

Crankshaft and Bearing Removal and Installation

Single Use Fasteners and Components

- Accessory Drive Auxiliary Belt
- Accessory Drive Primary Belt
- Air Conditioning Compressor and Condenser Hose Seal [2x]
- Automatic Transmission Flex Plate Bolt [8x]
- Camshaft Position Actuator Solenoid Valve
- Connecting Rod Bolt [16x]
- Crankshaft Balancer Bolt
- Crankshaft Bearing Cap Bolt - Inner [10x]
- Crankshaft Bearing Cap Bolt - Outer [10x]
- Crankshaft Bearing Cap Bolt - Side [10x]
- Crankshaft Front Oil Seal
- Crankshaft Rear Oil Seal
- Crankshaft Rear Oil Seal Housing Gasket
- Cylinder Head Bolt [20x]
- Cylinder Head Gasket [2x]
- Engine Oil Cooler Gasket
- Engine Oil Cooler Retainer [2x]
- Exhaust Manifold Gasket [2x]
- Exhaust System Seal [2x]
- Fuel Feed Intermediate Pipe - Position 1
- Fuel Feed Intermediate Pipe - Position 2
- Intake Manifold Gasket [8x]
- Oil Filter
- Oil Level Indicator Tube Seal
- Oil Pan Front Seal
- Oil Pan High Pressure Port Seal [2x]
- Transmission Fluid Cooler Pipe Fitting Seal [2x]
- Valve Rocker Arm Cover Gasket [2x]
- Water Pump Gasket [2x]

Special Tools

- *EN-8087* Cylinder Bore Gauge
- *EN-24270* Cylinder Bore Ridge Reamer
- *EN-41478-A* Crankshaft Front Oil Seal Installer
- *EN-41479* Crankshaft Rear Oil Seal Installer
- *EN-41479-B* Crankshaft Rear Oil Seal Installation Guide
- *EN-41479-10* Crankshaft Rear Oil Seal Installer Adapter

- *EN-41556* Connecting Rod Guide
- *EN-41665-A* Crankshaft Balancer and Sprocket Installer
- *EN-41816-A* Crankshaft Balancer Remover
- *EN-42386-A* Flywheel Holding Tool
- *EN-45059* Angle Meter
- *EN-51091* Crankshaft Front Oil Seal Installer
- *EN-51096* Crankshaft Rear Seal Remover
- *GE-23907-1* Slide Hammer
- *J-41818* Crankshaft Bearing Cap Remover
- *J-6125-1B* Slide Hammer

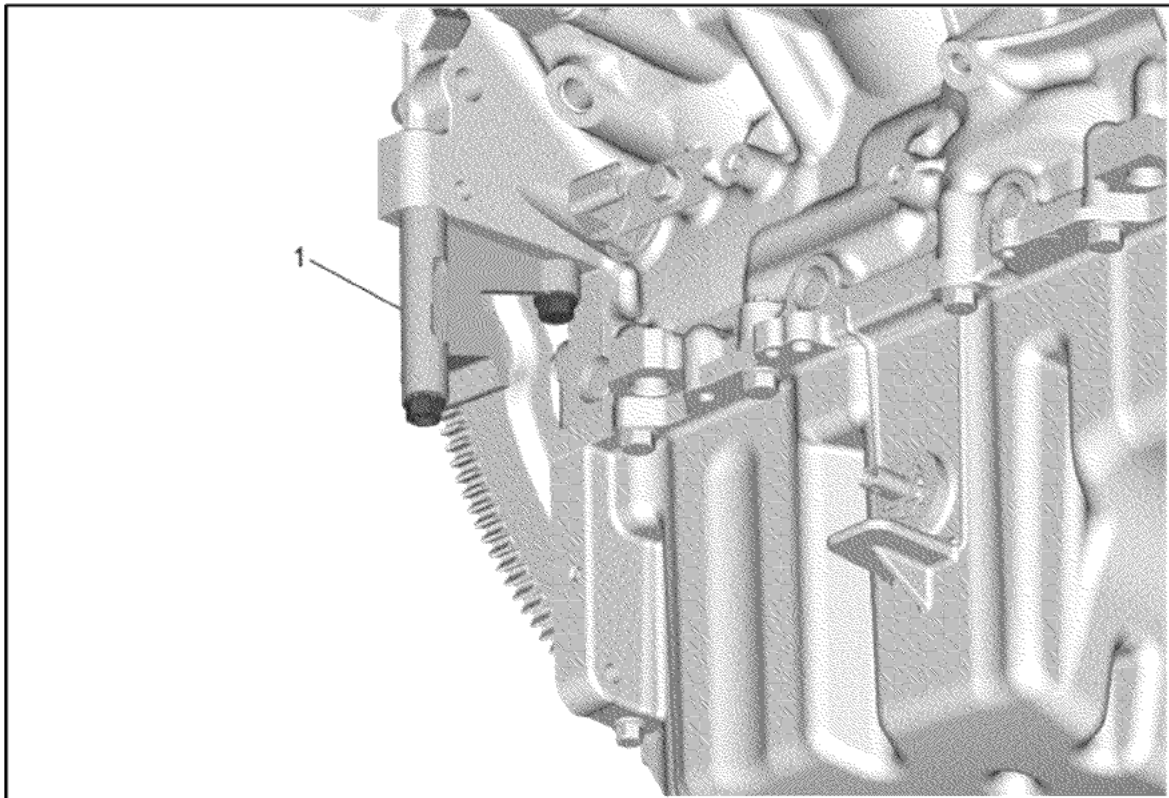
Equivalent regional tools: [Special Tools](#)

Warning: Refer to [Safety Glasses and Compressed Air Warning](#)

Removal Procedure

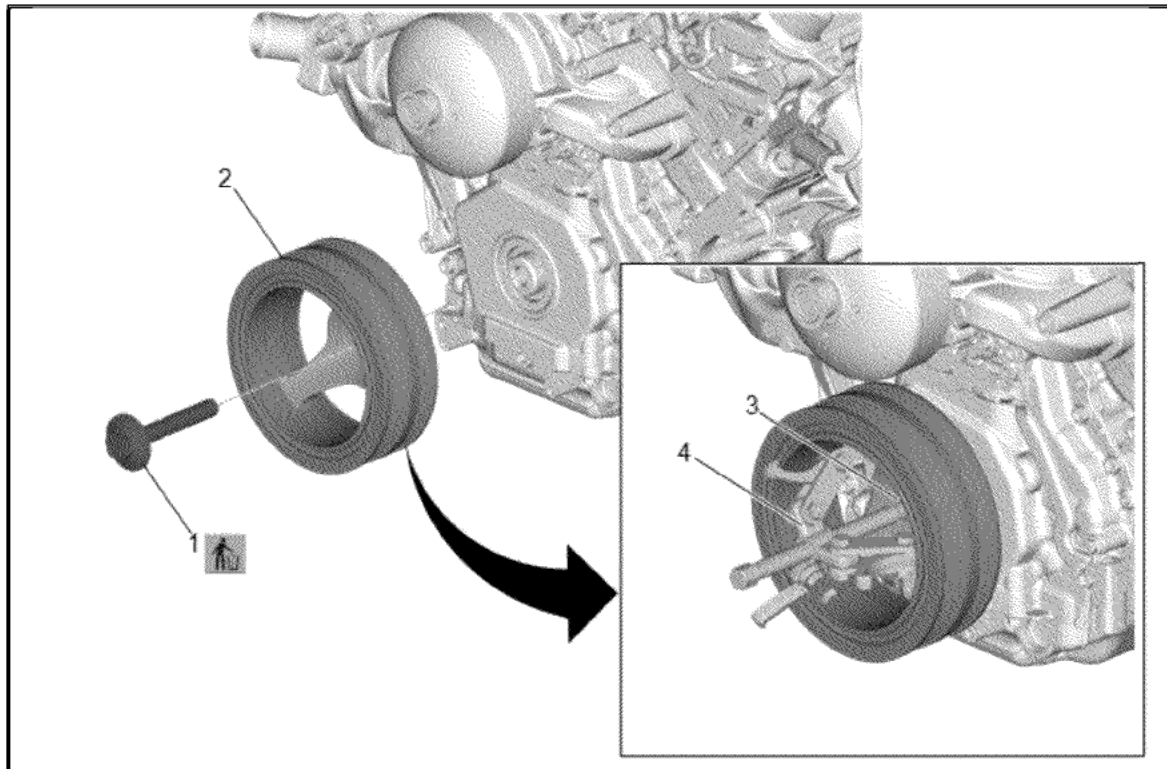
Engine » Remove — [Engine Removal and Installation](#)

Disassemble Procedure



Caution: Refer to [Fastener Caution](#).

1. *EN-42386-A* Flywheel Holding Tool(1) » Install
2. Use one **M10 - 1.5 x 120 mm** and one **M10 - 1.5 x 45 mm** bolt for proper tool operation. Tighten the *EN-42386-A* Flywheel Holding Tool bolts to **50 Y (37 lb ft)**

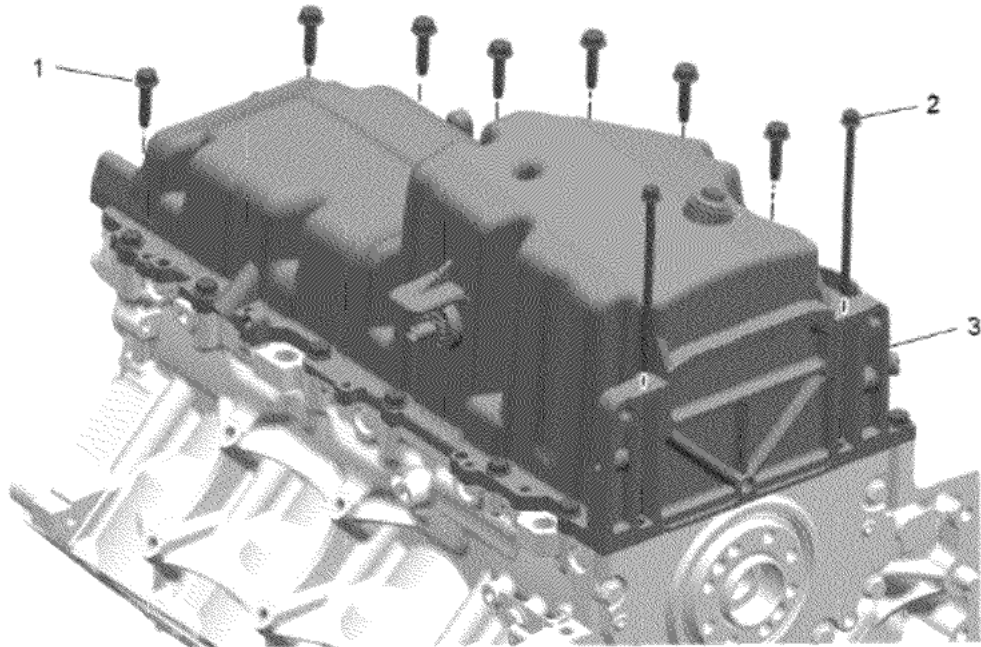


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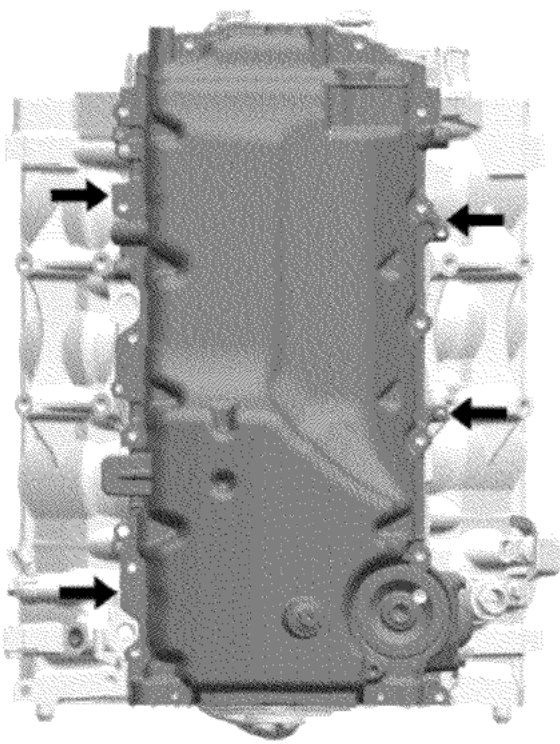


Note: Do NOT DISCARD the crankshaft balancer bolt at this time.

3. Crankshaft Balancer Bolt (1) » Remove
4. *EN-41816-5* Crankshaft End Protector(3) » Install
5. *EN-41816-A* Crankshaft Balancer Remover(4) » Install
6. Crankshaft Balancer (2) » Remove
7. Rotate the engine over on the engine stand.

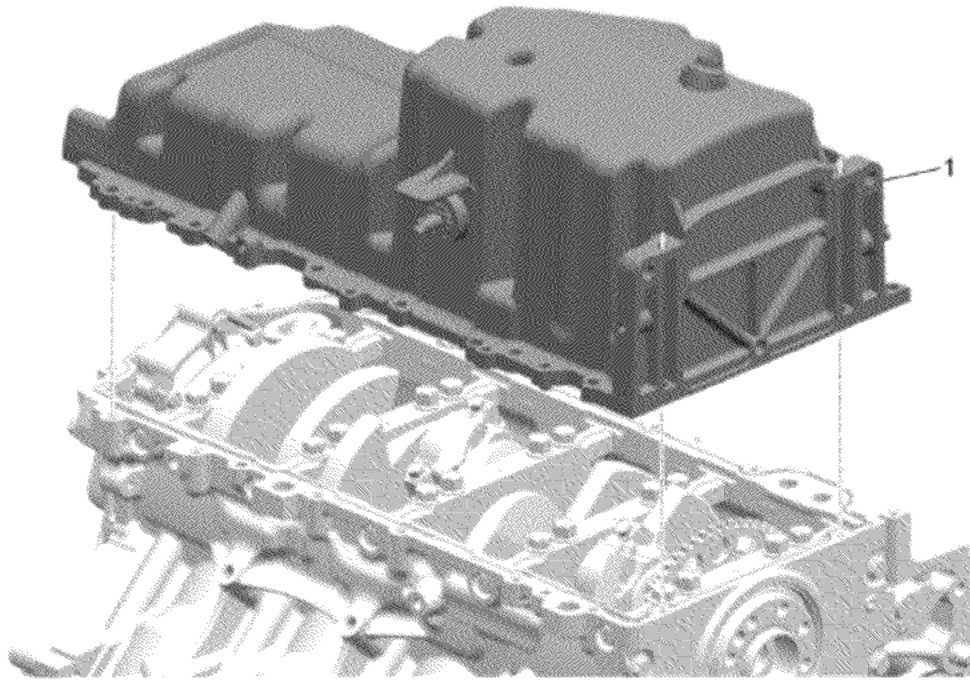


- 8. Oil Pan Bolt (1) » Remove [14x]
- 9. Oil Pan Bolt (2) » Remove [2x]

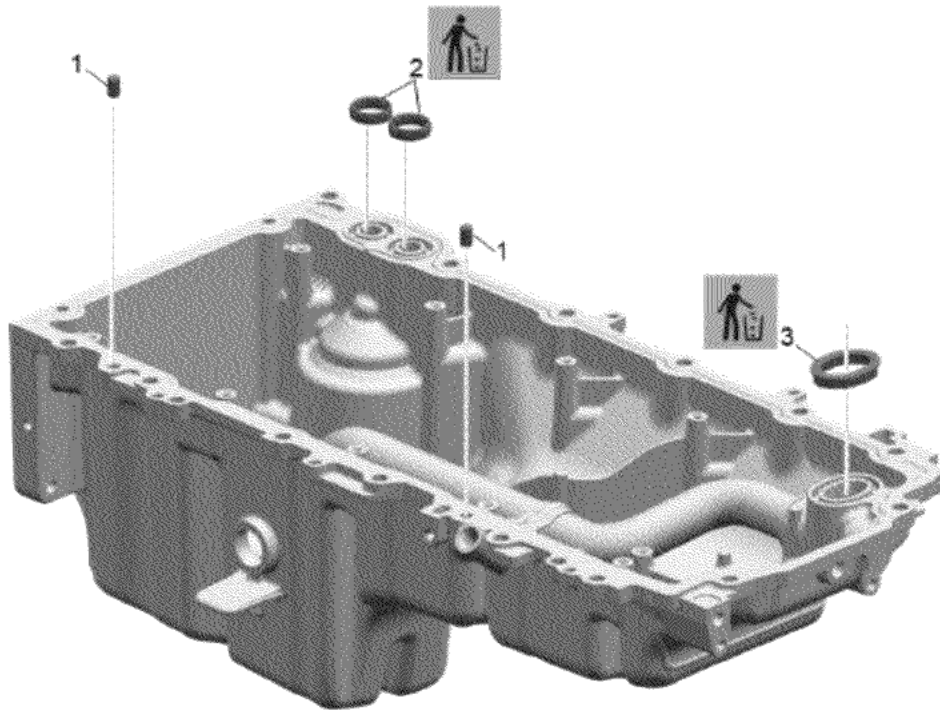


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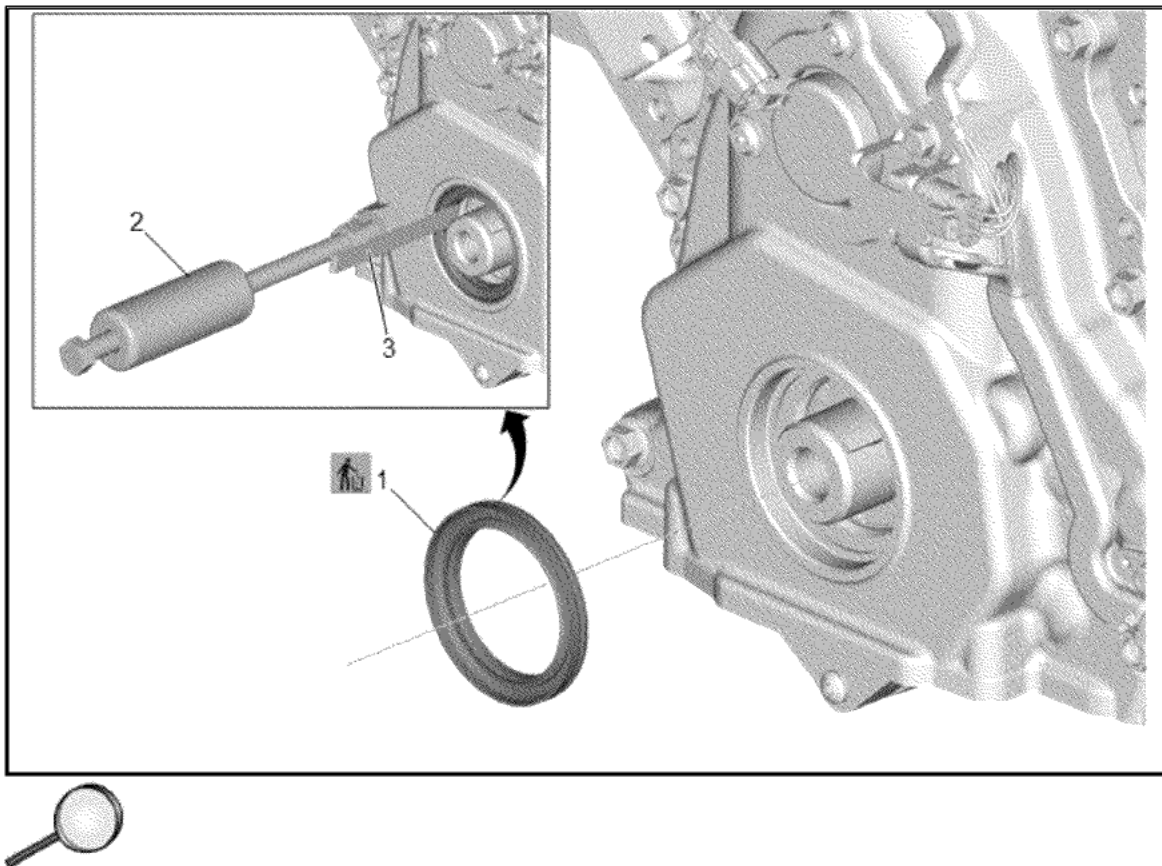
10. Using a suitable tool at the locations indicated by the arrows to pry, loosen the oil pan carefully from the engine block.



11. Oil Pan (1) » Remove

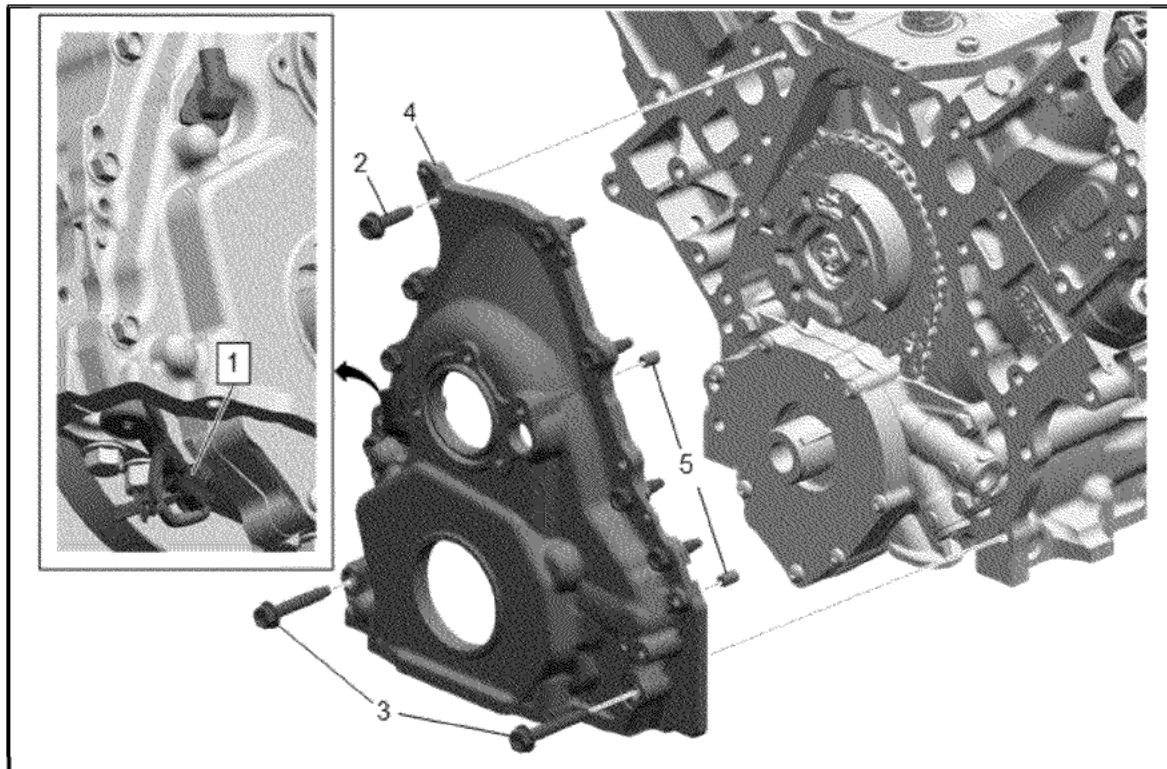


12. Oil Pan High Pressure Port Seal (2) » Remove and DISCARD
13. Oil Pan Front Seal (3) » Remove and DISCARD
14. Rotate the engine over on the engine stand.

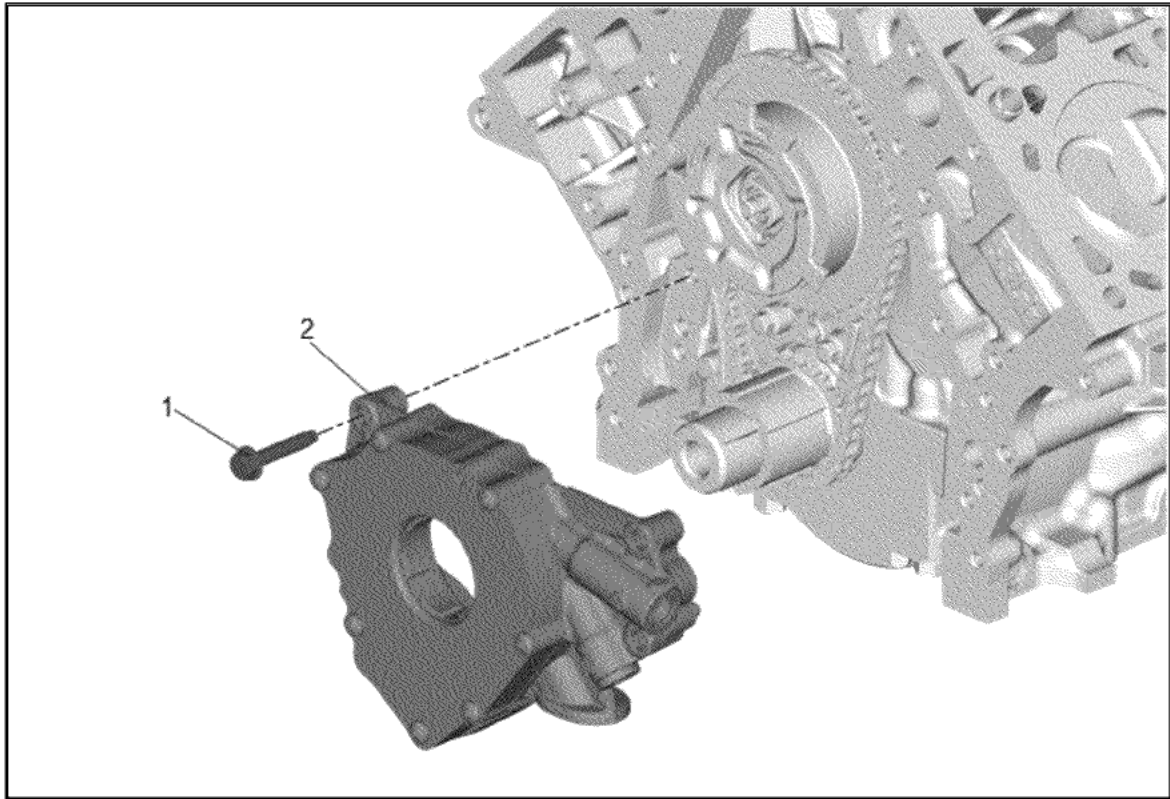


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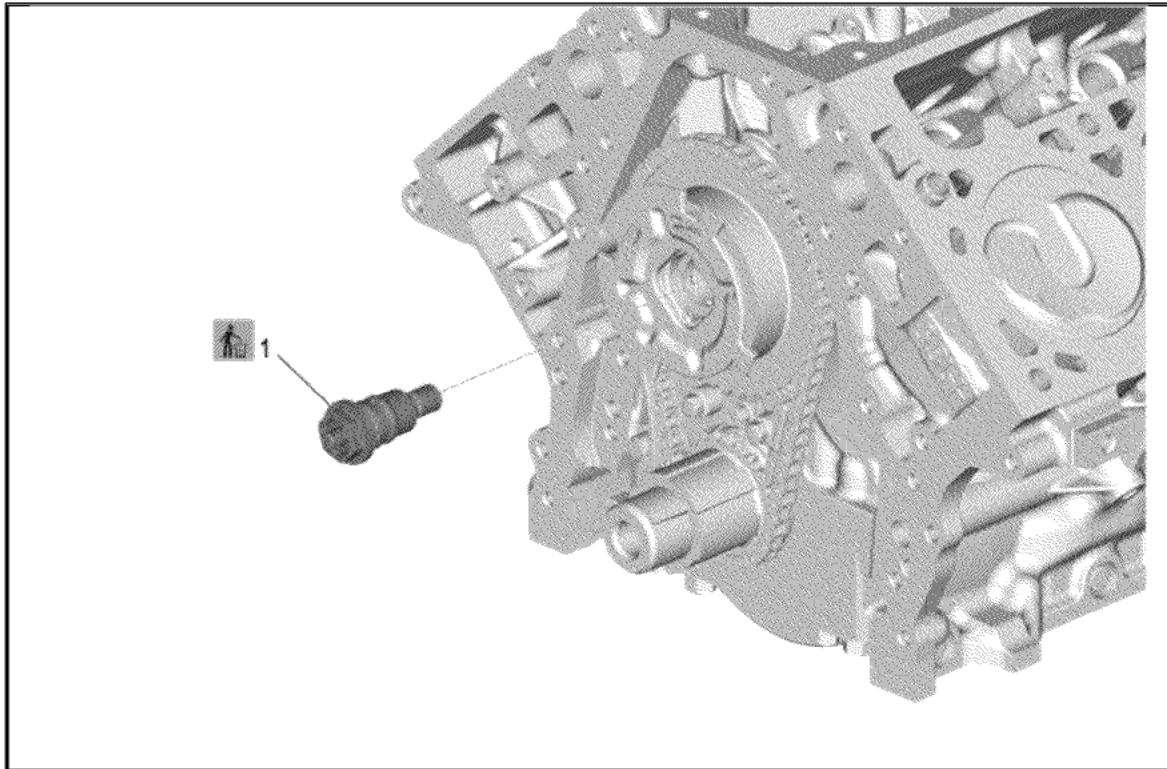
15. Install the *EN-51096* Crankshaft Rear Seal Remover onto *GE-23907-1* Slide Hammer.
16. Slide the small bend of *EN-51096* Crankshaft Rear Seal Remover between the lip of the front seal (1) and crankshaft. Ensure that the small bend of *EN-51096* Crankshaft Rear Seal Remover engages the rear side of the front seal (1). While rotating *EN-51096* Crankshaft Rear Seal Remover and *GE-23907-1* Slide Hammer around the seal, use the slide hammer to remove and DISCARD the seal.



17. {If equipped} Disconnect the oil pump flow control solenoid wire (1).
18. Engine Front Cover Bolt (2) » Remove [8x]
19. Engine Front Cover Bolt (3) » Remove [2x]
- Note:** Use pry points to separate the engine front cover from the block.
20. Engine Front Cover (4) Remove

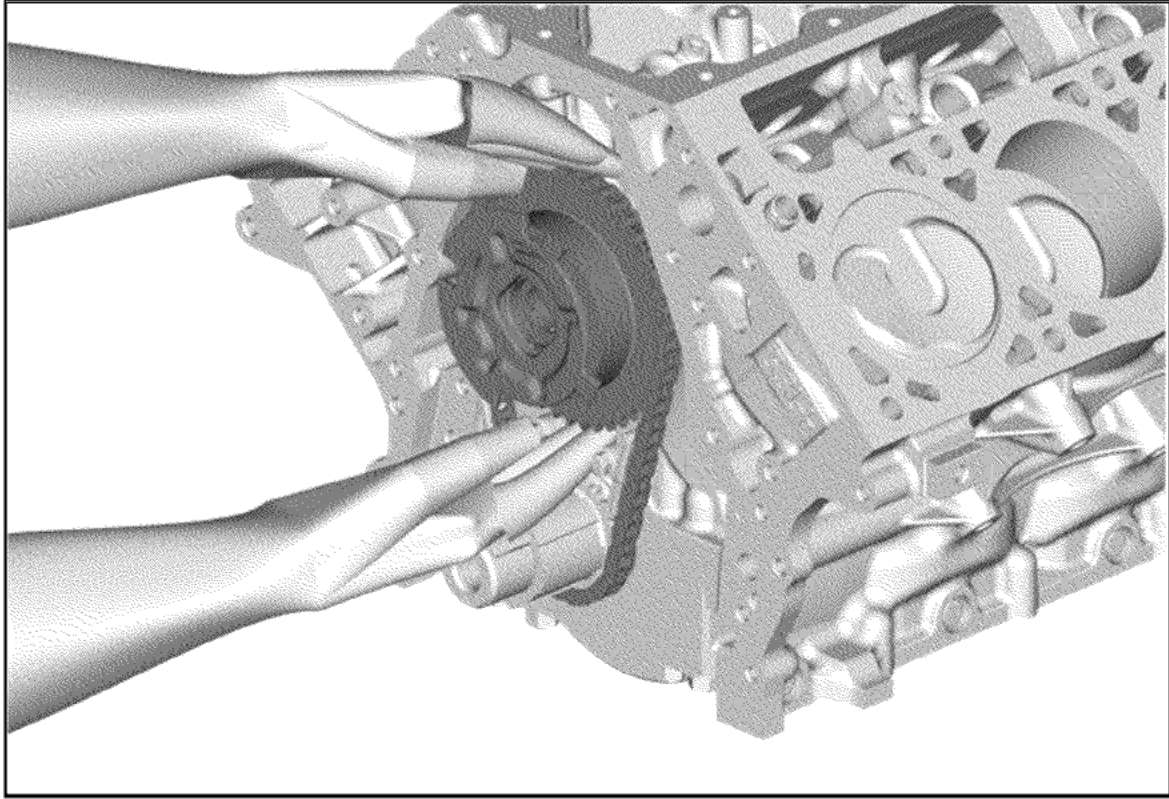


- 21. Oil Pump Bolt (1) » Remove [4x]
- 22. Oil Pump (2) » Remove



Note: Do not use the camshaft position actuator solenoid valve again. Upon installation of the camshaft position actuator and timing chain, install a NEW valve.

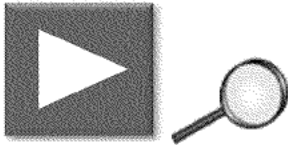
23. Camshaft Position Actuator Solenoid Valve (1) » Remove and DISCARD

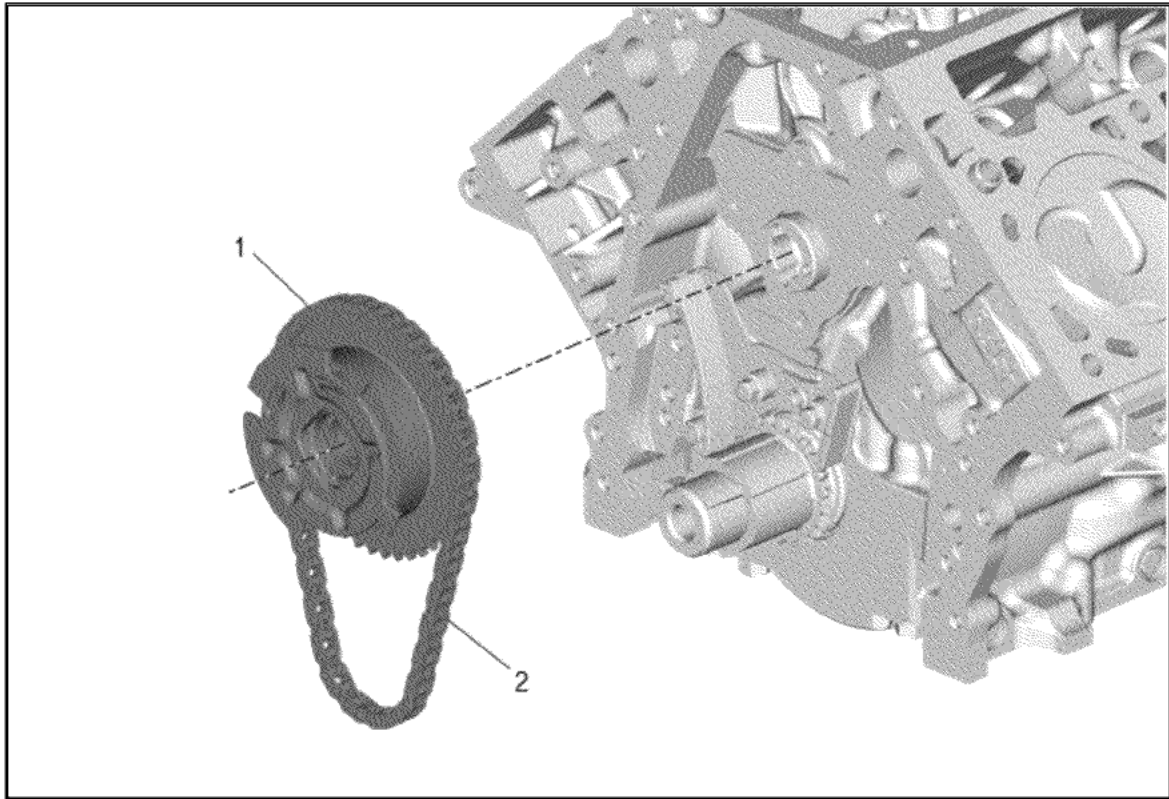


Warning: Refer to [Camshaft Position Actuator Removal and Installation Warning](#).

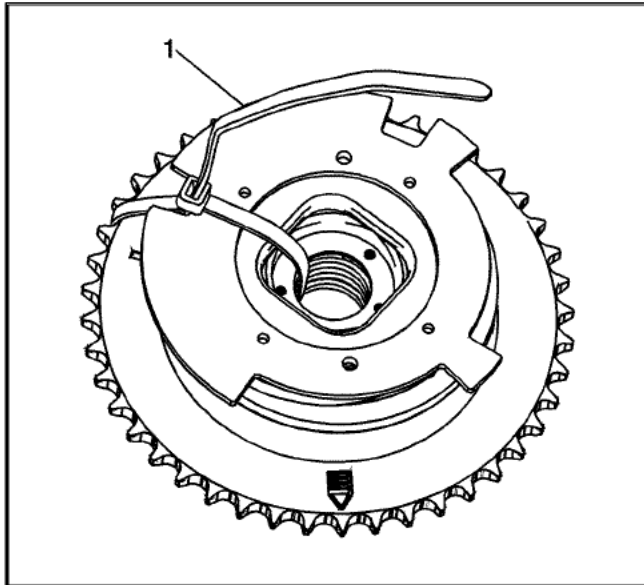
24. Loosen and separate the camshaft position actuator and timing chain from the camshaft. Position fingers behind the actuator sprocket and pull the actuator away from the front of the camshaft. Never pull on the reluctor wheel when attempting to remove the actuator.

Click Image For Video



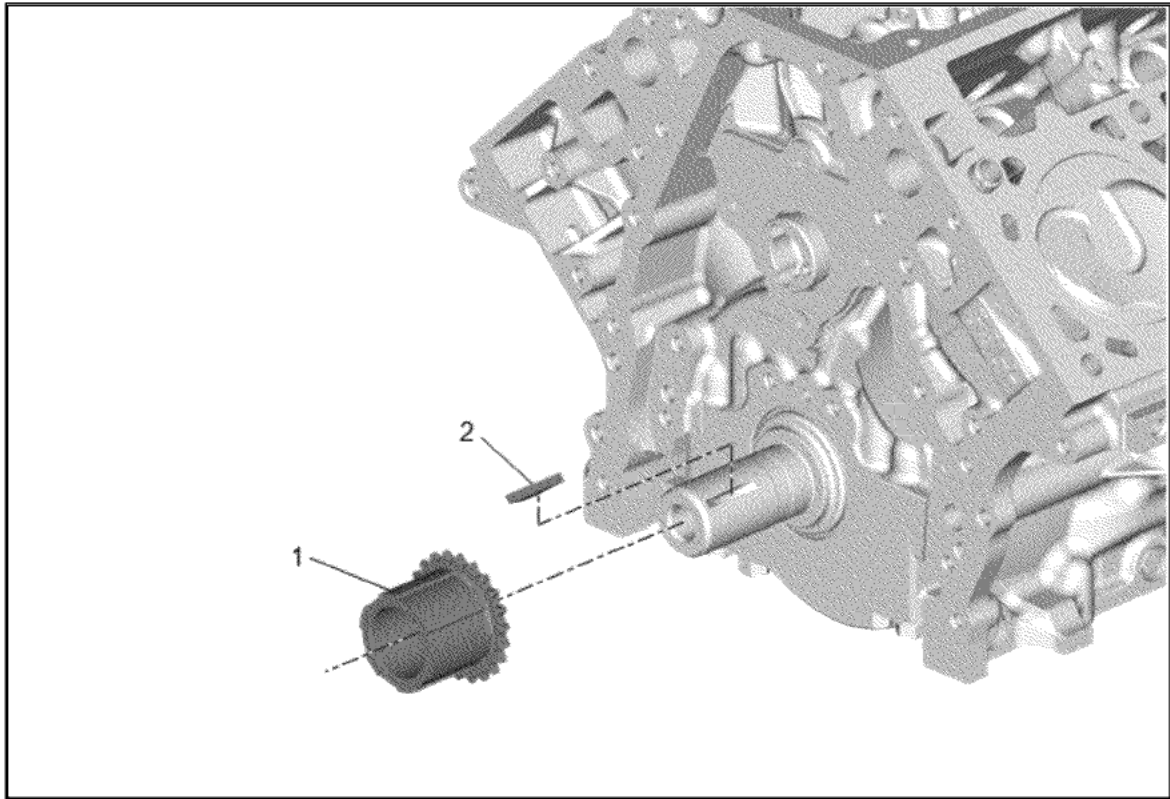


25. Remove the camshaft position actuator solenoid valve (1) and timing chain (2).

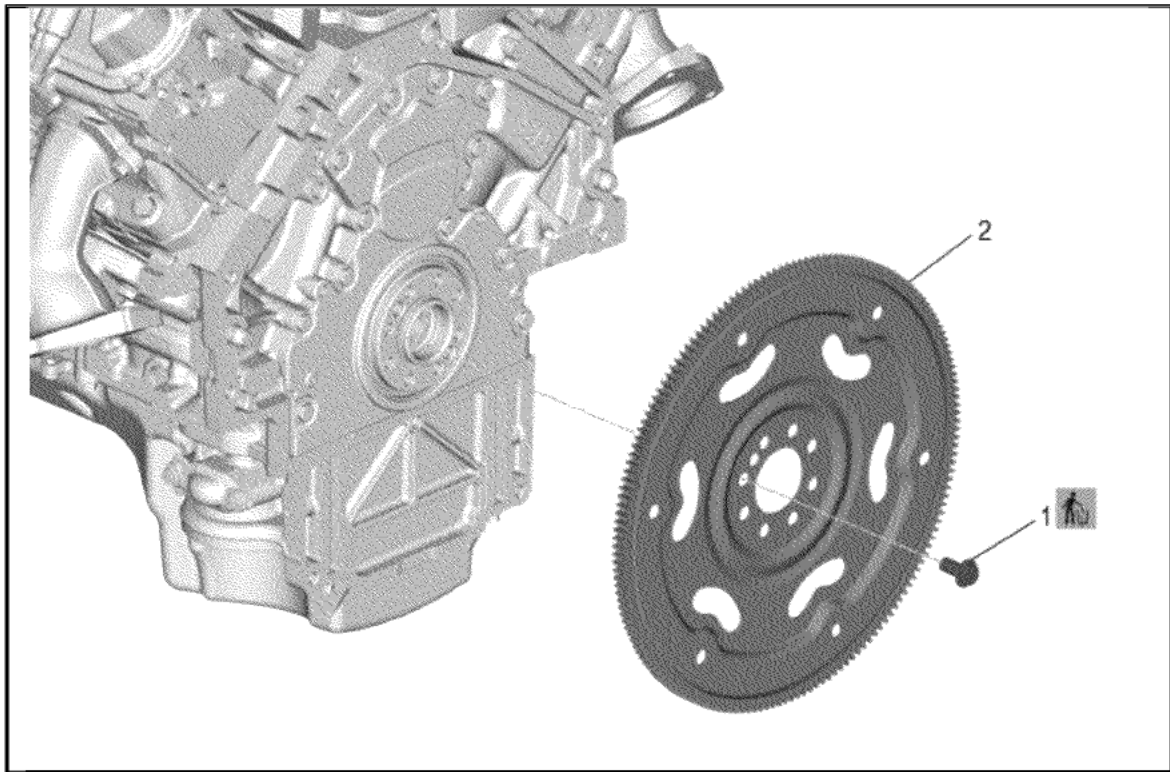


Warning: Refer to [Camshaft Position Actuator Removal and Installation Warning](#).

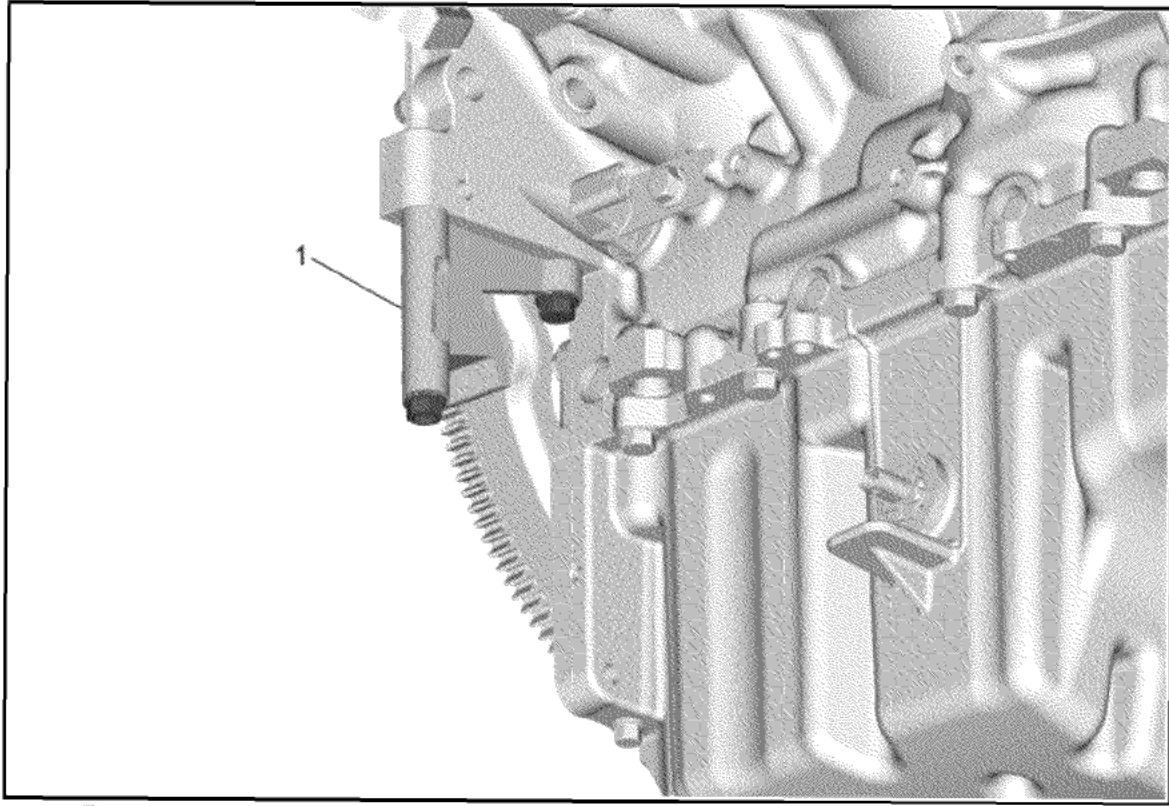
26. Insert a tie strap (1) through the center of the camshaft position (camshaft position) actuator and over the reluctor wheel.



27. Crankshaft Sprocket (1) » Remove

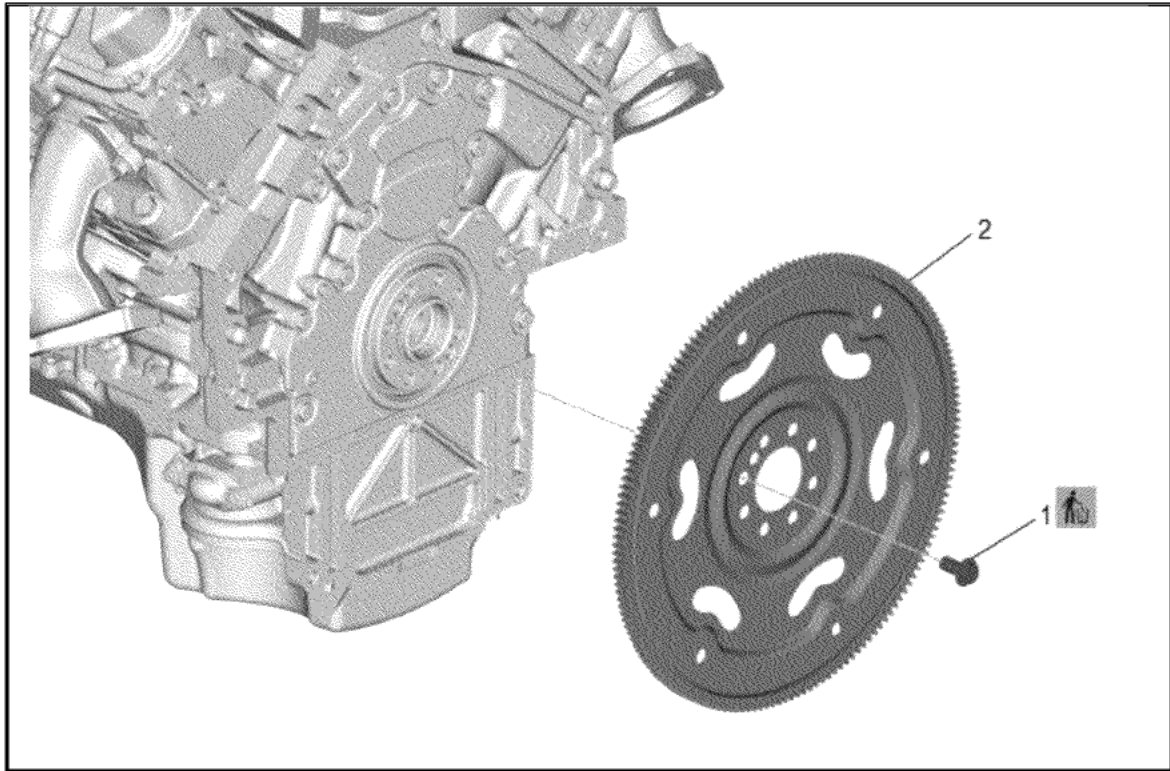


28. Mark or scribe the end of the crankshaft and the flex plate before removal.
29. Automatic Transmission Flex Plate Bolt (1) » Loosen [8x]



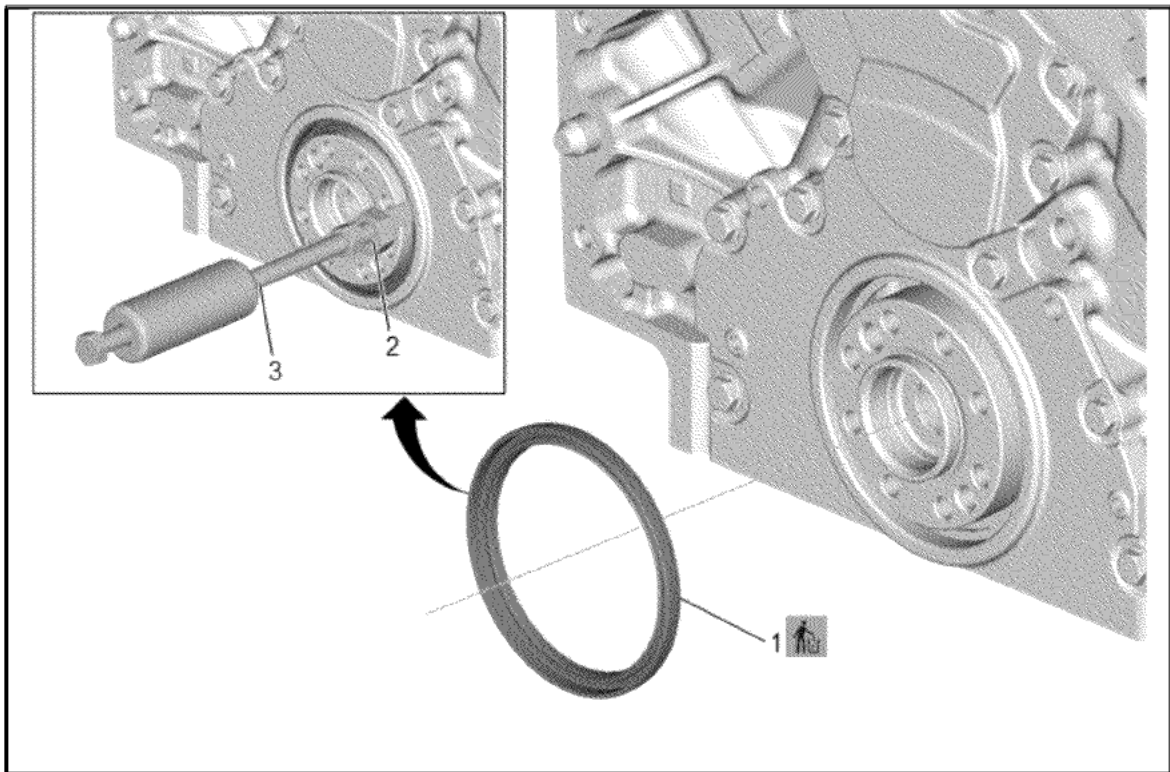
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30. Remove the **M10 - 1.5 x 120 mm** and **M10 - 1.5 x 45 mm** bolts.
31. *EN-42386-A* Flywheel Holding Tool(1) » Remove

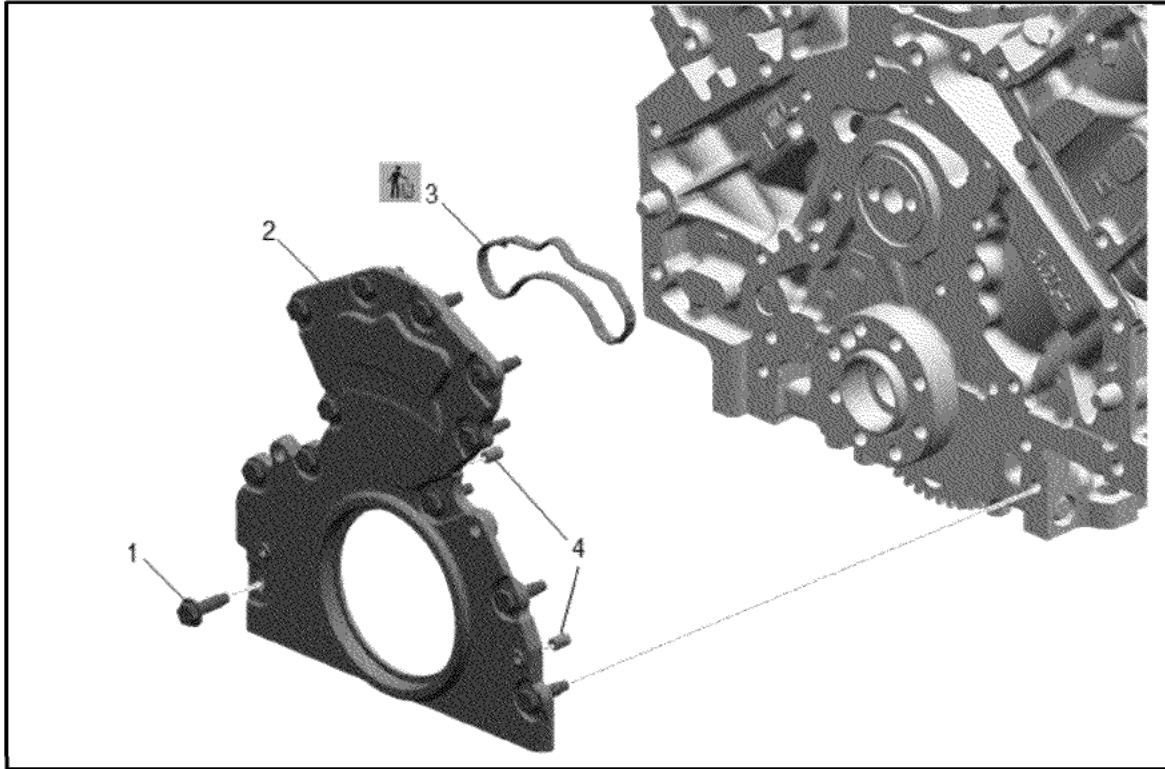


32. Automatic Transmission Flex Plate Bolt (1) » Remove and DISCARD [8x]

33. Automatic Transmission Flex Plate (2) » Remove

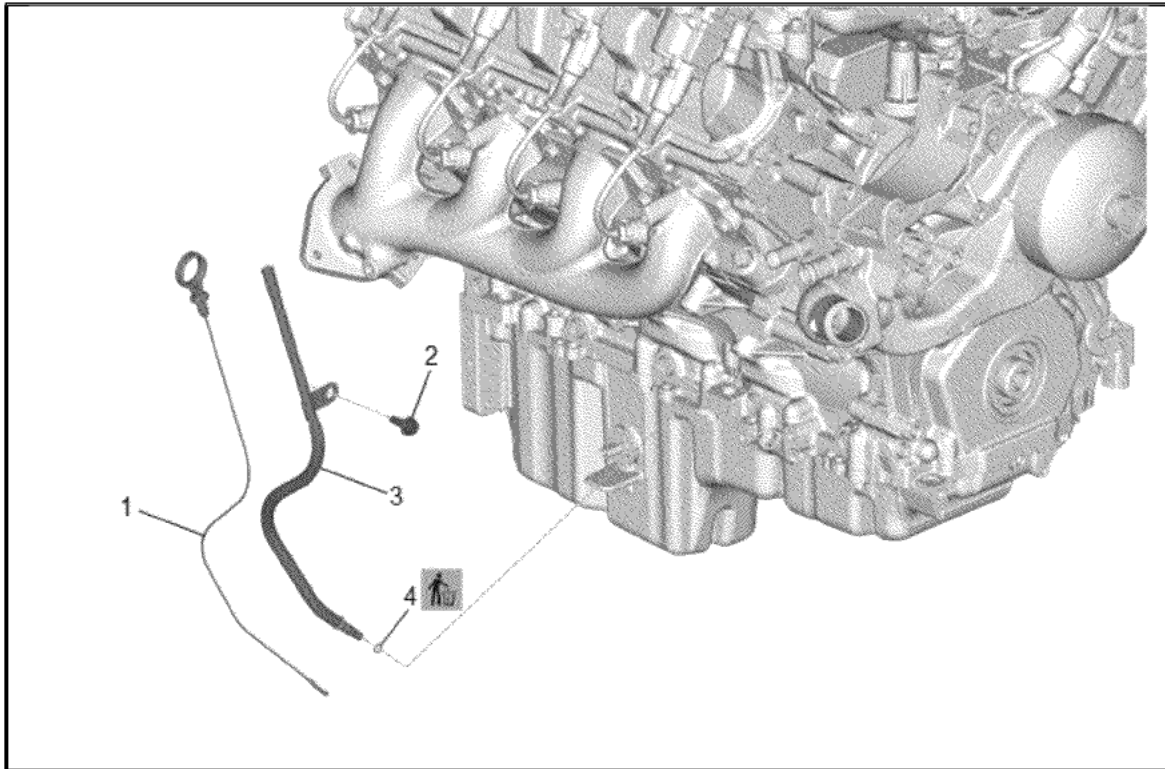


34. Install the *EN-51096* Crankshaft Rear Seal Remover (2) onto *GE-23907-1* Slide Hammer (3).
35. Slide the small bend of *EN-51096* Crankshaft Rear Seal Remover between the lip of the rear seal (1) and crankshaft. Ensure that the small bend of *EN-51096* Crankshaft Rear Seal Remover (2) engages the rear side of the rear seal (1). While rotating *EN-51096* Crankshaft Rear Seal Remover (2) and *GE-23907-1* Slide Hammer (3) around the seal, use the slide hammer to remove and DISCARD the seal.

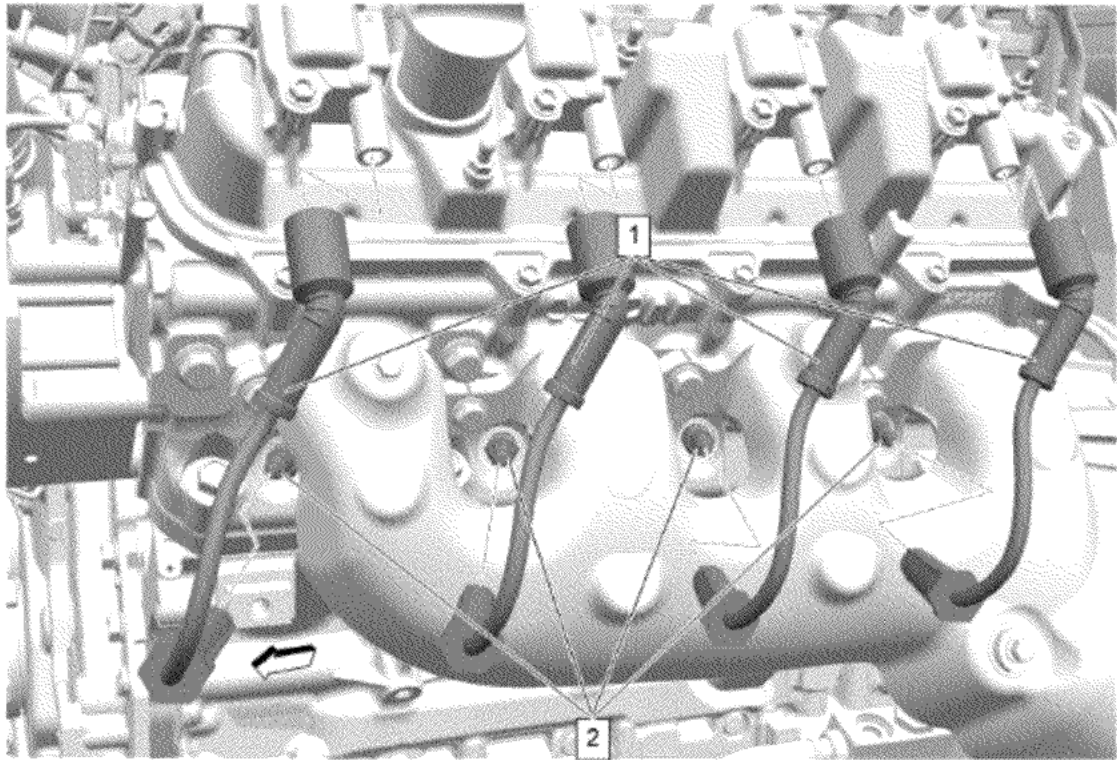


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36. Crankshaft Rear Oil Seal Housing Bolt (1) » Remove [12x]
- Note:** Use pry points to separate the crankshaft rear oil seal housing from the block.
37. Crankshaft Rear Oil Seal Housing (2) » Remove
38. Crankshaft Rear Oil Seal Housing Gasket (3) » Remove and DISCARD

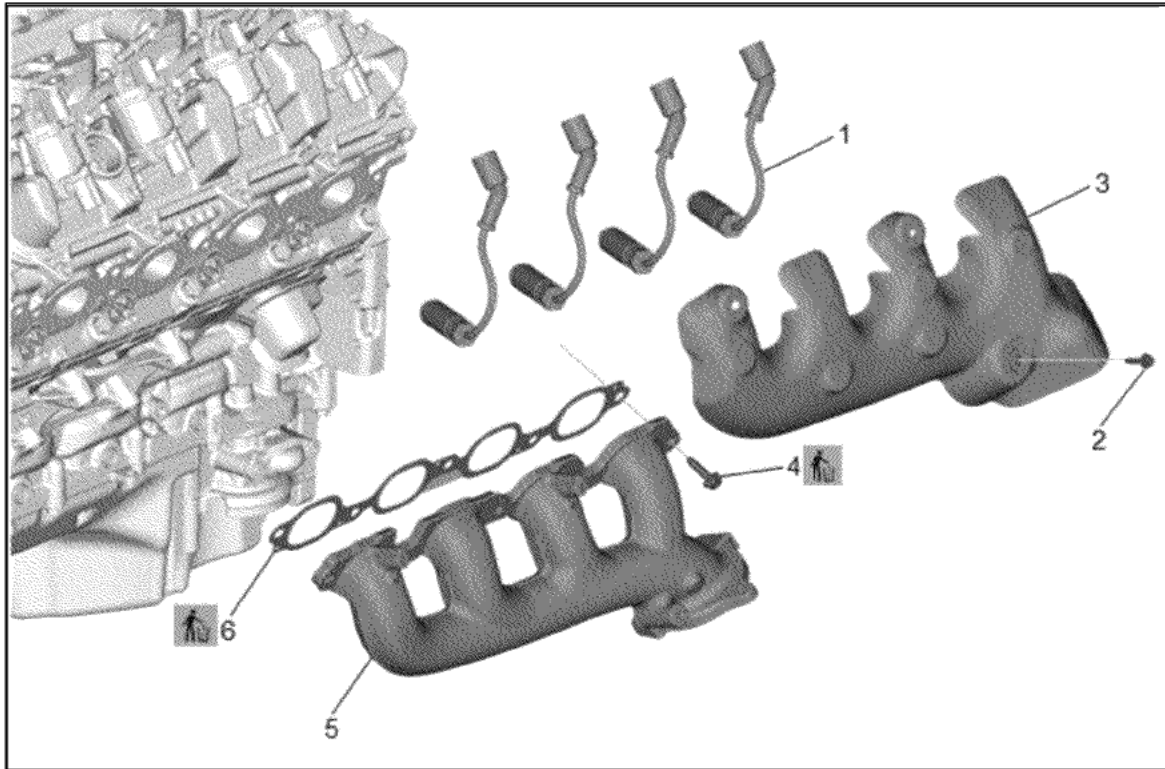


- 39. Oil Level Indicator (1) » Remove
- 40. Oil Level Indicator Tube Bolt (2) » Remove
- 41. Oil Level Indicator Tube (3) » Remove
- 42. Oil Level Indicator Tube Seal (4) » Remove and DISCARD

**Note:**

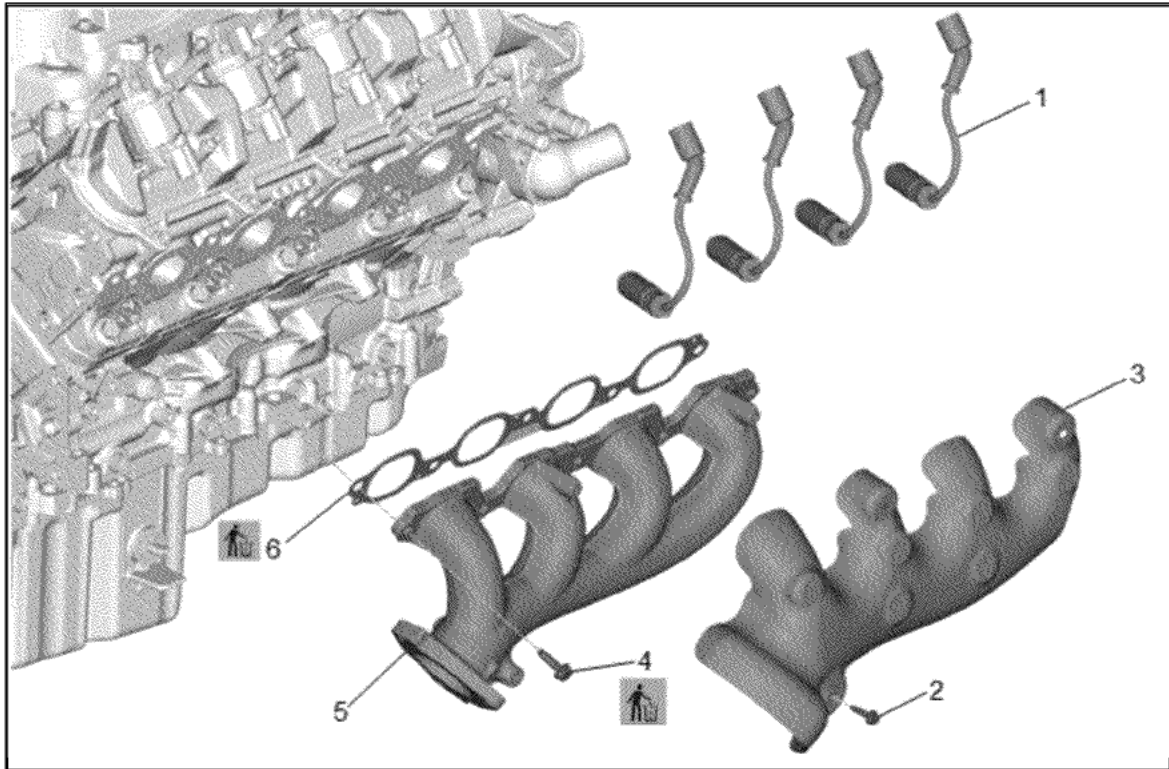
- Left side shown, right side similar.
- Pull only on the spark plug wire boot to remove the wire.
- Inspect the spark plug wires for damage and replace if necessary.

43. Twist the 8 spark plug wire boots a ½ turn and remove the spark plug wires from the gas engine ignition spark plugs.



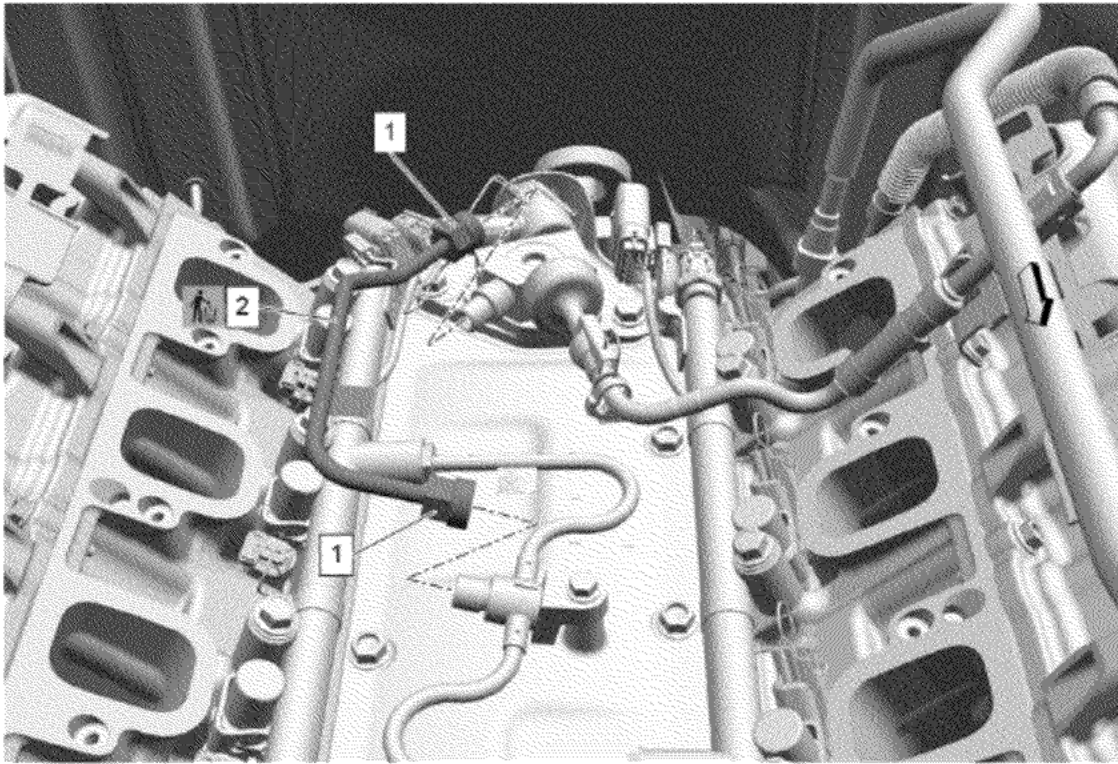
Note: Spark plug wires will be removed with the valve rocker arm covers.

44. Exhaust Manifold Heat Shield Bolt (2) » Remove [3x]
45. Exhaust Manifold Heat Shield - Left Side(3) » Remove [3x]
46. Exhaust Manifold Bolt (4) » Remove [5x]
47. Exhaust Manifold - Left Side (5) » Remove
48. Exhaust Manifold Gasket (6) » Remove and DISCARD

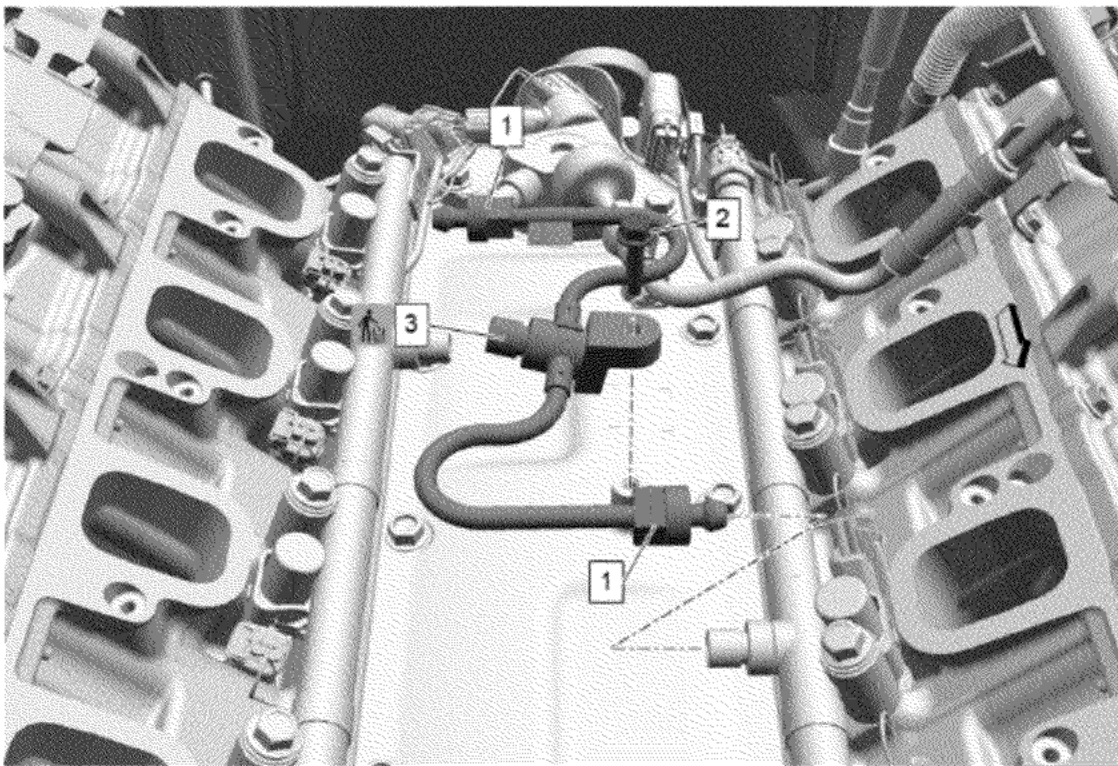


Note: Spark plug wires will be removed with the valve rocker arm covers.

49. Exhaust Manifold Heat Shield Bolt (2) » Remove [3x]
50. Exhaust Manifold Heat Shield - Right Side (3) » Remove [3x]
51. Exhaust Manifold Bolt (4) » Remove [5x]
52. Exhaust Manifold - Right Side (5) » Remove
53. Exhaust Manifold Gasket (6) » Remove and DISCARD

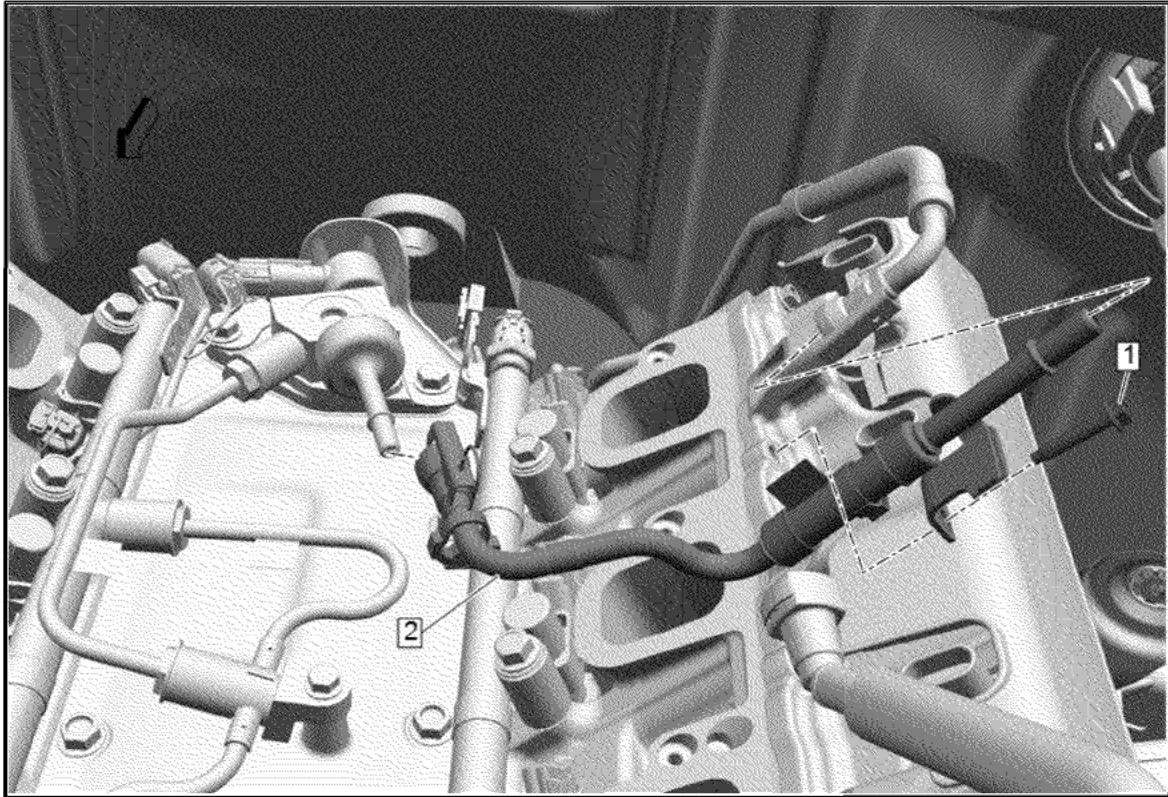


- 54. Fuel Feed Intermediate Pipe Nut (1) @ Fuel Feed Intermediate Pipe (2) » Loosen until disengaged [2x]
- 55. Fuel Feed Intermediate Pipe (2) » Remove and DISCARD

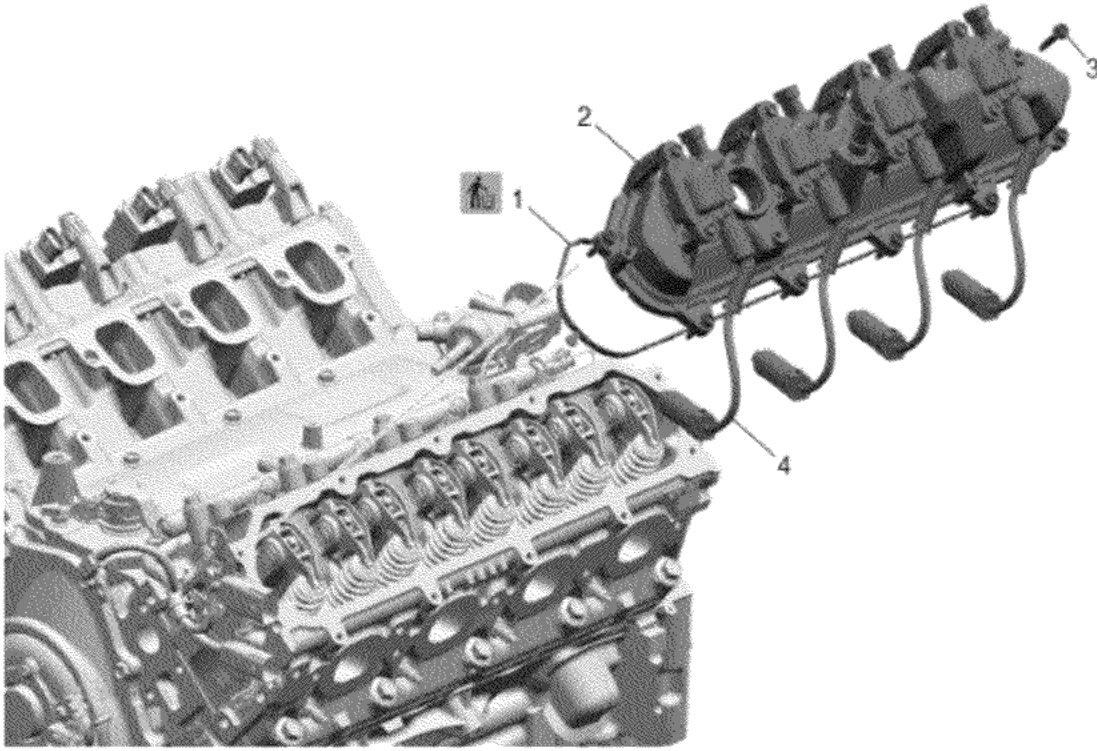


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56. Fuel Feed Intermediate Pipe Nut (1) @ Fuel Feed Intermediate Pipe (3) » Loosen until disengaged [2x]
57. Fuel Feed Pipe Bolt (2) » Remove
58. Fuel Feed Intermediate Pipe (3) » Remove and DISCARD



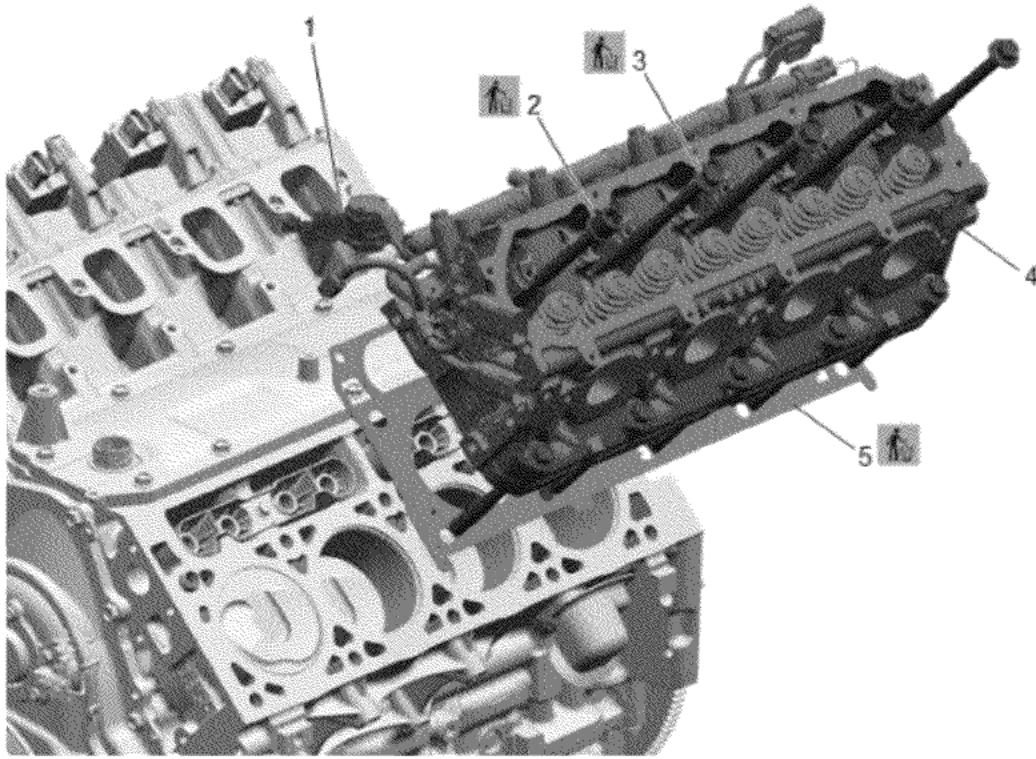
59. Remove the fuel feed pipe bolt (1) and disconnect the fuel feed pipe (2) from the fuel pump.
[Metal Collar Quick Connect Fitting Service](#)



Note:

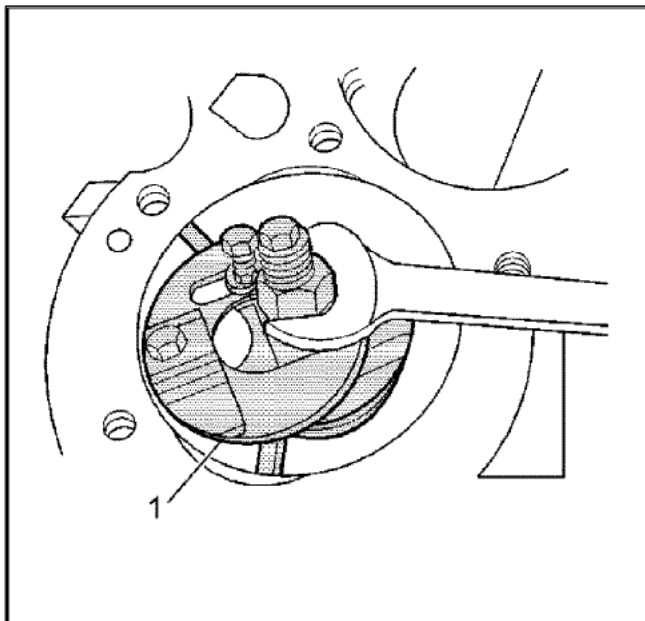
- Left side shown, right side similar.
- Pull only on the spark plug wire boot to remove the wire.
- Inspect the spark plug wire for damage and replace if necessary.

60. Twist the spark plug wire boot a ½ turn and remove the spark plug wire (8) from the gas engine ignition spark plug.
61. Valve Rocker Arm Cover Bolt (3) » Remove [19x] [9x]
62. Valve Rocker Arm Cover (2) » Remove [2x]
63. Valve Rocker Arm Cover Gasket (1) » Remove and DISCARD [2x]

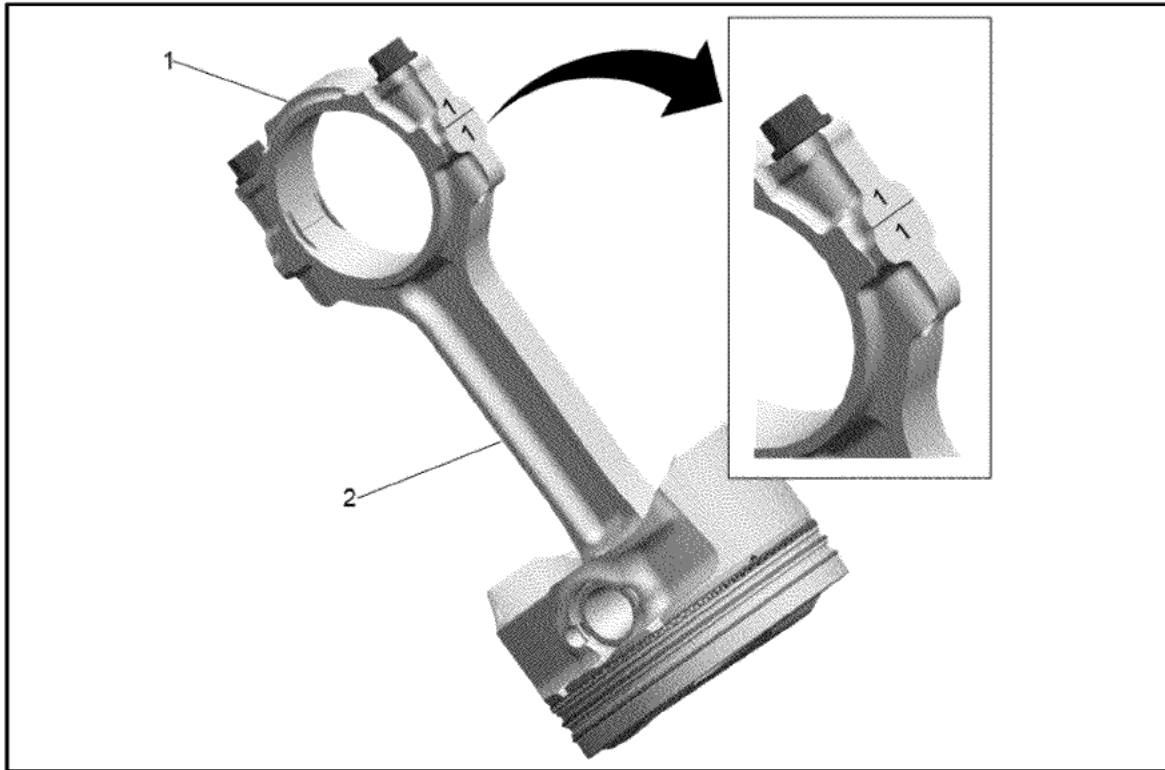


Note: Left side shown, right side similar.

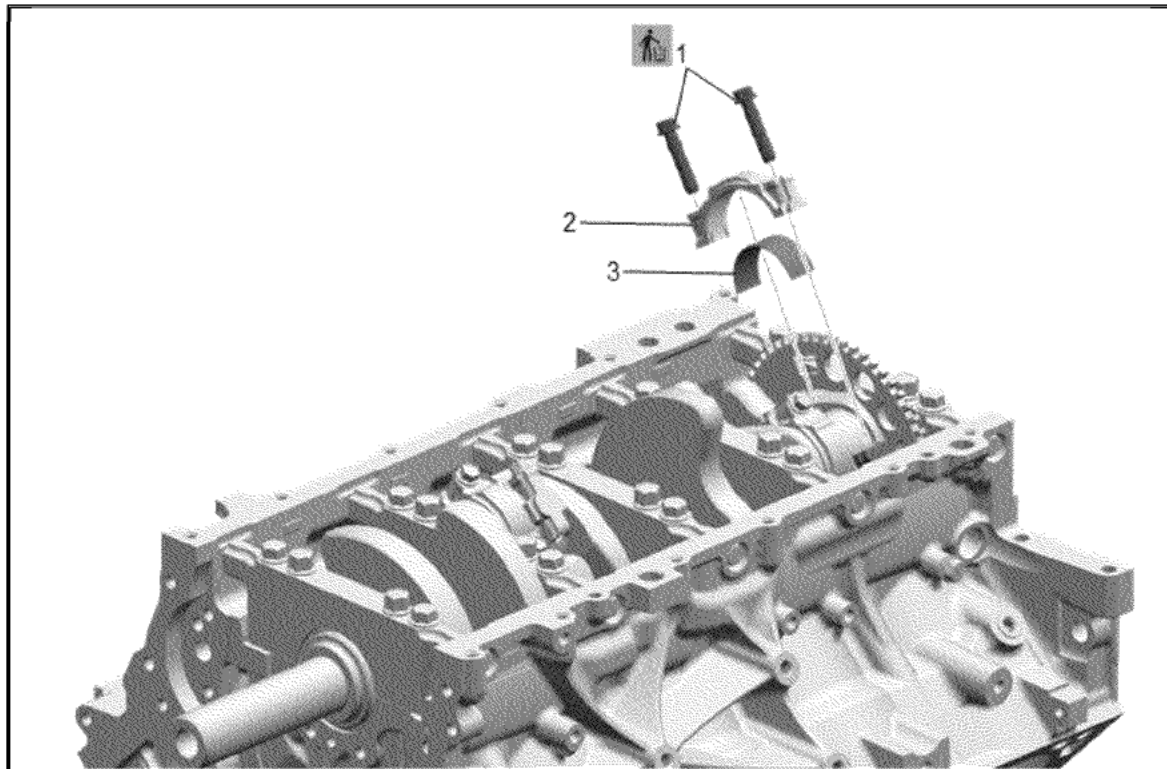
66. Disconnect the valve rocker arm oil control valve extension harness connector (1) from the valve rocker arm oil control valve harness.
67. Cylinder Head Bolt (2) » Remove and DISCARD
68. Cylinder Head Bolt (3) » Remove and DISCARD [19x]
69. Cylinder Head (4) » Remove [2x]
70. Cylinder Head Gasket (5) » Remove and DISCARD [2x]



71. Use the *EN-24270* Cylinder Bore Ridge Reamer (1) in order to remove the cylinder bore ring ridge, if required.
 - 71.1. Turn the crankshaft until the piston is at the bottom of the stroke.
 - 71.2. Place a cloth on top of the piston.
 - 71.3. Use the *EN-24270* Cylinder Bore Ridge Reamer to remove a cylinder ring ridge.
 - 71.4. Turn the crankshaft so the piston is at the top of the stroke.
 - 71.5. Remove the cloth.
 - 71.6. Remove the cutting debris from the cylinder and piston.

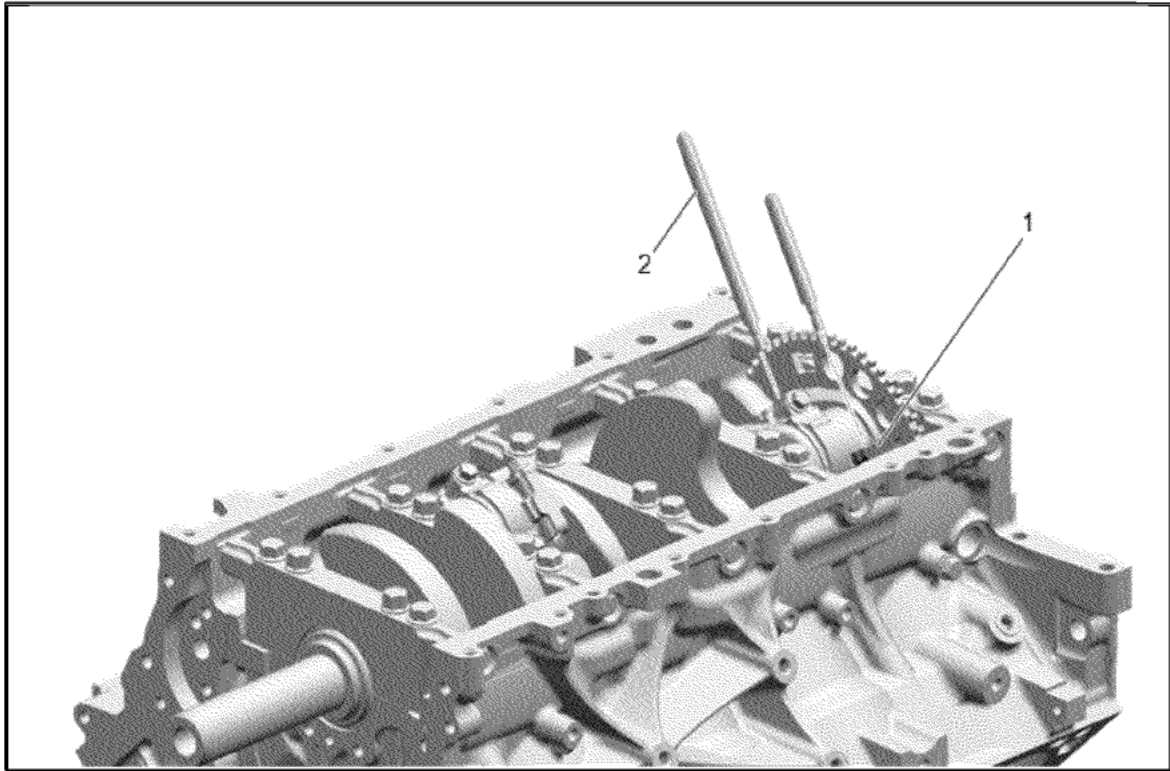


72. Using a paint stick or etching tool, place matchmarks or numbers on the connecting rods and the connecting rod caps. The connecting rods and caps **MUST** be assembled to their original position and direction.
 - A stamping mark on the side of the connecting rod, at the crankshaft journal, may affect component geometry.
 - Mark the top of the piston to the specific cylinder bore.

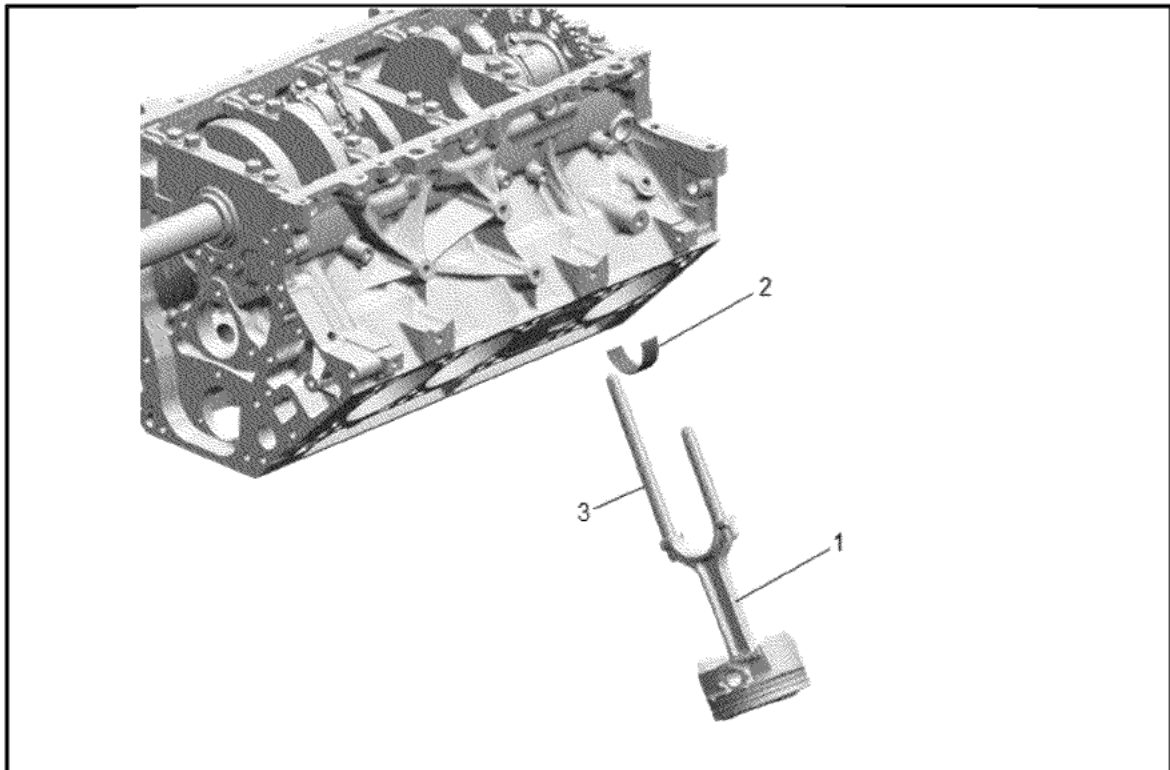


73. Mark, sort, or organize the connecting rod bearings so they may be installed to their original position and location. The connecting rods and the bearing caps are NOT interchangeable.
- Note:** The bolts are single use and must be discarded before final installation.
74. Remove the connecting rod bolts (1), cap (2) and bearing (3).

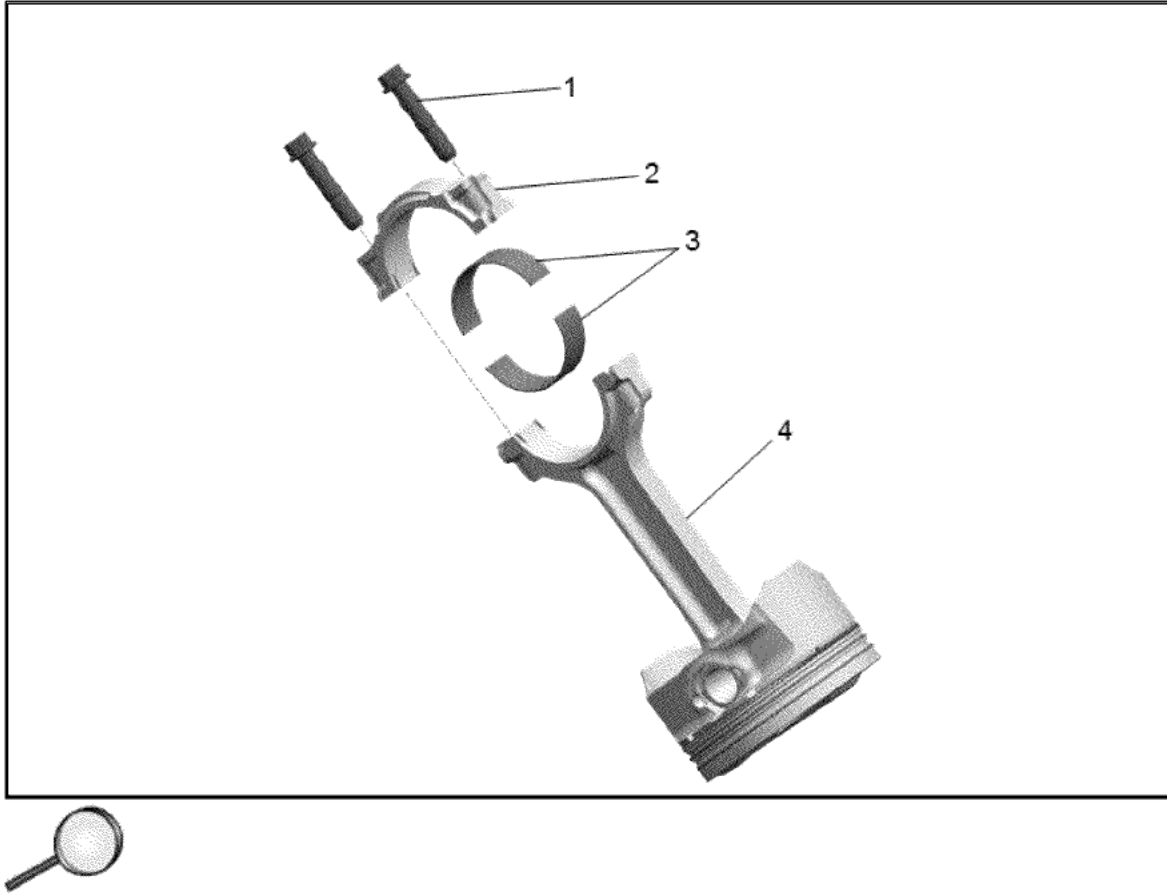
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75. Install the *EN-41556* Connecting Rod Guide (2) to the connecting rod (1).



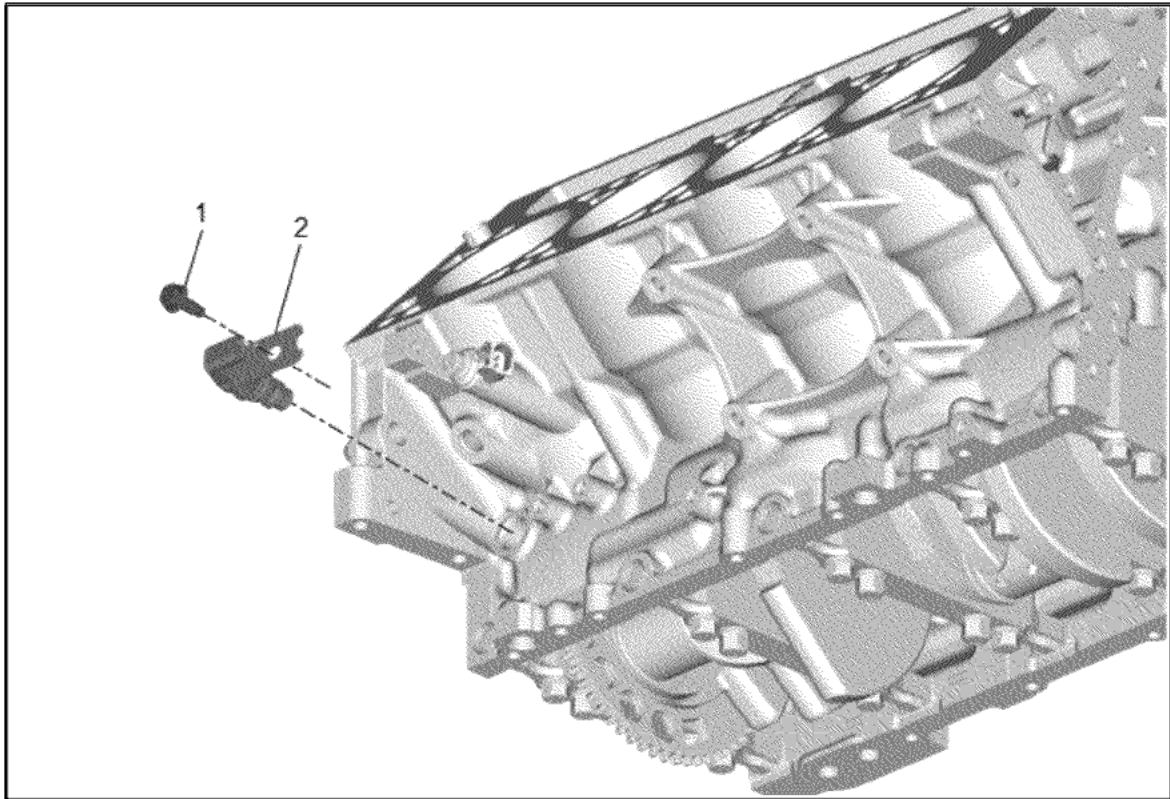
76. Using a hammer, tap lightly on the end of the *EN-41556* Connecting Rod Guide (3) to remove the piston and connecting rod assembly (1) from the cylinder bore.
77. Remove the bearing (2).
78. Remove the *EN-41556* Connecting Rod Guide (3).



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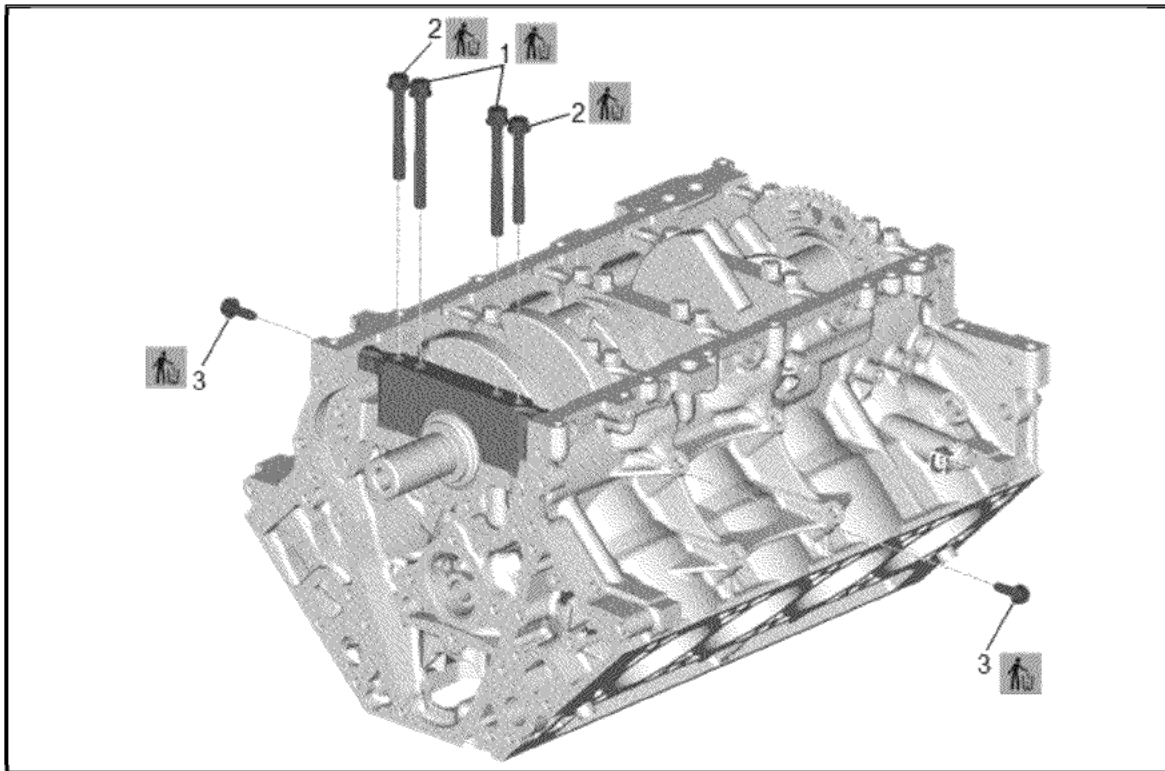
Note: The bolts are single use and must be discarded before final installation.

79. Upon removal of the piston and connecting rod assembly (4), assemble the connecting rod cap (2) and bolts (1) onto the matching connecting rod.



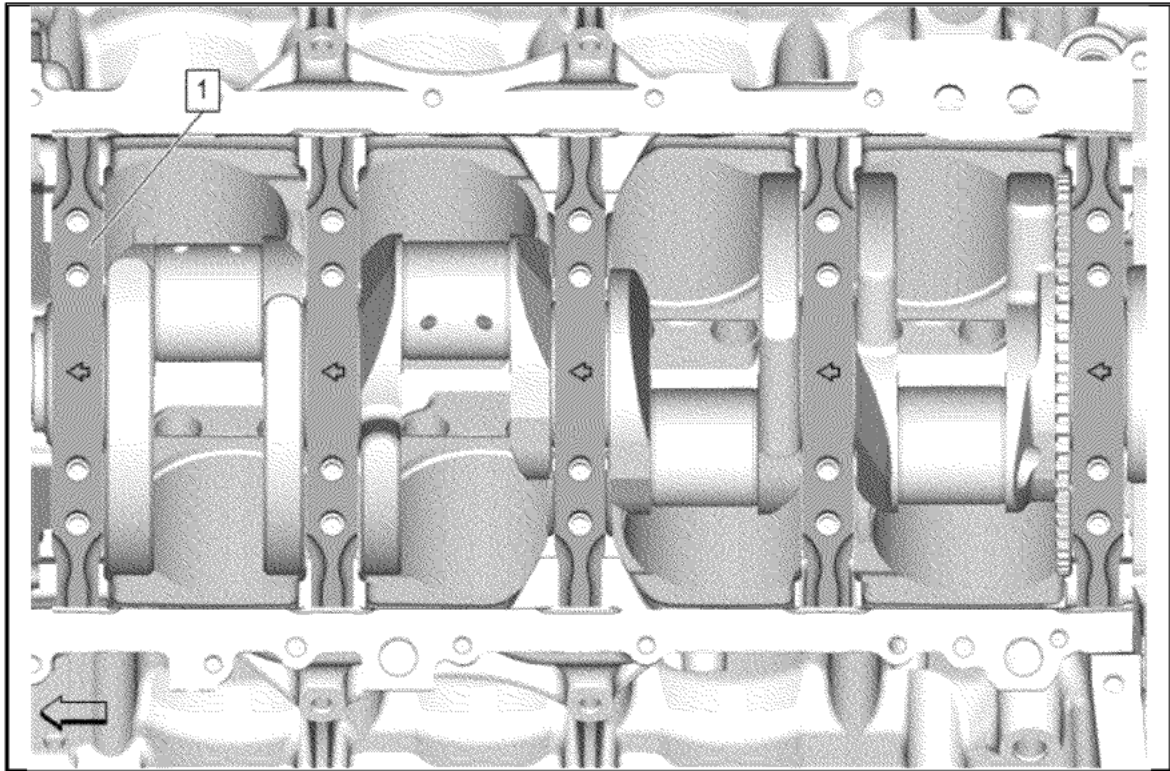
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- 80. Crankshaft Position Sensor Bolt (1) » Remove
- 81. Crankshaft Position Sensor (2) » Remove



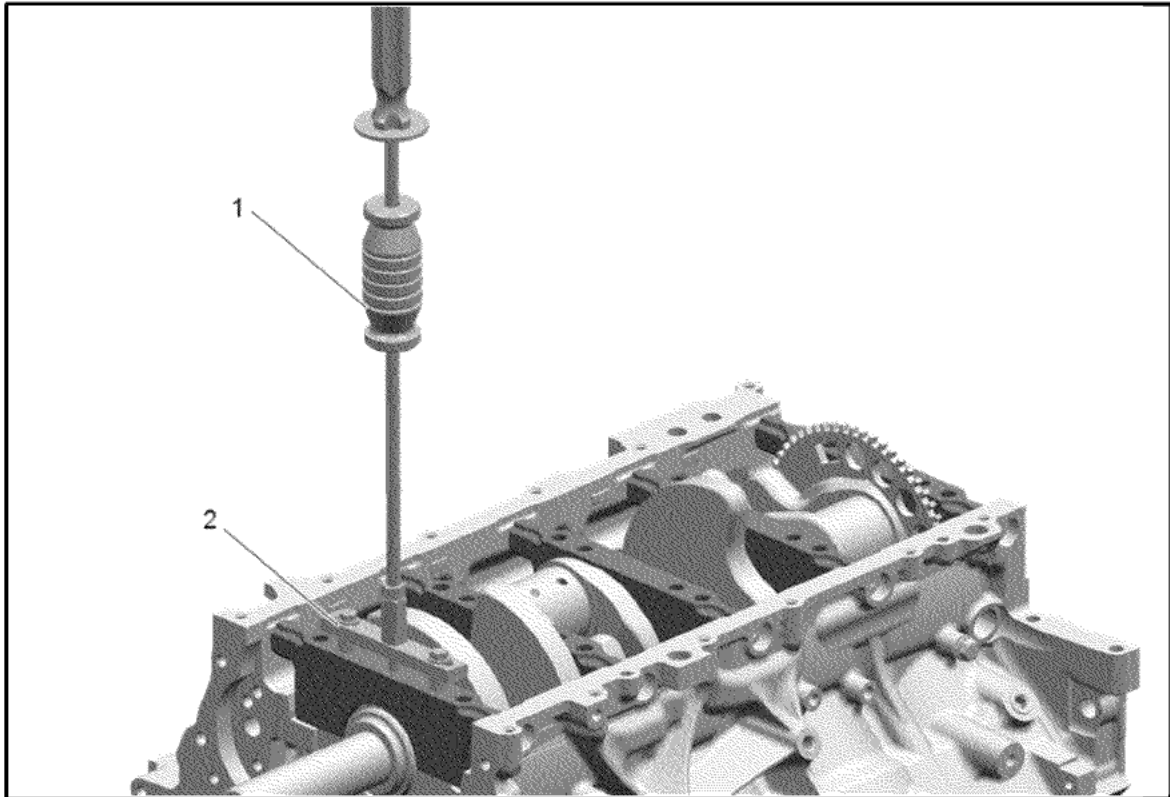
Note: The crankshaft bearing caps are machined with the engine block, for the proper clearances. Mark or identify each crankshaft bearing cap location and direction before removal. The crankshaft bearing caps **MUST** be installed to their original position and direction.

- 82. Crankshaft Bearing Cap Bolt - Inner (1) » Remove and DISCARD [10x]
- 83. Crankshaft Bearing Cap Bolt - Outer (2) » Remove and DISCARD [10x]
- 84. Crankshaft Bearing Cap Bolt - Side (3) » Remove and DISCARD [10x]



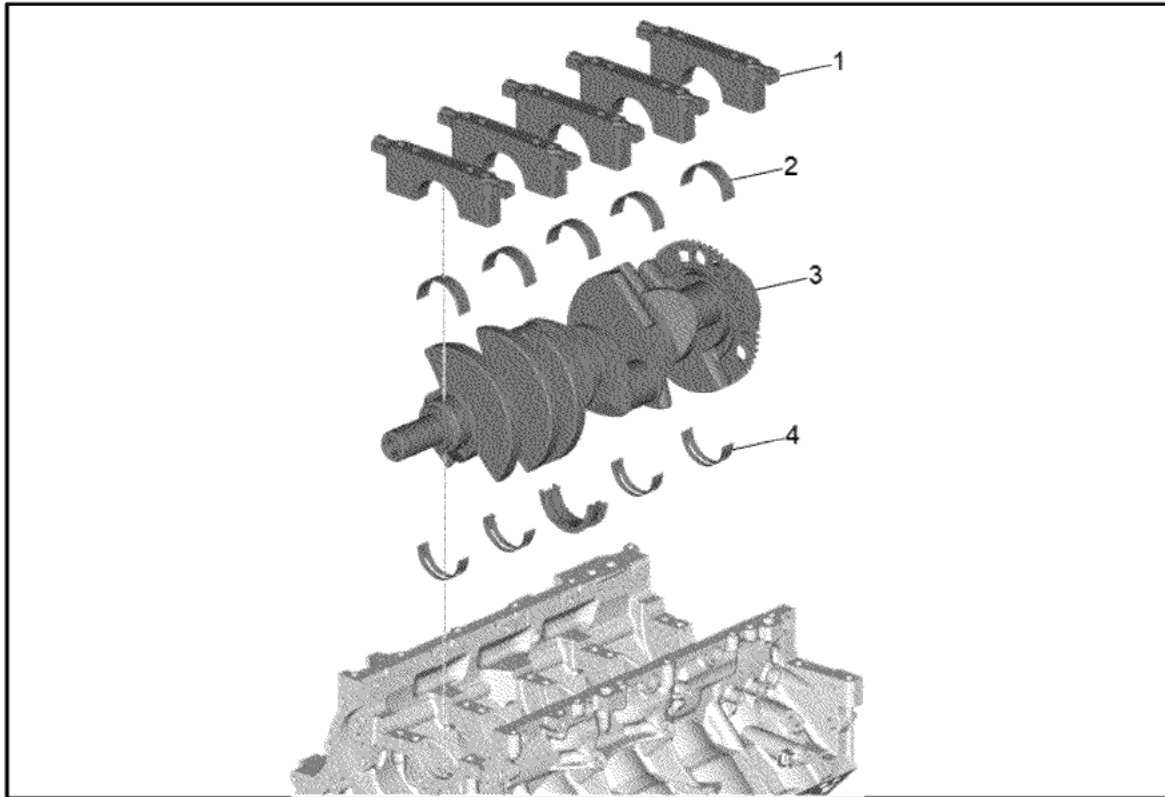
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85. Before removal note the direction of the bearing caps arrows and location.



86. Install the *J-41818* Crankshaft Bearing Cap Remover (2) and tighten to **11 Y (100 lb in)**.

87. Install the *J-6125-1B* Slide Hammer (1) to the *J-41818* Crankshaft Bearing Cap Remover (2).

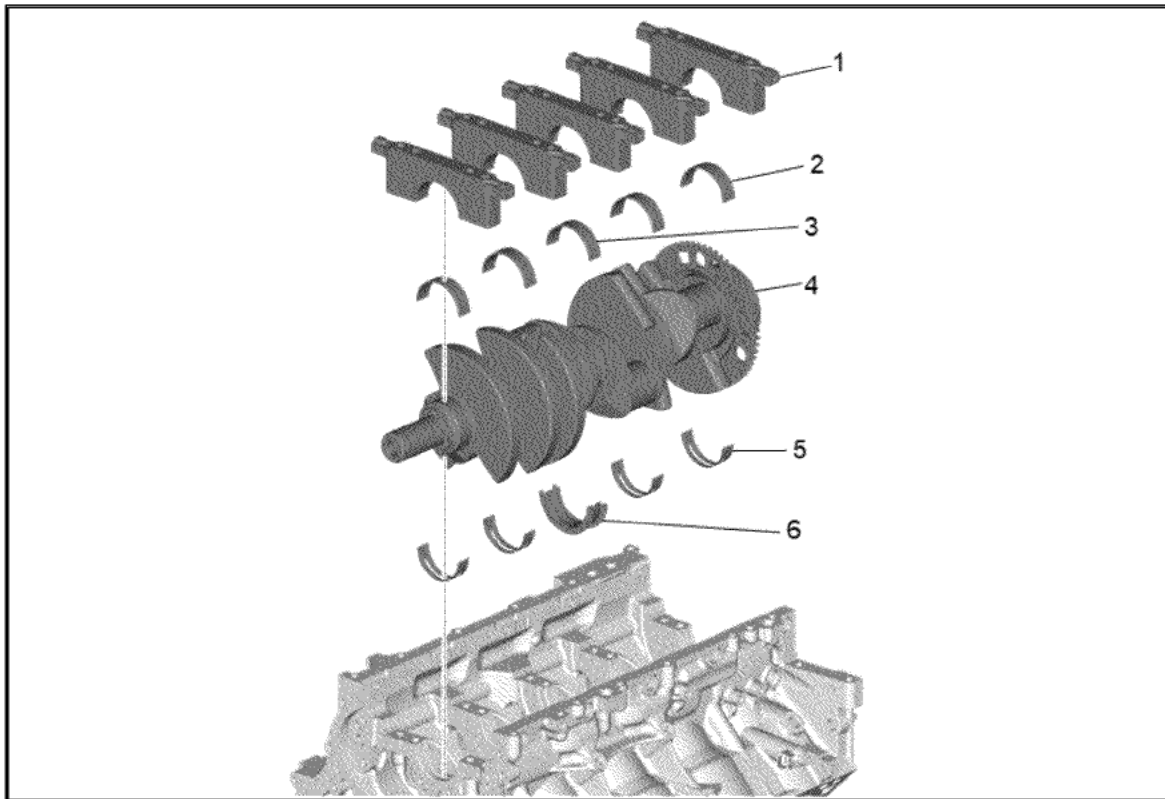


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Note: Use care when handling the crankshaft. Avoid damage to the CKP sensor reluctor ring teeth. Nicks, burrs or other damage to the teeth may affect on-board diagnostics (OBD) II system performance.

88. Crankshaft Bearing Cap (1) » Remove [5x]
89. Crankshaft Lower Bearing (2) » Remove [5x]
90. Crankshaft (3) » Remove
91. Crankshaft Upper Bearing (4) » Remove [5x]
92. Mark, sort, or organize the crankshaft bearings so they may be installed to their original position and location.
93. Lay the crankshaft onto 2 wooden V-blocks or other protective surface.

Measuring Crankshaft Bearing Clearance

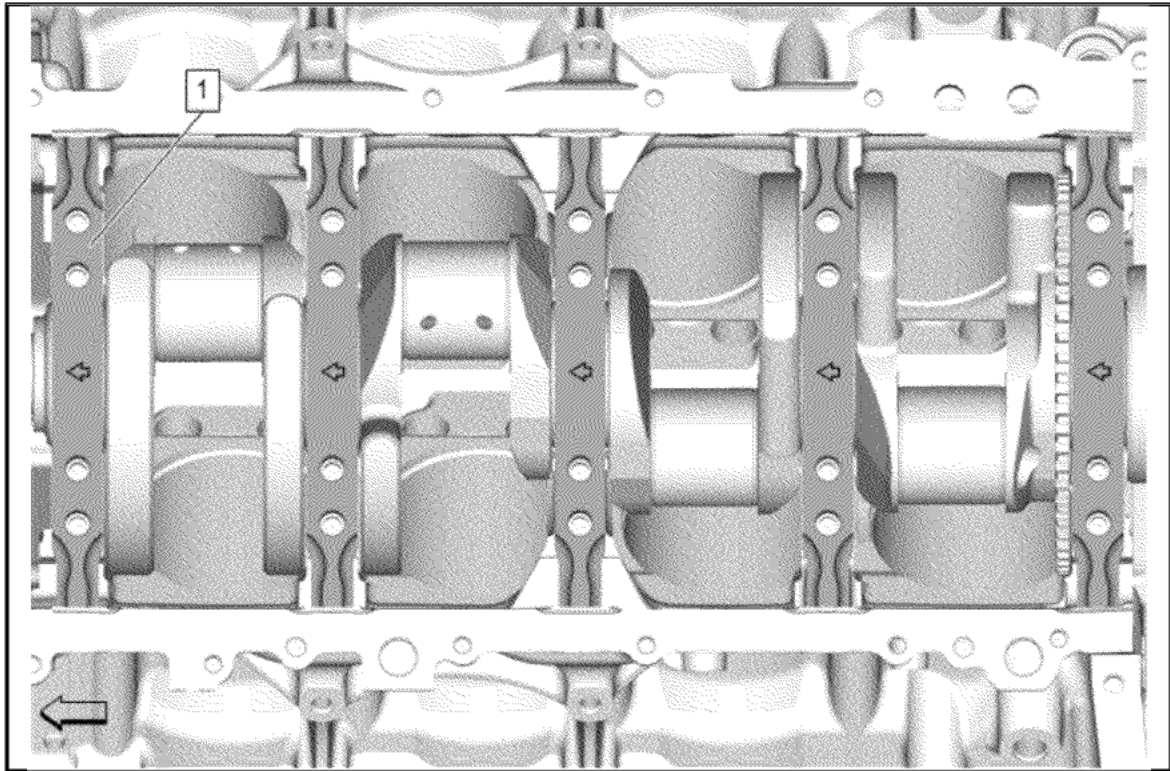


Note:

- 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 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 crankshaft bearing cap side bolts.

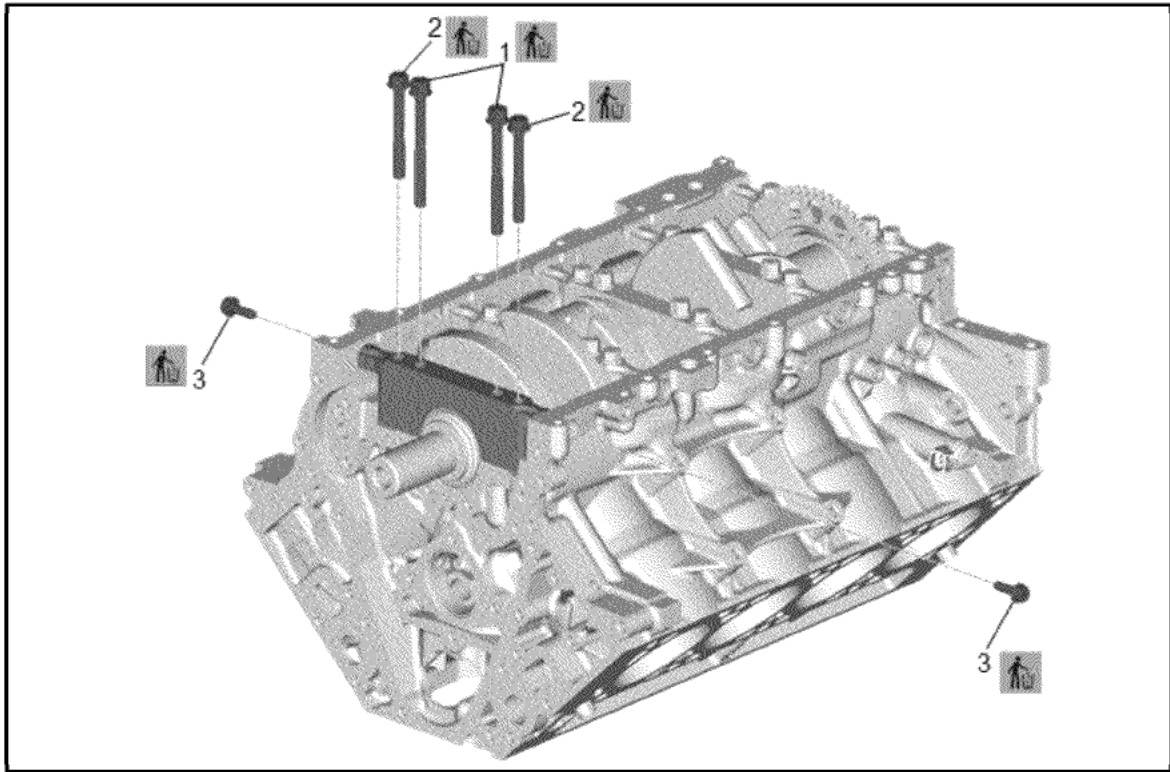
1. Install the crankshaft bearings (2 and 5) to the engine block and bearing caps (1). The thrust bearings (6) are to be installed into center journal.
2. Lubricate the bearing surfaces and crankshaft journals with clean engine oil.

Caution: To maintain proper crankshaft end play, use extreme care during crankshaft installation. Avoid scoring or damaging the thrust bearing.
3. Install the crankshaft (4).



4. Ensure the bearing caps are installed correctly.

The bearing caps must be installed in the proper location and direction. The arrows on the bearing caps must point toward front of engine.

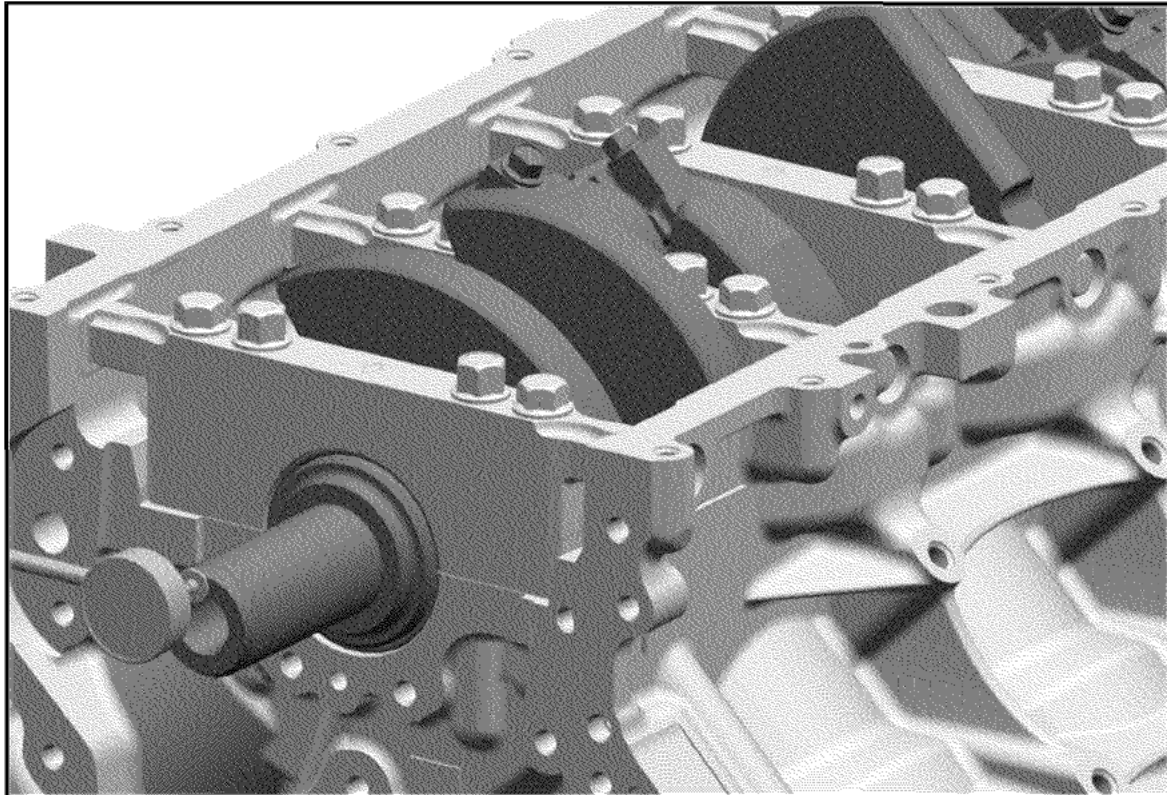


Caution: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

Caution: Refer to Fastener Caution.

Note: The inner bearing cap bolts are longer than the outer bearing cap bolts.

5. Install NEW inner bearing cap bolts (1) and NEW outer bearing cap bolts (2) and hand tighten.
 6. Using a plastic-face hammer, tap the bearing caps into place.
 7. Install the NEW bearing cap side bolts (3) and hand tighten.
 8. Tighten the inner bearing cap bolts in sequence. Fastener Specifications
- Note:** 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.
 10. Tighten the outer bearing cap bolts in sequence. Fastener Specifications
 11. Tighten the main bearing cap side bolts in sequence. Fastener Specifications

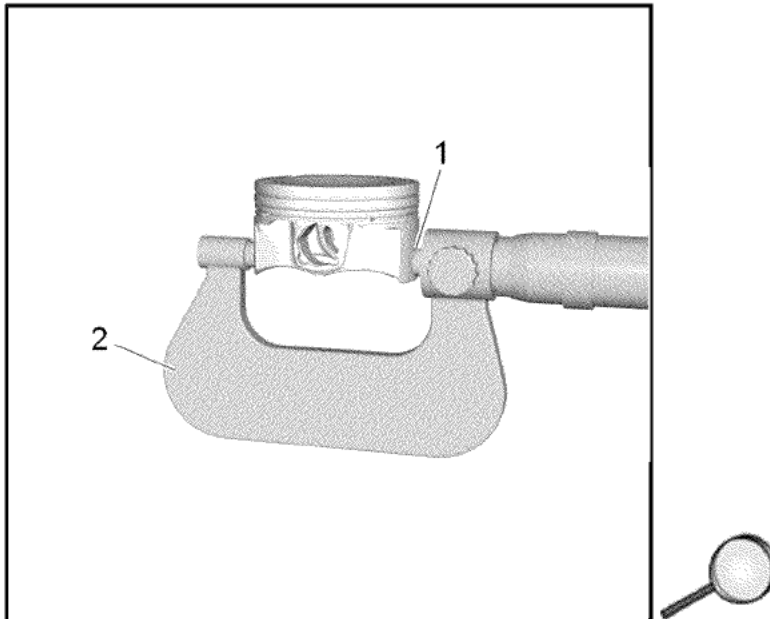


12. Measure the crankshaft end play.
 - 12.1. Thrust the crankshaft forward or rearward.
 - 12.2. Mount a dial indicator gauge with the tip engaging the front face of the nose of the crankshaft.
 - 12.3. Thrust the crankshaft in the opposite direction as step 12.1. Record the measurement from the dial indicator.

Compare the measurement to the required end play specification. [Engine Mechanical Specifications](#)

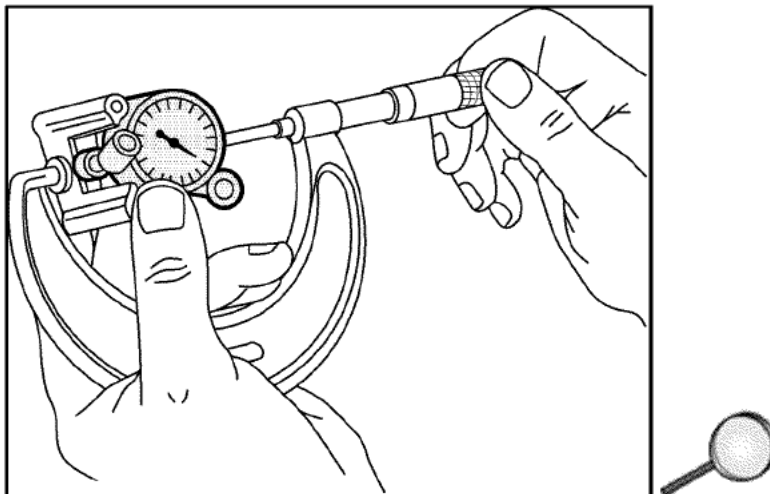
- 12.4. If the bearing clearance is not within specifications, inspect the thrust surfaces for nicks, gouges or raised metal. Minor imperfections may be removed with a fine stone.

Measuring Piston to Bore Clearance

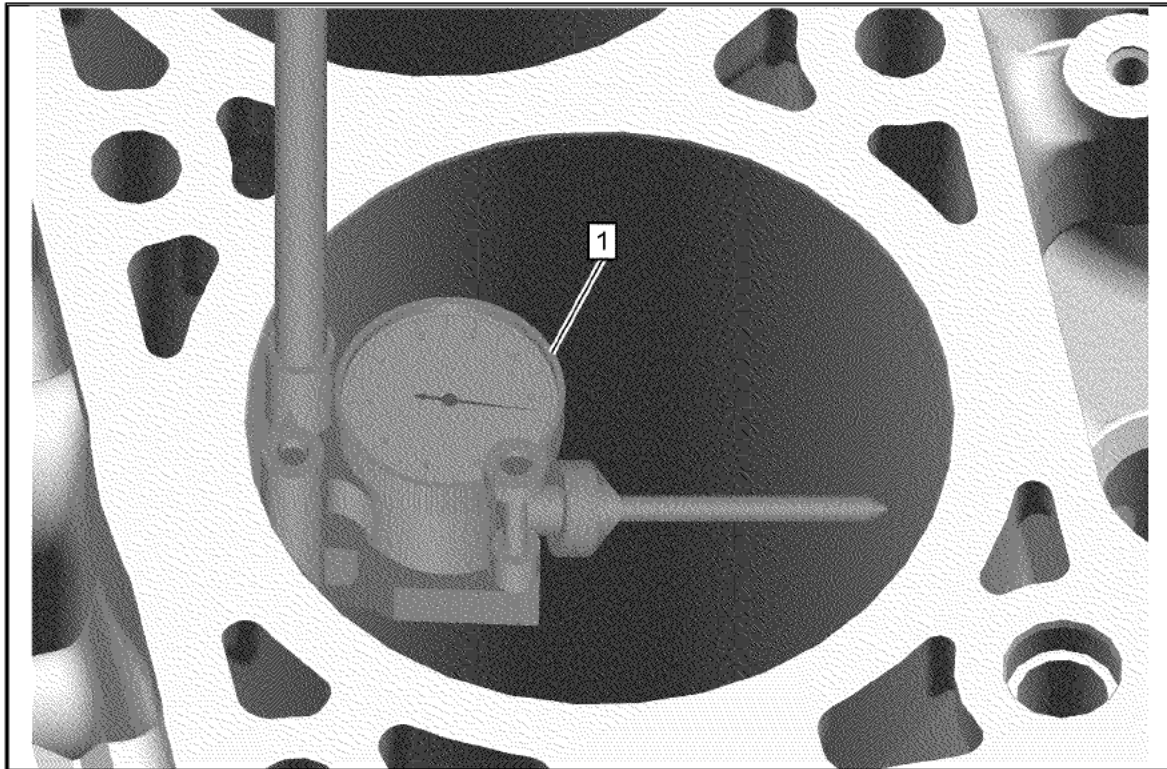


Note: Measurements of all components should be taken with the components at normal room temperature. For proper piston fit, the engine block cylinder bores must not have excessive wear or taper. A used piston, pin, and connecting rod assembly may be installed if, after inspection is within specifications.

1. With a micrometer (2) at a right angle, measure the piston (1) outside diameter (OD). Measure the diameter **43 mm (1.69 in)** from the top of the piston. [Engine Mechanical Specifications](#)
2. Record the piston OD.



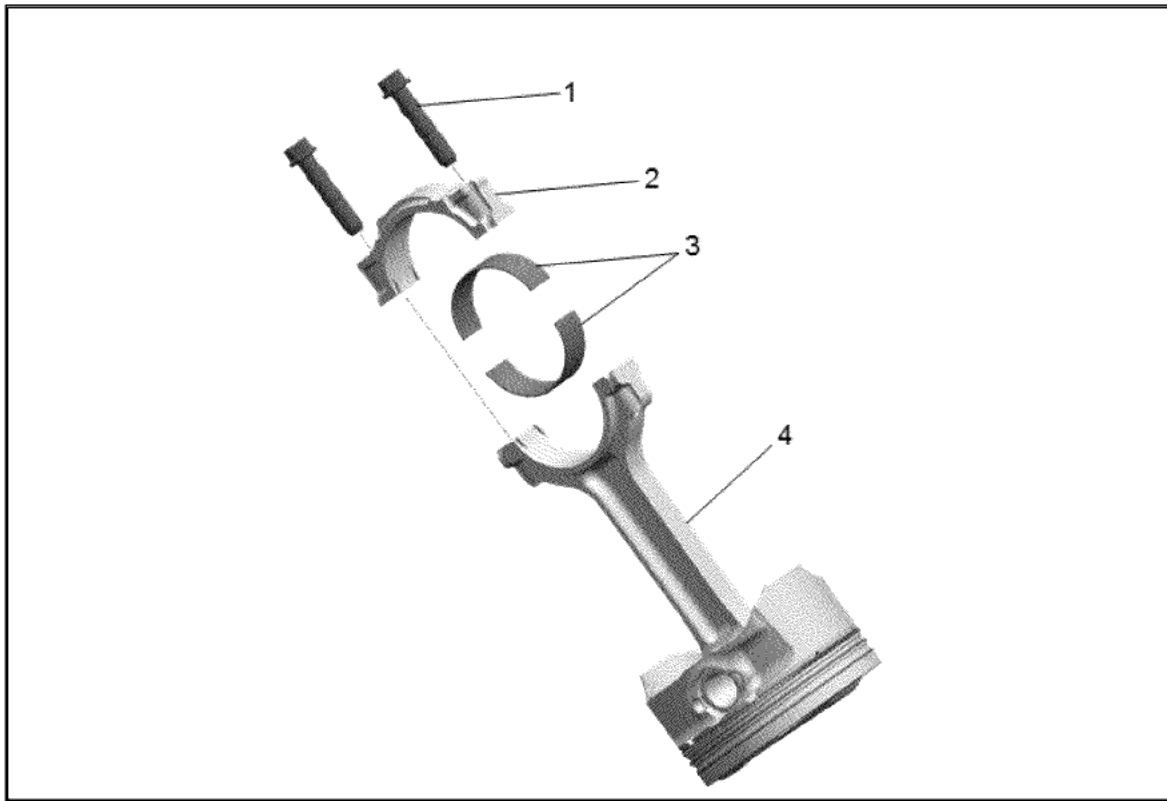
3. Adjust the micrometer to the recorded piston OD.
4. Insert the *EN-8087* Cylinder Bore Gauge into the micrometer and zero the gauge dial.



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5. Using the *EN-8087* Cylinder Bore Gauge (1), measure the cylinder bore inside diameter (ID). 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. [Engine Mechanical Specifications](#)
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.

Measuring Connecting Rod Side Clearance



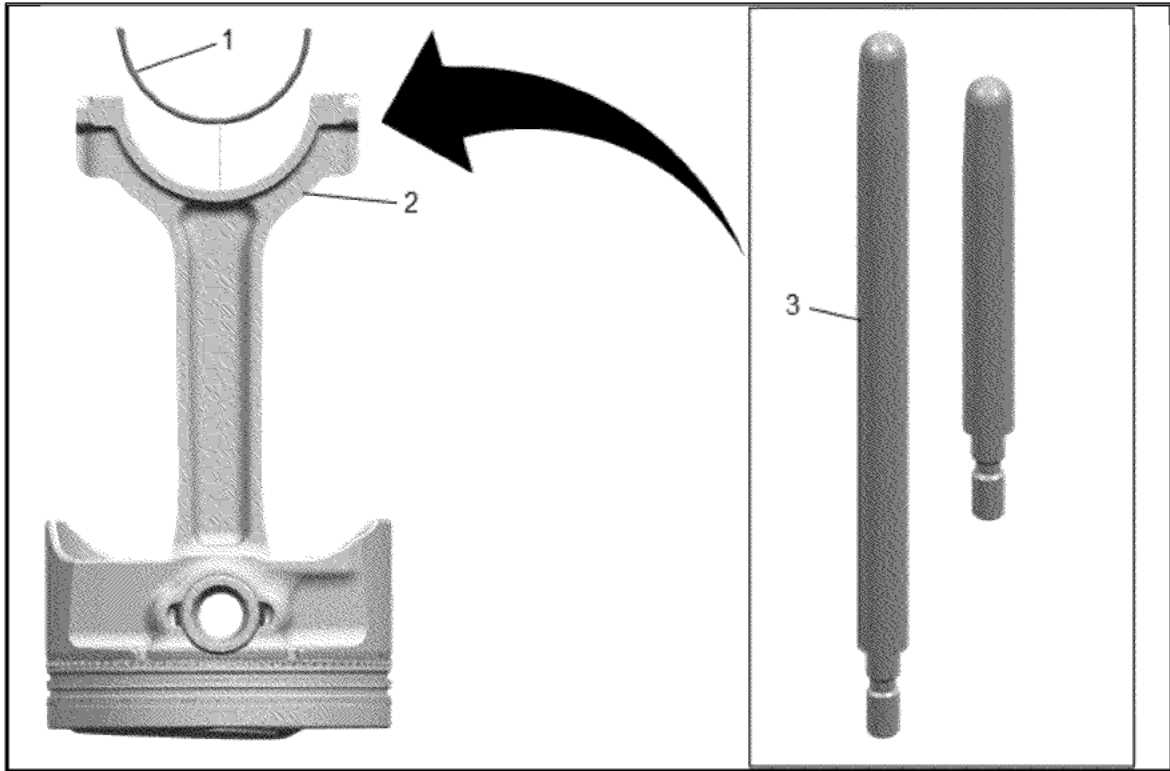
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1. Lubricate the following components with clean engine oil:

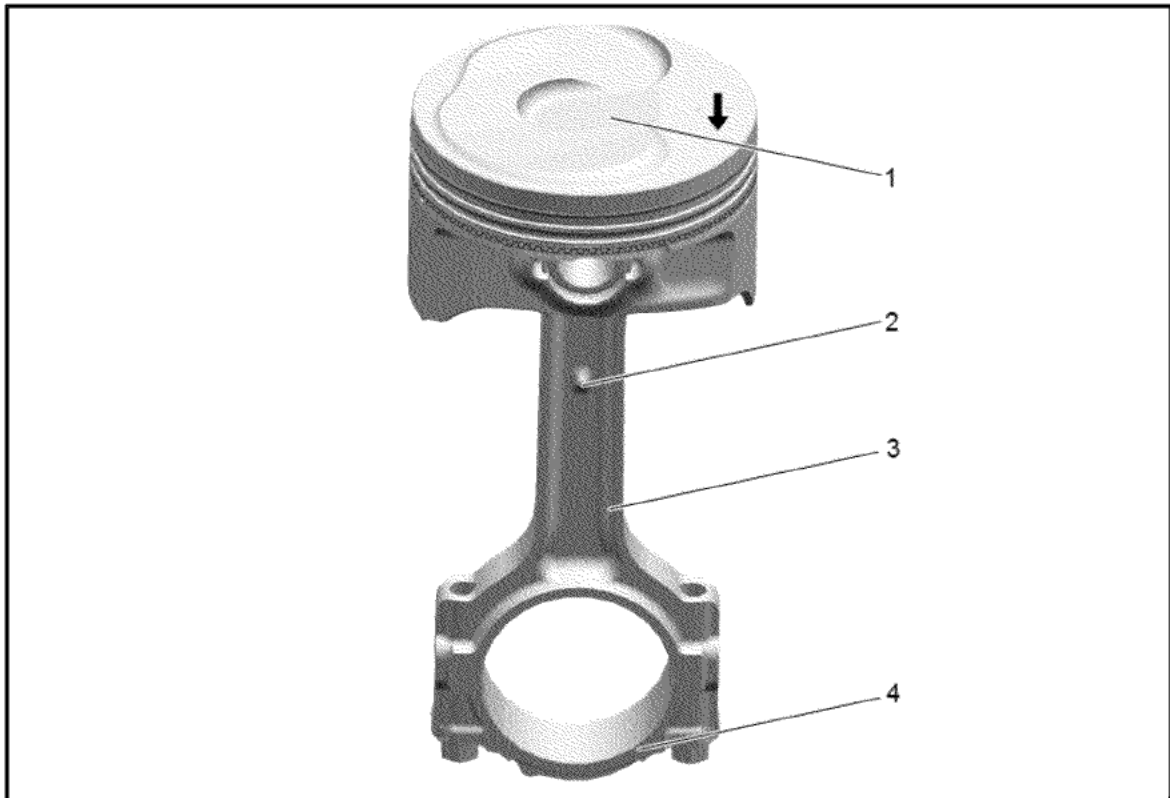
- Piston
- Piston rings
- Cylinder bore
- Bearings and bearing surfaces

Note: The bolts are single use and must be discarded before final installation.

2. Remove and DISCARD the bolts (1) before final installation.
3. Install the bearings (3) to the connecting rod and cap (2).
4. Position the oil control ring end gaps a minimum of **25 mm (1.0 in)** from each other.
5. Position the compression ring end gaps **180 degrees** opposite each other.

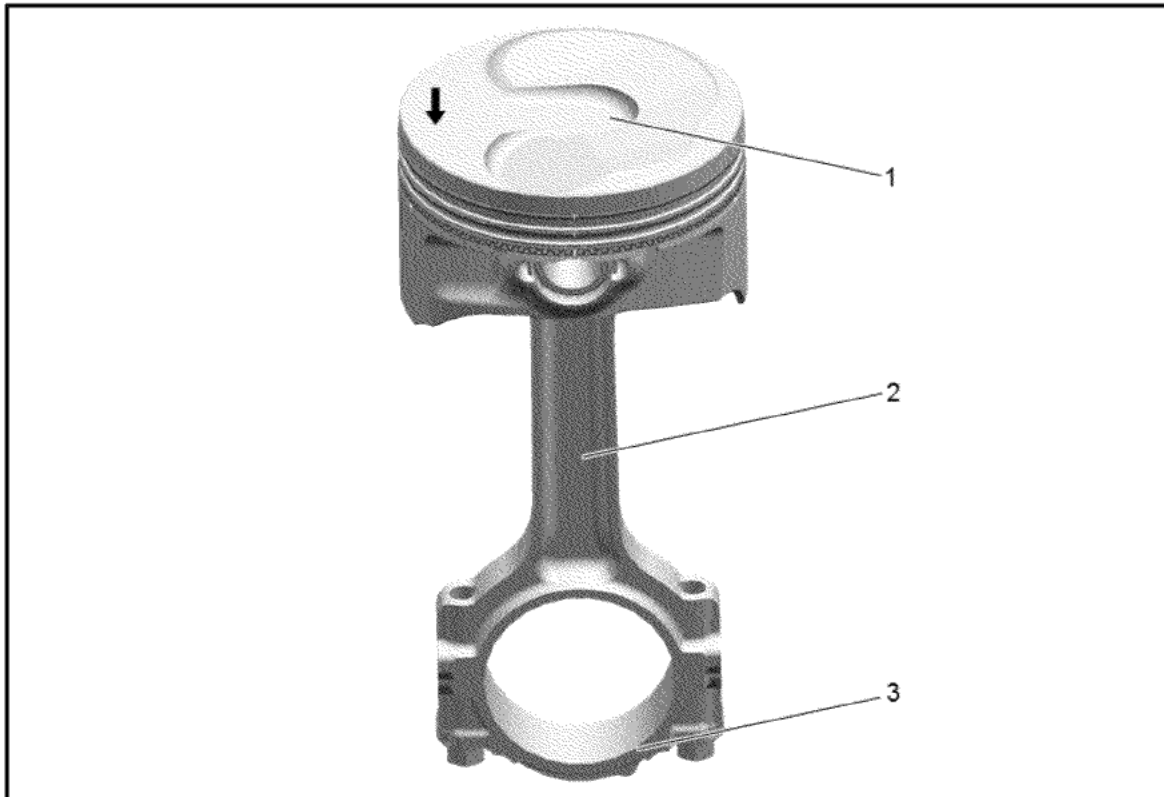


6. Install the *EN-41556* Connecting Rod Guide (3) to the connecting rod.



7. Piston - Right Side

- The arrow on top of the piston (1) and the dimple (2) on the rod face the same direction.
- When installing the right side piston and rod (3) assemblies, the arrow on top of the piston and the dimple (2) on the rod face the front of the engine.
- The raised bump (4) on bottom of rod (3) will be closest to the outside of the engine.



8. Piston - Left Side

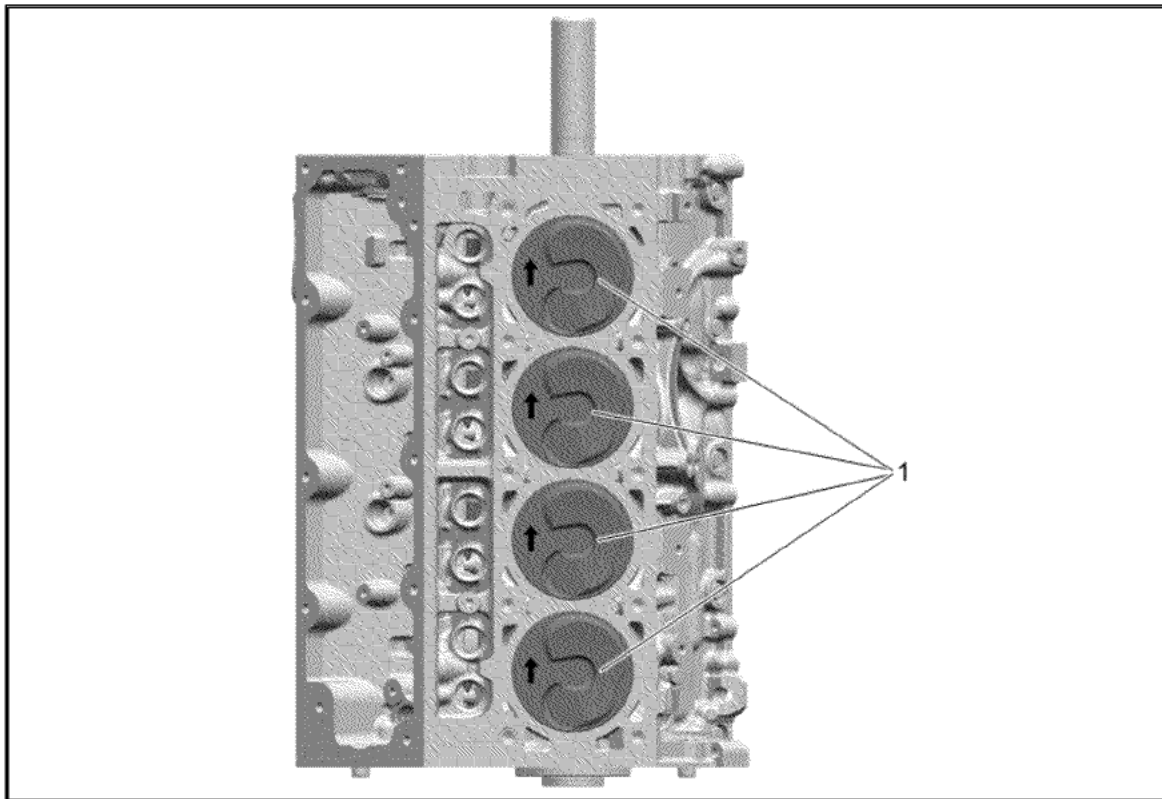
- The arrow on top of the piston (1) and the dimple on the rod face the opposite direction.
- When installing the left side piston and rod (2) assemblies, the arrow on top of the piston faces the front of the engine and the dimple on the rod faces the rear of the engine.
- The raised bump (3) on the bottom of rod will be closest to the outside of engine.

Note: When installing a piston into a cylinder, use a ring compressor sleeve or equivalent for best results. The following features should be looked for when selecting a ring compressor sleeve.

- Hard anodized and Teflon coated for low friction and prolonged wear resistance.
- Smooth radius that tapers down to the specific bore size.
- Sleeve should compress the piston rings smoothly and evenly.
- Using a ring compressor sleeve greatly reduces the difficulty with installing thin high-performance oil rings.

If a ring compressor sleeve is unavailable, a universal ring compressor will work, but is more difficult to use.

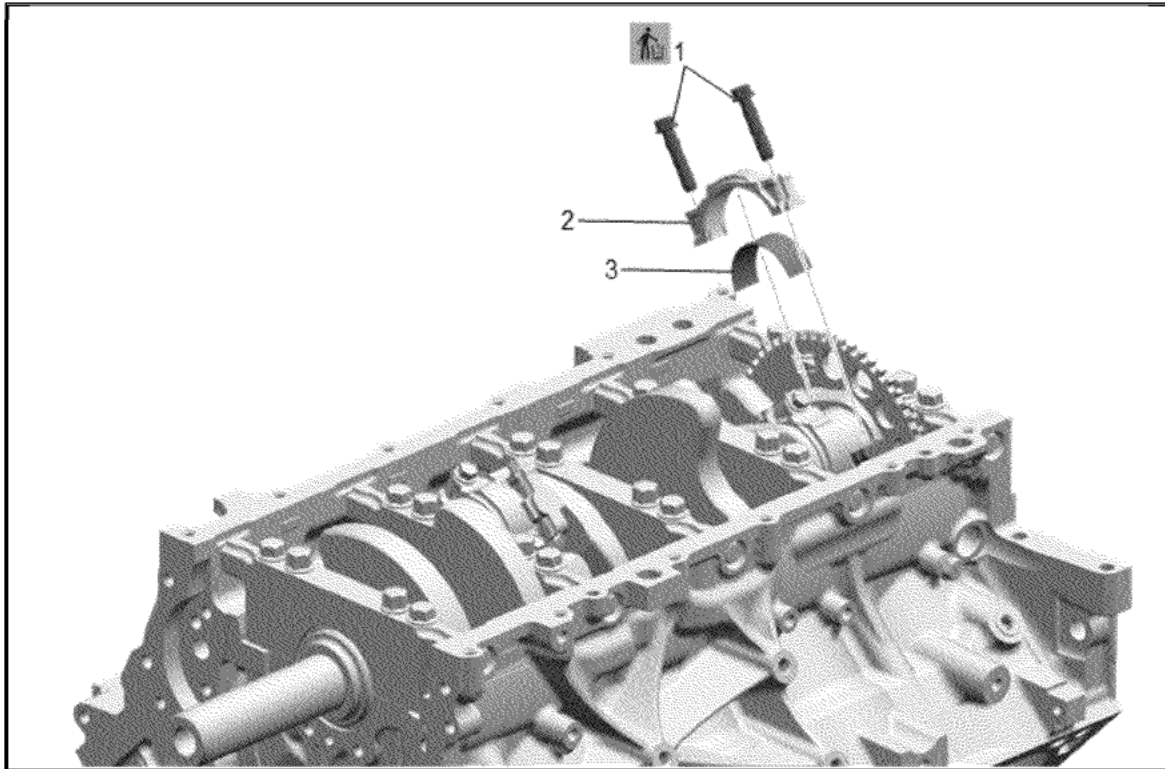
9. Compress the piston rings using a ring compressor sleeve or equivalent.



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Note: The arrow on the top of the piston **MUST** face the front of the engine block. The deepest portion of the fuel bowls (1) must be toward the outside of the engine.

10. Install the piston, pin, and connecting rod assembly into the cylinder bore. Tap the piston into the bore with a wooden hammer handle. Guide the connecting rod to the crankshaft journal using the *J-41556* Connecting Rod Guide while gently tapping the piston into place. Hold the ring compressor sleeve or equivalent against the engine block until all rings have entered the cylinder bore.
11. Remove the *EN-41556* Connecting Rod Guide from the connecting rod.



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

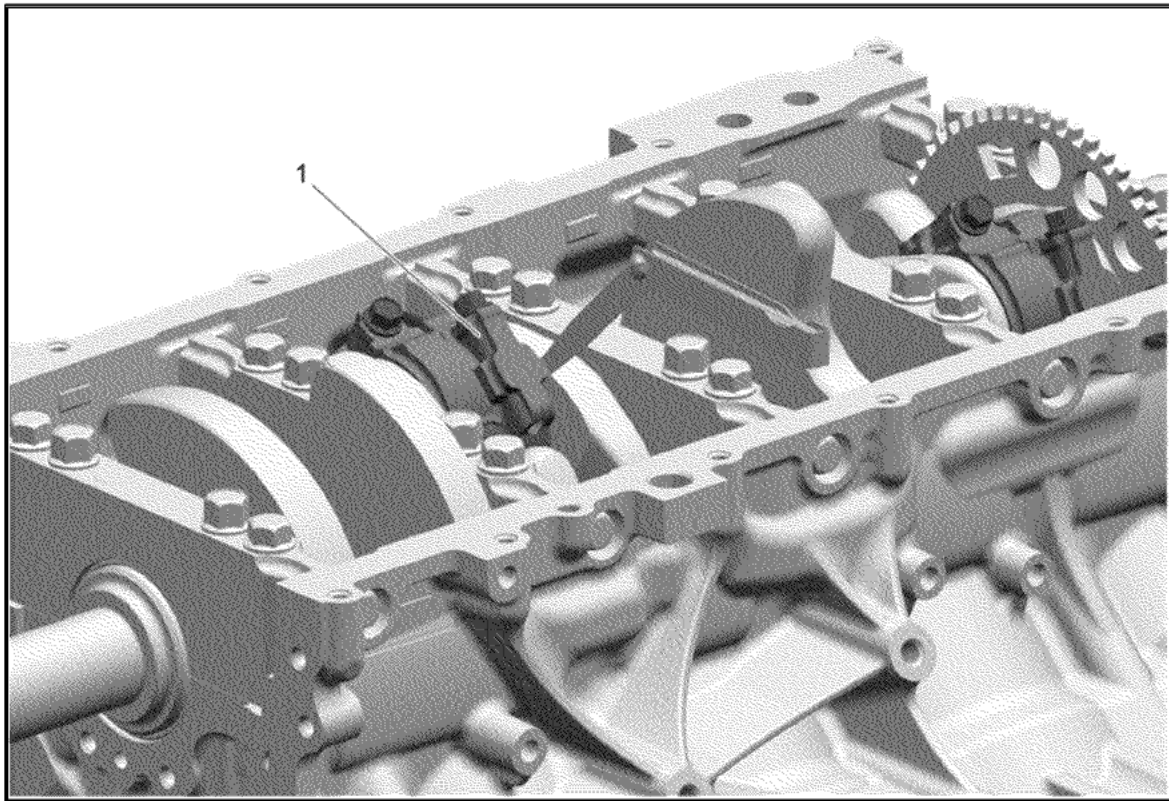
Caution: Refer to [Fastener Caution](#).

Note:

- The connecting rod and cap must be assembled with the mating surfaces properly aligned.
- If re-using connecting rods, DO NOT re-use connecting rod bolts. During an installation procedure, the new connecting rod bolts can be re-tightened a maximum of 3 times.

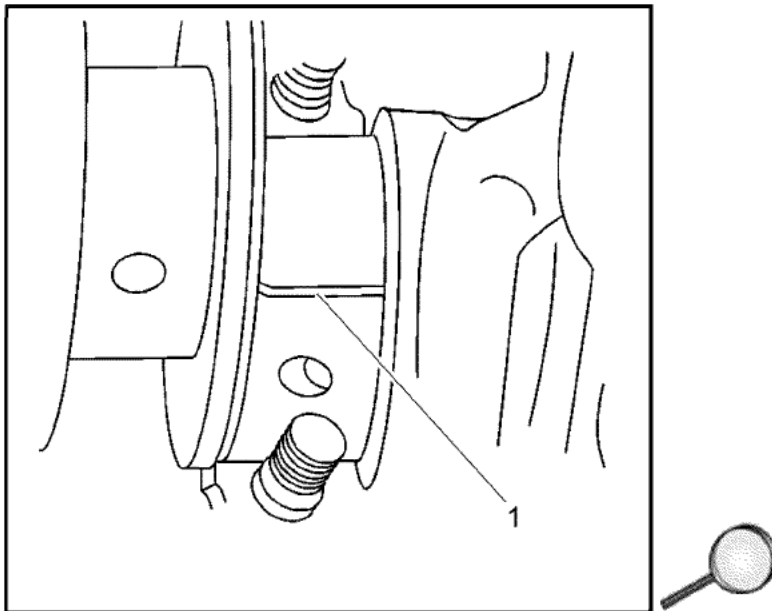
12. Install the bearing (3) and bearing cap (2).

13. Install NEW bolts (1) and tighten, using the *EN-45059* Angle Meter. [Fastener Specifications](#)



14. Measure the connecting rods (1) for the proper side clearance. Engine Mechanical Specifications

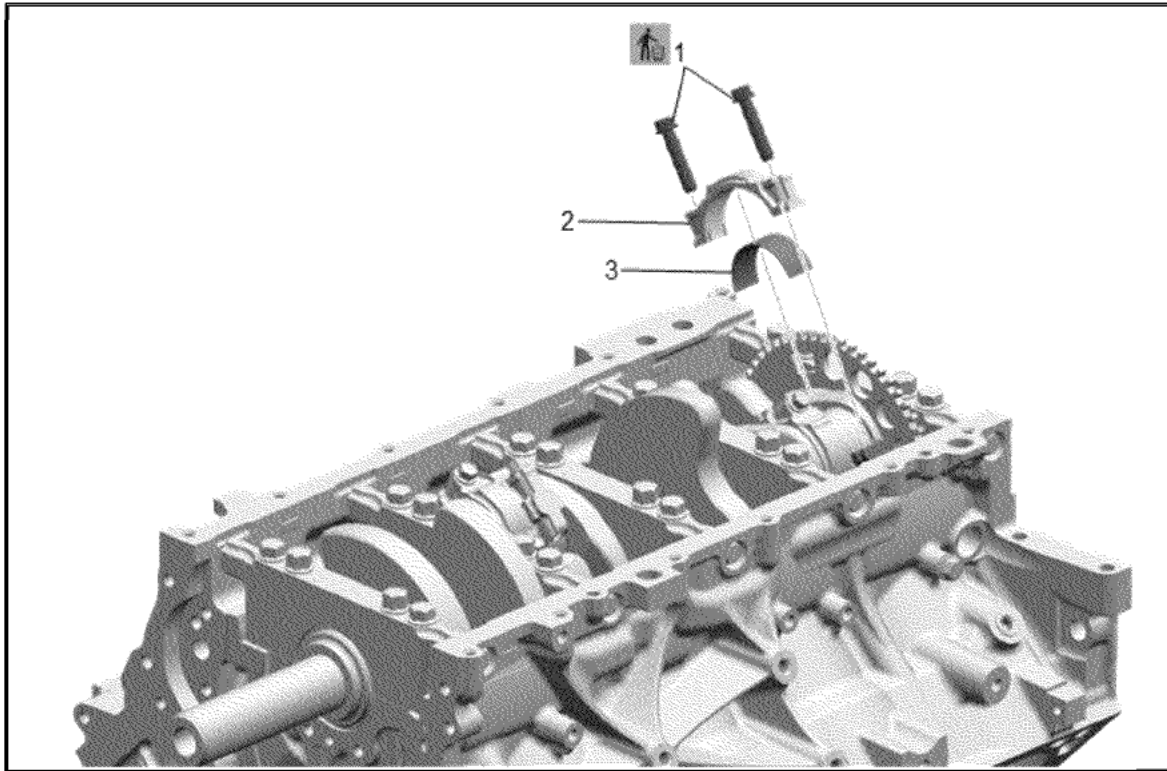
Measuring Connecting Rod Bearing Clearance – Gaging Plastic Method



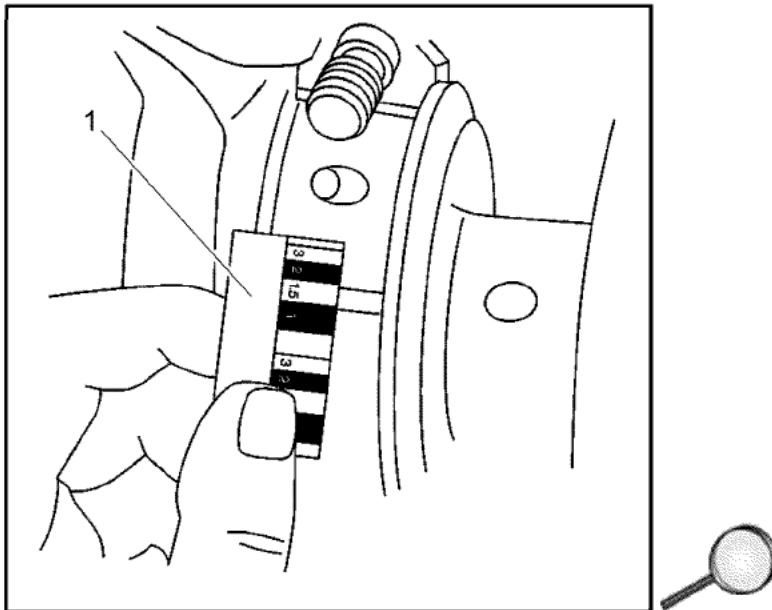
Note:

- Connecting rod bearings are a precision insert type. Connecting rods are of a powdered metal design and cannot be shimmed or filed 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. See steps above in removal procedure.
 2. Install the gaging plastic (1) 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. See steps below in installation procedure.

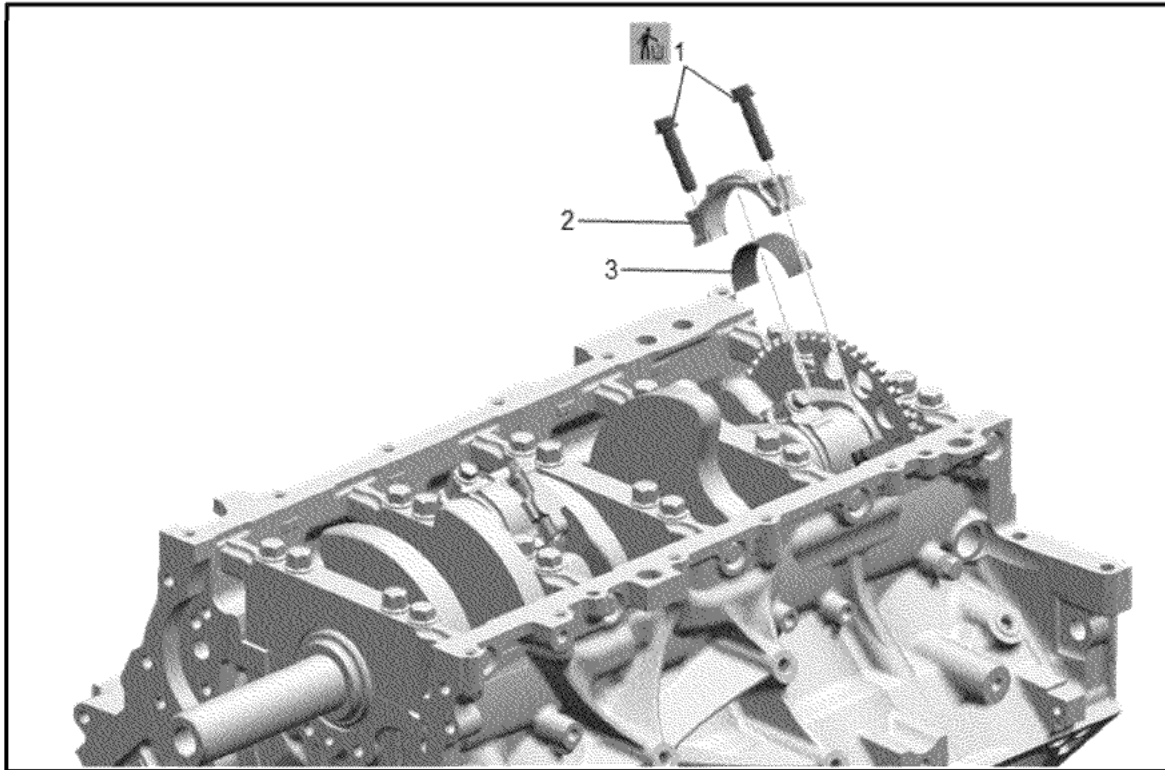


4. Remove the bearing cap, bearing half, and bolts. See steps above in removal procedure.



5. Using the scale (1) supplied with the plastic gaging kit, measure the gaging plastic at its widest area. [Engine Mechanical Specifications](#)

6. Service components as required, if a connecting rod is out of specifications.
7. Remove all components installed for the measurement procedures. Remove the gaging plastic residue, and prepare for the assemble procedure.



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

Caution: Refer to [Fastener Caution](#).

Note:

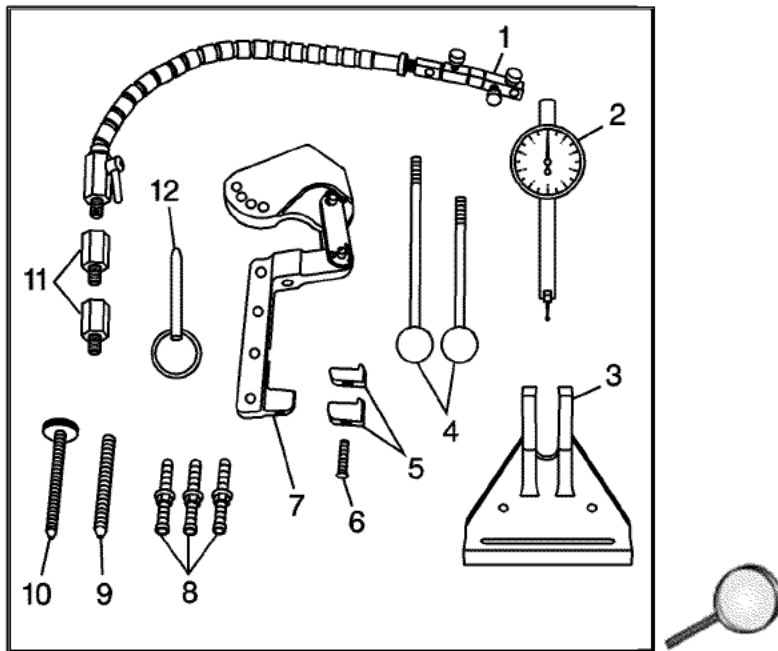
- o The connecting rod and cap must be assembled with the mating surfaces properly aligned.
- o If re-using connecting rods, DO NOT re-use connecting rod bolts. During an installation procedure, the new connecting rod bolts can be re-tightened a maximum of 3 times.

8. Install the bearing (3) and bearing cap (2).

9. Install NEW bolts (1) and tighten, using the *EN-45059* Angle Meter. [Fastener Specifications](#)

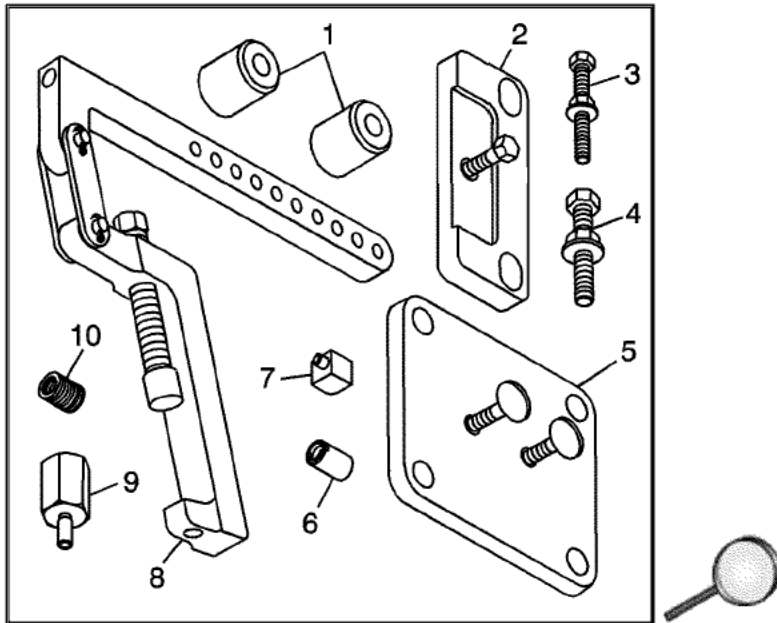
Measuring Connecting Rod Bearing Clearance – Using EN-43690 / EN-43690-100

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



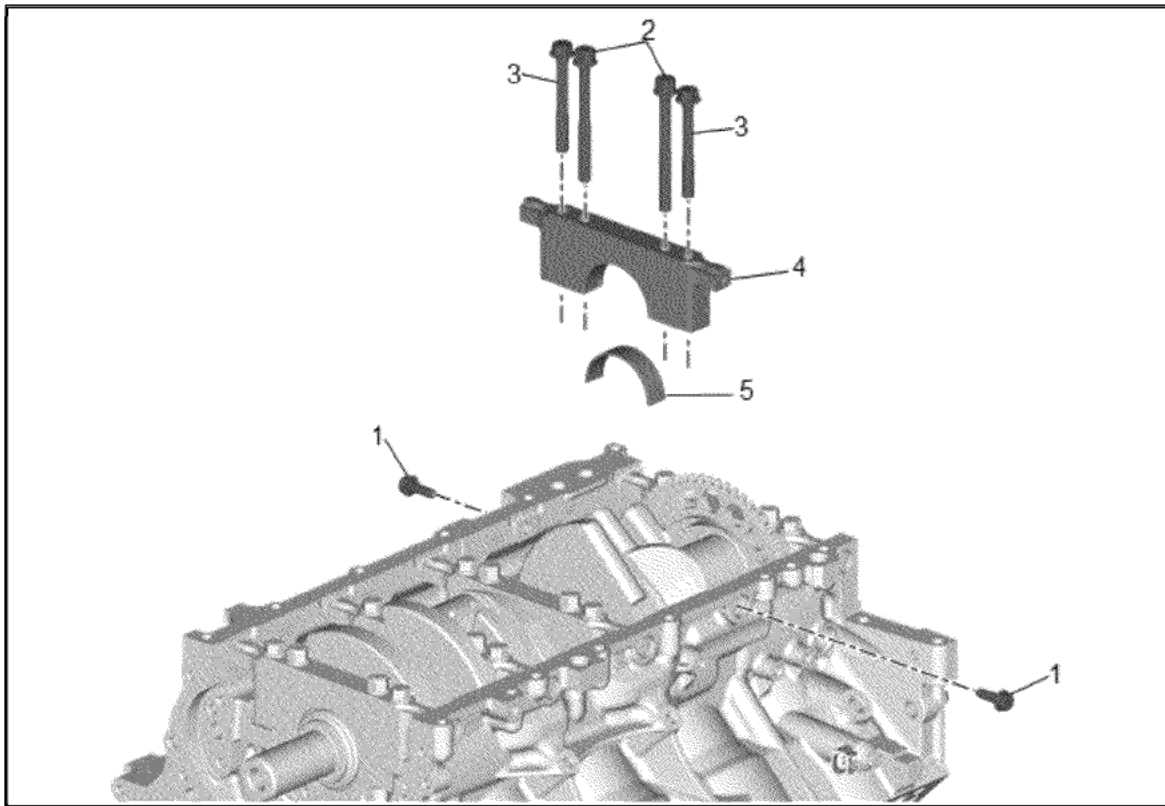
EN-43690 Rod Bearing Checking Tool

- EN-43690-20 Swivel Base (1)
- EN-43690-19 Dial Indicator (2)
- EN-43690-2 Base (3)
- EN-43690-5, EN-43690-6 Handle (4)
- EN-43690-10, EN-43690-11 Foot (5)
- 280307 Screw (6)
- EN-43690-1 Pivot Arm Assembly (7)
- EN-43690-3, EN-43690-7, EN-43690-8 Screws (8)
- 280319 Screw (9)
- 280311 Screw (10)
- EN-43690-17, EN-43690-18 Adapter (11)
- 280310 Pin (12)



EN-43690-100 Rod Bearing Checking Tool – Adapter Kit

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



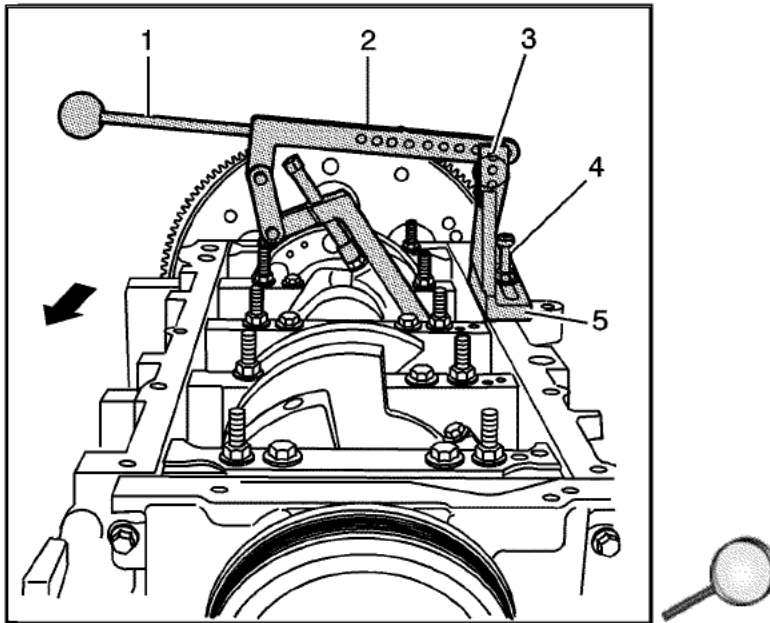
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Note: The crankshaft must be secure, with no movement or rotation, in order to obtain an accurate reading.

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 (1-4).
3. Remove the bearing half (5).
4. Insert a piece of paper, card stock onto the crankshaft journal.

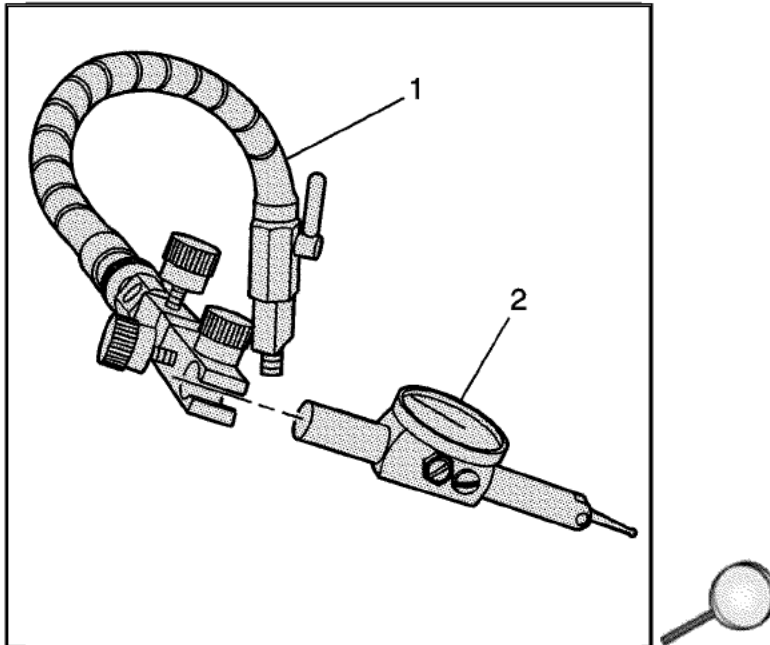
Caution: Refer to [Fastener Caution](#).

5. Install the bearing half (5) and cap and bolts (1-4). [Fastener Specifications](#)



6. Install the following:

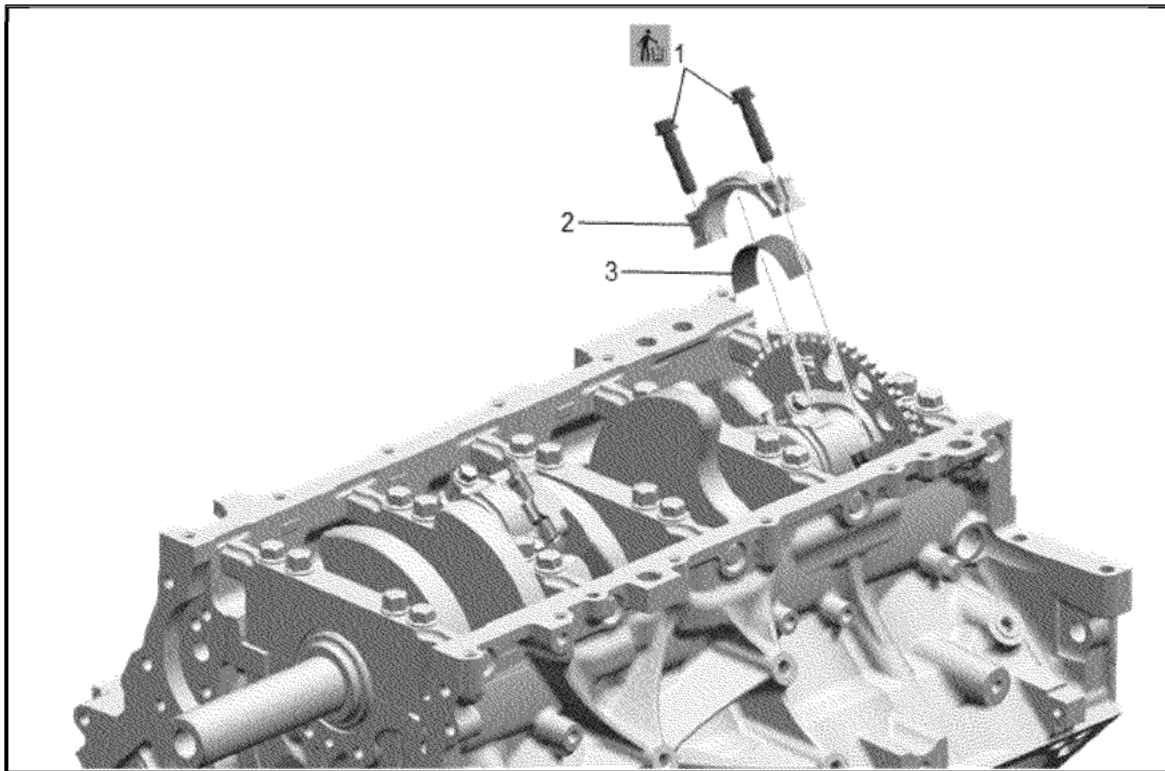
- 6.1. EN-43690-2 (5)
- 6.2. EN-43690-3 (4)
- 6.3. EN-43690-101 (2)
- 6.4. 280310 (3)
- 6.5. EN-43690-5 (1)



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.

9. Remove all components installed for the measurement procedures. Remove the paper card stock residue, and prepare for the assemble procedure.



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

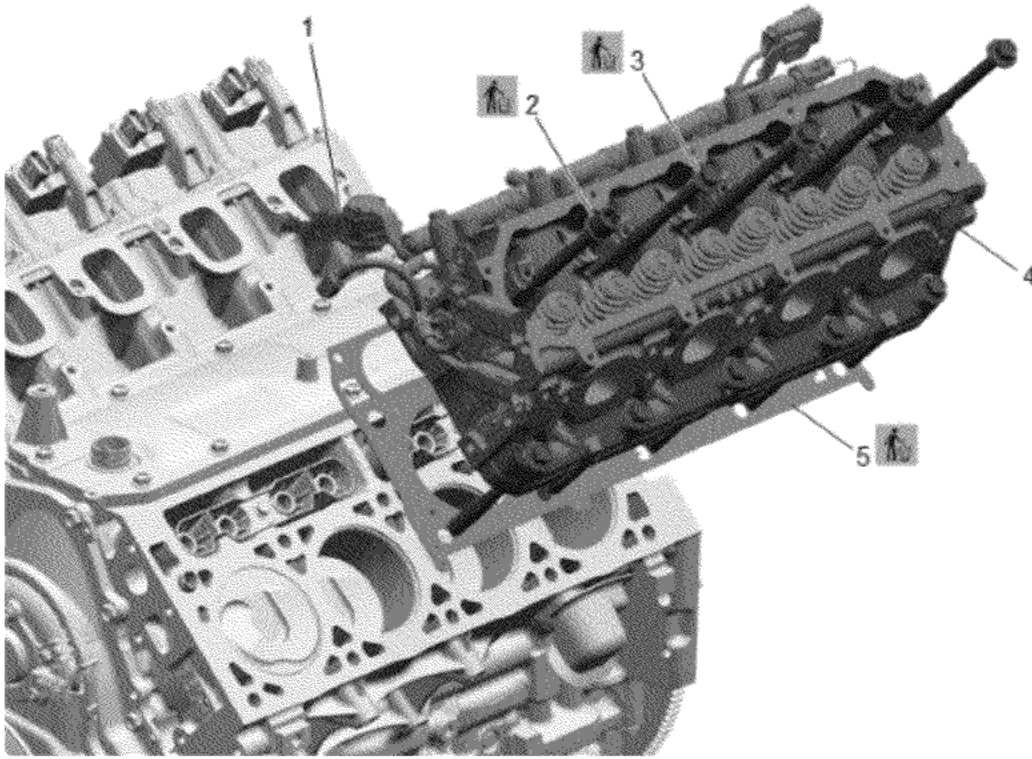
Note:

- The connecting rod and cap must be assembled with the mating surfaces properly aligned.
- If re-using connecting rods, DO NOT re-use connecting rod bolts. During an installation procedure, the new connecting rod bolts can be re-tightened a maximum of 3 times.

10. Install the bearing (3) and bearing cap (2).

11. Install NEW bolts (1) and tighten, using the *EN-45059* Angle Meter. [Fastener Specifications](#)

Assemble Procedure



Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

Note: Left side shown, right side similar.

1. Cylinder Head Gasket - Left Side and Right Side (5) » Install NEW [2x]
2. Cylinder Head - Left Side and Right Side (4) » Install [2x]

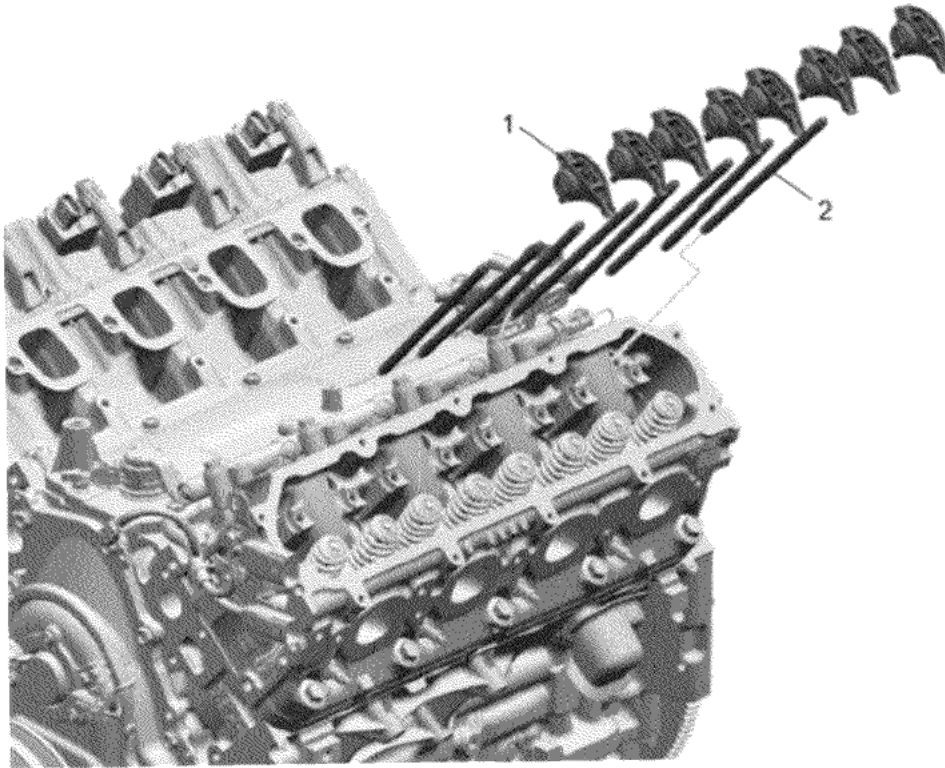
Caution: Refer to [Fastener Caution](#).

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

3. Cylinder Head Bolt - Left Side (2) » Install NEW and tighten in sequence — [Fastener Specifications](#)

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

4. Cylinder Head Bolt - Left Side and Right Side (3) » Install NEW and tighten in sequence [19x] — [Fastener Specifications](#)
5. Connect the electrical connector. (1)

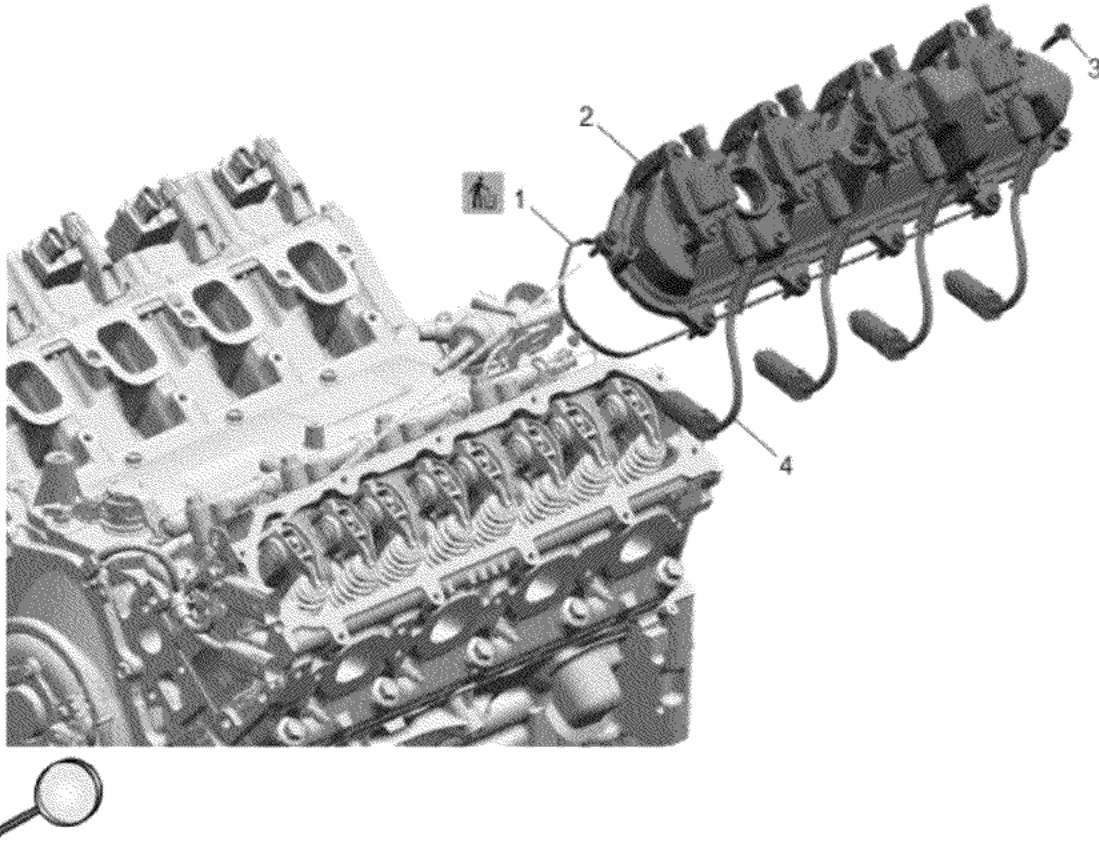


Note: Left side shown, right side similar.

6. Valve Push Rod (2) » Install [16x]

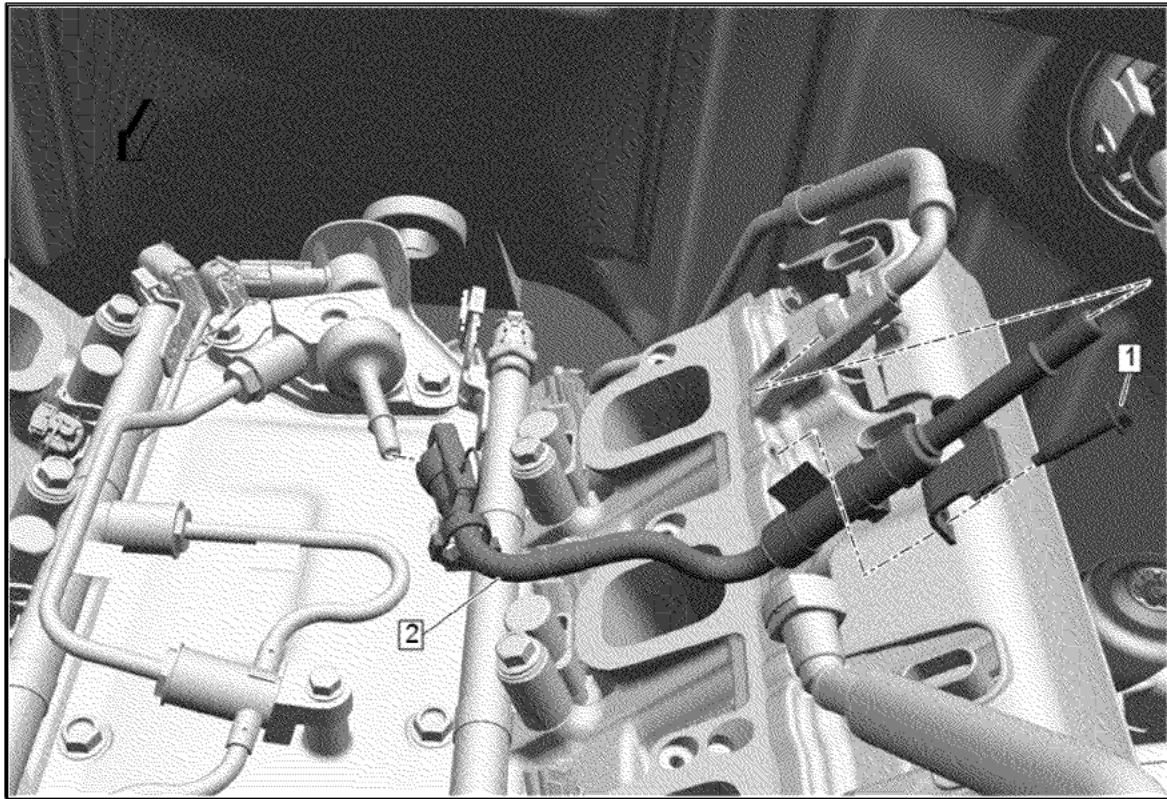
7. Valve Rocker Arm (1) » Install [16x] — Fastener Specifications

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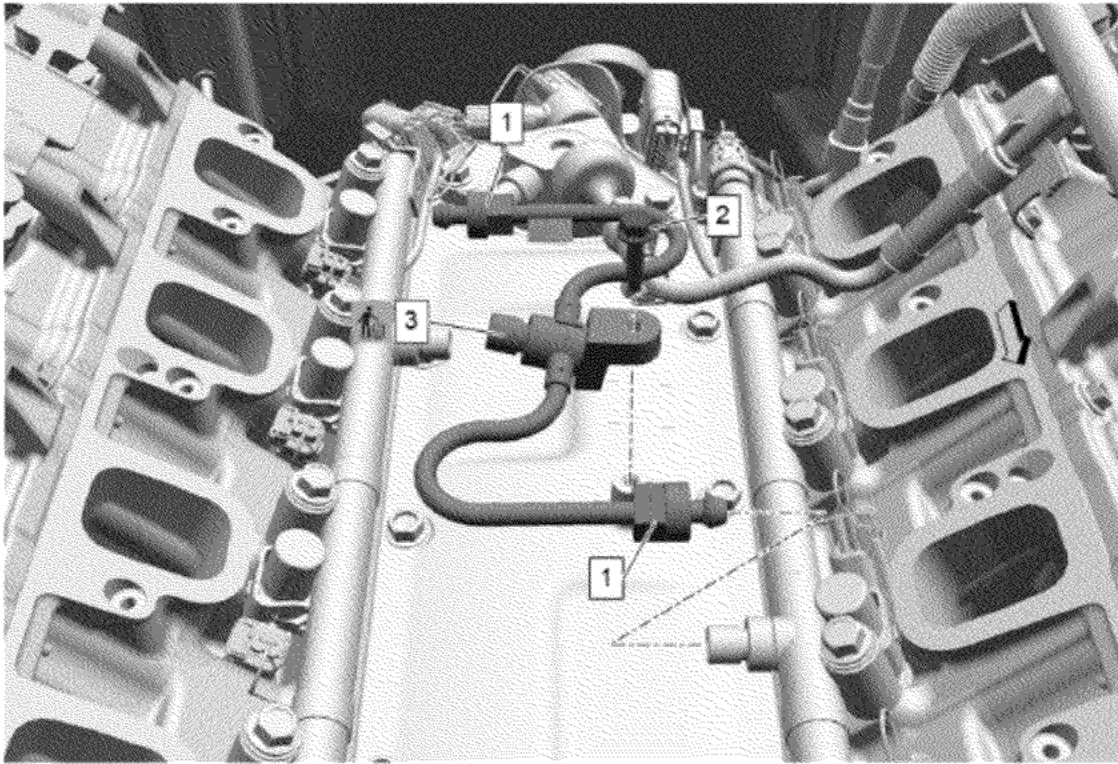


Note: Left side shown, right side similar.

8. Valve Rocker Arm Cover Gasket (1) » Install NEW [2x]
9. Valve Rocker Arm Cover (2) » Install [2x]
10. Valve Rocker Arm Cover Bolt (3) » Install and tighten in sequence [19x] — [Fastener Specifications](#)
11. Push the boot of the spark plug wire (8) onto the gas engine ignition spark plug until 2 audible clicks are heard.



12. Connect the fuel feed pipe (2) to the fuel pump. Press the fuel feed pipe until an audible click is heard and then install the secondary latch. [Metal Collar Quick Connect Fitting Service](#)
13. Fuel Feed Pipe Bolt (1) » Install and tighten — [Fastener Specifications](#)



Note: Do NOT reuse the fuel feed intermediate pipe. If the fuel feed intermediate pipe fittings are loosened or the pipes are removed, the pipes MUST be replaced.

14. Fuel Feed Intermediate Pipe (1) » Install NEW

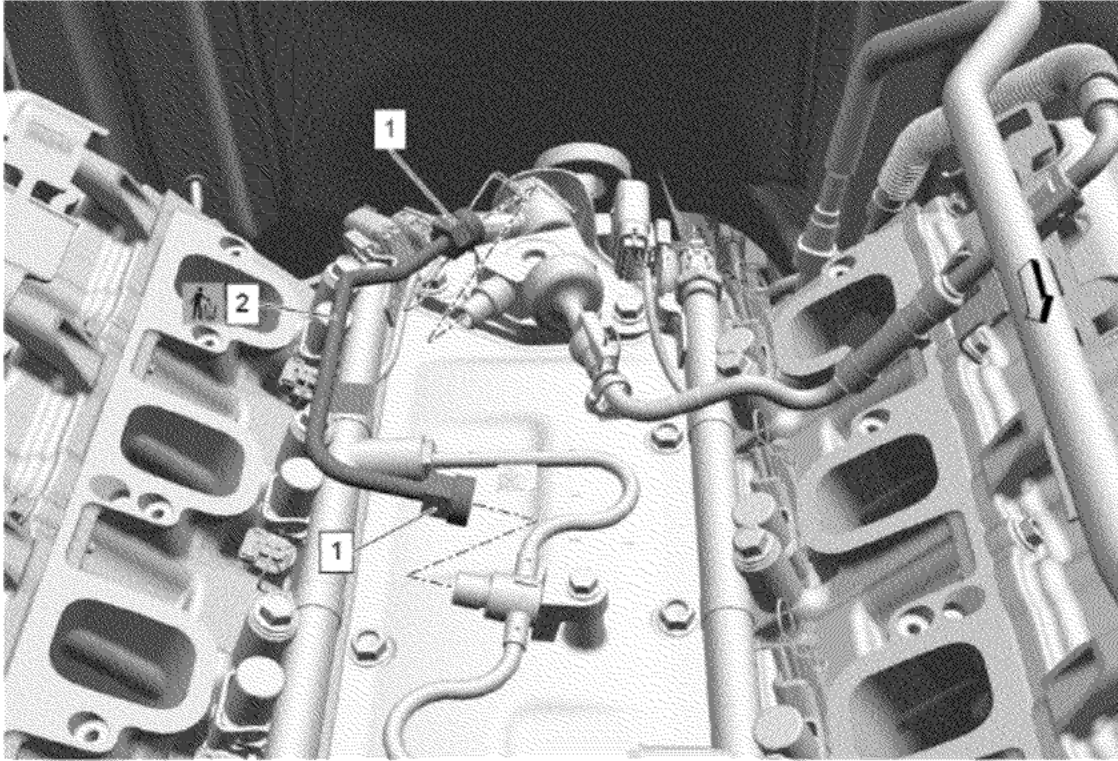
14.1. Slide fuel feed pipe fitting nuts (3) back along fuel feed intermediate pipe (1) to reveal the formed ends (2) of the fuel feed pipe.

14.2. Carefully install the formed ends (2) of the fuel feed pipe into the sockets of the left hand and right hand fuel rails, taking care not to hit the formed end of the pipes on the threaded sockets on the rails.

14.3. Hold the pipe firmly in place and hand tighten the fuel feed pipe fitting nuts (3) onto the threads on the fuel rails.

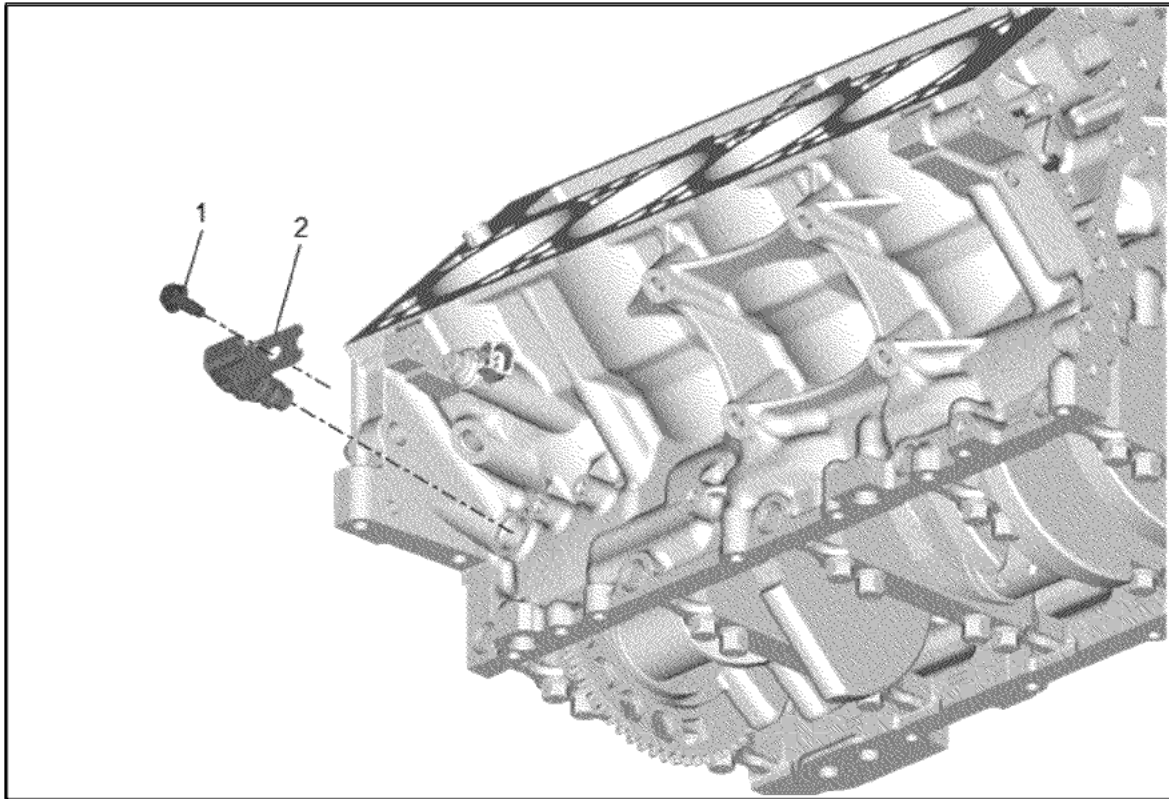
15. Fuel Feed Pipe Bolt (4) » Install and tighten — [Fastener Specifications](#)

16. Fuel Feed Intermediate Pipe Nut (3) @ Fuel Feed Intermediate Pipe (1) » Tighten [2x] — [Fastener Specifications](#)

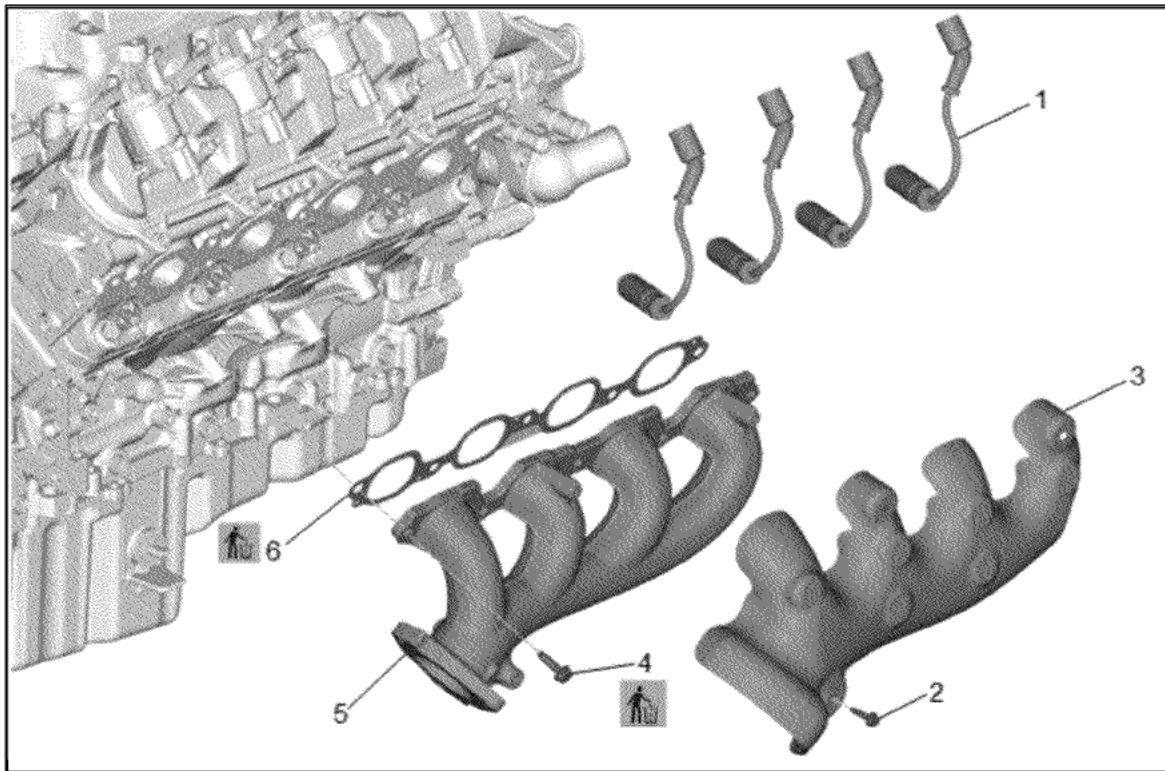


Note: Do NOT reuse the fuel feed intermediate pipe. If the fuel feed intermediate pipe fittings are loosened or the pipes are removed, the pipes MUST be replaced.

17. Clean the cylinder head pocket around the injectors of any dirt or buildup.
18. Fuel Feed Intermediate Pipe (1) » Install NEW
 - 18.1. Slide fuel feed pipe fitting nuts (2) back along fuel feed intermediate pipe (1) to reveal the formed ends (3) of the fuel feed pipe.
 - 18.2. Carefully install the formed ends (3) of the fuel feed pipe into the sockets of the fuel pump (4) and the fuel feed intermediate pipe (5), taking care not to hit the formed end of the pipes on the threaded sockets on the rails.
 - 18.3. Hold the pipe firmly in place and hand tighten the fuel feed pipe fitting nuts (2) onto the threads on the fuel rails.
19. Fuel Feed Intermediate Pipe Nut (2) @ Fuel Feed Intermediate Pipe (1) » Tighten [2x] — Fastener Specifications

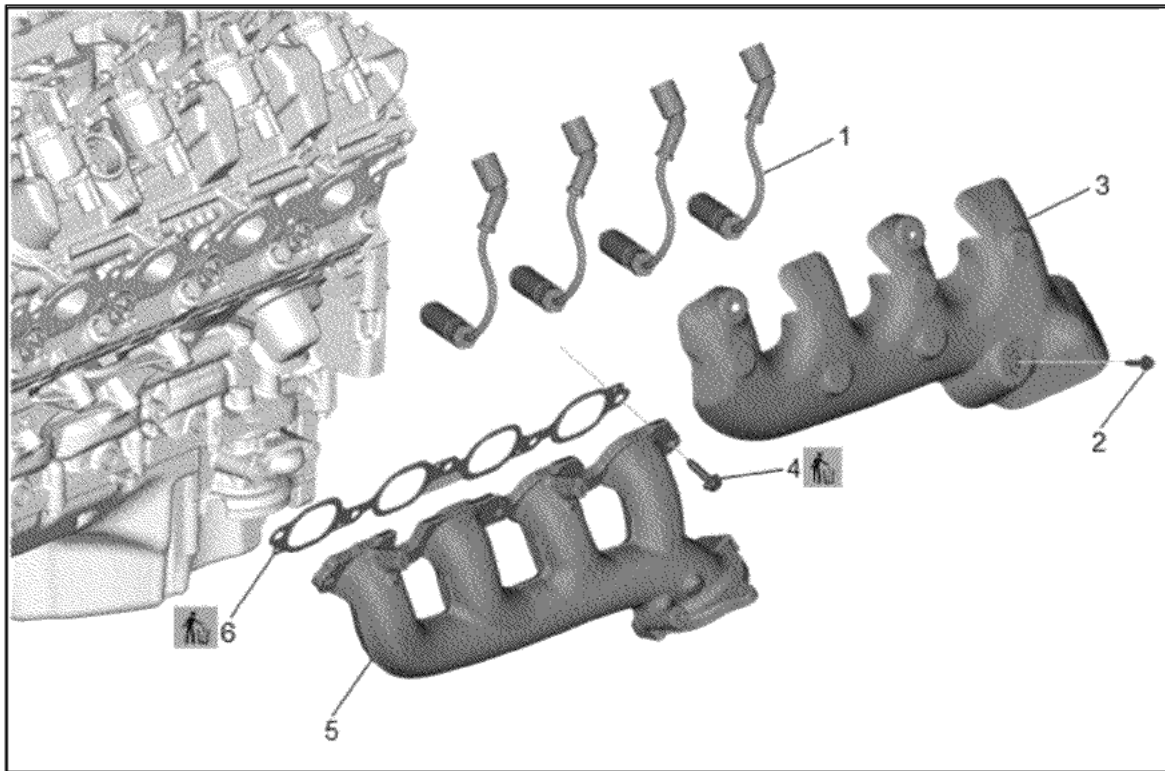


20. Install the crankshaft position sensor (2). Rotate the sensor until the locating hole in the bracket aligns with the bolt hole in the block.
21. Install and tighten the sensor bolt (1). [Fastener Specifications](#)

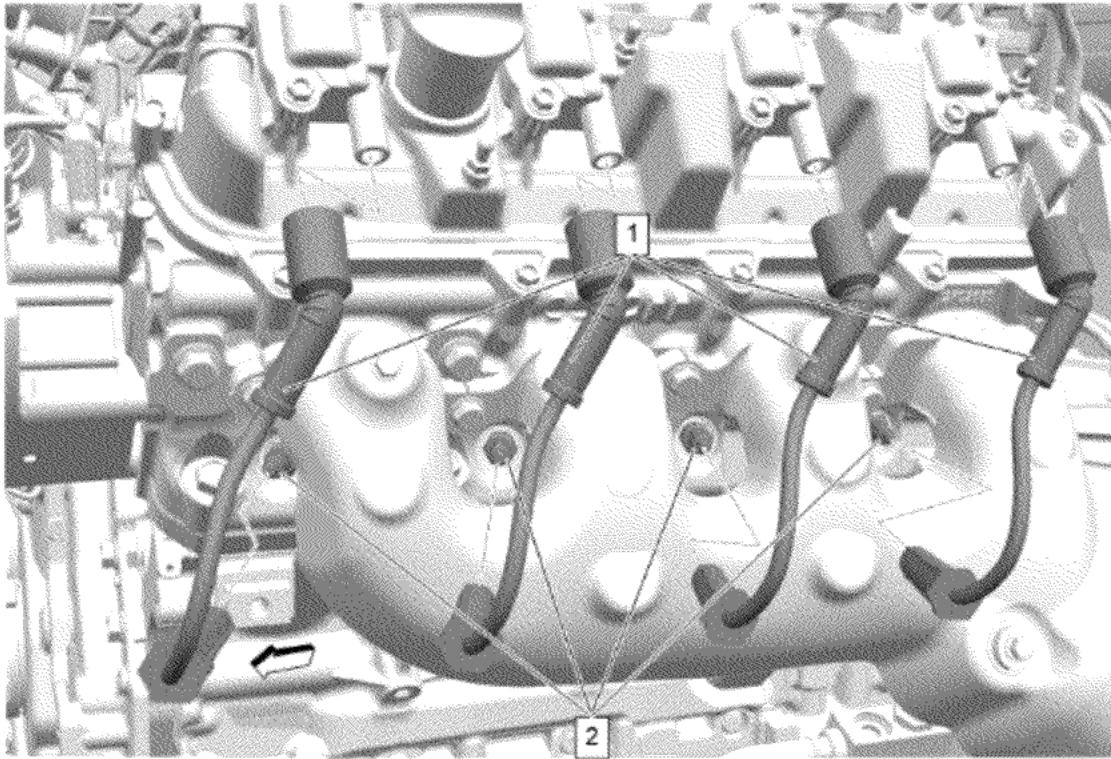


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22. Exhaust Manifold Gasket (6) » Install NEW
 23. Exhaust Manifold - Right Side (5) » Install
 24. If NEW threaded components are being installed, loosen the adhesive using a metal pick or similar tool before proceeding. If threaded components are reused, prepare the threaded components using the following steps:
 - 24.1. Remove any loose cured adhesive from the external threads of the components using a lint free cloth.
 - 24.2. Thread the cleaned components into the internal mating threads and remove to loosen trapped cured adhesive.
 - 24.3. Apply thread locking adhesive to the external threads of the components. Adhesives, Fluids, Lubricants, and Sealers
 - 24.4. Ensure there are no gaps in the thread locking adhesive once applied to the component.

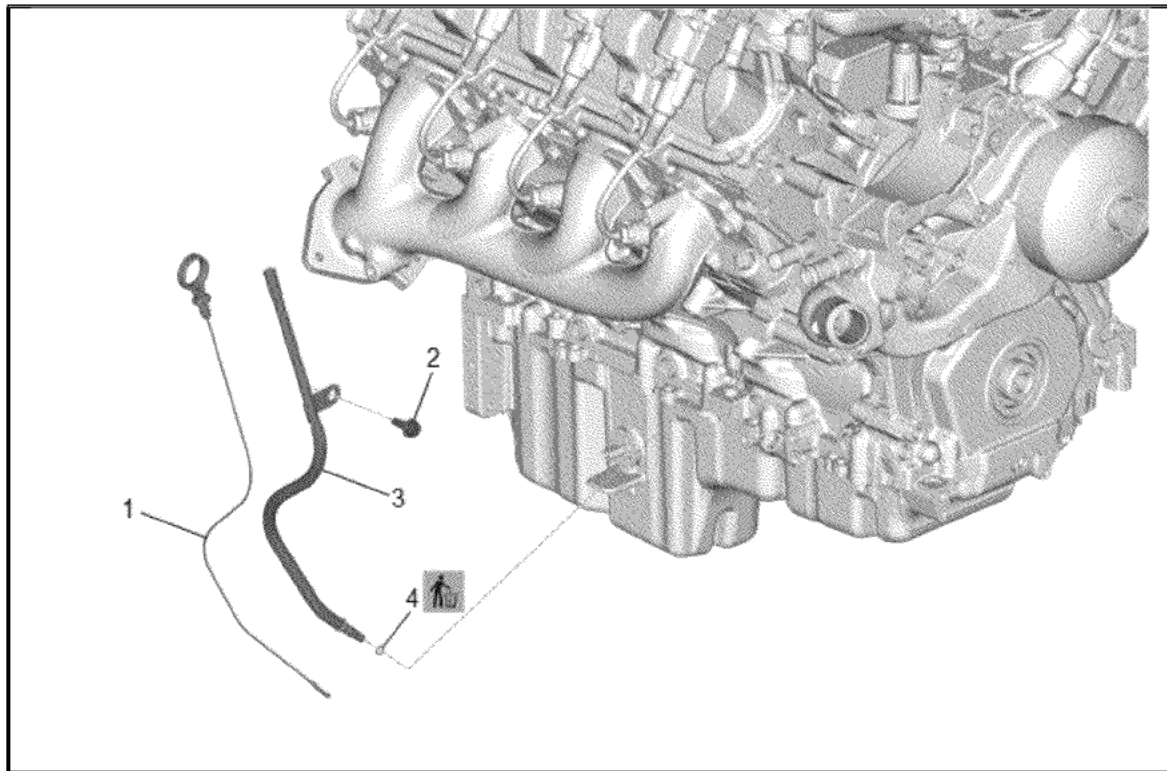
Caution: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.
 25. Exhaust Manifold Bolt (4) » Install NEW and tighten in sequence [5x] — Fastener Specifications
 26. Exhaust Manifold Heat Shield - Right Side (3) » Install [3x]
 27. Exhaust Manifold Heat Shield Bolt (2) » Install and tighten [3x] — Fastener Specifications



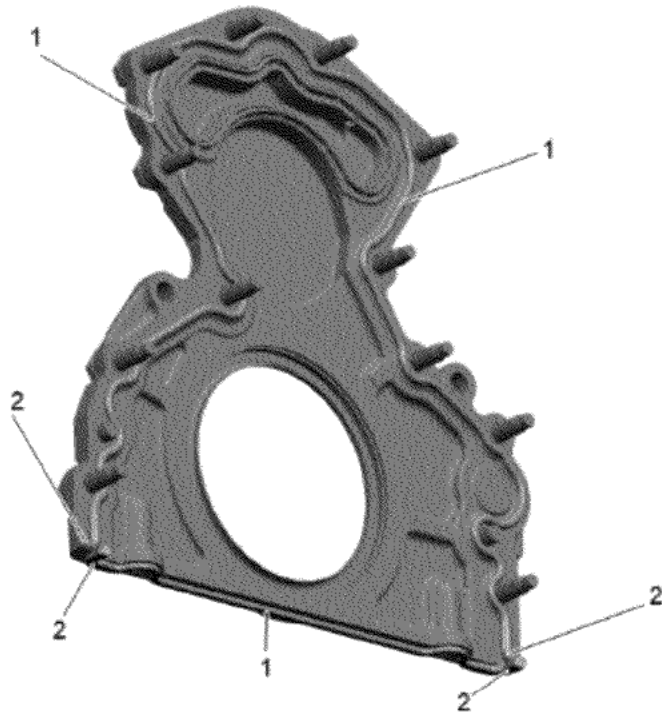
28. Exhaust Manifold Gasket (6) » Install NEW
29. Exhaust Manifold - Right Side (5) » Install
30. If NEW threaded components are being installed, loosen the adhesive using a metal pick or similar tool before proceeding. If threaded components are reused, prepare the threaded components using the following steps:
- 30.1. Remove any loose cured adhesive from the external threads of the components using a lint free cloth.
 - 30.2. Thread the cleaned components into the internal mating threads and remove to loosen trapped cured adhesive.
 - 30.3. Apply thread locking adhesive to the external threads of the components. Adhesives, Fluids, Lubricants, and Sealers
 - 30.4. Ensure there are no gaps in the thread locking adhesive once applied to the component.
- Caution:** This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.
31. Exhaust Manifold Bolt (4) » Install NEW and tighten in sequence [5x] — Fastener Specifications
32. Exhaust Manifold Heat Shield - Left Side(3) » Install [3x]
33. Exhaust Manifold Heat Shield Bolt (2) » Install and tighten [3x] — Fastener Specifications



34. Inspect the inside of the spark plug rubber boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, apply a thin coating of dielectric grease evenly to the inside of the spark plug rubber boot up to a depth of 15 mm from the end of the boot. Adhesives, Fluids, Lubricants, and Sealers
35. Push the boot of the spark plug wire (4) onto the gas engine ignition spark plug until 2 audible clicks are heard.

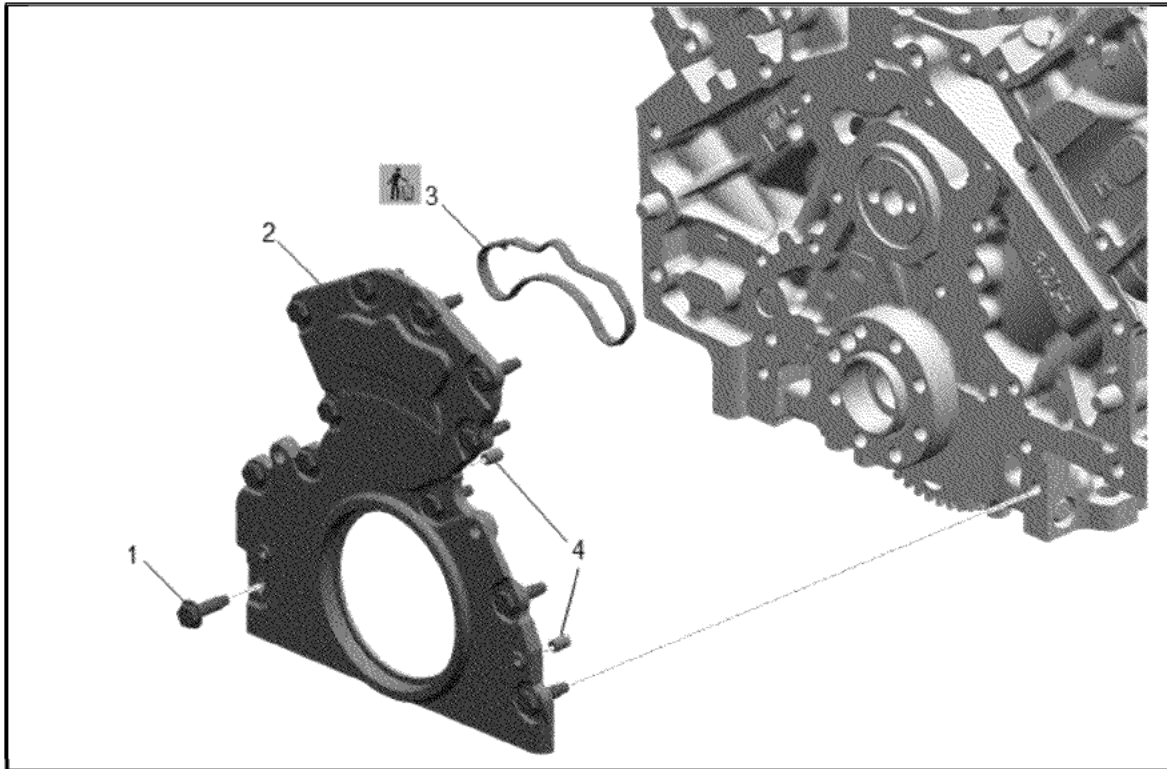


36. Oil Level Indicator Tube Seal (4) » Install NEW
37. Oil Level Indicator Tube (3) » Install
38. Oil Level Indicator Tube Bolt (2) » Install and tighten — [Fastener Specifications](#)
39. Oil Level Indicator (1) » Install

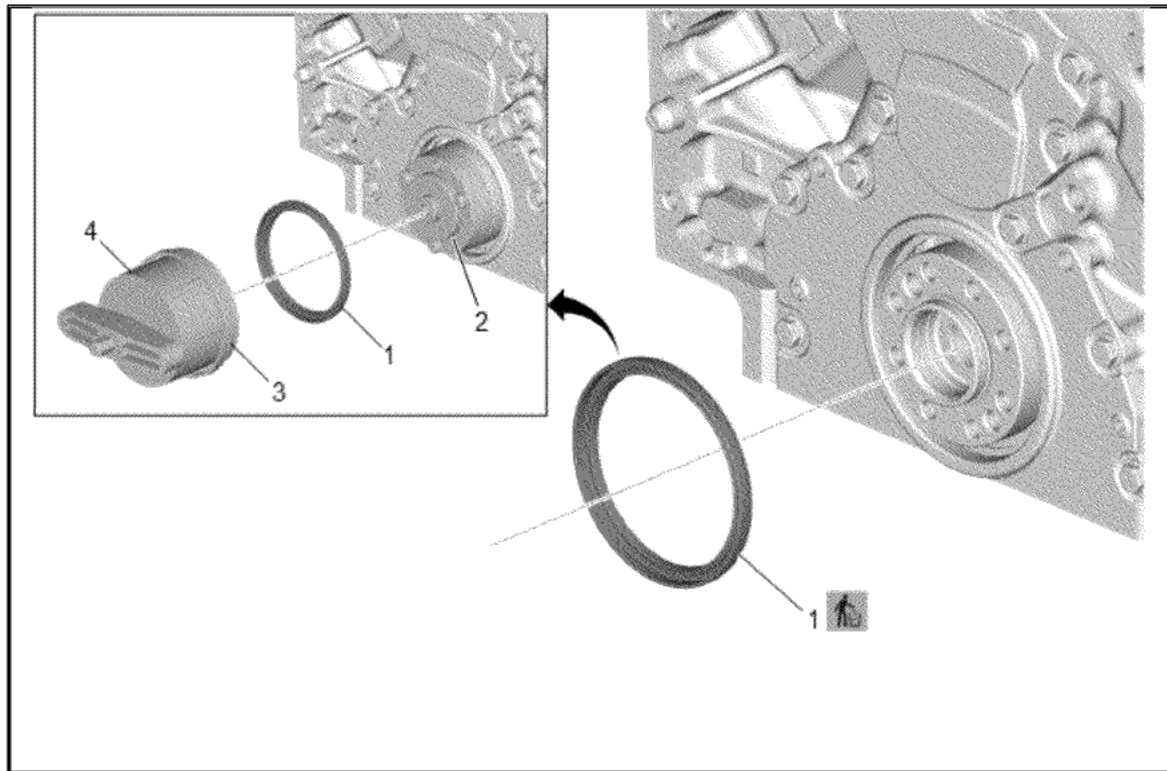
**Note:**

- Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant
- Install and align the crankshaft rear oil seal housing within 10 minutes of applying the sealer.

40. Apply a **3 mm (0.118 in)** bead of RTV sealant on the rear cover (1). Apply a **5 mm (0.197 in)** bead of RTV sealant on the rear cover as shown (2). Adhesives, Fluids, Lubricants, and Sealers



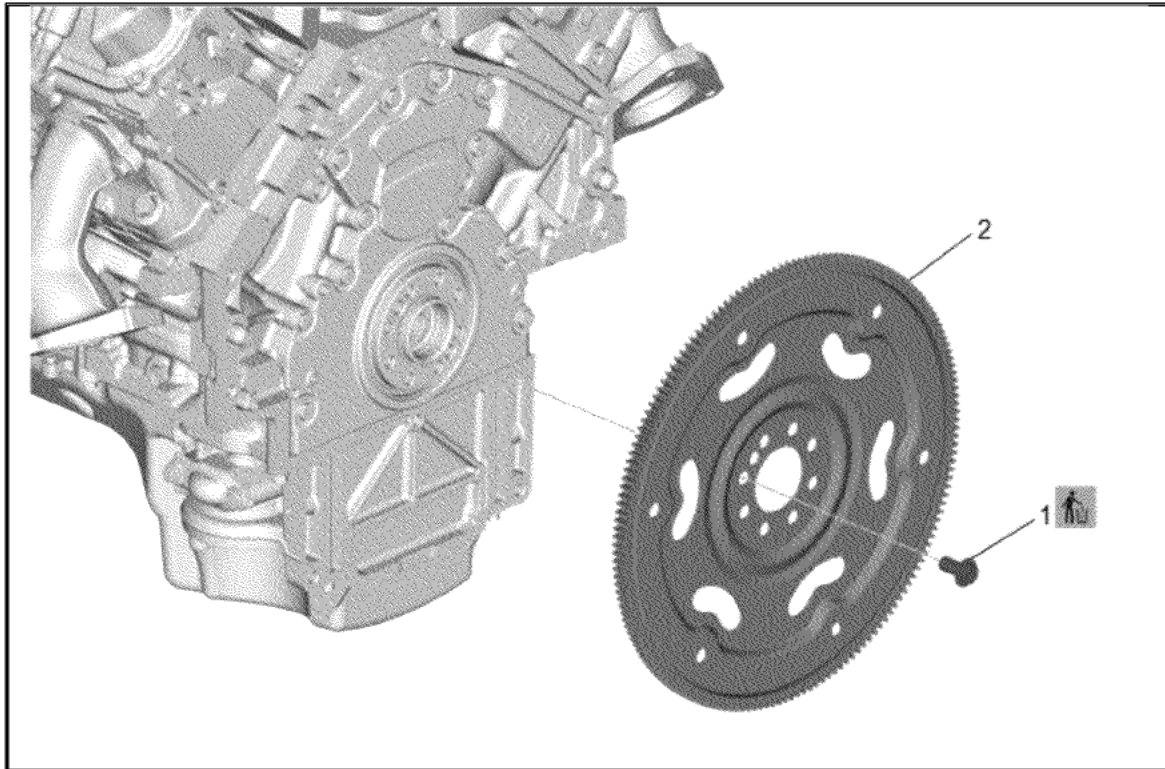
41. Crankshaft Rear Oil Seal Housing Locating Pin (4) » Install
42. Crankshaft Rear Oil Seal Housing Gasket (3) » Install NEW
43. Crankshaft Rear Oil Seal Housing (2) » Install
44. Crankshaft Rear Oil Seal Housing Bolt (1) » Install and tighten in sequence [12x] — [Fastener Specifications](#)



45. Install the *EN-41479* Crankshaft Rear Oil Seal Installer (2) and bolts onto the crankshaft snug, do NOT over tighten.

Note:

- For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. Install with "THIS SIDE OUT" displayed.
 - Do NOT lubricate the oil seal sealing surface.
46. Install the crankshaft rear oil seal onto the *EN-41479-B* Crankshaft Rear Oil Seal Installer Guide (2) and push the seal to the rear seal bore.
47. Install the *EN-41479-10* Crankshaft Rear Oil Seal Installer Adapter (3) onto *EN-41479* Crankshaft Rear Oil Seal Installer (4)
48. Thread the *EN-41479* Crankshaft Rear Oil Seal Installer (4) threaded rod into the *EN-41479-2B* Crankshaft Rear Oil Seal Installer Guide (2) until the tool contacts the oil seal.

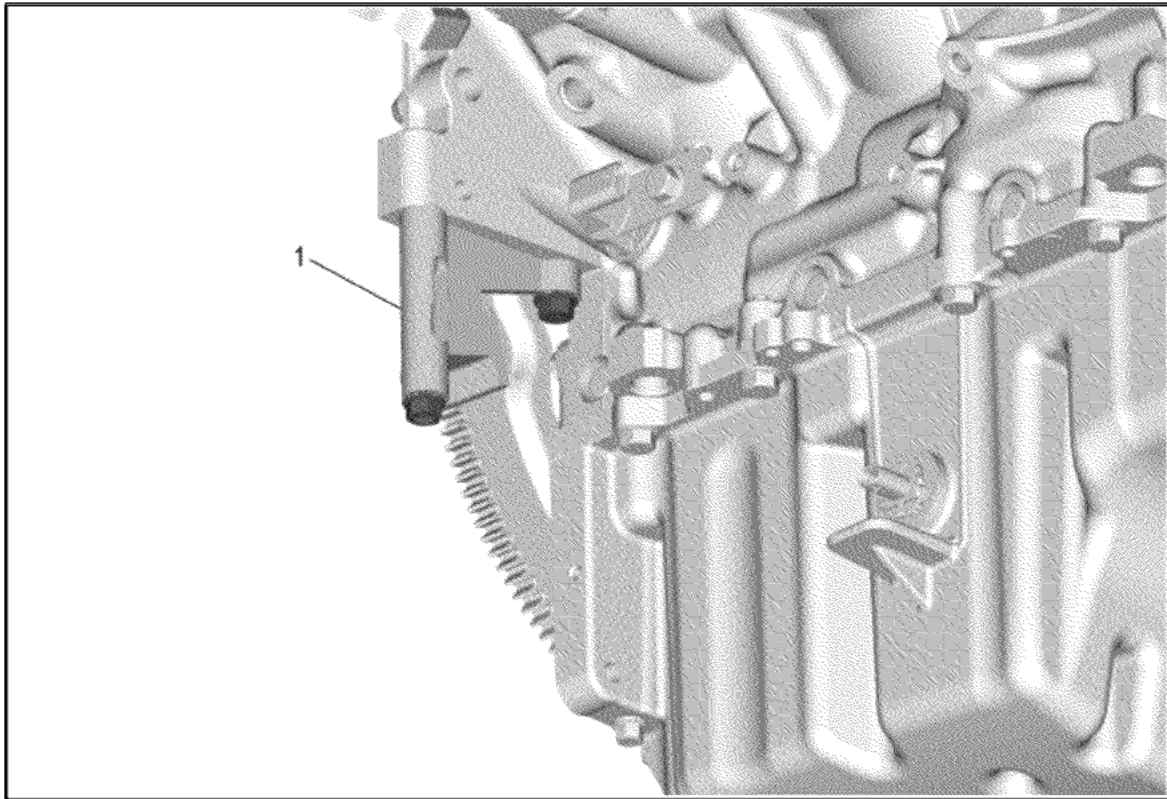


49. Automatic Transmission Flex Plate (2) » Install

50. If NEW threaded components are being installed, loosen the adhesive using a metal pick or similar tool before proceeding. If threaded components are reused, prepare the threaded components using the following steps:

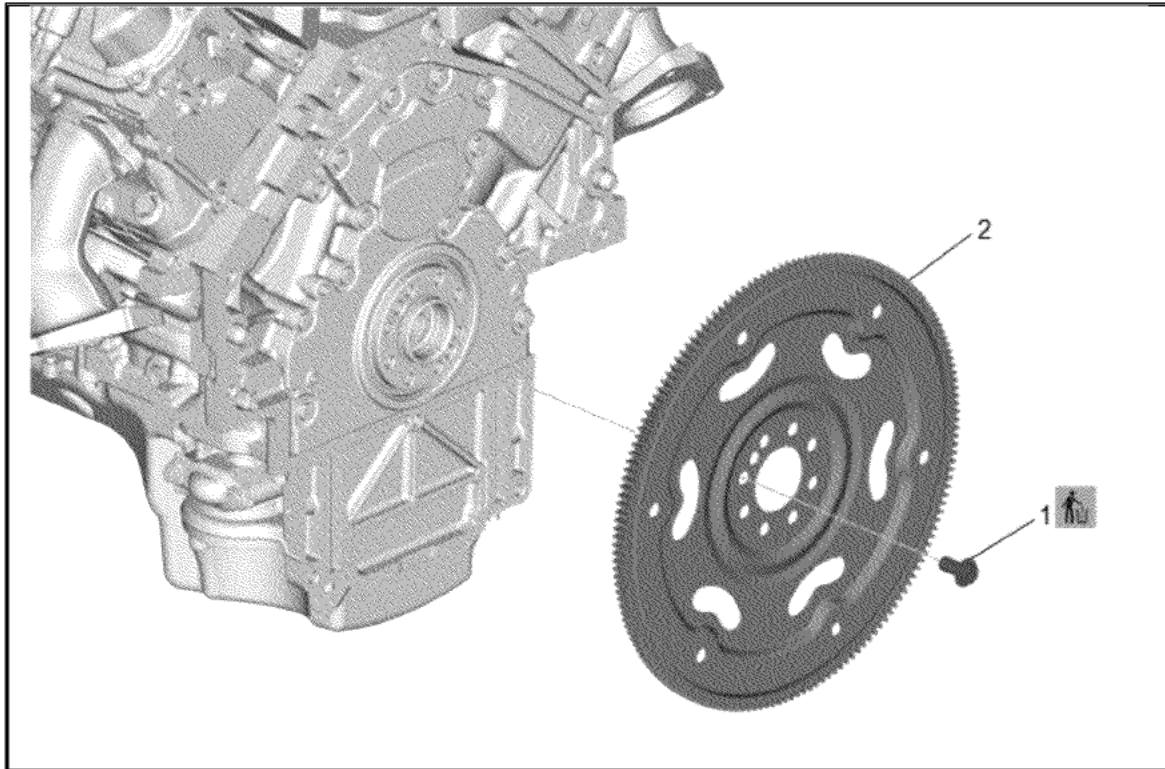
- 50.1. Remove any loose cured adhesive from the external threads of the components using a lint free cloth.
- 50.2. Thread the cleaned components into the internal mating threads and remove to loosen trapped cured adhesive.
- 50.3. Apply thread locking adhesive to the external threads of the components. [Adhesives, Fluids, Lubricants, and Sealers](#)
- 50.4. Ensure there are no gaps in the thread locking adhesive once applied to the component.

51. Automatic Transmission Flex Plate Bolt (1) » Install NEW and hand tighten [8x]



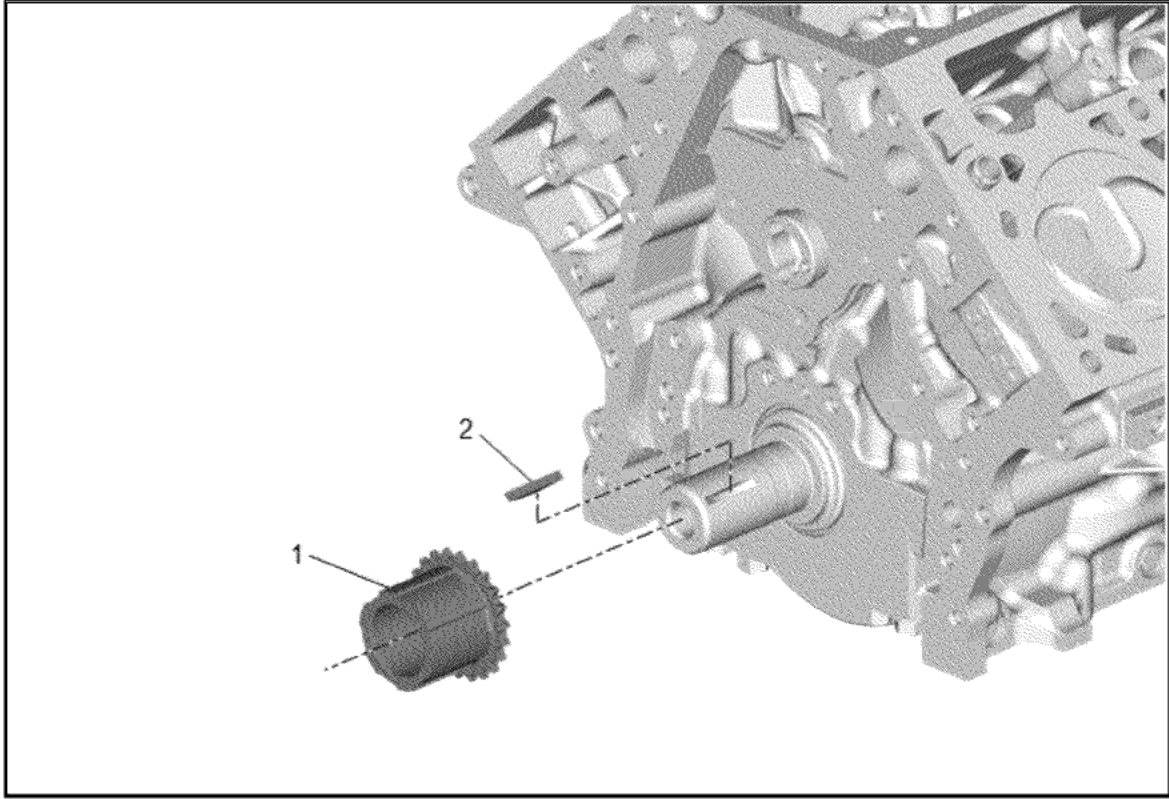
52. *EN-42386-A* Flywheel Holding Tool(1) » Install

53. Use one **M10 - 1.5 x 120 mm** and one **M10 - 1.5 x 45 mm** bolt for proper tool operation. Tighten the *EN-42386-A* Flywheel Holding Tool bolts to **50 Y (37 lb ft)**

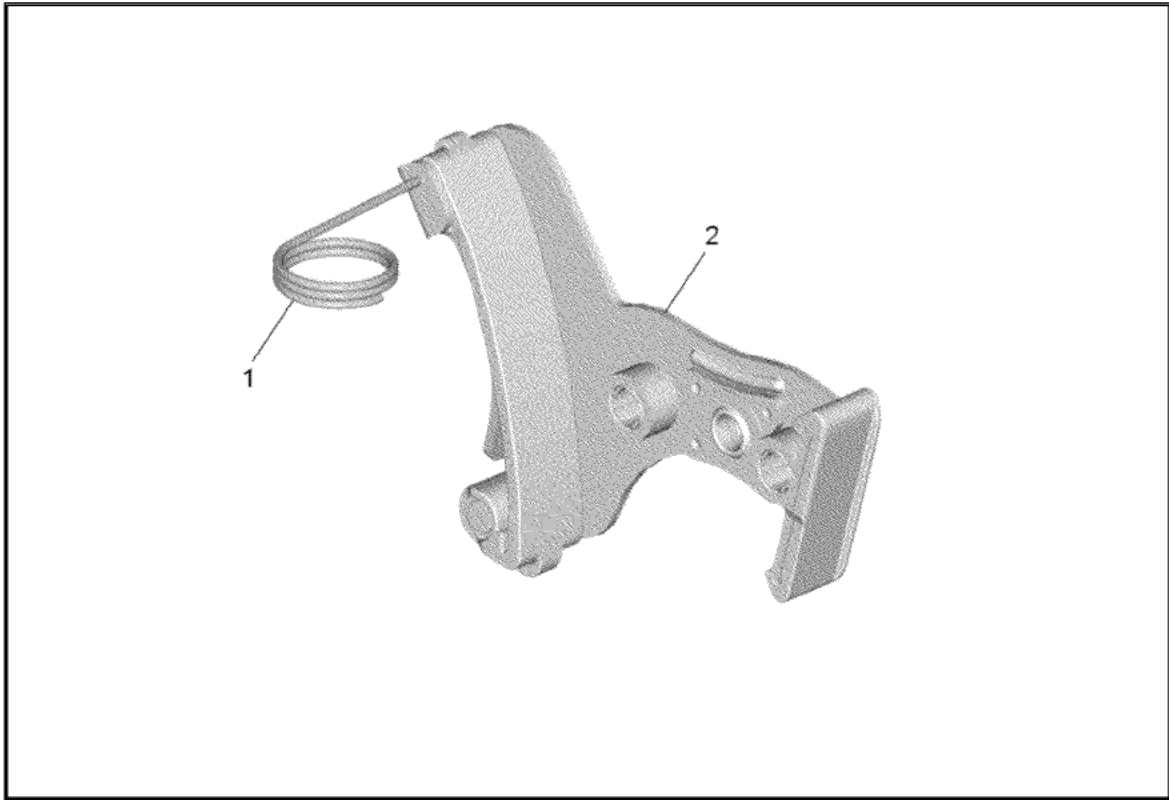


Caution: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

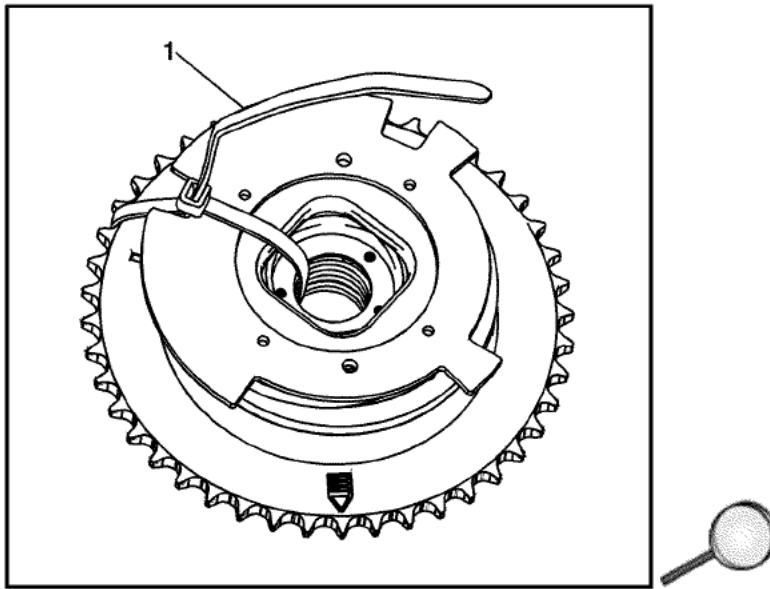
54. Automatic Transmission Flex Plate Bolt (1) » Tighten in sequence [8x] — [Fastener Specifications](#)



55. Crankshaft Sprocket (1) » Install

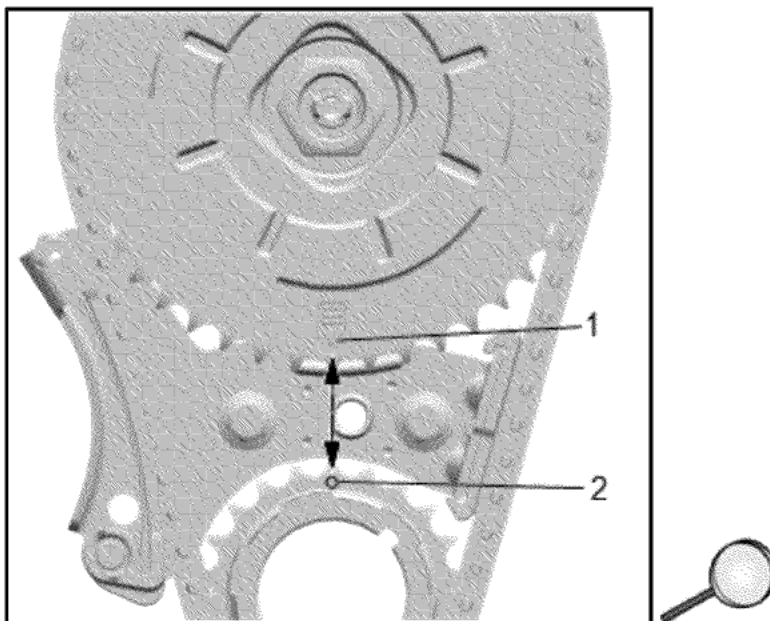


56. Compress the timing chain tensioner guide and install the *EN 46330* Timing Belt Tensioner Retaining Pin (1).



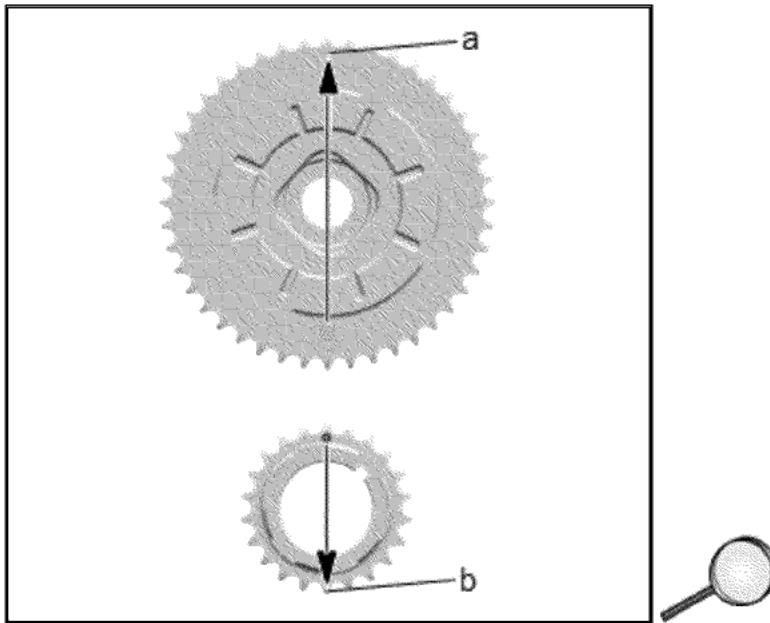
Warning: Refer to Camshaft Position Actuator Removal and Installation Warning.

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

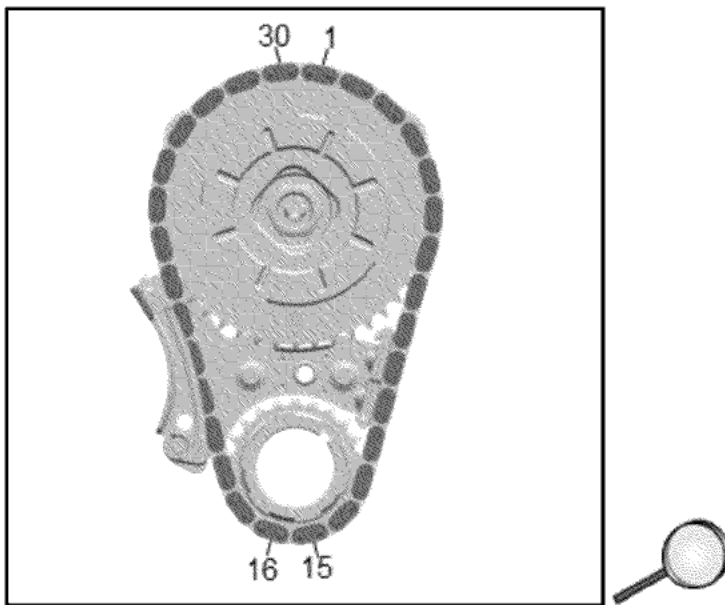


Note: The alignment mark on the camshaft position actuator and the alignment mark on the crankshaft sprocket are off-center from the oil pump feed hole gasket on the timing chain tensioner. The alignment marks need to be lined up with one another, but NOT with the oil feed hole.

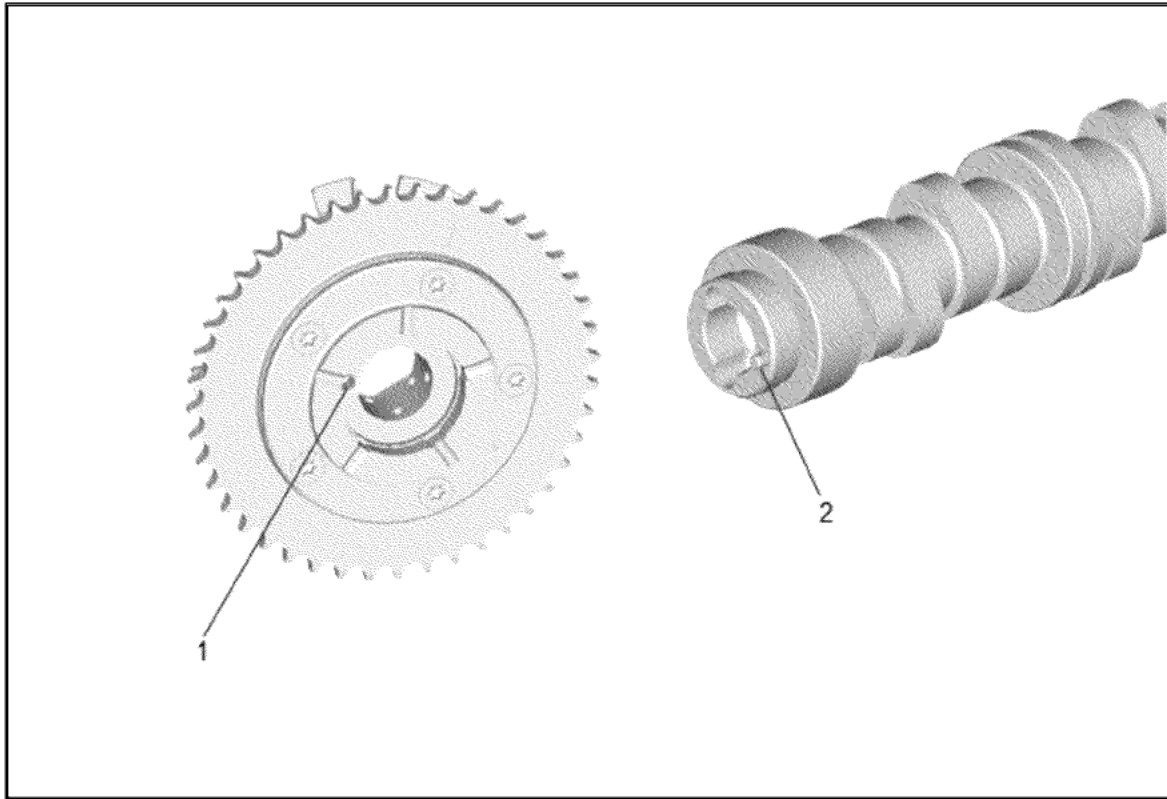
58. The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.



59. If the alignment marks on the camshaft position actuator and crankshaft sprocket are difficult to see or line up, an alternate method can be used. Mark the gear tooth directly opposite of the alignment mark on the camshaft position actuator (a). Mark the gear tooth directly opposite of the alignment mark on the crankshaft sprocket (b).

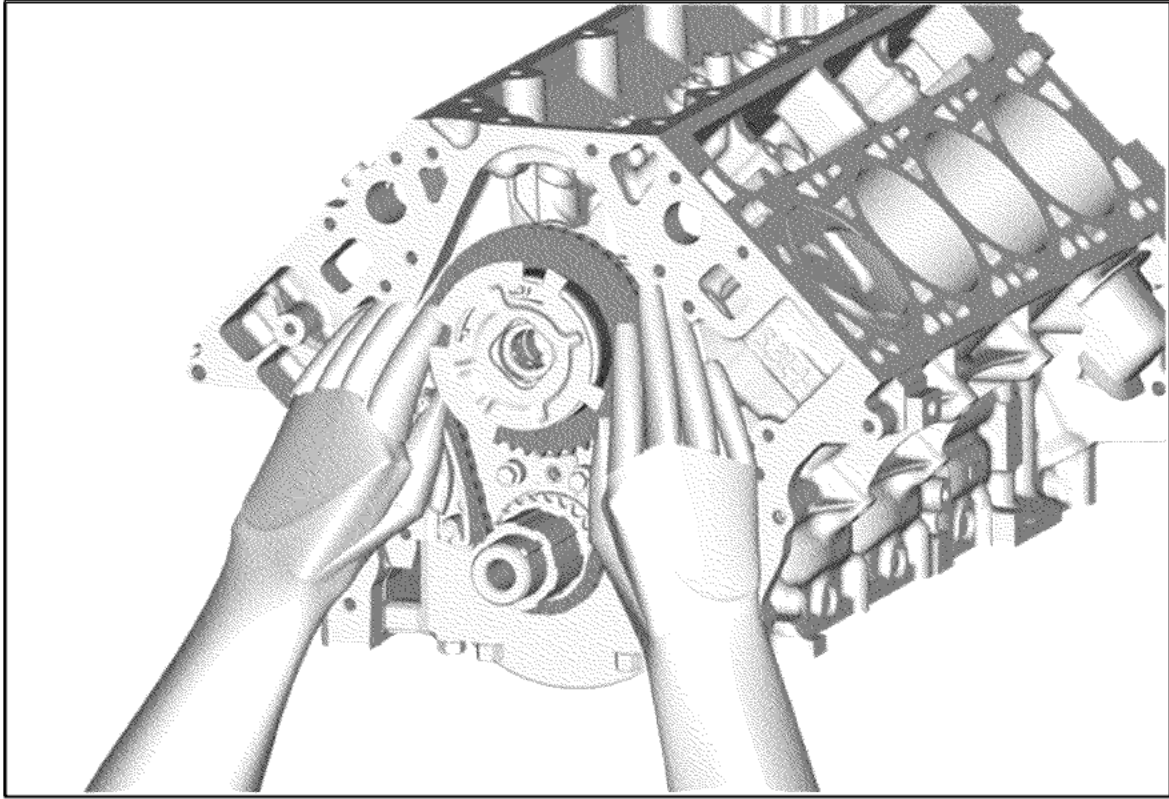


60. The timing chain has 30 links. Place links (1) and (30) on either side of the mark made on the camshaft position actuator and place links (15) and (16) on either side of the mark made on the crankshaft sprocket. This will ensure that the factory alignment marks are in the correct position and that the engine is properly timed.

**Note:**

- Properly locate the camshaft position 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 camshaft position solenoid valve again. Install a **NEW** valve during assembly.

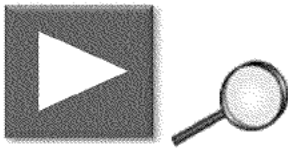
61. Identify the alignment hole (1) in the rear face of the camshaft position actuator and the locating pin (2) on the front face of the camshaft.

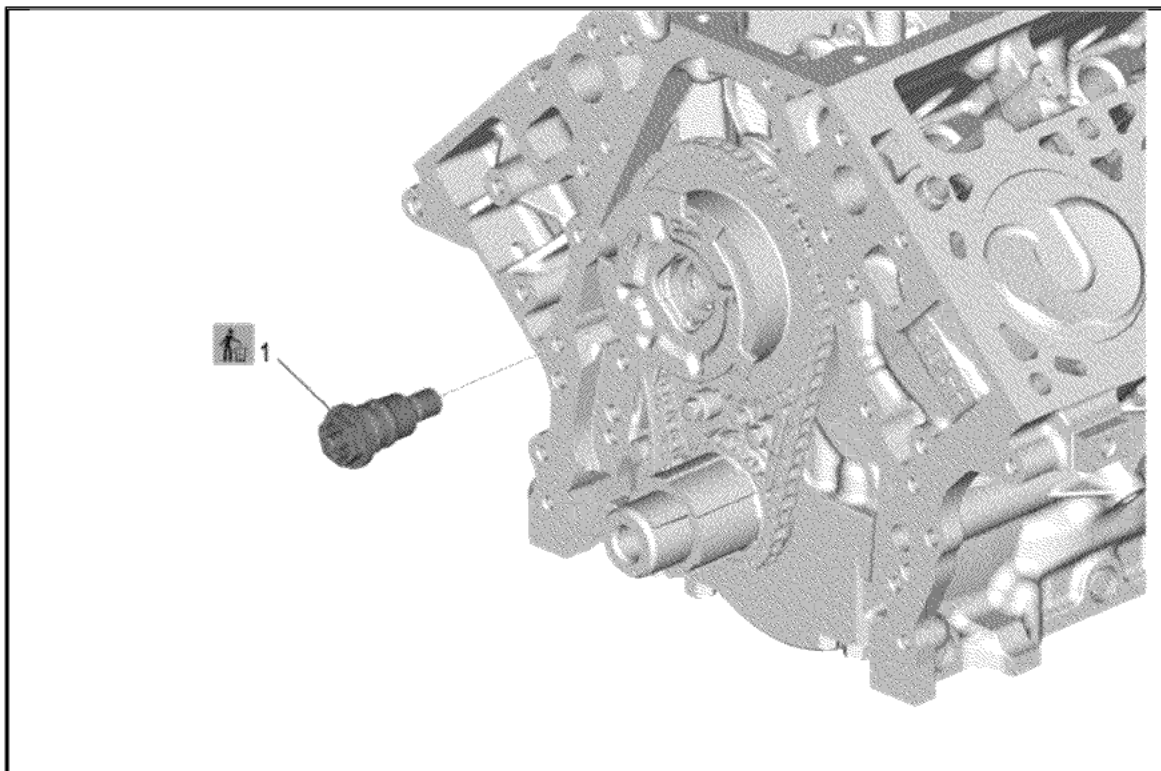


Warning: Refer to [Camshaft Position Actuator Removal and Installation Warning](#).

62. Install the camshaft position actuator and timing chain. Align the hole in the rear face of the camshaft position 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.

Click Image For Video

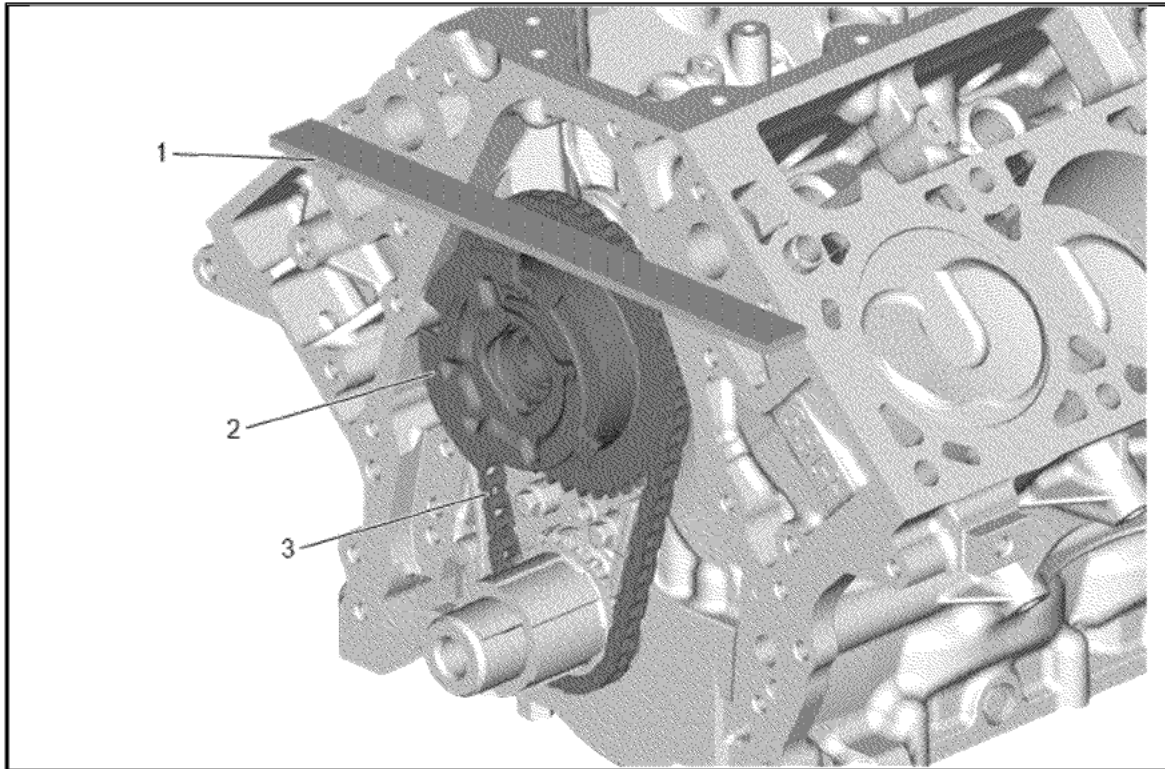




Caution: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

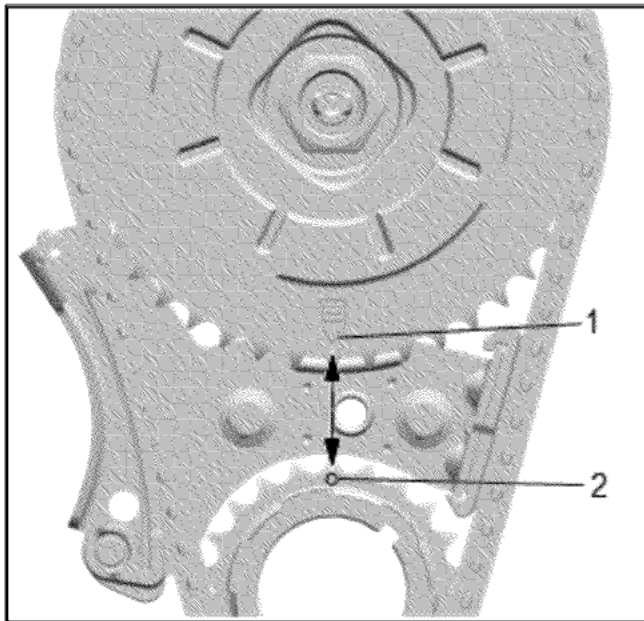
Caution: Refer to [Component Fastener Tightening Caution](#).

63. Camshaft Position Actuator Solenoid Valve (1) » Install NEW and tighten — [Fastener Specifications](#)

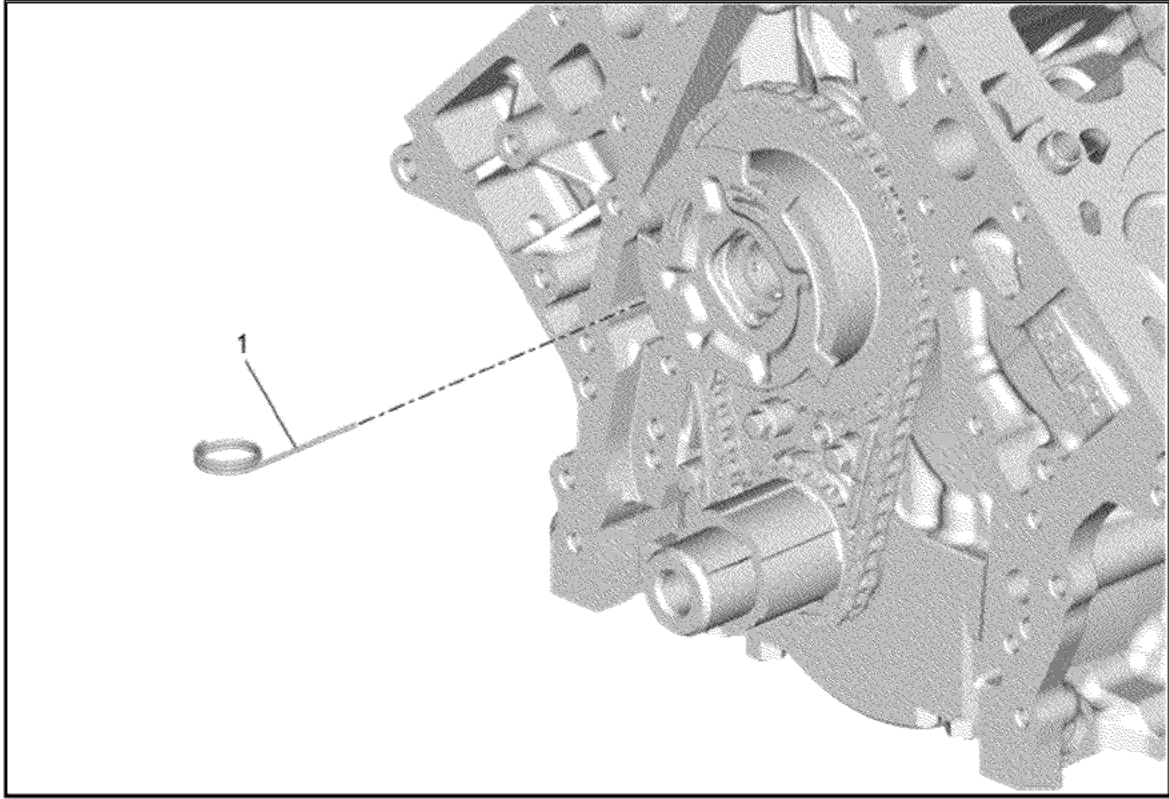


Note: It is possible to push the camshaft rearward when installing the camshaft position valve. Verify that the camshaft lobes are centered in the valve lifter bores after the camshaft position actuator is installed.

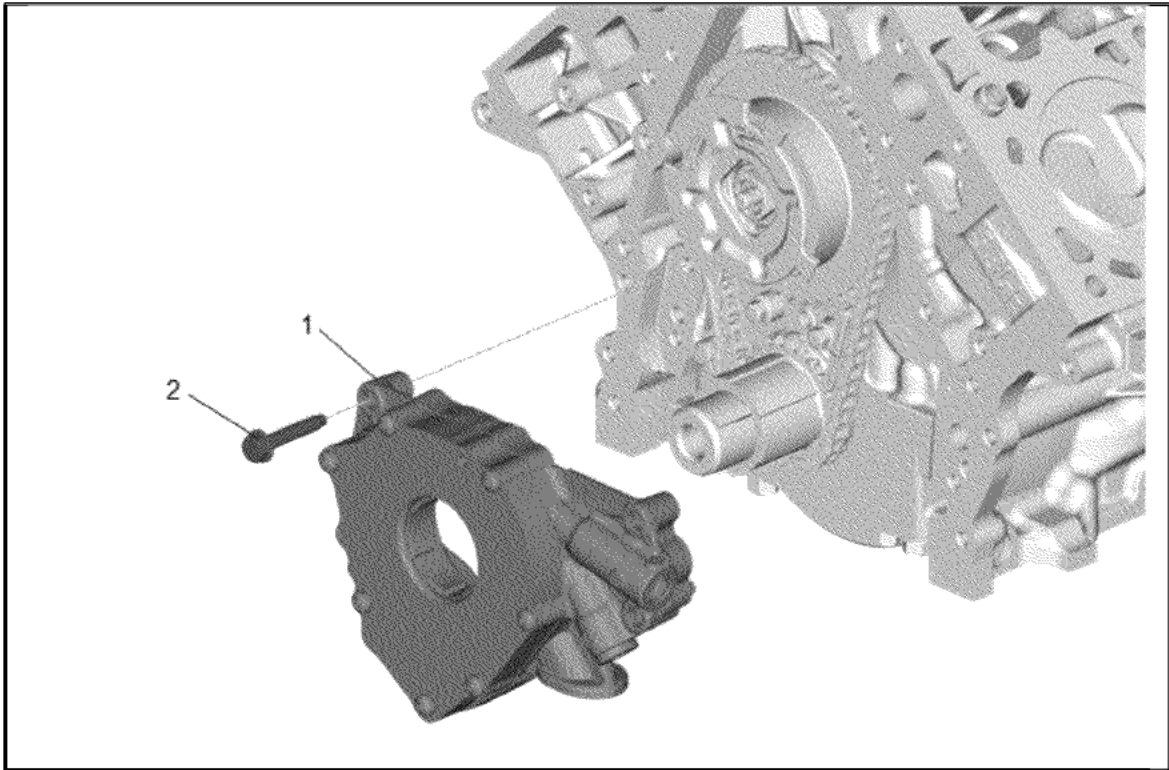
64. Locate a straight edge (1) across the front face of the engine block and inspect for proper installation of the camshaft position actuator (2) and timing chain (3). With the camshaft position actuator properly and completely installed onto the front of camshaft, the timing chain will not protrude beyond the front face of engine block.



65. Inspect the sprockets for proper alignment. The mark on the camshaft position 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.



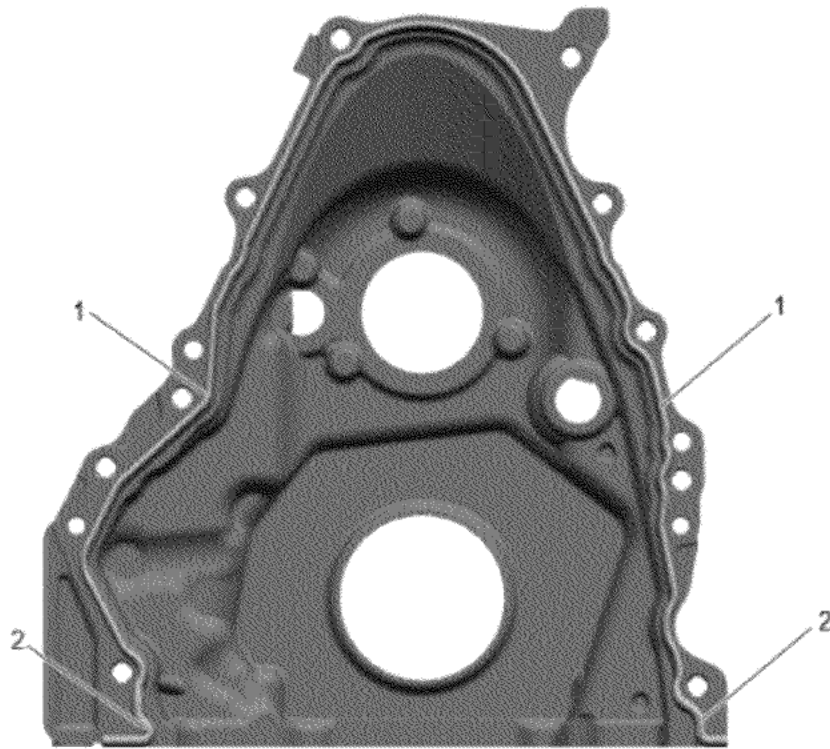
66. EN-46330 Timing Belt Tensioner Retaining Pin(1) » Remove



Note: Prior to installing the oil pump, ensure that oil pump housing gasket is fully installed in the timing chain tensioner assembly and is not damaged. If the gasket is missing or damaged, replace the tensioner assembly.

67. Oil Pump (1) » Install

68. Oil Pump Bolt (2) » Install and tighten in sequence [4x] — [Fastener Specifications](#)

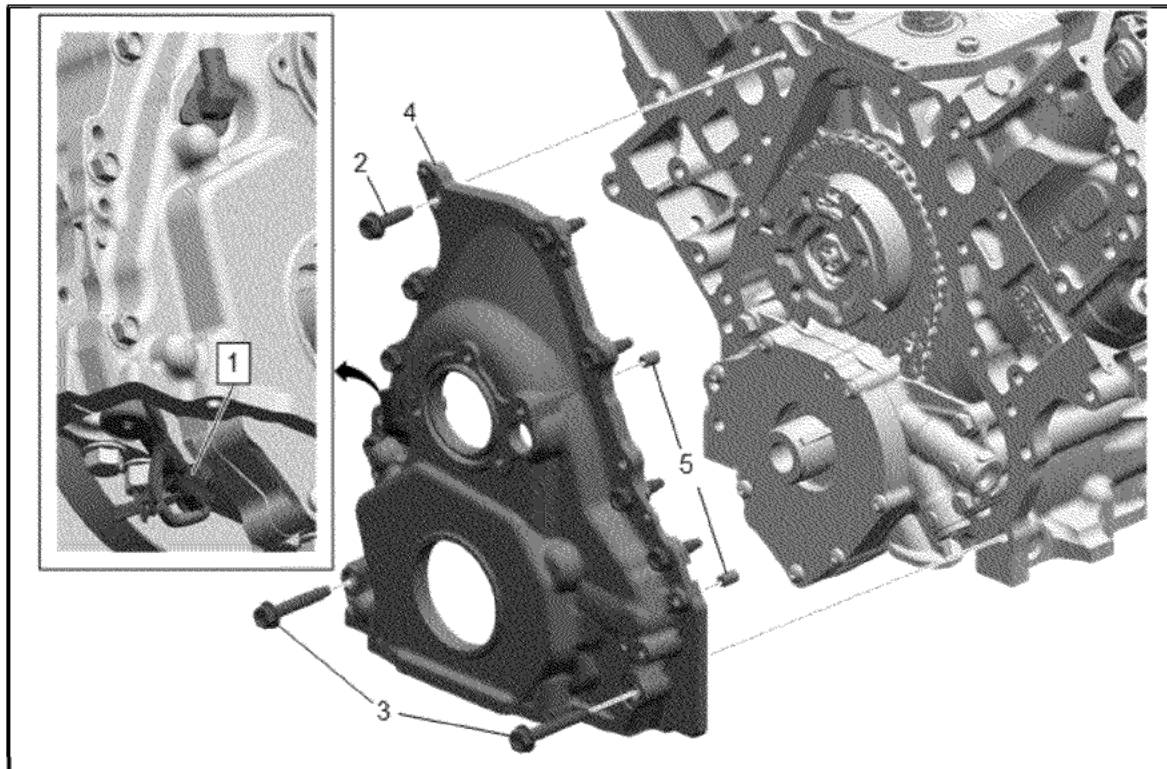


Note:

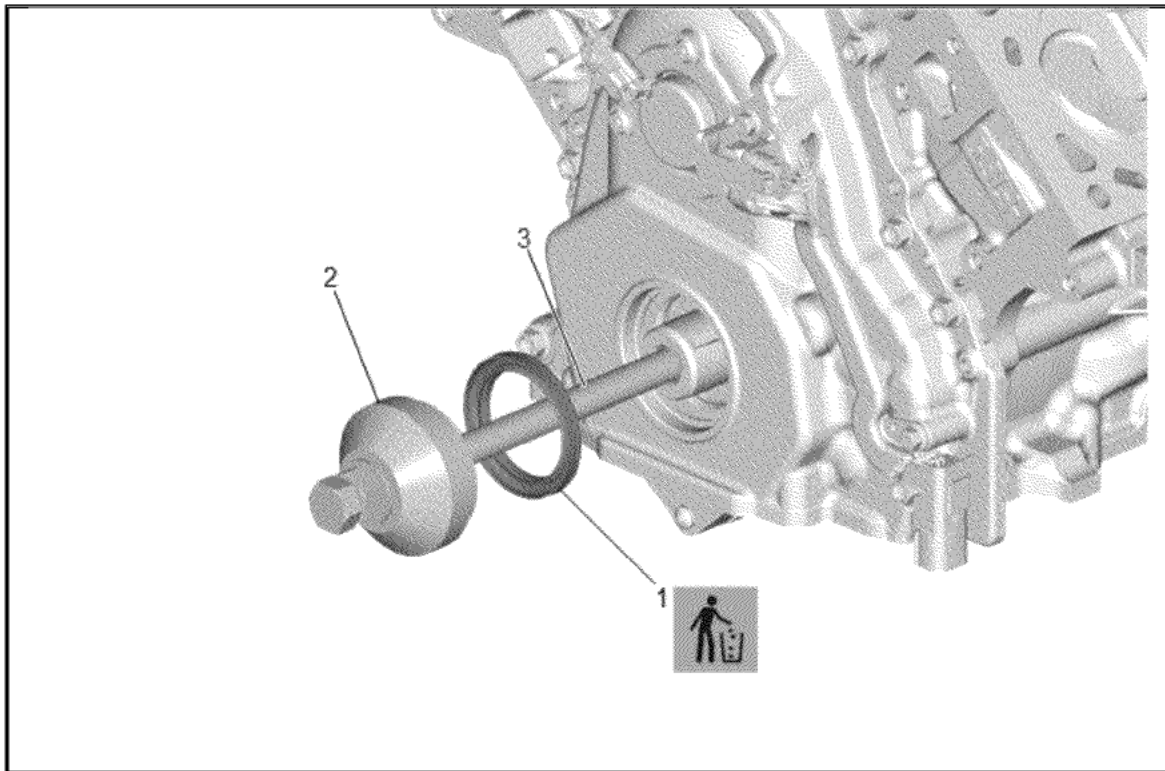
- Ensure proper use of room temperature vulcanizing (RTV) sealant. [Use of Room Temperature Vulcanizing \(RTV\) and Anaerobic Sealant](#)
- Install and align the front cover within 10 minutes of applying the sealer.

69. Apply a **3 mm (0.118 in)** bead of RTV sealant on the rear cover (1). [Adhesives, Fluids, Lubricants, and Sealers](#)

70. Apply a **5 mm (0.197 in)** bead of RTV sealant on the rear cover (2). [Adhesives, Fluids, Lubricants, and Sealers](#)



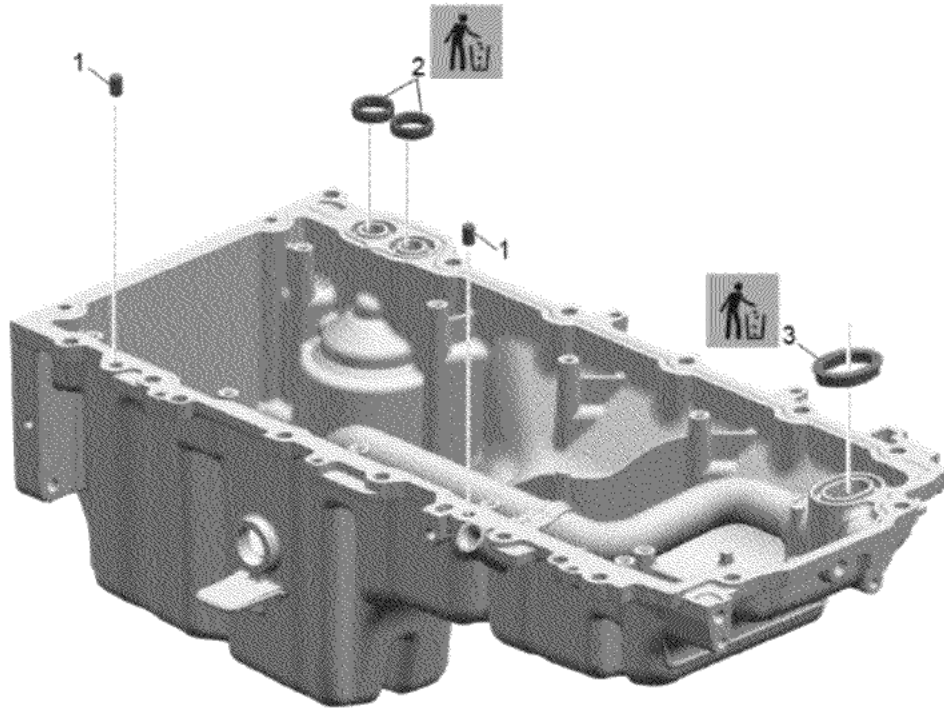
71. Engine Front Cover Locating Pin (5) » Install
72. { If equipped } Connect the oil pump flow control solenoid wire (1).
73. Engine Front Cover (4) » Install
74. Engine Front Cover Bolt (2) - M8 x 50.7 [2x] » Install and tighten in sequence — [Fastener Specifications](#)
75. Engine Front Cover Bolt (3) - M8 x 30.7 [8x] » Install and tighten in sequence — [Fastener Specifications](#)



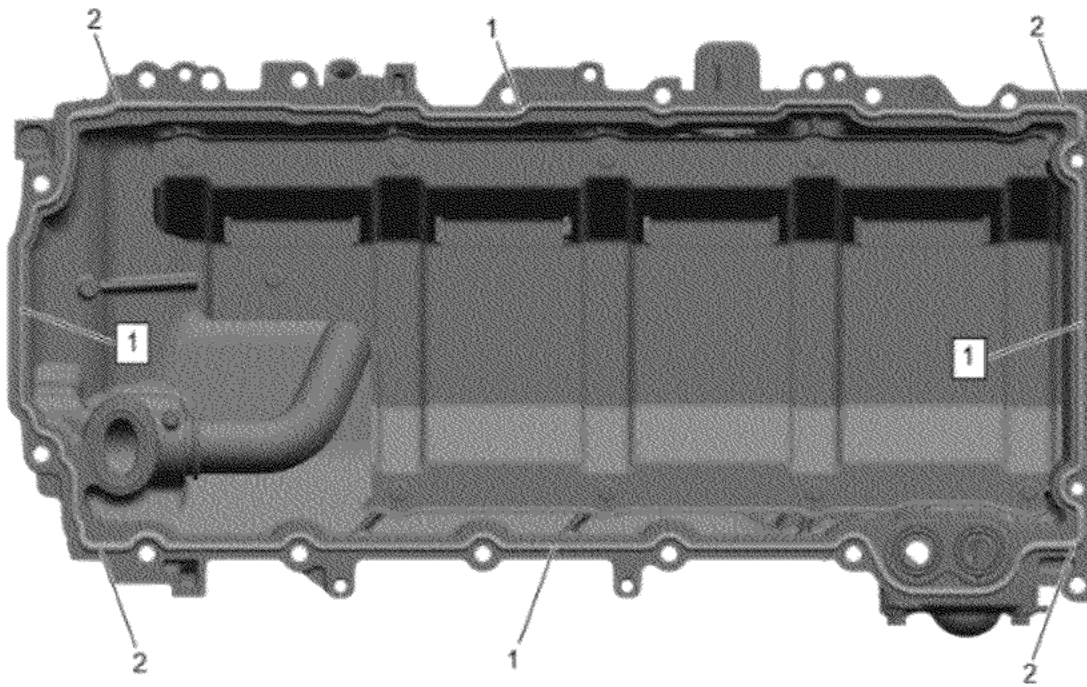
Note:

- For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. Install with "THIS SIDE OUT" displayed.
- Do NOT lubricate the oil seal sealing surface.

76. Install the crankshaft front oil seal (1) onto the threaded rod, nut and washer from *EN-41478-A Crankshaft Front Oil Seal Installer* and *EN-51091 Crankshaft Front Oil Seal Installer*.
77. Install the *EN-41478-A Crankshaft Front Oil Seal Installer* threaded rod, nut and washer (3) and *EN-51091 Crankshaft Front Oil Seal Installer* (2) and crankshaft front oil seal, into the end of the crankshaft.
78. Use the *EN-41478-A Crankshaft Front Oil Seal Installer* (3) and *EN-51091 Crankshaft Front Oil Seal Installer* (2) in order to install the crankshaft front oil seal into the cover bore.
 - 78.1. Use a wrench and hold the hex on the installer bolt.
 - 78.2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.
 - 78.3. Remove the tool.
 - 78.4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.
79. Rotate the handle of the tool clockwise until the seal enters the rear housing and bottoms into the seal bore.
80. Remove the tools.
81. Rotate the engine over on the engine stand.



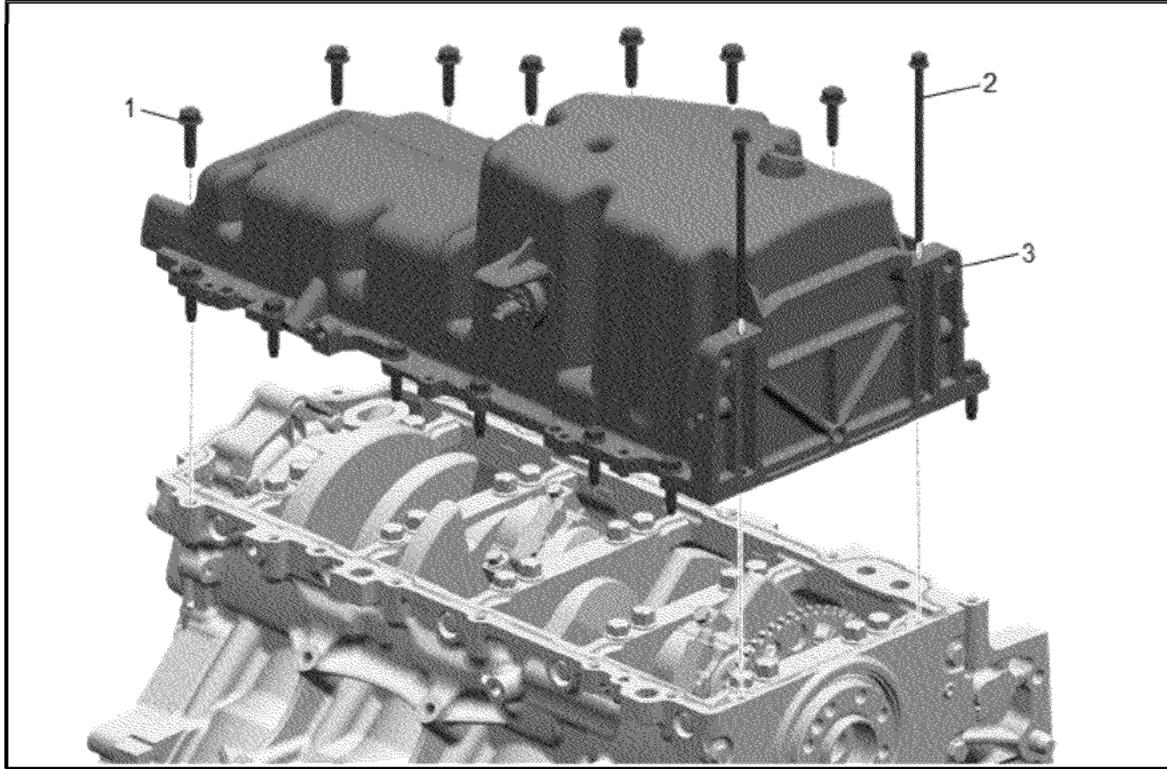
- 82. Oil Pan Front Seal (3) » Install NEW
- 83. Oil Pan High Pressure Port Seal (2) » Install NEW



Note:

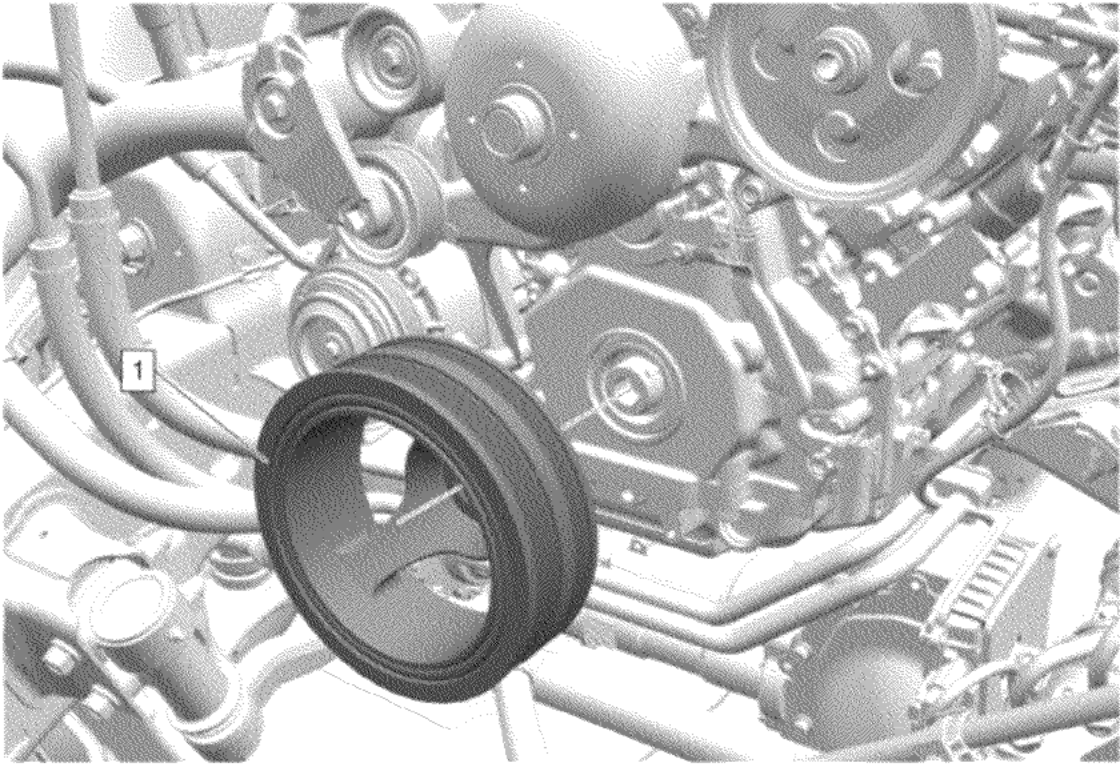
- Ensure proper use of room temperature vulcanizing (RTV) sealant. [Use of Room Temperature Vulcanizing \(RTV\) and Anaerobic Sealant](#)
- Install and align the oil pan within 10 minutes of applying the sealer.

84. Apply a **3 mm (0.118 in)** bead of RTV sealant on the engine front cover, engine block, and crankshaft rear oil seal housing as shown (1). Apply a **5 mm (0.197 in)** bead of RTV sealant at the corner areas as shown (2). [Adhesives, Fluids, Lubricants, and Sealers](#)

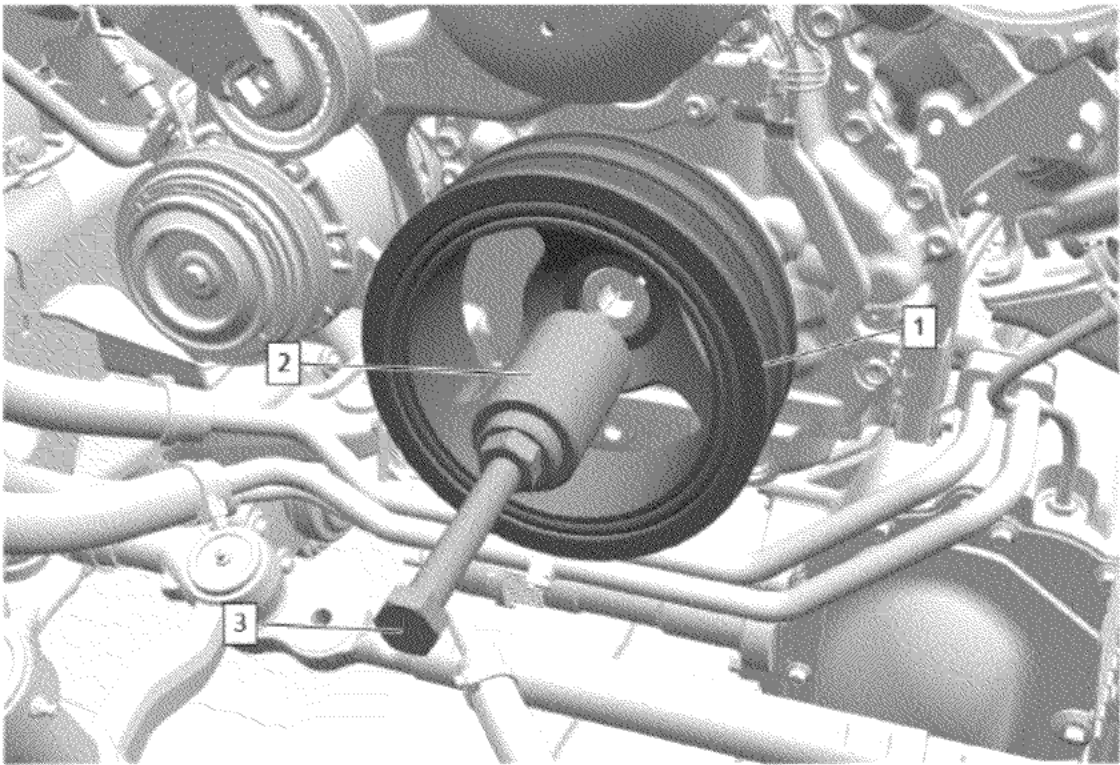


Note: Install and align the oil pan within 10 minutes of applying the sealer.

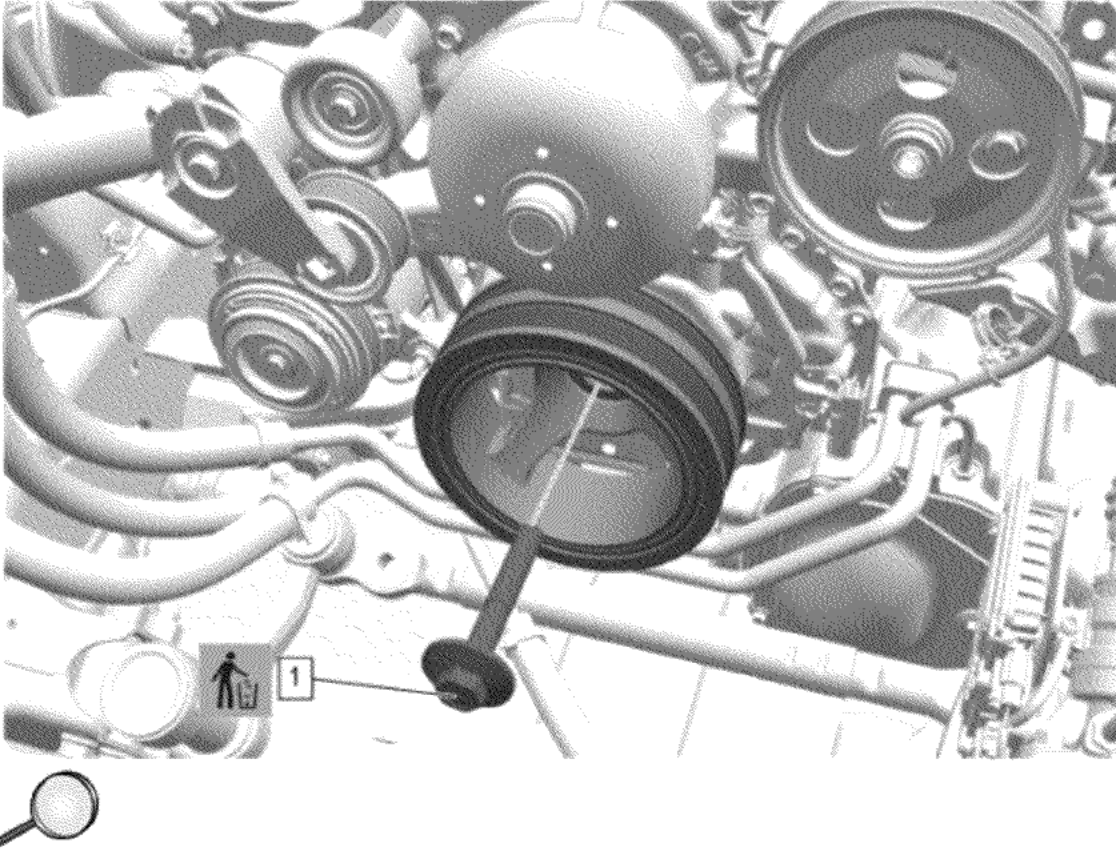
85. Oil Pan (3) » Install
86. Oil Pan Bolt (1) » Install and tighten in sequence [14x] — [Fastener Specifications](#)
87. Oil Pan Bolt (2) » Install and tighten in sequence [2x] — [Fastener Specifications](#)
88. Rotate the engine over on the engine stand.



89. Crankshaft Balancer (1) » Loosely install

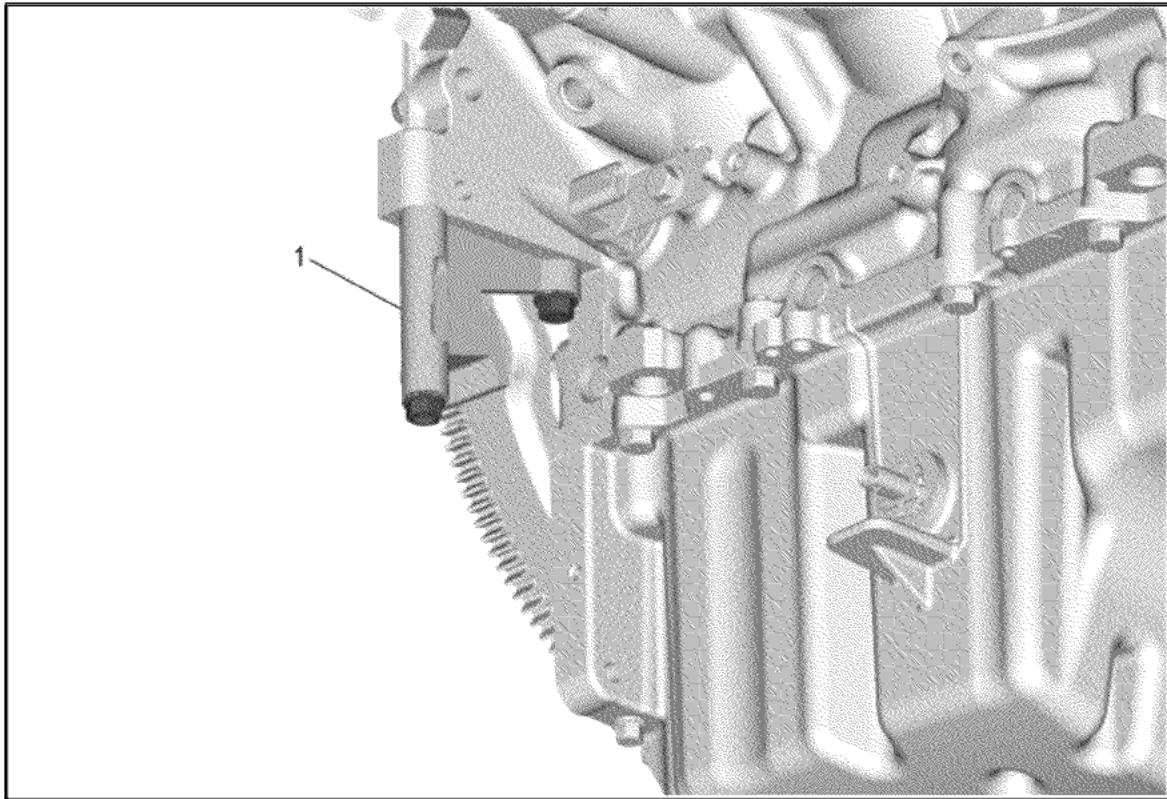


90. Install the *EN-41478-A* Crankshaft Front Oil Seal Installer (3) and *EN-41665-A* Crankshaft Balancer and Sprocket Installer (2) to the crankshaft.
91. Using the *EN-41665-A* Crankshaft Balancer and Sprocket Installer (2) properly seat the crankshaft balancer (1).
92. Remove the *EN-41478-A* Crankshaft Front Oil Seal Installer (3) and *EN-41665-A* Crankshaft Balancer and Sprocket Installer (2).



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93. Crankshaft Balancer Bolt (1) » Install NEW and tighten — [Fastener Specifications](#)



94. Remove the **M10 - 1.5 x 120 mm** and **M10 - 1.5 x 45 mm** bolts.

95. *EN-42386-A* Flywheel Holding Tool(1) » Remove

Installation Procedure

Engine » Install — Engine Removal and Installation