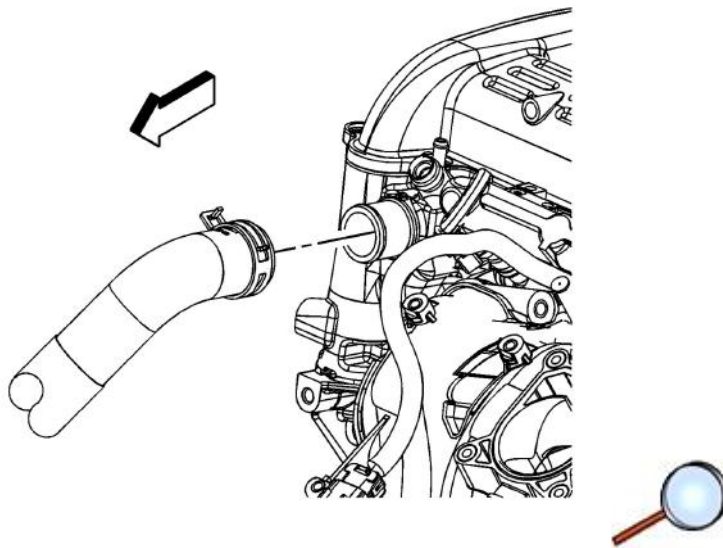


Cylinder Head Replacement

Special Tools

- [EN 46101](#) Spark Plug Tube Seal Guide
- [EN-48749](#) Timing Chain Retention Tool Kit
- [EN-48953](#) Camshaft Actuator Locking Tool
- [J 38185](#) Hose Clamp Pliers
- [J 45059](#) Angle Meter

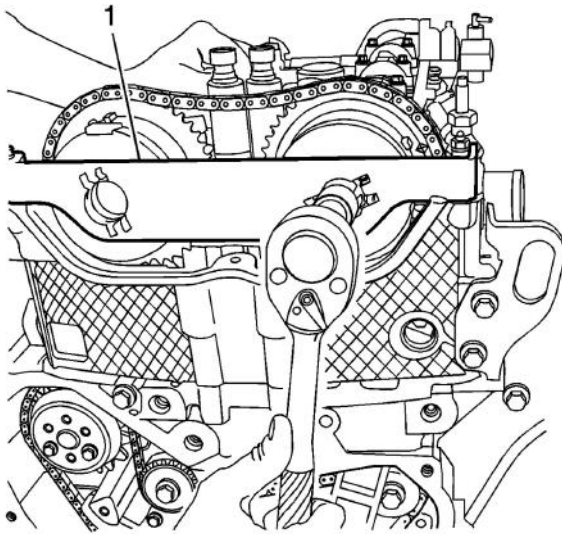
Removal Procedure



1. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
2. Remove the exhaust manifold. Refer to [Exhaust Manifold Replacement](#).
3. Remove the intake manifold. Refer to [Intake Manifold Replacement](#).
4. Reposition the radiator surge tank air bleed hose clamp.
5. Remove the radiator surge tank air bleed hose from the cylinder head.
6. Reposition the radiator inlet hose clamp using the [J 38185](#).
7. Remove the radiator inlet hose from the cylinder head.
8. Disconnect all electrical connectors as necessary.
9. Remove the spark plugs. Refer to [Spark Plug Replacement](#).
10. Remove the camshaft cover. Refer to [Camshaft Cover Replacement](#).
11. Remove the fuel pump. Refer to [Fuel Pump Replacement](#)

Note: If the intake camshaft actuator is moving independently of the camshaft, this means the camshaft is not locked to the actuator. Rotate the camshaft counter-clockwise while the holding tool is installed and this will lock the camshaft to the actuator.

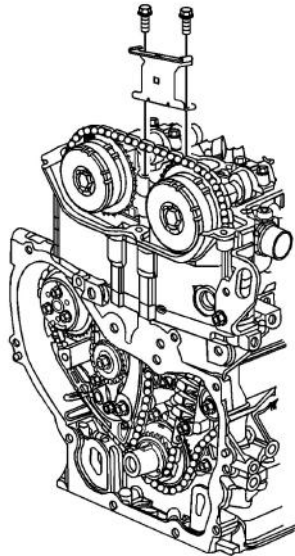
12. Rotate the crankshaft clockwise to install the camshaft actuator retaining tool *EN-48953* EGR Cooler Pressure Tester Adapter Set.



13. Install the [EN-48953](#) (1) .

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

14. Install the camshaft actuator retainer bolts and tighten to **10 N•m (89 lb in)**.



15. Remove the upper timing chain guide bolts and guide.

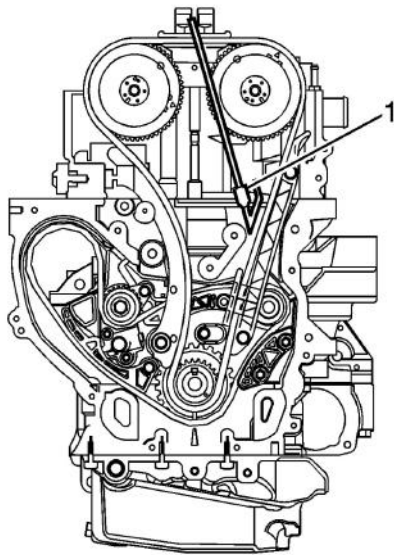
16. Clean the timing chain and gears with solvent.

Note: Ensure the timing chain and the camshaft position actuators are marked for proper assembly.

17. Mark the timing gear sprockets and the timing chain. It is recommended that the paint marks are located in the 12 o'clock position.

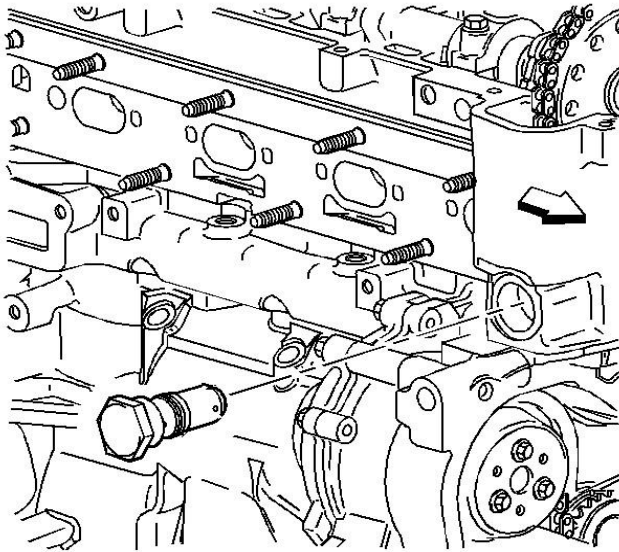
18. Loosen, but do not remove the intake and exhaust camshaft actuator bolts.

19. Remove the camshaft actuator locking tool, [EN-48953](#).

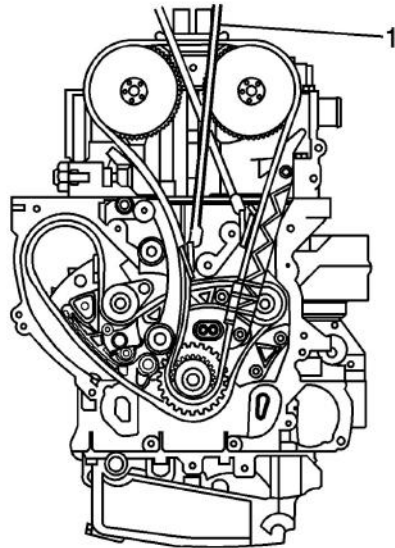


Note: Ensure the tips of the [EN-48749](#) are fully engaged into the timing chain. The retention tool rod can be used on the back side of the chain to ensure the teeth from the retention tool are engaged.

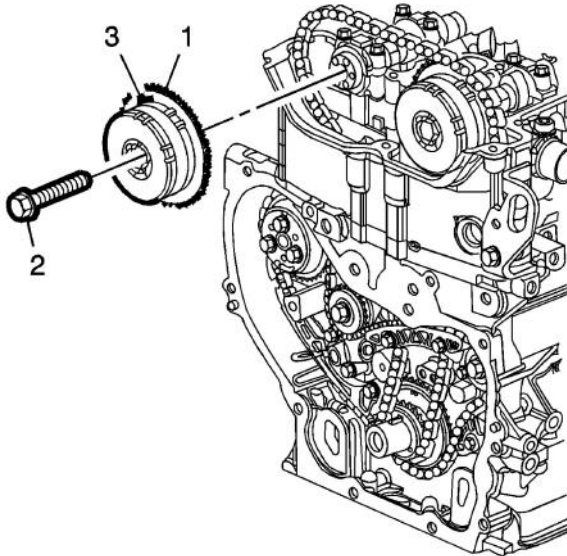
20. Install the timing chain retention tool [EN-48749](#) (1) to the intake side of the timing chain.



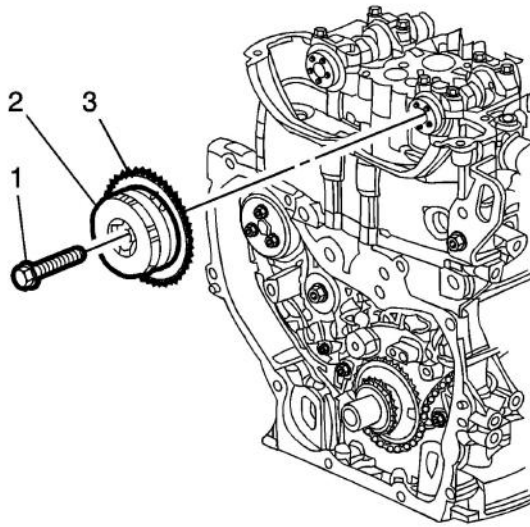
21. Remove the timing chain tensioner.



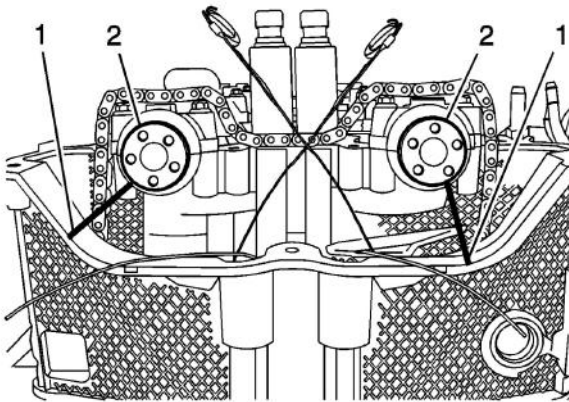
- Note:** The Intake camshaft and actuator should not rotate during the removal or installation.
22. Install the timing chain retention tool [EN-48749](#) (1) to the exhaust side of the timing chain.



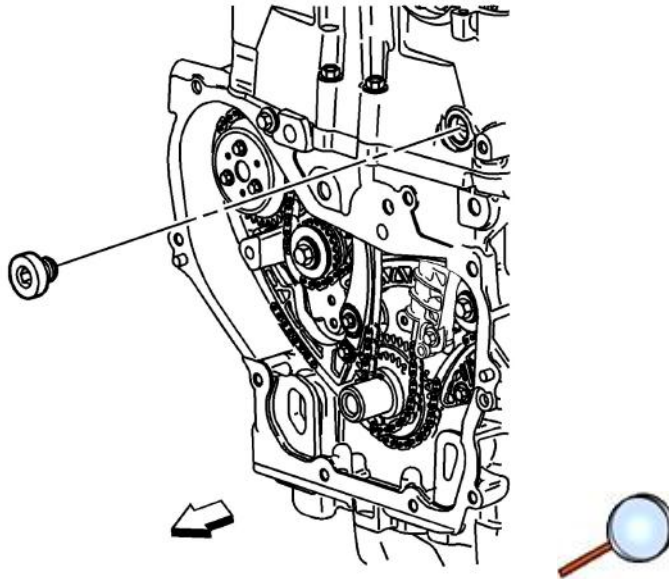
23. Remove and discard the exhaust camshaft actuator bolt (2).
24. Remove the exhaust cam actuator (3) from the exhaust camshaft while also removing the actuator from the chain.



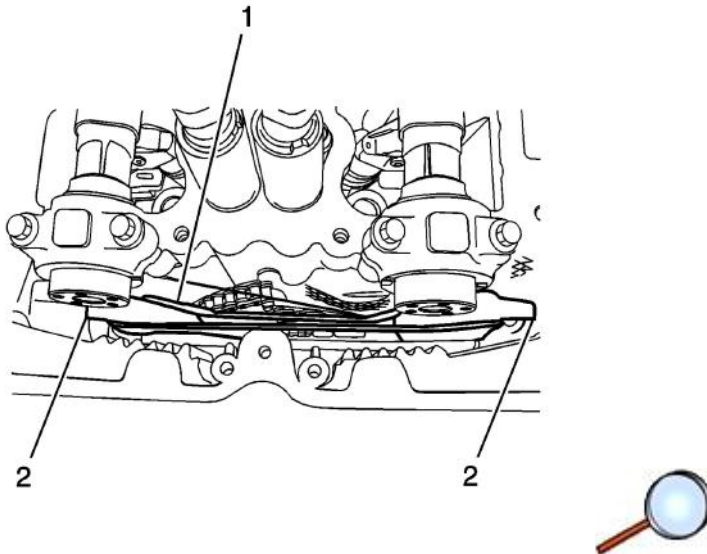
25. Remove and discard the intake camshaft actuator bolt (2).
26. Remove the intake camshaft actuator (3) from the camshaft while also removing the actuator from the timing chain.



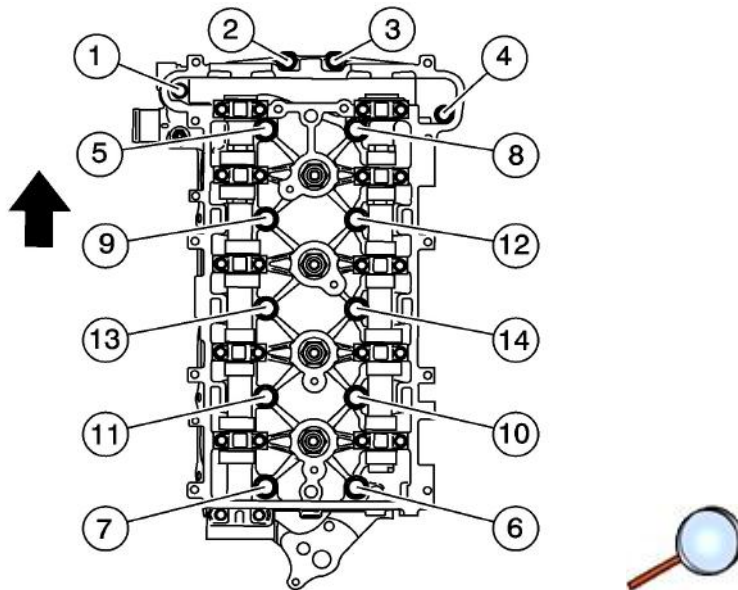
27. Mark the cylinder head (1) in relationship to the camshaft actuator notch is on the camshaft (2).



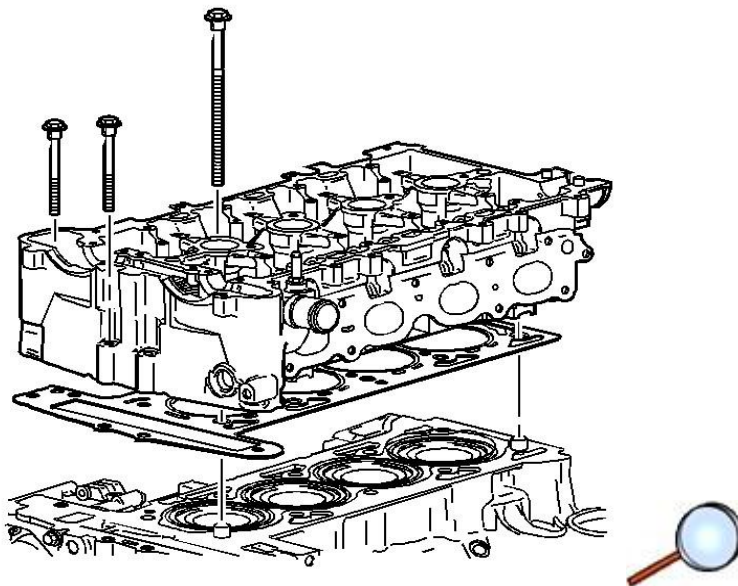
28. Remove the fixed timing chain guide access plug.
29. Remove the upper fixed timing chain guide bolt.



- Note:** The threaded rod from the timing chain retention tool can be used to help feed the rubber band around the chain guides.
30. Install a rubber band (1) around the top of the upper timing chain guides (2) in order to pull the guides together.



31. Remove the cylinder head bolts in the sequence shown. Discard the bolts.



32. Remove the cylinder head.

33. Remove the cylinder head gasket.

34. Clean all of the gasket surfaces.

35. Use the following steps when cleaning the cylinder head and cylinder block surfaces:

- Use a razor blade gasket scraper to clean the cylinder head and cylinder block gasket surfaces. Do not scratch or gouge either surface.

Note: DO NOT use any other method or technique to clean these gasket surfaces.

- Use a NEW razor blade on the cylinder head and a NEW blade on the cylinder block.

Note: Be careful not to gouge or scratch the gasket surfaces. DO NOT gouge or scrape the combustion chamber surfaces. The feel of the gasket surface is important, not the appearance. There will be indentations from the gasket left in the cylinder head after all of the gasket material is removed. These small indentations will be filled in by the NEW gasket.

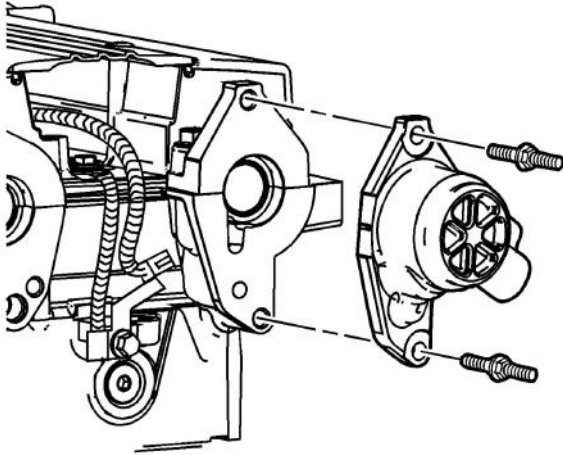
- Hold the razor blade as parallel to the gasket surface as possible.

36. Clean the old sealer/lube and any dirt from around the bolt holes.

Note: DO NOT use a tap to clean the cylinder head bolt holes.

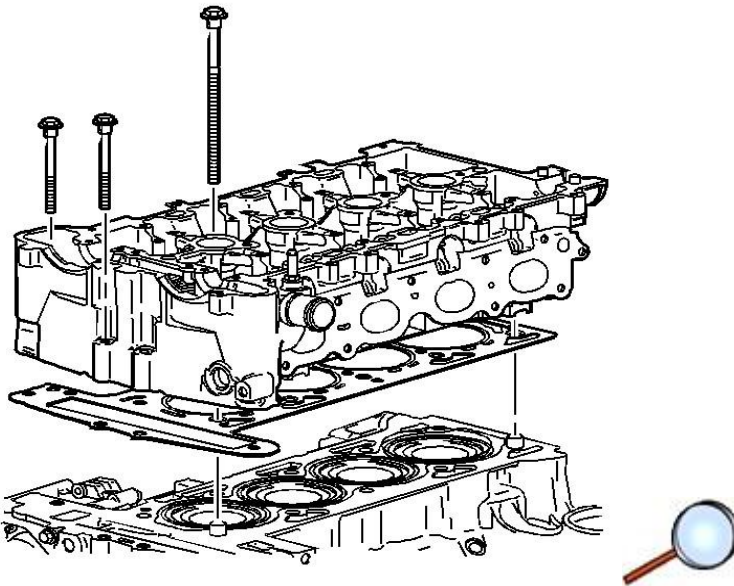
37. Clean the bolts holes with a nylon bristle brush.

38. When cleaning the cylinder head bolt holes use suitable commercial spray liquid solvent and compressed air from an extended-tip blow gun in order to reach the bottom of the holes.



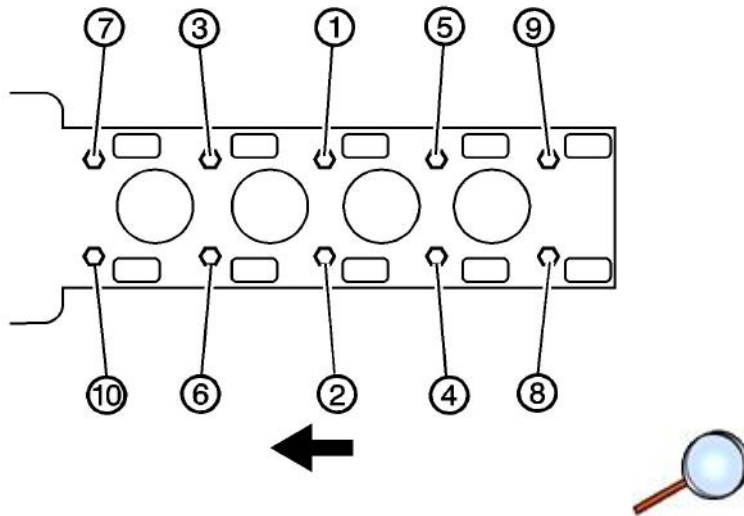
39. Remove the camshaft position sensor housing studs.
40. Remove and discard the camshaft position sensor housing seal.
41. If replacing the cylinder head, transfer all parts as necessary.

Installation Procedure



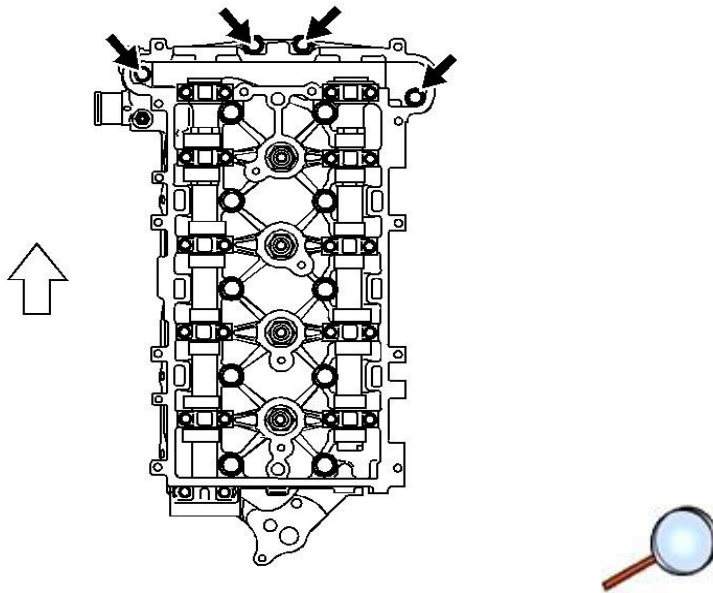
Note: DO NOT use any sealing material.

1. Install the cylinder head gasket.
2. Install the cylinder head.
3. Install NEW cylinder head bolts.

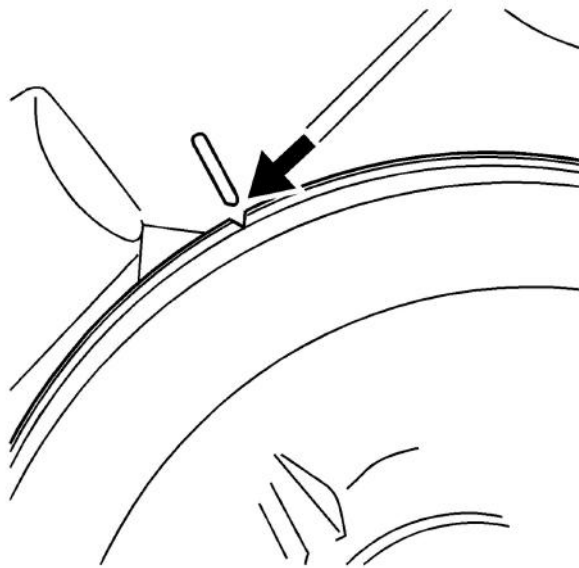


Caution: Refer to [Fastener Caution](#).

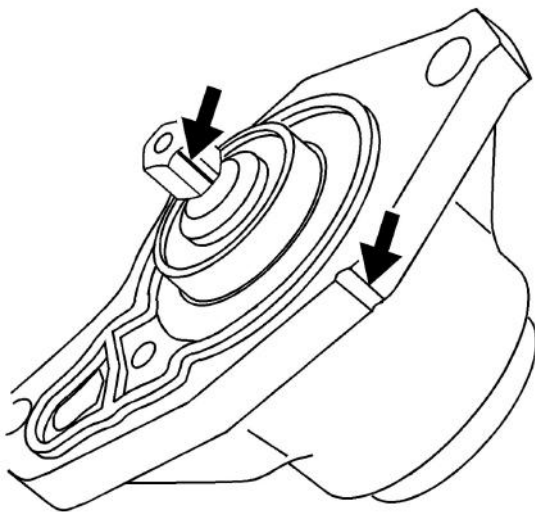
4. Install and tighten the cylinder head bolts in the sequence shown. Tighten the bolts to **30 N•m (22 lb ft) plus an additional 155 degrees** using the [J 45059](#).



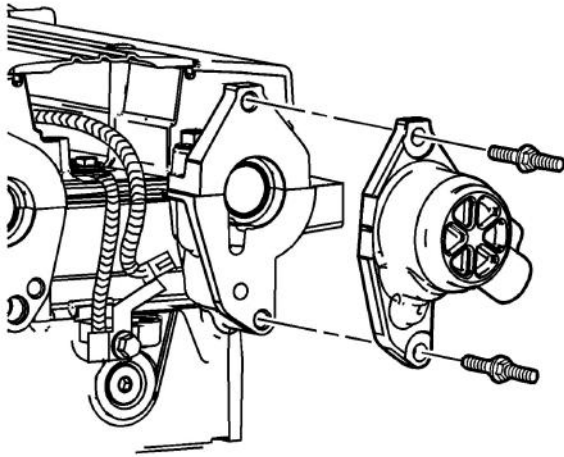
5. Install the NEW front cylinder head bolts and tighten to **35 N•m (26 lb ft)**.



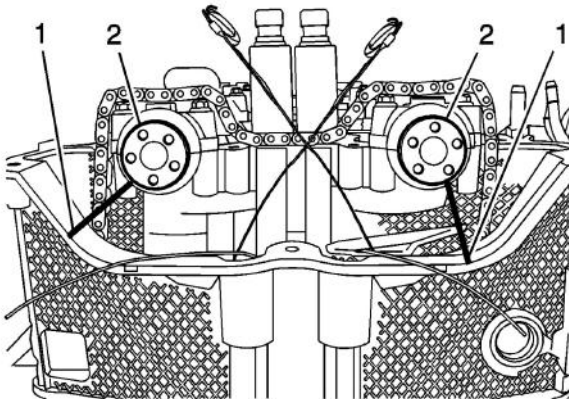
6. Rotate the crankshaft until number 4 piston is at top dead center (TDC) on the compression stroke. Refer to the crankshaft damper-to-front-cover timing marks.
7. Install a NEW camshaft position sensor housing seal.



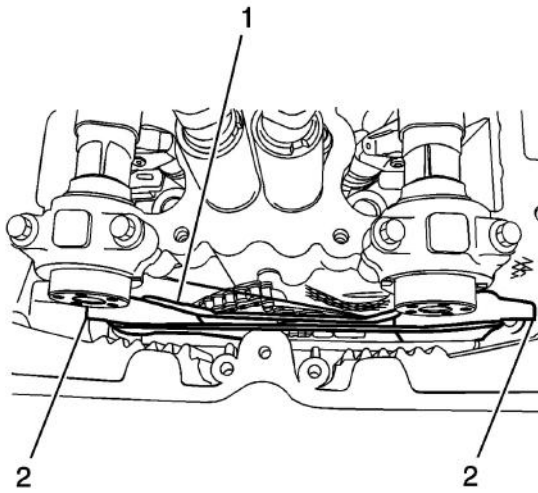
8. Align the timing mark on the housing with the timing mark on the hex shaft



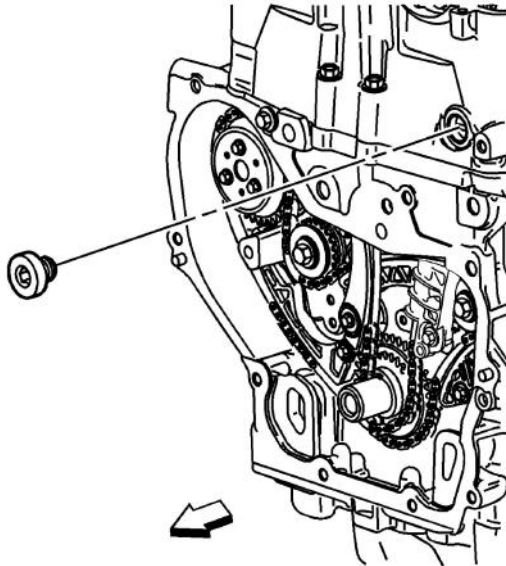
9. Install the camshaft position sensor housing.
10. Install the camshaft position sensor housing studs and tighten to **22N·m (16 lb ft)**.



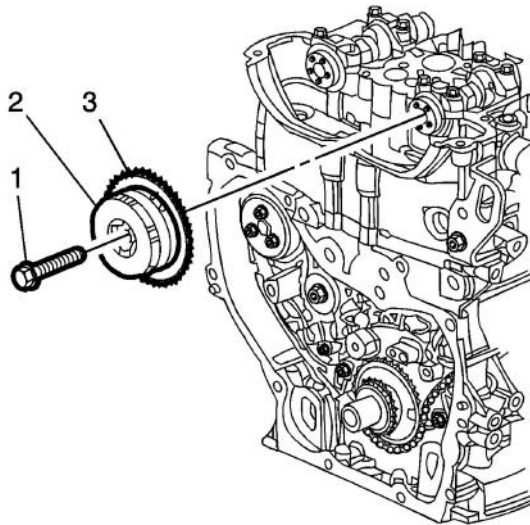
11. Ensure the cylinder head (1) and the camshaft (2) are correctly aligned.



12. Remove the rubber band (1) from around the top of the upper timing chain guides (2).
13. Install the fixed guide bolt into the cylinder head and tighten to **12 N•m (106 lb in)**.

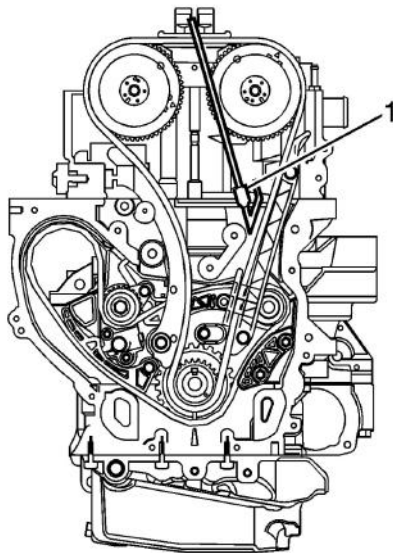


14. Apply sealant compound to thread and install the timing chain guide bolt access hole plug. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for the correct part number.
15. Install the fixed timing chain guide access plug and tighten to **90 N•m (59 lb ft)**.

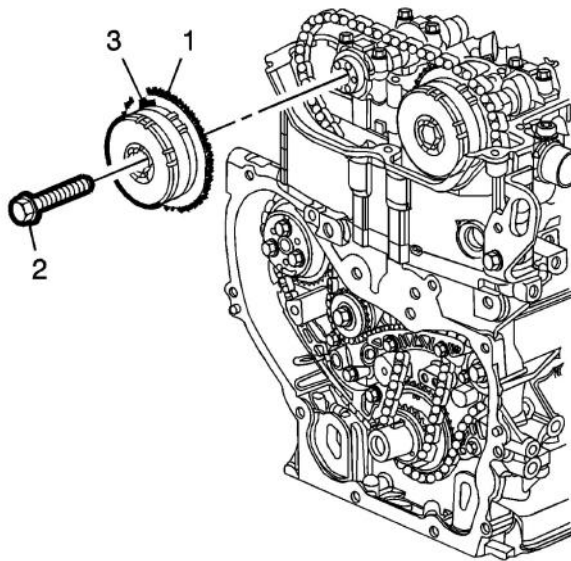


Note: Ensure that the alignment mark made previously on the intake camshaft actuator is still aligned properly with the mark on the timing chain. If the mark made previously on the intake camshaft actuator is not aligned properly, refer to [Camshaft Timing Chain, Sprocket, and Tensioner Replacement](#).

16. Install the timing chain onto the intake camshaft actuator.
17. Align the intake camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft.
18. Install a NEW intake camshaft actuator bolt (2) until snug.



19. Remove the timing chain retention tool [EN-48749](#) (1) from the intake side of the timing chain.

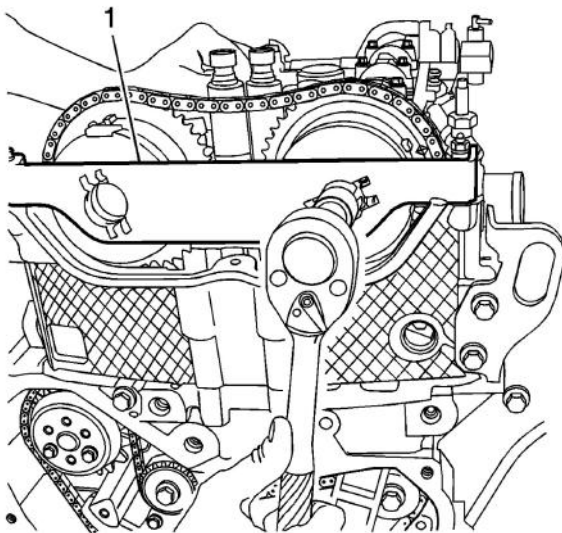


Note: Ensure that the alignment mark made previously on the exhaust camshaft actuator is still aligned properly with the mark on the timing chain. The exhaust cam may have to be rotated clockwise to install the exhaust actuator.

20. Install the timing chain onto the exhaust camshaft actuator.
21. Align the exhaust camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft.
22. Install a NEW exhaust camshaft actuator bolt (2) until snug.
23. Remove the timing chain retention tool [EN-48749](#) (1) from the exhaust side of the timing chain.

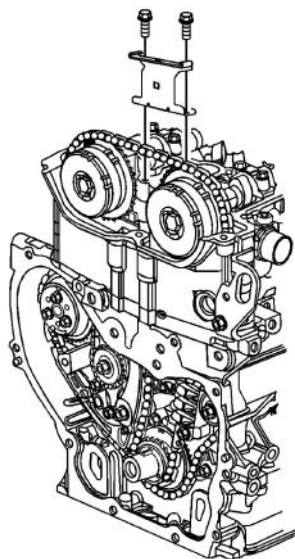
Note: Failure to reset the chain tensioner will put excess tension on the chain, limiting the chains life.

24. Reset and install the timing chain tensioner. Refer to [Timing Chain Tensioner Replacement](#).

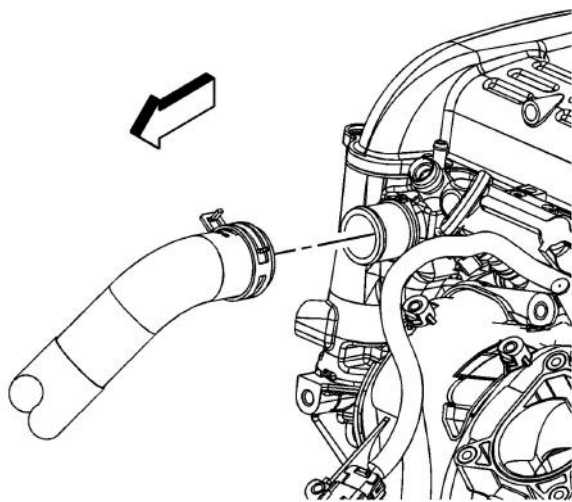


25. Install the [EN-48953](#) (1) to the actuators.
26. Install the camshaft actuator locking tool bolts and tighten to **10 N•m (89 lb in)**.
27. Tighten the NEW camshaft actuator bolt and tighten to **30 N•m (22 lb ft)**, plus an additional **100 degrees** using the [J 45059](#).

28. Release the tensioner by applying a counterclockwise rotational torque of **45 N•m (33 lb ft)** to the harmonic balancer bolt .
29. Remove the camshaft actuator locking tool, [EN-48953](#).



30. Install the upper timing chain guide bolts and guide and tighten the bolts to **10 N•m (89 lb in)**.
31. Install the fuel pump. Refer to [Fuel Pump Replacement](#)
32. Install the camshaft cover. Refer to [Camshaft Cover Replacement](#).
33. Install the spark plugs. Refer to [Spark Plug Replacement](#).



34. Connect all electrical connectors as necessary.
35. Install the radiator inlet hose to the cylinder head.
36. Position the radiator inlet hose clamp using the [J 38185](#).
37. Install the radiator surge tank air bleed hose to the cylinder head.
38. Position the radiator surge tank air bleed hose clamp.
39. Install the exhaust manifold. Refer to [Exhaust Manifold Replacement](#).
40. Install the intake manifold. Refer to [Intake Manifold Replacement](#).
41. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).