**2014 ENGINE**

**2.4L - Service Information - Dart**

# DESCRIPTION

## DESCRIPTION

The 2.4 Liter (146 cu. in.) in-line four cylinder engine is a single over head camshaft with mechanical lash adjusters 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.

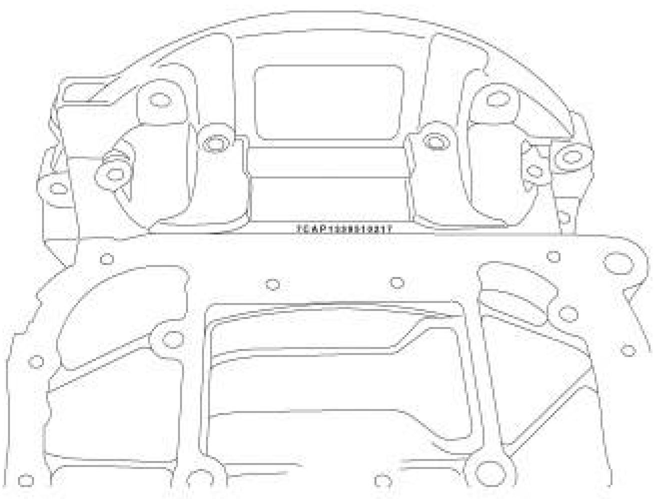


**Fig. 1: Serial Number Location**
**Courtesy of CHRYSLER GROUP, LLC**

The engine serial number is located on the rear of the cylinder block. The serial number contains engine build date information.

# DIAGNOSIS AND TESTING

## ENGINE DIAGNOSIS - 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 performance (e.g. engine idles rough and stalls) or mechanical (e.g. a strange noise).

Refer to **PERFORMANCE DIAGNOSTIC TABLE** and **ENGINE MECHANICAL DIAGNOSTIC**

**TABLE** for possible causes and corrections of malfunctions. . Refer to the **FUEL SYSTEM** article for the fuel system diagnosis.

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

- Cylinder Compression Pressure Test. Refer to **CYLINDER COMPRESSION PRESSURE LEAKAGE** .
- Cylinder Combustion Pressure Leakage Test. Refer to **CYLINDER COMBUSTION PRESSURE LEAKAGE** .
- Engine Cylinder Head Gasket Failure Diagnosis. Refer to **CYLINDER HEAD - DIAGNOSIS AND TESTING** .
- Intake Manifold Leakage Diagnosis. Leakage diagnosis is not available from manufacturer.

**PERFORMANCE DIAGNOSTIC TABLE**

| CONDITION | POSSIBLE CAUSE | CORRECTION |
|---|---|---|
| ENGINE WILL NOT START | 1. Weak battery. | 1. Test battery. Charge or replace as necessary. Refer to **DIAGNOSIS AND TESTING** . |
| | 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 **SPARK PLUG** . |
| | 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) |
| | 2. Incorrect fuel mixture. | 2. (Refer to Appropriate Diagnostic Information) |
| | 3. Intake manifold leakage. | 3. Inspect intake manifold, |

 

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| | | 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). **2.0L Only** | 5. Remove OCV and inspect for contamination. Replace OCV if contaminated. **2.0L Only** |
| 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 **DIAGNOSIS AND TESTING** . |
| | 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) |

 

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| | 4. Contamination in fuel system. | 4. Clean system and replace fuel filter. |

**ENGINE MECHANICAL DIAGNOSTIC TABLE**

| CONDITION | POSSIBLE CAUSES | CORRECTIONS |
|---|---|---|
| NOISY VALVES | 1. High or low oil level in crankcase. | 1. Refer to **OIL - STANDARD PROCEDURE** . |
| | 2. Thin or diluted oil. | 2. Change oil and filter. |
| | 3. Low oil pressure. | 3. Check oil pump, if OK, check rod and main bearings for excessive wear. |
| | 4. Dirt in lash adjusters. | 4. Replace as necessary. |
| | 5. Worn rocker arms. | 5. Replace as necessary. |
| | 6. Worn lash adjusters | 6. Replace as necessary. |
| | 7. Worn valve guides. | 7. Inspect the valve guides for wear, cracks or looseness. If either condition exists, replace the cylinder head. Refer to **CYLINDER HEAD - REMOVAL** . |
| | 8. Excessive runout of valve seats on valve faces. | 8. Refer to **VALVES, INTAKE AND EXHAUST - STANDARD PROCEDURE** . |
| CONNECTING ROD NOISE | 1. Insufficient oil supply. | 1. Refer to **OIL - STANDARD PROCEDURE** . |
| | 2. Low oil pressure. | 2. Check oil pump, if OK, check rod and main bearings for excessive wear. |
| | 3. Thin or diluted oil. | 3. Change oil and filter. |
| | 4. Excessive bearing clearance. | 4. Replace as necessary. |
| | 5. Connecting rod journal out-of-round. | 5. Service or replace crankshaft. |
| | 6. Misaligned connecting rods. | 6. Replace bent connecting rods. |
| MAIN BEARING NOISE | 1. Insufficient oil supply. | 1. Refer to **OIL - STANDARD PROCEDURE** . |
| | 2. Low oil pressure. | 2. Check oil pump, if OK, check rod and main bearings for excessive wear. |
| | 3. Thin or diluted oil. | 3. Change oil and filter. |
| | 4. Excessive bearing clearance. | 4. Replace as necessary. |
| | 5. Excessive end play. | 5. Check thrust washers for wear. |
| | 6. Crankshaft journal out-of round. | 6. Service or replace crankshaft. |
| | 7. Loose flywheel or torque | 7. Tighten to correct torque |

 

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| | converter. | |

## CYLINDER COMPRESSION PRESSURE LEAKAGE

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

**NOTE: 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. Clean the spark plug recesses with compressed air.
2. Remove the spark plugs and record the cylinder number of each spark plug for future reference.
3. Inspect the spark plug electrodes for abnormal firing indicators such as fouled, hot, oily, etc.
4. Disable the fuel system and perform the fuel system pressure release procedure. Refer to **FUEL DELIVERY, GAS - STANDARD PROCEDURE** .
5. Insert a compression pressure gauge and rotate the engine with the engine starter motor for three revolutions.
6. Record the compression pressure on the 3rd revolution. Continue the test for the remaining cylinders.

    **NOTE: 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.**

7. Compression should not be less than 689 kPa (100 psi) and not vary more than 25 percent from cylinder to cylinder.
8. If one or more cylinders have abnormally low compression pressures, repeat the compression test.

    **NOTE: 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.**

9. If one or more cylinders continue to have abnormally low compression pressures, perform the cylinder combustion pressure leakage test. Refer to **CYLINDER COMBUSTION PRESSURE LEAKAGE** .

## CYLINDER COMBUSTION PRESSURE LEAKAGE

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.

1. Check the coolant level and fill as required. DO NOT install the radiator cap.
2. Start and operate the engine until it attains normal operating temperature, then turn the engine OFF.
3. Remove the spark plugs.
4. Remove the oil filler cap.
5. Remove the air cleaner hose.
6. 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 and 552 kPa (80 psi) recommended.
7. Perform the test procedures on each cylinder according to the tester manufacturer's instructions. Set piston of cylinder to be tested at TDC compression. While testing, listen for pressurized air escaping through the throttle body, tailpipe and oil filler cap opening. Check for bubbles in the radiator coolant.

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

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

**CYLINDER COMBUSTION PRESSURE LEAKAGE DIAGNOSIS CHART**

| CONDITION | POSSIBLE CAUSE | CORRECTION |
|---|---|---|
| AIR ESCAPES THROUGH THROTTLE BODY | Intake valve bent, burnt, or not seated properly | Inspect valve and valve seat. Reface or replace, as necessary. Inspect valve springs. Replace as necessary. |
| AIR ESCAPES THROUGH TAILPIPE | Exhaust valve bent, burnt, or not seated properly | Inspect valve and valve seat. Reface or replace, as necessary. Inspect valve springs. Replace as necessary. |
| AIR ESCAPES THROUGH RADIATOR | Head gasket leaking or cracked cylinder head or block | Remove cylinder head and inspect. Replace defective part |
| MORE THAN 50% LEAKAGE FROM ADJACENT CYLINDERS | Head gasket leaking or crack in cylinder head or block between adjacent cylinders | Remove cylinder head and inspect. Replace gasket, head, or block as necessary |
| MORE THAN 25% LEAKAGE AND AIR ESCAPES THROUGH OIL FILLER CAP OPENING ONLY | Stuck or broken piston rings; cracked piston; worn rings and/or cylinder wall | Inspect for broken rings or piston. Measure ring gap and cylinder diameter, taper and out-of-round. Replace defective part as necessary |

**OIL CONSUMPTION TEST AND DIAGNOSIS**

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 test and cylinder leak down 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.

   If equipped with an engine driven vacuum pump, high oil consumption can be caused by unchecked airflow into the pump. This can be caused by anything that opens the vacuum pump intake port up to the atmosphere such as a faulty vacuum pump, hose fitting, hose and brake booster. If there is not a restriction (normally caused by the pump pulling vacuum on the brake booster), then the vacuum pump will pump a high volume of air. This high volume of air will pressurize the crankcase and cause excessive oil burning and oil flow through the PCV system.

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 LUBRICATION DIAGNOSTIC TABLE**

| CONDITION | POSSIBLE CAUSES | CORRECTION |
|---|---|---|
| OIL LEAKS | 1. Gaskets and O-rings. Misaligned or damaged. | 1. Replace as necessary. |
| | (a) Loose fasteners, broken or porous metal parts. | (a) Tighten fasteners, Repair or replace metal parts. |
| | 2. Crankshaft rear oil seal. | 2. Replace rear crankshaft oil seal. Refer to **SEAL, CRANKSHAFT OIL, REAR - REMOVAL** . |
| | 3. Crankshaft rear oil seal surface. Scratched, nicked or grooved. | 3. Polish or replace crankshaft. |
| | 4. Oil pan flange cracked. | 4. Replace oil pan. Refer to **PAN, OIL - REMOVAL** . |
| | 5. Crankshaft front oil seal. | 5. Replace front crankshaft oil seal. Refer to **SEAL, CRANKSHAFT OIL, FRONT - REMOVAL** . |
| | 6. Crankshaft front oil seal surface. Scratched, nicked or grooved. | 6. Polish or replace crankshaft. |
| OIL PRESSURE DROP | 1. Low oil level. | 1. Check and correct oil level. |
| | 2. Faulty oil pressure switch. | 2. Replace switch. Refer to **SENSOR, OIL PRESSURE - REMOVAL** . |
| | 3. Low oil pressure. | 3. Check main bearing clearance. Refer to **BEARING(S), CRANKSHAFT, MAIN - STANDARD PROCEDURE** .<br>3. Check rod bearing clearance. Refer to **BEARING(S), CONNECTING ROD - STANDARD PROCEDURE** . |
| | 4. Clogged oil filter. | 4. Replace oil filter. Refer to **FILTER, ENGINE OIL - REMOVAL** . |
| | 5. Worn oil pump. | 5. Replace oil pump. Refer to |

 

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| | | **PUMP, ENGINE OIL - REMOVAL** . |
| | 6. Thin or diluted oil. | 6. Change oil and filter. Refer to **OIL - STANDARD PROCEDURE** . |
| | 7. Excessive bearing clearance. | 7. Replace crankshaft bearings. Refer to **BEARING(S), CRANKSHAFT, MAIN - STANDARD PROCEDURE** .<br>7. Replace rod bearings. Refer to **BEARING(S), CONNECTING ROD - STANDARD PROCEDURE** . |
| | 8. Oil pump relief valve stuck. | 8. Replace oil pump. Refer to **PUMP, ENGINE OIL - REMOVAL** . |
| | 9. Oil pump pick-up tube loose, damaged or clogged. | 9. Replace oil pump pick-up. |
| OIL PUMPING AT RINGS; SPARK PLUGS FOULING | 1. Worn or damaged rings. | 1. Hone cylinder bores and replace rings. Refer to **RING(S), PISTON - STANDARD PROCEDURE** . |
| | 2. Carbon in oil ring slots. | 2. Replace rings. Refer to **ROD, PISTON AND CONNECTING - REMOVAL** . |
| | 3. Worn valve guides. | 3. Replace cylinder heads. Refer to **CYLINDER HEAD - REMOVAL** . |
| | 4. Leaking valve guide seals. | 4. Replace valve guide seals. Refer to **SEAL(S), VALVE GUIDE - REMOVAL** . |

## STANDARD PROCEDURE

### DUST COVERS AND CAPS

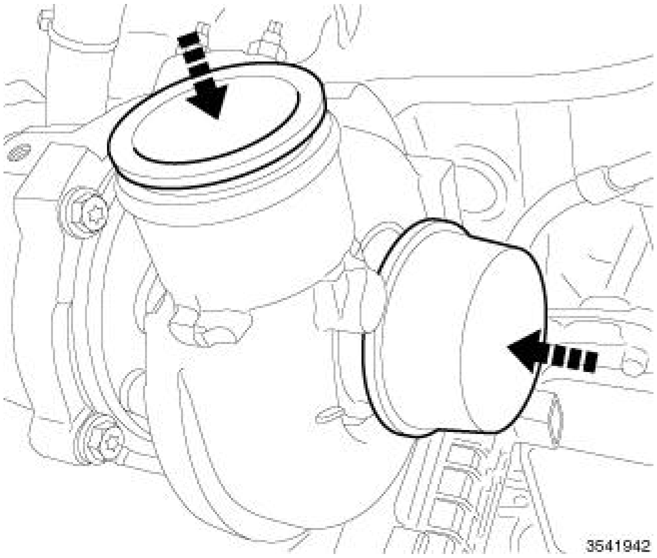


**Fig. 2: Covers/Caps**
**Courtesy of CHRYSLER GROUP, LLC**

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.

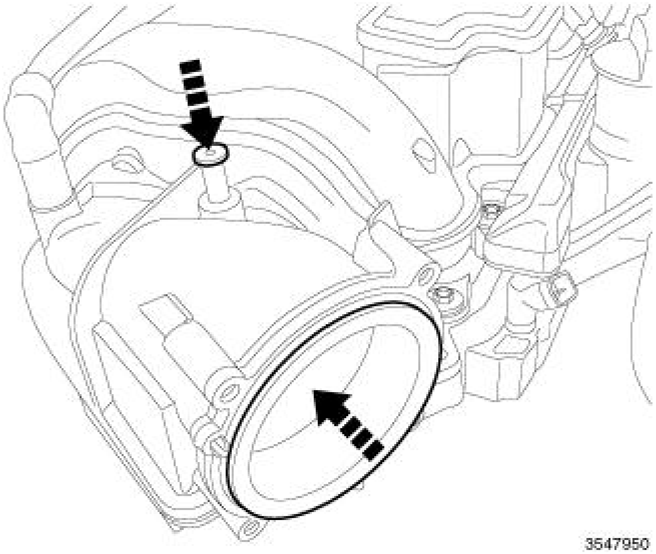


**Fig. 3: Opening Cover**
**Courtesy of CHRYSLER GROUP, LLC**

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.

**REPAIR DAMAGED OR WORN THREADS**

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

Damaged or worn 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.
- Installing an insert into the tapped hole to bring the hole back to its original thread size.

**FORM-IN-PLACE GASKETS AND SEALERS**

**NOTE: All of the sealants mentioned below are not used on every engine, they are listed as a general reference guide. See appropriate 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** be 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 within 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® THREEBOND ENGINE RTV SEALANT** is a unique gasket material that is specially made to retain adhesion and sealing properties when used to seal components exposed to engine oil.

**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® Threebond Engine RTV Sealant gasket material should be applied in a continuous bead approximately 3 mm (0.120 in.) in diameter. The gasket surfaces should be cleaned with isopropyl alcohol wipes in preparation for sealant application. 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 assembled within 20 minutes and torqued in place within 45 minutes. The usage of a locating dowel is recommended during assembly to prevent smearing material off the location.

## ENGINE GASKET SURFACE PREPARATION

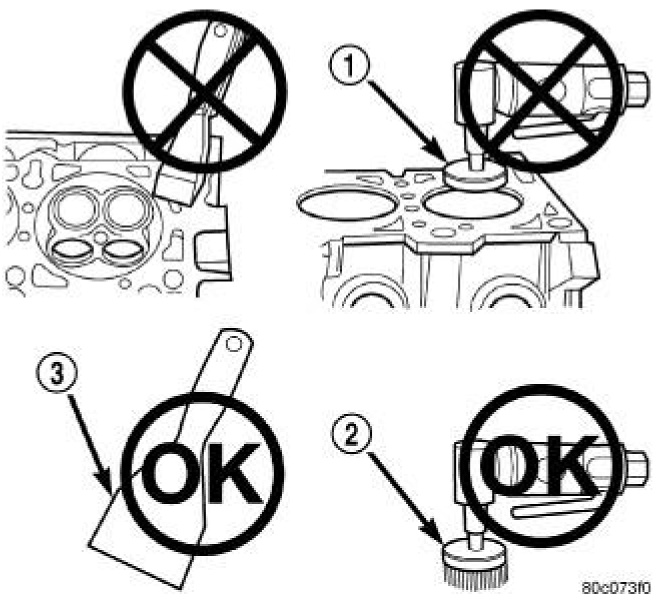


**Fig. 4: Proper Tool Usage For Surface Preparation**
**Courtesy of CHRYSLER GROUP, LLC**

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

**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 (3).
- Drill motor with 3M Roloc™ Bristle Disc (white or yellow) (2).

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

# SPECIFICATIONS

## ENGINE SPECIFICATIONS

### GENERAL SPECIFICATIONS

| DESCRIPTION | SPECIFICATION | |
|---|---|---|
| | Metric | Standard |
| Type | In-Line OHV, SOHC | |
| Number of Cylinders | 4 | |
| Firing Order | 1-3-4-2 | |
| Compression Ratio | 10.5:1 | |
| Displacement | 2.4 L | 146 cu. in. |
| Bore | 86 mm | 3.386 in. |
| Stroke | 86 mm | 3.386 in. |
| Compression Pressure | 1172 - 1551 kPa | 170 - 225 psi |
| Max. Variation Between Cylinders | 25% | |

### CYLINDER BLOCK

| DESCRIPTION | SPECIFICATION | |
|---|---|---|
| | Metric | Standard |
| Material | Cast Aluminum | |
| **Cylinder Bore Diameter** | | |
| A | 86.0 - 86.010 mm | 3.3858 - 3.3862 in. |
| | | |

| | | |
|---|---|---|
| B | 86.010 - 86.020 mm | 3.3862 - 3.3866 in. |
| C | 86.020 - 86.030 mm | 3.3866 - 3.3869 in. |
| Cylinder Bore Out-of-Round (Max.) | 0.020 mm | 0.0008 in. |
| Cylinder Bore Taper (Max.) | 0.028 mm | 0.001 in. |
| Deck Surface Flatness (Max.) | 0.0254 mm | .001 in. |
| **Main Bearing Bore Diameter** | | |
| 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 |
| **Piston Diameter** | | |
| A | 85.995 - 86.015 mm | 3.3856 - 3.3864 in. |
| B | 86.005 - 86.025 mm | 3.3860 - 3.3868 in. |
| C | 86.015 - 86.035 mm | 3.3864 - 3.3872 in. |
| Clearance to Bore | (-0.015) - 0.015 mm | (-0.0006) - 0.0006 in. |
| Weight | 345 - 355 grams | 12.17 - 12.52 oz. |
| Land Clearance (Diametrical) | 0.60 - 0.73 mm | 0.0236 - 0.0287 in. |
| Piston Length | 49.0 mm | 2.929 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. |
| 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 | 0.001 - 0.002 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 | | 0.0039 - 0.0098 in. |
| Wear Limit | | |
| DESCRIPTION | SPECIFICATION | |
| | Metric | Standard |
| Bearing Clearance | 0.032 - 0.060 mm | 0.001 - 0.002 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 - 0.0098 in. |
| Wear Limit | 0.27 mm | 0.0106 in. |
| Weight - Total (Less Bearing) | 490 grams | 17.28 oz. |

**CRANKSHAFT**

| DESCRIPTION | SPECIFICATION | |
|---|---|---|
| | Metric | Standard |
| **Connecting Rod Journal Diameter** | | |
| **Journal Grade** | | |
| 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. |
| **Main Bearing Journal Diameter** | | |
| **Journal Grade** | | |
| 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. |
| 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 |
| **Cam Bearing Bore** | | |
| Cam Bearing Bore | 24.000 - 24.021 mm | 0.9448 - 0.9457 in. |

**CAMSHAFT**

| DESCRIPTION | SPECIFICATION | |
|---|---|---|
| | Metric | Standard |
| **Cam Journal Diameter** | | |
| Cam Journal Diameter | 23.954 - 23.970 mm | 0.943 - 0.944 in. |
| **Bearing Clearance - Diametrical** | | |
| Cam Journal Clearance | 0.020 - 0.067 mm | 0.0008 - 0.0026 in. |
| End Play | 0.11 - 0.25 mm | 0.004 - 0.009 in. |
| **Max Lift @ 0.2mm (0.007 in.) lash** | | |
| Intake | 9.2 mm | 0.362 in. |
| **Max Lift @ 0.28mm (0.011 in.) lash** | | |
| Exhaust | 8.42 mm | 0.331 in. |
| **Intake Valve Timing** | | |
| Closes (ABDC) | Control By VVAA | |
| Opens (ATDC) | Control By VVAA | |
| Duration | Control By VVAA | |
| **Exhaust Valve Timing** | | |
| Closes (BTDC) | 8.45° | |
| Opens (BBDC) | 45° | |
| Duration | 216.55° | |
| Valve Overlap @ 0.5mm (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**

| 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. |
| Flatness (Head Gasket Surface) | .05 mm | .002 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. |
| **Valve Seat Width** | | |
| 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. |
| **Valve Lash** | | |
| Intake | 0.17 - 0.23 mm | 0.006 - 0.009 in. |
| Exhaust | 0.27 - 0.33 mm | 0.010 - 0.012 in. |
| **Valve Length (Overall)** | | |
| Intake | 113.18 mm | 4.455 in. |
| Exhaust | 105.887 mm | 4.168 in. |
| **Valve Stem Diameter** | | |
| Intake | 5.465 - 5.480 mm | 0.2151 - 0.2157 in. |
| 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 ± 9 @ 35.0 mm | 40.35 lbs. @ 1.38 in. |
| Nominal Force (Valve Open) | 364.8 N ± 17 N @ 29.25 mm | 82.01 lbs. ± 3.82 lbs. @ 1.152 in. |
| Installed Height | 35.00 mm | 1.378 in. |
| Number of Coils | 8.5 ± 0.1 | |
| Wire Diameter | 2.90 mm ± 0.03 | 0.114 in ± 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. |
| **CAUTION:** ***If pressure is ZERO at curb idle, DO NOT run engine at 3000 RPM.** | | |

**TORQUE SPECIFICATIONS**

| DESCRIPTION | N.m | Ft. Lbs. | In. Lbs. |
|---|---|---|---|
| Balance Shaft Module | Refer to tightening sequence Procedure under **PUMP, ENGINE OIL - INSTALLATION** | | |

 

| | | | |
|---|---|---|---|
| Bell Housing-Bolts | 50 | 36 | - |
| Camshaft Sprocket-Bolt | 10 + 65° | - | 89 + 65° |
| Camshaft Bearing Cap-Bolts<br>Coils | 15<br>8 | -<br>- | 133<br>71 |
| Connecting Rod Cap-Bolts | 20 + 90° | 15 + 90° | - |
| Coolant Temperature Sender | 50 | 36 | - |
| Crankshaft Main Bearing Cap-Bolts | Refer to tightening sequence Procedure under **CRANKSHAFT - INSTALLATION** | | |
| Crankshaft Damper-Bolt | 210 | 155 | - |
| Cylinder Head-Bolts | Refer to tightening sequence Procedure under **CYLINDER HEAD - INSTALLATION** | | |
| Cylinder Head Cover-Bolts | 10 | - | 90 |
| Engine Support Bracket-Bolts | Refer to appropriate Service Information Procedure under **ENGINE MOUNTING** | | |
| Exhaust Manifold-Bolts | 34 | 25 | - |
| Exhaust Manifold Heat Shield-Bolts<br>Flex Plate to Crankshaft-Bolts | 12<br>95 | <br>70 | 105<br>- |
| Intake Manifold-Bolts | 12 | 9 | - |
| Intake Manifold Silencer Cover-Bolts | 2.5 | - | 22 |
| Ladder Frame-Bolts | Refer to tightening sequence Procedure under **FRAME, LADDER - INSTALLATION** | | |
| Multi Air Fill Port Plug | 19 | 14 | |
| Oil Cooler Connector-Bolt | 49 | 36 | - |
| Oil Filter | 14 | 10 | - |
| Oil Filter Adapter | 49 | 36 | - |
| Oil Jet Fastener | 12 | - | 105 |
| Oil Pan-Bolts | | | |
| M6 Bolts | 12 | - | 105 |
| M8 Bolts | 22 | - | 195 |
| Oil Pan Drain-Plug | 40 | 30 | - |
| Oil Pressure Switch | 48 | 35 | - |
| Oil Temperature Sensor | 48 | 35 | - |
| PCV Valve | 4 | - | 35 |
| Spark Plugs | 27 | 20 | - |
| Thermostat Housing-Bolts | 9 | | 80 |
| Timing Chain Cover-Bolts | | | |
| M10 Bolts<br>M6 Bolts | 65<br>9 | 48<br>- | -<br>80 |
| M8 Bolts | 26 | 19 | - |
| Timing Chain Tensioner Assembly-Bolts | 12 | - | 105 |
| Timing Chain Guide-Bolts (stationary guide) | 12 | - | 106 |
| Timing Chain Guide-Bolts (pivoting guide) | 28 | 21 | - |

 

| | | | |
|---|---|---|---|
| Timing Chain Tensioner-Bolts | 9 | - | 80 |
| Vacuum Pump-Bolts | 20 | 15 | |

# REMOVAL

## REMOVAL

**CAUTION: If the original engine has experienced a catastrophic failure or an individual failure with the piston, cylinder bore, engine block, valve or valve seat, the intake manifold MUST be replaced with a new manifold.**

1. Release the fuel pressure. Refer to **FUEL DELIVERY, GAS , STANDARD PROCEDURE** .
2. Disconnect the battery negative cable.
3. Secure the steering wheel.
4. Remove the steering coupler bolt. Position the shaft out of the way.
5. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .
6. Drain the coolant.
7. Remove the battery. Refer to **BATTERY, REMOVAL** .
8. Remove the PCM. Refer to **MODULE, POWERTRAIN CONTROL, REMOVAL** .
9. Disconnect the heater core supply and return hoses at the fittings nearest the thermostat housing.
10. Remove the bolt securing the heater supply pipe at the left engine mount bracket.
11. Disconnect the heater hose at the thermostat outlet connector.
12. Separate the wire harness retainers at the transmission bell housing.
13. Loosen the upper starter bolt completely.

**NOTE: The upper bolt will not back out completely due to lack of clearance. Leave the bolt in the bell housing.**

14. Release the PDC locking tabs. Position the PDC aside and secure the assembly with an elastic strap to prevent dame during repairs.
15. Remove the engine cover.

 

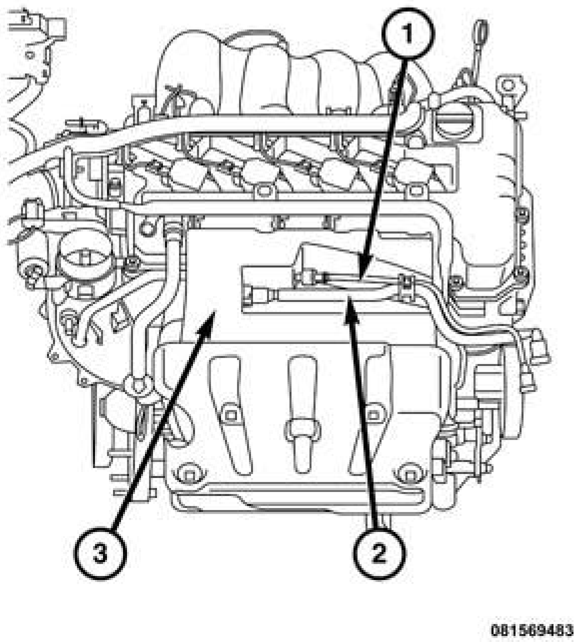


**Fig. 5: Foam Insulator, Fuel Line & Purge Line**
**Courtesy of CHRYSLER GROUP, LLC**

16. Disconnect the fuel line (1) and the purge line (2) quick connects.
17. Disconnect the positive and negative battery cables.

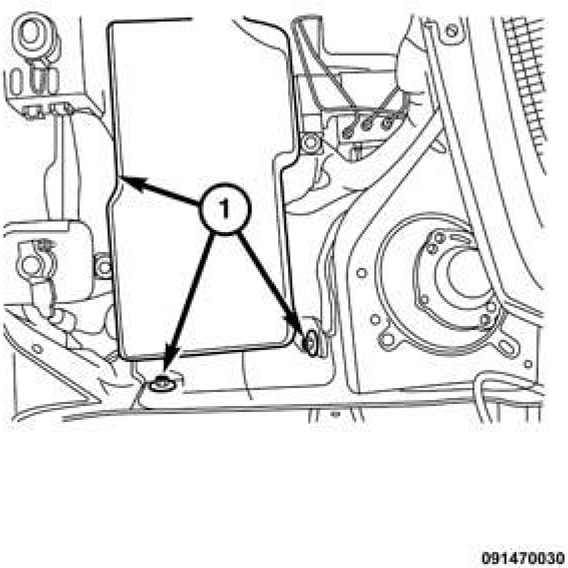


**Fig. 6: PDC Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

18. Remove the three bolts (1) that secure the PDC.

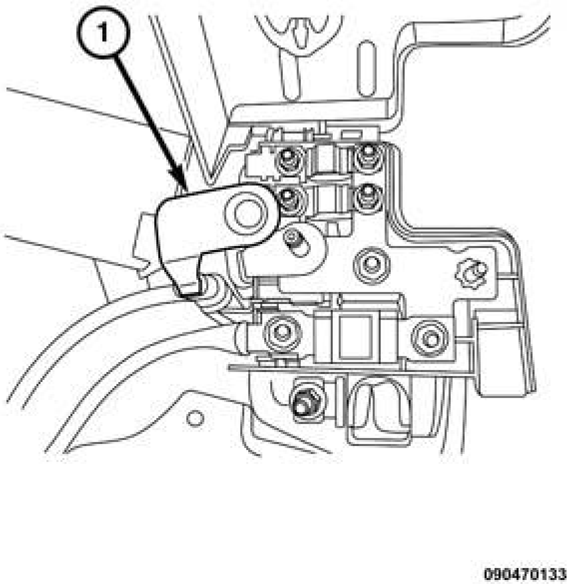


**Fig. 7: Starter Connector**
**Courtesy of CHRYSLER GROUP, LLC**

19. Remove the starter connector (1) at the power block.

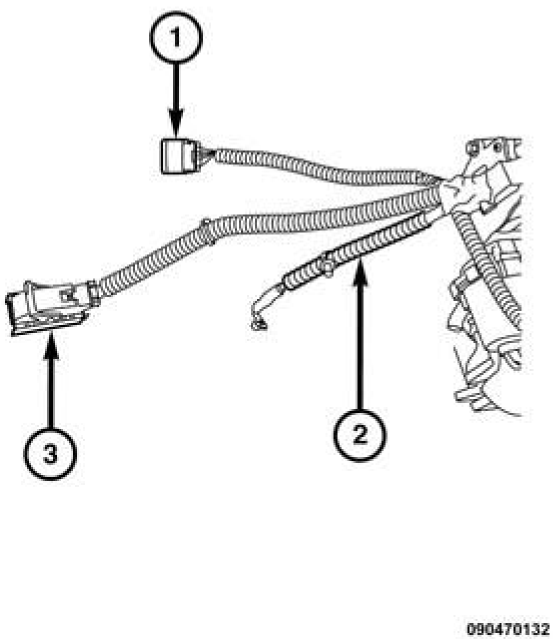


**Fig. 8: Intermediate Connector, Generator Feed Connector & PCM Connector**

**Courtesy of CHRYSLER GROUP, LLC**

20. Disconnect the intermediate connector (1), the generator feed connector (2) and the PCM connector (3).
21. Remove the battery. Refer to **BATTERY, REMOVAL** .
22. Recover the air conditioning system. Refer to **PLUMBING, STANDARD PROCEDURE** .
23. Drain the cooling system. Refer to **STANDARD PROCEDURE** .
24. Remove the bolt holding the windshield washer reservoir to the battery tray.
25. Release the retainer from the harness at the bottom of the battery tray.
26. Remove the battery tray. Refer to **TRAY, BATTERY, REMOVAL** .
27. Remove the fresh air hose from valve cover.
28. Raise and support the vehicle.
29. Remove the front tire and wheel assemblies.
30. Remove the left and right axle shafts. Refer to **REMOVAL** .
31. Separate the lower control arm from the knuckle by prying down with the pry bar.
32. Remove the left and right wheel well liners.
33. Remove the Belly pan. Refer to **BELLY PAN, REMOVAL** .
34. Remove the front closeout panel.
35. Remove the upper radiator hose.
36. Remove the radiator hoses at the crossover pipe.
37. Remove the crossover pipe bolts. Remove crossover pipe.
38. Remove the lower radiator hose.
39. Remove the radiator fan assembly. Refer to **FAN, COOLING, REMOVAL** .

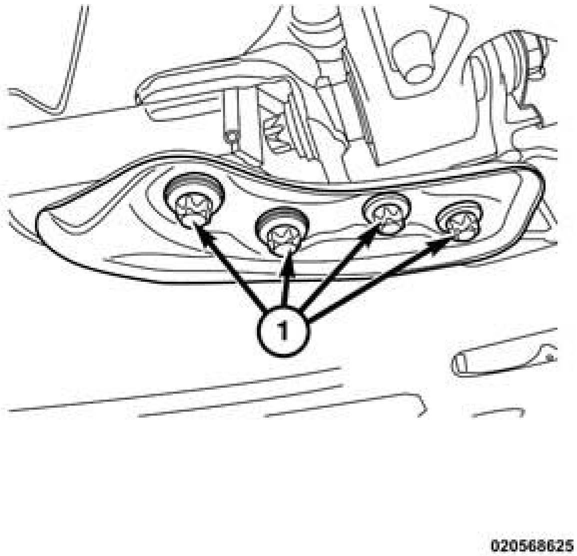

**Fig. 9: Crossmember To Fascia Support Beams Bracket Retaining Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

40. Remove the four bracket retaining bolts (1) from the cross member to fascia support beams bracket, then remove the bracket.

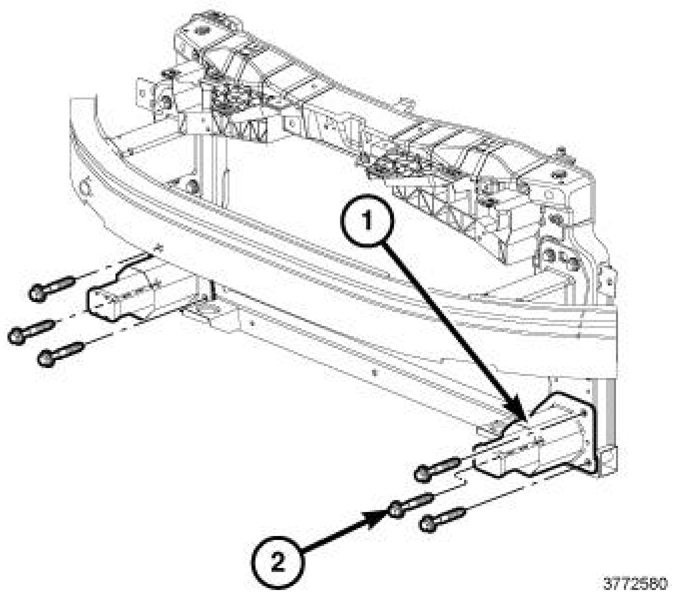


**Fig. 10: Lower Bumper Reinforcements & Fasteners**
**Courtesy of CHRYSLER GROUP, LLC**

41. Remove the fasteners (2) securing the lower bumper reinforcement (1) and front fascia support beams to the frame/front end module.

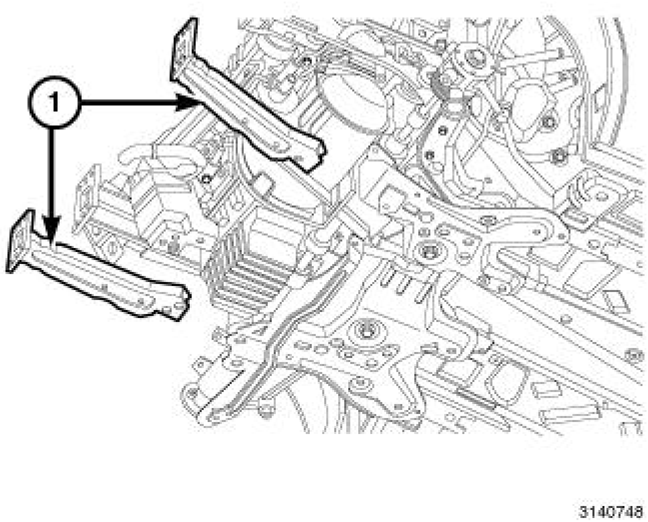


**Fig. 11: Front Fascia Support Beams**
**Courtesy of CHRYSLER GROUP, LLC**

 

42. Remove the front fascia support beams (1).

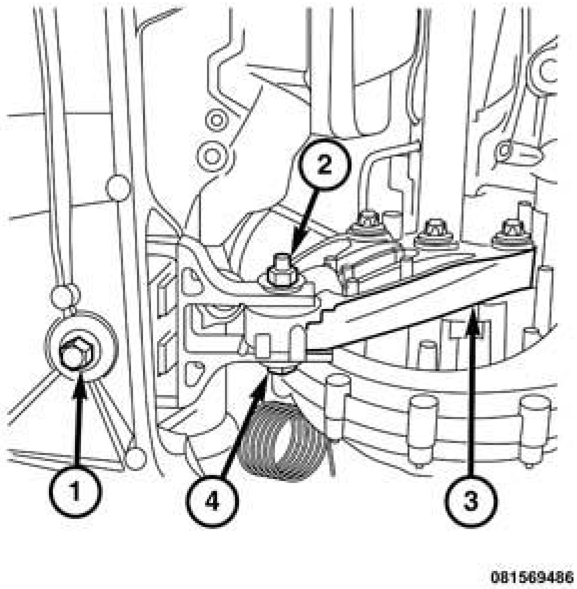


**Fig. 12: Rear Engine Isolator To Engine Mount Bracket Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

43. Remove the rear engine mount to bracket through bolt (4) and nut (2).
44. Remove the rear engine mount to crossmember through bolt (1).
45. Reposition the engine forward to allow the mount to be removed from the pocket past the engine bracket (3).
46. Remove the bolts holding the intermediate shaft to the engine support cradle.
47. Remove the exhaust cross-under pipe assembly. Refer to **PIPE, EXHAUST CROSSUNDER, REMOVAL** .

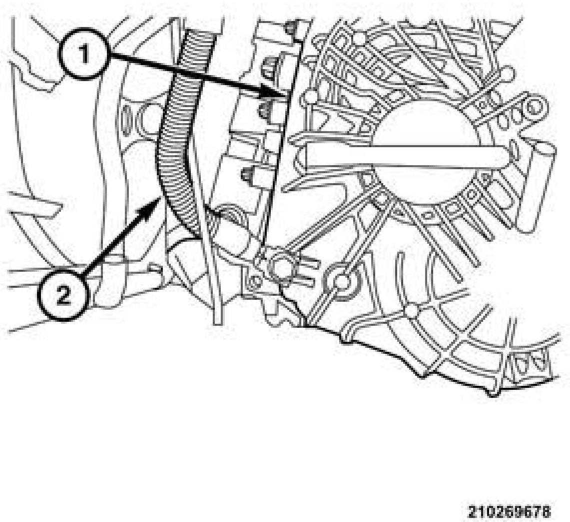


**Fig. 13: Transaxle & Ground Cable**
**Courtesy of CHRYSLER GROUP, LLC**

48. Remove the bolt holding the ground cable (2) to transaxle and separate cable from transaxle (1).

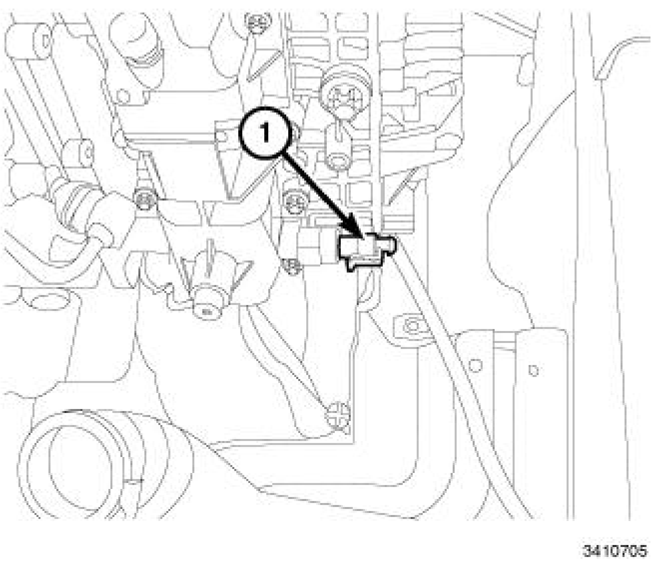


**Fig. 14: Reverse Lamp Sensor**
**Courtesy of CHRYSLER GROUP, LLC**

49. Disconnect the reverse lamp sensor (1).
50. Lower the vehicle.

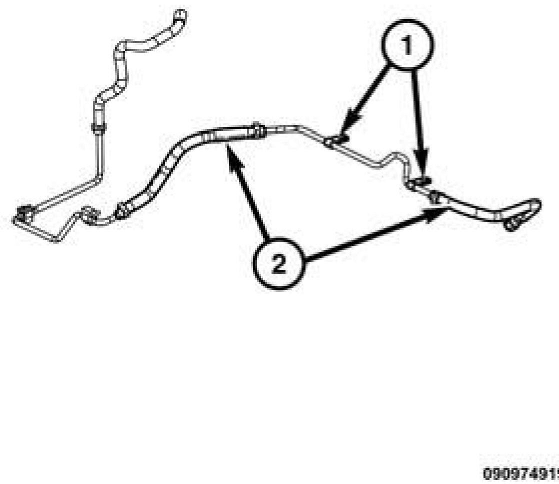


**Fig. 15: Hose Assembly & Hot Bottle Return Pipe Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

51. Remove the hot bottle return pipe bolts (1).
52. Disconnect the fitting at the thermostat housing and position the hose assembly to the side (2).
53. Remove the bolt holding the ground strap to left frame rail.

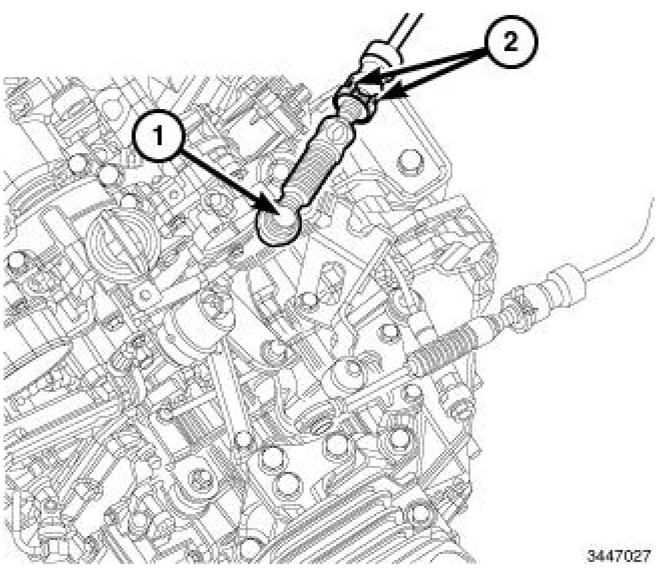


**Fig. 16: Cable Connector & Release Tabs**
**Courtesy of CHRYSLER GROUP, LLC**

54. Pry up on the cable connector (1) to disengage both the cables from the levers and separate cables end from the shift levers.

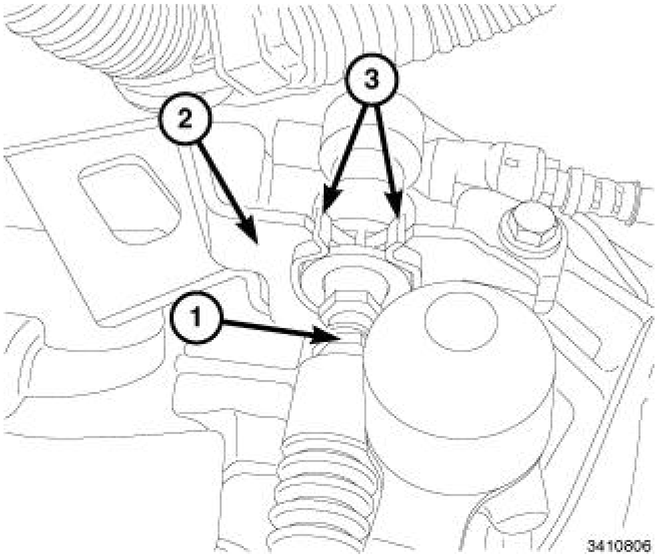


**Fig. 17: Gear Shift Selector Cable & Bracket**
**Courtesy of CHRYSLER GROUP, LLC**

55. Disconnect the gear shift selector cables (1) at the manual levers (2).

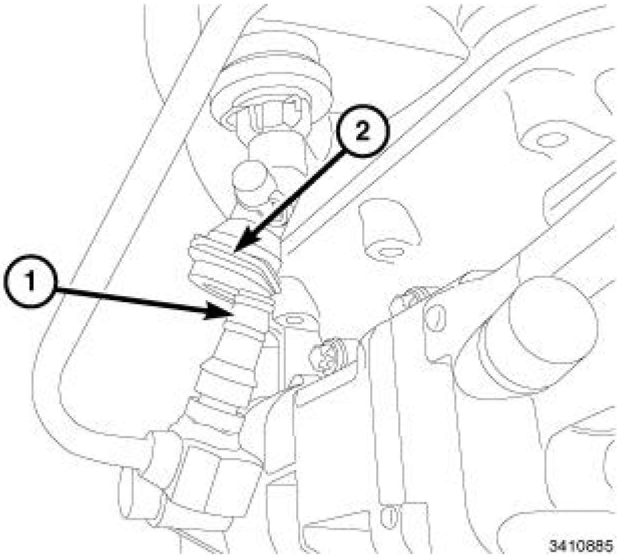


**Fig. 18: Hydraulic Supply Pipe & Concentric Slave Cylinder**
**Courtesy of CHRYSLER GROUP, LLC**

56. Disconnect the hydraulic supply pipe for the concentric slave cylinder.
57. Remove the exhaust manifold assembly. Refer to **MANIFOLD, EXHAUST, REMOVAL**.
58. Disconnect the heater hose quick connects at the heater core inlet and outlet tubes.
59. Disconnect the AC lines at the compressor. Discard the seals. Refer to **COMPRESSOR, A/C, REMOVAL** .
60. Disconnect the shifter cables from the transmission. Refer to **CABLE, GEARSHIFT CONTROL, REMOVAL** .

 

61. Reposition the main wire harness away from the engine.

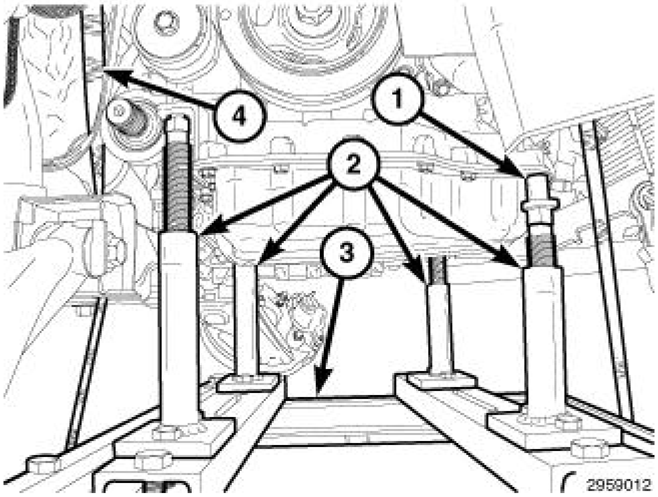


**Fig. 19: Adapter, Engine Support Cradle, Power Train Dolly & Safety Straps**
**Courtesy of CHRYSLER GROUP, LLC**

62. Raise and position the vehicle height to allow Power Train Dolly (special tool #6135, Dolly, Power Train) (3) and Engine Support Cradle (special tool #6710A, Cradle, Engine Support) (2) to be installed under the engine/transaxle assembly.
63. Loosen the cradle engine mounts to allow movement for positioning onto the engine locating holes on the engine block and oil pan rail. Place Adapter (special tool #6848-3, Adapter) (1) on the front post and align to the oil pan mounting stud. Lower the vehicle and position cradle until the engine is resting on the posts. Tighten the post mounts to the cradle frame. Secure the engine/transaxle assembly to the dolly/cradle with safety straps (4).
64. Remove the left engine mount. Refer to **INSULATOR, ENGINE MOUNT, LEFT, REMOVAL** .
65. Remove the right engine mount (Refer to **ENGINE MOUNTING**, Right/Removal).
66. Slowly raise the vehicle to allow the it to clear the powertrain assembly.

**CAUTION: Make sure that all components are clear of obstructions while raising the vehicle off of the powertrain assembly.**

67. On vehicles equipped with an automatic transaxle, remove torque converter bolts. On vehicles equipped with an manual transaxle, remove modular clutch bolts. Refer to **DISASSEMBLY** .
68. Remove lower bellhousing bolts.
69. Separate engine and transmission.

## INSTALLATION

### INSTALLATION

 

**CAUTION: If the original engine has experienced a catastrophic failure or an individual failure with the piston, cylinder bore, engine block, valve or valve seat, the intake manifold MUST be replaced with a new manifold.**

1. Attach the transmission to the engine. Refer to **INSTALLATION** .
2. With the engine and the transmission bolted together and on the engine cradle, slowly and carefully lower the vehicle down to a point that the engine assembly can be verified that it is in the proper alignment with the engine bay.

**NOTE: An assistant may be needed to help align the assembly.**

3. Slowly lower engine assembly in to position.
4. Install the right engine mount. Refer to **INSULATOR, ENGINE MOUNT, RIGHT, INSTALLATION**.
5. Install the left engine mount. Refer to **INSULATOR, ENGINE MOUNT, RIGHT, INSTALLATION**.
6. Remove the Engine Support Cradle straps and remove the cradle from below the engine/transmission assembly.
7. Connect the shifter cables to the transmission. Refer to **CABLE, GEARSHIFT CONTROL, INSTALLATION** .
8. Connect the AC lines at the compressor. Refer to **LINE, A/C DISCHARGE, INSTALLATION** .
9. Connect the heater hose quick connects at the heater core inlet and outlet tubes.
10. Install the exhaust manifold assembly. Refer to **MANIFOLD, EXHAUST, INSTALLATION**.

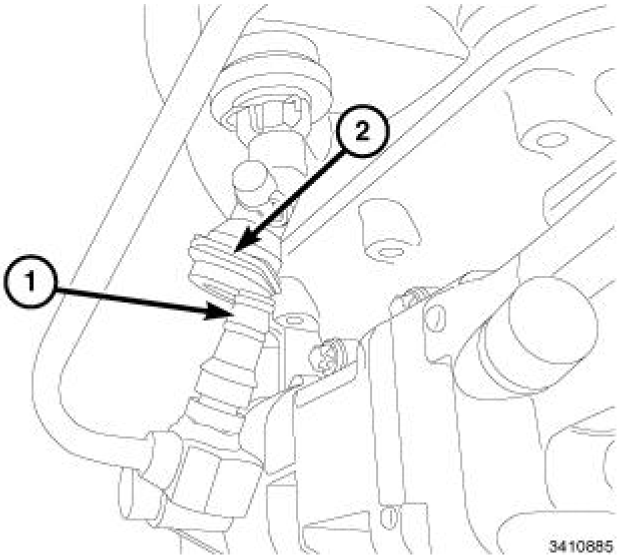


**Fig. 20: Hydraulic Supply Pipe & Concentric Slave Cylinder**
**Courtesy of CHRYSLER GROUP, LLC**

11. Connect the hydraulic supply pipe (1) for the concentric slave cylinder (2). Refer to **CYLINDER, CLUTCH SLAVE, INSTALLATION** .

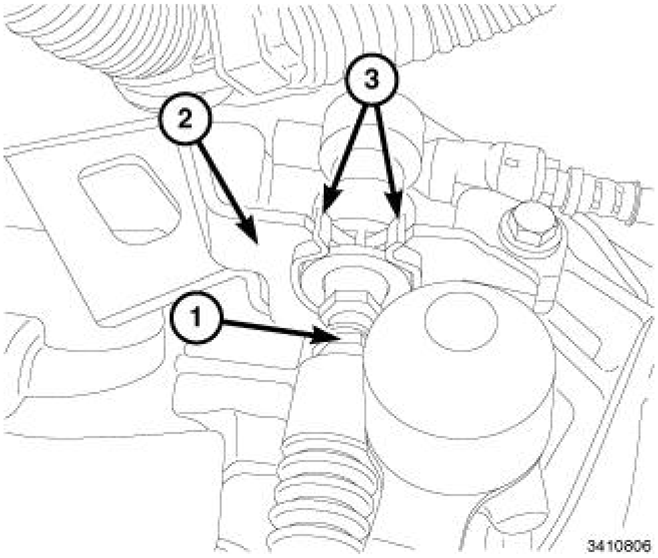


**Fig. 21: Gear Shift Selector Cable & Bracket**
**Courtesy of CHRYSLER GROUP, LLC**

12. Connect the gear shift selector cables (1) at the manual levers (2).
13. Install the bolt holding the ground strap to left frame rail. Tighten the bolt to 9 N.m (80 in. lbs.).

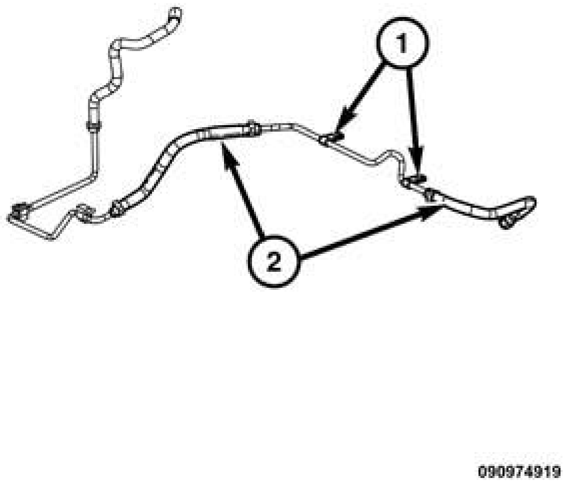


**Fig. 22: Hose Assembly & Hot Bottle Return Pipe Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

14. Attach the hot bottle hose (2) quick connect to the thermostat housing. Install the bolts (1). Tighten the bolts to 9 N.m (80 in. lbs.).
15. Raise and support the vehicle.

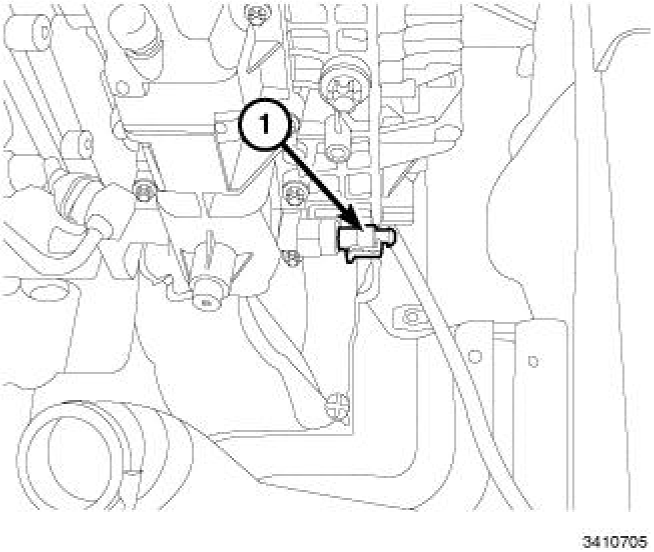


**Fig. 23: Reverse Lamp Sensor**
**Courtesy of CHRYSLER GROUP, LLC**

16. Connect the reverse lamp sensor (1).

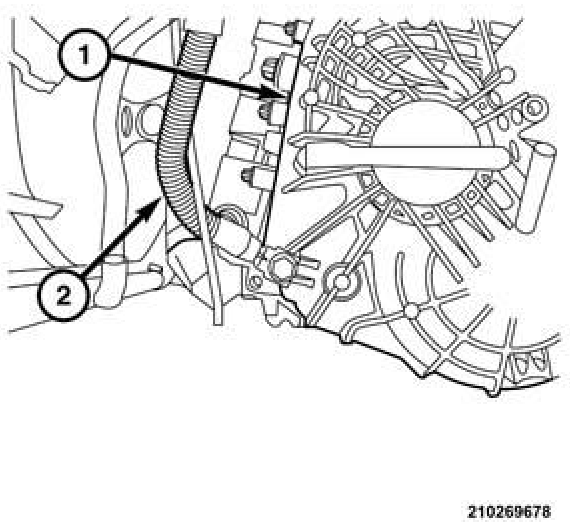


**Fig. 24: Transaxle & Ground Cable**
**Courtesy of CHRYSLER GROUP, LLC**

17. Install the ground cable (2) to the transaxle (1). Install the bolt and tighten to 24 N.m (18 ft. lbs.).
18. Install the exhaust crossunder pipe with **new** flange gaskets.
19. Install the intermediate shaft bracket bolts. Tighten bolts to 65 N.m (48 ft. lbs.)

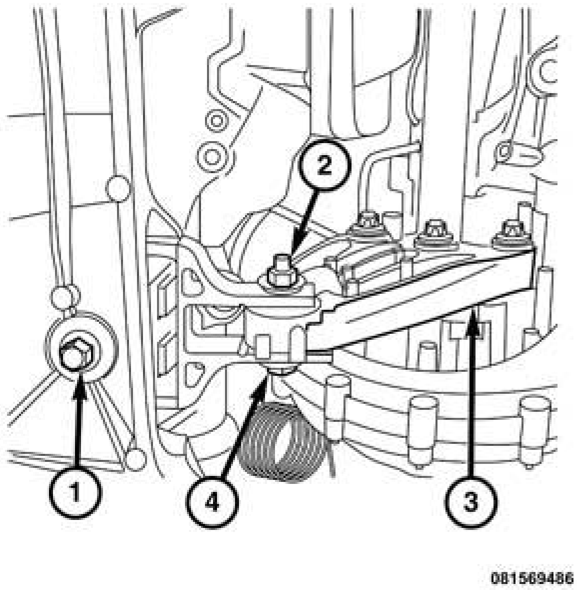


**Fig. 25: Rear Engine Isolator To Engine Mount Bracket Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

20. Reposition the engine forward to allow the mount to be inserted into the pocket past the engine bracket (3).
21. Install the rear engine mount to crossmember through bolt (1). Tighten the bolt to 87 N.m (64 ft. lbs)
22. Install the rear engine mount to engine bracket (3) through bolt (4) and nut (2). Tighten the bolt to 87 N.m (64 ft. lbs)
23. Install new oil filter.

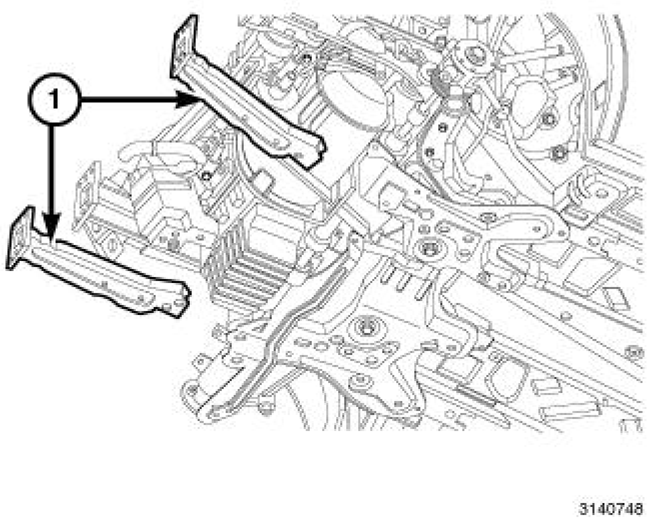


**Fig. 26: Front Fascia Support Beams**
**Courtesy of CHRYSLER GROUP, LLC**

24. Install the front fascia beams (1).

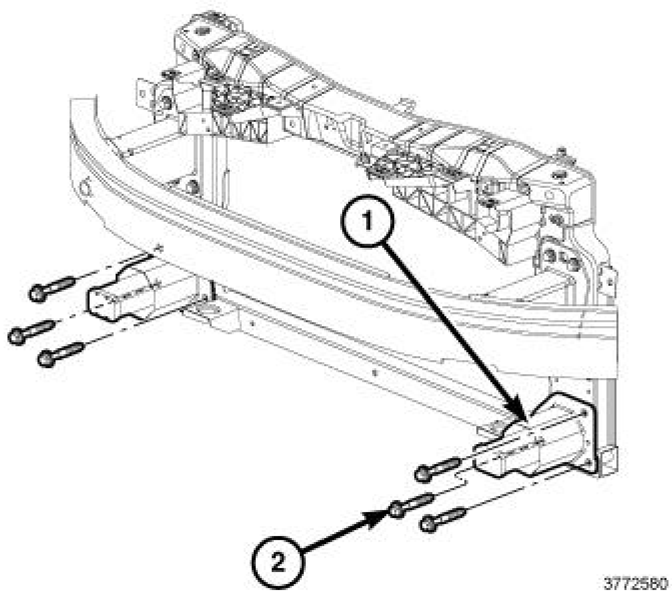


**Fig. 27: Lower Bumper Reinforcements & Fasteners**
**Courtesy of CHRYSLER GROUP, LLC**

25. Install the fasteners (2) securing the lower bumper reinforcement (1) to the frame/front end module. Tighten the fasteners to 45 N.m (33 ft. lbs.).

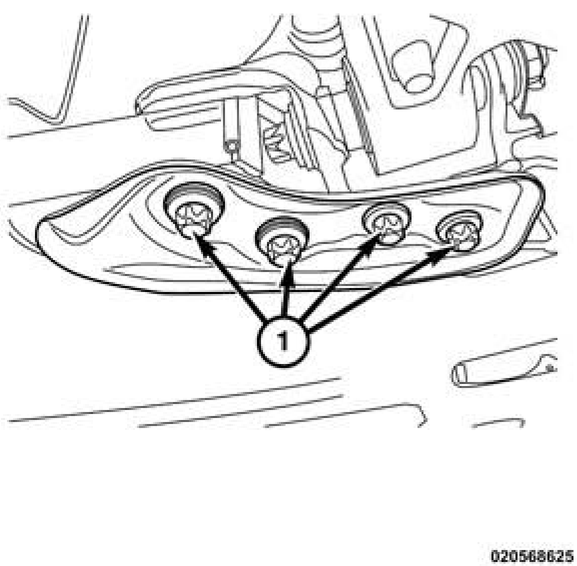


**Fig. 28: Crossmember To Fascia Support Beams Bracket Retaining Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

26. Install the crossmember to fascia support beam bracket and install the four retaining bolts (1) and tighten to 95 N.m (70 ft. lbs.).
27. Insert the lower ball joint into the knuckle and install the pinch bolt and nut and tighten to 70 N.m (52 ft. lbs.).
28. Install the radiator. Refer to **RADIATOR, ENGINE COOLING, INSTALLATION** .
29. Install accessory drive belt.
30. Install the coolant crossover pipe. Install bolts, tighten to 9 N.m (80 in. lbs.)
31. Install the hoses at the crossover tube.
32. Install the upper radiator hose.
33. Fill with coolant. Refer to **STANDARD PROCEDURE** .
34. Install the front closeout panel.
35. Install the bellypan. Refer to **BELLY PAN, INSTALLATION** .
36. Install the left and right wheel well liners
37. Install the left and right axle shafts. Refer to **INSTALLATION** .
38. Install the front wheel and tire assemblies.
39. Lower the vehicle.
40. Install the radiator fan assembly. Refer to **FAN, COOLING, INSTALLATION** .
41. Install the fresh air hose to the valve cover.
42. Install the battery tray. Refer to **TRAY, BATTERY, INSTALLATION** .
43. Lock the harness retainer at the bottom of the battery tray.
44. Install the windshield washer reservoir to the battery tray. Install the retainer bolt and tighten to 9 N.m (80 in. lbs.).
45. Install the battery. Refer to **BATTERY, INSTALLATION** .
46. Evacuate and recharge the AC system. Refer to **STANDARD PROCEDURE** .

 

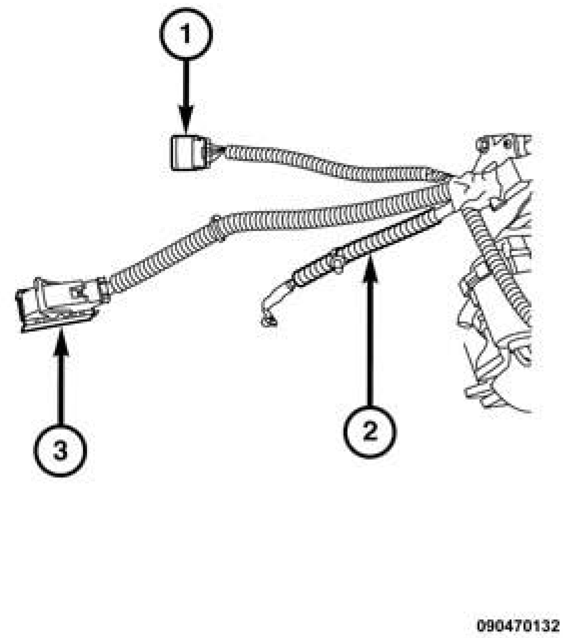


**Fig. 29: Intermediate Connector, Generator Feed Connector & PCM Connector**
**Courtesy of CHRYSLER GROUP, LLC**

47. Connect the intermediate connector (1), the generator feed connector (2) and the PCM connector (3).

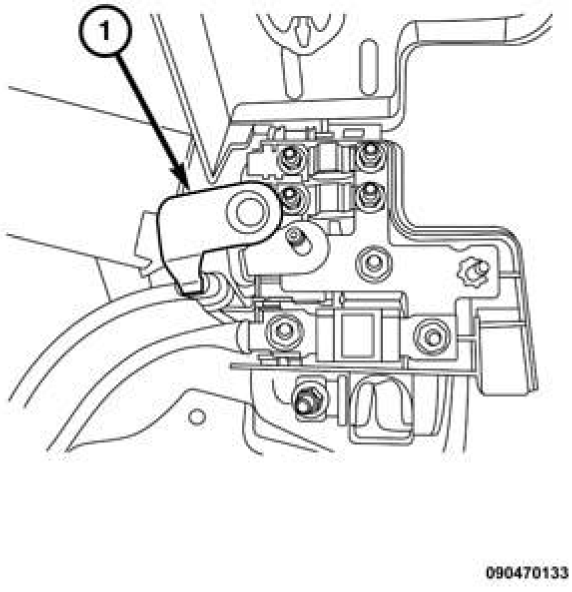


**Fig. 30: Starter Connector**
**Courtesy of CHRYSLER GROUP, LLC**

48. Install the starter connector (1) at the power block. Tighten the nut to 7 N.m (62 in. lbs.).

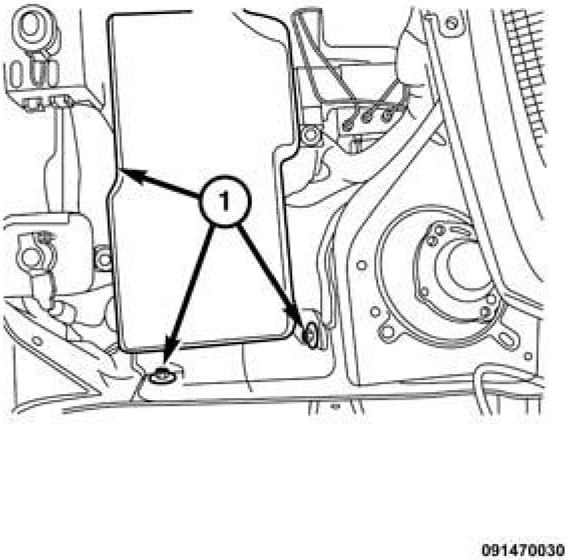


**Fig. 31: PDC Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

49. Install the three bolts (1) that secure the PDC. Tighten to 9 N.m (80 in. lbs.).
50. Install the battery cables.

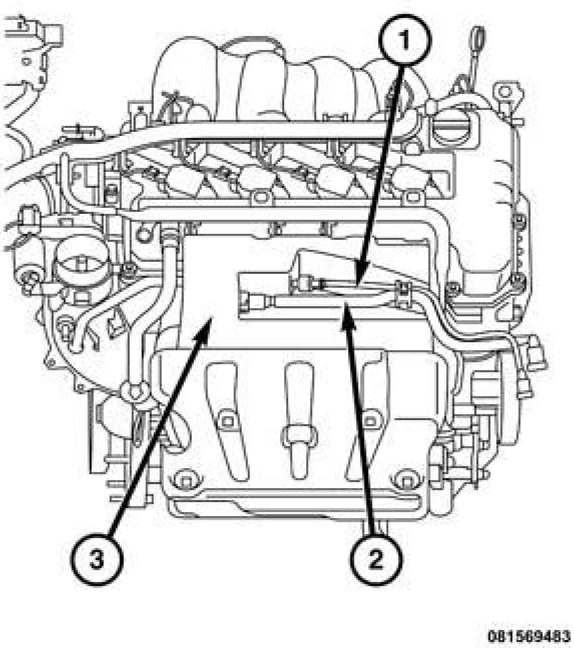

**Fig. 32: Foam Insulator, Fuel Line & Purge Line**
**Courtesy of CHRYSLER GROUP, LLC**

51.
52. Connect the fuel line (1) and the purge line (2) quick connects.
53. Connect the brake booster vacuum hose to intake manifold fitting.

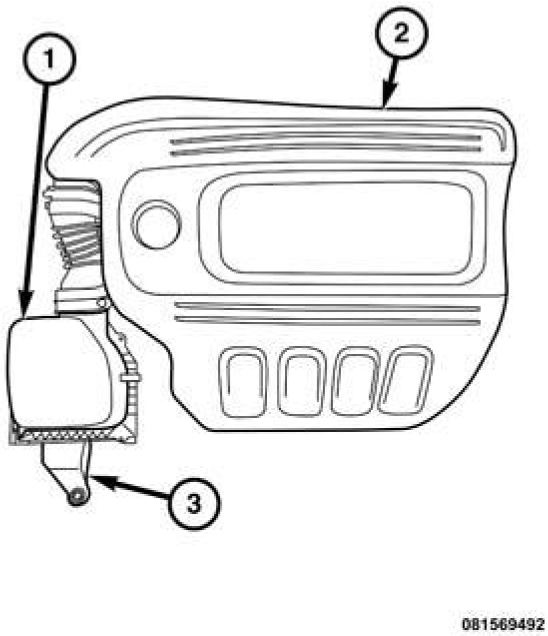


**Fig. 33: Air Box, Resonator & Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

54. Install the air box (1), the resonator (2) and the bolt (3). Tighten to 9 N.m (80 in. lbs.).
55. Connect the IAT sensor connector.
56. Tighten the snorkel clamp at the throttle body inlet.

# SPECIAL TOOLS

## SPECIAL TOOLS

 

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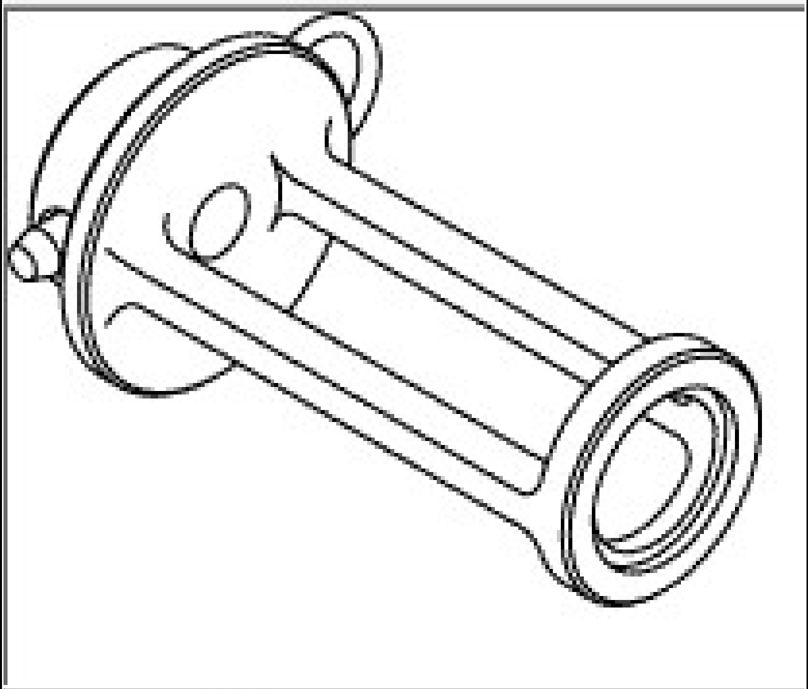
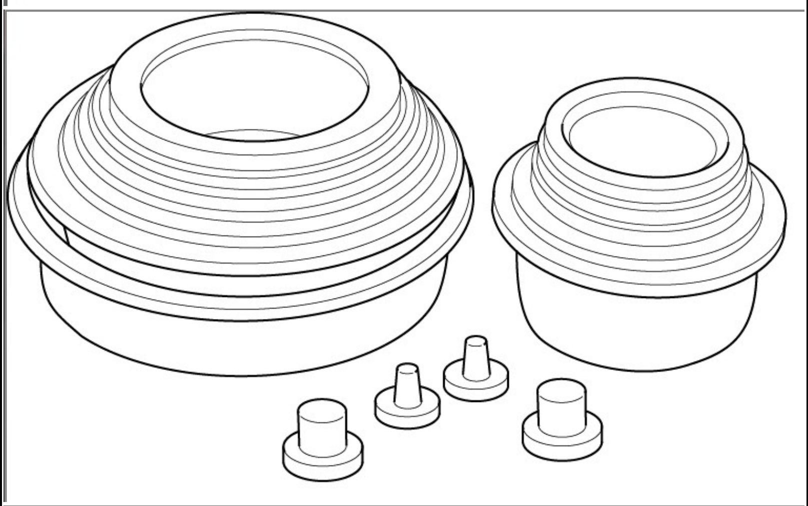
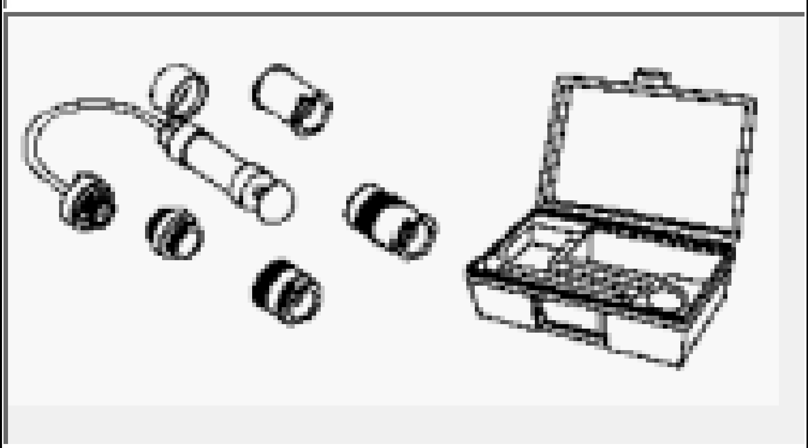
|  | 10224 - Adapter, Valve Spring (Originally Shipped In Kit Number(s) 10223.) |
|  | 10368 - Set, Universal Protective Cap |
|  | 7700-A - Tester, Cooling System |

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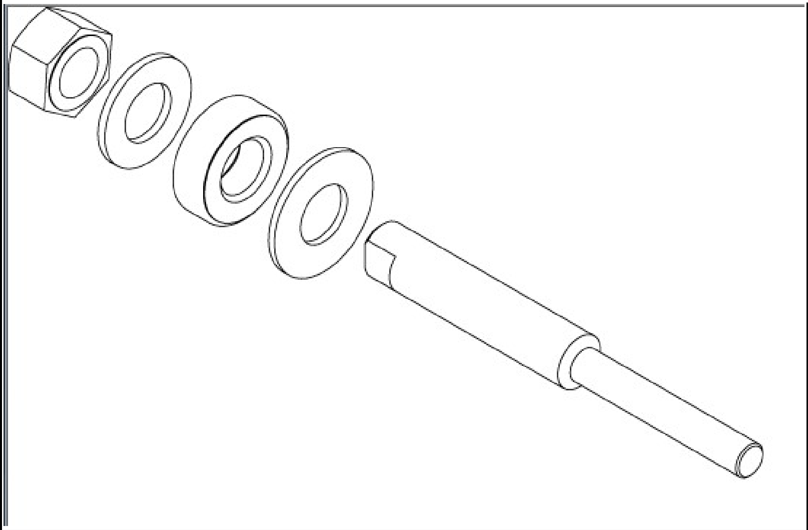
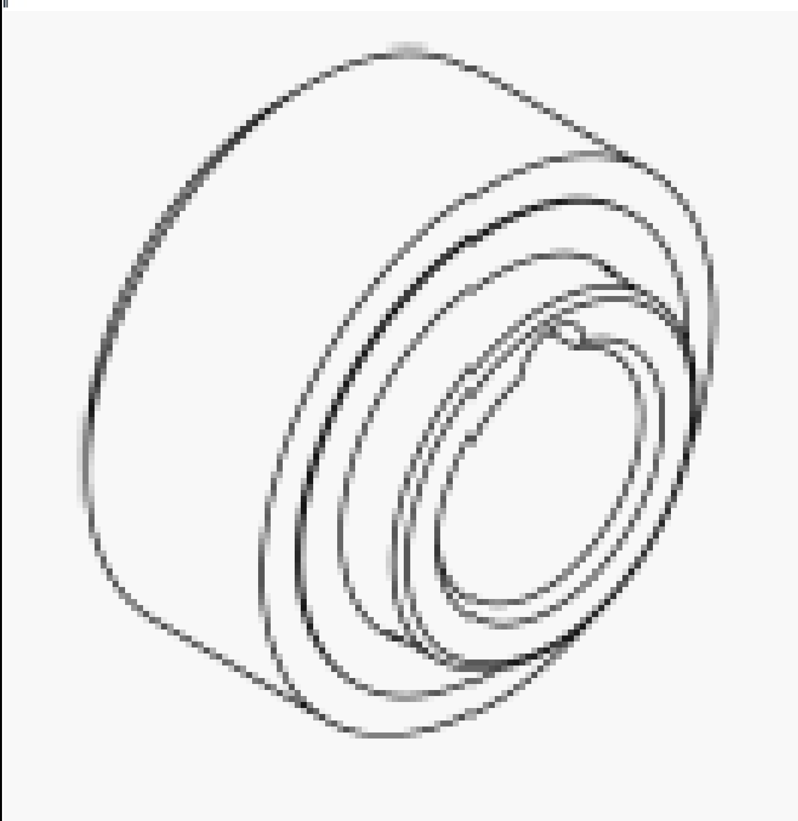
|  | 8189 - Guide Pins<br>(Originally Shipped In Kit Number(s) 8180, 8180CC, 8263, 8263CC.) |
|  | 9506 - Installer, Oil Seal<br>(Originally Shipped In Kit Number(s) 9610, 9970.) |

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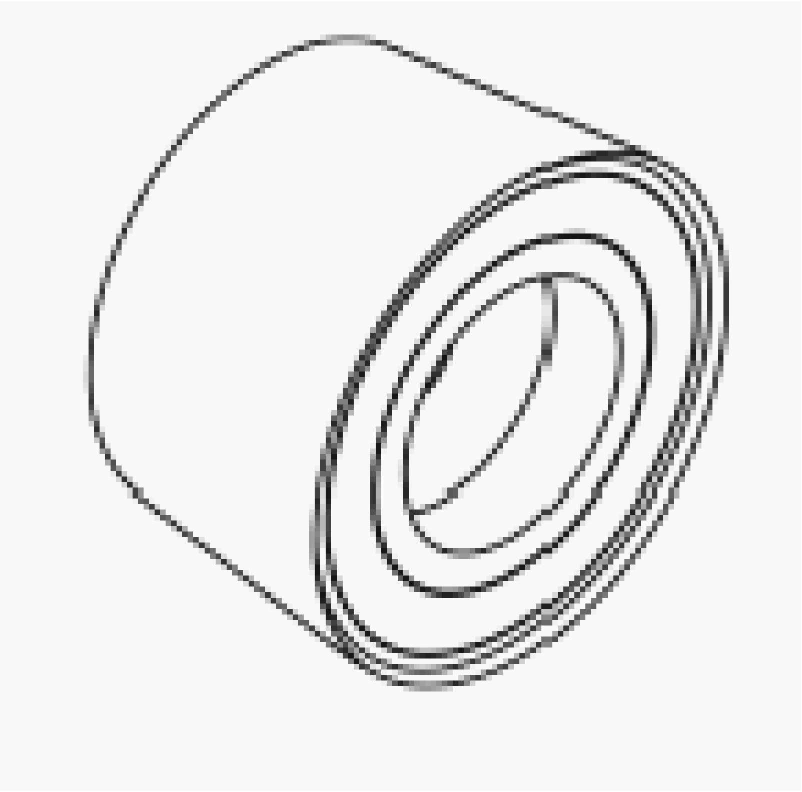
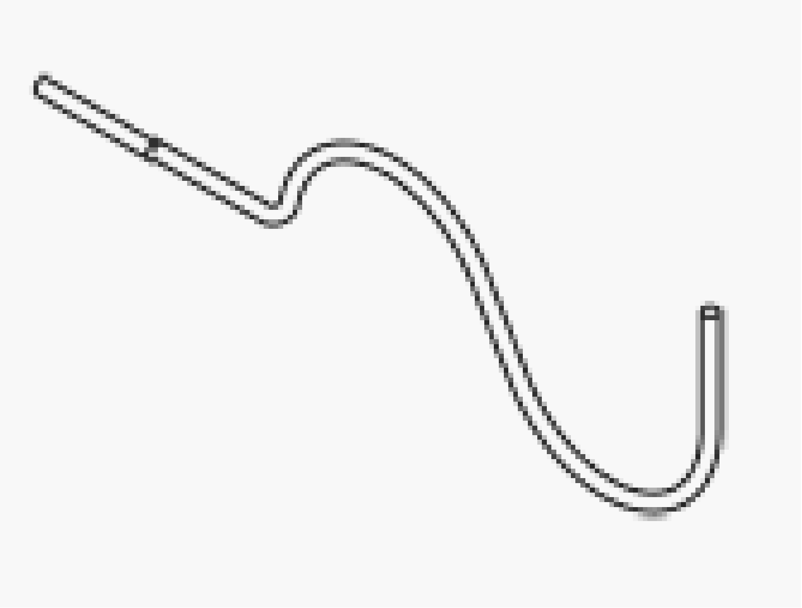
|  | 9509 - Installer, Oil Seal<br>(Originally Shipped In Kit Number(s) 9610, 9970.) |
|  | 9703 - Pin, Tensioner<br>(Originally Shipped In Kit Number(s) 9610, 9970.) |

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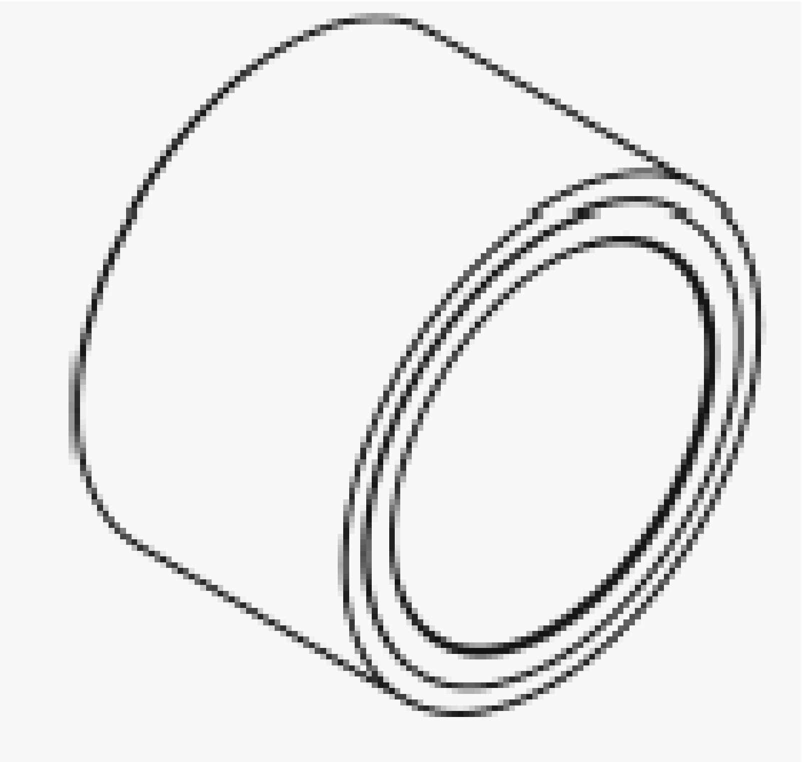
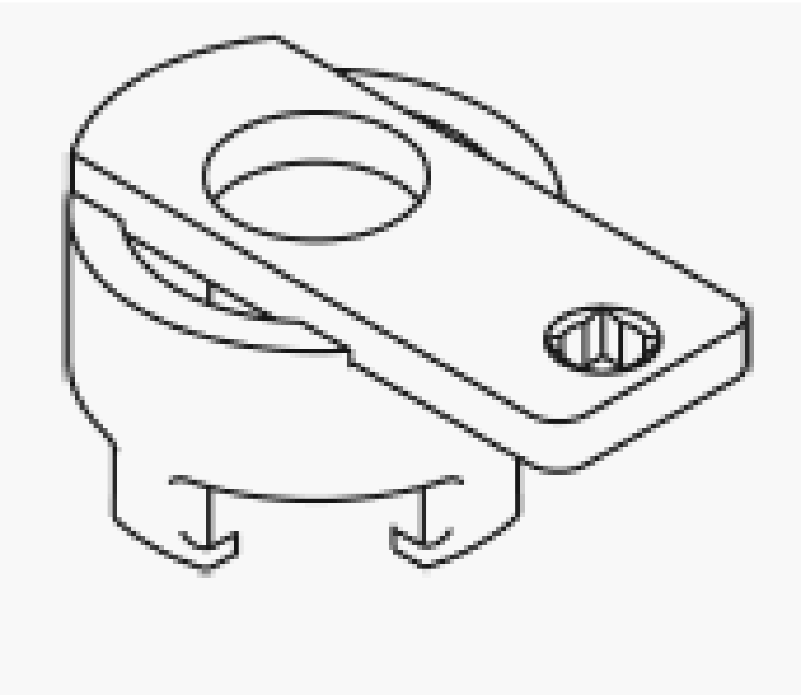
|  | 9706 - Installer, Crankshaft Rear Oil Seal (Originally Shipped In Kit Number(s) 9610, 9970.) |
|  | 9707 - Holder, Vibration Damper (Originally Shipped In Kit Number(s) 9610, 9970.) |

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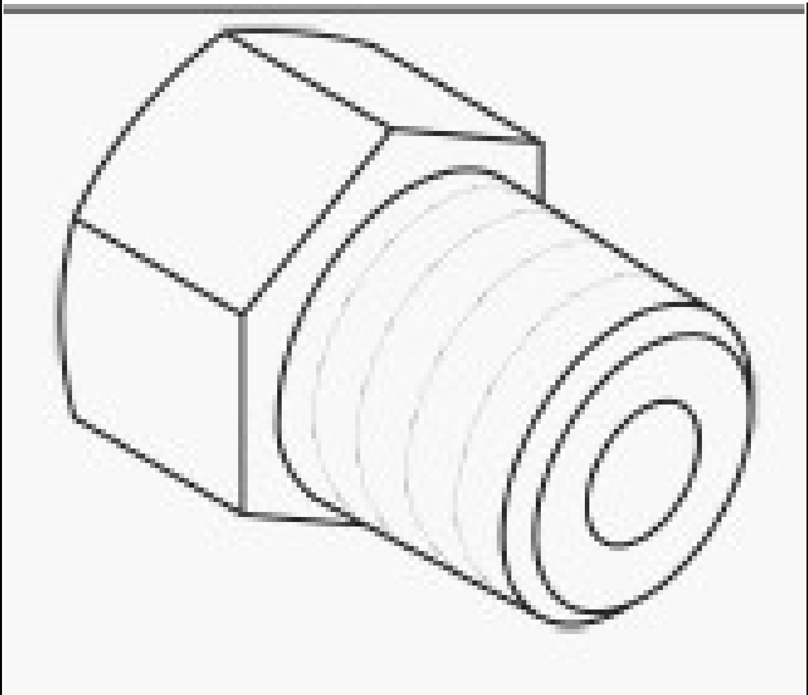
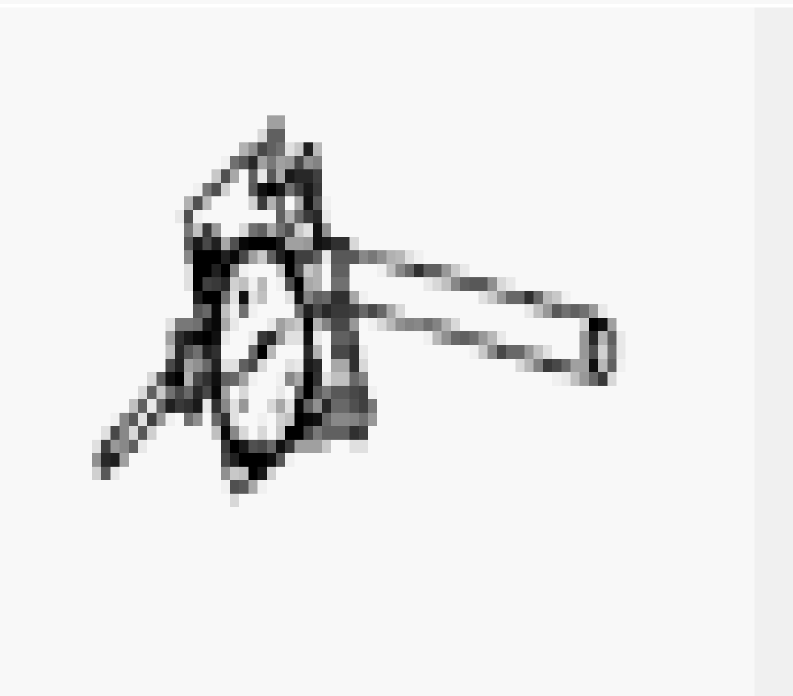
|  | 9879 - Adapter, Oil Pressure Test (Originally Shipped In Kit Number(s) 9998.) |
|  | C-119 - Cylinder Indicator |
| | C-3339A - Set, Dial Indicator |

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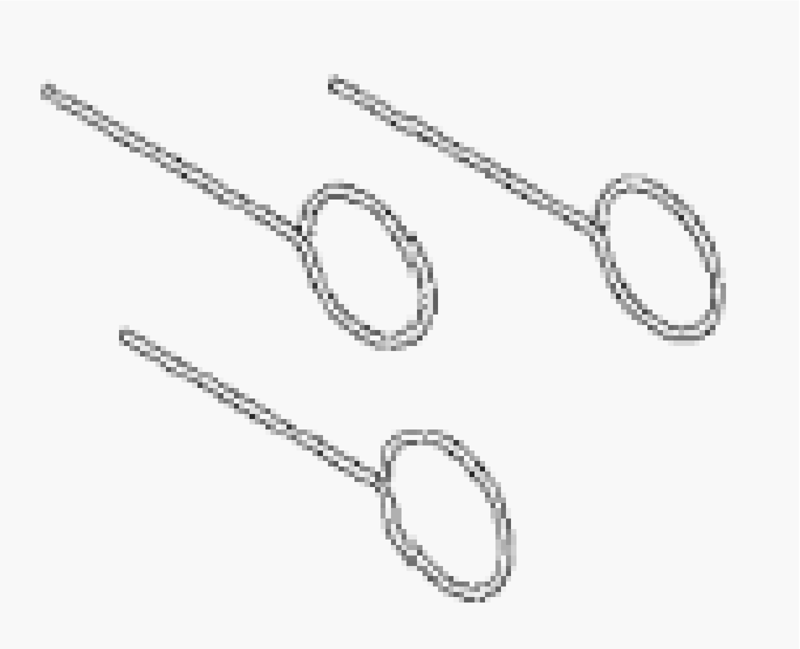
|  | (Originally Shipped In Kit Number(s) 9202.) |
|  | C-3685-A - Bloc-Chek Kit |

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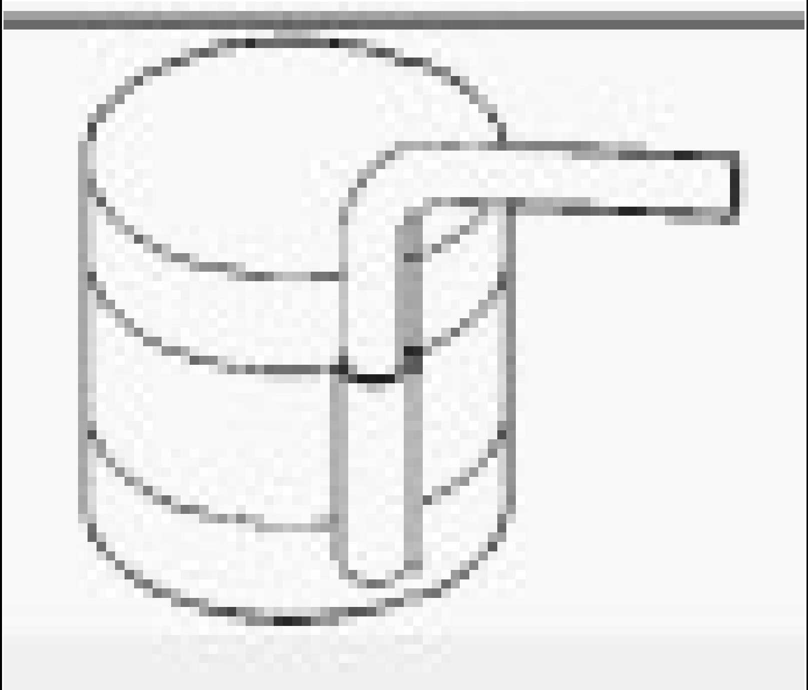
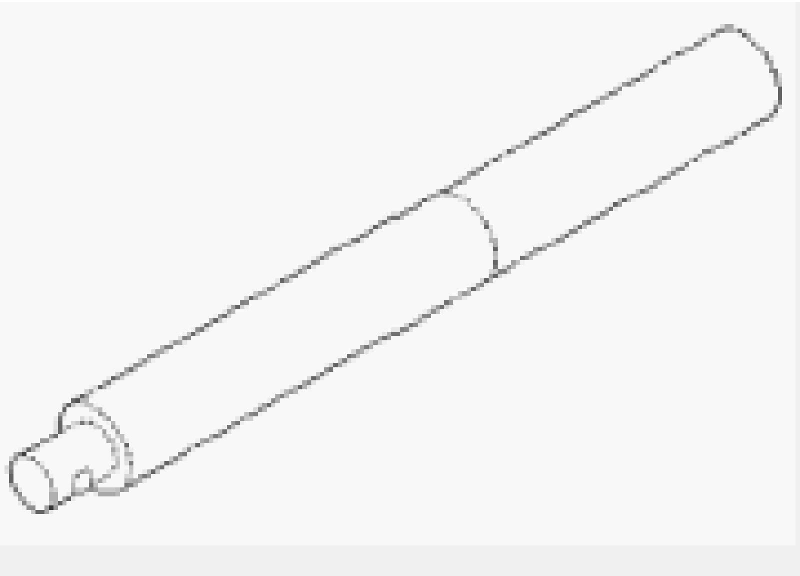
|  | C-385 - Compressor, Piston |
|  | C-4171 - Driver Handle, Universal (Originally Shipped In Kit Number(s) 9202, 9202A-CAN, 9202CC, 9299, 9299CC, 9299CC, 9300A-CAN.) |
| | C-4597 - Socket, Oil Pressure |

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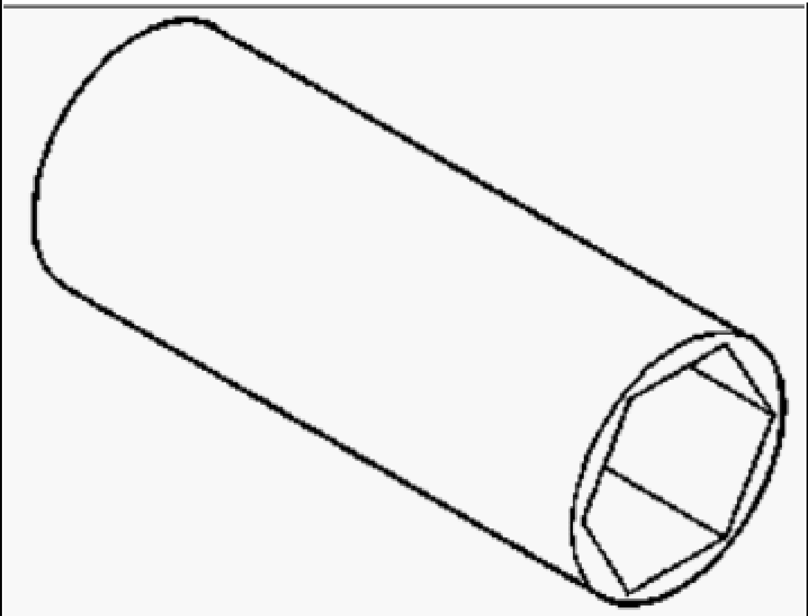
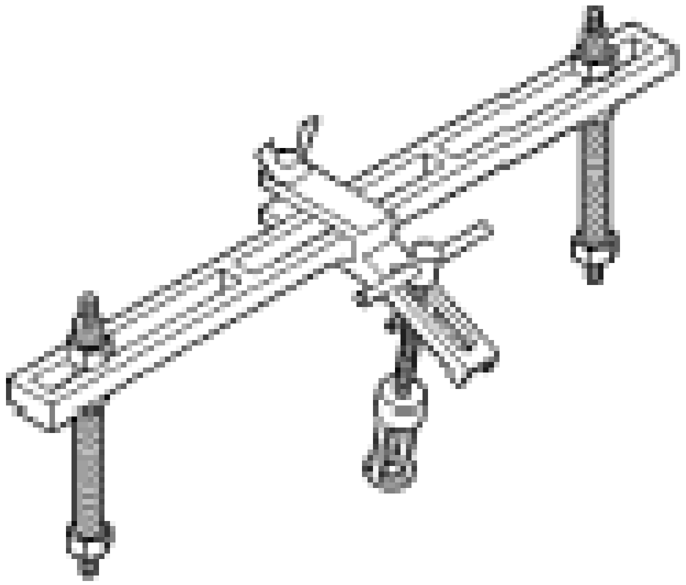
|  | |
|  | MD998772A - Compressor, Valve Spring (Originally Shipped In Kit Number(s) 8678, 8853, 8854.) |

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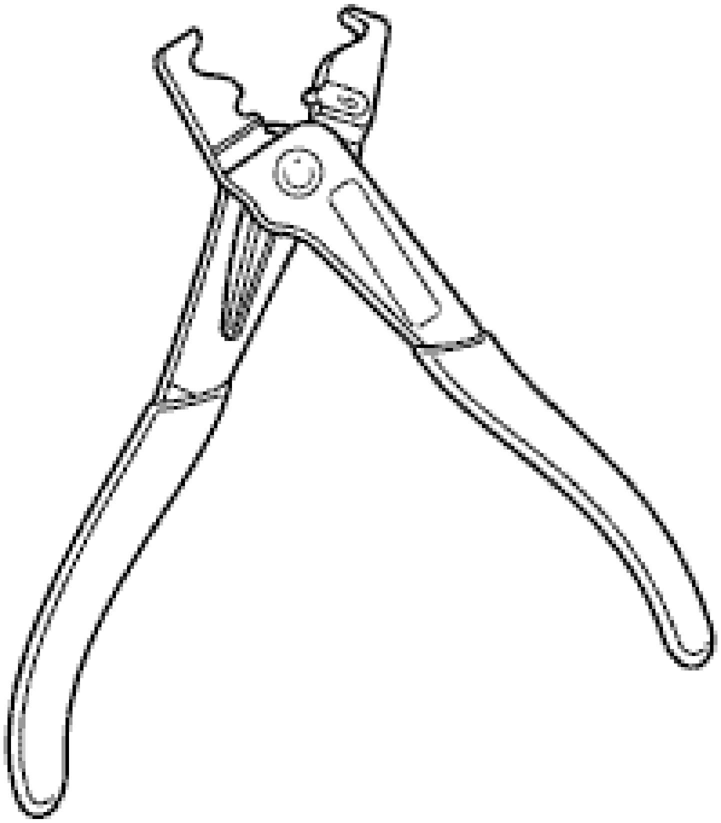
|  | 10288 - Pliers, Hose Clamp |
| | 10259B - Compressor, MultiAir® Spring |

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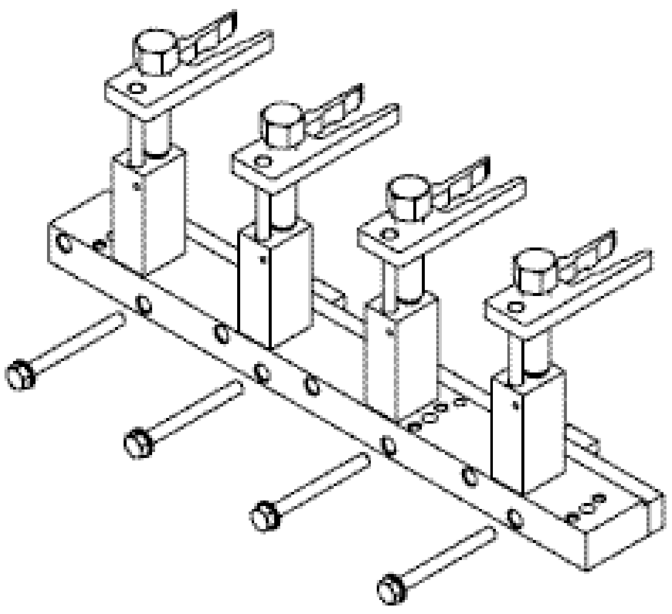
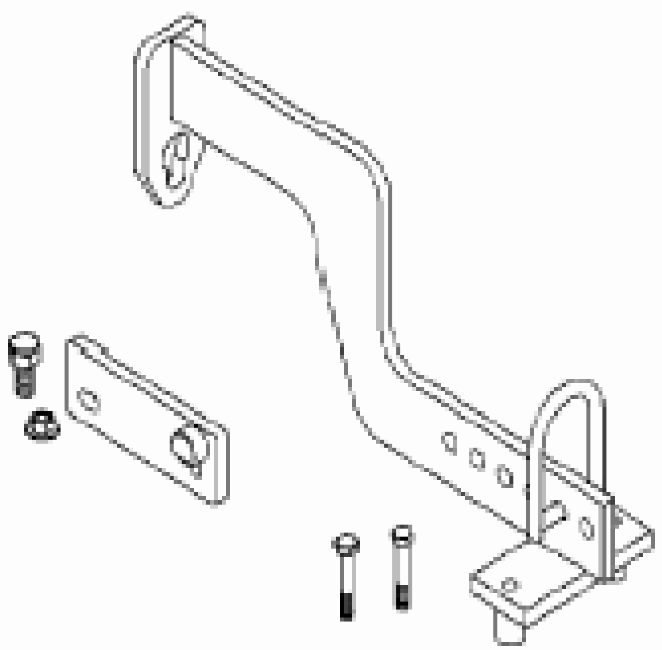
|  | |
|  | 8534B - Fixture, Driveline Support (Originally Shipped In Kit Number(s) 8534, 8534B, 8849, 9565.) |

## AIR INTAKE SYSTEM

### AIR CLEANER

**REMOVAL**

**REMOVAL**

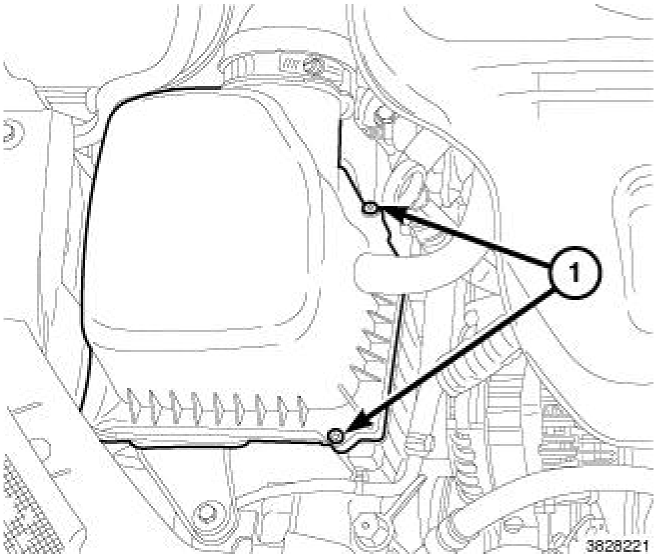



**Fig. 34: Air Cleaner Housing Cover Screws**
**Courtesy of CHRYSLER GROUP, LLC**

1. Remove two screws (1) from the air cleaner housing cover.

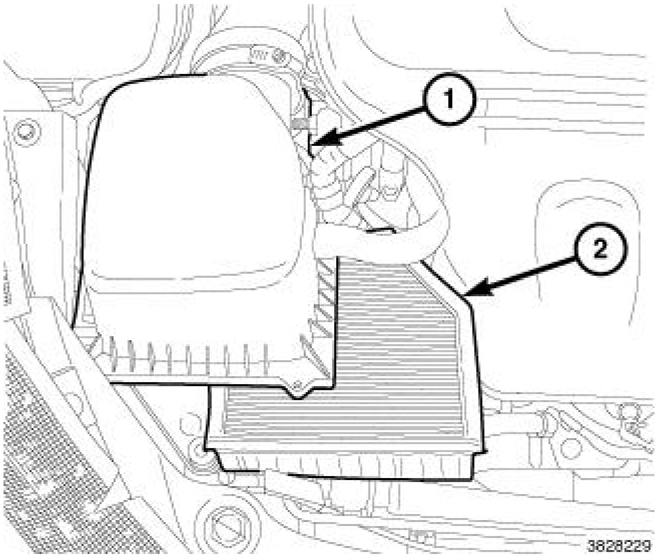



**Fig. 35: Air Cleaner Housing Cover & Air Filter**
**Courtesy of CHRYSLER GROUP, LLC**

2. Lift the air cleaner housing cover (1).
3. Pull the cover to disengage the rear tabs.
4. Remove the air filter element (2).

**INSTALLATION**

**INSTALLATION**

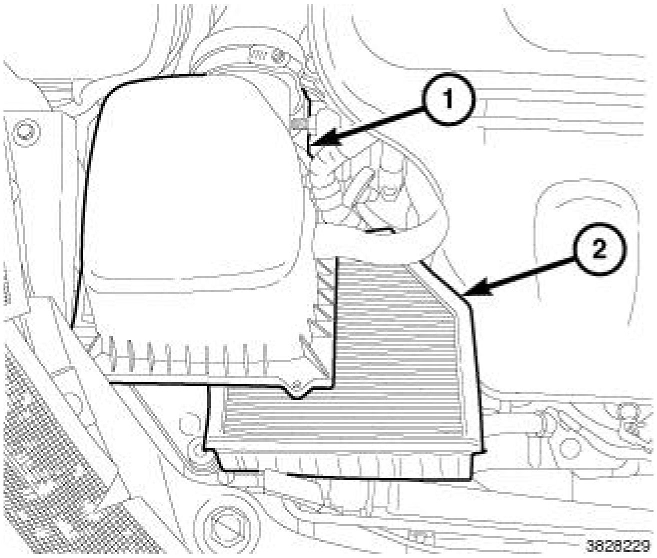



**Fig. 36: Air Cleaner Housing Cover & Air Filter**
**Courtesy of CHRYSLER GROUP, LLC**

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.

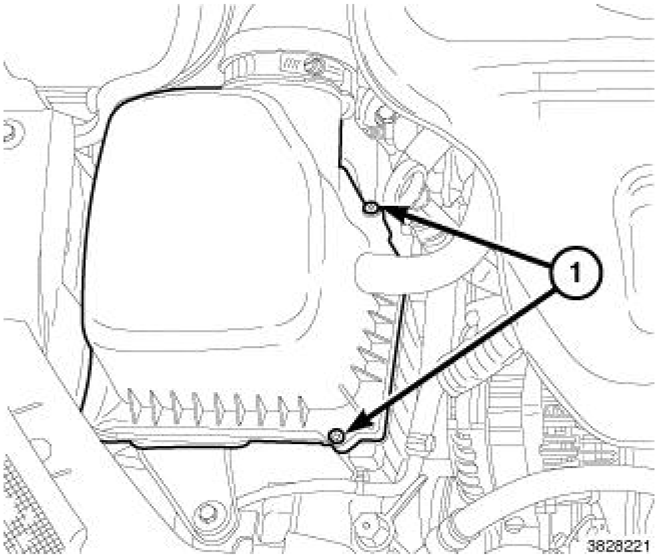



**Fig. 37: Air Cleaner Housing Cover Screws**
**Courtesy of CHRYSLER GROUP, LLC**

3. Seat the cover onto the housing and tighten the two housing cover screws (1).

**BODY, AIR CLEANER**

**REMOVAL**

**REMOVAL**

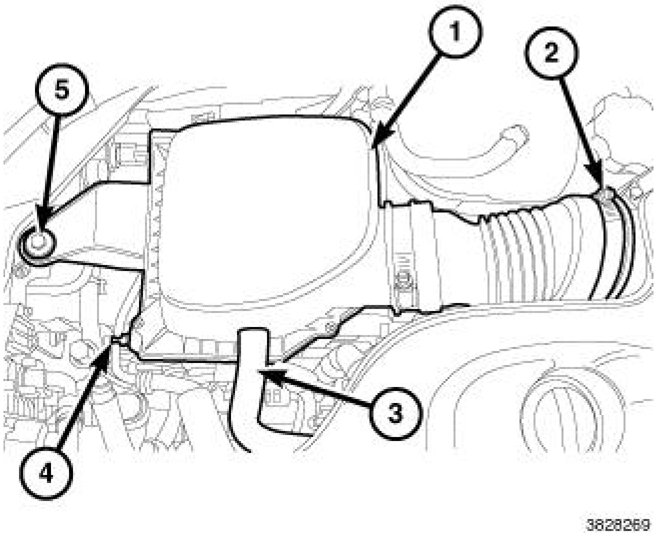



**Fig. 38: Air Cleaner Body, Clamp, Make Up Air Hose, Retainer & Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

1. Loosen the clamp (2) and disengage the hose from the resonator.
2. Remove the make up air hose (3) from the air cleaner body.
3. Disengage the coolant line retainer (4) from the air cleaner body.
4. Remove air cleaner housing retaining bolt (5).
5. Lift the air cleaner body (1) straight up off of the locating pins.

**INSTALLATION**

**INSTALLATION**

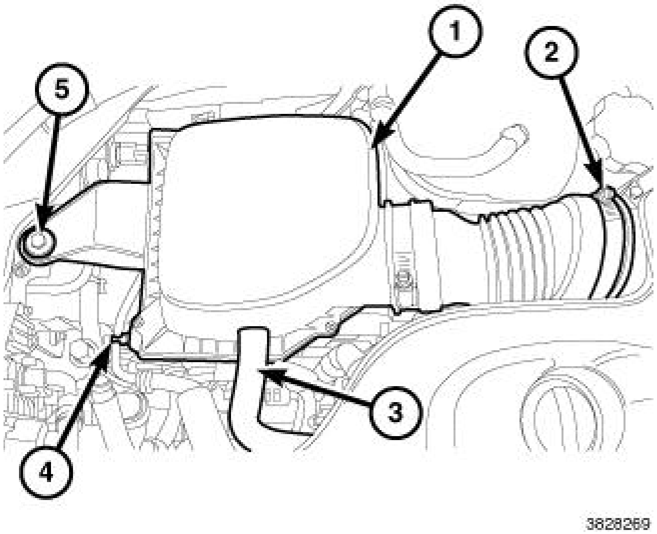



**Fig. 39: Air Cleaner Body, Clamp, Make Up Air Hose, Retainer & Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

1. Install the air cleaner body (1) straight down on the locating pins.
2. Install the retaining bolt (5).
3. Install the hose to the resonator and tighten the clamp (2) to 4 N.m (35 in. lbs.).
4. Engage the coolant line retainer (4) to the air cleaner body.
5. Install the make up air hose (3).

## RESONATOR, AIR CLEANER

### REMOVAL

#### REMOVAL

1. Remove the engine cover.

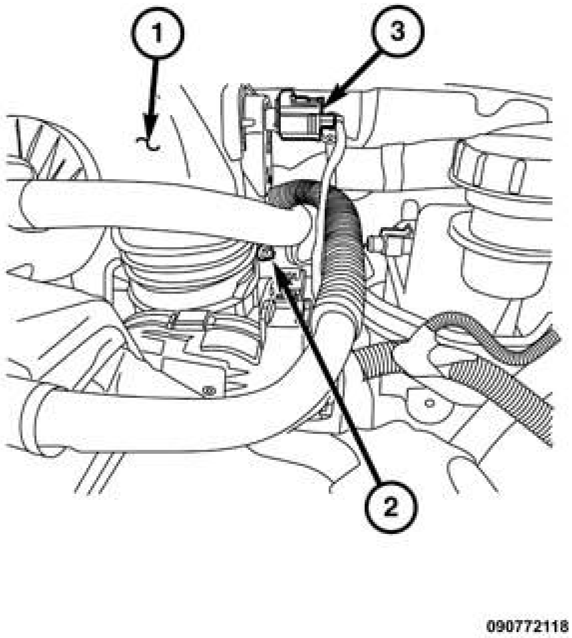



**Fig. 40: Resonator, Clamp & Connector**
**Courtesy of CHRYSLER GROUP, LLC**

2. Disconnect the electrical connector (2) from the Inlet Air Temperature (IAT) sensor.
3. Loosen the clamp (2) that secures the resonator (1) to the throttle body inlet.

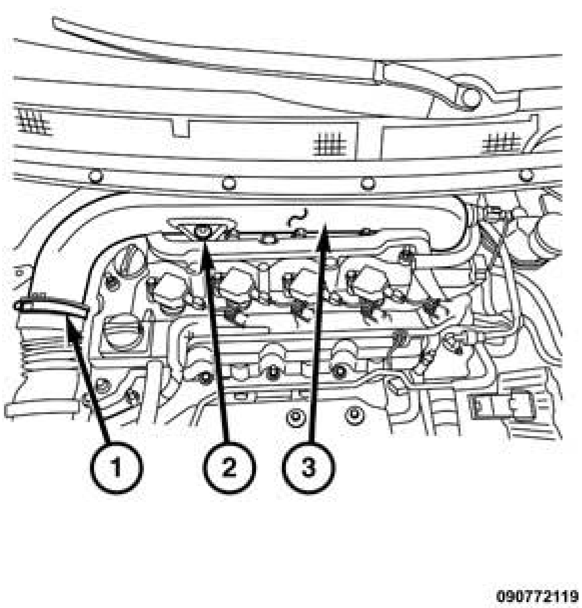



**Fig. 41: Resonator, Bolt & Clamp**
**Courtesy of CHRYSLER GROUP, LLC**

4. Loosen the clamp (1) and remove the air inlet hose from the resonator (3).
5. Remove the bolt (2) that secures the resonator to the cylinder head cover.
6. Pull the resonator (3) up while tipping the top edge of the resonator slightly forward and remove from the vehicle.

**INSTALLATION**

**INSTALLATION**

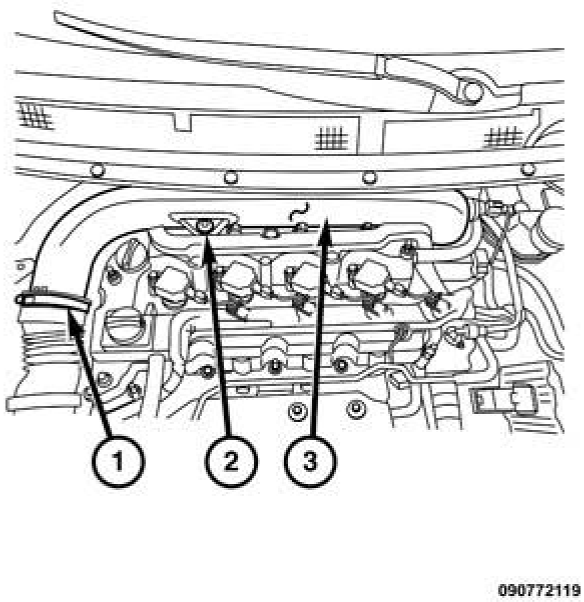



**Fig. 42: Resonator, Bolt & Clamp**
**Courtesy of CHRYSLER GROUP, LLC**

1. Position the resonator (3) between the forward edge of the cowl and the cylinder head cover. Align the openings with the throttle body intake and the airbox flex hose.
2. Install the bolt. Tighten the bolt to 9 N.m (81 in. lbs.).
3. Tighten the hose clamp (1).

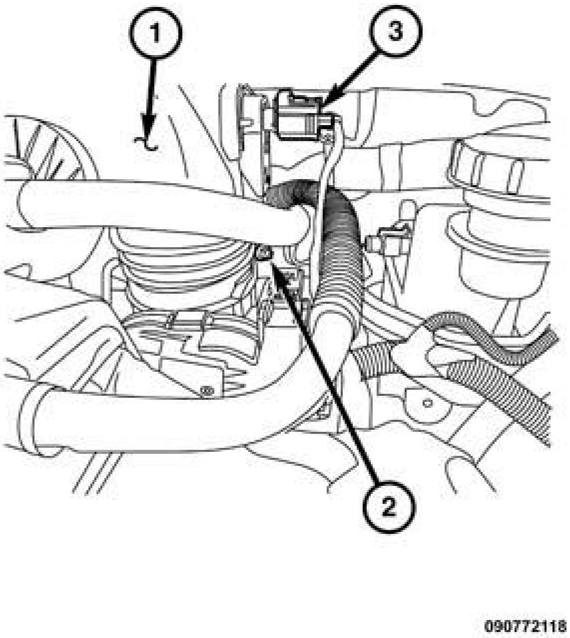



**Fig. 43: Resonator, Clamp & Connector**
**Courtesy of CHRYSLER GROUP, LLC**

4. Tighten the clamp (2) at the resonator outlet (1).
5. Connect the IAT connector (3).
6. Install the engine cover. Push downward to make sure all four rubber mounts are secure.

## CYLINDER HEAD

### DESCRIPTION

#### DESCRIPTION

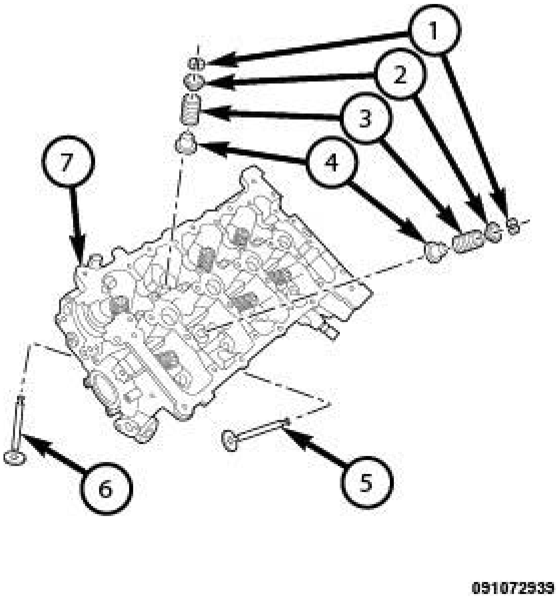



**Fig. 44: Cylinder Head, Valves & Springs**
**Courtesy of CHRYSLER GROUP, LLC**

The MultiAir, aluminum cylinder head (7) contains an exhaust camshaft and a variable valve actuator assembly (VVAA) with four valves per cylinder. The valves are arranged in two in-line banks. The exhaust valves (6) face toward the front of the vehicle. The intake valves face the dash panel (5). The valvetrain uses roller rocker arms with hydraulic lifters. The cylinder head incorporates pressed in powdered metal valve guides. The valve guides are not serviceable. The cylinder head is sealed to the block using a multi-layer steel head gasket and retaining bolts. The valves contain a stem seal (4), spring (3), spring retainer (2) and three groove keepers (1).

Integral oil galleries provide lubrication passages to the VVAA, camshaft, and valve mechanisms.

## DIAGNOSIS AND TESTING

### CYLINDER HEAD GASKET

A cylinder head gasket leak can be located between adjacent cylinders or between a cylinder and the adjacent water jacket.

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 LEAKAGE** . 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**

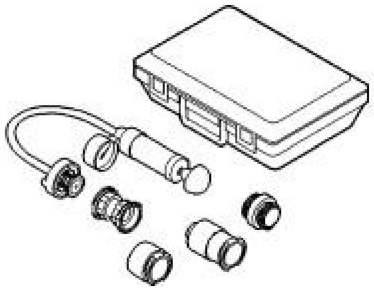


**Fig. 45: Cooling System Pressure Tester - 7700-A**
**Courtesy of CHRYSLER GROUP, LLC**

WARNING: **WITH THE 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 THE PRESSURE TO EXCEED 138 kPa (20 psi).**

Install Cooling System Tester (special tool #7700-A, 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**

**Fig. 46: Bloc-Chek-Kit - C-3685-A**
**Courtesy of CHRYSLER GROUP, LLC**

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

#### HYDRAULIC LASH ADJUSTER

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

1. Engine oil level too high or too low. This may cause aerated oil to enter the adjusters and cause them to be spongy.
2. Insufficient running time after rebuilding the cylinder head. Low speed running up to one hour may be required.
3. Turn engine off and let set for a few minutes before restarting. Repeat this several times after engine has reached normal operating temperature.
4. Low oil pressure.
5. The oil screen in cylinder head or the oil passage to the cylinder head is plugged with debris.
6. Air ingested into oil due to broken or cracked oil pump pick-up.
7. Worn valve guides.
8. Rocker arm ears contacting valve spring retainer.
9. Rocker arm loose, adjuster stuck or at maximum extension and still leaves lash in the system.
10. Oil leak or excessive cam bore wear in the cylinder head.
11. Faulty lash adjuster.

- Check lash adjusters for "sponginess" while installed in the cylinder head and cam lobe at base circle. Depress part of rocker arm over the adjuster. Normal adjusters should feel firm when pressed quickly. When pressed very slowly, lash adjusters should collapse.
- Remove suspected lash adjusters, and replace.
- Before installation, make sure adjusters are full of oil. This can be verified by little plunger travel when lash adjuster is depressed quickly.

### REMOVAL

#### REMOVAL

1. Perform the fuel system pressure release procedure. Refer to **FUEL DELIVERY, GAS , STANDARD PROCEDURE** .
2. Disconnect and isolate the battery negative cable.

3. Remove the engine cover.

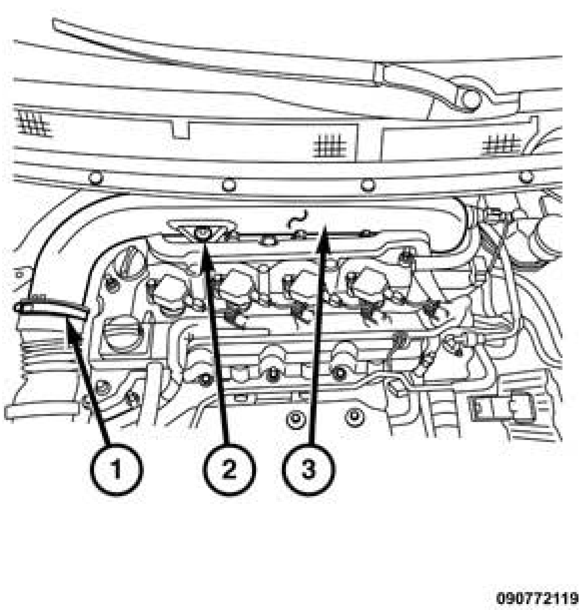



**Fig. 47: Resonator, Bolt & Clamp**
**Courtesy of CHRYSLER GROUP, LLC**

4. Remove the resonator (3). Refer to **RESONATOR, AIR CLEANER, REMOVAL**.
5. Remove the air cleaner body. Refer to **BODY, AIR CLEANER, REMOVAL**.
6. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .
7. Drain the cooling system. Refer to **STANDARD PROCEDURE** .

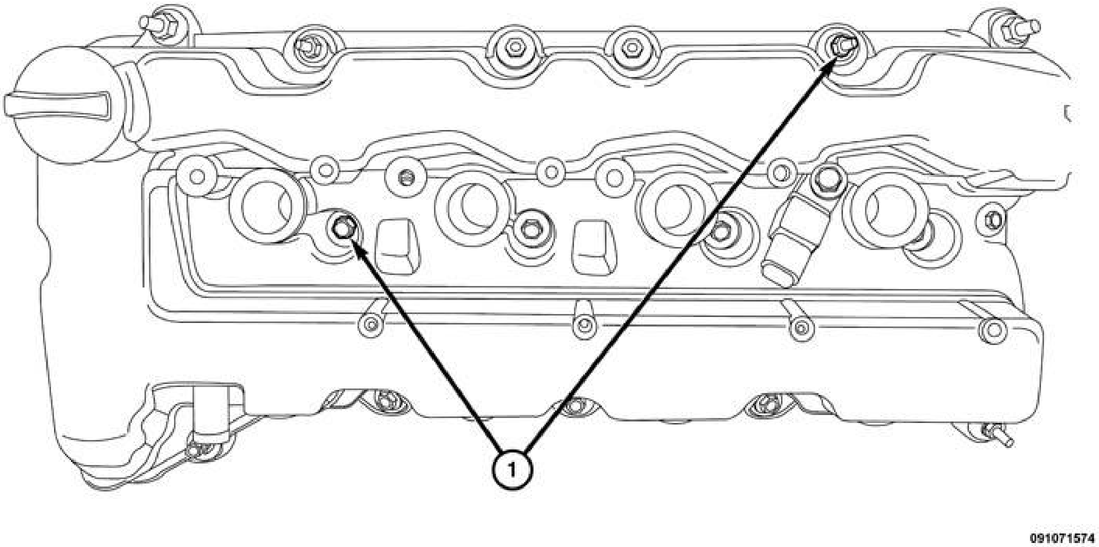



**Fig. 48: Cylinder Head Cover Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

8. Remove the cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.

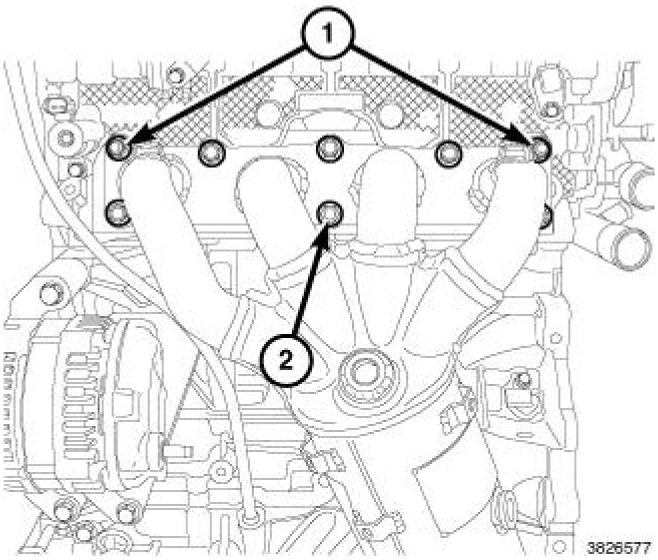



**Fig. 49: Exhaust Manifold Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

9. Remove the maniverter. Refer to **MANIFOLD, EXHAUST, REMOVAL**.

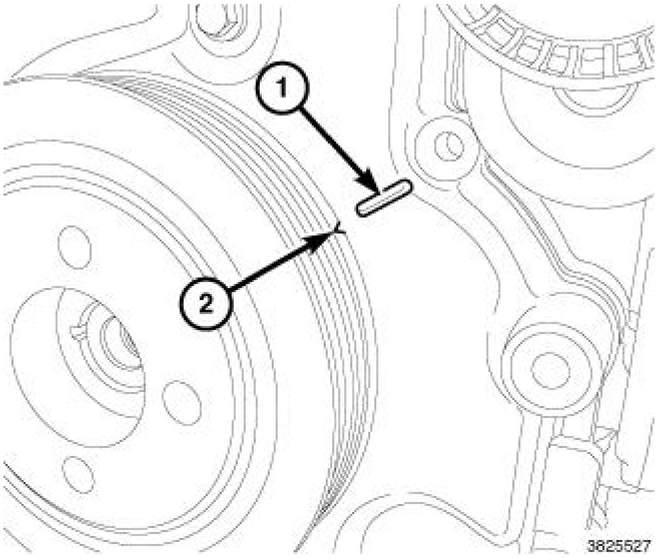



**Fig. 50: Timing Cover Mark & Notch**
**Courtesy of CHRYSLER GROUP, LLC**

10. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .

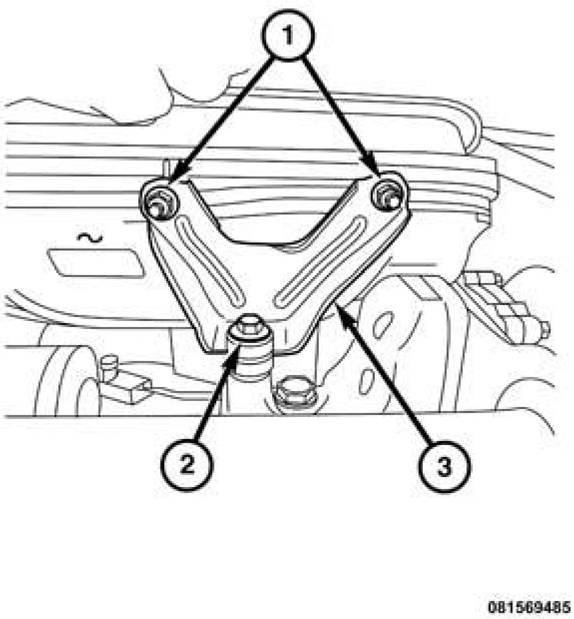



**Fig. 51: Intake Manifold Lower Bracket, Nuts & Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

11. Drain the coolant.
12. Remove the two nuts (1), the bolt (2) and the intake manifold lower bracket (3).
13. Remove the frame cover portion of the right splash shield. Refer to **SHIELD, SPLASH, FRONT WHEELHOUSE, REMOVAL** .

**CAUTION: When aligning timing marks, always rotate engine by turning the crankshaft. Failure to do so will result in valve and/or piston damage.**

14. Rotate the crankshaft clockwise (as viewed from the front) to align the timing cover mark (1) with the damper notch (2) to place the number one cylinder piston at top-dead-center on the compression stroke.

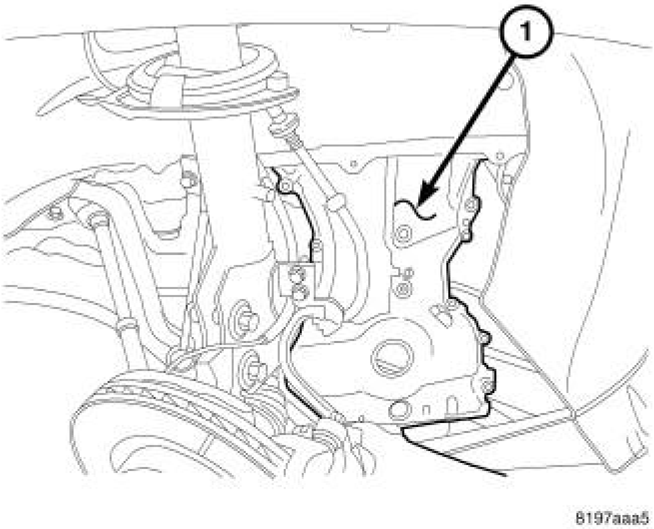



**Fig. 52: Timing Chain Cover Removal/Installation**
**Courtesy of CHRYSLER GROUP, LLC**

15. Remove the engine timing cover (1). Refer to **COVER(S), ENGINE TIMING, REMOVAL**.

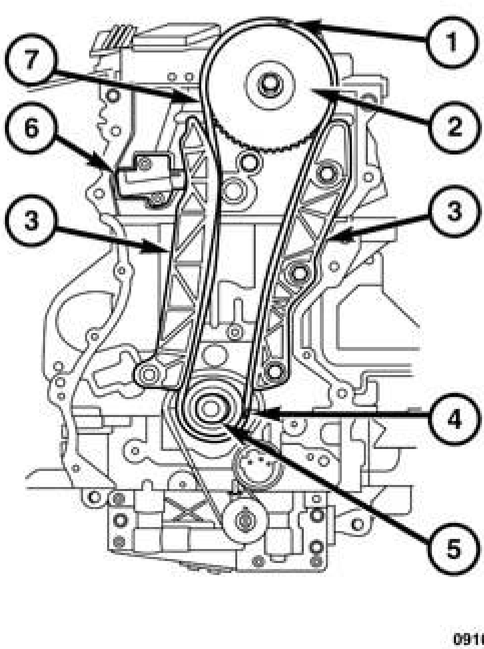



**Fig. 53: Timing Chain, Sprockets, Tensioner & Guides**

**Courtesy of CHRYSLER GROUP, LLC**

16. Remove the tensioner (6) and timing chain (7). Refer to **CHAIN AND SPROCKETS, TIMING, REMOVAL**.
17. Remove the timing chain guides (3).

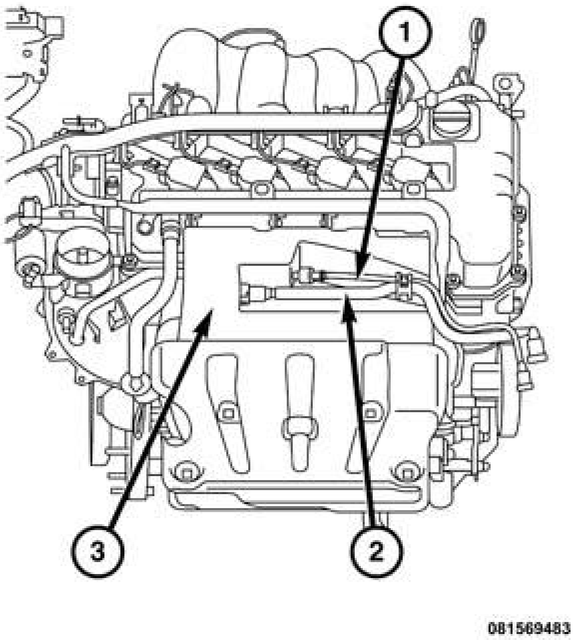



**Fig. 54: Foam Insulator, Fuel Line & Purge Line**
**Courtesy of CHRYSLER GROUP, LLC**

18. Disconnect the vapor line (2) at the purge vapor solenoid end of the line.
19. Remove the NVH foam pad (3) prior to disconnecting the fuel line (1).

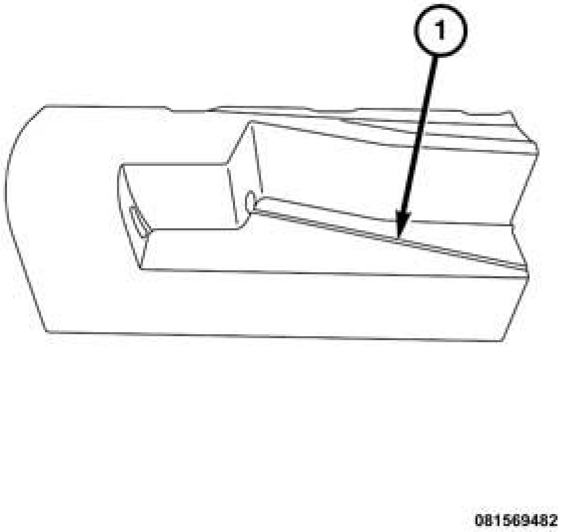



**Fig. 55: Score Line**
**Courtesy of CHRYSLER GROUP, LLC**

20. To remove the foam pad, cut the pad along the score line (1). Make sure care is taken to not make contact with any other components while cutting the pad. **Do not cut beyond the line**

    Remove the pad from the fuel rail once split.

21. Disconnect the fuel line from the fuel rail. Refer to **FITTING, QUICK CONNECT, STANDARD PROCEDURE** .
22. Unplug the Electronic Throttle Control (ETC) connector.
23. Disconnect the VVAA solenoids.
24. Unplug the purge solenoid.

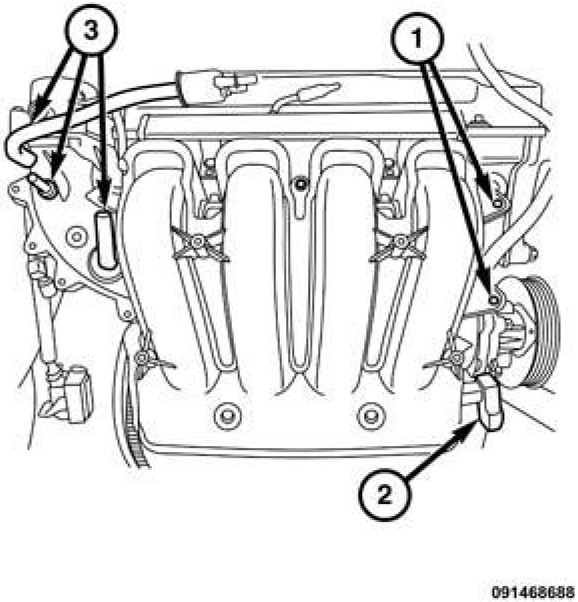



**Fig. 56: MAP Sensor Connector & Fittings**
**Courtesy of CHRYSLER GROUP, LLC**

25. Disconnect the three hoses from the intake manifold fittings (3).
26. Using a permanent ink or paint marker, identify the location and position on each camshaft bearing cap.

**CAUTION: DO NOT STAMP OR STRIKE THE CAMSHAFT BEARING CAPS. SEVERE DAMAGE WILL OCCUR TO THE BEARING CAPS.**

27. Loosen the camshaft bearing cap bolts and remove the camshaft bearing caps.
28. Remove the camshafts.

**NOTE: If the rocker arms are to be reused, identify their positions so that they can be reassembled into their original locations.**

29. Remove the rocker arm(s).

**NOTE: If the hydraulic lifters are to be reused, identify their positions so that they can be reassembled into their original locations.**

30. Remove the hydraulic lifter(s).

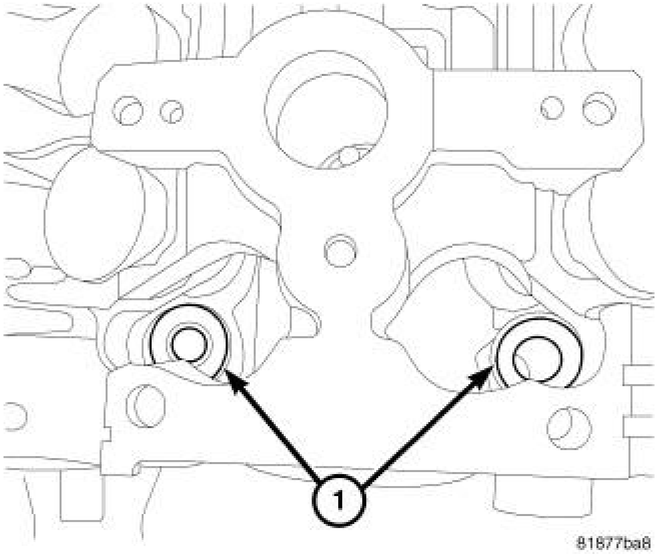



**Fig. 57: Front Head Bolt Washers**
**Courtesy of CHRYSLER GROUP, LLC**

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

31. Remove the cylinder head bolts and two uncaptured washers (1).
32. Remove the cylinder head from the engine block.

| | |
|---|---|
| **NOTE:** | **There is a foam insulator that is sandwiched between the intake manifold and the engine black that may fall off when the cylinder head is removed. The foam pad must be reinstalled during assembly.** |

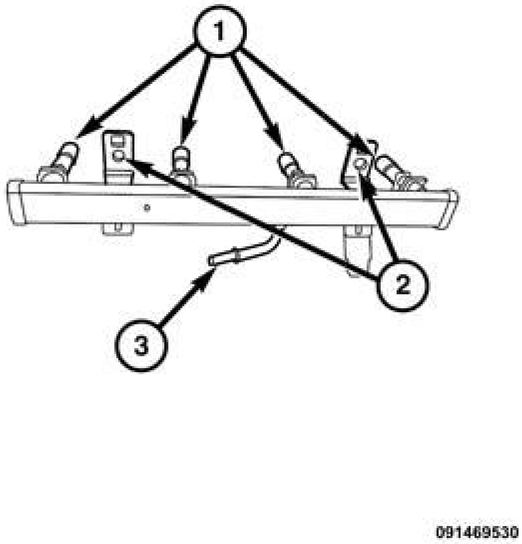



**Fig. 58: Fuel Injectors & Rail**
**Courtesy of CHRYSLER GROUP, LLC**

33. Disconnect the fuel injector electrical connectors (1). Remove the two bolts at the fuel rail (2).

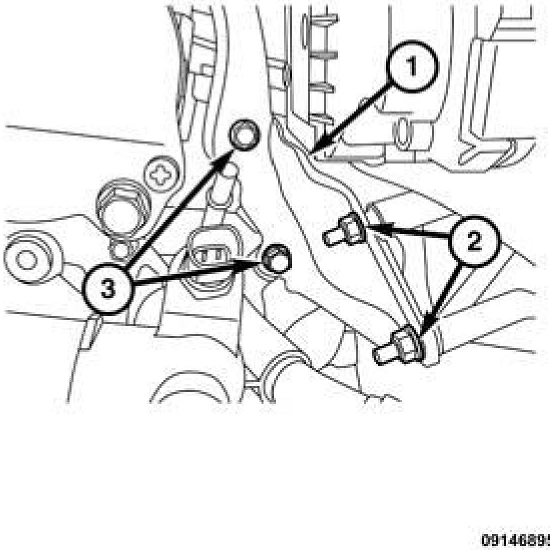



**Fig. 59: Intake Manifold Upper Support Bracket, Bolts & Nuts**
**Courtesy of CHRYSLER GROUP, LLC**

34. Remove the throttle body bracket bolts (3), loosen the nuts (2). Allow the throttle body bracket bolts to remain with the intake manifold.

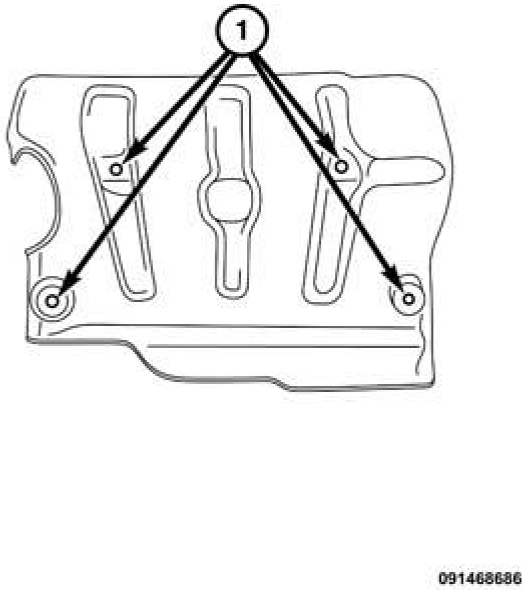



**Fig. 60: Intake Manifold Silencer Pad Screws**
**Courtesy of CHRYSLER GROUP, LLC**

35. Remove the four screws that secure the intake manifold silencer to the manifold (1).

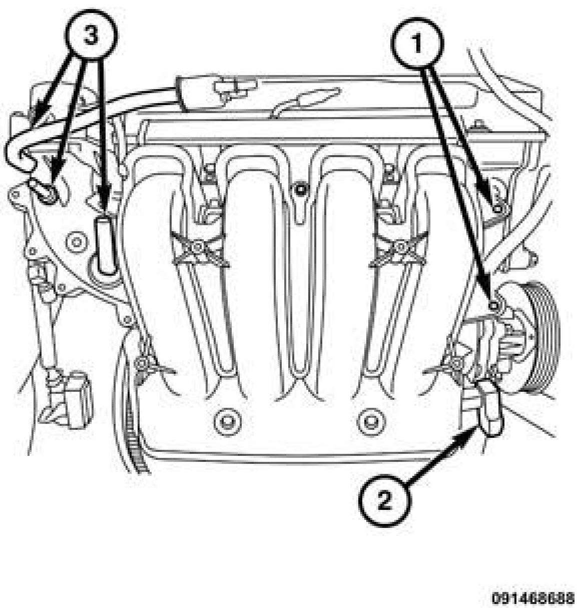


**Fig. 61: MAP Sensor Connector & Fittings**
**Courtesy of CHRYSLER GROUP, LLC**

36. Remove wiring harness retainer from the intake manifold eyelets (1)
37. Unplug the MAP sensor connector (2).

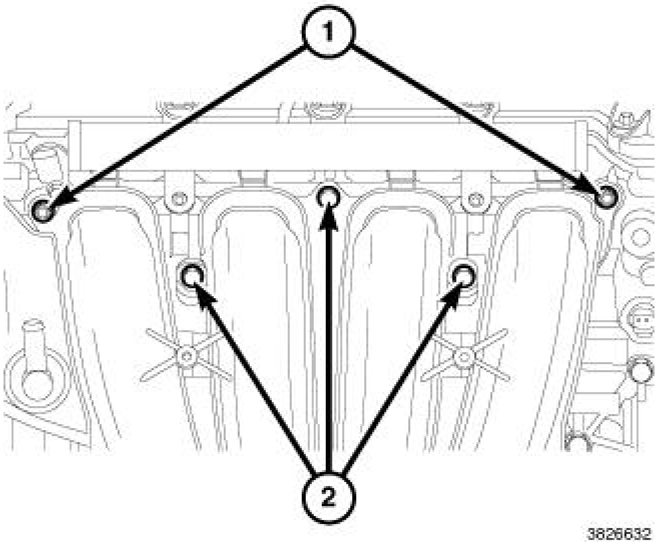



**Fig. 62: Intake Manifold Retaining Bolts & Nuts**
**Courtesy of CHRYSLER GROUP, LLC**

38. Remove intake manifold retaining bolts (2) and nuts (1).
39. Remove the intake manifold from the cylinder head.
40. Inspect the cylinder head and cylinder head components. Refer to **CYLINDER HEAD - INSPECTION** .

**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

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

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.**

1. 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.
2. Clean all engine oil passages.
3. Clean out the cylinder head bolt holes in the engine block.

## INSPECTION

### INSPECTION

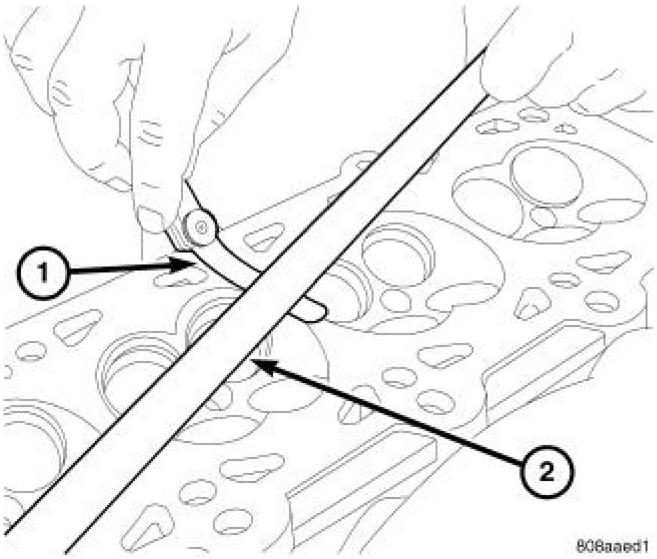



**Fig. 63: Checking Cylinder Head Flatness**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical Cylinder Head shown in illustration.**

1. Check for cylinder head warping with a straight edge (2) and feeler gauge (1).
2. Cylinder head must be flat within specification. Refer to **ENGINE SPECIFICATIONS** .
3. Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.
4. Inspect the following components and verify that they are within specification. Refer to **ENGINE SPECIFICATIONS** .
    - Springs
    - Valve Seats
    - Valve Guides
    - Valves

## INSTALLATION

### INSTALLATION

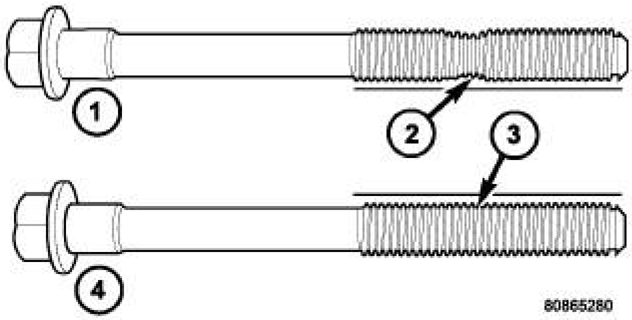



**Fig. 64: Checking Cylinder Head Bolts For Stretching (Necking)**
**Courtesy of CHRYSLER GROUP, LLC**

**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 the 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.

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

**NOTE: Prior to installing the cylinder head to the block, the intake manifold must installed onto the cylinder head.**

2. Replace the variable valve timing filter screen (3).
3. Clean all gasket surfaces.
4. Replace intake manifold gasket seals.
5. Position the foam pad over the coolant transfer tube.
6. **Apply 3-5 dabs of RTV to the foam pad where it makes contact with the coolant transfer tube prior to setting the foam pad in position. This will aid in holding the pad in the proper position while setting the head on the block.**

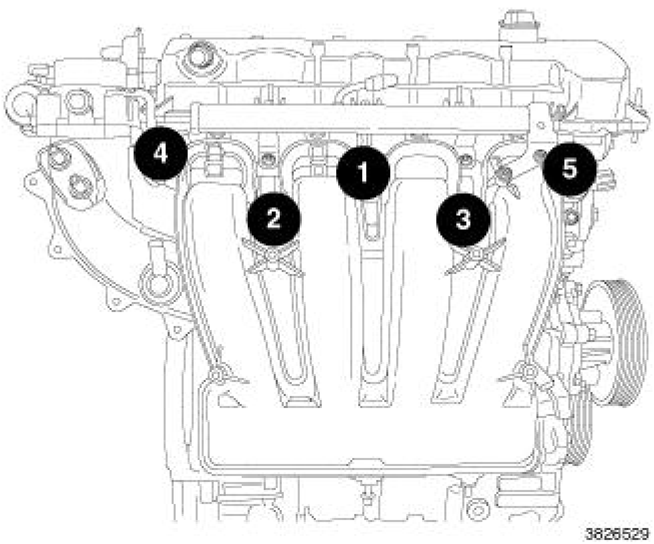



**Fig. 65: Intake Manifold Bolts Tightening Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

7. Position the intake manifold onto the cylinder head.
8. Install the three bolts and two nuts. Using the torque sequence pattern as a guide, tighten the bolts and nuts to 25 N.m (18 ft. lbs.).

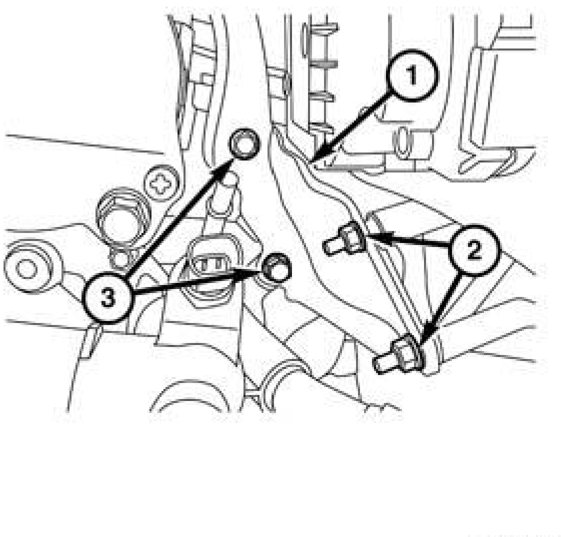



**Fig. 66: Intake Manifold Upper Support Bracket, Bolts & Nuts**
**Courtesy of CHRYSLER GROUP, LLC**

9. Install the manifold to head bracket (1). Tighten the nuts (2) and bolts to 9 N.m (81 in. lbs.)
10. Install the fuel rail assembly. Refer to **RAIL, FUEL, INSTALLATION** .

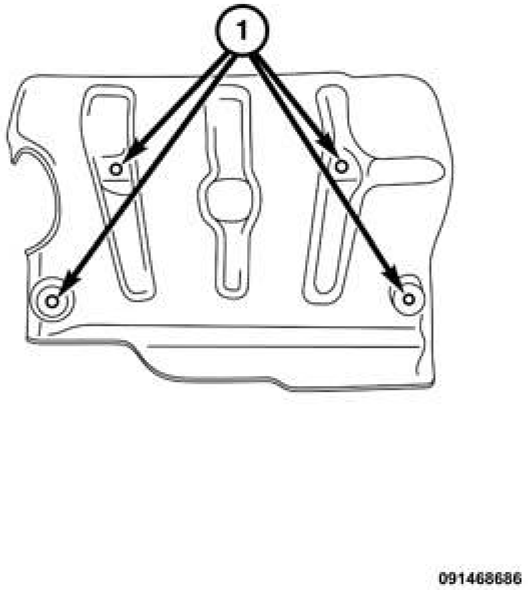



**Fig. 67: Intake Manifold Silencer Pad Screws**
**Courtesy of CHRYSLER GROUP, LLC**

11. Install the intake manifold silencer pad and screws. Tighten the screws to 2.5 N.m (22 in. lbs.).

**NOTE: When using RTV, components should be assembled within 10 minutes and tighten to specification within 45 minutes.**

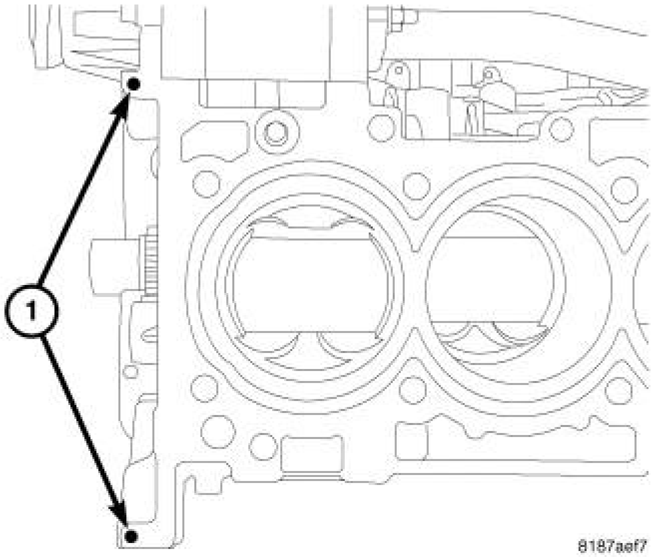



**Fig. 68: Engine Sealant RTV Location**
**Courtesy of CHRYSLER GROUP, LLC**

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

in illustration.

13. Position the new cylinder head gasket on the engine block with the part number facing up. Ensure gasket is seated over the locating dowels in the block.
14. Route the knock sensor wiring harness between the coolant transfer tube and the engine block. Insert the harness retainer into the holder.
15. Position the cylinder head onto the engine block.

**NOTE: Make sure the foam pad is not out of position. Inspect the positioning of the pad from below to make sure that no part of the pad is between the cylinder head and the engine block surface.**

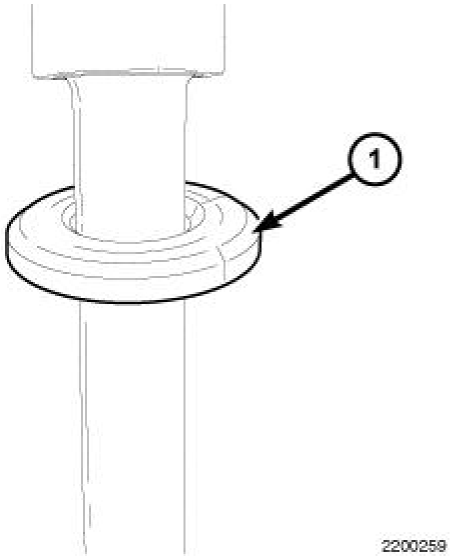



**Fig. 69: Washers Must Be Installed With Bevel Edge Up Towards Bolt Head**
**Courtesy of CHRYSLER GROUP, LLC**

**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.**

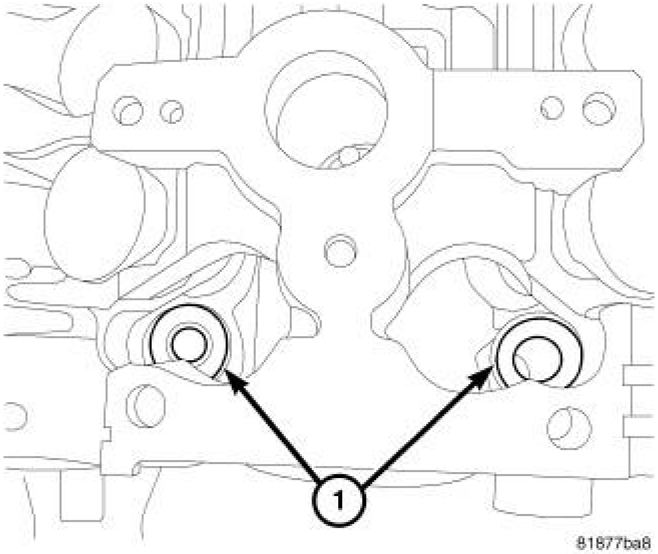



**Fig. 70: Front Head Bolt Washers**
**Courtesy of CHRYSLER GROUP, LLC**

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

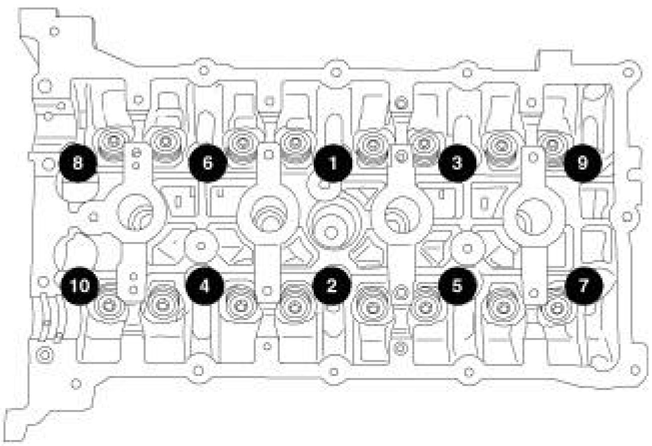



**Fig. 71: Cylinder Head Torque Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

| | |
|---|---|
| **NOTE:** | **DOHC shown in illustration, SOHC same sequence.** |
| **NOTE:** | **Before installing the cylinder head bolts, lubricate the threads with clean engine oil.** |

17. Install the ten cylinder head bolts finger tight.
18. Tighten the cylinder head bolts in the sequence shown in illustration, following this 4 step torque plus

angle method. Tighten according to the following torque values:

- Step 1: All to 30 N.m (22 ft. lbs.)
- Step 2: All to 73 N.m (54 ft. lbs.)
- Step 3: All again to 73 N.m (54 ft. lbs.)
- Step 4: All an additional 90° Turn **Do not use a torque wrench for this step.**

19. If the hydraulic lifters are being reused, reassemble them into their original locations.
20. Install the exhaust hydraulic lifters.

**NOTE: If the rocker arms are being reused, reassemble them into their original locations.**

21. Install the exhaust rocker arms.
22. Oil all of the camshaft journals with clean engine oil.
23. Install the camshaft

    Refer to **CAMSHAFT, ENGINE, INSTALLATION**.

24. Install the VVAA. Refer to **ASSEMBLY, VARIABLE VALVE ACTUATION, INSTALLATION**.
25. Install timing chain and tensioner. Refer to **CHAIN AND SPROCKETS, TIMING, INSTALLATION**.
26. Install timing chain cover, engine mount, pulleys and accessory drive belt. Refer to **COVER(S), ENGINE TIMING, INSTALLATION**.

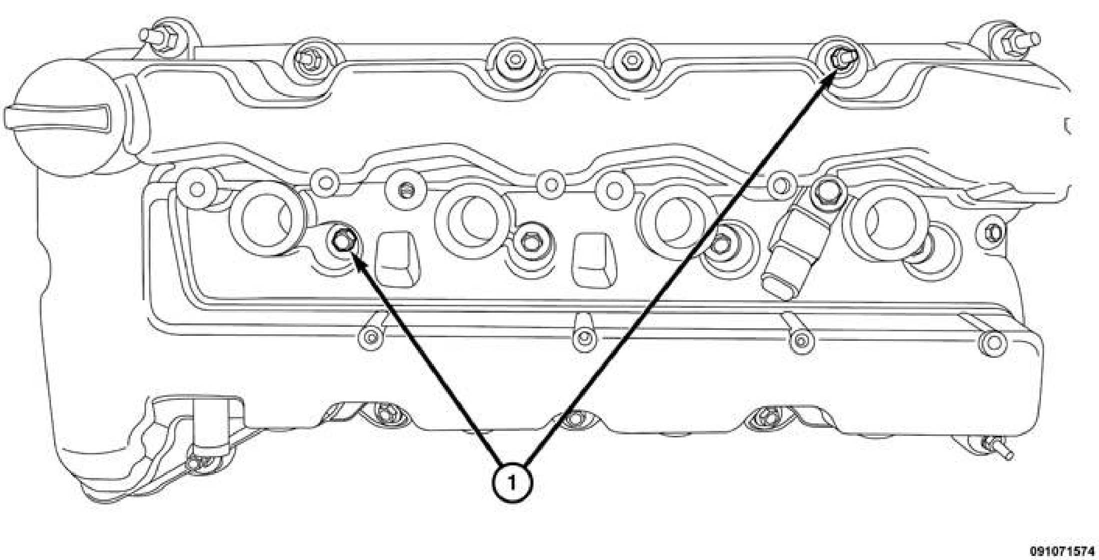



**Fig. 72: Cylinder Head Cover Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

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

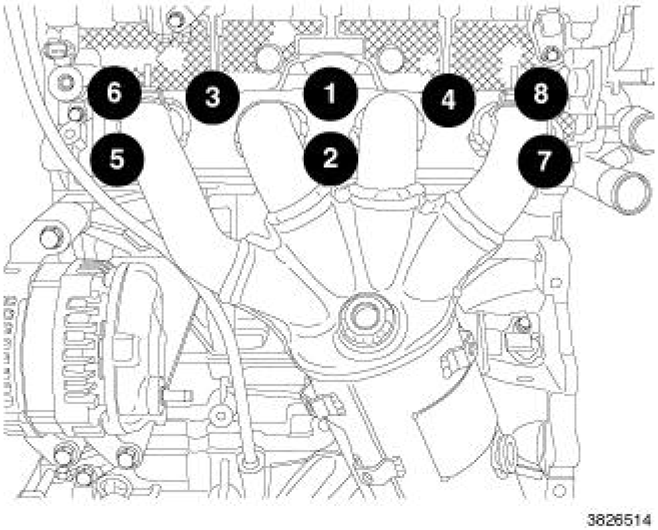



**Fig. 73: Exhaust Manifold Bolts Tightening Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

28. Install the exhaust manifold. Refer to **MANIFOLD, EXHAUST, INSTALLATION**.
29. Connect the electrical connectors to the ignition coils and fuel injectors.

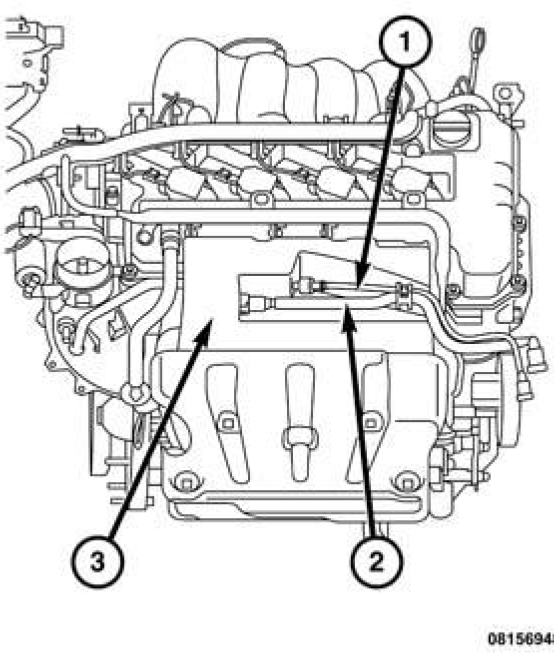



**Fig. 74: Foam Insulator, Fuel Line & Purge Line**
**Courtesy of CHRYSLER GROUP, LLC**

30. Insert the foam insulator (3) over the fuel rail.
31. Connect fuel line (1).
32. Connect the purge vapor line (2). Remove wiring harness retainer from the intake manifold eyelets (1).

33. Connect the three hose connectors (3).
34. Connect the knock sensor connector.

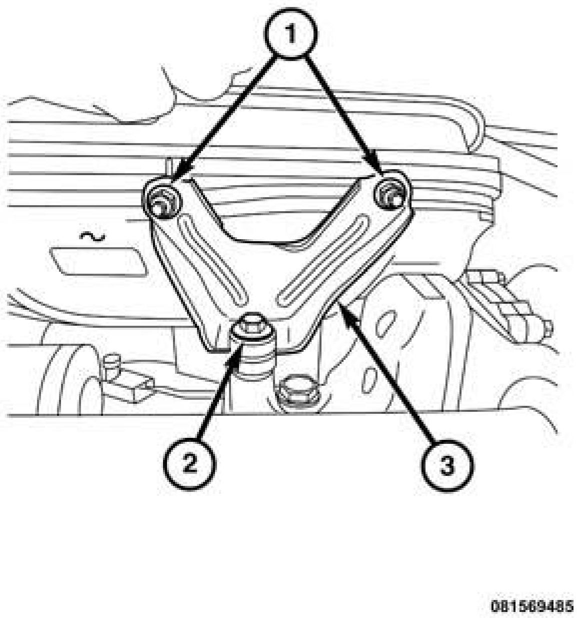



**Fig. 75: Intake Manifold Lower Bracket, Nuts & Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

35. Install the intake manifold lower bracket (3). Install the nuts (1) and bolt (2). Tighten to 9 N.m (81 in. lbs.)
36. Connect the VVAA solenoids.
37. Connect the MAP sensor connector (2).

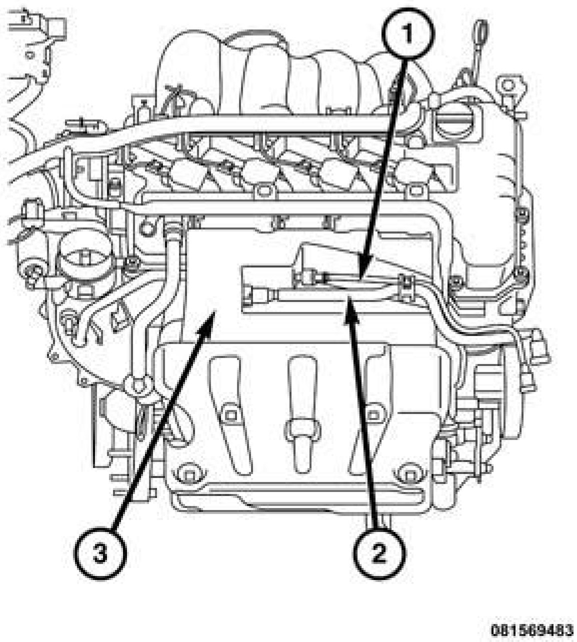



**Fig. 76: Foam Insulator, Fuel Line & Purge Line**
**Courtesy of CHRYSLER GROUP, LLC**

38. Inspect quick connect fittings for damage, replace if necessary. Refer to **FITTING, QUICK CONNECT, STANDARD PROCEDURE** .

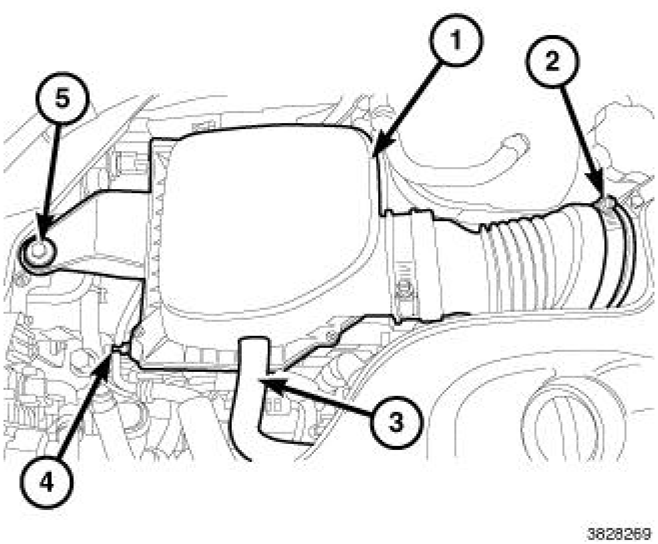



**Fig. 77: Air Cleaner Body, Clamp, Make Up Air Hose, Retainer & Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

39. Install the air cleaner body (1). Refer to **BODY, AIR CLEANER, INSTALLATION**.

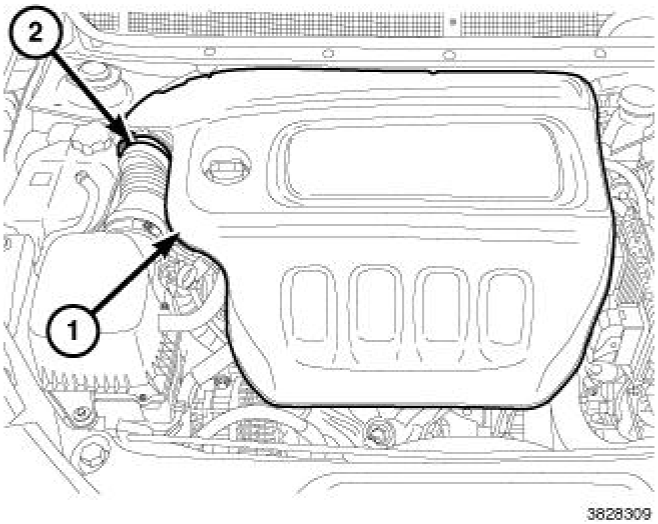



**Fig. 78: Engine Cover & Air Resonator Clamp**
**Courtesy of CHRYSLER GROUP, LLC**

40. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **OIL - STANDARD PROCEDURE** .
41. Fill the cooling system. Refer to **STANDARD PROCEDURE** .
42. Recharge the air conditioning system. Refer to **PLUMBING, STANDARD PROCEDURE** .
43. Install the resonator. Refer to **RESONATOR, AIR CLEANER, INSTALLATION**.
44. Connect the battery negative cable and tighten nut to 5 N.m (45 in. lbs.).
45. Run the engine until it reaches normal operating temperature. Check cooling system for correct fluid level. Refer to **STANDARD PROCEDURE** .
46. The Cam/Crank Variation Relearn procedure must be performed using the scan tool anytime there has been a repair/replacement made to a powertrain system, for example: flywheel, valvetrain, camshaft and/or crankshaft sensors or components. Refer to appropriate Diagnostic Information .

## CAMSHAFT, ENGINE

### DESCRIPTION

#### DESCRIPTION

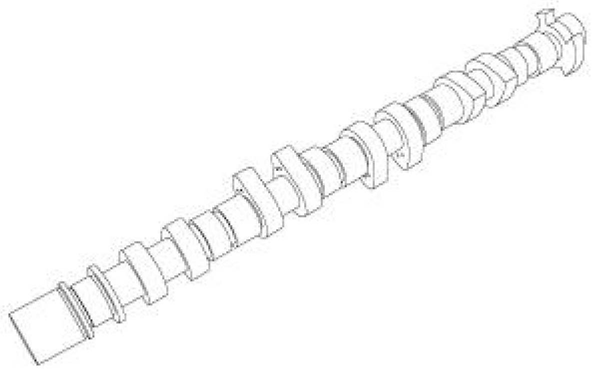



**Fig. 79: Engine Camshaft**
**Courtesy of CHRYSLER GROUP, LLC**

The 2.4L engine uses a Single Over Head Camshaft (SOHC) to provide valve actuation but the camshaft is in the standard position of an exhaust camshaft in a Dual Over Head Camshaft (DOHC) engine. The camshaft has five bearing journal surfaces and three cam lobes per cylinder. The camshaft is built up on a hollow tube with cam lobes, bearing journals and end caps pressed into position. The front end cap includes the camshaft sprocket mounting. The middle (number three) bearing surface has thrust walls machined into it to control end play. The rear has a camshaft position sensor pick-up wheel and also drives the vacuum pump.

**OPERATION**

**OPERATION**

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

**STANDARD PROCEDURE**

**STANDARD PROCEDURE - CAMSHAFT END PLAY**

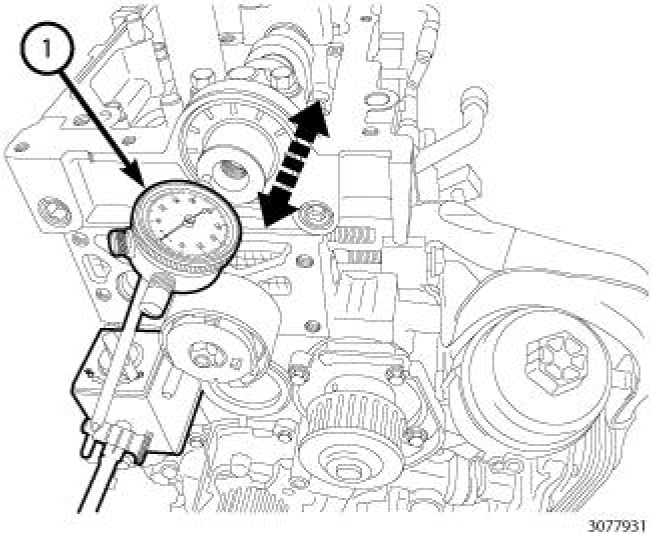



**Fig. 80: Measuring Camshaft End Play**
**Courtesy of CHRYSLER GROUP, LLC**

#### STANDARD PROCEDURE - CAMSHAFT ENDPLAY

1. Remove the cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.
2. Mount Dial Indicator Set (special tool #C-3339A, Set, Dial Indicator) (1) to a stationary point at the front of the engine. Locate the probe perpendicular against the nose of the camshaft.
3. Move the camshaft all the way to the rear of its travel.
4. Zero the dial indicator.
5. Move the camshaft forward to the limit of travel and read the dial indicator. Compare the measured end play to the specification. Refer to **ENGINE SPECIFICATIONS** .

### REMOVAL

#### REMOVAL

1. Disconnect and isolate the battery negative cable.
2. Remove the cylinder head cover . Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.
3. Remove the spark plugs. Refer to **SPARK PLUG, REMOVAL** .
4. Raise and support the vehicle. Refer to **HOISTING, STANDARD PROCEDURE** .

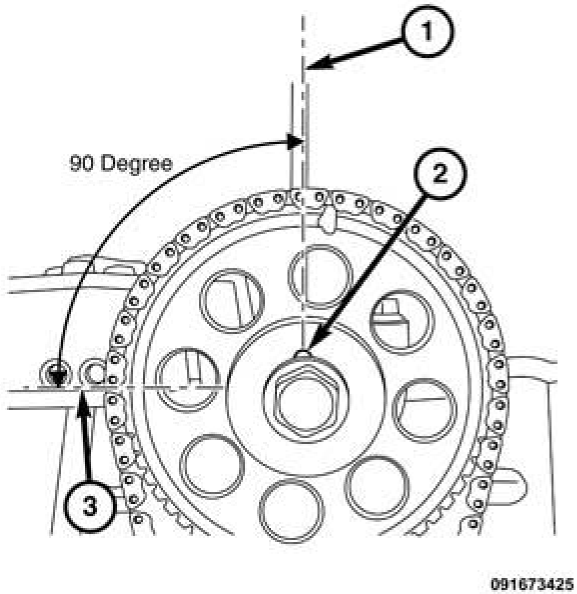



**Fig. 81: Vertical Center Line Of Camshaft, Dowel & Cylinder Head**
**Courtesy of CHRYSLER GROUP, LLC**

5. Remove the frame cover portion of the right splash shield. Refer to **SHIELD, SPLASH, FRONT WHEELHOUSE, REMOVAL** .

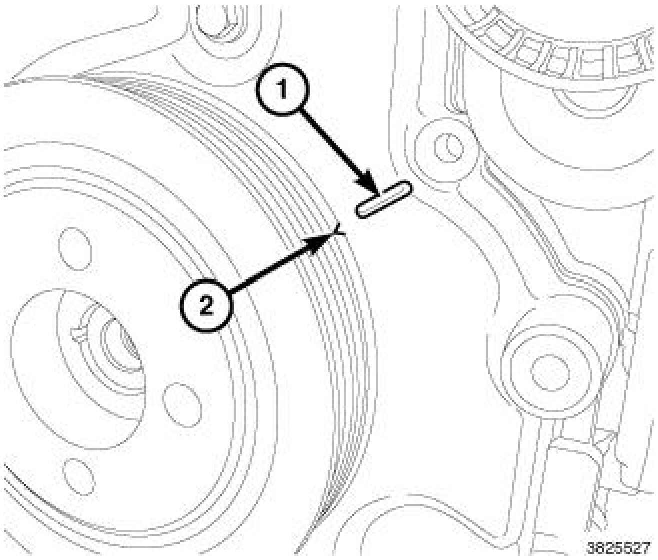



**Fig. 82: Timing Cover Mark & Notch**
**Courtesy of CHRYSLER GROUP, LLC**

6. Rotate the crankshaft clockwise (as viewed from the front) to align the timing cover mark (1) with the damper notch (2) to place the number one cylinder piston at top-dead-center on the compression stroke.

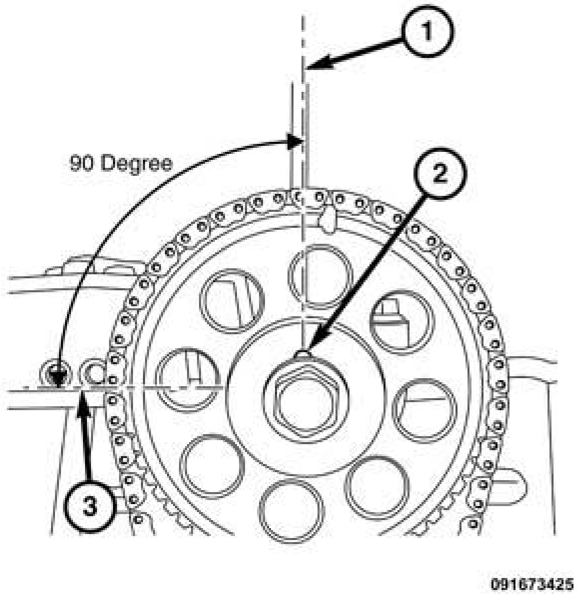



**Fig. 83: Vertical Center Line Of Camshaft, Dowel & Cylinder Head**
**Courtesy of CHRYSLER GROUP, LLC**

7. Verify that the camshaft timing is correct as viewed above. The vertical center line of the camshaft (1) and the horizontal surface of the top of the cylinder head (3)

   **MUST be**

   90° from each other.

**NOTE:** **The camshaft dowel (2) is slightly visible above the camshaft center bolt and should be at 12 o'clock when set.**

8. Lower the vehicle and support the engine with a jack stand.

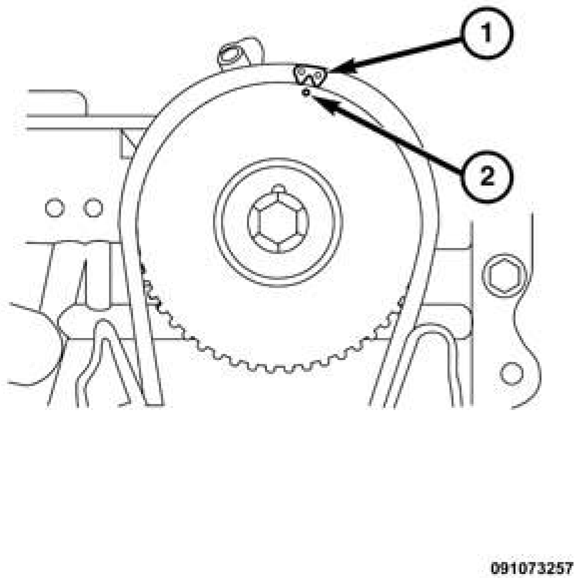



**Fig. 84: Sprocket Mark & Painted Link**
**Courtesy of CHRYSLER GROUP, LLC**

9. Using a paint pen or equivalent, mark both camshaft sprockets and corresponding chain links (1 and 2) to aid in reassembly.

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

**CAUTION: DO NOT STAMP OR STRIKE THE CAMSHAFT BEARING CAPS. SEVERE DAMAGE WILL OCCUR TO THE BEARING CAPS.**

10. Remove the vacuum pump.
11. Remove the right engine mount. Refer to **INSULATOR, ENGINE MOUNT, REAR, REMOVAL** and/or **INSULATOR, ENGINE MOUNT, RIGHT, REMOVAL**.
12. Remove the timing cover. Refer to **COVER(S), ENGINE TIMING, REMOVAL**.
13. Using a permanent ink or paint marker, identify the location and position on each camshaft bearing cap.

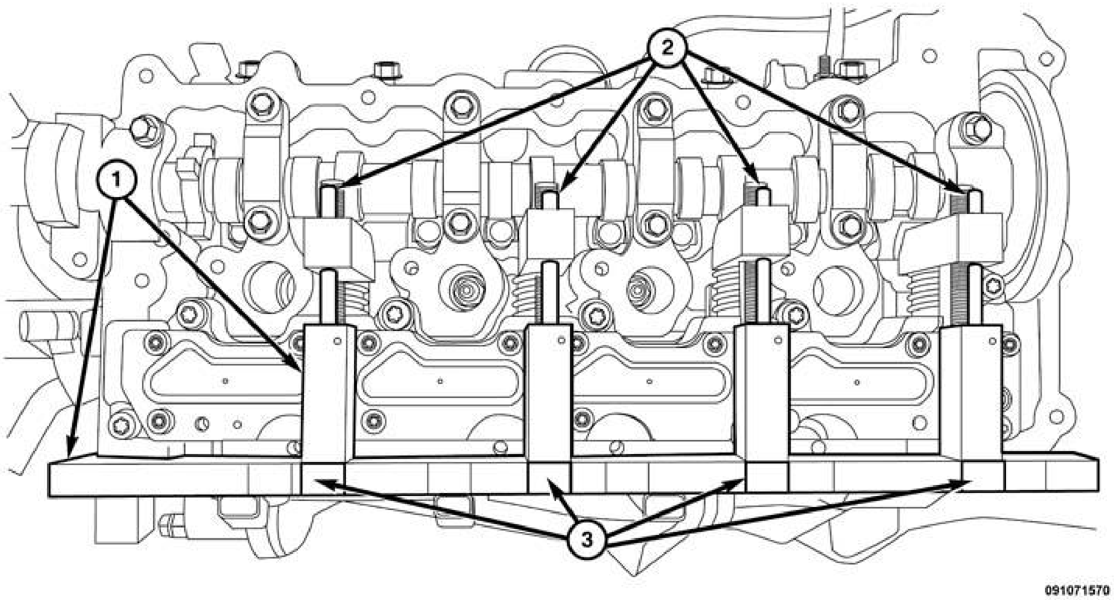



**Fig. 85: Special Tool, Spring Compressor & Indicators**
**Courtesy of CHRYSLER GROUP, LLC**

14. Using special tool 10259A (1), loosen the spring compressors (2) to fit over the valve and spring assemblies. Adjust the tool to align with the 2.4L indicators (3).
15. Install the (special tool #10259B, Compressor, MultiAir® Spring) spring compressor
16. Rotate the spring compressors counterclockwise until the springs are fully seated.

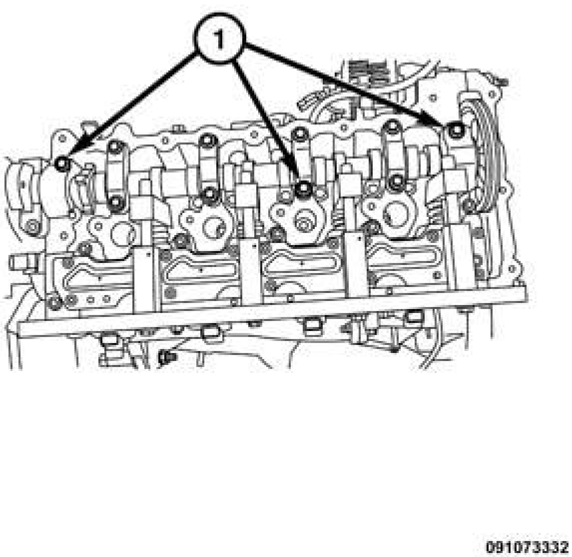



**Fig. 86: Bearing Cap Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

17. **Slowly** remove the exhaust camshaft bearing cap bolts (1) one turn at a time. Remove the camshaft bearing caps.

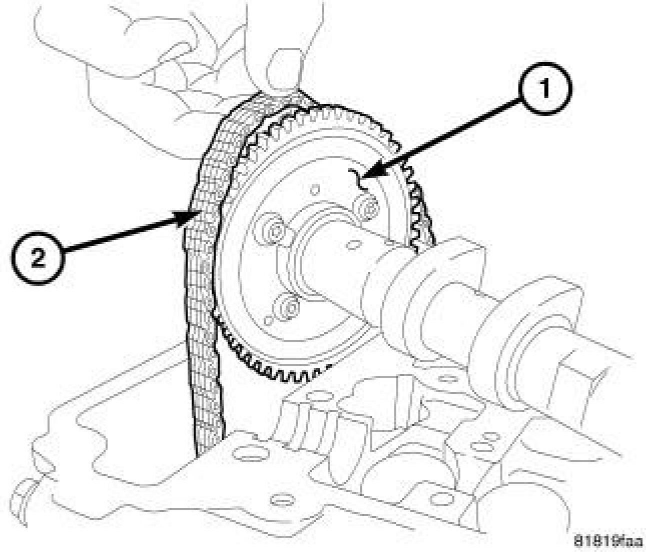



**Fig. 87: Chain Removal**
**Courtesy of CHRYSLER GROUP, LLC**

18. Lift the timing chain (2) off of the sprocket (1).
19. Remove the camshaft.
20. Remove the sprocket from the camshaft.

**INSPECTION**

**INSPECTION**

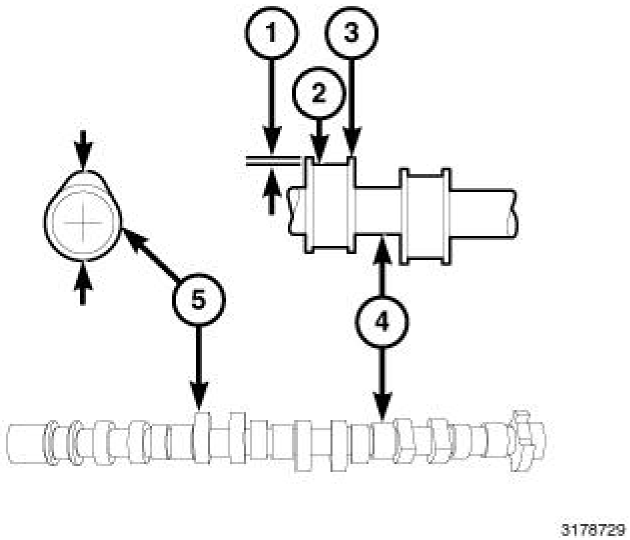



**Fig. 88: Inspecting Camshaft Wear Areas**
**Courtesy of CHRYSLER GROUP, LLC**

1. Inspect the camshaft bearing journals (4) for damage and binding. If the journals are binding, check the camshaft bearing housing for damage. Also check the oil supply holes for clogging.
2. Check the surface of the cam lobes (5) for abnormal wear (1). Measure and compare the unworn area (3) to the worn area (2). Replace the camshaft if it is not within specification. Refer to **ENGINE SPECIFICATIONS** .

**INSTALLATION**

**INSTALLATION**

**NOTE:** **Camshaft bearing caps are marked during engine manufacturing. For example, the front camshaft bearing cap is marked 1, the read cap is marked with a 5. The markings on the caps must be read while looking from the left bank of the engine (closest to the front of the vehicle).**

**NOTE:** **Following the installation of each camshaft bearing cap, visually verify that the camshaft has some endplay.**

1. Lubricate camshaft journals with clean engine oil.
2. Apply a seam of Anaerobic Loctite® 518 Sealant on the camshaft housing in the contact area of the front and rear camshaft caps.

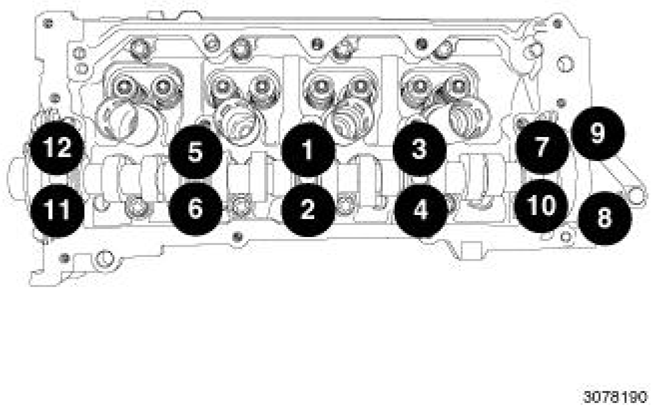



**Fig. 89: Camshaft Bearing Cap Tightening Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

Torque Sequence

**NOTE:** **VVAA removed for clarity**

3. Install the camshaft and camshaft bearing caps. Tighten the twelve bolts in two steps following the

sequence shown in illustration:

- Step 1: All to 5 N.m (44 in. lbs.).
- Step 2: All to 10 N.m (89 in. lbs.).

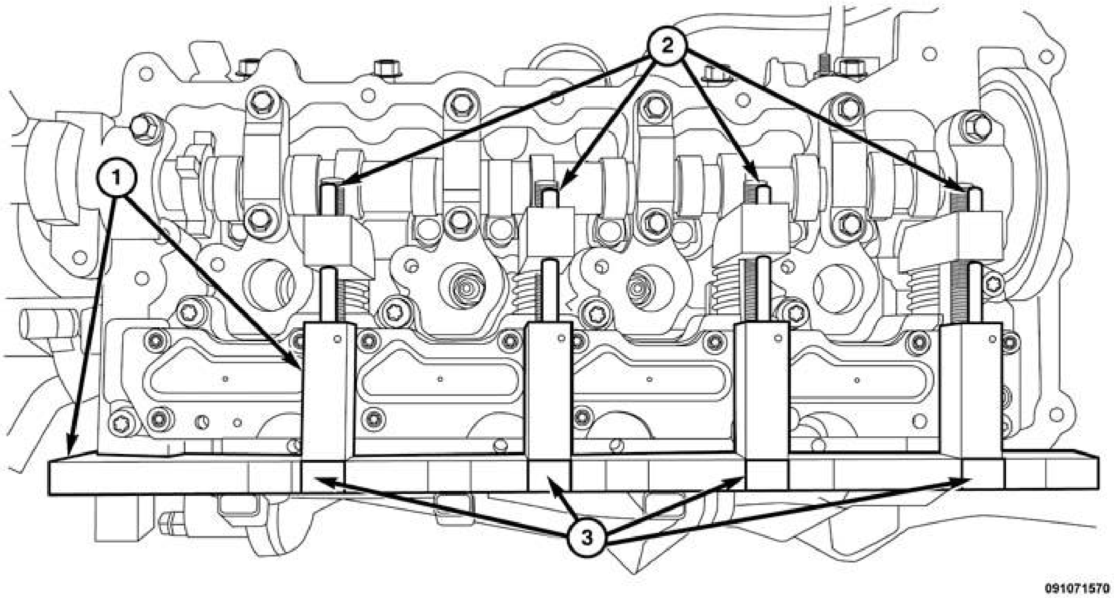



**Fig. 90: Special Tool, Spring Compressor & Indicators**
**Courtesy of CHRYSLER GROUP, LLC**

4. Loosen the spring compressors (2), remove the tool (special tool #10259B, Compressor, MultiAir® Spring) (1).

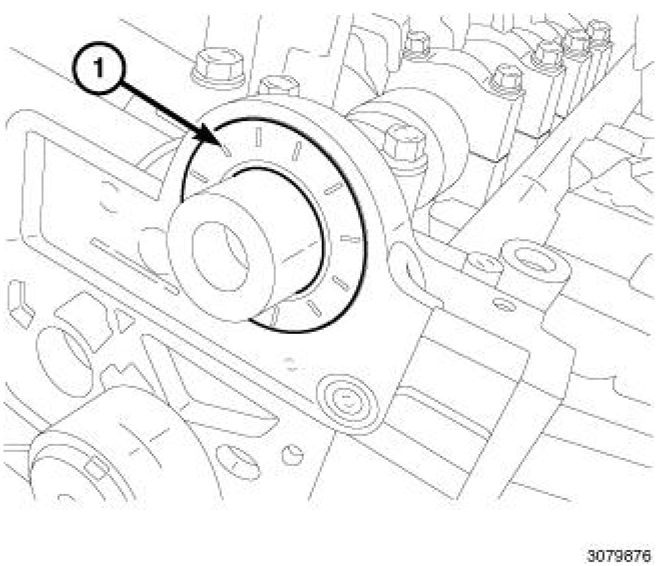



**Fig. 91: Camshaft Seal**
**Courtesy of CHRYSLER GROUP, LLC**

5. If required, install a new camshaft seal (1). Refer to **SEAL(S), CAMSHAFT, INSTALLATION** .

6. Install the camshaft sprocket and timing chain. Refer to **CHAIN AND SPROCKETS, TIMING, INSTALLATION**.
7. Install the timing cover. Refer to **COVER(S), ENGINE TIMING, INSTALLATION**.
8. Install the cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, INSTALLATION**.

| | |
|---|---|
| **NOTE:** | **The Cam/Crank Variation Relearn procedure must be performed using the scan tool anytime there has been a repair/replacement made to a powertrain system, for example: flywheel, valvetrain, camshaft and/or crankshaft sensors or components.** |

## COVER(S), CYLINDER HEAD

### DESCRIPTION

#### DESCRIPTION

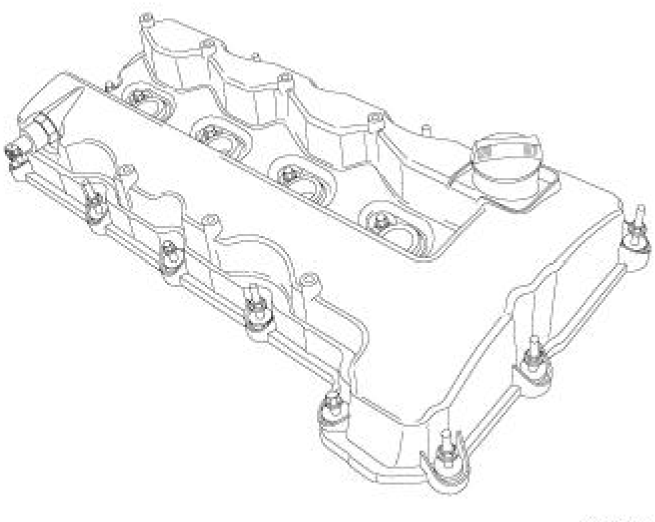



**Fig. 92: Cylinder Head Cover**
**Courtesy of CHRYSLER GROUP, LLC**

The cylinder head cover is made of die cast aluminum. The cylinder head cover is sealed with press-in-place gaskets at the cylinder head and spark plug ports. RTV is used to seal the T-joint at the cylinder head cover, front timing cover and cylinder head. RTV is also used to seal the cylinder head cover to the rear camshaft bearing cap at the vacuum pump.

### REMOVAL

#### REMOVAL

1. Remove the engine cover assembly.
2. Disconnect and isolate the battery negative cable.
3. Remove the make up air hose from the cylinder head cover fitting.

4. Remove the positive crankcase ventilation (PCV) hose.
5. Disconnect and remove the ignition coils. Refer to **COIL, IGNITION, REMOVAL** .

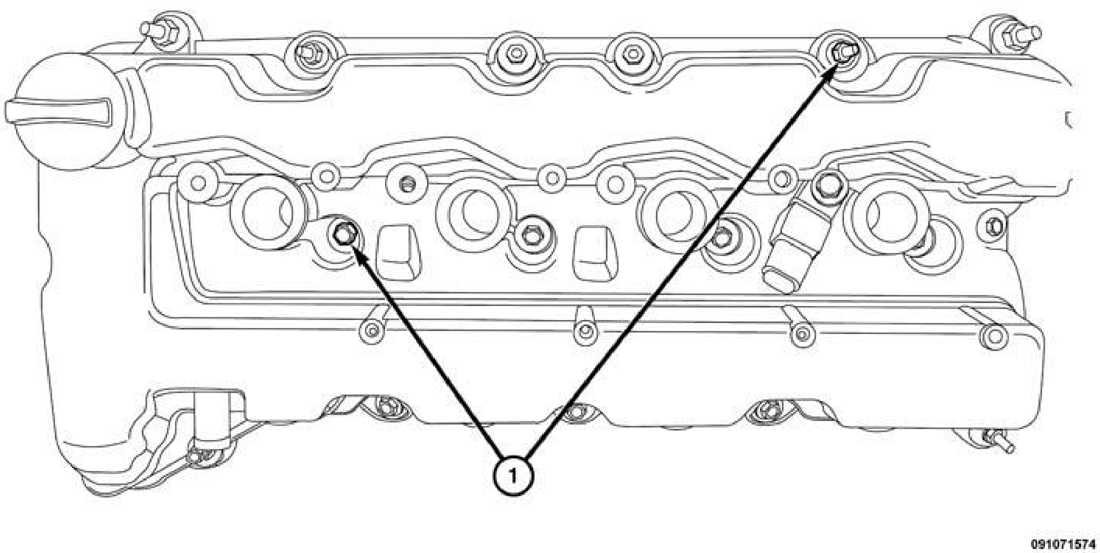



**Fig. 93: Cylinder Head Cover Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

6. Use compressed air to blow dirt and debris off of the cylinder head cover prior to removal.
7. Remove the push pins that secure the coil harness to the cover.

**NOTE: If any of the push pins break off in the cover, use a pick to rotate the lodged portion counterclockwise to back the portion out of the hole.**

8. Loosen twelve cylinder head cover mounting bolts and six stud bolts (1).
9. Remove the cylinder head cover from the cylinder head.

**NOTE: With the help of an assistant, hold the coil harness up and spread open as the cover is removed through the area between the left and right harness runs.**

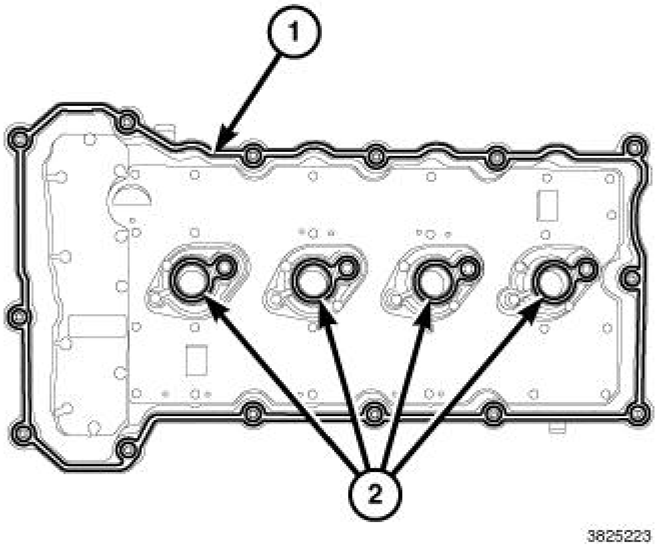



**Fig. 94: Cylinder Head Cover Gaskets**
**Courtesy of CHRYSLER GROUP, LLC**

10. Remove and discard the cylinder head cover gaskets (1 and 2).

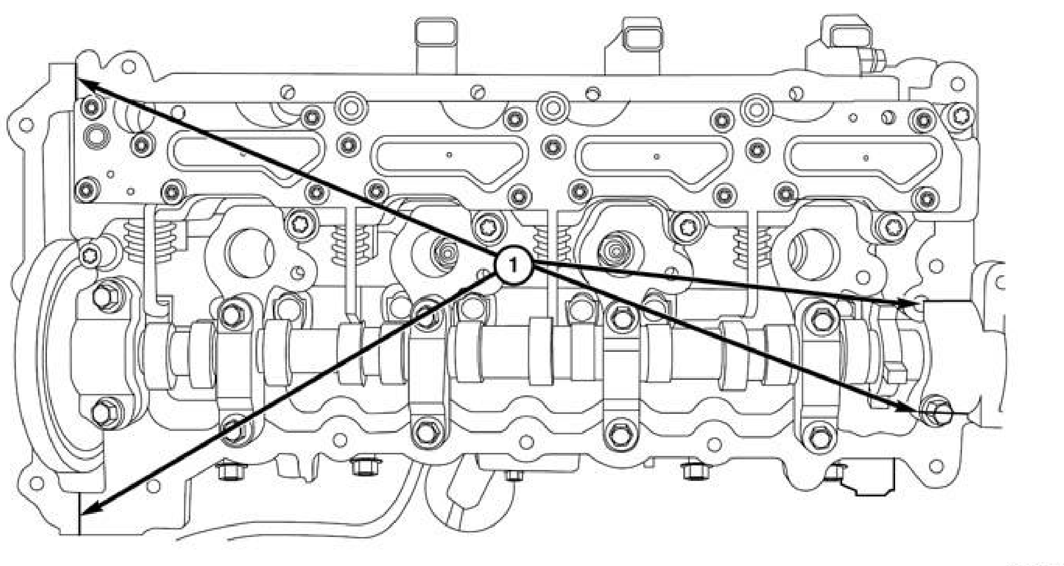



**Fig. 95: Sealant Application Areas**
**Courtesy of CHRYSLER GROUP, LLC**

11. Remove all residual sealant (1) from the cylinder head, timing chain cover, rear exhaust camshaft bearing cap and cylinder head cover mating surfaces. Refer to **ENGINE - STANDARD PROCEDURE** .

**INSTALLATION**

**INSTALLATION**

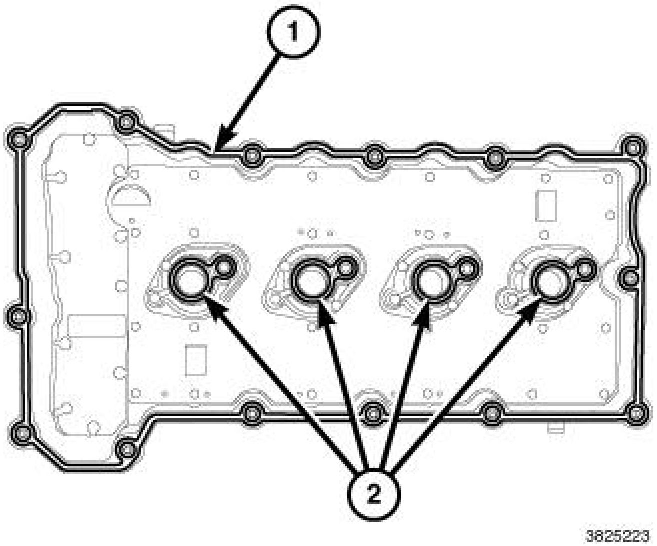



**Fig. 96: Cylinder Head Cover Gaskets**
**Courtesy of CHRYSLER GROUP, LLC**

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

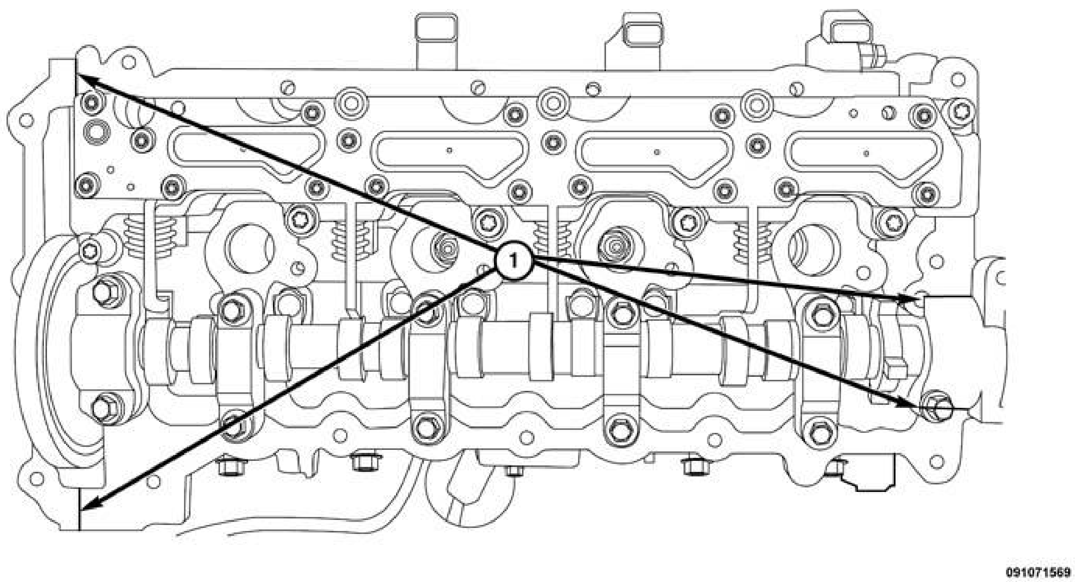



**Fig. 97: Sealant Application Areas**
**Courtesy of CHRYSLER GROUP, LLC**

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

| | |
|---|---|
| **NOTE:** | **When using RTV, components should be assembled within 10 minutes and tighten to specification within 45 minutes.** |

2. Apply a 2 to 3 mm wide bead of Mopar® engine sealant RTV or equivalent to the cylinder head/front cover T-joint (1) and the rear exhaust camshaft bearing cap/cylinder head T-joint (1).

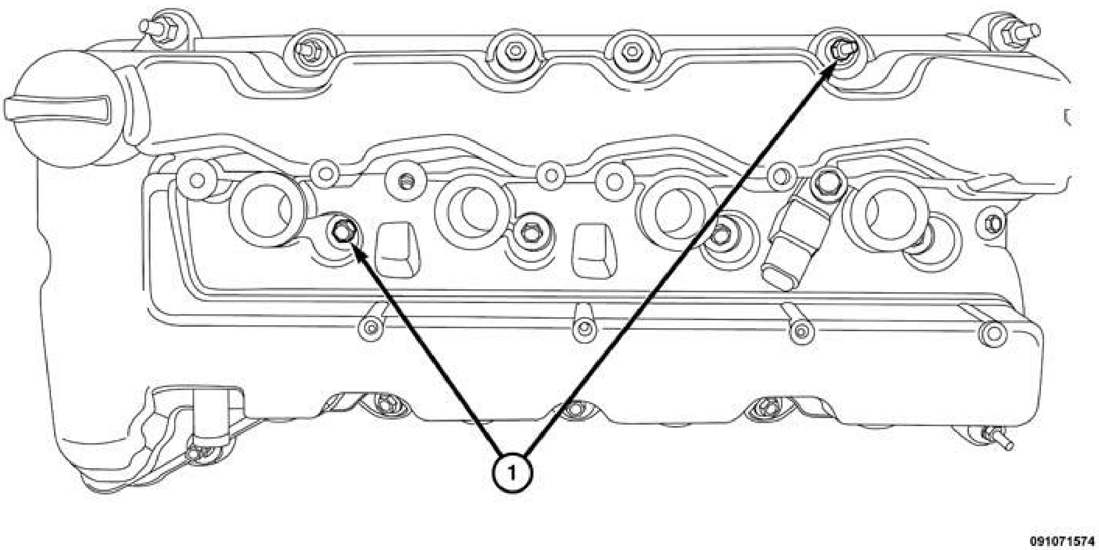



**Fig. 98: Cylinder Head Cover Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

3. Install the cylinder head cover to the cylinder head with twelve bolts and six stud bolts (1). Tighten all eighteen fasteners to 10 N.m (90 in. lbs.).
4. Install the cylinder cover ground strap and nut. Tighten the nut to 10 N.m (90 in. lbs.)
5. Install and connect the ignition coils. Refer to **COIL, IGNITION, INSTALLATION** .
6. If removed, install the positive crankcase ventilation (PCV) valve and tighten to 4 N.m (37 in. lbs.).

**NOTE: Make sure the O-ring is seated on the shoulder of the opening prior to reading the torque.**

7. Connect the PCV hose to the PCV valve.
8. Connect the make up air hose.
9. Connect the battery negative cable and tighten nut to 5 N.m (45 in. lbs.).
10. Install the engine cover assembly.

## LIFTER(S), HYDRAULIC

### DIAGNOSIS AND TESTING

#### DIAGNOSIS AND TESTING - LASH ADJUSTER (TAPPET) NOISE

Proper noise diagnosis is essential in locating the source of an NVH complaint. Locating a lash adjuster (tappet) type noise can sometimes be difficult. As a result, an initial misdiagnosis may occur.

Refer to the following chart for possible causes and correction of a lash adjuster (tappet) type noise:

**LASH ADJUSTER (TAPPET) NOISE CHART**

| POSSIBLE CAUSES | CORRECTION |
|---|---|
| 1. Engine oil level-too high or too low. This may allow aerated oil to enter the adjusters and cause them to be spongy. | 1. Check and correct the engine oil level. |
| 2. Insufficient running time after rebuilding a cylinder head. | 2. Low speed running of up to 1 hour may be required to fully evacuate trapped air from the valve train system. During this time, turn engine off and let set for a few minutes before restarting. Repeat this several times after engine has reached normal operating temperature. |
| 3. Air trapped in the lash adjuster (after 1 hour of run time). | 3. See below:<br>(a) Check lash adjusters for sponginess while installed in the cylinder head. Depress the lash adjuster. Normal adjusters should feel very firm. Very spongy adjusters can be bottomed out easily.<br>(b) If the lash adjuster(s) are still spongy, replace the lash adjuster(s). Refer to **LIFTER(S), HYDRAULIC, REMOVAL**. |
| 4. Low oil pressure. | 4. See below:<br>(a) Check and correct the engine oil level.<br>(b) Check the engine oil pressure. Refer to **LUBRICATION - DIAGNOSIS AND TESTING** .<br>(c) Check for excessive main bearing clearance and correct. Refer to **BEARING(S), CRANKSHAFT, MAIN - STANDARD PROCEDURE** .<br>(d) Check for a worn oil pump. |
| 5. Oil passage to the cylinder head(s) plugged with debris. | 5. Check cylinder head oil passages for blockage. Clean or replace as necessary. |
| 6. Worn valve guide(s). | 6. Measure valve stem-to-guide clearance. Refer to **VALVES, INTAKE AND EXHAUST - INSPECTION** . |
| 7. Air ingested into oil due to broken or cracked oil pump pickup tube. | 7. Inspect pickup tube and replace as necessary. Refer to **PICK-UP, OIL PUMP, REMOVAL** . |
| 8. Collapsed lash adjuster due to debris ingestion. | 8. Clean debris from engine and replace lash adjuster (s). Refer to **LIFTER(S), HYDRAULIC, REMOVAL**. |

**REMOVAL**

**REMOVAL**

1. Disconnect and isolate the negative battery cable.

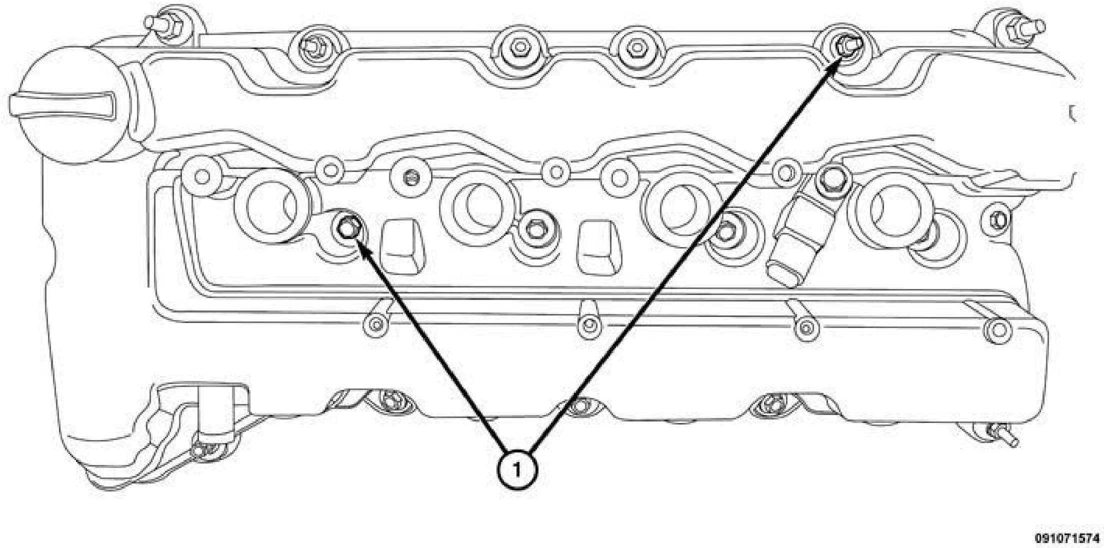



**Fig. 99: Cylinder Head Cover Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

2. Remove the cylinder head cover assembly bolts (1) and remove the cover from the cylinder head.

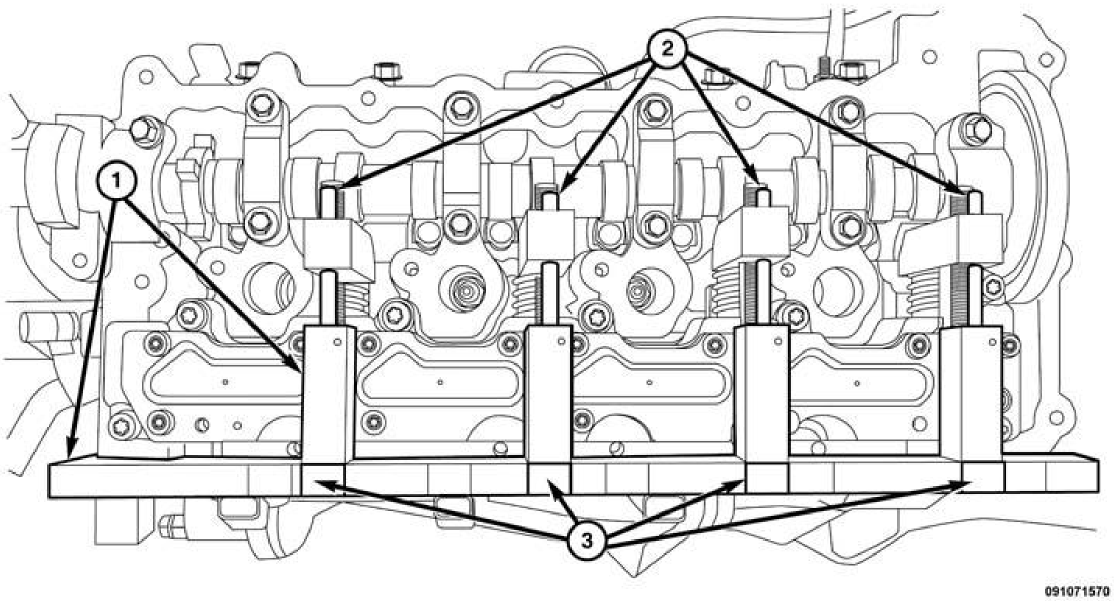



**Fig. 100: Special Tool, Spring Compressor & Indicators**
**Courtesy of CHRYSLER GROUP, LLC**

3. Install special (1) tool to the cylinder head. With the spring compressors lined up in the 2.4L position of the bridge (3), rotate the screw jacks counterclockwise to compress the springs enough to allow slight movement of the rockers.
4. Remove the camshaft(s). Refer to **CAMSHAFT, ENGINE, REMOVAL**.

**NOTE: If the rocker arms are to be reused, identify their positions so that they can be reassembled into their original locations.**

5. Remove the rocker arm(s). Refer to **ROCKER ARM, VALVE, REMOVAL**.

**NOTE: If the hydraulic lifters are to be reused, identify their positions so that they can be reassembled into their original locations.**

6. Remove the hydraulic lifter(s).

**INSTALLATION**

**INSTALLATION**

1. Verify that the hydraulic lifters are at least partially full of oil. There should be little or no plunger travel when the hydraulic lifter is depressed.

**NOTE: If the hydraulic lifters are being reused, reassemble them into their original locations.**

2. Install the hydraulic lifter(s)

**NOTE: If the rocker arms are being reused, reassemble them into their original locations.**

3. Install the rocker arm(s). Refer to **ROCKER ARM, VALVE, INSTALLATION**.
4. Install the camshaft. Refer to **CAMSHAFT, ENGINE, INSTALLATION**.

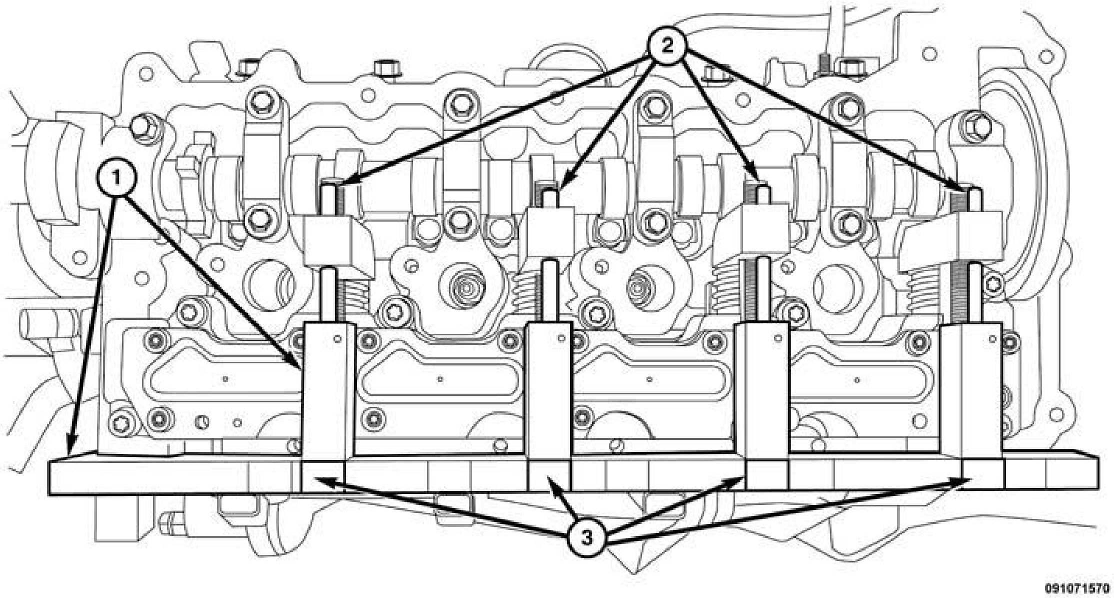



**Fig. 101: Special Tool, Spring Compressor & Indicators**

**Courtesy of CHRYSLER GROUP, LLC**

5. Install the VVAA. Refer to **ASSEMBLY, VARIABLE VALVE ACTUATION, INSTALLATION**.
6. Install the cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, INSTALLATION**.
7. Connect the battery negative cable and tighten nut to 5 N.m (45 in. lbs.).

## ROCKER ARM, VALVE

### DESCRIPTION

#### DESCRIPTION

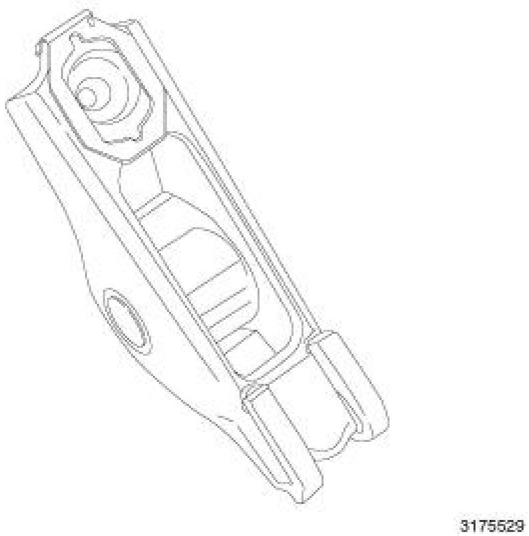



**Fig. 102: Valve Rocker Arm**
**Courtesy of CHRYSLER GROUP, LLC**

The valve rocker arms are steel stampings with an integral roller bearing. A spring clip helps to hold the rocker arm in position on the ball socket when removing or installing the variable valve actuation assembly. The rocker arm ball socket also incorporates a 0.5 mm oil hole for roller and camshaft lubrication.

### REMOVAL

#### REMOVAL

1. Disconnect and isolate the battery negative cable.
2. If the exhaust rockers are to be serviced, remove the exhaust camshaft. Refer to **CAMSHAFT, ENGINE, REMOVAL**.

**NOTE: If the rocker arms are to be reused, identify their positions so that they can be reassembled into their original locations.**

3. If the intake rockers are to be serviced, remove the Variable Valve Actuator Assembly (VVAA). Refer to

**ASSEMBLY, VARIABLE VALVE ACTUATION, REMOVAL**.

4. Remove the rocker arm(s).

**INSPECTION**

**INSPECTION**

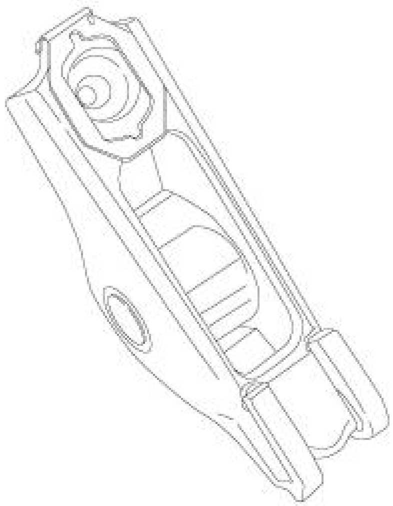



**Fig. 103: Valve Rocker Arm**
**Courtesy of CHRYSLER GROUP, LLC**

Inspect the valve rocker arm for wear or damage. Replace as necessary.

**INSTALLATION**

**INSTALLATION**

1. Lubricate the rocker arms with clean engine oil before installation.

   **NOTE: If the rocker arms are being reused, reassemble them into their original locations.**

2. Install the rocker arm(s).
3. If the intake rockers were serviced, install the VVAA

   Refer to **ASSEMBLY, VARIABLE VALVE ACTUATION, INSTALLATION**.

4. If the exhaust rockers were serviced, Install the camshaft and cylinder head cover. Refer to **CAMSHAFT, ENGINE, INSTALLATION**.
5. Connect the battery negative cable and tighten nut to 5 N.m (45 in. lbs.).

**SEAL(S), VALVE GUIDE**

**DESCRIPTION**

**DESCRIPTION**

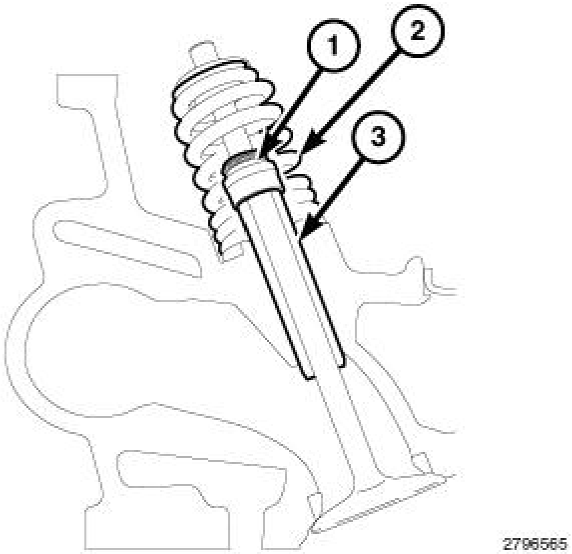



**Fig. 104: Valve Stem Oil Seal, Valve Spring & Valve Guide**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical valve configuration shown in illustration.**

The valve stem oil seals (1) are made of elastomer over-molded steel in a non-integrated type guide mounted configuration. The seal is not held in place by the valve spring (2). The valve stem seals are not reusable if removed from the valve guides (3), they must be replaced. Always coat the valve seals with clean engine oil before installing the valves.

**REMOVAL**

**REMOVAL**

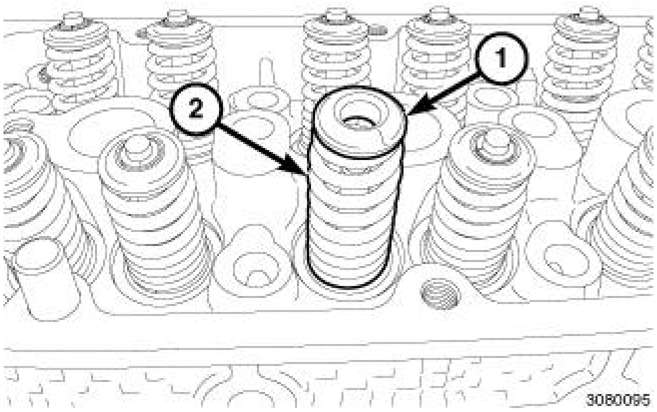



**Fig. 105: Valve Spring & Retainer**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE:** **If the springs are to be reused, identify their positions so that they can be reassembled into their original locations. Number 2 cylinder exhaust valve spring shown in illustration, all other valve springs similar.**

1. Remove the valve spring(s) (2). Refer to **SPRING(S), VALVE, REMOVAL**.

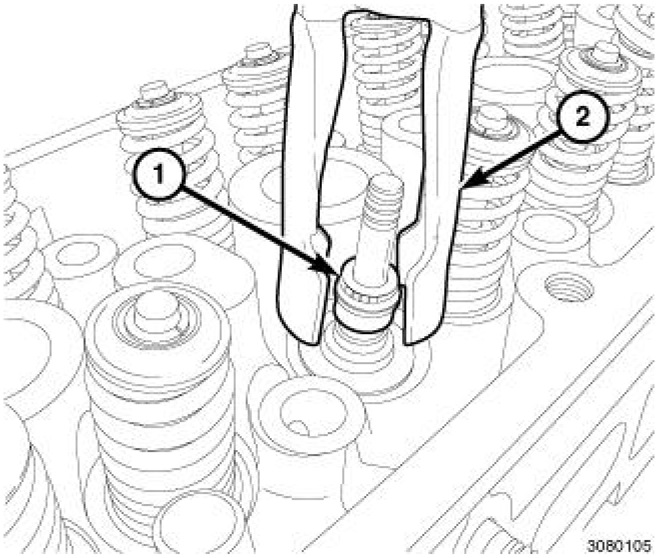



**Fig. 106: Valve Guide Seal & Valve Seal Tool**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE:** **Number 2 cylinder exhaust valve guide seal shown in illustration, all other valve guide seals similar.**

2. Remove the valve guide seal (1) using a valve seal tool (2). Discard the removed seal.

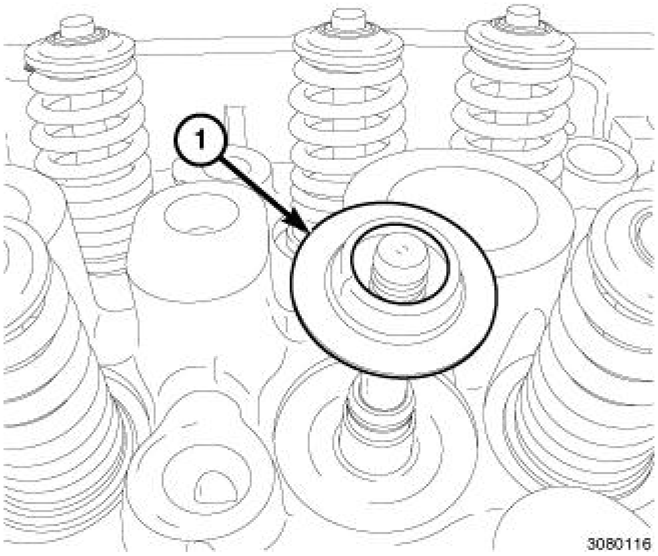



**Fig. 107: Valve Spring Seat**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Number 2 cylinder exhaust valve spring seat shown in illustration. Exhaust valve spring seats are marked with the letter "S" and have a thickness of 0.8 mm (0.031 in.). Intake valve spring seats are marked with the letter "A" and have a thickness of 3.2 mm (0.126 in.).**

3. If required, remove the valve spring seat (1).
4. If required, remove the valve(s). Refer to **VALVES, INTAKE AND EXHAUST, REMOVAL**.

**INSTALLATION**

**INSTALLATION**

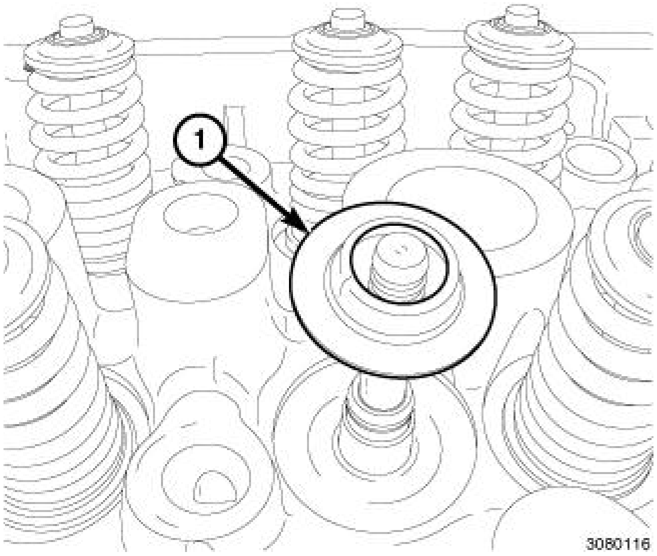



**Fig. 108: Valve Spring Seat**

**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Reassemble the valves into their original locations. If the valves or valve seats have been refinished, verify that the valve stem tip height is within specification. Refer to ENGINE SPECIFICATIONS .**

1. If removed, install the valve(s). Refer to **VALVES, INTAKE AND EXHAUST, INSTALLATION**.

**NOTE: Number 2 cylinder exhaust valve spring seat shown in illustration. Exhaust valve spring seats are marked with the letter "S" and have a thickness of 0.8 mm (0.031 in.). Intake valve spring seats are marked with the letter "A" and have a thickness of 3.2 mm (0.126 in.).**

2. If removed, install the spring seat (1) over the valve guide.

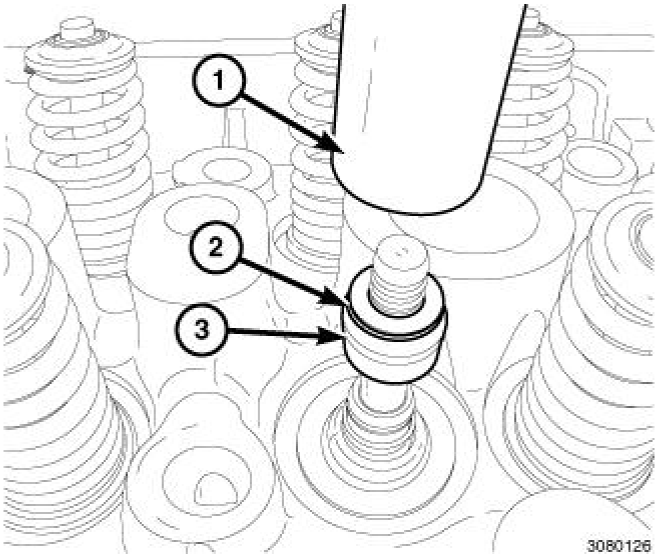



**Fig. 109: Driver, Garter Spring & Valve Guide Seal**
**Courtesy of CHRYSLER GROUP, LLC**

3. Apply engine oil to the lip of the valve guide seal (3). Install the valve guide seal (3) over the valve stem. Using an appropriate driver (1), push the seal firmly and squarely over the valve guide. **Do Not Force** the seal against the top of guide.

**NOTE: Make sure that the garter spring (2) is intact around the top of the valve guide seal (3). Number 2 cylinder exhaust valve guide seal shown in illustration, all other valves similar.**

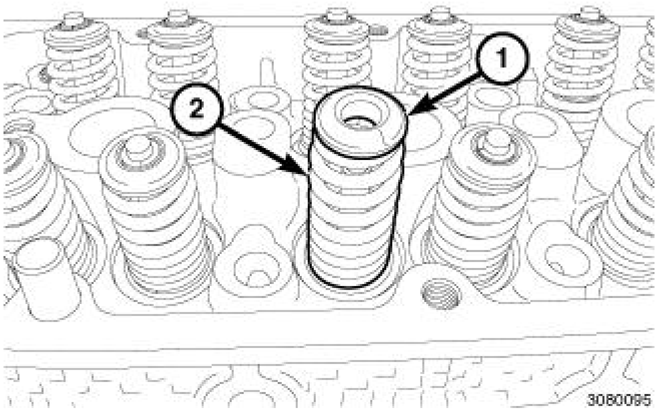



**Fig. 110: Valve Spring & Retainer**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: If the valve springs are being reused, reassemble them into their original locations. Number 2 cylinder exhaust valve spring shown in illustration, all other valves similar.**

4. Install the valve spring(s) (2). Refer to **SPRING(S), VALVE, INSTALLATION**.

## SPRING(S), VALVE

### DESCRIPTION

#### DESCRIPTION

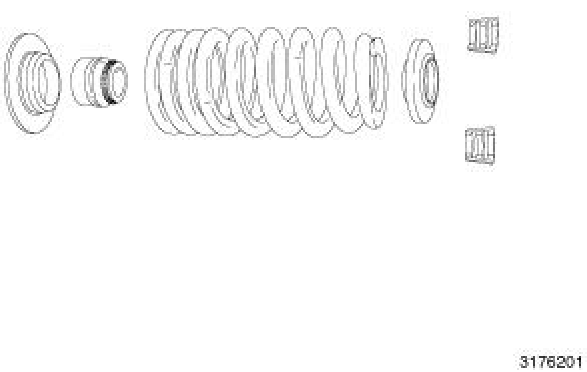



**Fig. 111: Valve Springs Assembly**

**Courtesy of CHRYSLER GROUP, LLC**

The valve springs are a beehive design and made from high strength chrome silicon steel. The springs are common for intake and exhaust applications. Valve guide seals are rubber overmolded on a steel support cylinder with a garter spring at the seal lip. The seals are not integrated with the valve spring seat. The steel valve spring retainers are designed for use with beehive springs and the valve spring retainer locks are a three bead Butt type design to promote valve rotation.

**REMOVAL**

**ON VEHICLE**

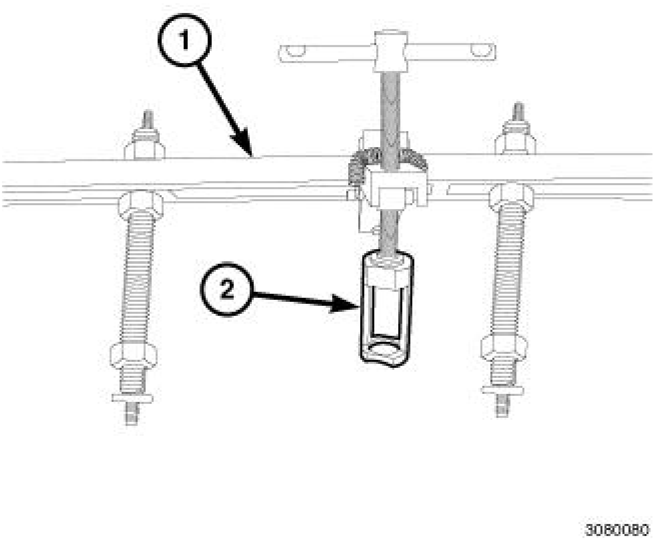



**Fig. 112: Valve Spring Compressor & Adapter**
**Courtesy of CHRYSLER GROUP, LLC**

1. Remove the camshaft(s). Refer to **CAMSHAFT, ENGINE, REMOVAL**.

   **NOTE: If the rocker arms are to be reused, identify their positions so that they can be reassembled into their original locations.**

2. Remove the rocker arm(s). Refer to **ROCKER ARM, VALVE, REMOVAL**.
3. Install the (special tool #10224, Adapter, Valve Spring) (2) on the (special tool #MD998772A, Compressor, Valve Spring) (1).

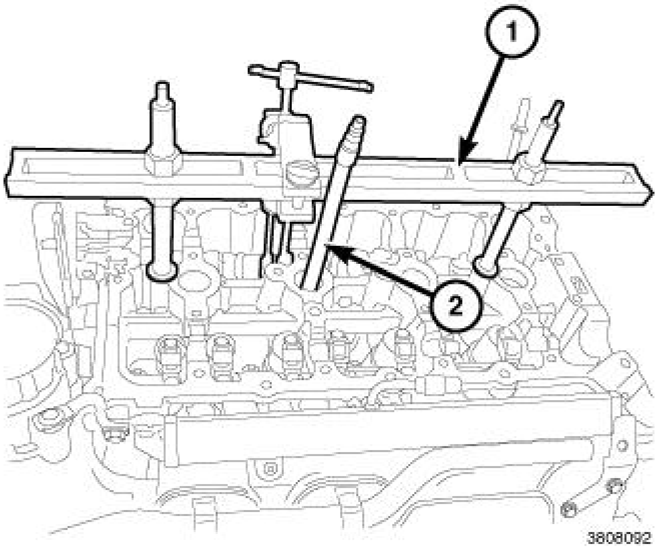



**Fig. 113: Valve Spring Compressor & Air Hose**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Number 3 cylinder exhaust valve spring compression shown in illustration, all other valves similar.**

4. Remove the spark plug. Refer to **SPARK PLUG, REMOVAL** .
5. Install the (special tool #MD998772A, Compressor, Valve Spring) (1) onto the cylinder head.
6. Install a spark plug adapter attached to a regulated shop air supply (2). Pressurize the cylinder being serviced to 620.5 - 689 kPa (90 - 100 psi) to hold the valves in place.

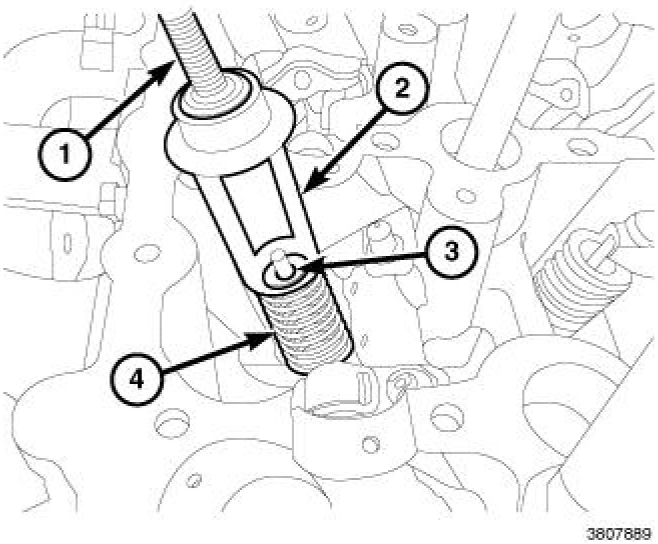



**Fig. 114: Compressing Valve Spring**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Number 3 cylinder exhaust valve spring compression shown in**

**illustration, all other valves similar.**

**CAUTION: Air pressure must be maintained as long as the valve springs are removed to prevent the valves from dropping into the cylinders.**

7. Using the (special tool #10224, Adapter, Valve Spring) (2), compress valve spring (4) and remove valve retaining locks (3).

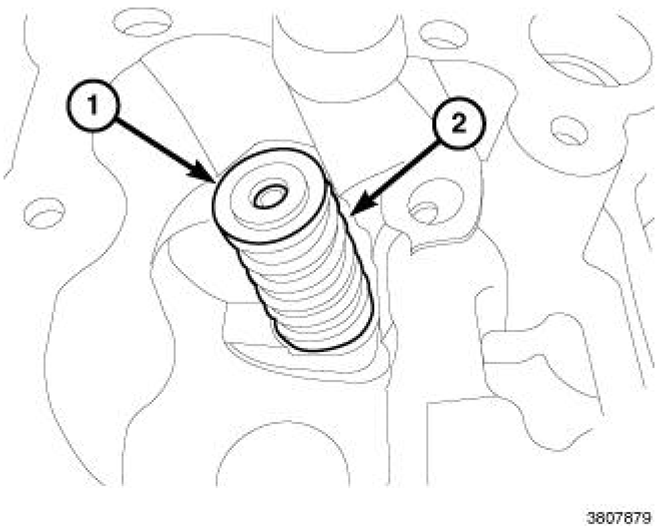



**Fig. 115: Valve Spring & Retainer**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: If the springs are to be reused, identify their positions so that they can be reassembled into their original locations. Number 2 cylinder exhaust valve spring shown in illustration, all other valve springs similar.**

8. Release the valve spring compression and remove the valve spring retainer (1) and valve spring (2).
9. If required, remove the valve guide seal. Refer to **SEAL(S), VALVE GUIDE, REMOVAL**.

**OFF VEHICLE**

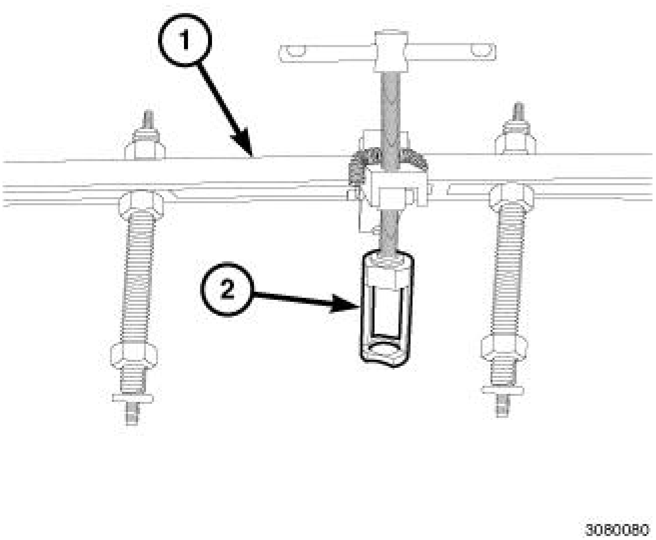



**Fig. 116: Valve Spring Compressor & Adapter**
**Courtesy of CHRYSLER GROUP, LLC**

1. Install the (special tool #10224, Adapter, Valve Spring) (2) on the (special tool #MD998772A, Compressor, Valve Spring) (1).

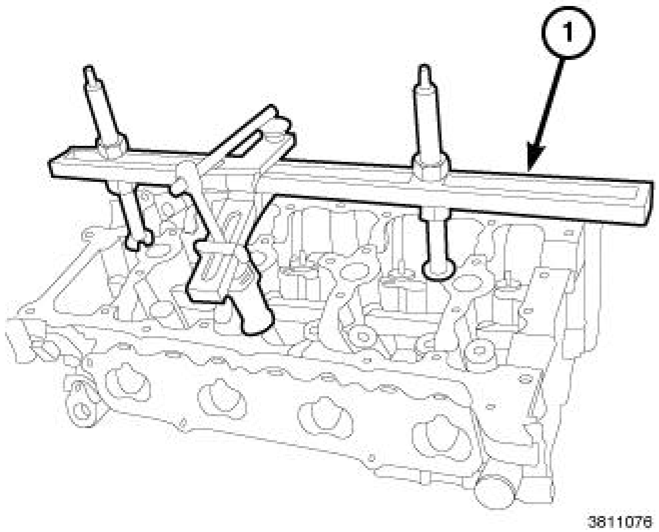



**Fig. 117: Valve Spring Compressor**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Number 3 intake valve spring compression shown in illustration, all other valves similar.**

2. Install the (special tool #MD998772A, Compressor, Valve Spring) (1) onto the cylinder head.
3. Place a ball of rags in the combustion chamber to hold the valves in place.

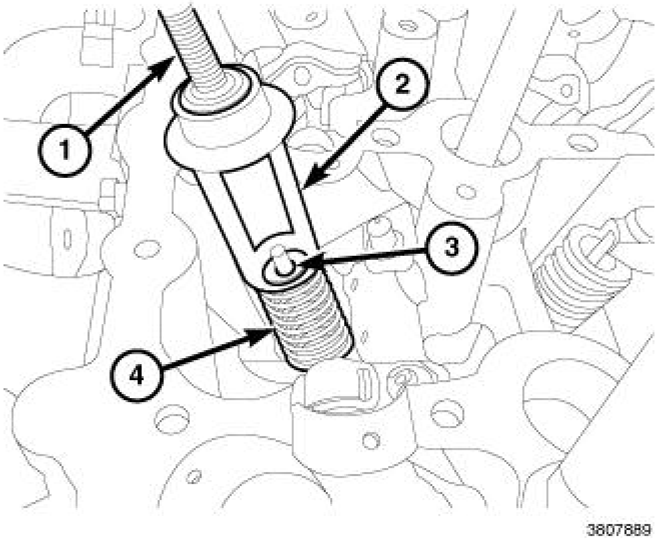



**Fig. 118: Compressing Valve Spring**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Number 3 cylinder exhaust valve spring compression shown in illustration, all other valves similar.**

4. Using the (special tool #10224, Adapter, Valve Spring) (2), compress valve spring (4) and remove valve retaining locks (3).

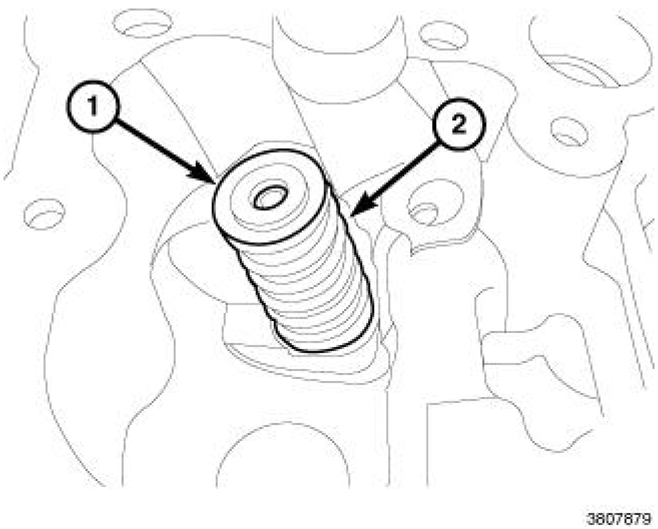



**Fig. 119: Valve Spring & Retainer**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: If the springs are to be reused, identify their positions so that they can be reassembled into their original locations. Number 2 cylinder exhaust valve spring shown in illustration, all other valve springs similar.**

5. Release the valve spring compression and remove the valve spring retainer (1) and valve spring (2).
6. If required, remove the valve guide seal. Refer to **SEAL(S), VALVE GUIDE, REMOVAL**.

**INSPECTION**

**INSPECTION**

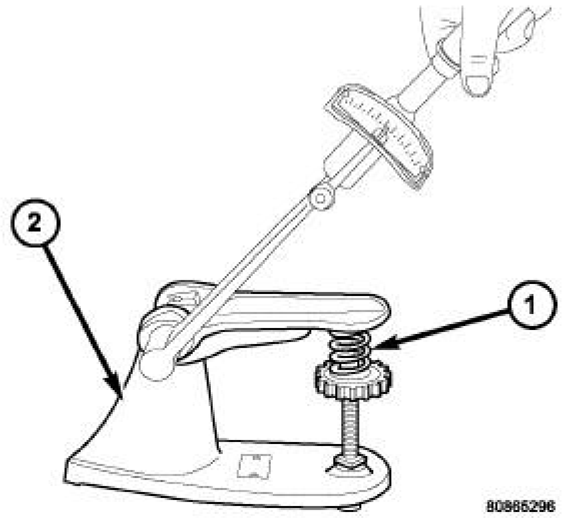



**Fig. 120: Testing Valve Spring**
**Courtesy of CHRYSLER GROUP, LLC**

When valves have been removed for inspection, reconditioning or replacement, valve springs should be checked against specifications for free-length, spring force and spring installed height. Refer to **ENGINE SPECIFICATIONS** .

Spring force can be measured with a test fixture (2). Follow the tool manufactures instructions. Replace any springs that do not meet specifications.

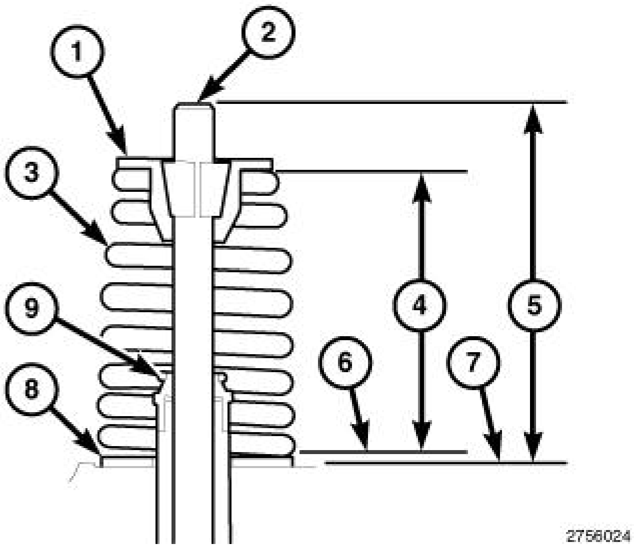



**Fig. 121: Checking Valve Spring Installed Height**
**Courtesy of CHRYSLER GROUP, LLC**

Installed height of the valve spring must be checked with the valve assembled into the cylinder head. Refer to **SPRING(S), VALVE, INSTALLATION**.

If the valves or valve seats have been refinished, check the installed height of the valve springs (4). Make sure the measurement is taken from the top of spring seat (6) to the bottom surface of spring retainer (1). Refer to **ENGINE SPECIFICATIONS** .

**INSTALLATION**

**ON VEHICLE**

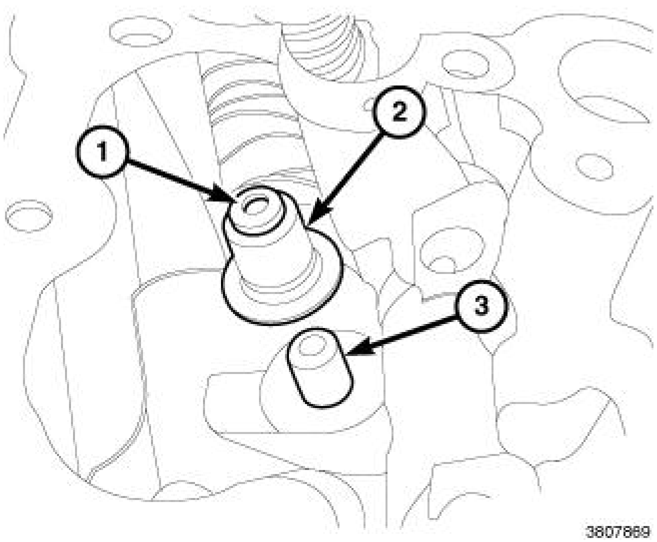



**Fig. 122: Valve Guide Seal & Valve**
**Courtesy of CHRYSLER GROUP, LLC**

1. If removed, install the valve guide seal (2) over the valve guide (3). Refer to **SEAL(S), VALVE GUIDE, INSTALLATION**.

| | |
|---|---|
| **NOTE:** | **Make sure that the garter spring (1) is intact around the top of the valve guide seal (2). Number 2 cylinder exhaust valve guide seal shown in illustration, all other valves similar.** |

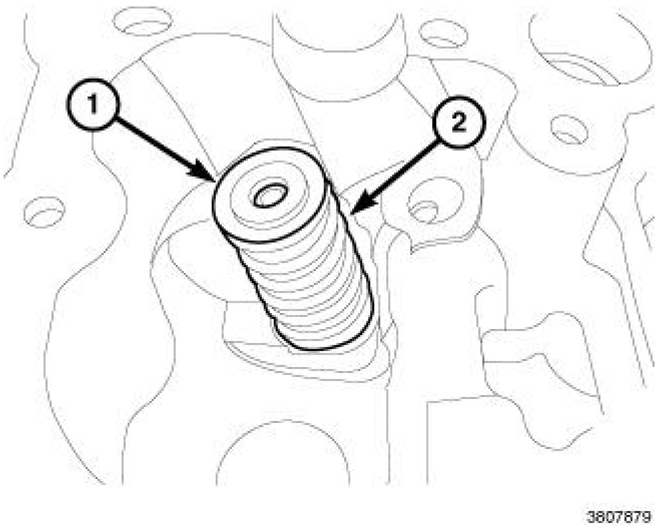



**Fig. 123: Valve Spring & Retainer**
**Courtesy of CHRYSLER GROUP, LLC**

| | |
|---|---|
| **NOTE:** | **If the valve springs are being reused, reassemble them into their original locations. Number 2 cylinder exhaust valve spring shown in illustration, all other valves similar.** |

2. Install the valve spring (2) and valve spring retainer (1).

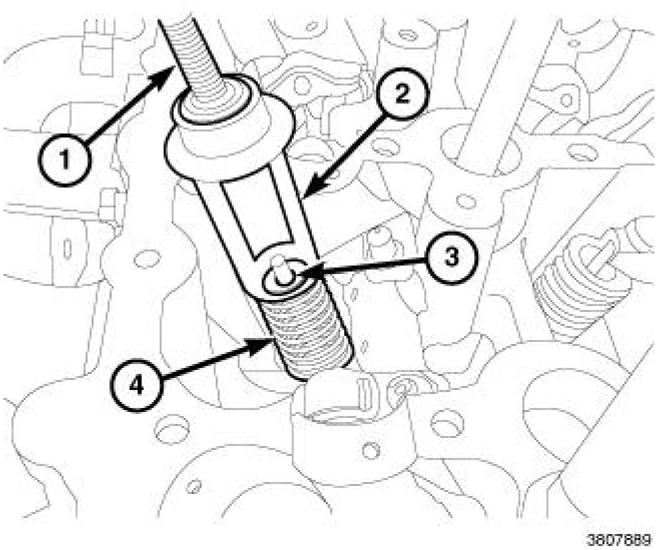


**Fig. 124: Compressing Valve Spring**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Number 3 cylinder exhaust valve spring compression shown in illustration, all other valves similar.**

3. Using the (special tool #10224, Adapter, Valve Spring) (2) with the (special tool #MD998772A, Compressor, Valve Spring) (1), compress the valve spring (4) **only enough** to install the valve retaining locks (3).
4. Relieve the air pressure and remove the spark plug adapter.
5. Install the spark plug and tighten to 19 N.m (14 ft. lbs.). Refer to **SPARK PLUG, INSTALLATION** .

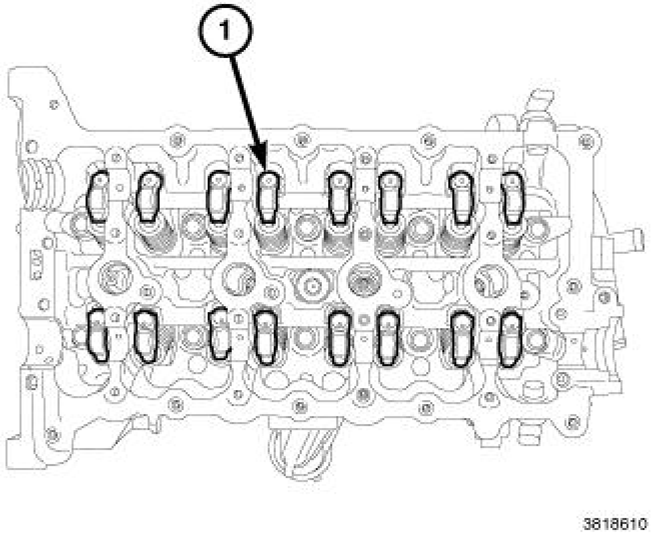



**Fig. 125: Rocker Arms**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: If the rocker arms are being reused, reassemble them into their original locations.**

6. Install the rocker arm(s) (1). Refer to **ROCKER ARM, VALVE, INSTALLATION**.
7. Install the camshaft(s) and cylinder head cover. Refer to **CAMSHAFT, ENGINE, INSTALLATION**.
8. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).

**OFF VEHICLE**

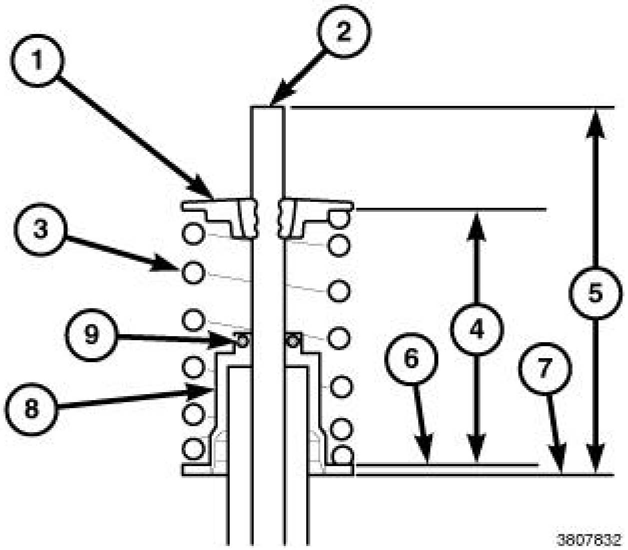



**Fig. 126: Valve Spring Component Measurements**
**Courtesy of CHRYSLER GROUP, LLC**

1. If removed, install the valve(s). Refer to **VALVES, INTAKE AND EXHAUST, INSTALLATION**.

**NOTE:** **Reassemble the valves into their original locations. If the valves or valve seats have been refinished, verify that the valve stem tip height (5) is within specification. Refer to ENGINE SPECIFICATIONS .**

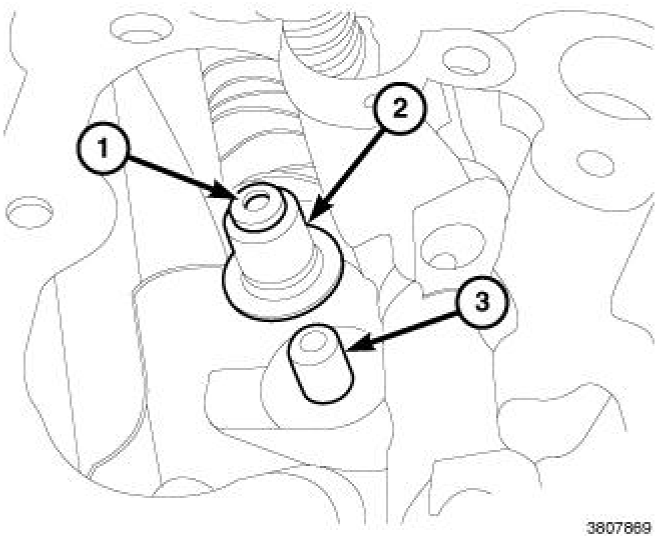



**Fig. 127: Valve Guide Seal & Valve**
**Courtesy of CHRYSLER GROUP, LLC**

2. If removed, install the valve guide seal (2) over the valve guide (3). Refer to **SEAL(S), VALVE GUIDE, INSTALLATION**.

**NOTE:** **Make sure that the garter spring (1) is intact around the top of the valve**

**guide seal (2). Number 2 cylinder exhaust valve guide seal shown in illustration, all other valves similar.**

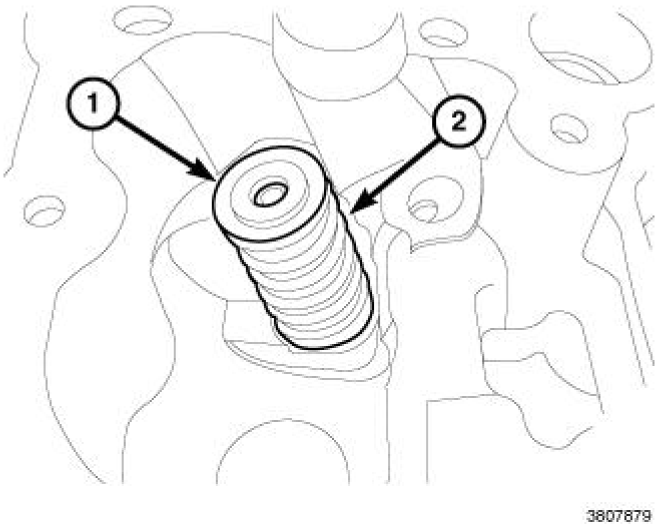



**Fig. 128: Valve Spring & Retainer**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: If the valve springs are being reused, reassemble them into their original locations. Number 2 cylinder exhaust valve spring shown in illustration, all other valves similar.**

3. Install the valve spring (2) and valve spring retainer (1).

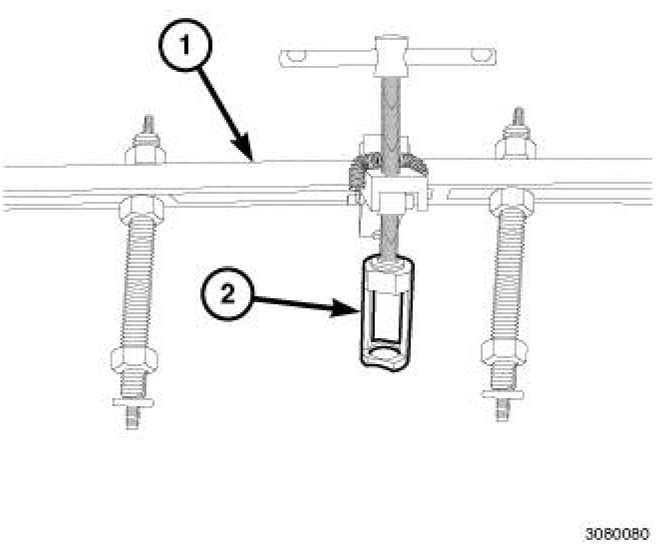



**Fig. 129: Valve Spring Compressor & Adapter**
**Courtesy of CHRYSLER GROUP, LLC**

4. Install the (special tool #10224, Adapter, Valve Spring) (2) on the (special tool #MD998772A,

Compressor, Valve Spring) (1).

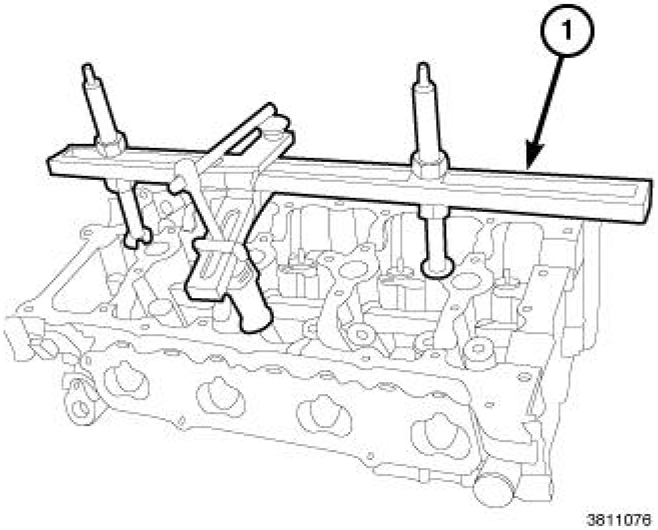



**Fig. 130: Valve Spring Compressor**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Number 3 intake valve spring compression shown in illustration, all other valves similar.**

5. Install the (special tool #MD998772A, Compressor, Valve Spring) (1) onto the cylinder head.
6. Place a ball of rags in the combustion chamber to hold the valves in place.

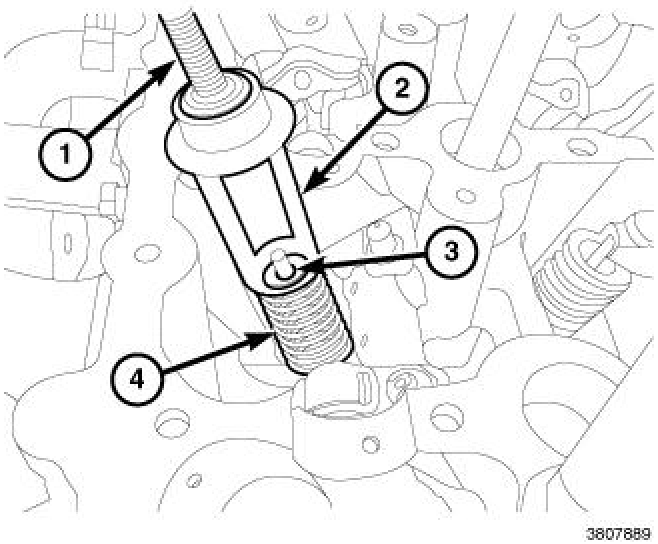



**Fig. 131: Compressing Valve Spring**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Number 3 cylinder exhaust valve spring compression shown in illustration, all other valves similar.**

7. Using the (special tool #10224, Adapter, Valve Spring) (2) with the (special tool #MD998772A, Compressor, Valve Spring) (1), compress the valve spring (4) **only enough** to install the valve retaining locks (3).

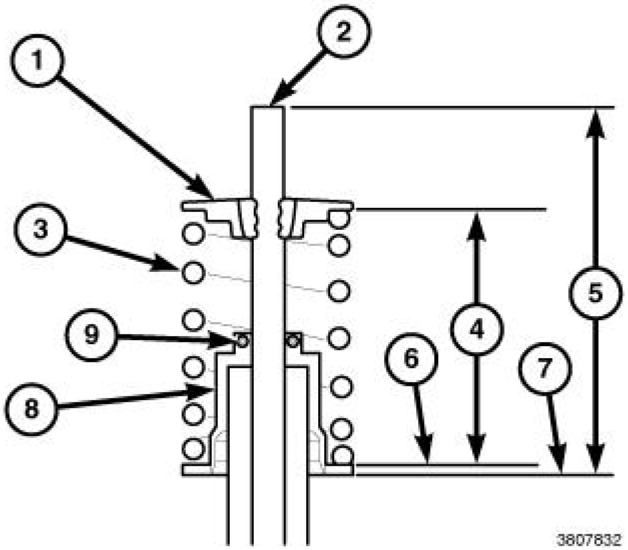



**Fig. 132: Valve Spring Component Measurements**
**Courtesy of CHRYSLER GROUP, LLC**

8. If the valves or valve seats have been refinished, verify that the installed height of the valve springs (4) are within specification. Make sure the measurement is taken from the top of spring seat (6) to the bottom surface of spring retainer (1). Refer to **ENGINE SPECIFICATIONS** .
9. Install the cylinder head. Refer to **CYLINDER HEAD, INSTALLATION**.

## VALVES, INTAKE AND EXHAUST

### DESCRIPTION

#### DESCRIPTION

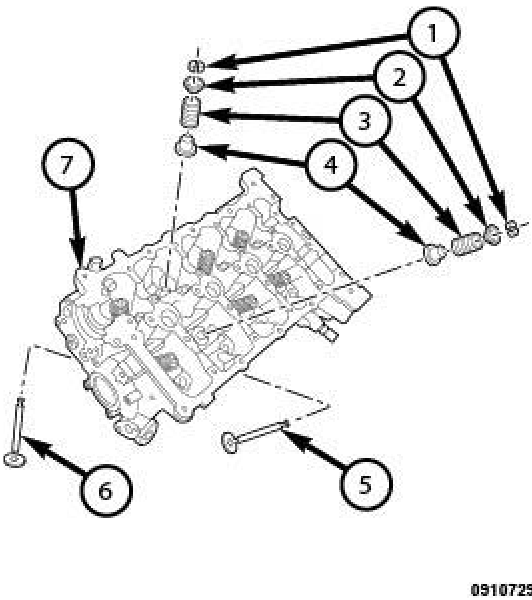



**Fig. 133: Cylinder Head, Valves & Springs**
**Courtesy of CHRYSLER GROUP, LLC**

Each of the four combustion chambers contains four valves, two intake and two exhaust, for a total of 16 valves. 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. All valves use three bead lock keepers (1) to retain springs (3) and to promote valve rotation.

**STANDARD PROCEDURE**

**STANDARD PROCEDURE - REFACING - INTAKE AND EXHAUST VALVES**

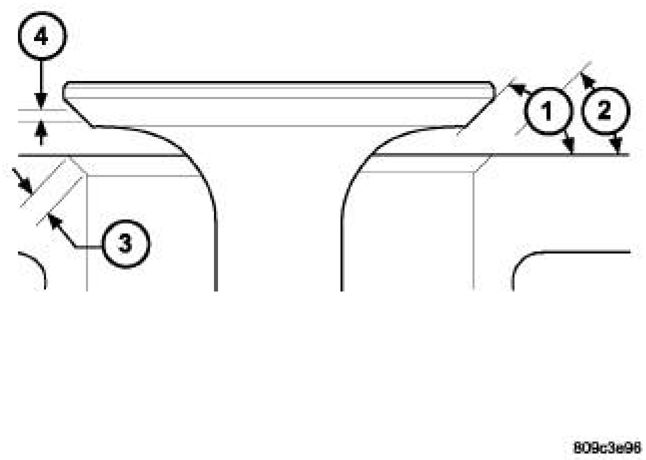



**Fig. 134: Valve Face & Seat**
**Courtesy of CHRYSLER GROUP, LLC**

| | |
|---|
| 1 - SEAT WIDTH<br>2 - FACE ANGLE<br>3 - SEAT ANGLE<br>4 - SEAT CONTACT AREA |

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

**VALVES**

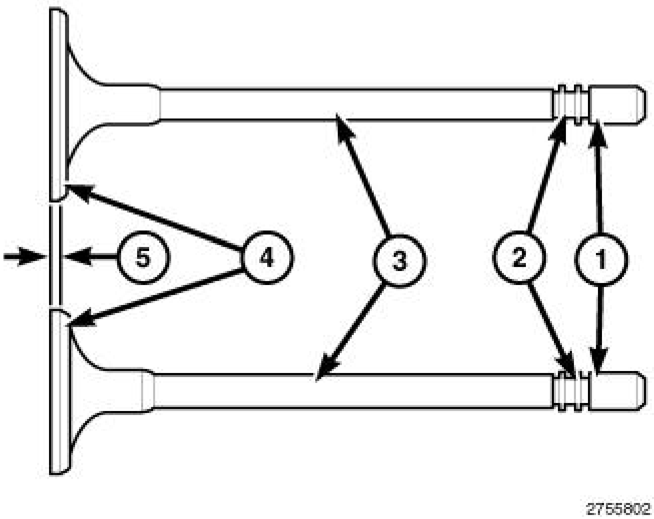



**Fig. 135: Inspecting Valve Margin**
**Courtesy of CHRYSLER GROUP, LLC**

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

**VALVE SEATS**

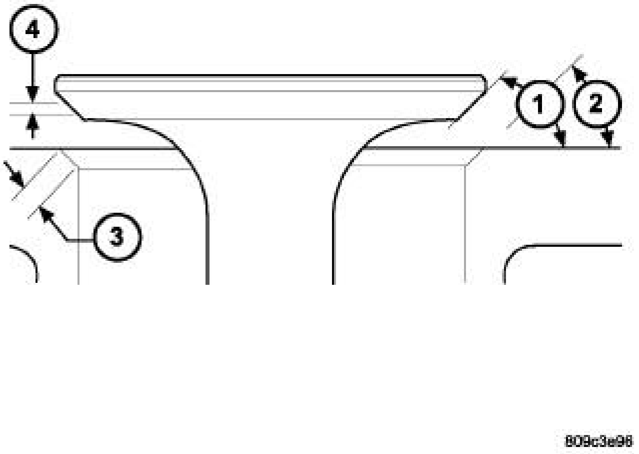



**Fig. 136: Valve Face & Seat**
**Courtesy of CHRYSLER GROUP, LLC**

| |
|---|
| 1 - SEAT WIDTH |
| 2 - FACE ANGLE |
| 3 - SEAT ANGLE |
| 4 - SEAT CONTACT AREA |

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

1. Measure the concentricity of the valve seat using a dial indicator. Refer to **ENGINE SPECIFICATIONS** .
2. Inspect the valve seat (3) with Prussian blue to determine where the valve contacts the seat. To do this, coat the valve seat (3) **LIGHTLY** with Prussian blue then set the valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of the valve face (4), contact is satisfactory. If the blue is transferred to the top edge of the valve face, then lower the valve seat with a 15 degree stone. If the blue is transferred to the bottom edge of the valve face, then raise the valve seat with a 65 degree stone.

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

3. When the seat is properly positioned the width of the intake and exhaust seats should be within specification. Refer to **ENGINE SPECIFICATIONS** .

**VALVE AND SPRING INSTALLED HEIGHT**

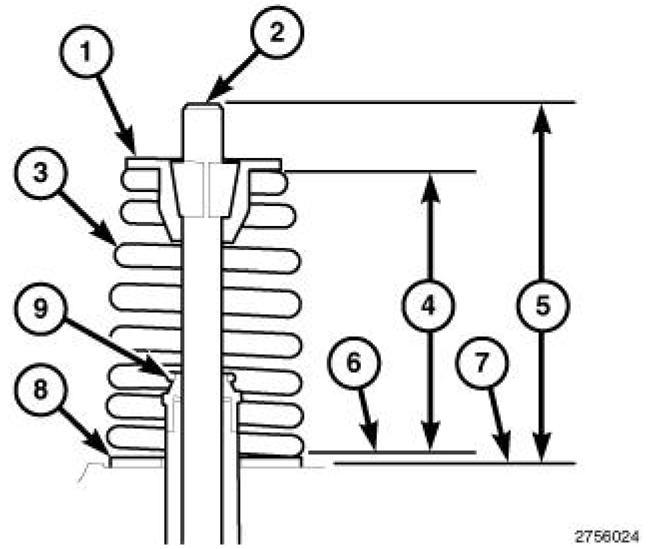


**Fig. 137: Checking Valve Spring Installed Height**
**Courtesy of CHRYSLER GROUP, LLC**

1. Coat the valve stems (2) with clean engine oil and install the valves into the cylinder head.

**NOTE: If the valves are being reused, reassemble them into their original locations.**

2. If the valves or valve seats have been refinished, check the valve tip height (5). If the valve tip height (5) exceeds the specification, grind the valve tip until it is within specification. Refer to **ENGINE SPECIFICATIONS** . Make sure the measurement is taken from the cylinder head surface (7) to the top of the valve stem (2).

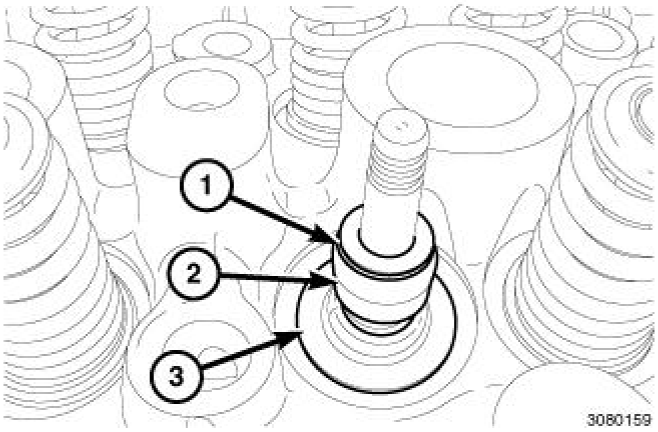


**Fig. 138: Garter Spring, Valve Guide Seal & Spring Seat**
**Courtesy of CHRYSLER GROUP, LLC**

3. If removed, install the spring seat (3) and valve guide seal (2) over the valve guide. Refer to **SEAL(S), VALVE GUIDE, INSTALLATION**.

| | |
|---|---|
| **NOTE:** | **Ensure that the garter spring (1) is intact around the top of the valve guide seal (2). Number 2 cylinder exhaust valve guide seal shown in illustration, all other valves similar.** |

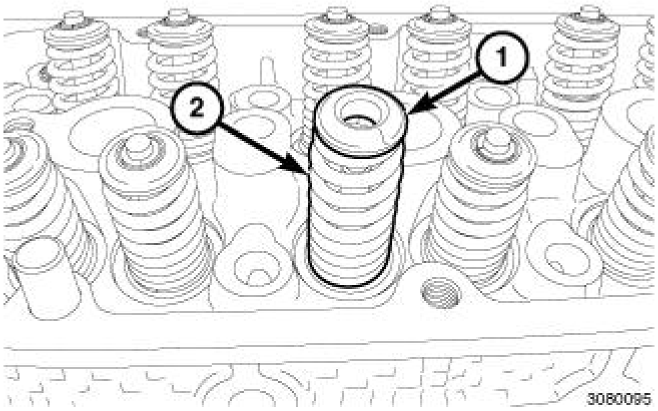



**Fig. 139: Valve Spring & Retainer**
**Courtesy of CHRYSLER GROUP, LLC**

| | |
|---|---|
| **NOTE:** | **If the valve springs are being reused, reassemble them into their original locations. Number 2 cylinder exhaust valve spring shown in illustration, all other valves similar.** |

4. Install the valve spring (2) and valve spring retainer (1).

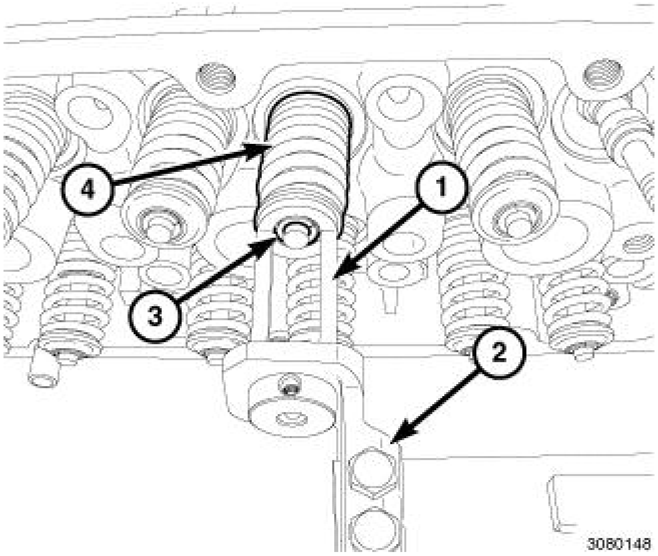


**Fig. 140: Valve Spring Adapter, Valve Spring Compressor, Retaining Locks & Valve Springs**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Number 3 cylinder exhaust valve spring compression shown in illustration, all other valves similar.**

5. Compress valve springs (4) with the Valve Spring Compressor Adapter (special tool #10224, Adapter, Valve Spring) (1) mounted in the Valve Spring Compressor (special tool #C-3422-D, Compressor, Valve Spring) (2). Install the retaining locks (3) and release the valve spring compression.

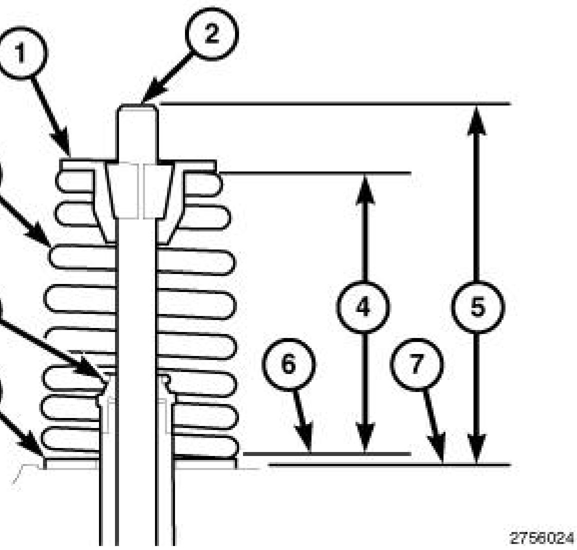



**Fig. 141: Checking Valve Spring Installed Height**
**Courtesy of CHRYSLER GROUP, LLC**

6. If the valves or valve seats have been refinished, check the installed height of the valve springs (4). Make sure the measurement is taken from the top of spring seat (6) to the bottom surface of spring retainer (1). Refer to **ENGINE SPECIFICATIONS** .

**REMOVAL**

**REMOVAL**

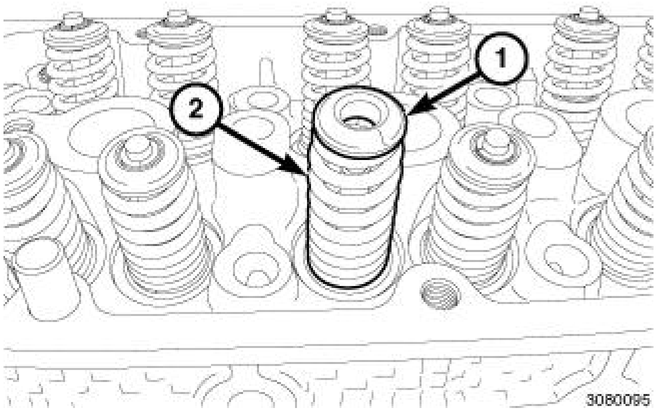



**Fig. 142: Valve Spring & Retainer**
**Courtesy of CHRYSLER GROUP, LLC**

1. Remove the cylinder head. Refer to **CYLINDER HEAD, REMOVAL**.

**NOTE: If the springs are to be reused, identify their positions so that they can be reassembled into their original locations. Number 2 cylinder exhaust valve spring shown in illustration, all other valve springs similar.**

2. Remove the valve spring(s) (2). Refer to **SPRING(S), VALVE, REMOVAL**.

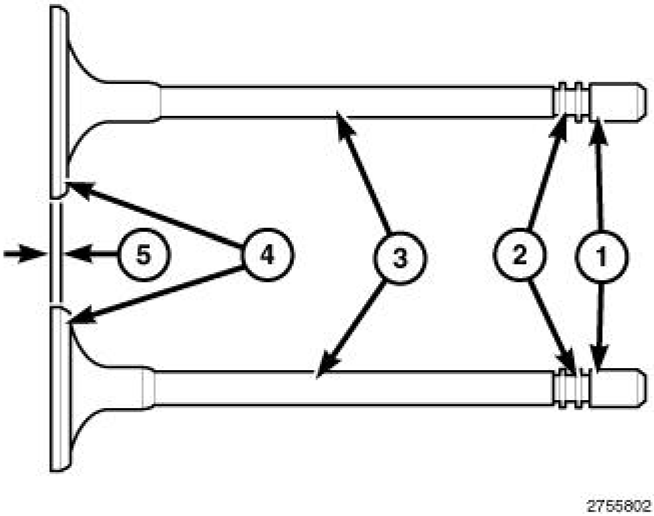



**Fig. 143: Inspecting Valve Margin**
**Courtesy of CHRYSLER GROUP, LLC**

**CAUTION: Before removing the valves, remove any burrs from the valve stem retainer lock grooves (2) and stem tip (1) to prevent damage to the**

**valve guides.**

3. Remove the valve(s). Identify each valve to ensure installation in the original location.

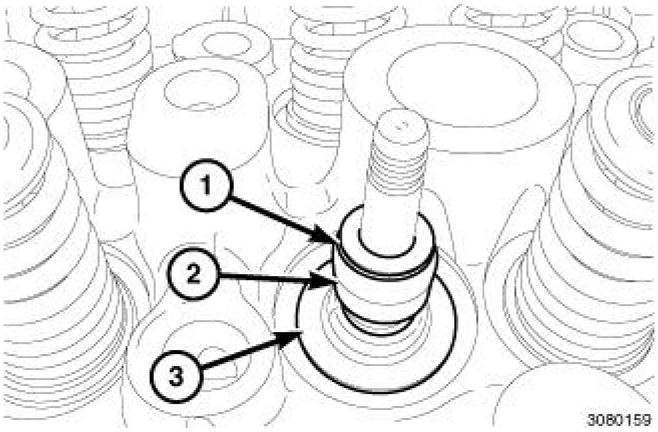



**Fig. 144: Garter Spring, Valve Guide Seal & Spring Seat**
**Courtesy of CHRYSLER GROUP, LLC**

4. If required, remove the valve guide seal (2) and spring seat (3). Refer to **SEAL(S), VALVE GUIDE, REMOVAL**.

**INSPECTION**

**INSPECTION**

**VALVES**

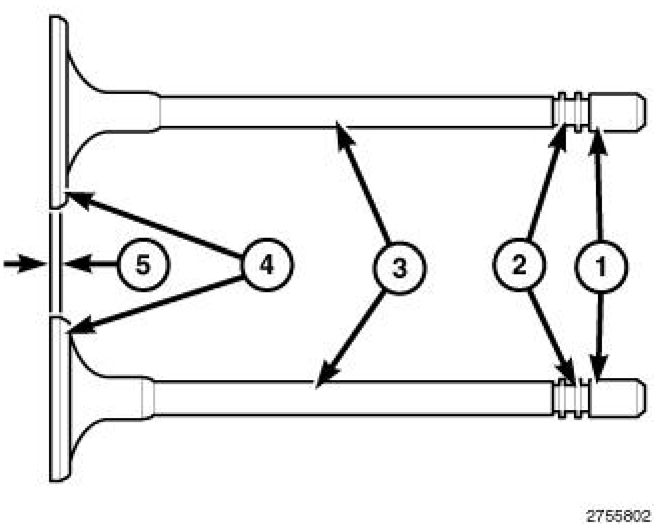



**Fig. 145: Inspecting Valve Margin**

**Courtesy of CHRYSLER GROUP, LLC**

1. Clean and inspect the valves thoroughly. Replace burned, warped and cracked valves.
2. Inspect the retainer lock grooves for wear or damage (2).
3. Inspect the valve face (4) for wear and pitting.
4. Measure the valve stems (3) and margins (5) for wear. Refer to **ENGINE SPECIFICATIONS** .

**VALVE GUIDES**

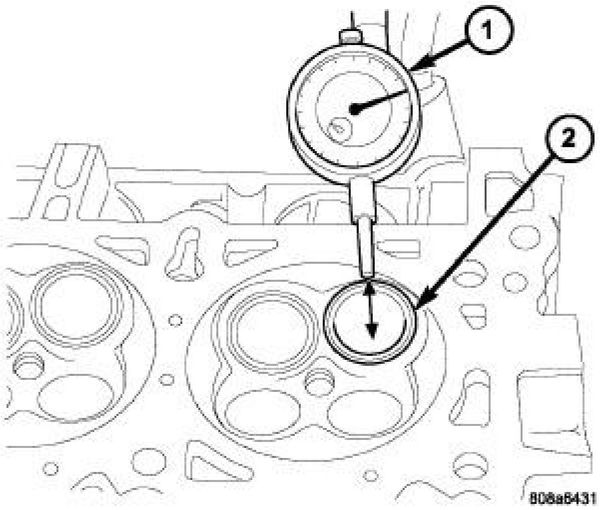



**Fig. 146: Measuring Valve Guide Wear**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical cylinder head shown in illustration.**

1. Remove carbon and varnish deposits from inside of the valve guides with a reliable guide cleaner.
2. Measure valve stem-to-guide clearance as follows:
3. Install the valve (2) into the cylinder head so that it is 15 mm (0.590 inch.) off of the valve seat. A small piece of hose may be used to hold the valve in place.
4. Attach the Dial Indicator Set (special tool #C-3339A, Set, Dial Indicator) (1) to the cylinder head and set it at a right angle to the valve stem being measured.
5. Move the valve to and from the indicator. Compare this reading to the specification. Refer to **ENGINE SPECIFICATIONS** .

**NOTE: If stem-to-guide clearance exceeds specifications, you must measure the valve stem. If the valve stem is within specification or if the valve guide is loose in the cylinder head, replace the cylinder head.**

**INSTALLATION**

**INSTALLATION**

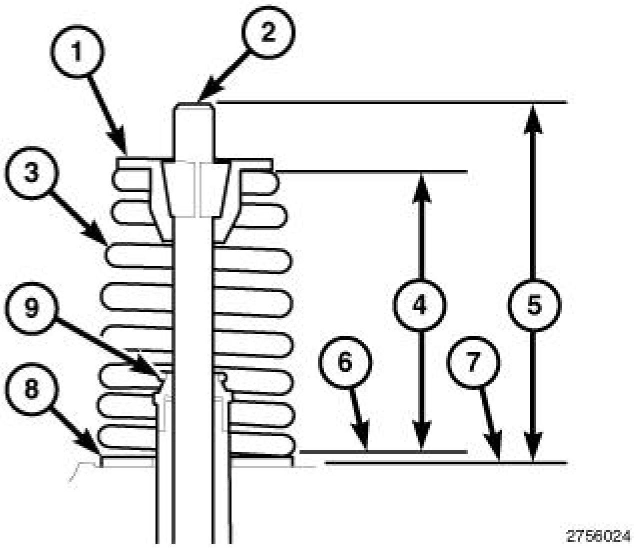



**Fig. 147: Checking Valve Spring Installed Height**
**Courtesy of CHRYSLER GROUP, LLC**

1. Coat the valve stems (2) with clean engine oil and install the valves into the cylinder head.

**NOTE: If the valves are being reused, reassemble them into their original locations.**

2. If the valves or valve seats have been refinished, check the valve tip height (5). If the valve tip height (5) exceeds the specification, grind the valve tip until it is within specification. Refer to **ENGINE SPECIFICATIONS** . Make sure the measurement is taken from the cylinder head surface (7) to the top of the valve stem (2).

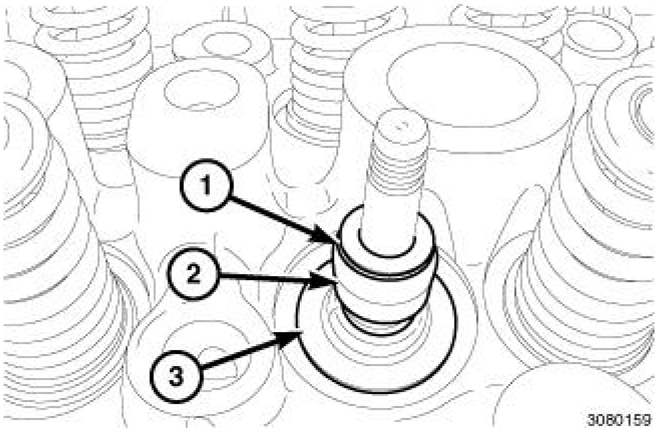



**Fig. 148: Garter Spring, Valve Guide Seal & Spring Seat**

**Courtesy of CHRYSLER GROUP, LLC**

3. If removed, install the spring seat (3) and valve guide seal (2) over the valve guide. Refer to **SEAL(S), VALVE GUIDE, INSTALLATION**.

| NOTE: | Make sure that the garter spring (1) is intact around the top of the valve guide seal (2). Number 2 cylinder exhaust valve guide seal shown in illustration, all other valves similar. |
|---|---|

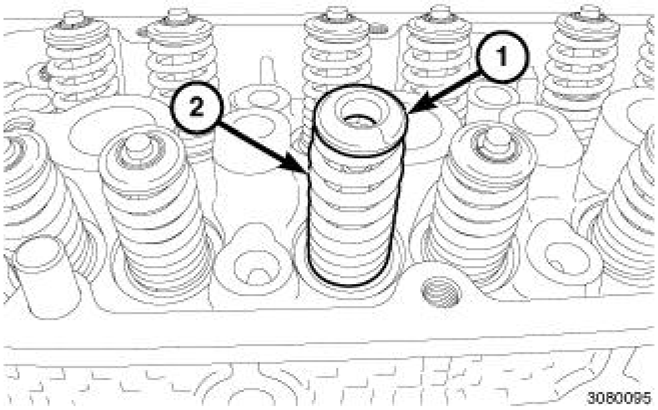



**Fig. 149: Valve Spring & Retainer**
**Courtesy of CHRYSLER GROUP, LLC**

4. Install the valve spring(s) (2). Refer to **SPRING(S), VALVE, INSTALLATION**.

| NOTE: | Reassemble the valves springs into their original locations. If the valves or valve seats have been refinished, verify that the valve spring installed height is within specification. Refer to ENGINE SPECIFICATIONS . Number 2 cylinder exhaust valve spring shown in illustration, all other valves springs similar. |
|---|---|

5. Install the cylinder head. Refer to **CYLINDER HEAD, INSTALLATION**.

## PUMP, VACUUM

### DESCRIPTION

#### DESCRIPTION

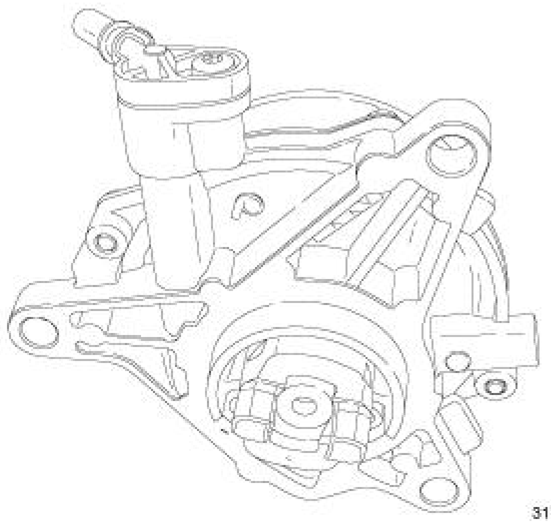



**Fig. 150: Vacuum Pump**
**Courtesy of CHRYSLER GROUP, LLC**

The vane-type vacuum pump is mounted to the rear of the cylinder head and is driven by the camshaft. The vacuum pump supplies vacuum to the brake booster.

**REMOVAL**

**REMOVAL**

1. Remove the engine cover. Refer to **RESONATOR, AIR CLEANER, REMOVAL**.
2. Remove the battery. Refer to **BATTERY, REMOVAL** .

**NOTE:** **Oil may leak from the vacuum pump drive when the pump is removed. Place a shop towel under the pump to prevent oil leakage onto the engine or transmission assembly.**

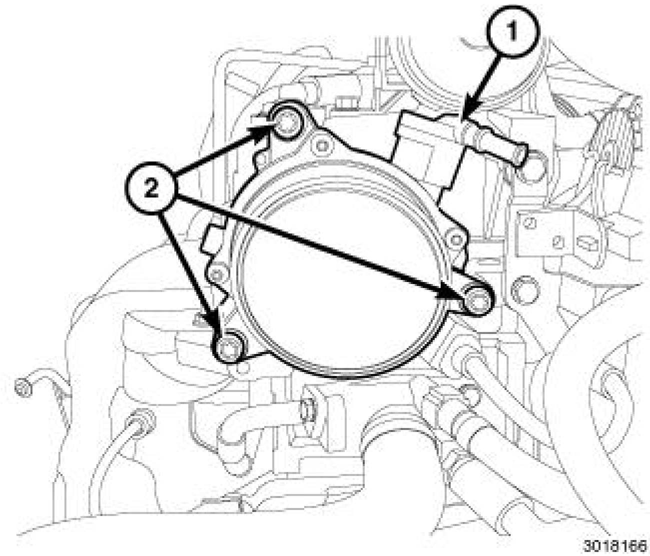



**Fig. 151: Vacuum Pump & Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

3. Disconnect the vacuum line at the pump (1).
4. Remove the vacuum pump mounting bolts (2) and the vacuum pump.

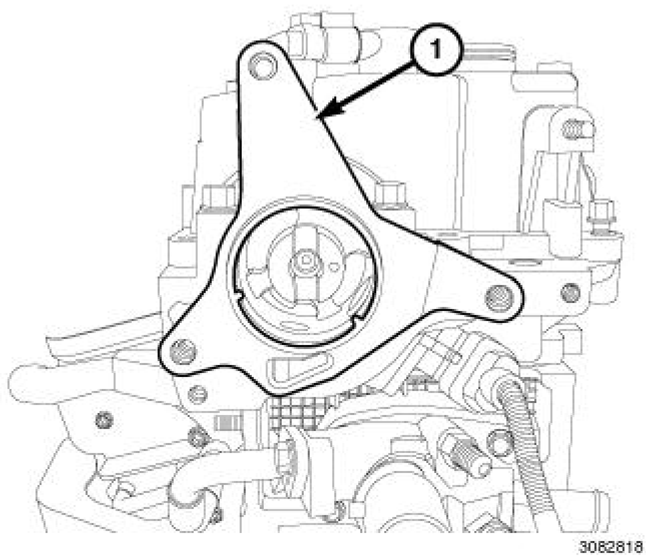



**Fig. 152: Vacuum Pump Gasket**
**Courtesy of CHRYSLER GROUP, LLC**

5. Remove and discard the vacuum pump gasket (1). Note the location of the pump drive tab.

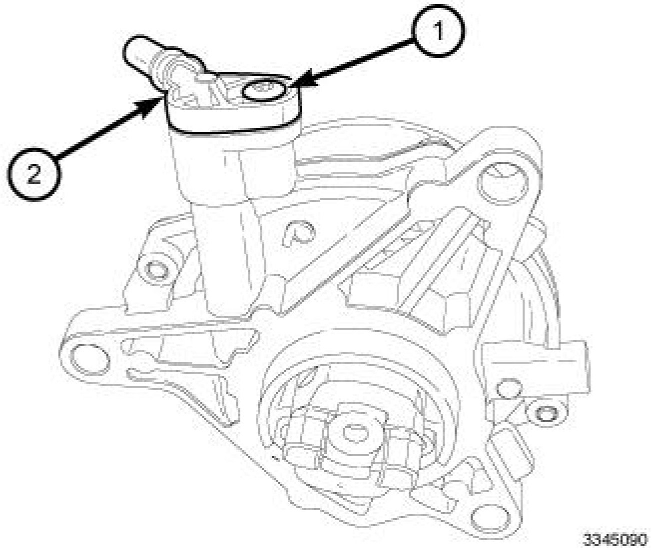



**Fig. 153: Vacuum Fitting & Screw**
**Courtesy of CHRYSLER GROUP, LLC**

6. If required, remove the screw (1) and the vacuum fitting (2).

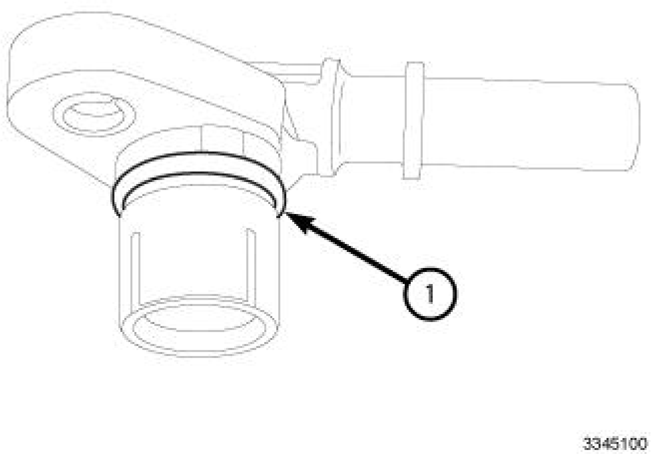



**Fig. 154: Vacuum Fitting O-Ring Seal**
**Courtesy of CHRYSLER GROUP, LLC**

7. The vacuum fitting O-ring seal (1) can be reused if not damaged.

**INSTALLATION**

**INSTALLATION**

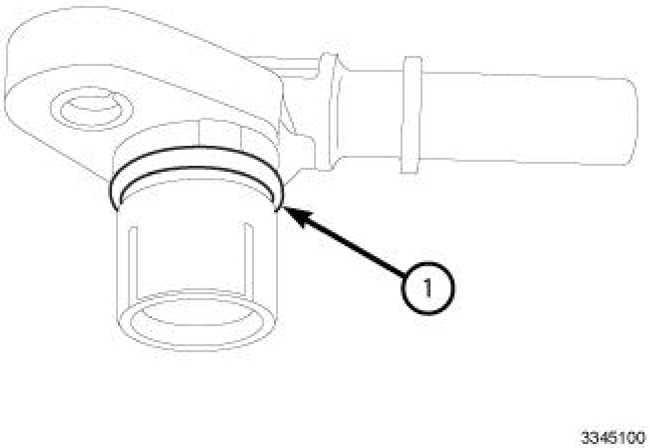



**Fig. 155: Vacuum Fitting O-Ring Seal**
**Courtesy of CHRYSLER GROUP, LLC**

1. The vacuum fitting O-ring seal (1) can be reused if not damaged. If removed, lightly lubricate the O-ring seal (1) with clean engine oil and install on the vacuum fitting.

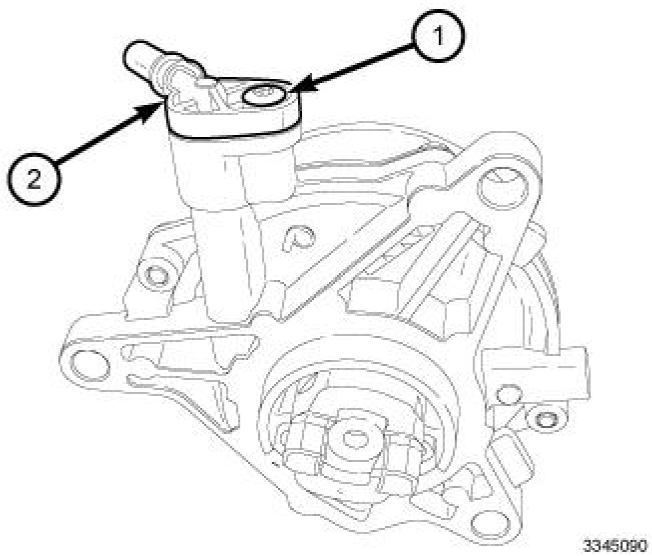



**Fig. 156: Vacuum Fitting & Screw**
**Courtesy of CHRYSLER GROUP, LLC**

2. If removed, install the vacuum fitting (2) to the vacuum pump with the screw (1) tightened to 8 N.m (71 in. lbs.).
3. Clean the mating surfaces of the cylinder head and the vacuum pump. Install a new vacuum pump gasket.
4. Align the pump drive tab with the pump drive slot located on the cam shaft.
5. Install the vacuum pump mounting bolts. Tighten the bolts to 20 N.m (15 ft. lbs.).
6. Connect the vacuum supply line to the pump.

**CAUTION: When servicing components near the vacuum pump, avoid contact with the plastic nipple that connects the vacuum pump to the brake booster hose. It is possible to crack the plastic nipple resulting in a brake booster vacuum leak.**

7. Install the battery (4). Refer to **BATTERY, INSTALLATION** .
8. Install the engine cover. Refer to **RESONATOR, AIR CLEANER, INSTALLATION**.
9. Run the engine a check the vacuum pump for proper operation.

## ASSEMBLY, VARIABLE VALVE ACTUATION

### DESCRIPTION

### DESCRIPTION

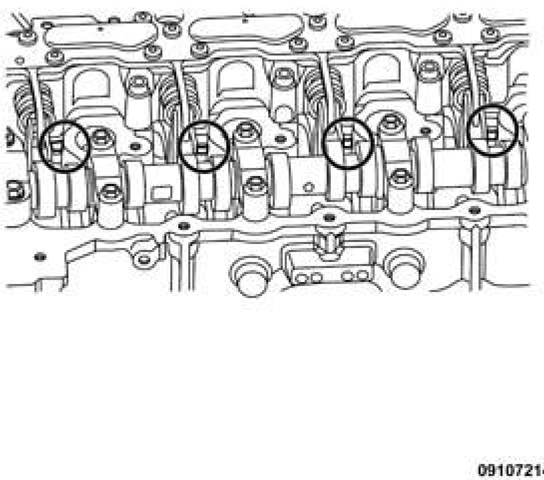



**Fig. 157: Intake Valve Tips**
**Courtesy of CHRYSLER GROUP, LLC**

The primary component of variable valve actuation is the variable valve actuation module. The variable valve actuation module is bolted to the top of the camshaft bearing housing above the intake valves, next to the camshaft. The intake lobes on the camshaft operate hydraulic pumping elements instead of directly acting on the valves. The pumping elements provide high-pressure oil to open the intake valves. The relationship between the camshaft lobe and the intake valves is controlled by a solenoid operated hydraulic port. By varying the solenoid operation, the Powertrain Control Module (PCM) is able to control intake valve lift and duration. The actuators sit directly on top of the intake valve tips (circled).

### OPERATION

**OPERATION**

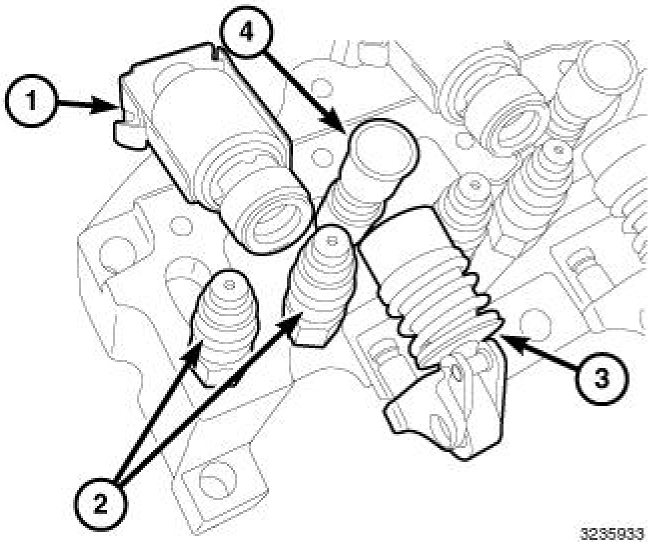



**Fig. 158: Solenoid Valve, Hydraulic Brake Pumping Element/Hydraulic Lash Adjusters, Upper Pumping Element & Oil Accumulator**
**Courtesy of CHRYSLER GROUP, LLC**

Variable valve actuation controls the operation of the intake valves. By using a hydraulic link between the camshaft and the intake valves, the valve lift and timing can be adjusted infinitely.

The main components of variable valve actuation are the Powertrain Control Module (PCM) programming and the variable valve actuation module. The variable valve actuation module contains one set of the following components for each cylinder:

- Upper Pumping Element (3)
- Solenoid Valve (1)
- Hydraulic Brake Pumping Element/Hydraulic Lash Adjusters (2)
- Oil Accumulator (4)

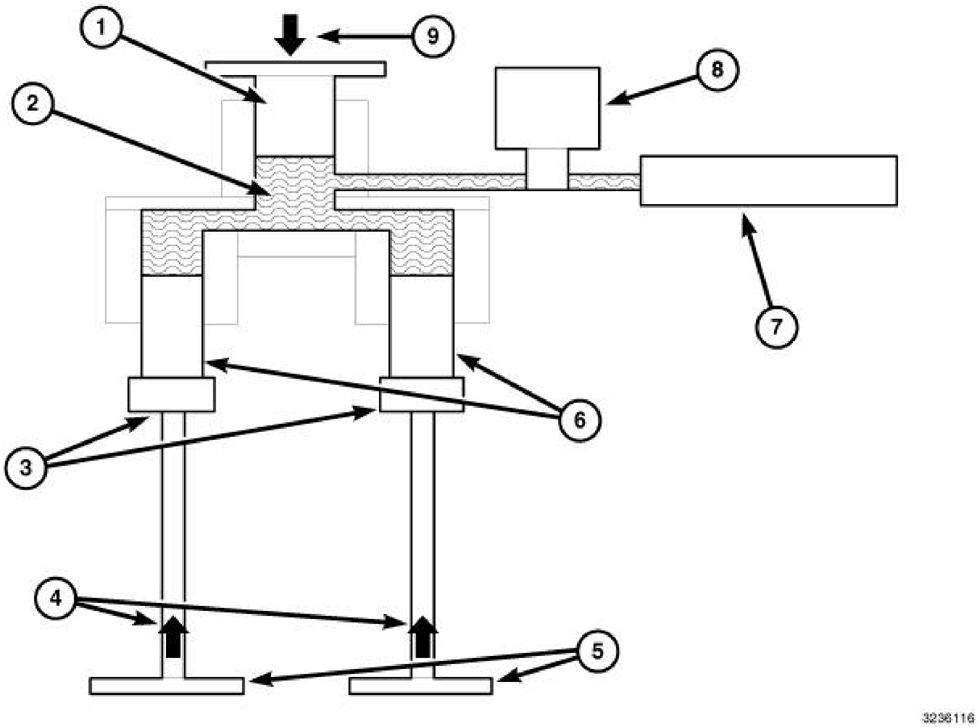



**Fig. 159: Variable Valve Actuation Assembly Operating Description**
**Courtesy of CHRYSLER GROUP, LLC**

The upper pumping elements (1) in the variable valve actuator are filled with oil from the engine lubrication system. The upper pumping elements (1) are driven by the rocker arms through camshaft motion (9) to create high-pressure oil inside the oil chamber (2). As the camshaft continues to rotate and the camshaft lobe ramps down, a spring in the upper pumping element returns the piston and the rocker arm to their home positions.

The high-pressure oil in the oil chamber passageway is delivered to the solenoid valve (8) from the upper pumping element. The solenoid valve (8) is a normally open hydraulic control valve. Therefore, the high-pressure oil is vented from the oil chamber to the accumulator (7) unless the solenoid valve is powered. When the solenoid valve is supplied 12 volts, the valve closes and high pressure oil instead acts upon the hydraulic brake pumping elements (6) to operate the intake valves (5).

The hydraulic brake pumping element (6) is essentially a piston that is operated by the high-pressure oil to open the intake valves (5). It also functions as a brake to stop the movement of the pumping element and intake valves. The braking function is the result of vent holes around the perimeter of the element's cylinder. When the piston approaches full stroke, the lower perimeter vent holes bleed off oil. This stops the piston from moving any farther. When the pressure from the solenoid is taken away, the upper supply holes in the cylinder become bleed holes that allow the piston to return to the home position. The piston is pushed back to the home position by the force of the intake valve springs. As the piston approaches the home position, some of the bleed holes are covered and the speed of the piston is regulated as it approaches the final resting position. This also controls the valve speed as it seats in the cylinder head. The hydraulic brake pumping element also functions as a hydraulic lash adjuster (3) because the valve stem clearance is hydraulically taken up by the piston. This occurs because the hydraulic brake pumping element/hydraulic lash adjuster is always under some oil pressure from the engine oil lubrication system. This creates enough pressure to take up valve clearance.

The variable valve actuator features three areas that function together as an oil reservoir so that the actuator always has a ready supply of engine oil. The engine lubrication system provides oil to the lower reservoir area and keeps it full of oil. To flow from the lower reservoir to the upper reservoir, the oil must pass through very small holes. This helps to purge air from the lower reservoir and to maintain engine oil pressure in the lower reservoir. The third reservoir area, the oil accumulator (7), is filled by oil vented from the oil chamber by the solenoid valve (8). The oil accumulator is a spring loaded accumulator that absorbs the hydraulic shock that would otherwise be created when the solenoid valves are opened. This helps to increase the durability of the system, maintains higher pressure in the lower pressure side of the system and lowers the overall load on the engine oil pump.

Variable valve actuation provides five possible phases of operation. Each phase offers unique advantages compared to normal camshaft operation. The five phases are:

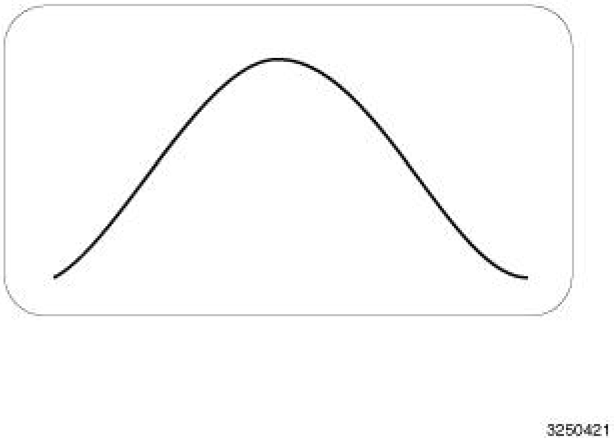



**Fig. 160: Full Lift**
**Courtesy of CHRYSLER GROUP, LLC**

- Full Lift. When variable valve actuation functions in the full lift phase, all of the camshaft lobe lift is transferred to the intake valves. The intake camshaft lobe is designed with a very aggressive lift and duration profile. This results in good power in the upper RPM ranges with high loads. This profile would rarely be used in everyday driving.

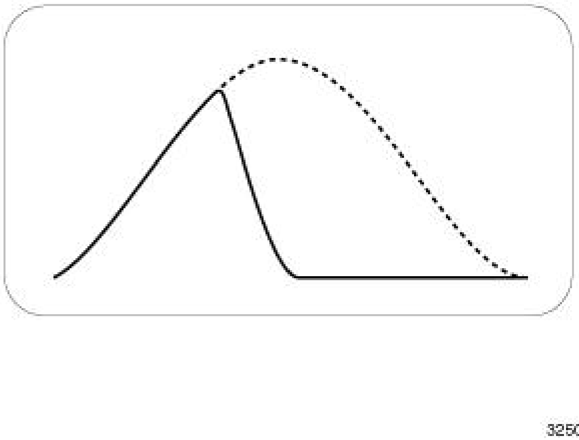



**Fig. 161: Early Intake Valve Closing (EVIC)**
**Courtesy of CHRYSLER GROUP, LLC**

- Early intake valve closing (EVIC). When variable valve actuation functions in the EVIC phase, the camshaft lobe lift is transferred to the intake valves at the beginning of the lift duration cycle. However, the hydraulic connection between the camshaft lobe and the valves is taken away before the lobe reaches full lift. The exact timing and lift can be infinitely varied to meet driver requirements. EVIC provides smooth engine performance and more torque at lower engine speeds.

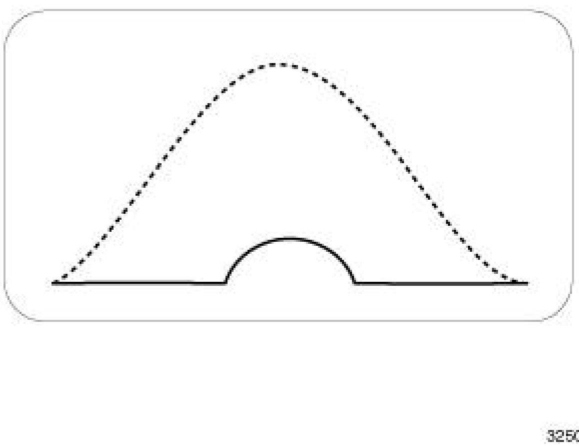



**Fig. 162: Late Intake Valve Opening (LIVO)**
**Courtesy of CHRYSLER GROUP, LLC**

- Late intake valve opening (LIVO). When variable valve actuation functions in the LIVO phase, the camshaft lobe lift is NOT transferred to the intake valves at the beginning of the lift duration cycle. The hydraulic connection between the camshaft lobe and the valves is completed after the rocker arm has already begun riding the ramp of the camshaft lobe. When the hydraulic connection is completed, the intake valves will begin to open. The valve lift timing can be varied infinitely within the full profile of the camshaft lobe. Therefore, as long as the hydraulic connection is completed before the camshaft lobe reaches its maximum lift, some valve lift will result. The lift profile will follow the camshaft lobe profile for the time that the hydraulic link is complete. Like EVIC, the exact timing and lift can be infinitely varied to meet driver requirements. LIVO provides lower emissions and a higher efficiency at lower loads or idle conditions.

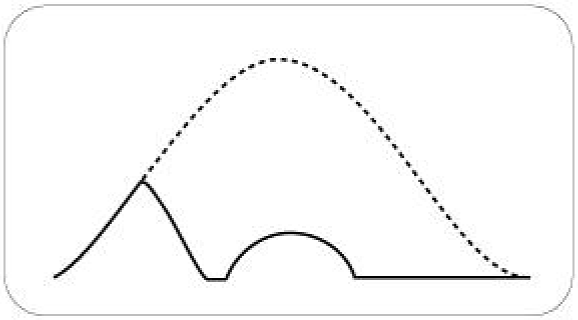


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**Fig. 163: Multi-Lift**
**Courtesy of CHRYSLER GROUP, LLC**

- Multi-Lift. Multi-Lift is a combination of EVIC and LIVO because the hydraulic connection between the camshaft lobe and the intake valves is closed early and then re-opened later in the cycle. This creates a longer duration valve lift with a smaller amount of lift. The result is a higher velocity of air flow into the cylinder over a longer period of time. Multi-Lift may be used in mixed driving of acceleration and deceleration with moderate engine speeds.

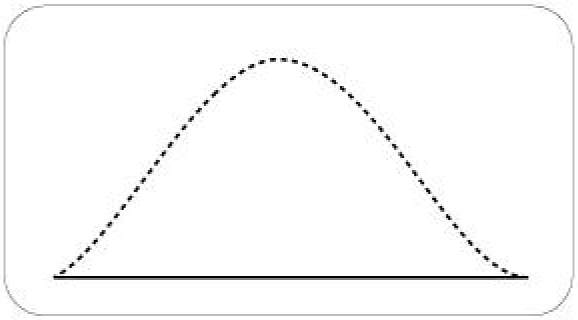

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**Fig. 164: Closed**
**Courtesy of CHRYSLER GROUP, LLC**

 

- Closed. The closed phase simply leaves the intake valves closed by not utilizing the camshaft lobe to lift the intake valves.

**REMOVAL**

**REMOVAL**

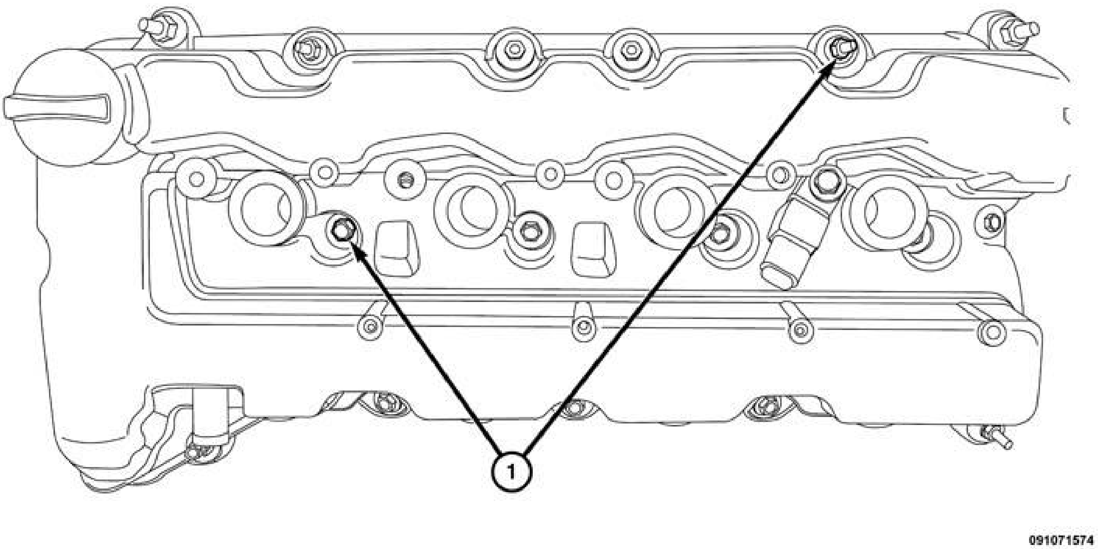


**Fig. 165: Cylinder Head Cover Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

1. Remove the cylinder head cover bolts (1). Remove the cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.
2. Unlock and disconnect the four variable valve timing actuator electrical connectors.

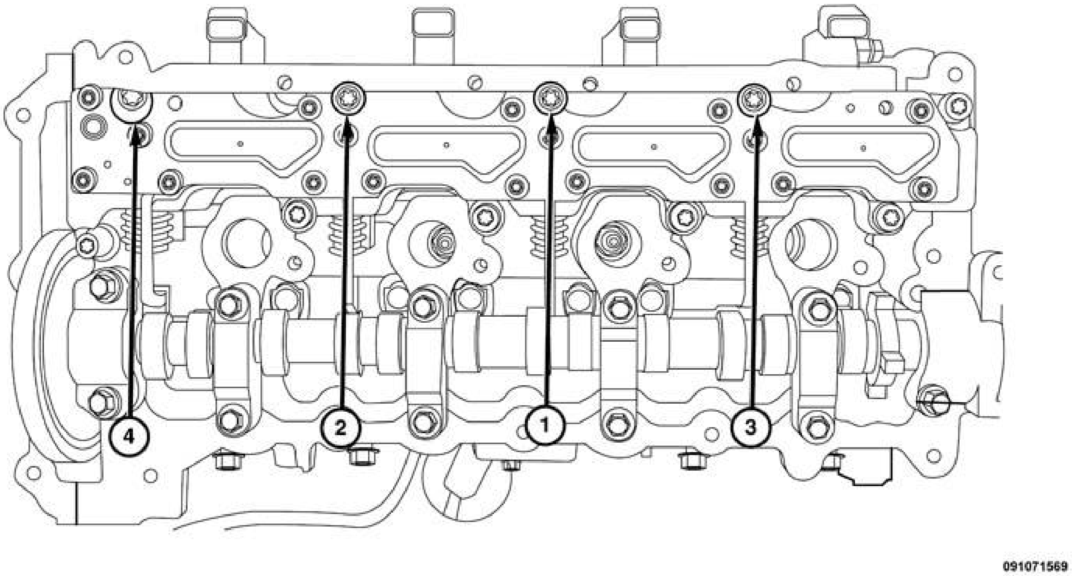


**Fig. 166: VVAA Block Removal Sequence (1 Of 2)**
**Courtesy of CHRYSLER GROUP, LLC**

3. Remove four bolts from the VVAA block.

**NOTE:** **The bolts need to be removed prior to the installation of the compressor tool due to the tool obstructs access to these bolts once the tool is installed.**

**NOTE:** **Be sure to follow the sequence shown in illustration above when removing the bolts.**

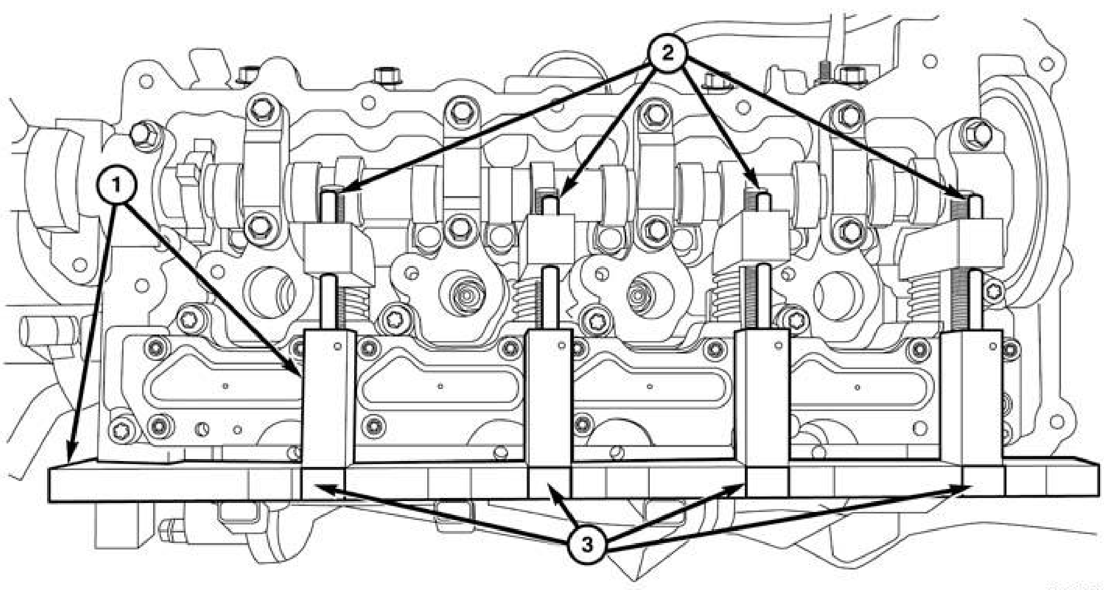


 

**Fig. 167: Special Tool, Spring Compressor & Indicators**
**Courtesy of CHRYSLER GROUP, LLC**

4. Using special tool 10259A (1), loosen the spring compressors (2) to fit over the valve and spring assemblies. Adjust the tool to align with the 2.4L indicators (3).
5. Install the (special tool #10259B, Compressor, MultiAir® Spring) spring compressor
6. Rotate the spring compressors counterclockwise until the springs are fully seated.

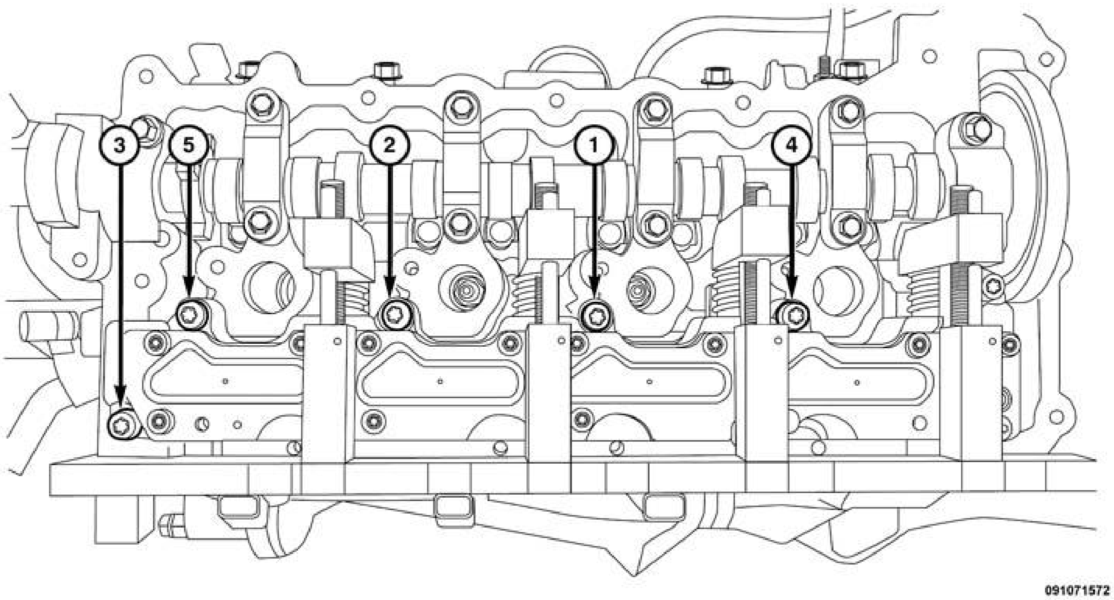


**Fig. 168: VVAA Block Removal Sequence (2 Of 2)**
**Courtesy of CHRYSLER GROUP, LLC**

**CAUTION: Do not invert the variable valve actuation assembly when it is removed from the engine. Oil will drain from the assembly and excessive engine cranking will be required to refill the assembly and start the engine.**

7. Remove the remaining five bolts from the VVAA.

**NOTE: Be sure to follow the sequence shown in illustration above when removing the bolts.**

8. Remove the variable valve timing actuation assembly, with the spring compressor attached, from the camshaft bearing housing.

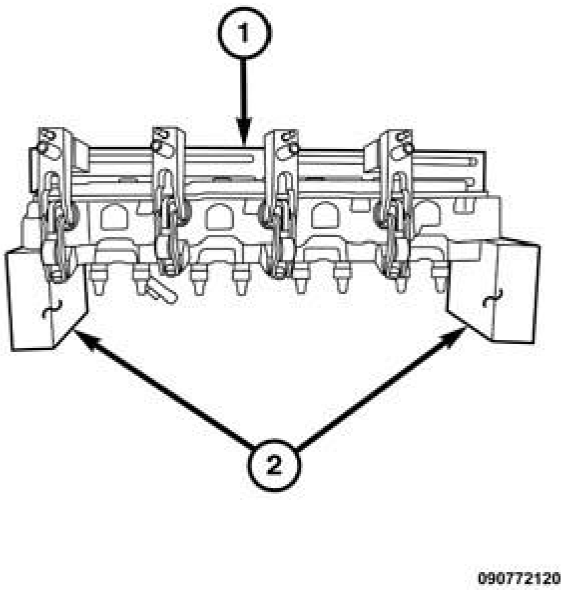


**Fig. 169: VVAA Assembly On Blocks Of Wood**
**Courtesy of CHRYSLER GROUP, LLC**

9. Set the assembly (1) onto two blocks of wood (2) to store during repairs.

| | |
|---|---|
| **NOTE:** | **Be sure to store the assembly in the upright position**<br><br>**AT ALL TIMES**<br><br>**to prevent oil related issues within the assembly.** |
| **NOTE:** | **There are two locating pins/dowels that properly position the VVAA. Be careful that both dowels remain installed in cylinder head after removing the VVAA. If a dowel comes loose,**<br><br>**locate the missing dowel and discard it**<br><br>**A new dowel will need to be used upon installation.**<br><br>**DO NOT REUSE A DOWEL THAT HAS BEEN REMOVED FROM THE CYLINDER HEAD.** |

10. Remove and discard the variable valve actuation assembly gasket.

 

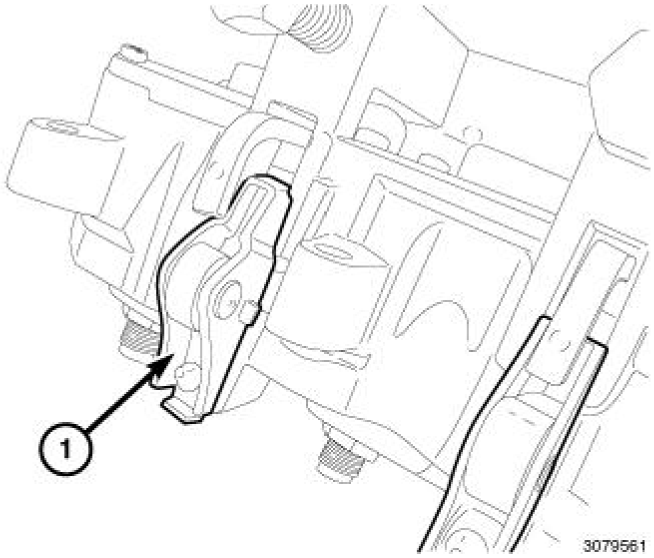


**Fig. 170: Rocker Arms**
**Courtesy of CHRYSLER GROUP, LLC**

11. If required, remove the rocker arms. Refer to **ROCKER ARM, VALVE, REMOVAL**.

**INSPECTION**

**INSPECTION**

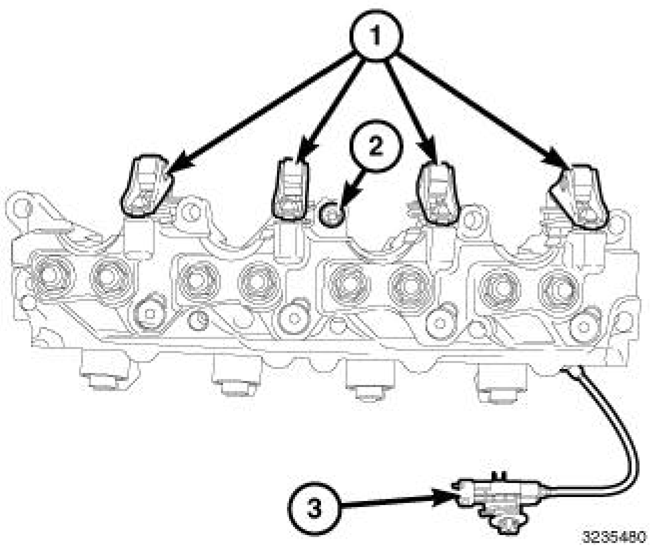


**Fig. 171: Valve Rocker Arms, Oil Supply O-Ring & Oil Temperature Sensor**
**Courtesy of CHRYSLER GROUP, LLC**

Because variable valve actuation is so closely monitored, the diagnostics of the system are strongly Diagnostic Trouble Code (DTC) driven. If the system does not perform according to design, many DTCs may be produced from a condition in the variable valve actuation system.

The variable valve actuation module includes very few serviceable components. The module has no internal components that are serviceable. The following components are serviceable:

- Valve rocker arms (1)
- Oil supply O-ring (2)
- Oil temperature sensor (3)

**INSTALLATION**

**INSTALLATION**

| | |
|---|---|
| YouTube | A multimedia supplement to the instructions contained in this article is available.<br>To view the multimedia example of the condition described go to;<br>**http://www.youtube.com/user/Mitchell1Tips**<br>**then type "A00646217.vid1" into the "Search Channel" box.** |

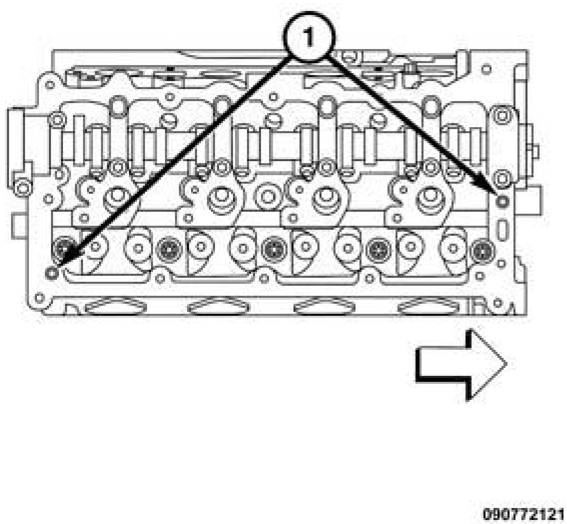


**Fig. 172: Locating Pins**
**Courtesy of CHRYSLER GROUP, LLC**

1. If the dowel/locating pins were removed, install two **NEW** variable valve actuation assembly locating pins (1).

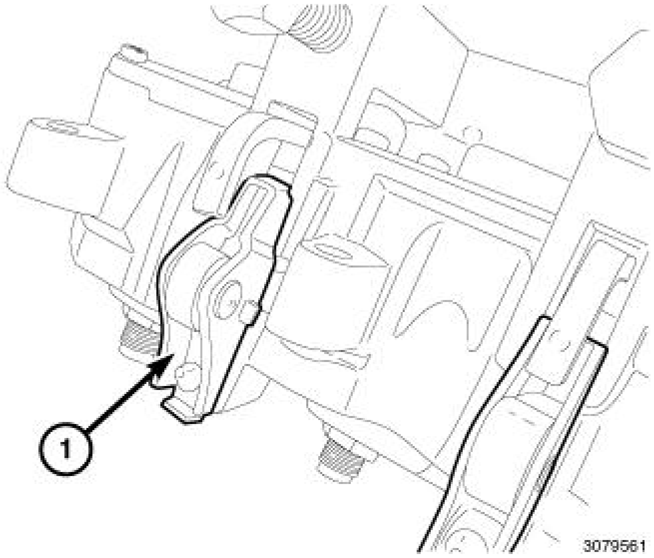


**Fig. 173: Rocker Arms**
**Courtesy of CHRYSLER GROUP, LLC**

2. If removed, install the rocker arms (1). Refer to **ROCKER ARM, VALVE, INSTALLATION**.

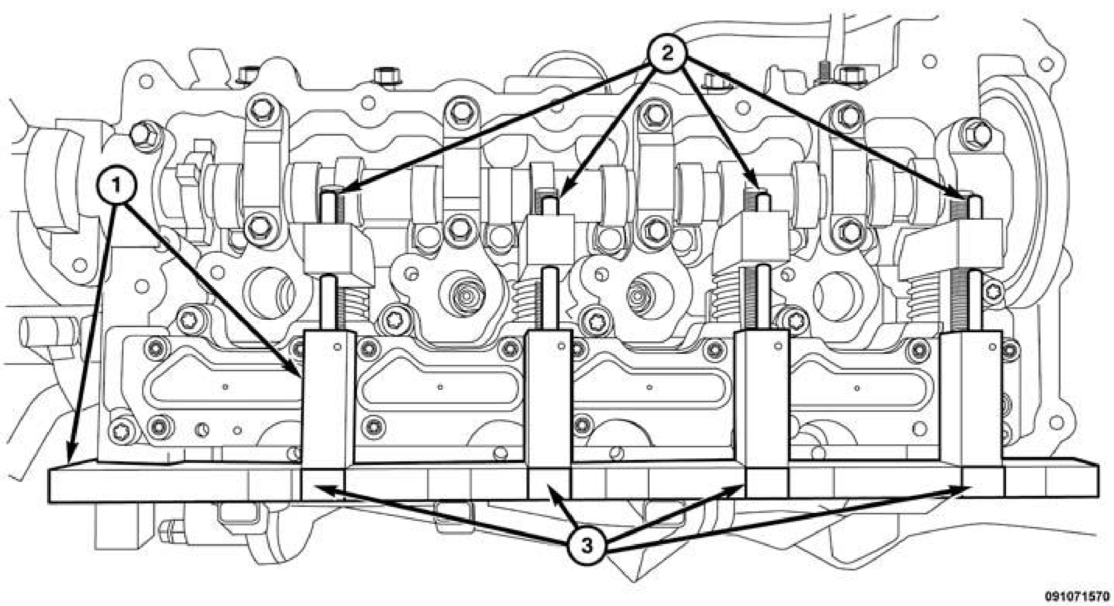


**Fig. 174: Special Tool, Spring Compressor & Indicators**
**Courtesy of CHRYSLER GROUP, LLC**

> **CAUTION: Do not invert the variable valve actuation assembly when it is removed from the engine. Oil will drain from the assembly and excessive engine cranking will be required to refill the assembly and start the engine.**

3. Rotate the spring compressors (2) counterclockwise until fully seated.

 

4. Install a **new** gasket.

**NOTE:** **To assist in the proper placement of the assembly, it is recommended to apply NEW/CLEAN MS-272 white grease or similar like Vaseline® onto the tips of the plungers to hold them in the retracted position. This will help to locate the assembly correctly while preventing the plunger tips from interfering with the valve stem tips. Use just enough to hold the plungers retracted.**

5. Set the VVAA into position onto the two dowels.

**NOTE:** **It is very important that the plungers of the VVAA are centered over the valve stem tips. When properly aligned, the VVAA will set down onto the cylinder head evenly and will not have a tendency to wobble when set onto the head.**

**NOTE:** **The VVAA should sit relatively flush to cylinder head with no more then a 1 to 2 mm gap between the mating surfaces. An excessive gap indicates the VVAA is not seated properly.**

6. Visually inspect the alignment of the VVAA plungers.

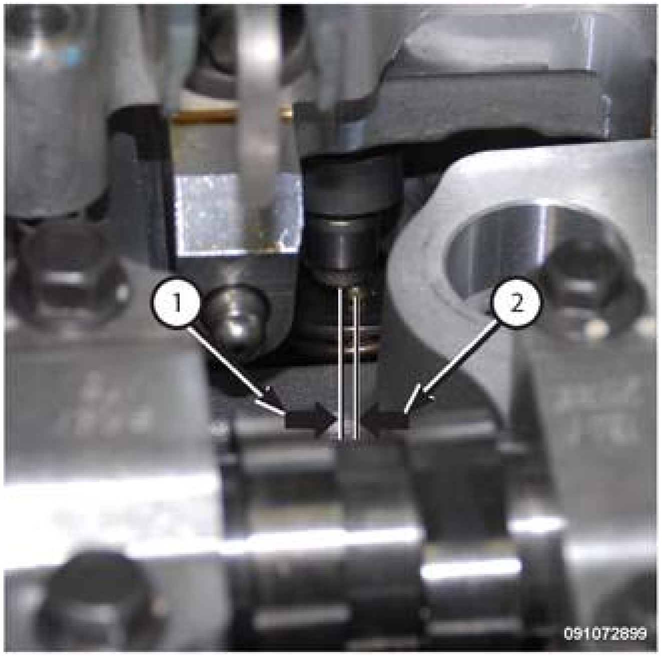


**Fig. 175: Improperly Aligned VVAA**
**Courtesy of CHRYSLER GROUP, LLC**

7. This is a visual indication of an IMPROPERLY aligned VVAA. The centerline of the plunger (1) and the centerline of the valve stem (2) are misaligned.

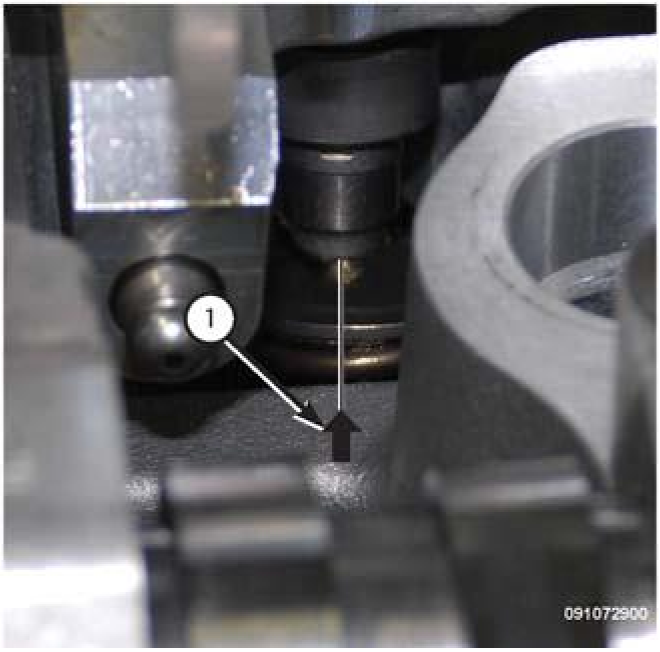


**Fig. 176: Properly Aligned VVAA**
**Courtesy of CHRYSLER GROUP, LLC**

8. This is a visual indication of a PROPERLY aligned VVAA. The centerline (1) of both the plunger and the valve stem are aligned.

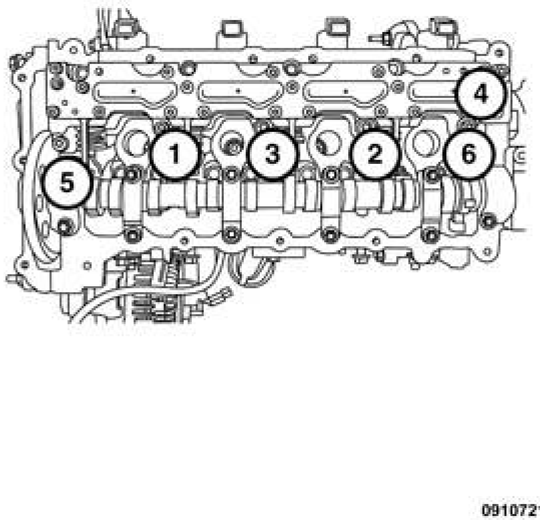


**Fig. 177: Six VVAA Retaining Bolts Hand Tightening Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

9. Install the six accessible bolts. Hand tighten the VVAA retaining bolts.

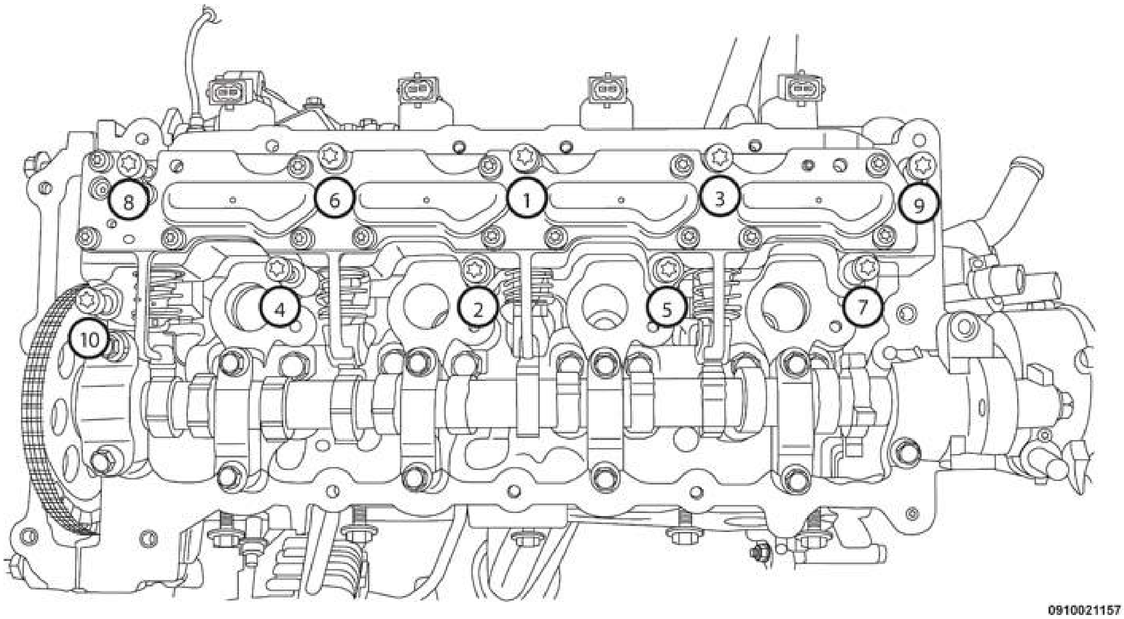


**Fig. 178: Variable Valve Actuation Assembly Tightening Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

10. Remove the spring compressor and tighten the ten bolts in three steps following the sequence shown in illustration:
    - Step 1: All to 10 N.m (89 in. lbs.).
    - Step 2: All to 22 N.m (16 ft. lbs.).
    - Step 3: All again to 22 N.m (16 ft. lbs.).
11. Connect and lock the four variable valve timing actuator electrical connectors.
12. Connect and lock the oil temperature sensor electrical connector.
13. Engage the oil temperature electrical connector to the bracket.

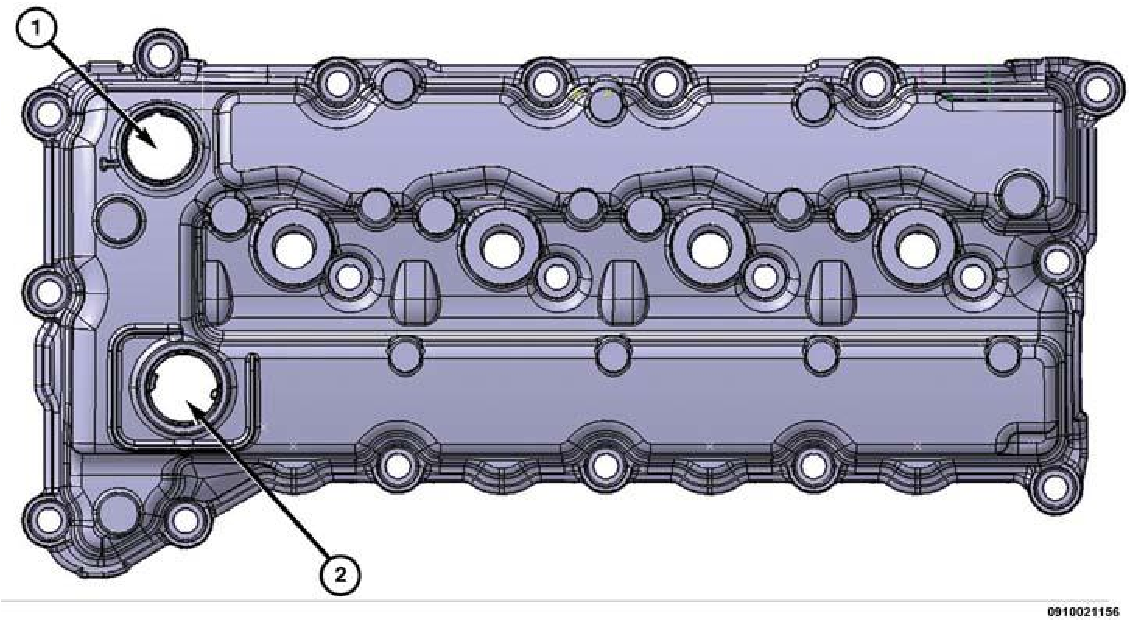


**Fig. 179: Cylinder Head Cover**
**Courtesy of CHRYSLER GROUP, LLC**

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

**NOTE: If the VVAA is being replaced (new part), it is recommended that the VVAA be primed with NEW/CLEAN oil after installation. This will limit the amount of time it takes for the assembly to fill while cranking the engine. If the cylinder head cover is installed the service port can be accessed through the opening at the rear of the cover (1).**

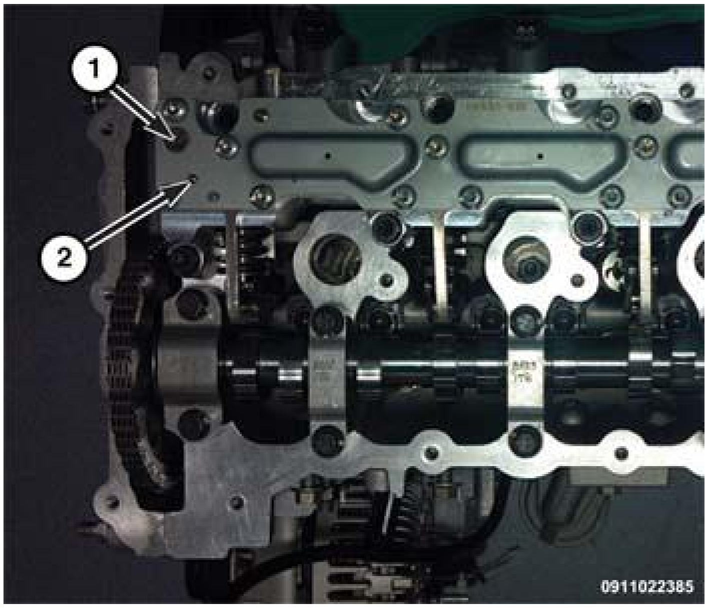


**Fig. 180: Service Port & Bleed Port**
**Courtesy of CHRYSLER GROUP, LLC**

15. Using an oil can with a **CLEAN** soft tip or similar tool like a **NEW** plastic syringe, force **CLEAN, UNUSED** oil into the service port (1). Continue to inject oil until oil flows continuously from the bleed port (2) or until a maximum of 200 mL has been injected.
16. The Cam/Crank Variation Relearn procedure must be performed using the scan tool anytime there has been a repair/replacement made to a powertrain system, for example: flywheel, valvetrain, camshaft and/or crankshaft sensors or components. Refer to appropriate Diagnostic Information .

# 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.

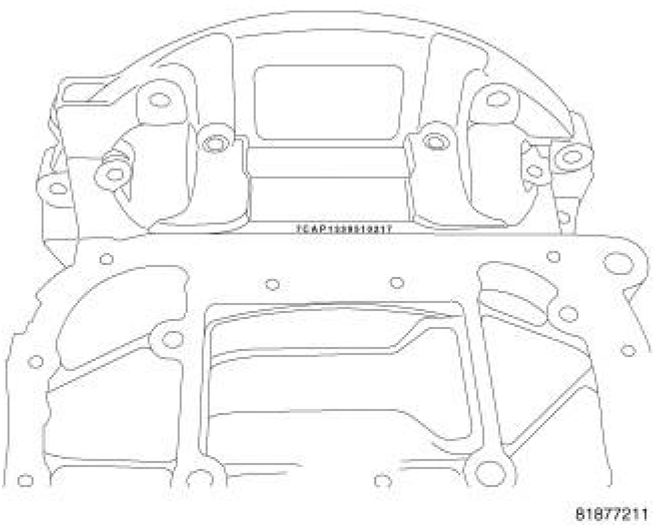


**Fig. 181: Serial Number Location**
**Courtesy of CHRYSLER GROUP, LLC**

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

## STANDARD PROCEDURE

### CYLINDER BORE DEGLAZING

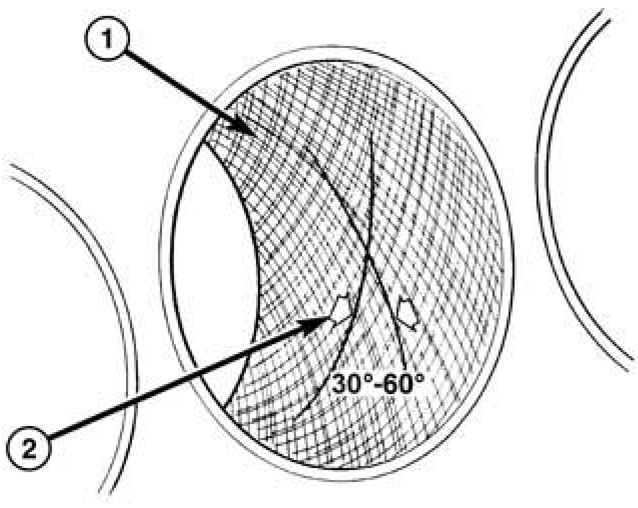


**Fig. 182: Cylinder Bore Crosshatch Pattern**
**Courtesy of CHRYSLER GROUP, LLC**

Before deglazing, mask the crankcase area to keep abrasive materials from entering the engine lower end. Tape off the water jacket and any openings to the oil circuit to prevent abrasive material from entering the coolant and oil circuits.

**CAUTION: DO NOT use rigid type hones to remove cylinder wall glaze.**

1. Select an appropriate size flexible ball hone.
2. Deglazing of the cylinder walls may be done if the cylinder bore is straight and round. About 20-60 strokes, depending on the condition of the cylinder bore, will be sufficient to provide a satisfactory surface. Use a light **honing** oil, available from major oil distributors.

**CAUTION: DO NOT use engine or transmission oil, mineral spirits, or kerosene.**

3. Deglazing should be done by moving the hone up and down fast enough to get a crosshatch pattern. The hone marks should intersect at 30° to 60° inclusive angle for proper seating of rings.
4. A controlled hone motor speed between 200 and 300 RPM is necessary to obtain the proper crosshatch angle (1). The number of up and down strokes per minute can be regulated to get the desired 30° to 60° inclusive angle (2). Faster up and down strokes increase the crosshatch angle.
5. After deglazing, it is necessary that the block be cleaned to remove all traces of abrasive. Use a brush to wash parts with a solution of hot water and detergent. Dry parts thoroughly. Use a clean, white, lint-free

cloth to check that the bore is clean. Oil the bores after cleaning to prevent rusting. Upon completion, perform a visual inspection of the cylinder block passages to inspect for abrasive debris. If any debris is found, repeat the cleaning process.

**NOTE: Cylinder bore diameter should not increase more than 20 microns during deglazing process from original nominal bore diameter, if the maximum of 20 microns is exceeded, the cylinder block must be replaced. If deglazing the cylinder bore cannot remove the light scratches and scuffs the cylinder block should be replaced.**

**MEASURING BEARING CLEARANCE USING PLASTIGAGE**

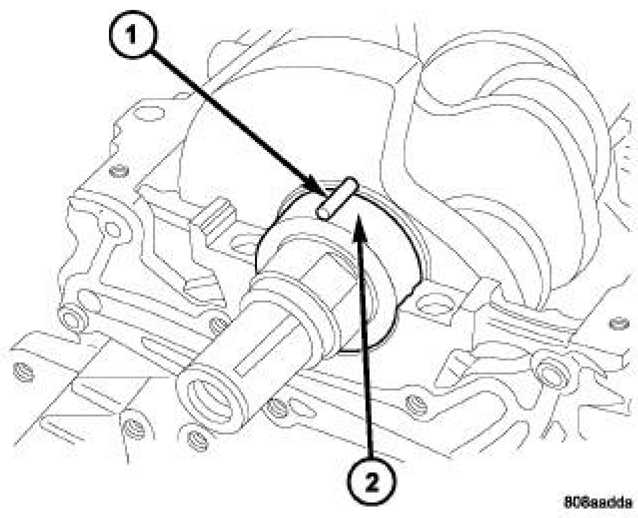


**Fig. 183: Plastigage Placed In Lower Shell**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical crankshaft journal shown in illustration.**

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

1. Remove the 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). Plastigage must not crumble in use. If brittle, obtain fresh stock.
3. Torque the bearing cap bolts of the bearing being checked to the proper. Refer to **TORQUE SPECIFICATIONS** .

**NOTE: DO NOT rotate the crankshaft. Plastigage will smear, causing inaccurate results.**

 

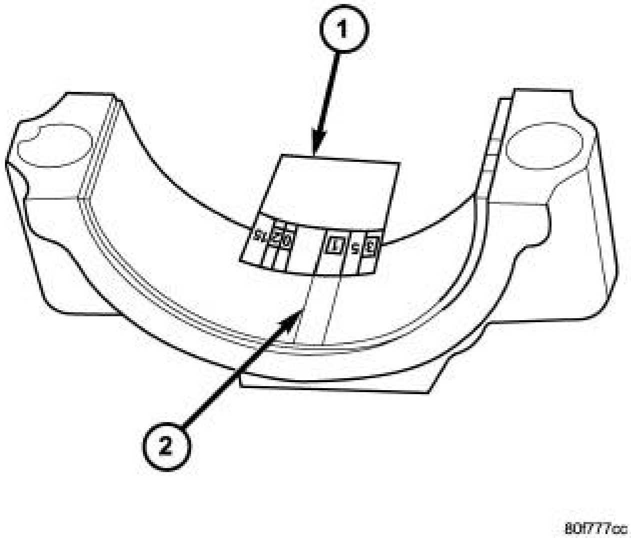


**Fig. 184: Measuring Bearing Clearance With Plastigage**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical connecting rod cap shown in illustration.**

4. Remove the bearing cap and compare the width of the flattened Plastigage (2) with the scale provided on the package (1). 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 or the possibility of foreign material trapped under the bearing insert.
5. Record all readings taken. Compare clearance measurements to. Refer to **ENGINE SPECIFICATIONS** .

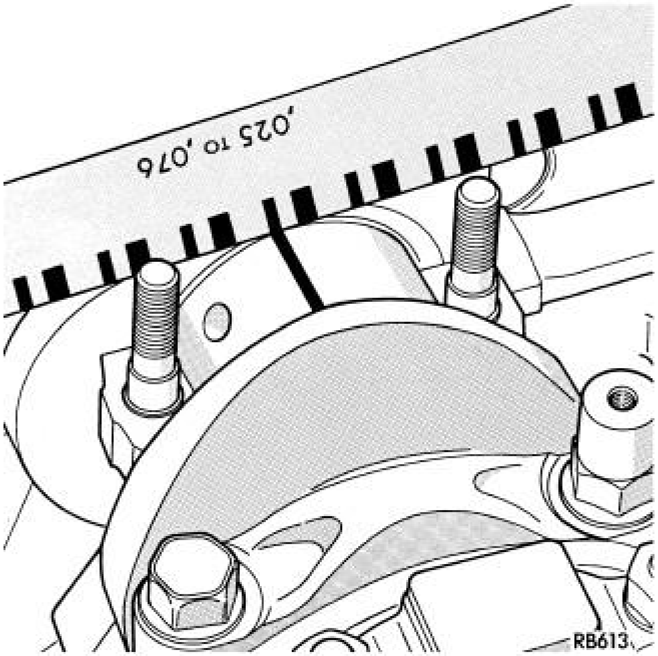


**Fig. 185: Checking Connecting Rod Bearing Clearance With Plastigage**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical connecting rod journal shown in illustration.**

**NOTE: Plastigage is available in a variety of clearance ranges. Use the most appropriate range for the specifications you are checking. Plastigage generally is accompanied by two scales. One scale is in inches, the other is a metric scale.**

6. Install the proper bearings to achieve the specified bearing clearances.
7. Repeat the Plastigage measurement to verify your bearing selection prior to final assembly.

## INSPECTION

### INSPECTION

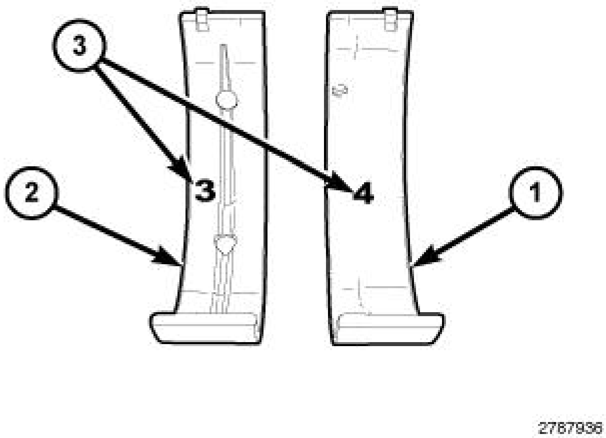


**Fig. 186: Main Bearing Inserts**
**Courtesy of CHRYSLER GROUP, LLC**

1. Wipe the main bearing inserts (1 and 2) clean.
2. Inspect the inserts for abnormal wear patterns, scoring, grooving, fatigue, pitting and for metal or other foreign material imbedded in the lining.
3. Inspect the back of the inserts for fractures, scrapes, or irregular wear patterns.
4. Inspect the insert locking tabs for damage.
5. Inspect the crankshaft thrust washers for scoring, scratches, wear or blueing.
6. Replace any bearing that shows abnormal wear. Refer to **BEARING(S), CRANKSHAFT, MAIN - STANDARD PROCEDURE** .
7. Inspect the main bearing bores for signs of scoring, nicks and burrs.
8. If the cylinder block main bearing bores show damage the engine block must be replaced.

 

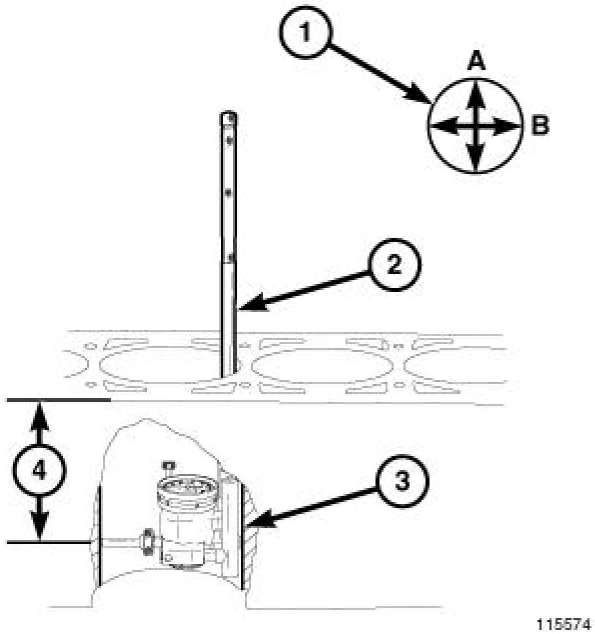


**Fig. 187: Measuring Cylinder Bore Diameter**
**Courtesy of CHRYSLER GROUP, LLC**

9. Use Cylinder Indicator (special tool #C-119, Cylinder Indicator) (2) to correctly measure the inside diameter of the cylinder bore (3). A cylinder bore gauge capable of reading in 0.003 mm (0.0001 in.) INCREMENTS is required. If a bore gauge is not available, do not use an inside micrometer.
10. Measure the inside diameter of the cylinder bore at three levels below the top of the bore (4). Start at the top of the bore, perpendicular (across or at 90 degrees) to the axis of the crankshaft at point A (1).
11. Repeat the measurement near the middle of the bore, then repeat the measurement near the bottom of the bore.
12. Determine taper by subtracting the smaller diameter from the larger diameter.
13. Rotate measuring device 90° to point B (1) and repeat the three measurements. Verify that the maximum taper is within specification. Refer to **ENGINE SPECIFICATIONS** .
14. Determine out-of-roundness by comparing the difference between A and B at each of the three levels. Verify that the maximum out of round is within specification. Refer to **ENGINE SPECIFICATIONS** .
15. If cylinder bore taper and out-of-roundness are within specification, the cylinder bore can be honed. Refer to **ENGINE BLOCK - STANDARD PROCEDURE** . If the cylinder bore taper or out-of-round condition exceeds the maximum limits, the cylinder block must be replaced.

**NOTE: A slight amount of taper always exists in the cylinder bore after the engine has been in use for a period of time.**

## BEARING(S), CONNECTING ROD

### STANDARD PROCEDURE

#### STANDARD PROCEDURE - CONNECTING ROD - FITTING

 

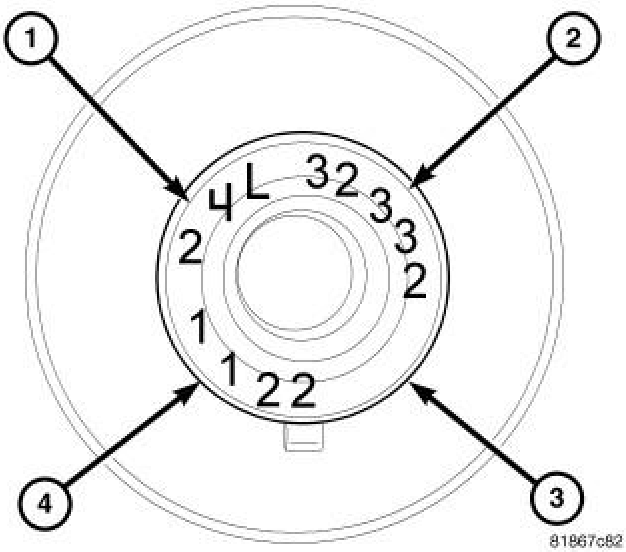


**Fig. 188: Bearing Selection**
**Courtesy of CHRYSLER GROUP, LLC**

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

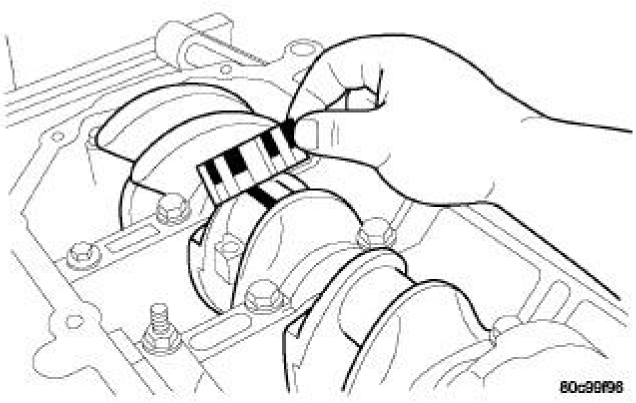

**Fig. 189: Connecting Rod Bearing Clearance - Typical**
**Courtesy of CHRYSLER GROUP, LLC**

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 tighten 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.**

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

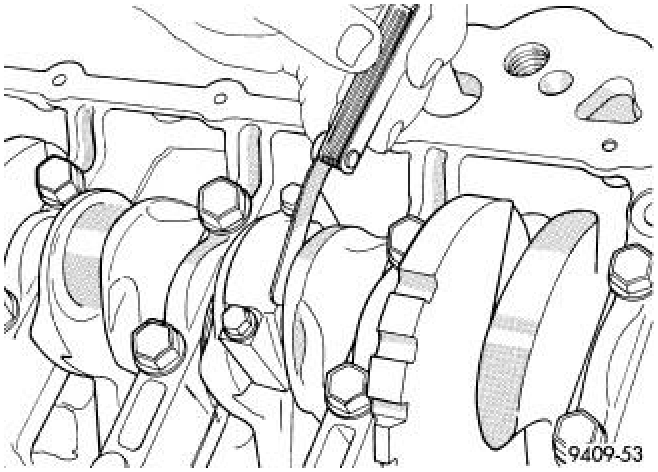


**Fig. 190: Connecting Rod Side Clearance**
**Courtesy of CHRYSLER GROUP, LLC**

5. Using a feeler gauge, check connecting rod side clearance. For clearance specifications. Refer to **ENGINE SPECIFICATIONS** .

**CONNECTING ROD BEARING REPLACEMENT**

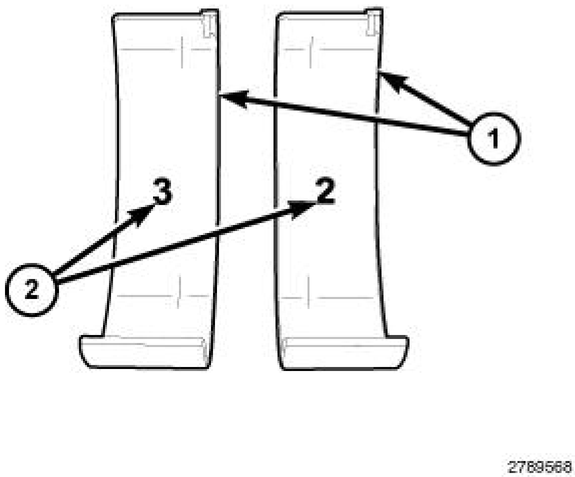


**Fig. 191: Connecting Rod Bearing Shells & Bearing Size**
**Courtesy of CHRYSLER GROUP, LLC**

The connecting rod bearings (1) are serviced in-vehicle. They must be replaced one-at-a-time in order to prevent the pistons from contacting the valves. The connecting rod bearings are "select fit" to achieve proper oil clearances. Refer to **BEARING(S), CONNECTING ROD - STANDARD PROCEDURE** .

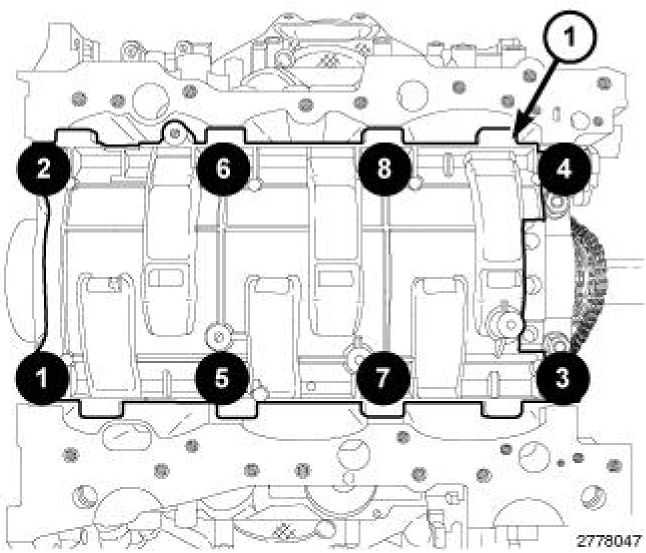


**Fig. 192: Main Bearing Cap Bolts From Windage Tray Removal Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

1. Disconnect and isolate the battery negative cable.
2. Remove the spark plugs. Refer to **SPARK PLUG, REMOVAL** .
3. Remove the oil pan, oil pump pick-up and engine oil pump. Refer to **PUMP, ENGINE OIL, REMOVAL**.
4. Remove the eight main bearing cap bolts in the sequence shown in illustration.

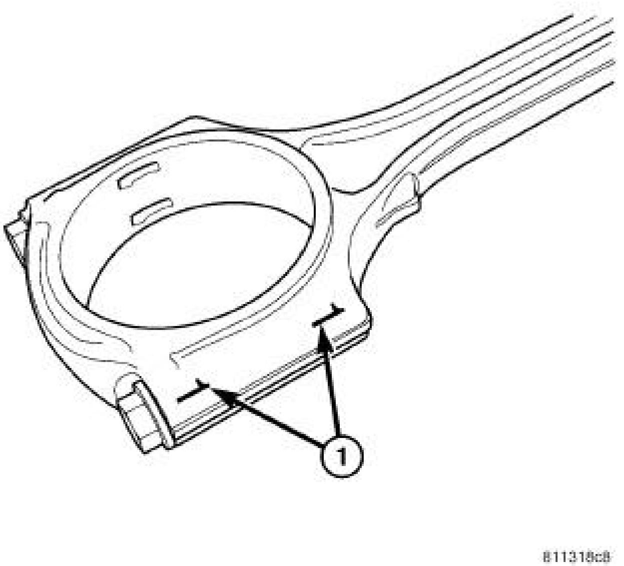


**Fig. 193: Connecting Rod To Cylinder Identification**
**Courtesy of CHRYSLER GROUP, LLC**

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

**NOTE: Connecting rods and bearing caps are not interchangeable and should be marked before removing to ensure correct reassembly.**

5. Mark connecting rod and bearing cap positions (1) using a permanent ink marker or scribe tool.

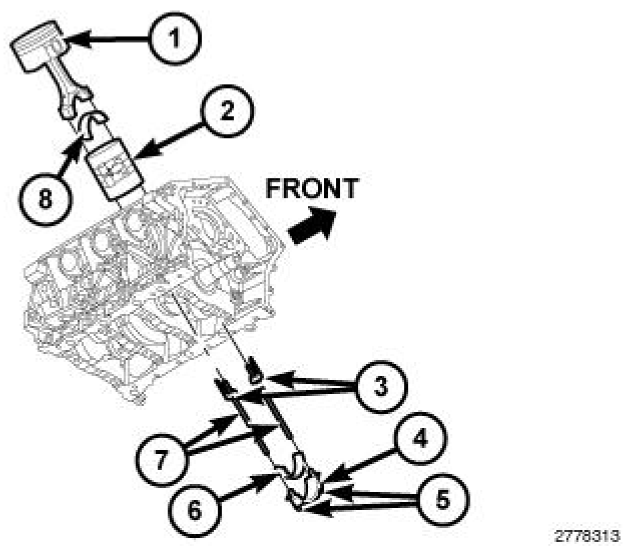

**Fig. 194: Piston, Connecting Rod Cap, Bolts, Plastic Guide Plates & Guide Pins**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical V6 engine configuration shown in illustration.**

**CAUTION: Replace only one connecting rod bearing at a time while all other connecting rod bearing caps remain properly tightened. If all connecting rod bearing caps are removed, crankshaft rotation will result in valve and/or piston damage.**

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

6. Remove the connecting rod cap bolts (5) and the connecting rod cap (4). Discard the cap bolts.
7. Remove the plastic guide plates (3) from the Guide Pins (special tool #8189, Guide Pins) (7) and install the Guide Pins to the connecting rod being removed.

**CAUTION: Care must be taken not to nick crankshaft journals, as engine damage may occur.**

8. Rotate the crankshaft away from the connecting rod and remove the bearing shell.
9. If required, select and fit new bearings to the connecting rod. Refer to **BEARING(S), CONNECTING ROD - STANDARD PROCEDURE** .
10. Install the bearing shell (8) on the connecting rod with the tang inserted into the machined groove in the rod. Lubricate the bearing surface with clean engine oil.
11. Rotate the crankshaft while guiding the connecting rod into position over the rod journal.

**CAUTION: The connecting rod bolts must not be reused. Always replace the connecting rod bolts whenever they are loosened or removed.**

12. Install the bearing shell (6) on the connecting rod cap (4) with the tang inserted into the machined groove in the cap. Lubricate the bearing surface with clean engine oil.

**NOTE: Do not lubricate the threads of the connecting rod cap bolts (5).**

13. Install the connecting rod cap and bearing with the tang on the same side as the rod. Tighten the **NEW** connecting rod cap bolts (5) to 20 N.m (15 ft. lbs.) plus 90°.
14. If required, check the connecting rod side clearance. Refer to **ROD, PISTON AND CONNECTING - STANDARD PROCEDURE** .
15. Repeat the previous steps for each connecting rod bearing being replaced.

 

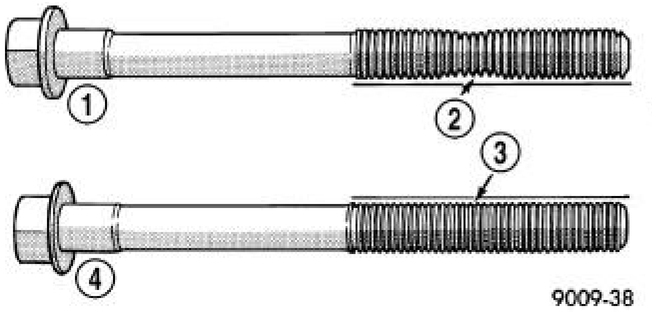


**Fig. 195: Checking Cylinder Head Bolts For Stretching (Necking)**
**Courtesy of CHRYSLER GROUP, LLC**

**CAUTION: The main bearing cap 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.**

16. Check the main bearing cap 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.

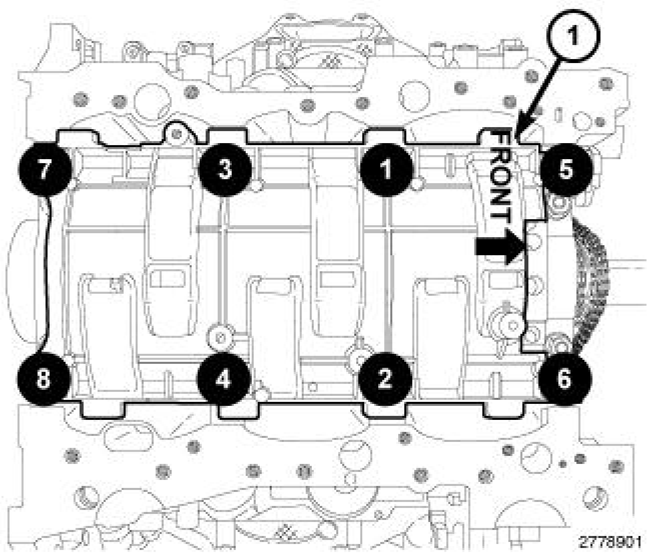


**Fig. 196: Windage Tray With Main Bearing Cap Bolts Installation Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

17. Install the eight main bearing cap bolts. Tighten the bolts in the sequence shown in illustration to 21 N.m (16 ft. lbs.) plus 90°.
18. Install the engine oil pump, oil pump pick-up and oil pan. Refer to **PUMP, ENGINE OIL, INSTALLATION**.
19. Install the spark plugs and ignition coils. Refer to **SPARK PLUG, INSTALLATION** .
20. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **OIL - STANDARD PROCEDURE** .
21. Connect the battery negative cable and tighten nut to 5 N.m (45 in. lbs.).

22. Operate the engine until it reaches normal operating temperature.

## BEARING(S), CRANKSHAFT, MAIN

### STANDARD PROCEDURE

#### STANDARD PROCEDURE - CONNECTING ROD - FITTING

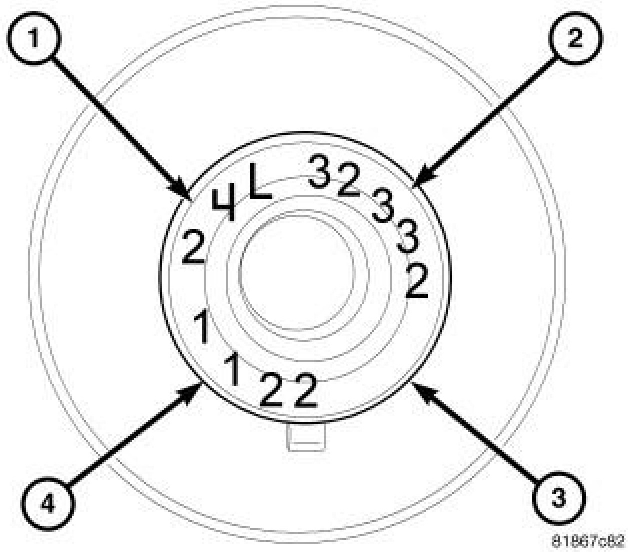


**Fig. 197: Bearing Selection**
**Courtesy of CHRYSLER GROUP, LLC**

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

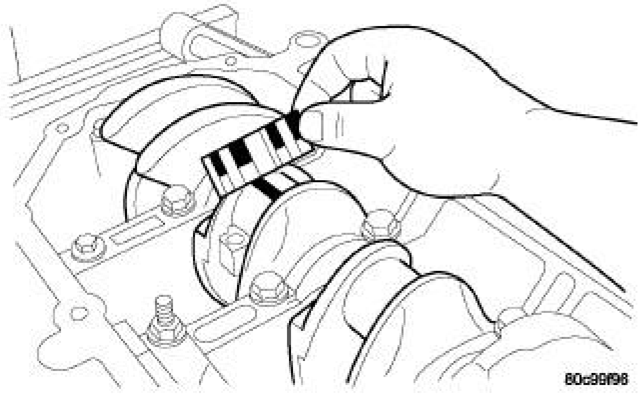


**Fig. 198: Connecting Rod Bearing Clearance - Typical**
**Courtesy of CHRYSLER GROUP, LLC**

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 tighten 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.**

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

 

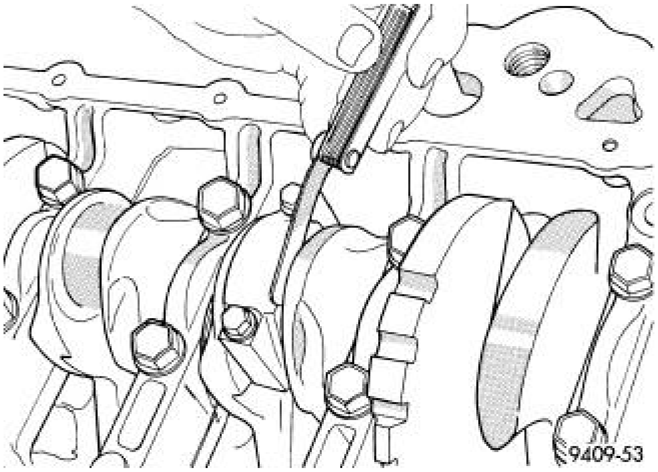


**Fig. 199: Connecting Rod Side Clearance**
**Courtesy of CHRYSLER GROUP, LLC**

5. Using a feeler gauge, check connecting rod side clearance. For clearance specifications. Refer to **ENGINE SPECIFICATIONS** .

**CONNECTING ROD BEARING REPLACEMENT**

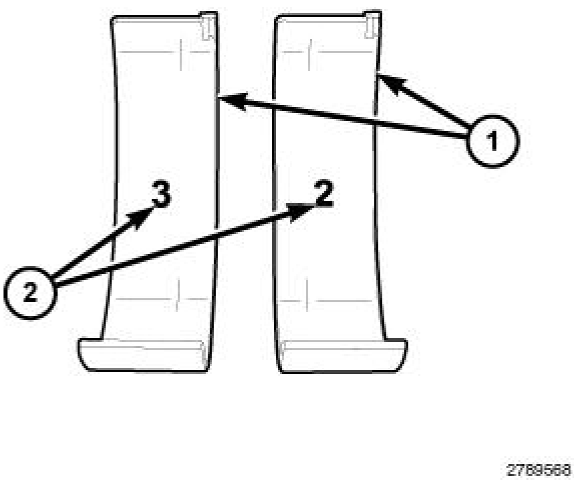


**Fig. 200: Connecting Rod Bearing Shells & Bearing Size**
**Courtesy of CHRYSLER GROUP, LLC**

The connecting rod bearings (1) are serviced in-vehicle. They must be replaced one-at-a-time in order to prevent the pistons from contacting the valves. The connecting rod bearings are "select fit" to achieve proper oil clearances. Refer to **BEARING(S), CONNECTING ROD - STANDARD PROCEDURE** .

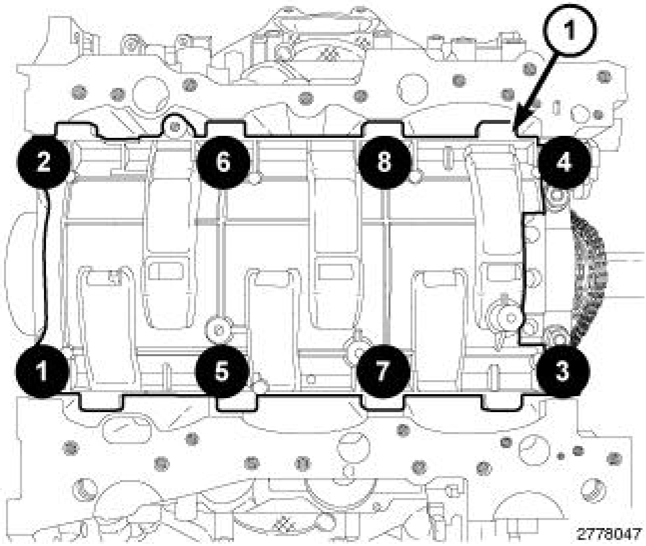


**Fig. 201: Main Bearing Cap Bolts From Windage Tray Removal Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

1. Disconnect and isolate the battery negative cable.
2. Remove the spark plugs. Refer to **SPARK PLUG, REMOVAL** .
3. Remove the oil pan, oil pump pick-up and engine oil pump. Refer to **PUMP, ENGINE OIL, REMOVAL**.
4. Remove the eight main bearing cap bolts in the sequence shown in illustration.

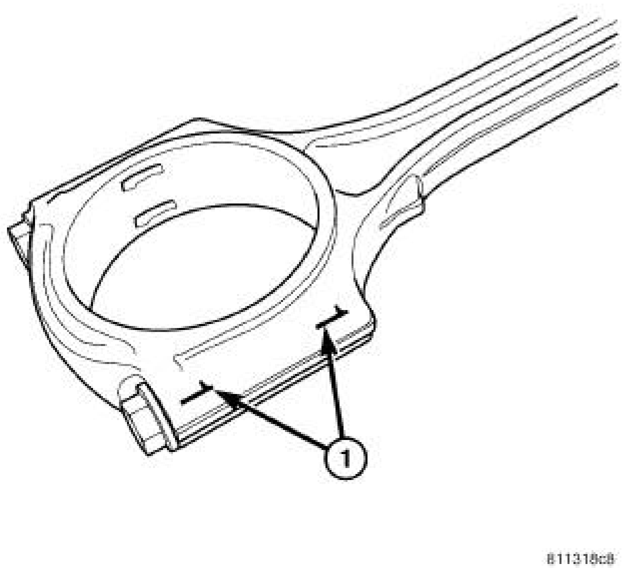


**Fig. 202: Connecting Rod To Cylinder Identification**
**Courtesy of CHRYSLER GROUP, LLC**

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

**NOTE: Connecting rods and bearing caps are not interchangeable and should be marked before removing to ensure correct reassembly.**

5. Mark connecting rod and bearing cap positions (1) using a permanent ink marker or scribe tool.

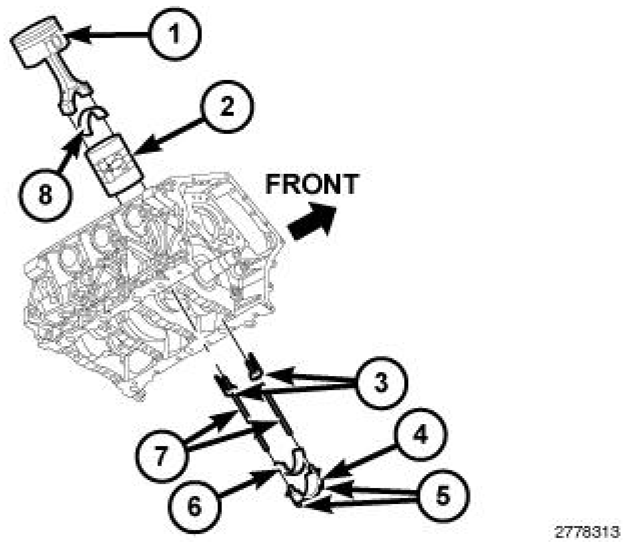


**Fig. 203: Piston, Connecting Rod Cap, Bolts, Plastic Guide Plates & Guide Pins**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical V6 engine configuration shown in illustration.**

**CAUTION: Replace only one connecting rod bearing at a time while all other connecting rod bearing caps remain properly tightened. If all connecting rod bearing caps are removed, crankshaft rotation will result in valve and/or piston damage.**

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

6. Remove the connecting rod cap bolts (5) and the connecting rod cap (4). Discard the cap bolts.
7. Remove the plastic guide plates (3) from the Guide Pins (special tool #8189, Guide Pins) (7) and install the Guide Pins to the connecting rod being removed.

**CAUTION: Care must be taken not to nick crankshaft journals, as engine damage may occur.**

8. Rotate the crankshaft away from the connecting rod and remove the bearing shell.
9. If required, select and fit new bearings to the connecting rod. Refer to **BEARING(S), CONNECTING ROD - STANDARD PROCEDURE** .
10. Install the bearing shell (8) on the connecting rod with the tang inserted into the machined groove in the rod. Lubricate the bearing surface with clean engine oil.
11. Rotate the crankshaft while guiding the connecting rod into position over the rod journal.

**CAUTION: The connecting rod bolts must not be reused. Always replace the connecting rod bolts whenever they are loosened or removed.**

12. Install the bearing shell (6) on the connecting rod cap (4) with the tang inserted into the machined groove in the cap. Lubricate the bearing surface with clean engine oil.

**NOTE: Do not lubricate the threads of the connecting rod cap bolts (5).**

13. Install the connecting rod cap and bearing with the tang on the same side as the rod. Tighten the **NEW** connecting rod cap bolts (5) to 20 N.m (15 ft. lbs.) plus 90°.
14. If required, check the connecting rod side clearance. Refer to **ROD, PISTON AND CONNECTING - STANDARD PROCEDURE** .
15. Repeat the previous steps for each connecting rod bearing being replaced.

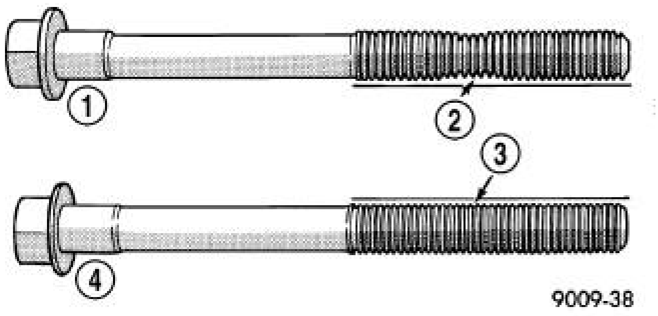


**Fig. 204: Checking Cylinder Head Bolts For Stretching (Necking)**
**Courtesy of CHRYSLER GROUP, LLC**

**CAUTION: The main bearing cap 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.**

16. Check the main bearing cap 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.

 

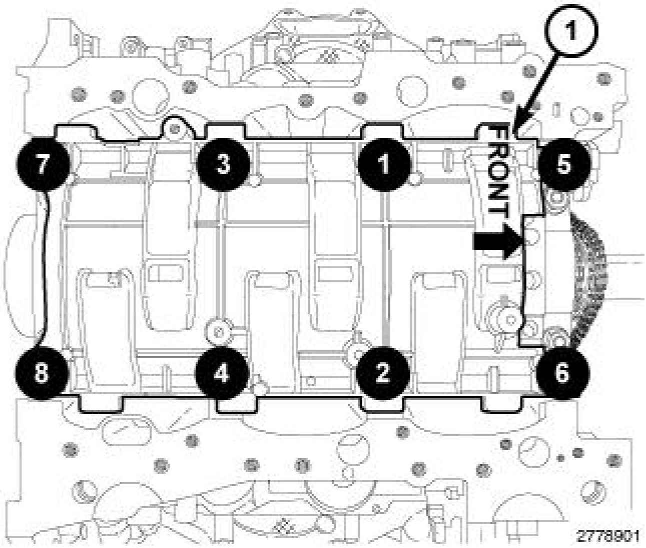


**Fig. 205: Windage Tray With Main Bearing Cap Bolts Installation Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

17. Install the eight main bearing cap bolts. Tighten the bolts in the sequence shown in illustration to 21 N.m (16 ft. lbs.) plus 90°.
18. Install the engine oil pump, oil pump pick-up and oil pan. Refer to **PUMP, ENGINE OIL, INSTALLATION**.
19. Install the spark plugs and ignition coils. Refer to **SPARK PLUG, INSTALLATION** .
20. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **OIL - STANDARD PROCEDURE** .
21. Connect the battery negative cable and tighten nut to 5 N.m (45 in. lbs.).
22. Operate the engine until it reaches normal operating temperature.

## CRANKSHAFT

### DESCRIPTION

#### DESCRIPTION

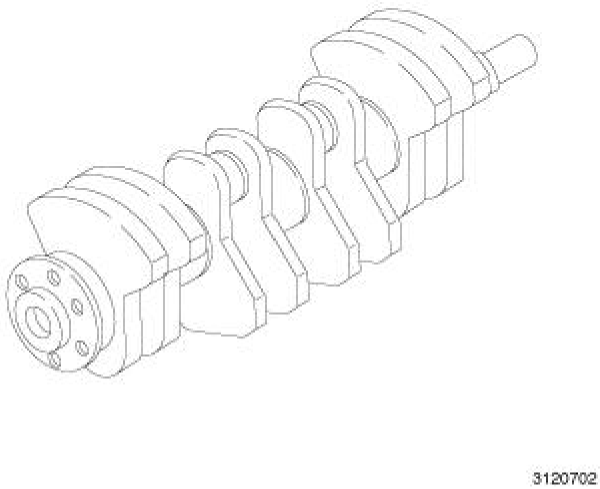


**Fig. 206: Crankshaft**
**Courtesy of CHRYSLER GROUP, LLC**

The crankshaft is made from induction hardened forged steel. Eight counterweights at 180° balance the crankshaft rotary mass. The main journals are crossed drilled for rod bearing lubrication. The crankshaft is supported by five select fit main bearings with the center bearing serving as the thrust washer location. Both the front and rear seals are a single piece design and are mounted to the oil pump and cylinder block.

### STANDARD PROCEDURE

#### STANDARD PROCEDURE - MEASURING CRANKSHAFT END PLAY

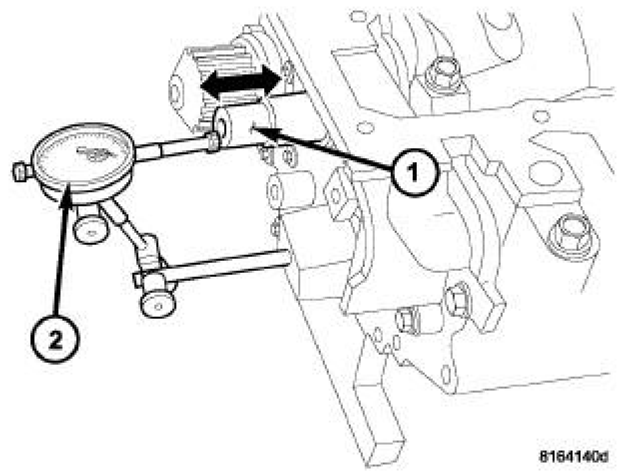


**Fig. 207: Checking Crankshaft End Play**
**Courtesy of CHRYSLER GROUP, LLC**

| |
|---|
| 1 - Crankshaft<br>2 - DIAL INDICATOR |

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

**REMOVAL**

**REMOVAL**

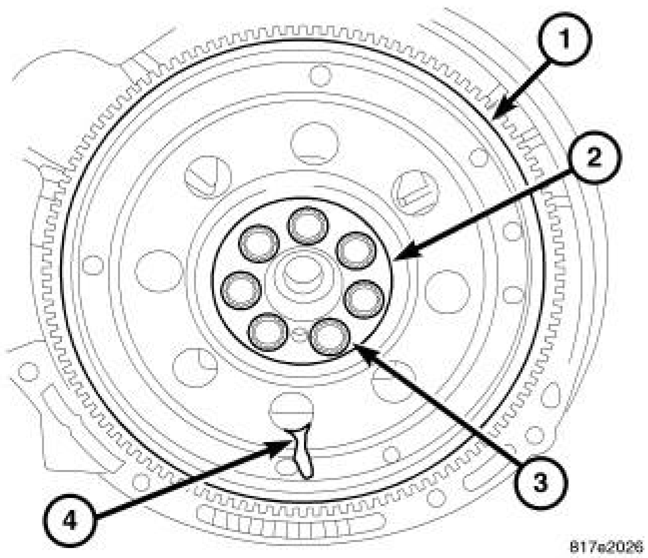


**Fig. 208: Flex Plate**
**Courtesy of CHRYSLER GROUP, LLC**

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

1. Remove engine assembly from vehicle. Refer to **ENGINE - REMOVAL**.
2. Remove flex plate/flywheel (1).
3. Remove crankshaft rear oil seal. Refer to **SEAL, CRANKSHAFT OIL, REAR, REMOVAL**.

 

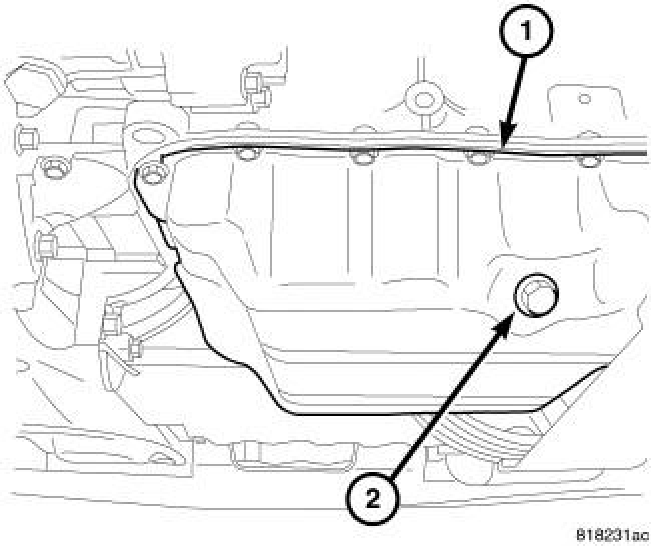


**Fig. 209: Oil Drain Plug & Oil Pan**
**Courtesy of CHRYSLER GROUP, LLC**

4. Install engine on suitable stand.
5. Drain engine oil (2).

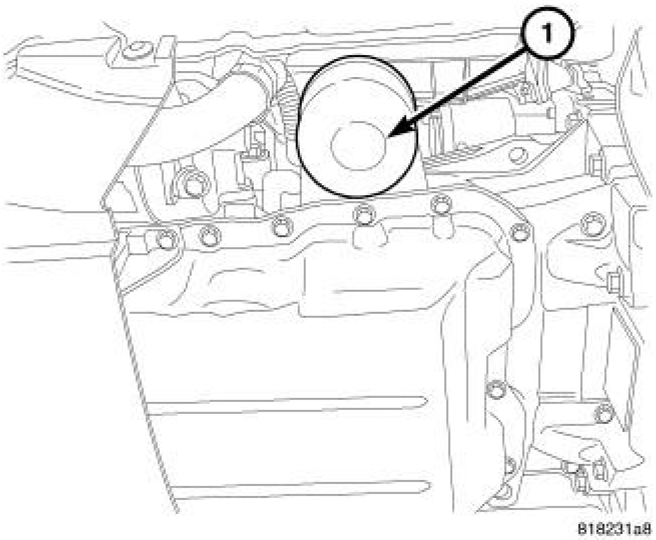


**Fig. 210: Oil Filter**
**Courtesy of CHRYSLER GROUP, LLC**

6. Remove oil filter (1).
7. Remove crankshaft vibration damper. Refer to **DAMPER, VIBRATION, REMOVAL**.
8. Remove water pump pulley.

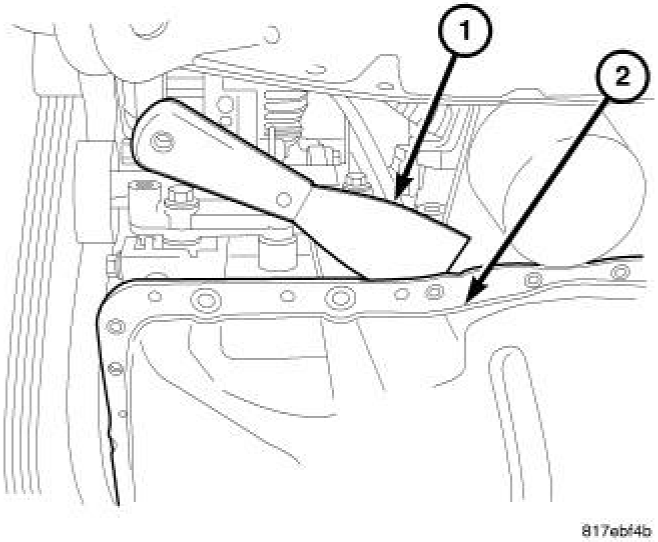


**Fig. 211: Using Putty Knife To Loosen Seal Around Oil Pan**
**Courtesy of CHRYSLER GROUP, LLC**

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

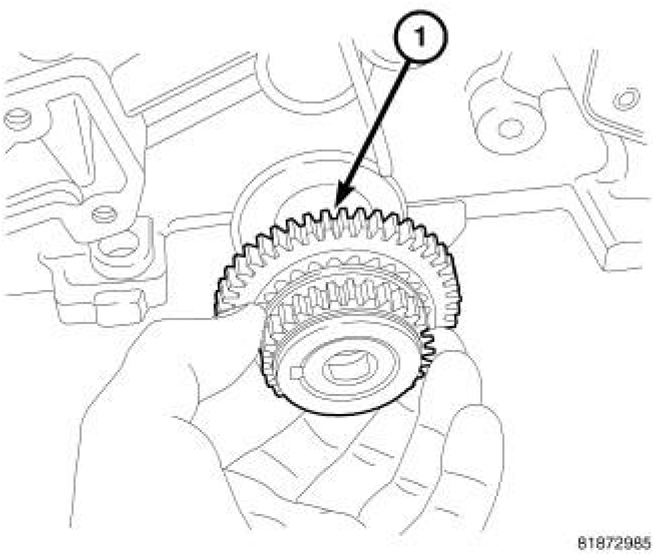


**Fig. 212: Crankshaft Sprocket**
**Courtesy of CHRYSLER GROUP, LLC**

13. Remove the crankshaft sprocket (1).

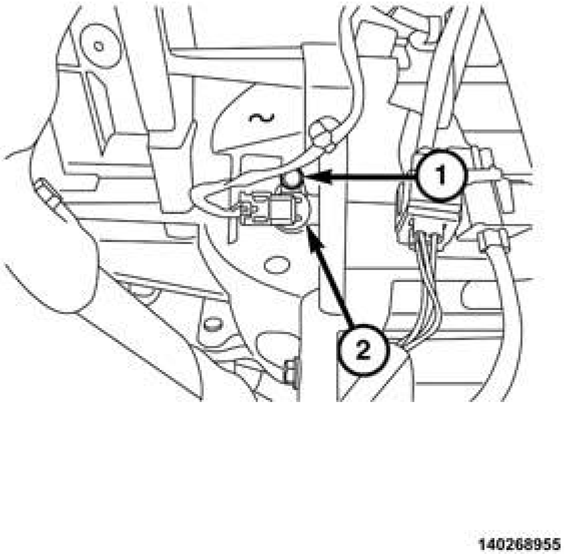


**Fig. 213: Crankshaft Position Sensor & Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

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

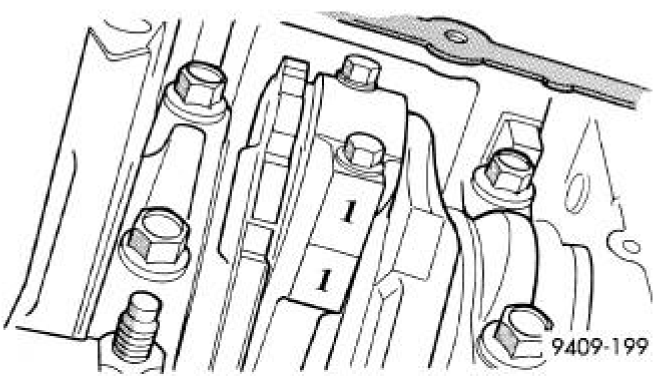


**Fig. 214: Identify Connecting Rod To Cylinder-Typical**
**Courtesy of CHRYSLER GROUP, LLC**

**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.**

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

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

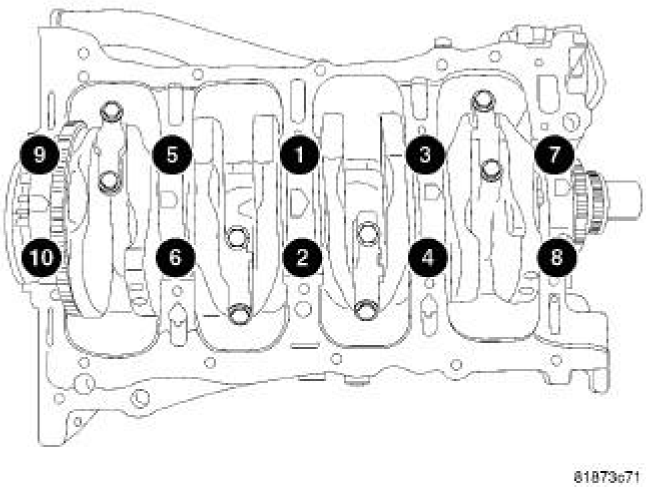


**Fig. 215: Main Bearing Cap Removal Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

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

18. Remove main bearing caps.

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

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

**INSPECTION**

**INSPECTION**

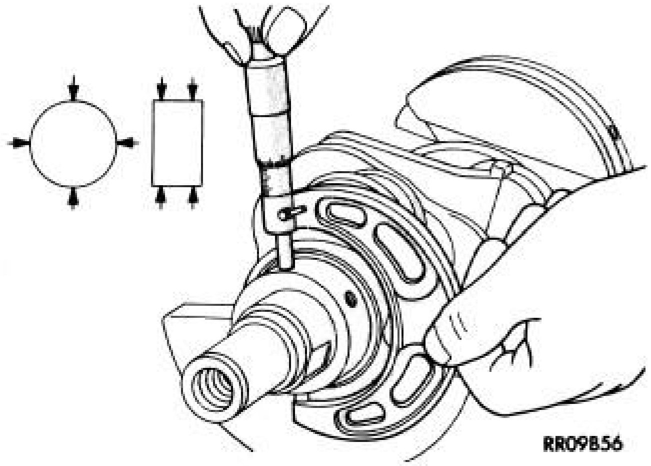


**Fig. 216: Measuring Crankshaft Journal**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical crankshaft journal measurements shown in illustration.**

1. Clean the oil off the bearing journals.
2. Determine the maximum diameter of the journals with a micrometer. Measure at two locations 90° apart at each end of the journals.
3. Compare the measured rod journal diameter to the crankshaft connecting rod bearing journal diameter grade marking chart. Refer to **BEARING(S), CONNECTING ROD - STANDARD PROCEDURE** . Select the bearing size that corresponds to the crankshaft markings for each rod bearing journal that will provide the proper oil clearance.
4. Compare the measured main bearing journal diameter to the crankshaft main bearing journal diameter grade marking chart. Refer to **BEARING(S), CRANKSHAFT, MAIN - STANDARD PROCEDURE** . Obtain the main bearing journal grade identification marks from the engine block and select the upper and lower main bearing sizes that will provide the proper oil clearance.
5. For connecting rod journals, verify that the maximum taper and maximum out of round are within specifications. Refer to **ENGINE SPECIFICATIONS** .
6. For main bearing journals, verify that the maximum taper and maximum out of round are within specifications. Refer to **ENGINE SPECIFICATIONS** .

**INSTALLATION**

**INSTALLATION**

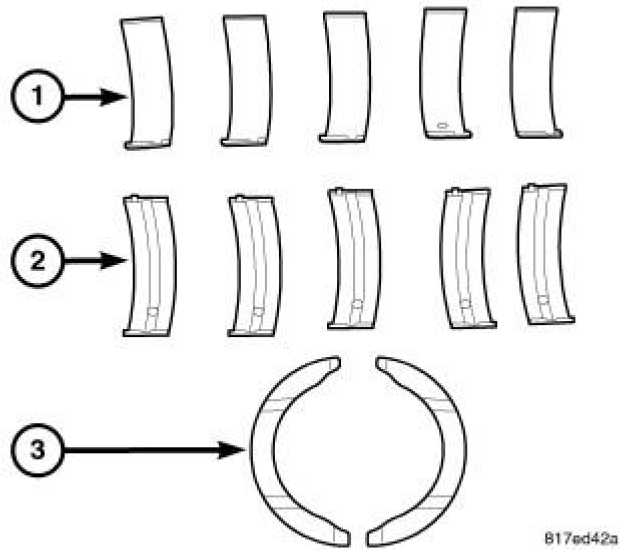


**Fig. 217: Bearing Identification**
**Courtesy of CHRYSLER GROUP, LLC**

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.

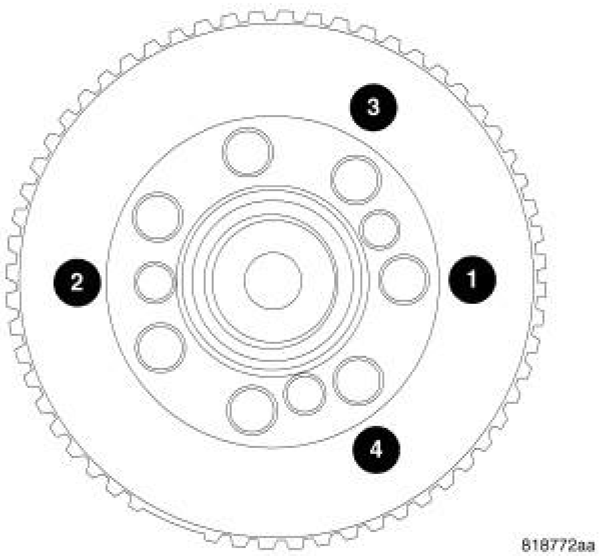


**Fig. 218: Target Wheel**
**Courtesy of CHRYSLER GROUP, LLC**

**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.

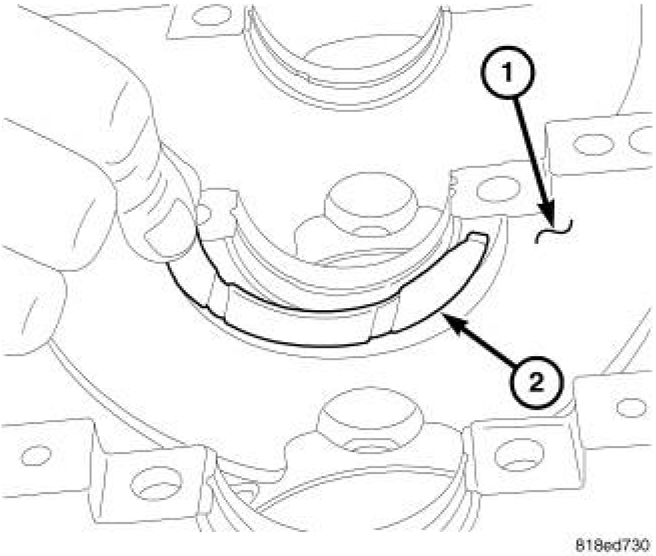


**Fig. 219: Installing Thrust Bearing**
**Courtesy of CHRYSLER GROUP, LLC**

**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.

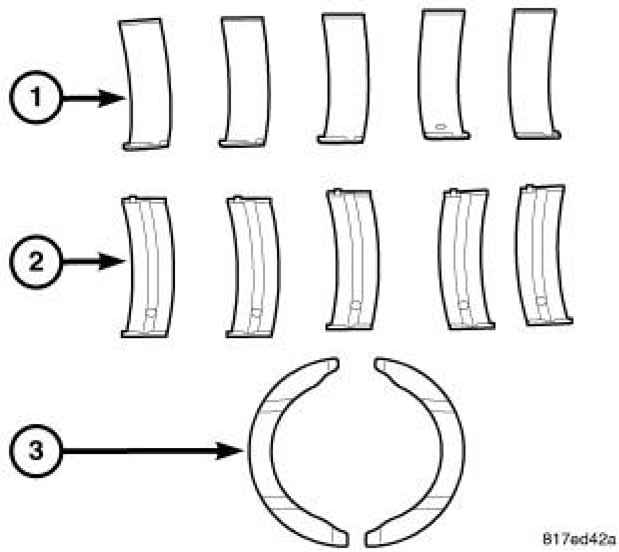


**Fig. 220: Bearing Identification**
**Courtesy of CHRYSLER GROUP, LLC**

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.**

 

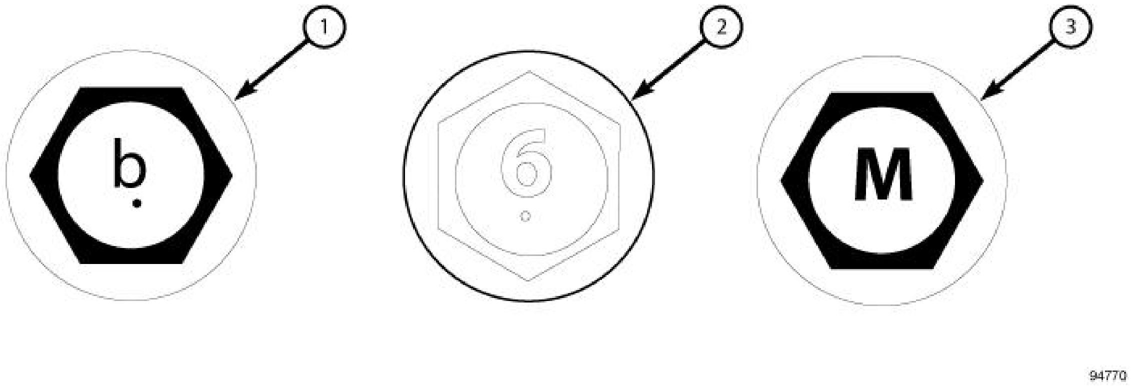


**Fig. 221: Main Bolt Identification**
**Courtesy of CHRYSLER GROUP, LLC**

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.

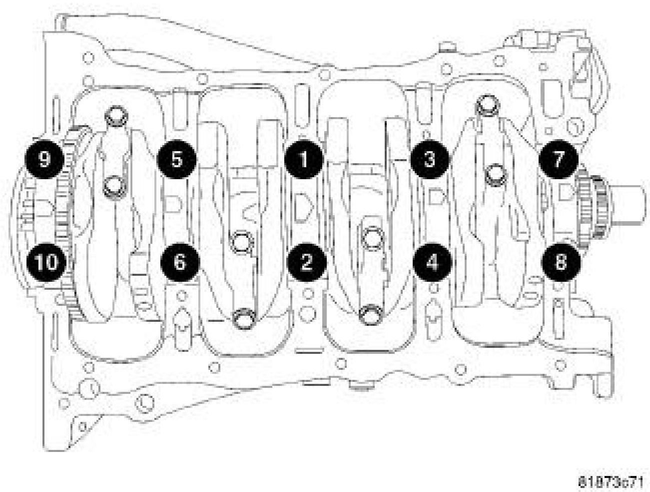


**Fig. 222: Main Bearing Cap Removal/Installation Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

**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 **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**.

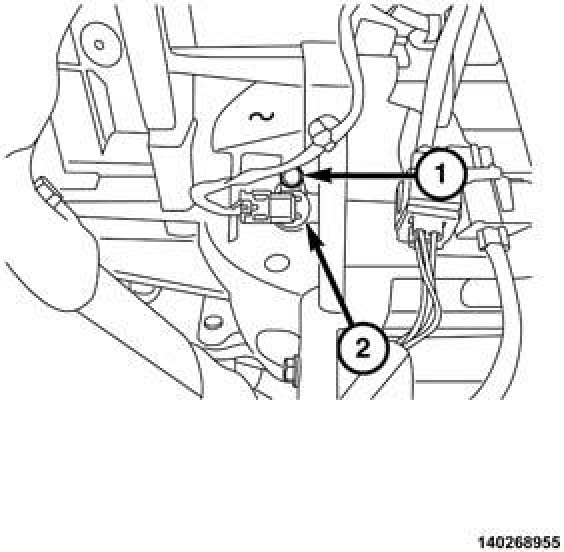


**Fig. 223: Crankshaft Position Sensor & Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

23. Install crankshaft position sensor (2) and bolt (1). Tighten the bolt to 9 N.m (80 in. lbs.)
24. Install cylinder head if it was removed. Refer to **CYLINDER HEAD, INSTALLATION**.

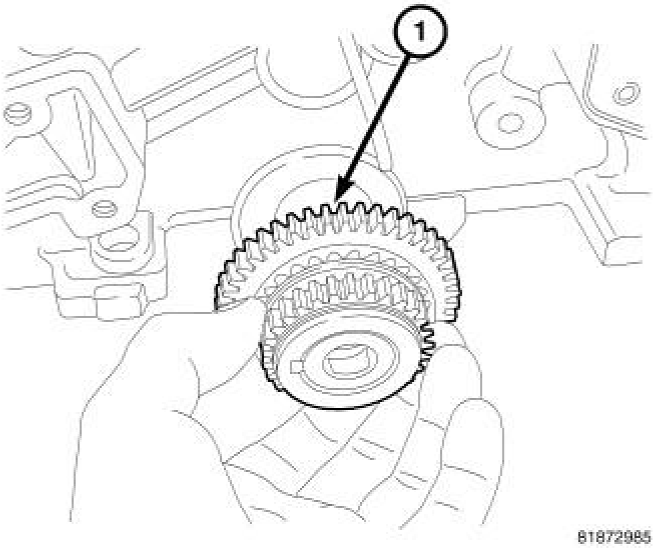


**Fig. 224: Crankshaft Sprocket**
**Courtesy of CHRYSLER GROUP, LLC**

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**.
31. Install crankshaft vibration damper. Refer to **DAMPER, VIBRATION, INSTALLATION**.
32. Install water pump pulley. Refer to **PUMP, WATER, INSTALLATION** .
33. Install crankshaft rear oil seal. Refer to **SEAL, CRANKSHAFT OIL, REAR, INSTALLATION**.
34. Install drive plate/flex plate using **new** bolts. Tighten bolts to 95 N.m (70 ft. lbs.).
35. Attach transaxle to engine. Tighten bellhousing bolts to 101 N.m (75 ft. lbs.).
36. Install the engine assembly into the vehicle. Refer to **ENGINE - INSTALLATION**.

 

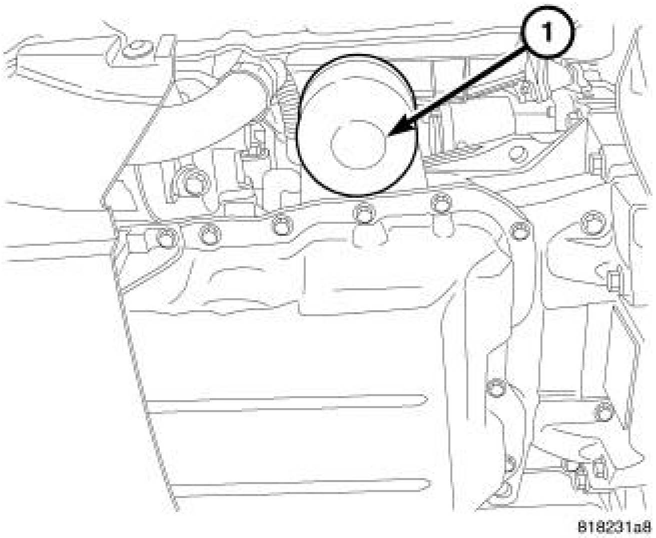


**Fig. 225: Oil Filter**
**Courtesy of CHRYSLER GROUP, LLC**

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

## DAMPER, VIBRATION

### REMOVAL

#### REMOVAL

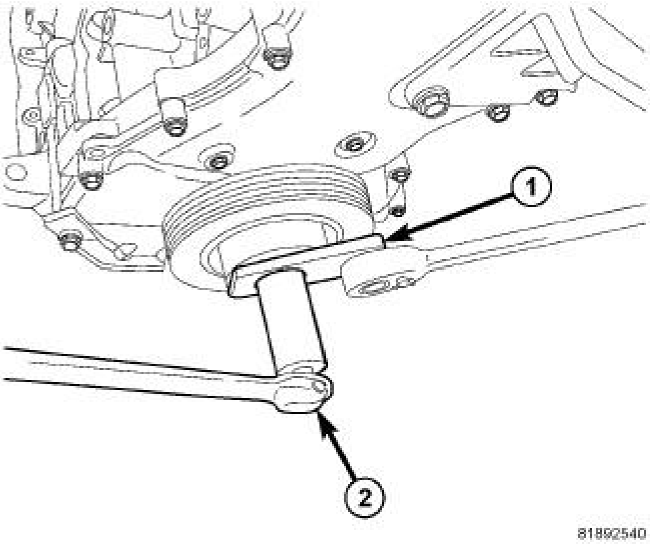


**Fig. 226: Removing/Installing Crankshaft Damper Bolt**

**Courtesy of CHRYSLER GROUP, 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**

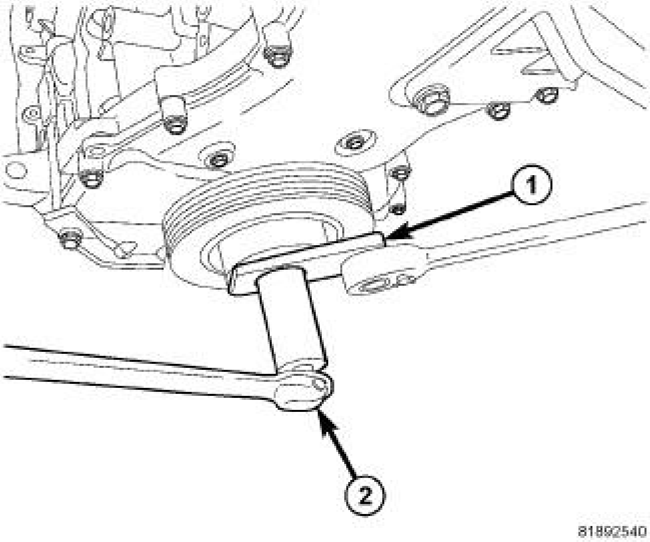


**Fig. 227: Removing/Installing Crankshaft Damper Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

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**

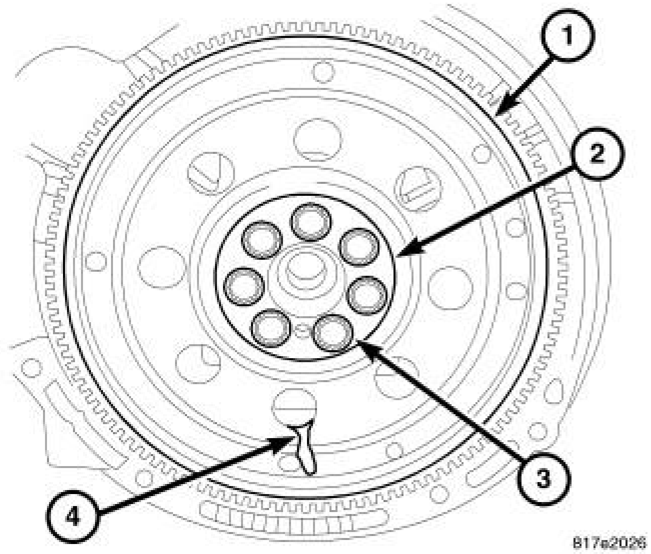


**Fig. 228: Flex Plate**
**Courtesy of CHRYSLER GROUP, LLC**

1. Remove transmission.
2. Remove flex plate bolts (3) and discard.
3. Remove washer (2).
4. Remove flex plate (1).

**INSTALLATION**

**INSTALLATION**

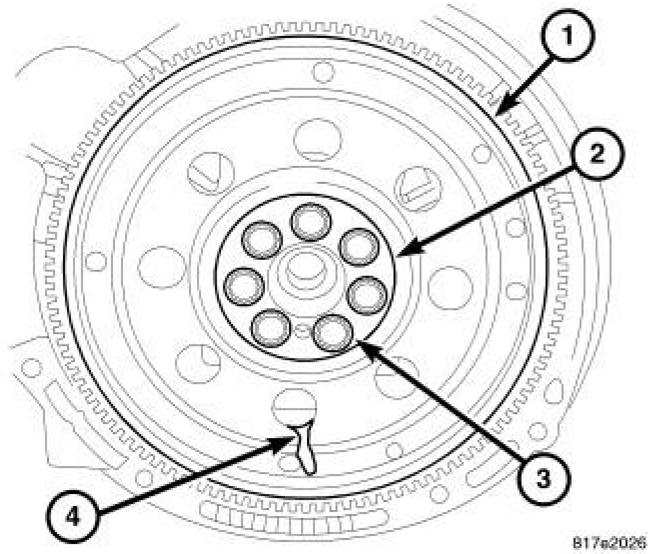


**Fig. 229: Flex Plate**
**Courtesy of CHRYSLER GROUP, LLC**

1. Install flex plate (1).

2. Install washer (2).
3. Install **new** flex plate bolts (3) and tighten in a criss-cross pattern to 95 N.m (70 ft. lbs.).
4. Install transaxle.

## FRAME, LADDER

### REMOVAL

#### REMOVAL

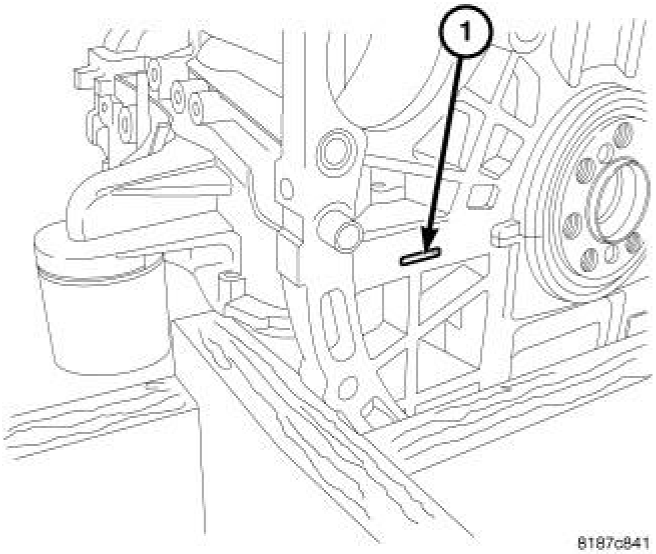


**Fig. 230: Pry Point 1**
**Courtesy of CHRYSLER GROUP, LLC**

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).

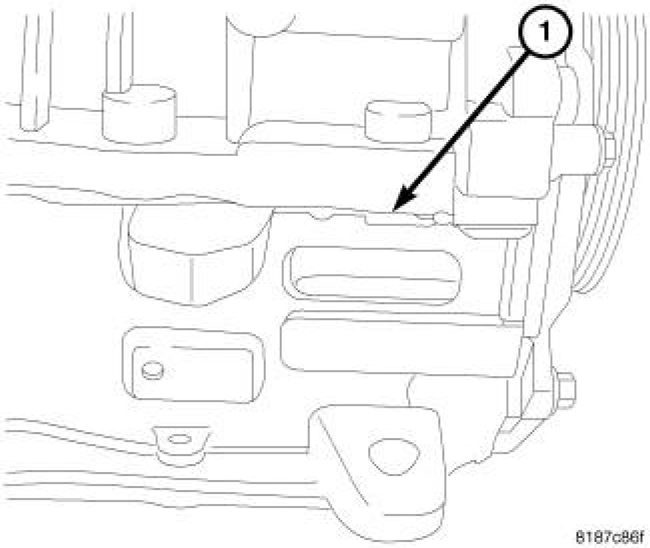


**Fig. 231: Pry Point 2**
**Courtesy of CHRYSLER GROUP, LLC**

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

**INSTALLATION**

**INSTALLATION**

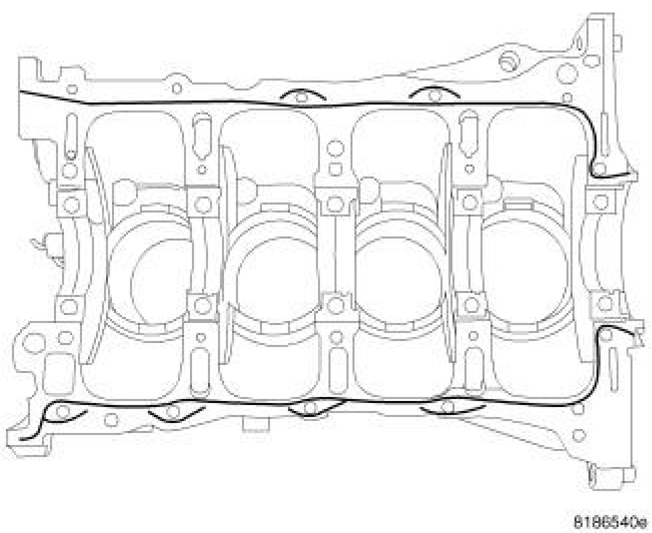


**Fig. 232: Sealing Ladder Frame**
**Courtesy of CHRYSLER GROUP, LLC**

| | |
|---|---|
| **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.

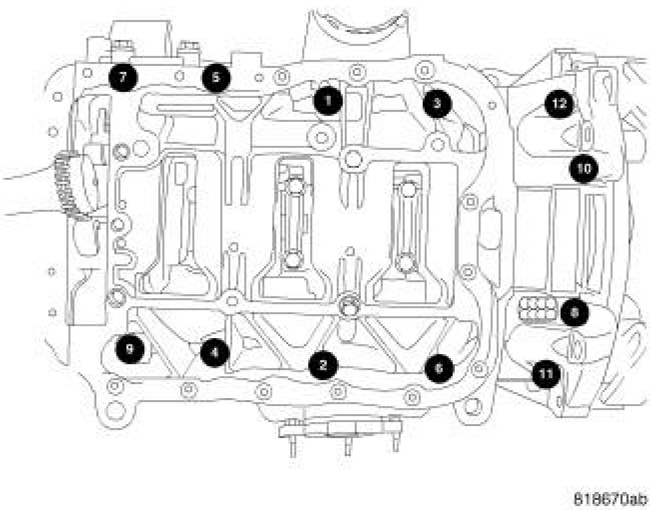


**Fig. 233: Ladder Frame Bolts Tightening Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

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

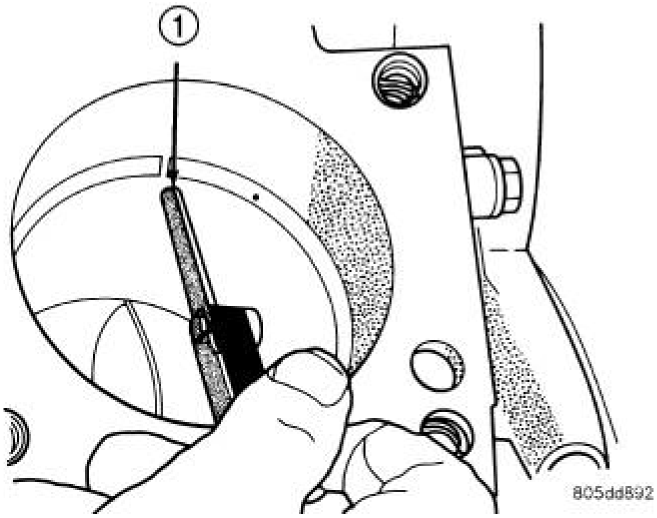


**Fig. 234: Measuring Piston Ring End Gap**
**Courtesy of CHRYSLER GROUP, LLC**

1. Wipe the cylinder bore clean.
2. Using a piston, to ensure that the ring is squared in the cylinder bore, slide the ring downward into the cylinder to a position 12 mm (0.50 in.) from the bottom of the cylinder bore.
3. Using a feeler gauge (1), check the ring end gap. Replace any rings not within specification.

| Ring Position | Ring End Gap |
|---|---|
| No. 1 (top) Ring | 0.25 - 0.40 mm (0.010 - 0.016 in.) |
| No. 2 (center) Ring | 0.30 - 0.45 mm (0.012 - 0.018 in.) |
| Oil Control Ring (Steel Rail) | 0.15 - 0.66 mm (0.006- 0.26 in.) |

 

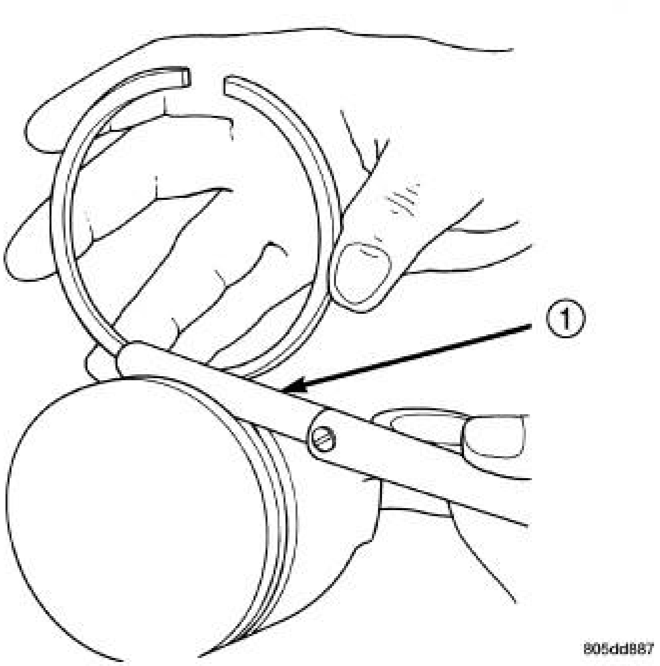


**Fig. 235: Checking Piston Ring Grooves Clearances**
**Courtesy of CHRYSLER GROUP, LLC**

4. Clean the piston ring grooves. Remove any nicks or burrs.
5. Measure the ring side clearance as shown in illustration. Make sure the feeler gauge (1) fits snugly between the ring land and the ring. Replace any ring not within specification.

| Ring Position | Ring Side Clearance |
|---|---|
| No. 1 (top) Ring | 0.025 - 0.033 mm (0.0010 - 0.0013 in.) |
| No. 2 (center) Ring | 0.030 - 0.078 mm (0.0012 - 0.0031 in.) |
| Oil Control Ring (Steel Rails) | 0.007 - 0.173 mm (.0003 - 0.0068 in.) |

**REMOVAL**

**REMOVAL**

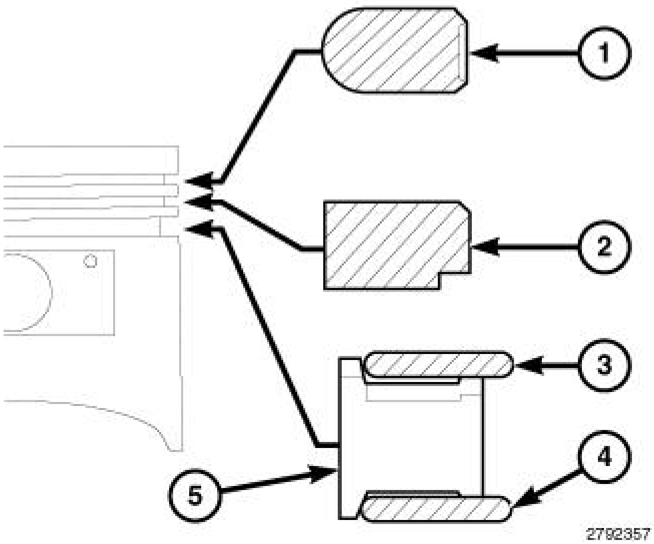


**Fig. 236: Piston Ring Removal/Installation Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical piston shown in illustration.**

1. Remove the piston and connecting rod(s). Refer to **ROD, PISTON AND CONNECTING, REMOVAL**.

**CAUTION: To avoid damage to the piston rings, they must be removed in the following order:**

- **No. 1 (upper) piston ring (1)**
- **No. 2 (intermediate) piston ring (2)**
- **Oil ring upper side rail (3)**
- **Oil ring lower side rail (4)**
- **Oil ring expander (5)**

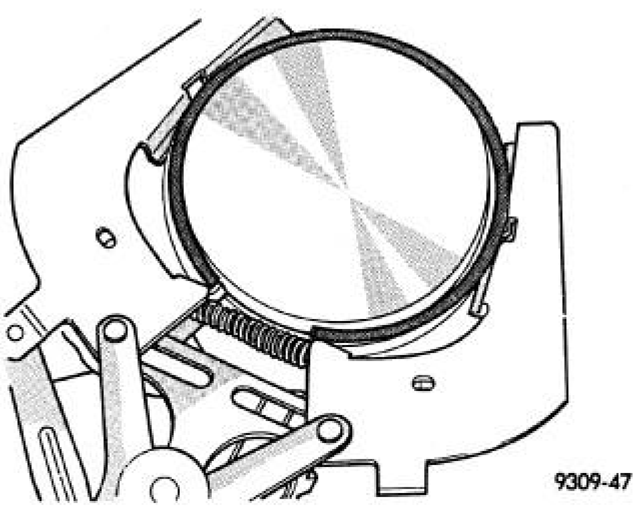


 

**Fig. 237: Removing/Installing Upper & Intermediate Rings**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical piston shown in illustration.**

2. Remove the No. 1 (upper) piston ring using a ring expander tool.
3. Remove the No. 2 (intermediate) piston ring using a ring expander tool.

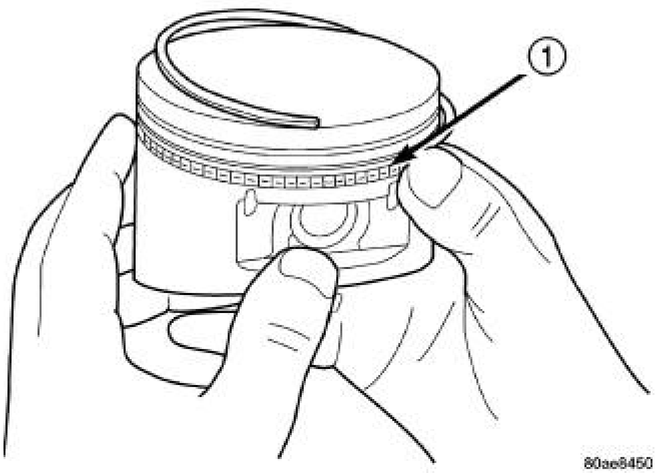


**Fig. 238: Removing/Installing Piston Ring Side Rail**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical piston shown in illustration. Do not use a piston ring expander to remove the oil ring side rails.**

4. Remove the oil ring upper side rail.
5. Remove the oil ring lower side rail.
6. Remove the oil ring expander (1).

**INSTALLATION**

**INSTALLATION**

 

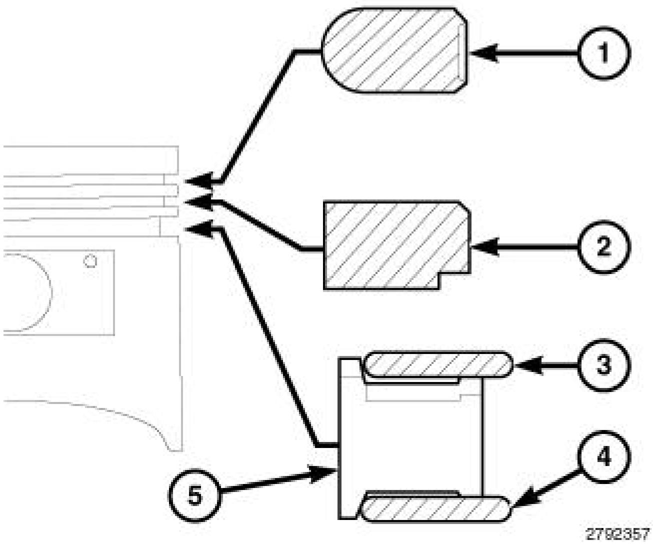


**Fig. 239: Piston Ring Removal/Installation Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical piston shown in illustration.**

1. If required, fit new rings to the piston. Refer to **RING(S), PISTON - STANDARD PROCEDURE** .

**CAUTION: To avoid damage to the piston rings, they must be installed in the following order:**

- **Oil ring expander (5)**
- **Oil ring lower side rail (4)**
- **Oil ring upper side rail (3)**
- **No. 2 (intermediate) piston ring (2)**
- **No. 1 (upper) piston ring (1)**


 

**Fig. 240: Removing/Installing Piston Ring Side Rail**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical piston shown in illustration. Do not use a piston ring expander to install the oil ring side rails.**

2. Install the oil ring expander (1).
3. Install the oil ring lower side rail by placing one end between the piston ring groove and the oil ring expander. Hold this end firmly and press down the portion to be installed until the side rail is in position.
4. Install the oil ring upper side rail in the same manner as the lower side rail.

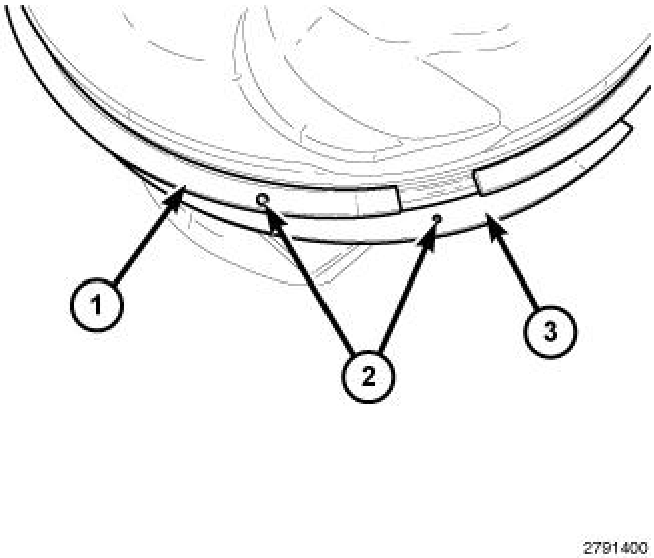


**Fig. 241: Dot Marks On Piston Rings**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: The No. 1 (upper) piston ring (1) and No. 2 (intermediate) piston ring (3) have a different cross section. Install the rings with manufacturers I.D. mark (dot) (2) facing up, towards the top of the piston.**

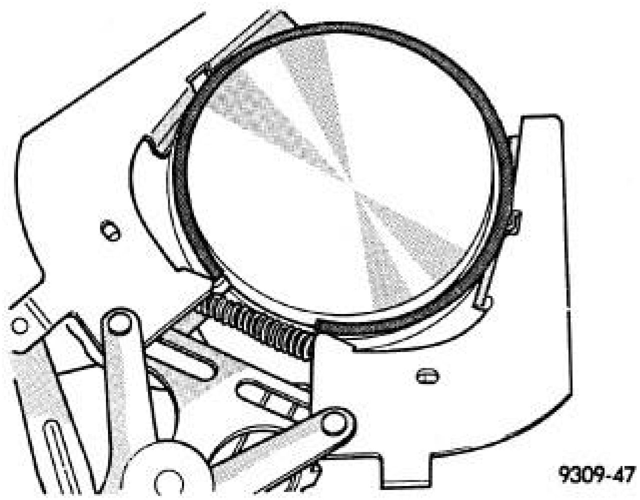


**Fig. 242: Removing/Installing Upper & Intermediate Rings**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical piston shown in illustration.**

5. Install the No. 2 (intermediate) piston ring using a ring expander tool.
6. Install the No. 1 (upper) piston ring using a ring expander tool.
7. Rotate the rings around the piston, the rings must rotate in the grooves with out binding.

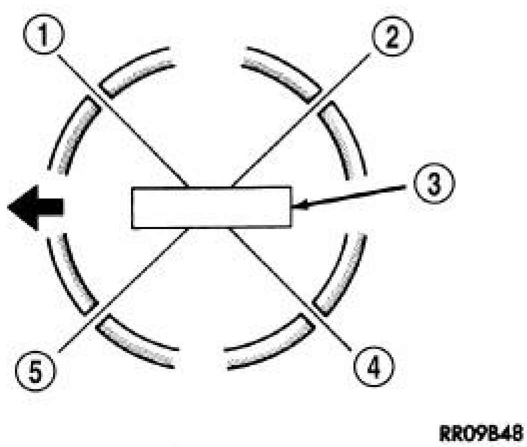


**Fig. 243: Piston Ring End Gap Position**
**Courtesy of CHRYSLER GROUP, LLC**

8. Position the piston ring end gaps as follows:
   - Oil ring expander gap (5)
   - Oil ring lower side rail end gap (4)
   - Oil ring upper side rail end gap (1)
   - No. 2 (intermediate) ring end gap (5)
   - No. 1 (upper) ring end gap (2)

9. Install the piston and connecting rod(s). Refer to **ROD, PISTON AND CONNECTING, INSTALLATION**.

## ROD, PISTON AND CONNECTING

### DESCRIPTION

#### DESCRIPTION

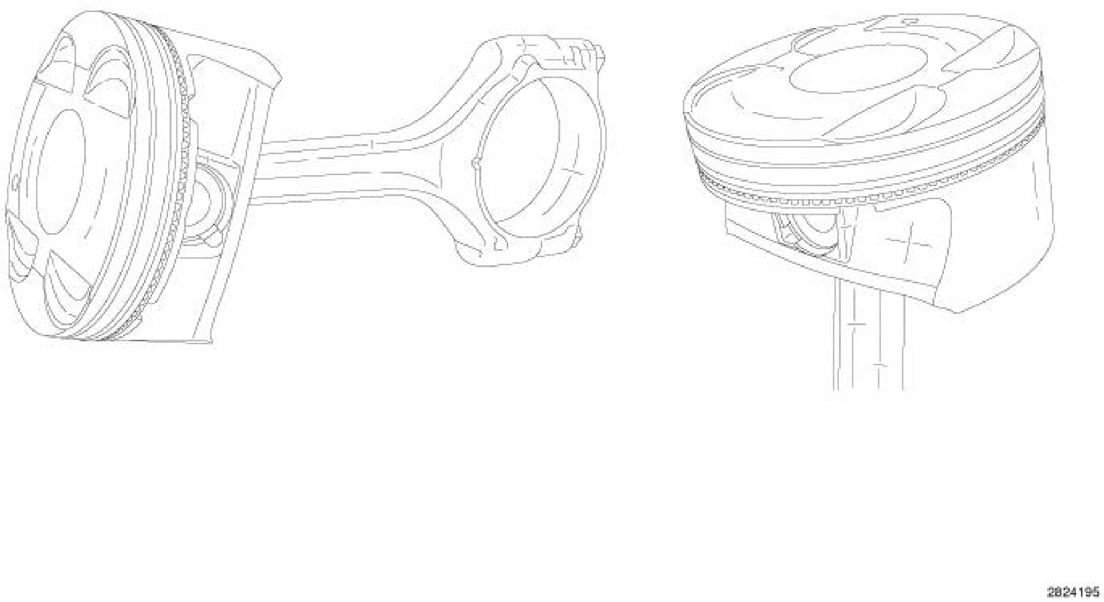


**Fig. 244: Piston & Connecting Rod**
**Courtesy of CHRYSLER GROUP, LLC**

**CAUTION: Do not use a metal stamp to mark connecting rods as damage may result, instead use ink or a scratch awl.**

The pistons are a lightweight design with ultra low tension piston rings for improved fuel economy. The pistons are made of a high strength aluminum alloy and the piston skirt has a Moly® coating. The top piston ring land has an anodized coating for improved wear. The piston is connected to the rod using a full floating pin with two locking clips. The connecting rod is forged steel with a bolted cracked cap design. The connecting rod bolts are not reusable. Pistons are available in two different diameters with grade markings for each bore indicated on the side of the cylinder block. The upper compression ring is a 1.2 mm steel ring with a spray coating. The intermediate compression ring is 1.2 mm micro napier design. Both compression rings have a dot or a mark on the piston ring. The marked side of the ring must face the top of the piston. The 2 mm three piece oil control ring is very thin. These are chrome plated rings and have a stainless steel expander.

 

**STANDARD PROCEDURE**

**PISTON FITTING**

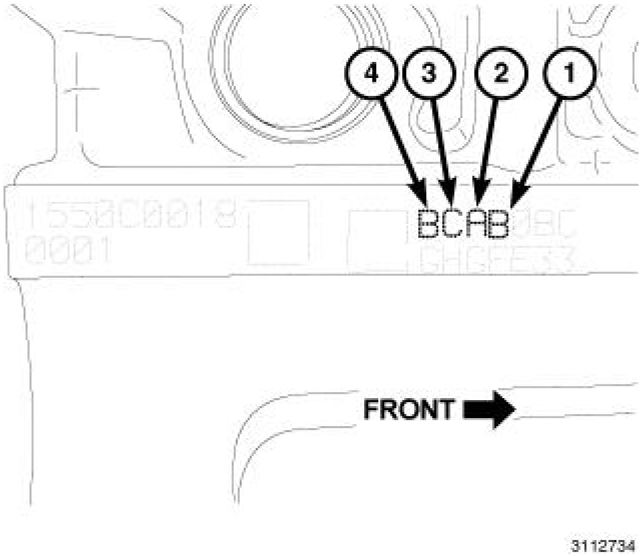


**Fig. 245: Engine Block Cylinder Bore Diameter Grade Markings**
**Courtesy of CHRYSLER GROUP, LLC**

The pistons are "select fit" to achieve proper oil clearance. Engine block cylinder bore diameter grade markings are stamped into the right side of the engine block. These marks are read from front to rear, corresponding with cylinder number 1, 2, 3, 4.

Engine block cylinder bore diameter grade markings correspond to specific cylinder bore diameters. The chart below identifies the three engine block grade markings and their associated cylinder bore diameters.

| Engine Block Marking | Cylinder Bore Size mm (in.) | |
|---|---|---|
| | Metric | Standard |
| A | 72.000 - 72.010 mm | 2.8346 - 2.8350 in. |
| B | 72.010 - 72.020 mm | 2.8350 - 2.8354 in. |
| C | 72.020 - 72.030 mm | 2.8354 - 2.8358 in. |

 

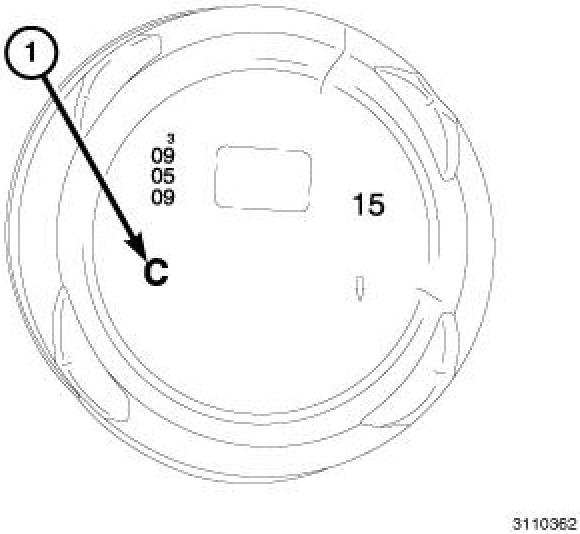


**Fig. 246: Piston Size Mark**
**Courtesy of CHRYSLER GROUP, LLC**

The piston is marked with the piston size (1) on the piston crown. The pistons are available in three different sizes in order to achieve the desired oil clearance. Select the piston size that corresponds to the engine block cylinder bore diameter grade markings for each cylinder.

Pistons are available in three sizes. The chart below identifies the three piston sizes.

| Piston Marking | Piston Size mm (in.) | |
|---|---|---|
| | Metric | Standard |
| A | 71.960 - 71.970 mm | 2.8331 - 2.8835 in. |
| B | 71.970 - 71.980 mm | 2.8835 - 2.8339 in. |
| C | 71.980 - 71.990 mm | 2.8339 - 2.8342 in. |

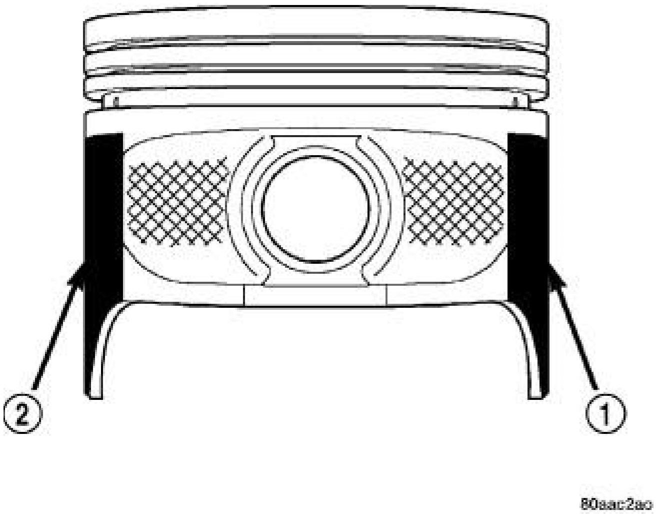


**Fig. 247: Coating Material On Piston**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical coated piston shown in illustration.**

The coated pistons are serviced with the piston pin and connecting rod pre-assembled. The coating material (1 and 2) is applied to the piston after the final piston machining process. Piston installation into the cylinder bore requires slightly more pressure than that required for non-coated pistons. The bonded coating on the piston will give the appearance of a line-to-line fit with the cylinder bore.

**CONNECTING ROD SIDE CLEARANCE**

**DIAL INDICATOR**

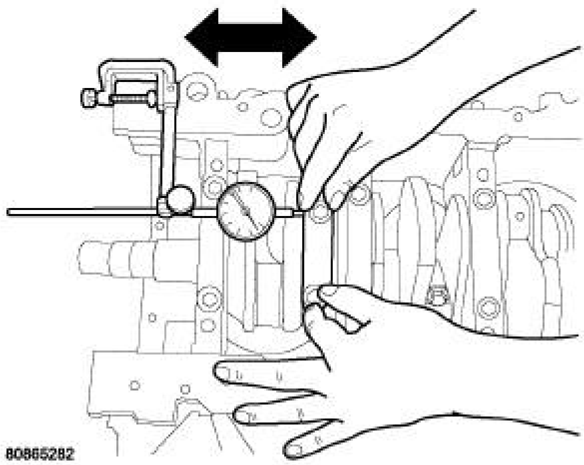


**Fig. 248: Measuring Connecting Rod Side Clearance**
**Courtesy of CHRYSLER GROUP, LLC**

1. Mount Dial Indicator Set (special tool #C-3339A, Set, Dial Indicator) to a stationary point on the engine. Locate the probe perpendicular to and resting against the connecting rod cap being checked.
2. Move the connecting rod all the way to the rear of its travel.
3. Zero the dial indicator.
4. Move the connecting rod forward to the limit of travel and read the dial indicator. Compare the measured side clearance to the specification. Refer to **ENGINE SPECIFICATIONS** .
5. Repeat this procedure for each connecting rod. Rotate the crankshaft for connecting rod accessibility.

**FEELER GAUGE**

 

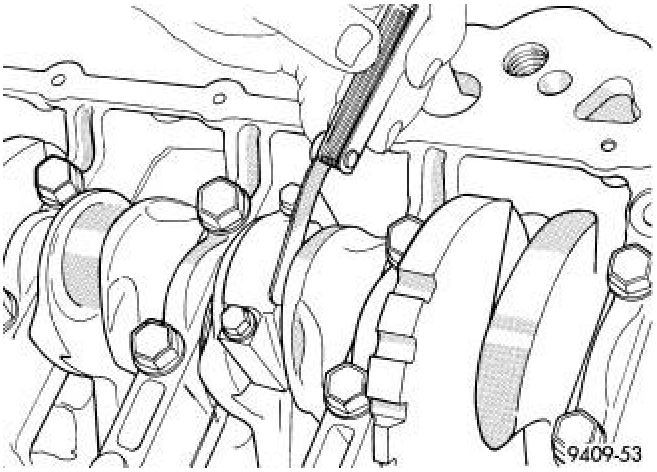


**Fig. 249: Connecting Rod Side Clearance**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical four cylinder engine shown in illustration.**

1. Slide a snug-fitting feeler gauge between the connecting rod and crankshaft journal flange. Compare the measured side clearance to the specification. Refer to **ENGINE SPECIFICATIONS** .
2. Repeat this procedure for each connecting rod. Rotate the crankshaft for connecting rod accessibility.

**REMOVAL**

**REMOVAL**

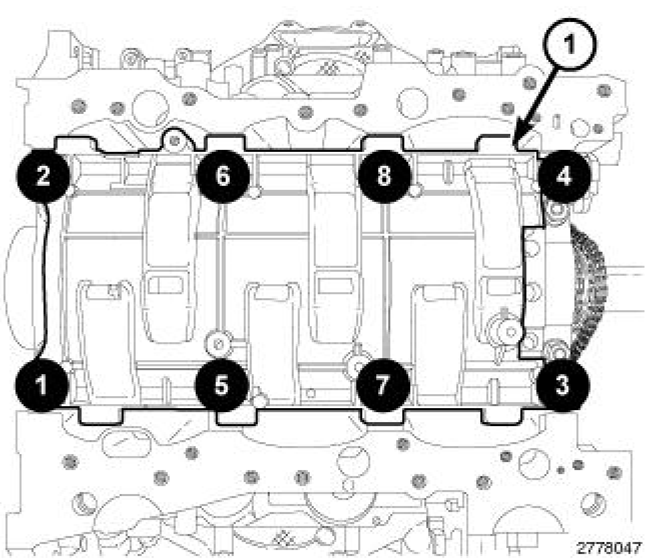


**Fig. 250: Main Bearing Cap Bolts From Windage Tray Removal Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

1. Disconnect and isolate the negative battery cable.

 

2. Remove the oil pans, engine timing cover and cylinder heads. Refer to **CYLINDER HEAD, REMOVAL**.
3. Remove the engine oil pump. Refer to **PUMP, ENGINE OIL, REMOVAL**.
4. Remove the eight main bearing cap bolts from the windage tray in the sequence shown in illustration and remove the windage tray (1).

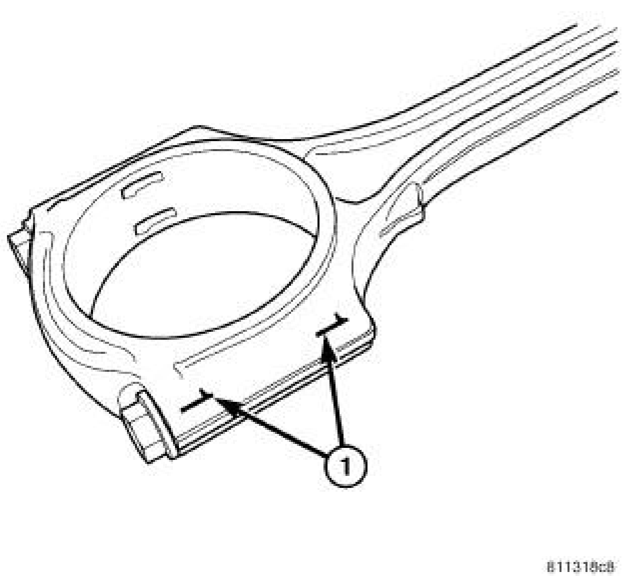


**Fig. 251: Connecting Rod To Cylinder Identification**
**Courtesy of CHRYSLER GROUP, LLC**

5. If necessary, remove the top ridge of the cylinder bores with a reliable ridge reamer before removing the pistons from the engine block. **Be sure to keep the tops of pistons covered during this operation.** Pistons and connecting rods must be removed from the top of the engine block. When removing piston and connecting rod assemblies from the engine, rotate the crankshaft CW so that each connecting rod is centered in the cylinder bore.

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

**NOTE: Connecting rods and bearing caps are not interchangeable and should be marked before removing to ensure correct reassembly.**

6. Mark connecting rod and bearing cap positions (1) using a permanent ink marker or scribe tool.

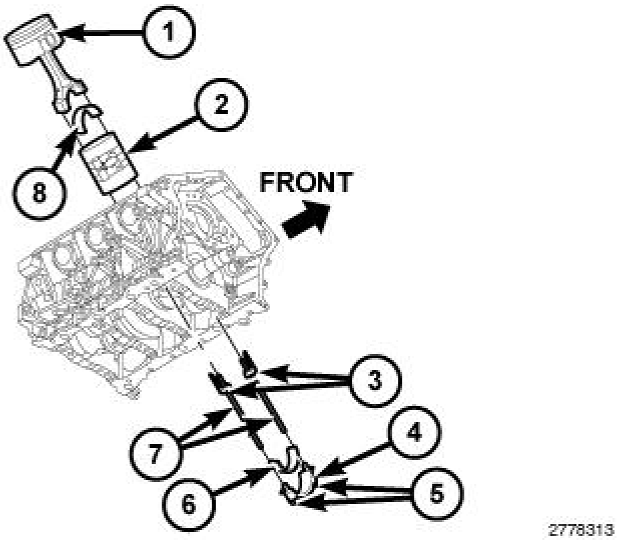


**Fig. 252: Piston, Connecting Rod Cap, Bolts, Plastic Guide Plates & Guide Pins**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical V6 engine configuration shown in illustration.**

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

7. Remove the connecting rod cap bolts (5) and the connecting rod cap (4). Discard the cap bolts.

**CAUTION: Care must be taken not to nick crankshaft journals, as engine damage may occur.**

8. Remove the plastic guide plates (3) from the Guide Pins (special tool #8189, Guide Pins) (7) and install the Guide Pins to the connecting rod being removed.

**CAUTION: Avoid contact with the piston oil cooler jet(s). Positioning of the oil cooler jet(s) is critical for proper engine operation.**

9. Remove the piston and connecting rod (1) from cylinder bore.
10. Repeat the previous steps for each piston being removed.
11. Immediately after piston and connecting rod removal, reinstall the bearing cap (4) on the mating connecting rod to prevent damage to the fractured cap and rod surfaces.
12. If required, remove the piston rings. Refer to **RING(S), PISTON, REMOVAL**.
13. Repeat the previous steps for each piston being removed.

**CLEANING**

**CLEANING**

 

**CAUTION: DO NOT use a wire wheel or other abrasive cleaning devise to clean the pistons or connecting rods. The pistons have a Moly coating, this coating must not be damaged.**

**CAUTION: Do not remove the piston pin from the piston and connecting rod assembly.**

1. Using a suitable cleaning solvent clean the pistons in warm water and towel dry.
2. Use a wood or plastic scraper to clean the ring land grooves.

**INSPECTION**

**INSPECTION**

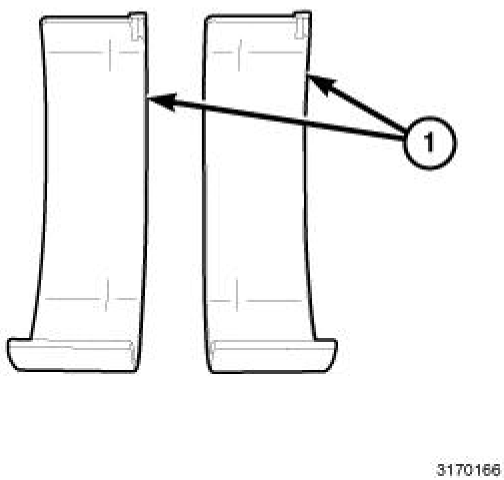


**Fig. 253: Inserts**
**Courtesy of CHRYSLER GROUP, LLC**

1. Wipe the inserts (1) clean.
2. Inspect the inserts for abnormal wear patterns, scoring, grooving, fatigue, pitting and for metal or other foreign material imbedded in the lining.
3. Inspect the back of the inserts for fractures, scrapes, or irregular wear patterns.
4. Inspect the insert locking tabs for damage.
5. Replace any bearing that shows abnormal wear. Refer to **BEARING(S), CONNECTING ROD - STANDARD PROCEDURE** .

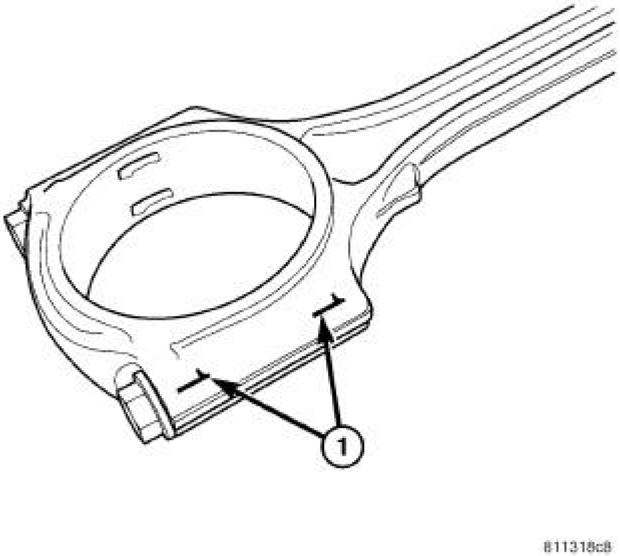


**Fig. 254: Connecting Rod To Cylinder Identification**
**Courtesy of CHRYSLER GROUP, LLC**

6. Inspect the connecting rod bearing bores for signs of scoring, nicks and burrs.

**NOTE:** **Misaligned or bent connecting rods can cause abnormal wear on pistons, piston rings, cylinder walls, connecting rod bearings and crankshaft connecting rod journals. If wear patterns or damage to any of these components indicate the probability of a misaligned connecting rod, inspect it for correct rod alignment.**

7. Replace misaligned, bent or twisted connecting rods.

**NOTE:** **Connecting rods are serviced with the piston pre-assembled. The pistons are "select fit" to achieve proper oil clearance. Refer to ROD, PISTON AND CONNECTING - STANDARD PROCEDURE .**

 

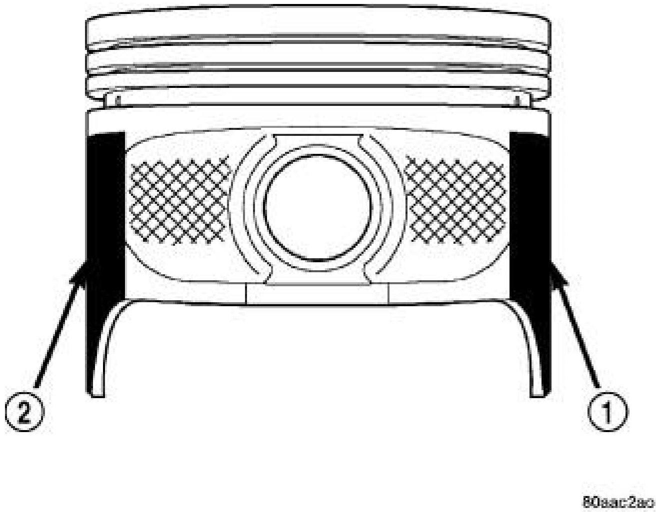


**Fig. 255: Coating Material On Piston**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: Typical coated piston shown in illustration.**

8. Inspect the piston for scoring or scraping marks in the piston skirts. Check the ring lands for cracks and/or deterioration.

**NOTE: The coating material (1 and 2) is applied to the piston after the final piston machining process. This coating may affect the outside diameter measurement of a coated piston may not provide accurate results.**

9. Check the piston for taper and out of round shape.

**NOTE: Piston installation into the cylinder bore may require slightly more pressure than that required for non-coated pistons. The bonded coating on the piston will give the appearance of a line-to-line fit with the cylinder bore.**

**NOTE: The coated pistons will be serviced with the piston pin and connecting rod pre-assembled.**

**INSTALLATION**

**INSTALLATION**

 

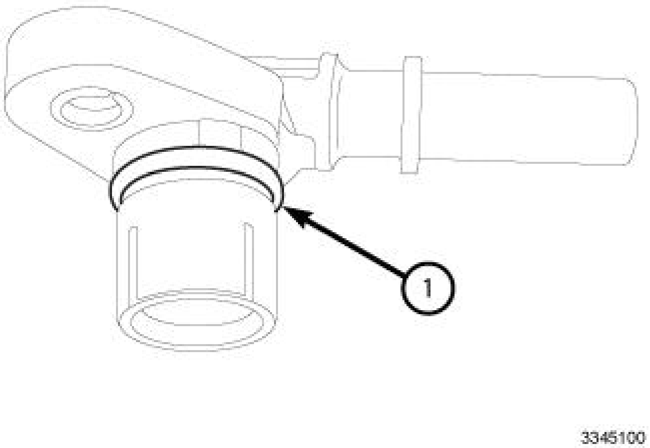


**Fig. 256: Vacuum Fitting O-Ring Seal**
**Courtesy of CHRYSLER GROUP, LLC**

1. The vacuum fitting O-ring seal (1) can be reused if not damaged. If removed, lightly lubricate the O-ring seal (1) with clean engine oil and install on the vacuum fitting.

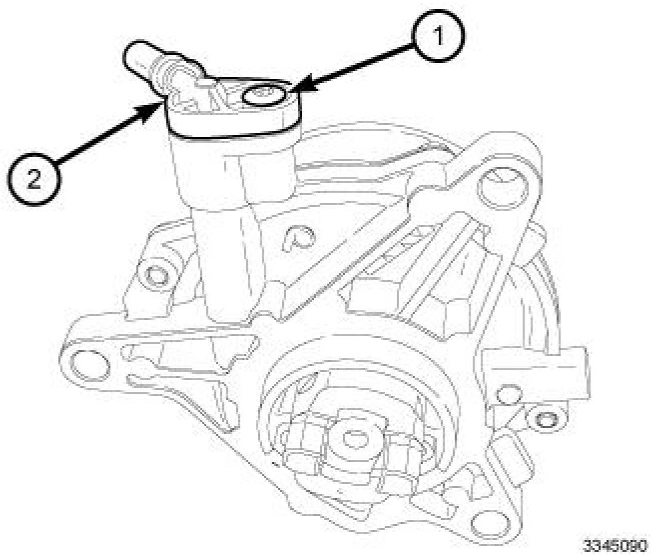


**Fig. 257: Vacuum Fitting & Screw**
**Courtesy of CHRYSLER GROUP, LLC**

2. If removed, install the vacuum fitting (2) to the vacuum pump with the screw (1) tightened to 8 N.m (71 in. lbs.).
3. Clean the mating surfaces of the cylinder head and the vacuum pump. Install a new vacuum pump gasket.
4. Align the pump drive tab with the pump drive slot located on the cam shaft.
5. Install the vacuum pump mounting bolts. Tighten the bolts to 20 N.m (15 ft. lbs.).
6. Connect the vacuum supply line to the pump.

 

**CAUTION: When servicing components near the vacuum pump, avoid contact with the plastic nipple that connects the vacuum pump to the brake booster hose. It is possible to crack the plastic nipple resulting in a brake booster vacuum leak.**

7. Install the battery (4). Refer to **BATTERY, INSTALLATION** .
8. Install the engine cover. Refer to **RESONATOR, AIR CLEANER, INSTALLATION**.
9. Run the engine a check the vacuum pump for proper operation.

## SEAL, CRANKSHAFT OIL, FRONT

### REMOVAL

#### REMOVAL

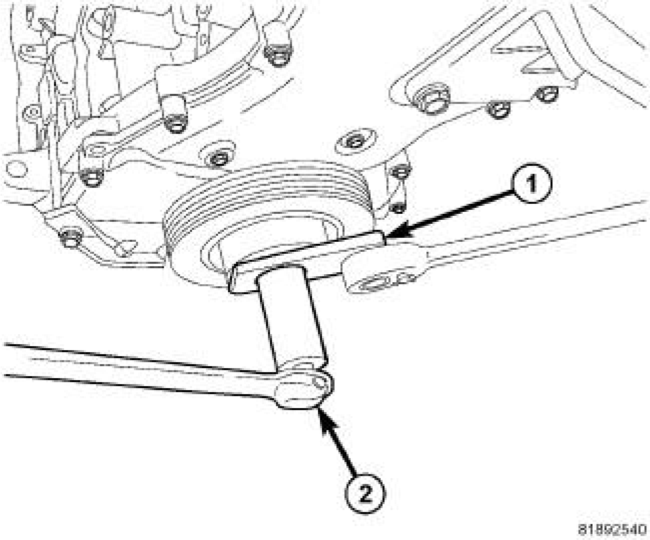


**Fig. 258: Removing/Installing Crankshaft Damper**
**Courtesy of CHRYSLER GROUP, LLC**

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.

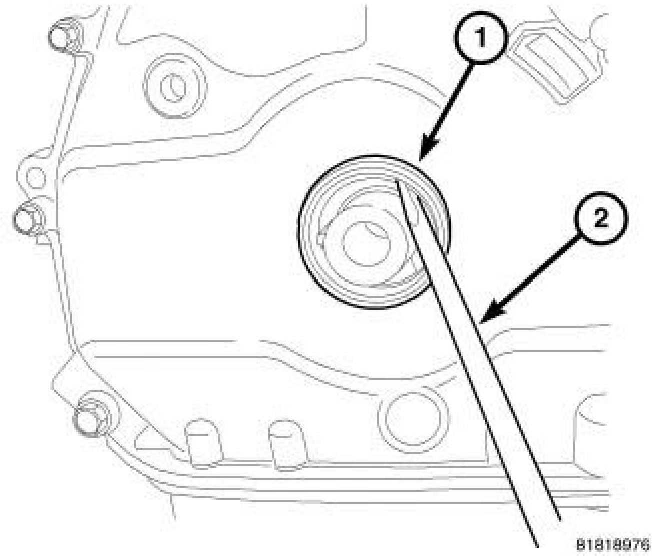


**Fig. 259: Removing Front Crankshaft Oil Seal By Prying Out With Screwdriver**
**Courtesy of CHRYSLER GROUP, LLC**

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**

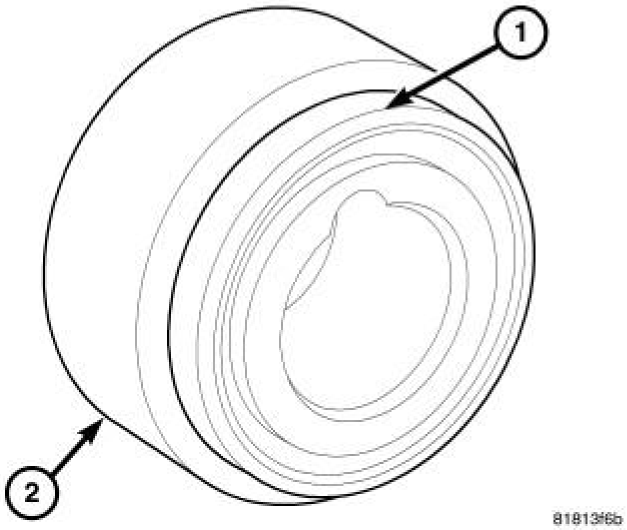


**Fig. 260: Crankshaft Oil Seal & Seal Installer 9506**
**Courtesy of CHRYSLER GROUP, LLC**

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

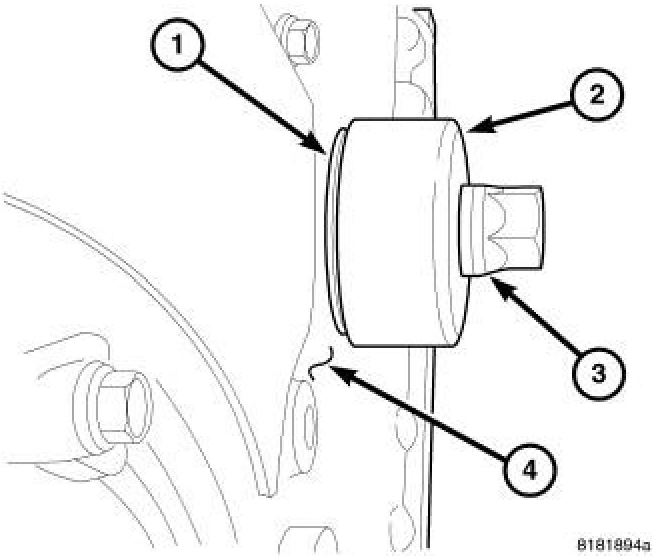


**Fig. 261: Installing New Seal By Using Seal Installer 9506 & Crankshaft Damper Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

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

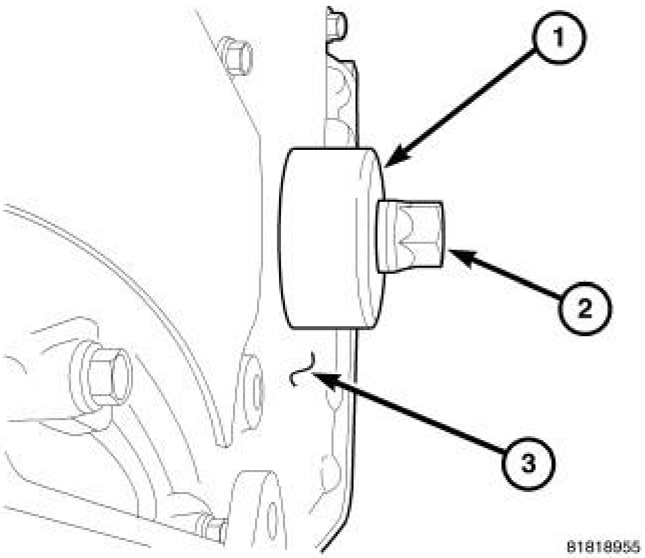


**Fig. 262: Seal Installer Seated Against Timing Chain Cover**
**Courtesy of CHRYSLER GROUP, LLC**

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

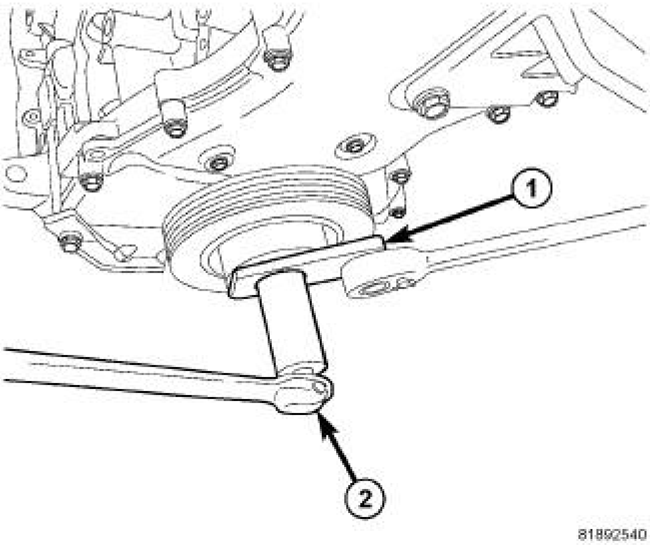


**Fig. 263: Installing Damper Holder 9707**
**Courtesy of CHRYSLER GROUP, LLC**

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

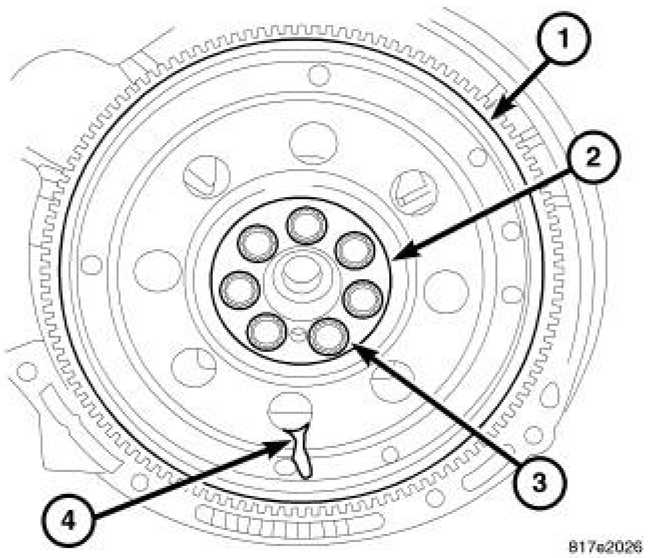


**Fig. 264: Flex Plate**

**Courtesy of CHRYSLER GROUP, LLC**

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

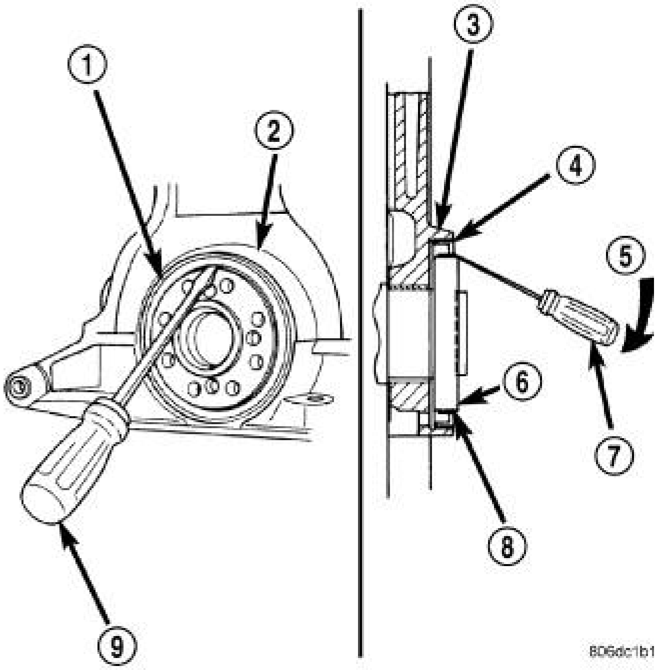


**Fig. 265: Rear Crankshaft Oil Seal - Removal**
**Courtesy of CHRYSLER GROUP, LLC**

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**

 

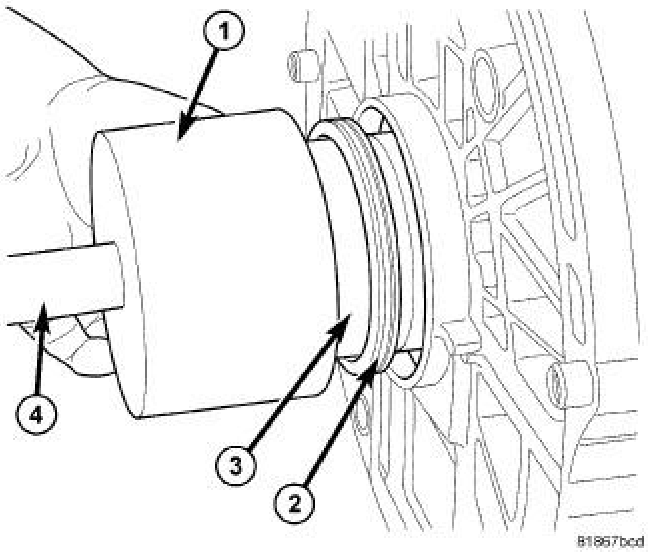


**Fig. 266: Rear Main Seal Installation**
**Courtesy of CHRYSLER GROUP, LLC**

**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.

 

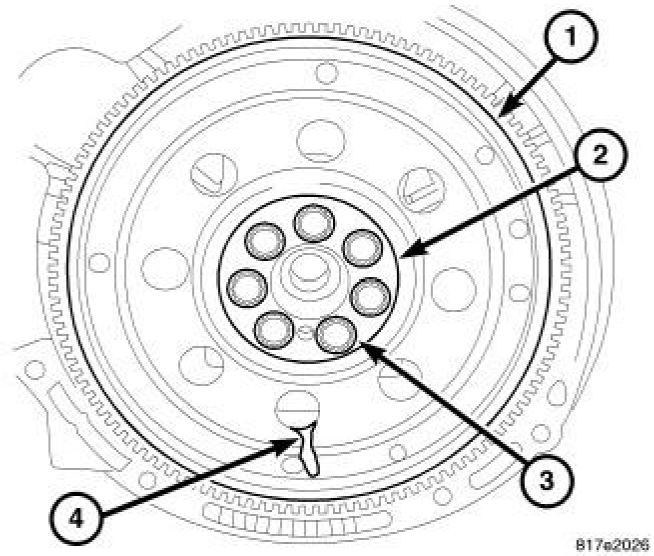


**Fig. 267: Flex Plate**
**Courtesy of CHRYSLER GROUP, LLC**

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

# ENGINE MOUNTING

## INSULATOR, ENGINE MOUNT, LEFT

### REMOVAL

#### REMOVAL

1. Raise and support the vehicle. Refer to **HOISTING - STANDARD PROCEDURE** .
2. Remove the belly pan. Refer to **BELLY PAN, REMOVAL** .
3. Lower the vehicle.
4. Remove the engine cover to prevent contact with the cowl.
5. Remove the battery and tray. Refer to **TRAY, BATTERY, REMOVAL** .
6. Remove the wire harness retainer from the top of the left engine mount.
7. Support transaxle with a suitable jack.

 

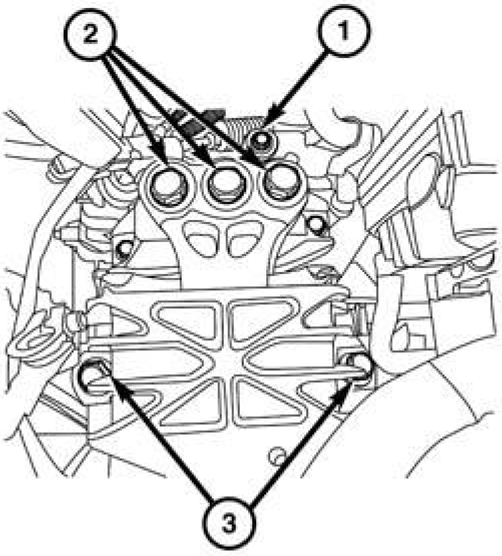


**Fig. 268: Coolant Tube Bracket Bolt, Transaxle Bracket Bolts & Frame Rail Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

8. Remove the coolant tube bracket bolt (1).
9. Remove the three mount to transaxle bracket bolts (2).
10. Remove the two mount to frame rail bolts (3).

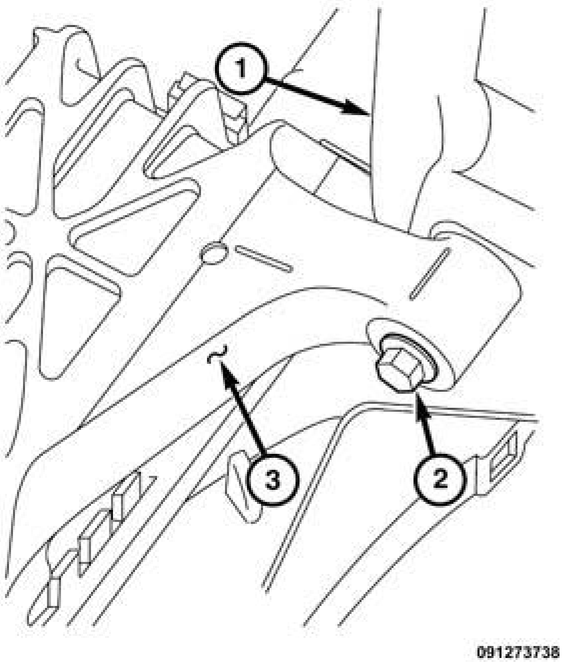


**Fig. 269: Strut Tower, Trans Mount & Bolt**

**Courtesy of CHRYSLER GROUP, LLC**

11. Loosen, **but do not remove** the bolt (2) for the trans mount (3) to strut tower (1) attachment.
12. Remove the mount.

**INSTALLATION**

**INSTALLATION**

1. Set the mount into position.

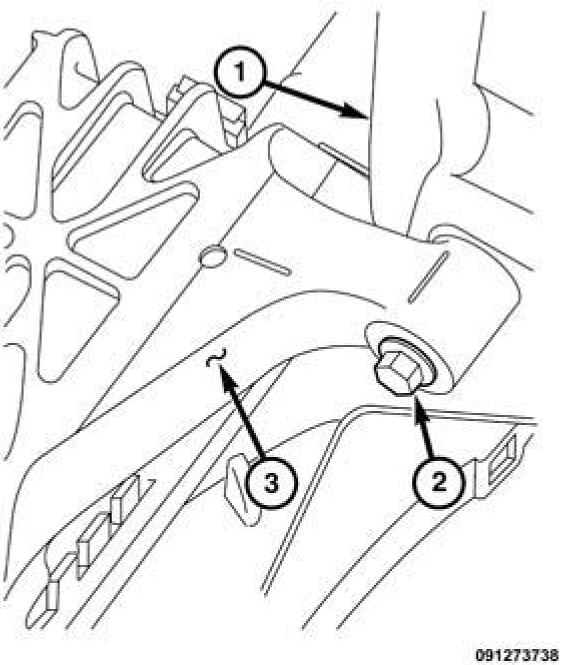


**Fig. 270: Strut Tower, Trans Mount & Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

2. Tighten the left mount to strut tower bolt (2) finger tight.

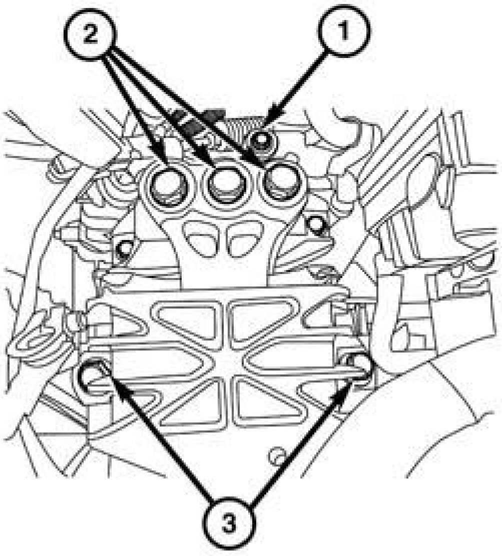


**Fig. 271: Coolant Tube Bracket Bolt, Transaxle Bracket Bolts & Frame Rail Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

3. Tighten the left mount to transaxle bracket bolts (2) finger tight.
4. Tighten the left mount to frame rail bolts (3) finger tight.

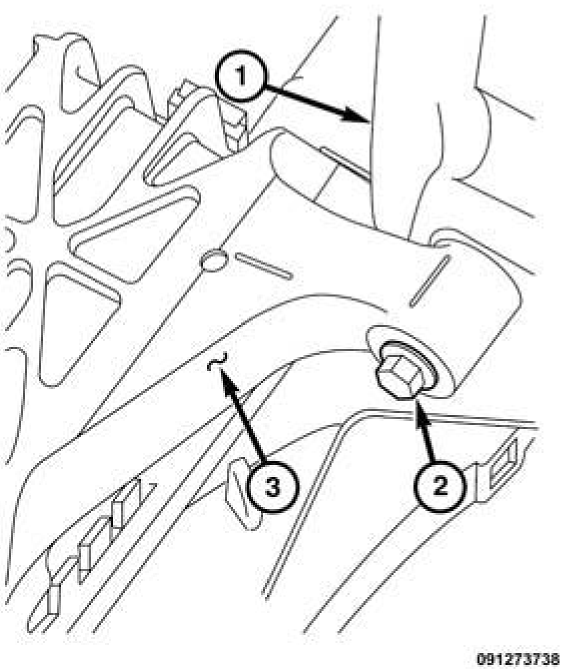


**Fig. 272: Strut Tower, Trans Mount & Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

5. Tighten the left mount to strut tower bolt (2) to 50 N.m (37 ft. lbs.).
6. Tighten the left mount to frame rail bolts to 87 N.m (64 ft. lbs.).

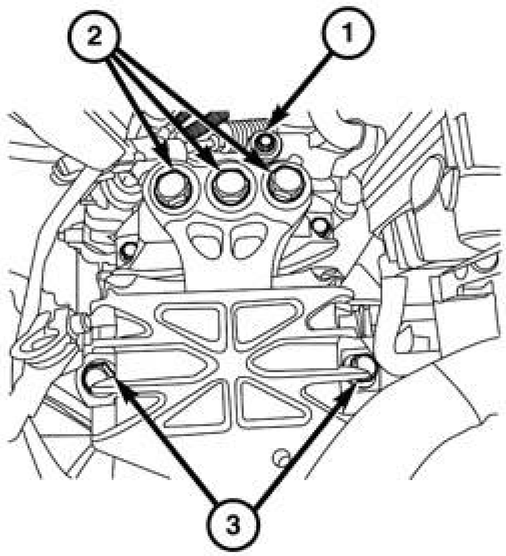


**Fig. 273: Coolant Tube Bracket Bolt, Transaxle Bracket Bolts & Frame Rail Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

7. Tighten the left mount to transaxle bracket bolts to 105 N.m (77 ft. lbs.).
8. Install the coolant tube bracket bolt (1). Tighten to 9 N.m (80 in. lbs.).
9. Remove the jack.
10. Install the battery tray. Refer to **TRAY, BATTERY, INSTALLATION** .
11. Install the belly pan. Refer to **BELLY PAN, INSTALLATION** .
12. Install the engine cover assembly.

## INSULATOR, ENGINE MOUNT, REAR

### REMOVAL

#### REMOVAL

1. Raise and support the vehicle.
2. Remove the belly pan.

 

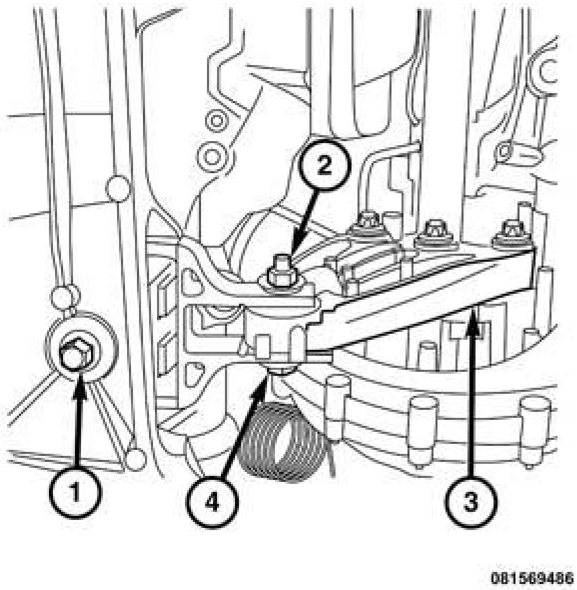


**Fig. 274: Rear Engine Isolator To Engine Mount Bracket Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

3. Remove the mount to bracket through bolt (4) and nut (2).
4. Remove the mount to crossmember through bolt (1).
5. Reposition the engine forward to allow the mount to be removed from the pocket past the engine bracket (3).

**NOTE: The exhaust system can remain intact. Carefully pry the engine forward enough to clear the bracket but not to overextend the exhaust hangers.**

6. Remove rear mount.

## INSTALLATION

### INSTALLATION

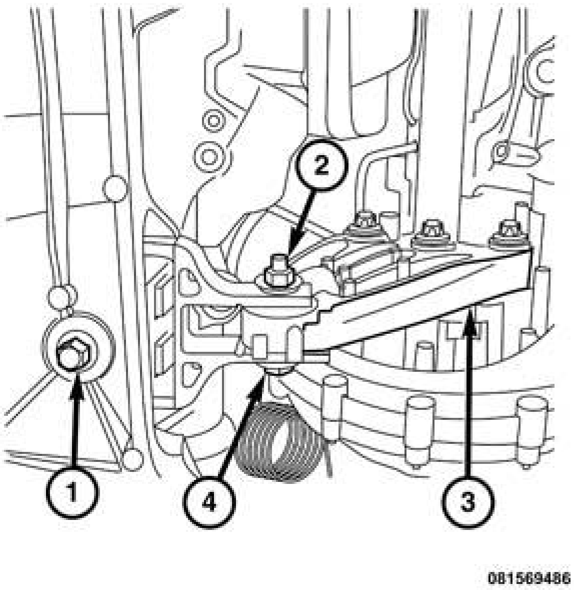


**Fig. 275: Rear Engine Isolator To Engine Mount Bracket Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

1. Position rear mount into the crossmember pocket.
2. Install the through bolt (1) into the cradle portion of the mount.
3. Position the front arm of the mount around the bracket (3) and install the through bolt and nut (4 and 2).
4. Tighten bolt (1) to 105 N.m (77 ft. lbs.).
5. Tighten the rear mount to engine bracket through bolt and nut (4 and 2) to 80 N.m (59 ft. lbs.).
6. Install belly pan. Refer to **BELLY PAN, INSTALLATION** .

## INSULATOR, ENGINE MOUNT, RIGHT

### REMOVAL

#### REMOVAL

1. Remove the engine cover.
2. Remove the air cleaner assembly. Refer to **BODY, AIR CLEANER, REMOVAL**.

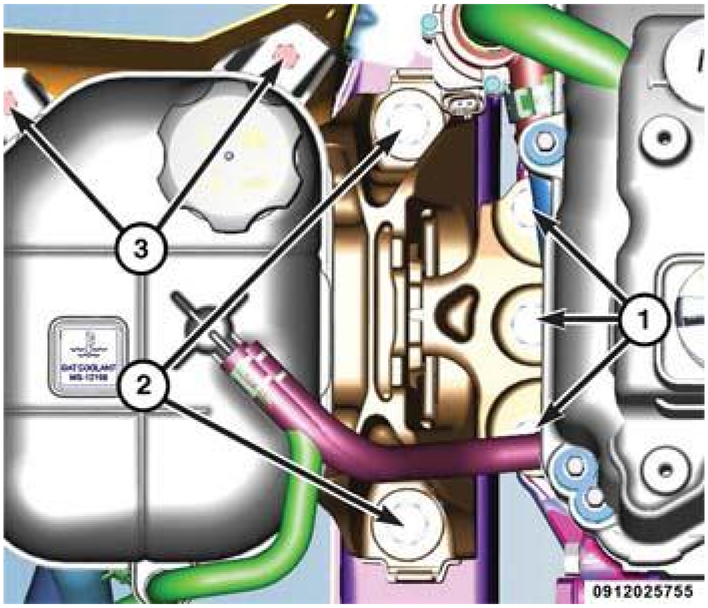


**Fig. 276: Timing Cover Bolts, Frame Retaining Bolts & Coolant Reservoir Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

3. Remove the coolant reservoir bolts (3) and set the reservoir aside.
4. Remove the belly pan. Refer to **BELLY PAN, REMOVAL** .
5. Properly support the powertrain with a suitable jack or stand.

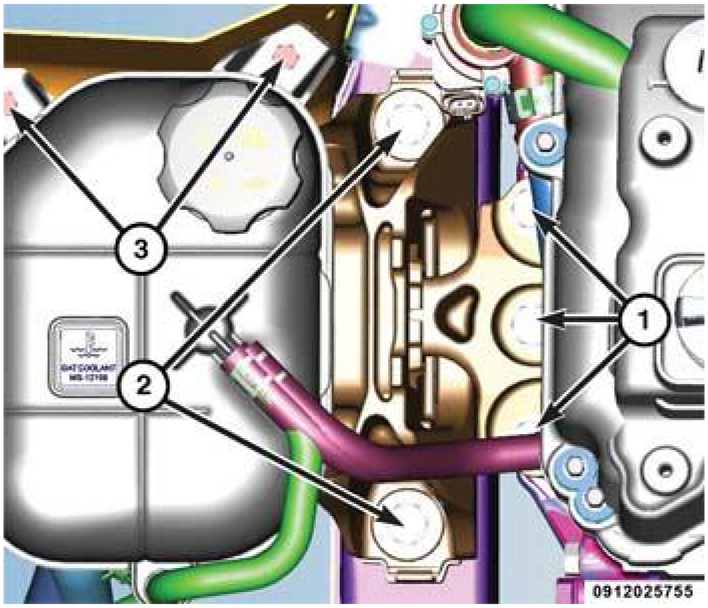


**Fig. 277: Timing Cover Bolts, Frame Retaining Bolts & Coolant Reservoir Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

6. Remove the three mount to timing cover bolts (1).
7. Remove the two mount to frame bolts (2).

 

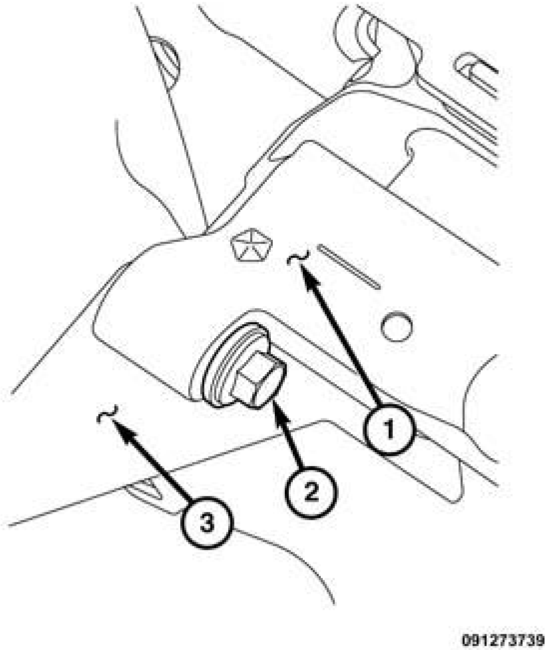


**Fig. 278: Strut Tower, Mount & Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

8. Loosen, **but do not remove** the mount (1) to strut tower (3) bolt (2).

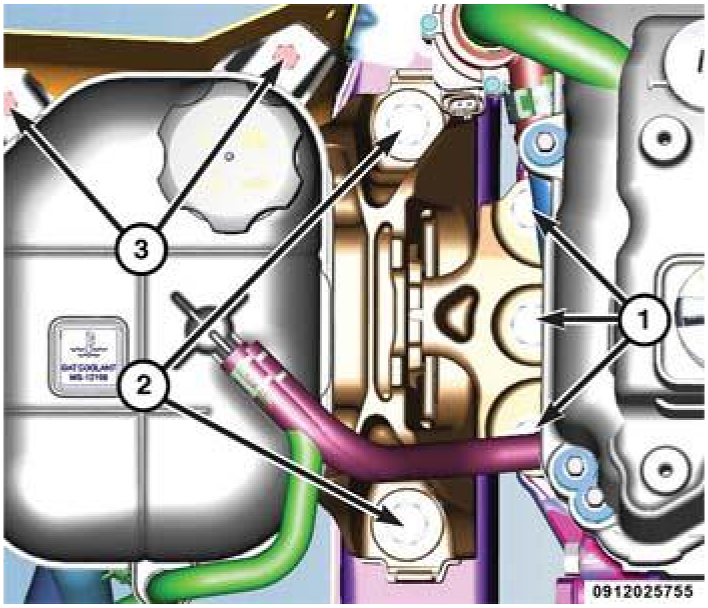


**Fig. 279: Timing Cover Bolts, Frame Retaining Bolts & Coolant Reservoir Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

9. Remove the engine mount.

**INSTALLATION**

**INSTALLATION**

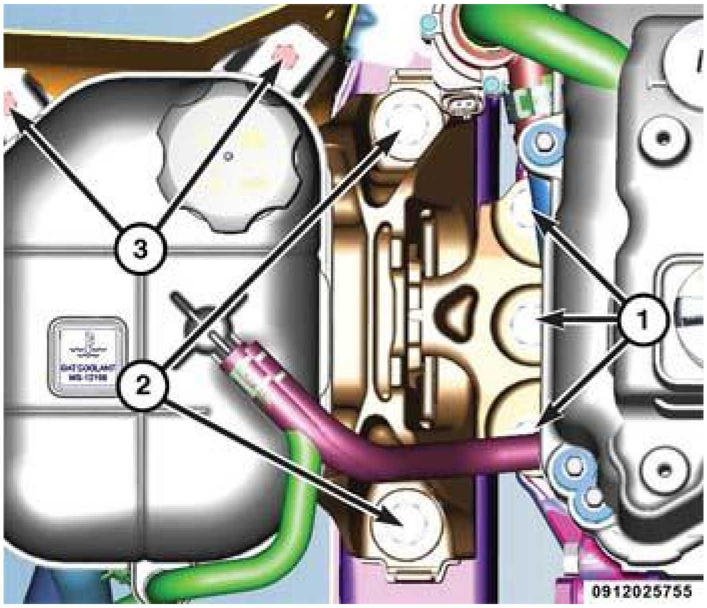


**Fig. 280: Timing Cover Bolts, Frame Retaining Bolts & Coolant Reservoir Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

1. Set the mount into position.

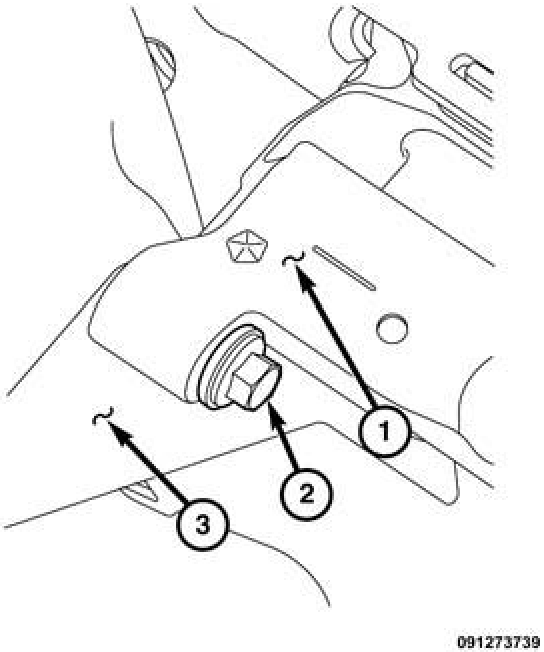


**Fig. 281: Strut Tower, Mount & Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

2. Tighten the right mount to strut tower bolt (2) finger tight.

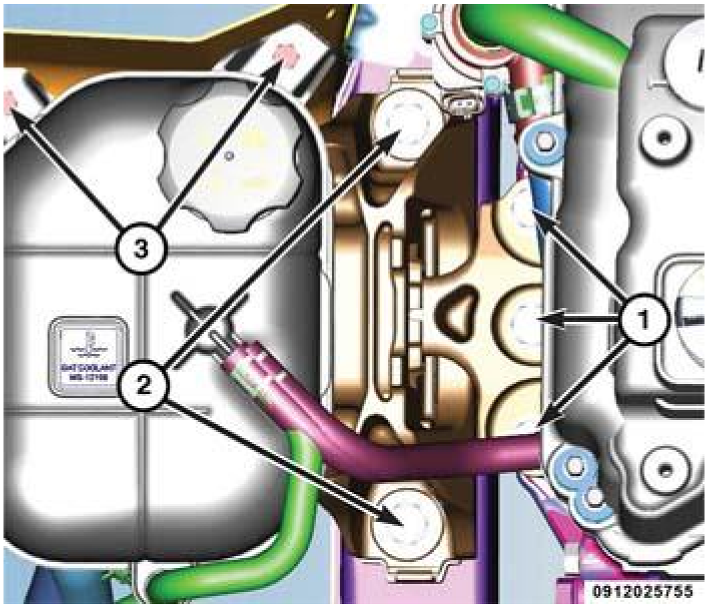


**Fig. 282: Timing Cover Bolts, Frame Retaining Bolts & Coolant Reservoir Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

3. Install engine mount to frame retaining bolts (2). Finger tighten the bolts.
4. Install the right mount to timing cover bolts (1). Finger tighten the bolts.

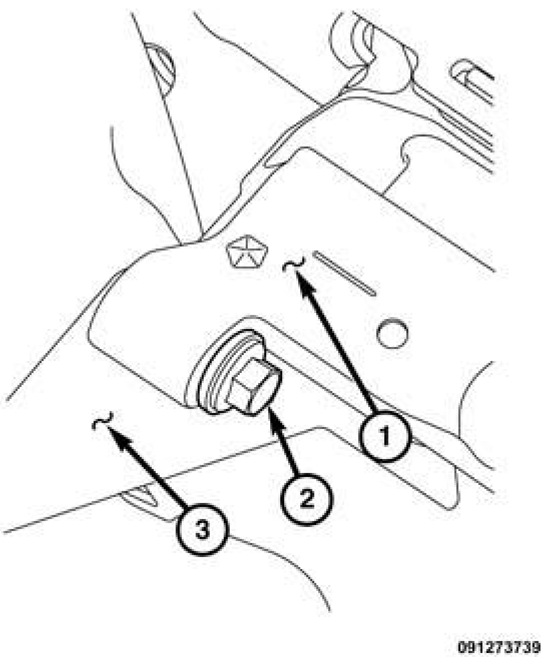


**Fig. 283: Strut Tower, Mount & Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

5. Tighten the right mount to strut tower (2) bolt to 50 N.m (37 ft. lbs.).

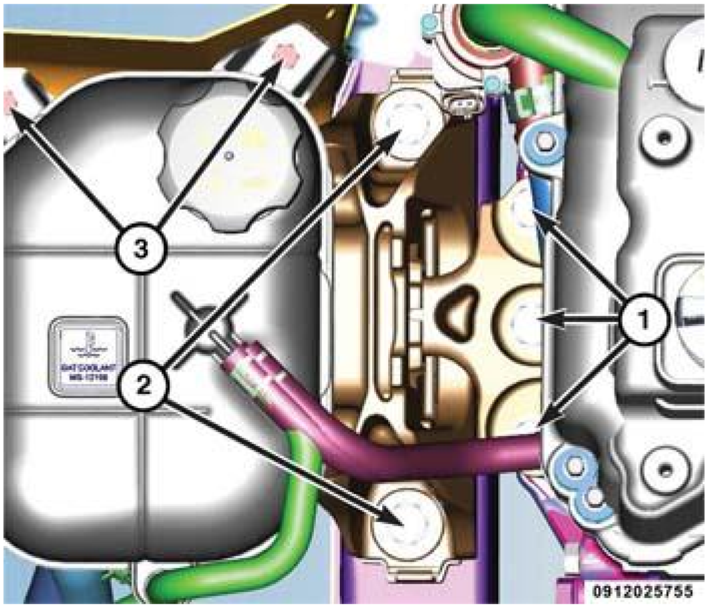


**Fig. 284: Timing Cover Bolts, Frame Retaining Bolts & Coolant Reservoir Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

6. Tighten the right mount to frame rail bolts (2) to 63 N.m (46 ft lbs.).
7. Tighten the engine mount to timing cover bolts (1). Tighten to 63 N.m (46 ft. lbs.).

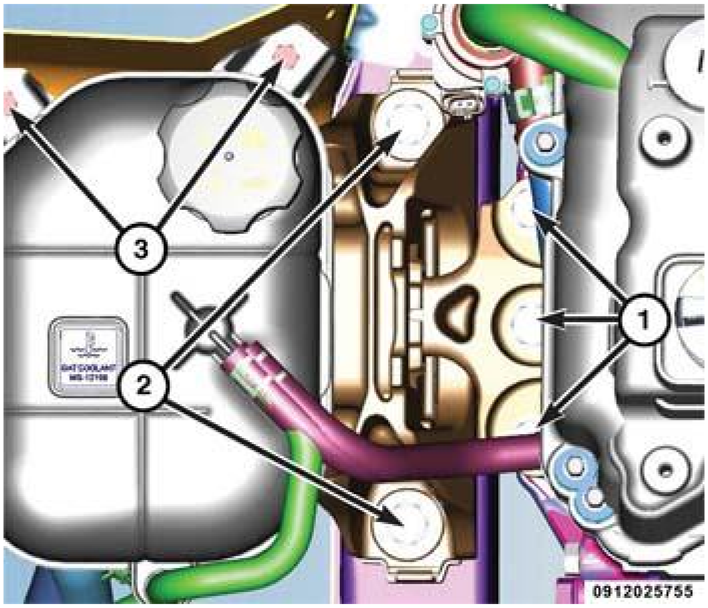


**Fig. 285: Timing Cover Bolts, Frame Retaining Bolts & Coolant Reservoir Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

8. Install the coolant reservoir bottle. Install and tighten the bolts (3) to 9 N.m (80 in. lbs.).
9. Install the air box assembly. Refer to **BODY, AIR CLEANER, INSTALLATION**.
10. Install the engine cover.
11. Remove the jack stand.

12. Install the belly pan. Refer to **BELLY PAN, INSTALLATION** .
13. Start the engine and check for vibrations.

# MANIFOLDS

## MANIFOLD, EXHAUST

### REMOVAL

#### REMOVAL

1. Remove engine cover.
2. Disconnect battery negative cable.
3. Disconnect the upstream and downstream oxygen sensors.
4. Raise and support the vehicle.
5. Remove the belly pan.

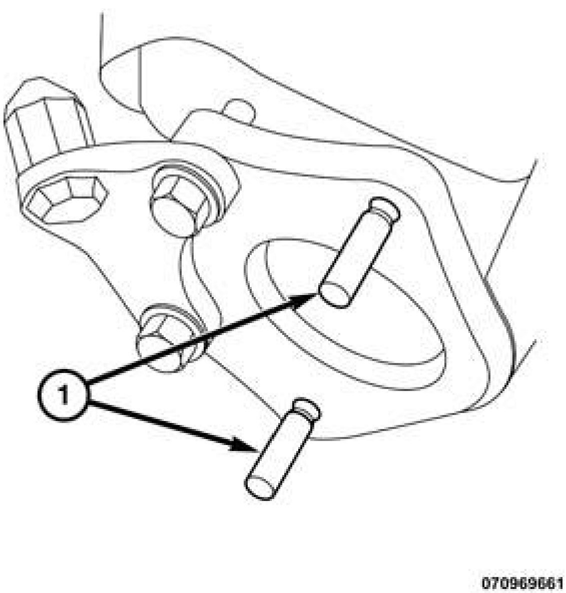


**Fig. 286: Converter Outlet Studs**
**Courtesy of CHRYSLER GROUP, LLC**

6. Remove the two nuts from the converter outlet. Discard the gasket

   .

7. Lower the vehicle.

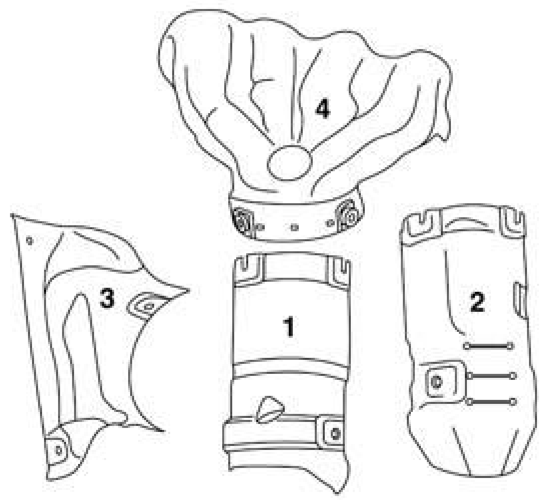


**Fig. 287: Exhaust Manifold Heat Shields**
**Courtesy of CHRYSLER GROUP, LLC**

8. Remove the four bolts from the upper shield (2)

   .

9. Remove the upper shield (2).

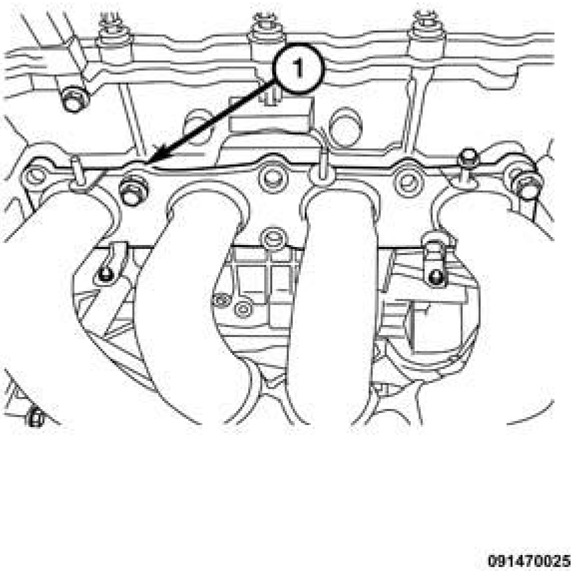


**Fig. 288: Exhaust Manifold Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

10. Remove the exhaust manifold bolts (1).
11. Remove the manifold out the top of the vehicle.
12. 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**

1. Install a new exhaust manifold gasket **DO NOT APPLY SEALER** .
2. Set the manifold into position. Install the manifold bolts.

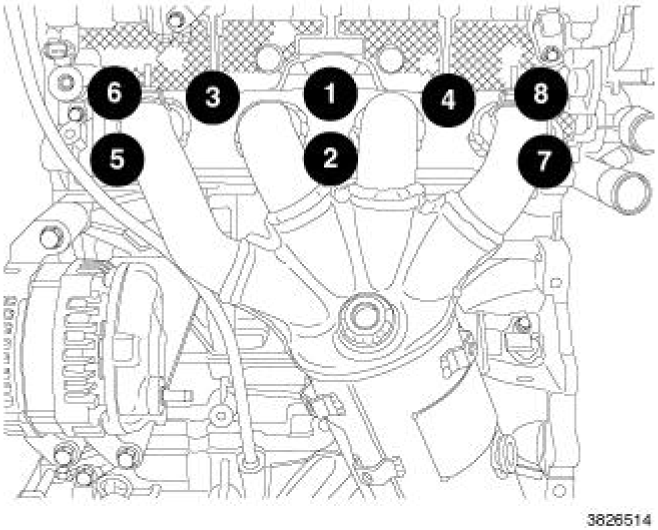


**Fig. 289: Exhaust Manifold Bolts Tightening Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

3. Following the torque sequence, tighten the exhaust manifold bolts to 34 N.m (25 ft. lbs.).

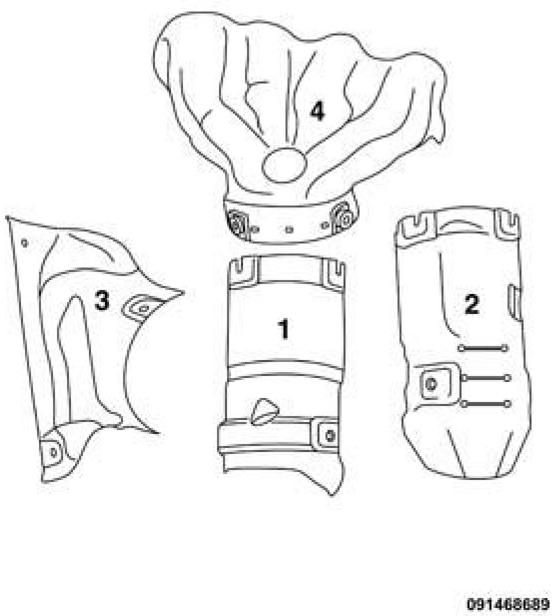


**Fig. 290: Exhaust Manifold Heat Shields**
**Courtesy of CHRYSLER GROUP, LLC**

4. Install the four shields in the proper sequence. Tighten bolts to 12 N.m (105 in. lbs.).
5. Install a new manifold lower gasket.
6. Install flange nuts. Tighten nuts to 28 N.m (21 ft. lbs.)
7. Install exhaust pipe to manifold (1). Tighten fasteners to (250 in. lbs.).

8. Install the oxygen sensors. Tighten to 50 N.m (37 ft. lbs.).
9. Connect the oxygen sensor connectors.
10. Install belly pan.
11. Lower vehicle.
12. Connect oxygen sensor electrical connector (3).
13. Connect negative cable to battery.
14. Install the engine cover.

## MANIFOLD, INTAKE

### 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.**

1. Perform fuel system pressure release procedure **before attempting any repairs. Refer to FUEL DELIVERY, GAS , STANDARD PROCEDURE .**
2. Disconnect and isolate the battery negative cable.
3. Remove the resonator assembly. Refer to **RESONATOR, AIR CLEANER, REMOVAL**.
4. Using a steering wheel holder, lock the steering wheel in place to keep it from rotating. This keeps the clockspring in the proper orientation.

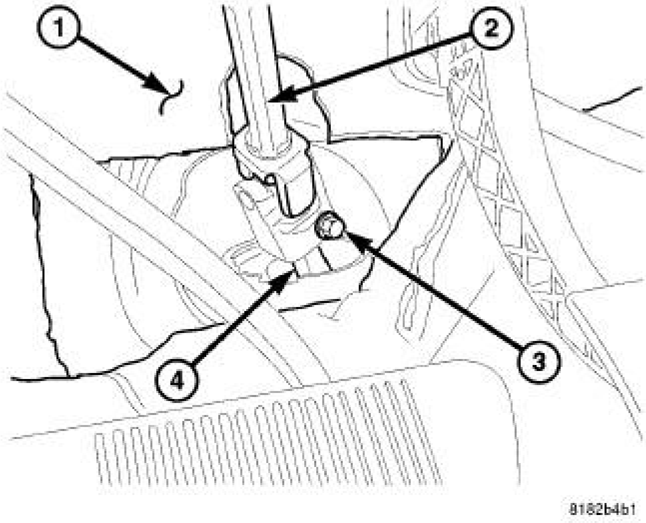


**Fig. 291: Lower Coupling Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

5. Remove the steering column lower coupler pinch bolt (3) and separate the column (2) from the steering gear (4).

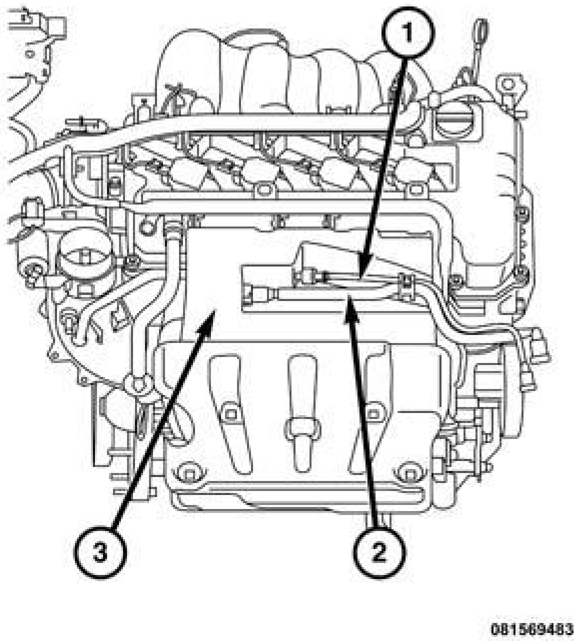


**Fig. 292: Foam Insulator, Fuel Line & Purge Line**
**Courtesy of CHRYSLER GROUP, LLC**

6. Disconnect the vapor line (2) at the purge vapor solenoid end of the line.
7. Remove the NVH foam pad (3) prior to disconnecting the fuel line (1).

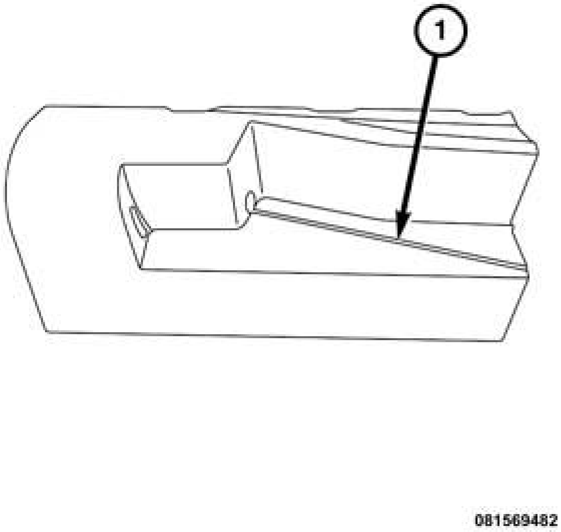


**Fig. 293: Score Line**
**Courtesy of CHRYSLER GROUP, LLC**

8. To remove the foam pad, cut the pad along the score line (1). Make sure care is taken to not make contact with any other components while cutting the pad. **Do not cut beyond the line** Remove the pad from the fuel rail once split.
9. Unplug the Electronic Throttle Control (ETC) connector.
10. Unplug the purge solenoid.

 

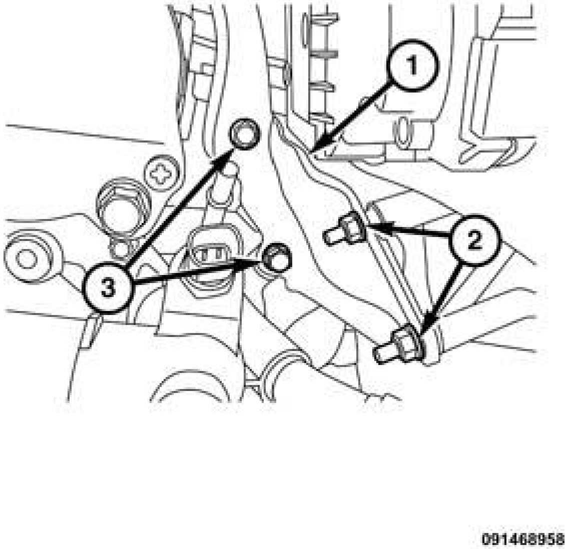


**Fig. 294: Intake Manifold Upper Support Bracket, Bolts & Nuts**
**Courtesy of CHRYSLER GROUP, LLC**

11. Remove the throttle body bracket bolts (3), loosen the nuts (2). Allow the throttle body bracket bolts to remain with the intake manifold.

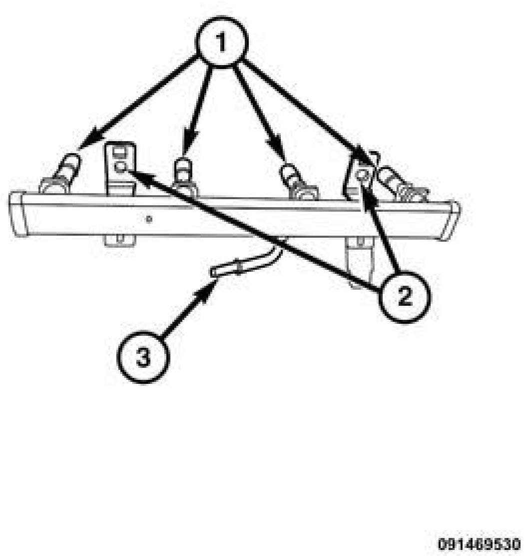


**Fig. 295: Fuel Injectors & Rail**
**Courtesy of CHRYSLER GROUP, LLC**

12. Disconnect the fuel injector electrical connectors (1).
13. Disconnect fuel line at rail (3).
14. Remove the two bolts at the fuel rail (2).

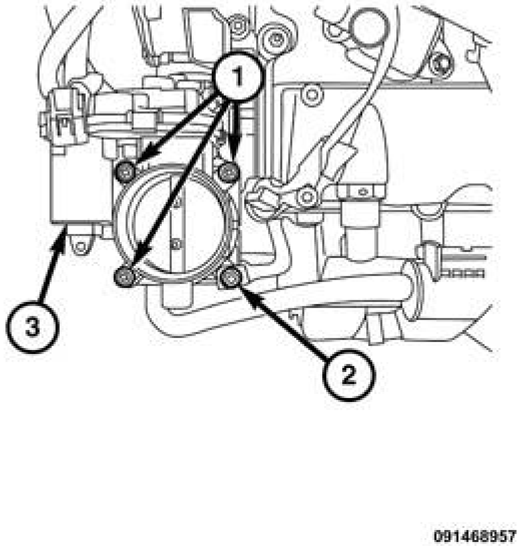


**Fig. 296: Throttle Body, Gasket & Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

15. Remove the throttle body bolts (1) and nut (2) then remove the throttle body assembly (3).
16. Raise and support the vehicle.
17. Remove the front suspension crossmember. Refer to **CROSSMEMBER, FRONT SUSPENSION, REMOVAL** .

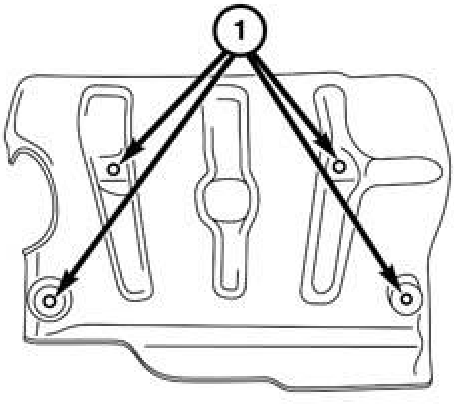


**Fig. 297: Intake Manifold Silencer Pad Screws**
**Courtesy of CHRYSLER GROUP, LLC**

18. Remove the four screws that secure the intake manifold silencer to the manifold (1).
19. Remove the intake manifold silencer assembly.

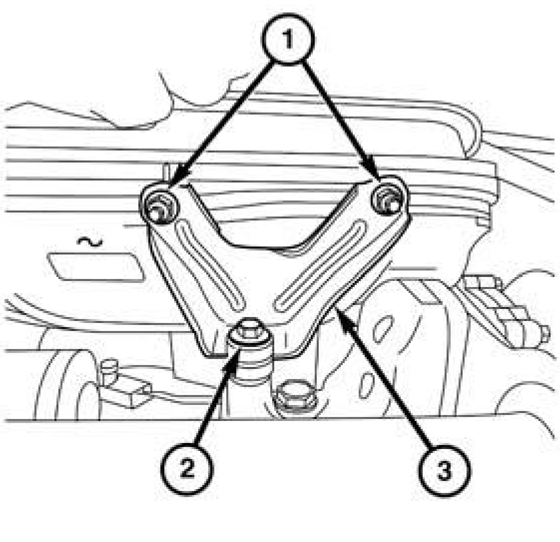


**Fig. 298: Intake Manifold Lower Bracket, Nuts & Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

20. Remove the two nuts (1), the bolt (2) and the intake manifold lower bracket (3).
21. Remove wiring harness retainer from the intake manifold eyelets (1).

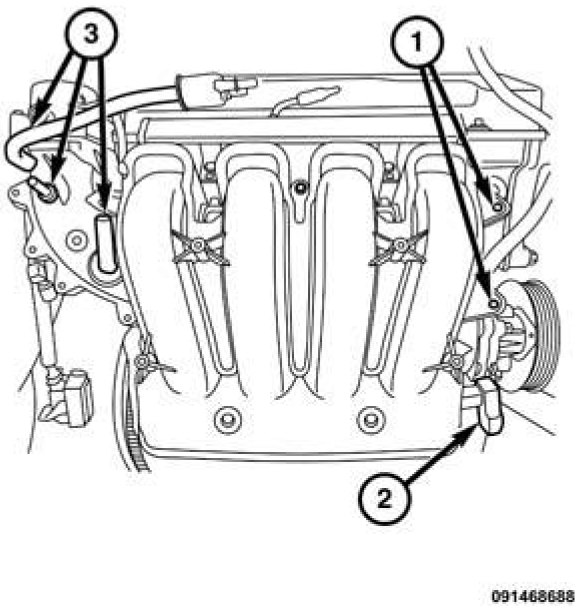


**Fig. 299: MAP Sensor Connector & Fittings**
**Courtesy of CHRYSLER GROUP, LLC**

22. Unplug the three hose connectors (3).
23. Unplug the MAP sensor connector (2).

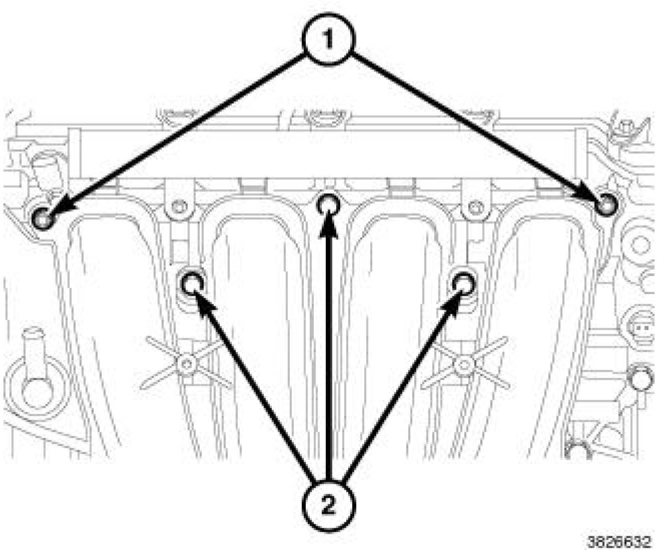


**Fig. 300: Intake Manifold Retaining Bolts & Nuts**
**Courtesy of CHRYSLER GROUP, LLC**

 

24. Remove intake manifold retaining bolts (2) and nuts (1).
25. Remove intake manifold through the bottom of the vehicle.

**CLEANING**

**CLEANING**

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

**INSTALLATION**

**INSTALLATION**

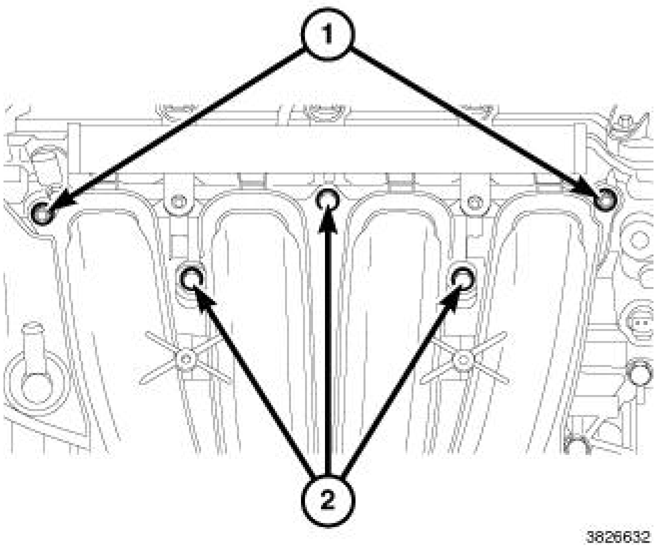


**Fig. 301: Intake Manifold Retaining Bolts & Nuts**
**Courtesy of CHRYSLER GROUP, LLC**

1. Clean all gasket surfaces.
2. Replace intake manifold gasket seals.
3. Position the foam pad over the coolant transfer tube.
4. Install intake manifold, tighten bolts to 12 N.m (9 ft. lbs.).

**NOTE:** **Install the upper fasteners (1) from the top of the engine and the remaining (2) from below.**

 

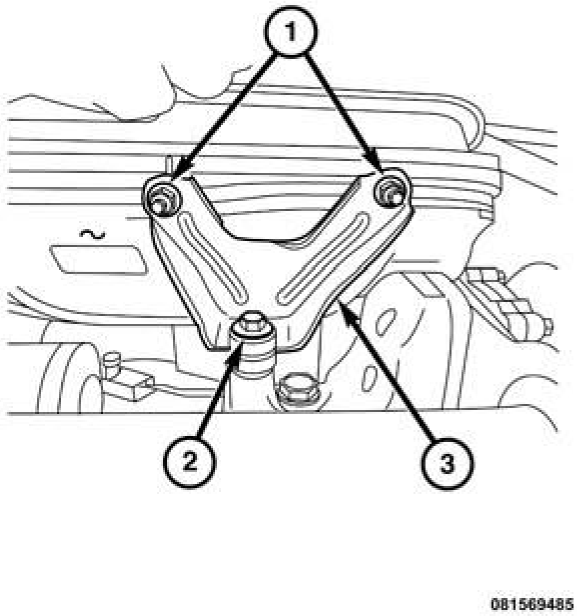


**Fig. 302: Intake Manifold Lower Bracket, Nuts & Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

5. Install the intake manifold silencer cover and screws. Tighten the screws to 2.5 N.m (22 in. lbs.).
6. Install the intake manifold lower bracket (3). Install the two nuts (1) and one bolt (2). Tighten to 9 N.m (80 in. lbs.).
7. Install new fuel injector O-rings and insert the fuel rail into the intake manifold. Tighten bolts
8. Install the fuel rail assembly to intake manifold. Tighten bolts to 8 N.m (71 in. lbs.).
9. Connect fuel injector electrical connectors (4).
10. Inspect quick connect fittings for damage, replace if necessary. Refer to **FITTING, QUICK CONNECT, STANDARD PROCEDURE** .
11. Connect the purge solenoid vapor line and electrical connector.

 

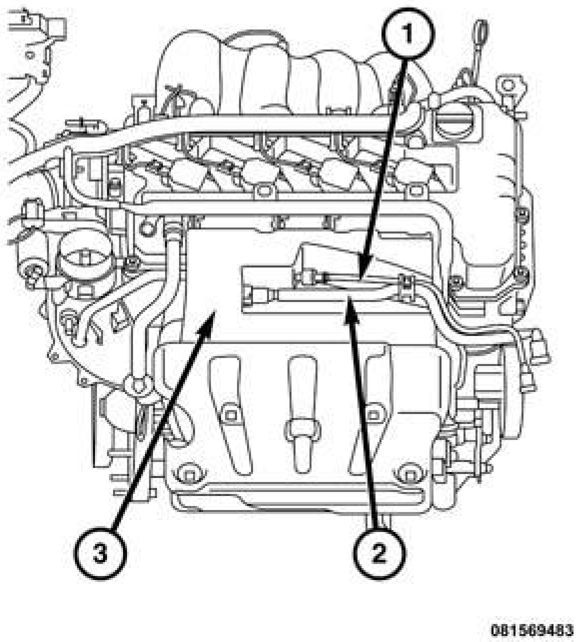


**Fig. 303: Foam Insulator, Fuel Line & Purge Line**
**Courtesy of CHRYSLER GROUP, LLC**

12. Insert the foam insulator over the fuel rail (3).
13. Connect fuel line (1).
14. Connect the purge vapor line (2). Remove wiring harness retainer from the intake manifold eyelets (1).
15. Connect the three hose connectors (3).
16. Connect the MAP sensor connector (2).
17. Install the front suspension crossmember. Refer to **CROSSMEMBER, FRONT SUSPENSION, INSTALLATION** .
18. Lower the vehicle.
19. Install intermediate shaft (2) to steering rack pinion shaft. Install a **NEW** pinch bolt and tighten to 55 N.m (40 ft. lbs.).
20. Remove the steering wheel lock.

 

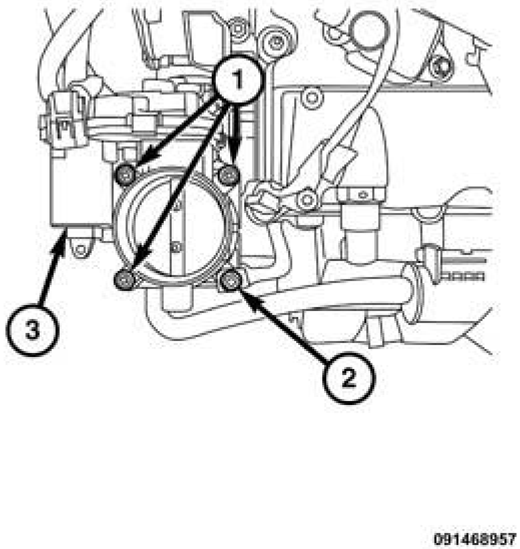


**Fig. 304: Throttle Body, Gasket & Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

21. Install throttle body (3) onto the intake manifold.
22. Install the three throttle body screws (1) and one throttle body bolt (2). Tighten to 8 N.m (71 in. lbs.).

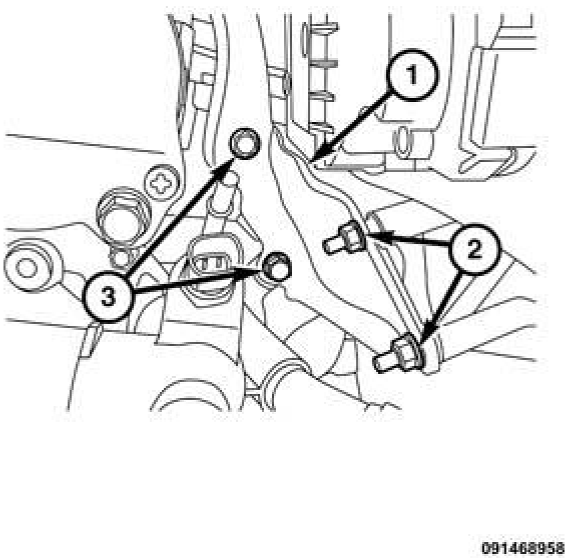


**Fig. 305: Intake Manifold Upper Support Bracket, Bolts & Nuts**
**Courtesy of CHRYSLER GROUP, LLC**

23. Install the intake manifold upper bracket (1). Install bolts (3) and nuts (2). Tighten to 9 N.m (80 in. lbs.).

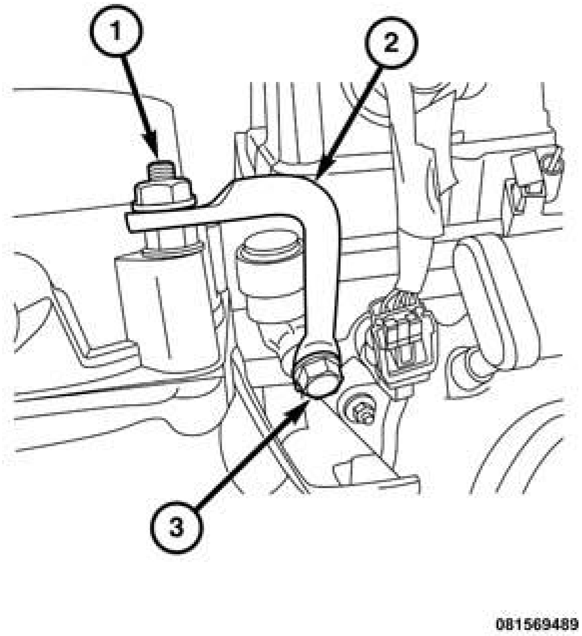


**Fig. 306: Throttle Body Support Bracket, Nut & Bolt**
**Courtesy of CHRYSLER GROUP, LLC**

24. Install the throttle body upper support (2). Tighten the bolts to 8 N.m (71 in. lbs.).
25. Connect the PCV valve hose.
26. Connect negative cable to battery.
27. Install the resonator assembly. Refer to **RESONATOR, AIR CLEANER, INSTALLATION**.

# LUBRICATION

## DESCRIPTION

### DESCRIPTION

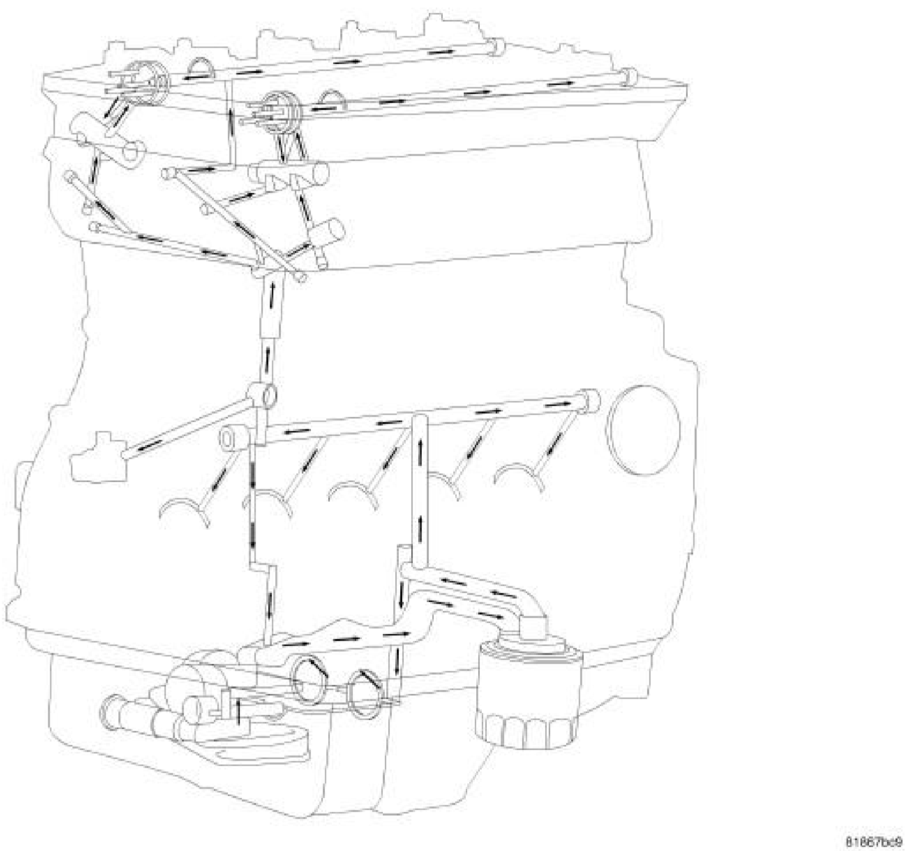


**Fig. 307: Oil Flow Diagram**
**Courtesy of CHRYSLER GROUP, LLC**

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.

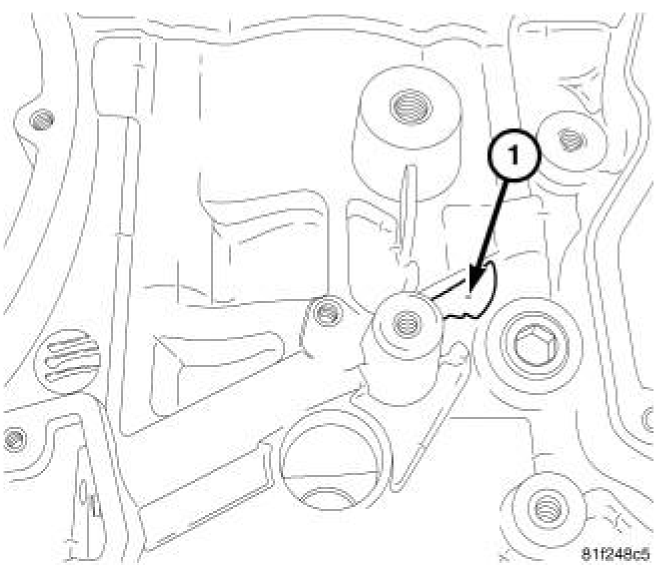


**Fig. 308: Oil Hole**

**Courtesy of CHRYSLER GROUP, 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 balance shaft module (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 two passages; one to the variable valve actuator assembly (VVAA) and one to the exhaust camshaft. The passage to the camshaft feeds the hollow exhaust camshaft at the second cam journal. The rest of the cam journals are feed oil through the hollow camshaft. 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

### ENGINE OIL LEAK

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 de-grease 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 the 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 the oil leak. If the oil leak is found and identified, repair per Service Information instructions.
4. If dye is not observed, drive the vehicle at various speeds for approximately 24 km (15 miles), and repeat the inspection.

   If the oil leak source is not positively identified at this time, proceed with the **AIR LEAK DETECTION TEST METHOD**.

#### AIR LEAK DETECTION TEST METHOD

1. Disconnect the fresh air make-up hose from the oil filler neck. Cap or plug the make-up air hose nipple.
2. Remove the PCV hose from the PCV valve. Cap or plug the PCV valve nipple.

 

3. Attach an air hose with a 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.**

4. Gradually increase air pressure from 7 kPa (1 psi) to 17 kPa (2.5 psi) maximum while applying soapy water at the suspected leak source. Adjust the regulator to a suitable test pressure within this range that provides the best bubble generation which will pinpoint the leak source. If the oil leak is detected and identified, repair per Service Information procedures.
5. If the leakage occurs at the rear crankshaft oil seal area, follow the procedures for rear seal area leaks. Refer to **LUBRICATION - DIAGNOSIS AND TESTING** .
6. If no leaks are detected, turn off the air supply and remove the air hose and all plugs and caps. Install the PCV valve and make-up air hoses.
7. Clean the oil off of 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.

**CHECKING ENGINE OIL PRESSURE**

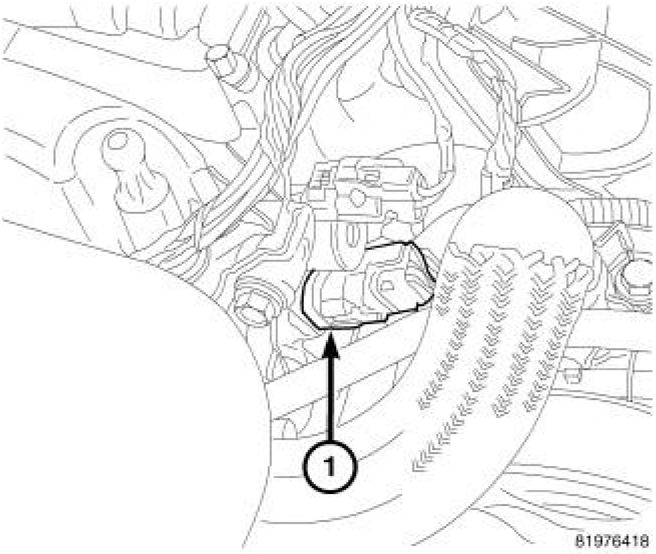


**Fig. 309: Oil Temperature Sensor**
**Courtesy of CHRYSLER GROUP, LLC**

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

1. Disconnect and remove oil temperature sensor (1).

 

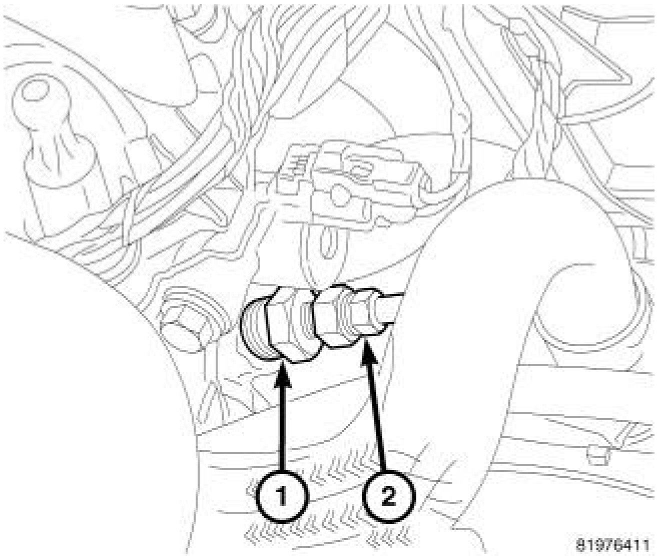


**Fig. 310: Oil Pressure Adapter 9879**
**Courtesy of CHRYSLER GROUP, LLC**

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

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

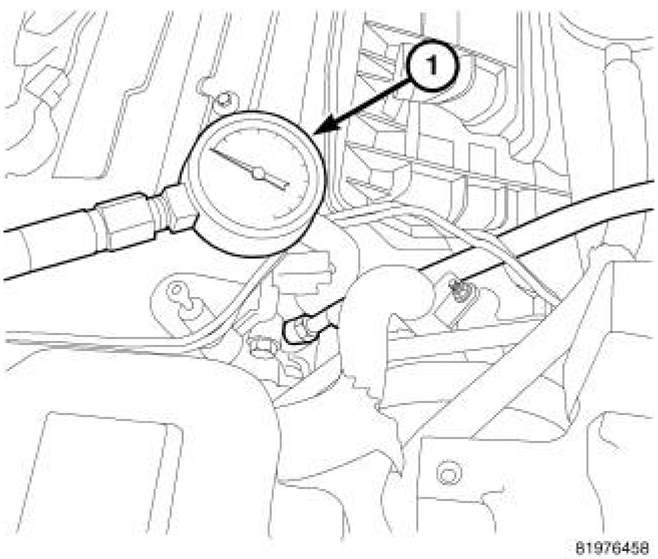


**Fig. 311: Oil PSI Gauge**
**Courtesy of CHRYSLER GROUP, LLC**

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. Check for pressure relief valve stuck open or a clogged oil pick-up screen.
6. Remove oil pan and inspect for debris. Refer to **PAN, OIL, REMOVAL**.
7. Remove oil pressure relief valve. Refer to **VALVE, OIL PRESSURE RELIEF, REMOVAL**.
8. Inspect oil pressure relief valve if damaged replace. Refer to **VALVE, OIL PRESSURE RELIEF - INSPECTION** .
9. If pressure relief valve is ok, replace balance shaft module assembly. Refer to **PUMP, ENGINE OIL, REMOVAL**.

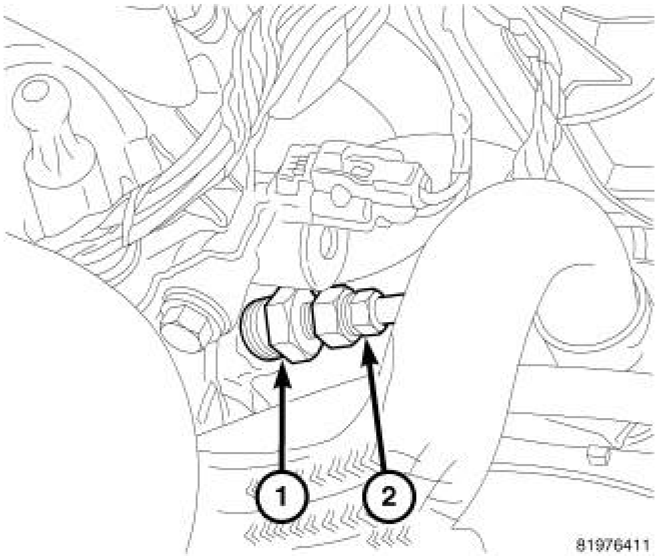


**Fig. 312: Oil Pressure Adapter 9879**
**Courtesy of CHRYSLER GROUP, LLC**

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

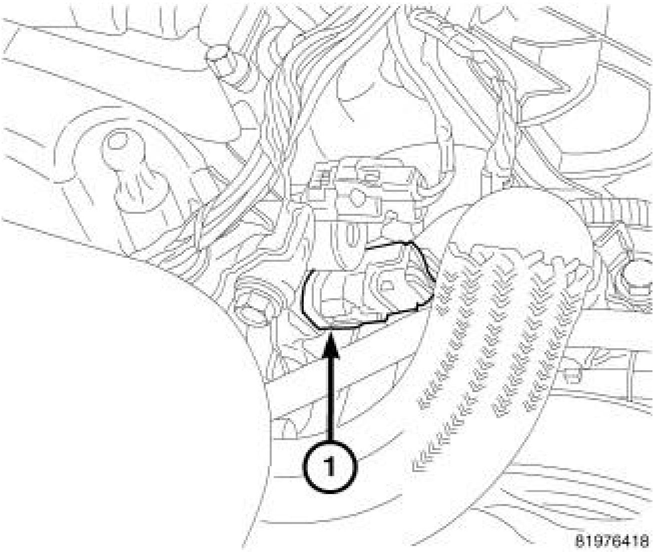


**Fig. 313: Oil Temperature Sensor**
**Courtesy of CHRYSLER GROUP, LLC**

11. Install a new oil pressure temperature sensor (1) and connect electrical connector.

**CHECKING VVT OIL PRESSURE**

This test can be used to help diagnose VVT faults.

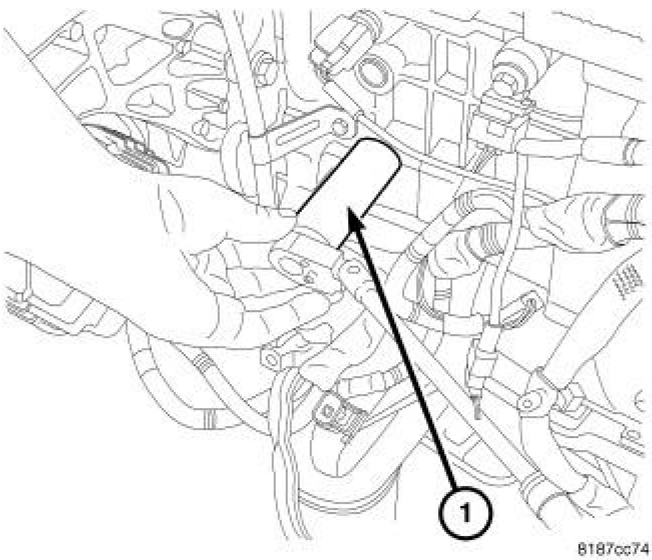


**Fig. 314: Oil Sender**
**Courtesy of CHRYSLER GROUP, LLC**

1. Disconnect and remove oil pressure sensor (1).

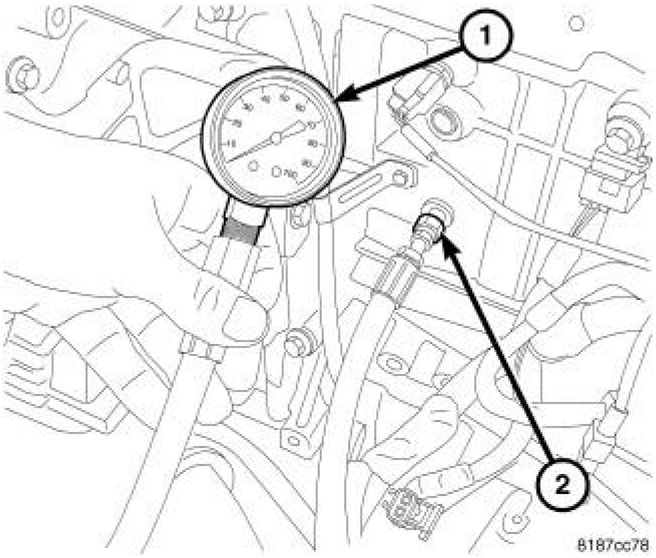


**Fig. 315: Oil Pressure Gauge**
**Courtesy of CHRYSLER GROUP, LLC**

**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 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. Check for pressure relief valve stuck open or a clogged oil pick-up screen.
6. Remove oil pan and inspect for debris. Refer to **PAN, OIL, REMOVAL**.
7. Remove oil pressure relief valve and inspect, if damaged replace pressure relief valve. Refer to **VALVE, OIL PRESSURE RELIEF, REMOVAL**.
8. If pressure relief valve is ok, replace balance shaft module assembly. Refer to **PUMP, ENGINE OIL, REMOVAL**.

 

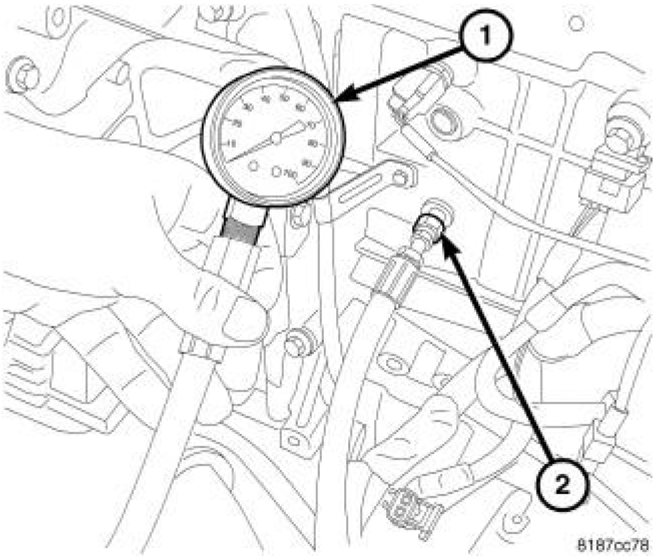


**Fig. 316: Oil Pressure Gauge**
**Courtesy of CHRYSLER GROUP, LLC**

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

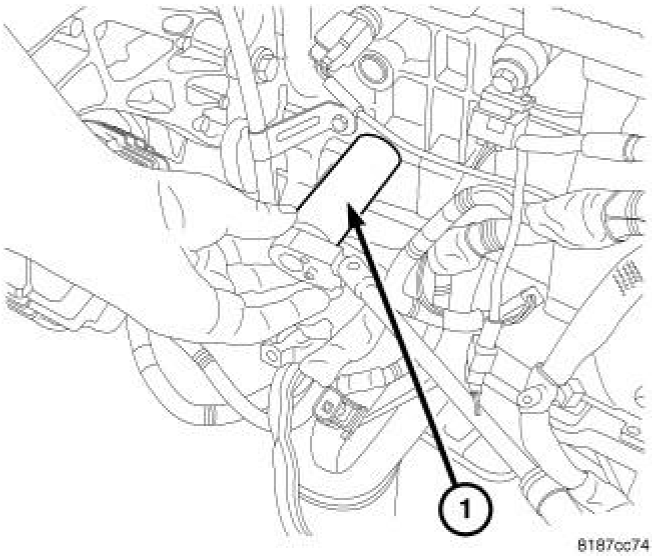


**Fig. 317: Oil Sender**
**Courtesy of CHRYSLER GROUP, LLC**

10. Install oil pressure sensor and electrical connector.

## 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.**

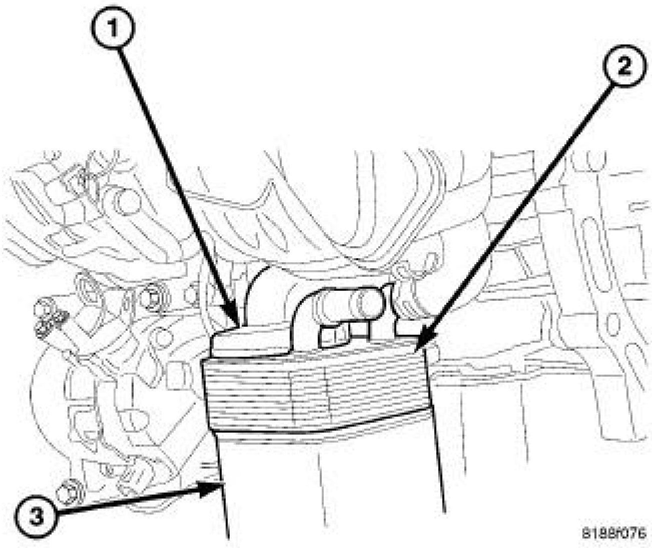


**Fig. 318: Identifying Oil Cooler**
**Courtesy of CHRYSLER GROUP, LLC**

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

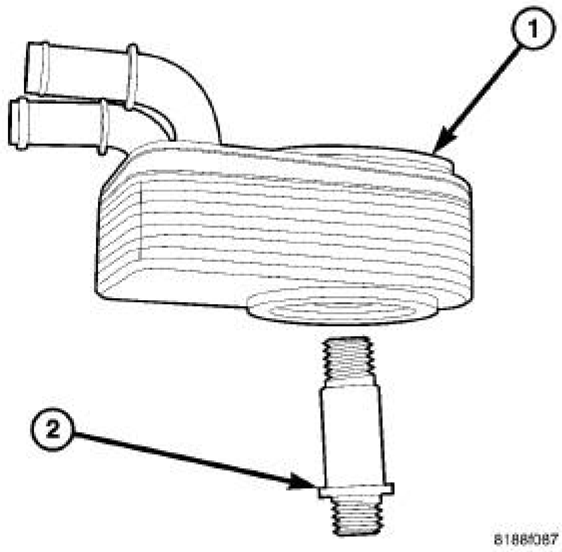


**Fig. 319: Oil Cooler Mounting**
**Courtesy of CHRYSLER GROUP, LLC**

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

**INSTALLATION**

**INSTALLATION**

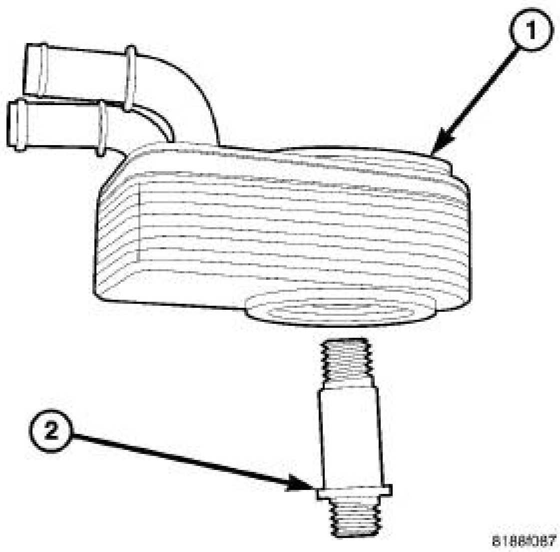


**Fig. 320: Oil Cooler Mounting**
**Courtesy of CHRYSLER GROUP, LLC**

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.).

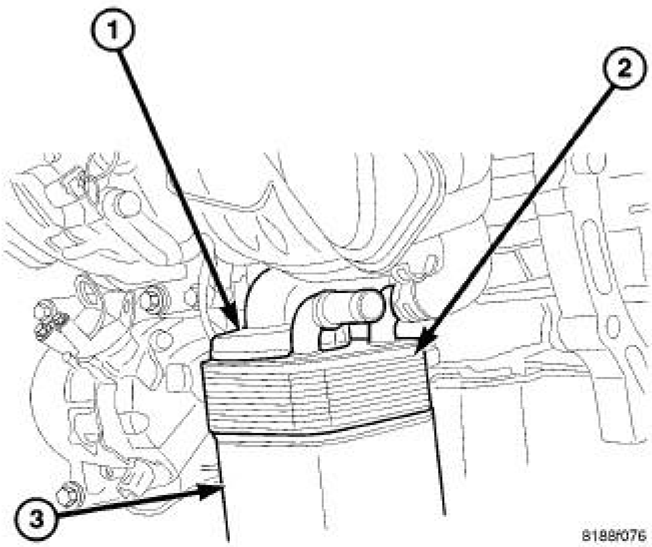


**Fig. 321: Identifying Oil Cooler**
**Courtesy of CHRYSLER GROUP, LLC**

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

 

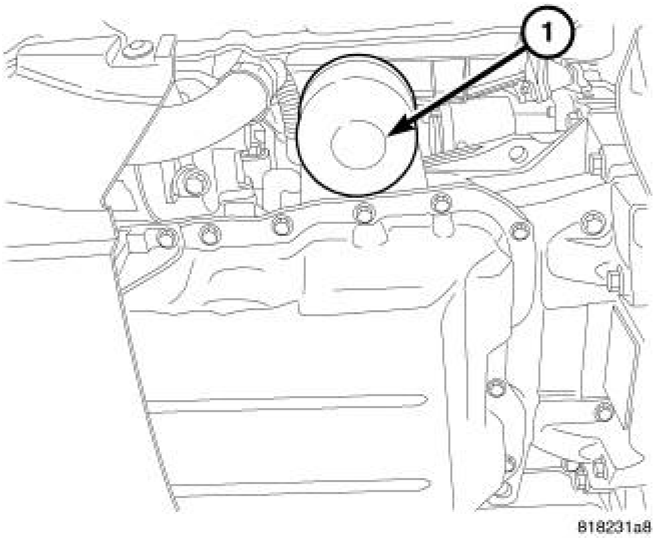


**Fig. 322: Oil Filter**
**Courtesy of CHRYSLER GROUP, LLC**

**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**

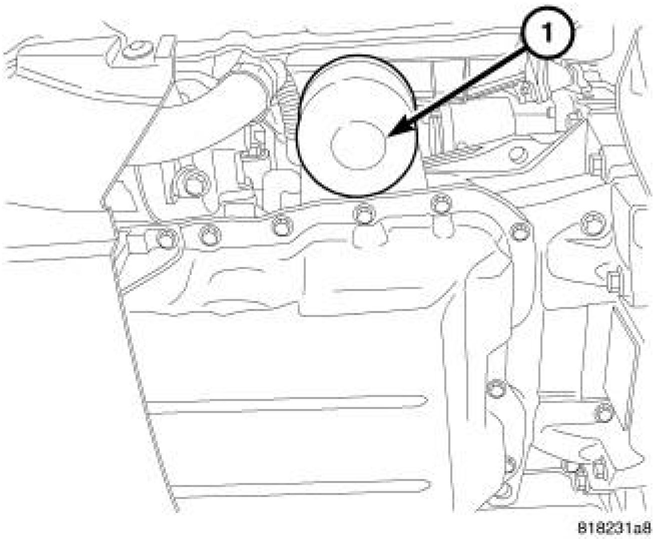


**Fig. 323: Oil Filter**
**Courtesy of CHRYSLER GROUP, LLC**

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 (124 in. lbs.).

## OIL

### STANDARD PROCEDURE

#### ENGINE OIL LEVEL CHECK

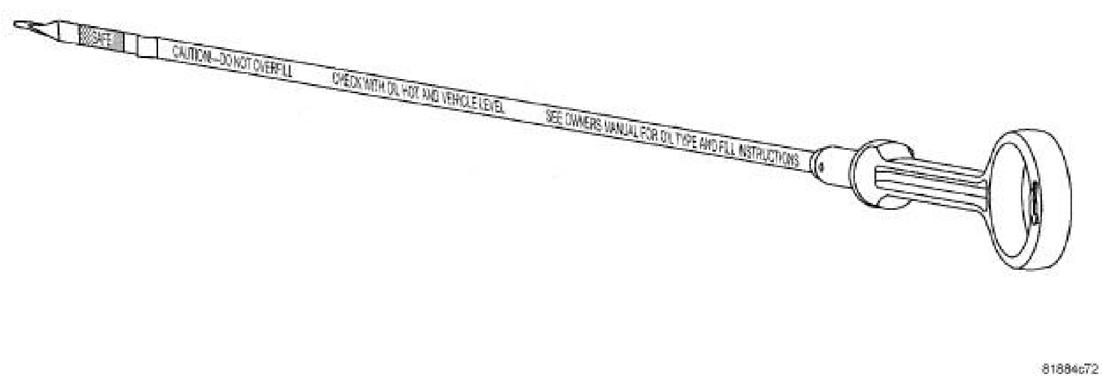


**Fig. 324: Oil Level Indicator**
**Courtesy of CHRYSLER GROUP, LLC**

**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.

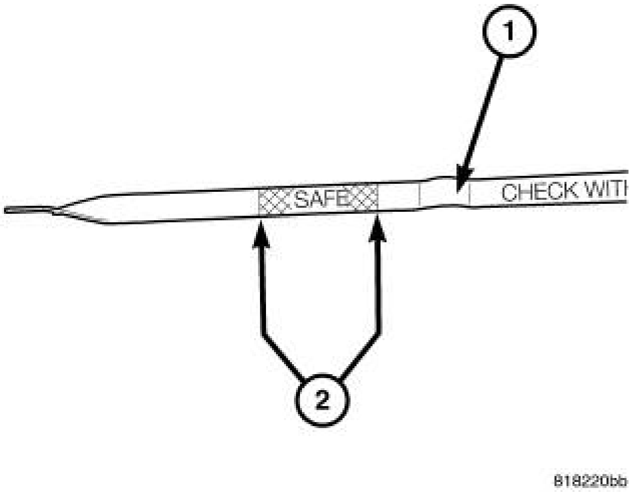


**Fig. 325: Dip Stick**
**Courtesy of CHRYSLER GROUP, LLC**

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 Owner's 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** .

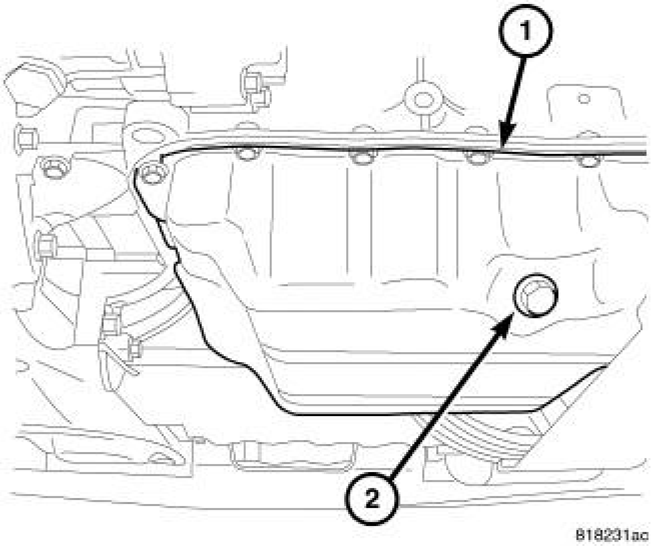


**Fig. 326: Oil Drain Plug & Oil Pan**
**Courtesy of CHRYSLER GROUP, LLC**

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.

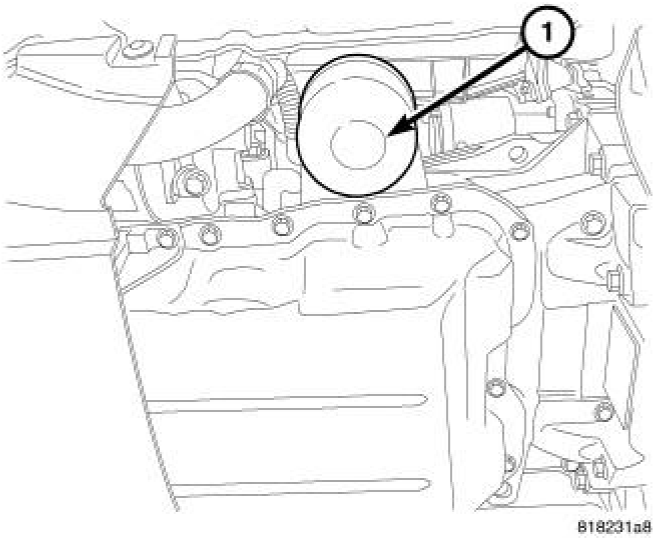


**Fig. 327: Oil Filter**
**Courtesy of CHRYSLER GROUP, LLC**

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

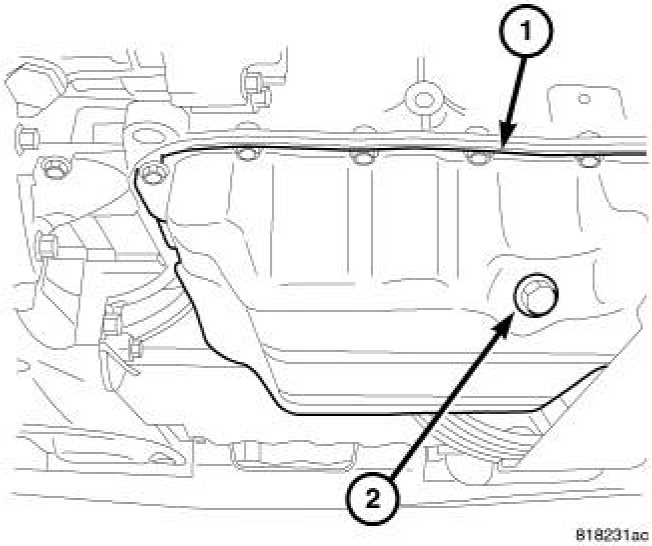


**Fig. 328: Oil Drain Plug & Oil Pan**
**Courtesy of CHRYSLER GROUP, LLC**

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

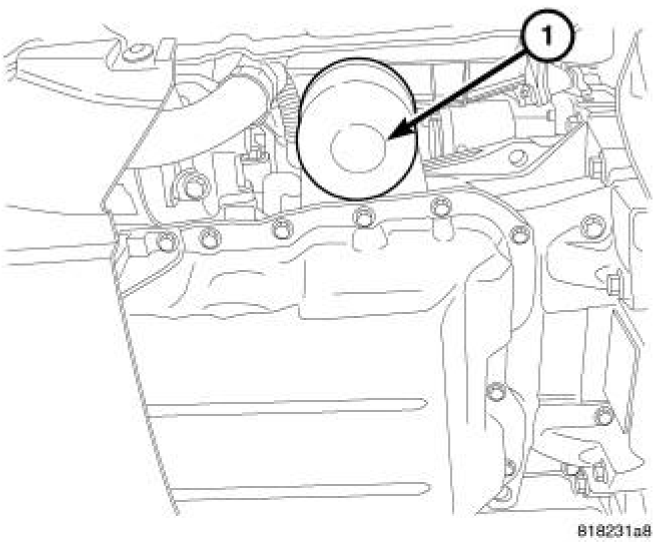


**Fig. 329: Oil Filter**
**Courtesy of CHRYSLER GROUP, LLC**

9. Install new oil filter (1). Refer to **FILTER, ENGINE OIL, INSTALLATION**.
10. Lower vehicle and fill crankcase with specified type and amount of engine oil . Refer to **CAPACITIES AND RECOMMENDED FLUIDS, SPECIFICATIONS** and **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 under **ENGINE OIL AND FILTER CHANGE**.

## PAN, OIL

#### REMOVAL

#### REMOVAL

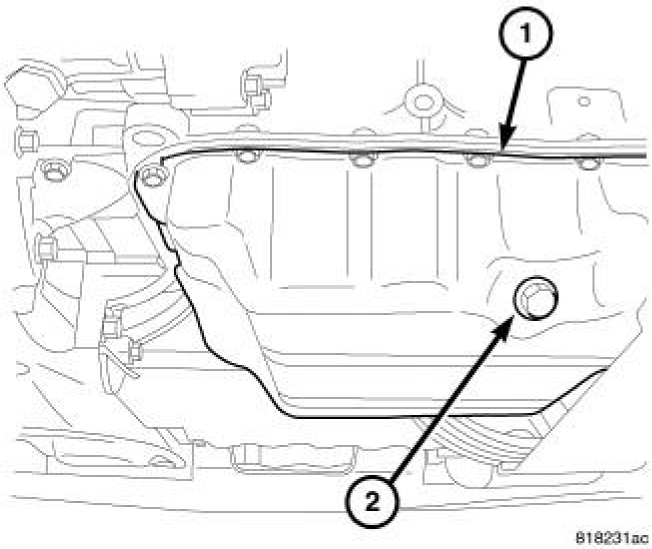


**Fig. 330: Oil Drain Plug & Oil Pan**
**Courtesy of CHRYSLER GROUP, LLC**

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

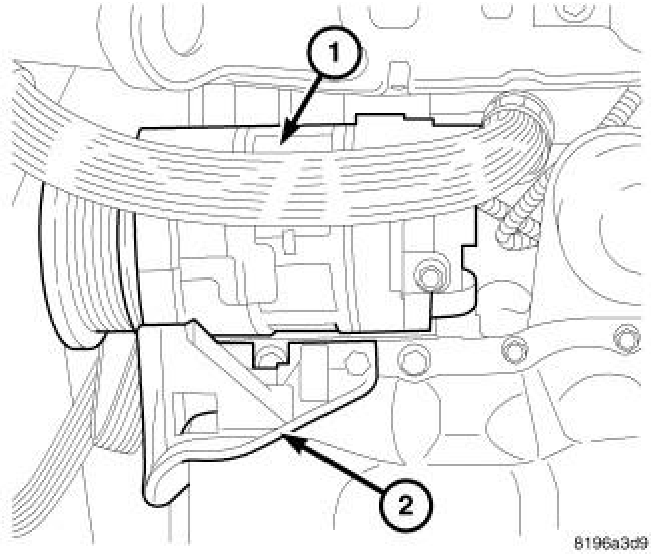


**Fig. 331: Locating A/C Compressor**
**Courtesy of CHRYSLER GROUP, LLC**

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

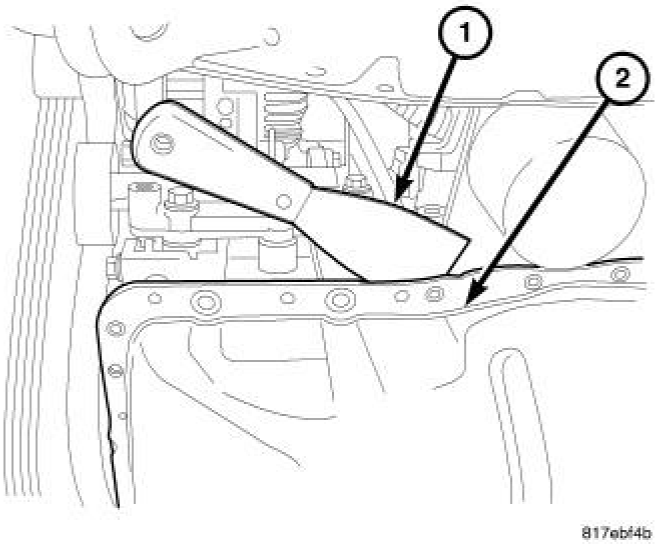


**Fig. 332: Using Putty Knife To Loosen Seal Around Oil Pan**
**Courtesy of CHRYSLER GROUP, LLC**

**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**

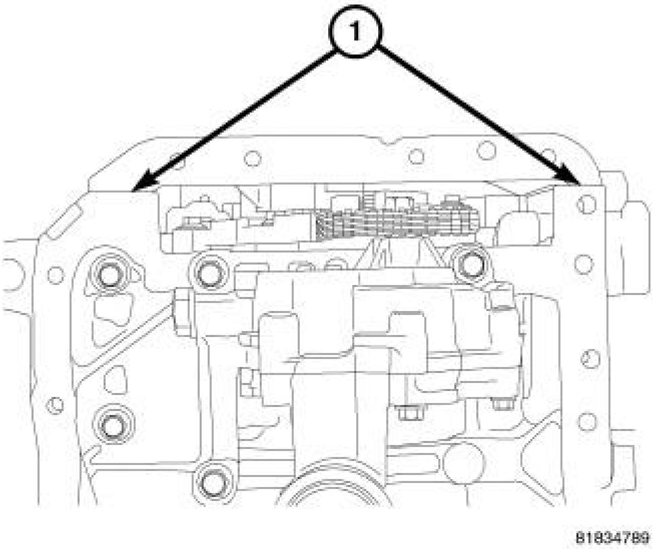


**Fig. 333: Sealer Location**
**Courtesy of CHRYSLER GROUP, LLC**

**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).

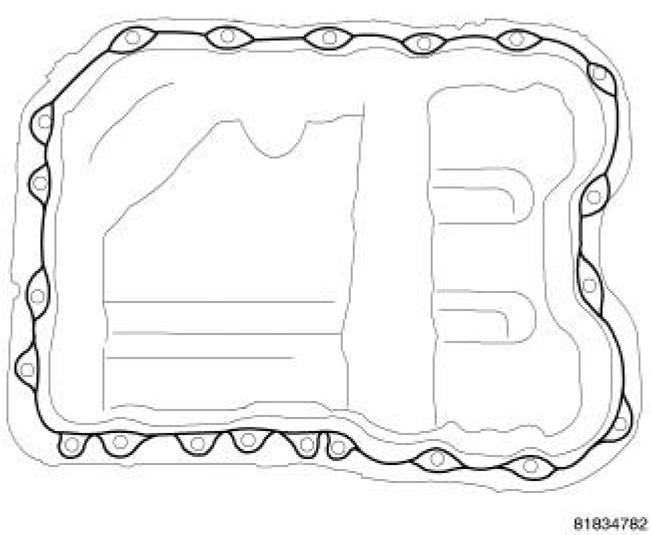


**Fig. 334: Sealing Oil Pan**
**Courtesy of CHRYSLER GROUP, LLC**

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.).**

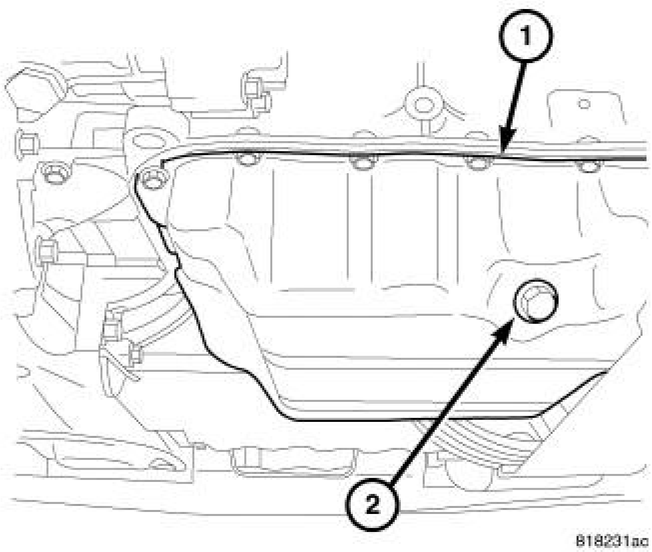


**Fig. 335: Oil Drain Plug & Oil Pan**
**Courtesy of CHRYSLER GROUP, LLC**

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

 

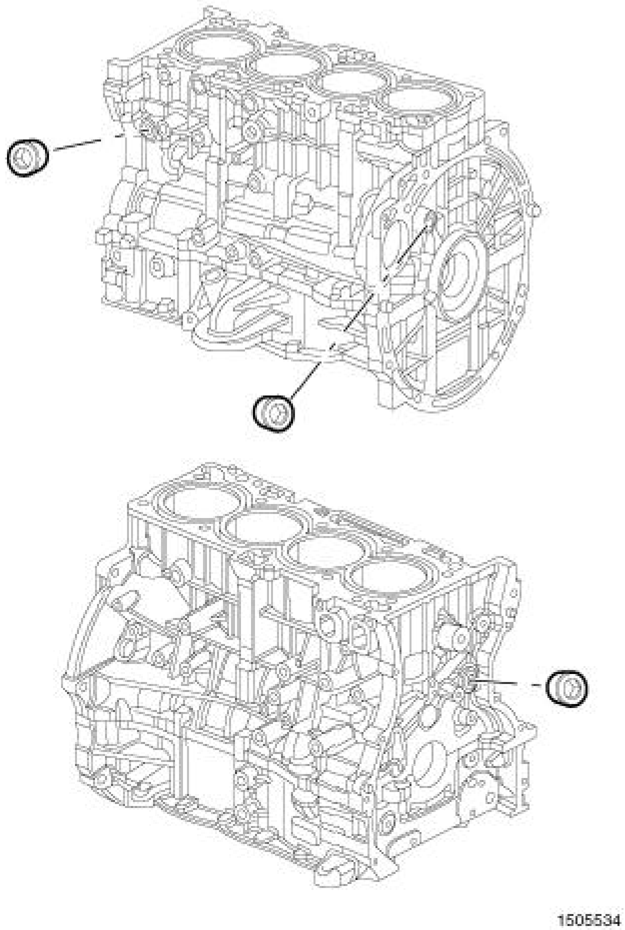


**Fig. 336: Tapered Plugs**
**Courtesy of CHRYSLER GROUP, LLC**

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**

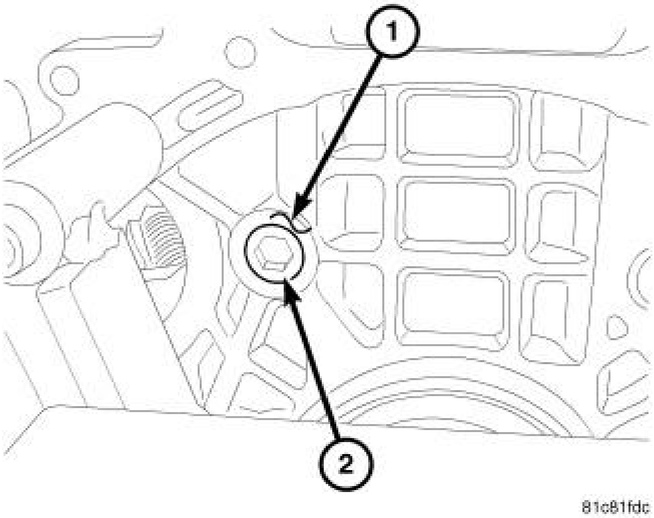


**Fig. 337: Gallery Plug**
**Courtesy of CHRYSLER GROUP, LLC**

**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**

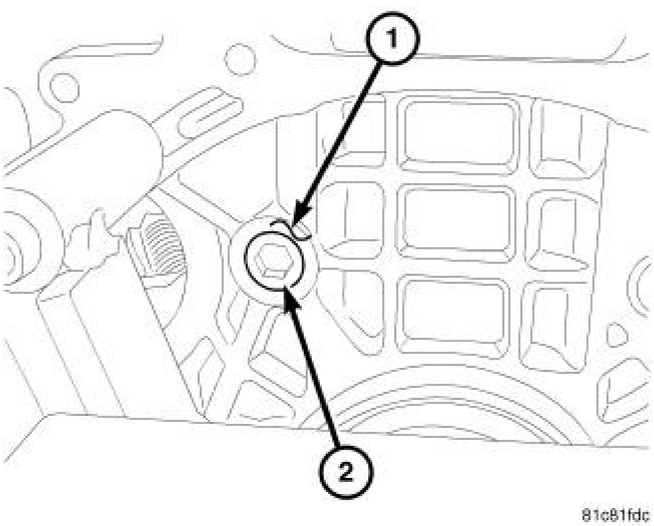

**Fig. 338: Gallery Plug**
**Courtesy of CHRYSLER GROUP, LLC**

**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

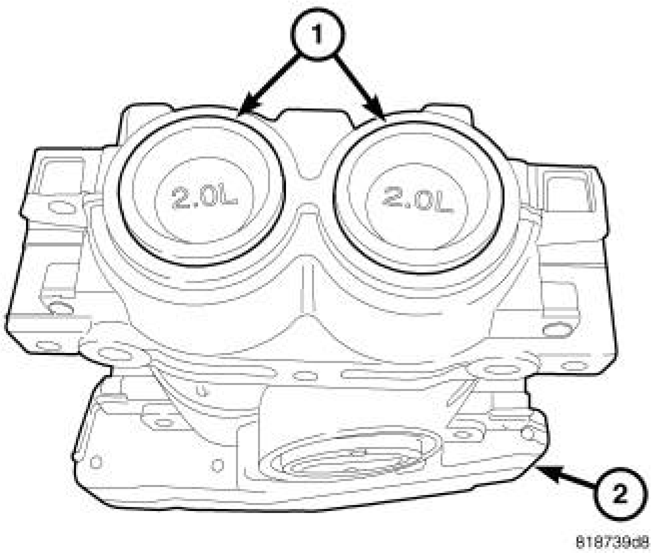


**Fig. 339: Balance Shaft Module & End Caps**
**Courtesy of CHRYSLER GROUP, LLC**

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

| | |
|---|---|
| | A multimedia supplement to the instructions contained in this article is available. |

| | |
|---|---|
| You Tube | To view the multimedia example of the condition described go to; **http://www.youtube.com/user/Mitchell1Tips** **then type "A00646217.vid2" into the "Search Channel" box.** |

**When removing and installing the Balance Shaft/Oil Pump assembly in the vehicle, it is not necessary to align the plated links on the drive chain as long as the reference marks are created during the procedure.**

1. Remove the oil pan. Refer to **PAN, OIL, REMOVAL**.


**Fig. 340: Aligning Balance Shaft/Oil Pump Drive Gear And Housing Indicator**
**Courtesy of CHRYSLER GROUP, LLC**

2. Rotate the engine clockwise until the balance shaft/oil pump drive gear and the housing indicator are aligned.

**NOTE:** **IT IS VERY IMPORTANT THAT THE CRANKSHAFT STAYS STATIONARY DURING THE FOLLOWING STEPS. DO NOT MOVE THE CRANKSHAFT UNTIL THE INSTALLATION PROCEDURE IS COMPLETED.**

3. Clean the balance shaft/oil pump assembly drive gear with Mopar® brake cleaner or similar.

**NOTE:** **Make sure the gear is clear of any oil to allow for marking.**

 

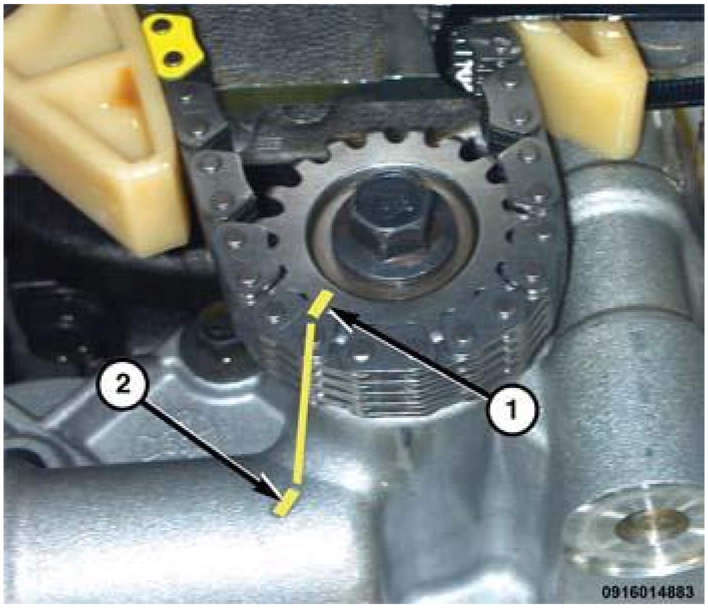


**Fig. 341: Oil Pump Chain And Sprocket To Module Body Marks**
**Courtesy of CHRYSLER GROUP, LLC**

4. If the balance shaft/oil pump assembly is being reused, mark the oil pump chain and the sprocket (1) to the module body (2) for reassembly.
5. Install one air-conditioning compressor bracket bolt into the left forward corner thread boss.

**NOTE: The bolt will provide a sturdy point to secure a tie strap to hold the tensioner in the compressed position.**

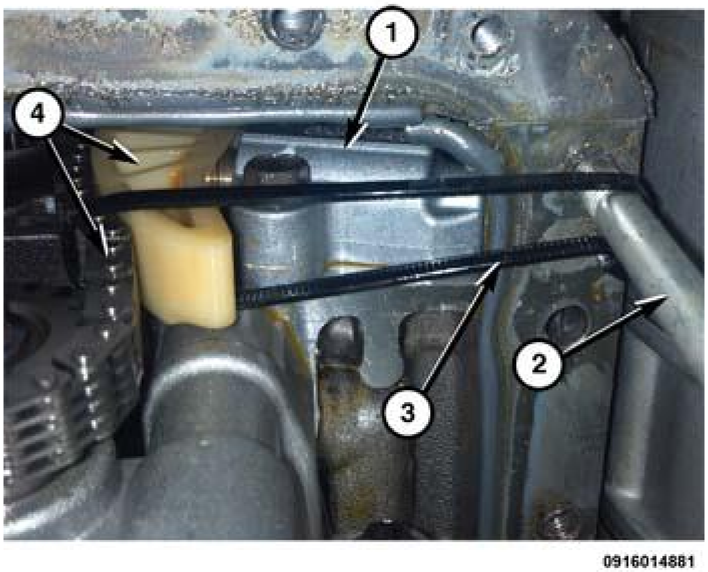


**Fig. 342: Positioning Plastic Tie Strap**
**Courtesy of CHRYSLER GROUP, LLC**

6. Position a plastic tie strap (3) around the chain, tensioner (4) and bolt (2) that was previously installed.
7. Push the chain, guide and tensioner (1) to the compressed position.
8. Tighten the tie strap to hold the components together.

**NOTE: The tighter the strap, the more room for removal and installation.**

9. Remove the balance shaft/oil pump assembly mounting bolts.
10. Remove assembly from the engine by tilting the rear of the balance shaft/oil pump assembly downward while lifting the drive gear out of the chain links.

**INSPECTION**

**INSPECTION**

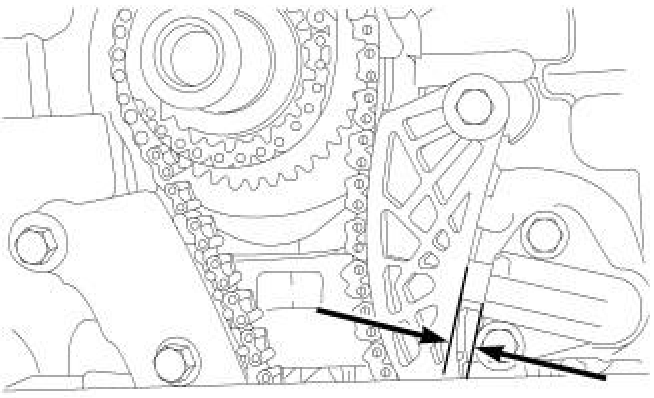


**Fig. 343: Oil Pump Chain Stretch**
**Courtesy of CHRYSLER GROUP, LLC**

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**

| | |
|---|---|
| | A multimedia supplement to the instructions contained in this article is available.<br>To view the multimedia example of the condition described go to;<br>**http://www.youtube.com/user/Mitchell1Tips** |

| | then type "A00646217.vid3" into the "Search Channel" box. |
|---|---|

**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.**

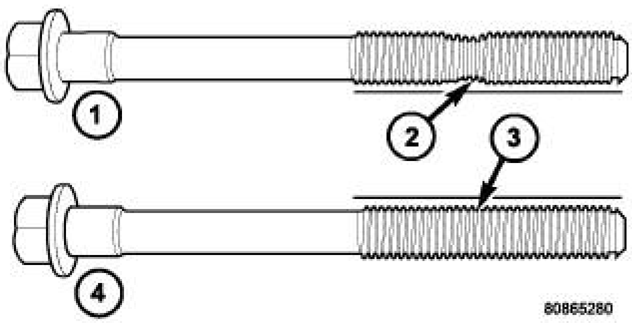


**Fig. 344: Checking Cylinder Head Bolts For Stretching (Necking)**
**Courtesy of CHRYSLER GROUP, LLC**

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.
2. Clean the balance shaft/oil pump assembly mounting holes with Mopar® brake parts cleaner.
3. Align the marks on the balance shaft/oil pump assembly and drive sprocket.

 


**Fig. 345: Aligning Balance Shaft/Oil Pump Drive Gear And Housing Indicator**
**Courtesy of CHRYSLER GROUP, LLC**

4. With the rear of the balance shaft/oil pump assembly on a slight downward angle, position the gear into the chain links. Make sure the paint marks are aligned.
5. Pivot balance shaft/oil pump assembly upwards and position on ladder frame.

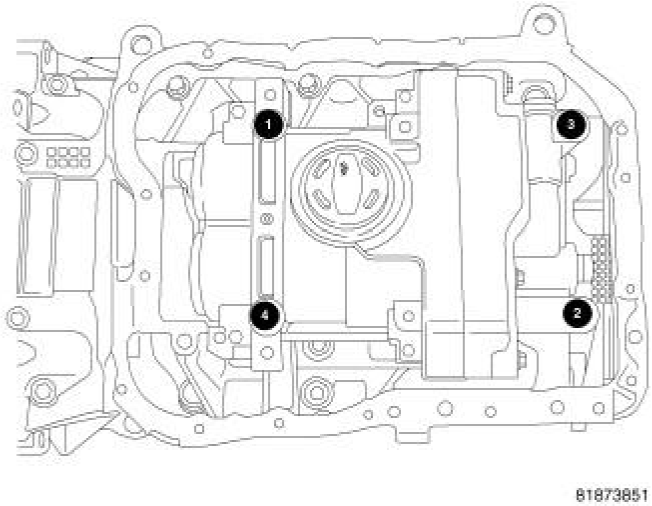


**Fig. 346: BSM Mounting Bolts Tightening Sequence**
**Courtesy of CHRYSLER GROUP, LLC**

6. Start balance shaft/oil pump assembly mounting bolts by hand.

**NOTE:** **Use a three step procedure when tightening balance shaft/oil pump assembly mounting bolts. For new 180 mm bolts, go to step 7. For 185 mm**

 

**bolts, go to step 8.**

7. Tighten new 180 mm balance shaft/oil pump assembly mounting bolts as follows:
    a. Tighten to 15 N.m (11 ft. lbs.) in the sequence shown in illustration.
    b. Tighten to 33 N.m (24 ft. lbs.) in the sequence shown in illustration.
    c. Rotate bolts an additional 90° in the sequence shown in illustration.
8. Tighten 185 mm balance shaft/oil pump assembly 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.

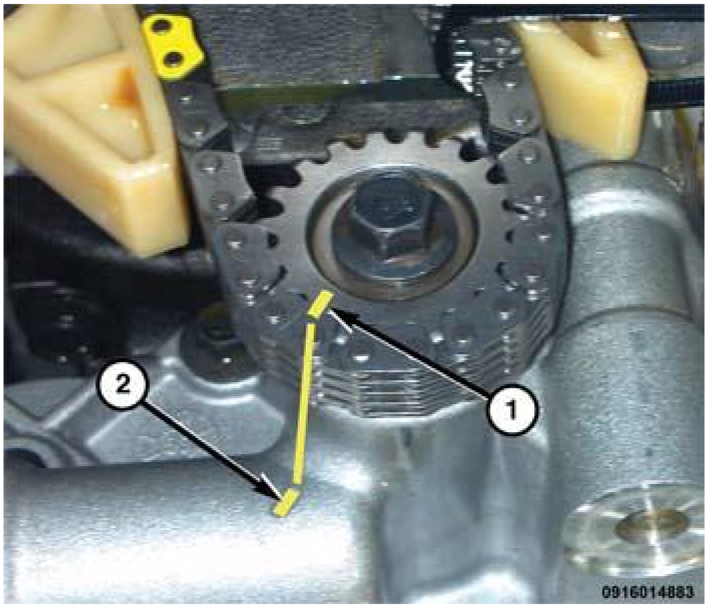


**Fig. 347: Oil Pump Chain And Sprocket To Module Body Marks**
**Courtesy of CHRYSLER GROUP, LLC**

9. Double check the alignment marks to ensure the gear (1) and balance shaft/oil pump assembly indicator (2) is aligned.

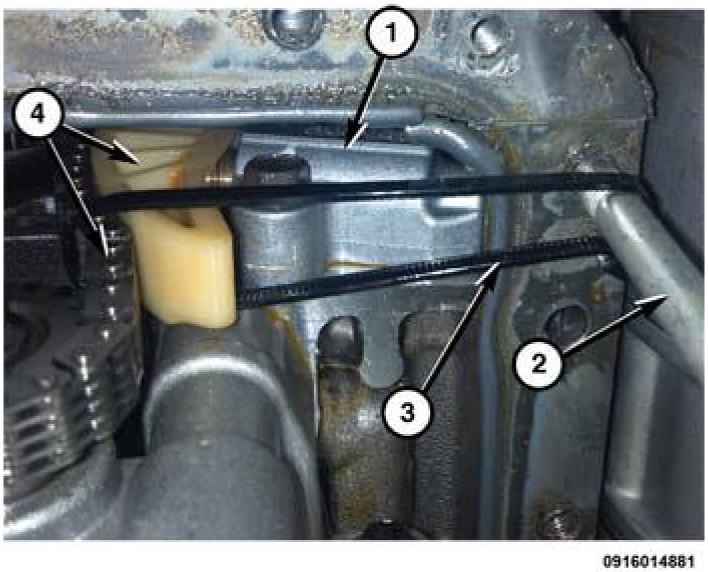


**Fig. 348: Positioning Plastic Tie Strap**
**Courtesy of CHRYSLER GROUP, LLC**

10. Remove the tie strap (3).
11. Remove the bracket bolt (2).
12. Inspect that the tensioner (1) has fully extended and applied pressure to the guide and chain (4).
13. Install the oil pan. Refer to **PAN, OIL, INSTALLATION**.
14. Fill engine with oil.
15. Start engine and check for leaks.

## SENSOR, OIL TEMPERATURE

### DESCRIPTION

#### DESCRIPTION

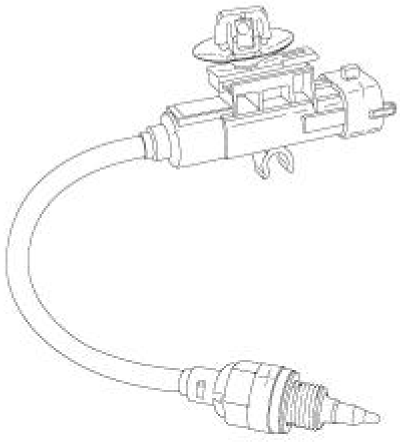


**Fig. 349: Oil Temperature Sensor**
**Courtesy of CHRYSLER GROUP, LLC**

The oil temperature sensor is a two wire sensor located on the variable valve actuation assembly at the cylinder head. The sensor probe is mounted to the variable valve actuation assembly through an access hole. A compression washer seals the oil temperature sensor to the variable valve actuation assembly.

**REMOVAL**

**REMOVAL**

1. Disconnect the battery negative cable.

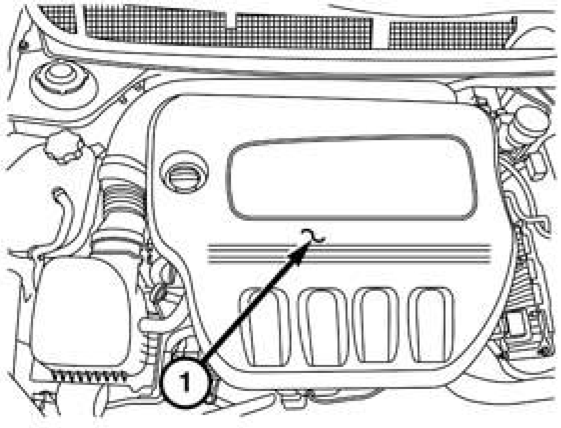

**Fig. 350: Engine Cover**
**Courtesy of CHRYSLER GROUP, LLC**

2. Remove the engine cover (1).

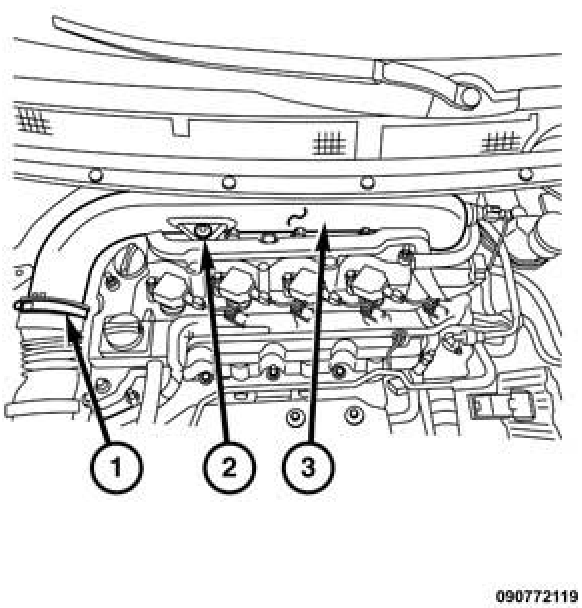


**Fig. 351: Resonator, Bolt & Clamp**
**Courtesy of CHRYSLER GROUP, LLC**

Loosen the intake clamp (1), remove the resonator bolt (2) and resonator (3).

3. Remove the engine cover (1).
4. Remove the wiring harness fastener from the intake manifold.
5. Disconnect oil temperature sensor electrical connector.

 

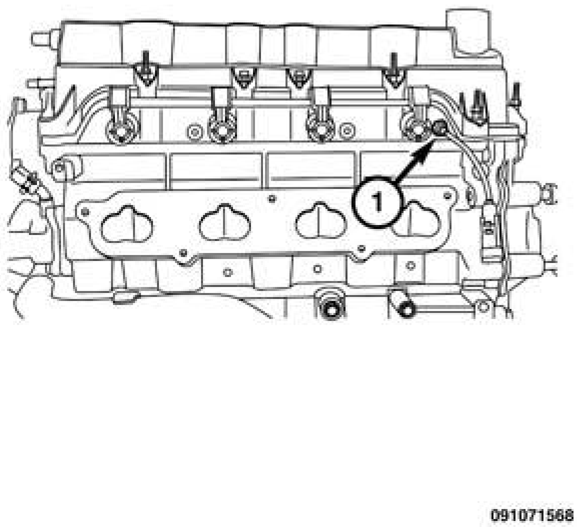


**Fig. 352: Oil Temperature Sensor Location**
**Courtesy of CHRYSLER GROUP, LLC**

6. Remove sensor (1).

**INSTALLATION**

**INSTALLATION**

1. If re-using the oil temperature sensor, coat the threads with Mopar® thread sealant.

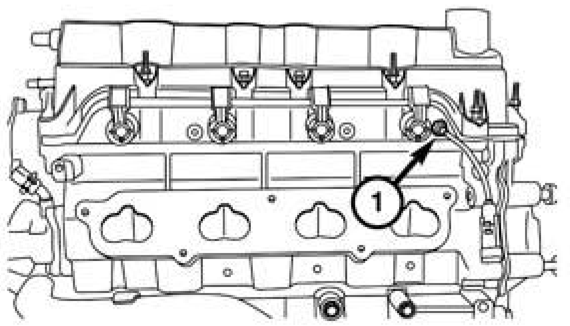


**Fig. 353: Oil Temperature Sensor Location**
**Courtesy of CHRYSLER GROUP, LLC**

2. Install oil temperature sensor (1). Tighten to 18 N.m (160 in. lbs.).

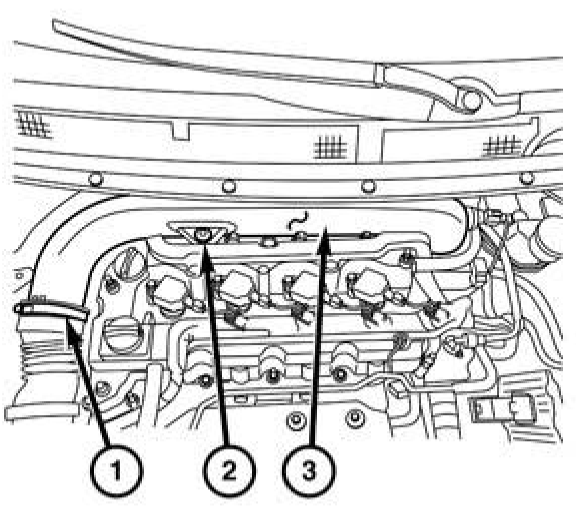


**Fig. 354: Resonator, Bolt & Clamp**
**Courtesy of CHRYSLER GROUP, LLC**

 

3. Install the resonator (3), bolt (2) and clamp (1). Tighten the bolt to 5 N.m (81 in. lbs.). Tighten the clamp.
4. Connect electrical connector.

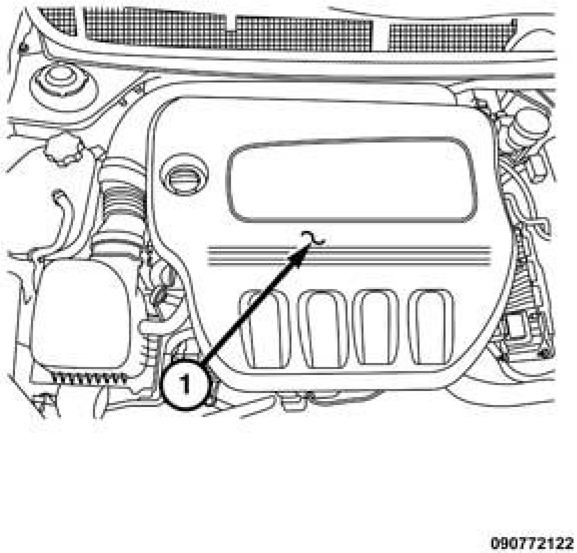


**Fig. 355: Engine Cover**
**Courtesy of CHRYSLER GROUP, LLC**

5. Install the engine cover (1).

## SENSOR, OIL PRESSURE

### DESCRIPTION

#### DESCRIPTION

The oil pressure sensor is located on the right front side of the engine block. The oil pressure sensor is a pressure sensitive switch that is activated by the engine's oil pressure (in the main oil galley). The sensor is a three terminal device.

### OPERATION

#### OPERATION

The oil pressure sending unit returns a voltage signal back to the PCM relating oil pressure. Ground for the sensor is supplied by the PCM.

### REMOVAL

#### REMOVAL

**NOTE: The oil pressure sensor is screwed into the cylinder block below the water pump.**

1. Raise and support the vehicle.
2. Remove the belly pan. Refer to **BELLY PAN, REMOVAL** .

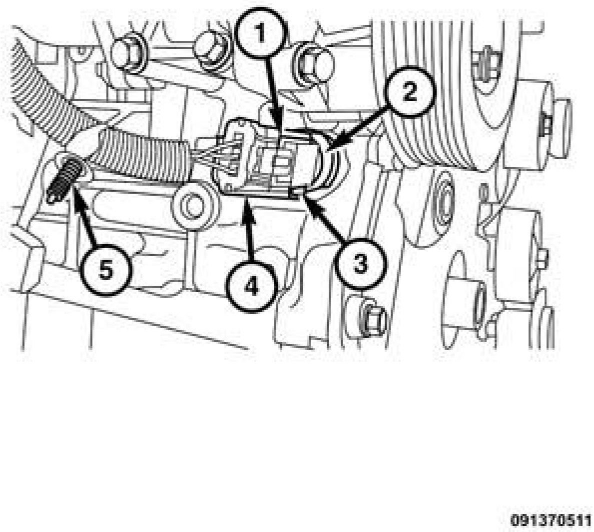


**Fig. 356: Oil Temperature Sensor & Connector**
**Courtesy of CHRYSLER GROUP, LLC**

3. Disengage the sensor harness at the block (5).
4. Unlock the connector (3).
5. Disconnect oil temperature sensor electrical connector (4).
6. Unscrew the sensor (2) from the cylinder block.
7. Remove sensor.

**INSTALLATION**

**INSTALLATION**

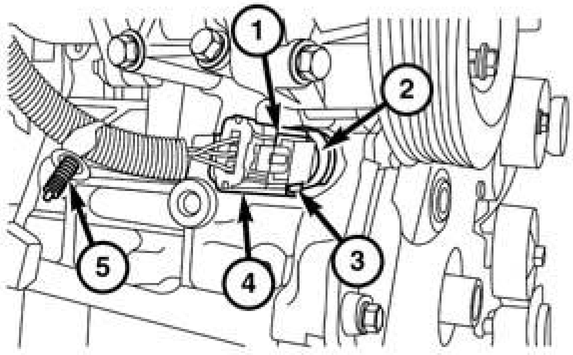


**Fig. 357: Oil Temperature Sensor & Connector**
**Courtesy of CHRYSLER GROUP, LLC**

1. Screw the sensor (2) into the block.
2. Tighten the sensor to 48 N.m (35 ft. lbs.).
3. Install the connector (4).
4. Lock the connector (3).
5. Engage the harness retainer (5) into the block.
6. Install the belly pan. Refer to **BELLY PAN, INSTALLATION** .

## VALVE, OIL PRESSURE RELIEF

### REMOVAL

#### REMOVAL

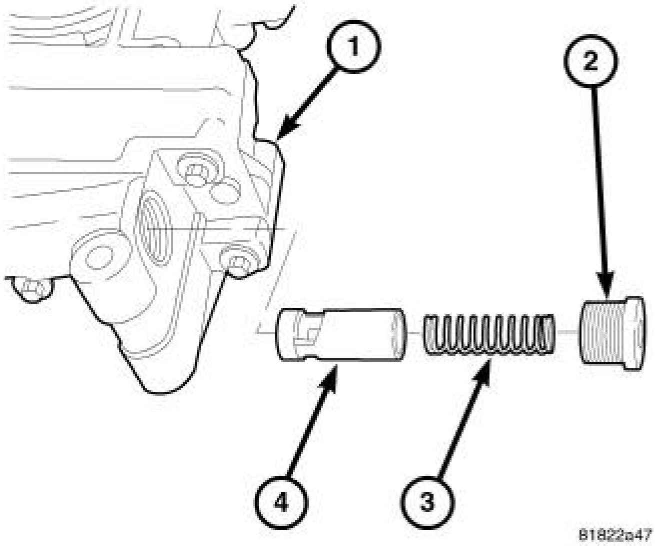


**Fig. 358: Oil Pressure Relief Valve**
**Courtesy of CHRYSLER GROUP, LLC**

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**

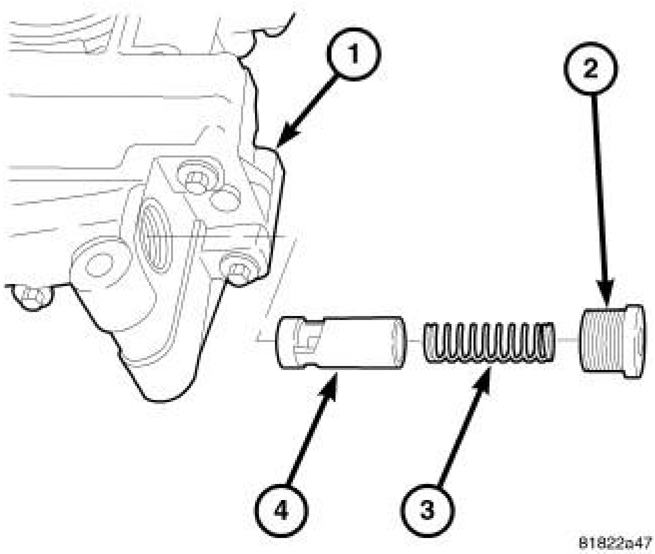


**Fig. 359: Oil Pressure Relief Valve**
**Courtesy of CHRYSLER GROUP, LLC**

| | |
|---|---|
| **NOTE:** | **Pressure regulating valve (4) can be serviced 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

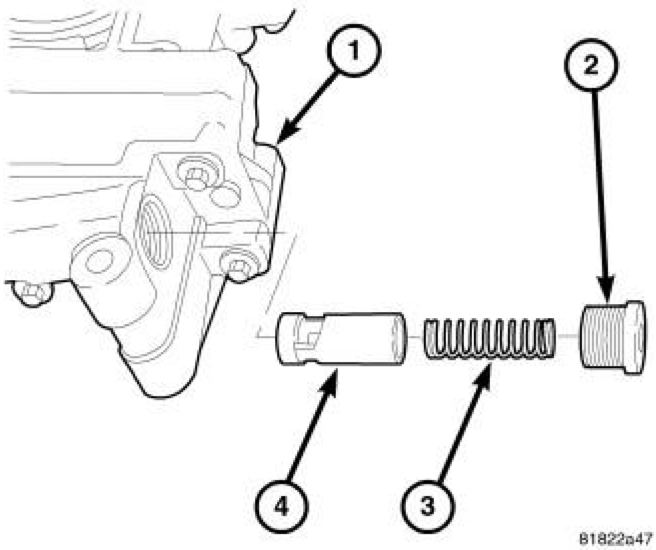


**Fig. 360: Oil Pressure Relief Valve**
**Courtesy of CHRYSLER GROUP, LLC**

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.).

## VALVE TIMING

### 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. Only use top-dead-center marks, cylinder head cover mounting surface and camshaft sprocket marks to verify valve timing or engine damage may result.**

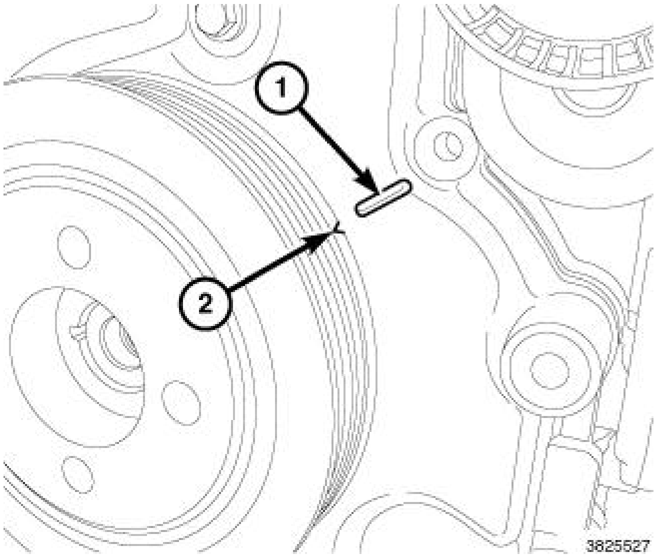


**Fig. 361: Timing Cover Mark & Notch**
**Courtesy of CHRYSLER GROUP, LLC**

Correct timing is critical for the NON free-wheeling designed engine. Engine timing can be verified by using the following procedures:

1. Remove the cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.
2. Remove the spark plugs. Refer to **SPARK PLUG, REMOVAL** .

**CAUTION: When aligning timing marks, always rotate engine by turning the crankshaft. Failure to do so will result in valve and/or piston damage.**

3. Rotate the crankshaft clockwise (as viewed from the front) to align the timing cover mark (1) with the damper notch (2) to place the number one cylinder piston at top-dead-center on the compression stroke.

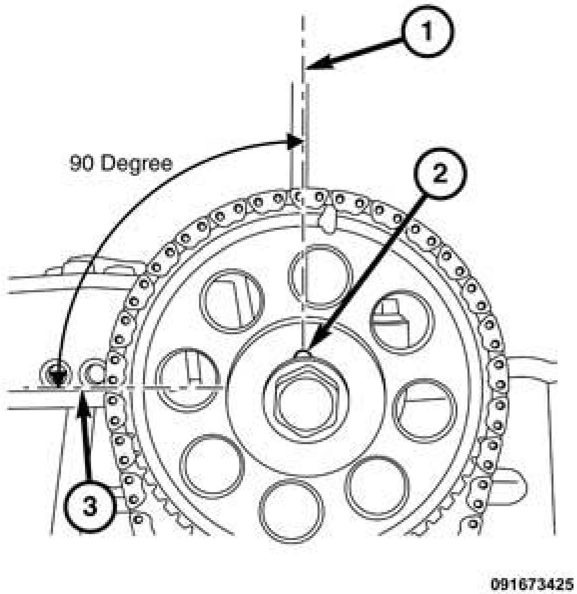


**Fig. 362: Vertical Center Line Of Camshaft, Dowel & Cylinder Head**
**Courtesy of CHRYSLER GROUP, LLC**

4. While maintaining this alignment, verify that the **dowel window** (2) on the camshaft sprocket point toward 12 o'clock.
5. Using a straightedge tool (1), place the tool vertically at the center of the cam gear. Using the top edge of the cylinder head (3) as a reference point, the angle between the straightedge and the cylinder head needs to be 90°.
6. If the engine timing is not correct, proceed to Timing Chain and Sprockets for service procedures. Refer to **CHAIN AND SPROCKETS, TIMING, REMOVAL**.

## CHAIN AND SPROCKETS, TIMING

### REMOVAL

#### TIMING CHAIN

1. Remove the timing chain cover. Refer to **COVER(S), ENGINE TIMING, REMOVAL**.
2. Verify that the number one cylinder piston is still set to top-dead-center on the compression stroke.

**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.**

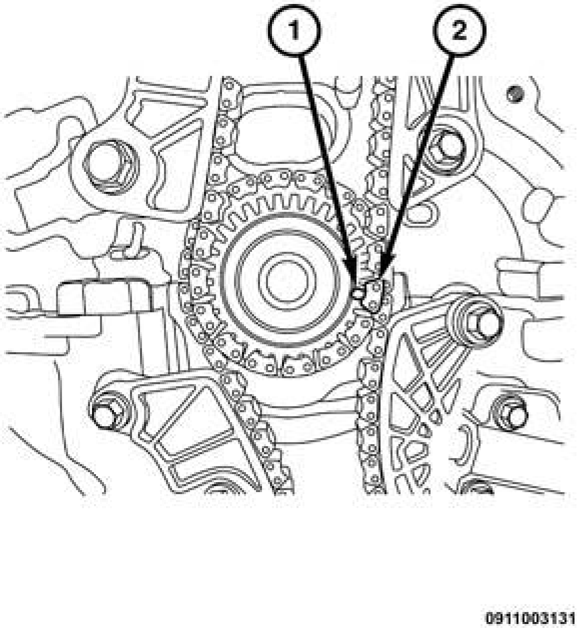


**Fig. 363: Chain Link & Crankshaft Timing Mark**
**Courtesy of CHRYSLER GROUP, LLC**

3. Mark chain link (2) corresponding to crankshaft timing mark (1).

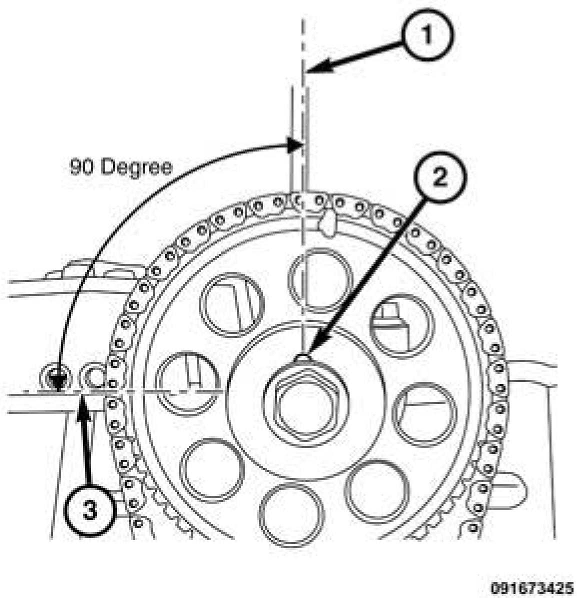


**Fig. 364: Vertical Center Line Of Camshaft, Dowel & Cylinder Head**
**Courtesy of CHRYSLER GROUP, LLC**

4. While maintaining this alignment, verify that the camshaft dowel (2) is at the 12 o'clock position. The dowel center line (1) will be 90° from the horizontal surface line at the top of the cylinder head (3).
5. Mark the chain links corresponding to camshaft and crankshaft timing marks.

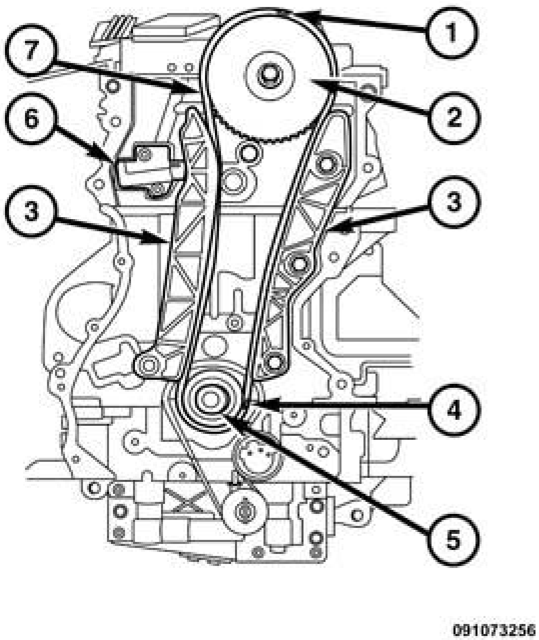


**Fig. 365: Timing Chain, Sprockets, Tensioner & Guides**
**Courtesy of CHRYSLER GROUP, LLC**

6. Remove timing chain tensioner (6). Refer to **TENSIONER, ENGINE TIMING, REMOVAL**.
7. Rotate the tensioner guide (3) away from the chain.
8. Remove timing chain (7).

**CAMSHAFT SPROCKET**

1. Set the timing at TDC. Refer to **VALVE TIMING - STANDARD PROCEDURE** .

 

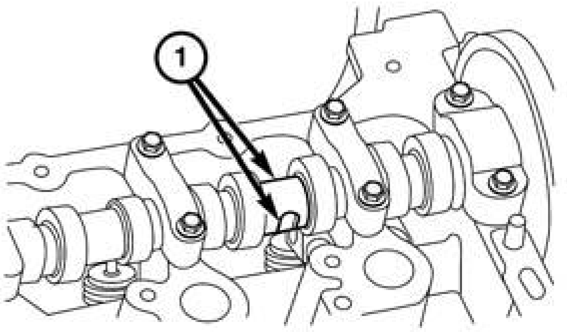


**Fig. 366: Wrench Flats**
**Courtesy of CHRYSLER GROUP, LLC**

2. Remove the timing cover. Refer to **COVER(S), ENGINE TIMING, REMOVAL**.
3. Hold the camshaft stationary by the wrench flats (1).

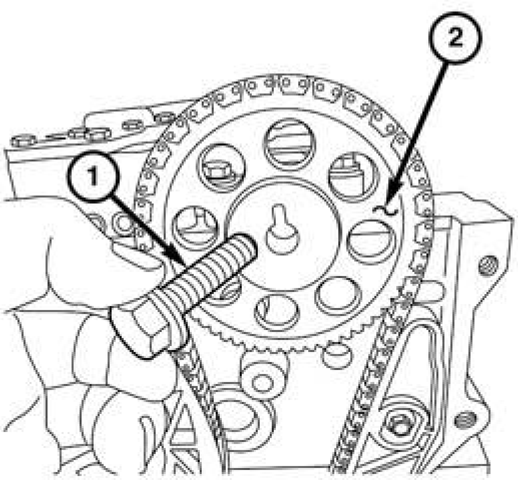


**Fig. 367: Camshaft Center Bolt & Sprocket**
**Courtesy of CHRYSLER GROUP, LLC**

4. Remove the camshaft center bolt (1) from the sprocket (2).
5. Once the sprocket is clear of the alignment dowel, lower the sprocket to allow chain to slacken, then remove the chain from the sprocket.
6. Remove the sprocket from the engine.

**CRANKSHAFT SPROCKET**

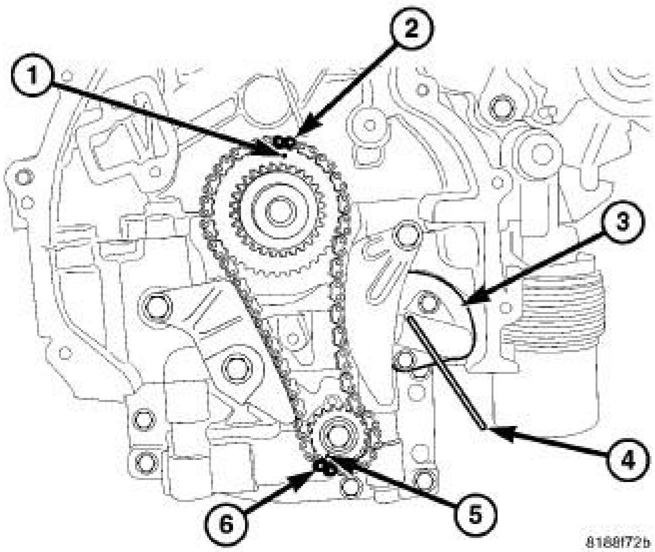


**Fig. 368: BSM Timing Chain Marks**
**Courtesy of CHRYSLER GROUP, LLC**

1. Remove the timing chain. Refer to **CHAIN AND SPROCKETS, TIMING, REMOVAL**.
2. Remove the oil pan. Refer to **PAN, OIL, REMOVAL**.
3. Remove the oil pump drive chain tensioner (3).
4. Remove the oil pump drive chain.

 

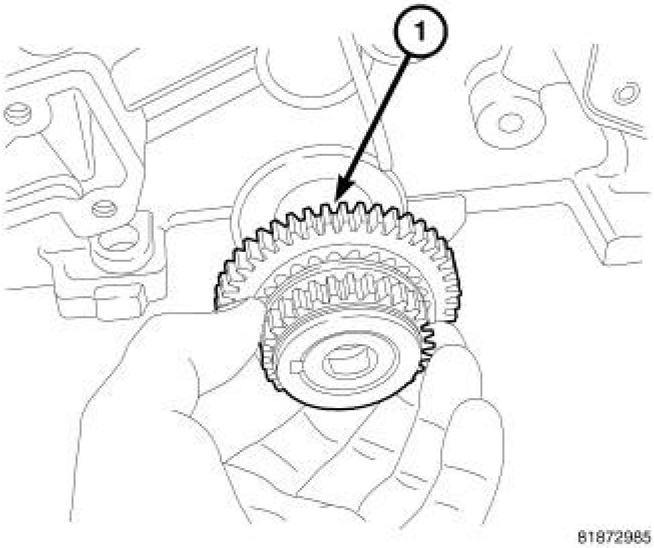


**Fig. 369: Crankshaft Sprocket**
**Courtesy of CHRYSLER GROUP, LLC**

5. Remove the crankshaft sprocket (1).

**INSPECTION**

**INSPECTION**

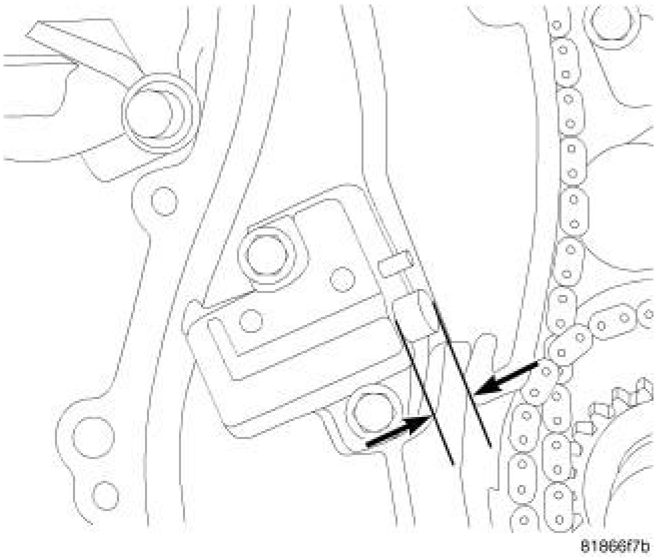


**Fig. 370: Measuring Distance From Tensioner Body To Edge Of Chain Guide**
**Courtesy of CHRYSLER GROUP, LLC**

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**

**TIMING CHAIN**

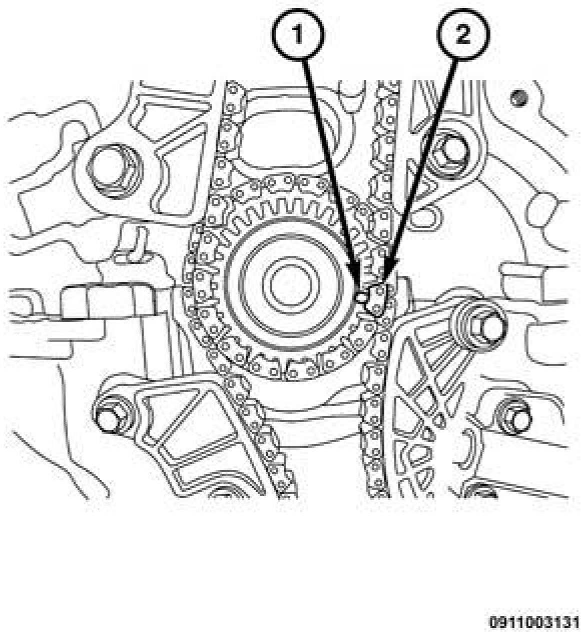


**Fig. 371: Chain Link & Crankshaft Timing Mark**
**Courtesy of CHRYSLER GROUP, LLC**

1. Align the timing chain onto the crank sprocket mark (1) using the painted link (2) as a guide.

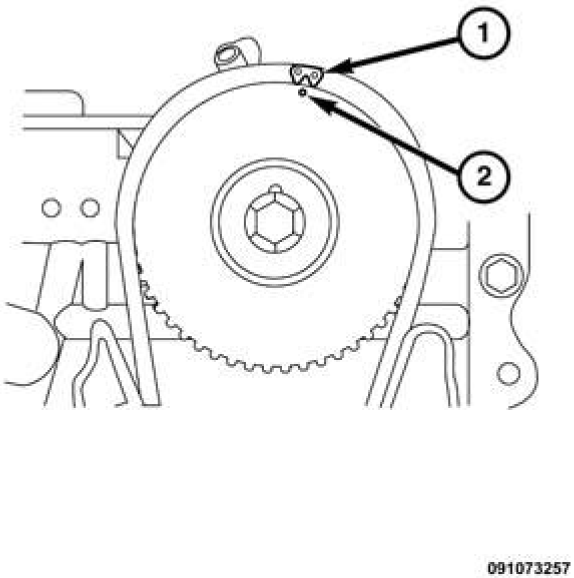


**Fig. 372: Sprocket Mark & Painted Link**
**Courtesy of CHRYSLER GROUP, LLC**

2. Align the timing chain onto the camshaft sprocket mark (2) using the painted link (1) as a guide.

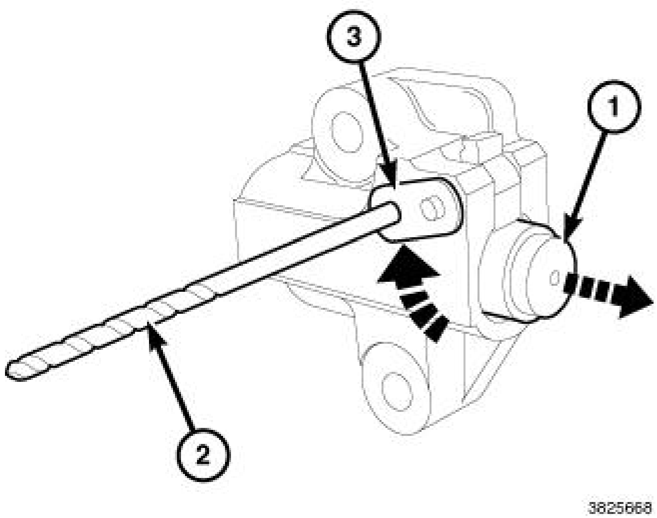


**Fig. 373: Piston, Ratchet Arm & Drill Bit**
**Courtesy of CHRYSLER GROUP, LLC**

3. Reset the cam chain tensioner. Refer to **VALVE TIMING - STANDARD PROCEDURE** .

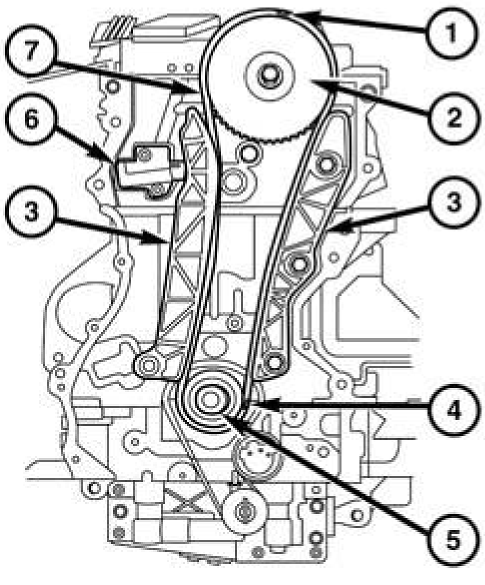


**Fig. 374: Timing Chain, Sprockets, Tensioner & Guides**
**Courtesy of CHRYSLER GROUP, LLC**

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

4. Install timing chain tensioner (6) and tighten bolts to 12 N.m (105 in. lbs.).
5. Remove the pin (1/8 in. drill bit) from the timing chain tensioner.
6. Verify that the valve timing is correct. Refer to **VALVE TIMING - STANDARD PROCEDURE** .
7. Install the engine timing cover. Refer to **COVER(S), ENGINE TIMING, INSTALLATION**.
8. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **OIL - STANDARD PROCEDURE** .
9. Connect the battery negative cable and tighten nut to 5 N.m (45 in. lbs.).
10. Install the resonator. Refer to **RESONATOR, AIR CLEANER, INSTALLATION**.
11. Install the engine cover.
12. Run the engine until it reaches normal operating temperature. Check cooling system for correct fluid level. Refer to **STANDARD PROCEDURE** .

**NOTE: The Cam/Crank Variation Relearn procedure must be performed using the scan tool anytime there has been a repair/replacement made to a powertrain system, for example: flywheel, valvetrain, camshaft and/or crankshaft sensors or components.**

**CAMSHAFT SPROCKET(S)**

**NOTE: Do not use an impact wrench to tighten the camshaft sprocket bolt. Damage to**

 

**the camshaft dowel pin and camshaft may occur.**

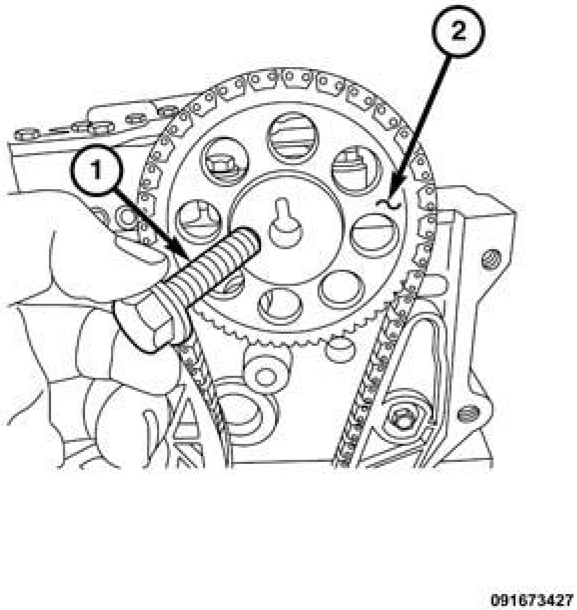


**Fig. 375: Camshaft Center Bolt & Sprocket**
**Courtesy of CHRYSLER GROUP, LLC**

1. Install the chain onto the sprocket (2), insert the bolt (1).

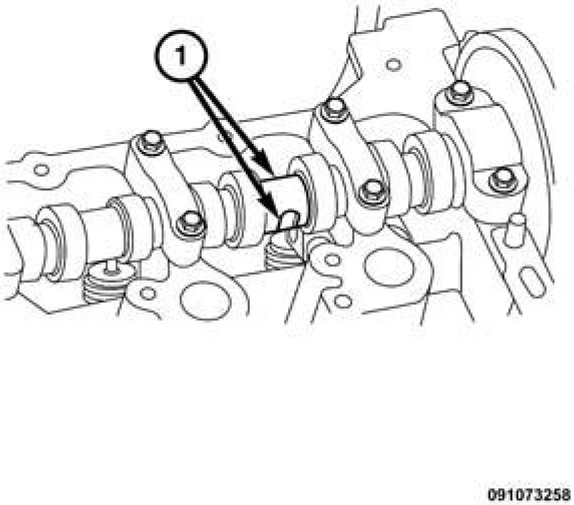


**Fig. 376: Wrench Flats**

**Courtesy of CHRYSLER GROUP, LLC**

2. Using a wrench to hold the camshaft flats (1) tighten the sprocket bolt to 10 N.m + 65° (88 in. lbs. + 65°).
3. Verify correct timing. Refer to **VALVE TIMING - STANDARD PROCEDURE** .
4. Install the timing cover. Refer to **COVER(S), ENGINE TIMING, INSTALLATION**.
5. Install the cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, INSTALLATION**.
6. Install engine cover.

**CRANKSHAFT SPROCKET**

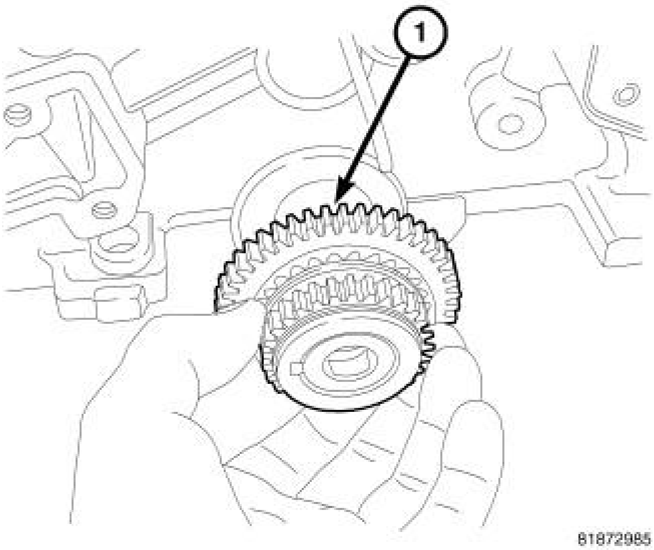


**Fig. 377: Crankshaft Sprocket**
**Courtesy of CHRYSLER GROUP, LLC**

1. Install the crankshaft sprocket (1) onto the crankshaft.

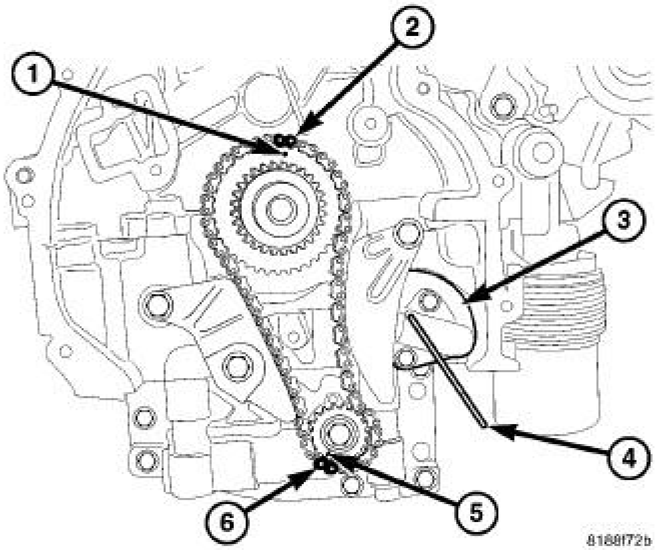


**Fig. 378: BSM Timing Chain Marks**
**Courtesy of CHRYSLER GROUP, LLC**

2. Install the oil pump drive chain. Verify that the oil pump is correctly timed (1, 2, 5, 6).

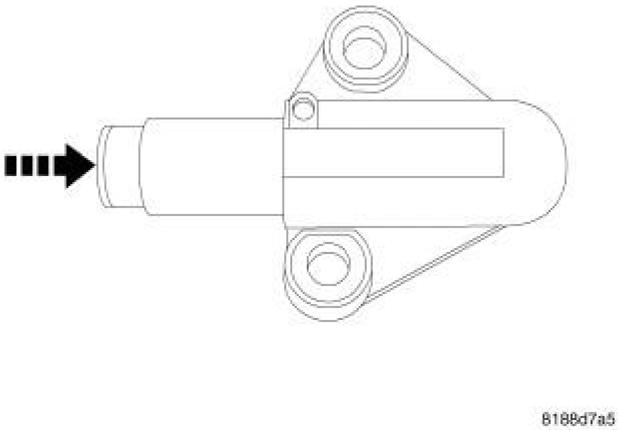


**Fig. 379: Pushing Tensioner Piston Back Into Tensioner Body**
**Courtesy of CHRYSLER GROUP, LLC**

3. Reset the oil pump drive chain tensioner by pushing the plunger inward and installing (special tool #9703, Pin, Tensioner).

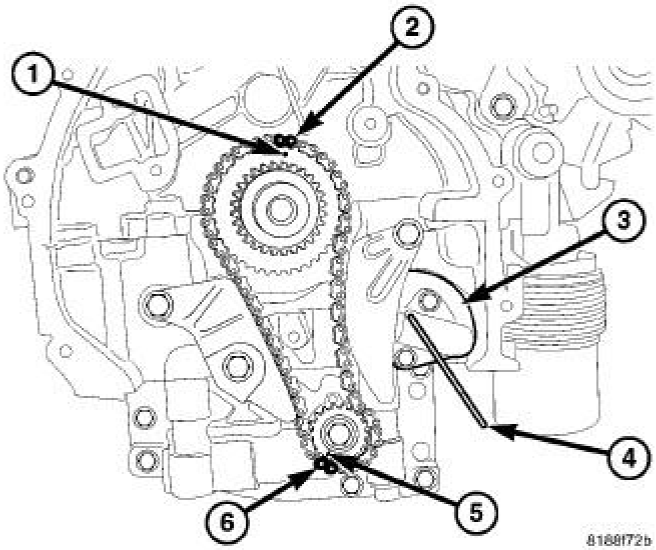


**Fig. 380: BSM Timing Chain Marks**
**Courtesy of CHRYSLER GROUP, LLC**

4. Install the oil pump drive chain tensioner (3) and remove (special tool #9703, Pin, Tensioner) (4).
5. Install the timing chain and timing chain cover. Refer to **CHAIN AND SPROCKETS, TIMING, INSTALLATION**.
6. Install the oil pan. Refer to **PAN, OIL, INSTALLATION**.
7. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **OIL - STANDARD PROCEDURE** .
8. Connect the negative battery cable and tighten nut to 5 N.m (45 in. lbs.).
9. Run the engine until it reaches normal operating temperature. Check cooling system for correct fluid level. Refer to **STANDARD PROCEDURE** .

**NOTE:** **The Cam/Crank Variation Relearn procedure must be performed using the scan tool anytime there has been a repair/replacement made to a powertrain system, for example: flywheel, valvetrain, camshaft and/or crankshaft sensors or components.**

## COVER(S), ENGINE TIMING

### REMOVAL

#### REMOVAL

1. Perform the fuel pressure release procedure. Refer to **FUEL DELIVERY, GAS , STANDARD PROCEDURE** .
2. Disconnect and isolate the battery negative cable.
3. Remove the resonator. Refer to **RESONATOR, AIR CLEANER, REMOVAL**.
4. Remove the air cleaner body. Refer to **BODY, AIR CLEANER, REMOVAL**.

 

5. Remove the coolant recovery bottle. Refer to **BOTTLE, PRESSURIZED COOLANT, REMOVAL** .

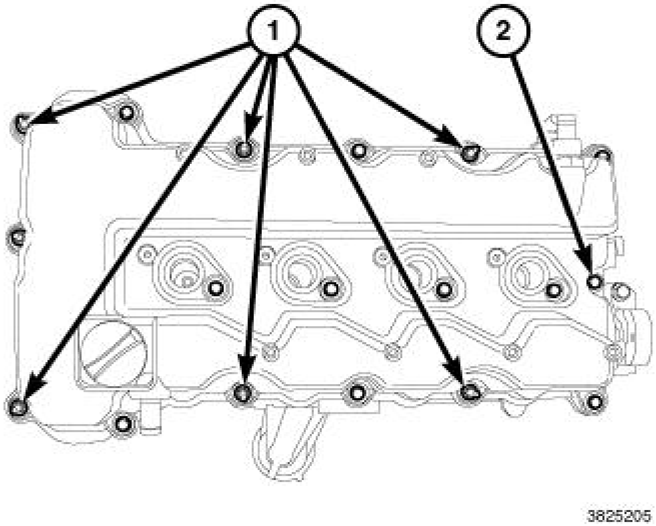


**Fig. 381: Identifying Six Stud Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

6. Remove the cylinder head cover. Refer to **COVER(S), CYLINDER HEAD, REMOVAL**.

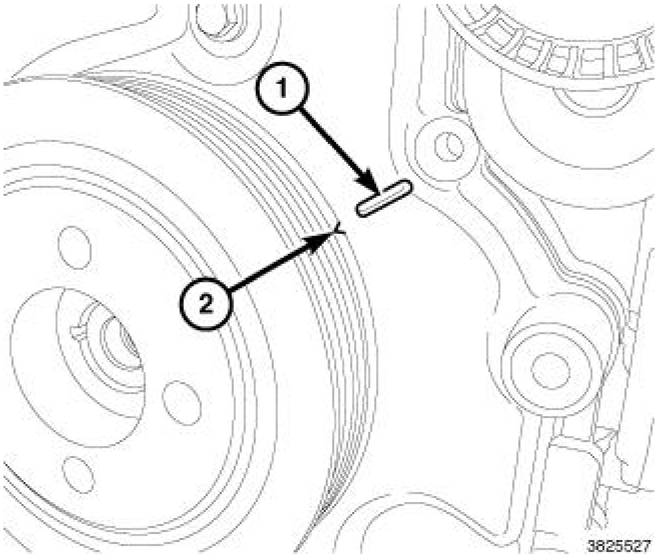


**Fig. 382: Timing Cover Mark & Notch**
**Courtesy of CHRYSLER GROUP, LLC**

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

**CAUTION: When aligning timing marks, always rotate engine by turning the crankshaft. Failure to do so will result in valve and/or piston damage.**

 

9. Rotate the crankshaft clockwise (as viewed from the front) to align the timing cover mark (1) with the damper notch (2) to place the number one cylinder piston at top-dead-center on the compression stroke.

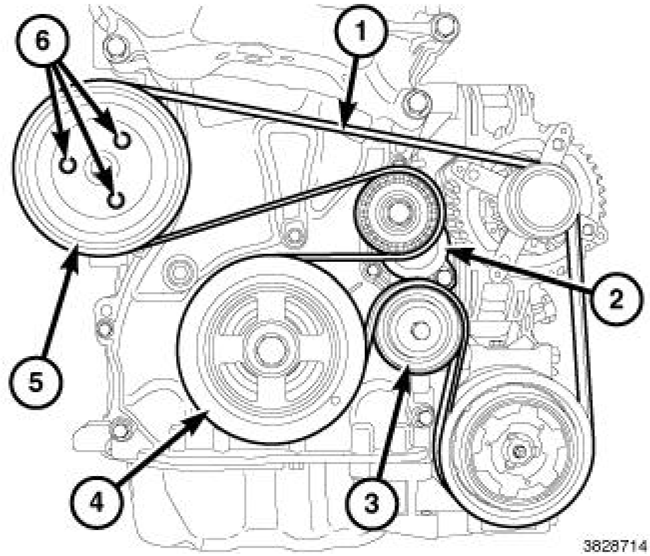


**Fig. 383: Accessory Drive Components & Belt Routing**
**Courtesy of CHRYSLER GROUP, LLC**

10. Remove the accessory drive belt (1). Refer to **BELT, SERPENTINE, REMOVAL** .
11. Remove the accessory drive belt idler pulley (3).
12. Remove the accessory drive belt tensioner (2).
13. Remove the crankshaft damper (4). Refer to **DAMPER, VIBRATION, REMOVAL**.
14. Remove three bolts (6) and the water pump pulley (5) from the water pump.

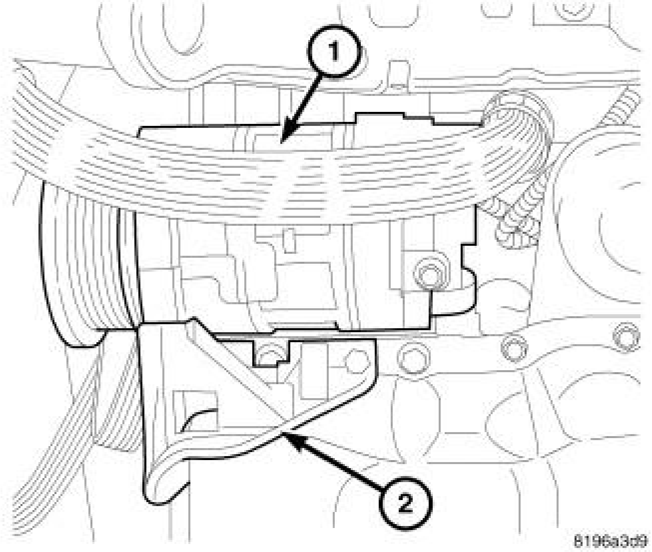


**Fig. 384: A/C Compressor & Bracket**
**Courtesy of CHRYSLER GROUP, LLC**

**NOTE: The oil pan will need to be removed and immediately reinstalled. This procedure is necessary because the oil pan sealant must be broken to allow the timing cover to be removed without damage to the oil pan. The reason the pan is to be reinstalled is to allow for a support surface when the timing cover is removed.**

15. Remove the oil pan. Refer to **PAN, OIL, REMOVAL**.
16. Temporarily reinstall the oil pan.
17. Install the oil pan bolts finger tight. **Do not install** the four oil pan to timing cover bolts (1) at this time.
18. Lower the vehicle.
19. Support the engine with a suitable jack.
20. Remove the right engine mount insulator. Refer to **INSULATOR, ENGINE MOUNT, RIGHT, REMOVAL**.
21. Remove one M8 studbolt (1), six M6 bolts (2), two M8 bolts (3) and five M10 bolts (4).

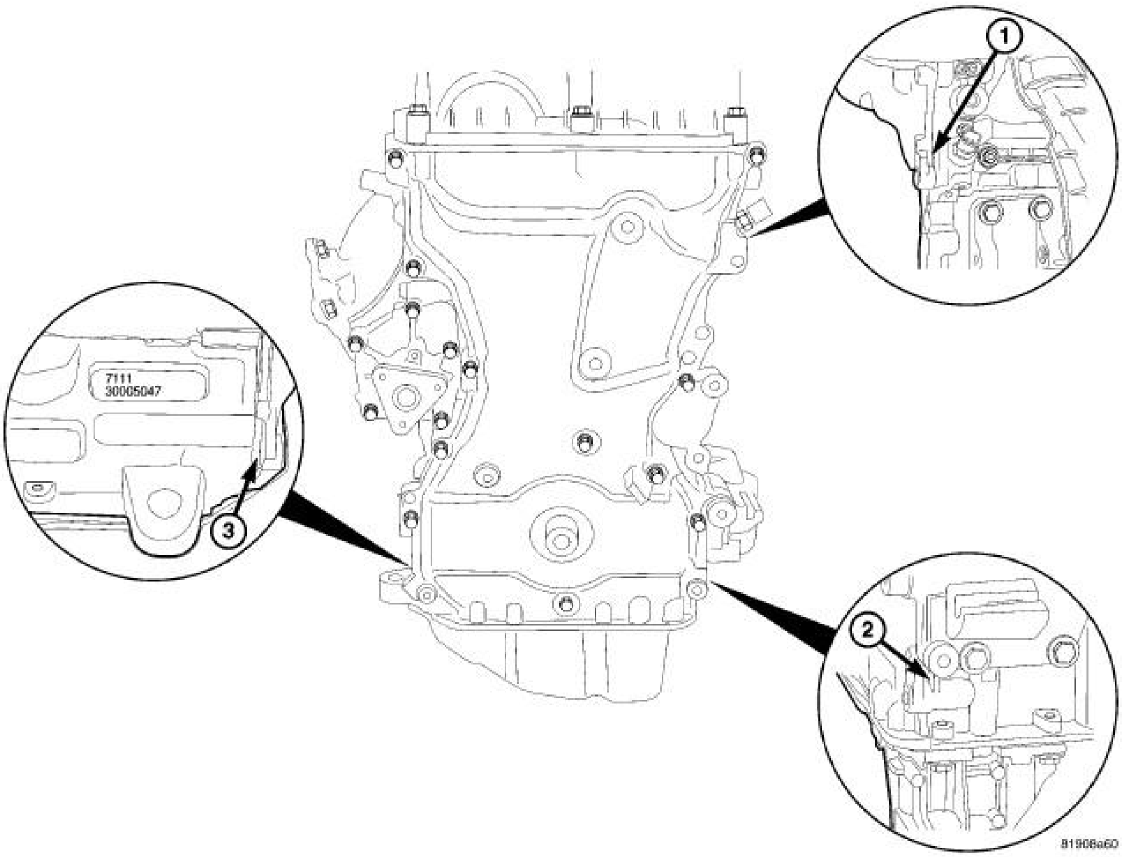


**Fig. 385: Timing Chain Cover Pry Points**
**Courtesy of CHRYSLER GROUP, LLC**

22. Remove the engine timing cover using pry points (1, 2 and 3).

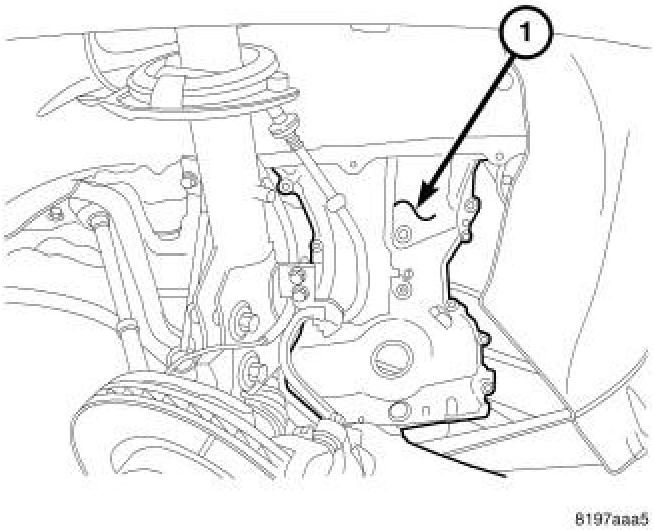


**Fig. 386: Timing Chain Cover Removal/Installation**
**Courtesy of CHRYSLER GROUP, LLC**

23. Remove the engine timing cover (1) out through the bottom of the vehicle.

**INSTALLATION**

**INSTALLATION**

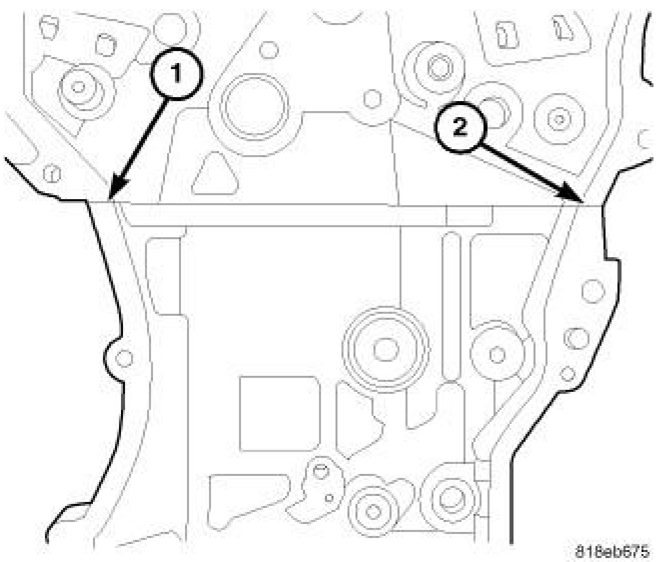


**Fig. 387: Applying Engine Sealant RTV (Or Equivalent) At Cylinder Head To Block Parting Line**
**Courtesy of CHRYSLER GROUP, LLC**

| | |
|---|---|
| **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. Install a new crankshaft seal if necessary.
2. Clean all sealing surfaces. Refer to **ENGINE - STANDARD PROCEDURE** .
3. Apply Mopar® engine sealant RTV (or equivalent) as shown in illustration at the cylinder head to block parting line (1 and 2).

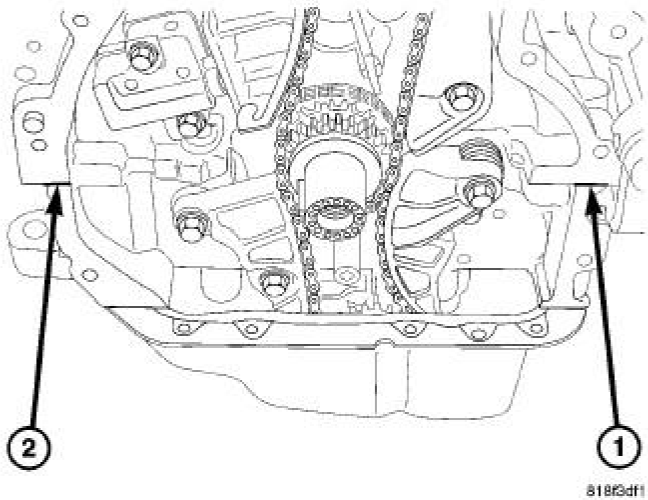


**Fig. 388: Applying Engine Sealant RTV (Or Equivalent) At Ladder Frame To Block Parting Line**
**Courtesy of CHRYSLER GROUP, LLC**

4. Apply Mopar® engine sealant RTV (or equivalent) as shown in illustration at the ladder frame to block parting line (1 and 2).

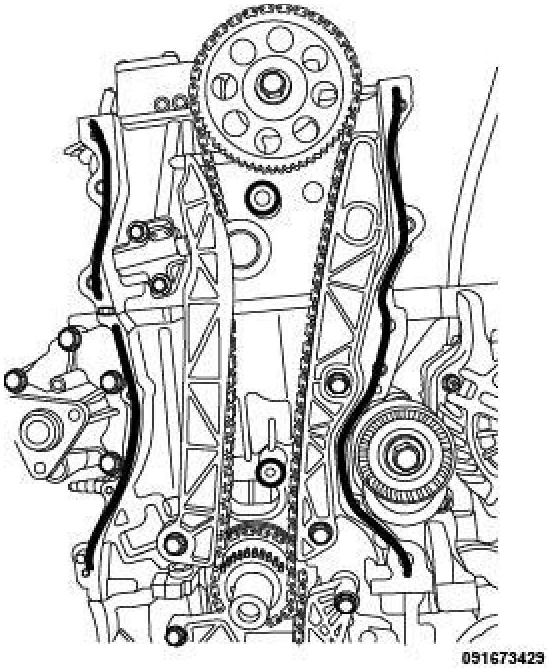


**Fig. 389: Engine Block And Cylinder Head To Timing Cover Sealant Application Points**
**Courtesy of CHRYSLER GROUP, LLC**

5. Apply 2 mm bead of Mopar® MS-GF-46 (or equivalent) to the engine block and cylinder head to timing cover mating surfaces as shown in illustration. Be sure to apply a bead at the two center bolt lands that are between the timing chain.

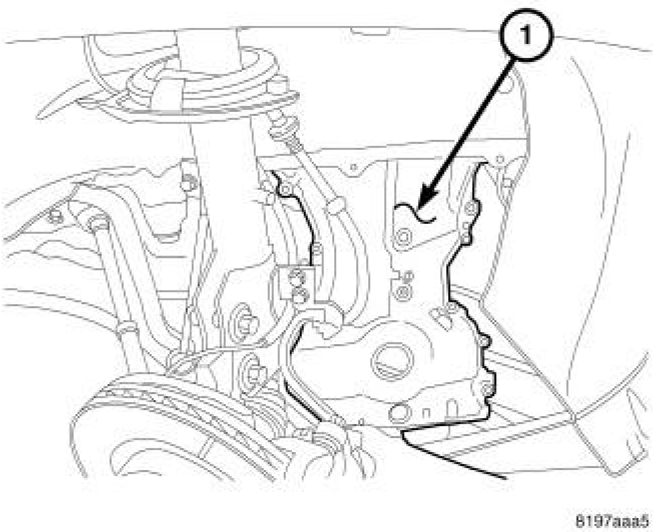


**Fig. 390: Timing Chain Cover Removal/Installation**
**Courtesy of CHRYSLER GROUP, LLC**

6. Install timing chain cover (1) upwards from under the vehicle.
7. Install the timing chain cover retaining bolts. Tighten six M6 bolts (2) to 9 N.m (80 in. lbs.), two M8 bolts (3) and one studbolt (1) to 26 N.m (19 ft. lbs.) and five M10 bolts (4) to 65 N.m (48 ft. lbs.).

8. Install the right engine mount. Refer to **INSULATOR, ENGINE MOUNT, RIGHT, INSTALLATION**.
9. Install the coolant reservoir bottle. Tighten bolt to 9 N.m (80 in. lbs.).

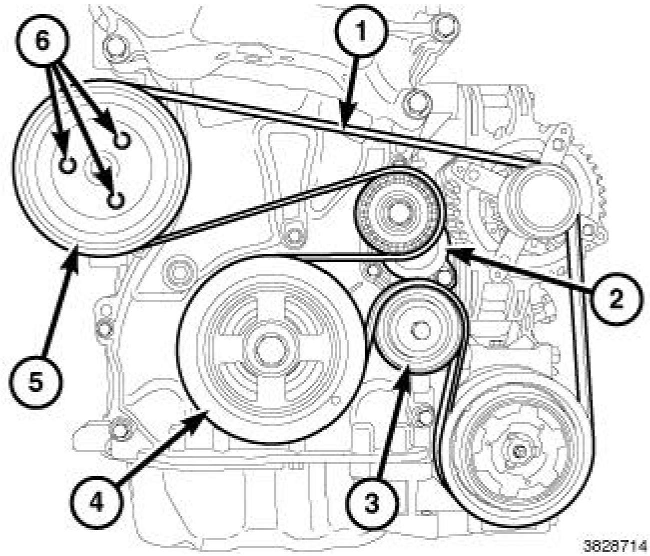


**Fig. 391: Accessory Drive Components & Belt Routing**
**Courtesy of CHRYSLER GROUP, LLC**

10. Install the water pump pulley (5) and tighten three bolts (6) to 9 N.m (80 in. lbs.).
11. Install the crankshaft damper (4). Refer to **DAMPER, VIBRATION, INSTALLATION**.
12. Install the accessory drive belt tensioner (2).
13. Install the accessory drive belt idler pulley (3). Tighten bolt to 25 N.m (18 ft. lbs.).
14. Install the accessory drive belt (1). Refer to **BELT, SERPENTINE, INSTALLATION** .
15. Reseal the oil pan. Refer to **PAN, OIL, INSTALLATION**.
16. Install the right lower splash shield. Refer to **SHIELD, SPLASH, FRONT WHEELHOUSE - INSTALLATION** .

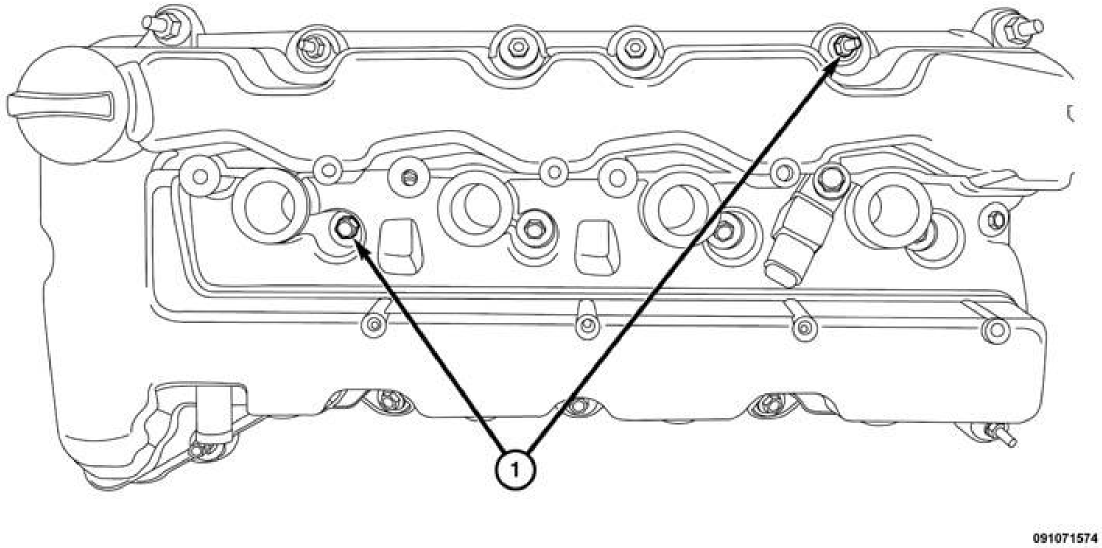


**Fig. 392: Cylinder Head Cover Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

17. Install the cylinder head cover and ignition coils . Refer to **COVER(S), CYLINDER HEAD, INSTALLATION**.
18. Install the air cleaner body. Refer to **BODY, AIR CLEANER, INSTALLATION**.

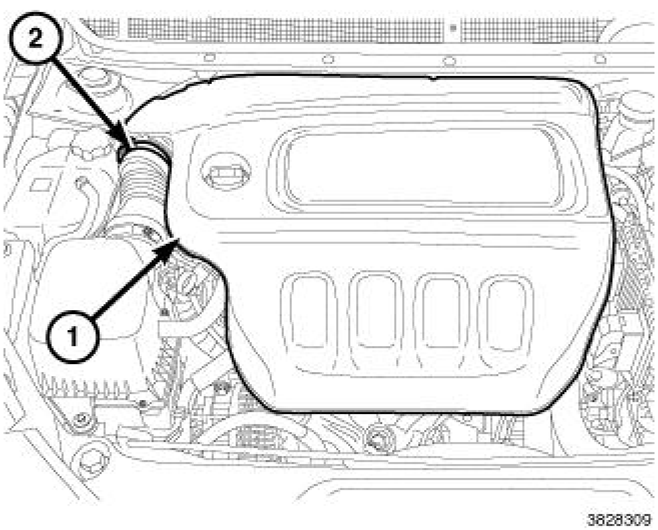


**Fig. 393: Engine Cover & Air Resonator Clamp**
**Courtesy of CHRYSLER GROUP, LLC**

19. Install the engine cover (1).
20. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **OIL - STANDARD PROCEDURE** .
21. Install the resonator (1). Refer to **RESONATOR, AIR CLEANER, INSTALLATION**.

22. Connect the battery negative cable and tighten nut to 5 N.m (45 in. lbs.).
23. Run the engine until it reaches normal operating temperature. Check cooling system for possible leaks and correct fluid level. Refer to **STANDARD PROCEDURE** .

**NOTE: The Cam/Crank Variation Relearn procedure must be performed using the scan tool anytime there has been a repair/replacement made to a powertrain system, for example: flywheel, valvetrain, camshaft and/or crankshaft sensors or components.**

## TENSIONER, ENGINE TIMING

### REMOVAL

### REMOVAL

1. Remove the engine timing cover. Refer to **COVER(S), ENGINE TIMING, REMOVAL**.

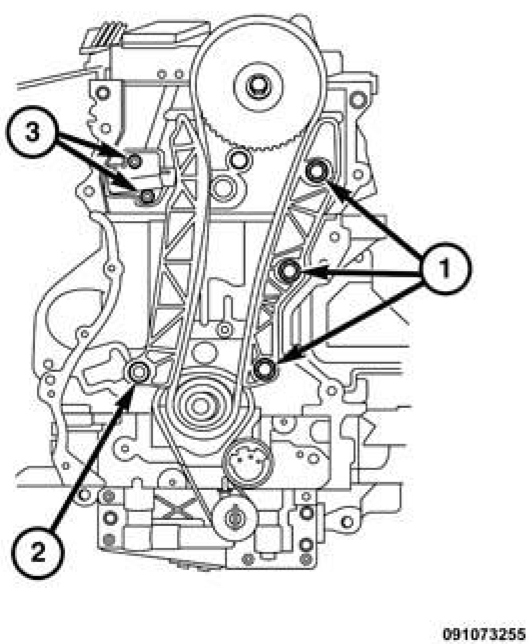


**Fig. 394: Timing Chain Tensioner Retaining Bolts**
**Courtesy of CHRYSLER GROUP, LLC**

2. Remove timing chain tensioner retaining bolts (3).
3. Remove the tensioner.

### INSTALLATION

### INSTALLATION

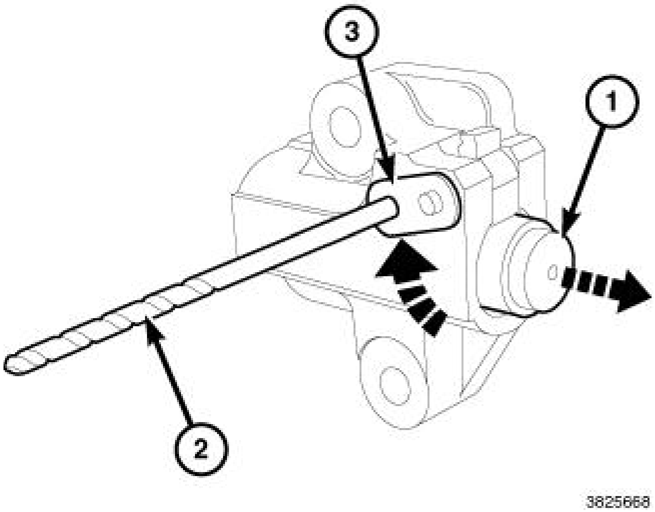


**Fig. 395: Piston, Ratchet Arm & Drill Bit**
**Courtesy of CHRYSLER GROUP, LLC**

1. Reset the cam chain tensioner. Refer to **VALVE TIMING - STANDARD PROCEDURE** .

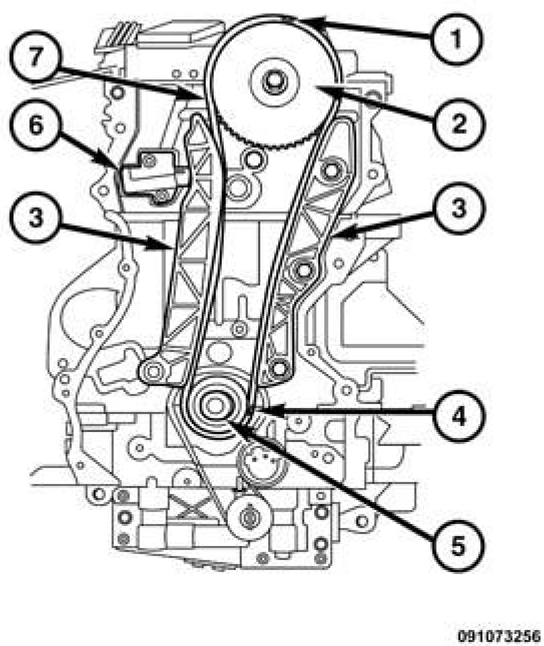


**Fig. 396: Timing Chain, Sprockets, Tensioner & Guides**
**Courtesy of CHRYSLER GROUP, LLC**

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

2. Install timing chain tensioner (6) and tighten bolts to 12 N.m (105 in. lbs.).
3. Remove the pin (1/8 in. drill bit) from the timing chain tensioner.

4. Verify that the valve timing is correct. Refer to **VALVE TIMING - STANDARD PROCEDURE** .
5. Install the engine timing cover. Refer to **COVER(S), ENGINE TIMING, INSTALLATION**.
6. If removed, install the oil filter and fill the engine crankcase with the proper oil to the correct level. Refer to **OIL - STANDARD PROCEDURE** .
7. Connect the battery negative cable and tighten nut to 5 N.m (45 in. lbs.).
8. Install the resonator. Refer to **RESONATOR, AIR CLEANER, INSTALLATION**.
9. Install the engine cover.
10. Run the engine until it reaches normal operating temperature. Check cooling system for correct fluid level. Refer to **STANDARD PROCEDURE** .

**NOTE:** **The Cam/Crank Variation Relearn procedure must be performed using the scan tool anytime there has been a repair/replacement made to a powertrain system, for example: flywheel, valvetrain, camshaft and/or crankshaft sensors or components.**

 