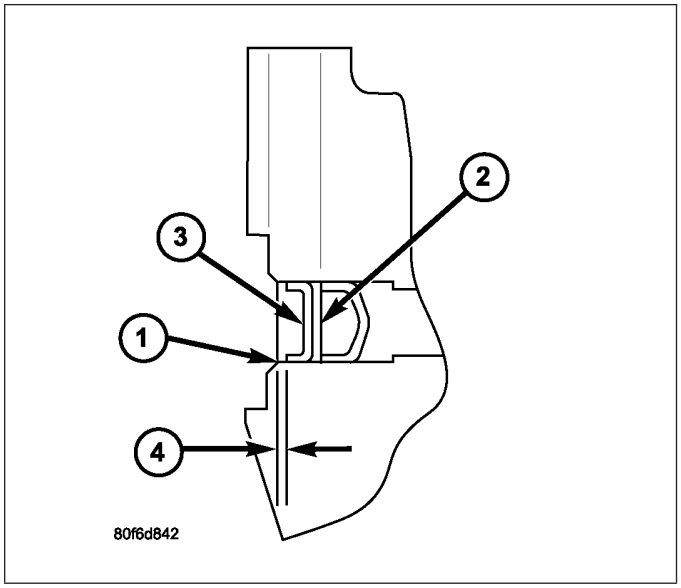
Repair Procedure

1. Remove component(s) necessary to gain access to the oil gallery cup plug requiring service.

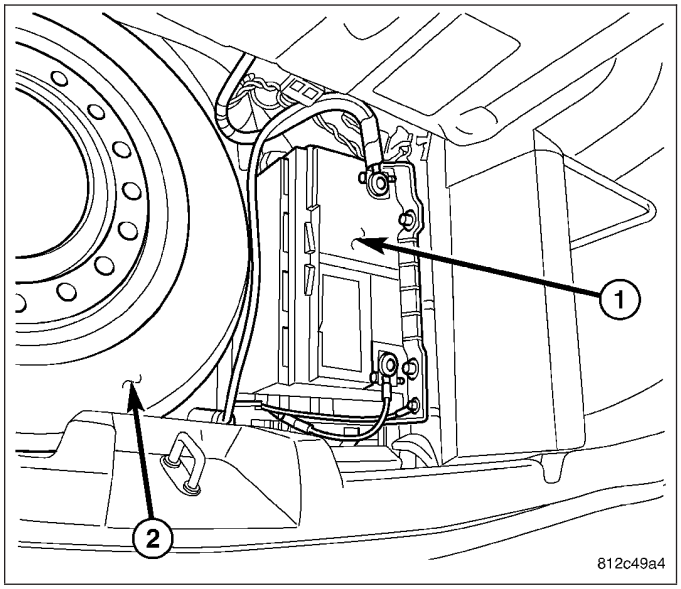
NOTE: Some of the oil gallery cup plugs are serviceable with the head installed on the engine and the engine in the vehicle, while others require removing the affected cylinder head from the engine. In either case only replace the cup plug requiring service.



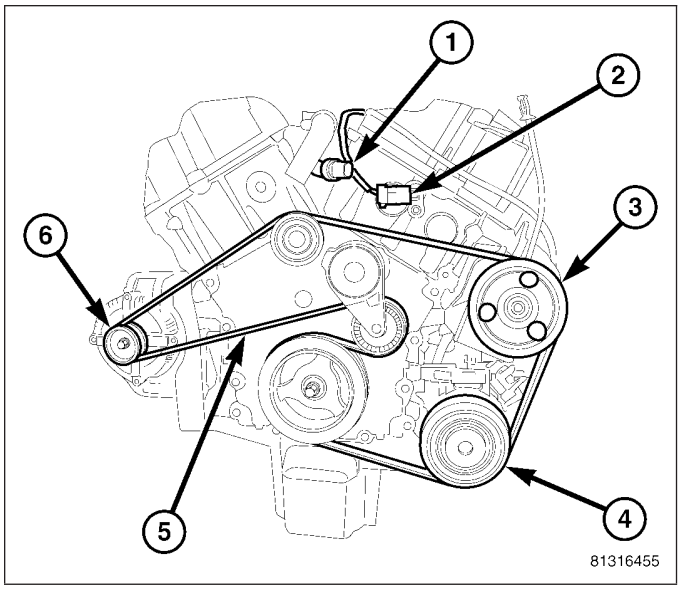
2. Clean the cup plug bore with brake cleaner and compressed air. It is not necessary to remove the existing cup plug.
3. Lightly coat the new cup plug with sealer; p/n 04318083.
4. Using an appropriate installation tool drive the new cup plug into the bore until the flanged edge of the plug is just inside (1-2 mm) the chamfered edge of the bore.
5. Allow the sealant to cure for at least 20 minutes.
6. Assemble any components removed in step #1 as necessary.

REMOVAL

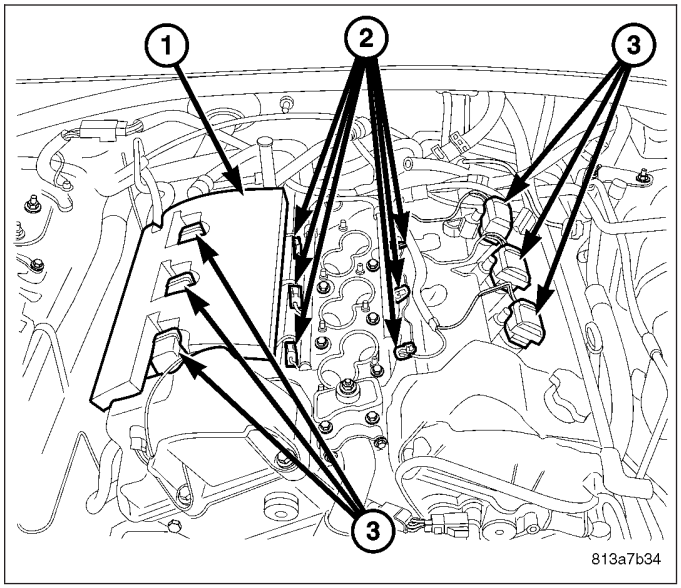
1. Perform fuel pressure release procedure **before attempting any repairs.** (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE)
2. Disconnect negative cable from battery (1).
3. Raise vehicle on hoist.
4. Drain cooling system (Refer to 7 - COOLING/ENGINE - STANDARD PROCEDURE).



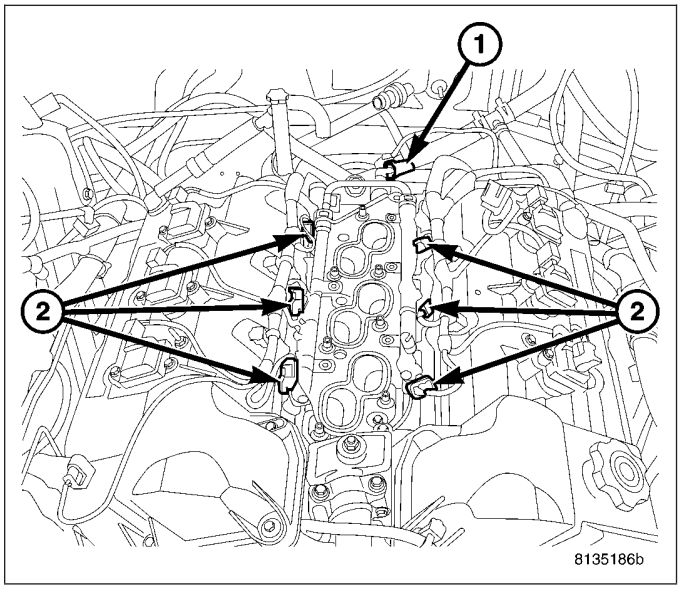
5. Remove accessory drive belt (5). (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
6. Remove the vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).
7. Disconnect camshaft position sensor (2), and coolant temperature sensor (1) connectors.
8. Remove upper intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).



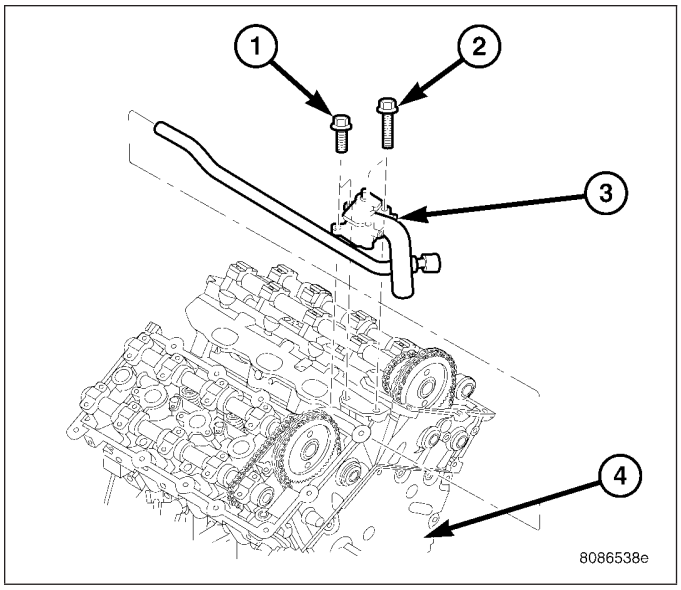
9. Disconnect coils (3), capacitors, and injector connectors (2).
10. Reposition harness out of the way.



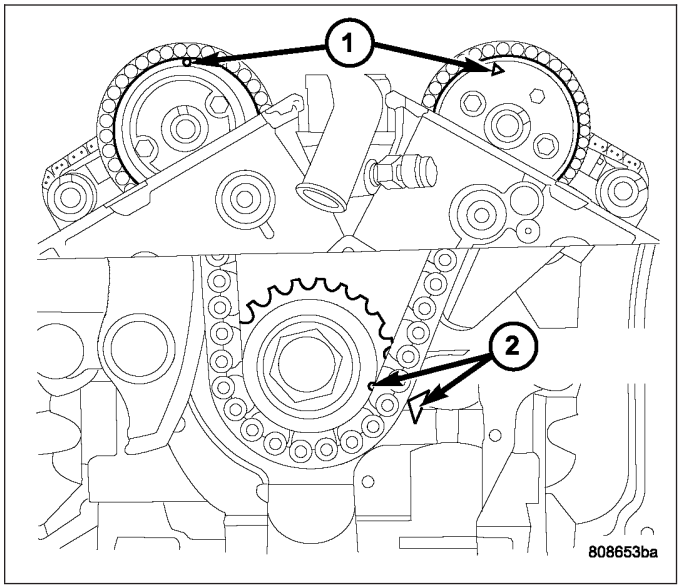
11. Disconnect fuel feed line (1) (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).
12. Remove lower intake manifold.
13. Remove cylinder head covers (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

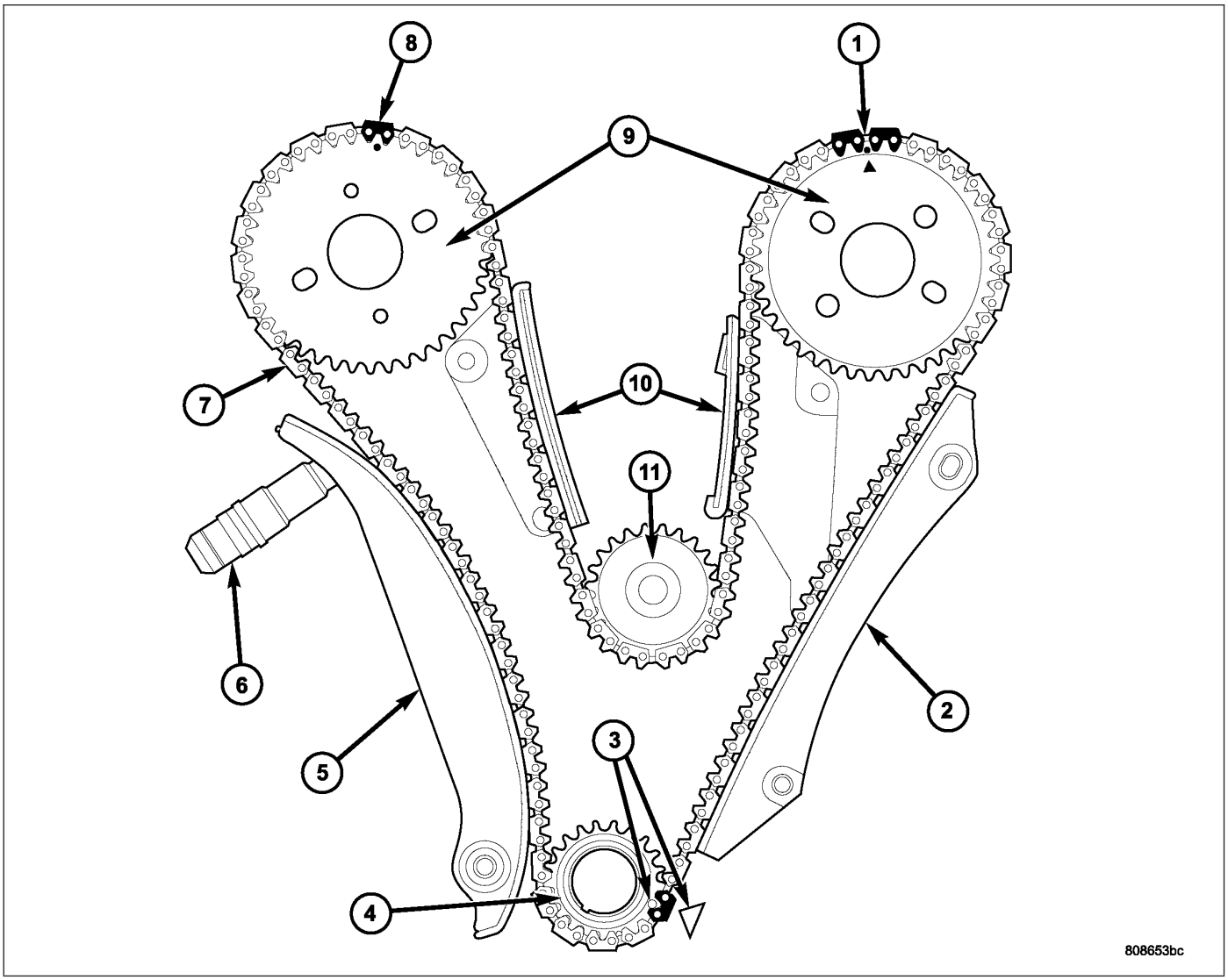


14. Remove coolant outlet (3) (Refer to 7 - COOLING/ENGINE/COOLANT OUTLET HOUSING - REMOVAL).
15. Remove timing chain cover (4) (Refer to 9 - ENGINE/VALVE TIMING/TIMING CHAIN COVER - REMOVAL).

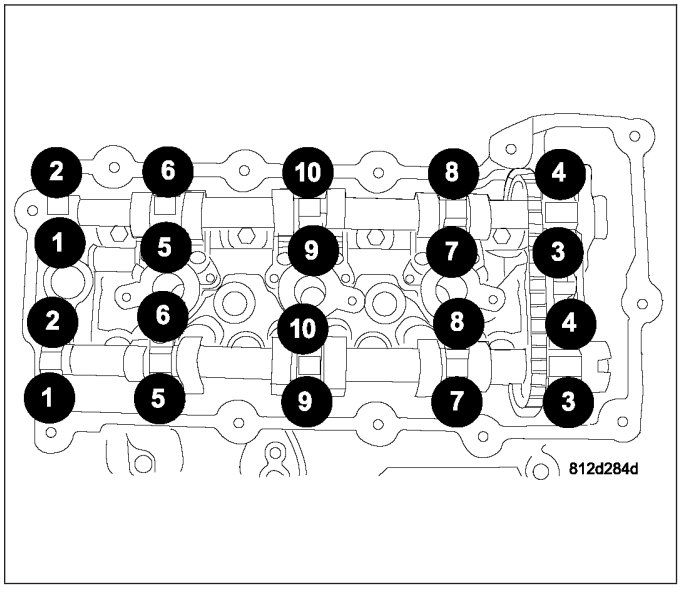


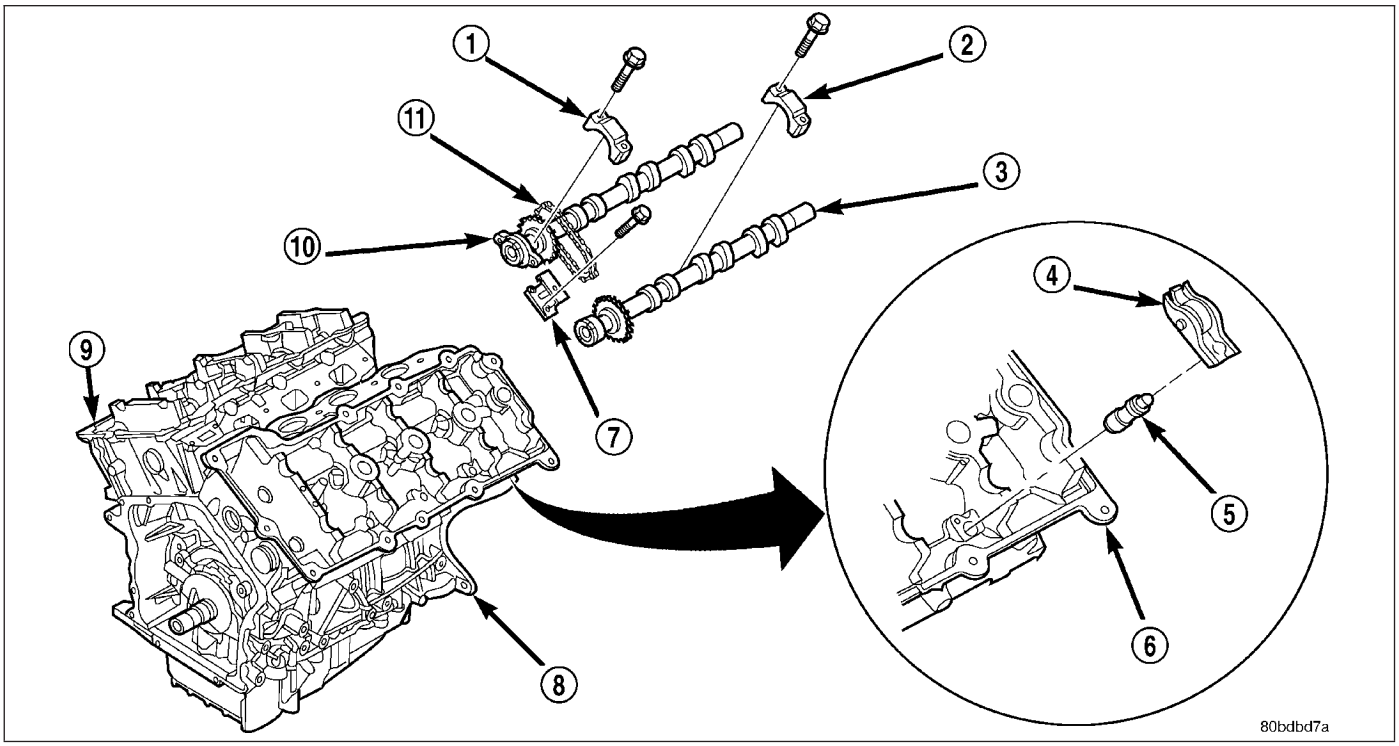
16. Rotate crankshaft until crankshaft sprocket timing mark aligns with timing mark on oil pump housing (2).





17. Remove primary timing chain (7) (Refer to 9 - ENGINE/VALVE TIMING/TIMING CHAIN AND SPROCKETS - REMOVAL).
18. Remove upper primary timing chain guides (10).
19. Remove camshaft bearing caps **gradually** in the sequence shown.

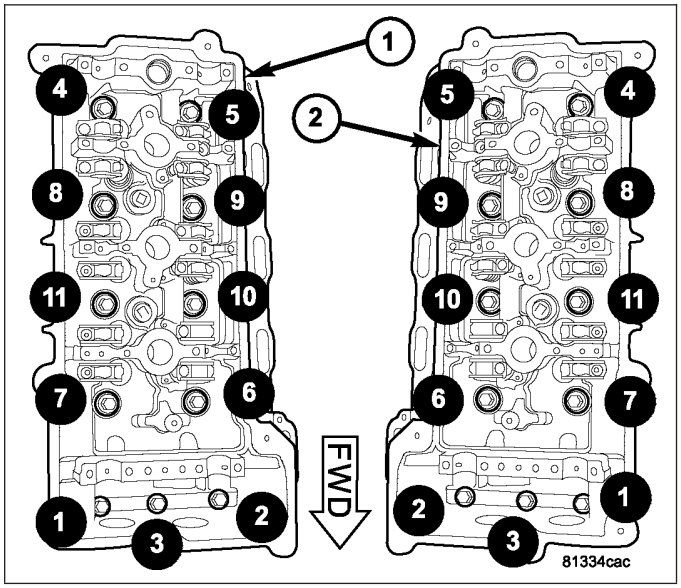




20. Remove camshafts (3) & (10) and valvetrain components from cylinder head. Note component locations for re-installation in original locations.
21. For left cylinder head removal:
    - Remove fastener securing engine oil dipstick tube to cylinder head. Remove engine oil dipstick tube.
    - Remove generator.
22. For right cylinder head removal:
    - Remove cylinder head ground strap.
    - Disconnect EGR valve electrical connector and remove EGR valve from head (Refer to 25 - EMISSIONS CONTROL/EXHAUST GAS RECIRCULATION/VALVE - REMOVAL).

CAUTION: Ensure cylinder head bolts 1 - 3 are removed before attempting the removal of cylinder head, as damage to cylinder head and/or block may occur.

23. Remove cylinder left head bolts (2) and right head bolts (1) in sequence shown.
24. Remove cylinder head(s).
25. Remove and discard cylinder head gasket.
26. Clean cylinder head and block sealing surfaces (Refer to 9 - ENGINE/CYLINDER HEAD - CLEANING).



CLEANING

To ensure engine gasket sealing, proper surface preparation must be performed, especially with the use of aluminum engine components and multi-layer steel cylinder head gaskets.

NOTE: Multi-Layer Steel (MLS) head gaskets require a scratch free sealing surface.

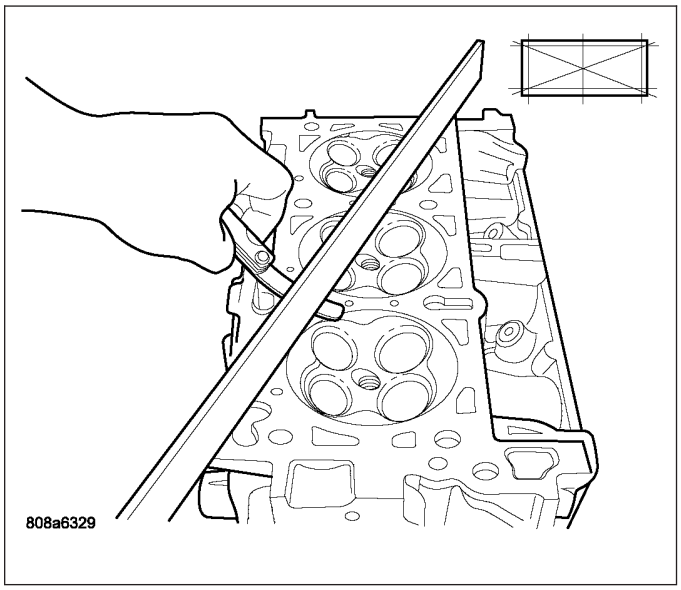
Remove all gasket material from cylinder head and block (Refer to 9 - ENGINE - STANDARD PROCEDURE). Be careful not to gouge or scratch the aluminum head sealing surface.

Clean all engine oil passages.

INSPECTION

1. Before cleaning, check for leaks, damage and cracks.
2. Clean cylinder head and oil passages.
3. Check cylinder head for flatness .
4. Cylinder head must be flat within:
   - Standard dimension = less than 0.05 mm (0.002 inch.)
   - Service Limit = 0.2 mm (0.008 inch.)
   - Grinding Limit = Maximum of 0.2 mm (0.008 inch.) is permitted.

CAUTION: 0.20 mm (0.008 in.) MAX is a combined total dimension of the stock removal limit from cylinder head and block top surface (Deck) together.



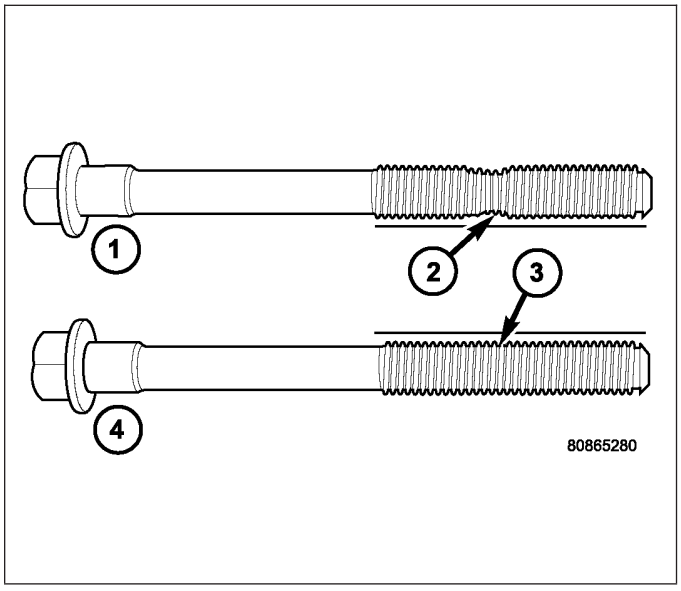
INSTALLATION

NOTE: The cylinder head bolts are tightened using a torque plus angle procedure. The bolts must be examined BEFORE reuse. If the threads are necked down the bolts must be replaced

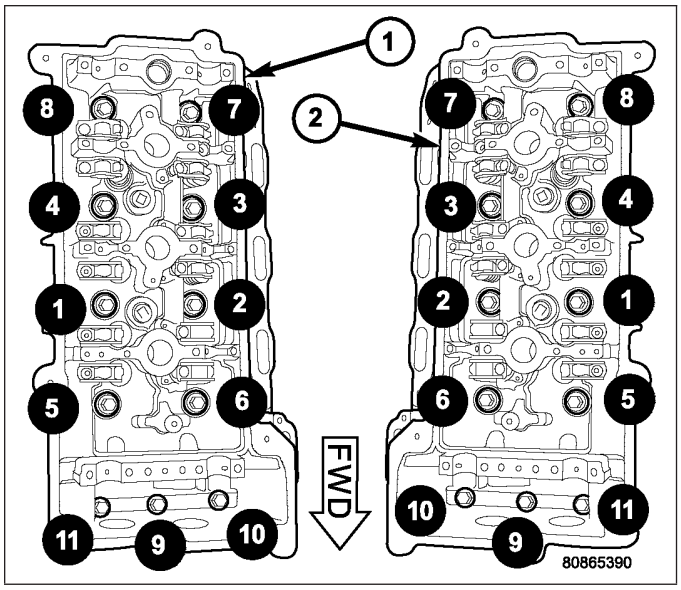
Necking can be checked by holding a straight edge against the threads (3). If all the threads do not contact the scale (2), the bolt must be replaced.

CAUTION: When cleaning cylinder head and cylinder block surfaces, DO NOT use a metal scraper because the surfaces could be cut or ground. Use ONLY a wooden or plastic scraper.

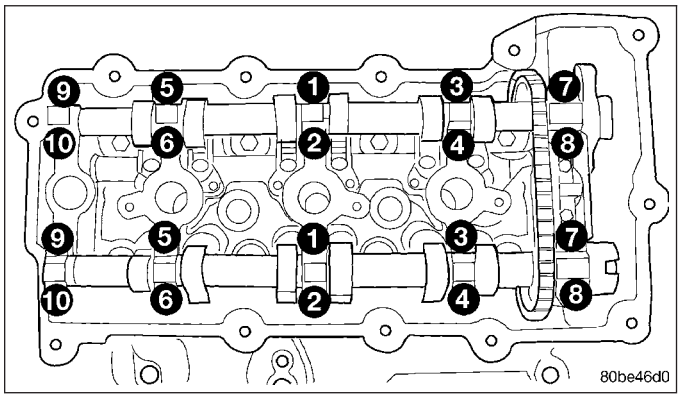
1. Clean sealing surfaces of cylinder head and block (Refer to 9 - ENGINE - STANDARD PROCEDURE).
2. Install new head gasket over locating dowels.
3. Install cylinder head to block, assuring head is properly positioned over locating dowels.

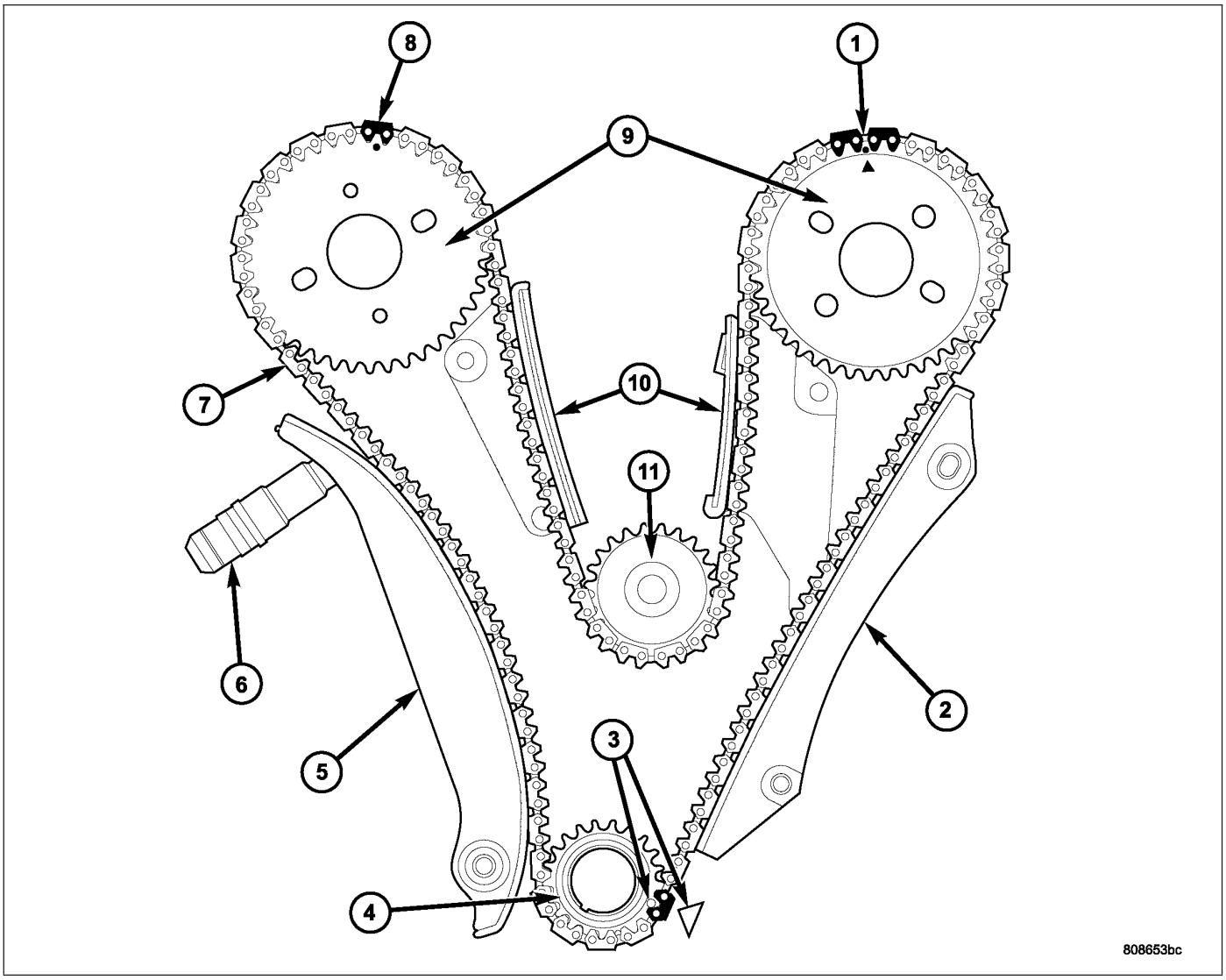


4. Lubricate bolt threads with clean engine oil and install bolts.
5. Tighten bolts in sequence shown for left head (2) and right head (1), using the following steps and torque values:
   - Step 1: Bolts 1–8 to 48 N·m (35 ft. lbs.)
   - Step 2: Bolts 1–8 to 75 N·m (55 ft. lbs.)
   - Step 3: Bolts 1–8 to 75 N·m (55 ft. lbs.)
   - Step 4: Bolts 1–8 to +90° Turn **Do not use a torque wrench for this step.**
   - Step 5: Bolts 9–11 to 28 N·m (250 in. lbs.)

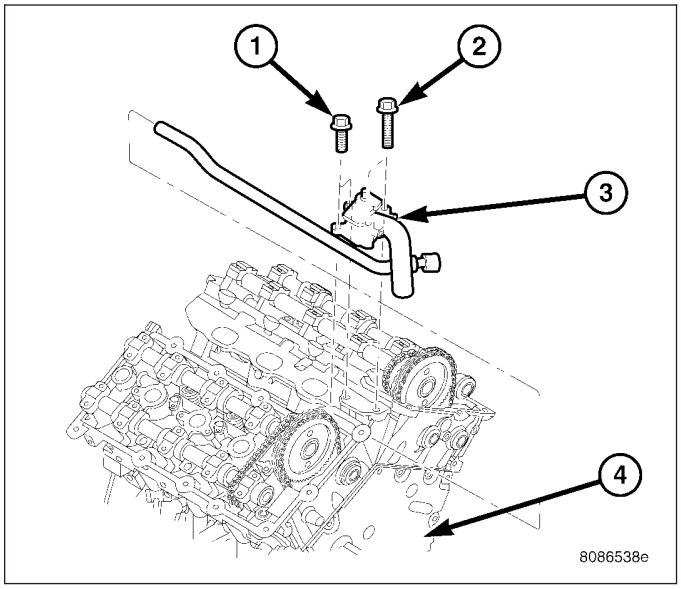


6. For left cylinder head installation:
   - Install engine oil dipstick tube.
   - Install generator.
7. For right cylinder head Installation:
   - Install cylinder head ground strap.
   - Install EGR valve (if equipped) (Refer to 25 - EMISSIONS CONTROL/EXHAUST GAS RECIRCULATION/ VALVE - INSTALLATION).
8. Install all valvetrain components and camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAM-SHAFT(S) - INSTALLATION). Tighten camshaft bearing caps in sequence shown to 12 N·m (105 in. lbs.).

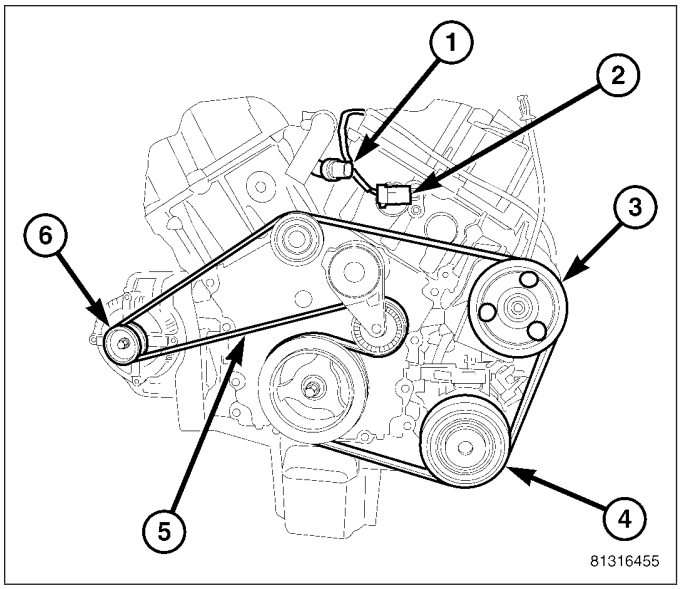




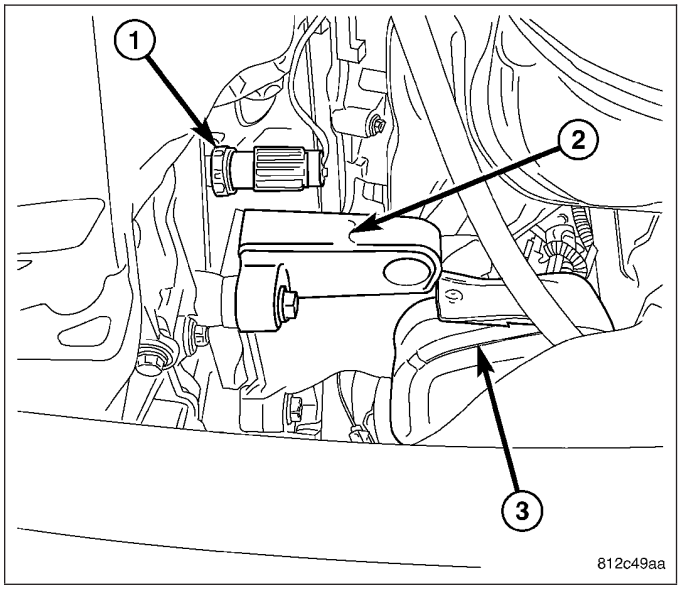
9. Install primary timing chain (7), guides (2,5,10) and sprockets (9) (Refer to 9 - ENGINE/VALVE TIMING/TIMING CHAIN AND SPROCKETS - INSTALLATION).
10. Install coolant outlet (3) (Refer to 7 - COOLING/ ENGINE/COOLANT OUTLET HOUSING - INSTALLATION).



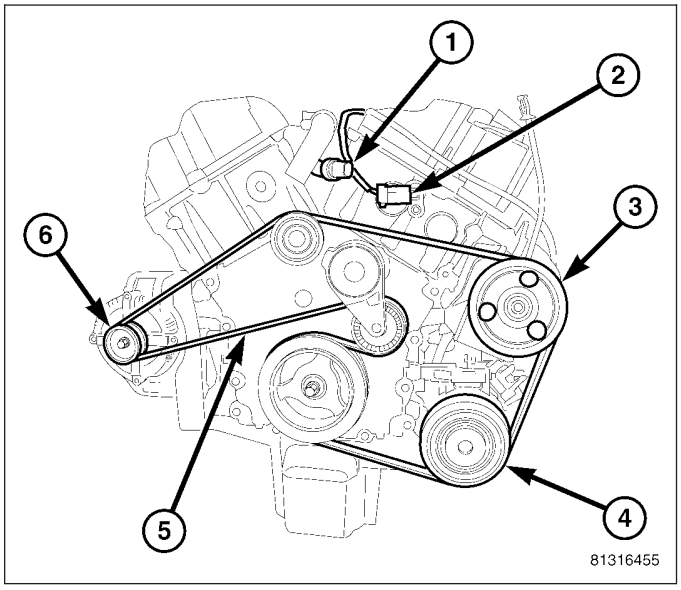
11. Install lower intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).
12. Install cylinder head covers (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).
13. Connect camshaft position sensor (2) and coolant temperature sensor (1) connectors.
14. Install timing chain cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING CHAIN COVER(S) - INSTALLATION).
15. Install crankshaft vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).
16. Install upper intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).



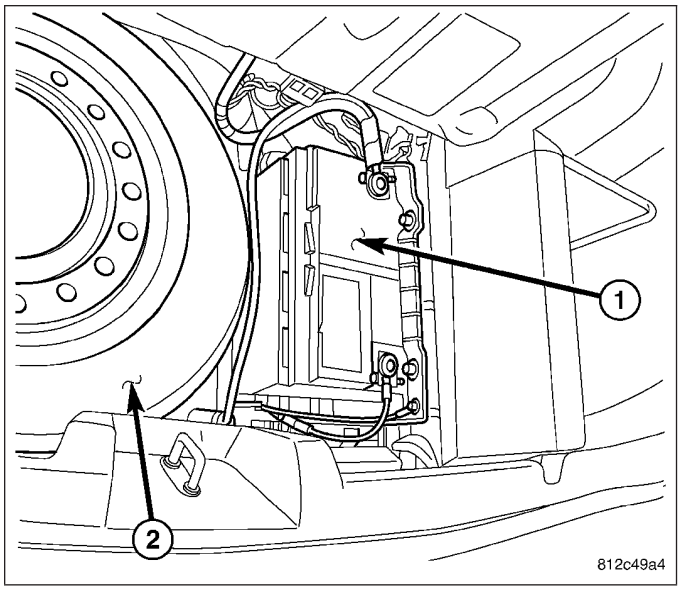
17. Connect oil pressure sensor (1) connector.



18. Install accessory drive belt (5) (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).
19. Fill cooling system (Refer to 7 - COOLING/ENGINE - STANDARD PROCEDURE).

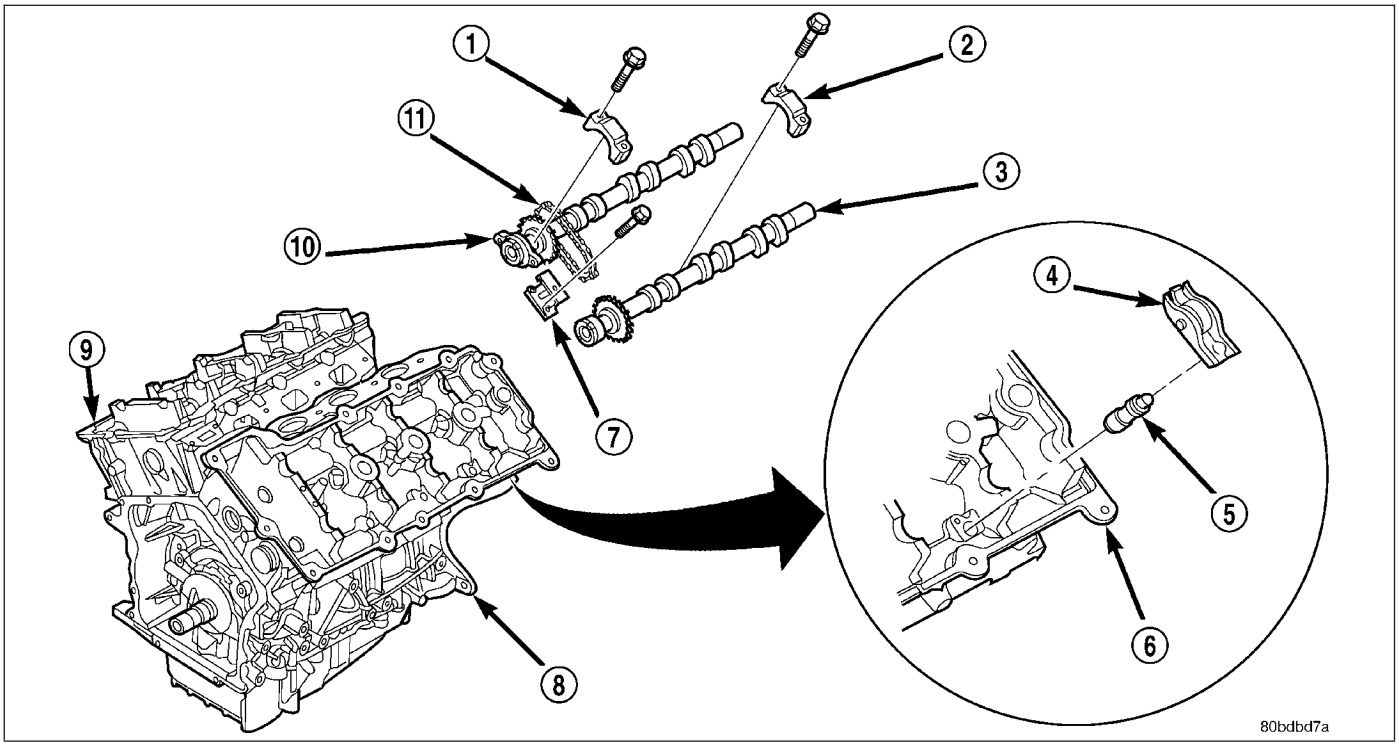


20. Connect negative battery (1) cable.
21. Start engine and check for leaks.



CAMSHAFT(S)

DESCRIPTION

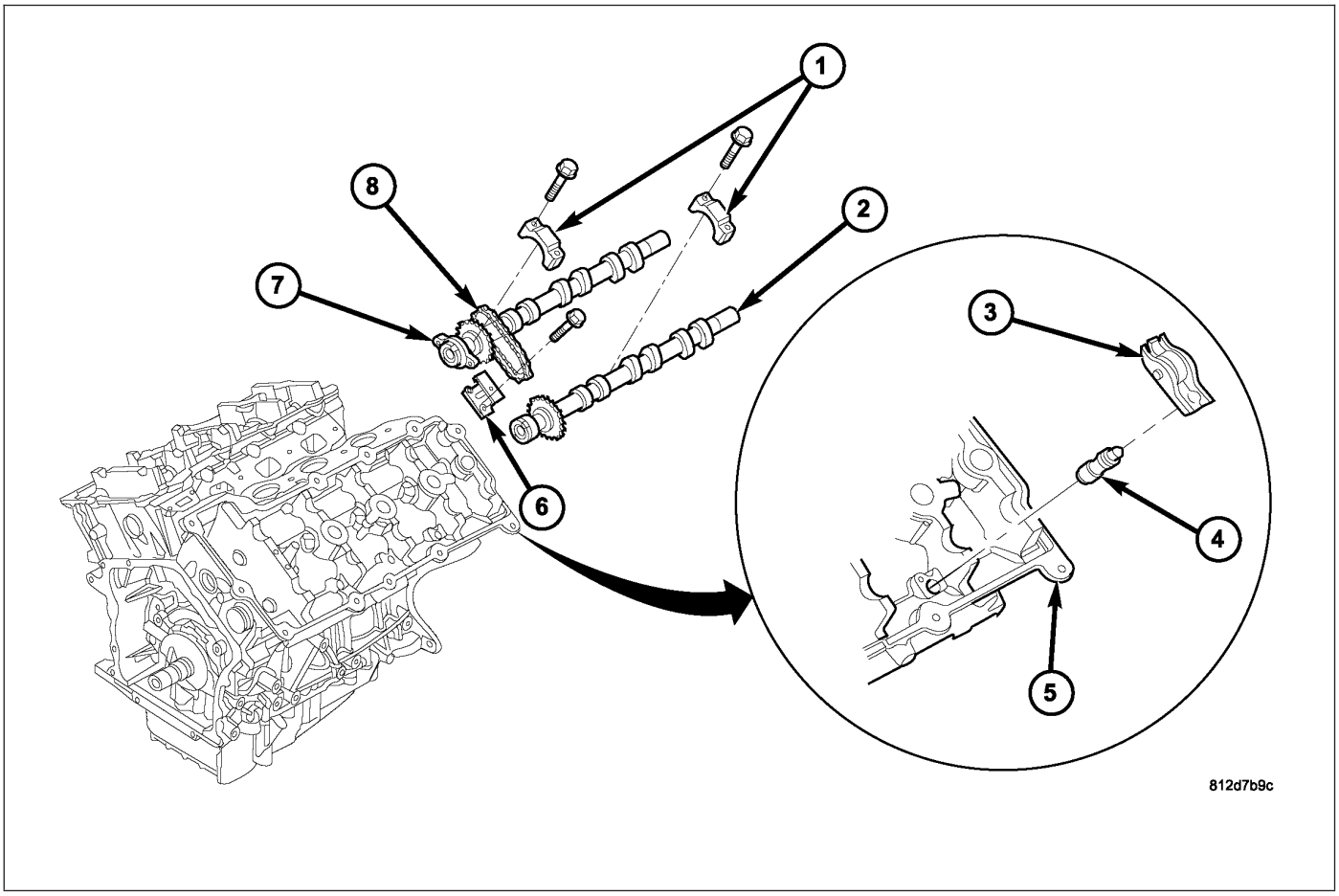


The assembled fabricated camshafts are composed of five bearing journals machined onto a hollow steel tube. The camshafts are secured in the cylinder head (6) by the camshaft bearing caps (1)&(2). Six steel lobes, a secondary timing drive sprocket, and a primary sprocket/thrust flange are pressed onto the camshaft tube using a unique assembly process. Camshaft end play is controlled by the primary camshaft sprocket attachment flange on the intake camshafts (7) and by a thrust flange on the exhaust camshafts (3). The intake camshafts are driven by the primary chain. The exhaust camshafts (3) are driven by the intake camshafts (10) through a secondary chain (11). The secondary chain tensioner (7) keeps tension on the secondary chain (11).

OPERATION

The camshaft has precisely machined (egg shaped) lobes to provide accurate valve timing and duration. The camshaft is driven by the crankshaft via drive sprockets and chains.

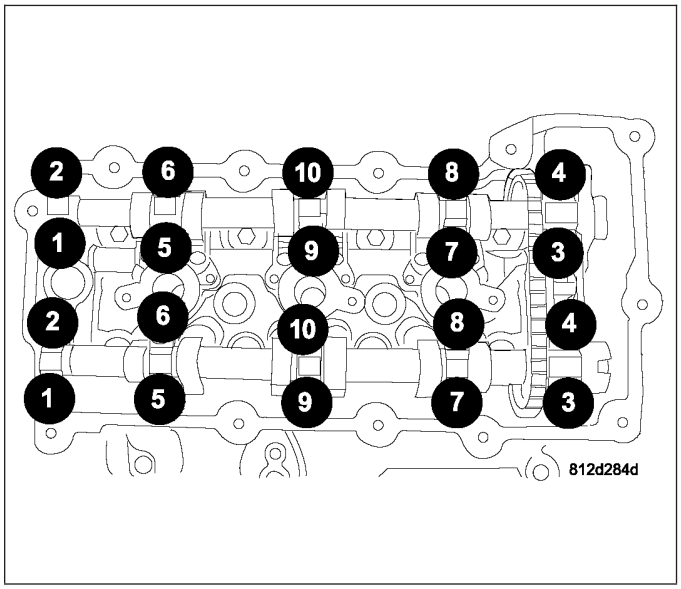
REMOVAL

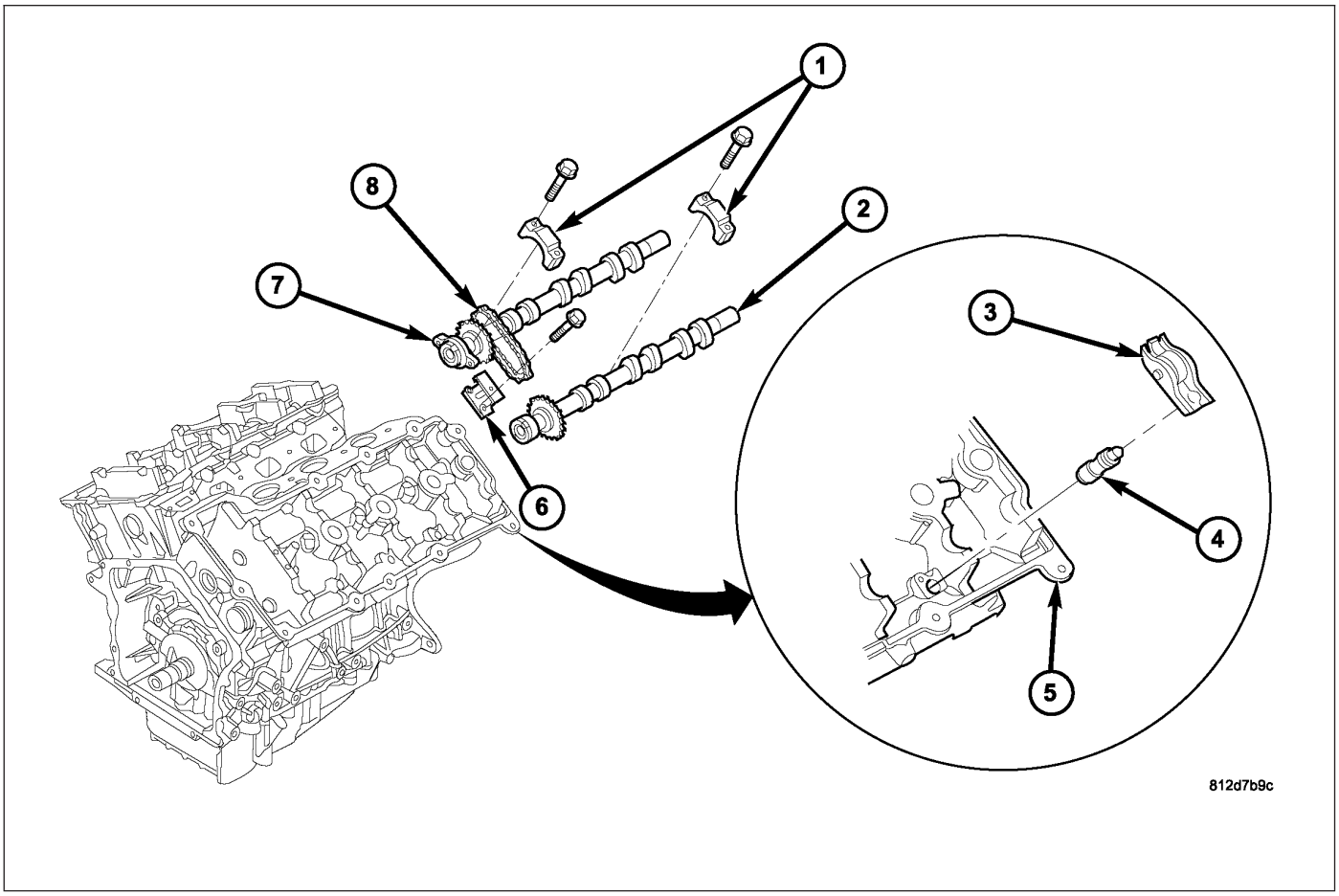


1. Remove the primary timing chain (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).
2. Remove secondary chain tensioner (6) mounting bolts.

NOTE: Camshaft bearing caps have been marked during engine manufacturing. For example, number one exhaust camshaft bearing is marked “1E”.

3. Slowly loosen camshaft bearing cap bolts in the order shown.

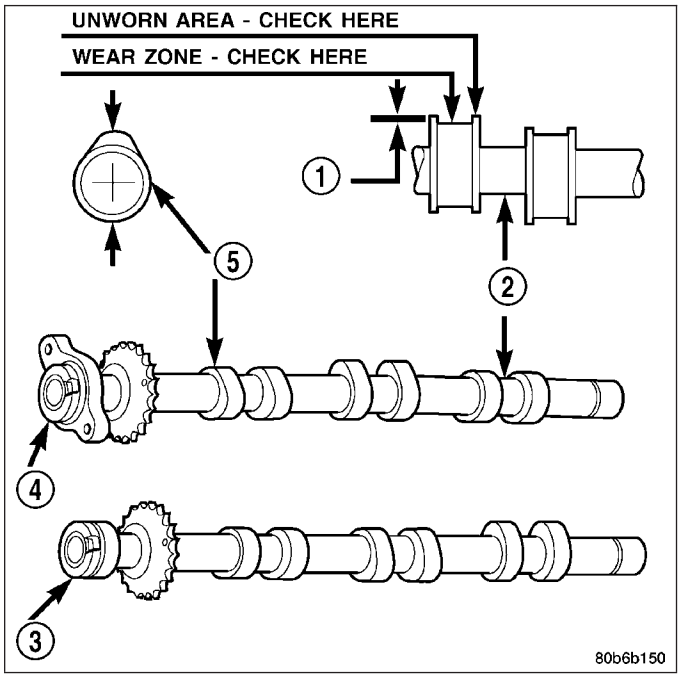




4. Remove camshaft bearing caps (1).
5. Remove intake camshaft (7), exhaust camshaft (2), secondary timing chain (8), and secondary timing chain tensioner (6) together as an assembly.
6. Remove secondary timing chain tensioner (6) and secondary timing chain (8) from camshafts (2)&(7).
7. Inspect camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - INSPECTION).

INSPECTION

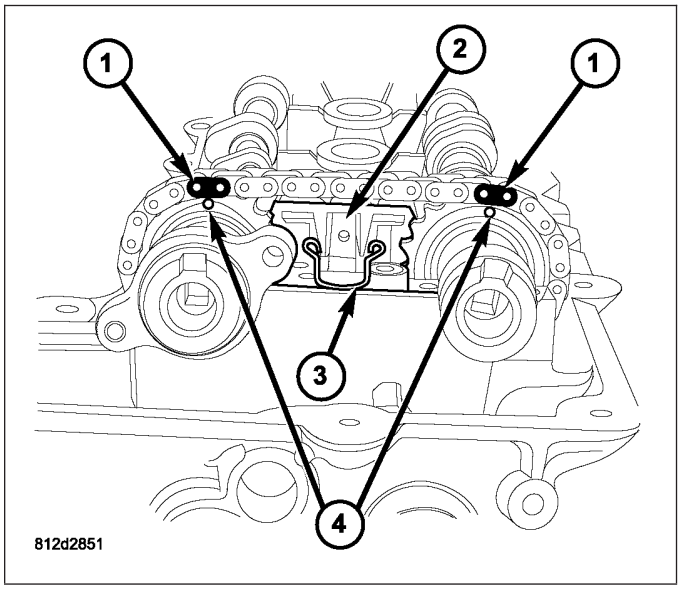
1. Inspect camshaft bearing journals (2) for damage and binding. If journals are binding, check the cylinder head for damage. Also check cylinder head oil holes for clogging.
2. Inspect camshaft sprockets for excessive wear. Replace camshafts if necessary.
3. Check the cam lobe (5) surfaces for abnormal wear and damage. Replace camshaft if defective. Measure the actual wear and replace, if out of limits—standard value is 0.0254 mm (0.001 in.); wear **limit** is 0.254 mm (0.010 in.).



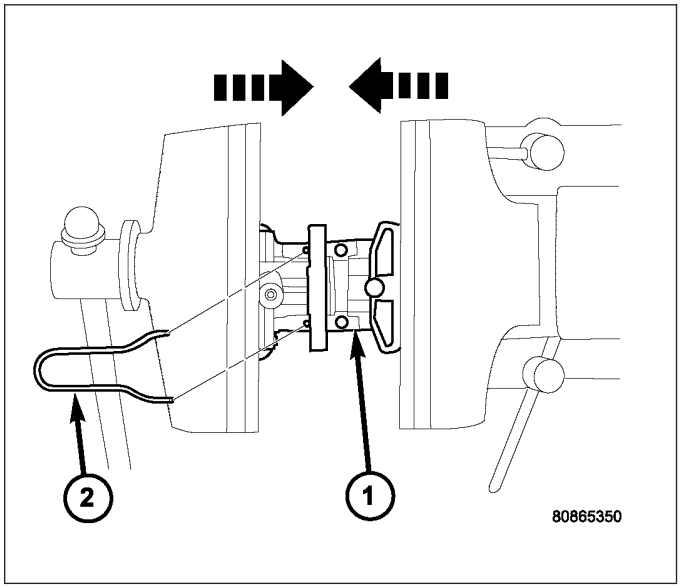
INSTALLATION

CAUTION: When the timing chain is removed and the cylinder heads are installed, DO NOT rotate the camshafts or crankshaft without first locating the proper crankshaft position. Failure to do so will result in valve and/or piston damage.

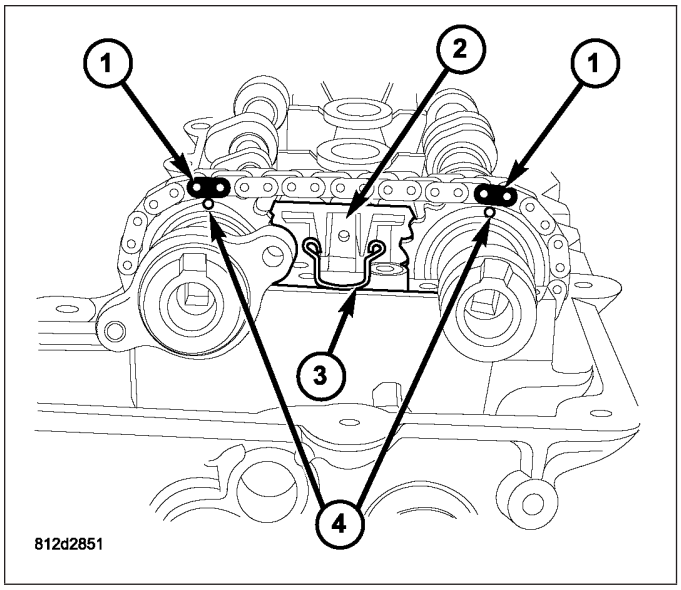
1. Assemble camshaft chain on the cams. Verify that plated links (1) are facing toward the front. Align the plated links (1) to the dots (4) on the camshaft sprockets.



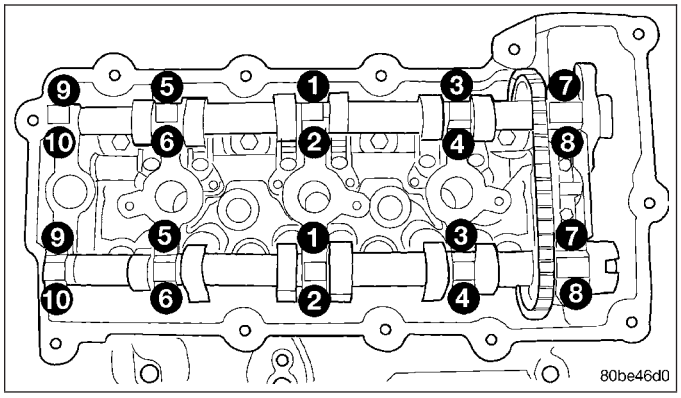
2. If camshaft chain tensioner is already in the compressed and locked position, proceed to step #4.
3. When the camshaft chain tensioner is removed, it is necessary to compress and lock the tensioner using the following procedures:
   a. Place tensioner (1) into a soft jaw vise.
   b. SLOWLY compress tensioner until fabricated lock pin (2) or the equivalent can be inserted into the locking holes.
   c. Remove compressed and locked tensioner from the vise.



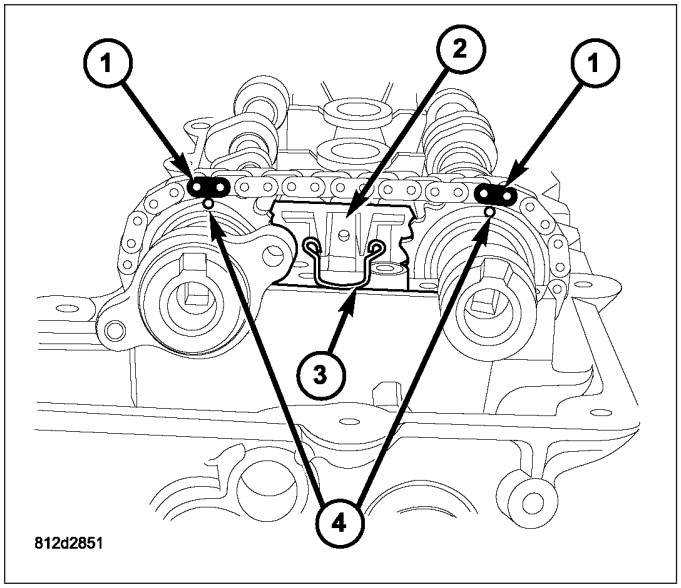
4. Insert the compressed and locked camshaft chain tensioner (2) in between the camshafts and chain.
5. Rotate the cams so that the plated links (1) and dots (4) are facing the 12:00 o'clock position.
6. Install cams to cylinder head. Verify that rocker arms are correctly seated and in proper positions.



7. Install camshaft bearing caps. Verify that bearing caps are installed in same position as removed.
8. Tighten cam bearing cap bolts gradually in sequence shown in to 12 N·m (105 in. lbs.).



9. Install secondary chain tensioner (2) bolts and tighten to 12 N·m (105 in. lbs.).
10. Remove locking pin (3) from secondary tensioners (2).
11. Measure camshafts end play (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - STANDARD PROCEDURE).
12. Install the primary timing chain (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

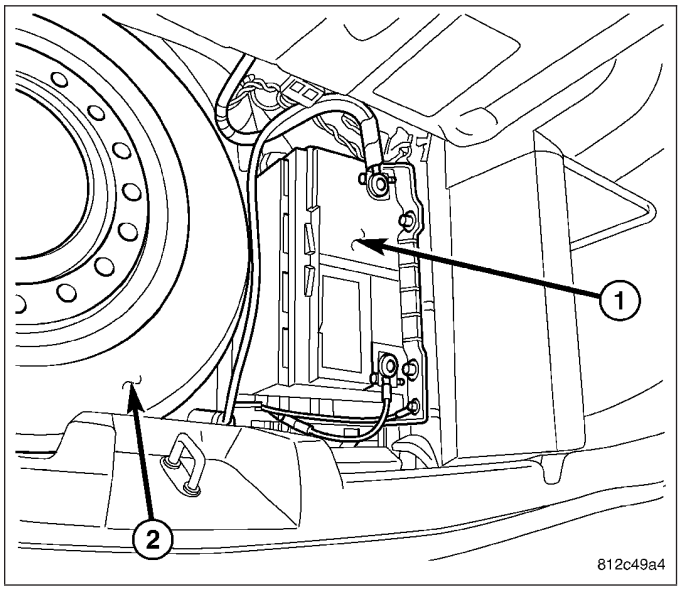


COVER(S)-CYLINDER HEAD

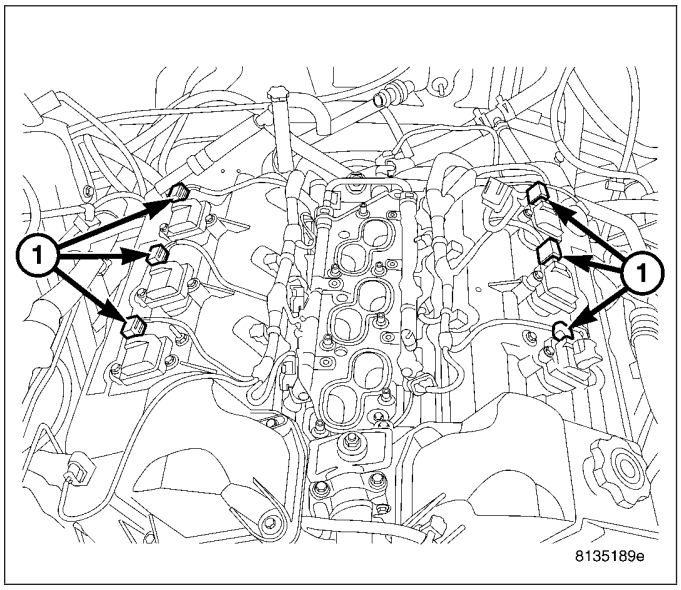
REMOVAL

LEFT

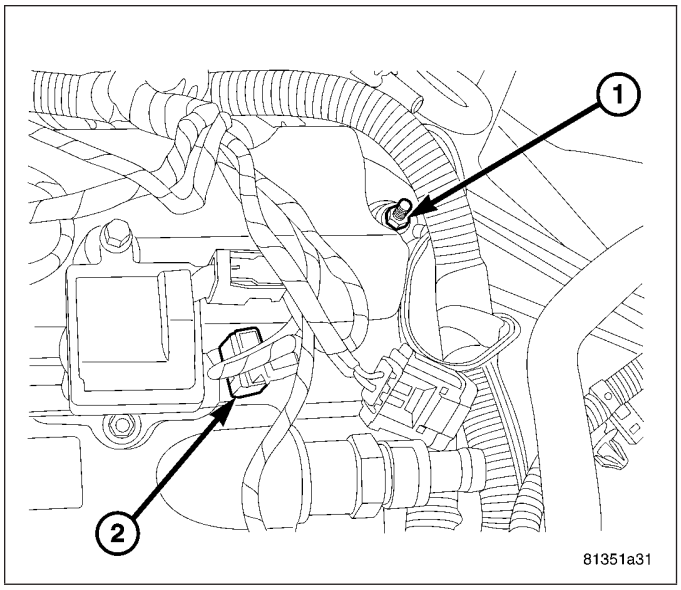
1. Disconnect negative battery (1) cable located in trunk.



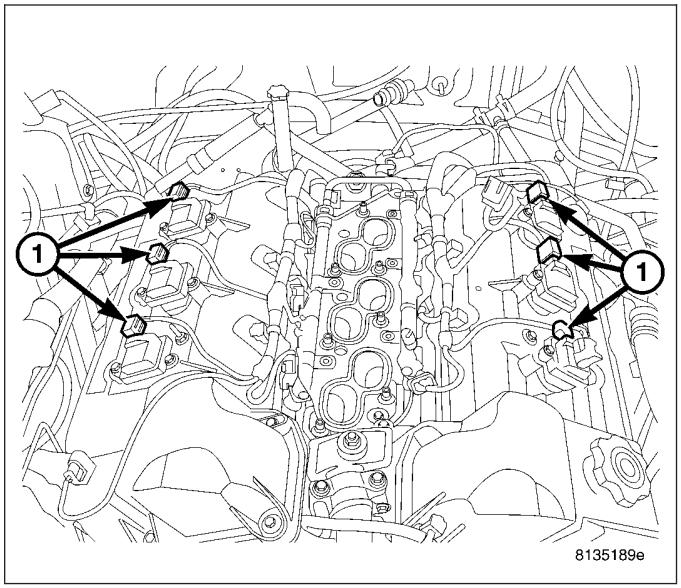
2. Remove upper intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).
3. Disconnect electrical connectors from ignition coils (1).



4. Remove ground strap from cylinder head cover stud (1) and disconnect capacitor connector (2). Reposition electrical harness.
5. Disconnect electrical harness retaining clips from cylinder head cover studs. Reposition electrical harness.



6. Remove make up air hose.
7. Remove fastener attaching ignition coil capacitor.
8. Remove ignition coils (1).

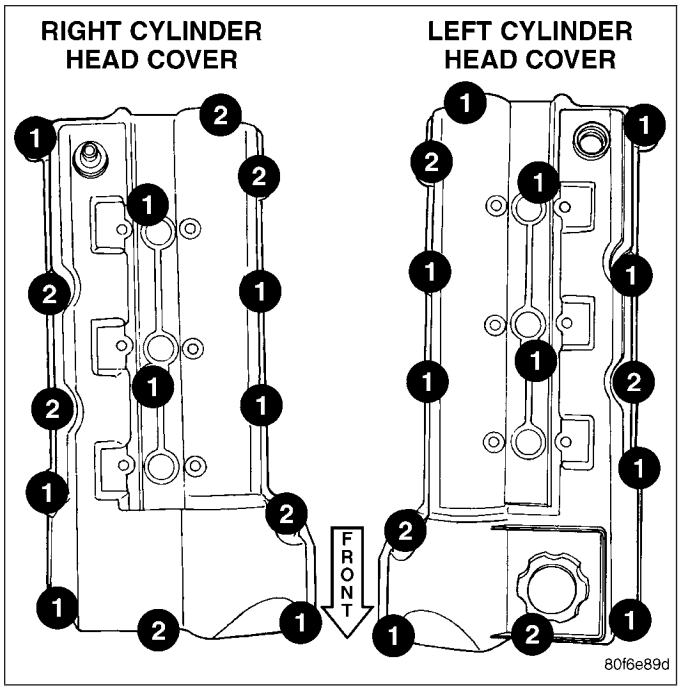


9. Loosen all cylinder head cover fasteners (1)&(2).

NOTE: Cylinder head cover attaching bolts are captured to the cover.

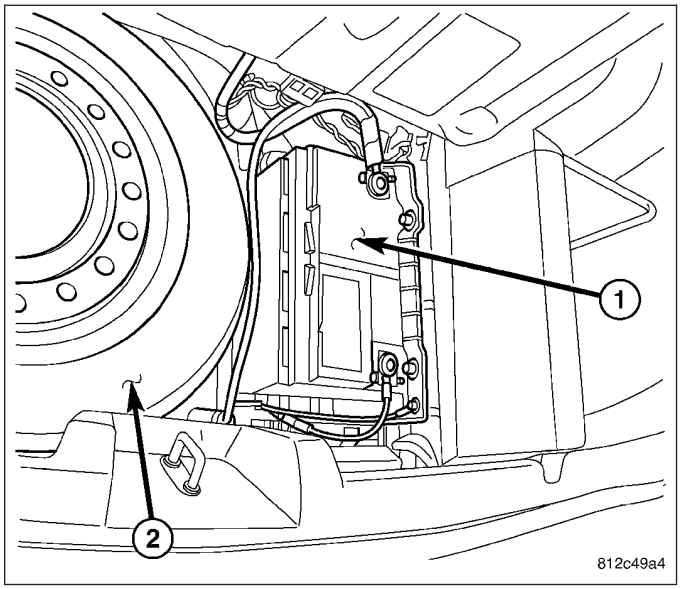
CAUTION: Make certain the double ended studs (1) in the center of the cylinder head cover are loose before attempting to remove cover.

10. Remove cylinder head cover.

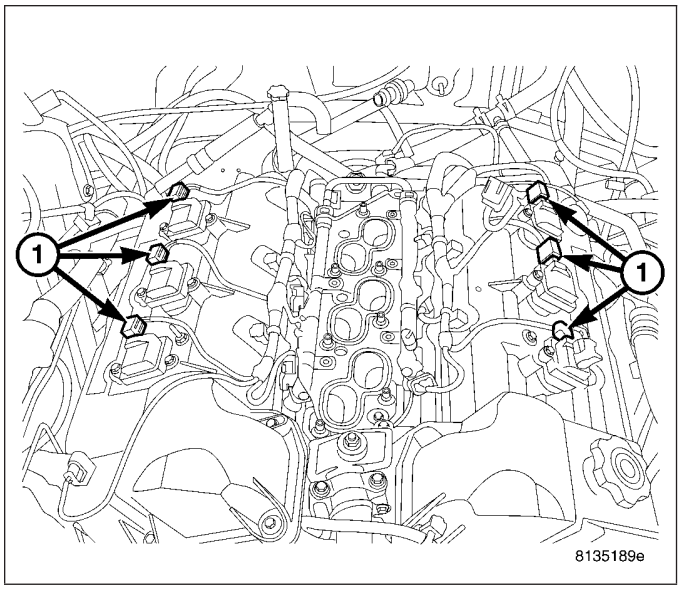


RIGHT

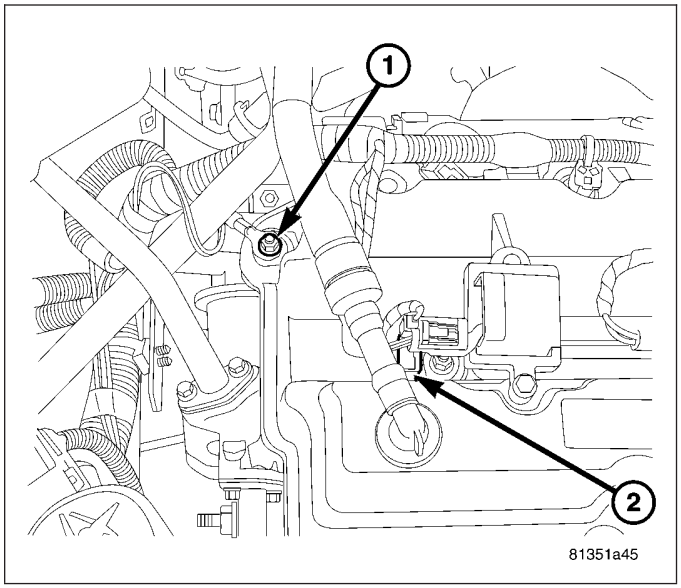
1. Disconnect negative battery (1) cable.



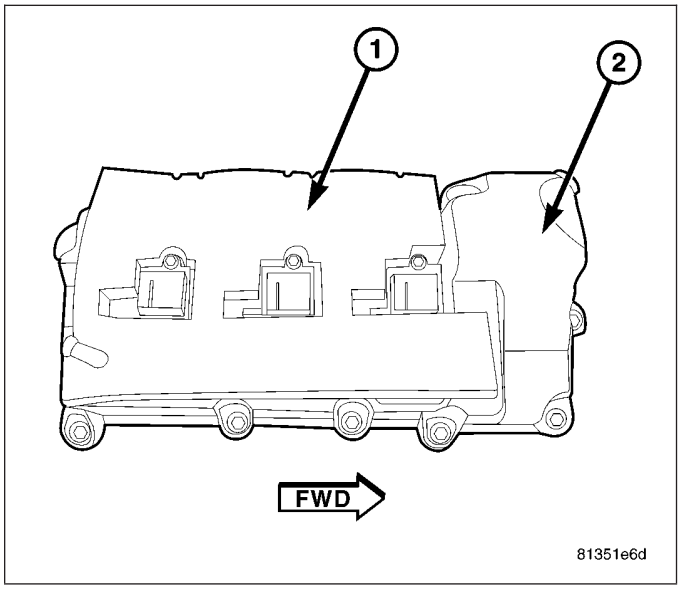
2. Remove upper intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).
3. Disconnect electrical connectors from ignition coils (1).



4. Disconnect capacitor electrical connector (2).
5. Remove PCV hose from cylinder head cover grommet.
6. Remove ground strap from cylinder head cover stud (1).
7. Disconnect electrical harness retaining clips from cylinder head cover studs. Reposition electrical harness.
8. Remove fastener attaching ignition coil capacitor.
9. Remove ignition coils.



10. Remove foam insulator (1).

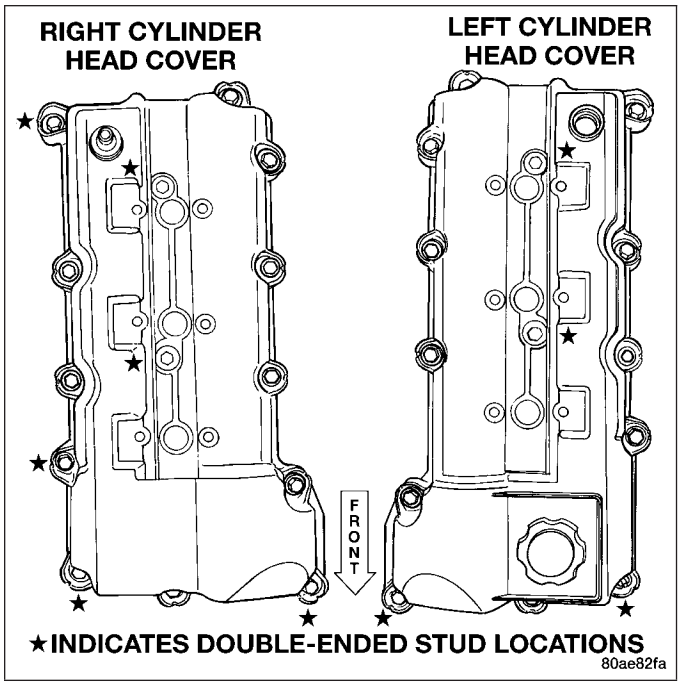


11. Loosen all cylinder head cover fasteners.

NOTE: Cylinder head cover attaching bolts are captured to the cover.

CAUTION: Make certain the double ended studs in the center of the cylinder head cover are loose before attempting to remove cover.

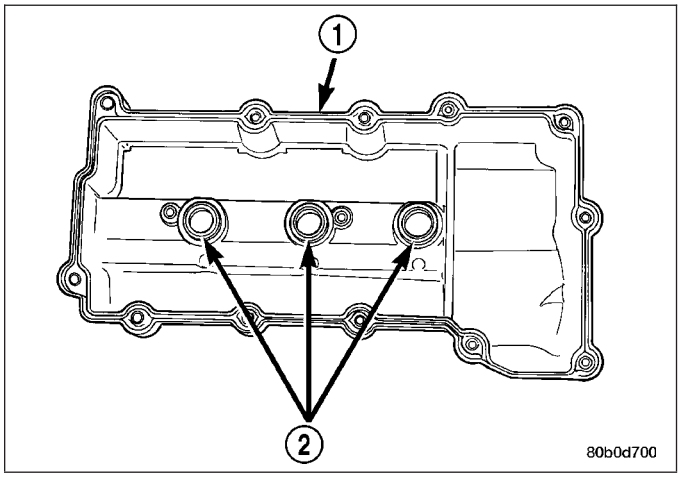
12. Remove cylinder head cover.



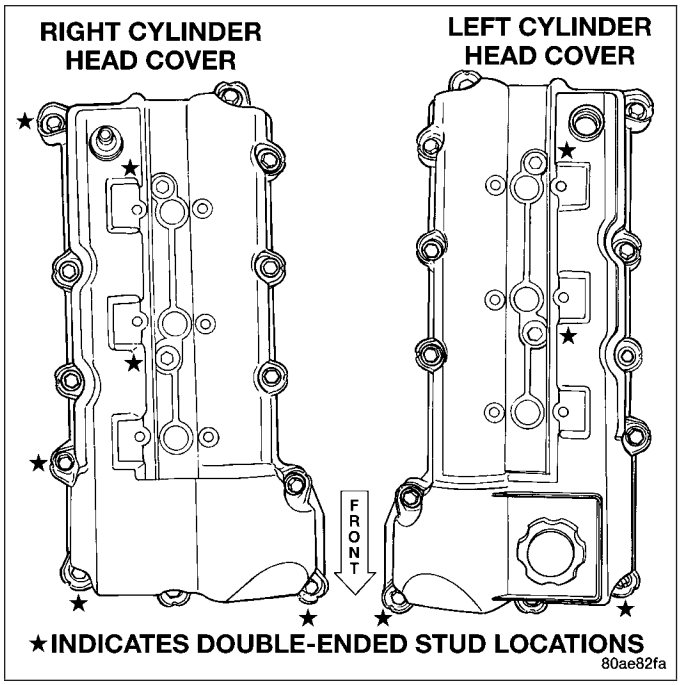
INSTALLATION

LEFT

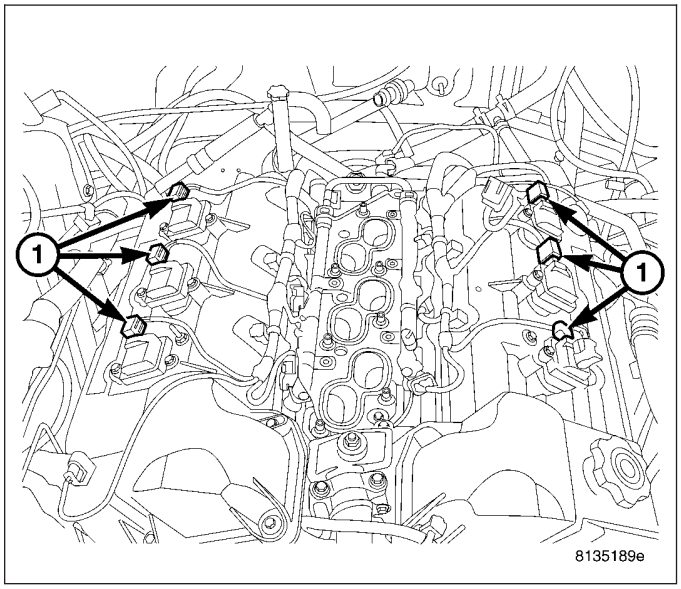
1. Clean cylinder head cover and both sealing surfaces. Inspect and replace gaskets (1)&(2) as necessary.



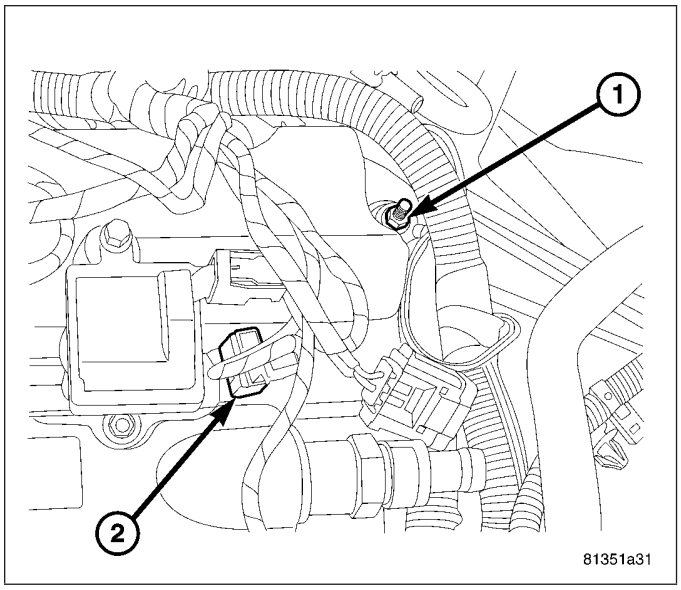
2. Install cylinder head cover and hand start all fasteners. Verify that all double-ended studs are in the correct locations.
3. Tighten cylinder head cover attaching bolts and double-ended studs to 12 N·m (105 in. lbs.).



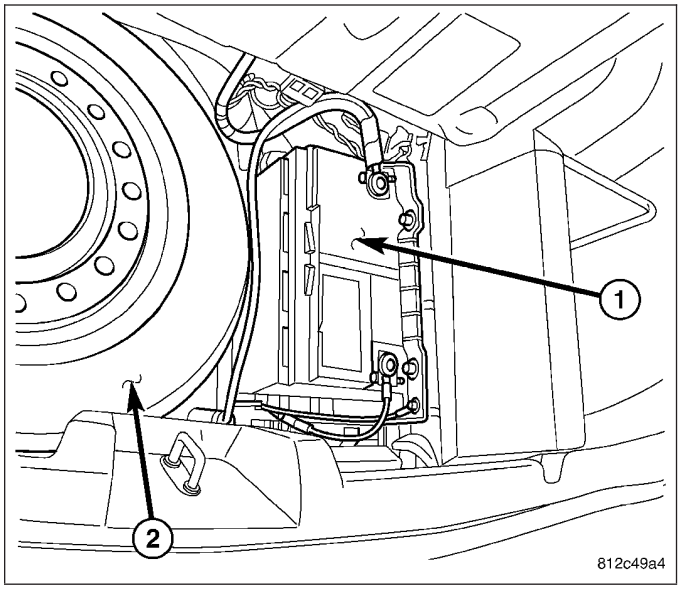
4. Install ignition coils (1).



5. Install ignition coil capacitor (2) and fastener.
6. Install ground strap (1) to cylinder head cover stud.
7. Connect all electrical connectors and harness clips.
8. Connect make up air hose.
9. Install upper intake manifold (Refer to 9 - ENGINE/ MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

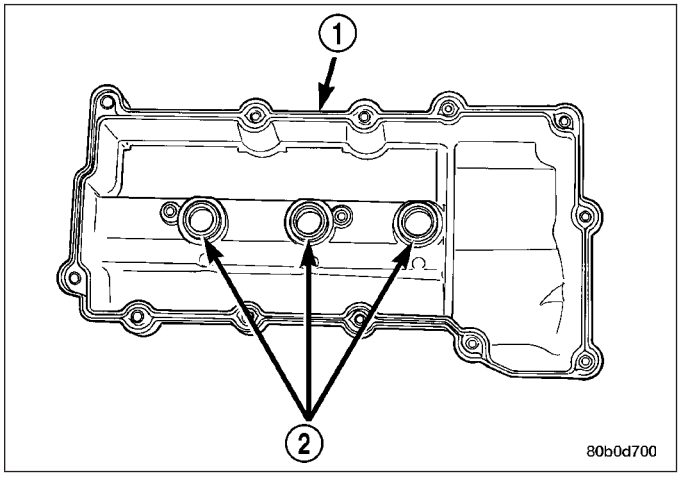


10. Connect negative battery (1) cable.

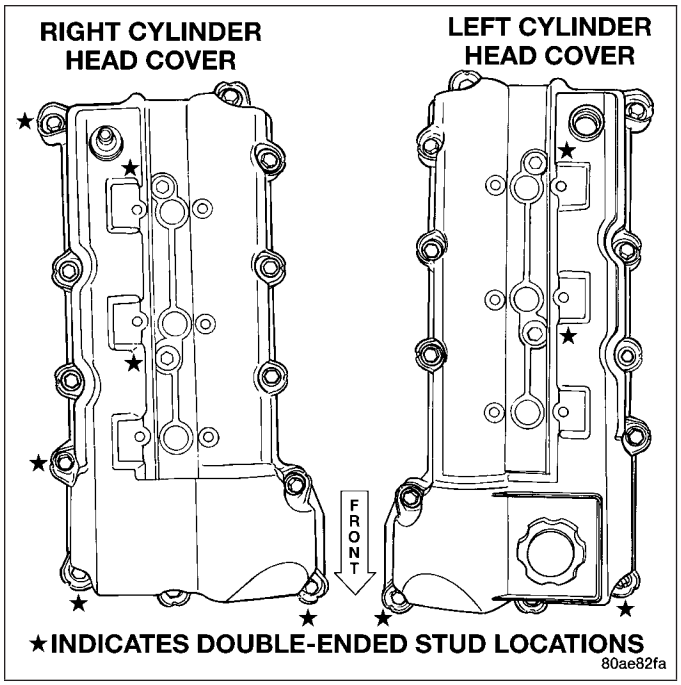


RIGHT

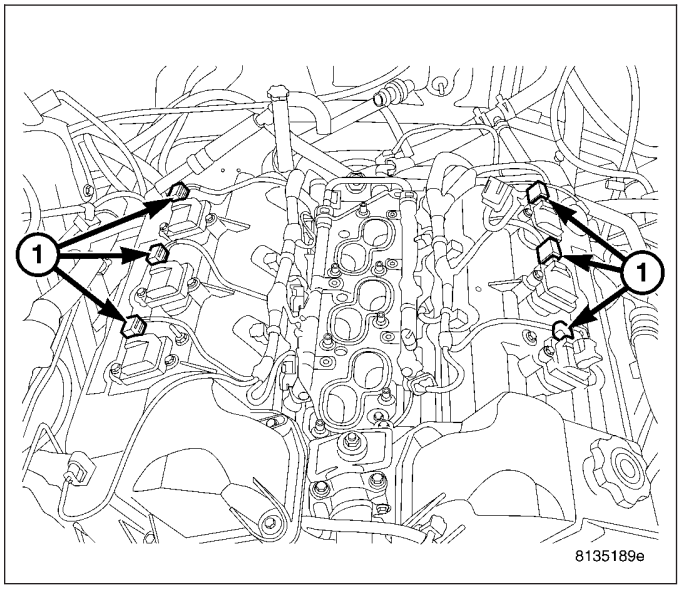
1. Clean cylinder head cover and both sealing surfaces. Inspect and replace gaskets (1)&(2) as necessary.



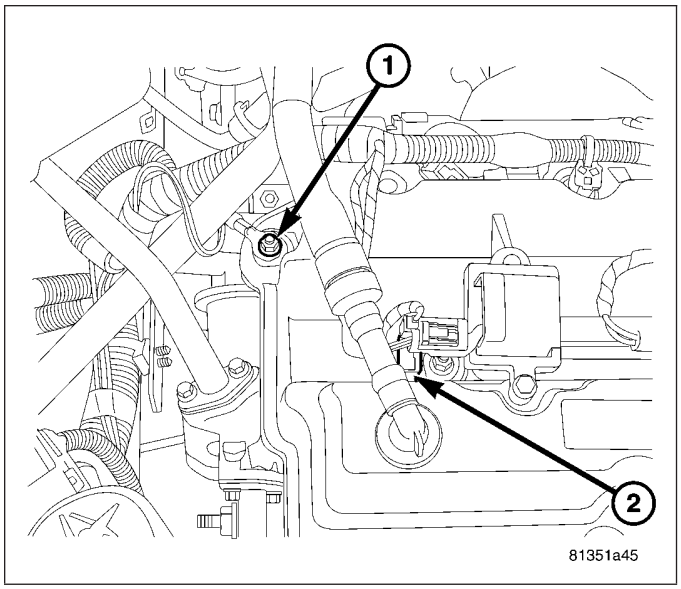
2. Install cylinder head cover and hand start all fasteners. Verify that all double-ended studs are in the correct locations.
3. Tighten cylinder head cover attaching bolts and double-ended studs to 12 N·m (105 in. lbs.).



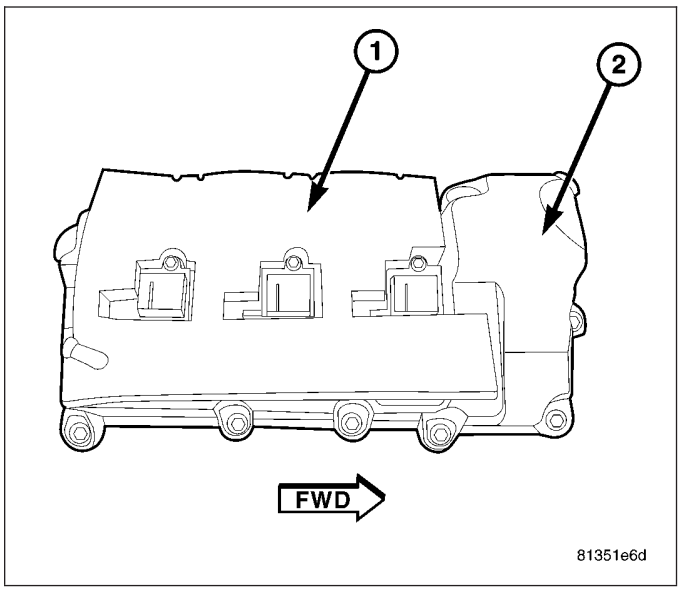
4. Install ignition coils (1).



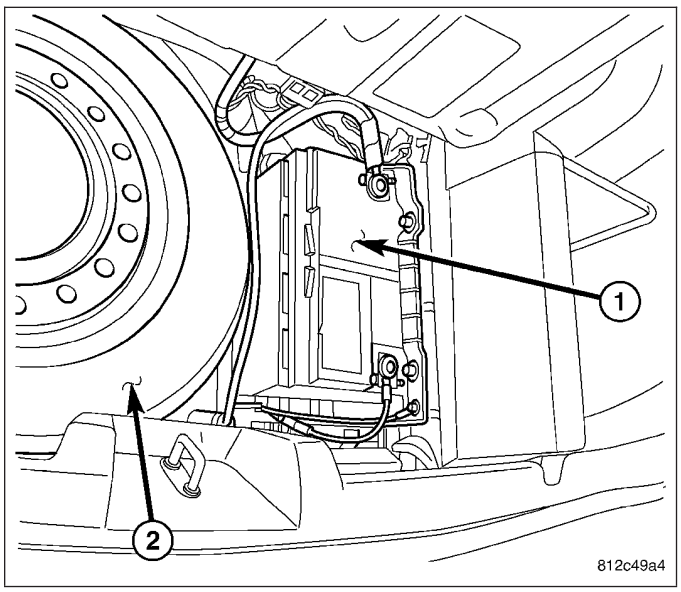
5. Install ignition coil capacitor (2) and fastener.
6. Connect ground strap (1) to cylinder head cover stud.
7. Connect PCV hose to cylinder head cover grommet.
8. Connect all electrical connectors and harness clips.



9. Install foam insulator (1) on top of cylinder head cover (2).
10. Install upper intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

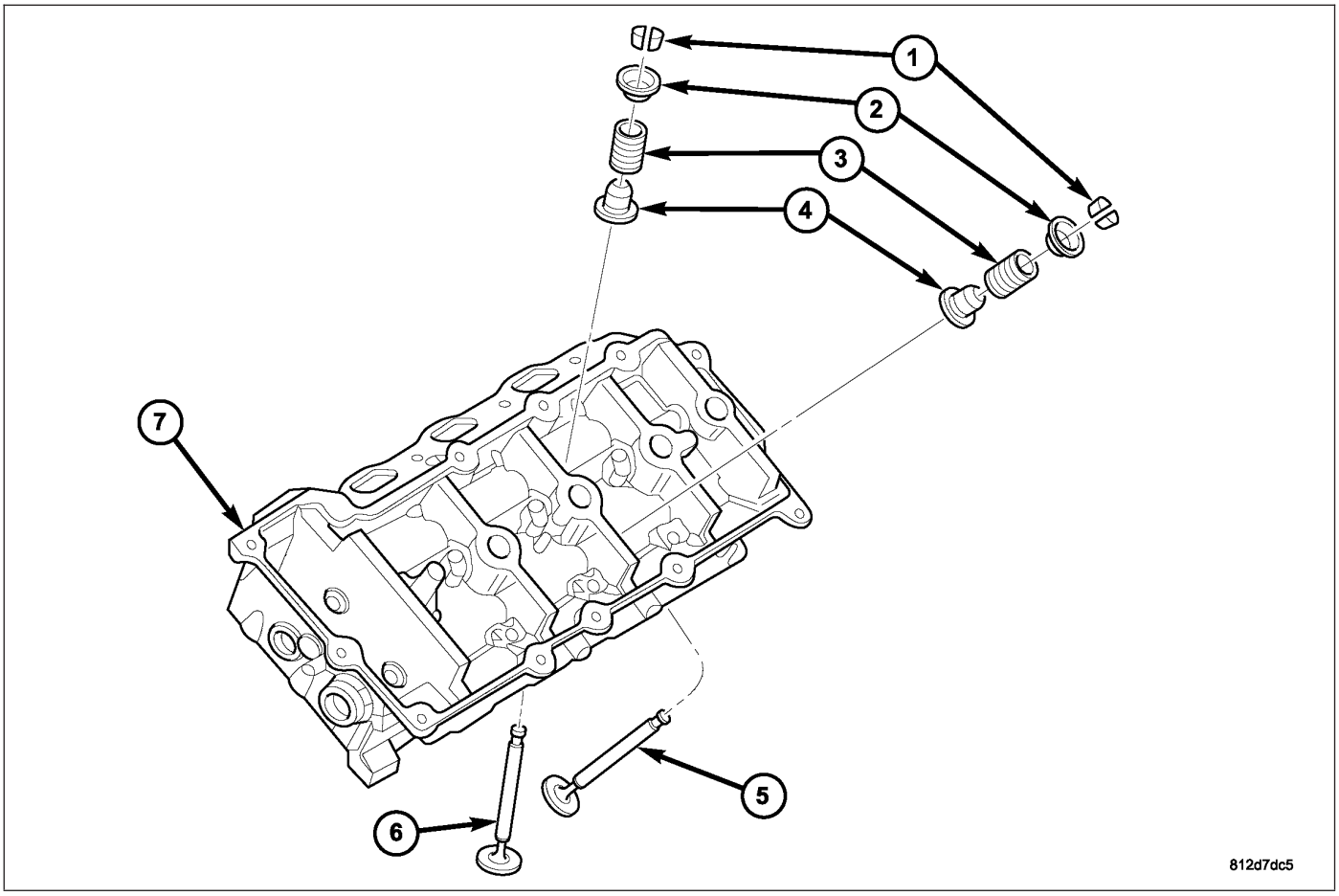


11. Connect negative battery (1) cable.



VALVES & SEATS-INTAKE/EXHAUST

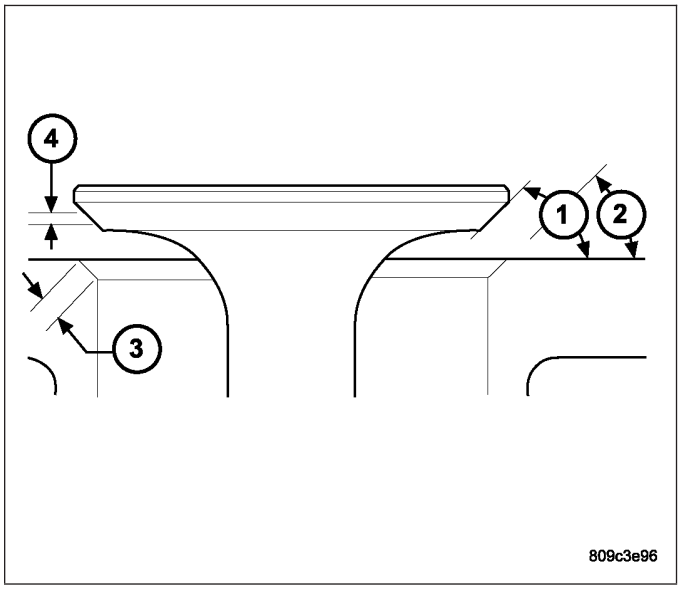
DESCRIPTION



The valves (5)&(6) are made of heat resistant steel, and have chrome plated stems to prevent scuffing. The four valves per cylinder (two intake (6) and two exhaust (5)) are actuated by roller rocker arms, which pivot on stationary lash adjusters. All valves use three bead lock keepers (1) to retain springs (3) and to promote valve rotation.

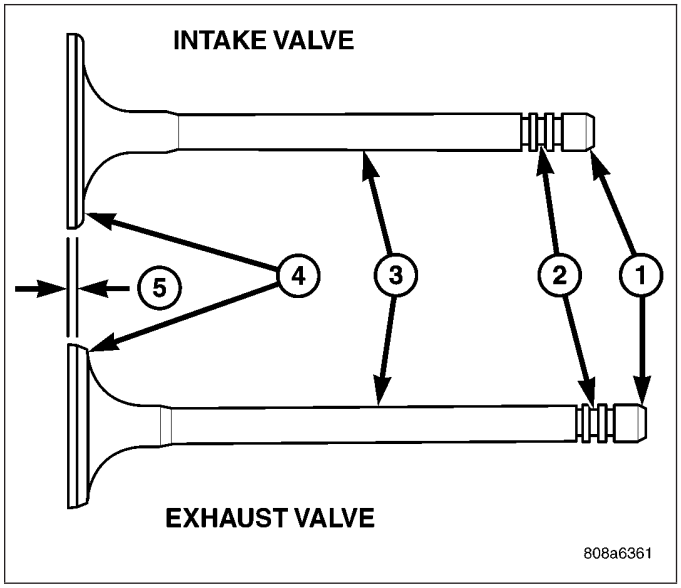
STANDARD PROCEDURE - VALVE AND VALVE SEAT REFACING

The intake and exhaust valves have a 44.5 to 45 degree face angle (1). The valve seats (2) have a 45 to 45.5 degree face angle.



VALVES

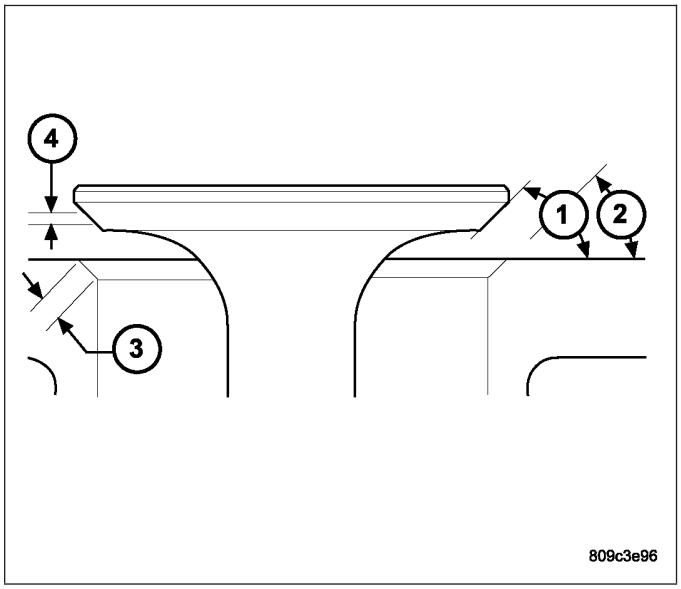
Inspect the remaining margin (5) after the valves are refaced (Refer to 9 - ENGINE - SPECIFICATIONS).



VALVE SEATS

NOTE: When refacing valve seats, it is important that the correct size valve guide pilot be used for reseating stones. A true and complete surface must be obtained.

1. Measure the concentricity of valve seat using dial indicator. Total runout should not exceed 0.051 mm (0.002 inch.) total indicator reading.
2. Inspect the valve seat (3) with Prussian blue to determine where the valve contacts the seat. To do this, coat valve seat (3)**LIGHTLY** with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face (4), contact is satisfactory. If the blue is transferred to top edge of valve face, then lower valve seat with a 15 degree stone. If the blue is transferred to the bottom edge of valve face, then raise valve seat with a 65 degree stone.



NOTE: Valve seats which are worn or burned can be reworked, provided that correct angle and seat width are maintained. Otherwise cylinder head must be replaced.

3. When seat is properly positioned the width of the intake 1.00 to 1.50 mm (0.0394 to 0.0591 in.) and exhaust seats should be 1.25 to 1.75 mm (0.049 to 0.069 in.).