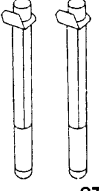
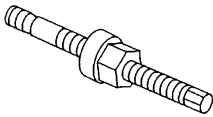
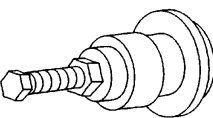
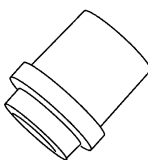
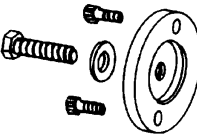
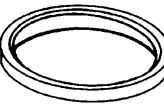
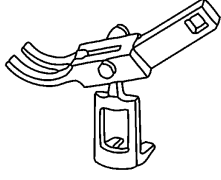
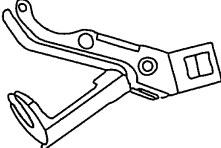
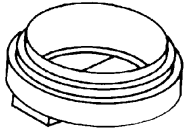
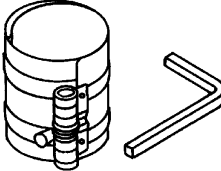
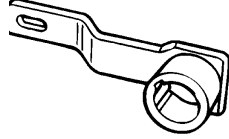


ASSEMBLY**Engine****Special Tool(s)**

 ST1337-A	Installer, Connecting Rod 303-442 (T93P-6136-A)
 ST1287-A	Installer, Crankshaft Vibration Damper 303-102 (T74P-6316-B)
 ST1328-A	Installer, Front Cover Oil Seal 303-335 (T88T-6701-A)
 ST2197-A	Installer, Crankshaft Front Oil Seal 303-635
 ST1480-A	Installer, Crankshaft Rear Oil Seal 303-518 (T95P-6701-DH)
 ST1482-A	Installer, Crankshaft Rear Oil Slinger 303-517 (T95P-6701-CH)

(Continued)

Special Tool(s)

 ST1718-A	Compressor, Valve Spring (Intake) 303-452 (T93P-6565-AR)
 ST1693-A	Compressor, Valve Spring (Exhaust) 303-567 (T97P-6565-AH)
 ST1479-A	Installer, Crankshaft Rear Oil Seal 303-516 (T95P-6701-BH)
 ST1335-A	Compressor, Piston Ring 303-D032 (D81L-6002-C) or equivalent
 ST1335-A	Holding Tool, Crankshaft 303-448 (T93P-6303-A)

Material

Item	Specification
Metal Surface Cleaner F4AZ-19A536-RA or equivalent	WSE-M5B392-A
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4
SAE 5W-20 Premium Synthetic Blend Engine Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

(Continued)

ASSEMBLY (Continued)

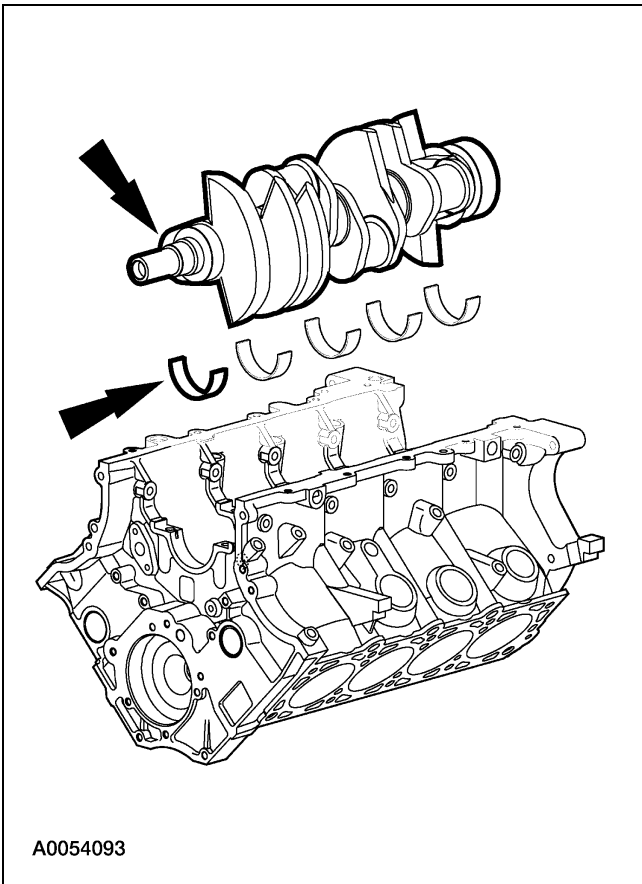
Material

Item	Specification
Motorcraft Premium Engine Coolant VC-4-A (in Canada CXC-10; in Oregon VC-5) or equivalent	ESE-M97B44-A
Motorcraft Premium Gold Engine Coolant VC-7-A (in Canada VC-7-B) or equivalent	WSS-M97B51-A1

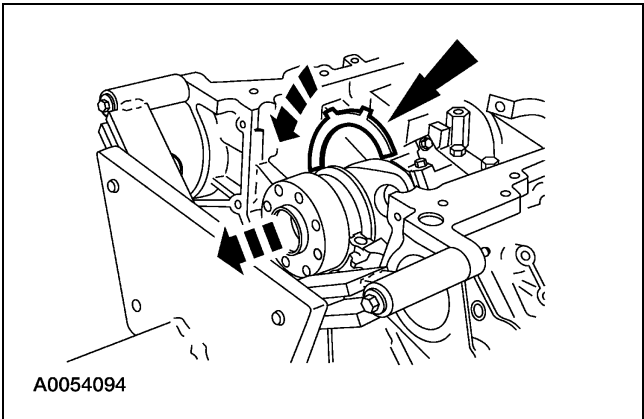
Assembly

NOTE: Before assembling the cylinder block, all sealing surfaces must be free from chips, dirt, paint and foreign material. Also, make sure the coolant and oil passages are clear.

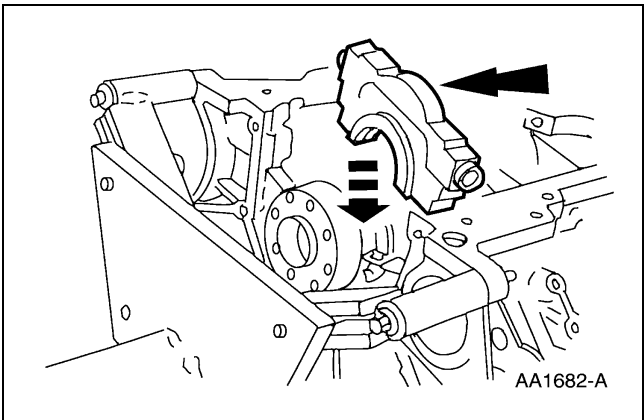
1. Install the crankshaft upper main bearings into the cylinder block and lubricate them with clean engine oil.
2. Install the crankshaft onto the upper main bearings.



3. **NOTE:** The oil groove on the thrust washer must face toward the rear of the engine (against the crankshaft thrust surface).
Install the thrust washer to the rear of the No. 5 upper main bearing.

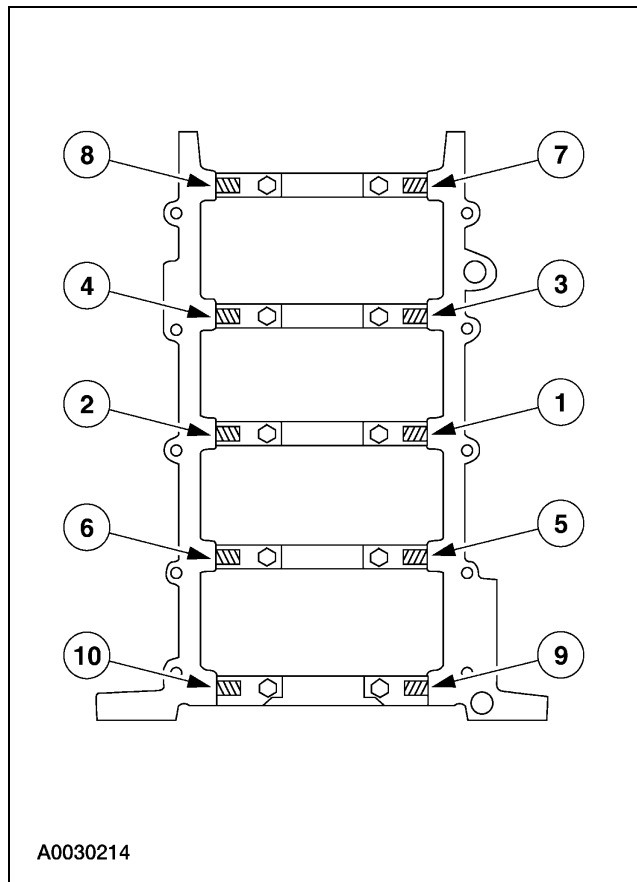
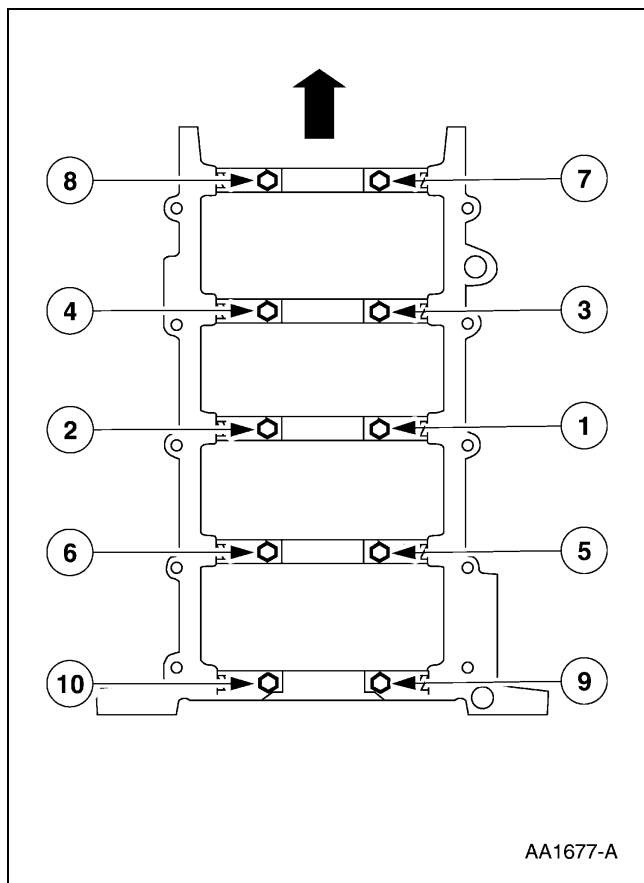


4. **NOTE:** Rotate the jack screws into the bearing caps enough to provide clearance to the cylinder block, prior to installing the bearing caps
NOTE: Install the thrust bearing to the rear main bearing cap and lubricate it with clean engine oil.
NOTE: Install the crankshaft lower main bearings into the main bearing caps and lubricate them with clean engine oil.
Apply forward force to the crankshaft, so that the crankshaft thrust face is against the No. 5 bulkhead. With the crankshaft in this position, locate the No. 5 main bearing cap on the cylinder block and tap into place using a plastic or dead blow hammer.
 - Install the four remaining main bearing caps.



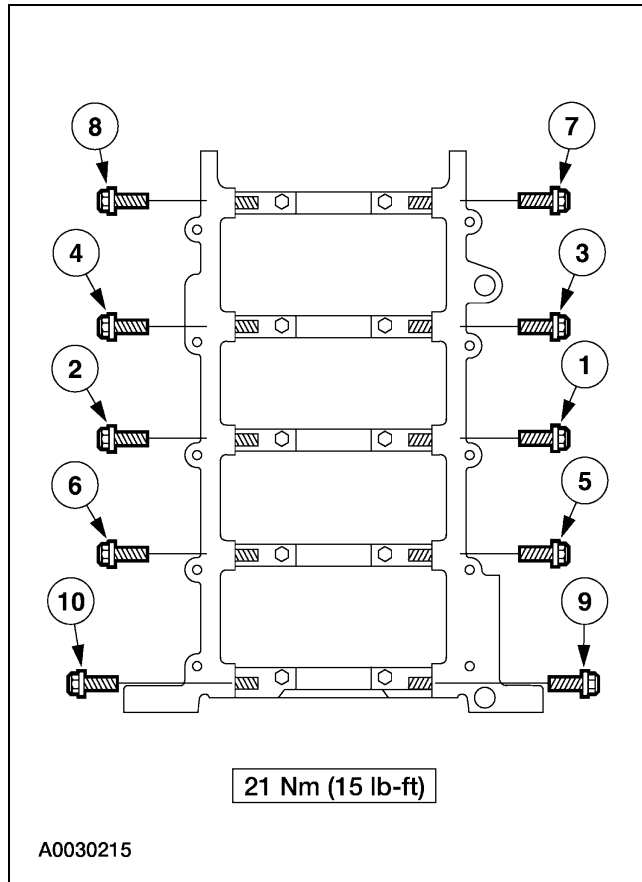
ASSEMBLY (Continued)

5. Install the vertical main bearing cap fasteners and tighten in the sequence shown, in two stages.
- Stage 1: Tighten to 40 Nm (30 lb-ft).
 - Stage 2: Tighten an additional 90 degrees.
6. Tighten the jack screws against the cylinder block in the sequence shown, in two stages.
- Stage 1: Tighten to 5 Nm (44 lb-in).
 - Stage 2: Tighten to 10 Nm (89 lb-in).



ASSEMBLY (Continued)

7. Install the side bolts and tighten them in the sequence shown.

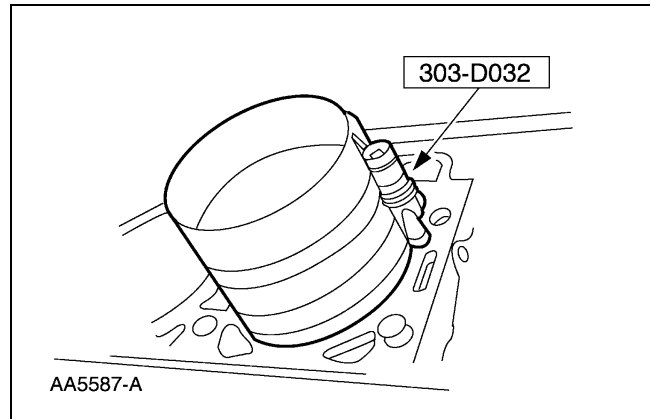


8. Check the crankshaft end play. For additional information, refer to Section 303-00.
9. **⚠ CAUTION: Do not scratch the cylinder walls or crankshaft journals with the connecting rod.**

NOTE: Make sure that the arrow or identification bump on the piston is facing forward.

NOTE: Lubricate the piston rings, cylinder walls and connecting rod bearings with clean engine oil.

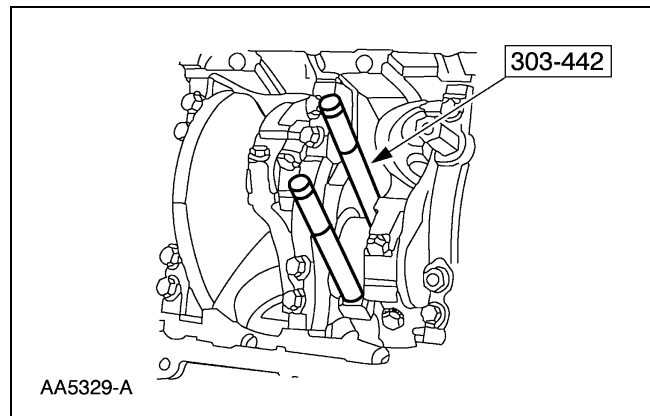
Using the special tool push the pistons through the top of the cylinder block.



10. **⚠ CAUTION: Do not scratch the cylinder walls or the crankshaft journals with the connecting rod.**

NOTE: Make sure the crankshaft is at top dead center (TDC).

Using the special tool, install the connecting rod assemblies.

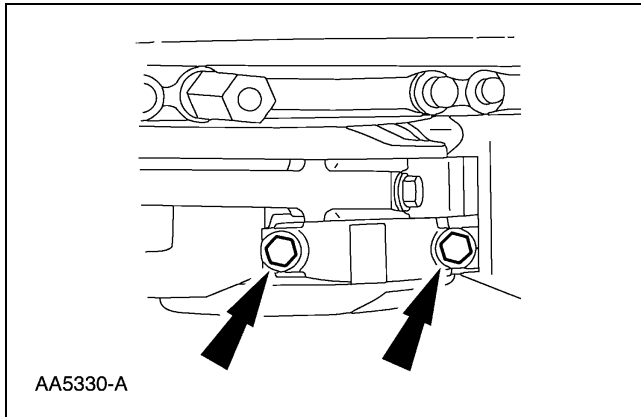


ASSEMBLY (Continued)

11. **NOTE:** The rod bearing cap bolts are not torque-to-yield and can be reused. Lubricate the cap bolt threads and thrust face in clean engine oil prior to assembly.

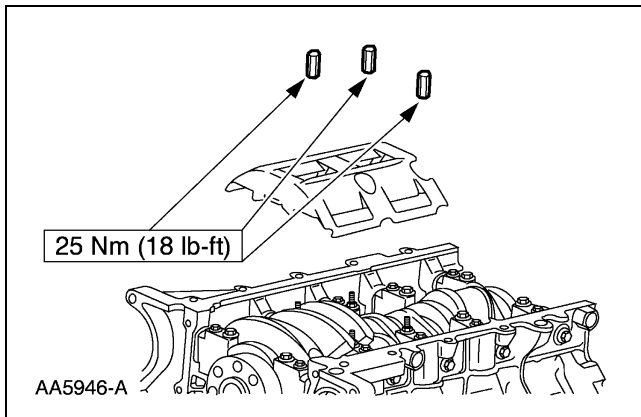
Install the connecting rod bearing caps and bolts and tighten in two stages.

- Stage 1: Tighten to 25 Nm (18 lb-ft).
- Stage 2: Tighten to 80 Nm (59 lb-ft).

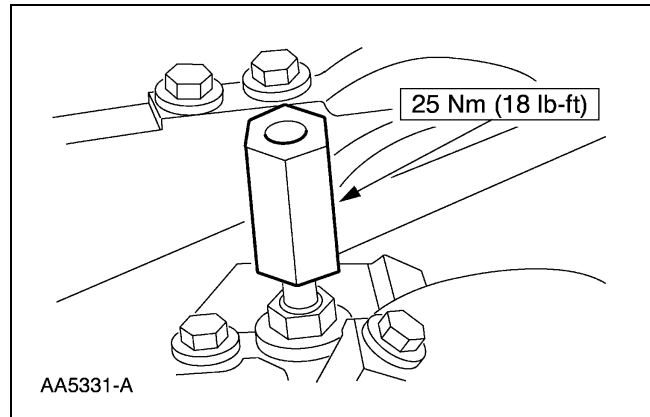


12. Check the connecting rod bearing clearance. For additional information, refer to Section 303-00.

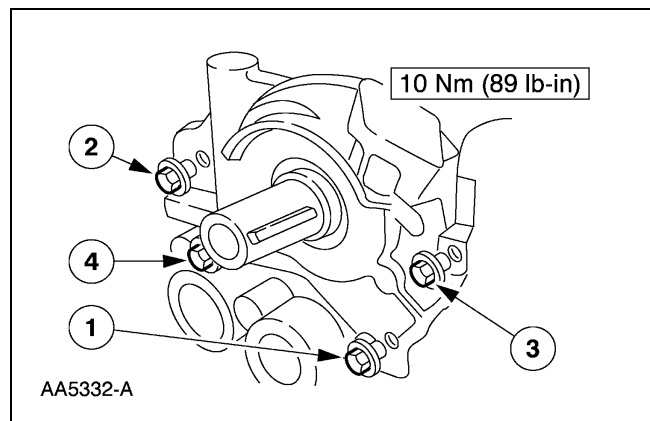
13. Install the windage tray.



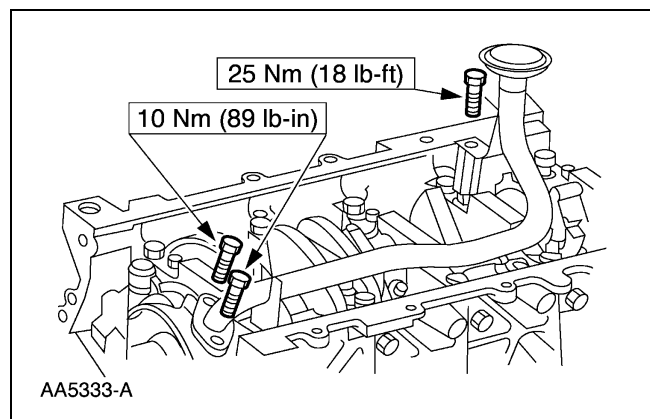
14. Install and tighten the oil pump screen spacer.



15. Position the oil pump; tighten the bolts in the sequence shown.

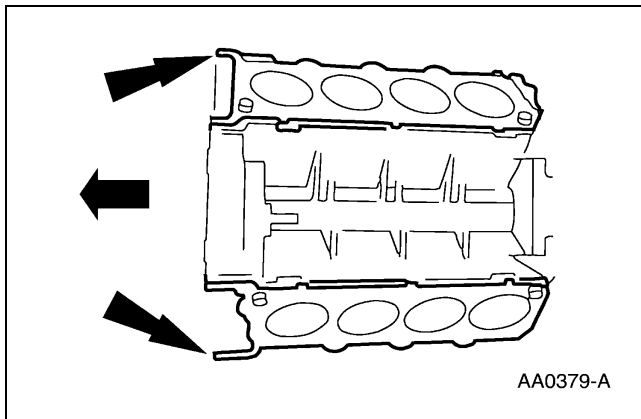


16. **NOTE:** Install a new O-ring if necessary. Install the oil pump screen cover and tube.



ASSEMBLY (Continued)

17. Install the cylinder head gaskets.



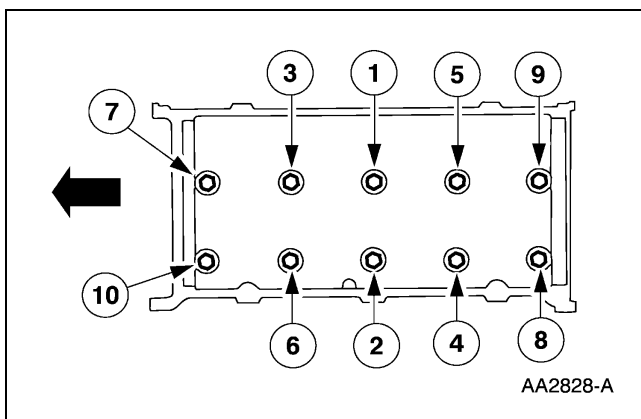
18. **NOTE:** Install new cylinder head bolts.


NOTE: LH is shown, RH is similar.

NOTE: Lubricate the bolt heads and threads. Use clean engine oil.

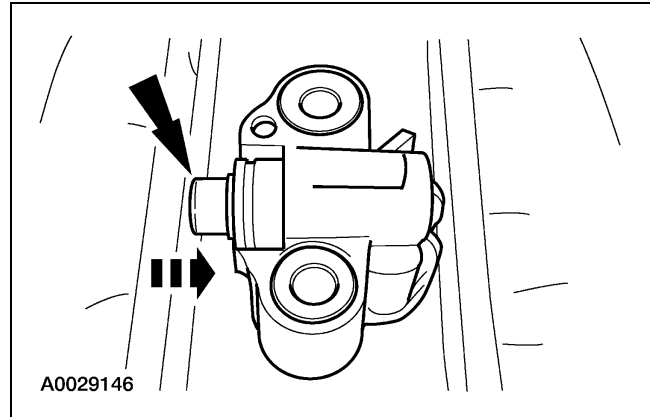
Install the LH and RH cylinder heads and tighten the bolts in six stages, in the sequence shown.

- Stage 1: Tighten to 40 Nm (30 lb-ft).
- Stage 2: Tighten an additional 90 degrees.
- Stage 3: Loosen the bolts a minimum of one full turn.
- Stage 4: Tighten to 40 Nm (30 lb-ft).
- Stage 5: Tighten an additional 90 degrees.
- Stage 6: Tighten an additional 90 degrees.

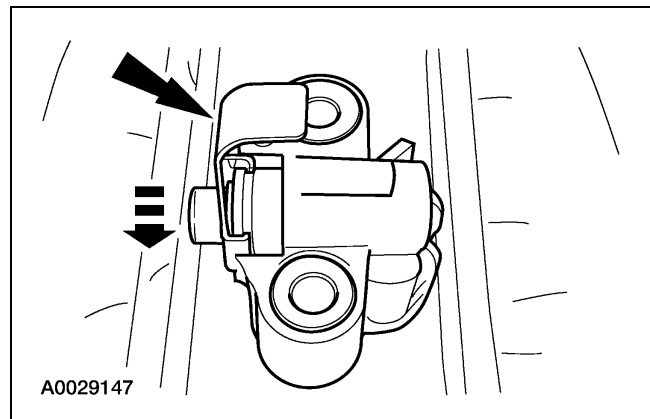


19.  **CAUTION:** Timing chain procedures must be followed exactly or damage to valves and pistons will result.

Compress the tensioner plunger, using a vise.

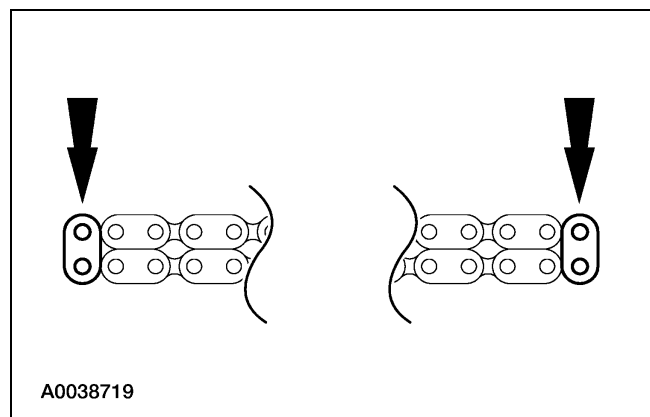


20. Install a retaining clip on the tensioner to hold the plunger in during installation.



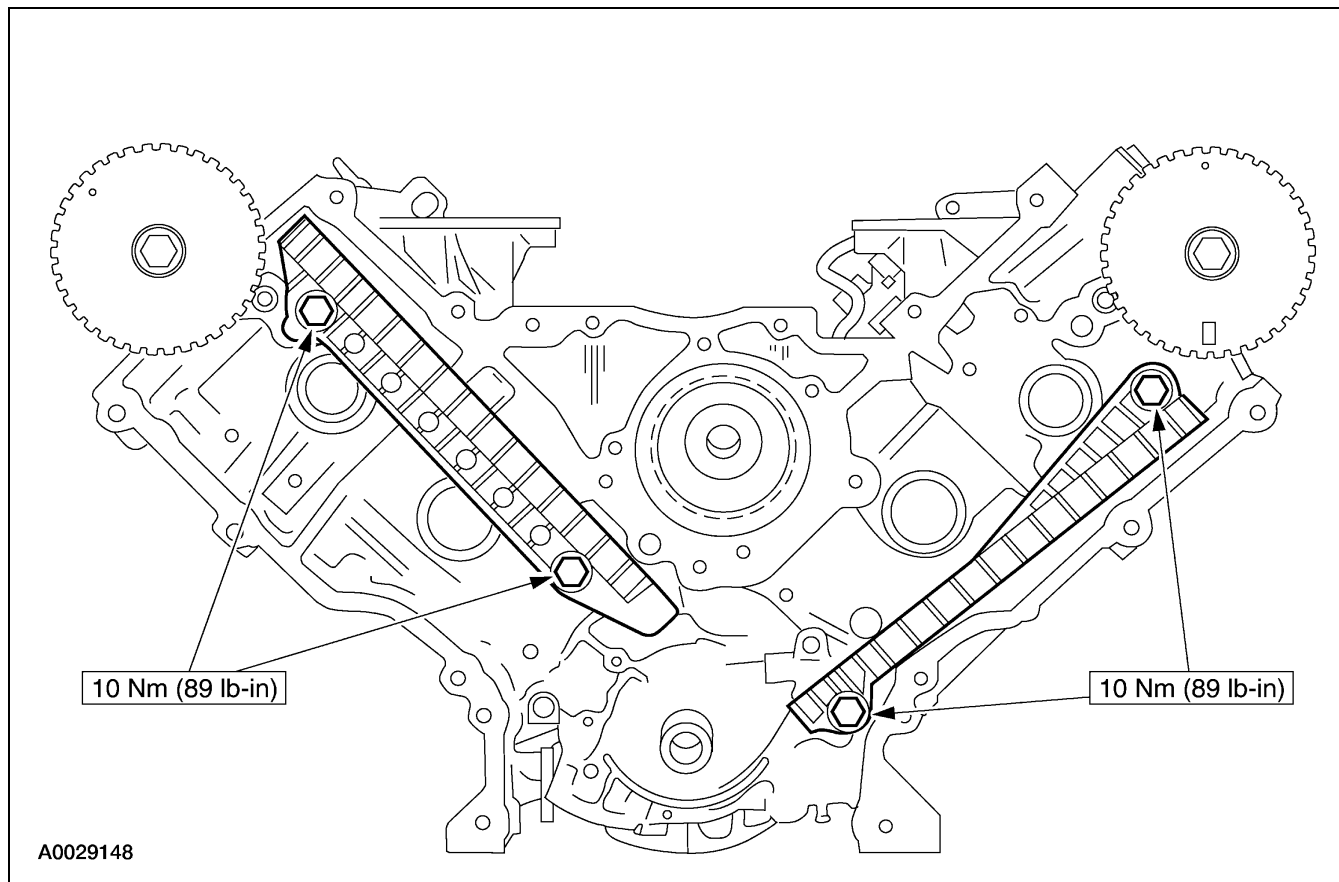
21. Remove the tensioner from the vise.

22. If the copper links are not visible, mark two links on one end and one link on the other end, and use as timing marks.



ASSEMBLY (Continued)

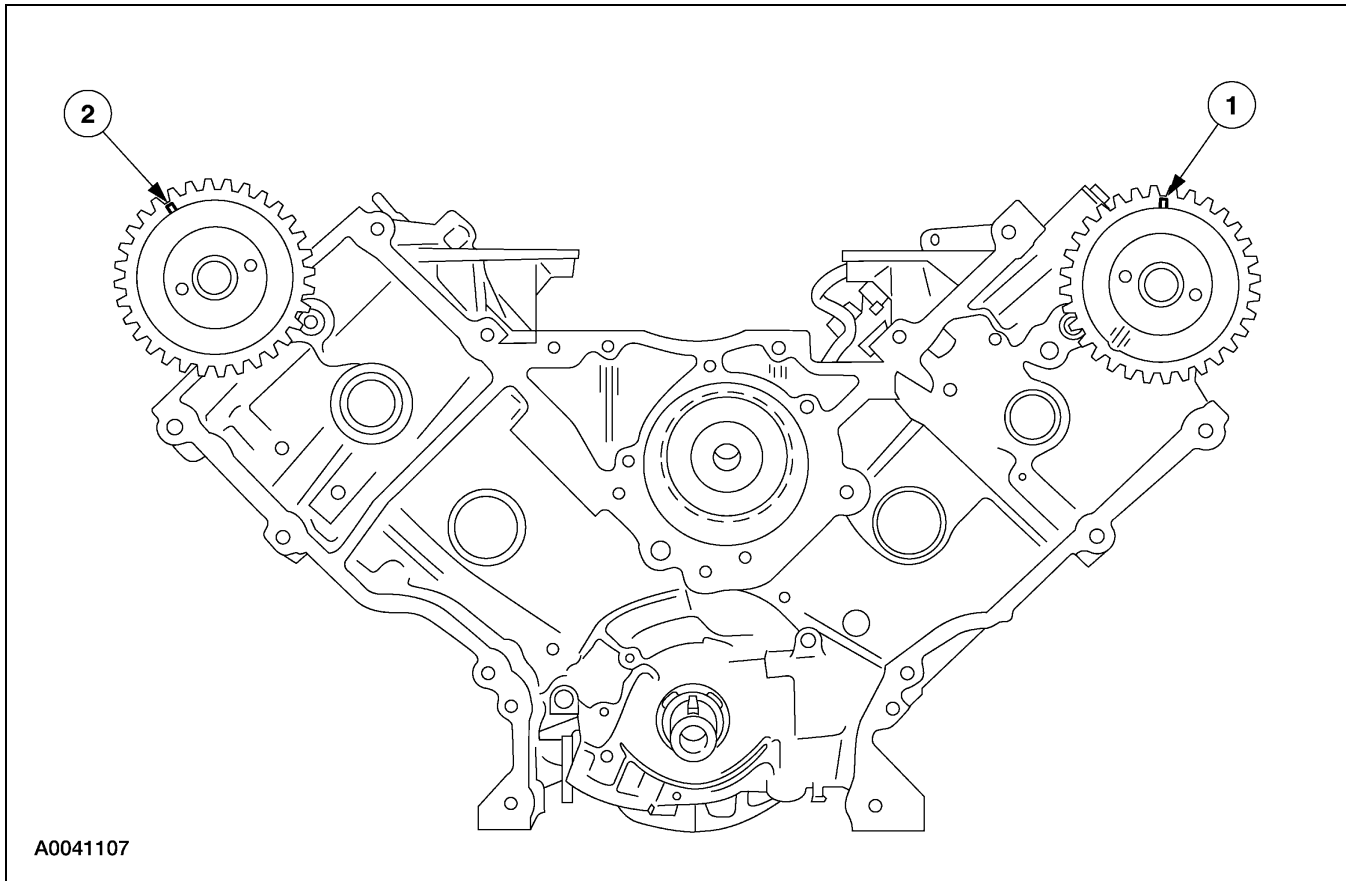
23. Install the timing chain guides.



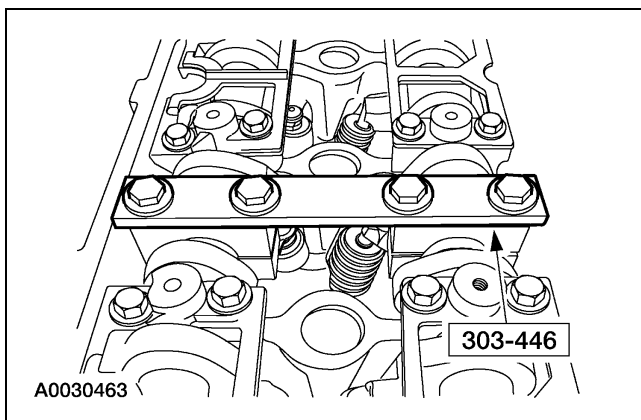
ASSEMBLY (Continued)

24. Pre-position the camshafts.


- 1 Rotate the LH camshaft until the timing mark is approximately at 12 o'clock.
- 2 Rotate the RH camshaft until the timing mark is approximately at 11 o'clock.




25. Install the special tool.



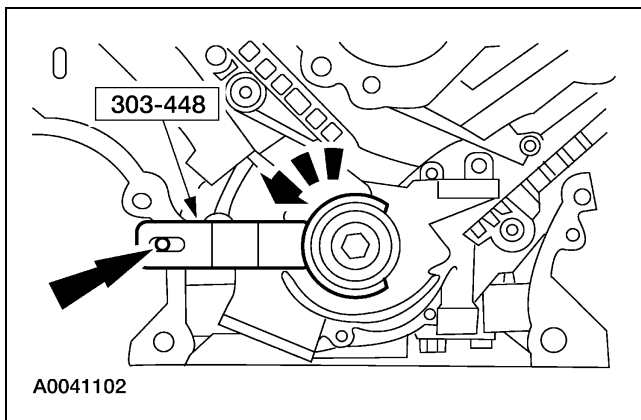
ASSEMBLY (Continued)

26.  **CAUTION:** Unless otherwise instructed, at no time when the timing chains are removed and the cylinder heads are installed is the crankshaft or camshaft to be rotated. Severe piston and valve damage will occur.

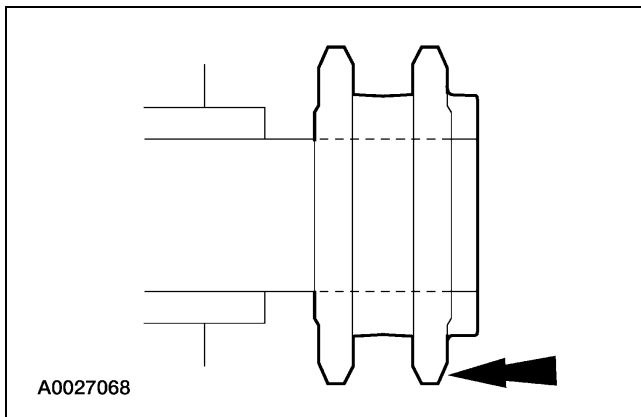
 **CAUTION:** Rotate the crankshaft counterclockwise only. Do not rotate past position shown or severe piston and/or valve damage will occur.

Using the special tool, position the crankshaft.

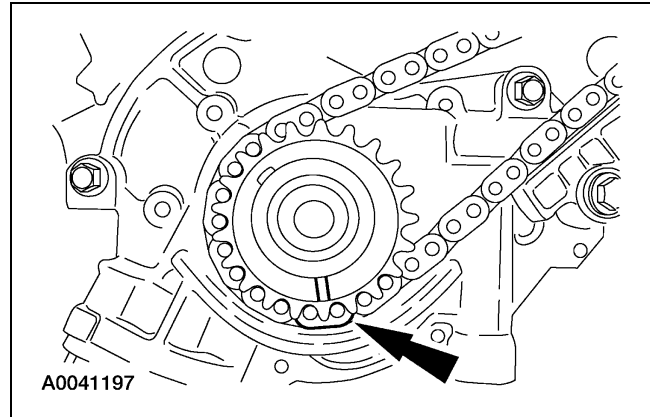
- Remove the special tool.



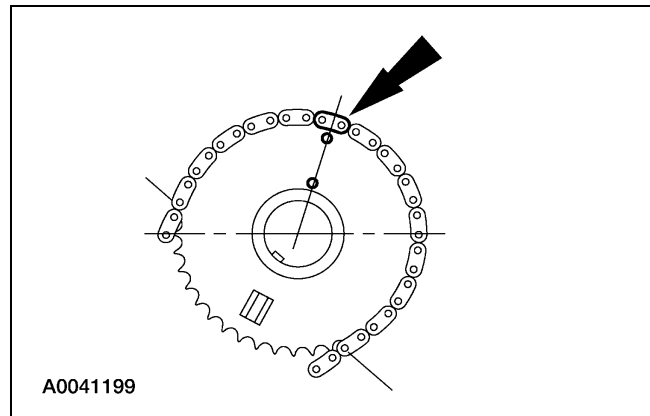
27. Install the crankshaft sprocket with the flange facing forward.



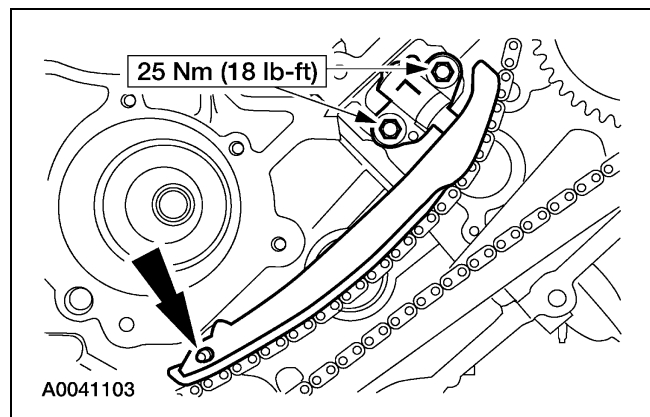
28. Position the LH (inner) timing chain onto the crankshaft sprocket, aligning the one copper link on the timing chain with the slot on the crankshaft sprocket.



29. Install the LH timing chain on the camshaft sprocket, aligning the copper (marked) link with the timing marks on the sprocket.

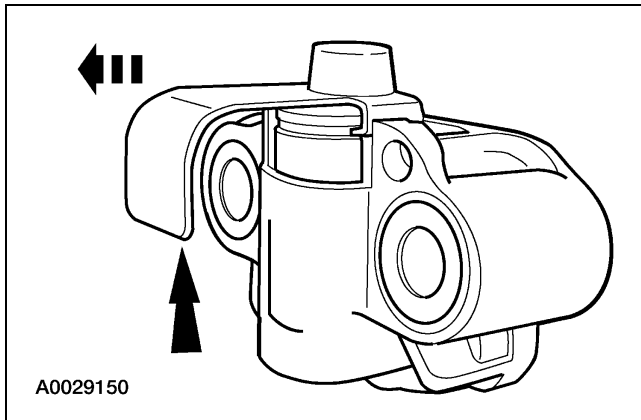


30. **NOTE:** The LH timing chain tensioner arm has a bump near the dowel hole for identification. Position the LH timing chain tensioner arm on the dowel pin and install the LH timing chain tensioner.

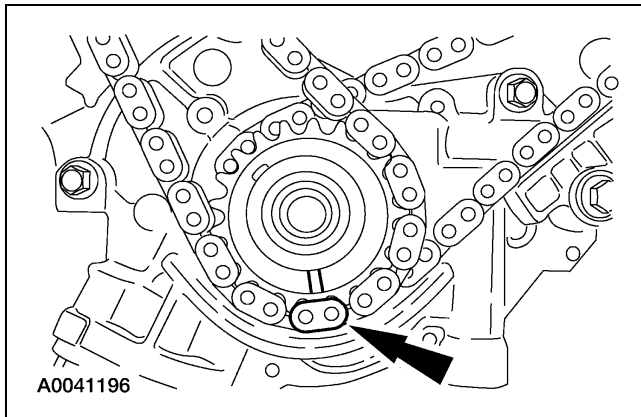


ASSEMBLY (Continued)

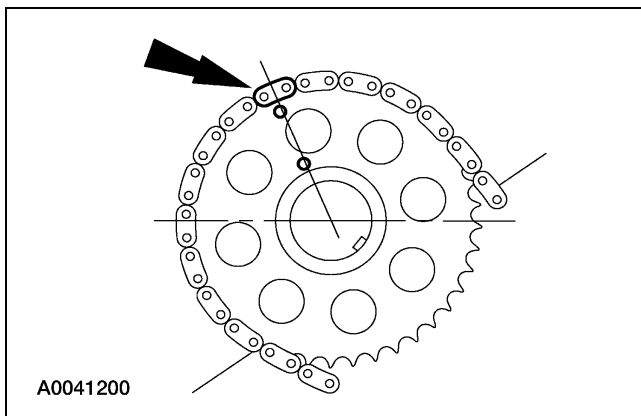
31. Remove the retaining clip from the LH timing chain tensioner.



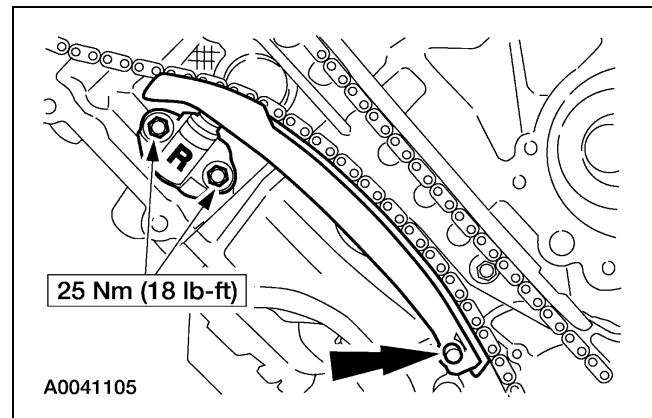
32. Position the RH (outer) timing chain on the crankshaft sprocket, aligning the copper (marked) link with the timing marks on the sprocket.



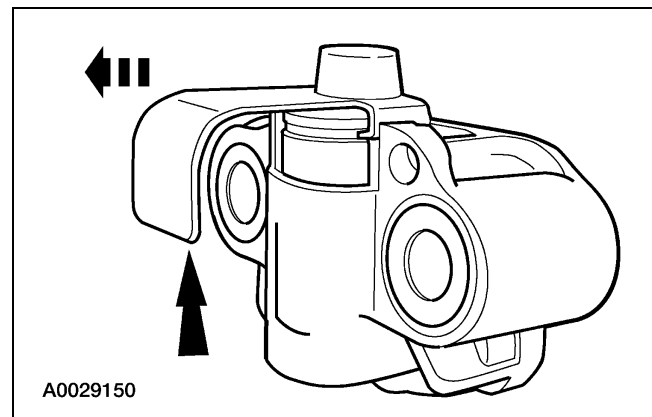
33. Install the RH timing chain on the camshaft sprocket, aligning the copper (marked) link with the timing marks on the sprocket.



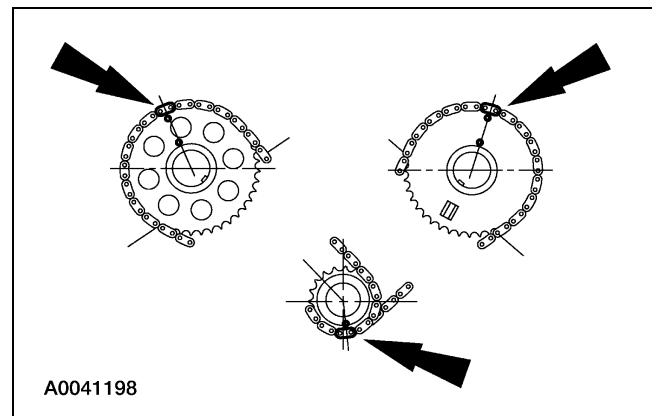
34. Position the RH timing chain tensioner arm on the dowel pin and install the RH timing chain tensioner.



35. Remove the retaining clip from the RH timing chain tensioner.

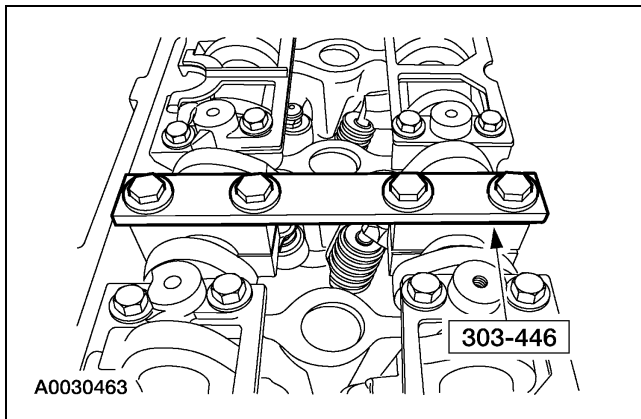


36. As a post-check, make sure that the copper (marked) chain links are lined up with the dots on the crankshaft sprockets and the camshaft sprockets.



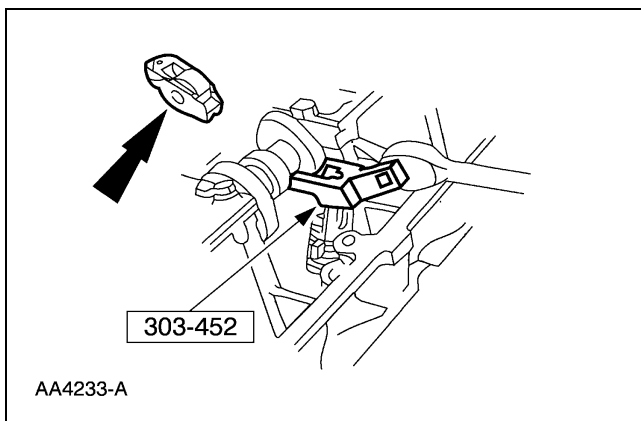
ASSEMBLY (Continued)

37. Remove the special tool.

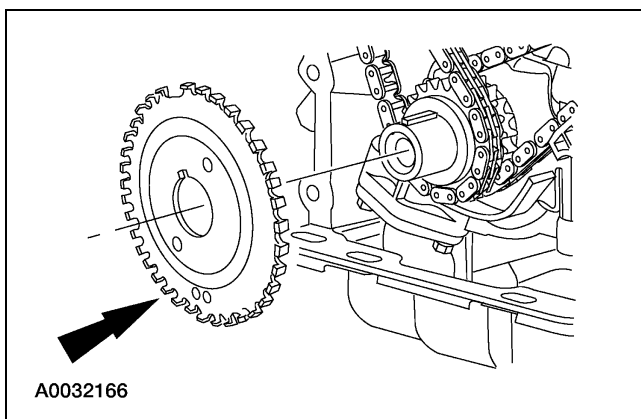


38. **NOTE:** Make sure the base circle of the camshaft is facing the roller follower being installed.

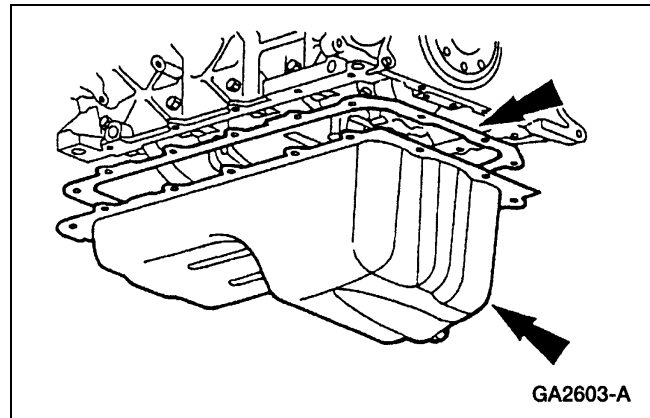
Using the special tool, install the 32 roller followers.



39. Position the crankshaft sensor ring on the crankshaft.

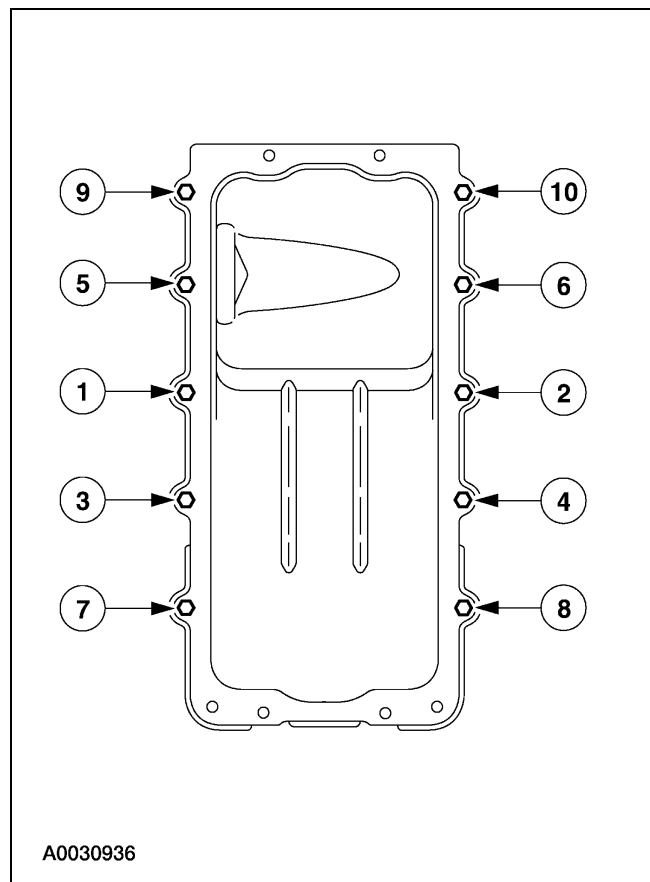


40. Install the oil pan and gasket, and loosely install the bolts.



41. Tighten the bolts in the sequence shown, in two stages.

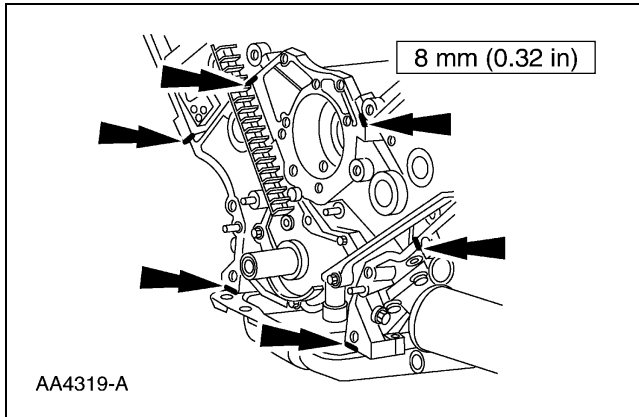
- Stage 1: Tighten to 20 Nm (15 lb-ft).
- Stage 2: Rotate an additional 60 degrees.



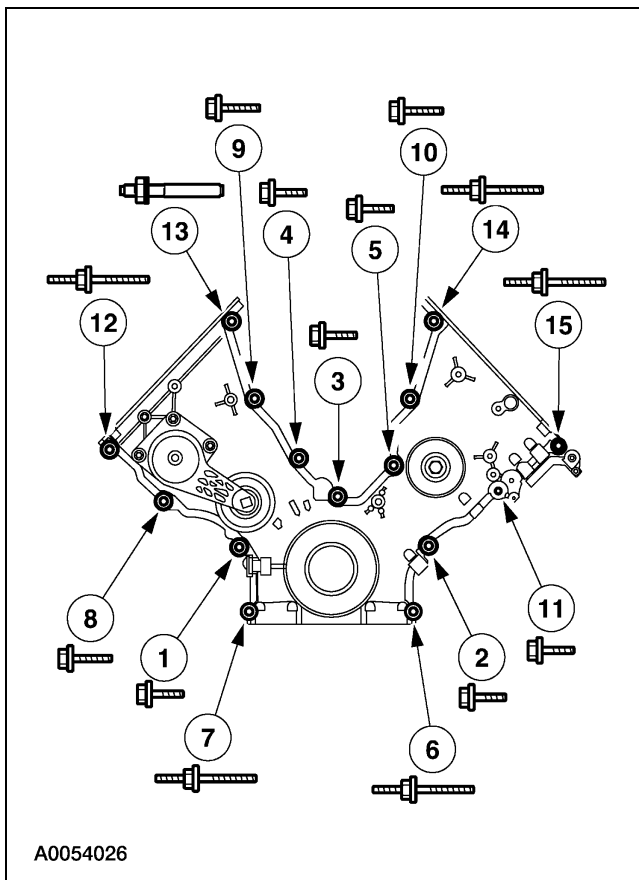
ASSEMBLY (Continued)

42. **NOTE:** If the engine front cover is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can result in future oil leakage.

Apply silicone gasket and sealant in the locations shown.



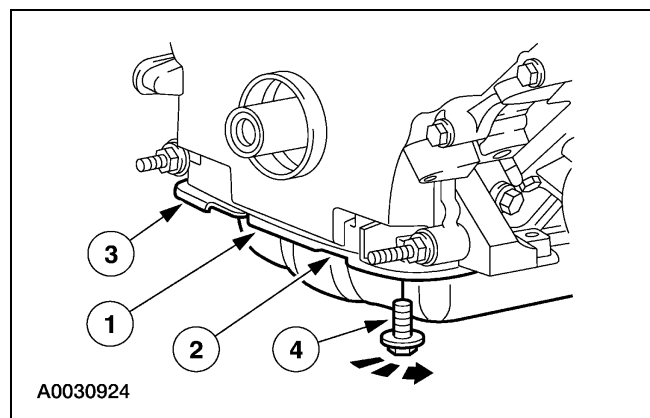
43. Install the engine front cover, the bolts and the studs, and tighten the fasteners in the sequence shown to 25 Nm (18 lb-ft).



Item	Part Number	Description
1	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
2	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
3	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
4	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
5	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
6	N806300	Stud, Hex Shldr Pilot, M8 x 1.25 x 1.25 x 91.1
7	N806300	Stud, Hex Shldr Pilot, M8 x 1.25 x 1.25 x 91.1
8	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
9	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
10	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
11	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 53
12	W706560	Stud, Hex Head Pilot, M8 x 1.25 x 65 — M8 x 1.25 x 16
13	N806300	Stud, Hex Shldr Pilot, M8 x 1.25 x 1.25 x 91.1
14	N806300	Stud, Hex Shldr Pilot, M8 x 1.25 x 1.25 x 91.1
15	N806300	Stud, Hex Shldr Pilot, M8 x 1.25 x 1.25 x 91.1

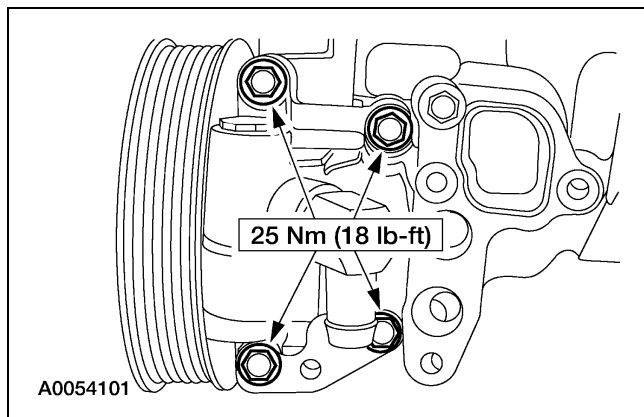
44. Tighten the four oil pan bolts in the sequence shown, in three stages.

- Stage 1: Tighten to 2 Nm (18 lb-in).
- Stage 2: Tighten to 20 Nm (15 lb-ft).
- Stage 3: Tighten an additional 60 degrees.

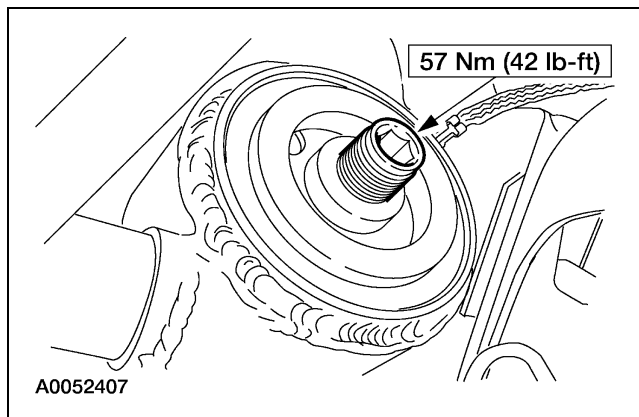


ASSEMBLY (Continued)

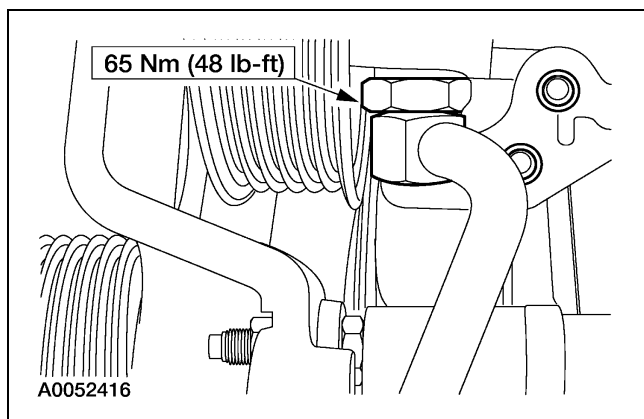
45. Install the power steering pump and the bolts.



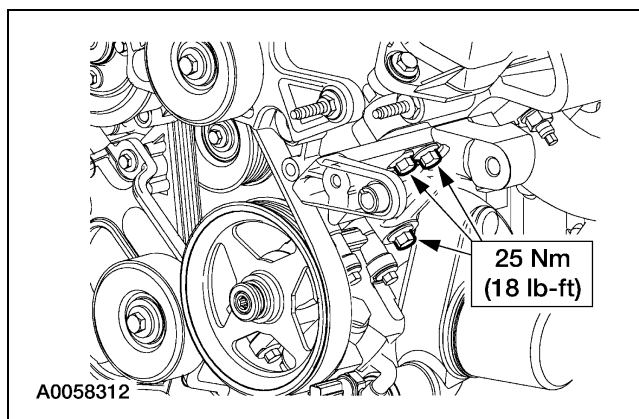
48. Install a new O-ring seal and the oil cooler.



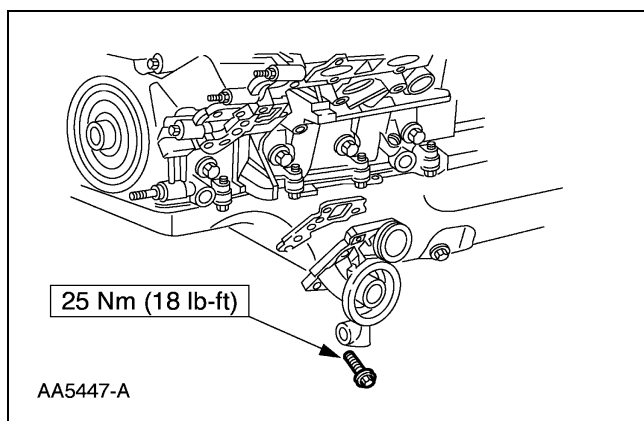
46. Install the power steering hose.



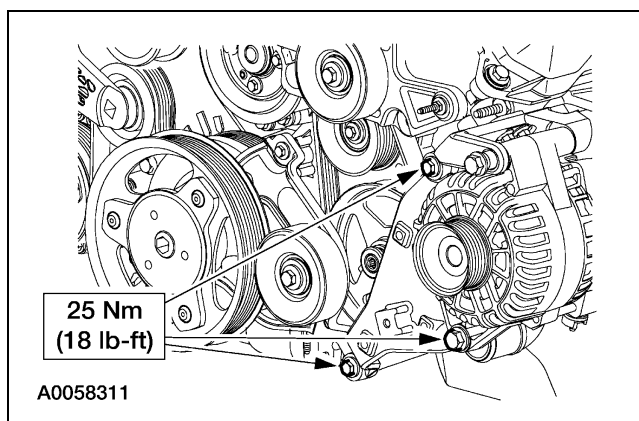
49. Install the generator support bracket.



47. Install a new gasket and the oil filter adapter.



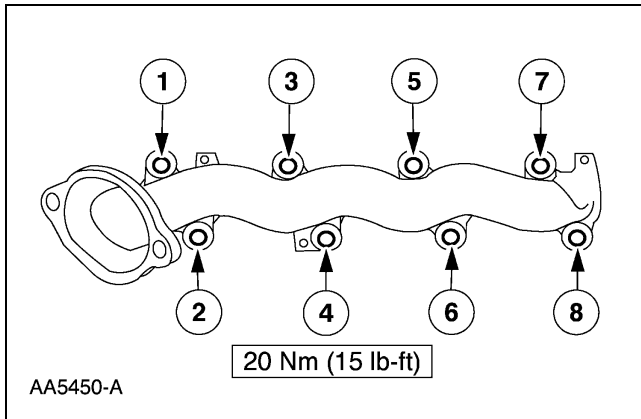
50. Install the generator.



ASSEMBLY (Continued)

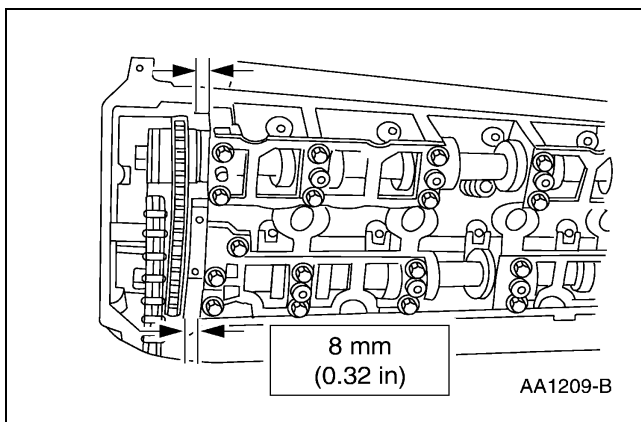
51. **NOTE:** RH is shown, LH is similar. Use new gaskets when installing the exhaust manifolds. Install the exhaust manifolds.

- Tighten the nuts in the sequence shown.

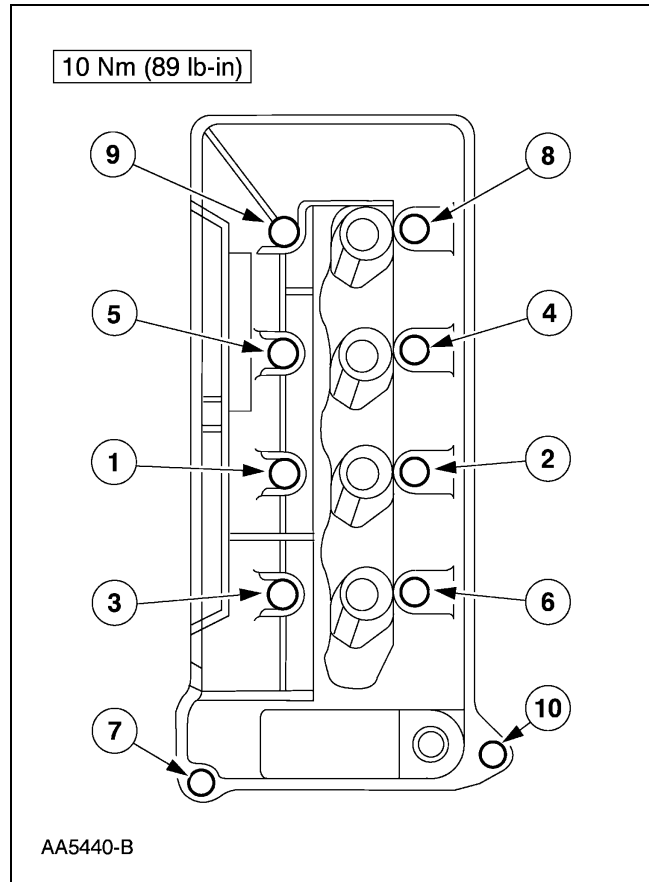


52. **NOTE:** If the valve cover is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can result in future oil leakage.

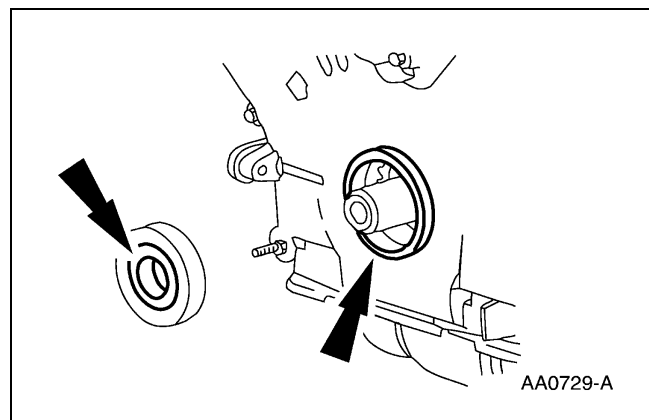
Apply silicone gasket and sealant in the locations shown.



53. **NOTE:** RH is shown, LH is similar. Inspect and install new O-ring seals if necessary. Install the valve covers and tighten the bolts in the sequence shown.

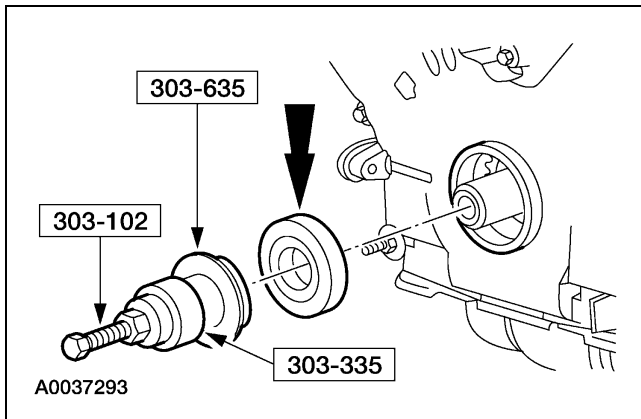


54. Lubricate the front oil seal and the engine front cover with clean engine oil.



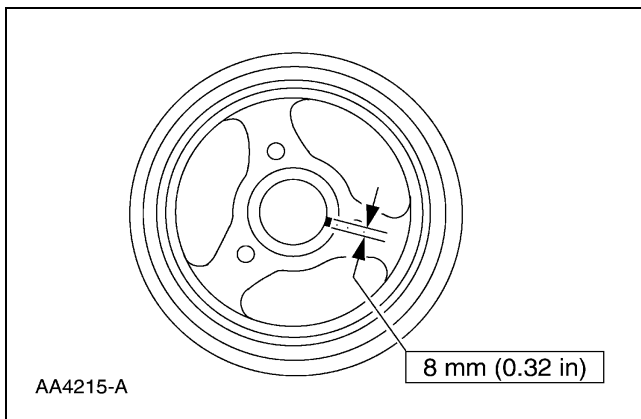
ASSEMBLY (Continued)

55. Using the special tools, install the front oil seal.

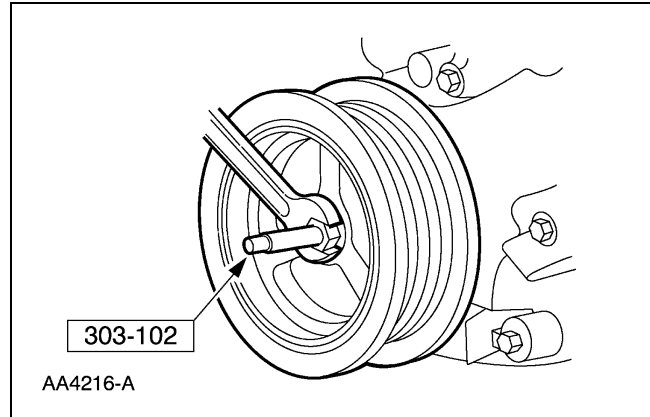


56. **NOTE:** If the crankshaft pulley is not installed within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can result in future oil leakage.

Apply silicone gasket and sealant to the Woodruff key on the crankshaft pulley.

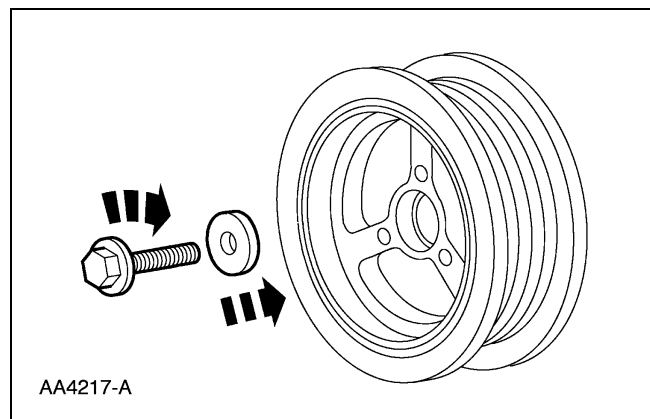


57. Using the special tool, install the crankshaft pulley.



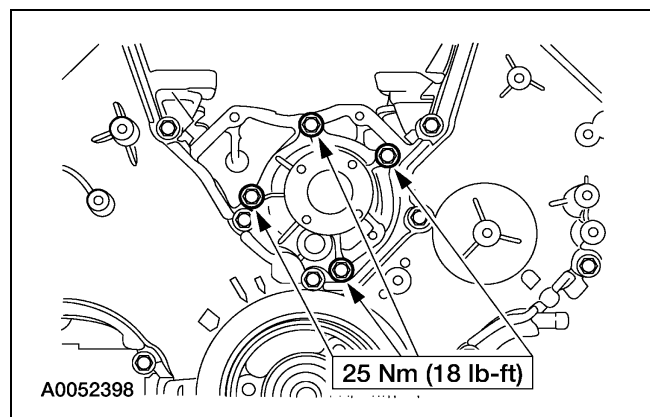
58. Install the crankshaft pulley and tighten the bolt in four stages.

- Stage 1: Tighten to 90 Nm (66 lb-ft).
- Stage 2: Loosen the bolt one full turn.
- Stage 3: Tighten to 50 Nm (37 lb-ft).
- Stage 4: Tighten an additional 90 degrees.



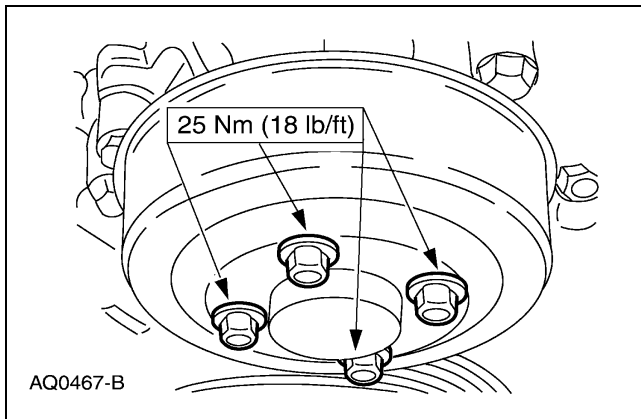
59. **NOTE:** Lubricate the O-ring seal with clean engine coolant.

Install the water pump.

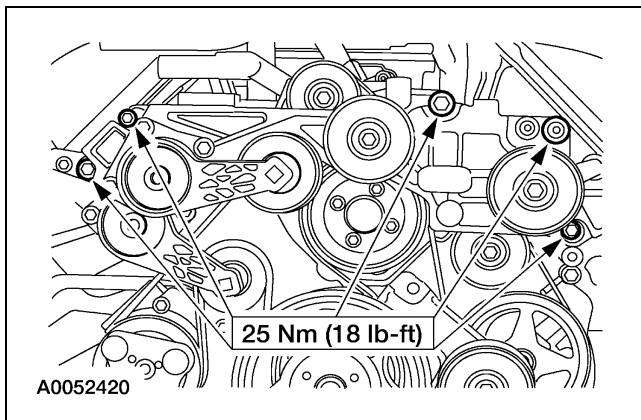


ASSEMBLY (Continued)

60. Install the water pump pulley and the bolts.



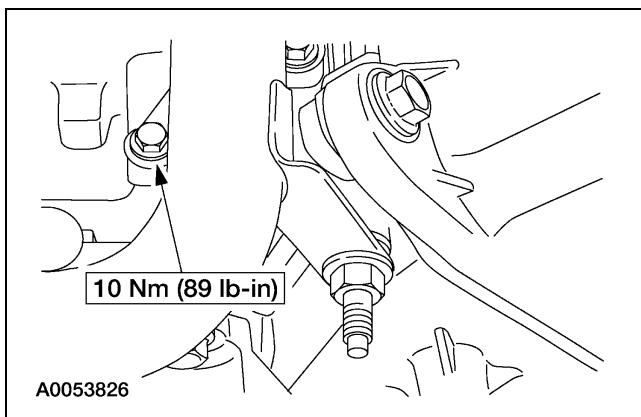
61. Install the supercharger belt idler support bracket assembly.



62. **NOTE:** Lubricate the O-rings with clean engine coolant.

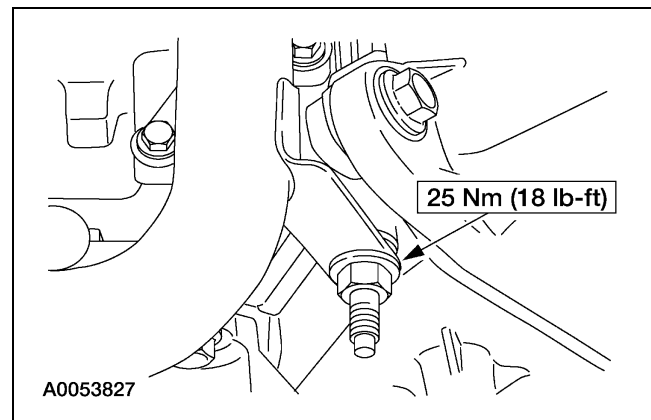
NOTE: LH is shown, RH is similar.

Install the coolant bypass tube and mounting bolts.



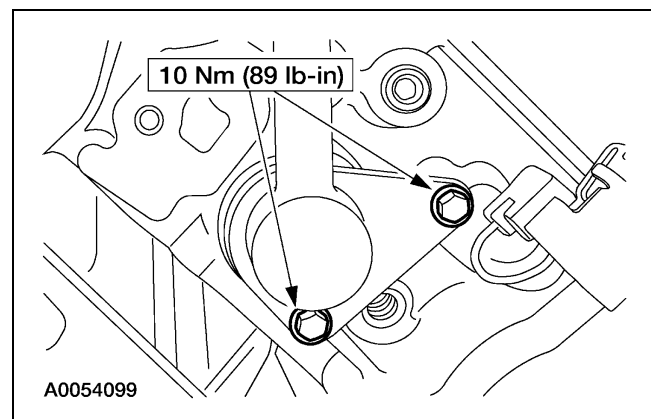
63. **NOTE:** LH is shown, RH is similar.

Install the coolant bypass tube studs.



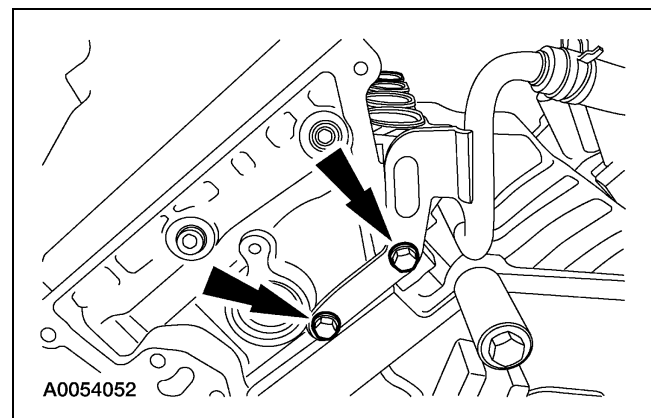
64. **NOTE:** Lubricate the O-ring with clean engine coolant.

Install the heater water inlet tube.



65. **NOTE:** Lubricate the O-rings with clean engine coolant.

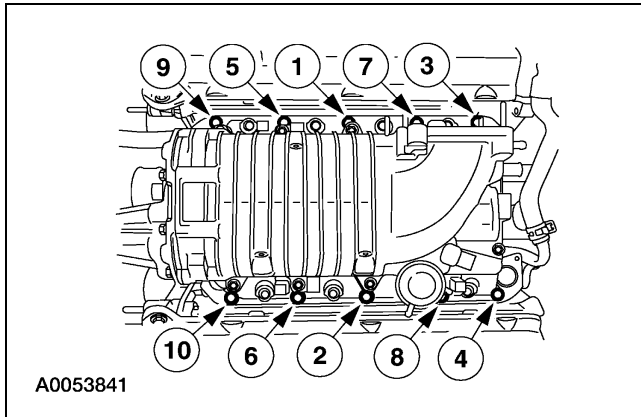
Install the heater water outlet tube and the mounting bolts.



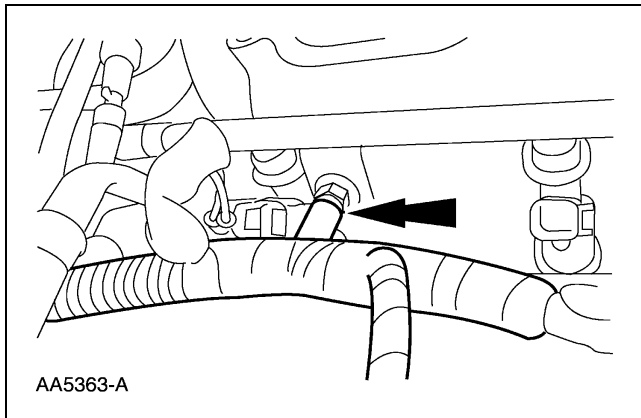
ASSEMBLY (Continued)

66. **NOTE:** Inspect the intake manifold gaskets and install new gaskets, if necessary.

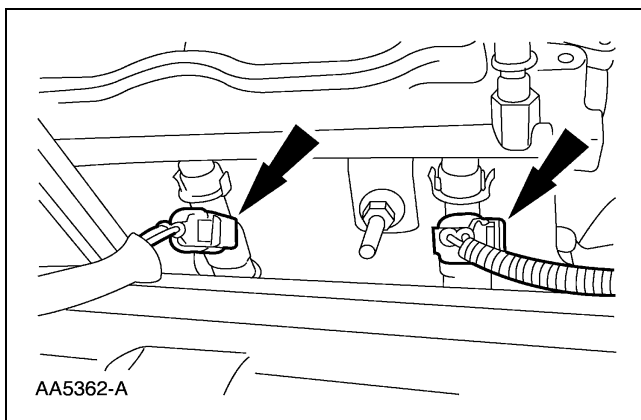
Install the intake manifold, supercharger and fuel supply manifold as an assembly, and tighten the bolts to 10 Nm (89 lb-in) in the sequence shown.



67. Position the wiring harness onto the engine and attach it to the four fuel supply manifold studs.

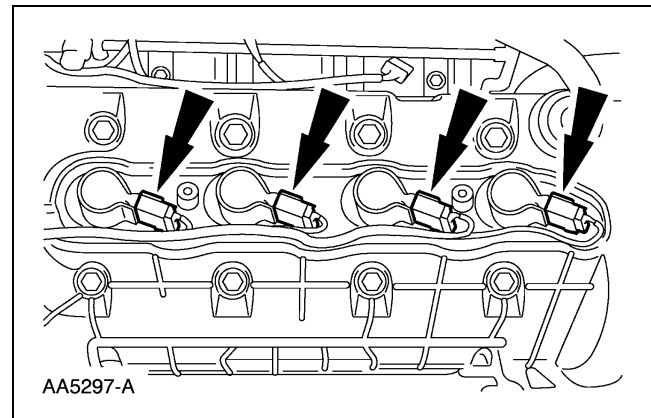


68. Connect the eight fuel injector electrical connectors.

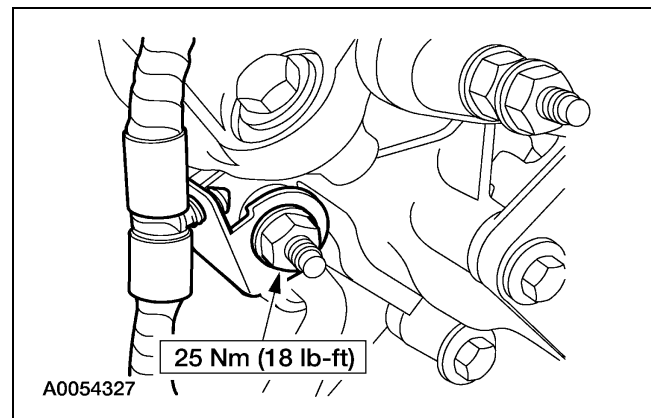


69. **NOTE:** RH is shown, LH is similar.

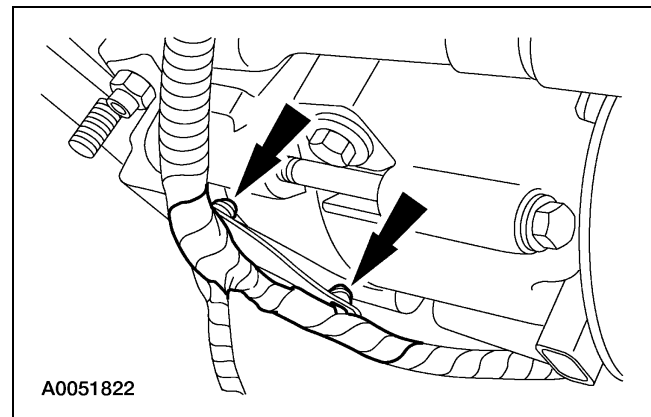
Install the RH and LH ignition coils and connect the electrical connectors.



70. Install the harness support bracket.

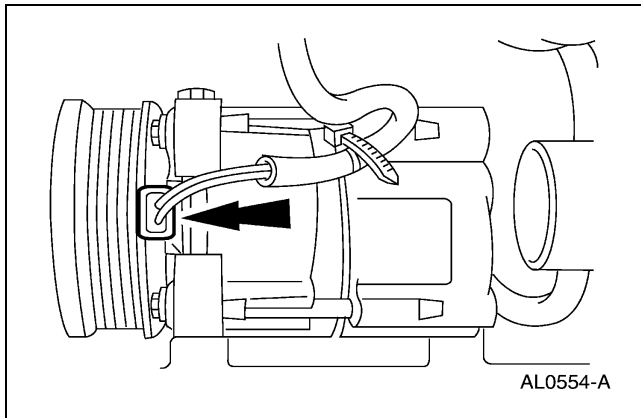


71. Clip the harness to the bracket.

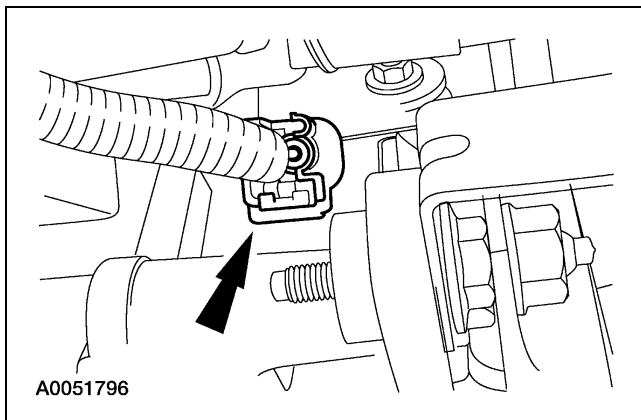


ASSEMBLY (Continued)

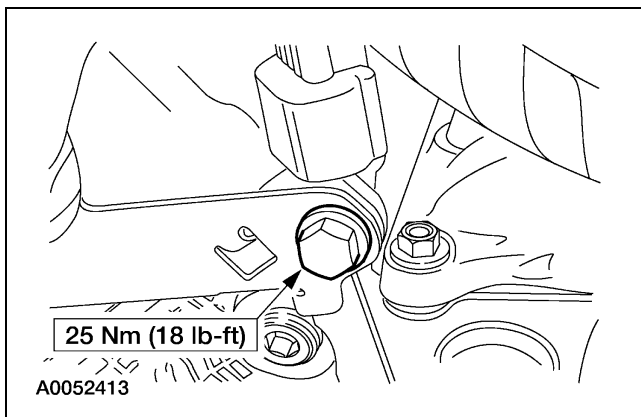
72. Connect the A/C compressor electrical connector.



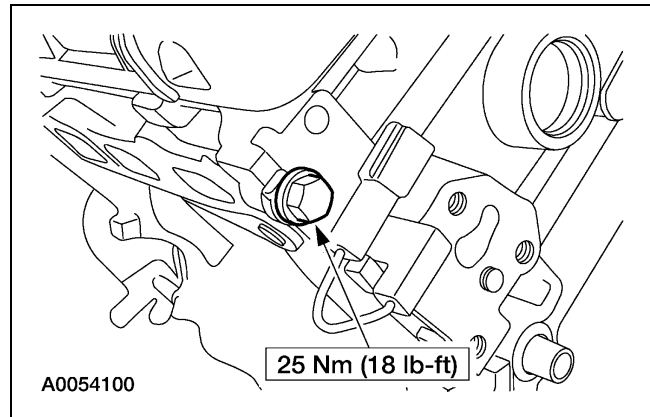
73. Connect the crankshaft position (CKP) sensor electrical connector.



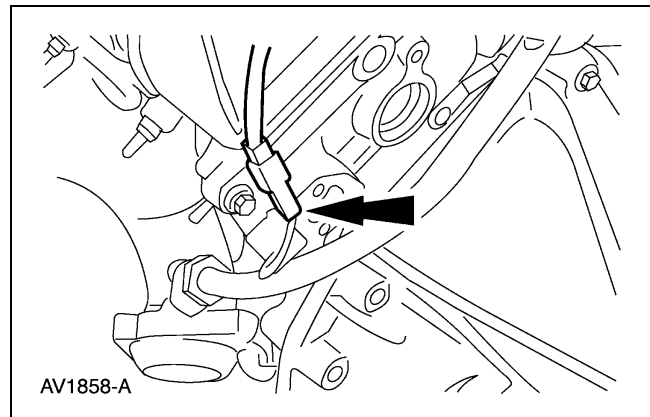
74. Install the fuel charging wiring harness bracket bolt.



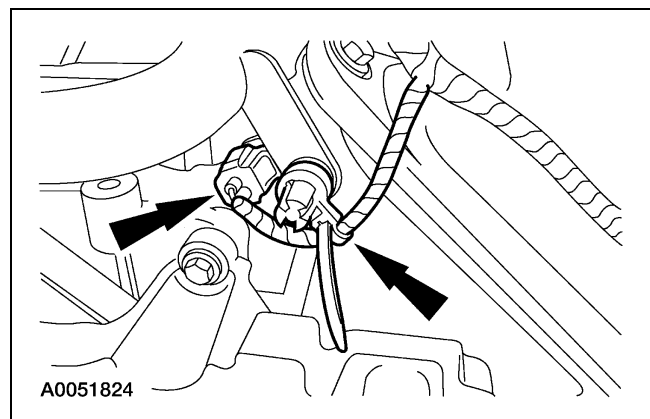
75. **NOTE:** LH is shown, RH is similar.
Install the RH and LH radio ignition interference capacitors.



76. **NOTE:** LH is shown, RH is similar.
Connect the two radio ignition interference capacitor electrical connectors.

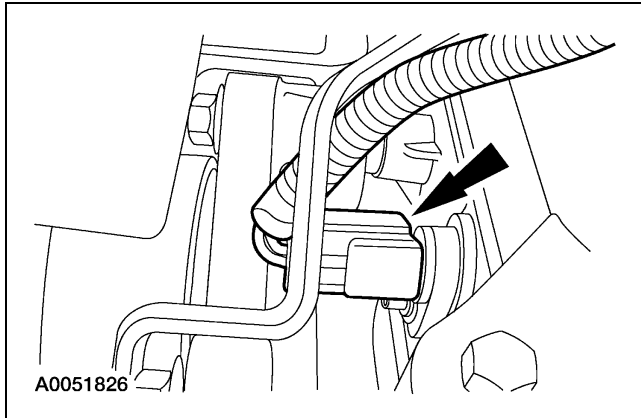


77. Connect the engine coolant temperature (ECT) sensor electrical connector, and attach the harness to the stud.

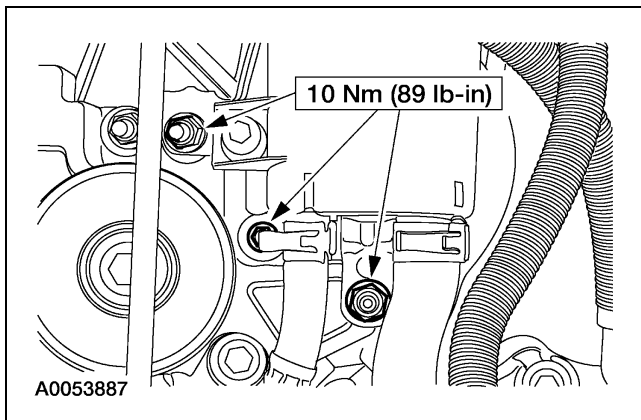


ASSEMBLY (Continued)

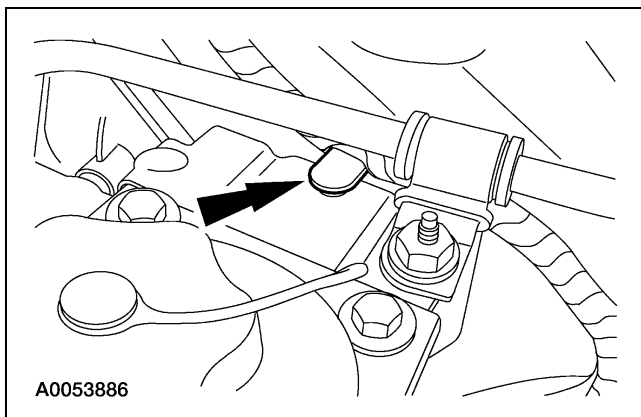
78. Connect the camshaft position (CMP) sensor electrical connector.



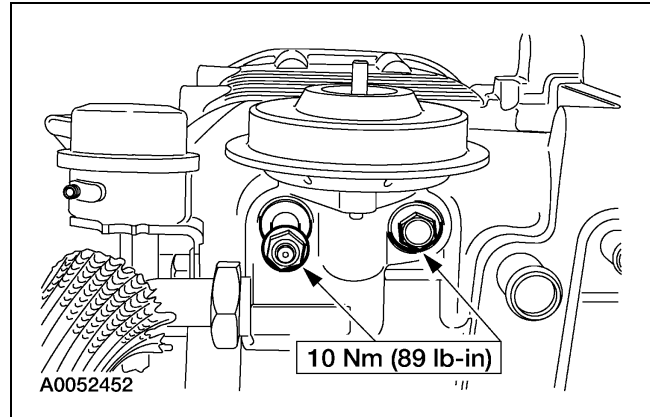
79. Install the power steering reservoir and mounting bolts.



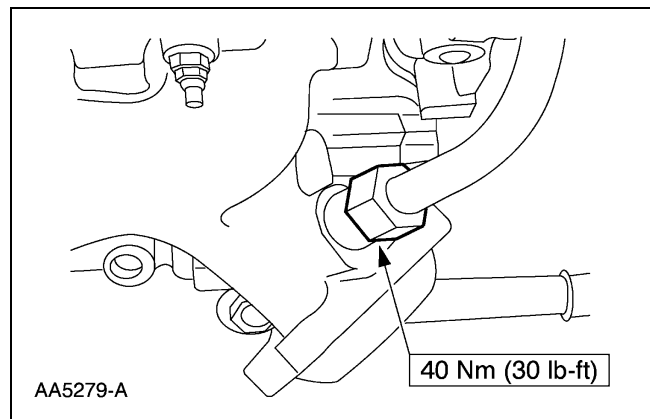
80. Attach the wiring harness to the power steering support bracket.



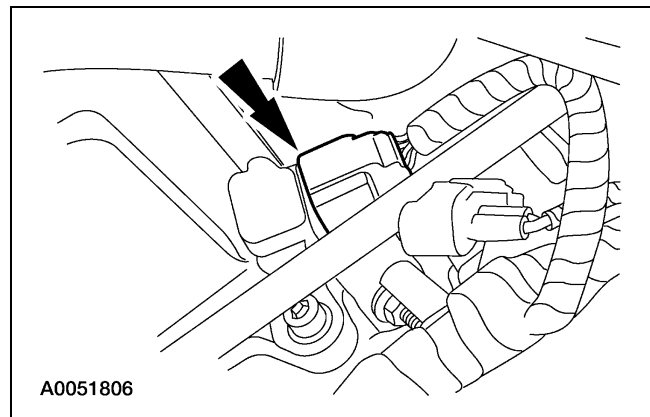
81. **NOTE:** Install a new exhaust gas recirculation (EGR) valve gasket.
Install the EGR valve and tube as an assembly.



82. Tighten the EGR tube to the exhaust manifold.

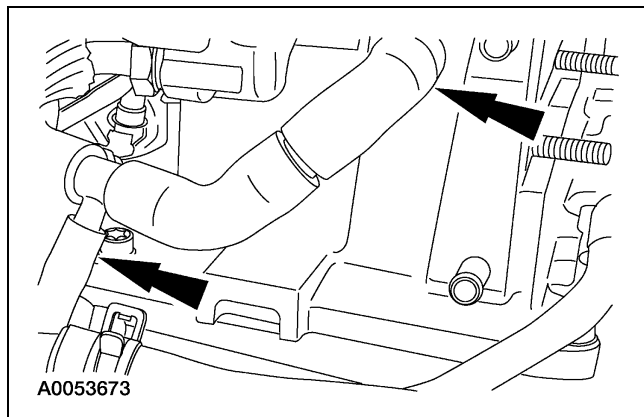


83. Connect the barometric pressure (BARO) sensor electrical connector.

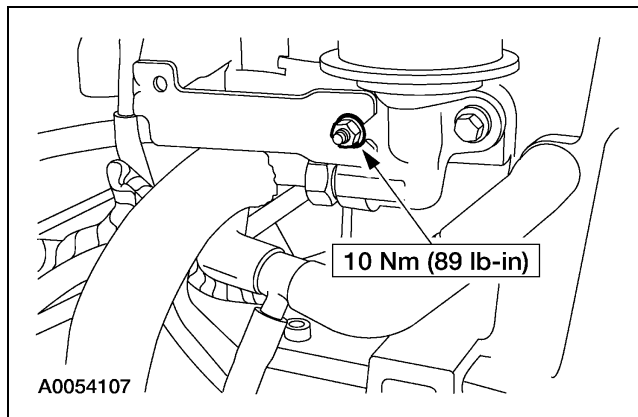


ASSEMBLY (Continued)

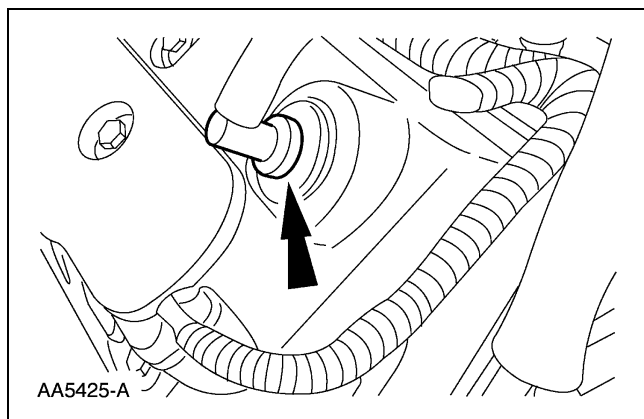
84. Install and connect the positive crankcase ventilation (PCV) hose.



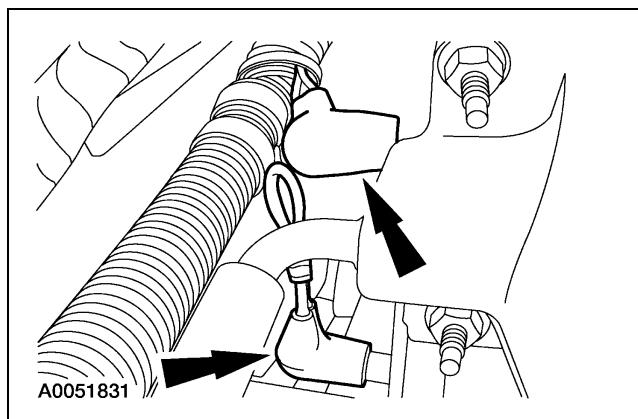
87. Install the vacuum accessory bracket mounting nut.



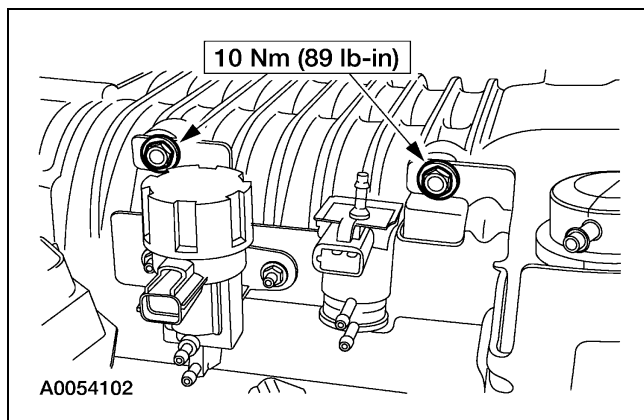
85. Install the PCV valve.



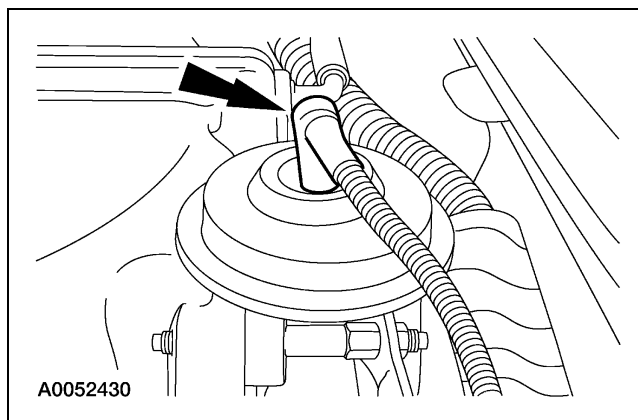
88. Position the vacuum harness and connect the vacuum hoses to the back of the supercharger.



86. Install the vacuum accessory bracket and the mounting bolts.

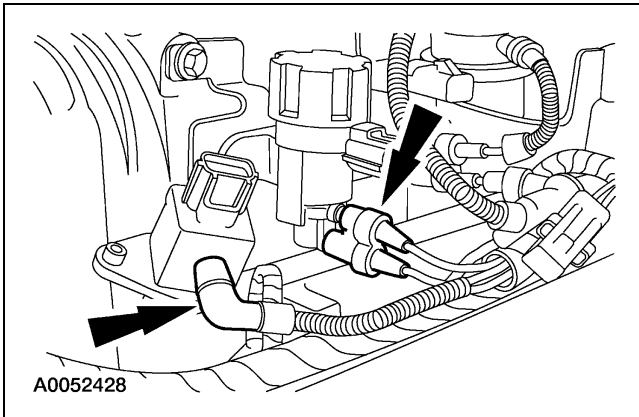


89. Connect the vacuum hose to the EGR valve.

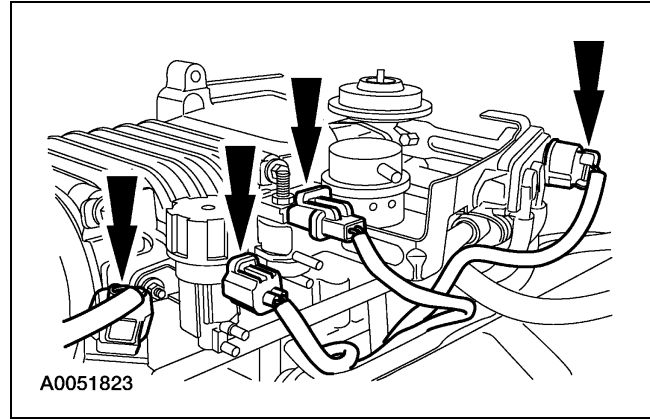


ASSEMBLY (Continued)

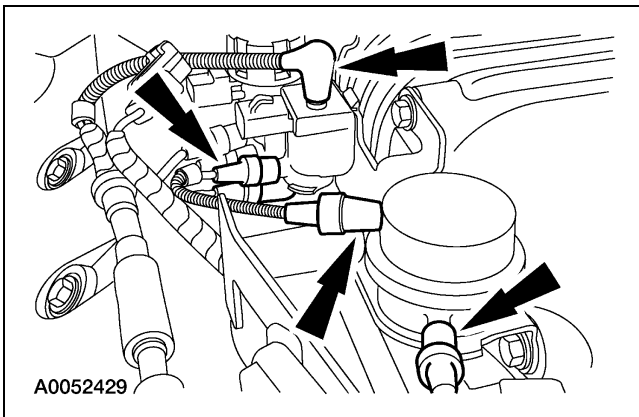
90. Connect the vacuum hoses to the fuel pulse damper and the EGR vacuum regulator solenoid.



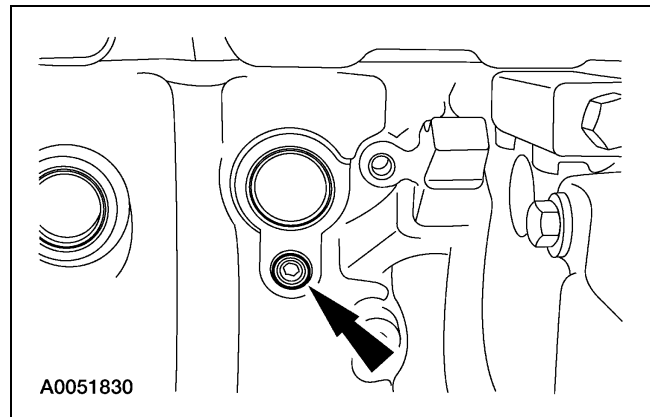
93. Connect the electrical connectors to the fuel pulse damper, EGR vacuum regulator solenoid, supercharger bypass vacuum solenoid, and the differential pressure feedback EGR system.



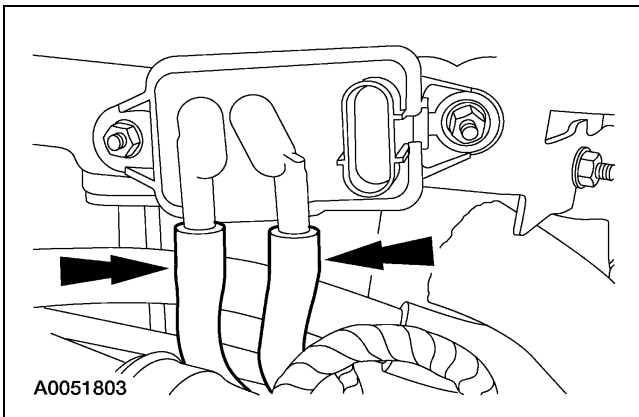
91. Connect the vacuum hoses to the supercharger bypass vacuum solenoid and the actuator.



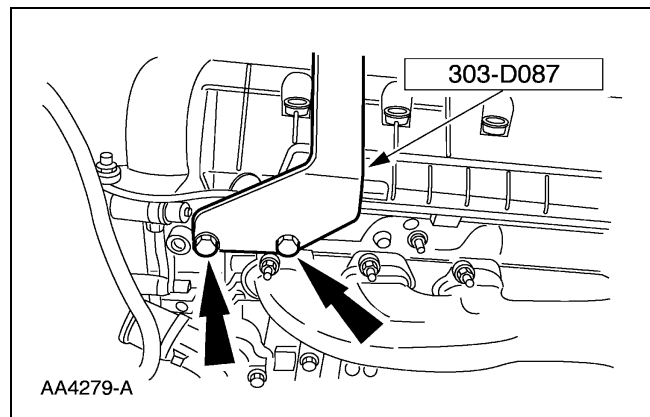
94. Install the drain plug.



92. Connect the vacuum hoses to the differential pressure feedback EGR system.

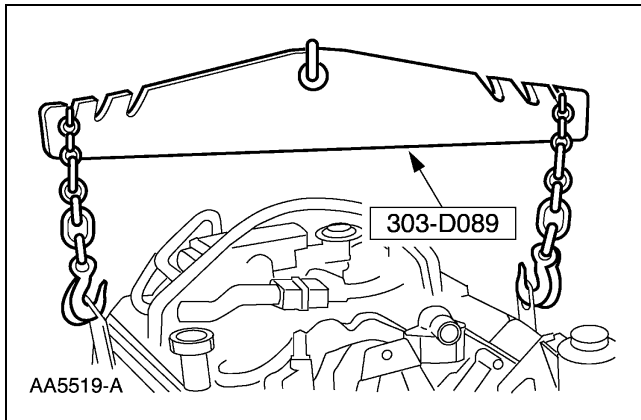


95. Install the special tools.



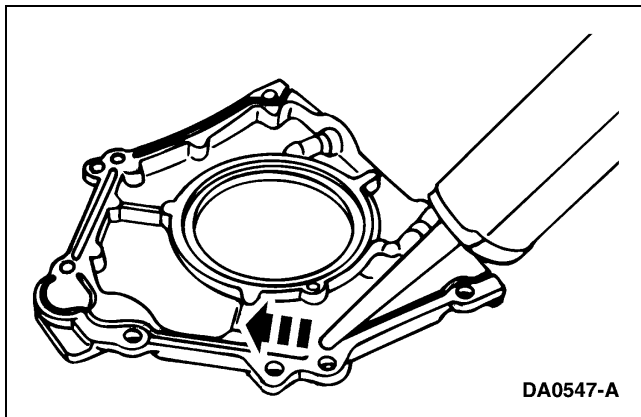
ASSEMBLY (Continued)

96. Attach the special tool to a floor crane and the engine, and remove the engine from the stand.



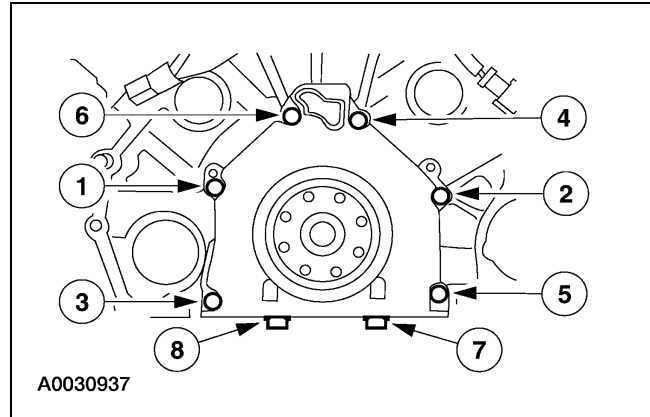
97. **NOTE:** If not secured within four minutes, the sealant must be removed and the sealing surface must be cleaned with metal surface cleaner. Allow the surface to dry until there is no sign of wetness or four minutes, whichever is longer. Failure to follow this procedure can result in future oil leakage.

Apply a 4 mm (0.16 in) bead of silicone gasket and sealant around the rear oil seal retainer plate sealing surface. Also apply a bead of silicone gasket and sealant at the junction where the cylinder block, oil pan and rear oil seal retainer plate meet.

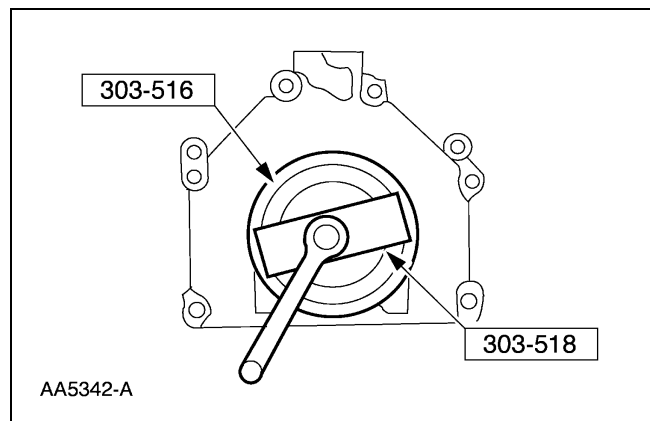


98. Install the rear oil seal retainer plate and tighten the bolts in the sequence shown.

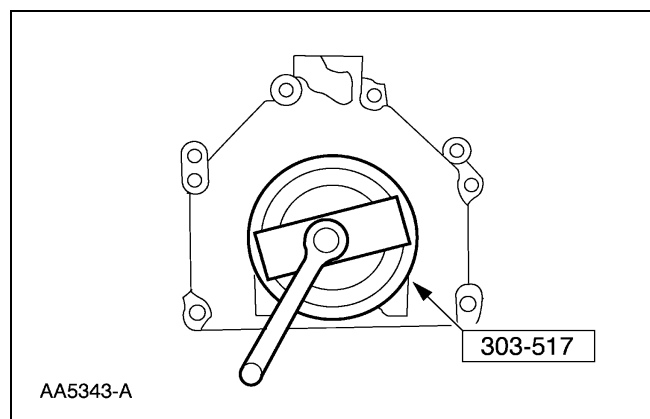
- Tighten bolts No. 1-6 to 10 Nm (89 lb-in).
- Tighten bolts No. 7 and 8 to 20 Nm (15 lb-ft)
- Tighten bolts No. 7 and 8 an additional 60 degrees.



99. Using the special tools, install the crankshaft rear main seal.



100. Using the special tool, install the crankshaft oil slinger.



ASSEMBLY (Continued)

101. Install the flywheel and the bolts.

- Tighten the bolts in the sequence shown.

