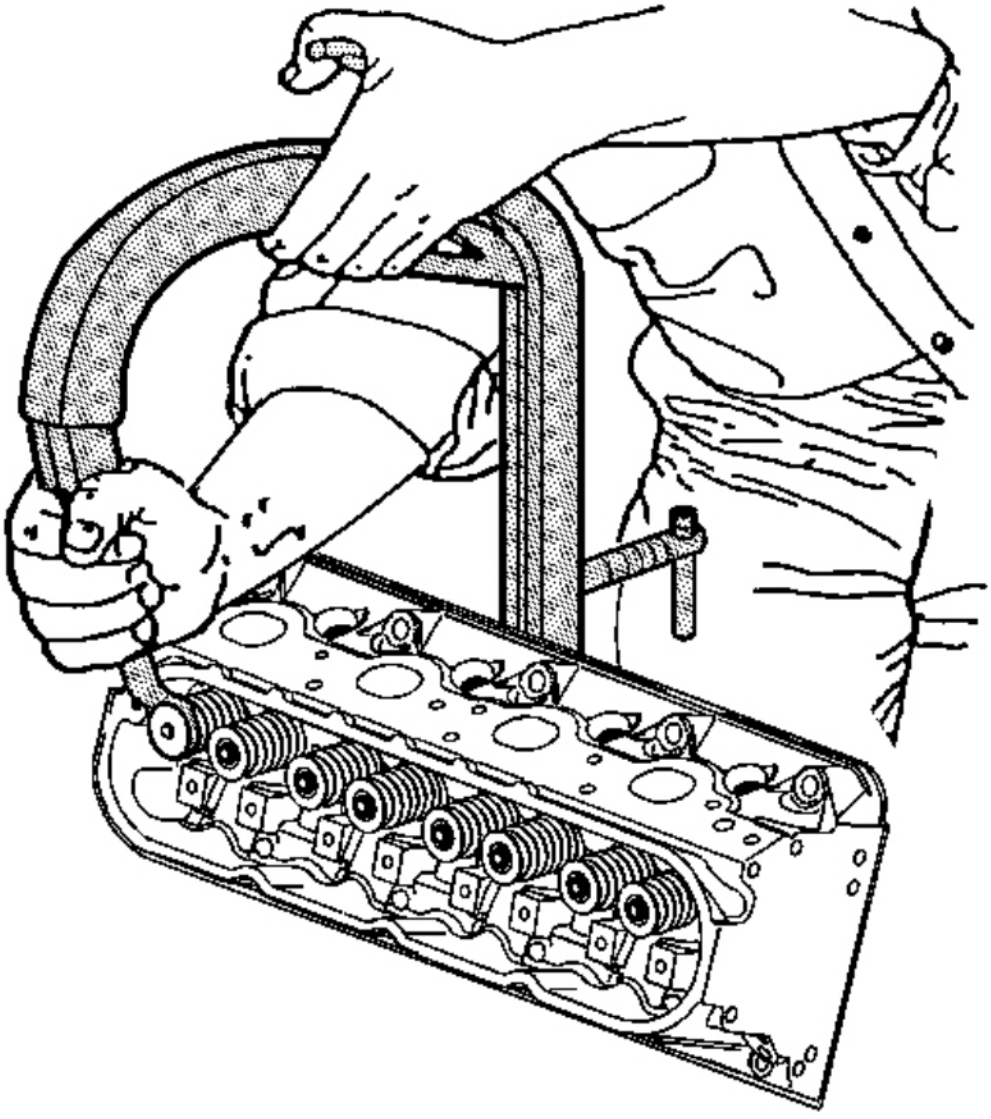


Fig. 101: Compressing Valve Spring Using J 8062
Courtesy of GENERAL MOTORS CORP.

6. Using the **J 8062** , compress the valve spring. See **Special Tools** .

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7. Install the valve stem keys.
    1. Use grease in order to hold the keys in place and remove the **J 8062** . See **Special Tools** .
    2. Ensure the keys seat properly in the groove of the valve stem.
    3. Tap the end of the valve stem with a plastic face hammer to seat the keys, if necessary.

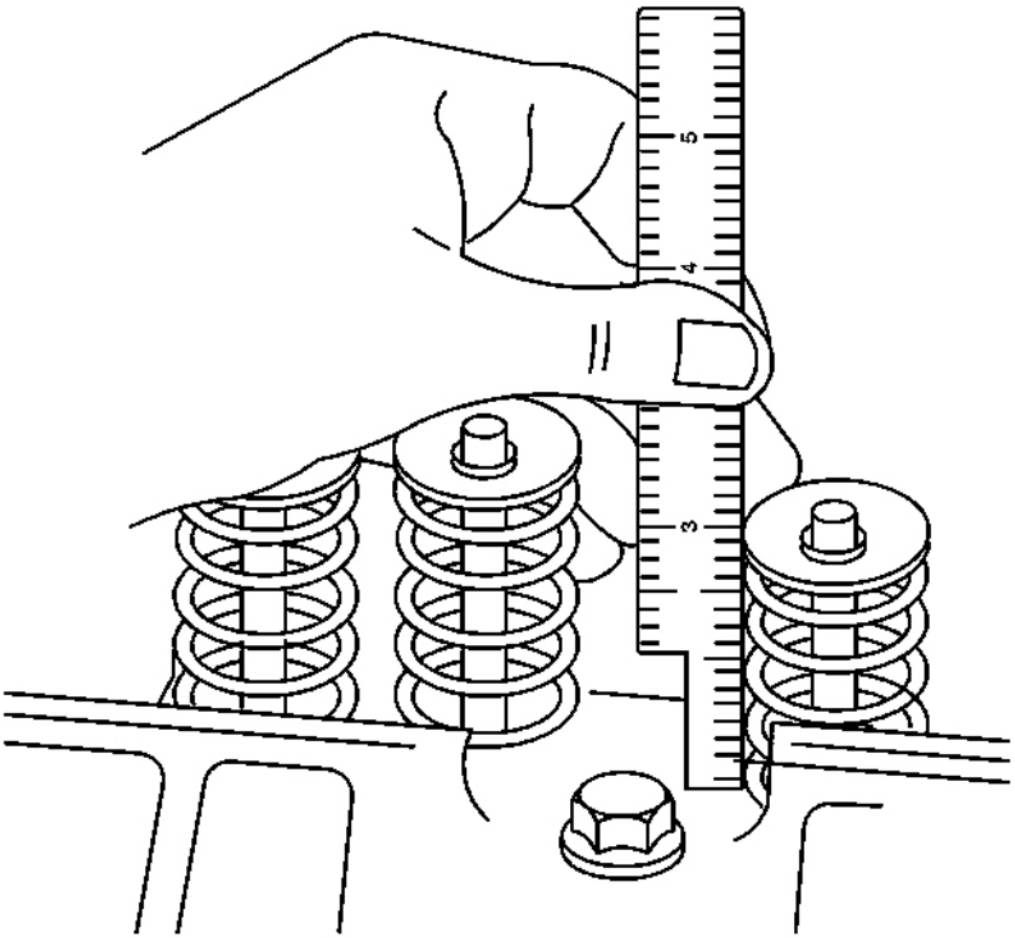


Fig. 102: Measuring Valve Spring Installed Height
Courtesy of GENERAL MOTORS CORP.

8. Using a ruler, measure the valve spring installed height.

    Measure from the base of the valve spring to the top of the valve spring.

    Specification:

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- If the installed height exceeds 46.25 mm (1.82 in), install a valve spring shim of approximately 0.5 mm (0.02 in) thick.
- Do not shim the valve spring to obtain less than the specified height.

  Do not assemble the components without a spring shim on the cylinder head.

9. Install the remaining valves, springs, and other components.

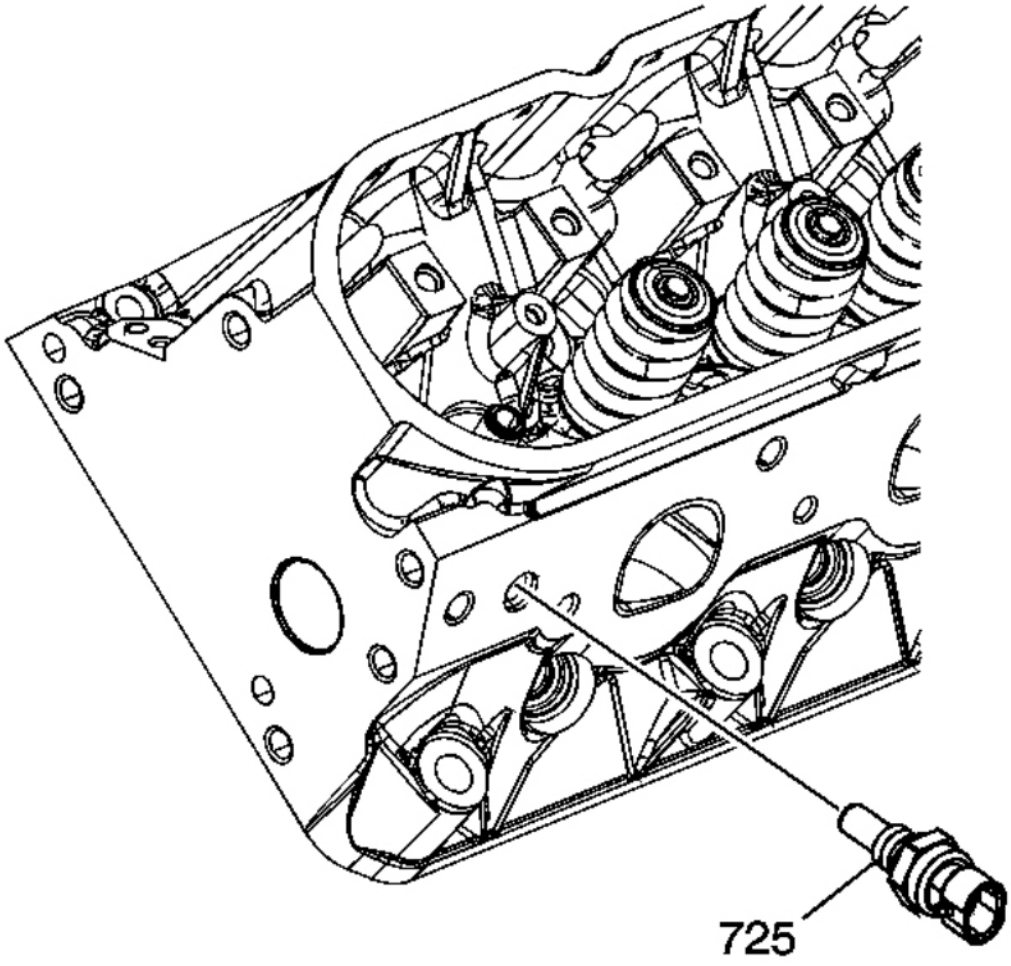


Fig. 103: Locating Coolant Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

10. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the coolant temperature sensor (725).

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NOTE: **Refer to Fastener Notice .**

11. Install the coolant temperature sensor into the left cylinder head.

    Tighten: Tighten the coolant temperature sensor to 20 N.m (15 lb ft).

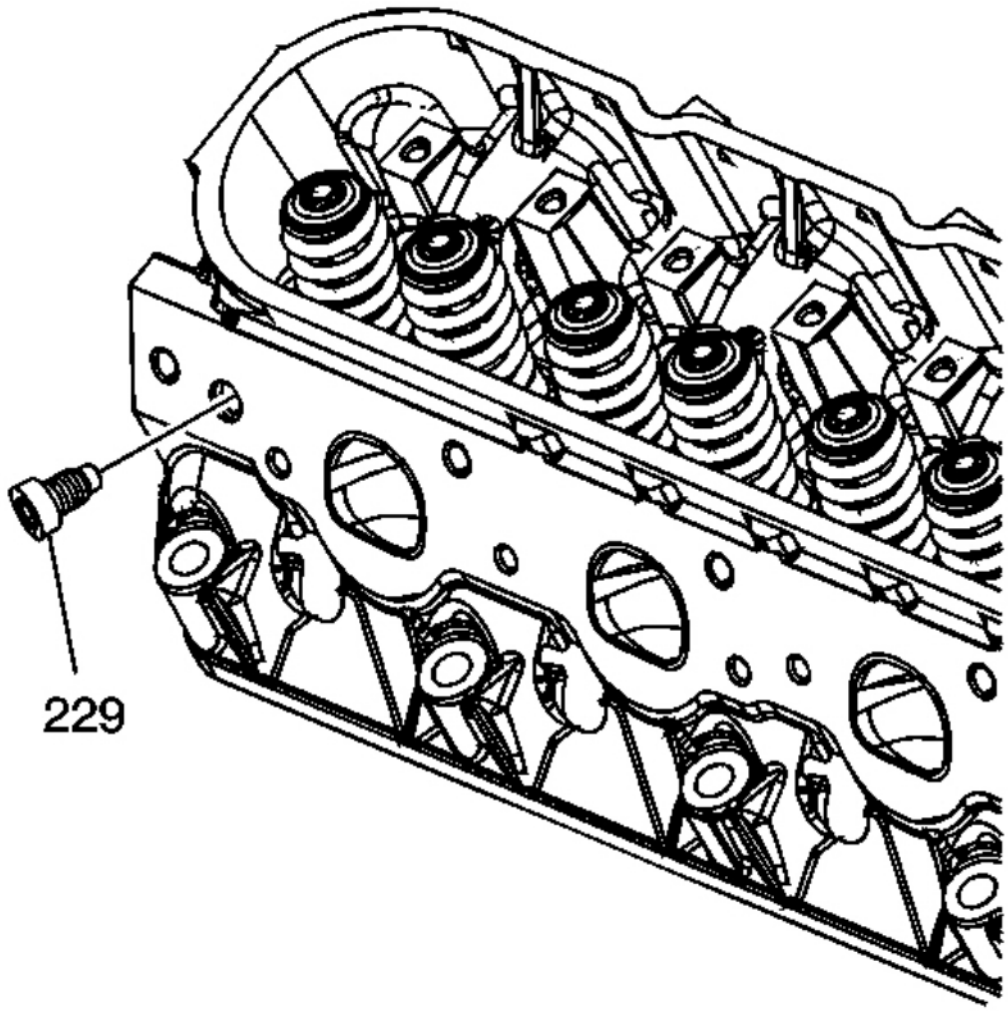


Fig. 104: Locating Coolant Plug
Courtesy of GENERAL MOTORS CORP.

12. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the cylinder head plug (229).

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13. Install the cylinder head plug to the right cylinder head.

    Tighten: Tighten the cylinder head plug to 20 N.m (15 lb ft).

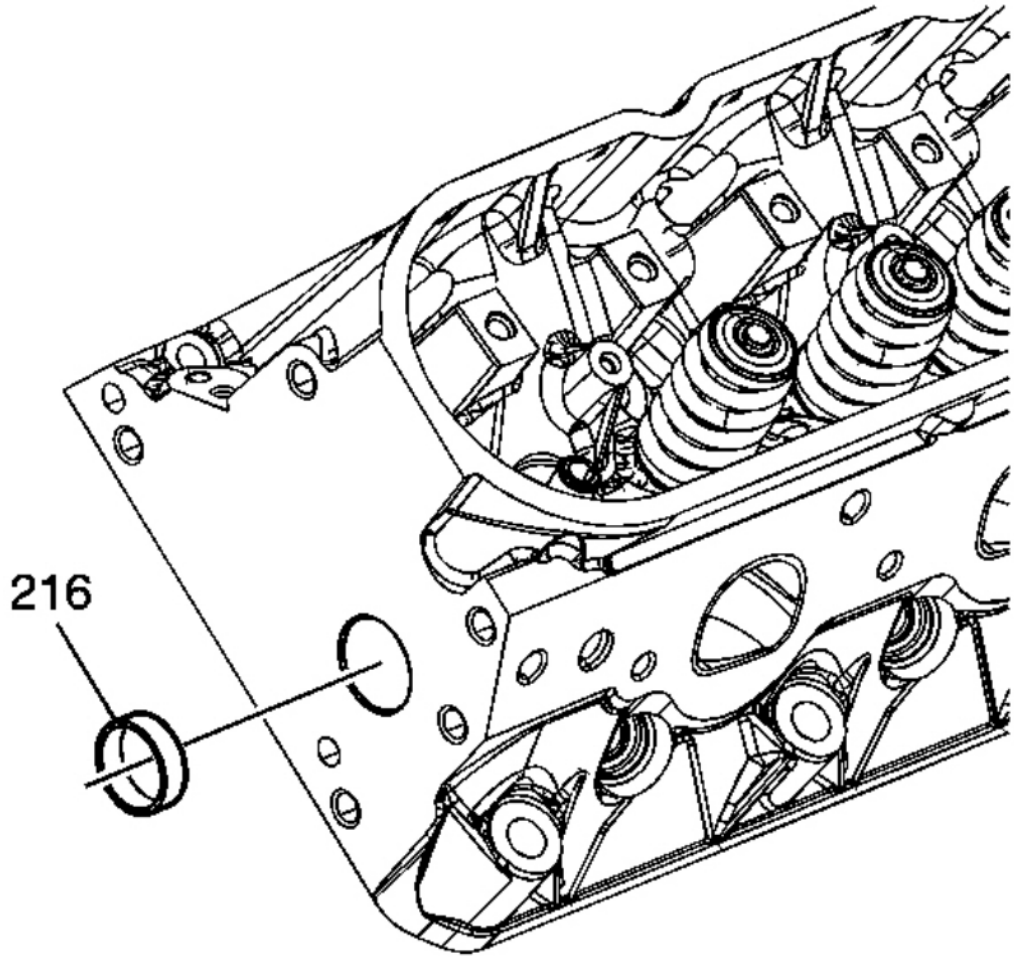


Fig. 105: Locating Cylinder Head Core Hole Plug
Courtesy of GENERAL MOTORS CORP.

14. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the sides of the cylinder head plugs (216).
15. Install the cylinder head plugs into the cylinder head.

    A properly installed plug should be installed 2.5 mm (0.1 in) below the end face of the head.

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OIL PUMP DISASSEMBLE

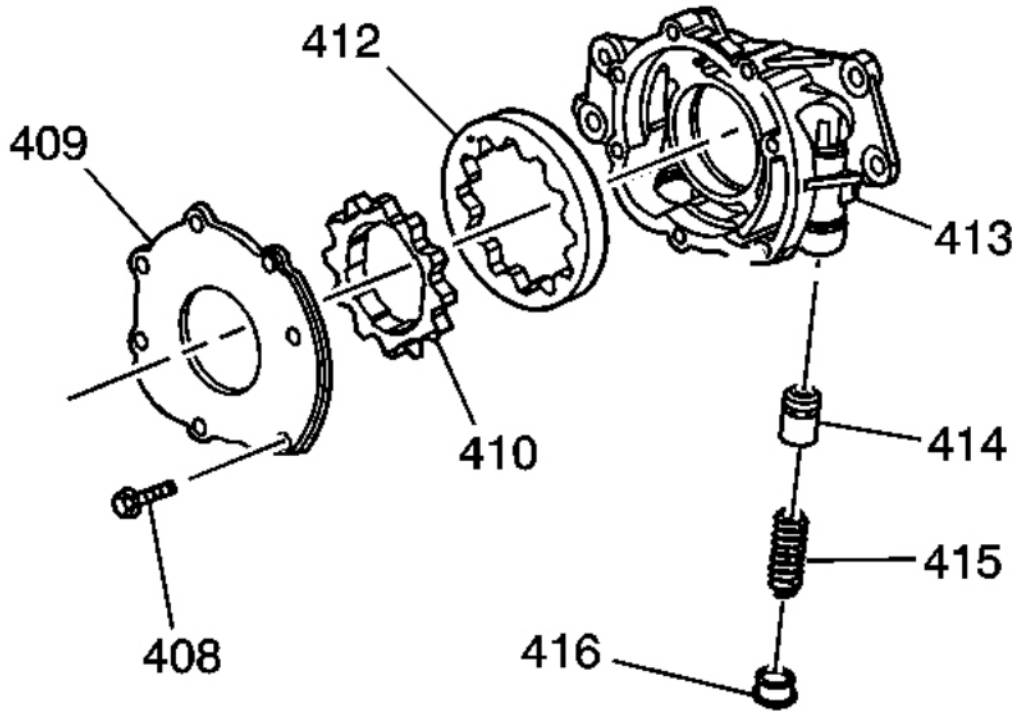


Fig. 106: Exploded View Of Oil Pump
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The internal parts of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.

1. Remove the oil pump cover bolts (408).
2. Remove the oil pump cover (409).

IMPORTANT: Mark or identify the gears for assembly. Refer to Separating Parts .

3. Remove the drive gear (410).
4. Remove the driven gear (412).
5. Remove the pressure relief valve plug (416).
6. Remove the pressure relief valve spring (415).

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7. Remove the pressure relief valve (414).
8. Inspect the oil pump components. Refer to **Oil Pump Cleaning and Inspection**.

OIL PUMP CLEANING AND INSPECTION

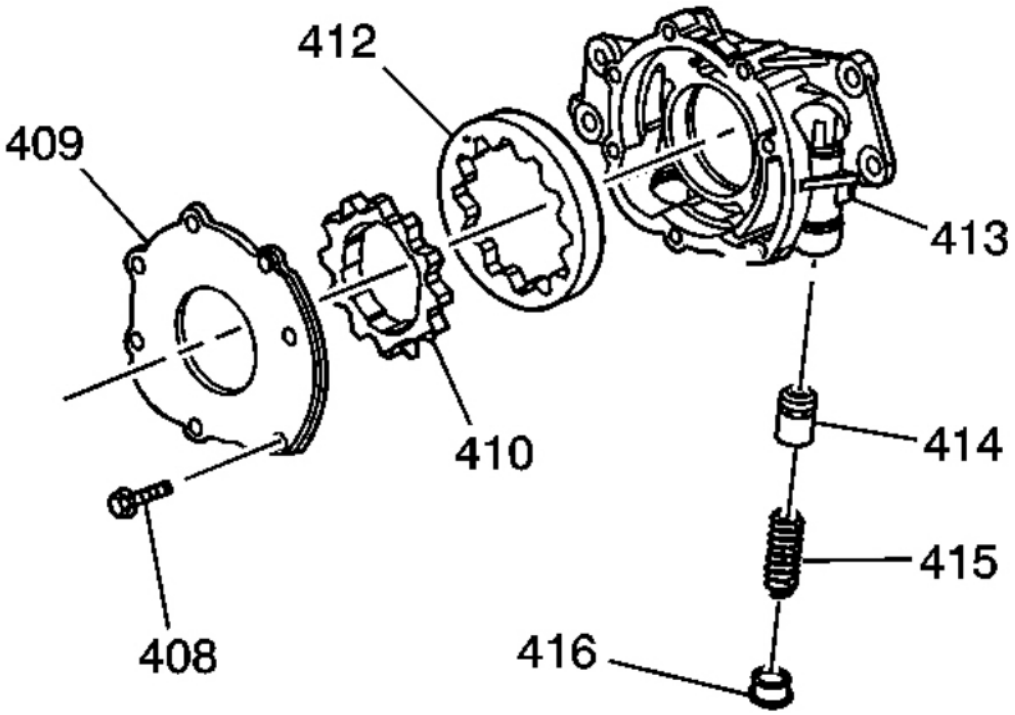


Fig. 107: Exploded View Of Oil Pump
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **The internal parts of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.**
- **The oil pump pipe and screen are to be serviced as an assembly. Do not attempt to repair the wire mesh portion of the pump and screen assembly.**

1. Clean the parts in solvent.

CAUTION: Refer to Safety Glasses Caution .

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2. Dry the parts with compressed air.
3. Inspect the oil pump housing (413) and the cover (409) for cracks, excessive wear, scoring, or casting imperfections.
4. Inspect the oil pump housing-to-engine block oil gallery surface for scratches or gouging.
5. Inspect the oil pump housing for damaged bolt hole threads.
6. Inspect the relief valve plug (416) and plug bore for damaged threads.
7. Inspect the oil pump internal oil passages for restrictions.
8. Inspect the drive gear (410) and driven gear (412) for chipping, galling, or wear.

   Minor burrs or imperfections on the gears may be removed with a fine oil stone.

9. Inspect the drive gear splines for excessive wear.
10. Inspect the pressure relief valve (414) and bore for scoring or wear.

    The valve must move freely in the bore, with no restrictions.

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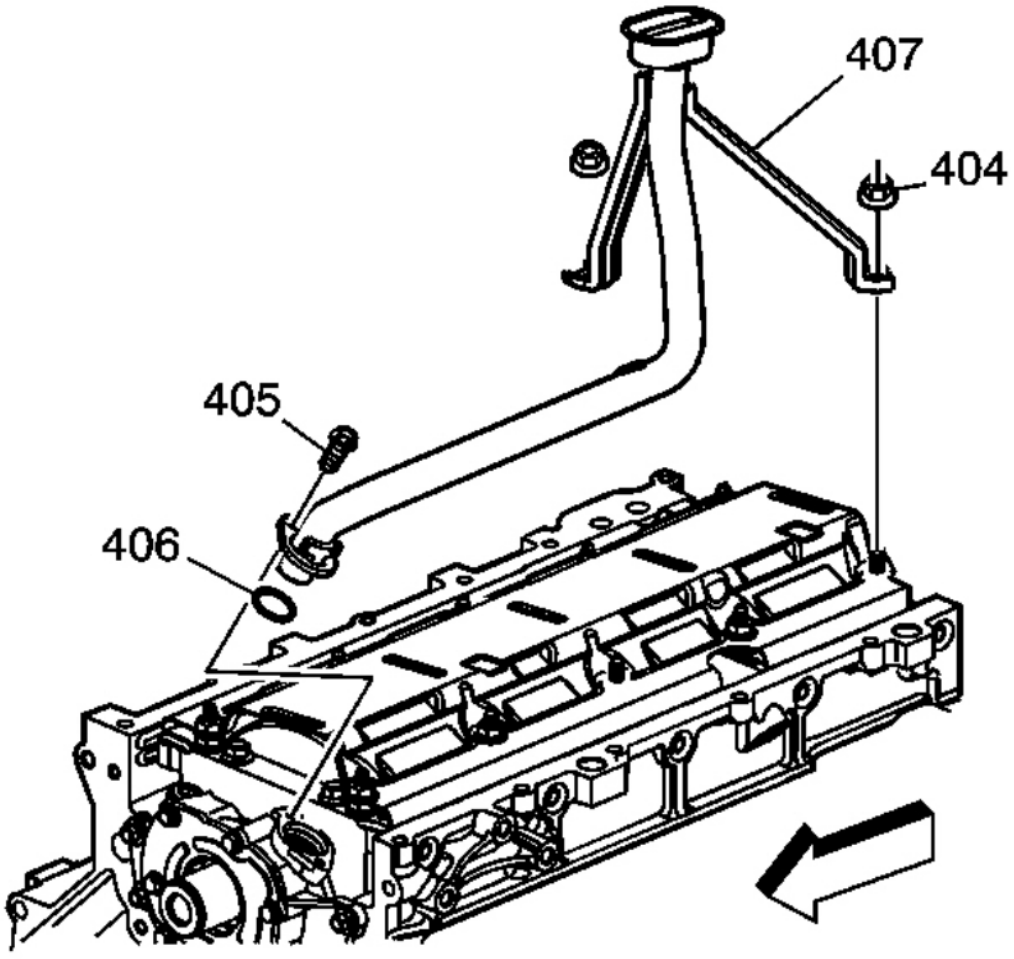


Fig. 108: View Of Oil Pump Screen, Bolt, Nuts, & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

11. Inspect the oil pump screen (407) for debris or restrictions.
12. Inspect the oil pump screen for broken or loose wire mesh.

OIL PUMP ASSEMBLE

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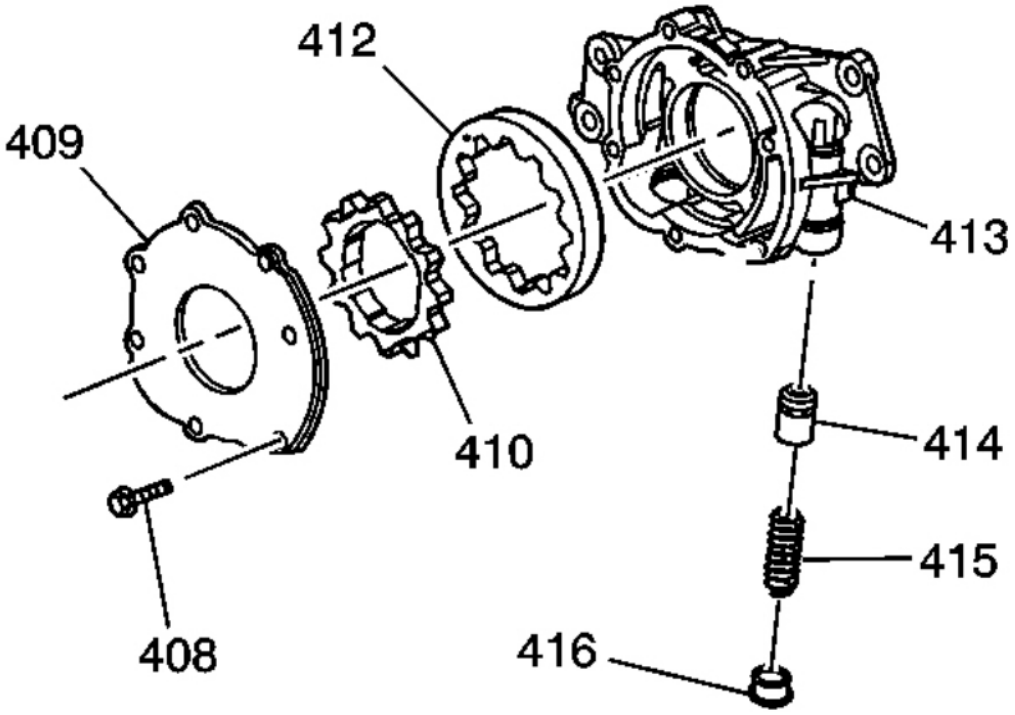


Fig. 109: Exploded View Of Oil Pump
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Prior to assembling the oil pump, coat all wear or internal surfaces with clean engine oil.

1. Install the driven gear (412) into the pump housing (413).

   Install the driven gear with the orientation mark facing the pump cover.

2. Install the drive gear (410) into the pump housing.
3. Install the oil pump cover (409).

NOTE: Refer to Fastener Notice .

4. Install the oil pump cover bolts (408).

Tighten: Tighten the oil pump cover bolts to 12 N.m (106 lb in).

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5. Install the relief valve (414).
6. Install the relief valve spring (415).
7. Install the relief valve plug (416).

   Tighten: Tighten the relief valve plug to 12 N.m (106 lb in).

8. Inspect the oil pump for smooth operation by rotating the drive gear.

ENGINE FRONT COVER CLEANING AND INSPECTION (RPO LY2/LC9/LY5/LMG)

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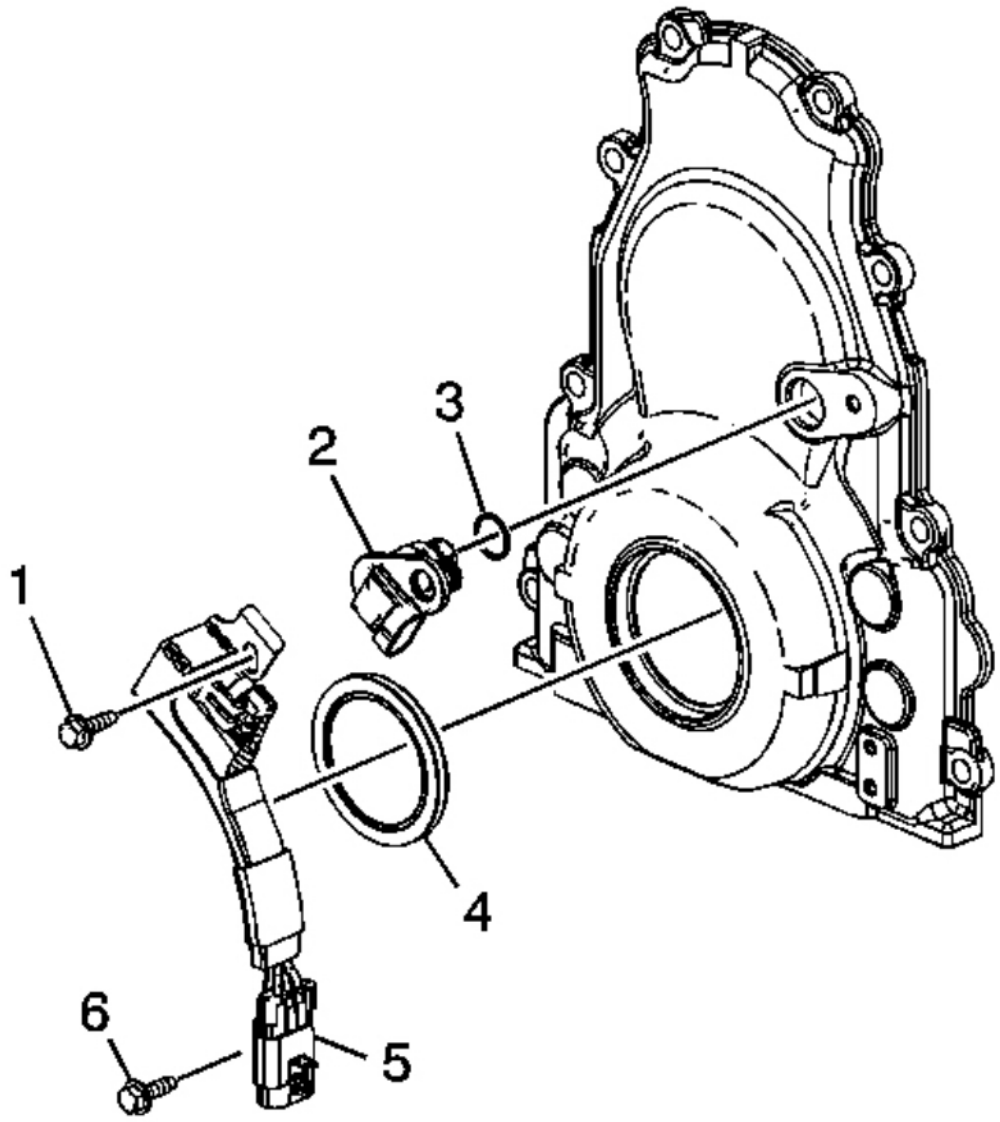


Fig. 110: View Of Front Cover, Oil Seal, Camshaft Position Sensor, Bracket & O Ring
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Do not use the crankshaft front oil seal again. Install a NEW crankshaft front oil seal during assembly.**
- **Do not use the front cover-to-engine block gasket again. Install a NEW gasket during assembly.**

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1. Remove the crankshaft front oil seal (4) from the front cover.
2. Clean the cover in solvent. Remove the sealant from the cover oil pan surface. Refer to **Replacing Engine Gaskets** .

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

3. Dry the cover with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal and camshaft position (CMP) sensor mounting bore for damage.

ENGINE FRONT COVER CLEANING AND INSPECTION (RPO LY6/L76/L92)

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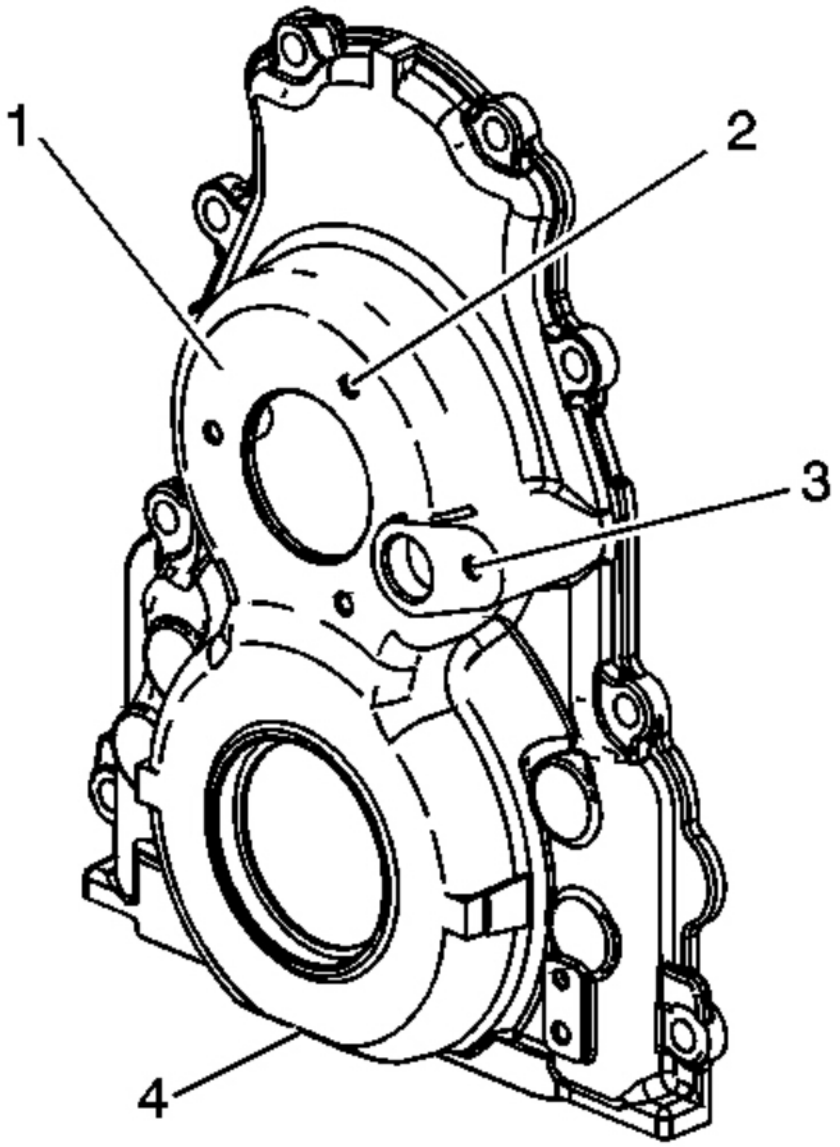


Fig. 111: View Of Gasket Sealing Surfaces & Bolt Holes
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Do not use the crankshaft front oil seal again. Install a NEW crankshaft front oil seal during assembly.**
- **Do not use the front cover-to-engine block gasket again. Install a**

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NEW gasket during assembly.

- **Do not use the camshaft position (CMP) actuator magnet gasket again. Install a NEW gasket during assembly.**

1. Clean the cover in solvent. Remove the sealant from the cover oil pan surface. Refer to **Replacing Engine Gaskets** .

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

2. Dry the cover with compressed air.
3. Inspect the gasket sealing surfaces (1, 4) for excessive scratches or gouging.
4. Inspect the threaded bolt holes (2, 3) for damaged threads or debris.

CRANKSHAFT REAR OIL SEAL HOUSING CLEANING AND INSPECTION

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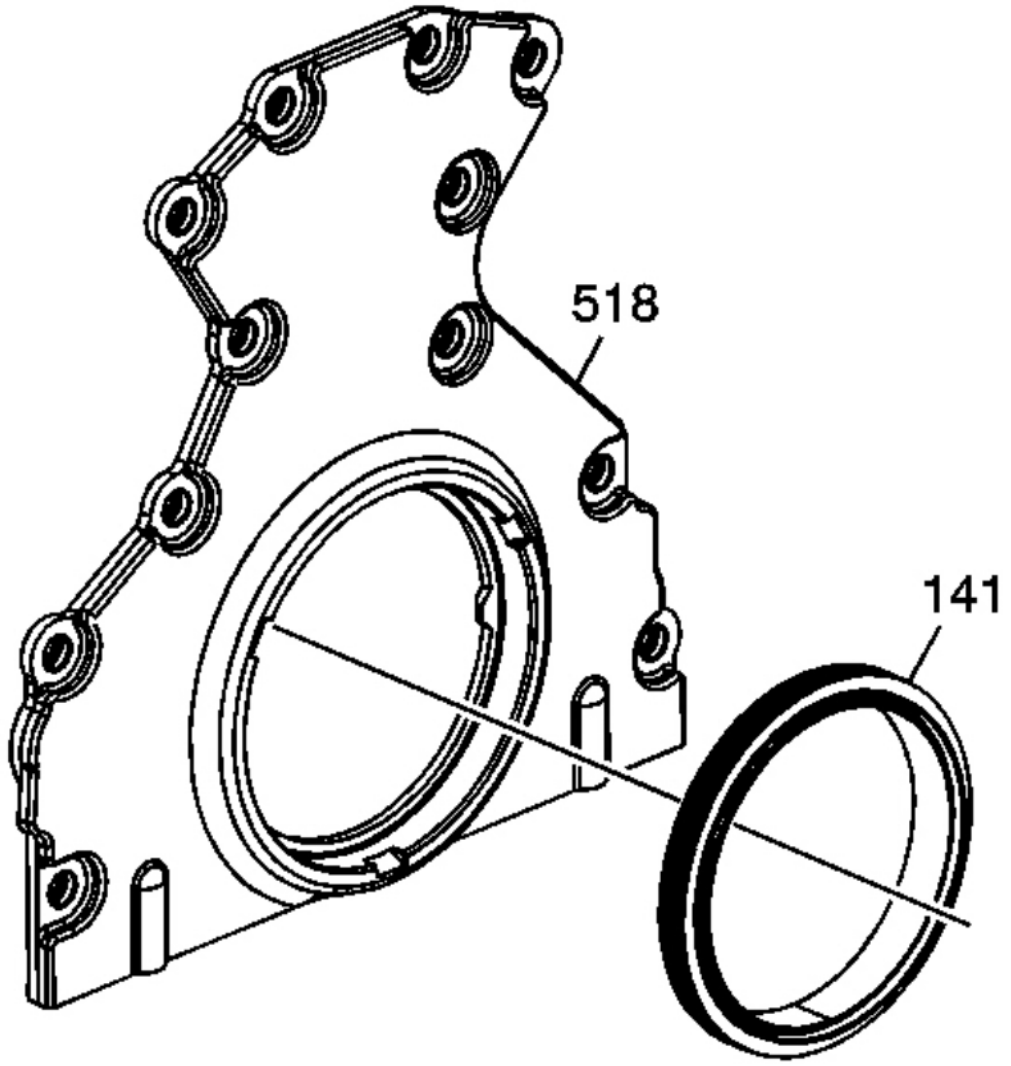


Fig. 112: View Of Crankshaft Rear Oil Seal & Housing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Do not use the crankshaft rear oil seal again. Install a NEW crankshaft oil seal during assembly.**
- **Do not use the rear housing-to-engine block gasket again. Install a NEW gasket during assembly.**

1. Remove the crankshaft oil seal (141) from the rear housing.

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2. Clean the housing in solvent. Remove the sealant from the housing oil pan surface. Refer to **Replacing Engine Gaskets** .

CAUTION: Refer to Safety Glasses Caution .

3. Dry the housing with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the housing-to-oil pan threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal mounting bore for damage.

ENGINE VALLEY COVER CLEANING AND INSPECTION

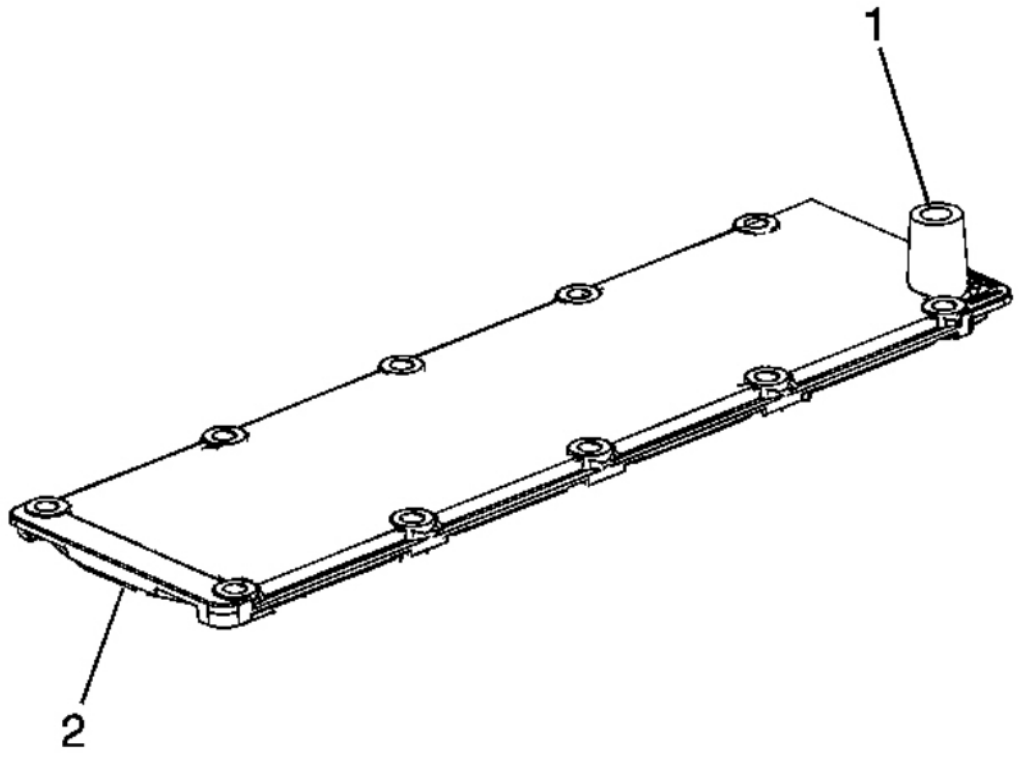


Fig. 113: View Of Engine Valley Cover
Courtesy of GENERAL MOTORS CORP.

1. Clean the valley cover in solvent.

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

2. Dry with compressed air.
3. Inspect for damaged threads (1) and damaged sealing surfaces (2).

VALVE LIFTER OIL MANIFOLD CLEANING AND INSPECTION

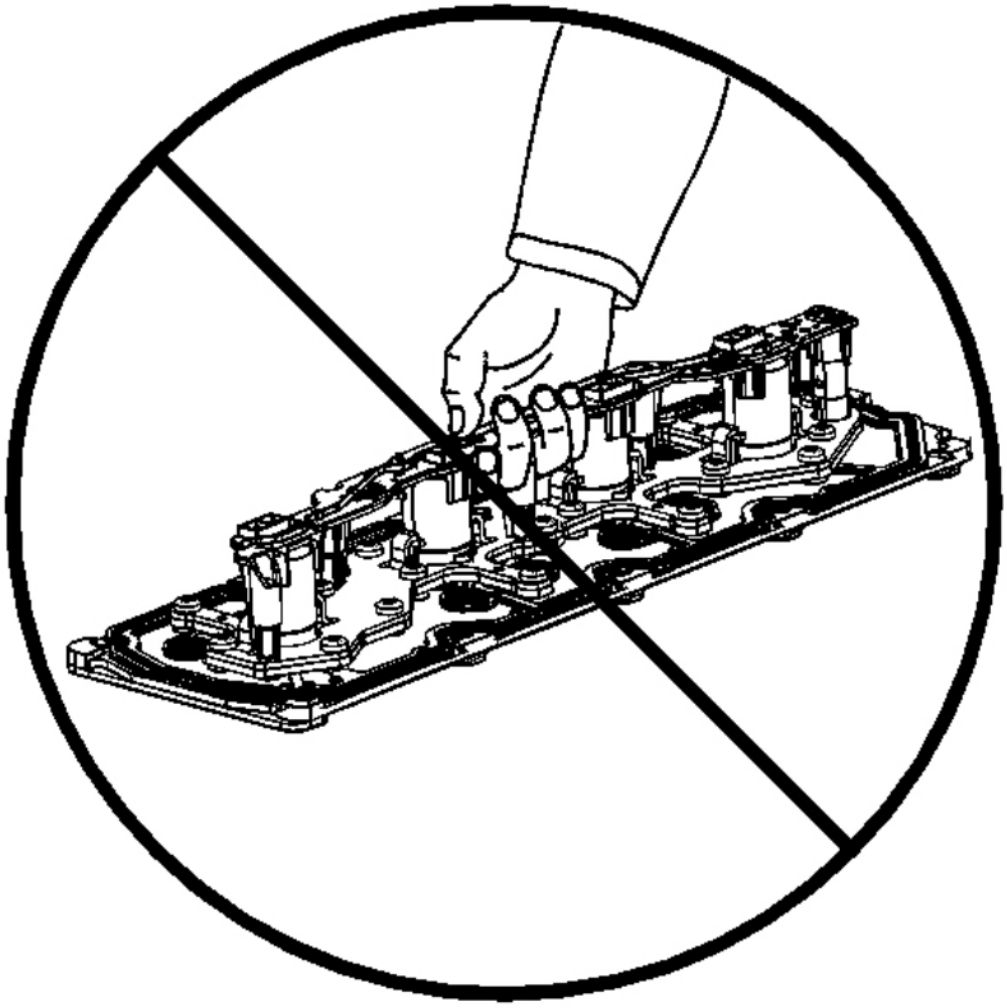


Fig. 114: Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS CORP.

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IMPORTANT:

- **Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.**
- **Do not disassemble the electrical components from the manifold.**
- **Do not submerge the electrical components in cleaning solvent.**
- **Do not use the manifold exterior gasket again. Remove the exterior gasket and install a NEW service gasket during assembly.**

1. Do not lift the manifold assembly by the electrical lead frame.

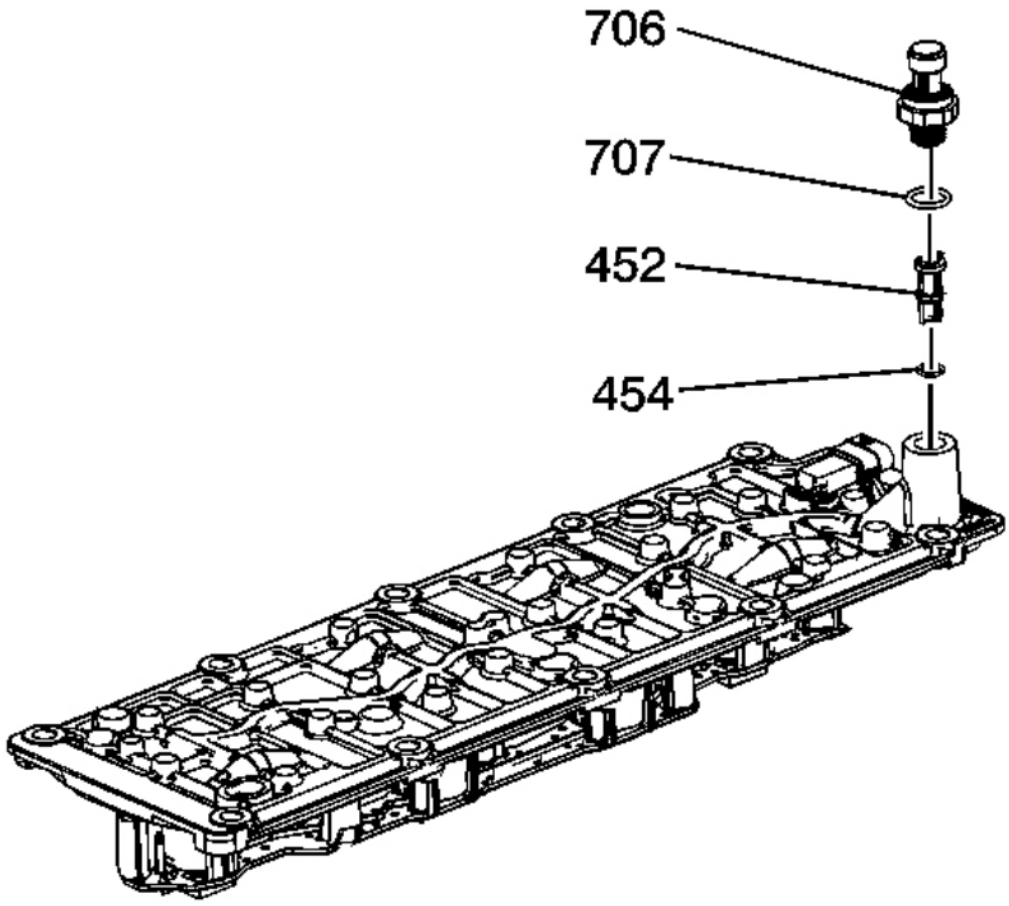


Fig. 115: View Of Oil Pressure Sensor, Washer & Valve Lifter Oil Filter
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pressure sensor (706) and washer (707).

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3. Remove the oil screen (452) with O-ring (454).

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

4. Clean the manifold with compressed air.

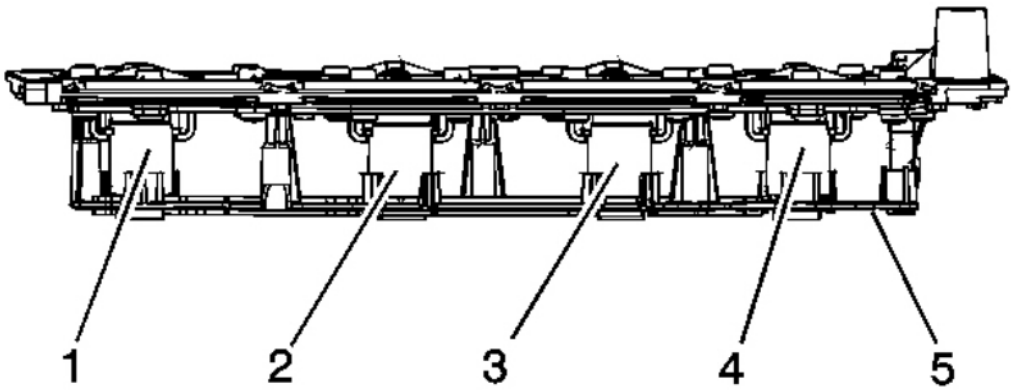


Fig. 116: Electrical Solenoids
Courtesy of GENERAL MOTORS CORP.

5. Inspect for loose electrical solenoids (1-4) or loose or missing bolts.
6. Inspect for damage to the electrical lead frame (5).
7. Inspect for a damaged electrical connector, for bent or corroded pins.

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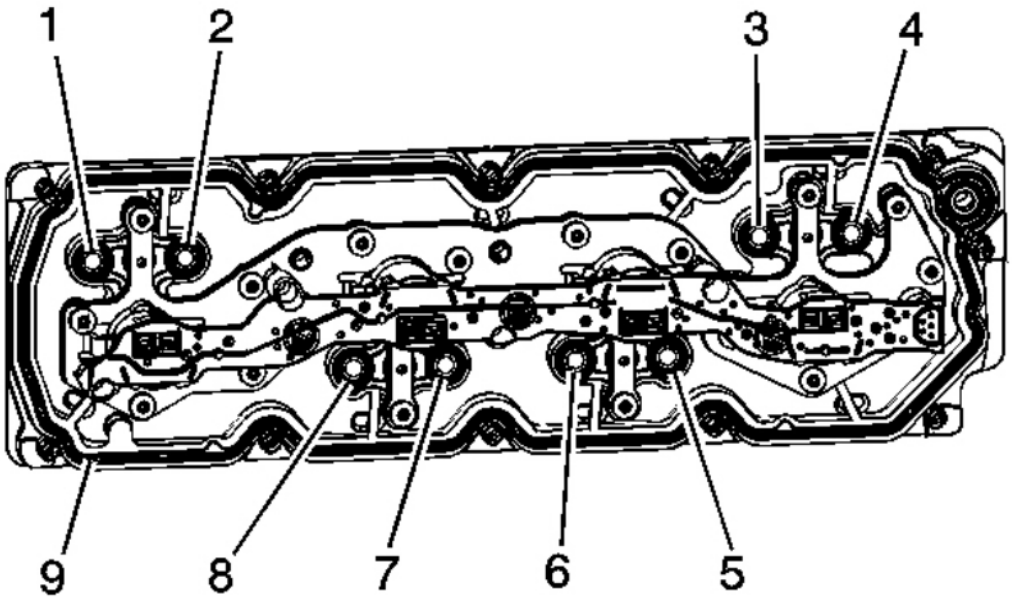


Fig. 117: Sealing Gaskets
Courtesy of GENERAL MOTORS CORP.

8. Inspect for damaged interior sealing gaskets (1-8). If the interior sealing gaskets are damaged, the manifold must be replaced as an assembly.
9. Inspect for a damaged exterior sealing gasket (9) or scored gasket surfaces.
10. Inspect for debris or restrictions within the oil passages of the manifold. Refer to **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing** .

VALVE ROCKER ARM COVER CLEANING AND INSPECTION

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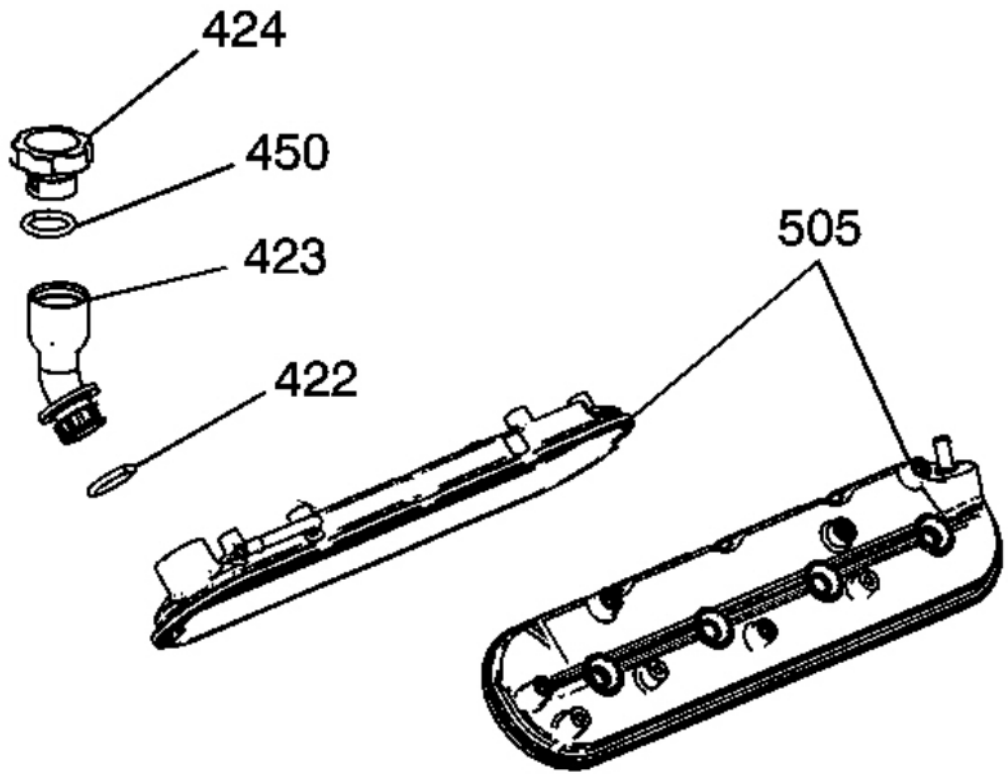


Fig. 118: View Of Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Do not use the valve rocker arm cover gasket again. Install a NEW gasket during assembly.**
- **Remove the ignition coils before cleaning the cover in solvent. Do not submerge the ignition coils in solvent.**
- **Do not remove the oil fill tube from the covers unless service is required. If the tube is removed from the cover, install a NEW tube (423) and seal (422) during assembly.**

1. Inspect the oil fill tube (423) for a loose fit or damage.
2. Inspect the covers (505) for the following conditions:
   - Scoring or damage to the gasket surfaces
   - Ventilation system passages for restrictions
   - Threaded bolt holes for damage or debris

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OIL PAN CLEANING AND INSPECTION

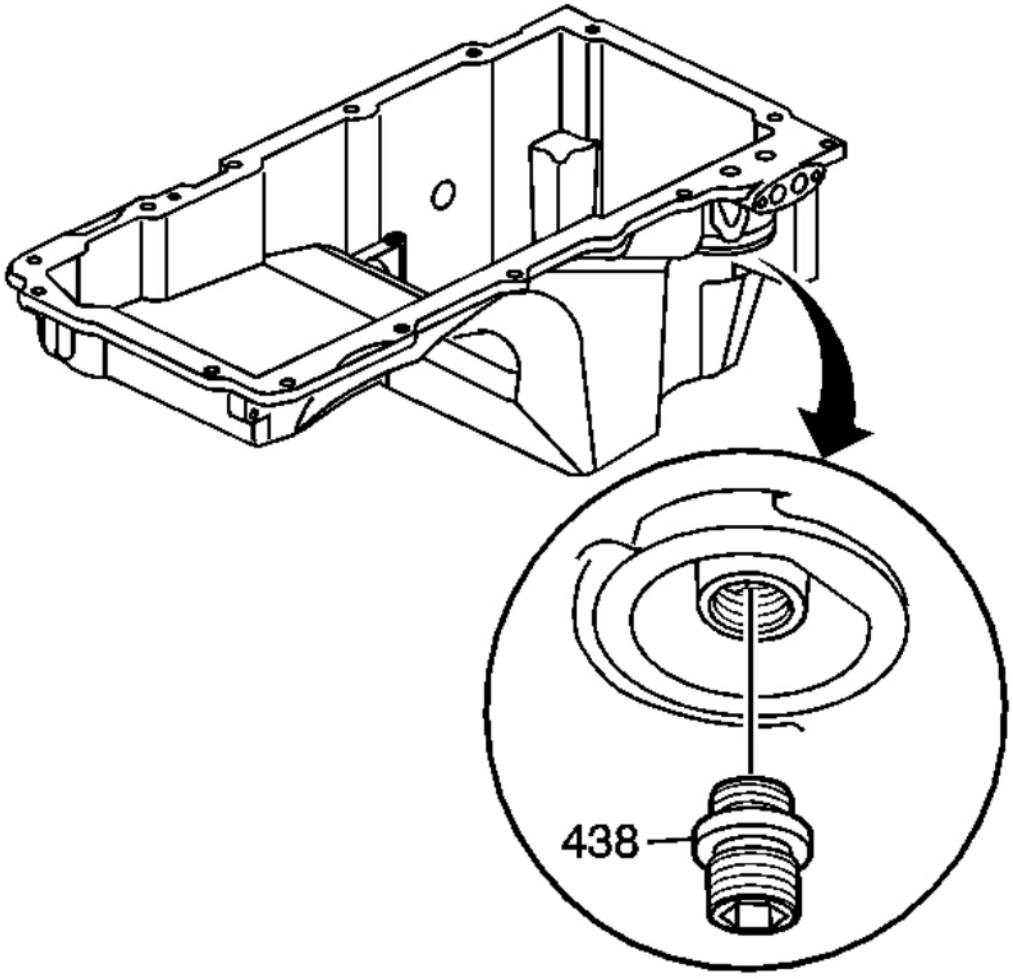


Fig. 119: View Of Oil Filter Fitting
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filter fitting (438), as required.

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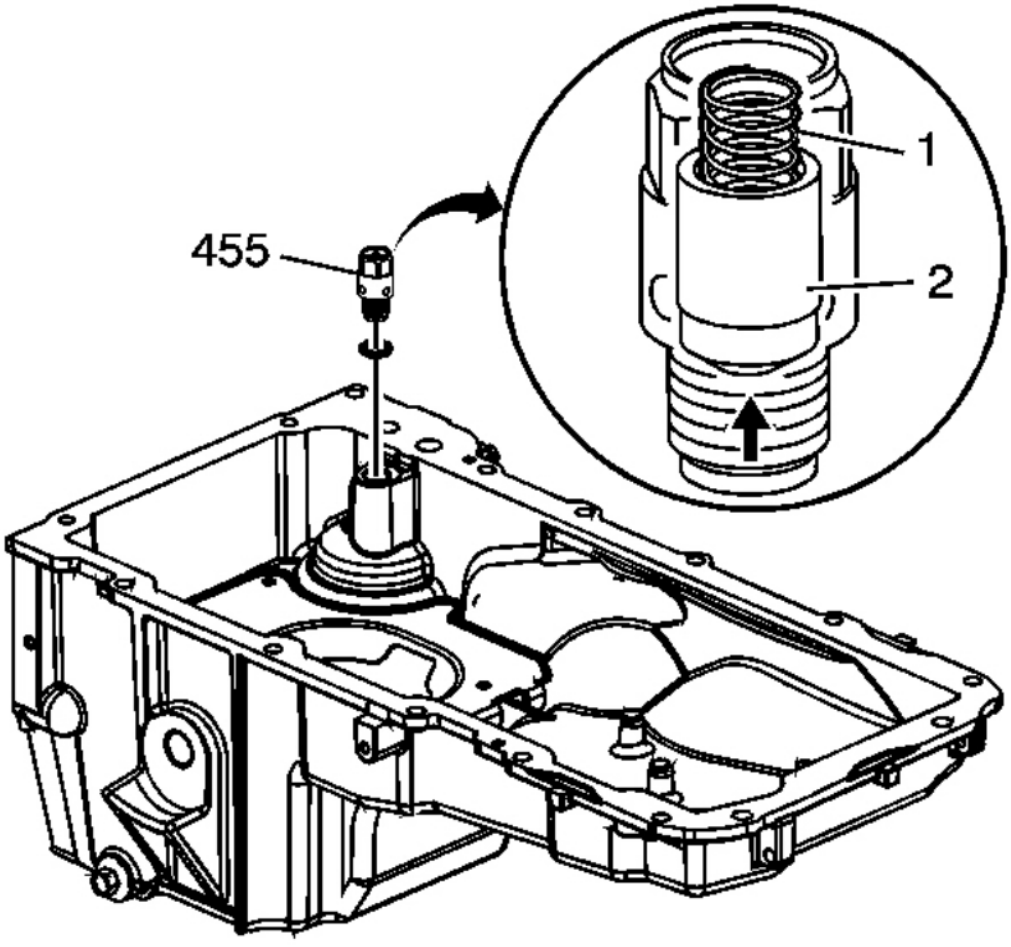


Fig. 120: View Of Oil Pressure Relief Valve Components
Courtesy of GENERAL MOTORS CORP.

2. Remove the active fuel management oil pressure relief valve (455) and washer.
3. Inspect the oil pressure relief valve for proper operation. Lightly depress the valve (2). The valve spring (1) should seat the valve to the proper closed position.

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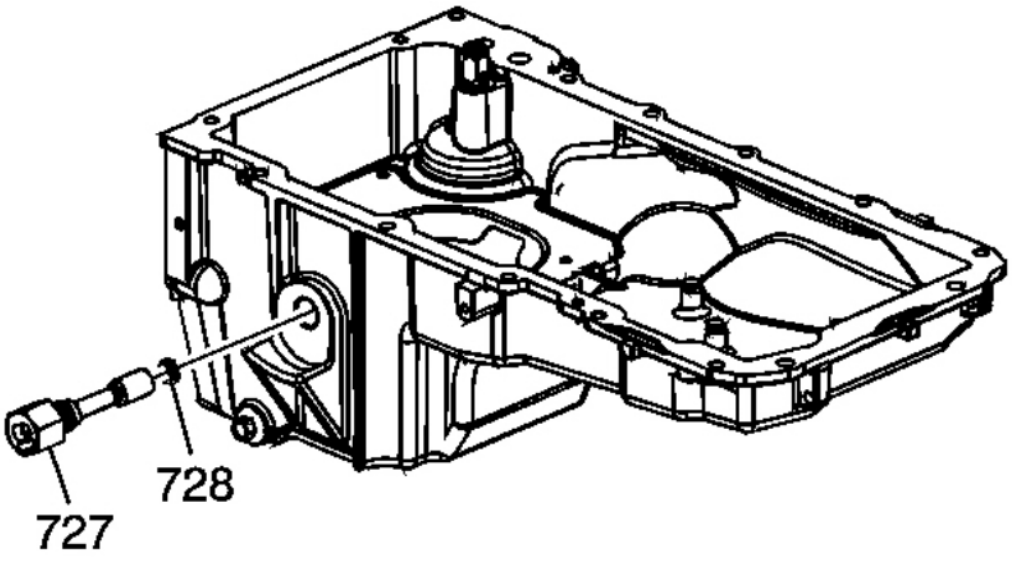


Fig. 121: View Of Oil Level Sensor & O-Ring
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil level sensor (727) and O-ring (728).

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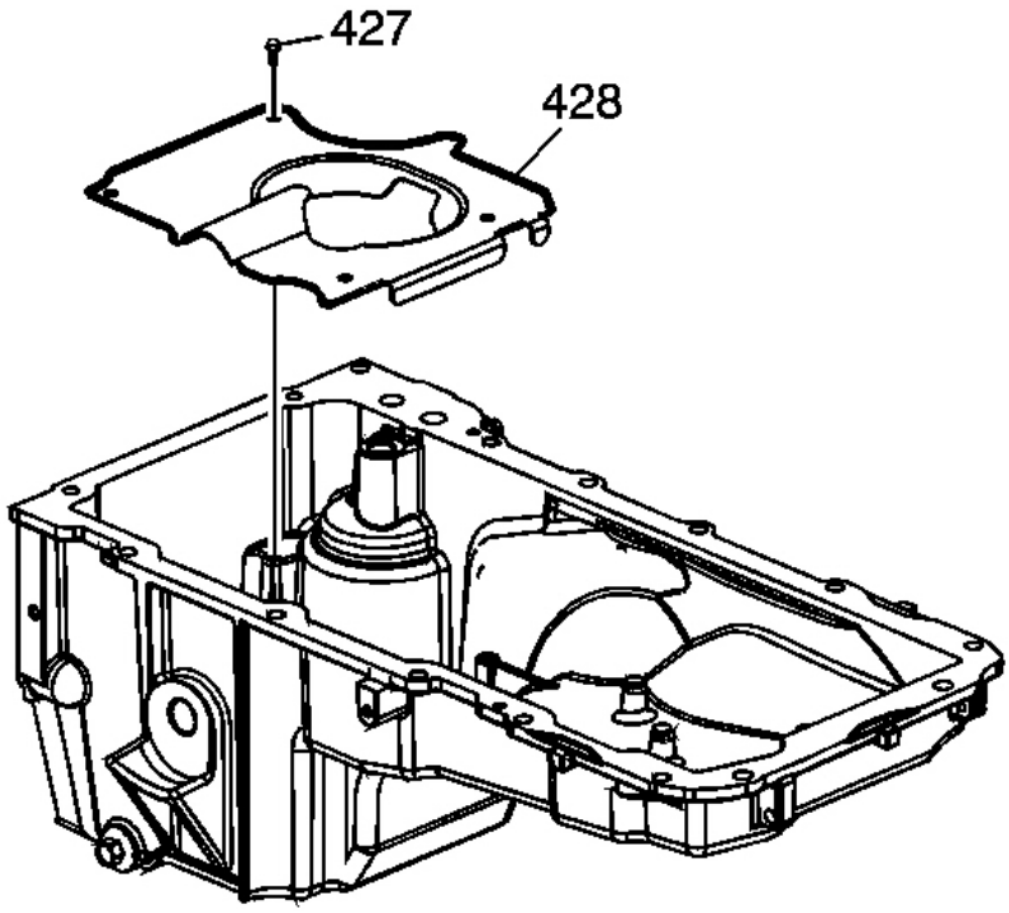


Fig. 122: View Of Baffle & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the bolts (427) and baffle (428).

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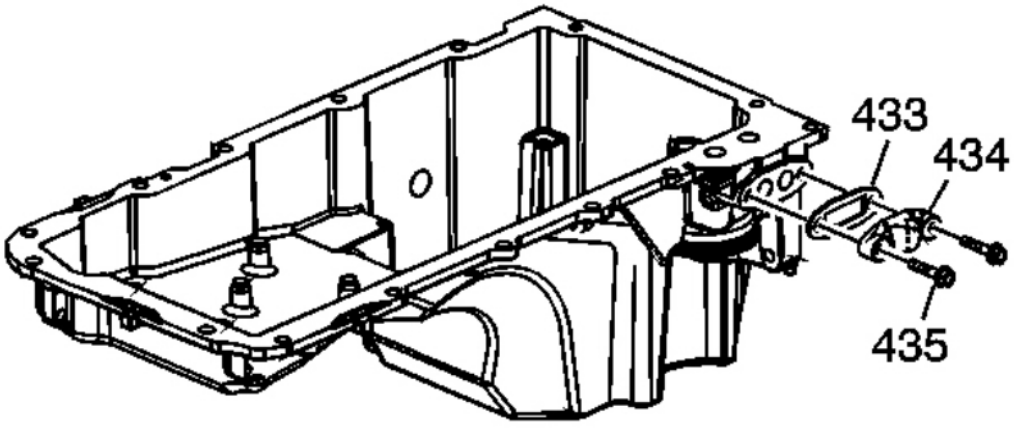


Fig. 123: View Of Oil Pan Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil pan cover (434), bolts (435), and gasket (433).
7. Clean the oil pan in solvent.

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

8. Dry the oil pan with compressed air.

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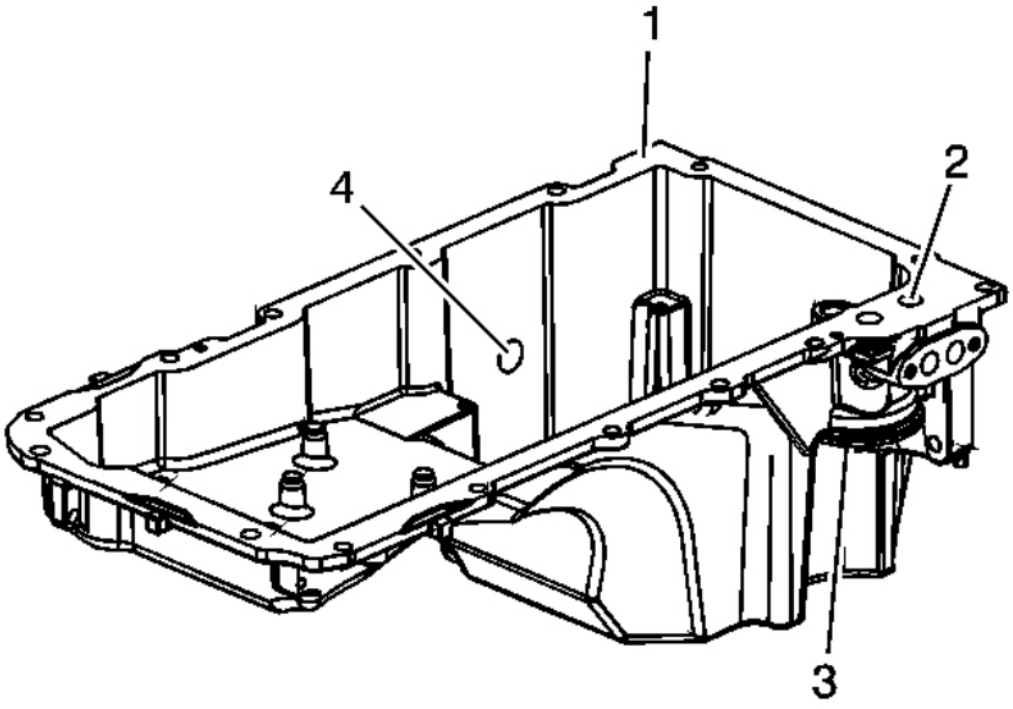


Fig. 124: View Of Oil Pan Inspection Points
Courtesy of GENERAL MOTORS CORP.

9. Inspect the oil pan for the following conditions:
    - Damaged gasket surfaces (1)
    - Restrictions within the oil passages (2) of the pan
    - Damaged oil filter seal surface (3)
    - Threaded oil level sensor hole (4) for damage

INTAKE MANIFOLD CLEANING AND INSPECTION

CLEANING PROCEDURE

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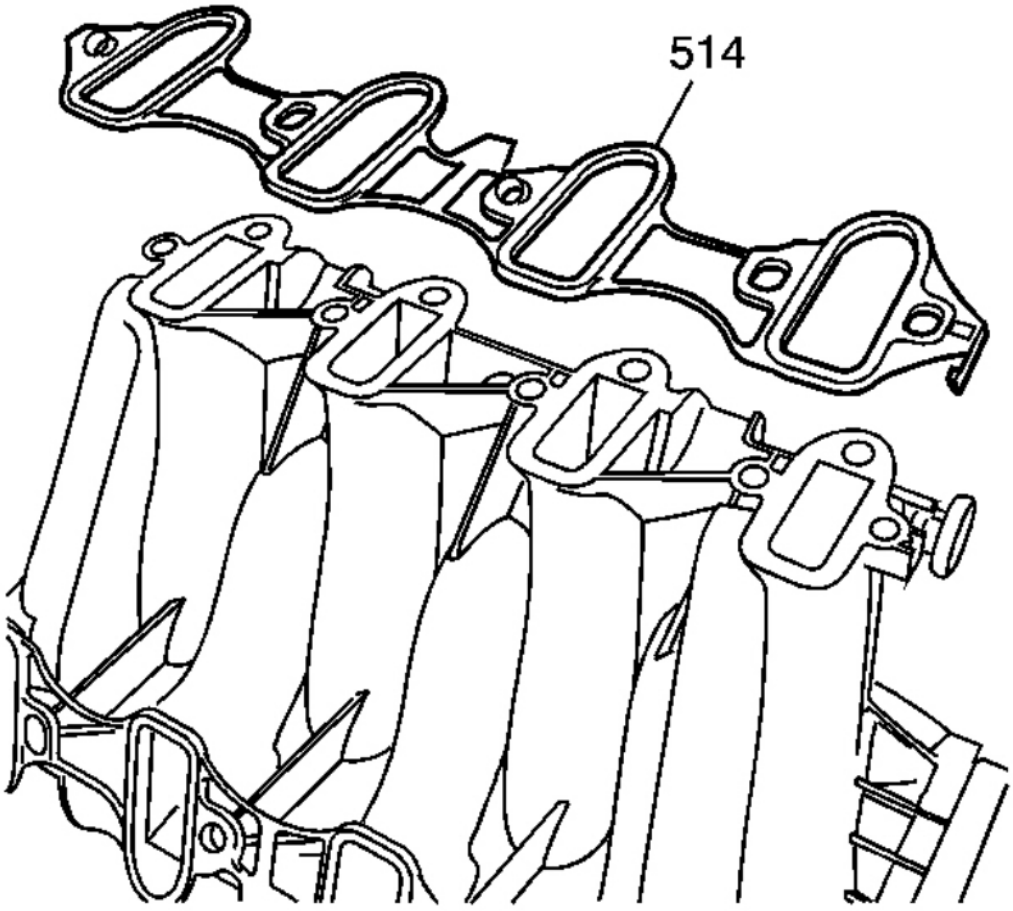


Fig. 125: View Of Intake Manifold-To-Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

1. Remove and discard the intake manifold-to-cylinder head gaskets (514).

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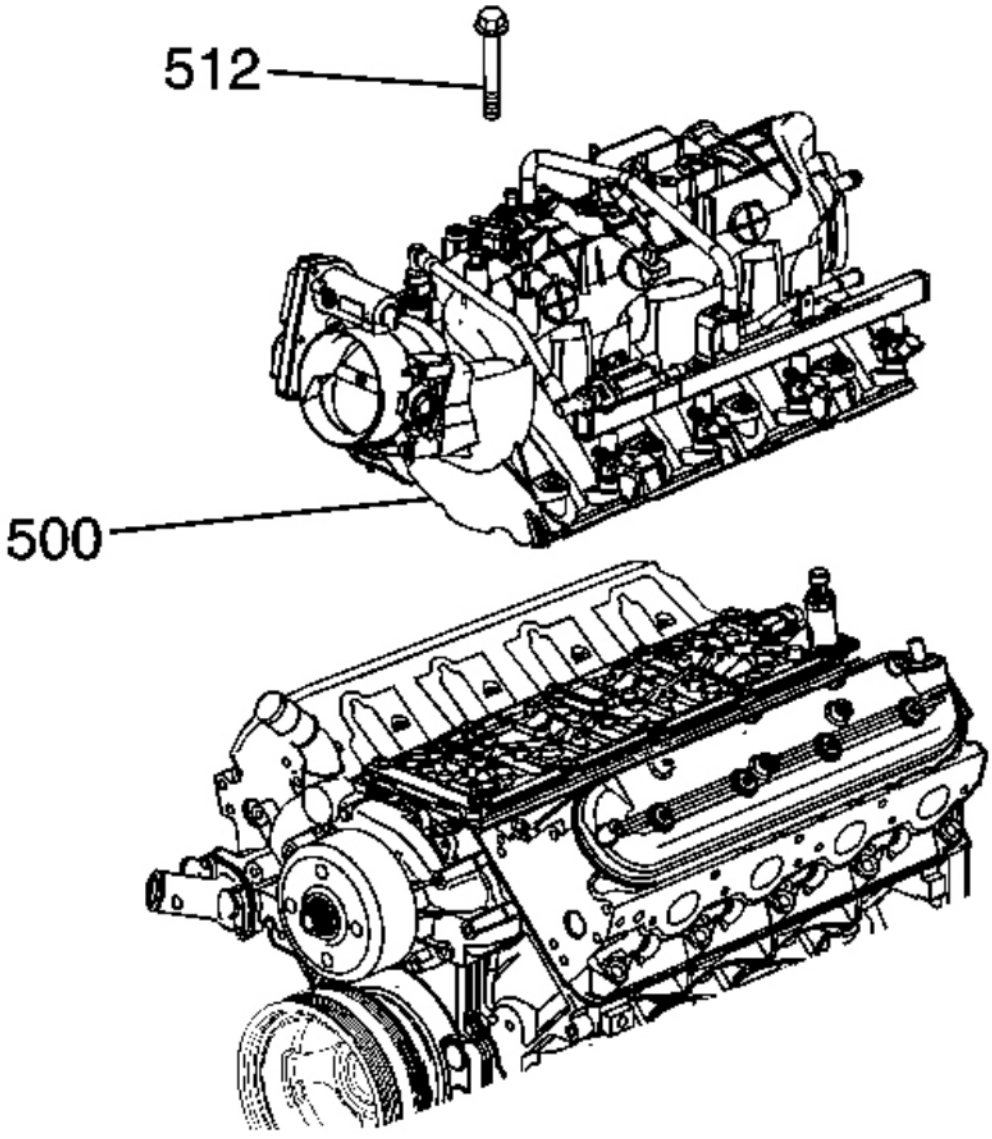


Fig. 126: View Of Intake Manifold
Courtesy of GENERAL MOTORS CORP.

2. Remove the manifold absolute pressure (MAP) sensor (714). Refer to **Intake Manifold Removal (RPO LY2/LY6)** or **Intake Manifold Removal (RPO LC9/LY5/LMG/L76)** or **Intake Manifold Removal (RPO L92)** .
3. Remove the evaporative emission (EVAP) canister purge solenoid valve, EVAP tubes, and fuel rail with

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injectors. Refer to **Fuel Rail and Injectors Removal** .

4. Remove the throttle body and gasket. Refer to **Throttle Body Removal** .
5. Clean the intake manifold (500) in solvent.

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

6. Dry the intake manifold with compressed air.

INSPECTION PROCEDURE

1. Inspect the manifold for the following conditions:
   - Damaged gasket or sealing surfaces
   - Loose threaded inserts or studs
   - Debris or restrictions within the passages of the manifold
   - Damaged or broken vacuum fittings
   - Inspect the composite intake manifold assembly for cracks or other damage.

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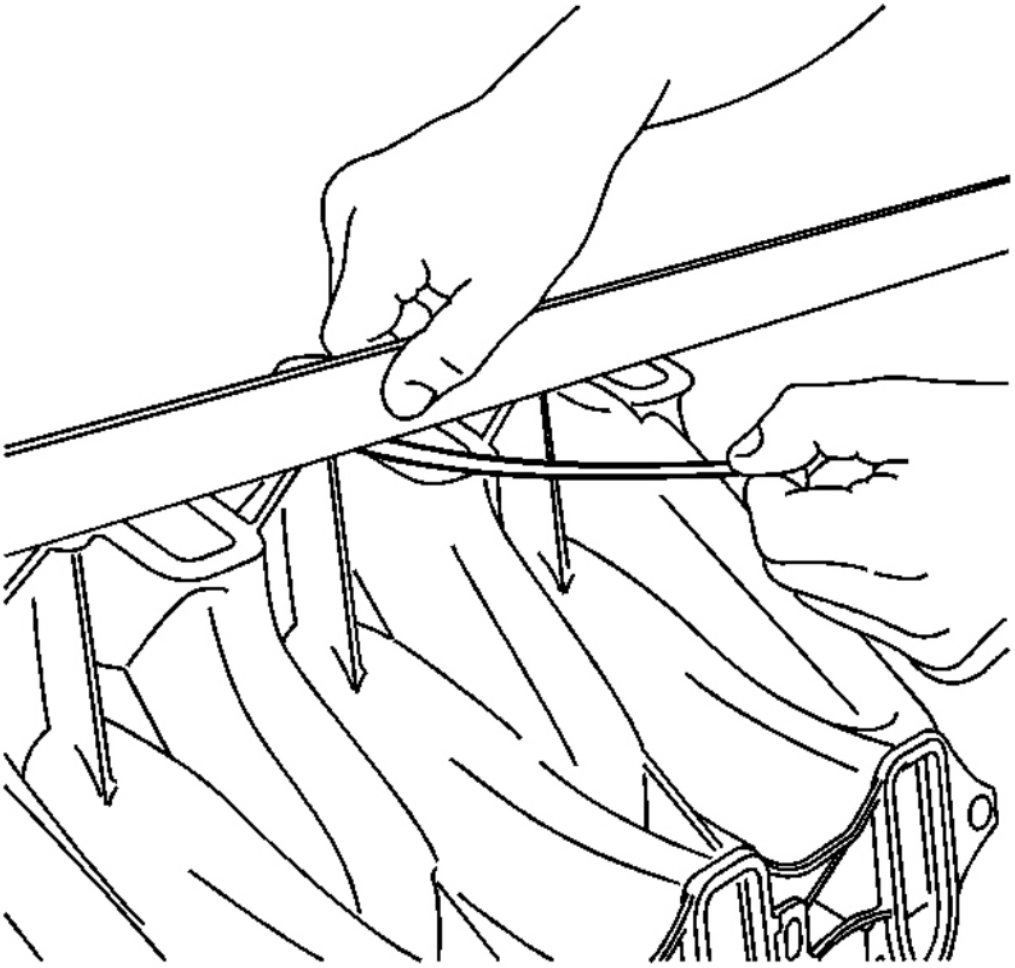


Fig. 127: Inspecting Intake Manifold Cylinder Head Deck For Warpage
Courtesy of GENERAL MOTORS CORP.

2. Inspect the intake manifold cylinder head deck for warpage.
    1. Locate a straight edge across the intake manifold cylinder head deck surface.

       Position the straight edge across a minimum of two runner port openings.

    2. Insert a feeler gage between the intake manifold and the straight edge.

       An intake manifold with warpage in excess of 3 mm (0.118 in) over a 200 mm (7.87 in) area is warped and should be replaced.

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EXHAUST MANIFOLD CLEANING AND INSPECTION

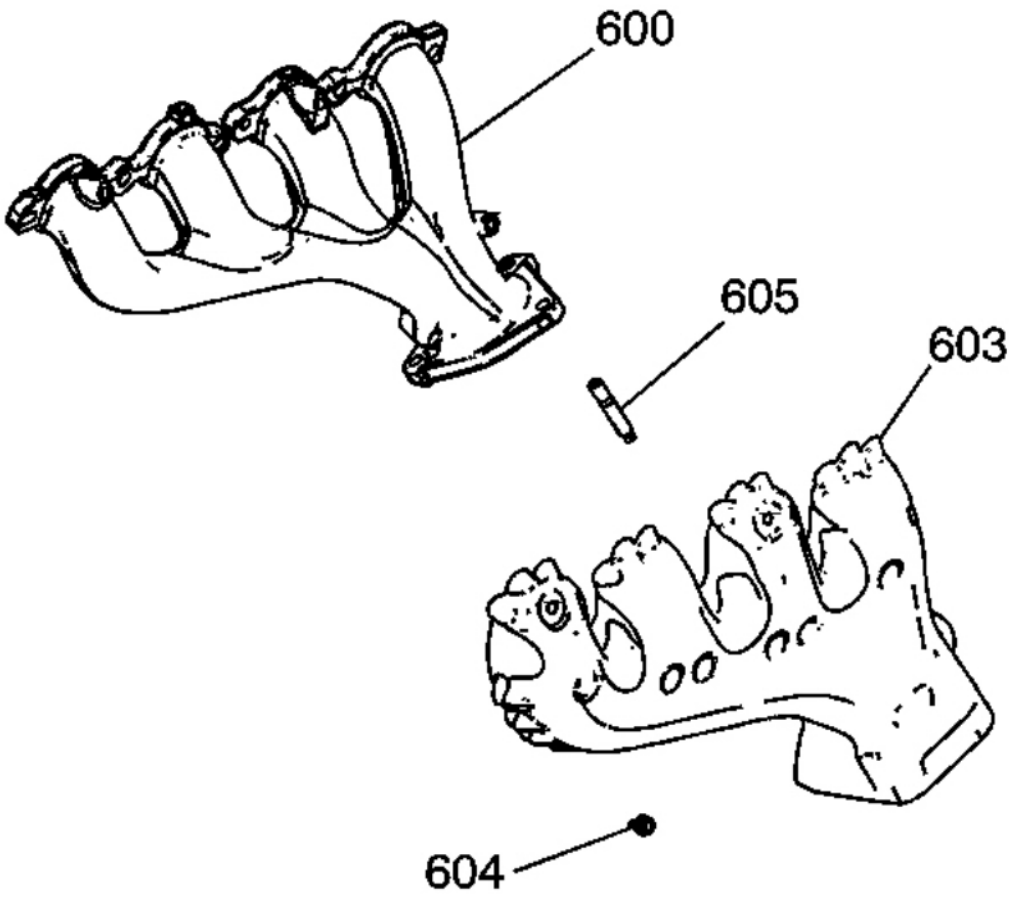


Fig. 128: View Of Exhaust Manifold & Heat Shield
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not use the exhaust manifold-to-cylinder head gaskets again. Upon installation of the exhaust manifold, install a NEW gasket. An improperly installed gasket or leaking exhaust system may effect on-board diagnostics (OBD) II system performance.

1. Clean the exhaust manifold (600) and heat shield (603) in solvent.

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

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2. Dry the exhaust manifold with compressed air.
3. Inspect the exhaust manifold-to-cylinder head gasket surface for excessive scratches or gouging.
4. Inspect for a loose, damaged, or cracked heat shield (603).
5. Inspect the studs (605) for damaged threads.

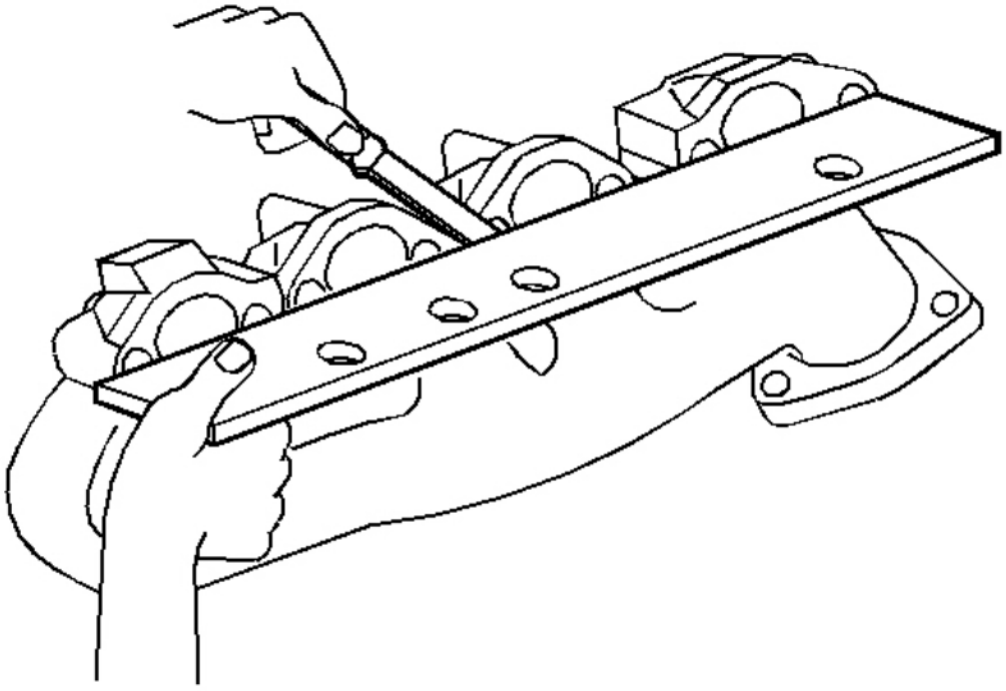


Fig. 129: Measuring Exhaust Manifold To Cylinder Head Surface For Warpage
Courtesy of GENERAL MOTORS CORP.

6. Use a straight edge and a feeler gage and measure the exhaust manifold cylinder head deck for warpage.

   An exhaust manifold deck with warpage in excess of 0.25 mm (0.01 in) within the two front or two rear runners or 0.5 mm (0.02 in) overall, may cause an exhaust leak and may effect OBD II system performance. Exhaust manifolds not within specifications must be replaced.

ENGINE COOLANT AIR BLEED PIPE AND HOLE COVER CLEANING AND INSPECTION

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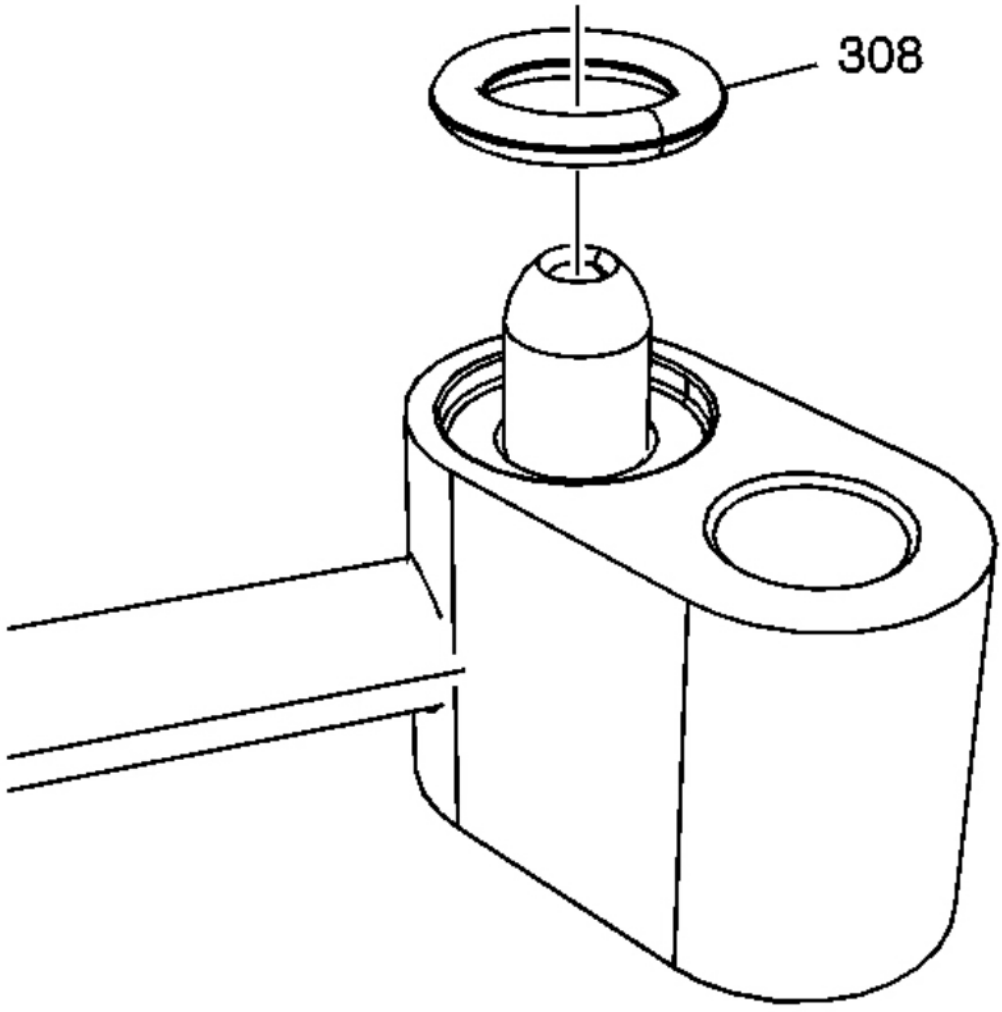


Fig. 130: View Of Coolant Air Bleed Pipe Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not use the engine coolant air bleed pipe and cover seals again. Upon installation of the pipe and covers, install NEW seals.

1. Remove the seals (308) from the pipe and covers.

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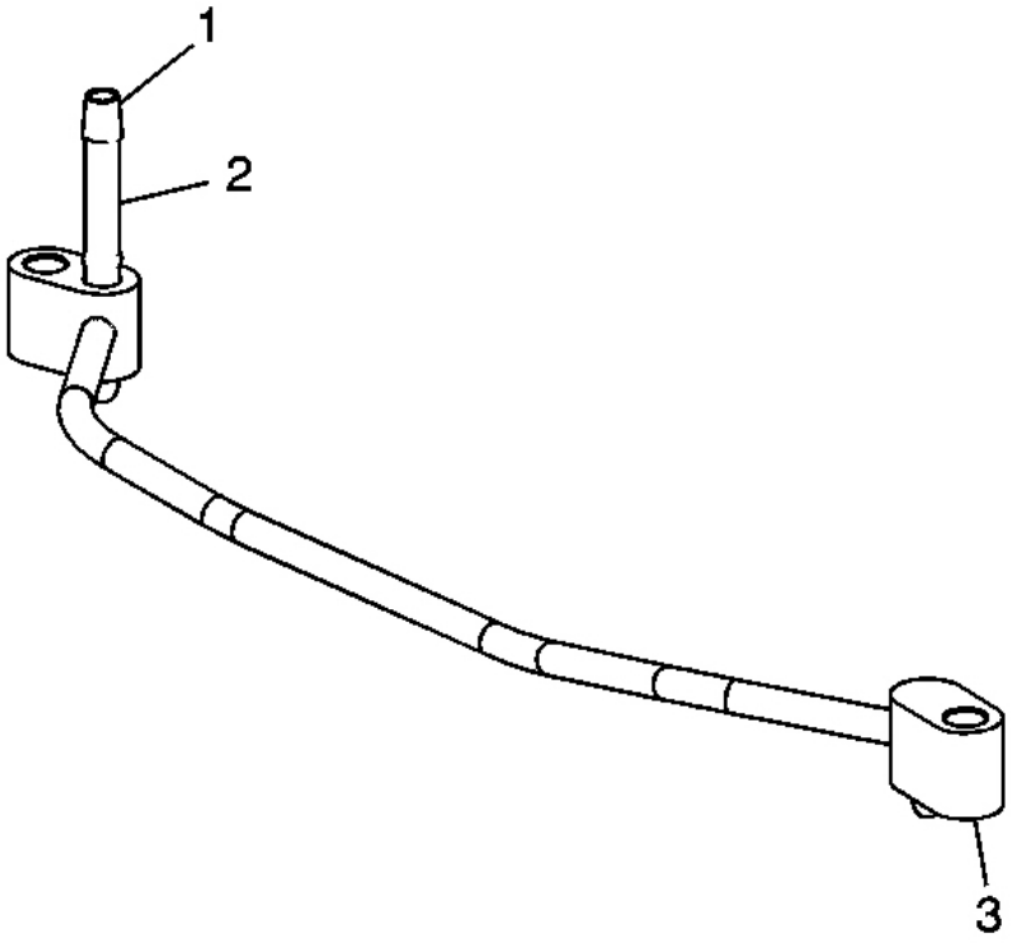


Fig. 131: View Of Coolant Air Bleed Pipe Components
Courtesy of GENERAL MOTORS CORP.

2. Clean the pipe and covers in solvent.

CAUTION: Refer to Safety Glasses and Compressed Air Caution .

3. Dry the pipe and covers with compressed air.
4. Inspect the pipe and covers for restrictions within the pipe (1) or damaged sealing surfaces (2, 3).

WATER PUMP CLEANING AND INSPECTION

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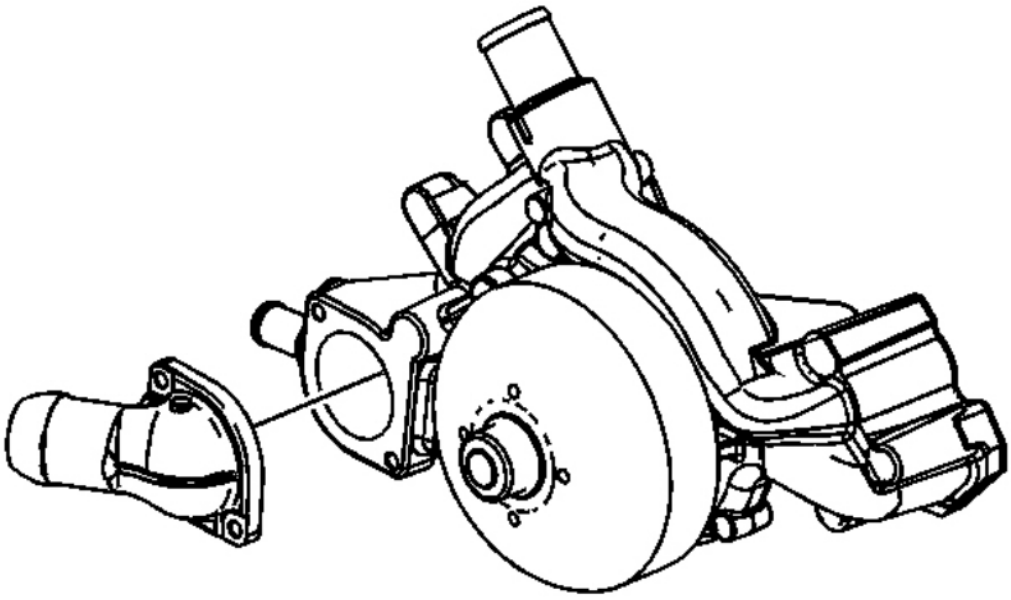


Fig. 132: View Of Water Pump
Courtesy of GENERAL MOTORS CORP.

1. Remove the old gasket from the water pump sealing surfaces. Refer to **Replacing Engine Gaskets** .
2. Clean all excess dirt and debris from the water pump housing.
3. Inspect the water pump for the following conditions:
   - Gasket and hose sealing surfaces for excessive scratches or gouging
   - Restrictions within the internal coolant passages
   - Excessive side-to-side play in the pulley shaft
   - Leakage at the water inlet housing or rear cover
   - Leakage at the water pump vent hole

     A stain around the vent hole is acceptable. If leakage, dripping, occurs with the engine running and the cooling system pressurized, replace the water pump.

   - Wear or damage in the belt tracking area of the pulley

THREAD REPAIR

Tools Required

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- **J 42385-100** Head/Main Bolt Thread Repair Kit. See **Special Tools** .
- **J 42385-200** Common Thread Repair Kit. See **Special Tools** .
- **J 42385-300** Fixtures and Hardware Kit. See **Special Tools** .

GENERAL THREAD REPAIR

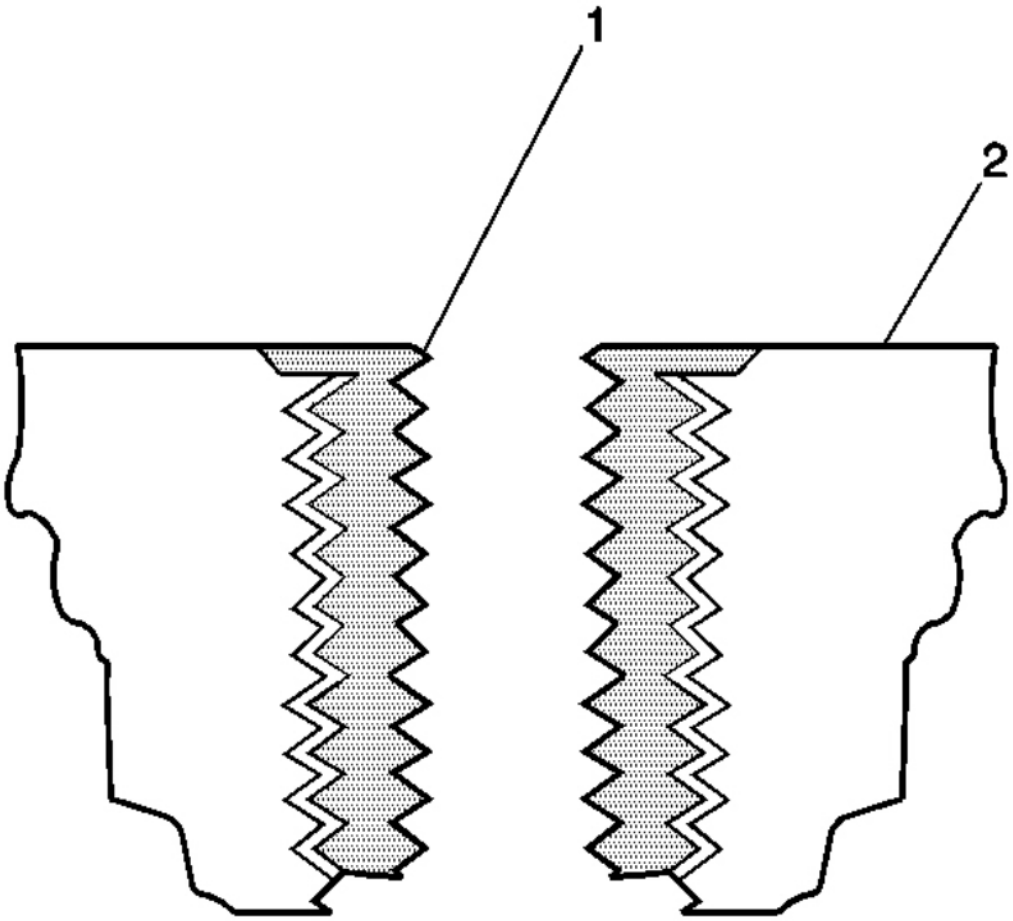


Fig. 133: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS CORP.

The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert (1). During the bushing installation process, the driver tool expands the bottom external threads of the insert into the base material (2). This action mechanically locks the insert in place. Also, when installed to the proper depth, the flange of the insert will be seated against the counterbore of the repaired hole.

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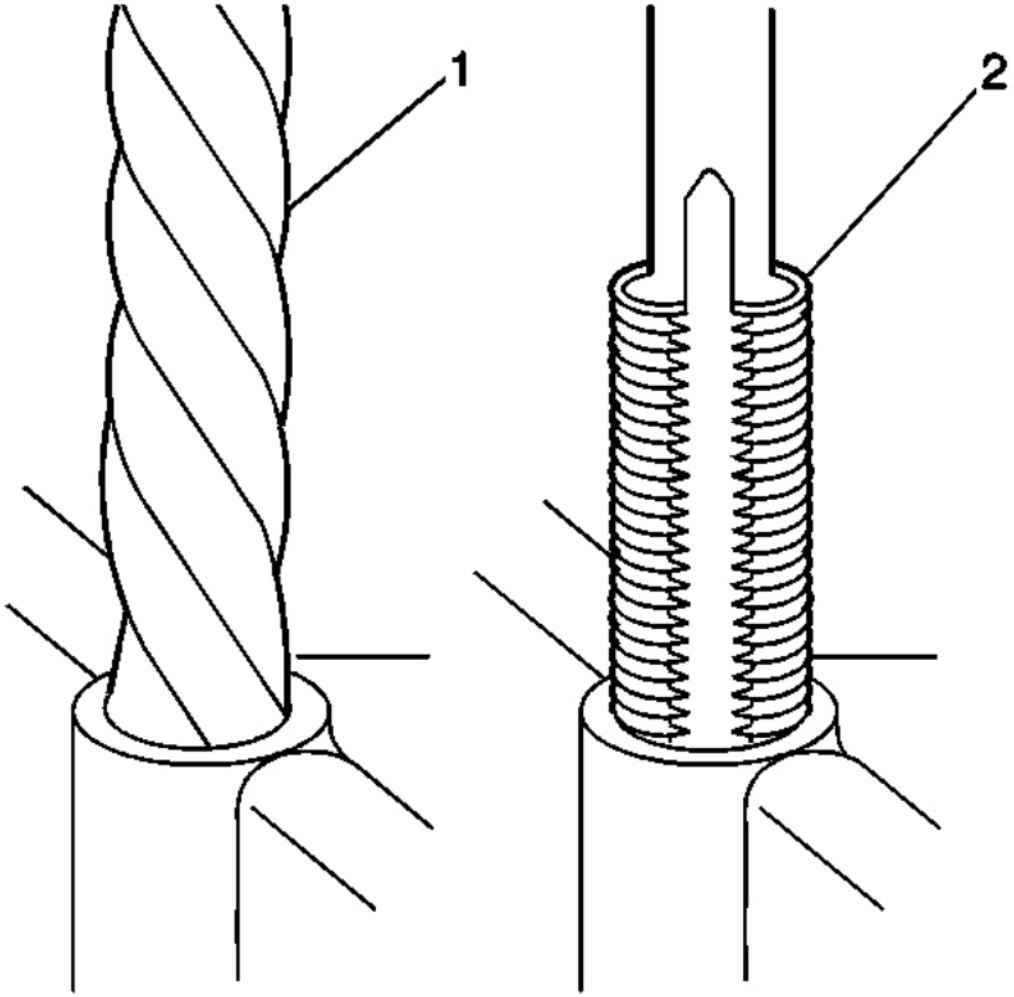


Fig. 134: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS CORP.

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

IMPORTANT:

- **The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881), WD 40®, or equivalent, is recommended when performing the drilling, counterboring, and tapping procedures.**
- **Driver oil MUST be used on the installer driver tool.**

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- **The tool kits are designed for use with either a suitable tap wrench or drill motor.**

1. Drill out the threads of the damaged hole (1).
   - 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.

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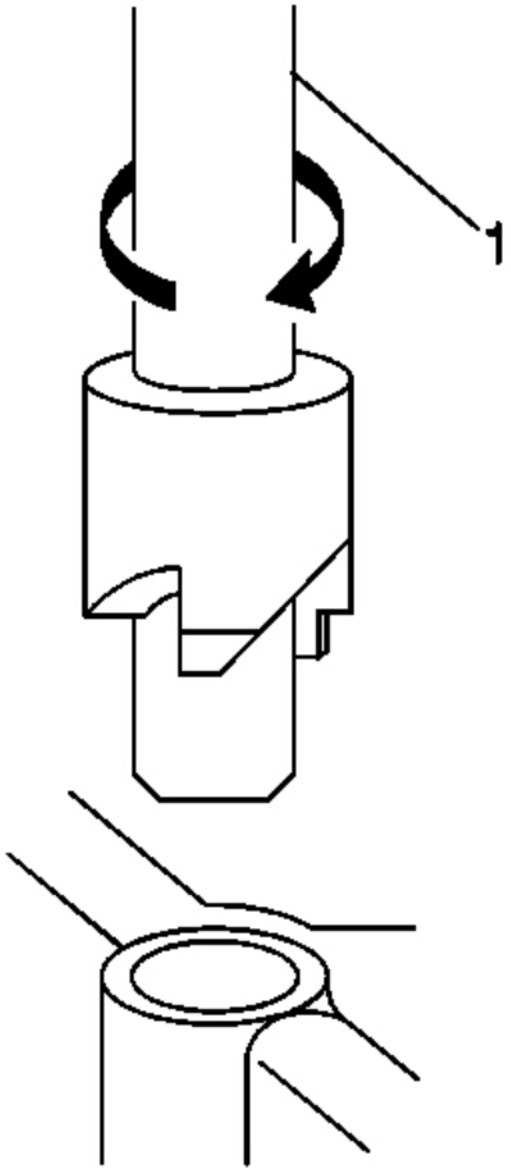


Fig. 135: View Of Counterbore Drill
Courtesy of GENERAL MOTORS CORP.

3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.

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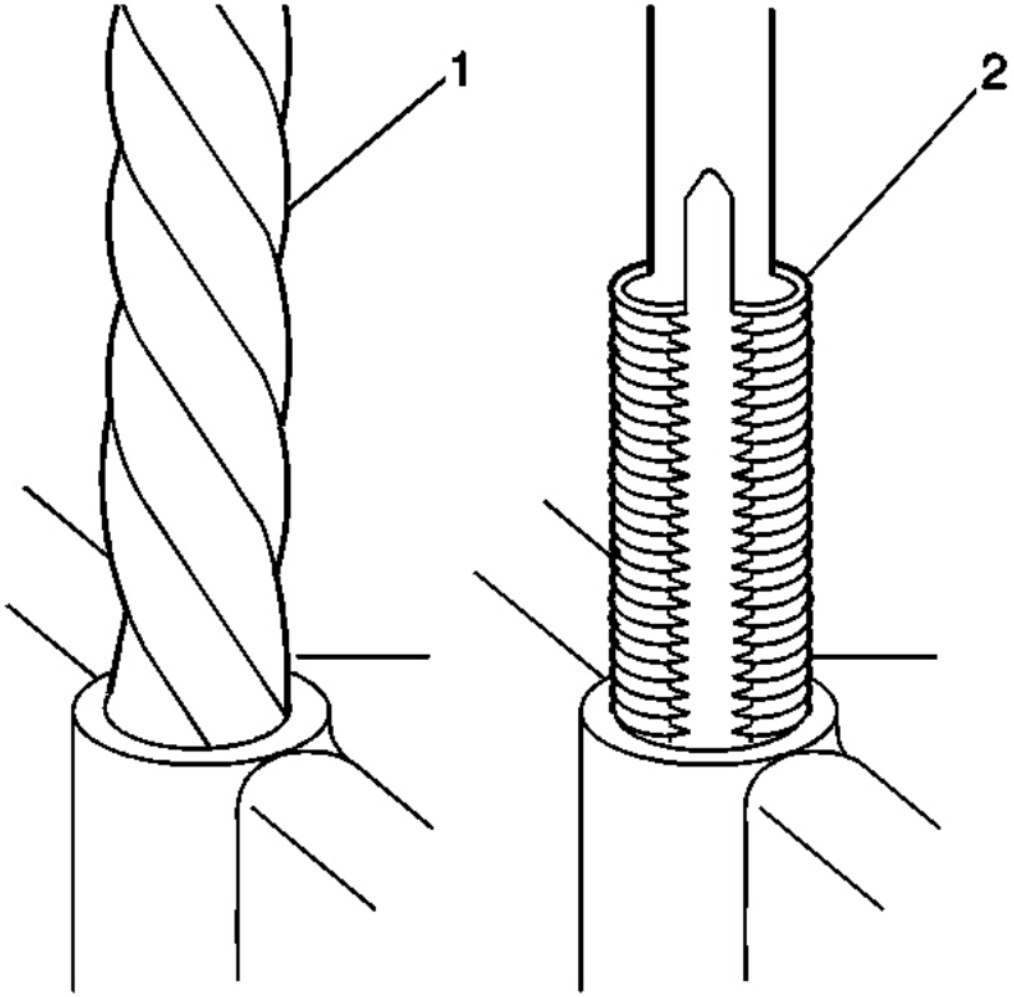


Fig. 136: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS CORP.

5. Using a tap wrench (2), tap the threads of the drilled hole.
   - 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.
7. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
8. Using compressed air, clean any cutting oil and chips out of the hole.

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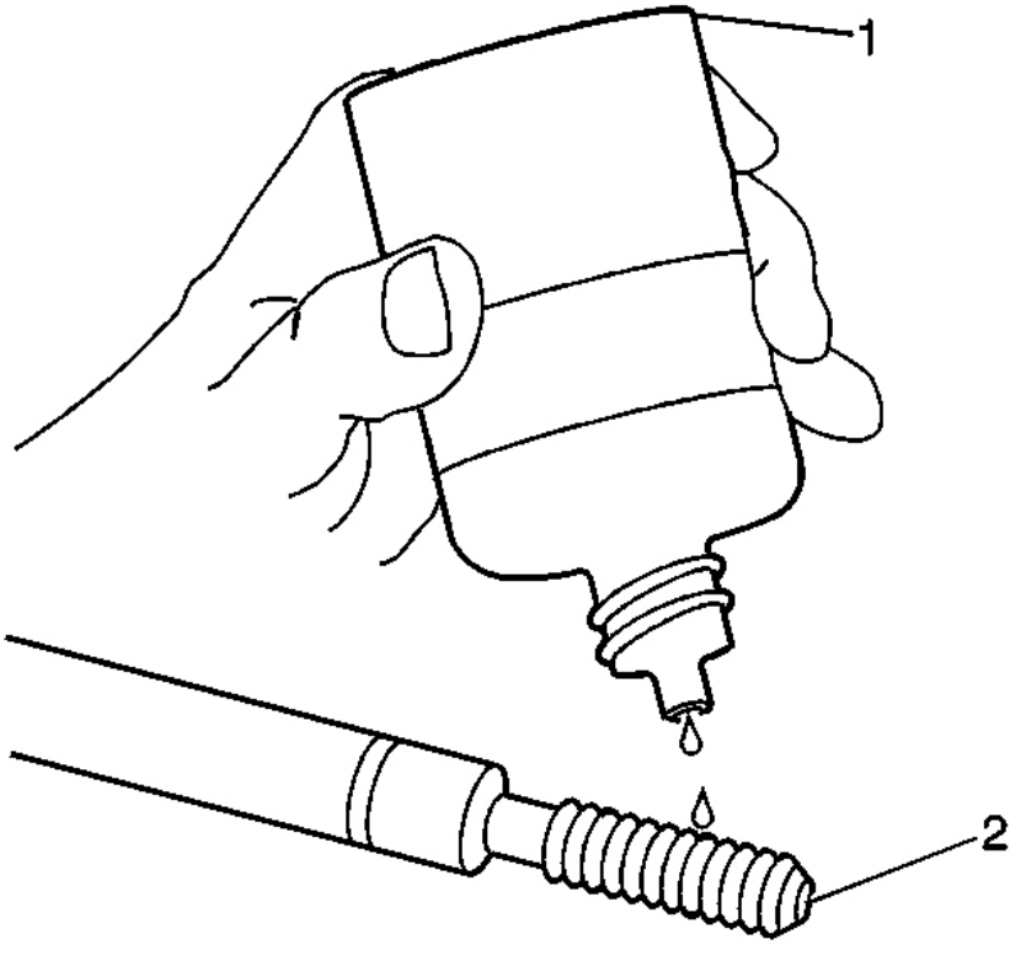


Fig. 137: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS CORP.

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

9. Lubricate the threads of the installer tool (2) with the driver oil (1).

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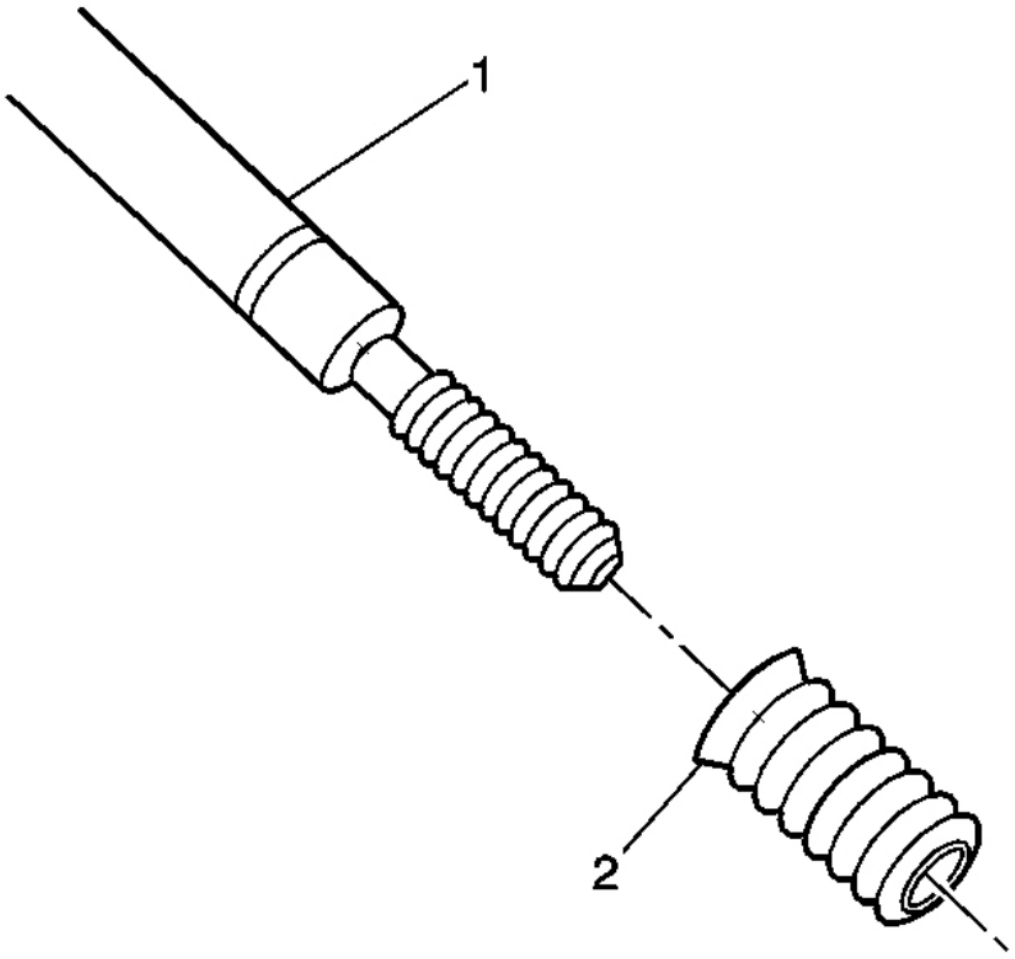


Fig. 138: View of Bushing Type Insert
Courtesy of GENERAL MOTORS CORP.

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

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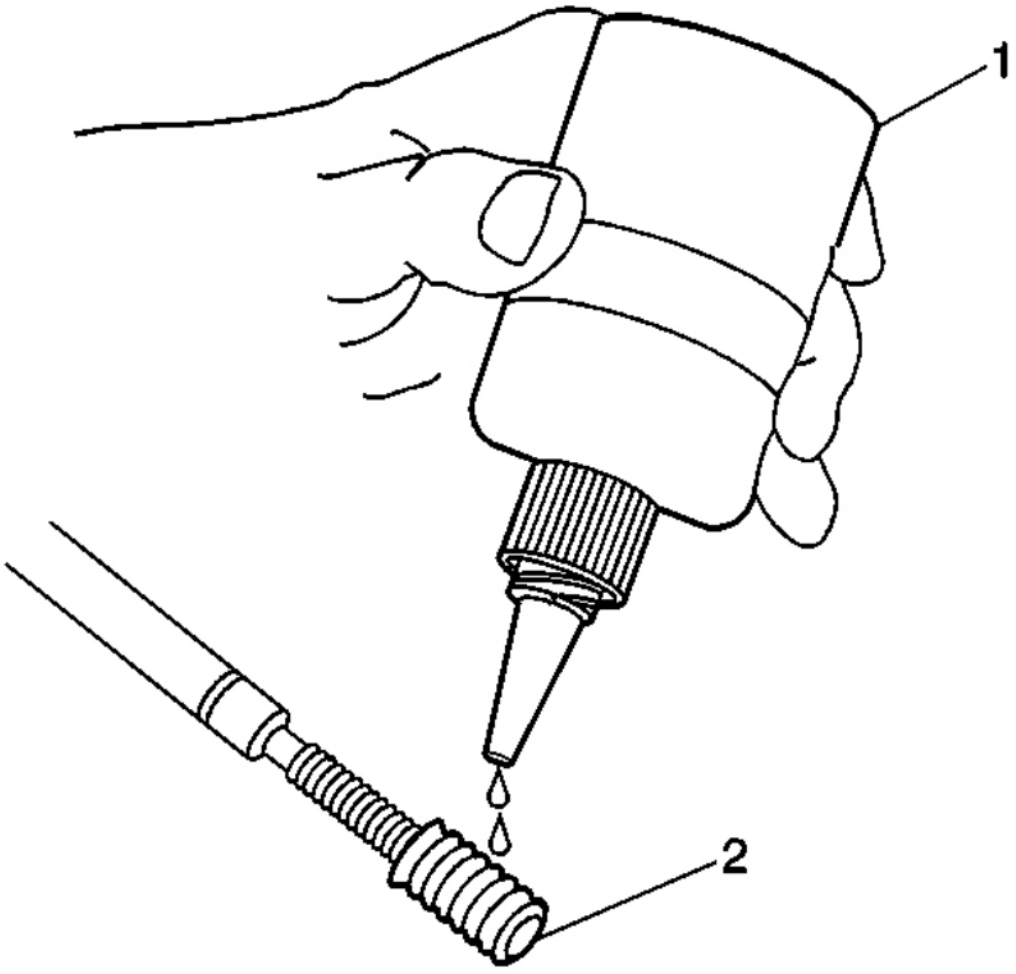


Fig. 139: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

11. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).

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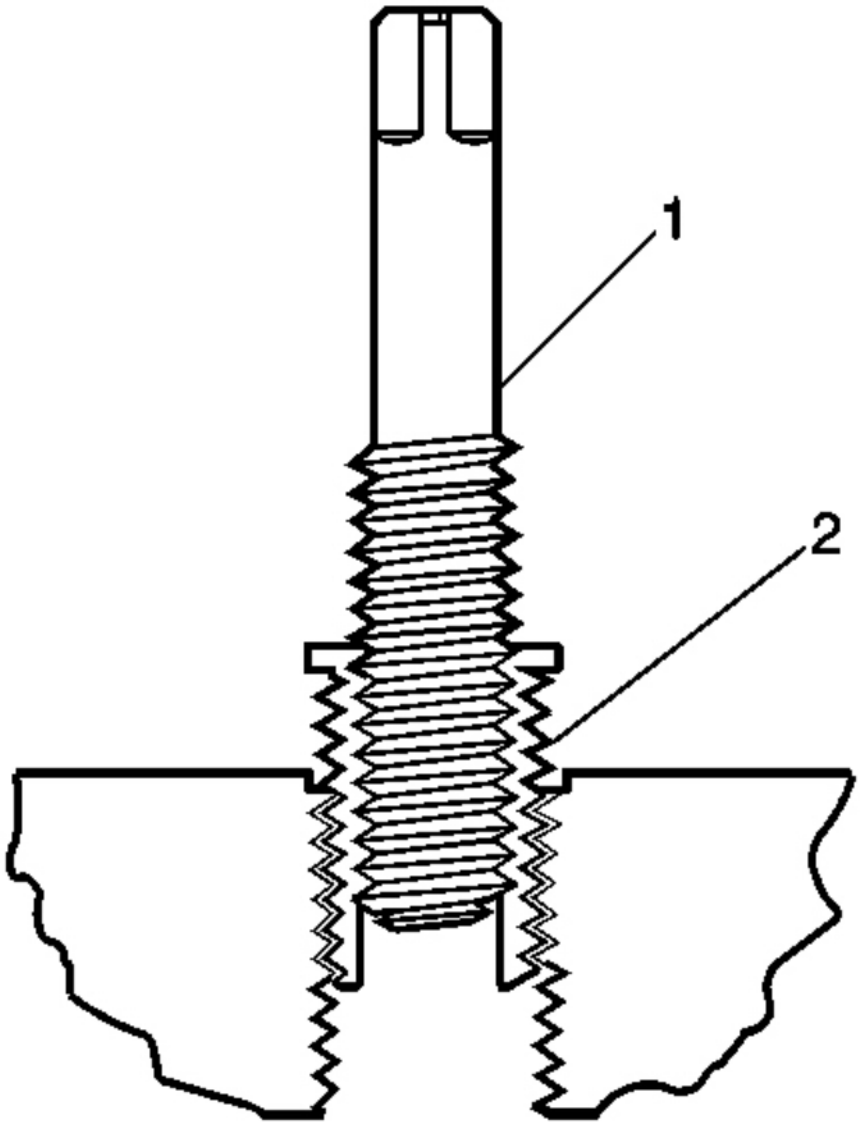


Fig. 140: View Of Insert In Tapped Bolt Hole
Courtesy of GENERAL MOTORS CORP.

12. Install the insert (2) into the hole.

    Install the insert until the flange of the insert contacts the counterbored surface. Continue to rotate the installer tool (1) through the insert.

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The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

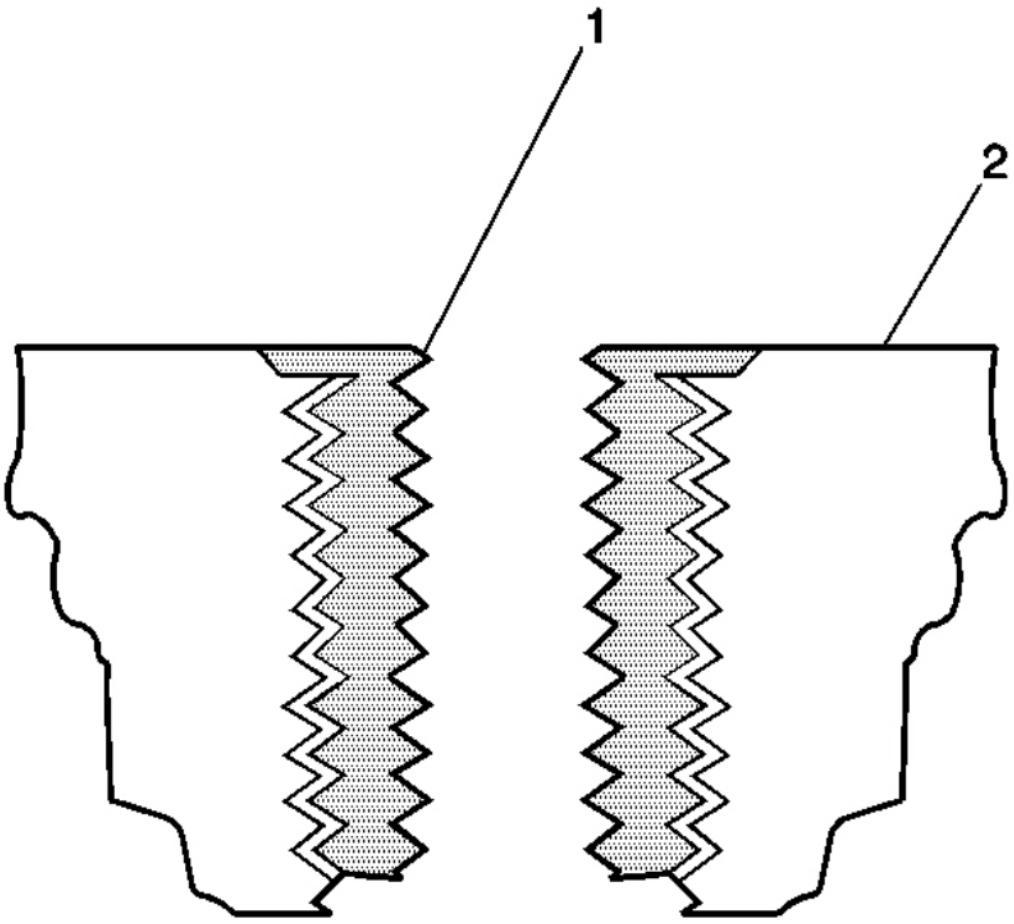


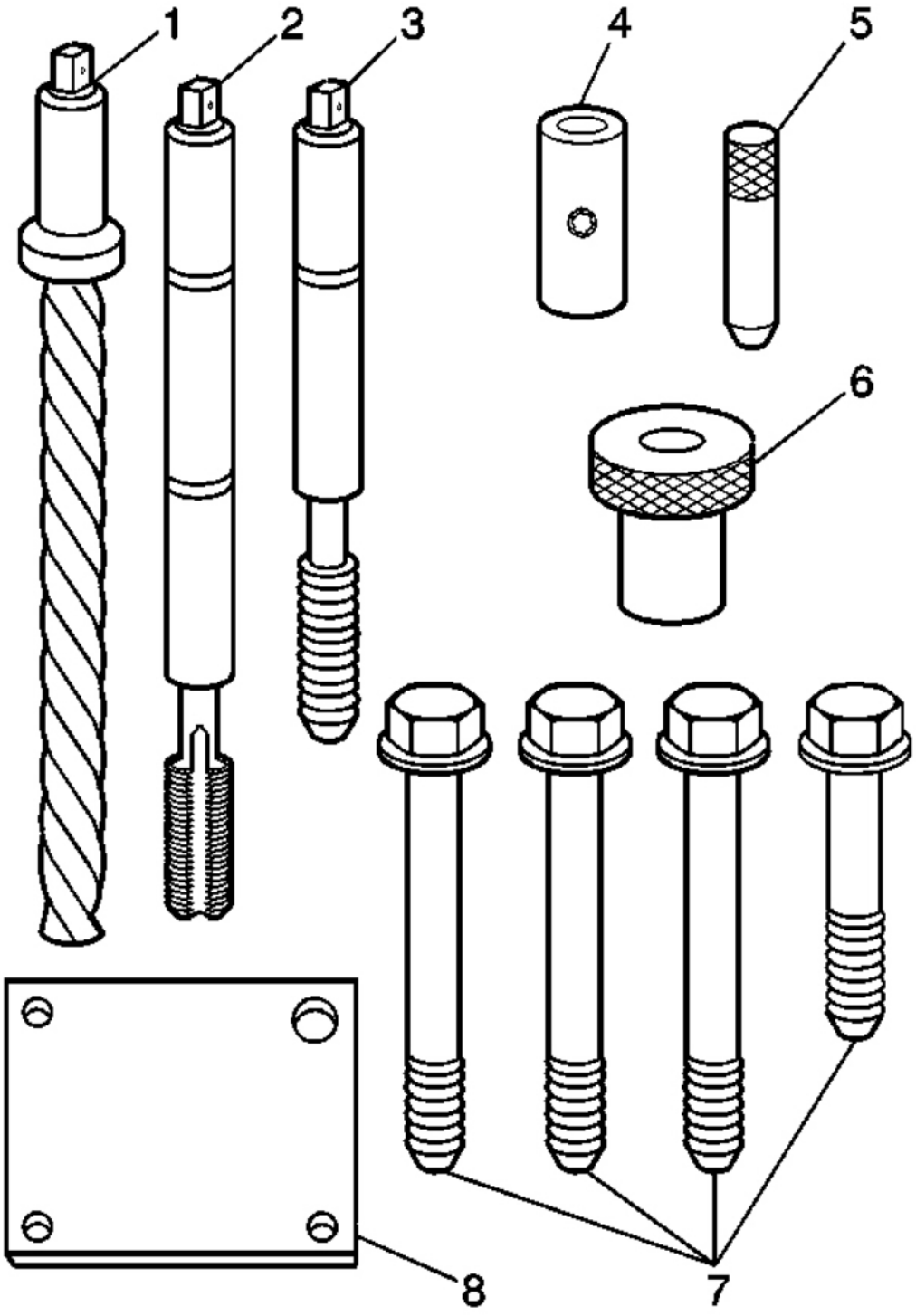
Fig. 141: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS CORP.

13. Inspect the insert for proper installation into the hole.

    A properly installed insert (1) will be either flush or slightly below flush with the surface of the base material (2).

CYLINDER HEAD BOLT HOLE THREAD REPAIR

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Fig. 142: Identifying Thread Repair Kit Components
Courtesy of GENERAL MOTORS CORP.

1. The cylinder head bolt hole thread repair kit consists of the following items:
   - The drill (1)
   - The tap (2)
   - The installer (3)
   - The sleeve (4)
   - The alignment pin (5)
   - The bushing (6)
   - The bolts (7)
   - The fixture plate (8)

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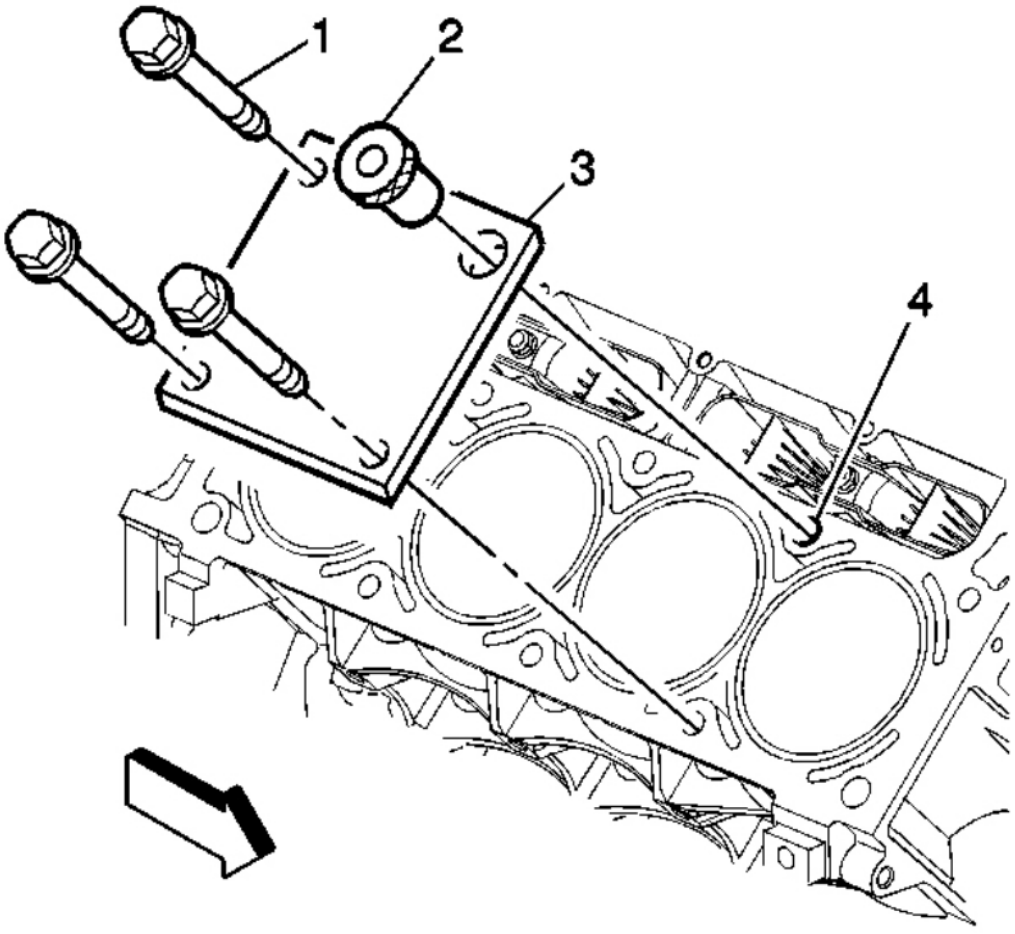


Fig. 143: View Of Fixture Plate, Bolts, Bushing & Cylinder Hole
Courtesy of GENERAL MOTORS CORP.

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

IMPORTANT:

- **The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881), WD 40®, or equivalent, is recommended when performing the drilling and tapping procedures.**
- **Driver oil MUST be used on the installer driver tool.**
- **The tool kits are designed for use with either a suitable tap wrench or drill motor.**

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2. Install the fixture plate (3), bolts (1), and bushing (2) onto the engine block deck.

   Position the fixture plate and bushing over the hole that is to be repaired (4).

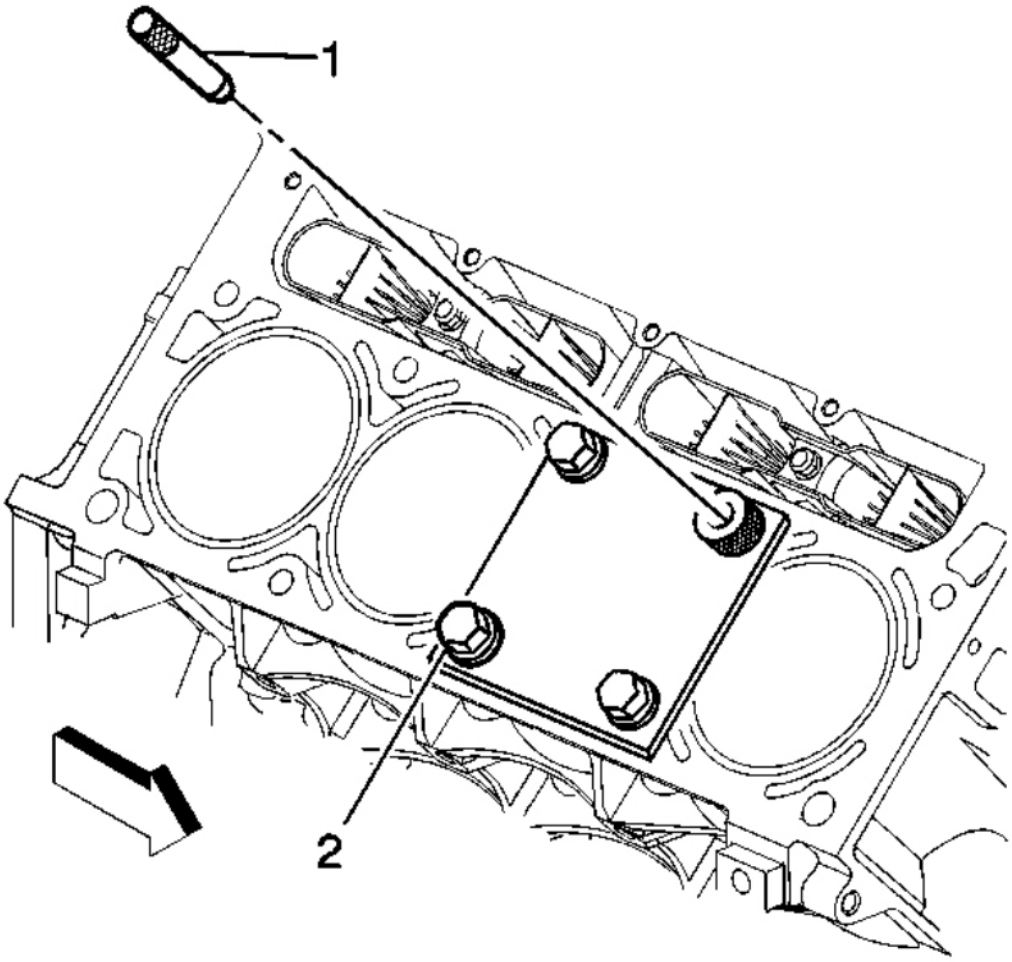


Fig. 144: View Of Alignment Pin & Fixture Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

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

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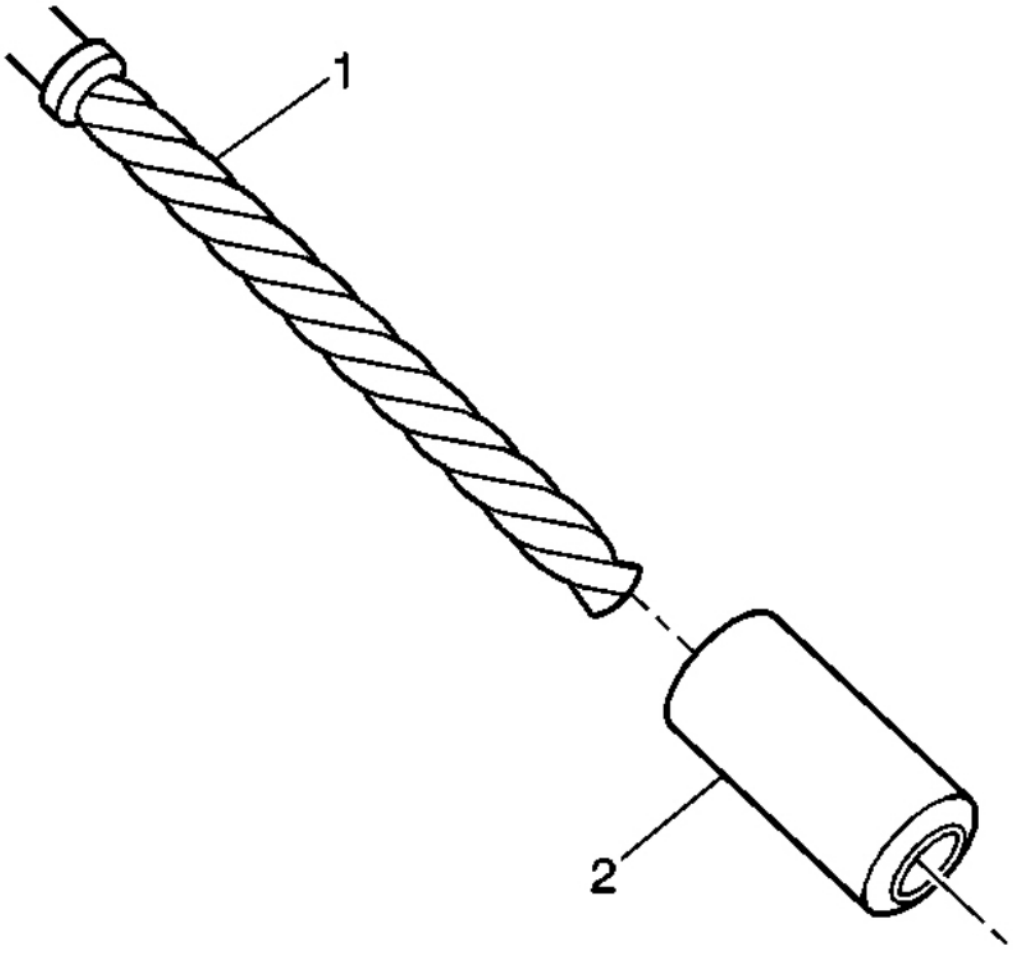


Fig. 145: View Of Stop Collar & Counterbore Drill
Courtesy of GENERAL MOTORS CORP.

6. Install the sleeve (2) onto the drill (1).

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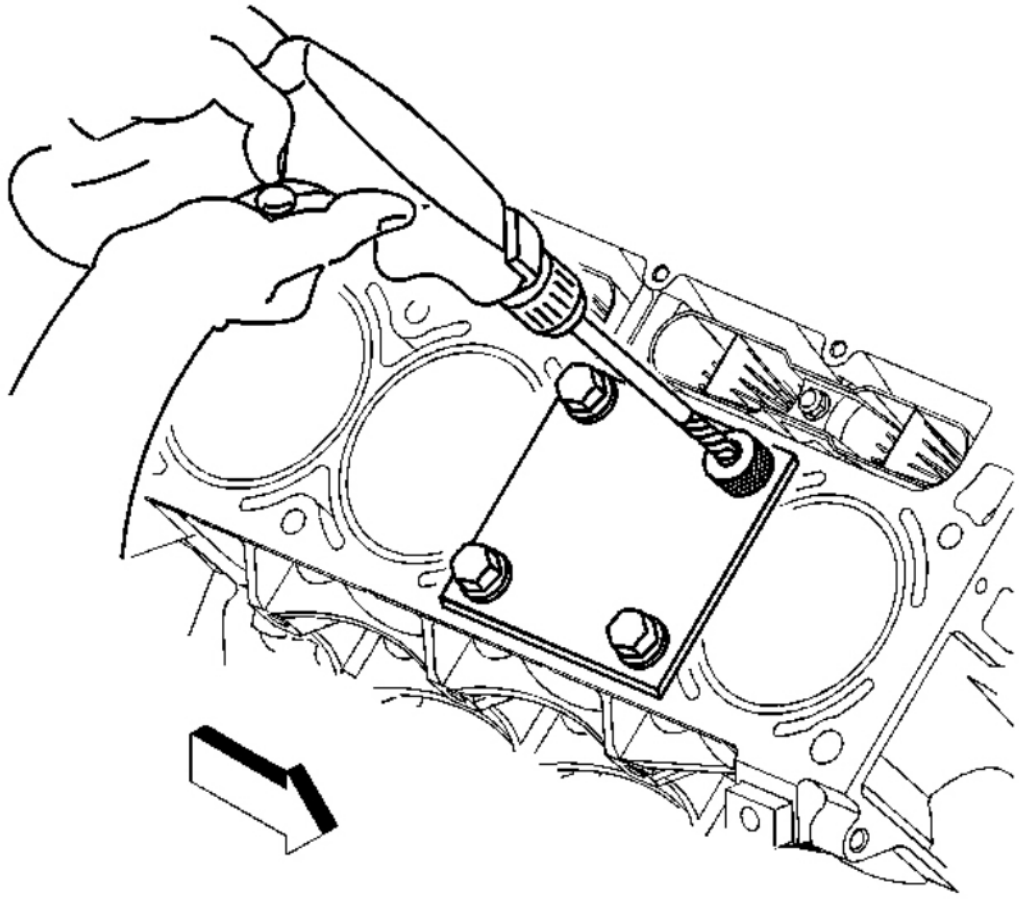


Fig. 146: Drilling Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: During the reaming process, it is necessary to repeatedly remove the drill and clean the chips from the hole.

7. Drill out the threads of the damaged hole.

   Drill the hole until the stop collar of the drill bit or the sleeve contacts the bushing.

8. Using compressed air, clean out any chips.

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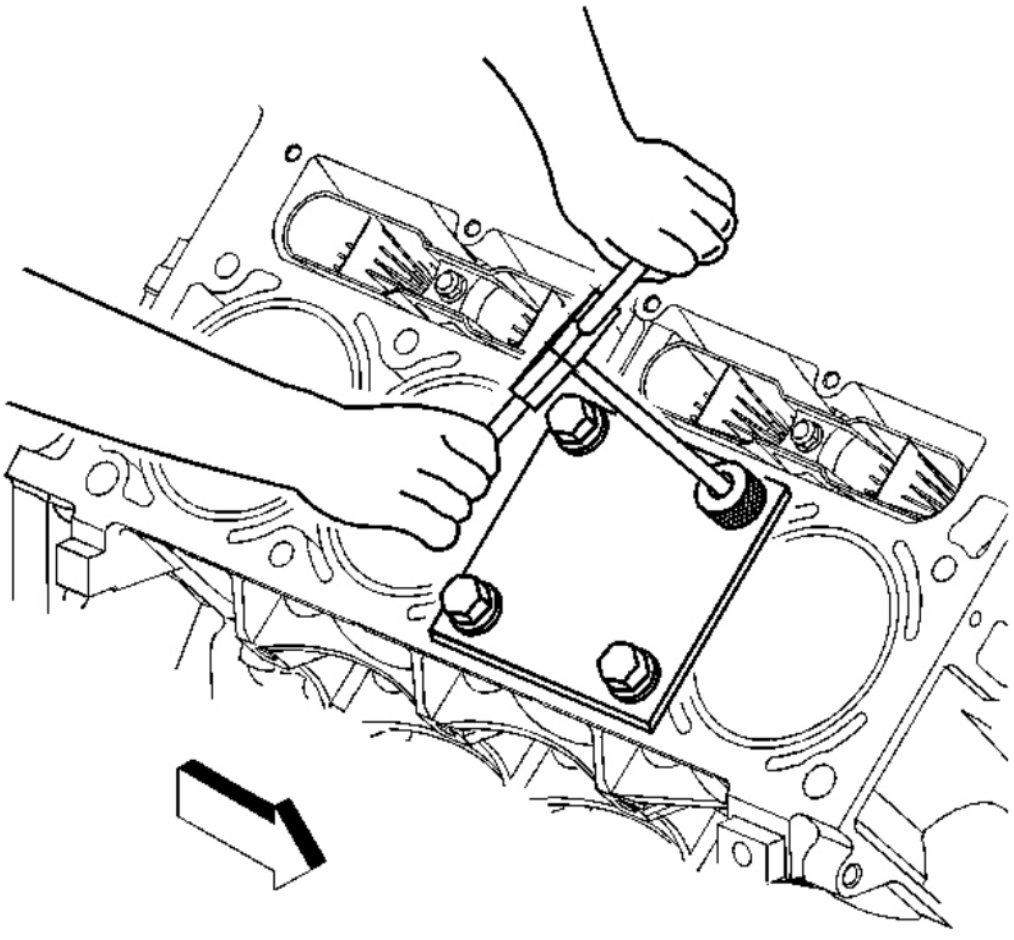


Fig. 147: Tapping Threads Of Drilled Hole Using Tapping Wrench
Courtesy of GENERAL MOTORS CORP.

9. Using a tap wrench, tap the threads of the drilled hole.

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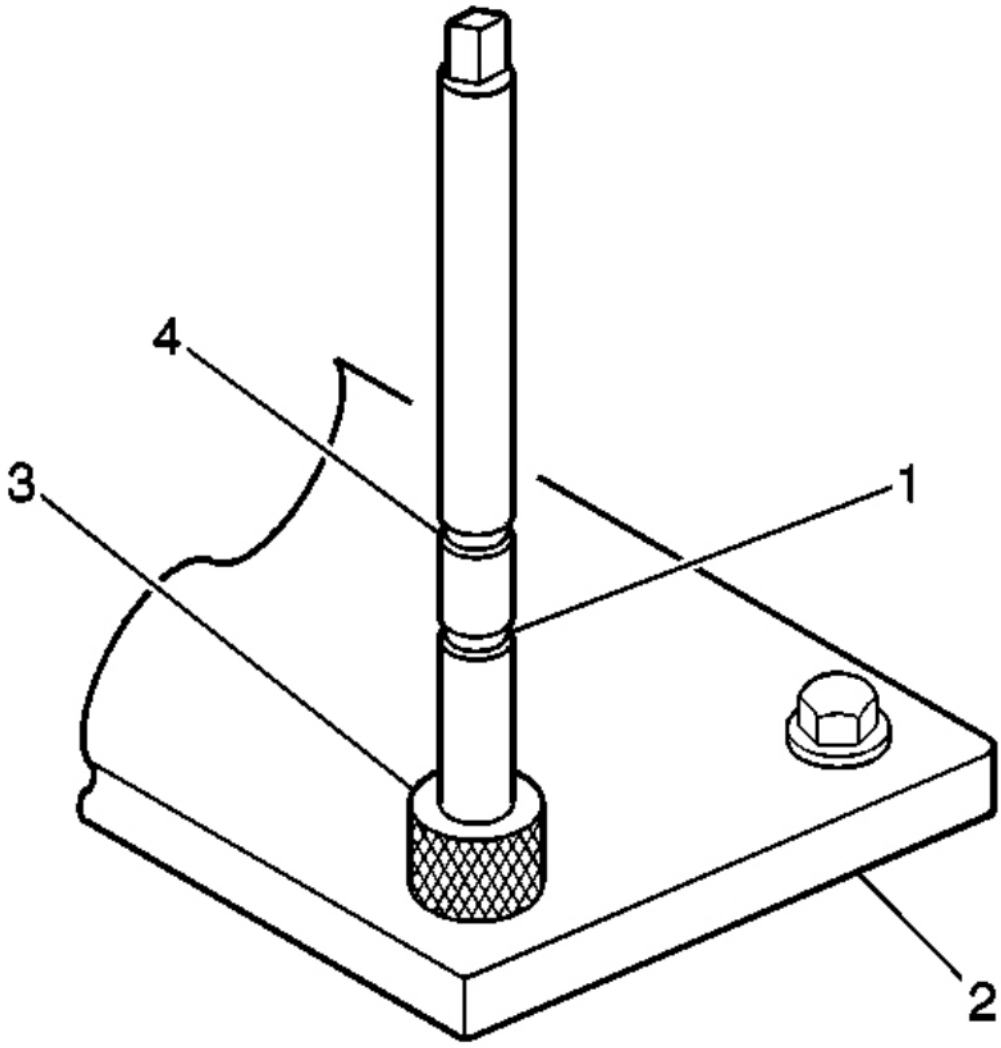


Fig. 148: View Of Tap Upper & Lower Marks, Fixture Plate & Bushing
Courtesy of GENERAL MOTORS CORP.

10. In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark (1) on the tap aligns with the top of the drill bushing (3).
11. Remove the fixture plate (2), bushing (3), and bolts.
12. Using compressed air, clean out any chips.
13. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.

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14. Using compressed air, clean any cutting oil and chips out of the hole.

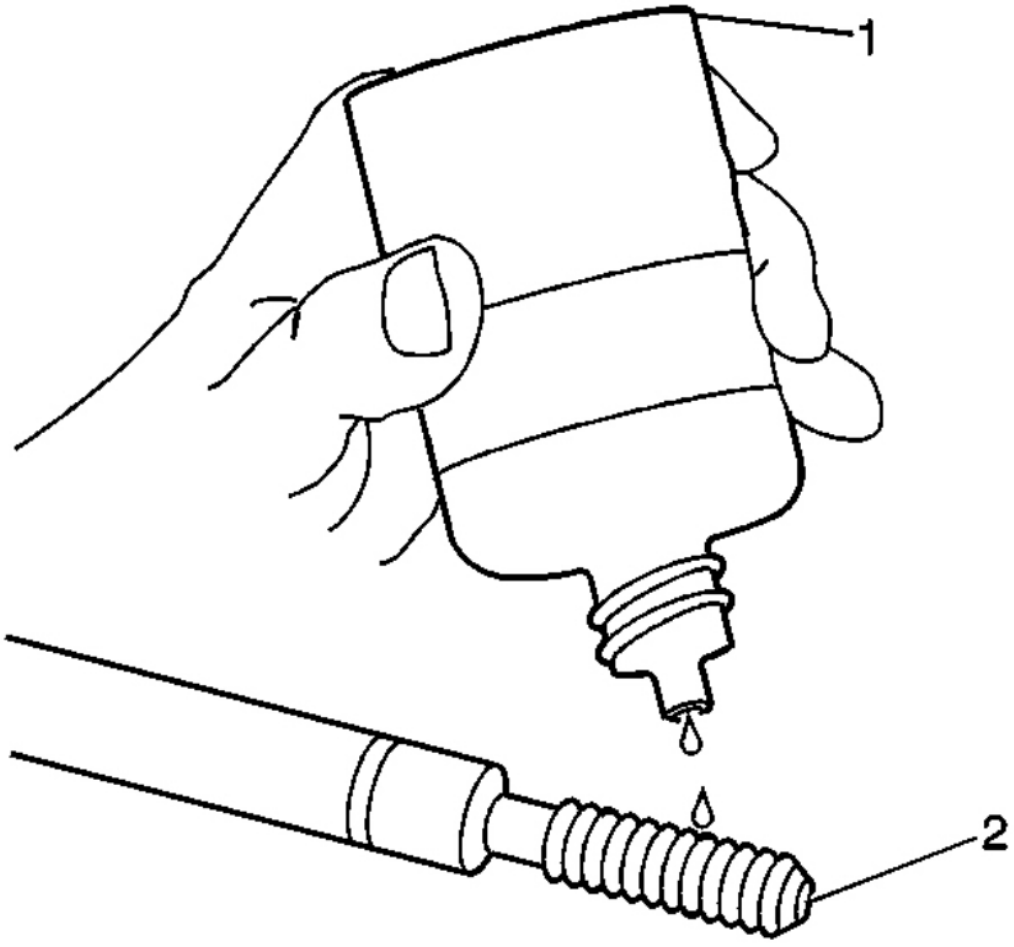


Fig. 149: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not allow oil or foreign material to contact the OD of the insert.

15. Lubricate the threads of the installer tool (2) with the driver oil (1).

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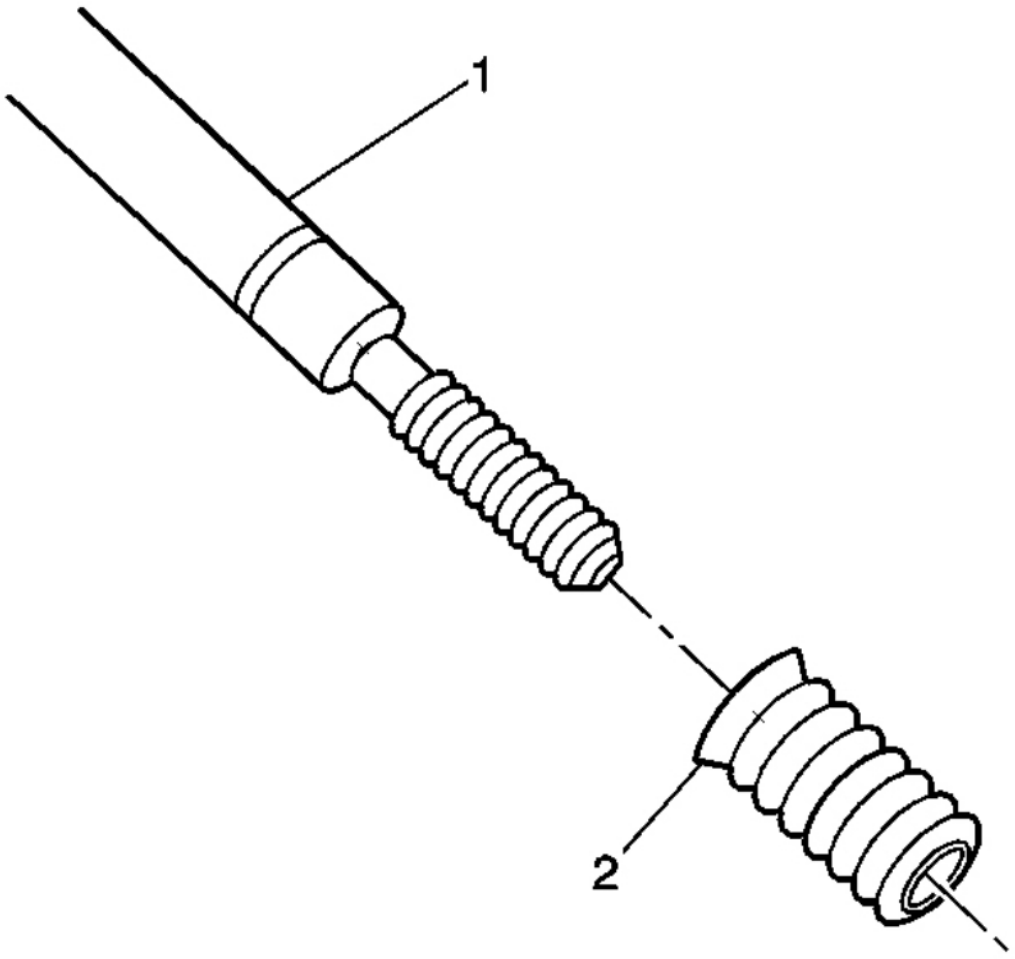


Fig. 150: View of Bushing Type Insert
Courtesy of GENERAL MOTORS CORP.

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

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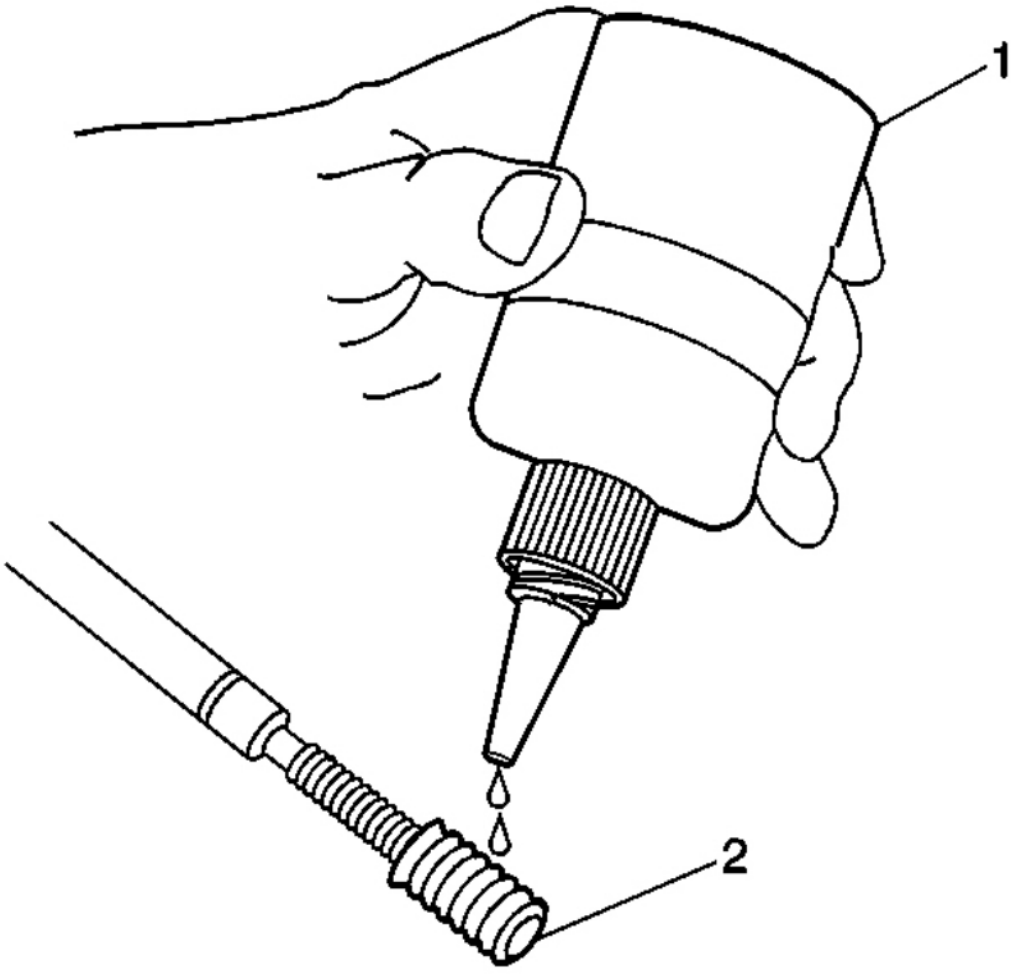


Fig. 151: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

17. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).

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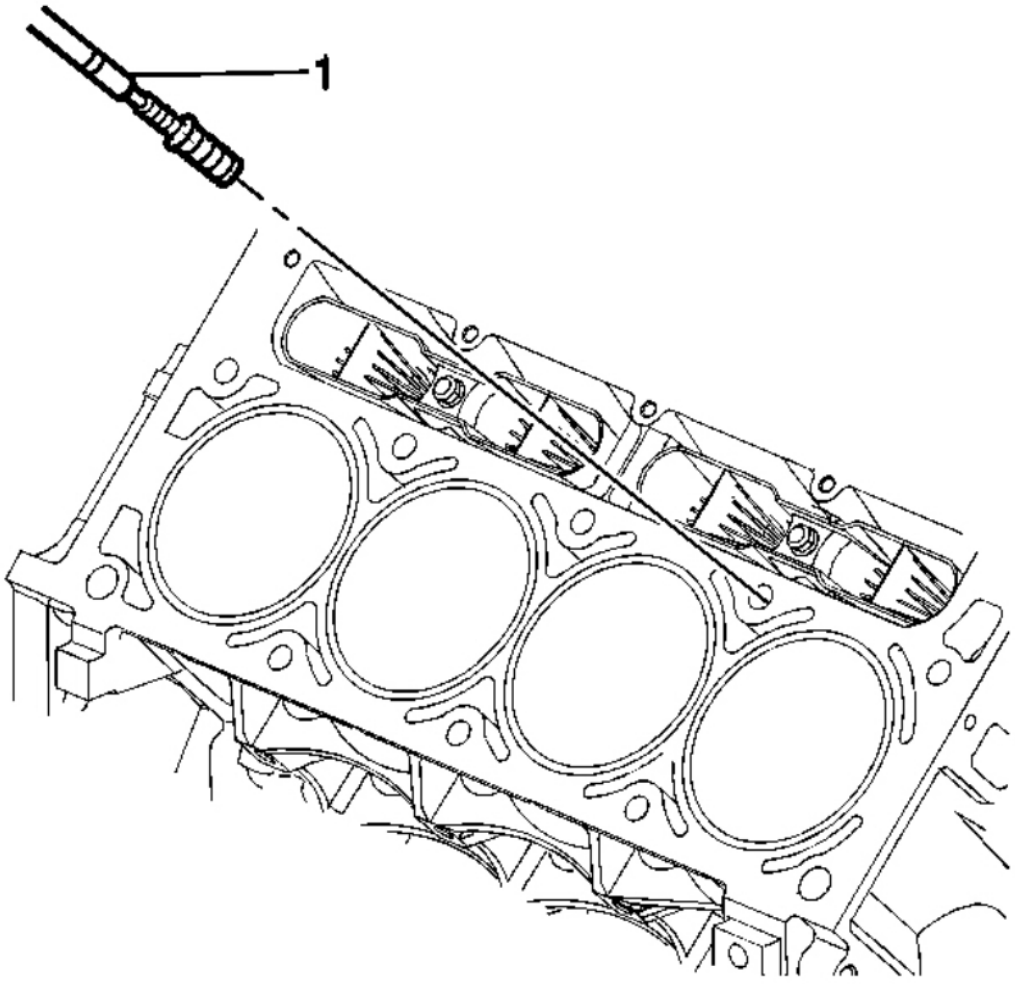


Fig. 152: View Of Insert, Driver & Cylinder Bolt Hole
Courtesy of GENERAL MOTORS CORP.

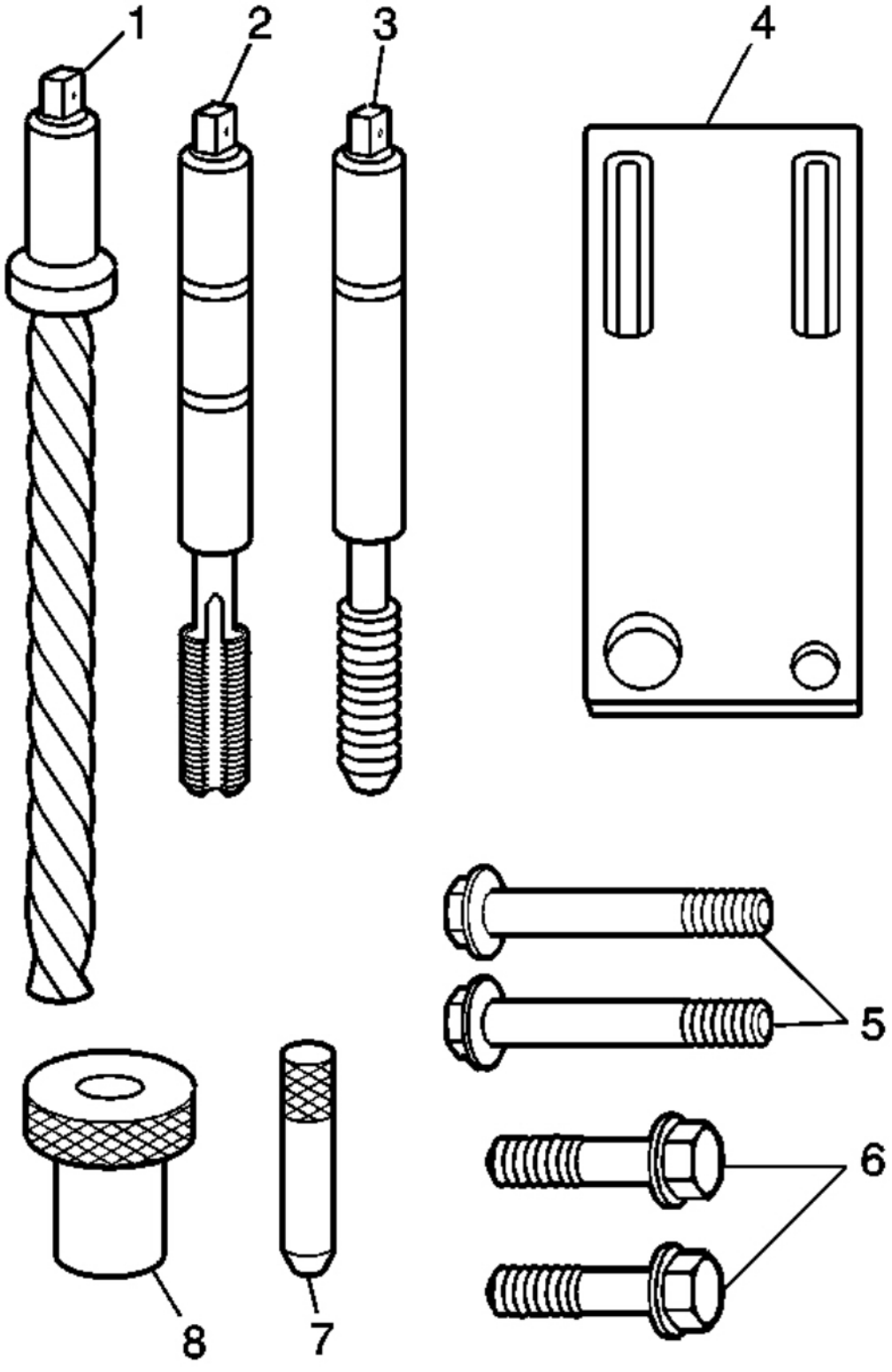
18. Install the insert and driver (1) into the hole.

    Rotate the driver tool until the mark on the tool aligns with the deck surface of the engine block.

    The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

MAIN CAP BOLT HOLE THREAD REPAIR

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Fig. 153: Identifying Thread Repair Kit Components
Courtesy of GENERAL MOTORS CORP.

1. The main cap bolt hole thread repair kit consists of the following items:
   - The drill (1)
   - The tap (2)
   - The installer (3)
   - The fixture plate (4)
   - The long bolts (5)
   - The short bolts (6)
   - The alignment pin (7)
   - The bushing (8)

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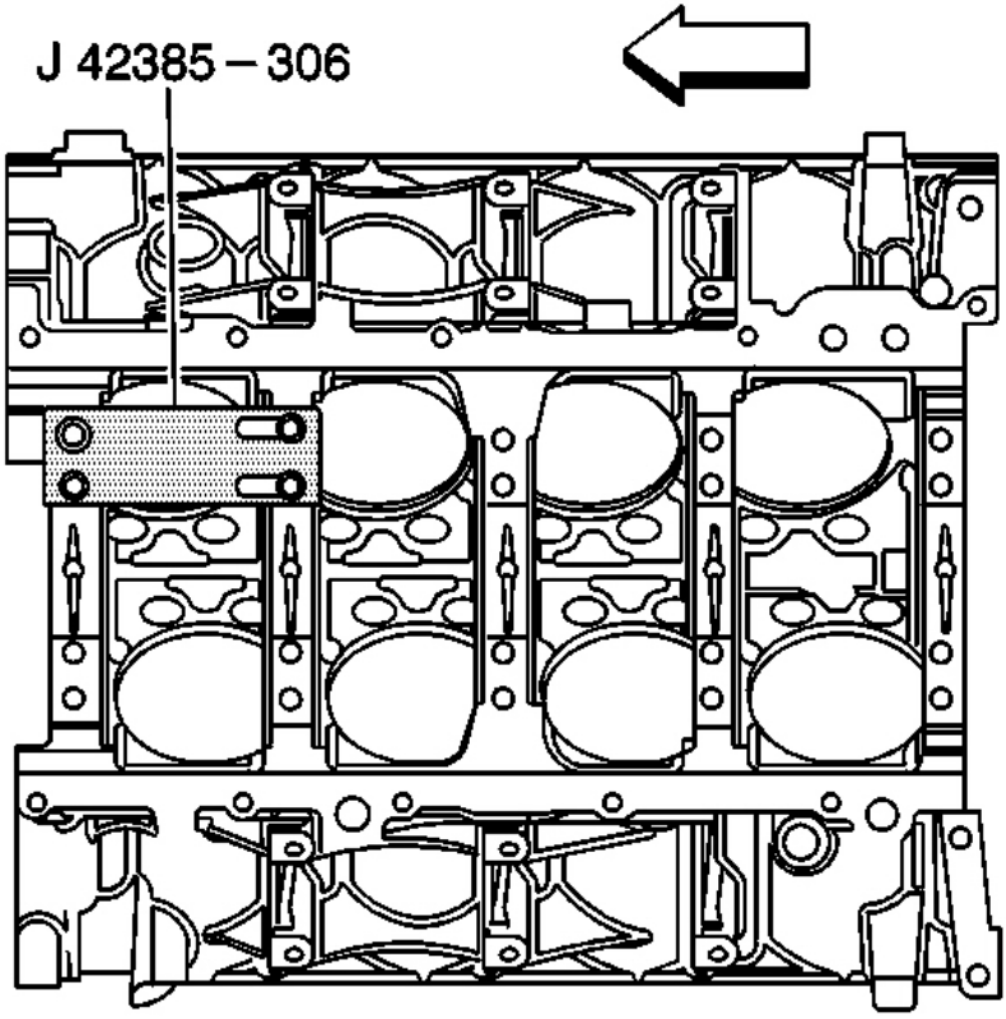


Fig. 154: View Of Fixture Plate, Bolt & Bushing
Courtesy of GENERAL MOTORS CORP.

2. Install the fixture plate, bolt, and bushing onto the engine block.

   Position the fixture plate and bushing over the hole that is to be repaired.

3. Position the alignment pin in the desired hole and tighten the fixture retaining bolts.

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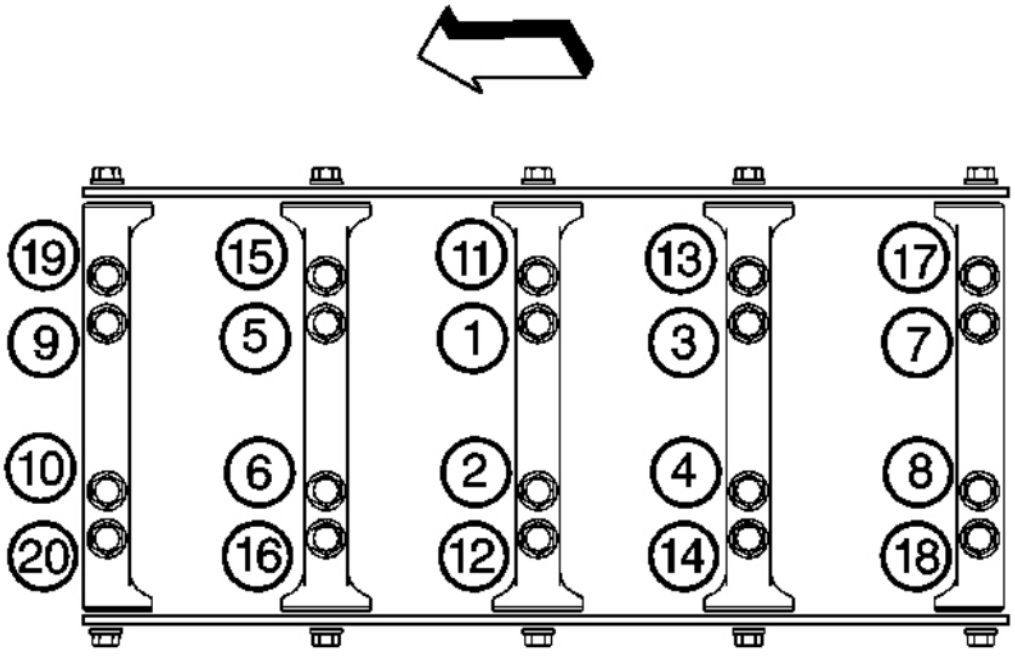


Fig. 155: Crankshaft Main Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

4. Drill out the damaged hole.

   The outer bolt hole locations 11-20 have the shallower counterbores. Use sleeve J 42385-316 with the drill.

   Drill until the stop collar of the drill bit or the sleeve contacts the bushing.

5. Using compressed air, clean out any chips.

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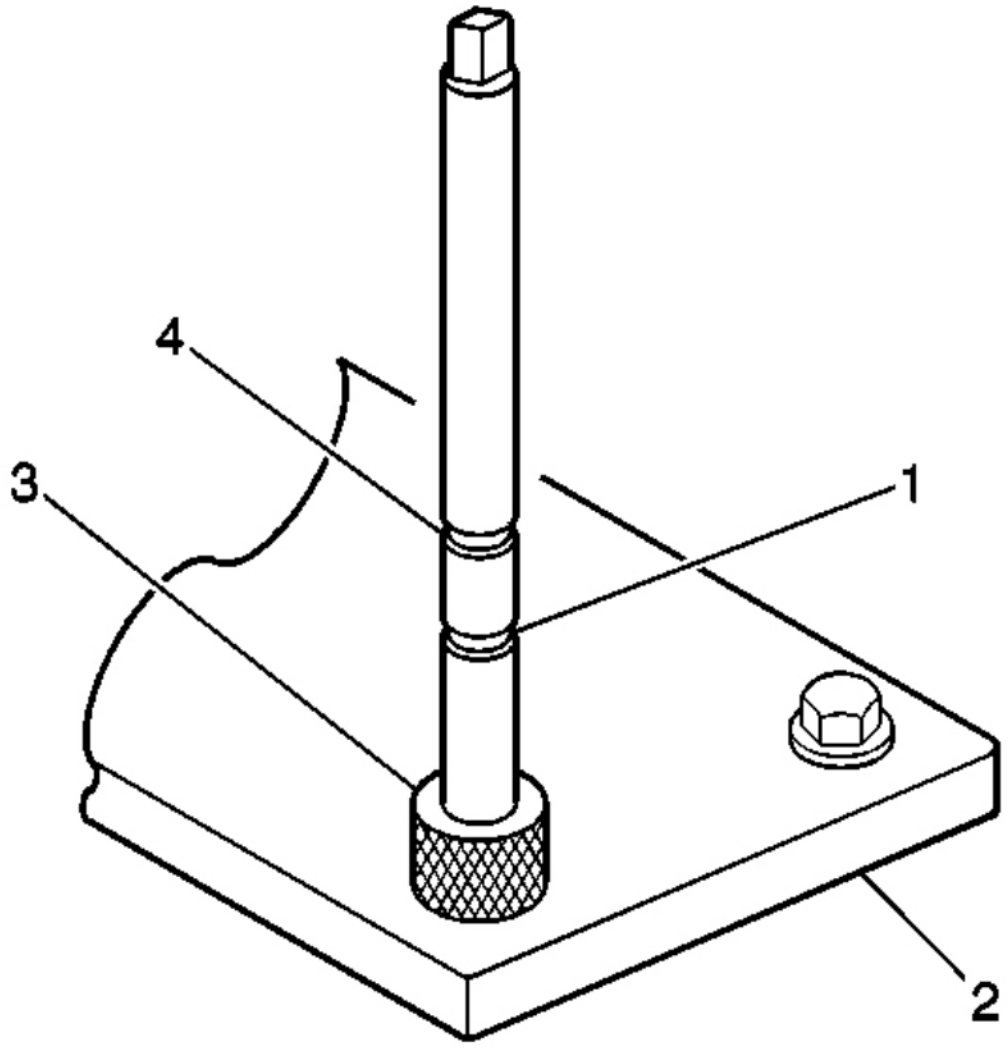


Fig. 156: View Of Tap Upper & Lower Marks, Fixture Plate & Bushing
Courtesy of GENERAL MOTORS CORP.

6. Using a tap wrench, tap the threads of the drilled hole.

   In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark on the tap aligns with the top of the bushing.

   For the deeper main cap holes 1-10, rotate the tap until the upper mark (4) on the tap aligns with the top of the bushing (3).

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For the shallower main cap holes 11-20, rotate the tap until the lower mark (1) on the tap aligns with top of the bushing (3).

7. Using compressed air, clean out any chips.
8. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), or equivalent, into the hole.
9. Using compressed air, clean any cutting oil and chips out of the hole.

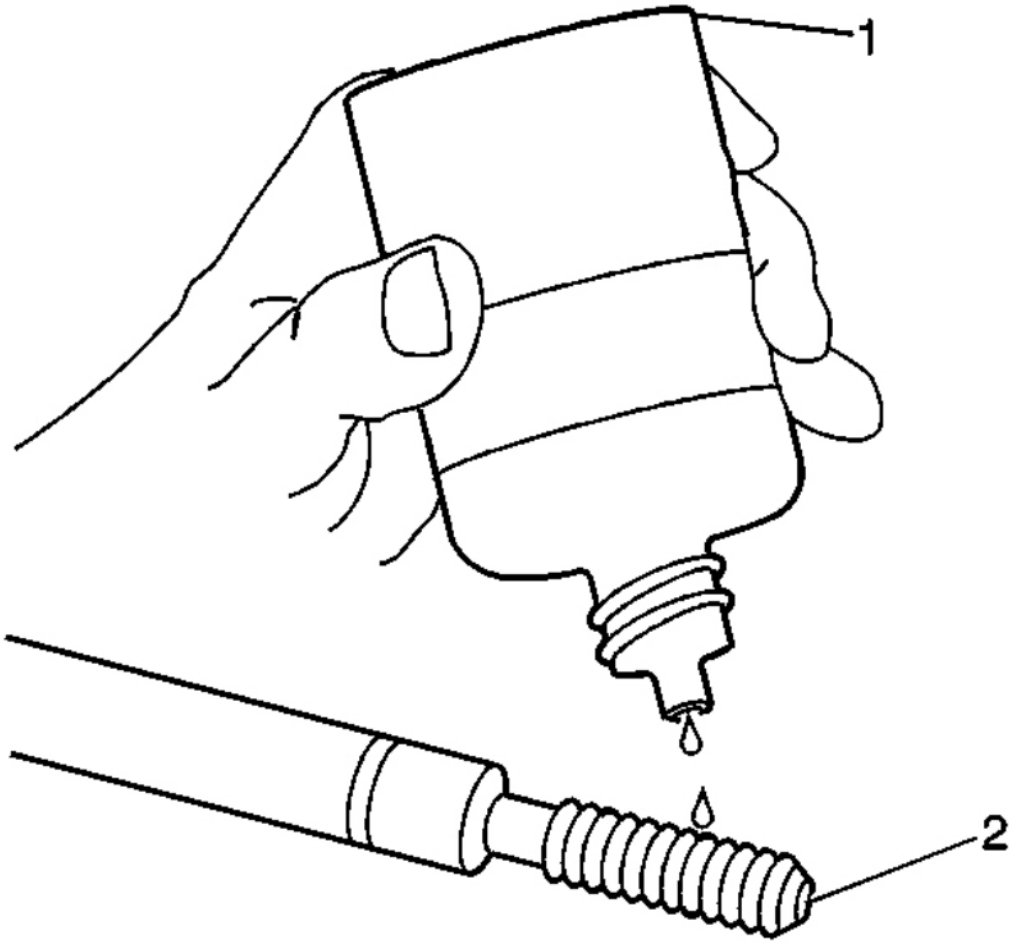


Fig. 157: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not allow oil or foreign material to contact the OD of the insert.

10. Lubricate the threads of the installer tool (2) with the driver oil (1).

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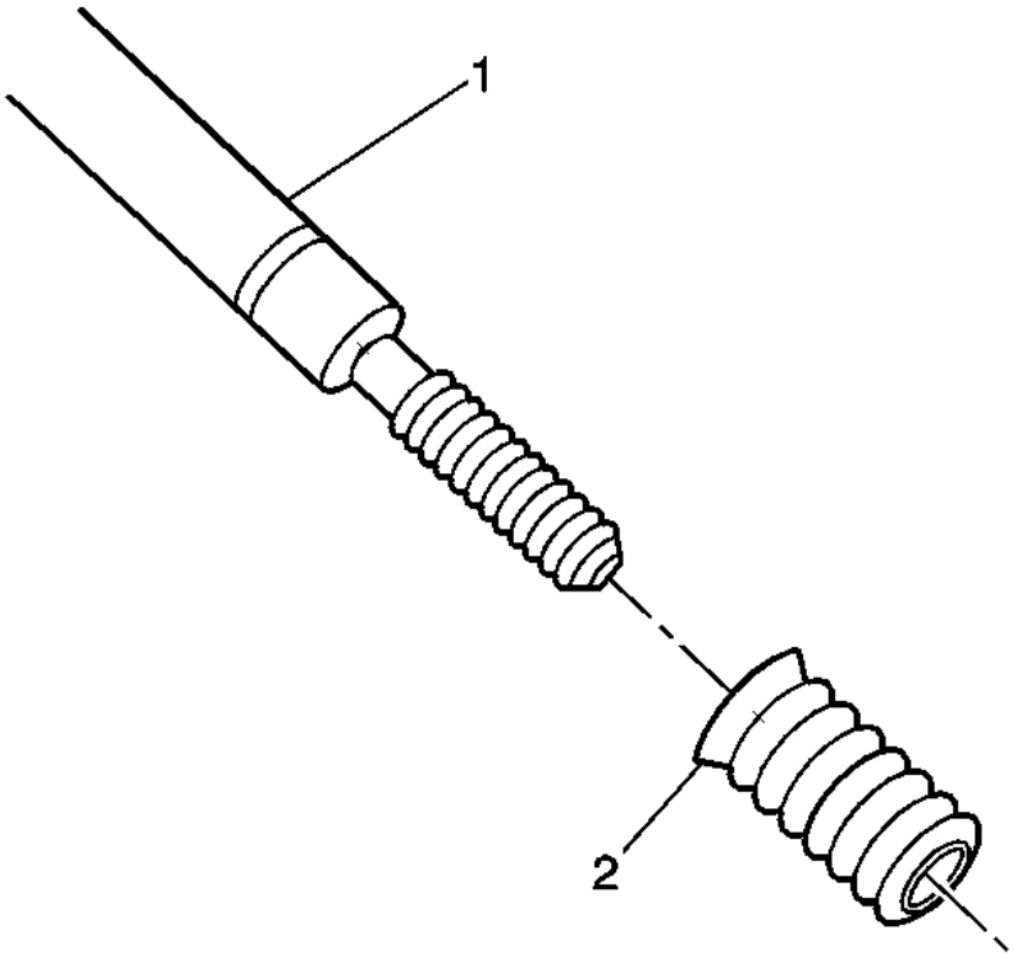


Fig. 158: View of Bushing Type Insert
Courtesy of GENERAL MOTORS CORP.

11. Install the insert (2) onto the driver tool (1).

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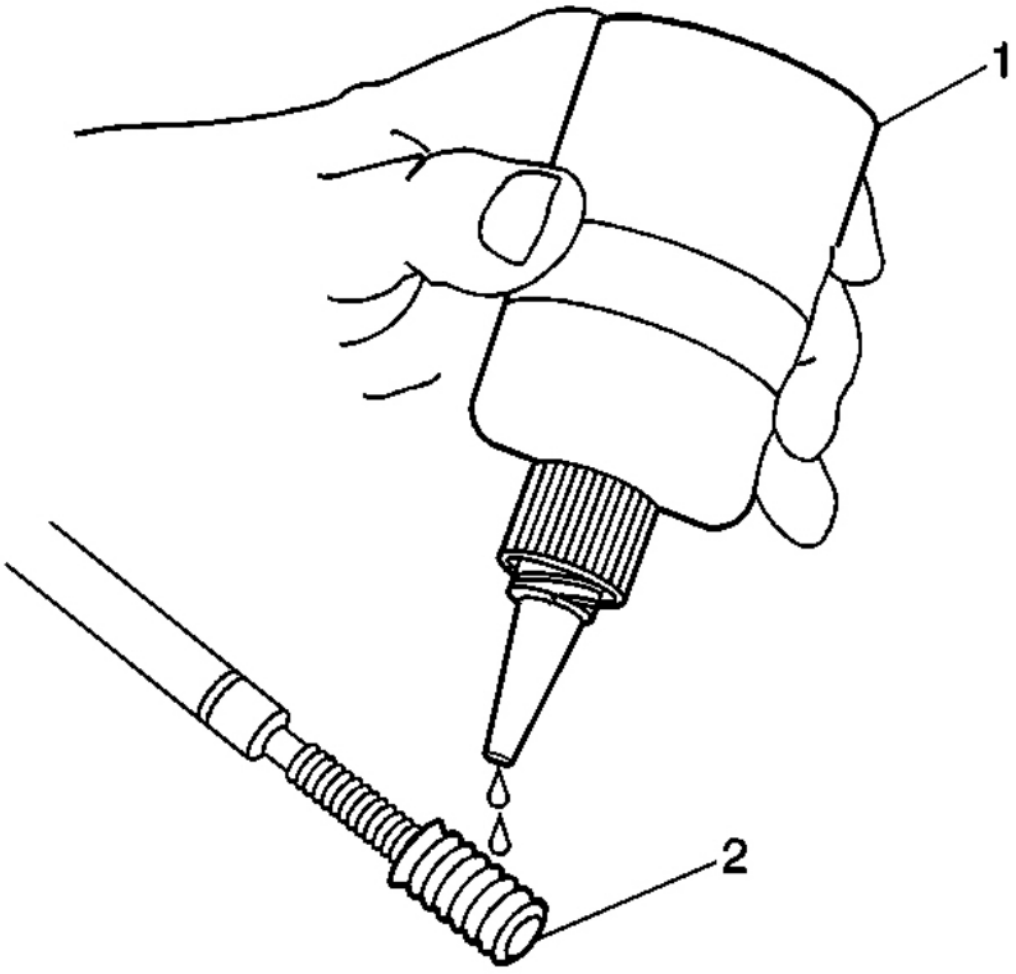


Fig. 159: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

12. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).

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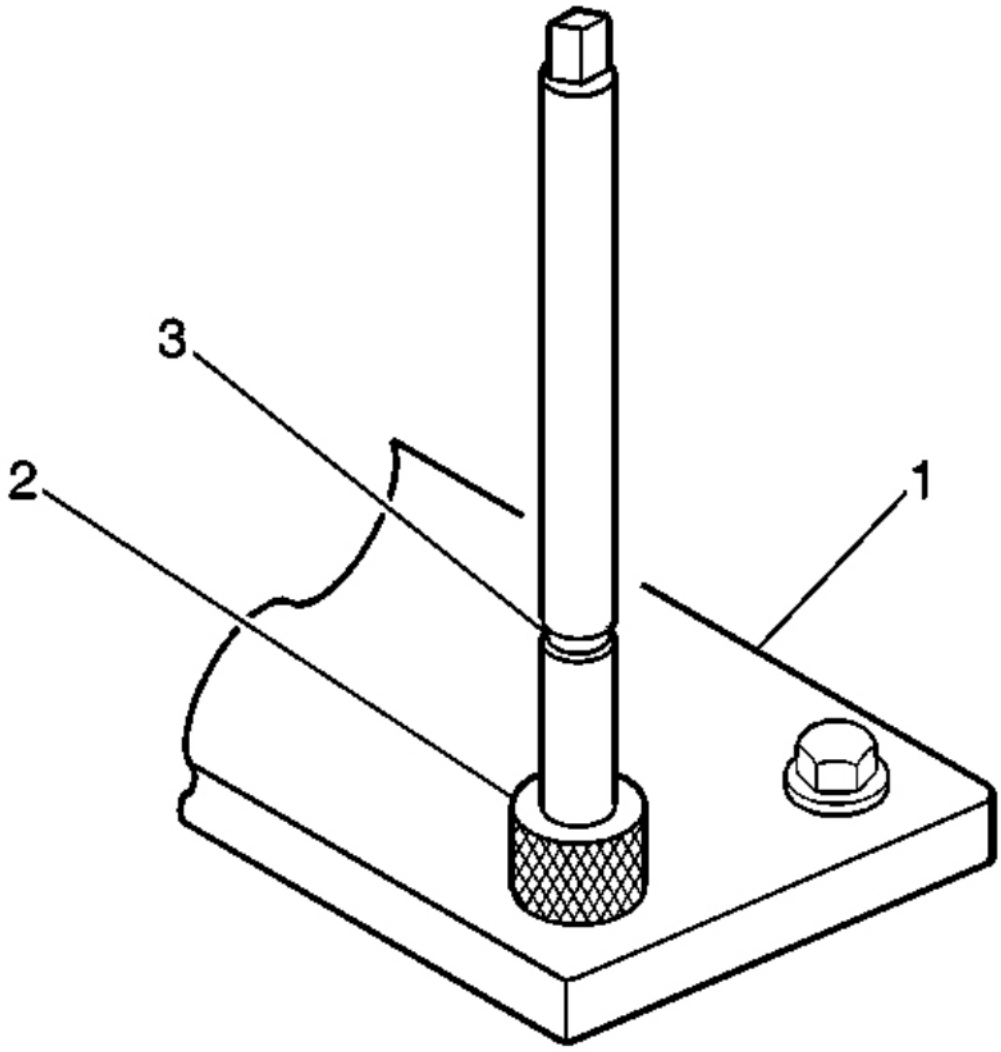


Fig. 160: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The fixture plate and bushing remains installed onto the engine block during the insert installation procedure.

13. Install the insert and driver (1) through the fixture plate and bushing and into the hole.

    Rotate the driver tool until the mark on the tool (3) aligns with the top of the bushing (2).

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The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

SERVICE PRIOR TO ASSEMBLY

- Dirt or debris will cause premature wear of the rebuilt engine. Clean all components. Refer to **Cleanliness and Care** .
- Use the proper tools to measure components when inspecting for excessive wear. Components that are not within the manufacturers specifications must be repaired or replaced.
- When the components are installed into an engine, return the components to their original location, position and direction. Refer to **Separating Parts** .
- During assembly, lubricate all moving parts with clean engine oil. This provides initial lubrication when the engine is first started.

ENGINE BLOCK PLUG INSTALLATION

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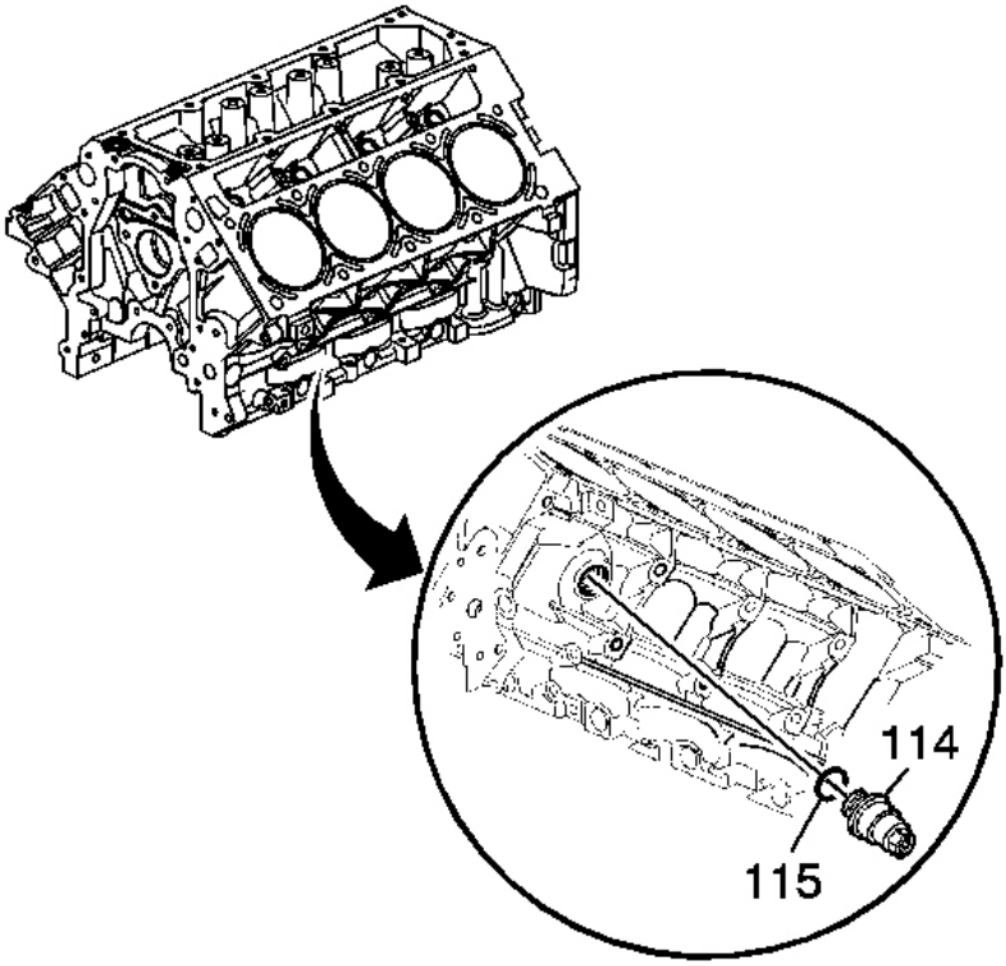


Fig. 161: Identifying Engine Block Coolant Heater
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Engine block plug, oil gallery, and coolant sealing washers may be used again if not bent, scored or otherwise damaged.

1. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block coolant heater sealing washer (115), if applicable. Refer to **Sealers, Adhesives, and Lubricants** .

NOTE: Refer to Fastener Notice .

2. Install the engine block coolant heater (114) to the engine block.

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Tighten: Tighten the engine block coolant heater to 50 N.m (37 lb ft).

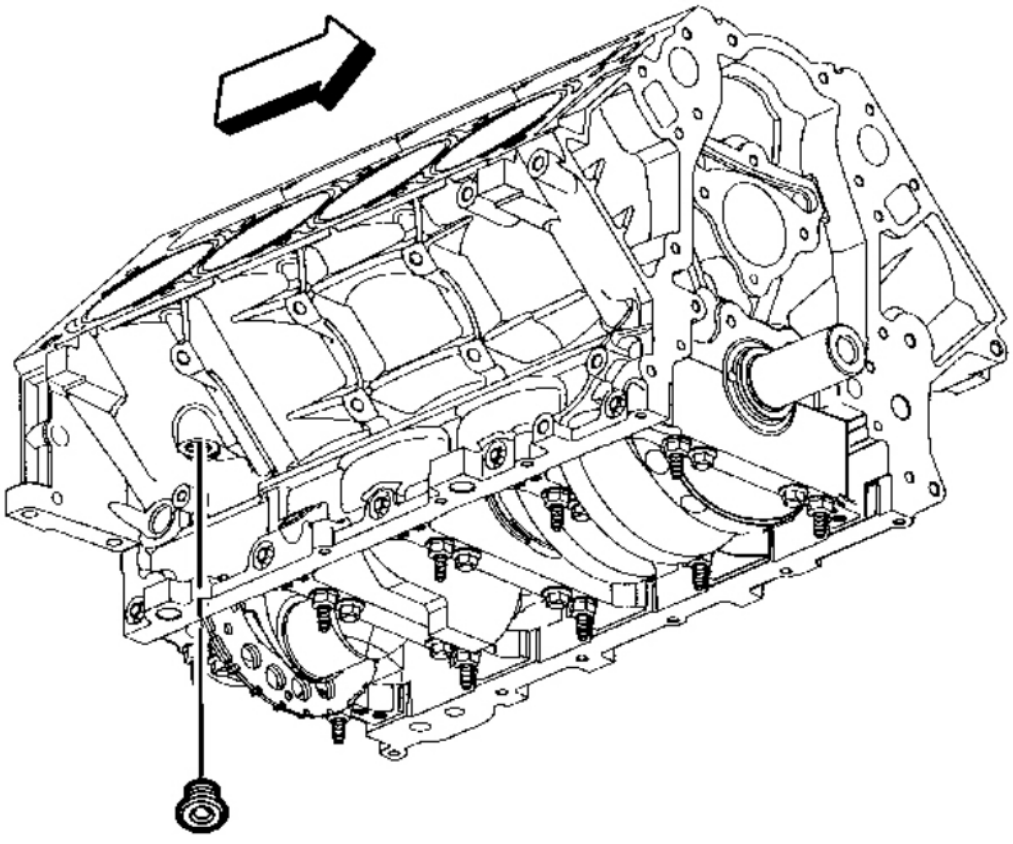


Fig. 162: Identifying Plug Location On Underside Of Block
Courtesy of GENERAL MOTORS CORP.

3. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block right rear coolant drain hole plug sealing washer.
4. Install the engine block right rear coolant drain hole plug.

Tighten: Tighten the engine block right rear coolant drain hole plug to 60 N.m (44 lb ft).

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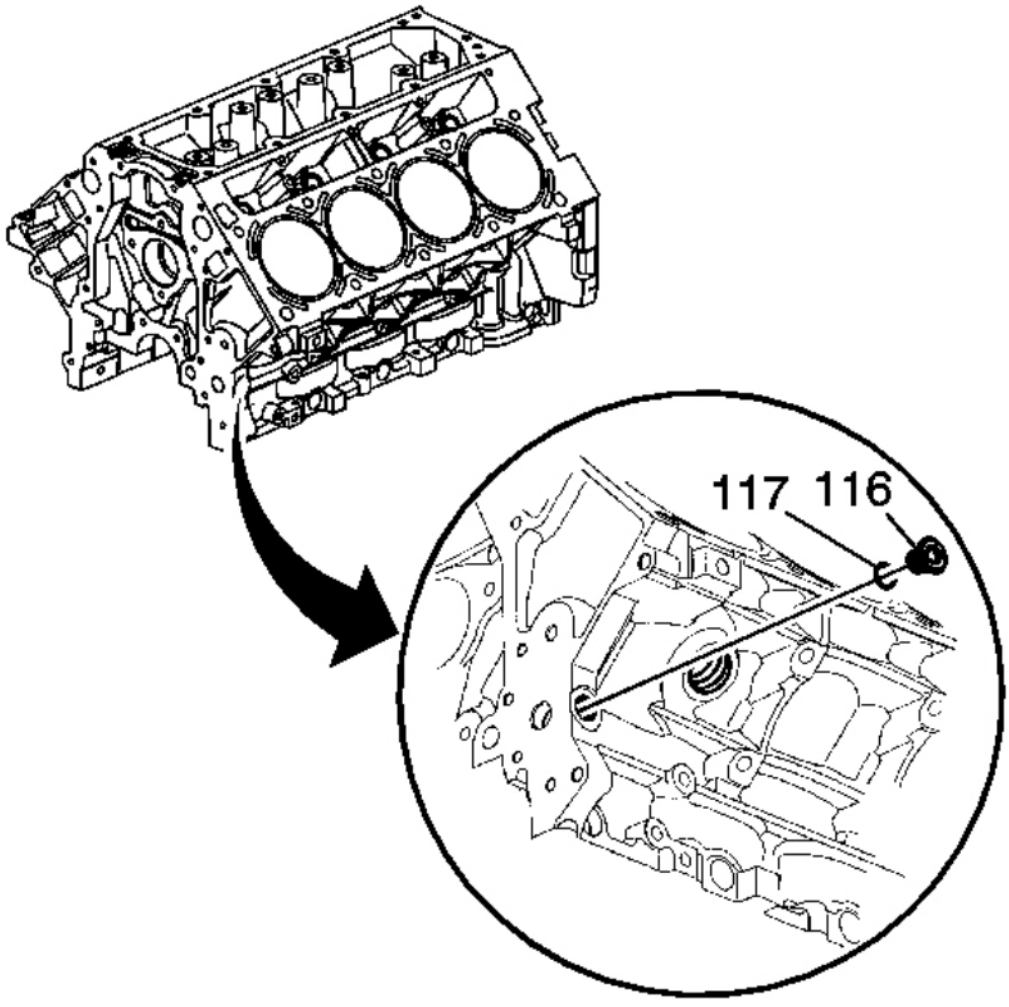


Fig. 163: Locating Engine Block Left Front Oil Gallery Plug & Seal
Courtesy of GENERAL MOTORS CORP.

5. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left front oil gallery plug sealing washer (117).
6. Install the engine block left front oil gallery plug (116).

Tighten: Tighten the engine block left front oil gallery plug to 60 N.m (44 lb ft).

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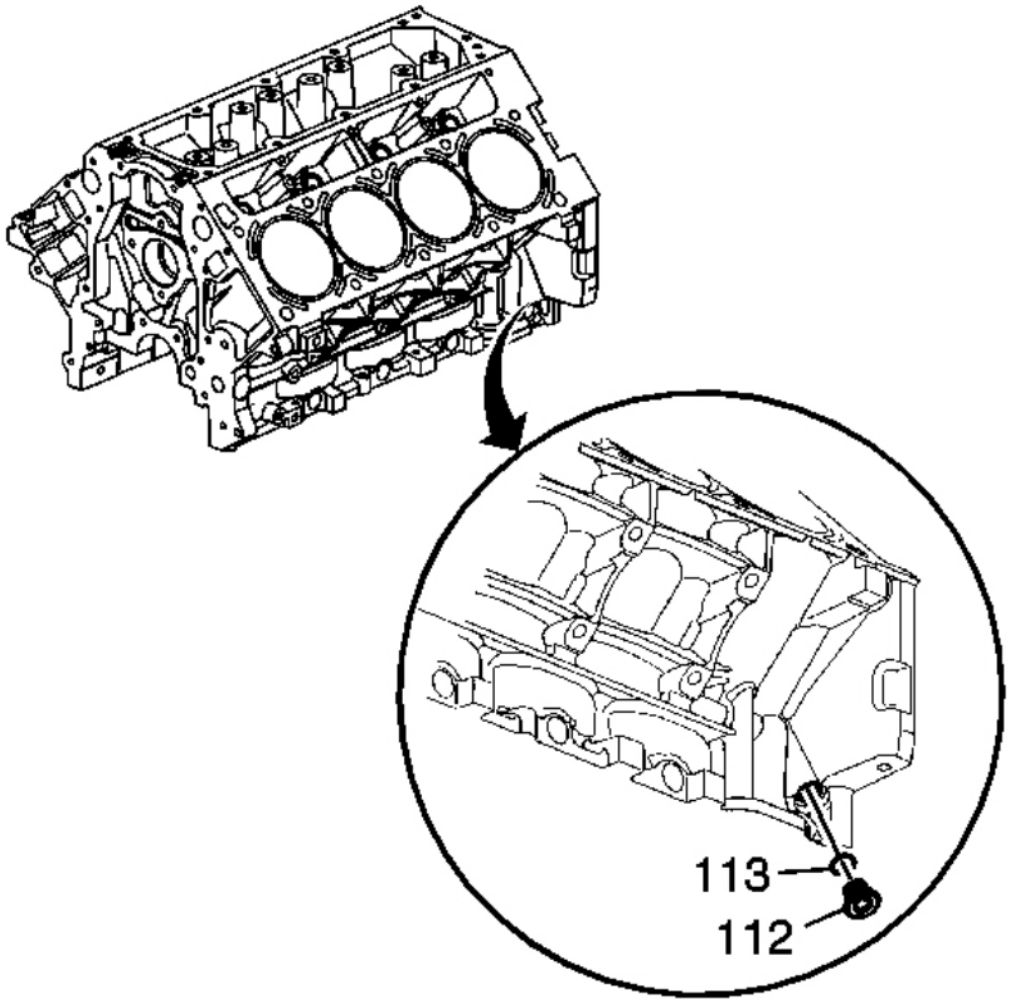
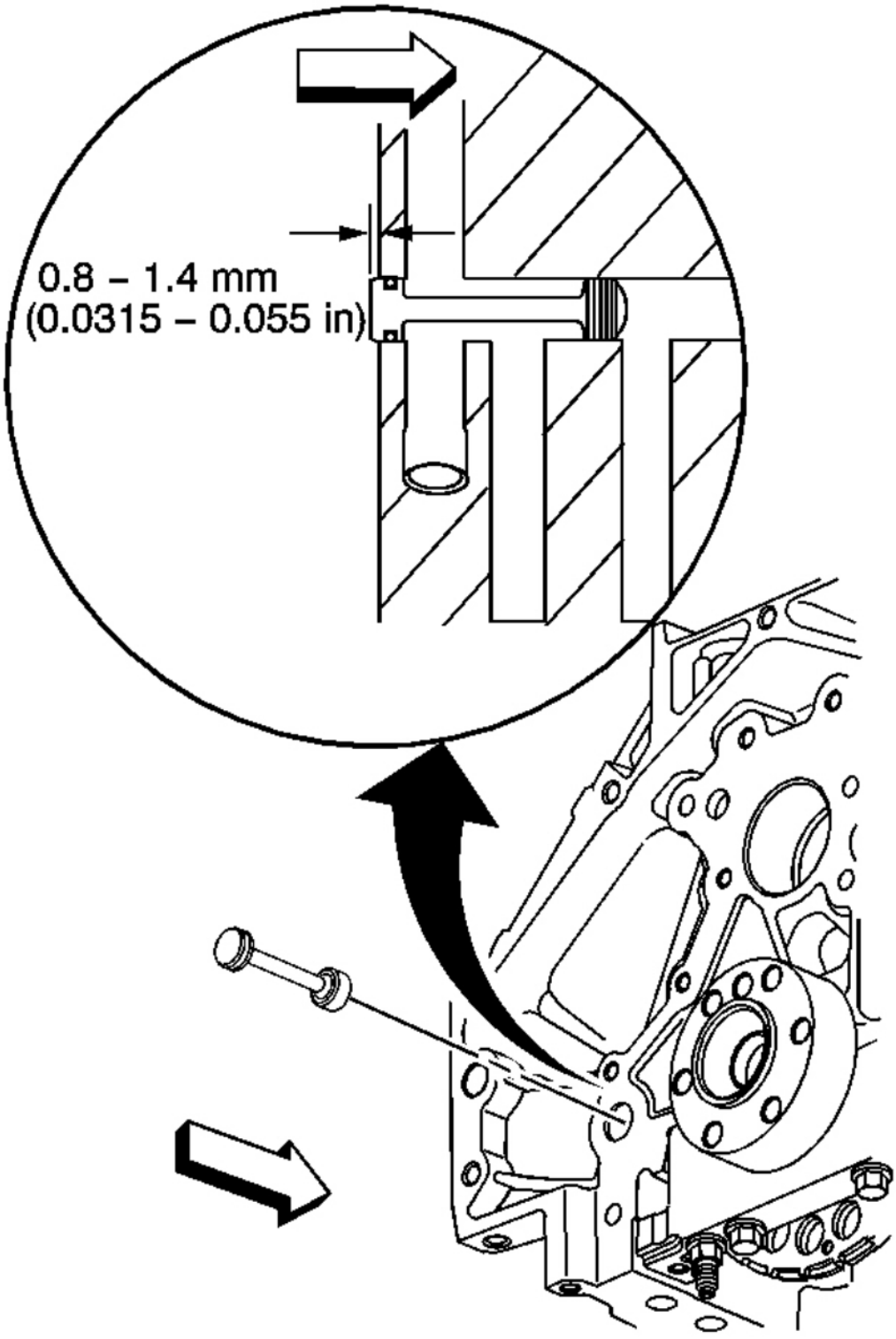


Fig. 164: Locating Engine Block Left Rear Oil Gallery Plug & Seal
Courtesy of GENERAL MOTORS CORP.

7. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left rear oil gallery plug sealing washer (113).
8. Install the engine block left rear oil gallery plug (112).

Tighten: Tighten the engine block left rear oil gallery plug to 60 N.m (44 lb ft).

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Fig. 165: View Of Engine Block Rear Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

9. Inspect the engine block rear oil gallery plug and O-ring seal. If the O-ring seal on the plug is not cut or damaged, the rear oil gallery plug may be used again.
10. Lubricate the O-ring seal with clean engine oil.
11. Install the O-ring seal onto the plug.
12. Install the engine block rear oil gallery plug into the oil gallery bore. A properly installed block plug will protrude 0.8-1.4 mm (0.0315-0.055 in) beyond the rear face of the block.

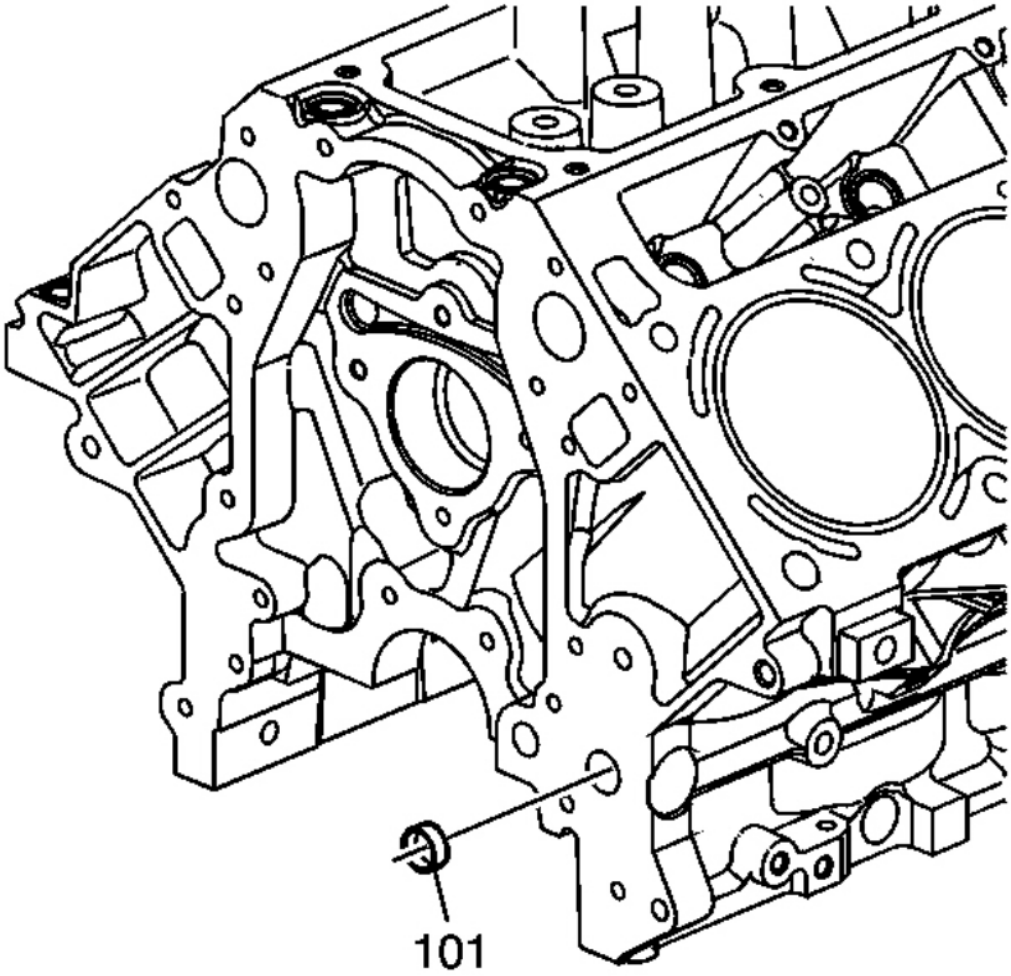


Fig. 166: View Of Engine Block Front Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

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13. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489) to the sides of the NEW front oil gallery plug (101).

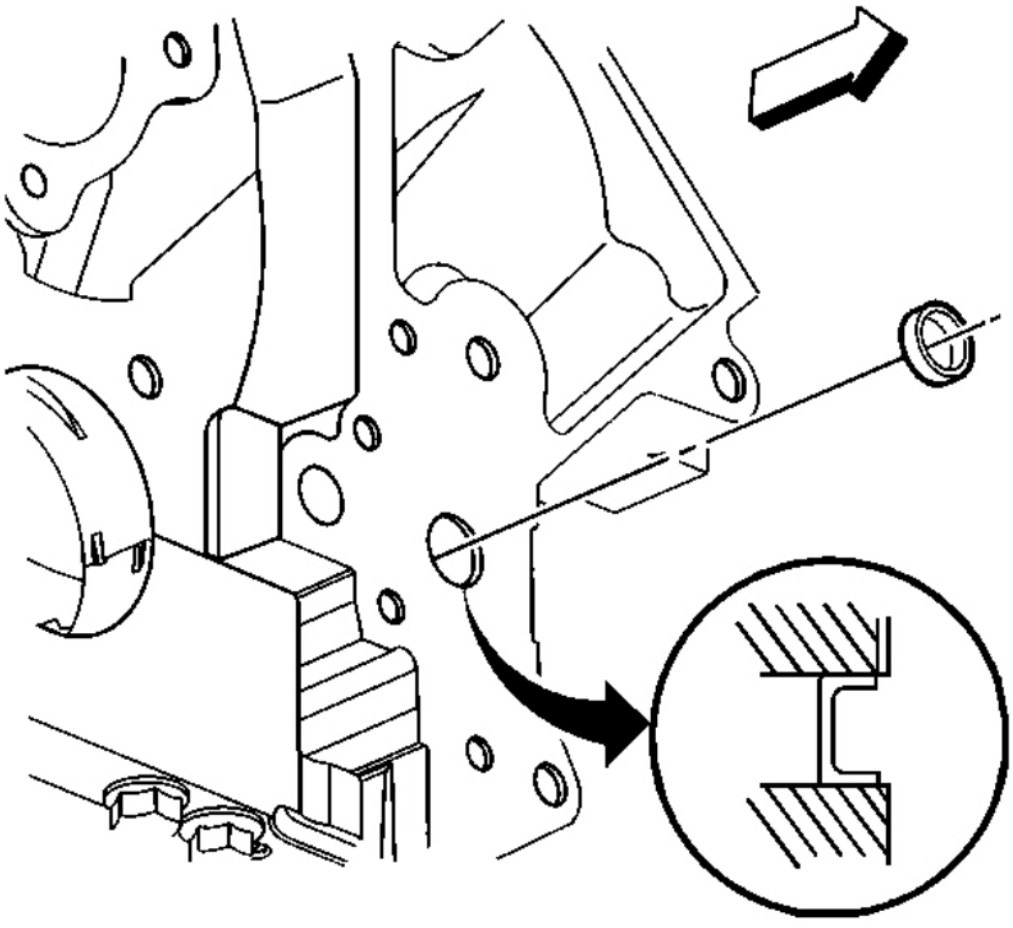


Fig. 167: View Of Engine Block Front Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

14. Install a NEW engine block front oil gallery plug. Install the plug into the oil gallery bore 2.2-2.8 mm (0.0086-0.011 in) below flush.

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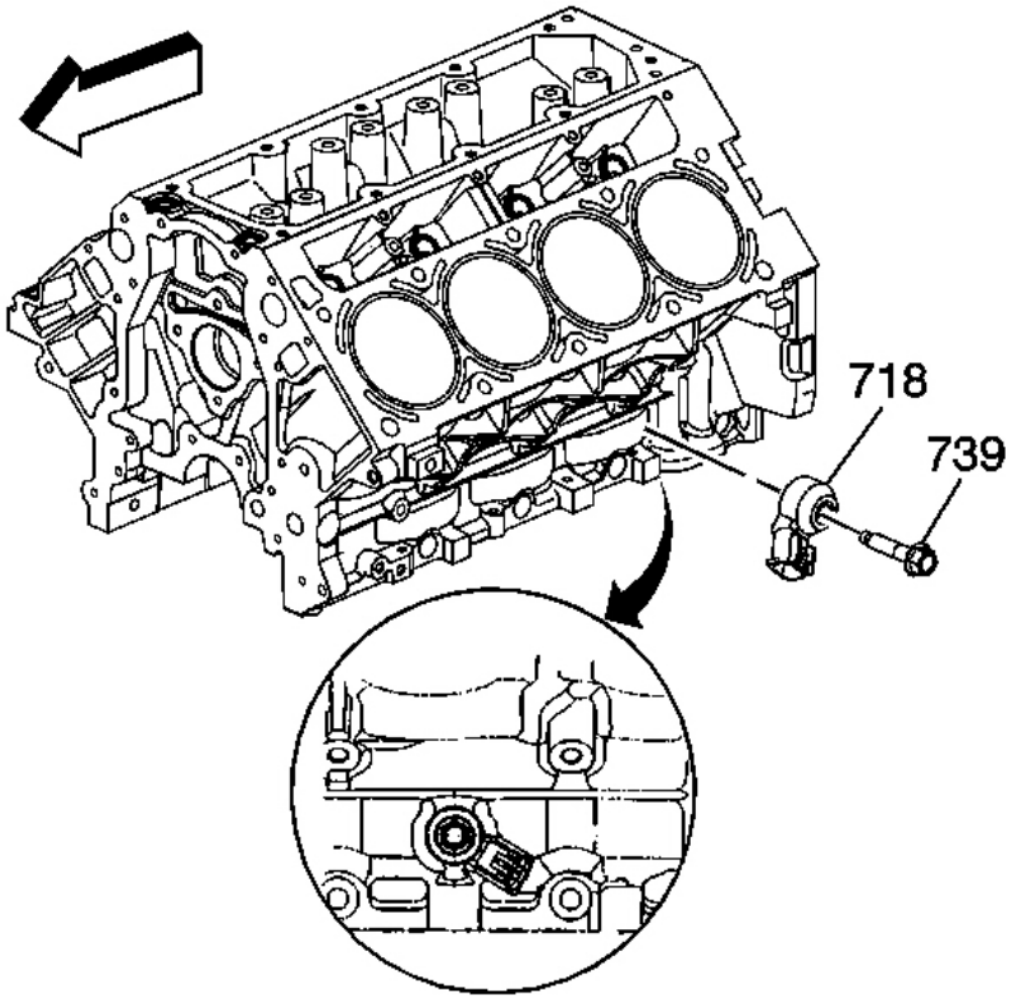


Fig. 168: Left Side Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

15. Install the left side knock sensor (718) and bolt (739).

    Tighten: Tighten the bolt to 20 N.m (15 lb ft).

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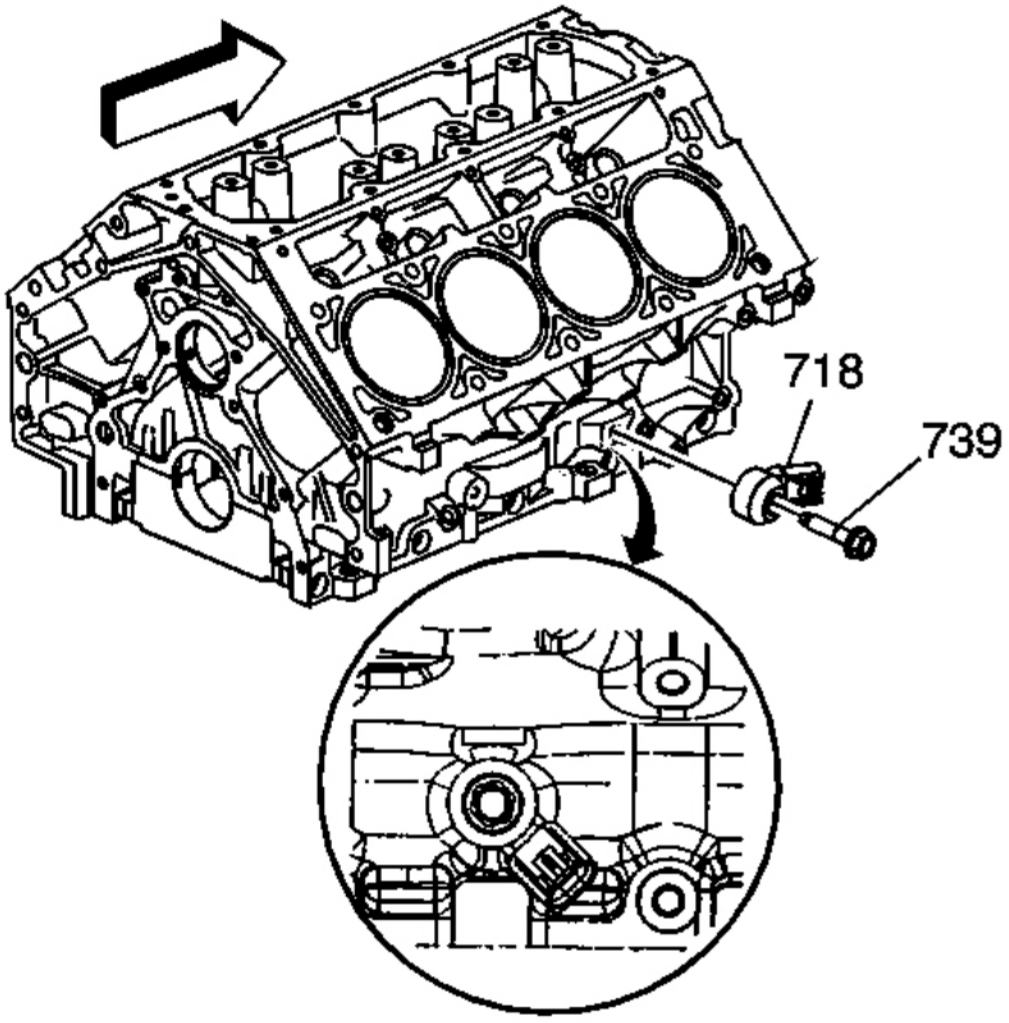


Fig. 169: Right Side Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

16. Install the right side knock sensor (718) and bolt (739).

    Tighten: Tighten the bolt to 20 N.m (15 lb ft).

CRANKSHAFT AND BEARINGS INSTALLATION

TOOLS REQUIRED

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J 45059 Angle Meter. See **Special Tools** .

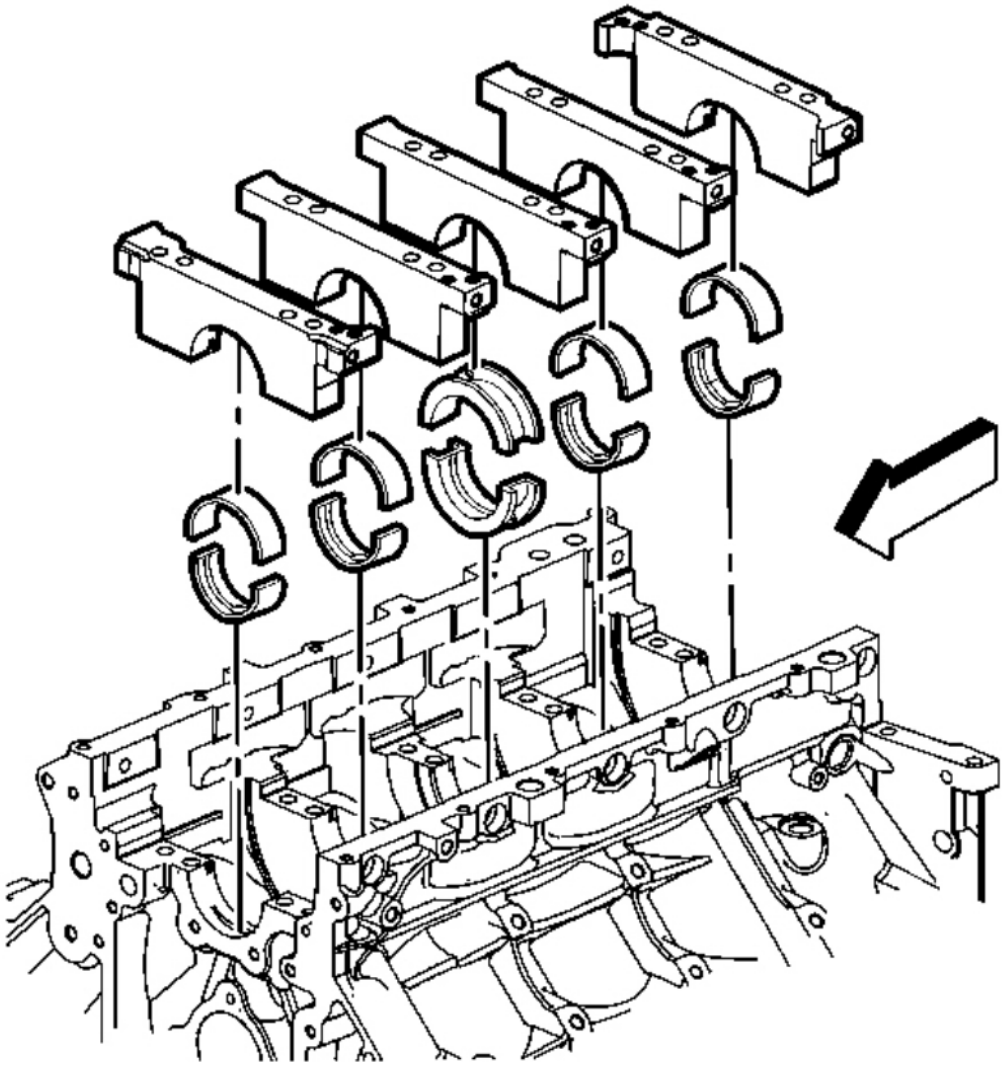


Fig. 170: View Of Crankshaft Bearings & Bearing Caps
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Crankshaft bearing clearances are critical. Excessive crankshaft bearing clearance may affect crankshaft position (CKP) sensor signals and/or on-board diagnostic (OBD) II system performance.**
- **Crankshaft bearing caps must be installed to the proper location and**

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direction.

- **When installing the crankshaft bearings, align the locating tabs on the bearings with the locating notches in the engine block journal bore and the bearing cap.**
- **Always install crankshaft bearings with their machined partner. Do not file bearings or mix bearing halves.**
- **In order to prevent engine block oil leakage, install NEW M8 crankshaft bearing cap side bolts.**

  The crankshaft bearing cap M8 side bolts have a pre-applied sealant patch applied to the bolt flange.

1. Install the crankshaft bearings to the engine block and bearing caps. The thrust bearings are to be installed into center journal.
2. Lubricate the bearing surfaces and crankshaft journals with clean engine oil.

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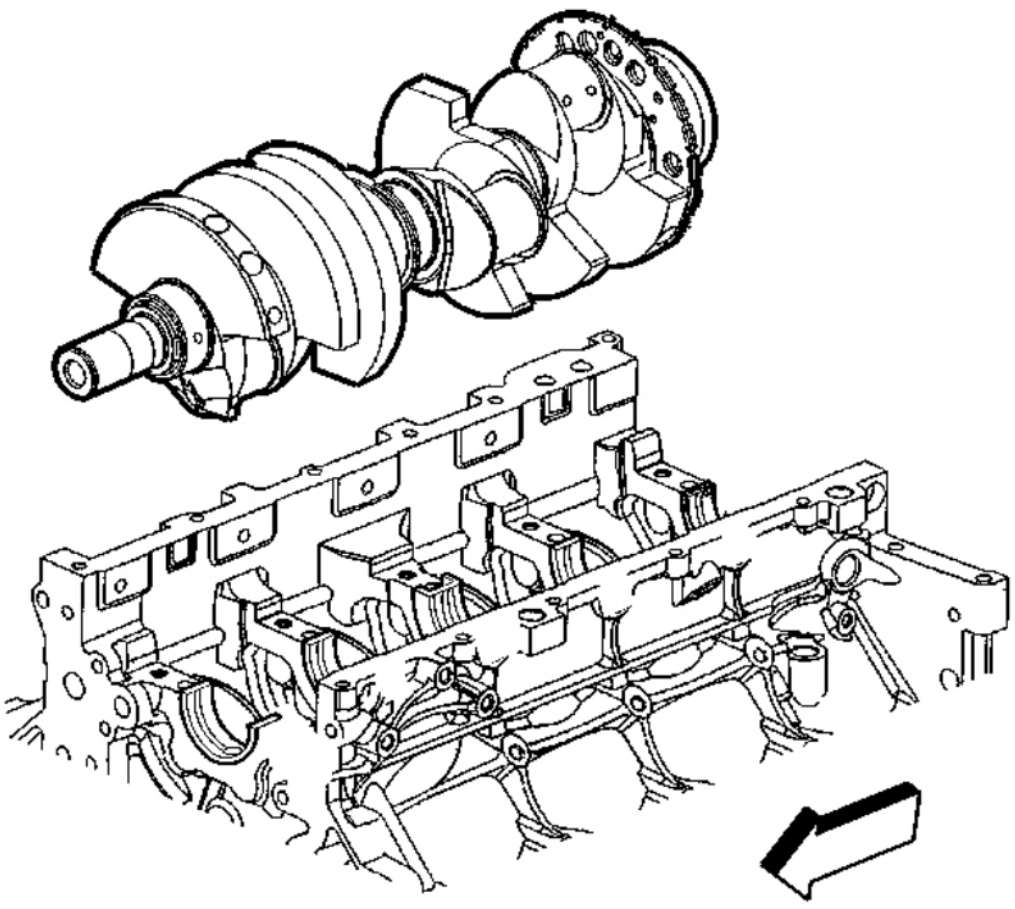


Fig. 171: View Of Crankshaft & Engine Block
Courtesy of GENERAL MOTORS CORP.

NOTE: To maintain proper crankshaft end play, use extreme care during crankshaft installation. Avoid scoring or damaging the thrust bearing.

3. Install the crankshaft.

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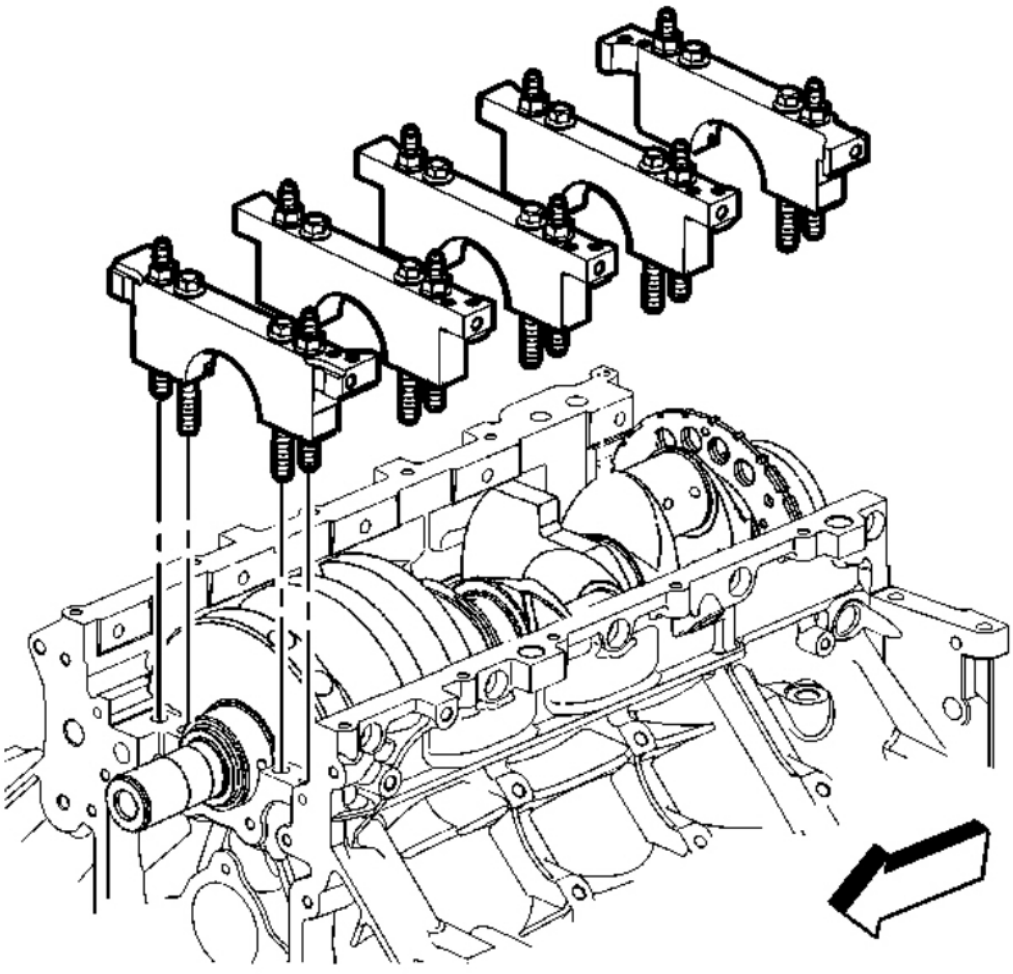


Fig. 172: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The bearing caps must be installed in the proper location and direction.

4. Install the crankshaft bearing caps, with bearings, into the engine block.

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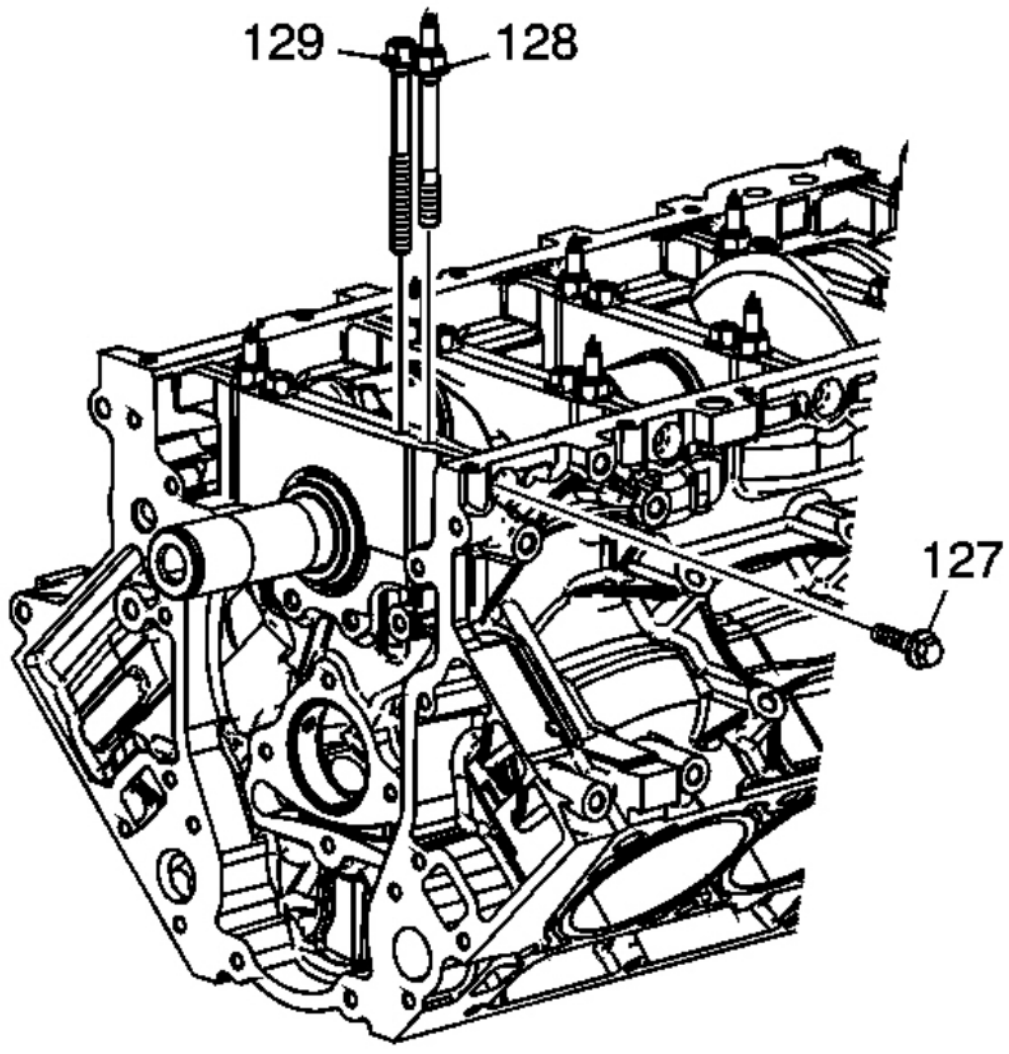


Fig. 173: View Of M10 Bolts, Studs & M8 Bearing Cap Side Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the M10 bolts (129) and studs (128).
6. Using a plastic-face hammer, tap the bearing caps into place.
7. Install the NEW M8 bearing cap side bolts (127).

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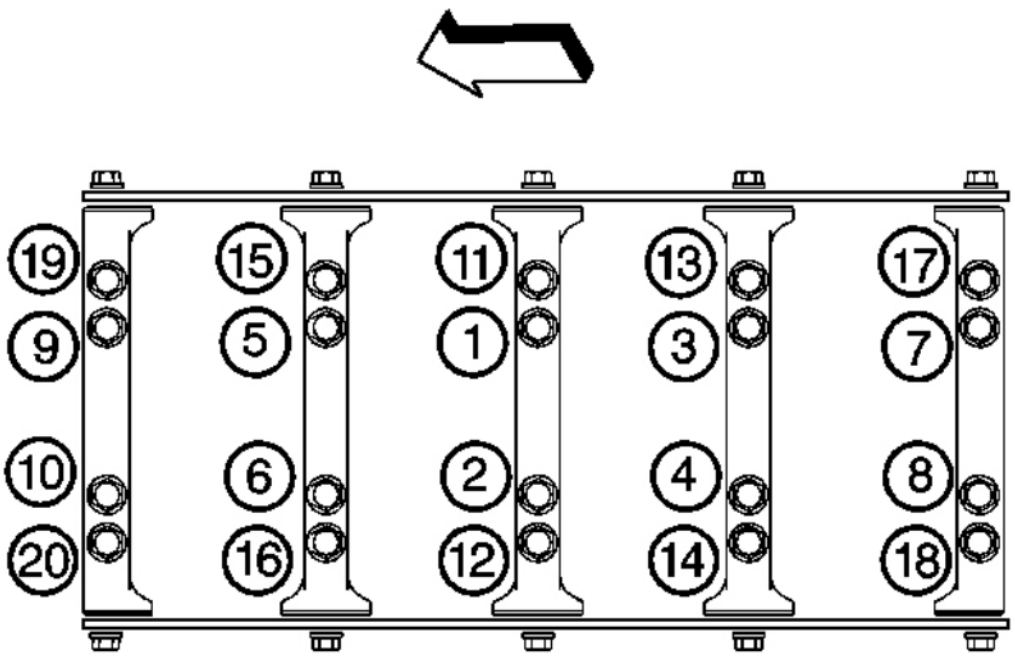


Fig. 174: Crankshaft Main Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice .**

8. Tighten the bearing cap M10 bolts (1-10).

   Tighten: Tighten the M10 bearing cap bolts (1-10) a first pass in sequence to 20 N.m (15 lb ft).

   IMPORTANT: To properly align the crankshaft thrust bearings, the final thrust of the crankshaft MUST be in the forward direction.

9. Using a plastic-face hammer, tap the crankshaft rearward, then forward in order to align the thrust bearings.

   Tighten:

   1. Tighten the M10 bolts (1-10) a final pass in sequence 80 degrees using the **J 45059** . See **Special Tools** .
   2. Tighten the M10 studs (11-20) a first pass in sequence to 20 N.m (15 lb ft).
   3. Tighten the M10 studs (11-20) a final pass in sequence 51 degrees using the **J 45059** . See **Special Tools**

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4. Tighten the bearing cap side M8 bolts to 25 N.m (18 lb ft).

   Tighten the bolt on 1 side of the bearing cap and then tighten the bolt on the opposite side of the same bearing cap.

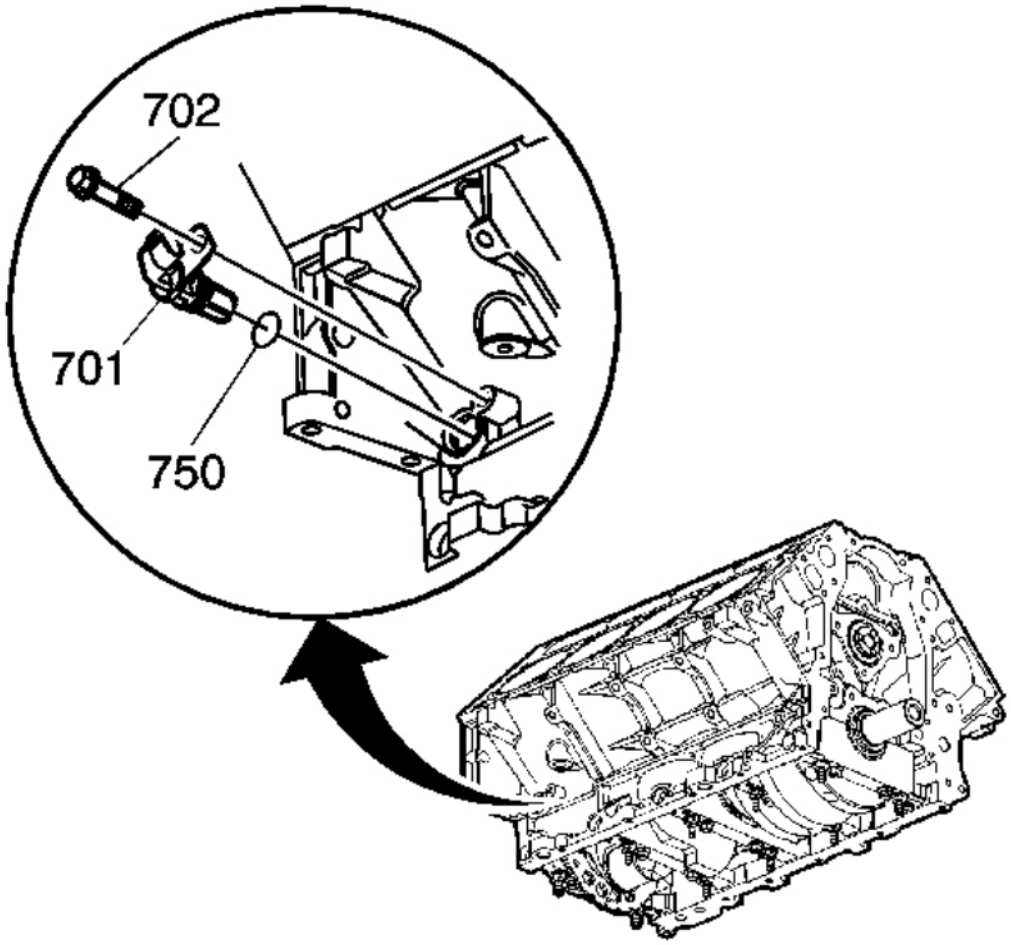


Fig. 175: CKP Sensor, Bolt & O-Ring
Courtesy of GENERAL MOTORS CORP.

10. Install the CKP sensor.
    1. Inspect the CKP sensor O-ring seal (750). If the O-ring seal is not cut or damaged, it may be used again.
    2. Coat the O-ring seal with clean engine oil.
    3. Install the O-ring onto the sensor.

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4. Install the sensor (701). Rotate the sensor until the locating hole in the bracket aligns with the bolt hole in the block.
5. Install the sensor bolt (702).

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

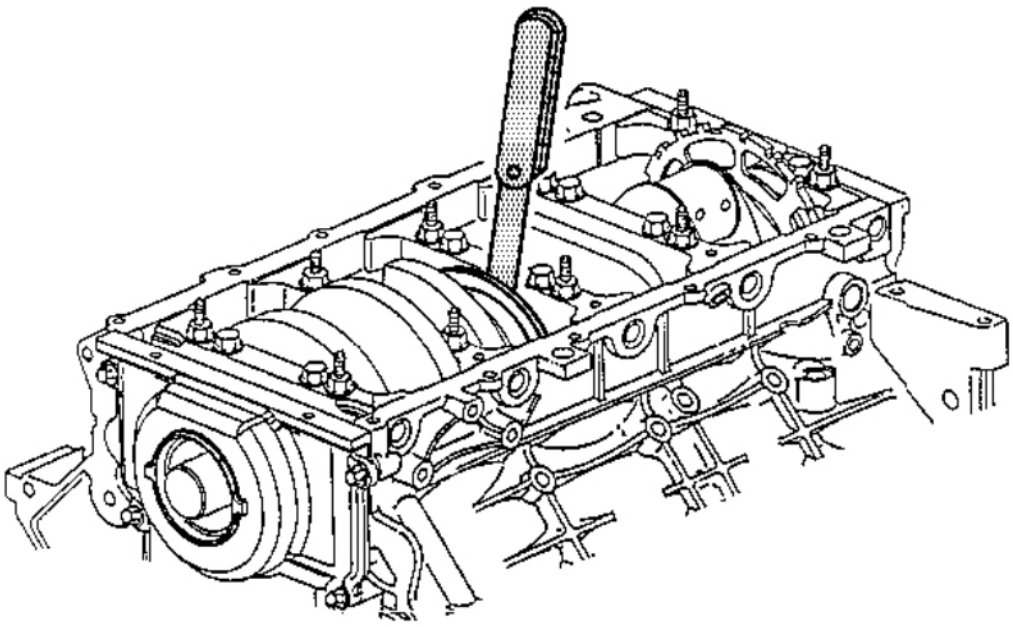


Fig. 176: Measuring Crankshaft End Play
Courtesy of GENERAL MOTORS CORP.

11. Measure the crankshaft end play.
    1. Thrust the crankshaft forward or rearward.
    2. Insert a feeler gage between the center crankshaft bearing and the bearing surface of the crankshaft and measure the bearing clearance.

       The proper crankshaft end play clearance is 0.04-0.2 mm (0.0015-0.0078 in).

    3. If the bearing clearance is not within specifications, inspect the thrust surfaces for nicks, gouges or raised metal. Minor imperfections may be removed with a fine stone.

PISTON, CONNECTING ROD, AND BEARING INSTALLATION

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Tools Required

- **J 8037** Piston Ring Compressor. See **Special Tools** .
- **J 8087** Cylinder Bore Gage. See **Special Tools** .
- **J 41556** Connecting Rod Guide. See **Special Tools** .
- **J 45059** Angle Meter. See **Special Tools** .

PISTON SELECTION

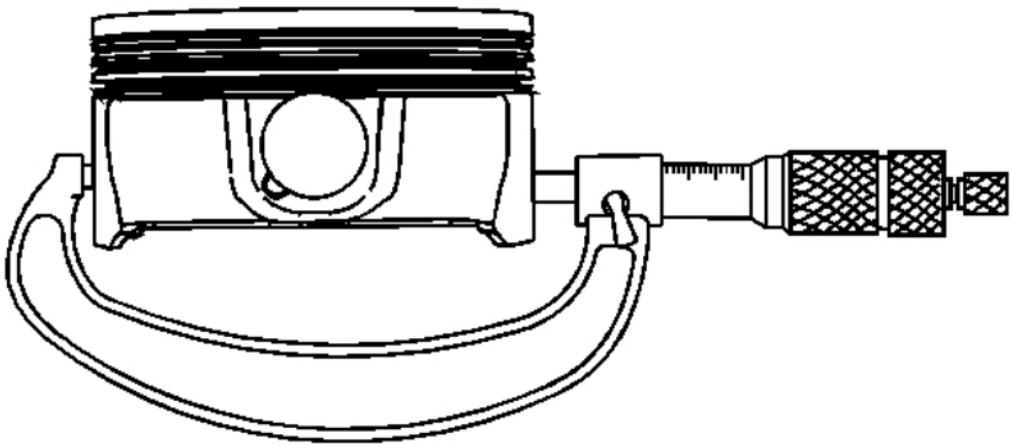


Fig. 177: Measuring Piston Outside Diameter
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Measurements of all components should be taken with the components at normal room temperature. For proper piston fit, the engine block cylinder bores must not have excessive wear or taper. A used piston, pin, and connecting rod assembly may be installed if, after inspection is within specifications.

1. With a micrometer at a right angle, measure the piston outside diameter (OD). Measure the diameter 43 mm (1.69 in) from the top of the piston. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .
2. Record the piston OD.

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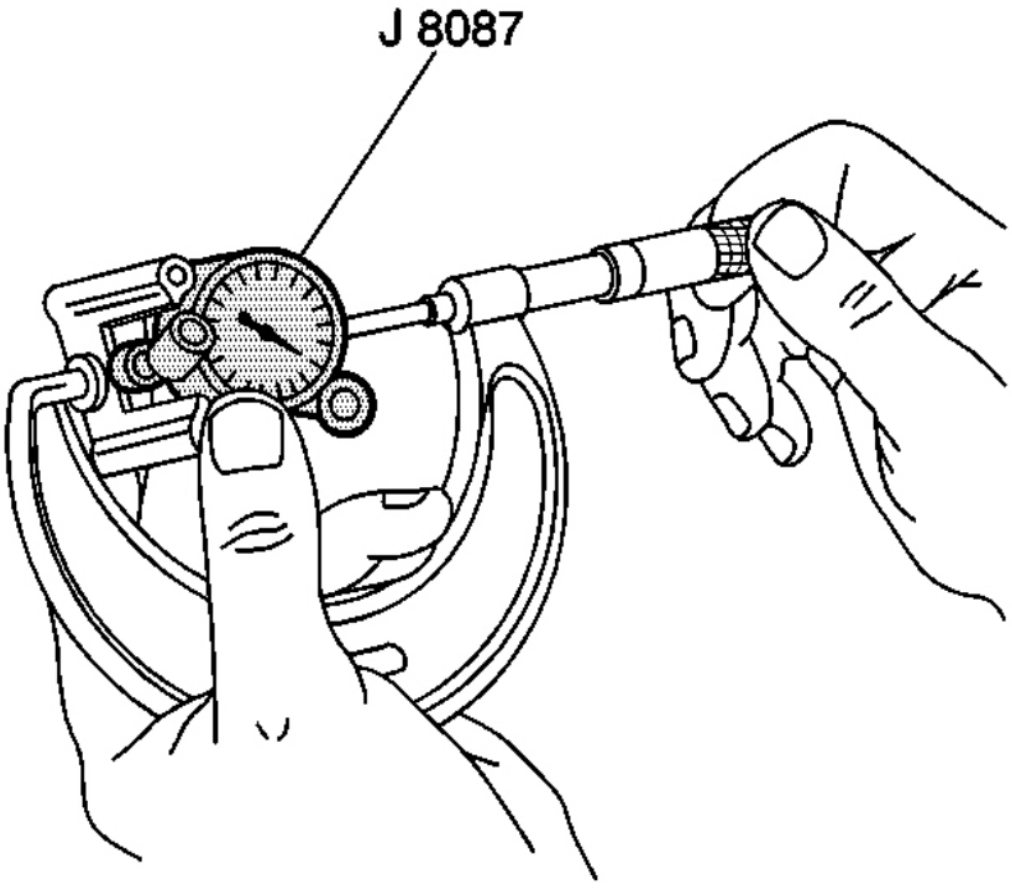


Fig. 178: Measuring Bore Gauge With Micrometer
Courtesy of GENERAL MOTORS CORP.

3. Adjust the micrometer to the recorded piston OD.
4. Insert the **J 8087** into the micrometer and zero the gage dial. See **Special Tools** .

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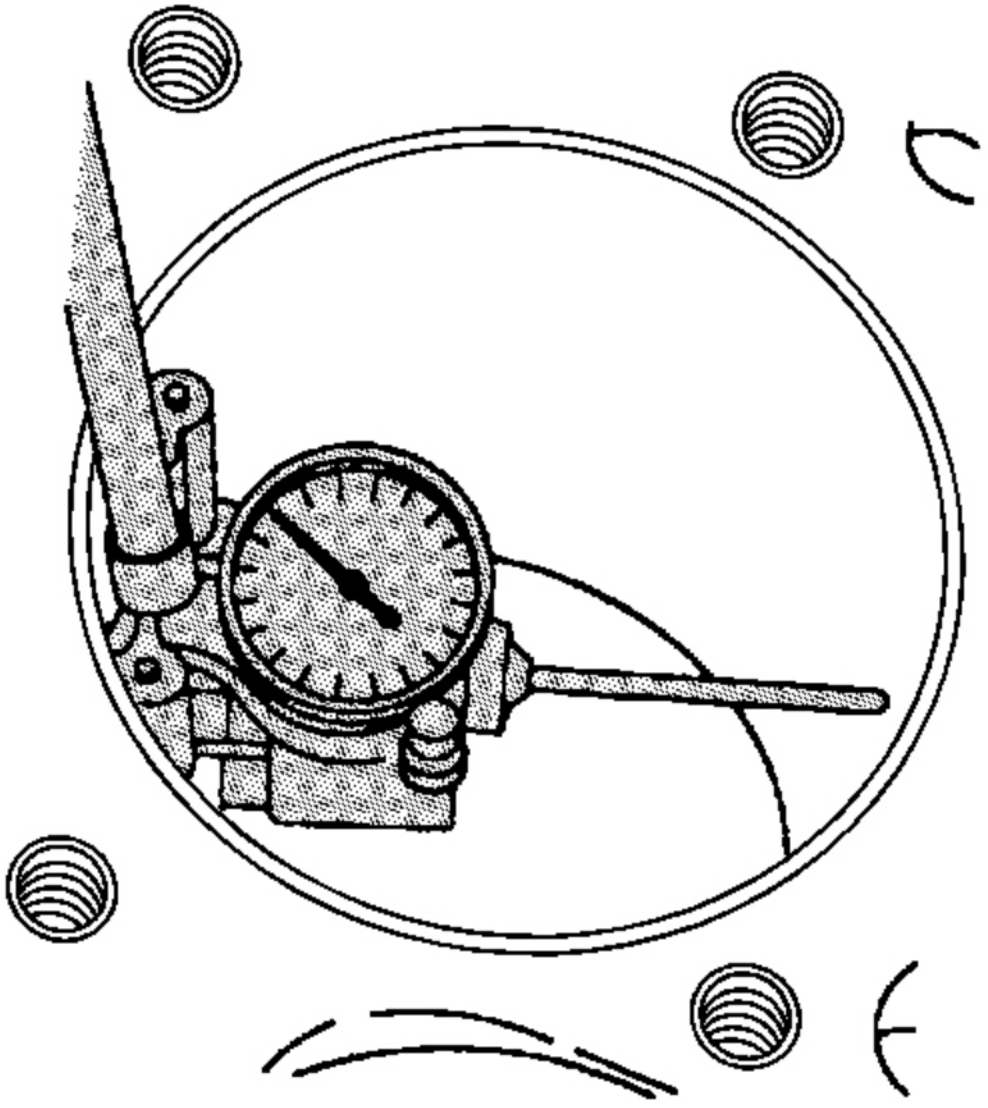


Fig. 179: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS CORP.

5. Using the **J 8087** , measure the cylinder bore inside diameter (ID). See **Special Tools** . Measure at a point 64 mm (2.5 in) from the top of the cylinder.
6. Record the cylinder bore ID.
7. Subtract the piston OD from the cylinder bore ID in order to determine the piston-to-bore clearance. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO**

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LMG VIN 0) or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

8. If the proper clearance cannot be obtained, select another piston and pin assembly and measure the clearances again. If the proper fit cannot be obtained, the cylinder bore may require honing for an oversize piston.

PISTON, PIN, AND CONNECTING ROD INSTALLATION

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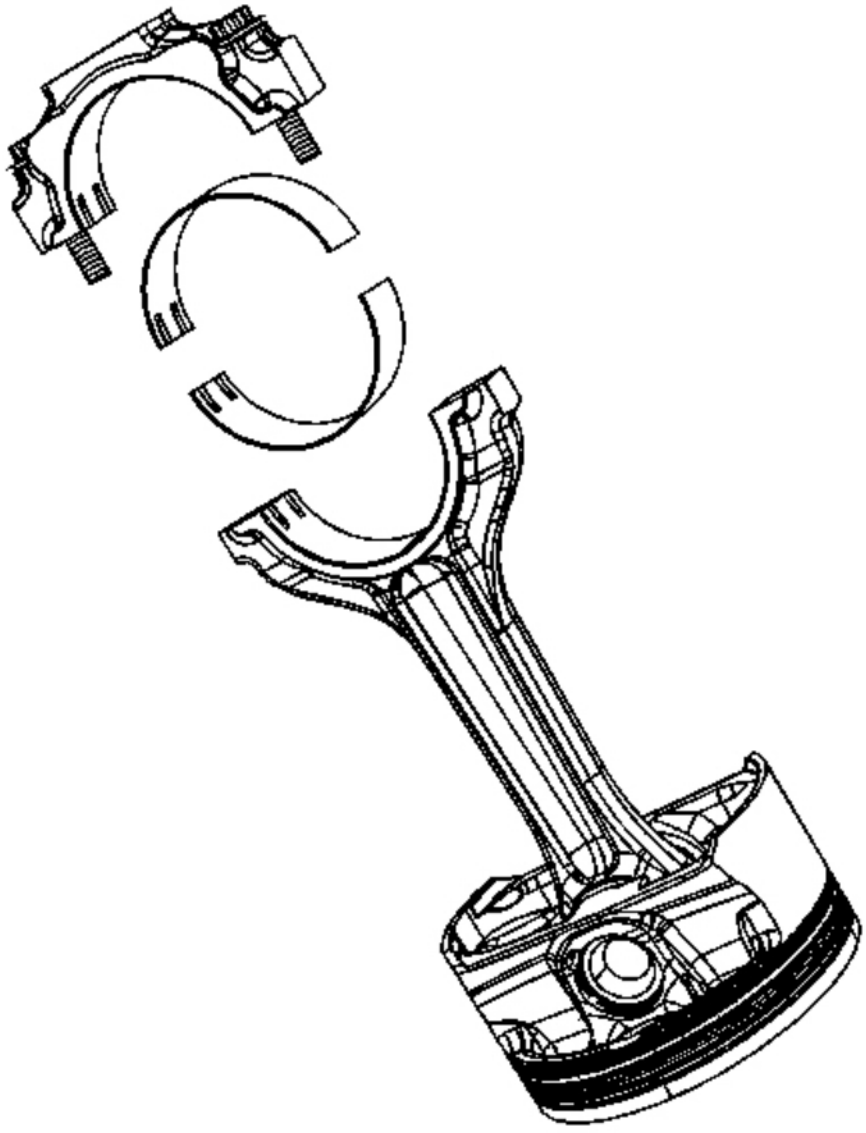


Fig. 180: View Of Piston, Connecting Rod & Bearing Assembly
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the following components with clean engine oil:
   - Piston
   - Piston rings
   - Cylinder bore

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- Bearings and bearing surfaces

2. Install the bearings to the connecting rod and cap.
3. Position the oil control ring end gaps a minimum of 25 mm (1.0 in) from each other.
4. Position the compression ring end gaps 180 degrees opposite each other.

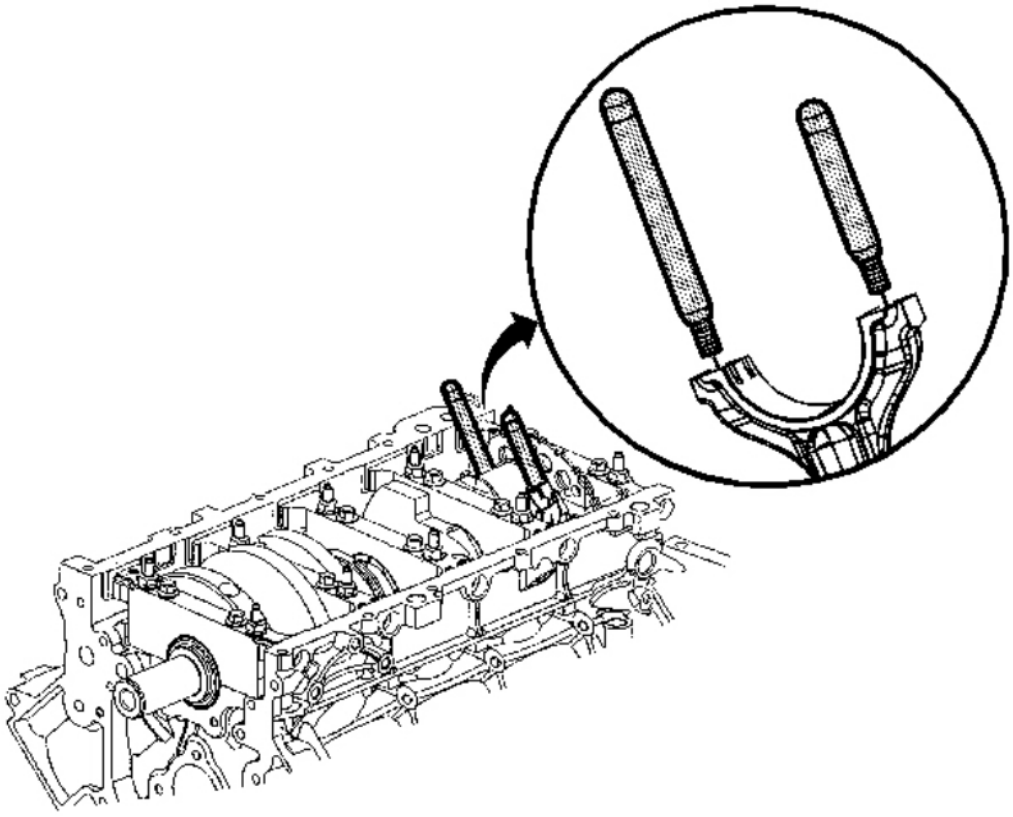


Fig. 181: View Of Piston & Connecting Rod Assembly
Courtesy of GENERAL MOTORS CORP.

5. Install the **J 41556** to the connecting rod. See **Special Tools** .

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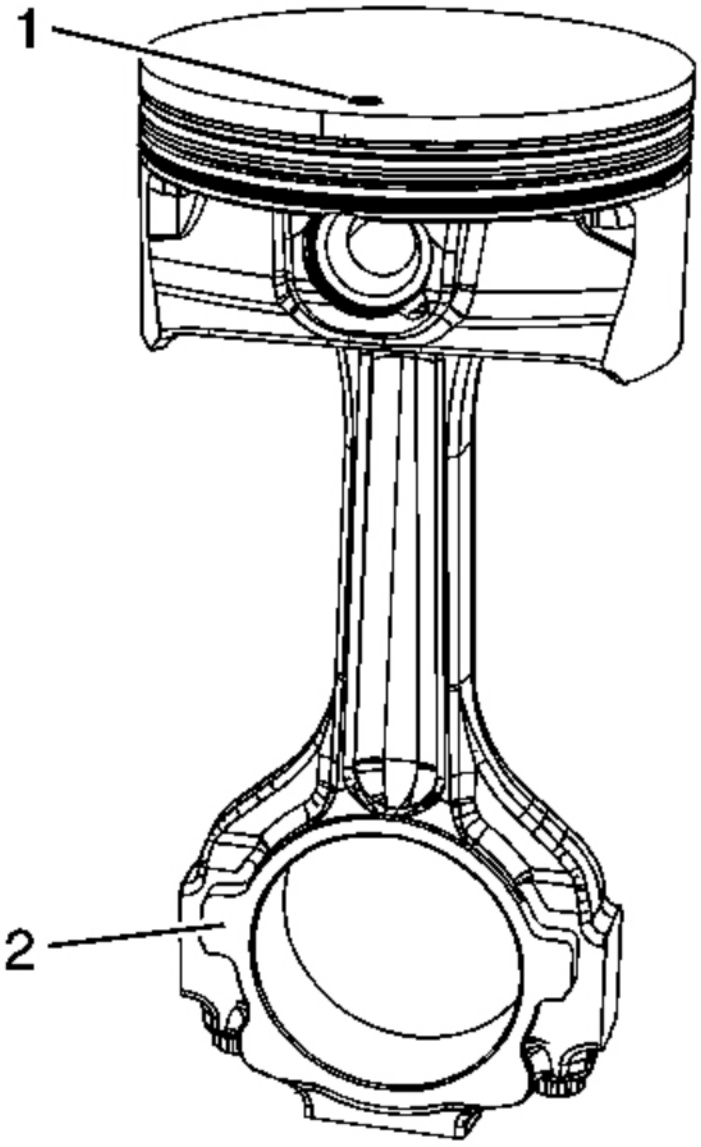


Fig. 182: View of Mark On Top Of Piston & Connecting Rod Tab
Courtesy of GENERAL MOTORS CORP.

6. Identify the proper installation direction of the piston and connecting rod assembly. When installing the piston and connecting rod assembly, the mark on the top of the piston (1) and the tab (2) on the side of the connecting rod should face the front of the engine.

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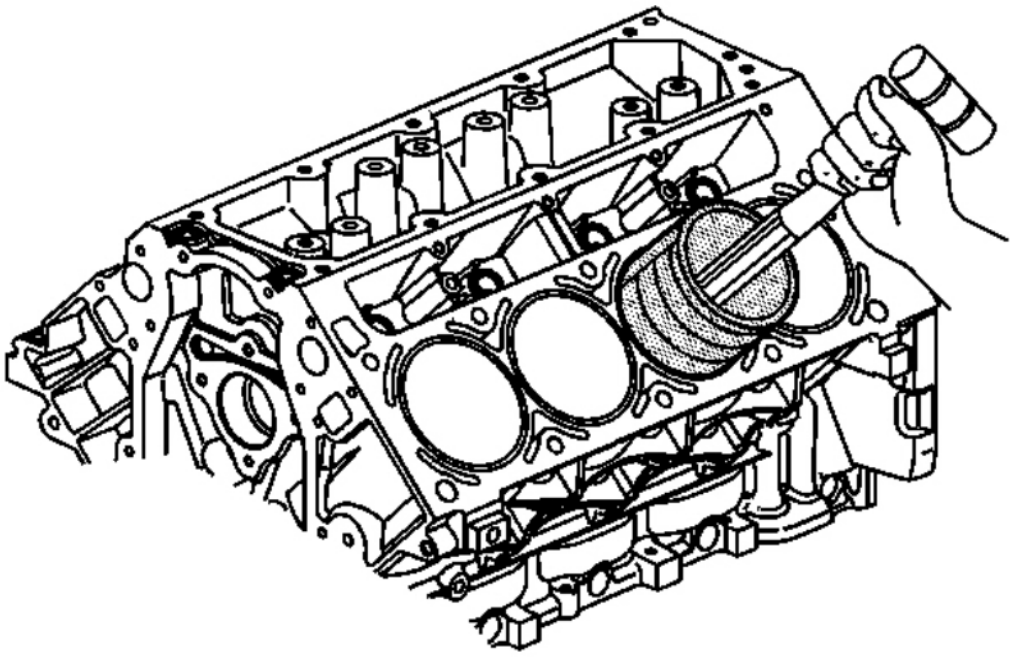


Fig. 183: Tapping Piston Using A Wooden Hammer
Courtesy of GENERAL MOTORS CORP.

7. Install the **J 8037** onto the piston and compress the piston rings. See **Special Tools** .

IMPORTANT: The piston alignment mark MUST face the front of the engine block.

8. Install the piston, pin, and connecting rod assembly into the cylinder bore. Hold the piston ring compressor firmly against the engine block. Using a wooden hammer handle, lightly tap the top of the piston until all piston rings have entered the cylinder bore.
9. Use the **J 41556** to guide the connecting rod onto the crankshaft journal. See **Special Tools** .
10. Remove the **J 41556** from the connecting rod. See **Special Tools** .

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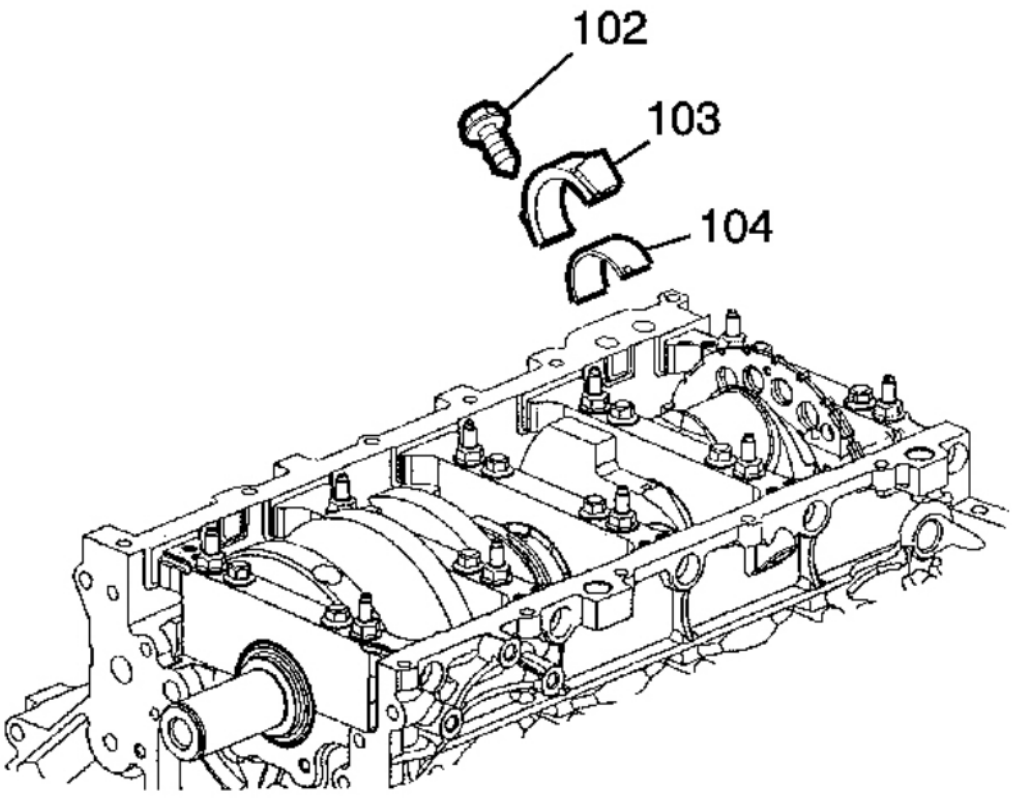


Fig. 184: Connecting Rod Bolt, Cap & Bearing
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice .**

IMPORTANT: The connecting rod and cap must be assembled with the mating surfaces properly aligned.

11. Install the bearing cap (103), bearing (104), and bolts (102).

Tighten:

1. Tighten the bolts a first pass to 20 N.m (15 lb ft).
2. Tighten the bolts a final pass to 75 degrees using the **J 45059** . See **Special Tools** .

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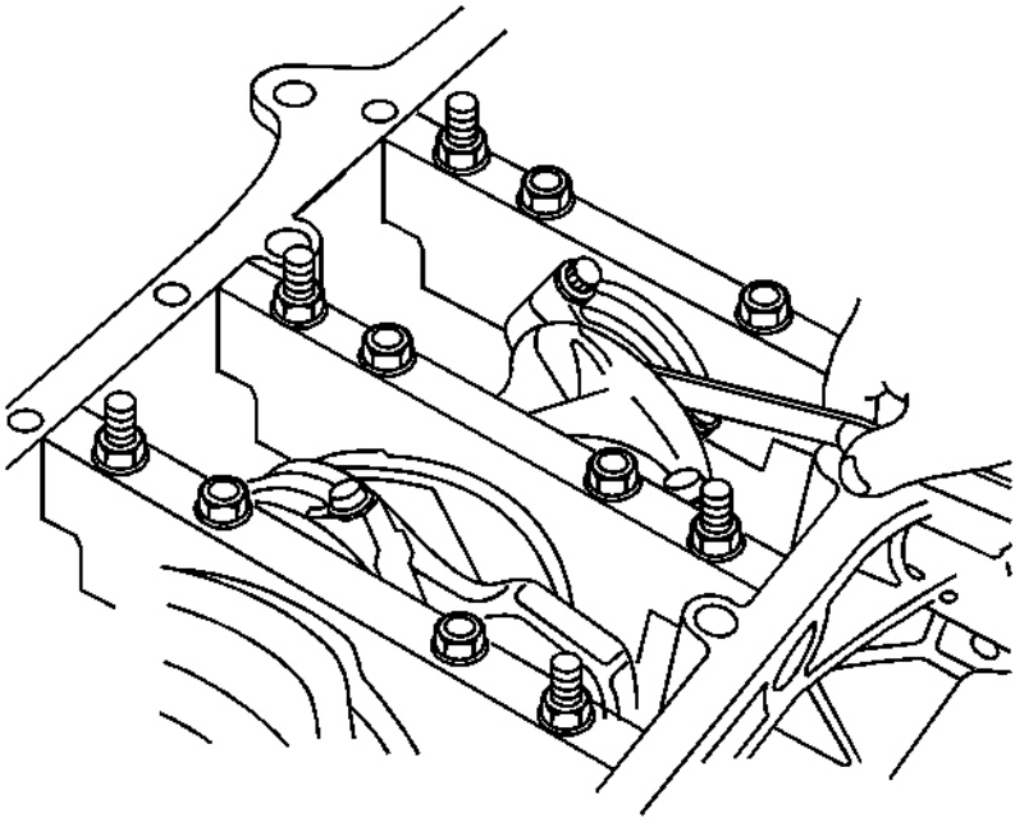


Fig. 185: Measuring Connecting Rod Side Clearance
Courtesy of GENERAL MOTORS CORP.

12. Measure the connecting rods for the proper side clearance. Refer to **Engine Mechanical Specifications (RPO LY2 VIN C)** or **Engine Mechanical Specifications (RPO LMG VIN 0)** or **Engine Mechanical Specifications (RPO LY5 VIN J)** or **Engine Mechanical Specifications (RPO LC9 VIN 3)** or **Engine Mechanical Specifications (RPO L76 VIN Y)** or **Engine Mechanical Specifications (RPO LY6 VIN K)** or **Engine Mechanical Specifications (RPO L92 VIN 8)** .

CAMSHAFT INSTALLATION

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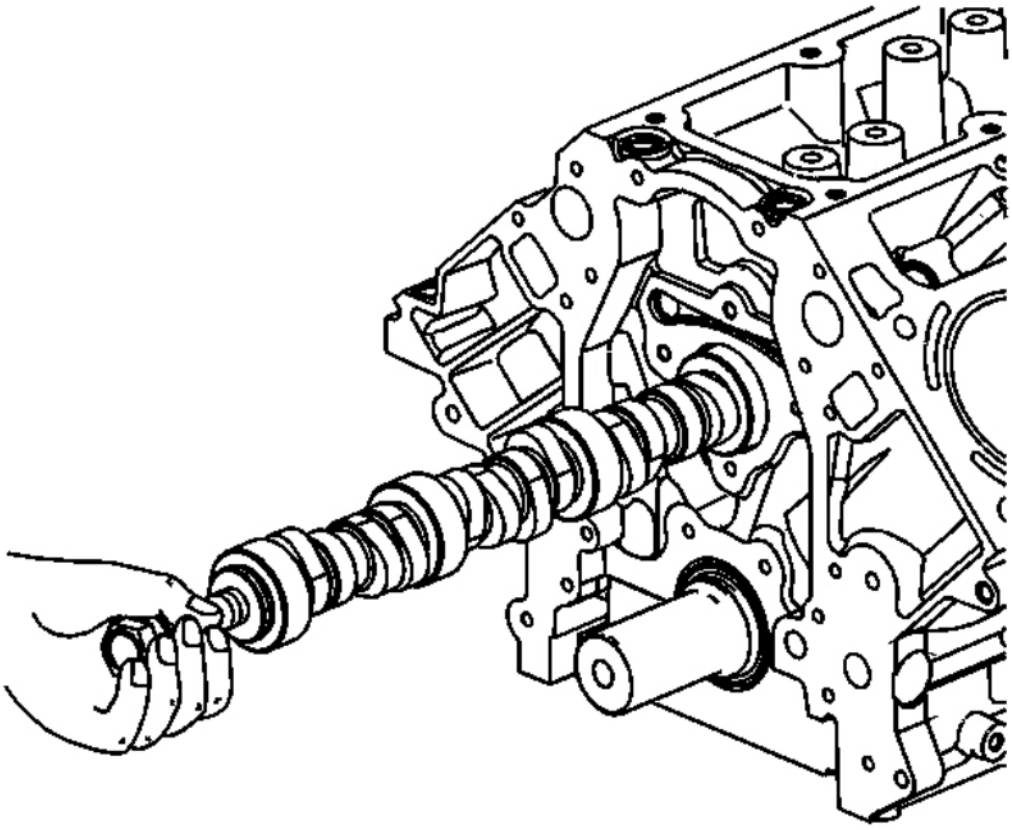


Fig. 186: Removing/Installing Camshaft
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the camshaft journals and the bearings with clean engine oil.
2. Install the camshaft sprocket bolt into the camshaft front bolt hole.

NOTE: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

3. Using the bolt as a handle, carefully install the camshaft into the engine block.
4. Remove the bolt from the front of the camshaft.

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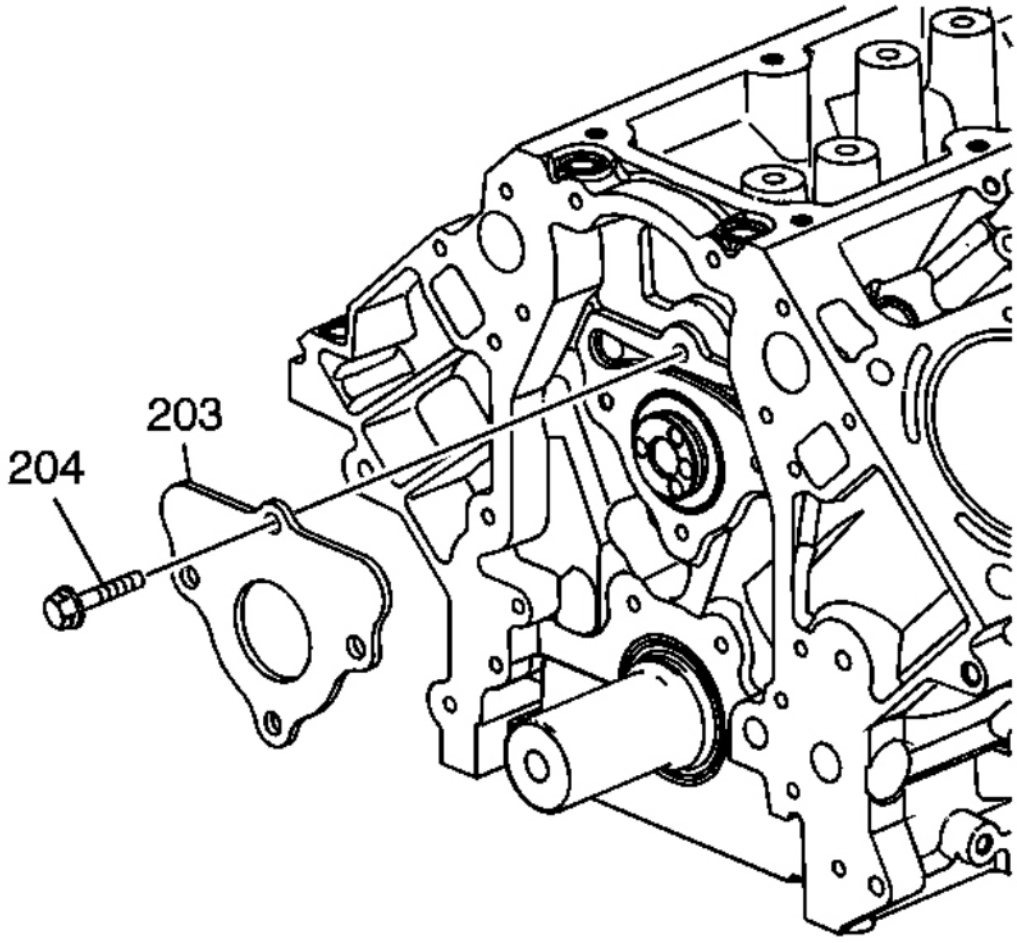


Fig. 187: Camshaft Retainer & Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The gasket surface on the engine block should be clean and free of dirt or debris.

5. Install the camshaft retainer (203) and the bolts (204). Install the retainer with the sealing gasket facing the front of the engine block.

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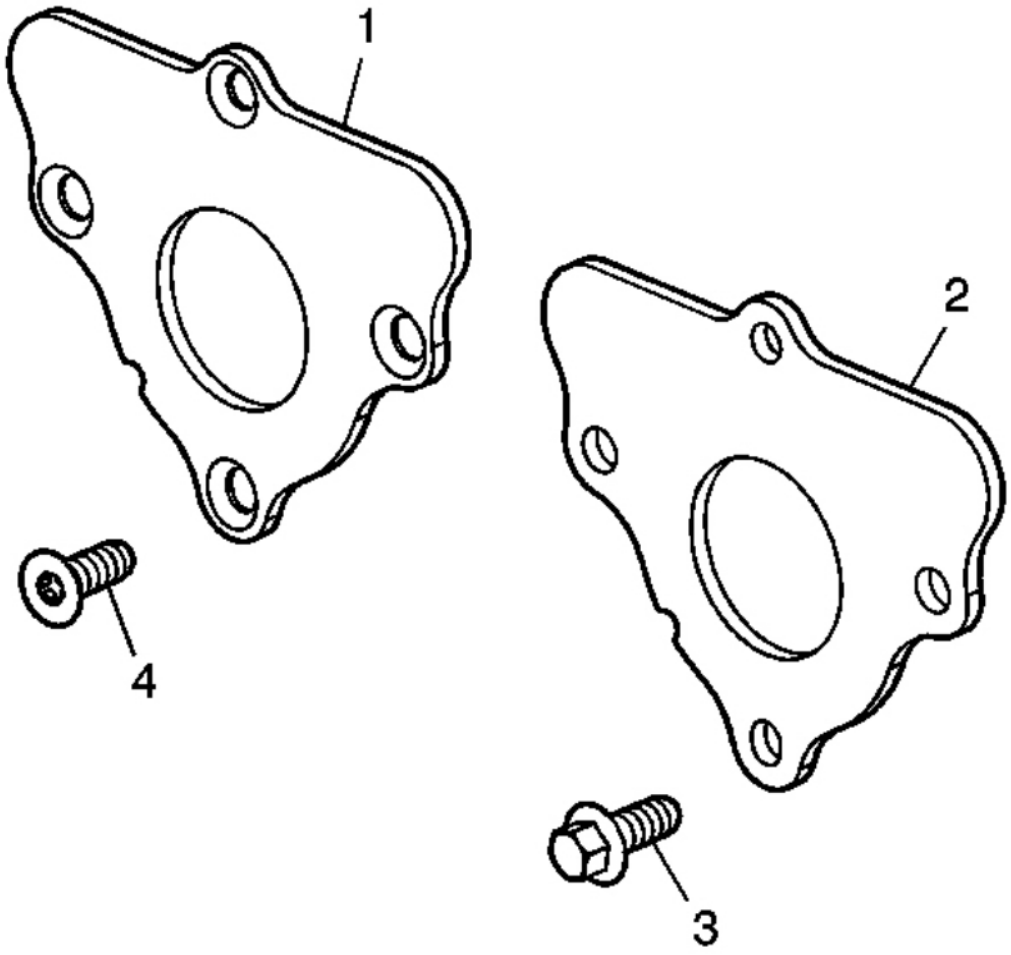


Fig. 188: First & Second Designs Of Head Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice .**

6. Tighten the camshaft retainer bolts.

Tighten:

- Tighten the first design hex head bolts (3) to 25 N.m (18 lb ft).
- Tighten the second design TORX® head bolts (4) to 15 N.m (11 lb ft).

CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE INSTALLATION

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Tools Required

- **EN 46330** Timing Belt Tensioner Retaining Pin. See **Special Tools** .
- **J 41478** Crankshaft Front Oil Seal Installer. See **Special Tools** .
- **J 41665** Crankshaft Balancer and Sprocket Installer. See **Special Tools** .
- **J 42386-A** Flywheel Holding Tool. See **Special Tools** .
- **J 45059** Angle Meter. See **Special Tools** .

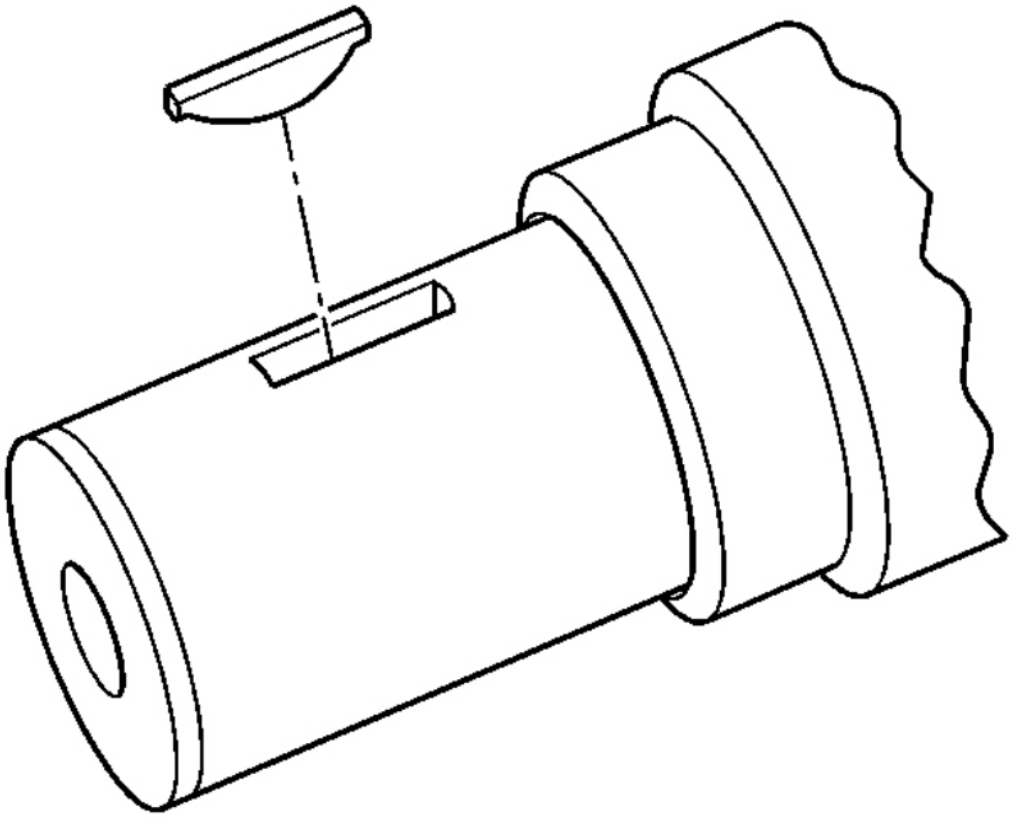


Fig. 189: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

1. Install the key into the crankshaft keyway, if previously removed.

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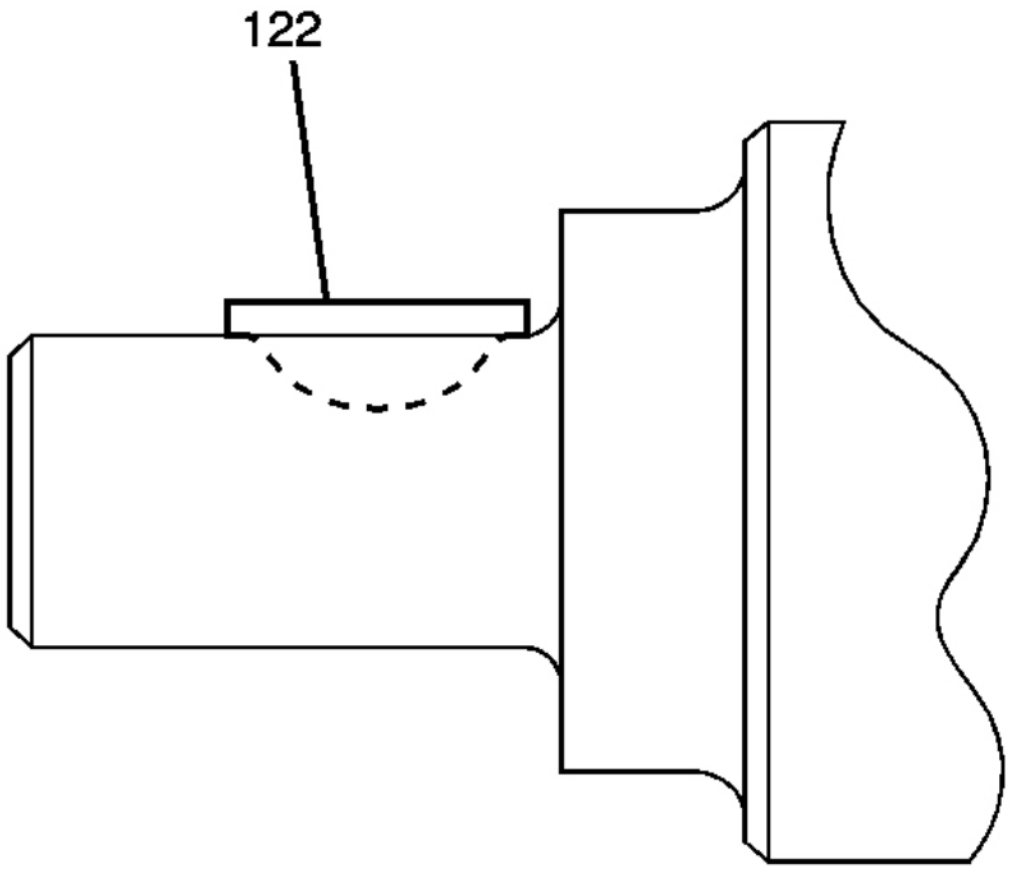


Fig. 190: View Of Installed Crankshaft Key
Courtesy of GENERAL MOTORS CORP.

2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.

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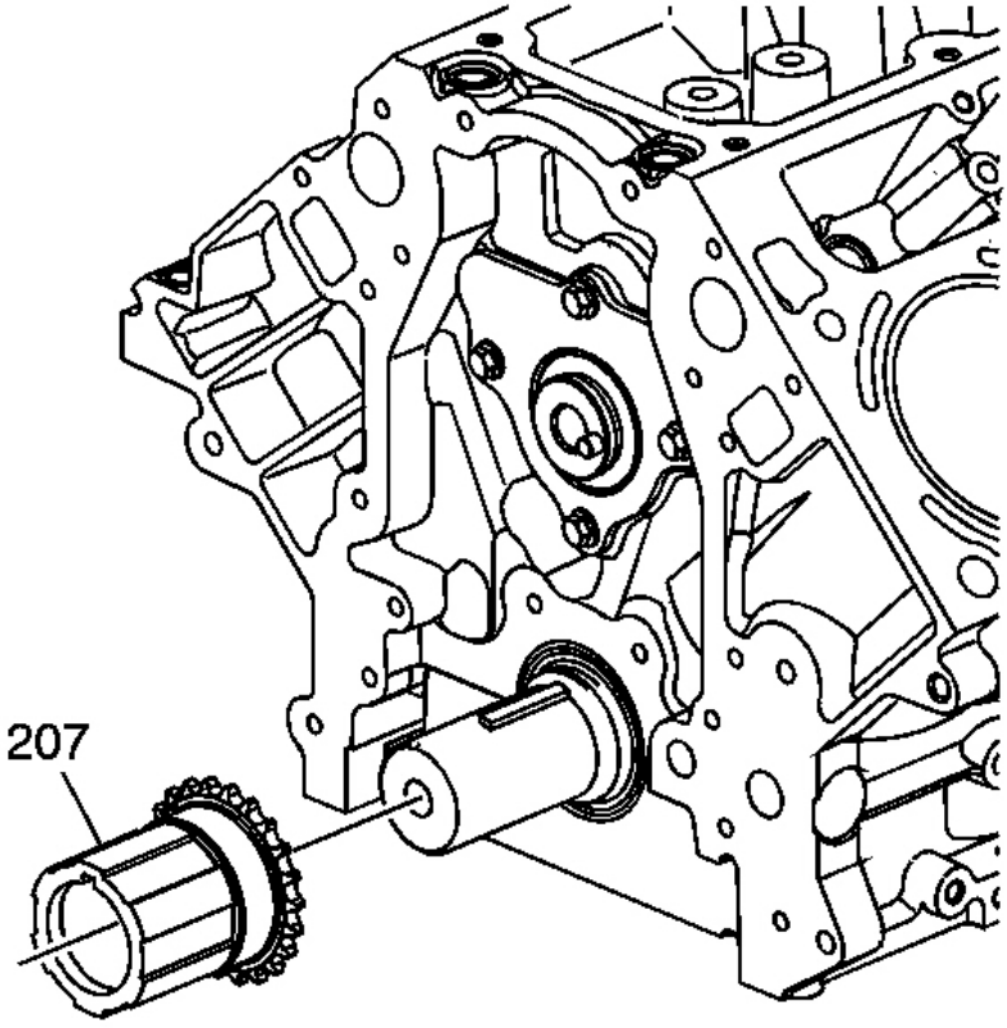


Fig. 191: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

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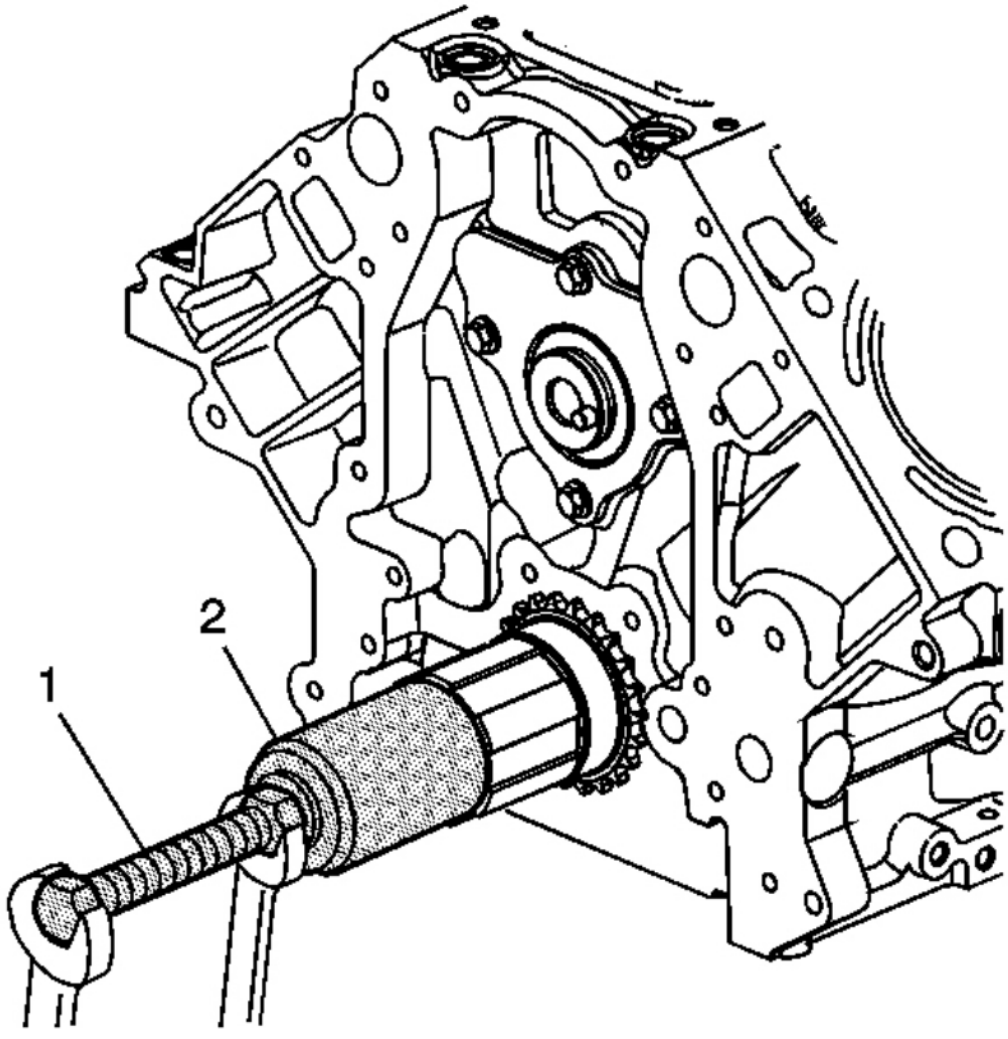


Fig. 192: View Of Crankshaft Sprocket & Installer
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 41478** (1) and the **J 41665** (2) in order to install the crankshaft sprocket. See **Special Tools** . Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.
5. Rotate the crankshaft sprocket until the sprocket alignment mark is in the 12 o'clock position.

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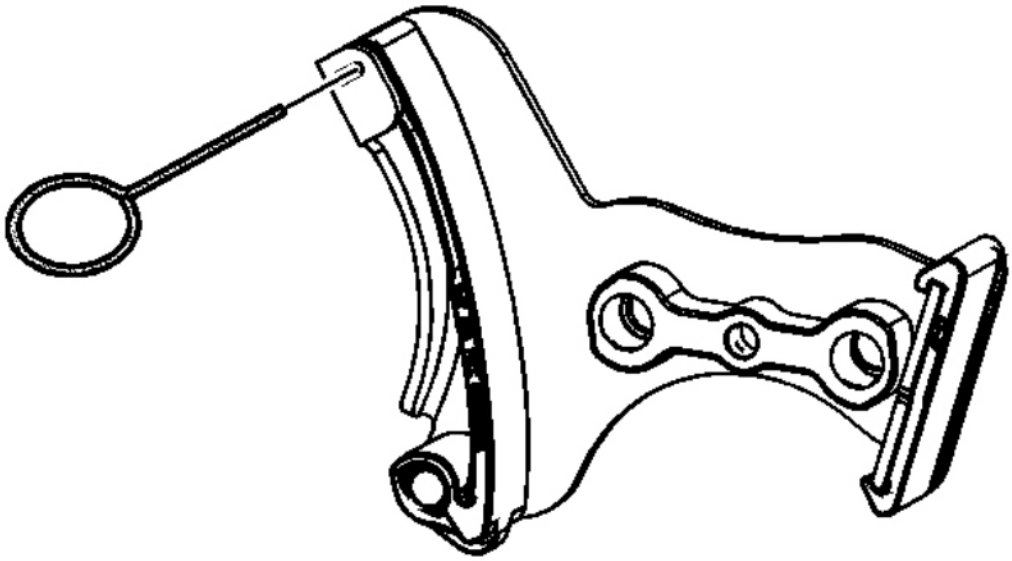


Fig. 193: Installing EN 46330 In Compressed Tensioner
Courtesy of GENERAL MOTORS CORP.

6. Compress the timing chain tensioner guide and install the **EN 46330** . See **Special Tools** .

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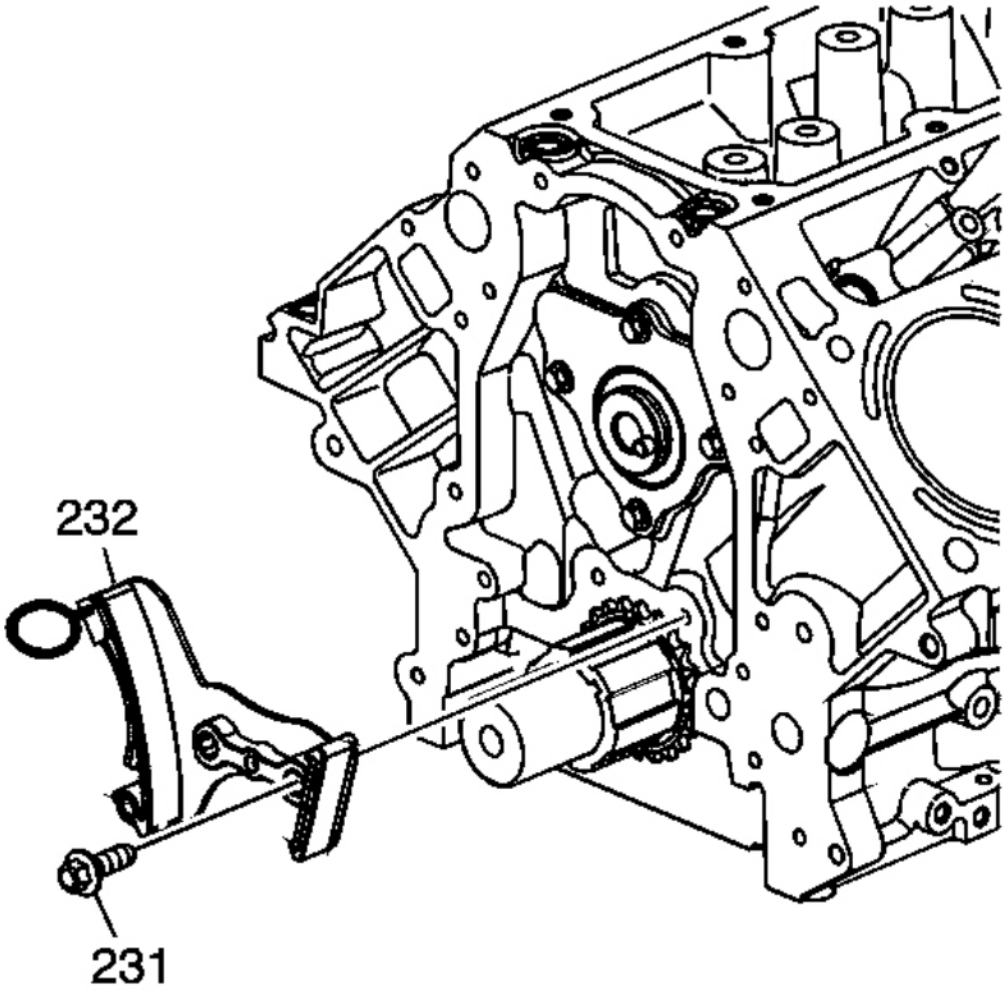


Fig. 194: View Of Timing Chain Tensioner & Left Side Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice .**

7. Install the timing chain tensioner (232) and left side bolt (231). Do not install the right side bolt at this time. The right side bolt will be installed after the camshaft position (CMP) actuator and chain have been installed onto the engine.

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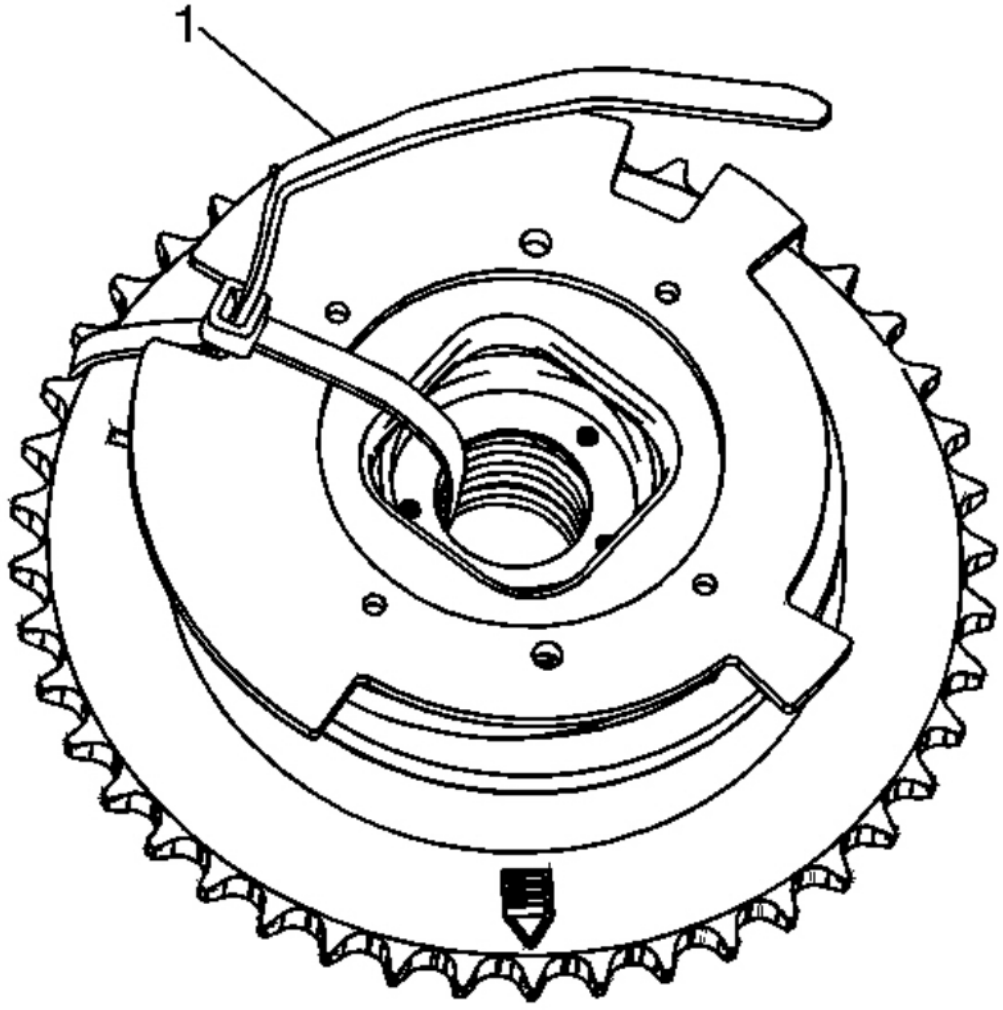


Fig. 195: View Of Tie Strap Through Center Of Actuator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Camshaft Position Actuator Removal and Installation Caution .

8. Remove the tie strap (1) from the actuator.

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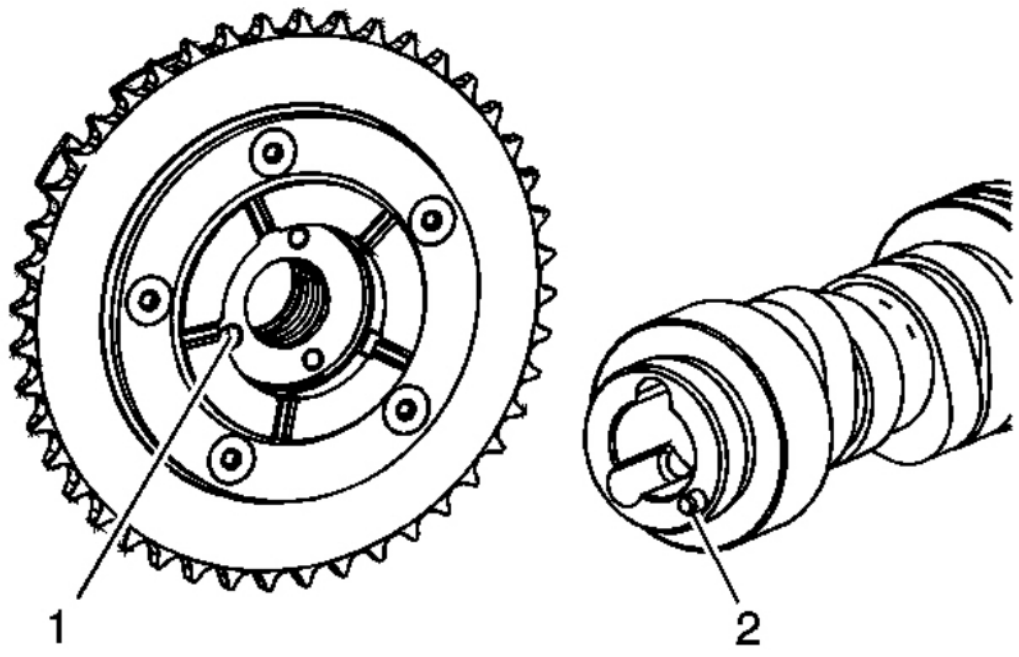


Fig. 196: Identifying Alignment Hole & Locating Pin
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Properly locate the CMP actuator onto the locating pin of the camshaft.**
- **The sprocket teeth and timing chain must mesh.**
- **The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.**
- **Do not use the CMP solenoid valve again. Install a NEW valve during assembly.**

9. Identify the alignment hole (1) in the rear face of the CMP actuator and the locating pin (2) on the front face of the camshaft.

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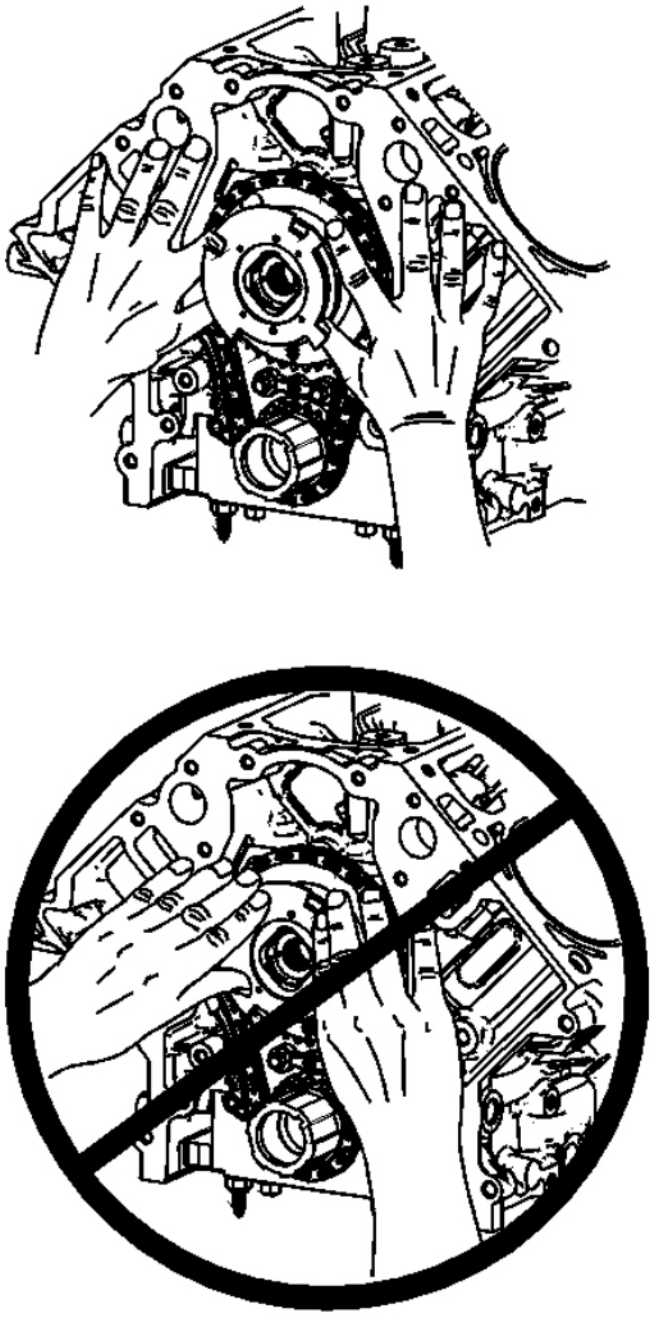


Fig. 197: Proper Installation Of CMP Actuator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Camshaft Position Actuator Removal and Installation

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Caution .

10. Install the CMP actuator and timing chain. Align the hole in the rear face of the CMP actuator with the locating pin on the front face of the camshaft. If necessary, rotate the camshaft or crankshaft sprockets in order to align the timing marks. Use care to install the actuator completely onto the front of the camshaft. Position fingers onto the face of the actuator sprocket and push the actuator onto the front of the camshaft. Never push on the reluctor wheel when attempting to install the actuator.

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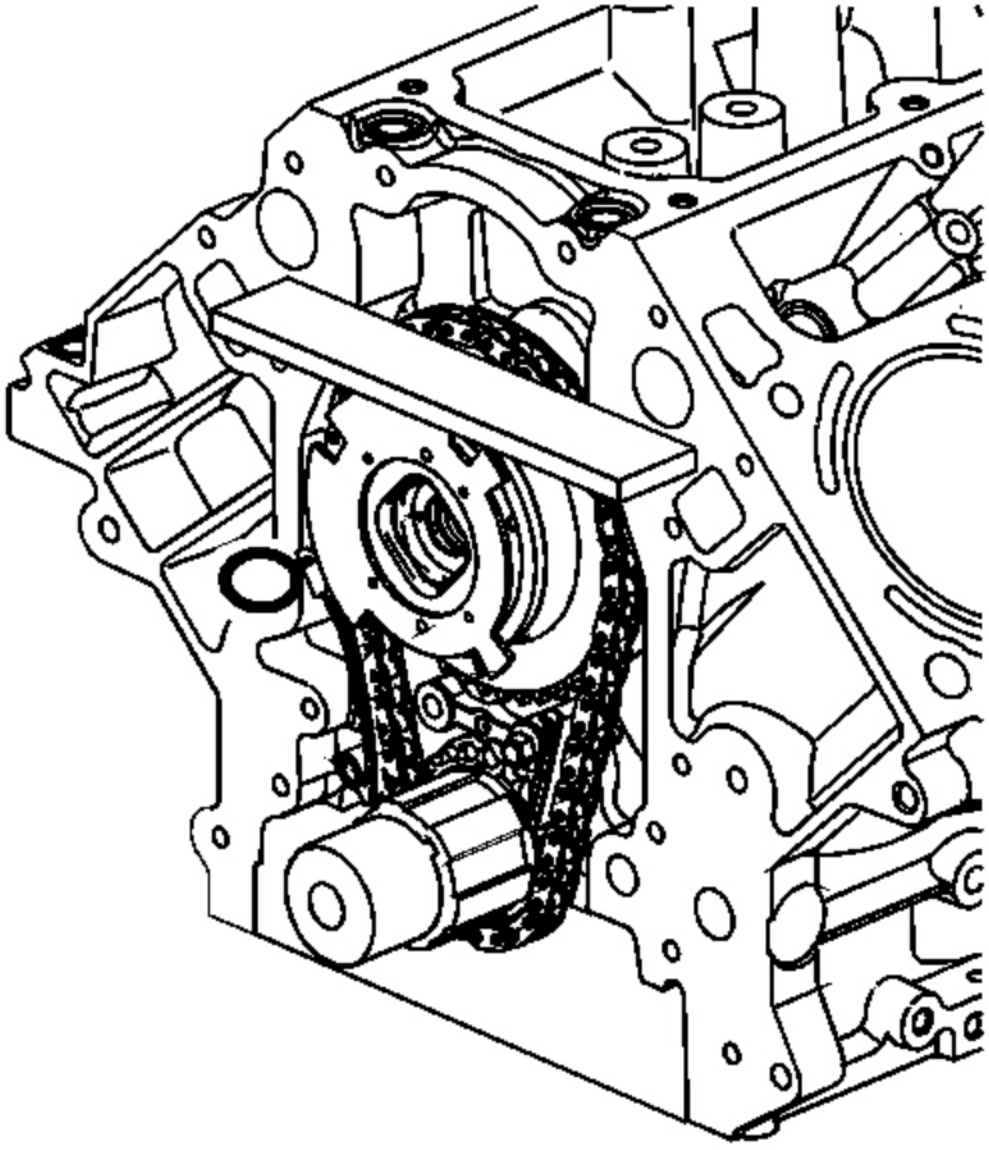


Fig. 198: Inspecting For Proper Installation Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

11. Locate a straight edge across the front face of the engine block and inspect for proper installation of the CMP actuator and timing chain. With the CMP actuator properly and completely installed onto the front of camshaft, the timing chain will not protrude beyond the front face of engine block.

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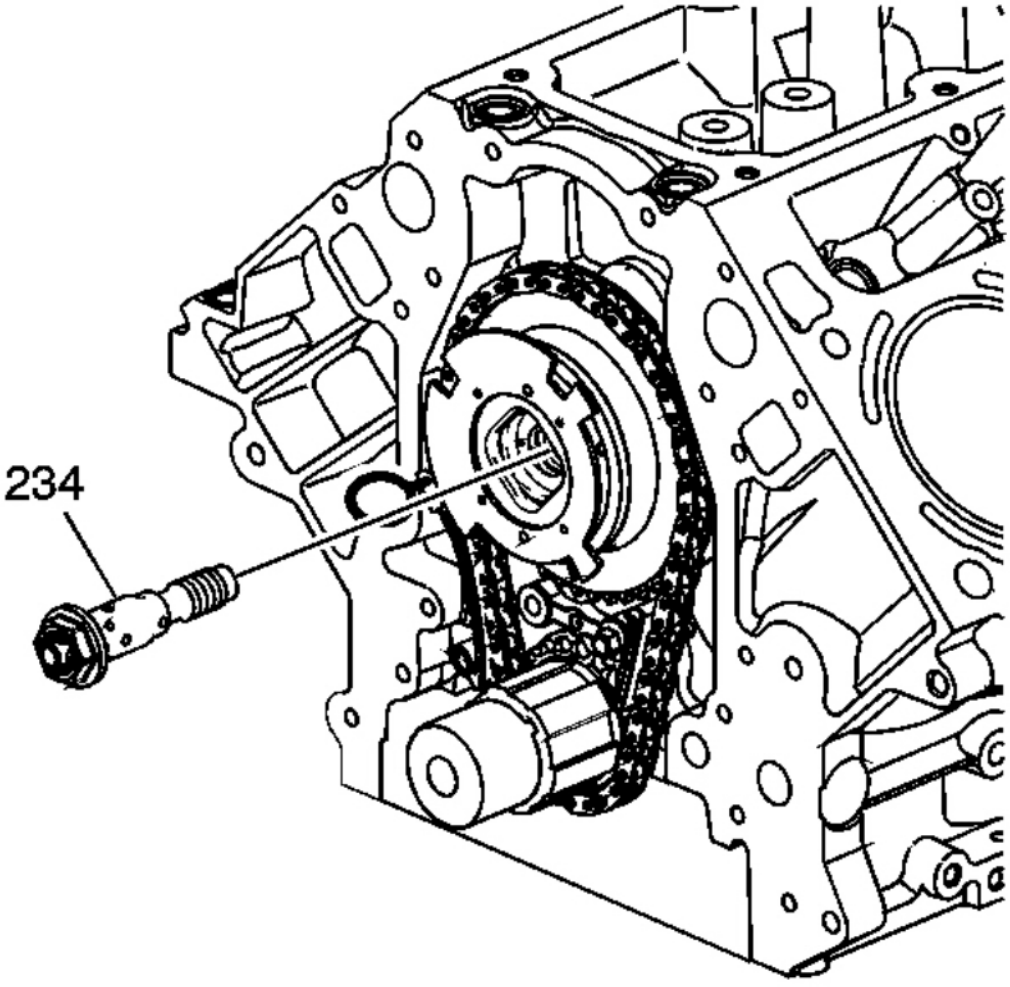


Fig. 199: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

12. Install a NEW CMP actuator solenoid valve (234). With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.

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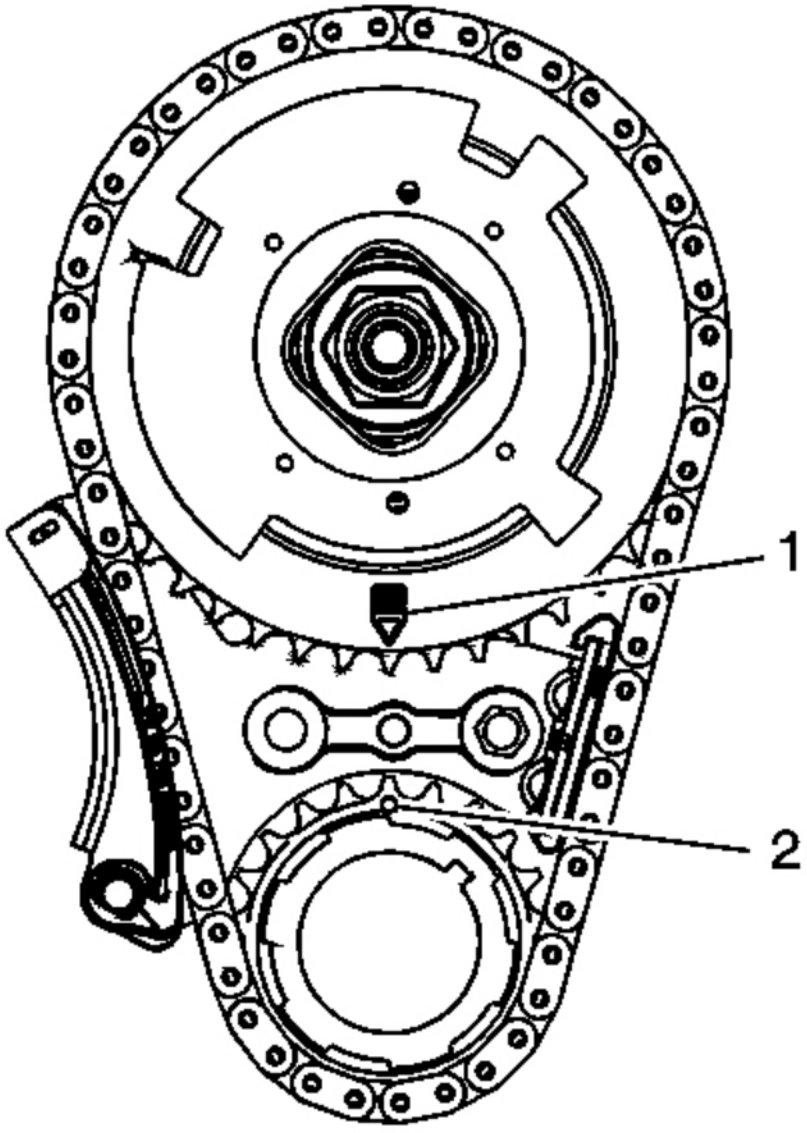


Fig. 200: View Of CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark
Courtesy of GENERAL MOTORS CORP.

13. Inspect the sprockets for proper alignment. The mark on the CMP actuator sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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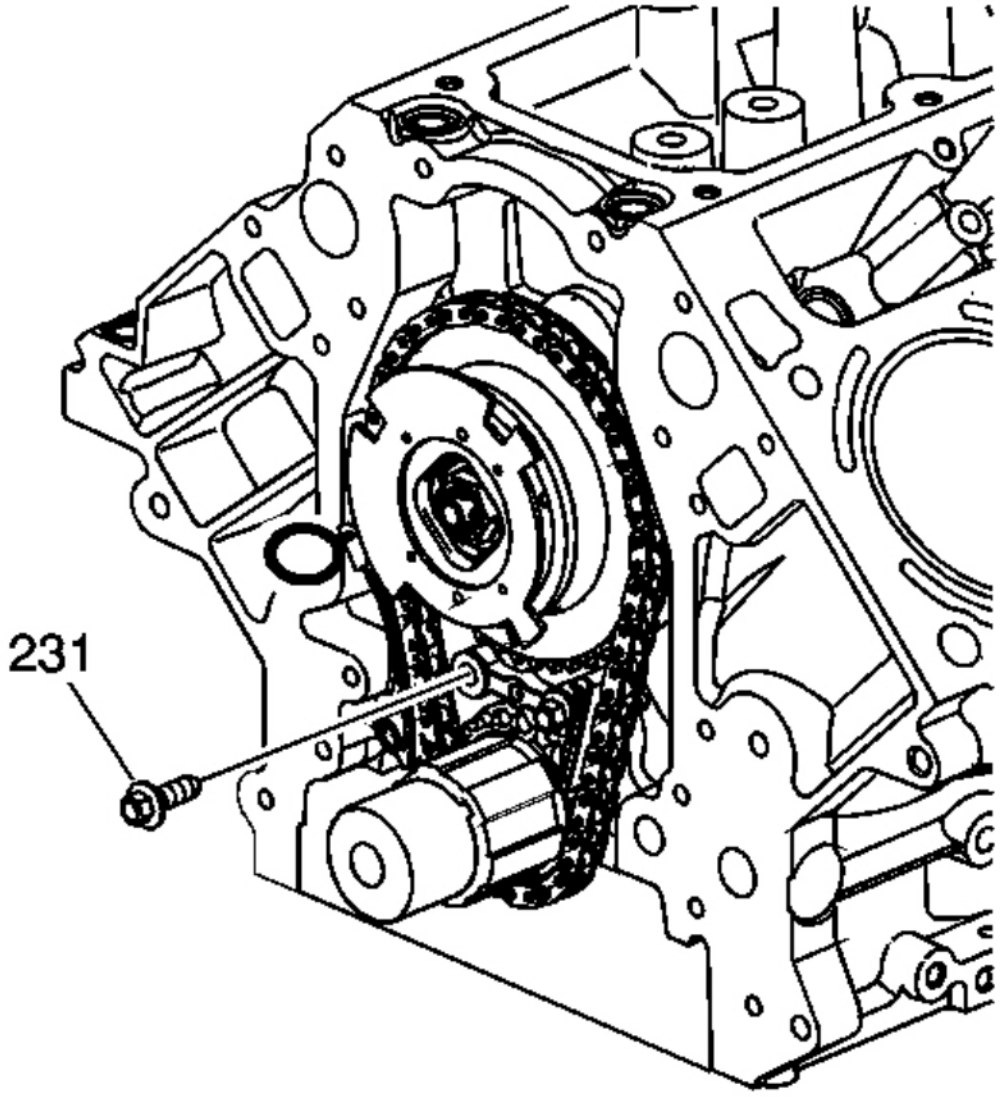


Fig. 201: View Of Timing Chain Tensioner Bolt
Courtesy of GENERAL MOTORS CORP.

14. Install the right side bolt (231) into the timing chain tensioner.

    Tighten: Tighten the timing chain tensioner bolts to 25 N.m (18 lb ft).

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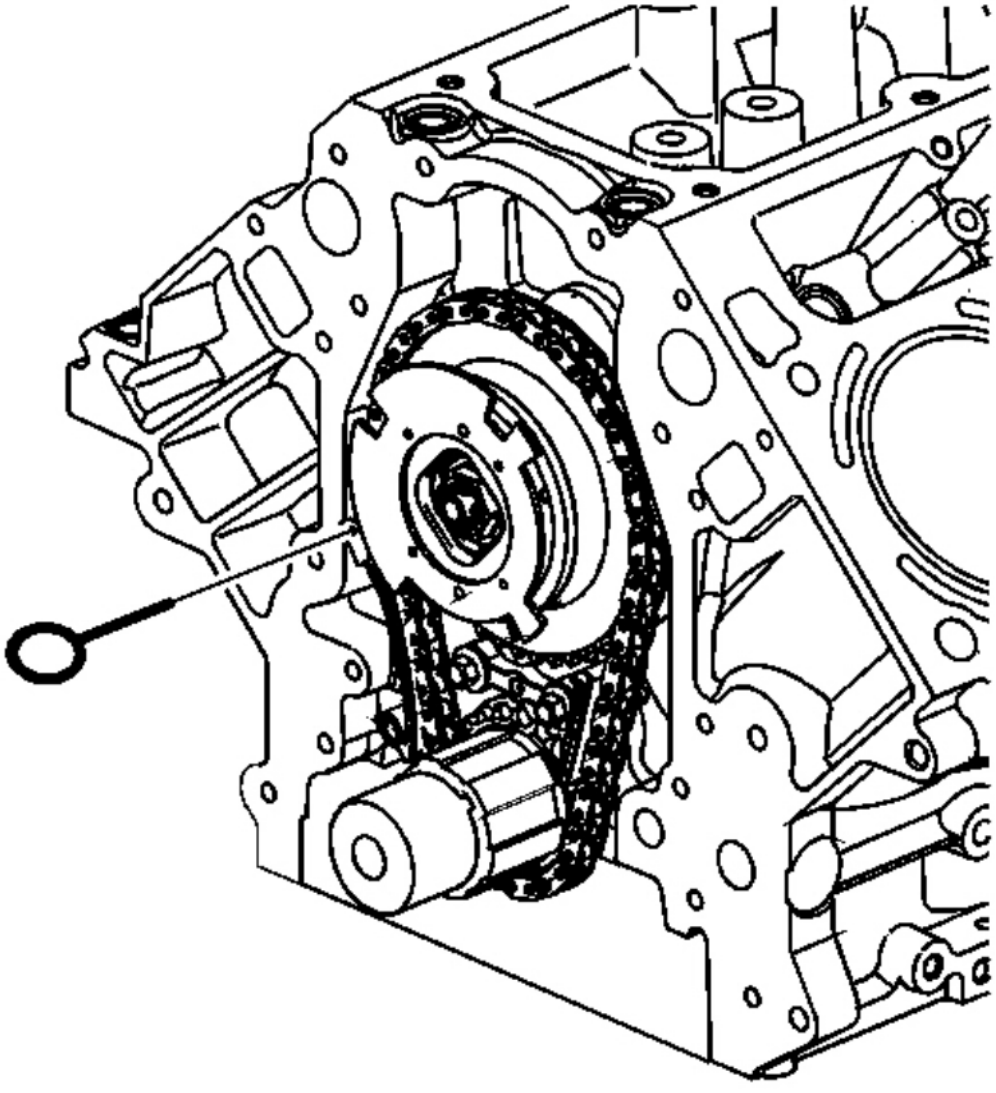


Fig. 202: View Of Special Tool EN 46330
Courtesy of GENERAL MOTORS CORP.

15. Remove the **EN 46330** . See **Special Tools** .

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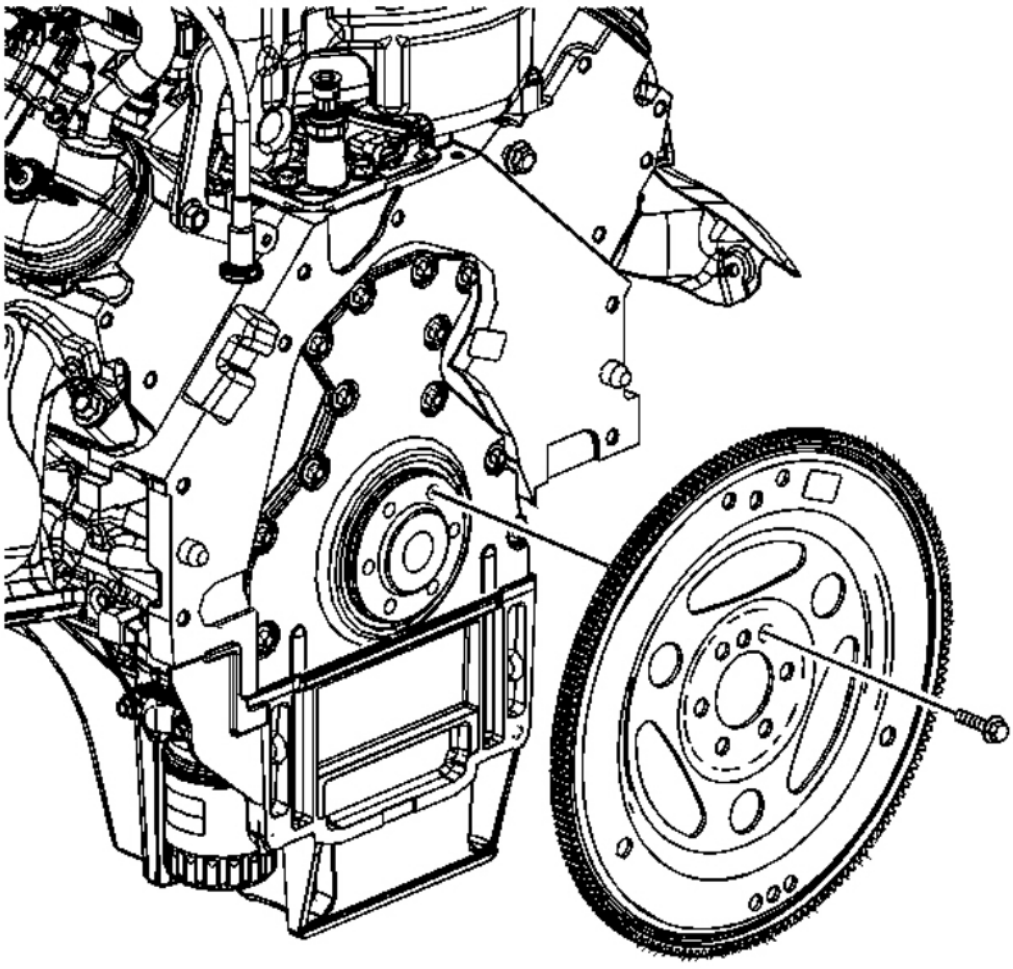


Fig. 203: View Of Flex Plate & Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not apply threadlock to the flex plate bolts at this time.

16. Temporarily install the automatic transmission flex plate and bolts. Refer to **Automatic Transmission Flex Plate Installation** .

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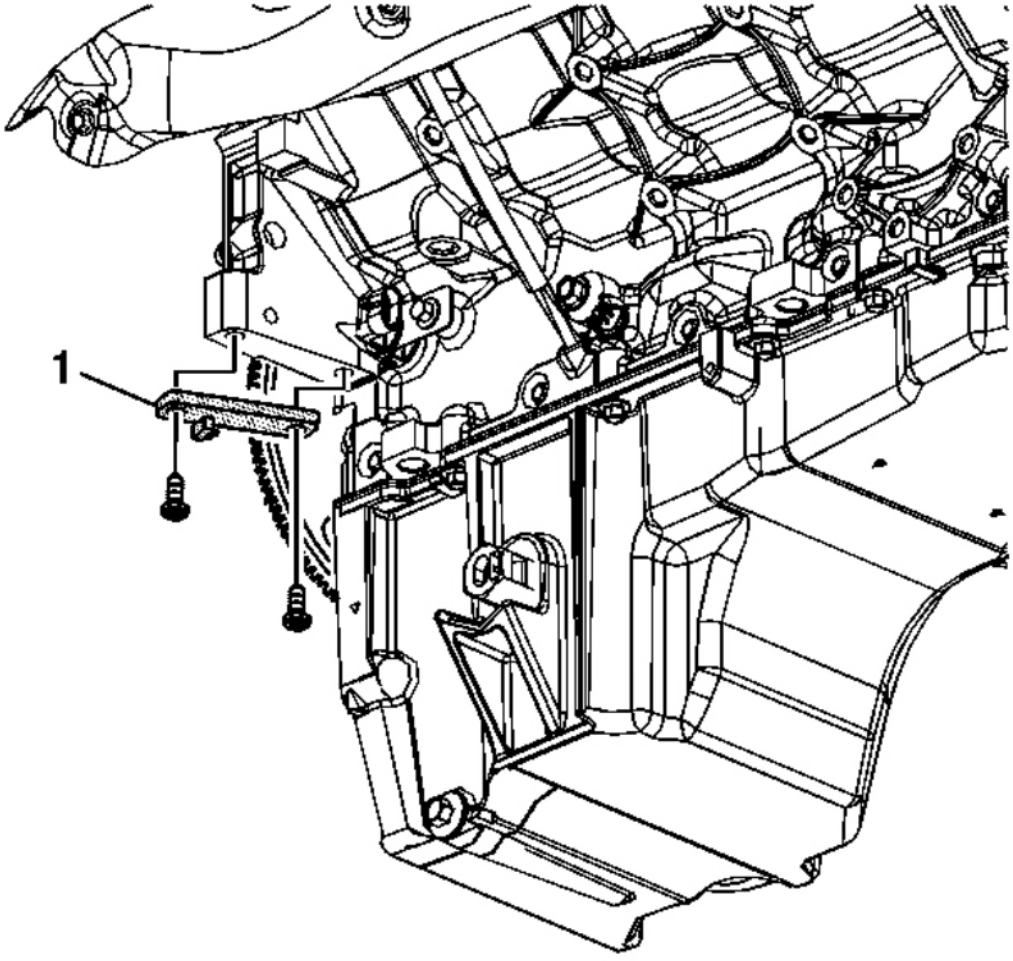


Fig. 204: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

17. Install the **J 42386-A** (1) and bolts. See **Special Tools** . Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation.

    Tighten: Tighten the **J 42386-A** bolts to 50 N. See **Special Tools** .m (37 lb ft).

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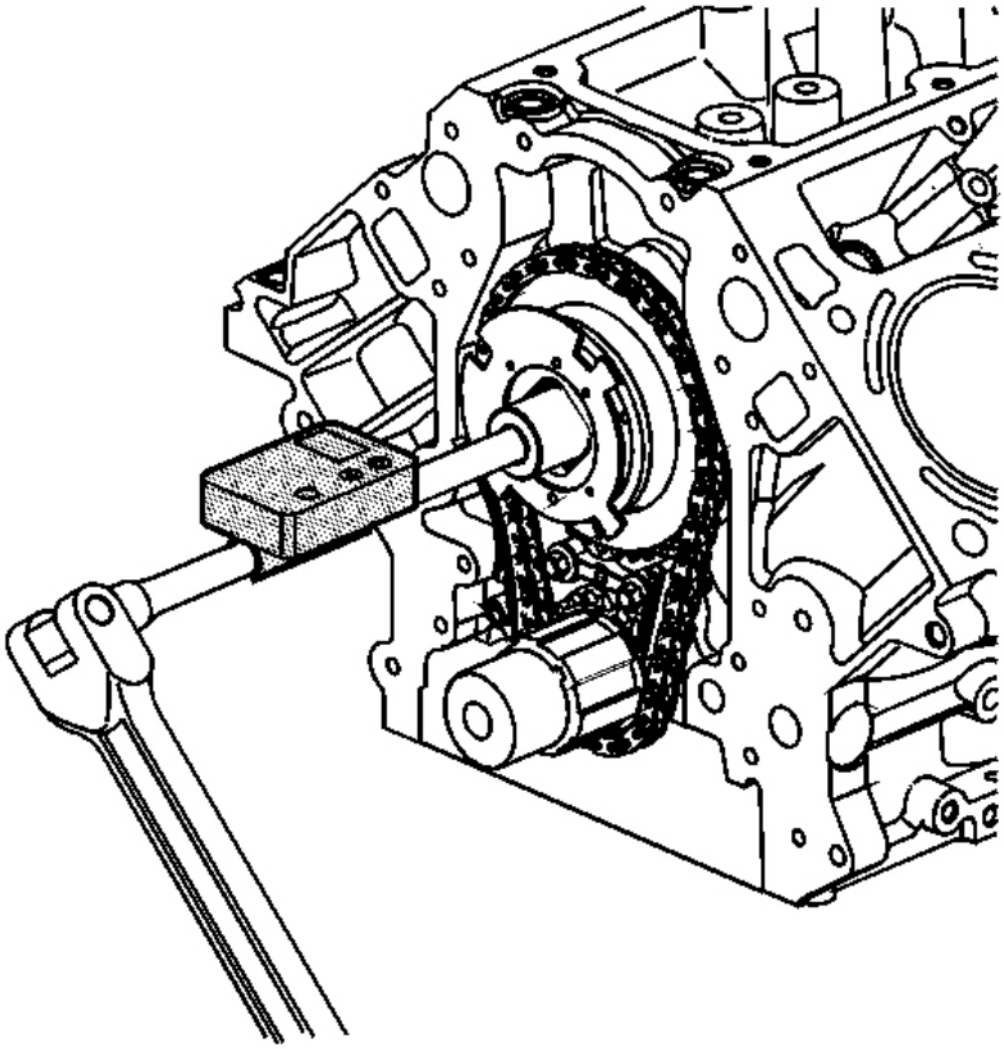


Fig. 205: Tightening The CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

18. Tighten the CMP actuator solenoid valve.

Tighten:

1. Tighten the CMP actuator solenoid valve a first pass to 65 N.m (48 lb ft).
2. Tighten the CMP actuator solenoid valve a final pass an additional 90 degrees using the **J 45059** . See **Special Tools** .

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19. Remove the **J 42386-A** and bolts. See **Special Tools** .
20. Remove the automatic transmission flex plate and bolts. Refer to **Automatic Transmission Flex Plate Removal** .

TIMING CHAIN AND SPROCKETS INSTALLATION

Tools Required

- **EN 46330** Timing Belt Tensioner Retaining Pin. See **Special Tools** .
- **J 41478** Crankshaft Front Oil Seal Installer. See **Special Tools** .
- **J 41665** Crankshaft Balancer and Sprocket Installer. See **Special Tools** .
- **J 42386-A** Flywheel Holding Tool. See **Special Tools** .
- **J 45059** Angle Meter. See **Special Tools** .

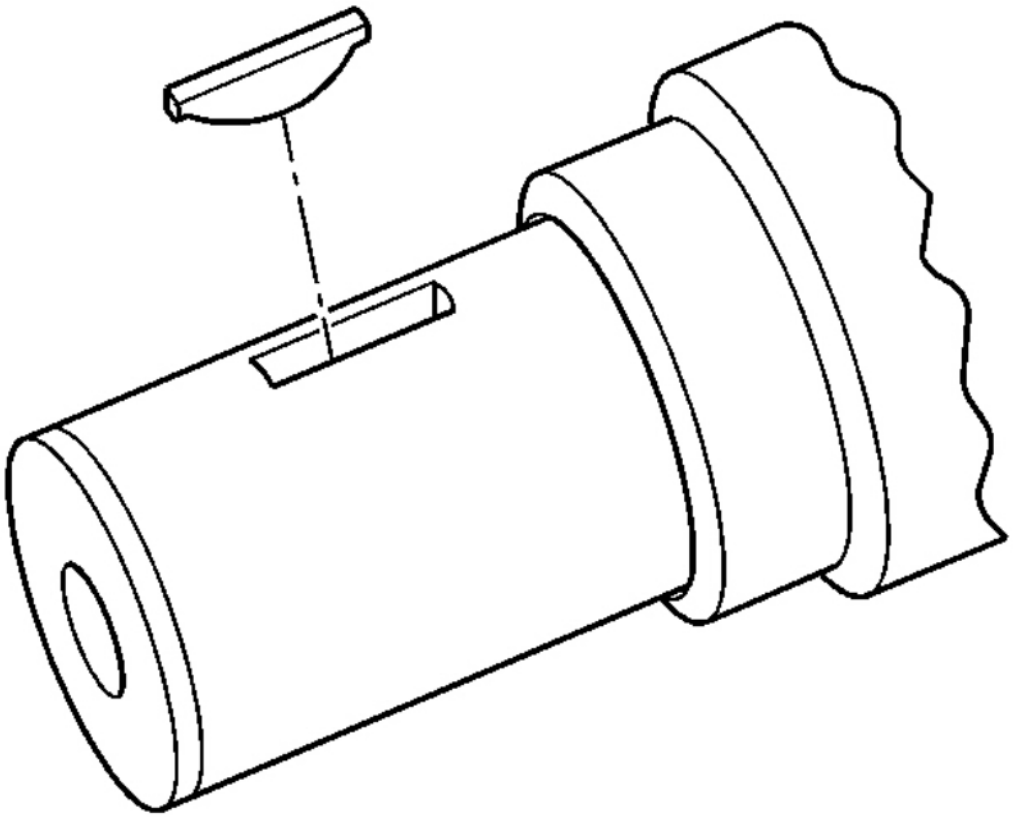


Fig. 206: View Of Crankshaft Key & Keyway

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Courtesy of GENERAL MOTORS CORP.

1. Install the key into the crankshaft keyway, if previously removed.

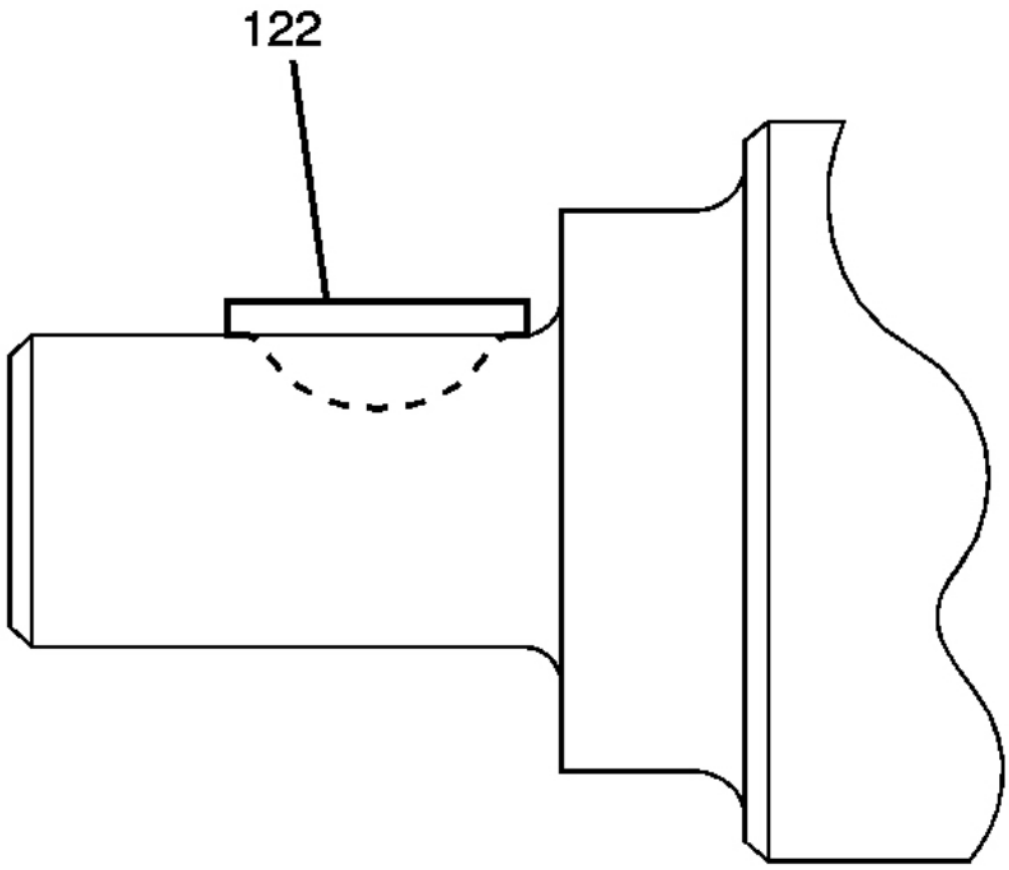


Fig. 207: View Of Installed Crankshaft Key
Courtesy of GENERAL MOTORS CORP.

2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.

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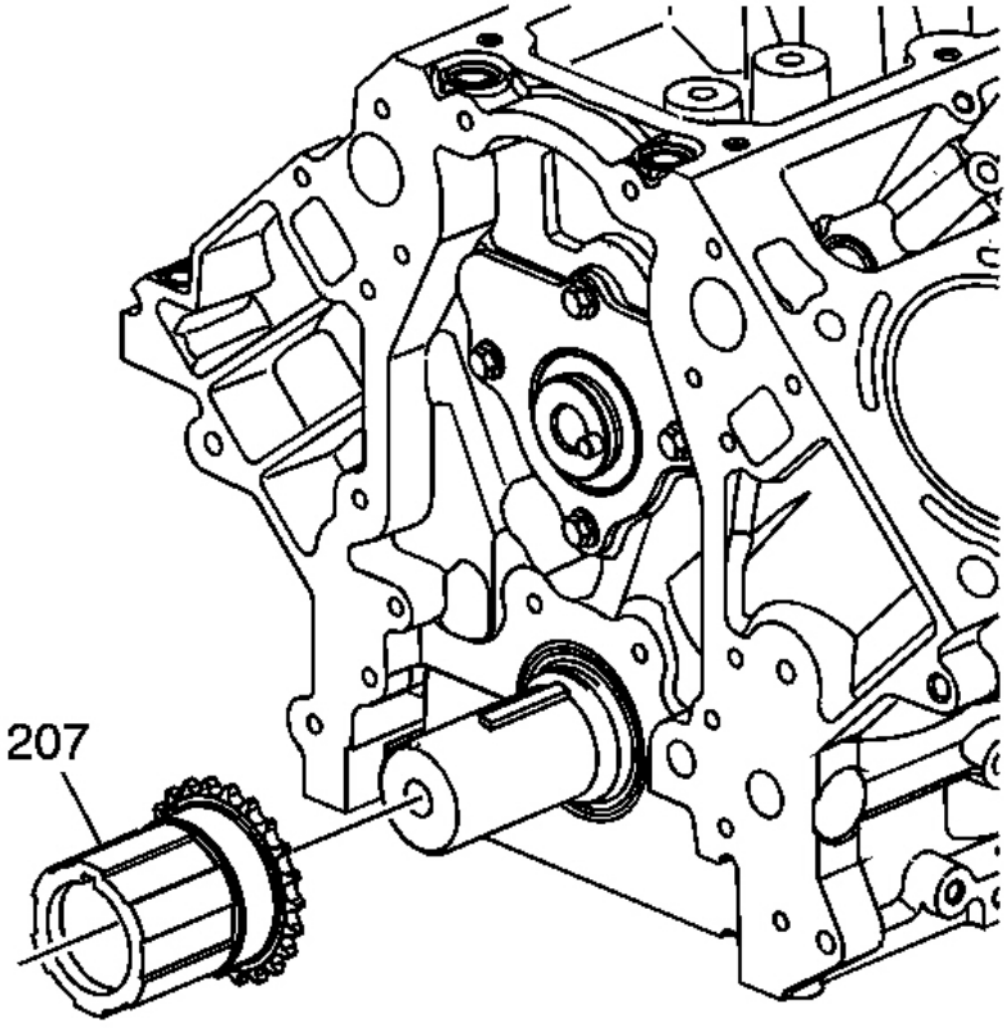


Fig. 208: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

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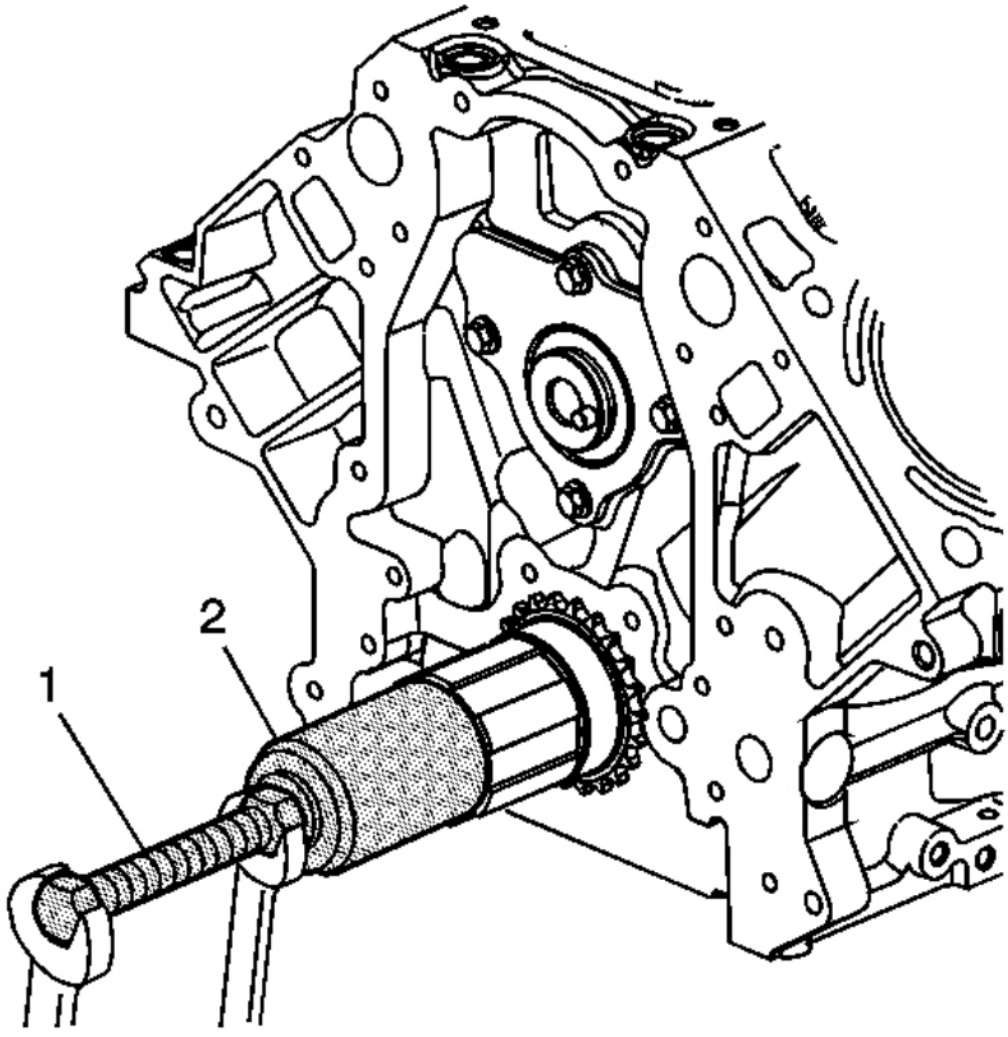


Fig. 209: View Of Crankshaft Sprocket & Installer
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 41478** (1) and the **J 41665** (2) in order to install the crankshaft sprocket. See **Special Tools** .

   Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.

5. Rotate the crankshaft sprocket until the alignment mark is in the 12 o'clock position.

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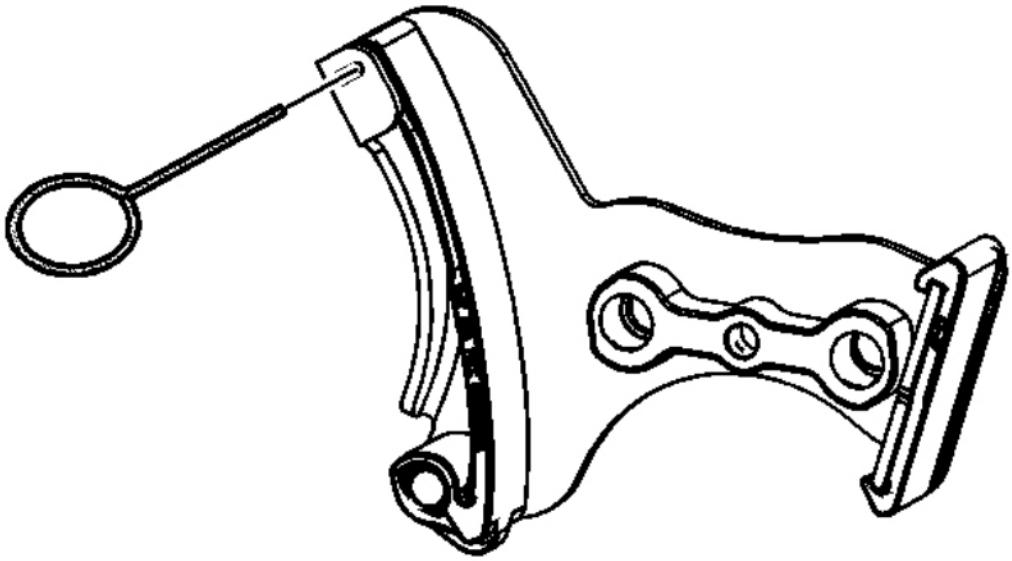


Fig. 210: Installing EN 46330 In Compressed Tensioner
Courtesy of GENERAL MOTORS CORP.

6. Compress the timing chain tensioner guide and install the **EN 46330** . See **Special Tools** .

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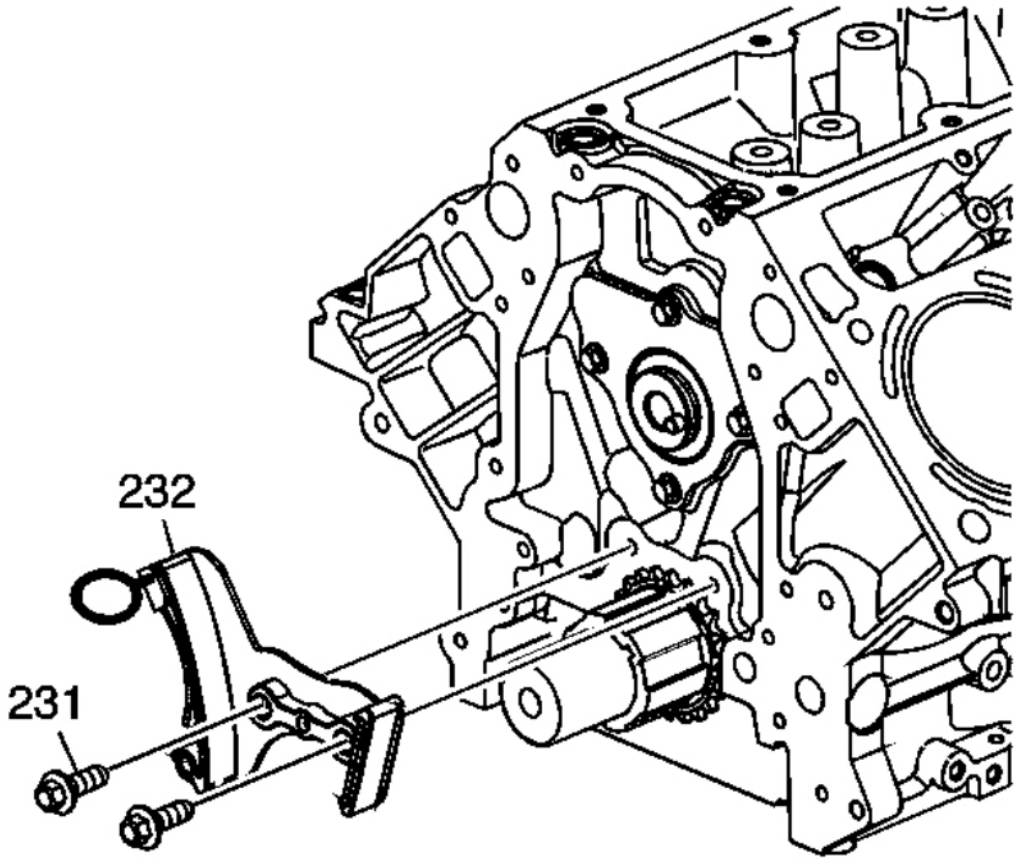


Fig. 211: View Of Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice .**

7. Install the timing chain tensioner (232) and bolts (231).

   Tighten: Tighten the timing chain tensioner bolts to 25 N.m (18 lb ft).

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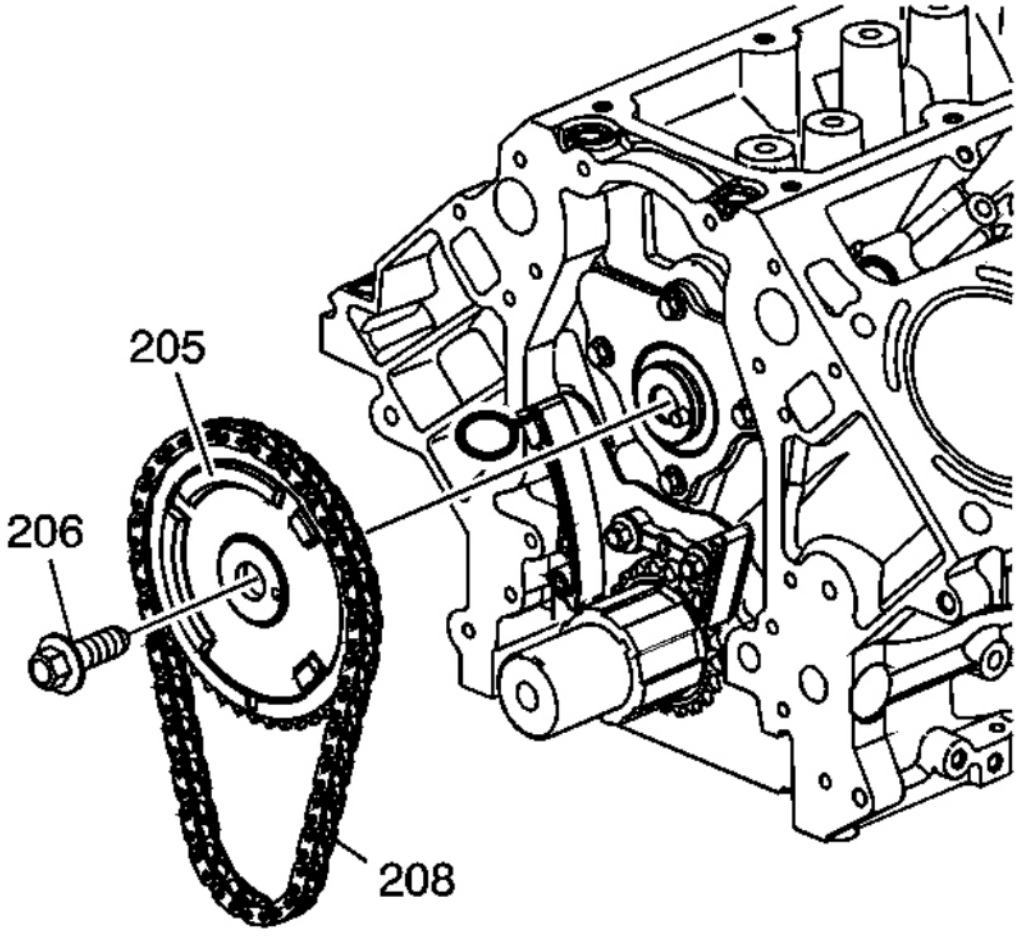


Fig. 212: View Of Camshaft Sprocket, Timing Chain & Bolt
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Do not use the camshaft sprocket bolt again. Install a NEW bolt during assembly.**
- **The sprocket teeth and timing chain must mesh.**
- **The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.**

8. Install the camshaft sprocket (205), timing chain (208), and NEW bolt (206).

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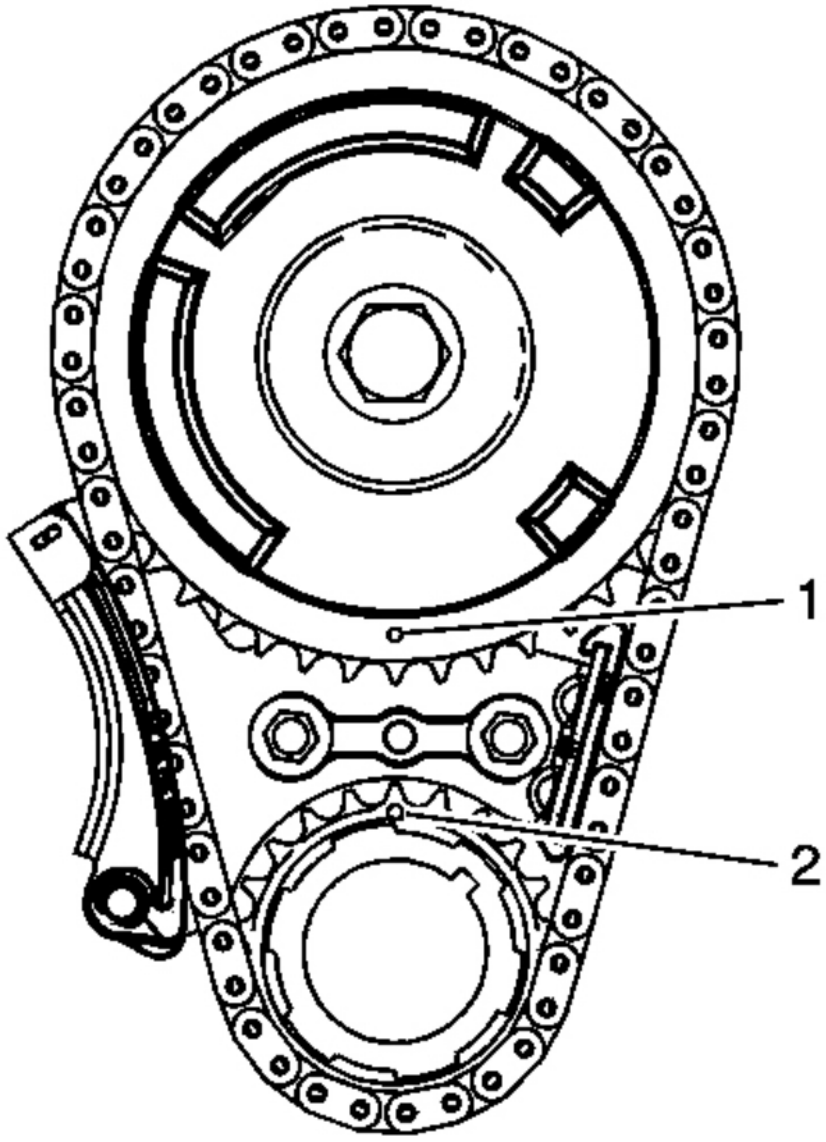


Fig. 213: Identifying Camshaft & Crankshaft Marks
Courtesy of GENERAL MOTORS CORP.

9. Inspect the sprockets for proper alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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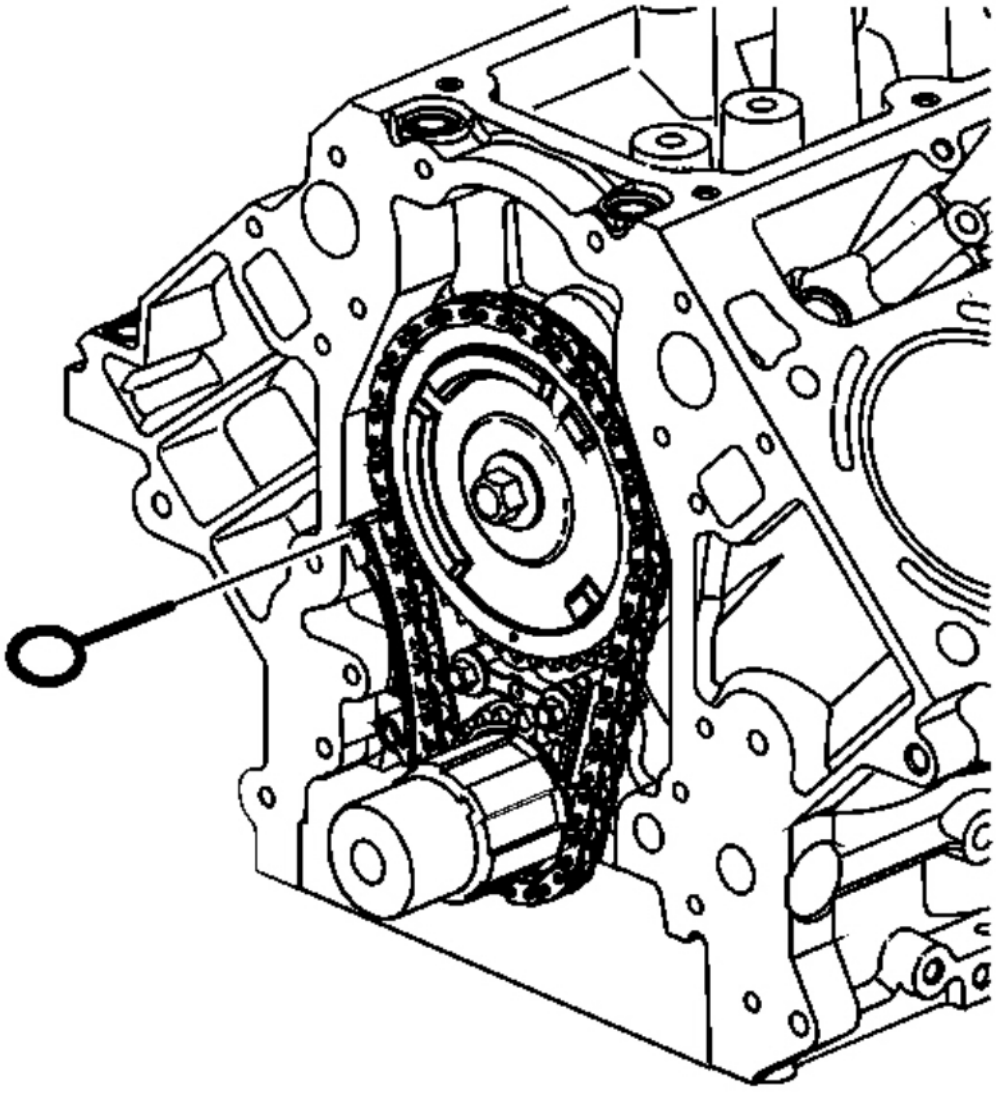


Fig. 214: Locating Tensioner Pin
Courtesy of GENERAL MOTORS CORP.

10. Remove the **EN 46330** . See **Special Tools** .

IMPORTANT: Do not apply threadlock to the flex plate bolts at this time.

11. Temporarily install the automatic transmission flex plate and bolts. Refer to **Automatic Transmission**

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Flex Plate Installation .

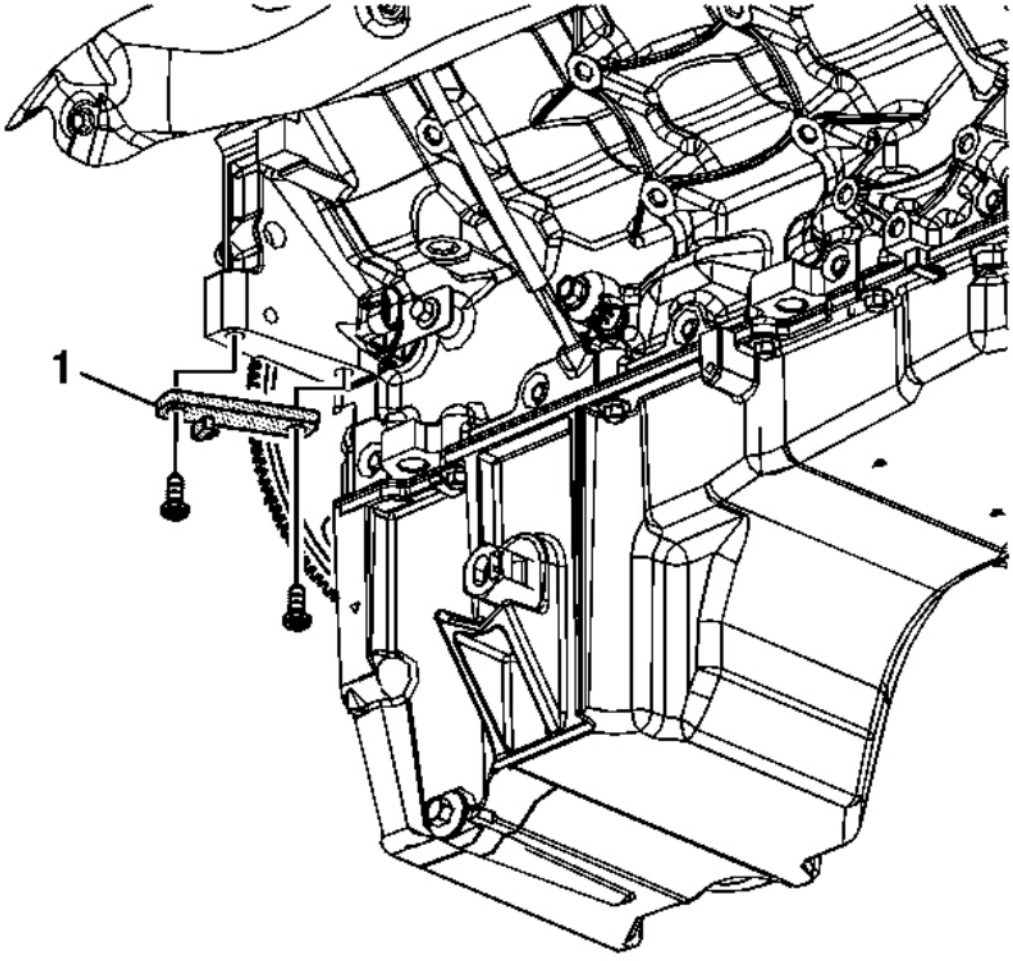


Fig. 215: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the **J 42386-A** (1) and bolts. See **Special Tools** . Use 1 M10-1.5 x 120 mm bolt and 1 M10-1.5 x 45 mm bolt for proper tool operation.

    Tighten: Tighten the **J 42386-A** bolts to 50 N. See **Special Tools** .m (37 lb ft).

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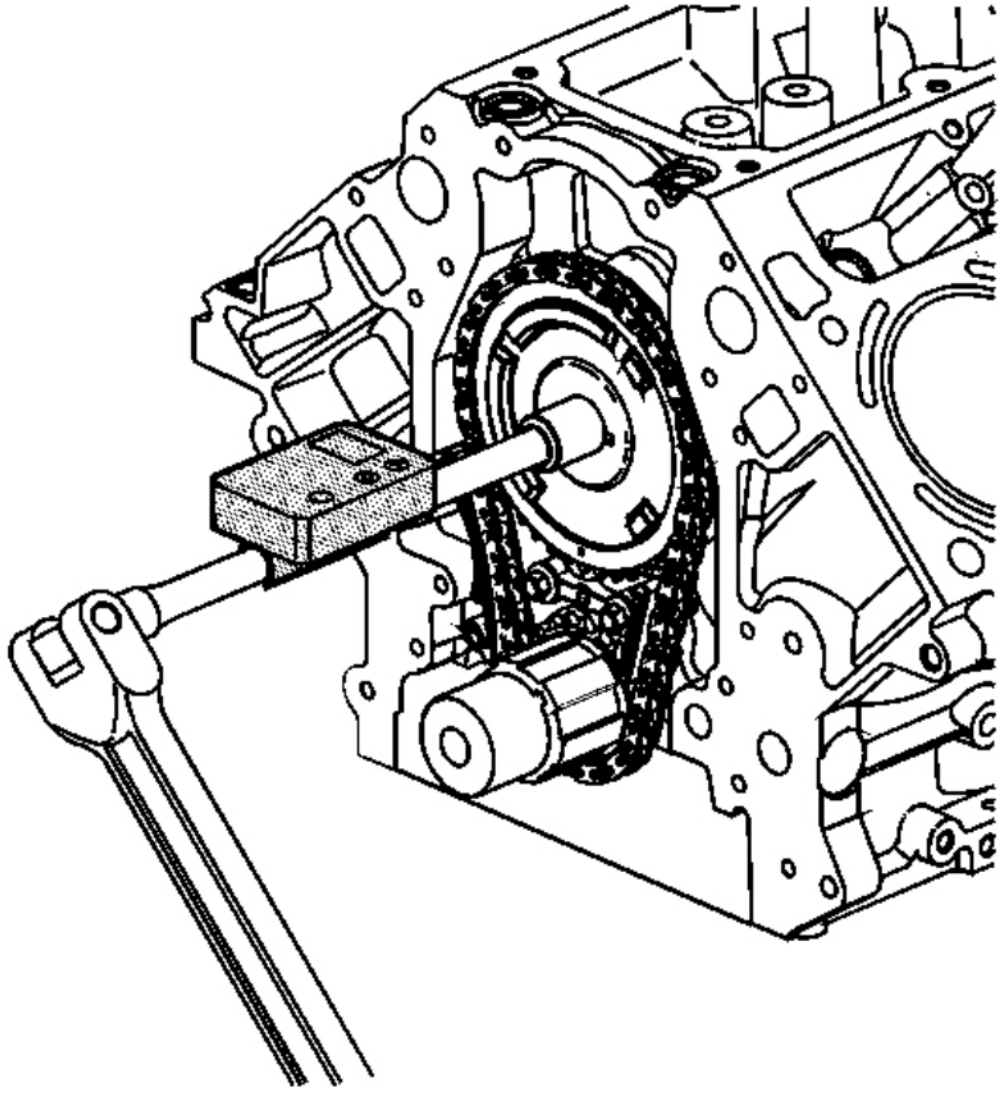


Fig. 216: Tightening Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

13. Tighten the camshaft sprocket bolt.

Tighten:

1. Tighten the camshaft sprocket bolt a first pass to 90 N.m (66 lb ft).
2. Tighten the camshaft sprocket bolt a final pass an additional 40 degrees using the **J 45059** . See

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Special Tools .

14. Remove the **J 42386-A** and bolts. See **Special Tools** .
15. Remove the automatic transmission flex plate and bolt. Refer to **Automatic Transmission Flex Plate Removal** .

OIL PUMP, SCREEN AND CRANKSHAFT OIL DEFLECTOR INSTALLATION (RPO LY2/LC9/LY5/LMG)

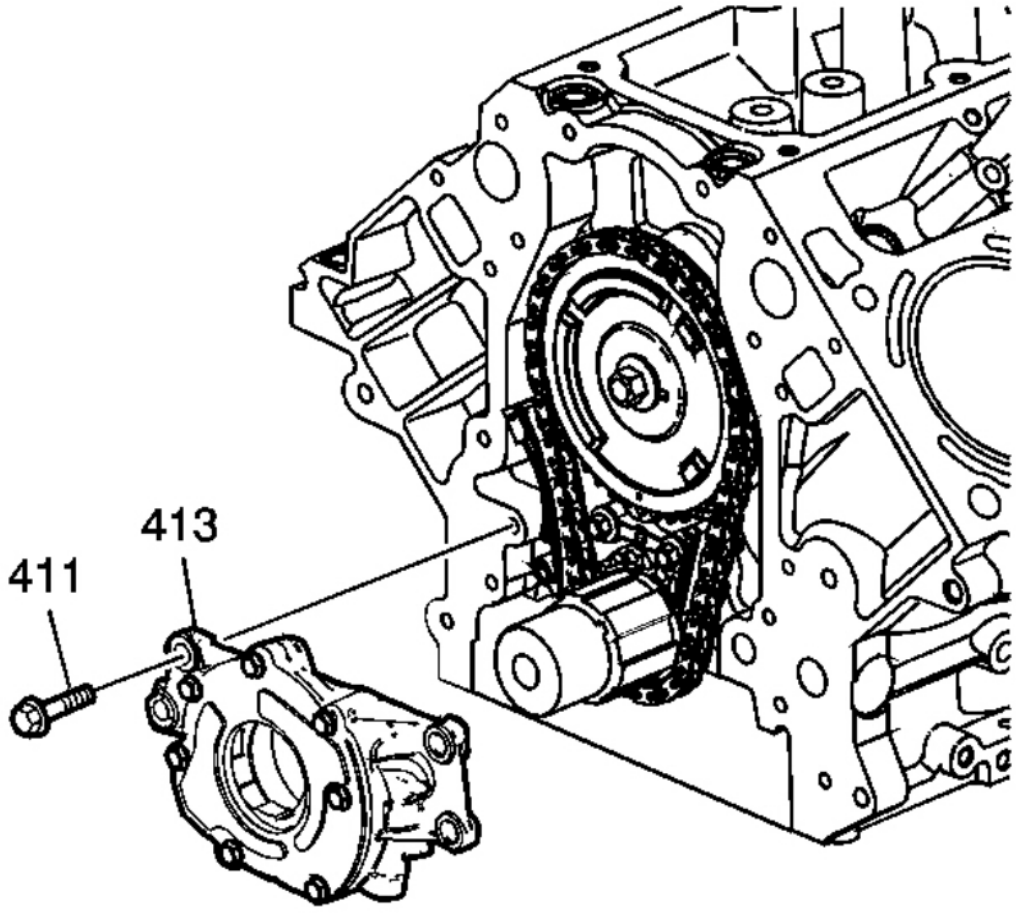


Fig. 217: View Of Oil Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Inspect the oil pump and engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

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1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (413).
2. Install the oil pump (413) onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

NOTE: **Refer to Fastener Notice .**

3. Install the oil pump bolts (411).

Tighten: Tighten the oil pump bolts to 25 N.m (18 lb ft).

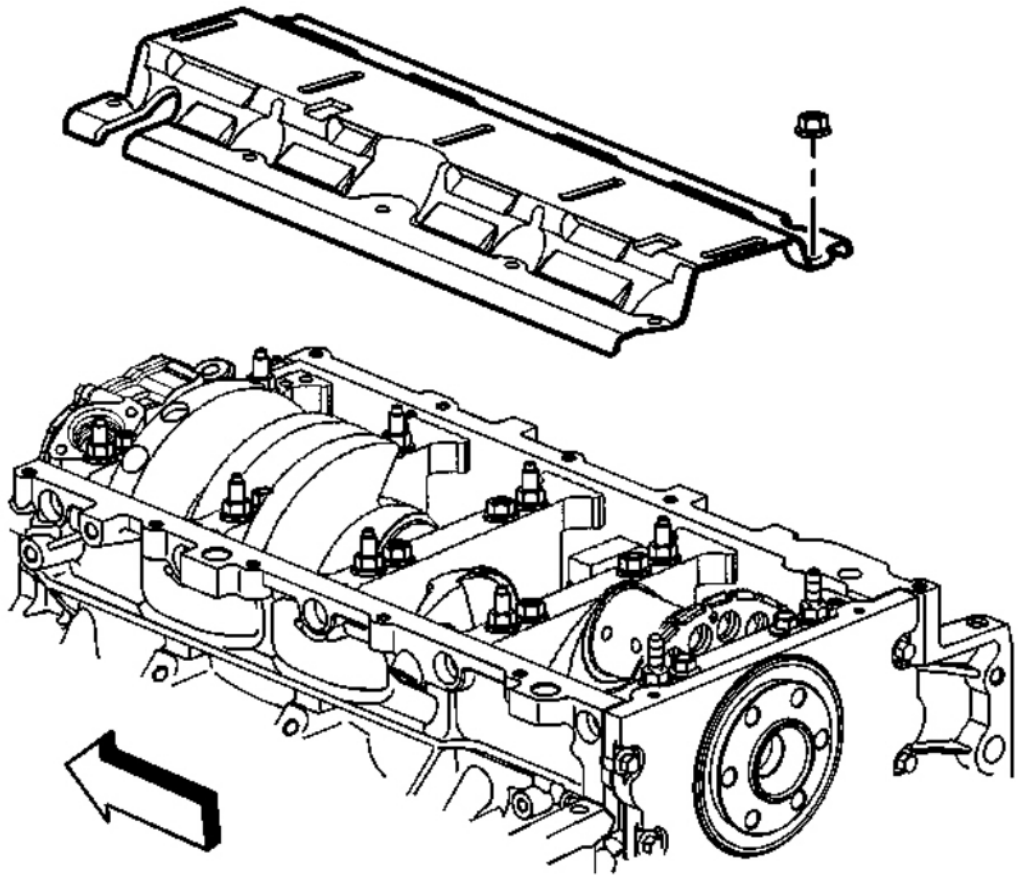


Fig. 218: View Of Crankshaft Oil Deflector
Courtesy of GENERAL MOTORS CORP.

4. Install the crankshaft oil deflector (425) and nuts (403).

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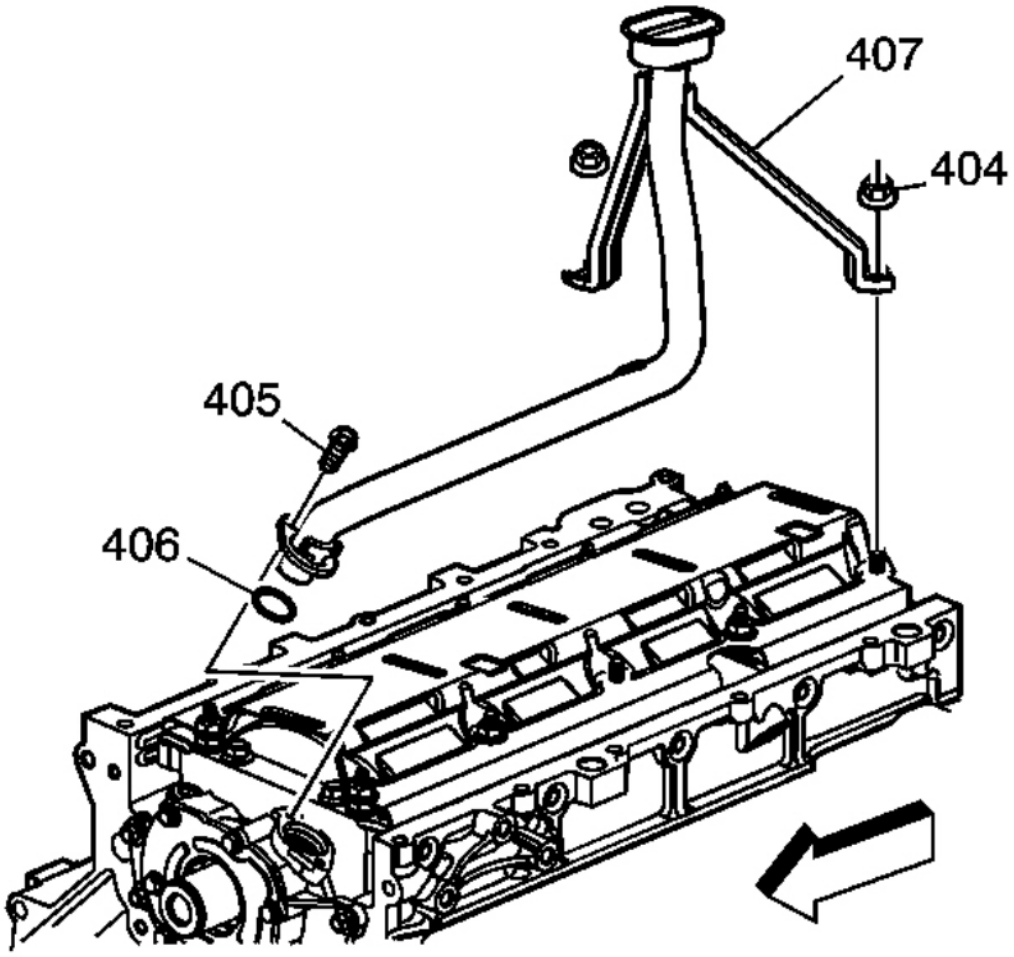


Fig. 219: View Of Oil Pump Screen, Bolt, Nuts, & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

5. Lubricate a NEW oil pump screen O-ring seal (406) with clean engine oil.
6. Install the NEW O-ring seal onto the oil pump screen.

IMPORTANT:

- **Push the oil pump screen tube completely into the oil pump prior to tightening the bolt. Do not allow the bolt to pull the tube into the pump.**
- **Align the oil pump screen mounting brackets with the correct crankshaft bearing cap bolt/studs.**

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7. Install the oil pump screen (407).
8. Install the oil pump screen bolt (405) and the nut (404).

Tighten:

1. Tighten the oil pump screen bolt to 12 N.m (106 lb in).
2. Tighten the crankshaft oil deflector nut to 25 N.m (18 lb ft).

OIL PUMP, SCREEN AND CRANKSHAFT OIL DEFLECTOR INSTALLATION (RPO LY6/L76/L92)

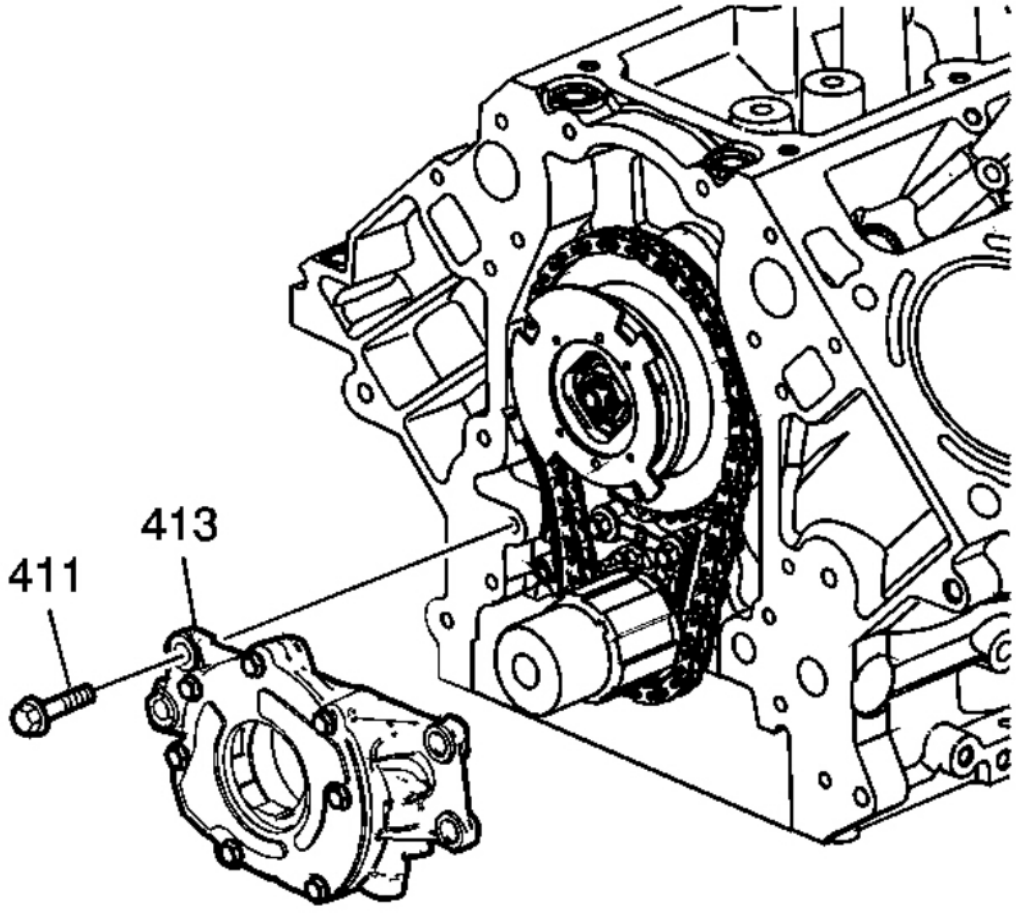


Fig. 220: View Of Oil Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

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IMPORTANT: Inspect the oil pump and engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (413).
2. Install the oil pump (413) onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

NOTE: **Refer to Fastener Notice .**

3. Install the oil pump bolts (411).

Tighten: Tighten the oil pump bolts to 25 N.m (18 lb ft).

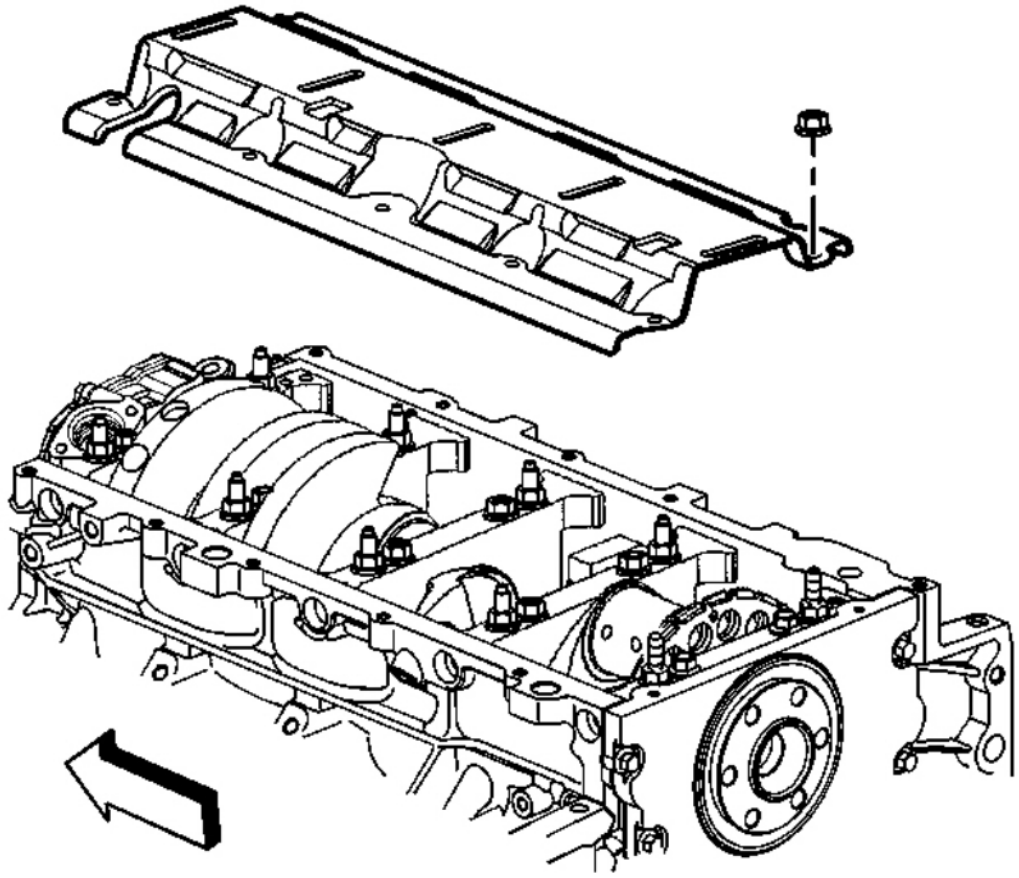


Fig. 221: View Of Crankshaft Oil Deflector

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Courtesy of GENERAL MOTORS CORP.

4. Install the crankshaft oil deflector (425) and nuts (403).

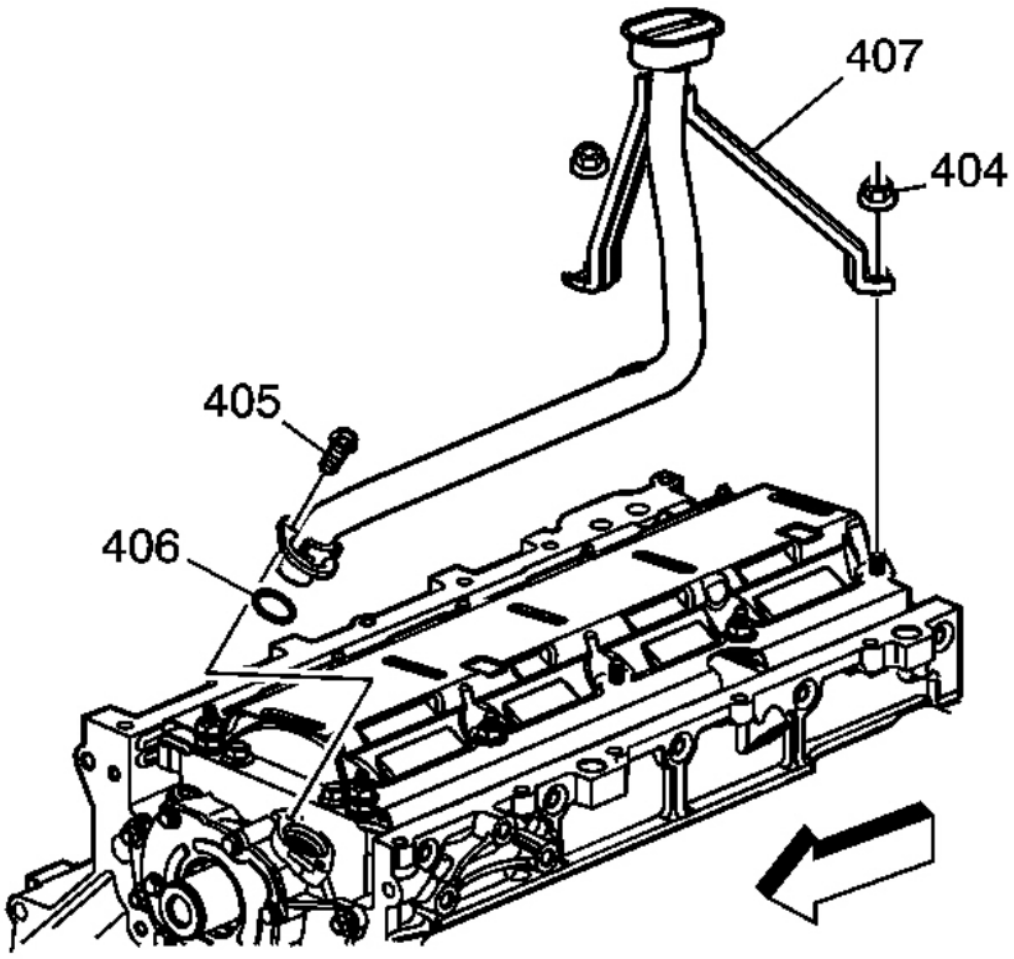


Fig. 222: View Of Oil Pump Screen, Bolt, Nuts, & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

5. Lubricate a NEW oil pump screen O-ring seal (406) with clean engine oil.
6. Install the NEW O-ring seal onto the oil pump screen.

IMPORTANT:

- **Push the oil pump screen tube completely into the oil pump prior to tightening the bolt. Do not allow the bolt to pull the tube into the pump.**

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- **Align the oil pump screen mounting brackets with the correct crankshaft bearing cap bolt/studs.**

7. Install the oil pump screen (407).
8. Install the oil pump screen bolt (405) and the nut (404).

Tighten:

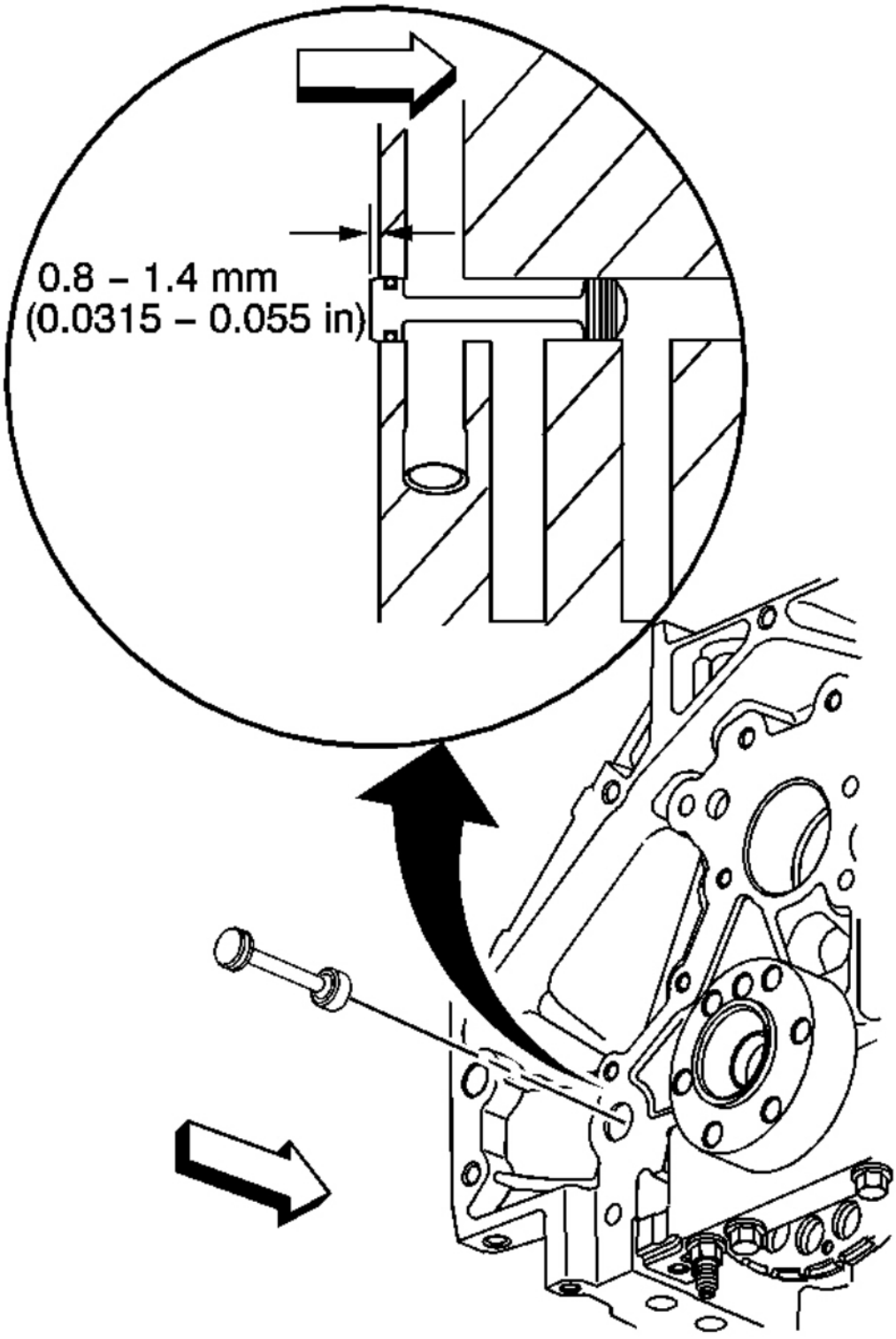
1. Tighten the oil pump screen bolt to 12 N.m (106 lb in).
2. Tighten the crankshaft oil deflector nut to 25 N.m (18 lb ft).

CRANKSHAFT REAR OIL SEAL HOUSING INSTALLATION

Tools Required

- **J 41476** Front and Rear Cover Alignment Tool. See **Special Tools** .
- **J 41480** Front and Rear Cover Alignment. See **Special Tools** .

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Fig. 223: View Of Engine Block Rear Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Do not use the crankshaft rear oil seal or the engine rear housing gasket again.**
- **Do not apply any type of sealant to the rear housing gasket, unless specified.**
- **The special tools in this procedure are used to properly align the engine rear housing at the oil pan surface and to center the crankshaft rear oil seal.**
- **The crankshaft rear oil seal will be installed after the rear housing has been installed and aligned. Install the rear housing without the crankshaft oil seal.**
  - **The crankshaft rear oil seal MUST be centered in relation to the crankshaft.**
  - **The oil pan sealing surface at the rear housing, and the engine block, MUST be aligned within specifications.**
  - **An improperly aligned rear housing may cause premature rear oil seal wear and/or engine assembly oil leaks.**

1. Inspect the rear oil gallery plug for proper installation.

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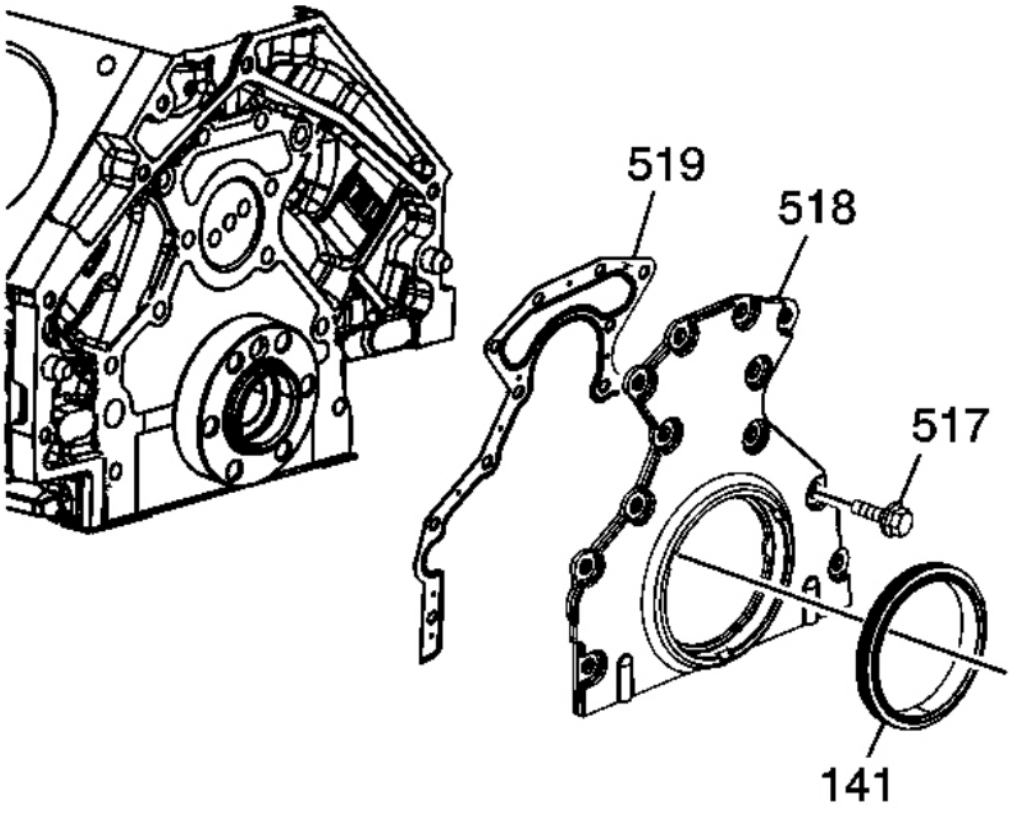


Fig. 224: View of Rear Housing, Gasket & Seal
Courtesy of GENERAL MOTORS CORP.

2. Install the rear housing gasket (519), rear housing (518), and bolts (517).
3. Tighten the bolts finger tight. Do not overtighten.

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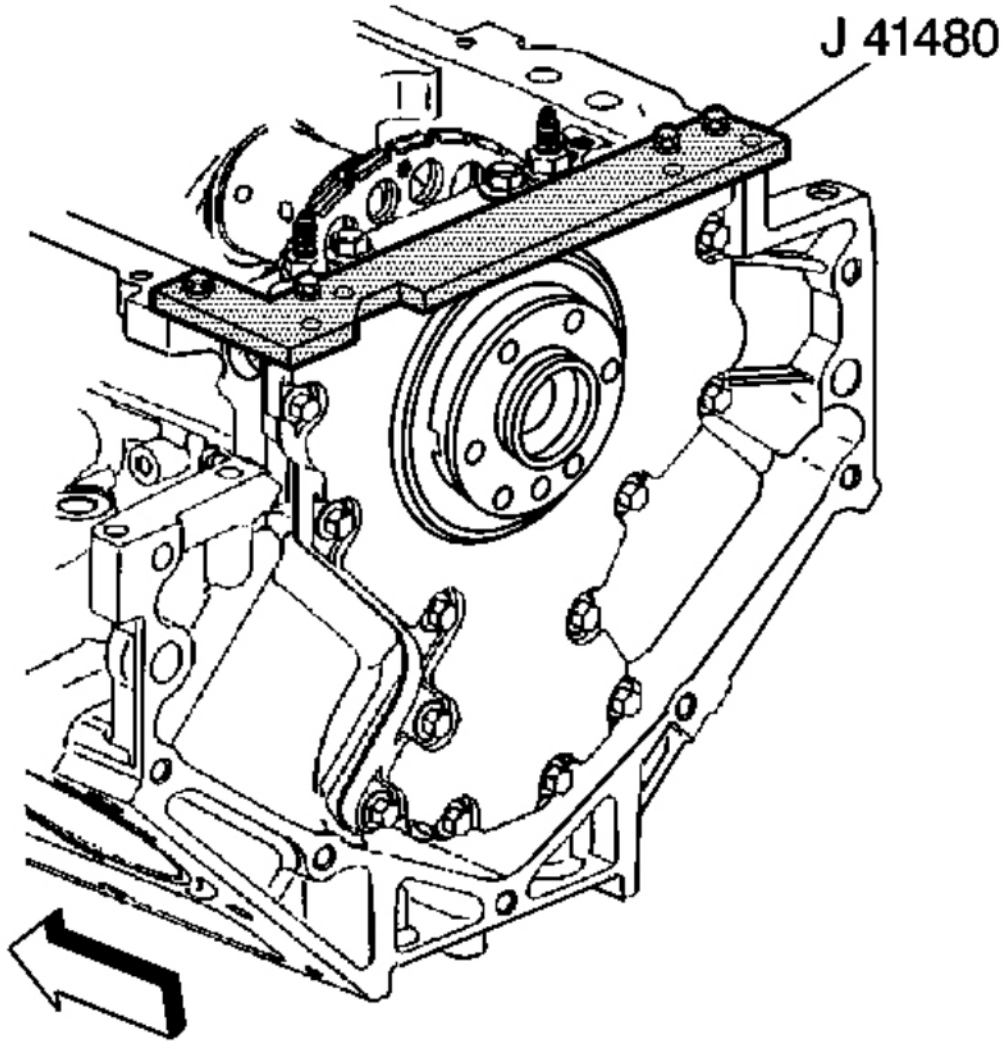


Fig. 225: View Of J 41480 Installed To Engine Block
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice .**

IMPORTANT: Start the J 41480 tool-to-rear housing bolts. See Special Tools . Do not tighten the bolts at this time.

4. Install the **J 41480** and bolts. See **Special Tools** .

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Tighten: Tighten the tool-to-engine block bolts to 25 N.m (18 lb ft).

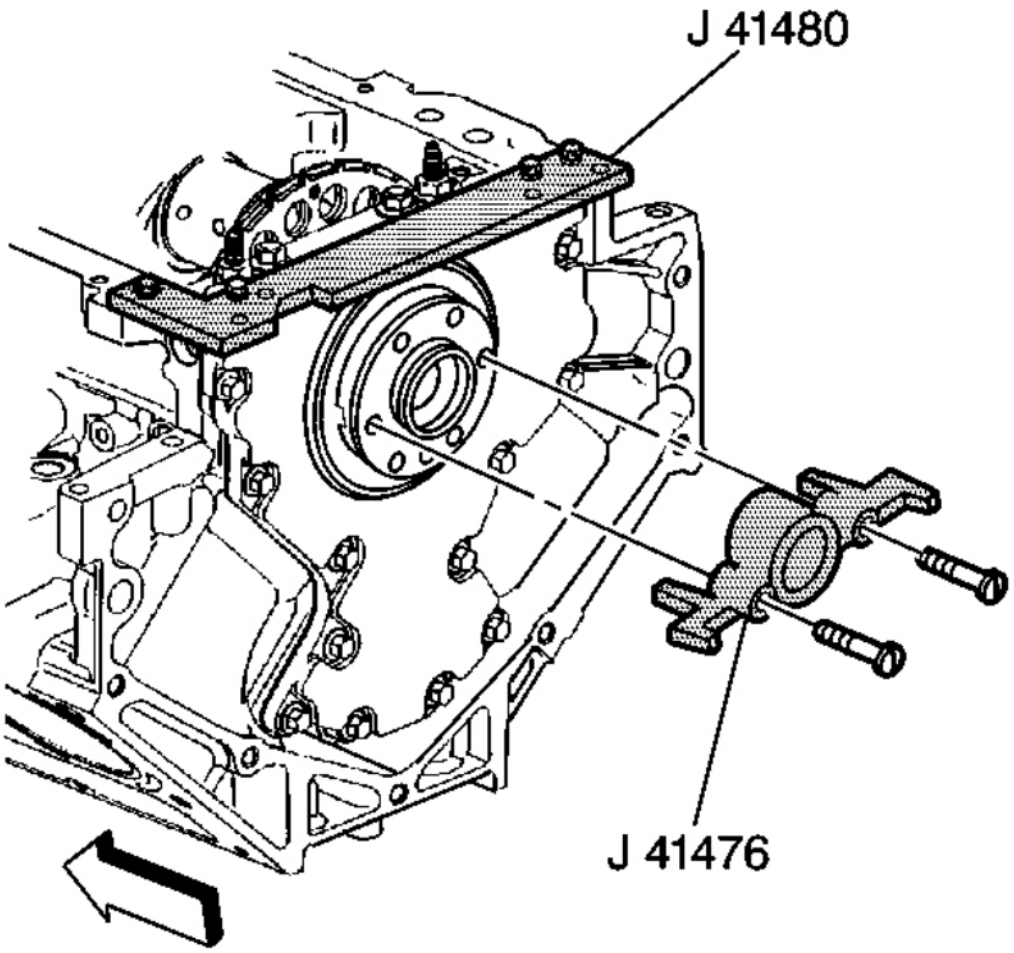


Fig. 226: View Of J 41480 & J 41476
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: To properly align the rear housing, the J 41476 must be installed onto the rear of the crankshaft with the tool mounting bolts parallel to the oil pan surface. See Special Tools .

5. Rotate the crankshaft until 2 opposing flywheel bolt holes are parallel to the oil pan surface.

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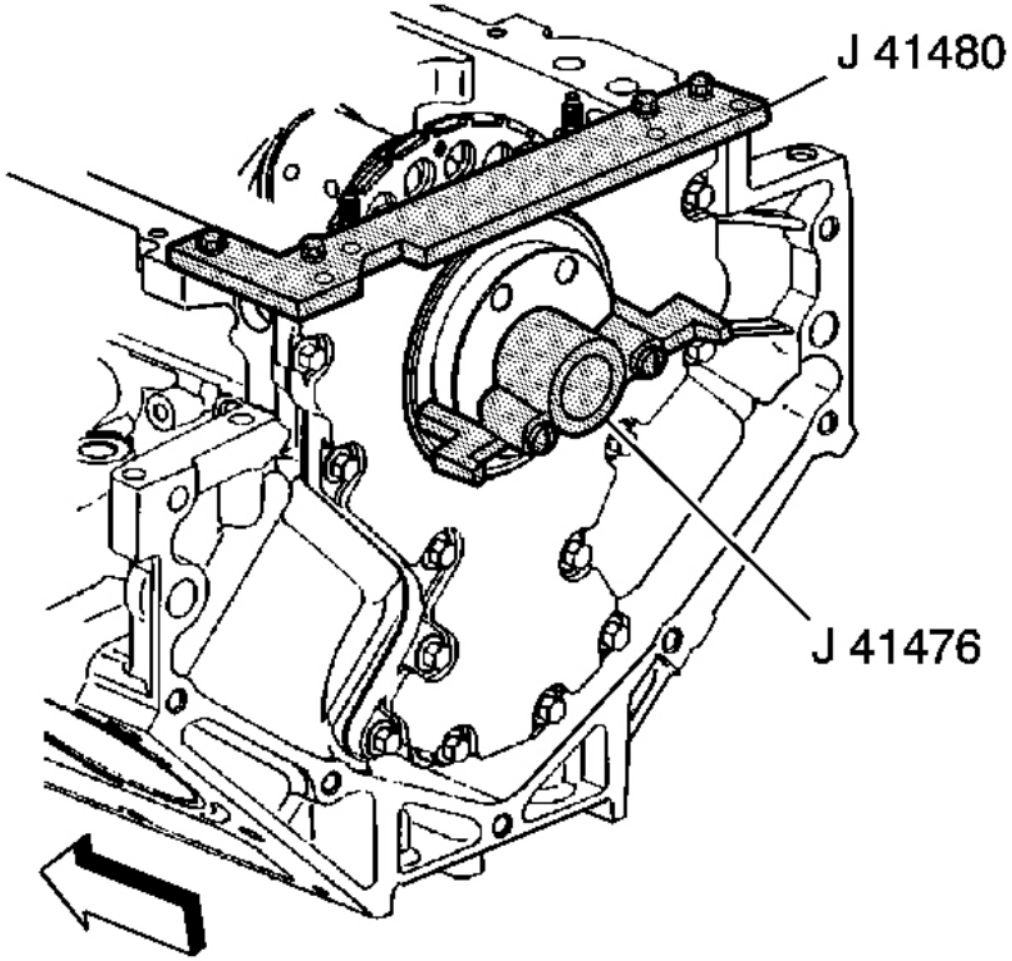


Fig. 227: View Of J 41480 & J 41476 Installed
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The tapered legs of the alignment tool must enter the rear housing oil seal bore.

6. Install the **J 41476** and bolts onto the rear of the crankshaft. See **Special Tools** .

Tighten:

1. Tighten the tool mounting bolts until snug. Do not overtighten.
2. Tighten the **J 41480** tool-to-rear housing bolts evenly to 12 N. See **Special Tools** .m (106 lb in).
3. Tighten the rear housing bolts to 30 N.m (22 lb ft).

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7. Remove the tools.

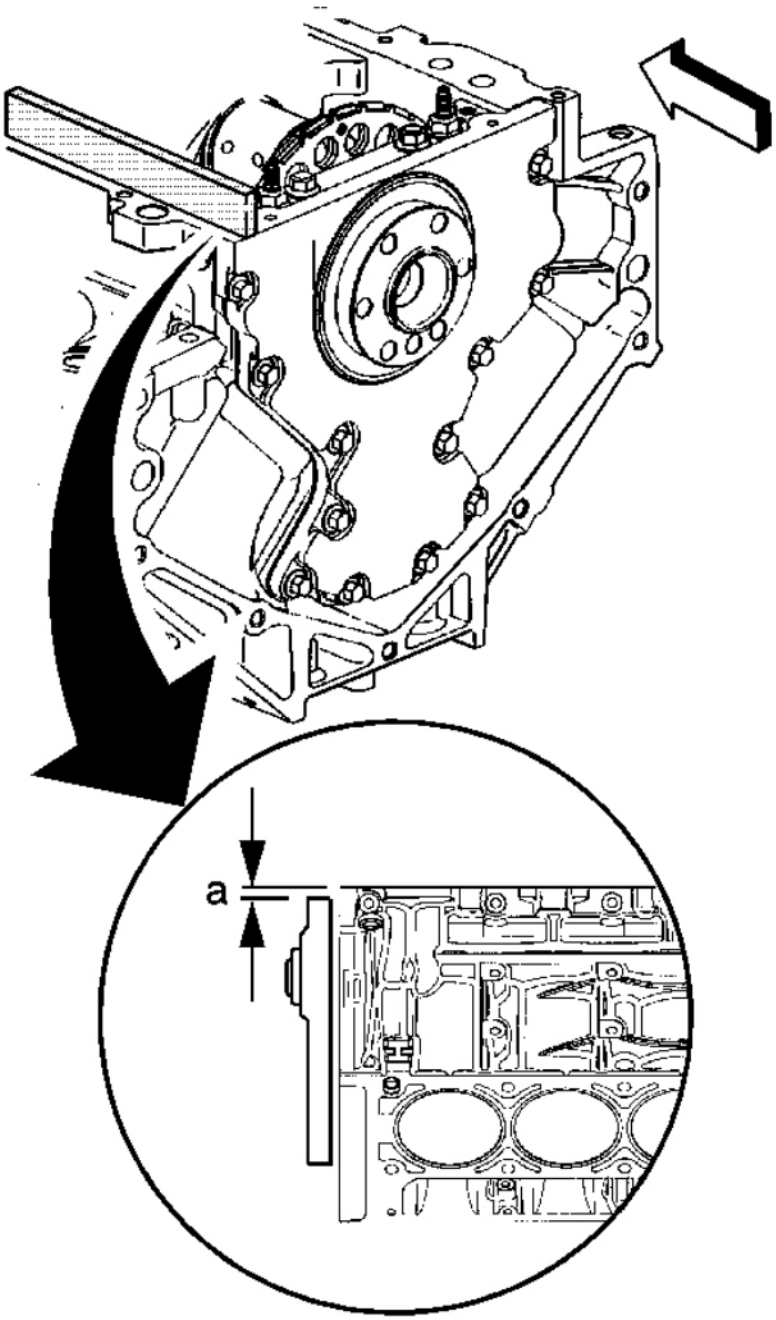


Fig. 228: Checking Rear Cover-To-Engine Block Proper Installation Position
Courtesy of GENERAL MOTORS CORP.

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8. Measure the rear housing-to-engine block oil pan surface for flatness.
    1. Place a straight edge onto the engine block and rear housing oil pan sealing surfaces.

       Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

    2. Insert a feeler gage between the rear housing and the straight edge. The housing must be flush with the oil pan or no greater than 0.5 mm (0.02 in) below flush.
9. If the rear housing-to-engine block oil pan surface alignment is not within specifications, repeat the housing alignment procedure.
10. If the correct rear housing-to-engine block alignment at the oil pan surface cannot be obtained, replace the rear housing.

CRANKSHAFT REAR OIL SEAL INSTALLATION

Tools Required

- **J 41479** Crankshaft Rear Oil Seal Installer. See **Special Tools** .
- **J 41479-2A** Crankshaft Rear Oil Seal Installation Guide

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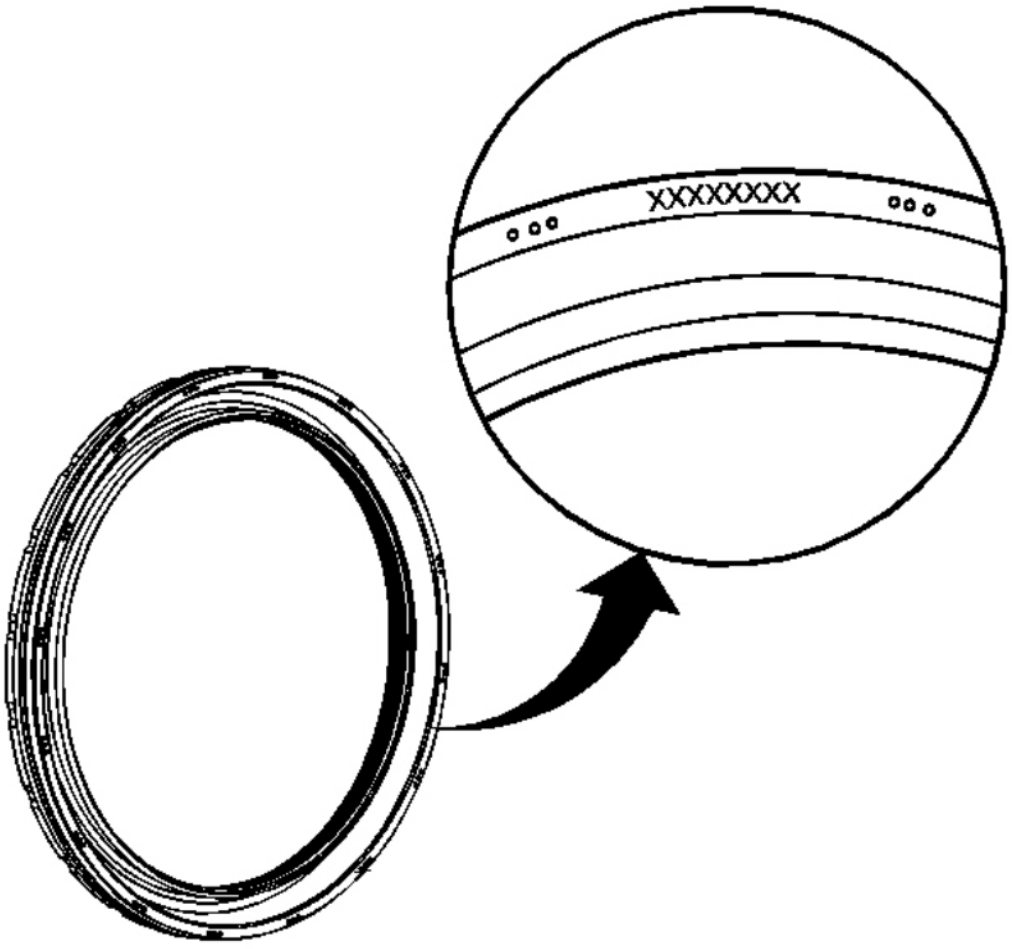


Fig. 229: Identifying Oil Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. The part number is applied to the outside face of the seal, as shown.

1. Inspect the seal and identify the part number markings for proper orientation.

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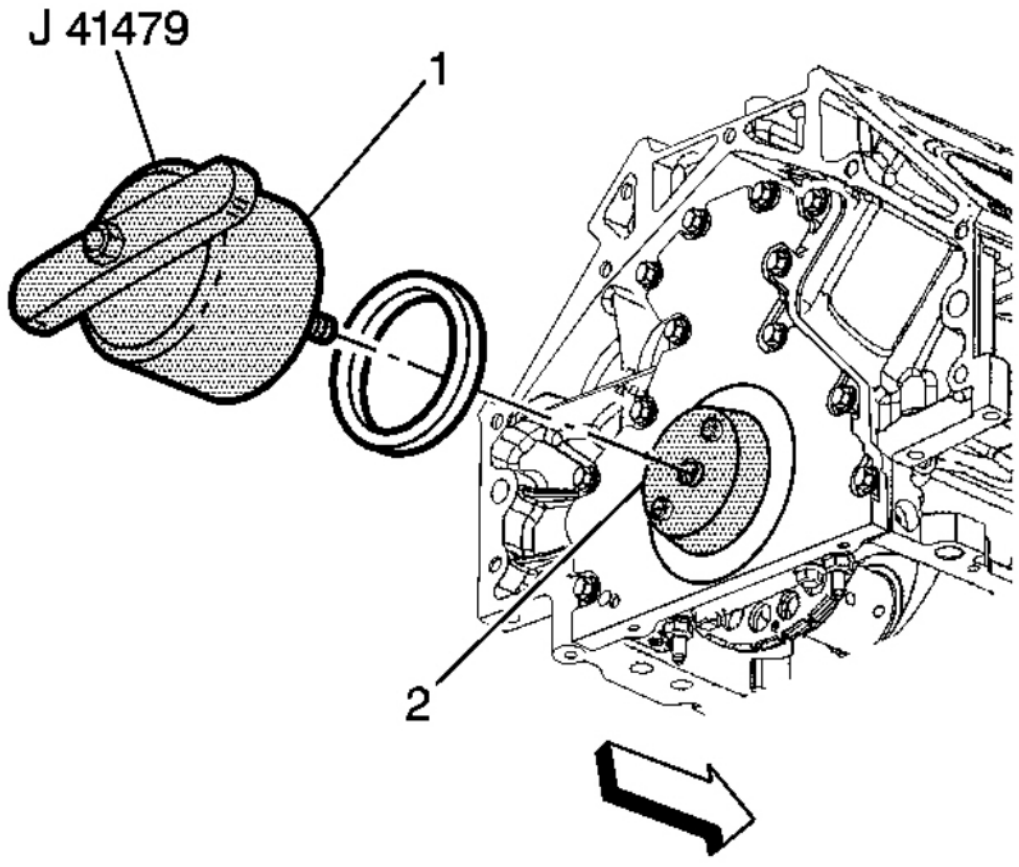


Fig. 230: Installing Crankshaft Rear Oil Seal Using J 41479
Courtesy of GENERAL MOTORS CORP.

2. Install the **J 41479** or **J 41479-2A** cone (2) and bolts onto the rear of the crankshaft. **J 41479-2A** may be required for manual transmission applications. See **Special Tools** .
3. Tighten the bolts until snug. Do not overtighten.
4. Install the rear oil seal onto the tapered cone (2) and push the seal to the rear seal bore. Install the oil seal with the part number markings facing away from the engine.
5. Thread the **J 41479** threaded rod into the tapered cone until the tool (1) contacts the oil seal. See **Special Tools** .
6. Align the oil seal onto the tool (1).
7. Rotate the handle of the tool (1) clockwise until the seal enters the rear housing and bottoms into the seal bore.
8. Remove the tool.

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ENGINE FRONT COVER INSTALLATION (RPO LY2/LC9/LY5/LMG)

Tools Required

- **J 41476** Front and Rear Cover Alignment Tool. See **Special Tools** .
- **J 41480** Front and Rear Cover Alignment. See **Special Tools** .

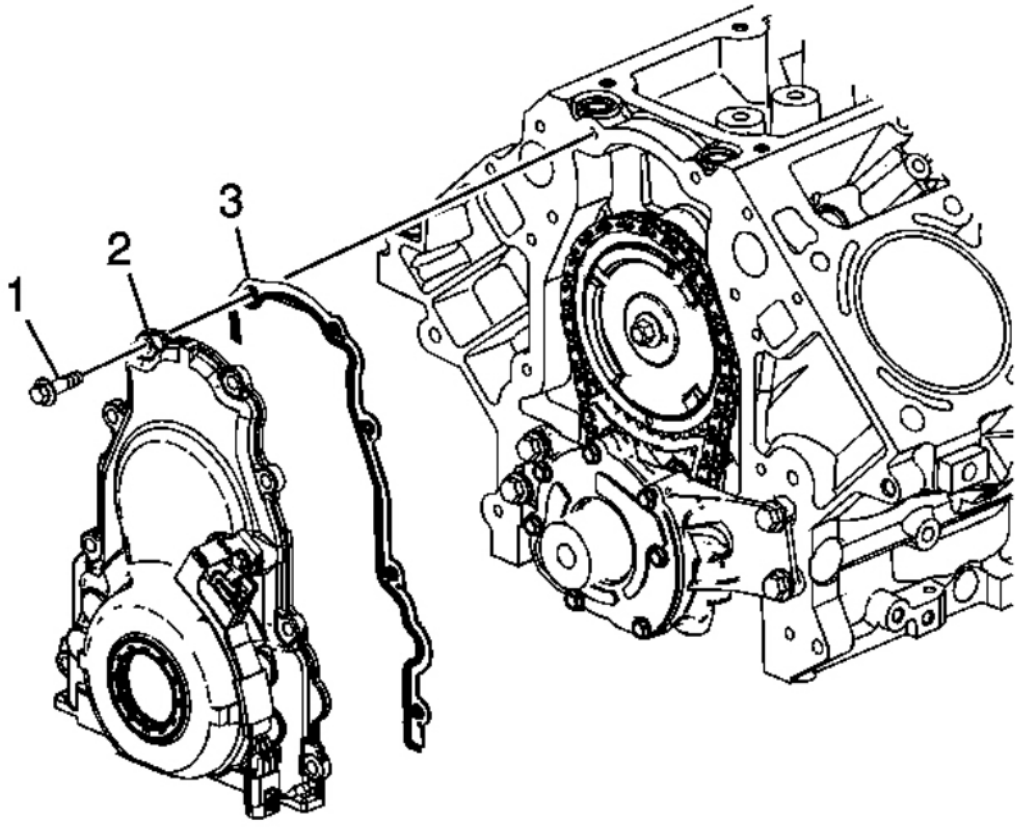


Fig. 231: View Of Front Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Do not use the crankshaft oil seal or the engine front cover gasket again.**
- **Do not apply any type of sealant to the front cover gasket, unless specified.**
- **The special tools in this procedure are used to properly align the**

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engine front cover at the oil pan surface and to center the crankshaft front oil seal.

- **All gasket surfaces should be free of oil or other foreign material during assembly.**

  The crankshaft front oil seal MUST be centered in relation to the crankshaft.

- **The oil pan sealing surface at the front cover and engine block MUST be aligned within specifications.**
- **An improperly aligned front cover may cause premature front oil seal wear and/or engine assembly oil leaks.**

1. Install the front cover gasket (3), front cover (2), and bolts (1).
2. Tighten the cover bolts finger tight. Do not overtighten.

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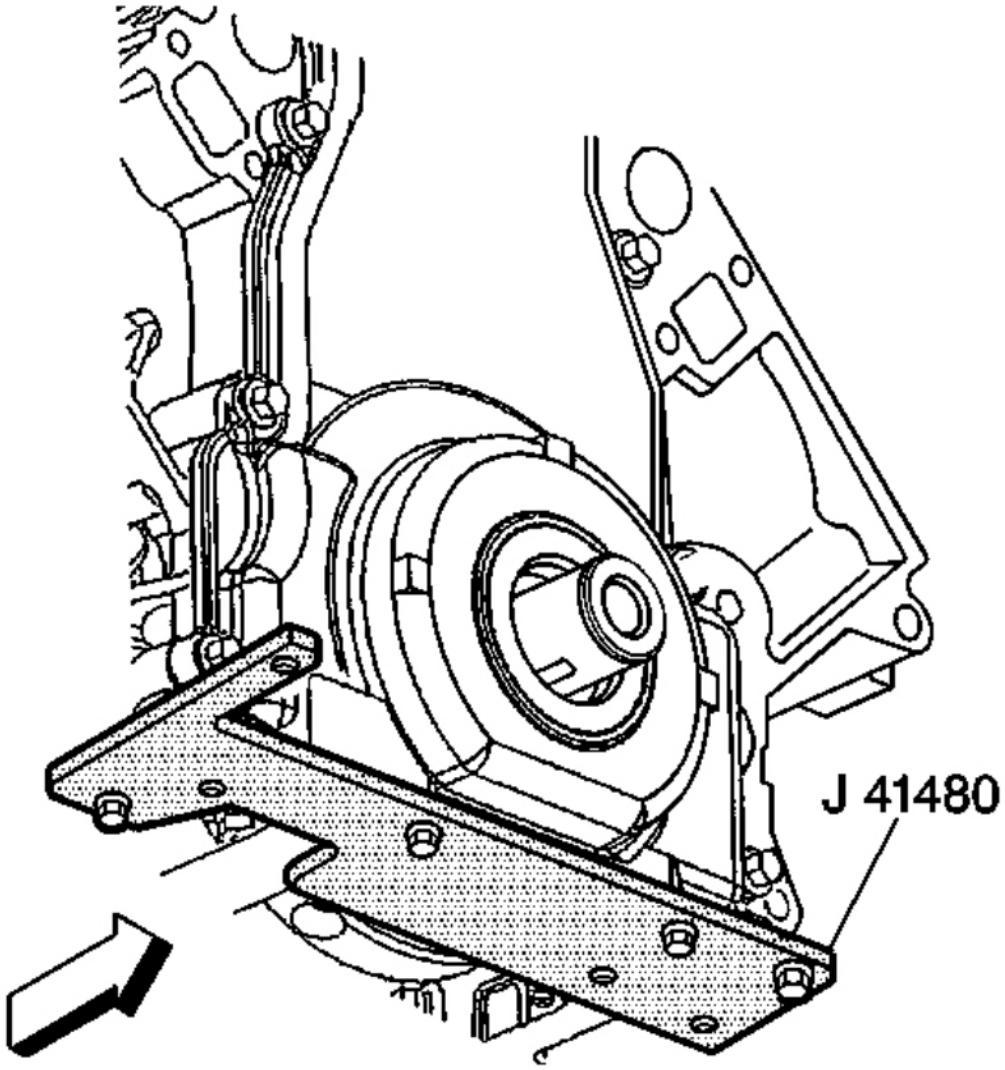


Fig. 232: View Of J 41480 Installed On Engine Block
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice .**

IMPORTANT: Start the tool-to-front cover bolts. Do not tighten the bolts at this time.

3. Install the **J 41480** . See **Special Tools** .

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Tighten: Tighten the tool-to-engine block bolts to 25 N.m (18 lb ft).

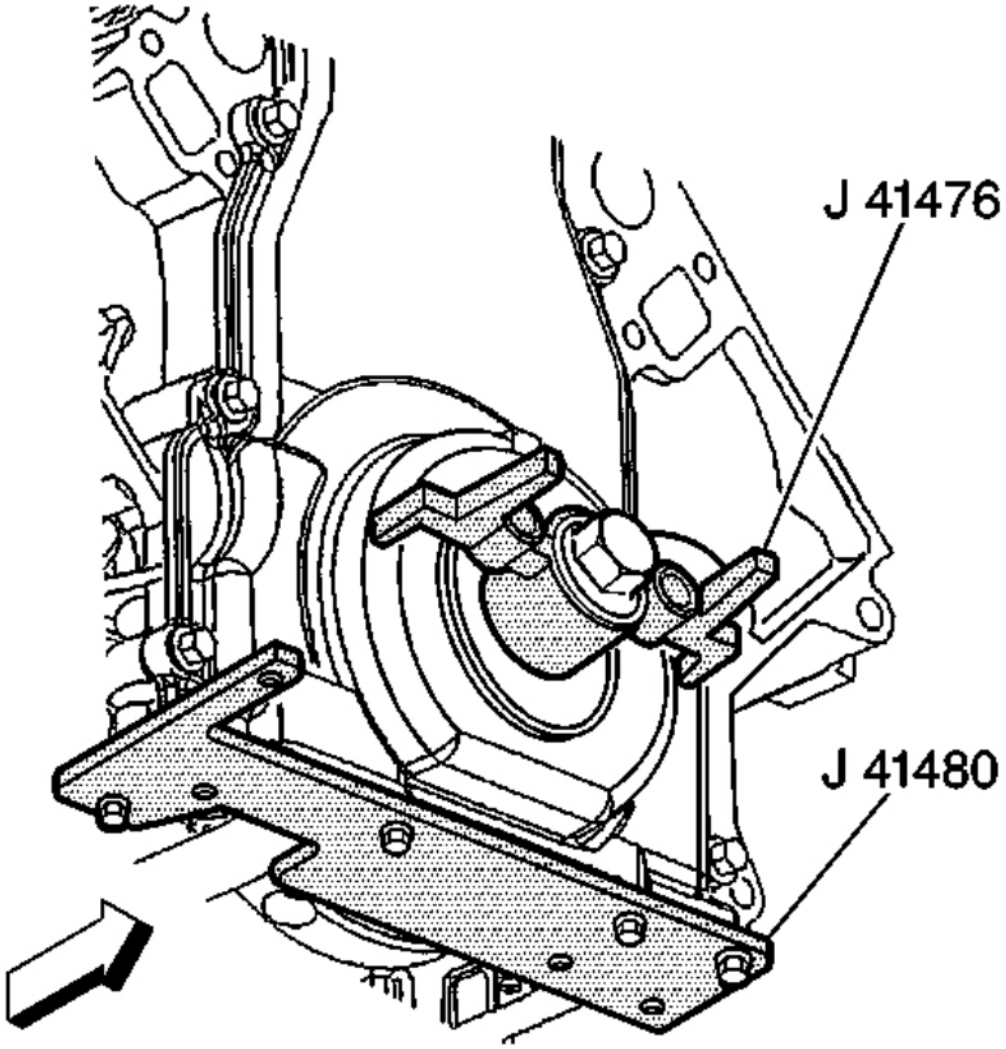


Fig. 233: View Of J 41476 & J 41480 Installed On Engine
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Align the tapered legs of the tool with the machined alignment surfaces on the front cover.

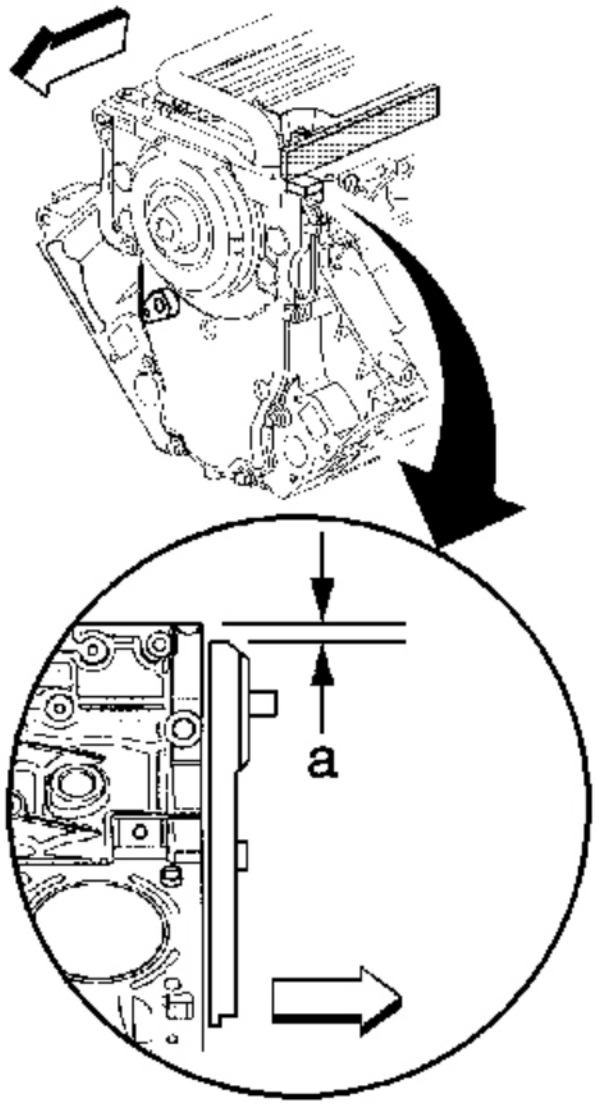
4. Install the **J 41476** . See **Special Tools** .
5. Install the crankshaft balancer bolt.

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Tighten:

1. Tighten the crankshaft balancer bolt by hand until snug. Do not overtighten.
2. Tighten the **J 41480** . See **Special Tools** .
3. Tighten the engine front cover bolts to 25 N.m (18 lb ft).

6. Remove the tools.



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Fig. 234: Measuring Oil Pan Surface Flatness & Front Cover-To-Engine Block
Courtesy of GENERAL MOTORS CORP.

7. Measure the oil pan surface flatness, front cover-to-engine block.
    1. Place a straight edge across the engine block and front cover oil pan sealing surfaces.

       Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

    2. Insert a feeler gage between the front cover and the straight edge tool. The cover must be flush with the oil pan surface or no greater than 0.5 mm (0.02 in) (a) below flush.
8. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
9. If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.

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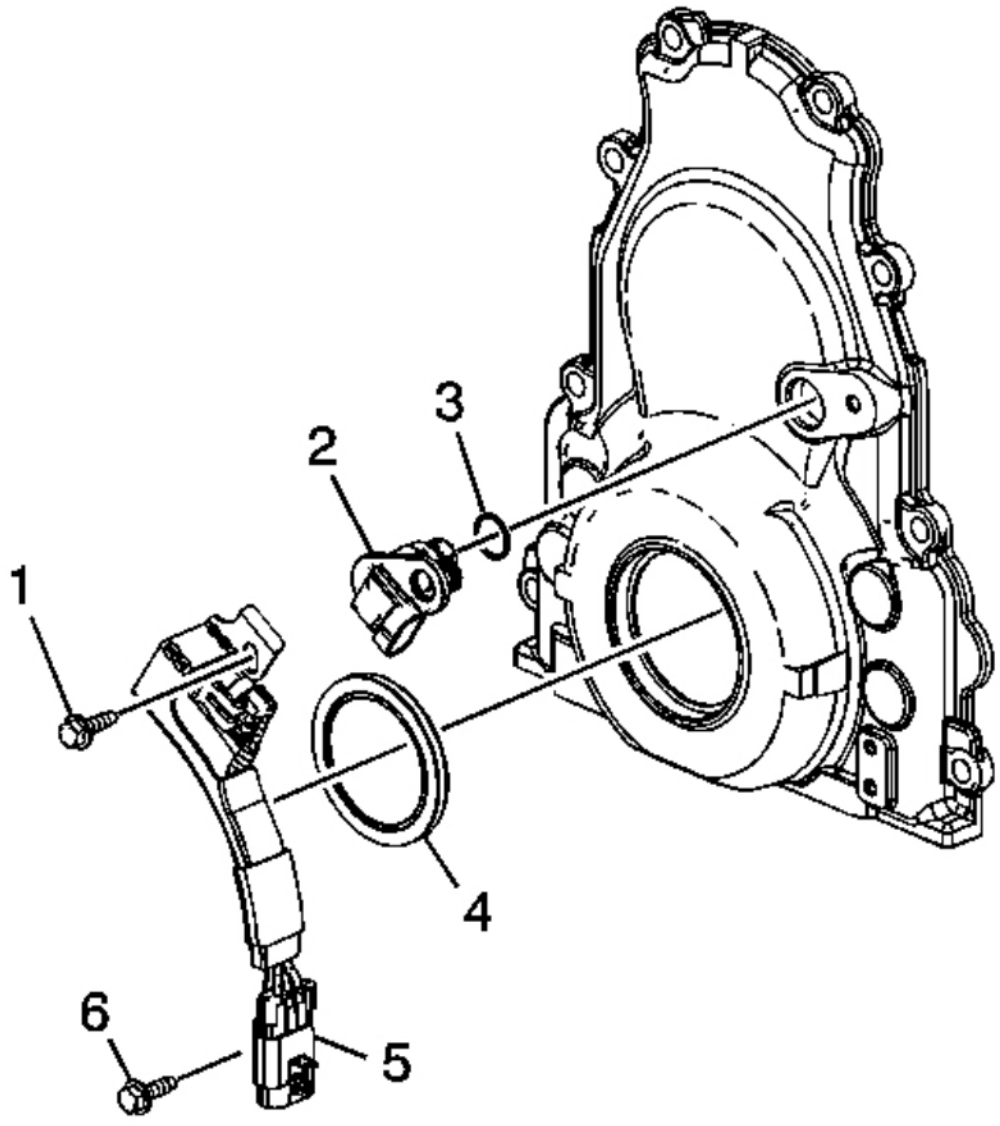


Fig. 235: View Of Front Cover, Oil Seal, Camshaft Position Sensor, Bracket & O Ring
Courtesy of GENERAL MOTORS CORP.

10. Inspect the camshaft position (CMP) sensor O-ring seal (3) for cuts or damage. If the seal is not cut or damaged, it may be used again.
11. Lubricate the O-ring seal with clean engine oil.
12. Install the O-ring seal onto the sensor (2).

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13. Install the sensor to the cover.
14. Install the CMP sensor wire harness (5) and bolts (1, 6).

Tighten: Tighten the bolts to 12 N.m (106 lb in).

ENGINE FRONT COVER INSTALLATION (RPO LY6/L76/L92)

Tools Required

- **J 41476** Front and Rear Cover Alignment Tool. See **Special Tools** .
- **J 41480** Front and Rear Cover Alignment. See **Special Tools** .

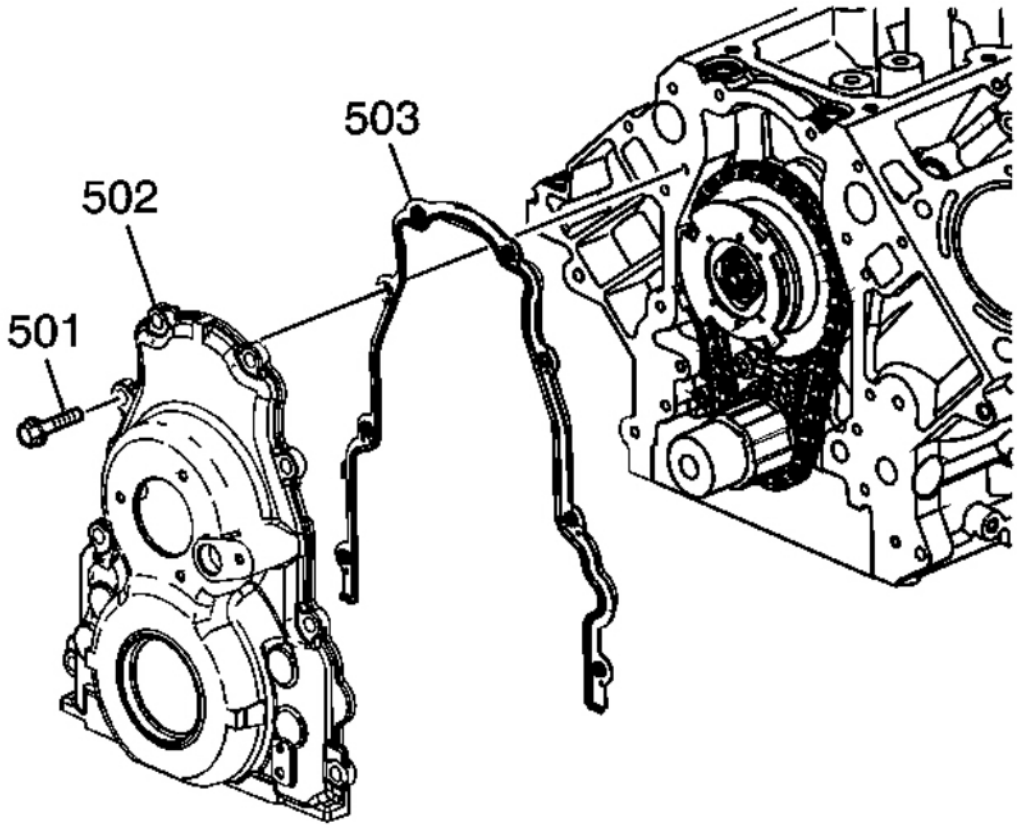


Fig. 236: Engine Front Cover Components
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **Fastener Notice** .

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IMPORTANT:

- **Do not use the crankshaft oil seal or the engine front cover gasket again.**
- **Do not apply any type of sealant to the front cover gasket, unless specified.**
- **The special tools in this procedure are used to properly align the engine front cover at the oil pan surface and to center the crankshaft front oil seal.**
  - **All gasket surfaces should be free of oil or other foreign material during assembly.**

    The crankshaft front oil seal MUST be centered in relation to the crankshaft.
  - **The oil pan sealing surface at the front cover and engine block MUST be aligned within specifications.**
  - **An improperly aligned front cover may cause premature front oil seal wear and/or engine assembly oil leaks.**

1. Install the front cover gasket (503), front cover (502), and bolts (501).
2. Tighten the cover bolts finger tight. Do not overtighten.

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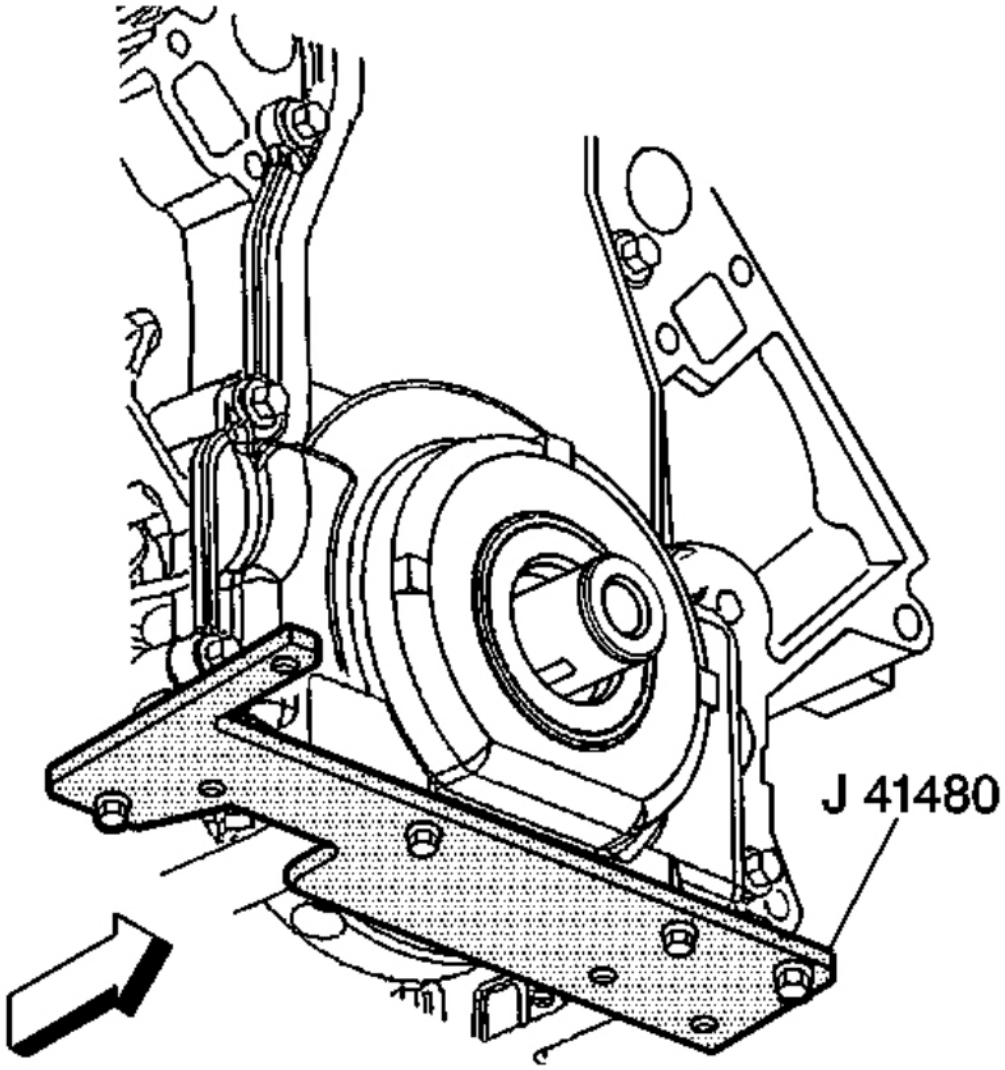


Fig. 237: View Of J 41480 Installed On Engine Block
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Start the tool-to-front cover bolts. Do not tighten the bolts at this time.

3. Install the **J 41480** . See **Special Tools** .

Tighten: Tighten the tool-to-engine block bolts to 25 N.m (18 lb ft).

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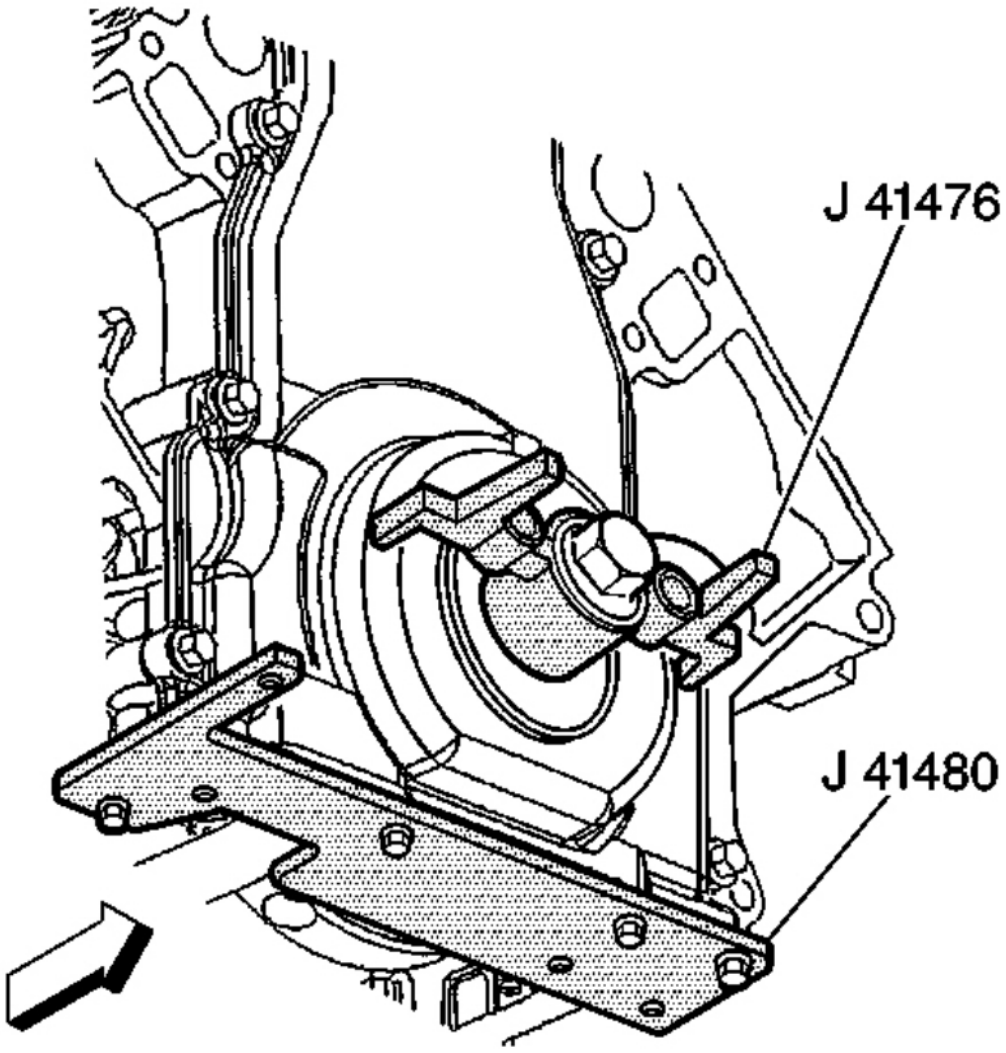


Fig. 238: View Of J 41476 & J 41480 Installed On Engine
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Align the tapered legs of the tool with the machined alignment surfaces on the front cover.

4. Install the **J 41476** . See **Special Tools** .
5. Install the crankshaft balancer bolt.

Tighten:

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1. Tighten the crankshaft balancer bolt by hand until snug. Do not overtighten.
2. Tighten the **J 41480** . See **Special Tools** .
3. Tighten the engine front cover bolts to 25 N.m (18 lb ft).

6. Remove the tools.

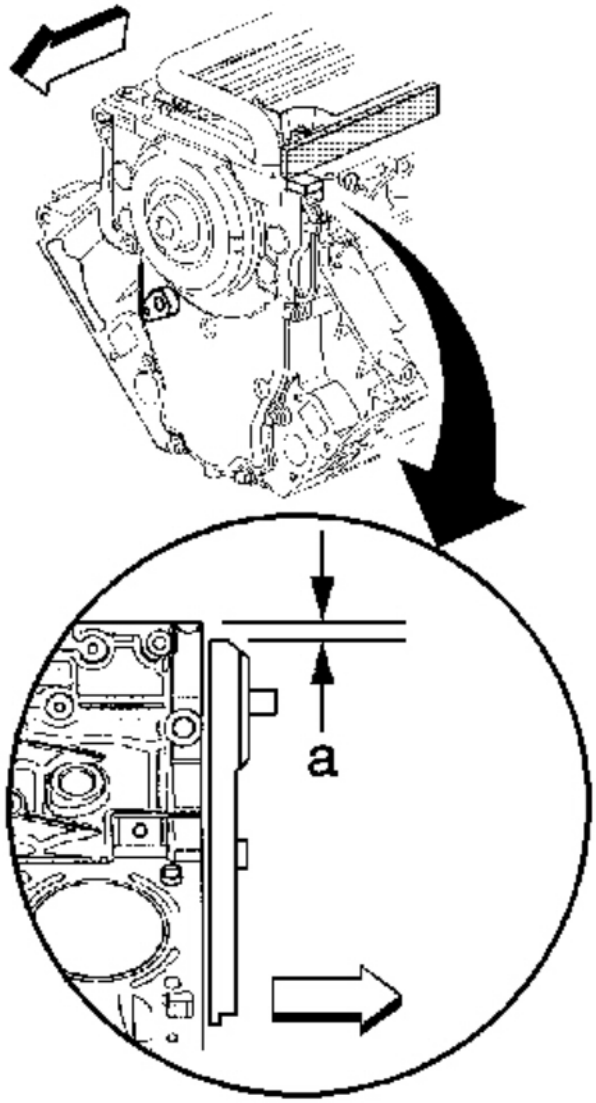


Fig. 239: Measuring Oil Pan Surface Flatness & Front Cover-To-Engine Block

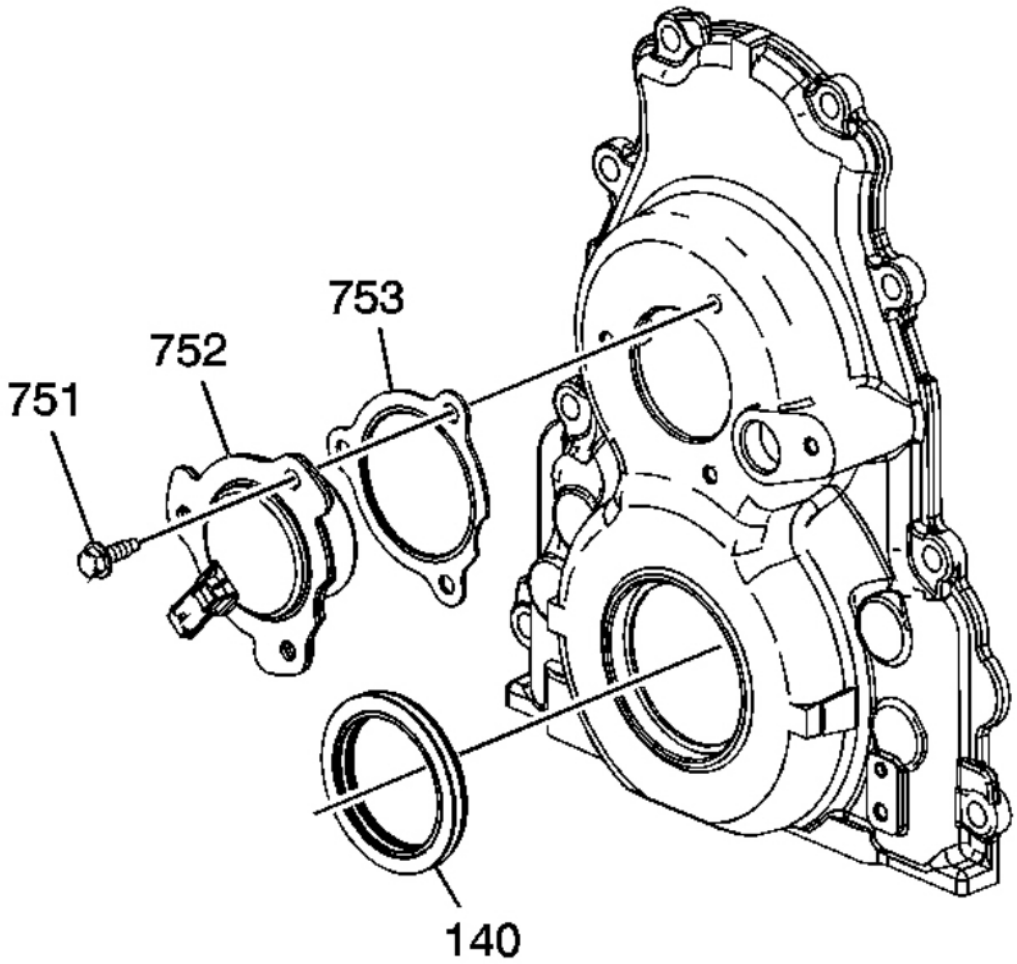
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Courtesy of GENERAL MOTORS CORP.

7. Measure the oil pan surface flatness, front cover-to-engine block.
    1. Place a straight edge across the engine block and front cover oil pan sealing surfaces.

       Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

    2. Insert a feeler gage between the front cover and the straight edge tool. The cover must be flush with the oil pan surface or no greater than 0.5 mm (0.02 in) (a) below flush.
8. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
9. If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.

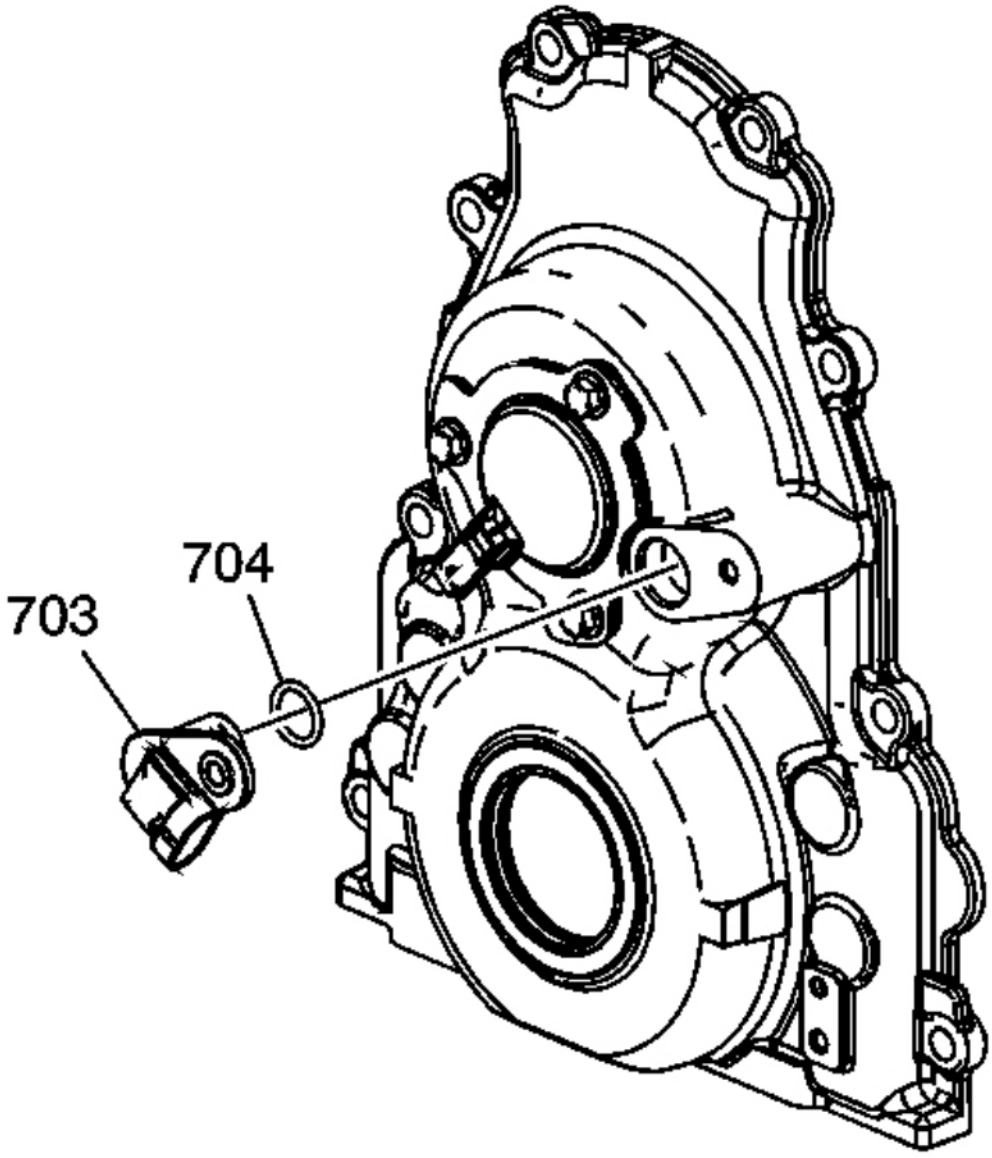


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Fig. 240: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS CORP.

10. Install the camshaft position (CMP) actuator magnet (752), gasket (753), and bolts (751).

    Tighten: Tighten the bolts to 12 N.m (106 lb in).



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Fig. 241: View Of CMP Sensor & O-Ring
Courtesy of GENERAL MOTORS CORP.

11. Install the CMP sensor (703) and O-ring (704).

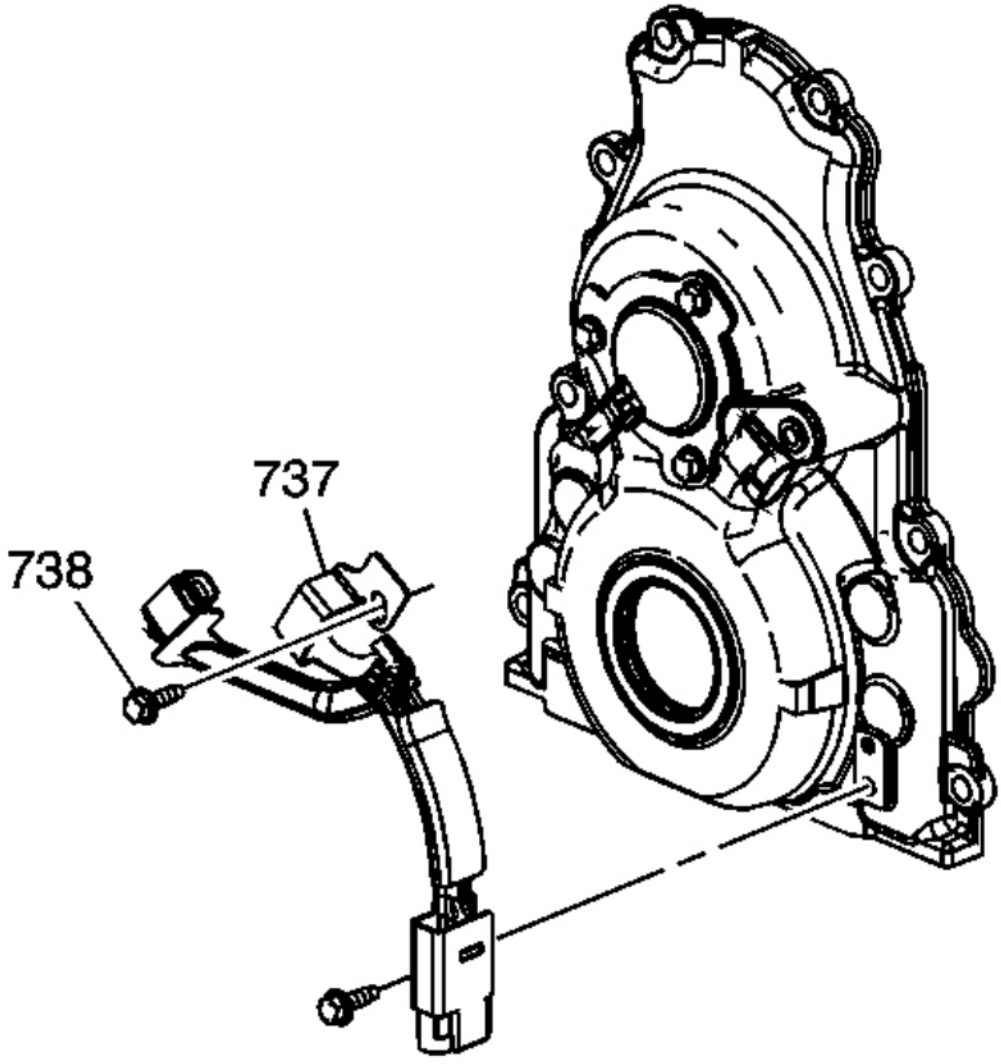


Fig. 242: View Of CMP Sensor Wire Harness & Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the CMP sensor wire harness (737) and bolts (738).

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Tighten: Tighten the bolts to 12 N.m (106 lb in).

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