

## ENGINE 1.8L WORLD

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## ENGINE 1.8L WORLD

### DESCRIPTION

The 1.8 Liter (110 cu. in.) in-line four cylinder engine is a double over head camshaft with mechanical lash buckets and four valves per cylinder design. This engine is NOT free-wheeling; meaning that the pistons will contact the valves in the event of a timing chain failure.

The cylinders are numbered from front of the engine to the rear. The firing order is 1–3–4–2.

The engine identification number is located on the rear of the cylinder block.

### DIAGNOSIS AND TESTING

#### INTRODUCTION

Engine diagnosis is helpful in determining the causes of malfunctions not detected and remedied by routine maintenance.

These malfunctions may be classified as either mechanical (e.g., a strange noise), or performance (e.g., engine idles rough and stalls).

Refer to the Engine Mechanical and the Engine Performance diagnostic charts, for possible causes and corrections of malfunctions (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING - MECHANICAL) (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING - PERFORMANCE).

For fuel system diagnosis, (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - DIAGNOSIS AND TESTING).

Additional tests and diagnostic procedures may be necessary for specific engine malfunctions that cannot be isolated with the Service Diagnosis charts. Information concerning additional tests and diagnosis is provided within the following:

- Cylinder Compression Pressure Test
- Cylinder Combustion Pressure Leakage Test
- Engine Cylinder Head Gasket Failure Diagnosis
- Lash Adjuster Noise Diagnosis
- Engine Oil Leak Inspection

**ENGINE PERFORMANCE**

CONDITION	POSSIBLE CAUSE	CORRECTION
ENGINE WILL NOT START	<ol style="list-style-type: none"> <li>1. Weak battery.</li> <li>2. Corroded or loose battery connections.</li> <li>3. Faulty starter.</li> <li>4. Faulty coil(s) or control unit.</li> <li>5. Incorrect spark plug gap.</li> <li>6. Contamination in fuel system.</li> <li>7. Faulty fuel pump.</li> <li>8. Incorrect engine timing.</li> </ol>	<ol style="list-style-type: none"> <li>1. Test battery. Charge or replace as necessary. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM - DIAGNOSIS AND TESTING)</li> <li>2. Clean and tighten battery connections. Apply a coat of light mineral grease to terminals.</li> <li>3. Test starting system. (Refer to 8 - ELECTRICAL/STARTING - DIAGNOSIS AND TESTING)</li> <li>4. Test and replace as needed. (Refer to Appropriate Diagnostic Information)</li> <li>5. Set gap. (Refer to 8 - ELECTRICAL/IGNITION CONTROL - SPECIFICATIONS)</li> <li>6. Clean system and replace fuel filter.</li> <li>7. Test fuel pump and replace as needed. (Refer to Appropriate Diagnostic Information)</li> <li>8. Check for a skipped timing chain.</li> </ol>
ENGINE STALLS OR IDLES ROUGH	<ol style="list-style-type: none"> <li>1. Incorrect fuel mixture.</li> <li>2. Intake manifold leakage.</li> <li>3. Faulty ignition coil(s).</li> </ol>	<ol style="list-style-type: none"> <li>1. (Refer to Appropriate Diagnostic Information)</li> <li>2. Inspect intake manifold, manifold gasket, and vacuum hoses.</li> <li>3. Test and replace as necessary. (Refer to Appropriate Diagnostic Information)</li> </ol>
ENGINE LOSS OF POWER	<ol style="list-style-type: none"> <li>1. Dirty or incorrectly gapped plugs.</li> <li>2. Contamination in fuel system.</li> <li>3. Faulty fuel pump.</li> <li>4. Incorrect valve timing.</li> <li>5. Leaking cylinder head gasket.</li> <li>6. Low compression.</li> <li>7. Burned, warped, or pitted valves.</li> <li>8. Plugged or restricted exhaust system.</li> <li>9. Faulty ignition coil(s).</li> </ol>	<ol style="list-style-type: none"> <li>1. Clean plugs and set gap.</li> <li>2. Clean system and replace fuel filter.</li> <li>3. Test and replace as necessary. (Refer to Appropriate Diagnostic Information)</li> <li>4. Correct valve timing.</li> <li>5. Replace cylinder head gasket.</li> <li>6. Test compression of each cylinder.</li> <li>7. Replace valves.</li> <li>8. Perform exhaust restriction test. (Refer to 11 - EXHAUST SYSTEM - DIAGNOSIS AND TESTING) Install new parts, as necessary.</li> <li>9. Test and replace as necessary. (Refer to Appropriate Diagnostic Information)</li> </ol>

CONDITION	POSSIBLE CAUSE	CORRECTION
ENGINE MISSES ON ACCELERATION	1. Dirty or incorrectly gapped spark plugs. 2. Contamination in Fuel System. 3. Burned, warped, or pitted valves. 4. Faulty ignition coil(s).	1. Clean spark plugs and set gap. 2. Clean fuel system and replace fuel filter. 3. Replace valves. 4. Test and replace as necessary. (Refer to Appropriate Diagnostic Information)
ENGINE MISSES AT HIGH SPEED	1. Dirty or incorrect spark plug gap. 2. Faulty ignition coil(s). 3. Dirty fuel injector(s). 4. Contamination in fuel system.	1. Clean spark plugs and set gap. 2. Test and replace as necessary. (Refer to Appropriate Diagnostic Information) 3. Test and replace as necessary. (Refer to Appropriate Diagnostic Information) 4. Clean system and replace fuel filter.

## ENGINE MECHANICAL

CONDITION	POSSIBLE CAUSES	CORRECTION
VALVETRAIN NOISE	1. High or low oil level in crankcase. 2. Thin or diluted oil. 3. Thick oil 4. Low oil pressure. 5. Dirt in lash adjusters. 6. Worn rocker arms. 7. Worn lash adjusters. 8. Worn valve guides. 9. Excessive runout of valve seats on valve faces. 10. Missing adjuster pivot.	1. Check and correct engine oil level. 2. Change oil to correct viscosity. 3. (a) Change engine oil and filter. (b) Run engine to operating temperature. (c) Change engine oil and filter again. 4. Check and correct engine oil level. 5. Replace rocker arm/hydraulic lash adjuster assembly. 6. Inspect oil supply to rocker arms. 7. Install new rocker arm/hydraulic lash adjuster assembly. 8. Replace cylinder head. 9. Grind valves, replace cylinder head. 10. Replace rocker arm/hydraulic lash adjuster assembly.

CONDITION	POSSIBLE CAUSES	CORRECTION
CONNECTING ROD NOISE	<ol style="list-style-type: none"> <li>1. Insufficient oil supply.</li> <li>2. Low oil pressure.</li> <li>3. Thin or diluted oil.</li> <li>4. Thick oil</li> <li>5. Excessive bearing clearance.</li> <li>6. Connecting rod journal out-of-round.</li> <li>7. Misaligned connecting rods.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check engine oil level.</li> <li>2. Check engine oil level. Inspect oil pump relief valve and spring.</li> <li>3. Change oil to correct viscosity.</li> <li>4. (a) Change engine oil and filter. (b) Run engine to operating temperature. (c) Change engine oil and filter again.</li> <li>5. Measure bearings for correct clearance. Repair as necessary.</li> <li>6. Replace crankshaft or grind surface.</li> <li>7. Replace bent connecting rods.</li> </ol>
MAIN BEARING NOISE	<ol style="list-style-type: none"> <li>1. Insufficient oil supply.</li> <li>2. Low oil pressure.</li> <li>3. Thin or diluted oil.</li> <li>4. Thick oil</li> <li>5. Excessive bearing clearance.</li> <li>6. Excessive end play.</li> <li>7. Crankshaft journal out-of-round or worn.</li> <li>8. Loose flywheel or torque converter.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check engine oil level.</li> <li>2. Check engine oil level. Inspect oil pump relief valve and spring.</li> <li>3. Change oil to correct viscosity.</li> <li>4. (a) Change engine oil and filter. (b) Run engine to operating temperature. (c) Change engine oil and filter again.</li> <li>5. Measure bearings for correct clearance. Repair as necessary.</li> <li>6. Check thrust bearing for wear on flanges.</li> <li>7. Replace crankshaft or grind journals.</li> <li>8. Tighten to correct torque.</li> </ol>
OIL PRESSURE DROP	<ol style="list-style-type: none"> <li>1. Low oil level.</li> <li>2. Faulty oil pressure switch.</li> <li>3. Low oil pressure.</li> <li>4. Clogged oil filter.</li> <li>5. Worn parts in oil pump.</li> <li>6. Thin or diluted oil.</li> <li>7. Oil pump relief valve stuck.</li> <li>8. Oil pump suction tube loose.</li> <li>9. Oil pump cover warped or cracked.</li> <li>10. Excessive bearing clearance.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check engine oil level.</li> <li>2. Install new oil pressure switch.</li> <li>3. Check sending unit and main bearing oil clearance.</li> <li>4. Install new oil filter.</li> <li>5. Replace worn parts or pump.</li> <li>6. Change oil to correct viscosity.</li> <li>7. Remove valve and inspect, clean, or replace.</li> <li>8. Remove oil pan and install new tube or clean, if necessary.</li> <li>9. Install new oil pump.</li> <li>10. Measure bearings for correct clearance.</li> </ol>

CONDITION	POSSIBLE CAUSES	CORRECTION
OIL LEAKS	<ol style="list-style-type: none"> <li>1. Misaligned or deteriorated gaskets.</li> <li>2. Loose fastener, broken or porous metal part.</li> <li>3. Misaligned or deteriorated cup or threaded plug.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace gasket(s).</li> <li>2. Tighten, repair or replace the part.</li> <li>3. Replace as necessary.</li> </ol>
OIL CONSUMPTION OR SPARK PLUGS FOULED	<ol style="list-style-type: none"> <li>1. PCV system malfunction.</li> <li>2. Worn, scuffed or broken rings.</li> <li>3. Carbon in oil ring slots.</li> <li>4. Rings fitted too tightly in grooves.</li> <li>5. Worn valve guide(s).</li> <li>6. Valve stem seal(s) worn or damaged.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check system and repair as necessary. (Refer to 25 - EMISSIONS CONTROL/ EVAPORATIVE EMISSIONS/PCV VALVE - DIAGNOSIS AND TESTING)</li> <li>2. Hone cylinder bores. Install new rings.</li> <li>3. Install new rings.</li> <li>4. Remove rings and check grooves. If groove is not proper width, replace piston.</li> <li>5. Replace cylinder head.</li> <li>6. Replace seal(s).</li> </ol>

## CYLINDER COMPRESSION PRESSURE TEST

The results of a cylinder compression pressure test can be utilized to diagnose several engine malfunctions.

Ensure the battery is completely charged and the engine starter motor is in good operating condition. Otherwise the indicated compression pressures may not be valid for diagnosis purposes.

1. Check engine oil level and add oil if necessary.
2. Drive the vehicle until engine reaches normal operating temperature. Select a route free from traffic and other forms of congestion, observe all traffic laws, and accelerate through the gears several times briskly.
3. Remove engine cover.
4. Disconnect coil electrical connectors and remove coils.
5. Remove all spark plugs from engine. As spark plugs are being removed, check electrodes for abnormal firing indicators fouled, hot, oily, etc. Record cylinder number of spark plug for future reference.
6. Disconnect injector electrical connectors.
7. Insert compression gauge adaptor Special Tool 8116 or the equivalent, into the #1 spark plug hole in cylinder head. Connect the 0–500 psi (Blue) pressure transducer (Special Tool CH7059) with cable adaptors to the DRBIII®. For Special Tool identification, (Refer to 9 - ENGINE - SPECIAL TOOLS).
8. Crank engine until maximum pressure is reached on gauge. Record this pressure as #1 cylinder pressure.
9. Repeat the previous step for all remaining cylinders.
10. Compression should not be less than 689 kPa (100 psi) and not vary more than 25 percent from cylinder to cylinder.
11. If one or more cylinders have abnormally low compression pressures, repeat the compression test.
12. If the same cylinder or cylinders repeat an abnormally low reading on the second compression test, it could indicate the existence of a problem in the cylinder in question. **The recommended compression pressures are to be used only as a guide to diagnosing engine problems. An engine should not be disassembled to determine the cause of low compression unless some malfunction is present.**

## CYLINDER COMBUSTION PRESSURE LEAKAGE TEST

The combustion pressure leakage test provides an accurate means for determining engine condition.

Combustion pressure leakage testing will detect:

- Exhaust and intake valve leaks (improper seating).
- Leaks between adjacent cylinders or into water jacket.
- Any causes for combustion/compression pressure loss.

**WARNING: DO NOT REMOVE THE PRESSURE CAP WITH THE SYSTEM HOT AND UNDER PRESSURE BECAUSE SERIOUS BURNS FROM COOLANT CAN OCCUR.**

Check the coolant level and fill as required. DO NOT install the pressure cap.

Start and operate the engine until it attains normal operating temperature, then turn the engine OFF.

Clean spark plug recesses with compressed air.

Remove the spark plugs.

Remove the oil filler cap.

Remove the air cleaner.

Calibrate the tester according to the manufacturer's instructions. The shop air source for testing should maintain 483 kPa (70 psi) minimum, 1,379 kPa (200 psi) maximum, with 552 kPa (80 psi) recommended.

Perform the test procedures on each cylinder according to the tester manufacturer's instructions. While testing, listen for pressurized air escaping through the throttle body, tailpipe and oil filler cap opening. Check for bubbles in the coolant.

All gauge pressure indications should be equal, with no more than 25% leakage per cylinder.

**FOR EXAMPLE:** At 552 kPa (80 psi) input pressure, a minimum of 414 kPa (60 psi) should be maintained in the cylinder.

## CYLINDER HEAD GASKET

A cylinder head gasket leak can be located between adjacent cylinders, between a cylinder and the adjacent water jacket or from an oil passage to the exterior of the engine.

Possible indications of the cylinder head gasket leaking between adjacent cylinders are:

- Loss of engine power
- Engine misfiring
- Poor fuel economy

Possible indications of the cylinder head gasket leaking between a cylinder and an adjacent water jacket are:

- Engine overheating
- Loss of coolant
- Excessive steam (white smoke) emitting from exhaust
- Coolant foaming

## CYLINDER-TO-CYLINDER LEAKAGE TEST

To determine if an engine cylinder head gasket is leaking between adjacent cylinders, follow the procedures in Cylinder Compression Pressure Test (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING). An engine cylinder head gasket leaking between adjacent cylinders will result in approximately a 50–70% reduction in compression pressure.

## CYLINDER-TO-WATER JACKET LEAKAGE TEST

**WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING WITH COOLANT PRESSURE CAP REMOVED.**

### VISUAL TEST METHOD

With the engine cool, remove the coolant pressure cap. Start the engine and allow it to warm up until thermostat opens.

If a large combustion/compression pressure leak exists, bubbles will be visible in the coolant.



## COOLING SYSTEM TESTER METHOD

**WARNING: WITH COOLING SYSTEM TESTER IN PLACE, PRESSURE WILL BUILD UP FAST. EXCESSIVE PRESSURE BUILT UP, BY CONTINUOUS ENGINE OPERATION, MUST BE RELEASED TO A SAFE PRESSURE POINT. NEVER PERMIT PRESSURE TO EXCEED 138 kPa (20 psi).**

Install Cooling System Tester 7700 or equivalent to pressure cap neck. Start the engine and observe the tester's pressure gauge. If gauge pulsates with every power stroke of a cylinder a combustion pressure leak is evident.

## CHEMICAL TEST METHOD

Combustion leaks into the cooling system can also be checked by using Bloc-Chek Kit C-3685-A or equivalent. Perform test following the procedures supplied with the tool kit.

## ENGINE OIL LEAK INSPECTION

Begin with a thorough visual inspection of the engine, particularly at the area of the suspected leak. If an oil leak source is not readily identifiable, the following steps should be followed:

1. Do not clean or degrease the engine at this time because some solvents may cause rubber to swell, temporarily stopping the leak.
2. Add an oil soluble dye (use as recommended by manufacturer). Start the engine and let idle for approximately 15 minutes. Check the oil dipstick to make sure the dye is thoroughly mixed as indicated with a bright yellow color under a black light.
3. Using a black light, inspect the entire engine for fluorescent dye, particularly at the suspected area of oil leak. If the oil leak is found and identified, repair as necessary.
4. If dye is not observed, drive the vehicle at various speeds for approximately 24 km (15 miles), and repeat inspection.
5. **If the oil leak source is not positively identified at this time**, proceed with the air leak detection test method as follows:
  - Disconnect the fresh air hose (make-up air) at the cylinder head cover and plug or cap the nipple on the cover.
  - Remove the PCV valve hose from the cylinder head cover. Cap or plug the PCV valve nipple on the cover.
  - Attach an air hose with pressure gauge and regulator to the dipstick tube.

**CAUTION: Do not subject the engine assembly to more than 20.6 kPa (3 PSI) of test pressure.**

- Gradually apply air pressure from 1 psi to 2.5 psi maximum while applying soapy water at the suspected source. Adjust the regulator to the suitable test pressure that provides the best bubbles which will pinpoint the leak source. If the oil leak is detected and identified, repair per service manual procedures.
  - If the leakage occurs at the crankshaft rear oil seal area, refer to the section, Inspection for Rear Seal Area Leak.
6. If no leaks are detected, turn off the air supply. Remove the air hose, all plugs, and caps. Install the PCV valve and fresh air hose (make-up air). Proceed to next step.
  7. Clean the oil off the suspect oil leak area using a suitable solvent. Drive the vehicle at various speeds approximately 24 km (15 miles). Inspect the engine for signs of an oil leak by using a black light.

**NOTE: If oil leakage is observed at the dipstick tube to block location; remove the tube, clean and reseal using Mopar® Stud & Bearing Mount (press fit tube applications only), and for O-ring style tubes, remove tube and replace the O-ring seal.**

## INSPECTION FOR REAR SEAL AREA LEAKS

Since it is sometimes difficult to determine the source of an oil leak in the rear seal area of the engine, a more involved inspection is necessary. The following steps should be followed to help pinpoint the source of the leak.

If the leakage occurs at the crankshaft rear oil seal area:

1. Disconnect the battery.
2. Raise the vehicle.

3. Remove torque converter or clutch housing cover and inspect rear of block for evidence of oil. Use a black light to check for the oil leak. If a leak is present in this area, remove transmission for further inspection.
  - a. Circular spray pattern generally indicates seal leakage or crankshaft damage.
  - b. Where leakage tends to run straight down, possible causes are a porous block, oil gallery cup plug, bedplate to cylinder block mating surfaces and seal bore. See proper repair procedures for these items.
4. If no leaks are detected, pressurize the crankcase as previously described.

**CAUTION: Do not exceed 20.6 kPa (3 psi).**

5. If the leak is not detected, very slowly turn the crankshaft and watch for leakage. If a leak is detected between the crankshaft and seal while slowly turning the crankshaft, it is possible the crankshaft seal surface is damaged. The seal area on the crankshaft could have minor nicks or scratches that can be polished out with emery cloth.

**CAUTION: Use extreme caution when crankshaft polishing is necessary to remove minor nicks and scratches. The crankshaft seal flange is especially machined to complement the function of the rear oil seal.**

6. For bubbles that remain steady with shaft rotation, no further inspection can be done until disassembled.
7. After the oil leak root cause and appropriate corrective action have been identified, replace component(s) as necessary.

## STANDARD PROCEDURE

### REPAIR OF DAMAGED OR WORN THREADS

Damaged or worn threads (excluding spark plug and camshaft bearing cap attaching threads) can be repaired. Essentially, this repair consists of drilling out worn or damaged threads, tapping the hole with a special Heli-Coil Tap, (or equivalent) and installing an insert into the tapped hole. This brings the hole back to its original thread size.

**CAUTION: Be sure that the tapped holes maintain the original center line.**

Heli-Coil tools and inserts are readily available from automotive parts jobbers.

### HYDROSTATIC LOCKED ENGINE

When an engine is suspected to be hydrostatically locked, regardless of what caused the problem, the following steps should be used.

**CAUTION: DO NOT use starter motor to rotate the engine, severe damage may occur.**

1. Inspect air cleaner, induction system and intake manifold to insure system is dry and clear of foreign material.
2. Remove negative battery cable.
3. Place a shop towel around the spark plugs when removing them from the engine. This will catch any fluid that may possibly be in the cylinder under pressure.
4. With all spark plugs removed, rotate engine crankshaft using a breaker bar and socket.
5. Identify the fluid in the cylinder(s) (i.e., coolant, fuel, oil or other).
6. Make sure all fluid has been removed from the cylinders. Inspect engine for damage (i.e., connecting rods, pistons, valves, etc.)
7. Repair engine or components as necessary to prevent this problem from re-occurring.

**CAUTION: Squirt approximately one teaspoon of oil into the cylinders, rotate engine to lubricate the cylinder walls to prevent damage on restart.**

8. Install new spark plugs.
9. Drain engine oil and remove oil filter.
10. Install a new oil filter.
11. Fill engine with specified amount of approved oil.
12. Connect negative battery cable.

13. Start engine and check for any leaks.

## FORM-IN-PLACE GASKETS AND SEALERS

There are numerous places where form-in-place gaskets are used on the engine. Care must be taken when applying form-in-place gaskets to assure obtaining the desired results. **Do not use form-in-place gasket material unless specified.** Bead size, continuity, and location are of great importance. Too thin a bead can result in leakage while too much can result in spill-over which can break off and obstruct fluid feed lines. A continuous bead of the proper width is essential to obtain a leak-free gasket.

There are numerous types of form-in-place gasket materials that are used in the engine area. Mopar® Engine RTV GEN II, Mopar® ATF-RTV, and Mopar® Gasket Maker gasket materials, each have different properties and can not be used in place of the other.

**MOPAR® ENGINE RTV GEN II** is used to seal components exposed to engine oil. This material is a specially designed black silicone rubber RTV that retains adhesion and sealing properties when exposed to engine oil. Moisture in the air causes the material to cure. This material is available in three ounce tubes and has a shelf life of one year. After one year this material will not properly cure. Always inspect the package for the expiration date before use.

**MOPAR® ATF RTV** is a specifically designed black silicone rubber RTV that retains adhesion and sealing properties to seal components exposed to automatic transmission fluid, engine coolants, and moisture. This material is available in three ounce tubes and has a shelf life of one year. After one year this material will not properly cure. Always inspect the package for the expiration date before use.

**MOPAR® GASKET MAKER** is an anaerobic type gasket material. The material cures in the absence of air when squeezed between two metallic surfaces. It will not cure if left in the uncovered tube. The anaerobic material is for use between two machined surfaces. Do not use on flexible metal flanges.

**MOPAR® BED PLATE SEALANT** is a unique (green-in-color) anaerobic type gasket material that is specially made to seal the area between the bed plate and cylinder block without disturbing the bearing clearance or alignment of these components. The material cures slowly in the absence of air when torqued between two metallic surfaces, and will rapidly cure when heat is applied.

**MOPAR® GASKET SEALANT** is a slow drying, permanently soft sealer. This material is recommended for sealing threaded fittings and gaskets against leakage of oil and coolant. Can be used on threaded and machined parts under all temperatures. This material also will prevent corrosion. Mopar® Gasket Sealant is available in a 13 oz. aerosol can or 4oz./16 oz. can w/applicator.

## SEALER APPLICATION

Mopar® Gasket Maker material should be applied sparingly 1 mm (0.040 in.) diameter or less of sealant to one gasket surface. Be certain the material surrounds each mounting hole. Excess material can easily be wiped off. Components should be torqued in place within 15 minutes. The use of a locating dowel is recommended during assembly to prevent smearing material off the location.

Mopar® Engine RTV GEN II or ATF RTV gasket material should be applied in a continuous bead approximately 3 mm (0.120 in.) in diameter. All mounting holes must be circled. For corner sealing, a 3.17 or 6.35 mm (1/8 or 1/4 in.) drop is placed in the center of the gasket contact area. Uncured sealant may be removed with a shop towel. Components should be torqued in place while the sealant is still wet to the touch (within 10 minutes). The usage of a locating dowel is recommended during assembly to prevent smearing material off the location.

Mopar® Gasket Sealant in an aerosol can should be applied using a thin, even coat sprayed completely over both surfaces to be joined, and both sides of a gasket. Then proceed with assembly. Material in a can w/applicator can be brushed on evenly over the sealing surfaces.

## ENGINE GASKET SURFACE PREPARATION

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.

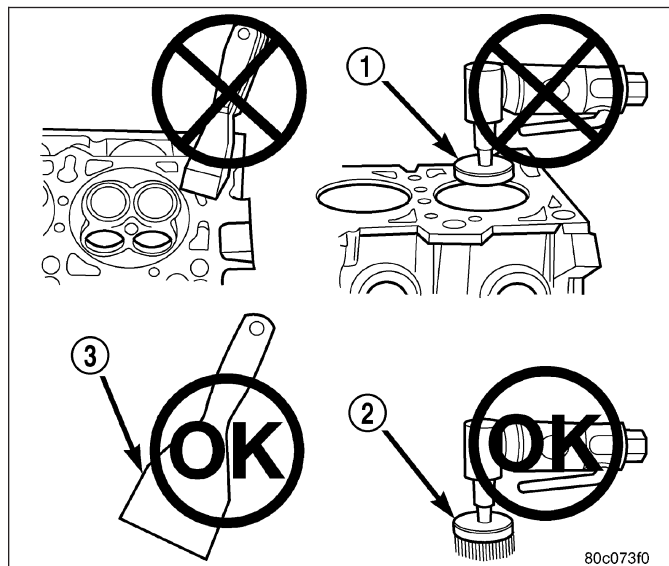
**Never** use the following to clean gasket surfaces:

- Metal scraper
- Abrasive pad or paper to clean cylinder block and head
- High speed power tool with an abrasive pad or a wire brush

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

Only use the following for cleaning gasket surfaces:

- Solvent or a commercially available gasket remover
- Plastic or wood scraper
- Drill motor with 3M Roloc™ Bristle Disc (white or yellow)

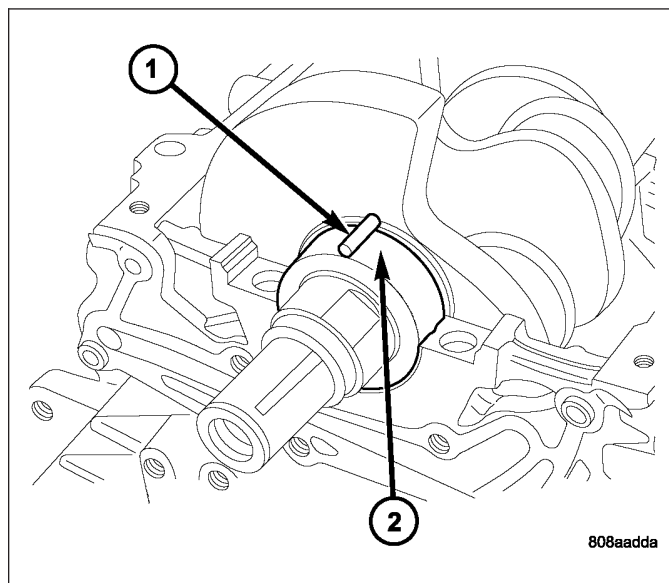


**CAUTION: Excessive pressure or high RPM (beyond the recommended speed), can damage the sealing surfaces. The mild (white, 120 grit) bristle disc is recommended. If necessary, the medium (yellow, 80 grit) bristle disc may be used on cast iron surfaces with care.**

## MEASURING BEARING CLEARANCE USING PLASTIGAGE

Engine crankshaft bearing clearances can be determined by use of Plastigage or equivalent. The following is the recommended procedure for the use of Plastigage:

1. Remove oil film from surface to be checked. Plastigage is soluble in oil.
2. Place a piece of Plastigage across the entire width of the bearing shell in the cap approximately 6.35 mm (1/4 in.) off center and away from the oil holes. (In addition, suspected areas can be checked by placing the Plastigage in the suspected area). Torque the bearing cap/bed plate bolts of the bearing being checked to the proper specifications.
3. Remove the bearing cap and compare the width of the flattened Plastigage with the metric scale provided on the package. Locate the band closest to the same width. This band shows the amount of clearance in thousandths of a millimeter. Differences in readings between the ends indicate the amount of taper present. Record all readings taken. Compare clearance measurements to specs found in engine specifications (Refer to 9 - ENGINE - SPECIFICATIONS). **Plastigage generally is accompanied by two scales. One scale is in inches, the other is a metric scale.**



**NOTE: Plastigage is available in a variety of clearance ranges. Use the most appropriate range for the specifications you are checking.**

4. Install the proper crankshaft bearings to achieve the specified bearing clearances.

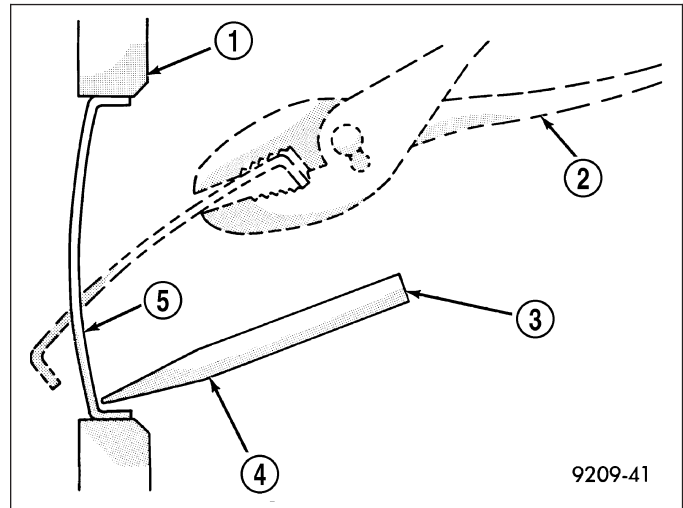
## CYLINDER HEAD CORE PLUGS

Using a blunt tool such as a drift and a hammer, strike the bottom edge of the cup plug. With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug.

**CAUTION: Do not drive cup plug into the casting as restricted cooling can result and cause serious engine problems.**

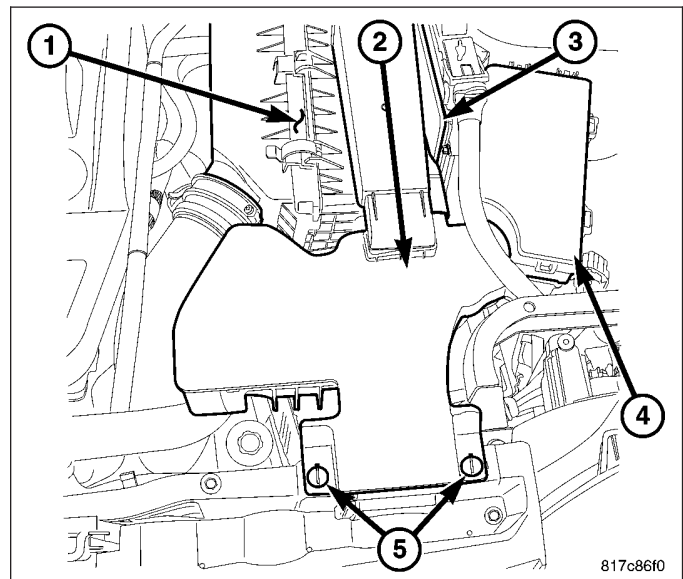
Thoroughly clean inside of cup plug hole in cylinder block or head. Be sure to remove old sealer. Lightly coat inside of cup plug hole with Mopar® Stud and Bearing Mount. Make certain the new plug is cleaned of all oil or grease. Using proper drive plug, drive plug into hole so that the sharp edge of the plug is at least 0.5 mm (0.020 in.) inside the lead-in chamfer.

It is not necessary to wait for curing of the sealant. The cooling system can be refilled and the vehicle placed in service immediately.



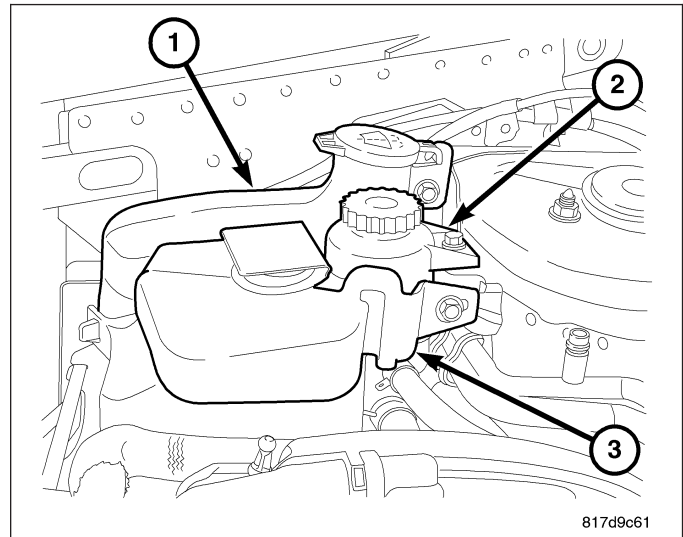
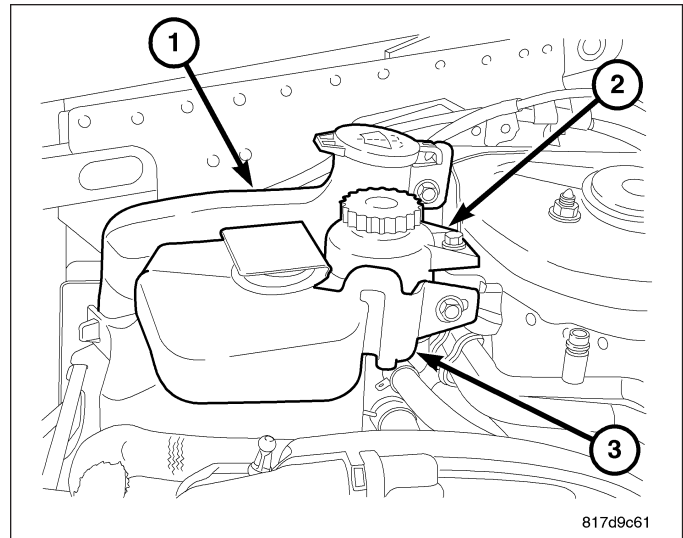
## REMOVAL - ENGINE ASSEMBLY

1. Perform fuel pressure release procedure, then disconnect and remove fuel line (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE).
2. Remove air cleaner housing assembly (1) and clean air hose (Refer to 9 - ENGINE/AIR INTAKE SYSTEM/AIR CLEANER HOUSING - REMOVAL).
3. Disconnect both cables from battery.
4. Remove battery and battery tray.
5. Discharge air conditioning system, if equipped (Refer to 24 - HEATING & AIR CONDITIONING - STANDARD PROCEDURE).
6. Drain cooling system (Refer to 7 - COOLING/ENGINE - STANDARD PROCEDURE).



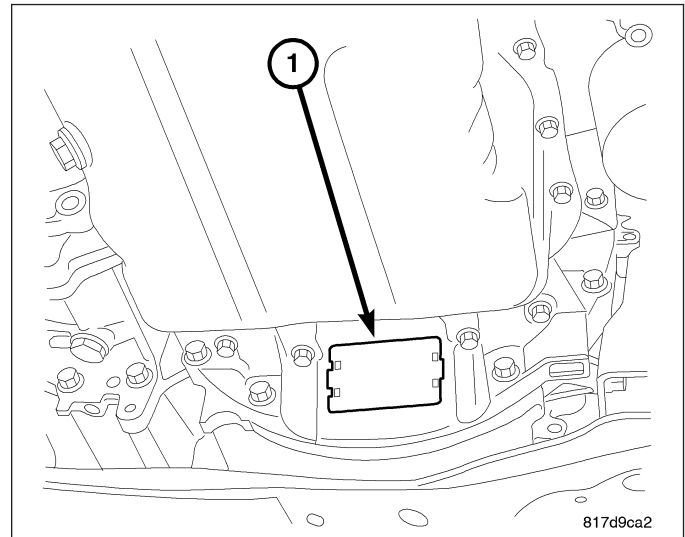


7. Remove coolant reservoir (3).
8. Remove grill trim panel.
9. Remove upper radiator hose from radiator and coolant manifold.
10. Remove upper radiator hose support.
11. Remove lower radiator hose at coolant manifold.
12. Remove coolant hose from coolant manifold.
13. Disconnect the following electrical connectors, Variable Valve Timing Solenoids, oil temperature sensor, injectors, map, coils, cam position sensors, coolant temperature sensors, capacitor, oxygen sensor, intake air temperature sensor.
14. Remove air intake tube from throttle body.
15. Remove vacuum lines from throttle body.
16. Unclip harness from intake.
17. Disconnect electronic throttle control and manifold flow control valve electrical connectors.
18. Remove PCV hose from valve cover.
19. Remove dipstick.
20. Remove throttle body support bracket.
21. Remove intake bolts and remove intake.
22. Disconnect coolant temperature sensor at block, Knock sensor, oil pressure sensor, generator, starter, block heater, A/C compressor, and block ground.
23. Remove accessory drive belt.
24. Remove power steering reservoir (2).
25. Remove power steering line support.
26. Remove power steering pump and set aside.
27. Remove upper idler pulley.
28. Remove transaxle filler tube.
29. Disconnect transmission linkage and electrical connectors.
30. Remove transmission vent hose.
31. Remove ground strap near right tower.
32. Remove rear heat shield.
33. Remove maniverter heat shields.
34. Raise vehicle.
35. Remove wheels.
36. Remove right front splash shield.
37. Remove axle nuts.
38. Remove ball joint pinch bolts and separate steering knuckle from ball joint.
39. Remove axles.
40. Drain oil.
41. Mark drive shaft and flange.
42. Remove carrier bearing and heat shield.
43. Remove driveshaft.
44. Remove exhaust pipe to maniverter bolts.
45. Remove maniverter support bracket.
46. Lower vehicle.
47. Remove coolant manifold.
48. Remove maniverter bolts.

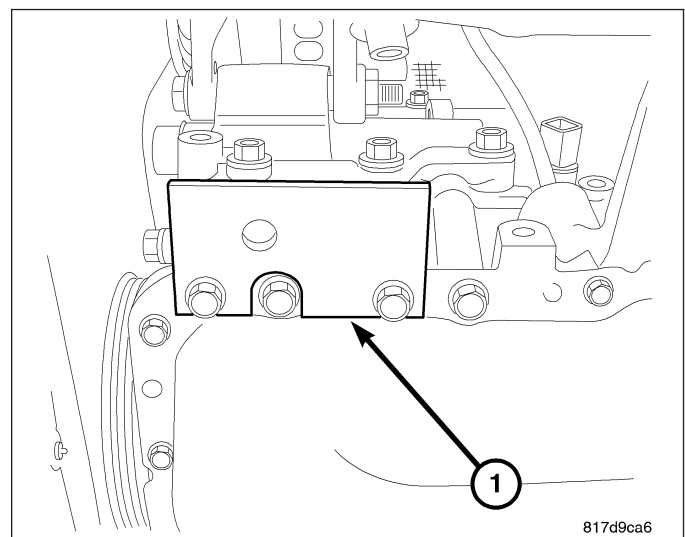


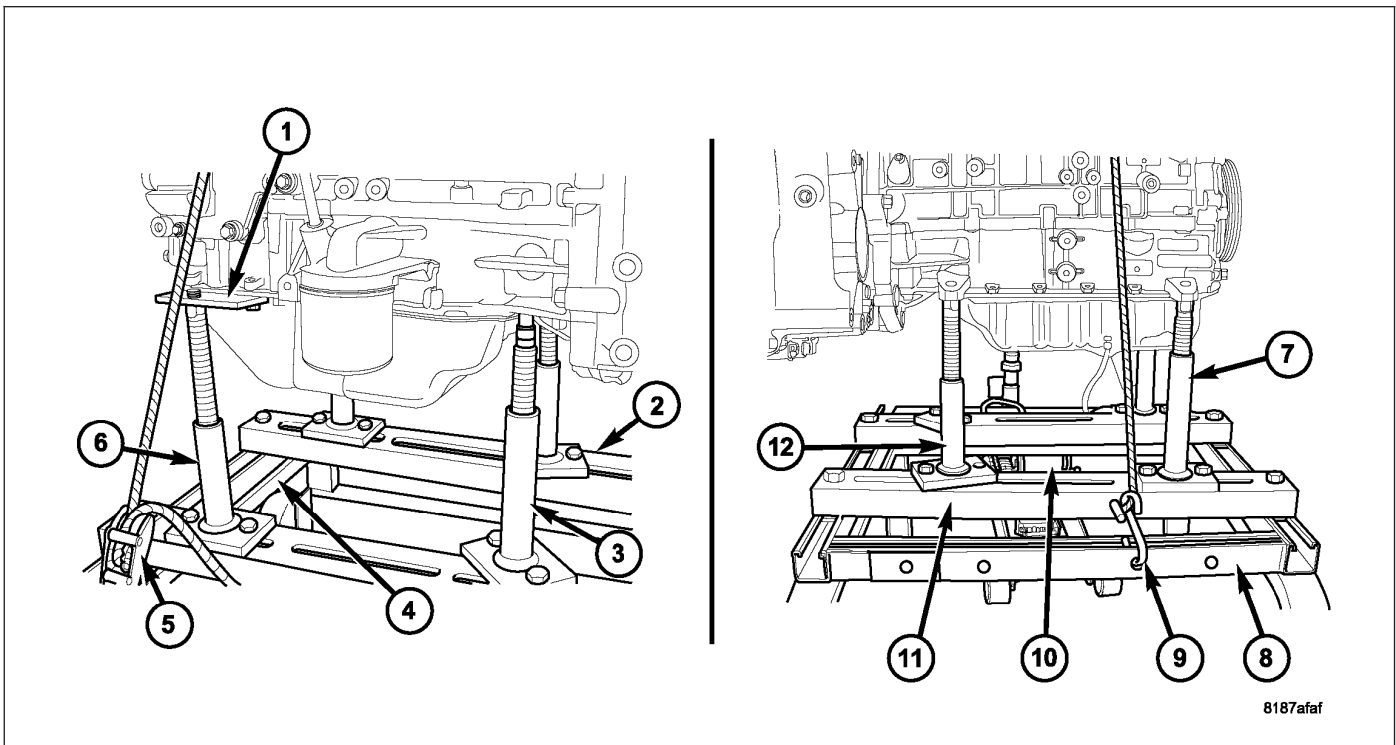
49. Remove maniverter to left of engine.
50. Hoist up.
51. Remove front mount through bolt.
52. Remove crossmember.
53. Remove front mount bracket.
54. Remove rear mount through bolt.
55. Remove rear mount.
56. Remove rear mount bracket.
57. Pull engine forward and support.
58. Remove PTU assembly (Refer to 21 - TRANSMISSION/TRANSAXLE/POWER TRANSFER UNIT - REMOVAL).

59. Remove inspection cover and mark torque converter to flywheel.
60. Remove torque converter bolts.
61. Remove lower bell housing bolts.
62. Remove A/C lines from compressor and remove A/C compressor.
63. Remove A/C mounting bracket.



64. Install Adapter 9704.
65. Remove generator and lower idler pulley.
66. Disconnect transmission electrical connector.
67. Disconnect CKP electrical connector.
68. Remove coolant hoses at transaxle cooler.
69. Remove transaxle cooler lines from cooler.





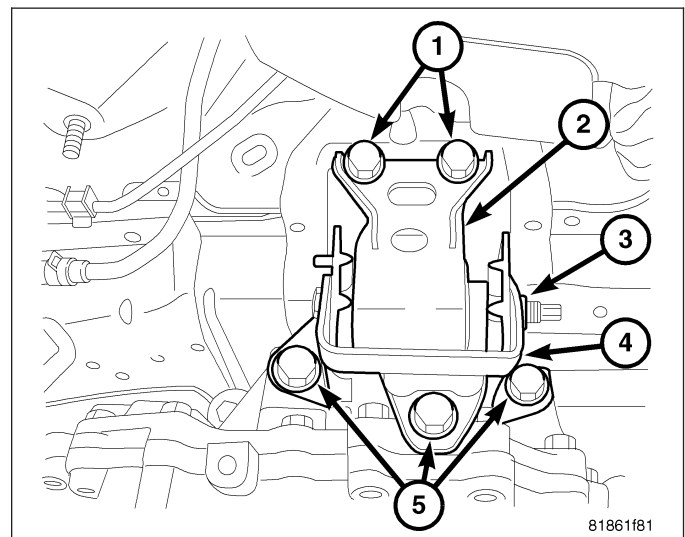
70. Position dolly under engine and lower vehicle.

**WARNING: Safety straps MUST be used.**

71. Install safety straps.

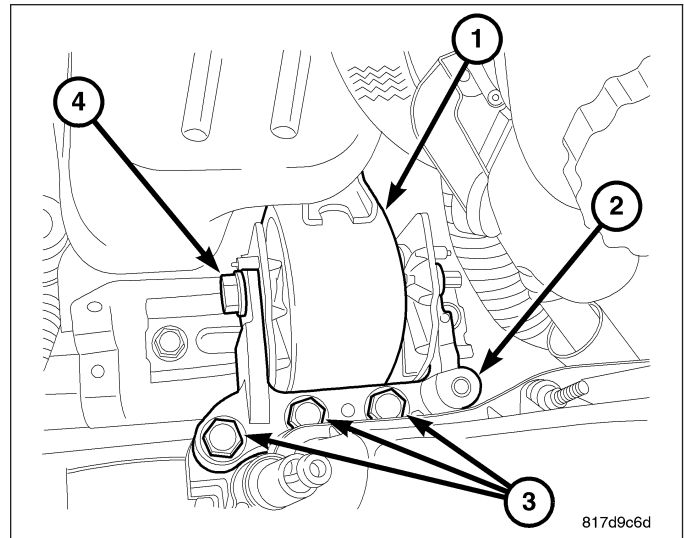
72. Remove PCM bracket and set aside.

73. Remove left engine mount through bolt (3).

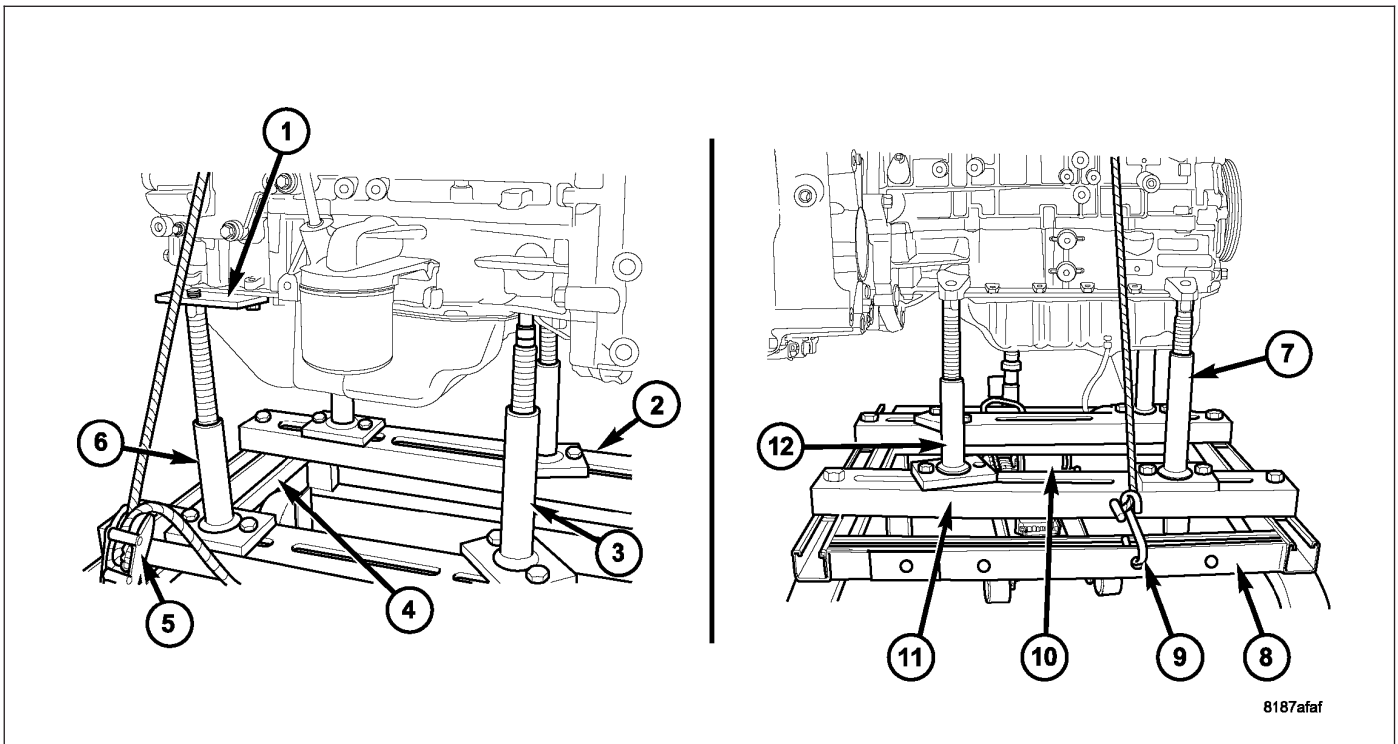




74. Remove right engine mount through bolt (4).
75. Raise vehicle away from engine and transaxle.
76. Separate engine from transaxle.



## INSTALLATION - ENGINE ASSEMBLY



1. Position engine and transmission assembly under vehicle and slowly lower the vehicle over the engine/transaxle assembly.
2. Continue lowering vehicle until engine/transaxle aligns to mounting locations.
3. Install mounting bolts at the right and left engine/transaxle mount bolts and Tighten bolts to 118 N·m (87 ft. lbs.).
4. Install mounting bolts at the right and left engine/transaxle mount bolts and Tighten bolts to 118 N·m (87 ft. lbs.).
5. Remove safety straps from engine/transaxle assembly. Slowly raise vehicle enough to remove the engine dolly and cradle.
6. Remove Adapter 9704.
7. Install pcm bracket.
8. Install maniverter assembly and upper lower heat shields.
9. Install oxygen sensor and connect electrical connector.
10. Install coolant manifold assembly.

11. Install transaxle linkage and adjust as necessary.
12. Install transaxle vent hose.
13. Connect transaxle range sensor electrical connector.
14. Connect TIS and TOS electrical connectors.
15. Install Ground strap near right strut tower.
16. Raise vehicle.
17. Pull engine forward and restrain engine.

**NOTE: Be sure to install O-ring prior to installing PTU assembly.**

18. Install PTU.
19. Remove engine restraint.
20. Install front mount bracket and tighten bolts.
21. Install frame cross member.
22. Install front engine mount.
23. Install rear mount bracket.
24. Install rear mount and tighten bolts.
25. Connect CKP electrical connector.
26. Install maniverter to exhaust pipe bolts and tighten.
27. Align driveshaft marks and install and heat shield.
28. Install generator
29. Install A/C bracket.
30. Install A/C lines on compressor and install compressor.
31. Install lower bell housing bolts and tighten.
32. Align torque converter and flex plate mark and install torque converter bolts and tighten.
33. Install inspection cover.
34. Install transaxle connector.
35. Connect trans cooler lines.
36. Install coolant hoses at transmission cooler.
37. Install axles.
38. Install ball joint pinch bolts and tighten.
39. Install axle nuts and tighten.
40. Install splash shields.
41. Install wheels.
42. Install new oil filter.
43. Lower vehicle.
44. Install transaxle filler tube.
45. Install upper idler pulley.
46. Install power steering pump.
47. Install power steering line support bracket.
48. Install power steering pump.
49. Install accessory drive belt.
50. Connect electrical connectors at block ground, starter, A/C compressor, knock sensor, Oil pressure sensor, generator, Coolant temperature sensor at block, and block heater.
51. Install intake manifold. Install intake manifold retaining bolts and tighten.
52. Install throttle body support bracket.
53. Install engine oil dip stick.
54. Install PCV hose to valve cover.

55. Connect manifold flow control valve and electronic throttle control electrical connectors and fasten harness to intake.
56. Install vacuum lines at throttle body.
57. Install intake air tube on throttle body.
58. Connect variable valve timing solenoids, oil temperature sensor, coolant temperature sensor, intake air temperature sensor, injectors, coils, manifold absolute pressure sensor, cam position sensors, oxygen sensor, and capacitor electrical connectors.
59. Install upper radiator support bracket.
60. Install coolant hoses at coolant manifold.
61. Install grill trim panel.
62. Install coolant reservoir and connect hose.
63. Connect fuel line to fuel rail.
64. Install battery tray and battery.
65. Connect battery cables.
66. Install air cleaner housing and connect inlet air hose.
67. Install fresh air inlet.
68. Fill with coolant.
69. Fill with oil.

**CAUTION: Do NOT run the engine with a vacuum pump in operation or with a vacuum present within the A/C system. Failure to follow this caution will result in serious A/C compressor damage.**

70. Evacuate the refrigerant system (refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE - REFRIGERANT SYSTEM EVACUATE).
71. Charge the refrigerant system (refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - STANDARD PROCEDURE - REFRIGERANT SYSTEM CHARGE).
72. Start engine and check for leaks.

## SPECIFICATIONS

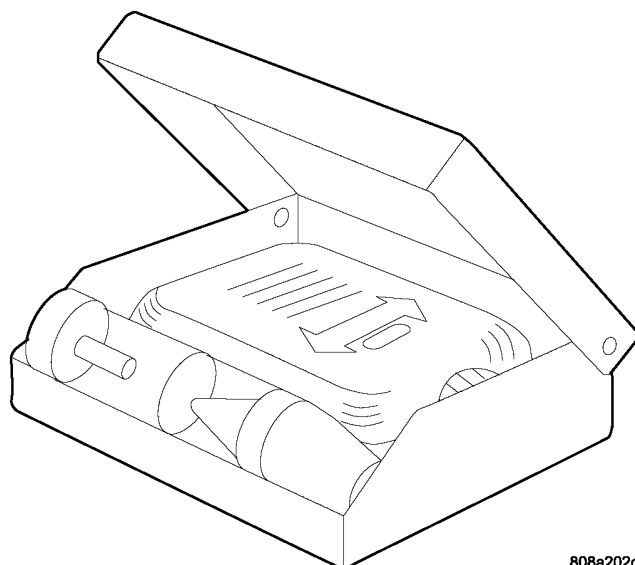
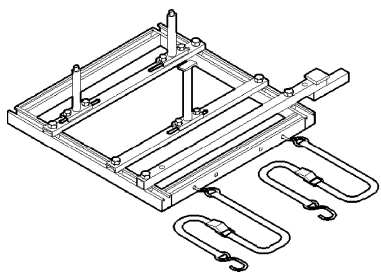
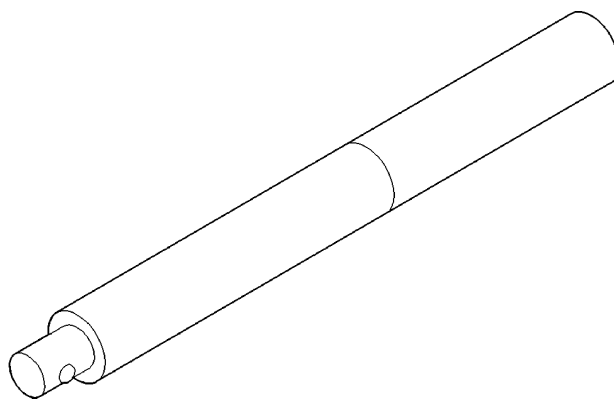
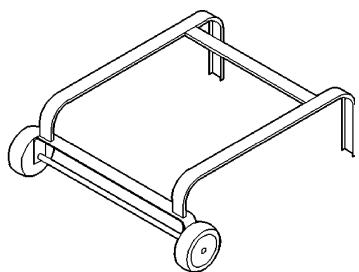
### TORQUE

DESCRIPTION	N-m	Ft. Lbs.	In. Lbs.
Balance Shaft Module	22 +90°	16 +90°	-
Camshaft Sprocket-Bolt	40	30	-
Camshaft Bearing Cap-Bolts			
Front Bearing Cap-Bolts	34	25	-
Bearing Cap-Bolts	12	-	105
Connecting Rod Cap-Bolts	20 +90°	15 +90°	-
Crankshaft Main Bearing Cap-Bolts	27 + 45°	20 + 45°	-
Crankshaft Damper-Bolt	210°	155	-
Cylinder Head-Bolts	Refer to Procedure		
Cylinder Head Cover-Bolts	10	-	90
Engine Support Bracket-Bolts	40	30	-
Exhaust Manifold-Bolts	34	25	-
Exhaust Manifold Heat Shield-Bolts	9	-	80
Flex Plate to Crankshaft-Bolts	95	70	-
Intake Manifold	24	18	-
Ladder Frame	28	21	-

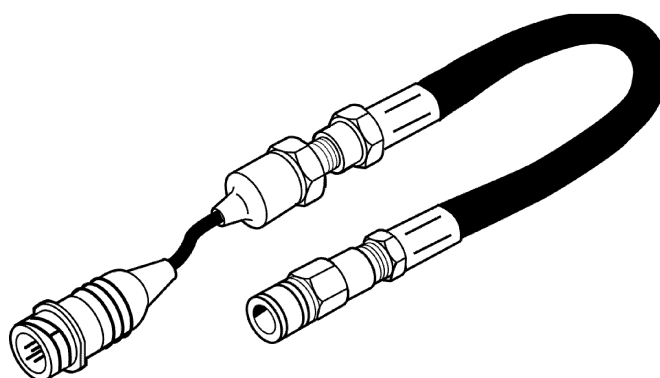
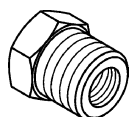
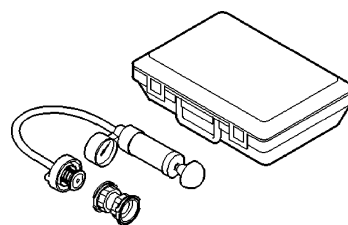
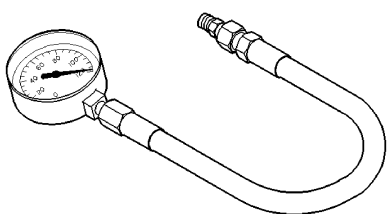
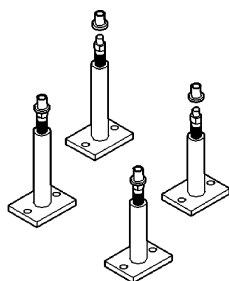
DESCRIPTION		N·m	Ft. Lbs.	In. Lbs.
Oil Cooler Connector Bolt		49	36	-
Oil Filter		14	10	-
Oil Filter Nipple		49	36	-
Oil Jet Fastener		12	-	105
Oil Pan-Bolts				
	M6 Bolts	12	-	105
	M8 Bolts	24	18-	-0
Oil Pan Drain-Plug		40	30	-
PCV Valve		5	-	40
Spark Plugs		27	20	-
Timing Chain Cover				
	M6 Bolts	12 N·m	-	105
	M8 Bolts	23 N·m	17	-
Timing Chain Tensioner Assembly-Bolts		12 N·m	-	105
Timing Chain Guides		12 N·m	-	105

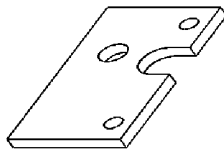
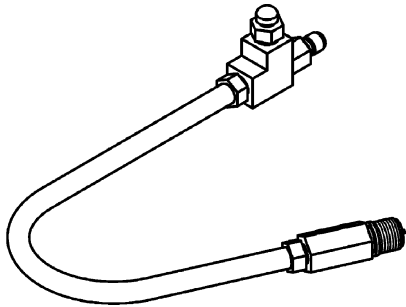
## SPECIAL TOOLS

### 2.4L ENGINE

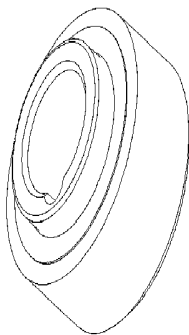


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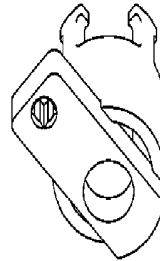




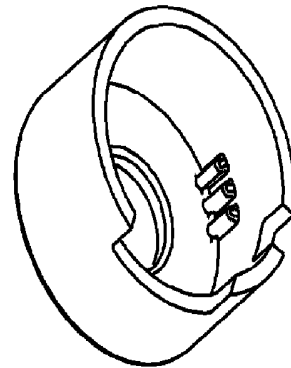
**ENGINE LIFT FIXTURE 9704**



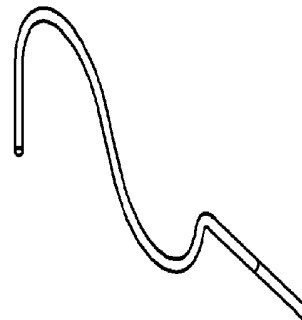
**FRONT SEAL INSTALLER 9506**



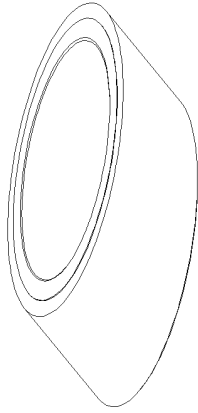
**HOLDING FIXTURE 9707**



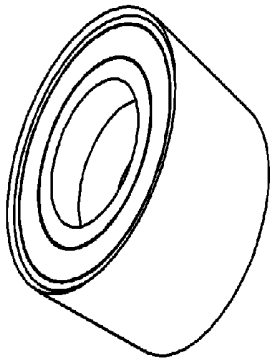
**1.8L SPROCKET HOLDER 9711**



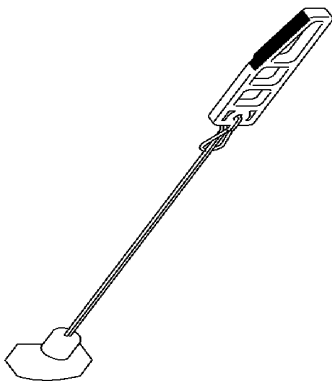
**TENSIONER PIN 9703**



***REAR MAIN SEAL DRIVER 9706***



***REAR CRANKSHAFT SEAL GUIDE 9509***

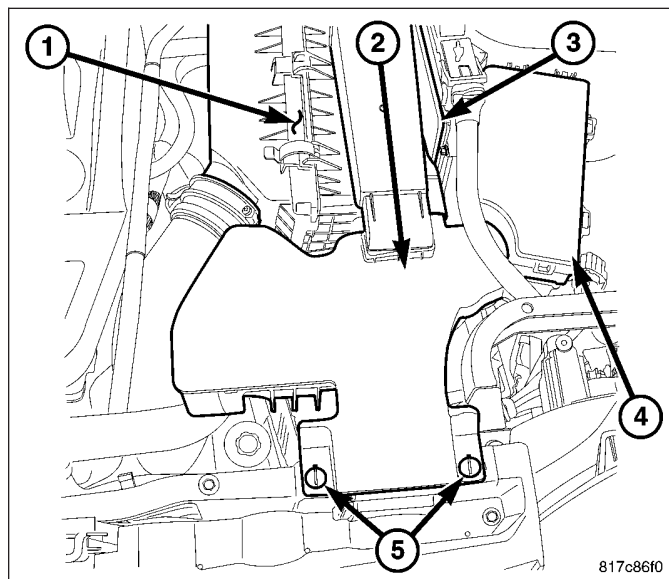


***LOCKING WEDGE 9701***

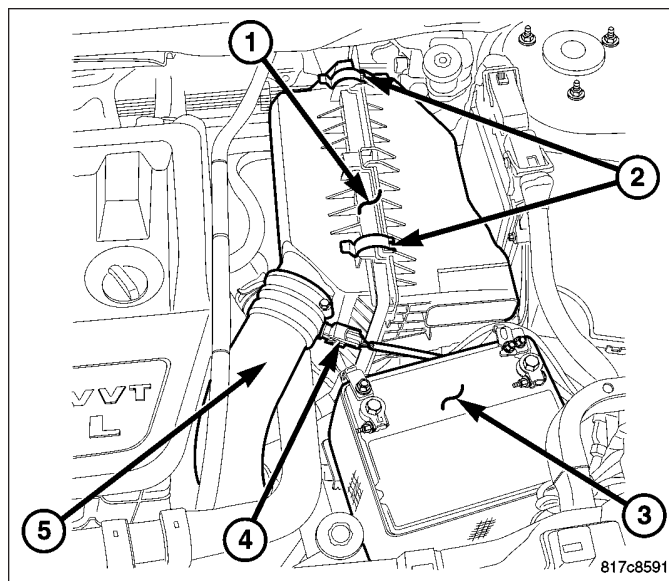
## ELEMENT-AIR CLEANER

### REMOVAL

1. Turn Lock Retainers (5) and remove fresh air inlet (2) from air cleaner housing (1).

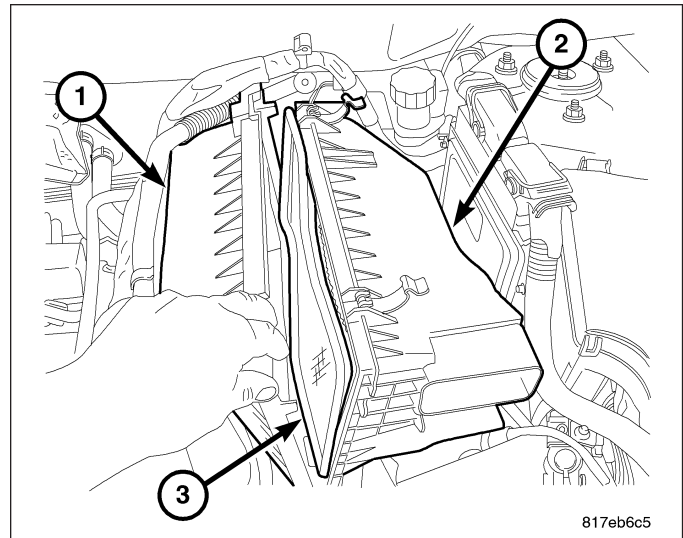


2. Disconnect intake air temperature sensor connector (4).
3. Remove Air inlet tube (5) from air cleaner housing (1).
4. Unfasten clasps (2) on sides of air cleaner housing cover (1).



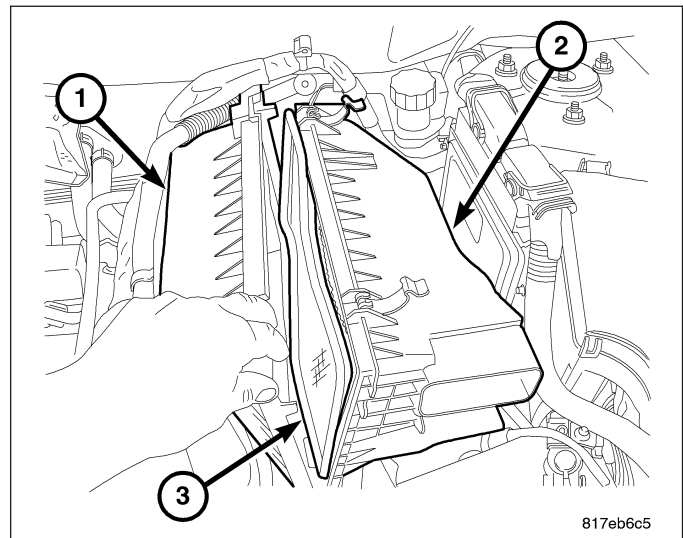


5. Pull air cleaner cover (1) aside.
6. Remove filter element (3).
7. If necessary, clean the inside of the air cleaner housing (2).

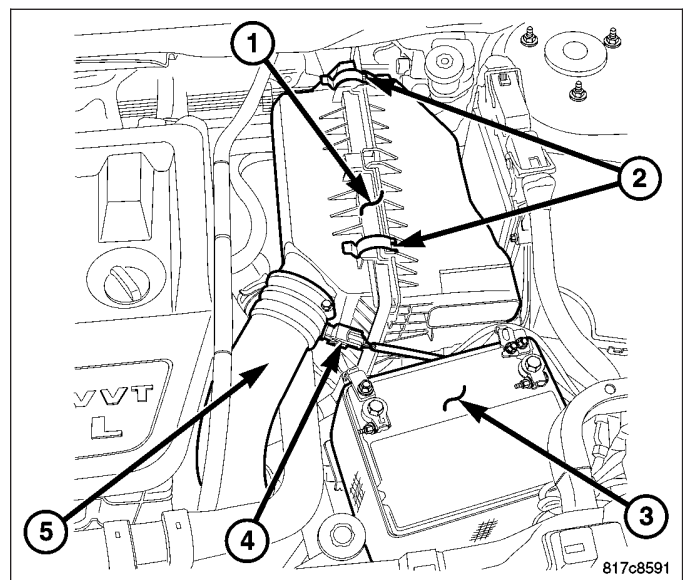


## INSTALLATION

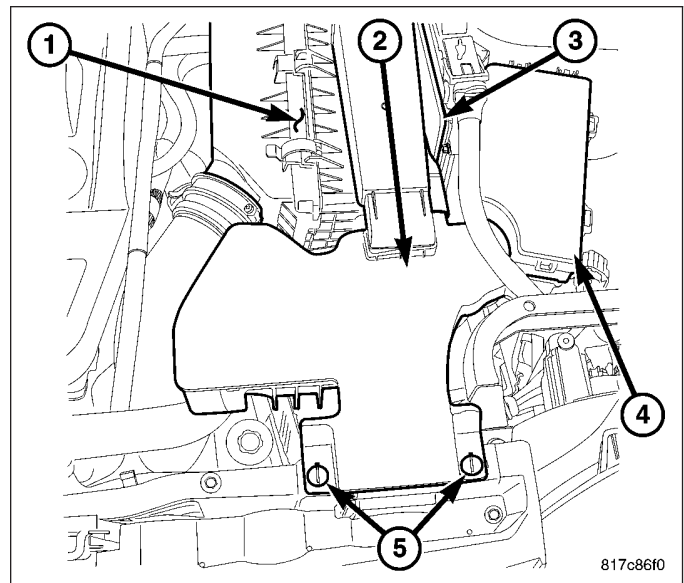
1. Install new filter element.



2. Place cover over air cleaner housing. Snap clasps (2) in place.
3. Install air inlet tube (5).
4. Connect intake air temperature sensor connector (4).



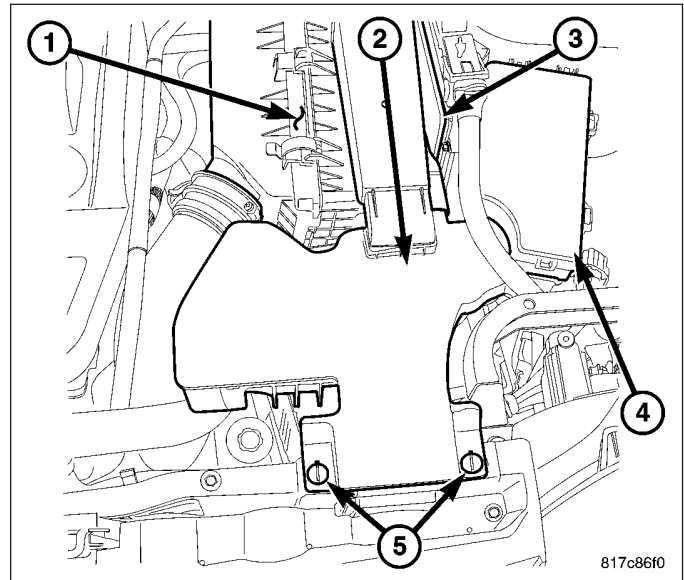
5. Install fresh air inlet (2) on air cleaner housing (1) and lock retainers (5).



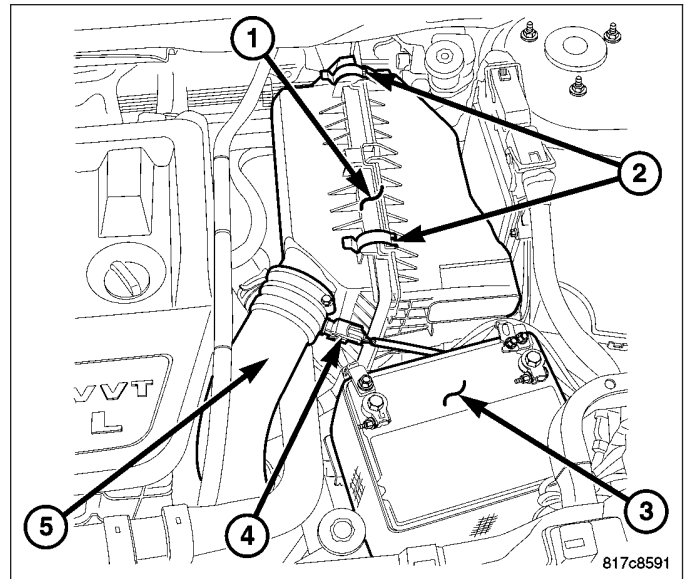
## HOUSING-AIR CLEANER

### REMOVAL

1. Remove fresh air inlet (2) from air cleaner housing (1).

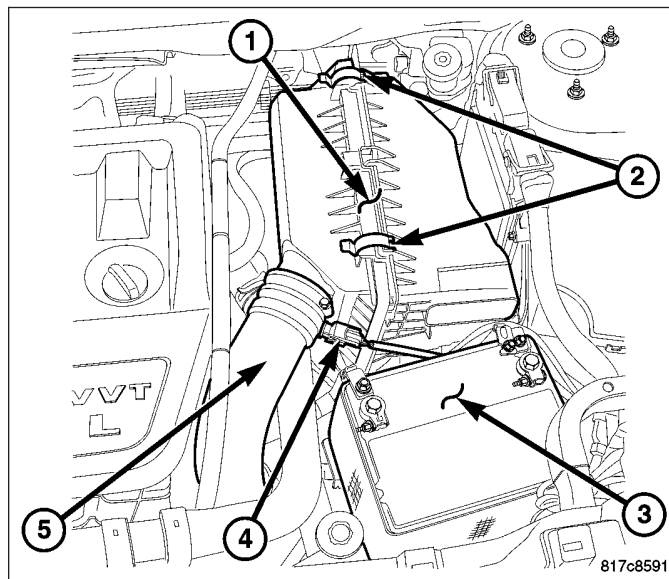


2. Remove intake air temperature sensor electrical connector (4).
3. Remove air inlet tube (5) from housing (1).
4. Pull housing (1) upward to remove.

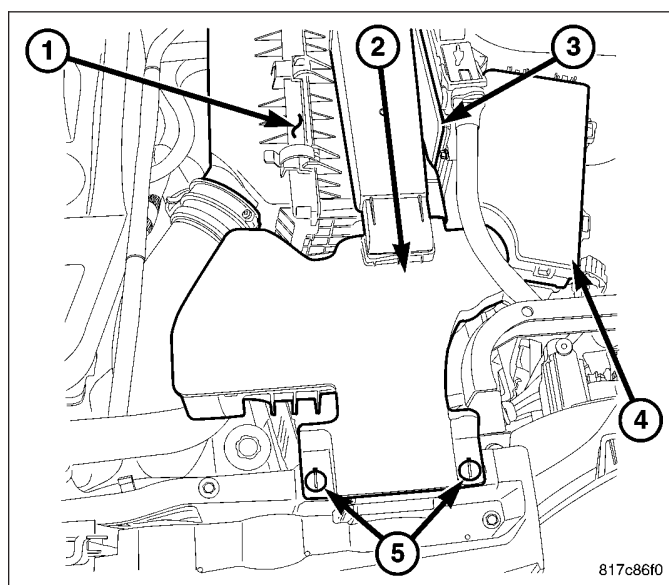


## INSTALLATION

1. Make sure the rubber grommets, for the air cleaner housing lower pins, are in place when reinstalling the air cleaner housing. The rubber grommets mount to the PDC bracket.
2. Push air cleaner housing (1) down while aligning pins into the grommets.
3. Connect the throttle body air inlet hose (5) to the air cleaner housing (1).
4. Connect intake air temperature sensor connector (4).



5. Install fresh air inlet (2) and lock retainers (5).



## CYLINDER HEAD

### DESCRIPTION

The cross flow designed, aluminum cylinder head contains dual over-head camshafts with four valves per cylinder. The valves are arranged in two in-line banks. The intake valves face toward the front of the vehicle. The exhaust valves face the dash panel. The cylinder head incorporates powdered metal valve guides and seats. The cylinder head is sealed to the block using a multi-layer steel head gasket and retaining bolts.

Integral oil galleries provide lubrication passages to the variable camshaft timing phasers, camshafts, and valve mechanisms.

**NOTE: Replacement cylinder heads will come complete with valves, seals, springs, retainers, keepers, lash buckets, and camshafts.**

### DIAGNOSIS AND TESTING

#### CYLINDER HEAD GASKET

A cylinder head gasket leak can be located between adjacent cylinders, between a cylinder and the adjacent water jacket or from an oil passage to the exterior of the engine.

Possible indications of the cylinder head gasket leaking between adjacent cylinders are:

- Loss of engine power
- Engine misfiring
- Poor fuel economy

Possible indications of the cylinder head gasket leaking between a cylinder and an adjacent water jacket are:

- Engine overheating
- Loss of coolant
- Excessive steam (white smoke) emitting from exhaust
- Coolant foaming

#### CYLINDER-TO-CYLINDER LEAKAGE TEST

To determine if an engine cylinder head gasket is leaking between adjacent cylinders, follow the procedures in Cylinder Compression Pressure Test (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING). An engine cylinder head gasket leaking between adjacent cylinders will result in approximately a 50–70% reduction in compression pressure.

#### CYLINDER-TO-WATER JACKET LEAKAGE TEST

**WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING WITH COOLANT PRESSURE CAP REMOVED.**

##### VISUAL TEST METHOD

With the engine cool, remove the coolant pressure cap. Start the engine and allow it to warm up until thermostat opens.

If a large combustion/compression pressure leak exists, bubbles will be visible in the coolant.

##### COOLING SYSTEM TESTER METHOD

**WARNING: WITH COOLING SYSTEM TESTER IN PLACE, PRESSURE WILL BUILD UP FAST. EXCESSIVE PRESSURE BUILT UP, BY CONTINUOUS ENGINE OPERATION, MUST BE RELEASED TO A SAFE PRESSURE POINT. NEVER PERMIT PRESSURE TO EXCEED 138 kPa (20 psi).**

Install Cooling System Tester 7700 or equivalent to pressure cap neck. Start the engine and observe the tester's pressure gauge. If gauge pulsates with every power stroke of a cylinder a combustion pressure leak is evident.

## CHEMICAL TEST METHOD

Combustion leaks into the cooling system can also be checked by using Bloc-Chek Kit C-3685-A or equivalent. Perform test following the procedures supplied with the tool kit.

## REMOVAL - CYLINDER HEAD

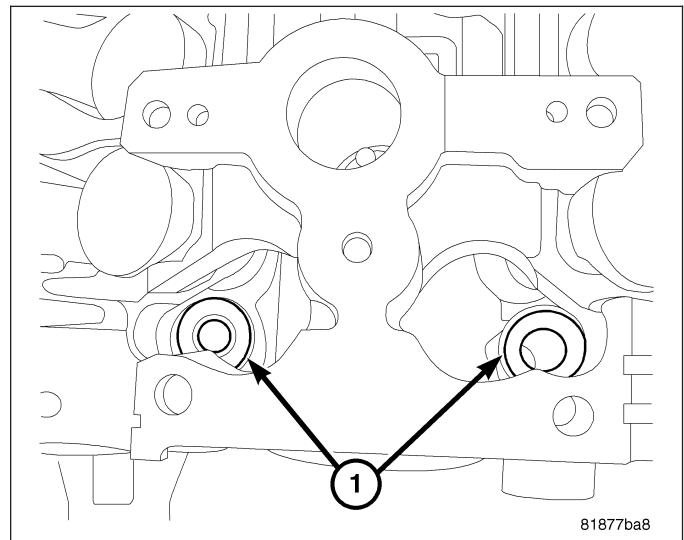
1. Perform fuel system pressure release procedure **before attempting any repairs**
2. Remove clean air hose and air cleaner housing (Refer to 9 - ENGINE/AIR INTAKE SYSTEM/AIR CLEANER HOUSING - REMOVAL).
3. Disconnect negative cable from battery.
4. Drain cooling system.
5. Remove engine cover.
6. Remove coolant recovery bottle.
7. Remove power steering pump and reposition.
8. Remove windshield washer bottle.
9. Disconnect breather hose.
10. Disconnect PCV hose.
11. Disconnect ignition coil electrical connectors.
12. Remove valve cover.
13. Raise vehicle.
14. Remove right splash shield.
15. Set engine to TDC.
16. Remove accessory drive belts (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
17. Remove lower A/C compressor bolts if equipped.
18. Remove lower A/C compressor mount.
19. Remove accessory drive belt lower idler pulley.
20. Remove crankshaft and water pump pulleys.
21. Remove right side engine mount bracket lower bolt.
22. Remove timing chain cover lower bolts.
23. Disconnect oxygen sensor electrical connectors.
24. Remove exhaust pipe at manaverter (AWD).
25. Remove manaverter support bracket retaining bolts (AWD).
26. Lower vehicle.
27. Remove power steering pump and set aside.
28. Support engine with suitable jack.
29. Remove right engine mount.
30. Remove accessory drive upper idler pulley.
31. Remove right upper engine mount bracket.
32. Remove accessory drive belt tensioner.
33. Remove upper timing chain cover retaining bolts.
34. Remove timing chain cover.
35. Remove timing chain tensioner.
36. Remove timing chain.
37. Remove timing chain guides.
38. Disconnect fuel line at the fuel rail.
39. Disconnect fuel injector electrical connectors.
40. Disconnect top engine electrical connectors and reposition harness.
41. Remove fuel rail.
42. Remove lower intake manifold support bracket retaining bolt.

43. Disconnect electronic throttle control electrical connector.
44. Disconnect map sensor electrical connector.
45. Disconnect vacuum lines at intake.
46. Remove intake manifold retaining bolts.
47. Remove upper radiator hose retaining bolts.
48. Remove intake manifold.
49. Remove coolant outlet manifold and set aside.
50. Remove ground strap at right rear of cylinder head.
51. Remove oxygen sensor from maniverter (AWD).
52. Remove maniverter heat shields (AWD).
53. Remove maniverter retaining bolts (AWD).
54. Remove maniverter from cylinder head and reposition out of the way (AWD).
55. Remove camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - REMOVAL).

**NOTE: All of the cylinder head bolts have captured washersEXCEPTthe front two (1).**

56. Remove cylinder head bolts.
57. Remove cylinder head from engine block.
58. Inspect and clean cylinder head and block sealing surfaces. Refer to Cleaning and Inspection in this section for procedures.

**NOTE: Ensure cylinder head bolt holes in the block are clean, dry (free of residual oil or coolant), and threads are not damaged.**



## 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.**

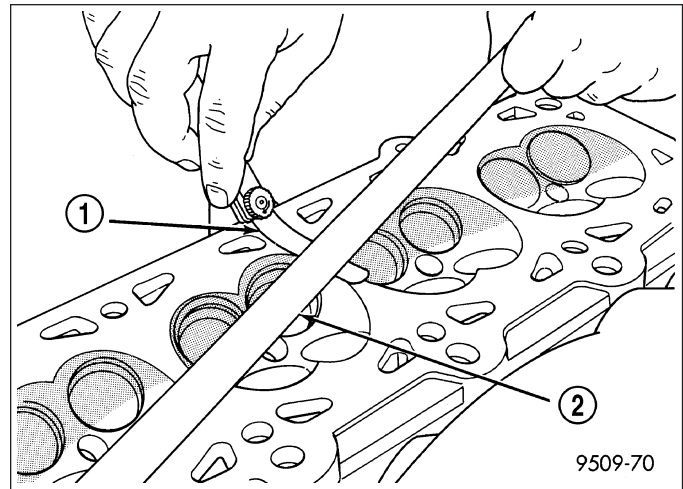
Remove all gasket material from cylinder head and block (Refer to 9 - ENGINE - STANDARD PROCEDURE). Be careful not to gouge or scratch the aluminum head sealing surface.

Clean all engine oil passages.

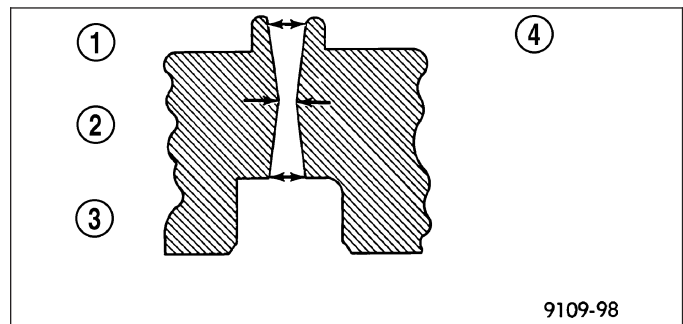
## INSPECTION

**NOTE: Replacement cylinder heads will come complete with valves, seals, springs, retainers, keepers, lash buckets, and camshafts.**

1. Cylinder head must be flat within 0.1 mm (0.004 in.).



2. Inspect camshaft bearing journals for scoring.
3. Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.
4. Using a small hole gauge and a micrometer, measure valve guides in 3 places top (1), middle (2), and bottom (3). (Refer to 9 - ENGINE - SPECIFICATIONS) Replace guides if they are not within specification.
5. Check valve guide height.
6. Prior to installing cylinder head, the cylinder block should be checked for flatness (Refer to 9 - ENGINE/ENGINE BLOCK - INSPECTION).

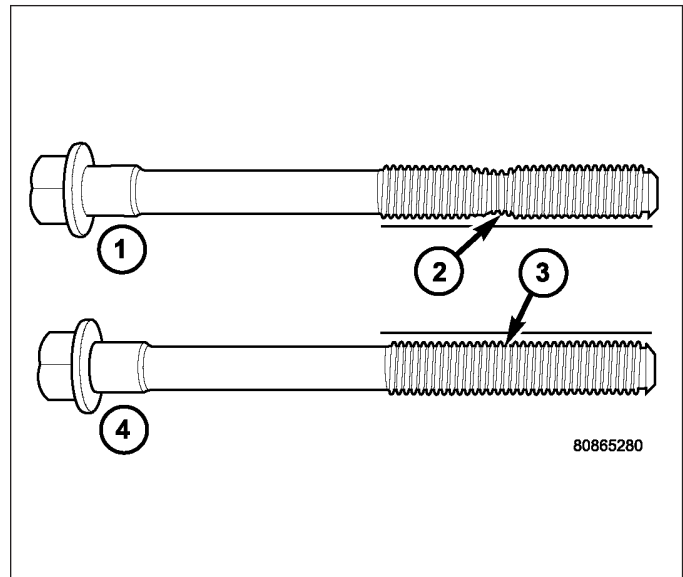


## INSTALLATION - CYLINDER HEAD

**NOTE:** Ensure cylinder head bolt holes in the block are clean, dry (free of residual oil or coolant), and threads are not damaged.

**NOTE:** The Cylinder head bolts should be examined **BEFORE** reuse. If the threads are necked down, the bolts should be replaced.

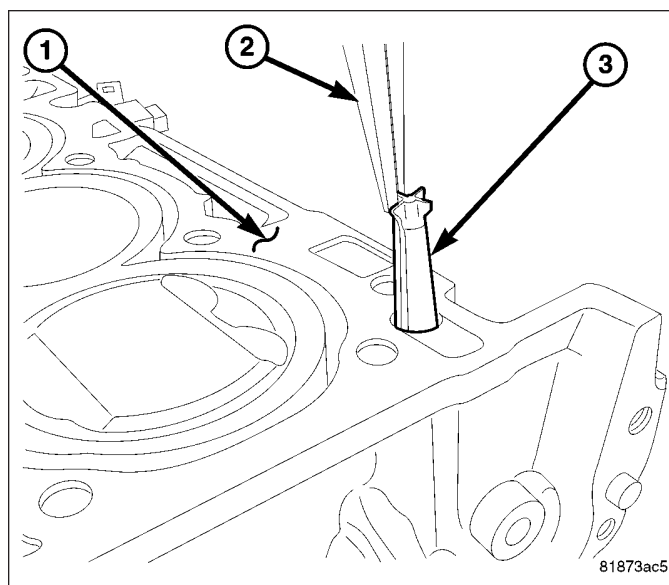
Necking can be checked by holding a scale or straight edge against the threads. If all the threads do not contact the scale (2), the bolt should be replaced.



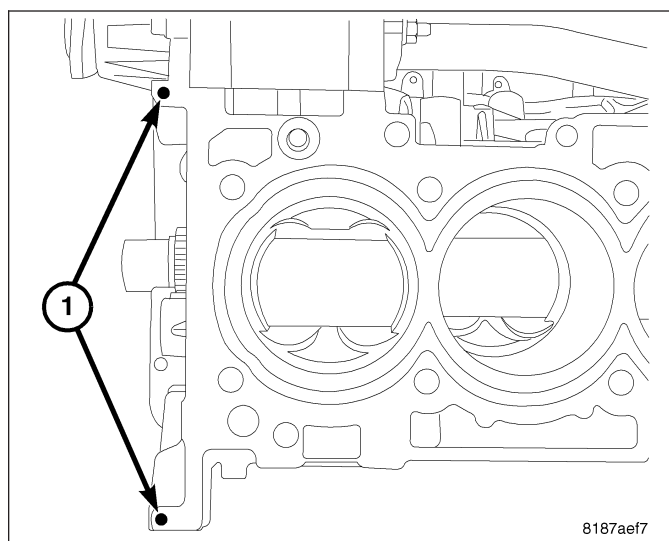


**CAUTION:** Always replace the variable valve timing filter screen (3) when servicing the head gasket or engine damage could result.

1. Replace the variable valve timing filter screen (3).



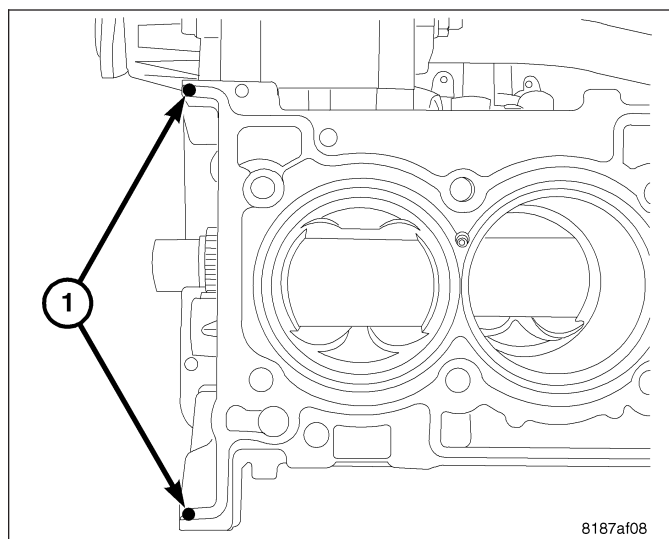
2. Place two pea size dots of RTV (1) on cylinder block as shown.



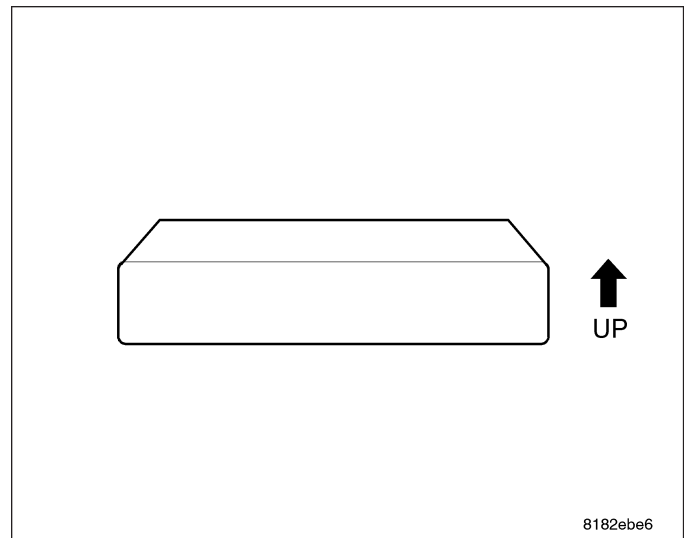
3. Position the new cylinder head gasket on engine block with the part number facing up. Ensure gasket is seated over the locating dowels in block.
4. Place two pea size dots of RTV (1) on cylinder head gasket as shown.

**NOTE:** The head must be installed within 15 minutes before the RTV skins.

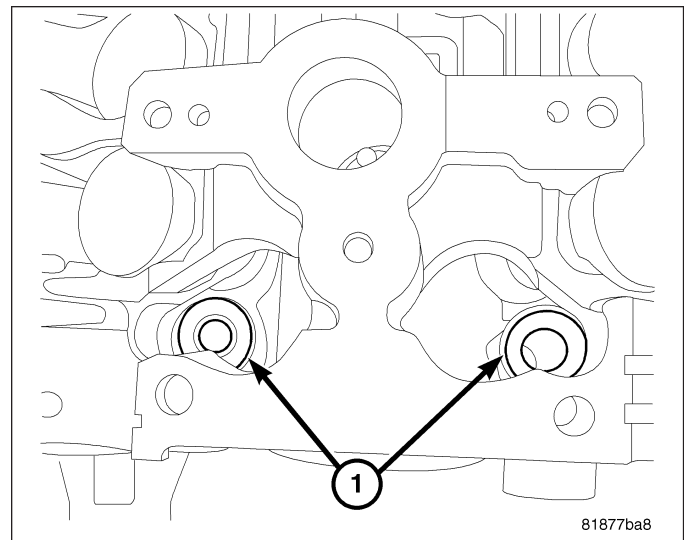
5. Position cylinder head onto engine block.



**NOTE:** The front two cylinder head bolts do not have captured washers. The washers must be installed with the bevel up towards the bolt head.



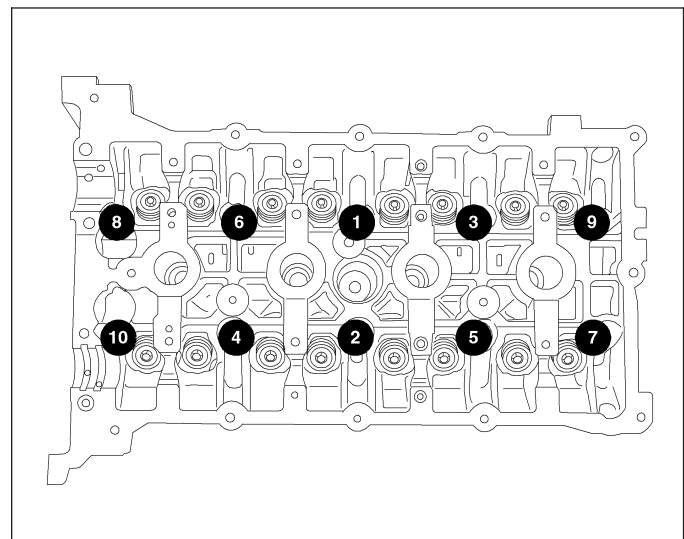
6. Install washers (1) for the front two cylinder head bolts.



7. Before installing the bolts, the threads should be lightly coated with engine oil.
8. Install the cylinder head bolts and torque in the sequence shown above.
- First: All to 30 N·m (25 ft. lbs.)
  - Second: All to 61 N·m (50 ft. lbs.)
  - Third: All to 61 N·m (45 ft. lbs.)
  - Fourth: All an additional 90°

**CAUTION:** Do not use a torque wrench for the Fourth step.

9. Install camshafts. (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - INSTALLATION).
10. Install cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER - INSTALLATION).



11. Install manifold/exhaust manifold to cylinder head. Torque fasteners to 34 N·m (25 ft.lbs.).
12. Install heat shields. Torque fasteners to 9 N·m ( ).
13. Install oxygen sensor in manifold.
14. Install ground strap at right rear of cylinder head.

15. Install coolant manifold.
16. Install intake manifold.
17. Install intake manifold bolts and torque to 24 N·m (18 ft.lbs.).
18. Install upper radiator hose retaining bracket.
19. Install timing chain (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).
20. Install timing chain cover, torque m6 bolts to 12 N·m (105 in.lbs.) and m8 bolts to 23 N·m (17 ft.lbs.).
21. Connect cam sensor wiring connector.
22. Install spark plugs and torque to 27 N·m (20 ft.lbs.).
23. Install ignition coils and torque to 8 N·m (70 in.lbs.).
24. Install power steering pump reservoir/bracket to cylinder head.
25. Install exhaust pipe to manifold. Torque fasteners to 28 N·m (20 ft. lbs.).
26. Install accessory drive belts (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).
27. Connect engine coolant temperature sensor connector.
28. Connect upper radiator hose. Connect heater hoses to thermostat housing.
29. Install heater tube support bracket to cylinder head.
30. Install fastener attaching dipstick tube to lower intake manifold
31. Connect fuel supply line quick-connect at the fuel rail assembly (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/ QUICK CONNECT FITTING - STANDARD PROCEDURE).
32. Fill cooling system (Refer to 7 - COOLING/ENGINE - STANDARD PROCEDURE).
33. Connect negative cable to battery.
34. Install clean air hose and air cleaner housing (Refer to 9 - ENGINE/AIR INTAKE SYSTEM/AIR CLEANER HOUSING - INSTALLATION).

## CAMSHAFT(S)

### DESCRIPTION

Both camshafts have six bearing journal surfaces and two cam lobes per cylinder. Flanges on the third journal control camshaft end play. Cam position sensors are located on the intake and exhaust camshafts on the rear of the cylinder head.

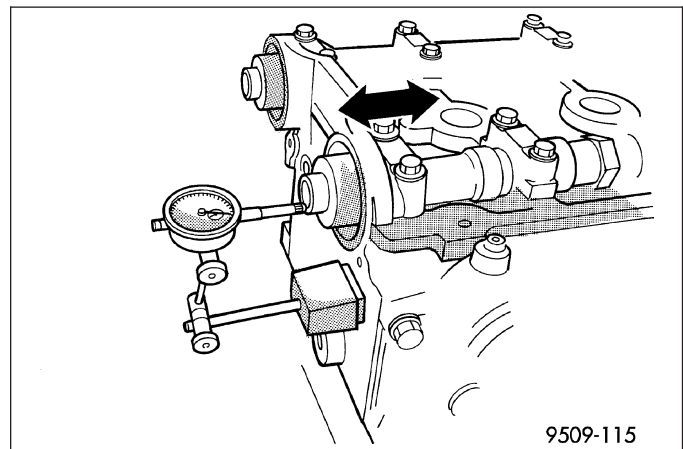
### OPERATION

The camshaft is driven by the crankshaft via drive sprockets and a chain. The camshaft has precisely machined lobes to provide accurate valve timing and duration.

### STANDARD PROCEDURE

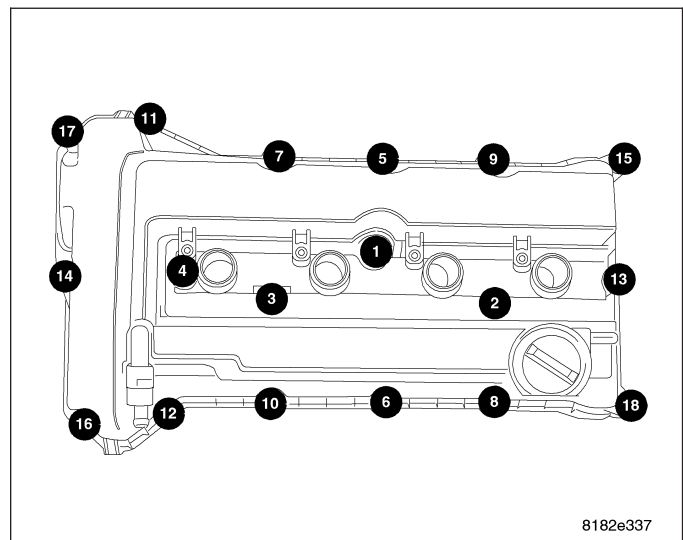
#### MEASURING CAMSHAFT END PLAY

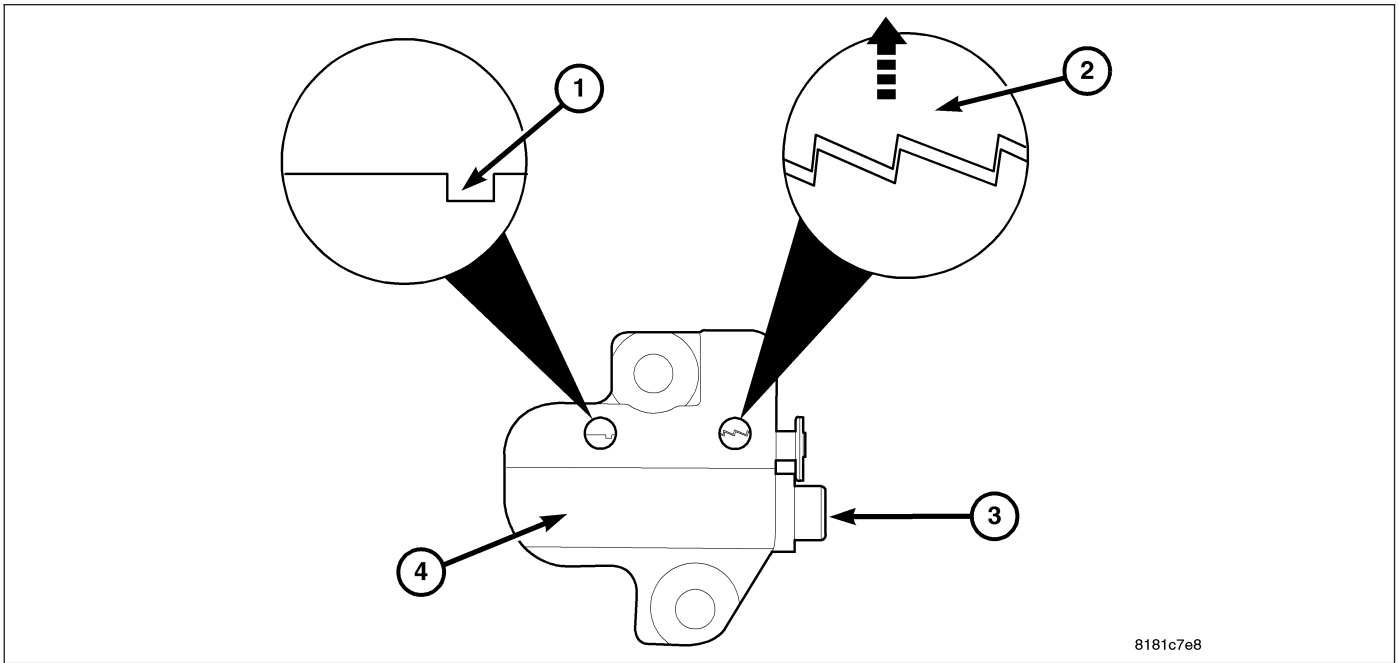
1. Using a suitable tool, move camshaft as far rearward as it will go.
2. Zero dial indicator.
3. Move camshaft as far forward as it will go.
4. Record reading on dial indicator. For end play specification, (Refer to 9 - ENGINE - SPECIFICATIONS).
5. If end play is excessive, check cylinder head and camshaft for wear; replace as necessary.



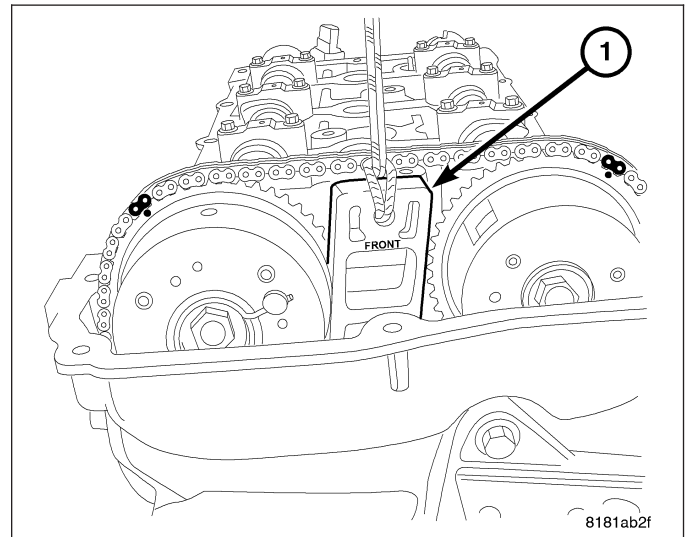
### REMOVAL

1. Remove engine cover by pulling upward.
2. Disconnect negative battery cable.
3. Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).
4. Raise vehicle.
5. Remove right splash shield.

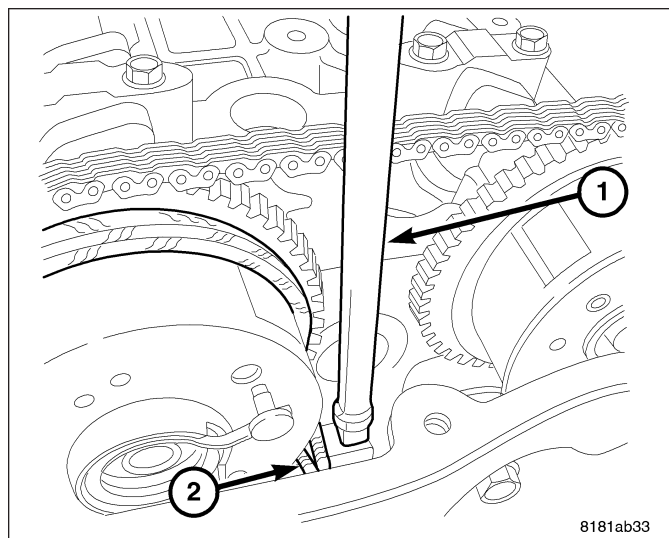




6. Remove timing tensioner plug from front cover.
7. Insert small allen wrench and lift ratchet (2) upward to release the tensioner. Leave the allen wrench installed during the remainder of this procedure.
8. Insert wedge 9701 (1).

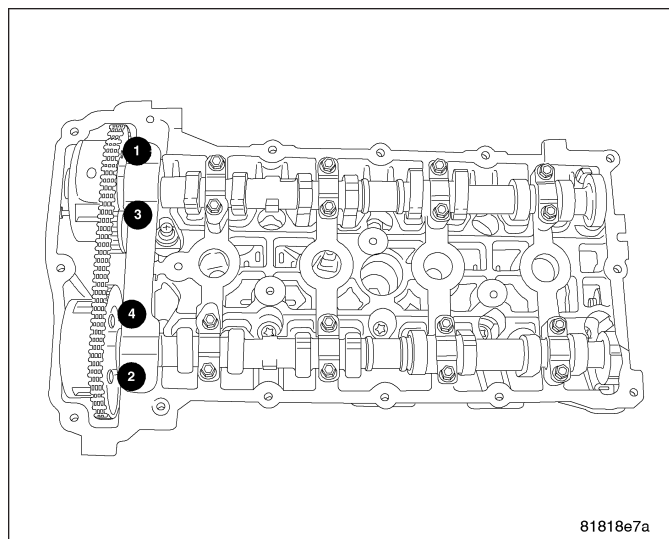


9. Lightly tap Wedge 9701(2) into place.

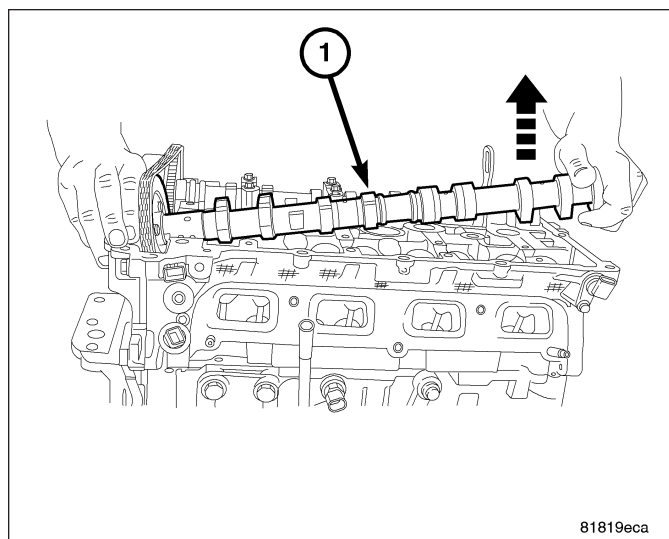


10. Remove the front camshaft bearing cap.

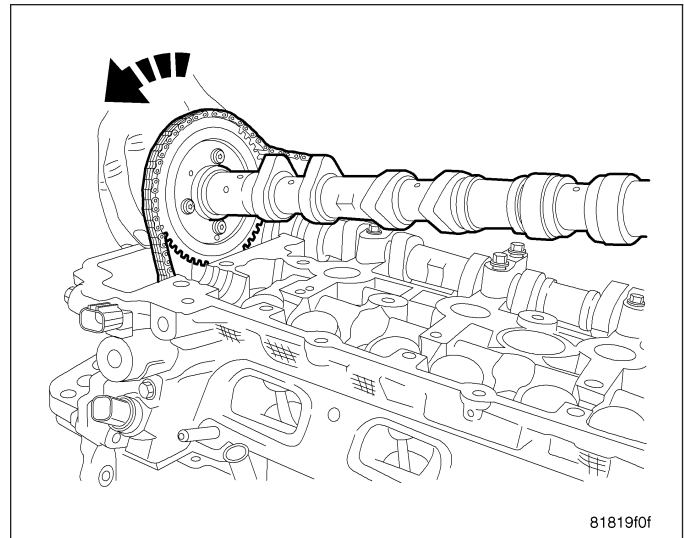
11. Slowly remove the remaining camshaft bearing bolts one turn at a time following the above sequence.



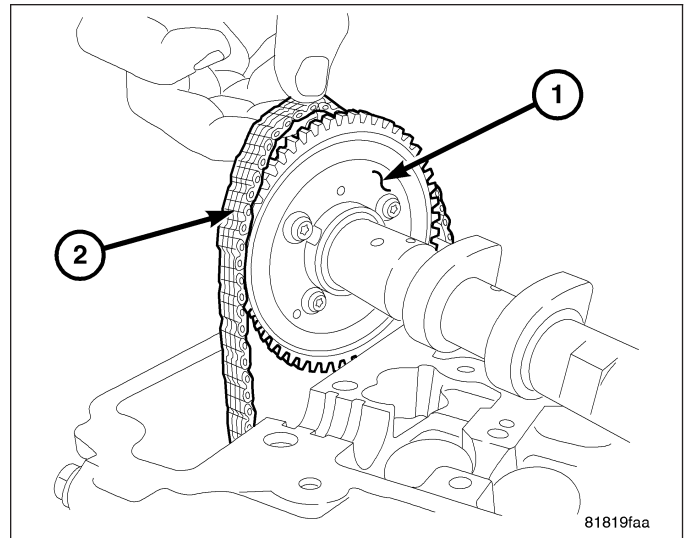
12. Remove intake camshaft (1) by lifting the rear of the camshaft upward.



13. Rotate the camshaft while lifting out of the front bearing cradle.



14. Lift the timing chain (2) off the sprocket (1).
15. Remove exhaust camshaft.



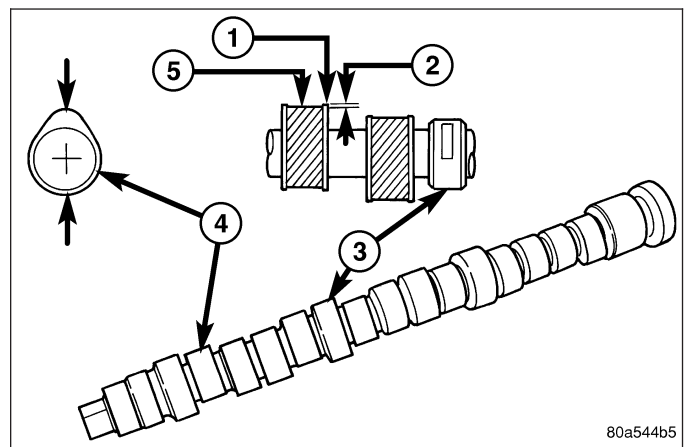
## CLEANING

Clean camshafts with a suitable solvent.

## INSPECTION

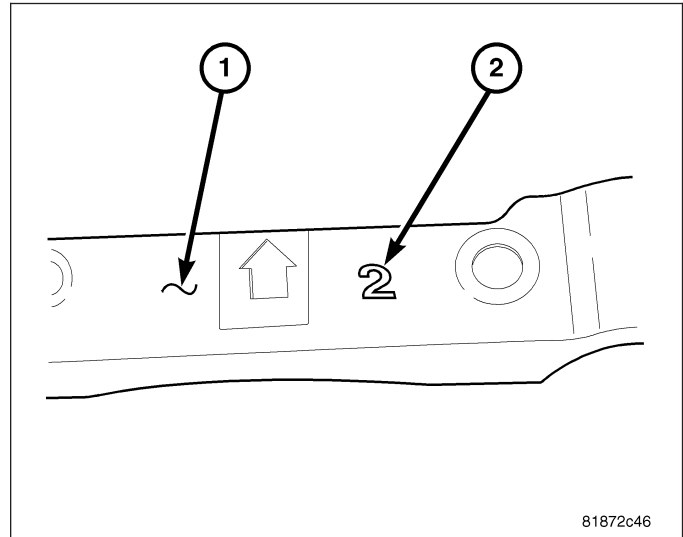
1. Inspect camshaft bearing journals for damage and binding. If journals are binding, check the cylinder head for damage. Also check cylinder head oil holes for clogging.
2. Check the cam lobe and bearing surfaces for abnormal wear and damage. Replace camshaft if defective.

**NOTE:** If camshaft is replaced due to lobe wear or damage, always replace the lash buckets.

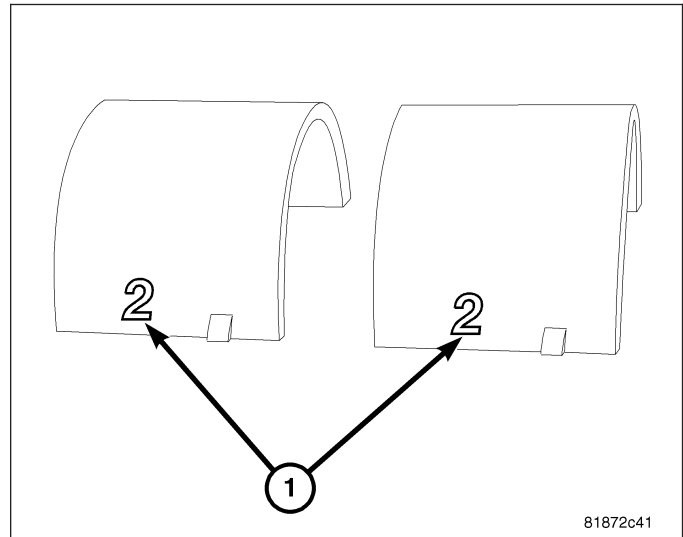


## INSTALLATION

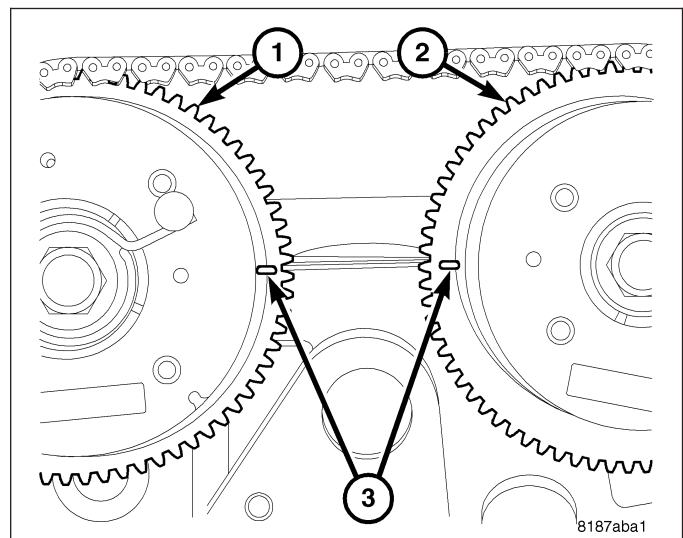
1. Identify which front cam cap (1) is installed on the engine you are working on.
2. The cam cap (1) is numbered (2) either one, two, or three, this corresponds to the select fit bearing to use.



3. Install the corresponding select fit bearing that will also be numbered (1) one, two, or three.
4. Oil all of the camshaft journals with clean engine oil.
5. Install exhaust camshaft and position on bearing journals in the cylinder head.

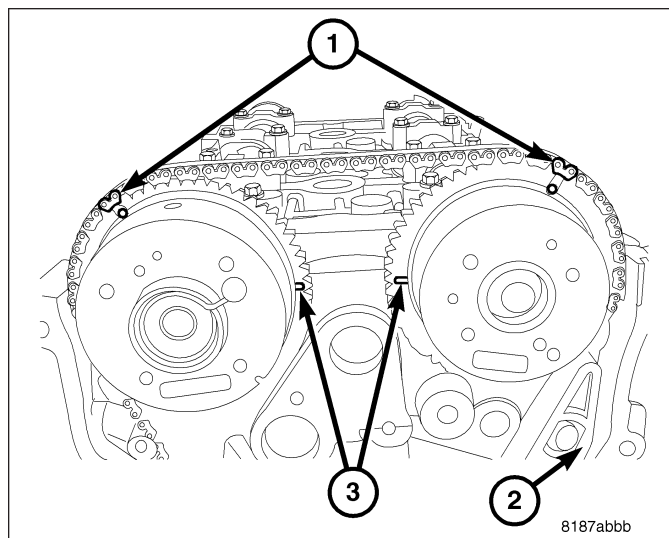


6. Align exhaust cam timing mark so it is parallel to the cylinder head as shown.

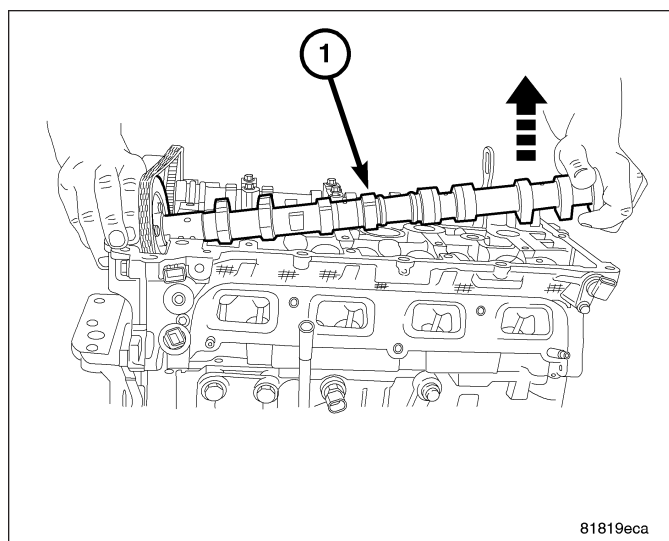




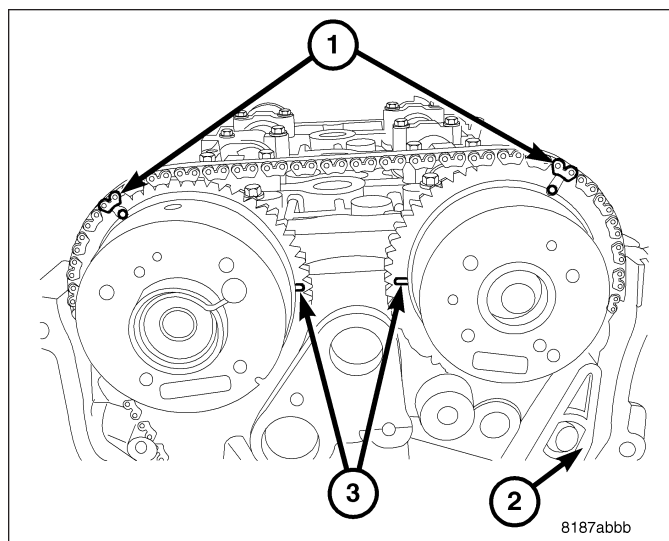
7. Install timing chain onto exhaust cam sprocket making sure that the timing marks (1) on the sprocket and chain are aligned.



8. Install intake camshaft by raising the rear of the camshaft upward and roll the sprocket into the chain.



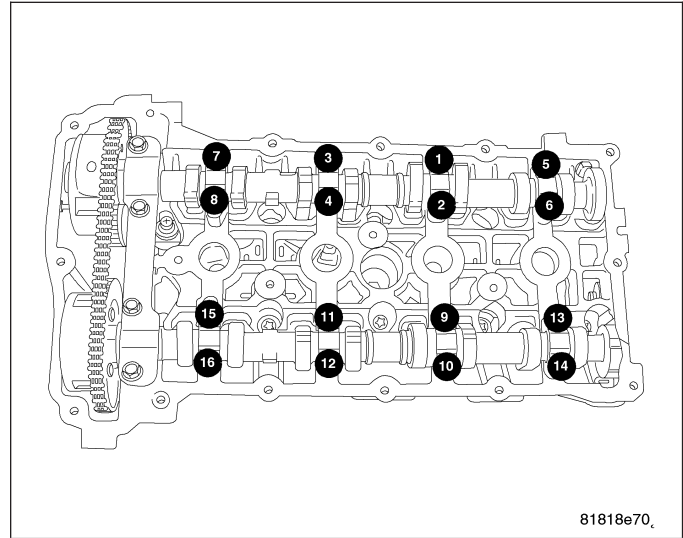
9. Align the timing marks (1) on the intake cam sprocket with the mark in the chain.
10. Position the intake camshaft into the bearing journals in the cylinder head.
11. Verify that the timing marks (1) are aligned on both camshafts and that the timing marks (3) are parallel with the cylinder head.



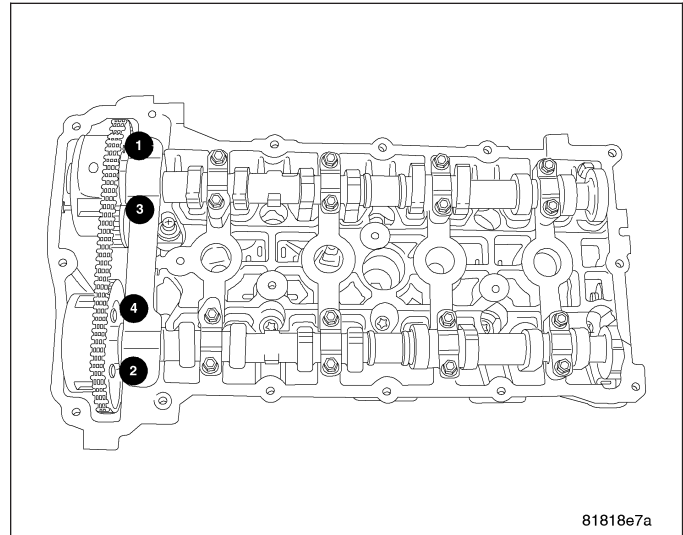
**CAUTION:** Install the front intake and exhaust camshaft bearing cap last. Ensure that the dowels are seated and follow torque sequence or damage to engine could result.

**NOTE:** If the front camshaft bearing cap is broken, the cylinder head **MUST** be replaced.

12. Install intake and exhaust camshaft bearing caps slowly torque bolts in the sequence shown.



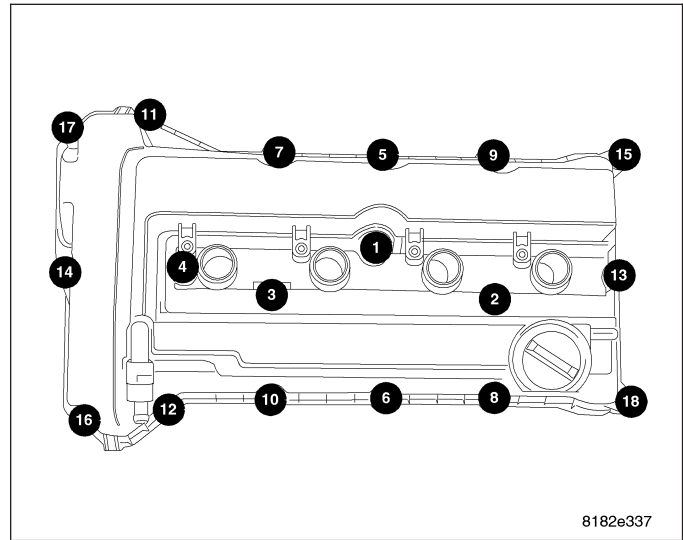
13. Install the front intake and exhaust bearing cap and torque bolts in the sequence shown.  
14. Verify that all timing marks are aligned.  
15. Remove allen wrench from timing chain tensioner.  
16. Remove locking wedge 9701.  
17. Apply MOPAR® thread sealant to timing tensioner plug and Install.  
18. Install right splash shield.  
19. Install cylinder head cover (Refer to 9 - ENGINE/ CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).  
20. Install engine cover.  
21. Connect negative battery cable.  
22. Fill cooling system.  
23. Fill with oil.  
24. Start engine and check for leaks.



## COVER-CYLINDER HEAD

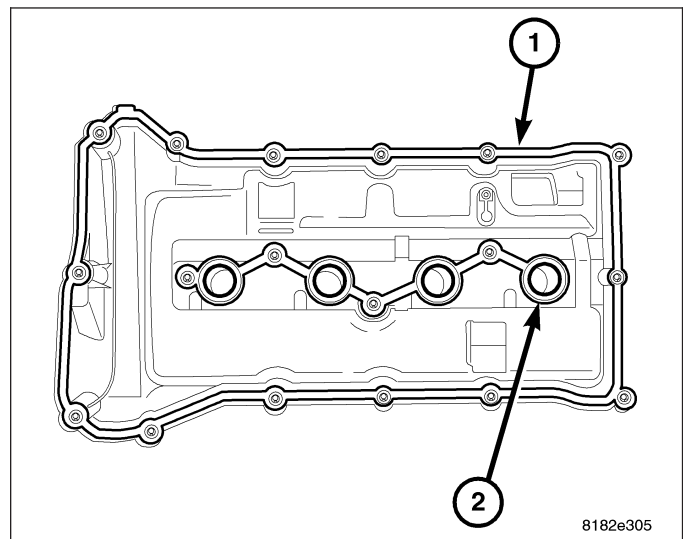
### REMOVAL

1. Remove engine cover.
2. Disconnect ignition coil electrical connectors.
3. Disconnect PCV and make-up air hoses from cylinder head cover.
4. Use compressed air to blow dirt and debris off the cylinder head cover prior to removal.
5. Remove cylinder head cover bolts.
6. Remove cylinder head cover from cylinder head.

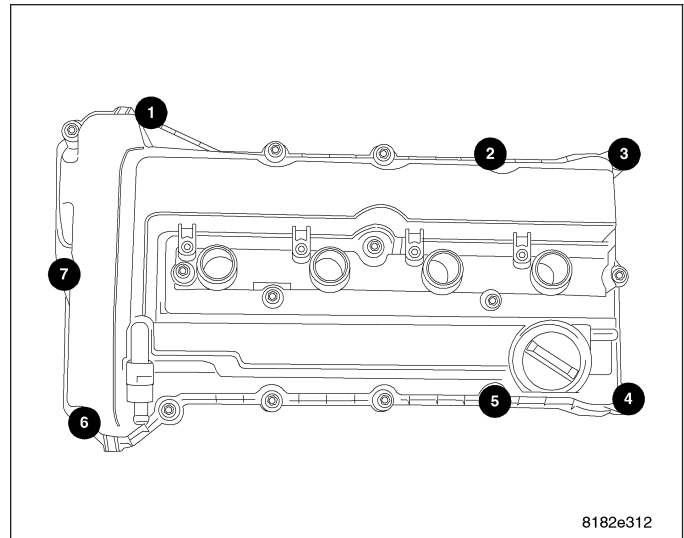


### INSTALLATION

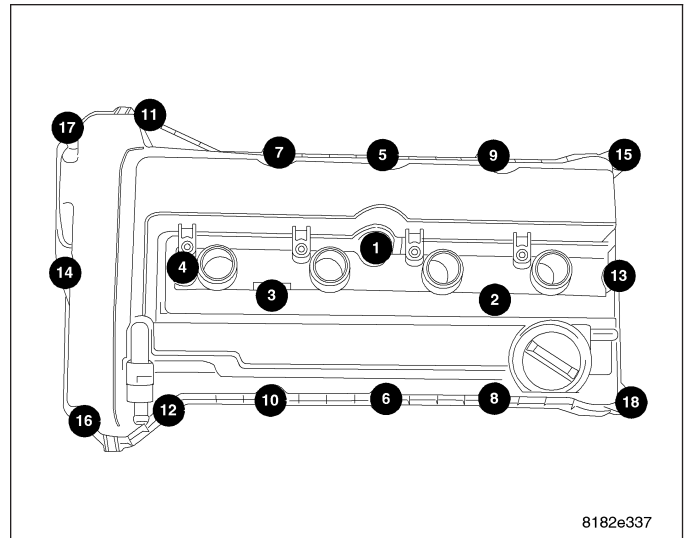
1. Install new cylinder head cover gaskets (1,2).



2. Install studs in cover as shown.



3. Clean all RTV from cylinder head.
4. Apply RTV to cylinder head/front cover joint.
5. Install cylinder head cover assembly to cylinder head and install all bolts, ensuring the studs are located as shown.
6. Tighten bolts in sequence shown in Using a 2 step torque method as follows:
  - a. Tighten all bolts to 4.5 N·m (40 in. lbs.)
  - b. Tighten all bolts to 10 N·m (90 in. lbs.)
7. Install ignition coils. Tighten fasteners to 8 N·m (70 in. lbs.).
8. If the PCV valve was removed, tighten PCV valve to 4.5 N·m (40 in. lbs.).
9. Connect PCV and make-up air hoses to cylinder head cover.
10. Install engine cover.



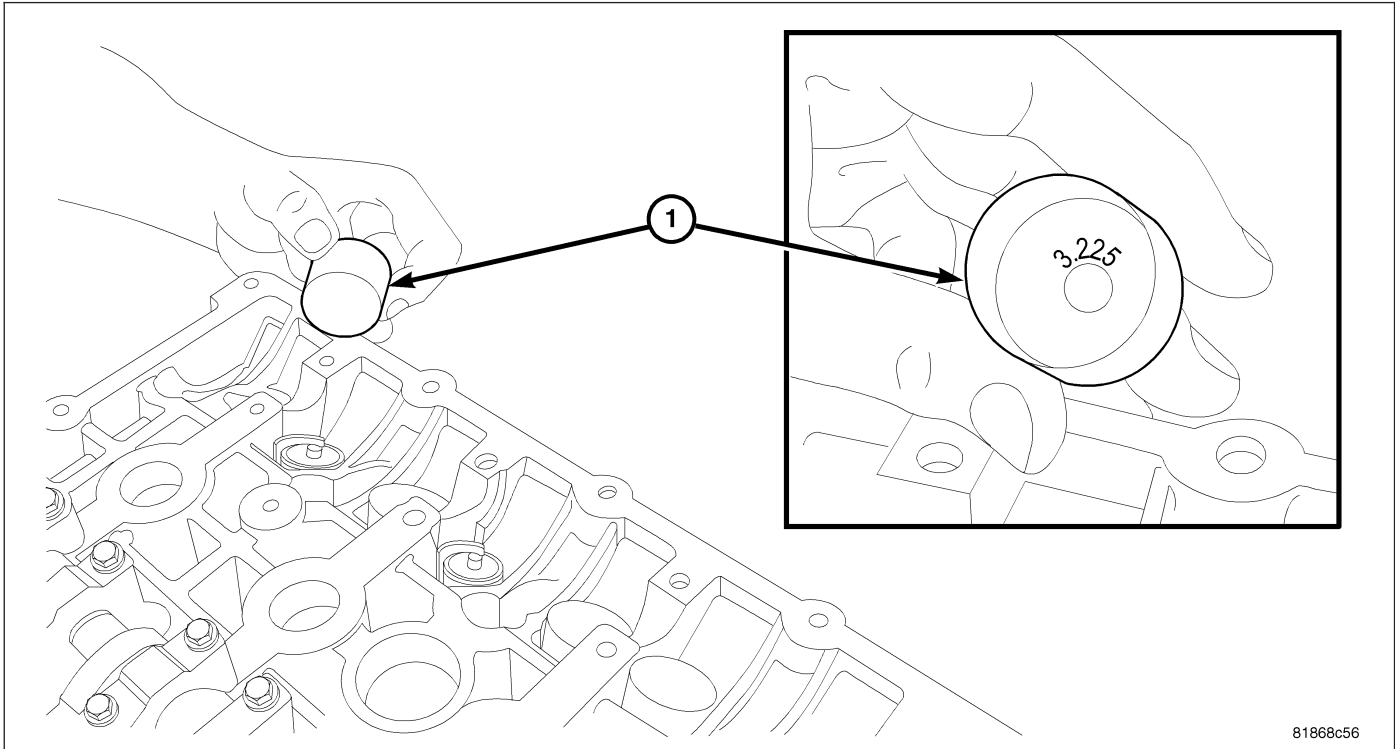
## TAPPETS-VALVE

### DIAGNOSIS AND TESTING

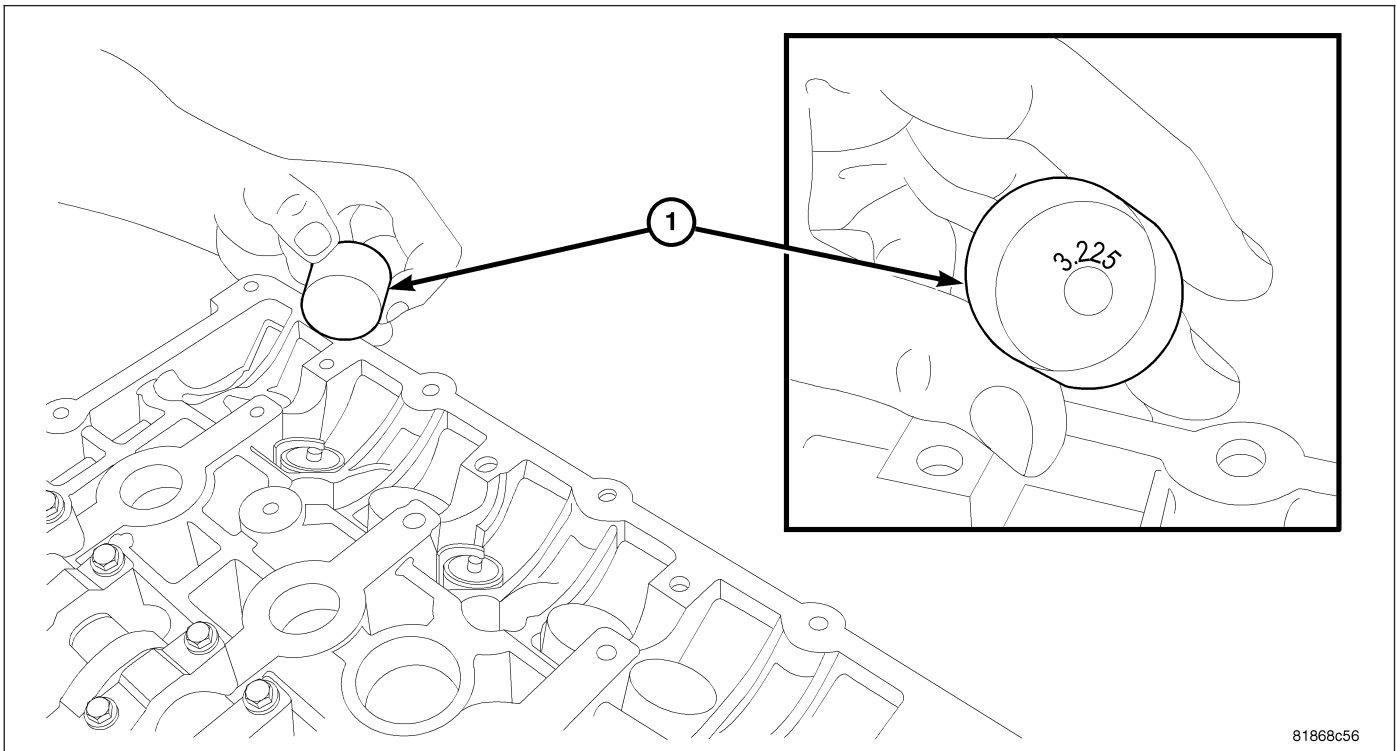
#### MECHANICAL VALVE TAPPET NOISE DIAGNOSIS

A tappet-like noise may be produced from several items. Check the following items.

#### STANDARD PROCEDURE - MEASURING VALVE LASH



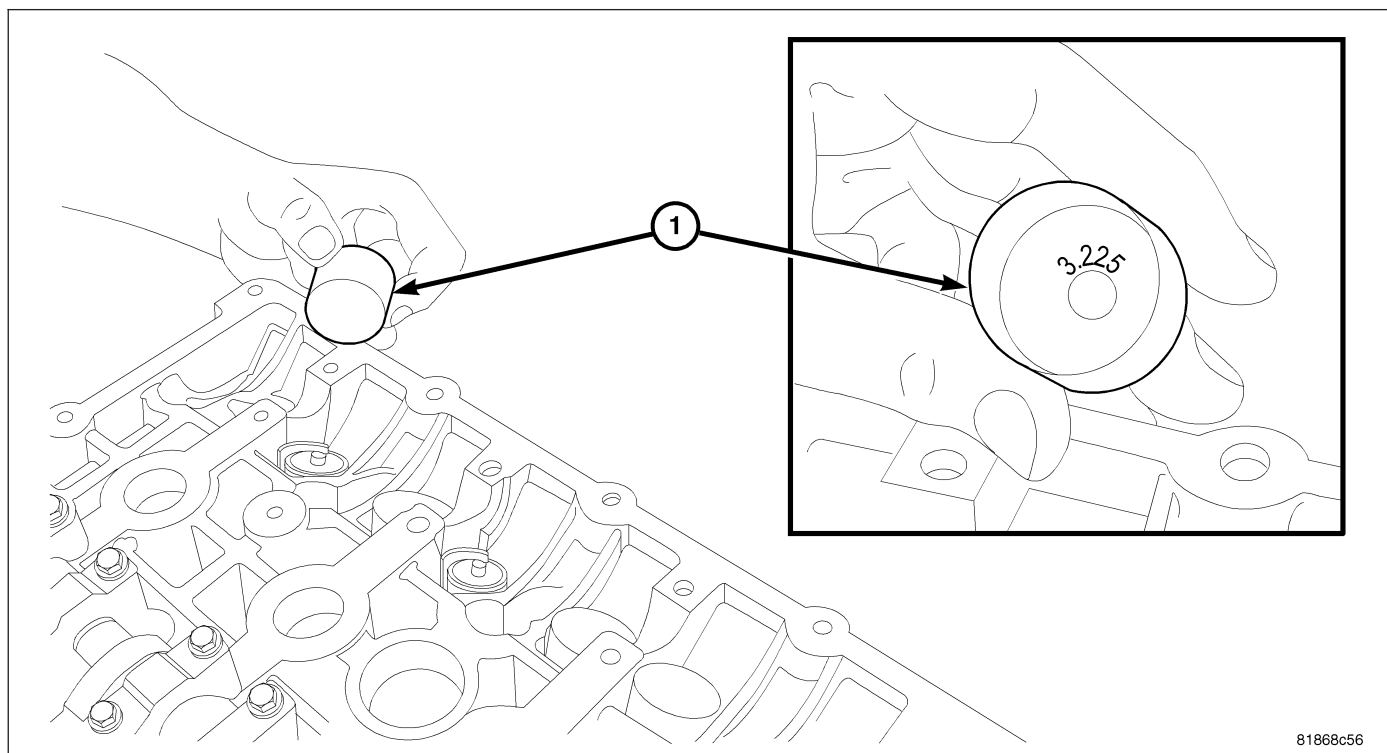
1. Remove engine cover.
2. Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).
3. Rotate camshaft so lobes are vertical.
4. Check clearance using feeler gauges.
5. Repeat for all tappets.
6. If clearance was too small Clearance too Small .
7. If clearance was too large Clearance too Large .

**Clearance too Small**

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1. Remove camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - REMOVAL).
2.  $\text{spec} - \text{measured} = \text{delta}$
3. Decrease bucket thickness by delta.
4. Install camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - INSTALLATION).
5. Verify that valve lash is correct.

## Clearance too Large



1. Remove camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - REMOVAL).
2. Measured – spec = delta
3. Increase bucket thickness by delta.
4. Install camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - INSTALLATION).
5. Verify that valve lash is correct.

## REMOVAL

**NOTE:** This procedure is for in-vehicle service with camshafts installed.

**NOTE:** Camshaft buckets must be replaced if cylinder head or camshafts are replaced.

1. Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).
2. Remove camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - REMOVAL).
3. Remove camshaft buckets.
4. Repeat removal procedure for each camshaft bucket.
5. If reusing, mark each camshaft bucket for reassembly in original position.

## INSTALLATION

**NOTE:** If reinstalling original buckets they must go back in their original location or engine damage could result.

1. Apply a light coat of clean engine oil to camshafts buckets prior to assembly.
2. Install camshaft bucket into cylinder head.
3. Repeat installation procedure for each camshaft bucket.

**NOTE:** If installing new buckets, the valve lash procedure must be performed.

4. Install camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - INSTALLATION).
5. Install cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).



## **VALVES & SEATS-INTAKE/EXHAUST**

### **DESCRIPTION**

The valves are made of heat resistant steel. They have nitrided stems to prevent scuffing. Viton rubber valve stem seals are integral with the spring seats. The valves have a single bead lock keepers to retain the springs.

### **OPERATION**

The four valves per cylinder (two intake and two exhaust) are opened by using direct acting buckets which are actuated by the camshaft.

### **CLEANING**

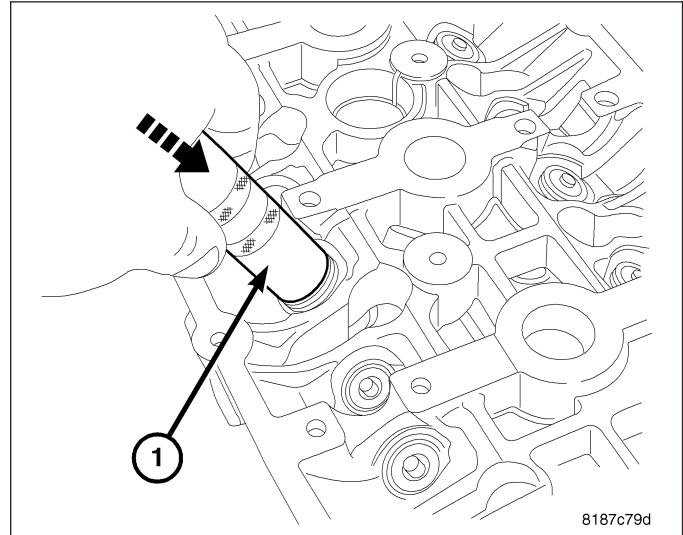
1. Clean all valves thoroughly and discard burned, warped and cracked valves.

## SPRINGS & SEALS-VALVE

### REMOVAL

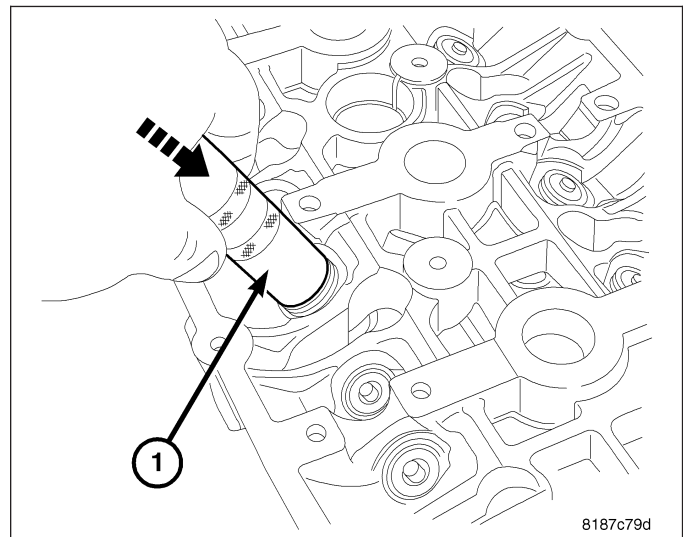
#### CYLINDER HEAD ON

1. Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).
2. Remove camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - REMOVAL).
3. Rotate crankshaft until piston is at TDC on compression.
4. With air hose attached to adapter tool installed in spark plug hole, apply 90-120 psi air pressure.
5. Using metric valve keeper remover (1), and remove valve spring keepers and retainer.
6. Remove valve spring(s).
7. Remove valve stem seal(s) by using valve stem seal tool.



#### CYLINDER HEAD OFF

1. With cylinder head removed from cylinder block, place a ball of rags in the combustion chamber.
2. Using Snap On metric valve keeper remover (1) or equivalent, remove valve keepers with a downward push.
3. Remove retainer and springs.
4. Before removing valves, **remove any burrs from valve stem lock grooves to prevent damage to the valve guides.** Identify valves, locks and retainers to insure installation in original location.
5. Inspect the valves. (Refer to 9 - ENGINE/CYLINDER HEAD/VALVE SPRINGS - INSPECTION).



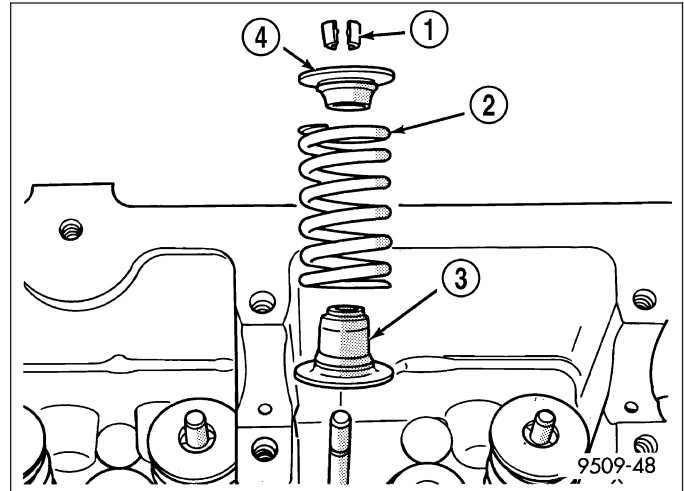
### INSPECTION

1. Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested for correct tension. Discard the springs that do not meet specifications. The following specifications apply to both intake and exhaust valves springs:
  - Valve Closed Nominal Tension—75 lbs. @ 38.0 mm (1.50 in.)
  - Valve Open Nominal Tension—134 lbs. @ 29.75 mm (1.17 in.)
2. Inspect each valve spring for squareness with a steel square and surface plate, test springs from both ends. If the spring is more than 1.5 mm (1/16 inch) out of square, install a new spring.

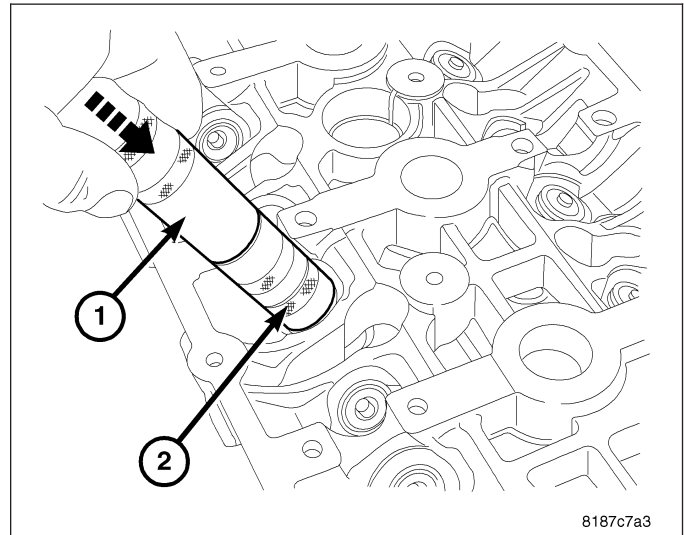
## INSTALLATION

### CYLINDER HEAD ON

1. Install valve seal/valve spring seat (3) assembly. Push the assembly down with appropriate size socket to seat it onto the valve guide.
2. Install valve spring (2) and retainer (4) with keepers (1).

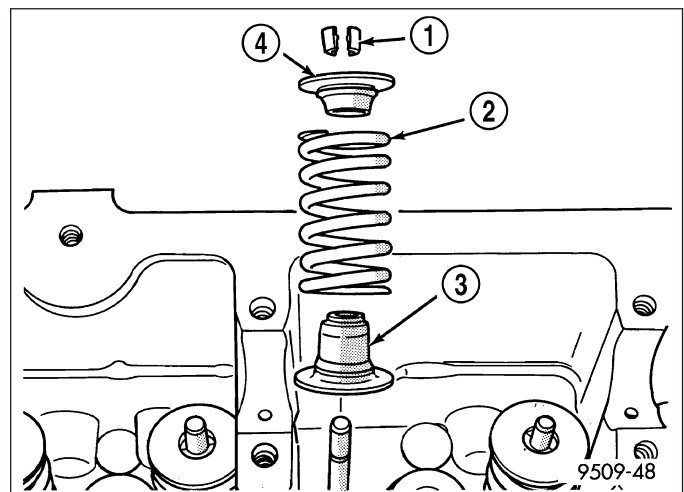


3. Place the valve keepers in the retainer. Using Snap On metric valve keeper installer (2) and remover (1) as a handle, install valve keepers with a downward push.
4. Remove air hose and install spark plugs.
5. Install camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - INSTALLATION).
6. Install cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

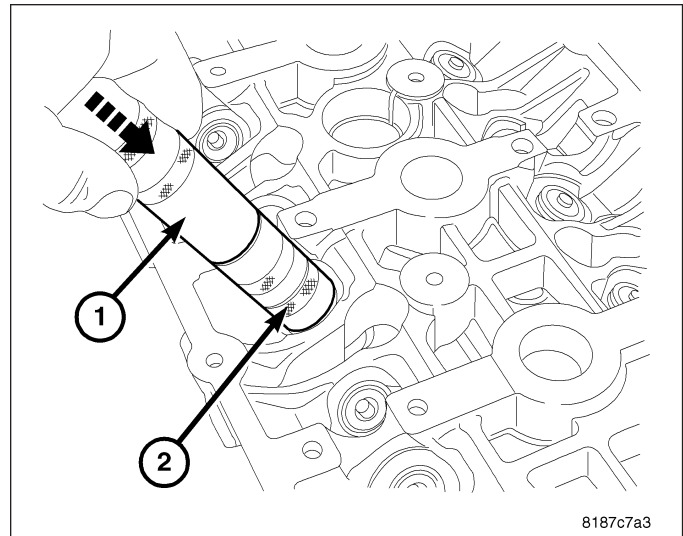


### CYLINDER HEAD OFF

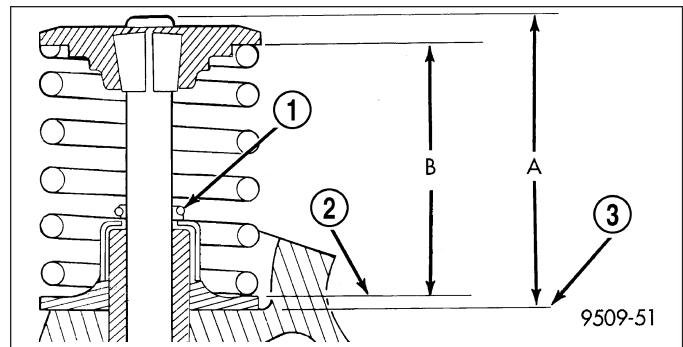
1. Coat valve stems with clean engine oil and insert in cylinder head.
2. Install new valve stem seals (3) on all valves using an appropriate sized socket to seat the seal/spring seat. The valve stem seals should be pushed firmly and squarely over valve guide.
3. Install valve springs (2), retainers (4), and keepers (1) in place.



4. Using Snap-on metric valve keeper installer (2) and remover (1) as a handle, push downward to install keepers.



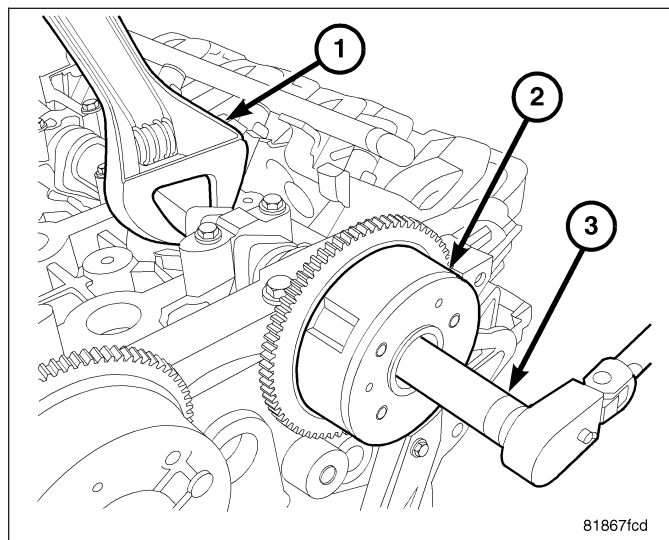
5. Check the valve spring installed height B after refacing the valve and seat. Make sure measurements are taken from top of spring seat to the bottom surface of spring retainer. If height is greater than 38.75 mm (1.525 in.), install a 0.762 mm (0.030 in.) spacer under the valve spring seat to bring spring height back within specification.



## PHASERS-CAMSHAFT

### REMOVAL

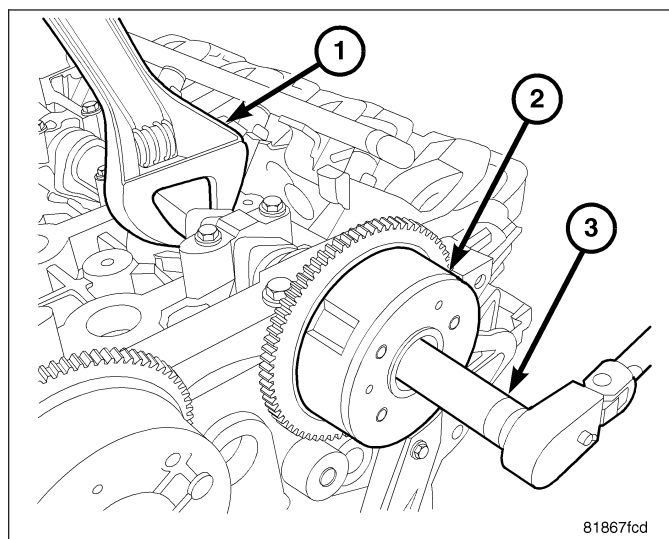
1. Remove camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - REMOVAL).
2. Remove camshaft phaser (2) retaining bolt while holding the camshaft in place with a wrench (1).
3. Remove phaser (2) assembly from camshaft.



### INSTALLATION

**CAUTION:** Do not use an impact wrench to tighten camshaft sprocket bolts. Damage to the camshaft-to-sprocket locating dowel pin and camshaft phaser may occur.

1. Install phaser (2) assembly on camshaft.
2. Install phaser retaining bolt and torque while holding camshaft in place with a wrench (1).
3. Install camshafts (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - INSTALLATION).

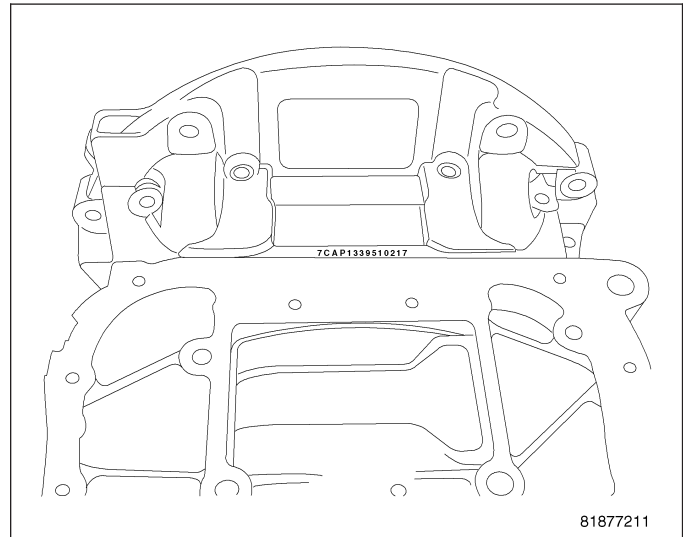


## ENGINE BLOCK

### DESCRIPTION

The die cast aluminum cylinder block is a two-piece assembly, consisting of the cylinder block and ladder frame. The block is an open deck design with cast in place cast iron cylinder liners. The cast iron cylinder liners are recessed below the aluminum deck surface. The ladder frame bolts to the cylinder block and does not incorporate the main bearing caps. This design offers a much stronger lower end and increased cylinder block and transaxle rigidity. The rear oil seal retainer is integral with the block and ladder frame. The ladder frame and block are serviced as an assembly.

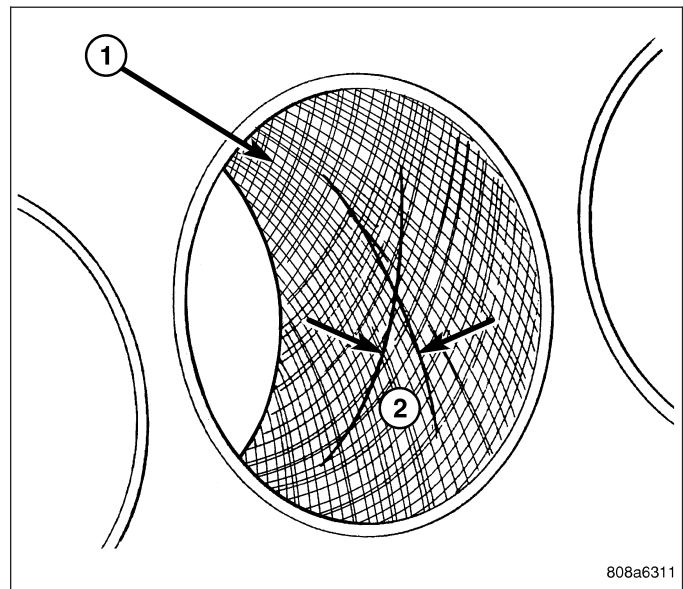
The engine build date is located on the bottom of the ladder frame just behind the oil pan. The date can be seen with the oil pan in place.



### STANDARD PROCEDURE

#### CYLINDER BORE HONING

1. Used carefully, a quality commercially available cylinder bore resizing hone equipped with 220 grit stones, is the best tool for this honing procedure. In addition to deglazing, it will reduce taper and out-of-round as well as removing light scuffing, scoring or scratches. Usually a few strokes will clean up a bore and maintain the required limits.
2. Deglazing of the cylinder walls may be done using a quality commercially available cylinder surfacing hone, recommended tool C-3501 or equivalent, equipped with 280 grit stones, if the cylinder bore is straight and round. 20–60 strokes depending on the bore condition, will be sufficient to provide a satisfactory surface. Use a light honing oil. **Do not use engine or transmission oil, mineral spirits or kerosene.** Inspect cylinder walls after each 20 strokes.
3. Honing should be done by moving the hone up and down fast enough to get a cross-hatch pattern. When hone marks **intersect** at 30-50 degrees, the cross hatch angle is most satisfactory for proper seating of rings.
4. A controlled hone motor speed between 200–300 RPM is necessary to obtain the proper cross-hatch angle. The number of up and down strokes per minute can be regulated to get the desired 40–60 degree angle. Faster up and down strokes increase the cross-hatch angle.
5. After honing, it is necessary that the block be cleaned again to remove all traces of abrasive.



**CAUTION:** Ensure all abrasives are removed from engine parts after honing. It is recommended that a solution of soap and hot water be used with a brush and the parts then thoroughly dried. The bore can be considered clean when it can be wiped clean with a white cloth and cloth remains clean. Oil the bores after cleaning to prevent rusting.

## CLEANING

Clean cylinder block thoroughly using a suitable cleaning solvent.

## INSPECTION

### ENGINE BLOCK

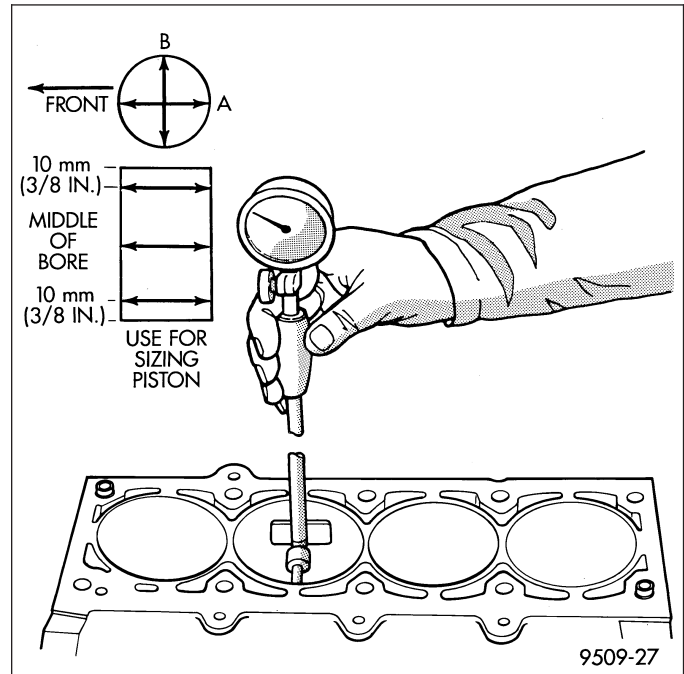
1. Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.
2. If new core plugs are to be installed, (Refer to 9 - ENGINE - STANDARD PROCEDURE - ENGINE CORE AND OIL GALLERY PLUGS).
3. Examine block and cylinder bores for cracks or fractures.
4. Check block deck surfaces for flatness. Deck surface must be within service limit of 0.050 mm (0.002 in.).

### CYLINDER BORE

**NOTE:** The cylinder bores should be measured at normal room temperature, 21°C (70°F).

The cylinder walls should be checked for out-of-round and taper with Tool C119 or equivalent (Refer to 9 - ENGINE - SPECIFICATIONS). If the cylinder walls are badly scuffed or scored, the cylinder block should be replaced, and new pistons and rings fitted.

Measure the cylinder bore at three levels in directions A and B. Top measurement should be 10 mm (3/8 in.) down and bottom measurement should be 10 mm (3/8 in.) up from bottom of bore. (Refer to 9 - ENGINE - SPECIFICATIONS).

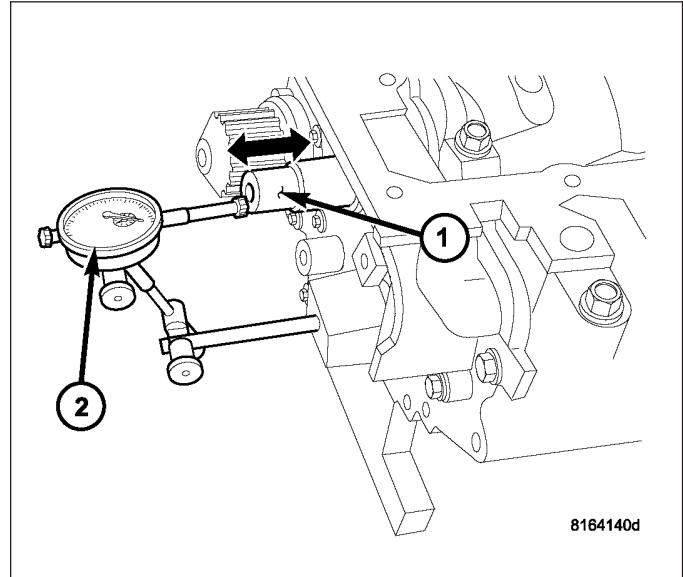


## CRANKSHAFT

### STANDARD PROCEDURE

#### MEASURING CRANKSHAFT END PLAY

1. Mount a dial indicator (2) to front of engine with the locating probe on nose of crankshaft (1).
2. Move crankshaft all the way to the rear of its travel.
3. Zero the dial indicator.
4. Move crankshaft all the way to the front and read the dial indicator. (Refer to 9 - ENGINE - SPECIFICATIONS) for end play specification.



#### REMOVAL - CRANKSHAFT

**NOTE:** Crankshaft can not be removed when engine is in vehicle.

1. Remove engine assembly from vehicle (Refer to 9 - ENGINE - REMOVAL).
2. Separate transaxle from engine.
3. Remove drive plate/flex plate.
4. Remove crankshaft rear oil seal (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT OIL SEAL - REAR - REMOVAL).
5. Mount engine on a suitable repair stand.
6. Drain engine oil and remove oil filter.
7. Remove crankshaft vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).
8. Remove engine mount support bracket.
9. Remove timing chain cover.
10. Remove the timing chain
11. Remove the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).
12. Remove balance shaft module.
13. Remove the crankshaft sprocket.
14. Remove crankshaft position sensor.
15. Remove all ladder frame bolts from the engine block.
16. Using a pry bar gently pry the ladder frame loose from the engine block dowel pins using the pry points cast into the block and ladder frame.
17. Ladder frame should be removed evenly from the cylinder block dowel pins to prevent damage to the dowel pins.

**NOTE:** If piston/connecting rod replacement is necessary, remove cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).



18. Using a permanent ink or paint marker, identify cylinder number on each connecting rod cap.

**CAUTION: DO NOT use a number stamp or a punch to mark connecting rods. Damage to connecting rod could occur.**

19. Remove all connecting rod bolts and caps. Care should be taken not to damage the fracture rod and cap surfaces.

**NOTE: Do not reuse connecting rod bolts.**

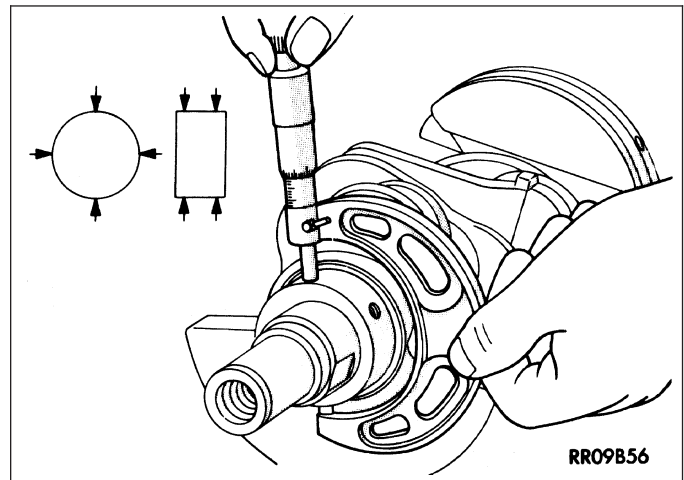
20. Remove main bearing caps.

**CAUTION: Use extreme care when handling crankshaft. Tone wheel damage can occur if crankshaft is mis-handled.**

21. Lift out crankshaft from cylinder block. Do not damage the main bearings or journals when removing the crankshaft.

## INSPECTION

The crankshaft journals should be checked for excessive wear, taper and scoring. Limits of taper or out of round on any crankshaft journals should be held to 0.025 mm (0.001 in.). Journal grinding should not exceed 0.305 mm (0.012 in.) under the standard journal diameter. **DO NOT** grind thrust faces of No. 3 main bearing. **DO NOT** nick crank pin or bearing fillets. After grinding, remove rough edges from crankshaft oil holes and clean out all passages.



## INSTALLATION - CRANKSHAFT

The crankshaft is supported in five main bearings. All upper bearing shells in the crankcase have oil grooves and holes. All lower bearing shells are smooth. Crankshaft end play is controlled by a two piece thrust bearing on the number three main bearing journal.

1. Install the main bearing upper shells with the lubrication groove and oil hole in the engine block.
2. Make certain oil holes in block line up with oil hole in bearings and bearing tabs seat in the block tab slots.

**NOTE: If the crankshaft is sent out for machine work, it must be balanced as an assembly with the target ring installed.**

3. Clean crankshaft and target ring with MOPAR® Brake Parts cleaner and dry with compressed air to ensure that the crankshaft mating surface and target ring mounting holes are free from oil and lock patch debris.

**NOTE: Always use NEW mounting screws whether installing original or new target ring.**

4. Install **NEW** mounting screws finger tight starting with the #1 location. Make sure engagement occurs with the shoulder of the screws and mounting hole before starting all other screws.
5. Torque all mounting screws with T30 torx bit to 13 Nm (110 in-lbs) following the torque sequence.

**NOTE: Lightly apply trans gel to thrust bearings to hold bearings in block.**

6. Install thrust bearings (3) in block.

**CAUTION: Do not get oil on the ladder frame mating surface. It will affect the ability of the RTV to seal the ladder frame to cylinder block.**

7. Oil the bearings and journals. Install crankshaft in engine block.

8. Install lower main bearings (1) into main bearing cap. Make certain the bearing tabs are seated into the bearing cap slots.

9. Before installing the bolts the threads should be clean and dry.

10. Install main bearing caps to engine block, install bolts finger tight.

11. To ensure correct thrust bearing alignment, perform the following steps:

- Step 1: Rotate crankshaft until number 4 piston is at TDC.
- Step 2: Move crankshaft rearward to limits of travel.
- Step 3: Then, move crankshaft forward to limits of travel.
- Step 4: Wedge an appropriate tool between the rear of the cylinder block and the rear crankshaft counterweight. This will hold the crankshaft in it's furthest forward position.

12. Tighten bolts (1–10) again to 41 N·m (30 ft. lbs.) in sequence shown.

13. Remove wedge tool used to hold crankshaft.

14. Check the crankshaft turning torque, it should not exceed 5.6 N·m (50 in. lbs.).

15. Check crankshaft end play (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT - STANDARD PROCEDURE).

16. Install connecting rod bearings and caps. **Do Not Reuse Connecting Rod Bolts.** Torque connecting rod bolts to 27 N·m (20 ft. lbs.) plus 1/4 turn.

17. Install the ladder frame assembly (Refer to 9 - ENGINE/ENGINE BLOCK/LADDER FRAME - INSTALLATION).

18. Install the balance shaft module (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSTALLATION).

19. Install the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

20. Install crankshaft position sensor.

21. Install cylinder head if it was removed (Refer to 9 - ENGINE/CYLINDER HEAD - INSTALLATION).

22. Install front crankshaft sprocket.

23. Install the timing chain (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).

24. Install the timing chain front cover.

25. Install front crankshaft oil seal.

26. Install engine mount support bracket.

27. Install crankshaft vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).

28. Remove engine from repair stand and position on Special Tools 6135 and 6710 Engine Dolly and Cradle. Install safety straps around the engine to cradle and tighten and lock them into position.

29. Install crankshaft rear oil seal (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT OIL SEAL - REAR - INSTALLATION).

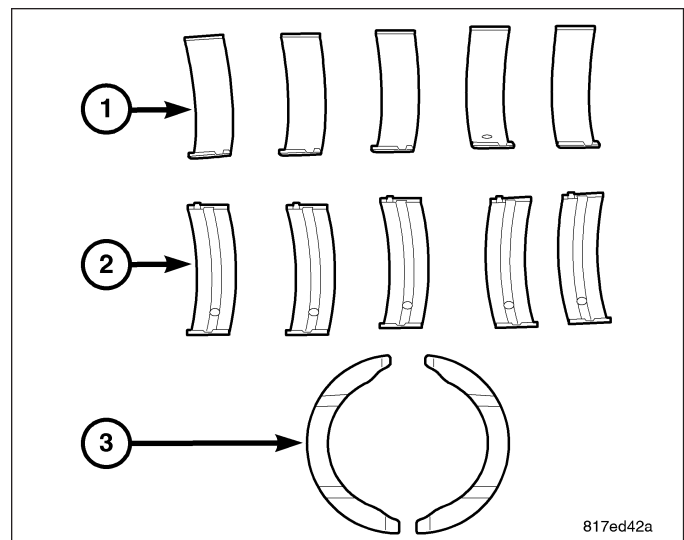
30. Install drive plate/flex plate. Apply Mopar® Lock & Seal Adhesive to bolt threads and tighten to 95 N·m (70 ft. lbs.).

31. Attach transaxle to engine. Tighten attaching bolts to 101 N·m (75 ft. lbs.).

32. Install the engine assembly (Refer to 9 - ENGINE - INSTALLATION).

33. Install new oil filter and fill with oil.

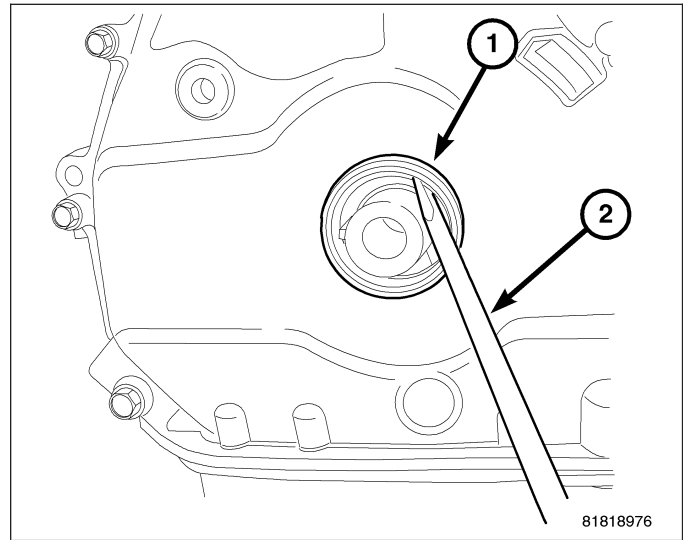
34. Start engine and check for leaks.



## SEAL-CRANKSHAFT OIL FRONT

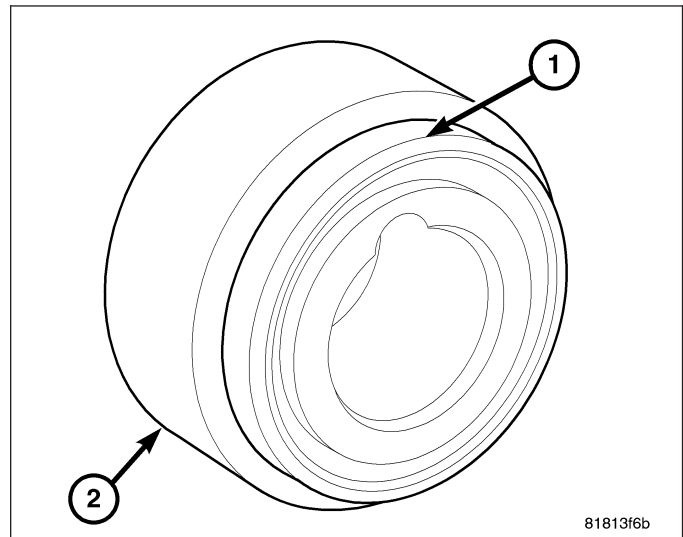
### REMOVAL

1. Remove the crankshaft vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).
2. Remove front crankshaft oil seal (1) by prying out with a screw driver (2). Be careful not to damage the cover seal surface.

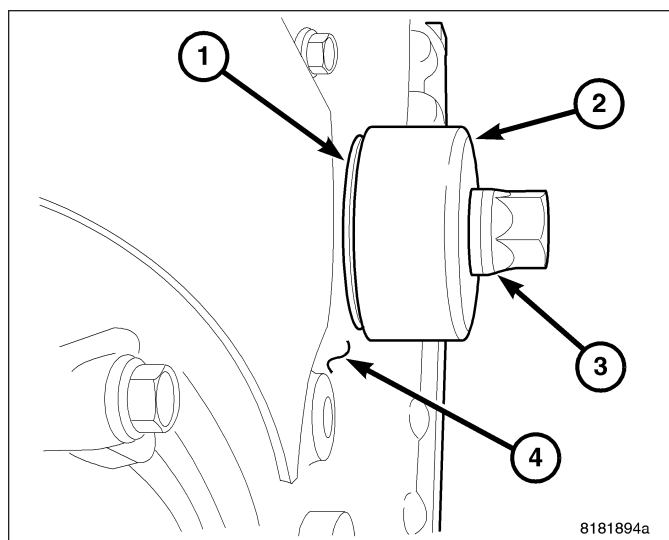


### INSTALLATION

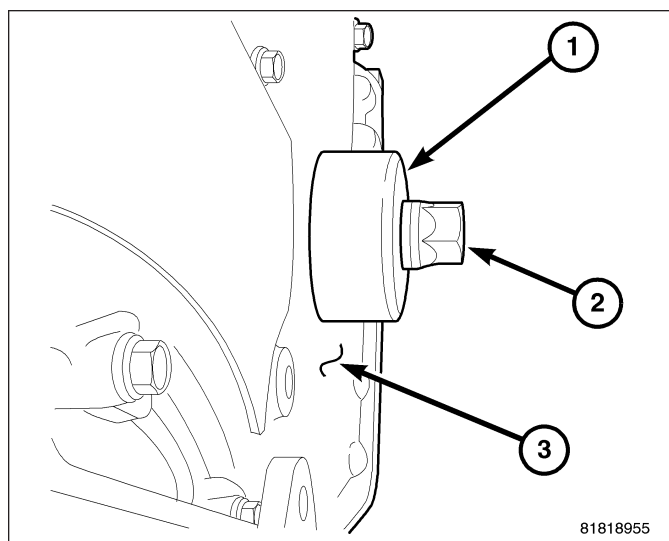
1. Place seal (1) onto Seal installer 9506 (2) with seal spring towards the inside of engine.



2. Install new seal (1) by using Seal installer 9506 (2) and crankshaft damper bolt (3).



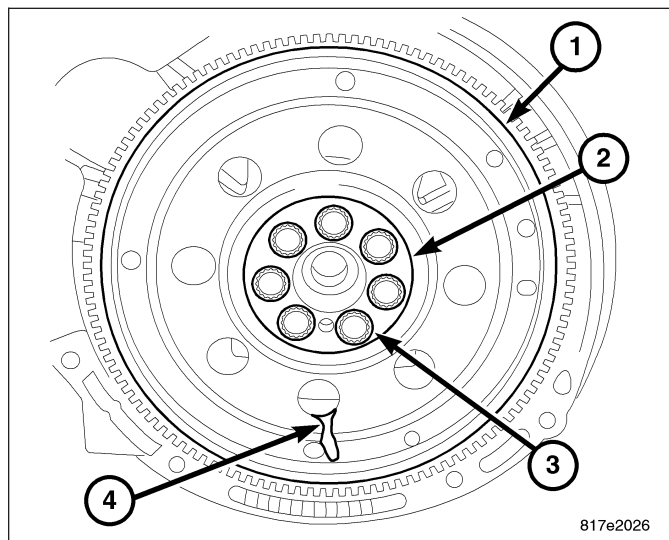
3. Press seal into front cover until Seal Installer 9506 (1) seats against timing chain cover (3).
4. Remove seal installer 9506 (1).
5. Install crankshaft vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).



## SEAL-CRANKSHAFT OIL REAR

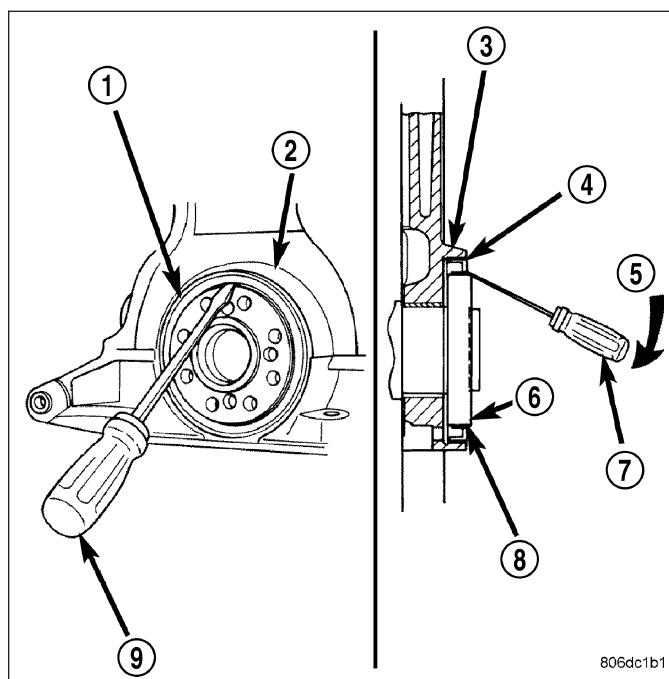
### REMOVAL

1. Remove transaxle
2. Remove flex plate bolts and discard.
3. Remove flex plate (1).



4. Insert a 3/16 flat bladed screwdriver (7) between the dust lip (8) and the metal case (4) of the crankshaft seal (1). Angle the screwdriver through the dust lip against metal case of the seal. Pry out seal.

**CAUTION:** Do not permit the screwdriver blade to contact crankshaft seal surface. Contact of the screwdriver blade against crankshaft edge (chamfer) is permitted.

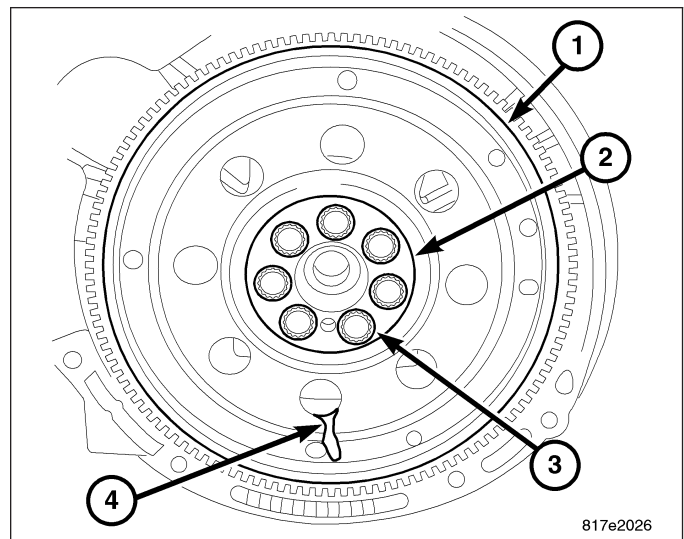
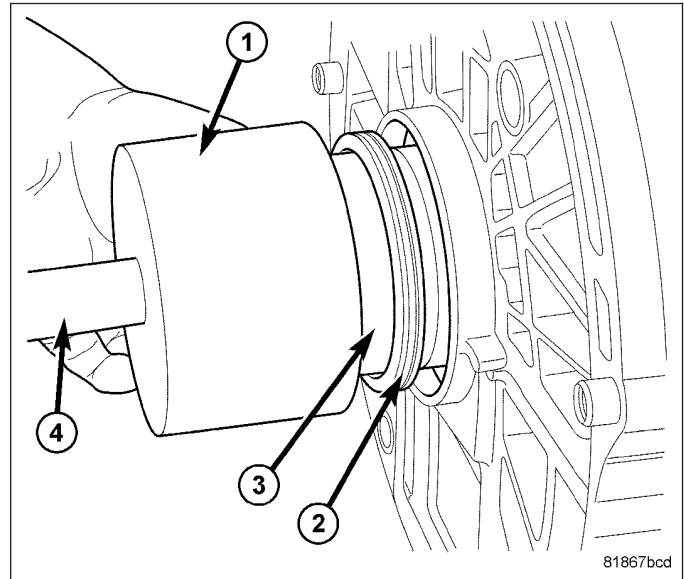


## INSTALLATION

**CAUTION:** If a burr or scratch is present on the crankshaft edge (chamfer), cleanup with 400 grit sand paper to prevent seal damage during installation of new seal.

**NOTE:** When installing seal, no lube on seal is needed.

1. Place Special Tool 9509 (3) Seal Guide on crankshaft.
2. Position seal (2) over guide tool. Guide tool should remain on crankshaft during installation of seal. Ensure that the lip of the seal is facing towards the crankcase during installation.
3. Drive the seal into the block using Special Tool 9706 (1) and handle C-4171 (4) until the tool bottoms out against the block.
4. Install flex plate (1). Install new flex plate bolts and torque to 95 N·m (70 ft. lbs.).
5. Install transaxle. Refer to TRANSMISSION/TRANSAXLE - INSTALLATION for procedure.



## ROD-PISTON & CONNECTING

### DESCRIPTION

The pistons are made of a cast aluminum alloy. The pistons have pressed-in pins attached to forged connecting rods. The pistons pin is offset 0.8 mm (0.0314 in.) towards the thrust side of the piston. The connecting rods are a cracked cap design and are not repairable. The pistons with rings and connecting rods are serviced as an assembly.

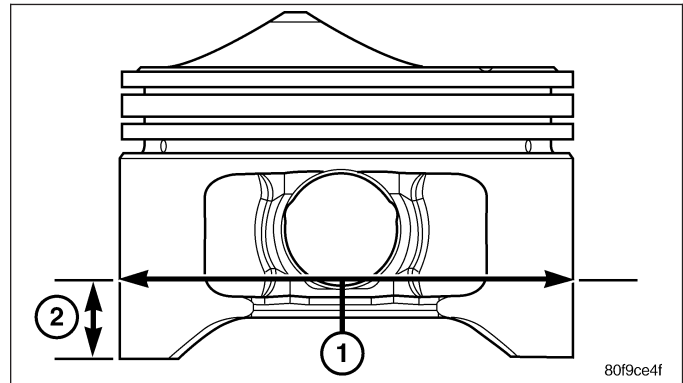
### STANDARD PROCEDURE

#### PISTON TO CYLINDER BORE FITTING

**NOTE:** Pistons and cylinder bores should be measured at normal room temperature, 21°C (70°F).

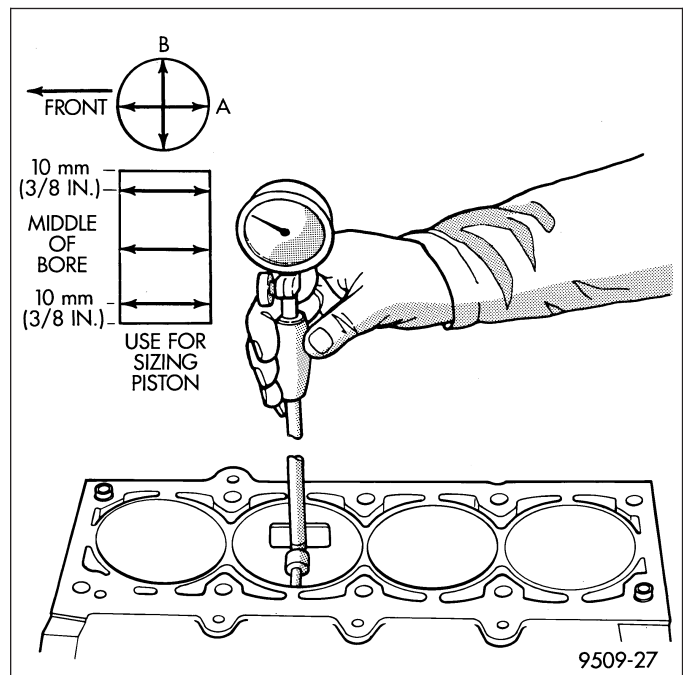
Piston and cylinder wall must be clean and dry. Piston diameter should be measured 90 degrees to piston pin (1).

1. Measurement should be taken approximately 16 mm (0.629 in.) from the bottom of the skirt (2) as shown in.



**NOTE:** Correct piston to bore clearance must be established in order to assure quiet and economical operation.

2. Cylinder bores should be measured halfway down the cylinder bore and transverse (measurement location B) to the engine crankshaft center line shown in. Refer to for Engine Specifications (Refer to 9 - ENGINE - SPECIFICATIONS).



### REMOVAL

**NOTE:** Pistons, rings, and rods are serviced as an assembly.

**CAUTION:** All four piston/rod assemblies must be replaced as a set or engine damage may result.

1. Remove engine (Refer to 9 - ENGINE - REMOVAL).
2. Separate engine from transaxle.
3. Remove cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).

4. Remove oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).
5. Remove balance shaft assembly.

**NOTE: Remove any carbon build up prior to piston removal.**

6. Remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. **Be sure to keep tops of pistons covered during this operation.**
7. Rotate crankshaft so that each connecting rod is centered in cylinder bore.
8. Using a permanent ink or paint marker, identify cylinder number on each connecting rod cap.

**CAUTION: DO NOT use a number stamp or a punch to mark connecting rods, as damage to connecting rod could occur.**

**CAUTION: Care must be taken not to damage the fractured rod and cap joint surfaces, as engine damage may occur.**

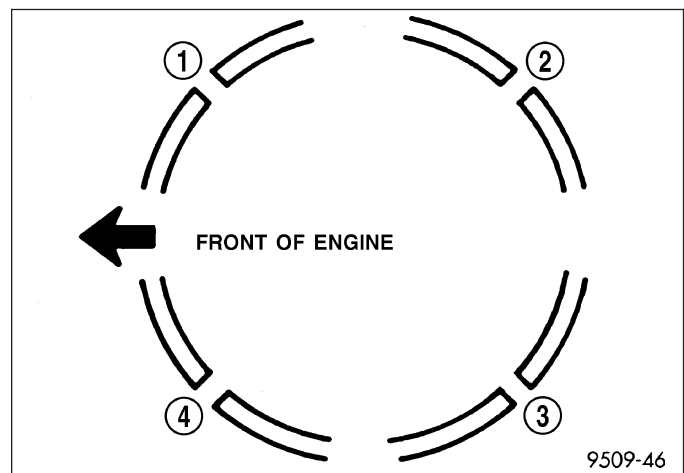
9. Remove connecting rod bolts and cap.

**NOTE: Do not reuse connecting rod bolts.**

10. Carefully push each piston and rod assembly out of cylinder bore. Re-install bearing cap on the mating rod.
11. Repeat procedure for each piston and connecting rod assembly.

## INSTALLATION

1. Install piston rings on piston (Refer to 9 - ENGINE/ENGINE BLOCK/PISTON RINGS - INSTALLATION).
2. Before installing pistons and connecting rod assemblies into the bore, be sure that compression ring gaps are staggered so that neither is in line with oil ring rail gap.
3. Before installing the ring compressor, make sure the oil ring expander ends are butted and the rail gaps located as shown above. As viewed from the top of the piston.
4. Immerse the piston head and rings in clean engine oil, slide the ring compressor, over the piston. **Be sure position of rings does not change during this operation.**



5. The directional arrow stamped on the piston should face toward the front of the engine.
6. Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Lubricate connecting rod journal with clean engine oil.

**NOTE: There are three different size rod bearings, perform rod bearing selection procedure.**

7. The rod bearing sizes are indicated on the nose of the crankshaft.
8. Install connecting rod upper bearing half into connecting rod.
9. Tap the piston down in cylinder bore, using a hammer handle. At the same time, guide connecting rod into position on connecting rod journal.

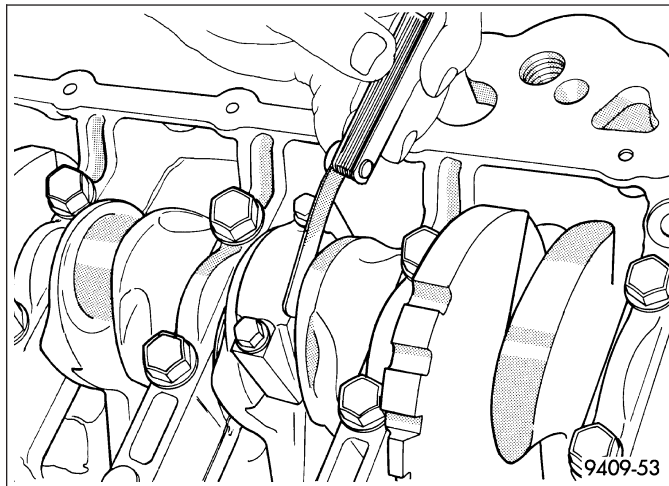
**NOTE: The connecting rod cap bolts should NOT be reused.**

10. Before installing the **NEW** bolts, the threads should be coated with clean engine oil.
11. Install connecting rod lower bearing half into connecting rod cap. Install connecting rod cap.
12. Install each bolt finger tight then alternately torque each bolt to assemble the cap properly.
13. Tighten the connecting rod bolts using the 2 step torque-turn method. Tighten according to the following values:



**CAUTION: Do not use a torque wrench for the second step.**

1. Tighten the bolts to 27 N·m (20 ft. lbs.).
2. Tighten the connecting rod bolts an additional **1/4 TURN**.
14. Using a feeler gauge, check connecting rod side clearance. (Refer to 9 - ENGINE - SPECIFICATIONS) for connecting rod side clearance.
15. Install the ladder frame.
16. Install oil pump/Balance Shaft Carrier Assembly (Refer to 9 - ENGINE/VALVE TIMING/BALANCE SHAFT CARRIER - INSTALLATION).
17. Install oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).
18. Install cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - INSTALLATION).



## BEARINGS-CRANKSHAFT MAIN

### STANDARD PROCEDURE - MAIN BEARING SELECTION

**NOTE:** There are three different possibilities for the upper main bearings and five different lower main bearings. The upper and lower bearing shells are not interchangeable.

The lower main bearing identification is stamped in the nose of the crankshaft (1). There are 5 different bearing sizes available 0 through 4.

CRANKSHAFT IDENTIFICATION		LOWER CRANKSHAFT BEARING SELECTION	
JOURNAL DIAMETER GRADE	DIMENSION	LOWER MAIN BEARING SIZE CLASSIFICATION	LOWER MAIN BEARING DIMENSION
0	52 mm	0 (Pink or Red)	2 mm
1	52 mm	1 (Black)	2 mm
2	52 mm	2 (No Color)	2 mm
3	52 mm	3 (Green)	2 mm
4	52 mm	4 (Blue)	2 mm

The upper main bearing shell identification is located in the middle of cylinder block on the right side of the engine when viewing from the flywheel. There are three different size bearings available.

### UPPER MAIN BEARING SELECTION

CYLINDER BLOCK IDENTIFICATION		UPPER CRANKSHAFT BEARING SELECTION	
MAIN BEARING GRADE	DIMENSION	UPPER MAIN BEARING SIZE CLASSIFICATION	UPPER MAIN BEARING DIMENSION
1	56 mm	1 (Black)	2 mm
2	56 mm	2 (No Color)	2 mm
3	56 mm	3 (Green)	2 mm

## BEARINGS-CONNECTING ROD

### STANDARD PROCEDURE

#### CONNECTING ROD - FITTING

There are three different sizes of rod bearings available. Connecting rod bearing identification can be found on the nose of the crankshaft. Use the table below for proper bearing selection.

#### CONNECTING ROD BEARING SELECTION

CRANKSHAFT PIN DIAMETER GRADE	DIMENSION	CONNECTING ROD BEARING CLASSIFICATION	CONNECTING ROD BEARING DIMENSION
1	48 mm	1 (Black)	1.5 mm
2	48 mm	2 (No Color)	1.5 mm
3	48 mm	3 (Green)	1.5 mm

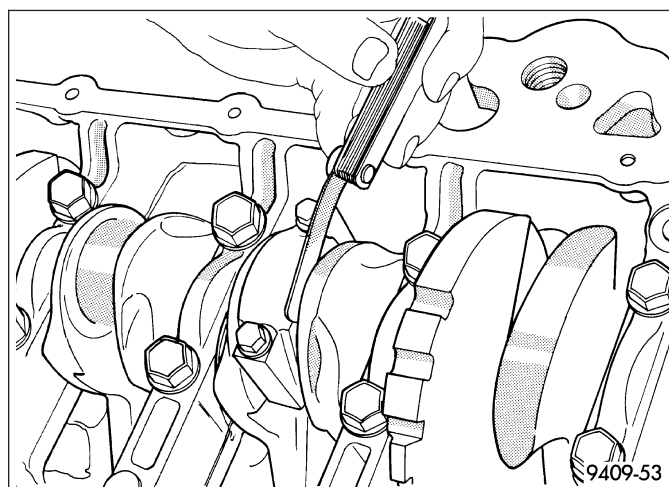
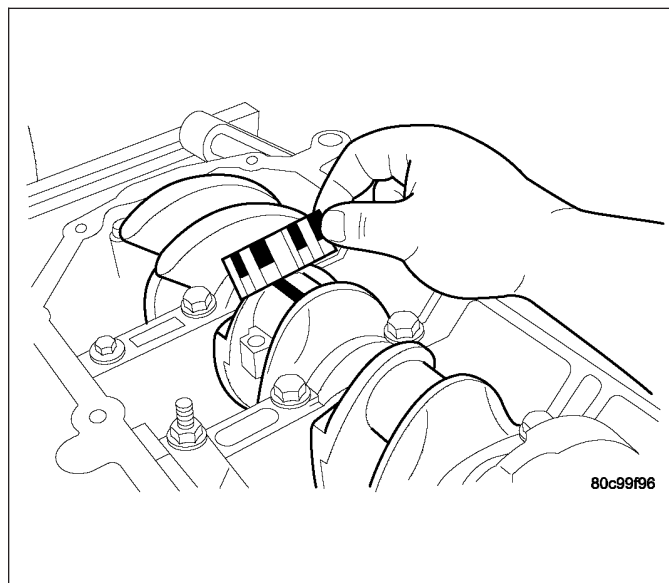
1. For measuring connecting rod bearing clearance procedure and use of Plastigage (Refer to 9 - ENGINE - STANDARD PROCEDURE) For bearing clearance refer to Engine Specifications. (Refer to 9 - ENGINE - SPECIFICATIONS).

**NOTE:** The rod bolts should not be reused.

2. Before installing the **NEW** rod bolts the threads and under the bolt head should be oiled with clean engine oil.
3. Install each bolt finger tight then alternately torque each bolt to assemble the cap properly.
4. Tighten the connecting rod bolts using the 2 step torque-turn method. Tighten according to the following values:

**CAUTION:** Do not use a torque wrench for the second step.

1. Tighten the bolts to 27 N·m (20 ft. lbs.).
2. Tighten the connecting rod bolts an additional 90°.
5. Using a feeler gauge, check connecting rod side clearance. Refer to clearance specifications (Refer to 9 - ENGINE - SPECIFICATIONS).

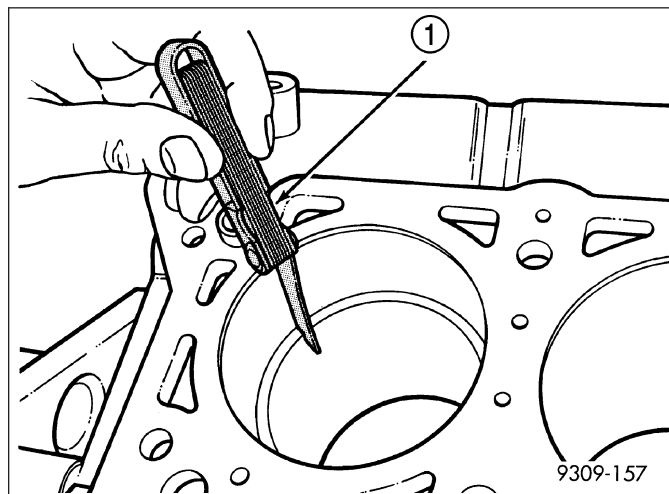


## RINGS-PISTON

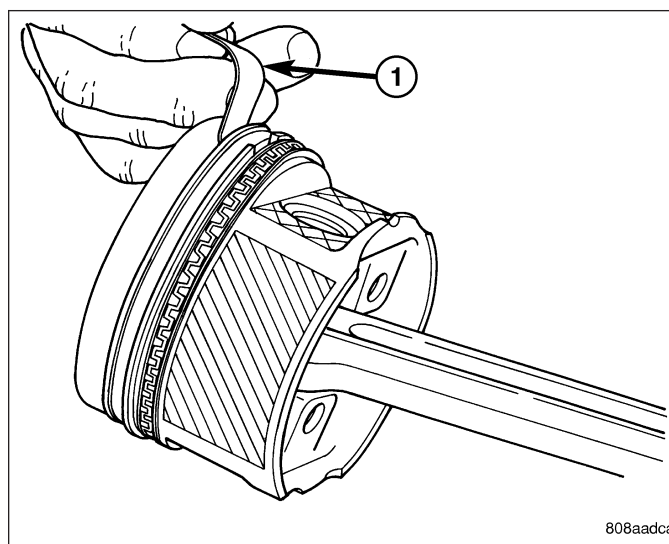
### STANDARD PROCEDURE

#### PISTON RING - FITTING

1. Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The ring gap measurement must be made with the ring positioning at least 12 mm (0.50 inch) from bottom of cylinder bore. Check gap with feeler gauge. Refer to Engine Specifications.

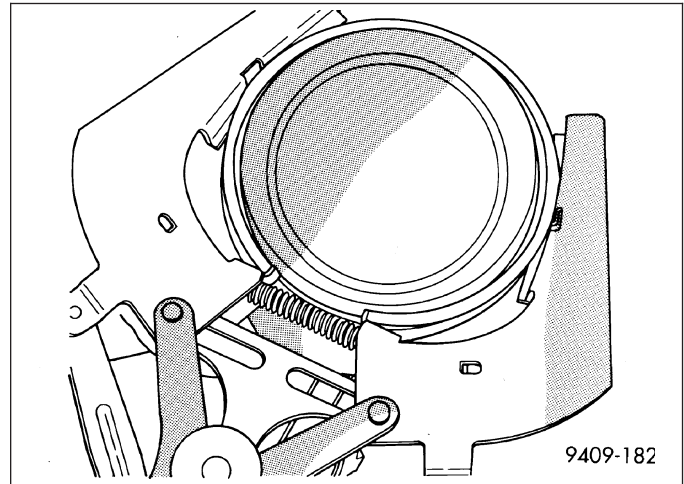


2. Check piston ring to groove side clearance. Refer to Engine Specifications.



## REMOVAL

1. Using a suitable ring expander, remove upper and intermediate piston rings.
2. Remove the upper oil ring side rail, lower oil ring side rail and then oil ring expander from piston.
3. Clean ring grooves of any carbon deposits.

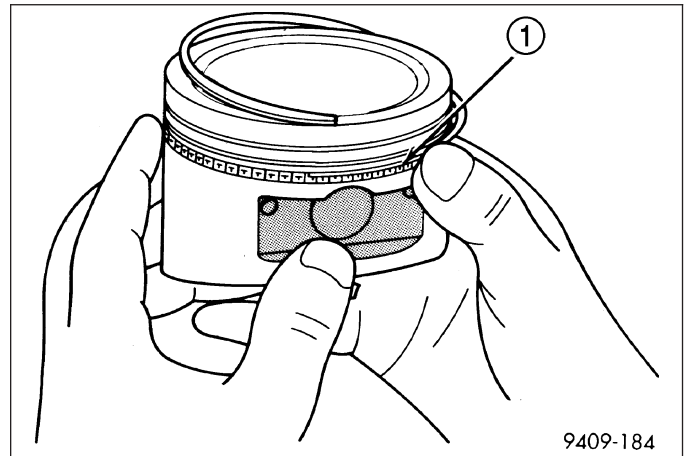


## INSTALLATION

**NOTE:** The identification mark on face of upper and intermediate piston rings must point toward top of piston.

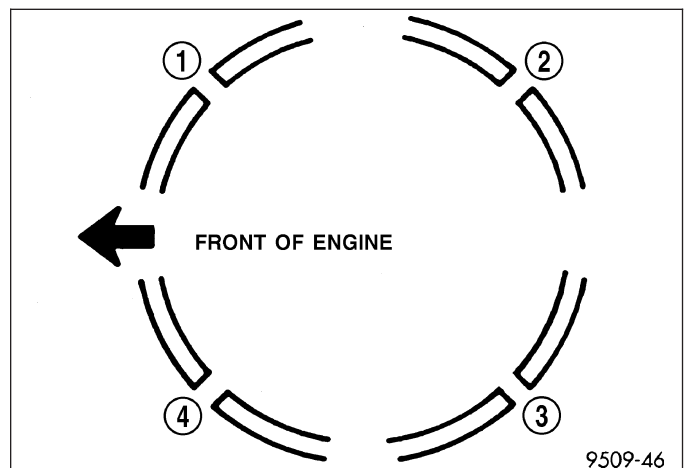
**CAUTION:** Install piston rings in the following order:

1. Oil ring expander.
  2. Upper oil ring side rail.
  3. Lower oil ring side rail.
  4. No. 2 Intermediate piston ring.
  5. No. 1 Upper piston ring.
1. Install oil ring expander.
  2. Install upper side rail first and then the lower side rail. Install the side rails by placing one end between the piston ring groove and the oil ring expander. Hold end firmly and press down the portion to be installed until side rail is in position. **Do not use a piston ring expander.**



**NOTE:** The compression rings are marked Y1 for the upper compression ring and Y2 for the second compression ring. These markings must face upward.

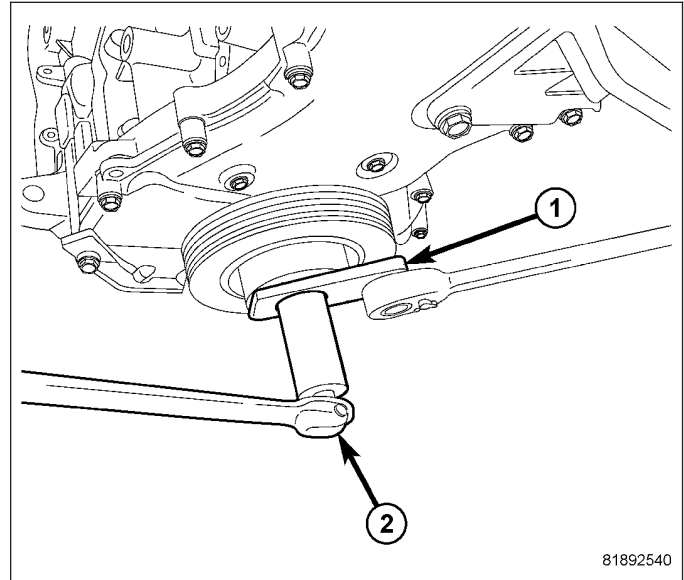
3. Install No. 2 piston ring and then No. 1 piston ring.
4. Position piston ring end gaps as shown in.
5. Position oil ring expander gap at least 45° from the side rail gaps but **not** on the piston pin center or on the thrust direction. Staggering ring gap is important for oil control.



## DAMPER-VIBRATION

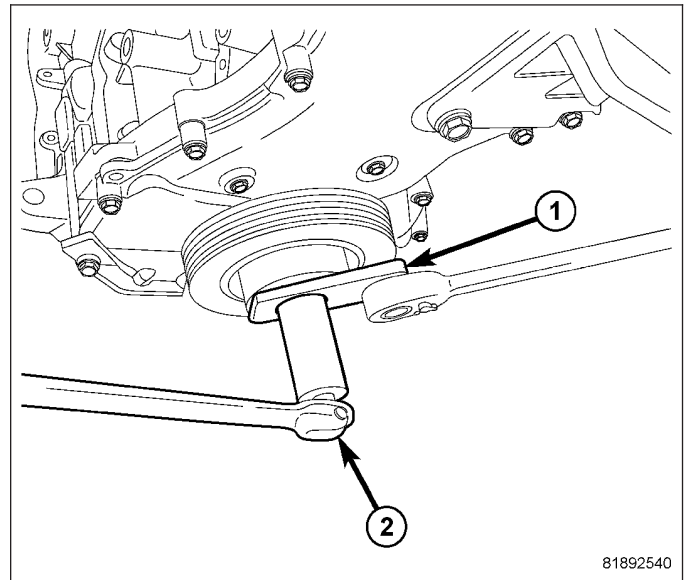
### REMOVAL

1. Remove accessory drive belts (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
2. Install Damper holder 9707 (1).
3. Remove crankshaft damper bolt.
4. Pull damper off crankshaft.



### INSTALLATION

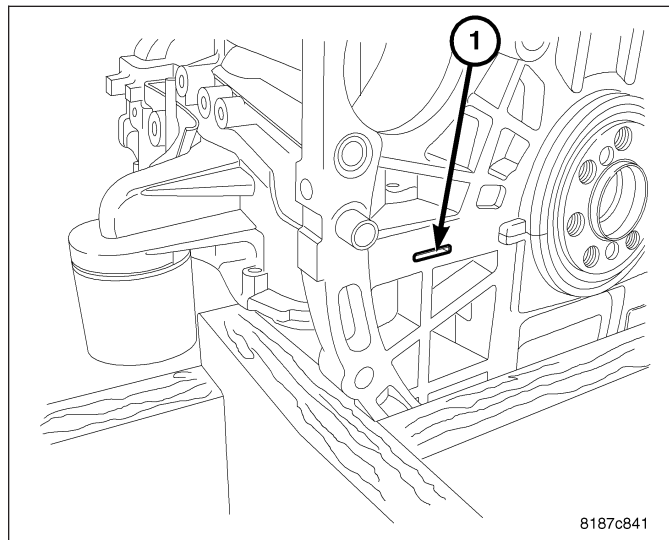
1. Install crankshaft damper.
2. Apply clean engine oil crankshaft damper bolt threads and between bolt head and washer. Torque bolt to 210 N·m (155 ft. lbs.).
3. Install accessory drive belts (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).



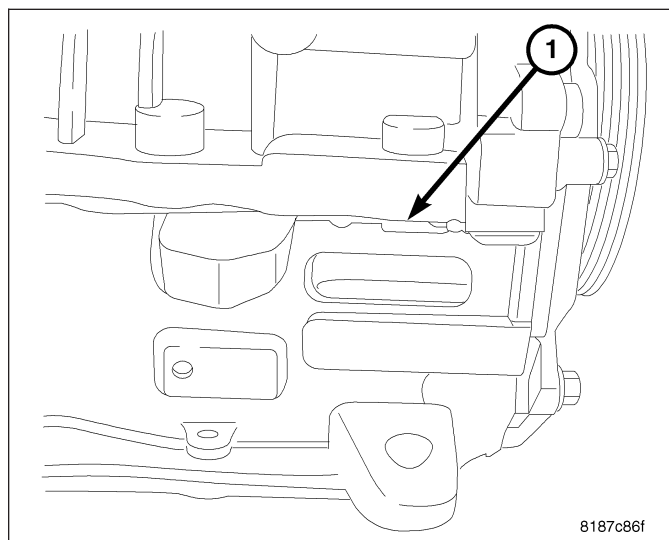
## FRAME-LADDER

### REMOVAL

1. Remove oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).
2. Remove oil pump/balance shaft assembly (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - REMOVAL).
3. Remove ladder frame retaining bolts.
4. Remove ladder frame using pry points cast in the rear of the block (1).



5. To assist in removing the ladder frame another (1) pry points cast in the left side of the block.

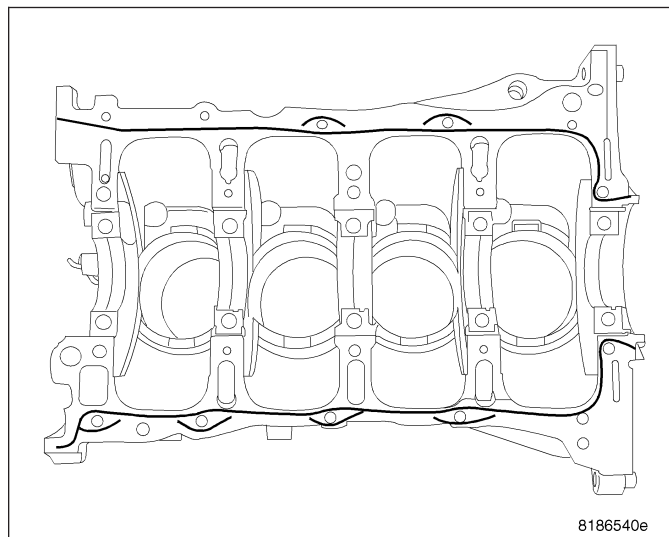


### CLEANING

Clean ladder frame with a plastic or wooden scraper and a suitable solvent.

## INSTALLATION

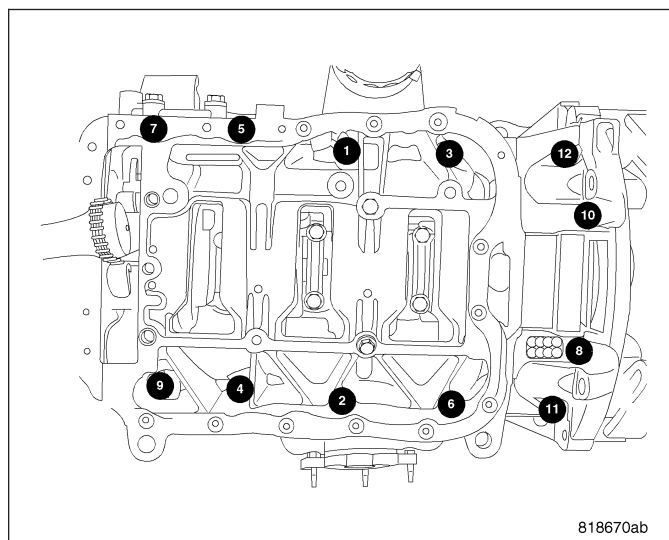
1. Apply a 2 mm bead of sealant as shown.



2. Install bolts and torque shown following a three step method.

- First: All to 20 N·m (15 ft. lbs.)
- Second: All to 49 N·m (36 ft. lbs.)
- Third: All to 49 N·m (36 ft. lbs.)

3. Install oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

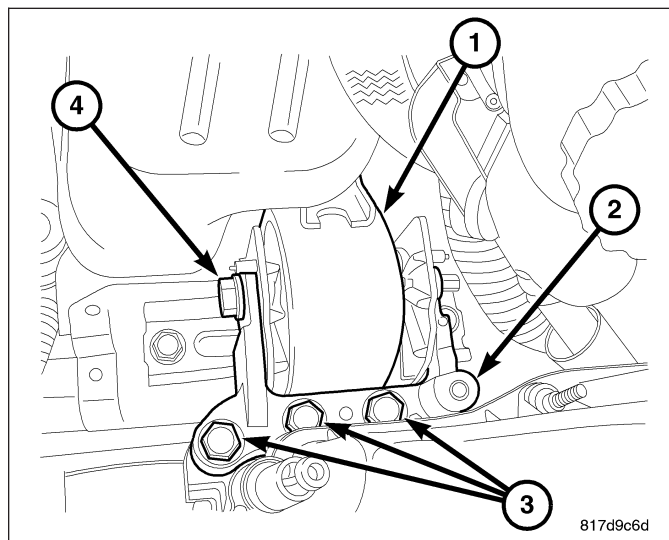




## MOUNT-RIGHT

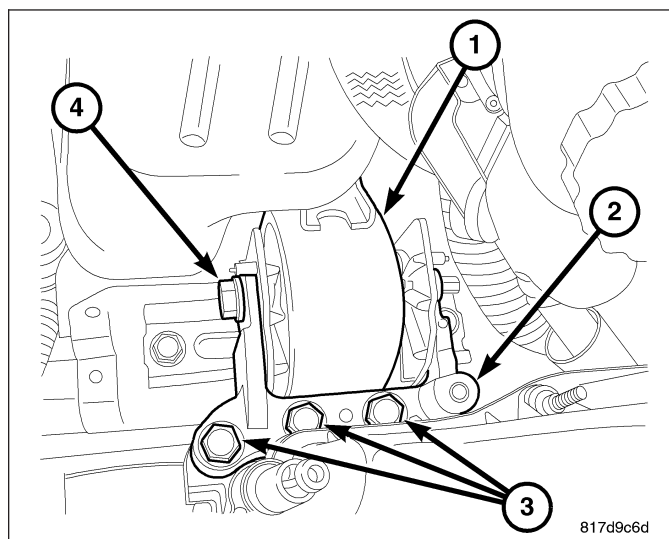
### REMOVAL

1. Remove coolant reservoir and set aside.
2. Remove power steering reservoir and set aside.
3. Remove windshield washer bottle.
4. Remove power steering line support bracket from engine mount.
5. Support transaxle with a block of wood and a suitable jack.
6. Remove engine mount through bolt (4).
7. Remove engine mount bracket bolts (3).
8. Remove engine mount retaining bolts.
9. Remove engine mount.



### INSTALLATION

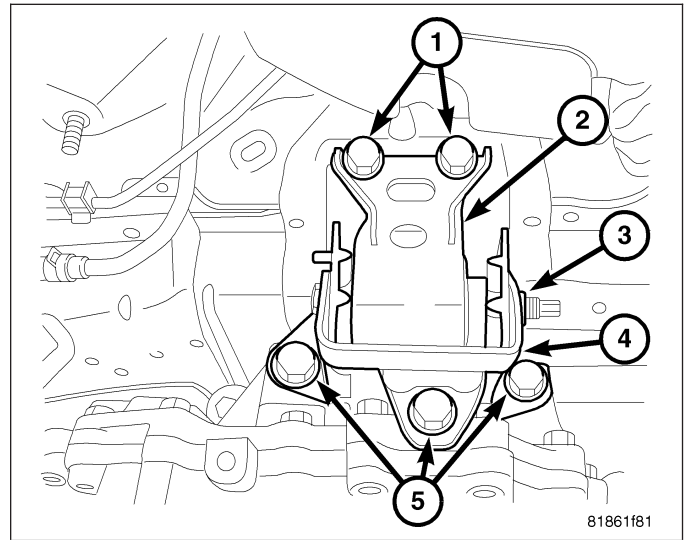
1. Install engine mount.
2. Install engine mount retaining bolts and torque to 28 N·m (250 in. lbs.).
3. Install engine mount bracket and torque bolts (3) to 68 N·m (50 ft. lbs.).
4. Install engine mount through bolt (4) and torque to 115 N·m (85 ft. lbs.).
5. Remove jack.
6. Install power steering line support bracket at engine mount.
7. Install windshield washer bottle.
8. Install power steering reservoir.
9. Install coolant reservoir.



## MOUNT-LEFT

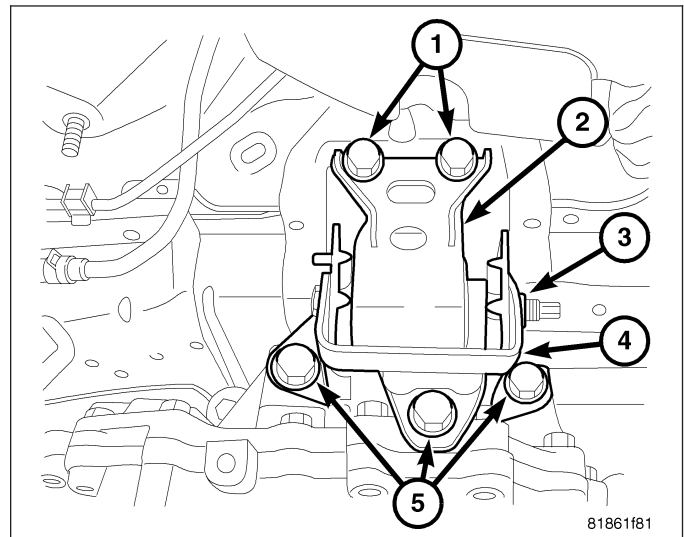
### REMOVAL

1. Remove air cleaner assembly.
2. Disconnect negative cable from battery.
3. Remove PCM.
4. Remove PCM mounting bracket.
5. Support transaxle with a suitable jack.
6. Remove left mount through bolt (3).
7. Remove mount to transaxle bolts (5).
8. Remove left mount bracket (4).
9. Remove left mount bracket to body frame rail fasteners.
10. Remove mount.



### INSTALLATION

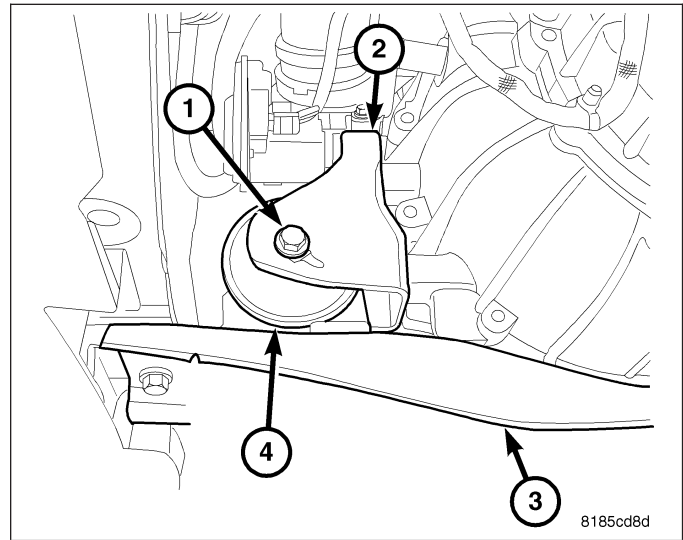
1. Install mount.
2. Install left mount to frame rail bolts and torque to 28N·m (250 in. lbs.).
3. Install left mount bracket (4).
4. Install mount to transaxle bolts (5) and torque to 68 N·m (50 ft.lbs.).
5. Install mount through bolt (3) and torque to 115 N·m (85 ft.lbs.).
6. Remove jack.
7. Install PCM mounting bracket.
8. Install PCM.
9. Connect negative battery cable.
10. Install air cleaner assembly.



## MOUNT-FRONT

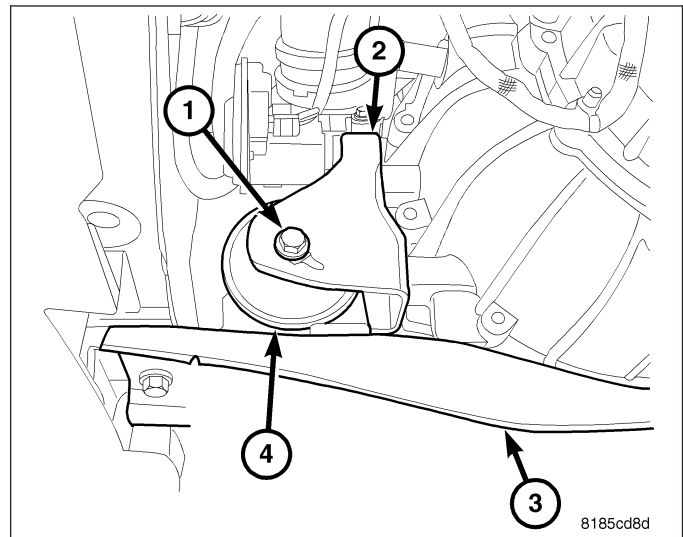
### REMOVAL

1. Raise vehicle.
2. Remove fore aft member (3) to mount (4) bolts.
3. Remove mount through bolt (1).
4. Remove fore aft member (3) mounting bolts and remove.
5. Remove front mount (4).



### INSTALLATION

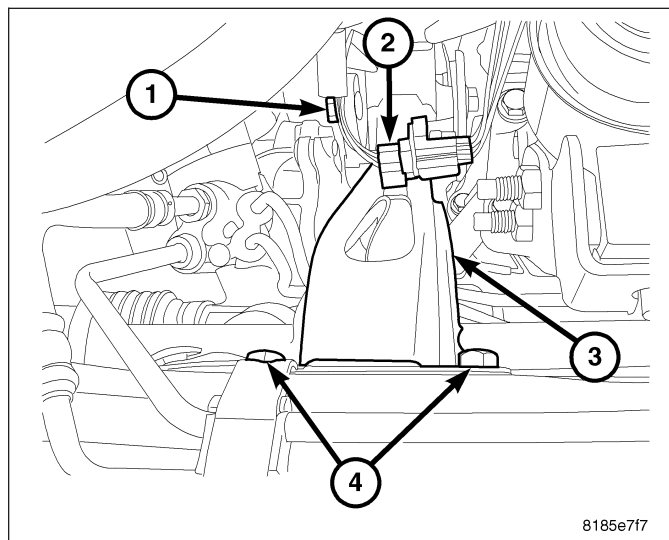
1. Install mount (4) and tighten bolts.
2. Install fore aft member (3) and tighten bolts.
3. Install mount through bolt (1) and tighten.
4. Lower vehicle.



## MOUNT-REAR

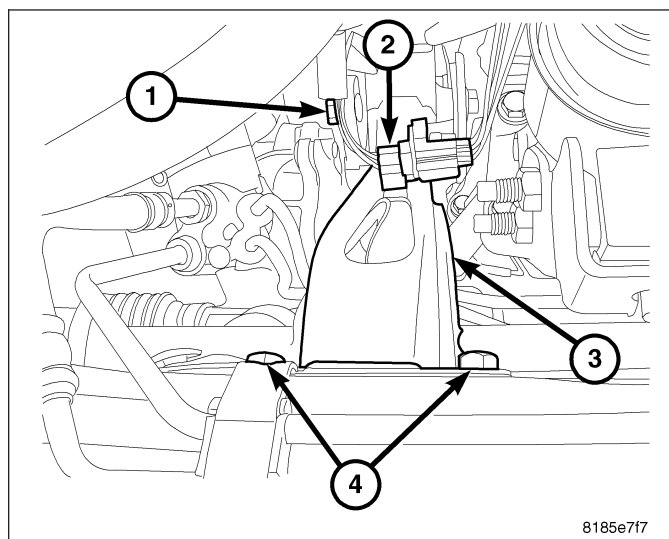
### REMOVAL

1. Remove rear mount retaining bolts (4).
2. Remove rear mount through bolt (1).
3. Remove oxygen sensor connector (2) from mount.
4. Remove rear mount (3).



### INSTALLATION

1. Install rear mount (3).
2. Install rear mount retaining bolts (4) and tighten.
3. Install rear mount through bolt (1) and tighten.
4. Install oxygen sensor connector (2) retainer to mount (3).



## LUBRICATION

### DESCRIPTION

The lubrication system is a full-flow filtration, pressure feed type. The oil pump is chain driven by the crankshaft. Oil pressure is controlled by a relief valve mounted inside the oil pump housing.

### OPERATION

Engine oil is drawn up through the pickup tube and is pressurized by the oil pump and routed through the oil filter to the main oil gallery running the length of the cylinder block. A diagonal hole in each bulkhead feeds oil to each main bearing. Drilled passages within the crankshaft route oil from the main bearing journals to the connecting rod journals. The main oil gallery also feeds oil pressure to the timing chain tensioner. A vertical hole at the number three main bearing area routes pressurized oil through a restrictor up into the cylinder head. The restrictor that is integral to the cylinder head gasket, provides increased oil flow to the main gallery. Upper engine lubrication is provided by one main feed to the number three camshaft bearing cap. Oil is then routed through the rocker shafts to the remaining camshaft bearing caps and rocker arms/hydraulic lash adjusters. Oil returning to the oil pan from the pressurized components supplies lubrication to the valve stems. The cylinder bores and wrist pins are splash lubricated from directed slots on the connecting rod thrust collar.

### DIAGNOSIS AND TESTING

#### CHECKING ENGINE OIL PRESSURE

Check oil pressure using a gauge at oil pressure switch location.

1. If equipped with A/C remove accessory drive belt and A/C compressor.
2. Remove pressure sending unit.
3. Install oil pressure test gauge, Special Tool C-3292 with Adapter 8406.

**CAUTION: If oil pressure is 0 at idle, Do Not Run engine at 3000 RPM.**

4. Warm engine to normal operating temperature.
5. Monitor gauge readings at idle and 3000 rpm. For specifications (Refer to 9 - ENGINE - SPECIFICATIONS).
6. If oil pressure is low (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSPECTION).

## FILTER-OIL

### REMOVAL

1. Turn oil filter cap counterclockwise 2 ½ turns and wait one minute.

**NOTE: A drain back valve incorporated into the oil filter cartridge housing allows oil to drain back into the crankcase as the oil filter cartridge is removed.**

2. Continue turning the oil filter cap counterclockwise. Remove cap slowly to avoid spill of oil.
3. Remove oil filter cartridge from the cap.

**NOTE: If the center tube separates from the cap and stays inside the filter cartridge, you must remove the center tube from the filter element and snap it back onto the cap with the spring.**

4. Remove and discard o-ring from cap.

### INSTALLATION

1. Install new o-ring on cap.
2. Install new oil filter cartridge over center tube of cap.

**NOTE: Before installation, make sure no grommet is left on the center post of the oil filter housing from the previous filter.**

3. Align the grommet hole of the oil filter cartridge with the center post of the filter housing.
4. Press in and turn oil filter cap clockwise. Tighten cap to 25 N·m (18 ft. lbs). Cap flange should sit tightly on the housing flange.
5. Fill oil to proper level.
6. Start engine. Check for leaks.

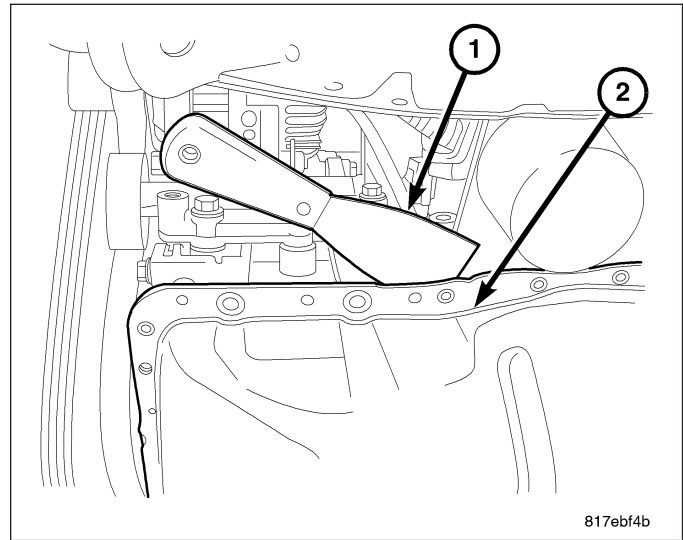
## PAN-OIL

### REMOVAL

1. Raise vehicle on hoist.
2. Drain engine oil.
3. Remove accessory drive belt splash shield.
4. Remove lower A/C compressor mounting bolt (if equipped).
5. Remove A/C mounting bracket.

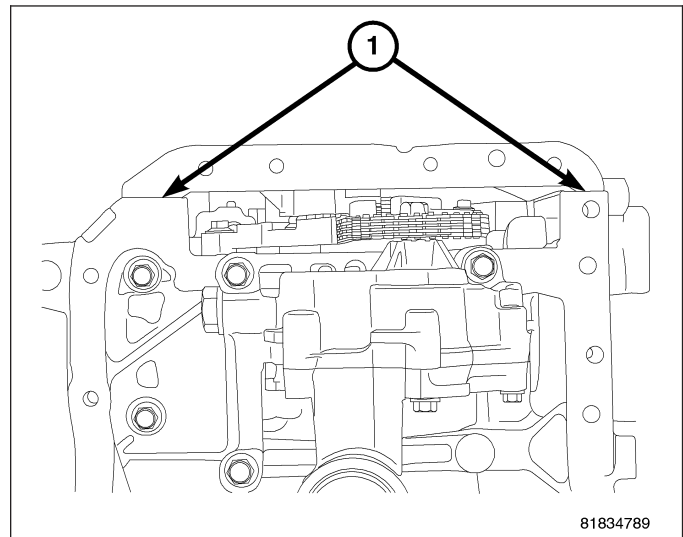
**NOTE: Do not use pry points in block to remove oil pan.**

6. Remove oil pan retaining bolts.
7. Using a putty knife (1), loosen seal around oil pan (2).
8. Remove oil pan (2).

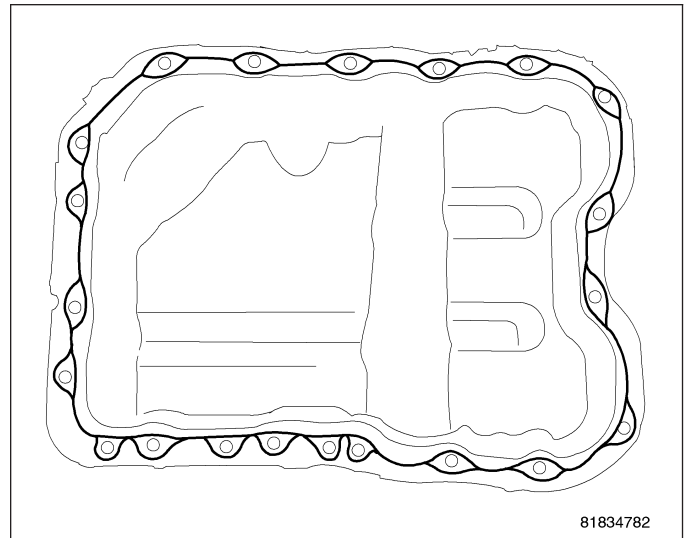


### INSTALLATION

1. Apply Mopar® Engine RTV GEN II at the front cover to engine block parting lines (1).



2. Apply a 2 mm bead of Mopar® Engine RTV GEN II around the oil pan as shown.



3. Tighten screws to 12 N·m (105 in. lbs.).
4. Install oil drain plug.
5. Lower vehicle and fill engine crankcase with proper oil to correct level.
6. Start engine and check for leaks.



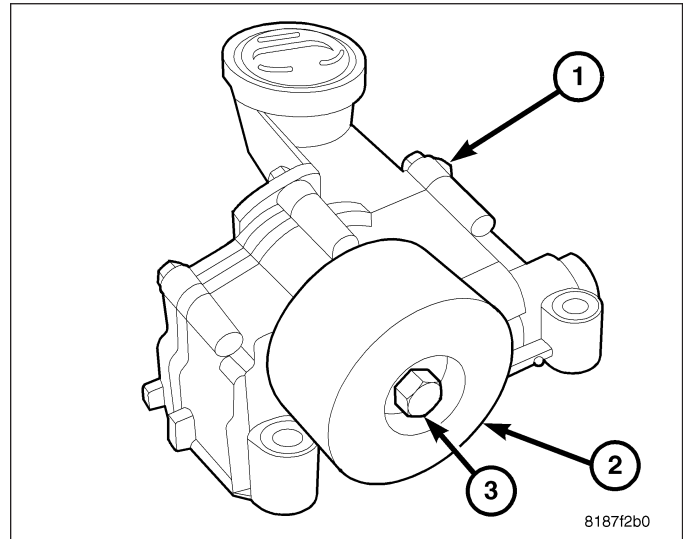
## PUMP-OIL

### REMOVAL

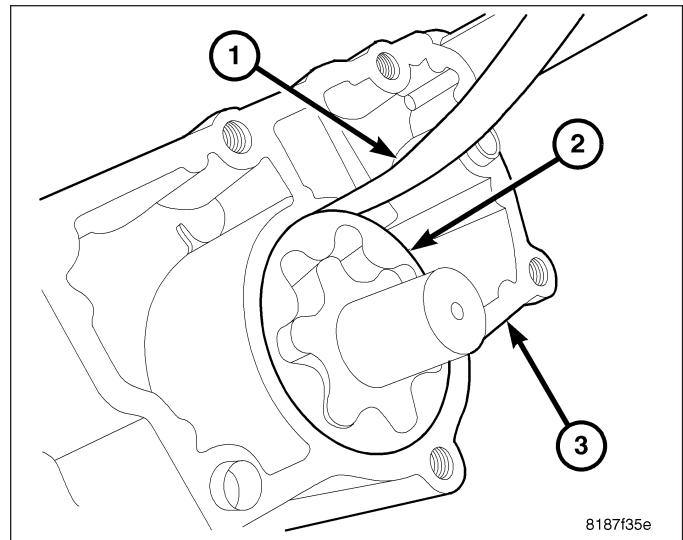
1. Remove timing chain cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING CHAIN COVER - REMOVAL).

### INSPECTION

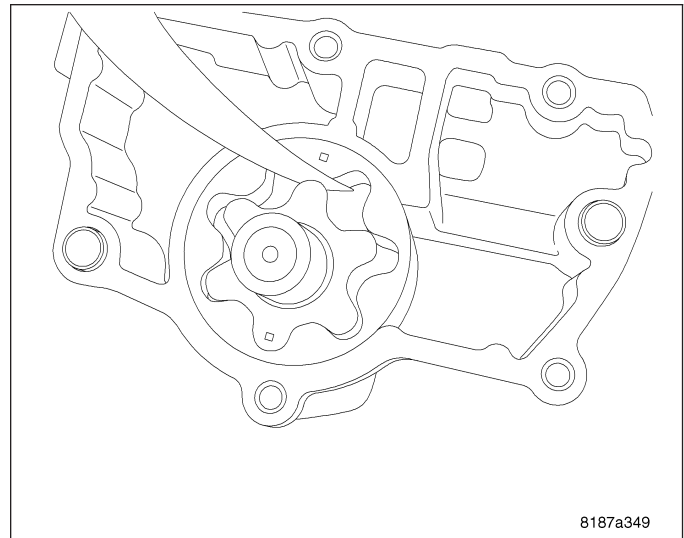
1. Remove pressure relief valve.
2. Inspect pressure relief valve for scoring or damage. If scored or damaged, replace valve.
3. Inspect oil pump housing bore for damage or scoring, if found replace pump.
4. Remove oil pump drive sprocket using holder 9711 (2).
5. Remove oil pump housing retaining bolts.
6. Remove oil pump housing.



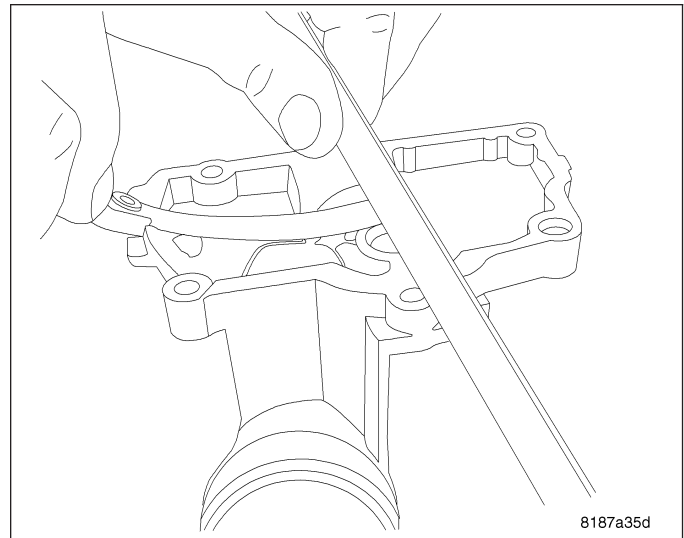
7. Measure outer rotor (2) to housing (3) clearance with feeler gauge (1).



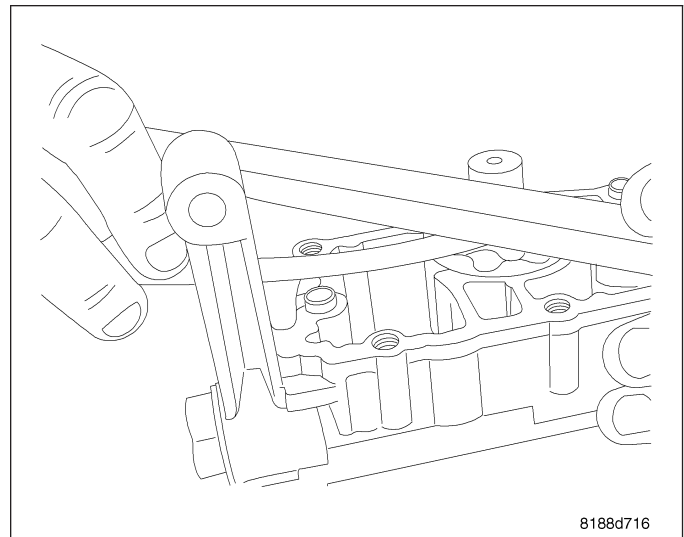
8. Measure tip clearance between outer and inner rotor.



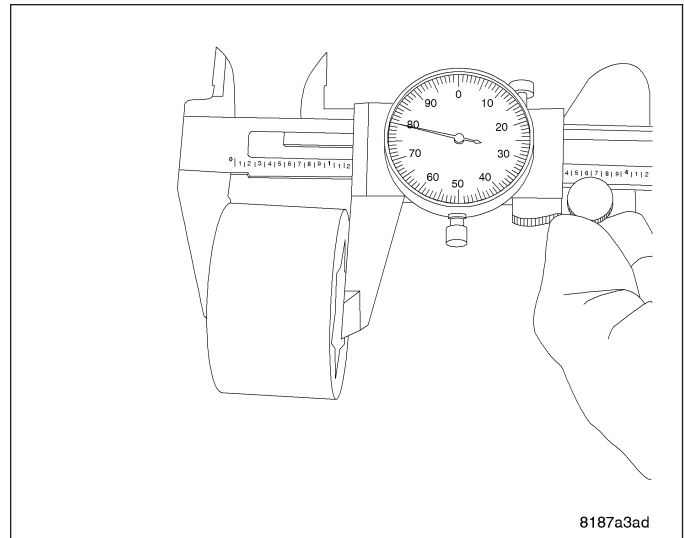
9. Measure pump cover flatness with a straight edge and feeler gauge.



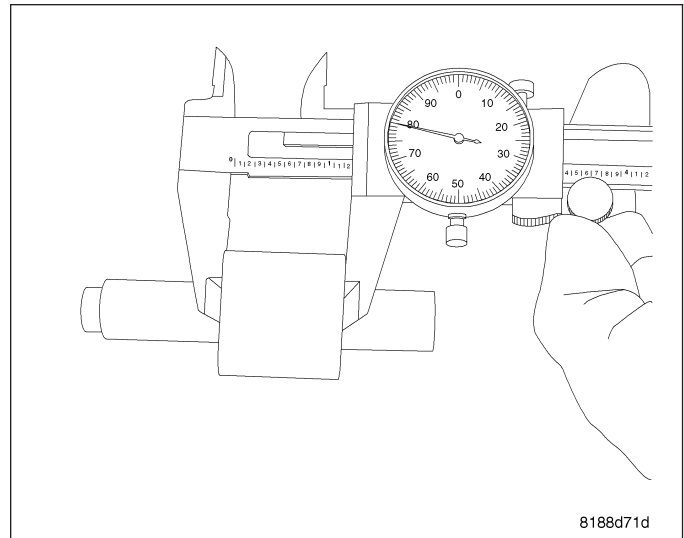
10. Measure clearance over rotors with a straight edge and feeler gauge.



11. Measure outer rotor thickness.



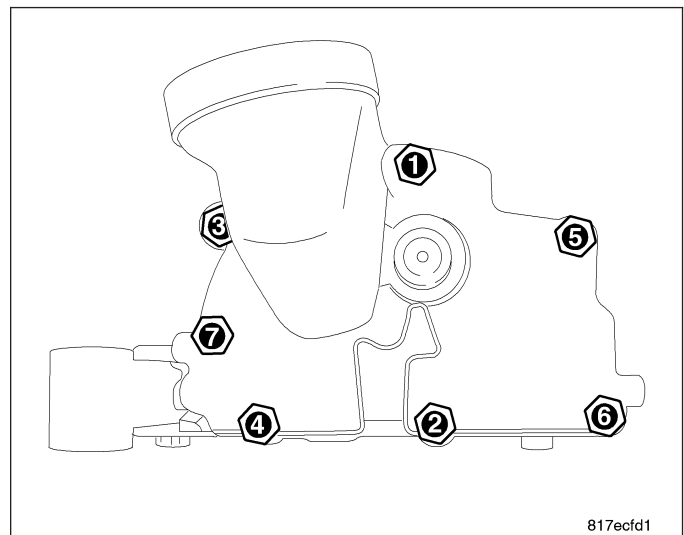
12. Measure inner rotor thickness.



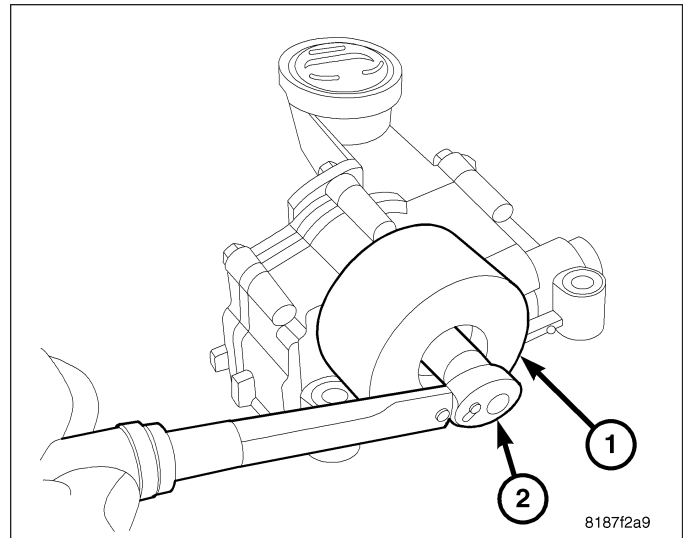
13. Inspect pump housing for scoring, replace as needed.

14. If pump passes inspections, install pump cover.

15. Install retaining bolts and tighten.



16. Install pump drive sprocket using holder 9711 (1) and tighten.



## INSTALLATION

1. Install timing chain cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING CHAIN COVER - INSTALLATION).

## SENSOR/SWITCH-ENGINE OIL PSI

### DESCRIPTION

The oil pressure switch is located on the left front side of the engine block. The oil pressure switch is a pressure sensitive switch that is activated by the engine's oil pressure (in the main oil gallery). The switch is a two terminal device (one terminal is provided to the wiring harness and the other terminal is the switch's metal housing that screws into the engine block).

### OPERATION

The oil pressure switch is normally "Closed." The switch changes from a "Closed" circuit to an "Open" circuit, on increasing pressure of 7 psig. The oil pressure switch changes from an "Open" circuit to a "Closed" circuit, on decreasing pressure, between 2 psig and 4 psig.

### REMOVAL

1. Raise vehicle.
2. Disconnect electrical connector.
3. Remove oil pressure sending unit using oil pressure socket C-4597.

### INSTALLATION

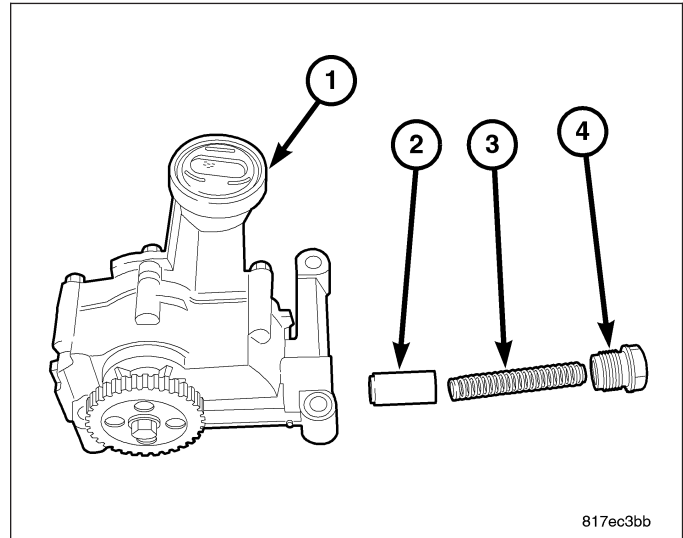
1. Install oil pressure sending unit using oil pressure socket C-4597.
2. Connect electrical connector.

## VALVE-OIL PRESSURE RELIEF

### REMOVAL

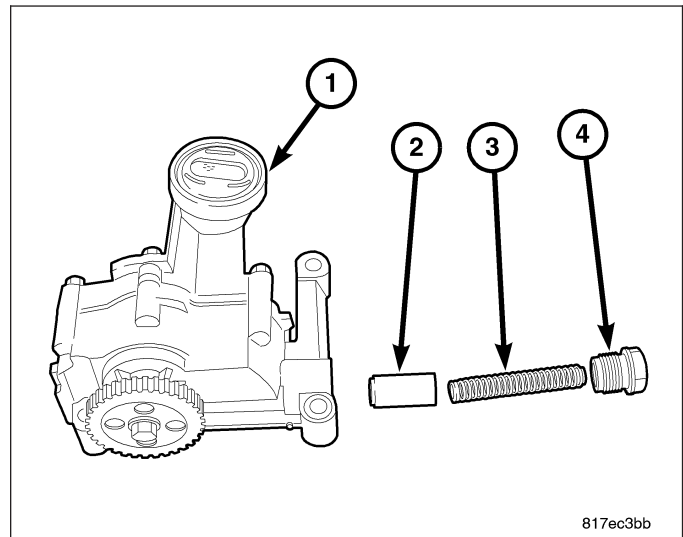
**NOTE:** Oil pressure relief valve can be serviced without removing oil pump from the engine.

1. Remove oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).
2. Remove cap (4).
3. Remove spring (3) and valve (2).
4. Inspect valve (2) and pump (1) bore seizure or scoring. Replace as needed.



### INSTALLATION

1. Lubricate valve (2) and pump (1) bore with clean engine oil.
2. Install valve (2) and spring (3).
3. Install cap (4) and tighten.
4. Install oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).



## MANIFOLD-INTAKE

### DIAGNOSIS AND TESTING

#### INTAKE MANIFOLD LEAKS

An intake manifold air leak is characterized by lower than normal manifold vacuum. Also, one or more cylinders may not be functioning.

**WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE CLOTHING.**

1. Start the engine.
2. Spray a small stream of water (Spray Bottle) at the suspected leak area.
3. If engine RPM'S change, the area of the suspected leak has been found.
4. Repair as required.

### REMOVAL

#### LOWER INTAKE MANIFOLD

**WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE SERVICING SYSTEM COMPONENTS. SERVICE VEHICLES IN WELL VENTILATED AREAS AND AVOID IGNITION SOURCES. NEVER SMOKE WHILE SERVICING THE VEHICLE.**

1. Remove engine cover.
2. Perform fuel system pressure release procedure **before attempting any repairs (Refer to 14 - FUEL SYSTEM/ FUEL DELIVERY - STANDARD PROCEDURE).**
3. Remove air cleaner housing.
4. Disconnect negative battery cable.
5. Disconnect fuel line at rail.
6. Remove fuel injector electrical connectors.
7. Remove fuel rail retaining bolts and remove fuel rail.
8. Disconnect oil temperature sensor.
9. Disconnect variable valve timing solenoid electrical connector.
10. Disconnect intake camshaft position sensor electrical connector.
11. Position harness out of the way.
12. Remove throttle body support bracket.
13. Disconnect electronic throttle control electrical connector.
14. Remove wiring harness retainer from the intake manifold.
15. Disconnect MAP sensor electrical connector.
16. Disconnect vacuum lines at intake.
17. Remove upper radiator hose retaining bracket.
18. Remove intake manifold retaining bolts.
19. Remove intake manifold.

## **CLEANING**

1. Discard gasket(s).
2. Clean all sealing surfaces.

## **INSPECTION**

1. Inspect manifold for cracks, distortion, or mounting surface warpage. Replace manifold if necessary.
2. Inspect manifold gasket for surface damage or excessive swelling. Replace gaskets as necessary.

## **INSTALLATION**

### **LOWER INTAKE MANIFOLD**

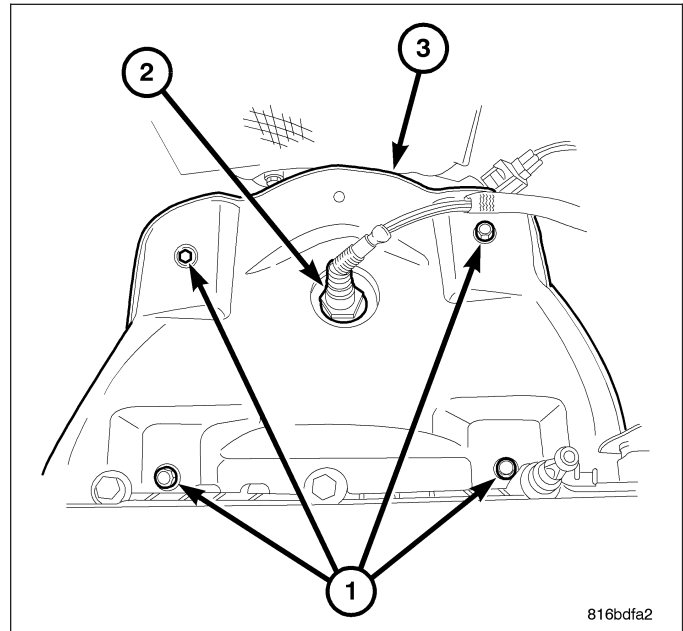
1. Clean all gasket surfaces.
2. Replace intake manifold gasket.
3. Install intake manifold, torque bolts to 25 N·m (220 in. lbs.).
4. Install the fuel rail assembly to intake manifold. Tighten screws to 23 N·m (200 in. lbs.).
5. Connect fuel injector electrical connectors.
6. Inspect quick connect fittings for damage, replace if necessary (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/ QUICK CONNECT FITTING - STANDARD PROCEDURE). Connect fuel supply hose to fuel rail assembly. Check connection by pulling on connector to insure it locked into position.
7. Connect negative cable to battery.
8. Fill the cooling system (Refer to 7 - COOLING/ENGINE - STANDARD PROCEDURE).



## MANIFOLD-EXHAUST

### REMOVAL

1. Remove engine cover.
2. Remove clean air hose and air cleaner housing.
3. Disconnect negative cable from battery.
4. Disconnect throttle and speed control cables from the throttle lever and bracket.
5. Disconnect MAP sensor electrical connector.
6. Remove fasteners securing power steering fluid reservoir to cylinder head.
7. Remove coolant recovery container (Refer to 7 - COOLING/ENGINE/COOLANT RECOVERY CONTAINER - REMOVAL).
8. Remove bolts attaching upper heat shield.
9. Remove upper heat shield.
10. Raise vehicle.
11. Disconnect exhaust pipe from manifold.
12. Remove engine wiring heat shield.
13. Remove manifold support bracket.
14. Remove lower exhaust manifold heat shield.
15. Disconnect oxygen sensor electrical connector.
16. Remove exhaust manifold lower retaining fasteners.
17. Lower vehicle and remove the upper exhaust manifold retaining fasteners.
18. Remove exhaust manifold from above/between the engine and cowl panel.
19. Remove and discard manifold gasket.
20. Mark prop shaft and differential for proper installation (if equipped).
21. Remove the rear prop shaft (if equipped) (Refer to 3 - DIFFERENTIAL & DRIVELINE/PROPELLER SHAFT - REMOVAL).
22. Remove the two exhaust to maniverter (exhaust manifold with catalytic converter) bolts.
23. Unplug the down - stream O2 sensor connector.
24. Remove the exhaust system (Refer to 11 - EXHAUST SYSTEM/MUFFLER - REMOVAL).
25. Lower the vehicle on the hoist.
26. Unplug the up - stream O2 sensor connector.
27. Remove up - stream O2 sensor from the maniverter (exhaust manifold with catalytic converter) using o2 sensor socket 8439 (2).
28. Remove the four maniverter heat shield bolts (1).
29. Remove the two retaining bolts and one nut from the maniverter side heat shield (3).
30. Remove the seven maniverter to head retaining bolts.
31. Slide the maniverter up and to the right, The support the maniverter (1) with the help of a bungie cord.
32. Raise the vehicle on the hoist.
33. Remove the four (1) engine to maniverter bracket bolts.
34. Remove the rear engine mount through bolt (2).
35. Remove the three front engine mount to frame bolts and the mount through bolt.
36. Remove the PTU mounting bolts.
37. Install a screw jack (2) on front engine mount bracket (1).
38. Raise the front of the engine until the rear mount has dropped (1,2).
39. Separate the PTU from the transaxle.



40. Remove and discard old O-ring between Transmission and PTU
41. Roll the PTU (1) forward and down to remove.

## CLEANING

1. Discard gasket (if equipped) and clean all surfaces of manifold and cylinder head.

## INSPECTION

1. Inspect manifold gasket surfaces for flatness with straight edge. Surface must be flat within 0.15 mm per 300 mm (0.006 in. per foot) of manifold length.
2. Inspect manifolds for cracks or distortion. Replace manifold as necessary.

## INSTALLATION

1. Install a new exhaust manifold gasket. **DO NOT APPLY SEALER.**
2. Position exhaust manifold in place. Tighten fasteners, starting at center and progressing outward in both directions to 23 N·m (200 in. lbs.). Raise and lower vehicle for fastener access as necessary. Repeat tightening procedure until all fasteners are at specified torque.
3. Install exhaust manifold heat shields. Tighten bolts to 12 N·m (105 in. lbs.).
4. Install exhaust manifold support bracket.
5. Install engine wiring heat shield.
6. Connect oxygen sensor electrical connector.
7. Install exhaust pipe to manifold. Tighten fasteners to 28 N·m (250 in. lbs.).
8. Install coolant recovery container (Refer to 7 - COOLING/ENGINE/COOLANT RECOVERY CONTAINER - INSTALLATION).
9. Install fasteners securing power steering fluid reservoir to cylinder head.
10. Connect MAP sensor electrical connector.
11. Connect throttle and speed control cables to the throttle lever and bracket.
12. Connect negative cable to battery.
13. Install clean air hose and air cleaner housing.
14. Roll the PTU in moving from front to back.
15. Rest the PTU on the frame while the engine and transaxle are raised back into position.
16. Lower screw jack until rear mount through bolt can be installed.
17. Install rear mount through bolt and torque bolt to 75 Nm (55 ft. lbs.).
18. Install the transmission crossmember and bolts, torque to 75 Nm (55 ft. lbs.).
19. Install the through bolt at the front transmission mount and torque to 75 Nm (55 ft. lbs.).
20. Insure that the O-ring between the PTU and transaxle is in place.
21. Slide the PTU into place.
22. Install and torque PTU mounting bolts to 58 N·m (43 lbf-ft).
23. Lower the hoist.
24. Place the maniverter back into place and install the seven bolts.
25. Torque the maniverter bolts.
26. Install the maniverter side heat shield into place.
27. Install the two retaining bolts and one retaining nut.
28. Install the maniverter heat shield and the four retaining bolts.
29. Torque the maniverter heat shield bolts.
30. Using tool 8439 install the O2 sensor.
31. Install the air box.
32. Install engine trim cover.
33. Raise the vehicle on the hoist.
34. Install the maniverter to block bracket and four mounting bolts.

35. Torque maniverter to block bracket mounting bolts.
36. Install the exhaust system (Refer to 11 - EXHAUST SYSTEM/MUFFLER - INSTALLATION).
37. Install the Prop shaft (Refer to 3 - DIFFERENTIAL & DRIVELINE/PROPELLER SHAFT - INSTALLATION).
38. install the right axle shaft (Refer to 3 - DIFFERENTIAL & DRIVELINE/HALF SHAFT - INSTALLATION).
39. Install the right front tire.
40. Fill PTU. (Refer to 21 - TRANSMISSION/TRANSAXLE/POWER TRANSFER UNIT - STANDARD PROCEDURE).
41. lower hoist
42. Connect battery cables.
43. Top off the fluids.

## VALVE TIMING

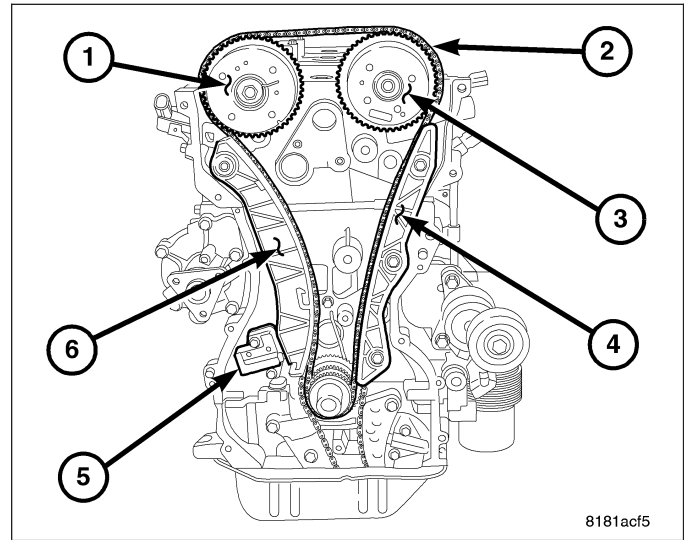
### DESCRIPTION

The timing drive system consists of the following:

- Timing Chain (2)
- Camshaft Sprockets (1,3)
- Crankshaft Sprocket
- Right Timing Chain Guide (Moveable) (6)
- Left Timing Chain Guide (Fixed) (4)
- Timing Chain Tensioner (5)

The camshaft sprockets are attached to the cam phasers which are attached to the front of the camshafts and is used with the timing chain and crankshaft sprocket to turn the camshafts. The camshaft position sensors target is part of the camshafts and is used with the camshaft position sensors to provide the PCM with valvetrain position information.

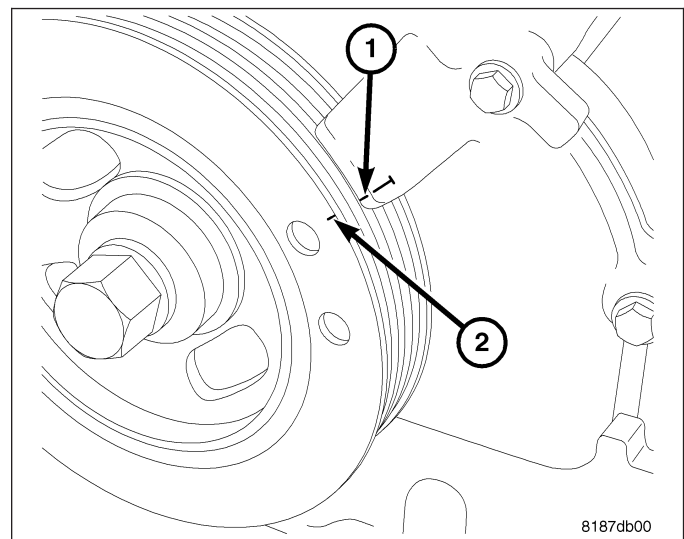
The timing chain tensioner is installed in the right side of the engine block. Using engine oil pressure, the tensioner applies constant pressure to the right side (movable) timing chain guide, which in turn applies pressure to the timing chain. Also as the tensioner extends, it ratchet locks in position to provide constant timing chain tension.



### STANDARD PROCEDURE

#### VALVE TIMING VERIFICATION

1. Remove engine cover.
2. Remove cylinder head cover (Refer to 9 - ENGINE/ CYLINDER HEAD/CYLINDER HEAD COVER - REMOVAL).
3. Set engine to TDC.
4. Using a dial indicator, set number one cylinder to TDC on the compression stroke.
5. The mark on the camshaft sprocket should be in line with the cylinder head cover sealing surface.
6. Using a suitable light, look down into the timing chain cavity at the crankshaft sprocket. A paint mark on the crankshaft sprocket should align with the edge of the engine block boss indicated in.
7. Install cylinder head cover (Refer to 9 - ENGINE/ CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).



## COVER-TIMING CHAIN

### REMOVAL

1. Remove engine cover.
2. Perform fuel pressure bleed procedure.
3. Remove air cleaner housing (Refer to 9 - ENGINE/AIR INTAKE SYSTEM/AIR CLEANER HOUSING - REMOVAL).
4. Disconnect negative battery cable.
5. Drain cooling system
6. Remove coolant recovery bottle.
7. Remove windshield washer bottle.
8. Remove power steering reservoir and set aside.
9. Remove make up air hose.
10. Remove PCV hose.
11. Disconnect ignition coil electrical connectors.
12. Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).
13. Raise vehicle.
14. Remove right lower splash shield.
15. Set engine to TDC.
16. Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
17. Remove lower A/C compressor retaining bolts.
18. Remove A/C compressor lower bracket.
19. Remove accessory drive belt lower idler pulley.
20. Remove crankshaft pulley.
21. Remove water pump pulley.
22. Remove timing chain cover lower bolts.
23. Lower vehicle.
24. Remove power steering pump and set aside.
25. Support engine with a suitable jack.
26. Remove right engine mount.
27. Remove accessory drive belt upper idler pulley.
28. Remove right engine mount bracket.
29. Remove accessory drive belt tensioner.
30. Remove timing chain cover upper retaining bolts.
31. Remove timing chain cover.

### INSTALLATION

1. Clean all sealing surfaces.
2. Apply RTV as shown at the cylinder head to block parting line.
3. Apply RTV as shown in the corner of the oil pan and block.
4. Apply 2mm bead of RTV as shown.
5. Install timing chain cover.
6. Install timing chain cover upper retaining bolts and torque bolts.
7. Install accessory drive belt tensioner.
8. Install right engine mount bracket and torque.
9. Install accessory drive belt upper idler pulley.
10. Install right engine mount and torque bolts.

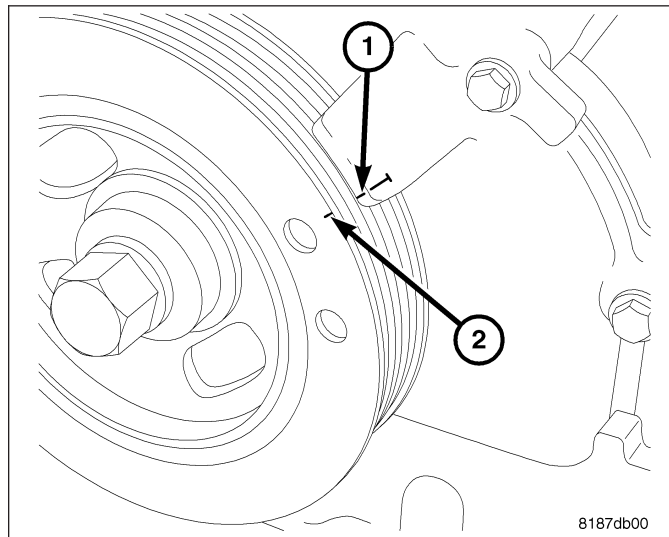
11. Remove jack from under engine.
12. Install power steering pump.
13. Raise vehicle.
14. Install timing chain cover lower retaining bolts and torque bolts.
15. Install oil pan to timing chain cover lower retaining bolts and torque bolts.
16. Install water pump pulley.
17. Install crankshaft pulley and torque bolt.
18. Install accessory drive belt lower idler pulley.
19. Install lower A/C compressor mounting bracket.
20. Install A/C compressor.
21. Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).
22. Install right lower splash shield.
23. Lower vehicle.
24. Install cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION)
25. Connect coil electrical connector,
26. Connect PCV hose to PCV valve.
27. Connect make up air hose.
28. Install power steering reservoir.
29. Install windshield washer bottle.
30. Install coolant recovery bottle.
31. Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).
32. Connect negative battery cable.
33. Install air cleaner housing (Refer to 9 - ENGINE/AIR INTAKE SYSTEM/AIR CLEANER HOUSING - INSTALLATION).
34. Install engine cover.

## CHAIN AND SPROCKETS-TIMING

### REMOVAL

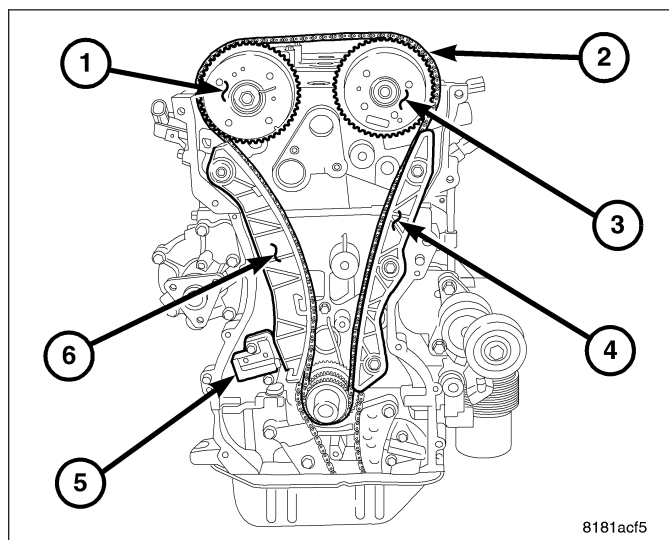
#### TIMING CHAIN

1. Perform fuel pressure bleed procedure.
2. Remove air cleaner housing.
3. Set engine to TDC.
4. Remove timing chain cover (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).



**NOTE:** If the timing chain plated links can no longer be seen, the timing chain links corresponding the timing marks must be marked prior to removal if the chain is to be reused.

5. Remove timing chain tensioner (5) (Refer to 9 - ENGINE/VALVE TIMING/TMNG BELT/CHAIN TENSIONER&PULLEY - REMOVAL).
6. Remove timing chain (2).

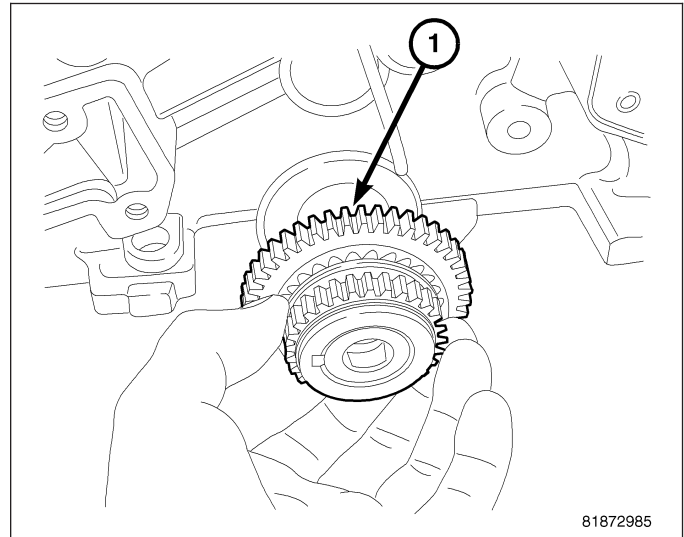


#### CAMSHAFT SPROCKET(S)

Refer to camshaft phasor removal (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - REMOVAL).

## CRANKSHAFT SPROCKET

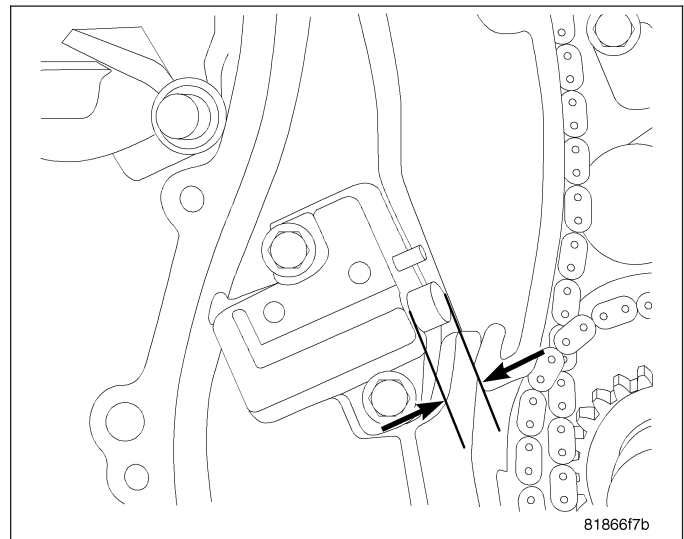
1. Remove timing chain (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).
2. Remove oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).
3. Remove oil pump drive chain tensioner.
4. Remove oil pump drive chain.
5. Remove crankshaft sprocket (1).



## INSPECTION

Inspect timing chain for stretching prior to removal.

1. Rotate engine while watching timing chain tensioner plunger. When the plunger reaches its maximum travel stop rotating engine.
2. Measure the distance from the tensioner body and the edge of the chain guide as shown.
3. If the distance is greater than 20.5 mm (0.81 in.) inspect guide shoes for excessive wear.
4. If guides are okay, replace timing chain.

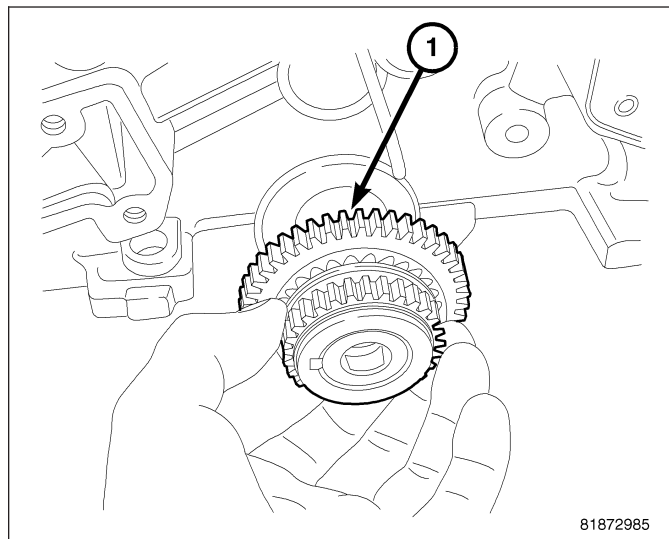




## INSTALLATION

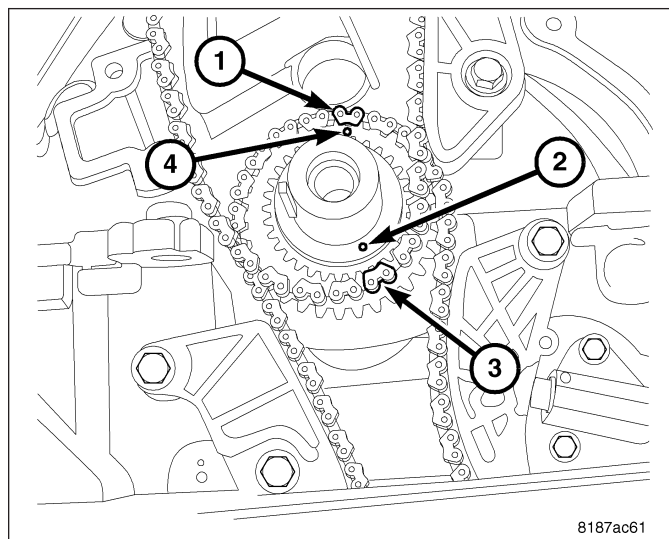
### CRANKSHAFT SPROCKET

1. Install crankshaft sprocket (1) onto crankshaft.
2. Install oil pump drive chain. Verify that Oil pump is correctly timed.
3. Reset oil pump drive chain tensioner by pushing plunger inward and install Tensioner Pin 8514.
4. Install oil pump drive chain tensioner and remove Tensioner Pin 8514.
5. Install timing chain (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).
6. Install oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).
7. Fill engine with oil (Refer to 9 - ENGINE/LUBRICATION/OIL - STANDARD PROCEDURE).
8. Start engine and check for leaks.

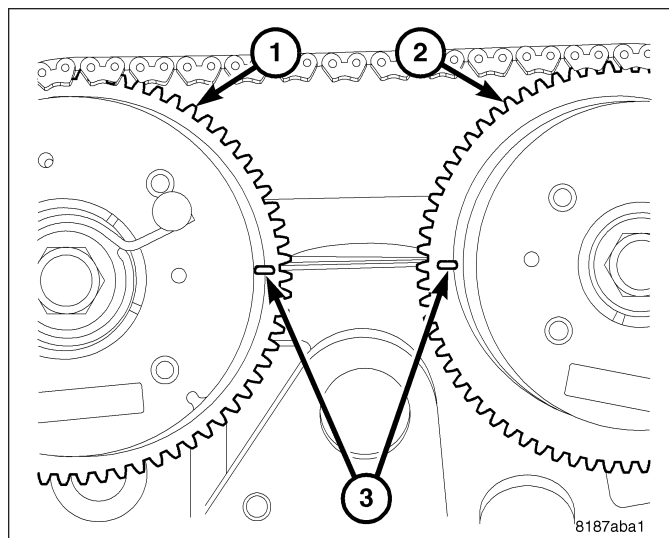


### TIMING CHAIN

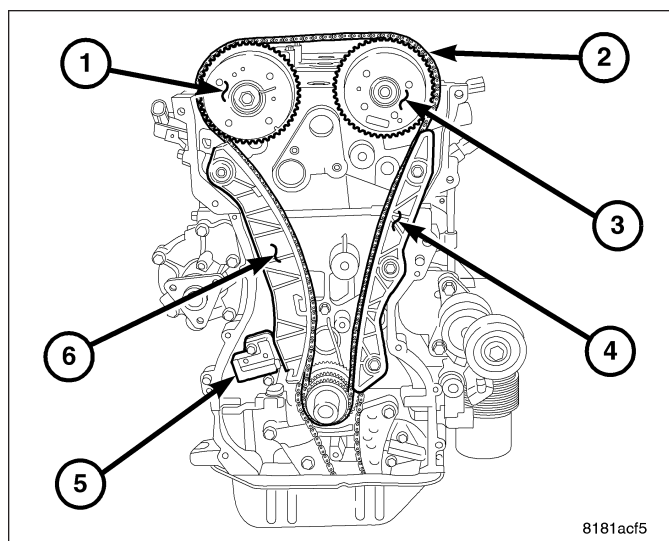
1. Verify that the crankshaft sprocket keyway is at the 9 o'clock position.



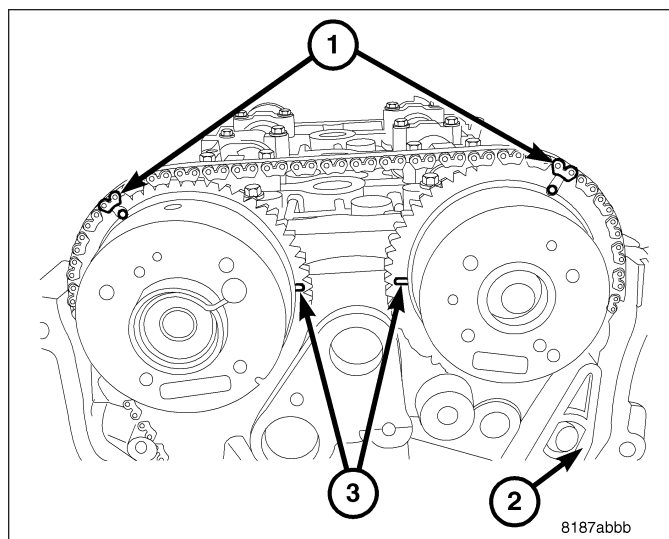
2. Align camshaft timing marks (3) so they are parallel to the cylinder head as shown.



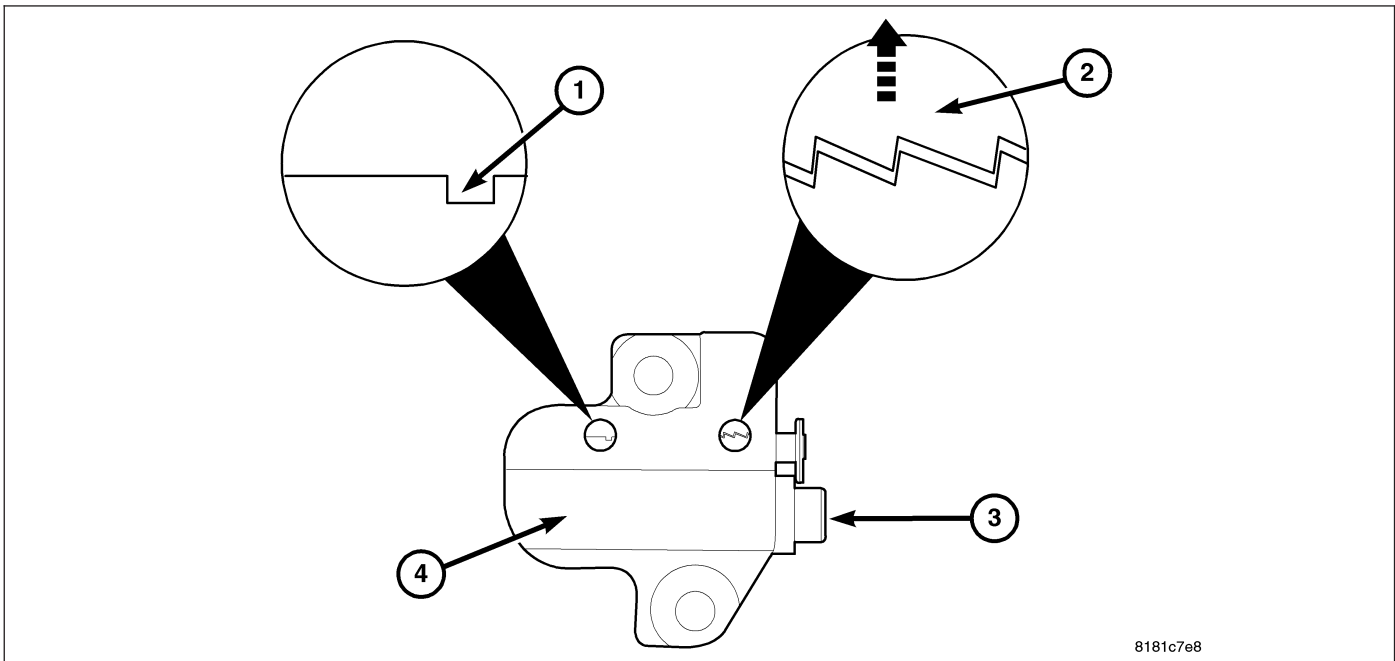
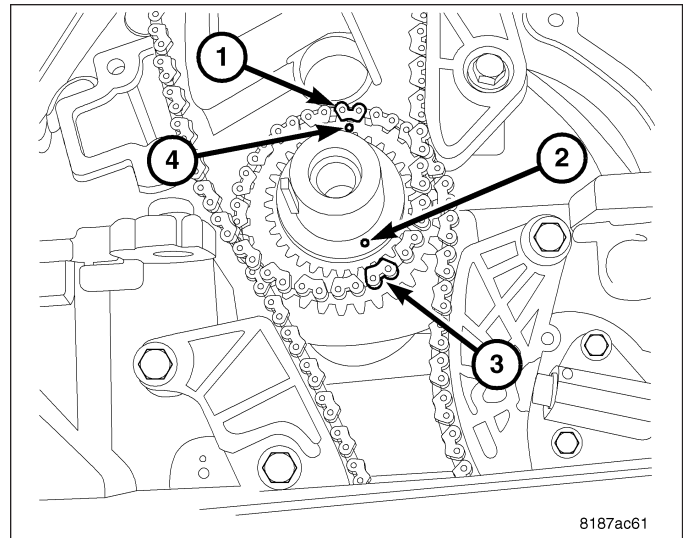
3. Install timing chain guide (4) and torque bolts.



4. Install timing chain so plated links on chain align with timing marks on camshaft sprockets (1).

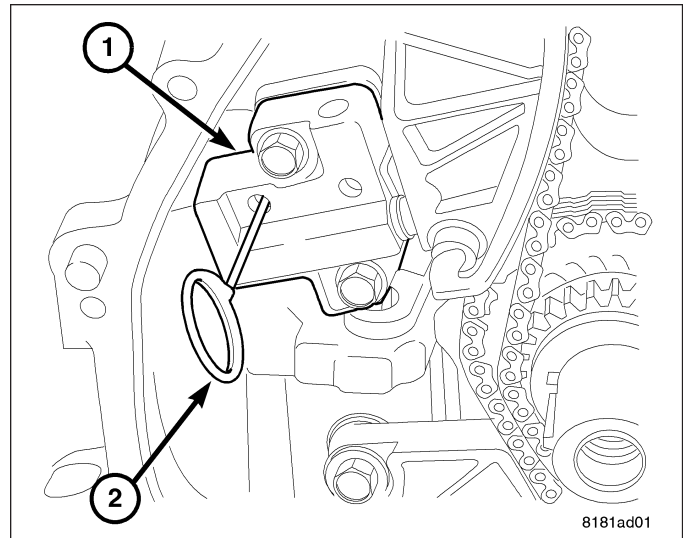


5. Align timing mark on the crankshaft sprocket (2) with the plated link (3) on the timing chain. Position chain so slack will be on the tensioner side.



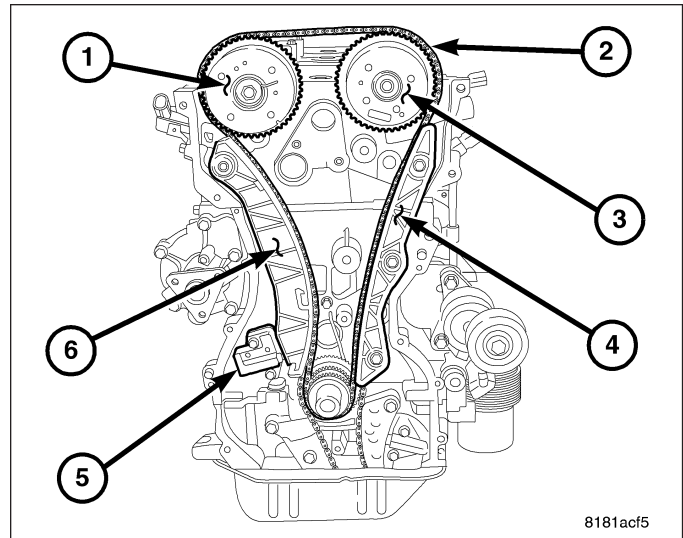
6. Reset timing chain tensioner (4) by lifting up on ratchet (2) and pushing plunger (3) inward towards the tensioner body (4). Insert tensioner pin 8514 into slot (1) to hold tensioner plunger in the retracted position.

7. Install timing chain tensioner (1) and torque bolts to 12 N·m (105 in. lbs.).

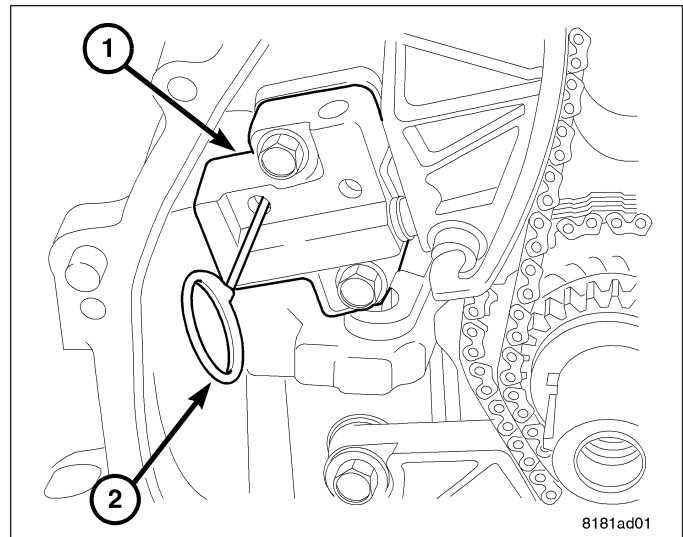


**NOTE:** Keep the slack in the timing chain on the tensioner side.

8. Install the moveable timing chain pivot guide (6) and torque bolt to 12 N·m (105 in. lbs.).



9. Remove timing tensioner pin 8514 (2).
10. Rotate the crankshaft CLOCKWISE two complete revolutions until the crankshaft is repositioned at the TDC position. Verify that the camshaft and crankshaft timing marks are in proper position.
11. Install front timing chain cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).
12. Connect negative battery cable.
13. Fill with oil, start engine and check for leaks.



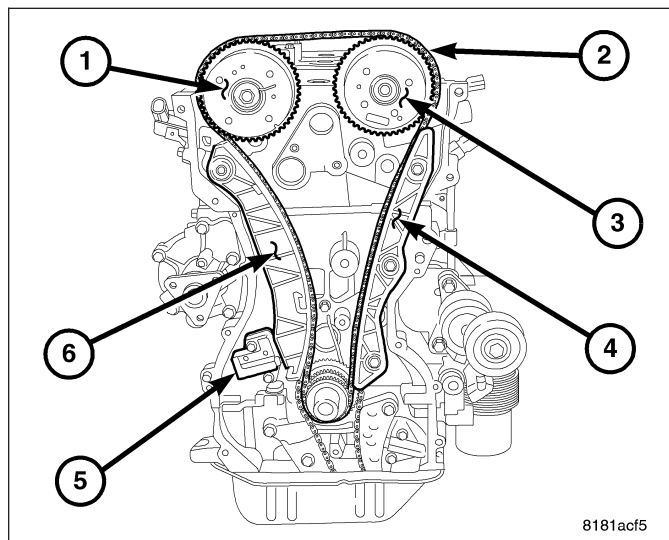
## TIMING-CHAIN TENSIONER

### REMOVAL

1. Remove timing chain (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - REMOVAL).

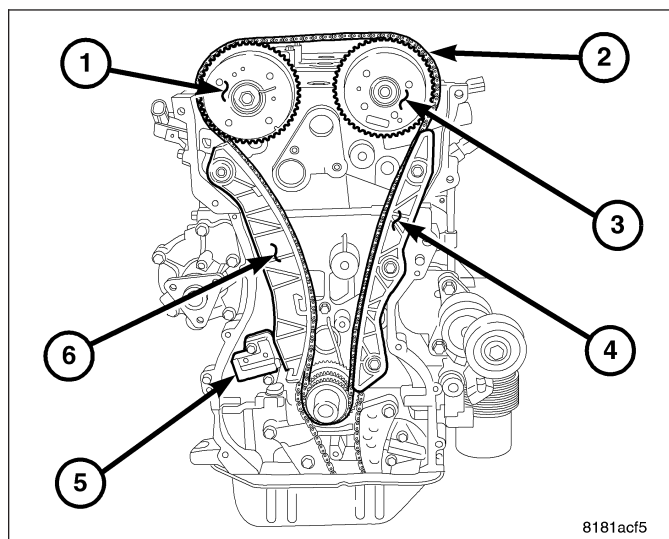
**NOTE:** Tensioner will not come apart during removal.

2. Remove timing chain tensioner retaining bolts and remove tensioner.



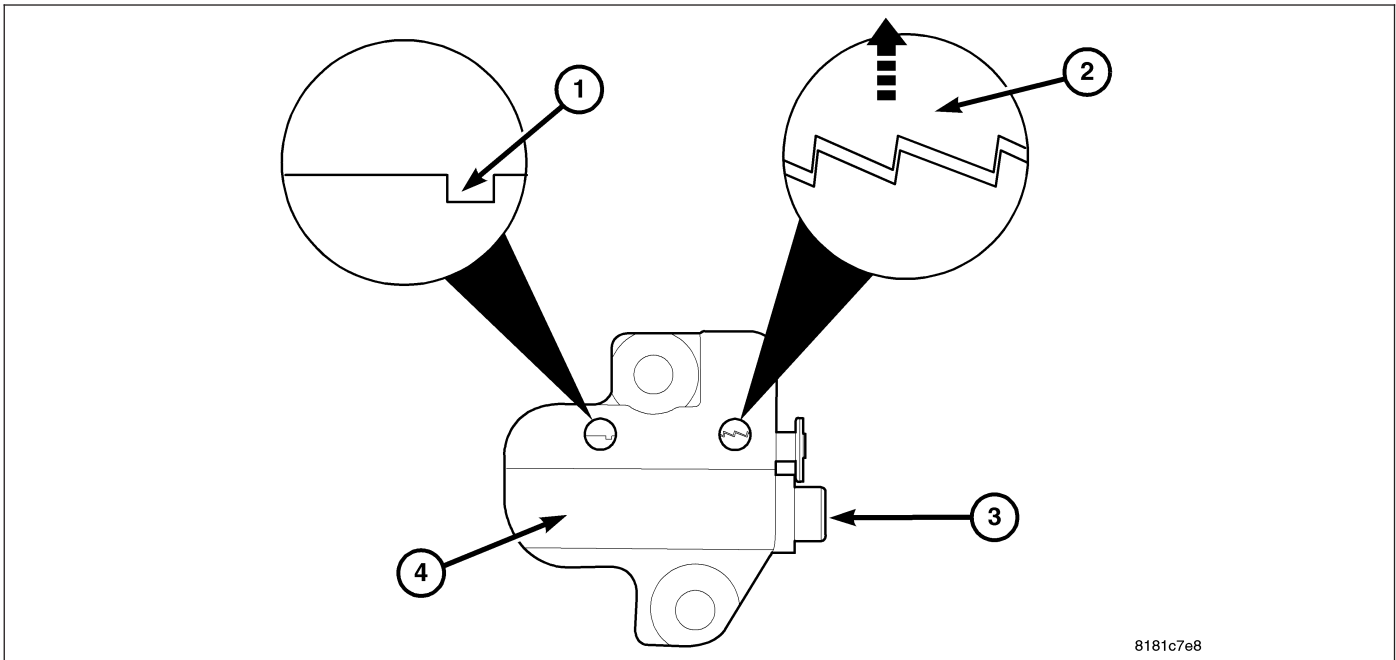
### INSTALLATION

1. Reset tensioner.
2. Install timing chain (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT/CHAIN AND SPROCKETS - INSTALLATION).



## ADJUSTMENTS

### ADJUSTMENT



1. Raise ratchet (2) with small screw driver.
2. Push plunger (3) towards tensioner body (4).
3. Insert tensioner pin 8514 into slot (1). This will hold the tensioner in the retracted position.