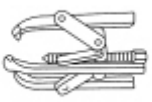

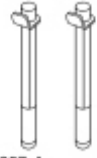

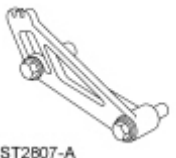

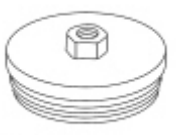

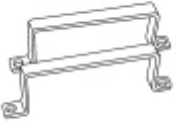
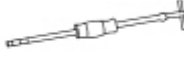


Engine

Special Tool(s)

 ST1184-A	<p>3-Jaw Puller 303-D121 or equivalent</p>
 ST2804-A	<p>Compressor, Valve Spring 303-1039</p>
 ST1337-A	<p>Installer, Connecting Rod 303-442 (T93P-6136-A)</p>
 ST1377-A	<p>Lifting Bracket, Engine 303-F047 (014-00073)</p>
 ST2807-A	<p>Locking Tool, Camshaft Phaser 303-1046</p>
 ST1730-A	<p>Remover, Crankshaft Front Oil Seal 303-107 (T74P-6700-A)</p>
 ST1382-A	<p>Remover, Crankshaft Rear Oil Seal 303-519 (T95P-6701-EH)</p>
 ST1481-A	<p>Remover, Crankshaft Rear Oil Slinger 303-514 (T95P-6701-AH)</p>

 <p>ST1668-A</p>	<p>Remover/Installer, Cylinder Head 303-572 (T97T-6000-A)</p>
 <p>ST1185-A</p>	<p>Slide Hammer 100-001 (T50T-100-A)</p>

Material

Item	Specification
Motorcraft® Metal Surface Prep ZC-31-A	—
Silicone Gasket Remover ZC-30	—

NOTICE: Remove the cylinder heads before removing the crankshaft. Failure to do so can result in engine damage.

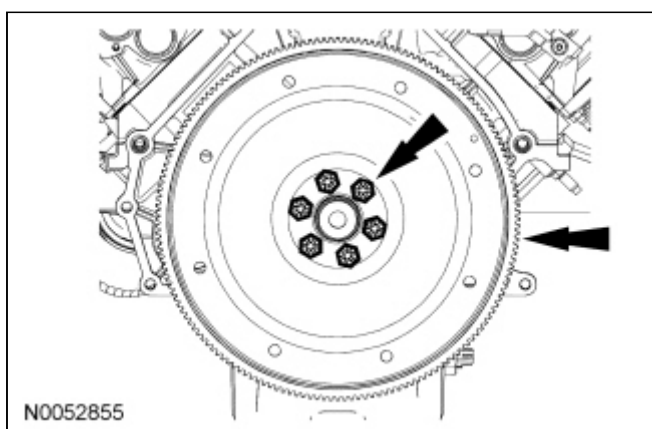
NOTICE: During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces that enters the oil passages, coolant passages or the oil pan, can cause engine failure.

NOTE: The flexplate or flywheel, crankshaft rear seal and the crankshaft rear oil slinger must be removed before mounting the engine on the engine stand.

NOTE: For additional information, refer to the exploded view under the Assembly procedure in this section.

Vehicles with automatic transmission

1. Remove the 6 bolts and the flexplate.

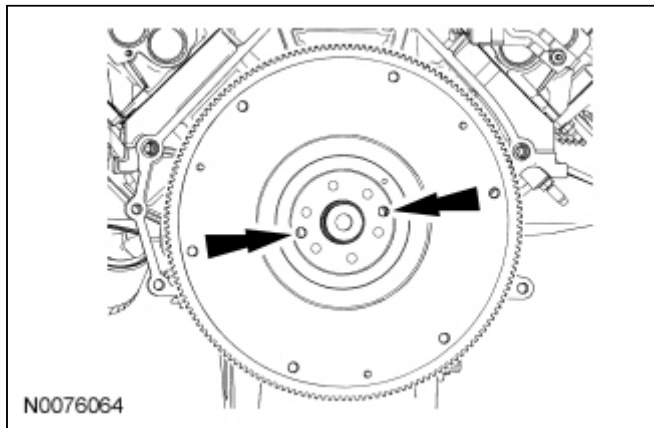


Vehicles with manual transmission

2. Remove the 6 flywheel bolts.
3. **NOTICE:** The flywheel is a press fit on the crankshaft pilot. Do not use screwdrivers or prybars to remove the flywheel or damage to the flywheel or engine may occur.

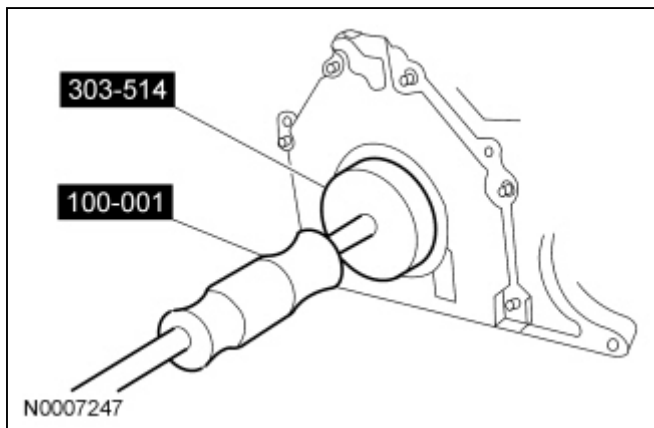
Remove the flywheel.

- Install 2 of the removed flywheel bolts in the 2 holes shown on the flywheel flange.
- Tighten the 2 bolts evenly to push the flywheel off the crankshaft pilot.

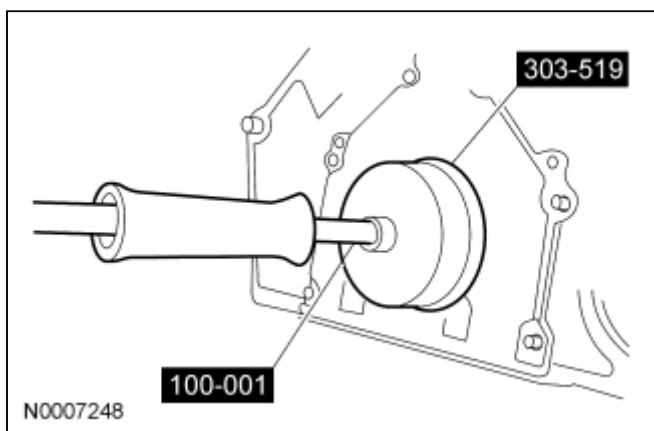


All vehicles

- Using the Slide Hammer and the Crankshaft Rear Oil Slinger Remover, remove the crankshaft rear oil slinger.
 - Discard the crankshaft rear oil slinger.

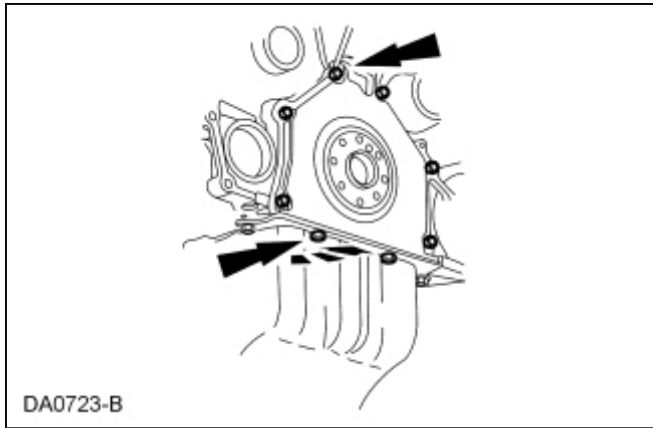


- Using the Slide Hammer and the Crankshaft Rear Oil Slinger Remover, remove the crankshaft rear seal.
 - Discard the crankshaft rear seal.

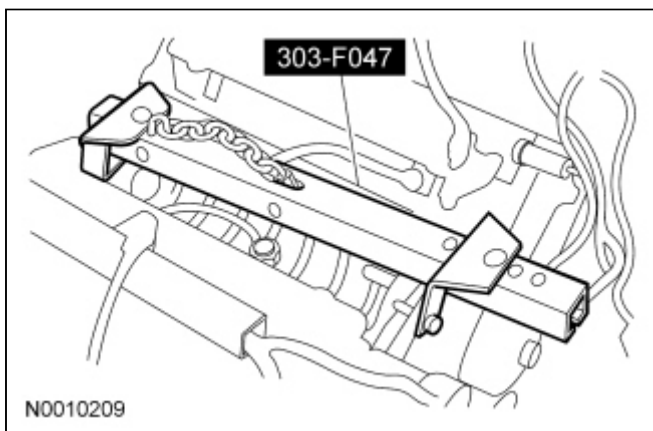


- Remove the 8 bolts and the crankshaft rear seal retainer plate.
 - **NOTICE: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.**

Clean and inspect the sealing surfaces.

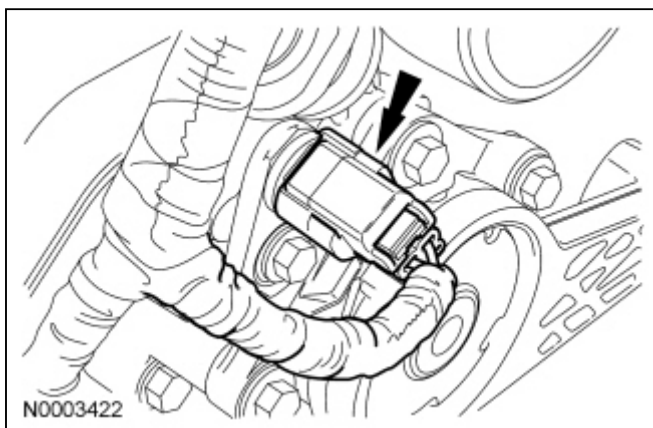


7. Mount the engine on a suitable work stand.
8. Remove the Engine Lifting Bracket.



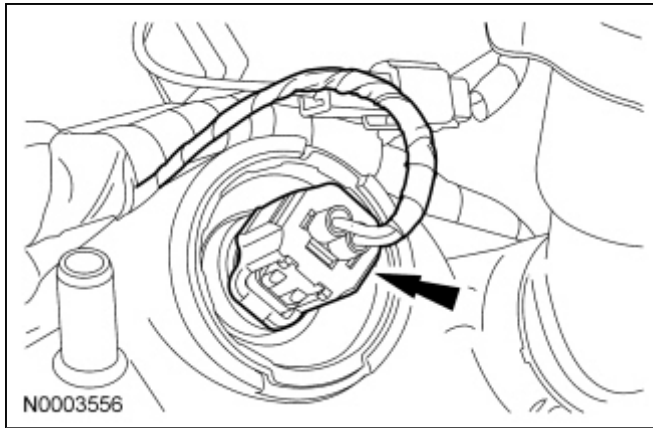
9. **NOTE:** RH shown, LH similar.

Disconnect the RH and LH Camshaft Position (CMP) sensor electrical connectors.

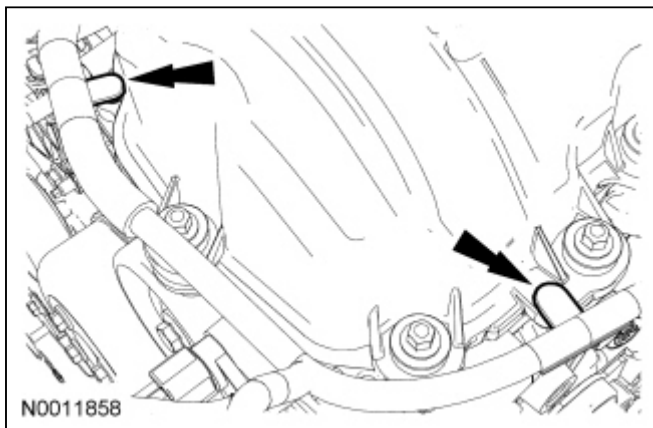


10. **NOTE:** RH shown, LH similar.

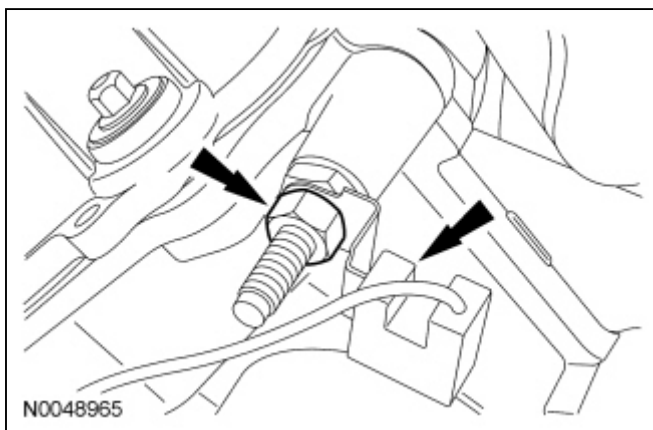
Disconnect the RH and LH Variable Camshaft Timing (VCT) solenoid electrical connectors.



11. Detach the engine wiring harness pin-type retainers.



12. Remove the nut and the RH radio ignition interference capacitor.

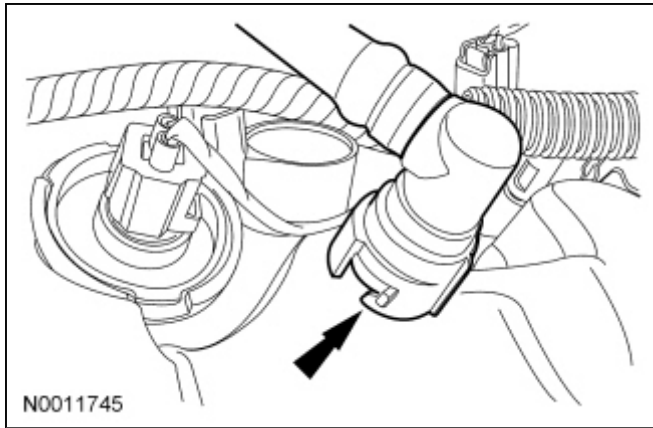


13. **NOTE:** When reusing liquid or vapor tube connectors, make sure to use compressed air to remove any foreign material from the connector retaining clip area before separating from the tube.

NOTE: LH shown, RH similar.

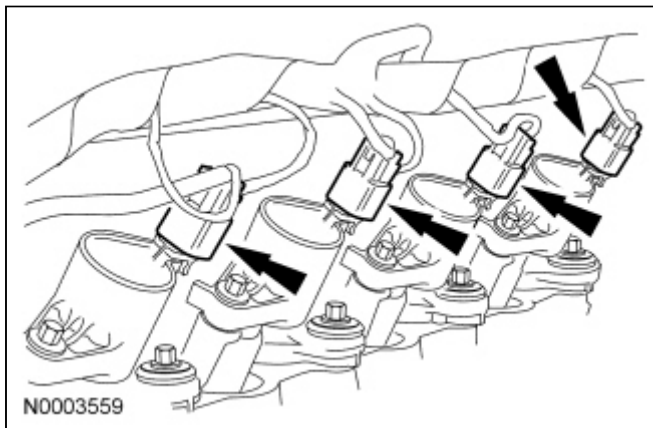
Remove the PCV tubes from the LH and RH valve covers.

- Disconnect the quick connect fittings.
 - Push the connector toward the valve cover to release pressure.
 - Push the release tab clockwise.
 - Disconnect the quick connect fitting.

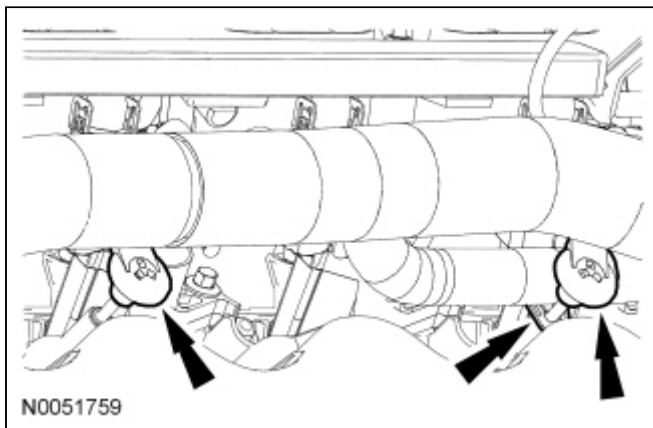


14. **NOTE:** RH shown, LH similar.

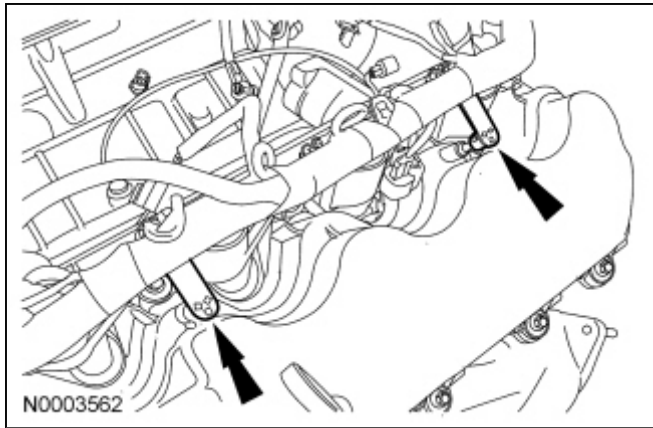
Disconnect the 4 RH and 4 LH ignition coil electrical connectors.



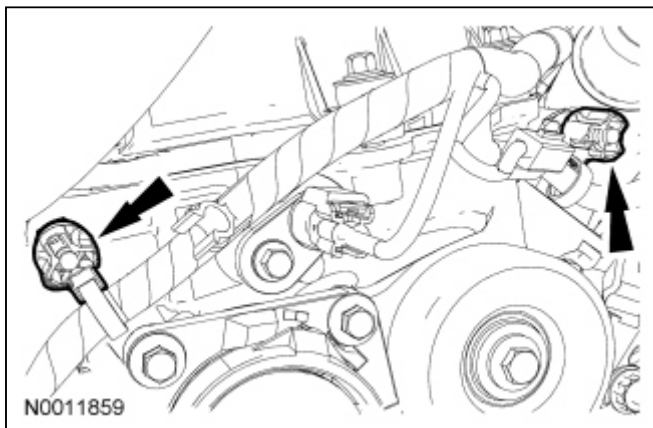
15. Disconnect the 3 engine wiring harness retainers from the RH valve cover studs.



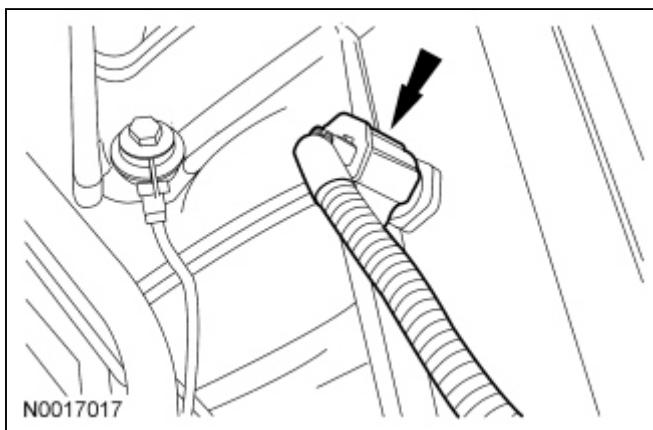
16. Disconnect the 2 engine wiring harness retainers from the LH valve cover studs.



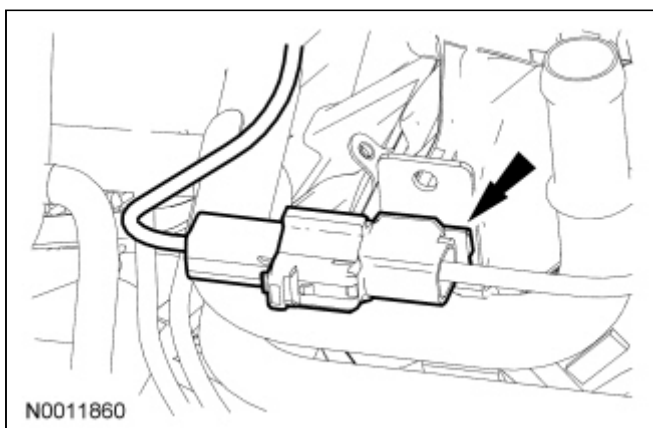
17. Detach the engine wiring harness pin-type retainers.



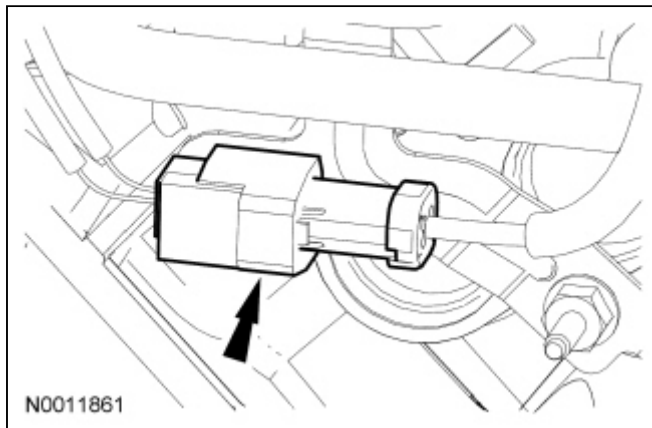
18. Disconnect the Cylinder Head Temperature (CHT) sensor electrical connector.



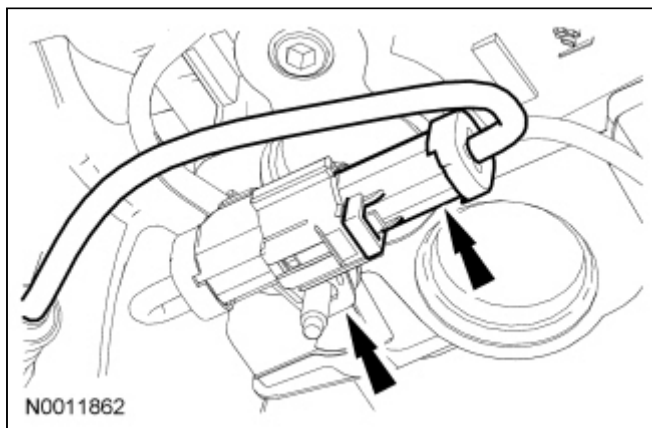
19. Detach the CHT sensor jumper harness electrical connector pin-type retainer.



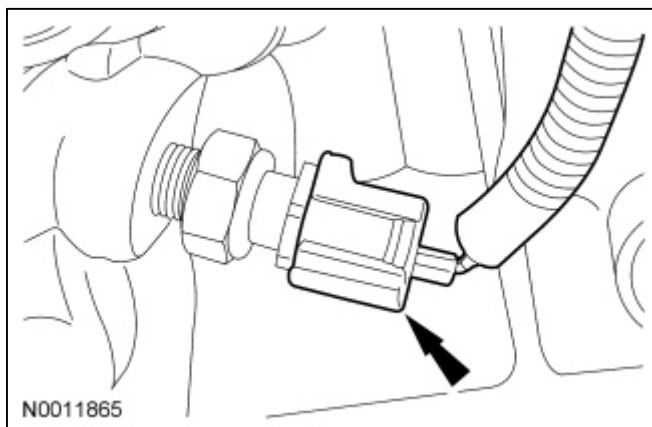
20. Disconnect the Knock Sensor (KS) electrical connector and pin-type retainer.



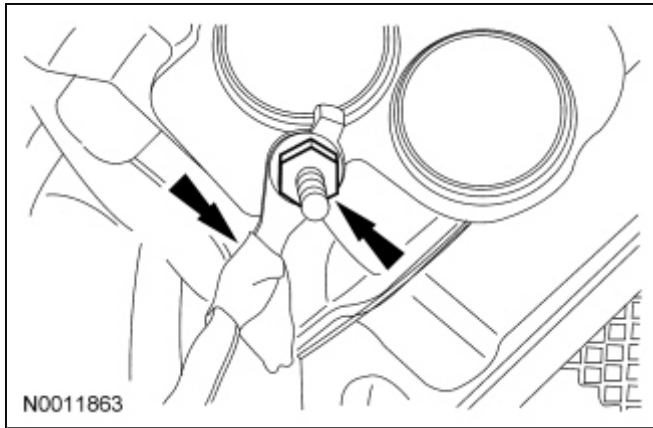
21. Disconnect the LH Heated Oxygen Sensor (HO2S) electrical connector.
- Detach the engine wiring harness retainer from the stud bolt.



22. Disconnect the Engine Oil Pressure (EOP) switch electrical connector.

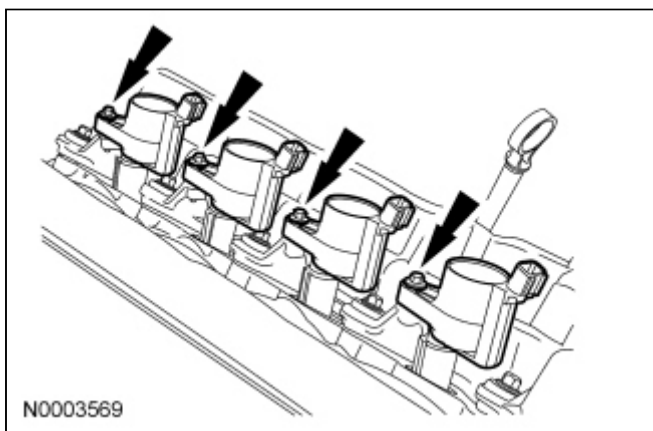


23. Remove the engine wiring harness from the engine.
24. Remove the nut and ground strap from the stud bolt.

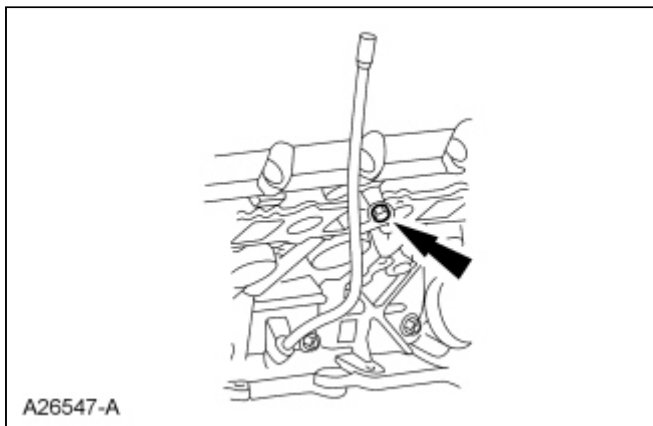


25. **NOTE:** LH shown, RH similar.

Remove the 8 bolts and the 8 ignition coils.



26. Remove the bolt and the oil level indicator tube.



27. **NOTICE:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

NOTE: When removing the valve cover, make sure to avoid damaging the Variable Camshaft Timing (VCT) solenoid.

NOTE: The bolts are part of the valve cover and should not be removed.

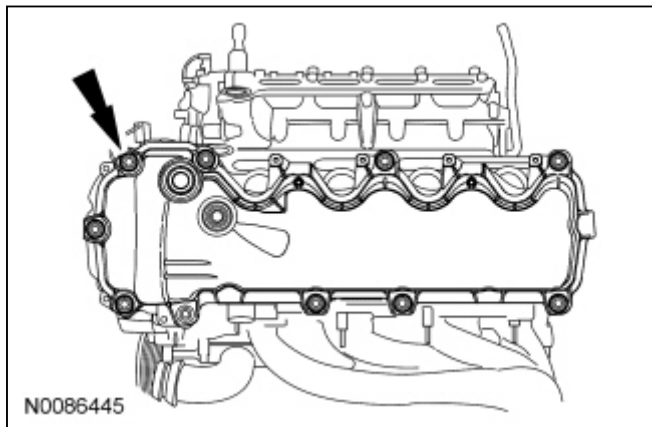
NOTE: LH shown, RH similar.

Loosen the 19 bolts and remove the valve covers.

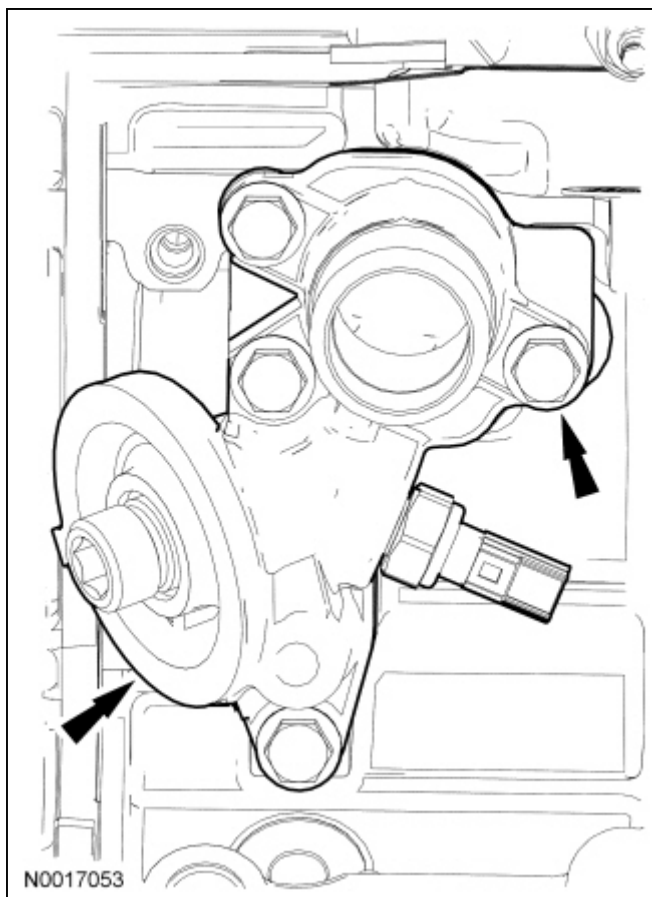
- Clean the valve cover mating surface of the cylinder head with silicone gasket remover and metal

surface prep. Follow the directions on the packaging.

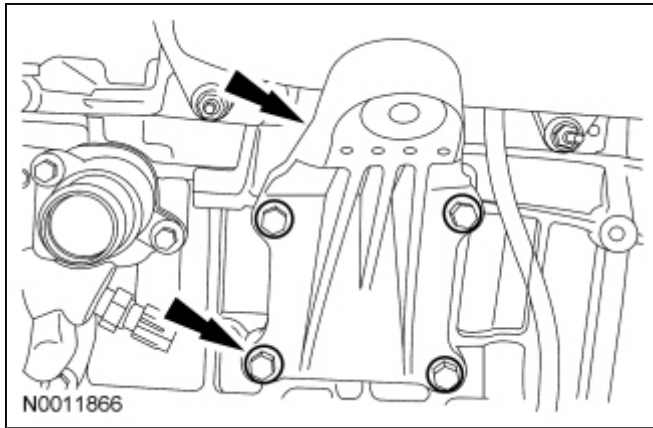
- Inspect the valve cover gasket. If the gasket is damaged, remove and discard the gasket. Clean the valve cover gasket groove with soap and water or a suitable solvent.



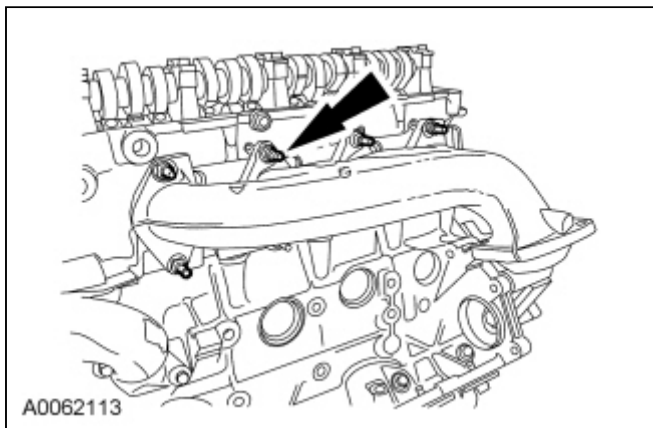
28. Remove and discard the oil filter.
29. Remove the 4 bolts and the oil filter adapter.
 - Discard the gasket.



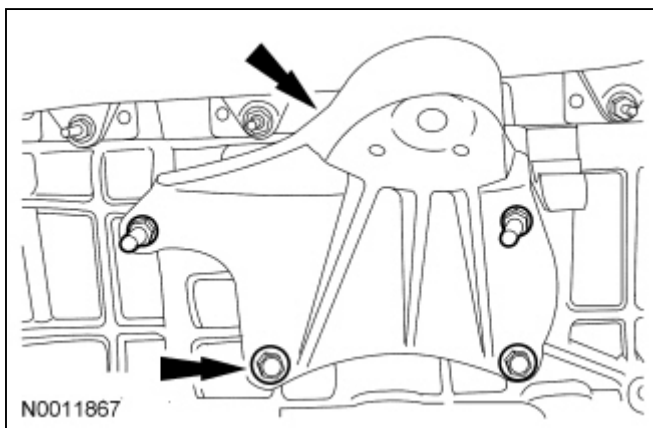
30. Remove the 4 bolts and the LH motor mount bracket.



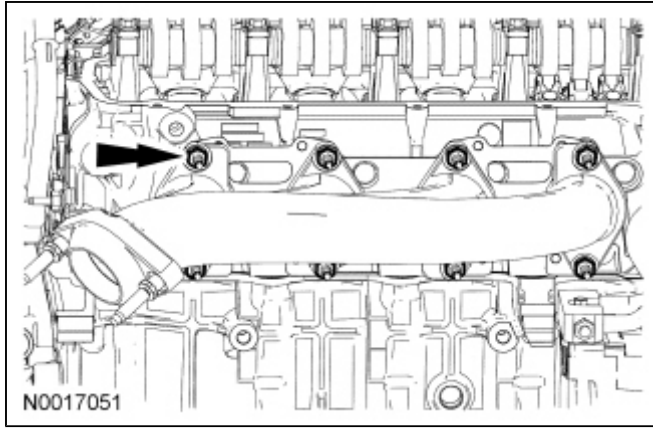
31. Remove the 8 nuts and the LH exhaust manifold.
 - Discard the nuts and gasket.



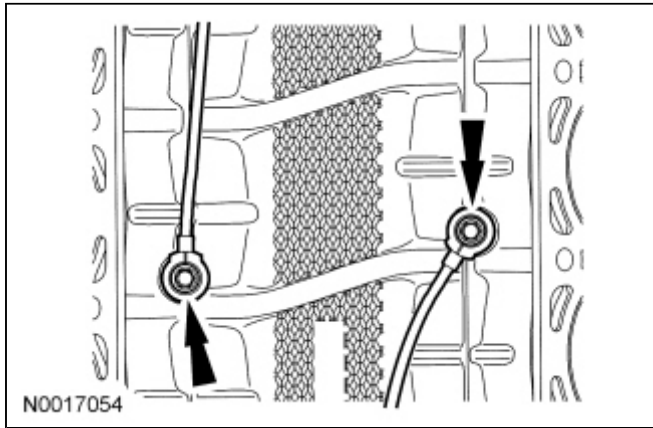
32. Clean and inspect the LH exhaust manifold. For additional information, refer to [Section 303-00](#).
33. Remove and discard the 8 LH exhaust manifold studs.
34. Remove the 2 bolts, 2 stud bolts and the RH motor mount bracket.



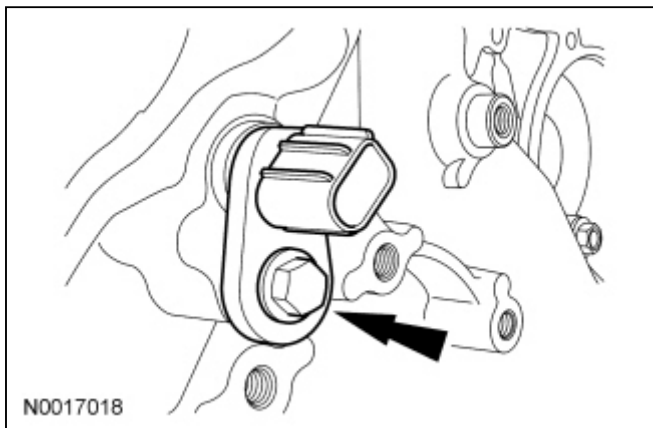
35. Remove the 8 nuts and the RH exhaust manifold.
 - Discard the nuts and gasket.



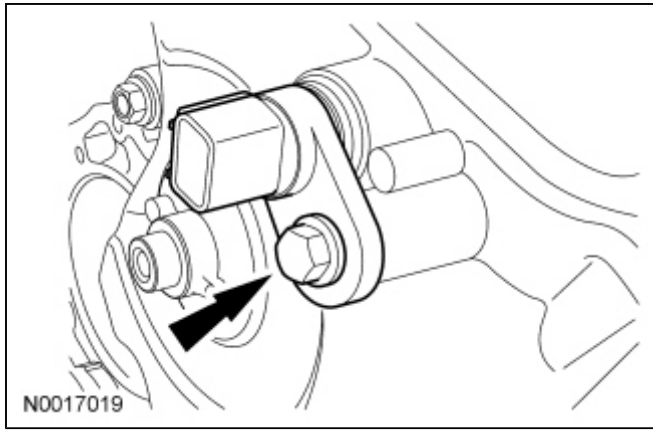
36. Clean and inspect the RH exhaust manifold. For additional information, refer to [Section 303-00](#).
37. Remove and discard the 8 RH exhaust manifold studs.
38. Remove the 2 bolts and the [KS](#).



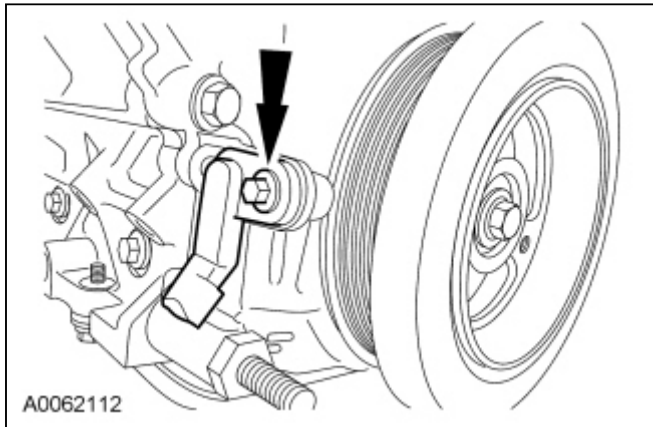
39. Remove the bolt and the RH [CMP](#) sensor.



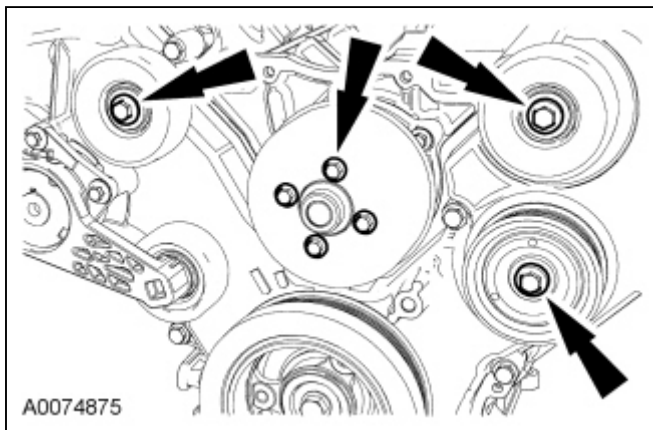
40. Remove the bolt and the LH [CMP](#) sensor.



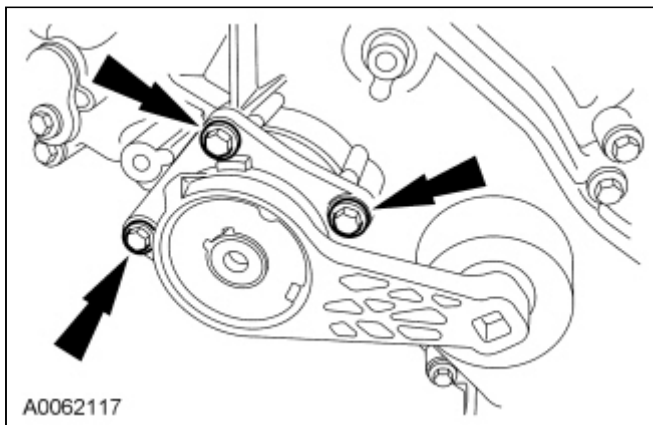
41. Remove the bolt and the [CKP](#) sensor.



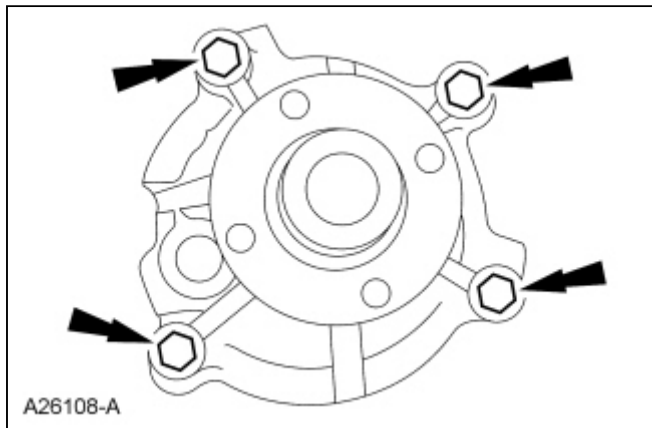
42. Remove the 7 bolts, the coolant pump pulley and the 3 accessory drive belt idler pulleys.



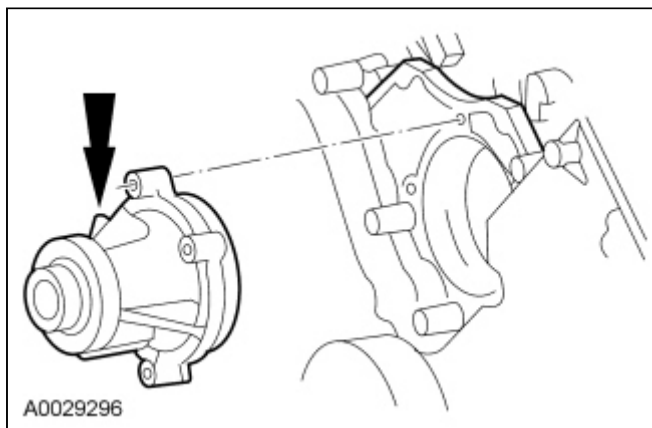
43. Remove the 3 bolts and the accessory drive belt tensioner.



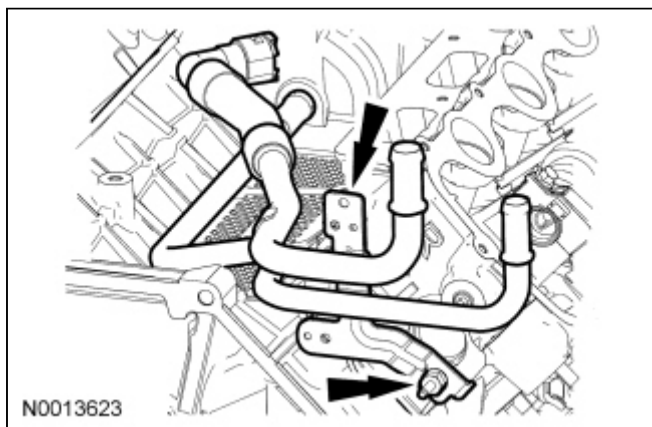
44. Remove the 4 coolant pump housing bolts.



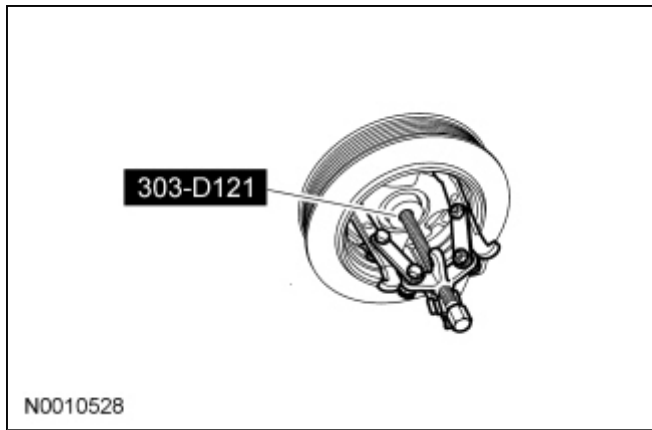
45. Remove the coolant pump housing from the cylinder block.
- Discard the O-ring seal.



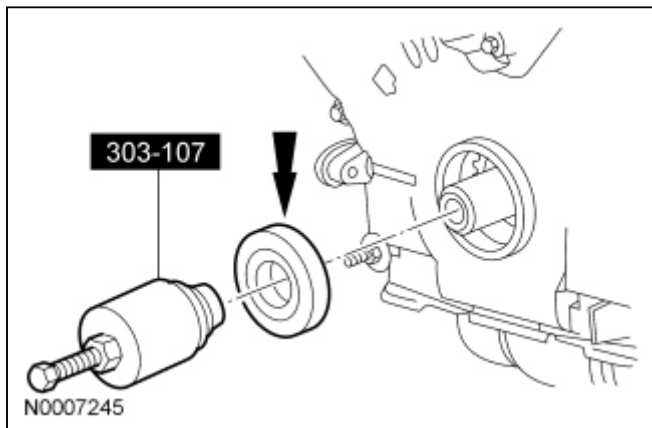
46. Remove the stud bolt and the coolant tube assembly.
- Discard the O-ring seal.



47. Remove and discard the crankshaft pulley bolt. Using the 3-Jaw Puller, remove the crankshaft pulley.



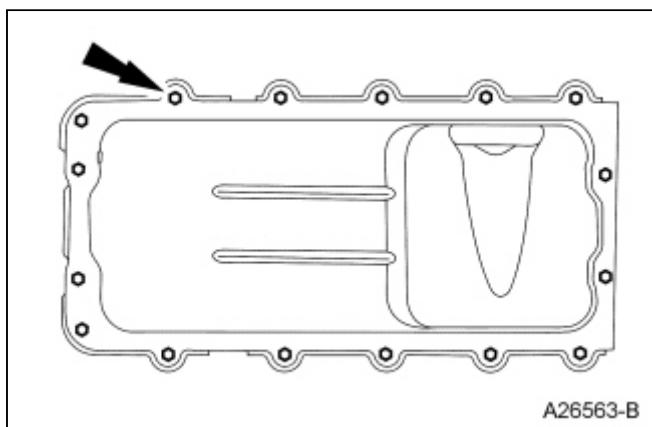
48. Using the Crankshaft Front Oil Seal Remover, remove the crankshaft front oil seal.



49. Remove the bolts, oil pan and oil pan gasket.

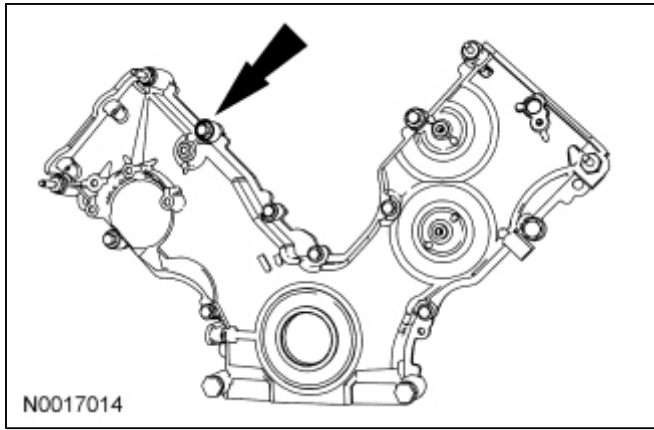
- Discard the oil pan gasket.
- **NOTICE: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.**

Clean and inspect the sealing surfaces.

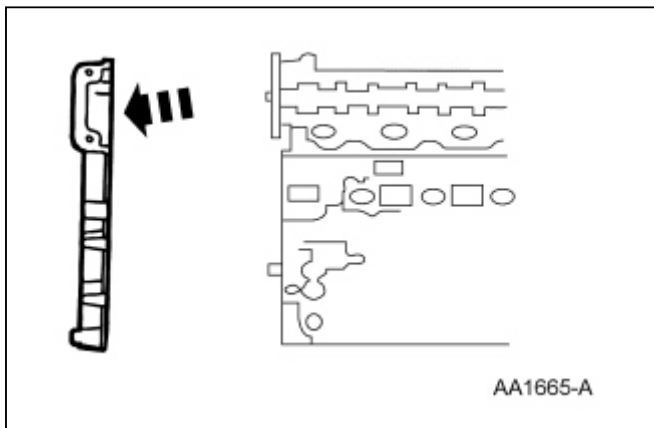


50. **NOTE:** Correct fastener location is essential for the assembly procedure. Record fastener location.

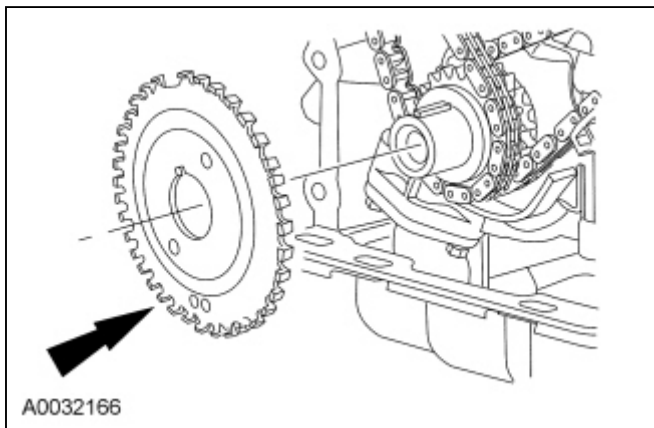
Remove the engine front cover fasteners.



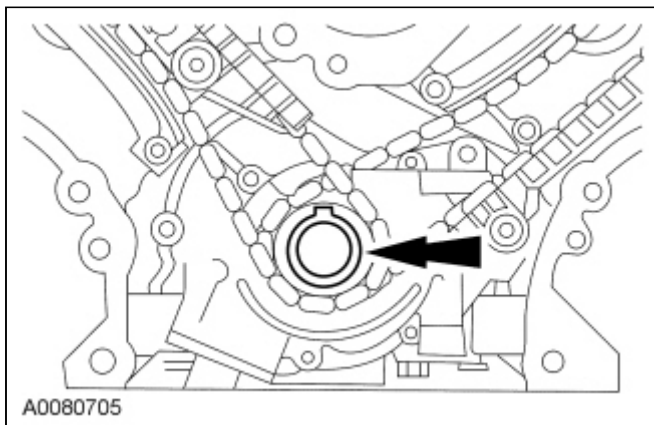
51. Remove the engine front cover from the cylinder block.



52. Remove the crankshaft sensor ring from the crankshaft.

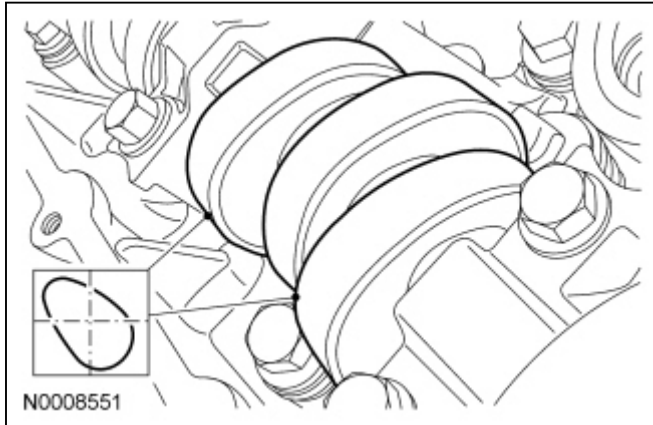


53. Position the crankshaft keyway at the 12 o'clock position.



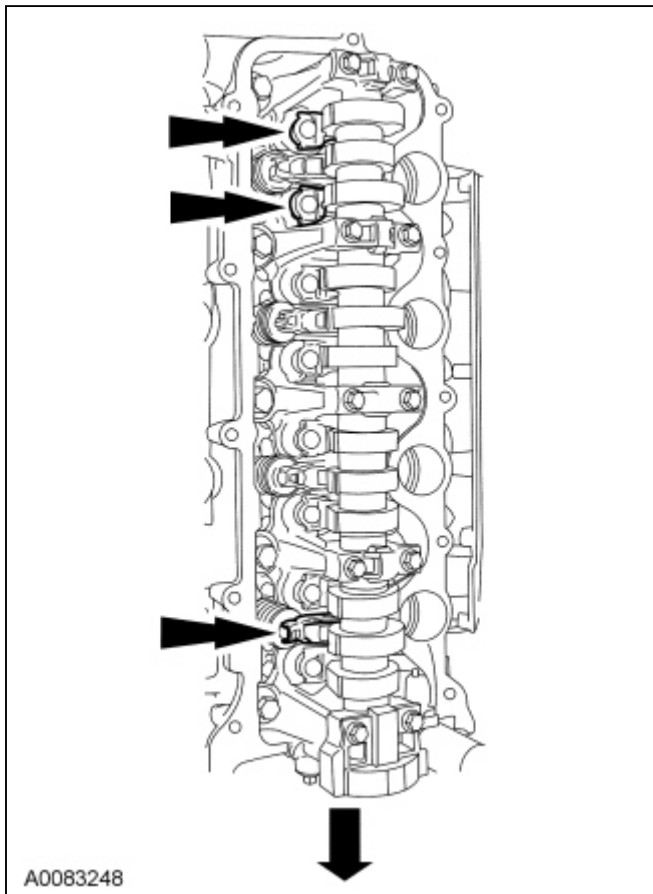
54. **NOTE:** If the camshaft lobes are not exactly positioned as shown, the crankshaft will require one full additional rotation to the 12 o'clock position.

The No. 1 cylinder camshaft exhaust lobe must be coming up on the exhaust stroke. Verify by noting the position of the 2 intake lobes and the exhaust lobe on the No. 1 cylinder.



55. **NOTICE:** If the components are to be reinstalled, they must be installed in their original positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

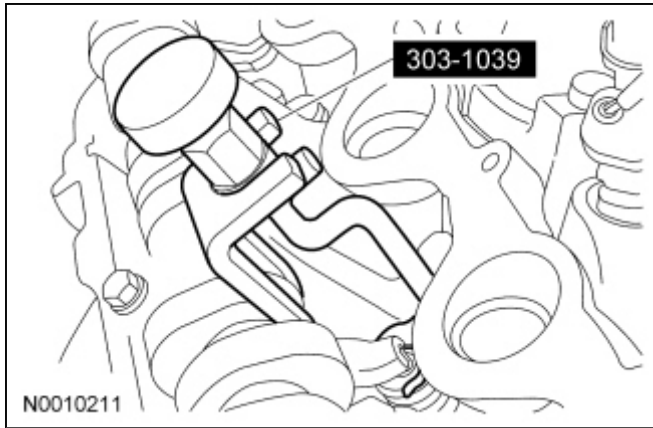
Remove only the 3 roller followers shown in the illustration from the RH cylinder head.



56. **NOTE:** Do not allow the valve keepers to fall off the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed.

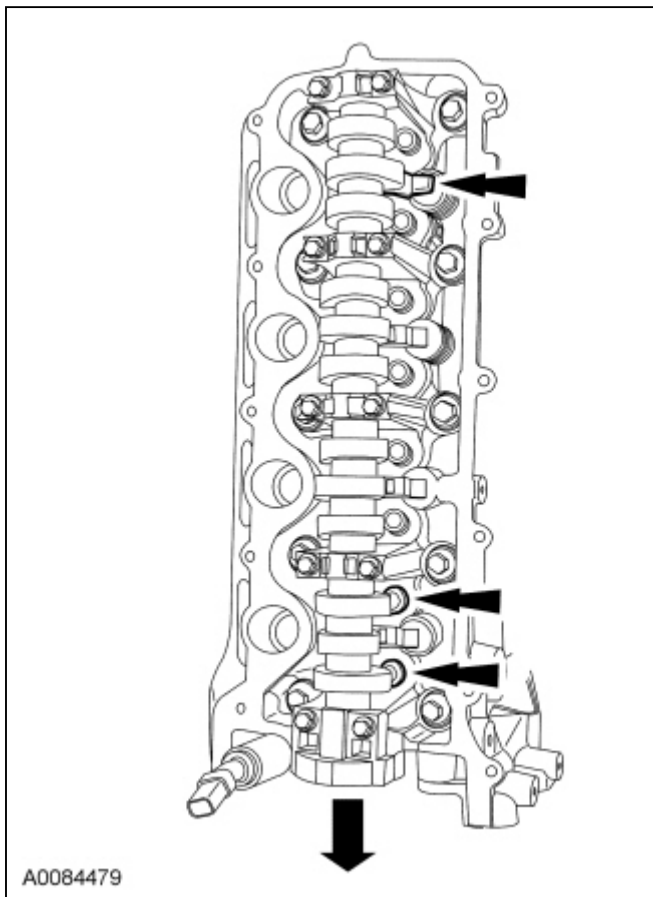
NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, remove the 3 roller followers designated in the previous step from the RH cylinder head.



57. **NOTICE:** If the components are to be reinstalled, they must be installed in their original positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

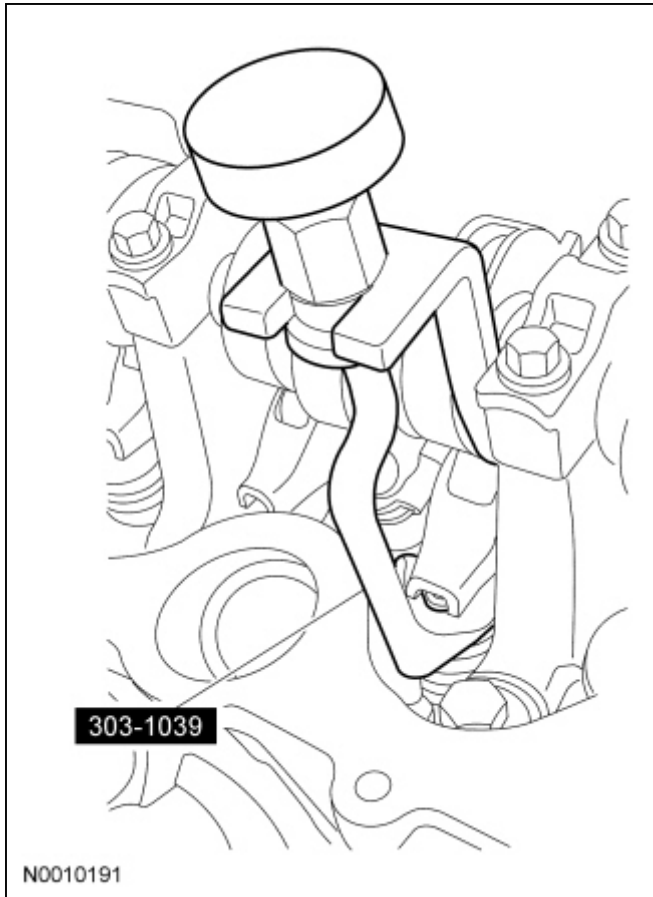
Remove only the 3 roller followers shown in the illustration from the LH cylinder head.



58. **NOTE:** Do not allow the valve keepers to fall off the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed.

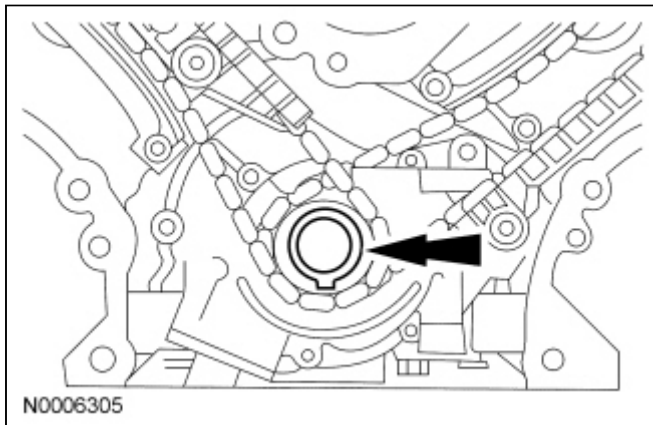
NOTE: It may be necessary to push the valve down while compressing the spring.

Using the Valve Spring Compressor, remove the 3 roller followers designated in the previous step from the LH cylinder head.

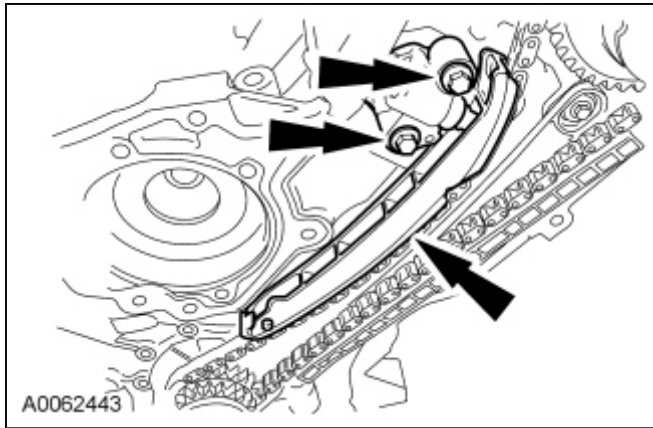


59. **NOTICE:** The crankshaft cannot be moved past the 6 o'clock position once set or engine damage may occur.

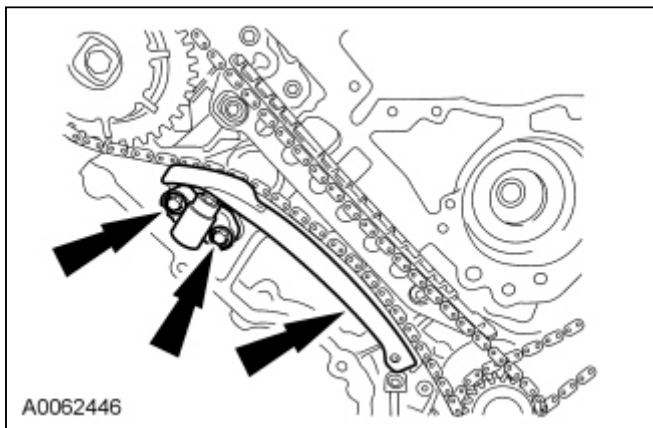
Rotate the crankshaft clockwise and position the crankshaft keyway at the 6 o'clock position.



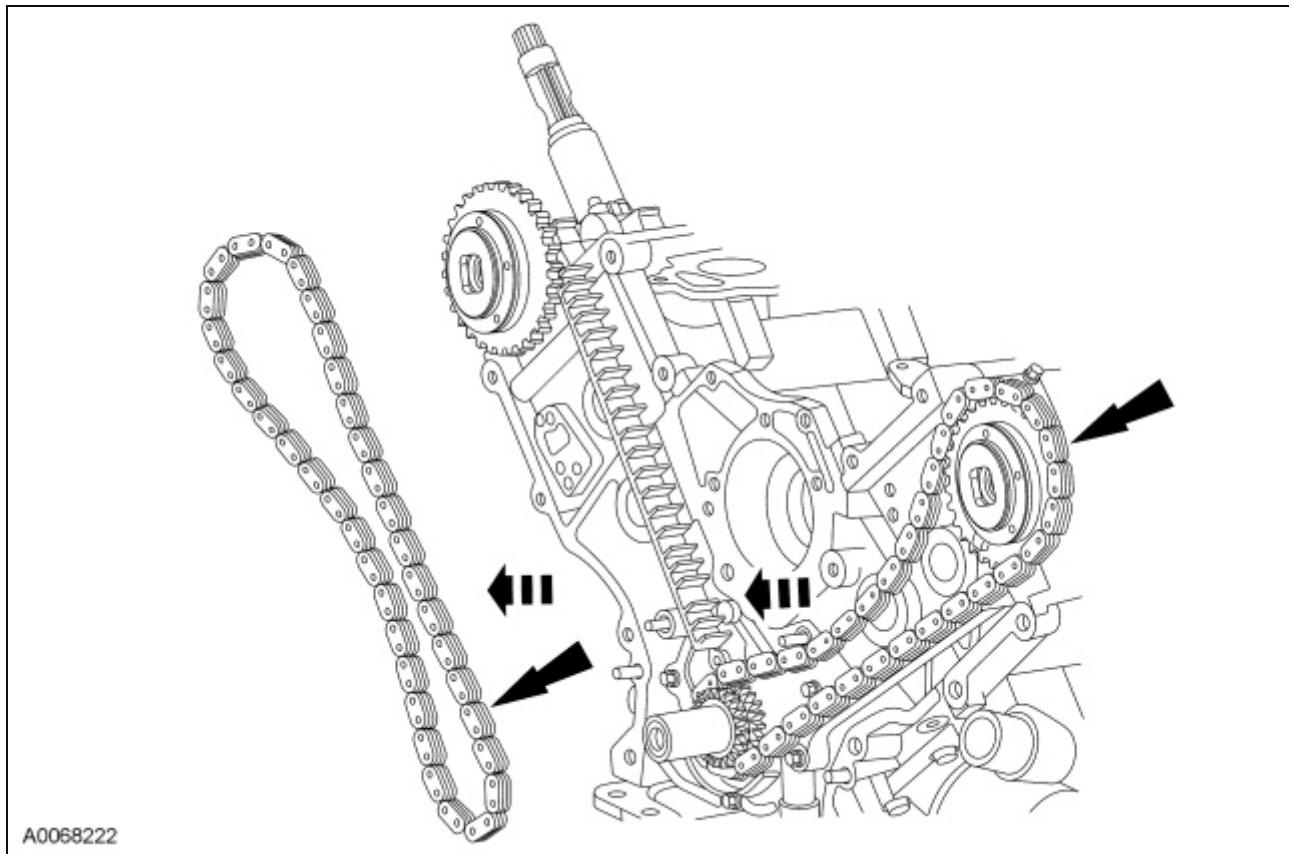
60. Remove the 2 bolts, the LH timing chain tensioner and tensioner arm.



61. Remove the 2 bolts, the RH timing chain tensioner and tensioner arm.



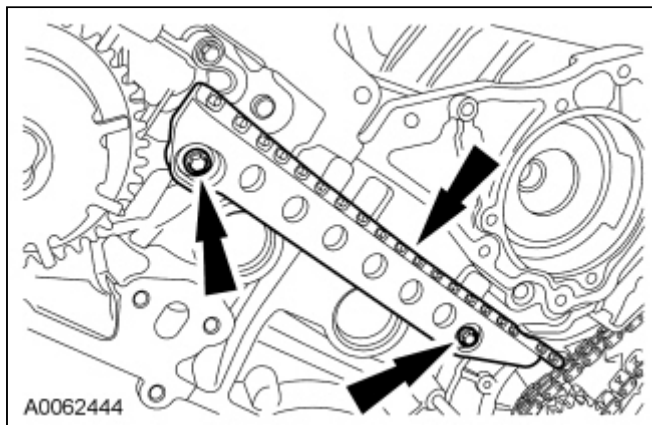
62. Remove the RH and LH timing chains and the crankshaft sprocket.
- Remove the RH timing chain from the camshaft sprocket.
 - Remove the RH timing chain from the crankshaft sprocket.
 - Remove the LH timing chain from the camshaft sprocket.
 - Remove the LH timing chain and crankshaft sprocket.



63. **NOTE:** RH shown, LH similar.

Remove the LH and RH timing chain guides.

- Remove the 2 bolts.
- Remove both timing chain guides.

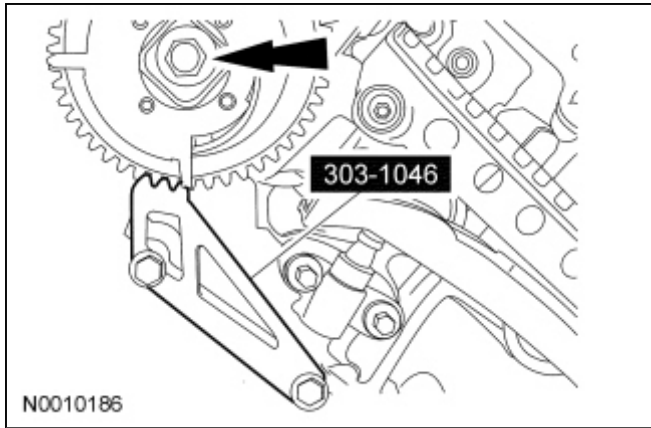


64. **NOTICE:** Damage to the camshaft phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

NOTICE: Only use hand tools to remove the camshaft phaser sprocket assembly or damage may occur to the camshaft or camshaft phaser unit.

Using the Camshaft Phaser Locking Tool, remove the bolt and the RH camshaft phaser sprocket assembly.

- Discard the camshaft phaser sprocket bolt.

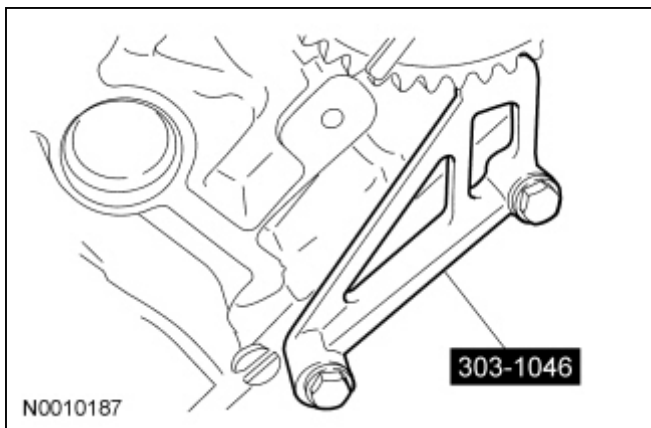


65. **NOTICE:** Damage to the camshaft phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

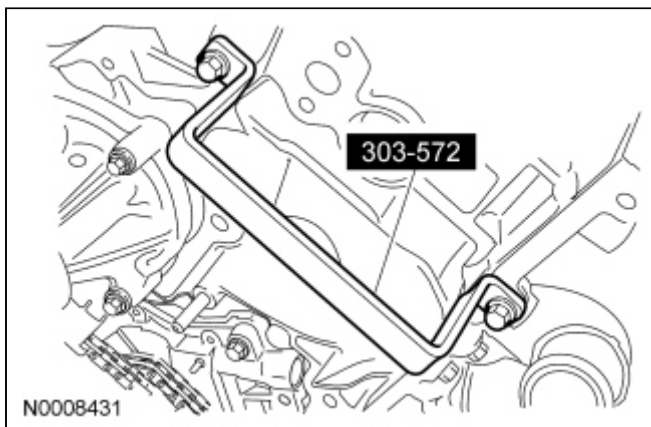
NOTICE: Only use hand tools to remove the camshaft phaser sprocket assembly or damage may occur to the camshaft or camshaft phaser unit.

Using the Camshaft Phaser Locking Tool, remove the bolt and the LH camshaft phaser sprocket assembly.

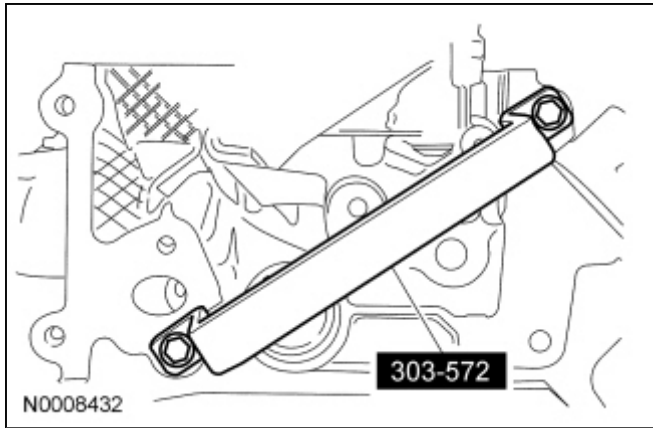
- Discard the camshaft phaser sprocket bolt.



66. Install the Cylinder Head Remover/Installer onto the LH cylinder head.

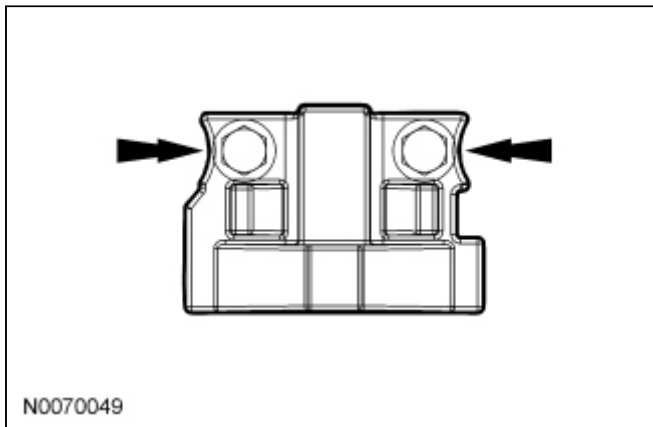


67. Install the Cylinder Head Remover/Installer onto the RH cylinder head.



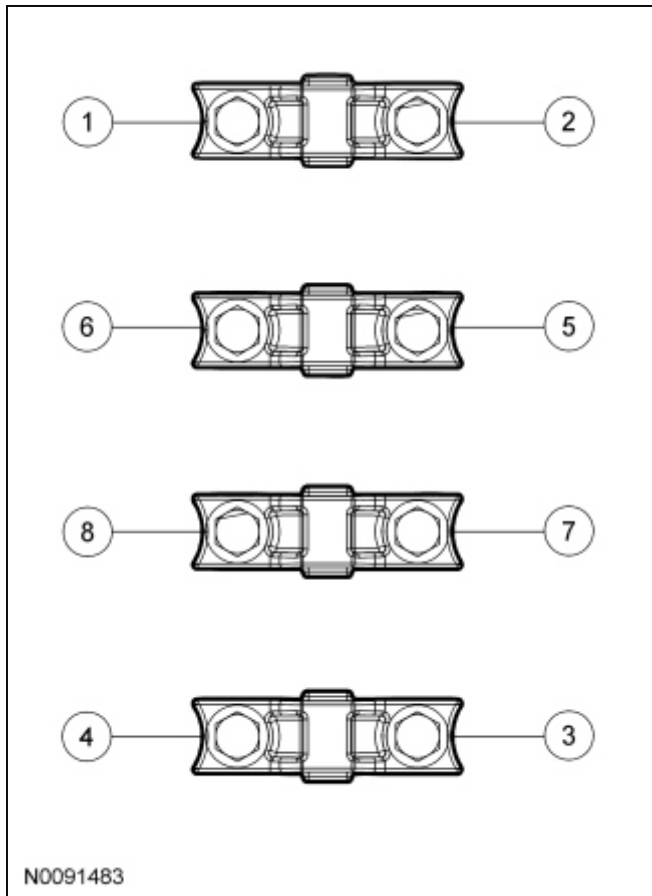
68. **NOTICE:** Remove the front thrust camshaft bearing cap straight upward from the bearing towers or the bearing cap may be damaged from side loading.

Remove the 2 bolts and the RH cylinder head camshaft front bearing cap.

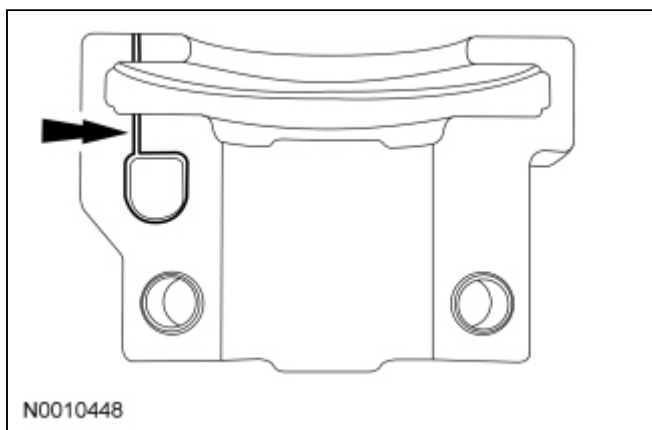


69. **NOTICE:** The camshaft bearing caps must be installed in their original locations. Record camshaft bearing cap locations. Failure to follow these instructions may result in engine damage.

Remove the remaining bolts in the sequence shown and remove the RH cylinder head camshaft bearing caps.



70. Clean and inspect the RH camshaft bearing caps.
- The camshaft front thrust bearing cap contains an oil metering groove. Make sure the groove is free of foreign material.



71. Remove the RH camshaft.
72. **NOTICE:** If the components are to be reinstalled, they must be installed in their original positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

Remove the remaining roller followers from the RH cylinder head.

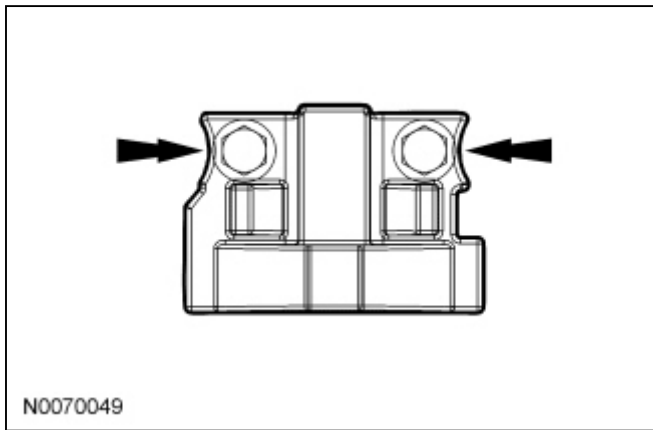
73. **NOTICE:** If the components are to be reinstalled, they must be installed in their original positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

Remove the hydraulic lash adjusters from the RH cylinder head.

74. **NOTICE:** Remove the front thrust camshaft bearing cap straight upward from the bearing towers

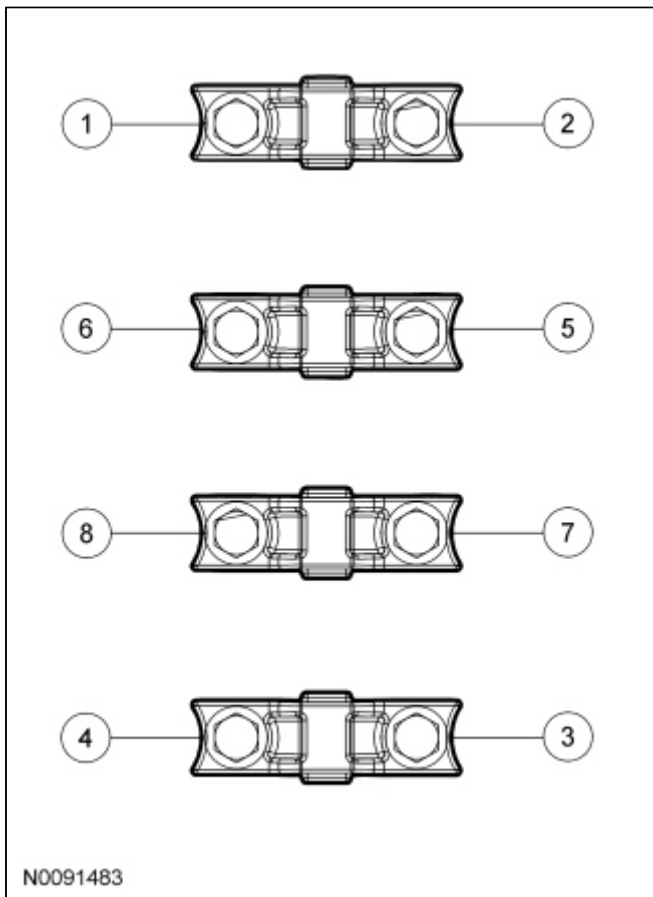
or the bearing cap may be damaged from side loading.

Remove the 2 bolts and the LH cylinder head camshaft front bearing cap.

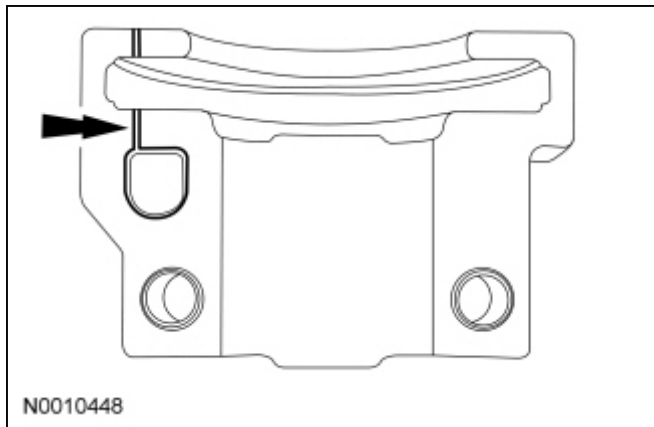


75. **NOTICE:** The camshaft bearing caps must be installed in their original locations. Record camshaft bearing cap locations. Failure to follow these instructions may result in engine damage.

Remove the remaining bolts in the sequence shown and remove the LH cylinder head camshaft bearing caps.



76. Clean and inspect the LH camshaft bearing caps.
- The camshaft front thrust bearing cap contains an oil metering groove. Make sure the groove is free of foreign material.



77. Remove the LH camshaft.
78. **NOTICE:** If the components are to be reinstalled, they must be installed in their original positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

Remove the remaining roller followers from the LH cylinder head.

79. **NOTICE:** If the components are to be reinstalled, they must be installed in their original positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

Remove the hydraulic lash adjusters from the LH cylinder head.

80. **NOTICE:** The cylinder head must be cool before removing it from the engine. Cylinder head warpage can result if a warm or hot cylinder head is removed.

NOTICE: Place clean shop towels over exposed engine cavities. Carefully remove the towels so foreign material is not dropped into the engine.

NOTICE: The cylinder head bolts must be discarded and new bolts must be installed. They are tighten-to-yield designed and cannot be reused.

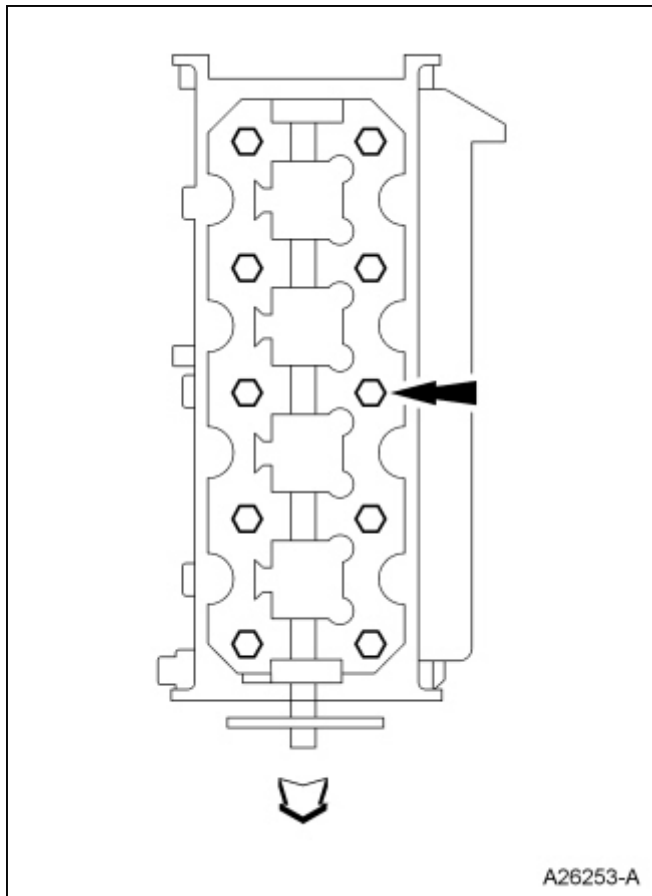
NOTICE: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges that make leak paths. Use a plastic scraping tool to remove all traces of the head gasket.

NOTICE: Aluminum surfaces are soft and can be scratched easily. Never place the cylinder head gasket surface, unprotected, on a bench surface.

NOTE: RH shown, LH similar.

Remove the 20 bolts and the cylinder heads.

- Discard the cylinder head gaskets.
- Discard the cylinder head bolts.



81. **NOTICE:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges that make leak paths. Use a plastic scraping tool to remove all traces of the head gasket.

NOTE: Observe all warnings or cautions and follow all application directions contained on the packaging of the silicone gasket remover and the metal surface prep.

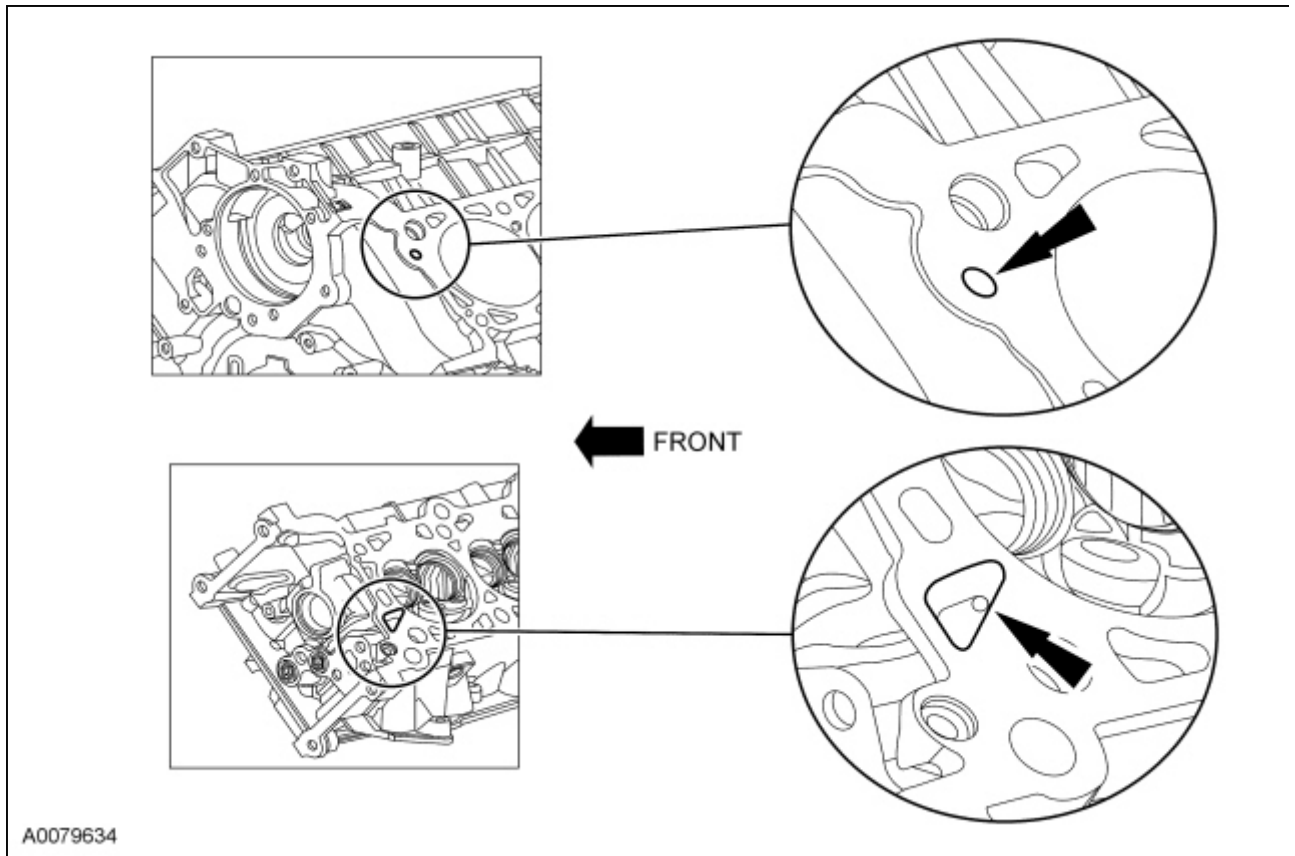
NOTE: If there is no residual gasket material present, metal surface prep can be used to clean and prepare the surfaces.

Clean the cylinder head-to-cylinder block mating surfaces of both the cylinder head and the cylinder block in the following sequence.

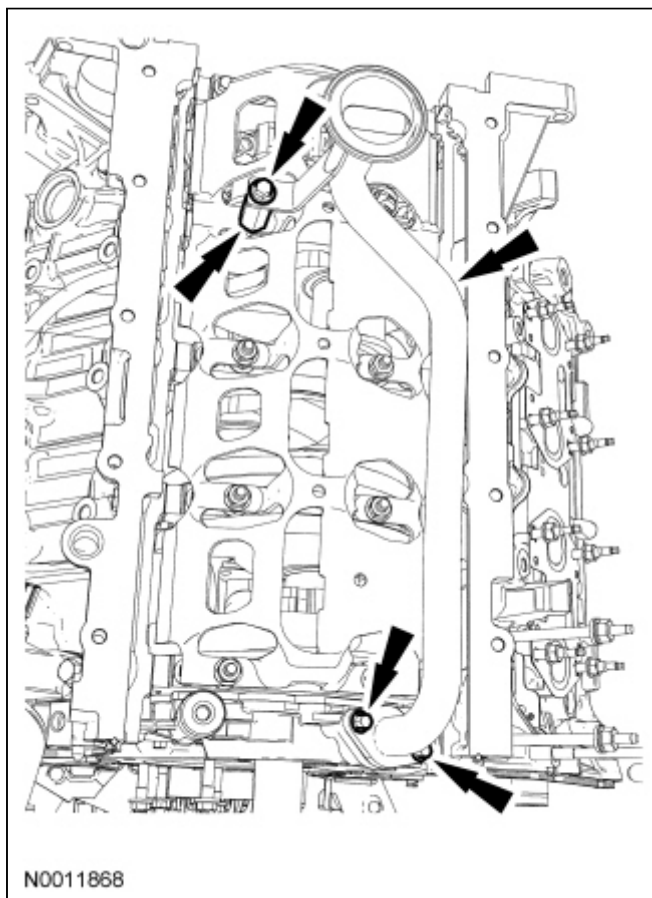
1. Remove any large deposits of silicone or gasket material with a plastic scraper.
2. Apply silicone gasket remover, following package directions and allow to set for several minutes.
3. Remove the silicone gasket remover with a plastic scraper. A second application of silicone gasket remover may be required if residual traces of silicone or gasket material remain.
4. Apply metal surface prep, following package directions, to remove any remaining traces of oil or coolant and to prepare the surfaces to bond with the new gasket. Do not attempt to make the metal shiny. Some staining of the metal surfaces is normal.

82. **NOTE:** LH shown, RH similar.

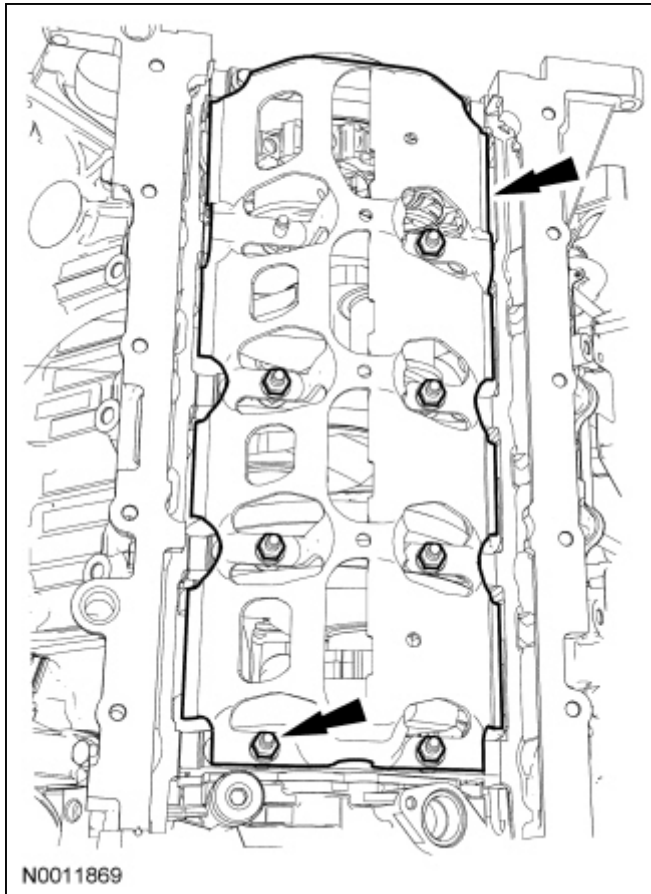
Support the cylinder heads on a bench with the head gasket side up. Check the cylinder head distortion and the cylinder block distortion, paying particular attention to the oil pressure feed area. For additional information, refer to [Section 303-00](#).



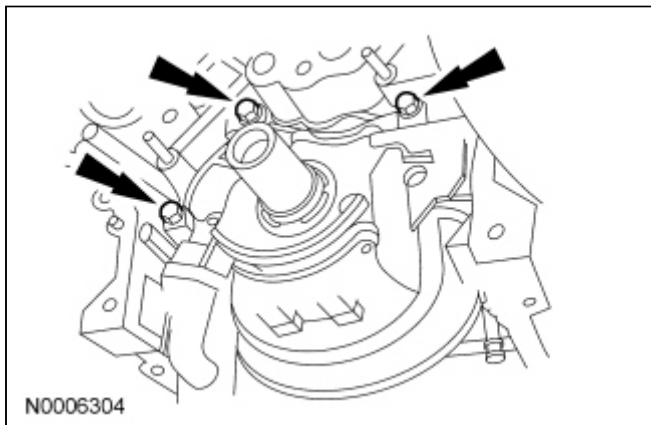
83. Remove the bolts, the oil pump screen and pickup tube and the spacer.



84. Remove the 7 nuts and the windage tray.

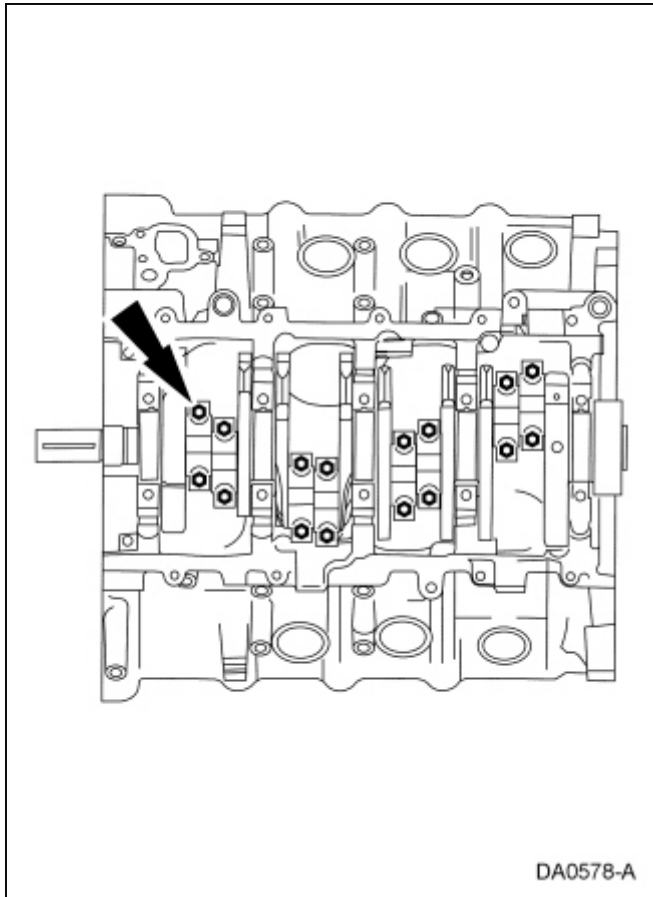


85. Remove the 3 bolts and the oil pump.



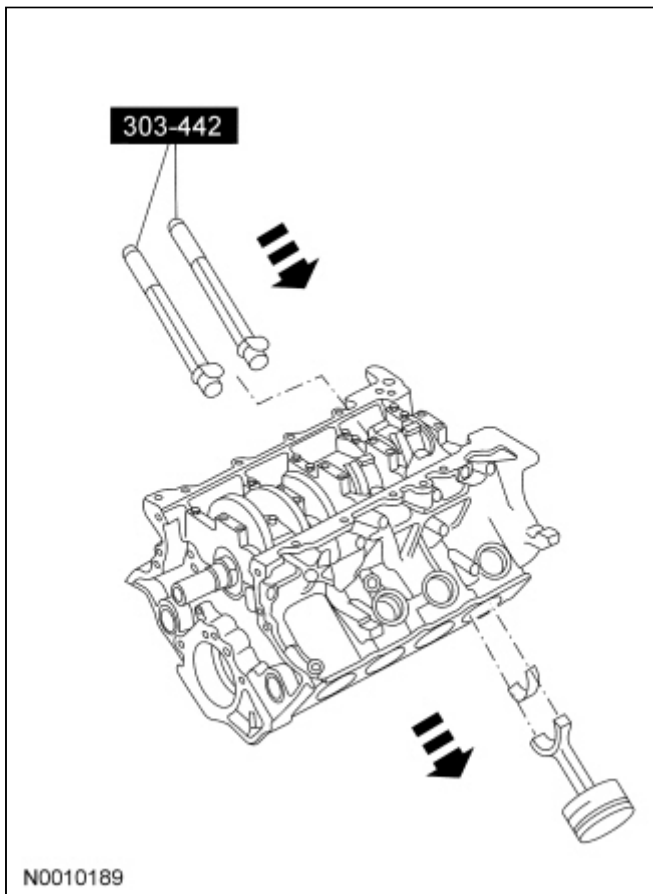
86. Before removing the pistons, inspect the top of the cylinder bores. If necessary, remove the ridge or carbon deposits from each cylinder using an abrasive pad or equivalent, following the manufacturer's instructions.
87. **NOTICE:** Verify that the connecting rods and rod caps have orientation numbers cast into them. If not, number the connecting rods and rod caps for correct orientation. Failure to do so can result in engine damage.

Remove the bolts and the connecting rod caps. Discard the bolts.

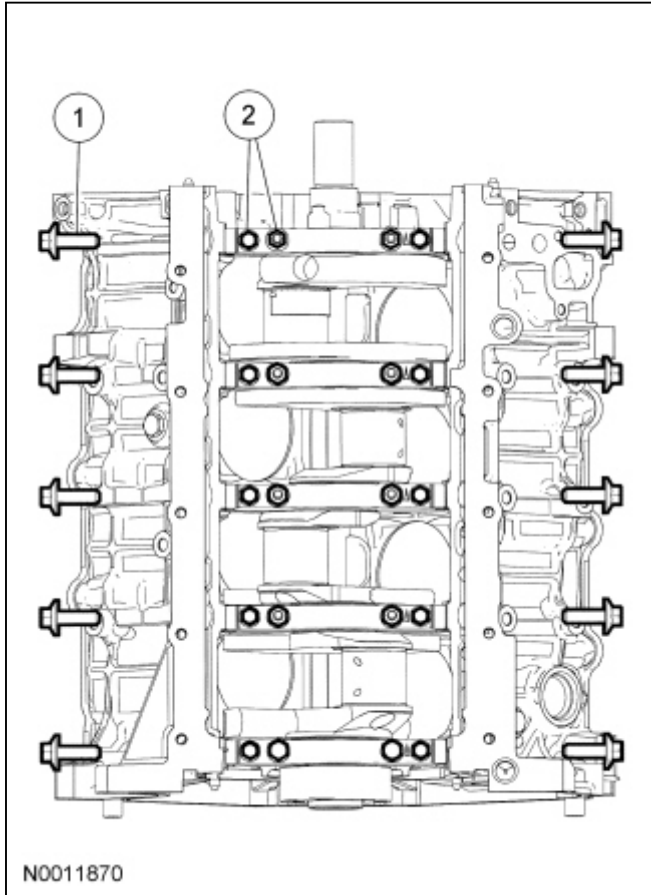


88. **NOTICE:** Do not scratch the cylinder walls or crankshaft journals with the connecting rod or engine damage may occur.

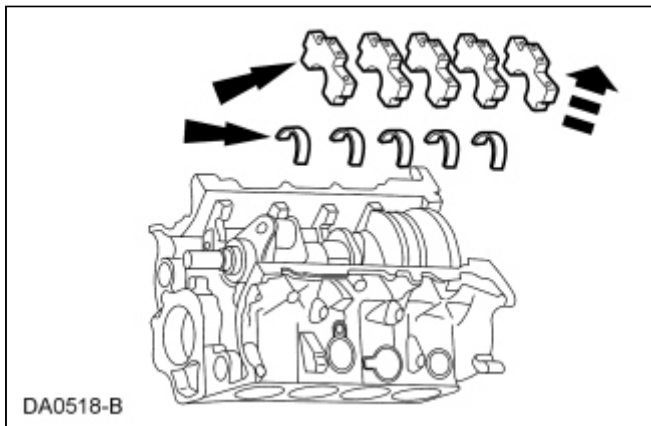
Use the Connecting Rod Installer to push the piston through the top of the cylinder block.



89. Disassemble the 8 pistons. For additional information, refer to [Piston](#) in this section.
90. Remove the fasteners.
1. Remove and discard the cross-mounted main cap bolts.
 2. Remove and discard the main bearing cap bolts and stud bolts.



91. Remove the 5 main bearing caps, the lower crankshaft main bearings and the lower thrust washer.



92. Remove the crankshaft, the upper crankshaft main bearings and the upper thrust washers from the cylinder block.

