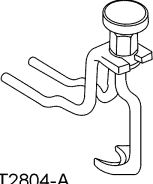
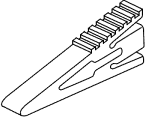
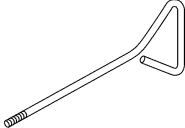


IN-VEHICLE REPAIR

Camshafts

Special Tool(s)

 <p>ST2804-A</p>	<p>Compressor, Valve Spring 303-1039</p>
 <p>ST2809-A</p>	<p>Wedge, Timing Chain 303-636</p>
 <p>ST2808-A</p>	<p>Wedge Handle, Timing Chain 303-637</p>

Material

Item	Specification
<p>Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (in Canada Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12) or equivalent</p>	<p>WSS-M2C930-A</p>

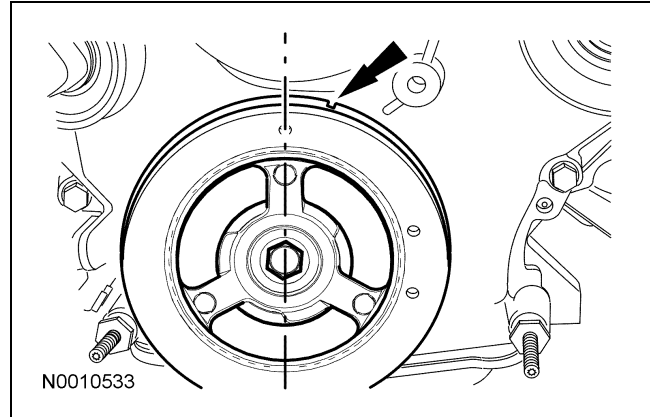
Removal

⚠ CAUTION: The camshaft procedure must be followed exactly or damage to the valves and pistons will result.

NOTE: If removing both camshafts, you must remove the RH camshaft first.

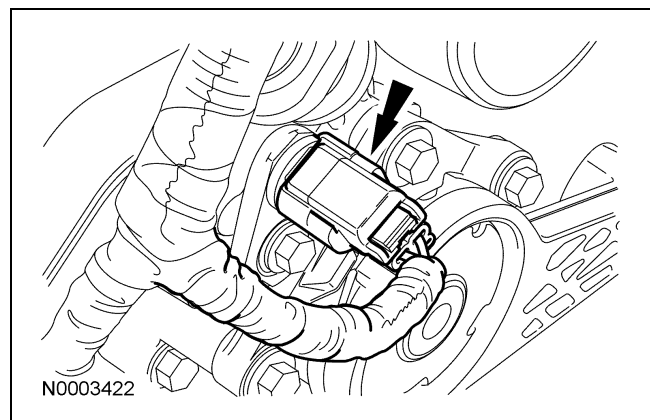
Both camshafts

1. Position the crankshaft damper spoke at the 12 o'clock position and the timing mark indentation at the 1 o'clock position.



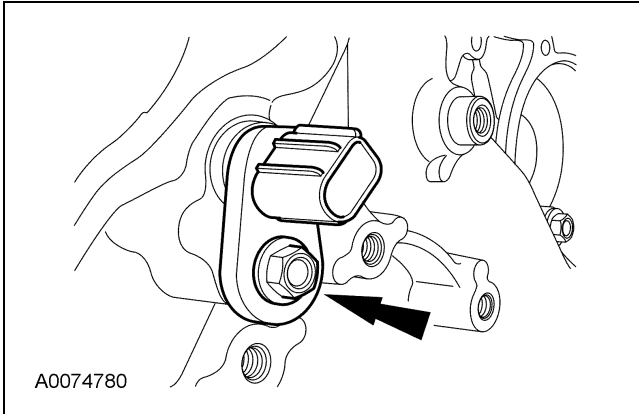
RH camshaft

2. Remove the RH valve cover. For additional information, refer to Valve Cover — RH in this section.
3. **⚠ CAUTION:** Damage to the camshaft phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.
Loosen and back off the RH camshaft phaser bolt one full turn.
4. Disconnect the RH camshaft position (CMP) sensor electrical connector.



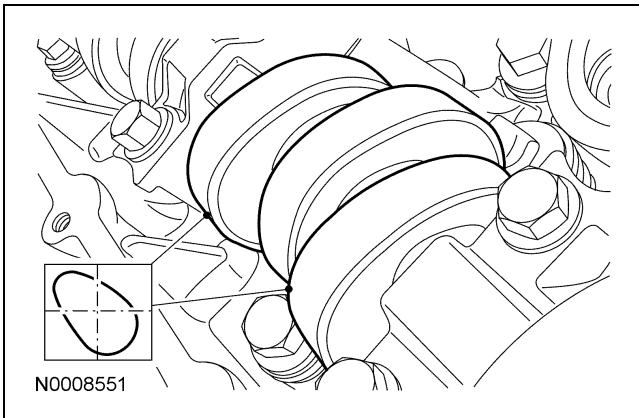
IN-VEHICLE REPAIR (Continued)

5. Remove the bolt and the RH CMP sensor.

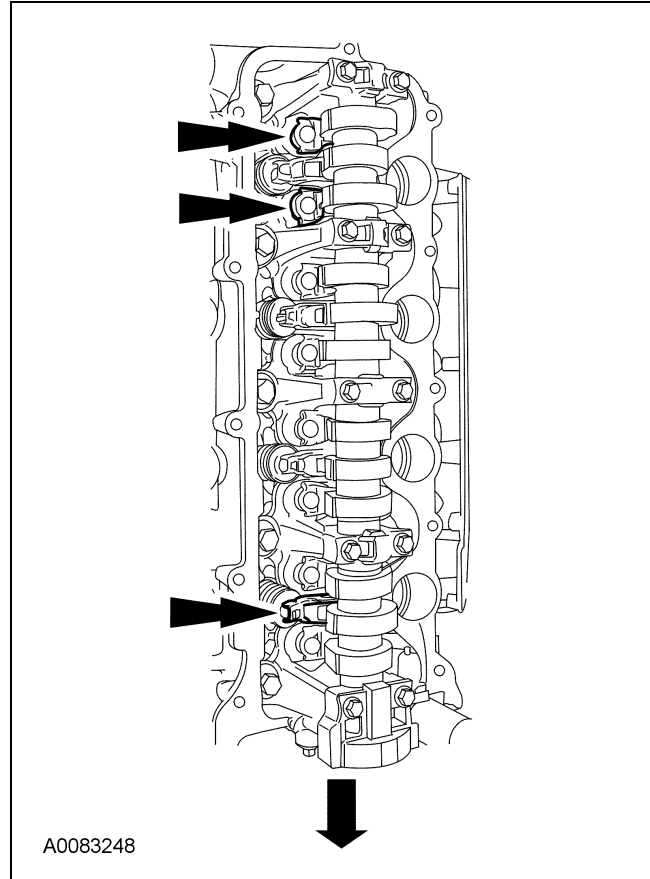


6. **NOTE:** If the camshaft lobes are not exactly positioned as shown, the crankshaft will require one full additional rotation to the 12 o'clock position.

The No. 1 cylinder must be coming up on the exhaust stroke with the crankshaft keyway at the 12 o'clock position. Verify by noting the position of the 2 intake lobes and the exhaust lobe on the No. 1 cylinder.



7. Remove only the 3 roller followers shown in the illustration.

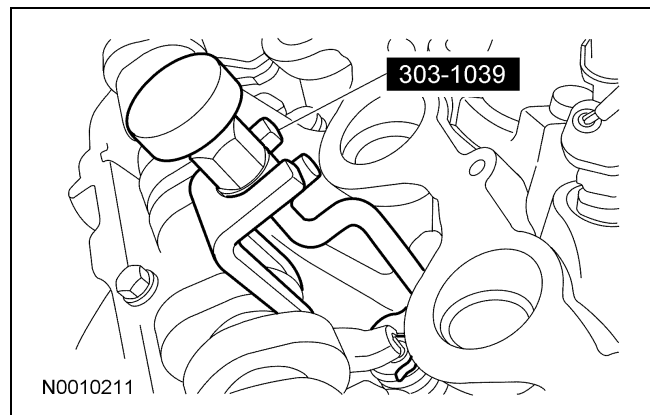


8. **⚠ CAUTION: Do not allow the valve keepers to fall off the valve or the valve may drop into the cylinder.**

NOTE: The camshaft roller followers must be installed in their original locations. Record camshaft roller follower locations.

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

Using the special tool, remove only the 3 roller followers designated in the previous step.



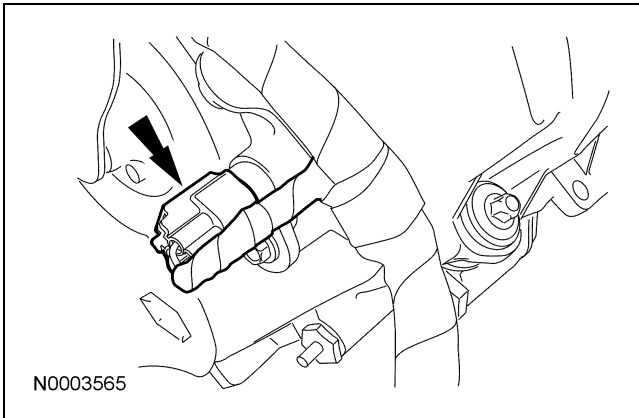
IN-VEHICLE REPAIR (Continued)**LH camshaft**

9. Remove the LH valve cover. For additional information, refer to Valve Cover — LH in this section.

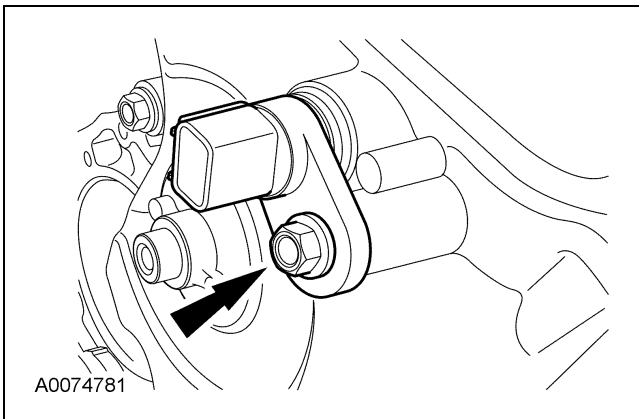
10. **⚠ CAUTION: Damage to the camshaft phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.**

Loosen and back off the LH camshaft phaser bolt one full turn.

11. Disconnect the LH camshaft position (CMP) sensor electrical connector.



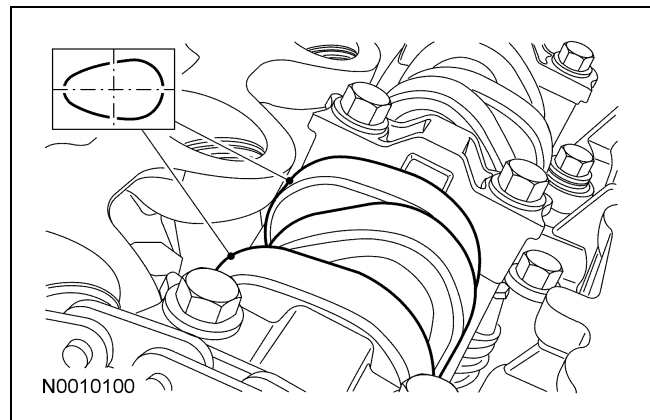
12. Remove the LH CMP sensor and the bolt.



13. **⚠ CAUTION: If servicing both camshafts, do not rotate the crankshaft. Camshaft position has been established in Step 6.**

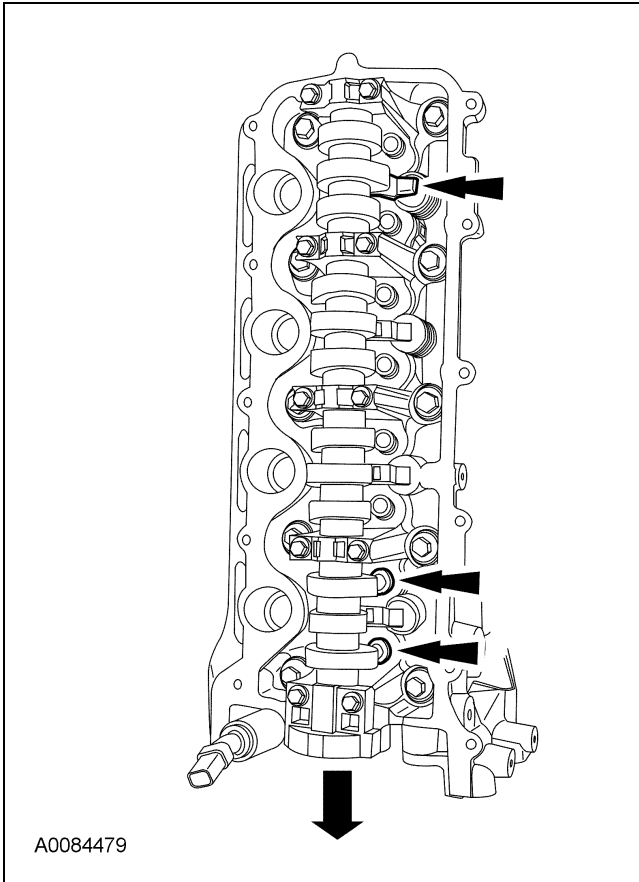
NOTE: If the camshaft lobes are not exactly positioned as shown, the crankshaft keyway will require one full additional rotation to the 12 o'clock position.

The No. 5 cylinder must be coming up on the exhaust stroke. Verify by noting the position of the 2 intake lobes and the exhaust lobe on the No. 5 cylinder.



IN-VEHICLE REPAIR (Continued)

14. Remove only the 3 roller followers shown in the illustration.

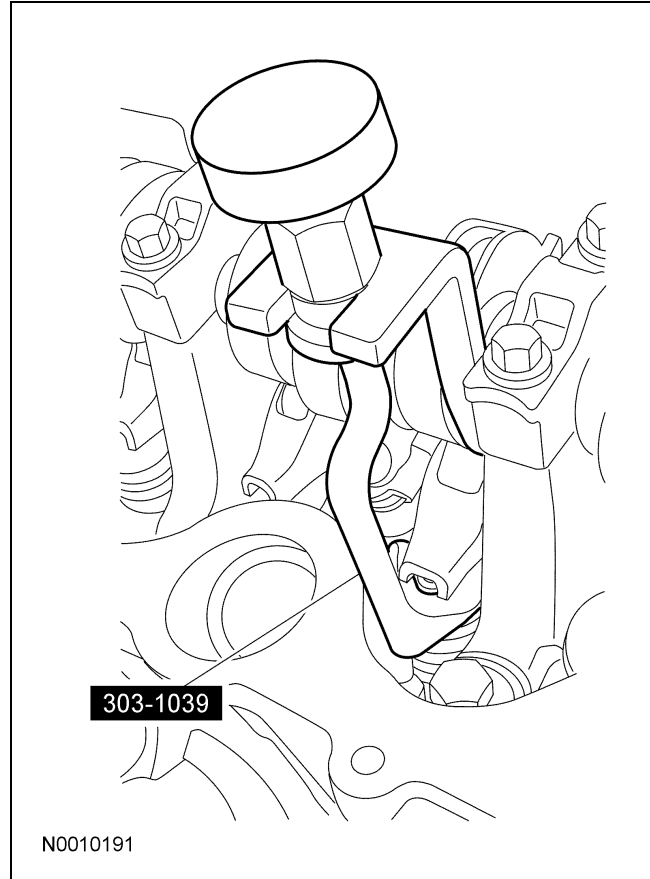


15. **⚠ CAUTION: Do not allow the valve keepers to fall off the valve or the valve may drop into the cylinder.**

NOTE: The camshaft roller followers must be installed in their original locations. Record camshaft roller follower locations.

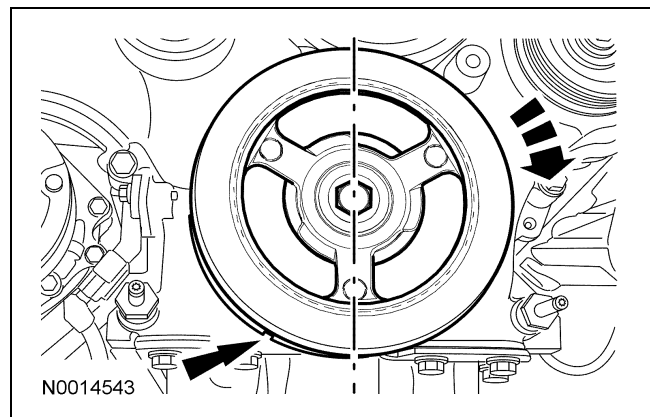
NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, remove only the 3 roller followers designated in the previous step.

**Both camshafts**


16. **⚠ CAUTION: The crankshaft cannot be moved past the 6 o'clock position once set.**


Rotate the crankshaft clockwise, as viewed from the front, positioning the crankshaft damper spoke at the 6 o'clock position and the timing mark indentation at the 7 o'clock position.



IN-VEHICLE REPAIR (Continued)

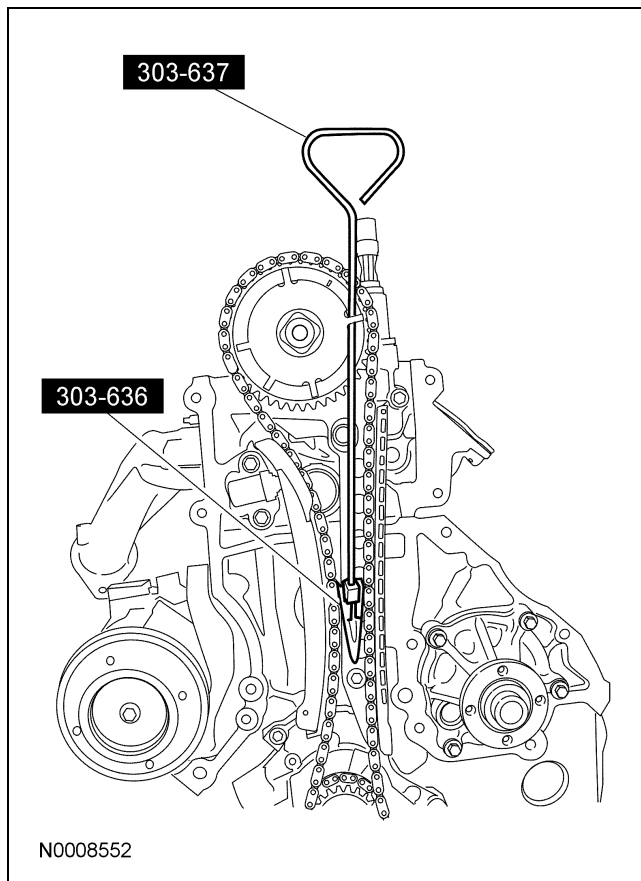
RH camshaft


17.  **CAUTION:** Engine is not freewheeling. Camshaft procedure must be followed exactly or damage to valves and pistons will result.


 **CAUTION:** The Timing Chain Wedge tool must be installed square to the timing chain and the engine block.

NOTE: Front cover removed for clarity.

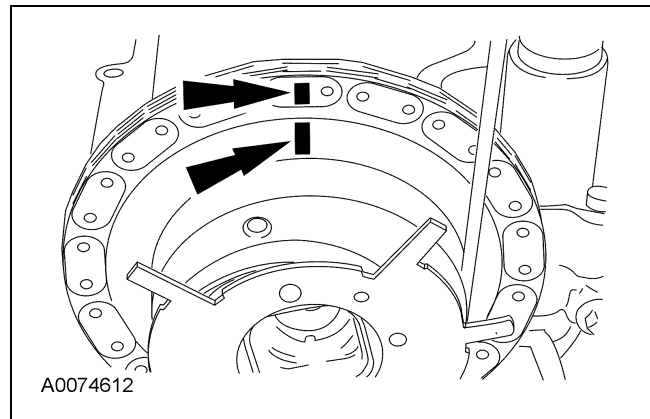
Install the special tool in the RH timing chain as shown.




18.  **CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.

 **CAUTION:** The timing chain must be installed in its original position onto the camshaft phaser sprocket using the scribed marks, or damage to valves and pistons will result.

Scribe a location mark on the timing chain and the camshaft phaser sprocket assembly.

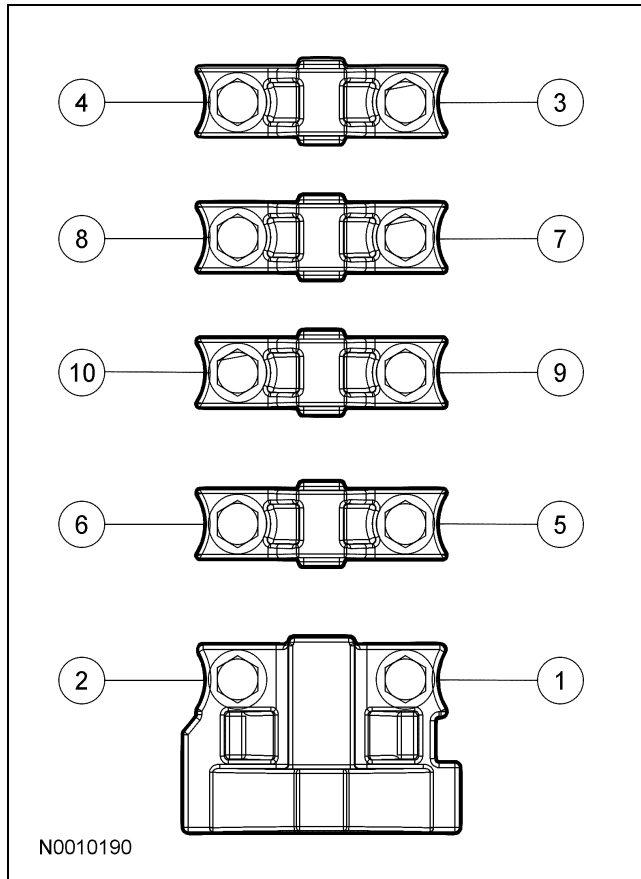


IN-VEHICLE REPAIR (Continued)

19.  **CAUTION:** Remove the front thrust camshaft bearing cap straight upward from the bearing towers, or the bearing cap may be damaged from sideloading.

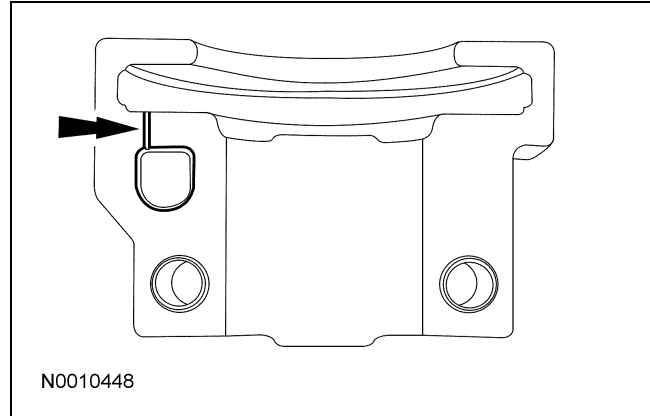
NOTE: The camshaft bearing caps must be installed in their original locations. Record camshaft bearing cap locations.


Remove the bolts in the sequence shown and remove the front camshaft bearing cap and then the remaining bearing caps.





20. Clean and inspect the RH camshaft bearing caps.

- The camshaft front thrust bearing cap contains an oil metering groove. Make sure the groove is free of foreign material.



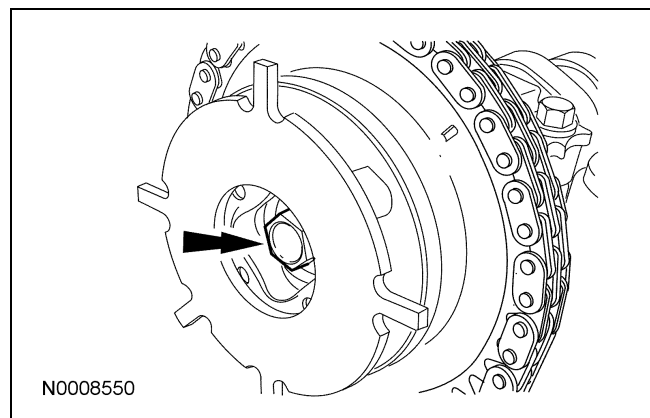
21.  **CAUTION:** Damage to the camshaft phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

 **CAUTION:** Only use hand tools to remove the camshaft phaser sprocket bolt or damage may occur to the camshaft or camshaft phaser unit.

 **CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to **Timing Drive Components** in this section.

Remove the bolt and withdraw the camshaft from the phaser sprocket assembly leaving the sprocket assembly in place.

- Discard the bolt and washer.



IN-VEHICLE REPAIR (Continued)

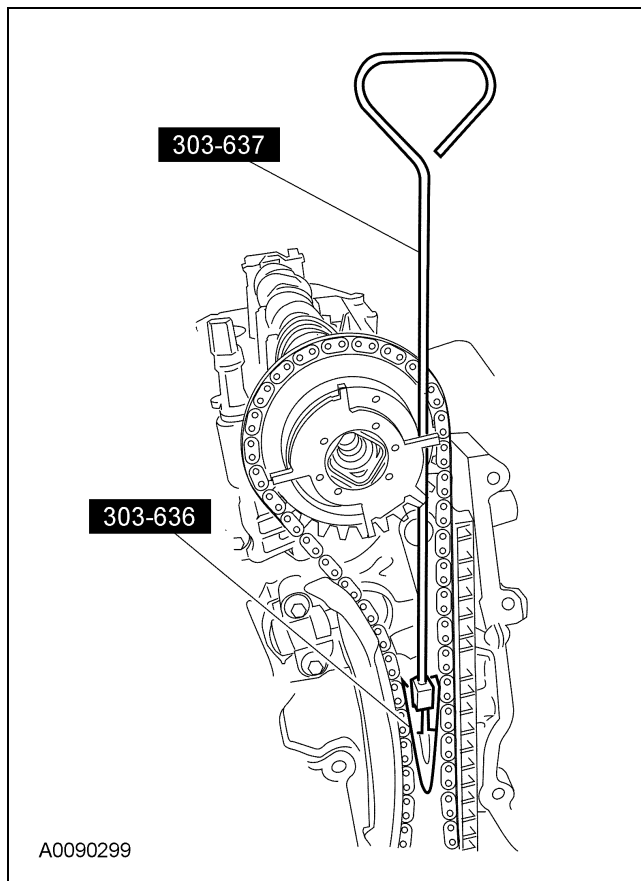
LH camshaft

22. ⚠ **CAUTION:** Engine is not freewheeling. Camshaft procedure must be followed exactly or damage to valves and pistons will result.

⚠ **CAUTION:** The Timing Chain Wedge tool must be installed square to the timing chain and the engine block.

NOTE: Front cover removed for clarity.

Install the special tool in the LH timing chain as shown.

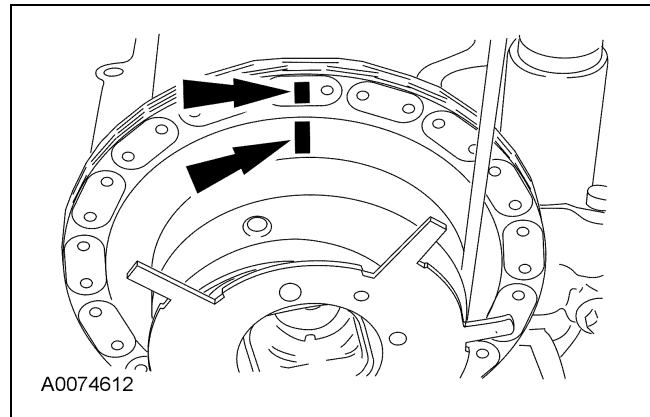


23. ⚠ **CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.


⚠ **CAUTION:** The timing chain must be installed in its original position onto the camshaft phaser sprocket using the scribed marks, or damage to valves and pistons will result.

NOTE: RH shown, LH similar.

Scribe a location mark on the timing chain and the camshaft phaser sprocket assembly.

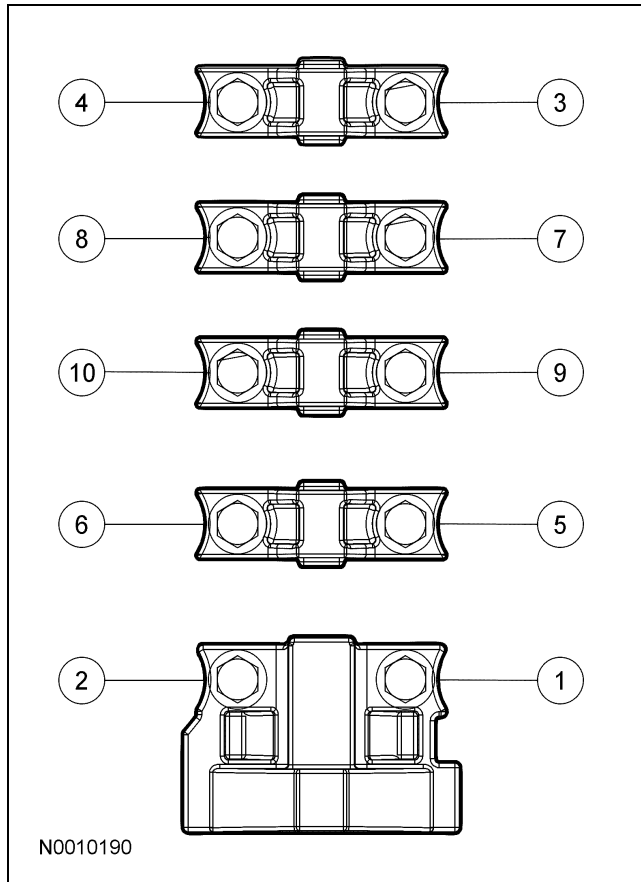


IN-VEHICLE REPAIR (Continued)

24.  **CAUTION:** Remove the front thrust camshaft bearing cap straight upward from the bearing towers, or the bearing cap may be damaged from sideloading.

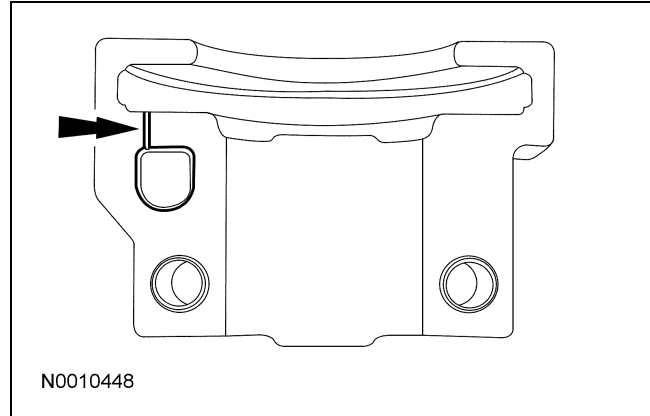
NOTE: The camshaft bearing caps must be installed in their original locations. Record camshaft bearing cap locations.


Remove the bolts in the sequence shown and remove the front camshaft bearing cap and then the remaining bearing caps.





25. Clean and inspect the LH camshaft bearing caps.

- The camshaft front thrust bearing cap contains an oil metering groove. Make sure the groove is free of foreign material.



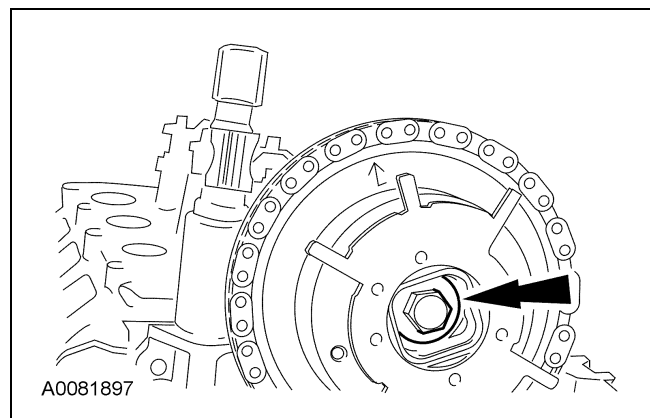
26.  **CAUTION:** Damage to the camshaft phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

 **CAUTION:** Only use hand tools to remove the camshaft phaser sprocket bolt or damage may occur to the camshaft or camshaft phaser unit.

 **CAUTION:** Do not remove the timing chain wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to **Timing Drive Components** in this section.

Remove the bolt and withdraw the camshaft from the phaser sprocket assembly leaving the sprocket assembly in place.

- Discard the bolt and washer.



IN-VEHICLE REPAIR (Continued)**Installation****Both camshafts**

1. Lubricate the camshaft and camshaft journals with clean engine oil.

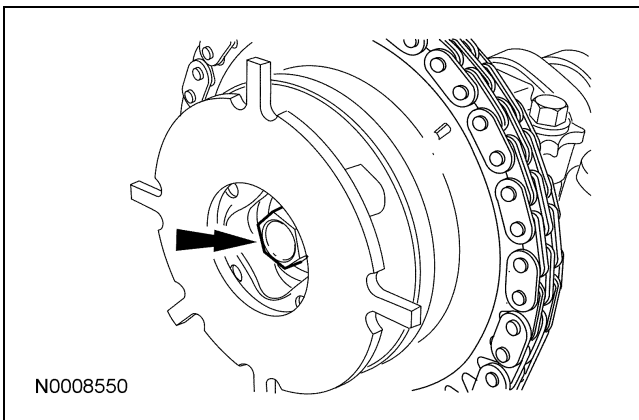
RH camshaft

2. **⚠ CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.

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

⚠ CAUTION: Do not allow the roller followers to move out of position when installing the camshaft.

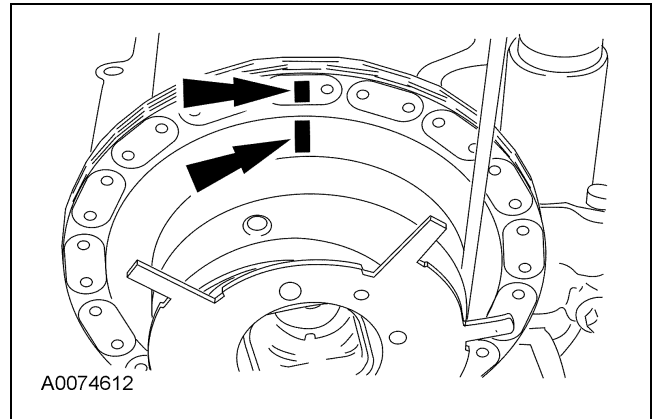
Install the camshaft into the camshaft phaser sprocket assembly and onto the head. Install a new camshaft phaser bolt finger tight.



3. **⚠ CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.

⚠ CAUTION: The timing chain must be installed in its original position onto the camshaft phaser sprocket using the scribed marks, or damage to valves and pistons will result.

Verify the camshaft phaser sprocket and timing chain scribe marks are still in alignment.



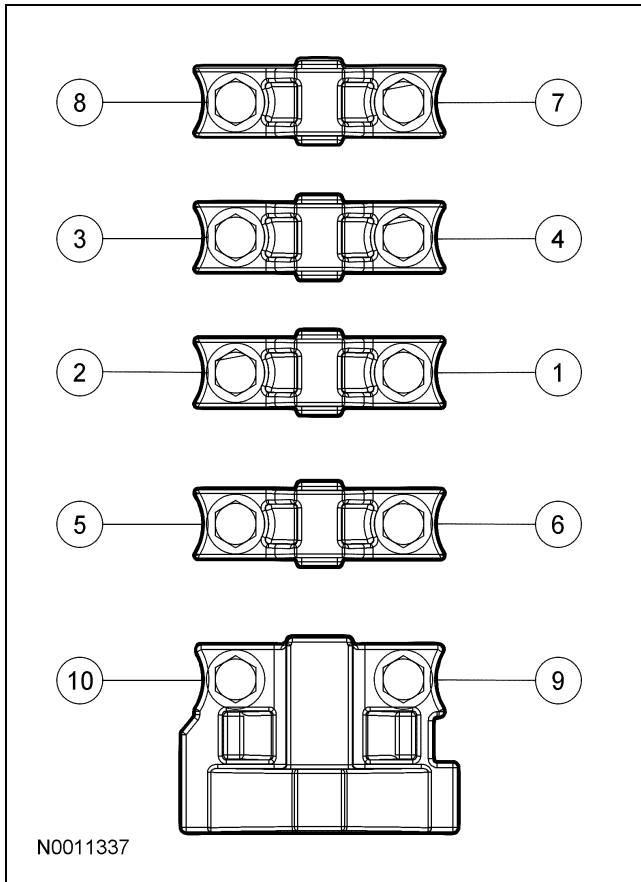
4. **⚠ CAUTION:** Do not allow the roller followers to move out of position when installing the camshaft.

Install the camshaft bearing caps in their original locations.

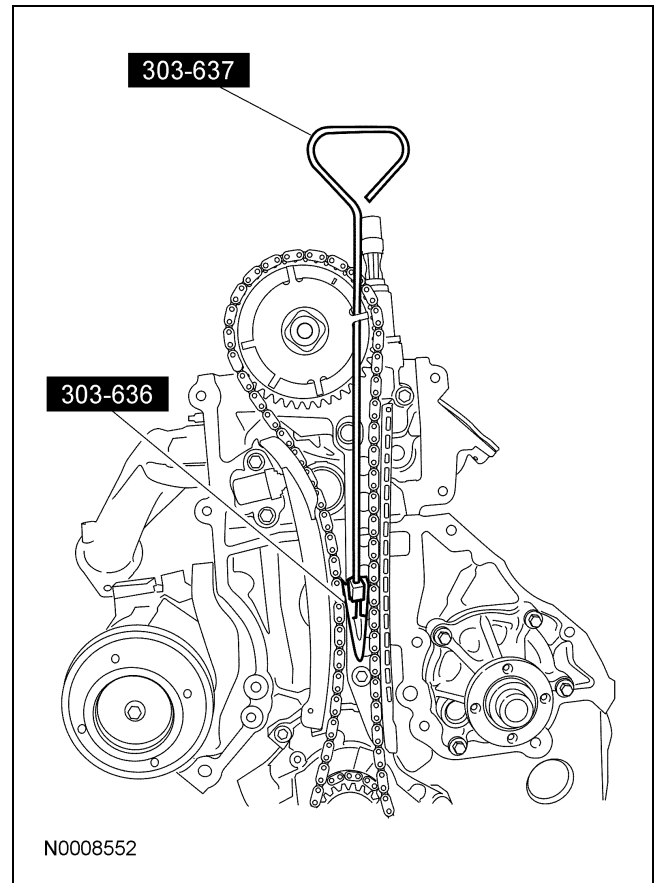
- Lubricate the camshaft bearing caps with clean engine oil.
- Position the front camshaft bearing cap.
- Position the remaining camshaft bearing caps.
- Install the bolts loosely.

IN-VEHICLE REPAIR (Continued)

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



6. Remove the special tools.



IN-VEHICLE REPAIR (Continued)

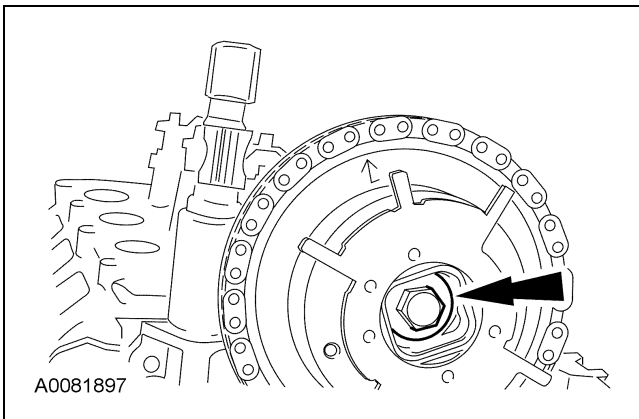
LH camshaft

7. **⚠ CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.

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

⚠ CAUTION: Do not allow the roller followers to move out of position when installing the camshaft.

Install the camshaft into the camshaft phaser sprocket assembly and onto the head. Install a new camshaft phaser bolt finger tight.

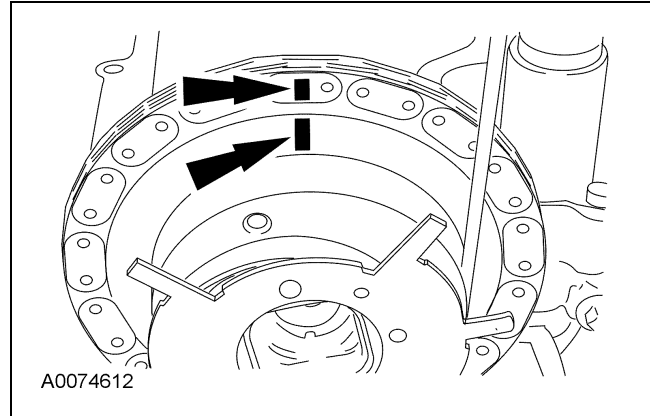


8. **⚠ CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.

⚠ CAUTION: The timing chain must be installed in its original position onto the camshaft phaser sprocket using the scribed marks, or damage to valves and pistons will result.

NOTE: RH shown, LH similar.

Verify the camshaft phaser sprocket and timing chain scribe marks are still in alignment.



9. **⚠ CAUTION:** Do not allow the roller followers to move out of position when installing the camshaft.

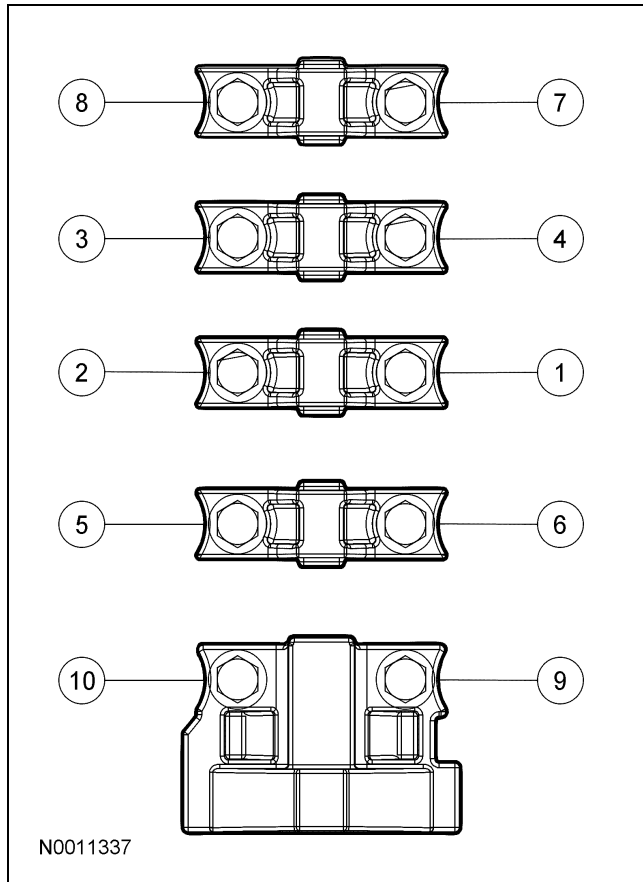
Install the camshaft bearing caps in their original locations.

- Lubricate the camshaft bearing caps with clean engine oil.
- Position the front camshaft bearing cap.
- Position the remaining camshaft bearing caps.
- Install the bolts loosely.

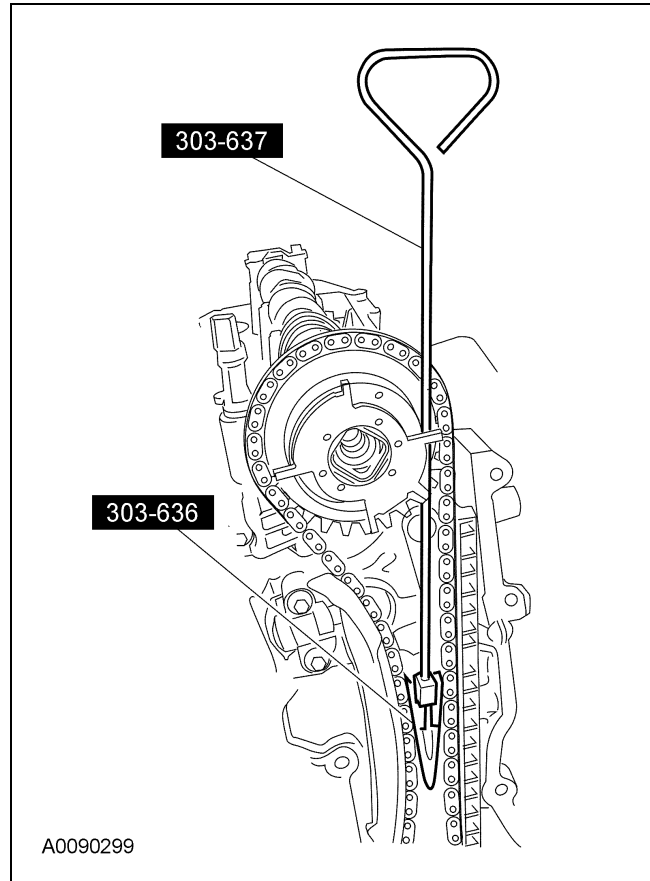
IN-VEHICLE REPAIR (Continued)

10. Tighten the bolts in the sequence shown.

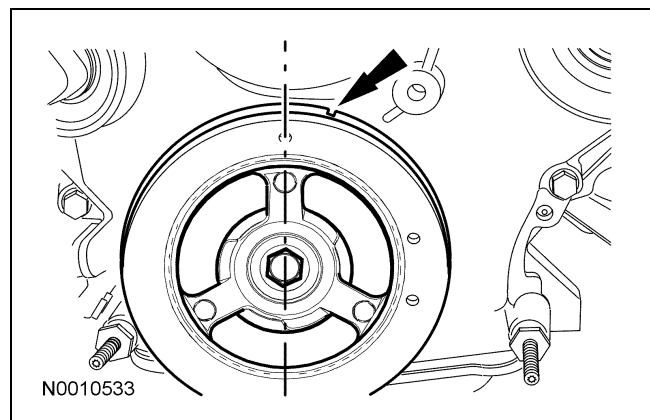
- Tighten to 10 Nm (89 lb-in).



11. Remove the special tools.

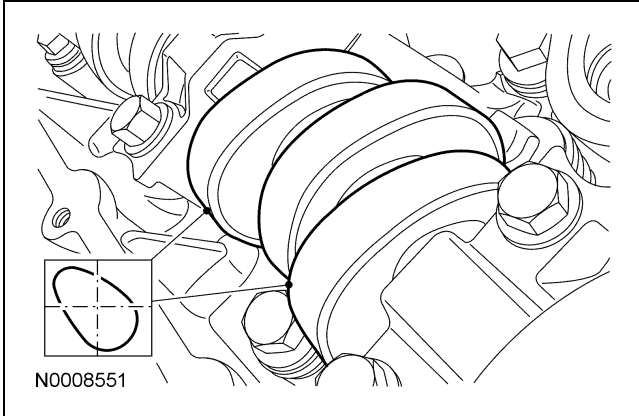
**Both camshafts**

12. Rotate the crankshaft a half turn counterclockwise and position the crankshaft damper spoke at the 12 o'clock position and the timing mark indentation at the 1 o'clock position.

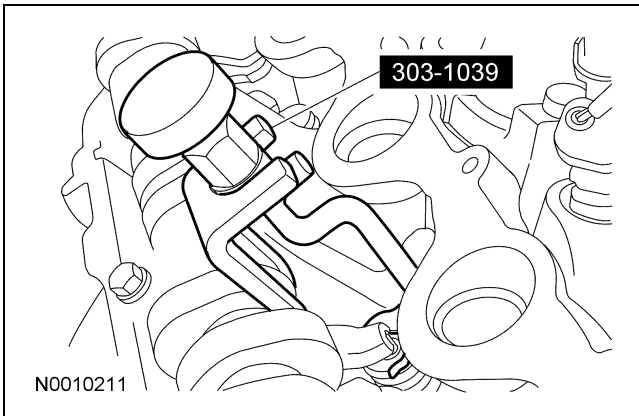


IN-VEHICLE REPAIR (Continued)**RH camshaft**

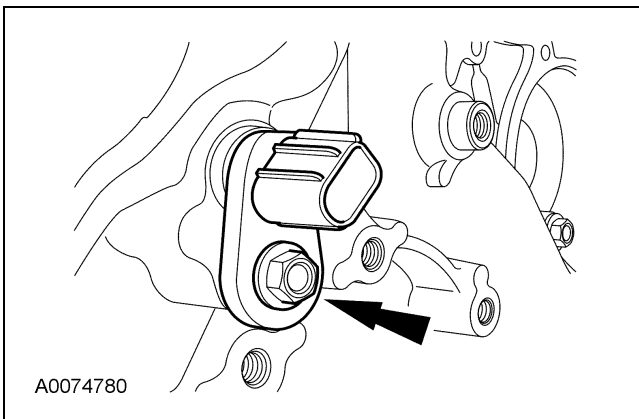
13. Verify correct cam position by noting the position of the 2 intake and the exhaust camshaft lobes on the No. 1 cylinder.



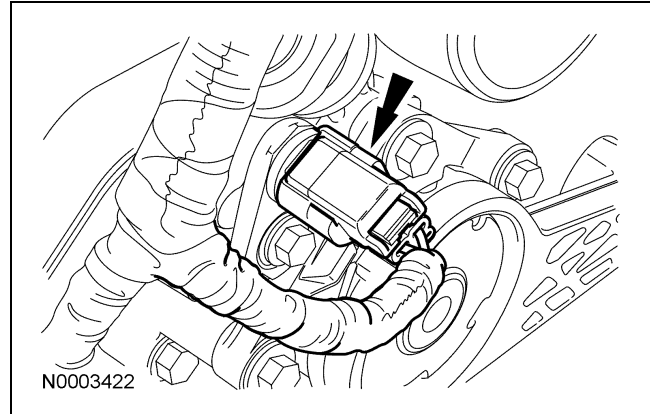
14. Using the special tool, install the 3 originally removed roller followers.



15. Install the CMP sensor and the bolt.



16. Connect the CMP electrical connector.

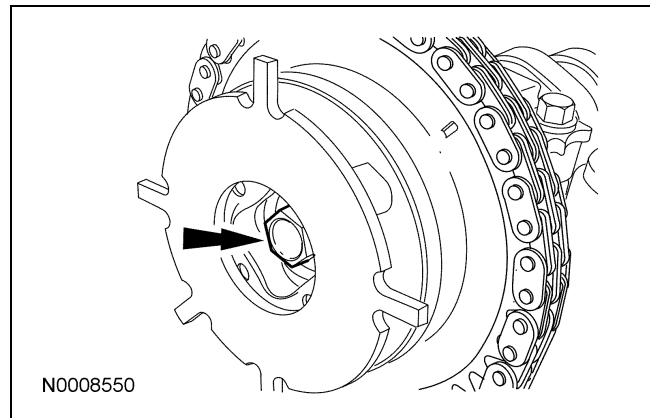


17. **⚠ CAUTION: Only use hand tools to install the camshaft phaser sprocket assembly or damage may occur to the camshaft or camshaft phaser unit.**

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

Tighten the camshaft phaser bolt in 2 stages:

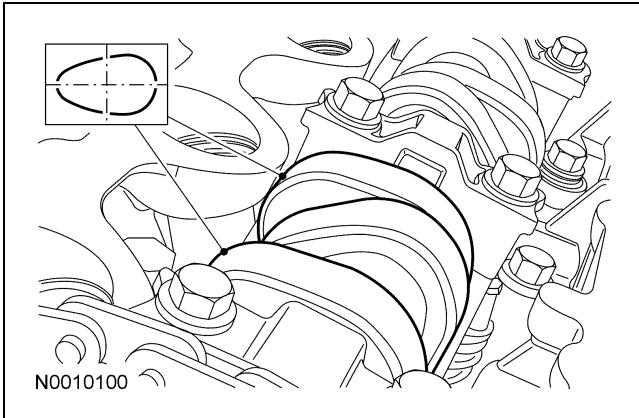
- Stage 1: Tighten to 40 Nm (30 lb-ft).
- Stage 2: Tighten an additional 90 degrees.



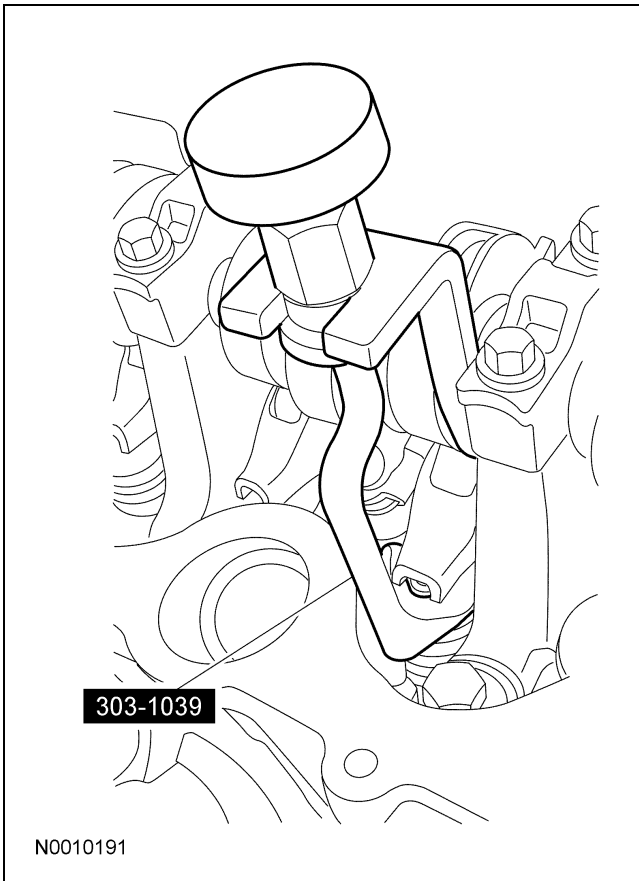
18. Install the RH valve cover. For additional information, refer to Valve Cover — RH in this section.

IN-VEHICLE REPAIR (Continued)**LH camshaft**

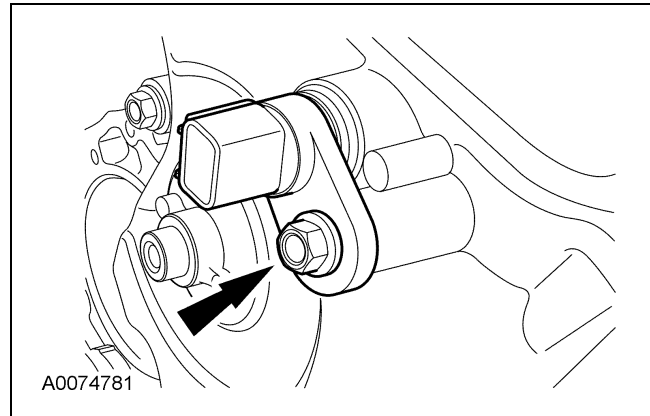
19. Verify correct cam position by noting the position of the 2 intake lobes and the exhaust lobe on the No. 5 cylinder.



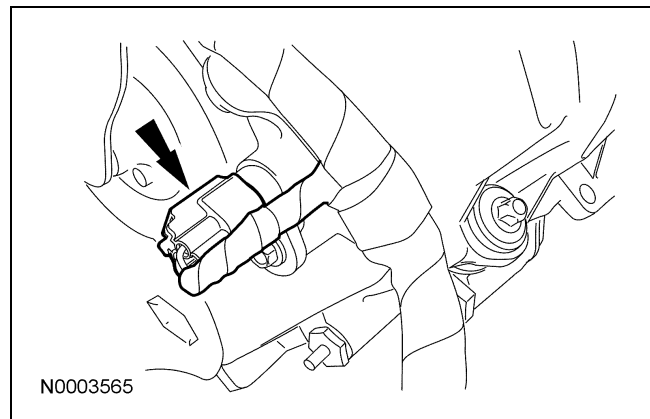
20. Using the special tool, install the 3 originally removed roller followers.




21. Install the CMP sensor and the bolt.




22. Connect the CMP sensor electrical connector.



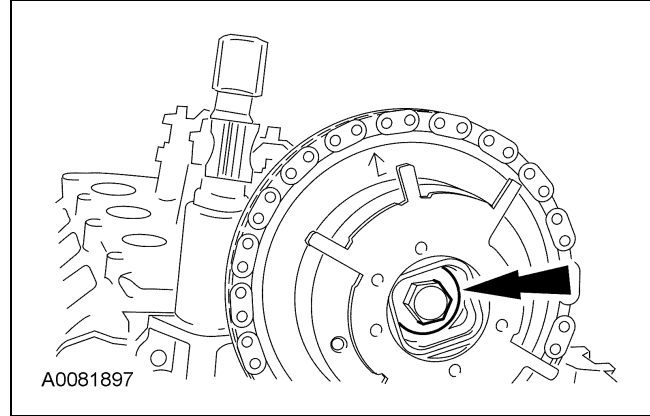
IN-VEHICLE REPAIR (Continued)

23.  **CAUTION:** Only use hand tools to install the camshaft phaser sprocket assembly or damage may occur to the camshaft or camshaft phaser unit.

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

Tighten the camshaft phaser bolt in 2 stages:

- Stage 1: Tighten to 40 Nm (30 lb-ft).
- Stage 2: Tighten an additional 90 degrees.



24. Install the LH valve cover. For additional information, refer to Valve Cover — LH in this section.