
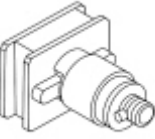

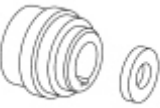
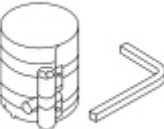

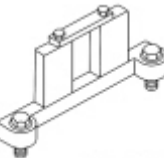



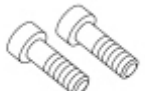






Engine

Special Tool(s)

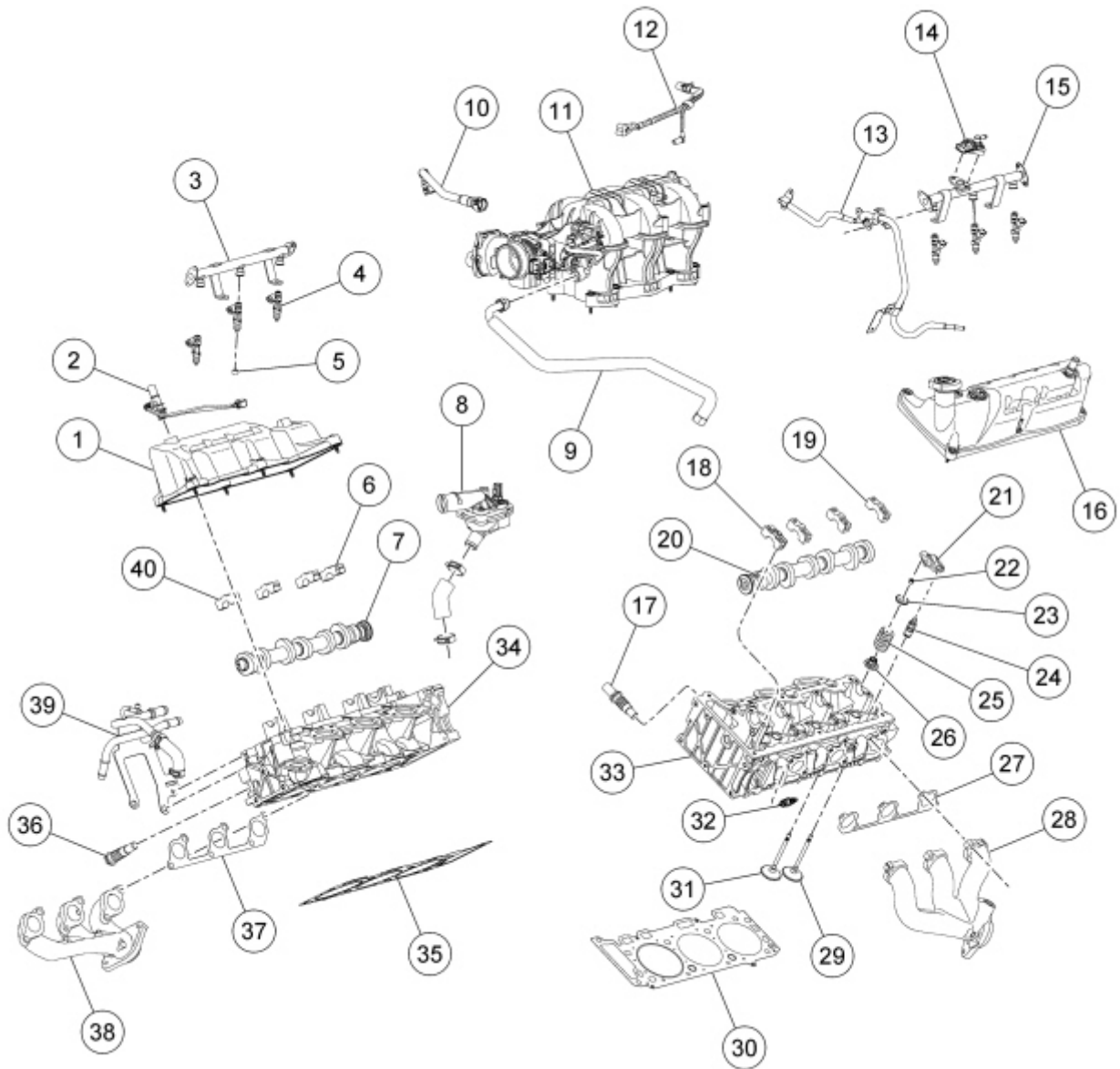
 <p>ST1776-A</p>	<p>Adapter for 303-564 303-578 (T97T-6256-A)</p>
 <p>ST1779-A</p>	<p>Adapter for 303-577 303-576 (T97T-6256-D)</p>
 <p>ST3074-A</p>	<p>Adapter for 303-579 (part of 303-S524) 303-527 (T95P-6701-A3)</p>
 <p>ST2439-A</p>	<p>Aligner, Front Cover 303-093 (T74P-6019-A)</p>
 <p>ST1380-A</p>	<p>Compressor, Piston Ring 303-D032 (D81L-6002-C)</p>
 <p>ST1330-A</p>	<p>Compressor, Valve Spring 303-581 (T97T-6565-A)</p>
 <p>ST1778-A</p>	<p>Holding Tool, Camshaft 303-577 (T97T-6256-C)</p>
 <p>ST1777-A</p>	<p>Holding Tool, Camshaft Sprocket 303-564 (T97T-6256-B)</p>

 <p>ST2132-A</p>	<p>Installer, Crankshaft Rear Oil Seal 303-579 (T97T-6701-A)</p>
 <p>ST1287-A</p>	<p>Installer, Crankshaft Vibration Damper 303-102 (T74P-6316-B)</p>
 <p>ST1831-A</p>	<p>Lifting Bracket, Engine 303-050 (T70P-6000)</p>
 <p>ST3075-A</p>	<p>Screws, Crankshaft Rear Oil Seal (part of 303-S524) 303-528 (T95T-6701-A4)</p>
 <p>ST2191-A</p>	<p>Socket, Rear Jack Shaft 303-634</p>
 <p>ST1602-A</p>	<p>Spreader Bar 303-D089 (D93P-6001-A3) or equivalent</p>
 <p>ST1438-A</p>	<p>Strap Wrench 303-D055 (85L-6000-A) or equivalent</p>
 <p>ST1774-A</p>	<p>Tensioner, Timing Chain 303-571 (T97T-6K254-A)</p>
 <p>ST1775-A</p>	<p>Timing Tool, Crankshaft TDC 303-573 (T97T-6303-A)</p>

Material

Item	Specification
Motorcraft® Metal Surface Prep ZC-31-A	—
Motorcraft® SAE 5W-30 Premium Synthetic Blend Motor Oil XO-5W30-QSP (US); Motorcraft® SAE 5W-30 Super Premium Motor Oil CXO-5W30-LSP12 (Canada); or equivalent	WSS-M2C929-A
Silicone Brake Caliper Grease and Dielectric Compound XG-3-A	ESE-M1C171-A
Silicone Gasket and Sealant TA-30	WSE-M4G323-A4
Motorcraft® Silicone Gasket Remover ZC-30	—
Thread Sealant with PTFE TA-24	WSK-M2G350-A2

Upper End

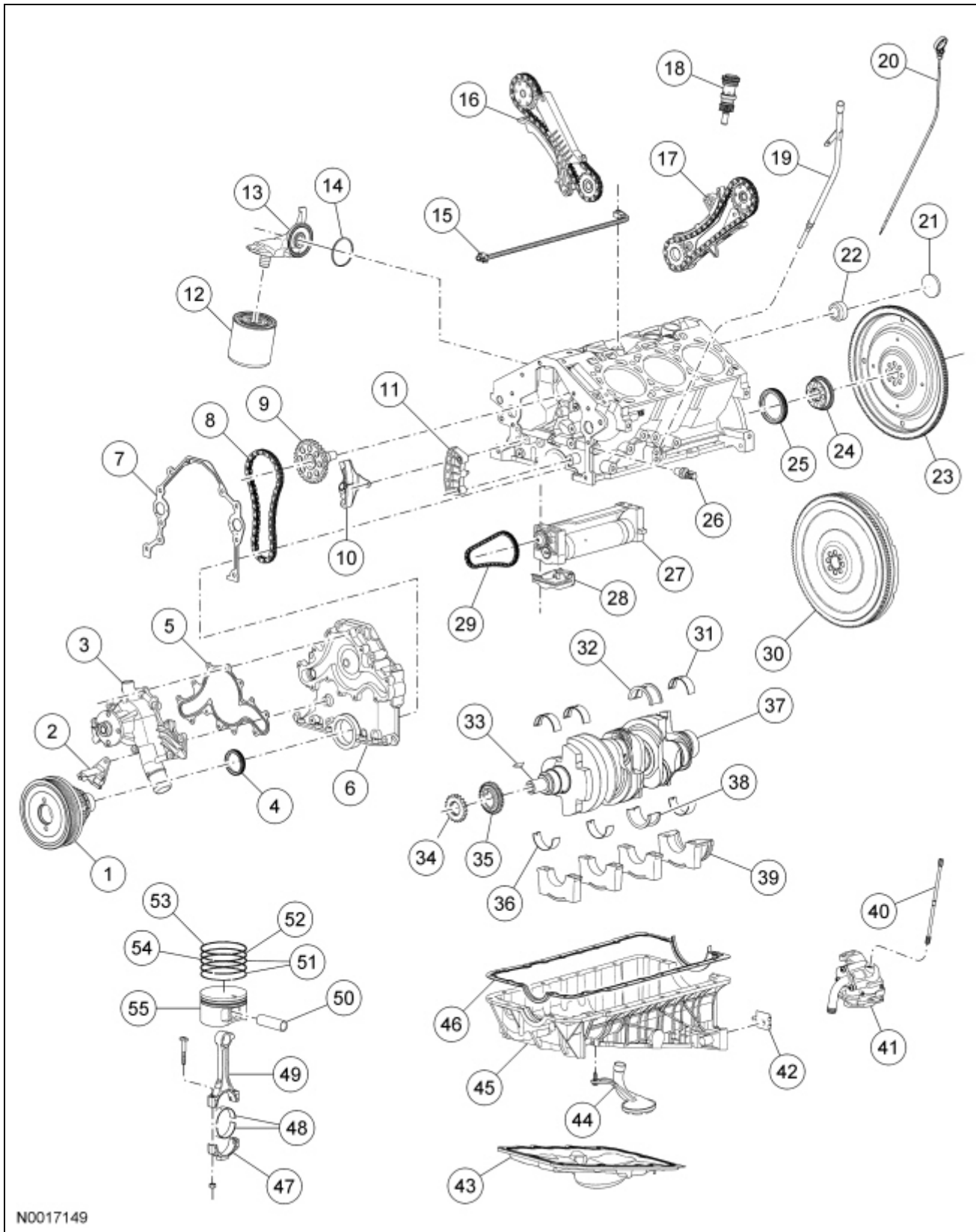


N0034712

Item	Part Number	Description
1	6582	RH valve cover
2	6769	Electric PCV valve
3	9D280	RH fuel rail
4	9F593	Fuel injector (6 required)
5	9G512	Fuel injector insert adapter (6 required)
6	6A258	RH camshaft thrust bearing cap
7	6250	RH camshaft
8	8A586	Thermostat housing
9	9E469	EGR system module tube
10	6K817	PCV tube
11	9K479	Intake manifold
12	9E498	Vacuum harness
13	9E964	Fuel supply tube
14	9G756	Fuel rail pressure and temperature sensor

15	9D280	LH fuel rail
16	6A505	LH valve cover
17	6K254	LH hydraulic chain tensioner
18	6A258	LH camshaft thrust bearing cap
19	6A258	LH camshaft bearing cap (3 required)
20	6A274	LH camshaft
21	6529	Roller follower (12 required)
22	6518	Valve spring retainer key (12 required)
23	6A536	Valve spring retainer (12 required)
24	6C501	Hydraulic lash adjuster (12 required)
25	6513	Valve spring (12 required)
26	6571	Valve stem seal (12 required)
27	9448	LH exhaust manifold gasket
28	9431	LH exhaust manifold
29	6507	Intake valve (6 required)
30	6083	LH cylinder head gasket
31	6505	Exhaust valve (6 required)
32	12405	Spark plug (6 required)
33	6049	LH cylinder head
34	6049	RH cylinder head
35	6051	RH cylinder head gasket
36	6K254	RH hydraulic chain tensioner
37	9448	RH exhaust manifold gasket
38	9430	RH exhaust manifold
39	18696	Coolant tube
40	6A258	RH camshaft bearing cap (3 required)

Lower End



N0017149

Item	Part Number	Description
1	6B321	Crankshaft pulley
2	6C315	Crankshaft Position (CKP) sensor
3	8501	Coolant pump
4	6700	Crankshaft front oil seal
5	8507	Coolant pump gasket
6	6019	Engine front cover
7	6020	Engine front cover gasket

8	6M270	Jackshaft chain
9	6M264	Jackshaft chain sprocket
10	6M271	Jackshaft chain tensioner
11	6M272	Jackshaft chain guide
12	6714	Oil filter
13	6884	Oil filter adapter
14	6L621	Oil filter adapter O-ring seal
15	12A699	Knock Sensor (KS)
16	6M290	RH camshaft drive cassette
17	6M289	LH camshaft drive cassette
18	6846	Oil pump drive assembly
19	6754	Oil level indicator tube
20	6750	Oil level indicator
21	6M296	Jackshaft seal
22	6M052	Jackshaft plug
23	6375	Flexplate
24	6434	Flexplate-to-crankshaft spacer
25	6701	Crankshaft rear oil seal
26	9278	Oil pressure sensor
27	6A311	Balance shaft (if equipped)
28	6K355	Balance shaft chain tensioner (if equipped)
29	6A364	Balance shaft chain (if equipped)
30	6375	Flywheel (manual transmission only)
31	6333	Crankshaft main bearing (3 required)
32	6337	Crankshaft main bearing cap
33	W702979	Woodruff key
34	6306	Jackshaft chain sprocket
35	6K350	Balance shaft chain sprocket (if equipped)
36	6A338	Crankshaft main bearing (3 required)
37	6303	Crankshaft
38	6A339	Crankshaft main bearing cap
39	6325	Crankshaft main thrust bearing
40	6A605	Oil pump drive shaft
41	6621	Oil pump
42	6C629	Shim (2 required)
43	6675	Oil pan
44	6617	Oil pump screen and pickup tube
45	6F092	Cylinder block cradle
46	6710	Cylinder block cradle gasket
47	6210	Connecting rod cap
48	6211	Connecting rod bearings
49	6200	Connecting rod
50	6135	Piston pin
51	6159	Oil control rings

	6152	Lower compression ring
53	6150	Upper compression ring
54	6161	Oil control ring spacer
55	6110	Piston

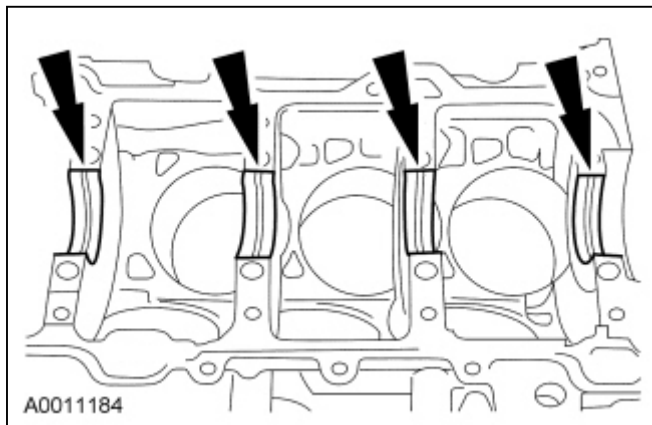
All vehicles

NOTICE: If used as a leverage device, the fuel rail may be damaged. Care must be taken when working around the fuel rail.

NOTE: During engine assembly it may be necessary to check the bearing clearances and crankshaft end play. For additional information, refer to [Section 303-00](#).

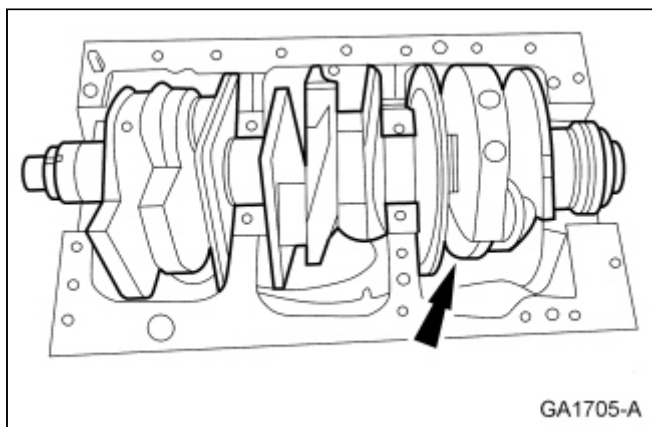
NOTE: Before engine assembly, use silicone gasket remover and metal surface prep and a suitable plastic or wooden scraper to clean the sealing surfaces. Follow the directions on the packaging. All sealing surfaces must be clean. Make sure coolant and oil passages are clear.

1. Install the crankshaft main bearings and the thrust bearing.
 - Lubricate the crankshaft main bearings with clean engine oil.



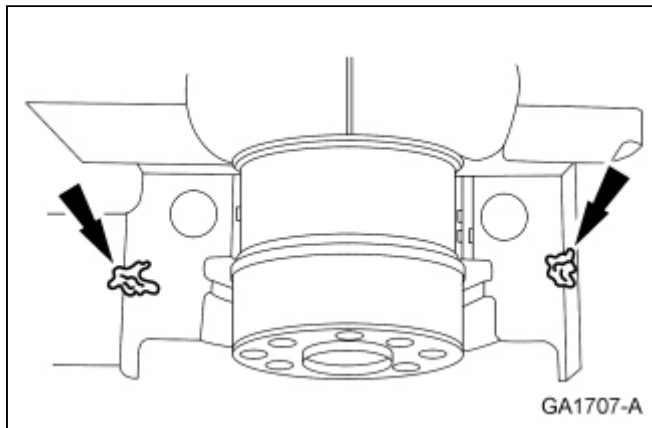
2. Install the lower main bearings in the bearing caps.
3. **NOTE:** The crankshaft main bearings are precision selective fit. Inspect the bearing clearance. For additional information, refer to [Section 303-00](#).

Install the crankshaft.

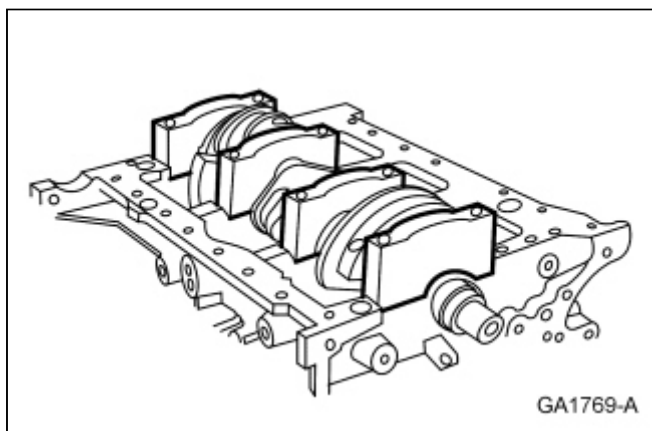


4. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use silicone gasket remover and metal surface prep. Follow the directions on the packaging. Failure to follow this procedure can cause future oil leakage.

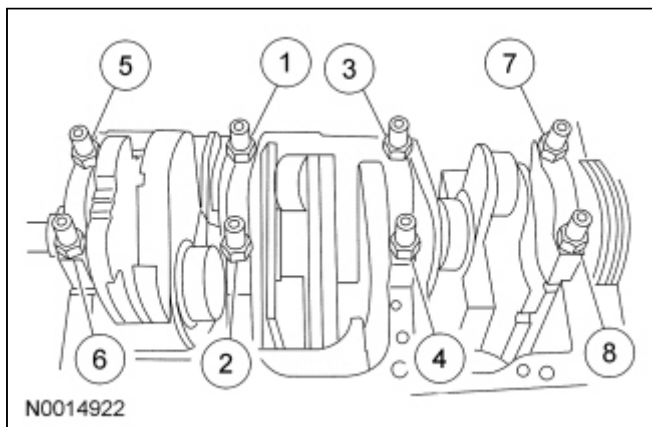
Apply silicone gasket and sealant to the rear main bearing cap to cylinder block parting line.



5. Install the 4 main bearing caps in the same position from which they were removed.



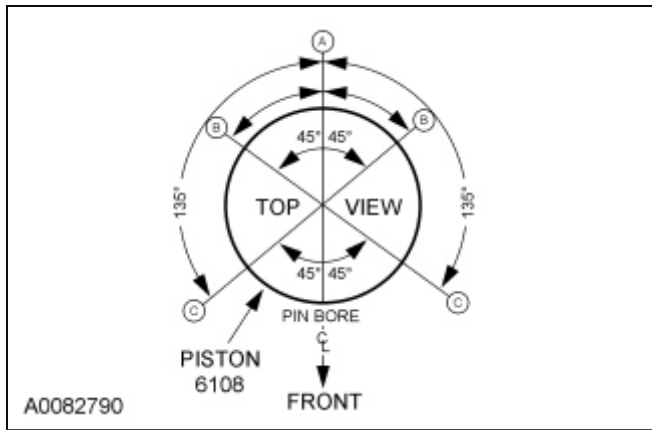
6. Tighten the 8 bolts in the sequence shown in 2 stages.
- Stage 1: Tighten to 35 Nm (26 lb-ft).
 - Stage 2: Tighten an additional 57 degrees.



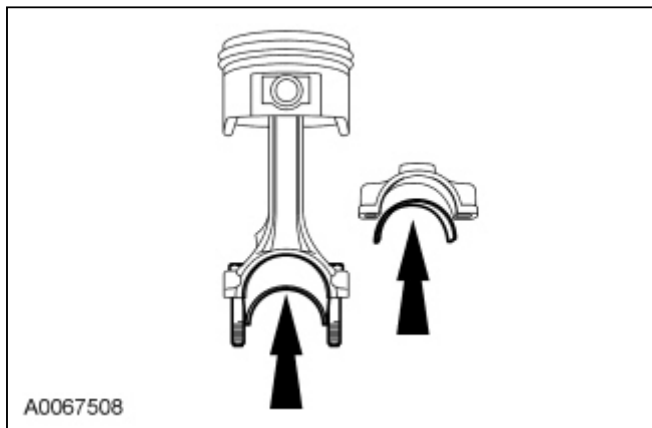
7. Check the piston to cylinder bore and ring clearance. For additional information, refer to [Section 303-00](#).
8. **NOTE:** Lubricate the piston rings with clean engine oil.

Install the piston rings.

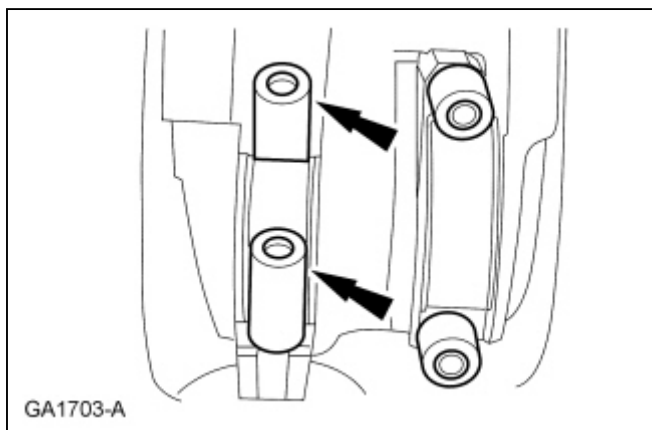
9. Make sure the ring gaps (oil spacer-A, oil ring-B, compression ring-C) are correctly spaced around the circumference of the piston.



10. Install the connecting rod bearings.



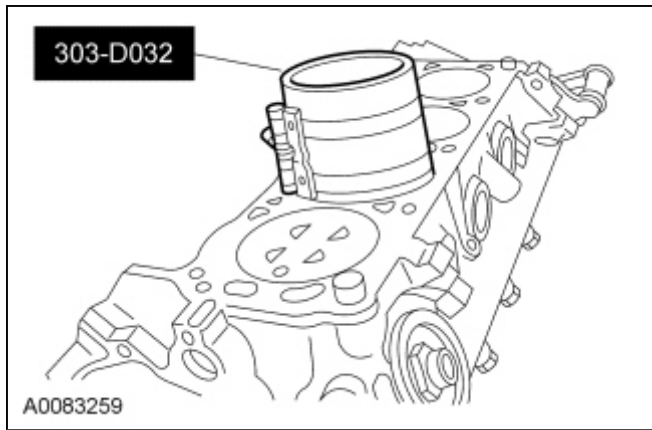
11. Install rubber hose pieces on the connecting rod bolts to protect the crankshaft.



12. **NOTE:** Position the piston with the indentation arrow toward the front of the cylinder block.

Using the Piston Ring Compressor, install the pistons.

- Rotate the crankshaft as necessary.

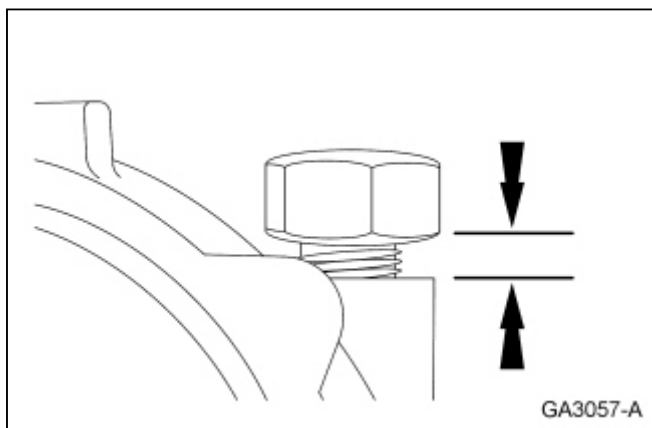


13. **NOTE:** The old nuts and bolts are used for checking clearances. New nuts and bolts must be used for reassembly.

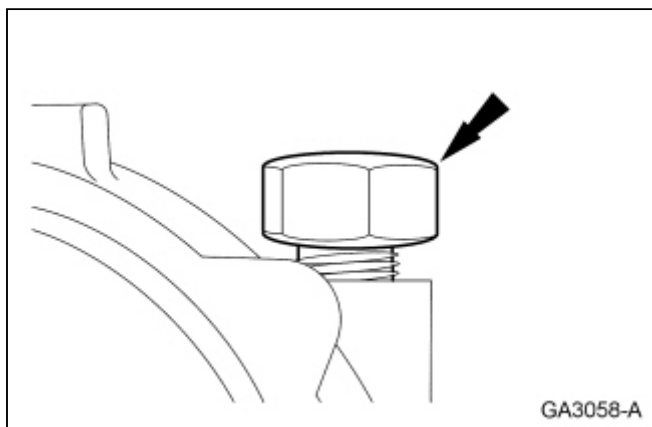
Check the clearance of each connecting rod bearing. For additional information, refer to [Section 303-00](#).

14. Rotate the crankshaft until the piston is at the bottom of its stroke.
15. **NOTE:** For cylinders 1, 2 and 3, remove the connecting rod nut at the oil split hole side first. For cylinders 4, 5 and 6, remove the opposite nut first.

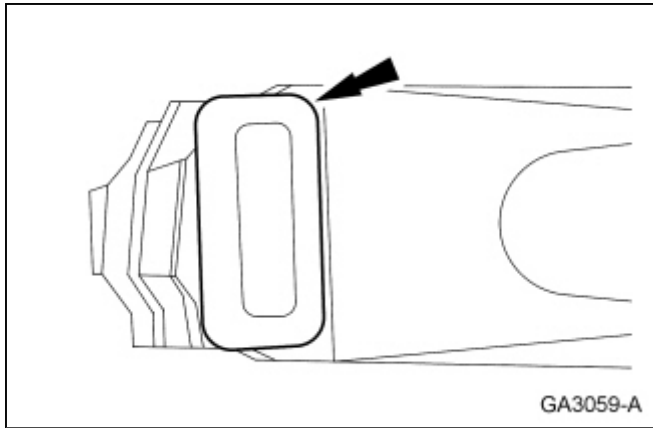
Loosen the first nut until the face is approximately 2 mm (0.08 in) over the end of the bolt.



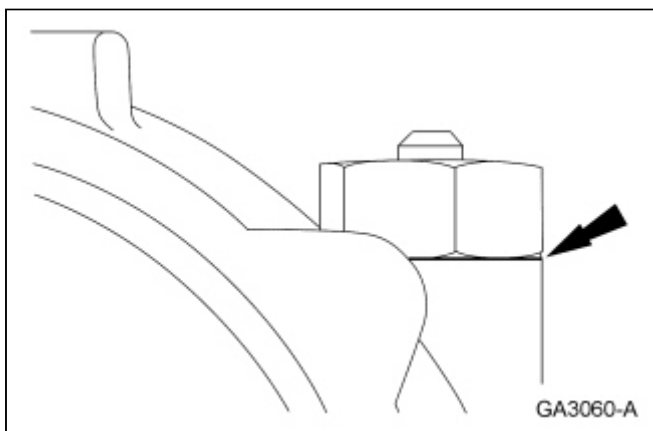
16. Tap on the nut until the bolt can be removed by hand.



17. Repeat the previous 2 steps for the opposite bolt.
18. Install the 2 new bolts, making certain that the bolt head is parallel to the sideward face of the connecting rod.



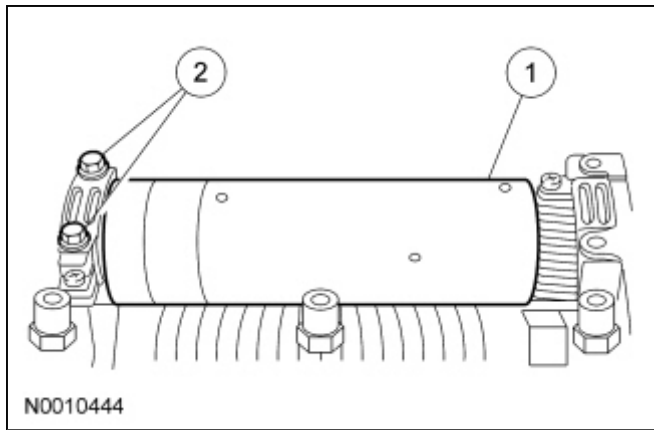
19. Install the connecting rod cap in the original position.
20. Install and tighten the 2 connecting rod nuts finger-tight.



21. Tighten the 2 connecting rod nuts in 2 stages.
 - Stage 1: Tighten to 20 Nm (177 lb-in).
 - Stage 2: Tighten an additional 90 degrees.
22. Repeat the previous 4 steps for the remaining connecting rods.
23. Rotate the crankshaft until the No. 1 piston is at Top Dead Center (TDC).

Vehicles equipped with a balance shaft

24. Install the balance shaft.
 1. Install the balance shaft assembly.
 2. Install the 2 bolts and tighten them in 2 stages.
 - Stage 1: Tighten to 15 Nm (133 lb-in).
 - Stage 2: Tighten an additional 90 degrees.

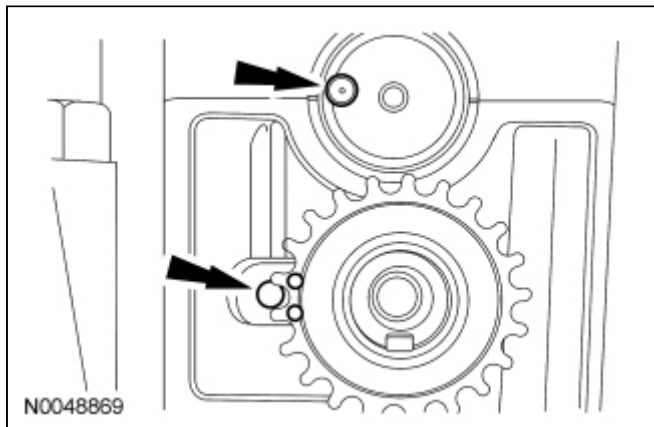


Early build vehicles equipped with a balance shaft

25. **NOTE:** Due to the gear ratio between the reversal shaft and the balance shaft, up to 7 complete turns of the balance shaft may be required to find the correct position.

Align the timing marks.

- Install a 4 mm (0.16 in) pin to hold the shaft in place.

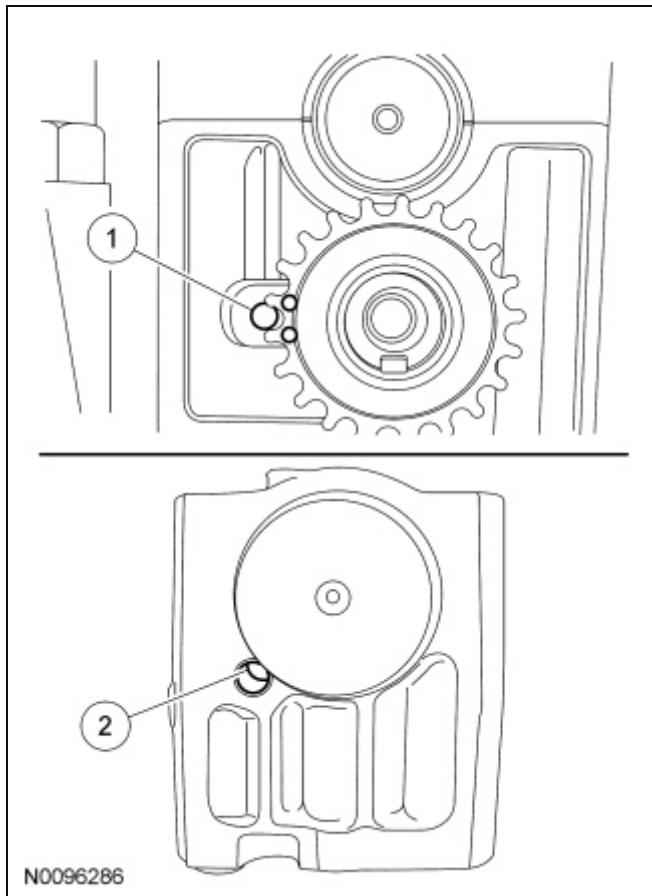


Late build vehicles equipped with a balance shaft

26. **NOTE:** Due to the gear ratio between the reversal shaft and the balance shaft, up to 7 complete turns of the balance shaft may be required to find the correct position.

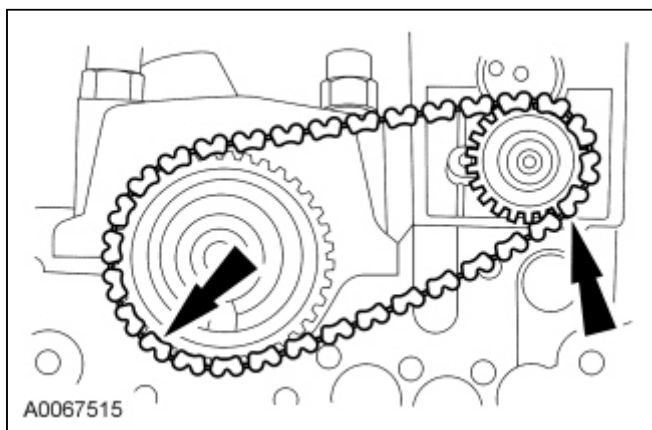
Align the timing marks.

1. Align the front balance shaft gear alignment marks with the hole in the balance shaft housing.
2. From the rear of the balance shaft, make sure the balance shaft gear alignment mark is visible through the hole in the balance shaft housing.

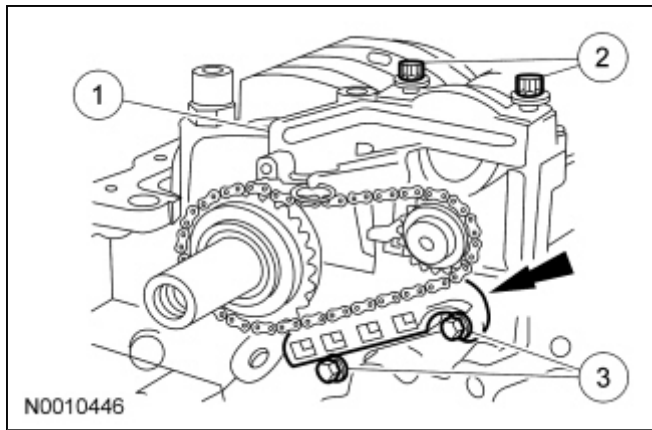


Vehicles equipped with a balance shaft

27. Install the balance shaft chain and crankshaft sprocket.

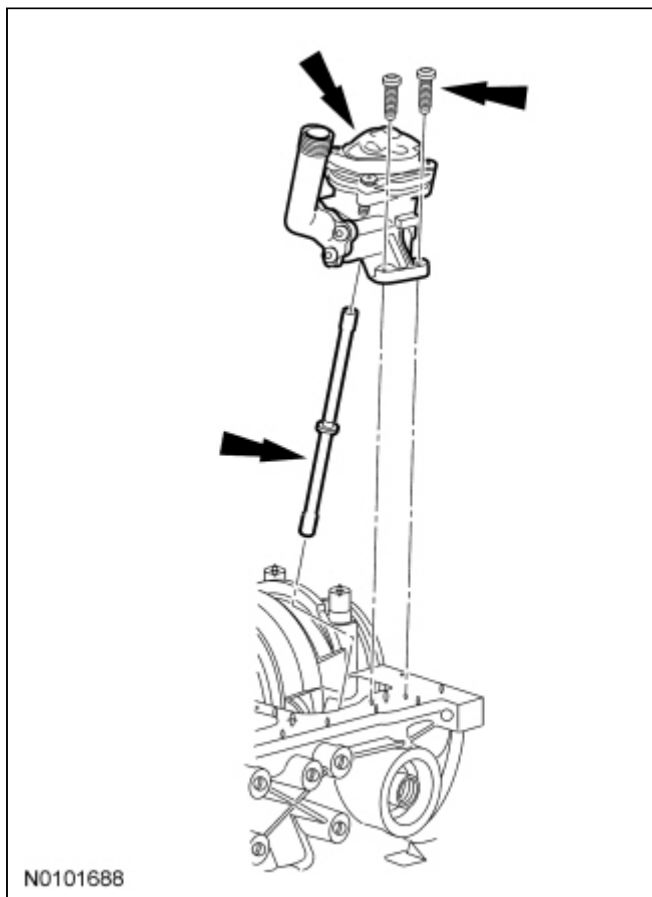


28. Install the balance shaft tensioner and chain guide.
 1. Install the balance shaft tensioner.
 2. Install the 2 bolts and tighten to 29 Nm (21 lb-ft).
 3. Position the balance shaft chain guide, install the 2 bolts and tighten to 10 Nm (89 lb-in).
 - Remove the pins from the tensioner and, if installed, the sprocket.

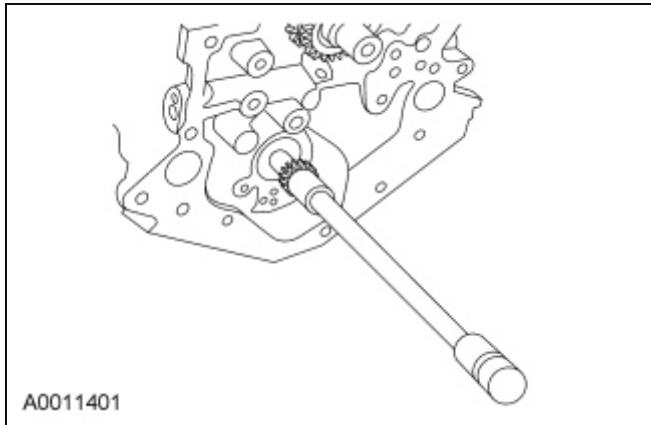


All vehicles

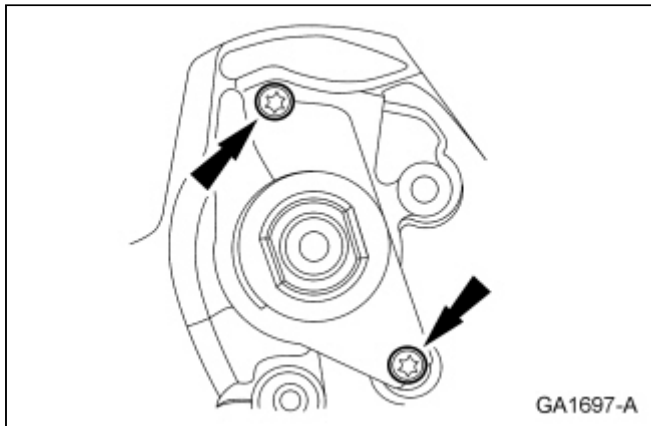
29. Install the oil pump intermediate shaft, the oil pump and the 2 bolts.
 - Tighten to 19 Nm (168 lb-in).



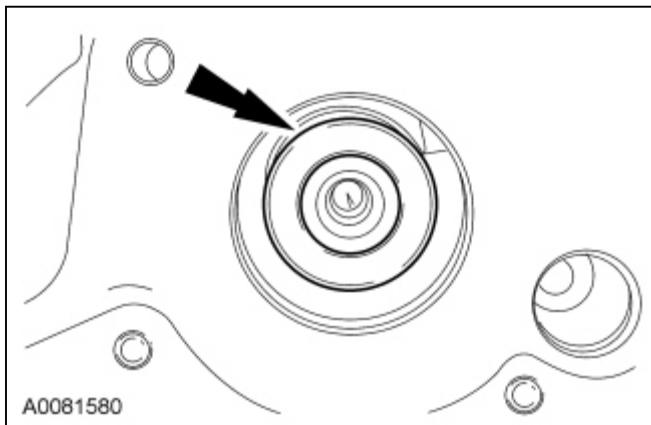
30. Install the jackshaft.



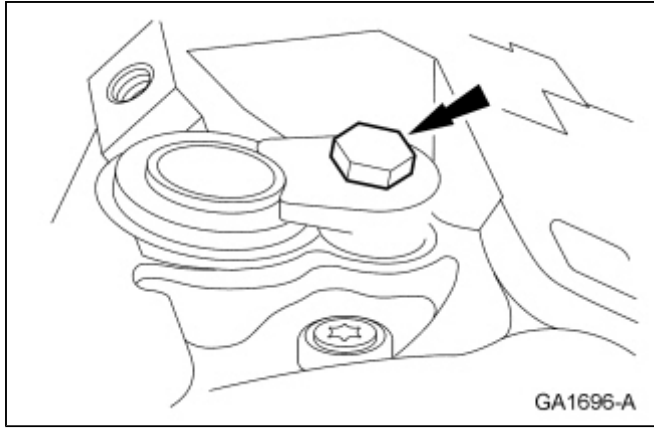
31. Install the jackshaft thrust plate and bolts.
- Tighten to 11 Nm (97 lb-in).



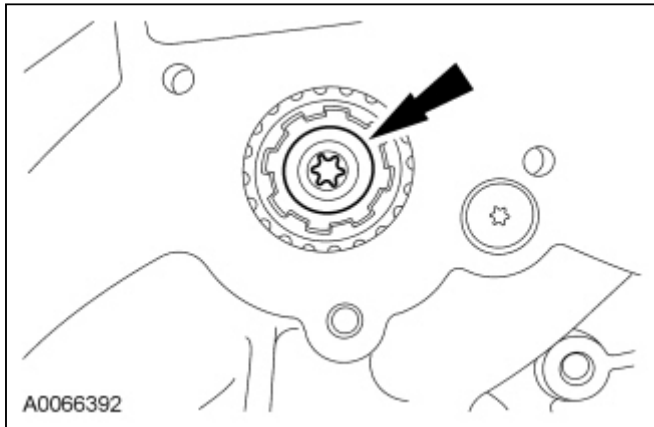
32. Install the jackshaft spacer.



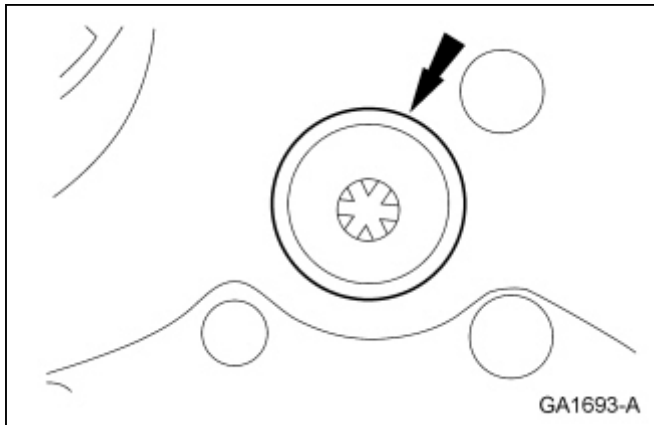
33. Install the oil pump drive and the hold down.
- Tighten to 19 Nm (168 lb-in).



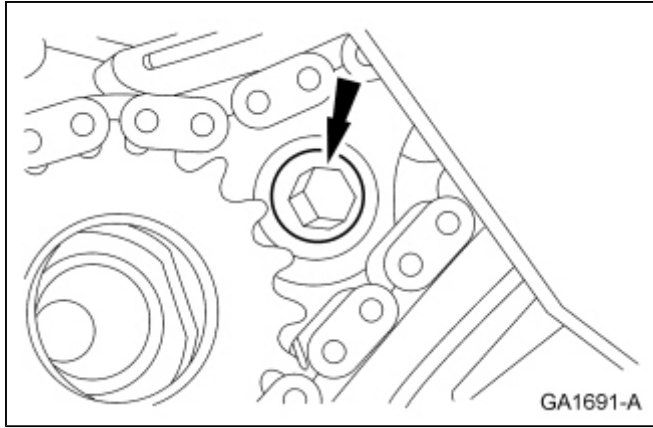
34. Position the RH camshaft drive cassette and install the sprocket bolt. Do not tighten the bolt at this time.



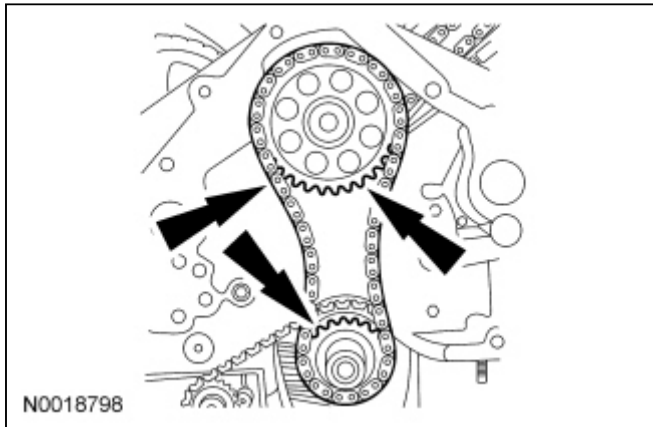
35. Install the RH drive cassette bolt and spacer.
- Tighten to 18 Nm (159 lb-in).



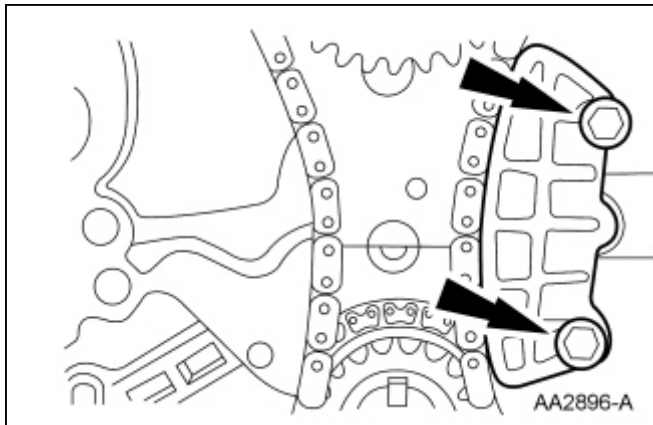
36. Install the LH cassette and the bolt.
- Tighten to 19 Nm (168 lb-in).



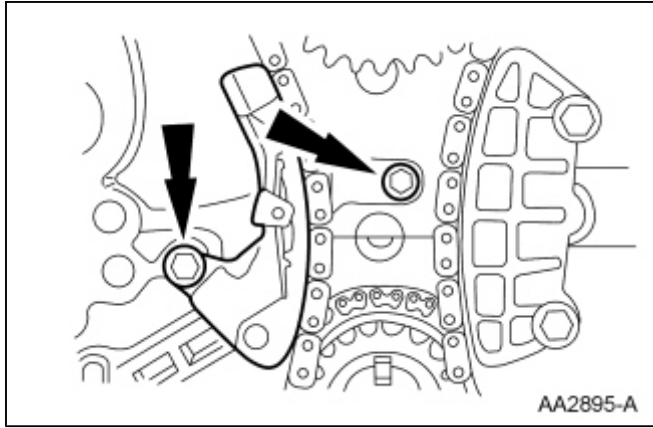
37. Install the crankshaft key. Position the jackshaft and crankshaft sprockets and the chain.



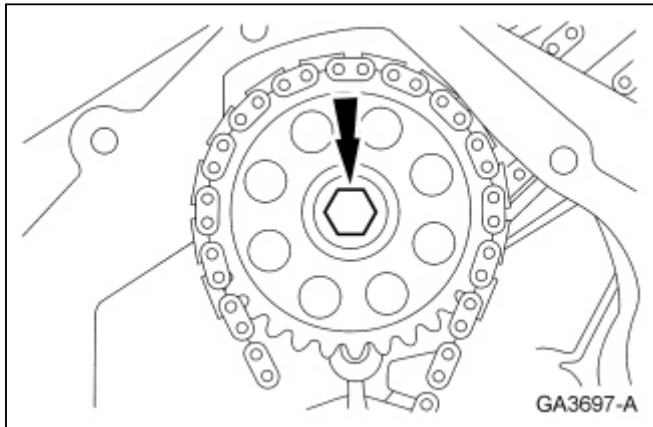
38. Install the chain guide and the 2 bolts.
- Tighten to 19 Nm (168 lb-in).



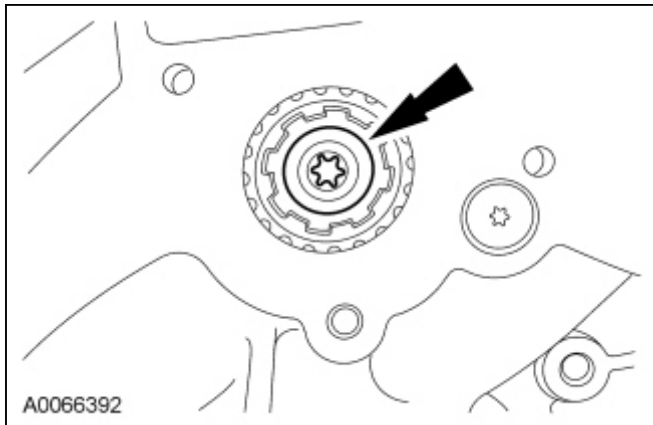
39. Install the chain tensioner and the 2 bolts.
- Tighten to 9 Nm (80 lb-in).



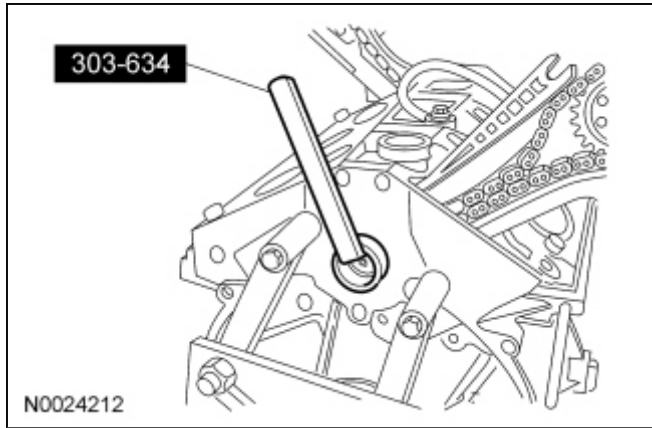
40. Install the jackshaft sprocket bolt. Do not tighten the bolt at this time.



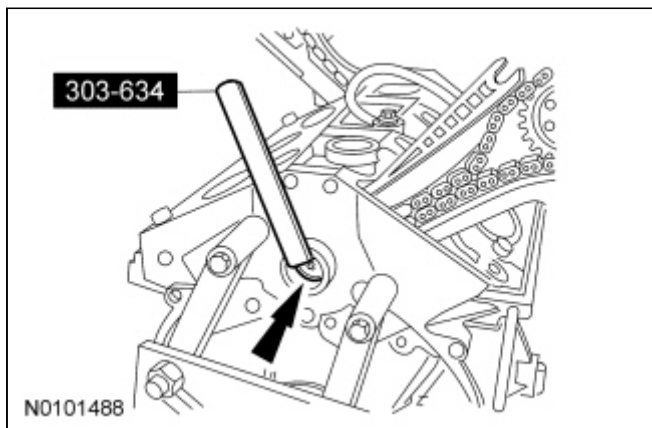
41. While holding the front jackshaft sprocket bolt secure, tighten the rear bolt.
• Tighten to 20 Nm (177 lb-in).



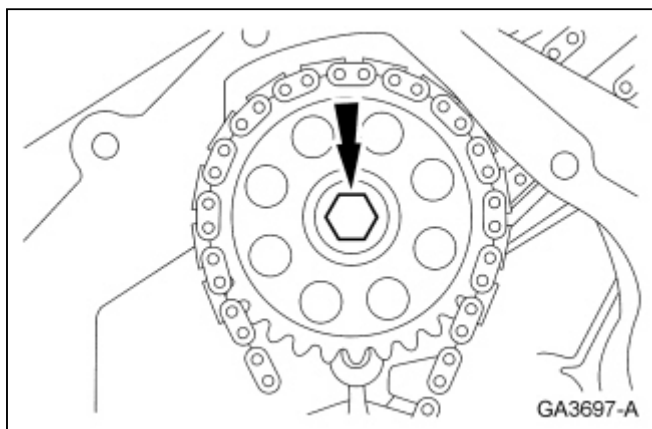
42. Install the Rear Jack Shaft Socket on the rear of the jackshaft.



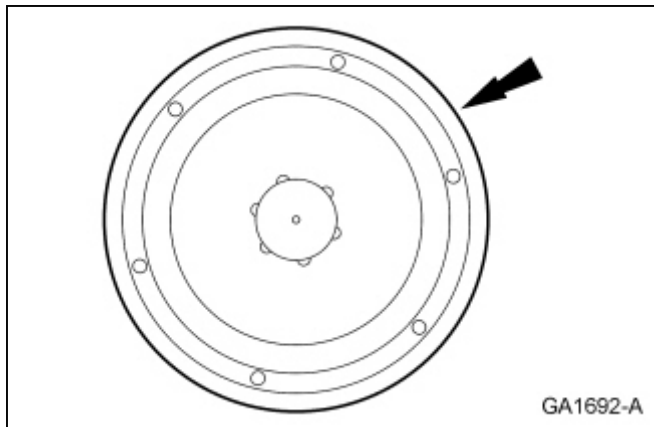
43. Using the Rear Jack Shaft Socket to hold the jackshaft, tighten the rear jackshaft bolt an additional 90 degrees.



44. Using the Rear Jack Shaft Socket to hold the jackshaft, tighten the front sprocket bolt in 2 stages.
- Tighten to 45 Nm (33 lb-ft).
 - Tighten an additional 90 degrees.

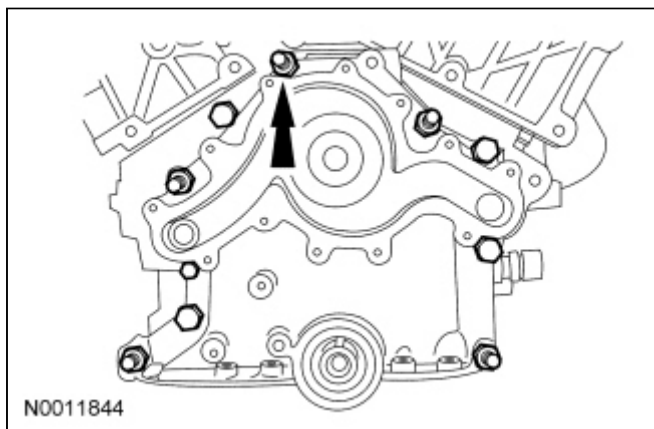


45. Remove the Rear Jack Shaft Sprocket and install the rear jackshaft plug.

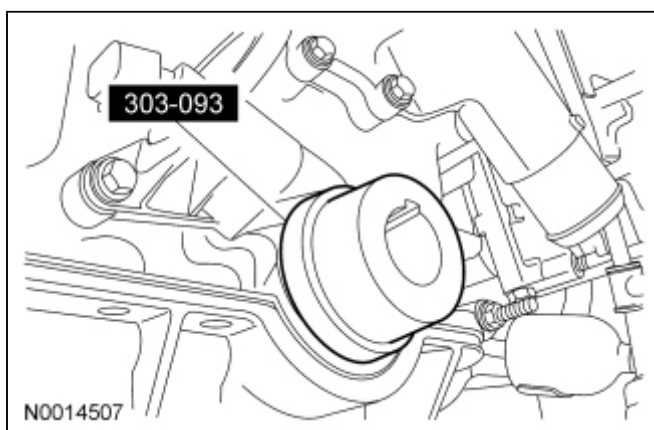


46. Position a new engine front cover gasket on the cylinder block.
47. **NOTE:** Apply thread sealant to the stud bolts and make sure that the stud bolts are installed in their original positions.

Position the front cover and loosely install the 5 bolts and the 5 stud bolts.

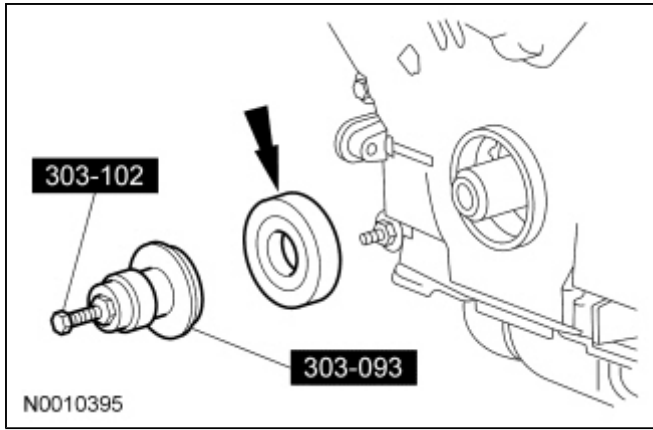


48. Install the Front Cover Aligner and tighten the 5 bolts and 5 stud bolts.
 - Tighten to 19 Nm (168 lb-in).



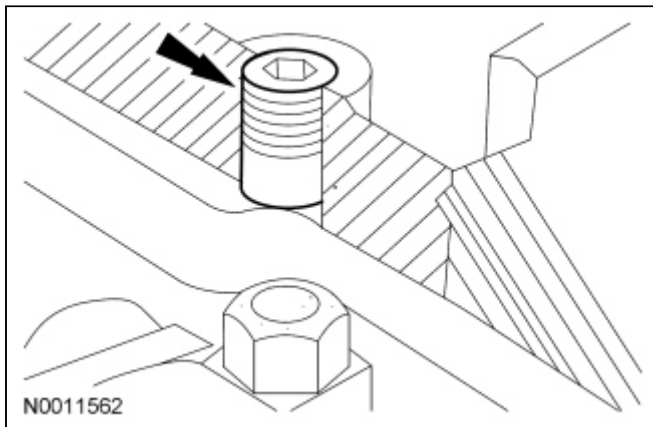
49. **NOTE:** Lubricate the seal lip with clean engine oil.

Using the Front Cover Aligner and the Crankshaft Vibration Damper Installer, install the crankshaft front oil seal.



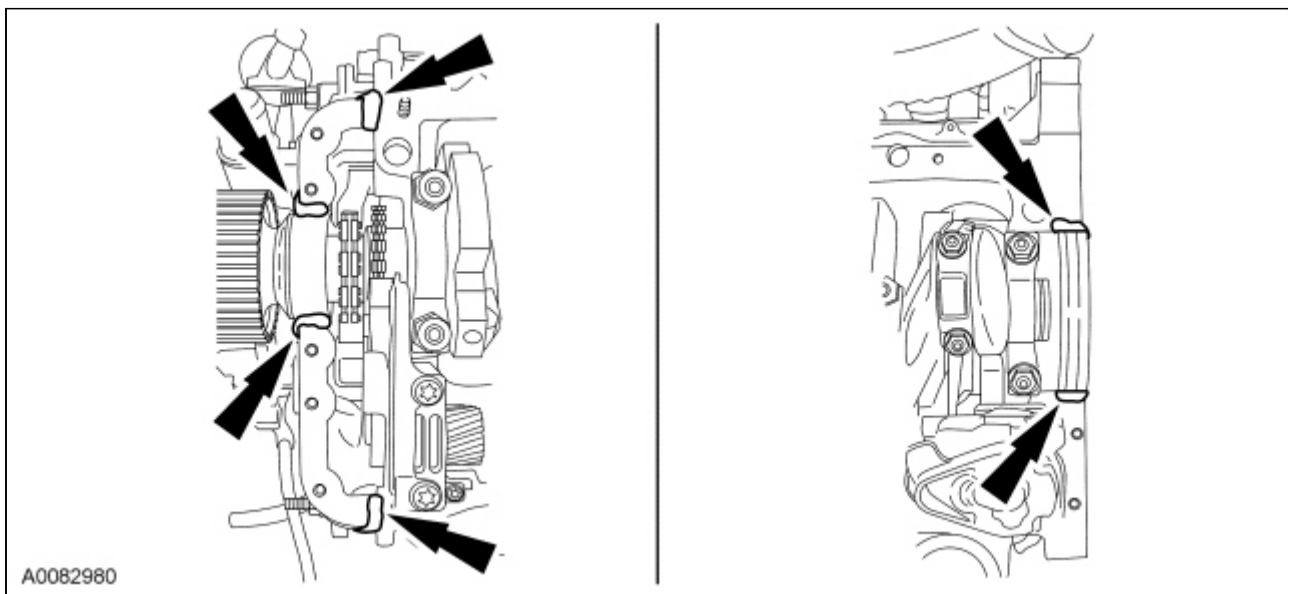
50. **NOTICE:** The cylinder block cradle inserts must be loosened completely or damage to the cylinder block cradle or oil leaks can result.

Loosen the 8 cylinder block cradle inserts.

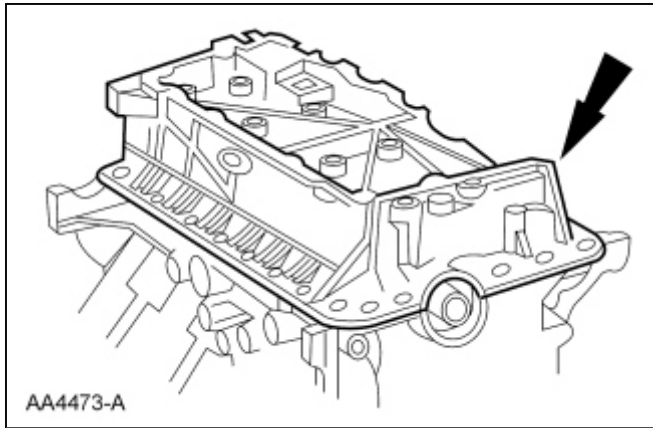


51. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use silicone gasket remover and metal surface prep. Follow the directions on the packaging. Failure to follow this procedure can cause future oil leakage.

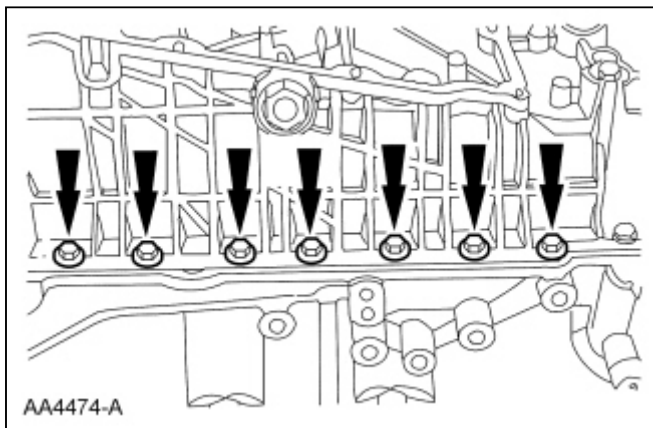
Apply silicone gasket and sealant in the 6 places shown.



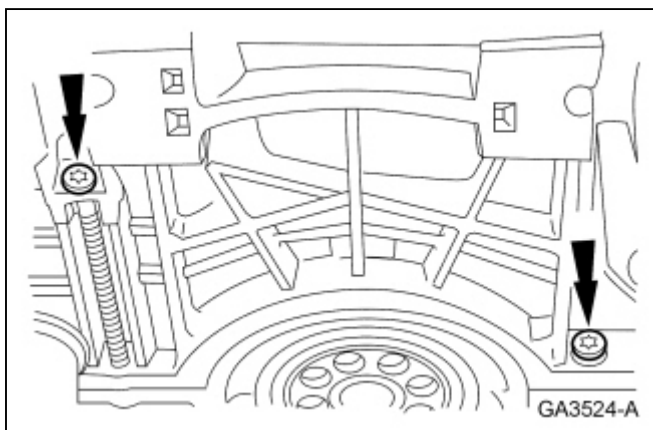
52. Position the cylinder block cradle and a new gasket assembly.



53. Install and finger-tighten the 20 bolts and 2 nuts.

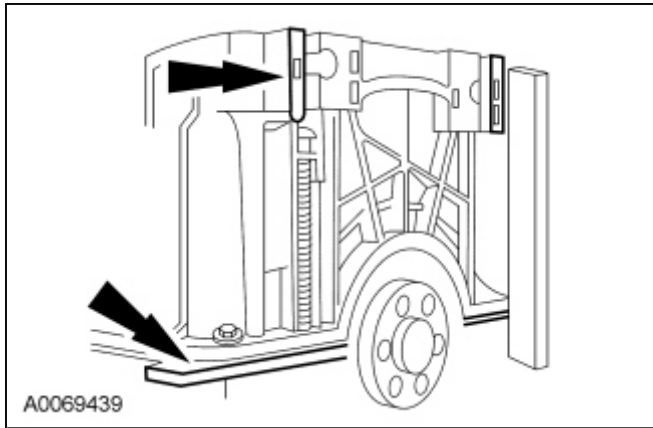


54. Install and finger-tighten the 2 Torx bolts.

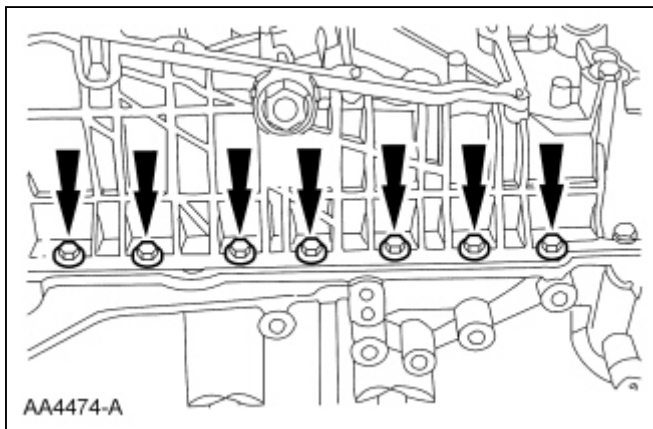


55. **NOTE:** The cylinder block cradle to the cylinder block alignment must be within a maximum mismatch of 0.25 mm (0.01 in) cylinder block cradle underflush or 0.05 mm (0.00196 in) cylinder block cradle protrusion.

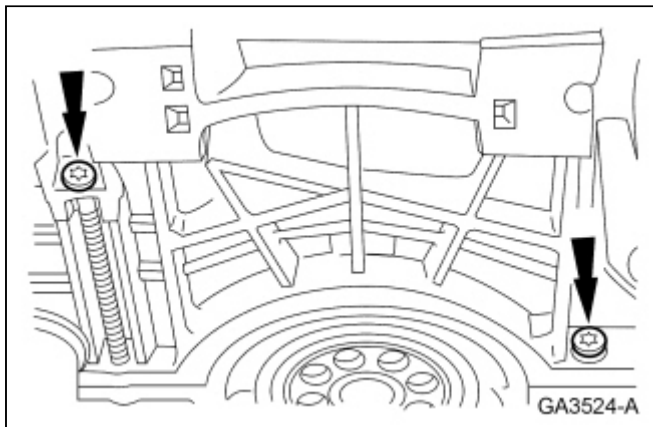
Using a straightedge, align the transmission face of the cylinder block cradle with the rear face of the cylinder block.



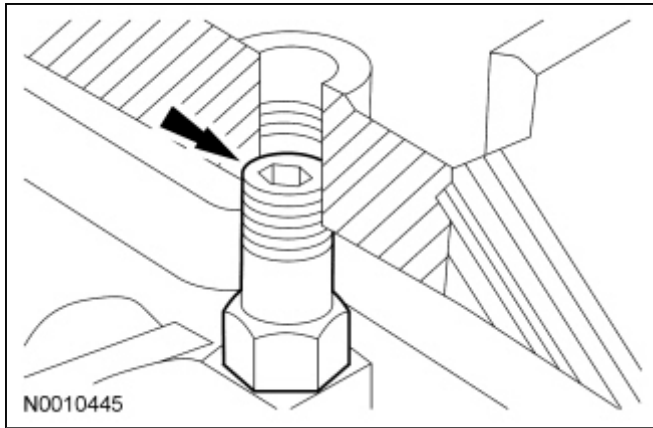
56. Tighten the 20 bolts and the 2 nuts.
- Tighten the nuts to 10 Nm (89 lb-in).
 - Tighten the bolts to 14 Nm (124 lb-in).



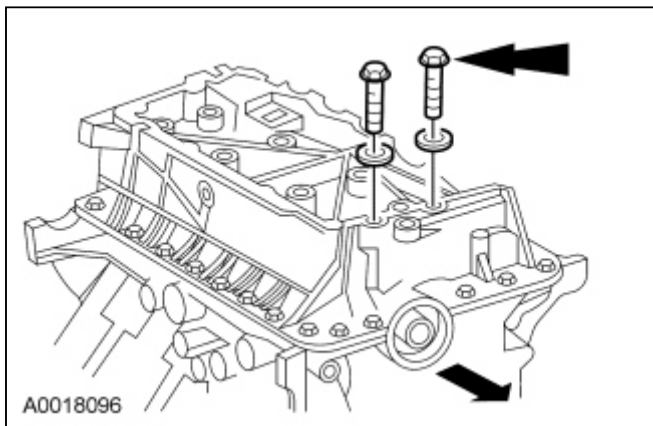
57. Tighten the Torx bolts.
- Tighten to 10 Nm (89 lb-in).



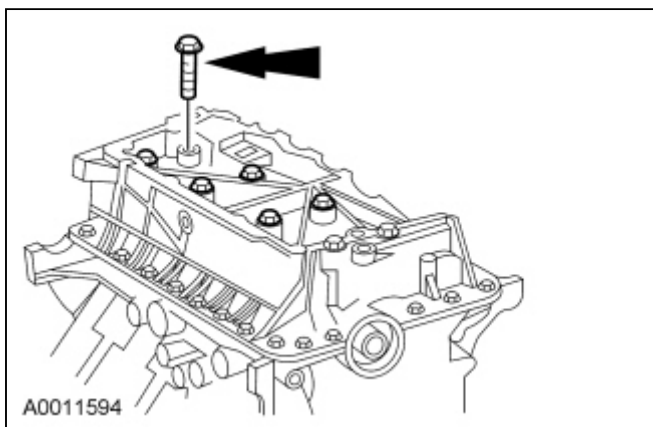
58. Tighten the 8 inserts.
- Tighten to 3 Nm (27 lb-in).



59. Install new seals on the 2 silver bolts and position them in the cylinder block cradle.

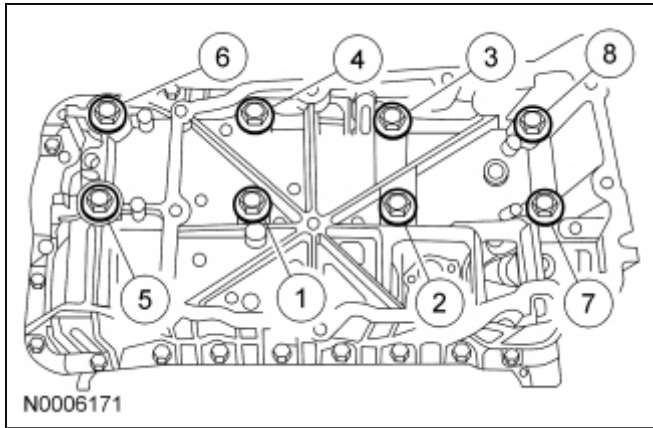


60. Position the 6 remaining bolts.



61. Tighten the 8 cylinder block cradle inner bolts in the sequence shown in 2 stages.

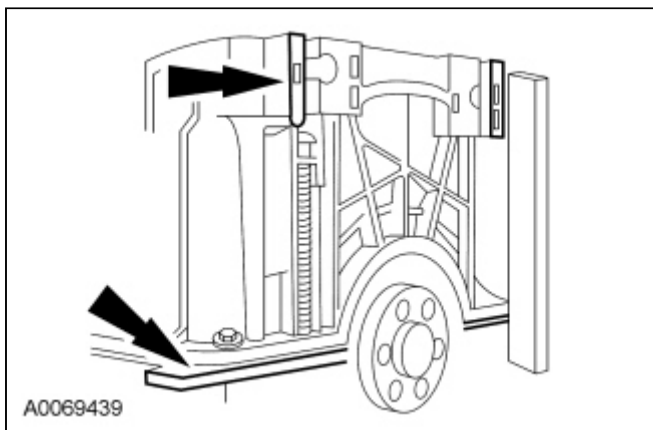
- Stage 1: Tighten to 15 Nm (133 lb-in).
- Stage 2: Tighten to 34 Nm (25 lb-ft).



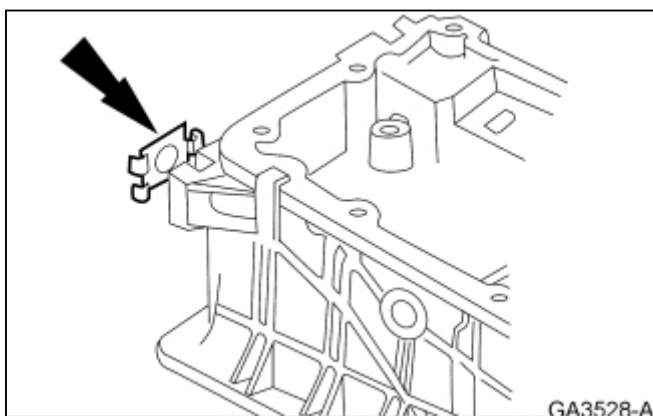
62. **NOTE:** The cylinder block cradle to the cylinder block alignment must be within a maximum mismatch of 0.25 mm (0.01 in) cylinder block cradle underflush or 0.05 mm (0.00196 in) cylinder block cradle protrusion.

Measure the step between the rear face of the cylinder block and the transmission face of the cylinder block cradle.

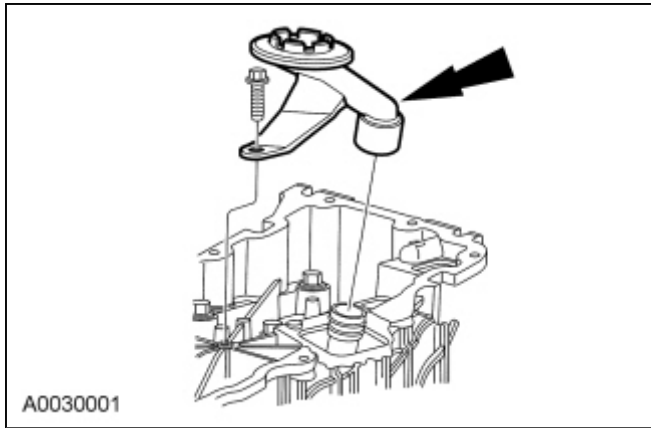
- Cradles that exceed protrusion specification must be removed and the appropriate assembly steps repeated.
- Cradles that exceed the underflush specification may be repaired by installing shims (next step).



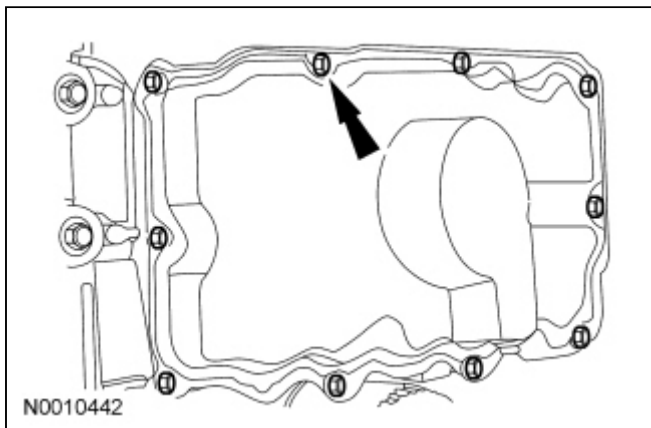
63. Repair all assemblies that exceed underflush specification by installing shims on one or both sides of the cylinder block cradle.



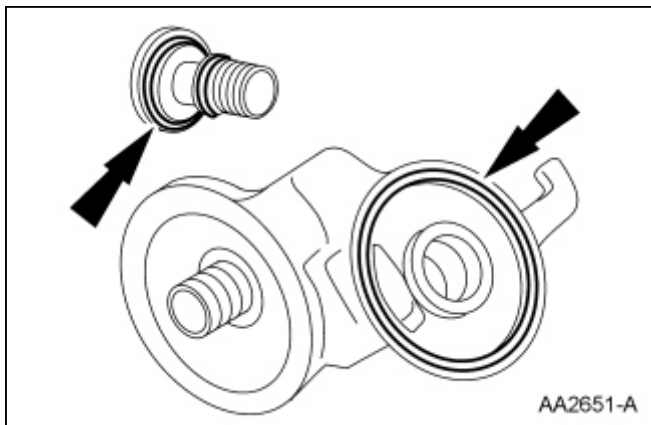
64. Install the oil pump screen cover and tube and the bolt.
- Tighten to 10 Nm (89 lb-in).



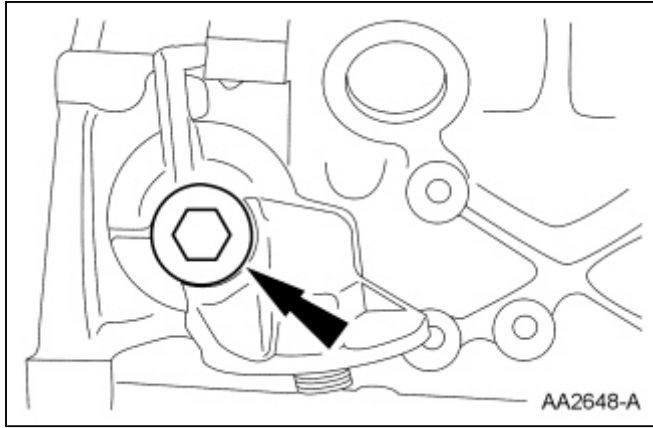
65. Install the gasket, the oil pan and the 10 bolts.
- Tighten to 11 Nm (97 lb-in).



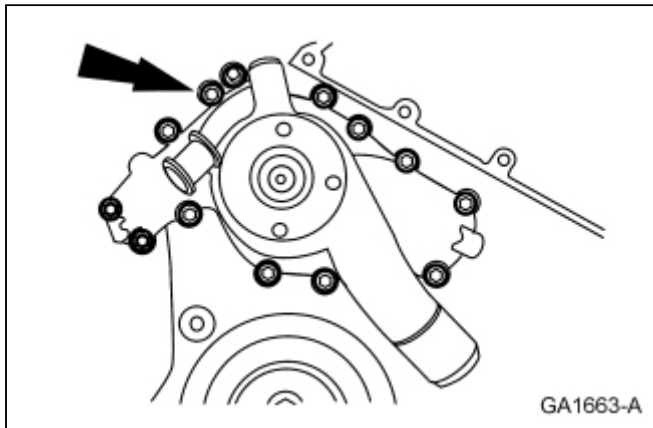
66. Inspect and install new oil filter adapter O-ring seals if necessary.



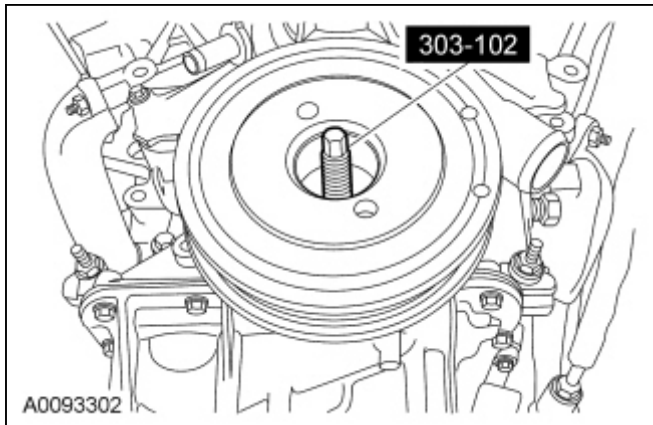
67. Install the oil filter adapter and the bolt.
- Tighten to 57 Nm (42 lb-ft).



68. Install a new gasket, the coolant pump and the 13 bolts.
- Tighten to 10 Nm (89 lb-in).



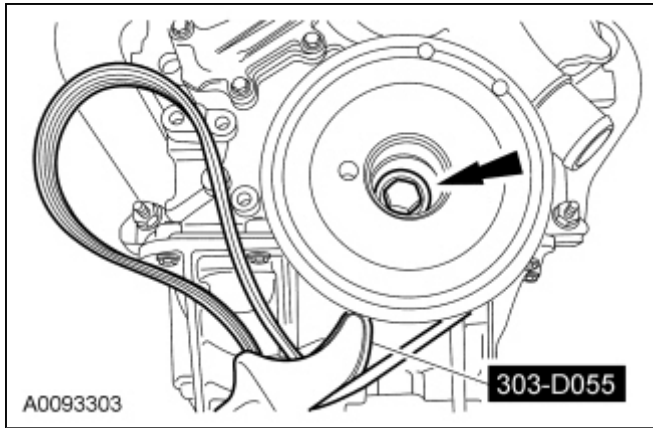
69. Using the Crankshaft Vibration Damper Installer, install the crankshaft pulley.



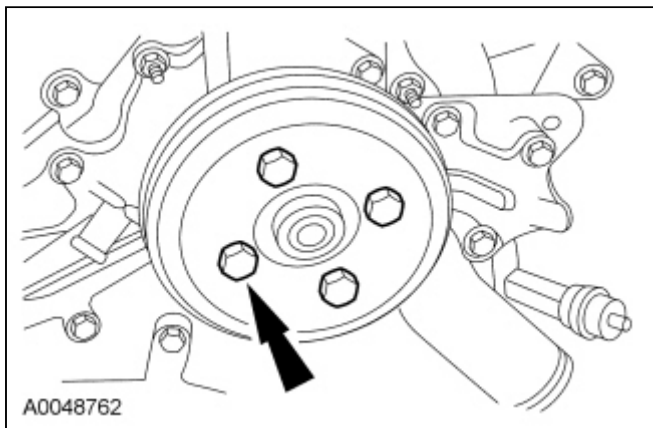
70. **NOTE:** A new bolt must be used each time it is removed.

Using the Strap Wrench, tighten the bolt in 2 stages.

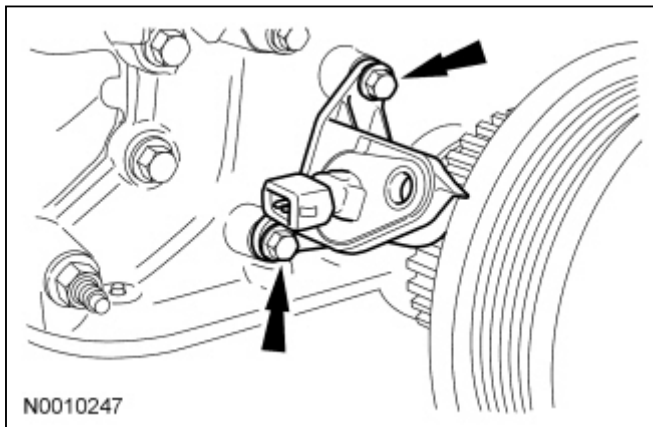
- Stage 1: Tighten to 55 Nm (41 lb-ft).
- Stage 2: Rotate an additional 85 degrees.



71. Install the coolant pump pulley and the 4 bolts.
- Tighten to 25 Nm (18 lb-ft).

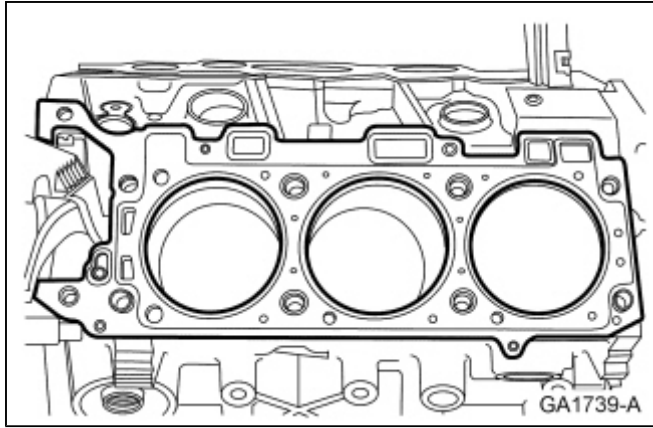


72. Position the Crankshaft Position (CKP) sensor and install the 2 bolts.
- Tighten to 10 Nm (89 lb-in).



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

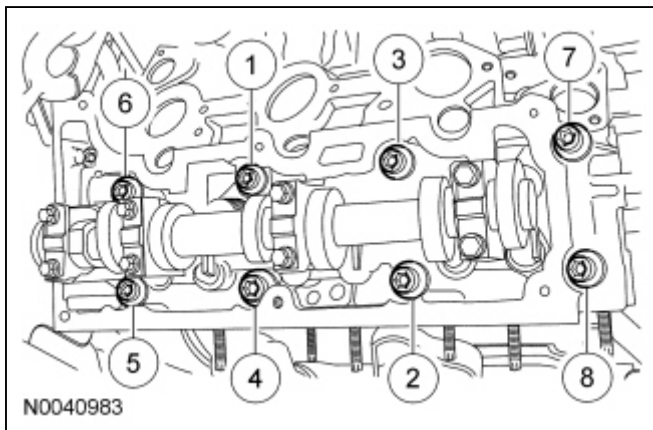
Install the cylinder head gaskets.



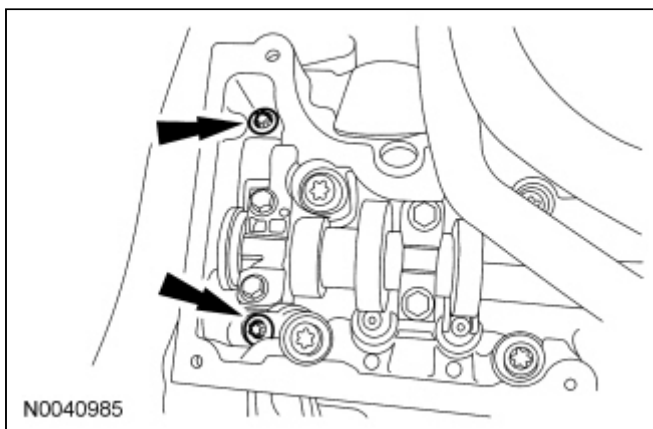
74. **NOTE:** New cylinder head bolts must be installed. They are a torque-to-yield design and cannot be reused.

Install the RH cylinder head. Install 8 new 12-mm bolts and tighten in the sequence shown in 2 stages.

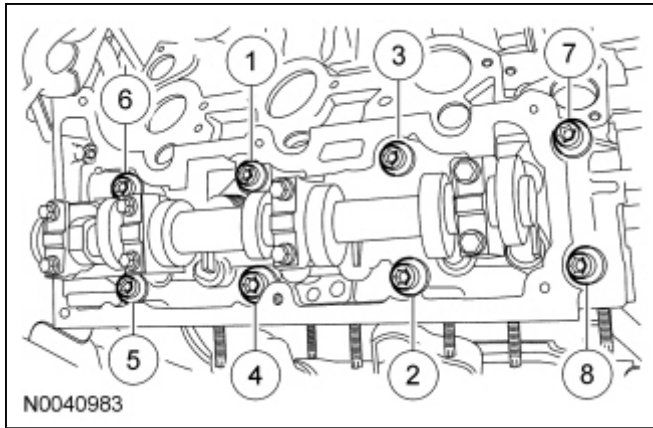
- Stage 1: Tighten to 12 Nm (106 lb-in).
- Stage 2: Tighten to 25 Nm (18 lb-ft).



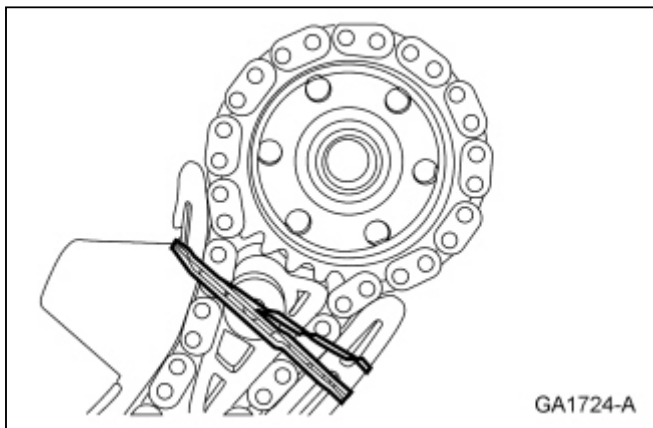
75. Install 2 new 8-mm bolts.
- Tighten to 32 Nm (24 lb-ft).



76. Tighten the 8 new 12-mm bolts in the sequence shown in 2 stages.
- Stage 1: Rotate 90 degrees.
 - Stage 2: Rotate an additional 90 degrees.



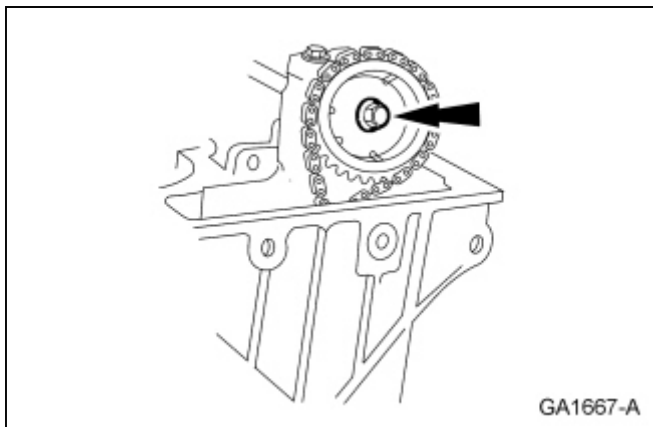
77. Position the RH camshaft sprocket.



78. **NOTICE:** The RH camshaft sprocket bolt is a LH-threaded bolt. Turning the bolt in the wrong direction can damage the bolt.

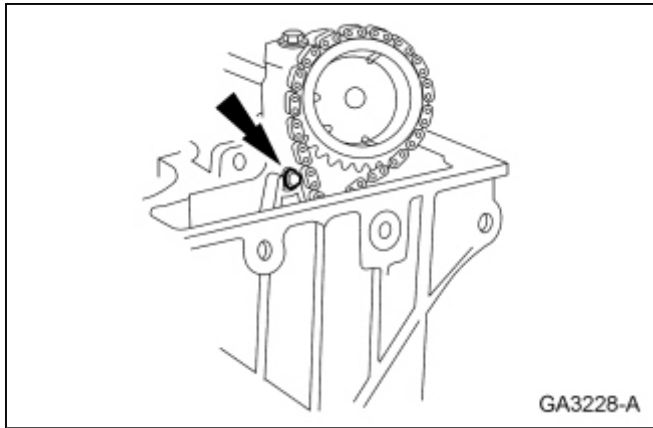
NOTE: The camshaft sprocket must turn freely on the camshaft. Do not tighten the bolt.

Loosely install the RH camshaft sprocket bolt.



79. Install the RH cassette-to-cylinder head bolt.

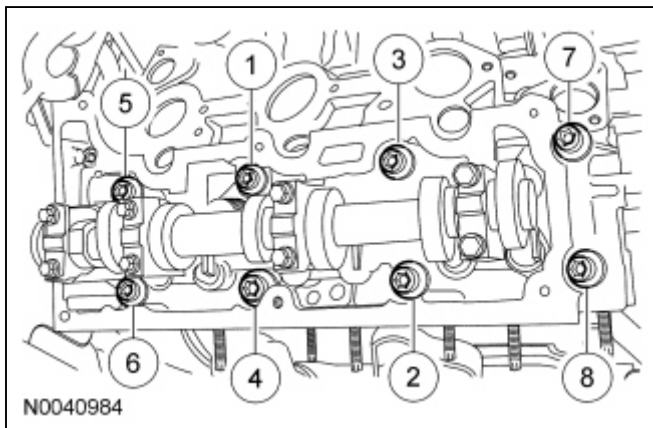
- Tighten to 10 Nm (89 lb-in).



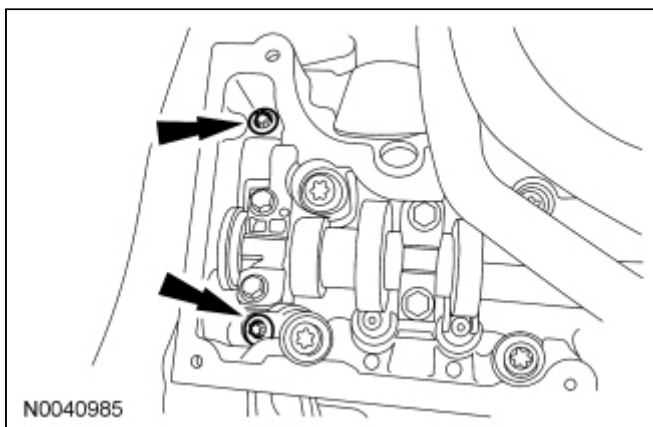
80. **NOTE:** New cylinder head bolts must be installed. They are a torque-to-yield design and cannot be reused.

Install the LH cylinder head and tighten the 8 new 12-mm bolts in the sequence shown in 2 stages.

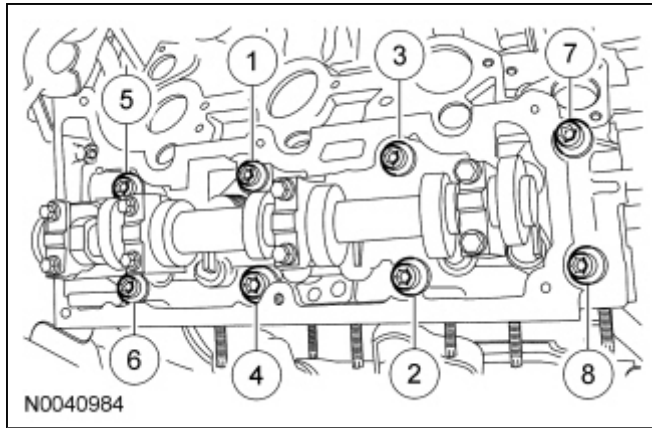
- Stage 1: Tighten to 12 Nm (106 lb-in).
- Stage 2: Tighten to 25 Nm (18 lb-ft).



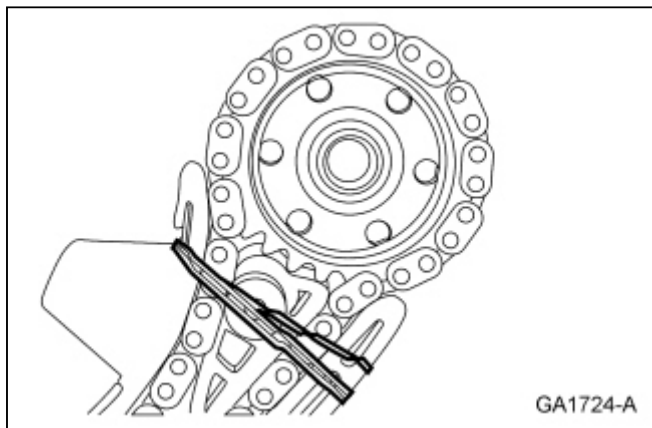
81. Install 2 new 8-mm bolts.
- Tighten to 32 Nm (24 lb-ft).



82. Tighten the 8 new 12-mm bolts in the sequence shown in 2 stages.
- Stage 1: Rotate 90 degrees.
 - Stage 2: Rotate an additional 90 degrees.

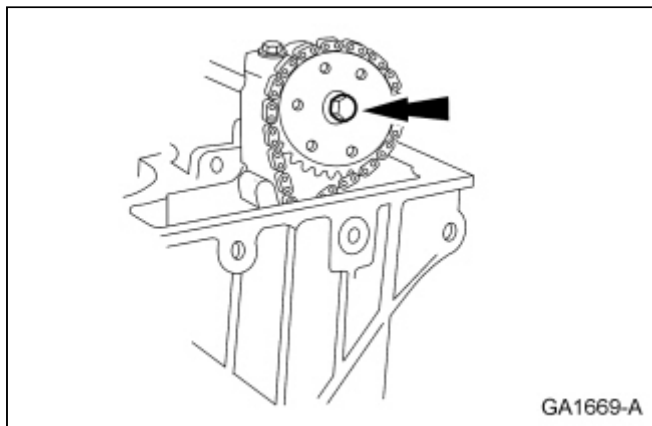


83. Position the LH camshaft sprocket.

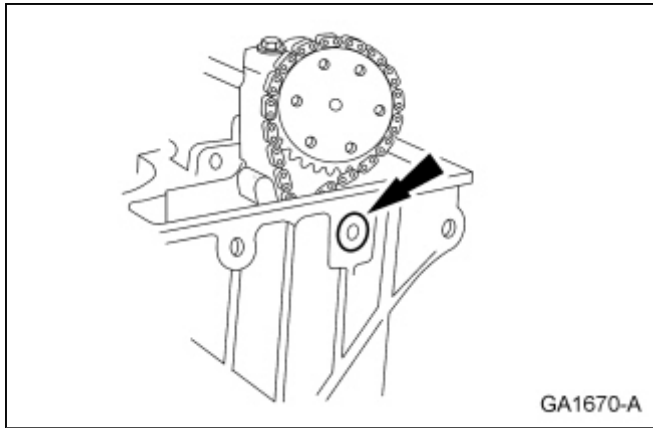


84. **NOTE:** The camshaft sprocket must turn freely on the camshaft. Do not tighten the bolt.

Loosely install the LH camshaft sprocket bolt.



85. Install the LH cassette-to-cylinder head bolt.
• Tighten to 12 Nm (106 lb-in).

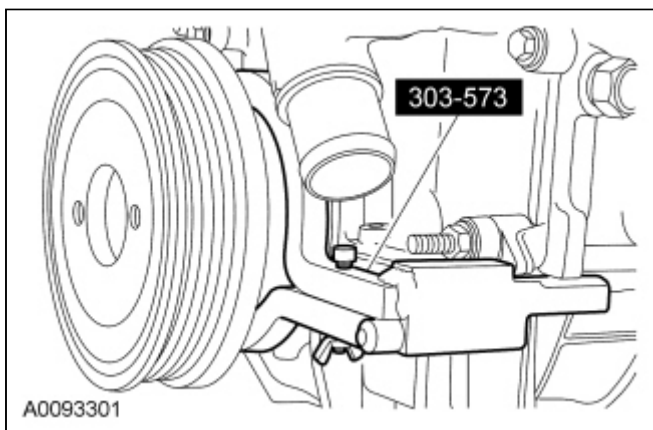


86. Turn the crankshaft one revolution clockwise.

87. **NOTICE:** Do not rotate the engine counterclockwise. Rotating the engine counterclockwise will result in incorrect timing of the engine.

NOTE: The Crankshaft TDC Timing Tool must be installed on the damper and should contact the engine block. This positions the engine at Top Dead Center (TDC).

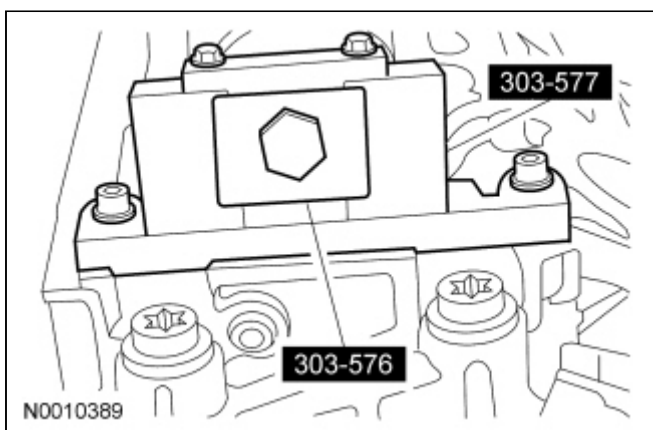
Install the Crankshaft TDC Timing Tool.



88. **NOTE:** Camshaft timing slots are off-center.

NOTE: Position the camshaft timing slots below centerline of camshaft.

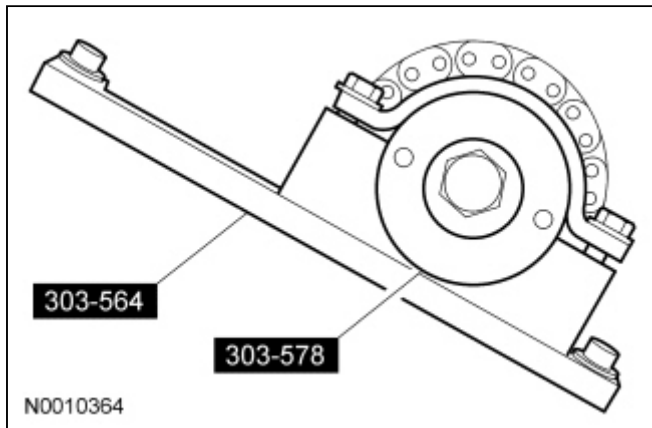
Install the Camshaft Holding Tool and the Adapter for 303-577 on the front of the RH cylinder head.



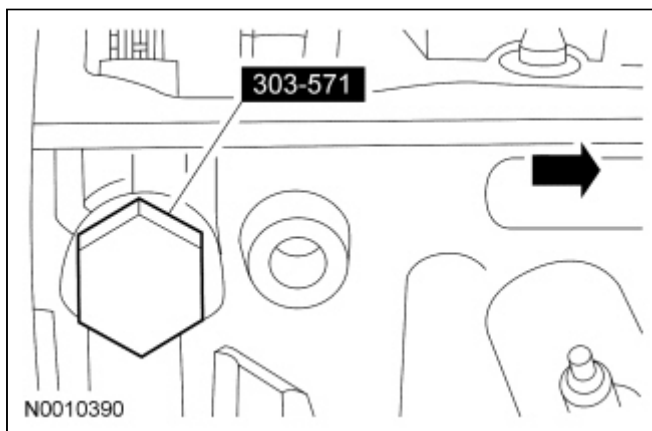
89. **NOTE:** Leave the top 2 Camshaft Sprocket Holding Tool clamp bolts loose.

Install the Camshaft Sprocket Holding Tool and the Adapter for 303-564 on the rear of the RH cylinder

head.



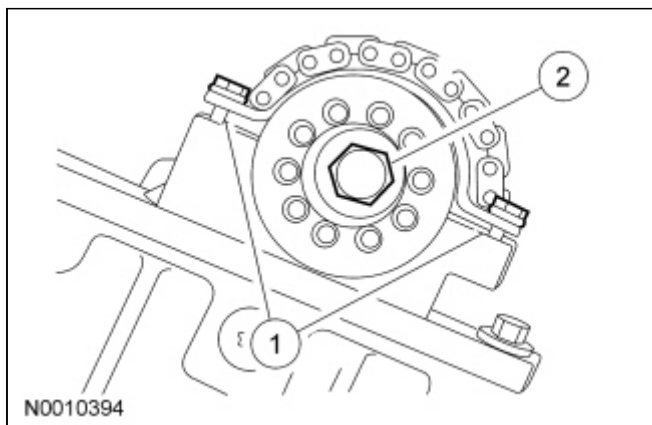
90. Install the Timing Chain Tensioner.



91. **NOTICE:** The RH camshaft sprocket bolt is a LH-threaded bolt. Turning the bolt in the wrong direction can damage the bolt.

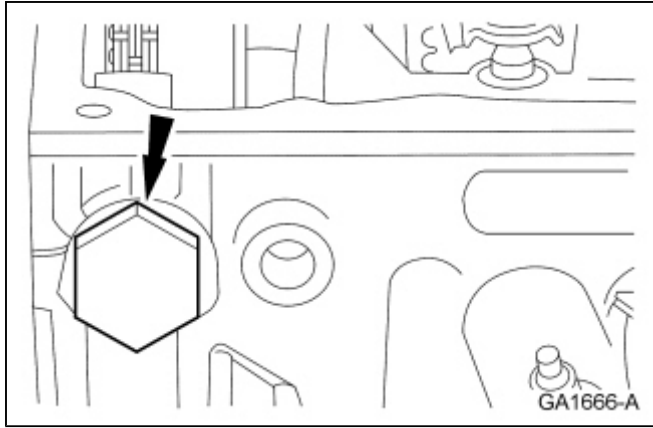
Tighten the bolts.

1. Tighten the Camshaft Sprocket Holding Tool top 2 clamp bolts to 10 Nm (89 lb-in).
2. Tighten the camshaft bolt to 85 Nm (63 lb-ft).



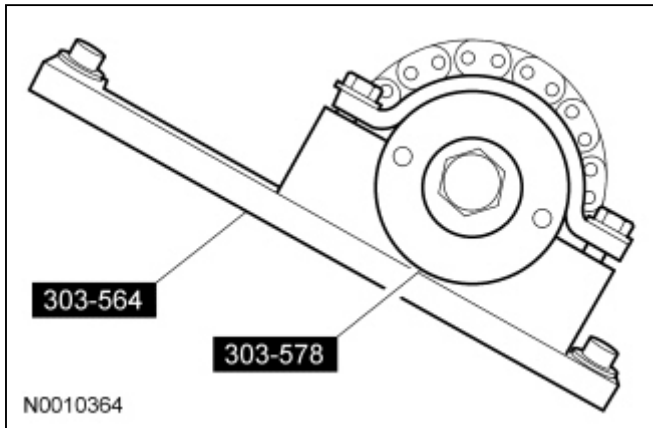
92. Install a new washer and the RH timing chain tensioner.

- Tighten to 44 Nm (32 lb-ft).



93. **NOTE:** Do not tighten the Camshaft Sprocket Holding Tool top 2 clamp bolts. The camshaft sprocket must rotate freely.

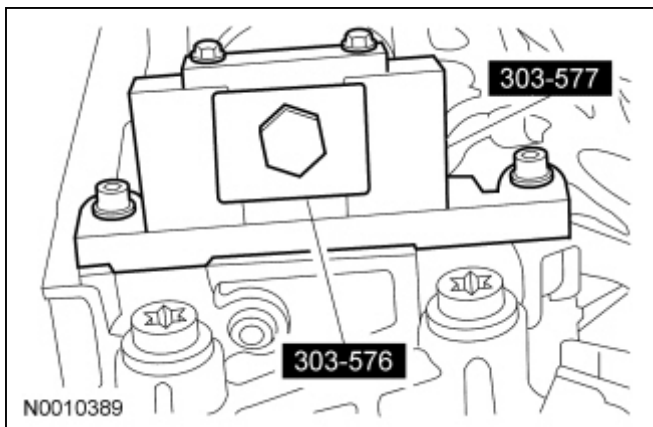
Install the Camshaft Sprocket Holding Tool and the Adapter for 303-564 on the front of the LH cylinder head.



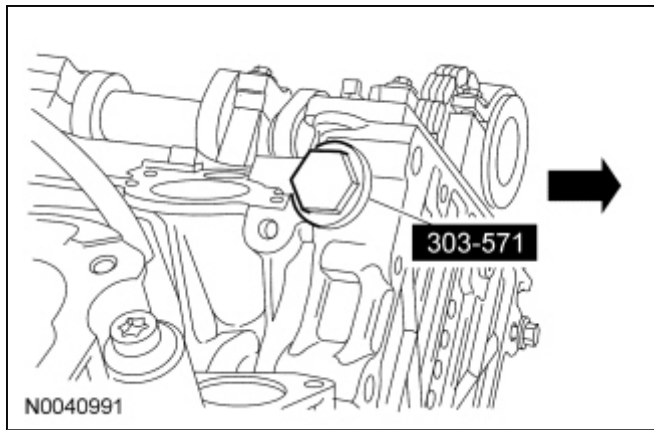
94. **NOTE:** Camshaft timing slots are off-center.

NOTE: Position the camshaft timing slots below centerline of camshaft.

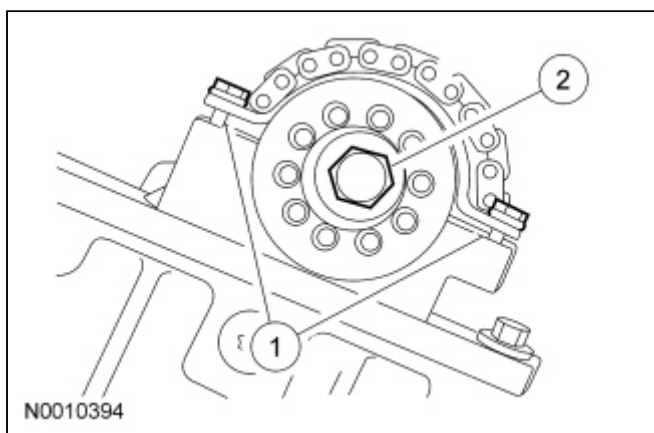
Install the Camshaft Holding Tool and the Adapter for 303-577 on the front of the LH cylinder head.



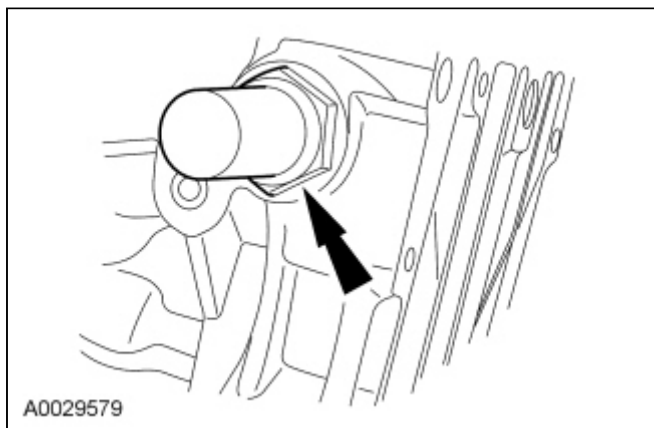
95. Install the Timing Chain Tensioner.



96. Tighten the bolts.
1. Tighten the Camshaft Sprocket Holding Tool top 2 clamp bolts to 10 Nm (89 lb-in).
 2. Tighten the camshaft bolt to 85 Nm (63 lb-ft).

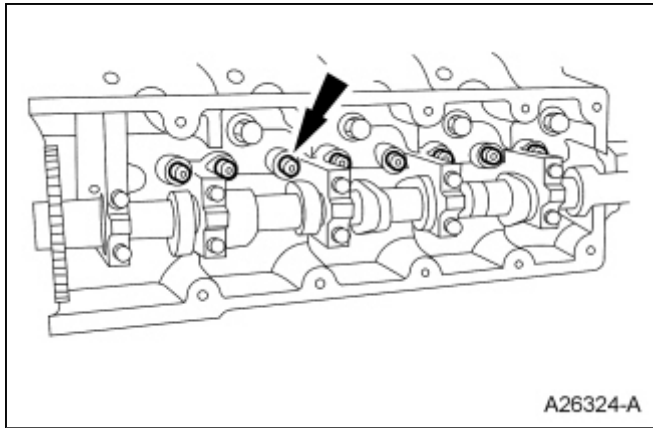


97. Install a new washer and the LH timing chain tensioner.
- Tighten to 44 Nm (32 lb-ft).

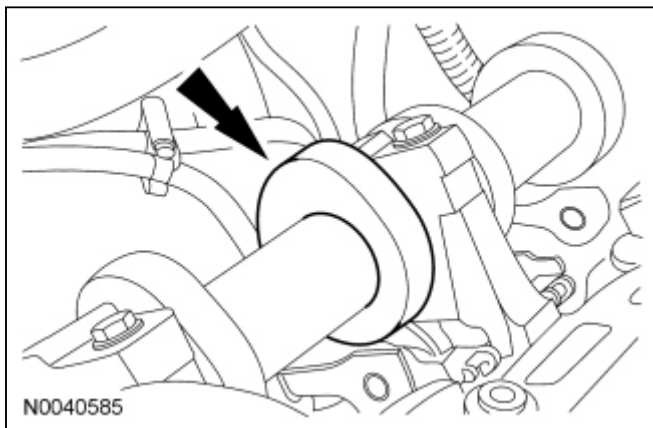


98. **NOTE:** Install the hydraulic lash adjuster in the same positions from which they were removed.

Install the hydraulic lash adjusters.

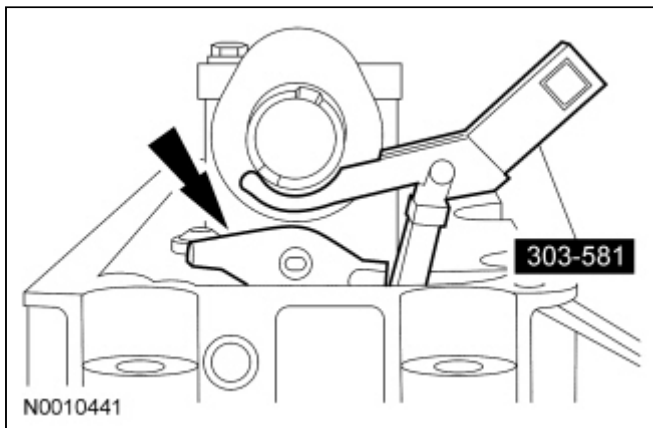


99. Rotate the crankshaft until the cam lobe on the cylinder being serviced is in the up position.

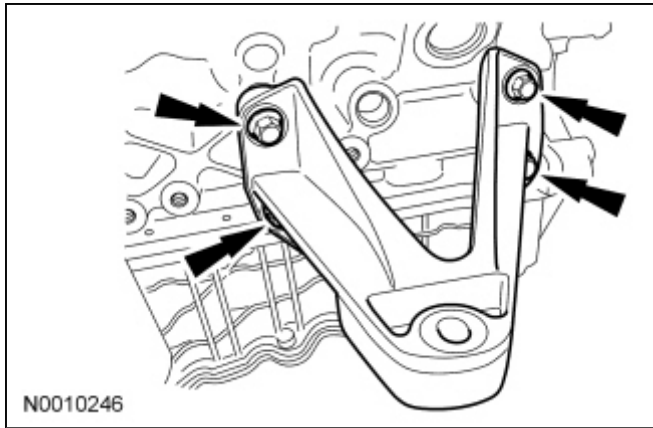


100. **NOTE:** Lubricate the parts with clean engine oil.

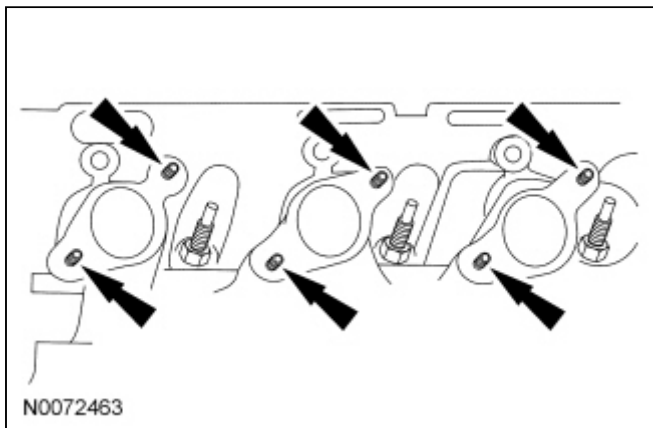
Using the Valve Spring Compressor, install the roller followers in their original positions.



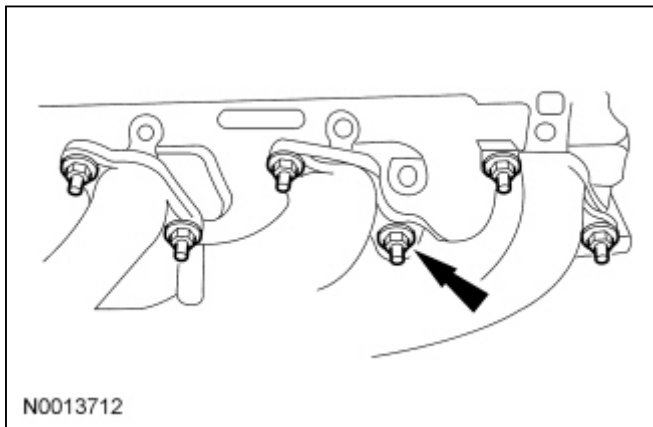
101. Inspect the RH and LH exhaust manifold gasket mating surfaces for flatness. For additional information, refer to [Section 303-00](#).
102. Position the RH engine mount bracket and install the 4 bolts.
- Tighten to 80 Nm (59 lb-ft).



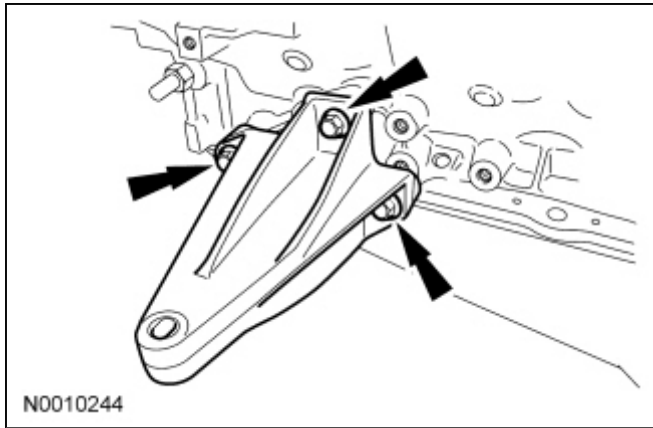
103. Install 6 new RH exhaust manifold studs.
- Tighten to 12 Nm (106 lb-in).



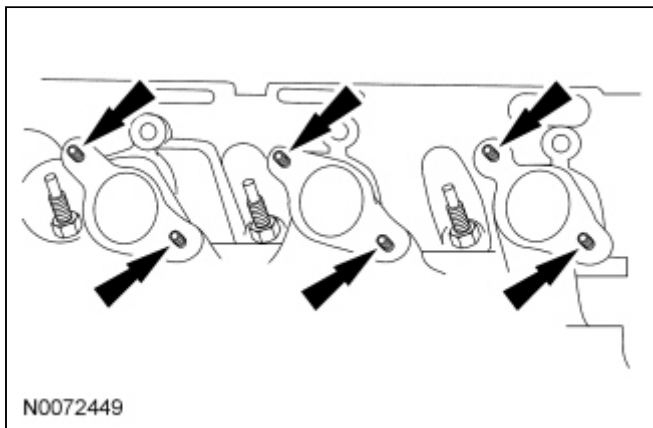
104. Install a new gasket, the RH exhaust manifold and the 6 new nuts.
- Tighten to 22 Nm (16 lb-ft).



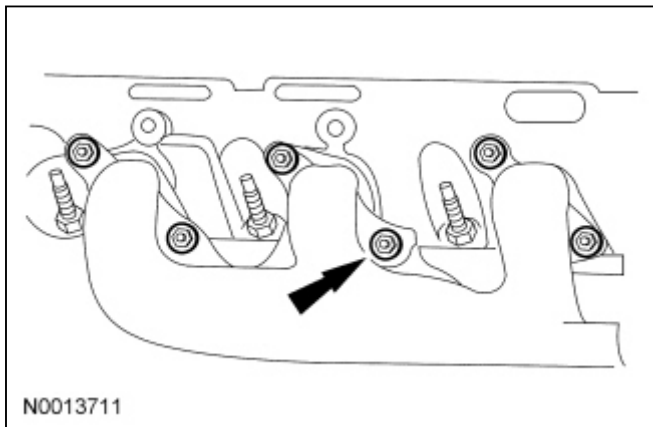
105. Position the LH engine mount bracket and install the 3 bolts.
- Tighten to 80 Nm (59 lb-ft).



106. Install 6 new LH exhaust manifold studs.
- Tighten to 12 Nm (106 lb-in).



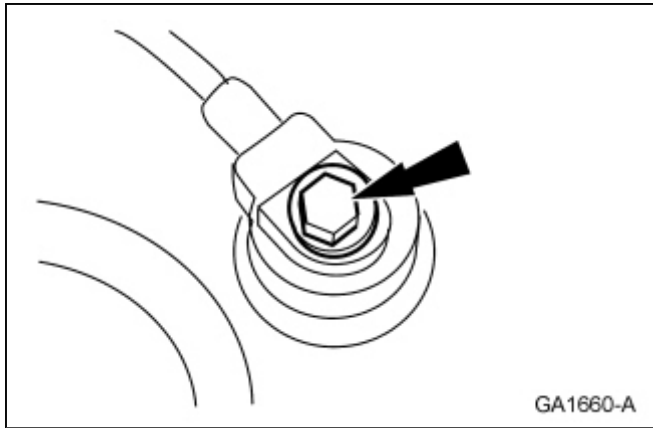
107. Install a new gasket, the LH exhaust manifold and the 6 new nuts.
- Tighten to 22 Nm (16 lb-ft).



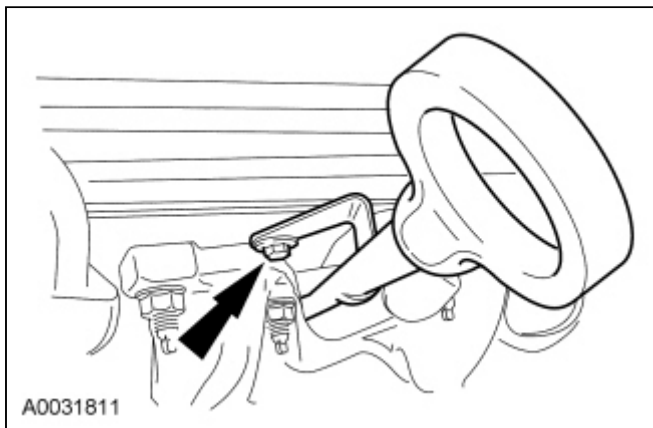
108. **NOTE:** Prior to installation, use metal surface prep to clean mating surfaces. Follow the directions on the packaging.

Install the Knock Sensor (KS) and the bolt.

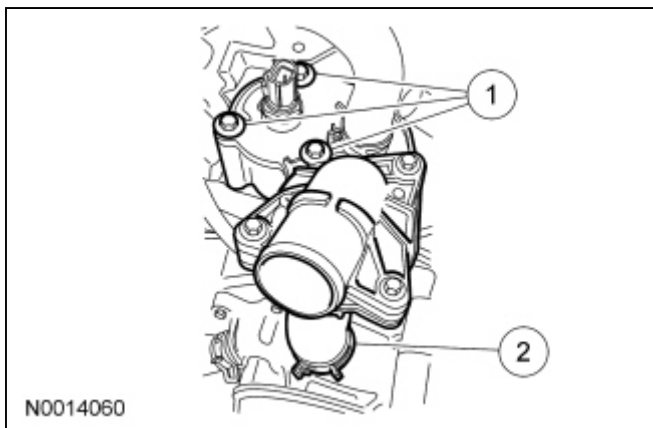
- Tighten to 20 Nm (177 lb-in).



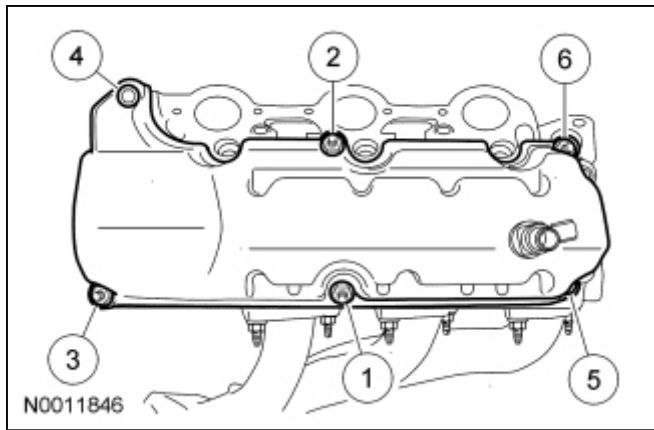
109. Install the oil level indicator tube and the bolt.
- Tighten to 10 Nm (89 lb-in).



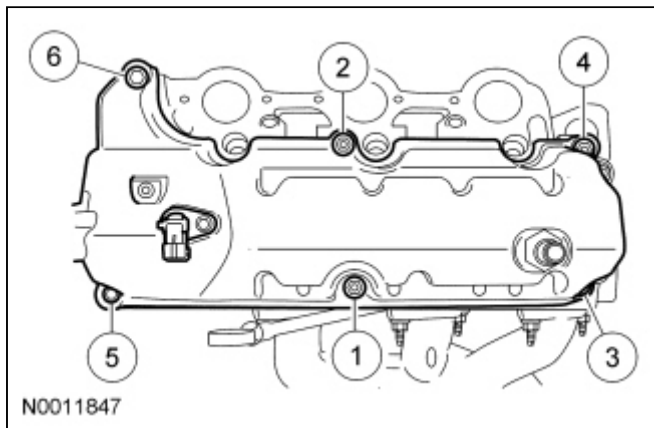
110. Position the thermostat housing and bypass hose on the coolant pump.
1. Install the 3 bolts.
 - Tighten to 11 Nm (97 lb-in).
 2. Position the bypass hose clamp.



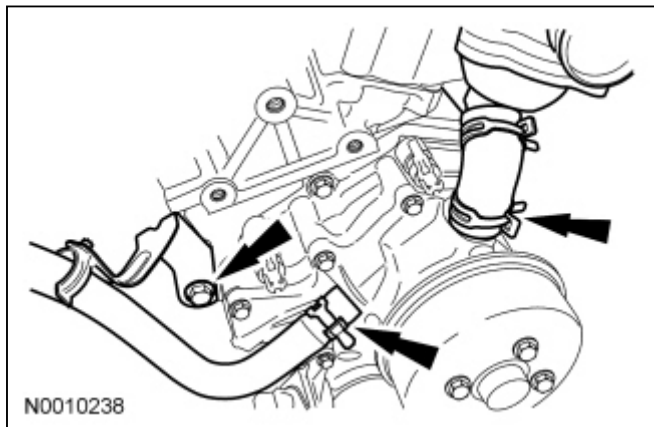
111. Clean the valve covers and cylinder head sealing surfaces with metal surface prep. Inspect and install new gaskets as necessary.
112. Position the RH valve cover and install the 2 bolts and the 4 stud bolts.
- Tighten in the sequence shown to 10 Nm (89 lb-in).



113. Position the LH valve cover and install the 3 bolts and the 3 stud bolts.
- Tighten in the sequence shown to 10 Nm (89 lb-in).



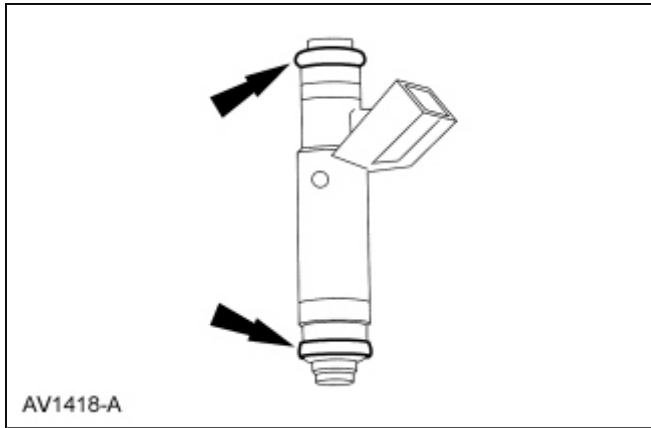
114. Connect the coolant hose to the coolant pump, position the bracket and install the bolt.
- Tighten to 45 Nm (33 lb-ft).



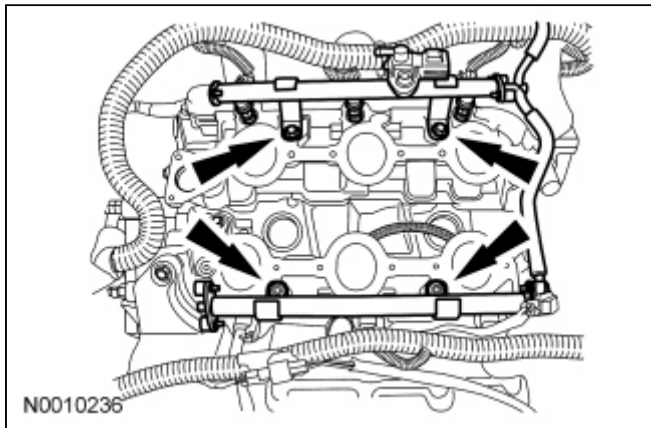
115. **NOTICE:** Use O-ring seals that are made of special fuel-resistant material. Use of ordinary O-rings seals can cause the fuel system to leak. Do not reuse the O-ring seals.

NOTE: Lubricate the O-ring seals with clean engine oil.

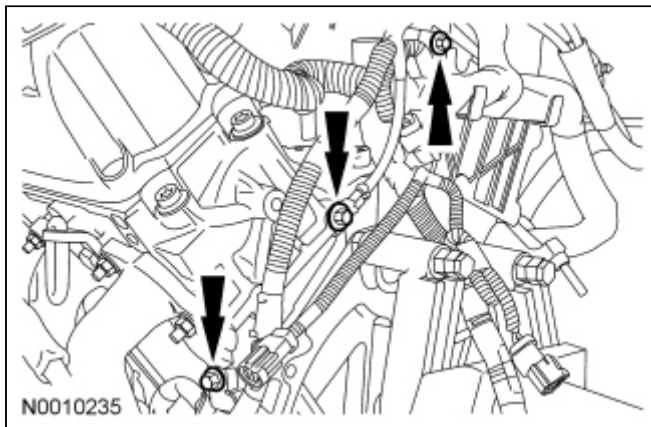
Install new O-ring seals on the 6 fuel injectors.



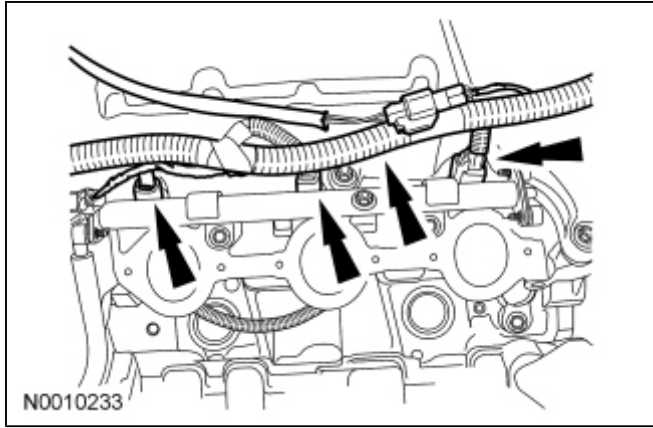
116. Position the fuel rail and injectors and install the 4 bolts.
- Tighten to 23 Nm (17 lb-ft).



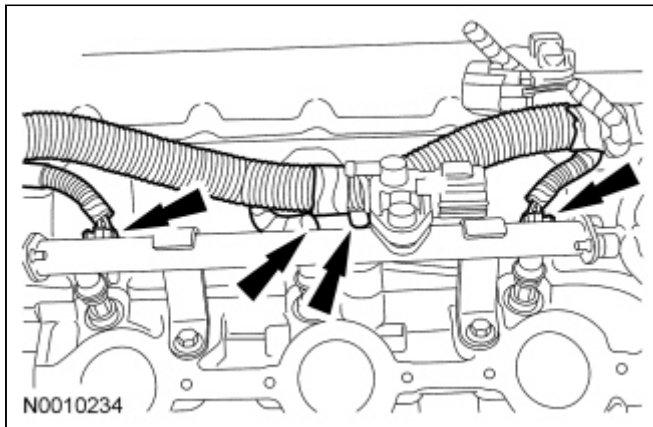
117. Position the main engine wiring harness on the engine and install the 3 bolts.
- Tighten to 40 Nm (30 lb-ft).
 - Attach the wiring retainers.



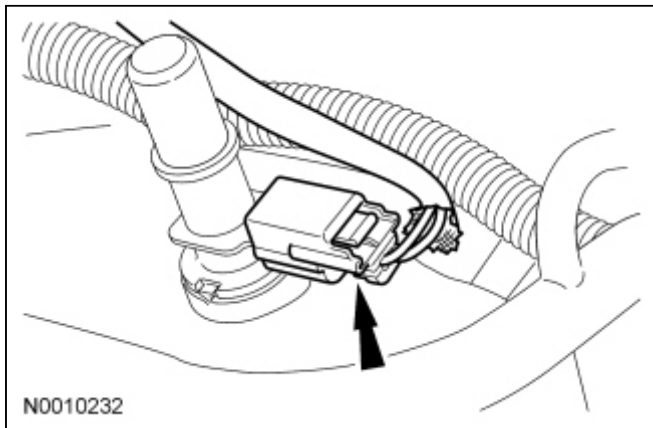
118. Connect the 3 RH fuel injector electrical connectors and attach the wiring retainer to the valve cover stud bolt.



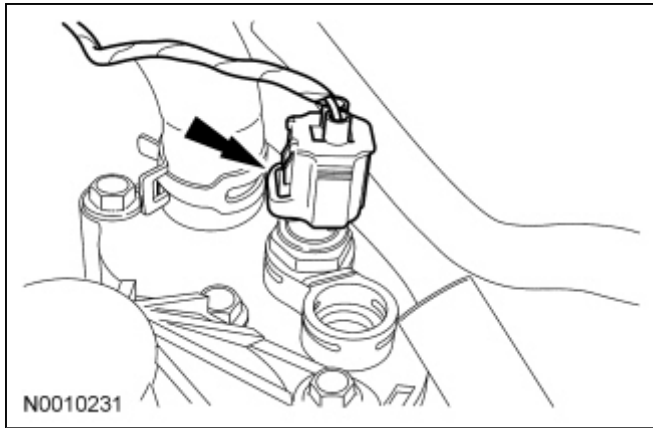
119. Connect the 3 LH fuel injector electrical connectors and attach the wiring retainer to the valve cover stud bolt.



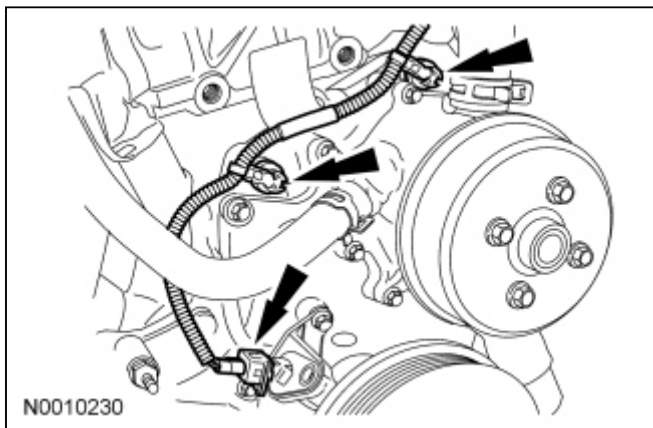
120. Connect the PCV valve electrical connector.



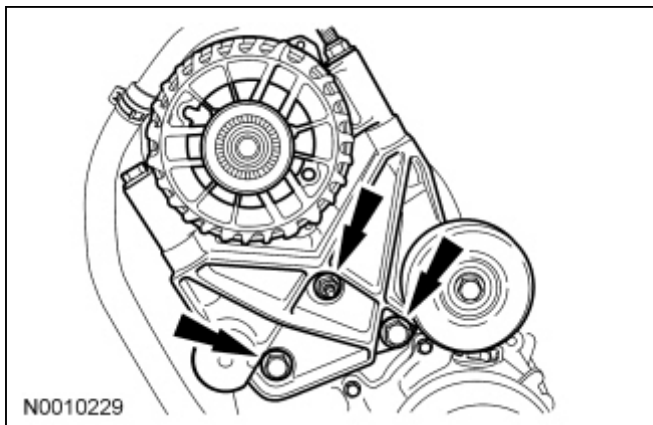
121. Connect the Engine Coolant Temperature (ECT) sensor electrical connector.



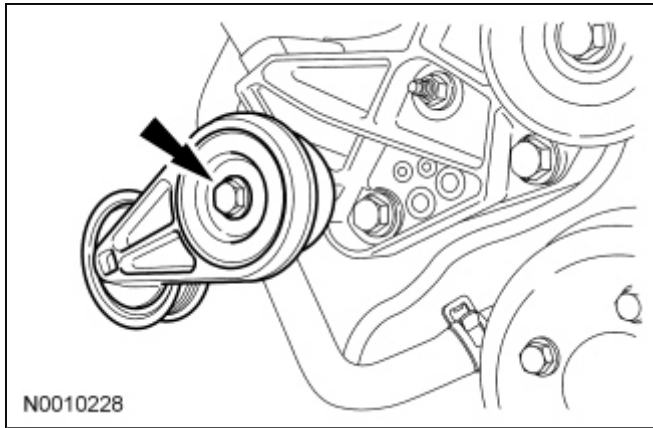
122. Connect the Crankshaft Position (CKP) sensor electrical connector and attach the 2 wiring retainers.



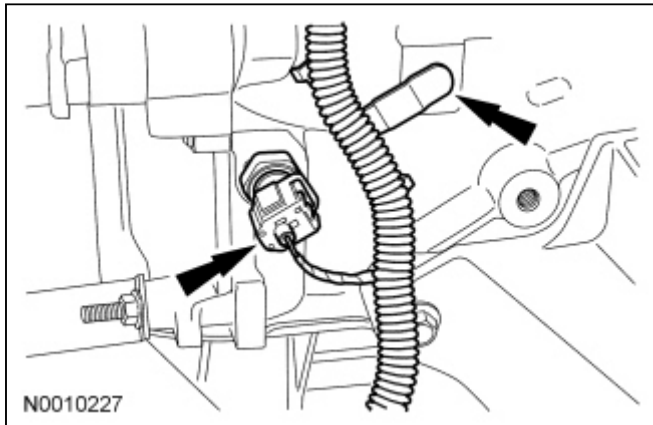
123. Position the generator and bracket. Install the 2 bolts and the nut.
- Tighten to 47 Nm (35 lb-ft).



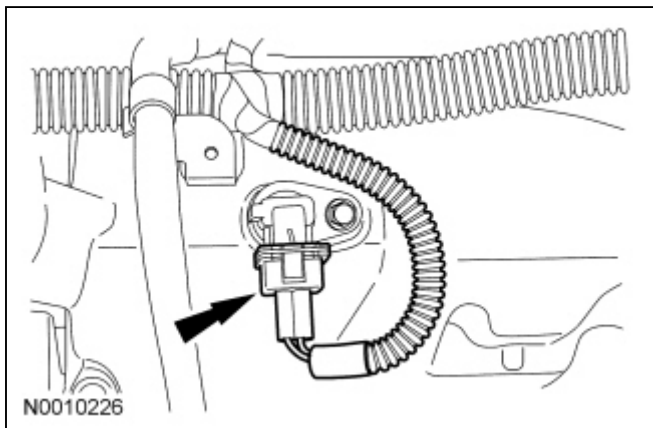
124. Install the accessory drive belt tensioner and the bolt.
- Tighten to 47 Nm (35 lb-ft).



125. Connect the Engine Oil Pressure (EOP) switch electrical connector and attach the wiring retainer.

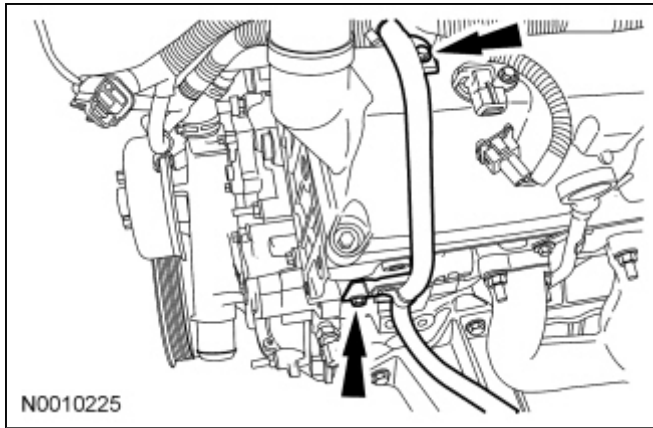


126. Connect the Camshaft Position (CMP) electrical connector.



127. Position the fuel rail supply tube brackets and install the 2 bolts.

- Tighten the bolt for the upper bracket to 6 Nm (53 lb-in).
- Tighten the bolt for the lower bracket to 10 Nm (89 lb-in).

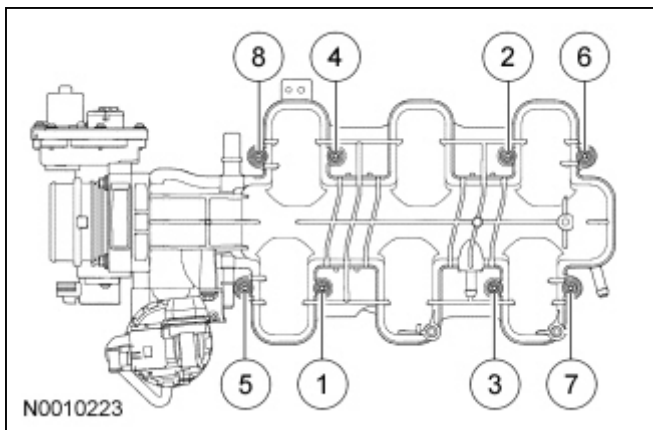


128. **NOTICE:** If the engine is repaired or replaced because of upper engine failure, typically including valve or piston damage, check the intake manifold for metal debris. If metal debris is found, install a new intake manifold. Failure to follow these instructions can result in engine damage.

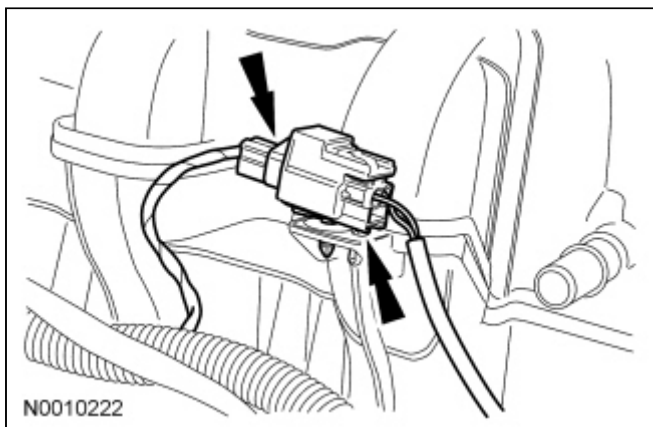
NOTE: Clean and inspect all sealing surfaces. Inspect and install new intake manifold gaskets as necessary.

Position the intake manifold and install the 8 bolts.

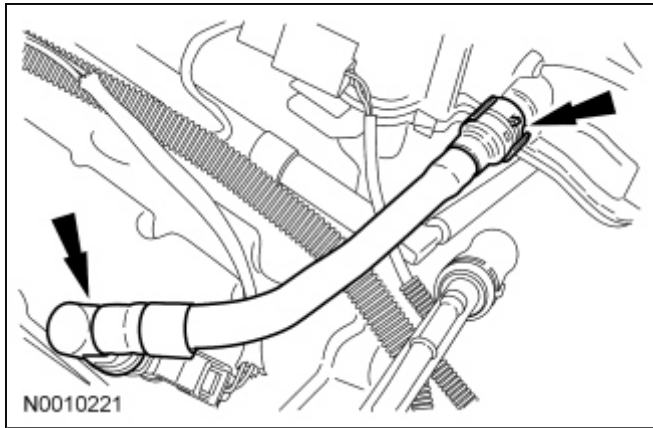
- Tighten in the sequence shown to 10 Nm (89 lb-in).



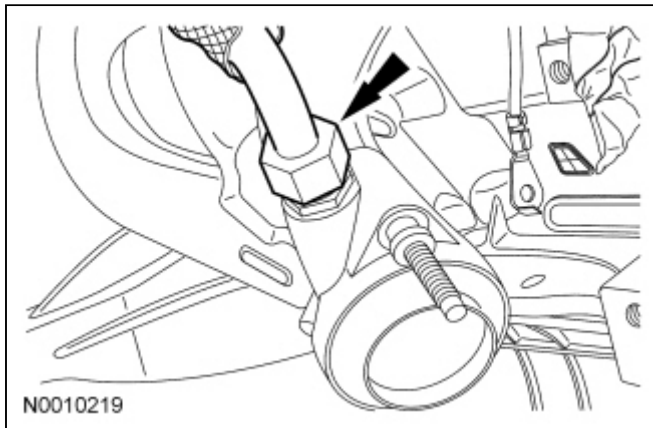
129. Connect the KS electrical connector and attach the wiring retainer.



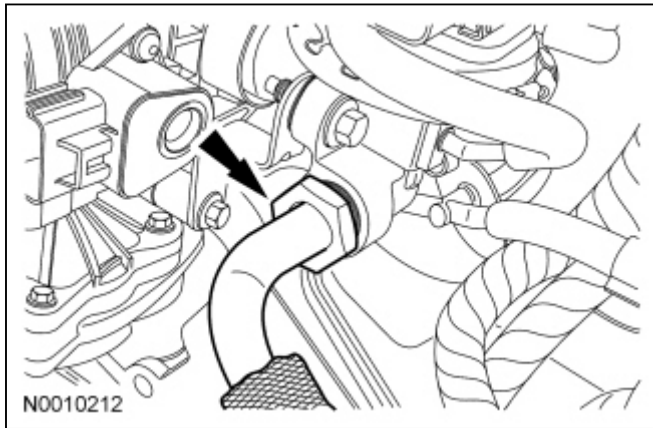
130. Install the PCV tube.



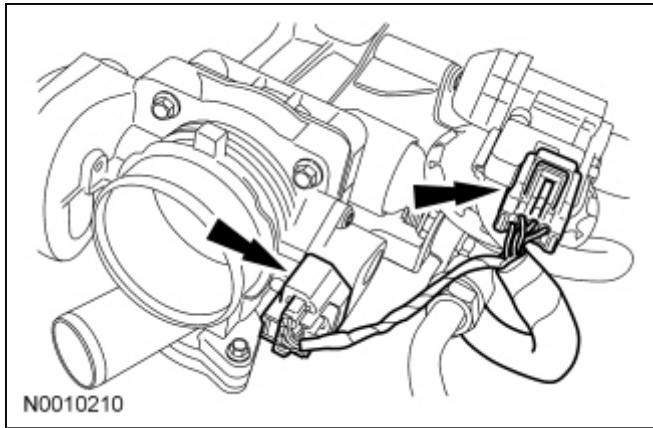
131. Position the EGR tube. Connect the fitting to the LH exhaust manifold.
- Tighten to 40 Nm (30 lb-ft).



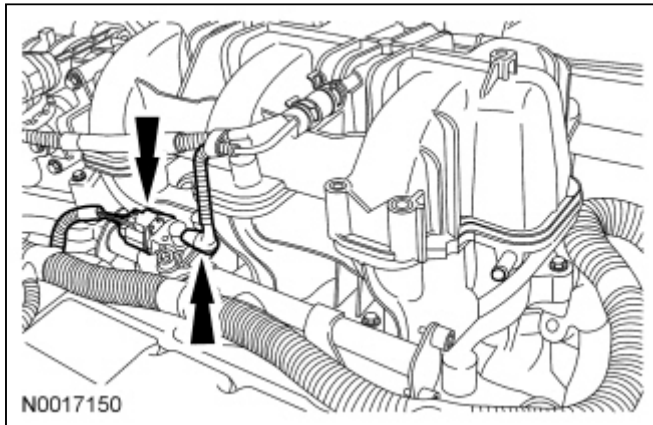
132. Connect the EGR tube fitting to the EGR system module.
- Tighten to 40 Nm (30 lb-ft).



133. Connect the EGR system module and Throttle Position (TP) sensor electrical connectors.

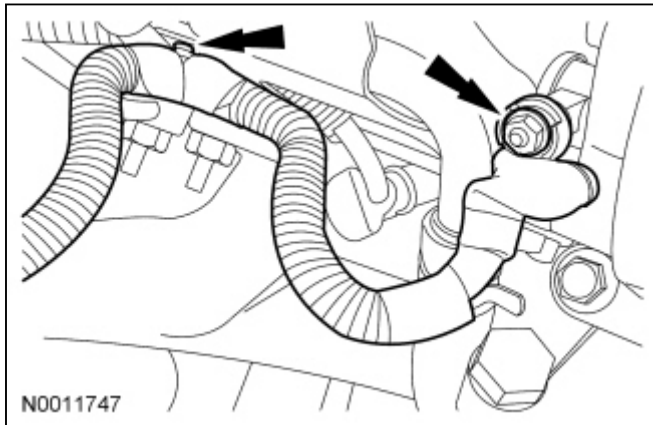


134. Connect the fuel rail pressure and temperature sensor electrical connector and the vacuum tube.

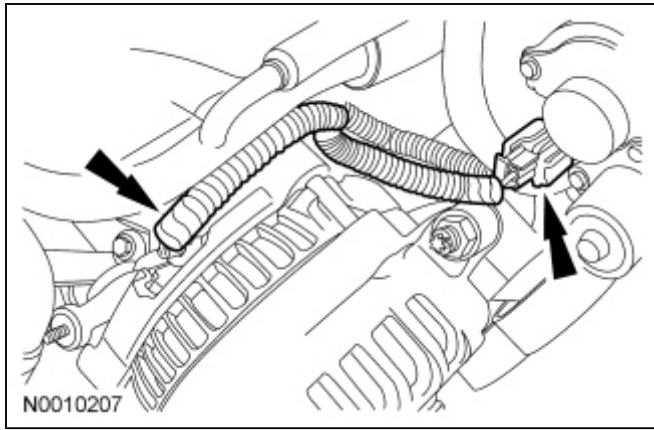


135. Attach the B+ terminal to the generator and install the nut.

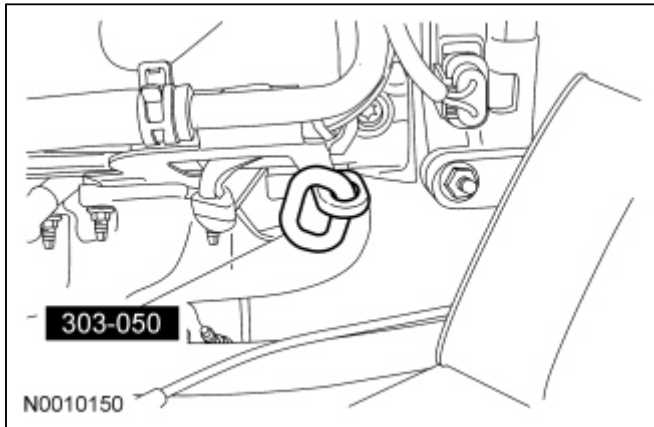
- Tighten to 8 Nm (71 lb-in).
- Attach the wiring retainer to the generator.



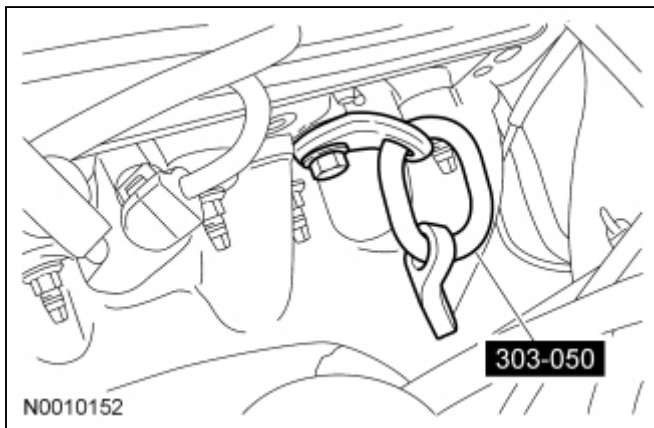
136. Connect the generator and Throttle Body (TB) electrical connectors.



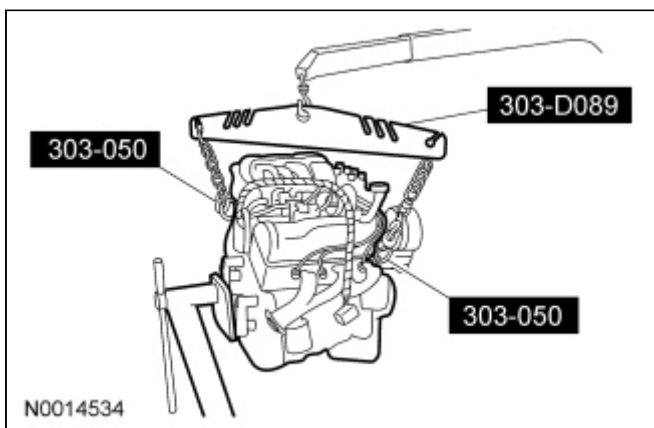
137. Install the Engine Lifting Bracket to the RH cylinder head.



138. Install the Engine Lifting Bracket to the LH cylinder head.



139. Using the Spreader Bar and Engine Lifting Brackets, remove the engine from the engine stand.

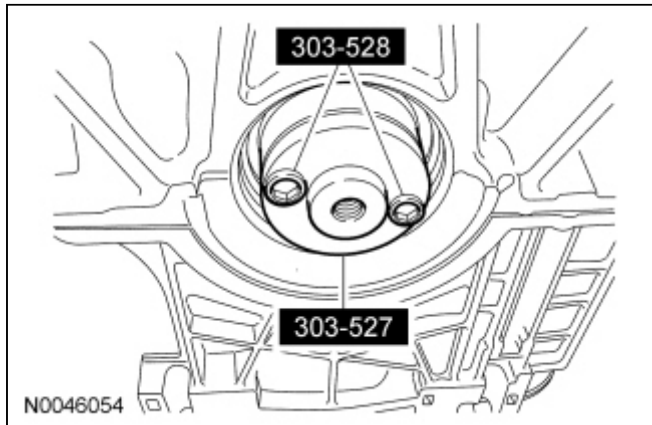


140. **NOTE:** The new replacement crankshaft rear seal comes with a speedy sleeve. Do not remove the speedy sleeve, it must be installed with the crankshaft rear seal.

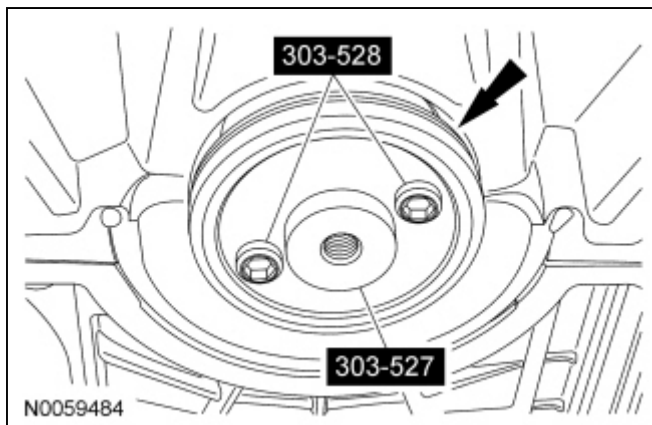
NOTE: Be sure the crankshaft rear sealing surface is clean and free from any rust or corrosion. To clean the crankshaft rear seal surface area, use extra-fine emery cloth or extra-fine 0000 steel wool with metal surface prep.

Lubricate the crankshaft rear oil seal with clean engine oil.

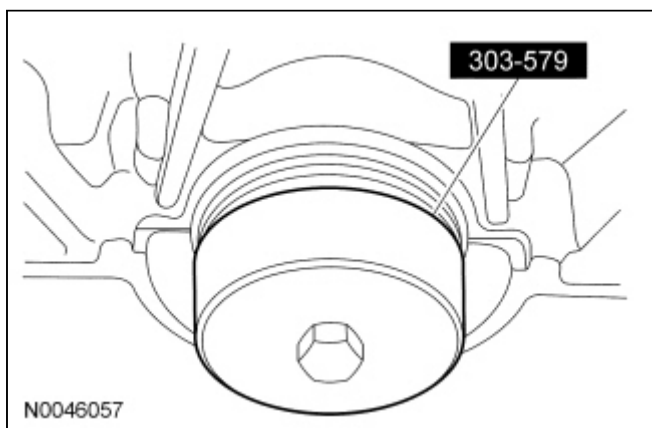
141. Install the Crankshaft Rear Oil Seal Screws and Adapter.



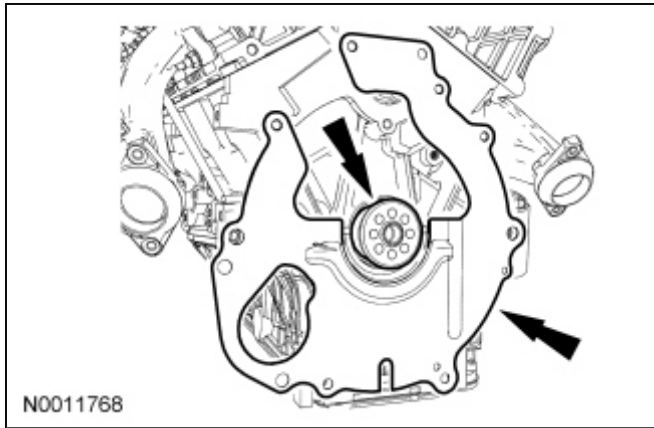
142. Position the crankshaft rear oil seal with speedy sleeve around the Crankshaft Rear Oil Seal Screws and Adapter.



143. Using the Crankshaft Rear Oil Seal Installer, install the crankshaft rear oil seal with speedy sleeve.



144. Install the spacer plate and if equipped, the flexplate-to-crankshaft spacer.



145. **NOTE:** New flexplate or flywheel bolts must be installed. They are a torque-to-yield design and cannot be reused.

Install the flexplate or flywheel.

- Tighten the 8 new bolts in the sequence shown in 3 stages.
 - Stage 1: Tighten to 13 Nm (115 lb-in).
 - Stage 2: Tighten to 50 Nm (37 lb-ft).
 - Stage 3: Tighten an additional 90 degrees.

