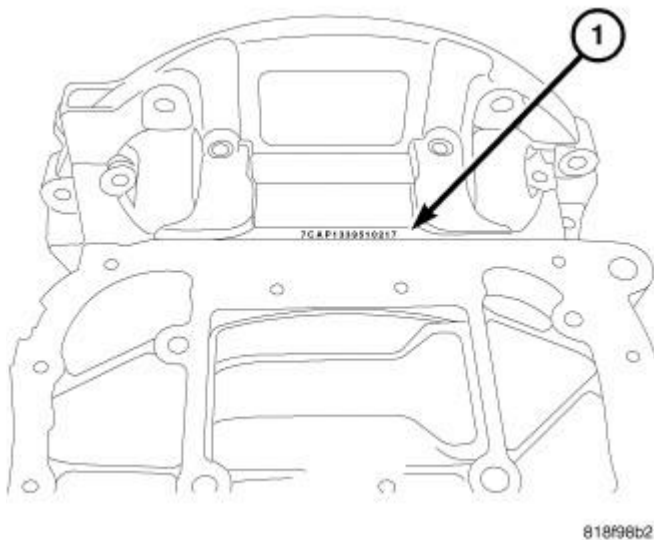


**2011 ENGINE****2.4L - Service Information - 200 & Avenger****DESCRIPTION****DESCRIPTION**

The 2.4 Liter (148 cu. in.) in-line four cylinder engine is a double over head camshaft design with mechanical lash tappets 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.



**Fig. 1: Engine Serial Number**  
Courtesy of CHRYSLER LLC

The engine serial number (1) is located on the rear of the cylinder block behind the oil pan. The serial number is visible with the oil pan in place. The serial number contains engine build date information.

**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 **MECHANICAL** and **PERFORMANCE**.

For fuel system diagnosis. Refer to **FUEL SYSTEM** article.

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. Refer to **CYLINDER COMPRESSION PRESSURE TEST**.
- Cylinder Combustion Pressure Leakage Test. Refer to **CYLINDER COMBUSTION PRESSURE LEAKAGE TEST**.
- Engine Cylinder Head Gasket Failure Diagnosis. Refer to **DIAGNOSIS AND TESTING - CYLINDER HEAD GASKET**.
- Intake Manifold Leakage Diagnosis. Refer to **DIAGNOSIS AND TESTING - INTAKE MANIFOLD LEAKS**.
- Mechanical Valve Tappet Noise Diagnosis. Refer to **DIAGNOSIS AND TESTING - MECHANICAL VALVE TAPPET NOISE DIAGNOSIS**.
- Engine Oil Leak Inspection. Refer to **ENGINE OIL LEAK INSPECTION**.

## PERFORMANCE

| CONDITION                    | POSSIBLE CAUSE                            | CORRECTION                                                                                      |
|------------------------------|-------------------------------------------|-------------------------------------------------------------------------------------------------|
| ENGINE WILL NOT START        | 1. Weak battery.                          | 1. Test battery. Charge or replace as necessary. Refer to <b><u>DIAGNOSIS AND TESTING</u></b> . |
|                              | 2. Corroded or loose battery connections. | 2. Clean and tighten battery connections. Apply a coat of light mineral grease to terminals.    |
|                              | 3. Faulty starter.                        | 3. Test starting system. Check for codes. (Refer to Appropriate Diagnostic Information)         |
|                              | 4. Faulty coil(s) or control unit.        | 4. Test and replace as needed. (Refer to Appropriate Diagnostic Information)                    |
|                              | 5. Incorrect spark plug gap.              | 5. Set gap. Refer to <b><u>SPECIFICATIONS</u></b> .                                             |
|                              | 6. Contamination in fuel system.          | 6. Clean system and replace fuel filter.                                                        |
|                              | 7. Faulty fuel pump.                      | 7. Test fuel pump and replace as needed. (Refer to Appropriate Diagnostic Information)          |
|                              | 8. Incorrect engine timing.               | 8. Check for a skipped timing belt/chain.                                                       |
| ENGINE STALLS OR IDLES ROUGH | 1. Idle speed too low.                    | 1. Test minimum air flow. (Refer to Appropriate Diagnostic Information)                         |

## 2011 Chrysler 200 Limited

2011 ENGINE 2.4L - Service Information - 200 & Avenger

|                               |                                              |                                                                                                               |
|-------------------------------|----------------------------------------------|---------------------------------------------------------------------------------------------------------------|
|                               | 2. Incorrect fuel mixture.                   | 2. (Refer to Appropriate Diagnostic Information)                                                              |
|                               | 3. Intake manifold leakage.                  | 3. Inspect intake manifold, manifold gasket, and vacuum hoses.                                                |
|                               | 4. Faulty ignition coil(s).                  | 4. Test and replace as necessary. (Refer to Appropriate Diagnostic Information)                               |
|                               | 5. Contamination in Oil Control Valve (OCV). | 5. Remove OCV and inspect for contamination. Replace OCV if contaminated.                                     |
| ENGINE LOSS OF POWER          | 1. Dirty or incorrectly gapped plugs.        | 1. Clean plugs and set gap.                                                                                   |
|                               | 2. Contamination in fuel system.             | 2. Clean system and replace fuel filter.                                                                      |
|                               | 3. Faulty fuel pump.                         | 3. Test and replace as necessary. (Refer to Appropriate Diagnostic Information)                               |
|                               | 4. Incorrect valve timing.                   | 4. Correct valve timing.                                                                                      |
|                               | 5. Leaking cylinder head gasket.             | 5. Replace cylinder head gasket.                                                                              |
|                               | 6. Low compression.                          | 6. Test compression of each cylinder.                                                                         |
|                               | 7. Burned, warped, or pitted valves.         | 7. Replace valves.                                                                                            |
|                               | 8. Plugged or restricted exhaust system.     | 8. Perform exhaust restriction test. Install new parts, as necessary. Refer to <b>DIAGNOSIS AND TESTING</b> . |
|                               | 9. Faulty ignition coil(s).                  | 9. Test and replace as necessary. (Refer to Appropriate Diagnostic Information)                               |
| ENGINE MISSES ON ACCELERATION | 1. Dirty or incorrectly gapped spark plugs.  | 1. Clean spark plugs and set gap.                                                                             |
|                               | 2. Contamination in Fuel System.             | 2. Clean fuel system and replace fuel filter.                                                                 |
|                               | 3. Burned, warped, or pitted valves.         | 3. Replace valves.                                                                                            |
|                               | 4. Faulty ignition coil(s).                  | 4. Test and replace as necessary. (Refer to Appropriate Diagnostic Information)                               |
| ENGINE MISSES AT HIGH SPEED   | 1. Dirty or incorrect spark plug gap.        | 1. Clean spark plugs and set gap.                                                                             |
|                               | 2. Faulty ignition coil(s).                  | 2. Test and replace as necessary. (Refer to Appropriate Diagnostic Information)                               |
|                               | 3. Dirty fuel injector(s).                   | 3. Test and replace as necessary. (Refer to Appropriate Diagnostic Information)                               |

## 2011 Chrysler 200 Limited

2011 ENGINE 2.4L - Service Information - 200 & Avenger

|                                  |                                          |
|----------------------------------|------------------------------------------|
|                                  | Information)                             |
| 4. Contamination in fuel system. | 4. Clean system and replace fuel filter. |

### MECHANICAL

| CONDITION            | POSSIBLE CAUSES                                    | CORRECTION                                                           |
|----------------------|----------------------------------------------------|----------------------------------------------------------------------|
| VALVETRAIN NOISE     | 1. High or low oil level in crankcase.             | 1. Check and correct engine oil level.                               |
|                      | 2. Thin or diluted oil.                            | 2. Change oil to correct viscosity.                                  |
|                      | 3. Thick oil                                       | 3. (a) Change engine oil and filter.                                 |
|                      |                                                    | (b) Run engine to operating temperature.                             |
|                      |                                                    | (c) Change engine oil and filter again.                              |
|                      | 4. Low oil pressure.                               | 4. (a) Check and correct engine oil level.                           |
|                      |                                                    | (b) Check pressure regulating valve.                                 |
|                      | 5. Worn cam lobe.                                  | 5. Install new camshaft.                                             |
|                      | 6. Worn tappet bucket.                             | 6. Install new select fit tappet bucket.                             |
|                      | 7. Worn valve guides.                              | 7. Replace cylinder head.                                            |
|                      | 8. Excessive runout of valve seats on valve faces. | 8. Grind valve seats and replace valves.                             |
| CONNECTING ROD NOISE | 1. Insufficient oil supply.                        | 1. Check engine oil level.                                           |
|                      | 2. Low oil pressure.                               | 2. Check engine oil level. Inspect oil pump relief valve and spring. |
|                      | 3. Thin or diluted oil.                            | 3. Change oil to correct viscosity.                                  |
|                      | 4. Thick oil                                       | 4. (a) Change engine oil and filter.                                 |
|                      |                                                    | (b) Run engine to operating temperature.                             |
|                      |                                                    | (c) Change engine oil and filter again.                              |
|                      | 5. Excessive bearing clearance.                    | 5. Measure bearings for correct clearance. Repair as necessary.      |
|                      | 6. Connecting rod journal out-of-round.            | 6. Replace crankshaft or grind surface.                              |
| MAIN BEARING NOISE   | 7. Connecting rod out-of-round.                    | 7. Replace connecting rod.                                           |
|                      | 8. Misaligned connecting rods.                     | 8. Replace bent connecting rods.                                     |
|                      | 1. Insufficient oil supply.                        | 1. Check engine oil level.                                           |
|                      | 2. Low oil pressure.                               | 2. Check engine oil level. Inspect oil pump relief valve and spring. |

# 2011 Chrysler 200 Limited

2011 ENGINE 2.4L - Service Information - 200 & Avenger

|                                       |                                                     |                                                                                                                                      |
|---------------------------------------|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
|                                       | 3. Thin or diluted oil.                             | 3. Change oil to correct viscosity.                                                                                                  |
|                                       | 4. Thick oil                                        | 4. (a) Change engine oil and filter.                                                                                                 |
|                                       |                                                     | (b) Run engine to operating temperature.                                                                                             |
|                                       |                                                     | (c) Change engine oil and filter again.                                                                                              |
|                                       | 5. Excessive bearing clearance.                     | 5. Measure bearings for correct clearance. Repair as necessary.                                                                      |
|                                       | 6. Excessive end play.                              | 6. Check thrust bearing for wear on flanges.                                                                                         |
|                                       | 7. Crankshaft journal out-of-round or worn.         | 7. Replace crankshaft or grind journals.                                                                                             |
|                                       | 8. Loose flywheel or torque converter.              | 8. Tighten to correct torque.                                                                                                        |
| OIL PRESSURE DROP                     | 1. Low oil level.                                   | 1. Check engine oil level.                                                                                                           |
|                                       | 2. Faulty oil pressure sending unit.                | 2. Install new sending unit.                                                                                                         |
|                                       | 3. Low oil pressure.                                | 3. Check sending unit and main bearing oil clearance.                                                                                |
|                                       | 4. Clogged oil filter.                              | 4. Install new oil filter.                                                                                                           |
|                                       | 5. Worn parts in oil pump.                          | 5. Replace balance shaft module.                                                                                                     |
|                                       | 6. Thin or diluted oil.                             | 6. Change oil to correct viscosity.                                                                                                  |
|                                       | 7. Oil pump relief valve stuck.                     | 7. Remove valve and inspect, clean, or replace.                                                                                      |
|                                       | 8. Excessive bearing clearance.                     | 8. Measure bearings for correct clearance.                                                                                           |
| OIL LEAKS                             | 1. Misaligned or deteriorated gaskets.              | 1. Replace gasket(s).                                                                                                                |
|                                       | 2. Loose fastener, broken or porous metal part.     | 2. Tighten, repair or replace the part.                                                                                              |
|                                       | 3. Misaligned or deteriorated cup or threaded plug. | 3. Replace as necessary.                                                                                                             |
| OIL CONSUMPTION OR SPARK PLUGS FOULED | 1. PCV system malfunction.                          | 1. Check system and repair as necessary. Refer to <b><u>VALVE, POSITIVE CRANKCASE VENTILATION (PCV), DIAGNOSIS AND TESTING</u></b> . |
|                                       | 2. Worn, scuffed or broken rings.                   | 2. Hone cylinder bores. Install new rings.                                                                                           |
|                                       | 3. Carbon in oil ring slots.                        | 3. Install new rings.                                                                                                                |
|                                       | 4. Rings fitted too tightly in grooves.             | 4. Remove rings and check grooves. If groove is not proper width, replace piston.                                                    |
|                                       | 5. Worn valve guide(s).                             | 5. Replace cylinder head.                                                                                                            |
|                                       | 6. Valve stem seal(s) worn or                       | 6. Replace seal(s).                                                                                                                  |

damaged.

## 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.

1. Check the coolant level and fill as required. DO NOT install the pressure cap.
2. Start and operate the engine until it attains normal operating temperature, then turn the engine OFF.
3. Clean spark plug recesses with compressed air.
4. Remove the spark plugs.
5. Remove the oil filler cap.
6. Remove the air cleaner.
7. 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.
8. 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.
9. All gauge pressure indications should be equal, with no more than 25% leakage per cylinder.
10. **FOR EXAMPLE:** At 552 kPa (80 psi) input pressure, a minimum of 414 kPa (60 psi) should be maintained in the cylinder.

## 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 such as fouled, hot, oily, etc. Record cylinder number of spark plug for future reference.
6. Disconnect injector electrical connectors.
7. Install a suitable compression test gauge into the #1 spark plug hole in cylinder head.
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.**

## **OIL CONSUMPTION TEST AND DIAGNOSIS**

### **Diagnostic Procedures**

The following diagnostic procedures are used to determine the source of excessive internal oil Consumption, these procedures and tests apply to vehicles with 50, 000 miles or less.

**NOTE:**        **Engine oil consumption may be greater than normal during engine break-in. Repairs should be delayed until vehicle has been driven at least 7, 500 miles.**

Severe service (high ambient temperature, short trips, heavy loading, trailer towing, taxi, off-road, or law enforcement use) may result in greater oil consumption than normal.

Sustained high speed driving and high engine RPM operation may result in increased oil consumption.

Failure to comply with the recommended oil type and viscosity rating, as outlined in the owner's manual, may impact oil economy as well as fuel economy.

Oil consumption may increase with vehicle age and mileage due to normal engine wear.

**NOTE:**        **Because a few drops of external oil leakage per mile can quickly account for the loss of one quart of oil in a few hundred miles, ensure no external engine oil leaks are present.**

- Oil leakage is not the same as oil consumption and all external leakage must be eliminated before any action can be taken to verify and/or correct oil consumption complaints.
- Verify that the engine has the correct oil level dipstick and dipstick tube installed.
- Verify that the engine is not being run in an overfilled condition. Check the oil level 15 minutes after a hot shutdown with the vehicle parked on a level surface. In no case should the level be above MAX or the FULL mark on the dipstick.

**OIL CONSUMPTION TEST**

1. Check the oil level at least 15 minutes after a hot shutdown.
2. If the oil level is low, top off with the proper viscosity and API service level engine oil. Add one bottle of MOPAR® 4-In-1 Leak Detection Dye into the engine oil.
3. Tamper proof the oil pan drain plug, oil filter, dipstick and oil fill cap.
4. Record the vehicle mileage.
5. Instruct the customer to drive the vehicle as usual.
6. Ask the customer to return to the servicing dealer after accumulating 500 miles, Check the oil level at least 15 minutes after a hot shutdown. If the oil level is half way between the "FULL" and "ADD" mark continue with the next step.
7. Using a black light, re-check for any external engine oil leaks, repair as necessary, if no external engine oil leaks are present, continue with oil consumption diagnosis.

**OIL CONSUMPTION DIAGNOSIS**

1. Check the positive crankcase ventilation (PCV) system. Make sure the system is not restricted and the PCV valve has the correct part number and correct vacuum source (18-20 in. Hg at idle below 3000 ft. above sea level is considered normal).
2. Perform a **CYLINDER COMPRESSION PRESSURE TEST** and **CYLINDER-TO-CYLINDER LEAKAGE TEST** using the standard leak down gauge following manufacturers suggested best practices.

**NOTE:**        **Verify the spark plugs are not oil saturated. If the spark plugs are oil saturated and compression is good it can be assumed the valve seals or valve guides are at fault.**

3. If one or more cylinders have more than 15% leak down further engine tear down and inspection will be required.

**TOP 19 REASONS THAT MAY LEAD TO ENGINE OIL CONSUMPTION****1. Tapered and Out-of-Round Cylinders**

The increased piston clearances permit the pistons to rock in the worn cylinders. While tilted momentarily, an abnormally large volume of oil is permitted to enter on one side of the piston. The rings, also tilted in the cylinder, permit oil to enter on one side. Upon reversal of the piston on each stroke, some of this oil is passed into the combustion chamber.

**2. Distorted Cylinders**

This may be caused by unequal heat distribution or unequal tightening of cylinder head bolts. This condition presents a surface which the rings may not be able to follow completely. In this case, there may be areas where the rings will not remove all of the excess oil. When combustion takes place, this oil will be burned and cause high oil consumption.

### **3. Improper operation of "PCV "system**

The main purpose of the Positive Crankcase Ventilation (PCV) valve is to recirculate blow-by gases back from the crankcase area through the engine to consume unburned hydrocarbons. The PCV system usually has a one way check valve and a make up air source. The system uses rubber hoses that route crankcase blow by gases to the intake manifold. Vacuum within the engine intake manifold pulls the blow by gases out of the crankcase into the combustion chamber along with the regular intake air and fuel mixture.

The PCV system can become clogged with sludge and varnish deposits and trap blow by gases in the crankcase. This degrades the oil, promoting additional formation of deposit material. If left uncorrected, the result is plugged oil rings, oil consumption, rapid ring wear due to sludge buildup, ruptured gaskets and seals due to crankcase pressurization.

### **4. Worn Piston Ring Grooves**

For piston rings to form a good seal, the sides of the ring grooves must be true and flat - not flared or shouldered. Piston rings in tapered or irregular grooves will not seal properly and, consequently, oil will pass around behind the rings into the combustion chamber.

### **5. Worn, Broken or Stuck Piston Rings**

When piston rings are broken, worn or stuck to such an extent that the correct tension and clearances are not maintained, this will allow oil to be drawn into the combustion chamber on the intake stroke and hot gases of combustion to be blown down the cylinder past the piston on the power stroke. All of these conditions will result in burning and carbon build up of the oil on the cylinders, pistons and rings.

### **6. Cracked or Broken Ring Lands**

Cracked or broken ring lands prevent the rings from seating completely on their sides and cause oil pumping. This condition will lead to serious damage to the cylinders as well as complete destruction of the pistons and rings. Cracked or broken ring lands cannot be corrected by any means other than piston replacement.

### **7. Worn Valve Stems and Guides**

When wear has taken place on valve stems and valve guides, the vacuum in the intake manifold will draw oil and oil vapor between the intake valve stems and guides into the intake manifold and then into the cylinder where it will be burned.

### **8. Bent or Misaligned Connecting Rods**

Bent or misaligned connecting rods will not allow the pistons to ride straight in the cylinders. This will prevent the pistons and rings from forming a proper seal with the cylinder walls and promote oil consumption. In addition, it is possible that a bearing in a bent connect rod will not have uniform clearance on the connecting rod wrist pin. Under these conditions, the bearing will wear rapidly and throw off an excessive amount of oil into the cylinder.

**9. Fuel Dilution**

If raw fuel is allowed to enter the lubrication system, the oil will become thinner and more volatile and will result in higher oil consumption. The following conditions will lead to higher oil consumption;

- Excess fuel can enter and mix with the oil via a leaking fuel injector
- Gasoline contaminated with diesel fuel
- Restricted air intake
- Excessive idling

**10. Contaminated Cooling Systems**

Corrosion, rust, scale, sediment or other formations in the water jacket and radiator will prevent a cooling system from extracting heat efficiently. This is likely to cause cylinder distortion thus leading to higher oil consumption.

**11. Oil Viscosity**

The use of oil with a viscosity that is too light may result in high oil consumption. Refer to the vehicle owner's manual for the proper oil viscosity to be used under specific driving conditions and/or ambient temperatures.

**12. Dirty Engine Oil**

Failure to change the oil and filter at proper intervals may cause the oil to be so dirty that it will promote accumulation of sludge and varnish and restrict oil passages in the piston rings and pistons. This will increase oil consumption; dirty oil by nature is also consumed at a higher rate than clean oil.

**13. Crankcase Overfull**

Due to an error in inserting the oil dip stick so that it does not come to a seat on its shoulder, a low reading may be obtained. Additional oil may be added to make the reading appear normal with the stick in this incorrect position which will actually make the oil level too high. If the oil level is so high that the lower ends of the connecting rods touch the oil in the oil pan excessive quantities of oil will be thrown on the cylinder walls and some of it will work its way up into the combustion chamber.

**14. Excessively High Oil Pressure**

A faulty oil pressure relief valve may cause the oil pressure to be too high. The result will be that the engine will be flooded with an abnormally large amount of oil in a manner similar to that which occurs with worn bearings. This condition may also cause the oil filter to burst.

**15. Aftermarket Performance Chips and Modification**

Increasing performance through the use of performance/power enhancement products to a stock or factory engine will increase the chance of excessive oil consumption.

**16. Lugging Engine**

Lugging is running the engine at a lower RPM in a condition where a higher RPM (more power/torque) should be implemented. Especially susceptible on vehicles equipped with a manual transmission. This driving habit causes more stress loading on the piston and can lead to increases in engine oil consumption.

**17. Turbocharged Engines**

There is a possibility for PCV "push-over" due to higher crankcase pressure (as compared to naturally aspirated engines) which is normal for turbocharged engines. This condition causes varying amounts of engine oil to enter the intake manifold, charge air cooler and associated plumbing to and from the charge air cooler, also a leaking turbocharger seal will draw oil into the combustion chamber where it will burn (blue smoke from tail pipe may be present) and form carbon deposits which contribute to further oil consumption as they interfere with proper engine function.

**18. Restricted Air Intake**

Excessive restriction in the air intake system will increase engine vacuum and can increase oil consumption, an extremely dirty air filter would be one example of this situation.

**19. Intake Manifold port seals**

Engines that have a "V" configuration and a "wet valley" (3.3/3.8L) could draw oil into the intake ports due to improper sealing between the intake manifold ports and cylinder head. Causes may include improper torque of intake manifold bolts, corrosion (aluminum intake manifold) and or warped sealing surface.

**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 information procedures.
  - If the leakage occurs at the crankshaft rear oil seal area, refer to INSPECTION FOR REAR SEAL AREA LEAK below.
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 AND 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.
  1. Circular spray pattern generally indicates seal leakage or crankshaft damage.
  2. 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).**

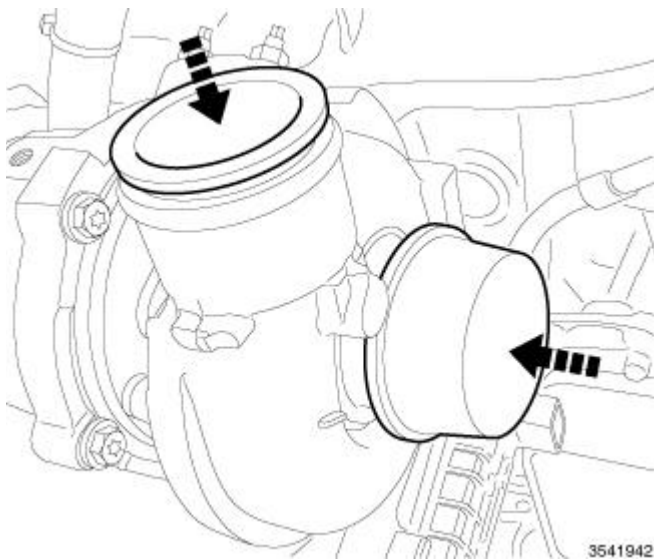
5. If the leak is not detected, very slowly turn the crankshaft and watch for leakage. If a leak is detected between the crankshaft and seal while slowly turning the crankshaft, it is possible the crankshaft seal surface is damaged. The seal area on the crankshaft could have minor nicks or scratches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

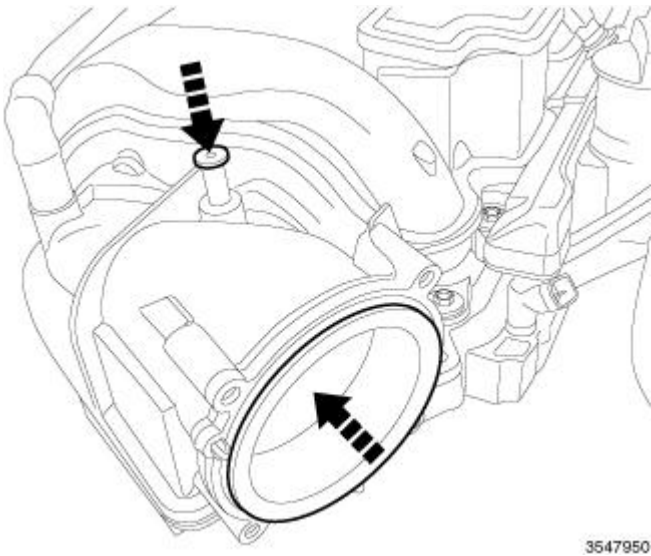
### DUST COVERS AND CAPS



**Fig. 2: Covers/Caps**

Courtesy of CHRYSLER LLC

Due to the high amounts of failures caused by dust, dirt, moisture and other foreign debris being introduced to the engine during service. Covers or caps are needed to reduce the possible damage that can be caused or created.



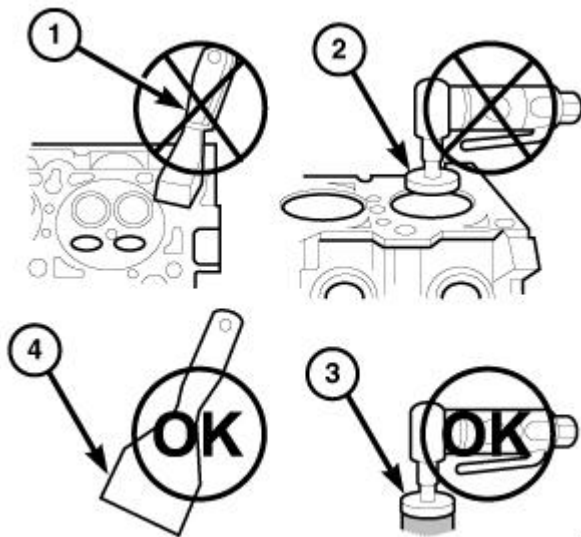
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**Fig. 3: Opening Cover**

Courtesy of CHRYSLER LLC

Covers over openings will reduce any possibilities for foreign materials to enter the engine systems. Using miller tool (special tool #10368, Set, Universal Protective Cap), Select the appropriated cover needed to the procedure.

## ENGINE GASKET SURFACE PREPARATION



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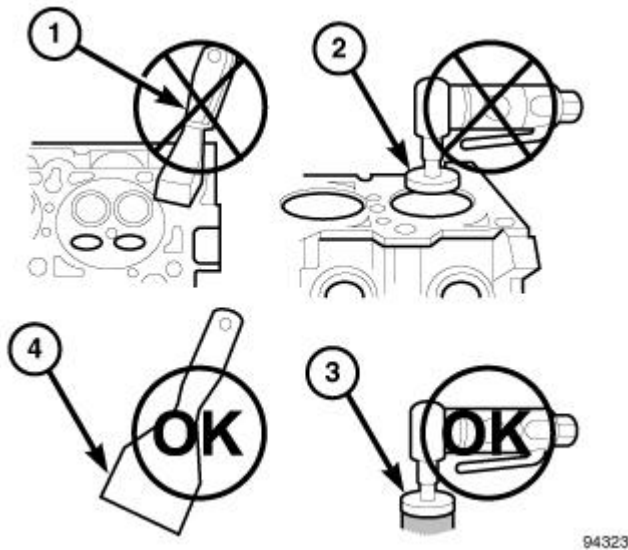
**Fig. 4: Proper Tool Usage For Surface Preparation**

Courtesy of CHRYSLER LLC

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 (1).
- Abrasive pad or paper to clean cylinder block and head.
- High speed power tool with an abrasive pad or a wire brush (2).



**Fig. 5: Proper Tool Usage For Surface Preparation**  
Courtesy of CHRYSLER LLC

**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 (4).
- High speed power tool with a plastic bristle brush style disc.

Sealing surfaces must be free of grease or oil residue. Clean surfaces with Mopar® brake parts cleaner (or equivalent).

## 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

**NOTE:** All of the sealants mentioned below are not used on every engine, they are listed as general reference guide. See service information for specific sealer usage.

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. All sealing surfaces that use form-in-place gaskets and sealers **must** free of grease or oil. Surfaces should be cleaned with Mopar® brake parts cleaner prior to sealer application. After the sealer is applied, the parts should be assembled in no more than 10 minutes.

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 4 oz./16 oz. can w/applicator.

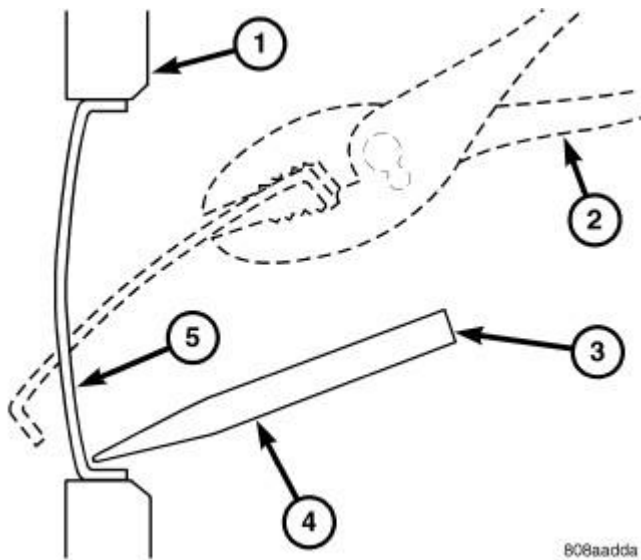
#### **SEALER APPLICATION**

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 and "T" joint locations, 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.

#### **CORE/GALLERY PLUGS**

**CYLINDER HEAD CORE PLUGS**

**Fig. 6: Core Hole Plug Removal**  
Courtesy of CHRYSLER LLC

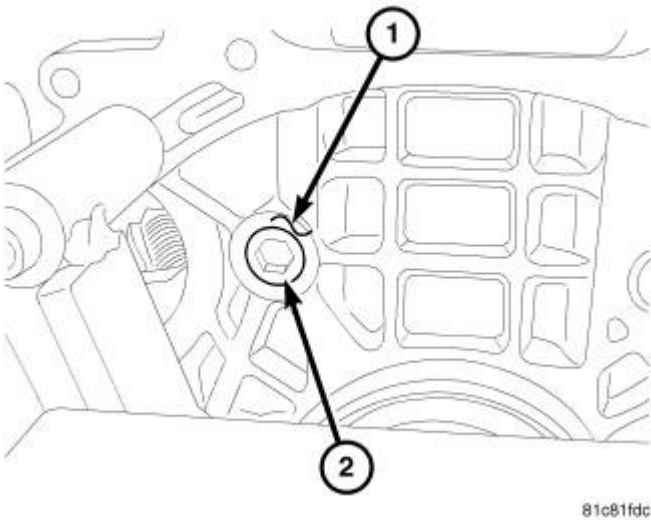
Using a blunt tool (3) such as a drift and a hammer, strike the bottom edge of the cup plug (5). With the cup plug rotated, grasp firmly with pliers or other suitable tool (2) and remove plug (5).

**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 head. Be sure to remove old sealer. Lightly coat inside of cup plug hole with Mopar® Stud and Bearing Mount (or equivalent). 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.

**CYLINDER BLOCK MAIN OIL GALLERY PLUGS**



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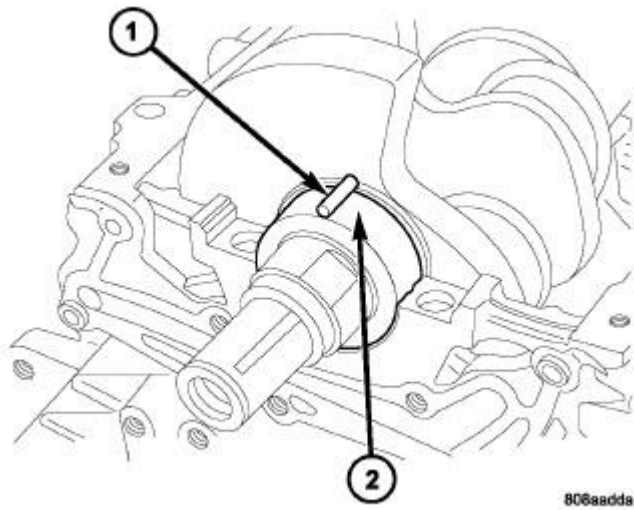
**Fig. 7: Gallery Plug**

Courtesy of CHRYSLER LLC

**CAUTION:** Excessive use of brake parts cleaner to clean threads in block could cause #5 main bearing failure.

1. Use Mopar® Brake Parts Cleaner (or equivalent) sparingly to clean plug and block.
2. Coat plug threads with Mopar® Thread Sealant (or equivalent).
3. Install plug (2). The plug (2) is correctly installed when it is protruding 1 mm to flush with the block boss face (1).

## MEASURING BEARING CLEARANCE USING PLASTIGAGE



808aadda

**Fig. 8: Plastigage Placed In Lower Shell**

## Courtesy of CHRYSLER LLC

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 (1) across the entire width of the journal. (In addition, suspected areas can be checked by placing the Plastigage in the suspected area). Torque the bearing cap 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 scale provided on the package. Locate the band closest to the same width. This band shows the amount of clearance. 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 **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.

## SPECIFICATIONS

### 2.4L ENGINE

#### GENERAL SPECIFICATIONS

| DESCRIPTION                      | SPECIFICATION     |               |
|----------------------------------|-------------------|---------------|
|                                  | Metric            | Standard      |
| Type                             | In-Line OHV, DOHC |               |
| Number of Cylinders              | 4                 |               |
| Firing Order                     | 1-3-4-2           |               |
| Compression Ratio                | 10.5:1            |               |
| Displacement                     | 2.4 Liters        | 146.5 cu. in. |
| Bore                             | 88 mm             | 3.465 in.     |
| Stroke                           | 97 mm             | 3.819 in.     |
| Compression Pressure             | 1172 - 1551 kPa   | 170 - 225 psi |
| Max. Variation Between Cylinders | 25%               |               |

#### CYLINDER BLOCK

CYLINDER BORE DIA

| DESCRIPTION            | SPECIFICATION      |                     |
|------------------------|--------------------|---------------------|
|                        | Metric             | Standard            |
| Material               | Cast Aluminum      |                     |
| Cylinder Bore Diameter |                    |                     |
| A                      | 88.000 - 88.010 mm | 3.4645 - 3.4649 in. |

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|                                         |                    |                     |
|-----------------------------------------|--------------------|---------------------|
| B                                       | 88.010 - 88.020 mm | 3.4649 - 3.4653 in. |
| C                                       | 88.020 - 88.030 mm | 3.4653 - 3.4657 in. |
| Cylinder Bore Out-of-Round (Max.)       | 0.020 mm           | 0.0008 in.          |
| Cylinder Bore Diameter Taper (Max.)     | 0.028 mm           | 0.001 in.           |
| <b>Main Bearing Bore Diameter</b>       |                    |                     |
| 1                                       | 56.000 - 56.006 mm | 2.2047 - 2.2049 in. |
| 2                                       | 56.006 - 56.012 mm | 2.2049 - 2.2051 in. |
| 3                                       | 56.012 - 56.018 mm | 2.2051 - 2.2054 in. |
| Main Bearing Bore Diameter Taper (Max.) | 0.0082 mm          | 0.0003 in.          |

### PISTONS

| DESCRIPTION                    | SPECIFICATION       |                        |
|--------------------------------|---------------------|------------------------|
|                                | Metric              | Standard               |
| <b>Piston Diameter</b>         |                     |                        |
| A                              | 87.995 - 88.015 mm  | 3.4644 - 3.4652 in.    |
| B                              | 88.005 - 88.025 mm  | 3.4648 - 3.4656 in.    |
| C                              | 88.015 - 88.035 mm  | 3.4652 - 3.4659 in.    |
| Clearance to Bore              | (-0.015) - 0.015 mm | (-0.0006) - 0.0006 in. |
| Weight                         | 302 - 312 grams     | 10.65 - 11.00 oz.      |
| Land Clearance (Diametrical)   | 0.60 - 0.73 mm      | 0.0236 - 0.0287 in.    |
| Piston Length                  | 51.5 mm             | 2.028 in.              |
| Piston Ring Groove Depth No. 1 | 3.51 - 3.68 mm      | 0.1382 - 0.0256 in.    |
| Piston Ring Groove Depth No. 2 | 4.05 - 4.25 mm      | 0.1594 - 0.1673 in.    |
| Piston Ring Groove Depth No. 3 | 2.70 - 2.90 mm      | 0.1063 - 0.1142 in.    |

### PISTON RINGS

| DESCRIPTION                           | SPECIFICATION  |                     |
|---------------------------------------|----------------|---------------------|
|                                       | Metric         | Standard            |
| Ring Gap-Top Compression Ring         | 0.15 - 0.30 mm | 0.0059 - 0.0118 in. |
| Wear Limit                            | 0.8 mm         | 0.031 in.           |
| Ring Gap-2nd Compression Ring         | 0.30 - 0.45 mm | 0.0118 - 0.0177 in. |
| Wear Limit                            | 0.8 mm         | 0.031 in.           |
| Ring Gap-Oil Control Steel Rails      | 0.20 - 0.70 mm | 0.0079 - 0.0276 in. |
| Wear Limit                            | 1.0 mm         | 0.039 in.           |
| Ring Side Clearance-Compression Rings | 0.03 - 0.07 mm | 0.1182 - 0.0028 in. |
| Wear Limit                            | 0.10 mm        | 0.004 in.           |
| Ring Side Clearance-Oil Ring Pack     | 0.06 - 0.15 mm | 0.0024 - 0.0059 in. |

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|                                     |                |                     |
|-------------------------------------|----------------|---------------------|
| Ring Width-Top Compression Ring     | 2.95 - 3.25 mm | 0.1161 - 0.1280 in. |
| Ring Width-2nd Compression Ring     | 3.45 - 3.75 mm | 0.1358 - 0.1476 in. |
| Ring Width-Oil Ring Pack            | 2.30 - 2.60 mm | 0.0906 - 0.1024 in. |
| Ring Thickness-Top Compression Ring | 1.17 - 1.19 mm | 0.0461 - 0.0469 in. |
| Ring Thickness-2nd Compression Ring | 1.17 - 1.19 mm | 0.0461 - 0.0469 in. |
| Ring Thickness-Oil Ring Pack        | 1.88 - 1.95 mm | 0.0740 - 0.0768 in. |

### CONNECTING ROD

| DESCRIPTION                  | SPECIFICATION      |                      |
|------------------------------|--------------------|----------------------|
|                              | Metric             | Standard             |
| Bearing Clearance            | 0.032 - 0.060 mm   | 0.0012 - 0.0023 in.  |
| Wear Limit                   | 0.070 mm           | 0.0027 in.           |
| Bore Diameter-Piston Pin     | 20.974 - 20.985 mm | 0.8257 - 0.8261 in.  |
| Bore Diameter-Crankshaft End | 51 - 51.015 mm     | 2.0078 - 2.0084 in.  |
| Side Clearance               | 0.1 - 0.25 mm      | 0.0039 - 0.00098 in. |
| Wear Limit                   | 0.27 mm            | 0.0106 in.           |
| Weight-Total (Less Bearing)  | 484 grams          | 17.07 oz.            |

### CRANKSHAFT

| DESCRIPTION                            | SPECIFICATION      |                     |
|----------------------------------------|--------------------|---------------------|
|                                        | Metric             | Standard            |
| <b>Connecting Rod Journal Diameter</b> |                    |                     |
| <b>Journal Grade</b>                   |                    |                     |
| 1                                      | 47.966 - 47.972 mm | 1.8884 - 1.8886 in. |
| 2                                      | 47.960 - 47.966 mm | 1.8884 - 1.8881 in. |
| 3                                      | 47.954 - 47.960 mm | 1.8879 - 1.8881 in. |
| Rod Journal- Taper (Max)               | 0.005 mm           | 0.0001 in.          |
| <b>Main Bearing Journal Diameter</b>   |                    |                     |
| <b>Journal Grade</b>                   |                    |                     |
| 0                                      | 51.985 - 51.988 mm | 2.0466 - 2.0467 in. |
| 1                                      | 51.982 - 51.985 mm | 2.0465 - 2.0466 in. |
| 2                                      | 51.979 - 51.982 mm | 2.0464 - 2.0465 in. |
| 3                                      | 51.976 - 51.979 mm | 2.0462 - 2.0464 in. |
| 4                                      | 51.973 - 51.976 mm | 2.0461 - 2.0462 in. |
| Journal Out-of-Round (Max.)            | 0.005 mm           | 0.0001 in.          |
| Journal Taper (Max.)                   | 0.006 mm           | 0.0002 in.          |
| End Play                               | 0.05 - 0.25 mm     | 0.0019 - 0.0098 in. |
| Wear Limit                             | 0.30 mm            | 0.0118 in.          |

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|                                          |                  |                     |
|------------------------------------------|------------------|---------------------|
| Main Bearing Diametrical Clearance       | 0.028 - 0.048 mm | 0.0011 - 0.0018 in. |
| Main Bearing Diametrical Clearance (Max) | 0.058 mm         | 0.0022 in.          |

**CYLINDER HEAD CAMSHAFT BEARING BORE DIAMETER**

| DESCRIPTION              | SPECIFICATION      |                     |
|--------------------------|--------------------|---------------------|
|                          | Metric             | Standard            |
| <b>Cam Bearing Bore</b>  |                    |                     |
| Front Intake             | 30.000 - 30.021 mm | 1.1810 - 1.1819 in. |
| Front Exhaust            | 40.000 - 40.024 mm | 1.5747 - 1.5756 in. |
| Cam Bearing Bore No. 1-4 | 24.000 - 24.021 mm | 0.9448 - 0.9457 in. |

**CAMSHAFT**

| DESCRIPTION                                                           | SPECIFICATION      |                     |
|-----------------------------------------------------------------------|--------------------|---------------------|
|                                                                       | Metric             | Standard            |
| Cam Journal Diameter                                                  |                    |                     |
| Front Intake Cam                                                      | 29.964 - 29.980 mm | 1.1797 - 1.1803 in. |
| Front Exhaust Cam                                                     | 35.984 - 36.000 mm | 1.4166 - 1.4173 in. |
| Cam Journal Diameter No. 1-4                                          | 23.954 - 23.970 mm | 0.943 - 0.944 in.   |
| Bearing Clearance - Diametrical                                       |                    |                     |
| Front Intake Journal                                                  | 0.020 - 0.057 mm   | 0.0008 - 0.0022 in. |
| Front Exhaust Journal                                                 | 0.019 - 0.051 mm   | 0.0007 - 0.0020 in. |
| All Others                                                            | 0.020 - 0.067 mm   | 0.0008 - 0.0026 in. |
| End Play                                                              | 0.11 - 0.25 mm     | 0.004 - 0.009 in.   |
| Max Lift @ 0.2 mm (0.007 in.) lash                                    |                    |                     |
| Intake                                                                | 9.2 mm             | 0.362 in.           |
| Max Lift @ 0.28 mm (0.011 in.) lash                                   |                    |                     |
| Exhaust                                                               | 8.42 mm            | 0.331 in.           |
| Intake Valve Timing w/ VVT in lock-pin position*                      |                    |                     |
| Closes (ABDC)                                                         | 49.3°              |                     |
| Opens (ATDC)                                                          | 10.3°              |                     |
| Duration                                                              | 219°               |                     |
| Exhaust Valve Timing w/ VVT in lock-pin position*                     |                    |                     |
| Closes (BTDC)                                                         | 8.45°              |                     |
| Opens (BBDC)                                                          | 45°                |                     |
| Duration                                                              | 216.55°            |                     |
| Valve Overlap @ 0.5 mm (0.019 in.) w/ VVT in lock-pin position        | 18.75°             |                     |
| * All reading in crankshaft degrees at 0.5 mm (0.019 in.) valve lift. |                    |                     |

**CYLINDER HEAD**

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2011 ENGINE 2.4L - Service Information - 200 & Avenger

| DESCRIPTION                   | SPECIFICATION                |                     |
|-------------------------------|------------------------------|---------------------|
|                               | Metric                       | Standard            |
| Material                      | Cast Aluminum - Heat treated |                     |
| Gasket Thickness (Compressed) | 0.54 mm                      | 0.021 in.           |
| Valve Tappet Bore I.D.        | 32.000 - 32.025 mm           | 1.2598 - 1.2608 in. |
| Valve Tappet O.D.             | 31.964 - 31.980 mm           | 1.2584 - 1.2590 in. |

### VALVE SEAT

| DESCRIPTION                   | SPECIFICATION    |                     |
|-------------------------------|------------------|---------------------|
|                               | Metric           | Standard            |
| Angle                         | 44.75° - 45.10°  |                     |
| Seat Outer Diameter - Intake  | 34.45 - 34.61 mm | 1.3562 - 1.3625 in. |
| Seat Outer Diameter - Exhaust | 28.04 - 28.20 mm | 1.1039 - 1.1102 in. |
| Runout (Max.)                 | 0.05 mm          | 0.002 in.           |
| <b>Valve Seat Width</b>       |                  |                     |
| Intake                        | 1.16 - 1.46 mm   | 0.0456 - 0.0574 in. |
| Service Limit                 | 2.0 mm           | 0.079 in.           |
| Exhaust                       | 1.35 - 1.65 mm   | 0.0531 - 0.0649 in. |
| Service Limit                 | 2.5 mm           | 0.098 in.           |

### VALVE GUIDE

| DESCRIPTION                             | SPECIFICATION      |                     |
|-----------------------------------------|--------------------|---------------------|
|                                         | Metric             | Standard            |
| Diameter I.D.                           | 5.500 - 5.518 mm   | 0.2165 - 0.2172 in. |
| Guide Bore Diameter                     | 10.983 - 11.001 mm | 0.432 - 0.4331 in.  |
| Guide Height (spring seat to guide tip) | 14.6 - 15.2 mm     | 0.5748 - 0.5984 in. |

### VALVES

| DESCRIPTION                     | SPECIFICATION    |                     |
|---------------------------------|------------------|---------------------|
|                                 | Metric           | Standard            |
| Face Angle - Intake and Exhaust | 45.25° - 45.75°  |                     |
| Head Diameter - Intake          | 34.9 - 35.1 mm   | 1.374 - 1.3818 in.  |
| Head Diameter - Exhaust         | 28.9 - 29.1 mm   | 1.1377 - 1.1456 in. |
| <b>Valve Lash</b>               |                  |                     |
| Intake                          | 0.17 - 0.23 mm   | 0.006 - 0.009 in.   |
| Exhaust                         | 0.27 - 0.33 mm   | 0.010 - 0.012 in.   |
| <b>Valve Length (Overall)</b>   |                  |                     |
| Intake                          | 113.18 mm        | 4.455 in.           |
| Exhaust                         | 105.887 mm       | 4.168 in.           |
| <b>Valve Stem Diameter</b>      |                  |                     |
| Intake                          | 5.465 - 5.480 mm | 0.2151 - 0.2157 in. |

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|         |                  |                     |
|---------|------------------|---------------------|
| Exhaust | 5.458 - 5.470 mm | 0.2148 - 0.2153 in. |
|---------|------------------|---------------------|

**VALVE MARGIN**

| DESCRIPTION | SPECIFICATION |             |
|-------------|---------------|-------------|
|             | Metric        | Standard    |
| Intake      | 0.672 mm      | 0.0264 in.  |
| Exhaust     | 0.744 mm      | 0.02929 in. |

**VALVE STEM TIP**

| DESCRIPTION | SPECIFICATION |           |
|-------------|---------------|-----------|
|             | Metric        | Standard  |
| Intake      | 48.04 mm      | 1.891 in. |
| Exhaust     | 47.99 mm      | 1.889 in. |

**VALVE STEM TO GUIDE CLEARANCE**

| DESCRIPTION    | SPECIFICATION    |                     |
|----------------|------------------|---------------------|
|                | Metric           | Standard            |
| Intake         | 0.020 - 0.053 mm | 0.0008 - 0.0021 in. |
| Max. Allowable | 0.076 mm         | 0.003 in.           |
| Exhaust        | 0.030 - 0.060 mm | 0.0012 - 0.0024 in. |
| Max. Allowable | 0.101 mm         | 0.004 in.           |

**VALVE SPRINGS**

| DESCRIPTION                  | SPECIFICATION                 |                                        |
|------------------------------|-------------------------------|----------------------------------------|
|                              | Metric                        | Standard                               |
| Free Length (Approx.)        | 47.0 mm                       | 1.850 in.                              |
| Nominal Force (Valve Closed) | 179.5 N $\pm$ 9 @ 35.0 mm     | 40.35 lbs. @ 1.38 in.                  |
| Nominal Force (Valve Open)   | 364.8 N $\pm$ 17 N @ 29.25 mm | 82.01 lbs. $\pm$ 3.82 lbs. @ 1.152 in. |
| Installed Height             | 35.00 mm                      | 1.378 in.                              |
| Number of Coils              | 8.5 $\pm$ 0.1                 |                                        |
| Wire Diameter                | 2.90 mm $\pm$ 0.03            | 0.114 in $\pm$ 0.001 in.               |

**OIL PRESSURE**

| DESCRIPTION                                                                          | SPECIFICATION |             |
|--------------------------------------------------------------------------------------|---------------|-------------|
|                                                                                      | Metric        | Standard    |
| At Curb Idle Speed*                                                                  | 25 kPa        | 4 psi min.  |
| At 3000 rpm                                                                          | 170 - 550 kPa | 25 - 80 psi |
| <b>CAUTION:</b><br>*If pressure is ZERO at curb idle, DO NOT run engine at 3000 rpm. |               |             |

**TORQUE SPECIFICATIONS**

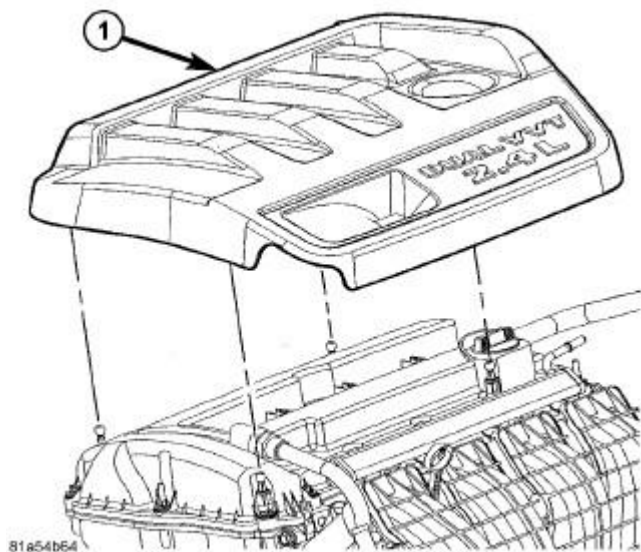
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| DESCRIPTION                           | N.m                                                                     | Ft. Lbs. | In. Lbs. |
|---------------------------------------|-------------------------------------------------------------------------|----------|----------|
| Balance Shaft Module                  | Refer to <b><u>PUMP, ENGINE OIL, INSTALLATION</u></b> Procedure.        |          |          |
| Bell Housing-Bolts                    | 48                                                                      | 35       | -        |
| Camshaft Bearing Cap-Bolts            |                                                                         |          |          |
| M6 Bolts                              | 12                                                                      | -        | 106      |
| M8 Bolts                              | 30                                                                      | 22       | -        |
| Coils                                 | 8                                                                       | -        | 71       |
| Connecting Rod Cap-Bolts              | 20 + 90°                                                                | 15 + 90° | -        |
| Coolant Temperature Sender            | 18                                                                      | 13       | -        |
| Crankshaft Main Bearing Cap-Bolts     | Refer to <b><u>CRANKSHAFT, INSTALLATION</u></b> Procedure.              |          |          |
| Crankshaft Damper-Bolt                | 210                                                                     | 155      | -        |
| Cylinder Head-Bolts                   | Refer to <b><u>CYLINDER HEAD, INSTALLATION</u></b> Procedure.           |          |          |
| Cylinder Head Cover-Bolts             | Refer to <b><u>COVER(S), CYLINDER HEAD, INSTALLATION</u></b> Procedure. |          |          |
| Engine Support Bracket-Bolts          | 40                                                                      | 30       | -        |
| Exhaust Manifold-Bolts                | 34                                                                      | 25       | -        |
| Exhaust Manifold Heat Shield-Bolts    |                                                                         |          |          |
| M6x25 mm Bolts                        | 7                                                                       | -        | 62       |
| M6x70 mm Bolts                        | 9                                                                       | -        | 80       |
| Flex Plate to Crankshaft-Bolts        | 29 + 51°                                                                | 22 + 51° | -        |
| Intake Manifold-Bolts                 | 24                                                                      | 18       | -        |
| Ladder Frame                          | 22                                                                      | 16       | -        |
| Oil Cooler Connector Bolt             | 49                                                                      | 36       | -        |
| Oil Filter                            | 14                                                                      | 10       | -        |
| Oil Filter Nipple                     | 49                                                                      | 36       | -        |
| Oil Jet Fastener                      | 12                                                                      | -        | 106      |
| Oil Pan-Bolts                         |                                                                         |          |          |
| M6 Bolts                              | 9                                                                       | -        | 80       |
| M8 Bolts                              | 24                                                                      | 18       | -        |
| Oil Pan Drain-Plug                    | 40                                                                      | 30       | -        |
| Oil Pressure Switch                   | 8                                                                       | -        | 71       |
| PCV Valve                             | 5                                                                       | -        | 44       |
| Phaser to Camshaft-Bolt               | 59                                                                      | 44       | -        |
| Spark Plugs                           | 27                                                                      | 20       | 239      |
| Timing Chain Cover                    |                                                                         |          |          |
| M6 Bolts                              | 9                                                                       | -        | 80       |
| M8 Bolts                              | 26                                                                      | 19       | -        |
| Timing Chain Tensioner Assembly-Bolts | 12                                                                      | -        | 106      |
| Timing Chain Guides                   | 12                                                                      | -        | 106      |

## REMOVAL

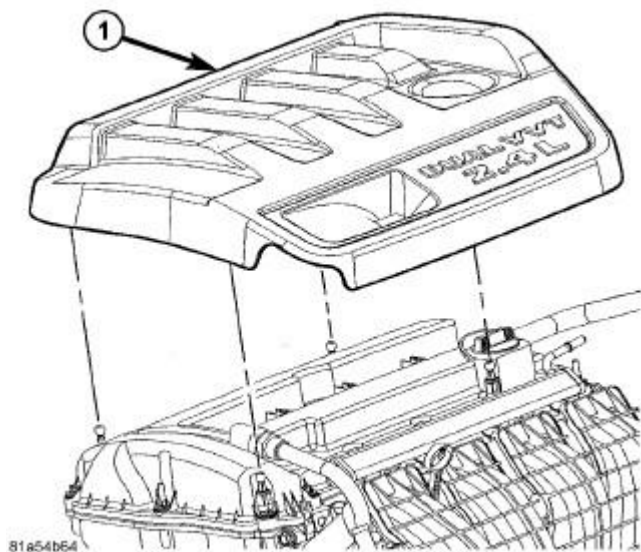
### ENGINE COVER



**Fig. 9: Engine Cover - 2.4L**  
Courtesy of CHRYSLER LLC

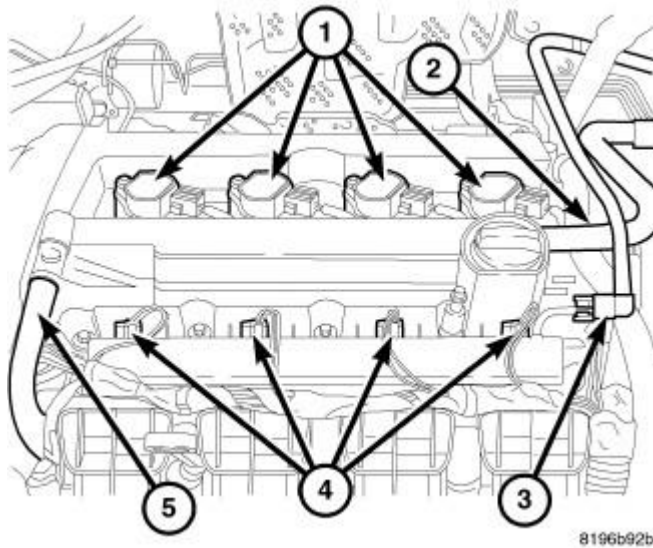
1. Remove engine cover (1) by pulling upwards.

### ENGINE ASSEMBLY



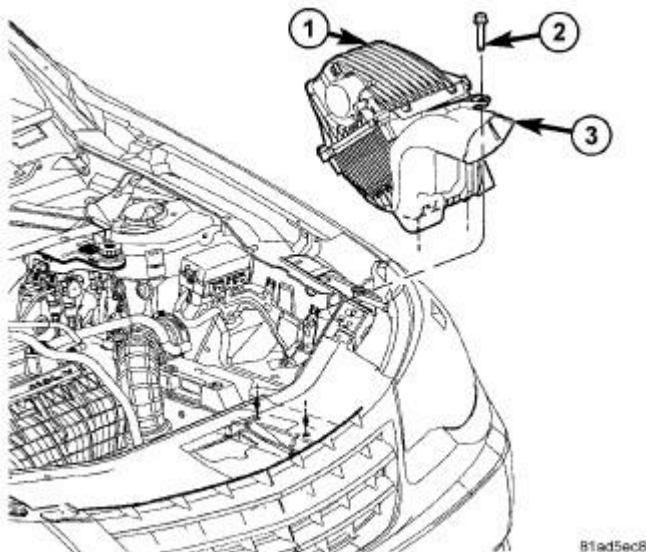
**Fig. 10: Engine Cover - 2.4L**  
Courtesy of CHRYSLER LLC

1. Remove engine cover (1).



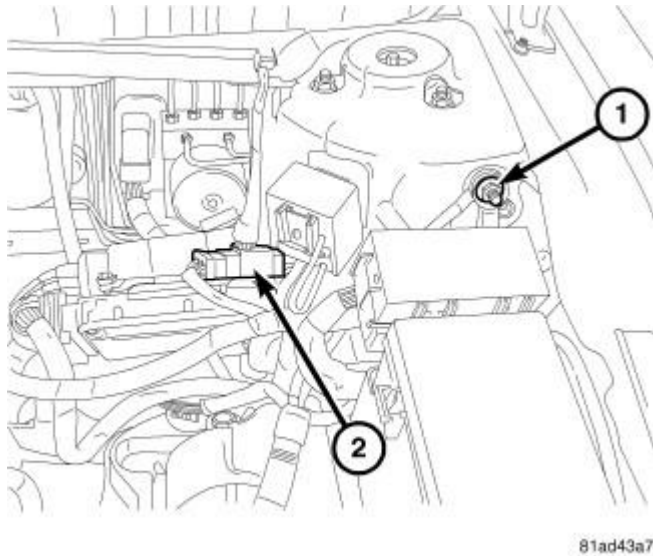
**Fig. 11: Coil Connectors, Air Hose, Fuel Line, Injectors & PCV Hose**  
Courtesy of CHRYSLER LLC

2. Perform fuel pressure release procedure, then disconnect and remove fuel line (3). Refer to **FUEL DELIVERY, GAS, STANDARD PROCEDURE**.
3. Remove make-up air hose (2).



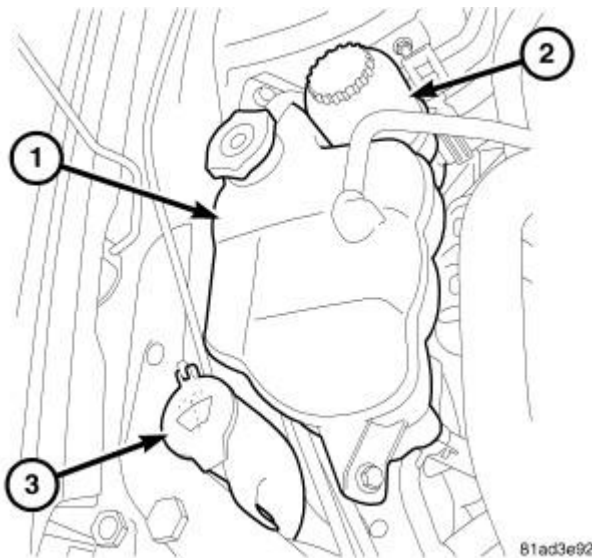
**Fig. 12: Air Cleaner Housing Assembly**  
Courtesy of CHRYSLER LLC

4. Remove air cleaner housing assembly (1). Refer to **BODY, AIR CLEANER, REMOVAL**.



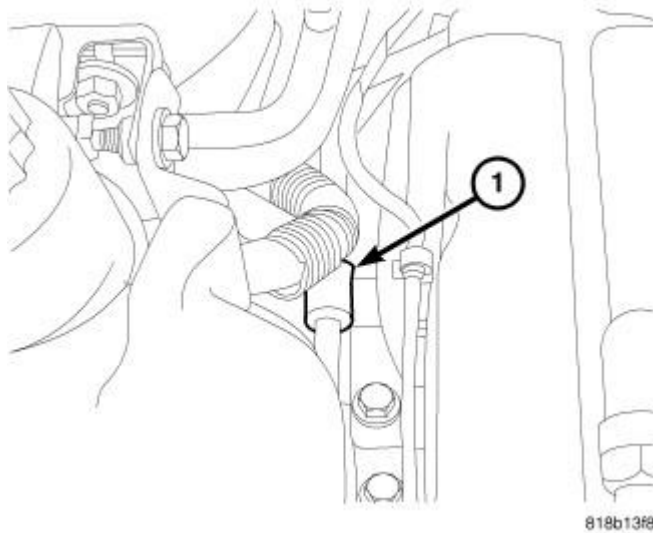
**Fig. 13: Battery Cables**  
Courtesy of CHRYSLER LLC

5. Disconnect negative battery cable (1).
6. Discharge air conditioning system, if equipped. Refer to **LINE, A/C DISCHARGE** .
7. Drain cooling system, refer to **DRAINING** .



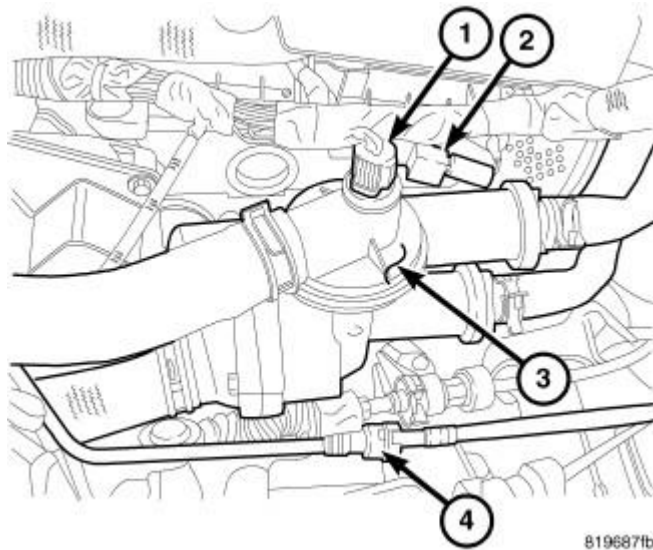
**Fig. 14: Coolant Reservoir, Power Steering Reservoir & Windshield Washer Bottle**  
Courtesy of CHRYSLER LLC

8. Remove coolant reservoir (1).
9. Remove power steering reservoir (2).



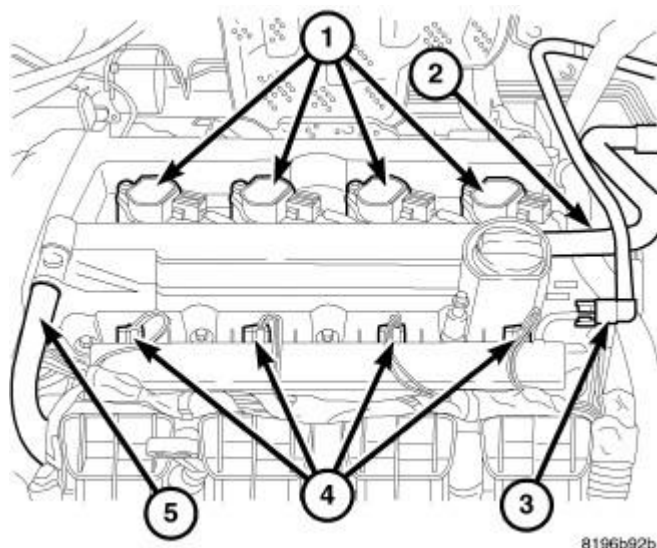
**Fig. 15: Power Steering Line Support**  
Courtesy of CHRYSLER LLC

10. Remove power steering line support at engine mount (1).
11. Remove power steering pump and set aside.



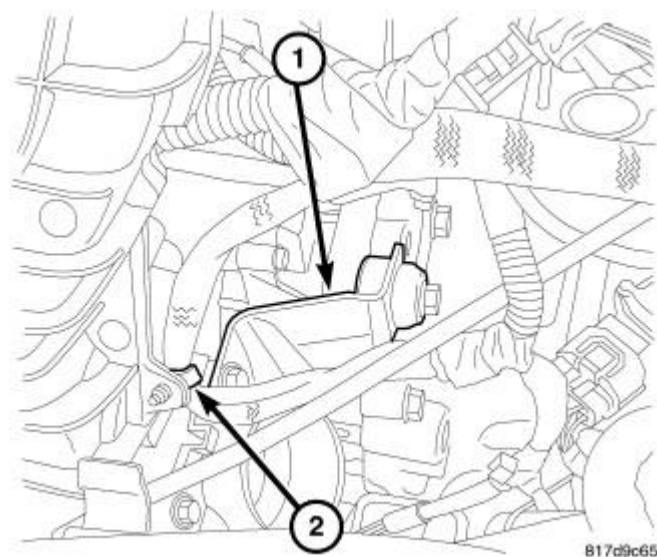
**Fig. 16: Coolant Temperature Sensor Connector, Capacitor Connector & Coolant Adapter**  
Courtesy of CHRYSLER LLC

12. Remove coolant hoses from coolant adapter (3).
13. Disconnect coolant temperature sensor connector (1) and capacitor connector (2).



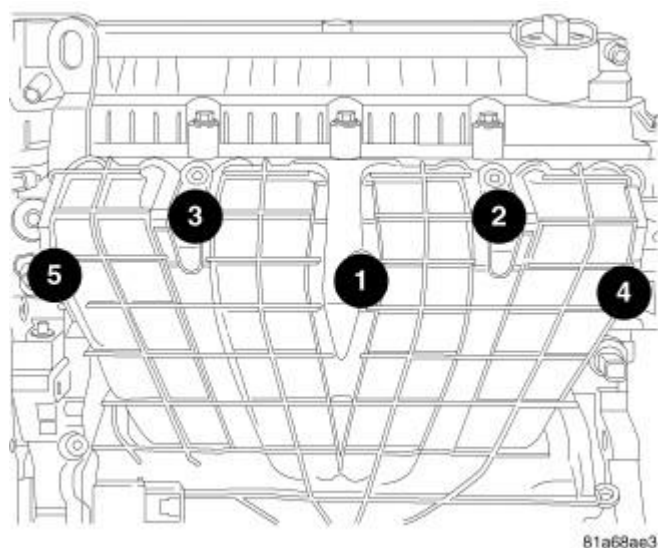
**Fig. 17: Coil Connectors, Air Hose, Fuel Line, Injectors & PCV Hose**  
Courtesy of CHRYSLER LLC

14. Disconnect coils (1), injectors (4), cam sensors, oil temperature sensor, and oil control valve electrical connectors and reposition harness.
15. Remove PCV hose (5) from valve cover.



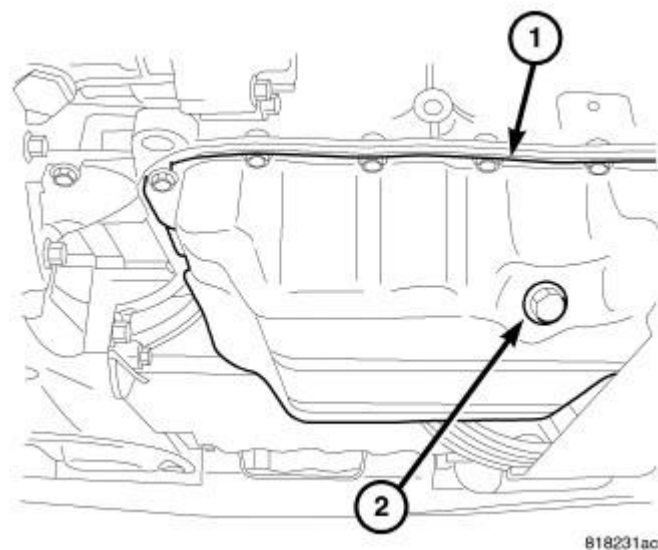
**Fig. 18: Throttle Body Support Bracket & Wiring Harness Retainer**  
Courtesy of CHRYSLER LLC

16. Remove harness from intake (2).
17. Remove throttle body support bracket (1).
18. Remove vacuum lines from throttle body and intake manifold.
19. Disconnect electronic throttle control and manifold flow control valve electrical connectors.



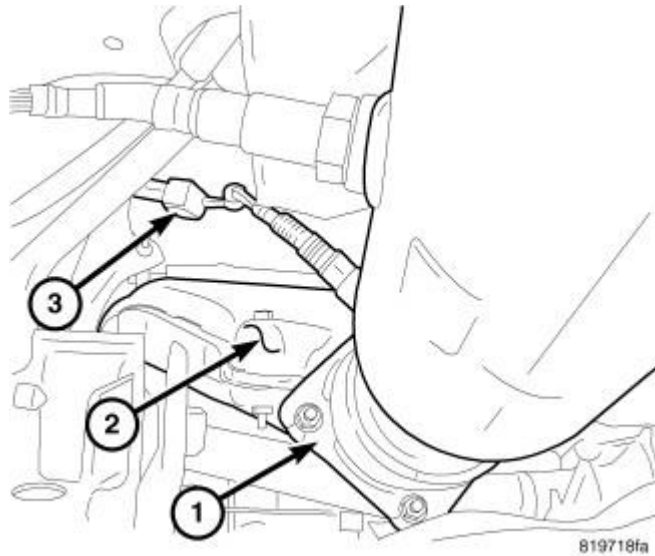
**Fig. 19: Intake Bolt Removal/Tightening Sequence**  
Courtesy of CHRYSLER LLC

20. Remove dipstick.
21. Remove intake bolts and remove intake.
22. Disconnect coolant temperature sensor at block, knock sensor, oil pressure sensor, generator, starter, block heater (if equipped), A/C compressor (if equipped), and block ground.
23. Remove accessory drive belt.



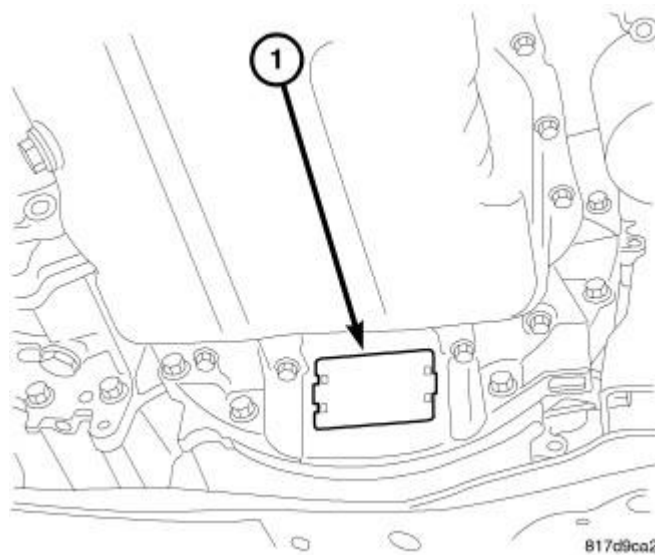
**Fig. 20: Oil Drain Plug & Oil Pan**  
Courtesy of CHRYSLER LLC

24. Raise vehicle.
25. Remove front splash shield.
26. Drain oil (2).



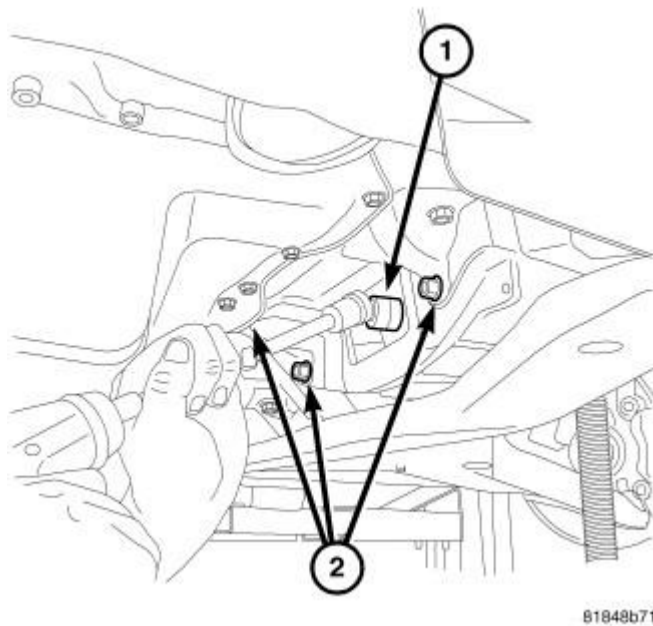
**Fig. 21: Exhaust Manifold Bolts, Heat Shield & Oxygen Sensor Connector**  
Courtesy of CHRYSLER LLC

27. Remove exhaust pipe to exhaust manifold bolts (1).
28. Disconnect oxygen sensor connector (3).
29. Remove exhaust manifold heat shield (2).
30. Remove exhaust manifold.



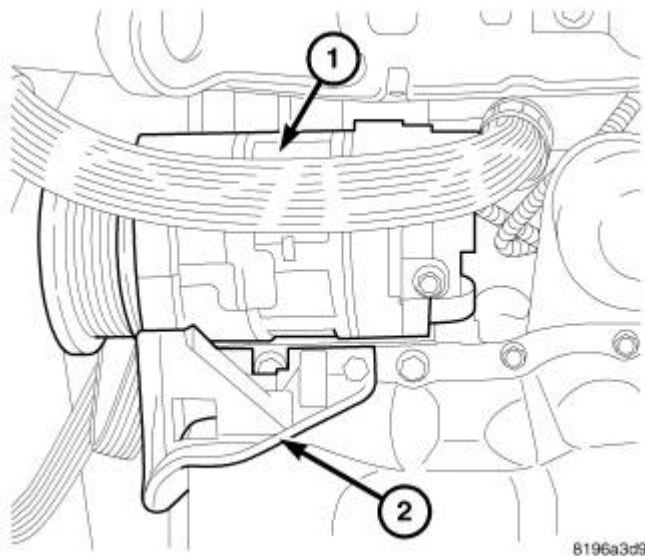
**Fig. 22: Inspection Cover**  
Courtesy of CHRYSLER LLC

31. Remove inspection cover (1) and mark torque converter to flywheel.



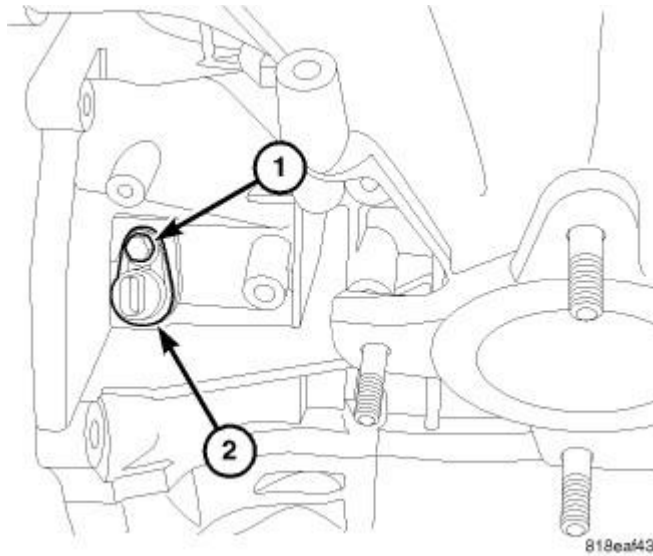
**Fig. 23: Removing/Installing Modular Clutch-To-Drive Plate Bolts**  
Courtesy of CHRYSLER LLC

32. On vehicles equipped with an automatic transaxle, remove torque converter bolts (1).
33. On vehicles equipped with an manual transaxle, remove modular clutch bolts (1).
34. Remove lower bellhousing bolts (2).



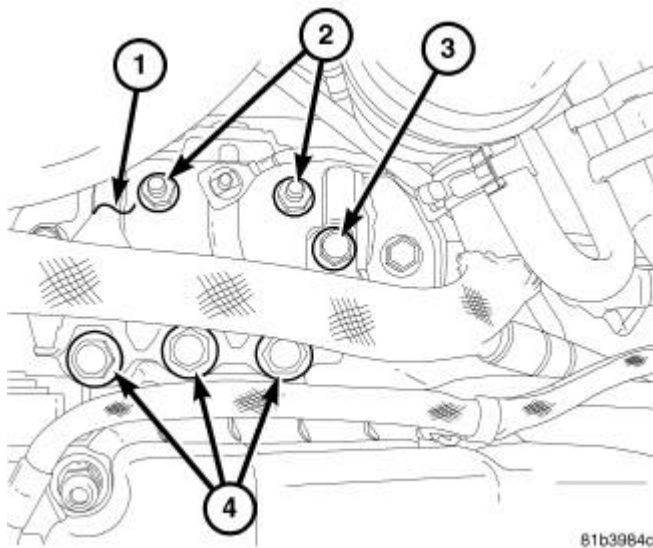
**Fig. 24: A/C Compressor & Bracket**  
Courtesy of CHRYSLER LLC

35. Remove A/C compressor (1) from engine and set aside.
36. Remove generator and lower idler pulley.



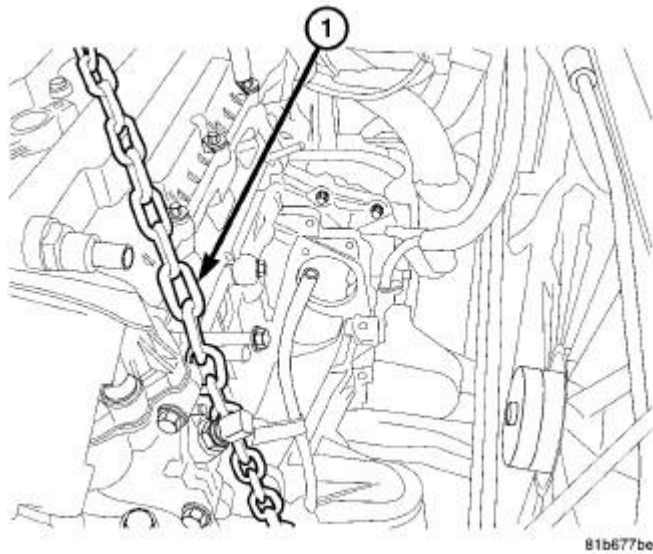
**Fig. 25: Crankshaft Position Sensor & Bolt**  
 Courtesy of CHRYSLER LLC

37. Disconnect CKP sensor (2) electrical connector.



**Fig. 26: Power Steering Hose Hold Down, Right Engine Mount Bracket & Fasteners**  
 Courtesy of CHRYSLER LLC

38. Remove right engine mount bracket retaining bolts (4).
39. Remove power steering hose hold down (3).
40. Remove retaining nuts (2) and position mount bracket (1) aside.

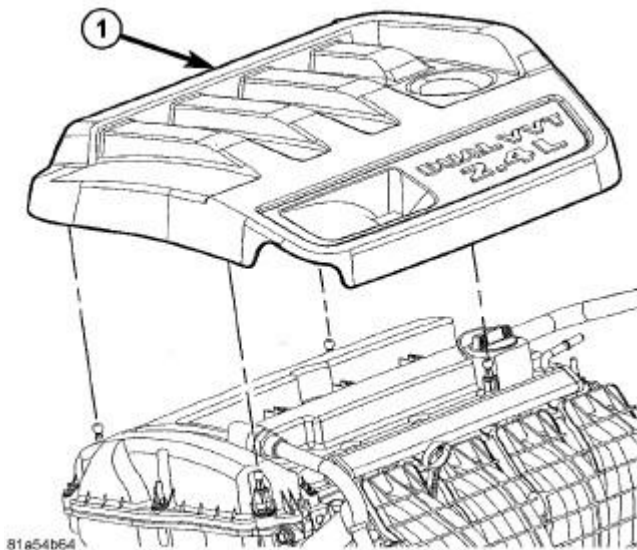
**Fig. 27: Lift Chain**

Courtesy of CHRYSLER LLC

41. Remove intake oil control valve to prevent damage.
42. Install engine lift chain to rear lift bracket and bolt to cylinder head (1) in the front.
43. Hoist engine from vehicle.
44. Separate engine and transmission.

## INSTALLATION

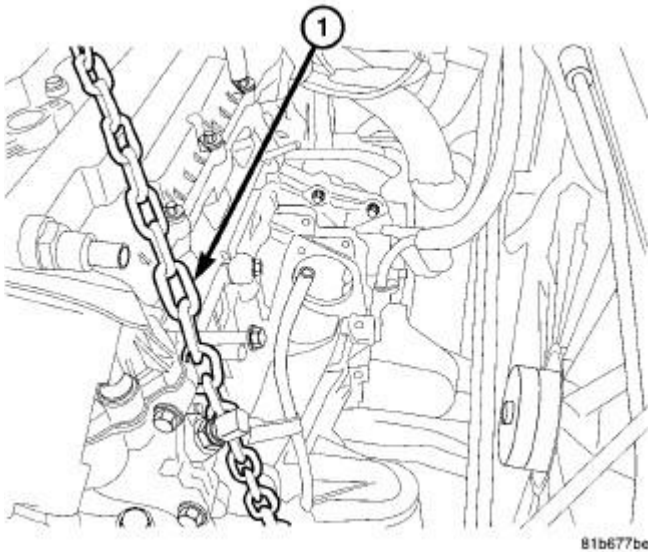
### ENGINE COVER

**Fig. 28: Engine Cover - 2.4L**

Courtesy of CHRYSLER LLC

1. Position engine cover (1) over mounting studs.
2. Seat the cover on the rear studs by pushing downwards.
3. Push downward on the front of the cover to seat the front studs.

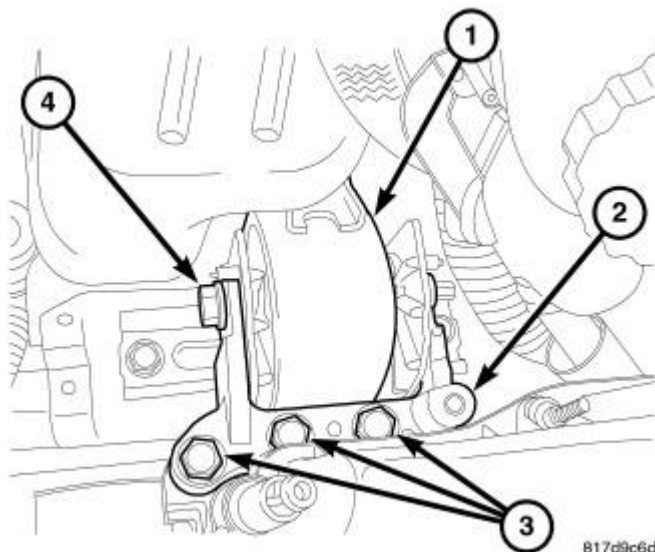
ENGINE ASSEMBLY



**Fig. 29: Lift Chain**

Courtesy of CHRYSLER LLC

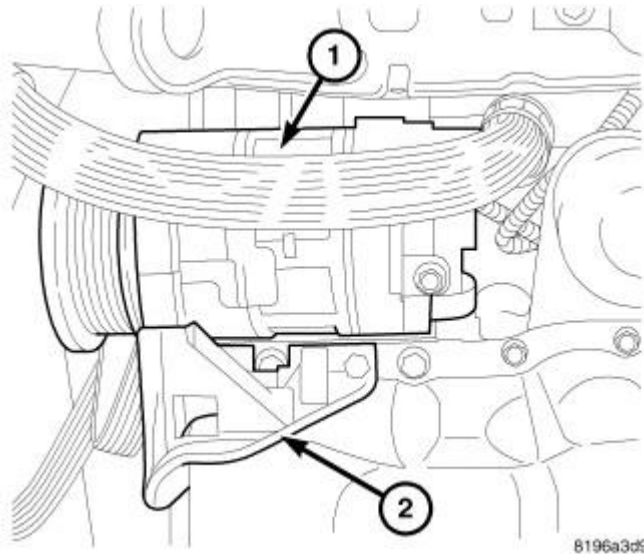
1. Connect engine lift chain (1) to engine.
2. Slowly lower engine assembly in to position.



**Fig. 30: Right Engine Mount & Fasteners**

Courtesy of CHRYSLER LLC

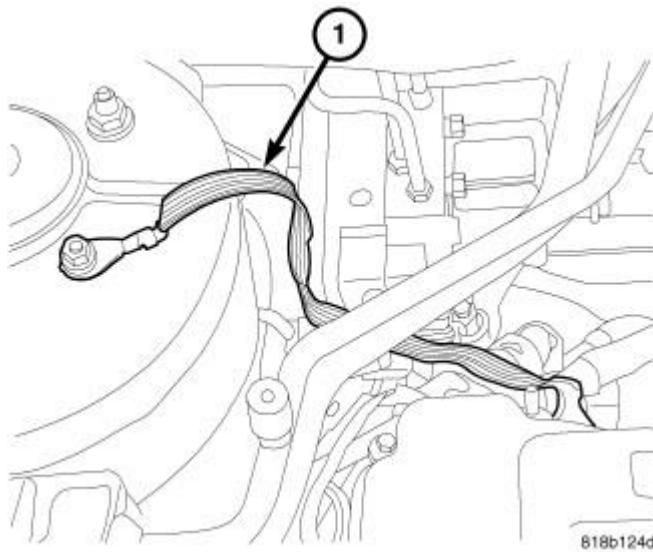
3. Position right mount bracket (2) and install bolts (3).
4. Install mounting bolts at the right engine mount bolts and tighten bolts to 118 N.m (87 ft. lbs.).
5. Install through bolt (4) and tighten to 118 N.m (87 ft. lbs.).



**Fig. 31: A/C Compressor & Bracket**

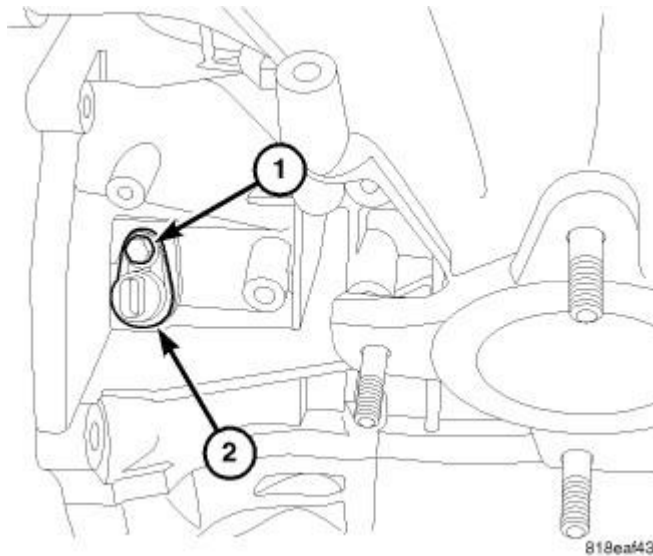
Courtesy of CHRYSLER LLC

6. Install A/C compressor mounting bracket (2).
7. Install A/C compressor (1) and connect lines.
8. Install exhaust manifold and upper lower heat shields. Refer to **MANIFOLD, EXHAUST, INSTALLATION**.
9. Install oxygen sensor and connect electrical connector.



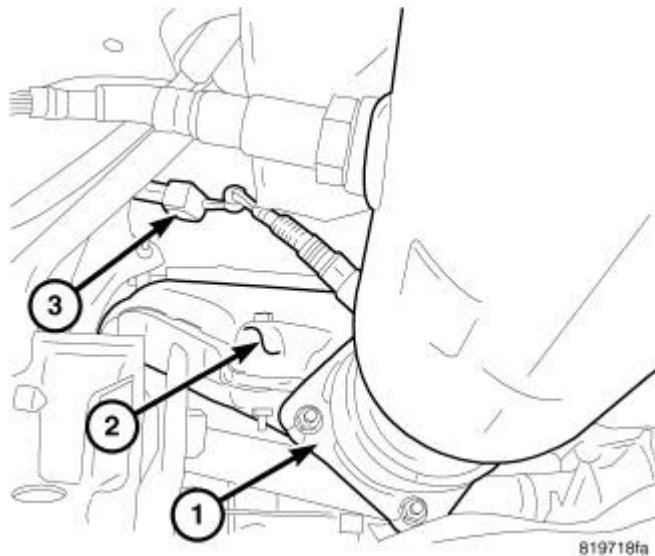
**Fig. 32: Ground Strap**  
Courtesy of CHRYSLER LLC

10. Install Ground strap (1) near right strut tower.
11. Raise vehicle.



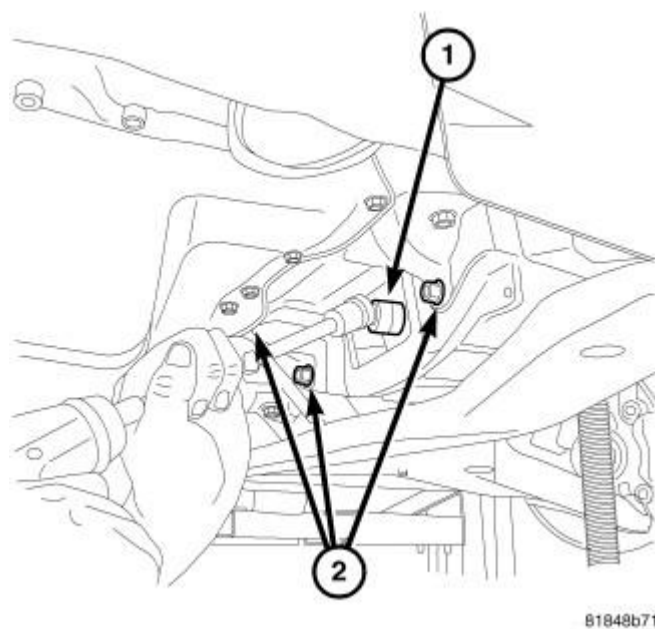
**Fig. 33: Crankshaft Position Sensor & Bolt**  
Courtesy of CHRYSLER LLC

12. Install crankshaft position sensor (CKP) (2).
13. Connect CKP electrical connector (2).



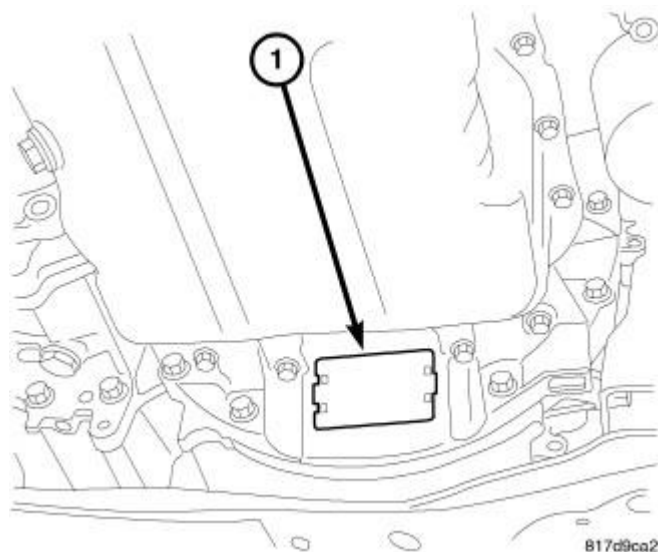
**Fig. 34: Exhaust Manifold Bolts, Heat Shield & Oxygen Sensor Connector**  
Courtesy of CHRYSLER LLC

14. Install manifold to exhaust pipe bolts (1) and tighten bolts.
15. Install generator.



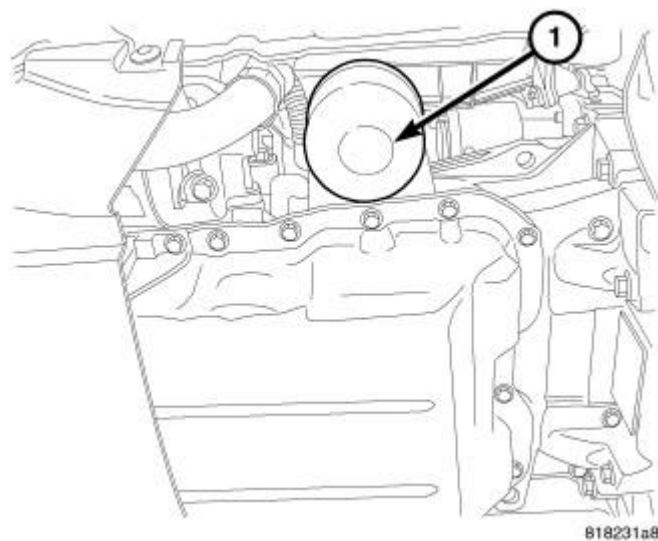
**Fig. 35: Removing/Installing Modular Clutch-To-Drive Plate Bolts**  
Courtesy of CHRYSLER LLC

16. Install lower bell housing bolts (2) and tighten.
17. Align torque converter and flex plate mark. Install torque converter bolts (1) and tighten.



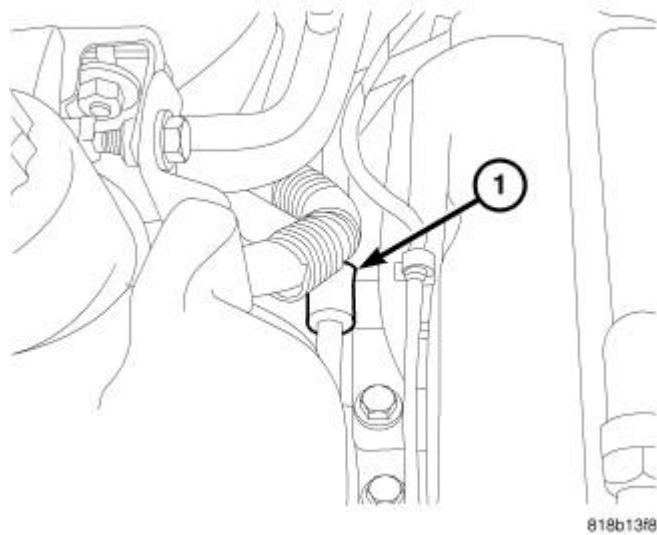
**Fig. 36: Inspection Cover**  
Courtesy of CHRYSLER LLC

18. Install inspection cover (1).



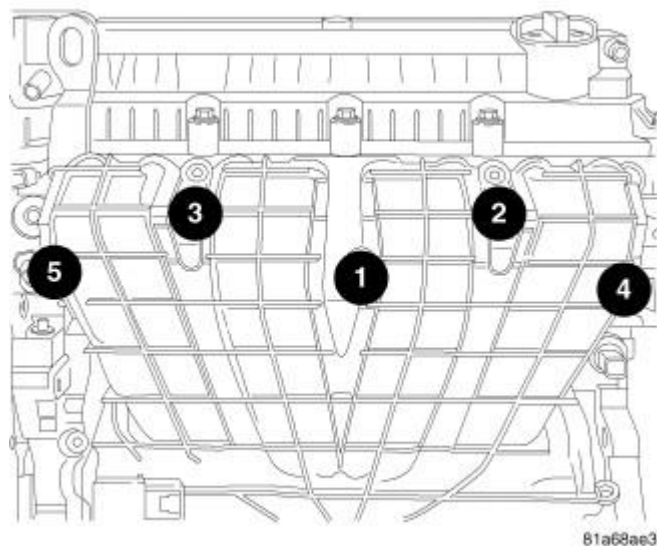
**Fig. 37: Oil Filter**  
Courtesy of CHRYSLER LLC

19. Install new oil filter (1).
20. Lower vehicle.
21. Install upper idler pulley.
22. Install power steering pump.



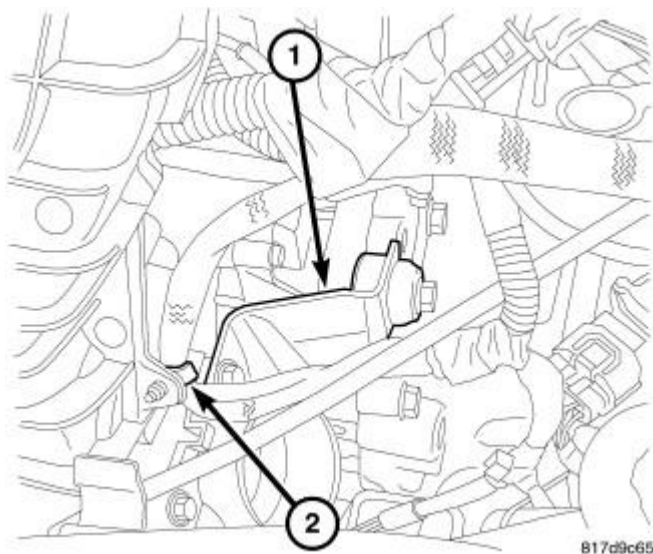
**Fig. 38: Power Steering Line Support**  
 Courtesy of CHRYSLER LLC

23. Install power steering line support bracket (1).
24. Install power steering pump.
25. Install accessory drive belt.
26. Connect electrical connectors at block ground, starter, A/C compressor, knock sensor, oil pressure sensor, generator, coolant temperature sensor at block, and block heater.



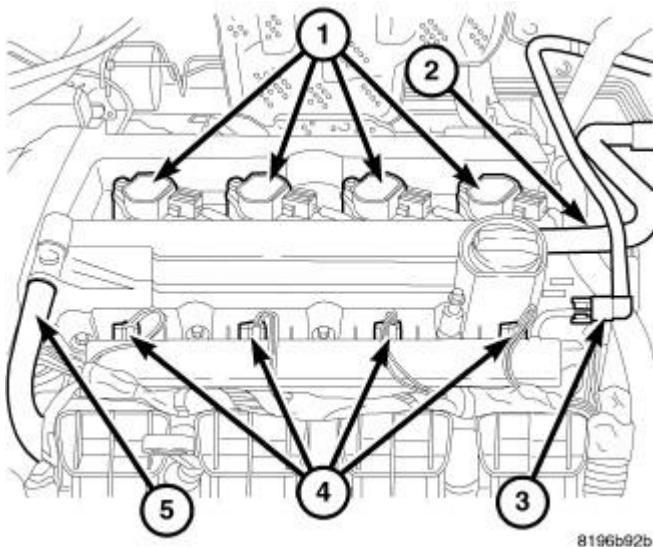
**Fig. 39: Intake Bolt Removal/Tightening Sequence**  
 Courtesy of CHRYSLER LLC

27. Install intake manifold and tighten bolts to 24 N.m (18 ft. lbs.) as shown in illustration.



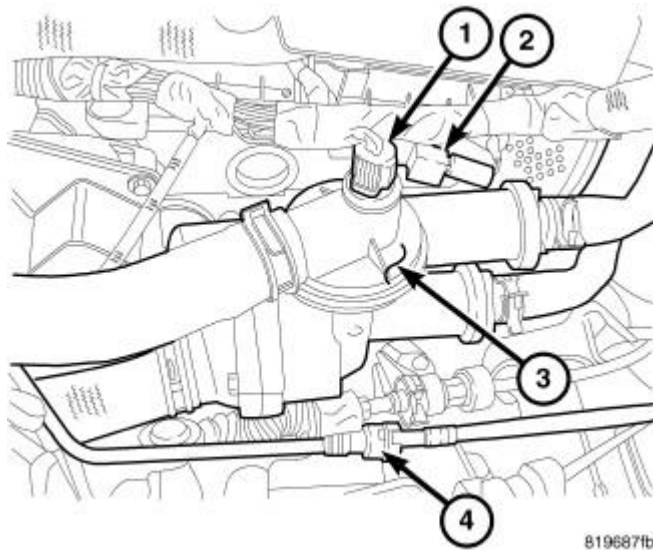
**Fig. 40: Throttle Body Support Bracket & Wiring Harness Retainer**  
Courtesy of CHRYSLER LLC

28. Install throttle body support bracket (1).
29. Connect manifold flow control valve and electronic throttle control electrical connectors.
30. Insert wiring harness retainer into intake manifold (2).
31. Install engine oil dip stick.



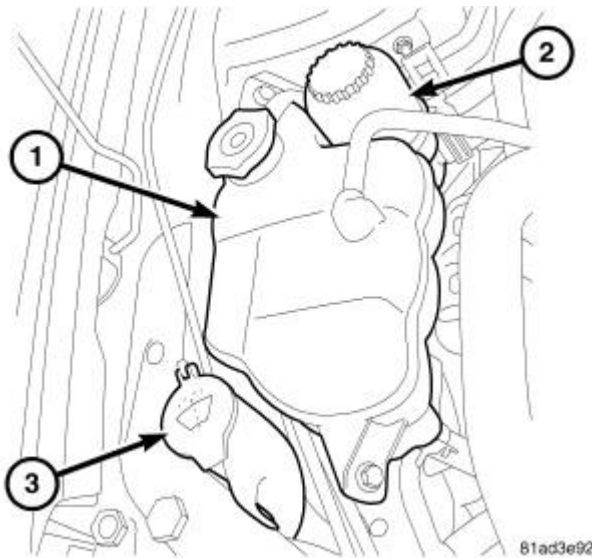
**Fig. 41: Coil Connectors, Air Hose, Fuel Line, Injectors & PCV Hose**  
Courtesy of CHRYSLER LLC

32. Install PCV hose (5).
33. Install vacuum lines at throttle body and intake manifold.
34. Install intake air tube on throttle body.
35. Connect engine harness electrical connectors.



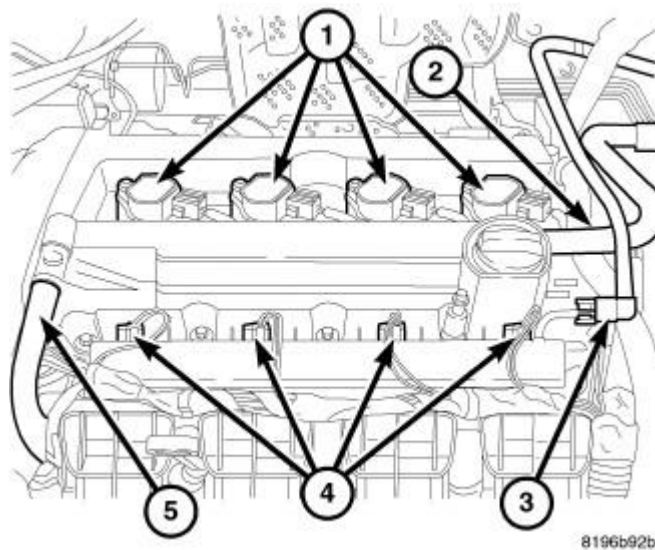
**Fig. 42: Coolant Temperature Sensor Connector, Capacitor Connector & Coolant Adapter**  
Courtesy of CHRYSLER LLC

36. Install coolant hoses at coolant adapter (3).



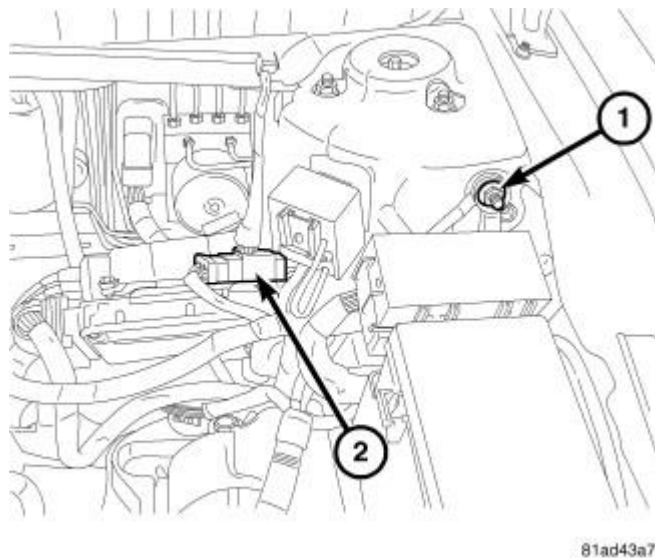
**Fig. 43: Coolant Reservoir, Power Steering Reservoir & Windshield Washer Bottle**  
Courtesy of CHRYSLER LLC

37. Install coolant reservoir (1) and connect hose.



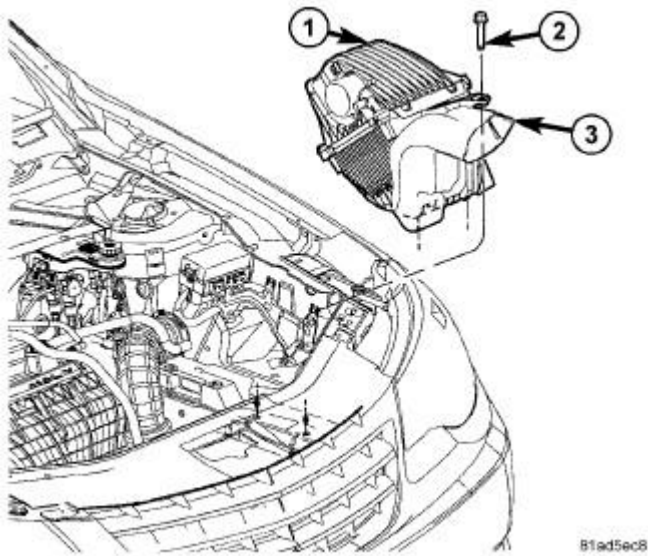
**Fig. 44: Coil Connectors, Air Hose, Fuel Line, Injectors & PCV Hose**  
Courtesy of CHRYSLER LLC

38. Connect fuel line to fuel rail (3).



**Fig. 45: Battery Cables**  
Courtesy of CHRYSLER LLC

39. Connect negative battery cable (1).

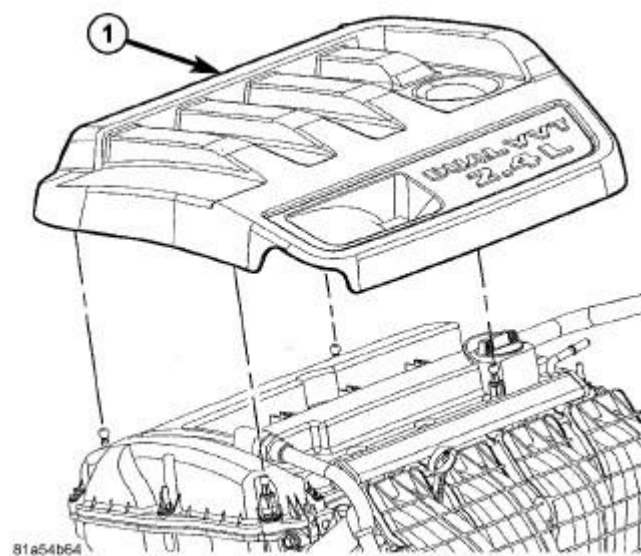


**Fig. 46: Air Cleaner Housing Assembly**  
Courtesy of CHRYSLER LLC

40. Install air cleaner housing (1) and connect inlet air hose. Refer to **ENGINE/AIR INTAKE SYSTEM/AIR CLEANER HOUSING - INSTALLATION**.
41. Fill with coolant.
42. 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.**

43. Evacuate the refrigerant system. Refer to **REFRIGERANT SYSTEM EVACUATE** .
44. Charge the refrigerant system. Refer to **REFRIGERANT SYSTEM CHARGE** .



**Fig. 47: Engine Cover - 2.4L**  
Courtesy of CHRYSLER LLC

45. Start engine and check for leaks.
46. Install engine cover (1).

## SPECIAL TOOLS

### SPECIAL TOOLS

10368 - Set, Universal Protective Cap  
7700 - Tester, Cooling System  
(Originally Shipped In Kit Number(s) 7700-A.)  
8514 - Pins, Tensioner  
(Originally Shipped In Kit Number(s) 8283, 8283CC, 8527, 8527CC, 8575, 8575CC, 9975.)  
9506 - Installer, Oil Seal  
(Originally Shipped In Kit Number(s) 9610, 9970.)  
9509 - Installer, Oil Seal  
(Originally Shipped In Kit Number(s) 9610, 9970.)  
9701 - Wedge, Locking  
(Originally Shipped In Kit Number(s) 9610, 9970.)  
9703 - Pin, Tensioner  
(Originally Shipped In Kit Number(s) 9610, 9970.)  
9706 - Installer, Crankshaft Rear Oil Seal  
(Originally Shipped In Kit Number(s) 9610, 9970.)  
9707 - Holder, Vibration Damper  
(Originally Shipped In Kit Number(s) 9610, 9970.)  
9879 - Adapter, Oil Pressure Test  
(Originally Shipped In Kit Number(s) 9998.)

C-3685-A - Bloc-Chek Kit

C-4171 - Driver Handle, Universal

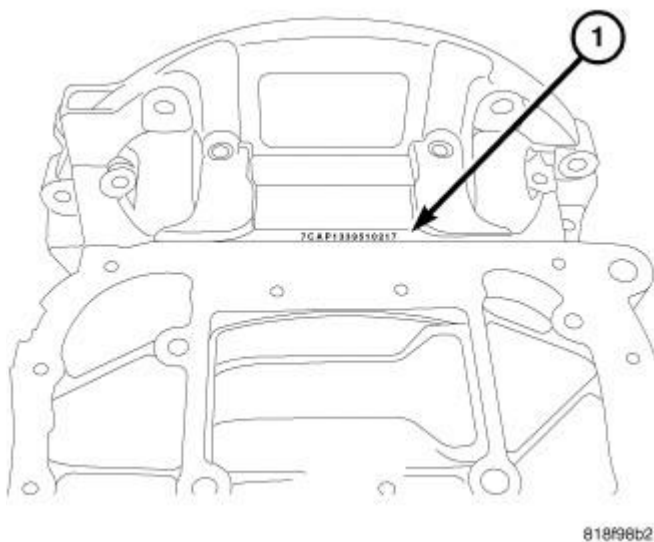
(Originally Shipped In Kit Number(s) 9202, 9202A-CAN, 9202CC, 9299, 9299CC, 9299CC, 9300A-CAN.)

C-4597 - Socket, Oil Pressure

## PLATE, IDENTIFICATION

### DESCRIPTION

### DESCRIPTION



**Fig. 48: Engine Serial Number**  
Courtesy of CHRYSLER LLC

The engine serial number (1) is located between the oil pan and the bellhousing. The serial number contains engine build date, build location, and displacement.

Example: 8CAP1339710217

| WORLD ENGINE  |                        |                                                                             |                                                                   |                             |                        |       |                       |
|---------------|------------------------|-----------------------------------------------------------------------------|-------------------------------------------------------------------|-----------------------------|------------------------|-------|-----------------------|
| 8             | C                      | A                                                                           | P1                                                                | 339                         | 7                      | 1     | 0217                  |
| Model<br>Year | Engine<br>Displacement | Engine<br>Build<br>Variation<br>(with oil<br>cooler,<br>turbo, for<br>MMNA) | Engine<br>Plant<br>P1 =<br>GEMA<br>North<br>P2 =<br>GEMA<br>South | Julian<br>Day<br>of<br>Year | Julian<br>Year<br>2007 | Shift | Build Sequence Number |
| 2008          | A = 1.8L<br>B = 2.0L   |                                                                             |                                                                   |                             |                        |       |                       |

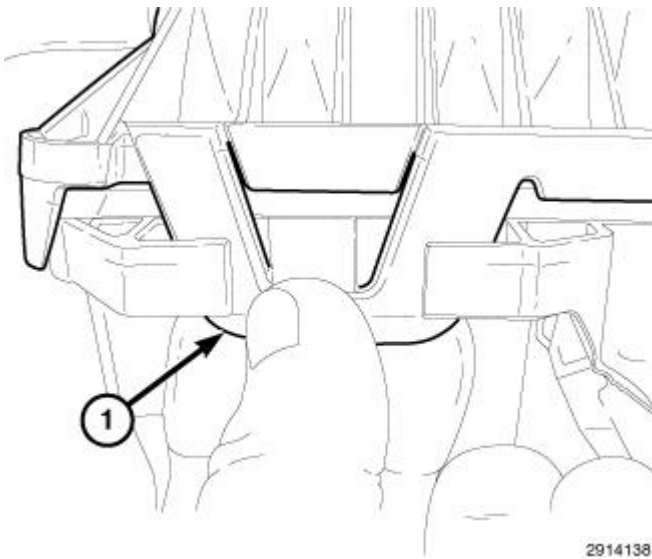
C = 2.4L

## AIR INTAKE SYSTEM

### AIR CLEANER

#### REMOVAL

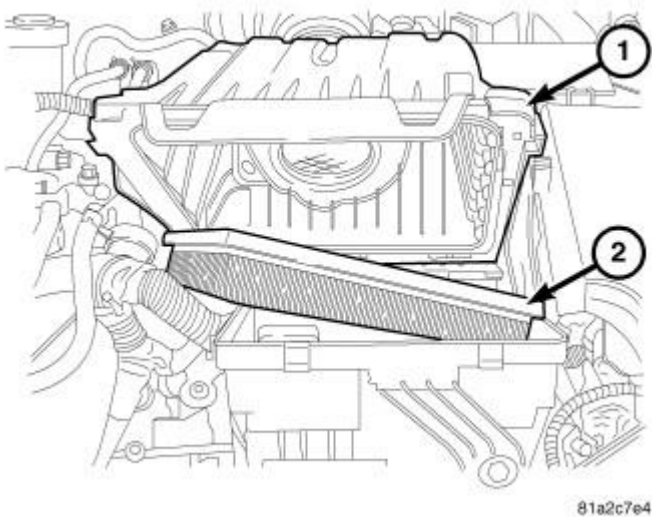
#### REMOVAL



**Fig. 49: Air Box Lid Tabs**

Courtesy of CHRYSLER LLC

**CAUTION:** Do not use an assist tool or excessive force when unlocking the air box lid tabs (1). Excessive force may break the tabs off of the lid.

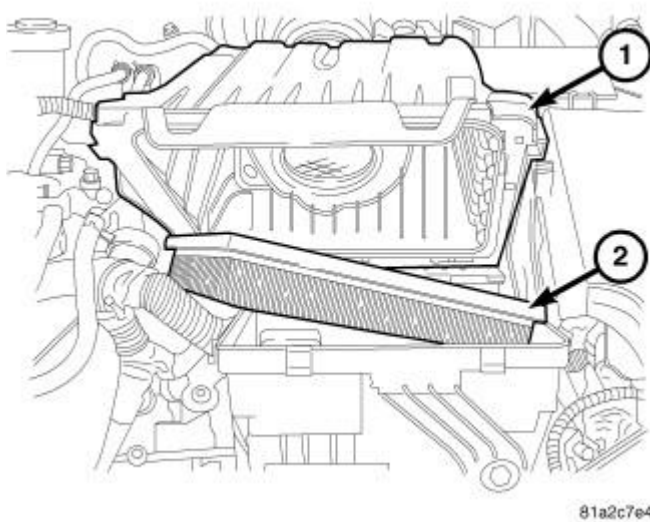


**Fig. 50: Air Cleaner Housing Cover & Air Filter Element**  
Courtesy of CHRYSLER LLC

1. Unlock the air box lid tabs and lift the air cleaner housing cover (1).
2. Pull the cover forward to disengage the rear tabs.
3. Remove the air filter element (2).

#### INSTALLATION

#### INSTALLATION



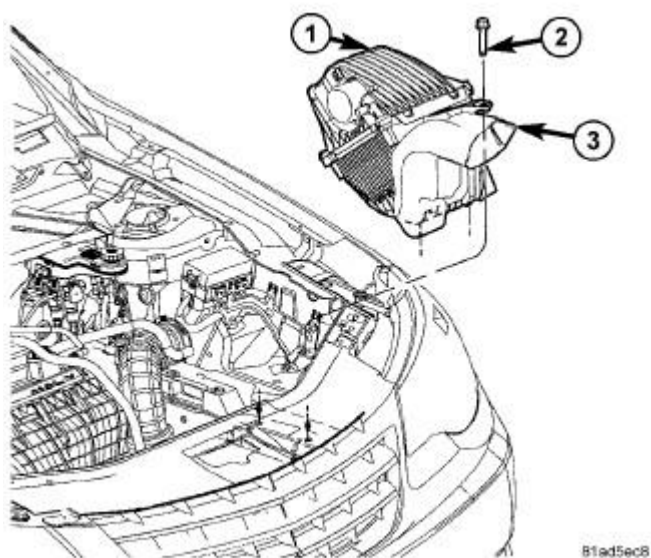
**Fig. 51: Air Cleaner Housing Cover & Air Filter Element**  
Courtesy of CHRYSLER LLC

1. Install the air filter element (2) into the air cleaner housing.
2. Install the cover (1) so that the rear tabs insert into the lower air box.
3. Push down on the cover to engage the front locking tabs.

#### BODY, AIR CLEANER

#### REMOVAL

#### REMOVAL

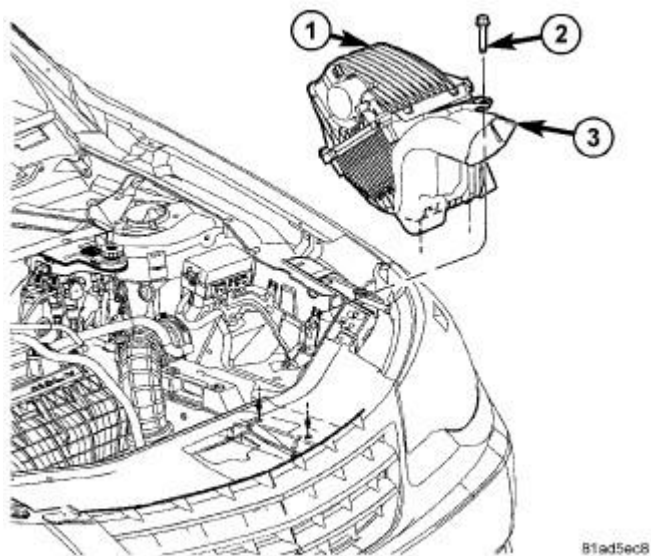


**Fig. 52: Air Cleaner Housing Assembly**  
Courtesy of CHRYSLER LLC

1. Remove air cleaner housing retaining bolt (2).
2. Remove clean air hose from air cleaner housing.
3. Lift air cleaner housing (1) upwards and remove.

#### INSTALLATION

#### INSTALLATION



**Fig. 53: Air Cleaner Housing Assembly**  
Courtesy of CHRYSLER LLC

1. Position air cleaner housing (1) in place.
2. Install retaining bolt (2).
3. Install clean air hose.

## CYLINDER HEAD

### DESCRIPTION

#### 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

#### 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 **CYLINDER COMPRESSION PRESSURE TEST**. 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**

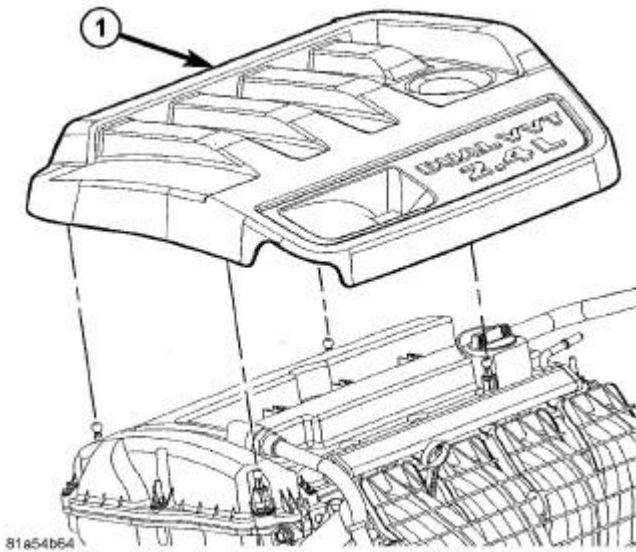
**WARNING: WITH COOLING SYSTEM TESTER IN PLACE, PRESSURE WILL BUILD UP FAST. EXCESSIVE PRESSURE BUILT UP, BY CONTINUOUS ENGINE OPERATION, MUST BE RELEASED TO A SAFE PRESSURE POINT. NEVER PERMIT PRESSURE TO EXCEED 138 kPa (20 psi).**

Install Cooling System Tester (special tool #7700, Tester, Cooling System) 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**

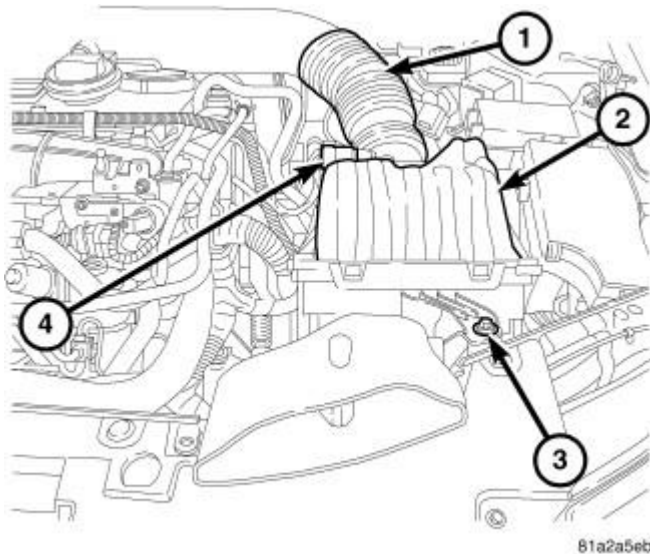
Combustion leaks into the cooling system can also be checked by using combustion leak tester (special tool #C-3685-A, Bloc-Chek Kit) or equivalent. Perform test following the procedures supplied with the tool kit.

**REMOVAL****REMOVAL**



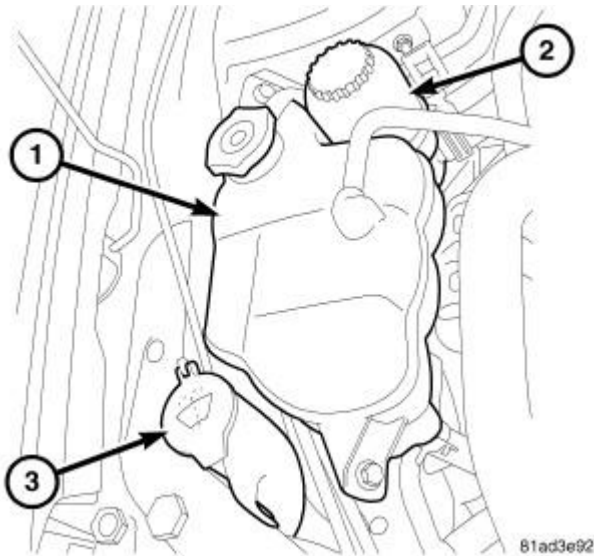
**Fig. 54: Engine Cover - 2.4L**  
 Courtesy of CHRYSLER LLC

1. Remove engine cover (1) by pulling upward.
2. Perform fuel system pressure release procedure. Refer to **FUEL DELIVERY, GAS, STANDARD PROCEDURE**.
3. Disconnect and isolate the negative battery cable.



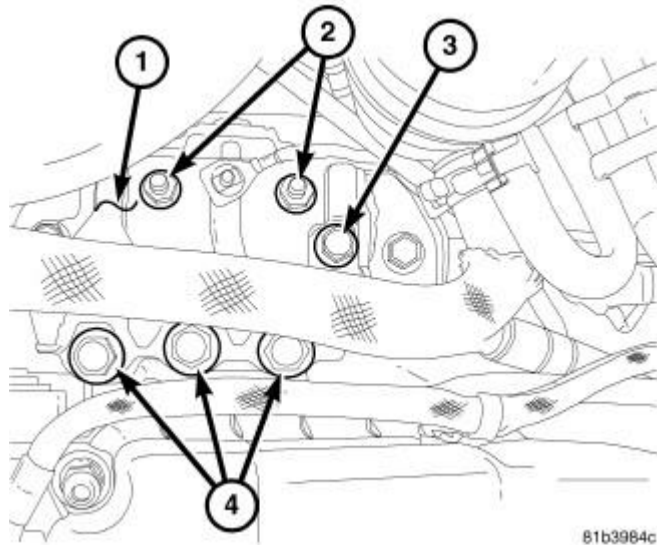
**Fig. 55: Air Cleaner Housing & Retaining Bolt**  
 Courtesy of CHRYSLER LLC

4. Drain cooling system. Refer to **STANDARD PROCEDURE**.
5. Remove clean air hose and air cleaner housing (2). Refer to **BODY, AIR CLEANER, REMOVAL**.



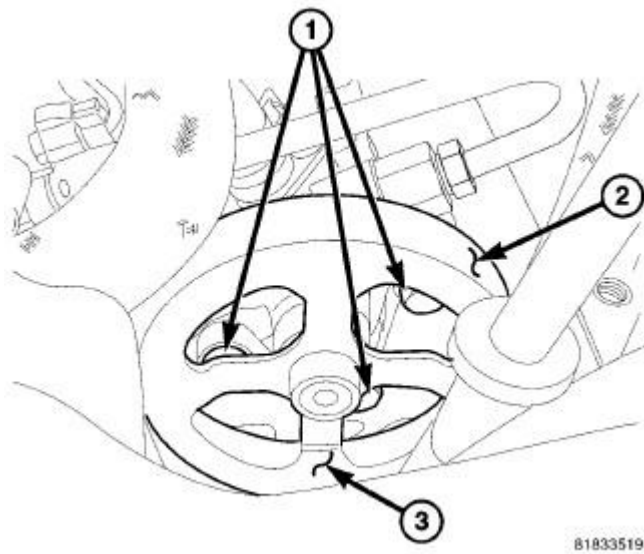
**Fig. 56: Coolant Reservoir, Power Steering Reservoir & Windshield Washer Bottle**  
Courtesy of CHRYSLER LLC

6. Remove coolant recovery bottle (1). Refer to **BOTTLE, COOLANT RECOVERY, REMOVAL** .
7. Remove and reposition power steering reservoir (2).
8. Remove accessory drive belt. Refer to **BELT, SERPENTINE, REMOVAL** .



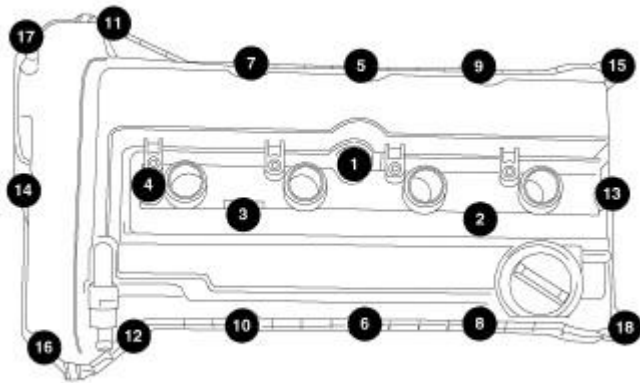
**Fig. 57: Power Steering Hose Hold Down, Right Engine Mount Bracket & Fasteners**  
Courtesy of CHRYSLER LLC

9. Remove power steering hose hold down (3).



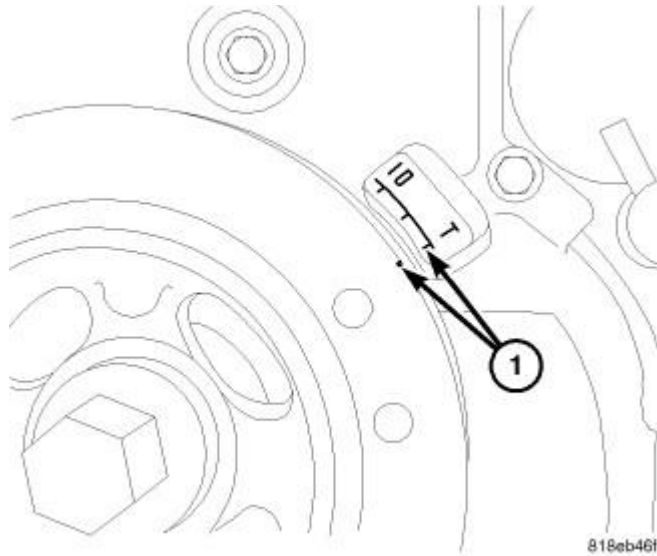
**Fig. 58: Power Steering Pump - Gas**  
Courtesy of CHRYSLER LLC

10. Remove the three power steering pump mounting bolts (1) through the openings in the pulley (3) and reposition the pump.



**Fig. 59: Removing/Installing Cylinder Head Cover Bolts In Sequence**  
Courtesy of CHRYSLER LLC

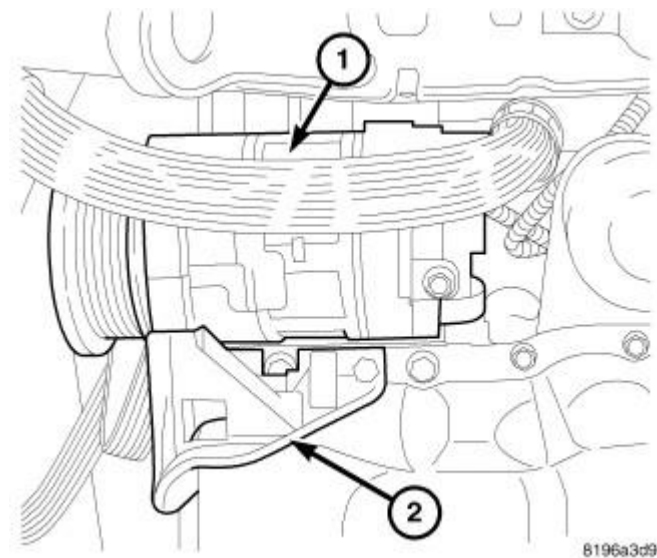
11. Remove the cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.
12. Remove ignition coils from the cylinder head cover.



**Fig. 60: TDC**

Courtesy of CHRYSLER LLC

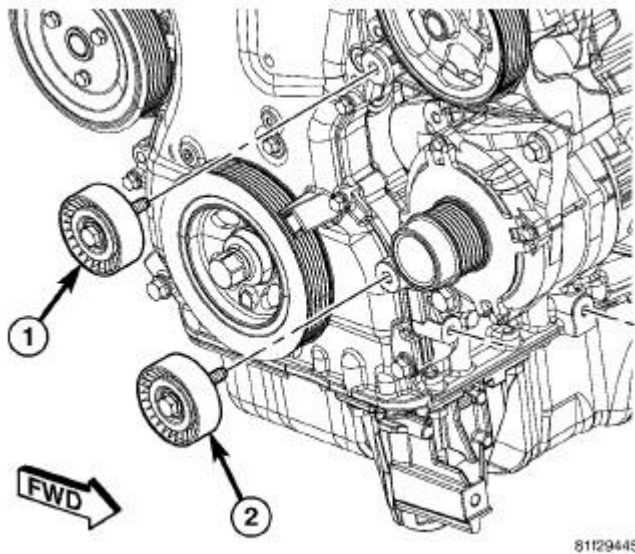
13. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
14. Remove the frame cover portion of the right splash shield. Refer to **SHIELD, SPLASH, FRONT WHEELHOUSE, REMOVAL** and **SHIELD, SPLASH, REAR WHEELHOUSE, REMOVAL**.
15. Set engine to TDC (1).



**Fig. 61: A/C Compressor & Bracket**

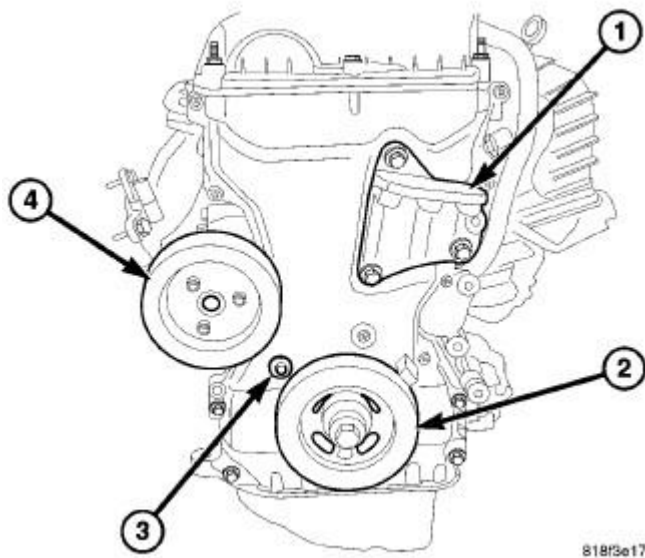
Courtesy of CHRYSLER LLC

16. Remove lower A/C compressor bolts if equipped.
17. Remove lower A/C compressor mount (2) if equipped.



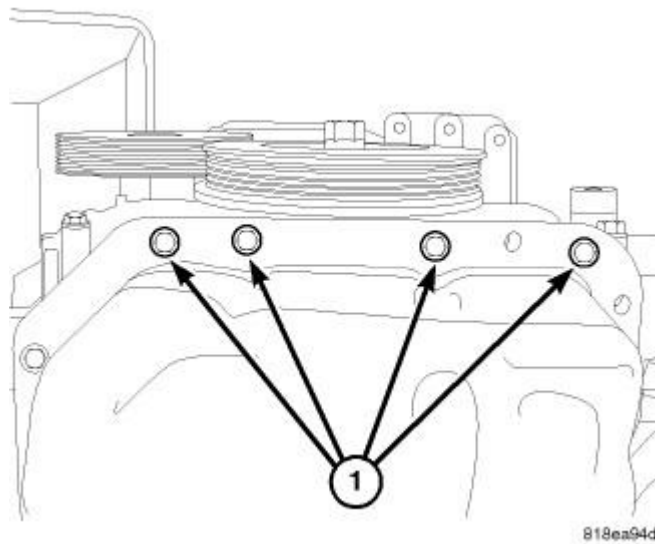
**Fig. 62: Removing/Installing Accessory Drive Belt Upper & Lower Idler Pulley**  
Courtesy of CHRYSLER LLC

18. Remove accessory drive belt lower idler pulley (2).



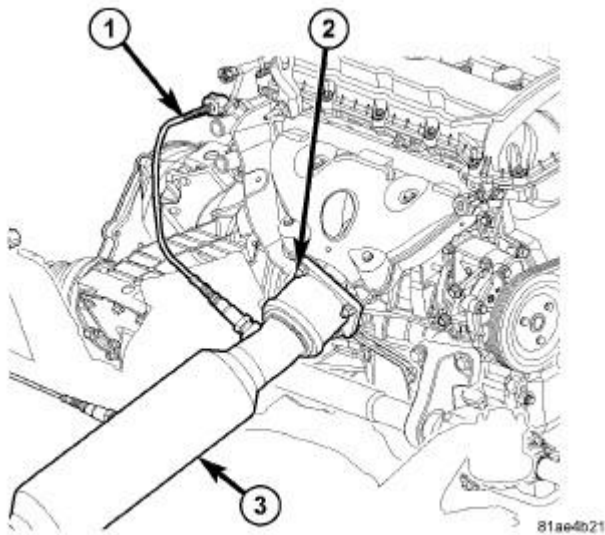
**Fig. 63: Right Side Engine Mount Bracket, Crankshaft Damper & Water Pump Pulley**  
Courtesy of CHRYSLER LLC

19. Remove crankshaft damper (2). Refer to **DAMPER, VIBRATION, REMOVAL**.
20. Remove three bolts and water pump pulley (4) from water pump.
21. Remove lower bolt from right side engine mount bracket (1).



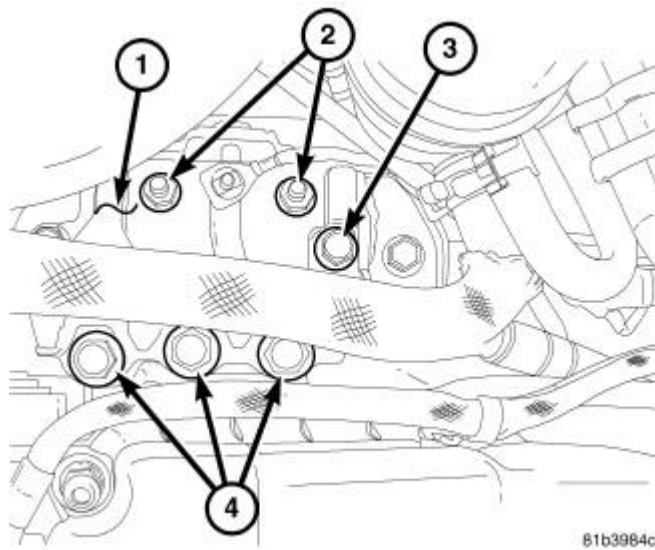
**Fig. 64: Oil Pan To Timing Chain Cover Lower Retaining Bolts**  
Courtesy of CHRYSLER LLC

22. Remove timing chain cover lower bolts (1).



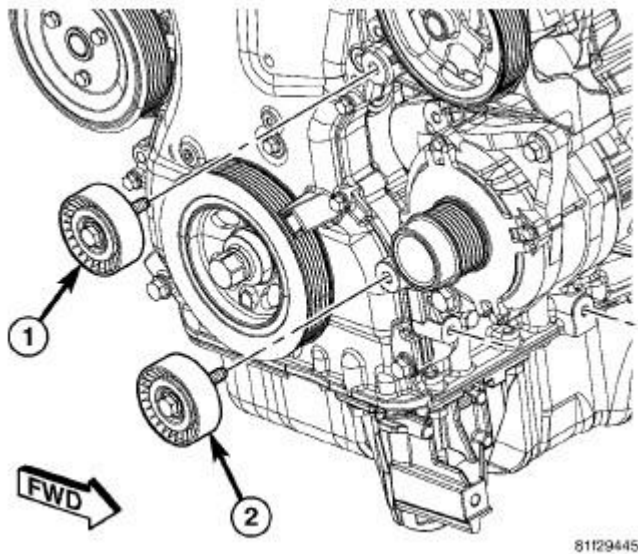
**Fig. 65: Oxygen Sensor Connector, Catalytic Converter & Bolts**  
Courtesy of CHRYSLER LLC

23. Remove exhaust manifold. Refer to **MANIFOLD, EXHAUST, REMOVAL**.
24. Lower vehicle.
25. Support engine with suitable jack.



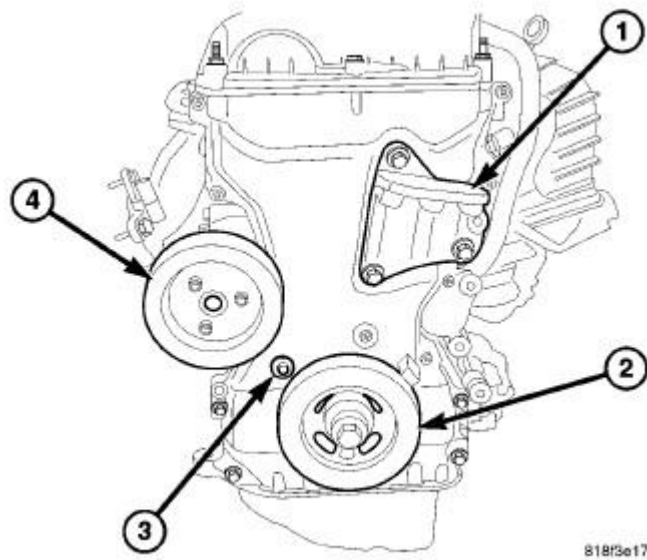
**Fig. 66: Power Steering Hose Hold Down, Right Engine Mount Bracket & Fasteners**  
 Courtesy of CHRYSLER LLC

26. Remove right engine mount bracket retaining bolts (4).
27. Remove retaining nuts (2) and reposition mount bracket (1).



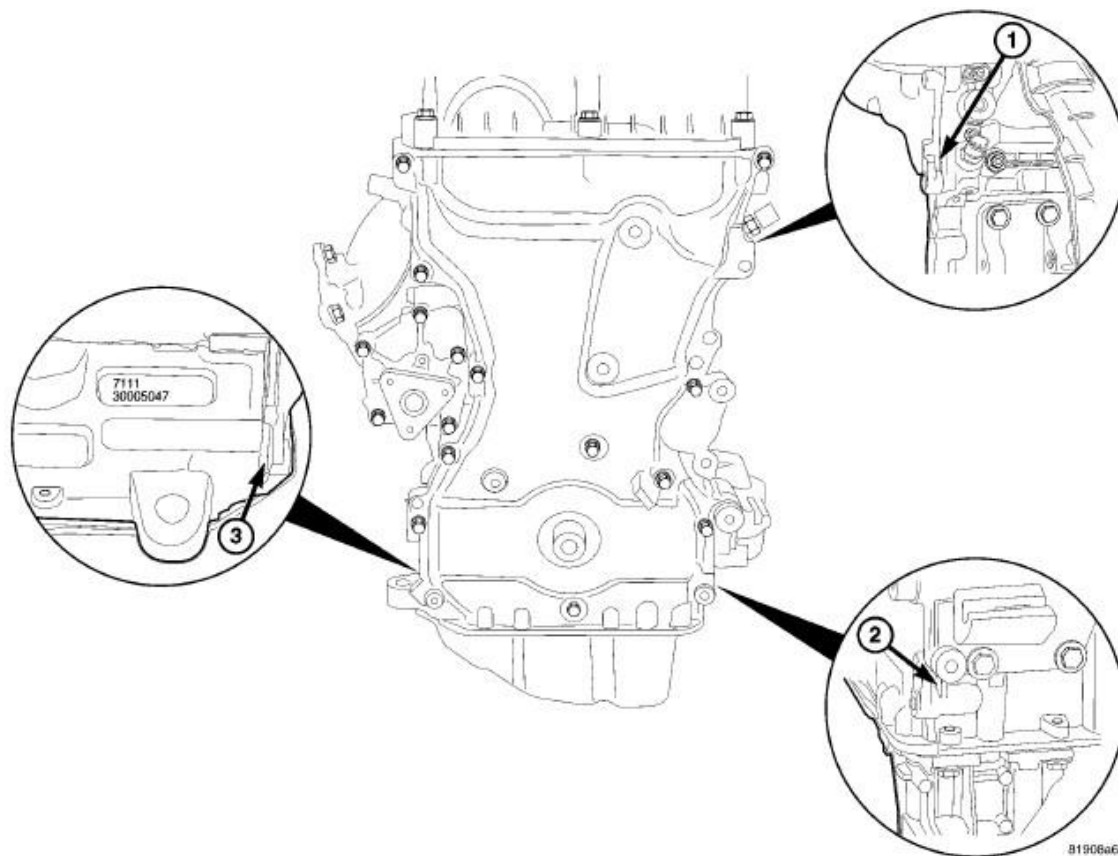
**Fig. 67: Removing/Installing Accessory Drive Belt Upper & Lower Idler Pulley**  
 Courtesy of CHRYSLER LLC

28. Remove accessory drive upper idler pulley (1).



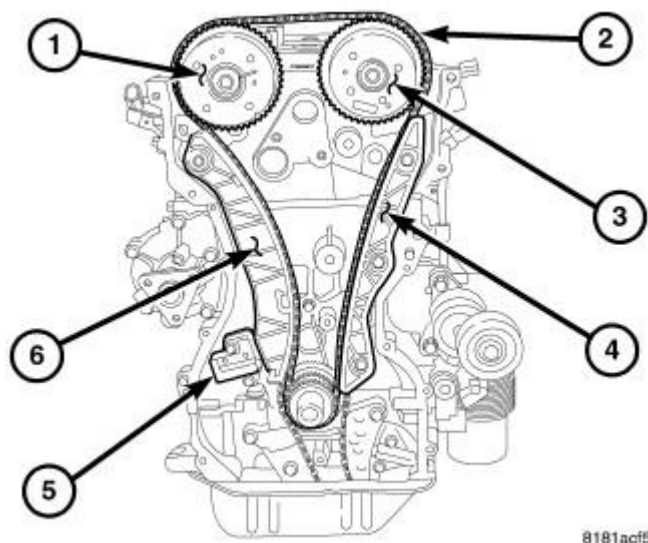
**Fig. 68: Right Side Engine Mount Bracket, Crankshaft Damper & Water Pump Pulley**  
Courtesy of CHRYSLER LLC

29. Remove right upper engine mount bracket (1).
30. Remove accessory drive belt tensioner.
31. Remove upper timing chain cover retaining bolts.



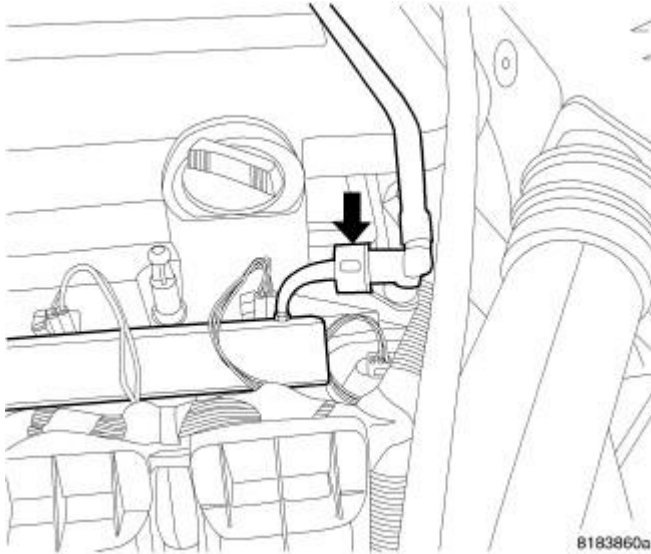
**Fig. 69: Timing Chain Cover Pry Points**  
Courtesy of CHRYSLER LLC

32. Remove timing chain cover using pry points (1, 2, 3).



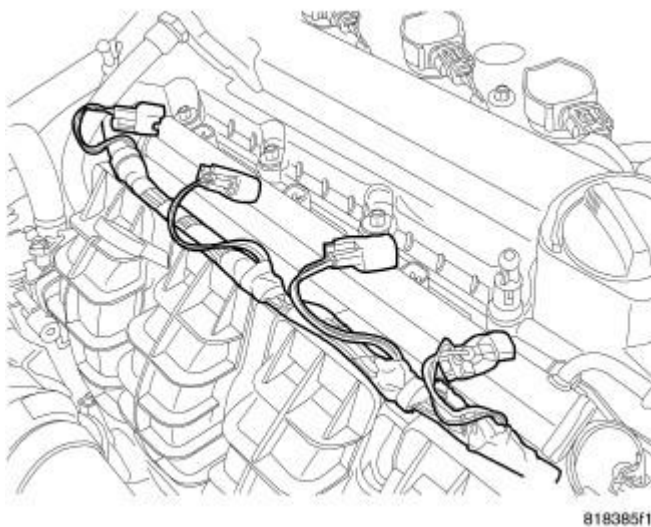
**Fig. 70: Timing Drive System**  
Courtesy of CHRYSLER LLC

33. Remove tensioner (5) and timing chain (2). Refer to **CHAIN AND SPROCKETS, TIMING, REMOVAL**.
34. Remove timing chain guide (4) and timing chain pivot guide (6).



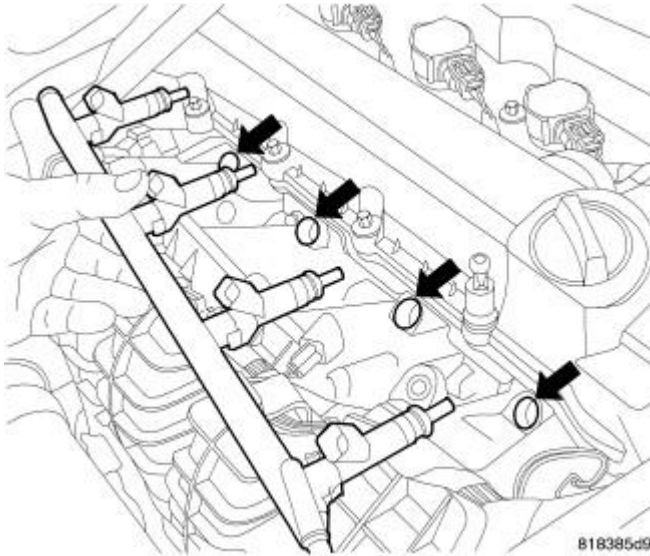
**Fig. 71: Fuel Line At Fuel Rail**  
Courtesy of CHRYSLER LLC

35. Disconnect the fuel line from the fuel rail. Refer to **FITTING, QUICK CONNECT, STANDARD PROCEDURE**.



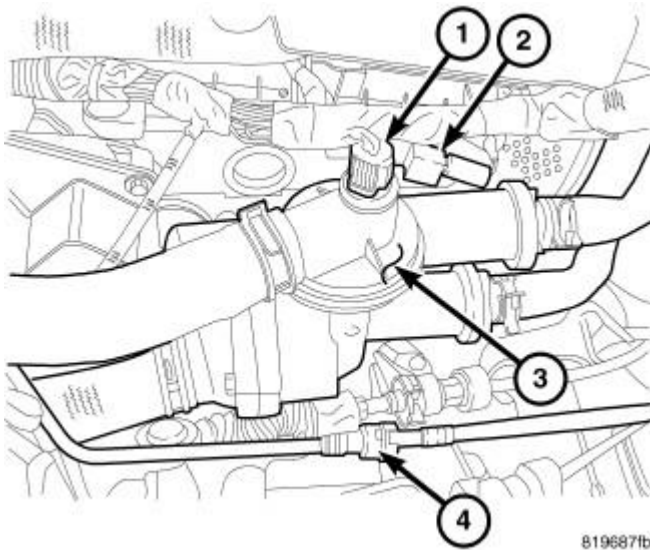
**Fig. 72: Fuel Injector Electrical Connectors**  
Courtesy of CHRYSLER LLC

36. Unlock and disconnect the electrical connectors from the fuel injectors.



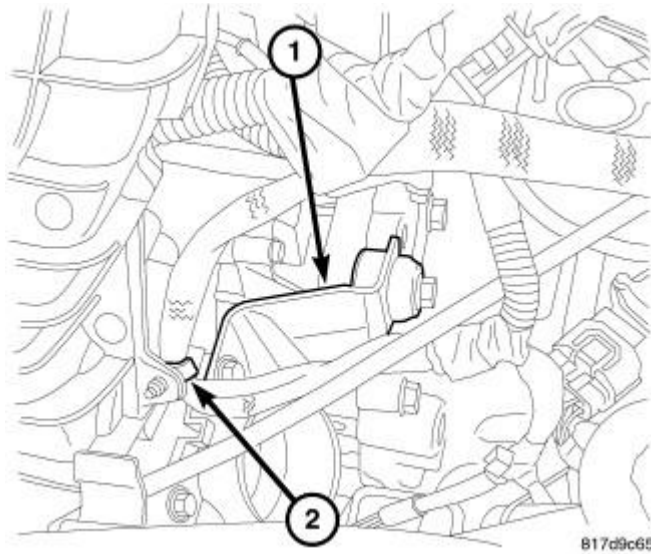
**Fig. 73: Removing/Installing Fuel Rail**  
Courtesy of CHRYSLER LLC

37. Remove two fuel rail retaining bolts and remove fuel rail.



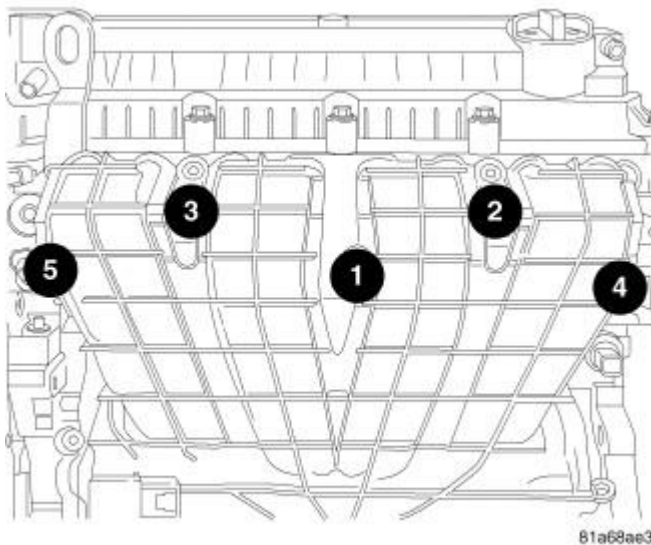
**Fig. 74: Coolant Temperature Sensor Connector, Capacitor Connector & Coolant Adapter**  
Courtesy of CHRYSLER LLC

38. Disconnect electrical connectors from coolant temperature sensor (1), oil temperature sensor, variable valve timing solenoids, camshaft position sensors, MAP sensor, manifold tuning valve, ignition interference suppressor (2) and electronic throttle control.



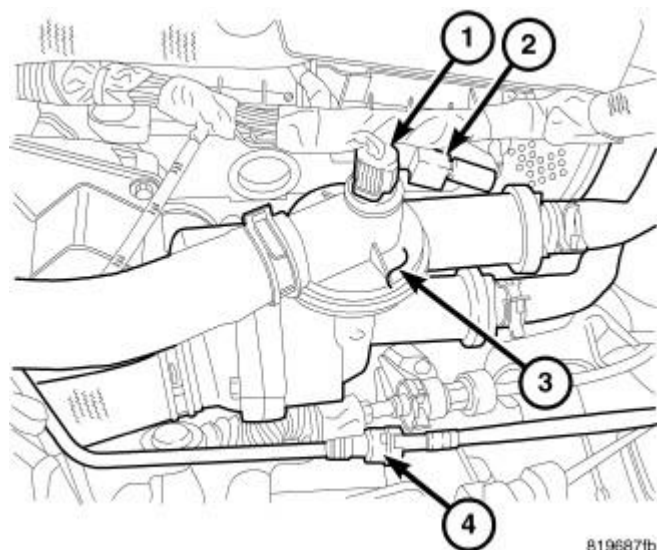
**Fig. 75: Throttle Body Support Bracket & Wiring Harness Retainer**  
 Courtesy of CHRYSLER LLC

39. Remove wiring harness retainer from intake manifold (2) and reposition harness.
40. Remove throttle body support bracket (1).
41. Disconnect vacuum lines at intake.



**Fig. 76: Intake Bolt Removal/Tightening Sequence**  
 Courtesy of CHRYSLER LLC

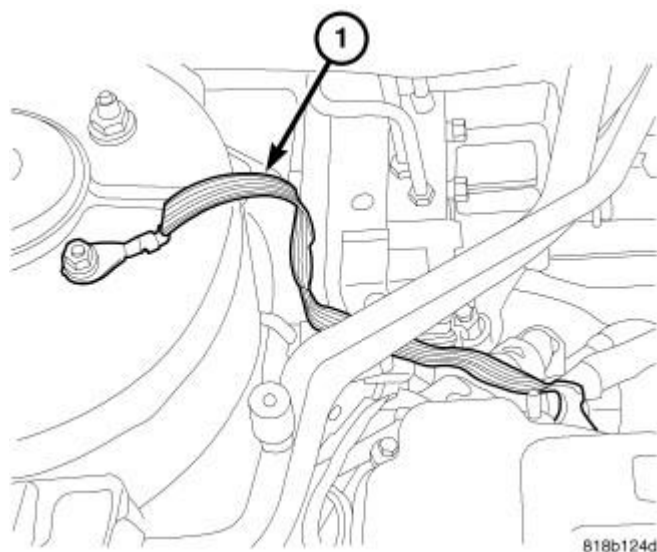
42. Remove intake manifold retaining bolts and remove intake manifold.



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**Fig. 77: Coolant Temperature Sensor Connector, Capacitor Connector & Coolant Adapter**  
Courtesy of CHRYSLER LLC

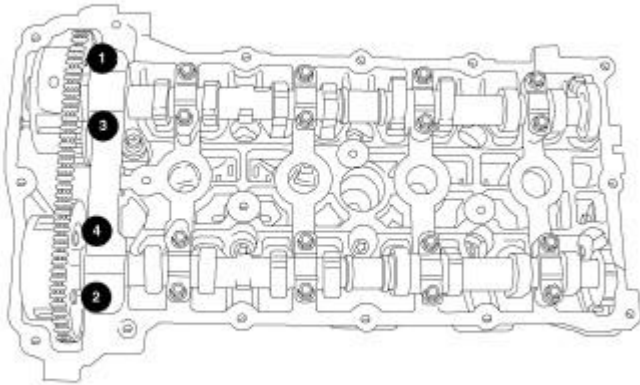
43. Remove four bolts and reposition coolant adapter (3).



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**Fig. 78: Ground Strap**  
Courtesy of CHRYSLER LLC

44. Remove ground strap (1) at right rear of cylinder head if equipped.



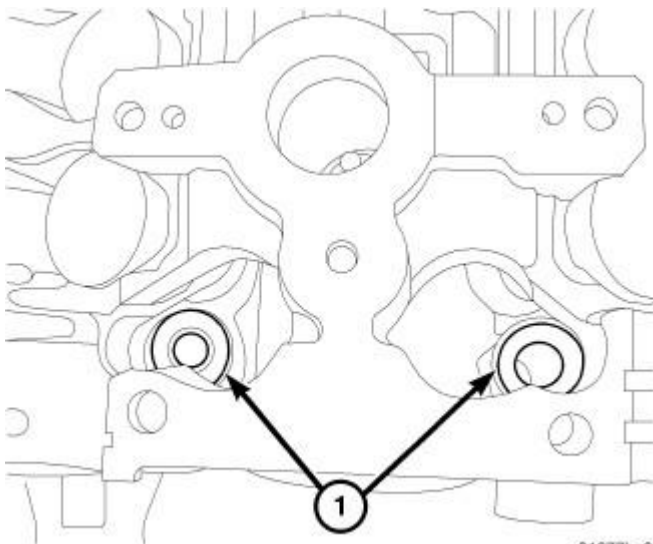
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**Fig. 79: Removing/Installing Front Camshaft Bearing Caps**  
Courtesy of CHRYSLER LLC

**NOTE:** Camshaft bearing caps should have been marked during engine manufacturing. For example, number one exhaust camshaft bearing is marked "E1>".

**CAUTION:** DO NOT use a number stamp or a punch to mark camshaft bearing caps. Damage to bearing caps could occur.

45. Using a permanent ink or paint marker, identify location and position on each camshaft bearing cap.
46. Remove the front camshaft bearing cap.
47. Slowly remove the remaining intake and exhaust camshaft bearing cap bolts one turn at a time.
48. Remove the camshafts.



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**Fig. 80: Front Head Bolt Washers**

Courtesy of CHRYSLER LLC

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

49. Remove cylinder head bolts and two uncaptured washers.
50. Remove cylinder head from engine block.
51. Inspect and clean cylinder head and block sealing surfaces. Refer to Engine/Cylinder Head - Inspection. Refer to Engine/Cylinder Head - Cleaning.

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

**CLEANING****CLEANING**

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

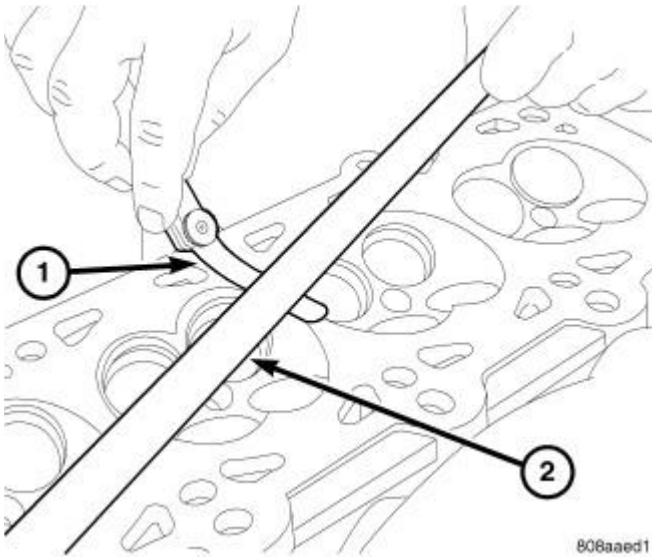
**NOTE:** Multi-Layer Steel (MLS) head gaskets require a scratch free sealing surface.

Remove all gasket material from cylinder head and block. Refer to Engine - Standard Procedure. Be careful not to gouge or scratch the aluminum head sealing surface.

Clean all engine oil passages.

**INSPECTION****INSPECTION**

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



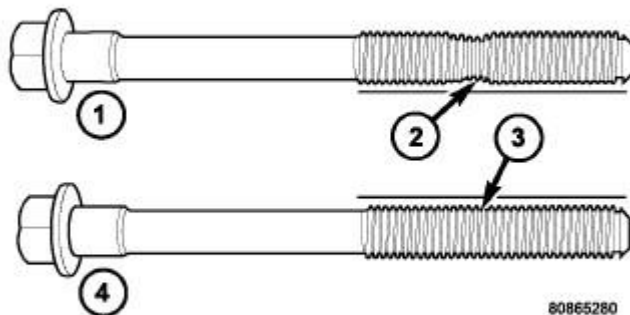
**Fig. 81: Checking Cylinder Head Flatness**

Courtesy of CHRYSLER LLC

1. Check cylinder head warpage with a straight edge (2) and feeler gauge (1).
2. Cylinder head must be flat within 0.1 mm (0.004 in.).
3. Verify that the valve tappets move freely in their bores and that they have been rotating.
4. Inspect camshaft bearing journals for scoring.
5. Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.
6. Inspect the following components and verify that they are within specification : Refer to **Engine - Specifications**.
  - Camshafts
  - Valve Tappets
  - Springs
  - Valve Seats
  - Valve Guides
  - Valves
7. Prior to installing cylinder head, the cylinder block should be checked for flatness. Refer to **Engine/Engine Block - Inspection**.

## INSTALLATION

## INSTALLATION

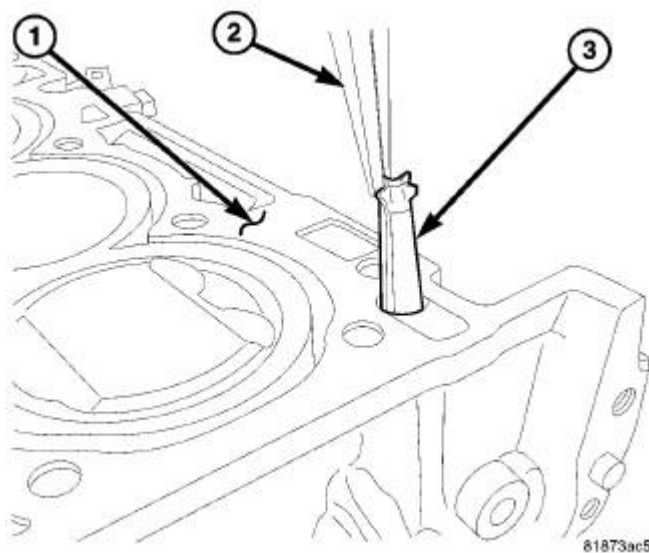


**Fig. 82: Checking Cylinder Head Bolts For Stretching (Necking)**

Courtesy of CHRYSLER LLC

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

1. Check cylinder head bolts for necking by holding a scale or straight edge against the threads. If all the threads do not contact the scale (2) the bolt must be replaced.



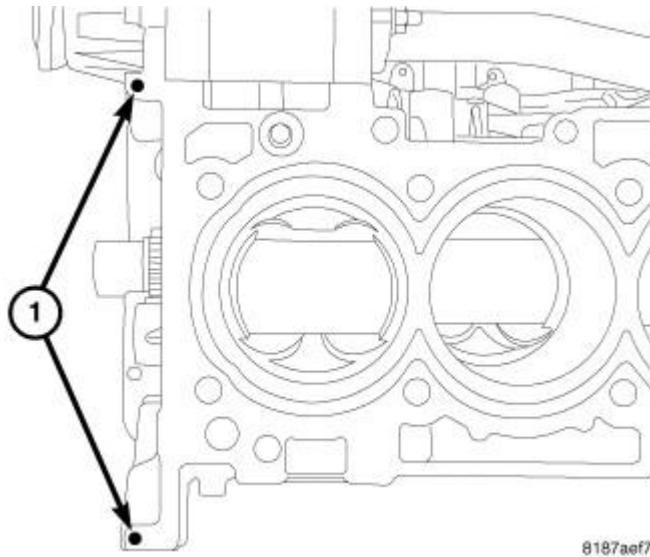
**Fig. 83: Variable Valve Timing Filter Screen**

Courtesy of CHRYSLER LLC

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

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

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

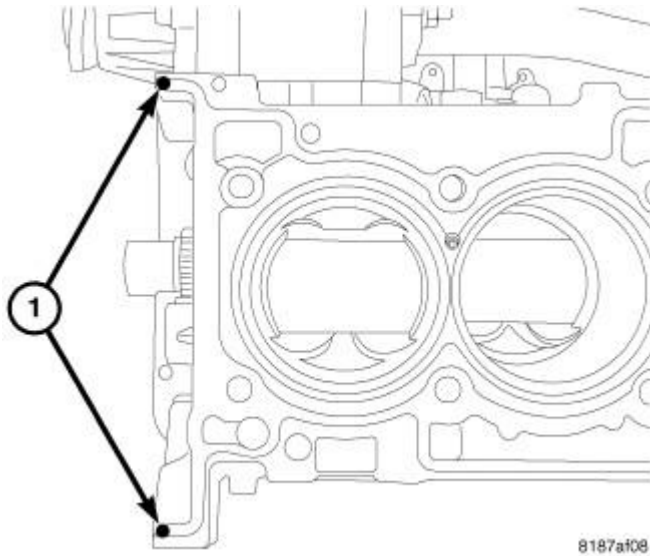


**Fig. 84: Engine Sealant RTV Location**  
Courtesy of CHRYSLER LLC

**NOTE:** When using RTV, the sealing surfaces must be clean and free from grease and oil.

**NOTE:** When using RTV, parts should be assembled in 10 minutes and tighten to final torque within 45 minutes.

3. Place two pea size dots of Mopar® engine sealant RTV or equivalent (1) on cylinder block as shown in illustration.



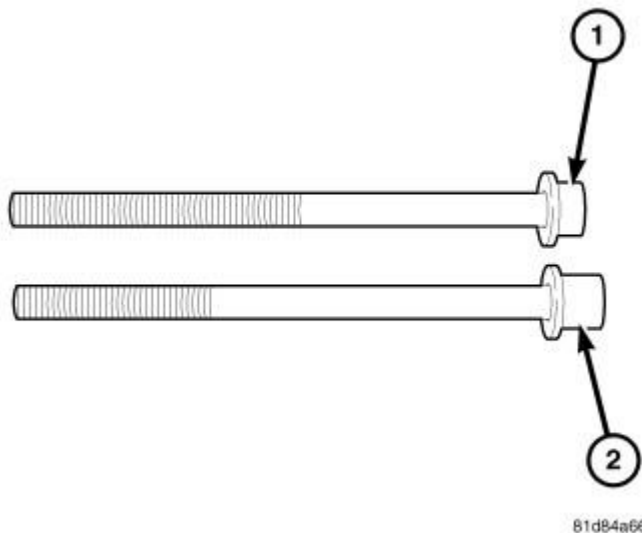
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**Fig. 85: Cylinder Head Gasket RTV**  
Courtesy of CHRYSLER LLC

4. 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.
5. Place two pea size dots of Mopar® engine sealant RTV or equivalent (1) on cylinder head gasket as shown in illustration.

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

6. Position cylinder head onto engine block.

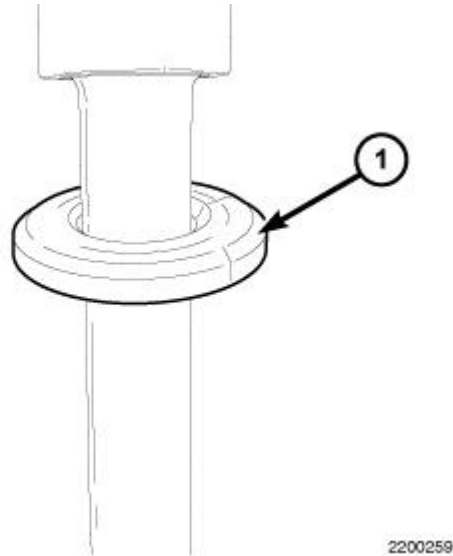


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**Fig. 86: Cylinder Head Bolt Identification**  
Courtesy of CHRYSLER LLC

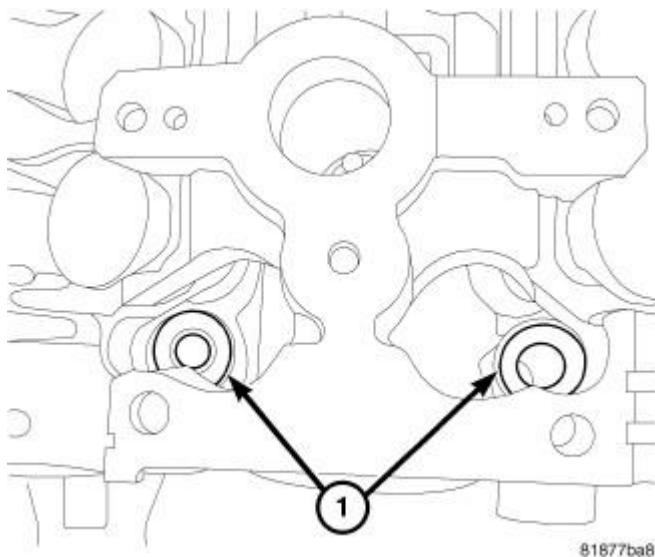
**CAUTION:** This engine was built with 2 different style cylinder head bolts. Each style bolt requires a different torque value. The bolts can be identified by the short bolt head (1) and the long bolt head (2).

7. Measure the bolt head from the washer to the top of the bolt head. The short bolt head (1) measures 8 mm (5/16") and the long bolt head (2) measures 13 mm (1/2").
8. Identify whether your engine has the short head design (1) or the long head design (2).



**Fig. 87: Washers Must Be Installed With Bevel Edge Up Towards Bolt Head**  
 Courtesy of CHRYSLER LLC

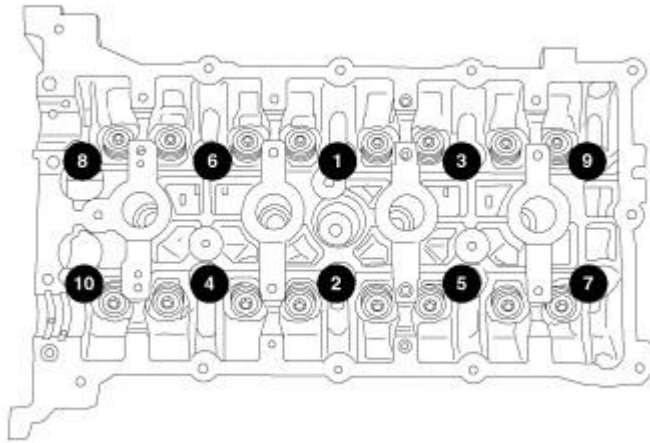
**NOTE:** The front two cylinder head bolts do not have captured washers. The washers must be installed with the bevel edge (1) up towards the bolt head.



**Fig. 88: Front Head Bolt Washers**

Courtesy of CHRYSLER LLC

9. Install washers (1) for the front two cylinder head bolts with the beveled edge facing up.

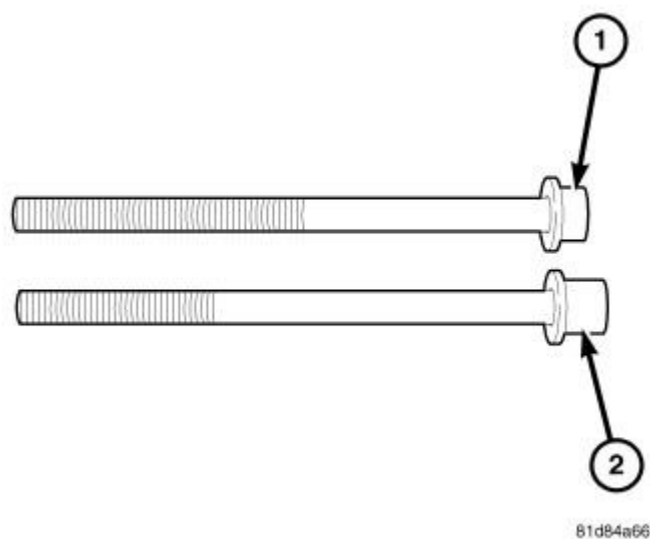


**Fig. 89: Cylinder Head Torque Sequence**

Courtesy of CHRYSLER LLC

**NOTE:** Before installing the cylinder head bolts, lubricate the threads with clean engine oil.

10. Install the cylinder head bolts and tighten in the sequence shown in illustration.



**Fig. 90: Cylinder Head Bolt Identification**

Courtesy of CHRYSLER LLC

11. If your bolt has the short head (1), use the following torque specifications:

- First: All to 30 N.m (25 ft. lbs.)
- Second: All to 61 N.m (45 ft. lbs.)
- Third: All to 61 N.m (45 ft. lbs.)
- Fourth: All an additional 90°

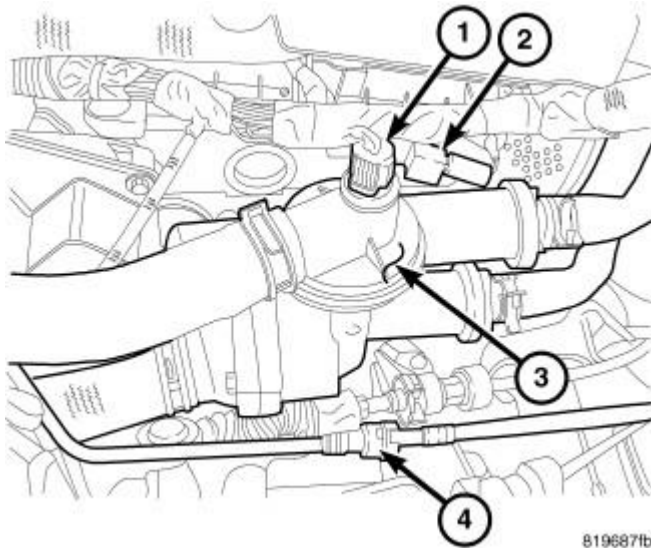
**CAUTION: Do not use a torque wrench for the Fourth step.**

12. If your bolt has the long head (2), use the following torque specifications:

- First: All to 30 N.m (25 ft. lbs.)
- Second: All to 73 N.m (54 ft. lbs.)
- Third: All to 73 N.m (54 ft. lbs.)
- Fourth: All an additional 90°

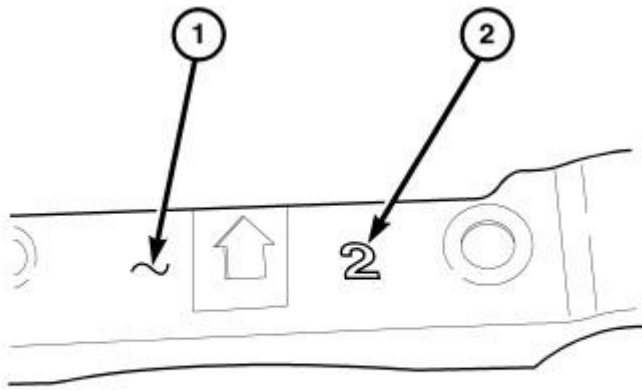
**CAUTION: Do not use a torque wrench for the Fourth step.**

13. Clean excess RTV from the timing chain cover sealing surface.



**Fig. 91: Coolant Temperature Sensor Connector, Capacitor Connector & Coolant Adapter**  
Courtesy of CHRYSLER LLC

14. Install coolant adapter (3) with new seals. Tighten bolts to 18.1 N.m (159 in. lbs.).

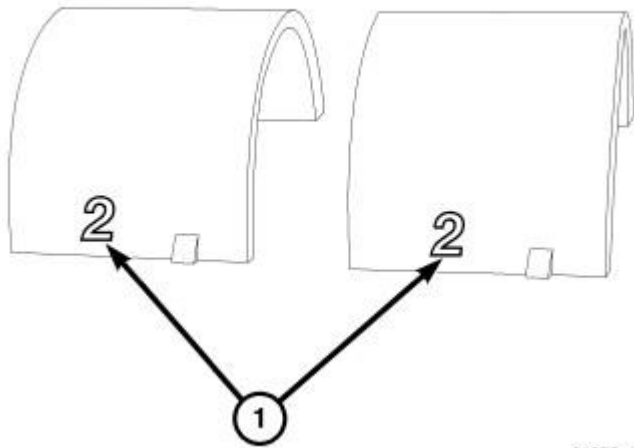


81872c46

**Fig. 92: Cam Cap Bearing Identification**

Courtesy of CHRYSLER LLC

15. The front camshaft bearing cap (1) is numbered (2) either one, two, or three, this corresponds to the select fit front exhaust camshaft bearing to use.

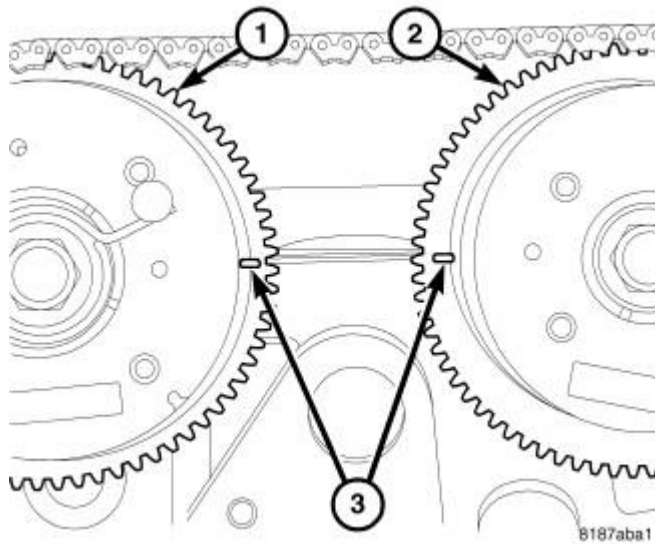


81872c41

**Fig. 93: Cam Bearing Identification**

Courtesy of CHRYSLER LLC

16. Install the corresponding select fit front exhaust camshaft bearing (1).
17. Oil all of the camshaft journals with clean engine oil.

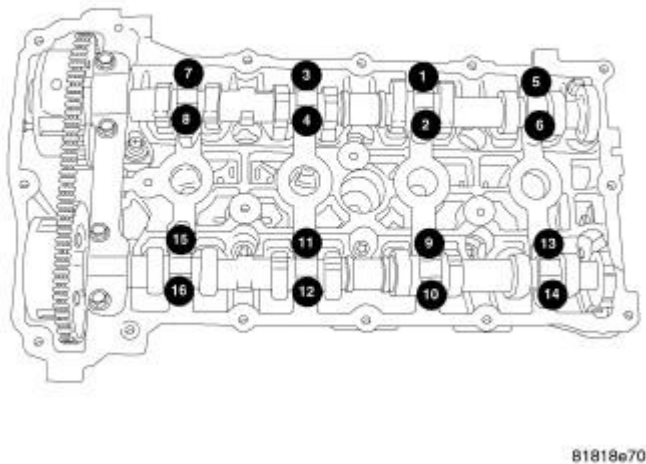


**Fig. 94: Camshaft Timing Marks**  
Courtesy of CHRYSLER LLC

18. Position exhaust camshaft (1) and intake camshaft (2) on bearing journals in the cylinder head.
19. Align camshaft timing marks (3) so that they are facing each other and are in line with the cylinder head cover sealing surface.

**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.

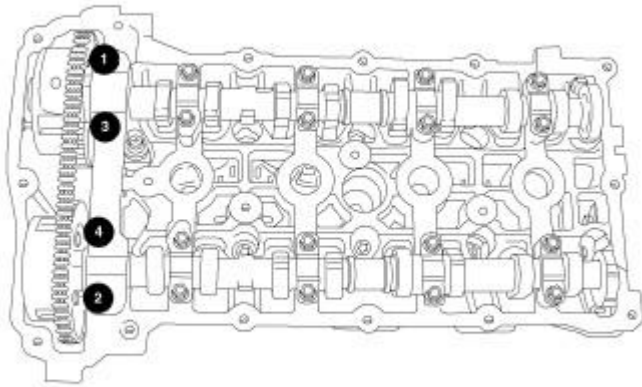
**NOTE:** If the front camshaft bearing cap is broken, the cylinder head **MUST** be replaced.



**Fig. 95: Camshaft Cap Torque Sequence**

Courtesy of CHRYSLER LLC

20. Install intake and exhaust camshaft bearing caps and slowly tighten bolts to 9.5 N.m (85 in. lbs.) in the sequence shown in illustration.



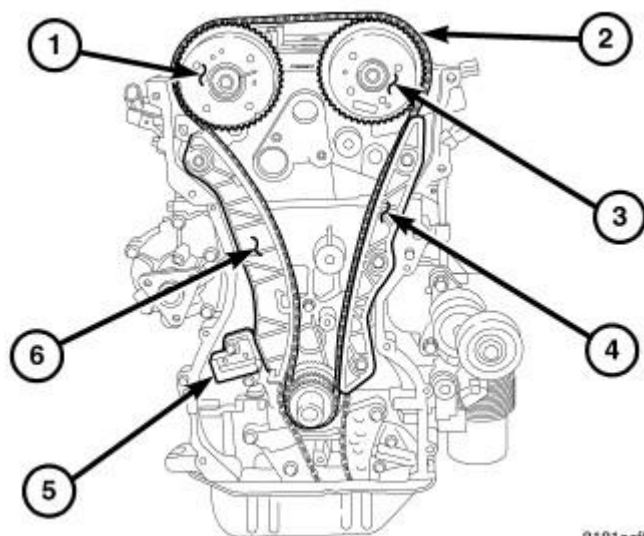
81818e7a

**Fig. 96: Removing/Installing Front Camshaft Bearing Caps**

Courtesy of CHRYSLER LLC

**NOTE:** Verify that the exhaust bearing shells are correctly installed, and the dowels are seated in the head, prior to torquing bolts.

21. Install the front intake and exhaust bearing cap and tighten bolts to 25 N.m (18 ft. lbs.) in the sequence shown in illustration.

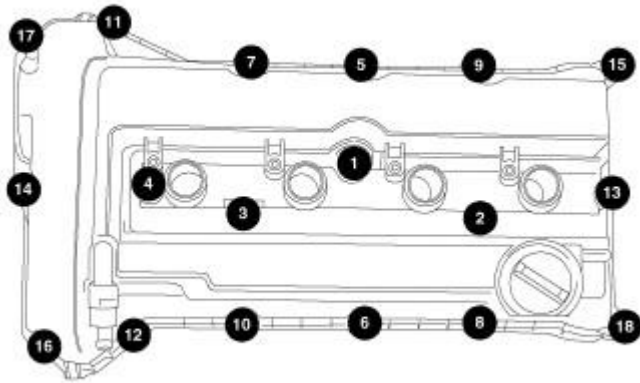


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**Fig. 97: Timing Drive System**

Courtesy of CHRYSLER LLC

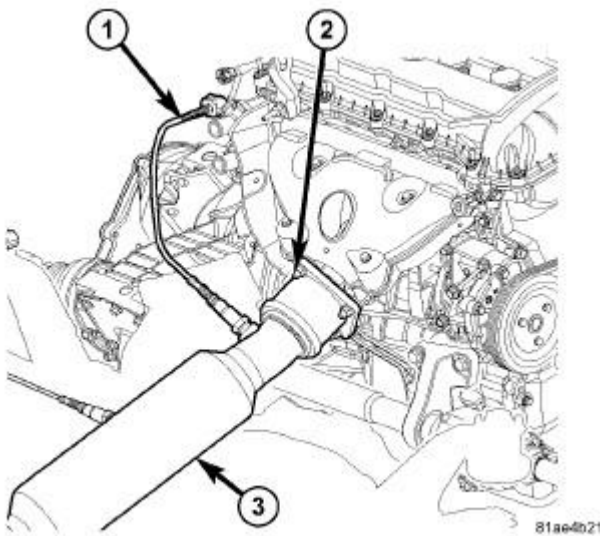
22. Install timing chain guide (4) and tighten bolts to 12 N.m (105 in. lbs.).
23. Install the moveable timing chain pivot guide (6) and tighten bolt to 12 N.m (105 in. lbs.).
24. Install timing chain (2) and tensioner (5). Refer to **CHAIN AND SPROCKETS, TIMING, INSTALLATION**.
25. Install timing chain cover, engine mount, pulleys and accessory drive belt. Refer to **COVER(S), ENGINE TIMING, INSTALLATION**.



8182e337

**Fig. 98: Remove/Install Cylinder Head Cover Bolts In Sequence**  
 Courtesy of CHRYSLER LLC

26. Install cylinder head cover and ignition coils. Refer to **COVER(S), CYLINDER HEAD, INSTALLATION**.

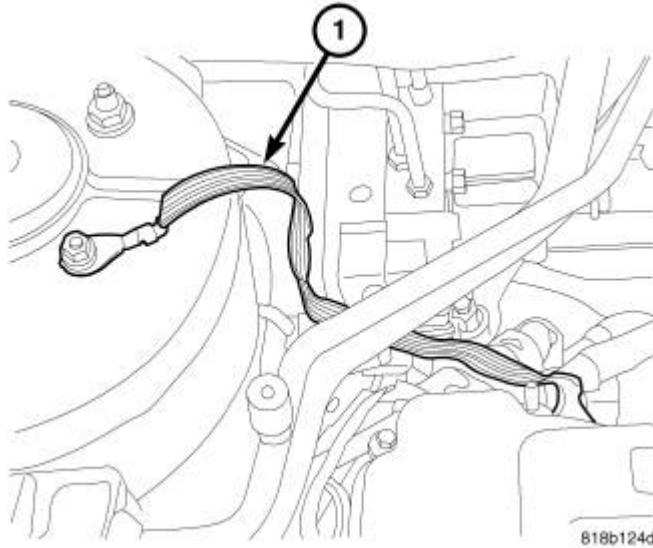


81ae4b21

**Fig. 99: Oxygen Sensor Connector, Catalytic Converter & Bolts**

Courtesy of CHRYSLER LLC

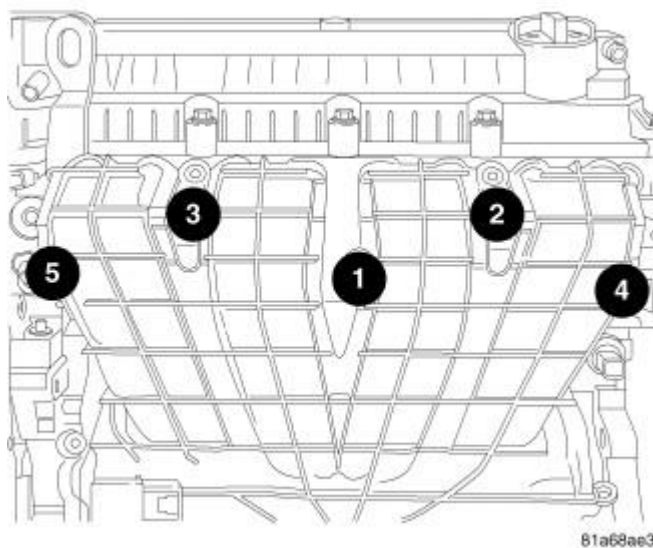
27. Install exhaust manifold. Refer to **MANIFOLD, EXHAUST, INSTALLATION**.



**Fig. 100: Ground Strap**

Courtesy of CHRYSLER LLC

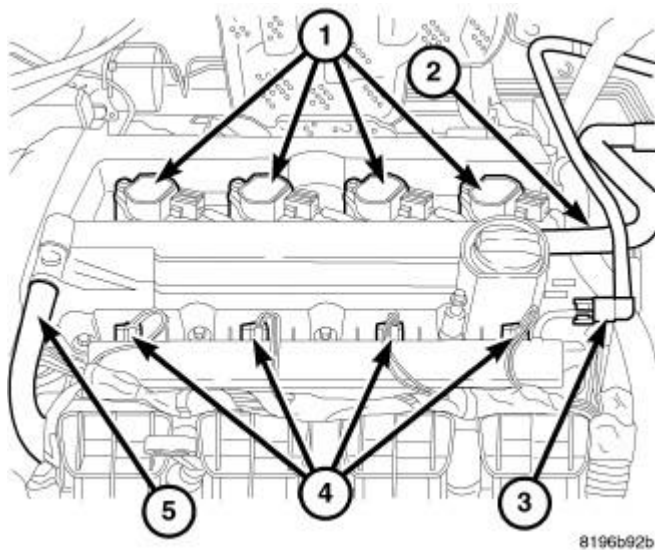
28. Install ground strap (1) at right rear of cylinder head if equipped.



**Fig. 101: Intake Bolt Removal/Tightening Sequence**

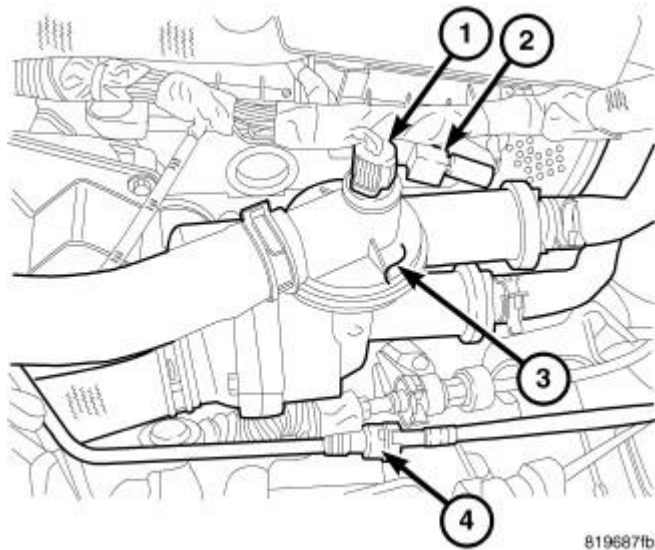
Courtesy of CHRYSLER LLC

29. Install intake manifold, vacuum lines and fuel rail. Refer to **MANIFOLD, INTAKE, INSTALLATION**.



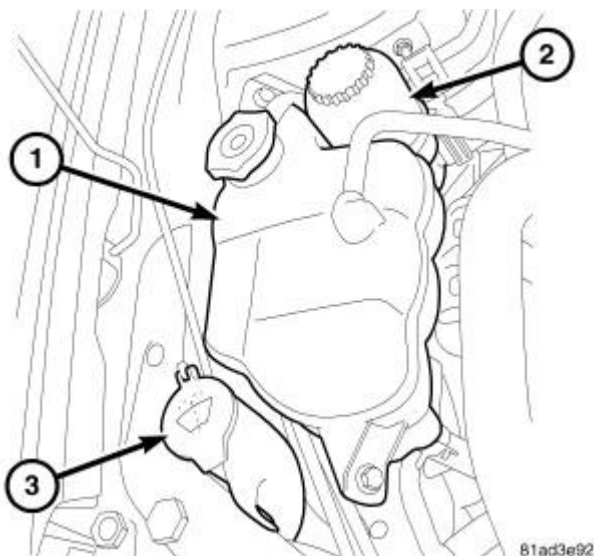
**Fig. 102: Coil Connectors, Air Hose, Fuel Line, Injectors & PCV Hose**  
 Courtesy of CHRYSLER LLC

30. Connect coil (1) and injector (4) electrical connectors.



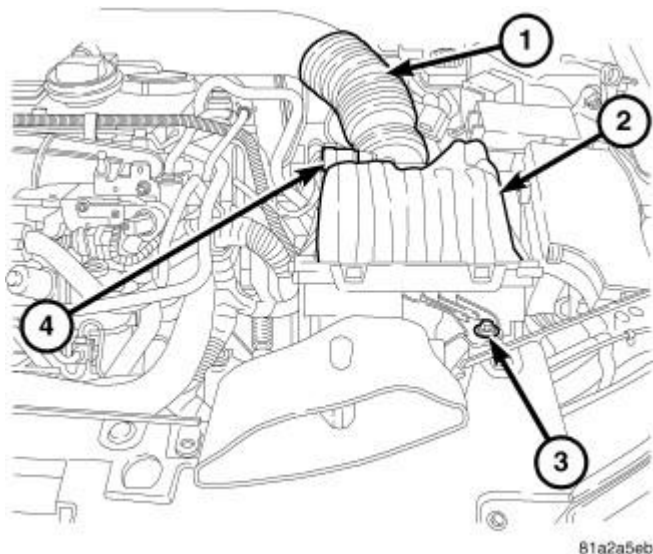
**Fig. 103: Coolant Temperature Sensor Connector, Capacitor Connector & Coolant Adapter**  
 Courtesy of CHRYSLER LLC

31. Connect electrical connectors to coolant temperature sensor (1), camshaft position sensors, oil temperature sensor, variable valve timing solenoids, MAP sensor, manifold tuning valve, ignition interference suppressor (2) and electronic throttle control.



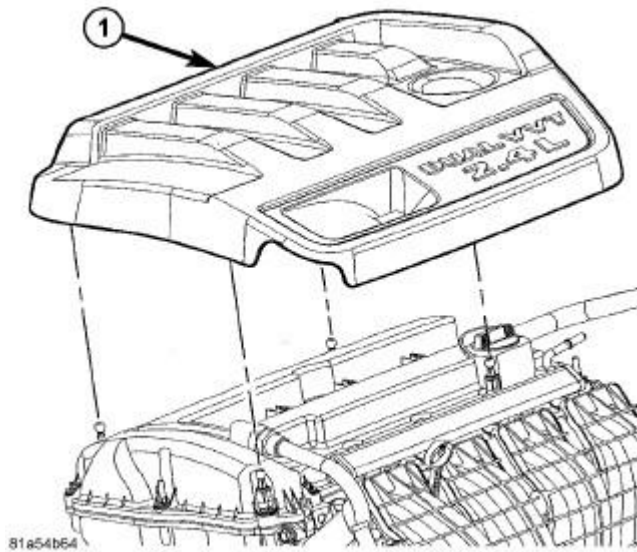
**Fig. 104: Coolant Reservoir, Power Steering Reservoir & Windshield Washer Bottle**  
 Courtesy of CHRYSLER LLC

32. Install power steering pump reservoir (2). Tighten mounting screw to 12 N.m (106 in. lbs.).
33. Install coolant recovery reservoir (1). Tighten mounting bolts to 10 N.m (89 in. lbs.).



**Fig. 105: Air Cleaner Housing & Retaining Bolt**  
 Courtesy of CHRYSLER LLC

34. Install clean air hose (1) and air cleaner housing (2). Refer to **BODY, AIR CLEANER, INSTALLATION**.
35. Fill cooling system. Refer to **STANDARD PROCEDURE**.
36. Install new oil filter and fill engine with oil.
37. Connect negative battery cable.



**Fig. 106: Engine Cover - 2.4L**  
Courtesy of CHRYSLER LLC

38. Operate engine until it reaches normal operating temperature. Check oil and cooling systems for leaks and correct fluid levels.
39. Install engine cover (1).

## ASSEMBLY, VARIABLE VALVE TIMING

### DESCRIPTION

### DESCRIPTION

The world engine is equipped with Variable Valve Timing (VVT). This system advances and/or retards intake and/or exhaust camshaft timing to improve engine performance, mid-range torque, idle quality, fuel economy, and reduce emissions. The camshaft sprockets are integrated with the VVT assemblies and are serviced as an assembly. VVT assemblies are sometimes referred to as camshaft phasers.

### OPERATION

### OPERATION

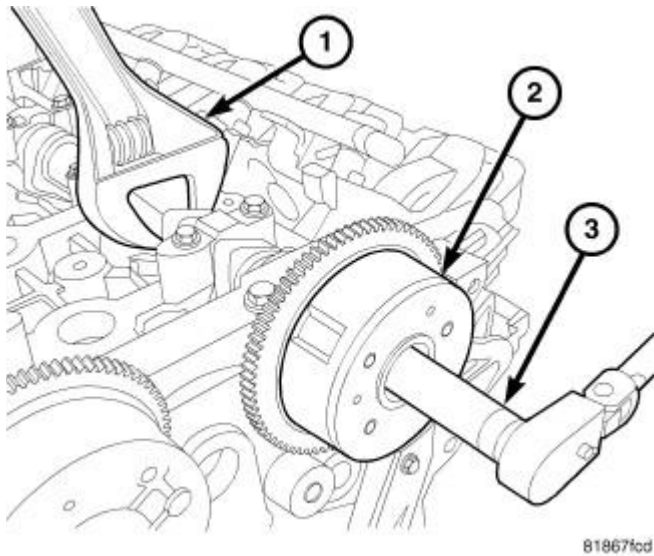
The Variable Valve Timing (VVT) assemblies are actuated with engine oil pressure. The oil flow to the VVT assemblies are controlled by two Oil Control Valves (OCV). There is an OCV and Camshaft Position Sensor (CMP) for each camshaft. The OCV's consist of a Pulse Width Modulated (PWM) solenoid and a spool valve. The PCM actuates the OCV to control oil flow through the spool valve into the VVT assemblies. The VVT assembly consists of a rotor, stator, and sprocket. The stator is connected to the timing chain through the sprocket. The rotor is connected to the camshaft. Oil flow in to the VVT assembly rotates the rotor with respect to the stator, thus rotating the camshaft with respect to the timing chain. Thus, the VVT assemblies change valve timing by changing the relationship between the camshaft and the timing chain. An integral oil pressure activated pin is used to lock base camshaft timing for engine start up. Oil pressure releases the pin and allows

the PCM to control cam timing once the engine is running. An infinitely variable valve timing position can be achieved within the limits of the hardware. The CMP monitors the position of the camshaft with respect to the crankshaft and provides feedback to the PCM.

## REMOVAL

## REMOVAL

**NOTE:** Camshaft phaser and camshaft sprocket are supplied as an assembly, do not attempt to disassemble.

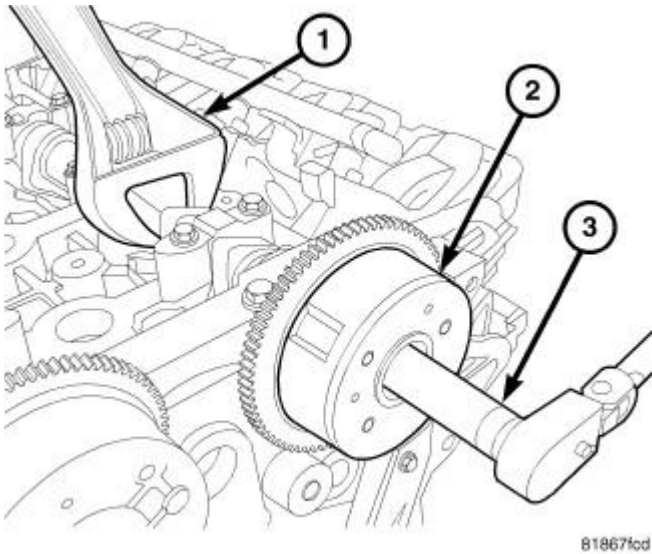


**Fig. 107: Camshafts Phaser Removal/Installation**  
 Courtesy of CHRYSLER LLC

1. Remove camshafts. Refer to **CAMSHAFT, ENGINE, REMOVAL**.
2. Remove camshaft phaser (2) retaining bolt while holding the camshaft in place with a wrench (1) on the camshaft flats.
3. Remove phaser (2) assembly from camshaft.

## INSTALLATION

## INSTALLATION



**Fig. 108: Camshafts Phaser Removal/Installation**  
Courtesy of CHRYSLER LLC

**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.

**NOTE:** Make sure the dowel is seated in the dowel hole and not in a oil feed hole. The dowel hole is larger than the 4 oil feed holes.

2. Install phaser retaining bolt. Hold camshaft in place with a wrench (1) and tighten bolt to 59 N.m (44 ft. lbs.).
3. Install camshafts. Refer to **CAMSHAFT, ENGINE, INSTALLATION.**

## BUCKET, TAPPET

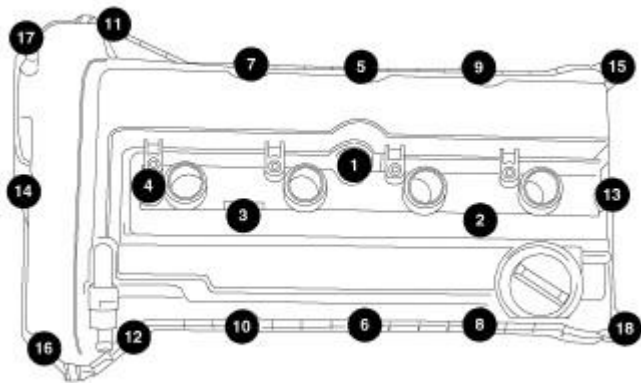
### DIAGNOSIS AND TESTING

#### DIAGNOSIS AND TESTING - MECHANICAL VALVE TAPPET NOISE DIAGNOSIS

A tappet-like noise may be produced from incorrect valve lash. Refer to **BUCKET, TAPPET, STANDARD PROCEDURE.**

### STANDARD PROCEDURE

#### STANDARD PROCEDURE - MEASURING VALVE LASH

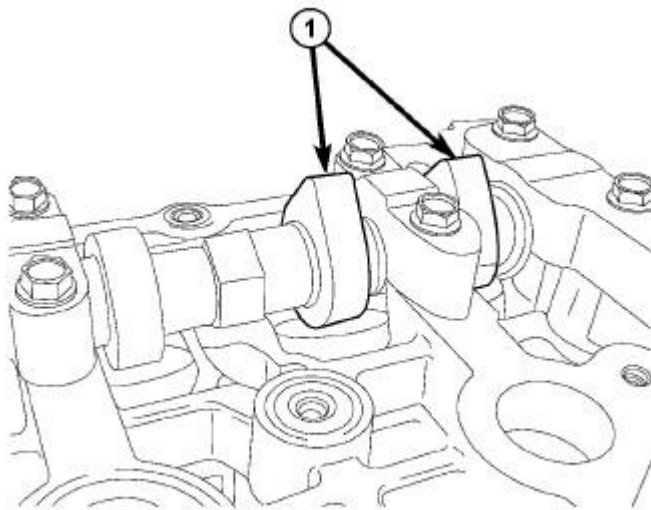


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**Fig. 109: Removing/Installing Cylinder Head Cover Bolts In Sequence**  
Courtesy of CHRYSLER LLC

**NOTE:** The engine must be cold to measure valve lash.

1. Remove engine cover.
2. Remove cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.

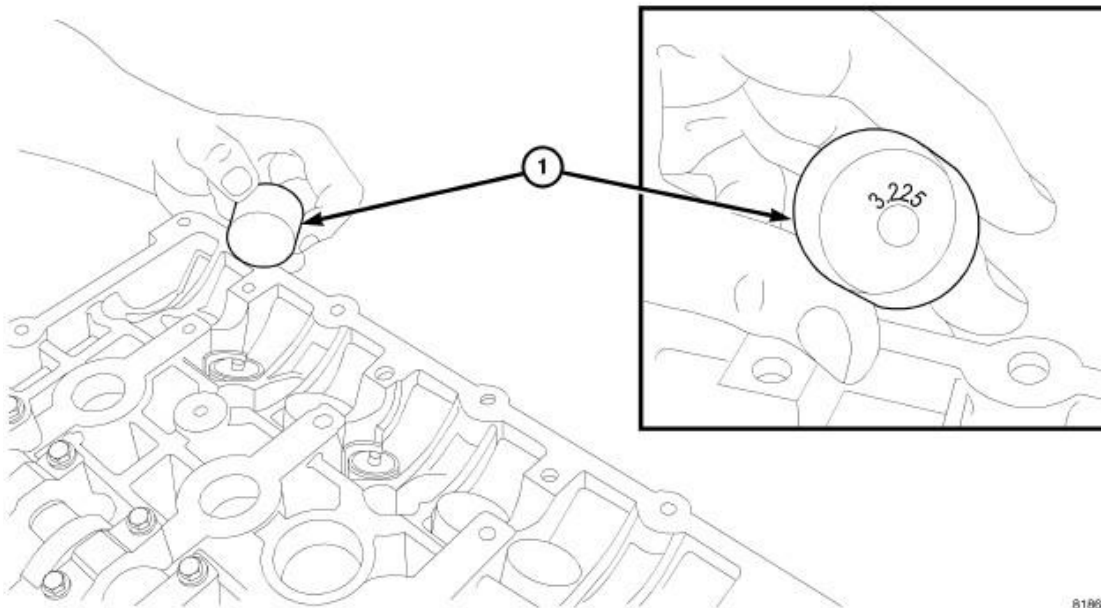


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**Fig. 110: Identifying Camshaft So Lobes Are Vertical**  
Courtesy of CHRYSLER LLC

3. Rotate camshaft so lobes are vertical (1).
4. Check clearance using feeler gauges.
5. Repeat for all tappets and record readings.

6. If clearance was too small, refer to the Clearance too Small procedure. Refer to **CLEARANCE TOO SMALL**.
7. If clearance was too large, refer to the Clearance too Large procedure. Refer to **CLEARANCE TOO LARGE**.

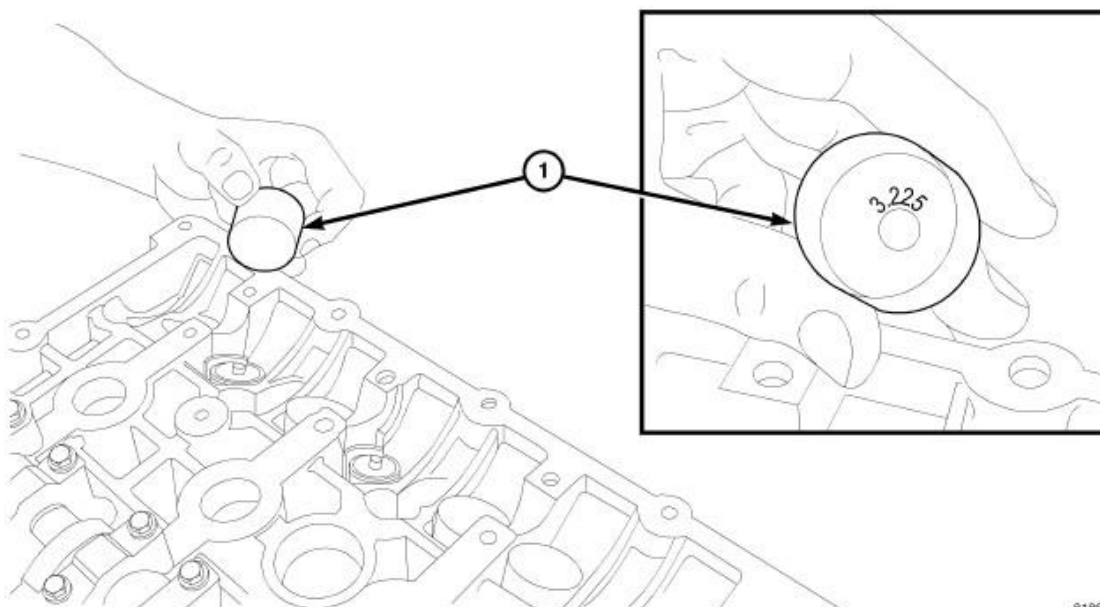
**CLEARANCE TOO SMALL**

61969c56

**Fig. 111: Tappet Identification**  
Courtesy of CHRYSLER LLC

1. Remove camshafts. Refer to **CAMSHAFT, ENGINE, REMOVAL**.
2. Specification - clearance = change.
3. Decrease tappet thickness by change figure.
4. Install camshafts. Refer to **CAMSHAFT, ENGINE, INSTALLATION**.
5. Verify that valve lash is correct.

**CLEARANCE TOO LARGE**



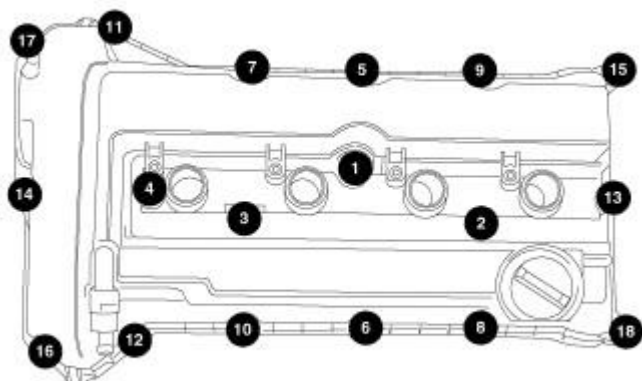
81868c56

**Fig. 112: Tappet Identification**  
Courtesy of CHRYSLER LLC

1. Remove camshafts. Refer to **CAMSHAFT, ENGINE, REMOVAL.**
2. Clearance - specification = change.
3. Increase tappet thickness by change figure.
4. Install camshafts. Refer to **CAMSHAFT, ENGINE, INSTALLATION.**
5. Verify that valve lash is correct.

## REMOVAL

## REMOVAL



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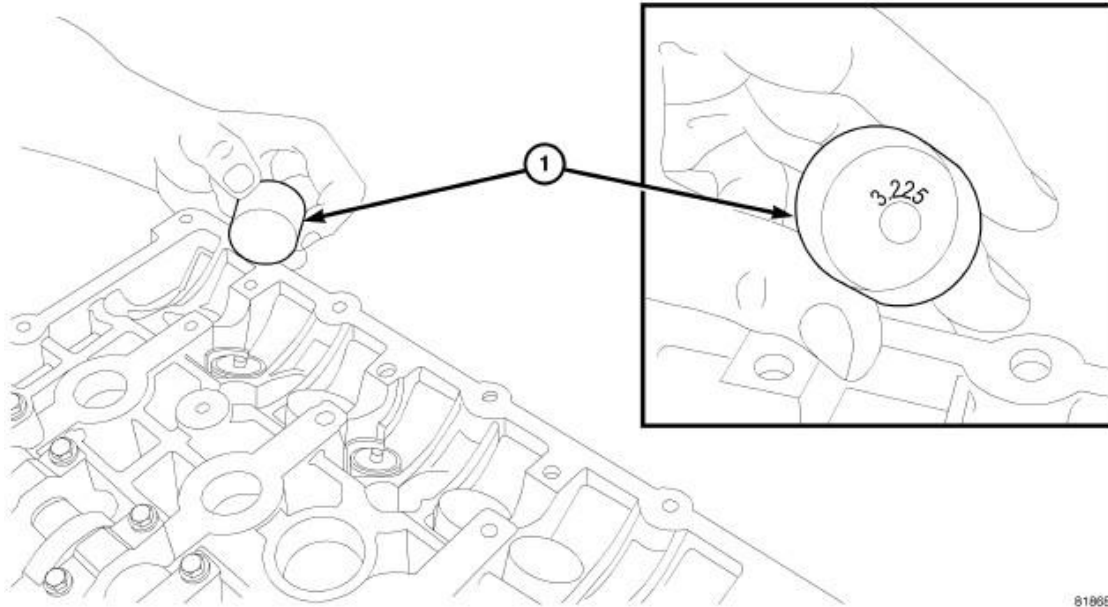
**Fig. 113: Remove/Install Cylinder Head Cover Bolts In Sequence**

Courtesy of CHRYSLER LLC

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

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

1. Remove cylinder head cover. Refer to COVER(S), CYLINDER HEAD, REMOVAL.
2. Remove camshafts. Refer to CAMSHAFT, ENGINE, REMOVAL.



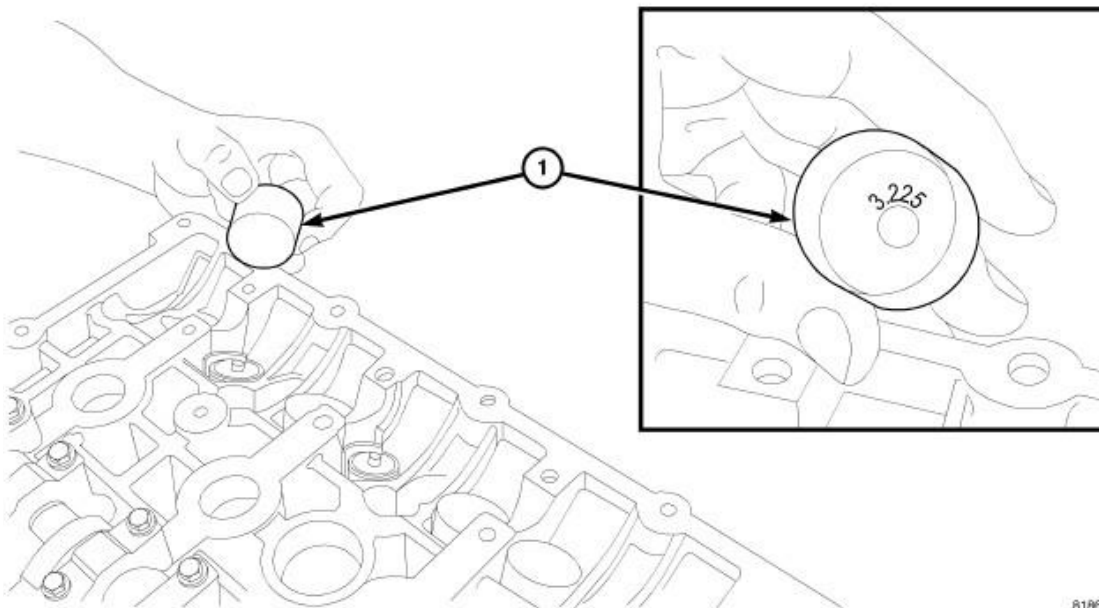
61988c56

**Fig. 114: Tappet Identification**  
Courtesy of CHRYSLER LLC

3. Remove camshaft tappets (1).
4. Repeat removal procedure for each camshaft tappet (1).
5. If reusing, mark each tappet for reassembly in original position.

## INSTALLATION

## INSTALLATION



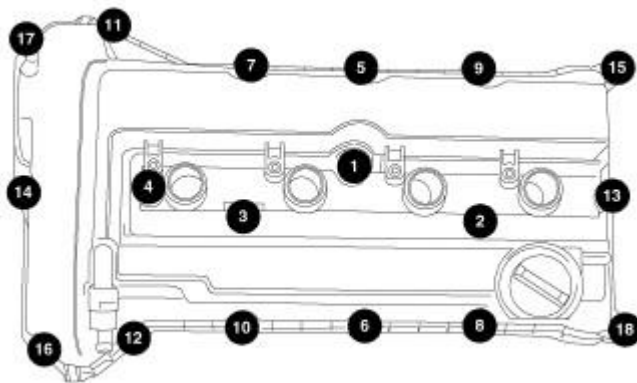
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**Fig. 115: Tappet Identification**  
 Courtesy of CHRYSLER LLC

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

1. Apply a light coat of clean engine oil to camshafts tappets (1) prior to assembly.
2. Install camshaft tappets (1) into cylinder head.
3. Repeat installation procedure for each camshaft tappet.
4. Install camshafts. Refer to **CAMSHAFT, ENGINE, INSTALLATION**.

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



8182a337

**Fig. 116: Remove/Install Cylinder Head Cover Bolts In Sequence**  
Courtesy of CHRYSLER LLC

5. Install cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, INSTALLATION.**

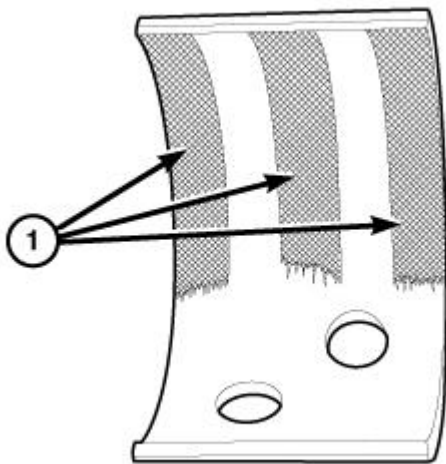
## CAMSHAFT, ENGINE

### DESCRIPTION

### DESCRIPTION

Both camshafts have five bearing journal surfaces and two cam lobes per cylinder. The two front journals are larger to allow for feeding oil to the variable valve timing (VVT) camshaft phasers. Flanges on the third smaller journal control camshaft end play. At the rear of each camshaft is an integral cam sensor target.

### CAMSHAFT BEARING CAPS



1528424

**Fig. 117: Uneven Wear Patterns**  
Courtesy of CHRYSLER LLC

The front cam bearing cap spans both camshafts, and includes dowels for precise alignment. The front exhaust camshaft journal has a select fit bearing insert. This bearing is required to seal the oil passage to the camshaft phaser, because a portion of the lower bearing saddle is machined away for head bolt access. The select fit is required to minimize bearing clearance and oil leakage. An exhaust bearing grade (1, 2, or 3) is stamped into the front bearing cap adjacent to the exhaust cam journal. The bearings are also marked with the corresponding grade markings. If the bearing is replaced, the same grade must be used. Due to the unique purpose of this bearing, it may appear to have uneven wear patterns (1). Maximum wear of 0.05 mm (.002 in.) is acceptable. Unless the wear is excessive it is no cause for concern and the bearing should not be replaced. Cam bearing inspection should not be the sole reason for removal of the exhaust camshaft. The upper cam bearing may be replaced if the front bearing cap is removed. The lower cam bearing should be replaced if the camshaft is removed due to a failure of a component within the cylinder head.

The front intake cam journal has a full lower bearing saddle, and therefore, no bearing insert is required.

All small bearing caps have a formed-in arrow to assist in assembly. All small bearing cap arrows must point towards the center of the cylinder head. The small bearing caps are marked for position during the manufacturing process, and must be reinstalled in their original position.

The #1 small cap includes a passage to direct oil from the cylinder head oil gallery to the #1 small bearing journal, and into the camshaft as well. The hollow camshaft then distributes oil to the remainder of the small journals. Oil flowing out of each cam journal lubricates the valve tappets.

The #3 small cap is machined at the front and rear face to control camshaft end-play. This cap has dowels for precise alignment.

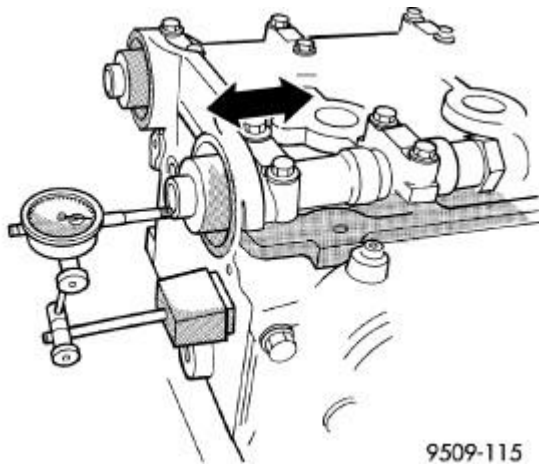
## OPERATION

### 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

### STANDARD PROCEDURE - MEASURING CAMSHAFT END PLAY

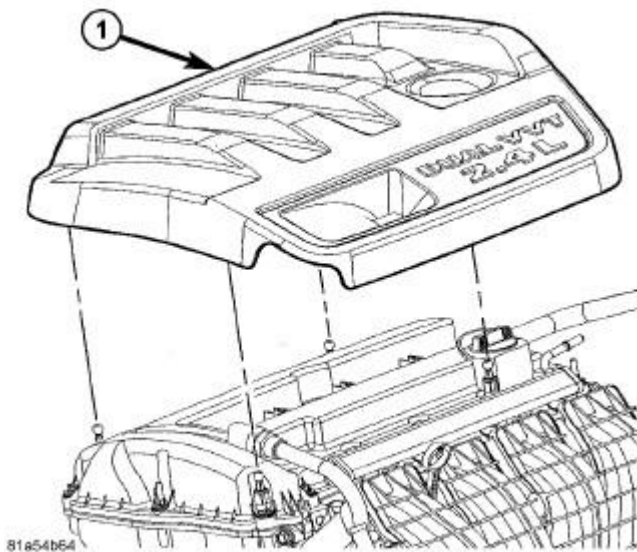


**Fig. 118: Measuring Camshaft End Play**  
Courtesy of CHRYSLER LLC

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 **Engine - Specifications**.
5. If end play is excessive, check cylinder head and camshaft for wear; replace as necessary.

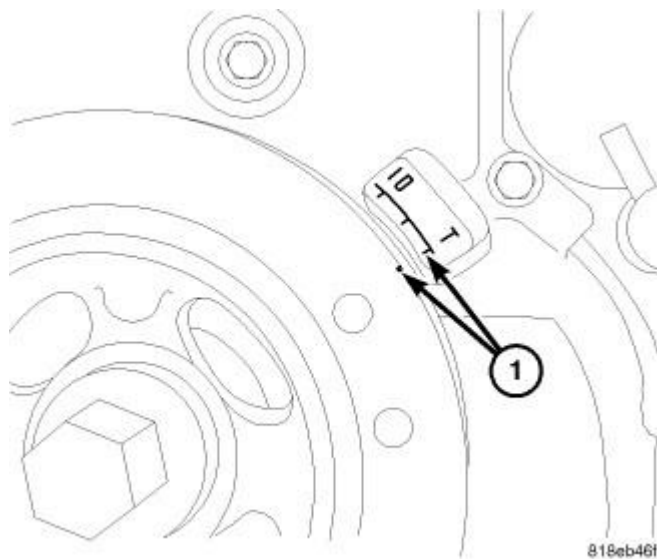
## REMOVAL

## REMOVAL



**Fig. 119: Engine Cover - 2.4L**  
Courtesy of CHRYSLER LLC

1. Remove engine cover (1) by pulling upward.
2. Disconnect and isolate the negative battery cable.
3. Remove cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.

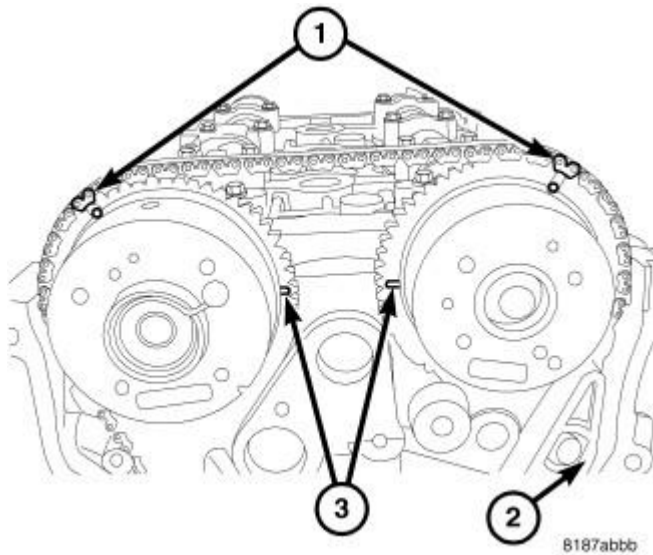


**Fig. 120: TDC**  
Courtesy of CHRYSLER LLC

4. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
5. Remove the frame cover portion of the right splash shield. Refer to **SHIELD, SPLASH, FRONT**.

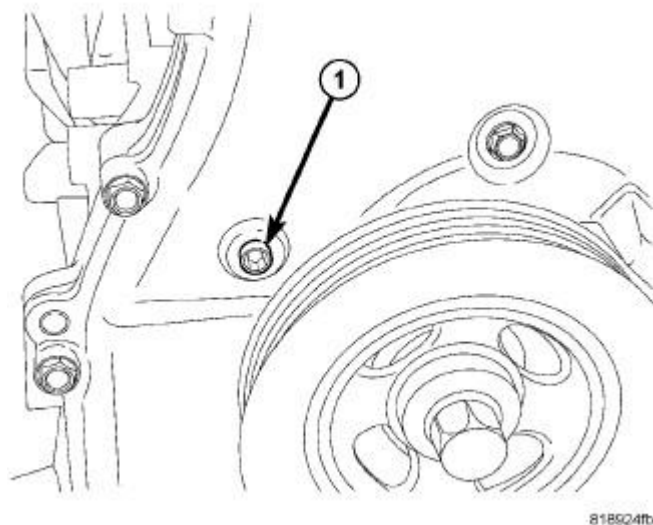
**WHEELHOUSE, REMOVAL and SHIELD, SPLASH, REAR WHEELHOUSE, REMOVAL .**

6. Rotate engine to TDC (1).



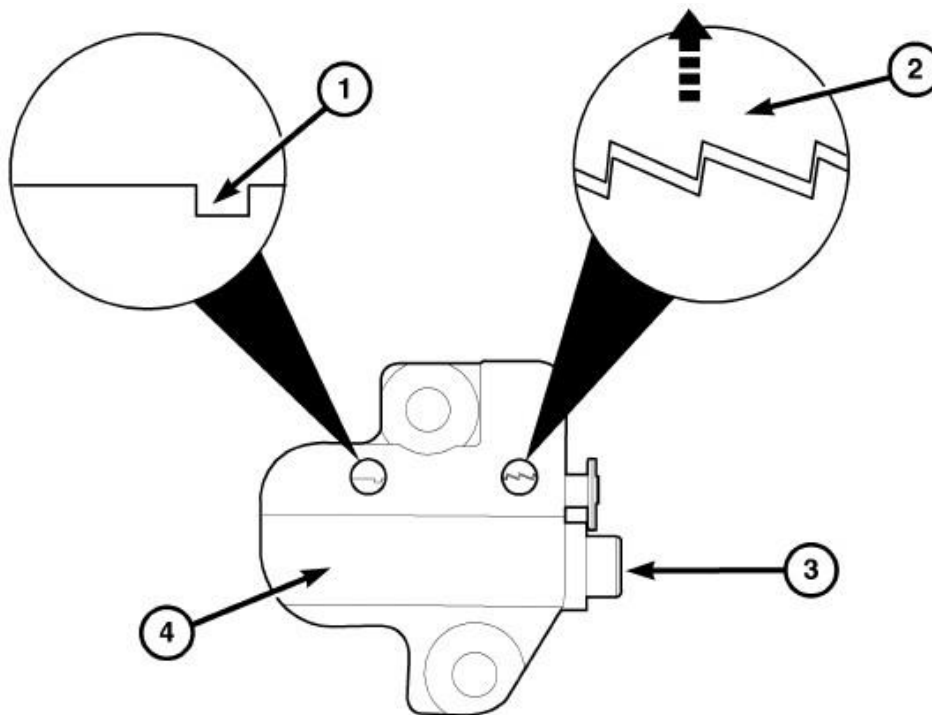
**Fig. 121: Timing Chain Timing Marks**  
Courtesy of CHRYSLER LLC

7. Make sure camshaft timing marks (3) are in line with the cylinder head cover sealing surface.
8. Mark the chain link corresponding to timing marks (1) with a paint marker.



**Fig. 122: Tensioner Access Plug**  
Courtesy of CHRYSLER LLC

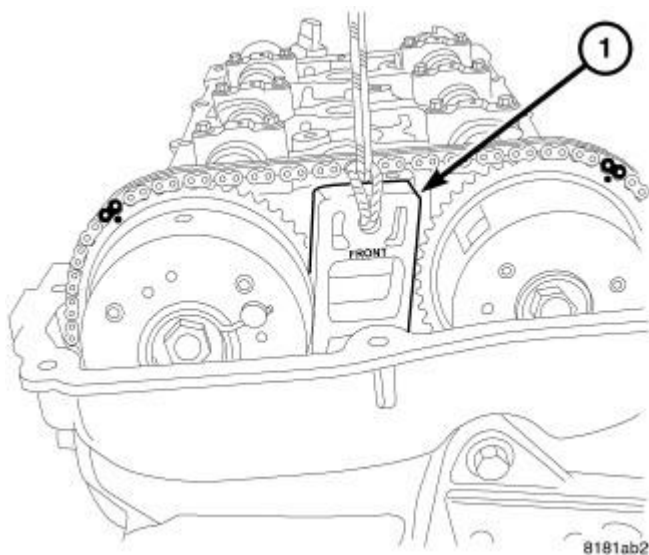
9. Remove timing tensioner plug (1) from front cover.



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**Fig. 123: Tensioner Reset**  
Courtesy of CHRYSLER LLC

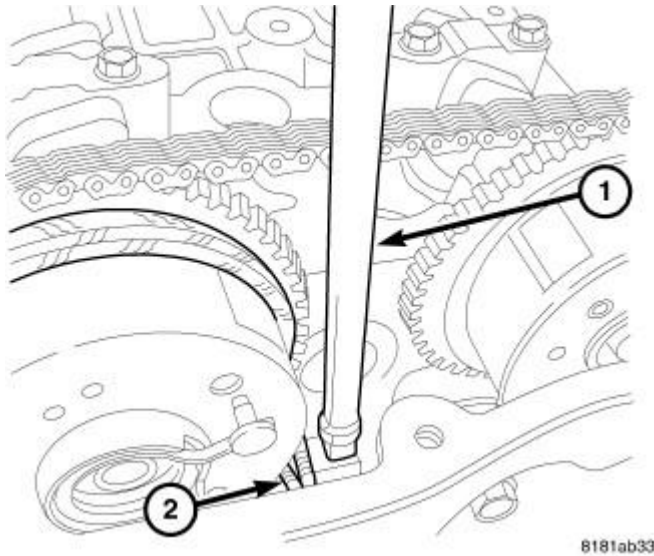
10. Insert small allen wrench through timing tensioner plug hole and lift ratchet (2) upward to release the tensioner and push allen wrench inward. Leave the allen wrench installed during the remainder of this procedure.



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**Fig. 124: Inserting Wedge 9701 Between Camshaft Phasers**  
Courtesy of CHRYSLER LLC

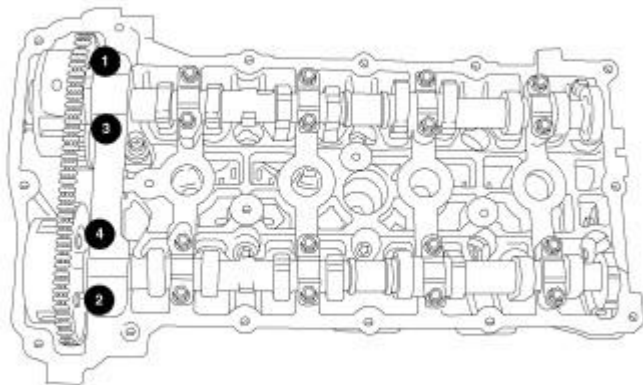
11. Insert Locking Wedge (special tool #9701, Wedge, Locking) (1) between camshaft phasers.



**Fig. 125: Seating Wedge Tool 9701**

Courtesy of CHRYSLER LLC

12. Lightly tap Locking Wedge (special tool #9701, Wedge, Locking) (2) into place until it will no longer sink down.



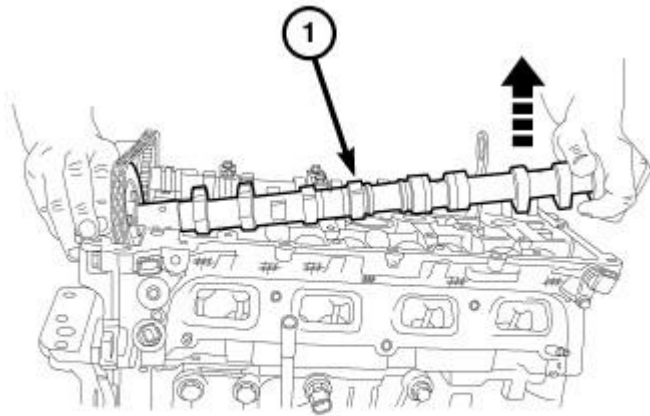
**Fig. 126: Removing/Installing Front Camshaft Bearing Caps**

Courtesy of CHRYSLER LLC

**NOTE:** Camshaft bearing caps should have been marked during engine manufacturing. For example, number one exhaust camshaft bearing is marked "E1>".

**CAUTION:** DO NOT use a number stamp or a punch to mark camshaft bearing caps. Damage to bearing caps could occur.

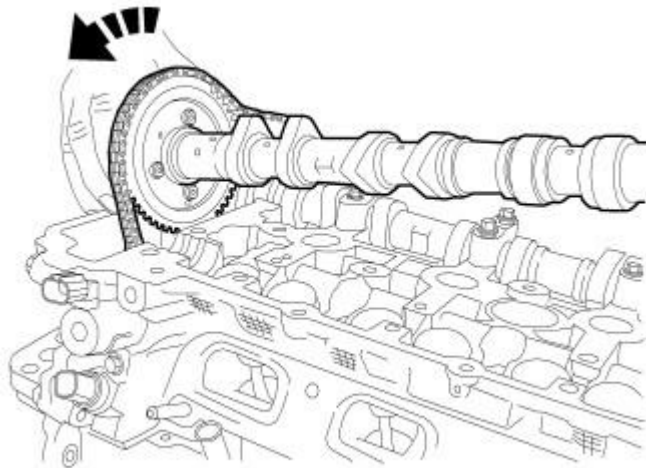
13. Using a permanent ink or paint marker, identify location and position on each camshaft bearing cap.
14. Remove the front camshaft bearing cap.
15. Slowly remove the remaining intake and exhaust camshaft bearing cap bolts one turn at a time.



81819ecc

**Fig. 127: Removing/Installing Intake Camshaft**  
Courtesy of CHRYSLER LLC

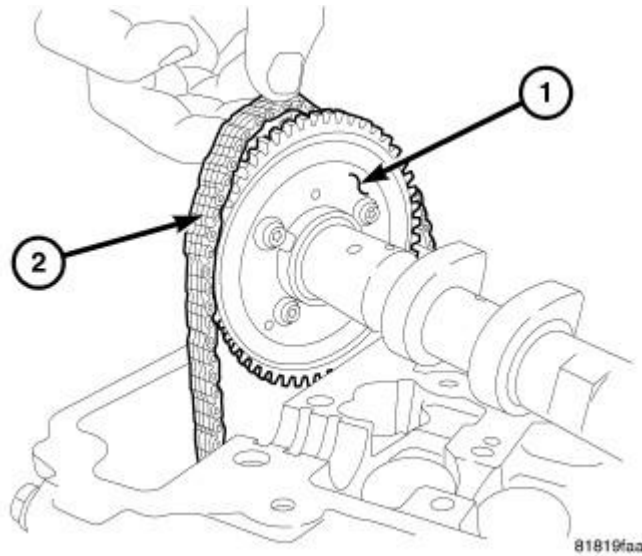
16. Remove intake camshaft (1) by lifting the rear of the camshaft upward.



81819K0F

**Fig. 128: Rotating Camshaft While Lifting Out Of Front Bearing Cradle**  
Courtesy of CHRYSLER LLC

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



**Fig. 129: Chain Removal**  
Courtesy of CHRYSLER LLC

18. Lift the timing chain (2) off the sprocket (1).
19. Remove exhaust camshaft.
20. Secure timing chain with wire so that it does not fall into the timing chain cover.

#### INSPECTION

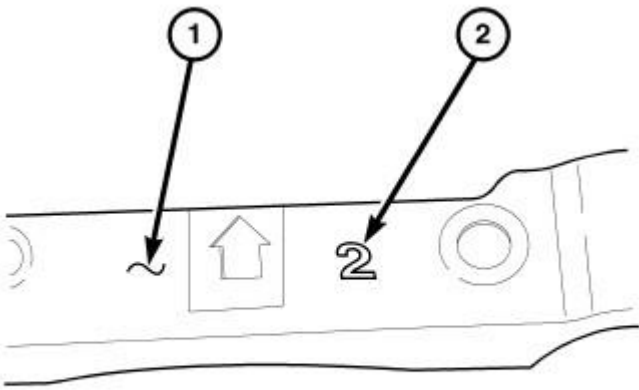
#### INSPECTION

1. Inspect camshaft bearing journals for damage. If journals are damaged, 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

#### INSTALLATION

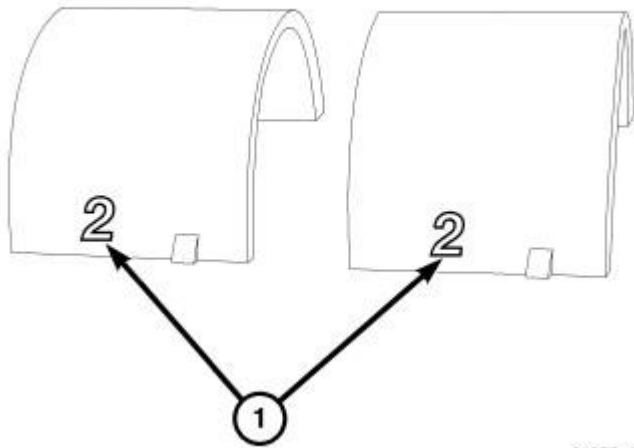


81872c46

**Fig. 130: Cam Cap Bearing Identification**

Courtesy of CHRYSLER LLC

1. The front camshaft bearing cap (1) is numbered (2) either one, two, or three, this corresponds to the select fit front exhaust camshaft bearing to use.

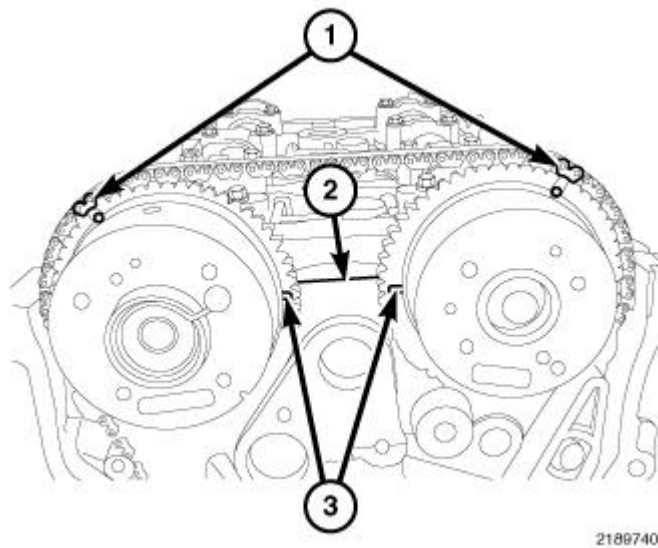


81872c41

**Fig. 131: Cam Bearing Identification**

Courtesy of CHRYSLER LLC

2. Install the corresponding select fit front exhaust camshaft bearing (1).
3. Oil all of the camshaft journals with clean engine oil.
4. Install camshaft phasers on camshafts if removed. Refer to **ASSEMBLY, VARIABLE VALVE TIMING, INSTALLATION**.

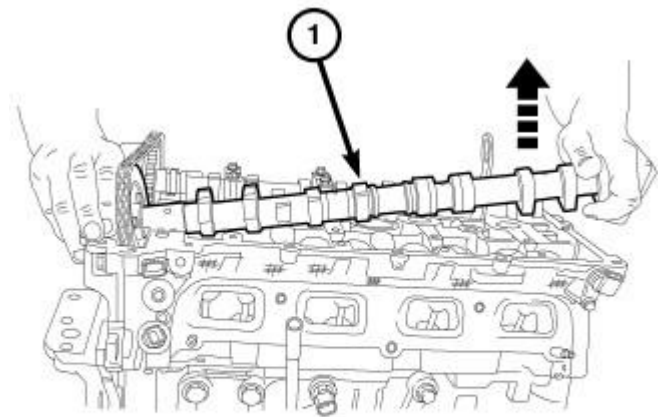


2189740

**Fig. 132: Timing Chain Timing Marks**

Courtesy of CHRYSLER LLC

5. Install timing chain onto exhaust cam sprocket making sure that the timing marks (1) on the sprocket and the painted chain link are aligned.
6. Position exhaust camshaft and on bearing journals in the cylinder head.
7. Align exhaust cam timing mark (3) so it is in line with the cylinder head cover sealing surface (2).

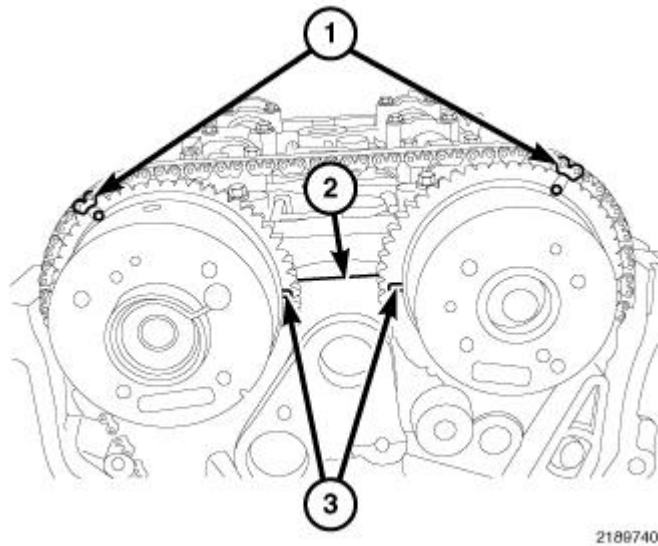


81819eca

**Fig. 133: Removing/Installing Intake Camshaft**

Courtesy of CHRYSLER LLC

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



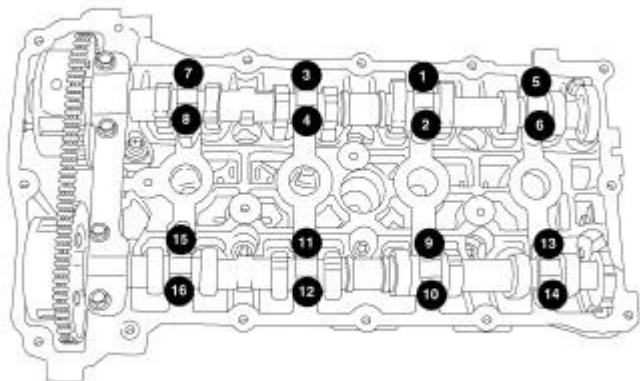
**Fig. 134: Timing Chain Timing Marks**

Courtesy of CHRYSLER LLC

9. Align the timing marks (1) on the intake cam sprocket with the painted chain link.
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 facing each other and are in line with the cylinder head cover sealing surface (2).

**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.

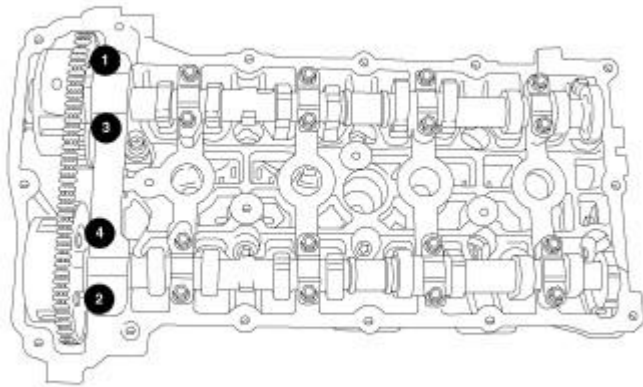
**NOTE:** If the front camshaft bearing cap is broken, the cylinder head **MUST** be replaced.



**Fig. 135: Camshaft Cap Torque Sequence**

Courtesy of CHRYSLER LLC

12. Install intake and exhaust camshaft bearing caps and slowly tighten bolts to 9.5 N.m (85 in. lbs.) in the sequence shown in illustration.



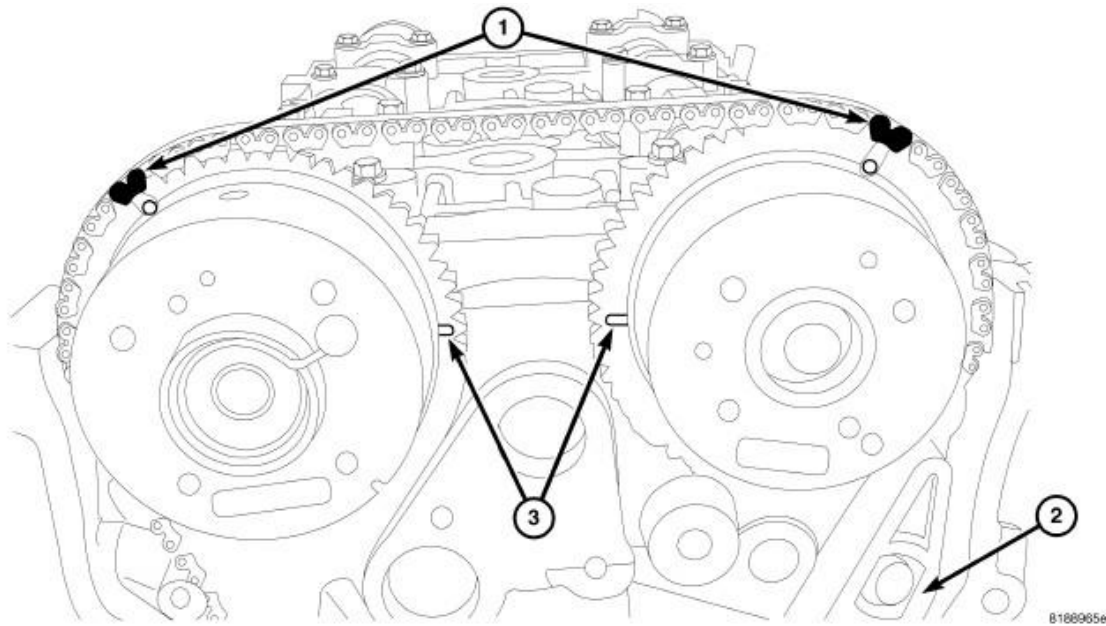
81818e7a

**Fig. 136: Removing/Installing Front Camshaft Bearing Caps**

Courtesy of CHRYSLER LLC

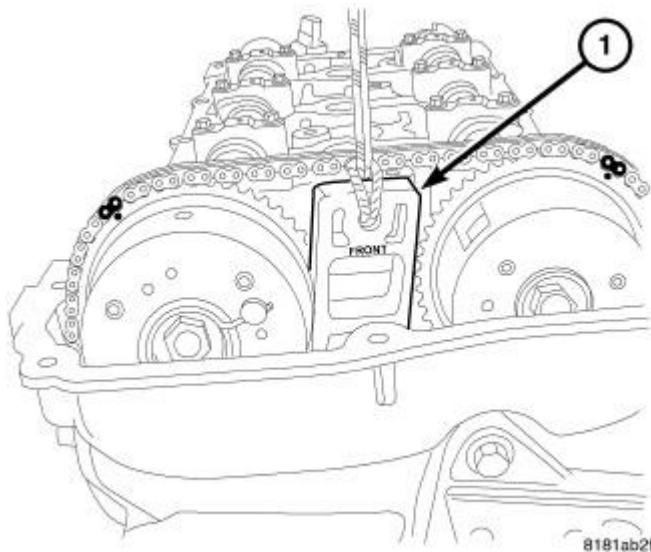
**NOTE:** Verify that the exhaust bearing shells are correctly installed, and the dowels are seated in the head, prior to torquing bolts.

13. Install the front intake and exhaust bearing cap and tighten bolts to 25 N.m (18 ft. lbs.) in the sequence shown in illustration.



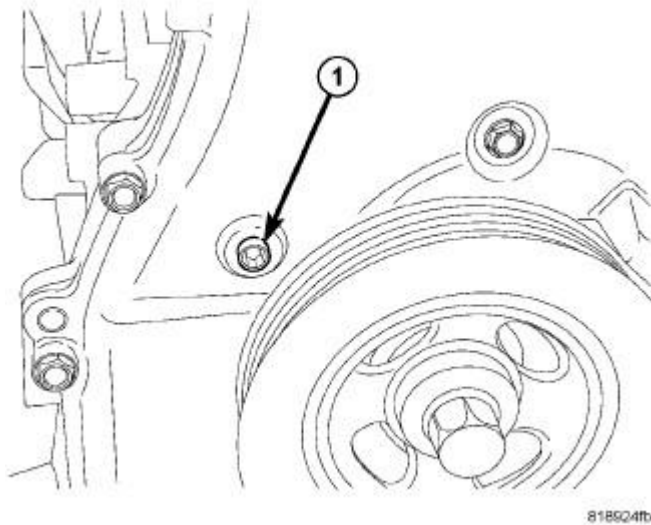
**Fig. 137: Timing Chain Timing Marks**  
Courtesy of CHRYSLER LLC

14. Verify that all timing marks (1, 3) are aligned.
15. Remove allen wrench from timing chain tensioner.



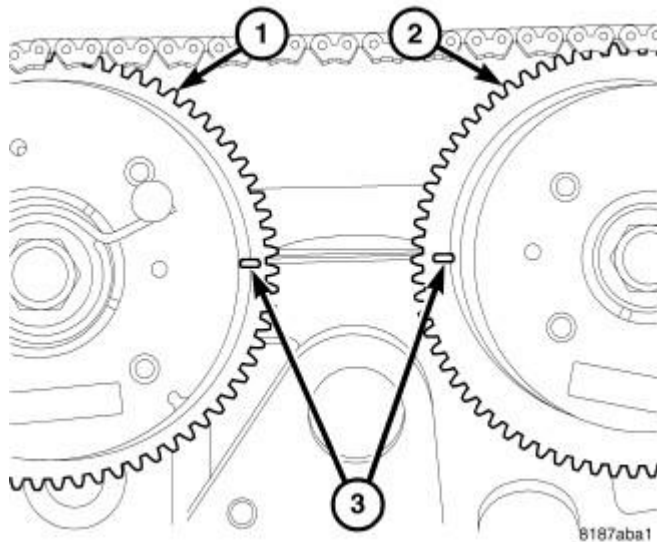
**Fig. 138: Inserting Wedge 9701 Between Camshaft Phasers**  
Courtesy of CHRYSLER LLC

16. Remove Locking Wedge (special tool #9701, Wedge, Locking) (1) by pulling straight upward on pull rope.



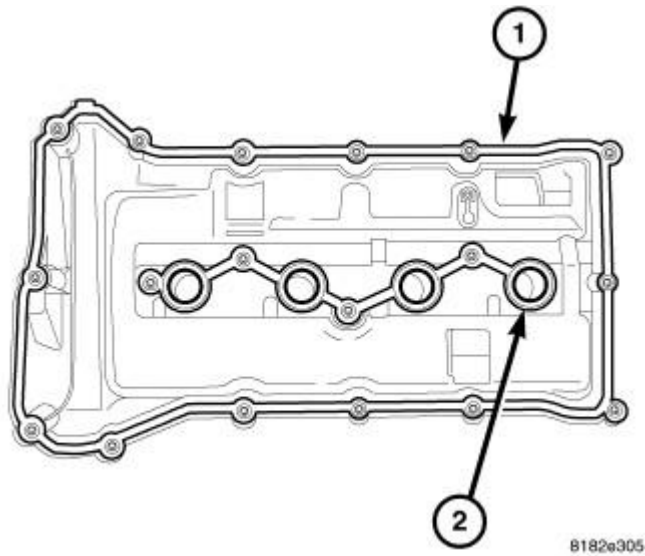
**Fig. 139: Tensioner Access Plug**  
 Courtesy of CHRYSLER LLC

17. Apply MOPAR® thread sealant to timing tensioner plug (1) and Install.
18. Rotate the crankshaft CLOCKWISE two complete revolutions until the crankshaft is repositioned at the TDC position.



**Fig. 140: Camshaft Timing Marks**  
 Courtesy of CHRYSLER LLC

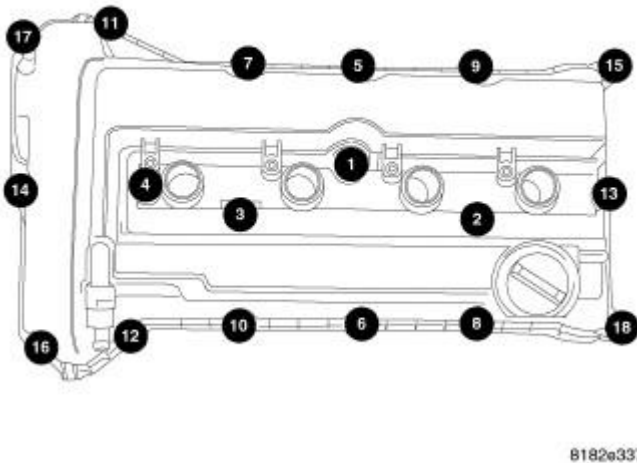
19. Verify that the camshafts timing marks (3) are in the proper position and in line with the cylinder head cover sealing surface. If the marks do not line up, the timing chain is not correctly installed.
20. Install right splash shield. Refer to **SHIELD, SPLASH, FRONT WHEELHOUSE, INSTALLATION** and **SHIELD, SPLASH, REAR WHEELHOUSE, INSTALLATION** .



**Fig. 141: Cylinder Head Cover Gaskets**

Courtesy of CHRYSLER LLC

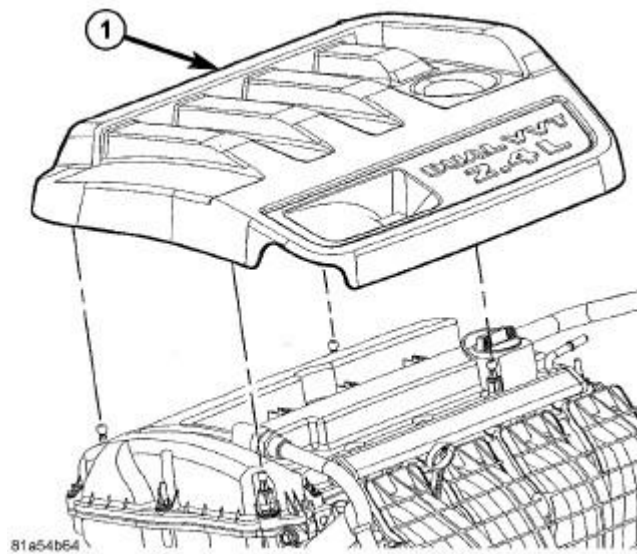
21. Remove RTV from gasket (1).
22. Inspect cylinder head cover gaskets (1, 2) for damage. If no damage is present, gaskets can be re-installed.



**Fig. 142: Remove/Install Cylinder Head Cover Bolts In Sequence**

Courtesy of CHRYSLER LLC

23. Install cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, INSTALLATION.**
24. Connect negative battery cable.
25. Fill cooling system. Refer to **STANDARD PROCEDURE** .
26. Fill with oil.



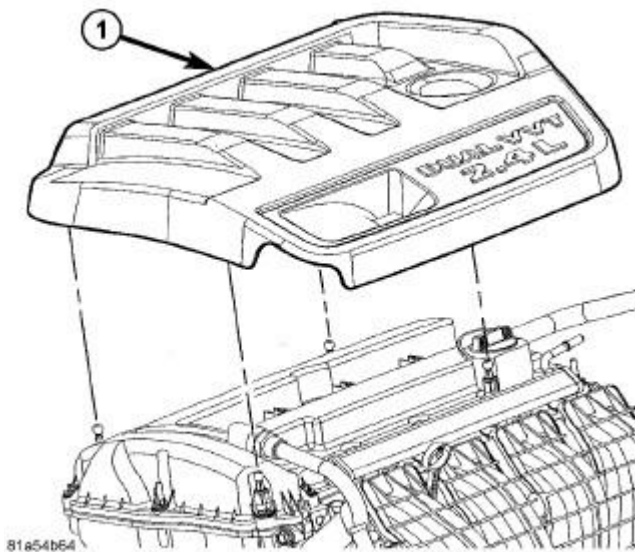
**Fig. 143: Engine Cover - 2.4L**  
Courtesy of CHRYSLER LLC

27. Operate engine until it reaches normal operating temperature. Check oil and cooling systems for correct fluid levels.
28. Install engine cover (1).

## **COVER(S), CYLINDER HEAD**

### **REMOVAL**

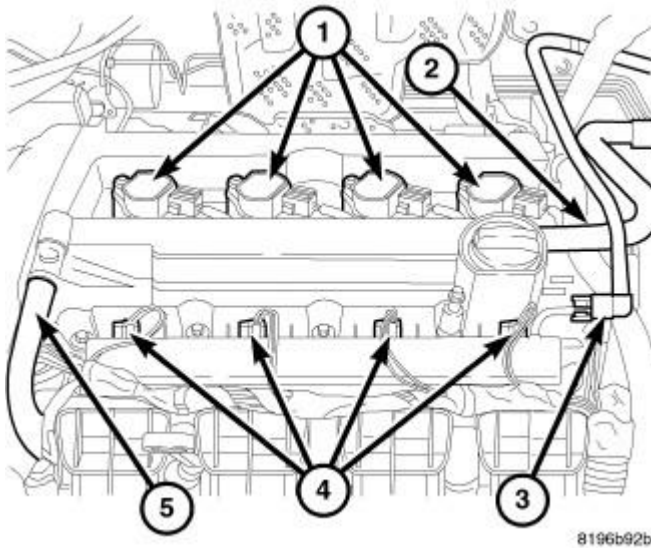
### **REMOVAL**



**Fig. 144: Engine Cover - 2.4L**

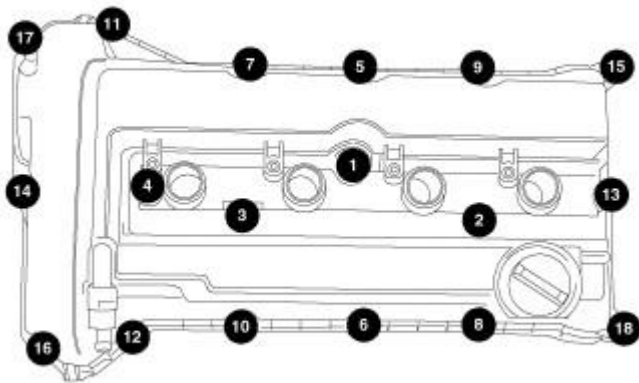
Courtesy of CHRYSLER LLC

1. Remove engine cover (1) by pulling upward.
2. Disconnect and isolate the negative battery cable.



**Fig. 145: Coil Connectors, Air Hose, Fuel Line, Injectors & PCV Hose**  
Courtesy of CHRYSLER LLC

3. Remove make up air hose (2).
4. Remove PCV hose (5).
5. Disconnect ignition coil electrical connectors (1).



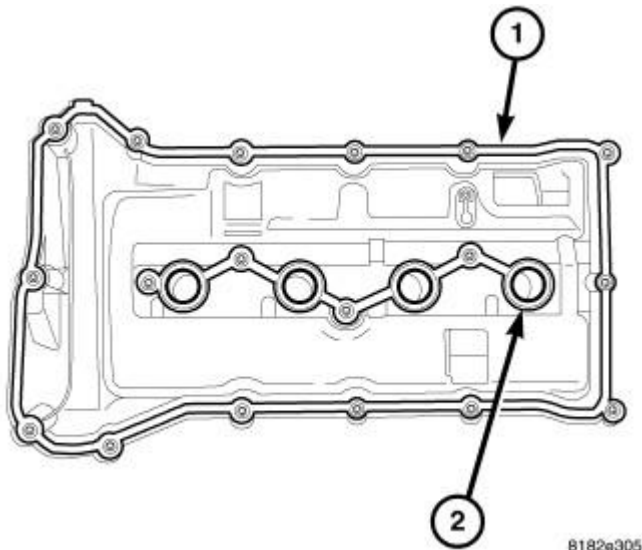
**Fig. 146: Removing/Installing Cylinder Head Cover Bolts In Sequence**  
Courtesy of CHRYSLER LLC

6. Use compressed air to blow dirt and debris off the cylinder head cover prior to removal.

7. Remove cylinder head cover bolts.
8. Remove cylinder head cover from cylinder head.

## INSTALLATION

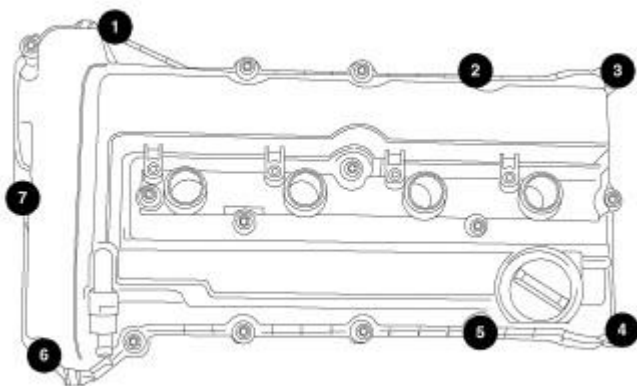
### INSTALLATION



8182e305

**Fig. 147: Cylinder Head Cover Gaskets**  
Courtesy of CHRYSLER LLC

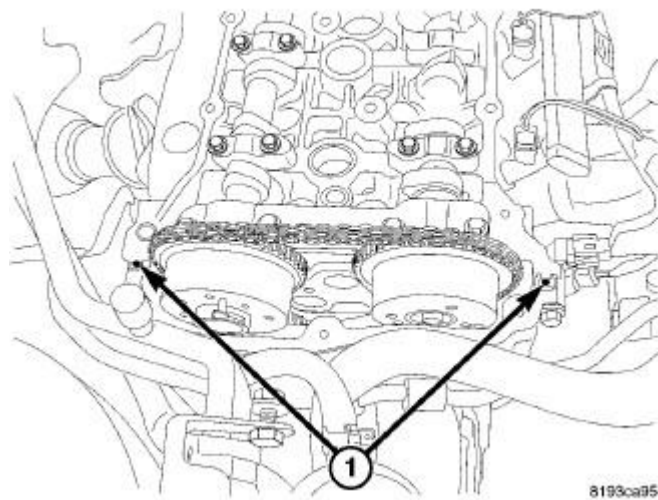
1. Install new cylinder head cover gaskets (1, 2).



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**Fig. 148: Cylinder Head Stud Installation Sequence**  
Courtesy of CHRYSLER LLC

2. Install studs in cover as shown in illustration.



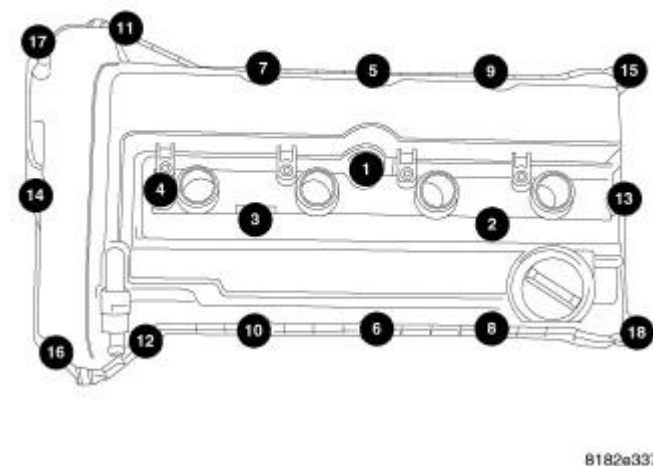
**Fig. 149: Cylinder Head/Front Cover T-Joint**  
Courtesy of CHRYSLER LLC

3. Clean all RTV from cylinder head. Refer to **CLEANING**.

**NOTE:** When using RTV, the sealing surfaces must be clean and free from grease and oil.

**NOTE:** When using RTV, parts should be assembled in 10 minutes and tighten to final torque within 45 minutes.

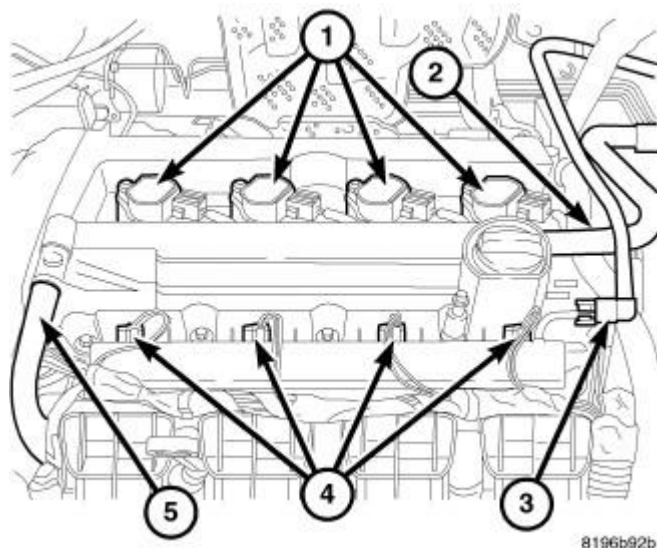
4. Apply a dot of Mopar® engine sealant RTV or equivalent to cylinder head/front cover T-joint (1).



**Fig. 150: Remove/Install Cylinder Head Cover Bolts In Sequence**

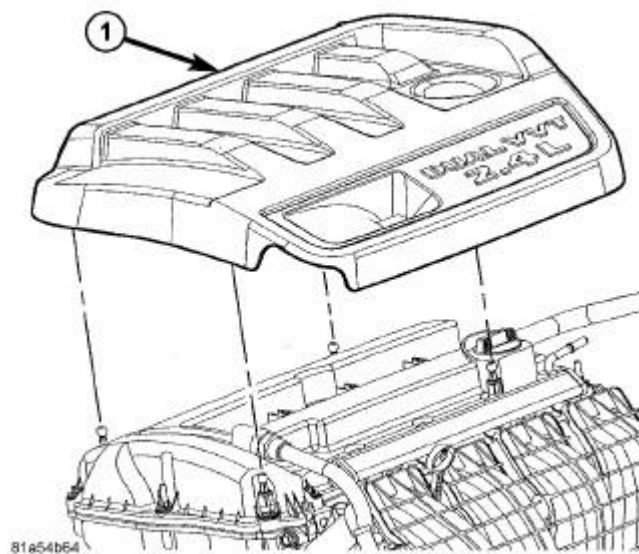
**Courtesy of CHRYSLER LLC**

5. Install cylinder head cover assembly to cylinder head and install all bolts, ensuring the studs are located as shown in illustration.
6. Tighten bolts in sequence shown in illustration using a 2 step torque method as follows:
  1. Tighten all bolts to 5 N.m (44 in. lbs.).
  2. Tighten all bolts to 10 N.m (90 in. lbs.).



**Fig. 151: Coil Connectors, Air Hose, Fuel Line, Injectors & PCV Hose**  
**Courtesy of CHRYSLER LLC**

7. Install ignition coils. Tighten fasteners to 8 N.m (70 in. lbs.).
8. If the PCV valve was removed, tighten PCV valve to 5 N.m (44 in. lbs.).
9. Connect coil electrical connectors (1).
10. Connect PCV hose (5) to PCV valve.
11. Connect make up air hose (2).



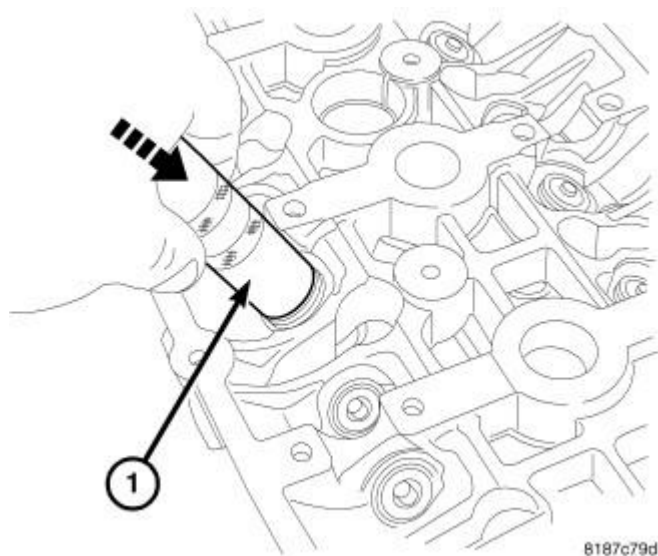
**Fig. 152: Engine Cover - 2.4L**  
Courtesy of CHRYSLER LLC

12. Connect negative battery cable.
13. Install engine cover (1) by pressing the rear of the cover down first.

## SPRING(S), VALVE

### REMOVAL

#### CYLINDER HEAD ON



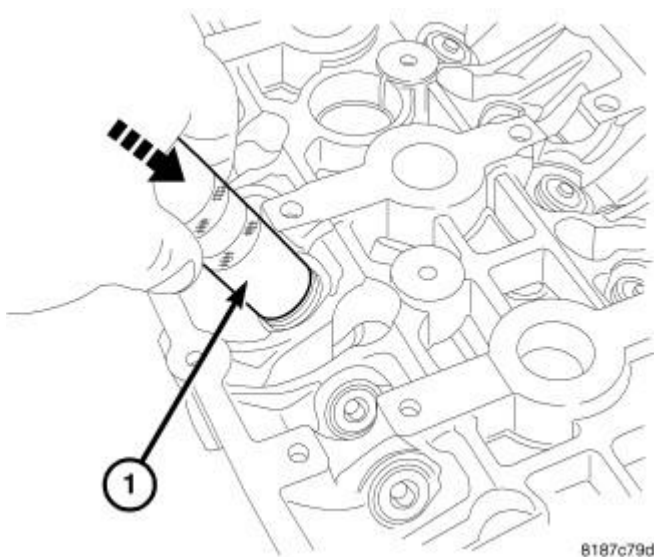
**Fig. 153: Valve Removal**  
Courtesy of CHRYSLER LLC

1. Remove cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.
2. Remove camshafts. Refer to **CAMSHAFT, ENGINE, REMOVAL**.
3. Mark valve tappet location for assembly.
4. Remove valve tappets.
5. Rotate crankshaft until piston is at TDC on compression.
6. With air hose attached to adapter tool installed in spark plug hole, apply 90-120 psi air pressure.

**CAUTION: Care must be taken not to damage the tappet bore or engine damage may result.**

7. Using metric valve keeper tool (1) such as Snap-on® GA317 (or equivalent), and remove valve spring keepers and retainer.
8. Remove valve spring(s).
9. Remove valve stem seal(s) by a using valve stem seal tool.

#### CYLINDER HEAD OFF



**Fig. 154: Valve Removal**  
Courtesy of CHRYSLER LLC

1. With cylinder head removed from cylinder block, place a ball of rags in the combustion chamber.

**CAUTION: Care must be taken not to damage the tappet bore or engine damage may result.**

2. Mark valve tappet location for assembly.
3. Remove valve tappets.
4. Using metric valve keeper tool such as Snap-on® GA317 (or equivalent) remover (1), remove valve

keepers with a downward push.

5. Remove retainer and springs.
6. 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.
7. Inspect the valves. Refer to **Engine/Cylinder Head/SPRING(S), Valve - Inspection.**

## INSPECTION

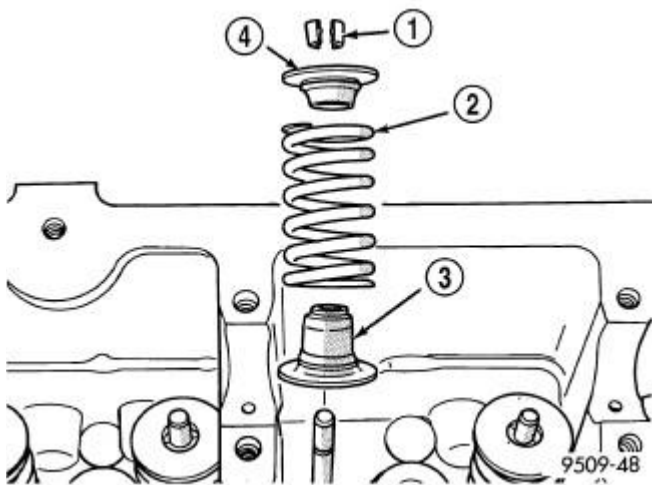
### INSPECTION

1. Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested for correct load. Discard the springs that do not meet specifications. The following specifications apply to both intake and exhaust valves springs:
  - Valve closed nominal load -  $179.5 \text{ N} \pm 9 \text{ N}$  @ 35.0 mm (40.35 lbs.  $\pm$  2 lbs. @ 1.38 in.).
  - Valve open nominal load -  $364.8 \text{ N} \pm 17 \text{ N}$  @ 29.25 mm (82 lbs.  $\pm$  3.8 lbs. @ 1.152 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

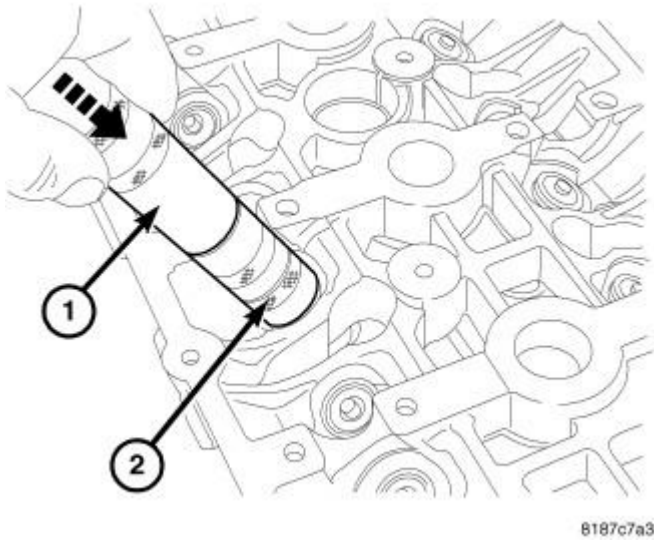
### CYLINDER HEAD ON

**CAUTION:** Care must be taken not to damage the tappet bore or engine damage may result.



**Fig. 155: Valve Spring Assembly**  
Courtesy of CHRYSLER LLC

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).

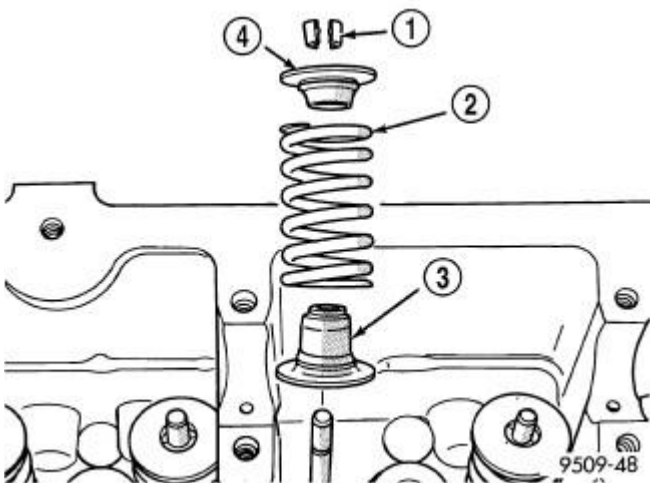


**Fig. 156: Valve Installation**  
Courtesy of CHRYSLER LLC

3. Place the valve keepers in the retainer. Using metric valve keeper tool such as Snap-on® GA317 (or equivalent) 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 valve tappets.
6. Install camshafts. Refer to **CAMSHAFT, ENGINE, INSTALLATION.**
7. Install cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, INSTALLATION.**

**CYLINDER HEAD OFF**

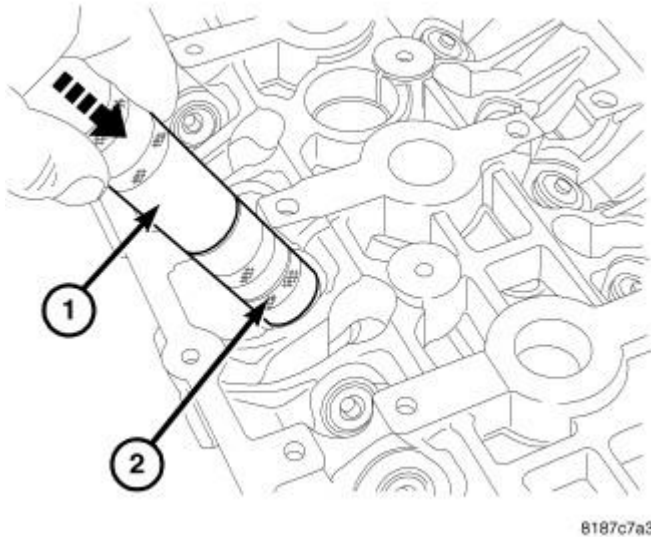
**CAUTION:** Care must be taken not to damage the tappet bore or engine damage may result.



**Fig. 157: Valve Spring Assembly**

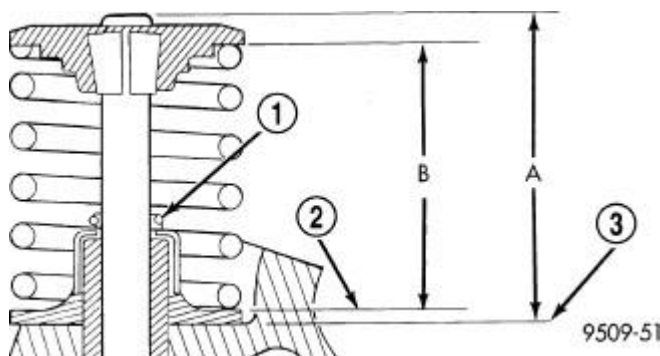
Courtesy of CHRYSLER LLC

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).
4. Install keepers in retainer and place on valve spring.



**Fig. 158: Valve Installation**  
Courtesy of CHRYSLER LLC

5. Using metric valve keeper tool such as Snap-on® GA317 (or equivalent) installer (2) and remover (1) as a handle, push downward to install keepers.



**Fig. 159: Spring Installed Height And Valve TIP To Spring Seat Dimensions**  
Courtesy of CHRYSLER LLC

6. 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.

7. Install valve tappets.

## **VALVES, INTAKE AND EXHAUST**

### **DESCRIPTION**

### **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**

### **OPERATION**

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

### **CLEANING**

### **CLEANING**

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

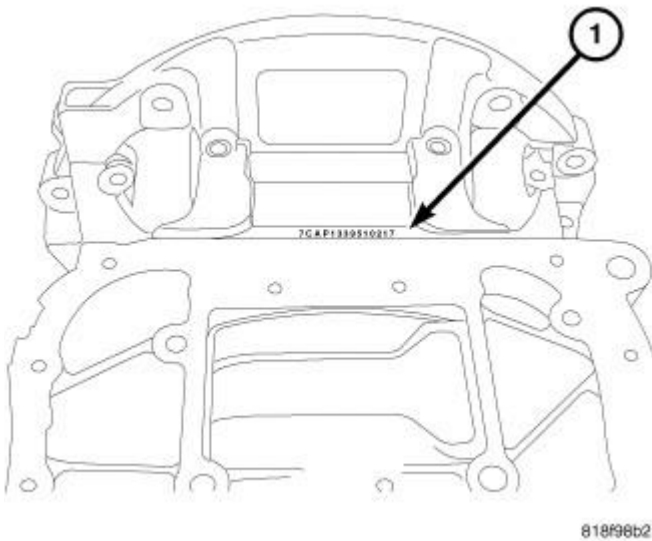
**CAUTION: Due to the small margin on the valves, grinding is not recommended.**

## **ENGINE BLOCK**

### **DESCRIPTION**

### **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.

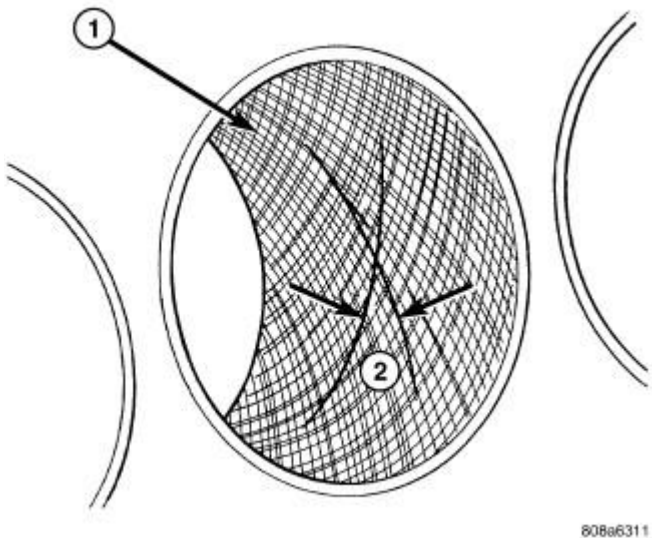


**Fig. 160: Engine Serial Number**  
 Courtesy of CHRYSLER LLC

The engine serial number (1) is located on the bottom of the ladder frame just behind the oil pan. The serial number can be seen with the oil pan in place.

## STANDARD PROCEDURE

### STANDARD PROCEDURE - CYLINDER BORE HONING



**Fig. 161: Cylinder Bore Cross-Hatch Pattern**  
 Courtesy of CHRYSLER LLC

1 - CROSS-HATCH PATTERN

2 - 40°-60°

1. Deglazing of the cylinder walls may be done using a quality commercially available flex hone, 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.
2. 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. Refer to **Fig. 161**.
3. 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 30-50 degree angle. Faster up and down strokes increase the cross-hatch angle.
4. 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

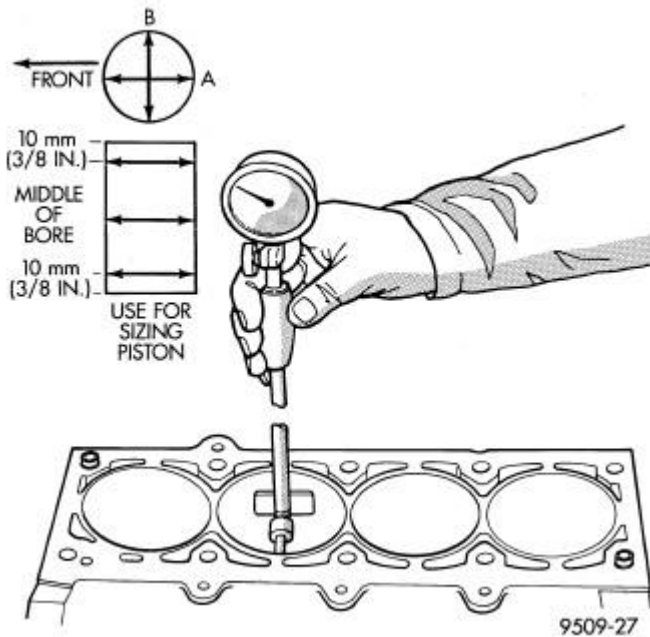
### CLEANING

Clean cylinder block thoroughly using a suitable cleaning solvent.

## INSPECTION

### INSPECTION

#### ENGINE BLOCK



**Fig. 162: Checking Cylinder Bore Size**  
Courtesy of CHRYSLER LLC

1. Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.
2. Examine block and cylinder bores for cracks or fractures.
3. 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).

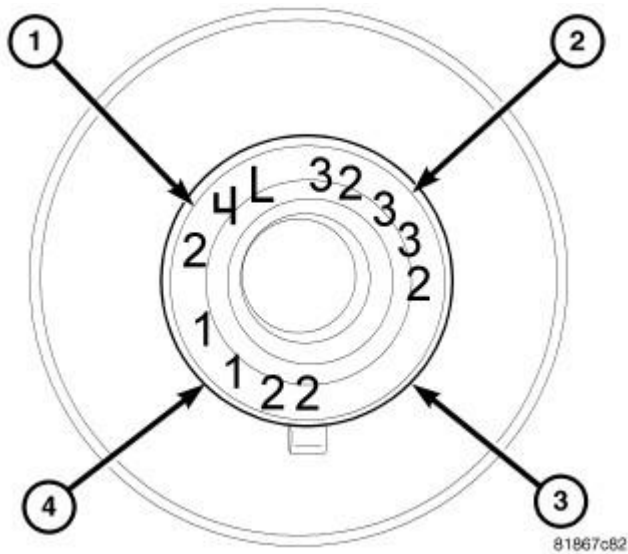
The cylinder walls should be checked for out-of-round and taper with Tool C119 or equivalent. Refer to **Engine - Specifications**. Refer to **Fig. 162**. If the cylinder walls are badly scuffed or scored, the cylinder block should be replaced, and new pistons and rings fitted.

Measure the cylinder bore at three levels in directions A and B. Refer to **Fig. 162**. 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 **Engine - Specifications**.

#### BEARING(S), CONNECTING ROD

##### STANDARD PROCEDURE

##### STANDARD PROCEDURE - CONNECTING ROD - FITTING



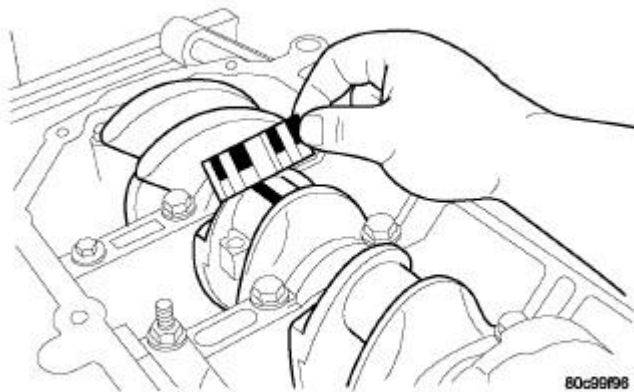
**Fig. 163: Bearing Selection**

Courtesy of CHRYSLER LLC

There are three different sizes of rod bearings available. Connecting rod bearing identification (4) can be found on the nose of the crankshaft (3). Use the table below for proper bearing selection.

#### CONNECTING ROD BEARING SELECTION

| CRANKSHAFT PIN<br>DIAMETER GRADE | DIMENSION | CONNECTING ROD<br>BEARING CLASSIFICATION | CONNECTING ROD<br>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                              |



**Fig. 164: Connecting Rod Bearing Clearance**

Courtesy of CHRYSLER LLC

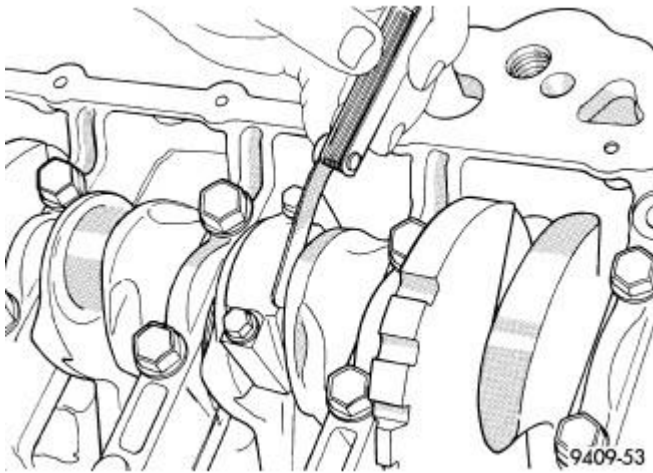
1. For measuring connecting rod bearing clearance procedure and use of Plastigage. Refer to **Engine - Standard Procedure**. For bearing clearance. Refer to **Engine - Specifications**.

**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 20 N.m (15 ft. lbs.).
2. Tighten the connecting rod bolts an additional 90°.



**Fig. 165: Connecting Rod Side Clearance**  
Courtesy of CHRYSLER LLC

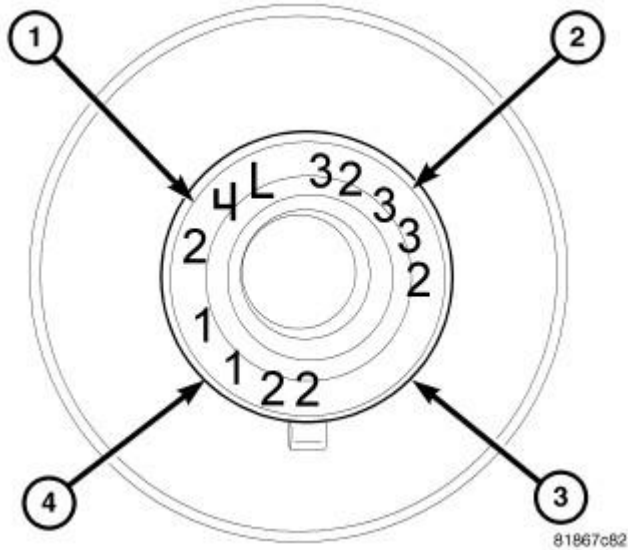
5. Using a feeler gauge, check connecting rod side clearance. Refer to clearance specifications. Refer to **Engine - Specifications**.

**BEARING(S), CRANKSHAFT, MAIN**

**STANDARD PROCEDURE**

**STANDARD PROCEDURE - MAIN BEARING SELECTION**

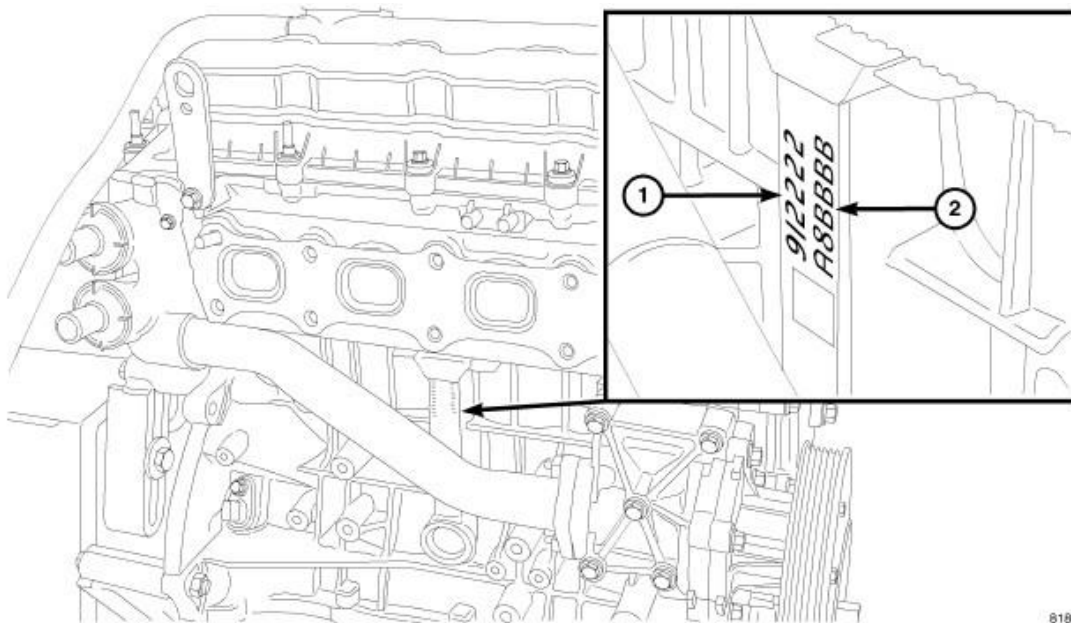
**NOTE:** There are three different possibilities for the upper main bearings and five different lower main bearings. The upper and lower bearing shells are not interchangeable.



**Fig. 166: Bearing Selection**  
Courtesy of CHRYSLER LLC

The lower main bearing identification (2) is stamped in the nose of the crankshaft (3). 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 BEARING DIMENSION |
| 0                         | 52 mm, -0.012 to -0.015 mm | 0 (Pink or Red)                        | 2 mm, 0 to -0.003 mm                 |
| 1                         | 52 mm, -0.015 to -0.018 mm | 1 (Black)                              | 2 mm, +0.003 to 0 mm                 |
| 2                         | 52 mm, -0.018 to -0.021 mm | 2 (No Color)                           | 2 mm, +0.006 to +0.003 mm            |
| 3                         | 52 mm, -0.021 to -0.024 mm | 3 (Green)                              | 2 mm, +0.009 to +0.006 mm            |
| 4                         | 52 mm, -0.024 to -0.027 mm | 4 (Blue)                               | 2 mm, +0.012 to +0.009 mm            |



**Fig. 167: Upper Main Bearing Shell Identification**  
Courtesy of CHRYSLER LLC

The upper main bearing shell identification (1) is located in the middle of cylinder block on the right side of the engine. There are three different size bearings available. The bearing class is read downward from top and corresponds to the front journal to the rear journal on the bottom.

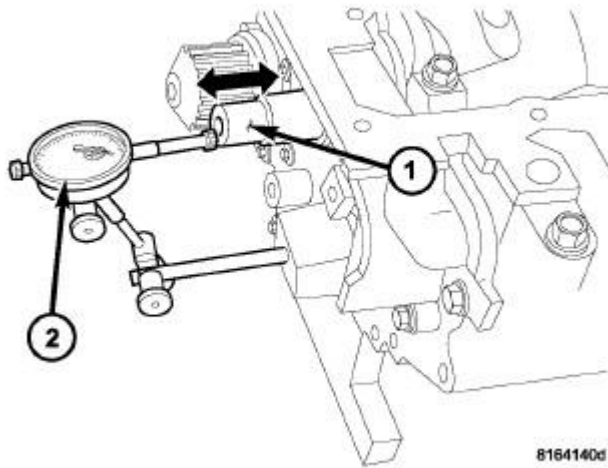
#### UPPER MAIN BEARING SELECTION

| CYLINDER BLOCK IDENTIFICATION |                  | UPPER CRANKSHAFT BEARING SELECTION     |                              |
|-------------------------------|------------------|----------------------------------------|------------------------------|
| MAIN BEARING GRADE            | DIMENSION        | UPPER MAIN BEARING SIZE CLASSIFICATION | UPPER MAIN BEARING DIMENSION |
| 1                             | 56.000<56.006 mm | 1 (Black)                              | 2 mm, 0 to -0.006 mm         |
| 2                             | 56.006<56.012 mm | 2 (No Color)                           | 2 mm, +0.006 to 0 mm         |
| 3                             | 56.012<56.018 mm | 3 (Green)                              | 2 mm, +0.012 to +0.006 mm    |

#### CRANKSHAFT

##### STANDARD PROCEDURE

##### STANDARD PROCEDURE - MEASURING CRANKSHAFT END PLAY



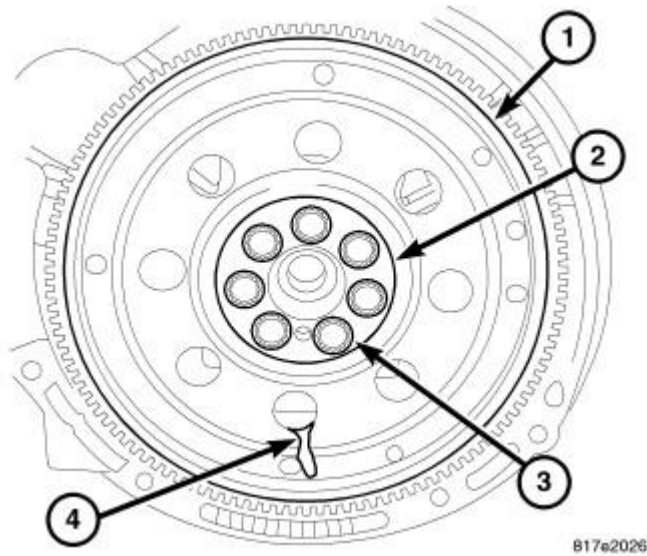
**Fig. 168: Checking Crankshaft End Play Using Dial Indicator**  
Courtesy of CHRYSLER LLC

- |                    |
|--------------------|
| 1 - Crankshaft     |
| 2 - DIAL INDICATOR |

1. Mount a dial indicator (2) to front of engine with the locating probe on nose of crankshaft (1). Refer to **Fig. 168**.
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. for end play specification. Refer to **Engine - Specifications**.

#### REMOVAL

#### REMOVAL

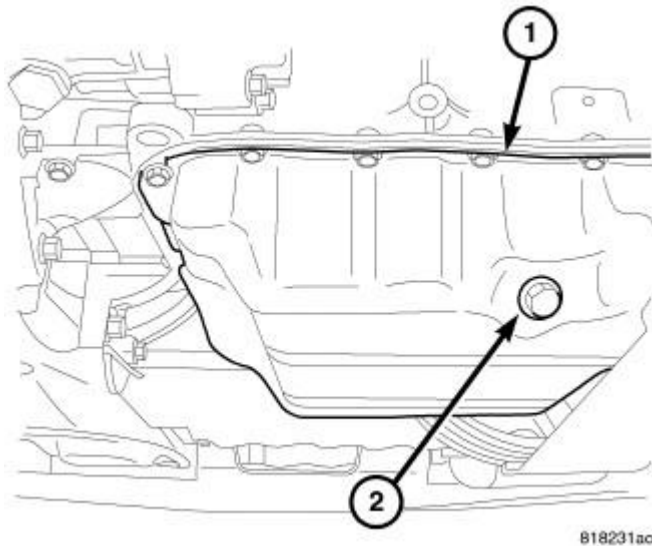


**Fig. 169: Flex Plate**

Courtesy of CHRYSLER LLC

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

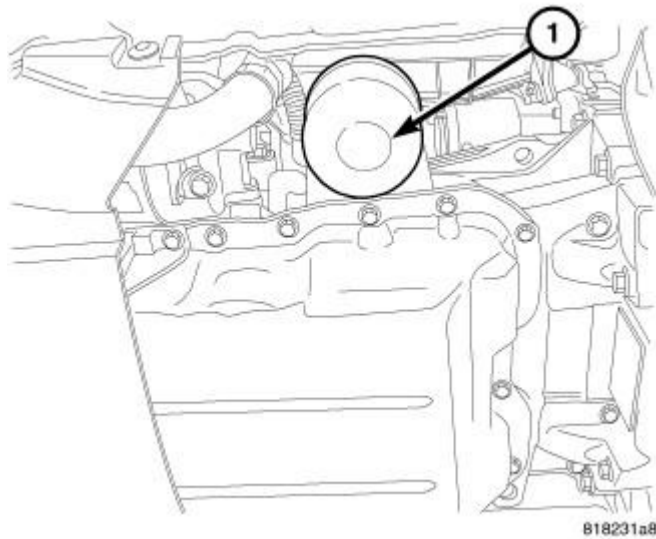
1. Remove engine assembly from vehicle. Refer to **REMOVAL**.
2. Separate transaxle from engine.
3. Remove flex plate/flywheel (1).
4. Remove crankshaft rear oil seal. Refer to **SEAL, CRANKSHAFT OIL, REAR, REMOVAL**.
5. Mount engine on a suitable repair stand.



**Fig. 170: Oil Drain Plug & Oil Pan**

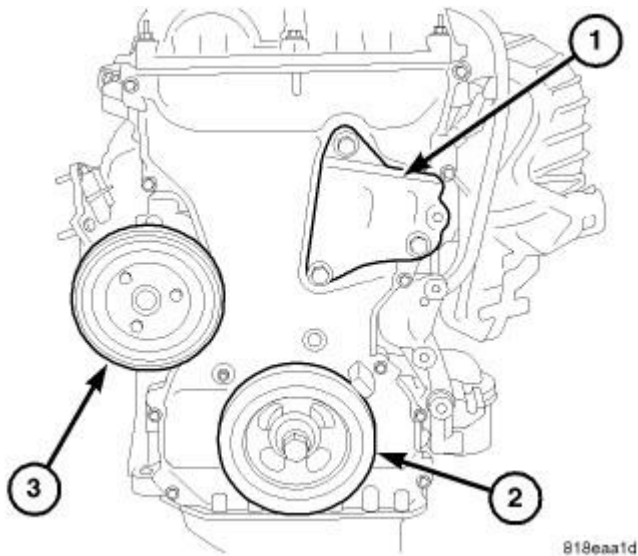
Courtesy of CHRYSLER LLC

6. Drain engine oil (2).



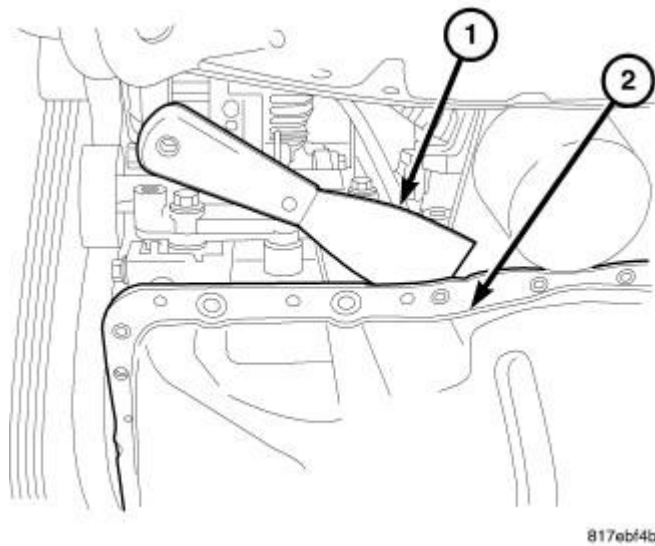
**Fig. 171: Oil Filter**  
Courtesy of CHRYSLER LLC

7. Remove oil filter (1).



**Fig. 172: Engine Mount Support Bracket, Crankshaft Vibration Damper & Water Pump Pulley**  
Courtesy of CHRYSLER LLC

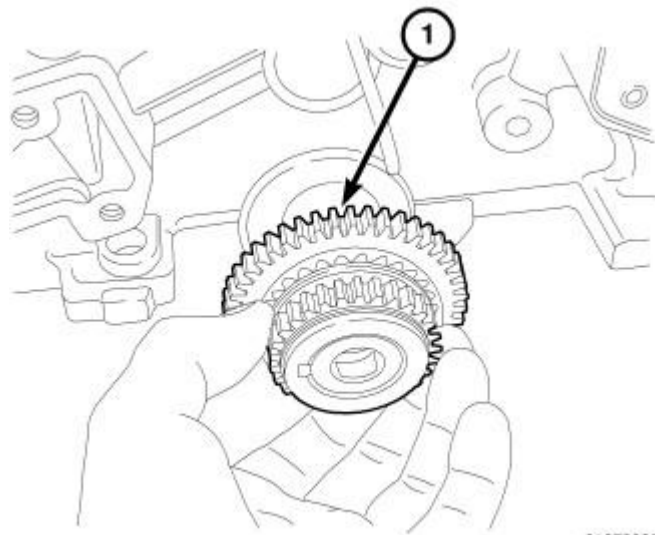
8. Remove crankshaft vibration damper (2). Refer to **DAMPER, VIBRATION, REMOVAL**.
9. Remove water pump pulley (3).
10. Remove engine mount support bracket (1).



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**Fig. 173: Using Putty Knife To Loosen Seal Around Oil Pan**  
 Courtesy of CHRYSLER LLC

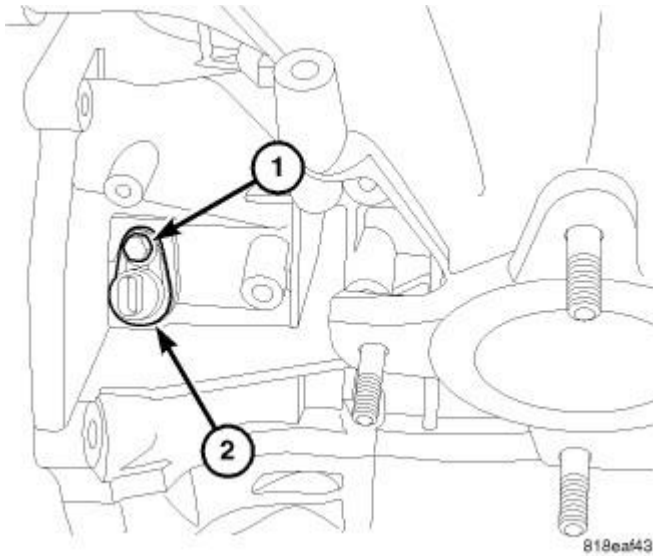
11. Remove the oil pan (2). Refer to **PAN, OIL, REMOVAL**.
12. Remove timing chain cover. Refer to **COVER(S), ENGINE TIMING, REMOVAL**.
13. Remove the timing chain. Refer to **CHAIN AND SPROCKETS, TIMING, REMOVAL**.
14. Remove balance shaft module.



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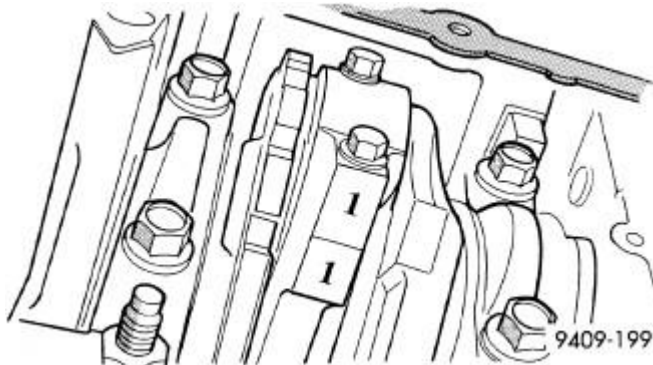
**Fig. 174: Crankshaft Sprocket**  
 Courtesy of CHRYSLER LLC

15. Remove the crankshaft sprocket (1).



**Fig. 175: Crankshaft Position Sensor & Bolt**  
Courtesy of CHRYSLER LLC

16. Remove crankshaft position sensor retaining bolt (1) and remove sensor (2).
17. Remove ladder frame. Refer to **FRAME, LADDER, REMOVAL**.

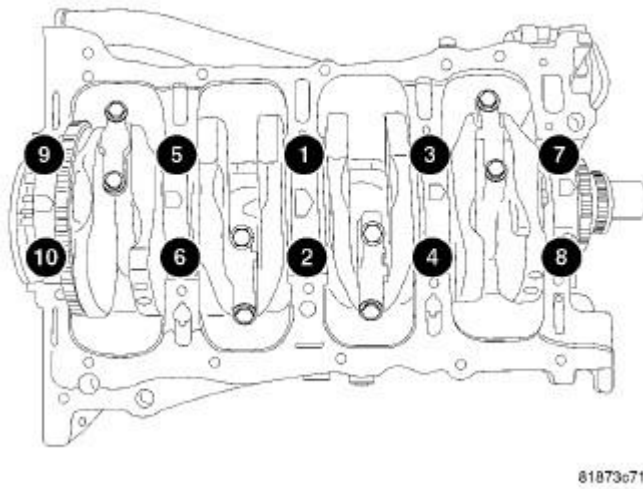


**Fig. 176: Connecting Rod Bolts & Caps**  
Courtesy of CHRYSLER LLC

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

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

18. Using a permanent ink or paint marker, identify cylinder number on each connecting rod and cap.
19. Remove all connecting rod bolts and caps. Care should be taken not to damage the fracture rod and cap surfaces.



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**Fig. 177: Main Bearing Cap Removal/Installation Sequence**  
Courtesy of CHRYSLER LLC

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

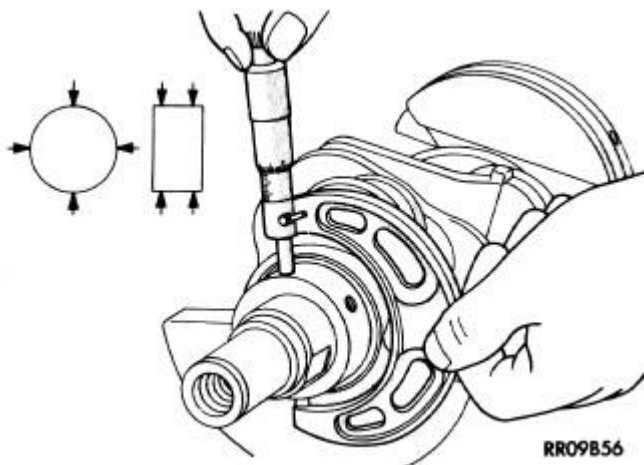
20. Remove main bearing caps.

**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**

**INSPECTION**

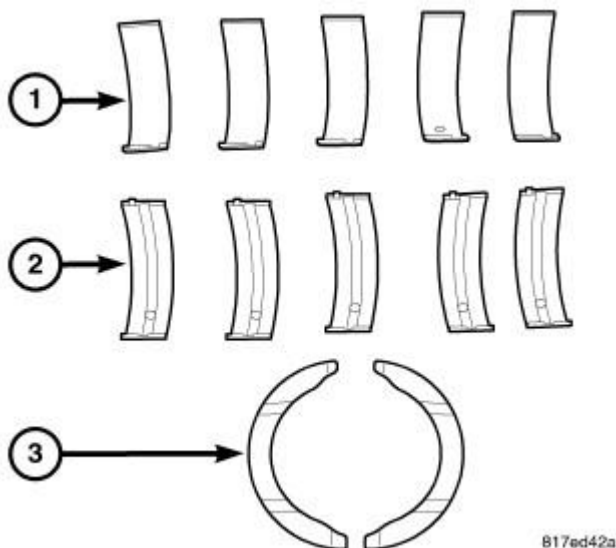


**Fig. 178: Measuring Crankshaft Journal**  
Courtesy of CHRYSLER LLC

The crankshaft main journals should be checked for excessive wear, taper and scoring. Limits of taper on any crankshaft main journals should be held to 0.006 mm (0.00024 in.). Limits of taper on any crankshaft rod journals should be held to 0.005 mm (0.0002 in.). DO NOT nick crank pin or bearing fillets. Limits of out of round on any crankshaft journals should be held to 0.005 mm (0.0002 in.). DO NOT nick crank pin or bearing fillets.

## INSTALLATION

### INSTALLATION

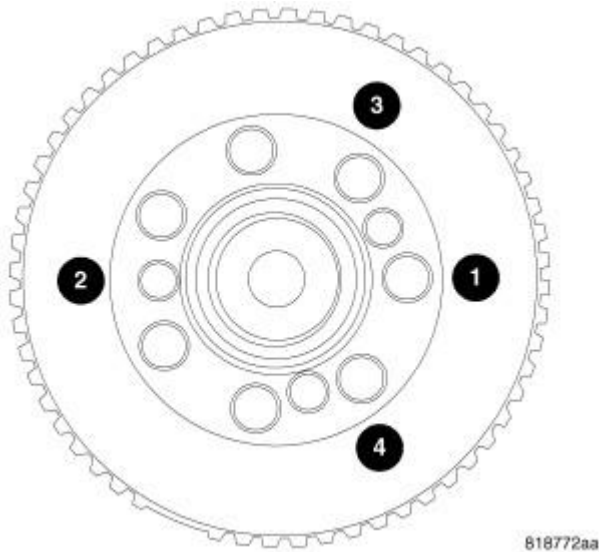


**Fig. 179: Bearing Identification**  
Courtesy of CHRYSLER LLC

The crankshaft is supported in five main bearings. All upper bearing shells (2) in the crankcase have oil grooves and holes. All lower bearing shells (1) are smooth. Crankshaft end play is controlled by a two piece thrust

bearing (3) on the number three main bearing journal.

1. Clean main bearing cap bolt holes with Mopar® brake parts cleaner or equivalent and blow out with compressed air.
2. Install the main bearing upper (2) shells with the lubrication groove and oil hole in the engine block.
3. Make certain oil holes in block line up with oil hole in bearings and bearing tabs seat in the block tab slots.



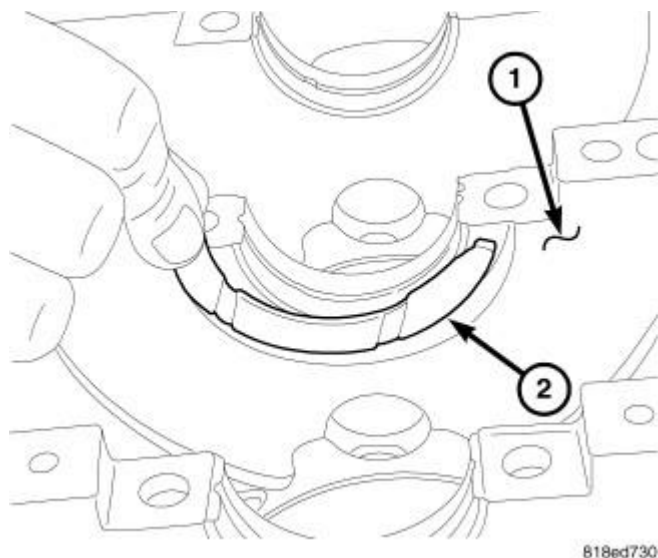
**Fig. 180: Target Ring Mounting Screws - Tightening Sequence**  
Courtesy of CHRYSLER LLC

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

4. Clean crankshaft and target ring with Mopar® brake parts cleaner or equivalent 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.

5. 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.
6. Tighten all mounting screws to 13 N.m (110 in. lbs.) in the sequence shown in illustration.



**Fig. 181: Removing/Installing Thrust Bearings**

Courtesy of CHRYSLER LLC

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

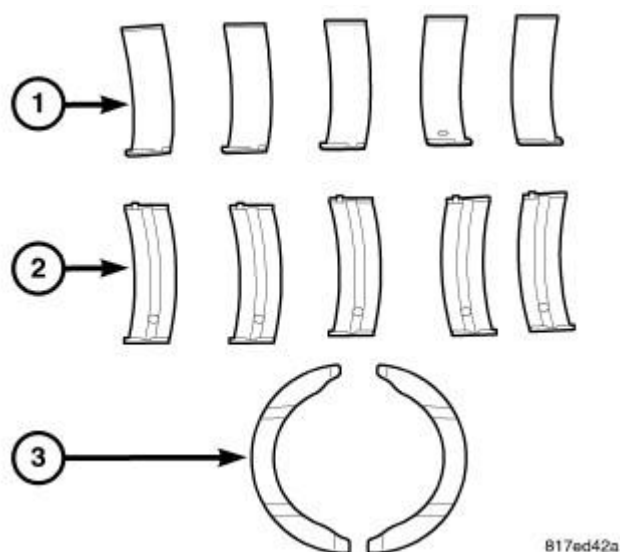
**NOTE:** The thrust bearings must be installed with the notches facing the crankshaft.

7. Install thrust bearings (2) in block (1).

**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.

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

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



**Fig. 182: Bearing Identification**

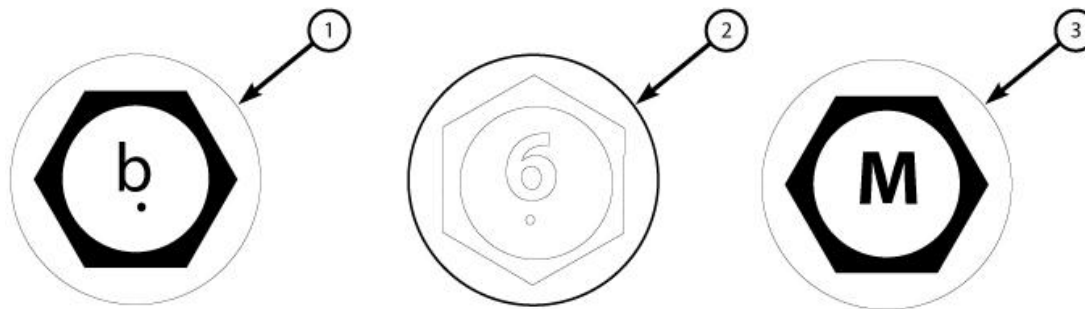
Courtesy of CHRYSLER LLC

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

**NOTE:** Main bearing caps are stamped 1 - 5 front to rear. Arrows on the caps must point towards the front of the engine.

10. Install main bearing caps to engine block.
11. Before installing the bolts the threads should be clean and dry.
12. Loosely install main bearing cap bolts.
13. 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 its furthest forward position.

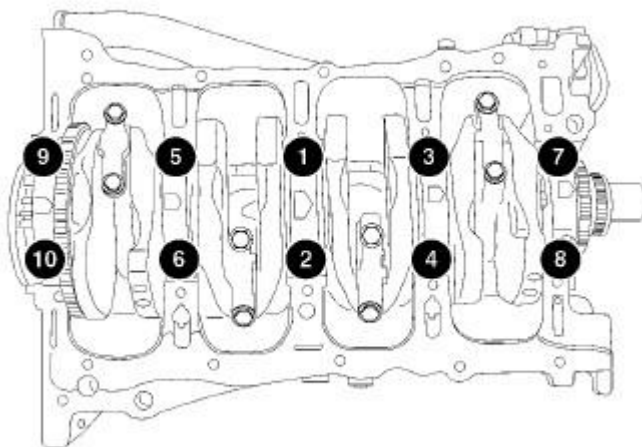
**CAUTION:** There are different sets main bolts supplied with this engine. Each bolt set has a different torque value and engine damage could result if bolts are not torqued correctly. The bolts are not interchangeable.



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**Fig. 183: Main Bolt Identification**  
Courtesy of CHRYSLER LLC

14. If your bolt heads are marked with **b** (1) or **6** (2), go to step 15. If your bolt heads are marked with **M** (3) or any other marking, go to step 16.



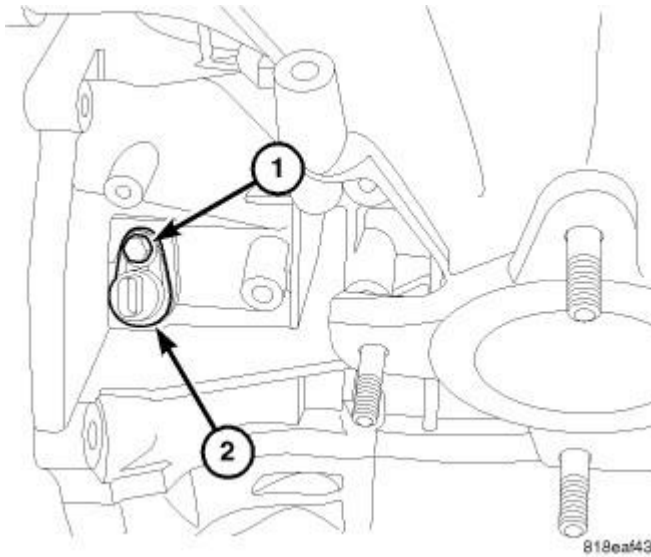
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**Fig. 184: Main Bearing Cap Removal/Installation Sequence**  
Courtesy of CHRYSLER LLC

**CAUTION:** Before tightening bolts, you must identify the bolt head to obtain the correct torque value. Failure to identify the bolts correctly, could result in improperly tightened bolts which could result in engine damage.

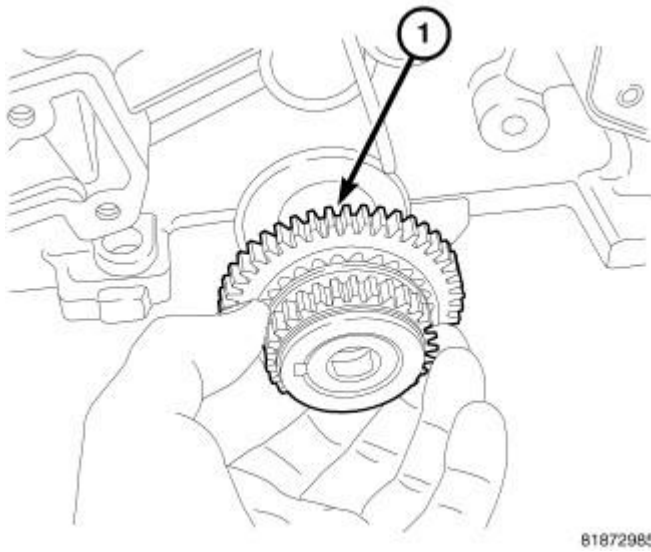
15. Tighten bolts marked with **b** or **6** using the following three step method, in the sequence shown in illustration:
- Tighten all bolts to 15 N.m (11 ft. lbs.)

- Tighten all bolts to 27 N.m (20 ft. lbs.)
  - Tighten all bolts an additional 45°.
16. Tighten bolts marked with **M** using the following three step method, in the sequence shown in illustration:
    - Tighten all bolts to 15 N.m (11 ft. lbs.)
    - Tighten all bolts to 45 N.m (33 ft. lbs.)
    - Tighten all bolts an additional 45°.
  17. Remove wedge tool used to hold crankshaft.
  18. Check the crankshaft turning torque, it should not exceed 5.6 N.m (50 in. lbs.).
  19. Check crankshaft end play. Refer to **Engine/Engine Block/CRANKSHAFT - Standard Procedure.**
  20. Install connecting rod bearings and caps. **Do Not Reuse Connecting Rod Bolts.** Tighten connecting rod bolts to 20 N.m + 90° (15 ft. lbs.) + 90°. Refer to **ROD, PISTON AND CONNECTING, INSTALLATION.**
  21. Install the ladder frame assembly. Refer to **FRAME, LADDER, INSTALLATION.**
  22. Install the balance shaft module. Refer to **PUMP, ENGINE OIL, INSTALLATION.**



**Fig. 185: Crankshaft Position Sensor & Bolt**  
 Courtesy of CHRYSLER LLC

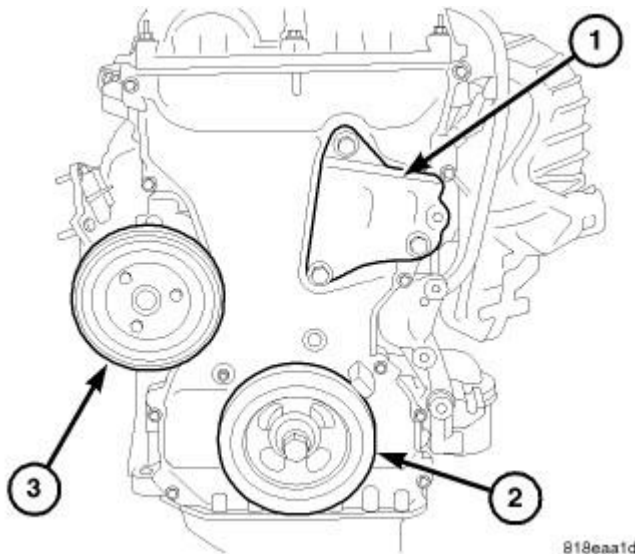
23. Install crankshaft position sensor (2) and tighten bolt (1).
24. Install cylinder head if it was removed. Refer to **CYLINDER HEAD, INSTALLATION.**



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**Fig. 186: Crankshaft Sprocket**  
Courtesy of CHRYSLER LLC

25. Install front crankshaft sprocket (1).
26. Install the timing chain. Refer to **CHAIN AND SPROCKETS, TIMING, INSTALLATION**.
27. Install the timing chain front cover. Refer to **COVER(S), ENGINE TIMING, INSTALLATION**.
28. Install the oil pan. Refer to **PAN, OIL, INSTALLATION**.
29. Install rear crankshaft oil seal. Refer to **SEAL, CRANKSHAFT OIL, REAR, INSTALLATION**.
30. Install front crankshaft oil seal. Refer to **SEAL, CRANKSHAFT OIL, FRONT, INSTALLATION**.

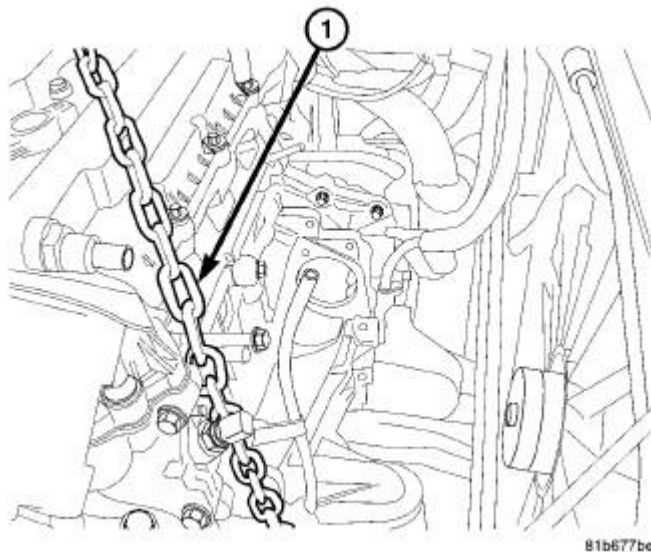


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**Fig. 187: Engine Mount Support Bracket, Crankshaft Vibration Damper & Water Pump Pulley**  
Courtesy of CHRYSLER LLC

31. Install engine mount support bracket (1).
32. Install crankshaft vibration damper (2). Refer to **DAMPER, VIBRATION, INSTALLATION**.

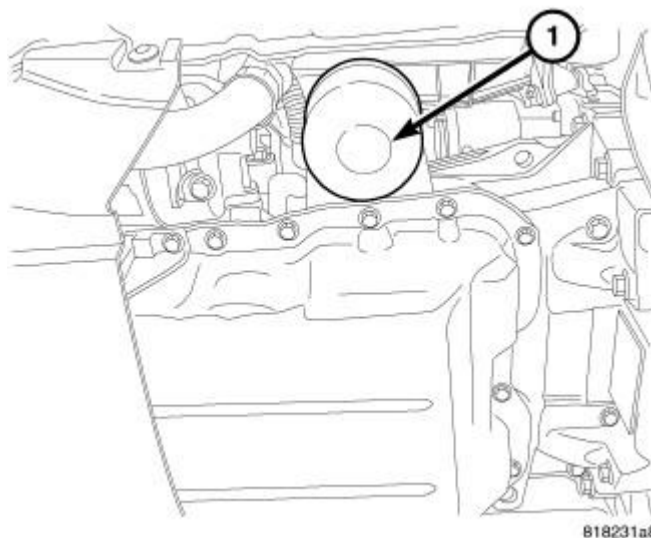
33. Install water pump pulley (3).



**Fig. 188: Lift Chain**

Courtesy of CHRYSLER LLC

34. Install engine lift chain (1) and remove engine from repair stand.
35. Install crankshaft rear oil seal. Refer to **SEAL, CRANKSHAFT OIL, REAR, INSTALLATION**.
36. Install drive plate/flex plate using **new** bolts. Tighten bolts to 95 N.m (70 ft. lbs.).
37. Attach transaxle to engine. Tighten bellhousing bolts to 101 N.m (75 ft. lbs.).
38. Install the engine assembly into the vehicle. Refer to **INSTALLATION**.



**Fig. 189: Oil Filter**

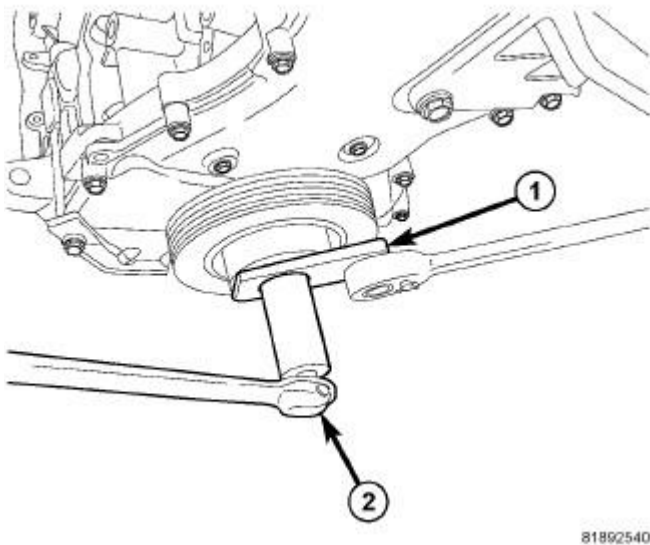
Courtesy of CHRYSLER LLC

39. Install new oil filter (1) and fill with oil.
40. Fill with coolant. Refer to **STANDARD PROCEDURE** .
41. Start engine and check for leaks.
42. Install engine cover.

## **DAMPER, VIBRATION**

### **REMOVAL**

### **REMOVAL**

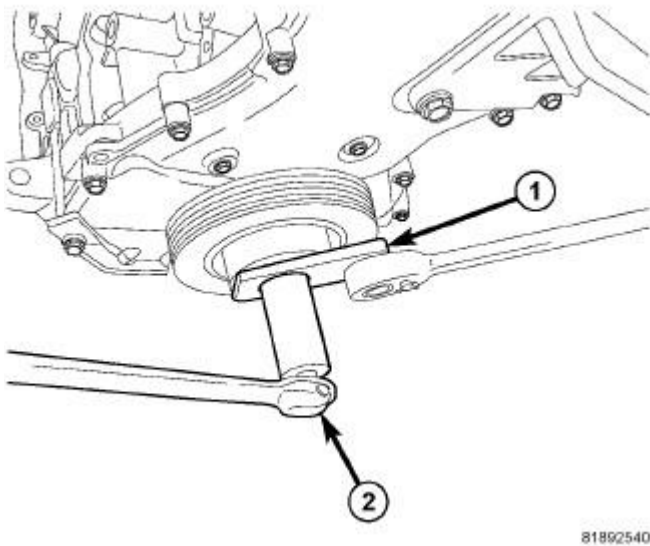


**Fig. 190: Removing/Installing Crankshaft Damper**  
Courtesy of CHRYSLER LLC

1. Remove accessory drive belts. Refer to **BELT, SERPENTINE, REMOVAL** .
2. Install Damper holder (special tool #9707, Holder, Vibration Damper) (1).
3. Remove crankshaft damper bolt.
4. Pull damper off crankshaft.

### **INSTALLATION**

### **INSTALLATION**



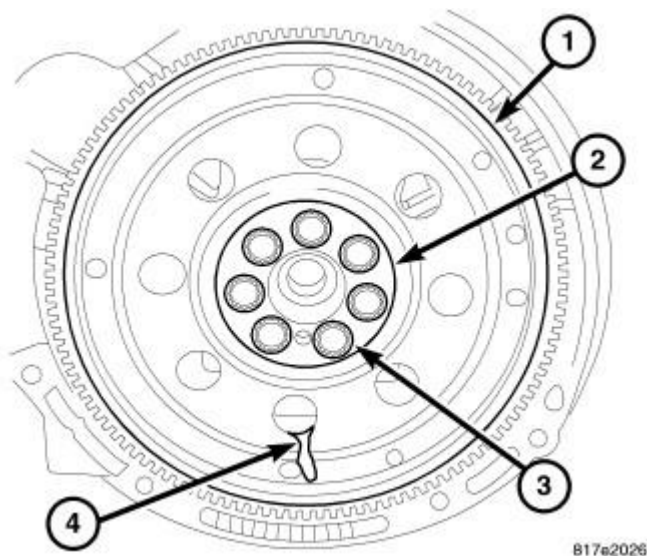
**Fig. 191: Removing/Installing Crankshaft Damper**  
Courtesy of CHRYSLER LLC

1. Install crankshaft damper.
2. Apply clean engine oil crankshaft damper bolt threads and between bolt head and washer. Tighten bolt to 210 N.m (155 ft. lbs.).
3. Install accessory drive belts. Refer to **BELT, SERPENTINE, INSTALLATION** .

## FLEXPLATE

### REMOVAL

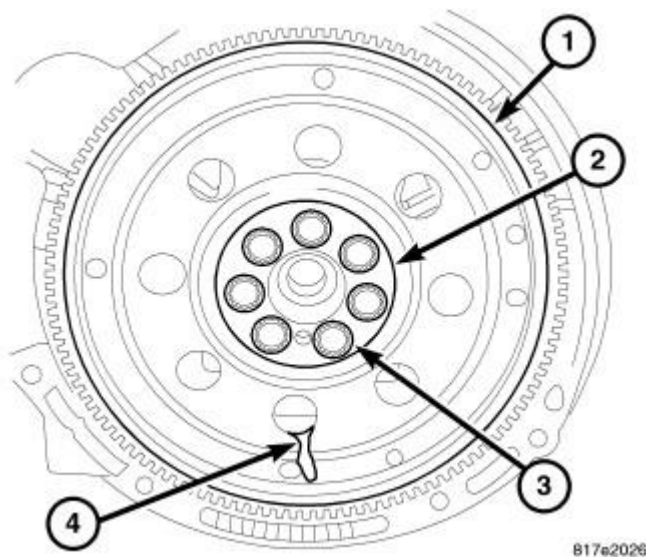
### REMOVAL



**Fig. 192: Flex Plate**

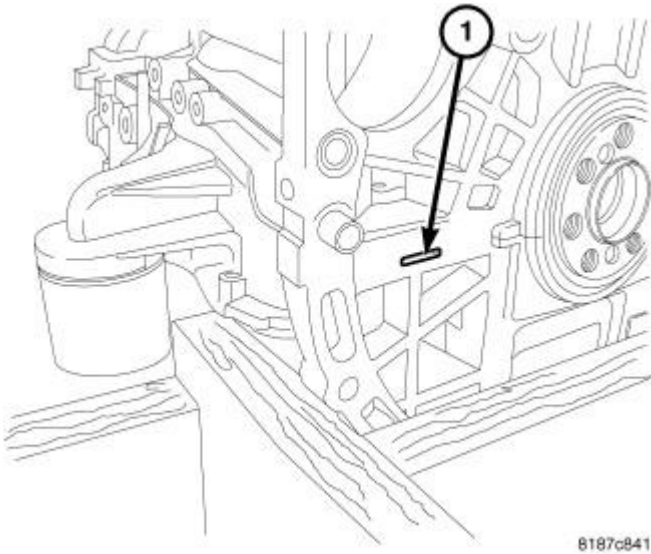
**Courtesy of CHRYSLER LLC**

1. Remove transmission. Refer to **REMOVAL** .
2. Remove flex plate bolts (3) and discard.
3. Remove washer (2).
4. Remove flex plate (1).

**INSTALLATION****INSTALLATION****Fig. 193: Flex Plate****Courtesy of CHRYSLER LLC**

1. Install flex plate (1).
2. Install washer (2).
3. Install **new** flex plate bolts (3) and tighten in a criss-cross pattern to 29 N.m (22 ft. lbs.) plus 51° rotation.
4. Install transaxle. Refer to **INSTALLATION** .

**FRAME, LADDER****REMOVAL****REMOVAL**

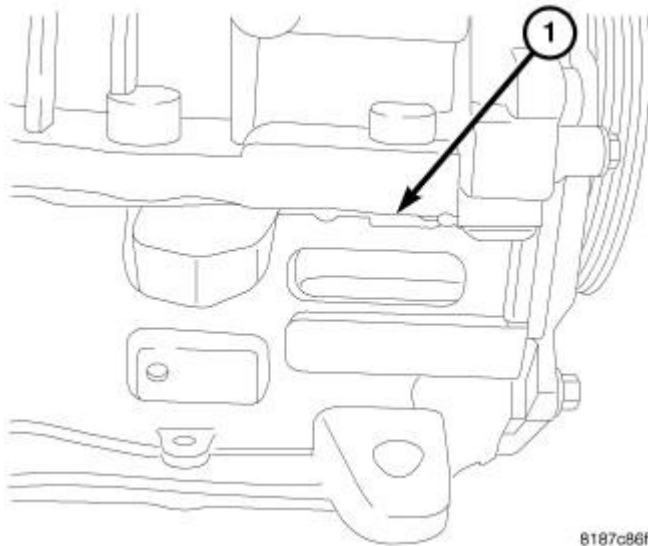


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**Fig. 194: Pry Point 1**

Courtesy of CHRYSLER LLC

1. Remove oil pan. Refer to **PAN, OIL, REMOVAL**.
2. Remove balance shaft assembly. Refer to **PUMP, ENGINE OIL, REMOVAL**.
3. Remove ladder frame retaining bolts.
4. Remove ladder frame using pry point cast in the rear of the block (1).



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**Fig. 195: Pry Point 2**

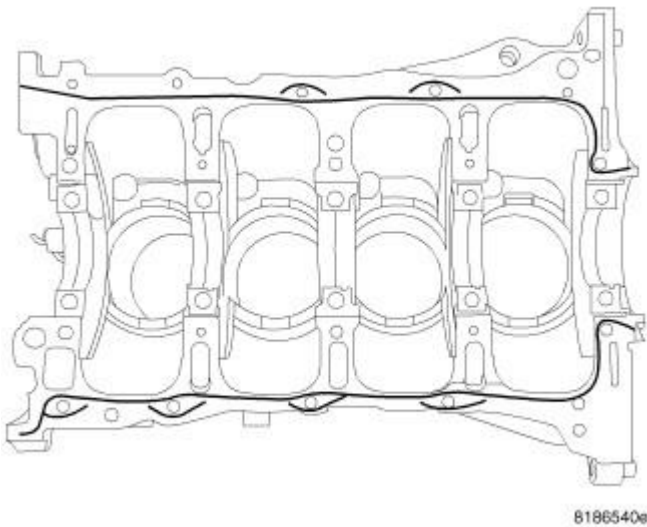
Courtesy of CHRYSLER LLC

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

## CLEANING

## CLEANING

Clean ladder frame with a plastic or wooden scraper and a suitable solvent. Refer to **Engine - Standard Procedure**.

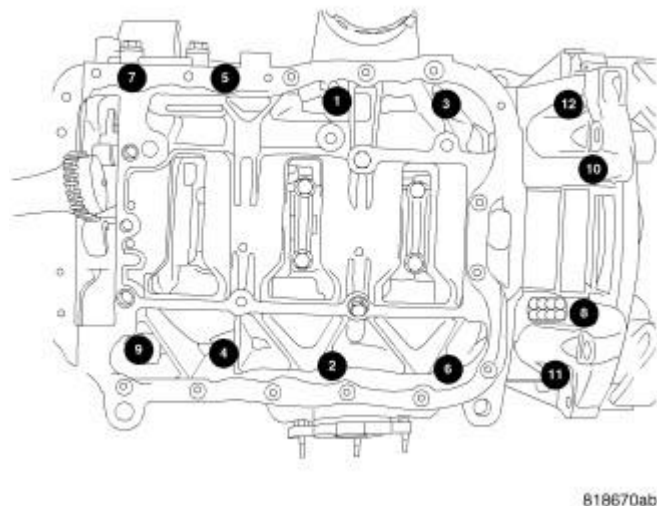
**INSTALLATION****INSTALLATION**

**Fig. 196: Sealing Ladder Frame**  
Courtesy of CHRYSLER LLC

**NOTE:** When using RTV, the sealing surfaces must be clean and free from grease and oil.

**NOTE:** When using RTV, parts should be assembled in 10 minutes and tighten to final torque within 45 minutes.

1. Apply a 2 mm bead of Mopar® engine sealant RTV or equivalent as shown in illustration.



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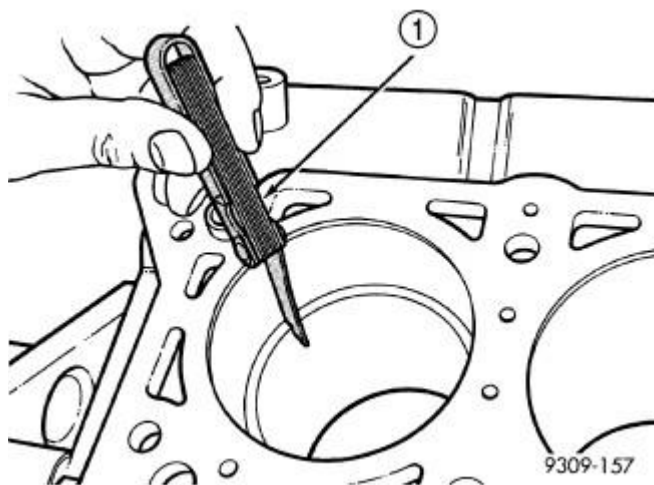
**Fig. 197: Ladder Frame Bolts Tightening Sequence**  
Courtesy of CHRYSLER LLC

2. Install bolts and tighten as shown in illustration following a two step method.
  - First: All to 10 N.m (89 in. lbs.).
  - Second: All to 26 N.m (19 ft. lbs.).
3. Install balance shaft module. Refer to **PUMP, ENGINE OIL, INSTALLATION.**
4. Install oil pan. Refer to **PAN, OIL, INSTALLATION.**

## RING(S), PISTON

### STANDARD PROCEDURE

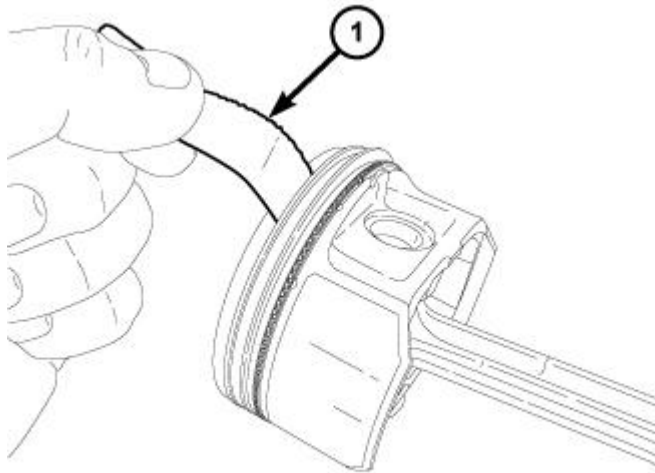
#### STANDARD PROCEDURE - PISTON RING - FITTING



**Fig. 198: Check Gap On Piston Rings**  
Courtesy of CHRYSLER LLC

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 13 mm (0.50 inch) from bottom of cylinder bore and below the bottom of the oil ring travel where cylinder bore has minimal wear. Check gap with feeler gauge. Refer to Engine - Specifications.

**NOTE:** Ring end gap measurements are sensitive to the ring being square in the bore. Care must be used to avoid tilting the rings in cylinder bores when taking measurements.



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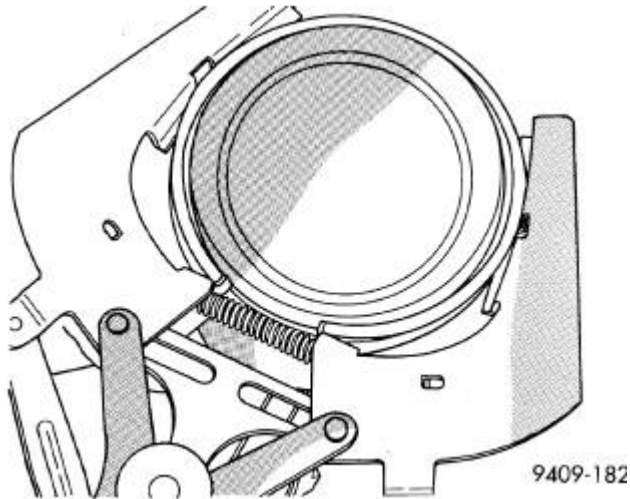
**Fig. 199: Checking Piston Ring To Groove Side Clearance**  
Courtesy of CHRYSLER LLC

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

**CAUTION:** Exercise care when using tools on piston. Do not scratch or gouge piston surface or ring grooves as this may cause engine damage.

## REMOVAL

## REMOVAL

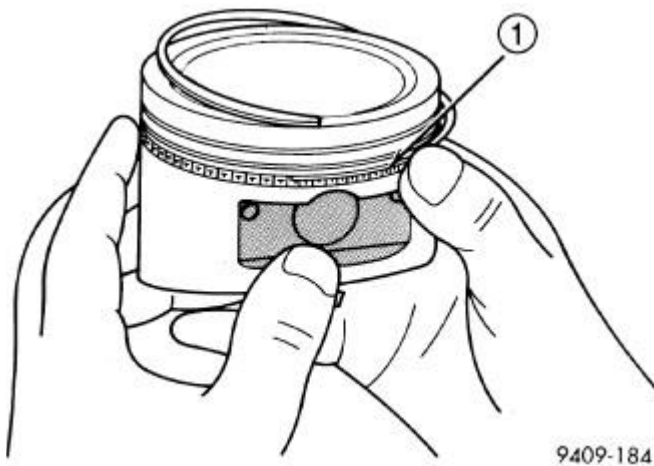


**Fig. 200: Removing Piston Rings**  
Courtesy of CHRYSLER LLC

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

### INSTALLATION



**Fig. 201: Installing Side Rail**  
Courtesy of CHRYSLER LLC

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

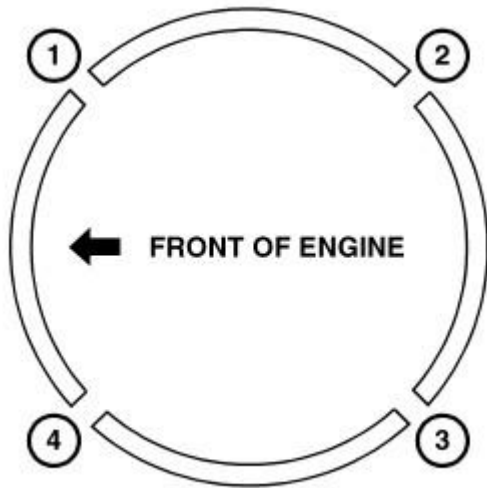
**CAUTION:** Install piston rings in the following order:

- A. Oil ring expander.
- B. Upper oil ring side rail.
- C. Lower oil ring side rail.
- D. No. 2 Intermediate piston ring.
- E. 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.



**Fig. 202: Piston Ring End Gap Position**  
Courtesy of CHRYSLER LLC

4. Position piston ring end gaps as shown in illustration.
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.

## ROD, PISTON AND CONNECTING

### DESCRIPTION

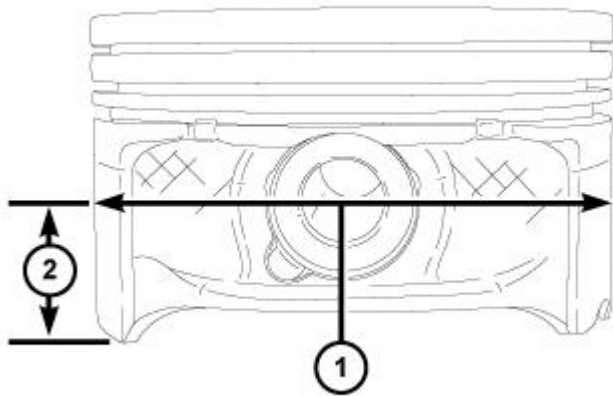
### DESCRIPTION

The pistons are made of a cast aluminum alloy. The pistons have pressed-in pins attached to forged connecting

rods. The piston 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 piston with rings, connecting rod and piston pin are serviced as an assembly.

## STANDARD PROCEDURE

### PISTON AND BORE MEASUREMENT



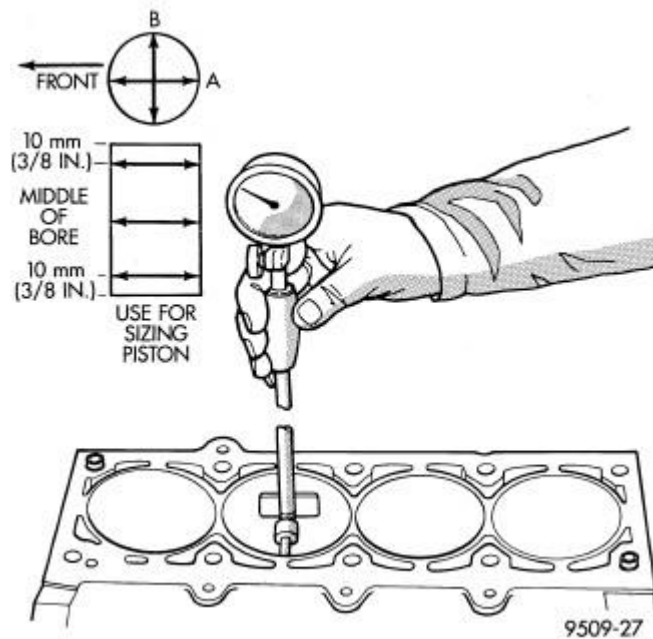
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**Fig. 203: Piston Pin Measurements**  
Courtesy of CHRYSLER LLC

**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 17 mm (0.669 in.) from the bottom of the skirt (2) as shown in illustration.



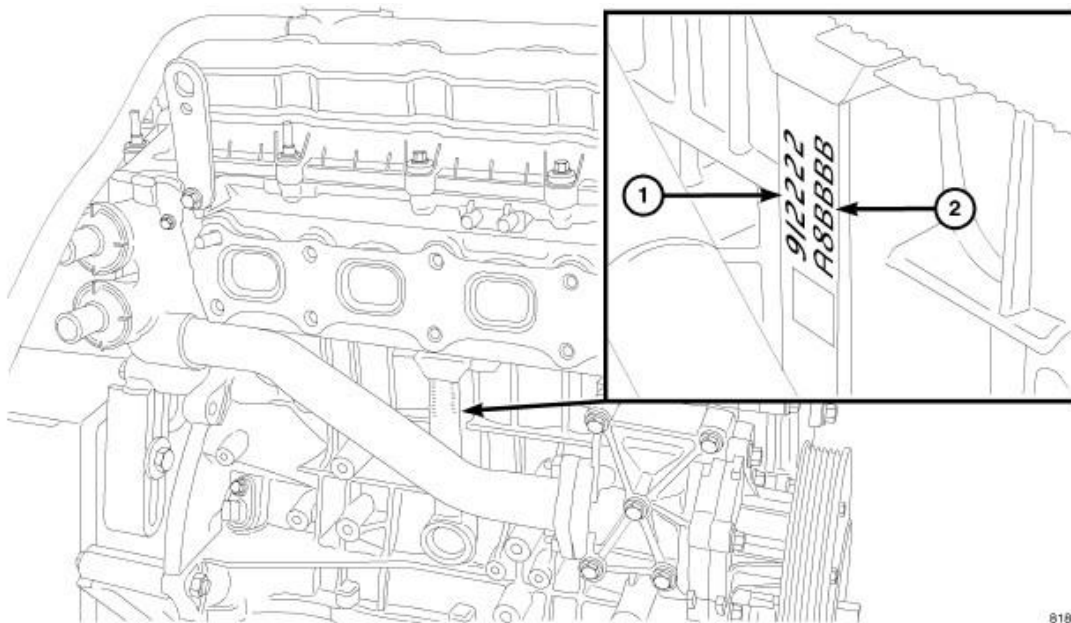
**Fig. 204: Checking Cylinder Bore Size**

Courtesy of CHRYSLER LLC

**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 illustration. Refer to **Engine - Specifications**.

#### PISTON SELECTION



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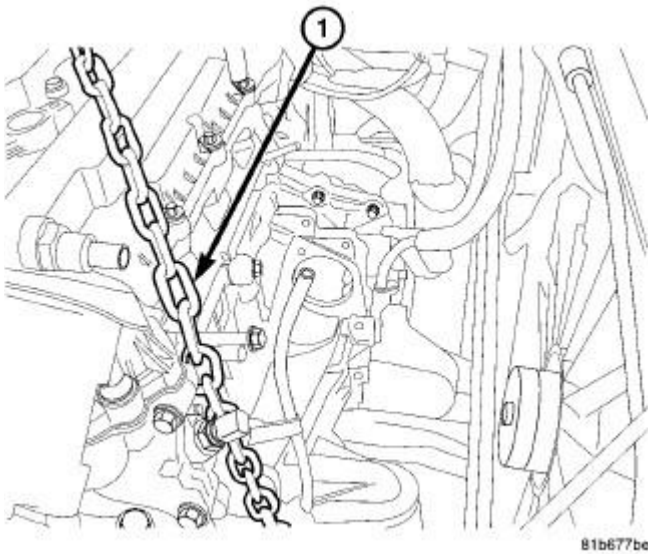
**Fig. 205: Upper Main Bearing Shell Identification**  
Courtesy of CHRYSLER LLC

The pistons are select fit to each bore. There are three different grades of pistons available; A, B, and C. The piston identification (2) is located in the middle of the block on the right side of the engine. The bore identification starts at the top and reads downward. Bore #1 is at the top and bore #4 is at the bottom.

The piston, rings and rod are serviced as an assembly, after determining what size piston is needed, to determine correct rod bearing size. Refer to **Engine/Engine Block/BEARING(S), Connecting Rod - Standard Procedure**.

## REMOVAL

## REMOVAL



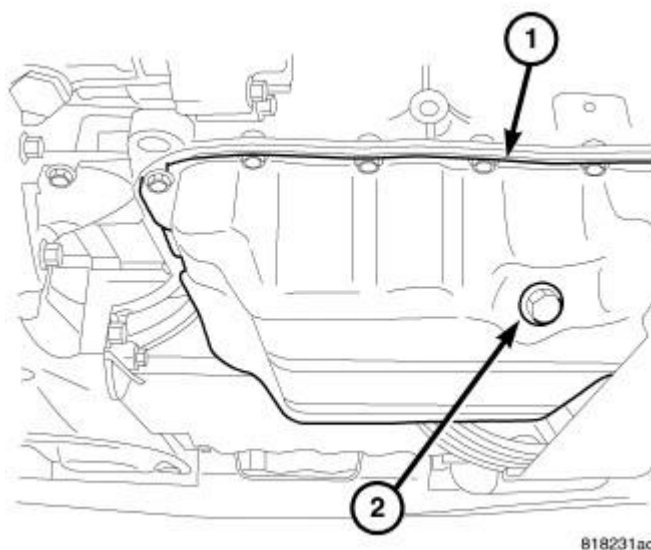
**Fig. 206: Lift Chain**

Courtesy of CHRYSLER LLC

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

**CAUTION:** To maintain engine balance, 1, 3, or 4 pistons can be replaced. If 2 pistons are replaced, engine will be out of balance.

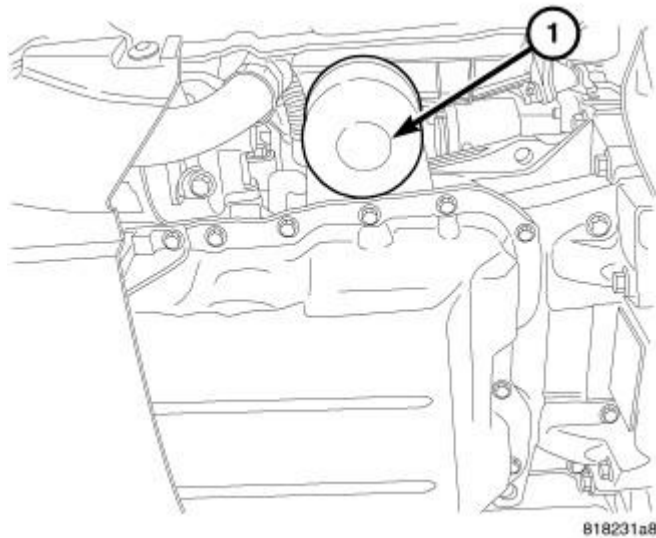
1. Remove engine. Refer to **REMOVAL**.
2. Separate engine from transaxle.
3. Mount engine on a suitable engine stand and remove engine lift chain (1).
4. Remove cylinder head. Refer to **CYLINDER HEAD, REMOVAL**.



**Fig. 207: Oil Drain Plug & Oil Pan**

Courtesy of CHRYSLER LLC

5. Drain engine oil (2).
6. Remove oil pan (1). Refer to **PAN, OIL, REMOVAL**.

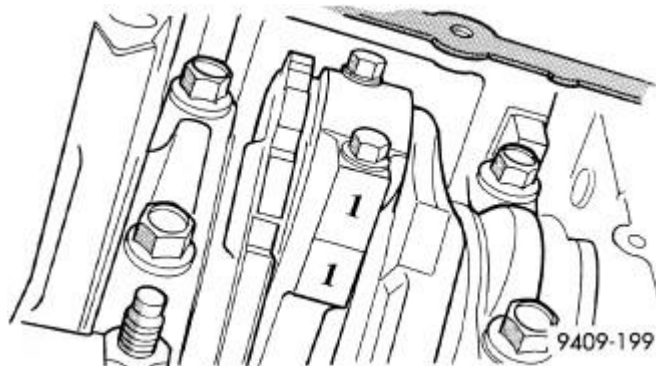
**Fig. 208: Oil Filter**

Courtesy of CHRYSLER LLC

7. Remove oil filter (1).
8. Remove balance shaft assembly.
9. Remove ladder frame.

**NOTE:** Remove any carbon build up and clean debris from cylinder prior to piston removal to avoid scratching piston skirts.

10. 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 .**

**Fig. 209: Connecting Rod Bolts & Caps**

**Courtesy of CHRYSLER LLC**

11. Rotate crankshaft so that each connecting rod is centered in cylinder bore.
12. Using a permanent ink or paint marker, identify cylinder number on each connecting rod cap.

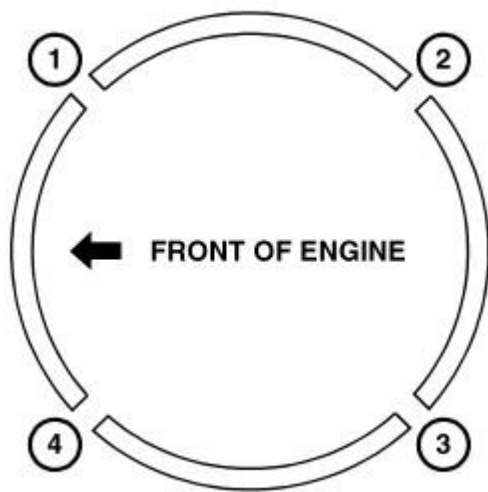
**CAUTION: DO NOT use a number stamp or a punch to mark connecting rods, as damage to connecting rod could occur.**

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

13. Remove connecting rod bolts and cap.

**CAUTION: Do not reuse connecting rod bolts. These are one-time-use bolts and reuse could result in engine failure.**

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

**INSTALLATION****INSTALLATION**

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**Fig. 210: Piston Ring End Gap Position**  
**Courtesy of CHRYSLER LLC**

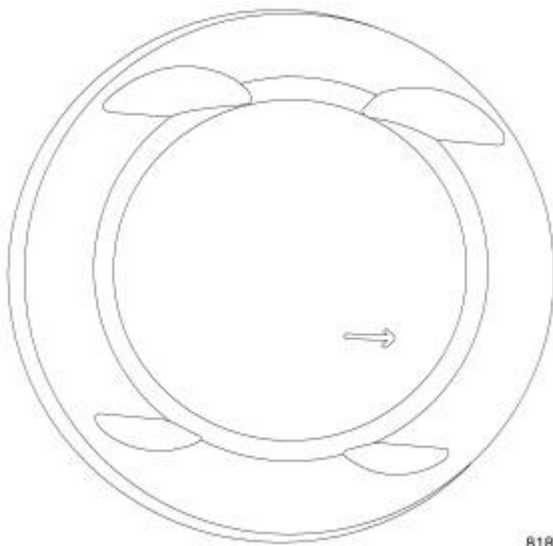
1. Install piston rings on piston. Refer to **RING(S), PISTON, INSTALLATION**.
2. Before installing pistons and connecting rod assemblies into the bore, be sure that top compression ring

gap (1) and the second compression ring gap (3) 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 (1) and the rail gaps (2, 4) located as shown in illustration above. As viewed from the top of the piston.

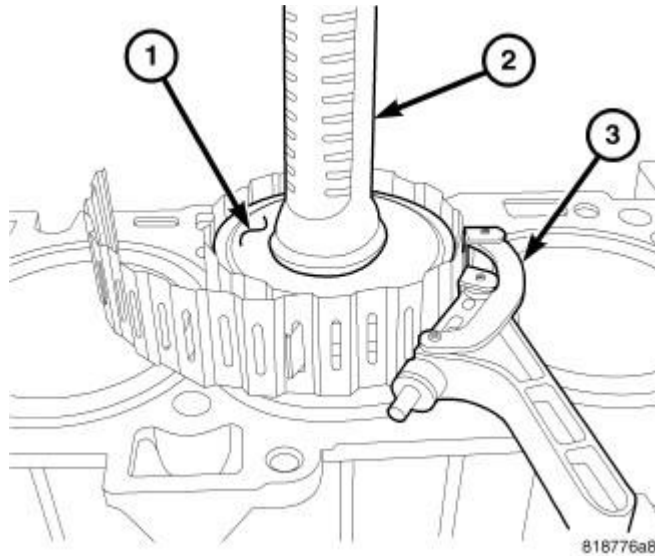
**NOTE:** Be sure the position of piston rings on the piston does not change during the following step.

4. Immerse the piston head and rings in clean engine oil, slide the ring compressor, over the piston.



**Fig. 211: Positioning Piston Toward Front Of Engine**  
Courtesy of CHRYSLER LLC

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.



**Fig. 212: Piston, Hammer Handle & Ring Compressor**  
Courtesy of CHRYSLER LLC

**NOTE:** Rod bearing sizes are indicated on the nose of the crankshaft. There are three different size rod bearings, perform rod bearing selection procedure.

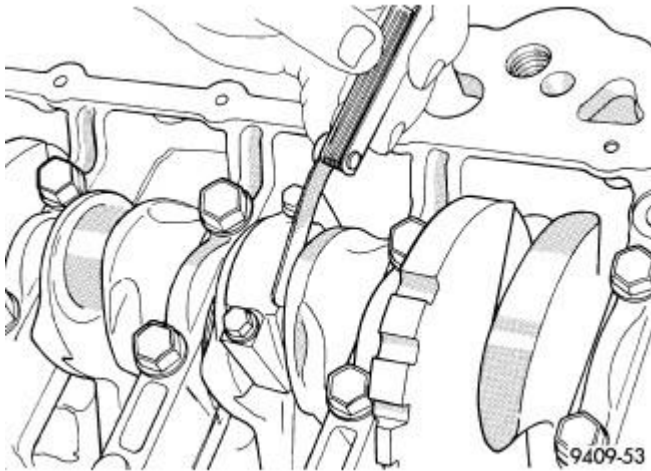
7. Install connecting rod upper bearing half into connecting rod.
8. Install ring compressor (3).
9. Tap the piston (1) down in cylinder bore, using a hammer handle (2). At the same time, guide connecting rod into position on connecting rod journal.

**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.

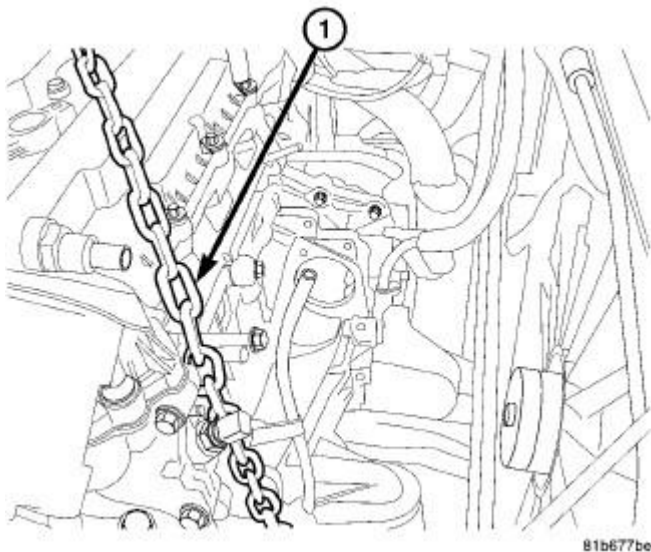
**CAUTION:** Do not use a torque wrench for the second step.

13. Tighten the connecting rod bolts using the 2 step torque-turn method. Tighten the bolts to 20 N.m (15 ft. lbs.), then an additional 90°.



**Fig. 213: Connecting Rod Side Clearance**  
Courtesy of CHRYSLER LLC

14. Using a feeler gauge, check connecting rod side clearance for connecting rod side clearance. Refer to **Engine - Specifications**.
15. Install the ladder frame. Refer to **FRAME, LADDER, INSTALLATION**.
16. Install oil pump/balance shaft carrier assembly. Refer to **PUMP, ENGINE OIL, INSTALLATION**.
17. Install oil pan. Refer to **PAN, OIL, INSTALLATION**.
18. Install cylinder head. Refer to **CYLINDER HEAD, INSTALLATION**.



**Fig. 214: Lift Chain**  
Courtesy of CHRYSLER LLC

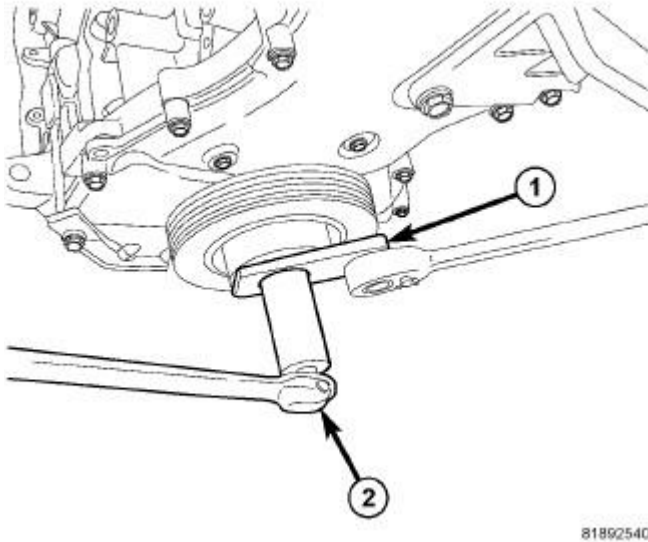
19. Install engine lift chain (1).
20. Connect transaxle assembly to engine.

21. Install engine. Refer to **INSTALLATION**.

## SEAL, CRANKSHAFT OIL, FRONT

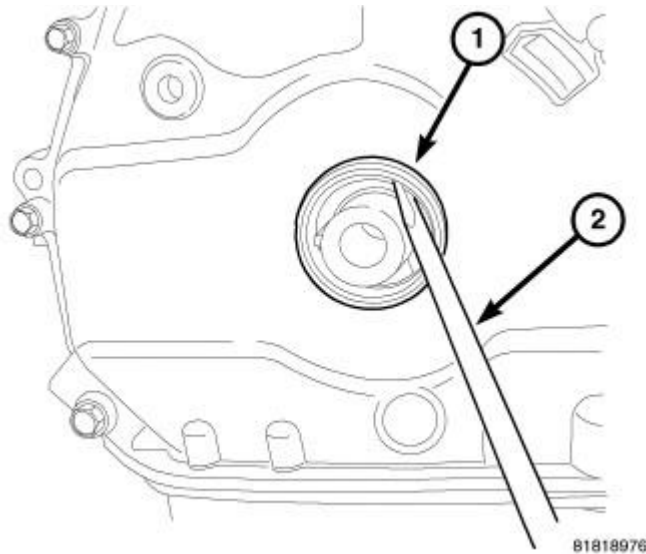
### REMOVAL

### REMOVAL



**Fig. 215: Removing/Installing Crankshaft Damper**  
 Courtesy of CHRYSLER LLC

1. Remove accessory drive belt.
2. Install damper holder (special tool #9707, Holder, Vibration Damper) (1) and remove damper retaining bolt.
3. Pull damper off crankshaft.

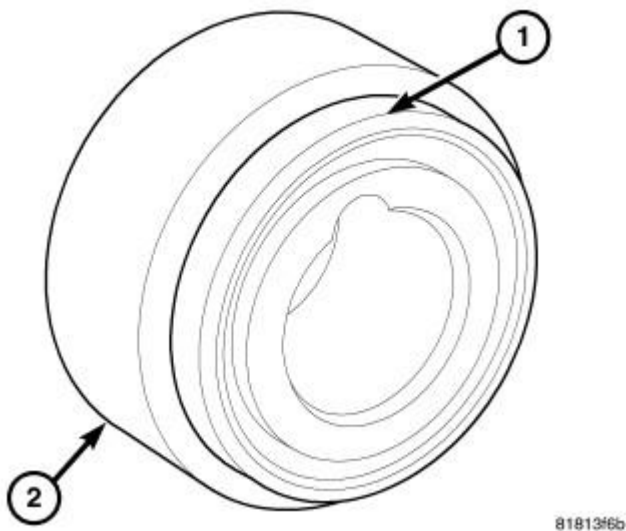


**Fig. 216: Removing Front Crankshaft Oil Seal By Prying Out With Screwdriver**  
 Courtesy of CHRYSLER LLC

4. Remove front crankshaft oil seal (1) by prying out with a screw driver (2). Be careful not to damage the cover seal surface.

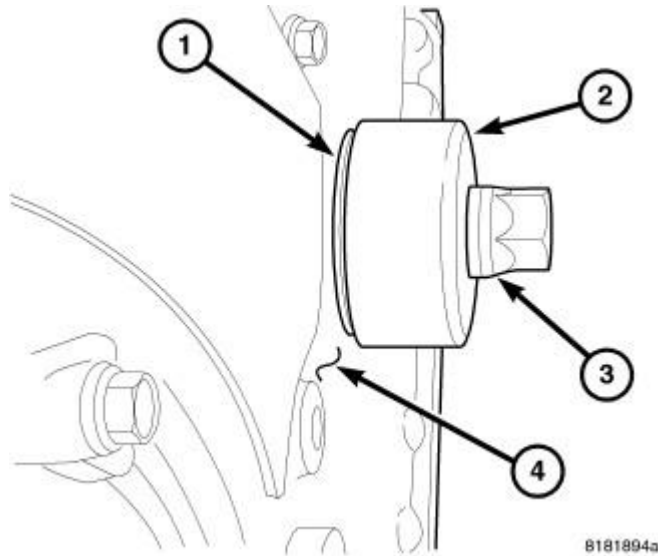
## INSTALLATION

## INSTALLATION



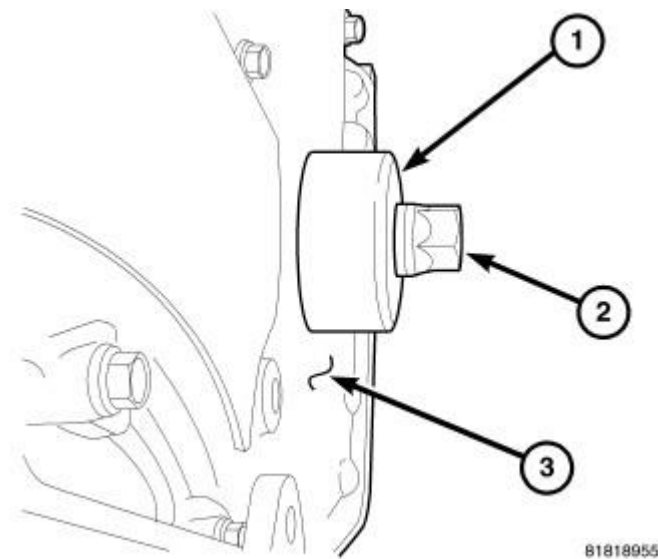
**Fig. 217: Crankshaft Oil Seal & Seal Installer 9506**  
 Courtesy of CHRYSLER LLC

1. Place seal (1) onto Seal installer (special tool #9506, Installer, Oil Seal) (2) with seal spring towards the inside of engine.



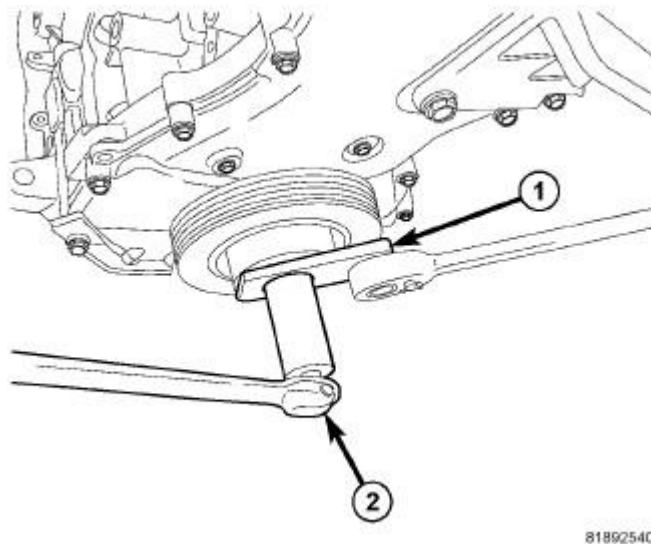
**Fig. 218: Installing New Seal By Using Seal Installer 9506 & Crankshaft Damper Bolt**  
Courtesy of CHRYSLER LLC

2. Install new seal (1) by using Seal installer (special tool #9506, Installer, Oil Seal) (2) and crankshaft damper bolt (3).



**Fig. 219: Front Seal Installed**  
Courtesy of CHRYSLER LLC

3. Press seal into front cover until Seal Installer (special tool #9506, Installer, Oil Seal) (1) seats against timing chain cover (3).
4. Remove seal installer (special tool #9506, Installer, Oil Seal) (1).



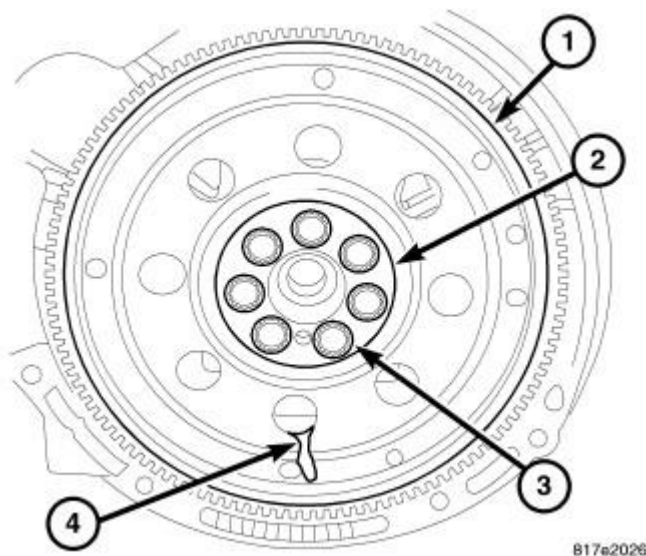
**Fig. 220: Removing/Installing Crankshaft Damper**  
Courtesy of CHRYSLER LLC

5. Install crankshaft vibration damper.
6. Oil the bolt threads and between the bolt head and washer.
7. Install damper retaining bolt and damper holder (special tool #9707, Holder, Vibration Damper) (1). Tighten bolt to 210 N.m (155 ft. lbs.).

## SEAL, CRANKSHAFT OIL, REAR

### REMOVAL

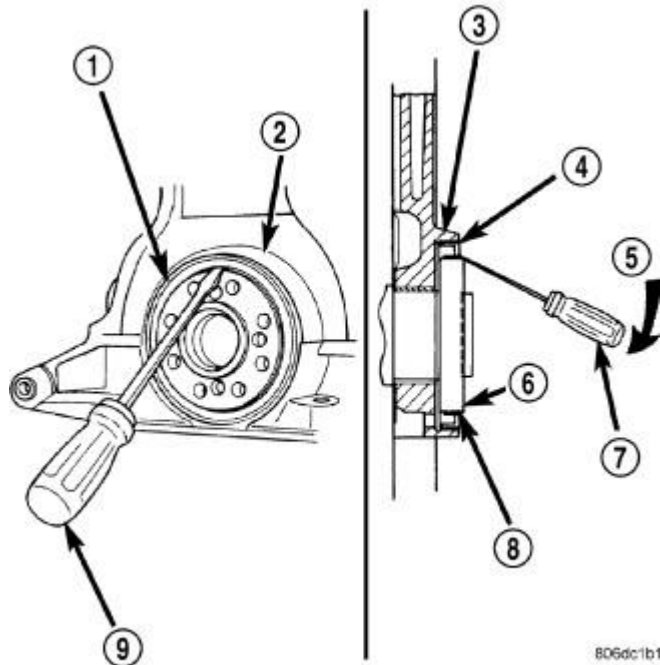
### REMOVAL



**Fig. 221: Flex Plate**

Courtesy of CHRYSLER LLC

1. Remove transmission and flexplate (1). Refer to **FLEXPLATE, REMOVAL**.



**Fig. 222: Removing Rear Crankshaft Oil Seal**  
Courtesy of CHRYSLER LLC

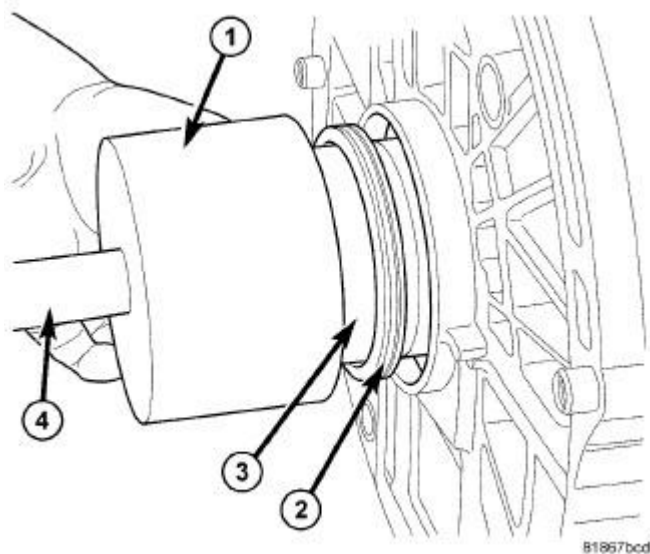
2. Insert a 3/16 flat bladed screwdriver (7) between the dust lip (8) and the metal case (4) of the crankshaft seal (1). Angle the screwdriver through the dust lip against metal case of the seal. Pry out seal.

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

3. Check to make sure the seals garter spring is not on the crankshaft.

## INSTALLATION

## INSTALLATION



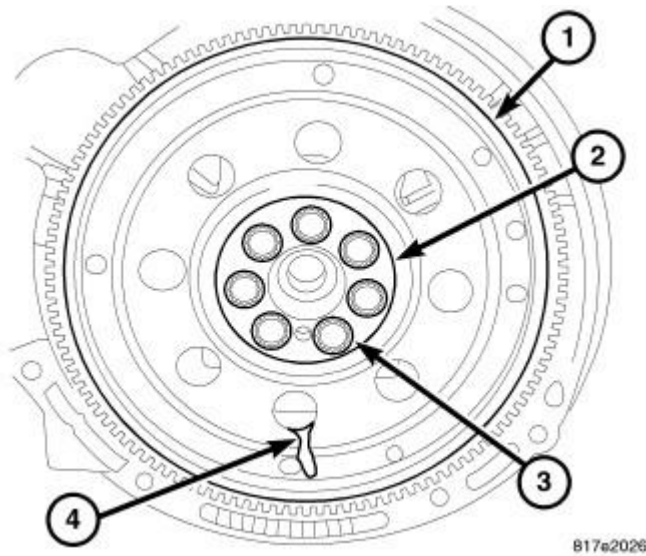
**Fig. 223: Rear Main Installation**

Courtesy of CHRYSLER LLC

**CAUTION:** If a burr or scratch is present on the crankshaft edge (chamfer), cleanup with 800 emery cloth to prevent seal damage during installation of new seal. If emery cloth is used, the crankshaft must be cleaned off Mopar® brake parts cleaner.

**NOTE:** When installing seal, lubricate Seal Guide (special tool #9509, Installer, Oil Seal) with clean engine oil.

1. Place Seal Guide (special tool #9509, Installer, Oil Seal) (3) 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 Seal Driver (special tool #9706, Installer, Crankshaft Rear Oil Seal) (1) and Driver Handle (special tool #C-4171, Driver Handle, Universal) (4) until Seal Driver (special tool #9706, Installer, Crankshaft Rear Oil Seal) bottoms out against the block.



**Fig. 224: Flex Plate**  
Courtesy of CHRYSLER LLC

4. Install the flexplate (1) and transmission. Refer to **FLEXPLATE, INSTALLATION**.

## ENGINE MOUNTING

### DESCRIPTION

### DESCRIPTION

The engine mounting system consists of a four-point system utilizing two load-carrying mounts and two torque controlling mounts. The load-carrying mounts are located on each frame rail. The right and left mounts are hydro-elastic mounts. The two torque controlling mounts are attached to a fore/aft member and the front and rear of the engine.

### OPERATION

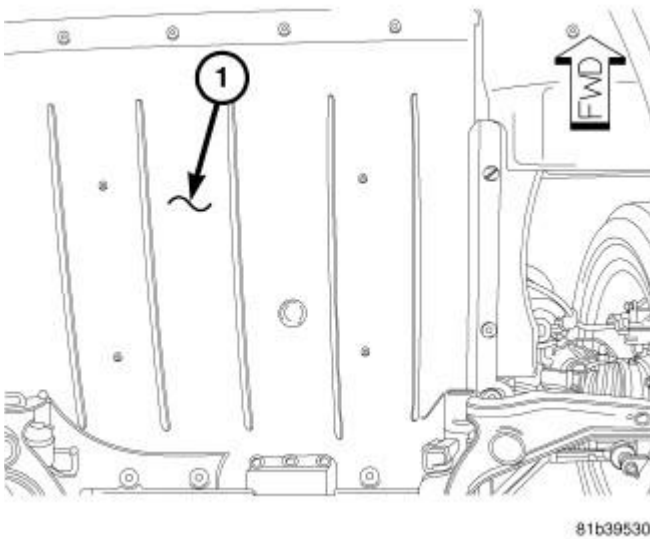
### OPERATION

The four-point engine mounting system minimizes the transmission of structure-borne engine noise to the passenger compartment. The load-carrying right and left mounts dampen and isolate vertical motion and vibration. The front and rear mount absorb torque reaction forces and torsional vibrations.

### INSULATOR, ENGINE MOUNT, FRONT

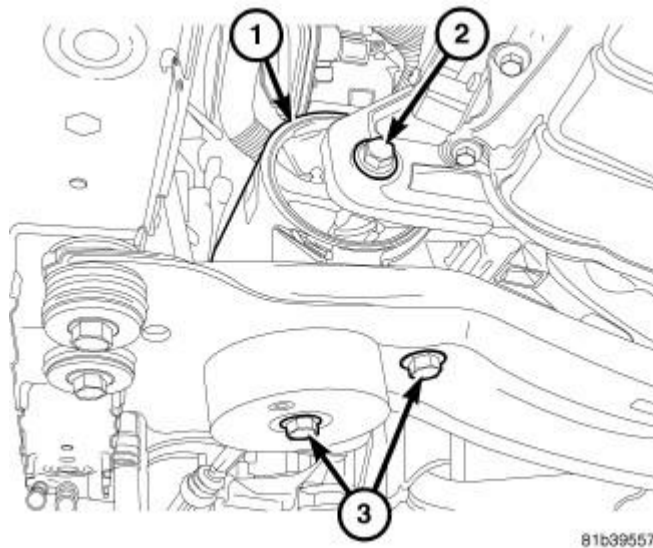
### REMOVAL

### REMOVAL



**Fig. 225: Lower Silencer**  
Courtesy of CHRYSLER LLC

1. Raise vehicle.
2. Remove lower silencer (1).

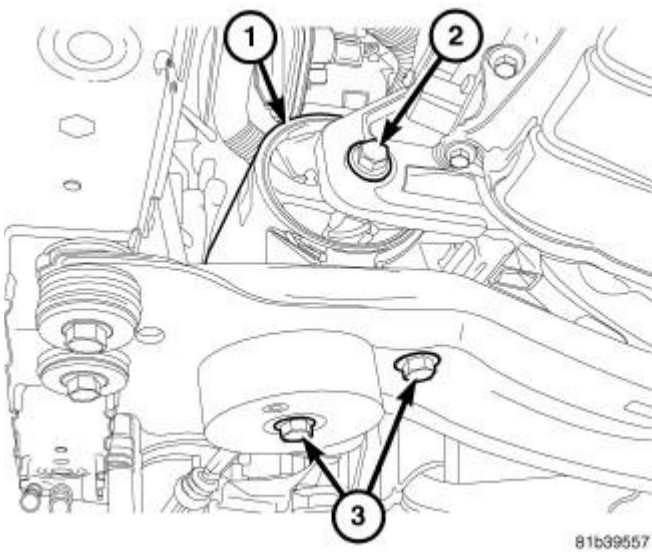


**Fig. 226: Front Mount & Bolts**  
Courtesy of CHRYSLER LLC

3. Remove mount through bolt (2).
4. Remove front mount retaining bolts (3).
5. Remove front mount (1).

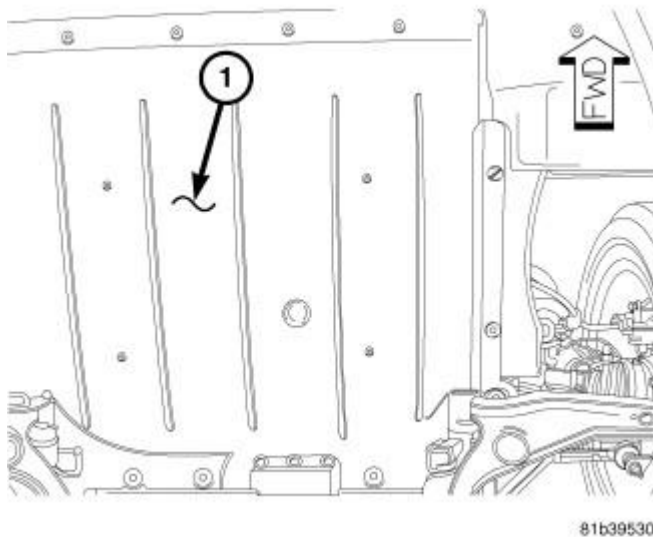
## INSTALLATION

## INSTALLATION



**Fig. 227: Front Mount & Bolts**  
Courtesy of CHRYSLER LLC

1. Position mount (1) and
2. Install retaining bolts (3) and torque to 47 N.m (35 ft. lbs.).
3. Install mount through bolt (2) and torque to 47 N.m (35 ft. lbs.).



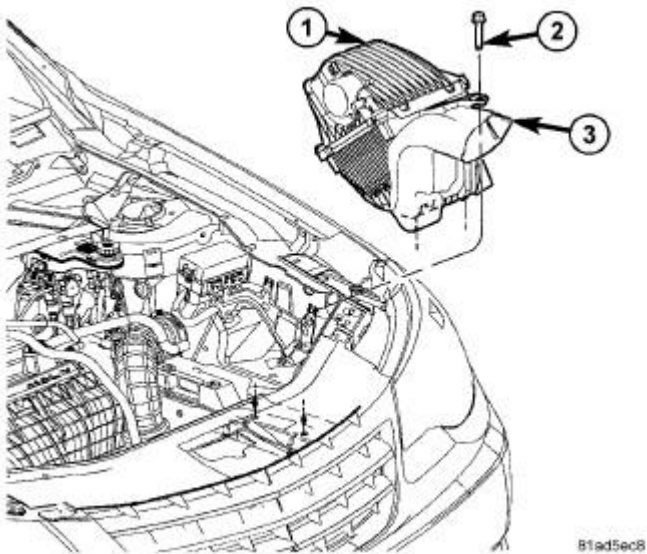
**Fig. 228: Lower Silencer**  
Courtesy of CHRYSLER LLC

4. Install lower silencer (1).
5. Lower vehicle.

## INSULATOR, ENGINE MOUNT, LEFT

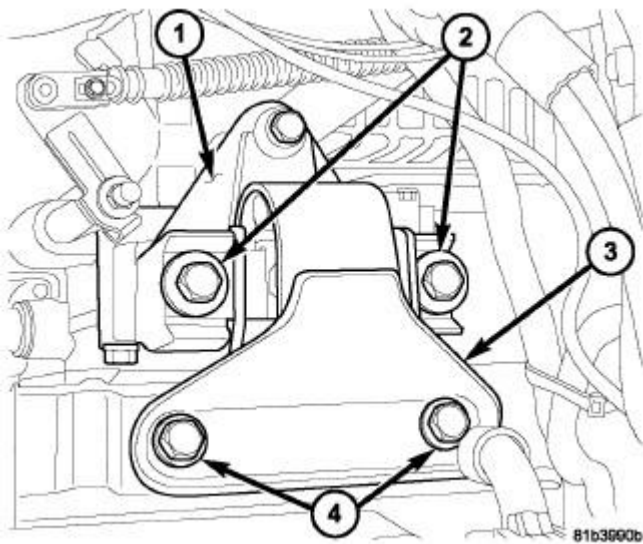
### REMOVAL

## REMOVAL



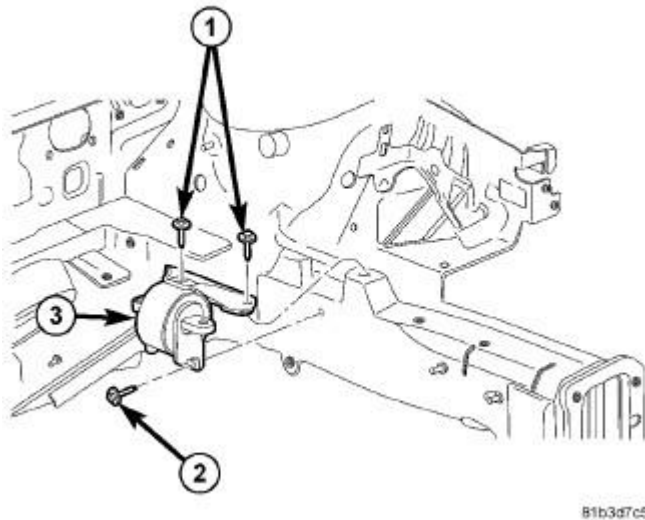
**Fig. 229: Air Cleaner Housing Assembly**  
Courtesy of CHRYSLER LLC

1. Remove the air cleaner body (1). Refer to **BODY, AIR CLEANER, REMOVAL**.
2. Disconnect and isolate the negative battery cable.
3. Remove the PCM and PCM mounting bracket. Refer to **MODULE, POWERTRAIN CONTROL, REMOVAL**.



**Fig. 230: Left Engine Mount & Bolts**  
Courtesy of CHRYSLER LLC

4. Support the transaxle with a suitable jack.
5. Remove the mount to transaxle bolts (2).
6. Remove the left mount to frame rail fasteners (4).



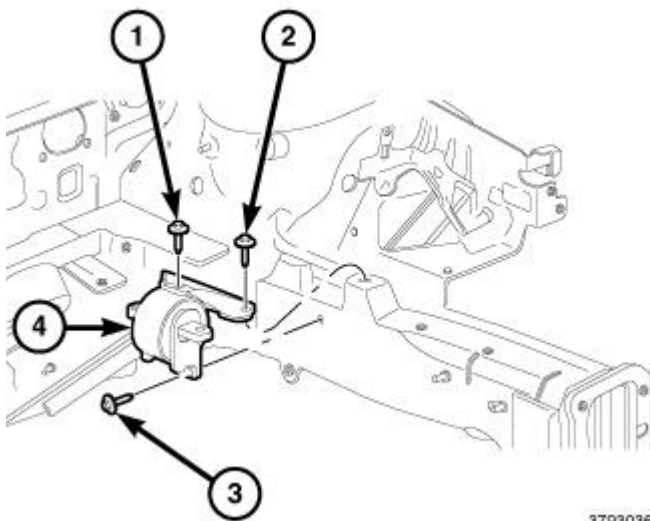
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**Fig. 231: Left Mount Isolator & Bolts**  
Courtesy of CHRYSLER LLC

7. Lower the transaxle to gain access to the mount to frame rail fastener (2).
8. Remove the mount isolator (3).

## INSTALLATION

## INSTALLATION

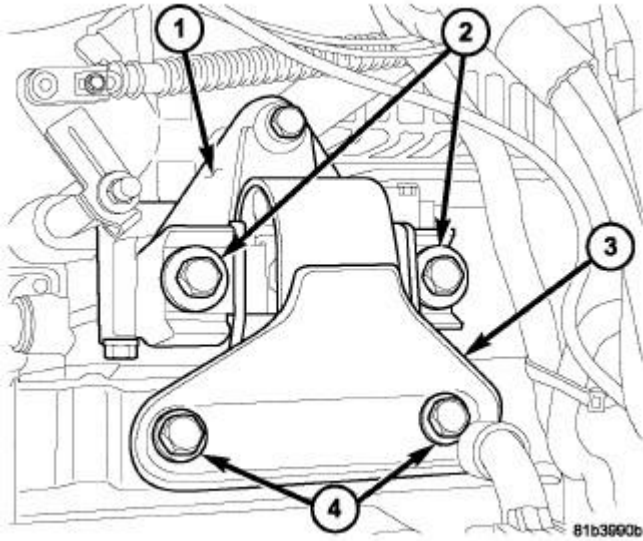


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**Fig. 232: Left Mount Isolator & Bolt Tightening Sequence**

Courtesy of CHRYSLER LLC

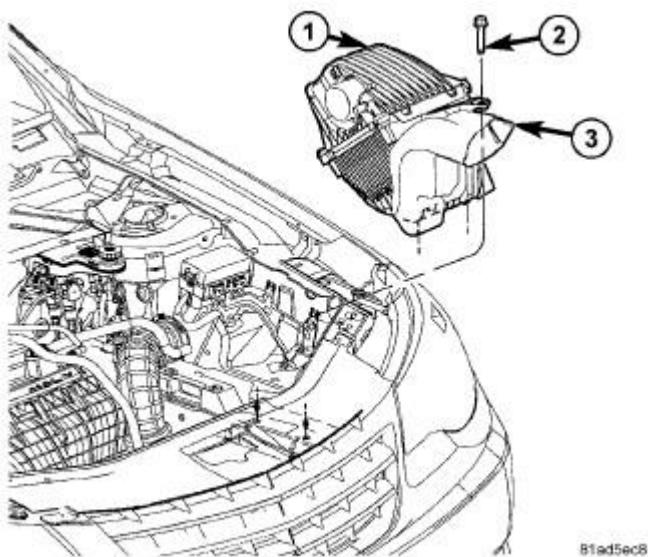
1. Position mount isolator (4) in place and install the bolts hand tight in the following sequence (3), (1) and (2). Tighten the bolts to 54 N.m (40 ft. lbs.) in the following sequence; (2), (1) and (3).



**Fig. 233: Left Engine Mount & Bolts**

Courtesy of CHRYSLER LLC

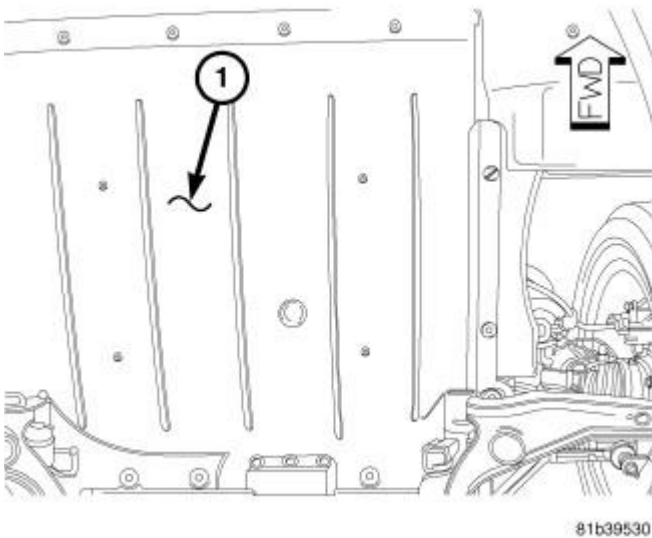
2. Raise the transaxle into position, install bolts (2) and tighten to 110 N.m (81 ft. lbs.).
3. Remove the jack.



**Fig. 234: Air Cleaner Housing Assembly**

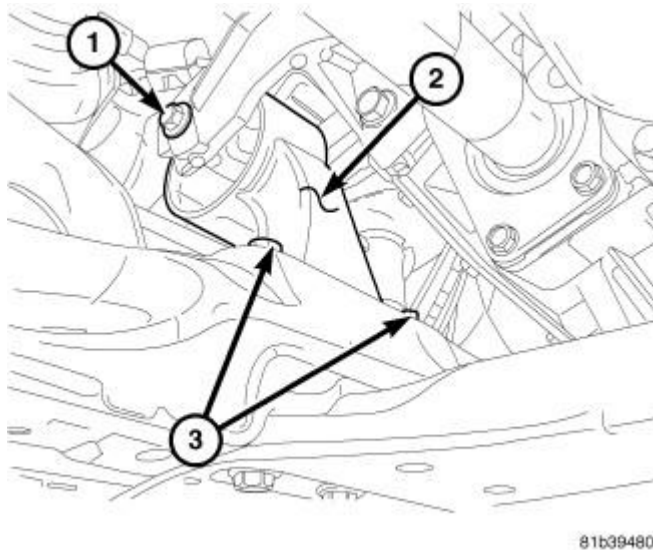
Courtesy of CHRYSLER LLC

4. Install the PCM and PCM mounting bracket. Refer to **MODULE, POWERTRAIN CONTROL, INSTALLATION**.
5. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
6. Install the air cleaner body (1). Refer to **BODY, AIR CLEANER, INSTALLATION**.

**INSULATOR, ENGINE MOUNT, REAR****REMOVAL****REMOVAL**

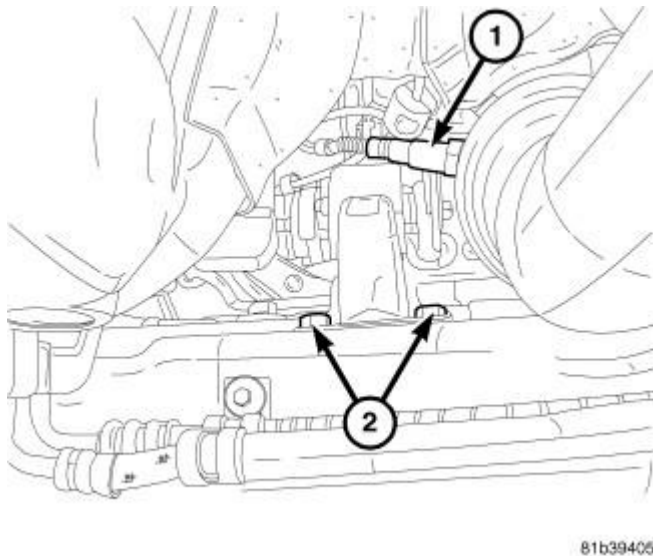
**Fig. 235: Lower Silencer**  
Courtesy of CHRYSLER LLC

1. Raise vehicle.
2. Remove lower silencer (1).



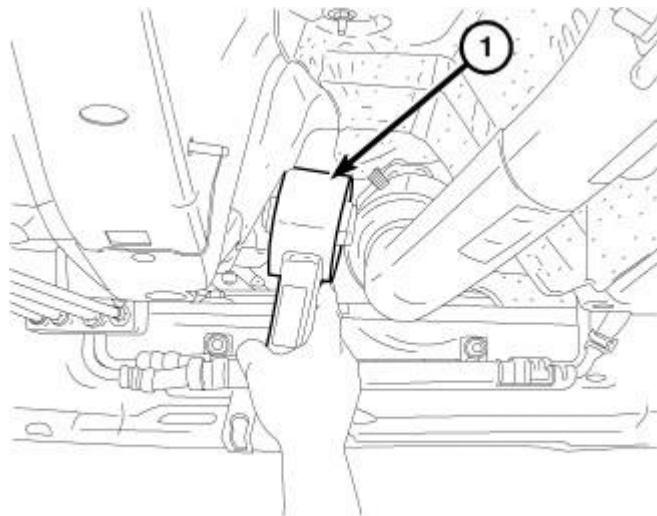
**Fig. 236: Rear Engine Mount & Bolts**  
 Courtesy of CHRYSLER LLC

3. Remove rear mount retaining bolts (3).
4. Remove rear mount through bolt (1).



**Fig. 237: Oxygen Sensor & Rear Mount Retaining Bolts**  
 Courtesy of CHRYSLER LLC

5. Remove oxygen sensor (1).
6. Remove rear mount retaining bolts (2).



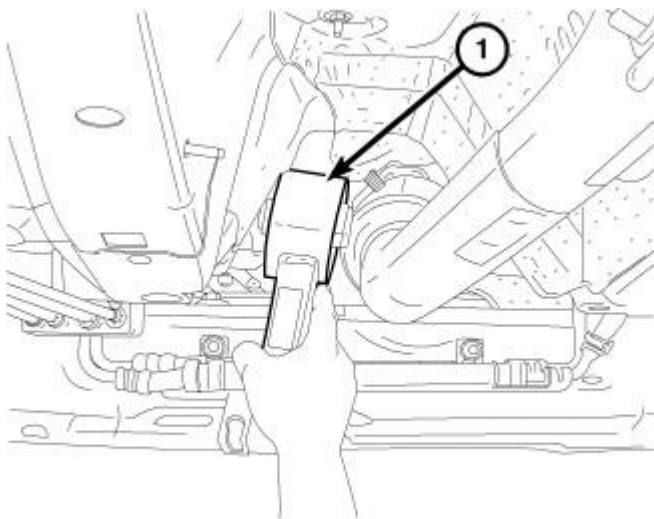
81b39412

**Fig. 238: Removing/Installing Rear Mount**  
Courtesy of CHRYSLER LLC

7. Remove rear mount (1) towards the rear of the vehicle.

#### INSTALLATION

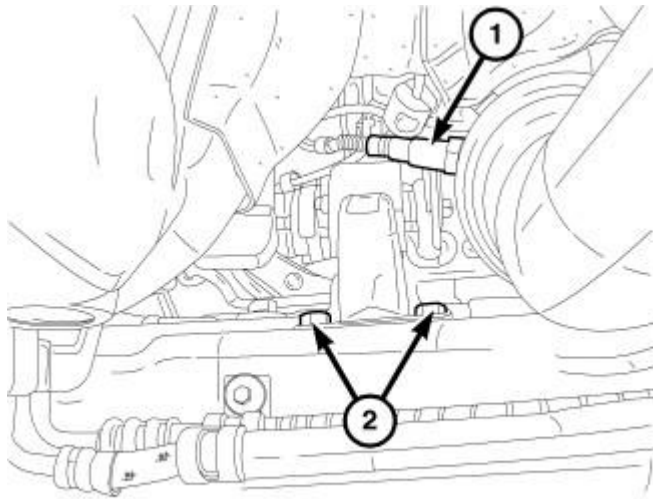
#### INSTALLATION



81b39412

**Fig. 239: Removing/Installing Rear Mount**  
Courtesy of CHRYSLER LLC

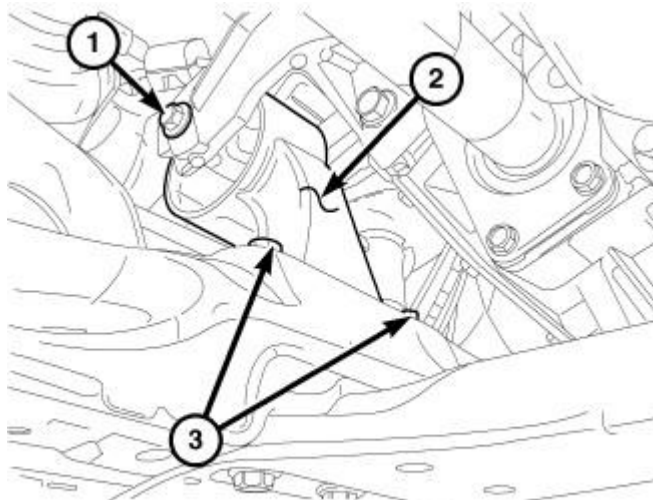
1. Position rear mount (1) in place from the rear of the vehicle.



81b39405

**Fig. 240: Oxygen Sensor & Rear Mount Retaining Bolts**  
Courtesy of CHRYSLER LLC

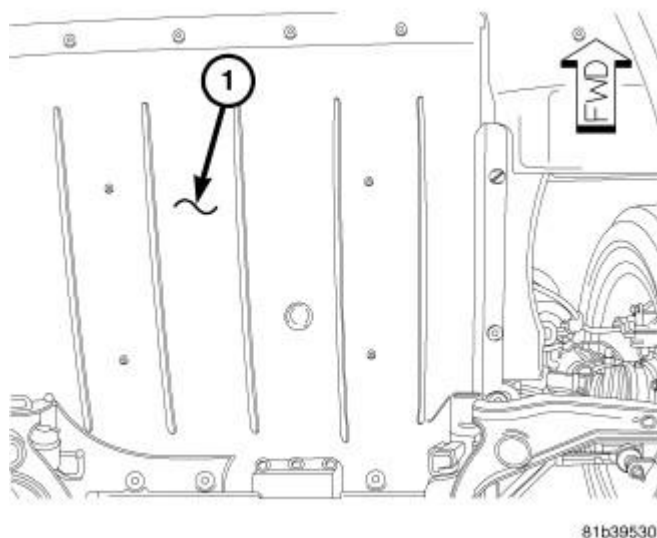
2. Install rear mount retaining bolts (2) and torque to 50 N.m (37 ft. lbs.).
3. Install oxygen sensor (1).



81b39480

**Fig. 241: Rear Engine Mount & Bolts**  
Courtesy of CHRYSLER LLC

4. Install rear mount retaining bolts (3) and torque to 50 N.m (37 ft. lbs.).
5. Install rear mount through bolt (1) and torque to 47 N.m (35 ft. lbs.).



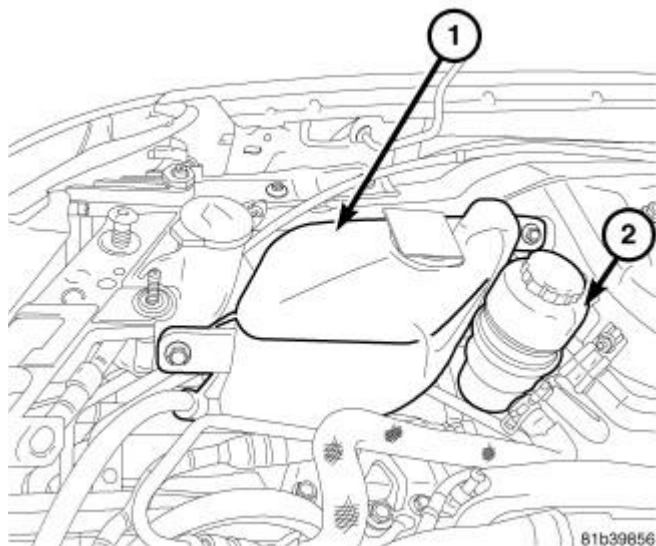
**Fig. 242: Lower Silencer**  
Courtesy of CHRYSLER LLC

6. install lower silencer (1).

## INSULATOR, ENGINE MOUNT, RIGHT

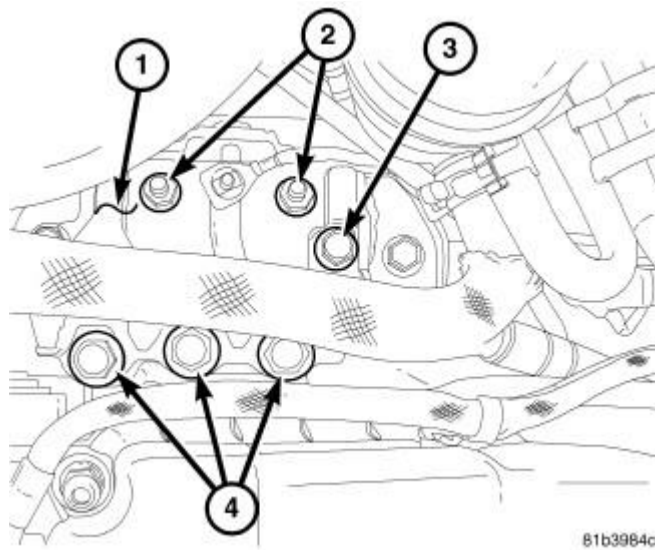
### REMOVAL

### REMOVAL



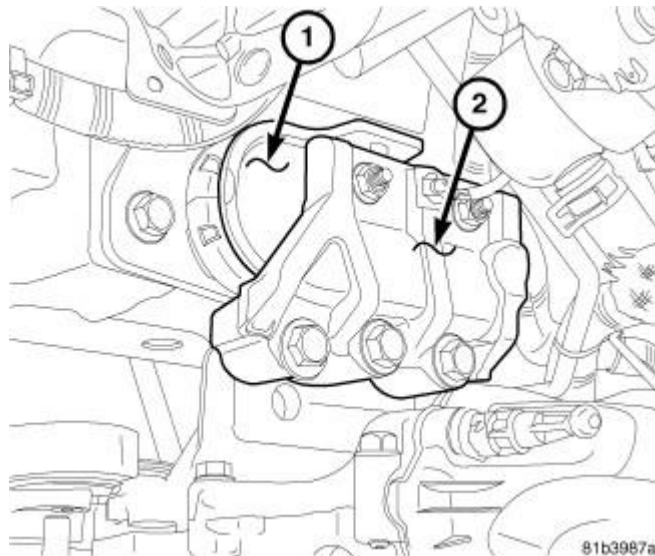
**Fig. 243: Coolant Reservoir & Power Steering Reservoir**  
Courtesy of CHRYSLER LLC

1. Remove coolant reservoir (1) and set aside.



**Fig. 244: Power Steering Hose Hold Down, Right Engine Mount Bracket & Fasteners**  
 Courtesy of CHRYSLER LLC

2. Remove power steering line support bracket (3) from engine mount.
3. Support transaxle with a block of wood and a suitable jack.

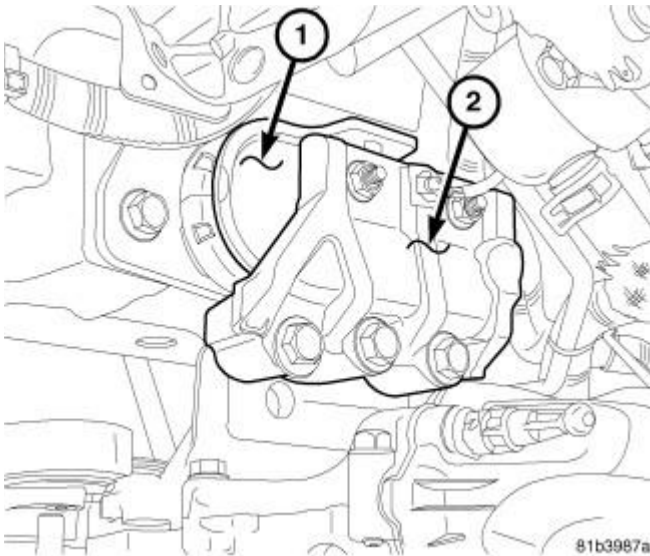


**Fig. 245: Engine Mount Isolator & Bracket**  
 Courtesy of CHRYSLER LLC

4. Remove engine mount bracket (2) retaining bolts.
5. Remove engine mount isolator bolts.
6. Remove engine mount isolator (1).

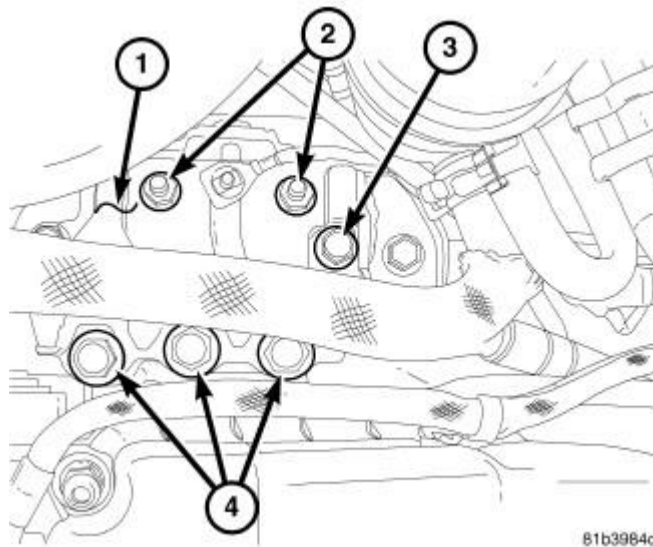
## INSTALLATION

## INSTALLATION



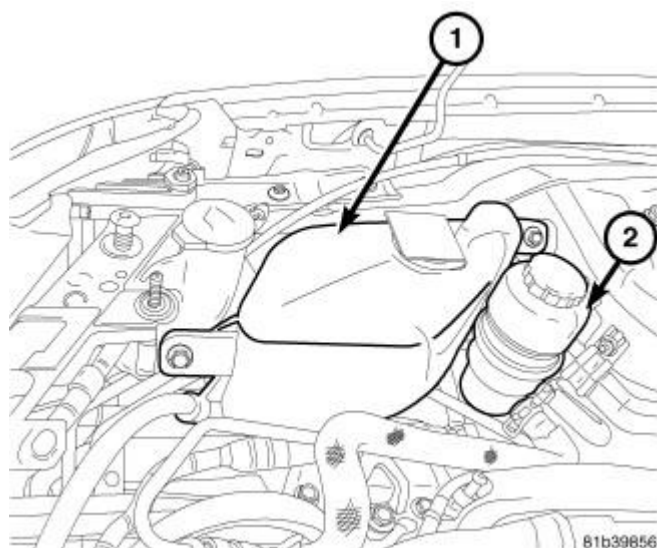
**Fig. 246: Engine Mount Isolator & Bracket**  
 Courtesy of CHRYSLER LLC

1. Position right engine mount isolator (1).
2. Install engine mount isolator retaining bolts and tighten to 75 N.m (55 ft. lbs.).
3. Install engine mount bracket (2) and tighten bolts (3) to 68 N.m (50 ft. lbs.).



**Fig. 247: Power Steering Hose Hold Down, Right Engine Mount Bracket & Fasteners**  
 Courtesy of CHRYSLER LLC

4. Remove jack.
5. Install power steering line support (3) at engine mount.



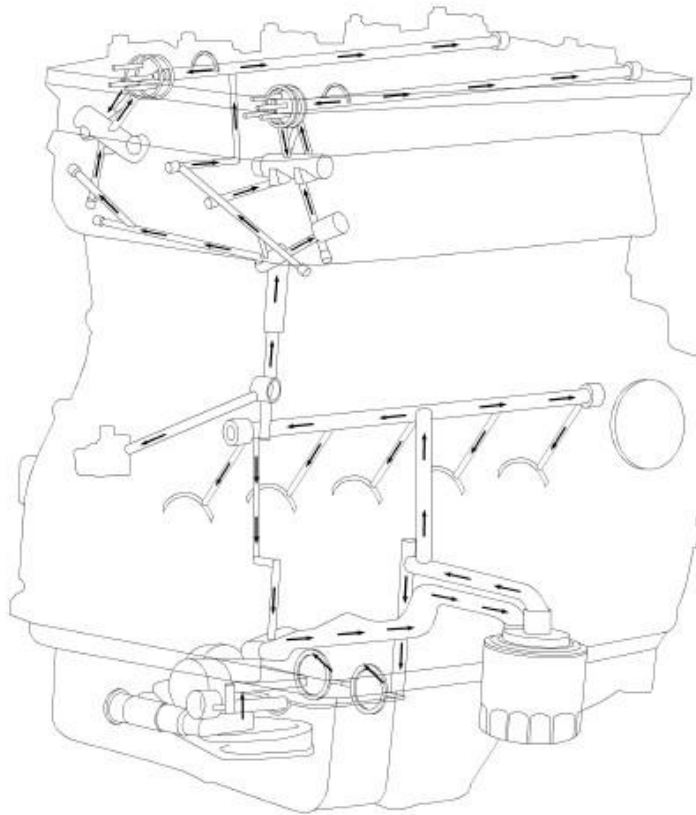
**Fig. 248: Coolant Reservoir & Power Steering Reservoir**  
Courtesy of CHRYSLER LLC

6. Install coolant reservoir (1).

## LUBRICATION

### DESCRIPTION

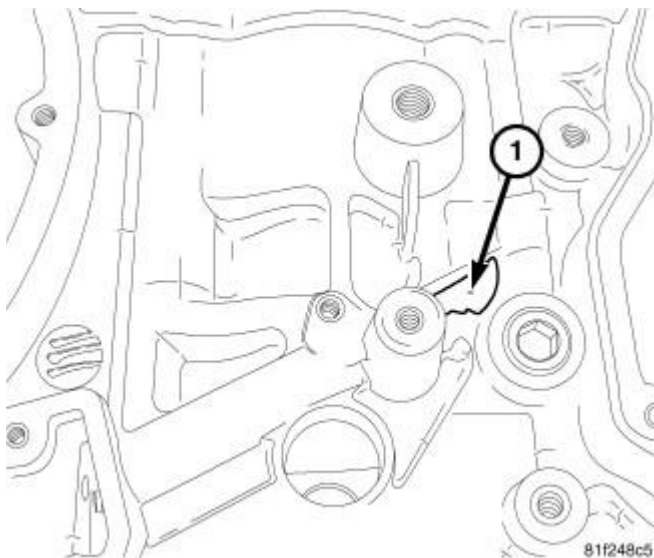
### DESCRIPTION



81867bc9

**Fig. 249: Oil Flow Diagram**  
Courtesy of CHRYSLER LLC

The lubrication system is a full-flow filtration, pressure feed type. The balance shaft module (BSM) is mounted below the ladder frame and chain driven by the crankshaft. The BSM consists of a non-serviceable pump, oil pressure relief valve, and a non-serviceable balance assembly.



81f248c5

**Fig. 250: Oil Hole**

Courtesy of CHRYSLER LLC

**NOTE:** Not all blocks have the bolt on timing chain oil squirter. Engine blocks either have a bolt-on oil squirter or a 1.0 mm hole (1) drilled into the oil gallery passage. Engine blocks with the 1.0 mm hole no longer use an oil squirter even though the threaded mounting hole may still be present.

## OPERATION

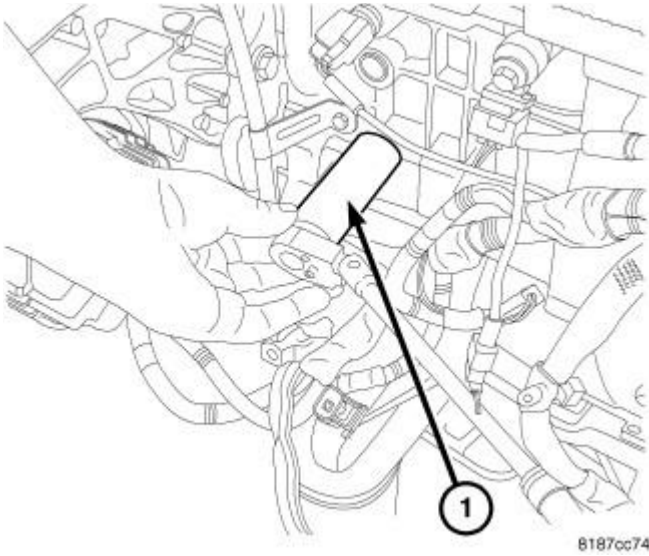
### OPERATION

Engine oil is drawn up through the pickup tube and is pressurized by the oil pump and routed through the full-flow 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 main bearing journals to connecting rod journals. Balance shaft lubrication is provided through an internal oil passage at the #3 bearing location around the BSM mounting bolt. A vertical hole at the number one bulkhead routes pressurized oil through a filter screen and head gasket up to the cylinder head. The oil then divides into three passages; one to the intake cam phaser, one to the exhaust cam phaser and one to the camshafts. The passage to the camshafts divides to feed both of the hollow camshafts at the second cam journal. The rest of cam journals are fed oil through the hollow camshafts. The #1 cam journals are fed oil through the VVT oil passages. Oil passages to the phasers are directed through the OCV (oil control valves) to the #1 journals. The oil then flows through the camshafts then to the cam phasers. Oil returning to the pan from pressurized components supplies lubrication to the valve stems, cam lobes, and tappets. Cylinder bores and wrist pins are splash lubricated from directed slots on the connecting rod thrust collars.

## DIAGNOSIS AND TESTING

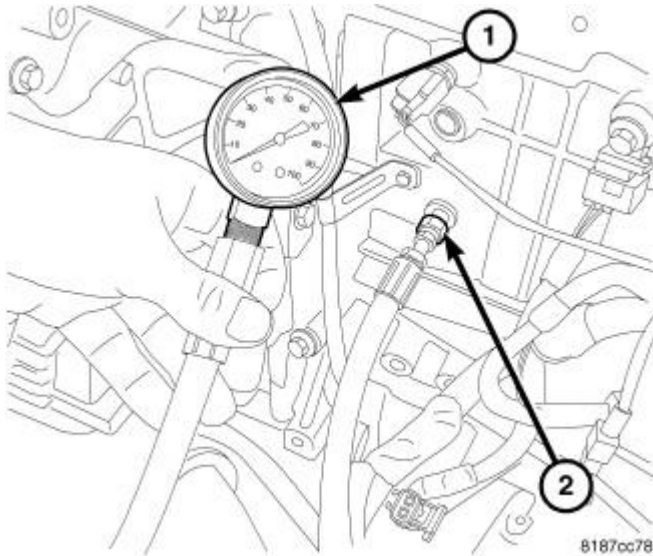
### CHECKING ENGINE OIL PRESSURE

**NOTE:** Due to restricted access to the oil pressure switch, it is recommended to first check VVT oil pressure at the oil temperature sensor. Refer to Engine/Lubrication - Diagnosis and Testing.



**Fig. 251: Oil Pressure Switch**  
Courtesy of CHRYSLER LLC

1. Remove the oil pressure switch (1). Refer to **SWITCH, OIL PRESSURE, REMOVAL**.



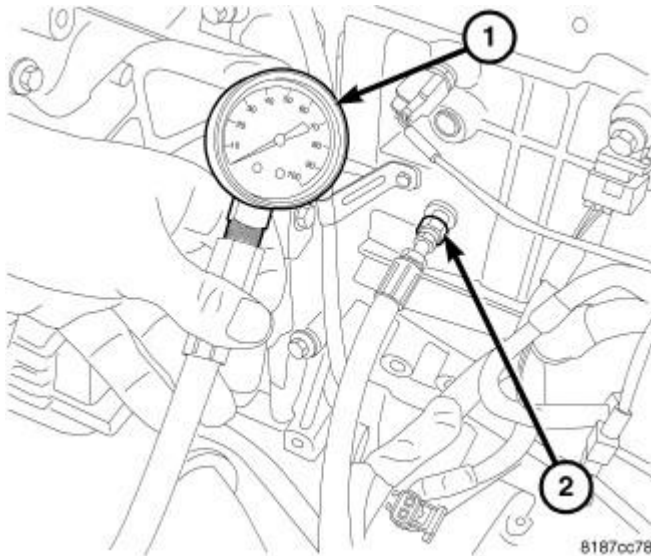
**Fig. 252: Oil Pressure Gauge & Adapter**  
Courtesy of CHRYSLER LLC

**CAUTION:** Threads in block are 1/8"-28 British Standard Pipe (BSP). Do not install a National Pipe Thread (NPT) threaded adapter, this could crack the cylinder block.

2. Install an 1/8-28 BSP male to 1/8-27 female threaded adapter (2).
3. Install an oil pressure gauge (1).
4. Start engine and record oil pressure.

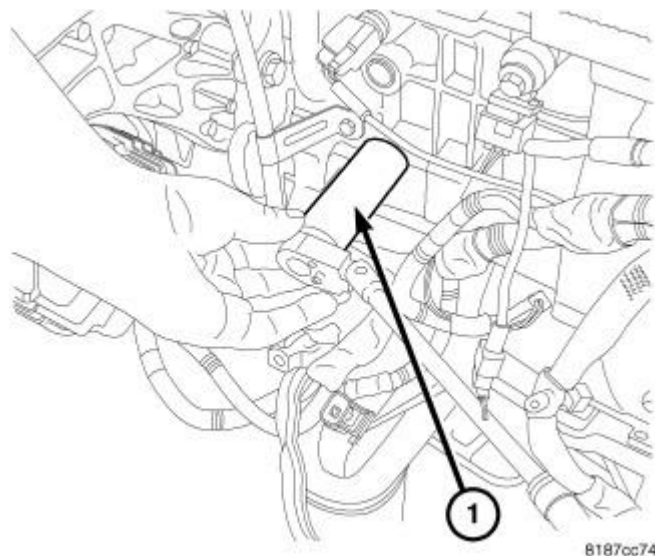
**CAUTION:** If oil pressure is 0 at idle, do not perform the 3000 RPM test

5. If oil pressure is 0 at idle, shut off engine. No oil pressure or low oil pressure at the oil pressure switch can be due to the following:
  - Pressure relief valve stuck open.
  - Clogged oil pump pick-up screen.
6. Remove the oil pan and inspect for debris. Refer to **PAN, OIL, REMOVAL**.
7. Remove the oil pressure relief valve. Refer to **VALVE, OIL PRESSURE RELIEF, REMOVAL**.
8. Inspect the oil pressure relief valve. Refer to **VALVE, OIL PRESSURE RELIEF, INSPECTION**.
9. If pressure relief valve is OK, replace the balance shaft module assembly. Refer to **PUMP, ENGINE OIL, REMOVAL**.



**Fig. 253: Oil Pressure Gauge & Adapter**  
Courtesy of CHRYSLER LLC

10. After test is complete, remove test gauge (1) and fitting (2).



**Fig. 254: Oil Pressure Switch**  
Courtesy of CHRYSLER LLC

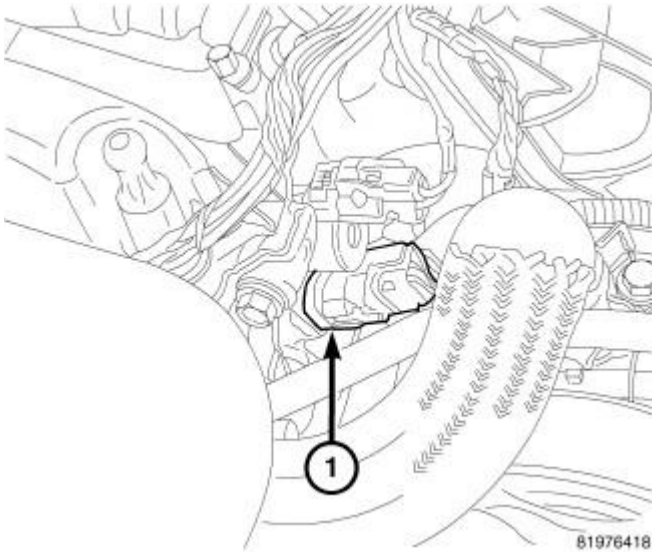
**CAUTION:** The oil pressure switch has tapered threads, over tightening could crack the engine block.

**NOTE:** If the oil pressure switch is removed, it must be replaced with a new switch.

11. Install the oil pressure switch and electrical connector. Refer to **SWITCH, OIL PRESSURE, INSTALLATION**.

#### CHECKING VVT OIL PRESSURE

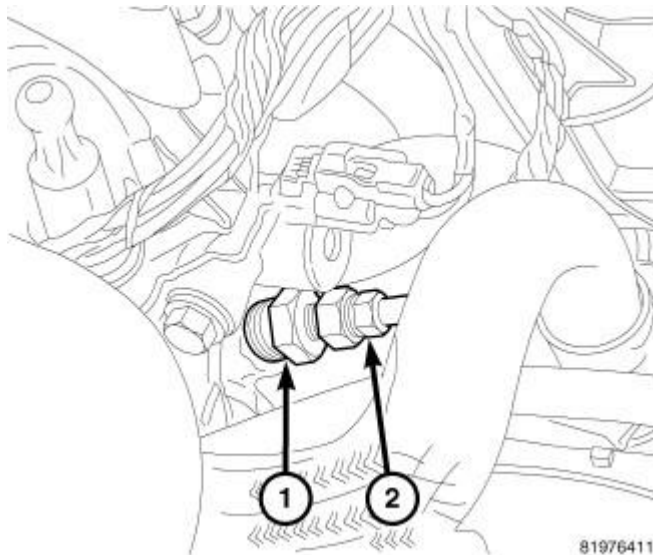
**NOTE:** This test can be used to help diagnose VVT faults. Due to restricted access to the oil pressure switch, it is recommended to first perform this procedure to check VVT oil pressure at the oil temperature sensor.



**Fig. 255: Oil Temperature Sensor**  
Courtesy of CHRYSLER LLC

**NOTE:** Anytime the oil temperature sensor is removed, it should be replaced with a new sensor.

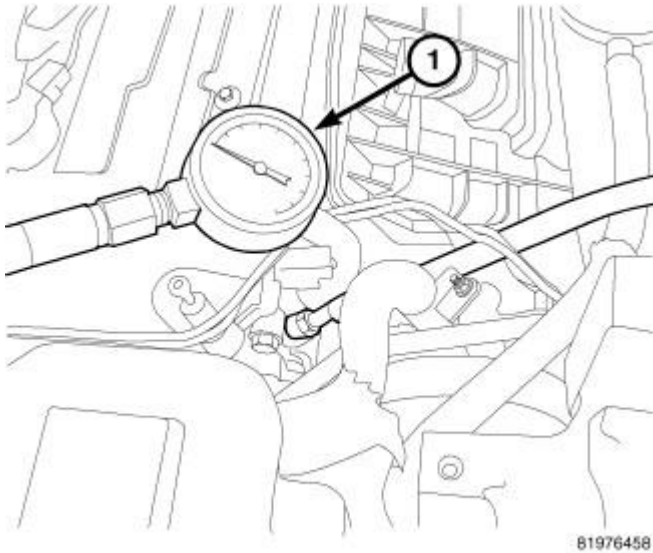
1. Disconnect and remove the oil temperature sensor (1). Refer to **SENSOR, OIL TEMPERATURE, REMOVAL.**



**Fig. 256: Oil Pressure & Adapter**  
Courtesy of CHRYSLER LLC

**CAUTION:** Threads in cylinder head are British Standard Pipe (BSP). Do not install a NPT threaded adapter, this could crack the cylinder head.

2. Install threaded adapter (special tool #9879, Adapter, Oil Pressure Test) (1).
3. Install an oil pressure gauge (2).

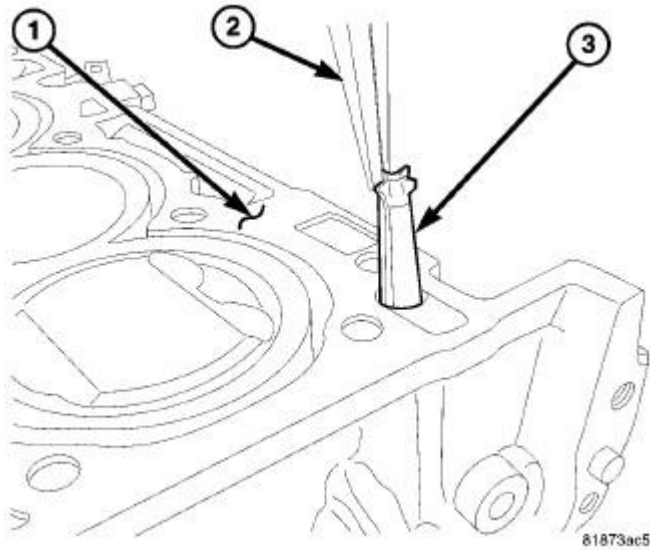


**Fig. 257: Oil PSI Gauge**  
Courtesy of CHRYSLER LLC

4. Start engine and record reading on oil pressure gauge (1).

**CAUTION: If oil pressure is 0 at idle, do not perform the 3000 RPM test**

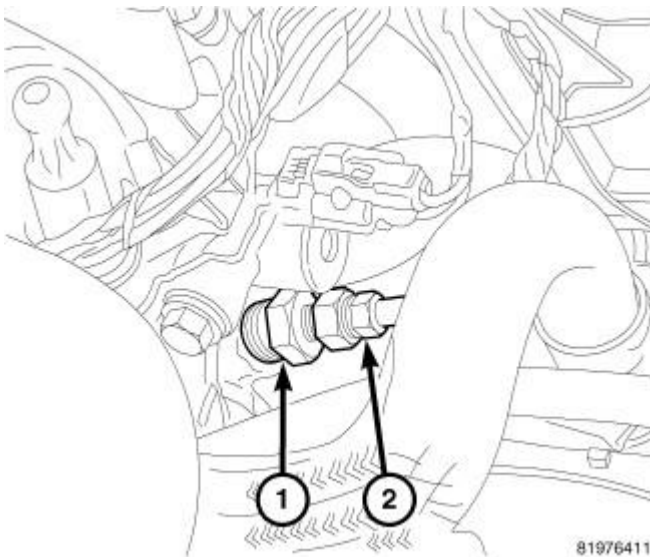
5. If oil pressure is 0 at idle, shut off engine. No oil pressure or low oil pressure at the oil temperature sensor can be due to the following:
  - Clogged variable valve timing filter screen
  - Pressure relief valve stuck open
  - Clogged oil pump pick-up screen



**Fig. 258: VVT Filter**

Courtesy of CHRYSLER LLC

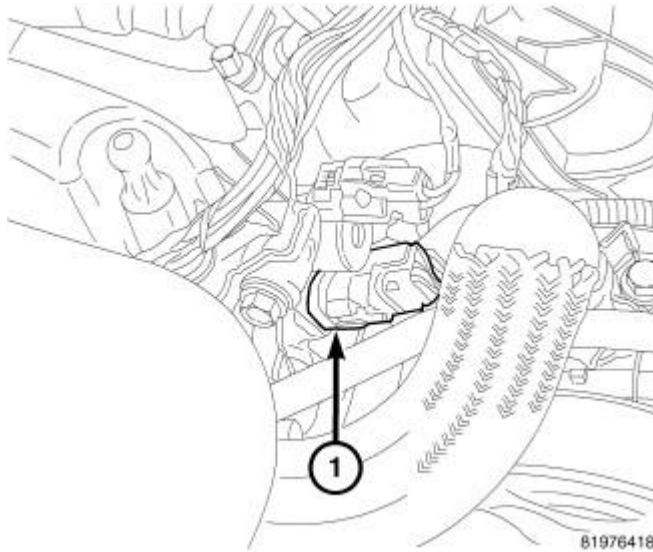
6. To determine if the variable valve timing filter screen is clogged, check engine oil pressure at the oil pressure switch. Refer to **Engine/Lubrication - Diagnosis and Testing**.
7. If oil pressure is acceptable at the oil pressure switch, but low at the oil temperature sensor, remove the cylinder head (1) and inspect the variable valve timing filter screen (3). Refer to **CYLINDER HEAD, REMOVAL**.



**Fig. 259: Oil Pressure & Adapter**

Courtesy of CHRYSLER LLC

8. After test is complete, remove oil pressure gauge (2) and adapter (special tool #9879, Adapter, Oil Pressure Test) (1).



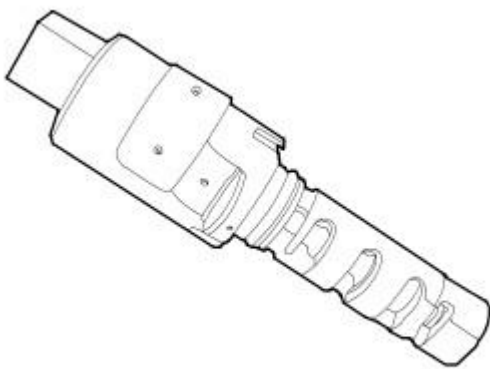
**Fig. 260: Oil Temperature Sensor**  
Courtesy of CHRYSLER LLC

9. Install a new oil temperature sensor (1) and connect the electrical connector. Refer to **SENSOR, OIL TEMPERATURE, INSTALLATION**.

## CONTROL VALVE, OIL INTAKE

### DESCRIPTION

### DESCRIPTION



**Fig. 261: Solenoid Assembly**  
Courtesy of CHRYSLER LLC

Variable valve timing solenoid assembly. The solenoid receives pulse width modulation signal and the current is controlled within 0 ma to 1000 ma. The spool position is controllable at any position to control supply of oil

between the advance and retard ports.

## OPERATION

### OPERATION

There is both an Intake and an exhaust camshaft sensor on vehicles equipped with a World Engine. The variable valve timing system used on World Engines requires the exact position of both the intake and exhaust camshaft. The GPEC1 uses camshaft sensor data along with crankshaft data to determine the actual position of the camshafts. Intake and exhaust phaser oil control valves are required on World Engine vehicles using variable valve timing. The oil valves direct oil to the Intake and exhaust phasers. Oil pressure in the phasers moves the camshafts to an advanced or retarded position.

To resolve this inherent conflict between optimum high and low speed valve timing, the GPEC1 controlled engine uses a variable valve timing system. The variable valve timing system advances and retards valve timing by rotating the position of both the intake and exhaust camshafts. With this system, the intake valve opening can range from 80 to 120 crankshaft degrees after Top Dead Center. Likewise, the exhaust valve opening can range from 85 to 120 crankshaft degrees before Top Dead Center. This degree of flexibility provides many benefits, including: Improved Engine Performance, Increased Fuel Economy, Improved Idle Stability and Decreased Engine Emissions. In non operating condition, the camshaft stays in lockpin position of cam phases. This is 120 degrees ATDC for intake camshaft and 120 degrees BTDC for exhaust camshaft.

The variable valve timing system is electronically controlled and hydraulically operated. The GPEC1 receives information from many sensors to determine the optimum valve timing. It then pulse-width modulates oil control valves which direct oil to the cam phasers. The cam phasers use oil pressure to rotate the intake and exhaust camshafts. The rotation of the camshafts is referred to as cam phasing. Before the GPEC1 can begin commanding the camshaft phasing, several enabling conditions must be met:

- The engine oil temperature must be at least -6.6°C (20°F)
- The oil control valve coil temperature must be less than 140°C (284°F)
- Engine speed must be at least 600 to 1000 rpm to achieve minimum oil pressure.
- Battery voltage must be at least 10 volts
- And there must be no camshaft or crankshaft sensor faults, engine timing faults, or oil control valve faults

First we will examine variable valve timing enabling conditions, and then we will take a closer look at the inputs and outputs of the system:

- Accelerator pedal position sensor
- Oil temperature sensor
- Map sensor
- Intake cam sensor
- Exhaust cam sensor
- Crankshaft sensor
- GPEC1
- Exhaust phaser oil control valve

- Intake phaser oil control valve
- Inputs
- Engine control module
- Outputs
- Sensing battery voltage

A minimum oil temperature is required to enable variable valve timing operation. Oil temperature and viscosity also have an impact on the operation of variable valve timing after start-up. Oil is used to control the movement of the camshafts. An incorrect oil viscosity could adversely affect the operation of the system or even render the system inoperative. It may even set a fault code.

The accelerator pedal position sensor indicates how far the driver wants to open the throttle plate. The GPEC1 calculates an initial camshaft set point based on whether the accelerator pedal is at part throttle or wide open throttle.

The MAP sensor provides information regarding engine load.

Sensing battery voltage provides information regarding current system voltage. Sensing battery voltage must be at least 10 volts in order for the oil control valves to function properly.

This information allows the GPEC1 to adjust camshaft timing to achieve the best fuel economy, the best engine performance or a combination of both. The hall-effect crankshaft sensor provides RPM information and determines when the number one piston is approaching Top Dead Center. The sensor generates a signal as the tone wheel, attached to the crankshaft, rotates. The tone wheel has 60 teeth minus two. When the gap, created by the missing teeth passes by the sensor, a signal is produced that indicates the number one piston is at Top Dead Center. The GPEC1 uses crankshaft sensor data along with camshaft data to determine the actual position of the camshaft. There are two hall-effect camshaft sensors on engines equipped with variable valve timing. The GPEC1 uses camshaft sensor data along with crankshaft data to determine the actual position of the camshaft.

The GPEC1 individually controls each valve. It sends a pulse width modulated signal to move a spool within the outer casing of the valve. Depending upon spool movement, oil is directed through the passages to advance or retard cam timing. The oil control valve also has a special cleaning strategy at key-on. The cleaning strategy is known as "debris crush mode". At key-on the GPEC1 cycles the oil control valve on and off several (5) times to crush any debris in the oil control valve and prevent the spool valve from sticking. In non operating condition, the camshaft stays in lockpin position of cam phases. This is 120 degrees ATDC for intake camshaft and 120 degrees BTDC for exhaust camshaft.

There are two oil control valves. One valve directs oil to the intake cam phaser, the other valve directs oil to the exhaust cam phaser. The valves are designed and function in the same manner. The outer casing of each oil valve has five oil passages. A passage for pressurized supply oil. A passage to the advance chamber of the cam phaser. A passage to the retard chamber of the cam phaser. A passage for oil return from the advance chamber of the cam phaser. A passage for oil return from the retard chamber of the cam phaser. Oil flows through the passages and applies pressure to the cam phasers to change cam timing.

There are two cam phasers. One phaser controls the position of the intake camshaft. The other phaser controls the position of the exhaust camshaft. The phasers consist of a sprocket, a rotor vane, and a housing or stator.

The exhaust cam phaser also consists of a front bushing and spring. We will discuss the purpose and function of the bushing and spring later. The housing is bolted and permanently fixed to the camshaft sprocket, while the rotor vane is bolted and permanently fixed to the camshaft. With this design, any movement of the rotor vane in relation to the housing will also move the camshaft. The phaser and sprocket are serviced as an assembly.

Camshaft and crankshaft sensors provide feedback to the GPEC1 regarding the actual position of the camshafts. The GPEC1 then compares the actual camshaft positioning with desired positioning. If the desired positioning is not achieved within a specified time, during the second key cycle a trouble code is set.

There are six new diagnostic trouble codes available to help you determine if the control circuit from the GPEC1 to the oil control valve is intact and operating properly. The codes identify whether the control circuit is open, shorted to ground, or shorted to power. Three trouble codes are related to intake camshaft positioning, the other three codes are specific to exhaust camshaft positioning.

The oil control valve contains both electrical and mechanical components. It is electrically controlled by the GPEC1. The electrical current that energizes the coil results in mechanical motion of the spool valve. It is possible to verify both the electrical and mechanical operation of the valve. The oil control valve consists of a coil that is energized to move a spool within an outer casing. The condition of the coil can be tested with a Digital Volt Ohmmeter or DVOM. With the DVOM set to measure resistance, check the coil for an open, a short to ground, or excessive resistance. The correct resistance value of the coil is between 6 and 8 ohms. The mechanical operation of the oil control valve can be tested using actuator commands on the scan tool. Remove the oil control valve, then navigate to the actuator menu and select the oil control valve. Use commands to activate the valve and watch as the spool valve moves back and forth inside the casing.

Because the cam phasers are hydraulically operated by engine oil, the condition of the oil is very important. The oil must be of the correct viscosity, not obstructed by debris, to maintain correct pressure. Maintaining the correct oil viscosity is critical to the operation of the variable valve timing system. The wrong oil viscosity may cause the variable valve timing to malfunction and trouble codes to set. The correct oil viscosity for this system is 5W20. Oil must be clean, unobstructed and free to flow through the variable valve timing system. Oil could become obstructed in oil passages located in the cylinder head, cylinder block, or even in the oil screen. In the event oil flow is obstructed, further diagnosis or disassembly may be required to pinpoint the source of the obstruction. The variable valve timing system relies on oil pressure to advance or retard the position of the camshaft. Insufficient oil pressure will adversely affect the operation of variable valve timing. The minimum oil pressure for this system is 15 psi at normal operating temperature.

Though not directly used to change camshaft positioning, the oil screen is an important component of the variable valve timing system. It helps to remove debris going to the variable valve timing components. The oil screen is located in the cylinder block, immediately below the cylinder head. Oil must pass through the oil screen before entering the oil control valve. The cylinder head must be removed to service the oil screen. The intention is not to service the oil screen during vehicle life.

How the cam phaser works. The cam phaser assembly has eight separate chambers; four advance chambers and four retard chambers. When camshaft advance is requested, oil enters all four advance chambers and exerts force on the rotor vane. Because the rotor vane is bolted to the camshaft, the entire camshaft profile moves along with the rotor vane. At the same time, oil is forced out of the retard chambers. When camshaft retard is requested oil enters the retard chambers to move the camshaft in the opposite direction. There is a lock pin on one side of the rotor vane that fits inside a recessed area in the housing. The lock pin ensures that the default position of the intake cam phaser is 120 crankshaft degrees full retard and the default position of the exhaust

cam phaser is 120 crankshaft degrees full advance. When the engine is turned off, rotational force and inertia move the intake camshaft and rotor vane toward the retard position. The exhaust cam phaser includes a spring and bushing to work against the rotational force of the engine, allowing the exhaust cam phaser to lock in the fully advanced position. Under most conditions the cam phasers are returned to lock pin position when the engine is turned off. In the unique condition of an engine stall, which abruptly shuts off the engine, the cam phasers may not return to the lock pin position. In this case, the phasers will return to the lock pin position at the next start-up. Lock pin position is the most ideal cam timing for idle stability. When engine rpm exceeds approximately 600 to 1000 rpm, oil pressure unlocks the pins and variable valve timing resumes. Once enabling conditions are met, the GPEC1 uses input from sensors to calculate optimum valve timing.

There are four preprogrammed modes from which the GPEC1 bases initial valve timing.

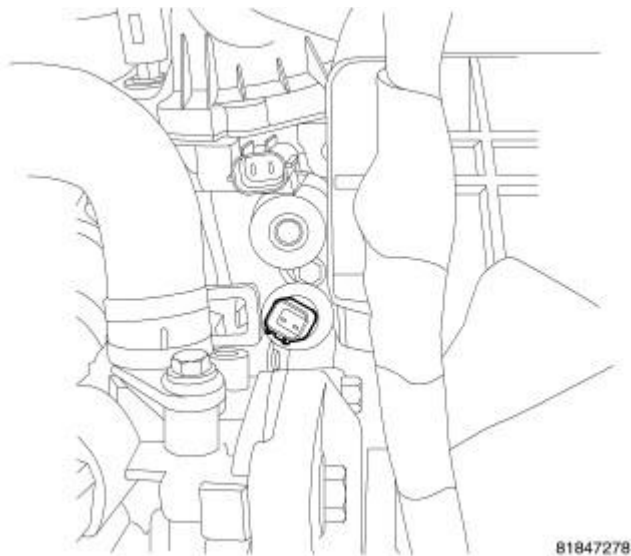
- Starting
- Idle or Part throttle
- Wide open throttle
- Limp-in or Default

From each preprogrammed mode, the GPEC1 adjusts valve timing based on operating conditions.

GPEC1 has calculated optimum intake valve timing of 112 degrees after Top Dead Center and optimum exhaust valve timing of 97 degrees before Top Dead Center. The GPEC1 pulse width modulates the oil control valves to advance or retard the camshaft to their desired location. The spool valve inside the intake oil control valve is energized and moves to allow pressurized oil into the advance chambers of the intake cam phaser. At the same time, the spool valve inside the exhaust oil control valve is energized and moves to allow pressurized oil into the retard chambers of the exhaust cam phaser. Oil enters the advance chambers of the intake phaser and the retard chambers of the exhaust phaser. Oil pressure releases the lock pin from its locked position and pushes against the rotor vane. Both the rotor vanes are moved, advancing the intake camshaft and retarding the exhaust camshaft.

## **REMOVAL**

### **FRONT SOLENOID 1/1**

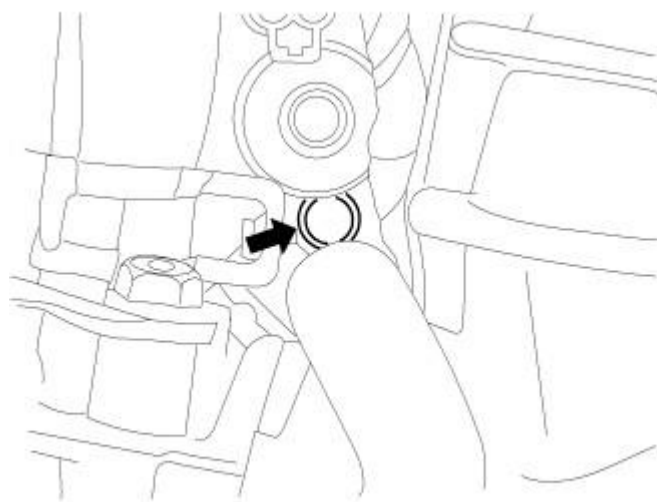


81847278

**Fig. 262: Oil Pressure Sensor**

Courtesy of CHRYSLER LLC

1. Disconnect negative battery cable.
2. Remove engine cover.
3. Rotate hose clamp out of way.
4. Disconnect oil pressure sensor electrical connector.
5. Remove oil pressure sensor.
6. Disconnect variable valve timing solenoid electrical connector.



81847274

**Fig. 263: Solenoid Mounting Bolt**

Courtesy of CHRYSLER LLC

7. Remove variable valve timing solenoid mounting bolt.

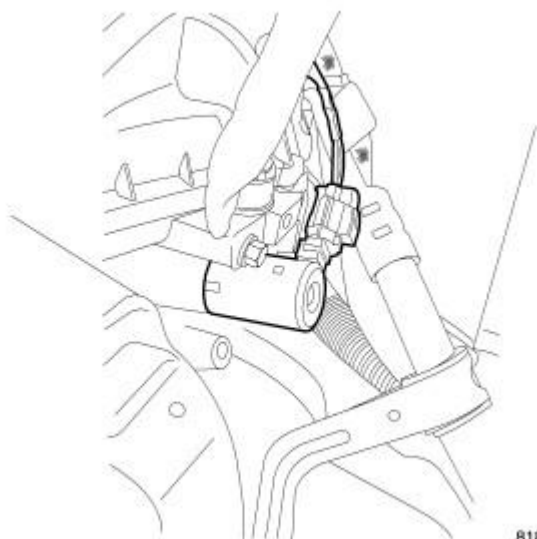


8184726c

**Fig. 264: Solenoid Mounting Tab 1/1**  
Courtesy of CHRYSLER LLC

8. Pull solenoid straight out of cylinder head.

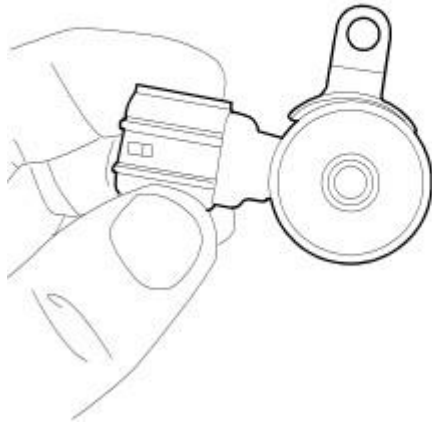
#### **REAR SOLENOID 1/2**



81847264

**Fig. 265: Solenoid Location 1/2**  
Courtesy of CHRYSLER LLC

1. Disconnect negative battery cable.
2. Remove engine cover.
3. Disconnect variable valve timing solenoid electrical connector.
4. Remove variable valve timing solenoid mounting bolt.



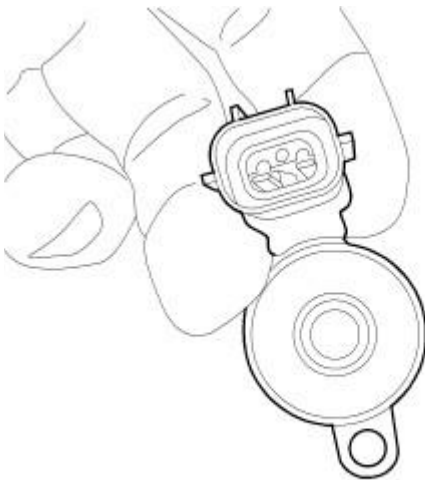
81847268

**Fig. 266: Solenoid Mounting Tab 1/2**  
 Courtesy of CHRYSLER LLC

5. Pull solenoid straight out of cylinder head.

## INSTALLATION

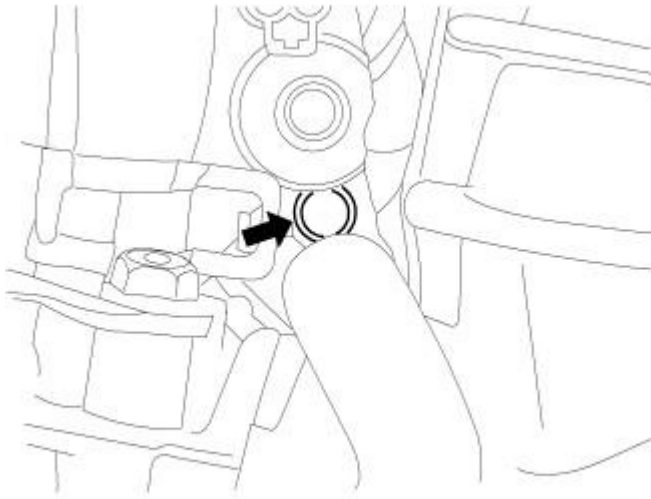
### FRONT SOLENOID 1/1



8184726c

**Fig. 267: Solenoid Mounting Tab 1/1**  
 Courtesy of CHRYSLER LLC

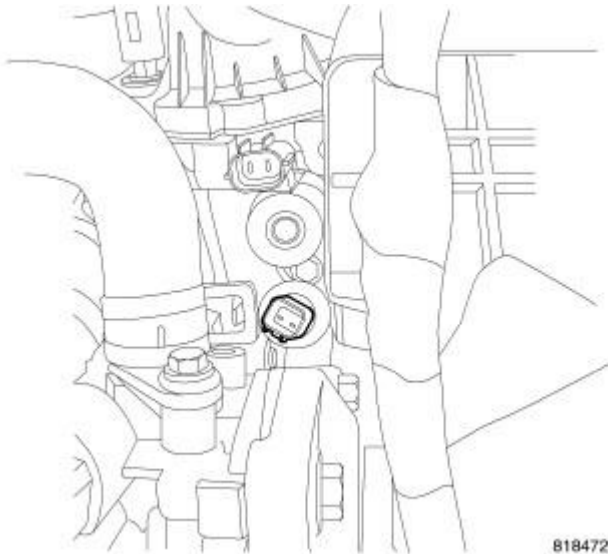
1. Solenoid for front location 1/1. Note mounting tab location is different between front and rear solenoids.



81847274

**Fig. 268: Solenoid Mounting Bolt**  
Courtesy of CHRYSLER LLC

2. Install solenoid into cylinder head.
3. Install mounting bolt and tighten to 12 N.m (9 ft. lbs.).

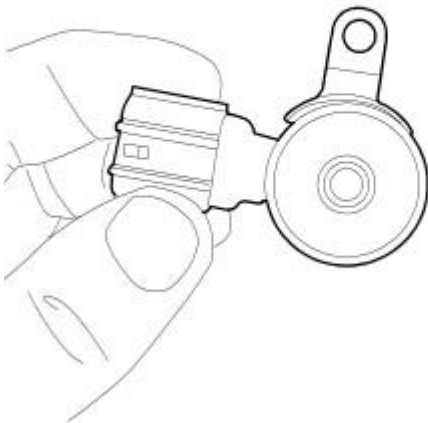


81847278

**Fig. 269: Oil Pressure Sensor**  
Courtesy of CHRYSLER LLC

4. Install oil pressure sensor.
5. Connect electrical connector to oil pressure sensor.
6. Connect electrical connector to Variable valve timing solenoid.
7. Connect negative battery cable.
8. Install engine cover.

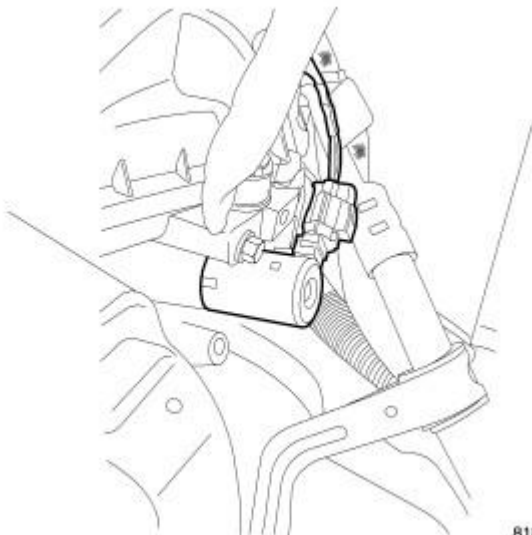
## REAR SOLENOID 1/2



81847268

**Fig. 270: Solenoid Mounting Tab 1/2**  
Courtesy of CHRYSLER LLC

1. Rear variable valve timing solenoid. Note mounting tab location is different between front and rear solenoids.
2. Install solenoid into cylinder head.
3. Install mounting bolt and tighten to 12 N.m (9 ft. lbs.).
4. Connect electrical connector to Variable valve timing solenoid.



81847264

**Fig. 271: Solenoid Location 1/2**  
Courtesy of CHRYSLER LLC

5. Connect negative battery cable.
6. Install engine cover.

## COOLER, OIL

### DESCRIPTION

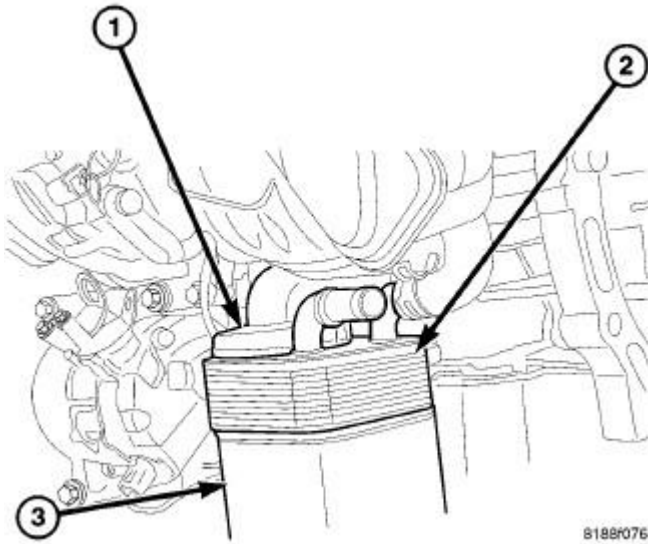
### DESCRIPTION

An engine oil cooler is used on some engine packages. The cooler is a coolant-to-oil type and mounted between the oil filter and oil filter adapter.

### REMOVAL

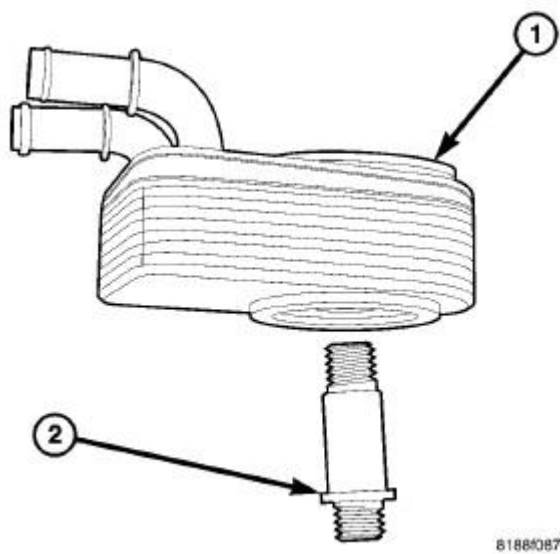
### REMOVAL

**NOTE:** The oil cooler can not be cleaned out. In the event that the engine requires rebuilding or replacement, the oil cooler should be replaced.



**Fig. 272: Oil Cooler Housing, Oil Cooler & Oil Filter**  
Courtesy of CHRYSLER LLC

1. Raise vehicle on hoist.
2. Drain cooling system. Refer to **STANDARD PROCEDURE**.
3. Disconnect oil cooler coolant hoses.
4. Remove oil filter (3).

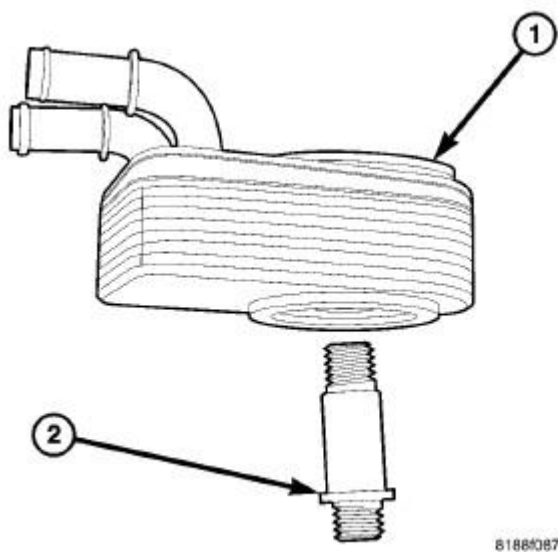


**Fig. 273: Oil Cooler Seal & Oil Cooler Connector Bolt**  
Courtesy of CHRYSLER LLC

5. Remove oil cooler connector bolt (2).
6. Remove oil cooler (1).

#### INSTALLATION

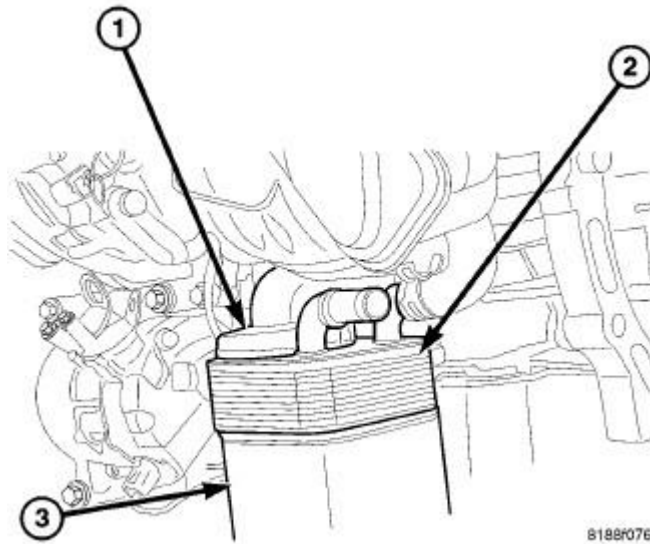
#### INSTALLATION



**Fig. 274: Oil Cooler Seal & Oil Cooler Connector Bolt**  
Courtesy of CHRYSLER LLC

1. Replace oil cooler seal (1).

2. Lubricate seal and position oil cooler to oil filter adapter, aligning notch to tab.
3. Install oil cooler connector bolt (2). Tighten connector bolt to 49 N.m (36 ft. lbs.).



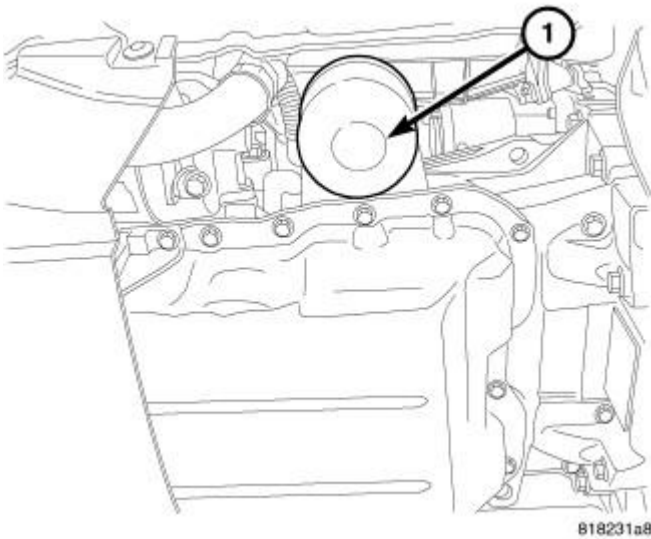
**Fig. 275: Oil Cooler Housing, Oil Cooler & Oil Filter**  
 Courtesy of CHRYSLER LLC

4. Install oil filter (3).
5. Connect oil cooler coolant hose.
6. Lower vehicle.
7. Fill cooling system. Refer to **STANDARD PROCEDURE**.

## FILTER, ENGINE OIL

### REMOVAL

### REMOVAL



**Fig. 276: Oil Filter**

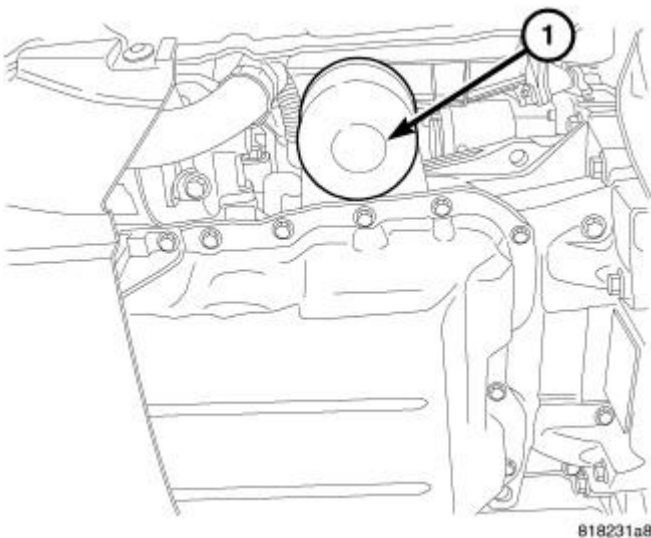
Courtesy of CHRYSLER LLC

**CAUTION:** When servicing the oil filter, avoid deforming the filter can by installing the remove/install tool band strap against the can to base lock seam. The lock seam joining the can to the base is reinforced by the base plate.

1. Using a suitable filter wrench, turn oil filter (1) counterclockwise to remove.

## INSTALLATION

## INSTALLATION



**Fig. 277: Oil Filter**

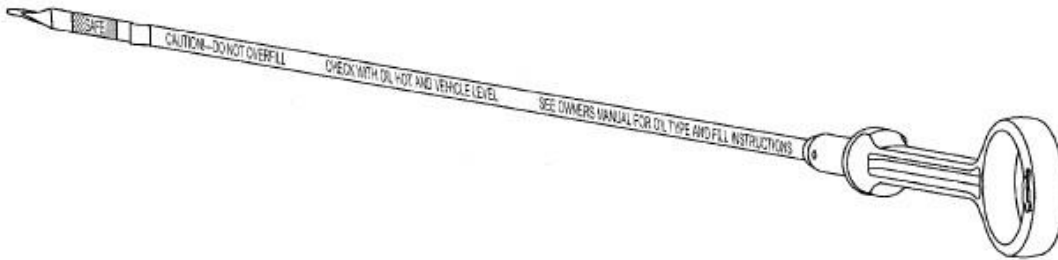
Courtesy of CHRYSLER LLC

1. Clean and check filter mounting surface. The surface must be smooth, flat and free of debris or pieces of gasket.
2. Lubricate new oil filter gasket.
3. Screw oil filter (1) on until the gasket contacts base. Tighten to 14 N.m (10 ft. lbs.).

## **OIL**

### **STANDARD PROCEDURE**

#### **ENGINE OIL LEVEL CHECK**



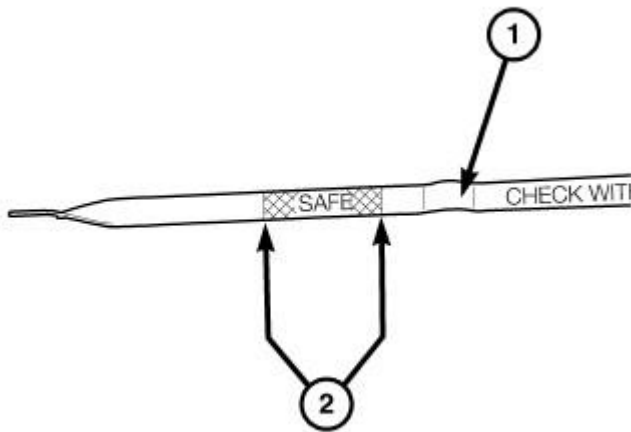
81884c72

**Fig. 278: Dip Stick**

Courtesy of CHRYSLER LLC

**NOTE:**        **The engine must be HOT when checking oil level.**

The best time to check engine oil level is after the engine is at operating temperature. Allow the engine to be shut off for at least 5 minutes before checking oil level.



818220bb

**Fig. 279: Oil Level Indicator**  
Courtesy of CHRYSLER LLC

Checking the oil while the vehicle is on level ground will improve the accuracy of the oil level reading. Remove dipstick (1), and observe oil level. Add oil only when the level is at or below the SAFE mark. If the oil level is in the safe (2) range, do not add oil.

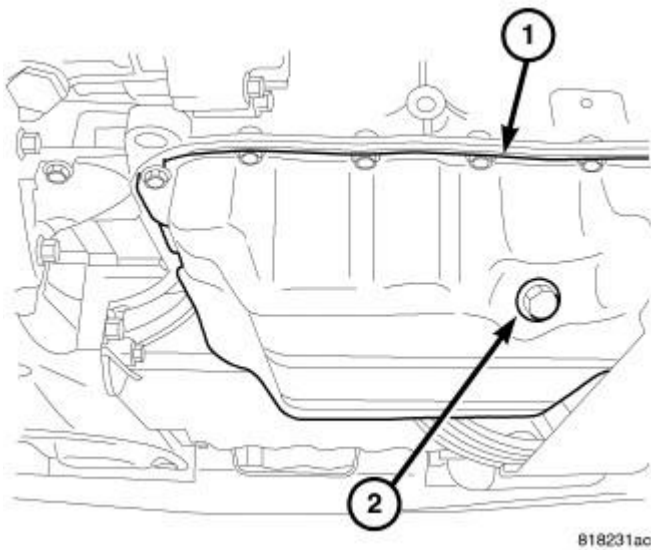
**CAUTION:** Do not operate engine if the oil level is above the MAX mark on the dipstick. Excessive oil volume can cause oil aeration which can lead to engine failure due to loss of oil pressure or increase in oil temperature.

#### ENGINE OIL AND FILTER CHANGE

**WARNING:** New or used engine oil can be irritating to the skin. Avoid prolonged or repeated skin contact with engine oil. Contaminants in used engine oil, caused by internal combustion, can be hazardous to your health. Thoroughly wash exposed skin with soap and water. Do not wash skin with gasoline, diesel fuel, thinner, or solvents, health problems can result. Do not pollute, dispose of used engine oil properly. Contact your dealer or government agency for location of collection center in your area.

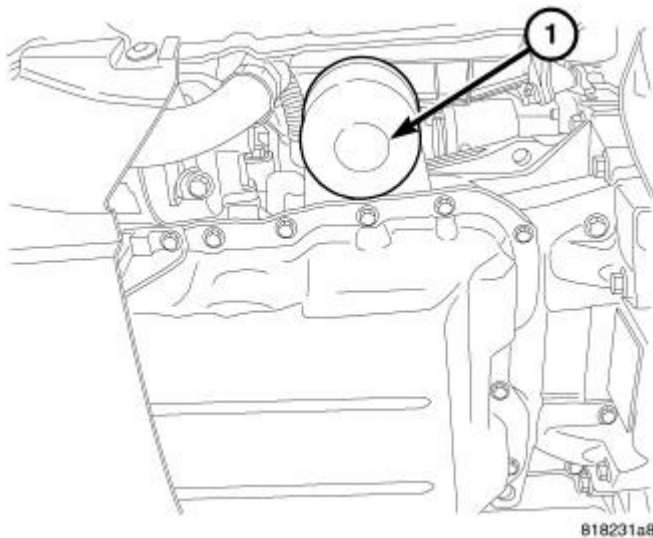
**CAUTION:** On export vehicles, refer to the owners manual for the correct grade of oil.

Change engine oil at mileage and time intervals described in the Maintenance Schedule. Refer to **MAINTENANCE SCHEDULES, DESCRIPTION**.



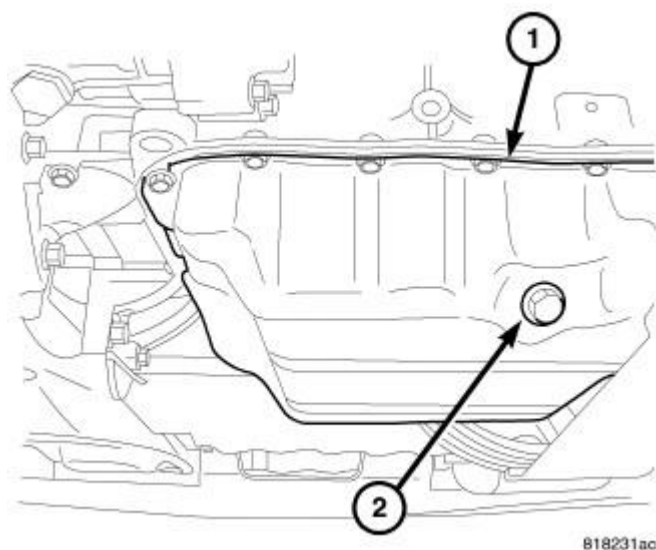
**Fig. 280: Oil Drain Plug & Oil Pan**  
Courtesy of CHRYSLER LLC

1. Run engine until achieving normal operating temperature.
2. Position the vehicle on a level surface and turn engine off.
3. Remove oil fill cap.
4. Raise vehicle on hoist.
5. Place a suitable oil collecting container under oil pan drain plug (2).
6. Remove oil pan drain plug (2) or and allow oil to drain into collecting container. Inspect drain plug threads for stretching or other damage. Replace drain plug and gasket if damaged.



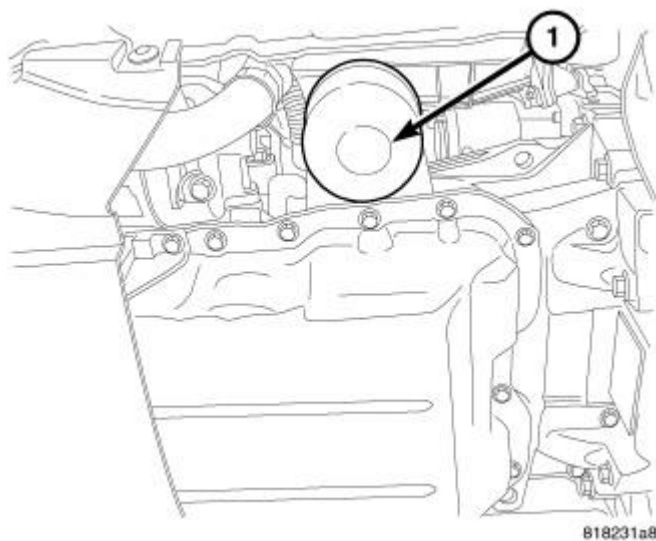
**Fig. 281: Oil Filter**  
Courtesy of CHRYSLER LLC

7. Remove oil filter (1). Refer to **FILTER, ENGINE OIL, REMOVAL**.



**Fig. 282: Oil Drain Plug & Oil Pan**  
Courtesy of CHRYSLER LLC

8. Install oil pan drain plug (2) and tighten drain plug to 40 N.m (30 ft. lbs.).



**Fig. 283: Oil Filter**  
Courtesy of CHRYSLER LLC

9. Install new oil filter (1), tighten to 14 Nm (10 ft. lbs.). Refer to **FILTER, ENGINE OIL, INSTALLATION.**
10. Lower vehicle and fill crankcase with specified type and amount of engine oil and. Refer to **CAPACITIES AND RECOMMENDED FLUIDS, SPECIFICATIONS** . Refer to **CAPACITIES AND RECOMMENDED FLUIDS, DESCRIPTION** .
11. Install oil fill cap.
12. Start engine and inspect for leaks.

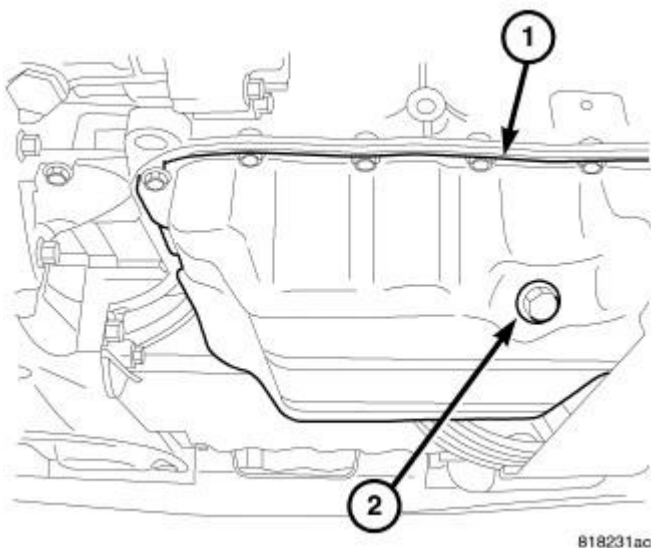
13. Stop engine and inspect oil level.

**OIL FILTER SPECIFICATION**

All engines are equipped with a high quality full-flow, disposable type oil filter. Replace oil filter with a Mopar® or the equivalent.

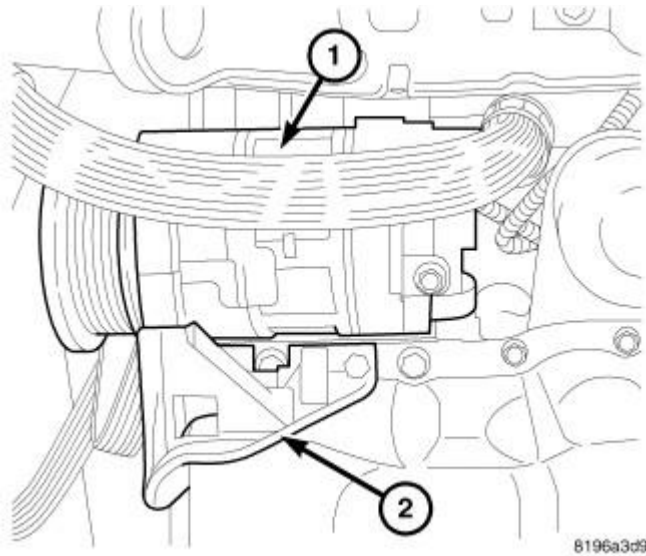
**USED ENGINE OIL DISPOSAL**

Care should be exercised when disposing used engine oil after it has been drained from a vehicle engine. Refer to the WARNING listed above.

**PAN, OIL****REMOVAL****REMOVAL**

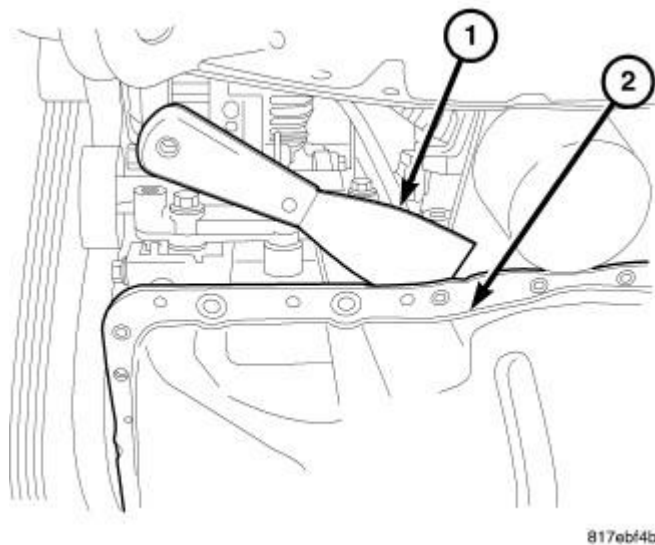
**Fig. 284: Oil Drain Plug & Oil Pan**  
Courtesy of CHRYSLER LLC

1. Raise vehicle on hoist.
2. Remove oil drain plug (2) and drain the engine oil.
3. Remove accessory drive belt splash shield.



**Fig. 285: A/C Compressor & Bracket**  
Courtesy of CHRYSLER LLC

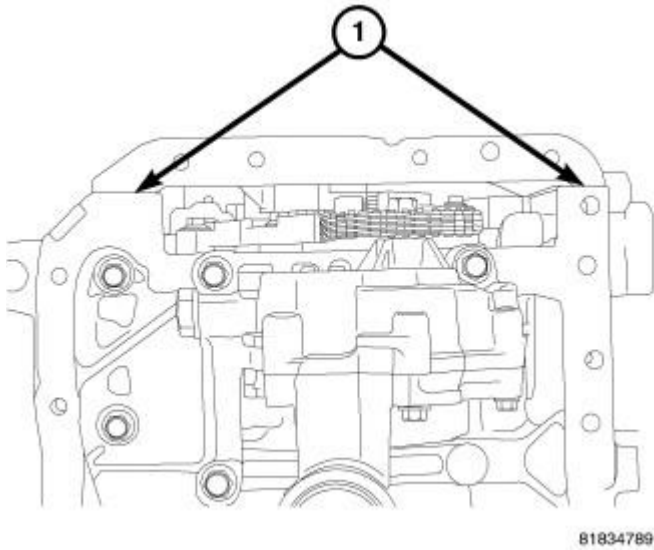
4. Remove lower A/C compressor mounting bolt (if equipped).
5. Remove A/C mounting bracket (2).



**Fig. 286: Using Putty Knife To Loosen Seal Around Oil Pan**  
Courtesy of CHRYSLER LLC

**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).

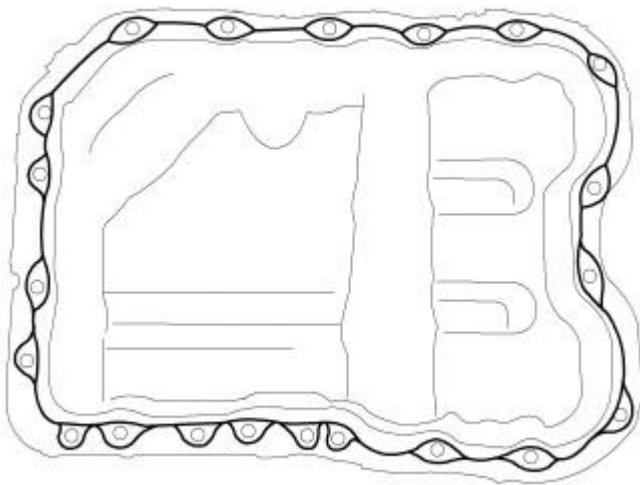
**INSTALLATION****INSTALLATION****Fig. 287: Sealer Location**

Courtesy of CHRYSLER LLC

**NOTE:** Oil pan sealing surfaces must be free of grease or oil.

**NOTE:** Parts must be assembled within 10 minutes of applying RTV.

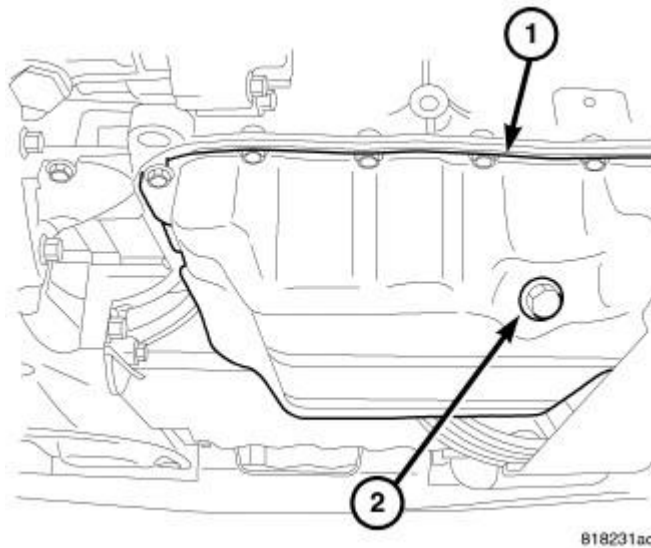
1. Apply Mopar® Engine RTV GEN II at the front cover to engine block parting lines (1).

**Fig. 288: Sealing Oil Pan**

Courtesy of CHRYSLER LLC

2. Apply a 2 mm bead of Mopar® Engine RTV GEN II around the oil pan as shown in illustration.
3. Position oil pan and install bolts. Tighten bolts to 12 N.m (105 in. lbs.).

**NOTE:** The 2 long bolts must be tightened to 22 N.m (195 in.lbs.).



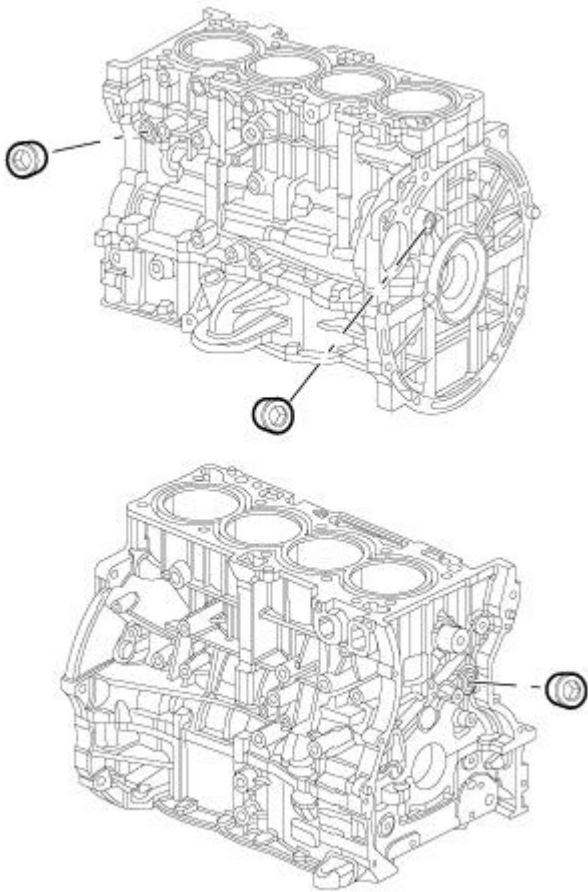
**Fig. 289: Oil Drain Plug & Oil Pan**  
Courtesy of CHRYSLER LLC

4. Install oil drain plug (2).
5. Lower vehicle and fill engine crankcase with proper oil to correct level.
6. Start engine and check for leaks.

## PLUG, OIL

### DESCRIPTION

### DESCRIPTION



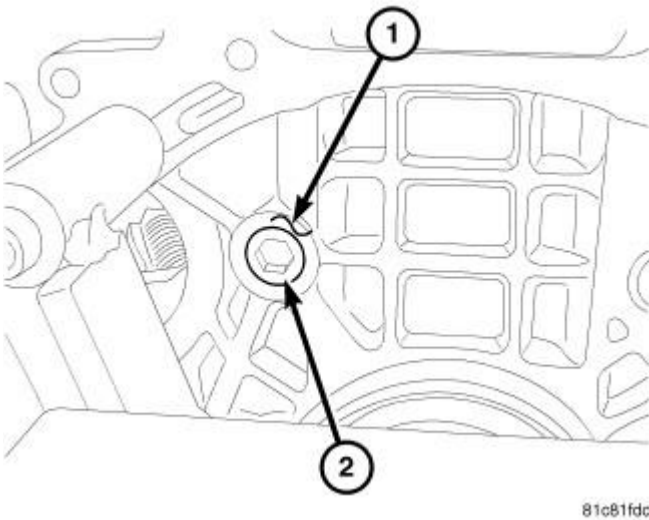
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**Fig. 290: Engine Block Tapered Plugs**  
Courtesy of CHRYSLER LLC

The engine block has three tapered plugs sealing the high pressure oil gallery. These threaded plugs do not have a torque specification but instead are installed to a specific depth. Do not attempt to further tighten these plugs, damage to the engine block could result. Whenever these plugs are removed they must be replaced. Service plugs have a lock patch and do not require the application of additional sealant.

#### REMOVAL

#### REMOVAL



**Fig. 291: Gallery Plug**

Courtesy of CHRYSLER LLC

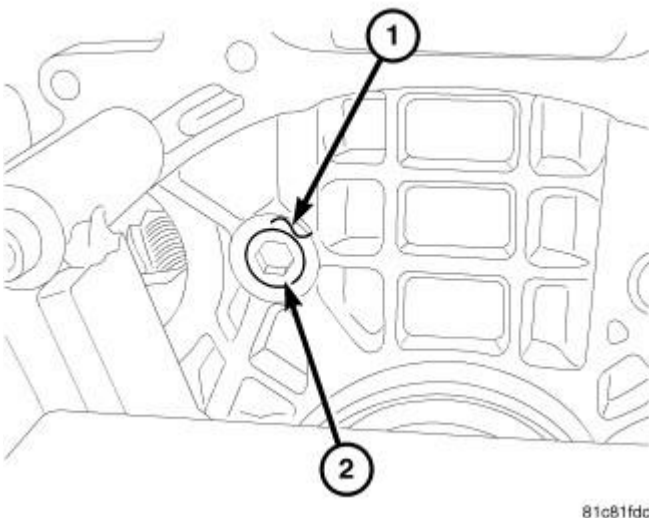
**CAUTION:** Excessive use of brake parts cleaner to clean threads in block could cause #5 main bearing failure.

**NOTE:** Rear plug shown in illustration, other plugs are similar.

1. Remove the plug (2) from the engine block.
2. Use Mopar® Brake Parts Cleaner (or equivalent) sparingly to clean the block.

#### INSTALLATION

#### INSTALLATION



**Fig. 292: Gallery Plug**

Courtesy of CHRYSLER LLC

**CAUTION:** Excessive use of brake parts cleaner to clean threads in block could cause #5 main bearing failure.

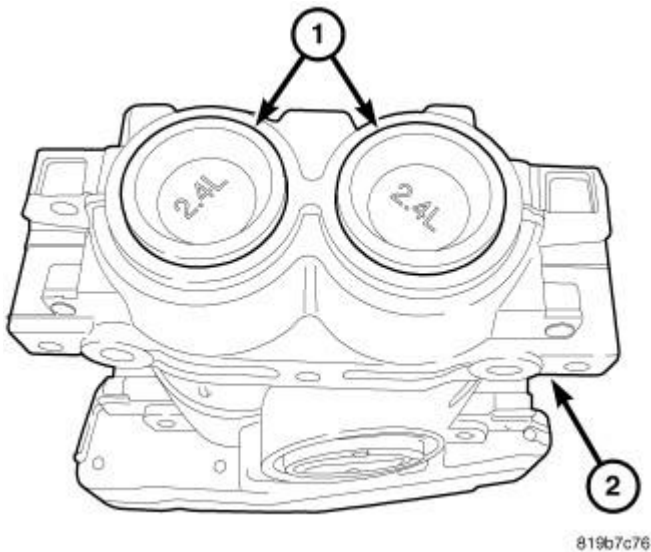
**NOTE:** Rear plug shown in illustration, other plugs are similar.

1. Use Mopar® Brake Parts Cleaner (or equivalent) sparingly to clean the block.
2. Install the plug (2) flush with the block boss face (1). The plug (2) is correctly installed when it is flush or protruding no more than 1 mm from the block boss face (1).

## PUMP, ENGINE OIL

### DESCRIPTION

### DESCRIPTION

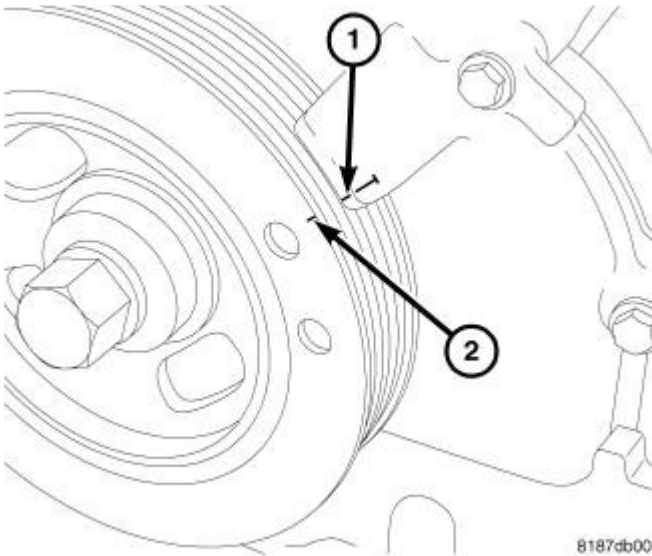
**Fig. 293: Plastic End Caps & Balance Shaft Module (BSM)**

Courtesy of CHRYSLER LLC

The oil pump is integral to the balance shaft module (BSM) (2). The oil pump cannot be disassembled for inspection. The pressure relief valve is serviceable and can be removed and inspected. The BSM can be identified by the plastic end caps (1).

### REMOVAL

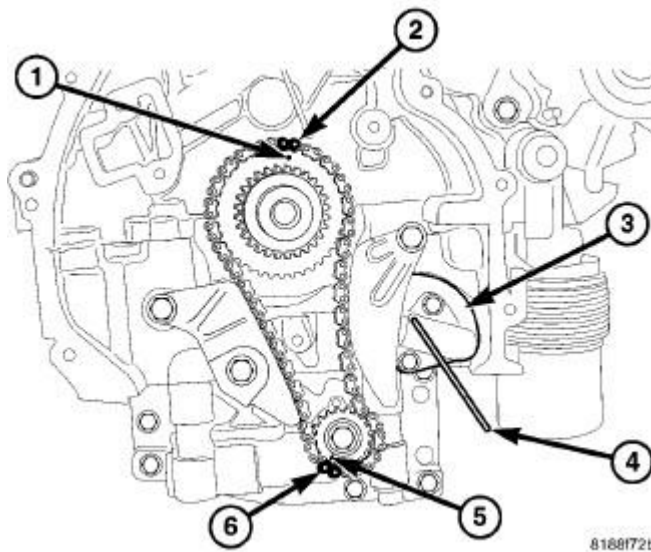
### REMOVAL



**Fig. 294: TDC**

Courtesy of CHRYSLER LLC

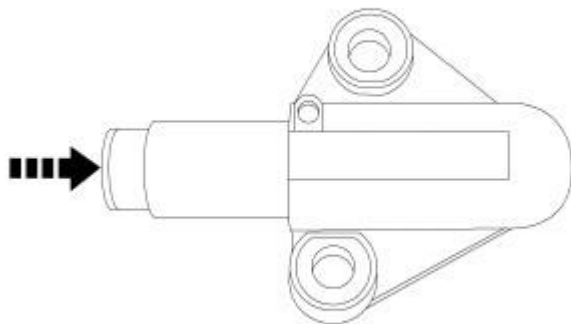
1. Rotate engine to TDC (1, 2) on #1 compression stroke.



**Fig. 295: Oil Pump Drive Chain, Oil Pump Drive Chain Tensioner & Timing Marks On Chain**

Courtesy of CHRYSLER LLC

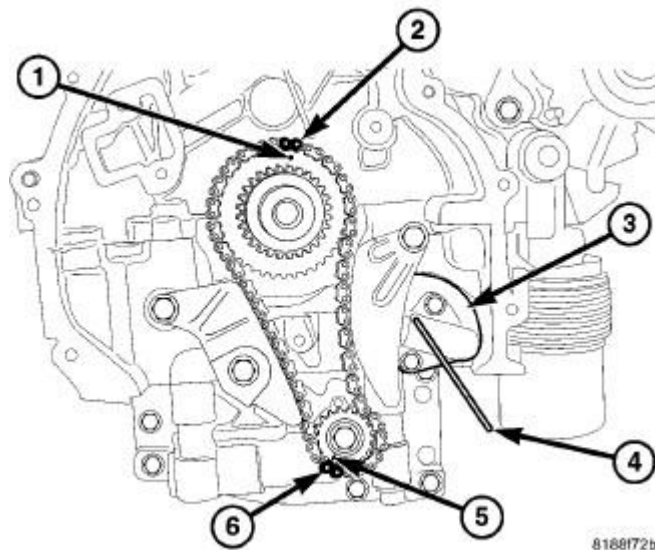
2. Remove the oil pan. Refer to **PAN, OIL, REMOVAL**.
3. Remove the engine timing cover. Refer to **COVER(S), ENGINE TIMING, REMOVAL**.
4. Mark the chain (6) and the sprocket (5) for reassembly.



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**Fig. 296: Oil Pump Tensioner Reset**  
Courtesy of CHRYSLER LLC

5. Push tensioner piston back into the tensioner body.



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**Fig. 297: Oil Pump Drive Chain, Oil Pump Drive Chain Tensioner & Timing Marks On Chain**  
Courtesy of CHRYSLER LLC

6. With piston held back insert tensioner pin (special tool #9703, Pin, Tensioner) (4) into the tensioner body to hold the piston in the retracted position.

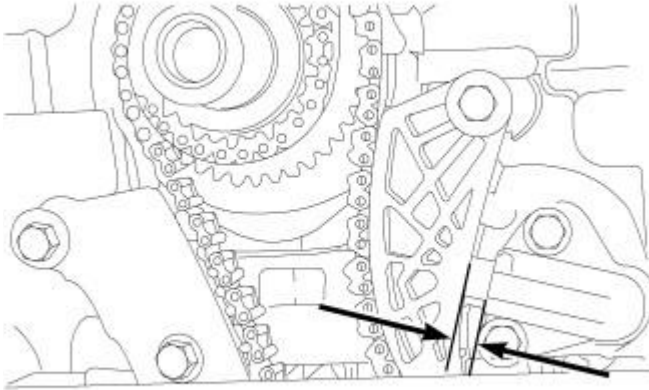
**NOTE:** Do not remove sprocket from BSM.

7. Remove BSM mounting bolts. Discard 180 mm bolts, 185 mm bolts can be reused.

8. Lower the back of the BSM and remove the chain (6) from the sprocket (5).
9. Remove BSM from the engine.

## INSPECTION

## INSPECTION



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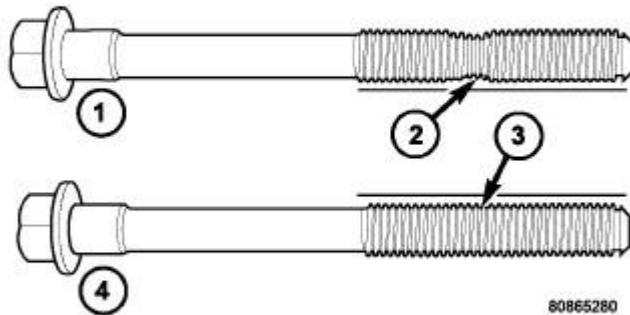
**Fig. 298: Measuring Distance Between Tensioner Body & Guide Shoe**  
 Courtesy of CHRYSLER LLC

1. Remove timing chain cover. Refer to **COVER(S), ENGINE TIMING, REMOVAL**.
2. Remove oil pan. Refer to **PAN, OIL, REMOVAL**.
3. Measure the distance between the tensioner body and the guide shoe as shown in illustration.
4. If the distance is 10.1 mm (0.397 in.) or greater, replace the chain.

## INSTALLATION

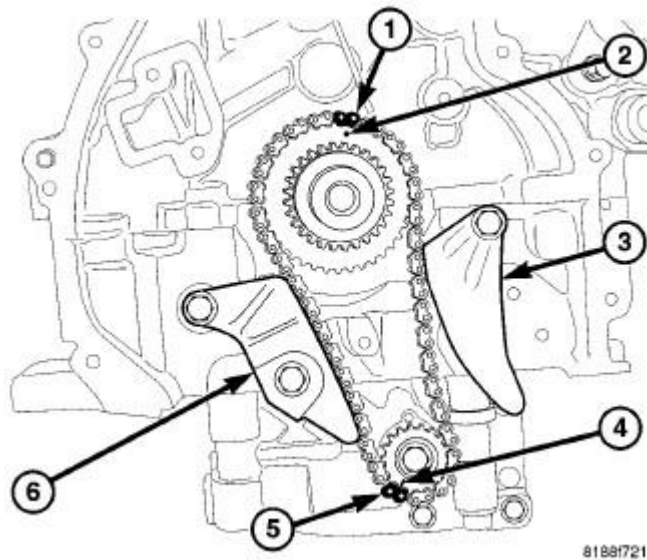
## INSTALLATION

**CAUTION:** There are two different Balance Shaft Module (BSM) to engine block bolts used. 180 mm bolts with a lock-patch on the threads or 185 mm bolts without lock-patch. Do not reuse the 180 mm bolts. Always discard 180 mm bolts after removing. Failure to replace these bolts can result in engine damage. The 185 mm bolts are reusable. Install the same length bolts that were removed and use either four new 180 mm bolts or four 185 mm bolts.



**Fig. 299: Checking Cylinder Head Bolts For Stretching (Necking)**  
Courtesy of CHRYSLER LLC

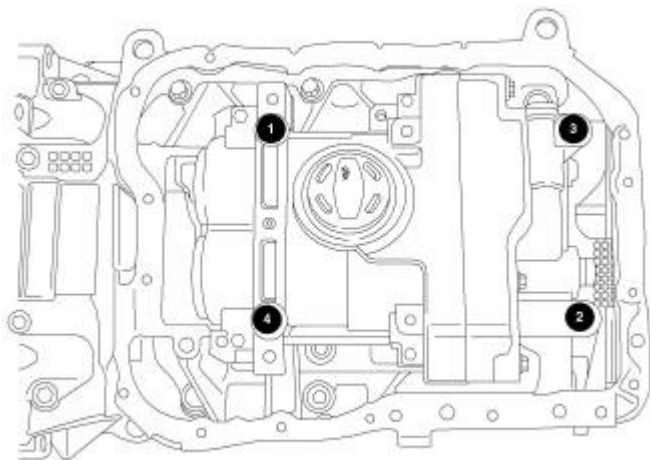
1. The 185 mm (7.283 in.) length bolts must be checked for stretching. Check the bolts with a straight edge for necking (2). If the bolts are necked down, they must be replaced.



**Fig. 300: Aligning Timing Marks On Components**  
Courtesy of CHRYSLER LLC

2. Clean BSM mounting holes with Mopar® brake parts cleaner.
3. If chain was removed, align marks on crankshaft sprocket (2) and chain (1).
4. Align marks on oil pump sprocket (5) and chain (4).
5. Install chain on sprocket.

6. Pivot BSM assembly upwards and position on ladder frame.



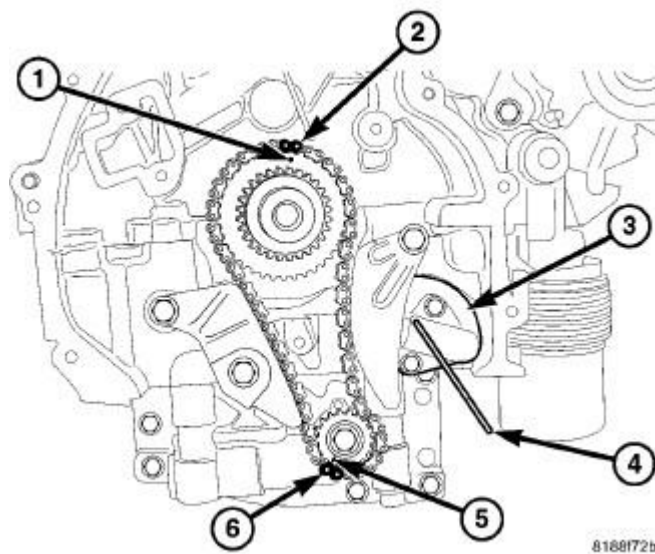
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**Fig. 301: BSM Mounting Bolts Tightening Sequence**  
Courtesy of CHRYSLER LLC

7. Start BSM mounting bolts by hand.

**NOTE:** Use a three step procedure when tightening BSM mounting bolts. For new 180 mm bolts, go to step 8. For 185 mm bolts, go to step 9.

8. Tighten new 180 mm BSM mounting bolts as follows:
  1. Tighten to 15 N.m (11 ft. lbs.) in the sequence shown in illustration.
  2. Tighten to 33 N.m (24 ft. lbs.) in the sequence shown in illustration.
  3. Rotate bolts an additional 90° in the sequence shown in illustration.
9. Tighten 185 mm BSM mounting bolts as follows:
  1. Tighten to 15 N.m (11 ft. lbs.) in the sequence shown in illustration.
  2. Tighten to 29 N.m (22 ft. lbs.) in the sequence shown in illustration.
  3. Rotate bolts an additional 90° in the sequence shown in illustration.



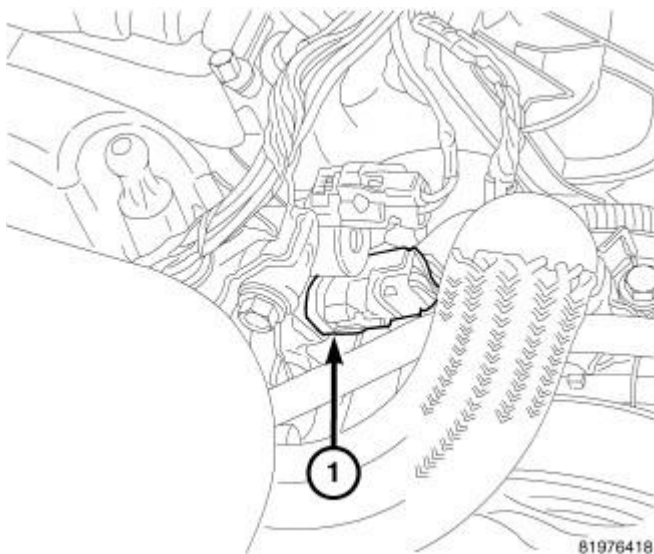
**Fig. 302: Oil Pump Drive Chain, Oil Pump Drive Chain Tensioner & Timing Marks On Chain**  
Courtesy of CHRYSLER LLC

10. Remove tensioner pin (special tool #9703, Pin, Tensioner) (4).
11. Install the engine timing cover. Refer to **COVER(S), ENGINE TIMING, INSTALLATION**.
12. Install the oil pan. Refer to **PAN, OIL, INSTALLATION**.
13. Fill engine with oil.
14. Start engine and check for leaks.

## SENSOR, OIL TEMPERATURE

### REMOVAL

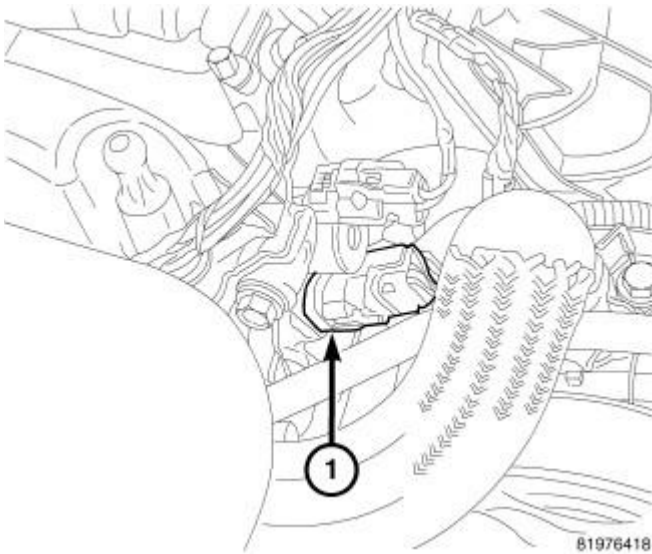
### REMOVAL



**Fig. 303: Oil Temperature Sensor**

Courtesy of CHRYSLER LLC

1. Disconnect oil temperature sensor (1) electrical connector.
2. Remove sensor (1).

**INSTALLATION****INSTALLATION****Fig. 304: Oil Temperature Sensor**

Courtesy of CHRYSLER LLC

1. If re-using the oil temperature sensor, coat the threads with Mopar® thread sealant.
2. Install oil temperature sensor (1). Tighten to 18 N.m (160 in. lbs.).
3. Connect electrical connector.

**SWITCH, OIL PRESSURE****DESCRIPTION****DESCRIPTION**

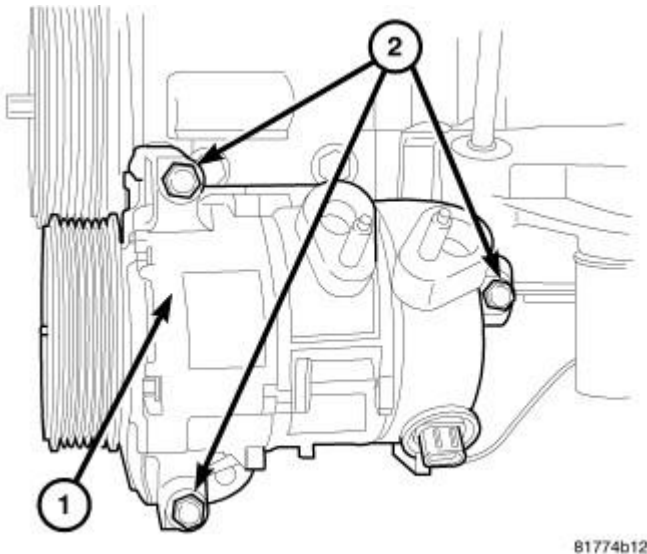
The oil pressure switch is located on the left front side of the engine block. The oil pressure switch is a pressure sensitive switch that is activated by the engine's oil pressure (in the main oil gallery). The switch is a two terminal device (one terminal is provided to the wiring harness and the other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

**OPERATION****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

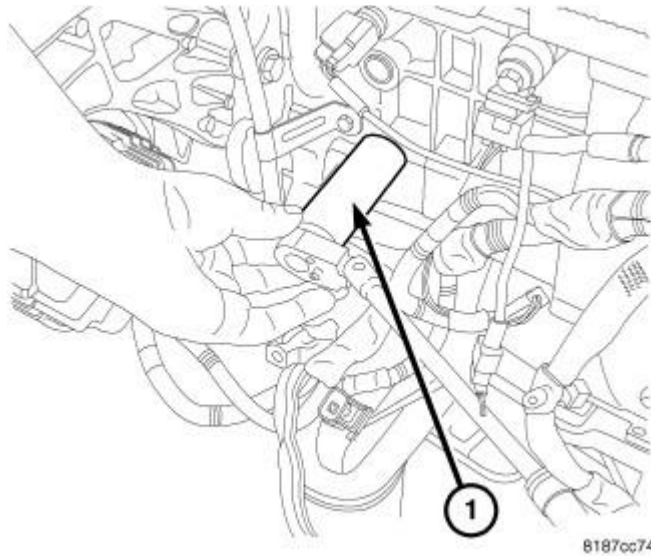
## REMOVAL



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**Fig. 305: Removing/Installing A/C Compressor**  
Courtesy of CHRYSLER LLC

1. Disconnect and isolate the negative battery cable.
2. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .
3. Remove the splash shield from the right side frame rail. Refer to **SHIELD, SPLASH, FRONT WHEELHOUSE, REMOVAL** and **SHIELD, SPLASH, REAR WHEELHOUSE, REMOVAL** .
4. Remove the accessory drive belt. Refer to **BELT, SERPENTINE, REMOVAL** .
5. Remove the three bolts (2) and reposition the A/C compressor (1).

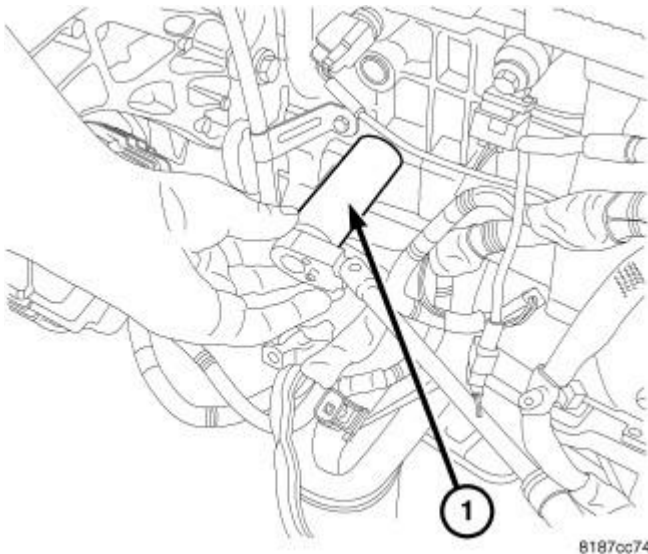


**Fig. 306: Oil Sender**  
Courtesy of CHRYSLER LLC

6. Disconnect the oil pressure switch electrical connector.
7. Remove the oil pressure switch using oil pressure socket (special tool #C-4597, Socket, Oil Pressure) (1) or equivalent.

## INSTALLATION

## INSTALLATION

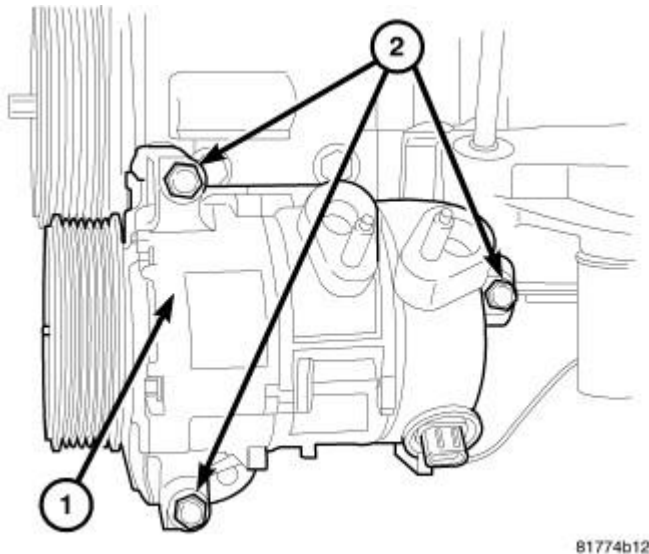


**Fig. 307: Oil Sender**  
Courtesy of CHRYSLER LLC

**NOTE:** If the oil pressure switch is removed, it must be replaced with a new switch.

**CAUTION:** The oil pressure switch has tapered threads, over tightening could crack the engine block.

1. Install the oil pressure switch using oil pressure socket (special tool #C-4597, Socket, Oil Pressure) (1) or equivalent. Tighten switch to 8 N.m (71 in. lbs.).
2. Connect the oil pressure switch electrical connector.



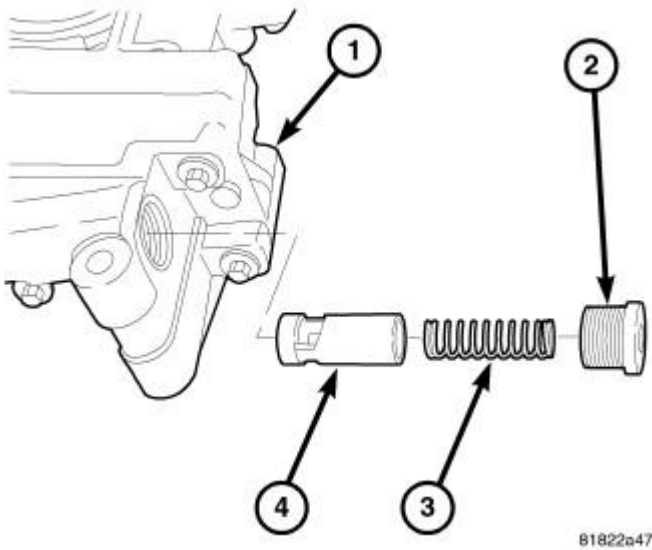
**Fig. 308: Removing/Installing A/C Compressor**  
Courtesy of CHRYSLER LLC

3. Position the A/C compressor (1) and install three mounting bolts (2). Tighten bolts to 25 N.m (18 ft. lbs.).
4. Install the accessory drive belt. Refer to **BELT, SERPENTINE, INSTALLATION**.
5. Install the splash shield to the right side frame rail. Refer to **SHIELD, SPLASH, FRONT WHEELHOUSE, INSTALLATION** and **SHIELD, SPLASH, REAR WHEELHOUSE, INSTALLATION**.
6. Reconnect the negative battery cable.

## VALVE, OIL PRESSURE RELIEF

### REMOVAL

### REMOVAL

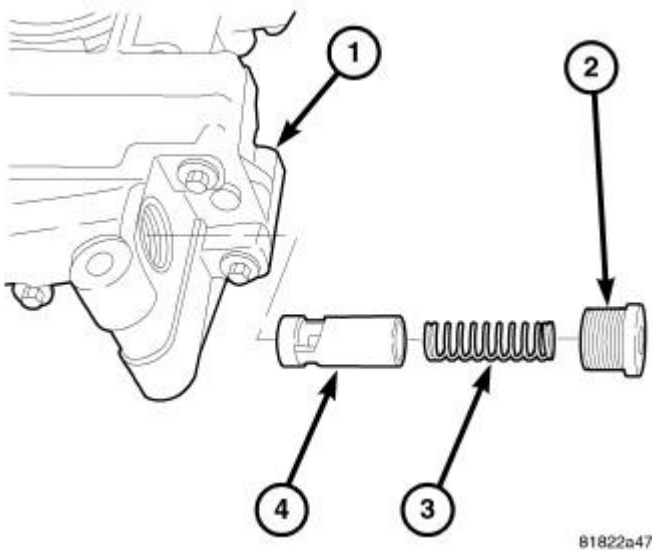


**Fig. 309: Oil Pressure Relief Valve**  
Courtesy of CHRYSLER LLC

1. Remove oil pan. Refer to **PAN, OIL, REMOVAL**.
2. Remove pressure regulating valve cap (2).
3. Remove pressure regulating valve spring (3) and valve (4).

#### INSPECTION

#### INSPECTION



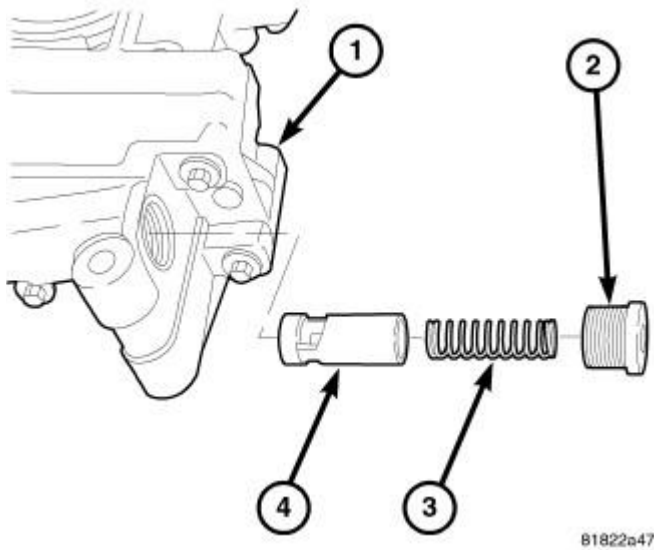
**Fig. 310: Oil Pressure Relief Valve**  
Courtesy of CHRYSLER LLC

**NOTE:** Pressure regulating valve (4) can be service separately from the oil pump assembly.

1. Inspect pressure relief valve (4) scoring, gouging, or debris. Replace as needed.
2. Inspect the pressure relief valve bore in the pump for scoring, gouging, or debris.
3. If pump bore is damaged, replace balance shaft module.

## INSTALLATION

## INSTALLATION



**Fig. 311: Oil Pressure Relief Valve**  
Courtesy of CHRYSLER LLC

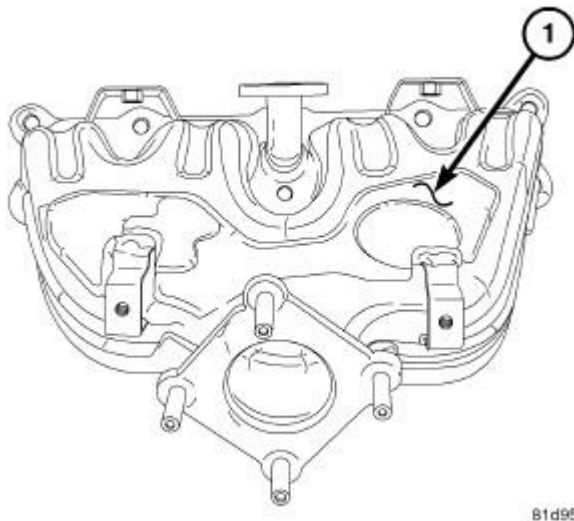
1. Lightly coat pressure regulating valve with clean engine oil and install valve (4).
2. Install spring (3) and cap (2).
3. Tighten cap to 44 N.m (32 lbs.ft.).

## MANIFOLDS

### MANIFOLD, EXHAUST

#### DESCRIPTION

#### DESCRIPTION



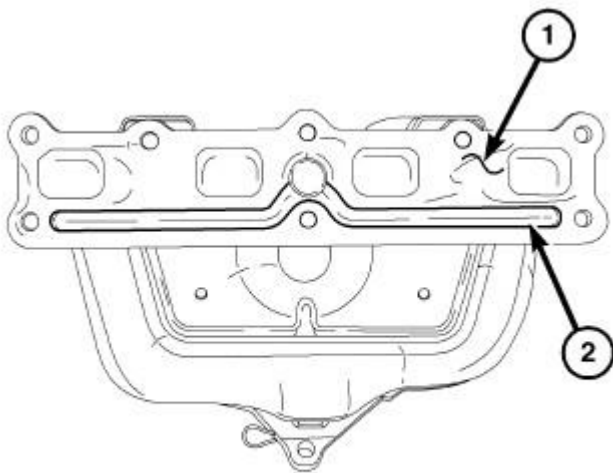
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**Fig. 312: Partially Zero Emission Vehicle Manifold**  
Courtesy of CHRYSLER LLC

The 2.4L engine can be equipped with a Partially Zero Emission Vehicle (PZEV) package. The PZEV package has a specific manifold and gasket that can not be interchanged with non-PZEV engines.

#### OPERATION

#### OPERATION



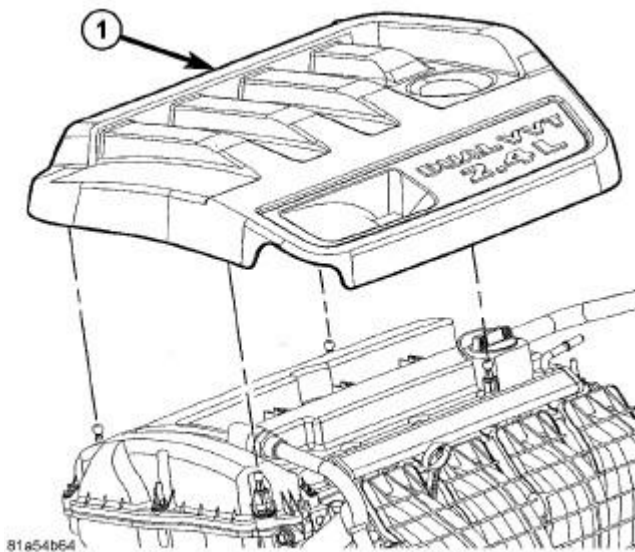
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**Fig. 313: Manifold & Passage**  
Courtesy of CHRYSLER LLC

Air is pumped into the manifold (1) through a check valve and is distributed to the cylinders through a passage (2) machined in the manifold.

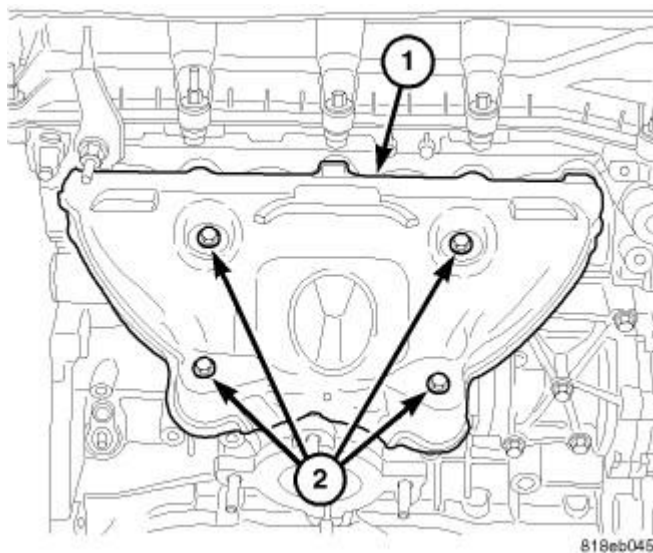
#### REMOVAL

## REMOVAL



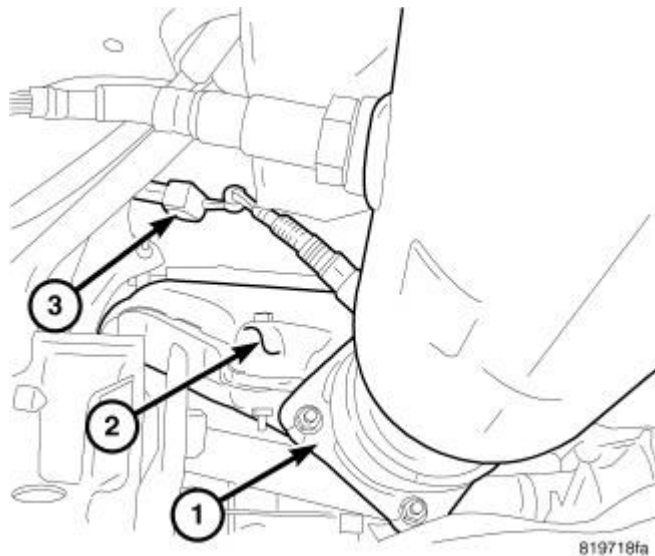
**Fig. 314: Engine Cover - 2.4L**  
Courtesy of CHRYSLER LLC

1. Remove engine cover (1).
2. Disconnect negative cable from battery.



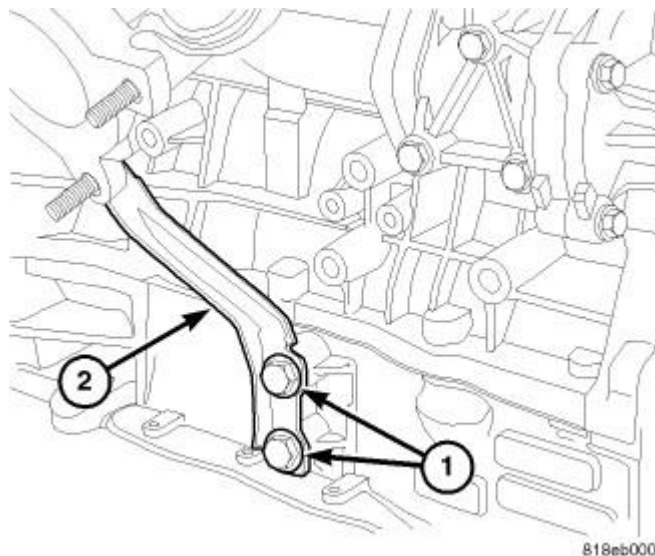
**Fig. 315: Exhaust Manifold Heat Shield & Bolts**  
Courtesy of CHRYSLER LLC

3. Remove bolts (2) attaching upper heat shield.
4. Remove upper heat shield (1).



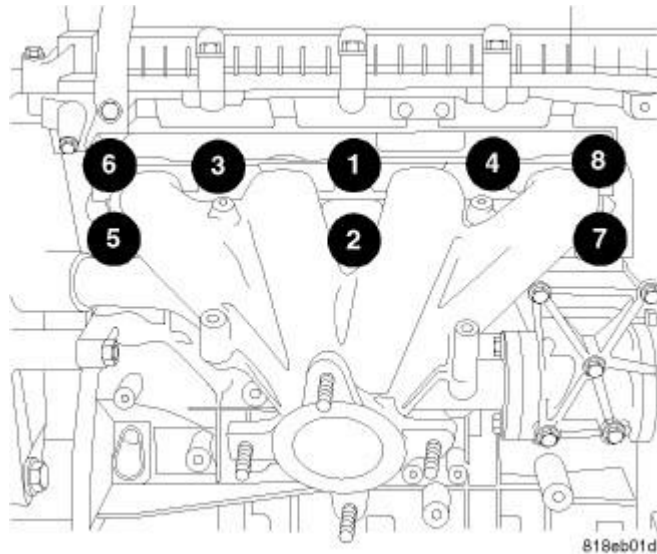
**Fig. 316: Exhaust Manifold Bolts, Heat Shield & Oxygen Sensor Connector**  
 Courtesy of CHRYSLER LLC

5. Disconnect exhaust pipe (1) from manifold.
6. Disconnect oxygen sensor electrical connector (3).



**Fig. 317: Exhaust Manifold Support Bracket & Bolts**  
 Courtesy of CHRYSLER LLC

7. Remove manifold support bracket (2).
8. Remove lower exhaust manifold heat shield.



**Fig. 318: Exhaust Manifold Retaining Fasteners Removal/Tightening Sequence**  
Courtesy of CHRYSLER LLC

9. Remove exhaust manifold retaining fasteners.
10. Remove and discard manifold gasket.

#### **CLEANING**

#### **CLEANING**

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

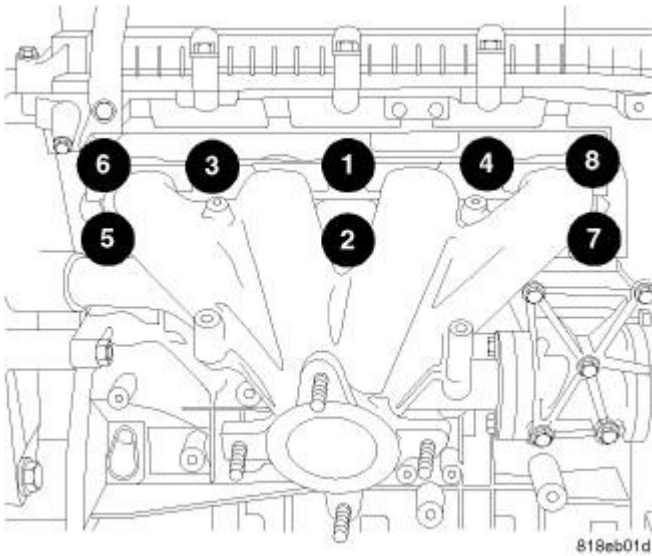
#### **INSPECTION**

#### **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.

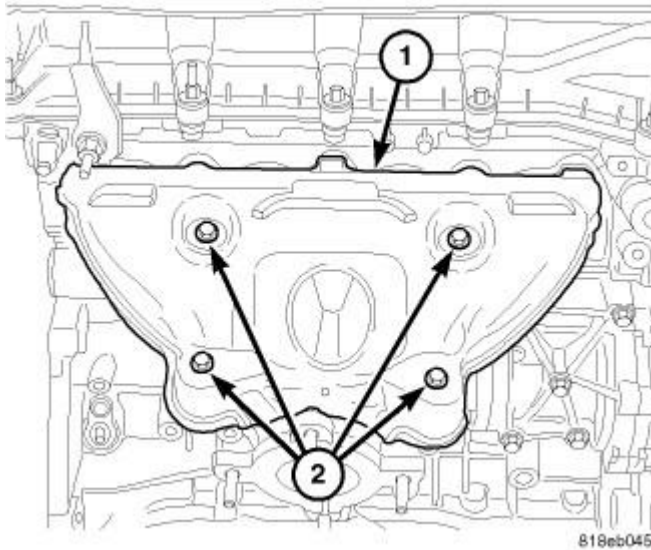
#### **INSTALLATION**

#### **INSTALLATION**



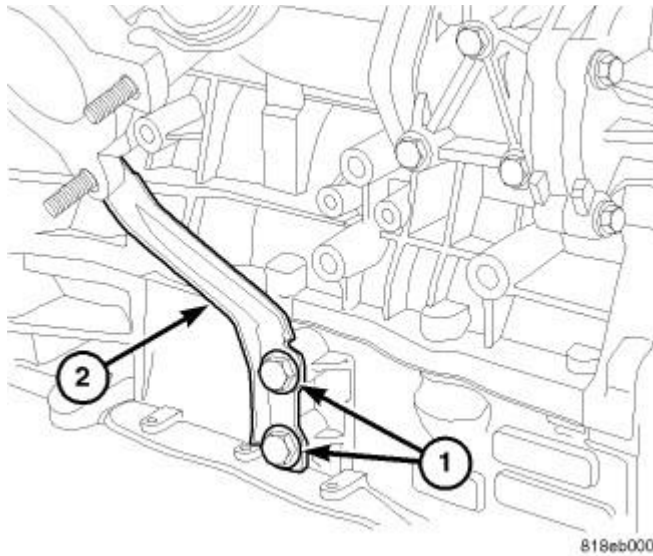
**Fig. 319: Exhaust Manifold Retaining Fasteners Removal/Tightening Sequence**  
Courtesy of CHRYSLER LLC

1. Install a new exhaust manifold gasket **DO NOT APPLY SEALER**.
2. Position exhaust manifold in place.
3. Tighten the exhaust manifold bolts to 34 N.m (25 ft. lbs.).



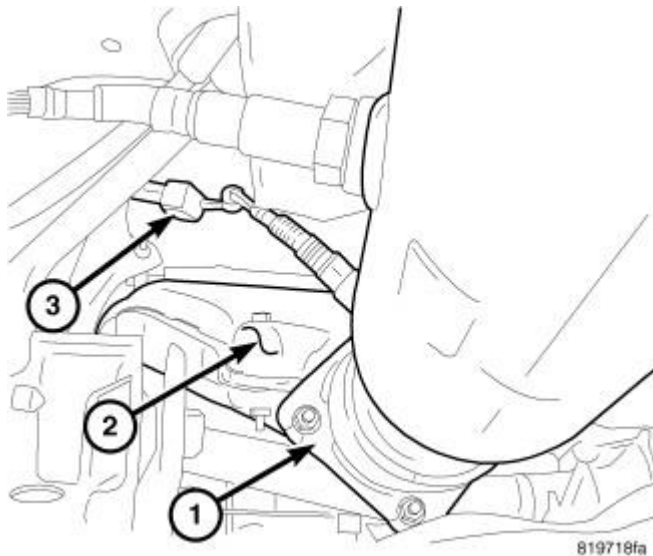
**Fig. 320: Exhaust Manifold Heat Shield & Bolts**  
Courtesy of CHRYSLER LLC

4. Install exhaust manifold heat shields (1). Tighten bolts (2) to 12 N.m (105 in. lbs.).



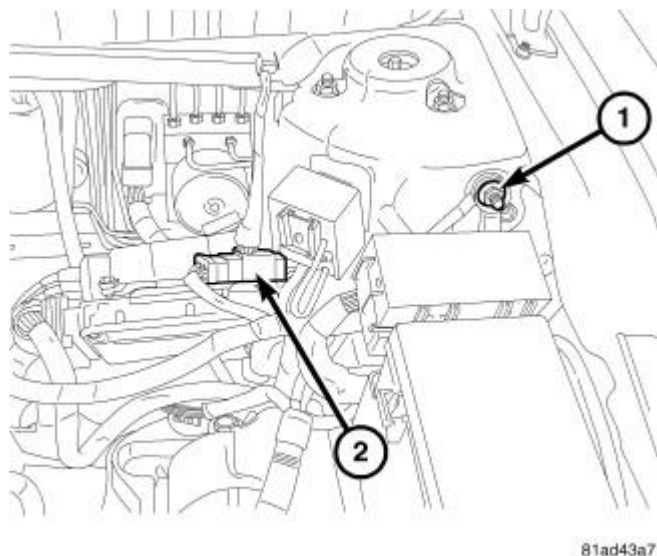
**Fig. 321: Exhaust Manifold Support Bracket & Bolts**  
 Courtesy of CHRYSLER LLC

5. Install exhaust manifold support bracket (2).



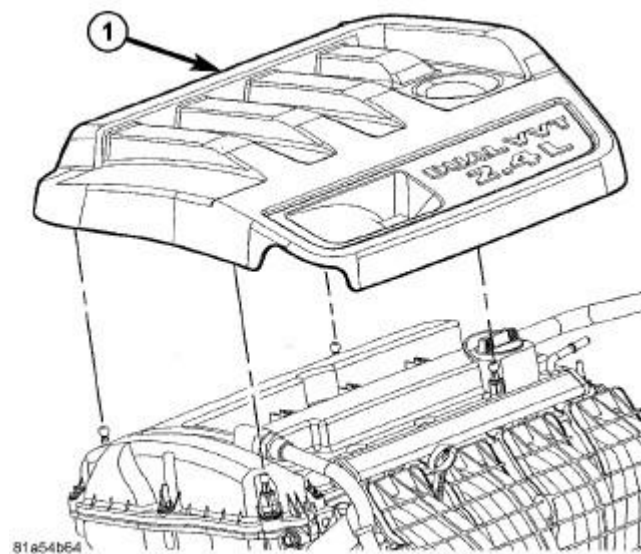
**Fig. 322: Exhaust Manifold Bolts, Heat Shield & Oxygen Sensor Connector**  
 Courtesy of CHRYSLER LLC

6. Install new catalytic converter gasket.
7. Install exhaust pipe to manifold (1). Tighten fasteners to 28 N.m (250 in. lbs.).
8. Connect oxygen sensor electrical connector (3).



**Fig. 323: Battery Cables**  
Courtesy of CHRYSLER LLC

9. Connect negative battery cable (1).



**Fig. 324: Engine Cover - 2.4L**  
Courtesy of CHRYSLER LLC

10. Install engine cover (1).

## MANIFOLD, INTAKE

### DIAGNOSIS AND TESTING

#### 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.

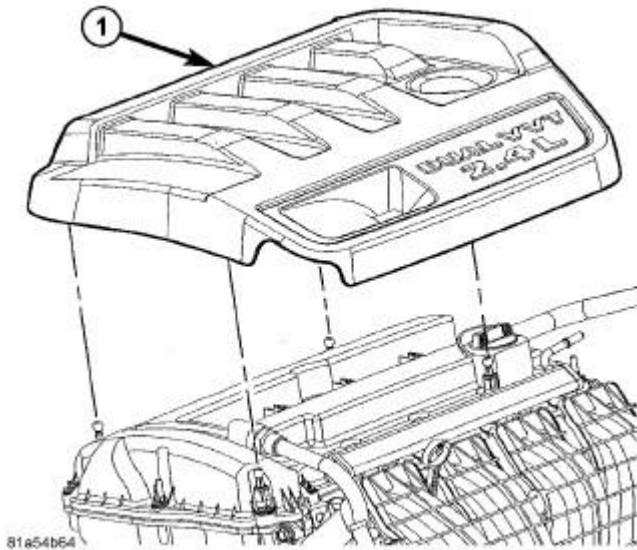
**WARNING:** Use extreme caution when the engine is operating. Do not stand in a direct line with the fan. Do not put your hands near the pulleys, belts or the fan. Do not wear loose clothing.

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

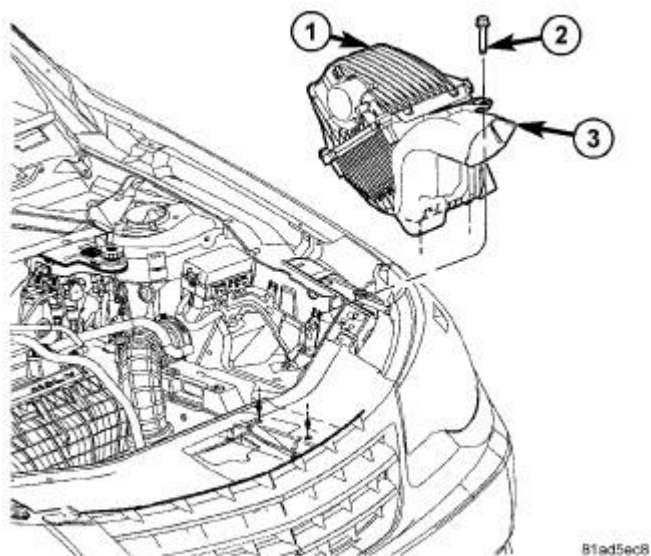
## REMOVAL

**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.



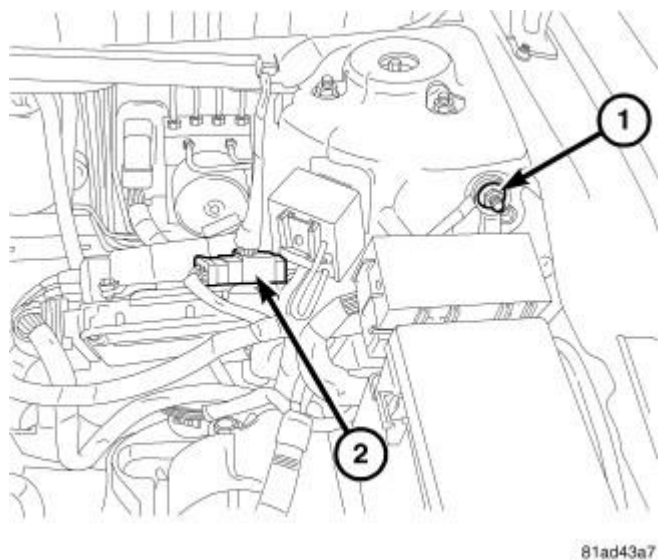
**Fig. 325: Engine Cover - 2.4L**  
 Courtesy of CHRYSLER LLC

1. Remove engine cover (1).
2. Perform fuel system pressure release procedure **before attempting any repairs. Refer to FUEL DELIVERY, GAS, STANDARD PROCEDURE** .



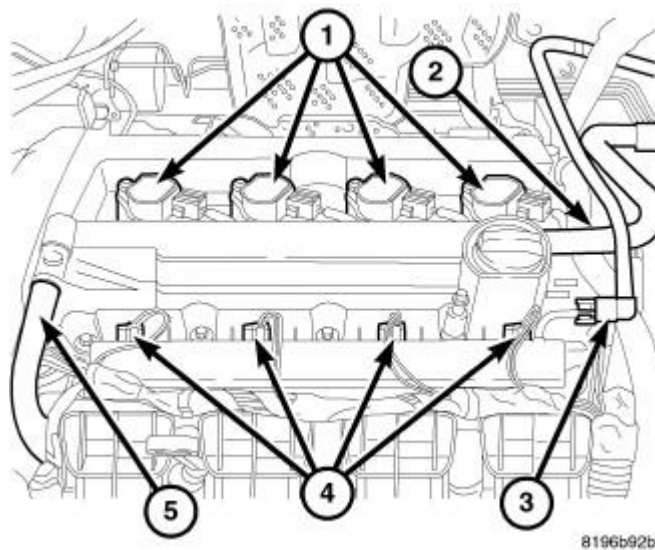
**Fig. 326: Air Cleaner Housing Assembly**  
Courtesy of CHRYSLER LLC

3. Remove air cleaner housing (1).



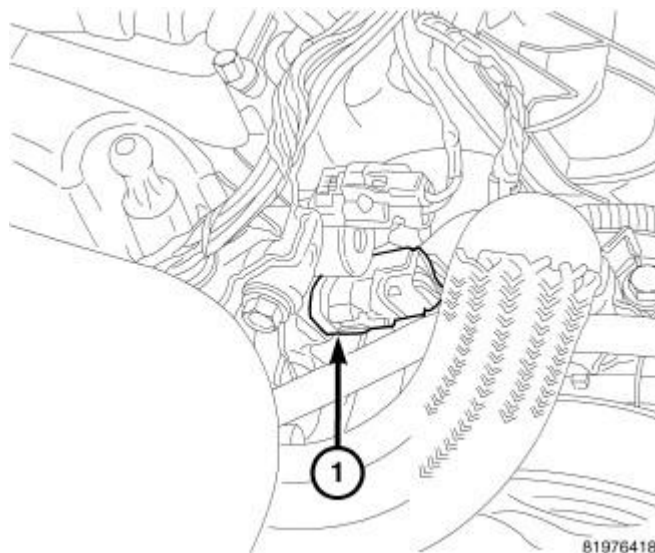
**Fig. 327: Battery Cables**  
Courtesy of CHRYSLER LLC

4. Disconnect negative battery cable (1).



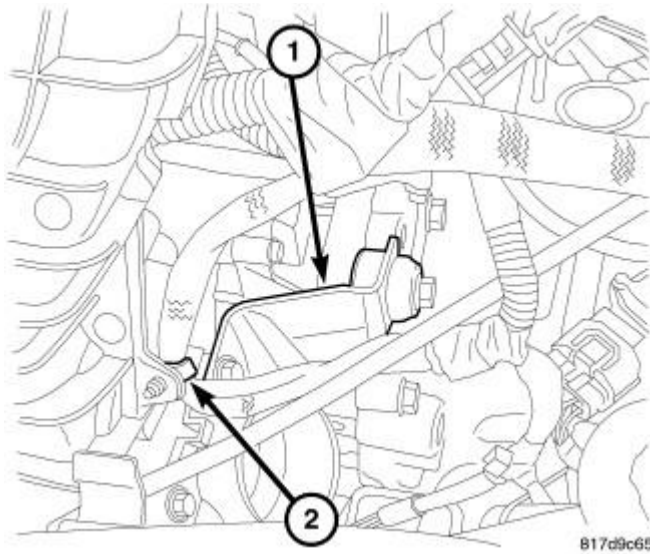
**Fig. 328: Coil Connectors, Air Hose, Fuel Line, Injectors & PCV Hose**  
Courtesy of CHRYSLER LLC

5. Disconnect fuel line at rail (3).
6. Remove fuel injector electrical connectors (4).
7. Remove fuel rail retaining bolts and remove fuel rail.



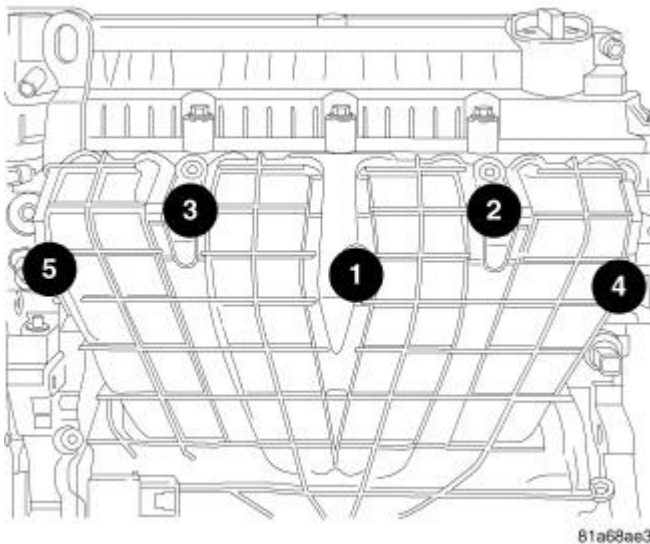
**Fig. 329: Oil Temperature Sensor**  
Courtesy of CHRYSLER LLC

8. Disconnect oil temperature sensor (1).
9. Disconnect variable valve timing solenoid electrical connector.
10. Disconnect intake camshaft position sensor electrical connector.
11. Position harness out of the way.



**Fig. 330: Throttle Body Support Bracket & Wiring Harness Retainer**  
 Courtesy of CHRYSLER LLC

12. Remove throttle body support bracket (1).
13. Disconnect electronic throttle control electrical connector.
14. Remove wiring harness retainer from the intake manifold (2).
15. Disconnect MAP sensor electrical connector.
16. Disconnect vacuum lines at intake.

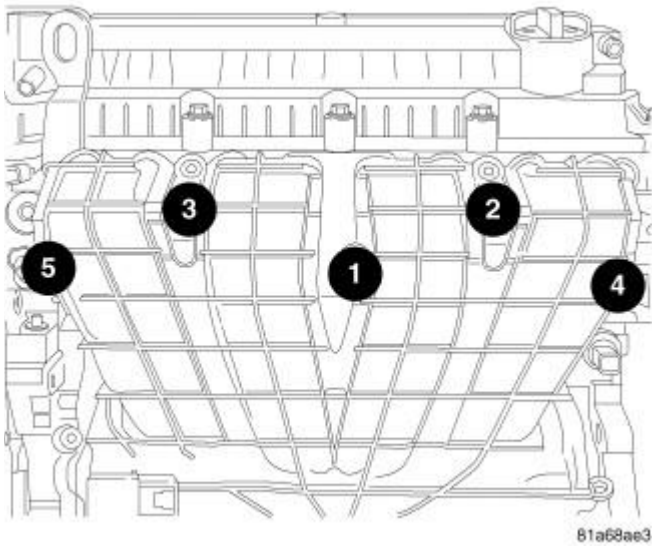


**Fig. 331: Intake Bolt Removal/Tightening Sequence**  
 Courtesy of CHRYSLER LLC

17. Remove intake manifold retaining bolts.
18. Remove intake manifold.

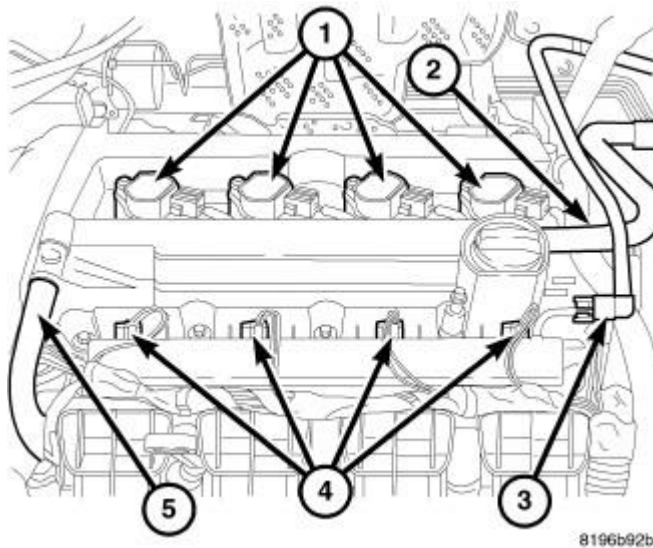
**INSPECTION****INSPECTION**

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****INSTALLATION**

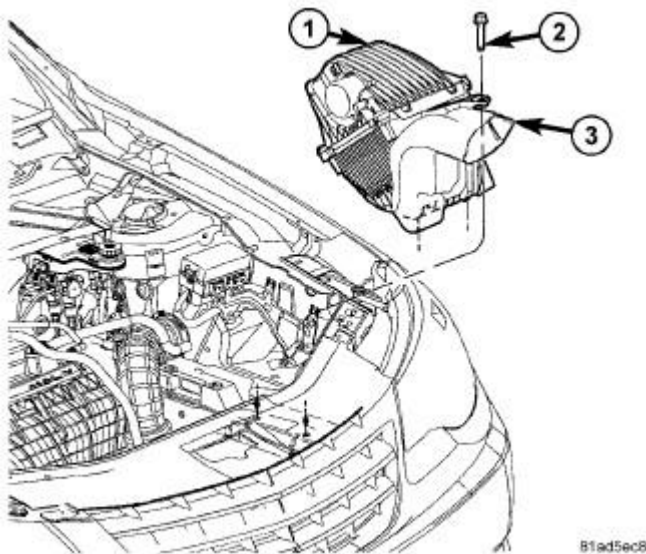
**Fig. 332: Intake Bolt Removal/Tightening Sequence**  
Courtesy of CHRYSLER LLC

1. Clean all gasket surfaces.
2. Replace intake manifold gasket.
3. Install intake manifold, tighten bolts to 25 N.m (220 in. lbs.).
4. Install the fuel rail assembly to intake manifold. Tighten bolts to 23 N.m (200 in. lbs.).



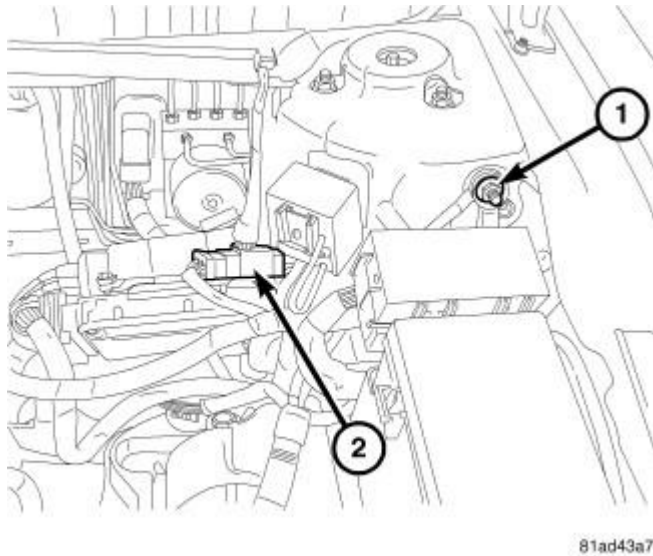
**Fig. 333: Coil Connectors, Air Hose, Fuel Line, Injectors & PCV Hose**  
Courtesy of CHRYSLER LLC

5. Connect fuel injector electrical connectors (4).
6. Inspect quick connect fittings for damage, replace if necessary. Refer to **FITTING, QUICK CONNECT, STANDARD PROCEDURE**.
7. Connect fuel supply hose (3) to fuel rail assembly. Check connection by pulling on connector to make sure it is locked into position.



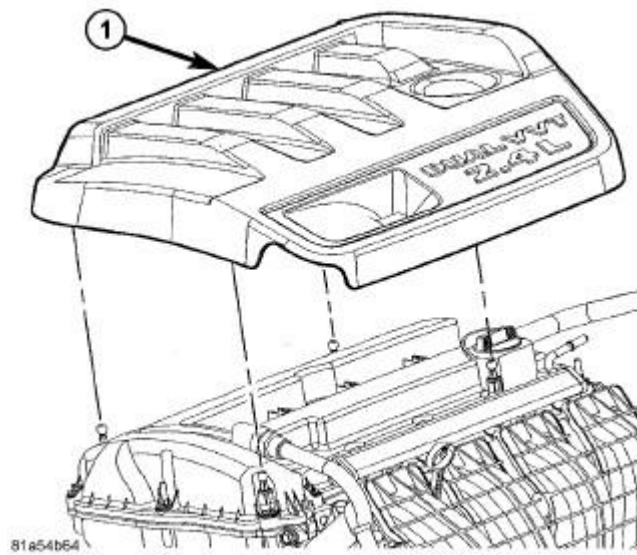
**Fig. 334: Air Cleaner Housing Assembly**  
Courtesy of CHRYSLER LLC

8. Install air cleaner housing (1).



**Fig. 335: Battery Cables**  
Courtesy of CHRYSLER LLC

9. Connect negative battery cable (1).
10. Fill the cooling system. Refer to **STANDARD PROCEDURE** .



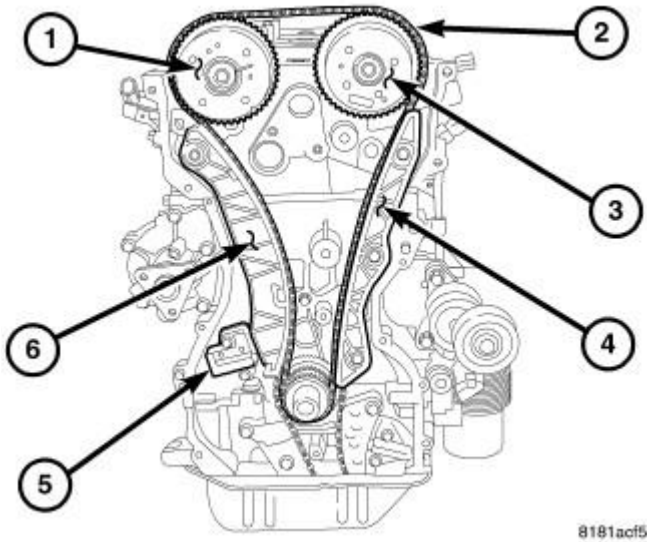
**Fig. 336: Engine Cover - 2.4L**  
Courtesy of CHRYSLER LLC

11. Start engine and check for leaks.
12. Install engine cover.

## VALVE TIMING

## DESCRIPTION

### DESCRIPTION



**Fig. 337: Timing Drive System**  
Courtesy of CHRYSLER LLC

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)

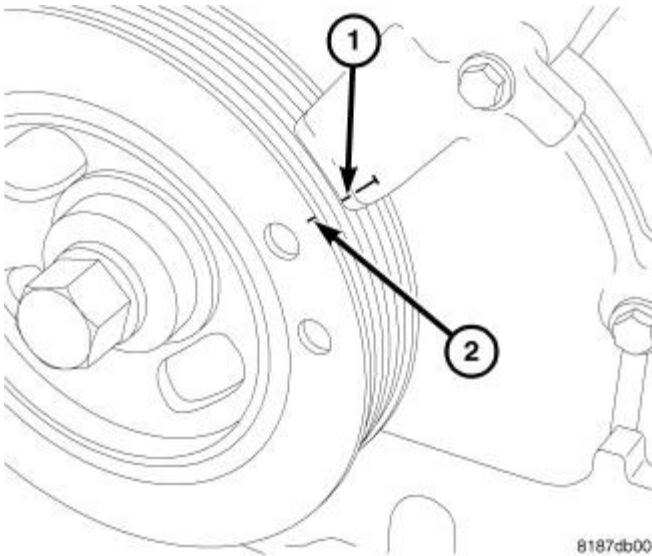
The camshaft sprockets are attached to the cam phasers which are attached to the front of the camshafts and are used with the timing chain and crankshaft sprocket to turn the camshafts. The camshaft position sensors target is part of the camshafts and is used with the camshaft position sensors to provide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

### STANDARD PROCEDURE - VALVE TIMING VERIFICATION

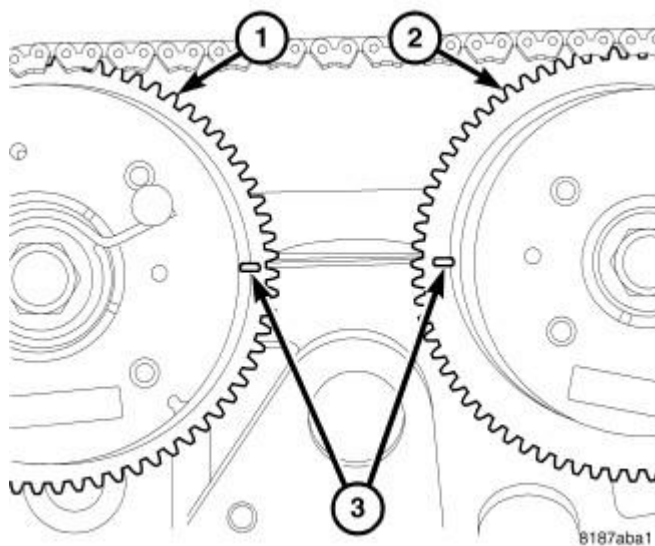
**CAUTION:** Painted or colored chain links are used during initial engine assembly and can not be relied upon for valve timing verification. These markings are in different locations for early production, late production and service parts. Only use TDC marks, cylinder head cover sealing surface and camshaft sprocket marks to verify valve timing or engine damage may result.



**Fig. 338: TDC**

Courtesy of CHRYSLER LLC

1. Remove engine cover.
2. Remove cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, REMOVAL.**
3. Set engine to TDC (1, 2).



**Fig. 339: Camshaft Timing**

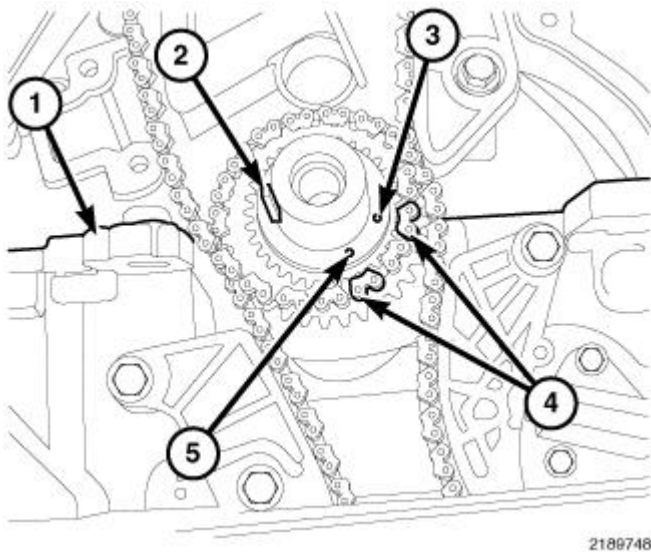
Courtesy of CHRYSLER LLC

4. The marks on the camshaft sprockets (3) should be in line with the cylinder head cover sealing surface.
5. Install cylinder head cover. Refer to COVER(S), CYLINDER HEAD, INSTALLATION.
6. Install the engine cover.

## CHAIN AND SPROCKETS, TIMING

### REMOVAL

#### TIMING CHAIN



**Fig. 340: Crankshaft Timing Marks**  
Courtesy of CHRYSLER LLC

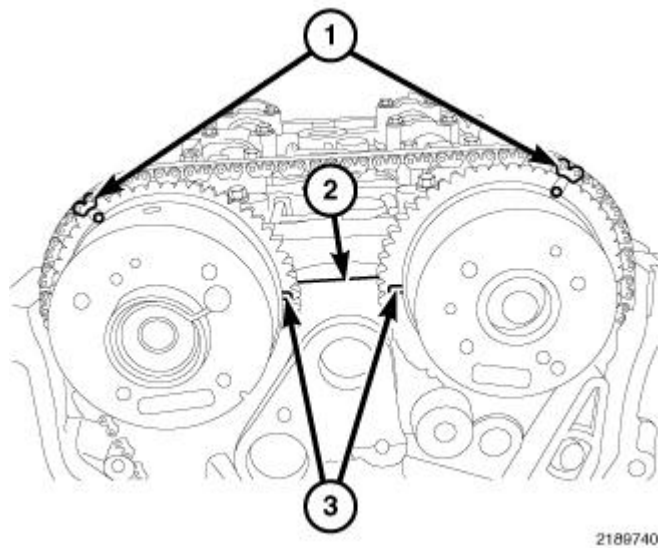
1. Remove timing chain cover. Refer to COVER(S), ENGINE TIMING, REMOVAL.

**NOTE:** The crankshaft timing mark (3) or (5) can be in one of two locations depending on whether the engine is early production (5), late production (3) or assembled with service parts (3). In all cases the keyway (2) will always be in the 9:00 position, in line with the ladder frame mounting surface (1) when the engine is at TDC.

2. Verify that the engine is still set to TDC.

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

3. Mark chain link (4) corresponding to crankshaft timing mark (3) or (5).

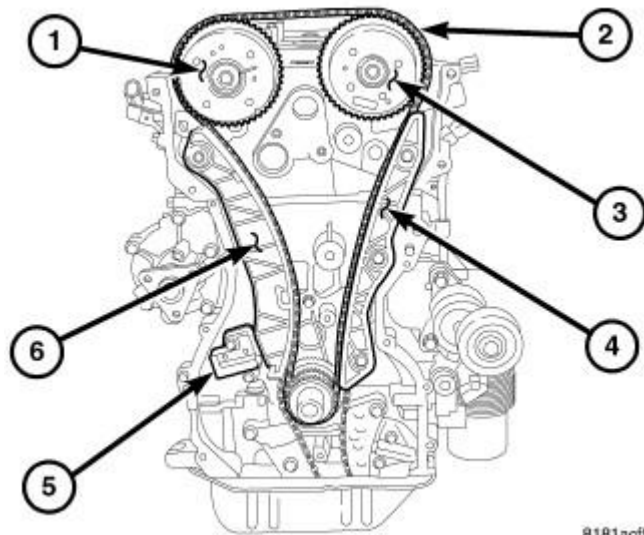


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**Fig. 341: Timing Chain Timing Marks**

Courtesy of CHRYSLER LLC

4. With the engine still set to TDC, verify that the marks on the camshaft sprockets (3) are in line with the cylinder head cover sealing surface (2). If the marks do not line up, the timing chain is not correctly installed.
5. Mark chain link (1) corresponding to camshaft timing mark.



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**Fig. 342: Timing Drive System**

Courtesy of CHRYSLER LLC

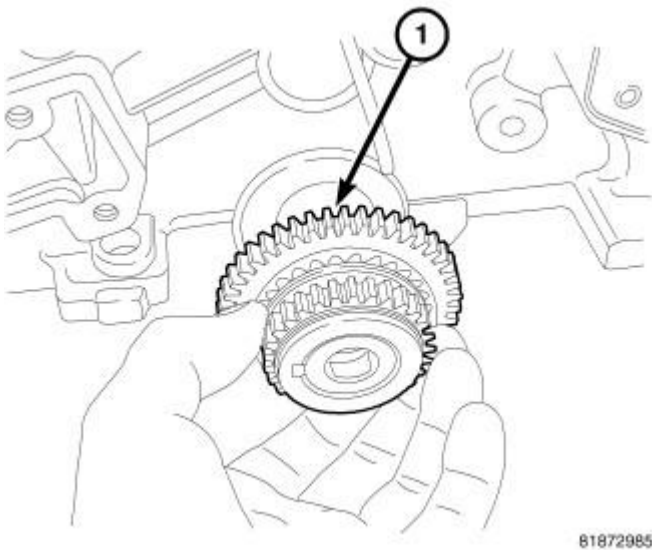
6. Remove timing chain tensioner (5). Refer to **TENSIONER, ENGINE TIMING, REMOVAL**.
7. Remove timing chain (2).

#### CAMSHAFT SPROCKET(S)

**NOTE:** Camshaft phasers and camshaft sprockets are supplied as an assembly, do not attempt to disassemble.

Refer to **CAMSHAFT, ENGINE, REMOVAL**.

#### CRANKSHAFT SPROCKET

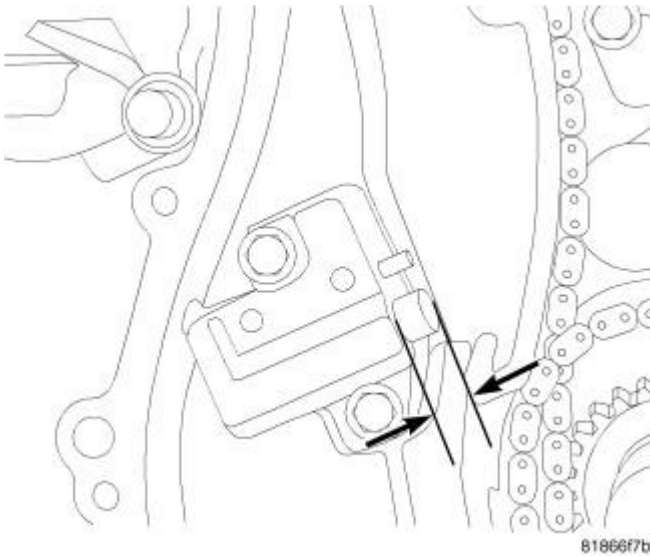


**Fig. 343: Crankshaft Sprocket**  
Courtesy of CHRYSLER LLC

1. Remove timing chain. Refer to **CHAIN AND SPROCKETS, TIMING, REMOVAL**.
2. Remove oil pan. Refer to **PAN, OIL, REMOVAL**.
3. Remove oil pump drive chain tensioner.
4. Remove oil pump drive chain.
5. Remove crankshaft sprocket (1).

#### INSPECTION

#### INSPECTION



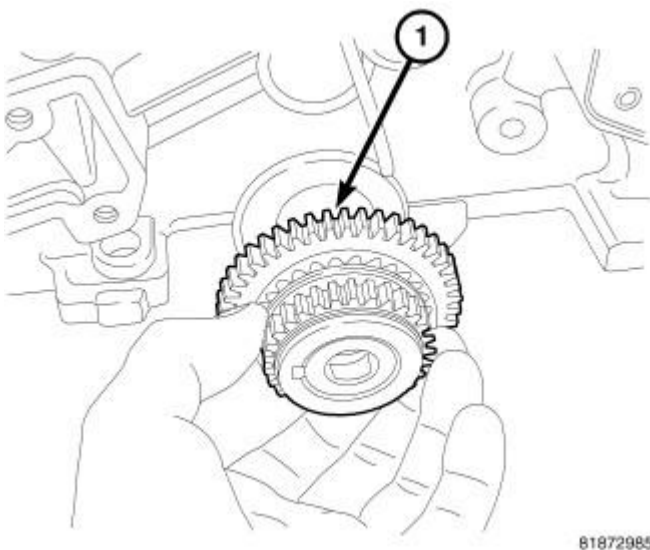
**Fig. 344: Measuring Distance From Tensioner Body To Edge Of Chain Guide**  
 Courtesy of CHRYSLER LLC

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 in illustration.
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

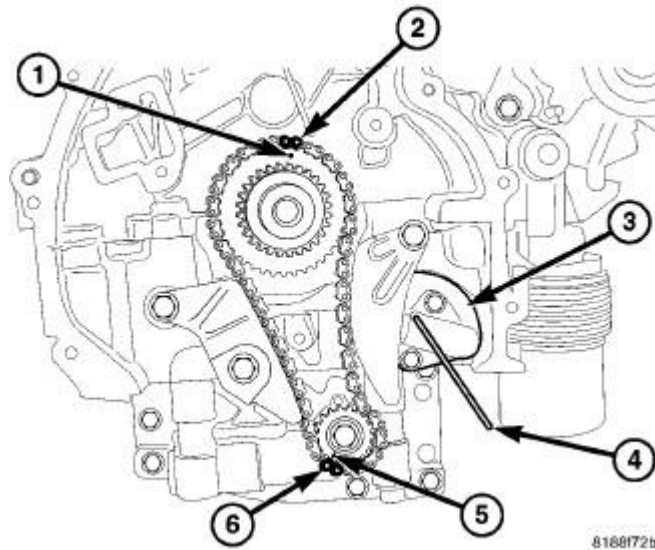
### CRANKSHAFT SPROCKET



**Fig. 345: Crankshaft Sprocket**

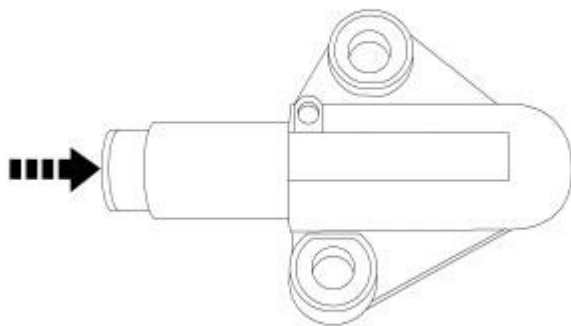
Courtesy of CHRYSLER LLC

1. Install crankshaft sprocket (1) onto crankshaft.



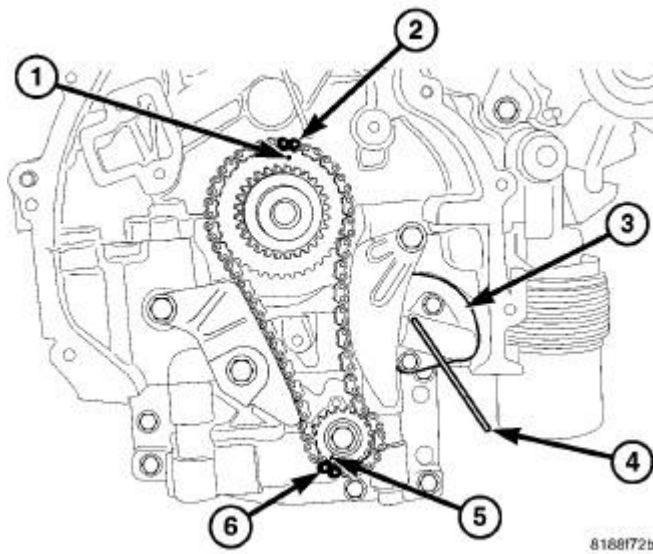
**Fig. 346: Oil Pump Drive Chain, Oil Pump Drive Chain Tensioner & Timing Marks On Chain**  
Courtesy of CHRYSLER LLC

2. Install oil pump drive chain. Verify that Oil pump is correctly timed (1, 2, 5, 6).



**Fig. 347: Oil Pump Tensioner Reset**  
Courtesy of CHRYSLER LLC

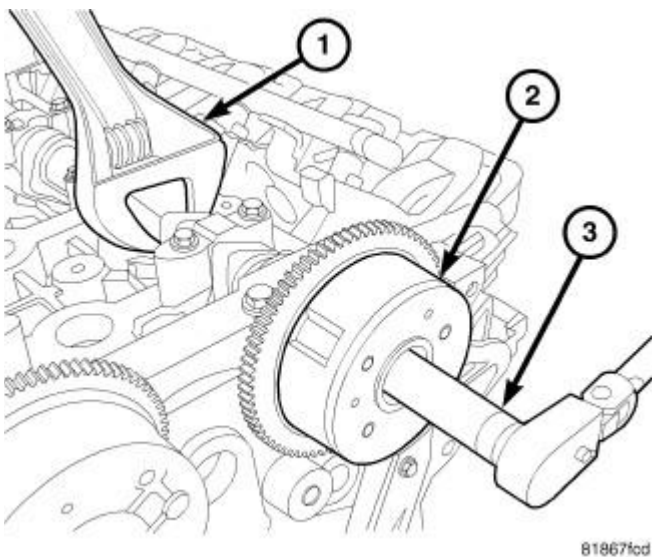
3. Reset oil pump drive chain tensioner by pushing plunger inward and install tensioner pin (special tool #8514, Pins, Tensioner).



**Fig. 348: Oil Pump Drive Chain, Oil Pump Drive Chain Tensioner & Timing Marks On Chain**  
Courtesy of CHRYSLER LLC

4. Install oil pump drive chain tensioner (3) and remove Tensioner Pin (special tool #8514, Pins, Tensioner) (4).
5. Install timing chain. Refer to **CHAIN AND SPROCKETS, TIMING, INSTALLATION**.
6. Install oil pan. Refer to **PAN, OIL, INSTALLATION**.
7. Fill engine with oil. Refer to **Engine/Lubrication/OIL - Standard Procedure**.
8. Start engine and check for leaks.

#### CAMSHAFT SPROCKET(S)



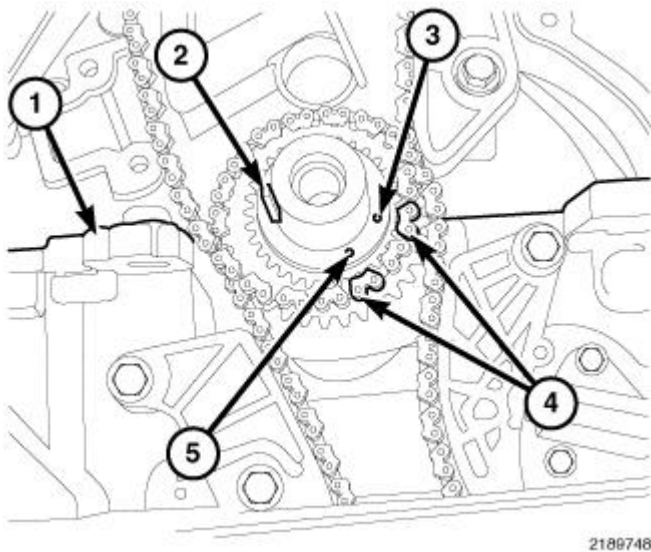
**Fig. 349: Camshafts Phaser Removal/Installation**  
Courtesy of CHRYSLER LLC

**NOTE:** The camshaft sprockets and the camshaft phasers are an assembly and cannot be serviced separately.

**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. Refer to Camshaft phaser (2) installation. Refer to CAMSHAFT, ENGINE, INSTALLATION.

#### TIMING CHAIN

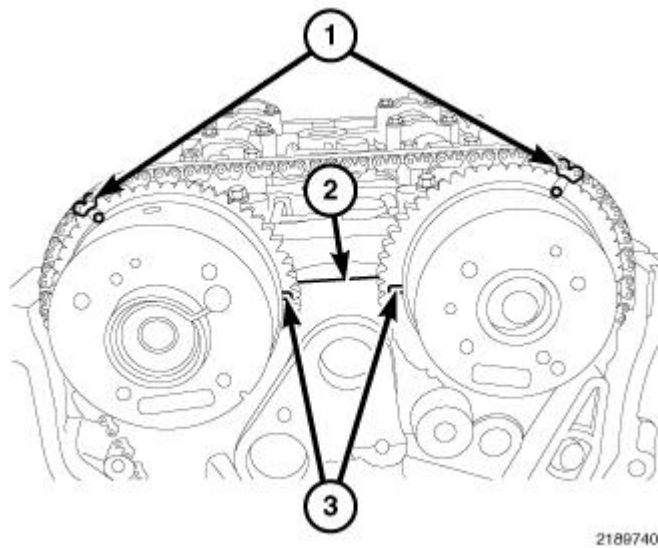


**Fig. 350: Crankshaft Timing Marks**

Courtesy of CHRYSLER LLC

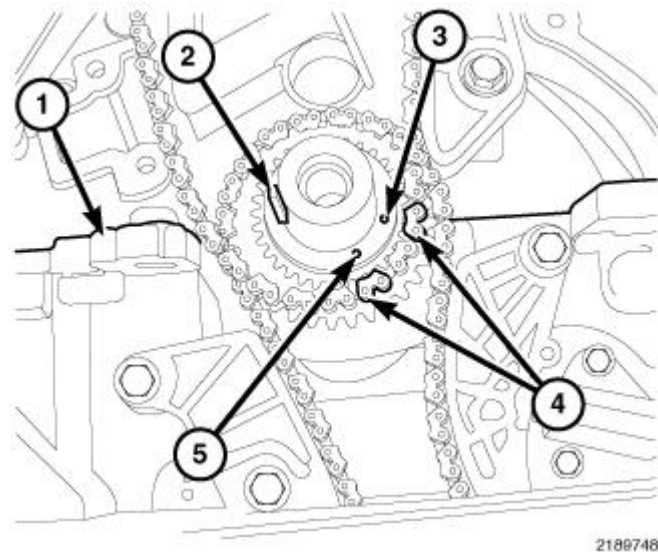
**NOTE:** The crankshaft timing mark (3) or (5) can be in one of two locations depending on whether the engine is early production (5), late production (3) or assembled with service parts (3). In all cases the keyway (2) will always be in the 9:00 position, in line with the ladder frame mounting surface (1) when the engine is at TDC.

1. Verify that the engine is still set to TDC.



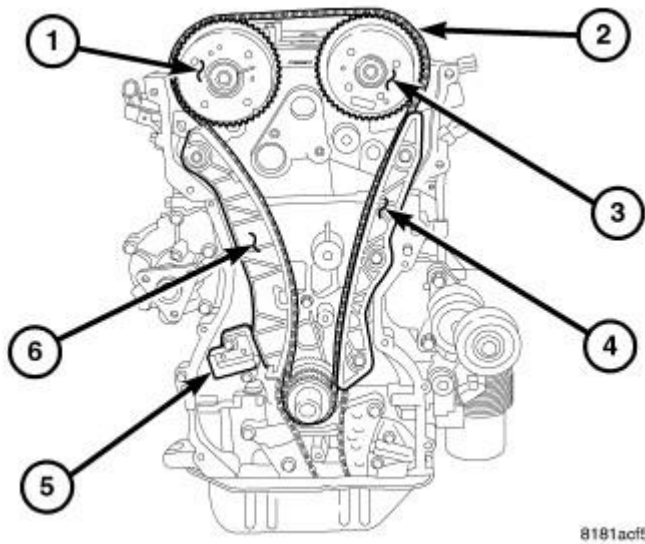
**Fig. 351: Timing Chain Timing Marks**  
Courtesy of CHRYSLER LLC

2. Align camshaft timing marks (3) so they are facing each other and in line with the cylinder head cover sealing surface (2).
3. Install timing chain so plated (or marked) links on chain align with timing marks on camshaft sprockets (1).



**Fig. 352: Crankshaft Timing Marks**  
Courtesy of CHRYSLER LLC

4. Align timing mark on the crankshaft sprocket (3) or (5) with the plated (or marked) link (4) on the timing chain. Position chain so slack will be on the tensioner side.

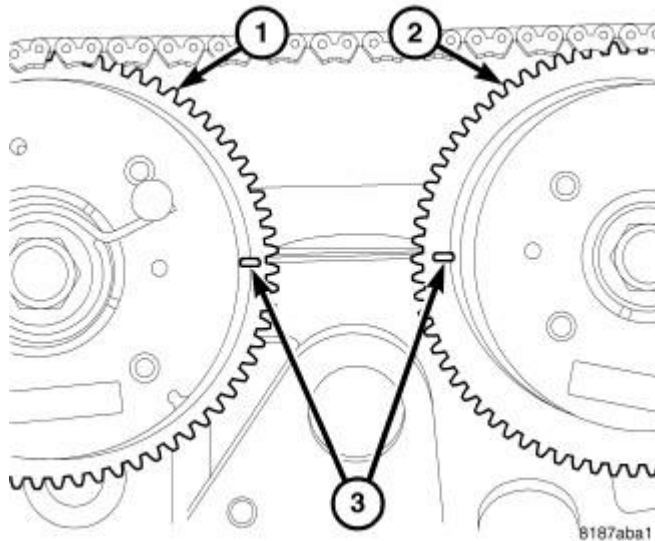


**Fig. 353: Timing Drive System**  
Courtesy of CHRYSLER LLC

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

5. Install the timing chain tensioner (5). Refer to **TENSIONER, ENGINE TIMING, INSTALLATION**.

Rotate the crankshaft CLOCKWISE two complete revolutions until the crankshaft is repositioned at the TDC position with the key way at the 9 o'clock position.



**Fig. 354: Camshaft Timing Marks**  
Courtesy of CHRYSLER LLC

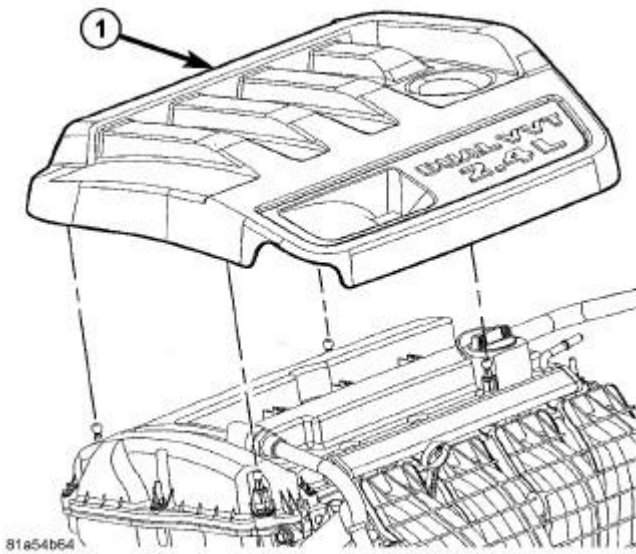
6. Verify that the camshafts timing marks (3) are in the proper position and in line with the cylinder head cover sealing surface. If the marks do not line up, the timing chain is not correctly installed.
7. Install front timing chain cover. Refer to **COVER(S), ENGINE TIMING, INSTALLATION**.

8. Connect negative battery cable.
9. Operate engine until it reaches normal operating temperature. Check oil and cooling systems for correct fluid levels.

## **COVER(S), ENGINE TIMING**

### **REMOVAL**

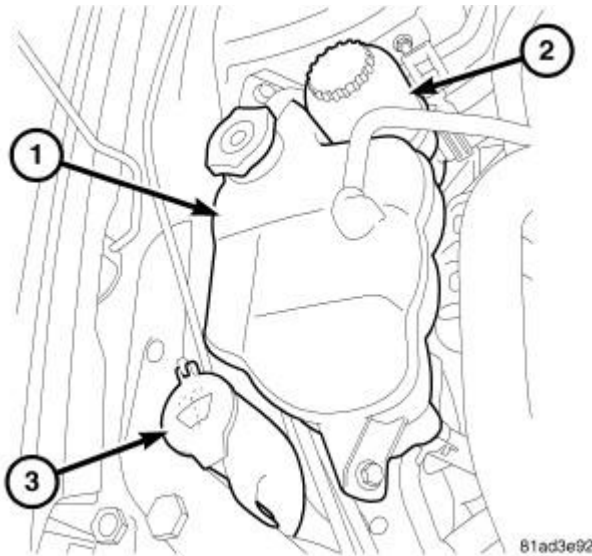
### **REMOVAL**



**Fig. 355: Engine Cover - 2.4L**

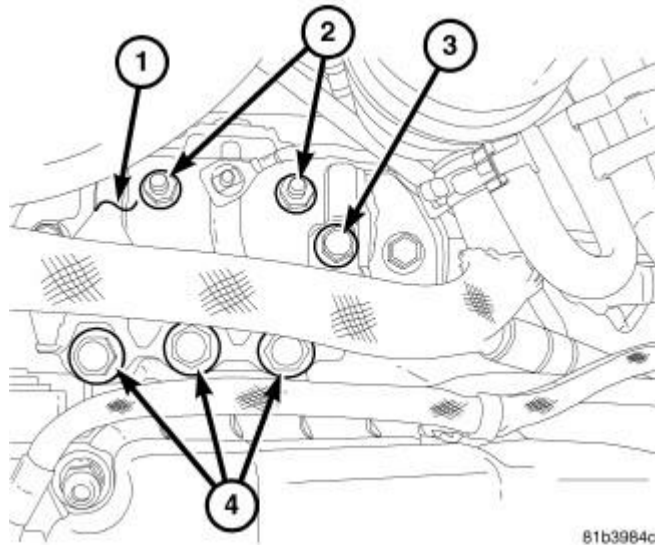
Courtesy of CHRYSLER LLC

1. Remove engine cover (1) by pulling upward.
2. Perform fuel pressure bleed procedure. Refer to **FUEL DELIVERY, GAS, STANDARD PROCEDURE**.
3. Disconnect and isolate the negative battery cable.



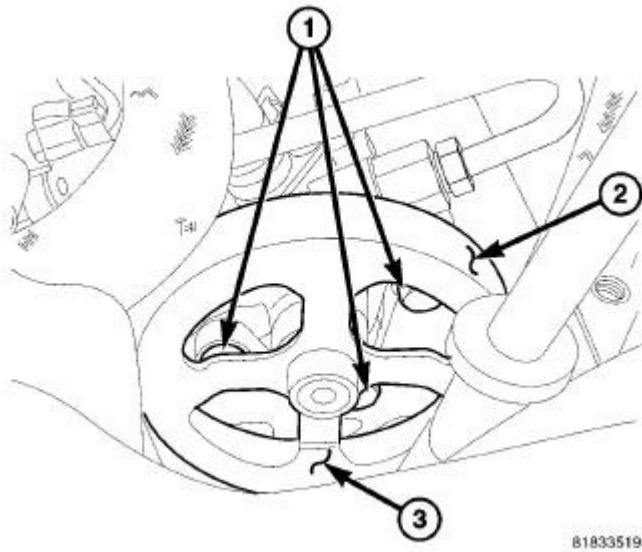
**Fig. 356: Coolant Reservoir, Power Steering Reservoir & Windshield Washer Bottle**  
 Courtesy of CHRYSLER LLC

4. Remove coolant recovery bottle (1). Refer to **BOTTLE, COOLANT RECOVERY, REMOVAL** .
5. Remove and reposition power steering reservoir (2).
6. Remove accessory drive belt. Refer to **BELT, SERPENTINE, REMOVAL** .



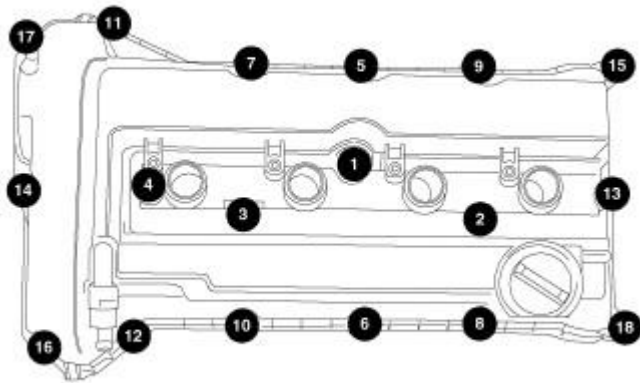
**Fig. 357: Power Steering Hose Hold Down, Right Engine Mount Bracket & Fasteners**  
 Courtesy of CHRYSLER LLC

7. Remove power steering hose hold down (3).



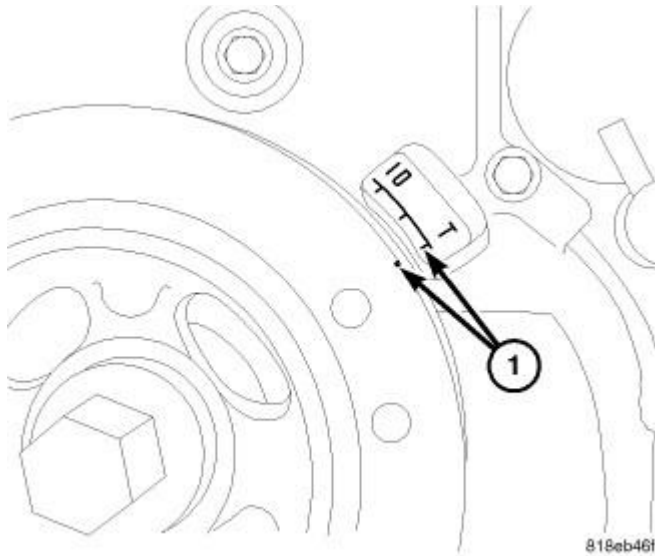
**Fig. 358: Power Steering Pump - Gas**  
Courtesy of CHRYSLER LLC

8. Remove the three power steering pump mounting bolts (1) through the openings in the pulley (3) and reposition the pump.



**Fig. 359: Removing/Installing Cylinder Head Cover Bolts In Sequence**  
Courtesy of CHRYSLER LLC

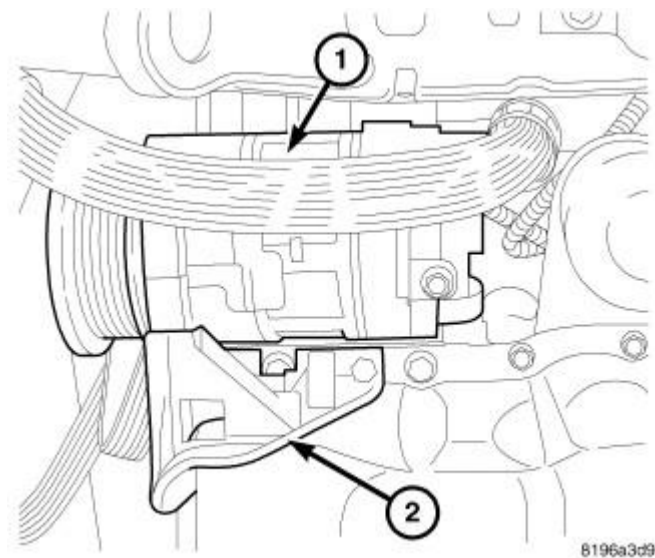
9. Remove the cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, REMOVAL.**
10. Remove ignition coils from the cylinder head cover.



**Fig. 360: TDC**

Courtesy of CHRYSLER LLC

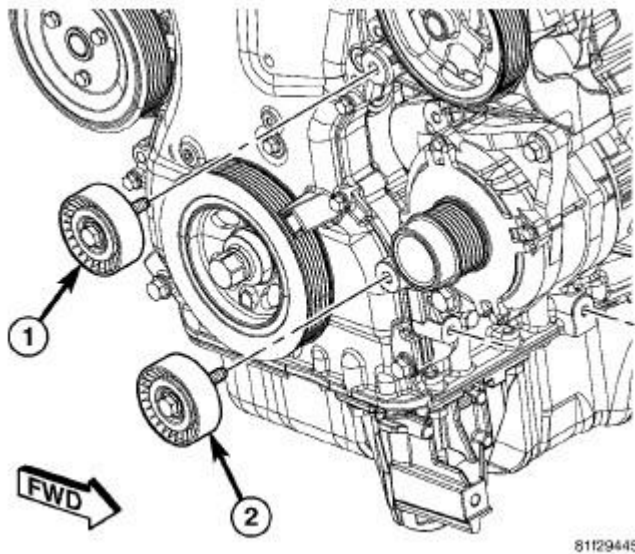
11. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
12. Remove the frame cover portion of the right splash shield. Refer to **SHIELD, SPLASH, FRONT WHEELHOUSE, REMOVAL** and **SHIELD, SPLASH, REAR WHEELHOUSE, REMOVAL**.
13. Set engine to TDC (1).



**Fig. 361: A/C Compressor & Bracket**

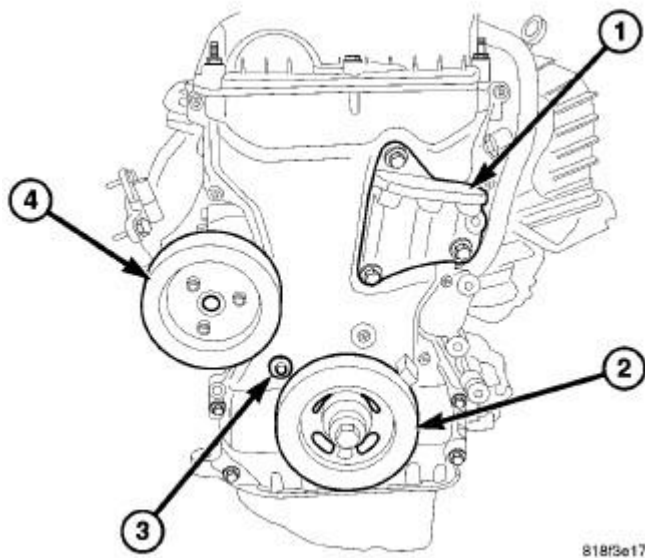
Courtesy of CHRYSLER LLC

14. Remove lower A/C compressor bolts if equipped.
15. Remove lower A/C compressor mount (2) if equipped.



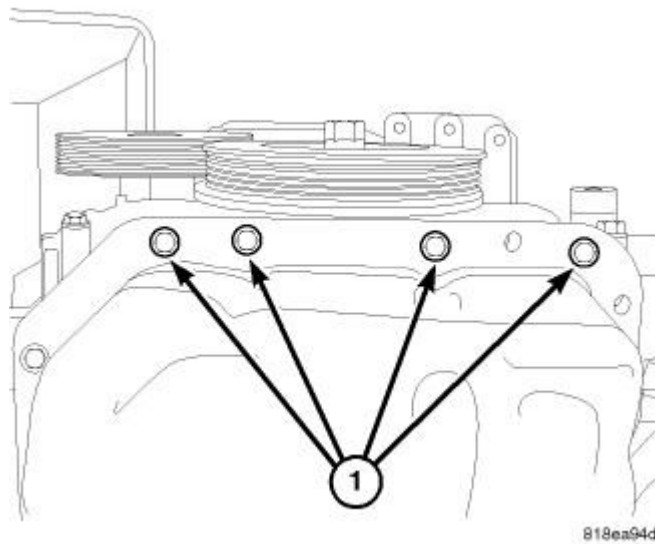
**Fig. 362: Removing/Installing Accessory Drive Belt Upper & Lower Idler Pulley**  
Courtesy of CHRYSLER LLC

16. Remove accessory drive belt lower idler pulley (2).



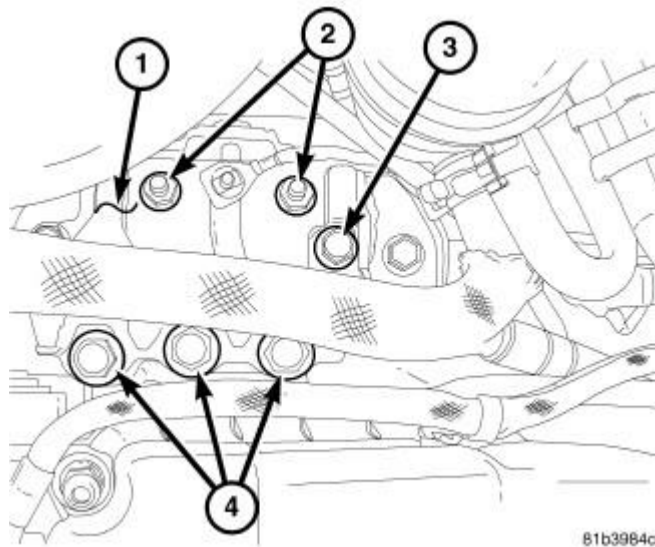
**Fig. 363: Right Side Engine Mount Bracket, Crankshaft Damper & Water Pump Pulley**  
Courtesy of CHRYSLER LLC

17. Remove crankshaft damper (2). Refer to **DAMPER, VIBRATION, REMOVAL**.
18. Remove three bolts and water pump pulley (4) from water pump.
19. Remove lower bolt from right side engine mount bracket (1).



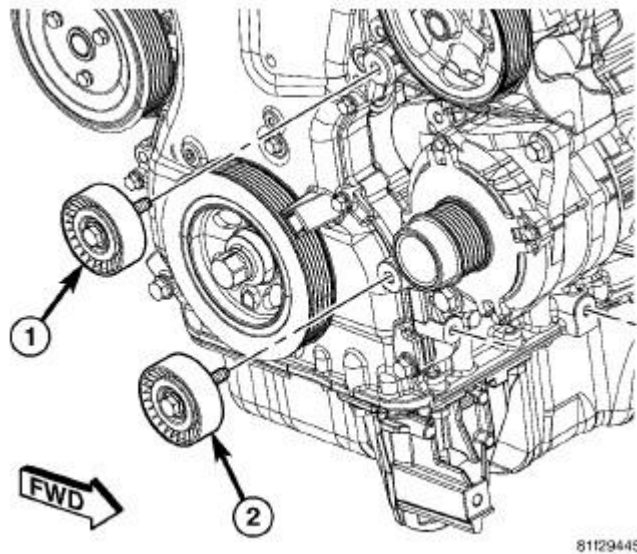
**Fig. 364: Oil Pan To Timing Chain Cover Lower Retaining Bolts**  
Courtesy of CHRYSLER LLC

20. Remove timing chain cover lower bolts (1).
21. Lower vehicle.
22. Support engine with suitable jack.



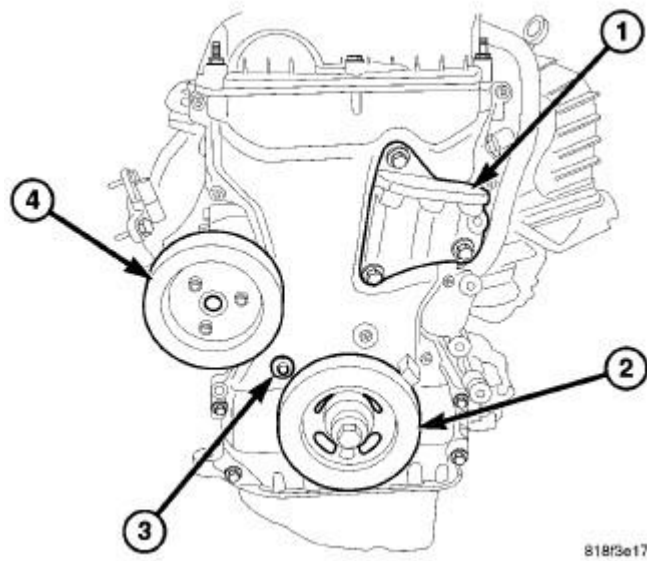
**Fig. 365: Power Steering Hose Hold Down, Right Engine Mount Bracket & Fasteners**  
Courtesy of CHRYSLER LLC

23. Remove right engine mount bracket retaining bolts (4).
24. Remove retaining nuts (2) and reposition mount bracket (1).



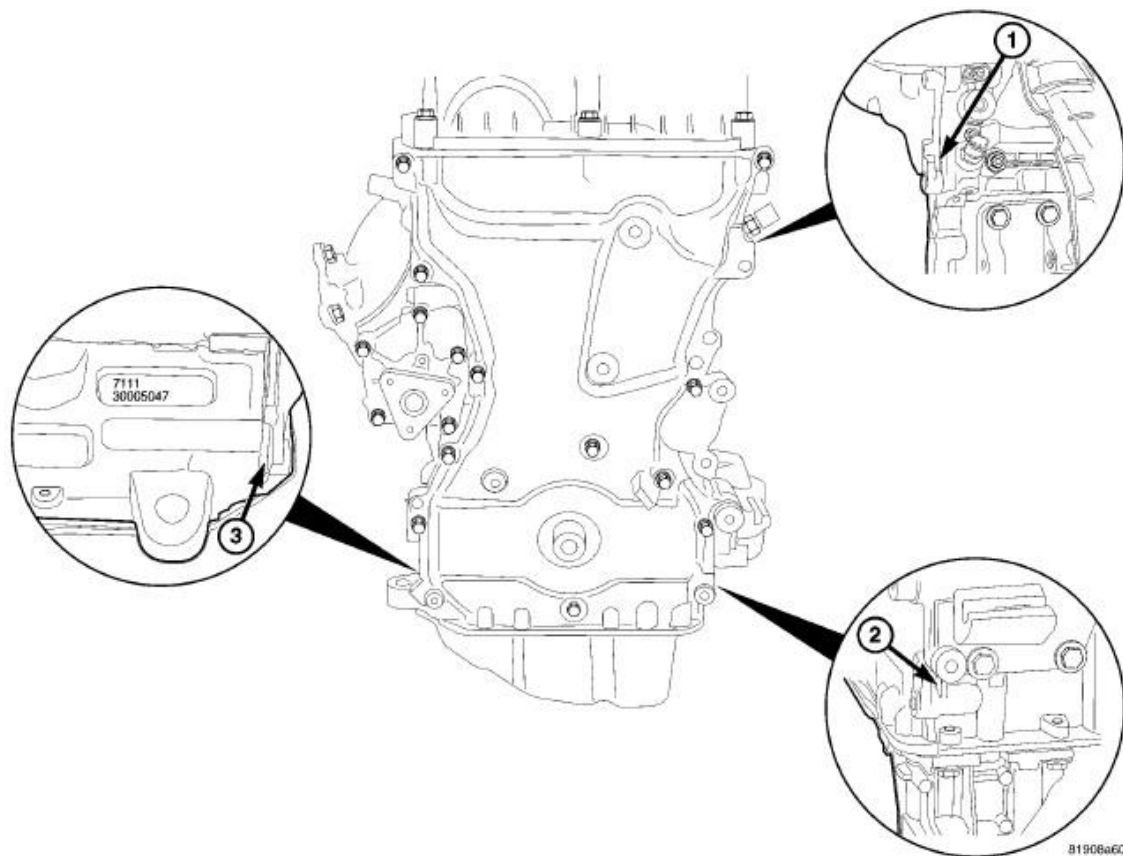
**Fig. 366: Removing/Installing Accessory Drive Belt Upper & Lower Idler Pulley**  
Courtesy of CHRYSLER LLC

25. Remove accessory drive upper idler pulley (1).



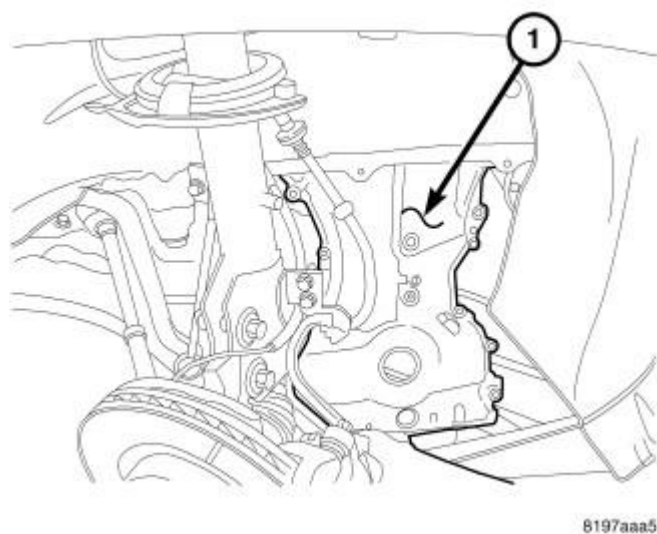
**Fig. 367: Right Side Engine Mount Bracket, Crankshaft Damper & Water Pump Pulley**  
Courtesy of CHRYSLER LLC

26. Remove right upper engine mount bracket (1).
27. Remove accessory drive belt tensioner.
28. Remove upper timing chain cover retaining bolts.



**Fig. 368: Timing Chain Cover Pry Points**  
Courtesy of CHRYSLER LLC

29. Remove timing chain cover using pry points (1, 2, 3).

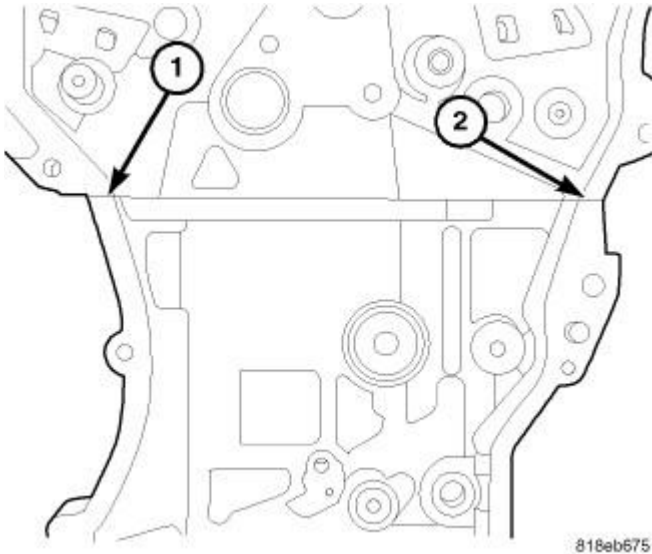


**Fig. 369: Timing Chain Cover Removal/Installation**  
Courtesy of CHRYSLER LLC

30. Remove timing chain cover (1) out through the bottom of the vehicle.

## INSTALLATION

## INSTALLATION

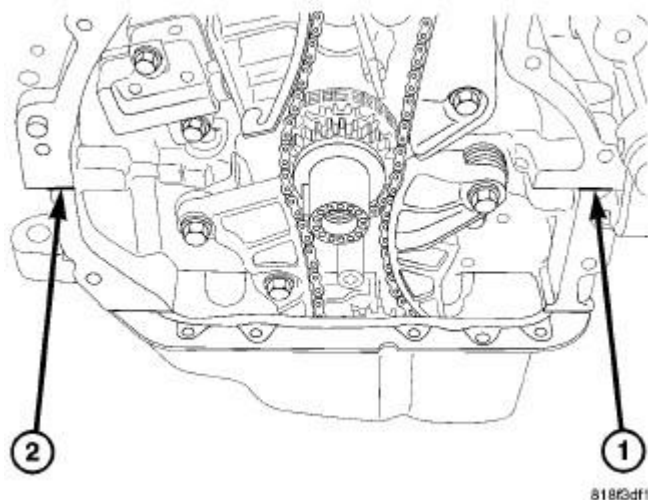


**Fig. 370: Applying Engine Sealant RTV (Or Equivalent) At Cylinder Head To Block Parting Line**  
 Courtesy of CHRYSLER LLC

**NOTE:** When using RTV, the sealing surfaces must be clean and free from grease and oil.

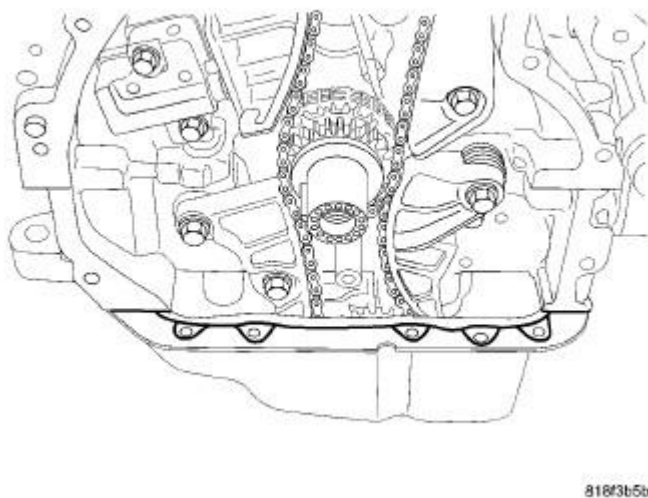
**NOTE:** When using RTV, parts should be assembled in 10 minutes and tighten to final torque within 45 minutes.

1. Clean all sealing surfaces. Refer to **Engine - Standard Procedure**.
2. Apply Mopar® engine sealant RTV (or equivalent) as shown in illustration at the cylinder head to block parting line (1, 2).



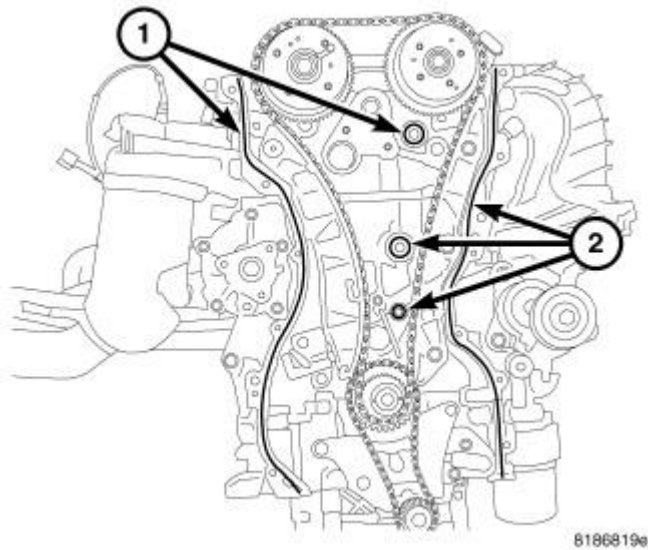
**Fig. 371: Applying Engine Sealant RTV (Or Equivalent) At Ladder Frame To Block Parting Line**  
Courtesy of CHRYSLER LLC

3. Apply Mopar® engine sealant RTV (or equivalent) as shown in illustration at the ladder frame to block parting line (1, 2).



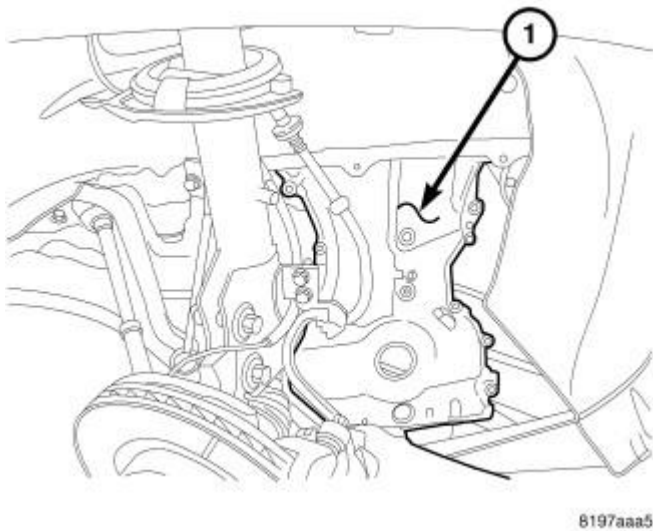
**Fig. 372: Applying Engine Sealant RTV (Or Equivalent) In Corner Of Oil Pan & Block**  
Courtesy of CHRYSLER LLC

4. Apply Mopar® engine sealant RTV (or equivalent) as shown in illustration in the corner of the oil pan and block.
5. Apply 2 mm bead of Mopar® engine sealant RTV (or equivalent) to the oil pan as shown in illustration.



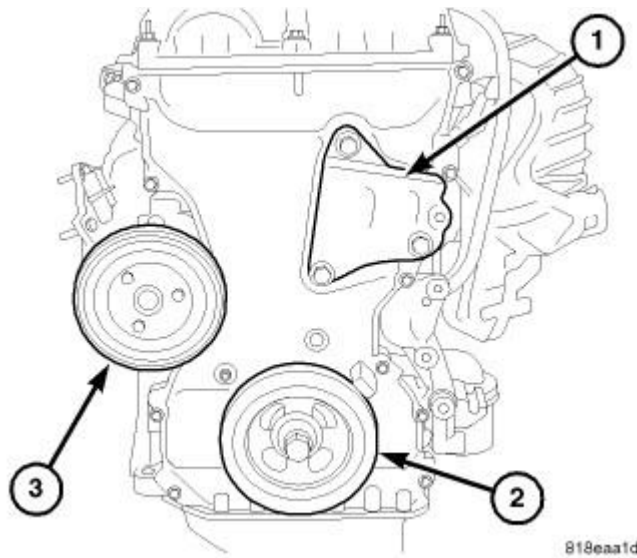
**Fig. 373: Timing Chain Cover Sealing**  
Courtesy of CHRYSLER LLC

6. Apply 2 mm bead of Mopar® engine sealant RTV (or equivalent) to the engine block (1, 2) as shown in illustration.



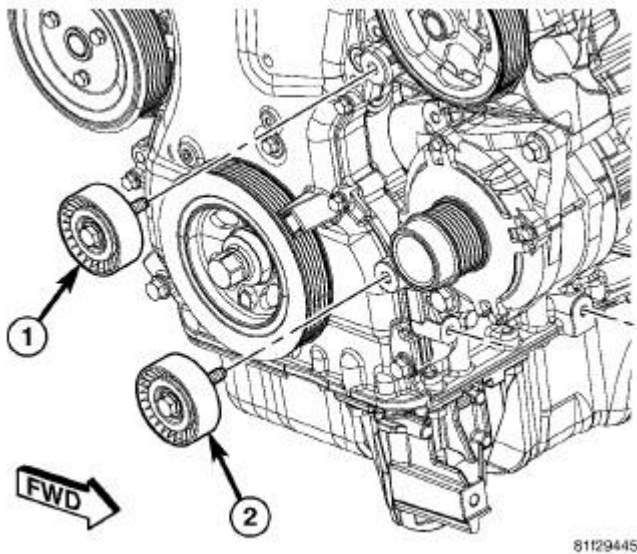
**Fig. 374: Timing Chain Cover Removal/Installation**  
Courtesy of CHRYSLER LLC

7. Install timing chain cover (1) upwards from under the vehicle.
8. Install timing chain cover upper retaining bolts and tighten M6 bolts to 9 N.m (80 in. lbs.) and M8 bolts to 26 N.m (230 in. lbs.).
9. Install accessory drive belt tensioner. Tighten bolt to 24 N.m (212 in. lbs.).



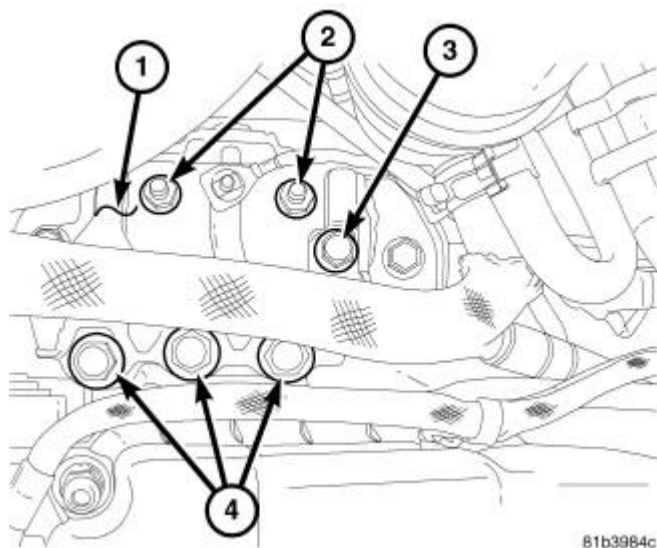
**Fig. 375: Engine Mount Support Bracket, Crankshaft Vibration Damper & Water Pump Pulley**  
Courtesy of CHRYSLER LLC

10. Install right engine mount bracket (1). Tighten bolts to 50 N.m (37 ft. lbs.).



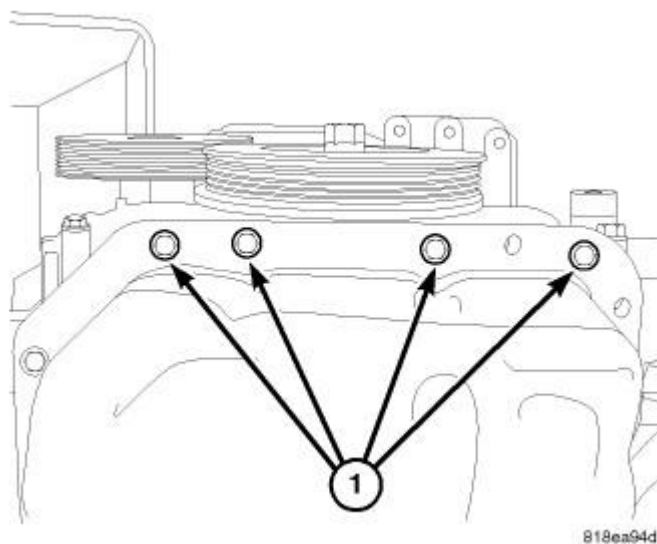
**Fig. 376: Removing/Installing Accessory Drive Belt Upper & Lower Idler Pulley**  
Courtesy of CHRYSLER LLC

11. Install accessory drive belt upper idler pulley (1). Tighten bolt to 48 N.m (35 ft. lbs.).



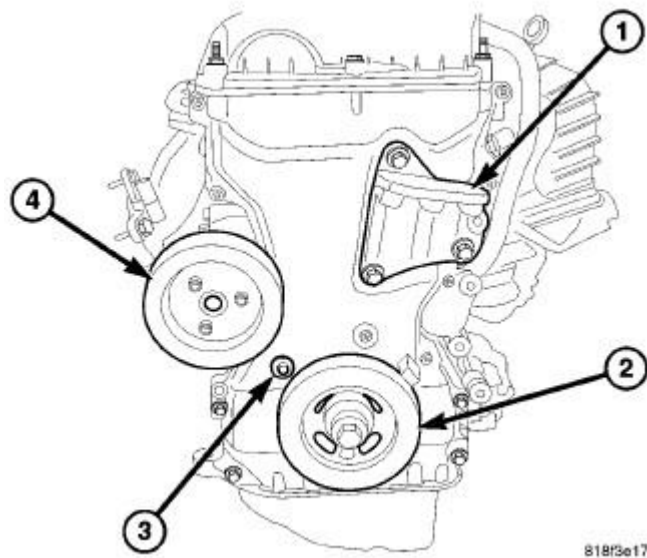
**Fig. 377: Power Steering Hose Hold Down, Right Engine Mount Bracket & Fasteners**  
Courtesy of CHRYSLER LLC

12. Position engine mount adapter (1) and install bolts (4).
13. Install retaining nuts (2) and tighten nuts (2) to 30 N.m (22 ft. lbs.).
14. Tighten bolts (4) to 50 N.m (37 ft. lbs.).
15. Remove jack from under engine.



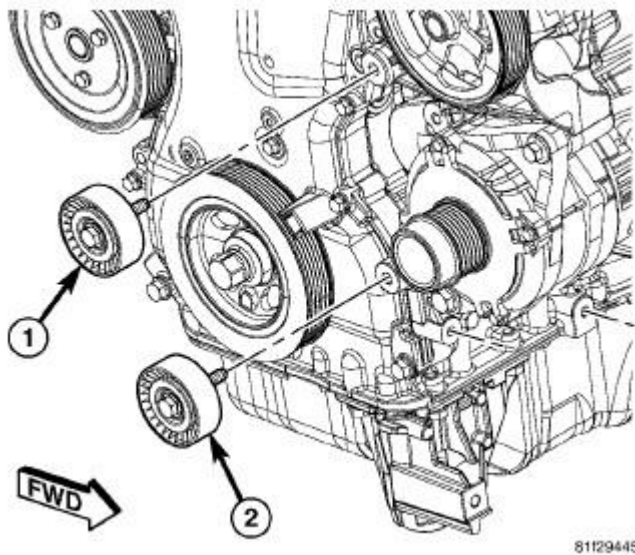
**Fig. 378: Oil Pan To Timing Chain Cover Lower Retaining Bolts**  
Courtesy of CHRYSLER LLC

16. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE**.
17. Install oil pan to timing chain cover lower retaining bolts (1) and tighten M6 bolts to 9 N.m (80 in. lbs.).



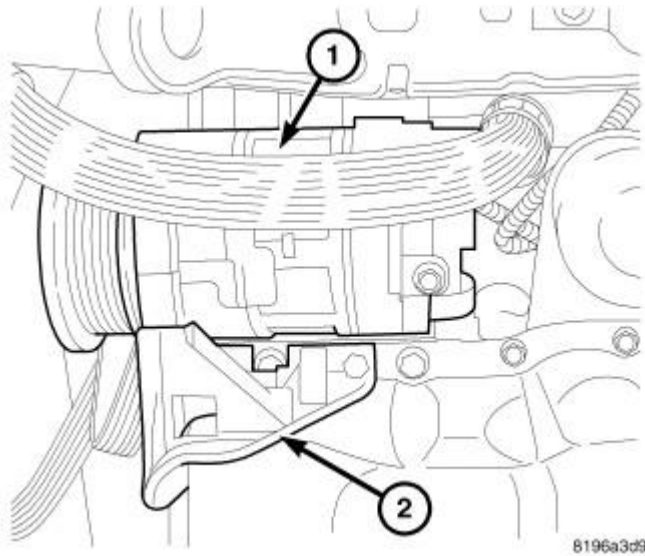
**Fig. 379: Right Side Engine Mount Bracket, Crankshaft Damper & Water Pump Pulley**  
Courtesy of CHRYSLER LLC

18. Install water pump pulley (4) and tighten three bolts to 9 N.m (80 in. lbs.).
19. Install crankshaft damper (2). Refer to **DAMPER, VIBRATION, INSTALLATION**.



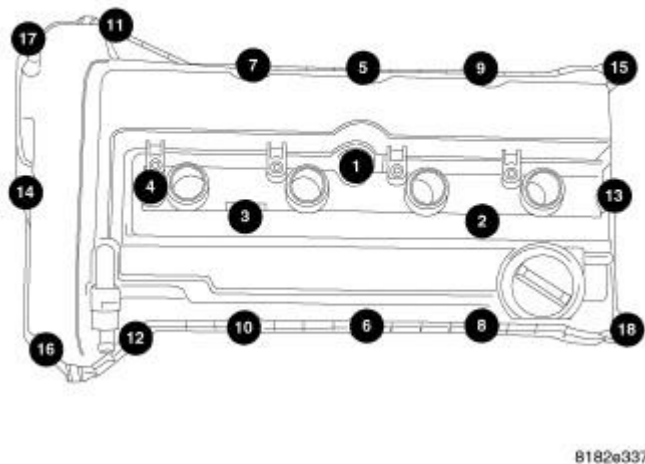
**Fig. 380: Removing/Installing Accessory Drive Belt Upper & Lower Idler Pulley**  
Courtesy of CHRYSLER LLC

20. Install accessory drive belt lower idler pulley (2). Tighten bolt to 48 N.m (35 ft. lbs.).



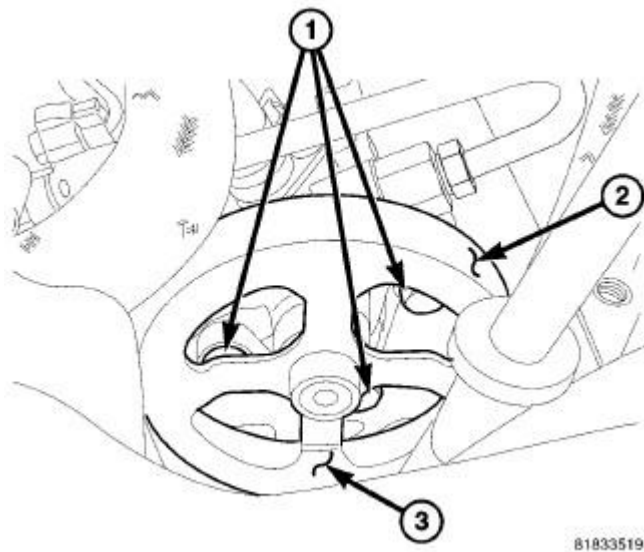
**Fig. 381: A/C Compressor & Bracket**  
Courtesy of CHRYSLER LLC

21. Install lower A/C compressor mounting bracket (2). Tighten the bolts to 24 N.m (18 ft. lbs.).
22. Install A/C compressor (1). Tighten the bolts to 25 N.m (18 ft. lbs.).
23. Install right lower splash shield. Refer to **SHIELD, SPLASH, FRONT WHEELHOUSE, INSTALLATION** and **SHIELD, SPLASH, REAR WHEELHOUSE, INSTALLATION**.
24. Lower vehicle.



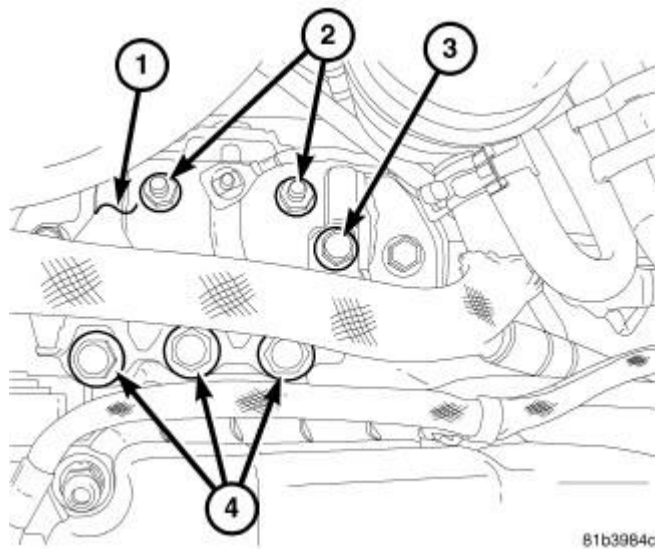
**Fig. 382: Remove/Install Cylinder Head Cover Bolts In Sequence**  
Courtesy of CHRYSLER LLC

25. Install cylinder head cover and ignition coils. Refer to **COVER(S), CYLINDER HEAD, INSTALLATION**.



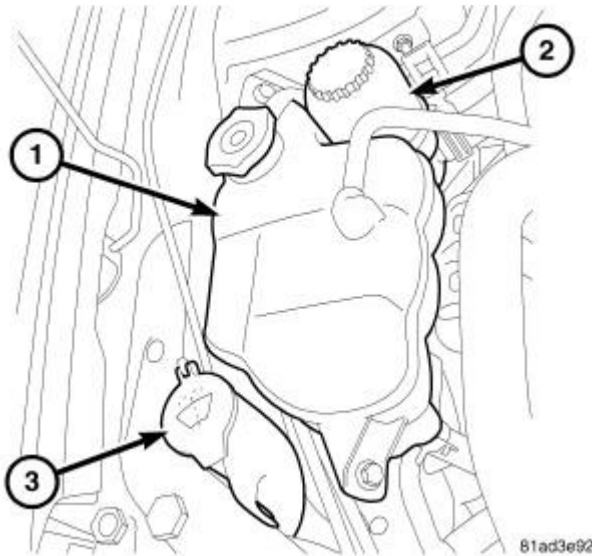
**Fig. 383: Power Steering Pump - Gas**  
Courtesy of CHRYSLER LLC

26. Place the power steering pump in mounting position. Install the three bolts (1) through openings in the pulley (3). Tighten the mounting bolts (1) to 26 N.m (19 ft. lbs.).



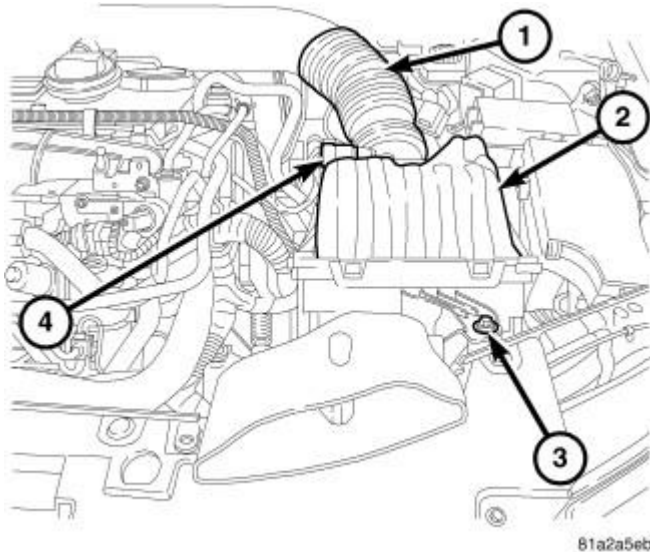
**Fig. 384: Power Steering Hose Hold Down, Right Engine Mount Bracket & Fasteners**  
Courtesy of CHRYSLER LLC

27. Install the power steering hose hold down (3).  
28. Install accessory drive belt. Refer to **BELT, SERPENTINE, INSTALLATION**.



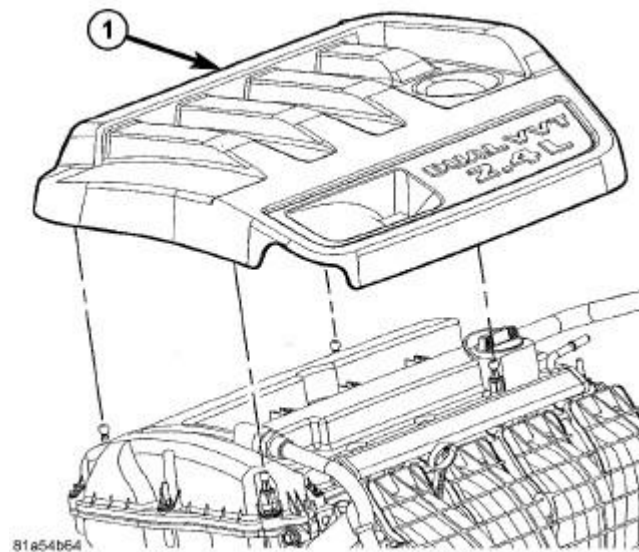
**Fig. 385: Coolant Reservoir, Power Steering Reservoir & Windshield Washer Bottle**  
Courtesy of CHRYSLER LLC

29. Install power steering pump reservoir (2). Tighten mounting screw to 12 N.m (106 in. lbs.).
30. Install coolant recovery reservoir (1). Tighten mounting bolts to 10 N.m (89 in. lbs.).



**Fig. 386: Air Cleaner Housing & Retaining Bolt**  
Courtesy of CHRYSLER LLC

31. Install clean air hose (1) and air cleaner housing (2). Refer to **BODY, AIR CLEANER, INSTALLATION**.
32. Connect negative battery cable.



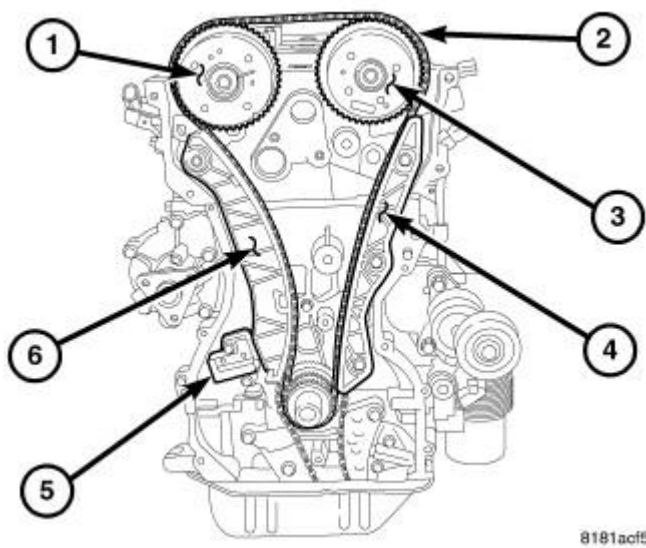
**Fig. 387: Engine Cover - 2.4L**  
Courtesy of CHRYSLER LLC

33. Operate engine until it reaches normal operating temperature. Check oil system for leaks and correct fluid level.
34. Install engine cover (1).

## TENSIONER, ENGINE TIMING

### REMOVAL

### REMOVAL



**Fig. 388: Timing Drive System**  
Courtesy of CHRYSLER LLC

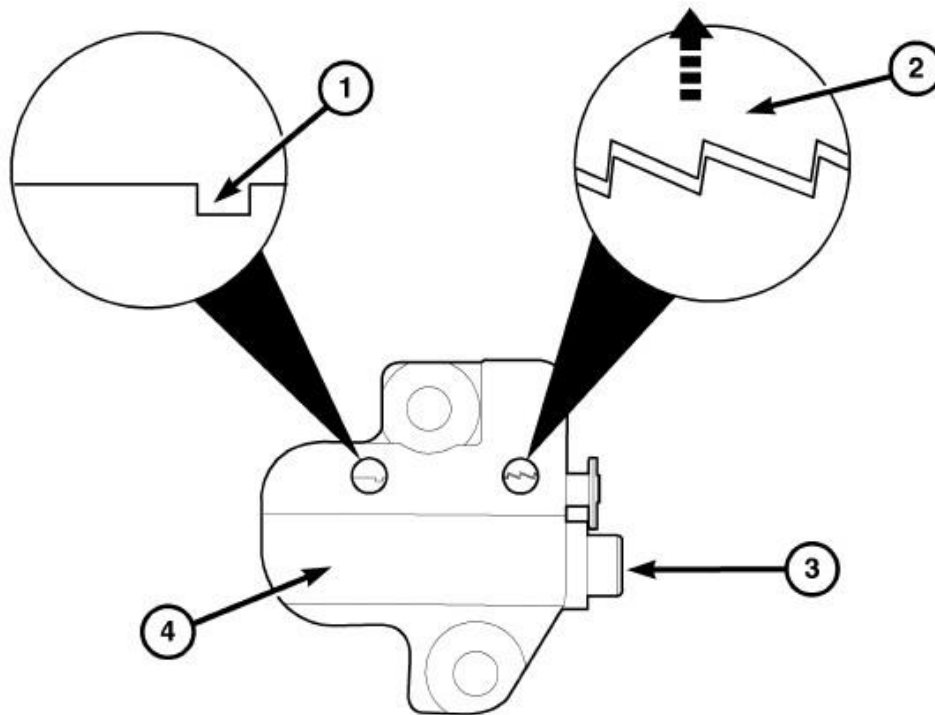
1. Remove the engine timing cover. Refer to COVER(S), ENGINE TIMING, REMOVAL.

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

2. Remove timing chain tensioner retaining bolts and remove tensioner (5).

## INSTALLATION

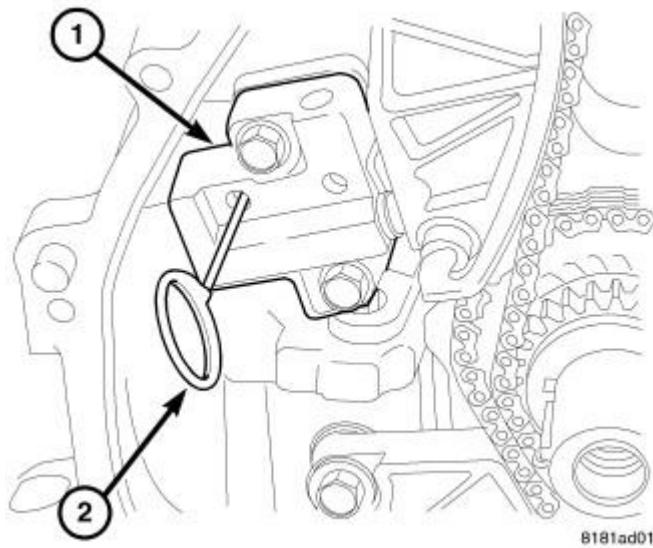
## INSTALLATION



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**Fig. 389: Tensioner Reset**  
Courtesy of CHRYSLER LLC

1. Reset timing chain tensioner (4) by lifting up on ratchet (2) and pushing plunger (3) inward towards the tensioner body (4). Insert Tensioner Pin (special tool #8514, Pins, Tensioner) into slot (1) to hold tensioner plunger in the retracted position.



**Fig. 390: Timing Chain Tensioner & Pin**  
Courtesy of CHRYSLER LLC

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

2. Install timing chain tensioner (1) and tighten bolts to 12 N.m (105 in. lbs.).
3. Remove timing Tensioner Pin (special tool #8514, Pins, Tensioner) (2).
4. Install the engine timing cover. Refer to **COVER(S), ENGINE TIMING, INSTALLATION**.